InterLab®

FCC Measurement/Technical Report on

Bluetooth low energy transceiver SEAL ONE 8300 pro

FCC ID: 2ABBY8300

Report Reference: MDE_SEAL_1302_FCCa_Rev2

Test Laboratory:
Borsigstrasse 11
Germany
7Layers AG
40880 Ratingen

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

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0 Applied Standards and Test Summary

0.1 Technical Report Summary

Type of Authorization
Certification for an Intentional Radiator (Digital Device / Spread Spectrum).

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 (10-1-13 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 Performing Compliance Measurements on Digital Transmission Systems (DTS)Operating Under §15.247, 558074 D01 DTS Meas Guidance v03r02, 2014-06-05".

Summary Test Results:

The EUT complied with all performed tests as listed in chapter 0.3 Measurement Summary.

0.2 FCC and IC Correlation Table

Correlation of measurement requirements for DTS devices (e.g. WLAN 2.4/5 GHz) equipment

The following tables show the correlation of measurement requirements for DTS (e.g. WLAN) equipment and Information Technology Equipment (ITE) from FCC and IC standards.

DTS equipment

Measurement	FCC reference	IC reference
Conducted emissions on AC Mains	§ 15.207	RSS-Gen Issue 4: 8.8
Occupied bandwidth	§ 15.247 (a) (2)	RSS-210 Issue 8: A8.2 (a)
Peak conducted output power	§ 15.247 (b) (3), (4)	RSS-210 Issue 8: A8.4 (4)
Transmitter spurious RF conducted emissions	§ 15.247 (d)	RSS-Gen Issue 4: 6.13 / 8.9/8.10; RSS-210 Issue 8: A8.5
Transmitter spurious radiated emissions	§ 15.247 (d); § 15.209 (a)	RSS-Gen Issue 4: 6.13 / 8.9/8.10; RSS-210 Issue 8: A8.5
Band edge compliance	§ 15.247 (d)	RSS-210 Issue 8: A8.5
Power density	§ 15.247 (e)	RSS-210 Issue 8: A8.2 (b)
Antenna requirement	§ 15.203 / 15.204	RSS-Gen Issue 4: 8.3
Receiver spurious emissions	–	RSS-210 Issue 8: 2.3 RSS Gen Issue 4: 5 / 7 *)

*) Receivers are exempted from certification besides if operating in stand-alone mode in the frequency range 30–960 MHz or if these are scanner receivers.

Information Technology Equipment (ITE)

Measurement	FCC reference	IC reference
Conducted emissions on AC Mains	§ 15.107	ICES-001 Issue 4 or ICES-003 Issue 5 or RSS-Gen Issue 3
Spurious Radiated Emissions	§ 15.109	ICES-001 Issue 4 or ICES-003 Issue 5 or RSS-Gen Issue 3

0.3 Measurement Summary

FCC Part 15, Subpart C	§ 15.207		
Conducted emissions (AC power line)			
The measurement was performed according to ANSI C63.4			2009
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 2b	Setup_03	AC port	Passed

FCC Part 15, Subpart C	§ 15.247 (a) (1)		
Occupied bandwidth			
The measurement was performed according to FCC § 15.31			10-1-13 Edition
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1b	Setup_01	Temp.ant.connector	Passed
op-mode 2b	Setup_01	Temp.ant.connector	Passed
op-mode 3b	Setup_01	Temp.ant.connector	Passed

FCC Part 15, Subpart C	§ 15.247 (b) (1)		
Peak power output			
The measurement was performed according to FCC § 15.31			10-1-13 Edition
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1b	Setup_01	Temp.ant.connector	Passed
op-mode 2b	Setup_01	Temp.ant.connector	Passed
op-mode 3b	Setup_01	Temp.ant.connector	Passed

FCC Part 15, Subpart C	§ 15.247 (d), § 15.35 (b), § 15.207		
Spurious conducted emissions			
The measurement was performed according to ANSI C63.4			2009
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1b	Setup_01	Temp.ant.connector	Passed
op-mode 2b	Setup_01	Temp.ant.connector	Passed
op-mode 3b	Setup_01	Temp.ant.connector	Passed

FCC Part 15, Subpart C	§ 15.247 (d), § 15.35 (b), § 15.209		
Spurious radiated emissions			
The measurement was performed according to ANSI C63.4			2009
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1b	Setup_02	Enclosure	Passed
op-mode 2b	Setup_02	Enclosure	Passed
op-mode 3b	Setup_02	Enclosure	Passed

FCC Part 15, Subpart C	§ 15.247 (d)		
Band edge compliance			
The measurement was performed according to FCC § 15.31 / ANSI C63.4			10-1-13 Edition / 2009
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1b	Setup_01	Temp.ant.connector	Passed
op-mode 3b	Setup_01	Temp.ant.connector	Passed
op-mode 3b	Setup_02	Enclosure	Passed

FCC Part 15, Subpart C **§ 15.247 (e)**
Power density
The measurement was performed according to FCC § 15.31 10-1-13 Edition

OP-Mode	Setup	Port	Final Result
op-mode 1b	Setup_01	Temp.ant.connector	Passed
op-mode 2b	Setup_01	Temp.ant.connector	Passed
op-mode 3b	Setup_01	Temp.ant.connector	Passed

N/A not applicable (the EUT is powered by DC)

Remark:

The tests were performed at a duty cycle lower than 98% as it could not be achieved due to overheating of the EUT.

Revision History

Report version control			
Version	**Release date**	**Change Description**	**Version validity**
initial	2014-09-19	--	invalid
rev1	2015-02-27	Added a remark about the duty cycle and removed the SBA antenna from the equipment list as it was not used	invalid
Rev2	2015-03-23	• FCC / IC correlation table updated • Remark to ANSI versions removed • Used Channels corrected • Band Edge compliance description adapted for BTLE • Duty Cycle calculation added in chapter 3.5.4	valid

Responsible for Accreditation Scope: Responsible for Test Report:

1 Administrative Data

1.1 Testing Laboratory

Company Name:	7 Layers AG
Address	Borsigstr. 11 40880 Ratingen Germany

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

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

Laboratory accreditation no.:	DAkkS D-PL-12140-01-01
Responsible for Accreditation Scope:	Dipl.-Ing. Bernhard Retka Dipl.-Ing. Robert Machulec Dipl.-Ing. Thomas Hoell Dipl.-Ing. Andreas Petz Dipl.-Ing. Marco Kullik
Report Template Version:	2014-08-22

1.2 Project Data

Responsible for testing and report:	Dipl.-Ing. Marco Kullik
Date of Test(s):	2014-01-28 to 2014-08-27
Date of Report:	2015-03-23

1.3 Applicant Data

Company Name:	SEAL One AG
Address:	Berliner Str. 44 60311 Frankfurt/Main Germany
Contact Person:	Mr. Maik Stohn

1.4 Manufacturer Data

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

2 Test object Data

2.1 General EUT Description

Equipment under Test:	Bluetooth Low Energy transceiver
Type Designation:	SEAL ONE 8300 pro
Kind of Device:	Bluetooth / USB Secure Online Banking Device
(optional)	
Voltage Type:	DC
Voltage Level:	DC 5.0 V
Tested Modulation Type:	GFSK

General product description:

The EUT is a mobile secure banking transaction signing device that can be connected to other devices by using the integrated Bluetooth low energy transceiver or the dedicated USB docking and charging station.

Specific product description for the EUT:

The EUT is a Bluetooth low energy transceiver working in the 2.4 GHz band with an integrated antenna.
It supports GFSK modulation with 1Mbit/s data rate.

The EUT provides the following ports:

Ports
Enclosure
Docking Station port (USB Data and DC)

The main components of the EUT are listed and described in Chapter 2.2

2.2 EUT Main components

Type, S/N, Short Descriptions etc. used in this Test Report

Short Description	Equipment under Test	Type Designation	Serial No.	HW Status	SW Status
EUT A (Code: VQ000b01)	BT LE transceiver	SEAL ONE 8300 pro	T2	1308	1401
Remark: EUT A is equipped with a temporary antenna connector.					
EUT B (Code: VQ000c02)	BT LE transceiver	SEAL ONE 8300 pro	T3	1308	1403
Remark: EUT B is equipped with an integral antenna with antenna gain = 1.62 dBi at 2.4 – 2.5 GHz frequency range.					

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

2.3 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.

Short Description	Equipment under Test	Type Designation	Serial No.	HW Status	SW Status
ANC1	–	–	–	–	–

2.4 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.

Short Description	Equipment under Test	Type Designation	Serial No.	HW Status	SW Status
AUX1	USB Cradle	–	–	–	–
AUX2	Keyboard	Cherry RS6000	G 0000273 2P28	-	-
AUX3	AC Adapter laptop	Fujitsu Siemens 0335C2065	A30638114250	-	-
AUX4	Laptop	Fujitsu Siemens Amilo Pro V3205	YK2H014267	-	-
AUX5	TFT Display	LG Flatron L1740BQ	509WANF1W607	-	-
AUX6	Mouse	Logitech MBB48	LZC90505478	-	-

2.5 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_01	EUT A + AUX1	setup for conducted radio measurements
Setup_02	EUT B	setup for radiated measurements
Setup_03	EUT B + AUX1 to AUX6	setup for conducted emissions (AC power line) measurements

2.6 Operating Modes

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

2.6.1 Test Channels

	2.4 GHz ISM 2400 - 2483.5 MHz		
	Bottom	**Middle**	**Top**
Channel	0	19	39
Frequency	2402	2440	2480

2.6.2 Datarates

Data rate / frequency	2402	2440	2480
BT LE, 1 Mbit/s	1b	2b	3b

2.7 Special software used for testing

A STMicroelectronics Test Tool Software was used to set the EUT into local TX mode.

2.8 Product labelling

2.8.1 FCC ID label

Please refer to the documentation of the applicant.

2.8.2 Location of the label on the EUT

Please refer to the documentation of the applicant.

3 Test Results

3.1 Conducted emissions (AC power line)

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C 63.4

3.1.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C 63.4
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 ES-K1 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
- Frequency range: 150 kHz – 30 MHz
- Frequency steps: 5 kHz
- IF–Bandwidth: 9 kHz
- Measuring time / Frequency step: 20 ms
- 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.

3.1.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.207

Frequency Range (MHz)	QP Limit (dBµV)	AV Limit (dBµV)
0.15 – 0.5	66 to 56	56 to 46
0.5 – 5	56	46
5 – 30	60	50

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

3.1.3 Test Protocol

Temperature: 25 °C
Air Pressure: 1010 hPa
Humidity: 39 %

Power line	Frequency MHz	Measured value QP dBµV	Measured value AV dBµV	QP Limit dBµV	AV Limit dBµV	Margin QP dB	Margin AV dB
L	0.415	47.80	–	58	48	9.8	–
L	0.635	45.90	–	56	46	10.1	–
L	1.025	47.70	–	56	46	8.3	–
N	1.600	42.40	–	56	46	13.6	–
L	2.365	42.30	–	56	46	13.7	–

Remark: The chosen operating mode is selected as representative mode to generate "worst-case" conditions, i.e. high power consumption.

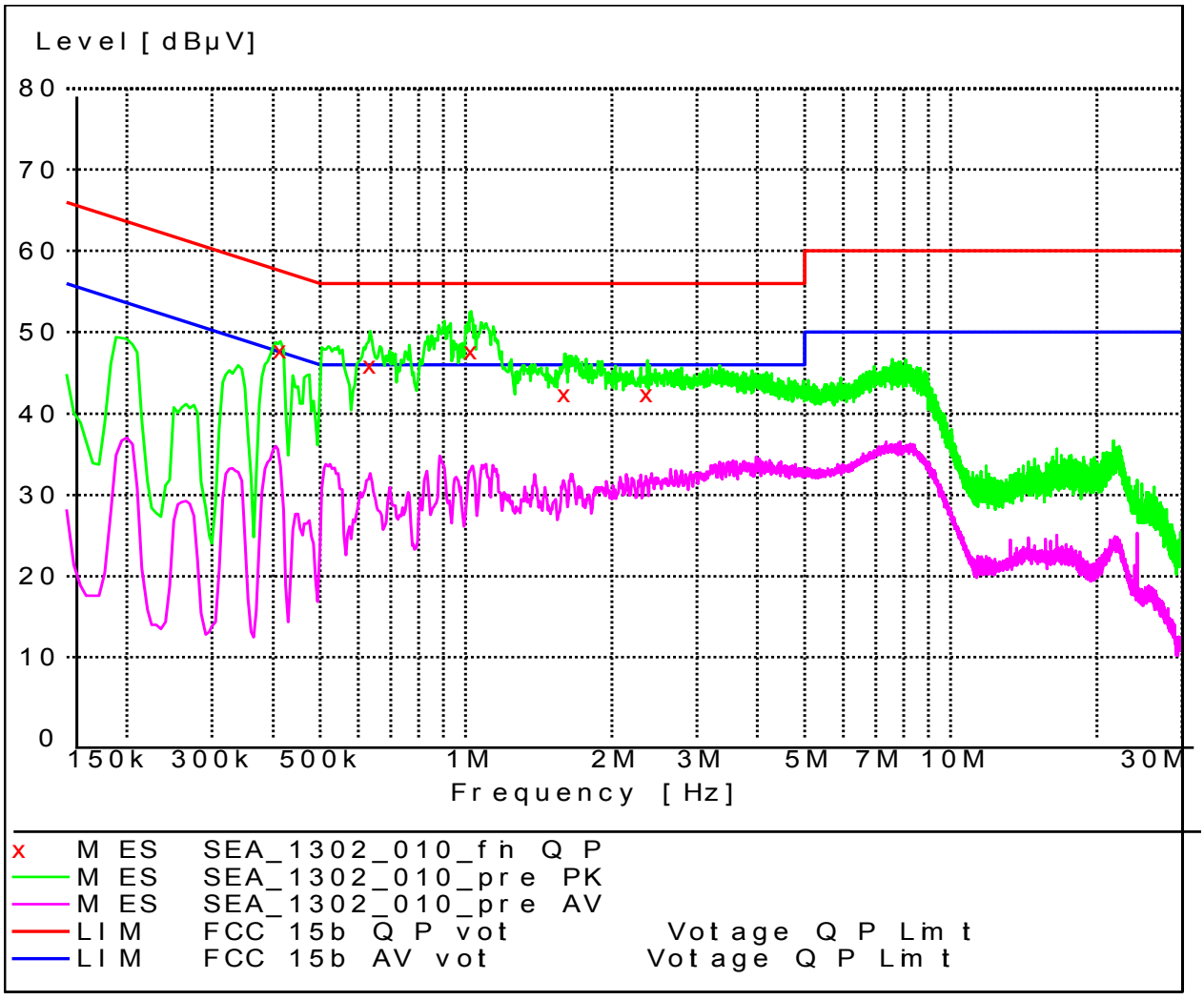
3.1.4 Measurement Plot (showing the highest value, "worst case")

AC MAINS CONDUCTED

```
EUT:                  (VQ000c02)
Manufacturer:         SEAL
Operating Condition:  BT low energy TX on 2440 MHz, data transfer via USB
Test Site:            7 layers Ratingen
Operator:             URO
Test Specification:   ANSI C63.4; FCC 15.107 / 15.207
Comment:              computer peripheral setup; 120V/60Hz
Start of Test:        23.08.2014 / 23:40:16
```

SCAN TABLE: "FCC Voltage"

Short Description:			FCC Voltage			
Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
150.0 kHz	30.0 MHz	5.0 kHz	MaxPeak Average	20.0 ms	9 kHz	ESH3-Z5



MEASUREMENT RESULT: "SEA_1302_010_fin QP"

23.08.2014 23:45

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Line	PE
0.415000	47.80	10.1	58	9.8	L1	FLO
0.635000	45.90	10.1	56	10.1	L1	FLO
1.025000	47.70	10.1	56	8.3	L1	GND
1.600000	42.40	10.1	56	13.6	N	GND
2.365000	42.30	10.2	56	13.7	L1	GND

3.2 Occupied bandwidth

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

3.2.1 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) occupied bandwidth.
The EUT was connected to spectrum analyzer via a short coax cable with a known loss.
Analyzer settings:
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Span: 3 MHz
- Detector: Peak / Sample (6 dB bandwidth / 99% bandwidth)

3.2.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (a) (2)
Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

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

3.2.3 Test Protocol

Temperature: 24 °C
Air Pressure: 1010 hPa
Humidity: 50 %

3.2.3.1 6 dB bandwidth

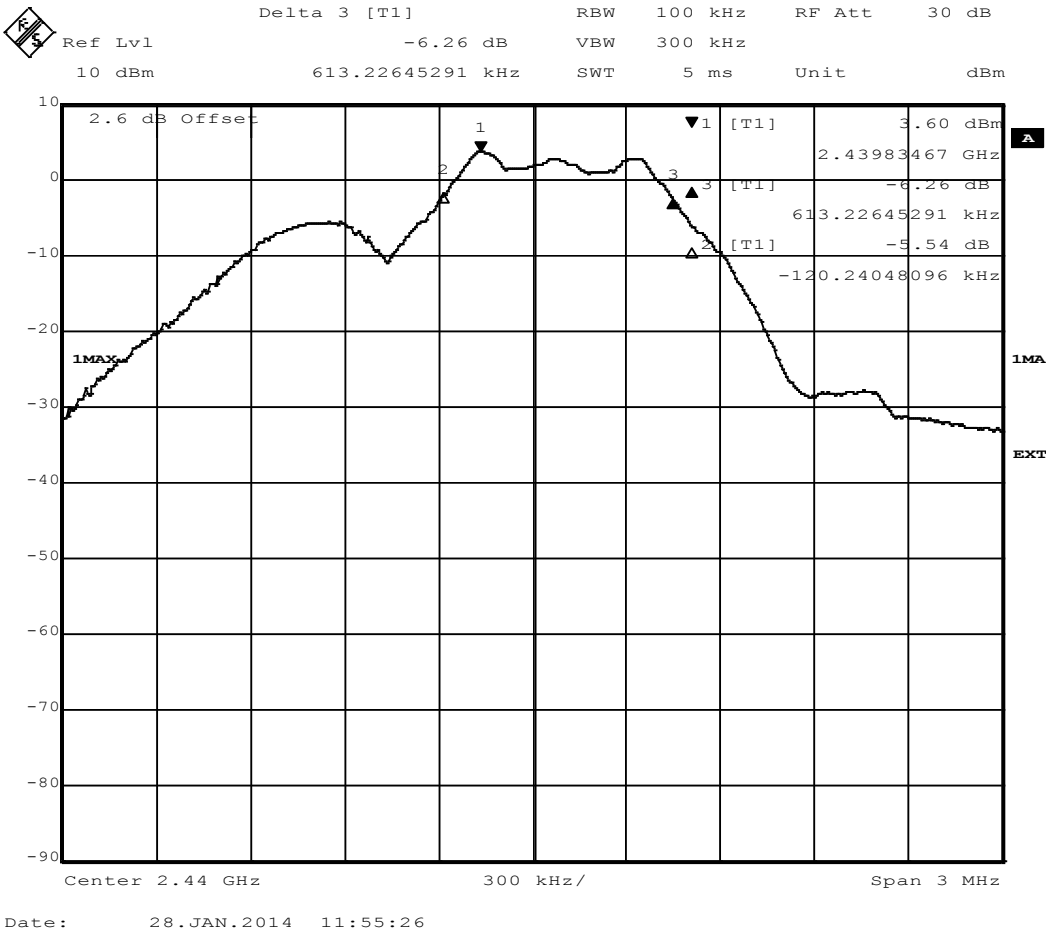
Ambient temperature: 23°C

Air Pressure: 1010 hPa

Humidity: 45%

BT LE; 1 Mbit/s					
Band	**Channel No.**	**Frequency [MHz]**	**6 dB Bandwidth [MHz]**	**Limit [MHz]**	**Margin to Limit [MHz]**
2.4 GHz ISM	0	2402	0.745	0.5	0.245
	19	2440	0.733	0.5	0.233
	39	2480	0.758	0.5	0.258

3.2.4 Measurement Plot (showing the highest value, "worst case")



3.3 Peak power output

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

3.3.1 Test Description

The Equipment Under Test (EUT) was set up to perform the output power measurements. The results recorded were measured with the modulation which produces the worst-case (highest) output power. The reference level of the spectrum analyzer was set higher than the output power of the EUT. The EUT was connected to the spectrum analyzer via a short coax cable with a known loss.
Analyzer settings:
- Detector: Peak

3.3.2 Test Requirements / Limits

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).

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

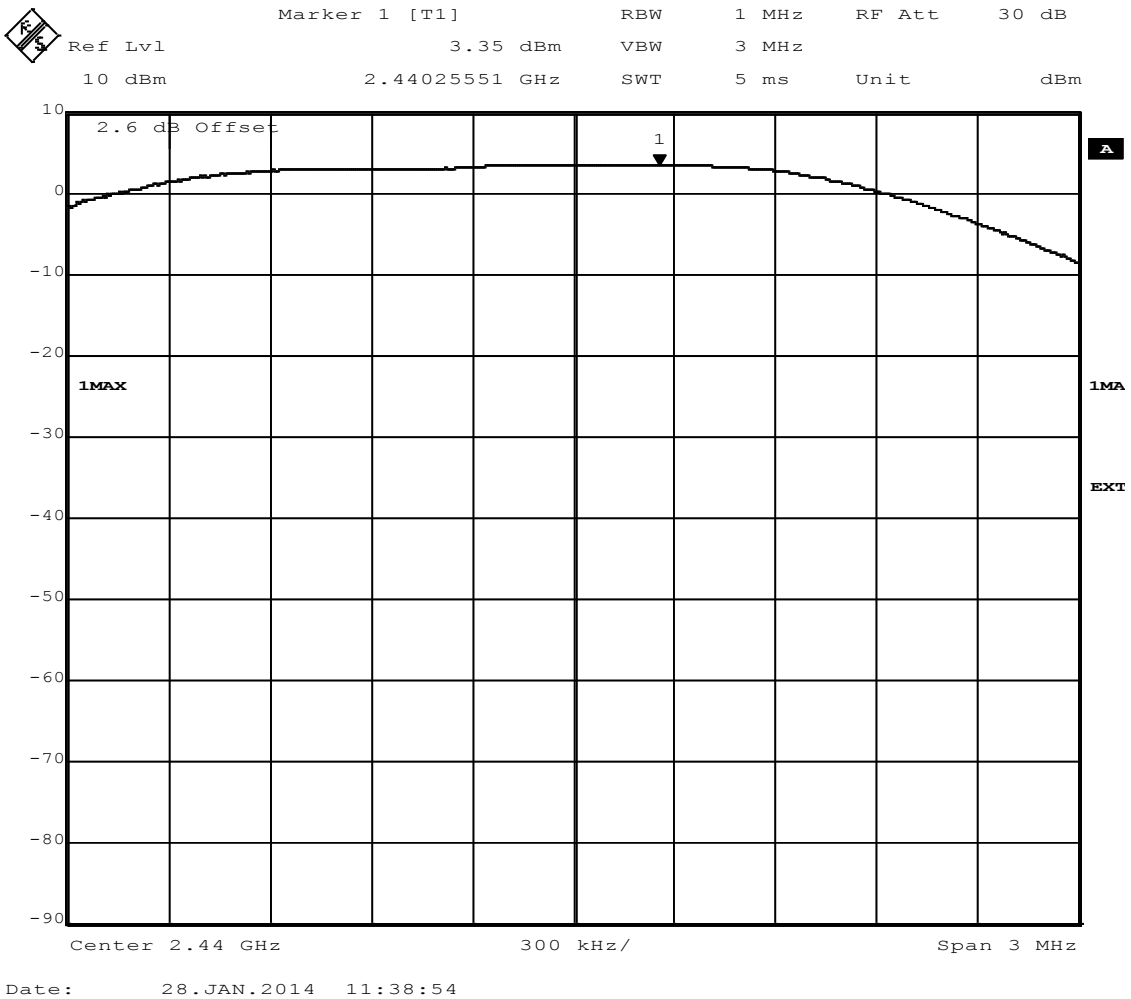
3.3.3 Test Protocol

Temperature:	23 °C
Air Pressure:	1010 hPa
Humidity:	45 %

The antenna gain is excluded in the table.

BT LE; 1 Mbit/s						
Band	**Channel No.**	**Frequency [MHz]**	**Peak Power [dBm]**	**Limit [dBm]**	**Margin to Limit [dB]**	**E.I.R.P [dBm]**
2.4 GHz ISM	0	2402	1.5	30.0	28.5	3.1
	19	2440	1.7	30.0	28.3	3.4
	39	2480	1.2	30.0	28.8	2.9

3.3.4 Measurement Plot (showing the highest value, "worst case")



Mid channel; the measured value contains the antenna gain

3.4 Spurious RF conducted emissions

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

3.4.1 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:

- Detector:	Peak-Maxhold
- Frequency range:	30 – 40000 MHz
- Resolution Bandwidth (RBW):	100 kHz
- Video Bandwidth (VBW):	300 kHz
- Sweep Time:	330 s

The reference value for the measurement of the spurious RF conducted emissions is determined during the test "band edge compliance" (cf. chapter 3.6). This value is used to calculate the 20 dBc limit.

3.4.2 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.

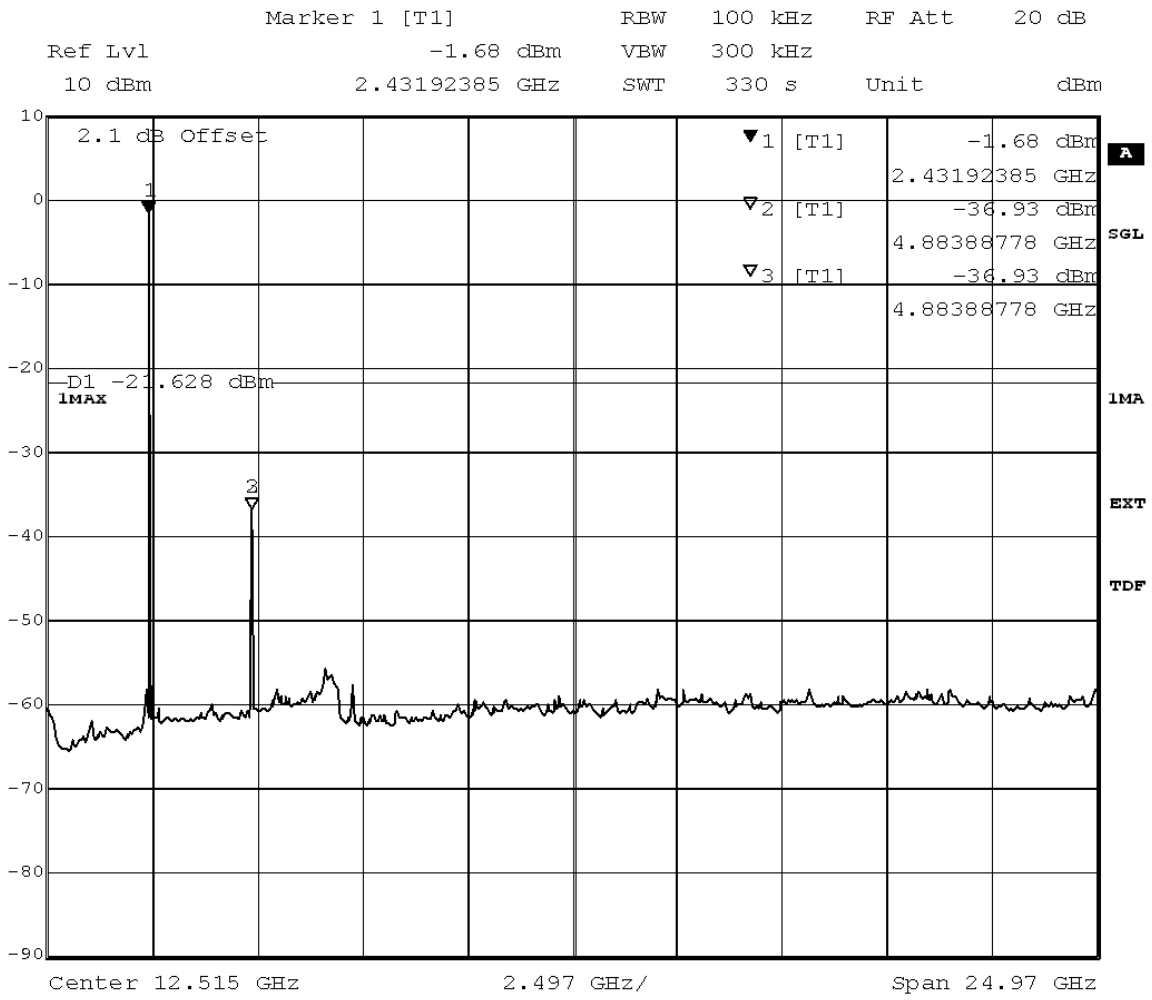
3.4.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1010 hPa
Humidity: 45 %

BT LE; 1 Mbit/s								
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	4783.8	-36.9	PEAK	100	-1.4	-21.4	15.5
19	2440	4883.9	-36.9	PEAK	100	-1.6	-21.6	15.3
39	2480	7435.9	-37.5	PEAK	100	-1.9	-21.9	15.6

Note: No (further) spurious emissions in the range 20 dB below the limit found.

3.4.4 Measurement Plot (showing the highest value, "worst case")



Title: spurious emissions
Comment A: CH M2: 2440 MHz
Date: 29.JAN.2014 11:31:46

3.5 Spurious radiated emissions

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C63.4

3.5.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.4 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 ES-K1 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 performed at 2 axes. A pre-check is performed while the EUT is powered from a DC power sourse.

1. Measurement up to 30 MHz
The Loop antenna HFH2-Z2 is used.
Step 1: pre measurement
- Anechoic chamber
- Antenna distance: 10 m
- Detector: Peak-Maxhold
- Frequency range: 0.009 - 0.15 MHz and 0.15 – 30 MHz
- Frequency steps: 0.1 kHz and 5 kHz
- IF–Bandwidth: 0.2 kHz and 10 kHz
- Measuring time / Frequency step: 100 ms

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: 100 ms

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
- Frequency range: 30 – 1000 MHz
- Frequency steps: 60 kHz
- IF–Bandwidth: 120 kHz
- Measuring time / Frequency step: 100 µs
- Turntable angle range: –180° to 180°
- 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: second 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 out the approximate turntable angle and antenna height for each frequency.

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: –180° to 180°
- Turntable step size: 45°
- Height variation range: 1 – 4 m
- Height variation step size: 0.5 m
- Polarisation: horizontal + vertical

After this step, the EMI test system has determined the following values for each frequency (of step 1):

- Frequency
- Azimuth value (of turntable)
- Antenna height

The last two values have now the following accuracy:

- Azimuth value (of turntable): 45°
- Antenna height: 0.5 m

Step 3: final 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 ± 22.5° 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 ± 25 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: ± 22.5 ° around the determined value
- Height variation range: ± 25 cm around the determined value

Step 4: 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:
The Equipment Under Test (EUT) was set up on a non-conductive support at 1.4 m height in the fully-anechoic chamber. The measurement distance was reduced to 1 m. The results were extrapolated by the extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements, inverse linear-distance squared for the power reference level measurements). Due to the fact, that in this frequency range a double-ridged wave guided horn antenna (up to 18 GHz) and a horn antenna (18–25 GHz) are used, the steps 2-4 are omitted. Step 1 was performed with one height of the receiving antenna only.
EMI receiver settings:
- Detector: Peak, Average
- IF Bandwidth = 1 MHz

For the data rate in mode n the test is performed as worst-case-check in order to verify that emissions have a comparable level as found at modes b and g. Typically, the measurement is performed in the frequency range 1 to 8 GHz but it depends on the emissions found during the test for the modes b and g. Please refer to the results for the used frequency range.

3.5.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (e)

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

3.5.3 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)	Calculated Limits(dBµV/m @10m)	Limits(dBµV/m @10m)
0.009 – 0.49	2400/F(kHz)	300 → 10	(48.5 – 13.8) + 59.1 dB	107.6 – 72.9
0.49 – 1.705	24000/F(kHz)	30 → 10	(48.9 – 23.0) + 19.1 dB	60.0 – 42.1
1.705 – 30	30	30 → 10	29.5 + 19.1 dB	48.6

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limit (dBµV/m)
30 – 88	100	3	40.0
88 – 216	150	3	43.5
216 – 960	200	3	46.0
above 960	500	3	54.0

§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)

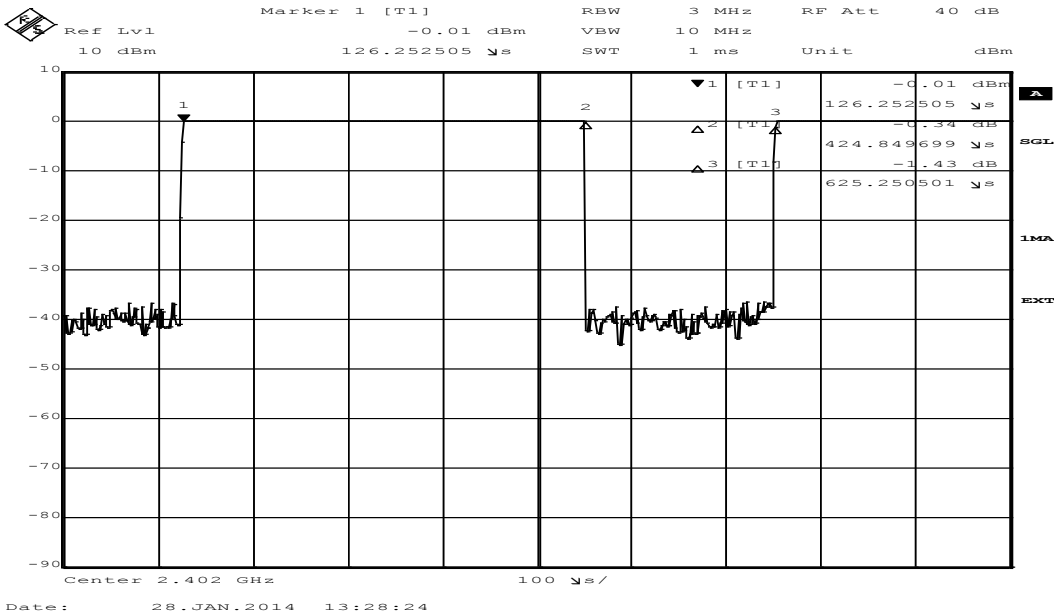
3.5.4 Test Protocol

Temperature: 25–26 °C
Air Pressure: 1004–1011 hPa
Humidity: 38–50 %

BT LE; 1 Mbit/s			Applied duty cycle correction (AV) [dB]:				1.7
Ch. No.	Ch. Center Freq. [MHz]	Spurious Freq. [MHz]	Measured Spurious Level [dBµV/m]	Detec-tor	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]
0	2402	4804.0	55.9	PEAK	1000	74.0	18.1
0	2402	4804.0	47.7	AV	1000	54.0	4.6
0	2402	12009.5	47.9	PEAK	1000	74.0	26.1
0	2402	12009.5	36.6	AV	1000	54.0	15.7
19	2440	4880.0	56.9	PEAK	1000	74.0	17.1
19	2440	4880.0	49.2	AV	1000	54.0	3.2
19	2440	7320.0	61.3	PEAK	1000	74.0	12.7
19	2440	7320.0	52.2	AV	1000	54.0	0.1
19	2440	12199.5	44.7	PEAK	1000	74.0	29.3
19	2440	12199.5	34.1	AV	1000	54.0	18.2
39	2480	4960.0	55.7	PEAK	1000	74.0	18.3
39	2480	4960.0	48.3	AV	1000	54.0	4.0
39	2480	7440.0	59.5	PEAK	1000	74.0	14.5
39	2480	7440.0	50.5	AV	1000	54.0	1.8

Note: No (further) spurious emissions in the range 20 dB below the limit found.
The duty cycle correction (for the AV detector) is taken into account in the "Margin to Limit" column.

Duty Cycle correction factor calculation:

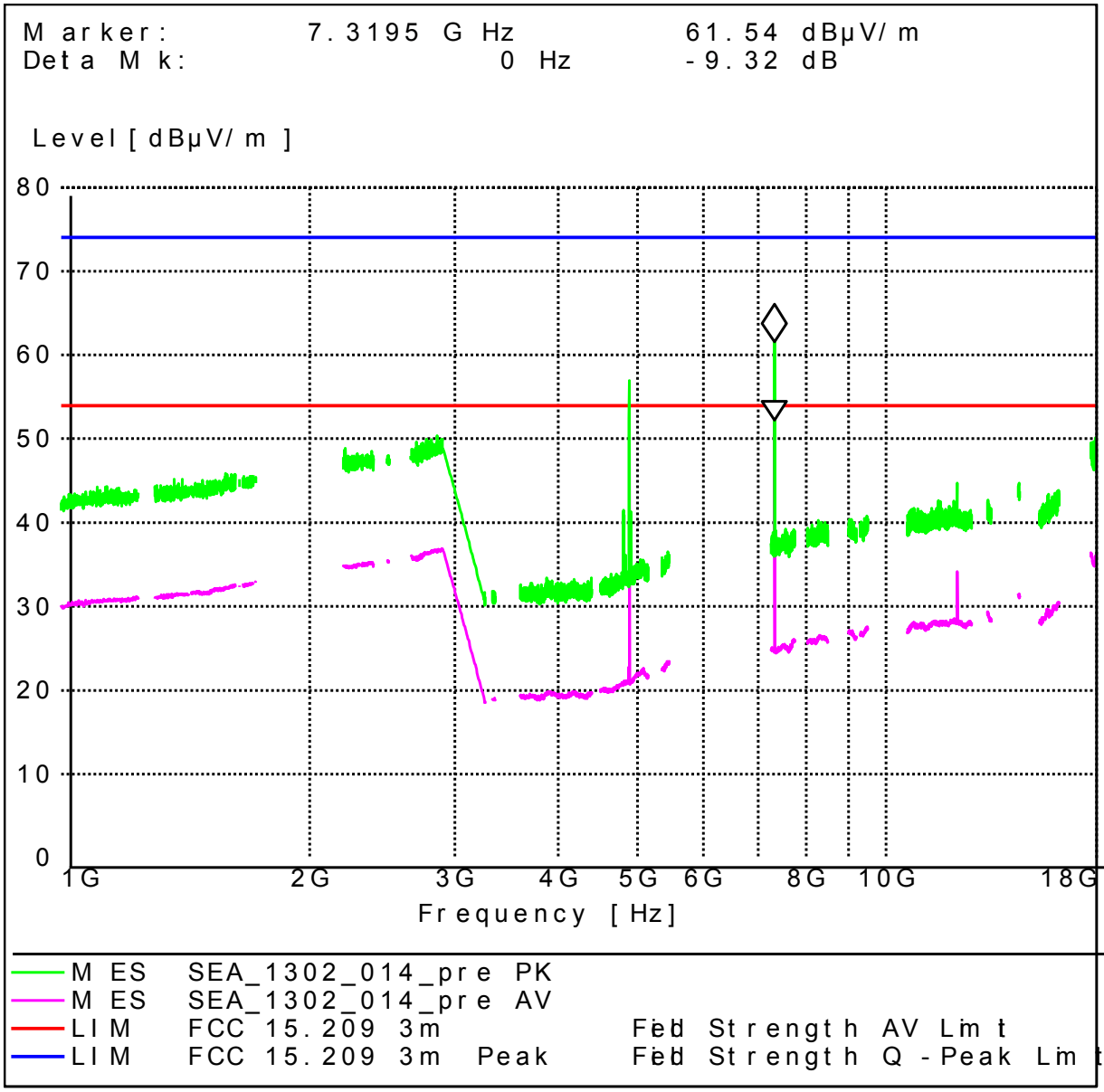


DC = 424.85 µs / 625.25 µs = 0.679
DC = 10 * log(1 / duty cycle) = 10 * log(1 / 0.679) = 10 * 0.1678 = 1.678 dB → 1.7 dB

3.5.5 Measurement Plot (showing the highest value, "worst case")

SPURIOUS EMISSION RADIATED

EUT: (VQ000c02)
Manufacturer: SEAL
Operating Condition: BT LE local TX on 2440 MHz
Test Site: 7 layers Ratingen
Operator: Doe
Test Specification: FCC 15.247 (15.35b, 15.209)
Comment: vertical + horizontal antenna polarisation
vertical EUT position



3.6 Band edge compliance

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C63.4–2009, FCC §15.31

3.6.1 Test Description

The procedure to show compliance with the band edge requirement is divided into two measurements:

1. Show compliance of the lower and higher band edge by a conducted measurement.
For the conducted measurement, the Equipment Under Test (EUT) is placed in a shielded room.
For the lower band edge the EUT is set to transmit as follows:
For a BT LE transmitter working in the 2.4 GHz band on lowest channel:
CH1 = 2402 MHz
The lower band edge is 2400 MHz for 2.4 GHz band transmitter.
For the higher band edge the EUT is set to transmit as follows:
For a BT LE transmitter working in the 2.4 GHz band on highest channel:
CH39 = 2480 MHz
The higher band edge is 2483.5 MHz for a 2.4 GHz band transmitter.
Analyzer settings for conducted measurement:
- Detector: Peak
- RBW / VBW = 100 / 300 kHz

2. Showing compliance of the higher band edge falls in to restricted bands by a radiated measurement.
The radiated emissions measurements are performed in a typical installation configuration inside the fully anechoic chamber using a horn antenna at 1 m distance.
EMI receiver settings for radiated measurement:
- Detector: Peak, Average
- IF Bandwidth = 1 MHz

3.6.2 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...”

For the radiated measurement of the higher band edge connected to a restricted band the limit is “specified in Section 15.209(a)”.

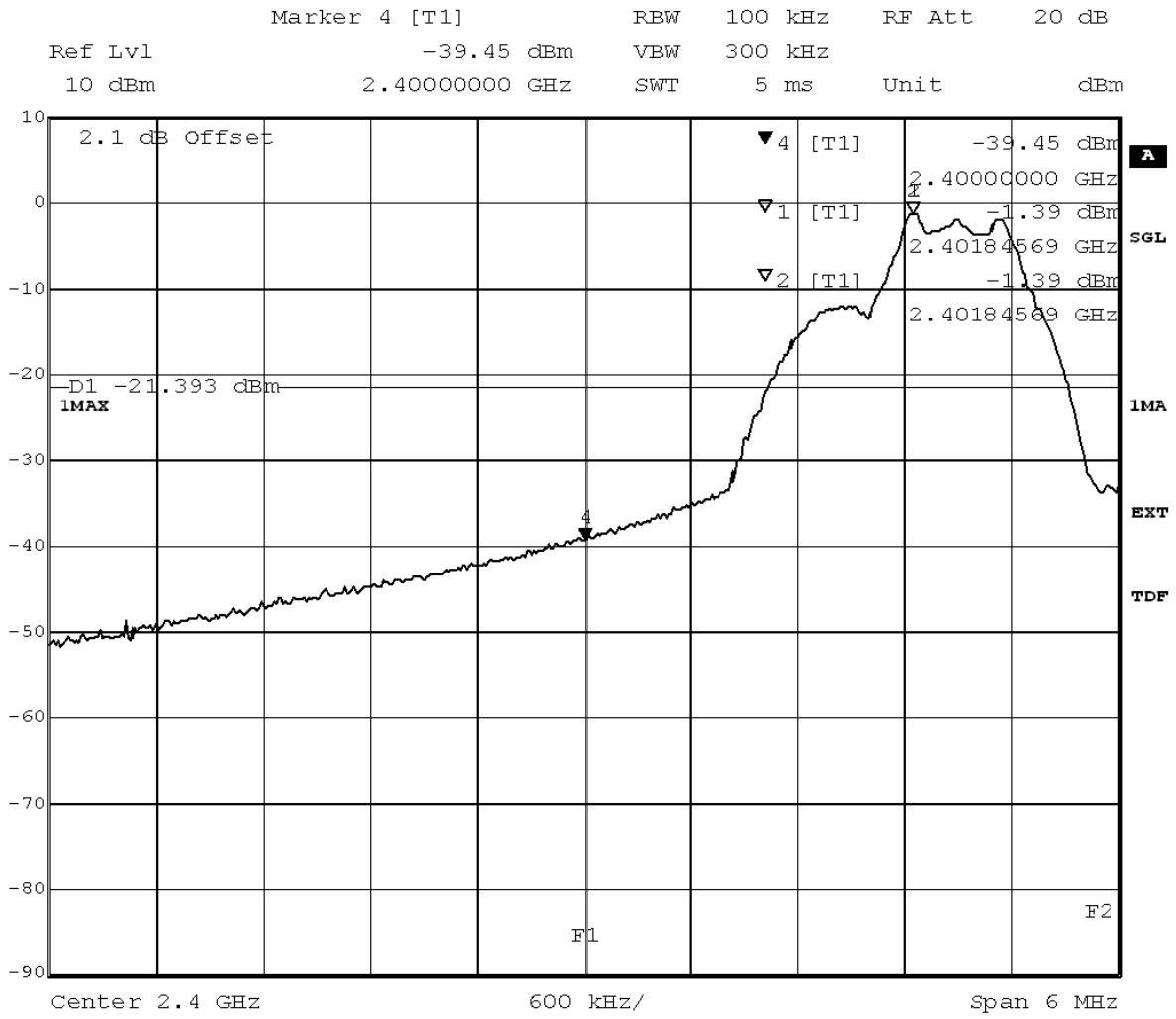
3.6.3 Test Protocol

3.6.3.1 Conducted measurement, lower and higher band edge

Temperature: 23 °C
Air Pressure: 1009 hPa
Humidity: 38 %

BT LE; 1MBit/s								
Channel No	Channel Center Frequency [MHz]	Frequency [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	Limit [dBµV/m]	Margin to Limit [dB]
0	2402	2400.0	-39.5	PEAK	100	-1.4	-21.4	18.1
39	2480	2484.0	-48.4	PEAK	100	-1.9	-21.9	26.5

3.6.3.2 Measurement Plot (showing the highest value, "worst case")



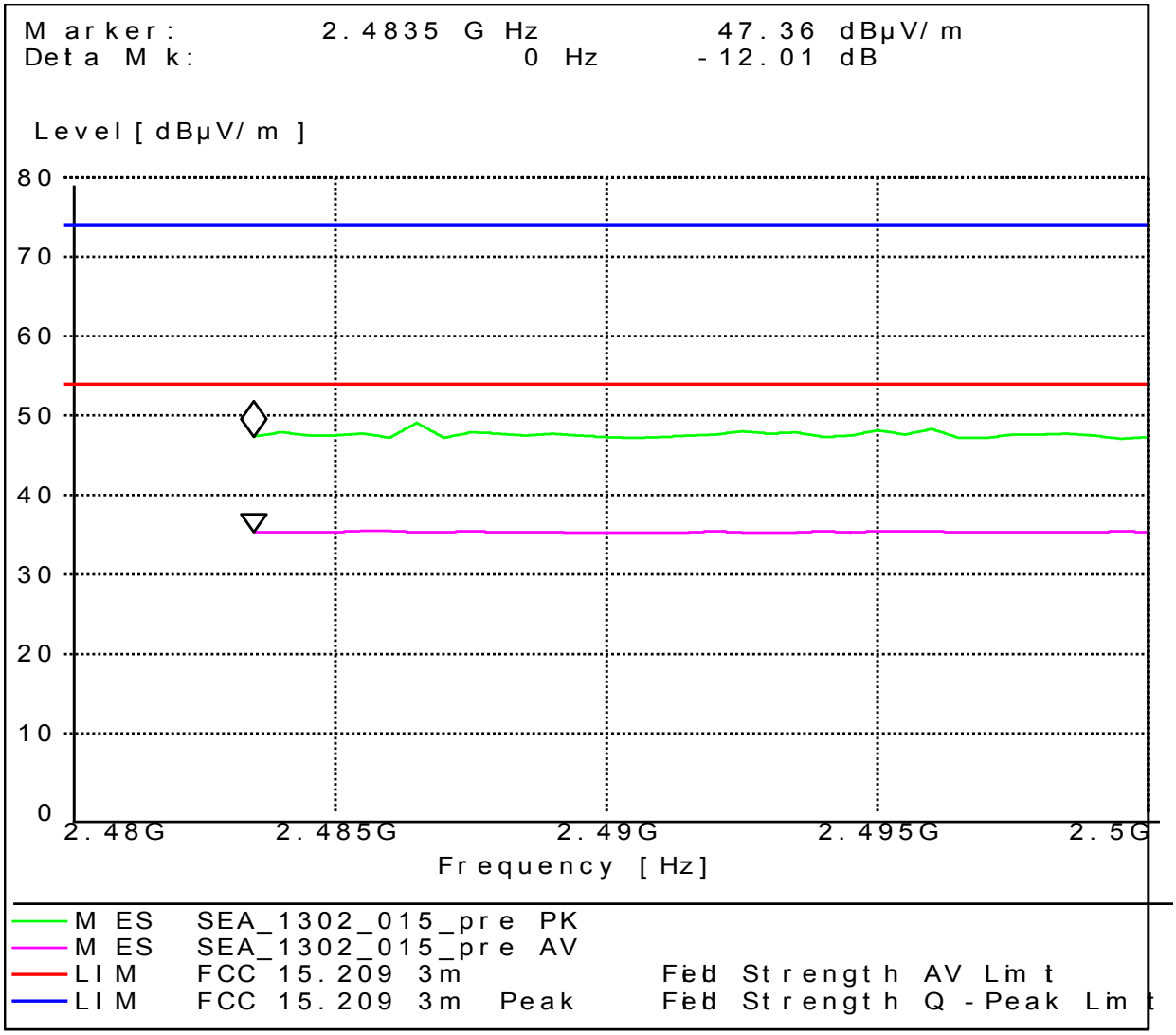
Title: Band Edge Compliance
Comment A: CH B: 2402 MHz
Date: 29.JAN.2014 11:05:32

3.6.3.3 Radiated measurement, higher band edge

Temperature: 25 °C
Air Pressure: 1004 hPa
Humidity: 43 %

BT LE; 1MBit/s							
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]
39	2480	2483.5	47.4	PEAK	1000	74.0	26.6
39	2480	2483.5	35.4	AV	1000	54.0	18.7

3.6.3.4 Measurement Plot (showing the highest value, "worst case")



3.7 Power density

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

3.7.1 Test Description

The EUT was connected to spectrum analyzer via a short coax cable with a known loss.
Analyzer settings:
- Detector: Peak-Maxhold
- Resolution Bandwidth (RBW): 3 kHz
- Video Bandwidth (VBW): 30 kHz
- Sweep Time: Coupled

3.7.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (e)

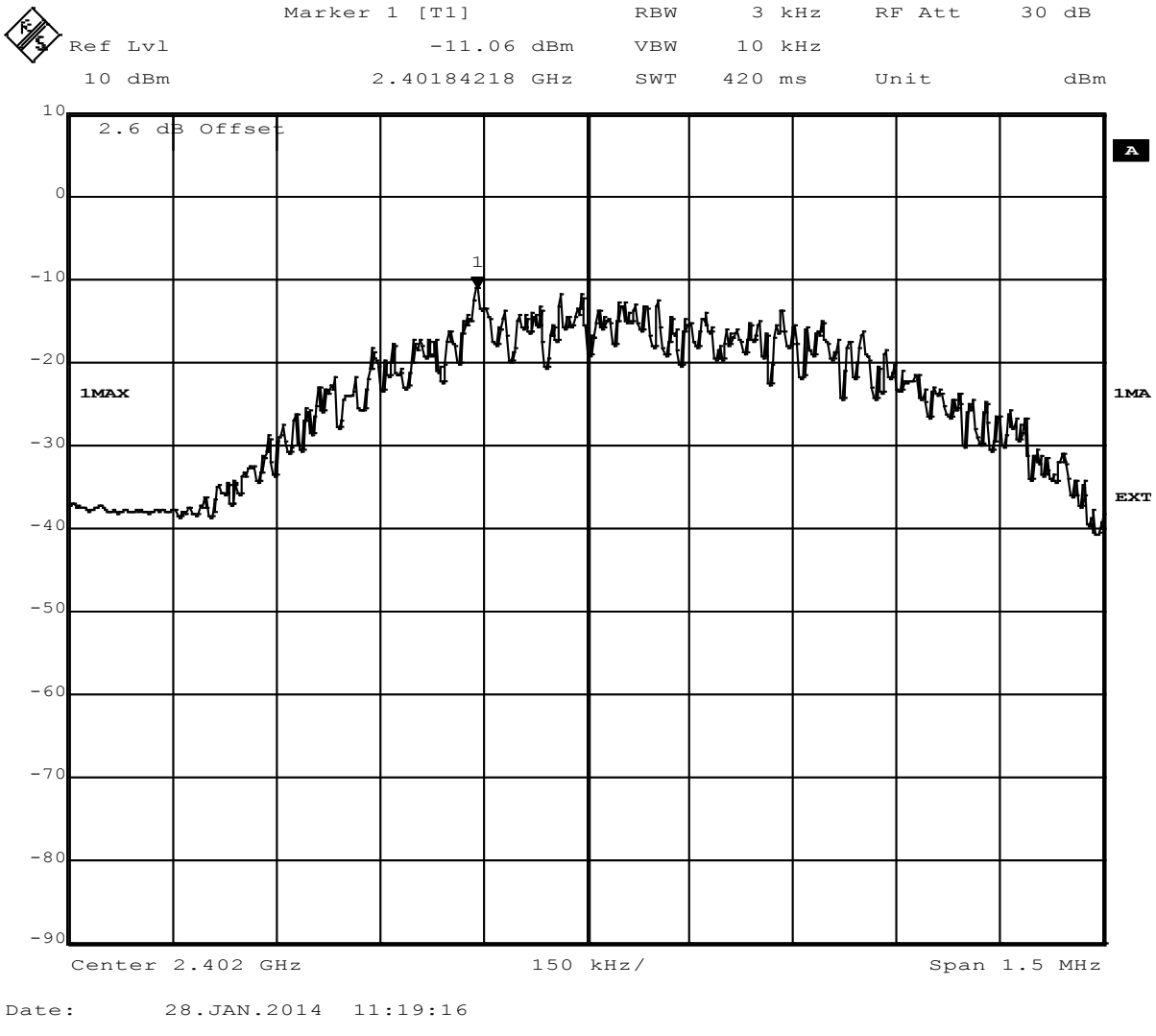
For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.
…
The same method of determining the conducted output power shall be used to determine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

3.7.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1010 hPa
Humidity: 45 %

BT LE; 1 Mbit/s					
Band	**Channel No.**	**Frequency [MHz]**	**Power Density [dBm/3kHz]**	**Limit [dBm/3kHz]**	**Margin to Limit [dB]**
2.4 GHz ISM	0	2402	-12.7	8.0	20.7
	19	2440	-12.9	8.0	20.9
	39	2480	-13.6	8.0	21.6

3.7.4 Measurement Plot (showing the highest value, "worst case")



Date: 28.JAN.2014 11:19:16

4 Test Equipment

The calibration, hardware and software states are shown for the testing period.

Test Equipment Anechoic Chamber

Lab ID:	**Lab 3**	
Manufacturer:	Frankonia	
Description:	Anechoic Chamber for radiated testing	
Type:	10.58x6.38x6.00 m³	
	NSA (FCC)	2014/01/09

Single Devices for Anechoic Chamber

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Air compressor	none	-	Atlas Copco
Anechoic Chamber	10.58 x 6.38 x 6.00 m³ IC listing 3699A-1 3m FCC listing 96716 3m Part15/18	none	Frankonia 2011/02/07 2014/01/09
Controller Maturo	MCU	961208	Maturo GmbH
EMC camera	CE-CAM/1	-	CE-SYS
EMC camera Nr.2	CCD-400E	0005033	Mitsubishi
Filter ISDN	B84312-C110-E1		Siemens&Matsushita
Filter Universal 1A	BB4312-C30-H3	-	Siemens&Matsushita

Test Equipment Auxiliary Equipment for Conducted emissions

Lab ID:	**Lab 1**
Manufacturer:	Rohde & Schwarz GmbH & Co.KG
Description:	EMI Conducted Auxiliary Equipment

Single Devices for Auxiliary Equipment for Conducted emissions

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Cable "LISN to ESI"	RG214	W18.03+W48.03	Huber&Suhner
Impedance Stabilization Network	ISN T800	36159	Teseq GmbH
	Calibration Details		*Last Execution*
	Standard Calibration		2014/02/06
Impedance Stabilization Network, Coupling Decoupling Network	ISN/CDN ENY41	100002	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution*
	Standard calibration		2013/03/01
Impedance Stabilization Network, Coupling Decoupling Network	ISN/CDN ST08	36292	Teseq GmbH
	Calibration Details		*Last Execution*
	Standard calibration		2014/01/10
Impedance Stabilization Network, Coupling Decoupling Network	ISN/CDN T8-Cat6	32187	Teseq GmbH
	Calibration Details		*Last Execution*

Single Devices for Auxiliary Equipment for Conducted emissions (continued)

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
	Standard Calibration		2014/01/08
One-Line V-Network	ESH 3-Z6	100489	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution*
	standard calibration		2014/06/18
	Standard calibration		2011/02/08
One-Line V-Network	ESH 3-Z6	100570	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution*
	Standard Calibration		2013/11/25
Two-Line V-Network	ESH 3-Z5	828304/029	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution*
	Standart Calibration		2013/03/01
Two-Line V-Network	ESH 3-Z5	829996/002	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution*
	Standard Calibration		2013/03/01

Test Equipment Auxiliary Equipment for Radiated emissions

Lab ID:	**Lab 3**
Description:	Equipment for emission measurements
Serial Number:	see single devices

Single Devices for Auxiliary Equipment for Radiated emissions

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
	Standard Calibration		
Biconical dipole	VUBA 9117	9117-108	Schwarzbeck
	Calibration Details		*Last Execution*
	Standard Calibration		2012/01/18
Broadband Amplifier 18MHz-26GHz	JS4-18002600-32-5P	849785	Miteq
Broadband Amplifier 1GHz-4GHz	AFS4-01000400-1Q-10P-4	-	Miteq
Broadband Amplifier 30MHz-18GHz	JS4-00101800-35-5P	896037	Miteq
Cable "ESI to EMI Antenna"	EcoFlex10	W18.01-2+W38.01-2	Kabel Kusch
Cable "ESI to Horn Antenna"	UFB311A+UFB293C	W18.02-2+W38.02-2	Rosenberger Micro-Coax
Double-ridged horn	HF 906	357357/001	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution*
	Standard Calibration		2012/05/18
Double-ridged horn	HF 906	357357/002	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution*
	Standard Calibration		2012/06/26
High Pass Filter	4HC1600/12750-1.5-KK	9942011	Trilithic
High Pass Filter	5HC2700/12750-1.5-KK	9942012	Trilithic
High Pass Filter	5HC3500/12750-1.2-KK	200035008	Trilithic
High Pass Filter	WHKX 7.0/18G-8SS	09	Wainwright
Horn Antenna Schwarzbeck 15-26 GHz BBHA 9170	BBHA 9170		
Log.-per. Antenna	HL 562 Ultralog	100609	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution*
	Standard Calibration		2012/12/18
Log.-per. Antenna	HL 562 Ultralog	830547/003	Rohde & Schwarz GmbH & Co. KG
Loop Antenna	HFH2-Z2	829324/006	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution*
	Standard calibration		2011/10/27

Single Devices for Auxiliary Equipment for Radiated emissions (continued)

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Pyramidal Horn Antenna 26,5 GHz	3160-09	00083069	EMCO Elektronik GmbH
Pyramidal Horn Antenna 40 GHz	3160-10	00086675	EMCO Elektronik GmbH
Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	TD1.5-10kg/024/3790709	Maturo GmbH

Test Equipment Auxiliary Test Equipment

Lab ID:	**Lab 3, Lab 4**
Manufacturer:	see single devices
Description:	Single Devices for various Test Equipment
Type:	various
Serial Number:	none

Single Devices for Auxiliary Test Equipment

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Broadband Power Divider N (Aux)	1506A / 93459	LM390	Weinschel Associates
Broadband Power Divider SMA	WA1515	A855	Weinschel Associates
Digital Multimeter 03 (Multimeter)	Fluke 177	86670383	Fluke Europe B.V.
	Calibration Details		*Last Execution*
	Customized calibration		2013/12/04
Fibre optic link Satellite (Aux)	FO RS232 Link	181-018	Pontis
Fibre optic link Transceiver (Aux)	FO RS232 Link	182-018	Pontis
Isolating Transformer	LTS 604	1888	Thalheimer Transformatorenwerke GmbH
Notch Filter Ultra Stable (Aux)	WRCA800/960-6EEK	24	Wainwright
Signal Analyzer	FSV30	103005	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution*
	Standard		2014/02/10
Spectrum Analyser	FSP3	836722/011	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution*
	Standard		2012/06/13
Spectrum Analyser	FSU26	200418	Rohde & Schwarz GmbH & Co.KG
	Calibration Details		*Last Execution*
	Standard calibration		2013/07/29
	Standard calibration		2014/07/29
Vector Signal Generator	SMIQ 03B	832492/061	Rohde & Schwarz GmbH & Co.KG

Test Equipment Digital Signalling Devices

Lab ID:	**Lab 1, Lab 3, Lab 4**
Description:	Signalling equipment for various wireless technologies.

Single Devices for Digital Signalling Devices

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Bluetooth Signalling Unit CBT	CBT	100589	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution*
	Standard calibration		2011/11/24
CMW500	CMW500	107500	Rohde & Schwarz GmbH & Co.KG
	Standard calibration		2014/01/27
Digital Radio Communication Tester	CMD 55	831050/020	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution*
	Standard calibration		2011/11/28
Universal Radio Communication Tester	CMU 200	102366	Rohde & Schwarz GmbH & Co. KG
	HW/SW Status		*Date of Start* *Date of End*
	Hardware: B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B56V14, B68 3v04, PCMCIA, U65V04 Software: K21 4v21, K22 4v21, K23 4v21, K24 4v21, K42 4v21, K43 4v21, K53 4v21, K56 4v22, K57 4v22, K58 4v22, K59 4v22, K61 4v22, K62 4v22, K63 4v22, K64 4v22, K65 4v22, K66 4v22, K67 4v22, K68 4v22, K69 4v22 Firmware: µP1 8v50 02.05.06 ---		2007/07/16
Universal Radio Communication Tester	CMU 200	837983/052	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution*
	Standard calibration		2011/12/07
	HW/SW Status		*Date of Start* *Date of End*
	HW options: B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B54V14, B56V14, B68 3v04, B95, PCMCIA, U65V02 SW options: K21 4v11, K22 4v11, K23 4v11, K24 4v11, K27 4v10, K28 4v10, K42 4v11, K43 4v11, K53 4v10, K65 4v10, K66 4v10, K68 4v10, Firmware: µP1 8v40 01.12.05 ---		2007/01/02
	SW: K62, K69		2008/11/03
Vector Signal Generator	SMU200A	100912	Rohde & Schwarz GmbH & Co. KG

Test Equipment Emission measurement devices

Lab ID:	**Lab 1, Lab 3**
Description:	Equipment for emission measurements
Serial Number:	see single devices

Single Devices for Emission measurement devices

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Personal Computer	Dell	30304832059	Dell
Power Meter	NRVD	828110/016	Rohde & Schwarz GmbH & Co.KG
	Standard calibration		2013/05/03
	Standard calibration		2014/05/13
Sensor Head A	NRV-Z1	827753/005	Rohde & Schwarz GmbH & Co.KG
	Standard calibration		2013/04/30
	Standard calibration		2014/05/13
Signal Generator	SMR 20	846834/008	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution*
	standard calibration		2011/05/12
Spectrum Analyzer	ESIB 26	830482/004	Rohde & Schwarz GmbH & Co. KG
	Standard Calibration		2014/01/07
	HW/SW Status		*Date of Start* *Date of End*
	Firmware-Update 4.34.4 from 3.45 during calibration		2009/12/03

Test Equipment Radio Lab Test Equipment

Lab ID:	**Lab 4**
Description:	Radio Lab Test Equipment

Single Devices for Radio Lab Test Equipment

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Broadband Power Divider SMA	WA1515	A856	Weinschel Associates
Coax Attenuator 10dB SMA 2W	4T-10	F9401	Weinschel Associates
Coax Attenuator 10dB SMA 2W	56-10	W3702	Weinschel Associates
Coax Attenuator 10dB SMA 2W	56-10	W3711	Weinschel Associates
Coax Cable Huber&Suhner	Sucotest 2,0m		Huber&Suhner
Coax Cable Rosenberger Micro Coax FA210A0010003030 SMA/SMA 1,0m	FA210A0010003030	54491-2	Rosenberger Micro-Coax
Power Meter	NRVD	828110/016	Rohde & Schwarz GmbH & Co.KG
	Standard calibration		2013/05/03
	Standard calibration		2014/05/13
RF Step Attenuator RSP	RSP	833695/001	Rohde & Schwarz GmbH & Co.KG
Rubidium Frequency Standard	Datum, Model: MFS	5489/001	Datum-Beverly
	Standard calibration		2013/06/24
	Standard calibration		2014/07/03
Sensor Head A	NRV-Z1	827753/005	Rohde & Schwarz GmbH & Co.KG
	Standard calibration		2013/04/30
	Standard calibration		2014/05/13
Signal Generator SME	SME03	827460/016	Rohde & Schwarz GmbH & Co.KG
	Calibration Details		*Last Execution*
	Standard calibration		2011/11/25
Signal Generator SMP	SMP02	836402/008	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution*
	Standard calibration		2013/05/06
Spectrum Analyser	FSIQ26	840061/005	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution*
	Standard Calibration		2013/02/12

Test Equipment Shielded Room 02

Lab ID:	**Lab 1**
Manufacturer:	Frankonia
Description:	Shielded Room for conducted testing
Type:	12 qm
Serial Number:	none

Test Equipment T/A Logger 13

Lab ID:	**Lab 1, Lab 3, Lab 4**
Description:	Lufft Opus10 TPR
Type:	Opus10 TPR
Serial Number:	13936

Single Devices for T/A Logger 13

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
ThermoAirpressure Datalogger 13 (Environ)	Opus10 TPR (8253.00)	13936	Lufft Mess- und Regeltechnik GmbH

Calibration Details	*Last Execution*
Customized calibration	2013/02/07

Test Equipment T/H Logger 02

Lab ID:	**Lab 1**
Description:	Lufft Opus10
Serial Number:	7489

Single Devices for T/H Logger 02

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
ThermoHygro Datalogger 02 (Environ)	Opus10 THI (8152.00)	7489	Lufft Mess- und Regeltechnik GmbH

Calibration Details	*Last Execution*
Customized calibration	2013/02/07

Test Equipment T/H Logger 03

Lab ID:	**Lab 4**
Description:	Lufft Opus10
Serial Number:	7482

Single Devices for T/H Logger 03

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
ThermoHygro Datalogger 03 (Environ)	Opus10 THI (8152.00)	7482	Lufft Mess- und Regeltechnik GmbH

Calibration Details	*Last Execution*
Customized calibration	2013/02/07

Test Equipment T/H Logger 12

Lab ID:	**Lab 3**
Description:	Lufft Opus10
Serial Number:	12482

Single Devices for T/H Logger 12

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
ThermoHygro Datalogger 12 (Environ)	Opus10 THI (8152.00)	12482	Lufft Mess- und Regeltechnik GmbH

Calibration Details	*Last Execution*
Customized calibration	2013/01/07

Test Equipment Temperature Chamber 05

Lab ID:	**Lab 4**
Manufacturer:	see single devices
Description:	Temperature Chamber VT4002
Type:	Vötsch
Serial Number:	see single devices

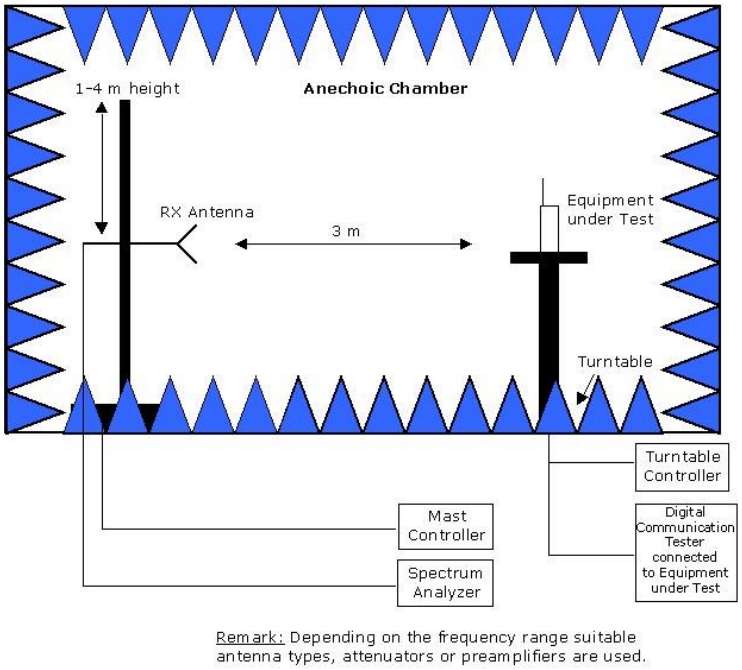
Single Devices for Temperature Chamber 05

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Temperature Chamber Vötsch 05	VT 4002	58566080550010	Vötsch
	Calibration Details		*Last Execution*
	Customized calibration		2012/03/12
	Customized calibration		2014/03/11

5 Photo Report

Please refer to external report.

6 Setup Drawings



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