InterLab®

FCC Measurement/Technical Report on

WLAN transceiver
Bittium Tough Mobile

FCC ID: ID V27SD-41
IC: 3282B-SD41

Report Reference: MDE_ELEKT_1502_FCCa

Test Laboratory:
7layers GmbH
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40880 Ratingen
Germany

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:
All tests were performed according:
ANSI C63.10–2013

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

0.3 Measurement Summary

FCC Part 15, Subpart C	**§ 15.207**		
Conducted emissions (AC power line)			
The measurement was performed according to ANSI C63.10			2013
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 ANSI C63.10			2013
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1b	Setup_01	Temp.ant.connector	passed
op-mode 1g	Setup_01	Temp.ant.connector	passed
op-mode 1n	Setup_01	Temp.ant.connector	passed
op-mode 2b	Setup_01	Temp.ant.connector	passed
op-mode 2g	Setup_01	Temp.ant.connector	passed
op-mode 2n	Setup_01	Temp.ant.connector	passed
op-mode 3b	Setup_01	Temp.ant.connector	passed
op-mode 3g	Setup_01	Temp.ant.connector	passed
op-mode 3n	Setup_01	Temp.ant.connector	passed
op-mode 1n+	Setup_01	Temp.ant.connector	passed
op-mode 2n+	Setup_01	Temp.ant.connector	passed
op-mode 3n+	Setup_01	Temp.ant.connector	passed

FCC Part 15, Subpart C	§ 15.247 (b) (1)		
Peak power output			
The measurement was performed according to ANSI C63.10			2013
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1b	Setup_01	Temp.ant.connector	passed
op-mode 1g	Setup_01	Temp.ant.connector	passed
op-mode 1n	Setup_01	Temp.ant.connector	passed
op-mode 2b	Setup_01	Temp.ant.connector	passed
op-mode 2g	Setup_01	Temp.ant.connector	passed
op-mode 2n	Setup_01	Temp.ant.connector	passed
op-mode 3b	Setup_01	Temp.ant.connector	passed
op-mode 3g	Setup_01	Temp.ant.connector	passed
op-mode 3n	Setup_01	Temp.ant.connector	passed
op-mode 1n+	Setup_01	Temp.ant.connector	passed
op-mode 2n+	Setup_01	Temp.ant.connector	passed
op-mode 3n+	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 C63.10			2013
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1b	Setup_01	Temp.ant.connector	passed
op-mode 1g	Setup_01	Temp.ant.connector	passed
op-mode 1n	Setup_01	Temp.ant.connector	passed
op-mode 2b	Setup_01	Temp.ant.connector	passed
op-mode 2g	Setup_01	Temp.ant.connector	passed
op-mode 2n	Setup_01	Temp.ant.connector	passed
op-mode 3b	Setup_01	Temp.ant.connector	passed
op-mode 3g	Setup_01	Temp.ant.connector	passed
op-mode 3n	Setup_01	Temp.ant.connector	passed
op-mode 1n+	Setup_01	Temp.ant.connector	passed
op-mode 2n+	Setup_01	Temp.ant.connector	passed
op-mode 3n+	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 C63.10			2013
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
op-mode 1g	Setup_02	Enclosure	passed
op-mode 2g	Setup_02	Enclosure	passed
op-mode 3g	Setup_02	Enclosure	passed

FCC Part 15, Subpart C	§ 15.247 (d)		
Band edge compliance			
The measurement was performed according to ANSI C63.10			2013
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1b	Setup_01	Temp.ant.connector	passed
op-mode 1g	Setup_01	Temp.ant.connector	passed
op-mode 1n	Setup_01	Temp.ant.connector	passed
op-mode 3b	Setup_01	Temp.ant.connector	passed
op-mode 3g	Setup_01	Temp.ant.connector	passed
op-mode 3n	Setup_01	Temp.ant.connector	passed
op-mode 1n+	Setup_01	Temp.ant.connector	passed
op-mode 3n+	Setup_01	Temp.ant.connector	passed
op-mode 3b	Setup_02	Enclosure	passed
op-mode 3g	Setup_02	Enclosure	passed
op-mode 3n	Setup_02	Enclosure	passed

FCC Part 15, Subpart C **§ 15.247 (e)**

Power density

The measurement was performed according to ANSI C63.10 2013

OP-Mode	Setup	Port	Final Result
op-mode 1b	Setup_01	Temp.ant.connector	passed
op-mode 1g	Setup_01	Temp.ant.connector	passed
op-mode 1n	Setup_01	Temp.ant.connector	passed
op-mode 2b	Setup_01	Temp.ant.connector	passed
op-mode 2g	Setup_01	Temp.ant.connector	passed
op-mode 2n	Setup_01	Temp.ant.connector	passed
op-mode 3b	Setup_01	Temp.ant.connector	passed
op-mode 3g	Setup_01	Temp.ant.connector	passed
op-mode 3n	Setup_01	Temp.ant.connector	passed
op-mode 1n+	Setup_01	Temp.ant.connector	passed
op-mode 2n+	Setup_01	Temp.ant.connector	passed
op-mode 3n+	Setup_01	Temp.ant.connector	passed

Responsible for Accreditation Scope: MARCO KULLIK 2015.10.23 18:24:22 +02'00'

Responsible for Test Report: DANIEL GALL 2015.10.23 18:18:29 +02'00'

1 Administrative Data

1.1 Testing Laboratory

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

This facility has been fully described in a report submitted to the FCC and accepted under the registration number: 96716 .
This facility has been fully described in a report submitted to the IC and accepted under the registration number: Site# 3699A-1
The test facility is also accredited by the following accreditation organisation:

Laboratory accreditation no.:	DAkkS D-PL-12140-01-01
Responsible for Accreditation Scope:	Dipl.-Ing. Bernhard Retka Dipl.-Ing. Robert Machulec Dipl.-Ing. Thomas Hoell Dipl.-Ing. Andreas Petz Dipl.-Ing. Marco Kullik
Report Template Version:	2015-02-23

1.2 Project Data

Responsible for testing and report:	Dipl.-Ing. Daniel Gall
Date of Test(s):	2015-06-04 to 2015-09-01
Date of Report:	2015-10-08

1.3 Applicant Data

Company Name:	Bittium Wireless Ltd.
Address:	Tutkijantie 8 90590, Oulu Finland
Contact Person:	Mr. Jyrki Juvani

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:	IEEE 802.11a/b/g/n/ac WLAN transceiver
Type Designation:	Bittium Tough Mobile
Kind of Device:	Module supporting these technologies:
(optional)	
Voltage Type:	DC (internal Battery); AC Adapter for charging
Voltage Level:	DC 3.8 V; AC 120V / 60Hz
Tested Modulation Type:	DBPSK; OFDM:BPSK; OFDM:64-QAM

General product description:

The EUT is a tough Mobile Phone supporting
GSM 850/900/1800/1900,
UMTS/WCDMA FDD I, II, IV, VIII
LTE FDD 2, 3, 4, 5, 7, 13, 14, 17, 20
WLAN 802.11 a, b, g, n, ac
Bluetooth (BDR, EDR, LE (4.0))
GPS & GLONASS
NFC 13.56 MHz

Specific product description for the EUT:

The EUT is a dual band WLAN (802.11 2.4 GHz b/g/n and 5 GHz a/n/ac) and Bluetooth module with one joint antenna connector for WLAN and Bluetooth. In IEEE 802.11n mode it supports 20 MHz and 40 MHz bandwidth channels (both with MCS7), providing 72.2 Mbit/s, and 150 Mbit/s transfer data rates respectively.

The object of this test report is the WLAN transceiver, consequently switched on the IEEE 802.11 b/g/n modes, working in the 2.4 band. In IEEE 802.11n mode, it was tested with 20 MHz and 40 MHz channel bandwidth.

The EUT provides the following ports:

Ports
Enclosure
AC port
USB (DC and Data) Port
Audio Port

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: DE1132001ae01)	WLAN transceiver	Tough Mobile	K0251300433	0302	Android Version 5.1.1
Remark: EUT A is equipped with a temporary antenna connector.					
EUT B (Code: DE1132001ah01)	WLAN transceiver	Tough Mobile	K02513004	0302	Andorid Version 5.1.1
Remark: EUT B is equipped with a dual-band integral antenna with antenna gain = -3.5 dBi at 2.4 – 2.5 GHz frequency range and 1.0 dBi for UNII SB1, 2.0 dBi for UNII SB2A / SB2 and 2.5 dBi for UNII SB2C /SB3 in 4.9 – 5.9 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	Battery from Celltech	Model: 3700034	3520001	–	–

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	AC Adapter from Seanen Electronics Co. LTD	KSA29B0500200D5	P0315	–	–
AUX2	Headset/Earphone from Foster	HS2-1.1	3520001	-	-
AUX3	USB cable from ASSMANN	AK-300116-010-S	-	-	-
AUX4	LG Monitor	L17MB-P	412WAPLOU560	-	-
AUX5	Fujitsu Laptop	Lifebook E-Series E781	DSCK013817	-	-
AUX6	Fujitsu AC Adapter for Laptop	PJW1942NA	13300281B	-	-
AUX7	Logitec Mouse	M-BT58	HC60915A2XC	-	-
AUX8	Cherry Keyboard	RS 6000 USB ON	G 0000273 2P28	-	-

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 + AUX1 to AUX3	setup for radiated measurements
Setup_03	EUT B + AUX1 to AUX8	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		
20 MHz Test Channels:	**Bottom**	**Middle**	**Top**
Channel:	1	6	11
Frequency [MHz]	2412	2437	2462

40 MHz Test Channels:	**Bottom**	**Middle**	**Top**
Channel:	3	6	11
Frequency [MHz]	2422	2437	2462

2.6.2 Datarates

WLAN b-Mode; 20 MHz; 1 Mbit/s
WLAN g-Mode; 20 MHz; 6 Mbit/s
WLAN n-Mode; 20 MHz; 72.2 Mbit/s - MCS7, 400ns GI
WLAN n-Mode; 40 MHz; 150 Mbit/s - MCS7, 400ns GI

Data rate / frequency	2412	2437	2462
b-mode, 1 Mbit/s	1b	2b	3b
g-mode, 6 Mbit/s	1g	2g	3g
n-Mode, 72.2 Mbit/s (MCS7)	1n	2n	3n
n-Mode, 150 Mbit/s (MCS7)	1n+	2n+	3n+

2.7 Special software used for testing

An Android-Application was used with the option to switch on a local WLAN transmitter with different settings for modulation type, data rate, channel bandwidth and output power level.

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 63.10

3.1.1 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 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).

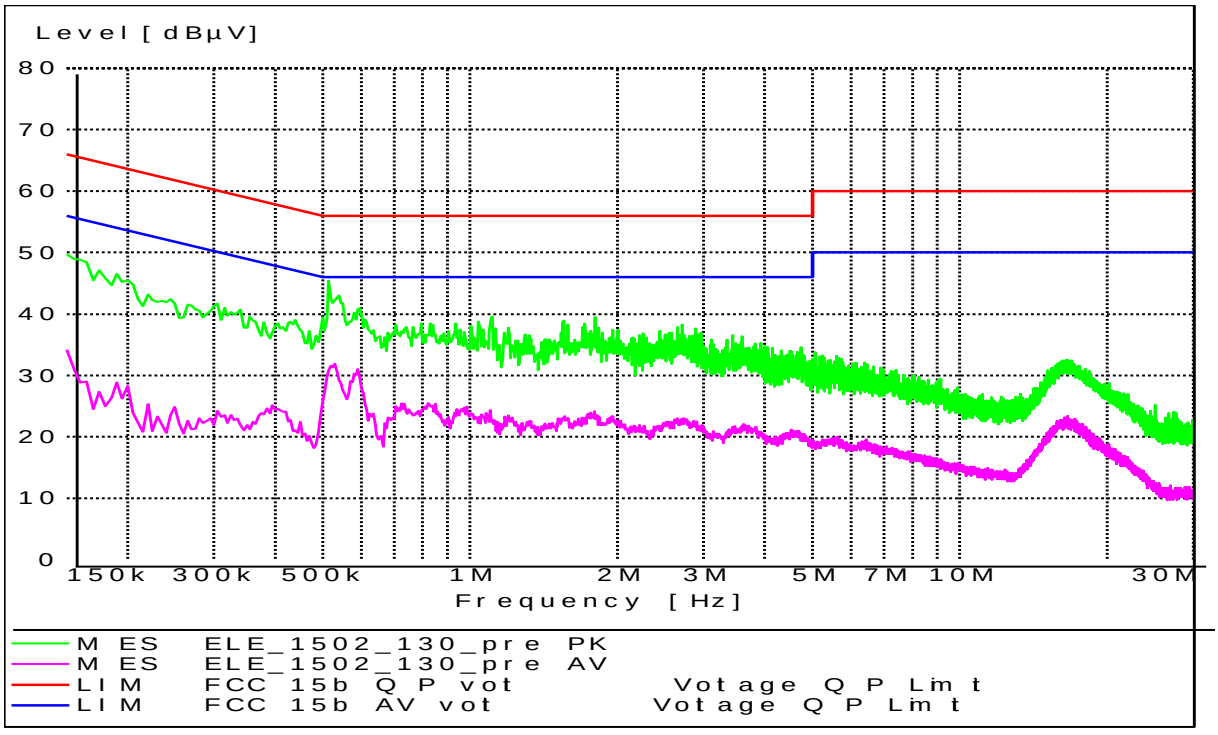
3.1.3 Test Protocol

Temperature: 25 °C
Air Pressure: 1003 hPa
Humidity: 44 %

Power line	Frequency MHz	Measured value QP dBµV	Measured value AV dBµV	QP Limit dBµV	AV Limit dBµV	Margin QP dB	Margin AV dB
N	–	–	–	–	–	–	–
L	–	–	–	–	–	–	–

Remark: No final measurement was performed because no frequencies (peaks) were found within the offset for acceptance analysis during the preliminary scan.
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")



WLAN TX on 2437 MHz, b-mode, 1Mbps, 19 dBm, 120V/60Hz

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 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: 30 / 50 MHz (for 20 / 40 MHz nominal bandwidth)
- 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 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: 23 °C
Air Pressure: 1004 hPa
Humidity: 40 %

3.2.3.1 6 dB bandwidth

WLAN b-Mode; 20 MHz; 1 Mbit/s					
Band	**Channel No.**	**Frequency [MHz]**	**6 dB Bandwidth [MHz]**	**Limit [MHz]**	**Margin to Limit [MHz]**
2.4 GHz ISM	1	2412	9.084	0.5	8.6
	6	2437	11.147	0.5	10.6
	11	2462	8.664	0.5	8.2

WLAN g-Mode; 20 MHz; 6 Mbit/s					
Band	**Channel No.**	**Frequency [MHz]**	**6 dB Bandwidth [MHz]**	**Limit [MHz]**	**Margin to Limit [MHz]**
2.4 GHz ISM	1	2412	17.676	0.5	17.2
	6	2437	17.676	0.5	17.2
	11	2462	17.616	0.5	17.1

WLAN n-Mode; 20 MHz; 72.2 Mbit/s - MCS7, 400ns GI					
Band	**Channel No.**	**Frequency [MHz]**	**6 dB Bandwidth [MHz]**	**Limit [MHz]**	**Margin to Limit [MHz]**
2.4 GHz ISM	1	2412	17.796	0.5	17.3
	6	2437	17.796	0.5	17.3
	11	2462	17.731	0.5	17.2

WLAN n-Mode; 40 MHz; 150 Mbit/s - MCS7, 400ns GI					
Band	**Channel No.**	**Frequency [MHz]**	**6 dB Bandwidth [MHz]**	**Limit [MHz]**	**Margin to Limit [MHz]**
2.4 GHz ISM	3	2422	36.533	0.5	36.0
	6	2437	36.490	0.5	36.0
	11	2462	36.150	0.5	35.7

3.2.3.2 99% bandwidth

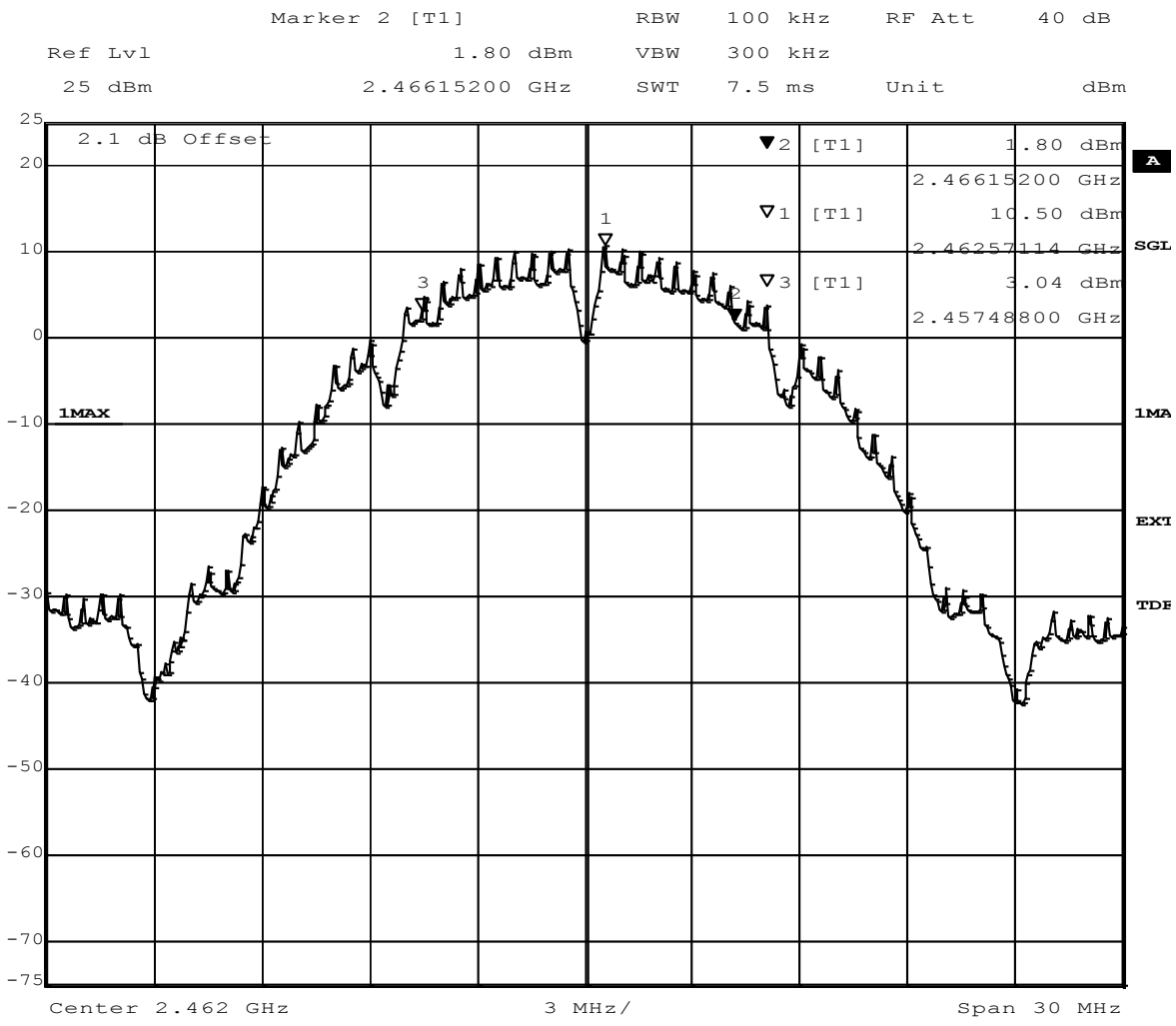
WLAN b-Mode; 20 MHz; 1 Mbit/s			
Band	**Channel No.**	**Frequency [MHz]**	**99 % Bandwidth [MHz]**
2.4 GHz ISM	1	2412	13.603
	6	2437	13.459
	11	2462	13.603

WLAN g-Mode; 20 MHz; 6 Mbit/s			
Band	**Channel No.**	**Frequency [MHz]**	**99 % Bandwidth [MHz]**
2.4 GHz ISM	1	2412	19.030
	6	2437	18.886
	11	2462	19.103

WLAN n-Mode; 20 MHz; 72.2 Mbit/s - MCS7, 400ns GI			
Band	**Channel No.**	**Frequency [MHz]**	**99 % Bandwidth [MHz]**
2.4 GHz ISM	1	2412	18.524
	6	2437	18.452
	11	2462	18.596

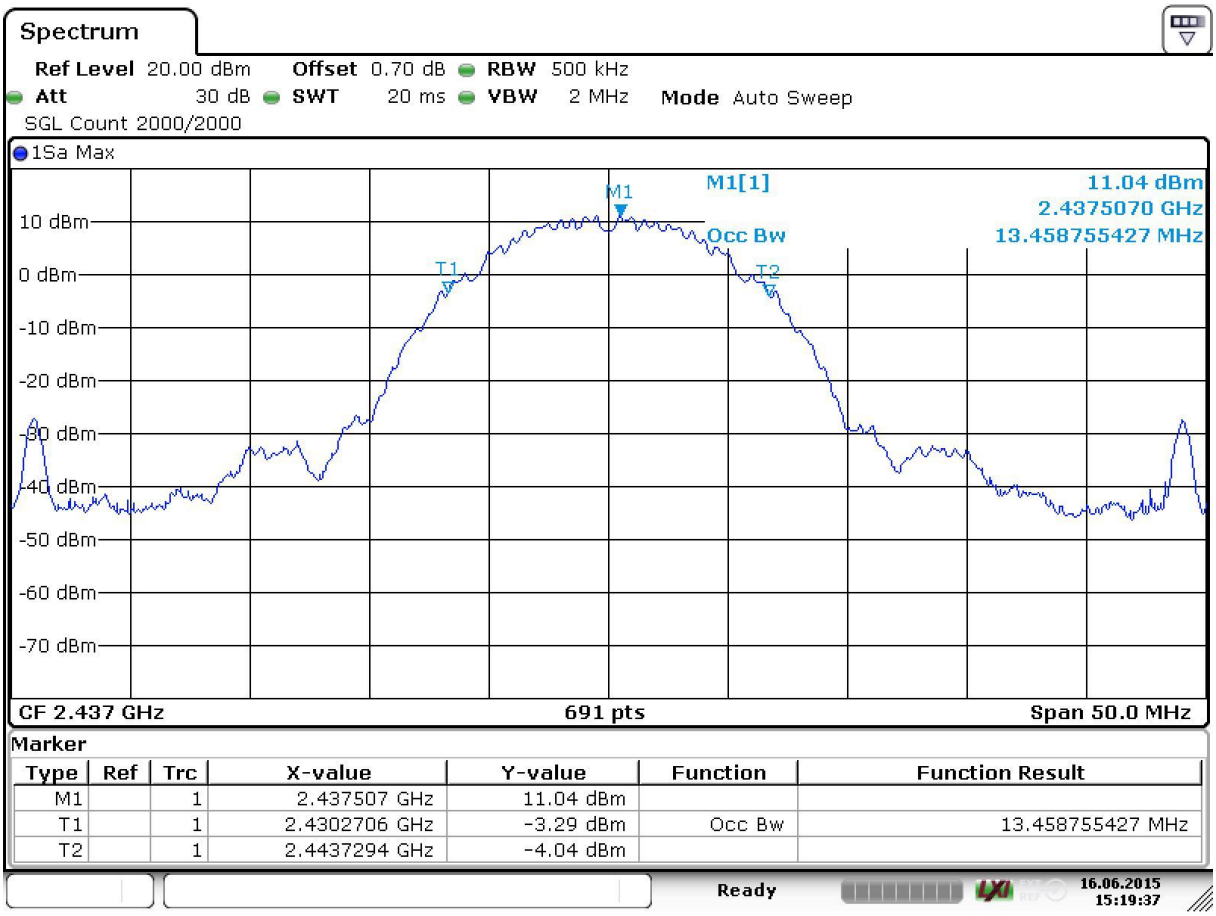
WLAN n-Mode; 40 MHz; 150 Mbit/s - MCS7, 400ns GI			
Band	**Channel No.**	**Frequency [MHz]**	**99 % Bandwidth [MHz]**
2.4 GHz ISM	3	2422	36.252
	6	2437	36.252
	11	2462	36.179

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



Title: 6dB Bandwidth
Comment A: CH T: 2462 MHz; 6dB bandwidth (kHz):8664
Date: 16.JUN.2015 07:31:34

6 dB bandwidth: mode b, 1Mbit/s, channel 11



Date: 16.JUN.2015 15:19:37

99% bandwidth: mode b, 1Mbit/s, channel 6

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: 1004 hPa
Humidity: 40 %

The antenna gain is excluded in the table.

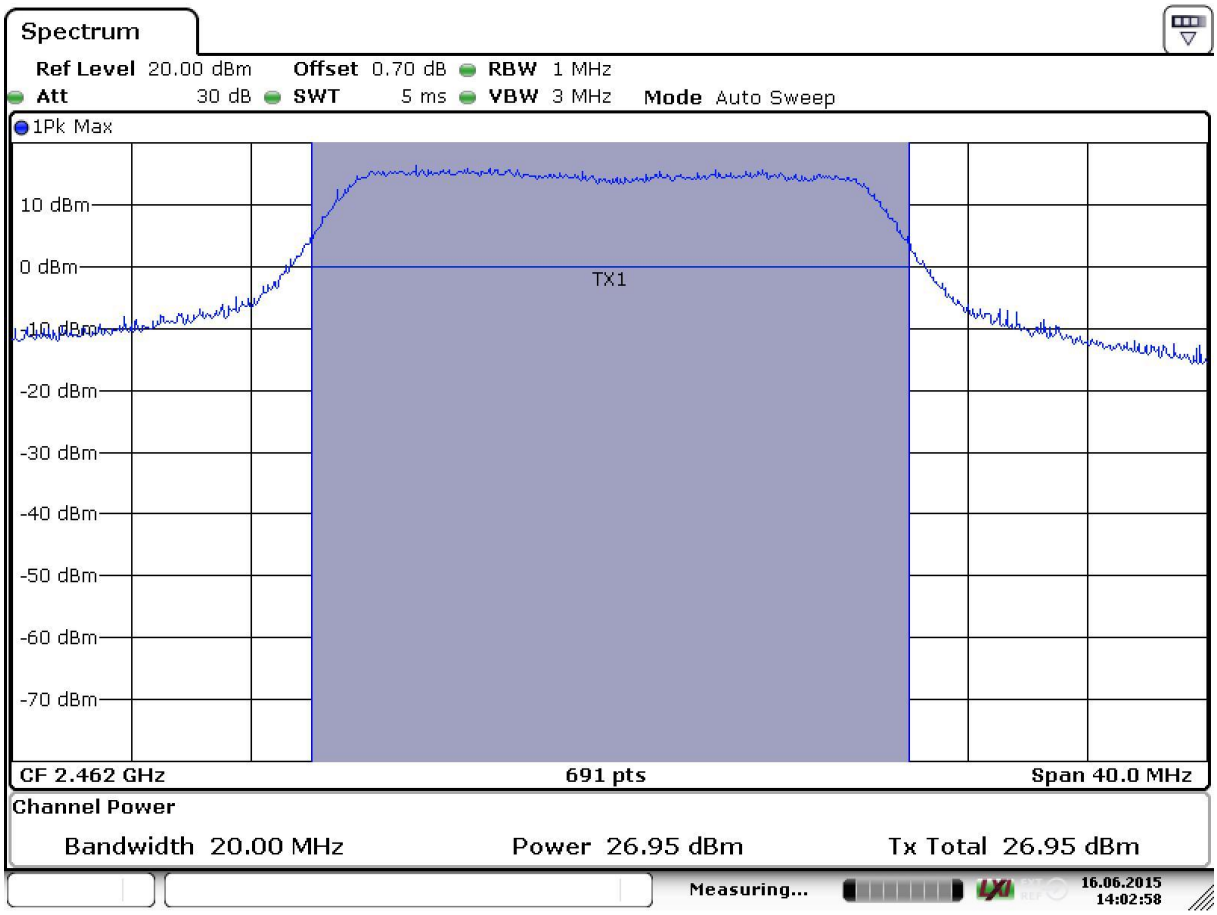
WLAN b-Mode; 20 MHz; 1 Mbit/s					
Band	**Channel No.**	**Frequency [MHz]**	**Peak Power [dBm]**	**Limit [dBm]**	**Margin to Limit [dB]**
2.4 GHz ISM	1	2412	22.5	30.0	7.5
	6	2437	22.4	30.0	7.7
	11	2462	22.3	30.0	7.7

WLAN g-Mode; 20 MHz; 6 Mbit/s					
Band	**Channel No.**	**Frequency [MHz]**	**Peak Power [dBm]**	**Limit [dBm]**	**Margin to Limit [dB]**
2.4 GHz ISM	1	2412	26.5	30.0	3.5
	6	2437	26.4	30.0	3.6
	11	2462	26.6	30.0	3.4

WLAN n-Mode; 20 MHz; 72.2 Mbit/s - MCS7, 400ns GI					
Band	**Channel No.**	**Frequency [MHz]**	**Peak Power [dBm]**	**Limit [dBm]**	**Margin to Limit [dB]**
2.4 GHz ISM	1	2412	26.9	30.0	3.1
	6	2437	26.8	30.0	3.2
	11	2462	27.0	30.0	3.0

WLAN n-Mode; 40 MHz; 150 Mbit/s - MCS7, 400ns GI					
Band	**Channel No.**	**Frequency [MHz]**	**Peak Power [dBm]**	**Limit [dBm]**	**Margin to Limit [dB]**
2.4 GHz ISM	3	2422	26.3	30.0	3.8
	6	2437	26.2	30.0	3.8
	11	2462	26.1	30.0	3.9

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



Date: 16.JUN.2015 14:02:58

mode n, 20MHz, 72.2Mbit/s, channel 11

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 – 25000 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: 1004 hPa
Humidity: 40 %

WLAN b-Mode; 20 MHz; 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]
1	2412	---	---	PEAK	100	10.7	-9.3	- - -
6	2437	---	---	PEAK	100	10.4	-9.6	- - -
11	2462	---	---	PEAK	100	10.3	-9.7	- - -

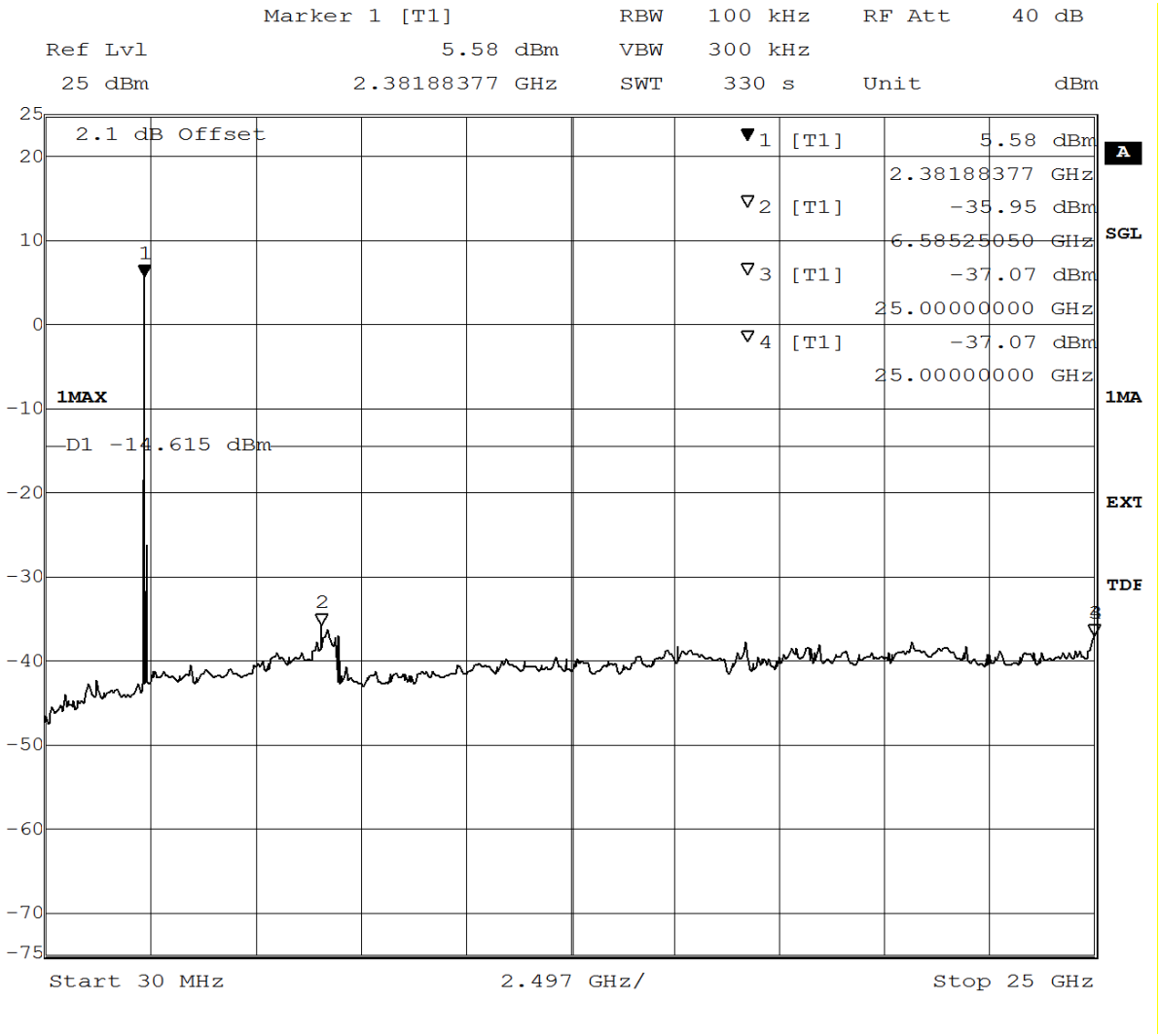
WLAN g-Mode; 20 MHz; 6 Mbit/s								
Channel No	Channel Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	Limit [dBm]	Margin to Limit [dB]
1	2412	---	---	PEAK	100	5.7	-14.3	- - -
6	2437	---	---	PEAK	100	5.3	-14.7	- - -
11	2462	---	---	PEAK	100	5.7	-14.3	- - -

WLAN n-Mode; 20 MHz; 72.2 Mbit/s - MCS7, 400ns GI								
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	2412	---	---	PEAK	100	5.4	-14.6	- - -
6	2437	---	---	PEAK	100	5.6	-14.4	- - -
11	2462	---	---	PEAK	100	5.9	-14.1	- - -

WLAN n-Mode; 40 MHz; 150 Mbit/s - MCS7, 400ns GI								
Channel No	Channel Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	Limit [dBm]	Margin to Limit [dB]
3	2422	---	---	PEAK	100	2.4	-17.6	- - -
6	2437	---	---	PEAK	100	2.5	-17.5	- - -
11	2462	---	---	PEAK	100	2.9	-17.6	- - -

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")



mode n, 20MHz, 72.2Mbit/s, channel 1

3.5 Spurious radiated emissions

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C63.10

3.5.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.10 in a typical installation configuration. The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m² in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.
The measurement procedure is implemented into the EMI test software 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 (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	(33.8 – 23.0) + 19.1 dB	52.9 – 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)

3.5.3 Test Protocol

Temperature: 23–27 °C
Air Pressure: 1004–1018 hPa
Humidity: 40–43 %

WLAN b-Mode; 20 MHz; 1 Mbit/s				Applied duty cycle correction (AV) [dB]:				0.0
Ch. No.	Ch. Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBµV/m]	Detec-tor	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]	Limit Type
6	2437	37.92	31.70	QP	120	40.0	8.3	RB
6	2437	408.0	38.10	QP	120	46.0	7.9	RB

Note: No (further) spurious emissions in the range 20 dB below the limit found.
The results of the pre-test with peak detector have been similar for all three transmit frequencies in the frequency range 30–1000 MHz and independent from the transmit frequency. Therefore the final test applying the QP-(quasi-peak-)detector was perfomed only for one transmit frequency.

WLAN b-Mode; 20 MHz; 1 Mbit/s				Applied duty cycle correction (AV) [dB]:				0.0
Ch. No.	Ch. Center Freq. [MHz]	Spurious Freq. [MHz]	Spurious Level [dBµV/m]	Detec-tor	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]	Limit Type
1	2412	2388.0	55.4	PEAK	1000	74.0	18.6	RB
1	2412	2388.0	49.1	AV	1000	54.0	4.9	RB
6	2437	4874.0	41.6	PEAK	1000	74.0	32.4	RB
6	2437	4874.0	35.4	AV	1000	54.0	18.6	RB
11	2462	2486.0	53.4	PEAK	1000	74.0	20.6	RB
11	2462	2486.0	45.4	AV	1000	54.0	8.6	RB

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

WLAN g-Mode; 20 MHz; 6 Mbit/s				Applied duty cycle correction (AV) [dB]:				0.3
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	2412	2390.0	71.3	PEAK	1000	74.0	2.7	RB
1	2412	2390.0	52.7	AV	1000	54.0	1.3	RB

Note: No (further) spurious emissions in the range 20 dB below the limit found.
The measurement was performed from 1 GHz up to 8 GHz because at pre-measurements no significant spurious emissions have been found outside this frequency range.

3.6 Band edge compliance

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C63.10–2013, 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 WLAN transmitter working in the 2.4 GHz band on lowest channel:
CH1 = 2412 MHz / CH3 = 2422 MHz for a channel bandwidth of 20 / 40 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 WLAN transmitter working in the 2.4 GHz band on highest channel:
CH11 = 2462 MHz or CH13 = 2472 MHz / CH11= 2462 MHz for a channel bandwidth of 20 / 40 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: 1004 hPa
Humidity: 40 %

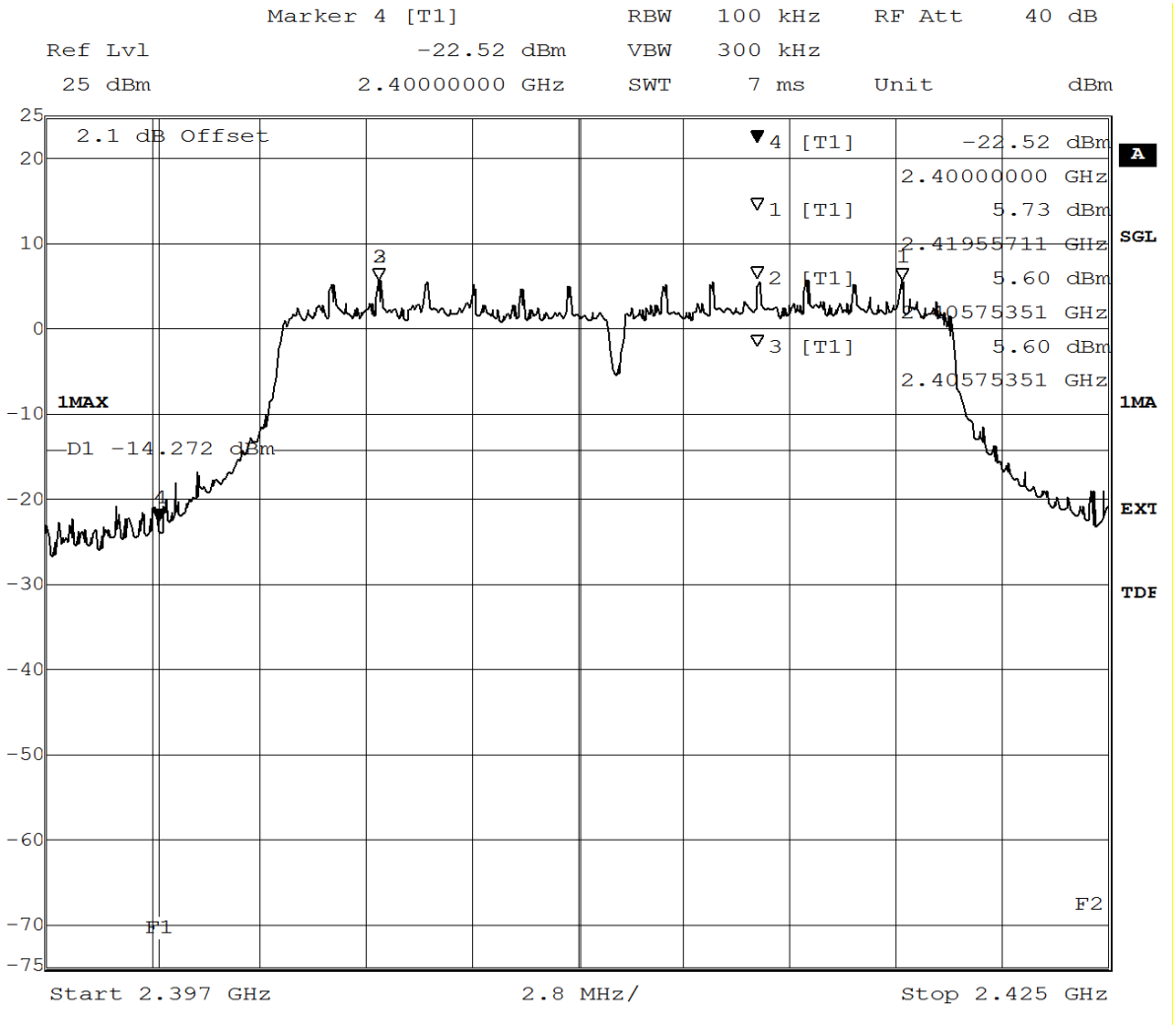
WLAN b-Mode; 20 MHz; 1 Mbit/s								
Channel No.	Channel Center Frequency [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Ref. Level [dBm]	Limit [dBµV/m]	Margin to Limit [dB]
1	2412	2400.0	-41.6	PEAK	100	10.7	-9.3	32.3
11	2462	2483.5	-44.2	PEAK	100	10.3	-9.7	34.5

WLAN g-Mode; 20 MHz; 6 Mbit/s								
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	2412	2400.0	-22.5	PEAK	100	5.7	-14.3	8.2
11	2462	2483.5	-33.4	PEAK	100	5.7	-14.3	19.1

WLAN n-Mode; 20 MHz; 72.2 Mbit/s								
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	2412	2400.0	-25.0	PEAK	100	5.4	-14.6	10.4
11	2462	2483.5	-36.6	PEAK	100	5.9	-14.1	22.5

WLAN n-Mode; 40 MHz; 150 Mbit/s								
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]
3	2422	2400.0	-28.9	PEAK	100	2.4	-17.6	11.3
11	2462	2483.5	-27.9	PEAK	100	2.9	-17.2	10.7

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



mode g, 6Mbit/s, channel 1

3.6.3.3 Radiated measurement, higher band edge

Temperature: 23 °C
Air Pressure: 1004 hPa
Humidity: 40 %

WLAN b-mode; 20 MHz; 1 Mbit/s				Applied duty cycle correction (AV) [dB]:				0.0
Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBµV/m]	Detec-tor	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]	Limit Type
11	2462	2483.5	52.1	PEAK	1000	74.0	21.9	BE
11	2462	2483.5	40.7	AV	1000	54.0	13.3	BE

WLAN g-Mode; 20 MHz; 6 Mbit/s				Applied duty cycle correction (AV) [dB]:				0.3
Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBµV/m]	Detec-tor	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]	Limit Type
11	2462	2483.5	61.3	PEAK	1000	74.0	12.7	BE
11	2462	2483.5	47.5	AV	1000	54.0	6.5	BE

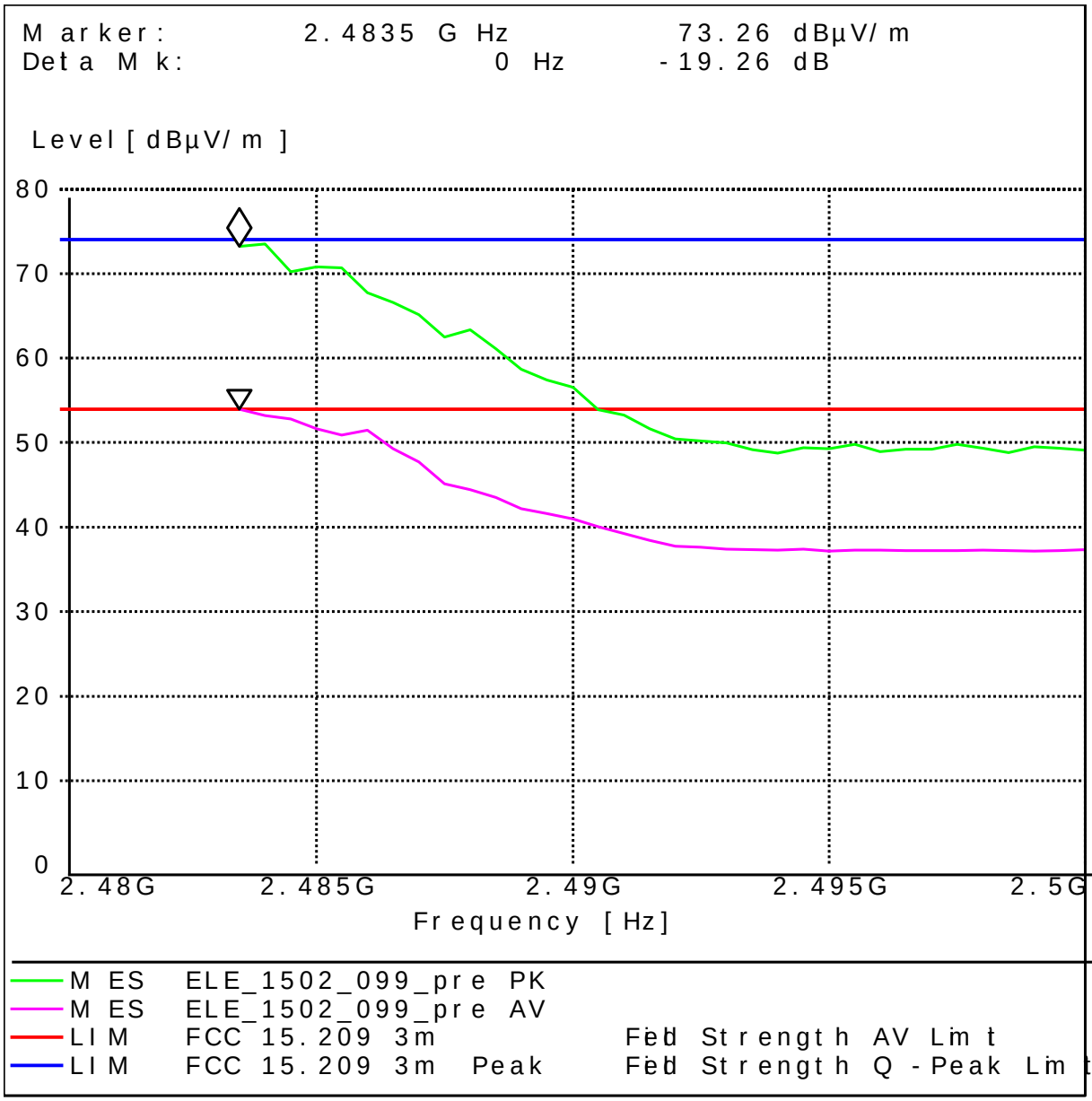
Note: Marker-delta procedure was performed for this operating mode. Please see chapter 3.6.3.5

WLAN n-Mode; 20 MHz; 150 Mbit/s				Applied duty cycle correction (AV) [dB]:				2.9
Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBµV/m]	Detec-tor	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]	Limit Type
11	2462	2483.5	70.3	PEAK	1000	74.0	3.7	BE
11	2462	2483.5	53.0	AV	1000	54.0	1.0	BE

WLAN n-Mode; 40 MHz; 150 Mbit/s				Applied duty cycle correction (AV) [dB]:				2.9
Ch. No.	Ch. Center Freq. [MHz]	Band Edge Freq. [MHz]	Spurious Level [dBµV/m]	Detec-tor	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]	Limit Type
11	2462	2483.5	62.2	PEAK	1000	74.0	11.8	BE
11	2462	2483.5	40.6	AV	1000	54.0	13.4	BE

Note: Marker-delta procedure was performed for this operating mode. Please see chapter 3.6.3.5

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



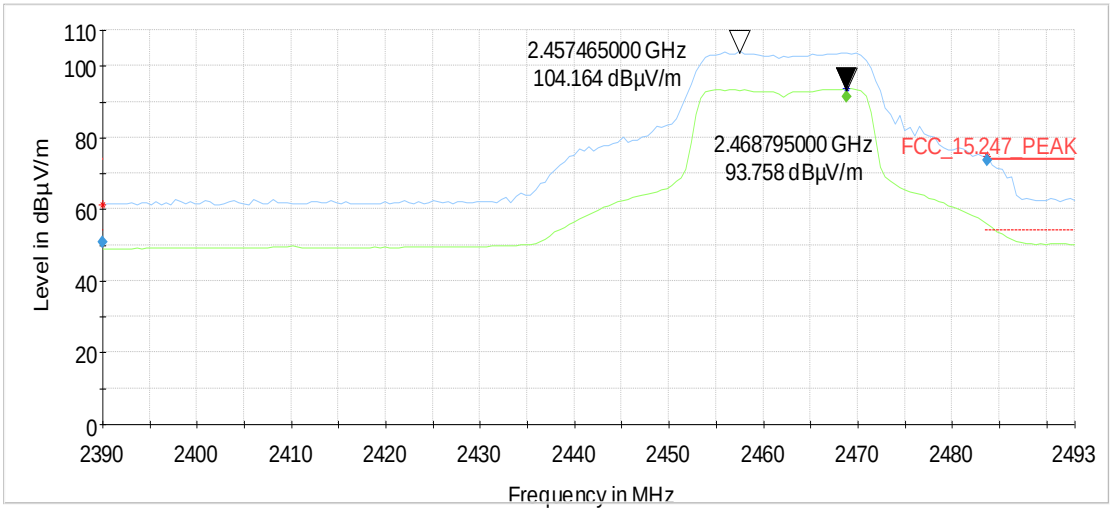
WLAN TX on 2462 MHz, n-mode, MSC7, 150 MBPS, BW 40 MHz

3.6.3.5 Marker-delta procedure

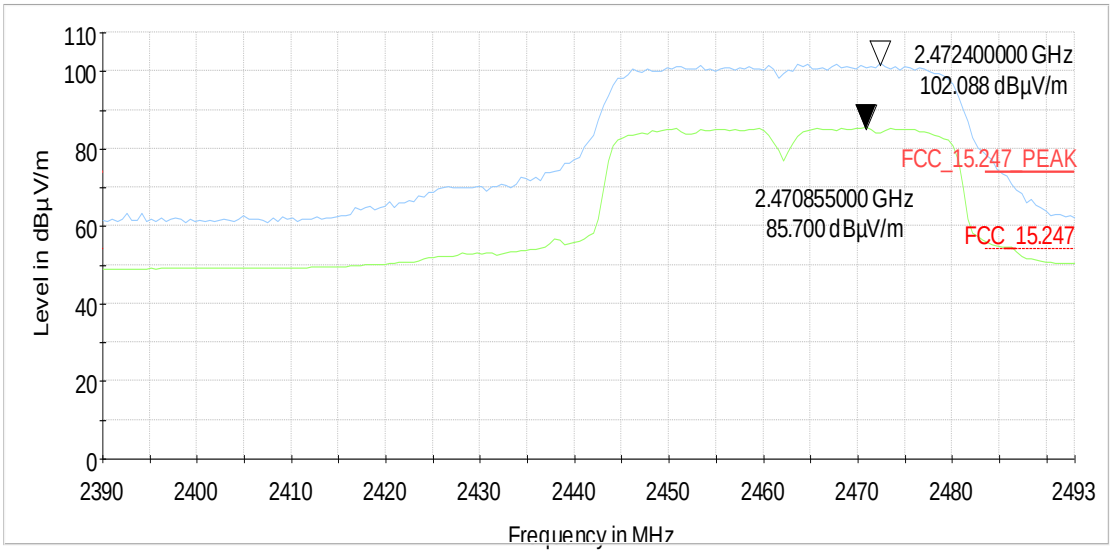
The following procedure is used for for the marker-delta method:

a) An in-band field strength measurement of the fundamental emission using the RBW and detector function required for the frequency being measured
b) The span of an EMI receiver or spectrum analyser is choosen in a way, that it encompasses both the peak of the fundamental emission and the band-edge emission under investigation. The instrument RBW is set to 1% of the total span, with a VBW equal to or greater than three times the RBW. The peak levels of the fundamental emission and the relevant band-edge emission are recorded. The delta between peak of the fundamental and the peak of the band-edge emission are measured. This is only a relative measurement to determine the amount by which the emission drops at the band edge relative to the highest fundamental emission level.
c) The delta measured in step b) is subtracted from the field strengths measured in step a). The resulting field strengths are then used to determine band-edge emissions compliance, where required.

Step a)

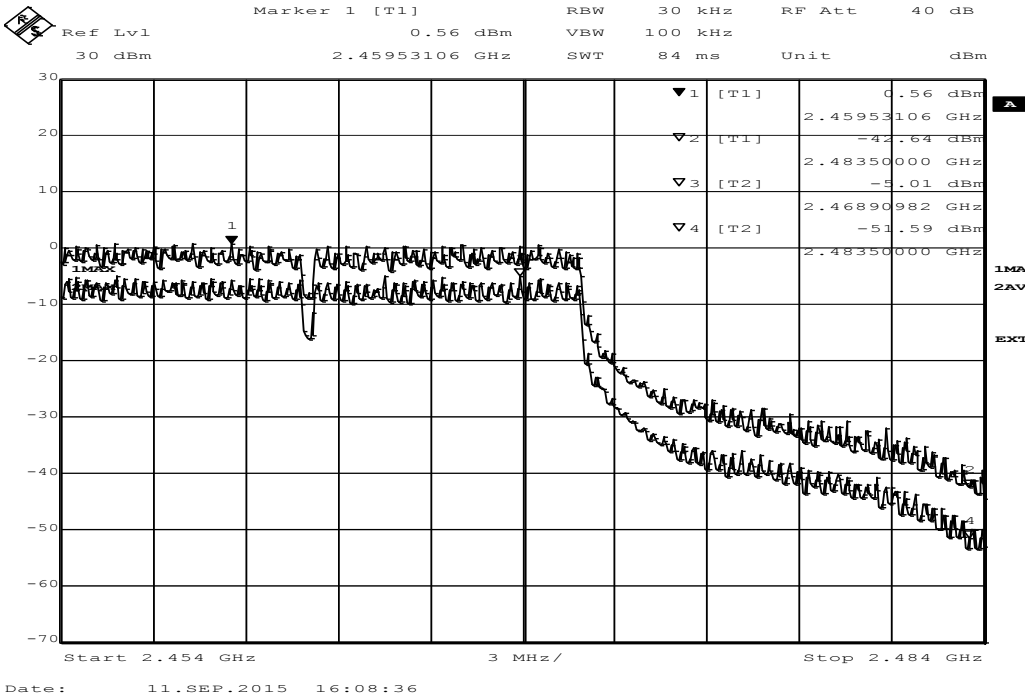


mode g, 6Mbit/s, channel 11

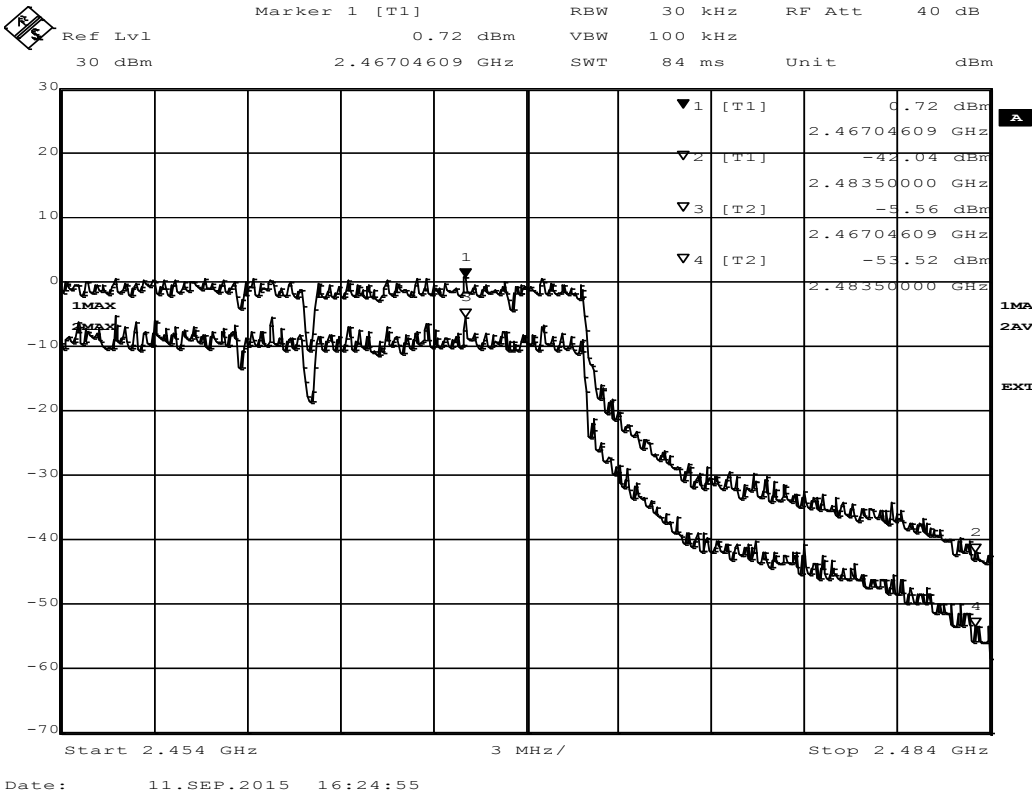


mode n, BW 40MHz, 150Mbit/s, channel 11

Step b)



mode g, 6Mbit/s, channel 11



mode n, BW 40MHz, 150Mbit/s, channel 11

Step c)

					correction factor	0.3
g-mode	**fundamental emission (radiated)**	**fundamental emission (conducted)**	**band-edge emission**	**DELTA**	**subtracted DELTA (uncorrected value)**	**subtracted DELTA (corrected value)**
PEAK	104.16	0.56	-42.64	43.2	60.96	61.26
AVERAGE	93.76	-5.01	-51.59	46.58	47.18	47.48

					correction factor	2.9
n-mode 40MHz	**fundamental emission (radiated)**	**fundamental emission (conducted)**	**band-edge emission**	**DELTA**	**subtracted DELTA (uncorrected value)**	**subtracted DELTA (corrected value)**
PEAK	102.08	0.72	-42.04	42.76	59.32	62.22
AVERAGE	85.7	-5.56	-53.52	47.96	37.74	40.64

3.7 Power density

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C63.10

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: 1004 hPa
Humidity: 40 %

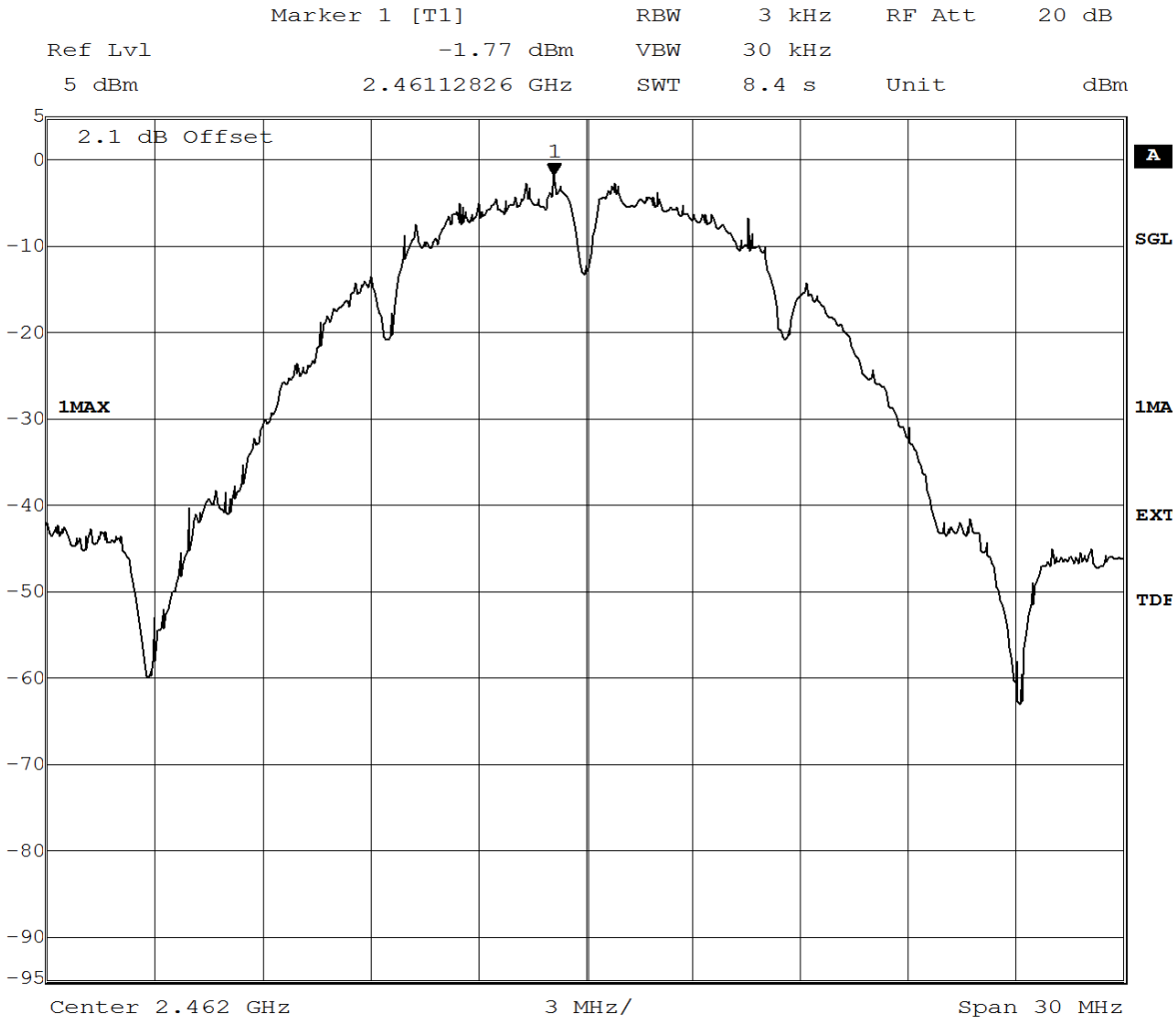
WLAN b-Mode; 20 MHz; 1 Mbit/s					
Band	**Channel No.**	**Frequency [MHz]**	**Power Density [dBm/3kHz]**	**Limit [dBm/3kHz]**	**Margin to Limit [dB]**
2.4 GHz ISM	1	2412	-2.4	8.0	10.4
	6	2437	-2.7	8.0	10.7
	11	2462	-1.8	8.0	9.8

WLAN g-Mode; 20 MHz; 6 Mbit/s					
Band	**Channel No.**	**Frequency [MHz]**	**Power Density [dBm/3kHz]**	**Limit [dBm/3kHz]**	**Margin to Limit [dB]**
2.4 GHz ISM	1	2412	-6.4	8.0	14.4
	6	2437	-8.3	8.0	16.3
	11	2462	-7.6	8.0	15.6

WLAN n-Mode; 20 MHz; 72.2 Mbit/s - MCS7, 400ns GI					
Band	**Channel No.**	**Frequency [MHz]**	**Power Density [dBm/3kHz]**	**Limit [dBm/3kHz]**	**Margin to Limit [dB]**
2.4 GHz ISM	1	2412	-8.7	8.0	16.7
	6	2437	-8.6	8.0	16.6
	11	2462	-9.2	8.0	17.2

WLAN n-Mode; 40 MHz; 150 Mbit/s - MCS7, 400ns GI					
Band	**Channel No.**	**Frequency [MHz]**	**Power Density [dBm/3kHz]**	**Limit [dBm/3kHz]**	**Margin to Limit [dB]**
2.4 GHz ISM	3	2422	-12.3	8.0	20.3
	6	2437	-11.9	8.0	19.9
	11	2462	-12.5	8.0	20.5

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



mode b, 1Mbit/s, channel 11

4 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		± 2.2 dB
Spurious Emissions at antenna terminal	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

5 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	2017/01/09

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 FCC listing 96716 3m Part15/18	none	Frankonia 2014/01/09	2017/01/08
Controller Innco 2000	CO 2000	CO2000/328/12470 406/L	Innco innovative constructions GmbH	
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*	
AC Power Source	Chroma 6404	64040001304	Chroma ATE INC.	
Cable "LISN to ESI"	RG214	W18.03+W48.03	Huber&Suhner	
Impedance Stabilization Network	ISN T800	36159	Teseq GmbH	
	Calibration Details		*Last Execution*	*Next Execution*
	Standard Calibration		2014/02/06	2016/02/28
Impedance Stabilization Network, Coupling Decoupling Network	ISN/CDN ENY41	100002	Rohde & Schwarz GmbH & Co. KG	
Impedance Stabilization Network, Coupling Decoupling Network	ISN/CDN ST08	36292	Teseq GmbH	
	Calibration Details		*Last Execution*	*Next Execution*
	Standard calibration		2014/01/10	2016/01/31
Impedance Stabilization Network, Coupling Decoupling Network	ISN/CDN T8-Cat6	32187	Teseq GmbH	

Single Devices for Auxiliary Equipment for Conducted emissions (continued)

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
	Calibration Details		*Last Execution*	*Next Execution*
	Standard Calibration		2014/01/08	2016/01/31
One-Line V-Network	ESH 3-Z6	100489	Rohde & Schwarz GmbH & Co. KG	
	standard calibration		2014/06/18	2017/11/30
One-Line V-Network	ESH 3-Z6	100570	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Execution*
	Standard Calibration		2013/11/25	2016/11/24
Two-Line V-Network	ESH 3-Z5	828304/029	Rohde & Schwarz GmbH & Co. KG	
	DAkkS Calibration		2015/03/30	2017/03/31
Two-Line V-Network	ESH 3-Z5	829996/002	Rohde & Schwarz GmbH & Co. KG	
	DAkks Calibration		2015/03/30	2017/03/31

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*	
Antenna mast	AM 4.0	AM4.0/180/11920513	Maturo GmbH	
Antenna mast	AS 620 P	620/37	HD GmbH	
Biconical Broadband Antenna	SBA 9119	9119-005	Schwarzbeck Mess-Elektronik OHG	
Biconical dipole	VUBA 9117	9117-108	Schwarzbeck Mess-Elektronik OHG	
Broadband Amplifier 1 GHz - 4 GHz	AFS4-01000400-1Q-10P-4	-	Miteq	
Broadband Amplifier 18 GHz - 26 GHz	JS4-18002600-32-5P	849785	Miteq	
Broadband Amplifier 30 MHz - 18 GHz	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"	SucoFlex	W18.02-2+W38.02-2	HUBER+SUHNER	
Cable "ESI to Horn Antenna"	UFB311A+UFB293C	W18.02-2+W38.02-2	Rosenberger Micro-Coax	
Double-ridged horn	HF 906	357357/002	Rohde & Schwarz GmbH & Co. KG	
	Standard Calibration		2012/06/26	2015/06/25
	Standard Calibration		2015/06/23	2018/06/22
Double-ridged horn	HF 907	102444	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Execution*
	Standard Calibration		2015/05/11	2018/05/10
Double-ridged horn-duplicated 2015-07-15 10:47:55	HF 906	357357/001	Rohde & Schwarz GmbH & Co. KG	
Dreheinheit	DE 325		HD GmbH	
High Pass Filter	4HC1600/12750-1.5-KK	9942011	Trilithic	
High Pass Filter	5HC2700/12750-1.5-KK	9942012	Trilithic	
High Pass Filter	5HC3500/18000-1.2-KK	200035008	Trilithic	
High Pass Filter	WHKX 7.0/18G-8SS	09	Wainwright	
Horn Antenna Schwarzbeck 15-26.5 GHz BBHA 9170	BBHA 9170	BBHA9170262	Schwarzbeck Mess-Elektronik OHG	
Log.-per. Antenna	HL 562 Ultralog	100609	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Execution*
	Standard Calibration		2012/12/18	2015/12/17
Log.-per. Antenna (upgraded)	HL 562 Ultralog new biconicals	830547/003	Rohde & Schwarz GmbH & Co. KG	
	Standard Calibration		2015/06/30	2018/06/29

Single Devices for Auxiliary Equipment for Radiated emissions (continued)

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Loop Antenna	HFH2-Z2	829324/006	Rohde & Schwarz GmbH & Co. KG
	DKD Calibration		2014/11/27 2017/11/27
Standard Gain / Pyramidal Horn Antenna 26.5 GHz	3160-09	00083069	EMCO Elektronik GmbH
Standard Gain / 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*
AC Power Source	Chroma 6404	64040001304	Chroma ATE INC.
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* *Next Execution*
	Customized calibration		2013/12/04 2015/12/03
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* *Next Execution*
	Standard		2014/02/10 2016/02/09
Spectrum Analyser	FSP3	836722/011	Rohde & Schwarz GmbH & Co. KG
	Standard		2012/06/13 2015/06/12
	DKD calibration		2015/06/23 2018/06/22
Spectrum Analyser	FSU26	200418	Rohde & Schwarz GmbH & Co.KG
	Standard calibration		2014/07/29 2015/07/28
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	
	Standart calibration		2015/01/21	2018/01/19
CMW500	CMW500	107500	Rohde & Schwarz GmbH & Co.KG	
	Standard calibration		2014/01/27	2016/01/26
Digital Radio Communication Tester	CMD 55	831050/020	Rohde & Schwarz GmbH & Co. KG	
	DKD calibration		2014/12/02	2017/12/01
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	
	DKD calibration		2014/12/03	2017/12/02
	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*	
EMI Receiver / Spectrum Analyser	ESR 7	101424	Rohde & Schwarz	
	Calibration Details		*Last Execution*	*Next Execution*
	Initial Factory Calibration		2014/11/13	2016/11/12
Personal Computer	Dell	30304832059	Dell	
Power Meter	NRVD	828110/016	Rohde & Schwarz GmbH & Co.KG	
	Standard calibration		2015/05/11	2016/05/10
Power Sensor	NRV-Z1	836219/005	Rohde & Schwarz GmbH & Co. KG	
Powermeter	NRVS	836333/064	Rohde & Schwarz GmbH & Co. KG	
Sensor Head A	NRV-Z1	827753/005	Rohde & Schwarz GmbH & Co.KG	
	Standard calibration		2015/05/11	2016/05/10
Signal Generator	SMR 20	846834/008	Rohde & Schwarz GmbH & Co. KG	
	Standard Calibration		2014/06/24	2017/06/23
Spectrum Analyser	FSW 43	103779	Rohde & Schwarz	
	Calibration Details		*Last Execution*	*Next Execution*
	Initial Factory Calibration		2014/11/17	2016/11/16
Spectrum Analyzer	ESIB 26	830482/004	Rohde & Schwarz GmbH & Co. KG	
	Standard Calibration		2014/01/07	2016/01/31
	HW/SW Status		*Date of Start*	*Date of End*
	Firmware-Update 4.34.4 from 3.45 during calibration		2009/12/03	

Test Equipment Multimeter 03

Lab ID:	**Lab 3, Lab 4**
Description:	Fluke 177
Serial Number:	86670383

Single Devices for Multimeter 03

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Digital Multimeter 03 (Multimeter)	Fluke 177	86670383	Fluke Europe B.V.	
	Calibration Details		*Last Execution*	*Next Execution*
	Customized calibration		2013/12/04	2015/12/03

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		2015/05/11	2016/05/10
Power Sensor	NRV-Z1	836219/005	Rohde & Schwarz GmbH & Co. KG	
Powermeter	NRVS	836333/064	Rohde & Schwarz GmbH & Co. KG	
RF Step Attenuator RSP	RSP	833695/001	Rohde & Schwarz GmbH & Co.KG	
Rubidium Frequency Standard	Datum, Model: MFS	5489/001	Datum-Beverly	
	Standard calibration		2014/07/03	2015/07/02
	Standard Calibration		2015/06/25	2016/06/24
Sensor Head A	NRV-Z1	827753/005	Rohde & Schwarz GmbH & Co.KG	
	Standard calibration		2015/05/11	2016/05/10
Signal Generator SME	SME03	827460/016	Rohde & Schwarz GmbH & Co.KG	
	Standard calibration		2014/12/02	2017/12/01
Signal Generator SMP	SMP02	836402/008	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Execution*
	Standard calibration		2013/05/06	2016/05/05
Spectrum Analyser	FSIQ26	840061/005	Rohde & Schwarz GmbH & Co. KG	
	Calibration after reparation		2015/04/02	2017/04/01
Vector Signal Generator	SMIQ 03B	837747/020	Rohde & Schwarz GmbH & Co. KG	

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	
	Customized calibration		2015/02/27	2017/02/26

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	
	Customized calibration		2015/02/27	2017/02/26

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	
	Customized calibration		2015/02/27	2017/02/26

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	
	Customized calibration		2015/03/10	2017/03/09

Test Equipment Temperature Chamber 05

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

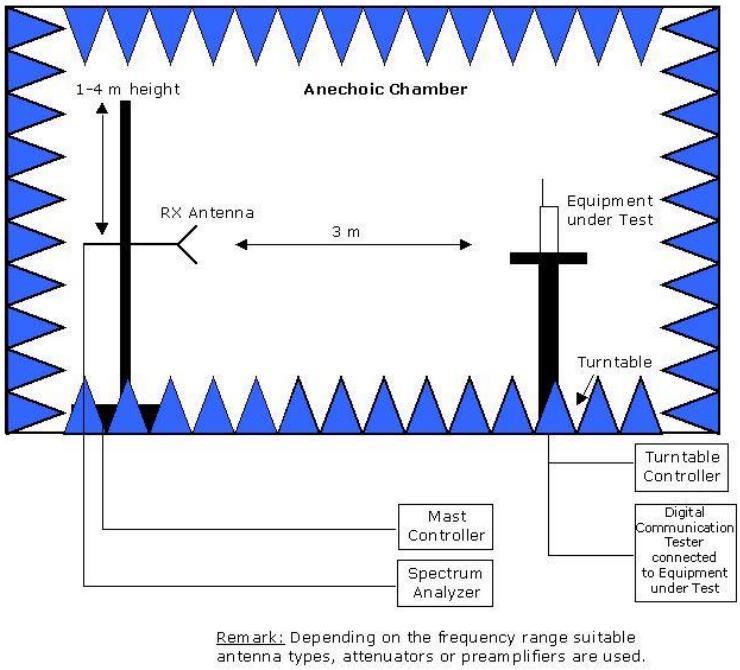
Single Devices for Temperature Chamber 05

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Temperature Chamber Vötsch 05	VT 4002	58566080550010	Vötsch	
	Customized calibration		2014/03/11	2016/03/10

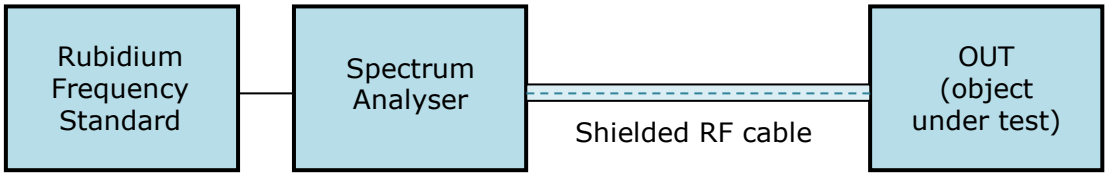
6 Photo Report

Please refer to external report.

7 Setup Drawings



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



Drawing 2: Setup for conducted radio tests.