InterLab®

FCC Measurement/Technical Report on

Wireless HD-Video-Transceiver (5 GHz) Q1025-X-xx

FCC ID: 2ABQT-Q1025

Report Reference: MDE_SRI_1201_FCCd_rev3

Test Laboratory:
7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany

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

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0 Applied Standards and Test Summary

0.1 Applied Standards

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 (10-1-14 Edition) and 15 (10-1-14 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

Part 15, Subpart E – Unlicensed National Information Infrastructure Devices

§ 15.403 Definitions

§ 15.407 General technical requirements

Note:
The tests were selected and performed with reference to the FCC Public Notice "Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, 789033 D02 General U-NII Test Procedures v01, 2014-06-06".

ANSI C63.10-2013 is applied.

FCC ET Docket No. 13-49, FIRST REPORT AND ORDER, April 1, 2014 ("new rules") is applied.

Summary Test Results:

The EUT complied with all performed tests as listed in chapter 0.2 Measurement Summary / Signatures.

0.2 Measurement Summary / Signatures

FCC Part 15, Subpart C		**§ 15.207**	
Conducted emissions (AC power line)			
The measurement was performed according to ANSI C63.10			
OP-Mode	**Setup**	**Port**	**Final Result**
CH 48, 20 MHz	Setup_05	AC Port (power line)	passed [1)]

FCC Part 15, Subpart E		**§ 15.403 (i), 15.407 (e)**	
26 / 6 dB Emission bandwidth			
The measurement was performed according to FCC § 15.31			
OP-Mode	**Setup**	**Port**	**Final Result**
CH 36, 20 MHz	Setup_03/04	Temp.ant.connector	passed
CH 44, 20 MHz	Setup_03/04	Temp.ant.connector	passed
CH 48, 20 MHz	Setup_03/04	Temp.ant.connector	passed
CH 149, 20 MHz	Setup_03/04	Temp.ant.connector	passed
CH 157, 20 MHz	Setup_03/04	Temp.ant.connector	passed
CH 165, 20 MHz	Setup_03/04	Temp.ant.connector	passed
CH 38, 40 MHz	Setup_03/04	Temp.ant.connector	passed
CH 46, 40 MHz	Setup_03/04	Temp.ant.connector	passed
CH 151, 40 MHz	Setup_03/04	Temp.ant.connector	passed
CH 159, 40 MHz	Setup_03/04	Temp.ant.connector	passed

FCC Part 15, Subpart E		**§ 15.407 (a)(1,2,3,4)**	
Maximum Conducted Output Power			
The measurement was performed according to FCC § 15.31			**Final Result**
OP-Mode	**Setup**	**Port**	**FCC**
CH 36, 20 MHz	Setup_03	Temp.ant.connector	passed
CH 44, 20 MHz	Setup_03	Temp.ant.connector	passed
CH 48, 20 MHz	Setup_03	Temp.ant.connector	passed
CH 149, 20 MHz	Setup_03	Temp.ant.connector	passed
CH 157, 20 MHz	Setup_03	Temp.ant.connector	passed
CH 165, 20 MHz	Setup_03	Temp.ant.connector	passed
CH 38, 40 MHz	Setup_03	Temp.ant.connector	passed
CH 46, 40 MHz	Setup_03	Temp.ant.connector	passed
CH 151, 40 MHz	Setup_03	Temp.ant.connector	passed
CH 159, 40 MHz	Setup_03	Temp.ant.connector	passed

FCC Part 15, Subpart E		§ 15.407 (a)(1,2,3,5)	
Maximum Power Spectral Density			
The measurement was performed according to FCC § 15.31			**Final Result**
OP-Mode	**Setup**	**Port**	**FCC**
CH 36, 20 MHz	Setup_03	Temp.ant.connector	passed
CH 44, 20 MHz	Setup_03	Temp.ant.connector	passed
CH 48, 20 MHz	Setup_03	Temp.ant.connector	passed
CH 149, 20 MHz	Setup_03	Temp.ant.connector	passed
CH 157, 20 MHz	Setup_03	Temp.ant.connector	passed
CH 165, 20 MHz	Setup_03	Temp.ant.connector	passed
CH 38, 40 MHz	Setup_03	Temp.ant.connector	passed
CH 46, 40 MHz	Setup_03	Temp.ant.connector	passed
CH 151, 40 MHz	Setup_03	Temp.ant.connector	passed
CH 159, 40 MHz	Setup_03	Temp.ant.connector	passed

FCC Part 15, Subpart E		§ 15.407 (g)	
Frequency Stability			
The measurement was performed according to FCC § 15.31			
OP-Mode	**Setup**	**Port**	**Final Result**
–	–	Temp.ant.connector	N/P

FCC Part 15, Subpart C & E		§ 15.205, § 15.209 § 15.407 (b)(1,2,3,4,5,6)	
Undesirable Emissions, General Field Strength Limits; Restricted Bands and Radiated Emission Limits The measurement was performed according to ANSI C63.10			**Final Result**
OP-Mode	**Setup**	**Port**	**FCC**
CH 36, 20 MHz	Setup_02/03	Enclosure	passed
CH 44, 20 MHz	Setup_03	Enclosure	passed
CH 48, 20 MHz	Setup_01	Enclosure	passed
CH 149, 20 MHz	Setup_05	Enclosure	passed
CH 157, 20 MHz	Setup_05	Enclosure	passed
CH 165, 20 MHz	Setup_05	Enclosure	passed
CH 38, 40 MHz	Setup_05	Enclosure	passed 2)
CH 159, 40 MHz	Setup_05	Enclosure	passed 2)

FCC Part 15, Subpart E		§ 15.407 (h)	
Dynamic Frequency selection The measurement was performed according to FCC § 15.31			**Final Result**
OP-Mode	**Setup**	**Port**	**FCC**
–	–	–	N/P

N/A Not applicable
N/P Not performed
1) the EUT itself is powered by DC
2) tested at band edges only

Revision History

Report version control			
Version	**Release date**	**Change Description**	**Version validity**
initial	2016-01-08	–	invalid
rev1	2016-01-11	Test results of sub-bands 2A and 2C removed, worst-case results adapted accordingly	invalid
rev3	2016-03-17	Changes of rev1 after TCB's review: limits of "old rules" removed from sub-clauses 3.3.2; limits changed in tables at 3.3.3 and 3.4.3; plots added at 3.2.4, 3.4.4 and 3.6.4	valid

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

Responsible for Accreditation Scope: _____ Responsible for Test Report: _____

1 Administrative Data

1.1 Testing Laboratory

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

This facility has been fully described in a report submitted to the 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:	2016-01-06

1.2 Project Data

Responsible for testing and report:	Dipl.-Ing. Andreas Petz
Employees who performed the tests:	documented internally at 7Layers
Date of Test(s):	2012-10-24 to 2015-08-12
Date of Report:	2016-03-17

1.3 Applicant Data

Company Name:	TQ-Systems GmbH
Address:	Gut Delling Mühlstrasse 2 82229 Seefeld Germany
Contact Person:	Mr. Bernd Wein

1.4 Manufacturer Data

Company Name:	TQ-Systems Durach GmbH
Address:	Johann-Georg-Halske-Strasse 1 87471 Durach Germany
Contact Person:	Mr. Bernd Wein

2 Test object Data

2.1 General EUT Description

Equipment under Test:	Wireless HD-Video-Transceiver (5 GHz)
Type Designation:	Q1025-X-xx
Kind of Device:	Module supporting this technology:
(optional)	5 GHz high performance RLAN equipment that is intended to operate in the frequency ranges 5150 MHz to 5250 MHz and 5725 MHz to 5850 MHz
Voltage Type:	DC
Voltage Level:	5.0 V, besides EUT E + AUX_E: 12.0 V
Tested Modulation Type:	OFDM: 16-QAM

General product description:

The Transceiver is operating in the 5 GHz band using Orthogonal Frequency Division Multiplexing (OFDM).

Specific product description for the EUT:

The EUT is a module which enables video transmission in the 5 GHz bands as part of a video system. It is using bi-directional communication with a proprietary modulation scheme and supports 20 MHz and 40 MHz bandwidth channels.
The transceiver is operating in the 5 GHz band in the ranges 5.15 – 5.25 GHz and 5.725 – 5.850 GHz.
The EUT is part of a video transfer system which uses a “logical transmitter” and a “logical receiver”. Both devices are RF transceivers.
In transmit direction for the video signal, 4 TX transmit chains are operating with symmetrical power distribution (MIMO), while the receiver operates with 1 RX receive chain in order to receive control commands.
In receive direction for the video signal, 4 RX receive chains are operating in MIMO mode while the transmitter operates with 1 TX transmit chain in order to send control commands.
The object of this test report is the “logical video receiver”, it was tested at 20 and 40 MHz channel bandwidth. For the tests a synthetic signal (OFDM) is provided as test mode, 1 transmit chain is always active and the duty cycle (linear) is 0.96 at 20 MHz bandwidth and 1.0 at 40 MHz (in this test mode).

The EUT provides the following ports:

Ports
Enclosure
Data / DC port (system connector to ANC1)
5 GHz Antennas (5x UFL connector)
DC power (at ANC1)

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: V5010a01)	Wireless HD-Video-Transceiver	Q1025-X-xx	Q1025-M-D2/ SRI/ CO222218	M-D2	1.1
EUT B (Code: V5010d01)	Wireless HD-Video-Transceiver	Q1025-X-xx	Q1025-M-D2/ SRI/ CO222216	M-D2	1.1
EUT C (Code: V5010w03)	Wireless HD-Video-Transceiver	Q1025-X-xx	Q1025-M-6/ SRI132228 1886	M-6	1.1
EUT D (Code: V5010e04)	Wireless HD-Video-Transceiver	Q1025-X-xx	Q1025-M-5/ SRI132228 1769	M-6	1.1
EUT E (Code: V5010g05)	Wireless HD-Video-Transceiver	Q1025-X-xx	SRI141921 7936	Q1025-X100-2	3.x.28.1
Remark: The EUTs are equipped with integral antennas (1x TX, 4x RX, each gain = 2.0 dBi, type: inverted-F) and each has a test antenna connector (the antenna is then deactivated when connected) to perform conducted tests.					

NOTE: The short description is 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
–	–	–	–	–	–

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
AUX_A	Baseboard	RX BaseBoard SDI (Q1034-M-6)	–	–	–
AUX_B	Baseboard	RX BaseBoard SDI (Q1034-M-6)	SRI1322281809	–	–
AUX_C	Baseboard	RX BaseBoard SDI (Q1034-M-6)	SRI1322281809	–	–
AUX_D	Baseboard	RX BaseBoard SDI (Q1034-M-6)	–	–	–
AUX_E	Baseboard	RX_MOD_HDMI_V2 (Q1042-M-2)	SRI1423229930	–	–
AUX_F	Controllerboard	Interfaceboard AMIMON Q1036-M-1	–	Rev 1.0	–
AUX_G	AC/DC Adapter	Fujitsu HP-OL093E03P	F3-080701850701	–	–

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 + AUX_A + AUX_F	setup for radiated measurements
Setup_02	EUT B + AUX_B + AUX_F	setup for radiated measurements
Setup_03	EUT C + AUX_C + AUX_F	setup for conducted radio and radiated measurements
Setup_04	EUT D + AUX_D + AUX_F	setup for conducted radio measurements
Setup_05	EUT E + AUX_E + AUX_F + AUX_G	setup for radiated measurements / 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

UNII-Subband 1 5150 - 5250 MHz			UNII-Subband 2A 5250 - 5350 MHz			UNII-Subband 2C 5470 - 5725 MHz			UNII-Subband 3 5725 - 5850 MHz			Nom. BW
Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	20 MHz
36	44	48	52	56	64	100	116	140	149	157	165	Ch.-No.
5180	5220	5240	5260	5280	5320	5500	5580	5700	5745	5785	5825	MHz

Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	40 MHz
38	-	46	54	-	62	102	110	134	151	-	159	Ch.-No.
5190	-	5230	5270	-	5310	5510	5550	5670	5755	-	5795	MHz

Note: No channel of sub-bands 2A and 2C are tested.

2.6.2 Datarates

variable, not specified (the OUT is a video modem and the data rate depends on the video signal)

2.7 Special software used for testing

A tool which is called “AppCom” (version 3.03.16 and 4.4.0.7) is used to set the EUT into the desired test modes. From the software, PRBS script files provided by the applicant, are used to control directly the EUT via a RS-232 port fastened at ANC1.
A software tool “Debug View” is used to check the correct execution of the commands (at the software layer).

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 & E

The test was performed according to: ANSI C63.10

3.1.1 Test Description

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 E, §15407 (b)(6) and 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).

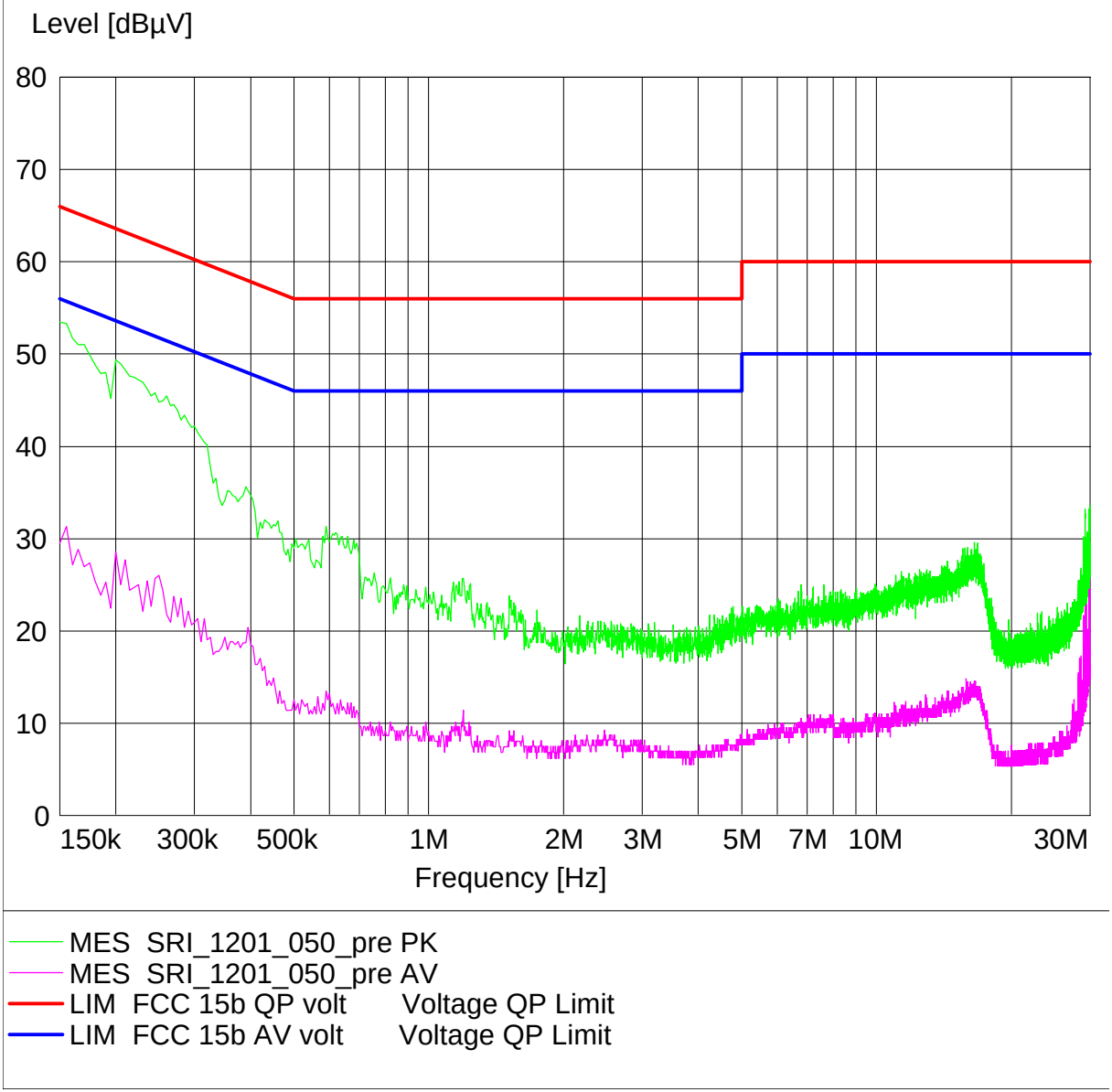
3.1.3 Test Protocol

Temperature: 27 °C
Air Pressure: 996 hPa
Humidity: 41 %

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.
Please see next sub-clause for the measurement plot. The chosen operating mode is selected as representative mode to generate “worst-case” conditions, i.e. high power consumption.
The EUT is operated at 12 V DC while supplied by AUX_G which is connected to AC Mains at 120 V / 60 Hz.

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



tested setup: Setup_05, nominal output power set to: 11 dBm

3.2 26 / 6 dB Emission bandwidth

Standard FCC Part 15, Subpart E

The test was performed according to: FCC §15.31

3.2.1 Test Description

The Equipment Under Test (EUT) was setup in a shielded room to perform the occupied bandwidth measurements.
The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical.
The results recorded were measured with the modulation which produce the worst-case (widest) emission bandwidth (26 / 6 dB).

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

Analyzer settings:
1) 26 bandwidth, sub-bands 1, 2A and 2C:
- Resolution Bandwidth (RBW): initially approx. 1 % of nominal emission bandwidth
- Video Bandwidth (VBW): > RBW
- re-adjust RBW close to 1 % of measured bandwidth and repeat the measurement
2) 6 dB bandwidth, sub-band 3:
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): ≥ 3 times the RBW
1+2) 26 / 6 dB bandwidth:
- Detector: Peak
- Trace: Maxhold
- Sweeps: ≥ 200
- Sweeptime: at least coupled

3.2.2 Test Requirements / Limits

FCC Part 15, Subpart E, §15.403 (i)
There exist no applicable limits for the U-NII subbands 1, 2A and 2C. The test was performed to determine the limits for the “Maximum Conducted Output Power” test case. Therefore no result was applied.

FCC Part 15, Subpart E, §15.407 (e)
Within the 5.725-5.850 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

3.2.3 Test Protocol

Temperature: 22–25 °C
Air Pressure: 997–1026 hPa
Humidity: 34–47 %

1) 26 dB bandwidth

HD-video mode 20 MHz			26 dB Bandwidth			
UNII-Sub-band	Channel No.	Frequency [MHz]	TX1 [MHz]	TX2 [MHz]	TX3 [MHz]	TX4 [MHz]
1	36	5180	19.551			
	44	5220	19.423			
	48	5240	19.359			
3	149	5745	19.615			
	157	5785	19.423			
	165	5825	19.551			

HD-video mode 40 MHz						
1	38	5190	37.948			
	46	5230	38.077			
3	151	5755	38.333			
	159	5795	38.333			

Maximum [MHz]:	**20 MHz:**	**19.615**	**40 MHz:**	**38.333**
Minimum [MHz]:		**19.359**		**37.821**

tested setup: Setup_03, nominal output power set to: 17 dBm

2) 6 dB bandwidth (UNII-band 3 only)

HD-video mode 20 MHz			6 dB Bandwidth			
UNII-Sub-band	Channel No.	Frequency [MHz]	TX1 [MHz]	TX2 [MHz]	TX3 [MHz]	TX4 [MHz]
3	149	5745	15.456			
	157	5785	15.500			
	165	5825	15.499			

HD-video mode 40 MHz						
3	151	5755	31.050			
	159	5795	31.050			

Maximum [MHz]:	**20 MHz:**	**15.500**	**40 MHz:**	**31.050**
Minimum [MHz]:		**15.456**		**31.050**

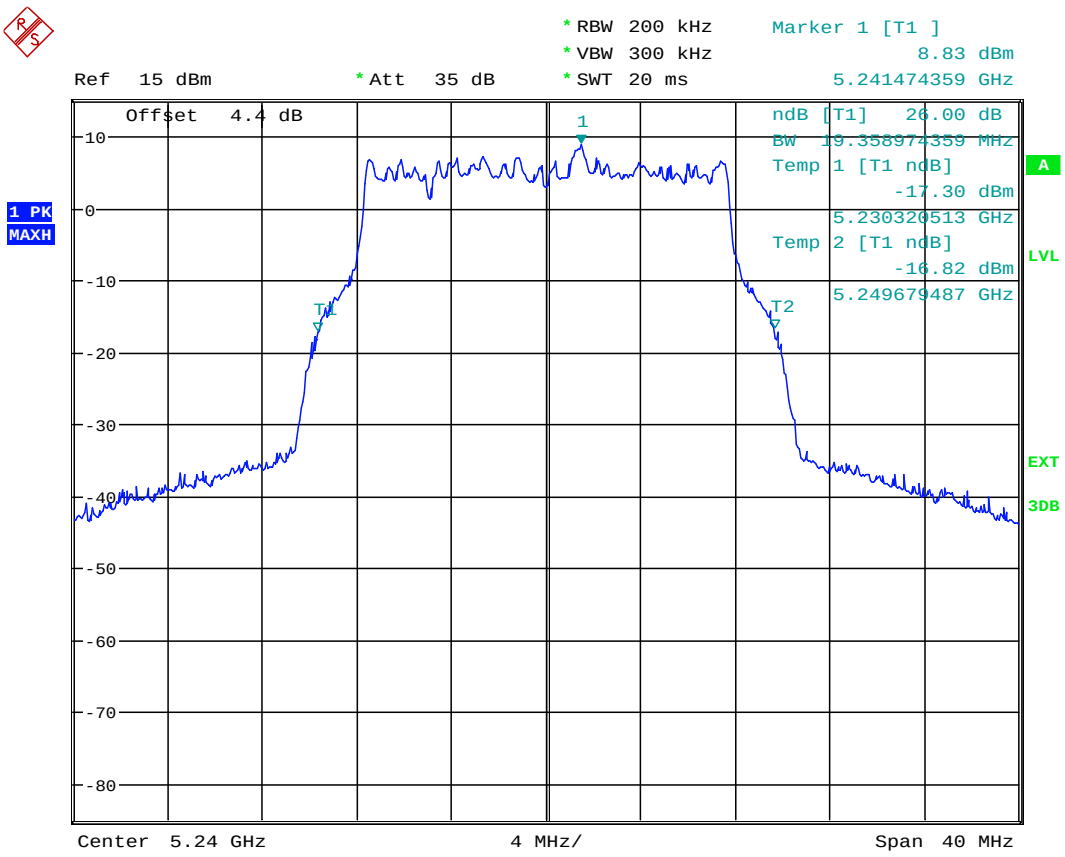
tested setup: Setup_04, nominal output power set to: 17 dBm

3) 99% bandwidth

(not tested)

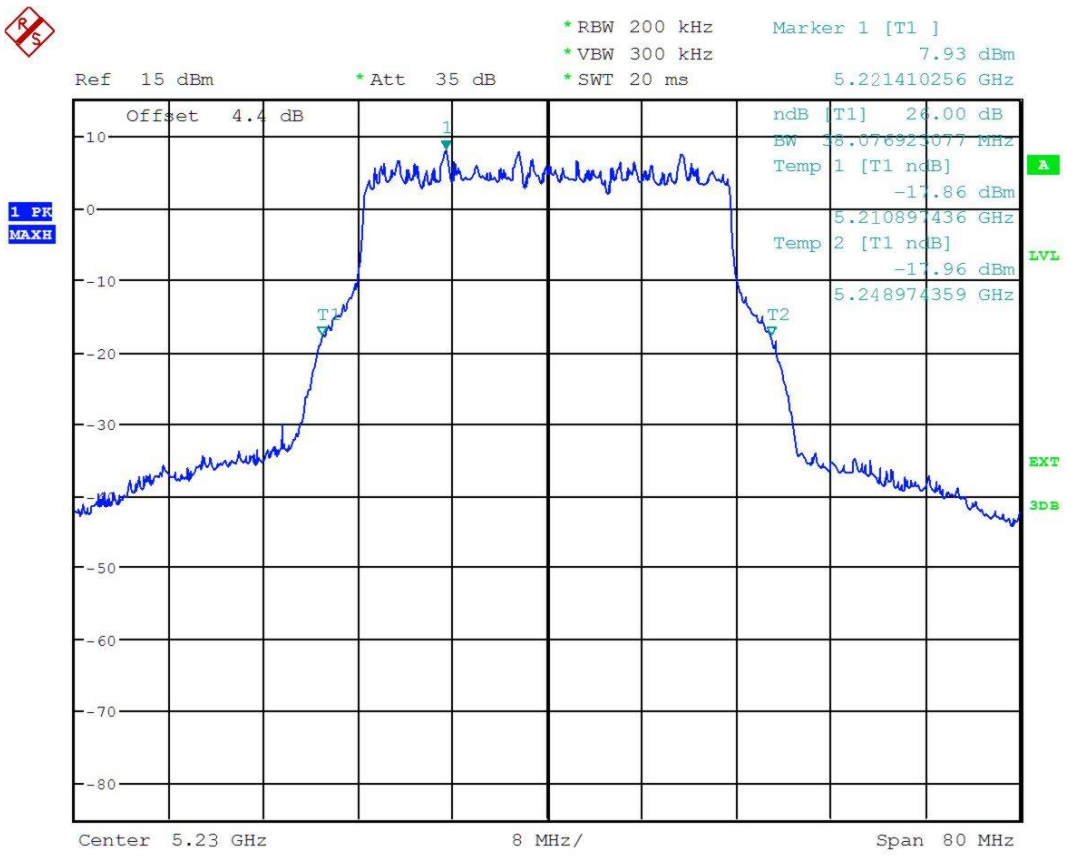
3.2.4 Measurement Plots (showing “worst case” value)

1) 26 dB bandwidth (showing the lowest value, “worst case” in respect to output power)



Date: 2.JAN.2014 10:21:57

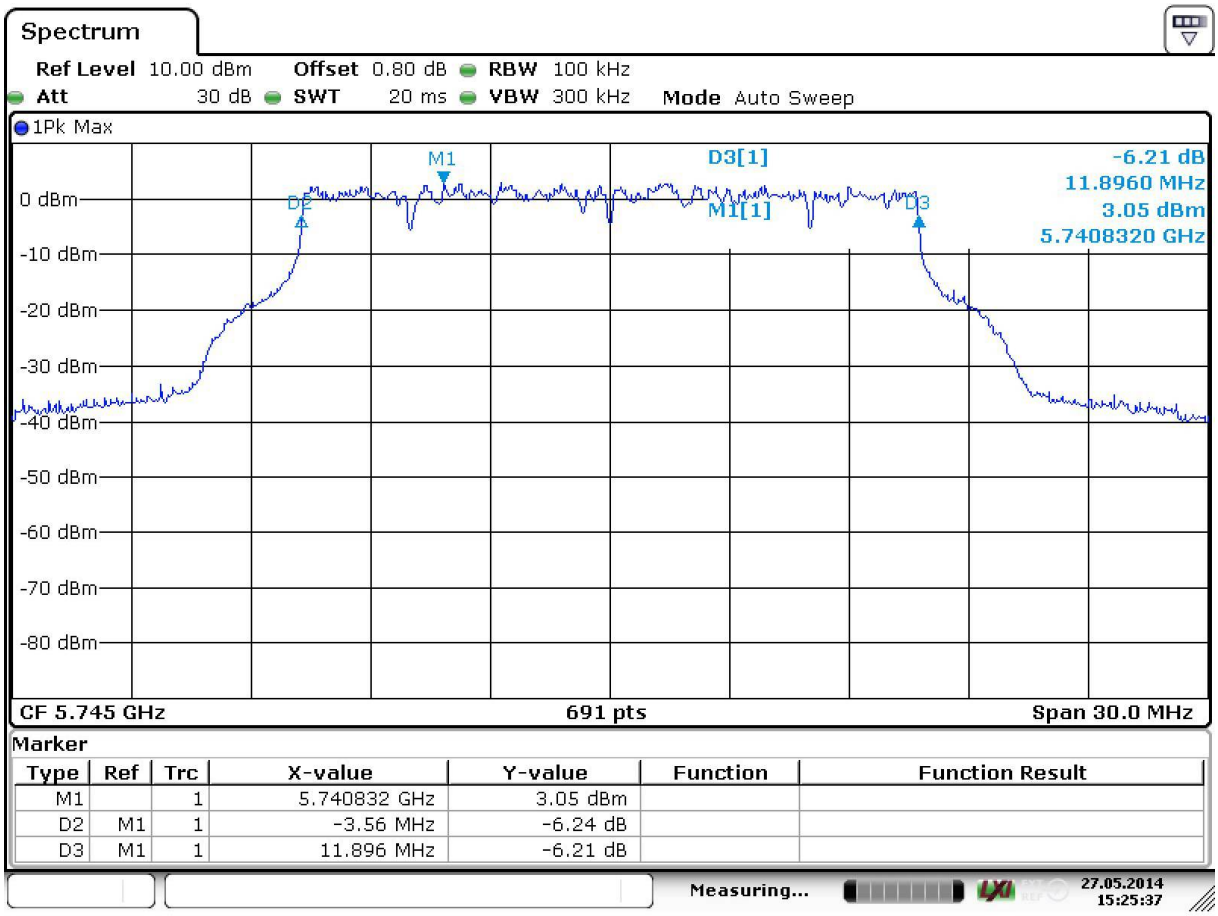
5240 MHz, 20 MHz



Date: 2.JAN.2014 11:16:29

5230 MHz, 40 MHz

2) 6 dB bandwidth (showing the lowest value, “worst case” in respect to the limit)



Date: 27.MAY.2014 15:25:37

5745 MHz, 20 MHz

3.3 Maximum conducted output power

Standard FCC Part 15, Subpart E

The test was performed according to: FCC §15.31

3.3.1 Test Description

The Equipment Under Test (EUT) was set up in a shielded room to perform the output power measurements. The results recorded were measured with the modulation which produces the worst-case (highest) output power. The EUT was connected to spectrum analyser via a short coax cable with a known loss.

Analyser settings:
- Resolution Bandwidth (RBW): 1 MHz
- Video Bandwidth (VBW): 3 MHz
- Detector: RMS
- Trace: Average, RMS power averaging mode
- Sweeps: 100
- Sweeptime: coupled
- Trigger: gated mode

Note:
The analyser settings are according FCC Public Note “Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, 789033 D02”, method **SA-1**.

3.3.2 Test Requirements / Limits

For systems using digital modulation techniques in the 5.15 – 5.25 GHz bands:
FCC ET Docket No. 13-49, FIRST REPORT AND ORDER, April 1, 2014 (“new rules”):
§15.407 (a) (1) (i): Outdoor access point:
Limit: 1 W (30 dBm) provided the maximum antenna gain does not exceed 6 dBi.
The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).
§15.407 (a) (1) (ii): Indoor access point:
Limit: 1 W (30 dBm) provided the maximum antenna gain does not exceed 6 dBi.
§15.407 (a) (1) (iv): Mobile and portable client devices:
Limit: 250 mW (24 dBm) provided the maximum antenna gain does not exceed 6 dBi.

For systems using digital modulation techniques in the 5.25 – 5.35 GHz and 5.47 – 5.725 GHz bands:
§15.407 (a) (2)
Limit: 250 mW (24 dBm) or 11 dBm + 10 log (26 dB bandwidth/MHz) whatever is the lesser.

For systems using digital modulation techniques in the 5.725 – 5.850 GHz bands:
FCC ET Docket No. 13-49, FIRST REPORT AND ORDER, April 1, 2014 (“new rules”):
§15.407 (a) (3):
Limit: 1 W (30 dBm).

§15.407 (a) (4):
The maximum conducted output power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage.

3.3.3 Test Protocol

Temperature: 20–25 °C
Air Pressure: 994–1031 hPa
Humidity: 35–48 %

HD-video mode 20 MHz					
UNII-Sub-band	Channel No.	Frequency [MHz]	Output Power [dBm]	Limit [dBm]	Margin to Limit [dB]
1	36	5180	13.7	24.0	10.3
	44	5220	14.0	24.0	10.0
	48	5240	13.7	24.0	10.3
3	149	5745	12.7	24.0	11.3
	157	5785	12.7	24.0	11.3
	165	5825	12.2	24.0	11.8

HD-video mode 40 MHz					
1	38	5190	15.7	24.0	8.3
	46	5230	15.5	24.0	8.5
3	151	5755	14.3	24.0	9.7
	159	5795	14.2	24.0	9.8

Maximum [dBm]: 20 MHz: 14.0 40 MHz: 15.7

tested setup: Setup_03, nominal output power set to: 17 dBm

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

Date: 3.JAN.2014 08:37:22

5190 MHz, 40 MHz (the value of the plot includes the antenna gain)

3.4 Maximum Power Spectral Density

Standard FCC Part 15, Subpart E

The test was performed according to: FCC §15.31

3.4.1 Test Description

The Equipment Under Test (EUT) was set up in a shielded room to perform the Maximum Power Spectral Density measurements.
The results recorded were measured with the modulation which produces the worst-case (highest) output power.

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

Analyser settings:
- Resolution Bandwidth (RBW): 1 MHz
- Video Bandwidth (VBW): 3 MHz
- Detector: RMS
- Trace: Average, RMS power averaging mode
- Sweeps: 100
- Sweeptime: coupled
- Marker: Peak
- Trigger: gated mode

Note:
The analyser settings are according FCC Public Note “Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E, 789033 D02”, method **SA-1.**

3.4.2 Test Requirements / Limits

FCC Part 15, Subpart E, §15.407 (a) (1)
For systems using digital modulation techniques in the 5.15 – 5.25 GHz bands:
(i) and (ii), outdoor and indoor access points: Limit: 17 dBm/MHz.
(iv), mobile and portable client devices: Limit: 11 dBm/MHz.

FCC Part 15, Subpart E, §15.407 (a) (2)
For systems using digital modulation techniques in the 5.25 – 5.35 GHz and 5.47 – 5.725 GHz bands:
Limit: 11 dBm/MHz.

FCC Part 15, Subpart E, §15.407 (a) (3)
For systems using digital modulation techniques in the 5.725 – 5.850 GHz bands:
Limit: 30 dBm/500 kHz.

Note by 7layers: The limit will be also fulfilled when measuring at any bandwidth greater than 500 kHz. This applies to signals where the maximum conducted output power was measured at a bandwidth exceeding 500 kHz and which fulfil that limit of 30 dBm.

3.4.3 Test Protocol

Temperature: 20–25 °C
Air Pressure: 994–1031 hPa
Humidity: 35–48 %

HD-video mode 20 MHz					
UNII-Sub-band	Channel No.	Frequency [MHz]	Power Density [dBm/MHz]	Limit [dBm]	Margin to Limit [dB]
1	36	5180	4.3	11.0	6.7
	44	5220	3.8	11.0	7.2
	48	5240	3.6	11.0	7.4
3	149	5745	2.4	30.0	27.6
	157	5785	2.3	30.0	27.7
	165	5825	1.9	30.0	28.1

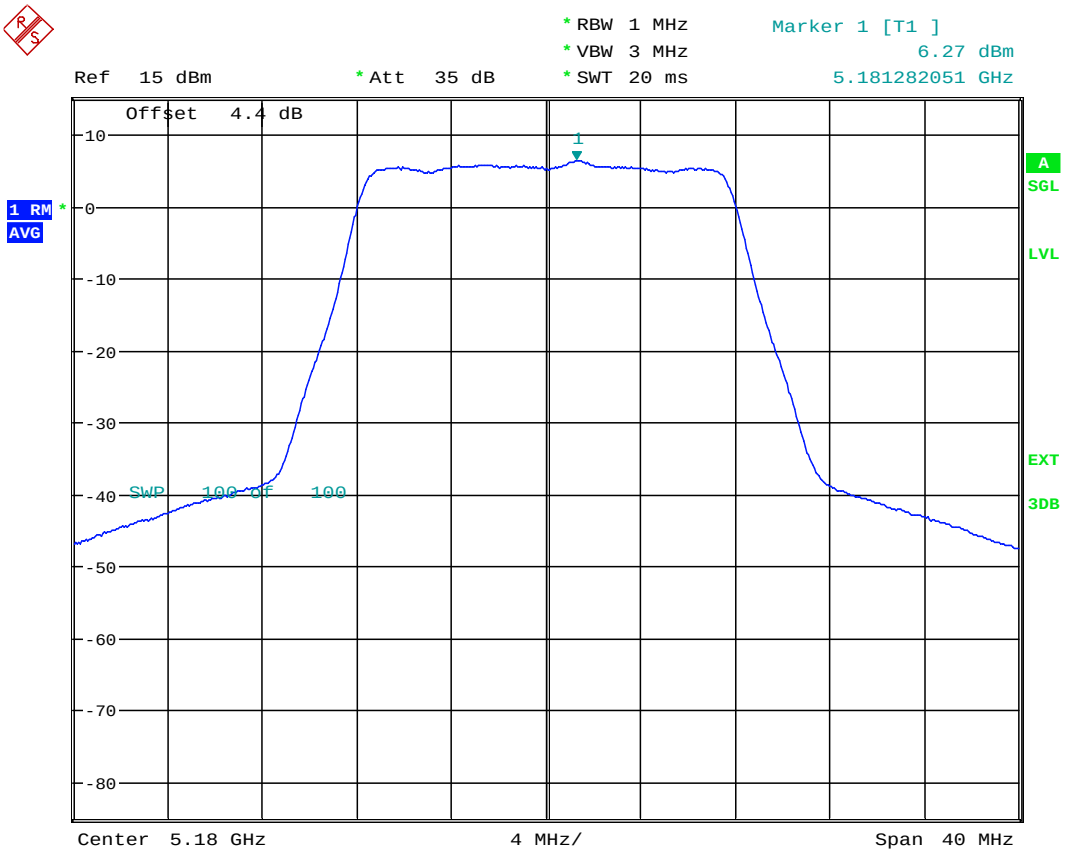
HD-video mode 40 MHz					
1	38	5190	2.5	11.0	8.5
	46	5230	2.3	11.0	8.7
3	151	5755	1.1	30.0	28.9
	159	5795	0.7	30.0	29.3

Maximum [dBm]: 20 MHz: 4.3 40 MHz: 2.5

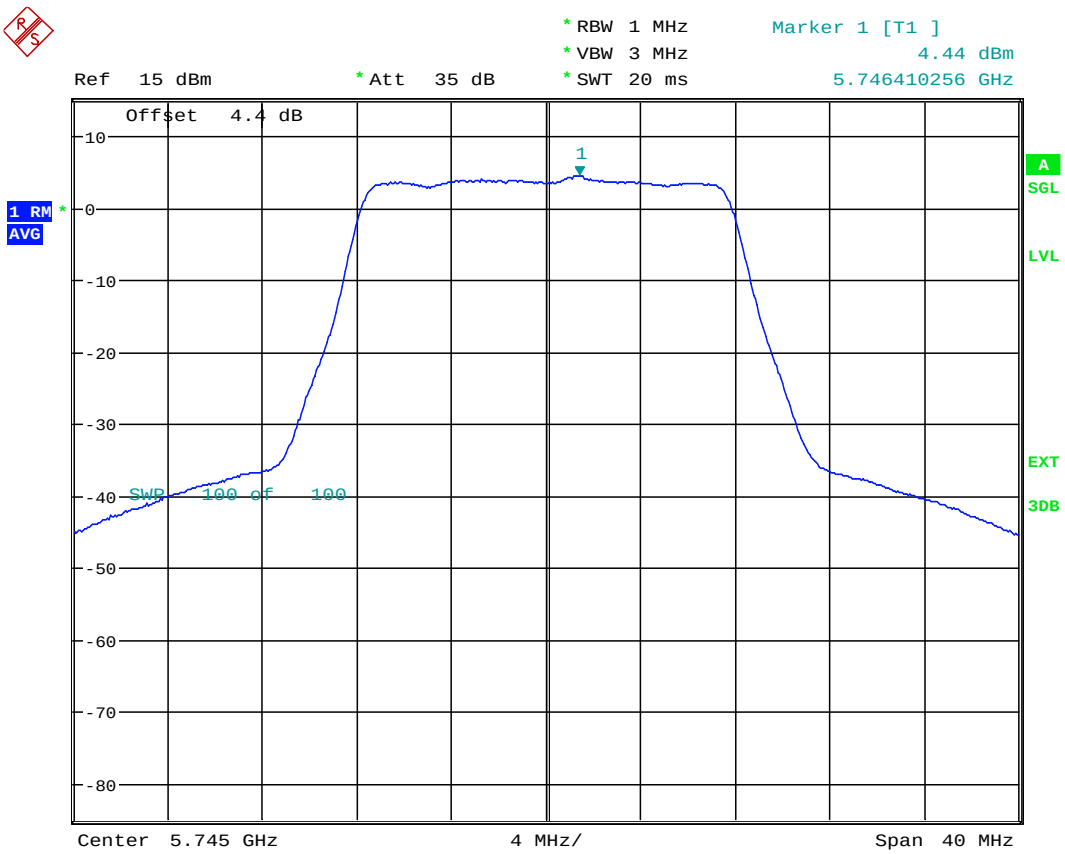
tested setup: Setup_03, nominal output power set to: 17 dBm

Note: MPSD for sub-band 3 is measured at 1 MHz bandwidth.

3.4.4 Measurement Plots (showing the highest value, “worst case”)



5180 MHz, 20 MHz (the value of the plot includes the antenna gain)



Date: 2.JAN.2014 13:58:06

5745 MHz, 20 MHz (the value of the plot includes the antenna gain)

3.5 Frequency Stability

Standard FCC Part 15, Subpart E

3.5.1 Test Description

The Equipment Under Test (EUT) was set up in an temperature chamber to perform the frequency stability test.
The results recorded, were measured while the EUT is transmitting a CW signal on the required frequency.

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

Analyser settings:
- Frequency Counter activated, Resolution 1 Hz

3.5.2 Test Requirements / Limits

FCC Part 15, Subpart E, § 15.407 (g)
Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the users manual.

3.5.3 Test Protocol

Test was not performed.

3.6 Undesirable Emissions / General Field Strength Limits; Restricted Band and Radiated Emission Limits, Band Edge

Standard FCC Part 15, Subpart C & E

The test was performed according to: ANSI C63.10

3.6.1 Test Description

The radiated emissions measurements were made in a typical installation configuration. The measurement procedure is implemented into the EMI test software ES-K1 from R&S.

1. Measurement up to 30 MHz
The Equipment Under Test (EUT) was set up on a non-conductive table in the anechoic chamber.
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 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: 200 Hz - 10 kHz
- Measuring time / Frequency step: 100 ms

2. Measurement above 30 MHz and up to 1 GHz
Step 1: Preliminary scan
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 be slowly varied 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 is also slowly varied 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° to +22.5° around the determined value
- Height variation range: –0.25 m to +0.25 m 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
- 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.

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 15 GHz) and a horn antenna (15-26 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 15 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.

In the frequency range 26 – 40 GHz the measurement was performed conducted.

3.6.2 Test Requirements / Limits

FCC Part 15 Subpart E , §15.407 (b)(1)
For transmitters operating in the 5150–5250 MHz band:
Limit: –27 dBm/MHz EIRP outside of the band 5150–5350 MHz.

FCC Part 15 Subpart E , §15.407 (b)(2)
For transmitters operating in the 5250–5350 MHz band:
Limit: –27 dBm/MHz EIRP outside of the band 5150–5350 MHz.

FCC Part 15 Subpart E , §15.407 (b)(3)
For transmitters operating in the 5470–5725 MHz band:
Limit: –27 dBm/MHz EIRP outside of the band 5470–5725 MHz.

FCC Part 15 Subpart E , §15.407 (b)(4)
For transmitters operating in the 5725–5850 MHz band:
Limit: –27 dBm/MHz EIRP outside of the band 5715–5860 MHz and additionally
Limit: –17 dBm/MHz EIRP within the frequency ranges 5715–5725 and 5850–5860 MHz.

FCC Part 15 Subpart E , §15.405 and §15.407 (b)(6,7)
Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in § 15.209. The provisions of §§ 15.203 and 15.205 are included.

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

Frequency in MHz	Limit (µV/m)	Specified distance (m)	Measurement distance (m)	Calculated Limit (dBµV/m @10m)	Limit (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)
Limit (dBµV/m) = EIRP [dBm] – 20 log (d [m]) + 104.8
where d is the measurement distance

3.6.3 Test Protocol

Limit types:
RB – Emissions falls into a "Restricted Band" according FCC §§15.205 and 15.209 *)
UE – "Undesirable Emission Limit" according FCC §15.407
BE-RB – Band Edge Limit basing on "Restricted Band Limits"
BE-UE – Band Edge Limit basing on "Undesirable Emission Limit"
*) Below 1 GHz the limits of §15.209 are applied for all frequencies.

Temperature: 21–28 °C
Air Pressure: 994–1038 hPa
Humidity: 32–49 %

3.6.3.1 Radiated spurious and undesired emissions

HD-video mode 20 MHz									
Channel No.	Channel Frequency [MHz]	Spurious Frequency [MHz]	Spurious Level [dBµV/m]	Detector	RBW [kHz]	Limit [dBµV /m]	Margin to Limit [dB]	Limit Type	Tested sample
36	5180	46.0	28.7	QP	120	40.0	11.3	RB	w03
36	5180	113.0	36.9	QP	120	43.5	6.6	RB	w03
36	5180	240.0	36.1	QP	120	46.0	9.9	RB	w03
36	5180	360.0	33.6	QP	120	46.0	12.4	RB	w03
36	5180	400.0	44.9	QP	120	46.0	1.1	RB	w03
36	5180	431.9	42.9	QP	120	46.0	3.1	RB	w03
36	5180	575.9	29.1	QP	120	46.0	16.9	RB	w03
36	5180	719.9	26.2	QP	120	46.0	19.8	RB	w03
36	5180	863.8	36.6	QP	120	46.0	9.4	RB	w03
36	5180	21000.0	55.0	PEAK	1000	74.0	19.0	RB	w03
36	5180	21000.0	51.2	AV	1000	54.0	2.8	RB	w03
149	5745	31.7	28.3	QP	120	40.0	11.7	RB	g05
149	5745	55.0	24.0	QP	120	40.0	16.0	RB	g05
149	5745	116.7	27.8	QP	120	43.5	15.7	RB	g05
149	5745	160.0	28.5	QP	120	43.5	15.0	RB	g05
149	5745	17432.0	61.5	PEAK	1000	68.3	6.8	UE	g05
157	5785	31.2	30.1	QP	120	40.0	9.9	RB	g05
157	5785	53.3	25.2	QP	120	40.0	14.8	RB	g05
157	5785	123.4	29.9	QP	120	43.5	13.6	RB	g05
157	5785	160.0	28.1	QP	120	43.5	15.4	RB	g05
157	5785	22000.5	59.3	PEAK	1000	68.3	9.0	UE	g05
165	5825	31.7	29.8	QP	120	40.0	10.2	RB	g05
165	5825	55.4	25.8	QP	120	40.0	14.2	RB	g05
165	5825	125.7	28.3	QP	120	43.5	15.2	RB	g05
165	5825	160.0	28.6	QP	120	43.5	14.9	RB	g05
165	5825	17108.8	62.5	PEAK	1000	68.3	5.8	UE	g05

Setup_01/02, nominal output power set to: 15 dBm;
Setup_03, nominal output power set to: 14 dBm;
Setup_05, nominal output power set to: 11 dBm.

Note: No (further) spurious emissions in the range 20 dB below the limit found.
Spurious emissions in the range 20 dB below the limit need not to be reported.
The measurement was performed from 9 kHz to 30 MHz for Setup_03 on CH52 and 157, from 30 MHz to 1 GHz for Setup_03 on CH36 and 52, for Setup_05 on CH149, 157 and 165, from 26 to 40 GHz for Setup_03 on CH36 only because at pre-measurements no significant spurious emissions have been found.

3.6.3.2 Band Edge

HD-video mode 20 MHz									
Channel No.	Channel Frequency [MHz]	Bandedge Frequency [MHz]	Spurious Level [dBµV/m]	Detector	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]	Limit Type	Tested sample
149	5745	5725.0	62.2	PEAK	1000	78.3	16.1	BE-UE	g05

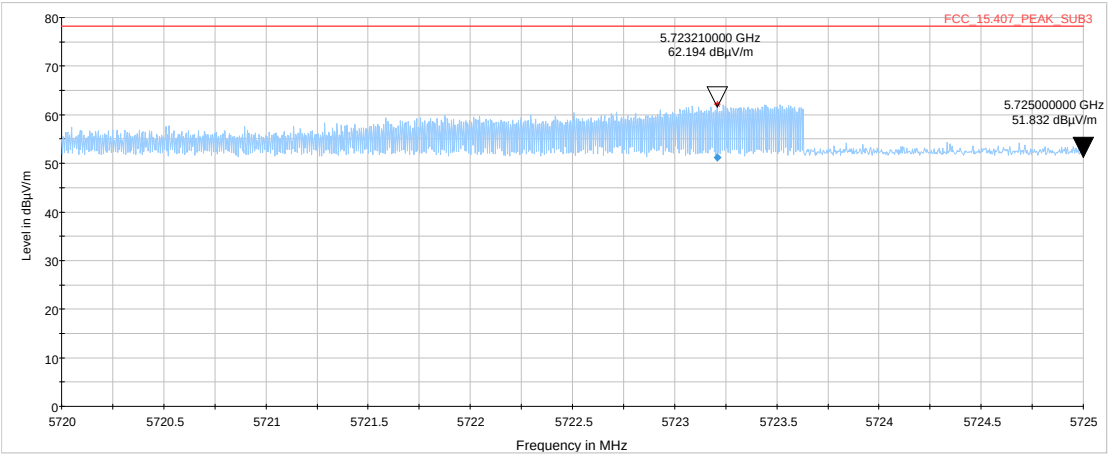
tested setups (20 MHz):
Setup_01, nominal output power set to: 15 dBm;
Setup_03, nominal output power set to: 14 dBm;
Setup_05, nominal output power set to: 11 dBm.

tested setups (40 MHz):
Setup_05, nominal output power set to: 11 dBm.

Note: Tests at the Band Edges are implicitly performed together with the undesired emission tests, which are performed as radiated test. The measurements are performed up to the band edges using the bandwidth specified for the undesired emissions.
If this test is passed, no additional test especially at the band edges will be performed, e.g. applying a reduced bandwidth or carrying out tests using the marker-delta method. Otherwise, the results will be reported in this sub-clause.
Band Edge tests are always performed and reported when the band directly adjacent to a Restricted Band.
Spurious emissions in the range 20 dB below the limit need not to be reported.

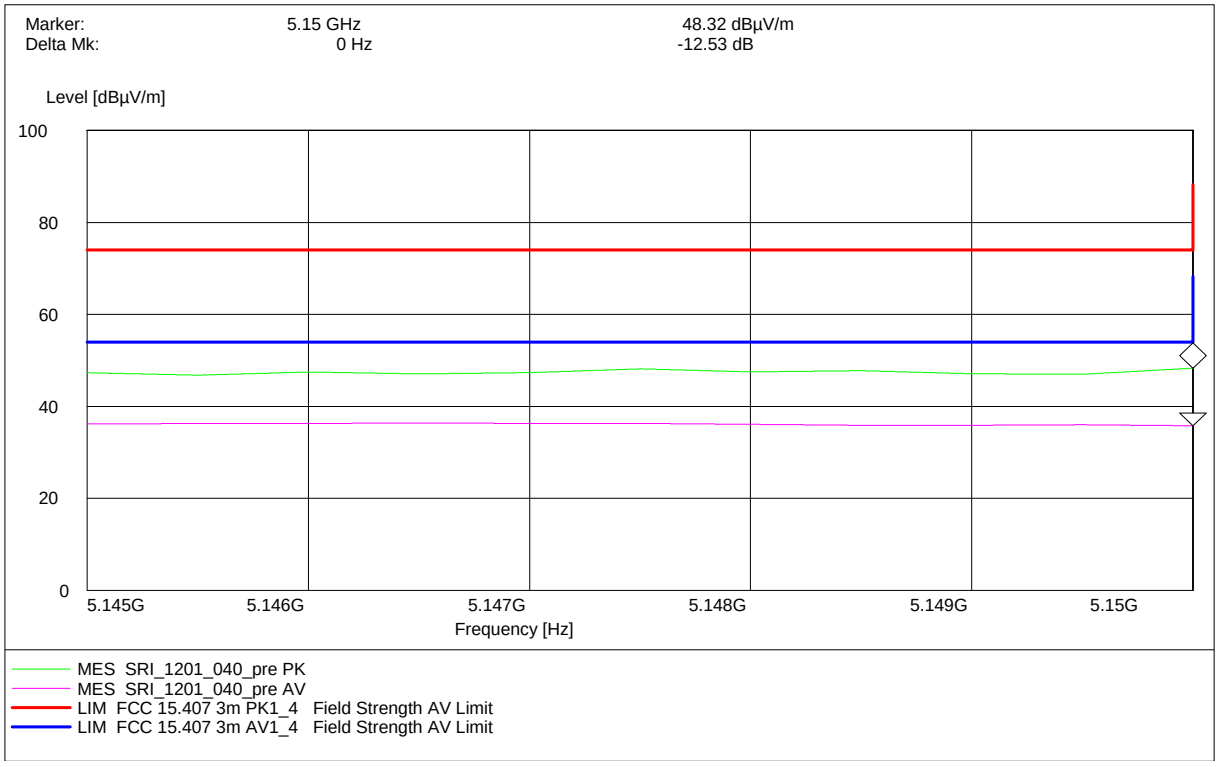
3.6.4 Measurement Plots Band Edge (showing the highest value, “worst case”)

3.6.4.1 Plot Band Edge (showing the highest value, “worst case”)



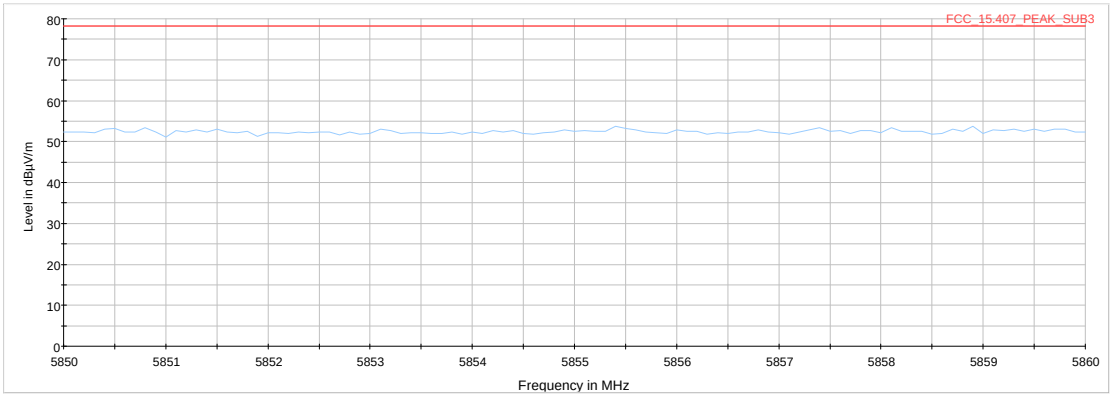
5745 MHz, 20 MHz

3.6.4.2 Plot Band Edge (showing the highest value at 5.15 GHz)



5180 MHz, 20 MHz

3.6.4.3 Plot Band Edge (showing the highest value at 5.85 GHz)



5795 MHz, 40 MHz

4 Measurement Uncertainty

Test Case	Parameter	Uncertainty
AC Power Line	Power	± 3.4 dB
Field Strength of spurious radiation	Power	± 5.5 dB
6 dB / 26 dB / 99% Bandwidth	Power Frequency	± 2.9 dB ± 11.2 kHz
Conducted Output Power	Power	± 2.2 dB
Band Edge Compliance	Power Frequency	± 2.2 dB ± 11.2 kHz
Frequency Stability	Frequency	± 25 Hz
Power Spectral Density	Power	± 2.2 dB

5 Test Equipment

List of Used 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

Calibration Details	*Last Execution*	*Next Exec.*
NSA (FCC, IC)	2011/01/10	2014/01/10
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	none	Frankonia	
	FCC listing 96716 3m Part15/18		2011/01/11	2014/01/10
	IC listing 3699A-1 3m		2011/02/07	2014/02/06
	FCC listing 96716 3m Part15/18		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	
	Path Calibration		2011/11/11	2012/11/10
Impedance Stabilization Network	ISN T800	36159	Teseq GmbH	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2014/02/06	2016/02/28
Impedance Stabilization Network, Coupling Decoupling Network	ISN/CDN ENY41	100002	Rohde & Schwarz GmbH & Co. KG	
	Standard calibration		2011/01/20	2013/01/31
	Standard calibration		2013/03/01	2015/03/31
Impedance Stabilization Network, Coupling Decoupling Network	ISN/CDN ST08	36292	Teseq GmbH	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2014/01/10	2016/01/31
Impedance Stabilization Network, Coupling Decoupling Network	ISN/CDN T8-Cat6	32187	Teseq GmbH	
	Calibration Details		*Last Execution*	*Next Exec.*
	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
	Standard calibration		2011/02/08	2014/02/07
One-Line V-Network	ESH 3-Z6	100570	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2013/11/25	2016/11/24
Two-Line V-Network	ESH 3-Z5	828304/029	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2013/03/01	2015/03/31
	DAkkS Calibration		2015/03/30	2017/03/31
Two-Line V-Network	ESH 3-Z5	829996/002	Rohde & Schwarz GmbH & Co. KG	
	Standard Calibration		2013/03/01	2015/02/28
	DAkks Calibration		2015/03/30	2017/03/31
	DKD Calibration		2011/01/20	2013/01/19

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	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2009/06/04	2014/06/03
Biconical dipole	VUBA 9117	9117-108	Schwarzbeck Mess-Elektronik OHG	
	Standard Calibration		2012/01/18	2015/01/17
Broadband Amplifier 1 GHz - 4 GHz	AFS4-01000400-1Q-10P-4	-	Miteq	
	Path Calibration		2012/05/24	2012/11/23
Broadband Amplifier 18 GHz - 26 GHz	JS4-18002600-32-5P	849785	Miteq	
	Path Calibration		2012/05/24	2012/11/23
Broadband Amplifier 30 MHz - 18 GHz	JS4-00101800-35-5P	896037	Miteq	
	Path Calibration		2012/05/24	2012/11/23
Cable "ESI to EMI Antenna"	EcoFlex10	W18.01-2+W38.01-2	Kabel Kusch	
	Path Calibration		2012/05/24	2012/11/23
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	
	Path Calibration		2012/05/24	2012/11/23
	Path Calibration		2012/11/23	2013/05/22
	Path Calibration		2013/05/22	2013/11/23
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 Exec.*
	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	
	Path Calibration		2012/05/24	2012/11/23
High Pass Filter	5HC2700/12750-1.5-KK	9942012	Trilithic	
	Path Calibration		2012/05/24	2012/11/23
High Pass Filter	5HC3500/18000-1.2-KK	200035008	Trilithic	
	Path Calibration		2012/05/24	2012/11/23

Single Devices for Auxiliary Equipment for Radiated emissions (continued)

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
High Pass Filter	WHKX 7.0/18G-8SS Path Calibration	09	Wainwright 2012/05/24	2012/11/23
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 Exec.*
	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
Loop Antenna	HFH2-Z2	829324/006	Rohde & Schwarz GmbH & Co. KG	
	DKD Calibration		2014/11/27	2017/11/27
	Standard calibration		2011/10/27	2014/10/26
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 Exec.*
	Customized calibration		2013/12/04	2015/12/03
	Customized calibration		2011/10/19	2013/12/03
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 Exec.*
	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	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2013/07/29	2014/07/28
	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	
	Standard calibration		2011/11/24	2014/11/23
	Standart calibration		2015/01/21	2018/01/19
CMW500	CMW500	107500	Rohde & Schwarz GmbH & Co.KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Initial factory calibration		2012/01/26	2014/01/25
	Standard calibration		2014/01/27	2016/01/26
Digital Radio Communication Tester	CMD 55	831050/020	Rohde & Schwarz GmbH & Co. KG	
	Standard calibration		2011/11/28	2014/11/27
	DKD calibration		2014/12/02	2017/12/01
Universal Radio Communication Tester	CMU 200	102366	Rohde & Schwarz GmbH & Co. KG	
	Standard calibration		2011/05/26	2013/05/25
	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	
	Standard calibration		2011/12/07	2014/12/06
	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 Exec.*
	Initial Factory Calibration		2014/11/13	2016/11/12
Personal Computer	Dell	30304832059	Dell	
Power Meter	NRVD	828110/016	Rohde & Schwarz GmbH & Co.KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2012/05/22	2013/05/21
	Standard calibration		2013/05/03	2014/05/02
	Standard calibration		2014/05/13	2015/05/10
	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	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2012/05/21	2013/05/20
	Standard calibration		2013/04/30	2014/04/29
	Standard calibration		2014/05/13	2015/05/10
	Standard calibration		2015/05/11	2016/05/10
Signal Generator	SMR 20	846834/008	Rohde & Schwarz GmbH & Co. KG	
	standard calibration		2011/05/12	2014/05/11
	Standard Calibration		2014/06/24	2017/06/23
Spectrum Analyser	FSW 43	103779	Rohde & Schwarz	
	Calibration Details		*Last Execution*	*Next Exec.*
	Initial Factory Calibration		2014/11/17	2016/11/16
Spectrum Analyzer	ESIB 26	830482/004	Rohde & Schwarz GmbH & Co. KG	
	Standard Calibration		2011/12/05	2013/12/31
	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 Exec.*
	Customized calibration		2013/12/04	2015/12/03
	Customized calibration		2011/10/19	2013/12/03

Test Equipment Multimeter 12

Lab ID:	**Lab 6**
Description:	Ex-Tech 520
Serial Number:	05157876

Single Devices for Multimeter 12

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Digital Multimeter 12 (Multimeter)	EX520	05157876	Extech Instruments Corp.	
	Calibration Details		*Last Execution*	*Next Exec.*
	Customized calibration		2013/12/04	2015/12/03
	Customized calibration		2011/10/18	2013/12/03

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
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2012/05/22 2013/05/21
	Standard calibration		2013/05/03 2014/05/02
	Standard calibration		2014/05/13 2015/05/10
	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		2012/06/21 2013/06/23
	Standard calibration		2013/06/24 2014/07/02
	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
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2012/05/21 2013/05/20
	Standard calibration		2013/04/30 2014/04/29
	Standard calibration		2014/05/13 2015/05/10
	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
	Standard calibration		2011/11/25 2014/11/24
Signal Generator SMP	SMP02	836402/008	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2013/05/06 2016/05/05

Single Devices for Radio Lab Test Equipment (continued)

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Spectrum Analyser	FSIQ26	840061/005	Rohde & Schwarz GmbH & Co. KG	
	Standard Calibration		2013/02/12	2015/02/11
	Standard Calibration		2011/02/10	2013/02/09
	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 Shielded Room 07

Lab ID:	**Lab 6**
Description:	Shielded Room 4m x 6m

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*	*Next Exec.*
	Customized calibration		2013/02/07	2015/02/26
	Customized calibration		2015/02/27	2017/02/26
	Customized calibration		2011/01/21	2013/01/20

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*	*Next Exec.*
	Customized calibration		2013/02/07	2015/02/26
	Customized calibration		2015/02/27	2017/02/26
	Customized calibration		2011/02/02	2013/02/01

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*	*Next Exec.*
Customized calibration	2013/02/07	2015/02/26
Customized calibration	2015/02/27	2017/02/26
Customized calibration	2011/02/02	2013/02/01

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*	*Next Exec.*
Customized calibration	2013/01/07	2015/03/09
Customized calibration	2015/03/10	2017/03/09
Customized calibration	2010/12/13	2012/12/12

Test Equipment T/H Logger 15

Lab ID:	**Lab 6**
Description:	Lufft Opus10
Serial Number:	13985

Single Devices for T/H Logger 15

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
ThermoHygro Datalogger 15 (Environ)	Opus10 THI (8152.00)	13985	Lufft Mess- und Regeltechnik GmbH

Calibration Details	*Last Execution*	*Next Exec.*
Customized calibration	2013/01/07	2015/03/09
Customized calibration	2015/03/10	2017/03/09
Customized calibration	2010/12/13	2012/12/12

Test Equipment Temperature Chamber 01

Lab ID:	**Lab 6**
Manufacturer:	see single devices
Description:	Temperature Chamber KWP 120/70
Type:	Weiss
Serial Number:	see single devices

Single Devices for Temperature Chamber 01

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Temperature Chamber Weiss 01	KWP 120/70	59226012190010	Weiss Umwelttechnik GmbH	
	Calibration Details		*Last Execution*	*Next Exec.*
	Customized calibration		2012/03/12	2014/03/11
	Customized calibration		2014/03/12	2016/03/11

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*	*Next Exec.*
	Customized calibration		2012/03/12	2014/03/11
	Customized calibration		2014/03/11	2016/03/10

Test Equipment WLAN RF Test Solution

Lab ID:	**Lab 6**
Manufacturer:	7 layers AG
Description:	Regulatory WLAN RF Tests
Type:	WLAN RF
Serial Number:	001

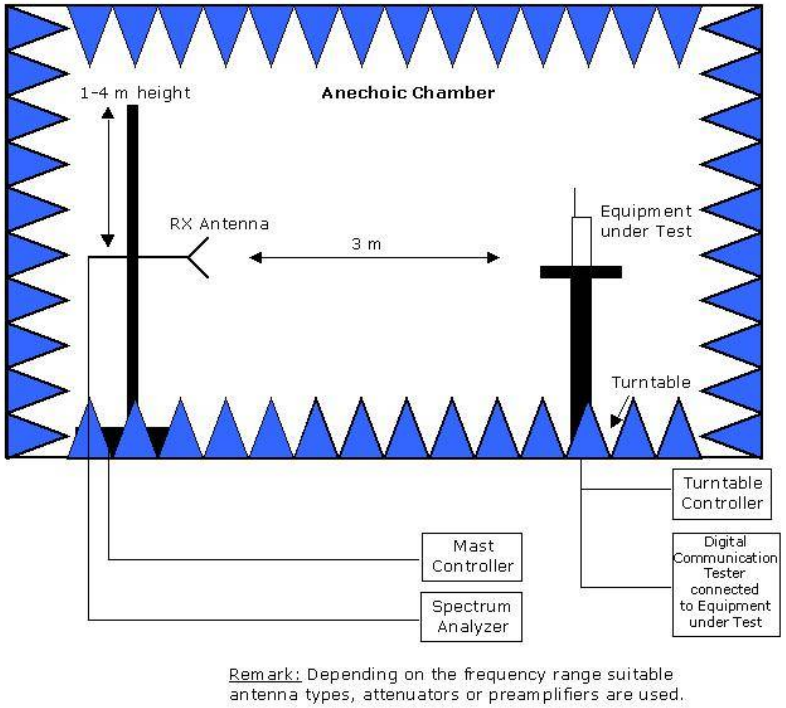
Single Devices for WLAN RF Test Solution

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Arbitrary Waveform Generator	TGA12101	284482		
Power Meter NRVD	NRVD	832025/059		
	Standard Calibration		2012/07/24	2013/07/23
	Standard calibration		2013/08/26	2014/08/25
	Standard calibration		2014/08/29	2015/08/28
Power Sensor NRV Z1 A	PROBE	832279/013		
	Standard Calibration		2012/07/23	2013/07/22
	Standard calibration		2013/08/28	2014/08/27
	Standard calibration		2014/08/28	2015/08/27
Power Supply	NGSM 32/10	2725		
	Standard Calibration		2011/06/15	2013/06/14
	Standard calibration		2013/06/20	2015/06/19
	Standard calibration		2015/06/22	2016/06/21
Rubidium Frequency Normal MFS	Datum MFS	002	Datum GmbH	
	Standard Calibration		2012/08/20	2013/08/19
	Standard calibration		2013/08/27	2014/08/26
	Standard calibration		2014/08/29	2015/08/28
Signal Analyser FSIQ26	1119.6001.26	832695/007	Rohde & Schwarz GmbH & Co.KG	
Signal Generator	SMP03	833680/003	Rohde & Schwarz GmbH & Co.KG	
	Standard		2013/10/29	2016/10/28
Spectrum Analyser	FSU26	100136	Rohde & Schwarz GmbH & Co.KG	
	Standard calibration		2012/06/20	2012/12/20
	Standard calibration		2012/12/21	2014/01/05
	Standard Calibration		2014/01/06	2015/02/01
	Standard Calibration		2015/02/02	2016/02/01
	FSU FW Update to v4.61 SP3, K5 v4.60 and K73 v4.61		2011/12/05	
Spectrum Analyser	FSU3	200046	Rohde & Schwarz GmbH & Co.KG	
	Standard calibration		2012/05/15	2013/06/19
	Standard calibration		2013/06/20	2014/06/30
	Standard calibration		2014/07/01	2015/06/30
	Standart calibration		2015/06/22	2016/06/21
	Firmware Version 4.51 SP1 Option FS-K72 4.50 SP1 Option FS-K73 4.50 SP1		2011/12/07	
TOCT Switching Unit	Switching Unit	040107	7 layers, Inc.	
Vector Signal Generator SMIQ03B	SMIQ03B	832870/017		
	Standard Calibration		2010/06/23	2013/06/22
	Standard calibration		2013/06/21	2016/06/20

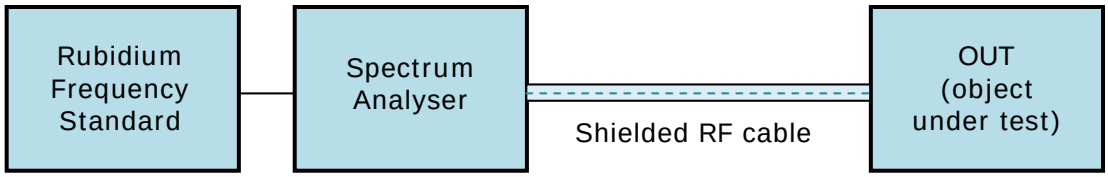
6 Photo Report

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.