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Test Report

Report Number:

F161944E1

Equipment under Test (EUT):

Anybus Wireless Bridge EPA

Applicant:

u-blox Malmö AB

Manufacturer:

u-blox Malmö AB

ilac-MRA
DAkkS Deutsche Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

References

[1] **ANSI C63.10-2013**, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

[2] **FCC CFR 47 Part 15 (March 2017)**, Radio Frequency Devices

[2] **RSS-247 (February 2017)**, Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

[2] **RSS-Gen Issue 4 (November 2014)**, General Requirements for Compliance of Radio Apparatus

Test Result

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test. The complete test results are presented in the following.

tested and written by:	Bernward ROHDE		16.03.2017
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		16.03.2017
	Name	Signature	Date

This test report is only valid in its original form.

Contents: Page

1 Identification

1.1 Applicant

Name:	u-blox Malmö AB
Address:	Östra varvsgatan 4, SE-211 75 Malmö
Country:	Sweden
Name for contact purposes:	Mr. Mats ANDERSSON
Phone:	+ 46 40 63 07 100
Fax:	+ 46 40 23 71 37
eMail Address:	mats.andersson@u-blox.com
Applicant represented during the test by the following person:	None

1.2 Manufacturer

Name:	u-blox Malmö AB
Address:	Östra varvsgatan 4, SE-211 75 Malmö
Country:	Sweden
Name for contact purposes:	Mr. Mats ANDERSSON
Phone:	+ 46 40 63 07 100
Fax:	+ 46 40 23 71 37
eMail Address:	mats.andersson@u-blox.com
Applicant represented during the test by the following person:	None

1.3 Test Laboratory

The tests were carried out by:

PHOENIX TESTLAB GmbH
Königswinkel 10
32825 Blomberg
Germany

Accredited by *Deutsche Akkreditierungsstelle GmbH* in compliance with DIN EN ISO/IEC 17025 under Reg. No. **< *D-PL-17186-01-02* >**.

1.4 EUT (Equipment Under Test)

Test object:*	WLAN / Bluetooth module for Anybus Wireless bridge
Model / PMN: *	ODIN-W2
FCC ID: *	PVH0965
ISED ID:*	5325A-0965
HVIN:*	ODIN-W260
Order number:*	None
PCB identifier:*	0965-02
Serial number:**	587D4CA6E703B670500
Hardware version:*	2.1
Software version (Radiated test mode):*	3.0
Software version (Final Version):*	3.0

* declared by the applicant.
** Decoded “data matrix”

Channel 01	RX:	2412 MHz	TX:	2412 MHz
Channel 02	RX:	2417 MHz	TX:	2417 MHz
Channel 03	RX:	2422 MHz	TX:	2422 MHz
Channel 04	RX:	2427 MHz	TX:	2427 MHz
Channel 05	RX:	2432 MHz	TX:	2432 MHz
Channel 06	RX:	2437 MHz	TX:	2437 MHz
Channel 07	RX:	2442 MHz	TX:	2442 MHz
Channel 08	RX:	2447 MHz	TX:	2447 MHz
Channel 09	RX:	2452 MHz	TX:	2452 MHz
Channel 10	RX:	2457 MHz	TX:	2457 MHz
Channel 11	RX:	2462 MHz	TX:	2462 MHz

Ancillary Equipment:

USB to UART:*	FTDT Chip: TTL-232RG-VREG1V8-WE
Laptop:**	Fujitsu S7220

* provided by the applicant
** provided by the test laboratory

Technical Data of Equipment

Fulfills WLAN specification: *	IEEE, 802.11b, 802.11g, 802.11n HT20 + HT40,					
Antenna type: *	PCB quarter wave monopole antenna					
Antenna name: *	PCB-2G4-1, PCB-2G4-5G-1					
Antenna gain: *	2.88 dBi (2.4 GHz MIMO) / 2.00 dBi (2.4 GHz Dual Band)					
Antenna connector: *	U-FL					
Power supply:	DC					
Supply voltage Board:	U_{nom} =	24.0 V DC	U_{min} =	9 V DC	U_{max} =	30 V DC
Power supply:	DC					
Supply voltage WLAN module:	U_{nom} =	3.3 V DC	U_{min} =	3.0 V DC	U_{max} =	3.6 V DC
Type of modulation: *	802.11b: CCK, DQPSK, DBPSK 802.11g: OFDM 802.11n: OFDM					
Operating frequency range:*	2412 MHz to 2462 MHz, 5180 MHz to 5240 MHz, 5260 MHz to 5320 MHz, 5500 MHz to 5700 MHz, 5745 to 5825 MHz					
Number of channels: *	11					
Temperature range: *	-40 °C to +85 °C					
Lowest / highest internal clock frequency: *	24.000 MHz / 26.000 MHz					

* declared by the applicant.

1.5 Dates

Date of receipt of test sample:	05.12.2016
Start of test:	09.01.2017
End of test:	08.03.2017

2 Operational States

The EUT is the ODIN-W2 with the “Anybus Wireless Bridge EPA PCB antennas” for an industrial environment. The EUT operates in the WLAN mode in 2.4 GHz and 5 GHz band. This test report shows the results of the 2.4 GHz band only.

The test modes were set using an ancillary laptop located outside the anechoic chamber via a console connection.

The u-blox WLAN/BT module ODIN-W2 was tested by Phoenix Testlab GmbH. The complete results were documented in test-report F151496E5.

This test-report contains only the worst-case tests for band edge compliance and the spurious emissions.

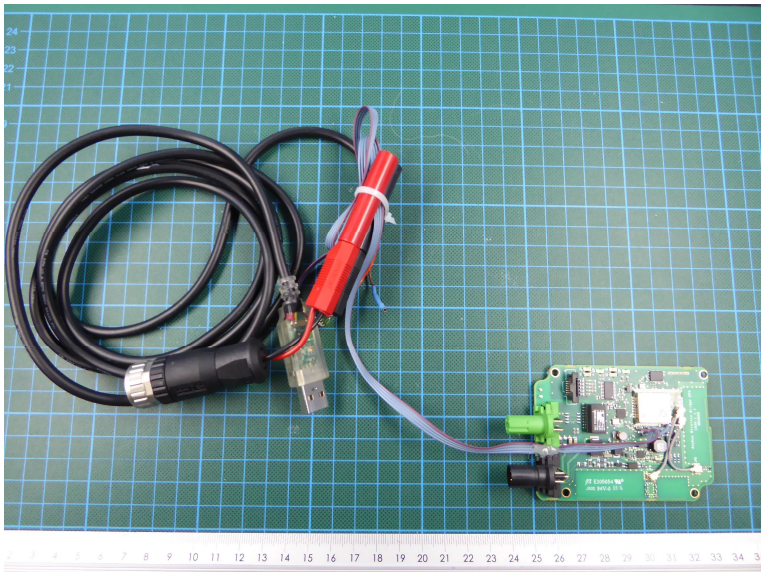
The following operation modes were identified in test-report F151496E5 as worst case condition and used during the tests:

Operation mode	Description of the operation mode	WLAN channel	WLAN mode	Data rate / Mbps
1	Continuous transmitting on 2412 MHz	1	802.11b	1 Mbps
2	Continuous transmitting on 2437 MHz	6	802.11b	1 Mbps
3	Continuous transmitting on 2462 MHz	11	802.11g	6 Mbps

Power Settings for all measurements:

	ch. 1	ch. 6	ch. 11
802.11b	13 dBm	14 dBm	---
802.11g	---	---	12 dBm

Photo of the EUT:



3 Additional Information

All tests were performed with unmodified samples.

The EUT had a UART cable directly soldered to the WLAN module pins for remote control via console.

The goal of this test-report is to add a new antenna to an existing filing of ODIN-W2.
Therefore only limited tests were performed.

The results of the conducted output power of this device are within the measurement uncertainty of the power values of the test-report F151496E5.

4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS-247 [3] or RSS-Gen, Issue 4 [4]	Status	Refer page
Band edge compliance	2400.0 - 2483.5	15.247 (d)	5.5 [3] 8.9 [4], 8.10 [4]	Passed	10 et seq.
Radiated emissions (transmitter)	0.009 – 25,000	15.247 (d) 15.205 (a) 15.209 (a)	5.5 [3] 8.9 [4], 8.10 [4]	Passed	14 et seq.

5 Results

5.1 Band-edge compliance

5.1.1 Methods of measurement (radiated emissions)

The radiated emission measurement is subdivided into two stages.

- A preliminary measurement carried out in a fully anechoic chamber with a variable antenna distance and height in the necessary frequency range
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the necessary frequency range

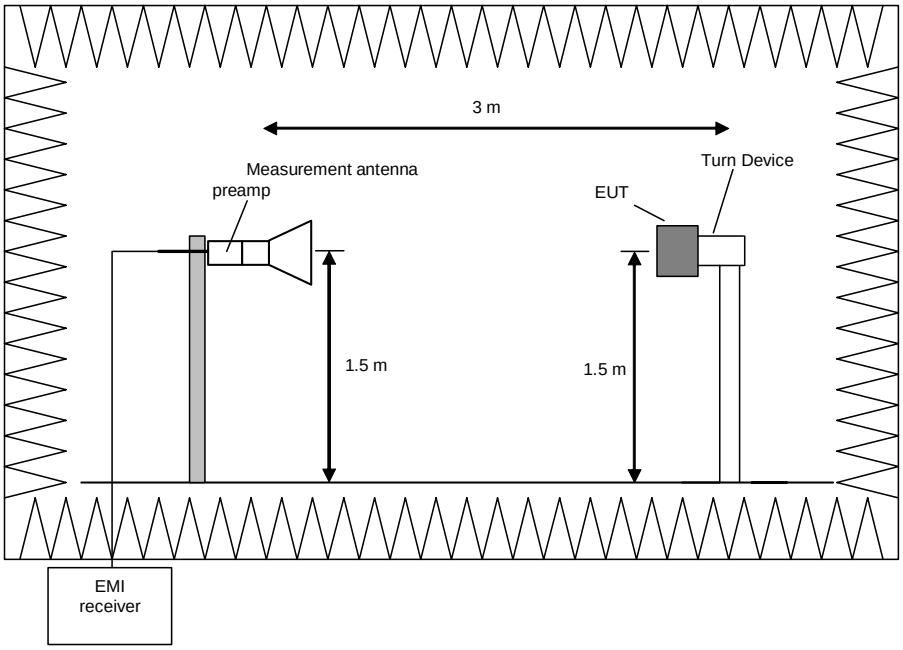
Preliminary and final measurement

This measurement will be performed in a fully anechoic chamber. Table top devices will set up on a non-conducting turn device on the height of 1.5m. The set-up of the Equipment under test will be in accordance to [1].

Preliminary measurement

The spectrum analyzer set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarization of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. This measurement is repeated after raising the EUT in 30° steps according 6.6.5.4 in [1].

The resolution bandwidth of the EMI Receiver will be set to 100 kHz.



Procedure preliminary measurement:

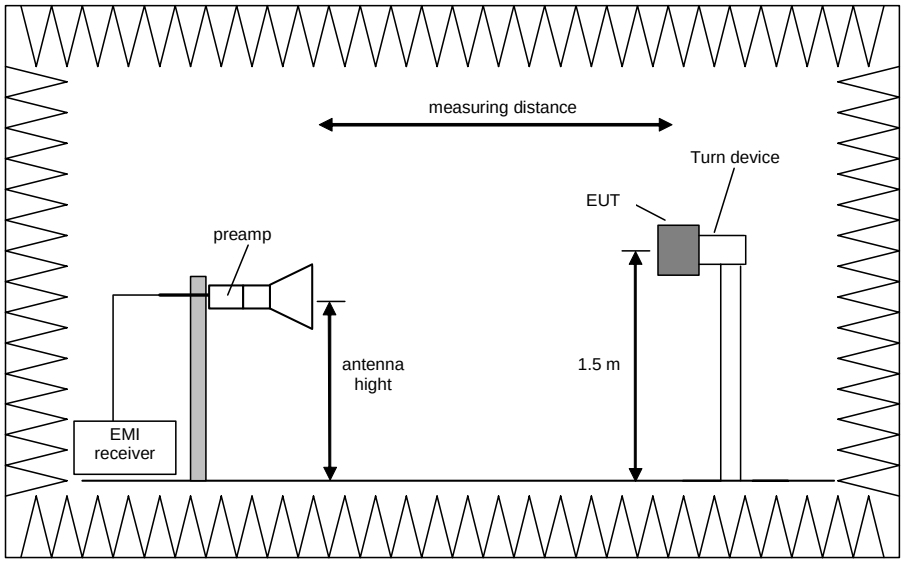
Pre-scans were performed in the necessary frequency range
The following procedure will be used:

1. Automated monitoring of the frequency range at horizontal polarization and a EUT azimuth of 0 °.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Automated hardcopy of the spectrum trace obtained by the measuring software.
4. Repeat 1) to 3) with the EUT raised by an angle of 30° (60°, 90°, 120° and 150°)
   According to 6.6.5.4 in [1].
5. Repeat 1) to 4) with the vertical polarization of the measuring antenna.
6. Automated hardcopy of the overall spectrum trace
7. The measurement antenna polarization, with the according EUT position (Turntable and Turn device) which produces the highest emission for each frequency will be used for the final measurement. The closest value to the applicable limit will be used for the final measurement.

Final measurement

The EMI Receiver set to peak and average mode and a resolution bandwidth of 1 MHz with a measuring time of 1000 milliseconds. The measurement will be performed by rotating the turntable and EUT positioner to the worst-case EUT orientation corresponding to the frequency which was obtained during the preliminary measurements.

The resolution bandwidth of the EMI Receiver will be set to 1 MHz.



Procedure of measurement:

The following procedure will be used:

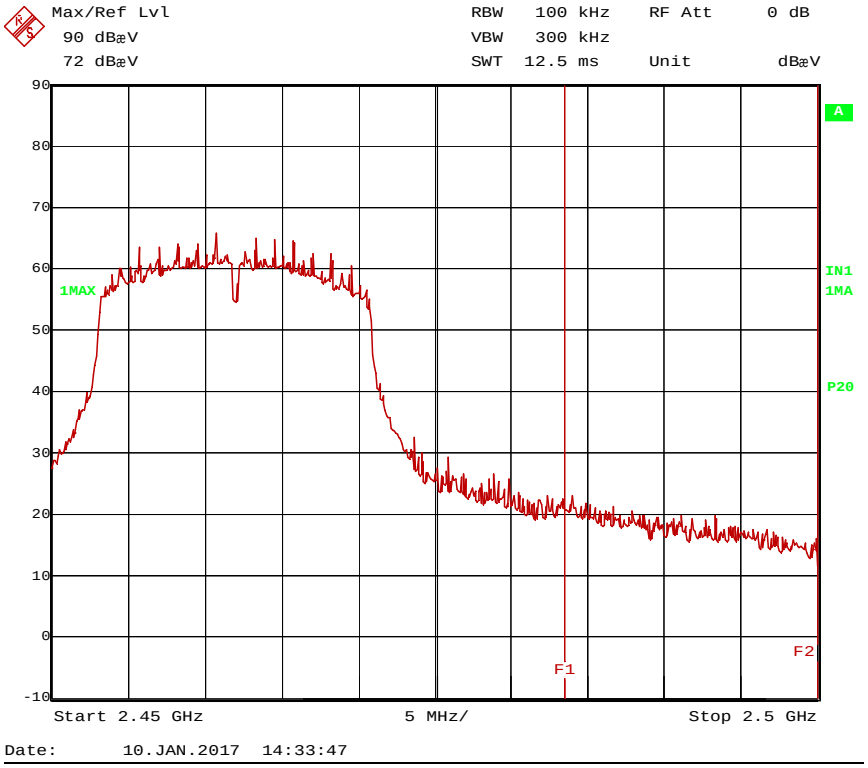
1) Set the turntable and the turn device to the worst-case position to obtain the worst case emission for the first frequency identified in the preliminary measurements.
2) Set the measurement antenna polarization to the orientation with the highest emission for the first frequency identified in the preliminary measurements.
3) Set the spectrum analyzer to “zero span” mode with peak and average detector activated.
4) Measure the emission with a measuring time of 1000 milliseconds with peak and average detector.
5) The displayed peak and average values will be stored and compared with the corresponding limits by the measuring software
6) Repeat the steps 1) to 5) for each frequency detected during the preliminary measurements.

5.1.1.1 Results Operation mode 3

In this case the worst case emission close to band edge was measured and compared with the restricted band requirements.

Worst case mode as identified in test-report F151496E5:

Mode	Data rate	Channel
802.11 g	6 Mbps	11



Final results

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
2485.400000	---	49.3	54.00	4.7	H	12	90.0	33.6
2485.400000	65.1	---	74.00	8.9	V	354	90.0	33.6

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
1-7,14,15

5.2 Maximum unwanted emissions

Due to the prior knowledge of the worst case cabinet emissions form test-report F151496E5 only the worst case emissions in the frequency range from 1 to 25 GHz were measured.

5.2.1 Method of measurement (radiated emissions)

The radiated emission measurement is subdivided into two stages.

- A preliminary measurement carried out in a fully anechoic chamber with a variable antenna distance and height in the frequency range 1 GHz to 25 / 40 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 25 / 40 GHz.

Preliminary and final measurement (1 GHz to 40 GHz)

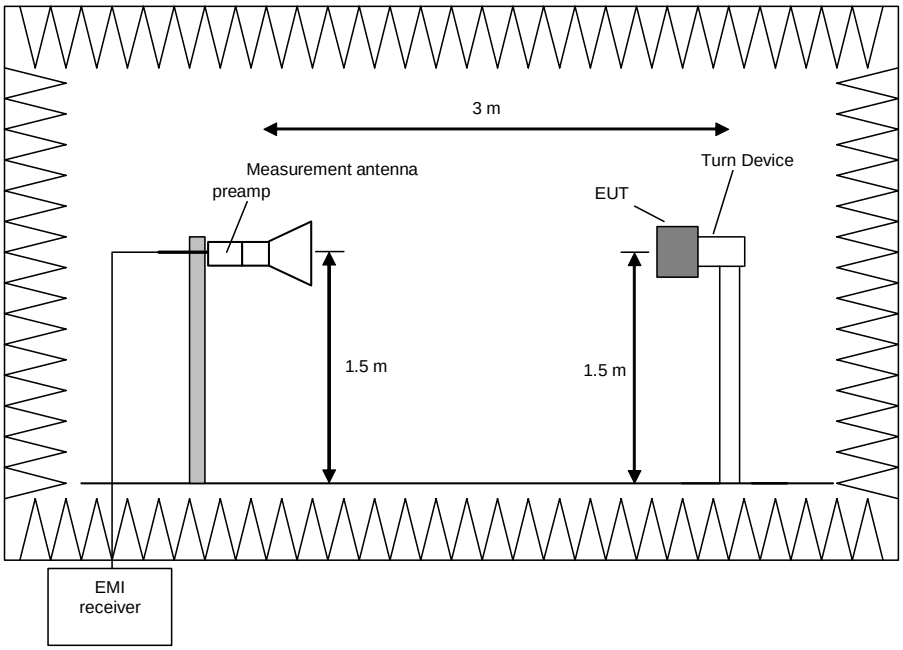
This measurement will be performed in a fully anechoic chamber. Table top devices will set up on a non-conducting turn device on the height of 1.5m. The set-up of the Equipment under test will be in accordance to [1].

Preliminary measurement (1 GHz to 40 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The spectrum analyzer set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarization of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. This measurement is repeated after raising the EUT in 30° steps according 6.6.5.4 in [1].

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	100 kHz
4 GHz to 12 GHz	100 kHz
12 GHz to 18 GHz	100 kHz
18 GHz to 25 / 26.5 GHz	100 kHz
26.5 GHz to 40 GHz	100 kHz



Procedure preliminary measurement:

Pre-scans were performed in the frequency range 1 to 25 GHz.
The following procedure will be used:

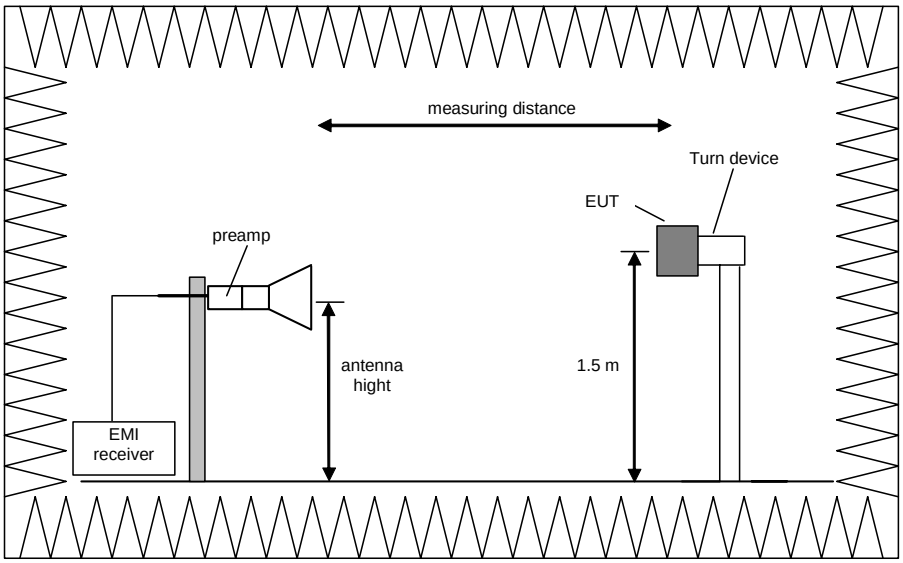
8. Automated monitoring of the frequency range at horizontal polarization and a EUT azimuth of 0 °.
9. Rotate the EUT by 360° to maximize the detected signals.
10. Automated hardcopy of the spectrum trace obtained by the measuring software.
11. Repeat 1) to 3) with the EUT raised by an angle of 30° (60°, 90°, 120° and 150°) According to 6.6.5.4 in [1].
12. Repeat 1) to 4) with the vertical polarization of the measuring antenna.
13. Automated hardcopy of the overall spectrum trace
14. The measurement antenna polarization, with the according EUT position (Turntable and Turn device) which produces the highest emission for each frequency will be used for the final measurement. The six closest values to the applicable limit will be used for the final measurement.

Final measurement (1 GHz to 25 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The EMI Receiver set to peak and average mode and a resolution bandwidth of 1 MHz with a measuring time of 1000 milliseconds. The measurement will be performed by rotating the turntable and EUT positioner to the worst-case EUT orientation corresponding to the frequency which was obtained during the preliminary measurements.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	1 MHz
4 GHz to 12 GHz	1 MHz
12 GHz to 18 GHz	1 MHz
18 GHz to 25 GHz	1 MHz



Procedure of measurement:

The measurements were performed in the frequency ranges 1 GHz to 4 GHz, 4 GHz to 12 GHz, 12 GHz to 18 GHz, 18 GHz to 25 GHz.
The following procedure will be used:

7) Set the turntable and the turn device to the worst-case position to obtain the worst case emission for the first frequency identified in the preliminary measurements.
8) Set the measurement antenna polarization to the orientation with the highest emission for the first frequency identified in the preliminary measurements.
9) Set the spectrum analyzer to “zero span” mode with peak and average detector activated.
10) Measure the emission with a measuring time of 1000 milliseconds with peak and average detector.
11) The displayed peak and average values will be stored and compared with the corresponding limits by the measuring software
12) Repeat the steps 1) to 5) for each frequency detected during the preliminary measurements.

5.2.1.1 Radiated emission measurement (1 GHz to 25 GHz)

Ambient temperature	22 °C	Relative humidity	55 %

Position of EUT: The EUT was set-up on an EUT turn device of a height of 1.5 m. The distance between EUT and antenna was 3 m.

Cable guide: For detail information of test set-up and the cable guide refer to the pictures in test setup photos.

Test record: All results are shown in the following.

Supply voltage: During all measurements the host of the EUT was powered with 24 V DC via an laboratory power supply.

Resolution bandwidth: For all preliminary measurements a resolution bandwidth of 100 kHz was used.
For all final measurements a resolution bandwidth of 1 MHz was used.

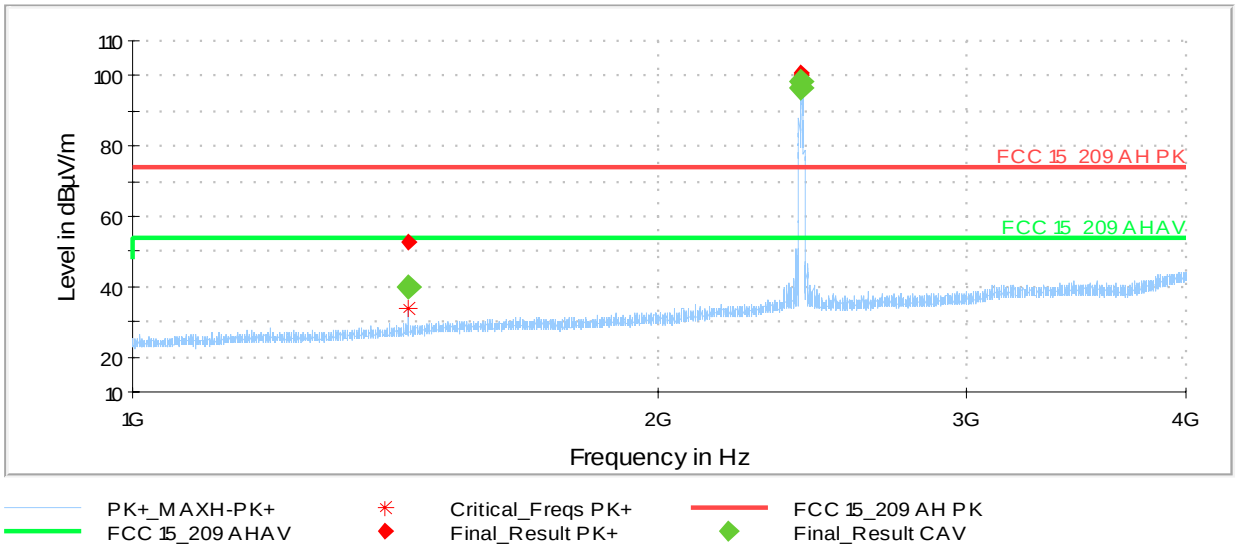
Additional information: For simplification all values were compared to the restricted band limits.

Worst case mode and frequency bands as identified in test-report F151496E5.

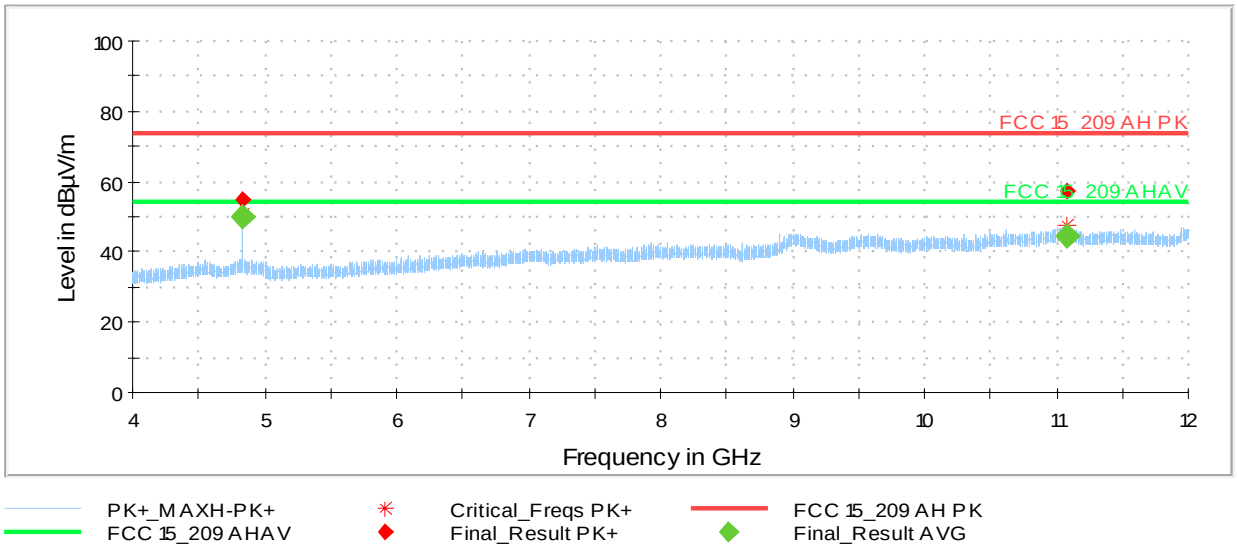
Frequency range	Mode	Data rate	Channel
1 - 4 GHz	802.11 b	1 Mbps	1
4 - 12 GHz	802.11 b	1 Mbps	1
12 - 18 GHz	802.11 b	1 Mbps	1
18 - 25 GHz	802.11 b	1 Mbps	6

5.2.1.1.1 Spurious Emissions

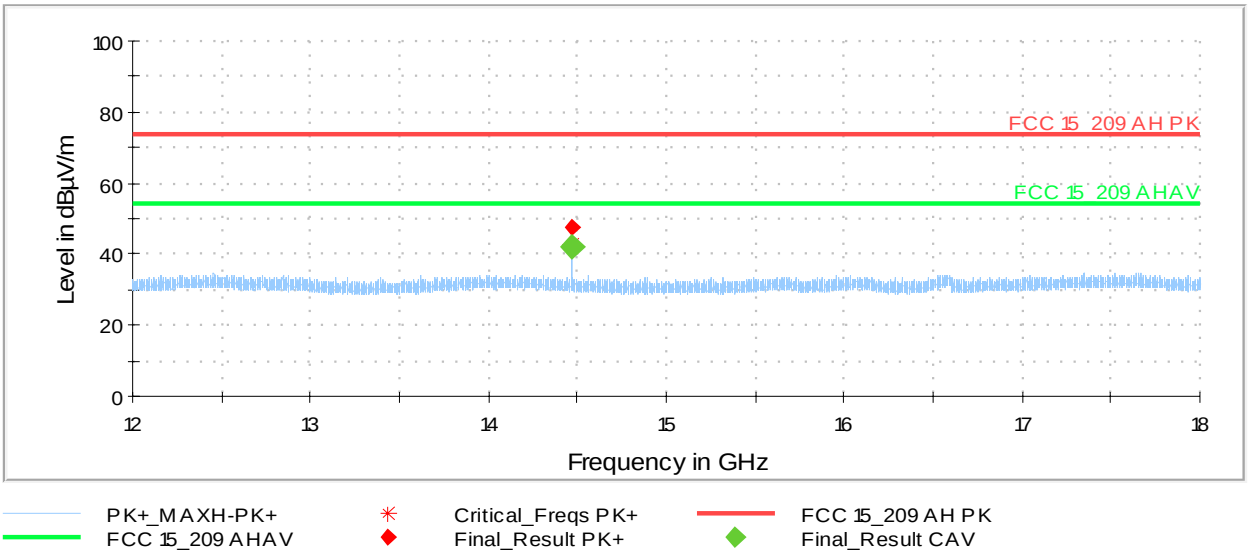
Worst case Spurious emissons form 1 to 4 GHz including the wanted signal in operation mode 1



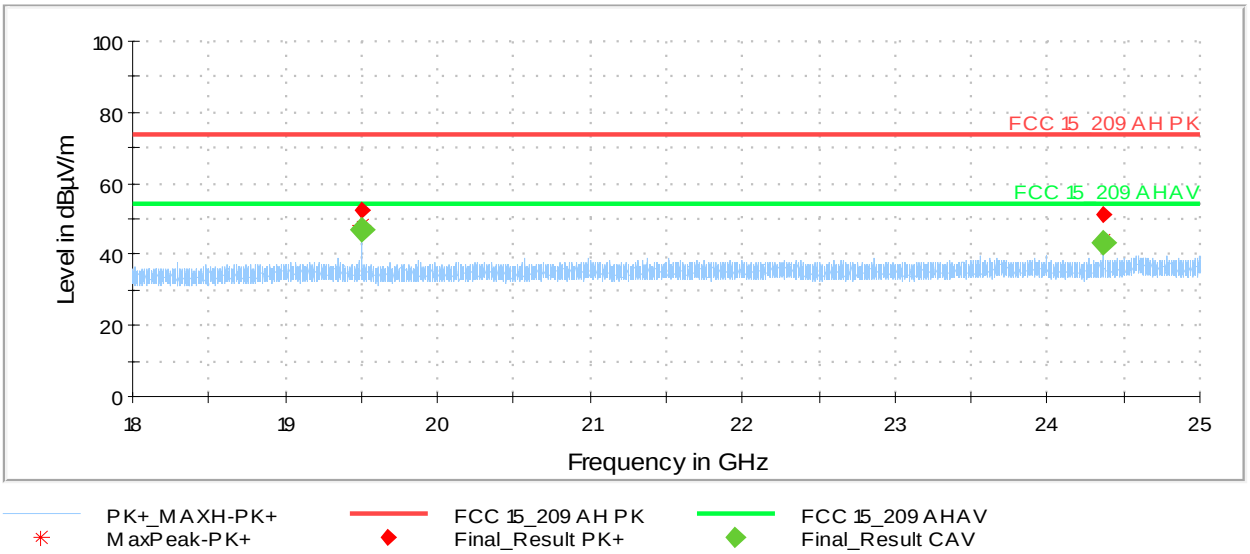
Worst case Spurious emissons form 4 to 12 GHz in operation mode 1



Worst case Spurious emissons form 12 to 18 GHz in operation mode 1



Worst case Spurious emissons form 18 to 25 GHz in operation mode 2



5.2.1.1.1.1 Results Operation mode 1 (EUT transmits @ 2412 MHz)

Measurement uncertainty +2.2 dB / -3.6 dB

The correction factor was calculated as follows:

Corr. (dB) = cable attenuation (dB) + amplifier (dB) + antenna factor (dBµV/m)

Therefore the reading can be calculated as follows:

Reading (dBµV/m) = result Peak/Average (dBµV/m) - Corr. (dB)

Final results including the wanted signal

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1437.400000	---	39.72	54.00	14.28	V	341.0	150.0	27.6
1437.400000	52.95	---	74.00	21.05	V	341.0	150.0	27.6
2410.900000	---	98.25	---	---*1	H	146.0	150.0	33.6
2410.900000	100.81	---	---	---*1	H	146.0	150.0	33.6
2412.400000	---	96.33	---	---*1	H	146.0	150.0	33.6
2412.400000	100.52	---	---	---*1	H	146.0	150.0	33.6
4823.900000	---	49.97	54.00	4.03	H	222.0	0.0	16.7
4823.900000	54.81	---	74.00	19.19	H	222.0	0.0	16.7
11079.800000	---	44.47	54.00	9.53	H	274.0	90.0	27.7
11079.800000	57.05	---	74.00	16.95	H	274.0	90.0	27.7
14471.900000	---	41.93	54.00	12.07	H	304.0	120.0	11.5
14471.900000	47.65	---	74.00	26.35	H	304.0	120.0	11.5

*1 Wanted signal and therefore not compared with the limits

Test: Passed

5.2.1.1.1.2 Results Operation mode 2 (EUT transmits @ 2437 MHz)

Measurement uncertainty +2.2 dB / -3.6 dB

The correction factor was calculated as follows:

Corr. (dB) = cable attenuation (dB) + amplifier (dB) + antenna factor (dBµV/m)

Therefore the reading can be calculated as follows:

Reading (dBµV/m) = result Peak/Average (dBµV/m) - Corr. (dB)

Final results

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
19495.550000	---	44.04	54.00	9.96	V	278.0	150.0	6.6
19495.550000	51.15	---	74.00	22.85	V	278.0	150.0	6.6

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
1-17

6 Test Equipment

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. Due
1	EMI Software	EMC32	Rohde & Schwarz	100061	481022	-	-
2	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
3	Spectrum analyzer	FSW43	Rohde & Schwarz	100586	481720	24.02.2016	24.02.2017
4	Controller	MCU	Maturo	MCU/043/971107	480832	-	-
5	Turntable	DS420HE	Deisel	420/620/80	480315	-	-
6	Antenna support	AS615P	Deisel	615/310	480187	-	-
7	Antenna	3115 A	EMCO	9609-4918	480183	10.11.2014	10.11.2017
8	Antenna	HL050	Rohde & Schwarz	100438	481170	27.08.2014	27.08.2017
9	Preamplifier	JS3-00101200-23-5A	Miteq	681851	48337	18.02.2016	18.02.2018
10	Standard Gain Horn 11.9 GHz – 18 GHz	18240-20	Flann Microwave	483	480294	Six month verification (system cal.)	
11	Preamplifier	JS3-12001800-16-5A	Miteq	571667	480343	18.02.2016	18.02.2018
12	Standard Gain Horn 17.9 GHz – 26.7 GHz	20240-20	Flann Microwave	411	480297	Six month verification (system cal.)	
13	Preamplifier	JS3-18002600-20-5A	Miteq	658697	480342	17.02.2016	17.02.2018
14	RF-cable No. 3	Sucoflex 106B	Huber&Suhner	0563/6B / Kabel 3	480670	Weekly verification (system cal.)	
15	RF-cable No. 40	Sucoflex 106B	Huber&Suhner	0708/6B / Kabel 40	481330	Weekly verification (system cal.)	
16	RF-cable 2 m	KPS-1533-800-KPS	Insulated Wire	-	480302	Six month verification (system cal.)	
17	4 GHz High Pass Filter	WHKX4.0/18G-8SS	Wainwright Instruments	1	480587	Weekly verification (system cal.)	
18	Power Meter	NRVD	Rohde & Schwarz	833697/030	480589	03/2017	03/2018
19	Peak Power Sensor	NRV-Z32	Rohde & Schwarz	849745/016	480551	03/2017	03/2018

7 Report History

Report Number	Date	Comment
F161944E1	16.03.2017	Initial Test Report

8 List of Annexes

ANNEX A	TEST SETUP PHOTOS		5 pages
	161944_TS001.jpg	Test setup - Detail view of EUT on positioner	
	161944_TS004.jpg	Test setup fully anechoic chamber Measurement form 1 to 4 GHz	
	161944_TS031.jpg	Test setup fully anechoic chamber Measurement form 4 to 12 GHz	
	161944_TS023.jpg	Test setup fully anechoic chamber Measurement form 12 to 25/26.5 GHz	
	161944_TS020.jpg	Test setup fully anechoic chamber Measurement form 26.5 – 40 GHz (15.407 only)	
ANNEX B	INTERNAL PHOTOS		5 pages
	161944eut001.jpg	EUT complete top view	
	161944eut002.jpg	EUT Detail top view	
	161944eut003.jpg	EUT side view	
	161944eut004.jpg	RF-Module detail view	
	161944eut005.jpg	EUT back view	