N° 1-6736
Scope available
on www.cofrac.fr

TEST REPORT

EUT Description	**WLAN and BT, 2x2 PCIe M.2 1216 adapter card**
Brand Name	**Intel® Wi-Fi 6E AX211**
Model Name	**AX211D2W**
Date of Test Start/End	**2020-12-05 / 2022-01-21**
Features	**802.11ax, Dual Band, 2x2 Wi-Fi + Bluetooth® 5.2 (see section 5)**

Applicant	**Intel Corporation SAS**
Address	**425 rue de Goa - Le Cargo B6 - 06600, Antibes, France**
Contact Person	**Laurence Peignot**
Telephone/Fax/ Email	**laurence.peignot@intel.com**

Reference Standards	**ETSI EN 300 328 V2.2.2 (see section 1)**

Test Report identification	**201120-03.TR13**
Revision Control	**Rev. 03** **This test report revision replaces any previous test report revision (see section 8)**

The test results relate only to the samples tested.
Reference to accreditation shall be used only by full reproduction of test report.

Issued by

Digitally signed by Requin
Date: 2023.01.10 11:00:00 +01'00'

Cedric REQUIN
(Test Lead)

Reviewed by

Date: 2023.01.10 11:02:41 +01'00'

Zayd OUACHICHA
(Technical Manager)

Table of Contents

1. Standards, reference documents and applicable test methods

1. ETSI EN300 328 v2.2.2, Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz band; Harmonised Standard for access to radio spectrum

2. General conditions, competences and guarantees

- ✓ Intel Corporation SAS Wireless RF Lab (Intel WRF Lab) is an ISO/IEC 17025:2017 testing laboratory accredited by the French Committee for Accreditation (Cofrac) with the certificate number 1-6736.
- ✓ Intel WRF Lab declines any responsibility with respect to the identified information provided by the customer and that may affect the validity of results.
- ✓ Intel WRF Lab only provides testing services and is committed to providing reliable, unbiased test results and interpretations.
- ✓ Intel WRF Lab is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.
- ✓ Intel WRF Lab has developed calibration and proficiency programs for its measurement equipment to ensure correlated and reliable results to its customers.
- ✓ This report is only referred to the item that has undergone the test.
- ✓ This report does not imply an approval of the product by the Certification Bodies or competent Authorities

3. Environmental Conditions

- ✓ At the site where the measurements were performed the following limits were not exceeded during the tests:

Temperature	22.6ºC ± 2.5ºC
Humidity	38.8% ± 11.5%

4. Test samples

Sample	Control #	Description	Model	Serial #	Date of receipt	Note
#01	201120-03.S03	WiFi 6E Module	AX211D2W	WFM:D8F8834C251B	2020-23-11	Used for conducted tests except Occupied Channel Bandwith & Transmitter unwanted emission in the out-of-band domain
	170000-01.S19	Laptop	Latitude E5450	4TXV562	2020-02-04	
	200611-01.S12	Extender	PCB00651_01	-	2020-11-30	
#02	201120-03.S09	WiFi 6E Module	AX211D2W	WFM:DF8834E4C92	2020-11-23	Used for 1GHz-6.4GHz Tx Radiated Spurious Emissions tests
	200102-01.S03	Extender	ADEXELEC	-	2020-01-02	
	200611-01.S06	Adaptor	PowerBy SNJ A4	-	2020-11-30	
	200602-03.S06	Absorber	MCS0	-	2020-07-03	
	180000-01.S05	Socket	Adapter 1216SD to M.2	-	2017-08-09	
	170801-01.S10	Laptop	Latitude E7470	7KNOXF2	2017-09-08	
	200611-03.S28	Main Antenna	SkyCross	-	2020-07-01	
	200611-03.S29	Aux Antenna	SkyCross	-	2020-07-01	
#03	201120-03.S08	WiFi 6E Module	AX211D2W	WFM:D8F8834E56AB	2020-11-23	Used for 30MHz-1GHz Radiated Spurious Emissions tests, and 6.4GHz-12.75GHz Tx Radiated Spurious Emissions tests
	200611-03.S26	Extender	ADEXELEC	-	2020-07-01	
	200611-01.S07	Adaptor	PowerBy SNJ A4	-	2020-11-30	
	200602-03.S06	Absorber	MCS0	-	2020-07-03	
	180000-01.S02	Socket	Adapter 1216SD to M.2	-	2017-08-09	
	170000-01.S01	Laptop	Latitude E5470	DBPLMC2	2017-03-28	
	200928-03.S08	Main Antenna	SkyCross	-	2020-09-01	
	200928-03.S09	Aux Antenna	SkyCross	-	2020-09-01	
#04	201120-03.S02	WiFi 6E Module	AX211D2W	WFM:D8F8834C2462	2020-11-23	Used for 1GHz - 12.75GHz Rx Radiated Spurious Emissions tests
	200611-01.S06	Adaptor	PowerBy SNJ A4	-	2020-11-30	
	200602-03.S06	Absorber	MCS0	-	2020-07-03	
	200615-05.S06	Host	Latitude 7490	63QMRQ2	2020-06-12	
#05	201120-03.S01	WiFi 6E Module	AX211D2W	WFM: D8F8834C252A	2020-11-23	Used for conducted tests except Occupied Channel Bandwith & Transmitter unwanted emission in the out-of-band domain
	170000-01.S19	Laptop	Latitude E5450	4TXV562	2020-02-04	
	200611-01.S19	Extender	PCB00651_01	-	2021-06-02	

5. EUT Features

The herein information is provided by the customer

<table>
<tr><td>Brand Name</td><td colspan="3">Intel® Wi-Fi 6E AX211</td></tr>
<tr><td>Model Name</td><td colspan="3">AX211D2W</td></tr>
<tr><td>Software Version</td><td colspan="3">DRTU version: 11195_99_2100_51G</td></tr>
<tr><td>Driver Version</td><td colspan="3">99.0.58.3_t64</td></tr>
<tr><td>Supported Radios</td><td colspan="3">802.11b/g/n/ax 2.4GHz (2400.0 – 2483.5 MHz)
802.11a/n/ac/ax 5.2GHz (5150.0 – 5350.0 MHz)
5.6GHz (5470.0 – 5725.0 MHz)
5.8GHz (5725.0 – 5875.0 MHz)
Bluetooth 2.4GHz (2400.0 – 2483.5 MHz)</td></tr>
<tr><td>Antenna Information</td><td colspan="3"><table>
<tr><th>Transmitter</th><th>Main</th><th>Aux</th></tr>
<tr><td>Manufacturer</td><td>SkyCross</td><td>Skycross</td></tr>
<tr><td>Antenna type</td><td>PIFA antenna</td><td>PIFA antenna</td></tr>
<tr><td>Part number</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Antenna peak gain (dBi)</td><td>+3</td><td>+3</td></tr>
</table></td></tr>
</table>

6. Remarks and comments

1. According to the applicant declaration, the device AX211D2W operating in BLE mode is non adaptive equipment so it is considered as receiver category 2.
2. At customer request, the test cases 4.3.2.7 & 4.3.2.8 were carried out at higher Tx Power: +3dB vs nominal declared power.

7. Test Verdicts summary

The statement of conformity to applicable standards in the table below are based on the measured values, without taking into account the measurement uncertainties.

7.1. BT Low Energy

Mode	ETSI clause	Test	Verdict
2.4GHz	4.3.2.2	RF output power	P
	4.3.2.3	Power spectral density	P
	4.3.2.4	Duty Cycle, Tx-sequence, TX gap	NA
	4.3.2.5	Medium Utilization (MU) factor.	NA
	4.3.2.6	Adaptivity (adaptive equipment using modulations other than FHSS)	NA
	4.3.2.7	Occupied Channel Bandwidth	P
	4.3.2.8	Transmitter unwanted emissions in the out-of-band domain	P
	4.3.2.9	Transmitter unwanted emissions in the spurious domain	P
	4.3.2.10	Receiver spurious emissions	P
	4.3.2.11	Receiver Blocking	P

P: Pass
F: Fail
NM: Not Measured
NA: Not Applicable

8. Document Revision History

Revision #	Modified by	Revision Details
Rev. 00	G. Roustan	First Issue
Rev. 01	G. Roustan	Retest of Occupied Channel Bandwith & Transmitter unwanted emission in the out-of-band domain test cases at higher TX power
Rev.02	Z.Ouachicha	Editorial update in section A.1
Rev.03	Z.Ouachicha	Reviewer signature added

Annex A. Test & System Description

A.1 Measurement System

According to clause 4.2.1 the manufacturer declared that Bluetooth LE on this device doesn't qualify for FHSS, but instead to non-FHSS equipment. Measurements were performed using the following setups and made in accordance to the general provisions of EN300 328 v2.2.2 agreeing to the requirements in clause 4.3.2.

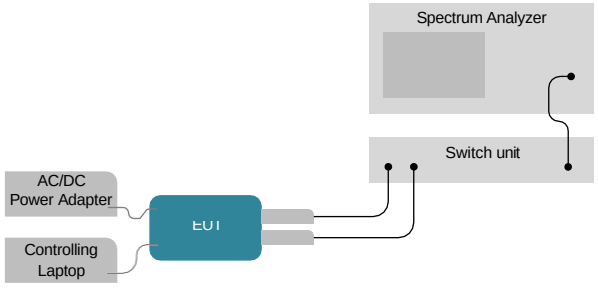
Rohde & Schwarz TS8997 system with the switching unit OSP120, OSP B-157 and software WMS32 were employed.

The DUT was installed in a test fixture and then connected to a laptop computer and AC/DC power adapter. The laptop computer was used to configure the EUT to continuously transmit at a specified output power using the Intel proprietary tool DRTU.

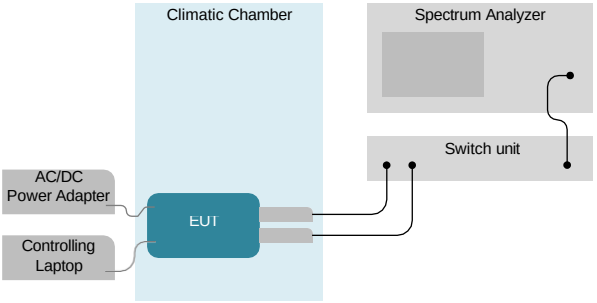
Setups for conducted and radiated measurements are shown below.

Conducted test setup

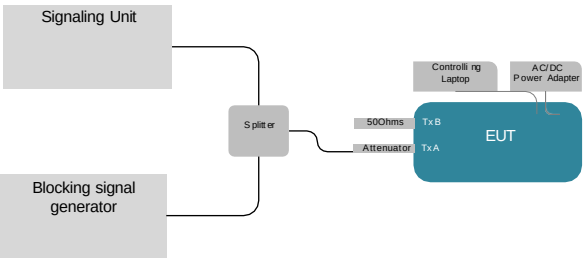
General test setup (SISO and MIMO)



Extreme conditions

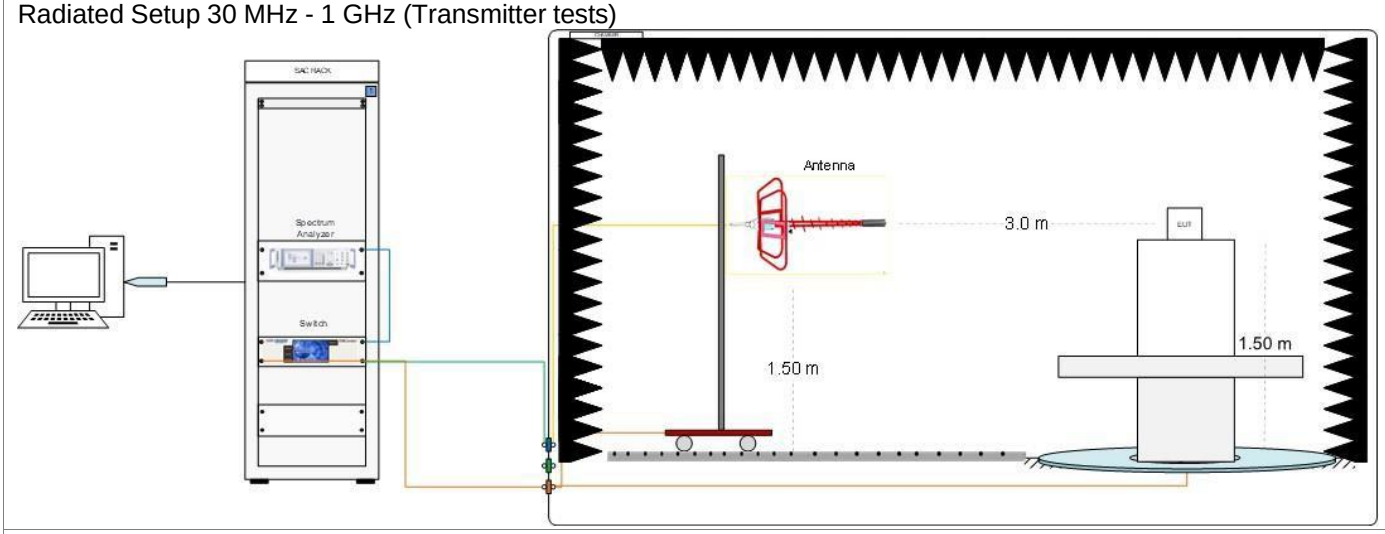


Receiver blocking

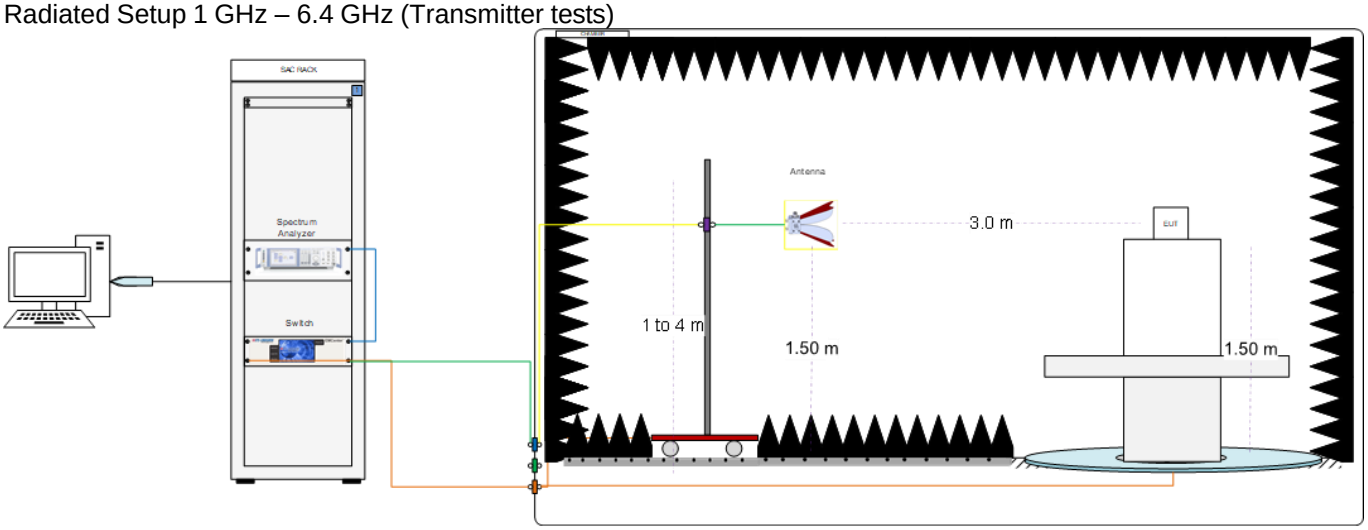


Radiated test setup

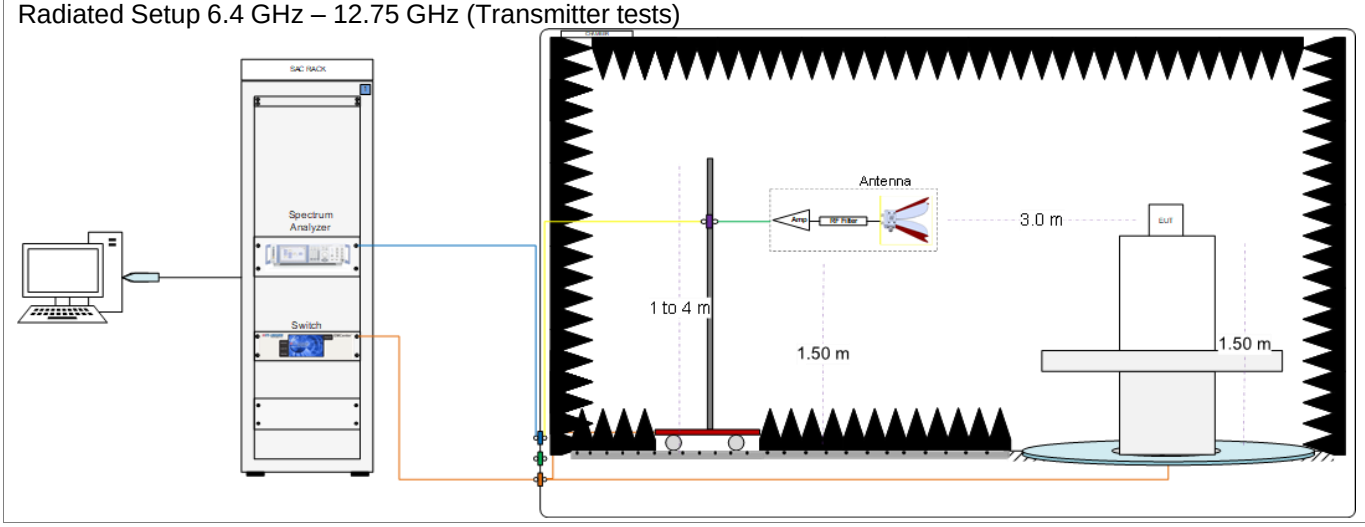
Radiated Setup 30 MHz - 1 GHz (Transmitter tests)



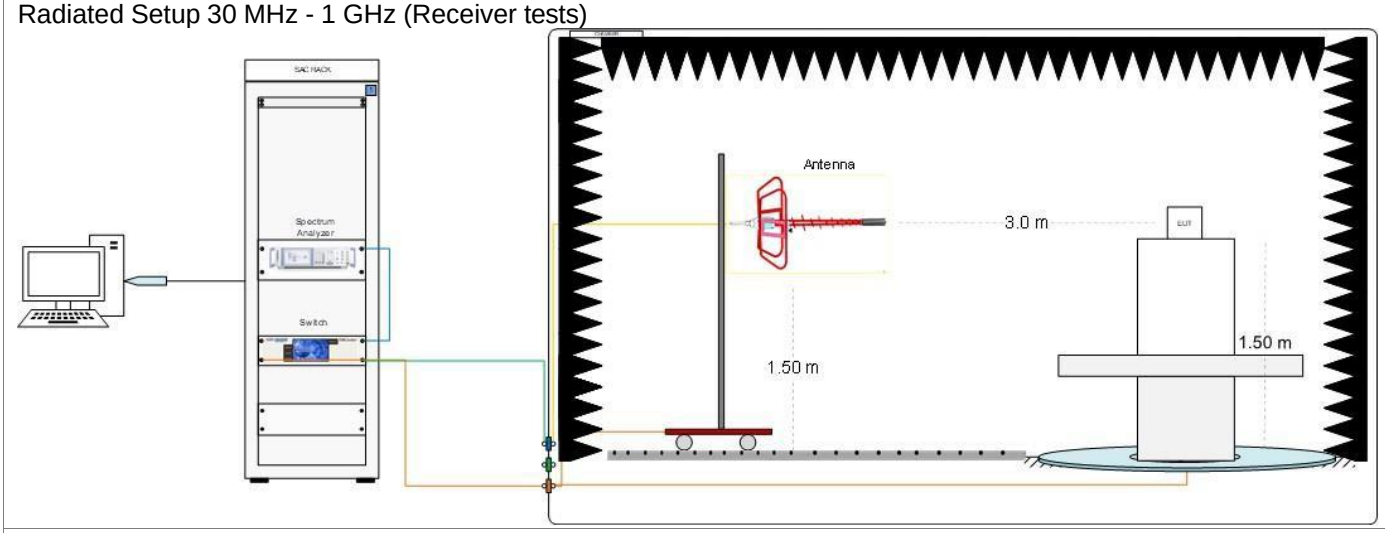
Radiated Setup 1 GHz – 6.4 GHz (Transmitter tests)



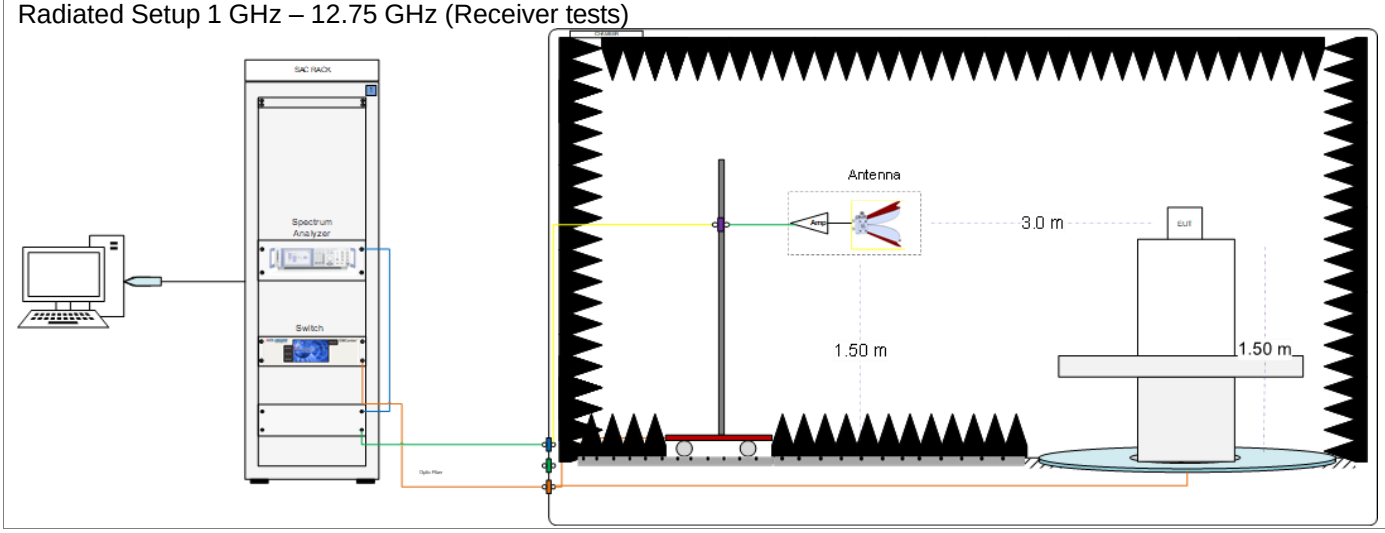
Radiated Setup 6.4 GHz – 12.75 GHz (Transmitter tests)



Radiated Setup 30 MHz - 1 GHz (Receiver tests)



Radiated Setup 1 GHz – 12.75 GHz (Receiver tests)



A.2 Test Equipment List

Conducted Setup

ID#	Device	Type/Model	Serial #	Manufacturer	Cal. Date	Cal. Due Date
017-015	Switch unit	OSP 120	100945	Rohde & Schwarz	2020-04-21	2022-04-21
017-003	DC Power supply	E3640A	MY40006885	Agilent	N/A	N/A
017-002	Multimeter	34401A	US36065790	HP	2019-12-11	2021-12-11
060-000	Multimeter	34401A	US36054685	Agilent	2020-10-26	2022-10-26
311-000	Climatic chamber	SLT34/40	56746020930010	Secasi	2019-11-20	2021-11-20
311-000	Climatic chamber	SLT34/40	56746020930010	Secasi	2021-12-13	2023-12-13
280-000	Spectrum analyzer	FSV30	103310	Rohde & Schwarz	2020-06-03	2022-06-03
145-000	Temp & Humidity Logger	RA12E-TH1-RAS	RA12-B89BE3	AVTECH	2020-01-23	2022-01-23
322-000	Temp & Humidity Logger	RA12E-TH1-RAS	RA12-B89702	AVTECH	2021-09-02	2023-09-02
017-000	Measurement Software	WMS32 v11.00.00	200226	Rohde & Schwarz	N/A	N/A
237-000	10dB directional coupler	MC2047-10	01-062	Fairview	2020-08-26	2022-02-26
017-005	RF Cable 0.5m	PE3CA1039	-	Pasternack	2020-08-26	2022-02-26
017-007	Cable SMA Male to ML51-P	HRMP-ML51LP	DTR178-100RS	Hirose	2020-08-26	2022-02-26
017-008	Cable SMA Male to ML51-P	HRMP-ML51LP	DTR178-100RS	Hirose	2020-08-26	2022-02-26
281-000	Thermometer	t3000FC	46320036	Fluke	2019-11-29	2021-11-29
053-000	Thermometer	t3000FC	46320032	Fluke	2021-11-15	2023-11-15
017-011	RF Cable 2m + 10dB ATT	0900670672000PJ	1936949	Radiall	2020-08-26	2022-02-26
017-012	RF Cable 2m + 10dB ATT	0900670672000PJ	1936947	Radiall	2020-08-26	2022-02-26
017-019	10dB attenuator	-	-	Pasternack	2020-08-26	2022-02-26
017-020	10dB attenuator	-	-	Pasternack	2020-08-26	2022-02-26

N/A: Not Applicable
Equipments were only used during their calibration period

Receiver blocking Setup

ID#	Device	Type/Model	Serial #	Manufacturer	Cal. Date	Cal. Due Date
125-000	Communication tester	CMW500	129337	Rohde & Schwarz	2019-04-02	2021-04-02
130-000	Signal generator	SMB100A	178217	Rohde & Schwarz	2020-04-17	2022-04-17
016-000	RF Cable 1.2m	UFA147A-0-0480-200200	MFR 64639 223720-001	Micro-coax	2020-08-26	2021-02-26
362-000	Temp & Humidity Logger	RA12E-TH1-RAS	RA12-D4F316	Avtech	2019-07-05	2021-07-05
016-003	RF Cable 0.5m	FMC0202085-18	-	Fairview	2020-08-26	2021-02-26
016-004	RF splitter	PE2083	-	Pasternack	N/A	N/A
016-001	RF Cable 0.9m	PE3CA 1039-36	-	Pasternack	2020-08-26	2021-02-26

N/A: Not Applicable
Equipments were only used during their calibration period

Radiated Setup #1

ID#	Device	Type/Model	Serial #	Manufacturer	Cal. Date	Cal. Due Date
006-000	Anechoic Chamber	FACT3	5720	ETS-Lindgren	2020-01-07	2022-01-07
006-001	Turn Table	ETS	-	ETS-Lindgren	N/A	N/A
147-000	Spectrum Analyzer	FSW43	101847	Rohde & Schwarz	2020-11-02	2022-11-02
006-008	Measurement SW	EMC32, v10.40.10	100623	Rohde & Schwarz	N/A	N/A
006-002	Switch & Positioning systems	EMC Center	00159757	ETS-Lindgren	N/A	N/A
006-022	Biconilog Antenna	3142E	00156946	ETS-Lindgren	2020-03-12	2022-03-12
056-000	Horn Antenna+ Amplifier + HPF6.4	3117	00157736	ETS-Lindgren	2020-04-02	2022-04-02
006-020	Horn antenna 3117	3117	00157734	ETS-Lindgren	2019-08-12	2021-08-12
059-000	Double-Ridged Horn Antenna with Pre-Amplifier	3117-PA	00201542	ETS-Lindgren	2019-08-16	2021-08-16
006-051	Cable 1.5m - DC-18GHz	CBL-1.5M-SMSM+	202879	Mini-Circuits	2020-11-27	2021-05-27
006-034	Cable 1m - 1GHz to 18GHz	UFA147A	-	Utilflex	2020-08-25	2021-02-25
006-036	Cable 1m – 30 MHz - 18GHz	UFB311A-0-0590-50U50U	MFR 64639 223230-001	Micro-coax	2020-08-25	2021-02-25
006-052	Cable 7m DC-18 GHz	0501051057000GX	19.35.850	Radial	2020-11-27	2021-05-27
006-039	Cable 2.5m - 30MHz to 18GHz	0500990992500KE	19.23.395	Radiall	2020-11-27	2021-05-27
006-011	Boresight antenna mast	BAM 4.0-P	P/278/2890.01	Maturo	N/A	N/A
363-000	Temp & Humidity Logger	RA12E-TH1-RAS	RA12-D0EB1A	Avtech	2019-07-04	2021-07-04

Equipments were only used during their calibration period
N/A: Not Applicable

Radiated Setup #2

ID#	Device	Type/Model	Serial #	Manufacturer	Cal. Date	Cal. Due Date
007-000	Anechoic chamber	RFD-FA-100	5996	ETS Lindgren	2020-07-06	2022-07-06
007-006	Switch & Positioner	EMCenter	00151232	ETS Lindgren	N/A	N/A
007-003	Antenna Tower	2171B-3.0M	00150123	ETS Lindgren	N/A	N/A
007-002	Turntable	-	-	ETS Lindgren	N/A	N/A
007-005	Measurement SW	EMC32, v10.50.10	100401	Rohde & Schwarz	N/A	N/A
127-000	Spectrum Analyzer	FSV40	101358	Rohde & Schwarz	2020-02-25	2022-02-25
007-007	Double Ridge Horn (1-18GHz)	3117	00152266	ETS Lindgren	2020-03-08	2022-03-08
056-000	Horn Antenna 3117 + Amplifier + HPF6.4	3117	00157736	ETS-Lindgren	2020-04-01	2022-04-01
059-000	Double-Ridged Horn Antenna with Pre-Amplifier	3117-PA	00201542	ETS-Lindgren	2019-08-16	2021-08-16
007-021	RF Cable 1-18GHz, 1.5 m	0501050991200GX	19.21.710	Radiall	2020-08-20	2021-02-20
007-020	RF Cable 1-18GHz, 1.2 m	2301761761200PJ	12.22.1104	Radiall	2020-08-20	2021-02-20
007-011	RF Cable 1-18GHz - 6.5m	140-8500-11-51	001	Spectrum	2020-08-20	2021-02-20
007-015	RF Cable 1GHz-18GHz 1.5m	-	-	Spirent	2020-08-20	2021-02-20
007-018	RF Cable 1-9.5GHz 1.2m	0500990991200KE	-	Radiall	2020-08-20	2021-02-20
362-000	Temp & Humidity Logger	RA12E-TH1-RAS	RA12-D4F316	Avtech	2019-07-05	2021-07-05

Equipments were only used during their calibration period
N/A: Not Applicable

Shared Radiated Equipment

ID#	Device	Type/Model	Serial #	Manufacturer	Cal. Date	Cal. Due Date
022-000	Power Sensor	NRP-Z81	104385	Rohde & Schwarz	2020-04-08	2022-04-08
061-000	Power Sensor	NRP-Z81	104386	Rohde & Schwarz	2020-04-08	2022-04-08
140-000	Power Sensor	NRP-Z81	104382	Rohde & Schwarz	2020-04-08	2022-04-08

A.3 Measurement Uncertainty Evaluation

The system uncertainty evaluation is shown in the table below with a coverage factor of k = 2 to indicate a 95% level of confidence:

Measurement type	Uncertainty	Unit
Occupied Channel Bandwidth	±2.08	%
RF Output Power, conducted	±0.99	dB
Power Spectral Density, conducted	±0.99	dB
Unwanted Emission, conducted	±1.53	dB
Receiver Blocking	±1.65	dB
Radiated test < 1GHz	±4.03	dB
Radiated test 1GHz –12.75 GHz	±4.01	dB
Temperature	±0.30	ºC
Supply voltages	<±0.01	%
Time	±0.02	%

Annex B. Test Results

The herein test results were performed by:

Test case measurement	Test Personnel
RF output power, duty cycle	G. Roustan
Power spectral density	G. Roustan
Occupied channel bandwidth	G. Roustan
Transmitter unwanted emission in the out-of-band domain	G. Roustan
Transmitter unwanted emissions in the spurious domain	A. Lounes, N. Bui, N. Nachabe
Receiver spurious emissions	A. Lounes, N. Bui, N. Nachabe
Receiver blocking	Z. Ouachicha

B.1 Test Conditions

ETSI clause	Conditions	ETSI EN 300 328 v2.2.2 Annex E
5.1.2.1	The normal temperature and humidity conditions for tests shall be any convenient combination of temperature and humidity within the following ranges: • Temperature: +15 °C to +35 °C; • Relative humidity: 20 % to 75 %.	
5.1.2.2	The normal test voltage for the equipment shall be the nominal voltage for which the equipment was designed.	**"Information provided by the customer"**
5.1.3	Some tests in the present document need to be repeated at extreme temperatures. Where that is the case, measurements shall be made over the extremes of the operating temperature range as declared by the manufacturer.	

B.2 RF output power

Test limits

ETSI clause	Limits
4.3.2.2.3	For non-adaptive non-FHSS equipment, where the manufacturer has declared an RF output power of less than 20 dBm e.i.r.p., the RF output power shall be equal to or less than that declared value. This limit shall apply for any combination of power level and intended antenna assembly.

Test conditions

ETSI clause	Conditions
5.4.2.1	The measurements for RF output power shall be performed at both normal environmental conditions and at the extremes of the operating temperature range. For equipment using wide band modulations other than FHSS, the measurement shall be performed at the lowest, the middle, and the highest channel on which the equipment can operate.

Test procedure

The conducted setups shown in section

Test & System Description were used to measure the RF output power. The antenna terminal of the EUT is connected to the OSP120 through a 10dB attenuator and a cable. System connection cable loss is compensated by the WMS32 software

Antenna gain is taken in account and added by the software to the measurements. The EIRP power (dBm) is calculated by adding the declared maximum antenna gain to the measured conducted power.

Results tables

Normal conditions

			Power [dBm]	
Mode	Meas. Duty Cycle [%]	Freq. [MHz]	Measured Conducted	EIRP
BLE	62.90	2402	6.7	9.7
		2442	6.8	9.8
		2480	7.0	10.0

Extreme temperature conditions (Tmax = +70°C)

			Power [dBm]	
Mode	Meas. Duty Cycle [%]	Freq. [MHz]	Measured Conducted	EIRP
BLE	62.90	2402	5.8	8.8
		2442	5.9	8.9
		2480	6.1	9.1

Extreme temperature conditions (Tmin = -10°C)

			Power [dBm]	
Mode	Meas. Duty Cycle [%]	Freq. [MHz]	Measured Conducted	EIRP
BLE	62.90	2402	6.7	9.7
		2442	6.8	9.8
		2480	6.9	9.9

B.3 Power Spectral Density

Test limits

ETSI clause	Limits
4.3.2.3.3	The maximum Power Spectral Density for non-FHSS equipment is 10 dBm per MHz.

Test conditions

ETSI clause	Conditions
5.4.3.1	These measurements shall only be performed at normal test conditions. The measurement shall be repeated for the equipment being configured to operate at the lowest, the middle, and the highest frequency of the stated frequency range. For the duration of the test, the equipment shall not change its operating frequency.

Test procedure

The conducted setup shown in section

Test & System Description was used to measure the power spectral density (PSD) accordingly to the test method described in ETSI EN 300 328 v2.2.2 §5.4.3.2.1. The antenna terminal of the EUT is connected to the OSP120 through a 10dB attenuator and a cable, the spectrum analyzer is connected to the receiver port on the OSP. System connection cable loss is compensated by the WMS32 software to measure all parameters.

Antenna gain is taken in account and added by the software to the measurements. The EIRP power (dBm) is calculated by adding the declared maximum antenna gain to the measured conducted power.

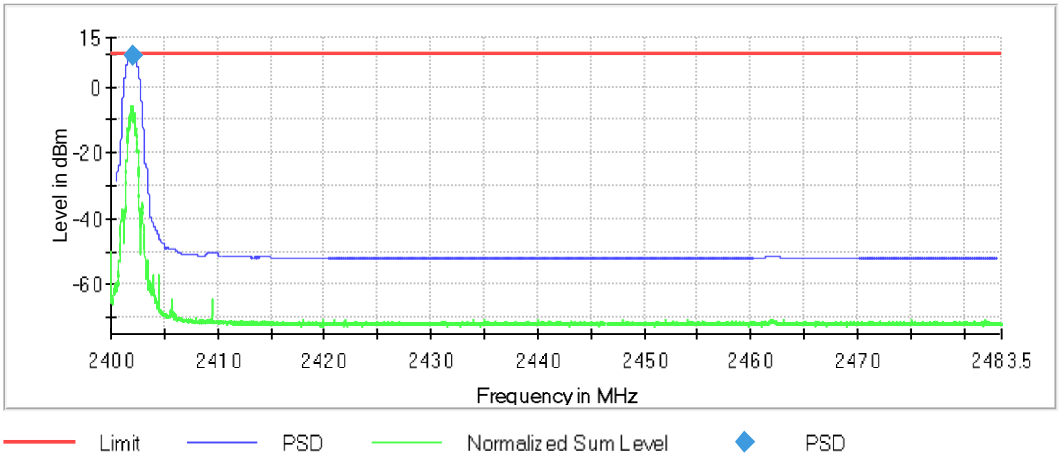
Results tables

Mode	Meas. Duty Cycle [%]	Freq. [MHz]	PSD [dBm/MHz]
BLE	62.90	2402	9.6
		2442	9.7
		2480	9.9

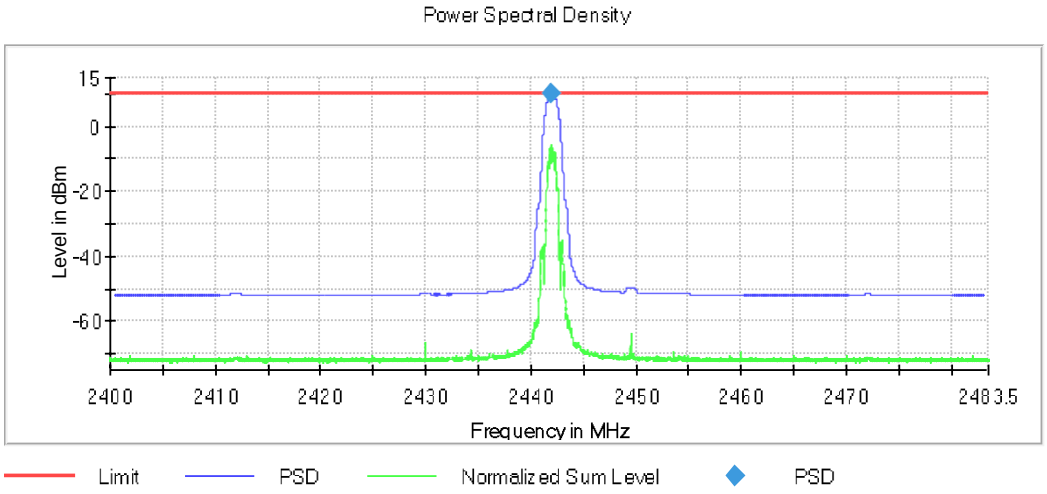
Results screenshot

BLE

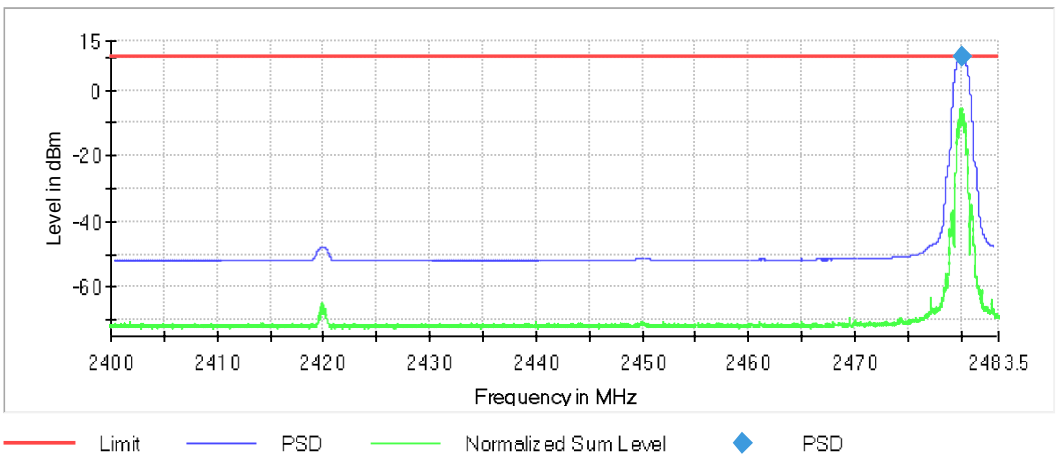
PSD – 2402 MHz



PSD – 2442 MHz



PSD – 2480 MHz



B.4 Occupied Channel Bandwidth

Tests limits

<table>
<tr><th>ETSI clause</th><th>Limits</th></tr>
<tr><td>4.3.2.7.3</td><td>The Occupied Channel Bandwidth shall fall completely within the band given in Table 1 (2.4 GHz to 2.4835 GHz).
Table 1: Service frequency bands
<table>
<tr><th></th><th>Service frequency bands</th></tr>
<tr><td>Transmit</td><td>2 400 MHz to 2 483,5 MHz</td></tr>
<tr><td>Receive</td><td>2 400 MHz to 2 483,5 MHz</td></tr>
</table>
In addition, for non-adaptive equipment using wide band modulations other than FHSS and with e.i.r.p greater than 10 dBm, the occupied channel bandwidth shall be less than 20 MHz.</td></tr>
</table>

Test conditions

ETSI clause	Conditions
5.4.7.1	These measurements shall only be performed at normal test conditions. In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains) measurements need only to be performed on one of the active transmit chains (antenna outputs). The measurement shall be performed only on the lowest and the highest frequency within the stated frequency range. If the equipment can operate with different Nominal Channel Bandwidths (e.g. 20 MHz and 40 MHz), then each channel bandwidth shall be tested separately.

Test procedure

The conducted setup shown in section

Test & System Description was used to measure the occupied bandwidth accordingly to the test method described in ETSI EN 300 328 v2.2.2 §5.4.7.2.1. The antenna terminal of the EUT is connected to the OSP120 through a 10 dB attenuator and a cable, the spectrum analyzer is connected to the receiver port on the OSP. System connection cable loss is compensated by the WMS32 software on measured parameters.

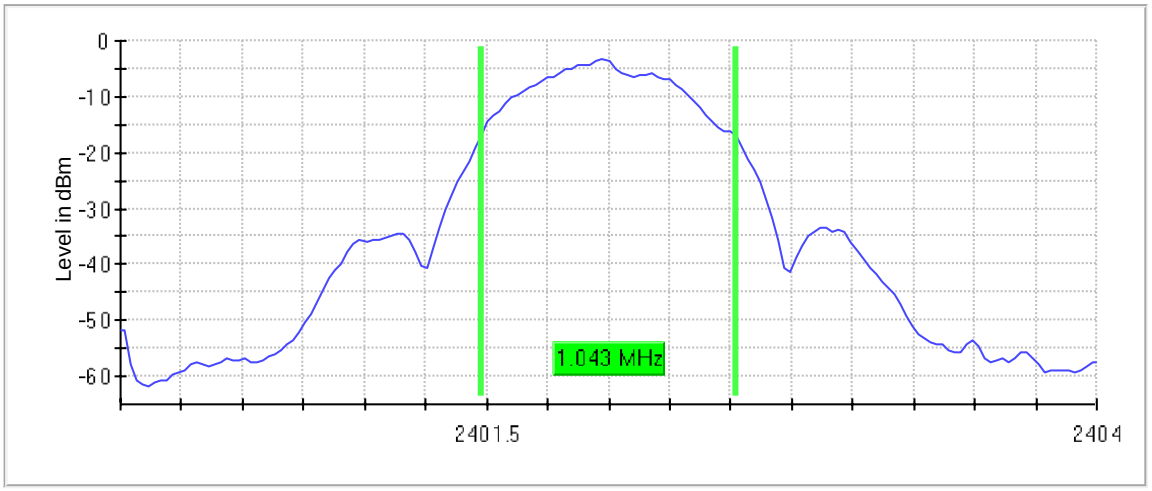
Results tables

Mode	Frequency [MHz]	Channel Nominal Bandwidth (MHz)	Channel Center Frequency (MHz)	Occupied Channel Bandwidth (MHz)	Lower Band Edge (MHz)	Upper Band Edge (MHz)
BLE	2402	1.00	2402	1.04	2401.48	2402.52
	2480	1.00	2480	1.04	2479.48	2480.52

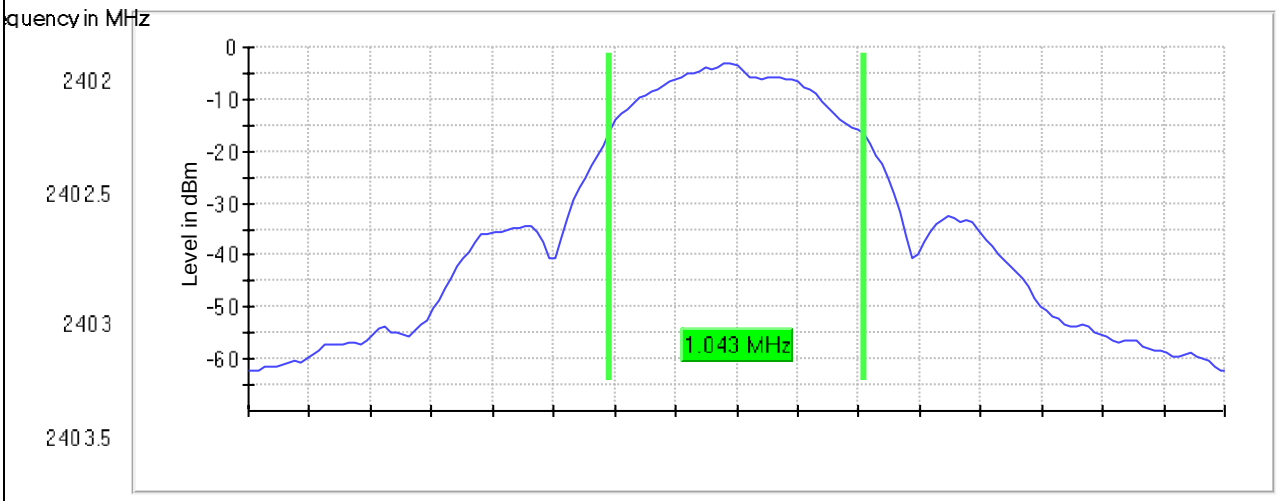
Results screenshot

BLE

OBW – 2402 MHz

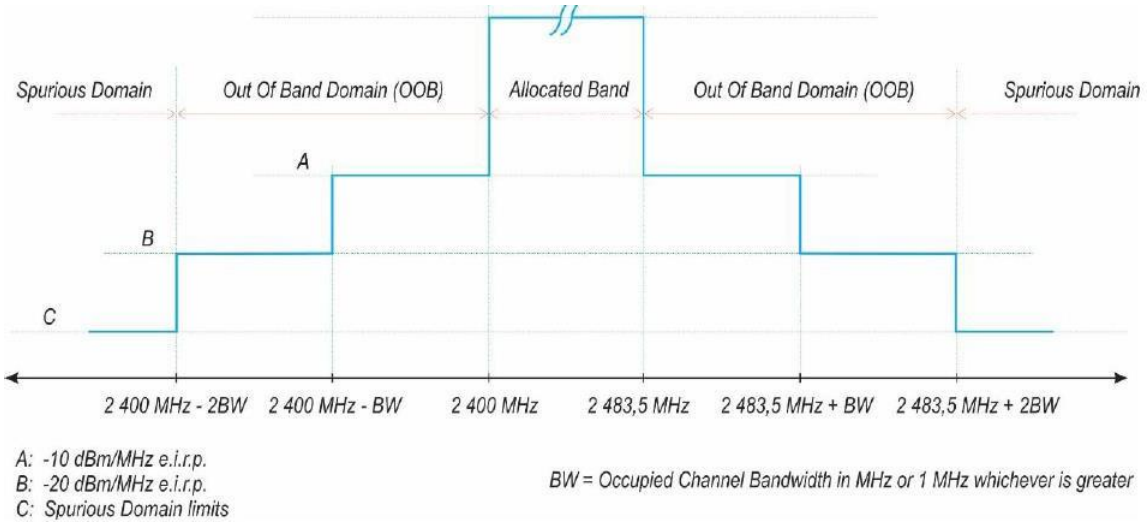


OBW – 2480 MHz



B.5 Transmitter unwanted emission in the out-of-band domain

Test limits Test limits

ETSI clause	Limits
4.3.2.8.3	The transmitter unwanted emissions in the out-of-band domain but outside the allocated band, shall not exceed the values provided by the mask below 

Test conditions

ETSI clause	Conditions
5.4.8.1	These measurements shall only be performed at normal test conditions. For non-FHSS equipment, the measurement shall be performed at the lowest and the highest channel on which the equipment can operate. These operating channels shall be recorded. The equipment shall be configured to operate under its worst case situation with respect to output power. If the equipment can operate with different Nominal Channel Bandwidths (e.g. 20 MHz and 40 MHz), then each channel bandwidth shall be tested separately.

Test procedure

The conducted setup shown in section

Test & System Description was used to measure the unwanted emissions in the out of band domain accordingly to the test method described in ETSI EN 300 328 v2.2.2 §5.4.8.2.1. The antenna terminal of the EUT is connected to the OSP120 through a 10dB attenuator and a cable, the spectrum analyzer is connected to the receiver port on the OSP. System connection cable loss is compensated by the WMS32 software on measured parameters.

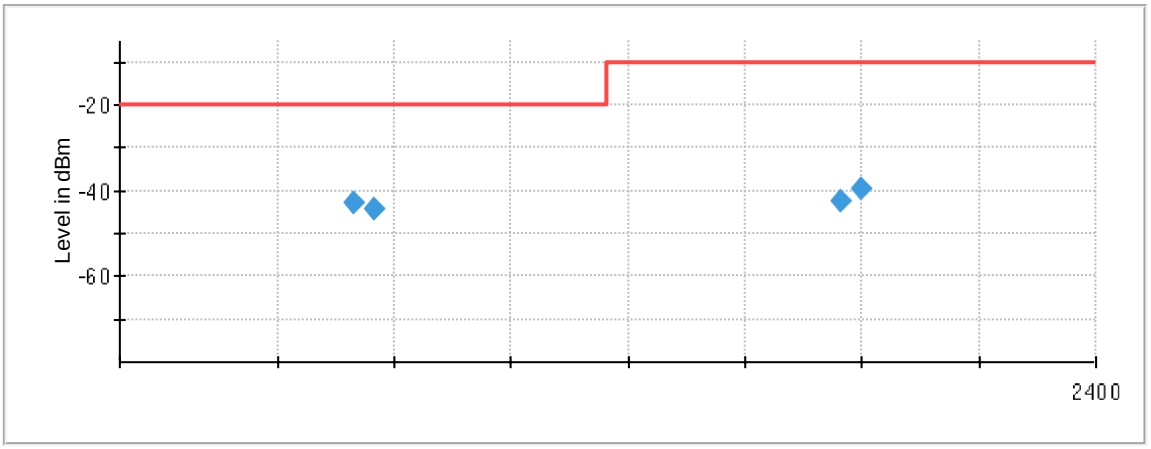
Antenna gain is taken into account and added by the software to the measurements.

WMS32 provides the mask and the frequency limits based in the measured channel bandwidth. Maximum values for each limit level (-10dBm and -20dBm) are pointed using markers.

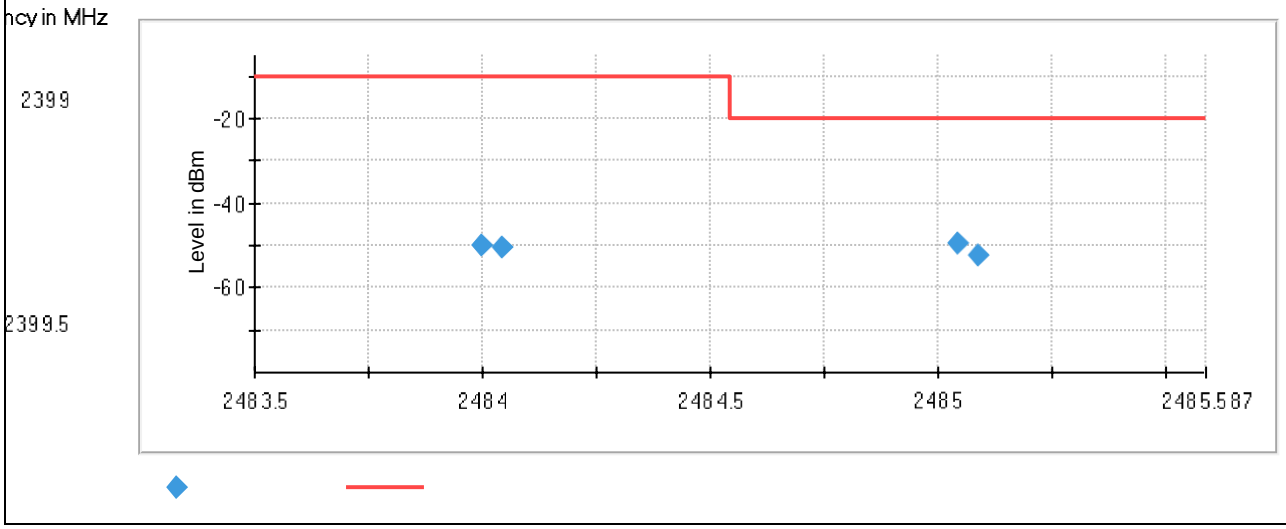
Results Screenshot

BLE

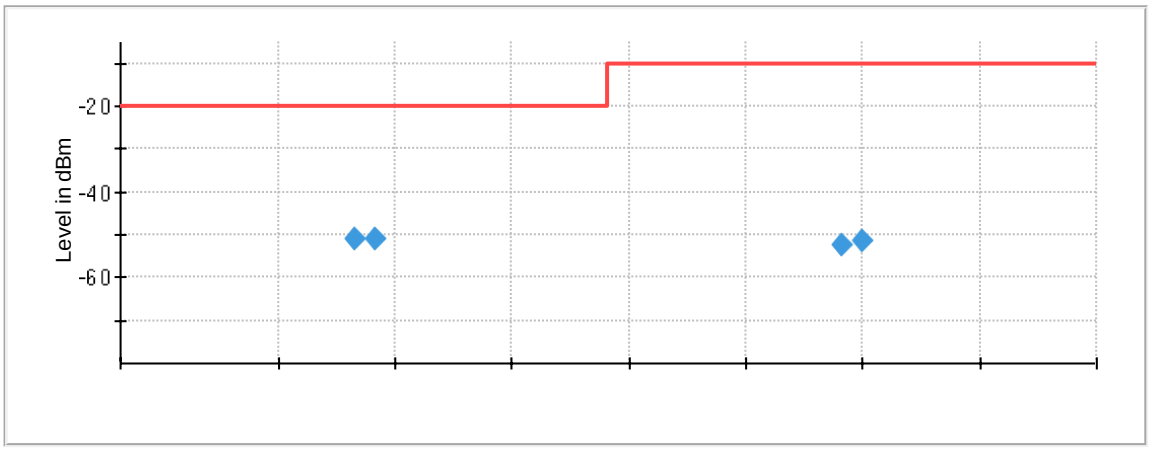
UNWANTED OOB Low Freq Section, 2402 MHz



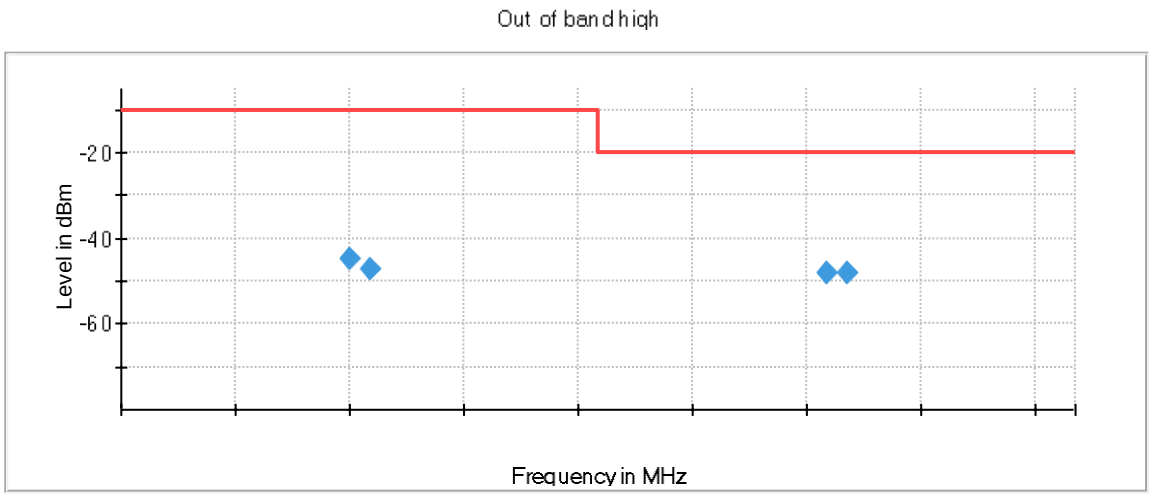
UNWANTED OOB High Freq Section, 2402 MHz



UNWANTED OOB Low Freq Section, 2480 MHz



UNWANTED OOB High Freq Section, 2480 MHz



B.6 Transmitter unwanted emissions in the spurious domain

Test limits

<table>
<tr><th>ETSI clause</th><th>Limits</th></tr>
<tr><td>4.3.2.9.3</td><td>The transmitter unwanted emissions in the spurious domain shall not exceed the values given in table below.

For emissions radiated by the cabinet or emissions radiated by integral antenna equipment (without antenna connectors), these limits are e.r.p. for emissions up to 1 GHz and as e.i.r.p. for emissions above 1 GHz

<table>
<tr><th>Frequency range</th><th>Maximum power</th><th>Bandwidth</th></tr>
<tr><td>30 MHz to 47 MHz</td><td>-36 dBm</td><td>100 kHz</td></tr>
<tr><td>47 MHz to 74 MHz</td><td>-54 dBm</td><td>100 kHz</td></tr>
<tr><td>74 MHz to 87.5 MHz</td><td>-36 dBm</td><td>100 kHz</td></tr>
<tr><td>87.5 MHz to 118 MHz</td><td>-54 dBm</td><td>100 kHz</td></tr>
<tr><td>118 MHz to 174 MHz</td><td>-36 dBm</td><td>100 kHz</td></tr>
<tr><td>174 MHz to 230 MHz</td><td>-54 dBm</td><td>100 kHz</td></tr>
<tr><td>230 MHz to 470 MHz</td><td>-36 dBm</td><td>100 kHz</td></tr>
<tr><td>470 MHz to 694 MHz</td><td>-54 dBm</td><td>100 kHz</td></tr>
<tr><td>694 MHz to 1 GHz</td><td>-36 dBm</td><td>100 kHz</td></tr>
<tr><td>1 GHz to 12.75 GHz</td><td>-30 dBm</td><td>1 MHz</td></tr>
</table>
</td></tr>
</table>

Test conditions

ETSI clause	Conditions
5.4.9.1	These measurements shall only be performed at normal test conditions. For non-FHSS equipment, the measurement shall be performed at the lowest and the highest channel on which the equipment can operate. The equipment shall be configured to operate under its worst case situation with respect to output power. If the equipment can operate with different Nominal Channel Bandwidths (e.g. 20 MHz and 40 MHz), then the equipment shall be configured to operate under its worst case situation with respect to spurious emissions.

Test procedure

The radiated setups (transmitter) shown in section

Test & System Description were used to measure the transmission spurious emissions accordingly with ETSI EN 300 328 v2.2.2 § 5.4.9.2.2. Depending of the frequency range and bands being tested, different antennas and filters were used; in consequence different setups are employed.

The final measurement is done by varying the antenna height from 1 to 4 meters, the EUT azimuth over 360º and for both Vertical and Horizontal polarizations.

The radiated spurious emission was measured on the worst case configuration on the low and high channel for each transmission mode.

Tx Spurious emission was carried out initially at Maximum Conducted Power

Test Results

Tx Spurious Emissions – 30MHz to 1GHz

Tx Spurious Emissions – All modes

Frequency	RMS	Limit (e.i.r.p)	Margin	Polarization
MHz	dBm	dBm	dB	---
71.9	-65.9	-51.9	14.0	V

Note 1: The spurious signals detected do not depend on either the operating channel or the modulation mode.

Tx Spurious Emissions – 1GHz to 12.75GHz

Tx Spurious Emissions – Bluetooth BLE , 2402 MHz

Frequency	RMS	Limit	Margin	Polar
MHz	dBm	dBm	dB	---
3385.0	-46.8	-30.0	16.8	V
10399.0	-59.2	-30.0	29.2	H

Tx Spurious Emissions – Bluetooth BLE , 2480 MHz

Frequency	RMS	Limit	Margin	Polar
MHz	dBm	dBm	dB	---
3279.5	-47.2	-30.0	17.2	H
10461.5	-59.6	-30.0	29.6	V

B.7 Receiver spurious emissions

Test limits

<table>
<tr><th>ETSI clause</th><th>Limits</th></tr>
<tr><td>4.3.2.10.3</td><td>The spurious emissions of the receiver shall not exceed the values given in table 13.

For emissions radiated by the cabinet or for emissions radiated by integral antenna equipment (without antenna connectors), these limits are e.r.p. for emissions up to 1 GHz and e.i.r.p. for emissions above 1 GHz.

Table 13: Spurious emission limits for recievers
<table>
<tr><th></th><th></th><th></th></tr>
<tr><td>30 MHz to 1GHz</td><td>-57 dBm</td><td>100 kHz</td></tr>
<tr><td>1GHz to 12.75 GHz</td><td>-47 dBm</td><td>1 MHz</td></tr>
</table>
</td></tr>
</table>

Test conditions

ETSI clause	Conditions
5.3.10.1	These measurements shall only be performed at normal test conditions. Testing shall be performed when the equipment is in a receive-only mode. For non-FHSS equipment, the measurement shall be performed at the lowest and the highest channel on which the equipment can operate

Test procedure

The radiated setups (receiver) shown in section

Test & System Description were used to measure receiver spurious emissions accordingly with ETSI EN 300 328 v2.2.2 § 5.4.10.2.2. Depending of the frequency range and bands being tested, different antennas and filters were used.

The final measurement is done by varying the antenna height from 1 to 4 meters, the EUT azimuth over 360º and for both Vertical and Horizontal polarizations.

The radiated spurious emission was measured on the worst case configuration and on the low and high channel for each transmission mode.

Test Results

Rx Spurious Emissions – 30MHz to 1GHz

Rx Spurious Emissions – All modes

Frequency	RMS	Limit (e.i.r.p)	Margin	Polarization
MHz	dBm	dBm	dB	---
72.0	-64.3	-54.9	9.4	V

Note 1: The spurious signals detected do not depend on either the operating channel or the modulation mode.

Rx Spurious Emissions – 1GHz to 12.75GHz

Rx Spurious Emissions – Bluetooth BLE , 2402 MHz

Frequency	RMS	Limit	Margin	Polar
MHz	dBm	dBm	dB	---
4797.5	-60.2	-47.0	13.2	V

Rx Spurious Emissions – Bluetooth BLE , 2480 MHz

Frequency	RMS	Limit	Margin	Polar
MHz	dBm	dBm	dB	---
12347.9	-58.3	-47.0	11.3	H

B.8 Receiver Blocking

Test limits

<table>
<tr><th>ETSI clause</th><th>Limits</th></tr>
<tr><td>4.3.2.11.3

4.3.2.11.4</td><td>For equipment that supports a PER or FER test to be performed, the minimum performance criterion shall be a PER or FER less than or equal to 10 %.

While maintaining the minimum performance criteria as defined in clause 4.3.2.11.3, the blocking levels at specified frequency offsets shall be equal to or greater than the limits defined for the applicable receiver category provided in table below.

Receiver blocking parameters for Receiver Category 2 equipment
<table>
<tr><th>Wanted signal mean power from companion device (dBm) (see notes 1 and 3)</th><th>Blocking signal frequency (MHz)</th><th>Blocking signal power (dBm) (see note 3)</th><th>Type of blocking signal</th></tr>
<tr><td>(-139 dBm + 10 × log10(OCBW) + 10 dB) or (-74 dBm + 10 dB) whichever is less (see note 2)</td><td>2380
2504
2300
2584</td><td>-34</td><td>CW</td></tr>
<tr><td colspan="4">NOTE 1: OCBW is in Hz
NOTE 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to Pmin + 26 dB where Pmin is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.
NOTE 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned as recorded in clause 5.4.3.2.2.</td></tr>
</table></td></tr>
</table>

Test conditions

ETSI clause	Conditions
5.4.11.1	These measurements shall only be performed at normal test conditions. For non-FHSS equipment, having more than one operating channel, the operating channels on which the testing has to be performed shall be selected as follows: • For testing blocking frequencies less than 2400 MHz, the equipment shall operate on the lowest operating channel. • For testing blocking frequencies greater than 2500 MHz, the equipment shall operate on the highest operating channel. Equipment which can change their operating channel automatically (adaptive channel allocation), and where this function cannot be disabled, shall be tested as a FHSS equipment. If the equipment can be configured to operate with different Nominal Channel Bandwidths (e.g. 20 MHz and 40 MHz) and different data rates, then the combination of the smallest channel bandwidth and the lowest data rate for this channel bandwidth which still allows the equipment to operate as intended shall be used. This mode of operation shall be aligned with the performance criteria defined in clause 4.3.1.12.3 or clause 4.3.2.11.3 and shall be described in the test report..

Test procedure

The receiver blocking setup shown in section

Test & System Description was used to measure receiver blocking signal. The signaling Unit is a CMW500.

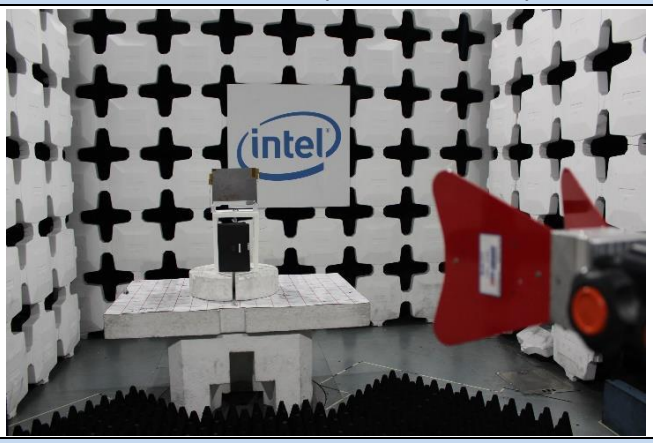
The packet error rate (PER) is measured with the CMW500. The blocking signal is emulated by the Signal generator SMB100A. Antenna gain and insertion loss are taken into account.

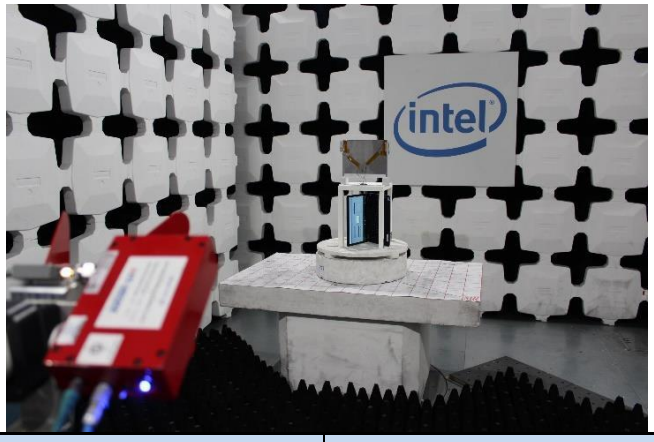
Test results

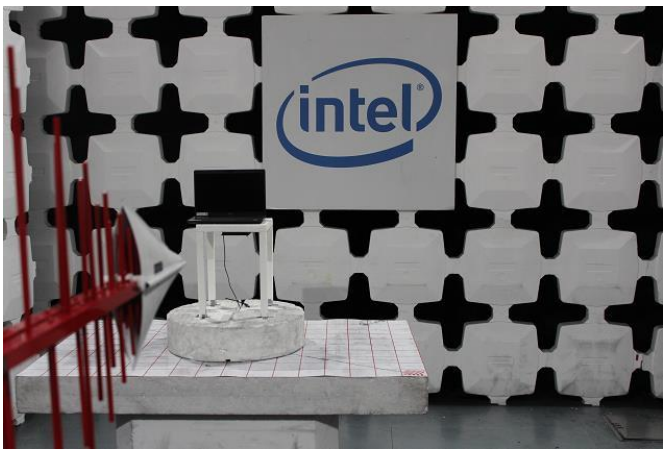
Configuration	99% Occupied bandwidth [MHz]	Wanted signal mean power from companion device (dBm)	PER [%] Without blocking signal	Blocking signal [MHz]	Blocking signal Power at DUT input [dBm]	PER [%] With Blocking signal	Verdict
		Without blocking signal		With blocking signal			
BLE Chain A 2402MHz	1.07	-70.71	1.80	2300	-36	0.95	Pass
		-70.71	1.80	2380	-36	1.18	Pass
BLE Chain A 2480MHz	1.04	-70.82	1.02	2504	-36	0.90	Pass
		-70.82	1.02	2584	-36	1.15	Pass

Annex C. Photographs

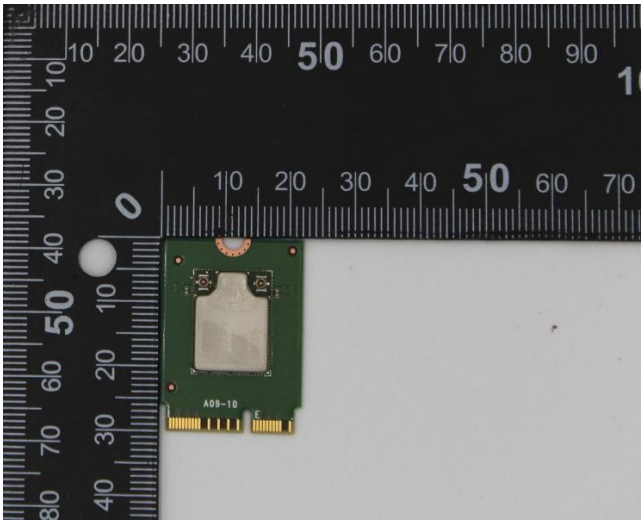
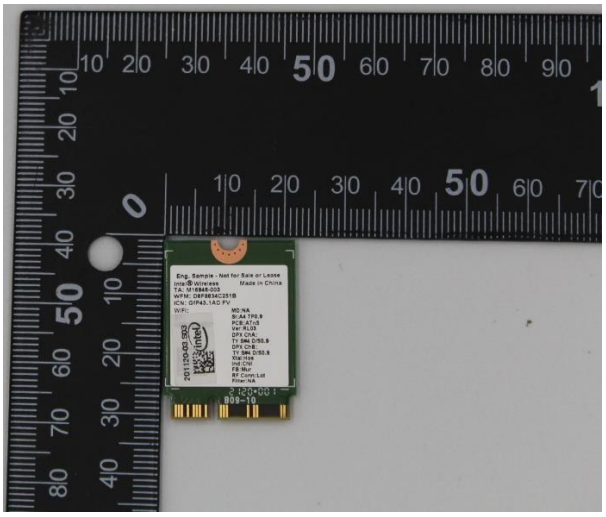
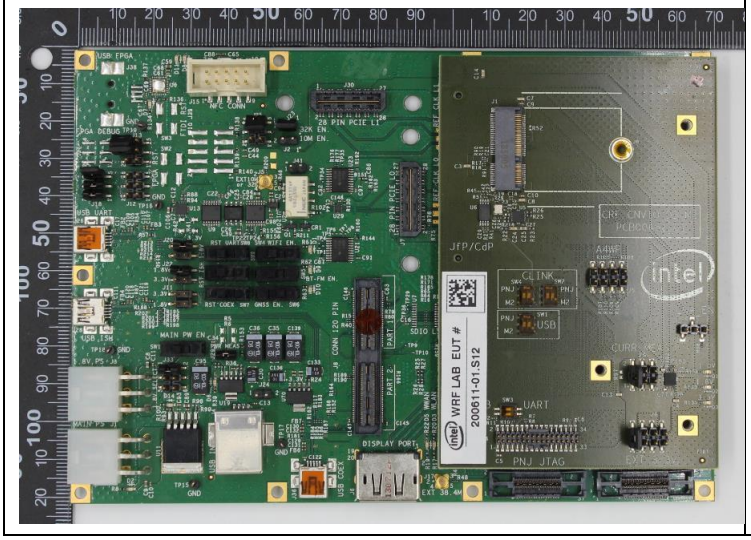
C.1 Test Setup

Radiated Setup 30 MHz – 1 GHz (Transmitter tests)	Radiated Setup 1 GHz – 6.4 GHz (Transmitter tests)
	

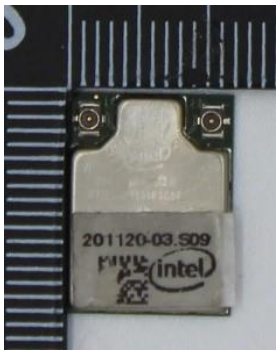
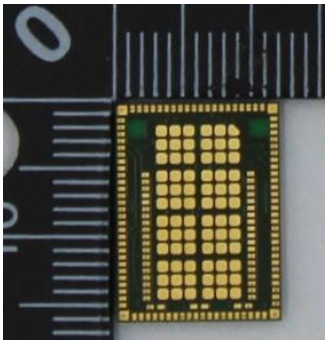
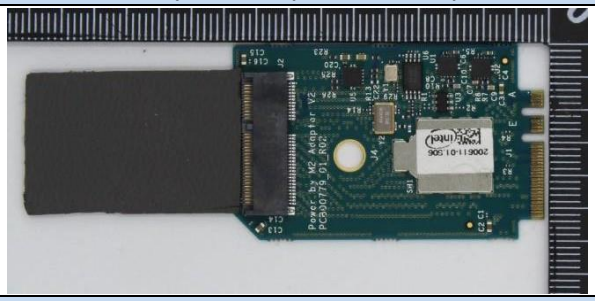
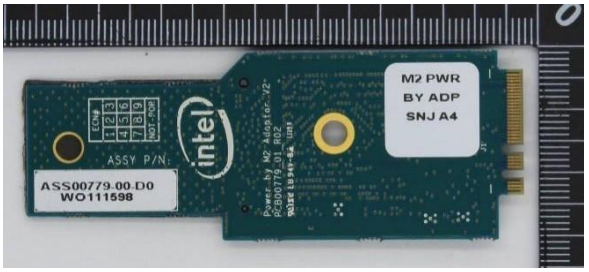
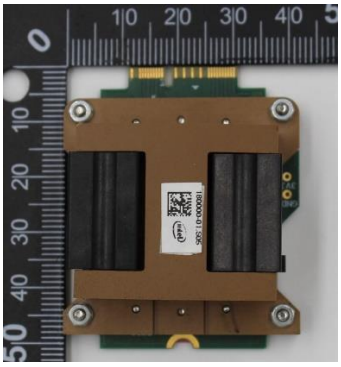
Radiated Setup 6.4 GHz – 12.75 GHz (Transmitter tests)


Radiated Setup 30 MHz – 1 GHz (Receiver tests)	Radiated Setup 1 GHz – 12.75 GHz (Receiver tests)
	

C.2 Test Sample

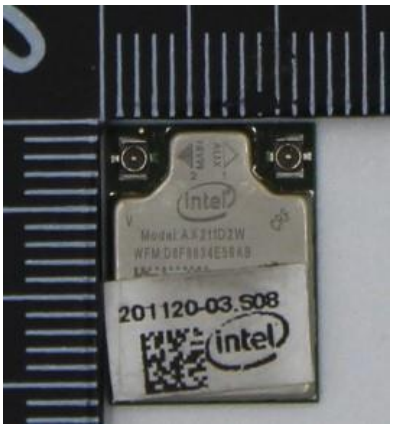
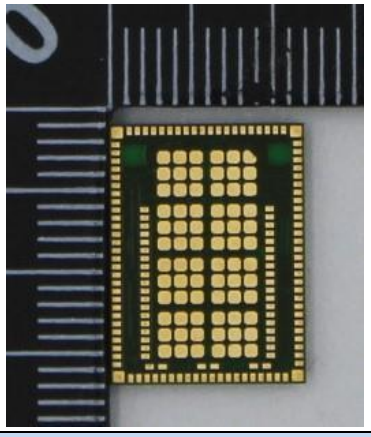
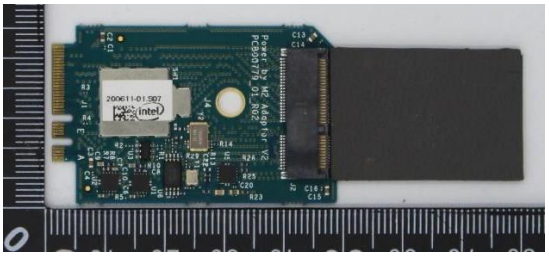
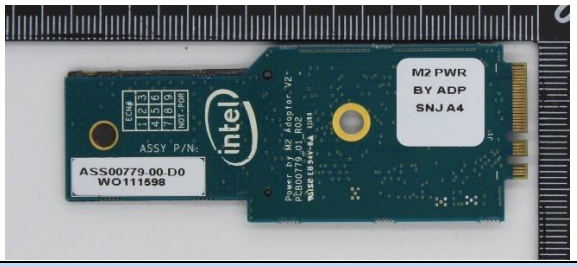
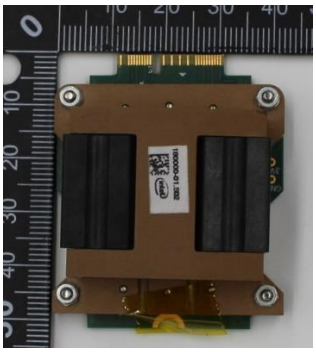
Sample #01	
Module Front	Module Back
	
Extender board	Laptop
	

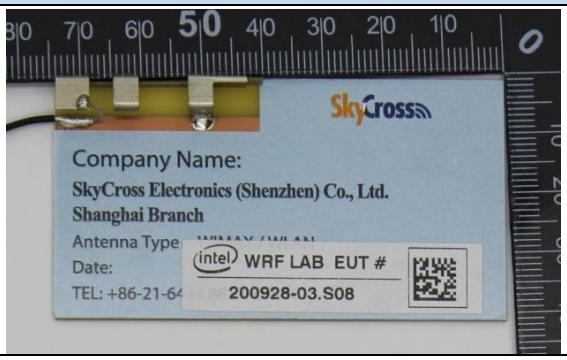
Sample #02

Module Front	Module Back
	
Adaptor front (with absorber)	**Adaptor back**
	
Socket front	**Socket back**
	
Extender board	**Laptop**
	

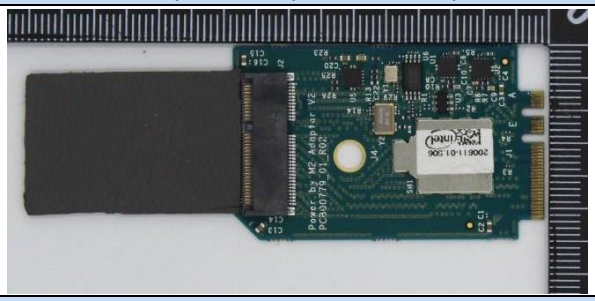
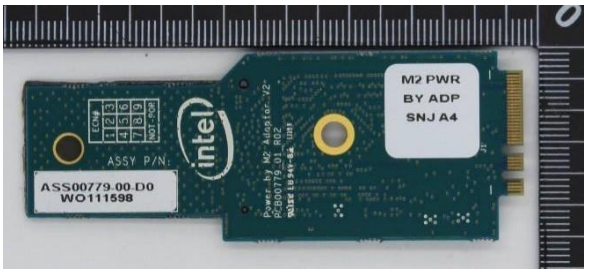
Main Antenna	Aux Antenna
	

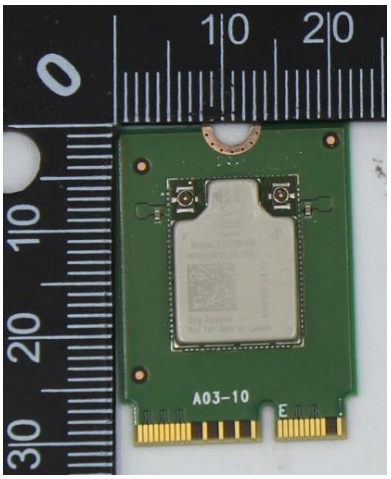
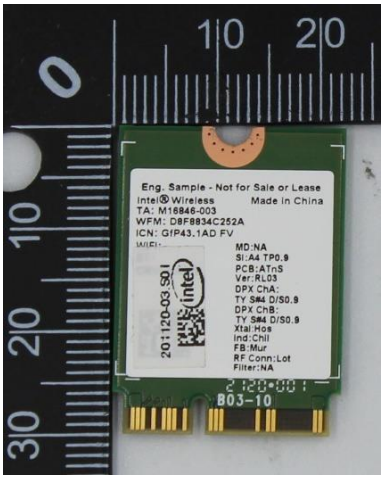
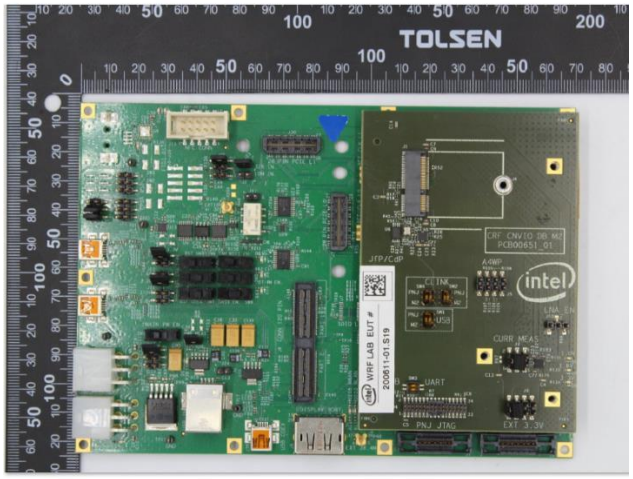
Sample #03

Module Front	Module Back
	
Adaptor front (with absorber)	**Adaptor back**
	
Socket front	**Socket back**
	
Extender board	**Laptop**
	

Main Antenna	Aux Antenna
	

Sample #04

Module Front	Module Back
	
Adaptor front (with absorber)	**Adaptor back**
	
Laptop (Host)	
	

Sample #05	
Module Front	Module Back
	
Extender board	Laptop
	

End of the report

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