

TEST REPORT

EUT Description	WLAN and BT, 2x2 PCIe M.2 2230 adapter card
Brand Name	Intel® Wi-Fi 6 AX201
Model Name	AX201NGW
Date of Test Start/End	2018-09-13 / 2018-11-21
Features	802.11ax, Dual Band, 2x2 Wi-Fi + Bluetooth® 5 (see section 5)
Applicant	Intel Corporation SAS
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Reference Standards	ETSI EN 300 328 V2.1.1 (see section 1)
Test Report identification	180717-02.TR13
Revision Control	Rev. 01 This test report revision replaces any previous test report revision (see section 8)

The test results relate only to the samples tested.
The test report shall not be reproduced in full, without written approval of the laboratory.

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1. Standards, reference documents and applicable test methods

1. ETSI EN 300 328 V2.1.1 – Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz ISM band and using wide band modulation techniques; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU.

2. General conditions, competences and guarantees

- ✓ Intel Corporation SAS Wireless RF Lab (Intel WRF Lab) is an ISO/IEC 17025:2005 testing laboratory accredited by the American Association for Laboratory Accreditation (A2LA) with the certificate number 3478.01.
- ✓ 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	23°C ±3 °C
Humidity	50% ± 15%

4. Test samples

Sample	Control #	Description	Model	Serial #	Date of receipt	Note
#1	170000-01.S14	LAPTOP	Latitude E5470	90LKMC2	2017-05-30	Used for conducted tests
	180326-01.S05	EXTENDER	PCB00651_01	6510818-199	2018-07-05	
	180717-02.S03	RF MODULE	AX201NGW	WFM:3413E8CA8726	2018-10-02	
#2	170000-01.S13	LAPTOP	Latitude E5470	FT6LMC2	2017-05-30	Used for Receiver Blocking tests (Conducted)
	180717-03.S21	EXTENDER	PCB00653_01	AS000653-1-300630818-186	2018-09-14	
	180717-02.S04	RF MODULE	AX201NGW	WFM:3413E8CA8816	2018-09-06	
#3	180717-02.S05	RF MODULE	AX201NGW	WFM : 3413E8CA86BD	2018-09-06	Used for Adaptivity tests (Conducted)
	180522-02.S03	EXTENDER	PCB00651_01	6510818-190	2018-05-31	
	170000-01.S04	LAPTOP	LATITUDE E5470	DMRKMC2	2017-05-10	
#4	180717-02.S07	RF MODULE	AX201NGW	WFM : 3413E8CA866D	2018-09-06	Radiated Spurious emission from 30 MHz to 1 GHz
	180326-01.S03	EXTENDER	PCB00651_01	6510818-198	2018-03-27	
	170209-01.S16	LAPTOP	LATITUDE E7470	C1HTPF2	2017-02-09	
#5	180717-02.S08	RF MODULE	AX201NGW	WFM:3413E8CA8681	2018-09-06	Radiated Spurious emission from 1 GHz to 12.75 GHz
	180717-03.S18	EXTENDER	PCB00651_01	6510817-133	2018-08-21	
	170801-01.S10	LAPTOP	LATITUDE E7470	7KNOXF2	2017-09-07	

5. EUT Features

Brand Name	Intel® Wi-Fi 6 AX201		
Model Name	AX201NGW		
Software Version	OEM DRTU_08048_11_1832_0G, Proset 20.80.0 (Adaptivity)		
Driver Version	20.70.0.2, 20.80.0.2 (Adaptivity)		
Supported Radios	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 – 5850.0 MHz)	
	Bluetooth 5	2.4GHz (2400.0 – 2483.5 MHz)	
Antenna Information	CHAIN A: PIFA antenna. WiFi 2.4GHz & 5GHz and BT CHAIN B: PIFA antenna. WiFi 2.4GHz & 5GHz		
Additional Information			

6. Remarks and comments

According to the applicant declaration the device AX201NGW operating in BDR/EDR mode is an adaptive equipment with a maximum RF output power greater than 10 dBm e.i.r.p. so it is considered as receiver category 1.

7. Test Verdicts summary

7.1. BT Basic Rate / Enhanced Data Rate

Mode	ETSI part	Test	Verdict
2.4GHz	4.3.1.2	RF output power	P
	4.3.1.3	Duty Cycle, Tx-sequence, TX gap	NA
	4.3.1.4	Accumulated Transmit Time, Frequency Occupation and Hopping Sequence	P
	4.3.1.5	Hopping Frequency Separation	P
	4.3.1.6	Medium Utilization (MU) factor	NA
	4.3.1.7	Adaptivity (Adaptive Frequency Hopping)	P
	4.3.1.8	Occupied Channel Bandwidth	P
	4.3.1.9	Transmitter unwanted emissions in the out-of-band domain	P
	4.3.1.10	Transmitter unwanted emissions in the spurious domain	P
	4.3.1.11	Receiver spurious emissions	P
	4.3.1.12	Receiver Blocking	P

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

8. Document Revision History

Revision #	Date	Modified by	Revision Details
Rev. 00	2018-12-13	I. KHARRAT A. Hagrais	First Issue
Rev. 01	2019-01-22	G. Roustan	Correction of interchanged values in section B.2

Annex A. Test & System Description

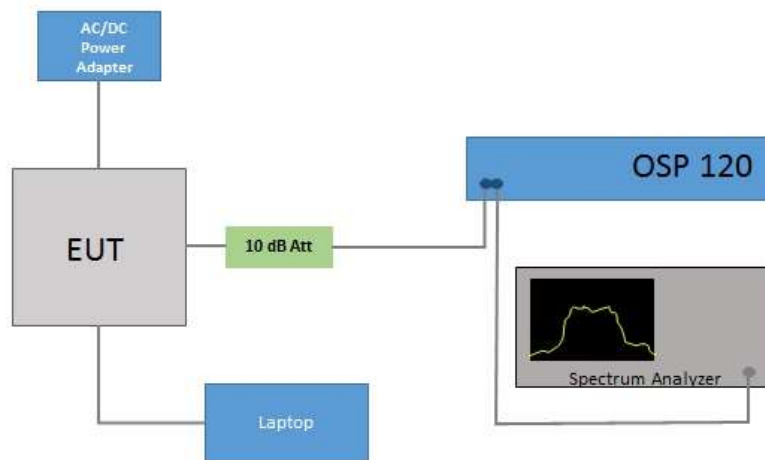
A.1 Measurement System

Measurements were performed using the following setups and made in accordance to the general provisions of ETSI EN 300 328 V2.1.1.

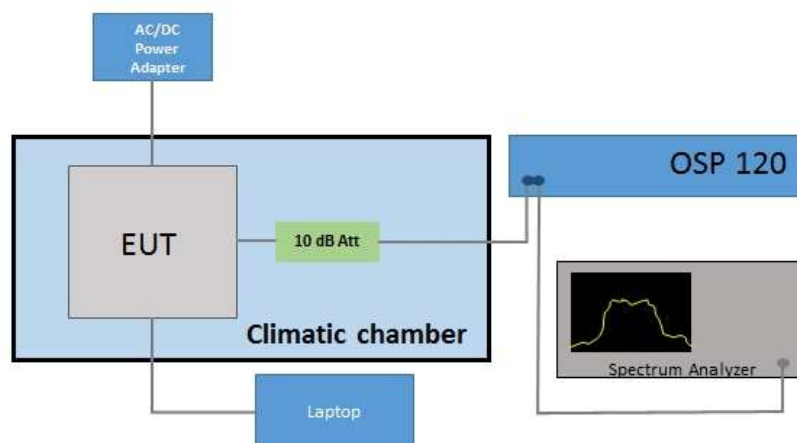
Rohde & Schwarz TS9887 system with the switching unit OSP120, OSP B-157 and software EMC32 were employed. The DUT was installed in a test fixture and then connected to a laptop computer and AC/DC power adapter. The laptop computer was used to configure the EUT to continuously transmit at a specified output power using all different modes and modulation schemes, using the Intel proprietary tool DRTU.

Setups for conducted and radiated measurements are shown below.

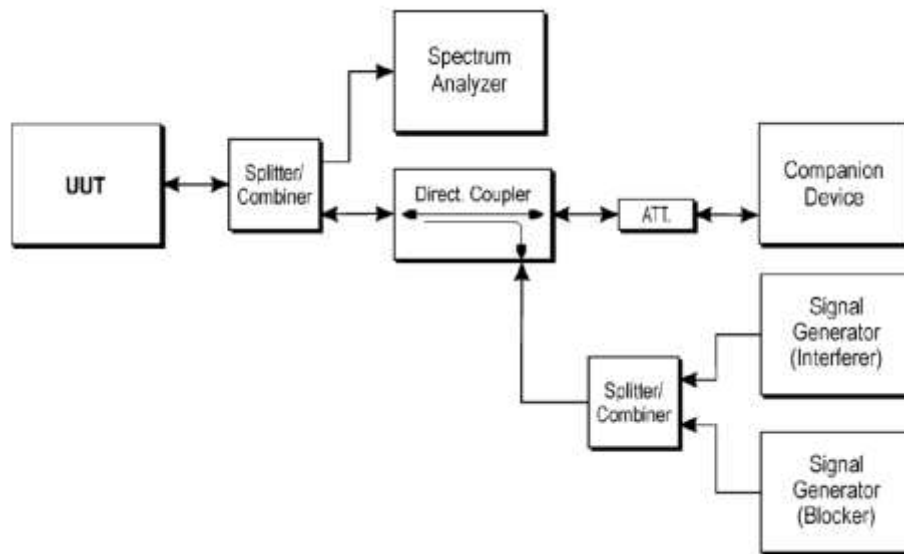
Conducted Setup (Normal condition)



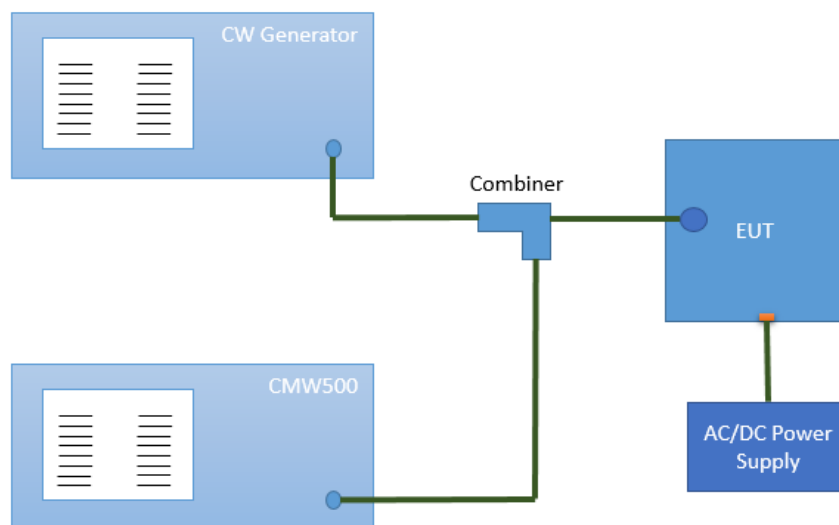
Conducted Setup (Extreme conditions)



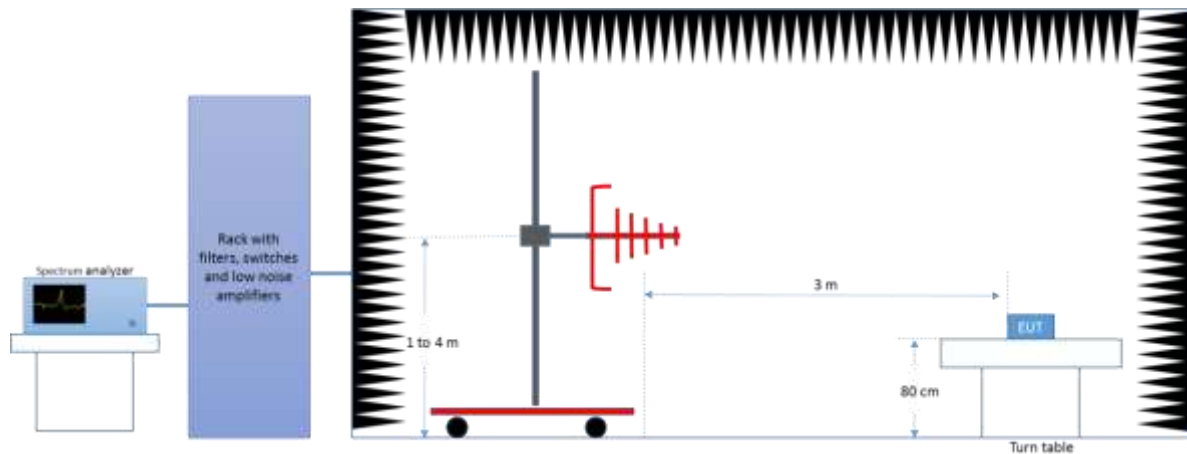
Adaptivity Setup



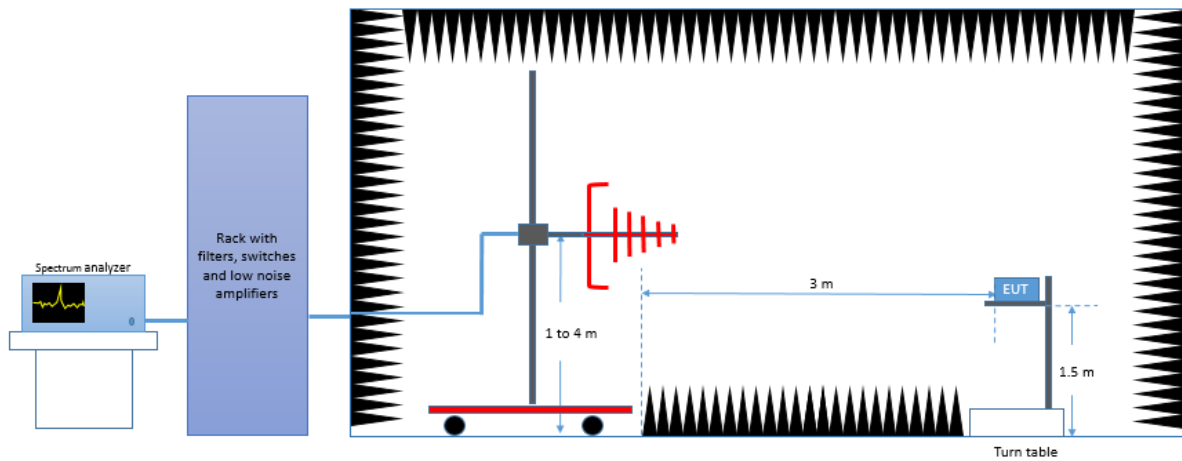
Receiver Blocking Setup



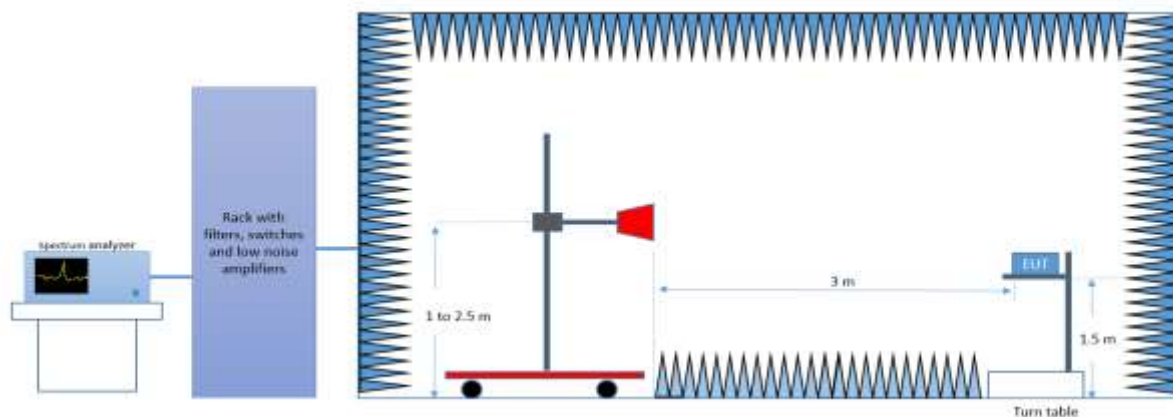
Radiated Setup 30MHz -1 GHz (Transmitter Tests)



Radiated Setup 30MHz -1 GHz (Receiver Tests)



Radiated Setup 1 GHz - 12.75 GHz



A.2 Test Equipment List

Conducted Setup

ID#	Device	Type/Model	Serial #	Manufacturer	Cal. Date	Cal. Due Date
0033	Spectrum analyzer	FSV40	101072	Rohde & Schwarz	2018-01-26	2020-01-26
0347	Switch unit	OSP 120	101396 / 100907 / 19C1D19	Rohde & Schwarz	2018-04-12	2020-04-12
0300	Climatic chamber	SLT34/40	56746020930010	SECASI	2017-03-09	2019-03-09
0741	Measurement Software	EMC32 v10.30.00	200226	Rohde & Schwarz	N/A	N/A

N/A: Not Applicable

Adaptivity Setup

ID#	Device	Type/Model	Serial #	Manufacturer	Cal. Date	Cal. Due Date
0316	Spectrum analyzer	FSV30	103309	Rohde & Schwarz	2017-09-22	2019-09-22
0016	Signal generator	SMF100A	102117	Rohde & Schwarz	2018-04-10	2020-04-10
0017	Vector signal generator	SMJ100A	100458	Rohde & Schwarz	2017-11-24	2019-11-24

N/A: Not Applicable

Receiver blocking Setup

ID#	Device	Type/Model	Serial #	Manufacturer	Cal. Date	Cal. Due Date
0309	Signal generator	SMB100A	178217	Rohde & Schwarz	2018-04-17	2020-04-17
0100	Network emulator	CMW500	129337	Rohde & Schwarz	2017-07-18	2019-07-18

Radiated Setup-1

ID#	Device	Type/Model	Serial #	Manufacturer	Cal. Date	Cal. Due Date
0420	Spectrum analyzer	FSV40	101556	Rohde & Schwarz	2018-05-17	2020-05-17
0137	Log antenna 30 MHz – 1 GHz	3142E	00156946	ETS Lindgren	2017-12-19	2019-12-19
0135	Semi Anechoic chamber	FACT 3	5720	ETS Lindgren	2018-04-18	2020-04-18
0530	Measurement Software	EMC32	100623	Rohde & Schwarz	N/A	N/A

N/A: Not Applicable

Radiated Setup-2

ID#	Device	Type/Model	Serial #	Manufacturer	Cal. Date	Cal. Due Date
0133	Spectrum analyzer	FSV40	101358	Rohde & Schwarz	2018-04-11	2020-04-11
0138	Double Ridged Horn antenna 1 GHz – 18 GHz	3117	00152266	ETS Lindgren	2018-03-29	2020-03-29
0141	Double Ridged Horn Antenna 1 GHz – 18 GHz	3117	00157736	ETS Lindgren	2018-05-11	2020-05-11
0343	Double ridged Horn antenna with preamplifier 1 GHz – 18 GHz	3117-PA	00201875	ETS Lindgren	2017-08-22	2019-08-22
0337	Full Anechoic chamber	RFD_FA_100	5996	ETS Lindgren	2018-04-17	2020-04-17
0329	Measurement Software	EMC32	100401	Rohde & Schwarz	N/A	N/A

N/A: Not Applicable

Radiated Setup - shared equipment

ID#	Device	Type/Model	Serial #	Manufacturer	Cal. Date	Cal. Due Date
0616	Power Sensor 50MHz-18GHz	NRP-Z81	104385	Rohde & Schwarz	2018-04-16	2020-04-16
0617	Power Sensor 50MHz-18GHz	NRP-Z81	104386	Rohde & Schwarz	2018-04-16	2020-04-16
0618	Power Sensor 50MHz-18GHz	NRP-Z81	104382	Rohde & Schwarz	2018-04-16	2020-04-16

A.3 Measurement Uncertainty Evaluation

The system uncertainty evaluation is shown in the below table:

Measurement type	Uncertainty [±dB]
Conducted Power	±1.0
Conducted spurious emission	±2.9
Radiated test < 1GHz	±3.8
Radiated test 1GHz - 40 GHz	±4.7

Annex B. Test Results

B.1 Test Conditions

ETSI part	Conditions	ETSI EN 300 328 v2.1.1 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.	
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 part	Limits
4.3.1.2.3	The maximum RF output power for adaptive Frequency Hopping equipment shall be equal to or less than 20 dBm.
	The maximum RF output power for non-adaptive Frequency Hopping equipment shall be declared by the manufacturer. See clause 5.4.1 m). The maximum RF output power for this equipment shall be equal to or less than the value declared by the manufacturer. This declared value shall be equal to or less than 20 dBm.
	This limit shall apply for any combination of power level and intended antenna assembly.

Test conditions

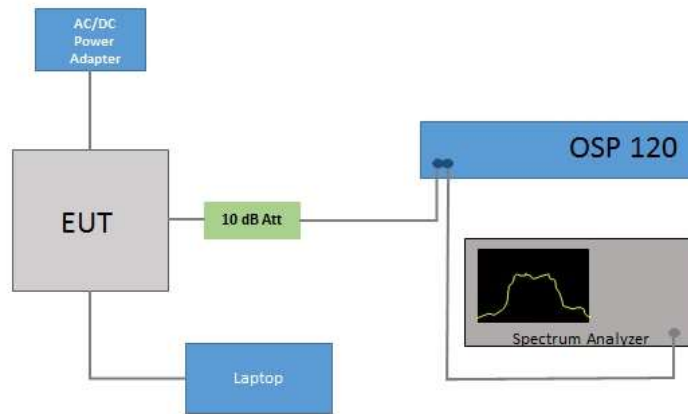
ETSI part	Conditions
5.4.2.1	The measurements for RF output power shall be performed at both normal environmental conditions and at the extremes of the operating temperature range.
	The equipment shall be operated under its worst case configuration (for example modulation, bandwidth, data rate, power) with regards to the requirement being tested.

Test procedure

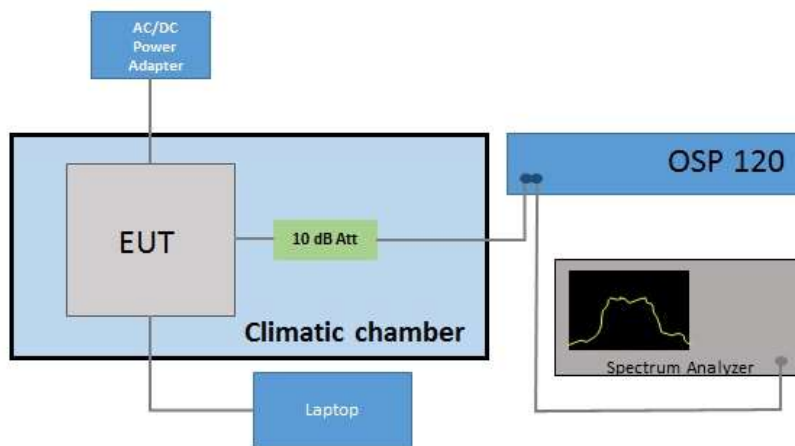
The setup below was used to measure the RF output power accordingly with ETSI EN 300 328 V2.1.1 §5.3.2. The antenna terminal of the EUT is connected to the OSP120 through an attenuator and a cable, the spectrum analyzer is connected to the receiver port on the OSP. System connection cable loss is compensated by the EMC32 software on the measured parameters.

Antenna gain is taken into 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. The declared maximum antenna gain is +3dBi.

Conducted Setup (Normal Conditions)



Conducted Setup (Extreme conditions)



Results tables

Normal conditions

Temperature: 23°C ± 1°C

Humidity: 55% ± 5%

Antenna gain: +3dBi

Mode	Modulation	Packet	Meas Duty Cycle. [%]	Power [dBm]	
				Measured Conducted	EIRP
BR	GFSK	DH5	76.95	9.8	12.8
EDR	$\pi/4$ -DQPSK	2DH5	77.02	9.9	12.9
EDR	8-PSK	3DH5	77.08	8.2	11.2

Extreme temperature conditions (Tmax = +70°C)

Antenna gain: +3dBi

Mode	Modulation	Packet	Meas Duty Cycle. [%]	Power [dBm]	
				Measured Conducted	EIRP
BR	GFSK	DH5	76.95	7.6	10.6
EDR	$\pi/4$ -DQPSK	2DH5	77.03	8.3	11.3
EDR	8-PSK	3DH5	77.08	10.0	13.0

Extreme temperature conditions (Tmin = -10°C)

Antenna gain: +3dBi

Mode	Modulation	Packet	Meas Duty Cycle. [%]	Power [dBm]	
				Measured Conducted	EIRP
BR	GFSK	DH5	76.94	10.6	13.6
EDR	$\pi/4$ -DQPSK	2DH5	77.02	8.8	11.8
EDR	8-PSK	3DH5	77.07	9.0	12.0

B.3 Accumulated Transmit Time, Frequency Occupation and Hopping Sequence

Test limits

ETSI part	Limits						
4.3.1.4.3.2	<i>Adaptive frequency hopping equipment</i> <i>Adaptive Frequency Hopping equipment shall be capable of operating over a minimum of 70 % of the band specified in table 1.</i> Table 1: Service frequency bands <table border="1"> <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> The Accumulated Transmit Time on any hopping frequency shall not be greater than 400 ms within any observation period of 400 ms multiplied by the minimum number of hopping frequencies (N) that have to be used. In order for the equipment to comply with the Frequency Occupation requirement, it shall meet either of the following two options: Option 1: Each hopping frequency of the hopping sequence shall be occupied at least once within a period not exceeding four times the product of the dwell time and the number of hopping frequencies in use. Option 2: The occupation probability for each frequency shall be between $((1 / U) \times 25 \%)$ and 77 % where U is the number of hopping frequencies in use. The hopping sequence(s) shall contain at least N hopping frequencies at all times, where N is 15 or 15 divided by the minimum Hopping Frequency Separation in MHz, whichever is the greater.		Service frequency bands	Transmit	2 400 MHz to 2 483,5 MHz	Receive	2 400 MHz to 2 483,5 MHz
	Service frequency bands						
Transmit	2 400 MHz to 2 483,5 MHz						
Receive	2 400 MHz to 2 483,5 MHz						

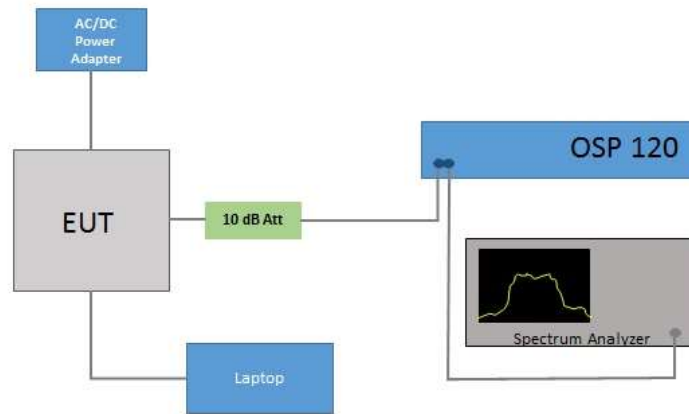
Test conditions

ETSI part	Conditions
5.4.4.1	These measurements shall only be performed at normal test conditions. The equipment shall be configured to operate at its maximum Dwell Time and maximum Duty Cycle. The measurement shall be performed on a minimum of two (active) hopping frequencies chosen arbitrary from the actual hopping sequence.

Test procedure

The setup below was used to measure the Accumulated Transmit Time accordingly with ETSI EN 300 328 V2.1.1 §5.4.4.2.1. Minimum Frequency Occupation and Hopping Sequence. The antenna terminal of the EUT is connected to the OSP120 through an attenuator and a cable, the spectrum analyzer is connected to the receiver port on the OSP. System connection cable loss is compensated by the EMC32 software on the measured parameters.

Conducted Setup



Results tables

Normal conditions

Temperature: 23°C ± 1°C
Humidity: 55% ± 5%
Antenna gain: +3dBi

Dwell Time

Mode	Packet Type	Frequency [MHz]	Accumulated Transmit Time (ms)	Measurement Time (ms)
BR	DH5	2402	68.800	6000
		2480	43.000	6000
EDR	2DH5	2402	62.000	6000
		2480	65.400	6000
EDR	3DH5	2402	43.600	6000
		2480	52.400	6000

Minimum Frequency Occupation

Mode	Packet Type	Frequency [MHz]	Minimum Frequency Occupation (ms)	Limit (ms)	Measurement Time (ms)
BR	DH5	2402	2936.693	> 306.414	126400
		2480	2966.187	> 306.414	126400
EDR	2DH5	2402	2717.600	> 307.747	126400
		2480	3042.027	> 307.747	126400
EDR	3DH5	2402	3138.933	> 307.302	126400
		2480	3303.253	> 307.302	126400

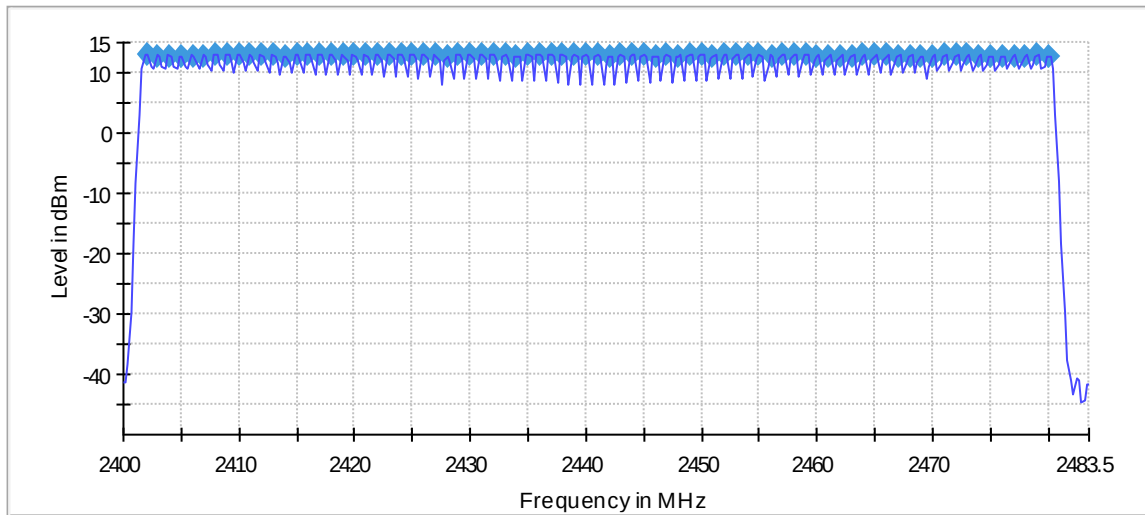
Hopping sequence

Mode	Packet Type	Number of Hopping frequencies
BR	DH5	79
EDR	2DH5	79
EDR	3DH5	79

Hopping Sequence Results

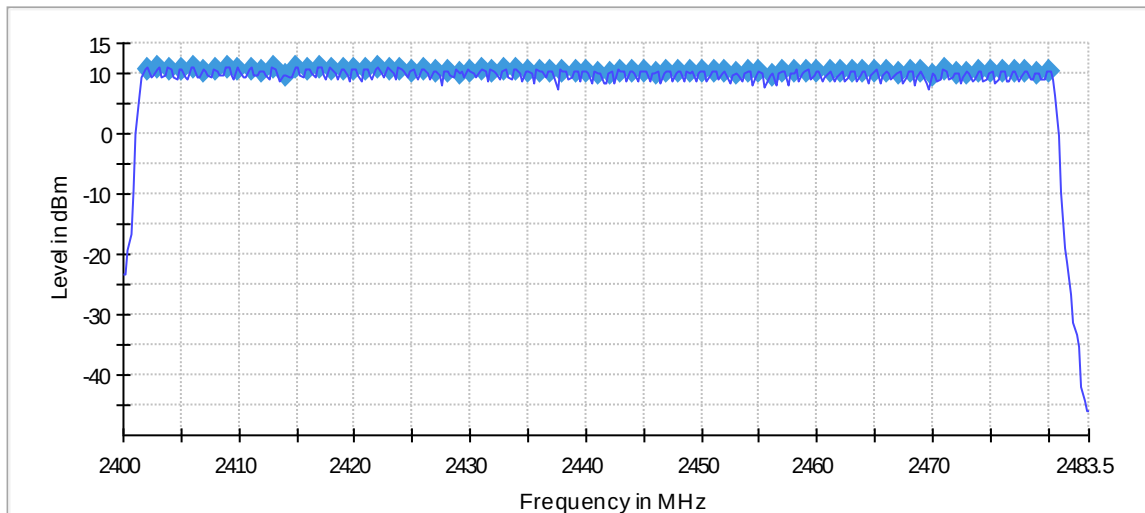
BR - GFSK

DH5



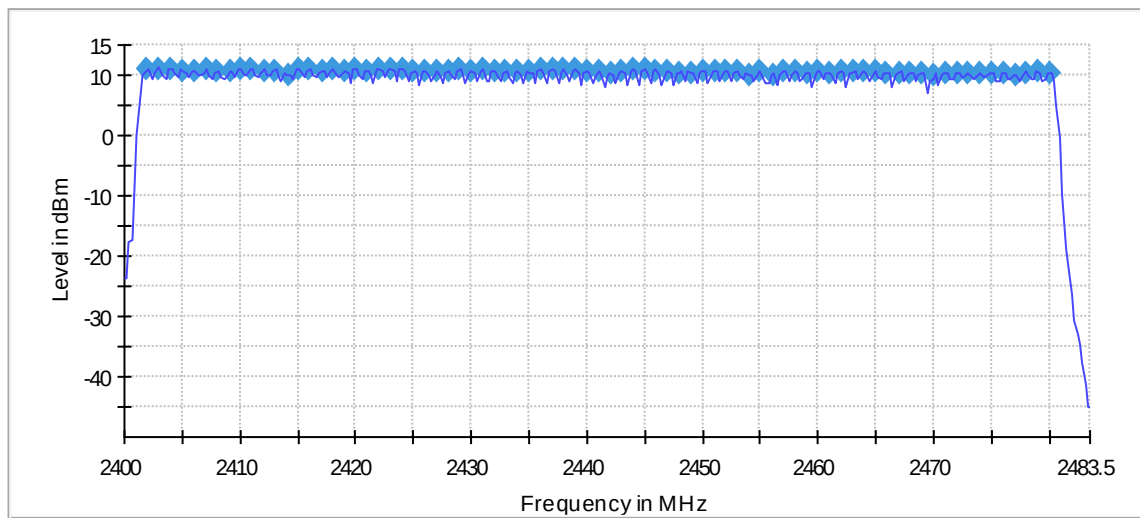
EDR - $\pi/4$ DQPSK

2DH5



EDR - 8PSK

3DH5



B.4 Hopping frequency separation

Tests limits

ETSI part	Limits
4.3.1.4.2.2	For adaptive Frequency Hopping equipment, the minimum Hopping Frequency Separation shall be 100 kHz.

Test conditions

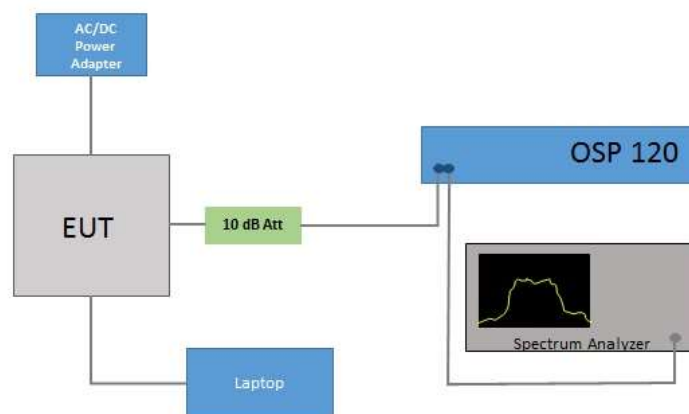
ETSI part	Conditions
5.4.5.1	These measurements shall only be performed at normal test conditions. The measurement shall be performed on two adjacent hopping frequencies.

Test procedure

The setup below was used to measure the hopping frequency separation accordingly with ETSI EN 300 328 V2.1.1 §5.4.5.2.1. The antenna terminal of the EUT is connected to the OSP120 through an attenuator and a cable, the spectrum analyzer is connected to the receiver port on the OSP. System connection cable loss is compensated by the EMC32 software on the measured parameters.

The declared maximum antenna gain is +3dBi.

Conducted Setup



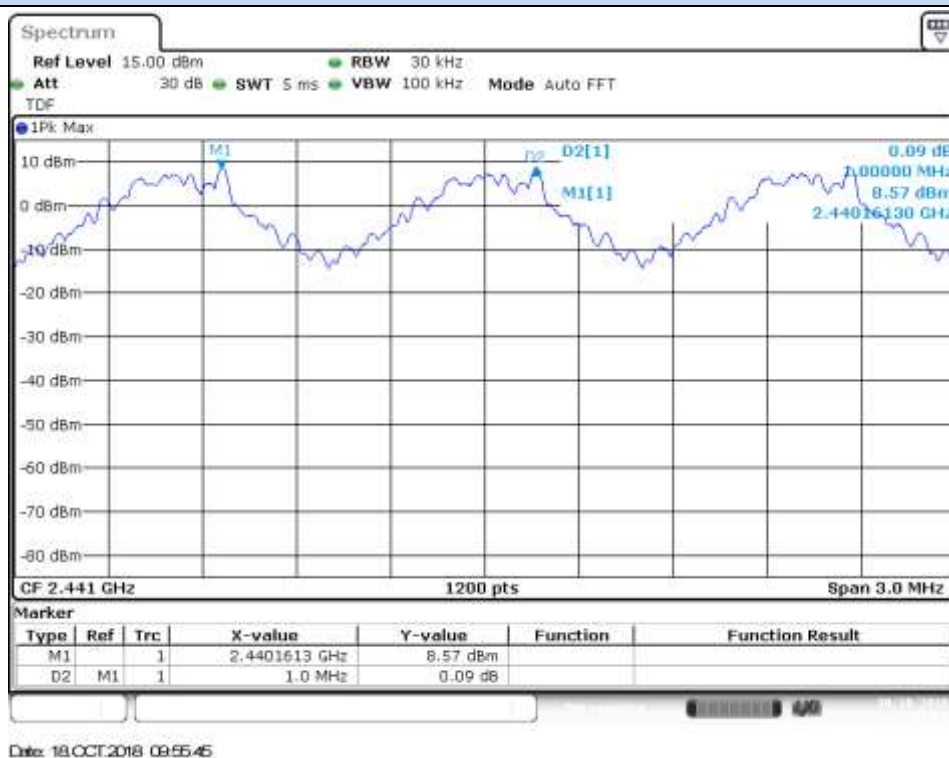
Results tables

Mode	Frequency [MHz]	Hopping frequency separation [MHz]
BR GFSK	2433	1.0000
	2434	
EDR $\pi/4$ -DQPSK	2433	1.0025
	2434	
EDR 8-DPSK	2433	1.0031
	2434	

Results screenshot

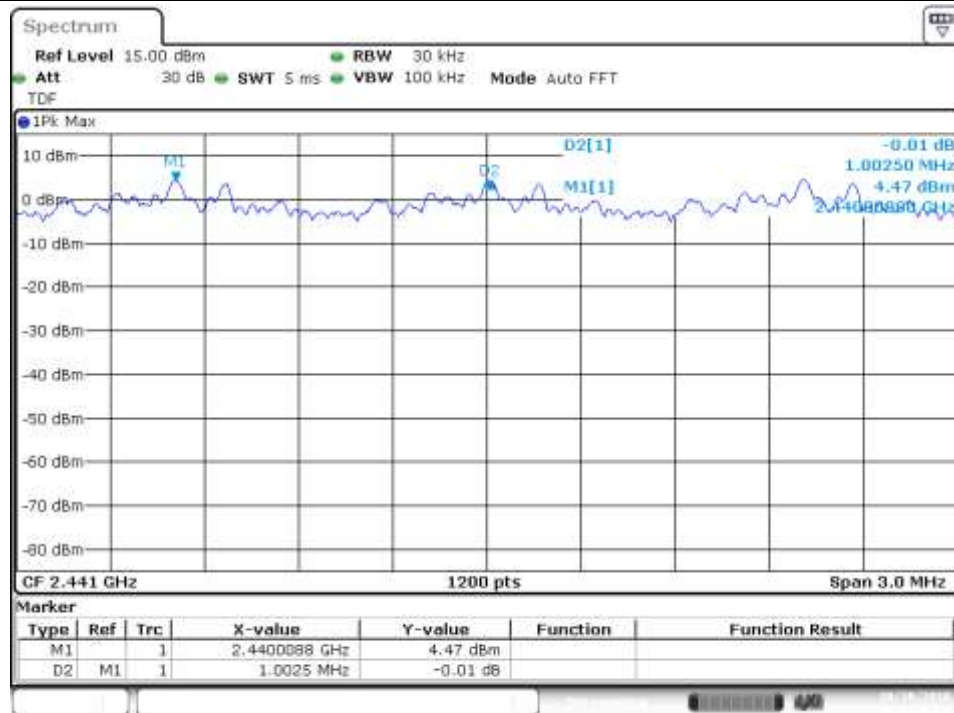
BR - GFSK

DH5



EDR - $\pi/4$ DQPSK

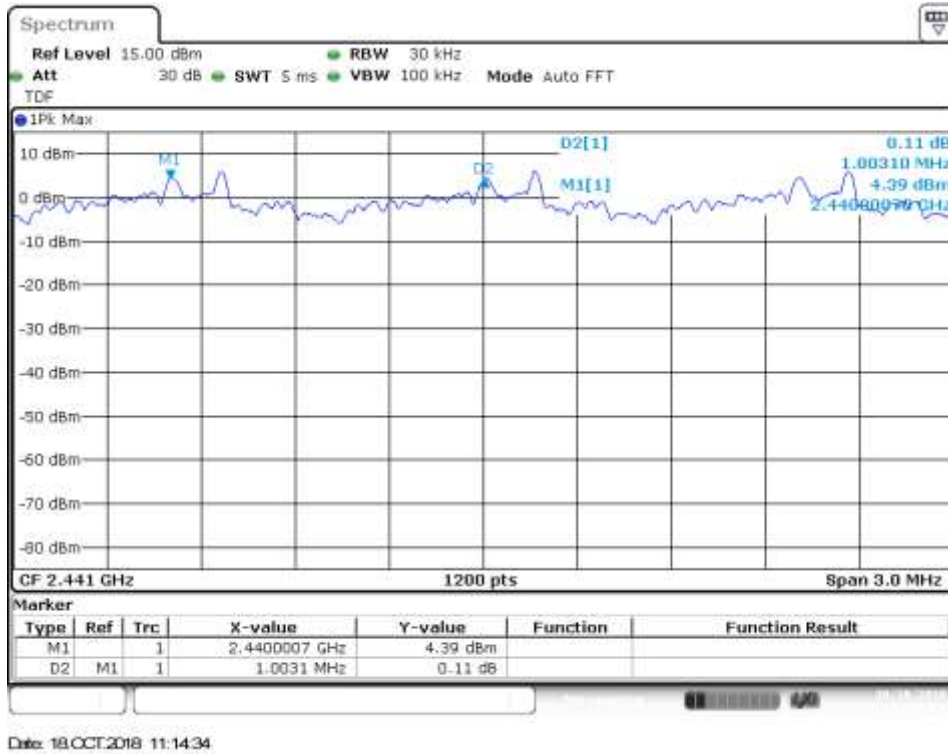
2DH5



Date: 18.OCT.2018 10:43:20

EDR - 8PSK

3DH5



B.5 Adaptivity (Adaptive Frequency Hopping)

Test limits

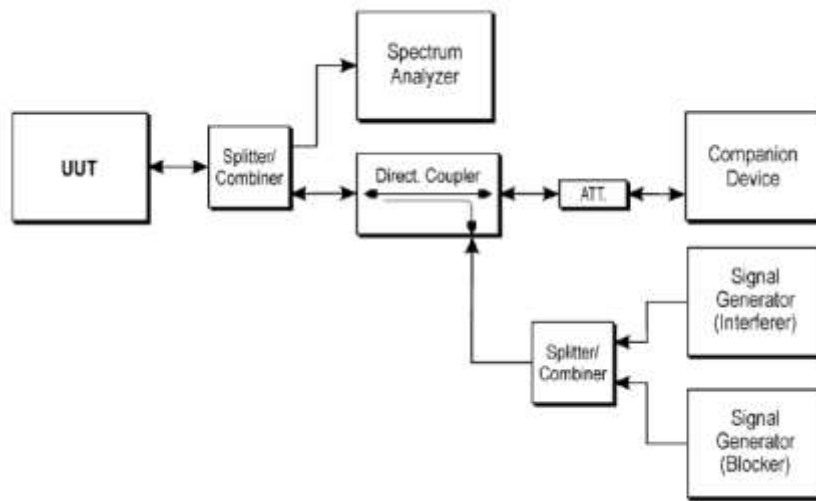
ETSI part	Limits												
4.3.1.7.3.2	<i>Adaptive Frequency Hopping using other forms of DAA (non-LBT based)</i> Adaptive Frequency Hopping equipment using non-LBT based DAA, shall comply with the following minimum set of requirements: 1) During normal operation, the equipment shall evaluate the presence of a signal for each of its hopping frequencies. If it is determined that a signal is present with a level above the detection threshold defined in step 5 the hopping frequency shall be marked as 'unavailable'. 2) The frequency shall remain unavailable for a minimum time equal to 1 second or 5 times the actual number of hopping frequencies in the current (adapted) channel map used by the equipment, multiplied with the Channel Occupancy Time whichever is the longest. There shall be no transmissions during this period on this frequency. After this, the hopping frequency may be considered again as an 'available' frequency 3) The Channel Occupancy Time for a given hopping frequency shall be less than 40 ms. For equipment using a dwell time > 40 ms that want to have other transmissions during the same hop (dwell time) an Idle Period (no transmissions) of minimum 5 % of the Channel Occupancy Period with a minimum of 100 µs shall be implemented. After the Idle Period has expired, the procedure as in step 1 needs to be repeated before having new transmissions on this hopping frequency during the same dwell time. 4)'Unavailable' channels may be removed from or may remain in the hopping sequence, but in any case: - apart from the Short Control Signalling Transmissions referred to in clause 4.3.1.7.4, there shall be no transmissions on 'unavailable' channels; - a minimum of N hopping frequencies as defined in clause 4.3.1.4.3.2 shall always be maintained. 5) The detection threshold shall be proportional to the transmit power of the transmitter: for a 20 dBm e.i.r.p. transmitter the detection threshold level (TL) shall be equal to or less than -70 dBm/MHz at the input to the receiver assuming a 0 dBi (receive) antenna assembly. This threshold level (TL) may be corrected for the (receive) antenna assembly gain (G); however, beamforming gain (Y) shall not be taken into account. For power levels below 20 dBm e.i.r.p., the detection threshold level may be relaxed to: $TL = -70 \text{ dBm/MHz} + 10 \times \log_{10} (100 \text{ mW} / P_{out})$ (Pout in mW e.i.r.p.) 6) The equipment shall comply with the requirements defined in step 1 to step 4 of the present clause in the presence of an unwanted CW signal as defined in table 3. Table 3: Unwanted Signal parameters <table><tr><th>Wanted signal mean power from companion device (dBm)</th><th>Unwanted signal frequency (MHz)</th><th>Unwanted CW signal power (dBm)</th></tr><tr><td>-30</td><td>2395 or 2488.5 (see note 1)</td><td>-35 (see note 2)</td></tr><tr><td>NOTE 1 :</td><td colspan="2">The highest frequency shall be used for testing operating channels within the range 2 400 MHz to 2 442 MHz, while the lowest frequency shall be used for testing operating channels within the range 2 442 MHz to 2 483,5 MHz. See clause 5.4.6.1.</td></tr><tr><td>NOTE 2:</td><td colspan="2">The level specified is the level in front of the UUT antenna. In case of conducted measurements, this level has to be corrected by the actual antenna assembly gain.</td></tr></table>	Wanted signal mean power from companion device (dBm)	Unwanted signal frequency (MHz)	Unwanted CW signal power (dBm)	-30	2395 or 2488.5 (see note 1)	-35 (see note 2)	NOTE 1 :	The highest frequency shall be used for testing operating channels within the range 2 400 MHz to 2 442 MHz, while the lowest frequency shall be used for testing operating channels within the range 2 442 MHz to 2 483,5 MHz. See clause 5.4.6.1.		NOTE 2:	The level specified is the level in front of the UUT antenna. In case of conducted measurements, this level has to be corrected by the actual antenna assembly gain.	
Wanted signal mean power from companion device (dBm)	Unwanted signal frequency (MHz)	Unwanted CW signal power (dBm)											
-30	2395 or 2488.5 (see note 1)	-35 (see note 2)											
NOTE 1 :	The highest frequency shall be used for testing operating channels within the range 2 400 MHz to 2 442 MHz, while the lowest frequency shall be used for testing operating channels within the range 2 442 MHz to 2 483,5 MHz. See clause 5.4.6.1.												
NOTE 2:	The level specified is the level in front of the UUT antenna. In case of conducted measurements, this level has to be corrected by the actual antenna assembly gain.												
5.4.6.2.1.2	Step4, Note 2: The UUT is assumed to stop transmissions within a period equal to the maximum Channel Occupancy Time												

Test conditions

ETSI part	Conditions
5.4.6.1	These measurements shall only be performed at normal test conditions.

Test procedure

The setup below was used to measure adaptivity. The EUT (client) is connected to a companion device through a power splitter and an attenuator. Proprietary software was used on the EUT to configure a normal transmission with sufficient payload.



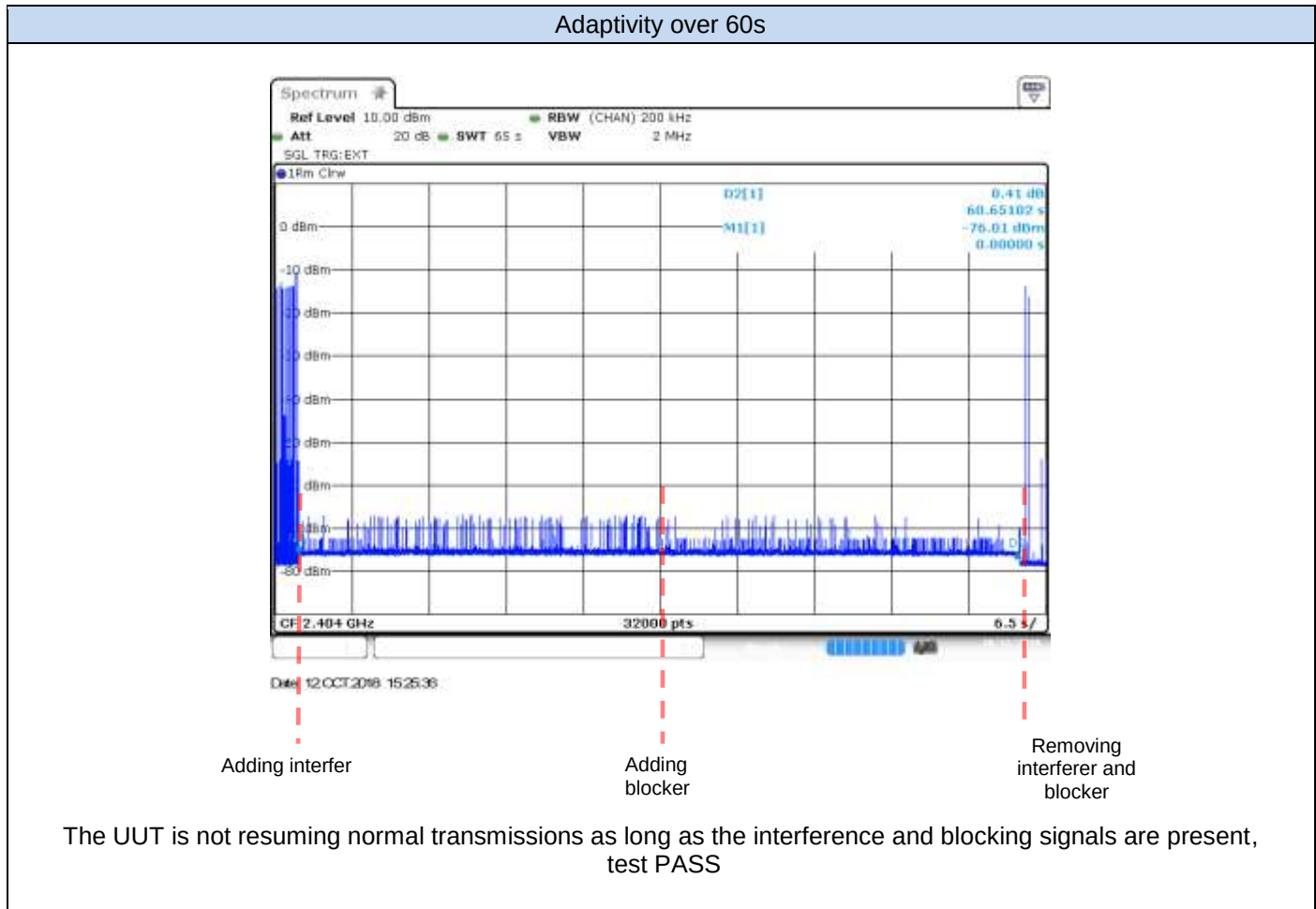
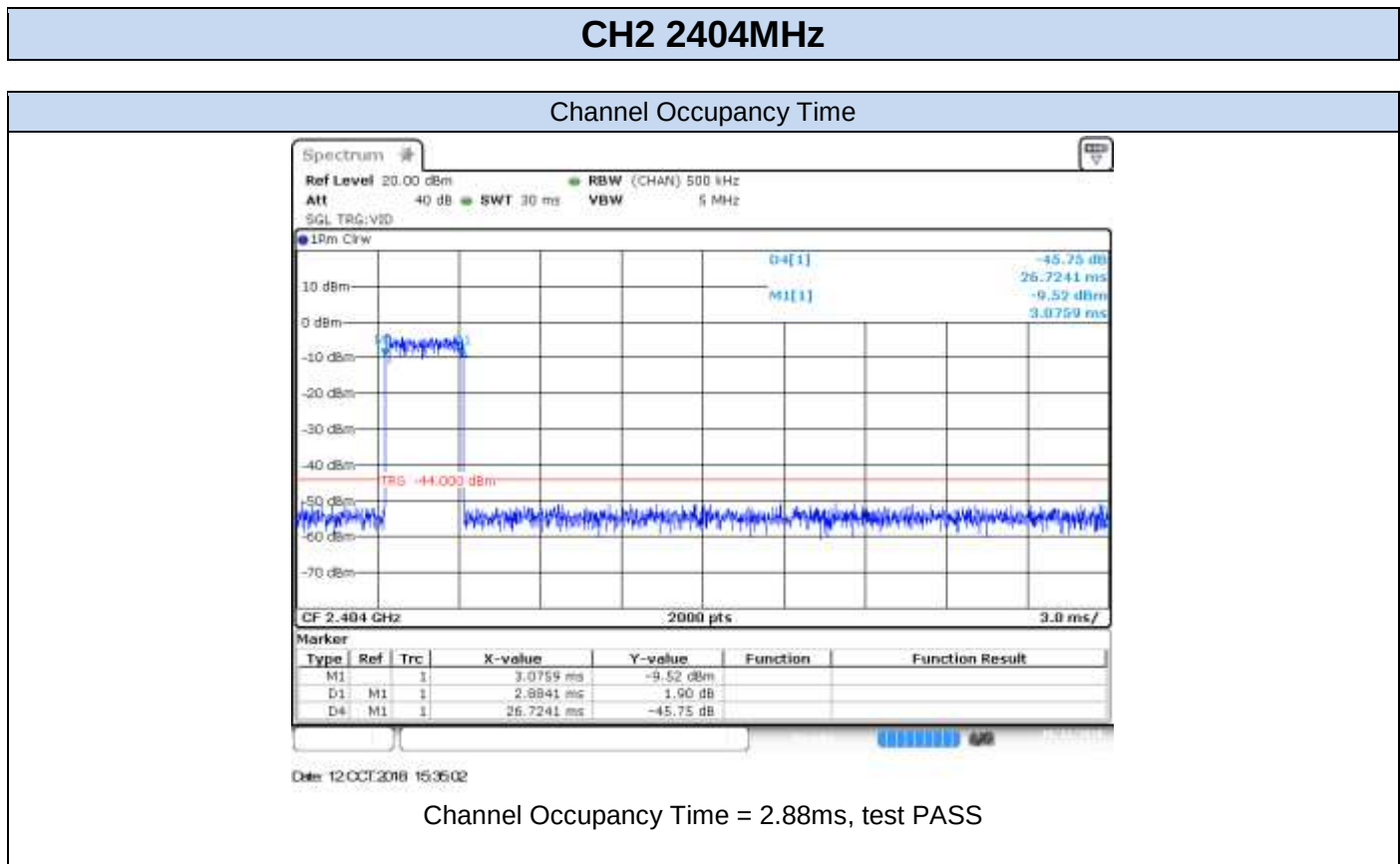
Interference and blocking signals are emulated by using a modulated signal and a continuous wave (CW) respectively, generated by the vector signal generator (VSG) and the continuous wave generator.

The power levels for the signals at the input of the receiver are as follows:

- EUT = max power level
- Companion device = -30dBm/MHz
- Interference signal = $TL + \text{Antenna gain} - \text{Margin} = -72\text{dBm/MHz}$
- Blocking signal (CW) = $cw\text{Power} + \text{Antenna gain} - \text{Margin} = -37\text{dBm}$
 $TL = -70\text{ dBm/MHz}$, limit of the ED Threshold Level assuming 0dBi antenna gain
 $cw\text{Power} = -35\text{dBm}$, assuming 0dBi antenna gain
 Antenna gain = Antenna gain declared by the applicant (+3dBi)
 Margin = Additional margin requested by the applicant (5dB)

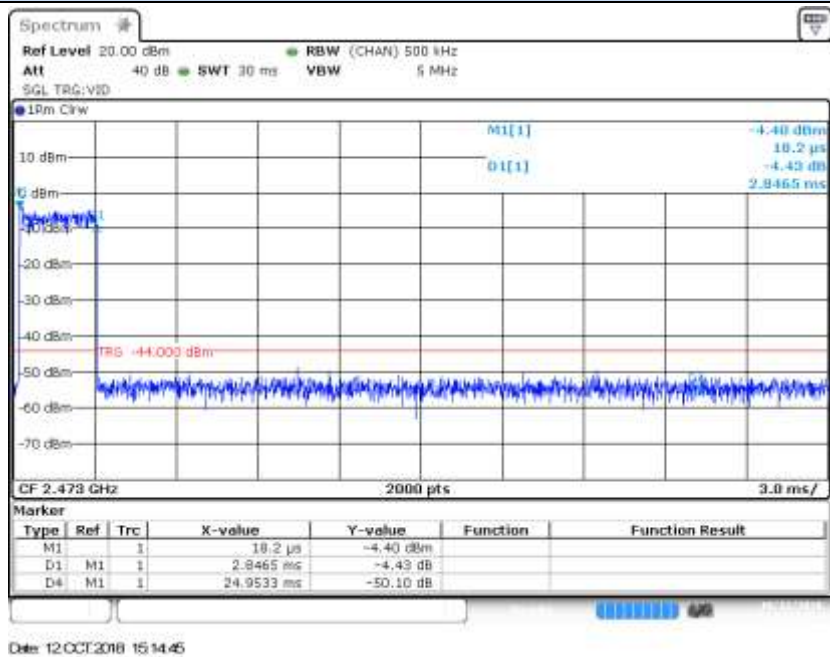
The frequency used for the interference signal is the same as the transmission frequency of the tested channel. The blocking signal is fixed at 2488.5 MHz for the lowest channel tested and at 2395 MHz for the highest channel tested.

Results Screenshot



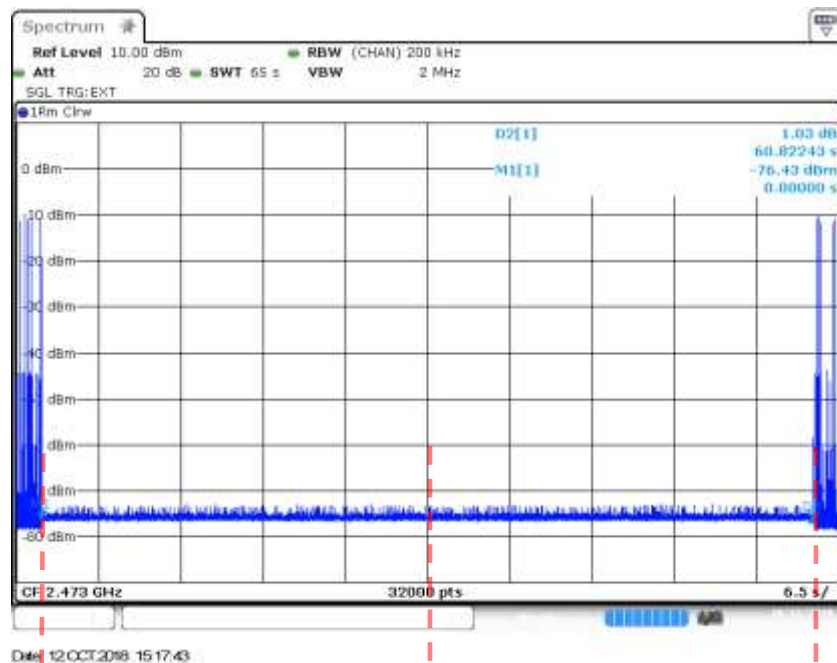
CH71 2473MHz

Channel Occupancy Time



Channel Occupancy Time = 2.85ms, test PASS

Adaptivity over 60s



Adding interfer

Adding blocker

Removing interferer and blocker

The UUT is not resuming normal transmissions as long as the interference and blocking signals are present, test PASS

B.6 Occupied Channel Bandwidth

Test limits

ETSI part	Limits
4.3.1.8.3	The Occupied Channel Bandwidth for each hopping frequency shall fall completely within the band given in clause 1. (2.4 GHz to 2.4835 GHz)

Test conditions

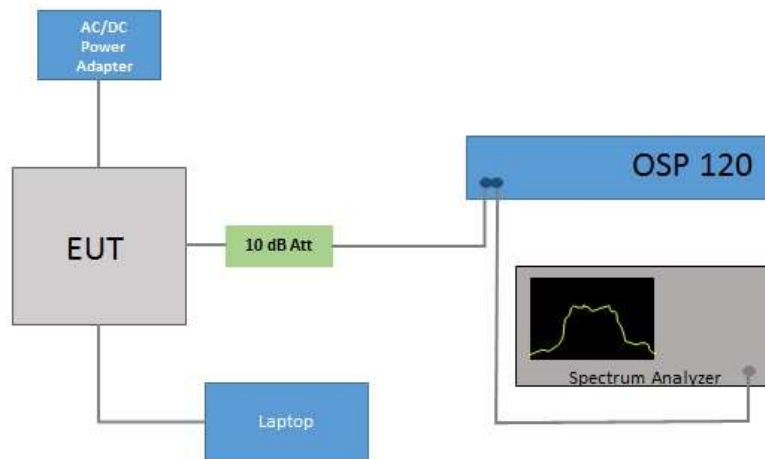
ETSI part	Conditions
5.4.7.1	These measurements shall only be performed at normal test conditions. The measurement shall be performed only on the lowest and the highest frequency within the stated frequency range.

Test procedure

The setup below was used to measure the occupied channel bandwidth accordingly with ETSI EN 300 328 V2.1.1 §5.4.7.2.1. The antenna terminal of the EUT is connected to the OSP120 through an attenuator and a cable, the spectrum analyzer is connected to the receiver port on the OSP. System connection cable loss is compensated by the EMC32 software on the measured parameters.

The declared maximum antenna gain is +3dBi.

Conducted Setup



Results tables

Low channel

Mode	Packet Type	Frequency [MHz]	Channel Center Frequency (MHz)	Occupied Channel Bandwidth (MHz)	Lower Band Edge (MHz)
BR	DH5	2402	2402.00	0.786070	2401.611940
EDR	2DH5	2402	2402.00	0.990049	2401.502488
EDR	3DH5	2402	2402.00	0.997512	2401.502488

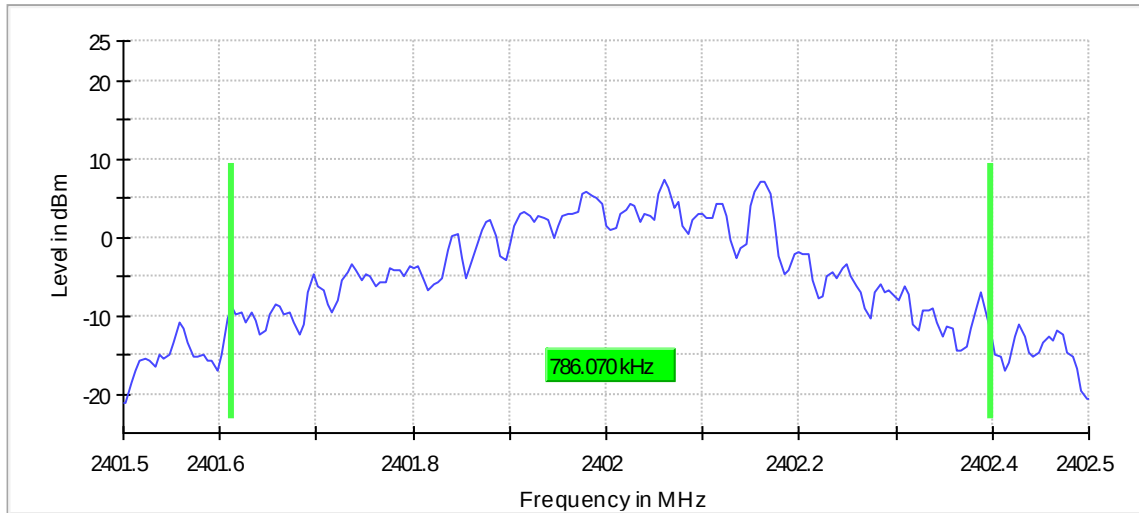
High channel

Mode	Packet Type	Frequency [MHz]	Channel Center Frequency (MHz)	Occupied Channel Bandwidth (MHz)	Upper Band Edge (MHz)
BR	DH5	2480	2480.00	0.810945	2479.597015
EDR	2DH5	2480	2480.00	0.992537	2479.500000
EDR	3DH5	2480	2480.00	0.997512	2479.502488

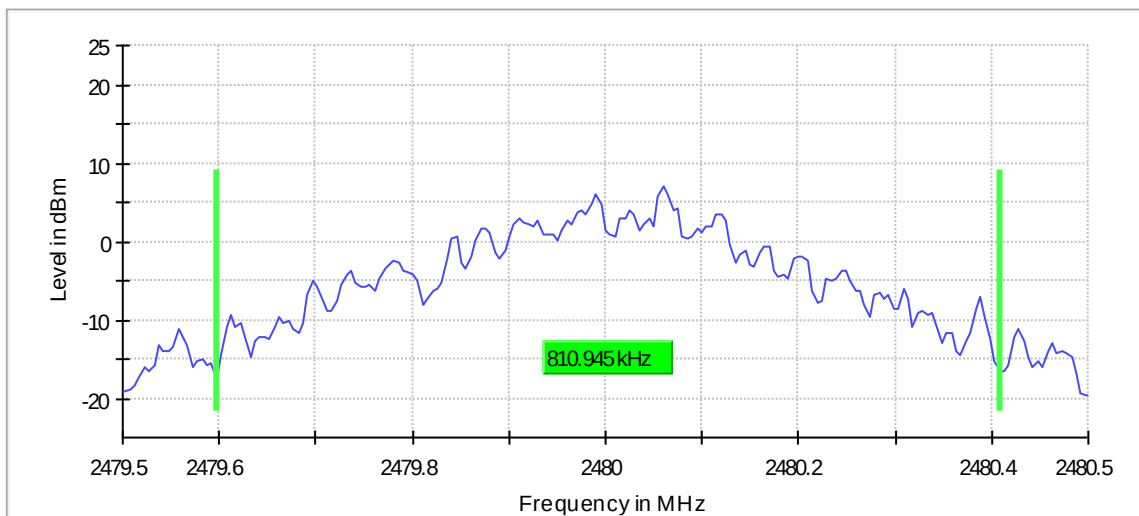
Results screenshot

BR – DH5

BW – CH0

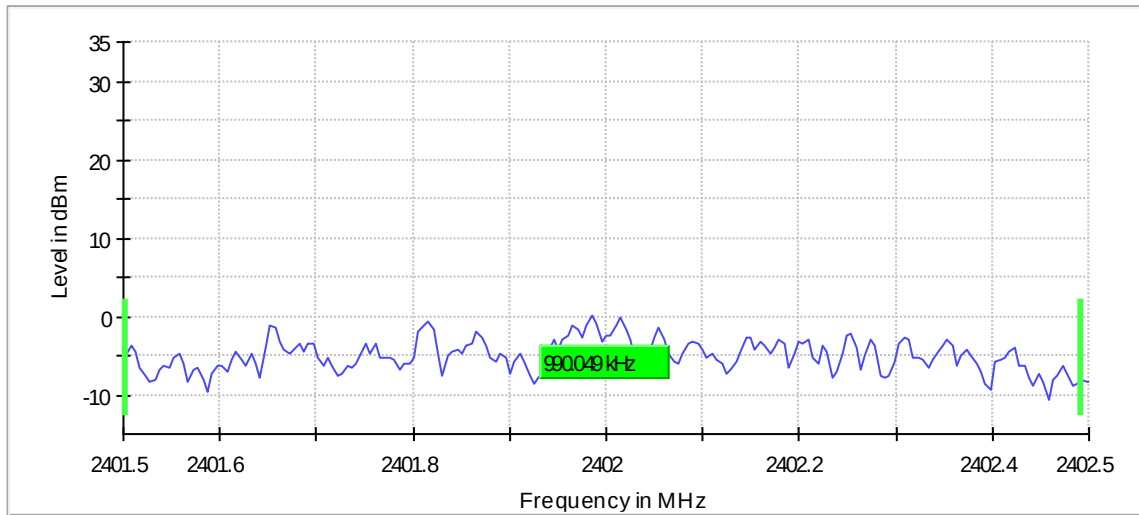


BW – CH78

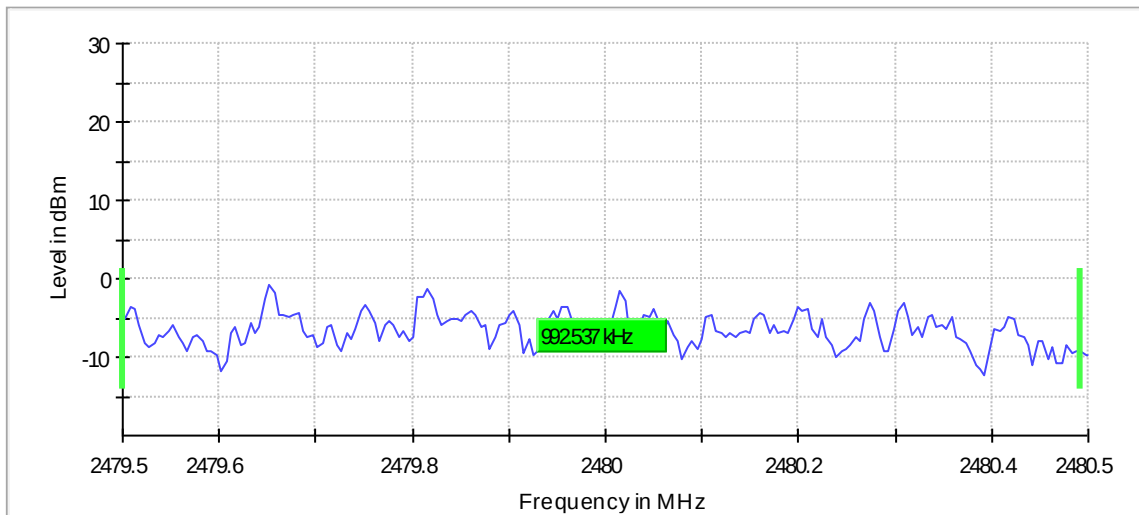


EDR – 2DH5

BW – CH0

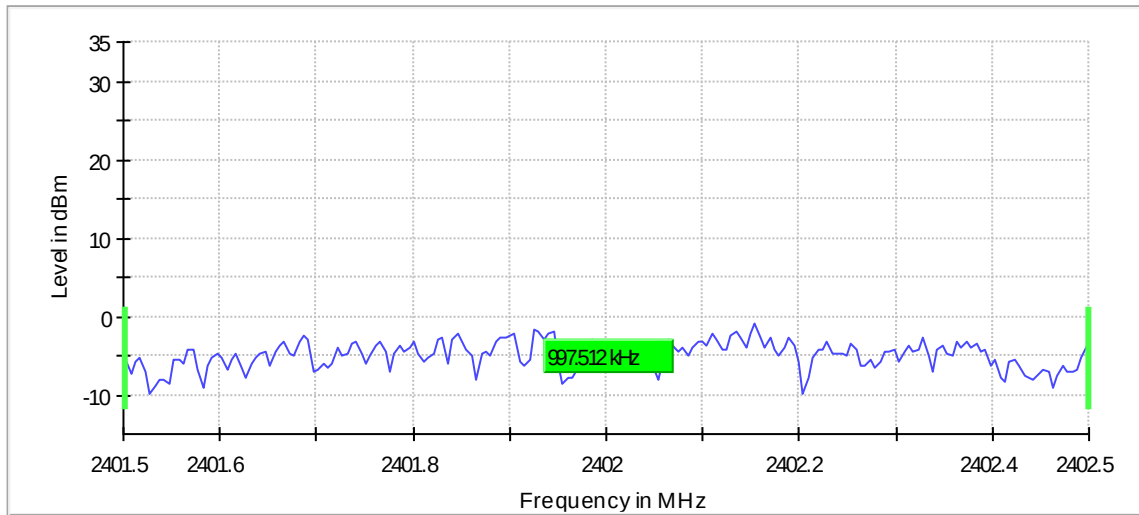


BW – CH78

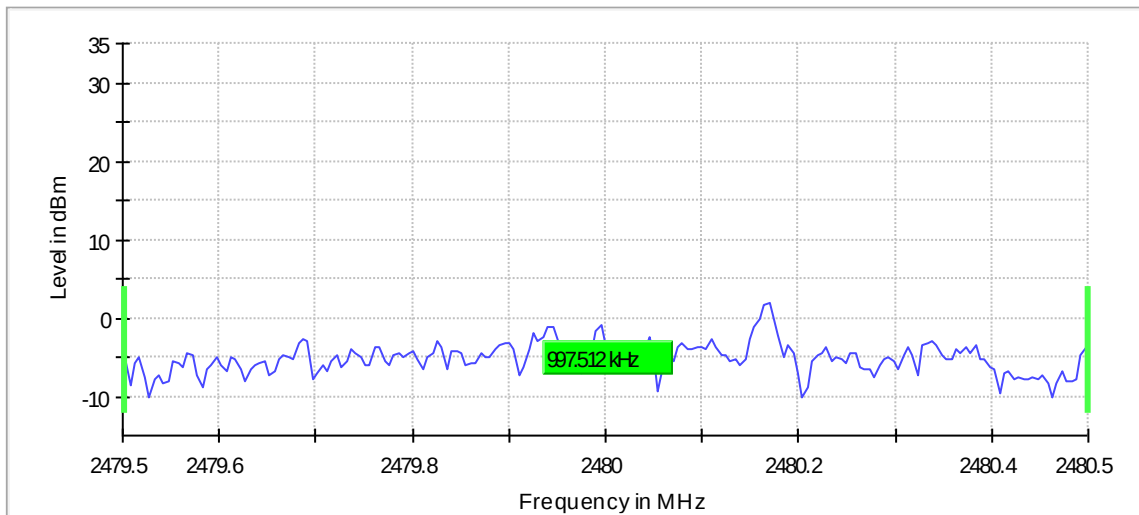


EDR – 3DH5

BW – CH0

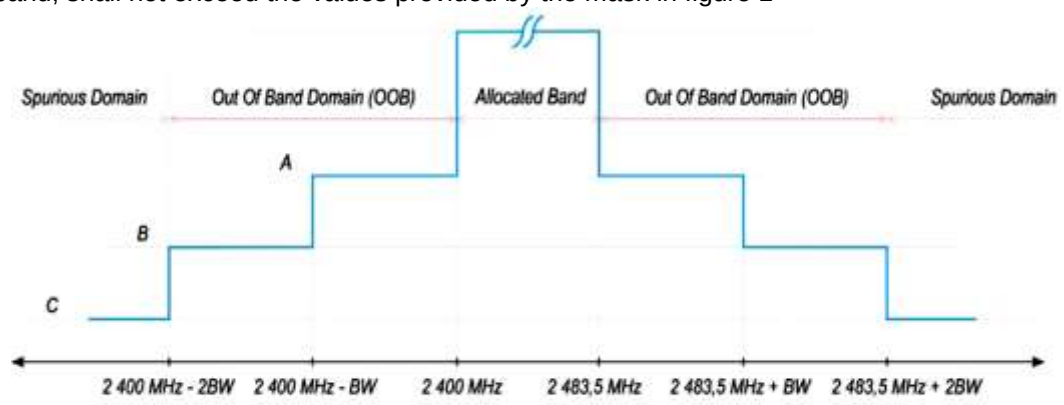


BW – CH78



B.7 Transmitter unwanted emission in the out-of-band domain

Test limits

ETSI part	Limits
4.3.1.9.3	The transmitter unwanted emissions in the out-of-band domain but outside the allocated band, shall not exceed the values provided by the mask in figure 1  A: -10 dBm/MHz e.i.r.p. B: -20 dBm/MHz e.i.r.p. C: Spurious Domain limits BW = Occupied Channel Bandwidth in MHz or 1 MHz whichever is greater

Test conditions

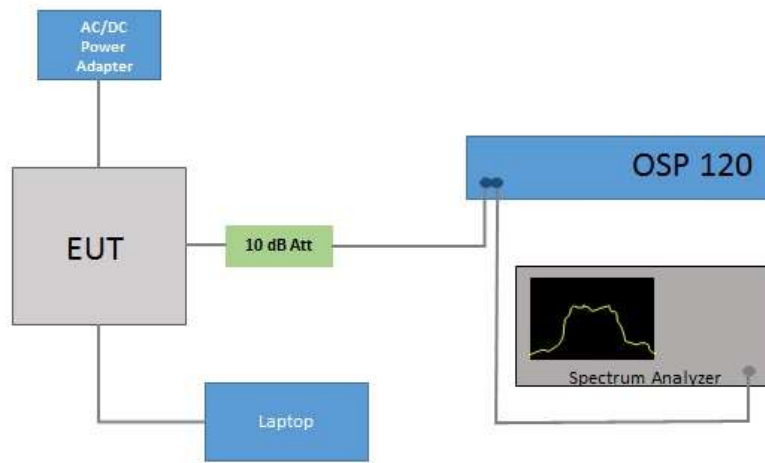
ETSI part	Limits
5.4.8.1	These measurements shall only be performed at normal test conditions. For equipment using FHSS modulation, the measurements shall be performed during normal operation (hopping).

Test procedure

The setup below was used to measure the unwanted emissions in the out of band domain (Band Edge) accordingly with ETSI EN 300 328 V2.1.1 §5.4.8.2.1. The antenna terminal of the EUT is connected to the OSP120 through an attenuator and a cable, the spectrum analyzer is connected to the receiver port on the OSP. System connection cable loss is compensated by the EMC32 software on measured parameters.

Antenna gain is taken in count and added by the software to the measurements. EMC32 provides the mask and the frequency limits based in the measured channel bandwidth. Maximum values for each limit level (-10dBm and -20dBm) are pointed by markers. The declared maximum antenna gain is +3dBi.

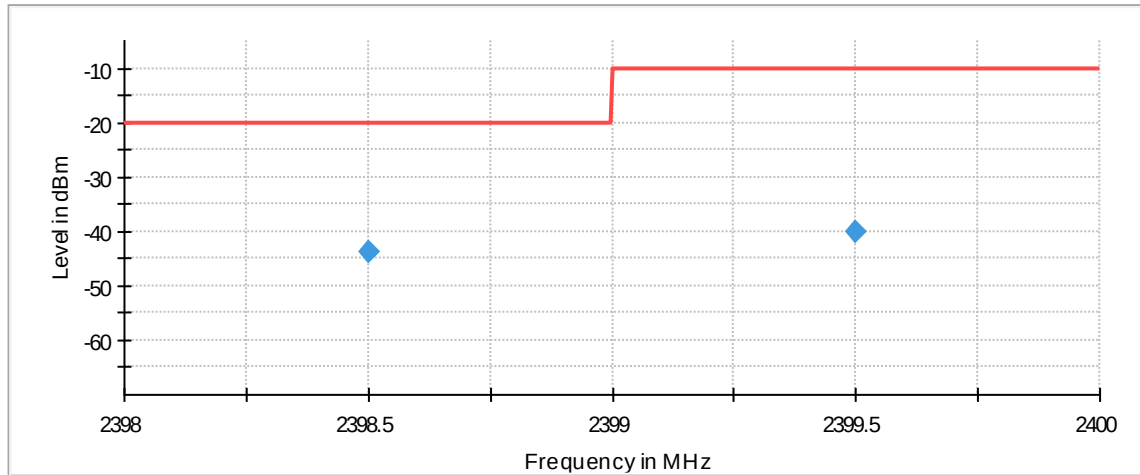
Conducted Setup



Results screenshot

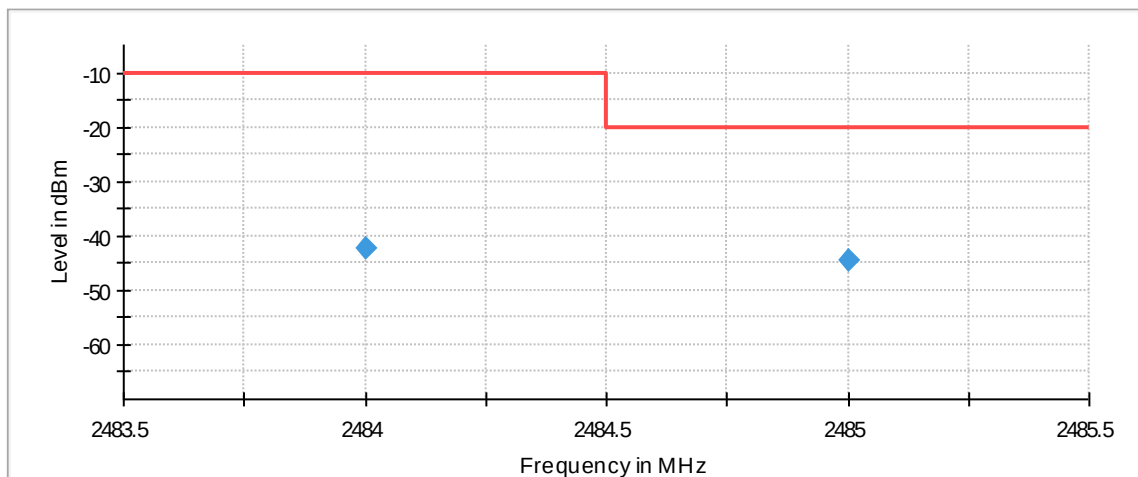
BR – DH5

UNWANTED OOB Low Freq Section



◆ Level — Limit

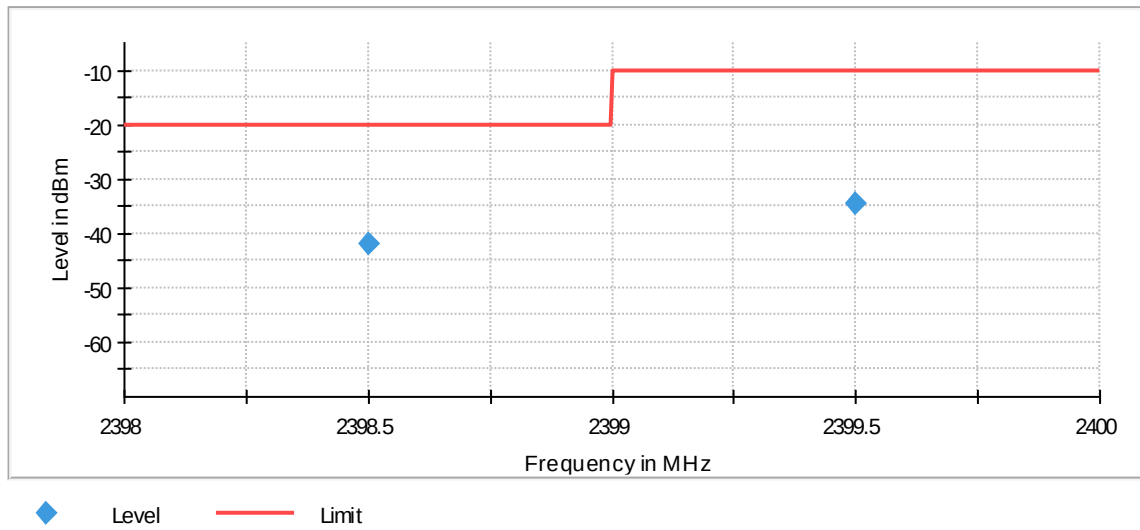
UNWANTED OOB High Freq Section



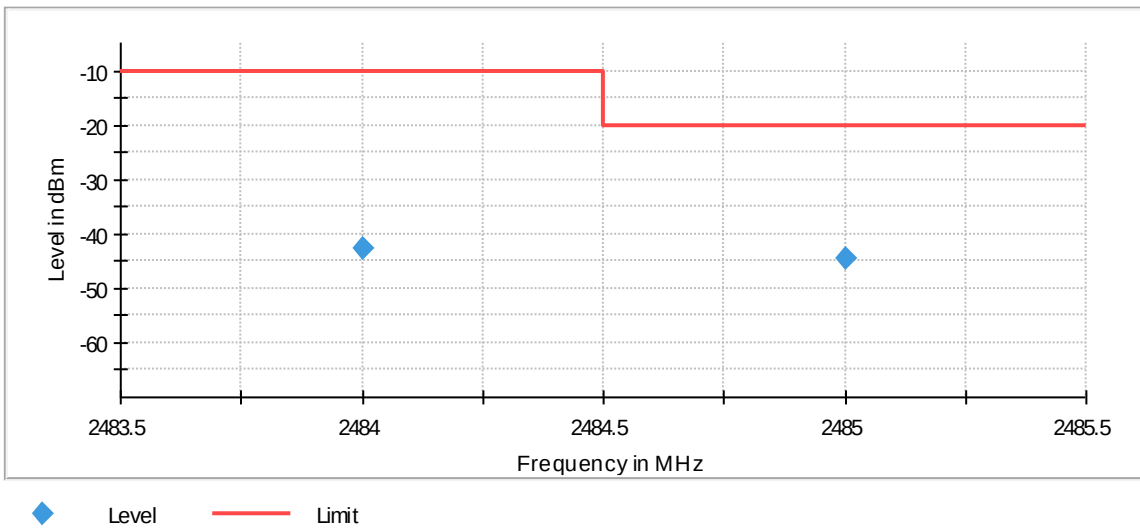
◆ Level — Limit

EDR – 2DH5

UNWANTED OOB Low Freq Section

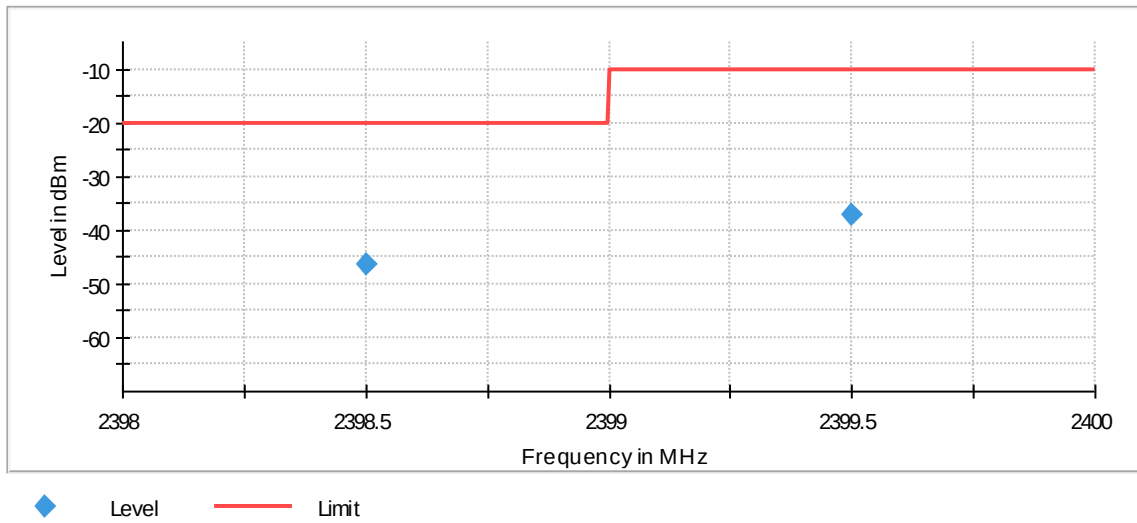


UNWANTED OOB High Freq Section

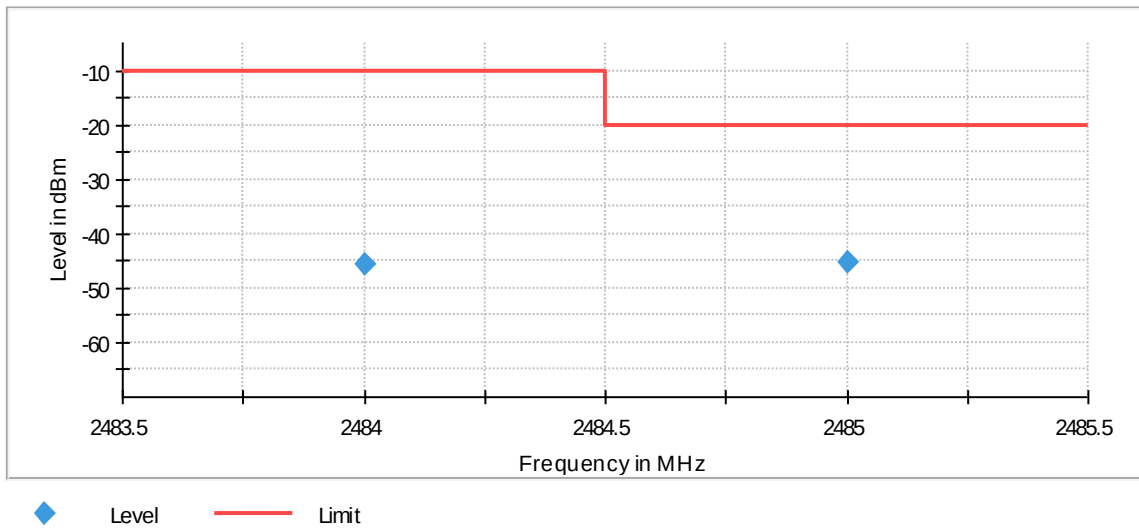


EDR – 3DH5

UNWANTED OOB Low Freq Section



UNWANTED OOB High Freq Section



B.8 Transmitter unwanted emissions in the spurious domain

Test limits

ETSI part	Limits																																	
4.3.1.10.3	The transmitter unwanted emissions in the spurious domain shall not exceed the values given in table 4.																																	
	Table 4: Transmitter limits for spurious emissions																																	
	<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 862 MHz</td><td>-54 dBm</td><td>100 KHz</td></tr><tr><td>862 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>	Frequency range	Maximum power	Bandwidth	30 MHz to 47 MHz	-36 dBm	100 KHz	47 MHz to 74 MHz	-54 dBm	100 KHz	74 MHz to 87.5 MHz	-36 dBm	100 KHz	87.5 MHz to 118 MHz	-54 dBm	100 KHz	118 MHz to 174 MHz	-36 dBm	100 KHz	174 MHz to 230 MHz	-54 dBm	100 KHz	230 MHz to 470 MHz	-36 dBm	100 KHz	470 MHz to 862 MHz	-54 dBm	100 KHz	862 MHz to 1 GHz	-36 dBm	100 KHz	1 GHz to 12.75 GHz	-30 dBm	1 MHz
	Frequency range	Maximum power	Bandwidth																															
	30 MHz to 47 MHz	-36 dBm	100 KHz																															
	47 MHz to 74 MHz	-54 dBm	100 KHz																															
	74 MHz to 87.5 MHz	-36 dBm	100 KHz																															
	87.5 MHz to 118 MHz	-54 dBm	100 KHz																															
	118 MHz to 174 MHz	-36 dBm	100 KHz																															
	174 MHz to 230 MHz	-54 dBm	100 KHz																															
	230 MHz to 470 MHz	-36 dBm	100 KHz																															
	470 MHz to 862 MHz	-54 dBm	100 KHz																															
862 MHz to 1 GHz	-36 dBm	100 KHz																																
1 GHz to 12.75 GHz	-30 dBm	1 MHz																																

Test conditions

ETSI part	Limits
5.4.8.1	These measurements shall only be performed at normal test conditions. For equipment using FHSS modulation, the measurements may be performed when normal hopping is disabled. In this case measurements need to be performed when operating at the lowest and the highest hopping frequency. When this is not possible, the measurement shall be performed during normal operation (hopping).

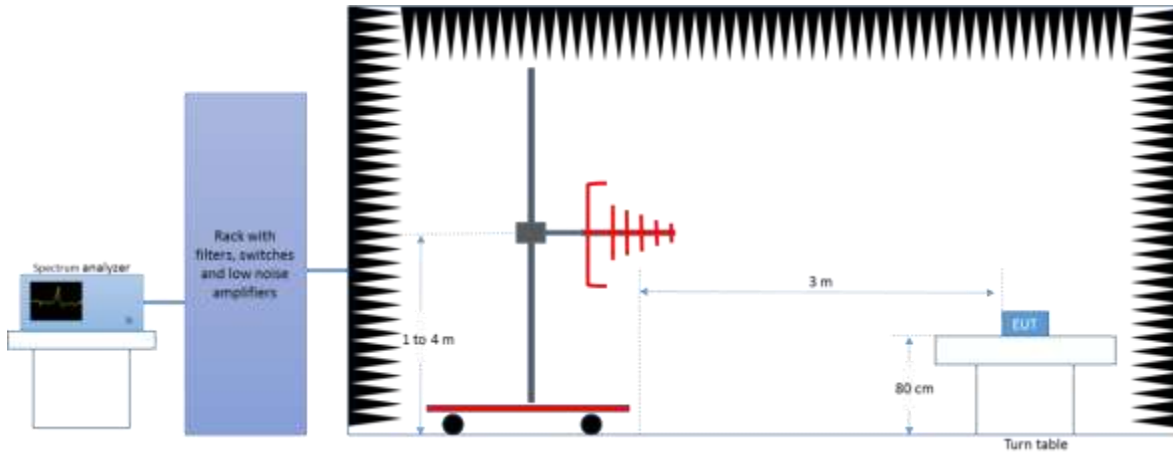
Test procedure

The setup bellow is used to measure the transmission spurious emissions accordingly with ETSI EN 300 328 V2.1.1 §5.4.9.2.1. Depending of the frequency range and bands being tested, different antennas and filters were used, in consequence different setups are employed.

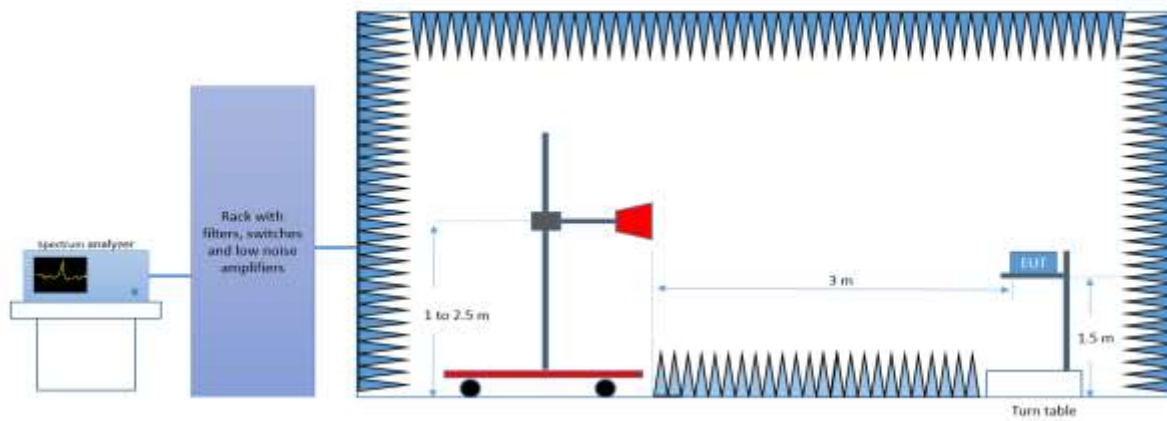
The final measurement is done by varying the antenna height from 1 to 4 meters, the EUT azimuth over 360° and for both Vertical and Horizontal polarizations.

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

Radiated Setup 30MHz- 1GHz



Radiated Setup 1GHz – 12.75GHz



Test Results

Tx Spurious Emissions – 30MHz to 12.75GHz

Tx Spurious Emissions – BR, GFSK, DH5, CH0

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
128.7	-68.5	-36.0	32.5
624.0	-64.2	-54.0	10.2
3369.0	-45.6	-30.0	15.6
12692.0	-54.3	-30.0	24.3

Tx Spurious Emissions – BR, GFSK, DH5, CH78

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
127.5	-69.9	-36.0	33.9
541.2	-70.3	-54.0	16.3
3192.5	-45.8	-30.0	15.8
12726.4	-54.5	-30.0	24.5

Tx Spurious Emissions – BR, $\pi/4$ -DQPSK, 2-DH5, CH0

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
128.7	-68.7	-36.0	32.7
730.2	-69.0	-54.0	15.0
3376.5	-46.1	-30.0	16.1
12711.4	-54.3	-30.0	24.3

Tx Spurious Emissions – BR, $\pi/4$ -DQPSK, 2-DH5, CH78

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
128.1	-73.3	-36.0	37.3
298.9	-71.9	-36.0	35.9
3380.5	-45.7	-30.0	15.7
12688.7	-54.4	-30.0	24.4

Tx Spurious Emissions – BR, EDR, 8-DPSK, 3-DH5, CH0

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
128.1	-72.9	-36.0	36.9
672.0	-65.4	-54.0	11.4
3360.5	-46.2	-30.0	16.2
12703.2	-54.3	-30.0	24.3

Tx Spurious Emissions – BR, EDR, 8-DPSK, 3-DH5, CH78

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
128.7	-69.5	-36.0	33.5
312.0	-68.2	-36.0	32.2
3374.0	-45.9	-30.0	15.9
12738.9	-55.2	-30.0	25.2

B.9 Receiver spurious emissions

Test limits

ETSI part	Limits
4.3.1.11.3	The spurious emissions of the receiver shall not exceed the values given in table below.

Test conditions

ETSI part	Limits
5.4.10.1	These measurements shall only be performed at normal test conditions. Testing shall be performed when the equipment is in a receive-only mode. For equipment using FHSS modulation, the measurements may be performed when normal hopping is disabled. In this case measurements need to be performed when operating at the lowest and the highest hopping frequency. These frequencies shall be recorded. When disabling the normal hopping is not possible, the measurement shall be performed during normal operation (hopping).

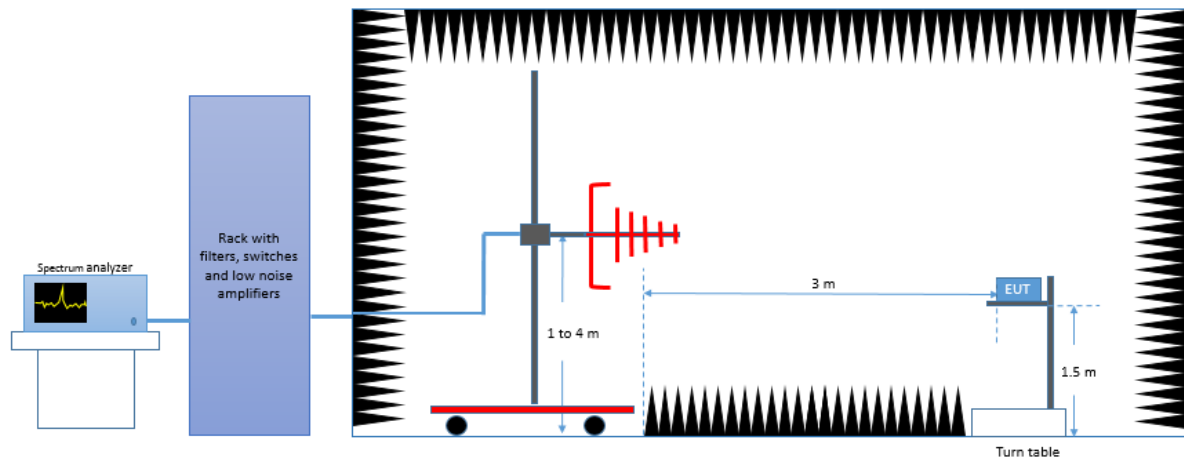
Test procedure

The setup bellow is used to measure the receiver spurious emissions accordingly with ETSI EN 300 328 V2.1.1 §5.4.10.2.2. Depending of the frequency range and bands being tested, different antennas and filters were used, in consequence different setups are employed.

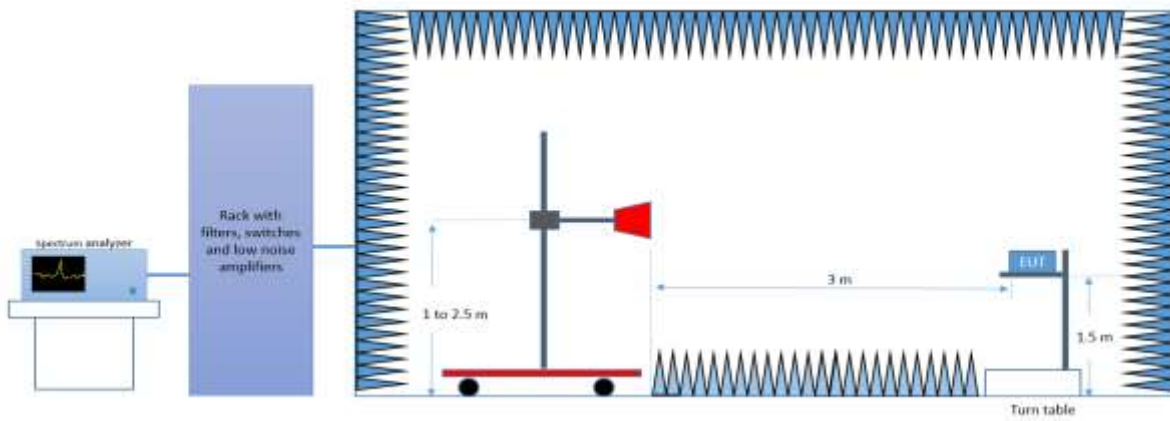
The final measurement is done by varying the antenna height from 1 to 4 meters, the EUT azimuth over 360° and for both Vertical and Horizontal polarizations.

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

Radiated Setup 30 MHz - 1 GHz



Radiated Setup 1 GHz - 12.75 GHz



Test Results

Rx Spurious Emissions – 30 MHz to 12.75 GHz

Rx Spurious Emissions – BR, GFSK, DH5, CH0

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
62.4	-64.0	-57.0	7.0
1332.4	-61.8	-47.0	14.8
2124.6	-56.1	-47.0	9.1
2131.9	-57.1	-47.0	10.1
6374.2	-59.5	-47.0	12.5
6395.7	-59.6	-47.0	12.6
10359.9	-55.6	-47.0	8.6

Rx Spurious Emissions – BR, GFSK, DH5, CH78

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
62.6	-66.3	-57.0	9.3
2123.6	-57.6	-47.0	10.6
2127.0	-54.7	-47.0	7.7
2131.4	-60.5	-47.0	13.5
2663.1	-62.3	-47.0	15.3
10360.3	-56.5	-47.0	9.5

Rx Spurious Emissions – BR, $\pi/4$ -DQPSK, 2-DH5, CH0

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
62.5	-64.9	-57.0	7.9
1394.6	-66.2	-47.0	19.2
2124.1	-56.4	-47.0	9.4
2132.9	-58.3	-47.0	11.3
2437.9	-59.8	-47.0	12.8
2663.6	-62.4	-47.0	15.4
6386.9	-59.5	-47.0	12.5
10360.3	-59.1	-47.0	12.1

Rx Spurious Emissions – BR, $\pi/4$ -DQPSK, 2-DH5, CH78

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
62.5	-60.7	-57.0	3.7
1327.5	-63.0	-47.0	16.0
2124.1	-55.3	-47.0	8.3
2162.8	-58.9	-47.0	11.9

Rx Spurious Emissions – BR, EDR, 8-DPSK, 3-DH5, CH0

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
62.3	-64.7	-57.0	7.7
1331.4	-63.7	-47.0	16.7
2159.3	-59.4	-47.0	12.4
2165.2	-62.0	-47.0	15.0
2655.3	-62.1	-47.0	15.1
2824.2	-62.0	-47.0	15.0

Rx Spurious Emissions – BR, EDR, 8-DPSK, 3-DH5, CH78

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
62.5	-64.9	-57.0	8.0
1166.5	-66.9	-47.0	19.9
1289.3	-67.0	-47.0	20.0
1330.0	-62.9	-47.0	15.9
2018.3	-63.7	-47.0	16.7
2089.8	-63.5	-47.0	16.5
2165.2	-60.5	-47.0	13.5

B.10 Receiver Blocking

Test limits

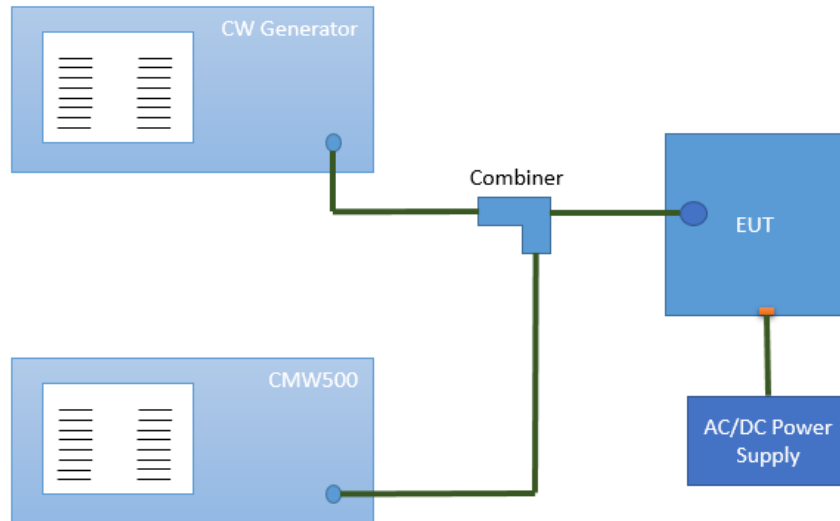
ETSI part	Limits																				
4.3.1.12.3	The minimum performance criterion shall be a PER less than or equal to 10 %.																				
4.3.1.12.4	While maintaining the minimum performance criteria as defined in clause 4.3.1.12.3, the blocking levels at specified frequency offsets shall be equal to or greater than the limits defined for the applicable receiver category provided in table below. Receiver blocking parameters for Receiver Category 1 equipment <table><tr><th>Wanted signal mean power from companion device (dBm)</th><th>Blocking signal frequency (MHz)</th><th>Blocking signal power (dBm) (see note 2)</th><th>Type of blocking signal</th></tr><tr><td>$P_{\min} + 6 \text{ dB}$</td><td>2 380 2 503,5</td><td>-53</td><td>CW</td></tr><tr><td>$P_{\min} + 6 \text{ dB}$</td><td>2 300 2 330 2 360</td><td>-47</td><td>CW</td></tr><tr><td>$P_{\min} + 6 \text{ dB}$</td><td>2 523,5 2 553,5 2 583,5 2 613,5 2 643,5 2 673,5</td><td>-47</td><td>CW</td></tr></table> <table><tr><td>NOTE 1:</td><td>$P_{\min}$ is the minimum level of wanted signal (in dBm) required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.</td></tr><tr><td>NOTE 2:</td><td>The levels specified are levels in front of the UUT antenna. In case of conducted measurements, the levels have to be corrected by the actual antenna assembly gain.</td></tr></table>	Wanted signal mean power from companion device (dBm)	Blocking signal frequency (MHz)	Blocking signal power (dBm) (see note 2)	Type of blocking signal	$P_{\min} + 6 \text{ dB}$	2 380 2 503,5	-53	CW	$P_{\min} + 6 \text{ dB}$	2 300 2 330 2 360	-47	CW	$P_{\min} + 6 \text{ dB}$	2 523,5 2 553,5 2 583,5 2 613,5 2 643,5 2 673,5	-47	CW	NOTE 1:	$P_{\min}$ is the minimum level of wanted signal (in dBm) required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.	NOTE 2:	The levels specified are levels in front of the UUT antenna. In case of conducted measurements, the levels have to be corrected by the actual antenna assembly gain.
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NOTE 2:	The levels specified are levels in front of the UUT antenna. In case of conducted measurements, the levels have to be corrected by the actual antenna assembly gain.																				

Test conditions

ETSI part	Conditions
5.4.11.1	These measurements shall only be performed at normal test conditions. 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 as declared by the manufacturer (see clause 5.4.1 t)) and shall be described in the test report. It shall be verified that this performance criteria as declared by the manufacturer is achieved.

Test procedure

The setup below was used to measure receiver blocking signal. The signaling Unit in our case is the CMW500.



The packet error rate (PER) is measured with the CMW500. The blocking signal is emulated by the Signal generator SMB100A.

The declared antenna gain is +3dBi.

Test results

Configuration tested: BT, Chain A, Mode DH5-Hopping.

Minimum performance result without interferer

Wanted signal mean power from companion device: Pmin [dBm]	PER [%]
-93.40	43.70
-93.20	44.25
-93.00	4.90

- Minimum performance results with interferer**

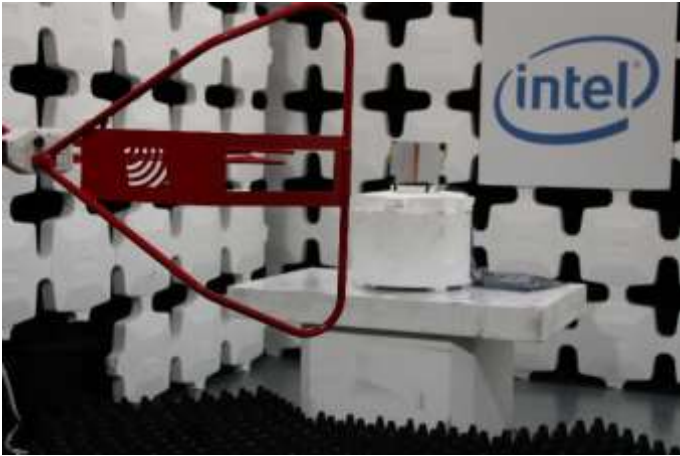
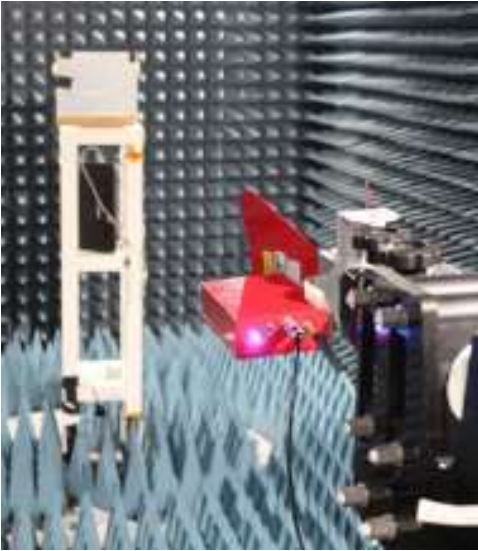
Wanted signal mean power from companion device:

✓ Pmin [dBm] + 6dB = -87.00 dBm

Blocking signal Frequency [MHz]	Blocking signal Power [dBm]	PER [%]	Verdict
2380	-50	3.38	PASS
2503.5	-50	3.52	PASS
2300	-44	3.40	PASS
2330	-44	3.80	PASS
2360	-44	2.90	PASS
2523.5	-44	3.00	PASS
2553.5	-44	3.60	PASS
2583.5	-44	3.35	PASS
2613.5	-44	3.45	PASS
2643.5	-44	3.00	PASS
2673.5	-44	3.38	PASS

Annex C. Photographs

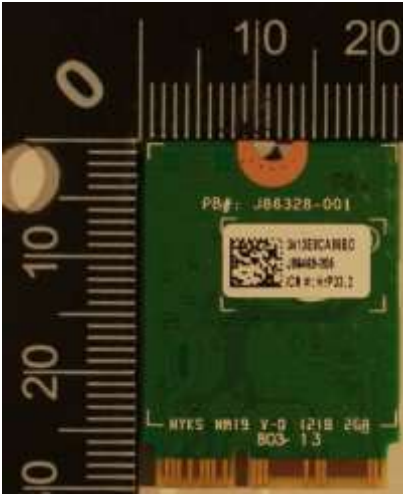
C.1 Test Setup

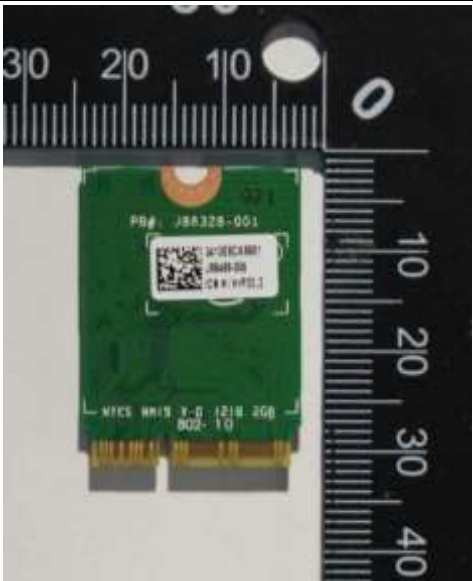
Radiated Setup-1 30 MHz – 1 GHz (Transmitter tests)	Radiated Setup-1 30 MHz – 1 GHz (Receiver tests)
	
Radiated Setup-2 1 GHz – 12.75 GHz (Transmitter tests)	
	

C.2 Test Sample

Sample #01	
Module Front	Module Back
	
Extender board	Laptop
	

Sample #02	
Module Front	Module Back
	
Extender board	Laptop
	

Sample #03	
Module Front	Module Back
	
Extender board	Laptop
	

Sample #05	
Module Front	Module Back
	
Extender board	Laptop
	