

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	2018-09-11 / 2018-12-05
Features	802.11ax, Dual Band, 2x2 Wi-Fi + Bluetooth® 5 (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 V2.1.1 (see section 1)
Test Report identification	180717-02.TR12
Revision Control	Rev. 00 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.

Issued by



Digitally signed by
Gregory ROUSTAN
Date: 2018.12.17 16:41:31
+01'00'

Gregory ROUSTAN
(Test Engineer Lead)

Reviewed by



Digitally signed by In Cheiel
Date: 2018.12.17 17:06:26
+01'00'
Adobe Acrobat DC version:
2015.006.30461

Cheiel IN
(Technical Manager)

Intel Corporation S.A.S – WRF Lab
425 rue de Goa – Le Cargo B6 - 06600, Antibes, France
Tel. +33493001400 / Fax +33493001401

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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 ± 3°C
Humidity	54% ± 20%

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	2018-09-06	
#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 6.4 GHz for Tx tests and 30 MHz to 1 GHz for Rx tests
	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 6.4 GHz to 12.75 GHz for Tx tests and 1 GHz to 12.75 GHz for Rx tests
	180717-03.S18	EXTENDER	PCB00651_01	6510817-133	2018-08-21	
	170801-01.S10	LAPTOP	LATITUDE E7470	7KNOXF2	2017-09-07	
#6	180717-02.S11	HOST LAPTOP	LATITUDE 7490	17640389594	2018-09-24	Radiated Spurious emission from 1 GHz to 12.75 GHz for Rx tests
	180717-02.S08	RF MODULE	AX201NGW	WFM:3413E8CA8681	2018-09-06	

5. EUT Features

Brand Name	Intel® Wi-Fi 6 AX201		
Model Name	AX201NGW		
Software Version	OEM DRTU_08048_11_1832_0G, Proset 99.0.39 (Adaptivity)		
Driver Version	99.0.39.1, 99.0.39.8 (Adaptivity)		
Prototype / Production	Production		
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

- At customer request, all tests except RF Output Power (4.3.2.2) & Power Spectral Density (4.3.2.3) were carried out at higher Tx Power: +2dB vs nominal declared power.
- According to the applicant declaration the device AX201NGW operating in 802.11b/g/n/a/ac/ax 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.
- According to applicant's request, the Rx Radiated Spurious tests in 1- 12.75 GHz band were performed with the module embedded inside a host as indicated in the section 4, sample #6

7. Test Verdicts summary

7.1. 802.11b/g/n/ax

Mode	ETSI part	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)	P
	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 #	Date	Modified by	Revision Details
Rev. 00	2018-12-13	F. Sauvan A. Hagras	First Issue

Annex A. Test & System Description

A.1 Measurement System

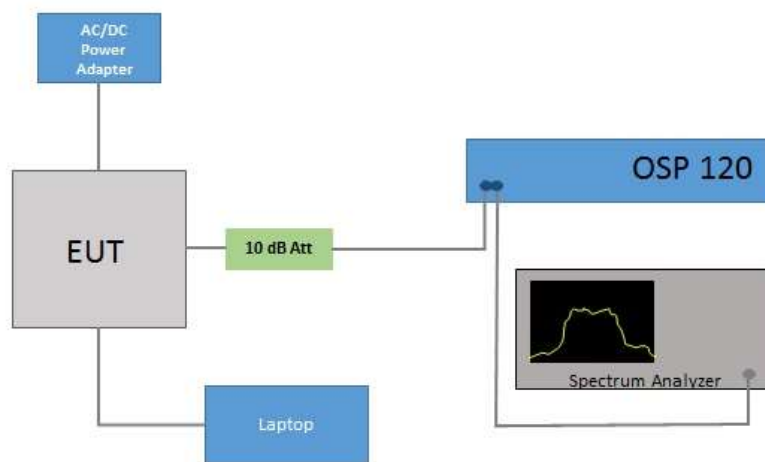
Measurements were performed using the following setups and made in accordance to the general provisions of ETSI EN 300 328 V2.1.1.

Rohde & Schwarz TS9887 system with the switching unit OSP120, OSP B-157 and software EMC32 were employed.

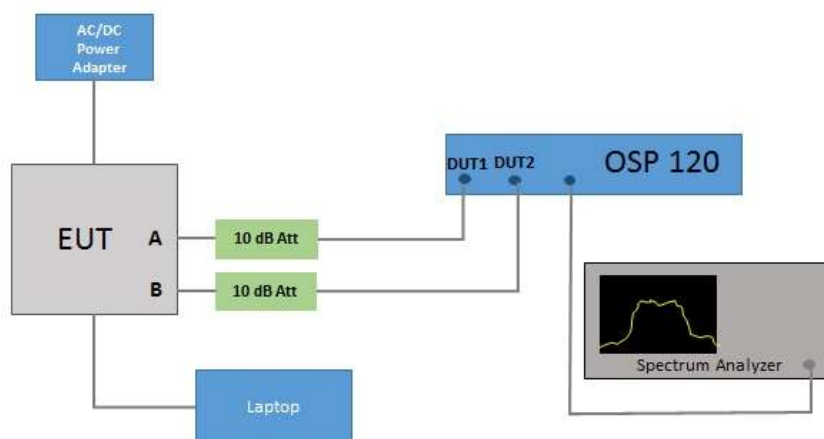
The DUT was installed in a test fixture and then connected to a laptop computer and AC/DC power adapter. The laptop computer was used to configure the EUT to continuously transmit at a specified output power using all different modes and modulation schemes, using the Intel proprietary tool DRTU.

Setups for conducted and radiated measurements are shown below.

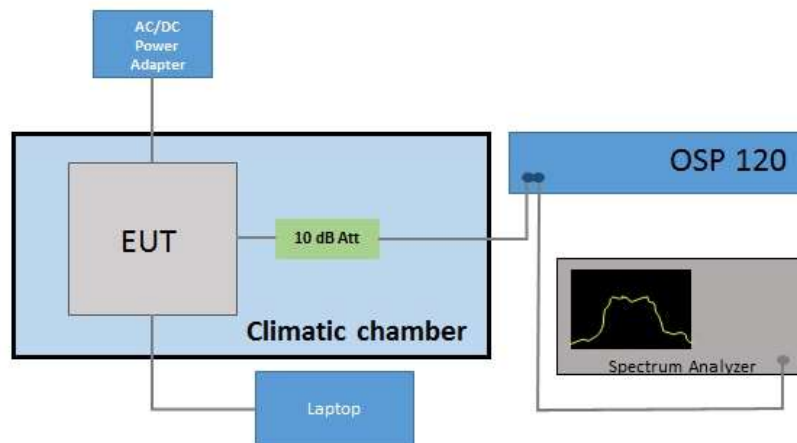
Conducted Setup



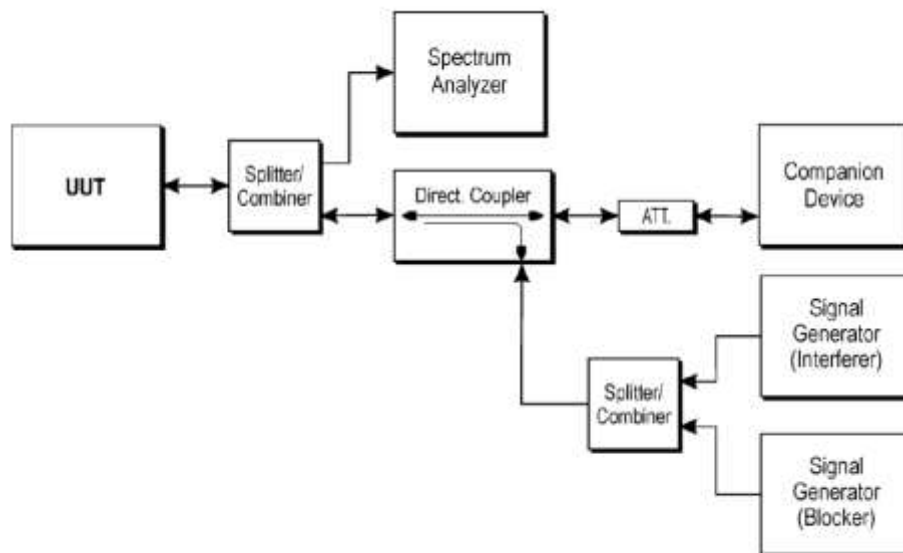
Conducted Setup (MIMO Measurements)



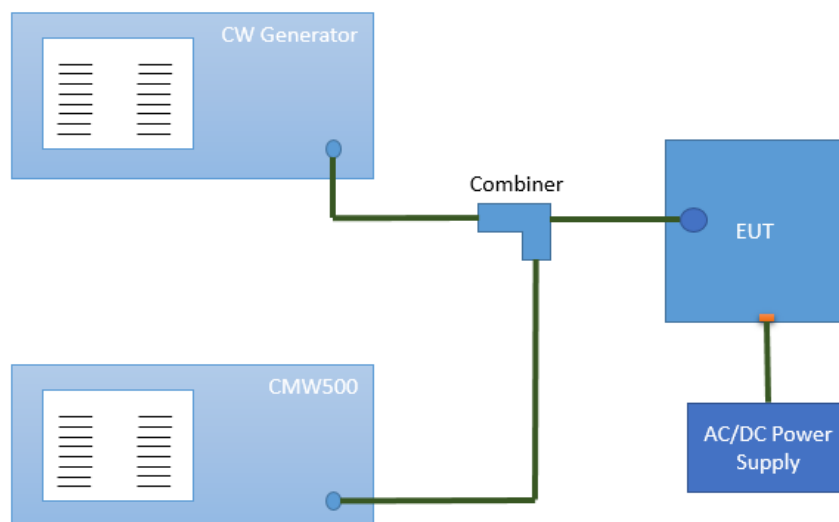
Conducted Setup (Extreme conditions)



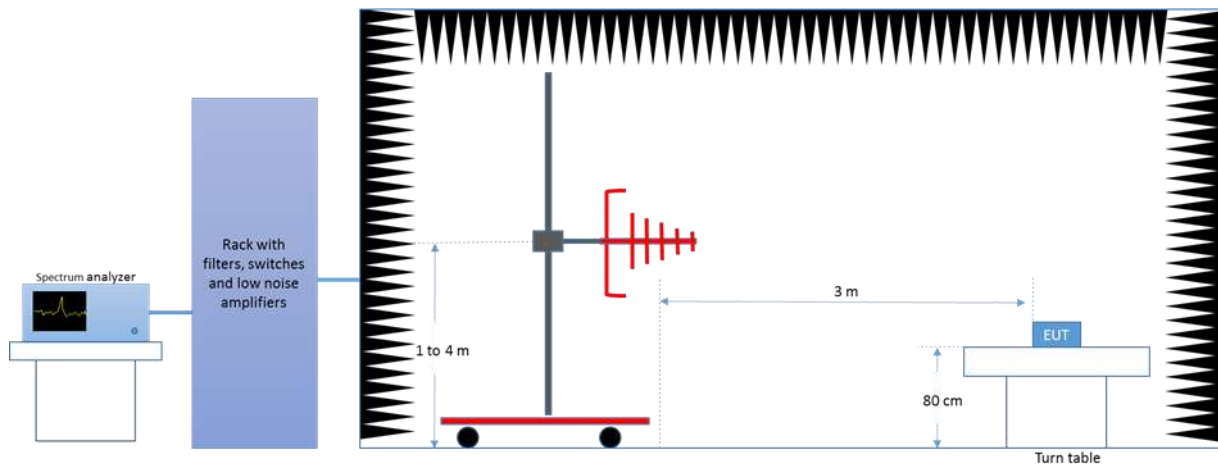
Adaptivity Setup



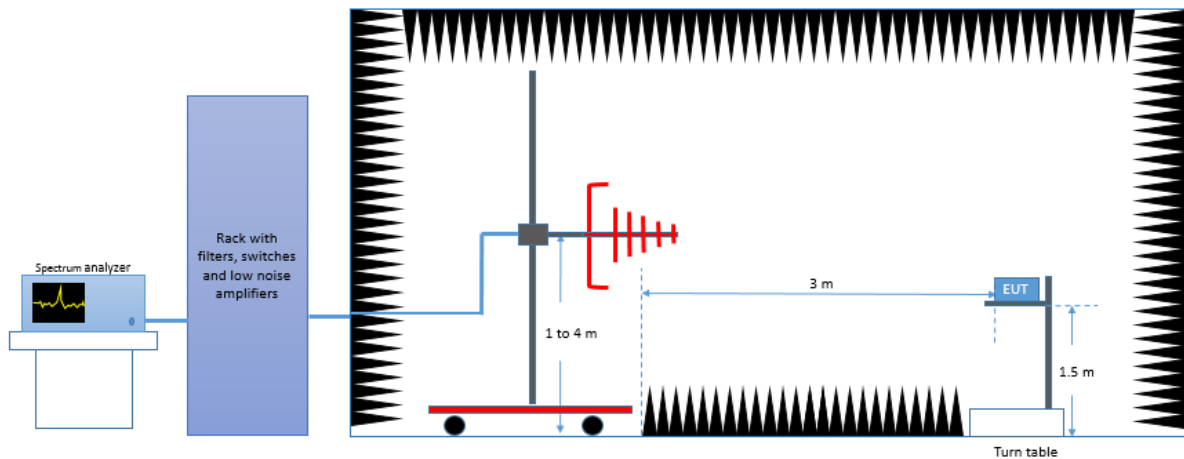
Receiver Blocking Setup



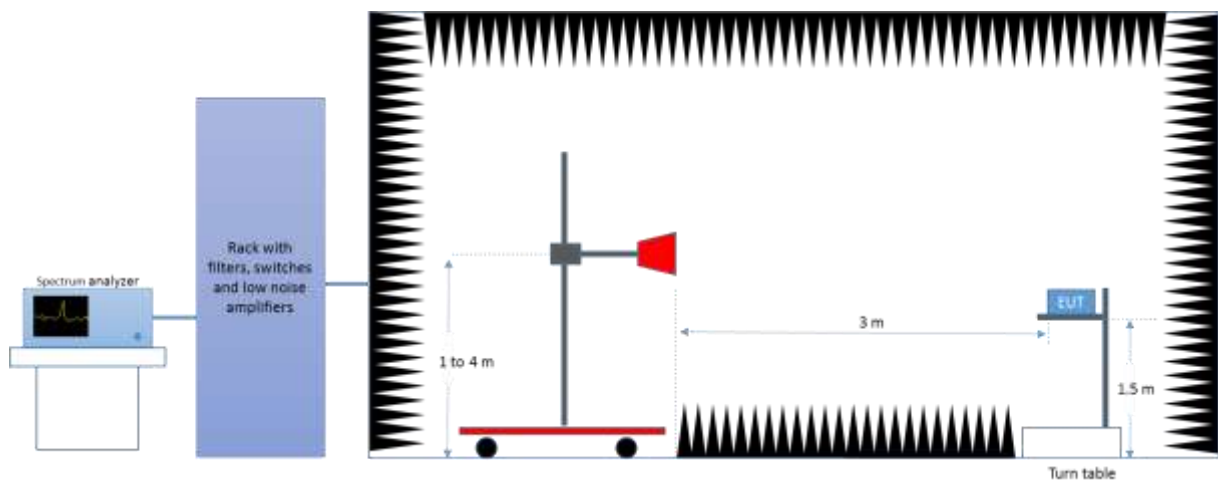
Radiated Setup 30 MHz - 1 GHz (Transmitter tests)



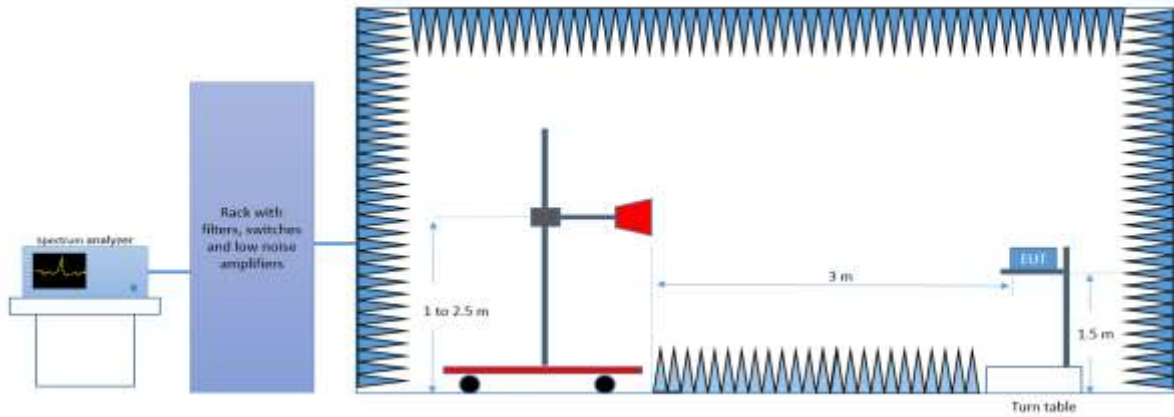
Radiated Setup 30 MHz - 1 GHz (Receiver tests)



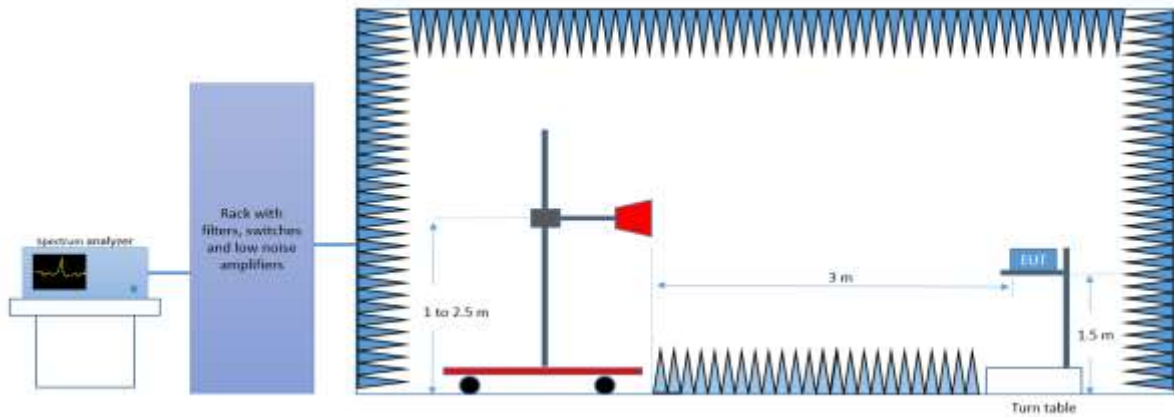
Radiated Setup 1 GHz – 6.4 GHz (Transmitter tests)



Radiated Setup 6.4 GHz - 12.75 GHz (Transmitter tests)



Radiated Setup 1GHz - 12.75 GHz (Receiver tests)



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
0261	Access point	Aironet IOS	FTX134390GV	Cisco	N/A	N/A

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

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
0325	Double Ridged Horn Antenna 1 GHz – 18 GHz	3117	00157734	ETS Lindgren	2017-08-22	2019-08-22
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
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 [$\pm$ 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.	

For 802.11b mode the EUT can transmit at both CHAIN A and CHAIN B RF outputs individually, but not simultaneously.

For 802.11n20, 802.11ax20 (20 MHz channel bandwidth), 802.11n40, 802.11ax40 (40MHz channel bandwidth), modes the EUT can transmit at both CHAIN A and CHAIN B RF outputs individually, and also simultaneously.

The conducted RF output power at each chain was adjusted according to the client's supplied Target values (see following table) using the Intel DRTU tool and measuring the power by using a calibrated average power meter. Measured values for adjustment were within -0.25 dB/+0.25 dB from the declared Target values.

Mode	BW (MHz)	Data Rate	CH #	Freq. (MHz)	Conducted Power Target Value (dBm)		
					SISO Chain A	SISO Chain B	MIMO at both ports A and B
802.11b	20	1Mbps	1	2412	16.0	16.0	-
			7	2442	16.0	16.0	-
			13	2472	16.0	16.0	-
802.11g	20	6 Mbps	1	2412	16.5	17.0	-
			7	2442	16.5	17.0	-
			13	2472	16.5	17.0	-
802.11n	20	HT0 HT8*	1	2412	17.0	17.0	16.5
			7	2442	16.0	17.0	16.5
			13	2472	16.0	17.0	16.5
	40	HT0 HT8*	3F	2422	17.0	17.0	16.5
			7F	2442	17.0	17.0	16.5
			11F	2462	16.5	17.0	16.5
802.11ax	20	HE0	1	2412	16.5	16.5	16.5
			7	2442	16.5	16.5	16.5
			13	2472	16.5	17.0	16.0
	40	HE0	3F	2422	16.5	17.0	16.5
			7F	2442	16.0	17.0	16.5
			11F	2462	16.5	17.0	16.5

* Note: HT8 for MIMO modes only.

The following data rates were selected based on preliminary testing that identified those rates as the worst cases for output power and spurious levels at the band edges:

- 802.11b → 1Mbps
- 802.11g → 6Mbps
- 802.11n20 and 802.11n40 (SISO) → HT0
- 802.11n20 and 802.11n40 (MIMO) → HT8
- 802.11ax20 and 802.11ax40 (SISO) → HE0
- 802.11ax20 and 802.11ax40 (MIMO) → HE0

B.2 RF output power

Test limits

ETSI part	Limits
4.3.2.2.3	For adaptive equipment using wide band modulations other than FHSS, the maximum RF output power shall be 20 dBm (E.I.R.P.). 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. 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

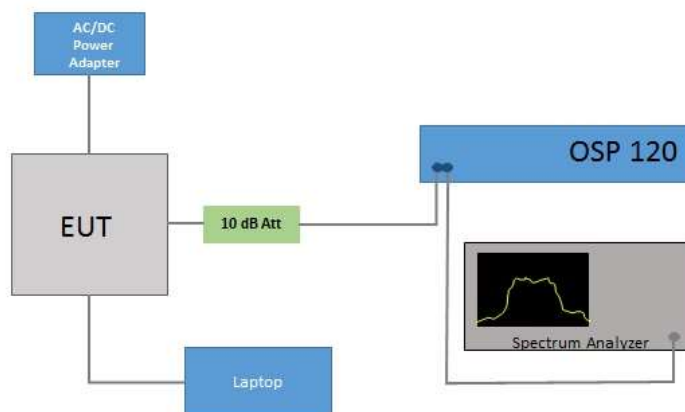
The setup below was used to measure the RF output power. The antenna terminal of the EUT is connected to the OSP120 through a 10dB attenuator and a cable, the spectrum analyzer is connected to the receiver port of the OSP. System connection cable loss is compensated by the EMC32 software

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

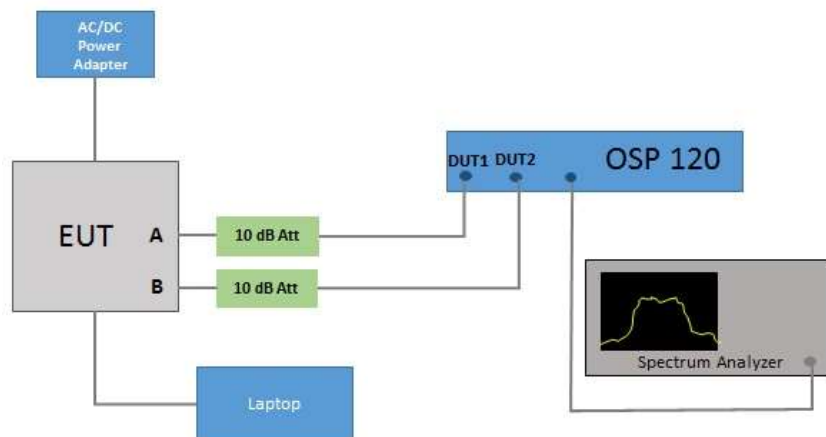
The declared maximum antenna gain is +3dBi.

For MIMO modes accordingly to the test procedure described in EN 300 328 V2.1.1 §5.4.2.2.1.2, the measurement is done synchronously on all transmit ports, the power of the individual samples is sum for all ports and then the reported power is the highest calculated RMS power for the active bursts.

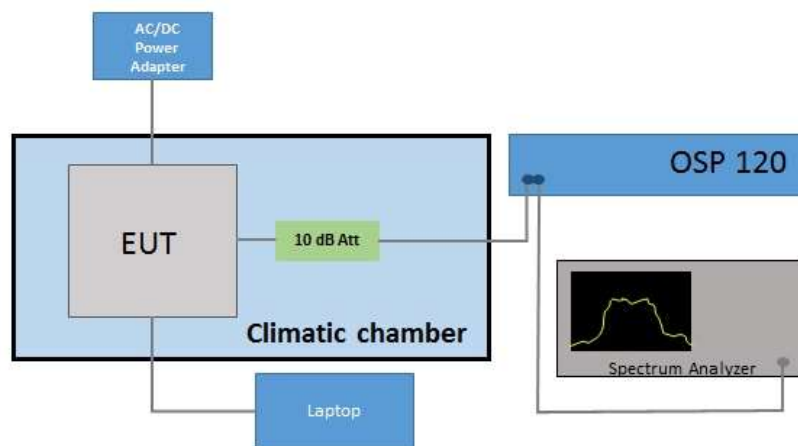
Conducted Setup (Normal Conditions)



Conducted Setup (MIMO Measurements)



Conducted Setup (Extreme conditions)



Results tables

Normal conditions

Temperature: $23 \pm 2^{\circ}\text{C}$

Humidity: $54\% \pm 20\%$

Antenna gain: +3dBi

Mode	Rate	Meas. Duty Cycle [%]	Channel	Freq. [MHz]	Antenna	Power [dBm]	
						Measured Conducted	EIRP
802.11b	1Mbps	98.97	1	2412	SISO CHAIN A	15.96	18.96
					SISO CHAIN B	15.90	18.90
			7	2442	SISO CHAIN A	15.98	18.98
					SISO CHAIN B	15.98	18.98
			13	2472	SISO CHAIN A	15.80	18.80
					SISO CHAIN B	16.00	19.00
802.11g	6Mbps	98.24	1	2412	SISO CHAIN A	16.75	19.75
					SISO CHAIN B	16.86	19.86
			7	2442	SISO CHAIN A	16.40	19.40
					SISO CHAIN B	16.90	19.90
			13	2472	SISO CHAIN A	16.40	19.40
					SISO CHAIN B	17.00	20.00
802.11n20	HT0	98.06	1	2412	SISO CHAIN A	16.71	19.71
					SISO CHAIN B	16.79	19.79
			7	2442	SISO CHAIN A	16.20	19.20
					SISO CHAIN B	16.96	19.96
			13	2472	SISO CHAIN A	16.20	19.20
					SISO CHAIN B	16.91	19.91
	HT8	89.55	1	2412	MIMO	16.40	19.40
			7	2442	MIMO	16.40	19.40
			13	2472	MIMO	16.30	19.30
802.11n40	HT0	96.136	3F	2422	SISO CHAIN A	16.80	19.80
					SISO CHAIN B	17.00	20.00
			7F	2442	SISO CHAIN A	16.85	19.85
					SISO CHAIN B	17.00	20.00
			11F	2462	SISO CHAIN A	16.73	19.73
					SISO CHAIN B	16.90	19.90
	HT8	92.18	3F	2422	MIMO	16.50	19.50
			7F	2442	MIMO	16.50	19.50
			11F	2462	MIMO	16.50	19.50

Mode	Rate	Meas. Duty Cycle [%]	Channel	Freq. [MHz]	Antenna	Power [dBm]	
						Measured Conducted	EIRP
802.11ax20	HE0	97.57	1	2412	SISO CHAIN A	16.61	19.61
					SISO CHAIN B	16.66	19.66
			7	2442	SISO CHAIN A	16.68	19.68
					SISO CHAIN B	16.70	19.70
			13	2472	SISO CHAIN A	16.40	19.40
					SISO CHAIN B	16.80	19.80
	HE0	89.61	1	2412	MIMO	16.30	19.30
			7	2442	MIMO	16.30	19.30
			13	2472	MIMO	16.10	19.10
802.11ax40	HE0	95.17	3F	2422	SISO CHAIN A	16.30	19.30
					SISO CHAIN B	16.90	19.90
			7F	2442	SISO CHAIN A	16.20	19.20
					SISO CHAIN B	16.90	19.90
			11F	2462	SISO CHAIN A	16.42	19.42
					SISO CHAIN B	17.00	20.00
	HE0	89.11	3F	2422	MIMO	16.50	19.50
			7F	2442	MIMO	16.50	19.50
			11F	2462	MIMO	16.50	19.50

Extreme temperature conditions ($T_{max} = +70\text{ }^{\circ}\text{C}$)

Antenna gain: +3dBi

						Power [dBm]	
Mode	Rate	Meas. Duty Cycle [%]	Channel	Freq. [MHz]	Antenna	Measured Conducted	EIRP
802.11b	1Mbps	98.974	1	2412	SISO CHAIN A	16.19	19.19
					SISO CHAIN B	16.80	19.80
			7	2442	SISO CHAIN A	15.64	18.64
					SISO CHAIN B	16.90	19.90
			13	2472	SISO CHAIN A	16.00	19.00
					SISO CHAIN B	16.80	19.80
802.11g	6Mbps	98.24	1	2412	SISO CHAIN A	16.80	19.80
					SISO CHAIN B	16.90	19.90
			7	2442	SISO CHAIN A	16.50	19.50
					SISO CHAIN B	17.00	20.00
			13	2472	SISO CHAIN A	16.50	19.50
					SISO CHAIN B	17.00	20.00
802.11n20	HT0	98.06	1	2412	SISO CHAIN A	16.74	19.74
					SISO CHAIN B	16.76	19.76
			7	2442	SISO CHAIN A	16.50	19.50
					SISO CHAIN B	16.80	19.80
			13	2472	SISO CHAIN A	16.50	19.50
					SISO CHAIN B	16.99	19.99
	HT8	84.6	1	2412	MIMO	16.50	19.50
			7	2442	MIMO	16.60	19.60
			13	2472	MIMO	16.00	19.00
802.11n40	HT0	96.13	3F	2422	SISO CHAIN A	16.40	19.40
					SISO CHAIN B	16.90	19.90
			7F	2442	SISO CHAIN A	16.50	19.50
					SISO CHAIN B	16.90	19.90
			11F	2462	SISO CHAIN A	16.40	19.40
					SISO CHAIN B	17.00	20.00
	HT8	84.45	3F	2422	MIMO	16.50	19.50
			7F	2442	MIMO	16.55	19.55
			11F	2462	MIMO	16.70	19.70

Mode	Rate	Meas. Duty Cycle [%]	Channel	Freq. [MHz]	Antenna	Power [dBm]	
						Measured Conducted	EIRP
802.11ax20	HE0	97.52	1	2412	SISO CHAIN A	16.87	19.87
					SISO CHAIN B	16.80	19.80
			7	2442	SISO CHAIN A	16.87	19.87
					SISO CHAIN B	16.80	19.80
			13	2472	SISO CHAIN A	16.20	19.20
					SISO CHAIN B	16.90	19.90
	HE0	84.7	1	2412	MIMO	16.40	19.40
			7	2442	MIMO	16.90	19.90
			13	2472	MIMO	16.30	19.30
802.11ax40	HE0	95.43	3F	2422	SISO CHAIN A	16.40	19.40
					SISO CHAIN B	17.00	20.00
			7F	2442	SISO CHAIN A	16.60	19.60
					SISO CHAIN B	16.90	19.90
			11F	2462	SISO CHAIN A	16.60	19.60
					SISO CHAIN B	17.00	20.00
	HE0	84.49	3F	2422	MIMO	16.64	19.64
			7F	2442	MIMO	16.60	19.60
			11F	2462	MIMO	16.60	19.60

Extreme temperature conditions ($T_{min} = -10^{\circ}\text{C}$)

Antenna gain: +3dBi

						Power [dBm]	
Mode	Rate	Meas. Duty Cycle [%]	Channel	Freq. [MHz]	Antenna	Measured Conducted	EIRP
802.11b	1Mbps	97.0	1	2412	SISO CHAIN A	16.90	19.90
					SISO CHAIN B	16.76	19.76
			7	2442	SISO CHAIN A	16.20	19.20
					SISO CHAIN B	16.88	19.88
			13	2472	SISO CHAIN A	16.90	19.90
					SISO CHAIN B	16.71	19.71
802.11g	6Mbps	88.79	1	2412	SISO CHAIN A	16.96	19.96
					SISO CHAIN B	16.89	19.89
			7	2442	SISO CHAIN A	16.93	19.93
					SISO CHAIN B	16.91	19.91
			13	2472	SISO CHAIN A	16.90	19.90
					SISO CHAIN B	16.96	19.96
802.11n20	HT0	89.72	1	2412	SISO CHAIN A	16.92	19.92
					SISO CHAIN B	16.97	19.97
			7	2442	SISO CHAIN A	16.87	19.87
					SISO CHAIN B	16.82	19.82
			13	2472	SISO CHAIN A	16.91	19.91
					SISO CHAIN B	16.95	19.95
	HT8	89.56	1	2412	MIMO	16.65	19.65
			7	2442	MIMO	16.95	19.95
			13	2472	MIMO	16.81	19.81
802.11n40	HT0	89.7	3F	2422	SISO CHAIN A	16.92	19.92
					SISO CHAIN B	16.86	19.86
			7F	2442	SISO CHAIN A	16.93	19.93
					SISO CHAIN B	16.89	19.89
			11F	2462	SISO CHAIN A	16.84	19.84
					SISO CHAIN B	16.98	19.98
	HT8	84.45	3F	2422	MIMO	16.87	19.87
			7F	2442	MIMO	16.96	19.96
			11F	2462	MIMO	17.00	20.00

Mode	Rate	Meas. Duty Cycle [%]	Channel	Freq. [MHz]	Antenna	Power [dBm]	
						Measured Conducted	EIRP
802.11ax20	HE0	94.71	1	2412	SISO CHAIN A	16.94	19.94
					SISO CHAIN B	16.94	19.94
			7	2442	SISO CHAIN A	16.92	19.92
					SISO CHAIN B	16.92	19.92
			13	2472	SISO CHAIN A	16.89	19.89
					SISO CHAIN B	16.89	19.89
	HE0	84.7	1	2412	MIMO	17.00	20.00
			7	2442	MIMO	16.93	19.93
			13	2472	MIMO	16.89	19.89
802.11ax40	HE0	84.75	3F	2422	SISO CHAIN A	16.94	19.94
					SISO CHAIN B	16.91	19.91
			7F	2442	SISO CHAIN A	16.79	19.79
					SISO CHAIN B	16.90	19.90
			11F	2462	SISO CHAIN A	16.96	19.96
					SISO CHAIN B	16.94	19.94
	HE0	84.49	3F	2422	MIMO	16.89	19.89
			7F	2442	MIMO	16.98	19.98
			11F	2462	MIMO	16.99	19.99

B.3 Power Spectral Density

Test limits

ETSI part	Limits
4.3.2.3.3	For equipment using wide band modulations other than FHSS, the maximum Power Spectral Density is limited to 10 dBm per MHz.

Test conditions

ETSI part	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.

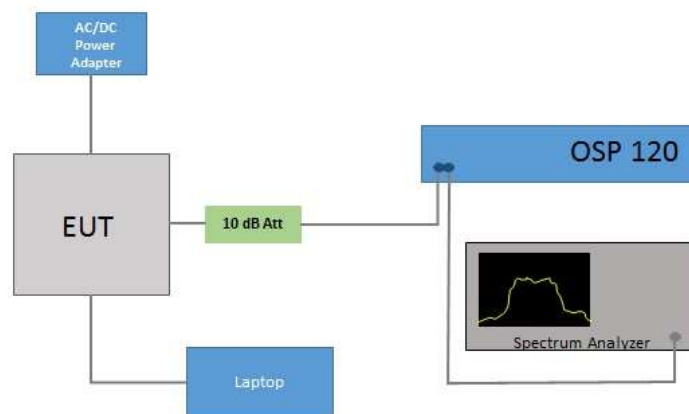
Test procedure

The setup below was used to measure the power spectral density (PSD). 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 EMC32 software to measure all parameters.

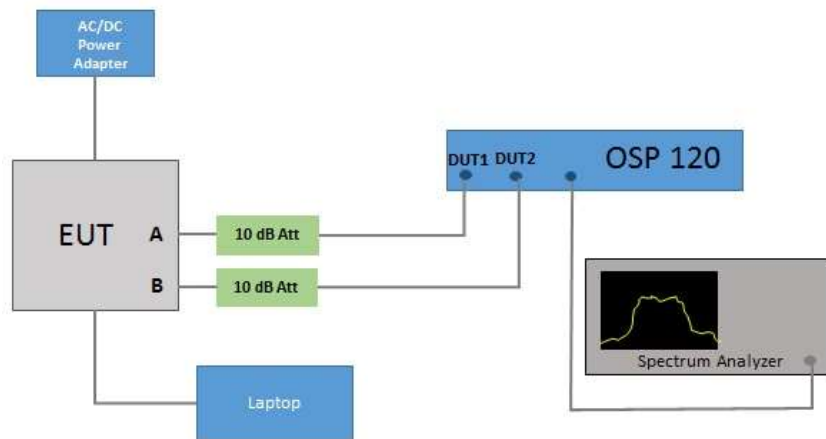
Antenna gain is taken in count and added by the software to the measurements. The E.I.R.P. power (dBm) is calculated by adding the declared maximum antenna gain to the measured conducted power. The declared maximum antenna gain is +3dBi.

For MIMO modes, accordingly to the test procedure described in EN 300 328 V2.1.1 §5.4.3.2.1, the measurement is done separately on each transmit ports and the power of the individual samples per frequency is sum for all ports. From all the recorded results, the highest value is the maximum Power Spectral Density.

Conducted Setup (Normal Conditions)



Conducted Setup (MIMO Measurements)



Results tables

Normal conditions

Temperature: 23 ± 2°C

Humidity: 54% ± 20%

Antenna gain: +3dBi

Mode	Rate	Meas. Duty Cycle [%]	Channel	Freq. [MHz]	Antenna	PSD [dBm/MHz]
802.11b	1Mbps	98.97	1	2412	SISO CHAIN A	9.91
					SISO CHAIN B	9.86
			7	2442	SISO CHAIN A	9.72
					SISO CHAIN B	9.95
			13	2472	SISO CHAIN A	9.88
					SISO CHAIN B	9.92
802.11g	6Mbps	98.24	1	2412	SISO CHAIN A	8.09
					SISO CHAIN B	8.11
			7	2442	SISO CHAIN A	7.71
					SISO CHAIN B	8.35
			13	2472	SISO CHAIN A	7.59
					SISO CHAIN B	8.21
802.11n20	HT0	98.06	1	2412	SISO CHAIN A	7.72
					SISO CHAIN B	7.60
			7	2442	SISO CHAIN A	7.09
					SISO CHAIN B	7.88
			13	2472	SISO CHAIN A	7.04
					SISO CHAIN B	7.81
	HT8	89.55	1	2412	MIMO	7.24
			7	2442	MIMO	7.27
			13	2472	MIMO	7.43
802.11n40	HT0	96.14	3F	2422	SISO CHAIN A	4.68
					SISO CHAIN B	4.90
			7F	2442	SISO CHAIN A	4.63
					SISO CHAIN B	4.87
			11F	2462	SISO CHAIN A	4.72
					SISO CHAIN B	4.90
	HT8	92.18	3F	2422	MIMO	4.49
			7F	2442	MIMO	4.45
			11F	2462	MIMO	4.52

Mode	Rate	Meas. Duty Cycle [%]	Channel	Freq. [MHz]	Antenna	PSD [dBm/MHz]
802.11ax20	HE0	97.57	1	2412	SISO CHAIN A	7.12
					SISO CHAIN B	7.26
			7	2442	SISO CHAIN A	6.84
					SISO CHAIN B	7.39
			13	2472	SISO CHAIN A	7.22
					SISO CHAIN B	7.31
		89.61	1	2412	MIMO	6.81
			7	2442	MIMO	6.70
			13	2472	MIMO	6.85
802.11ax40		95.17	3F	2422	SISO CHAIN A	3.95
					SISO CHAIN B	4.53
			7F	2442	SISO CHAIN A	4.03
					SISO CHAIN B	4.62
			11F	2462	SISO CHAIN A	3.88
					SISO CHAIN B	4.61
		89.11	3F	2422	MIMO	4.19
			7F	2442	MIMO	4.17
			11F	2462	MIMO	4.18

B.4 Adaptivity (adaptive equipment using modulations other than FHSS)

Test limits

ETSI part	Limits
4.3.2.6.3.2.3	<i>Load Based Equipment</i> Load Based Equipment may implement an LBT based spectrum sharing mechanism based on the Clear Channel Assessment (CCA) mode using energy detect as described in IEEE 802.11™-2012 [i.3], clause 9, clause 10, clause 16, clause 17, clause 19 and clause 20, or in IEEE 802.15.4™-2011 [i.4], clause 4, clause 5 and clause 8 providing the equipment complies with the conformance requirements referred to in clause 4.3.2.6.3.4. Load Based Equipment not using any of the mechanisms referenced above shall comply with the following minimum set of requirements: 1) Before a transmission or a burst of transmissions, the equipment shall perform a Clear Channel Assessment (CCA) check using energy detect. The equipment shall observe the operating channel for the duration of the CCA observation time which shall be not less than 18 µs. The channel shall be considered occupied if the energy level in the channel exceeds the threshold given in step 5 below. If the equipment finds the channel to be clear, it may transmit immediately. 2) If the equipment finds the channel occupied, it shall not transmit on this channel (see also the next paragraph). The equipment shall perform an Extended CCA check in which the channel is observed for a random duration in the range between 18 µs and at least 160 µs. If the extended CCA check has determined the channel to be no longer occupied, the equipment may resume transmissions on this channel. If the Extended CCA time has determined the channel still to be occupied, it shall perform new Extended CCA checks until the channel is no longer occupied. NOTE: The Idle Period in between transmissions is considered to be the CCA or the Extended CCA check as there are no transmissions during this period. The equipment is allowed to switch to a non-adaptive mode and to continue transmissions on this channel providing it complies with the requirements applicable to non-adaptive equipment. Alternatively, the equipment is also allowed to continue Short Control Signalling Transmissions on this channel providing it complies with the requirements given in clause 4.3.2.6.4. 3) The total time that an equipment makes use of a RF channel is defined as the Channel Occupancy Time. This Channel Occupancy Time shall be less than 13 ms, after which the device shall perform a new CCA as described in step 1 above. 4) The equipment, upon correct reception of a packet which was intended for this equipment can skip CCA and immediately (see also next paragraph) proceed with the transmission of management and control frames (e.g. ACK and Block ACK frames are allowed but data frames are not allowed). A consecutive sequence of transmissions by the equipment without a new CCA shall not exceed the maximum channel occupancy time as defined in step 3 above. For the purpose of multi-cast, the ACK transmissions (associated with the same data packet) of the individual devices are allowed to take place in a sequence. 5) The energy detection threshold for the CCA shall be proportional to the transmit power of the transmitter: for a 20 dBm e.i.r.p. transmitter the CCA 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 less than 20 dBm e.i.r.p., the CCA threshold level may be relaxed to: $TL = -70 \text{ dBm/MHz} + 10 \times \log_{10} (100 \text{ mW} / P_{out}) \text{ (Pout in mW e.i.r.p.)}$ 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 11.

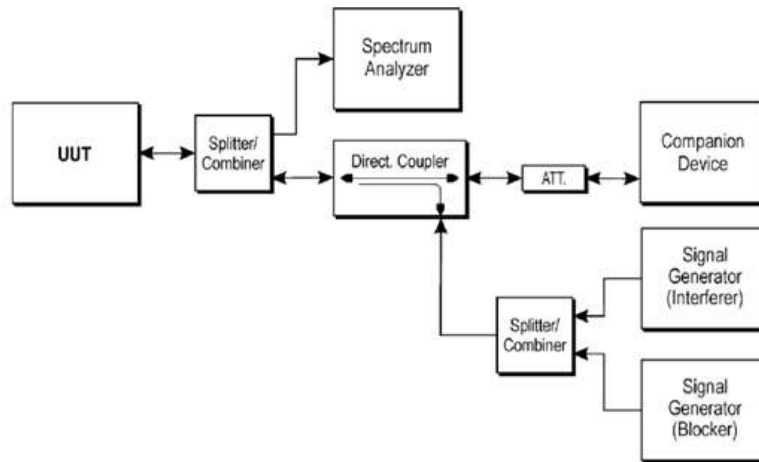
4.3.2.6.4.2	Table11: Unwanted Signal parameters		
	Wanted signal mean power from companion device	Unwanted signal frequency (MHz)	Unwanted signal power (dBm)
	sufficient to maintain the link (see note 2)	2 395 or 2 488,5 (see note 1)	-35 (see note 3)
	NOTE 1: The highest frequency shall be used for testing 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: A typical value which can be used in most cases is -50 dBm/MHz. NOTE 3: 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.		
	If implemented, Short Control Signalling Transmissions of adaptive equipment using wide band modulations other than FHSS shall have a maximum TxOn / (TxOn + TxOff) ratio of 10 % within any observation period of 50 ms. Note 3: 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 an access point 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.

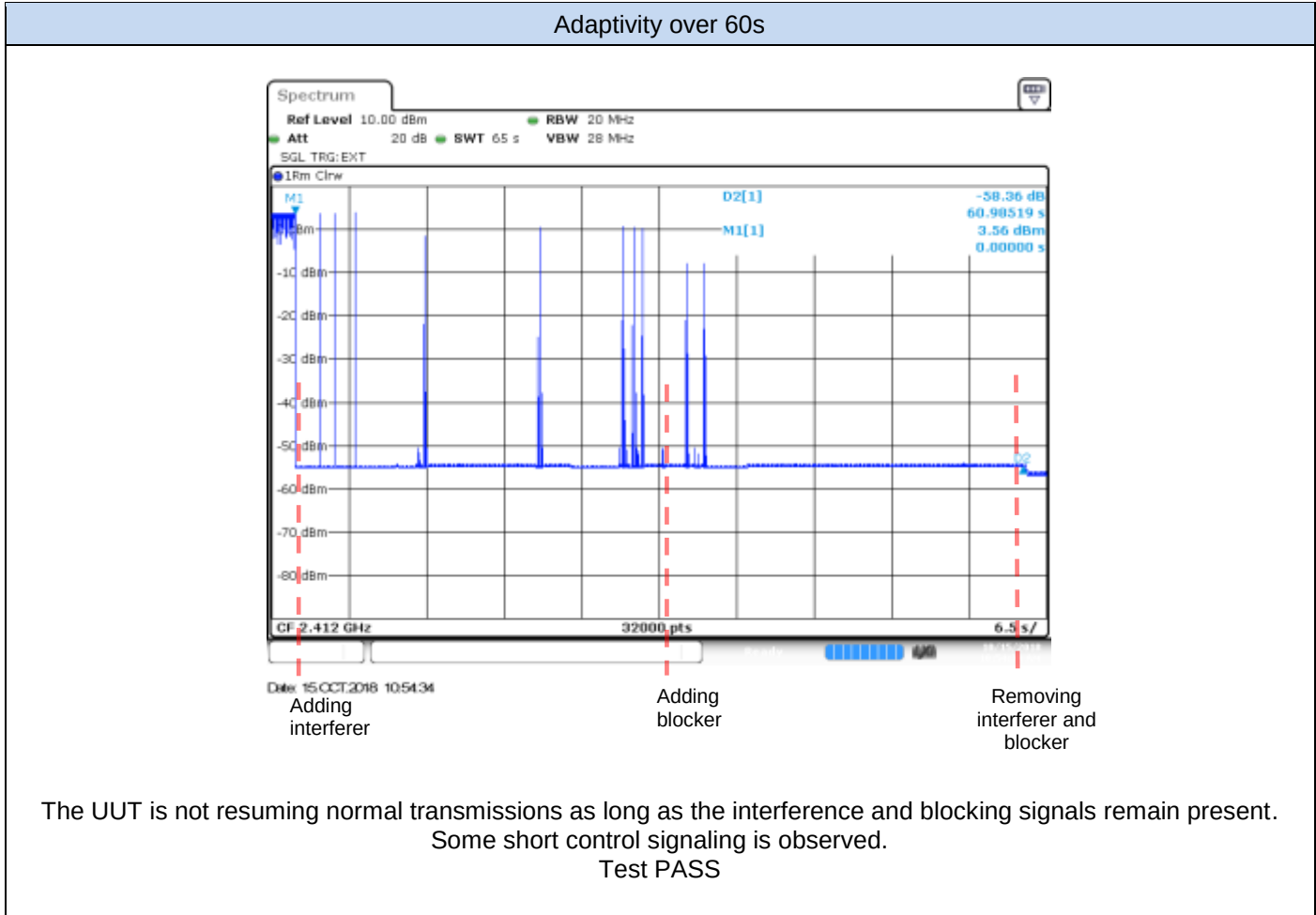
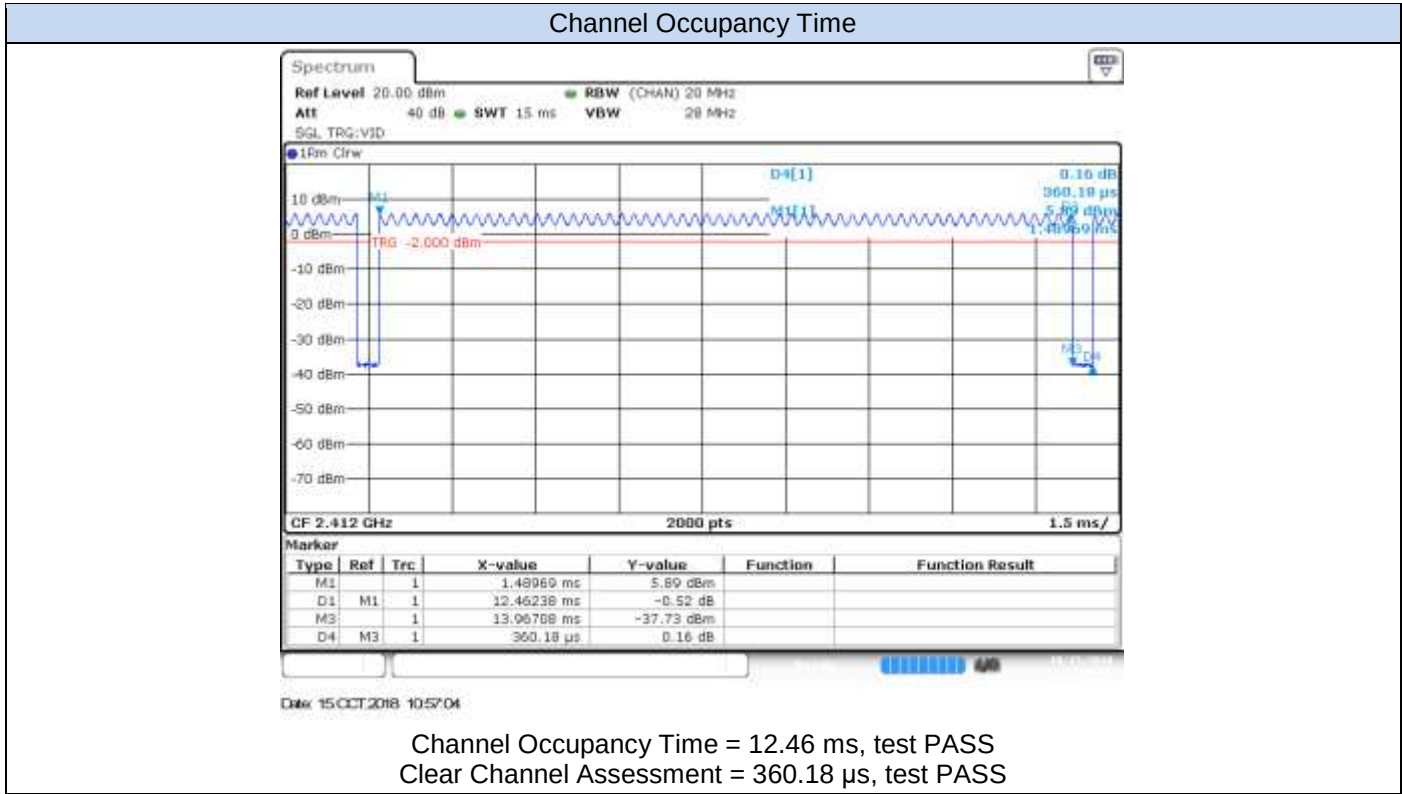
The power levels for the signals at the input of the receiver are as follows:

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

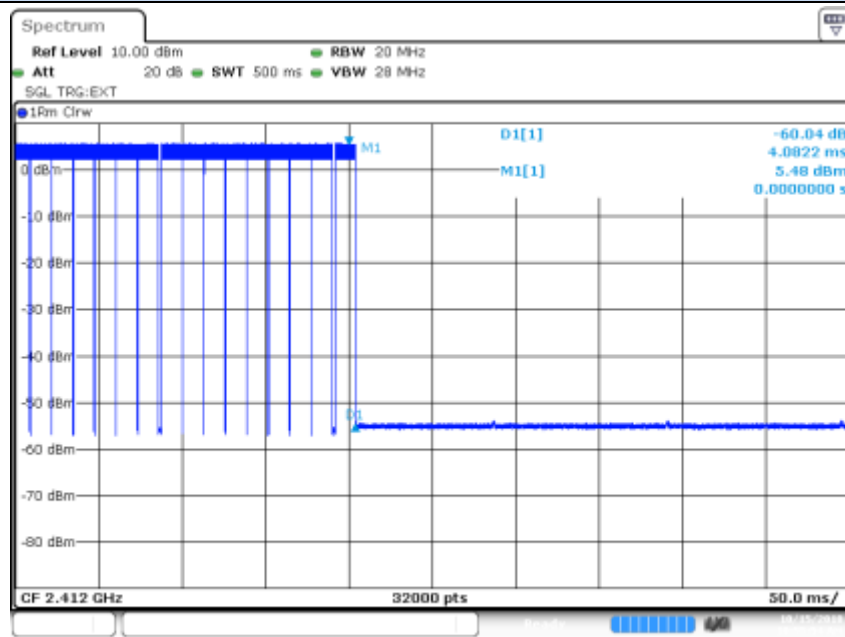
The frequency used for the interference signal is the same as the transmission frequency of the tested channel. The blocking signal is fixed at 2488.5 MHz for the lowest channel tested and at 2395 MHz for the highest channel tested.

Results Screenshot

802.11b Channel 1, 1Mbps



Adaptivity over 500ms

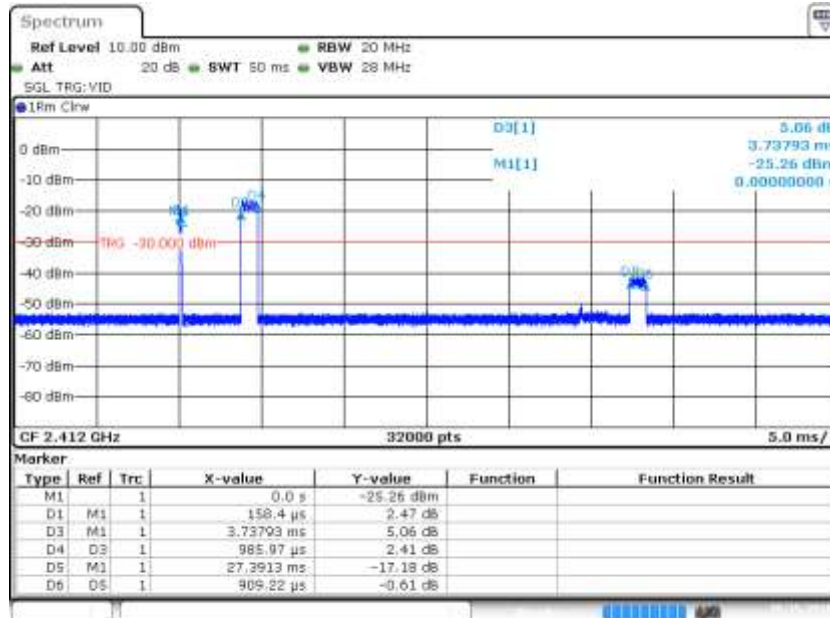


Date: 15.OCT.2018 10:56:54

M1: Marks the beginning of the Interference signal

Stop Transmissions period = 4.08 ms < Channel Occupancy Time.
Test PASS

Short Control signaling over 50ms

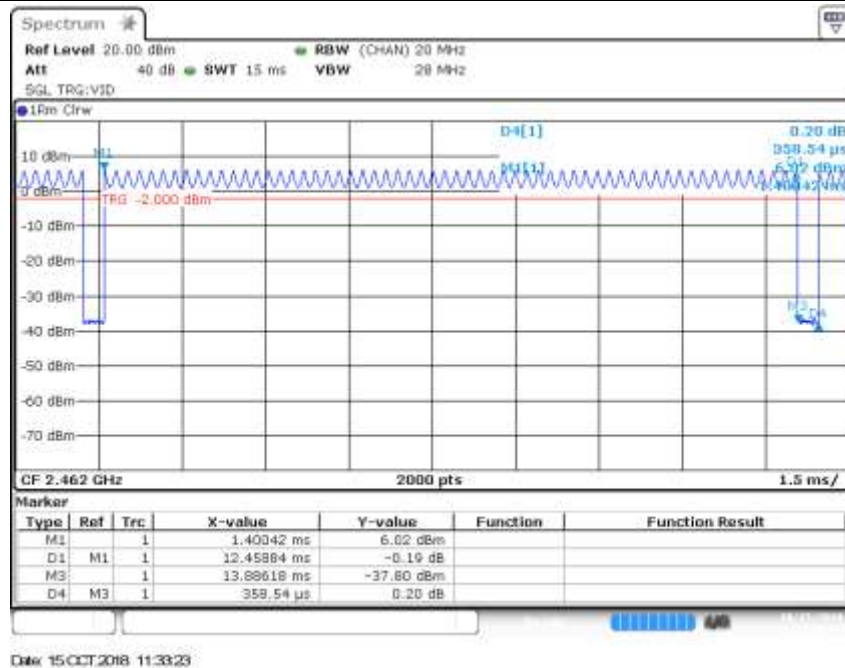


Date: 15.OCT.2018 11:14:33

Total duration of bursts over 50ms period: 2.06 ms
 $TxOn/(TxOn+TxOff) = 4.1\%$.
Test PASS

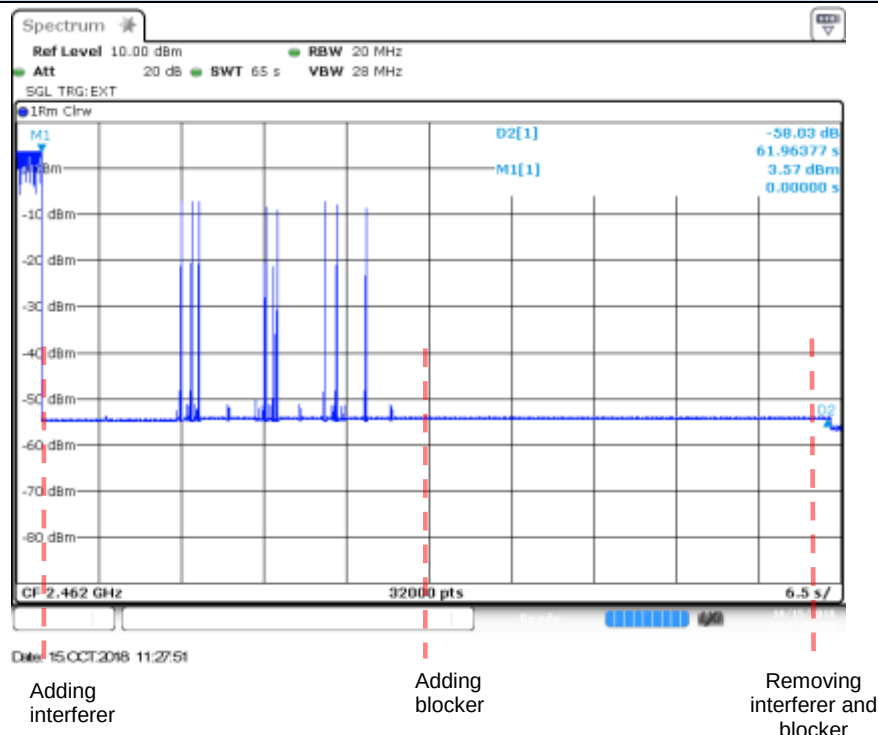
802.11b Channel 11, 1Mbps

Channel Occupancy Time



Channel Occupancy Time = 12.46 ms, test PASS
Clear Channel Assessment = 358.54 µs, test PASS

Adaptivity over 60s



The UUT is not resuming normal transmissions as long as the interference and blocking signals remain present.
Some short control signaling is observed.
Test PASS

Adaptivity over 500ms



Stop Transmissions period = 1.12 ms < Channel Occupancy Time.
Test PASS

Short Control signaling over 50ms



Total duration of bursts on 50ms period: 1.15 ms
TxOn/(TxOn+TxOff) = 2.3%.
Test PASS

B.5 Occupied Channel Bandwidth

Tests limits

ETSI part	Limits						
4.3.2.7.3	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.		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

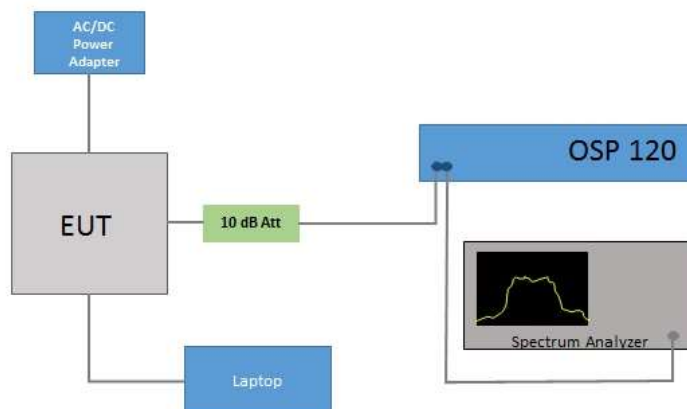
ETSI part	Conditions
5.4.7.1	These measurements shall only be performed at normal test conditions. In case of conducted measurements on smart antenna systems (equipment with multiple transmit chains) measurements need only to be performed on one of the active transmit chains (antenna outputs). The measurement 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 setup below was used to measure the occupied bandwidth accordingly to the test method described in EN 300 328 V2.1.1 §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 EMC32 software on measured parameters.

For MIMO modes, occupied bandwidth measurements are performed on Chain A.

Conducted Setup (Normal Conditions)



Results tables

Low channel

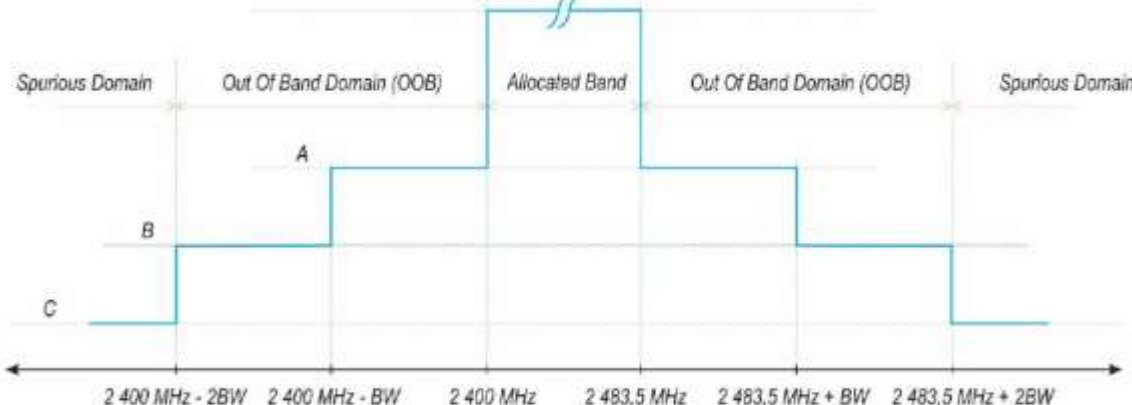
Mode	Rate	CH	Freq. [MHz]	Nominal BW [MHz]	Antenna	99% BW [MHz]	Lowest frequency [MHz]
802.11b	1Mbps	1	2412	20	SISO CHAIN A	13.42	2405.291925
				20	SISO CHAIN B	13.42	2405.291925
802.11g	6Mbps	1	2412	20	SISO CHAIN A	16.89	2403.552795
				20	SISO CHAIN B	16.89	2403.552795
802.11n20	HT0	1	2412	20	SISO CHAIN A	17.89	2403.055901
				20	SISO CHAIN B	17.89	2403.055901
	HT8	1	2412	20	MIMO	17.89	2403.055901
802.11n40	HT0	3F	2422	40	SISO CHAIN A	36.77	2403.614907
				40	SISO CHAIN B	36.77	2403.614907
	HT8	3F	2422	40	MIMO	36.77	2403.614907
802.11ax20	HE0	1	2412	20	SISO CHAIN A	19.13	2402.559006
				20	SISO CHAIN B	18.88	2402.559006
		1	2412	20	MIMO	18.88	2402.559006
802.11ax40	HE0	3F	2422	40	SISO CHAIN A	37.76	2403.118012
				40	SISO CHAIN B	37.76	2403.118012
		3F	2422	40	MIMO	37.76	2403.118012

High channel

Mode	Rate	CH	Freq. [MHz]	Nominal BW [MHz]	Antenna	99% BW [MHz]	Highest frequency [MHz]
802.11b	1Mbps	13	2472	20	SISO CHAIN A	13.42	2478.708075
				20	SISO CHAIN B	13.42	2478.708075
802.11g	6Mbps	13	2472	20	SISO CHAIN A	16.89	2480.447205
				20	SISO CHAIN B	16.89	2480.447205
802.11n20	HT0	13	2472	20	SISO CHAIN A	17.89	2480.944099
				20	SISO CHAIN B	17.89	2480.944099
	HT8	13	2472	20	MIMO	17.89	2480.944099
802.11n40	HT0	11F	2462	40	SISO CHAIN A	36.77	2480.385093
				40	SISO CHAIN B	36.77	2480.385093
	HT8	11F	2462	40	MIMO	36.77	2480.385093
802.11ax20	HE0	13	2472	20	SISO CHAIN A	18.88	2481.440994
				20	SISO CHAIN B	19.38	2481.689441
		13	2472	20	MIMO	18.88	2481.440994
802.11ax40	HE0	11F	2462	40	SISO CHAIN A	37.76	2480.881988
				40	SISO CHAIN B	38.76	2481.378882
		11F	2462	40	MIMO	37.76	2480.881988

B.6 Transmitter unwanted emissions in the out-of-band domain

Test limits

ETSI part	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  The diagram illustrates the emission mask for transmitter unwanted emissions. It shows a frequency axis with the following regions: Spurious Domain, Out Of Band Domain (OOB), Allocated Band, Out Of Band Domain (OOB), and Spurious Domain. The mask is defined by three levels: A (highest), B (middle), and C (lowest). The frequency markers on the x-axis are: 2 400 MHz - 2BW, 2 400 MHz - BW, 2 400 MHz, 2 483,5 MHz, 2 483,5 MHz + BW, and 2 483,5 MHz + 2BW. A break symbol (//) is shown above the Allocated Band. Below the diagram, the following definitions are provided: A: -10 dBm/MHz e.i.r.p., B: -20 dBm/MHz e.i.r.p., C: Spurious Domain limits. A note states: BW = Occupied Channel Bandwidth in MHz or 1 MHz whichever is greater. 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	Conditions
5.3.8.1	These measurements shall only be performed at normal test conditions. For equipment using wide band modulations other than FHSS, 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 each channel bandwidth shall be tested separately.

Test procedure

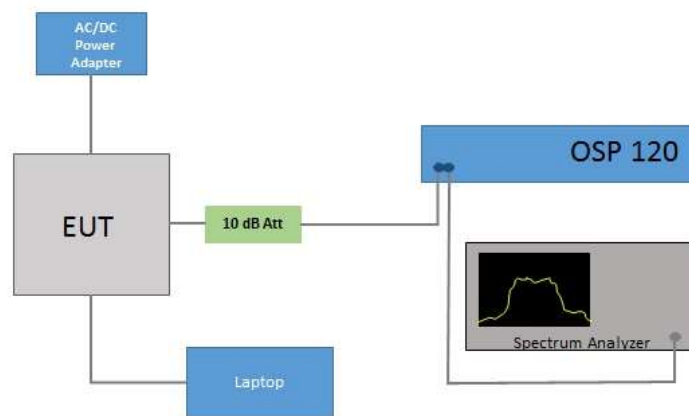
The setup below was used to measure the unwanted emissions in the out of band domain accordingly to the test method described in EN 300 328 V2.1.1 §5.4.8.2.1. The antenna terminal of the EUT is connected to the OSP120 through a 10dB attenuator and a cable, the spectrum analyzer is connected to the receiver port on the OSP. System connection cable loss is compensated by the EMC32 software on measured parameters.

Antenna gain is taken into account and added by the software to the measurements. The declared maximum antenna gain is +3dBi.

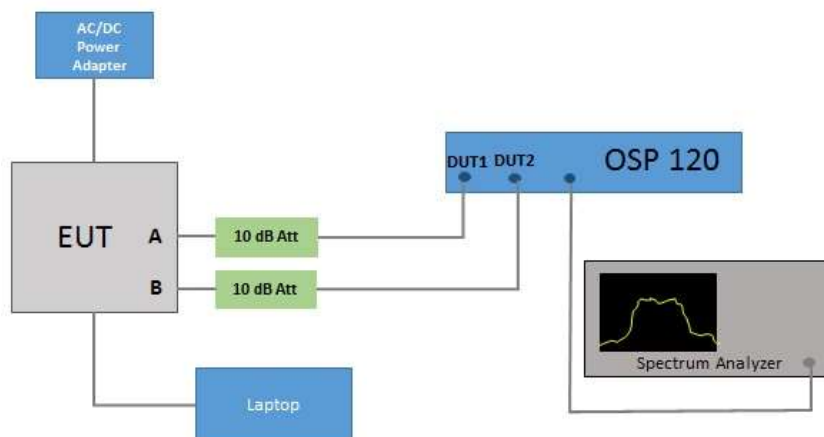
EMC32 provides the mask and the frequency limits based in the measured channel bandwidth. Maximum values for each limit level (-10dBm and -20dBm) are pointed using markers.

For MIMO modes the measurement is done separately on each transmit ports and the power of the individual 1MHz segments is sum for all ports.

Conducted Setup (Normal Conditions)



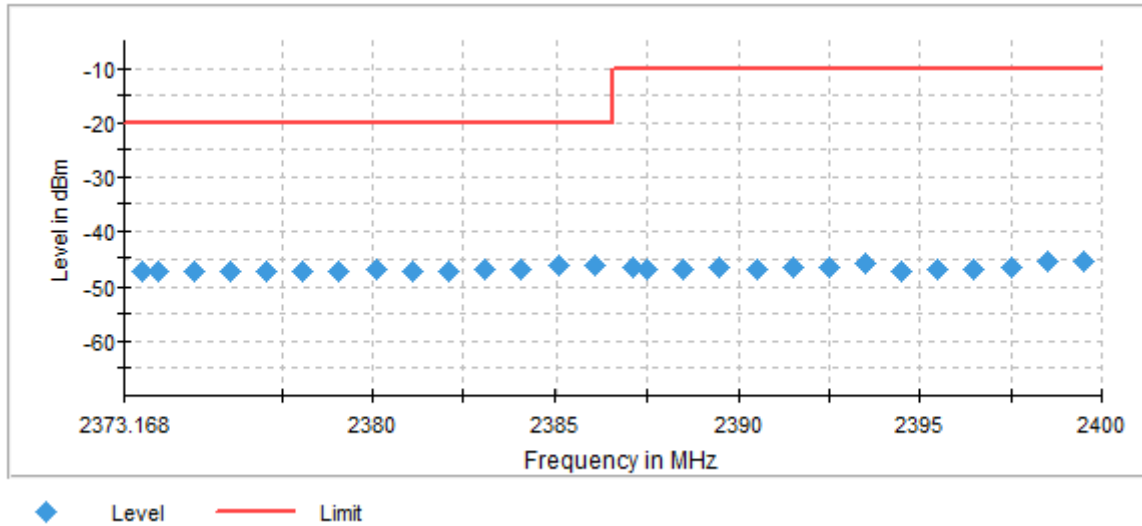
Conducted Setup (MIMO Measurements)



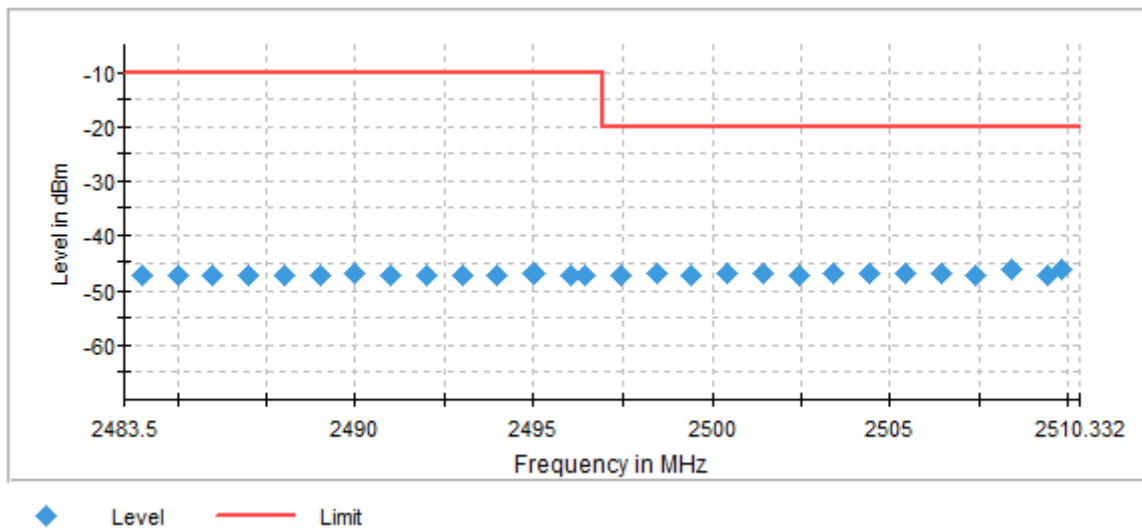
Results Screenshot

802.11b, 1Mbps – Chain A

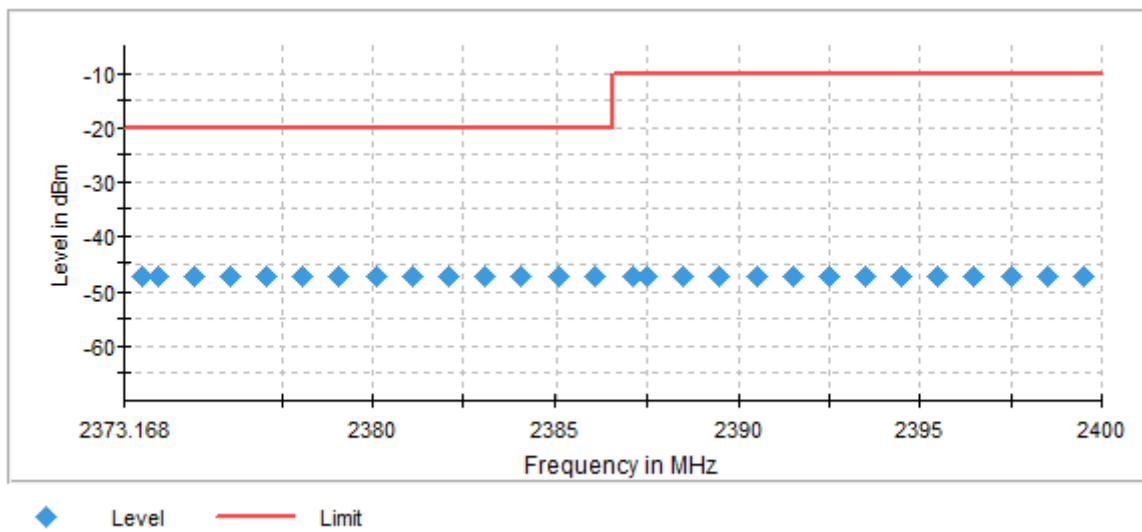
UNWANTED OOB Low Freq Section, Channel 1



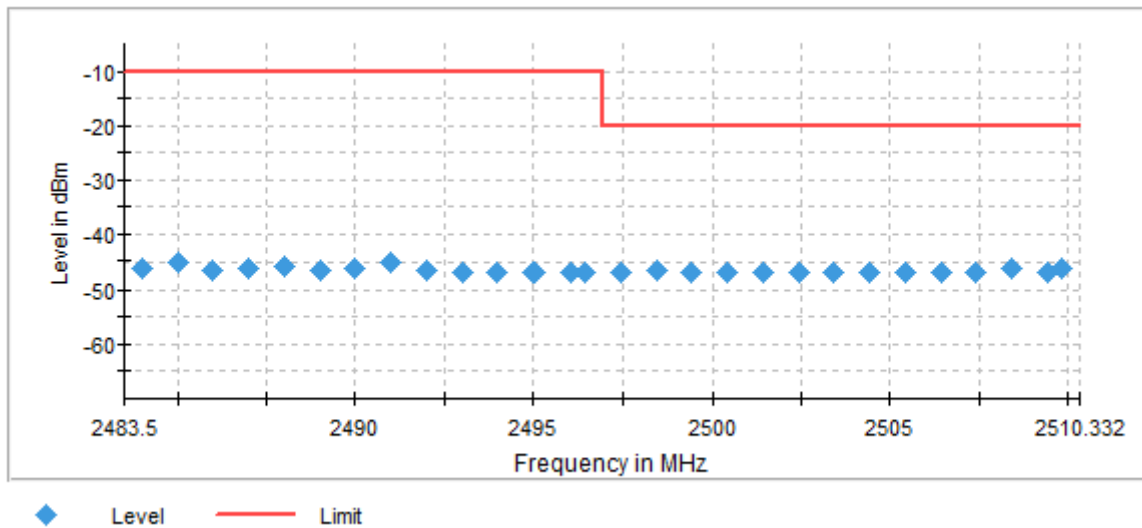
UNWANTED OOB High Freq Section, Channel 1



UNWANTED OOB Low Freq Section, Channel 13

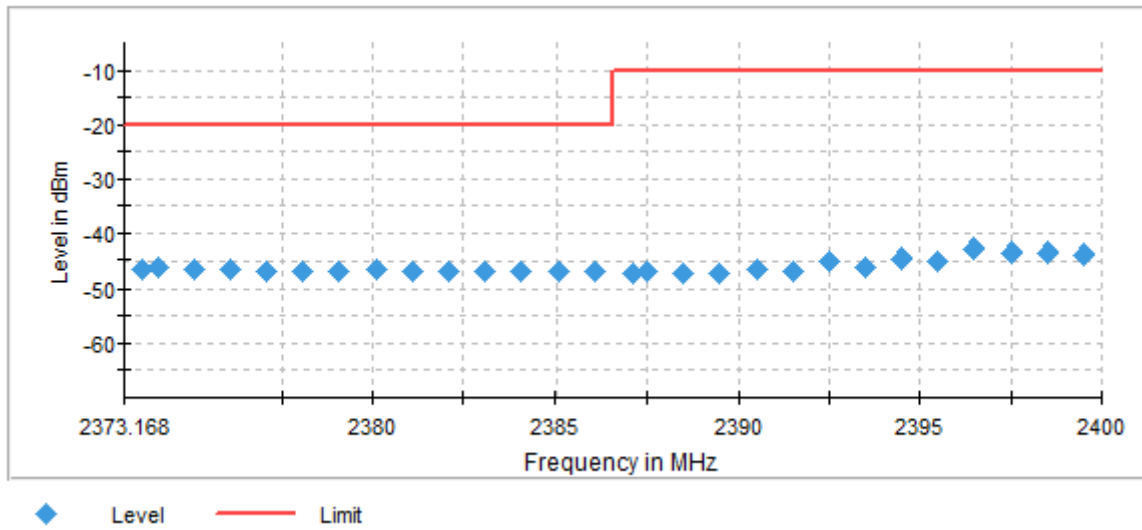


UNWANTED OOB High Freq Section, Channel 13

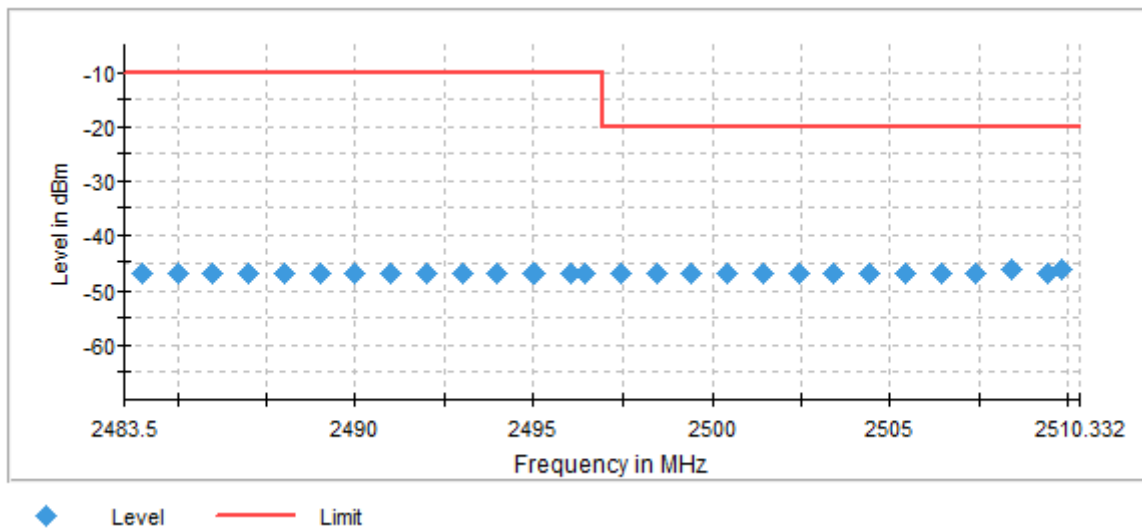


802.11b, 1Mbps – Chain B

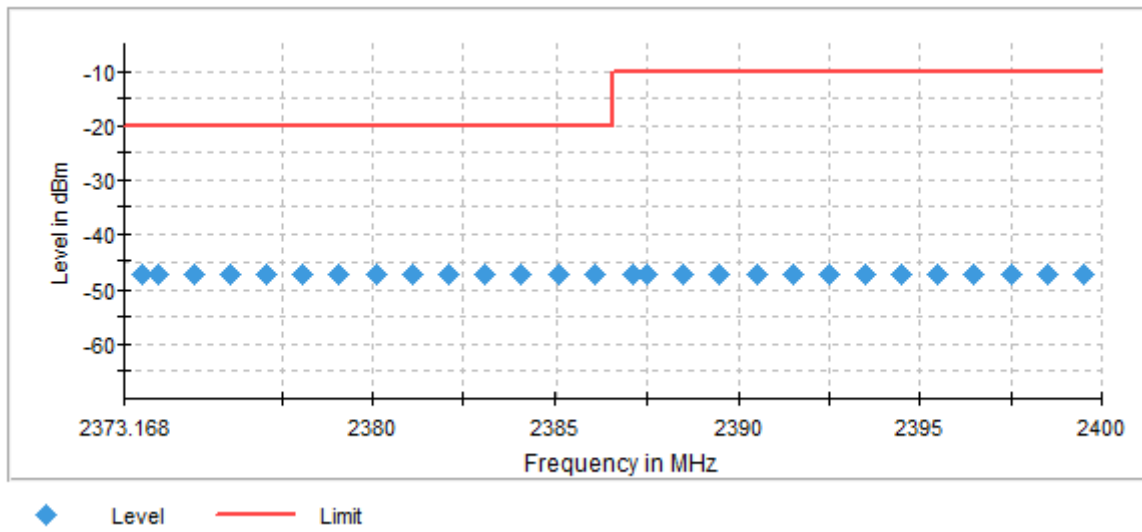
UNWANTED OOB Low Freq Section, Channel 1



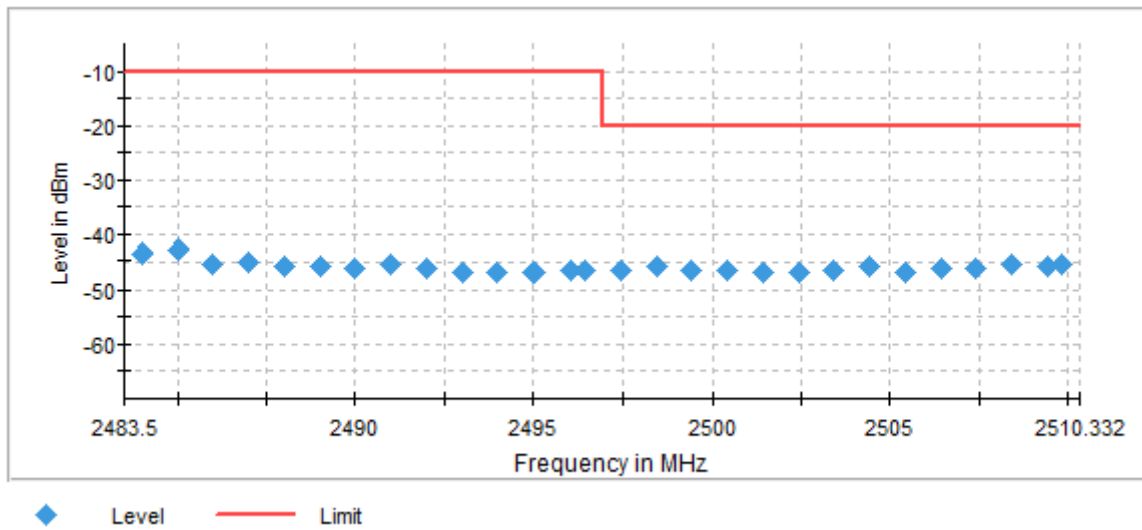
UNWANTED OOB High Freq Section, Channel 1



UNWANTED OOB Low Freq Section, Channel 13

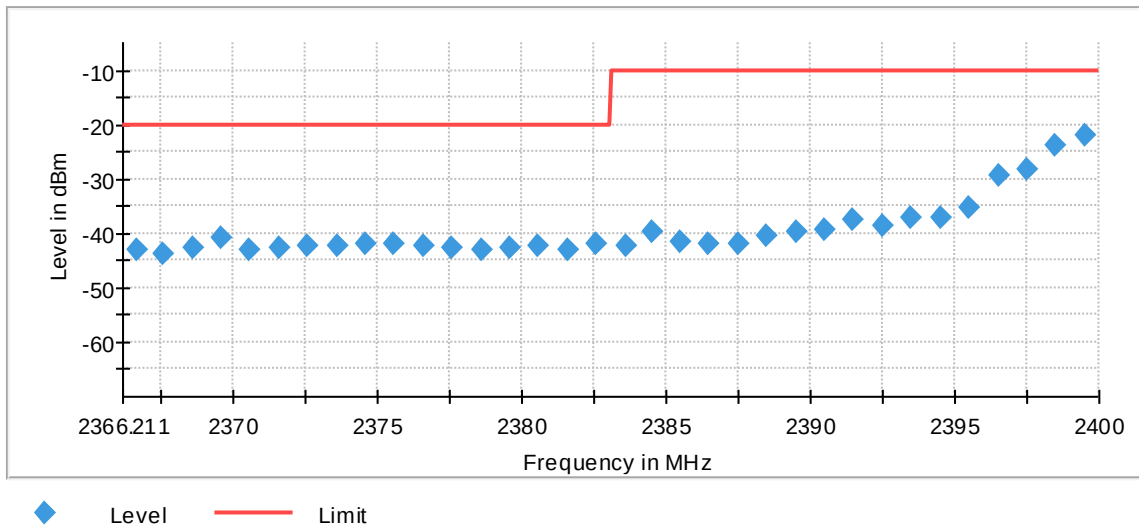


UNWANTED OOB High Freq Section, Channel13

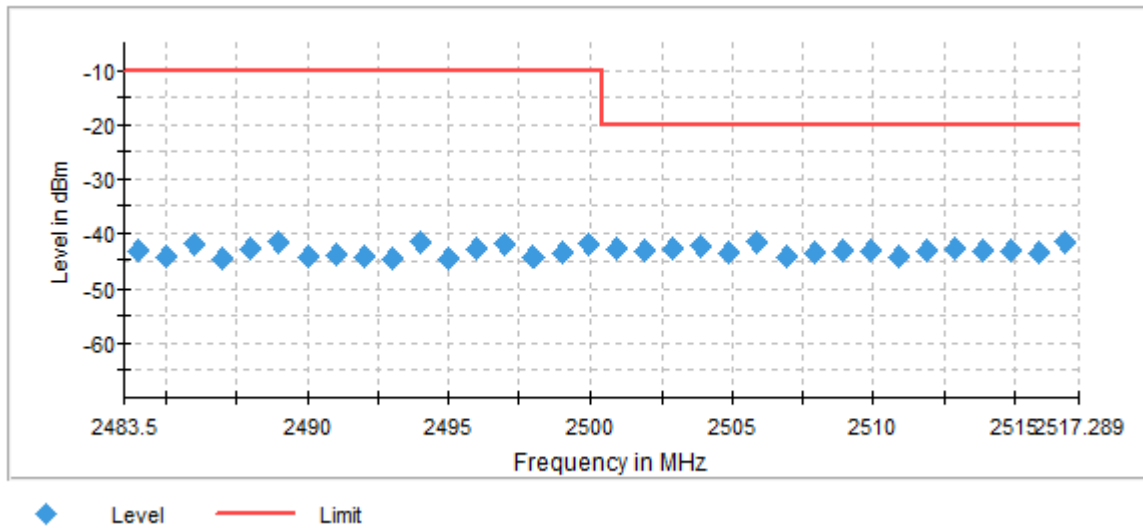


802.11g, 6 Mbps – Chain A

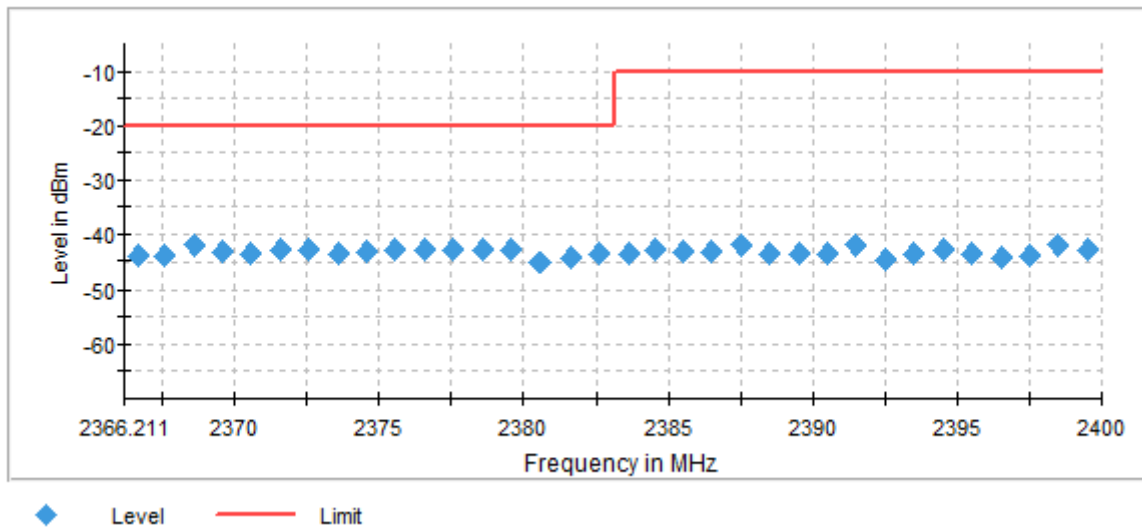
UNWANTED OOB Low Freq Section, Channel 1



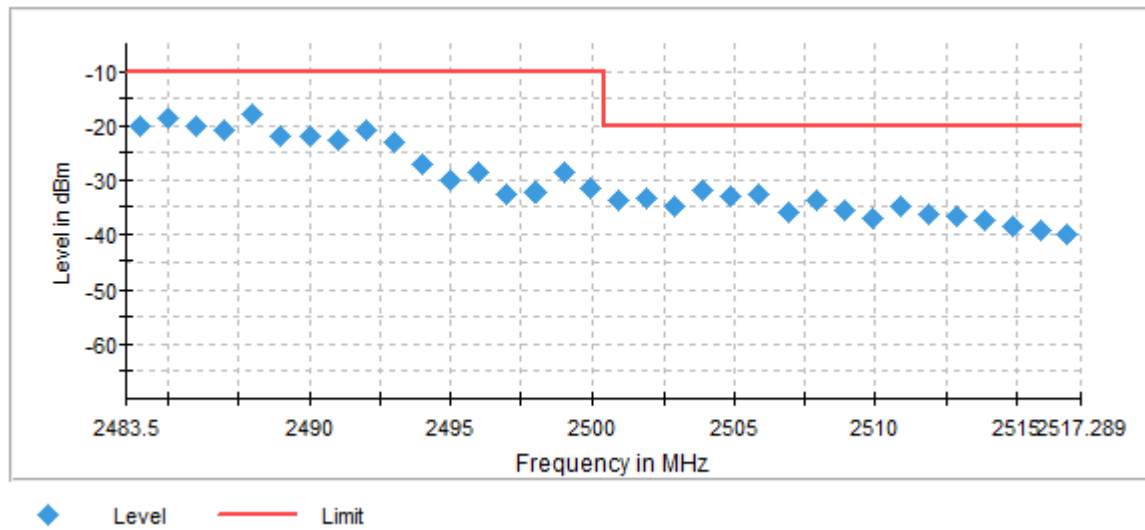
UNWANTED OOB High Freq Section, Channel 1



UNWANTED OOB Low Freq Section, Channel 13

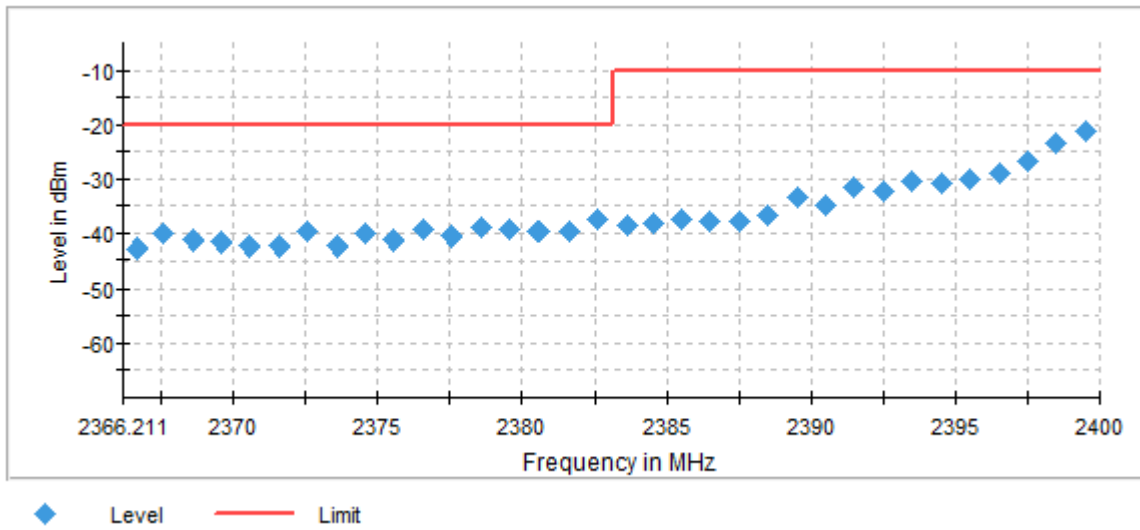


UNWANTED OOB High Freq Section, Channel 13

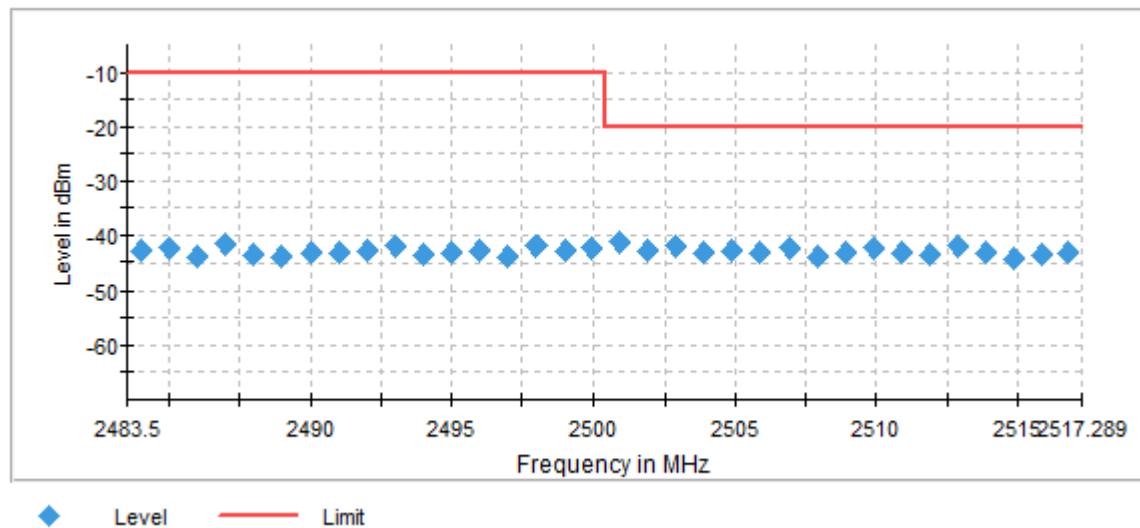


802.11g, 6 Mbps – Chain B

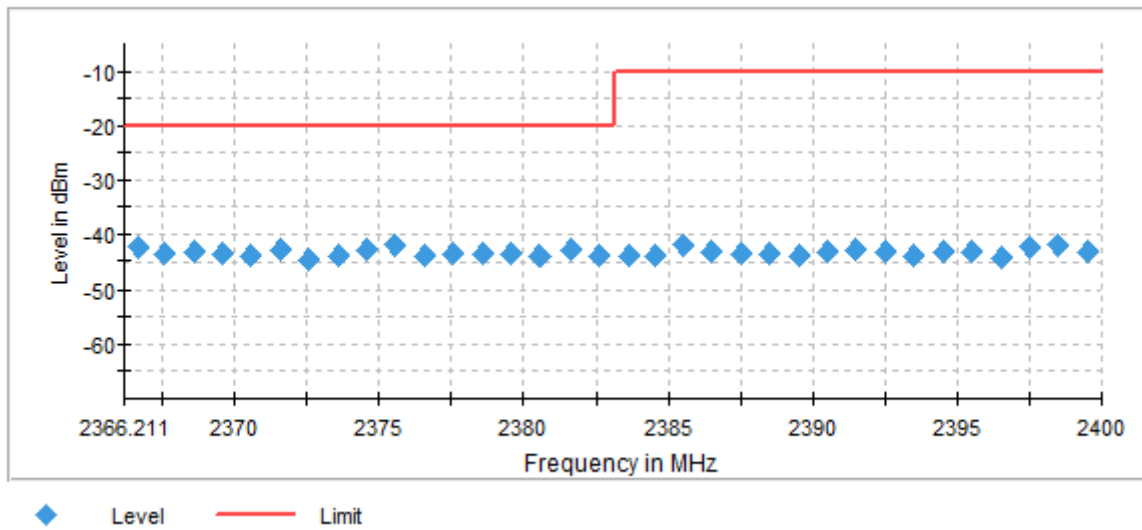
UNWANTED OOB Low Freq Section, Channel 1



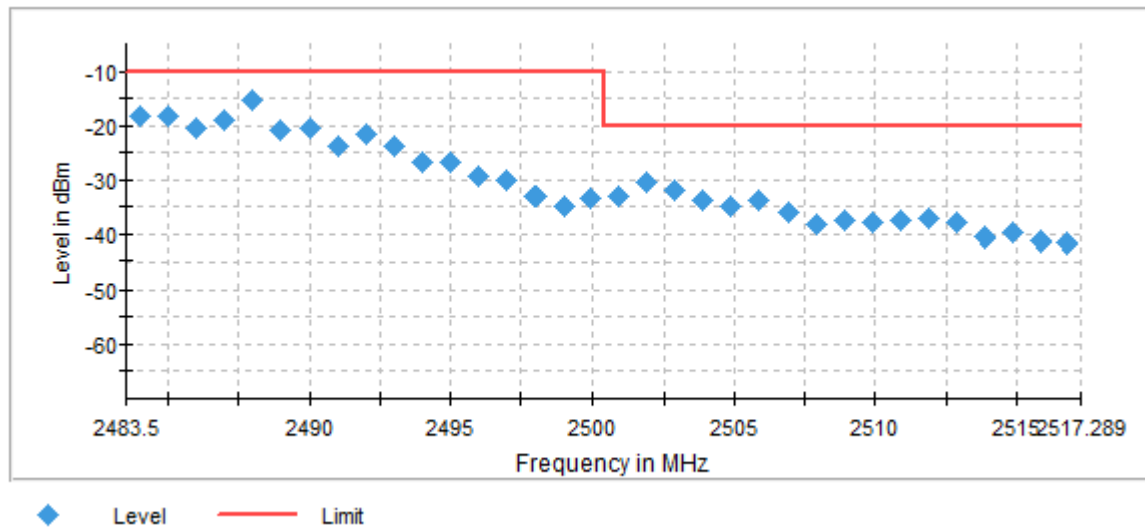
UNWANTED OOB High Freq Section, Channel 1



UNWANTED OOB Low Freq Section, Channel 13

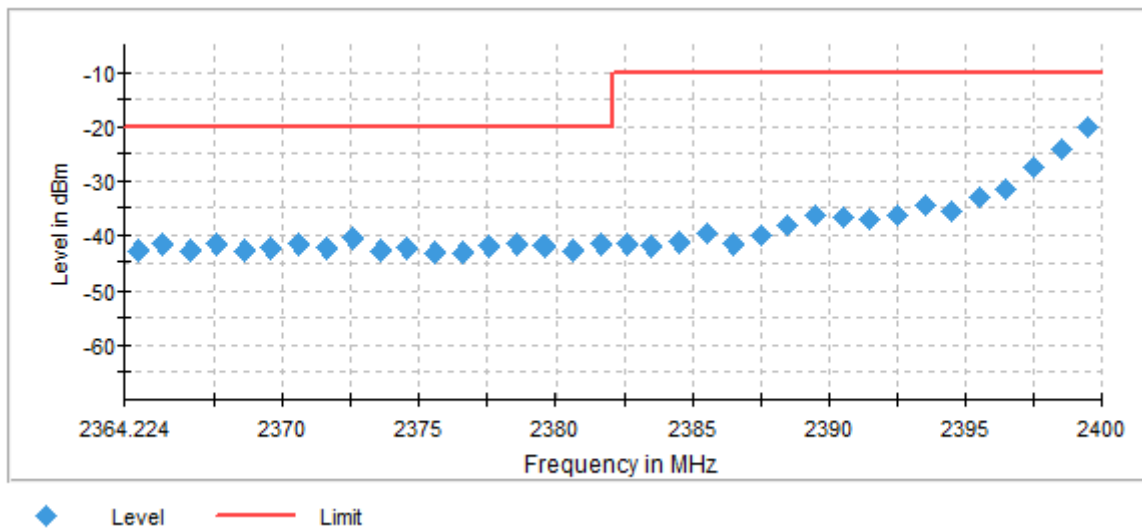


UNWANTED OOB High Freq Section, Channel 13

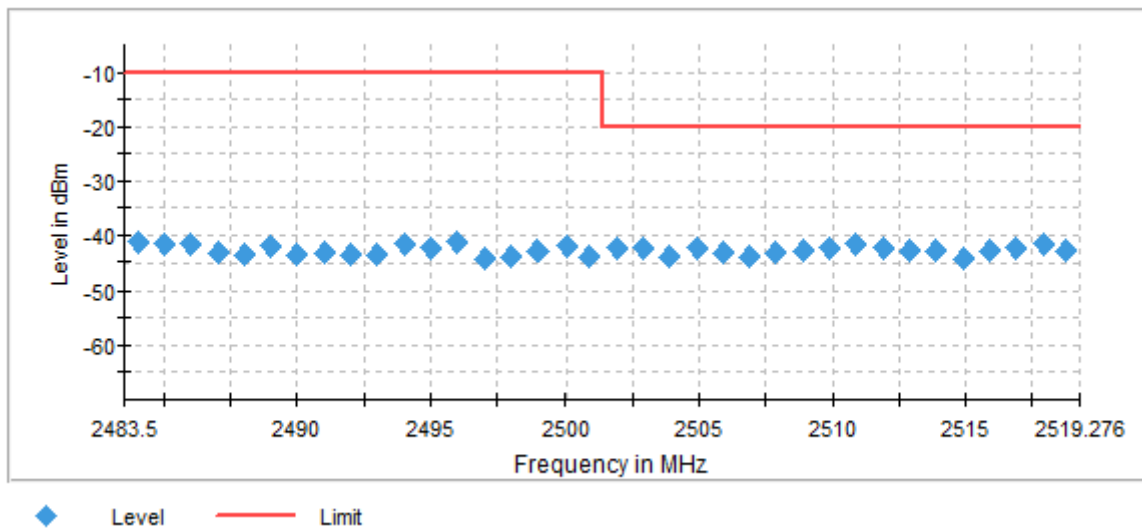


802.11n20, HT0 (SISO) – Chain A

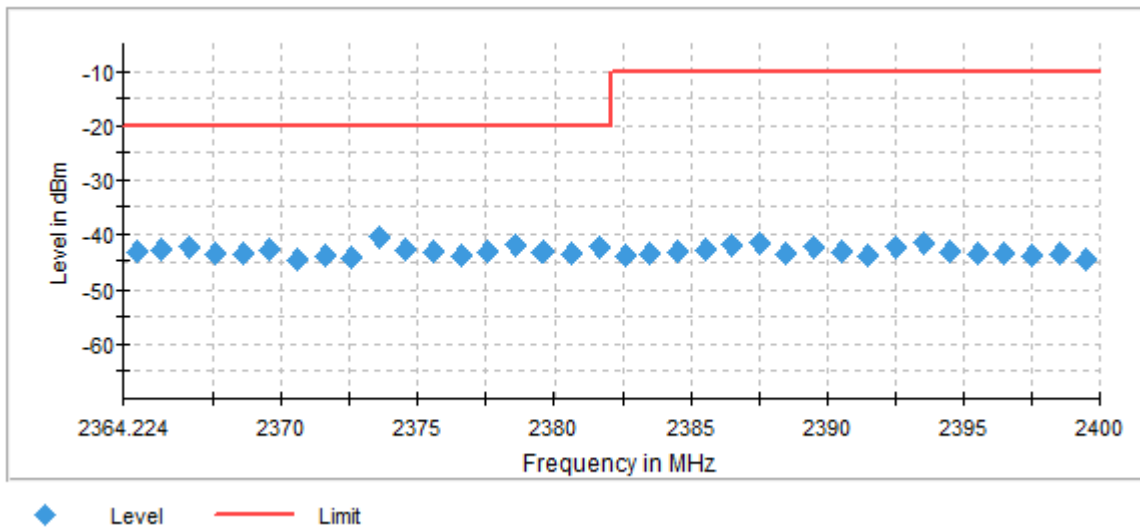
UNWANTED OOB Low Freq Section, Channel 1



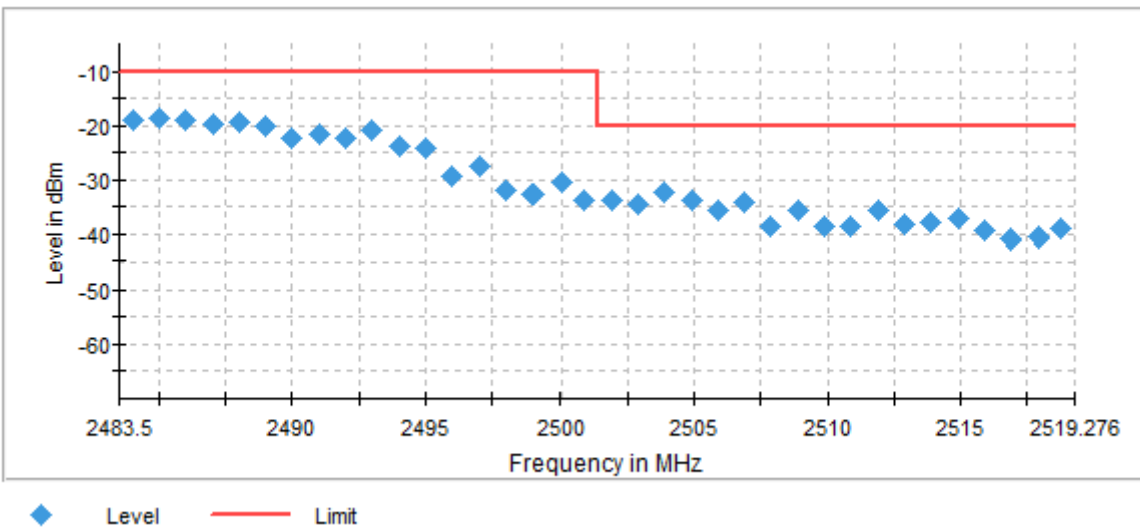
UNWANTED OOB High Freq Section, Channel 1



UNWANTED OOB Low Freq Section, Channel 13

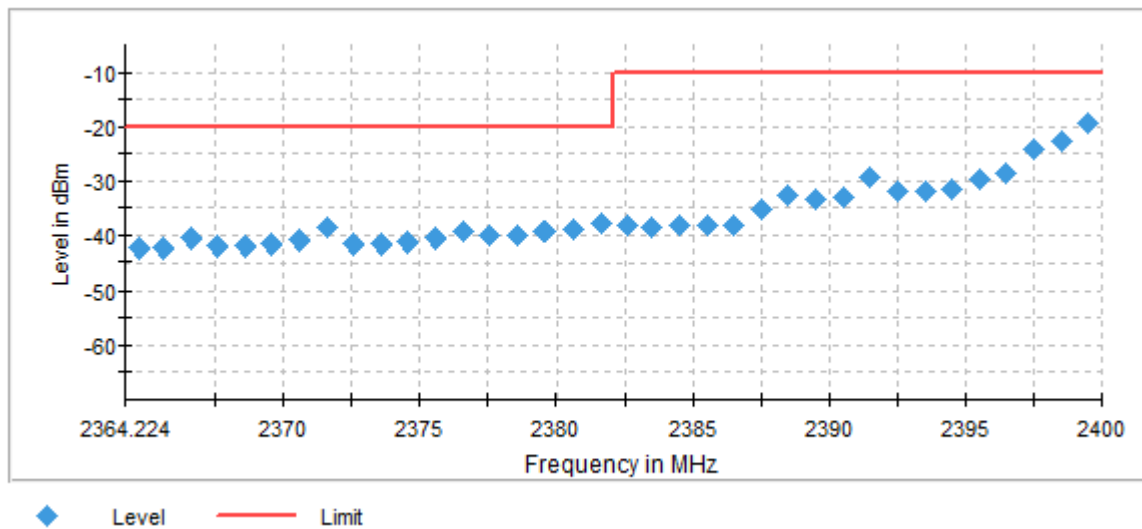


UNWANTED OOB High Freq Section, Channel 13

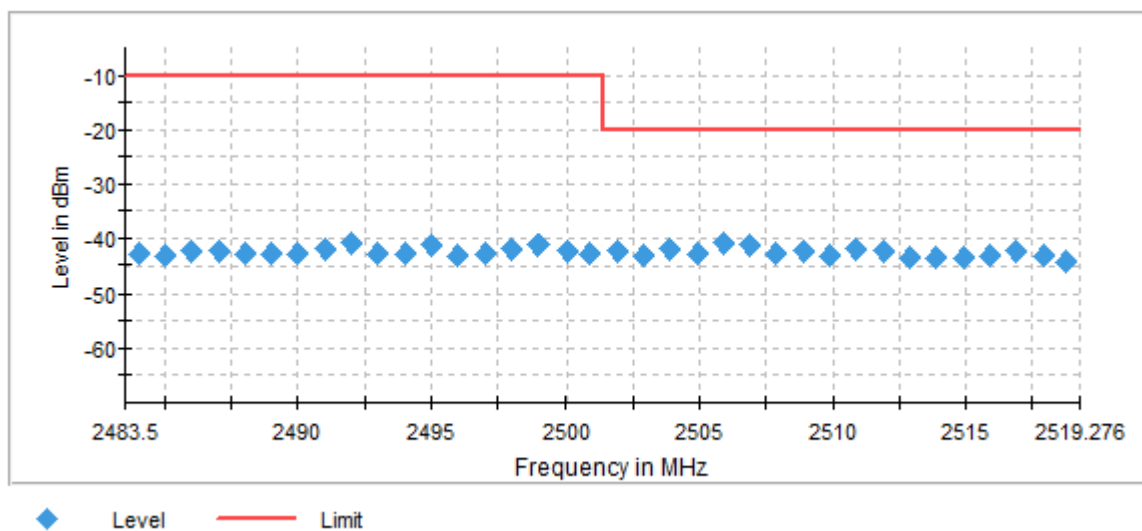


802.11n20, HT0 (SISO) – Chain B

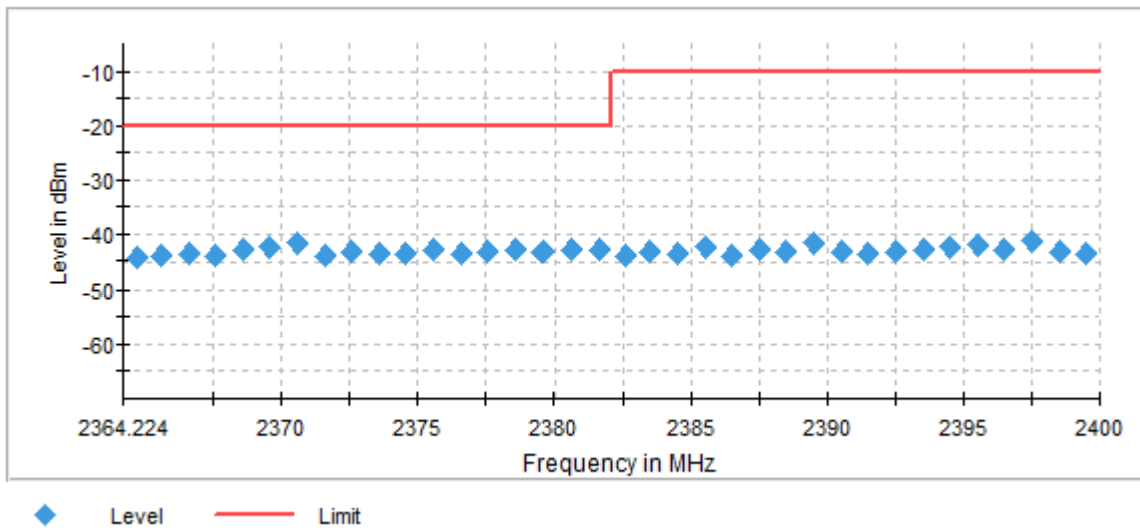
UNWANTED OOB Low Freq Section, Channel 1



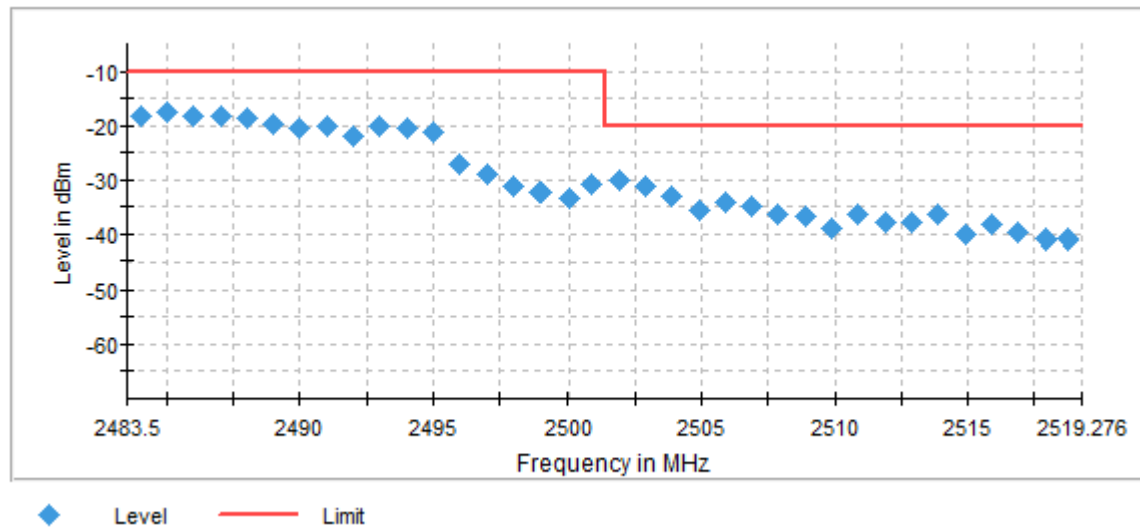
UNWANTED OOB High Freq Section, Channel 1



UNWANTED OOB Low Freq Section, Channel 13

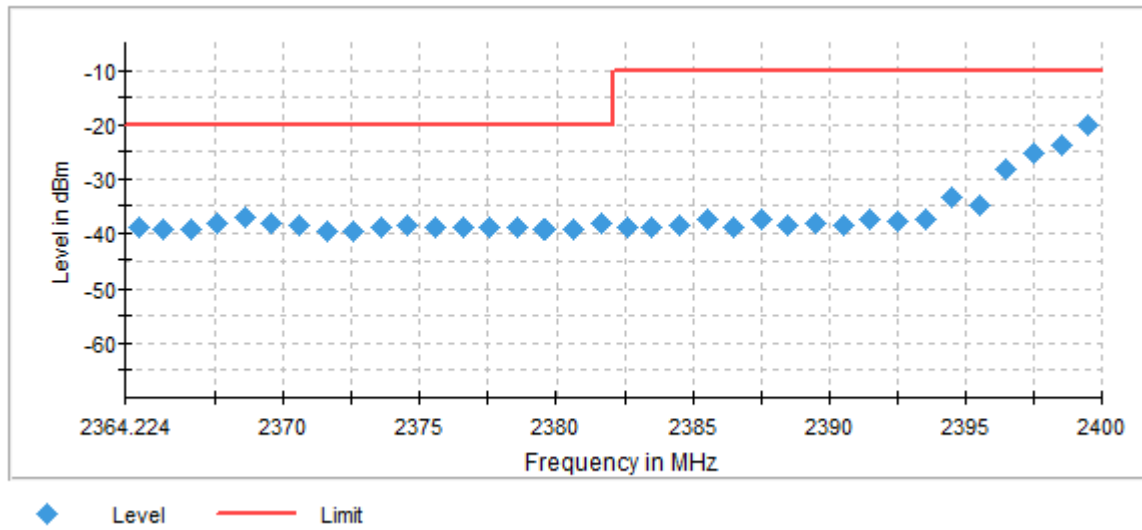


UNWANTED OOB High Freq Section, Channel 13

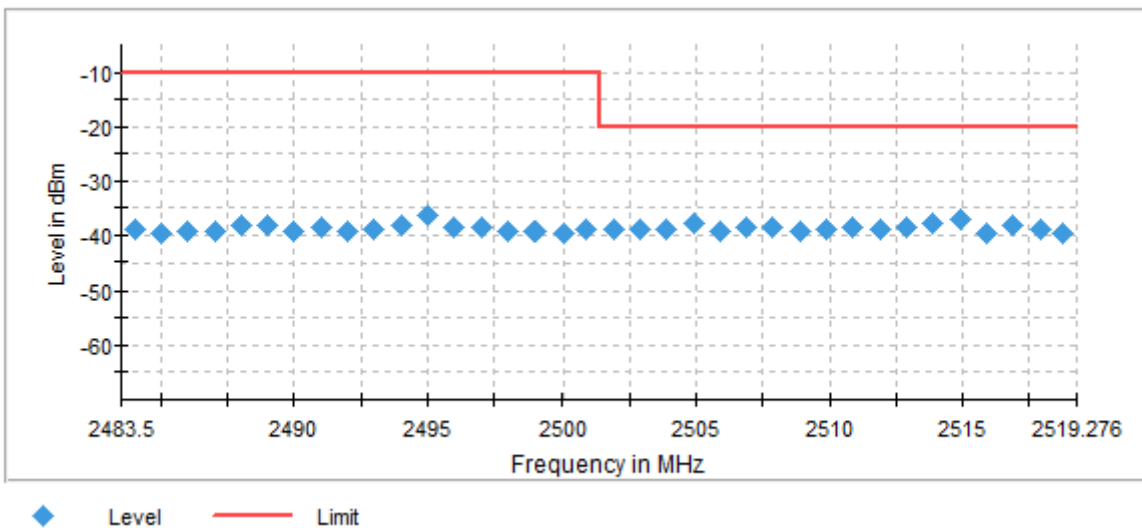


802.11n20, HT8 (MIMO)

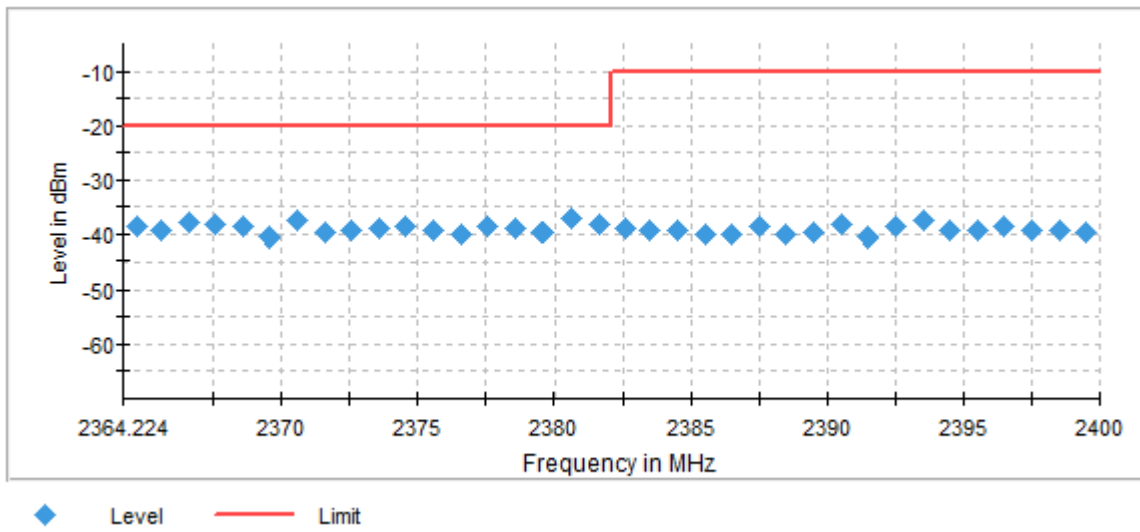
UNWANTED OOB Low Freq Section, Channel 1



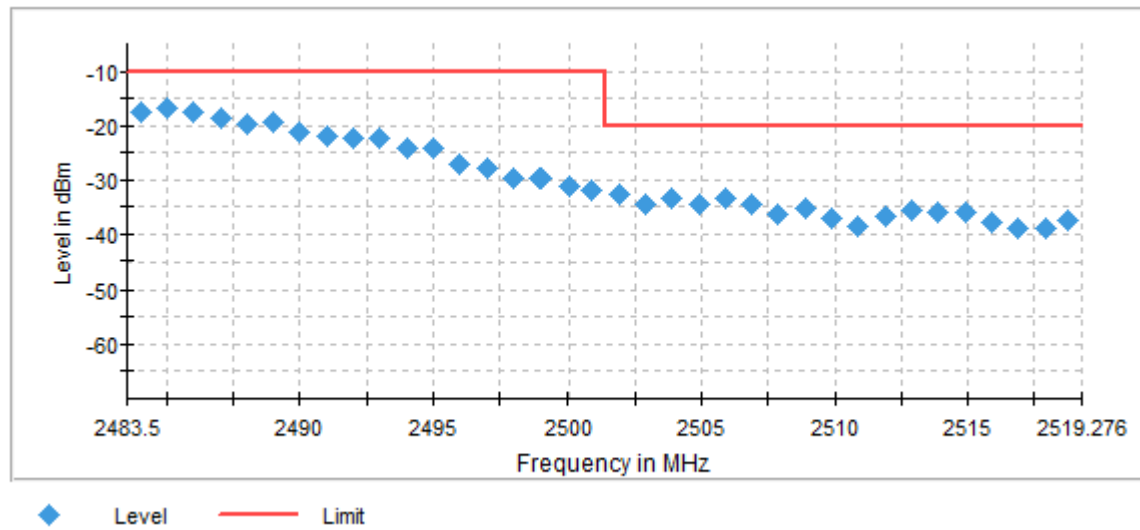
UNWANTED OOB High Freq Section, Channel 1



UNWANTED OOB Low Freq Section, Channel 13

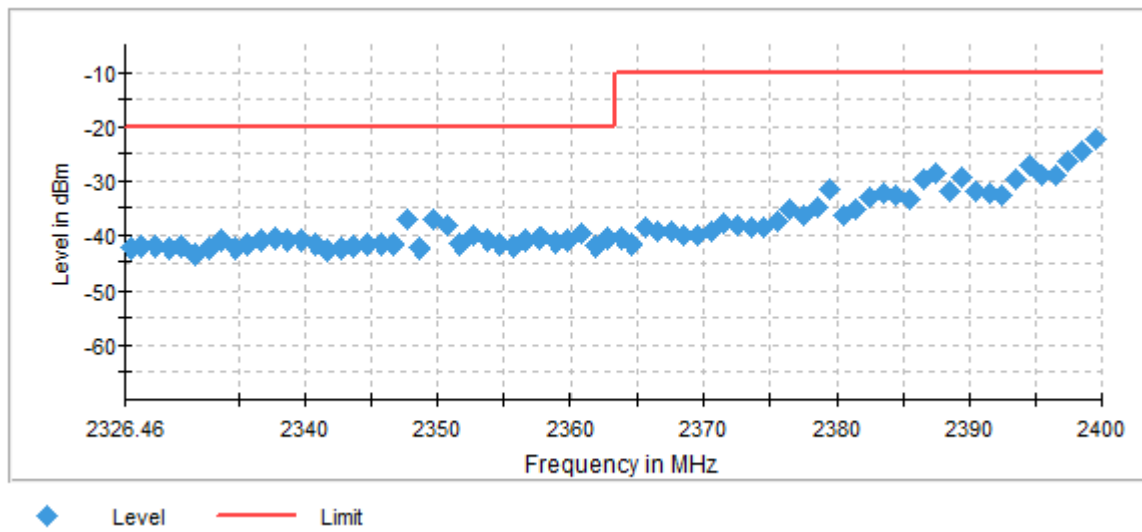


UNWANTED OOB High Freq Section, Channel 13

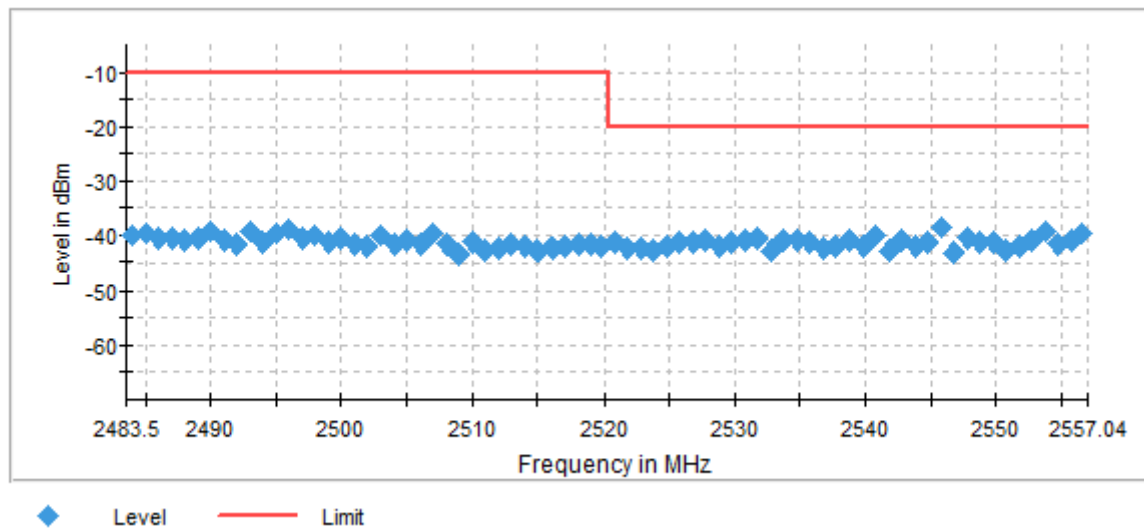


802.11n40, HT0 (SISO) – Chain A

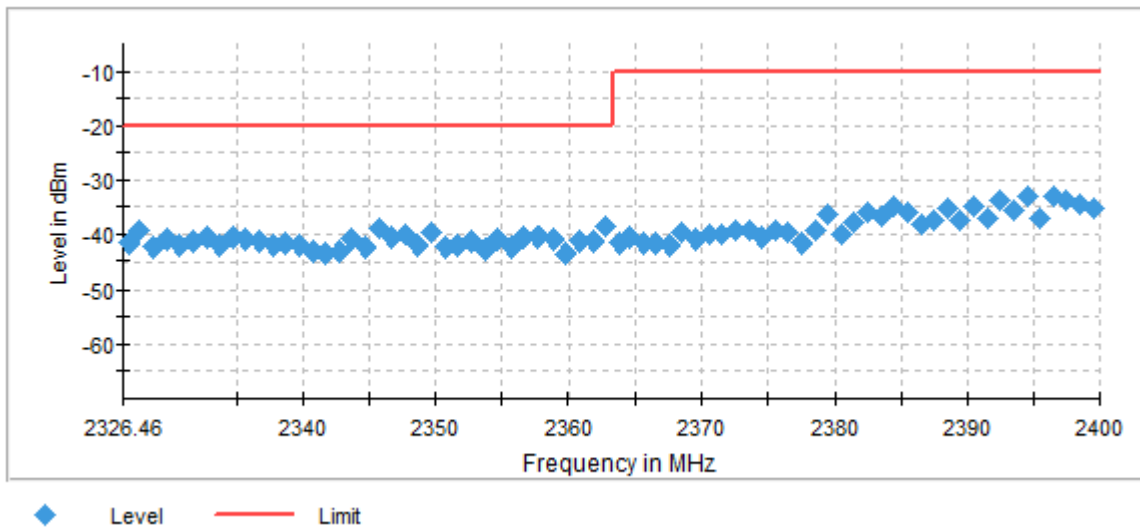
UNWANTED OOB Low Freq Section, Channel 3F



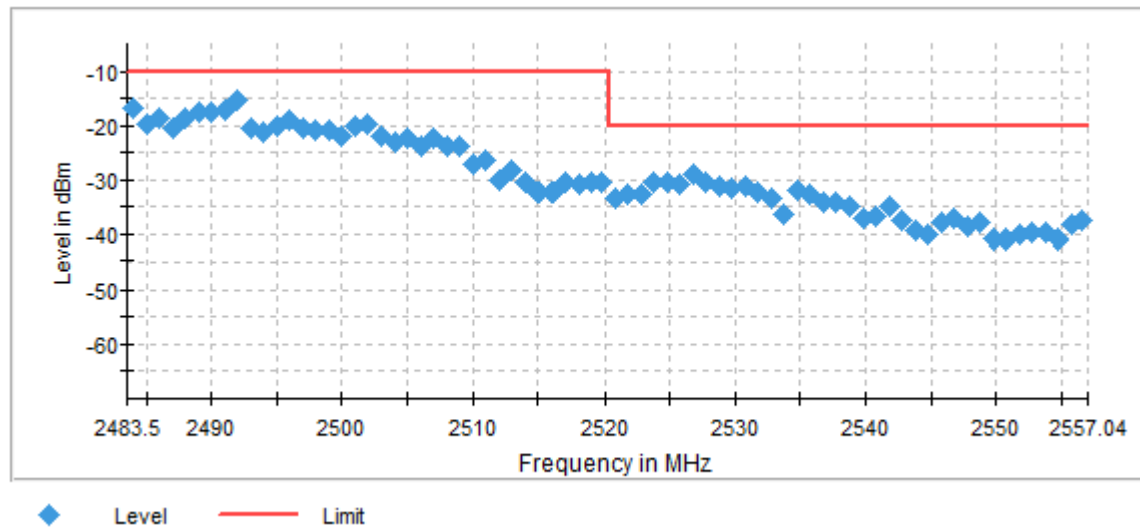
UNWANTED OOB High Freq Section, Channel 3F



UNWANTED OOB Low Freq Section, Channel 11F

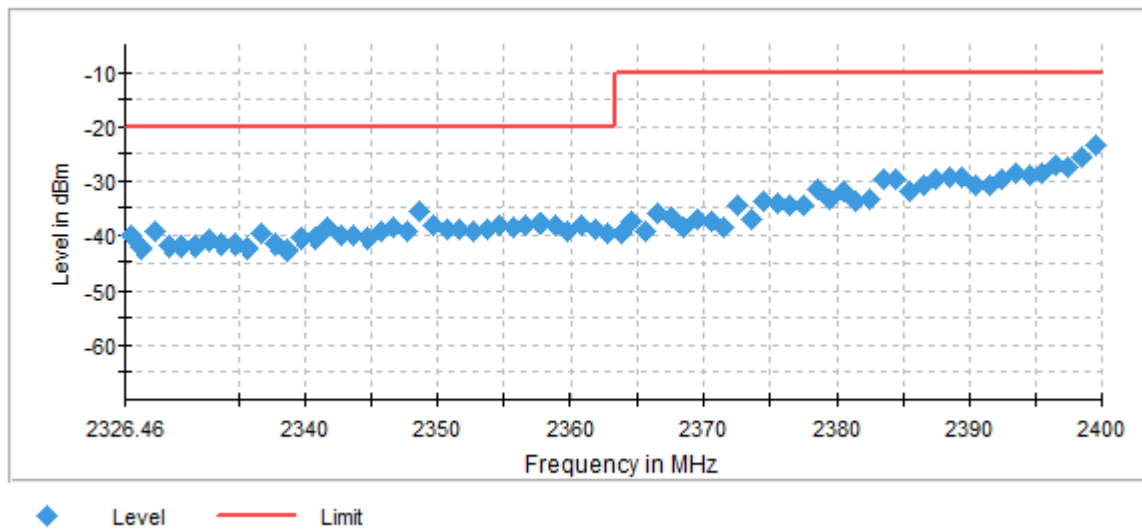


UNWANTED OOB High Freq Section, Channel 11F

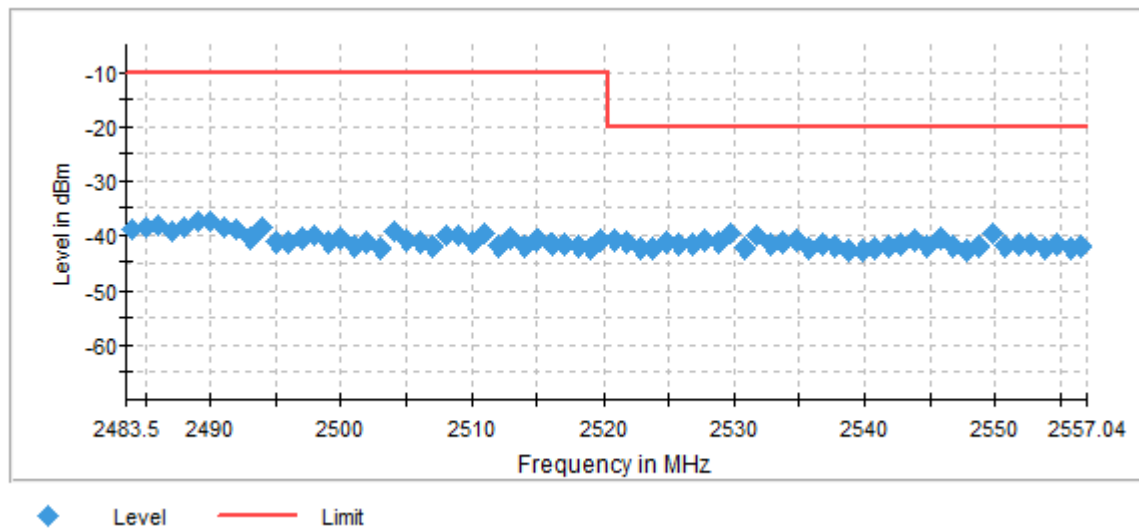


802.11n40, HT0 (SISO) – Chain B

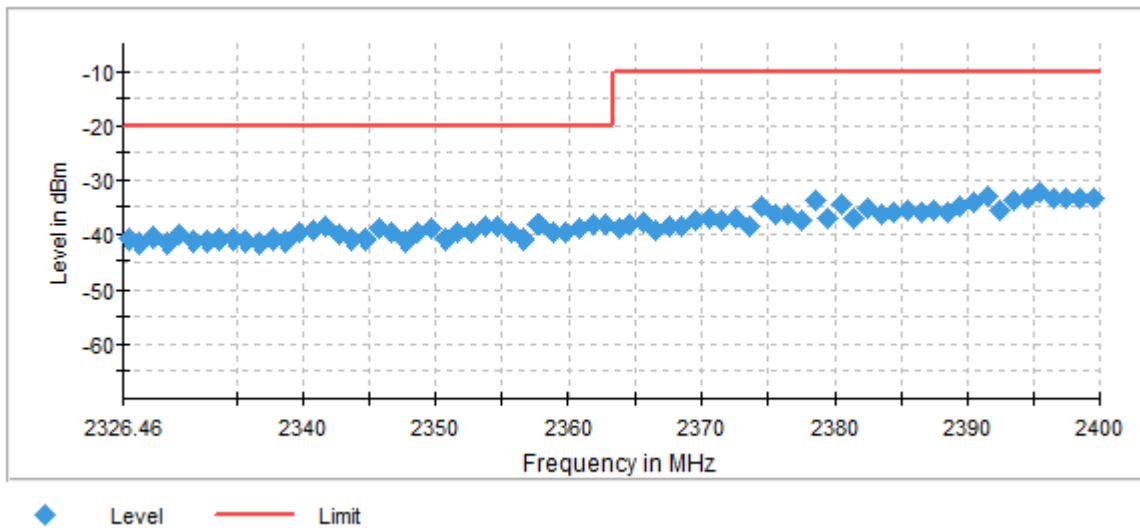
UNWANTED OOB Low Freq Section, Channel 3F



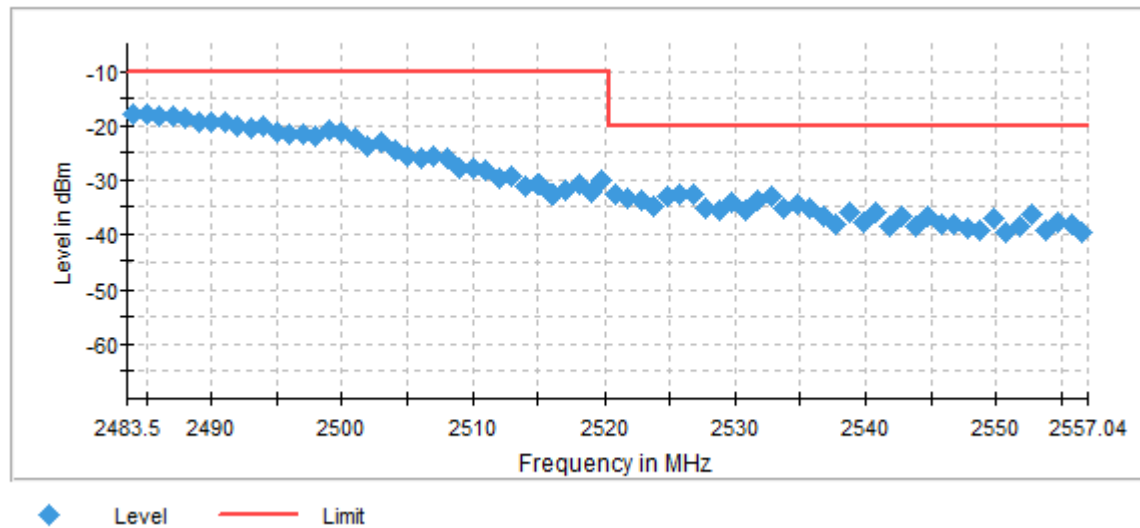
UNWANTED OOB High Freq Section, Channel 3F



UNWANTED OOB Low Freq Section, Channel 11F

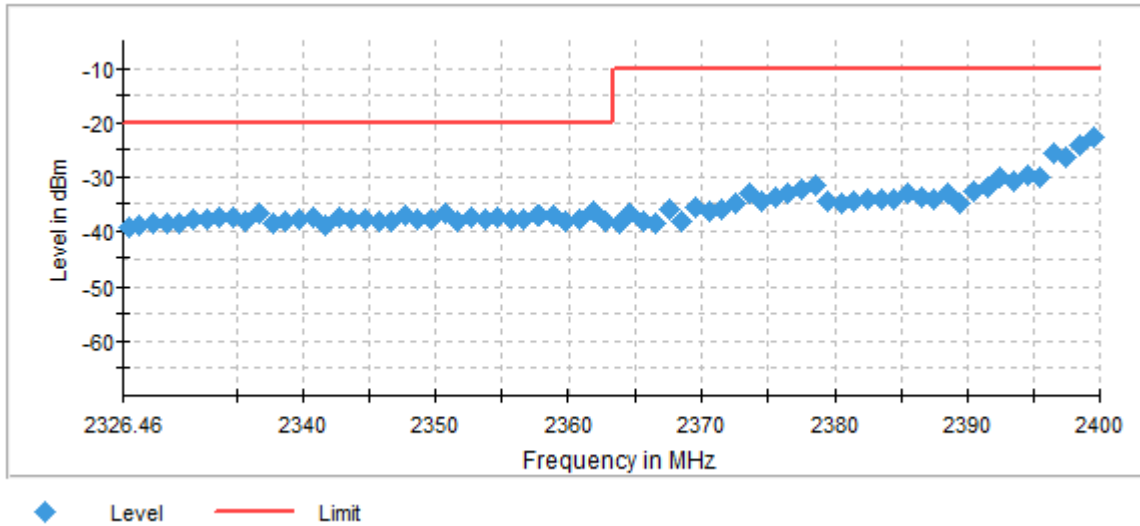


UNWANTED OOB High Freq Section, Channel 11F

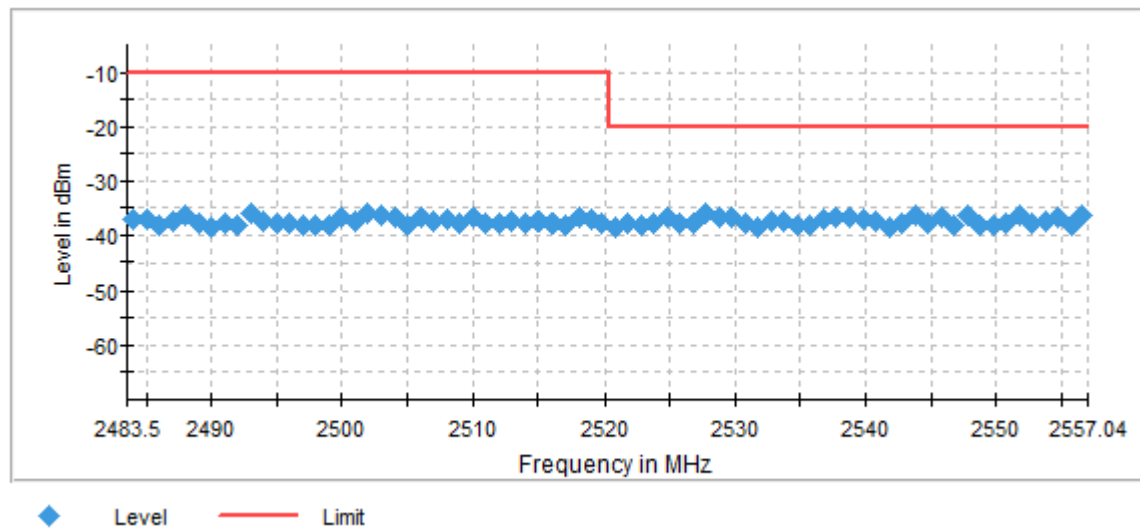


802.11n40, HT8 (MIMO)

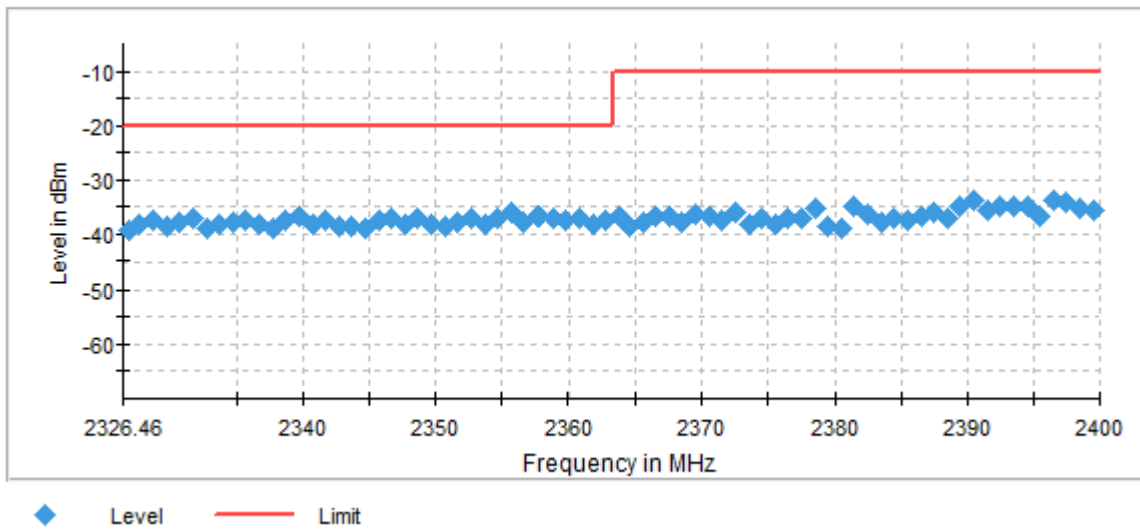
UNWANTED OOB Low Freq Section, Channel 3F



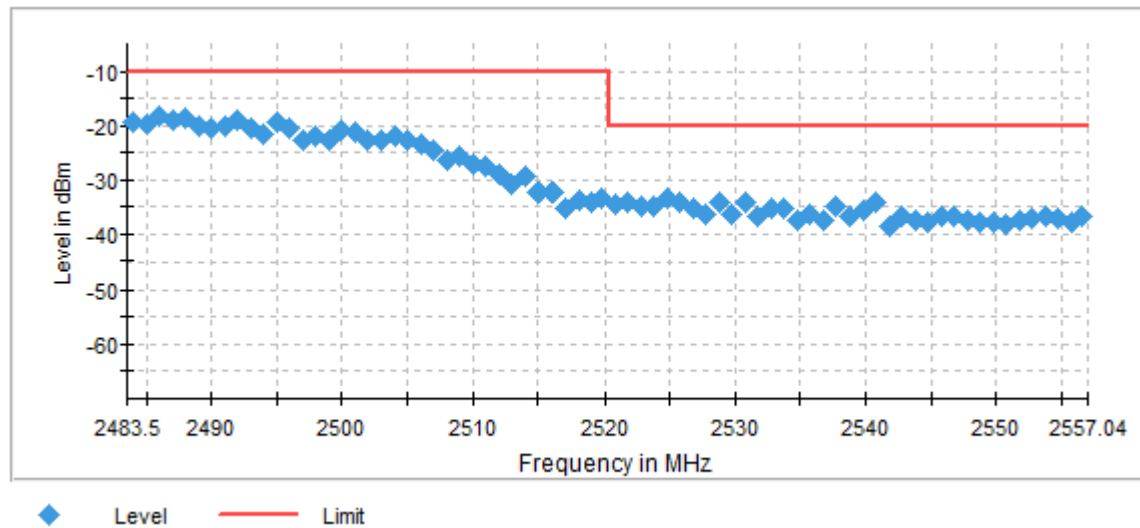
UNWANTED OOB High Freq Section, Channel 3F



UNWANTED OOB Low Freq Section, Channel 11F

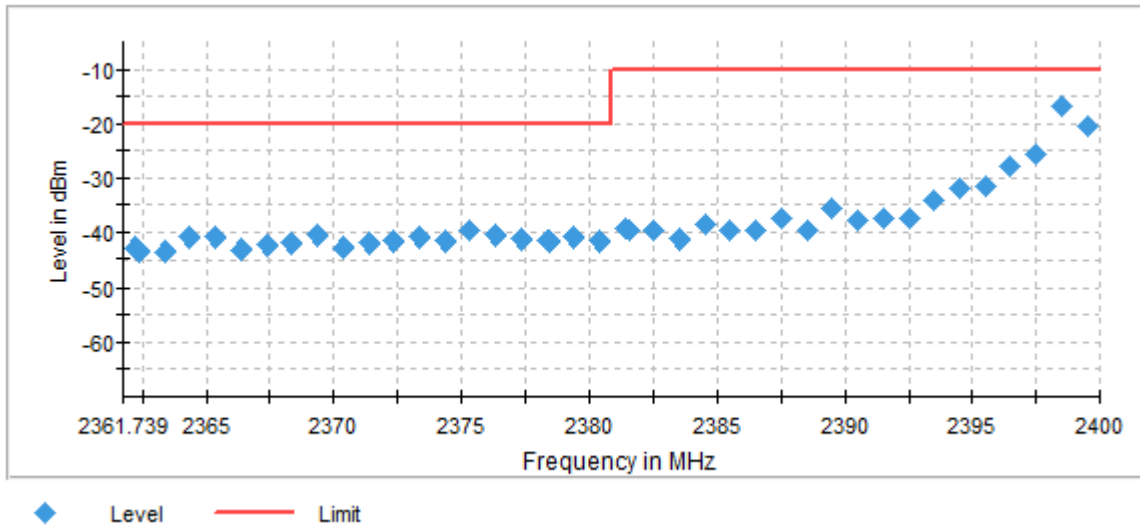


UNWANTED OOB High Freq Section, Channel 11F

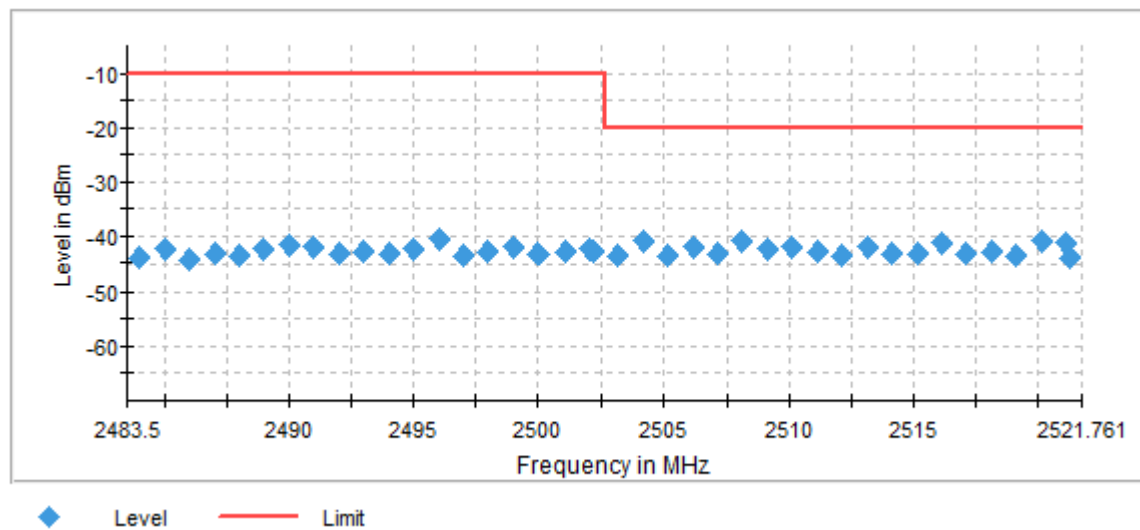


802.11ax20, HE0 – Chain A

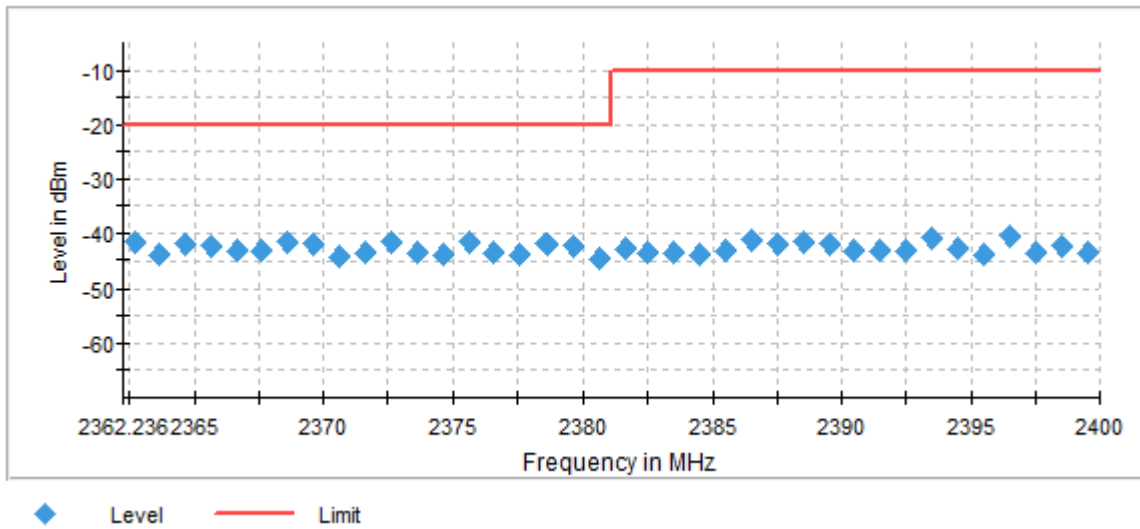
UNWANTED OOB Low Freq Section, Channel 1



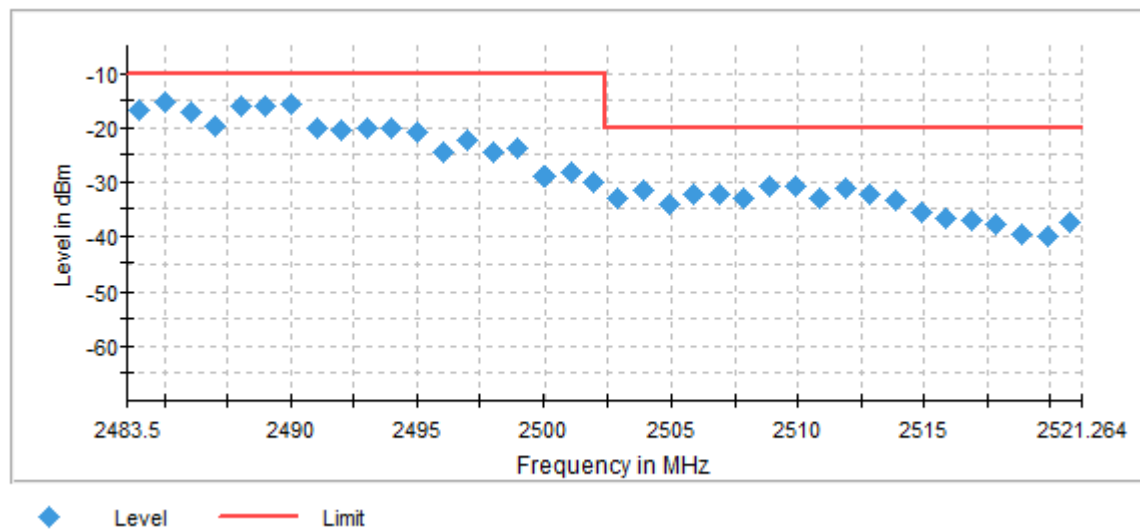
UNWANTED OOB High Freq Section, Channel 1



UNWANTED OOB Low Freq Section, Channel 13

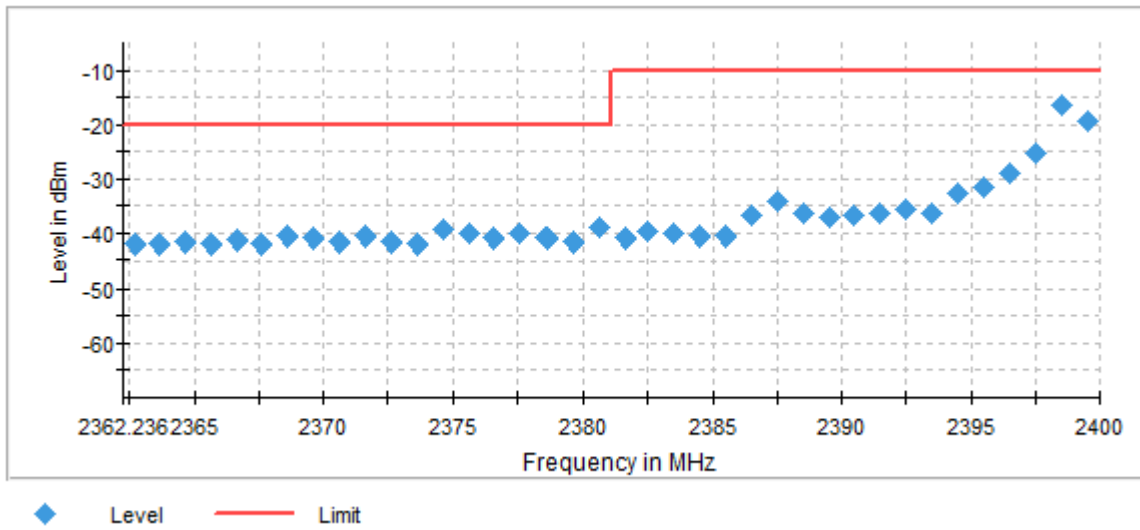


UNWANTED OOB High Freq Section, Channel 13

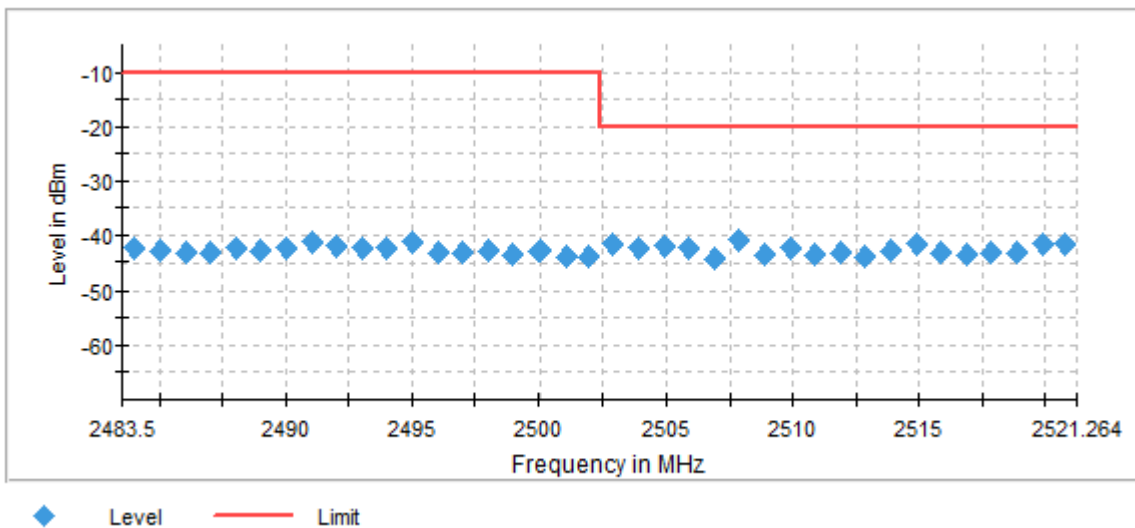


802.11ax20, HE0 – Chain B

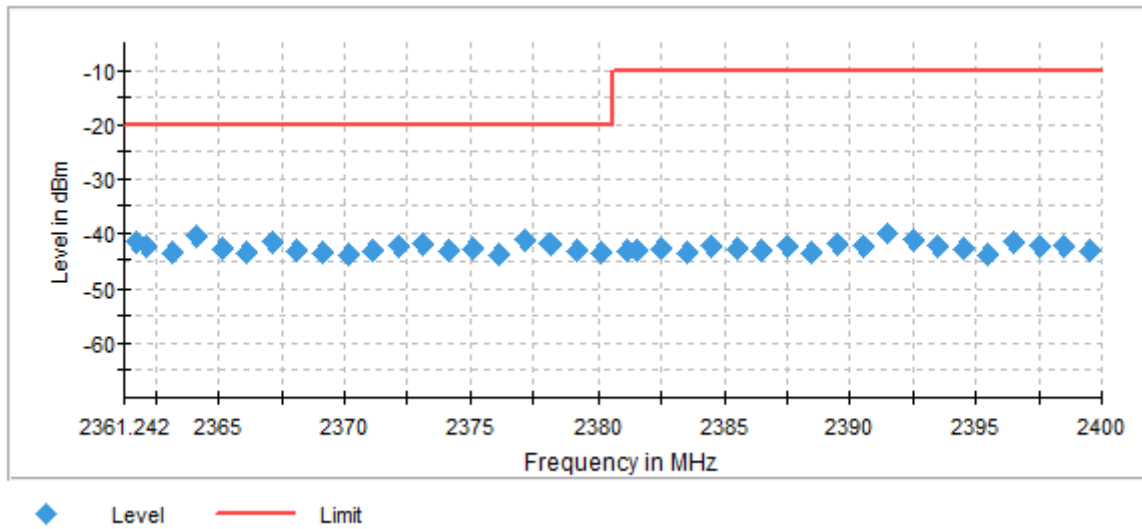
UNWANTED OOB Low Freq Section, Channel 1



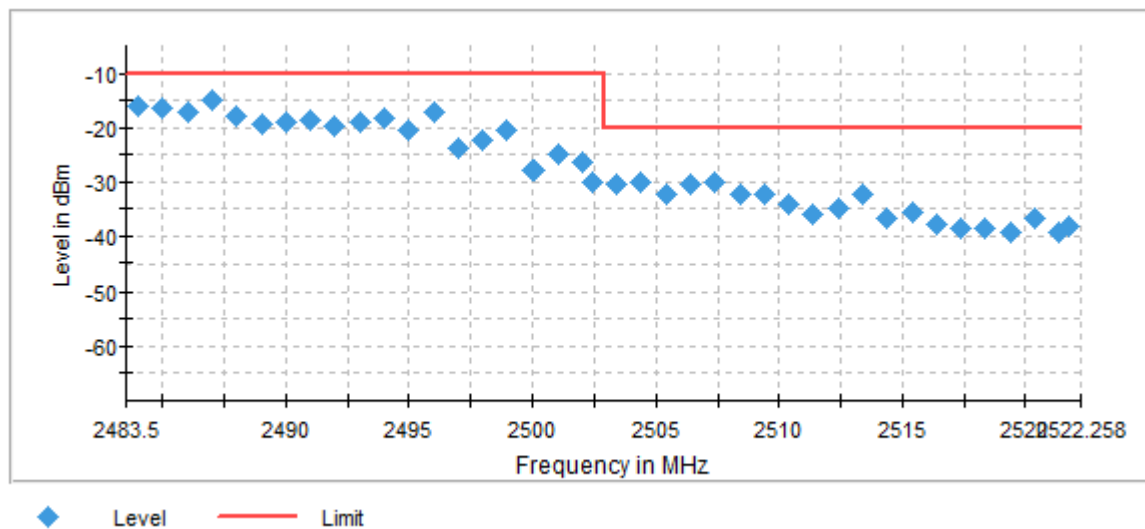
UNWANTED OOB High Freq Section, Channel 1



UNWANTED OOB Low Freq Section, Channel 13

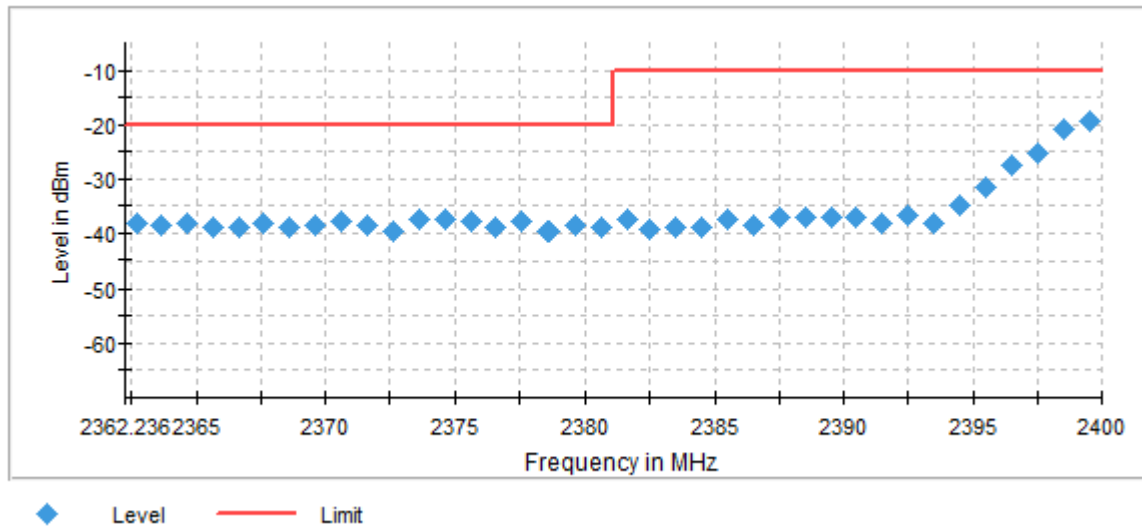


UNWANTED OOB High Freq Section, Channel 13

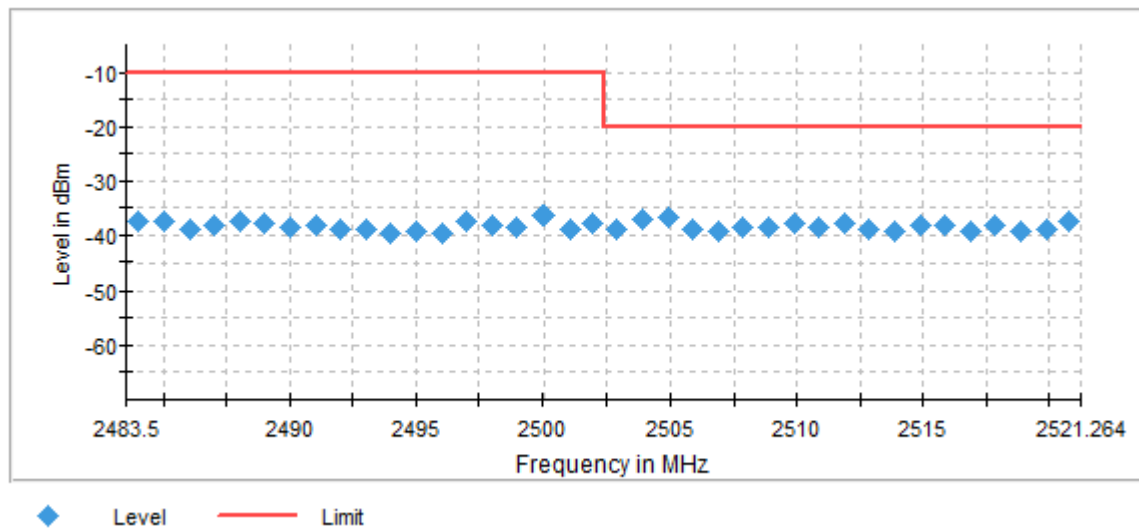


802.11ax20, HE0 (MIMO)

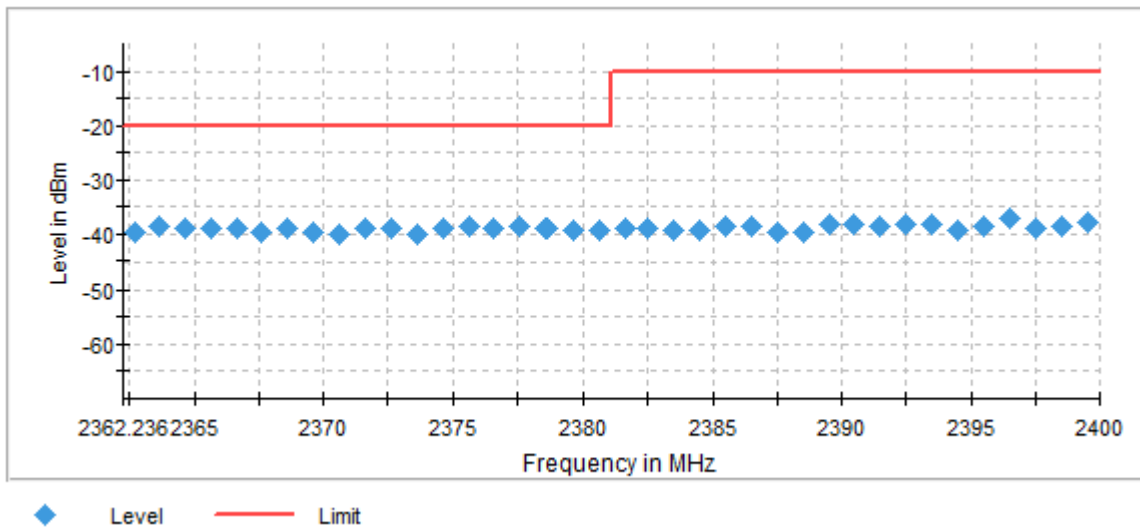
UNWANTED OOB Low Freq Section, Channel 1



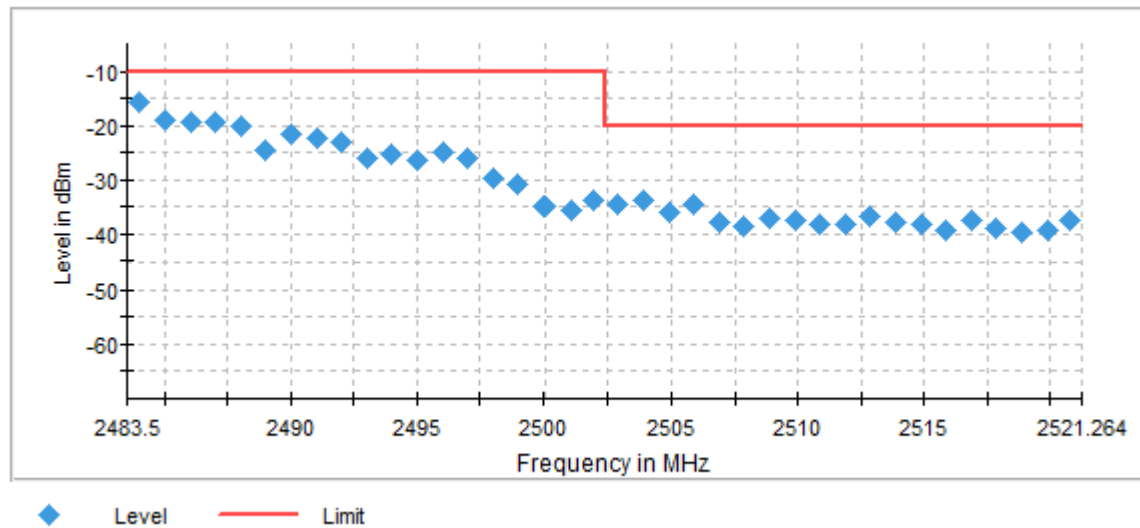
UNWANTED OOB High Freq Section, Channel 1



UNWANTED OOB Low Freq Section, Channel 13

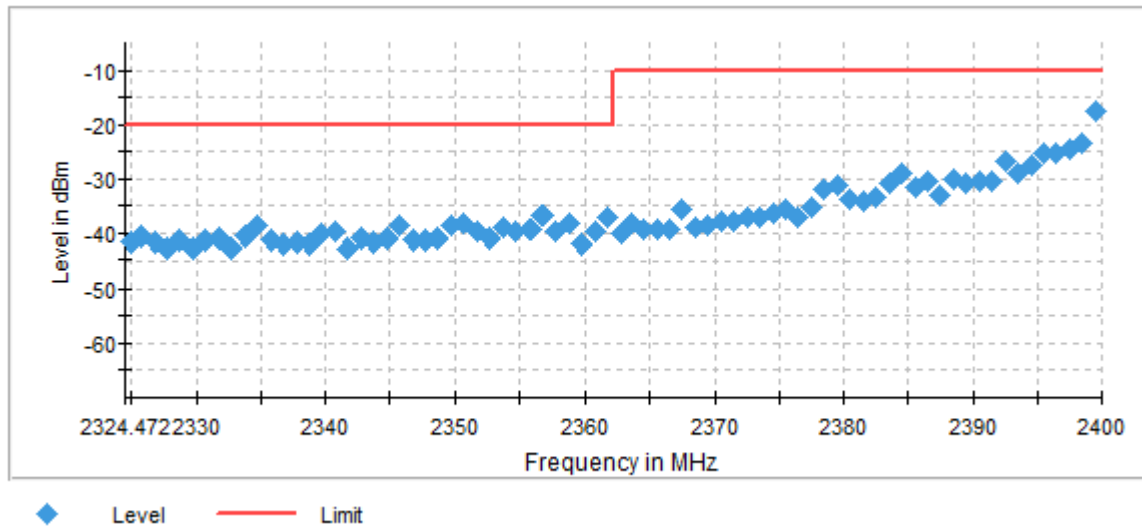


UNWANTED OOB High Freq Section, Channel 13

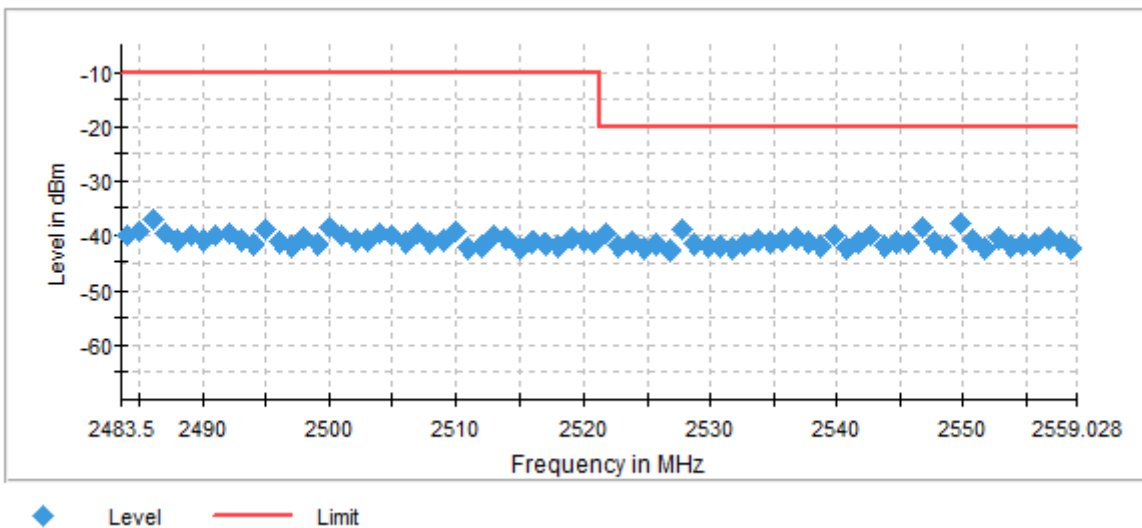


802.11ax40, HE0 – Chain A

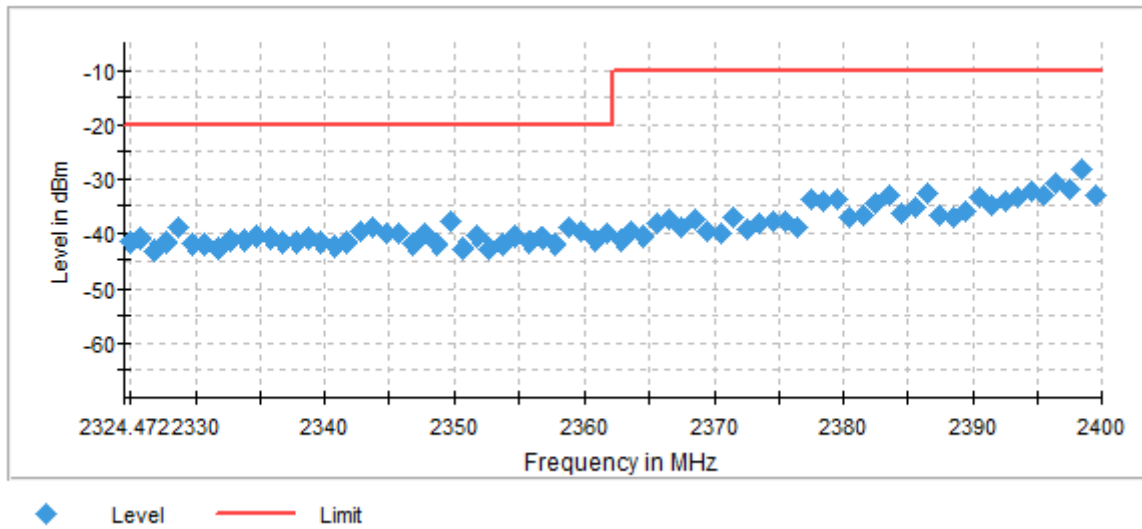
UNWANTED OOB Low Freq Section, Channel 3F



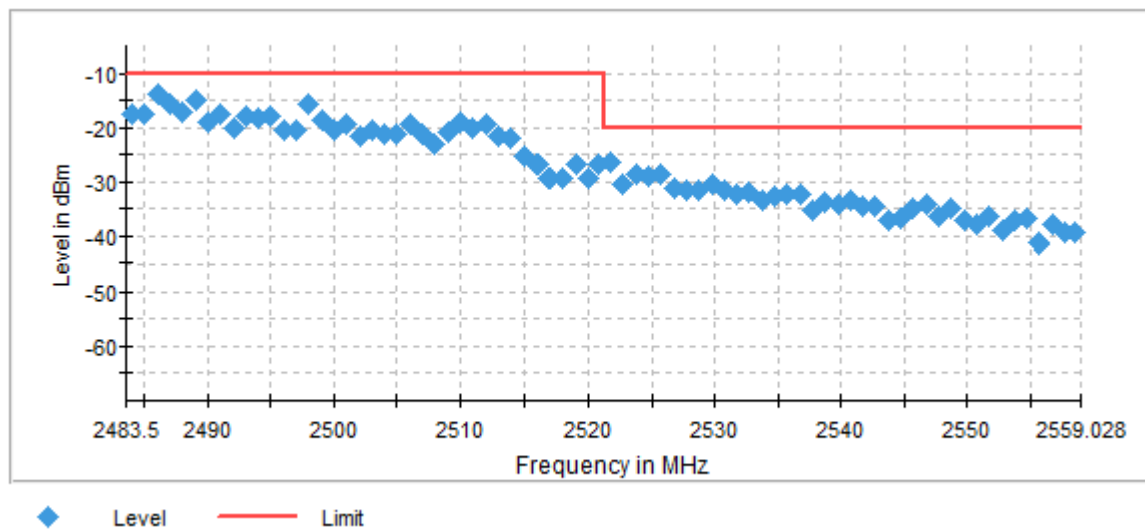
UNWANTED OOB High Freq Section, Channel 3F



UNWANTED OOB Low Freq Section, Channel 11F

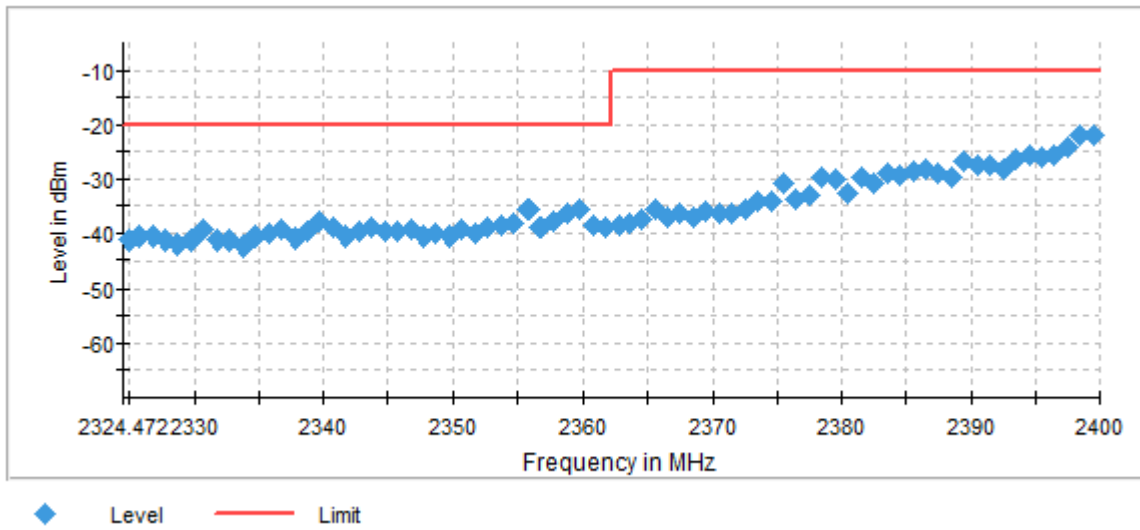


UNWANTED OOB High Freq Section, Channel 11F

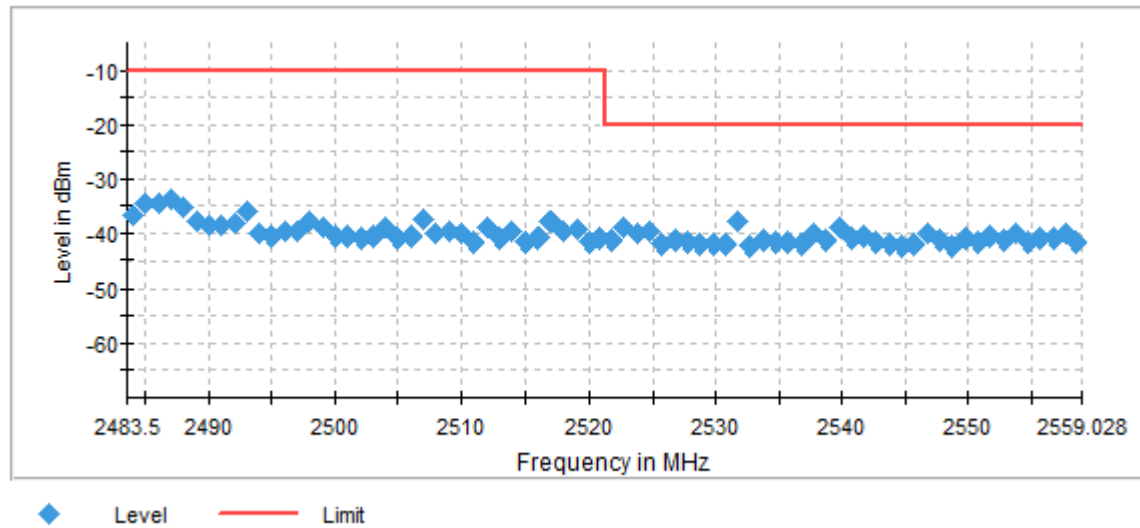


802.11ax40, HE0 – Chain B

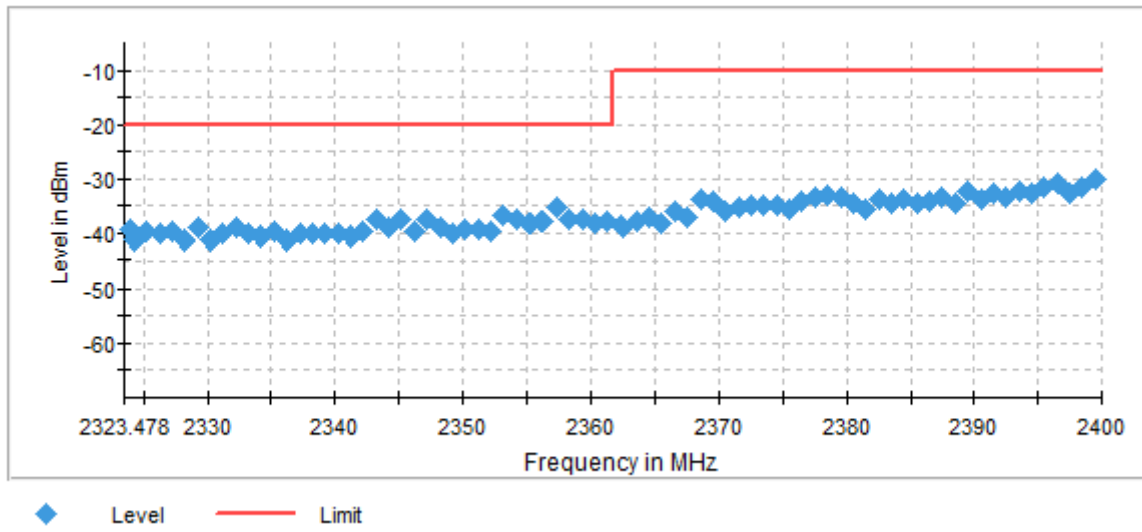
UNWANTED OOB Low Freq Section, Channel 3F



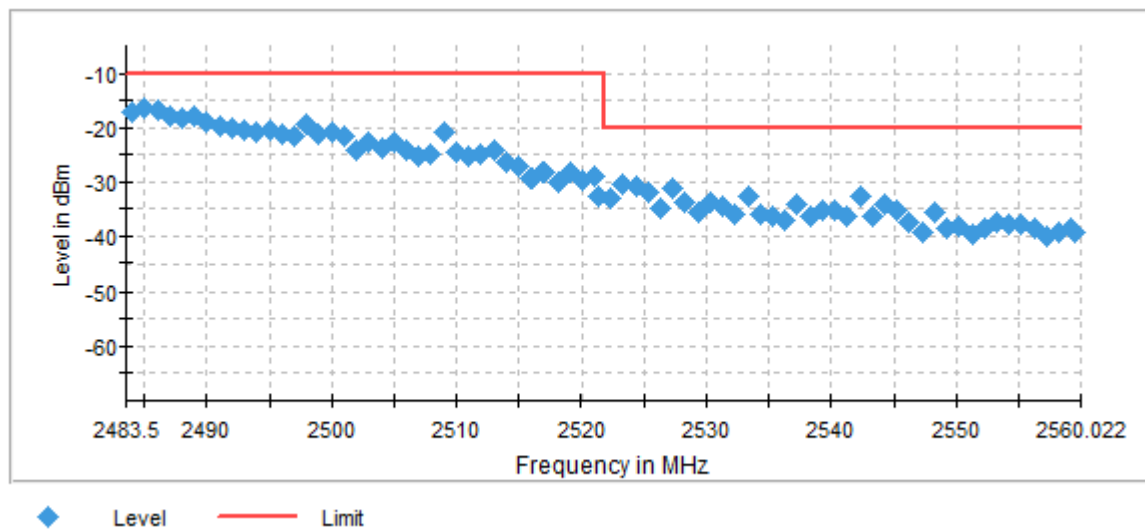
UNWANTED OOB High Freq Section, Channel 3F



UNWANTED OOB Low Freq Section, Channel 11F

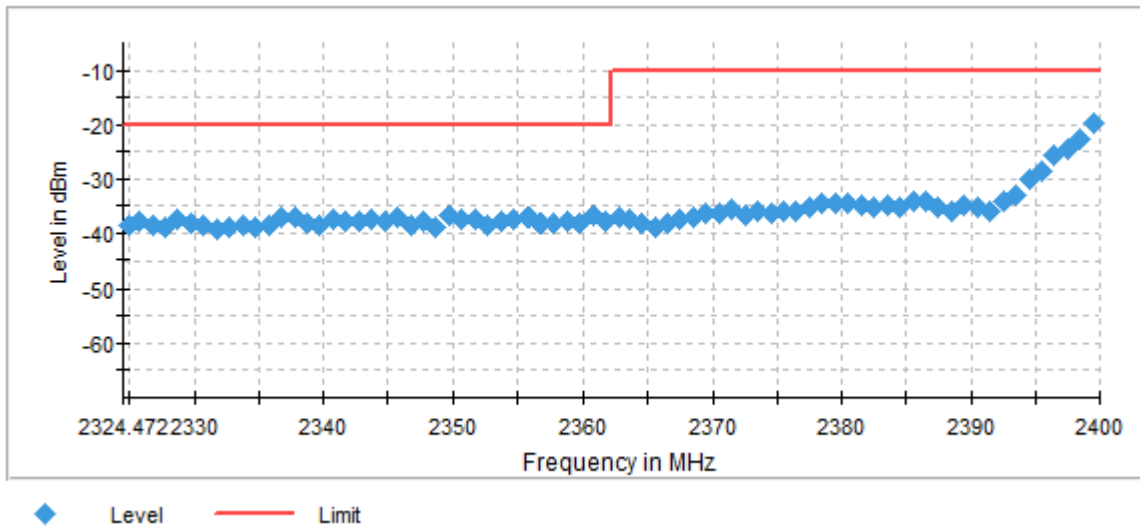


UNWANTED OOB High Freq Section, Channel 11F

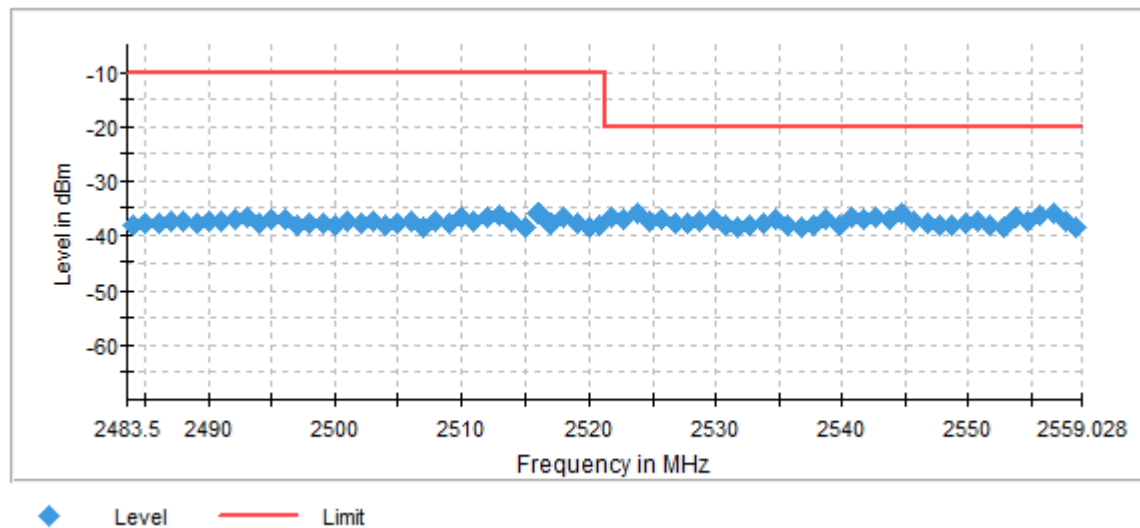


802.11ax40, HE0 (MIMO)

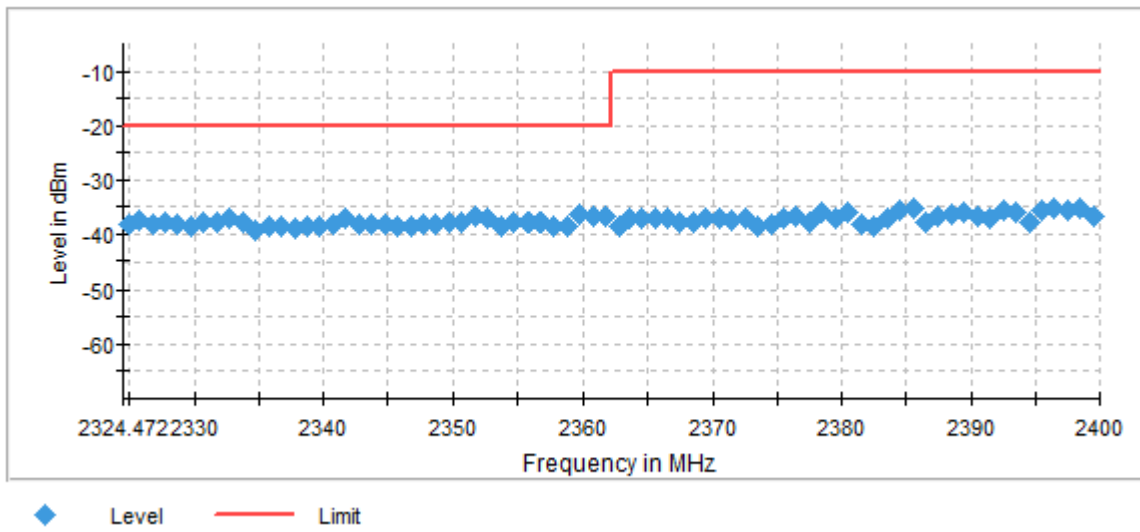
UNWANTED OOB Low Freq Section, Channel 3F



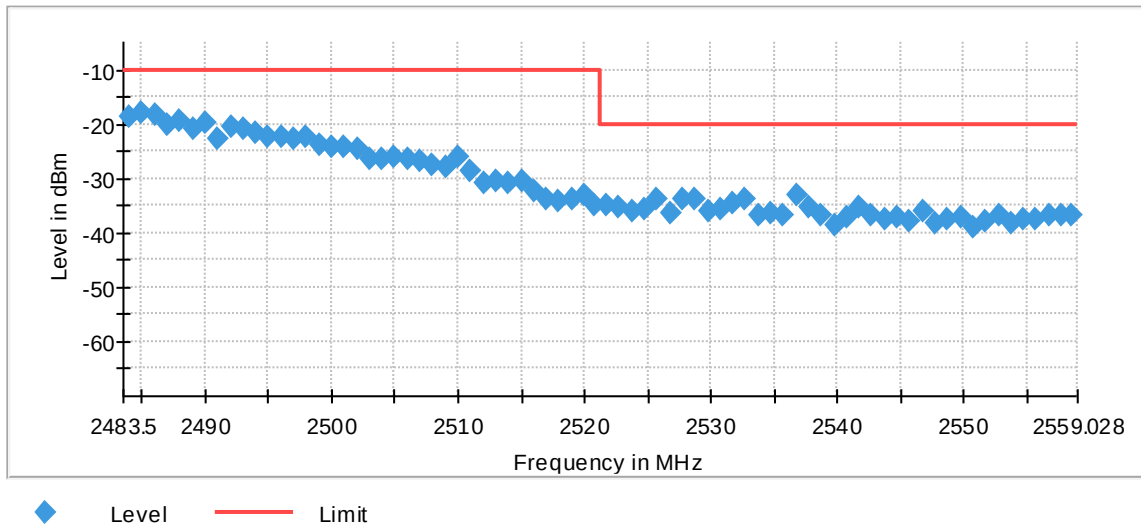
UNWANTED OOB High Freq Section, Channel 3F



UNWANTED OOB Low Freq Section, Channel 11F



UNWANTED OOB High Freq Section, Channel 11F



B.7 Transmitter unwanted emissions in the spurious domain

Test limits

ETSI part	Limits																																	
4.3.2.9.3	The transmitter unwanted emissions in the spurious domain shall not exceed the values given in table 12. 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. Table12: 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	Conditions
5.4.9.1	These measurements shall only be performed at normal test conditions. For equipment using wide band modulations other than FHSS, 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.

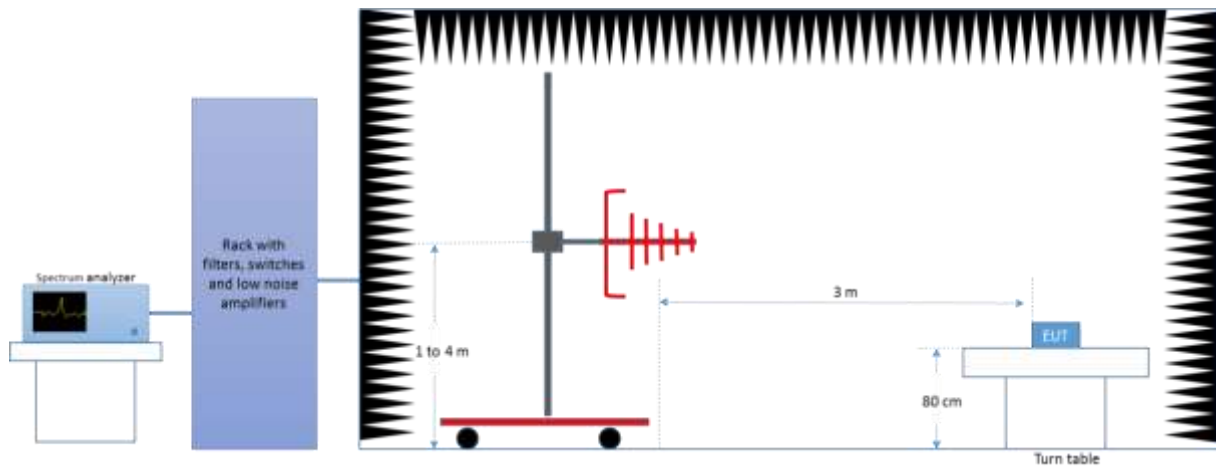
Test procedure

The setup below is used to measure the transmission spurious emissions accordingly with ETSI EN 300 328 V2.1.1 § 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.

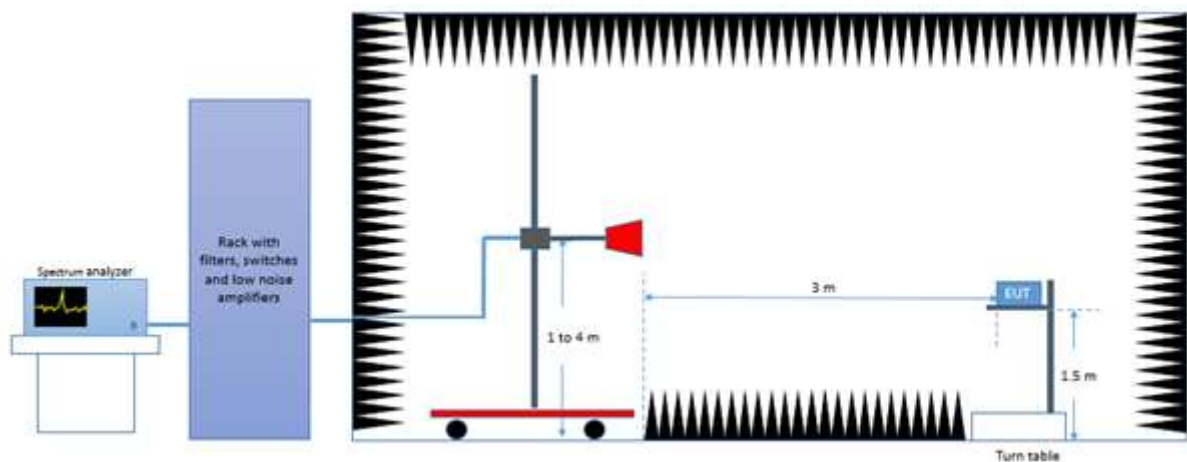
The final measurement is done by varying the antenna height from 1 to 4 meters, the EUT azimuth over 360° and for both Vertical and Horizontal polarizations.

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

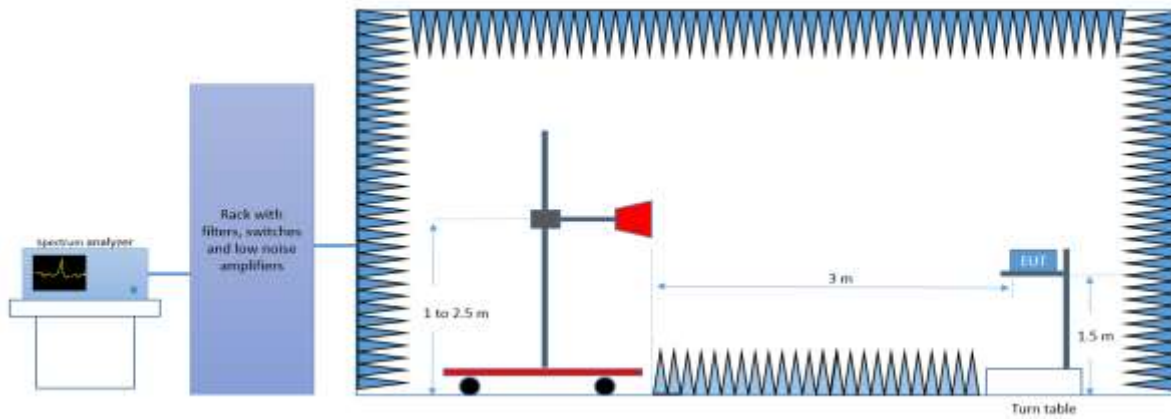
Radiated Setup 30 MHz - 1 GHz



Radiated Setup 1GHz – 6.4GHz



Radiated Setup 6.4 GHz – 12.75 GHz



Test Results

Tx Spurious Emissions – 30MHz to 12.75GHz

Tx Spurious Emissions – 802.11b (SISO), Chain A – Channel 1

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
576.0	-66.1	-54.0	12.1
4824.3	-47.1	-30.0	17.1
9647.5	-56.3	-30.0	26.3

Tx Spurious Emissions – 802.11b (SISO), Chain A – Channel 13

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
128.7	-70.2	-36.0	34.2
341.1	-72.1	-36.0	36.1
6362.0	-52.7	-30.0	22.7
12403.9	-44.7	-30.0	14.7

Tx Spurious Emissions – 802.11b (SISO), Chain B – Channel 1

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
624.0	-71.3	-54.0	17.3
4823.9	-52.2	-30.0	22.2
9648.0	-57.4	-30.0	27.4

Tx Spurious Emissions – 802.11b (SISO), Chain B – Channel 13

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
128.1	-69.8	-36.0	33.8
540.8	-68.8	-54.0	14.8
6286.5	-51.8	-30.0	21.8
12388.8	-44.3	-30.0	14.3

Tx Spurious Emissions – 802.11g (SISO), Chain A – Channel 1

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
576.0	-65.9	-54.0	11.9
4823.9	-52.2	-30.0	22.2
9648.0	-56.2	-30.0	26.2

Tx Spurious Emissions – 802.11g (SISO), Chain A – Channel 13

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
127.0	-69.9	-36.0	33.9
288.0	-70.8	-36.0	34.8
6350.5	-51.4	-30.0	21.4
12373.9	-44.3	-30.0	14.3

Tx Spurious Emissions – 802.11g (SISO), Chain B – Channel 1

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
576.0	-67.2	-54.0	13.2
6314.6	-50.1	-30.0	20.1
9648.0	-58.4	-30.0	28.4

Tx Spurious Emissions – 802.11g (SISO), Chain B – Channel 13

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
127.5	-70.6	-36.0	34.6
540.8	-68.9	-54.0	14.9
6357.5	-52.3	-30.0	22.3
12514.1	-44.3	-30.0	14.3

Tx Spurious Emissions – 802.11n20 (SISO), Chain A – Channel 1

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
576.0	-65.9	-54.0	11.9
6317.6	-50.7	-30.0	20.7
9648.0	-56.2	-30.0	26.2

Tx Spurious Emissions – 802.11n20 (SISO), Chain A – Channel 13

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
126.3	-69.9	-36.0	33.9
540.8	-69.2	-54.0	15.2
6288.5	-51.4	-30.0	21.4
12510.7	-44.1	-30.0	14.1

Tx Spurious Emissions – 802.11n20 (SISO), Chain B – Channel 1

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
576.0	-66.4	-54.0	12.4
6106.5	-50.9	-30.0	20.9
9647.5	-58.1	-30.0	28.1

Tx Spurious Emissions – 802.11n20 (SISO), Chain B – Channel 13

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
128.1	-71.3	-36.0	35.3
731.8	-68.2	-54.0	14.2
6269.5	-51.6	-30.0	21.6
12519.7	-44.2	-30.0	14.2

Tx Spurious Emissions – 802.11n20 (MIMO), Chain A+B – Channel 1

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
675.1	-70.7	-54.0	16.7
5829.9	-51.5	-30.0	21.5
9648.0	-55.5	-30.0	25.5

Tx Spurious Emissions – 802.11n20 (MIMO), Chain A+B – Channel 13

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
127.5	-69.7	-36.0	33.7
672.0	-67.6	-54.0	13.6
6308.0	-52.3	-30.0	22.3
12514.1	-44.2	-30.0	14.2

Tx Spurious Emissions – 802.11ax20 (SISO), Chain A – Channel 1

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
576.0	-65.9	-54.0	11.9
4806.5	-52.6	-30.0	22.6
9648.0	-55.5	-30.0	25.5

Tx Spurious Emissions – 802.11ax20 (SISO), Chain A – Channel 13

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
127.5	-70.8	-36.0	34.8
540.8	-68.3	-54.0	14.3
6279.0	-50.8	-30.0	20.8
12513.6	-44.3	-30.0	14.3

Tx Spurious Emissions – 802.11ax20 (SISO), Chain B – Channel 1

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
576.0	-66.4	-54.0	12.4
4807.3	-51.8	-30.0	21.8
12719.1	38.5	54.0	15.5

Tx Spurious Emissions – 802.11ax20 (SISO), Chain B – Channel 13

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
127.5	-70.6	-36.0	34.6
672.0	-67.7	-54.0	13.7
6260.5	-51.0	-30.0	21.0
12507.0	-44.2	-30.0	14.2

Tx Spurious Emissions – 802.11ax20 (MIMO), Chain A+B – Channel 1

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
675.1	-70.7	-54.0	16.7
4806.9	-52.5	-30.0	22.5
9648.0	-56.0	-30.0	26.0

Tx Spurious Emissions – 802.11ax20 (MIMO), Chain A+B – Channel 13

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
624.0	-69.5	-54.0	15.5
6288.5	-50.5	-30.0	20.6
12503.3	-44.6	-30.0	14.6

Tx Spurious Emissions – 802.11n40 (SISO), Chain A – Channel 3F

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
274.6	-60.3	-36.0	24.3
6293.8	-52.4	-30.0	22.4
9688.1	-56.3	-30.0	26.3

Tx Spurious Emissions – 802.11n40 (SISO), Chain A – Channel 11F

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
127.6	-70.4	-36.0	34.4
6286.5	-50.3	-30.0	20.3
12519.9	-44.3	-30.0	14.3

Tx Spurious Emissions – 802.11n40 (SISO), Chain B – Channel 3F

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
263.9	-60.2	-36.0	24.2
6317.6	-52.4	-30.0	22.4
9687.6	-58.7	-30.0	28.7

Tx Spurious Emissions – 802.11n40 (SISO), Chain B – Channel 11F

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
73.8	-81.3	-54.0	27.3
240.0	-70.0	-36.0	34.0
6299.0	-50.9	-30.0	20.9
12506.7	-44.3	-30.0	14.3

Tx Spurious Emissions – 802.11n40 (MIMO), Chain A+B – Channel 3F

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
280.8	-61.9	-36.0	25.9
6307.1	-52.5	-30.0	22.5
9688.1	-56.2	-30.0	26.2

Tx Spurious Emissions – 802.11n40 (MIMO), Chain A+B – Channel 11F

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
126.9	-70.6	-36.0	34.6
6260.5	-50.8	-30.0	20.8
12513.8	-44.3	-30.0	14.3

Tx Spurious Emissions – 802.11ax40 (SISO), Chain A – Channel 3F

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
278.2	-62.1	-36.0	26.1
5836.4	-51.3	-30.0	21.3
9688.1	-56.1	-30.0	26.1

Tx Spurious Emissions – 802.11ax40 (SISO), Chain A – Channel 11F

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
125.7	-70.9	-36.0	34.9
549.1	-69.8	-54.0	15.8
6317.5	-51.7	-30.0	21.7
12519.9	-44.3	-30.0	14.3

Tx Spurious Emissions – 802.11ax40 (SISO), Chain B – Channel 3F

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
124.5	-65.3	-36.0	29.3
6329.7	-50.3	-30	20.3
9688.1	-57.9	-30.0	27.9

Tx Spurious Emissions – 802.11ax40 (SISO), Chain B – Channel 11F

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
128.1	-71.9	-36.0	35.9
624.0	-70.5	-54.0	16.5
6287.0	-50.3	-30.0	20.3
12516.5	-44.4	-30.0	14.4

Tx Spurious Emissions – 802.11ax40 (MIMO), Chain A+B – Channel 3F

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
123.4	-67.2	-36.0	31.2
6176.0	-51.1	-30	21.1
9688.1	-55.8	-30.0	25.8

Tx Spurious Emissions – 802.11ax40 (MIMO), Chain A+B – Channel 11F

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
112.1	-76.8	-36.0	40.8
542.4	-73.4	-54.0	19.4
4888.0	-51.5	-30.0	21.5
12523.8	-44.5	-30.0	14.5

B.8 Receiver spurious emissions

Test limits

ETSI part	Limits								
4.3.2.10.3	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 receivers								
	<table><tr><th>Frequency range</th><th>Maximum power</th><th>Bandwidth</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>	Frequency range	Maximum power	Bandwidth	30 MHz to 1GHz	-57 dBm	100 kHz	1GHz to 12.75 GHz	-47 dBm
Frequency range	Maximum power	Bandwidth							
30 MHz to 1GHz	-57 dBm	100 kHz							
1GHz to 12.75 GHz	-47 dBm	1 MHz							

Test conditions

ETSI part	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 equipment using wide band modulations other than FHSS, the measurement shall be performed at the lowest and the highest channel on which the equipment can operate.

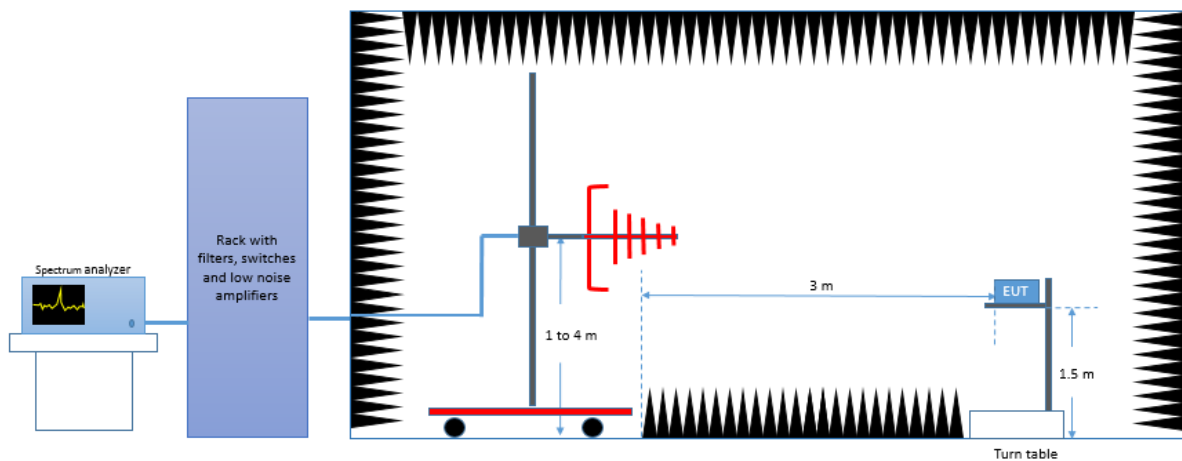
Test procedure

The setup below is used to measure 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.

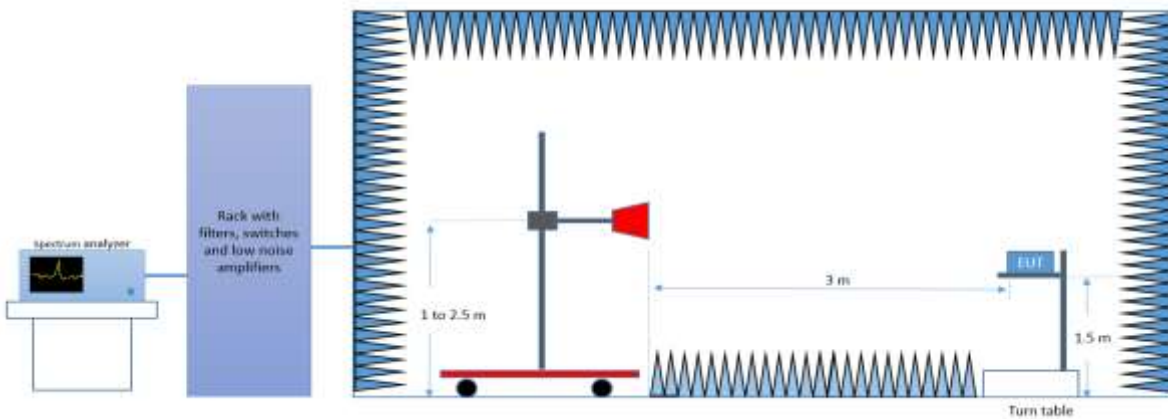
The final measurement is done by varying the antenna height from 1 to 4 meters, the EUT azimuth over 360° and for both Vertical and Horizontal polarizations.

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

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 – b/g/n20 (MIMO), Chain A+B – Channel 1

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
975.2	-70.1	-57.0	13.1
1243.3	-65.5	-47.0	18.5
1330.5	-65.5	-47.0	18.5
4264.5	-61.6	-47.0	14.6
6384.9	-59.9	-47.0	12.9
7675.5	-59.1	-47.0	12.1

Rx Spurious Emissions – b/g/n20 (MIMO), Chain A+B – Channel 13

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
983.4	-69.6	-57.0	12.6
1074.9	-67.3	-47.0	20.3
2432.0	-62.6	-47.0	15.6
6383.9	-57.9	-47.0	10.9

Rx Spurious Emissions – 802.11n40 (MIMO), Chain A+B, CH3F

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
181.4	-74.4	-57.0	17.4
1326.6	-65.7	-47.0	18.7
1332.9	-65.4	-47.0	18.4
2381.6	-63.9	-47.0	16.9
6385.4	-58.9	-47.0	11.9
12381.8	-58.7	-47.0	11.7

Rx Spurious Emissions – 802.11n40 (MIMO), Chain A+B, CH11F

Frequency	RMS	Limit	Margin
MHz	dBm	dBm	dB
912.0	-66.9	-57.0	9.9
1273.2	-65.2	-47.0	18.2
2655.3	-61.9	-47.0	14.9
3317.7	-62.7	-47.0	15.7
12319.2	-58.5	-47.0	11.5

B.9 Receiver Blocking

Test limits

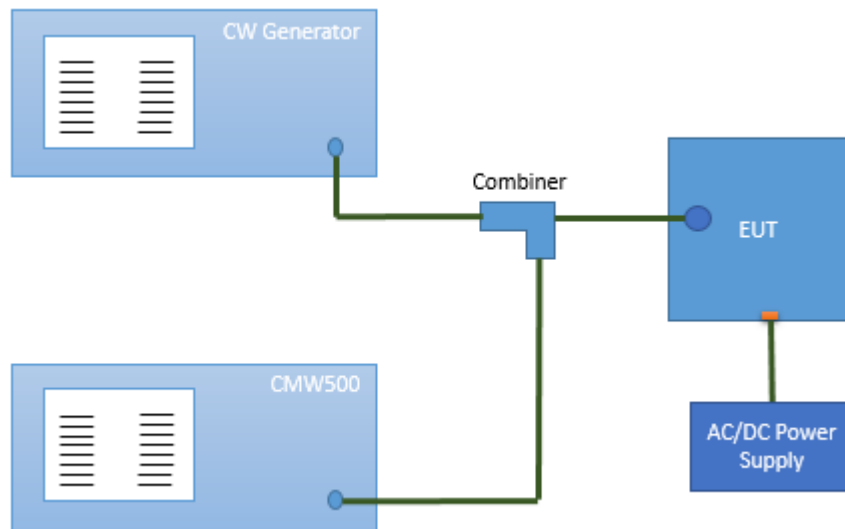
ETSI part	Limits																
4.3.2.11.3	The minimum performance criterion shall be a PER less than or equal to 10 %.																
4.3.2.11.4	While maintaining the minimum performance criteria as defined in clause 4.3.2.11.3, the blocking levels at specified frequency offsets shall be equal to or greater than the limits defined for the applicable receiver category provided in table below. Receiver blocking parameters for Receiver Category 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> NOTE 1: $P_{\min}$ is the minimum level of the wanted signal (in dBm) required to meet the minimum performance criteria as defined in clause 4.3.2.11.3 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.	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
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														

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.

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: 802.11b, Chain A, Channel 1, 1Mbps.

Minimum performance result without interferer

Wanted signal mean power from companion device: Pmin [dBm]	PER [%]
-88.00*	0.80

*Note: connection lost for Pmin < -88.00 dBm

Minimum performance results with interferer

Wanted signal mean power from companion device:

✓ Pmin [dBm] + 6dB = -82.00 dBm

Blocking signal Frequency [MHz]	Blocking signal Power [dBm]	PER [%]	Verdict
2380	-50	5.20	PASS
2503.5	-50	3.60	PASS
2300	-44	1.45	PASS
2330	-44	2.00	PASS
2360	-44	1.95	PASS
2523.5	-44	2.90	PASS
2553.5	-44	2.55	PASS
2583.5	-44	0.90	PASS
2613.5	-44	1.20	PASS
2643.5	-44	3.45	PASS
2673.5	-44	2.00	PASS

Configuration tested: 802.11b, Chain A, Channel 13, 1Mbps.

- Minimum performance result without interferer**

Wanted signal mean power from companion device: Pmin [dBm]	PER [%]
-96.50	7.15

- Minimum performance results with interferer**

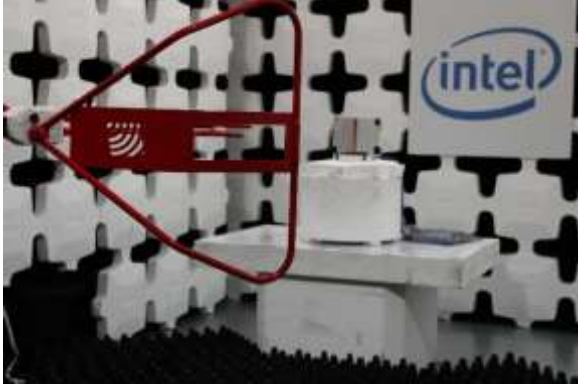
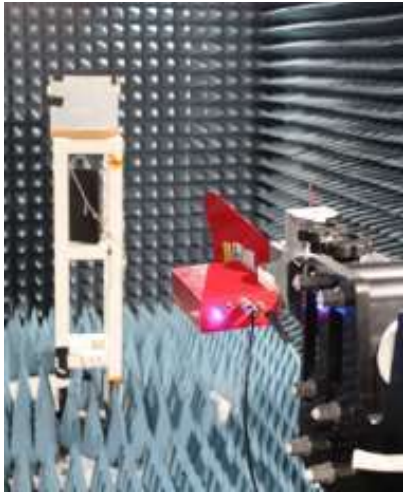
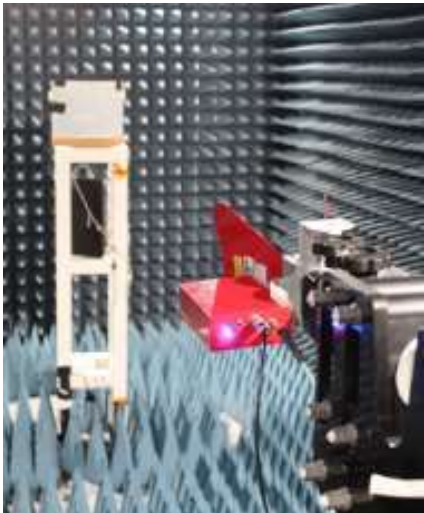
Wanted signal mean power from companion device:

✓ Pmin [dBm] + 6dB = -90.5 dBm

Blocking signal Frequency [MHz]	Blocking signal Power [dBm]	PER [%]	Verdict
2380	-50	1.30	PASS
2503.5	-50	2.00	PASS
2300	-44	1.60	PASS
2330	-44	3.45	PASS
2360	-44	0.80	PASS
2523.5	-44	1.65	PASS
2553.5	-44	2.80	PASS
2583.5	-44	1.15	PASS
2613.5	-44	1.20	PASS
2643.5	-44	1.40	PASS
2673.5	-44	1.30	PASS

Annex C. Photographs

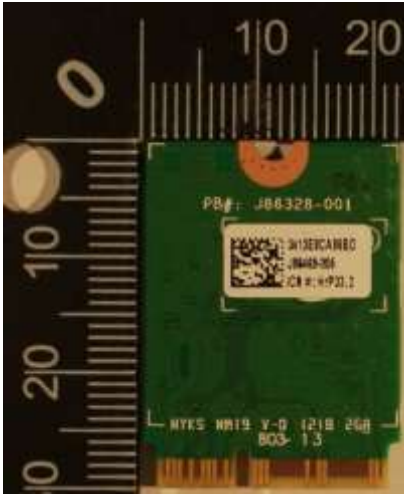
C.1 Test Setup

Radiated Setup-1 30 MHz – 1 GHz (Transmitter tests)	Radiated Setup-1 30 MHz – 1 GHz (Receiver tests)
	
Radiated Setup-1 1 GHz – 6.4 GHz (Transmitter tests)	Radiated Setup-2 6.4 GHz – 12.75 GHz (Transmitter tests)
	
Radiated Setup-2 1 GHz – 12.75 GHz (Receiver tests)	
	

C.2 Test Sample

Sample #01	
Module Front	Module Back
	
Extender board	Laptop
	

Module Front 	Module Back 
Extender board 	Laptop 

Sample #03	
Module Front	Module Back
	
Extender board	Laptop
	

Sample #04

Module Front



Module Back



Extender board



Laptop



Sample #05	
Module Front	Module Back
	
Extender board	Laptop
	

Sample #06

Module Front



Module Back



Laptop

