

RADIO PERFORMANCE TEST REPORT

Test Report No. : OT-221-RWD-064

Reception No. : 2109004007

Applicant : LG Electronics USA

Address : 111 Sylvan Avenue, North Building, Englewood Cliffs, New Jersey, 07632, United States

Manufacturer : LG Electronics Inc.

Address : 222 LG-ro, Jinwi-Myeon, Pyeongtaek -Si, Gyeonggi-Do, 451-713, Korea

Type of Equipment : Silverbox RADIO ASM-RECEIVER

FCC ID. : BEJVCUEB

Model Name : VCUEB

Multiple Model Name : N/A

Serial number : N/A

Total page of Report : 66 pages (including this page)

Date of Incoming : November 25, 2021

Date of issue : January 26, 2022

SUMMARY

The equipment complies with the regulation; **FCC PART 15 SUBPART C Section 15.247**

This test report only contains the result of a single test of the sample supplied for the examination.

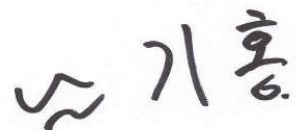
It is not a generally valid assessment of the features of the respective products of the mass-production.



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ONETECH Corp.



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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-221-RWD-064	January 26, 2022	Initial Release	All

1. VERIFICATION OF COMPLIANCE

Applicant : LG Electronics USA

Address : 111 Sylvan Avenue, North Building, Englewood Cliffs, New Jersey, 07632, United States

Contact Person : Sung Soo Kim / Director, Regulatory and Environmental Affairs

Telephone No. : +201-266-2215

FCC ID : BEJVCUEB

Model Name : VCUEB

Brand Name : -

Serial Number : N/A

Date : January 26, 2022

EQUIPMENT CLASS	DTS – DIGITAL TRNSMISSION SYSTEM
E.U.T. DESCRIPTION	Silverbox RADIO ASM-RECEIVER
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2020
TYPE OF EQUIPMENT TESTED	Pre-Production
KIND OF EQUIPMENT AUTHORIZATION REQUESTED	Certification
EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S)	FCC PART 15 SUBPART C Section 15.247 KDB 558074 D01 15.247 Meas Guidance v05r02
Modifications on the Equipment to Achieve Compliance	None
Final Test was Conducted On	3 m, Semi Anechoic Chamber

-. The above equipment was tested by ONETECH Corp. for compliance with the requirement set forth in the FCC Rules and Regulations. This said equipment in the configuration described in this report, shows the maximum emission levels emanating from equipment are within the compliance requirements.

2. TEST SUMMARY

2.1 Test items and results

SECTION	TEST ITEMS	RESULTS
15.247 (a) (2)	Minimum 6 dB Bandwidth	Met the Limit / PASS
15.247 (b) (3)	Maximum Peak Conducted Output Power	Met the Limit / PASS
15.247 (d)	100 kHz Bandwidth Outside the Frequency Band	Met the Limit / PASS
15.247 (d)	Radiated Emission which fall in the Restricted Band	Met the Limit / PASS
15.247 (e)	Peak Power Spectral Density	Met the Limit / PASS
15.209	Radiated Emission Limits	Met the Limit / PASS
15.207	Conducted Limits	N/A (See Note)
15.203	Antenna Requirement	Met requirement / PASS

Note: This test is not performed because the EUT is operated by DC Power.

2.2 Additions, deviations, exclusions from standards

No additions, deviations or exclusions have been made from standard.

2.3 Related Submittal(s) / Grant(s)

Original submittal only

2.4 Purpose of the test

To determine whether the equipment under test fulfills the requirements of the regulation stated in FCC PART 15 SUBPART C Section 15.247.

2.5 Test Methodology

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10: 2020. Radiated testing was performed at a distance of 3 m from EUT to the antenna.

2.6 Test Facility

The Onetech Corp. has been designated to perform equipment testing in compliance with ISO/IEC 17025.

The Electromagnetic compatibility measurement facilities are located at 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea.

-. Site Filing:

VCCI (Voluntary Control Council for Interference) – Registration No. R-20122/ C-14617/ G-10666/ T-11842

ISED (Innovation, Science and Economic Development Canada) – Registration No. Site# 3736A-3

KOLAS (Korea Laboratory Accreditation Scheme) - Accreditation NO. KT085

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

3. GENERAL INFORMATION

3.1 Product Description

The LG Electronics USA, Model VCUEB (referred to as the EUT in this report) is a Silverbox RADIO ASM-RECEIVER. The product specification described herein was obtained from product data sheet or user's manual.

DEVICE TYPE	Silverbox RADIO ASM-RECEIVER	
Temperature Range	-30 °C ~ 85 °C	
OPERATING FREQUENCY	Bluetooth	2 402 MHz ~ 2 480 MHz
	WLAN 2.4 GHz	2 412 MHz ~ 2 462 MHz (802.11b/g/n(HT20))
	5 150 MHz ~ 5 250 MHz Band	5 180 MHz ~ 5 240 MHz (802.11a/n(HT20)/ac(VHT20))
		5 190 MHz ~ 5 230 MHz (802.11n(HT40)/ac(VHT40))
		5 210 MHz (802.11ac(VHT80))
	5 725 MHz ~ 5 850 MHz Band	5 745 MHz ~ 5 825 MHz (802.11a/n(HT20)/ac(VHT20))
		5 755 MHz ~ 5 795 MHz (802.11n(HT40)/ac(VHT40))
		5 775 MHz (802.11ac(VHT80))
MODULATION TYPE	Bluetooth	GFSK for 1 Mbps, $\pi/4$ -DQPSK for 2 Mbps, 8-DPSK for 3 Mbps
	WLAN 2.4 GHz	802.11b: DSSS Modulation(DBPSK/DQPSK/CCK) 802.11g/n(HT20): OFDM Modulation(BPSK/QPSK/16QAM/64QAM)
	WLAN 5 GHz	802.11a/n(HT20)/n(HT40)/ac(VHT80): OFDM Modulation(BPSK/QPSK/16QAM/64QAM)

RF OUTPUT POWER	Bluetooth	1 Mbps	4.12 dBm
		2 Mbps	6.20 dBm
		3 Mbps	6.64 dBm
	WLAN 2.4 GHz	12.77 dBm(802.11b) 12.53 dBm(802.11g) 12.45 dBm(802.11n_HT20)	
	5 150 MHz ~ 5 250 MHz Band (UNII I)	Internal Antenna	14.58 dBm(802.11a) 15.54 dBm(802.11n_HT20) 12.50 dBm(802.11n_HT40) 10.36 dBm(802.11ac_VHT80)
		External Antenna	11.68 dBm(802.11a) 12.65 dBm(802.11n_HT20) 10.99 dBm(802.11n_HT40) 6.62 dBm(802.11ac_VHT80)
	5 725 MHz ~ 5 850 MHz Band (UNII 3)	Internal Antenna	13.94 dBm(802.11a) 14.97 dBm(802.11n_HT20) 13.89 dBm(802.11n_HT40) 9.87 dBm(802.11ac_VHT80)
		External Antenna	11.03 dBm(802.11a) 11.89 dBm(802.11n_HT20) 10.49 dBm(802.11n_HT40) 5.84 dBm(802.11ac_VHT80)

ANTENNA TYPE	Bluetooth	PCB Antenna	
	WLAN 2.4 GHz	PCB Antenna	
	WLAN 5 GHz	Internal Antenna	PCB Antenna
		External Antenna	PCB Antenna
ANTENNA GAIN	Bluetooth	4.73 dBi	
	WLAN 2.4 GHz	2.10 dBi	
	5 150 MHz ~	Internal Antenna	5.29 dBi
	5 250 MHz Band	External Antenna	2.60 dBi
	5 725 MHz ~	Internal Antenna	4.29 dBi
	5 850 MHz Band	External Antenna	2.80 dBi
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)		37.4 MHz, 100 MHz	

3.2 Alternative type(s)/model(s); also covered by this test report.

-. None

4. EUT MODIFICATIONS

-. None

5. SYSTEM TEST CONFIGURATION

5.1 Justification

This device was configured for testing in a typical way as a normal customer is supposed to be used. During the test, the following components were installed inside of the EUT.

DEVICE TYPE	MANUFACTURER	MODEL/PART NUMBER	FCC ID
Main Board	N/A	N/A	N/A
Module	N/A	N/A	N/A
Antenna	N/A	N/A	N/A

5.2 Peripheral equipment

Defined as equipment needed for correct operation of the EUT, but not considered as tested:

Model	Manufacturer	Description	Connected to
VCUEB	LG Electronics Inc.	Silverbox RADIO ASM-RECEIVER (EUT)	
GP-4303D	LG Precision Co.,Ltd	DC Power Supply (DC 30 V 3 A)	
ProBook 450 G7	HP	NoteBook	EUT

5.3 Mode of operation during the test

For the testing, software used to control the EUT for staying in continuous transmitting is programmed.

For final testing, the EUT was set at 2 412 MHz, 2 437 MHz, and 2 462 MHz to get a maximum emission levels from the EUT. The EUT was moved throughout the XY, XZ, and YZ planes and the worst case is “XY” axis, but the worst data was recorded in this report.

Modulation	DATA RATE	OUTPUT POWER[dBm]
802.11 b (Low Channel)	1 Mbps	12.18
	2 Mbps	12.00
	5.5 Mbps	11.92
	11 Mbps	11.75
802.11g (Low Channel)	6 Mbps	7.93
	9 Mbps	7.75
	12 Mbps	7.67
	18 Mbps	7.05
	24 Mbps	6.73
	36 Mbps	6.42
	48 Mbps	6.25
	54 Mbps	6.05
HT 20 (Low Channel)	6.5 Mbps	7.95
	13 Mbps	7.61
	19.5 Mbps	7.36
	26 Mbps	6.69
	39 Mbps	6.37
	52 Mbps	6.18
	58.5 Mbps	6.03
	65 Mbps	5.93

The worse case data rate for each modulation is determined 1 Mbpsfor IEEE 802.11b, 6 Mbps for IEEE 802.11g, 6.5 Mbps for HT20.

Modulation	DATA RATE	OUTPUT POWER[dBm]
802.11 b (Middle Channel)	1 Mbps	12.48
	2 Mbps	12.26
	5.5 Mbps	12.20
	11 Mbps	12.05
802.11g (Middle Channel)	6 Mbps	12.32
	9 Mbps	12.19
	12 Mbps	12.03
	18 Mbps	11.39
	24 Mbps	11.20
	36 Mbps	10.78
	48 Mbps	10.59
	54 Mbps	10.39
HT 20 (Middle Channel)	6.5 Mbps	12.24
	13 Mbps	12.01
	19.5 Mbps	11.78
	26 Mbps	11.22
	39 Mbps	10.76
	52 Mbps	10.52
	58.5 Mbps	10.42
	65 Mbps	10.31

The worse case data rate for each modulation is determined 1 Mbpsfor IEEE 802.11b, 6 Mbps for IEEE 802.11g, 6.5 Mbps for HT20.

Modulation	DATA RATE	OUTPUT POWER[dBm]
802.11 b (High Channel)	1 Mbps	12.72
	2 Mbps	12.52
	5.5 Mbps	12.44
	11 Mbps	12.29
802.11g (High Channel)	6 Mbps	8.40
	9 Mbps	8.20
	12 Mbps	8.06
	18 Mbps	7.45
	24 Mbps	7.14
	36 Mbps	6.84
	48 Mbps	6.67
	54 Mbps	6.52
HT 20 (High Channel)	6.5 Mbps	8.21
	13 Mbps	7.92
	19.5 Mbps	7.75
	26 Mbps	7.14
	39 Mbps	6.83
	52 Mbps	6.60
	58.5 Mbps	6.44
	65 Mbps	6.28

The worse case data rate for each modulation is determined 1 Mbps for IEEE 802.11b, 6 Mbps for IEEE 802.11g, 6.5 Mbps for HT20.

-. Channel List (WLAN 2.4 GHz)

Channel	Frequency[MHz]	Channel	Frequency[MHz]	Channel	Frequency[MHz]
1	2 412.00	6	2 437.00	11	2 462.00
2	2 417.00	7	2 442.00		
3	2 422.00	8	2 447.00		
4	2 427.00	9	2 452.00		
5	2 432.00	10	2 457.00		

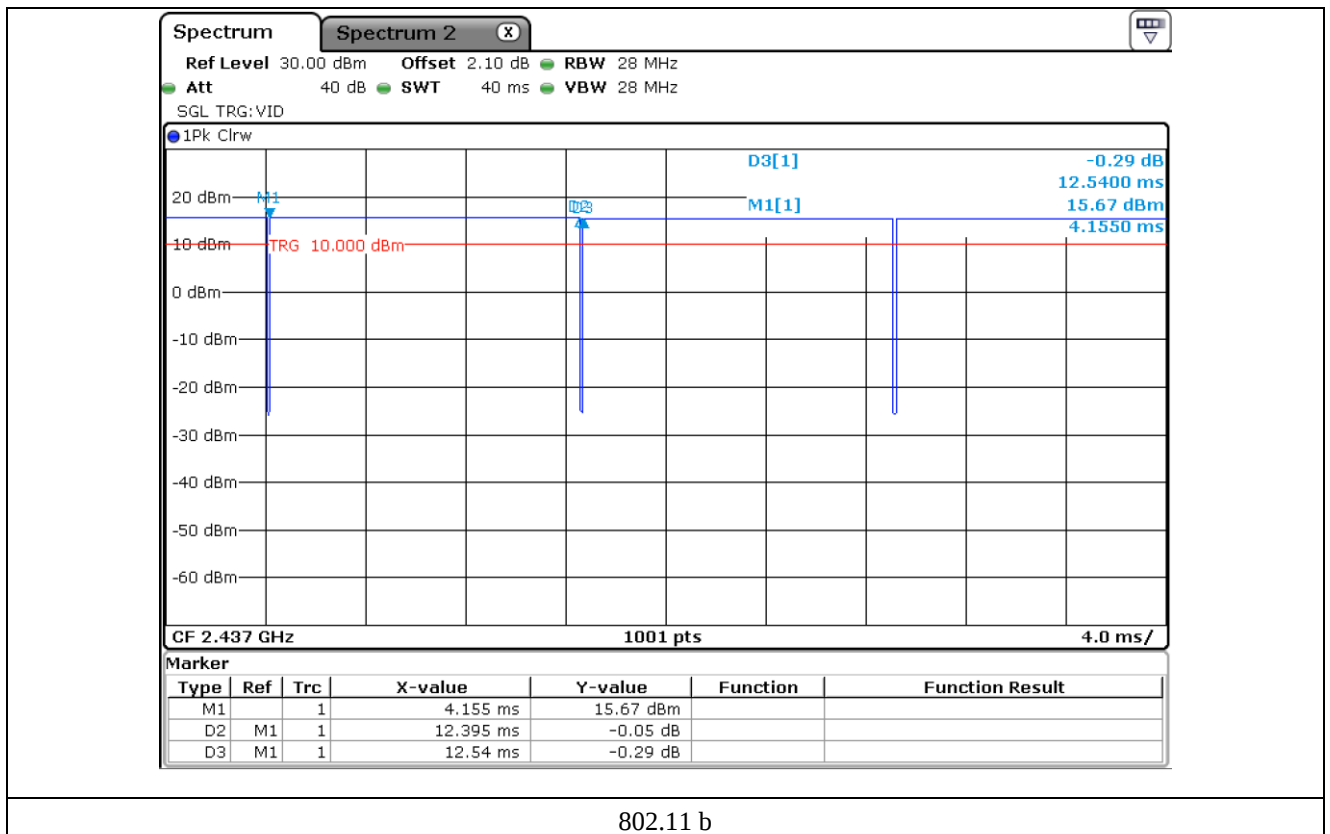
-. Duty Cycle

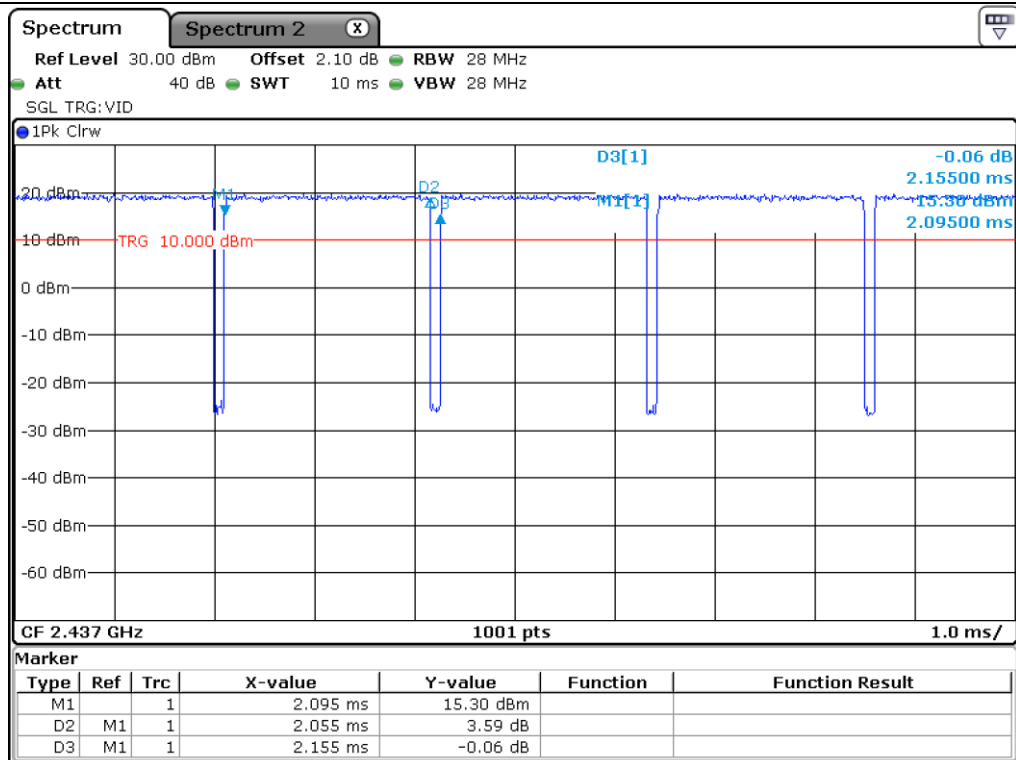
Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
802.11 b	12.395	0.145	98.84	0.05
802.11 g	2.055	0.100	95.36	0.21
802.11 HT 20	1.920	0.095	95.31	0.21

Note – Duty Cycle : (Tx On Time / (Tx On Time + Tx Off Time)) * 100

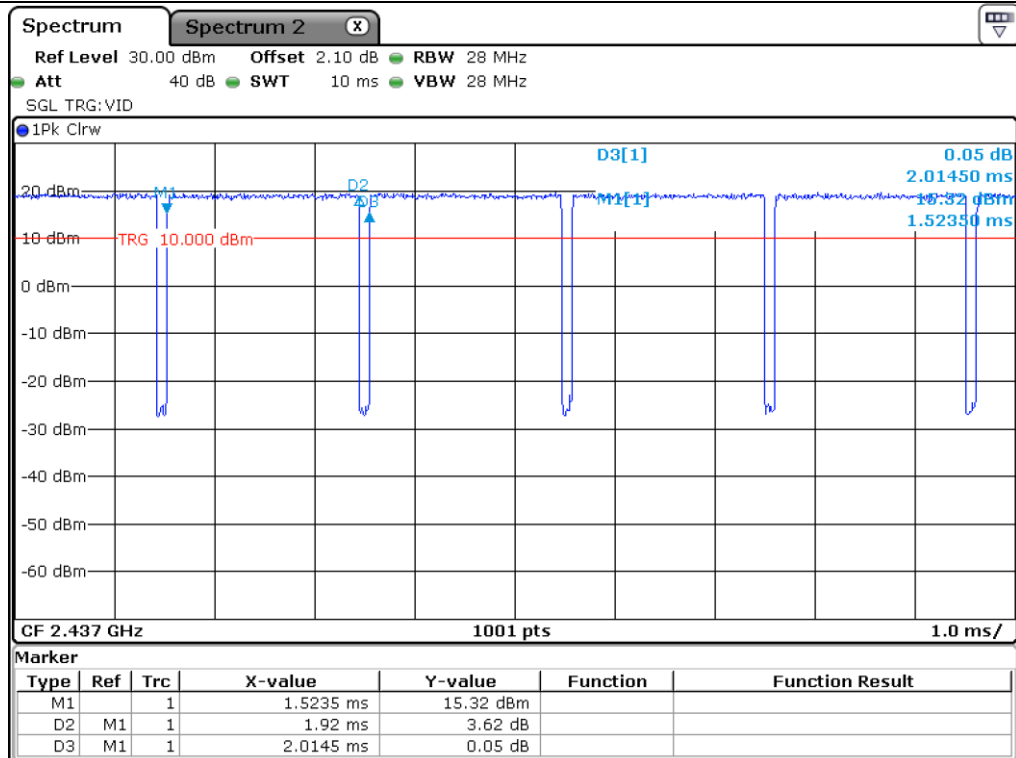
Correction Factor : 10 * Log(1 / (Duty Cycle / 100))

-. Test Plot





802.11 g



802.11 HT 20

5.4 Configuration of Test System

Line Conducted Test: It is not need to test this requirement, because the EUT shall be operated by DC Power.

Radiated Emission Test: Preliminary radiated emissions test were conducted using the procedure in ANSI C63.10: 2020 to determine the worse operating conditions. Final radiated emission tests were conducted at 3 meter Semi Anechoic Chamber.

The turntable was rotated through 360 degrees and the EUT was tested by positioned three orthogonal planes to obtain the highest reading on the field strength meter. Once maximum reading was determined, the search antenna was raised and lowered in both vertical and horizontal polarization.

5.5 Antenna Requirement

For intentional device, according to section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Antenna Construction:

The antenna of the EUT is a PCB Antenna on the main board in the EUT and a PCB antenna connected to the outside of the EUT by a special connector type, so no consideration of replacement by the user.

6. PRELIMINARY TEST

6.1 AC Power line Conducted Emissions Tests

During Preliminary Test, the following operating mode was investigated.

Operation Mode	The Worse operating condition (Please check one only)
It is not need to test this requirement, because the power of the EUT is supplied by DC Power.	

6.2 General Radiated Emissions Tests

During Preliminary Test, the following operating mode was investigated.

Operation Mode	The Worse operating condition (Please check one only)
Transmitting Mode	X

7. MINIMUM 6 dB BANDWIDTH

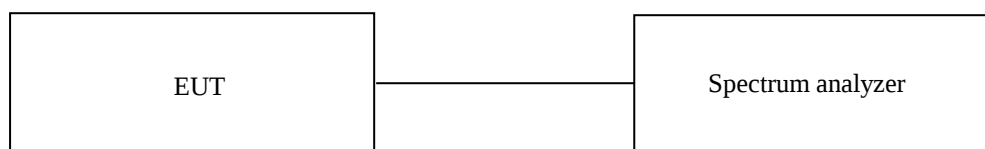
7.1 Operating environment

Temperature : 23 °C

Relative humidity : 41 % R.H.

7.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 100 kHz, and peak detection was used. The 6 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 6 dB.



7.3 Test Date

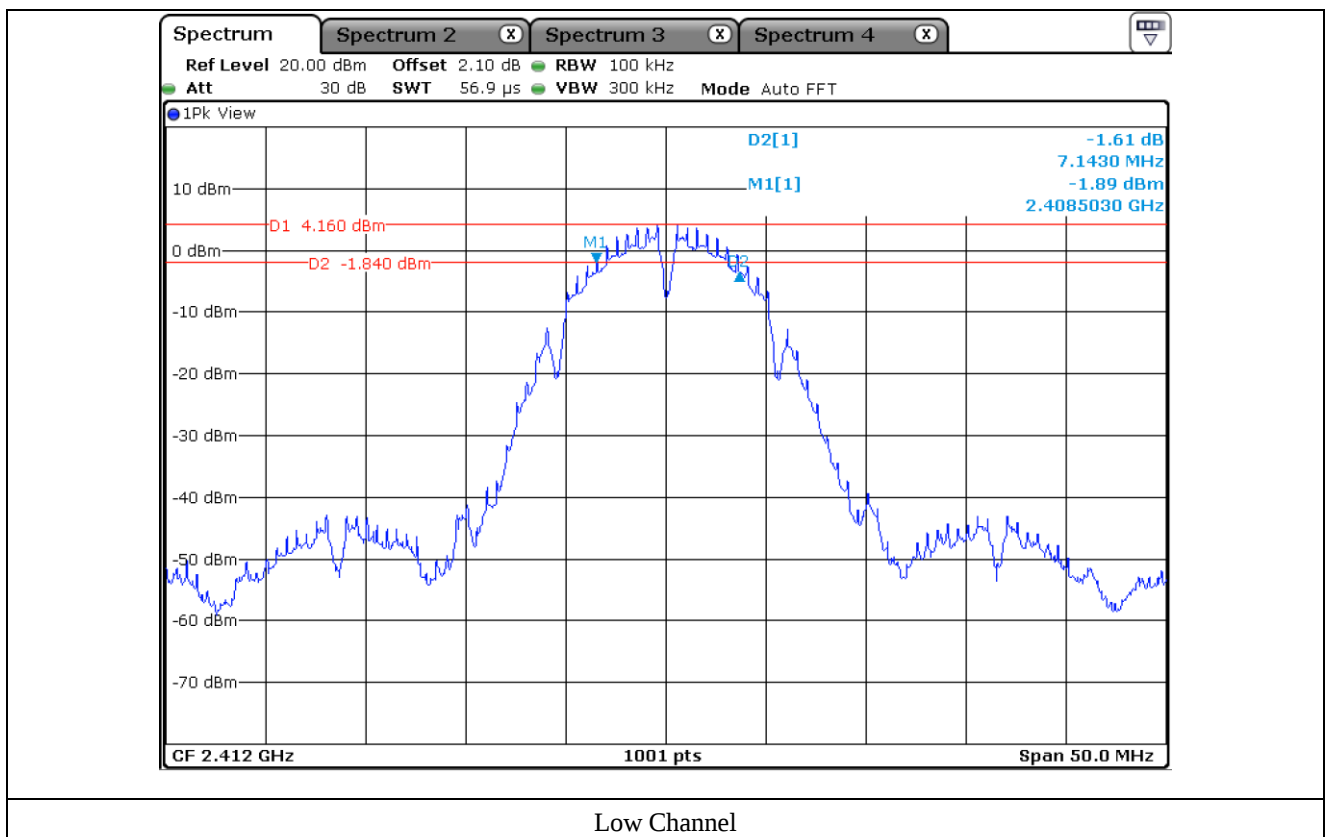
November 25, 2021 ~ January 18, 2022

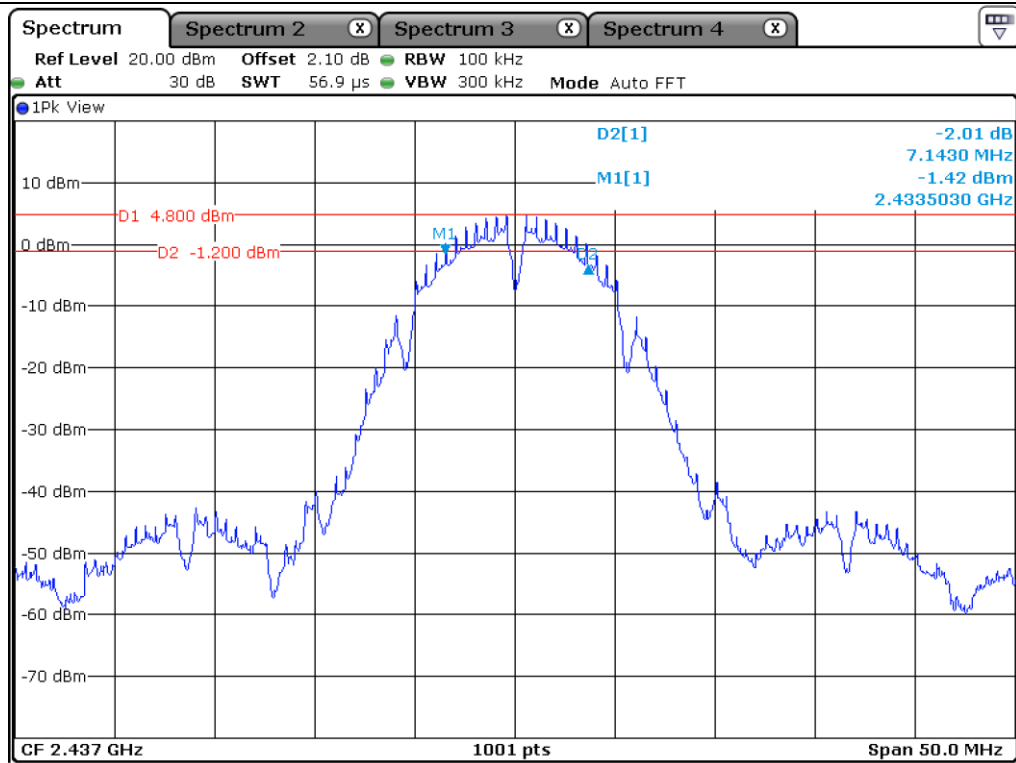
7.4 Test data for 802.11b WLAN Mode

-. Test Result : Pass

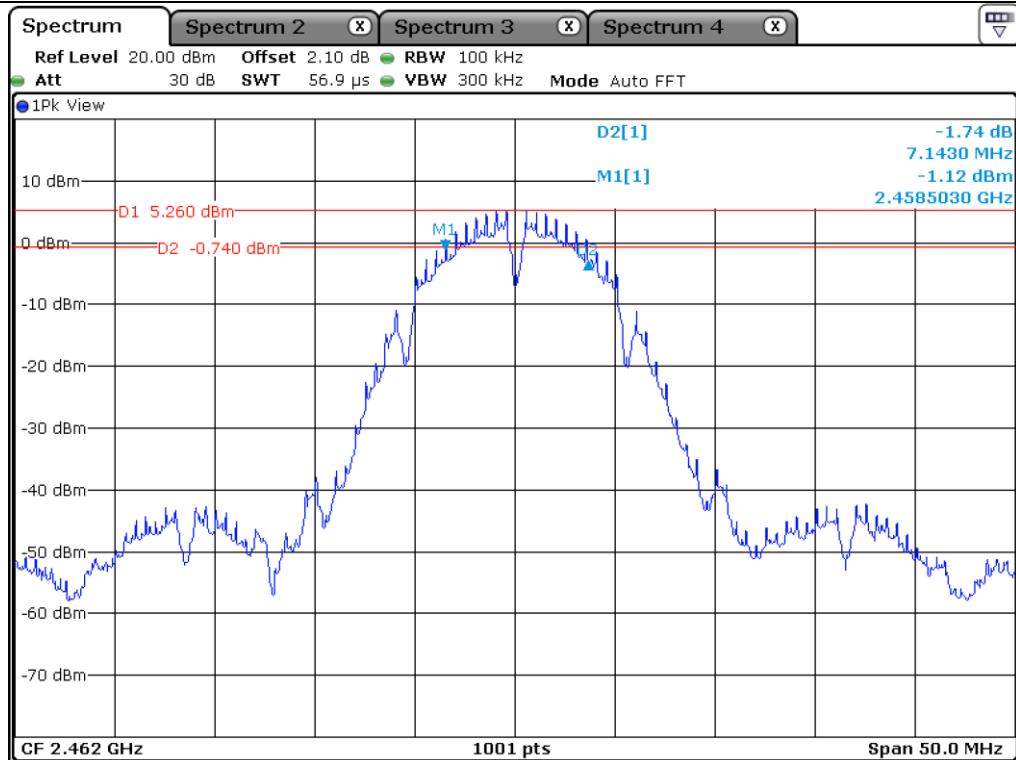
CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412.00	7.14	0.50	6.64
Middle	2 437.00	7.14	0.50	6.64
High	2 462.00	7.14	0.50	6.64

Remark. Margin = Measured Value - Limit





Middle Channel



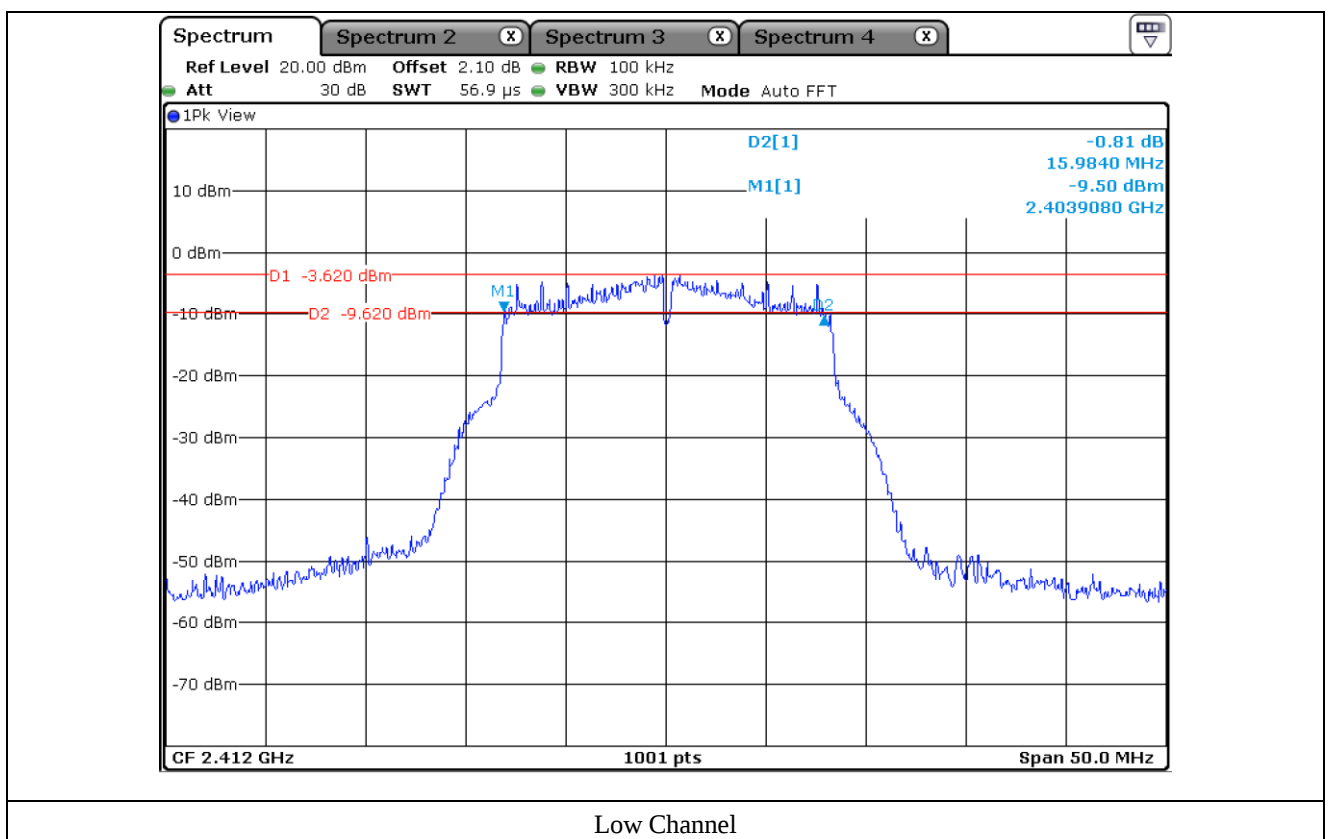
High Channel

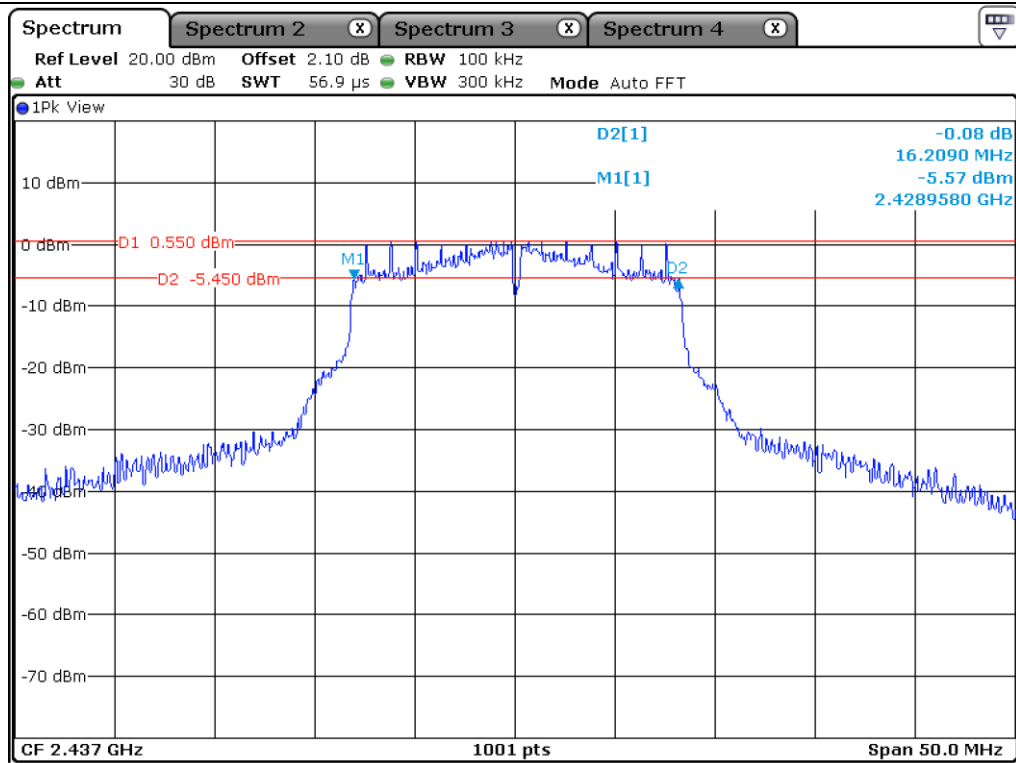
7.5 Test data for 802.11g WLAN Mode

-. Test Result : Pass

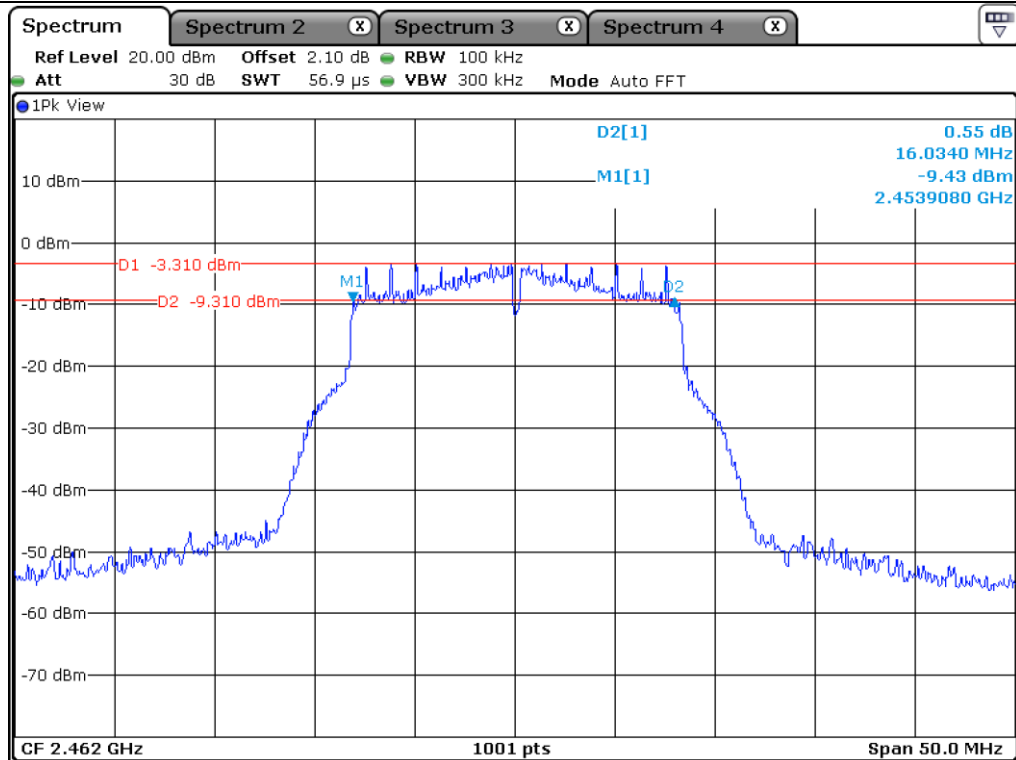
CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412.00	15.98	0.50	15.48
Middle	2 437.00	16.21	0.50	15.71
High	2 462.00	16.03	0.50	15.53

Remark. Margin = Measured Value - Limit





Middle Channel



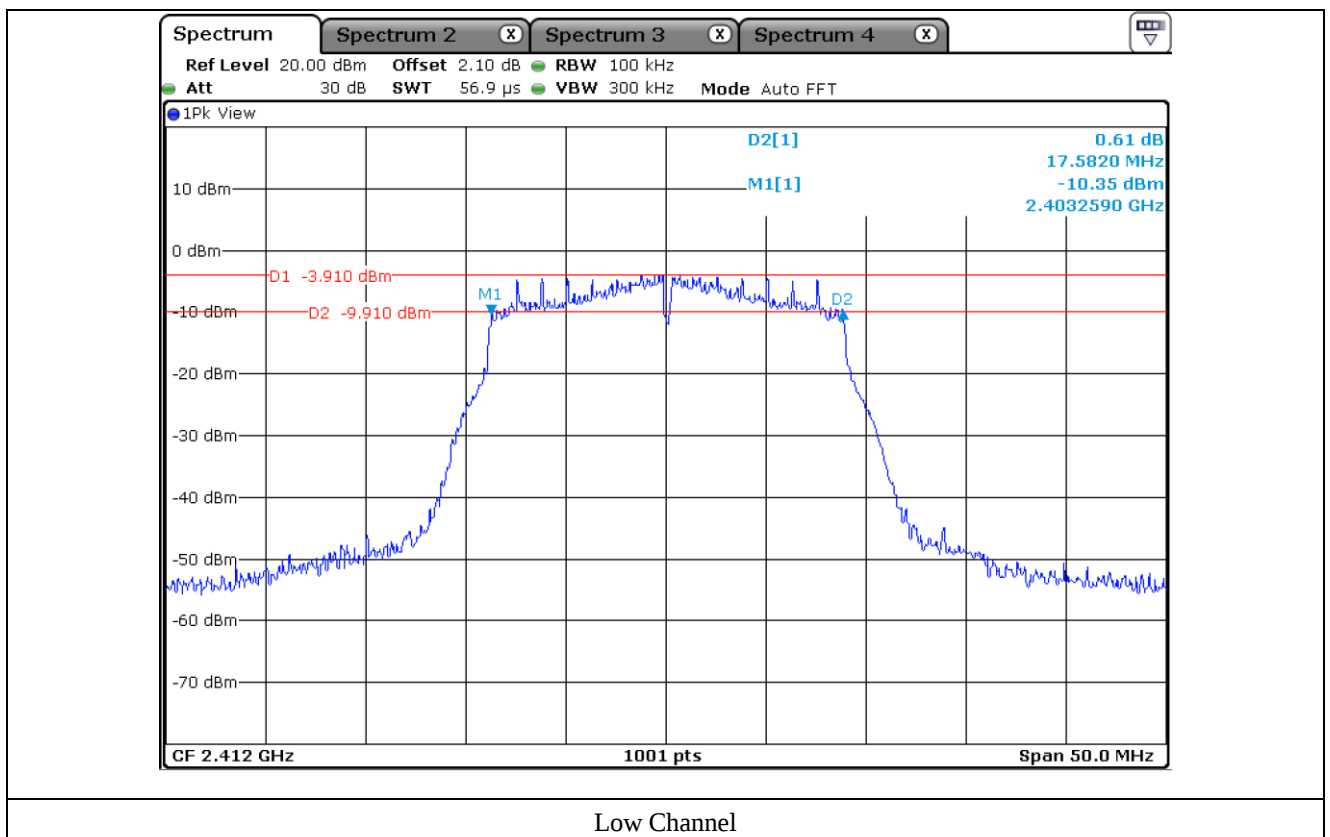
High Channel

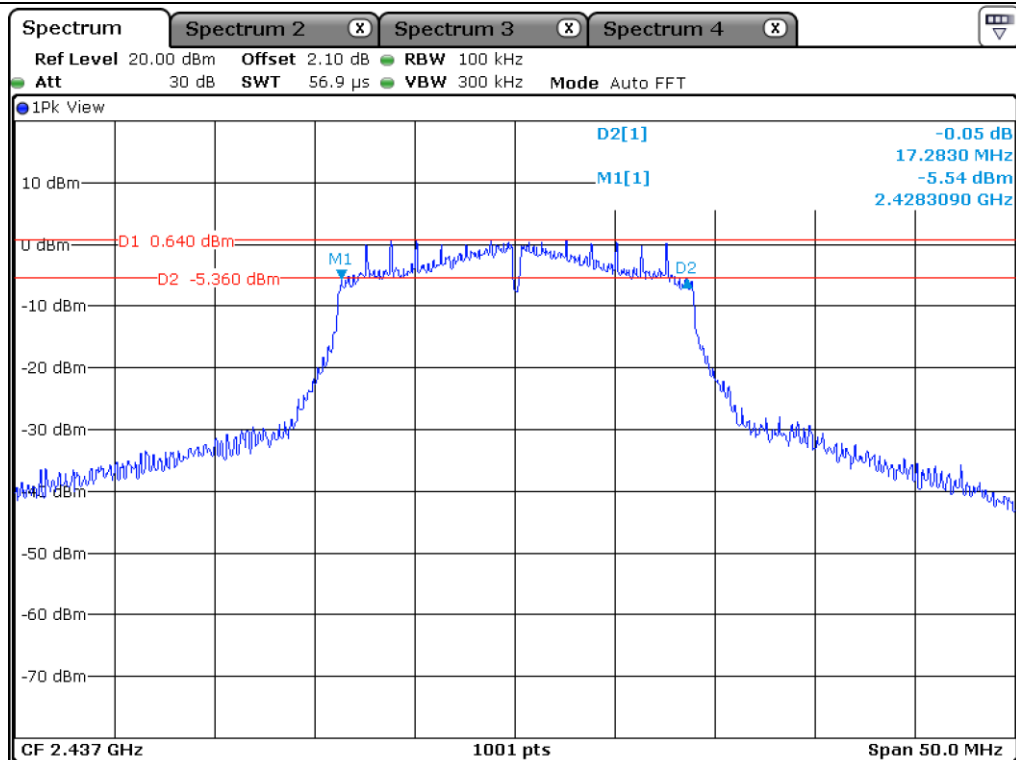
7.6 Test data for 802.11n_HT20 WLAN Mode

-. Test Result : Pass

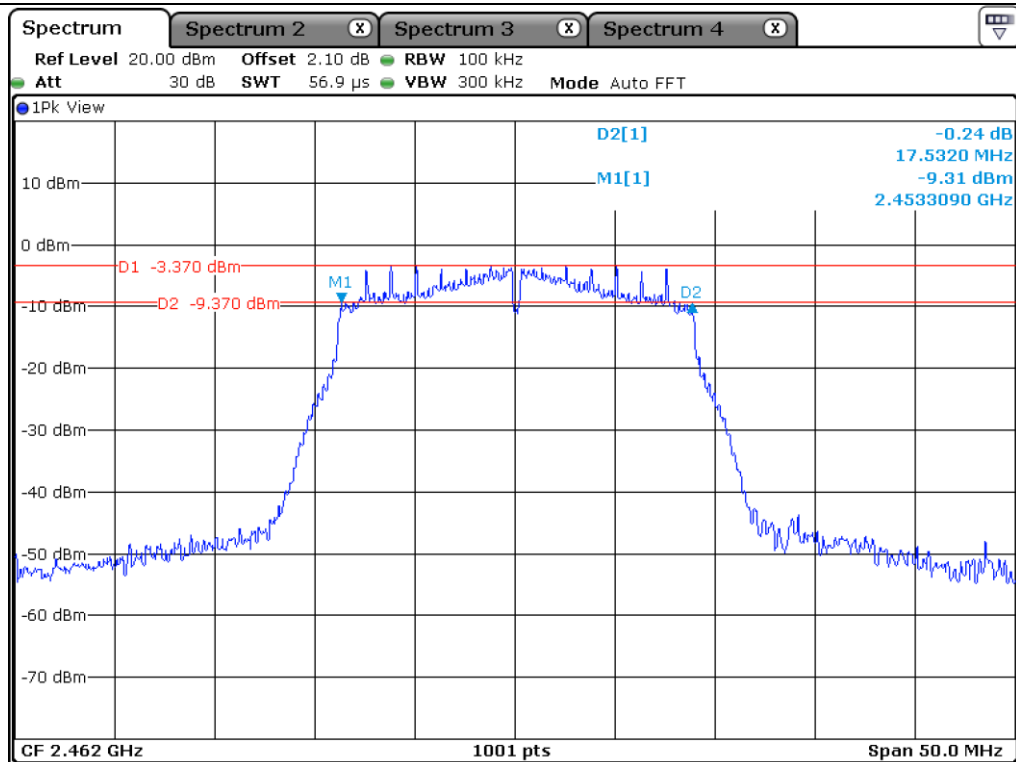
CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412.00	17.58	0.50	17.08
Middle	2 437.00	17.28	0.50	16.78
High	2 462.00	17.53	0.50	17.03

Remark. Margin = Measured Value - Limit





Middle Channel



High Channel

8. MAXIMUM PEAK OUTPUT POWER

8.1 Operating environment

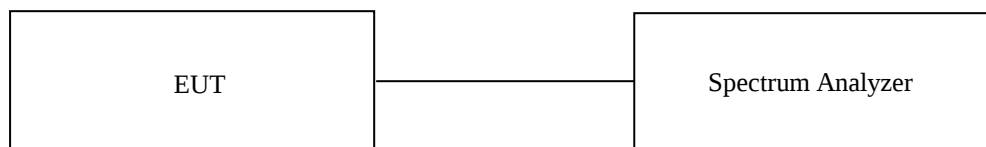
Temperature : 23 °C

Relative humidity : 41 % R.H.

8.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer.

The resolution bandwidth is set to 1 MHz, the video bandwidth is set to 3 times the resolution bandwidth.



8.3 Test Date

November 25, 2021 ~ January 18, 2022

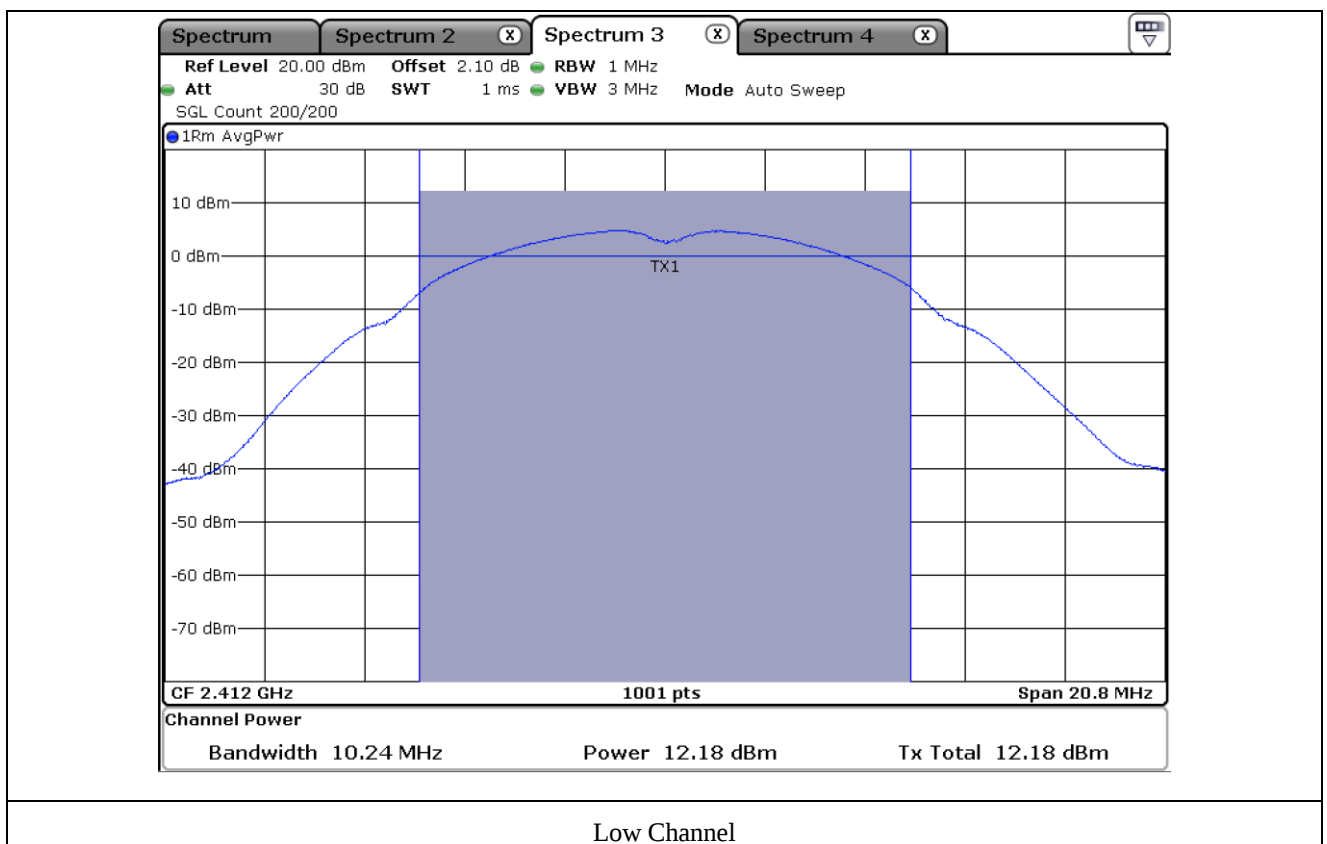
8.4 Test data for 802.11b WLAN Mode

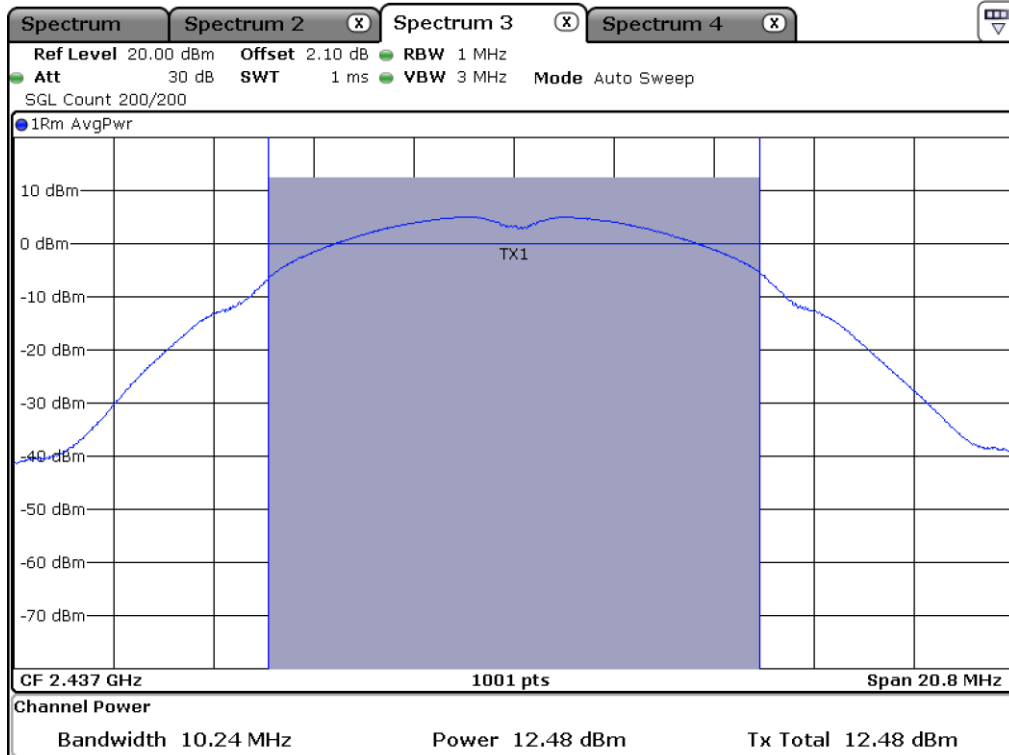
-. Test Result : Pass

-. Duty Cycle : 98.84 %

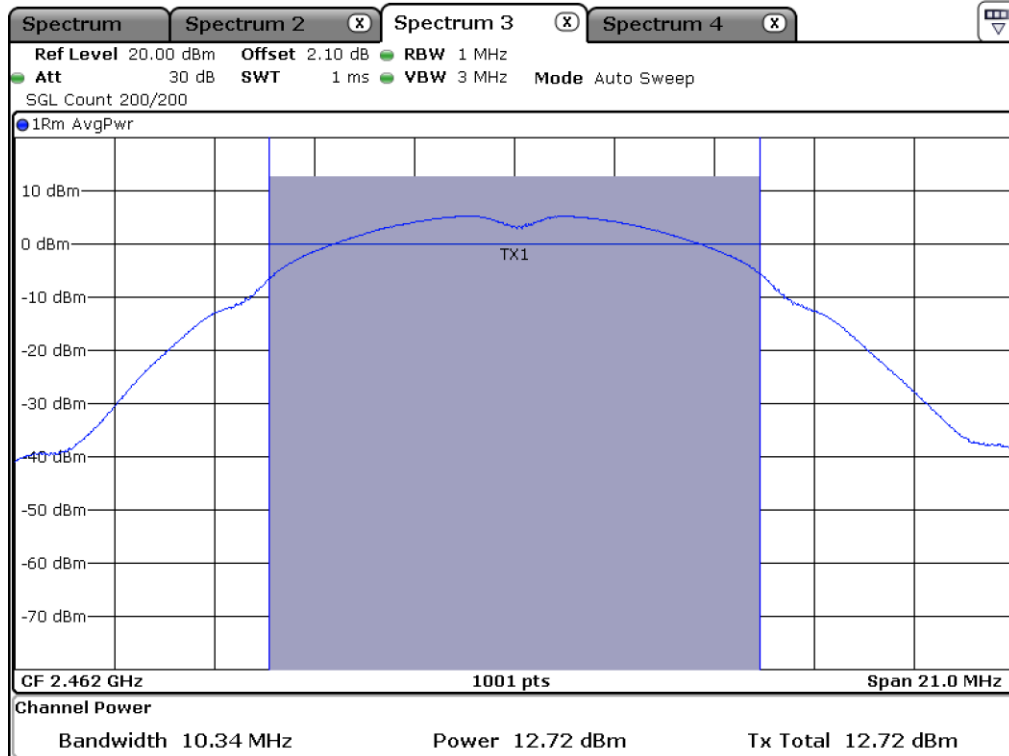
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	C.F (dB)	RESULT (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	12.18	0.05	12.23	30.00	17.77
MIDDLE	2 437.00	12.48	0.05	12.53	30.00	17.47
HIGH	2 462.00	12.72	0.05	12.77	30.00	17.23

Remark. Margin = Limit – Result (=Measured Value + C.F.)





Middle Channel



High Channel

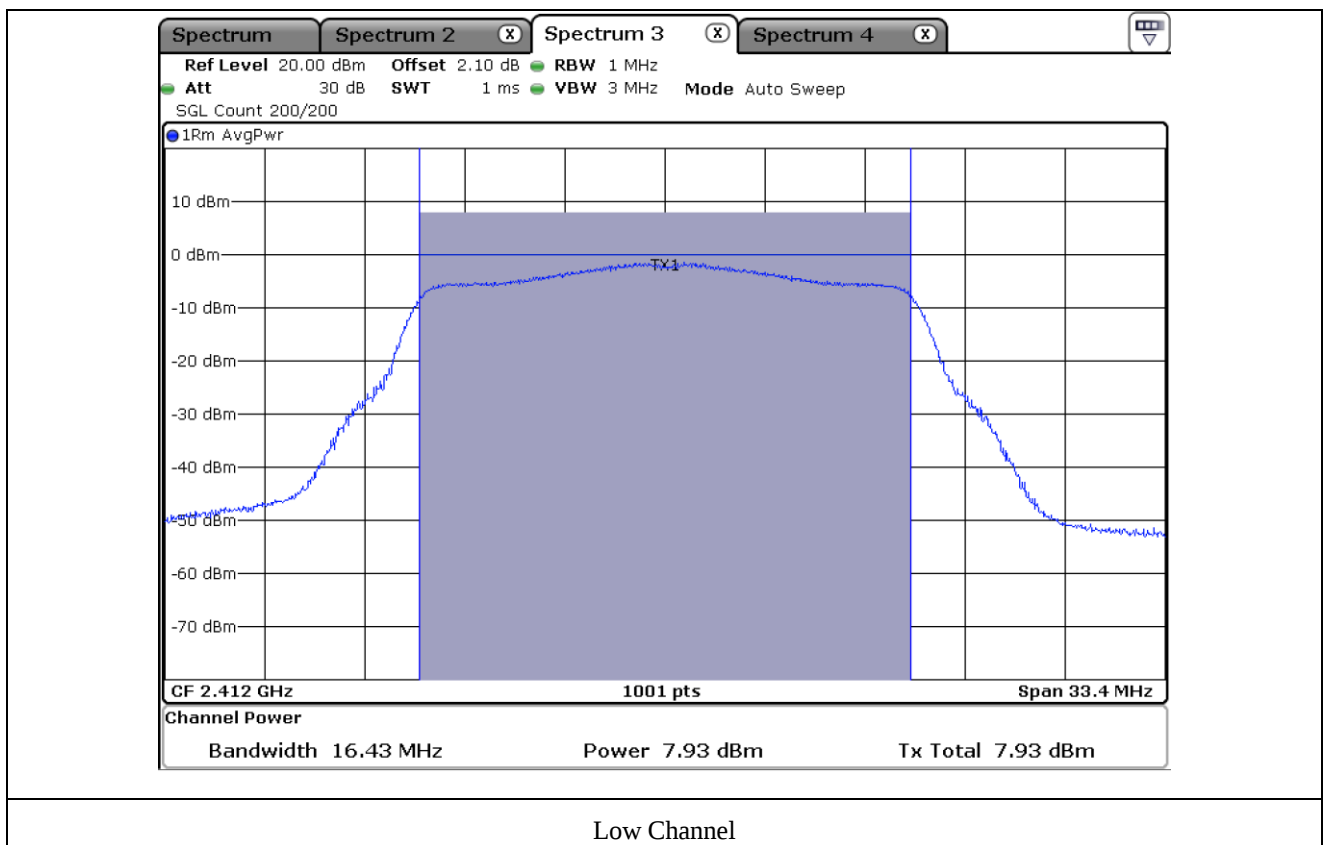
8.5 Test data for 802.11g WLAN Mode

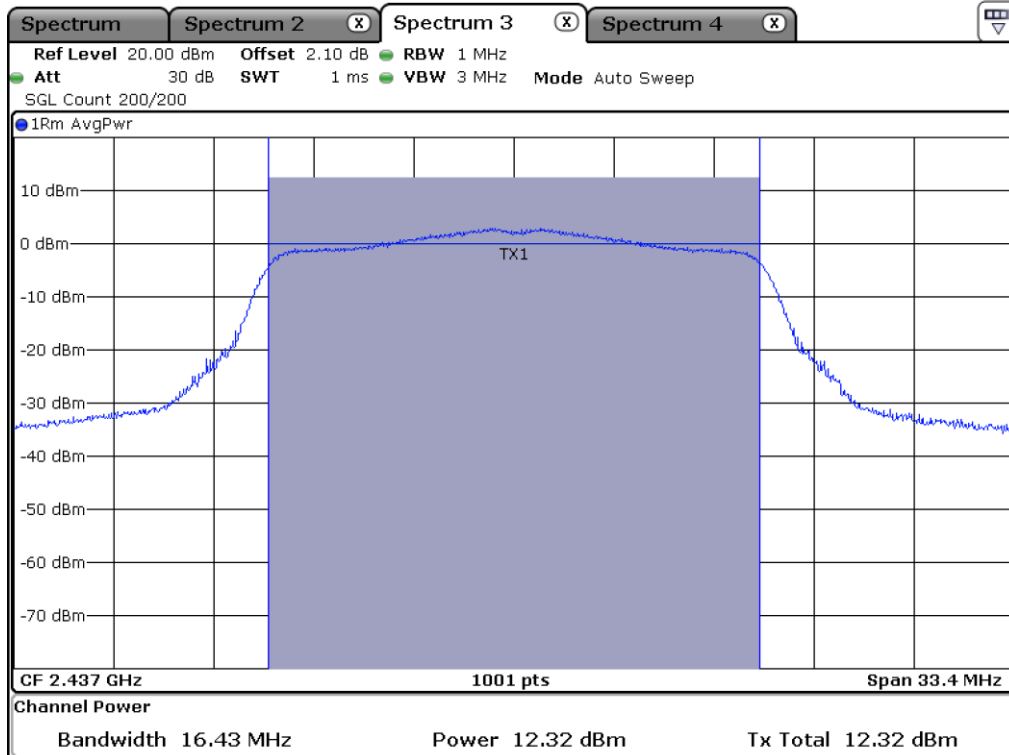
-. Test Result : Pass

-. Duty Cycle : 95.36 %

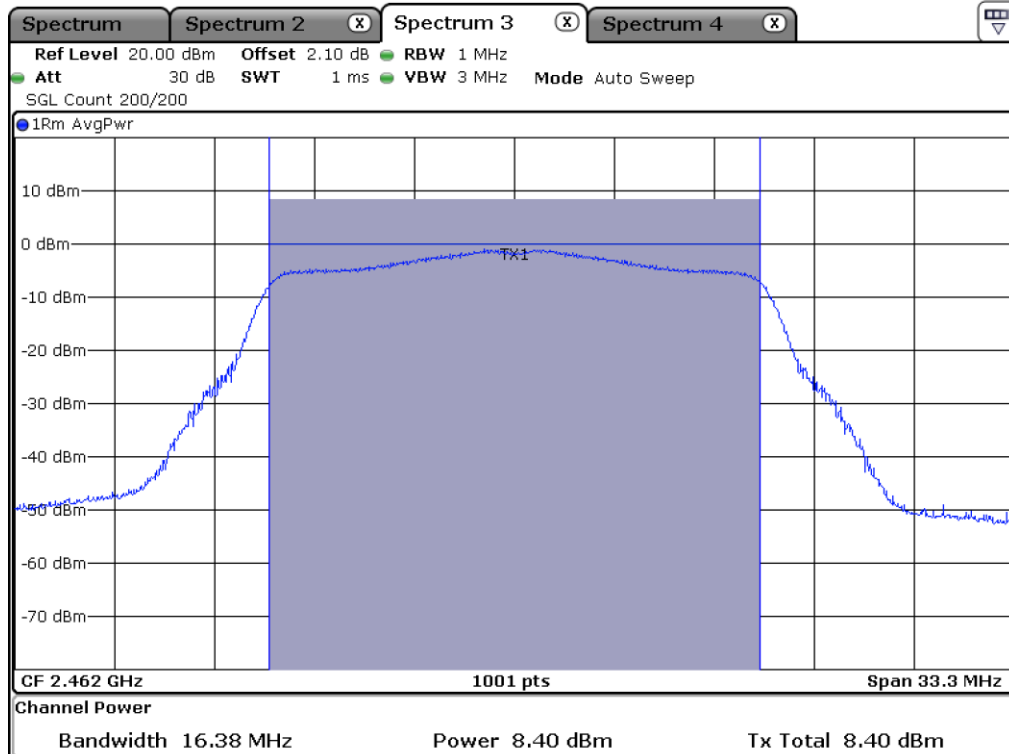
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	C.F (dB)	RESULT (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	7.93	0.21	8.14	30.00	21.86
MIDDLE	2 437.00	12.32	0.21	12.53	30.00	17.47
HIGH	2 462.00	8.40	0.21	8.61	30.00	21.39

Remark. Margin = Limit – Result (=Measured Value + C.F.)





Middle Channel



High Channel

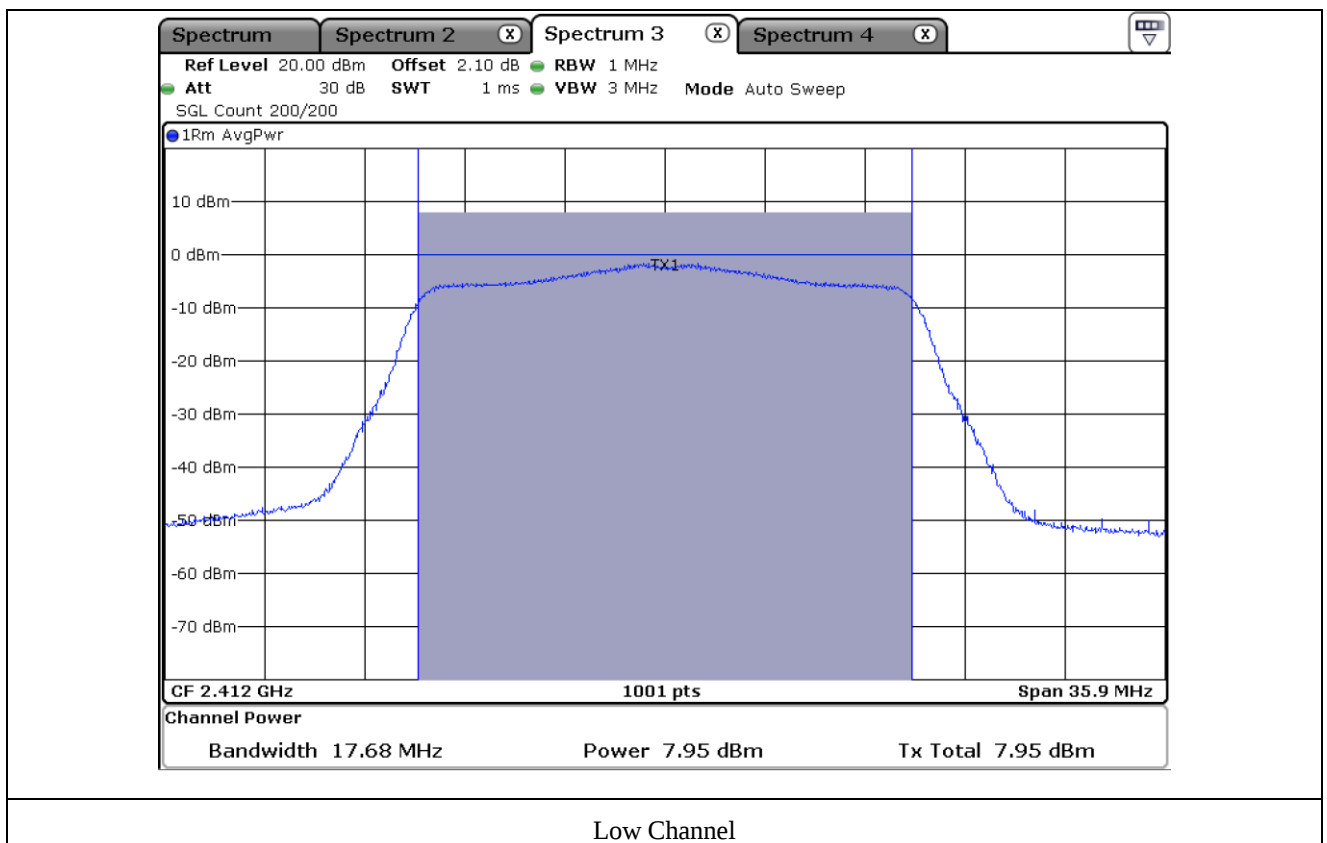
8.6 Test data for 802.11n_HT20 WLAN Mode

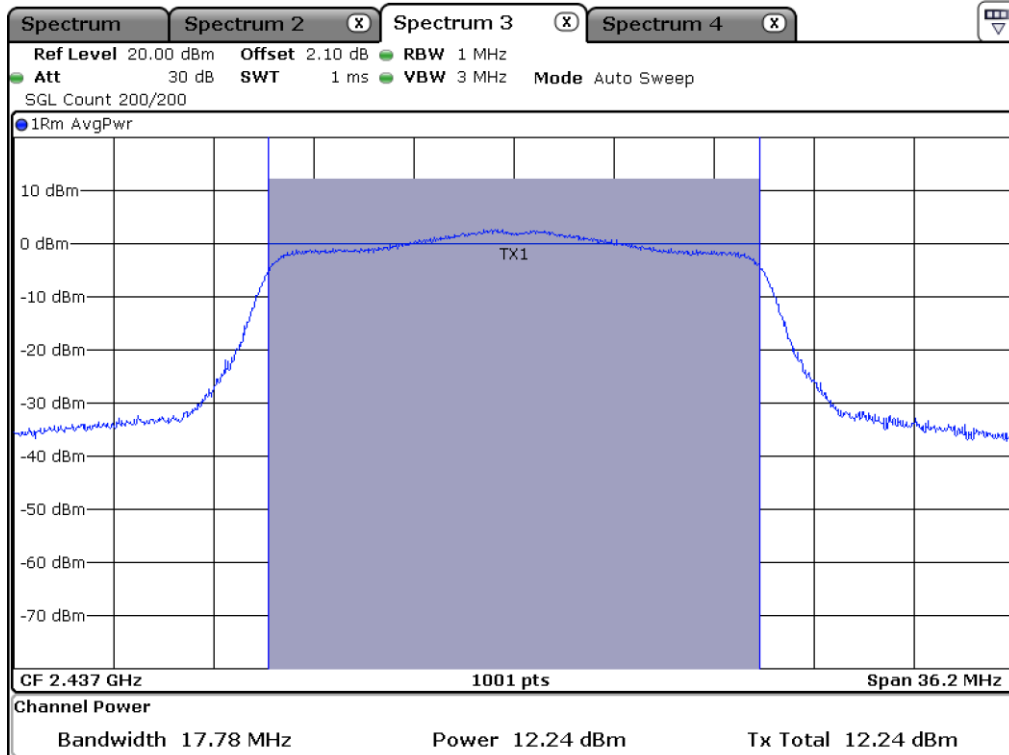
-. Test Result : Pass

-. Duty Cycle : 95.31 %

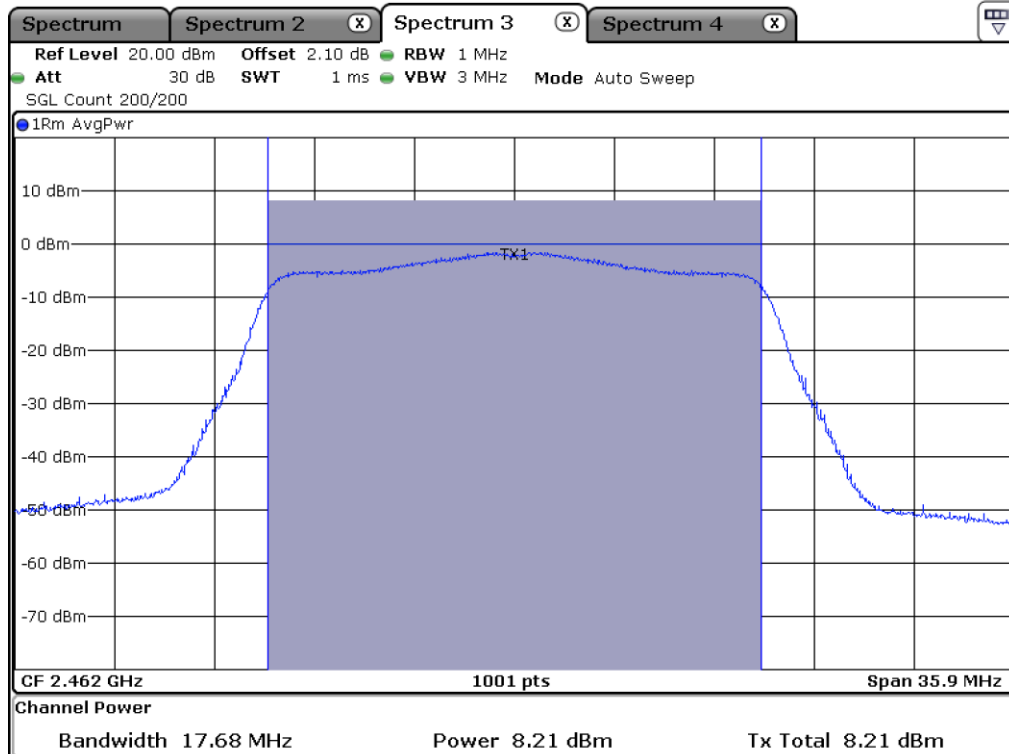
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	C.F (dB)	RESULT (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	7.95	0.21	8.16	30.00	21.84
MIDDLE	2 437.00	12.24	0.21	12.45	30.00	17.55
HIGH	2 462.00	8.21	0.21	8.42	30.00	21.58

Remark. Margin = Limit – Result (=Measured Value + C.F.)





Middle Channel



High Channel

9. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

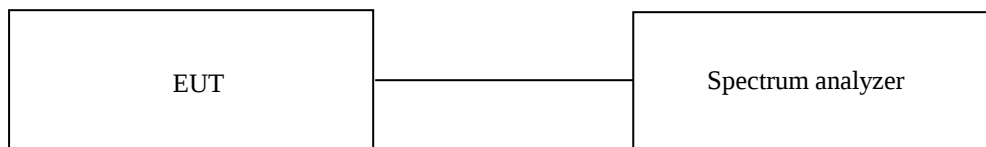
9.1 Operating environment

Temperature : 23 °C

Relative humidity : 41 % R.H.

9.2 Test set-up for conducted measurement

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 100 kHz and video bandwidth is set to 300 kHz, and peak detection was used.



9.3 Test set-up for radiated measurement

The radiated emissions measurements were performed on the 3 m semi anechoic chamber. The EUT was placed on turntable approximately 1.5 m above the ground plane.

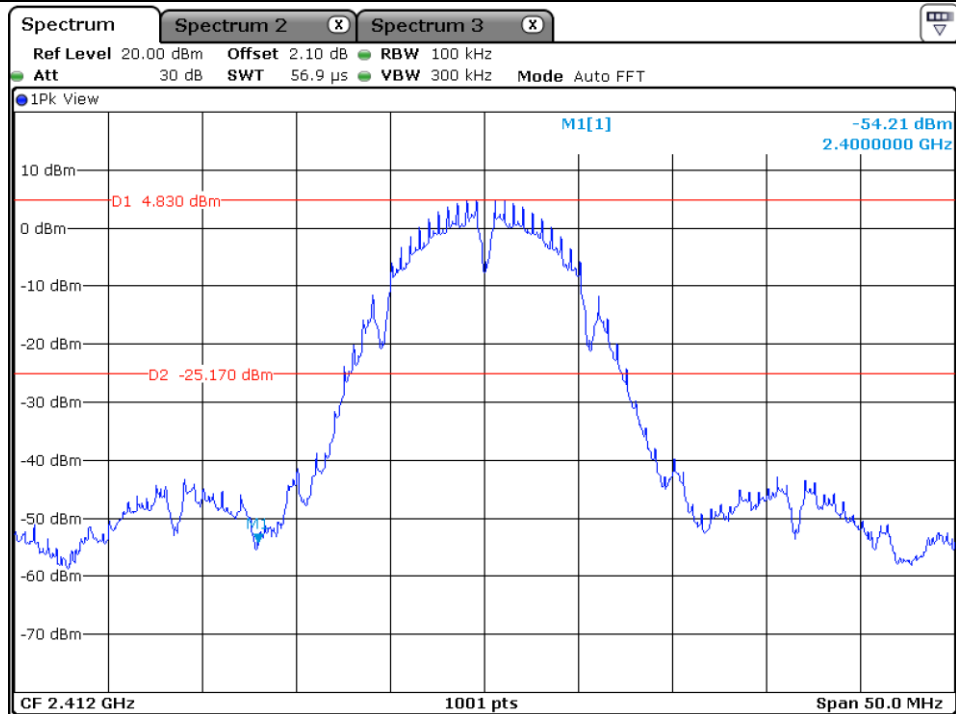
The frequency spectrum from 30 MHz to 26.5 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for horizontal and vertical polarization of the receiving antenna.

9.4 Test Date

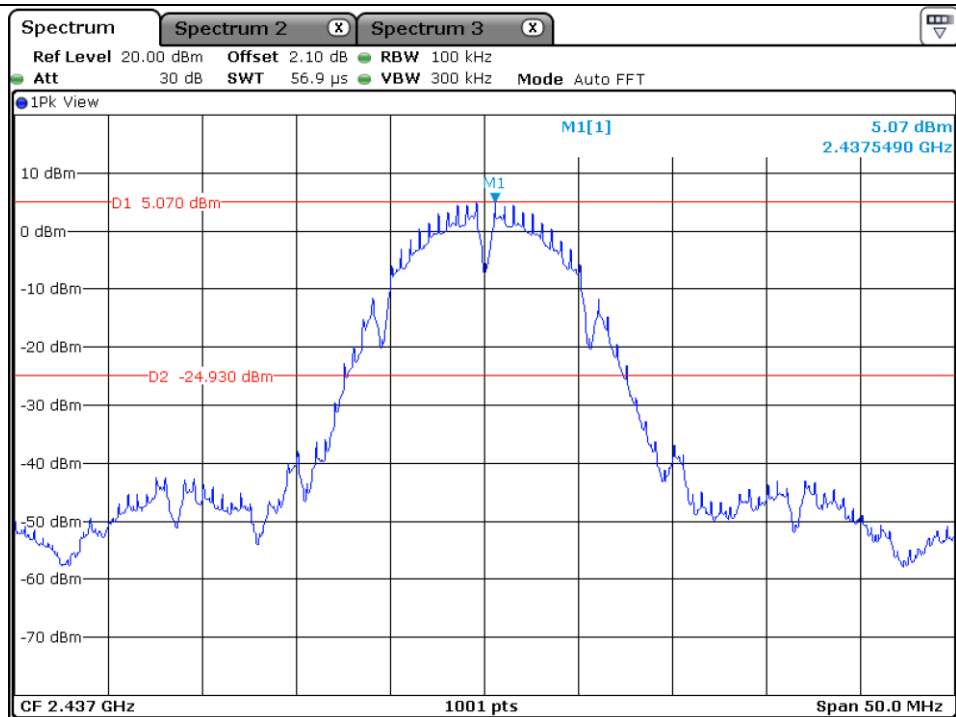
November 25, 2021 ~ January 18, 2022

9.5 Test data for conducted emission

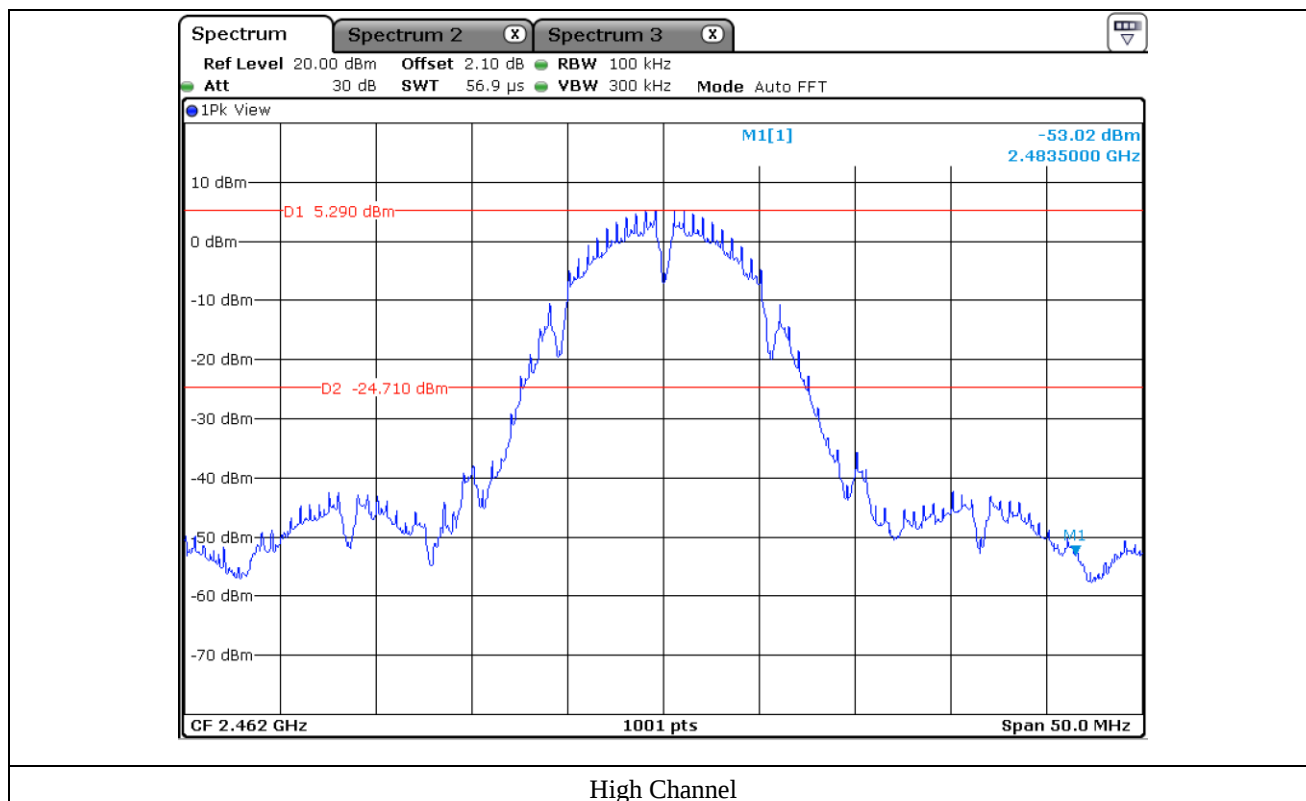
9.5.1 Test data for 802.11b WLAN Mode

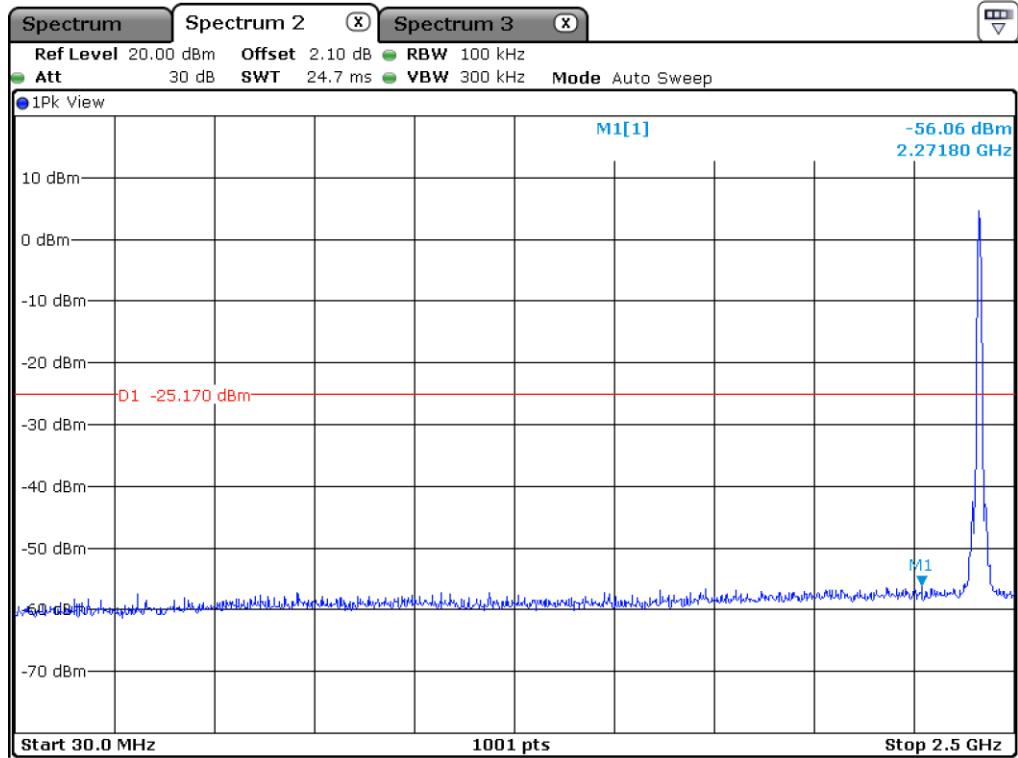


Low Channel

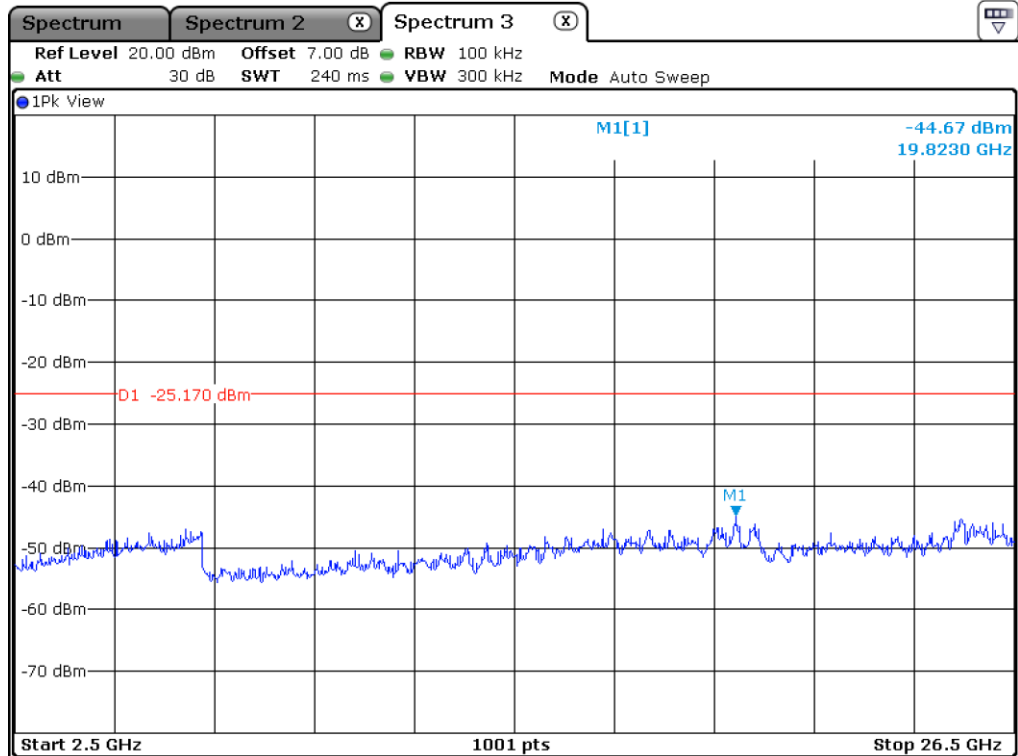


Middle Channel

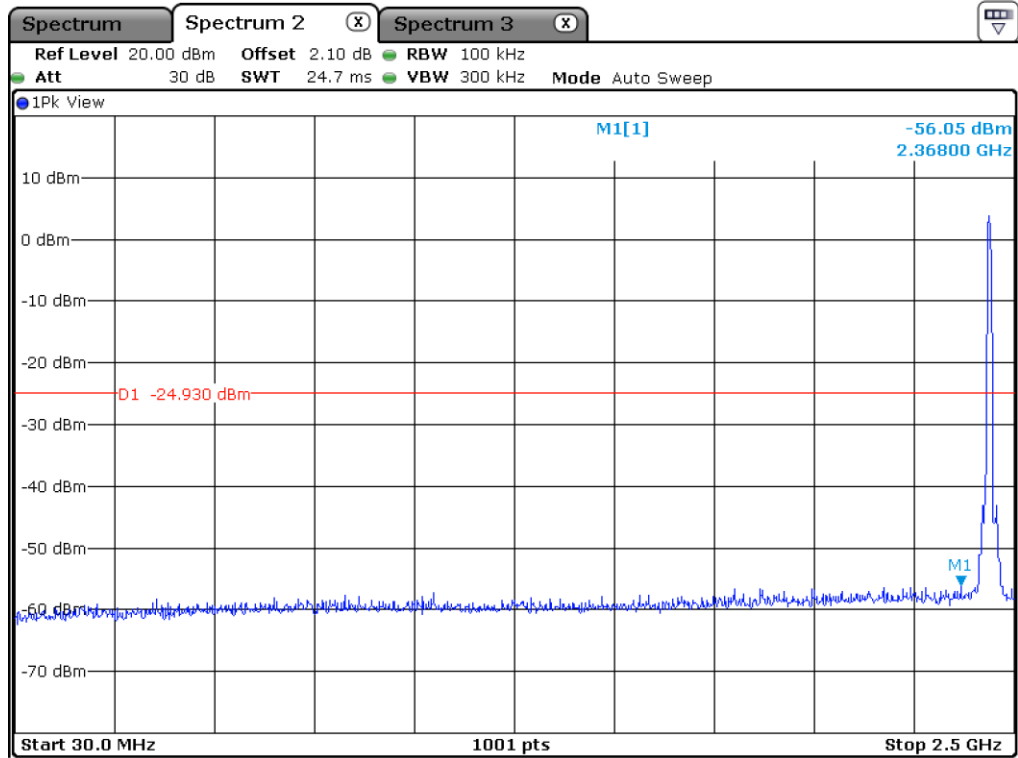




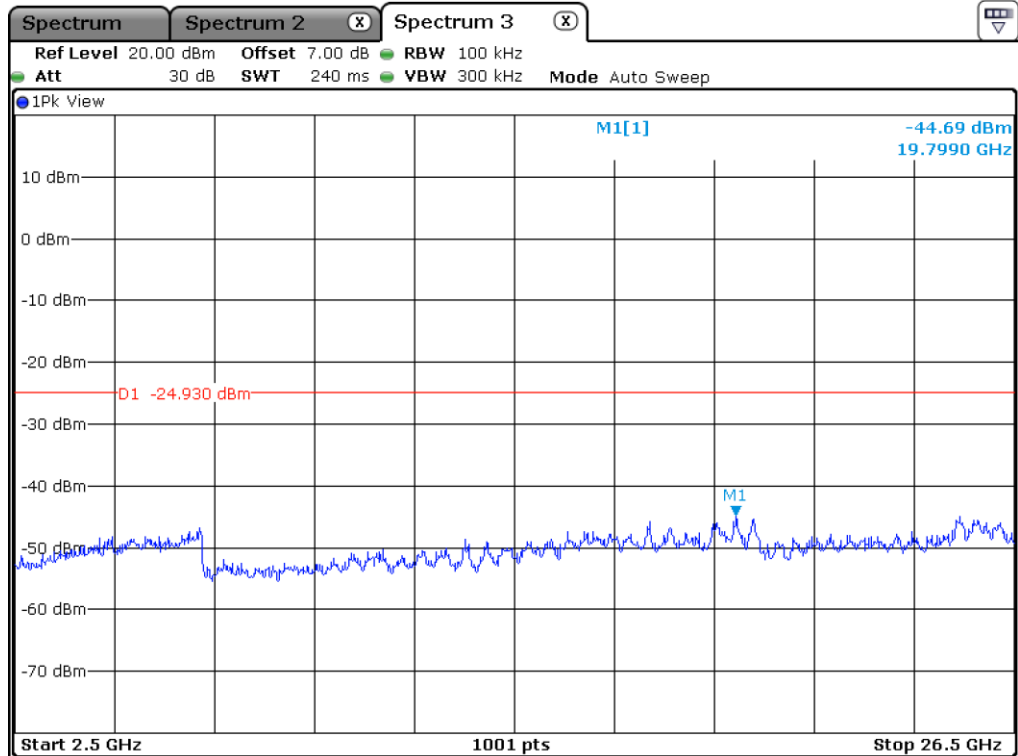
Low Channel



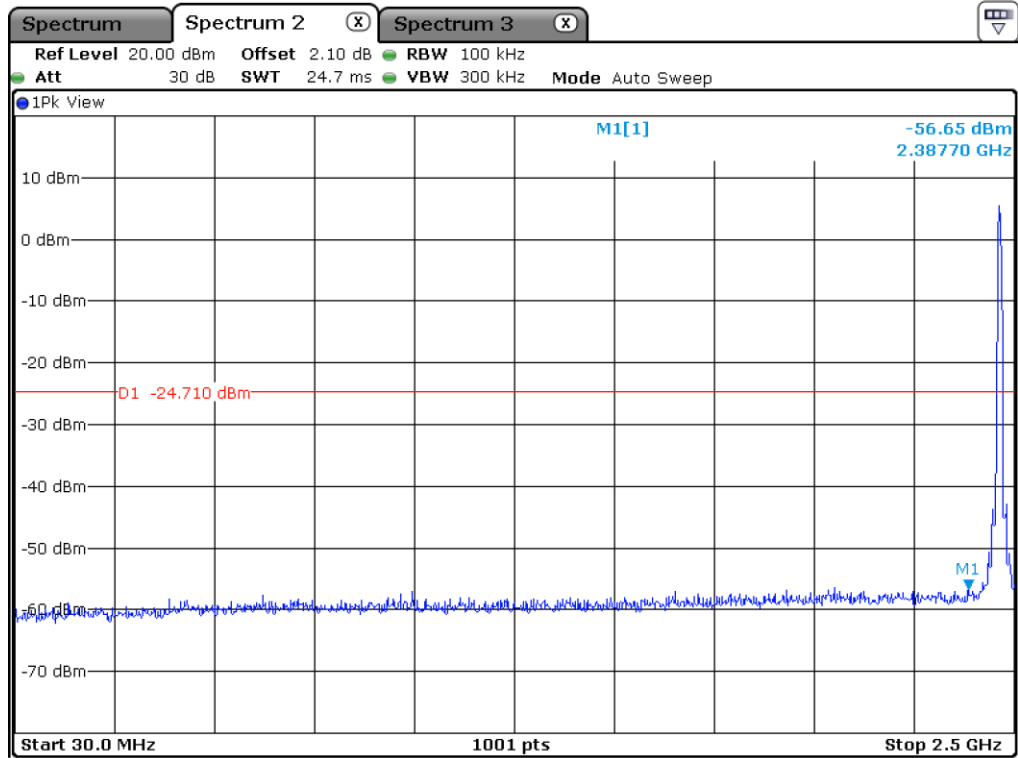
Low Channel



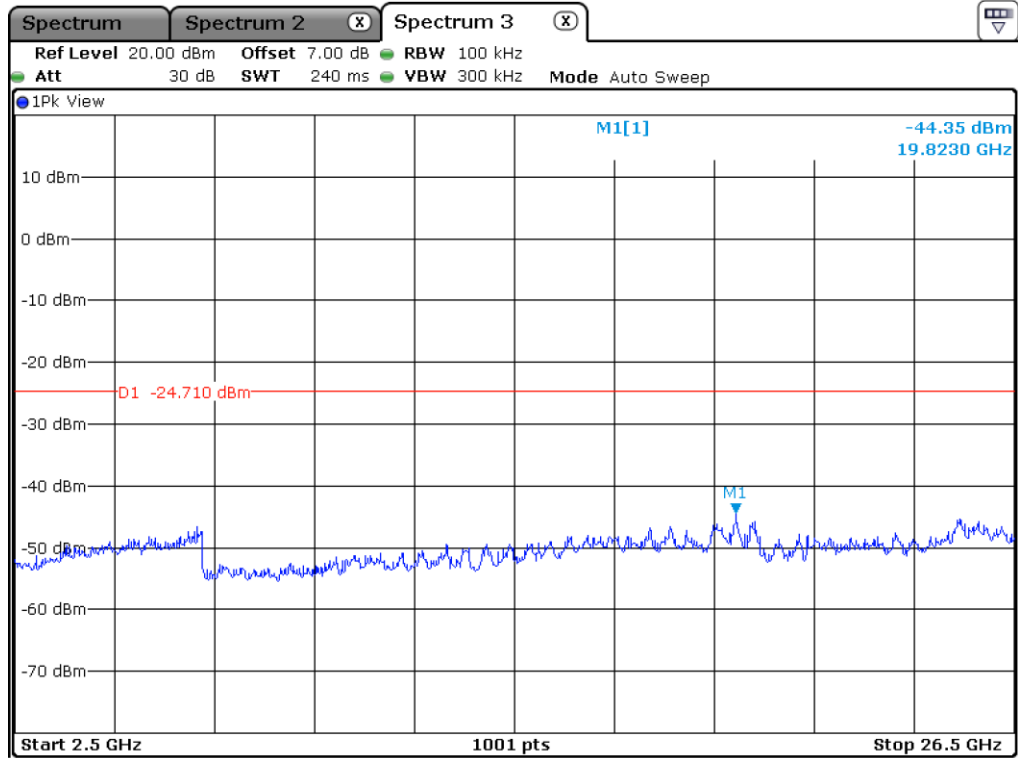
Middle Channel



Middle Channel

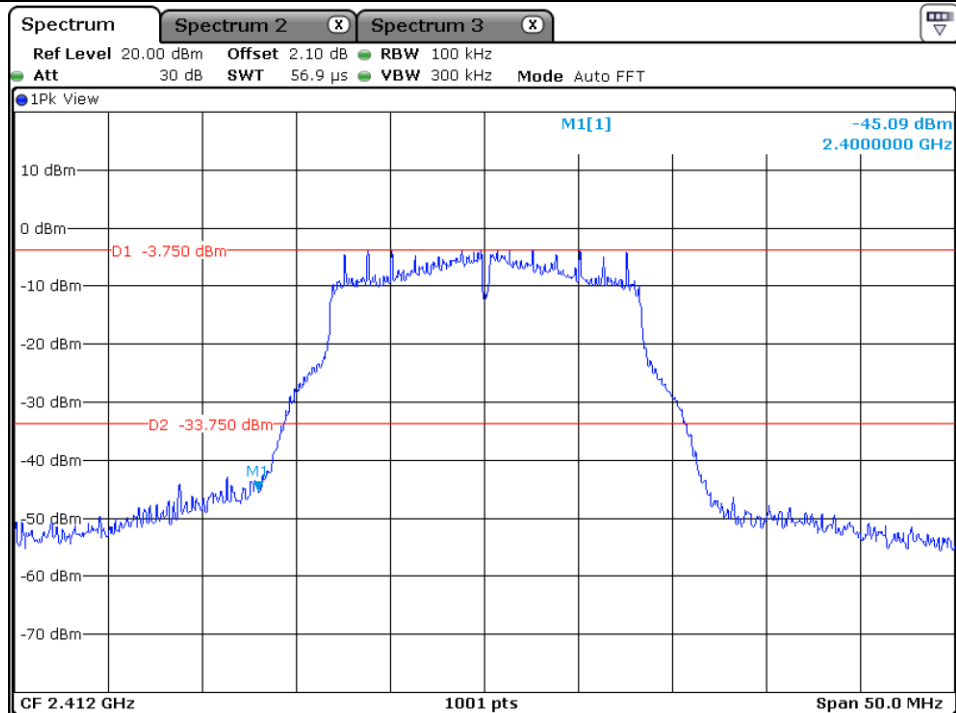


High Channel

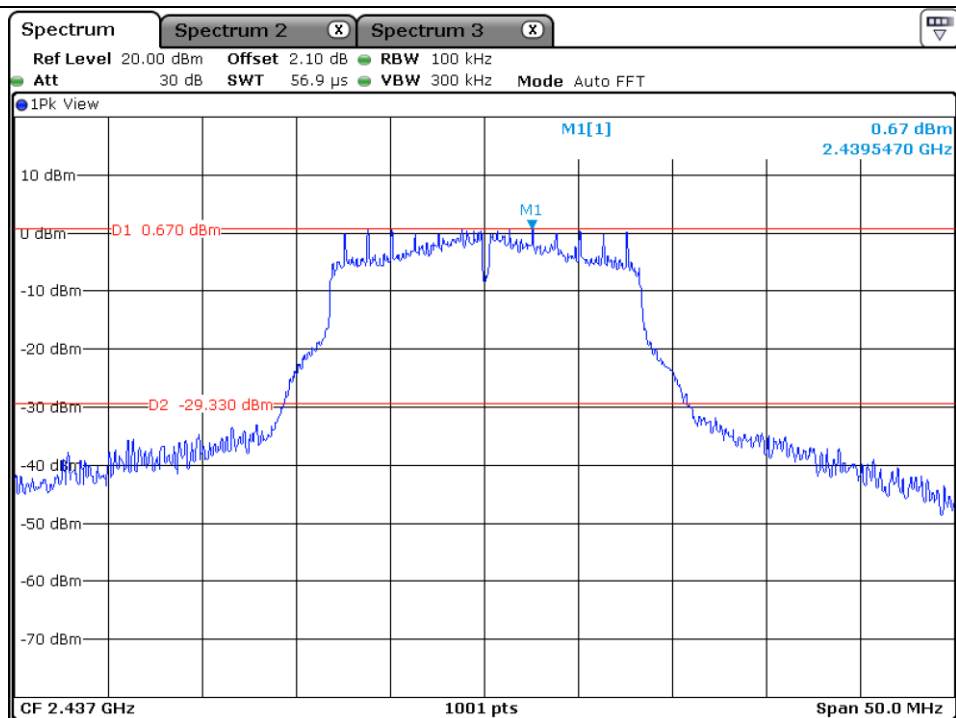


High Channel

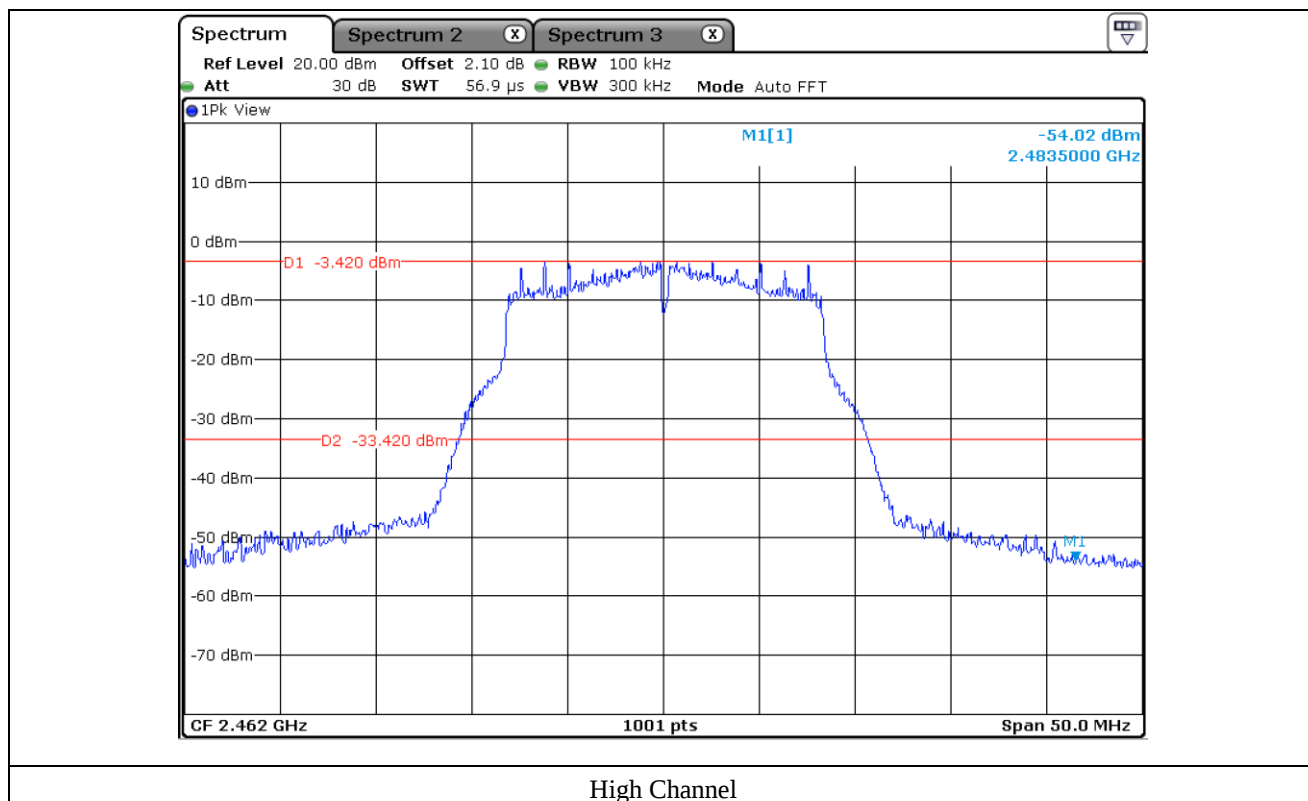
9.5.2 Test data for 802.11g WLAN Mode

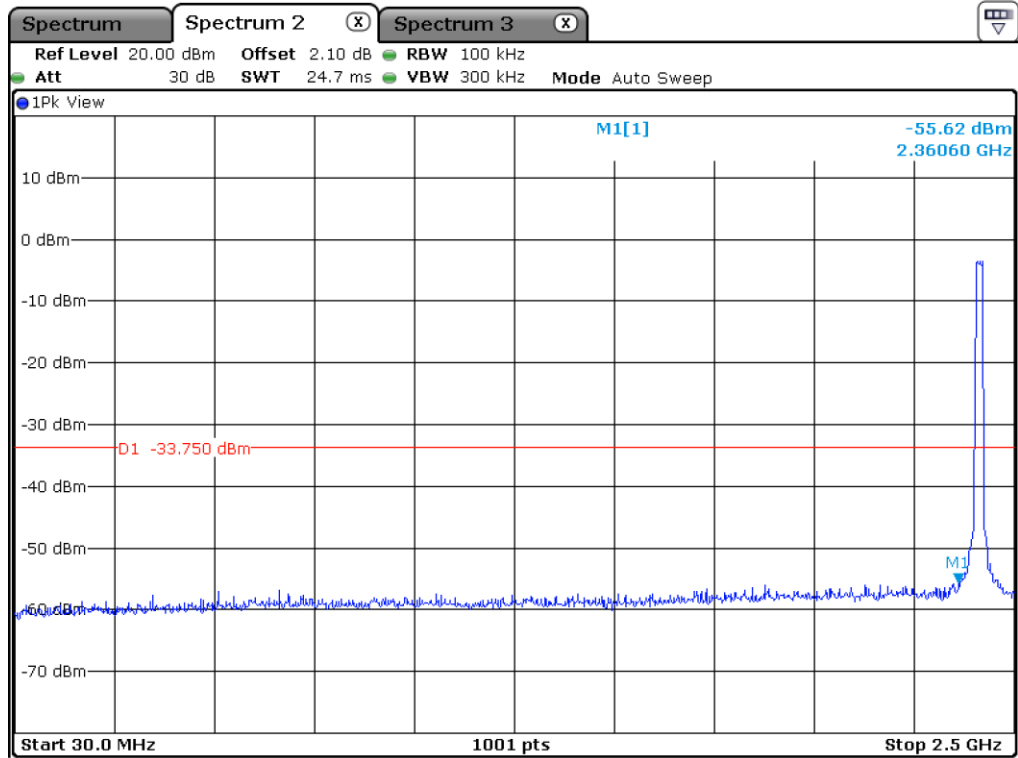


Low Channel

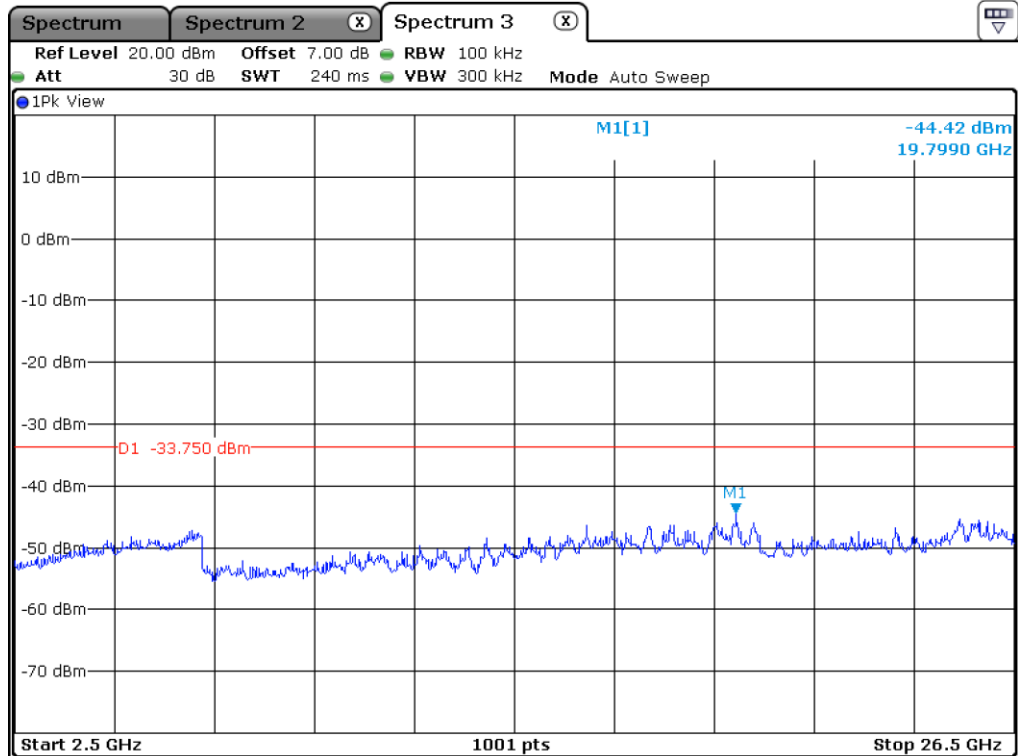


Middle Channel

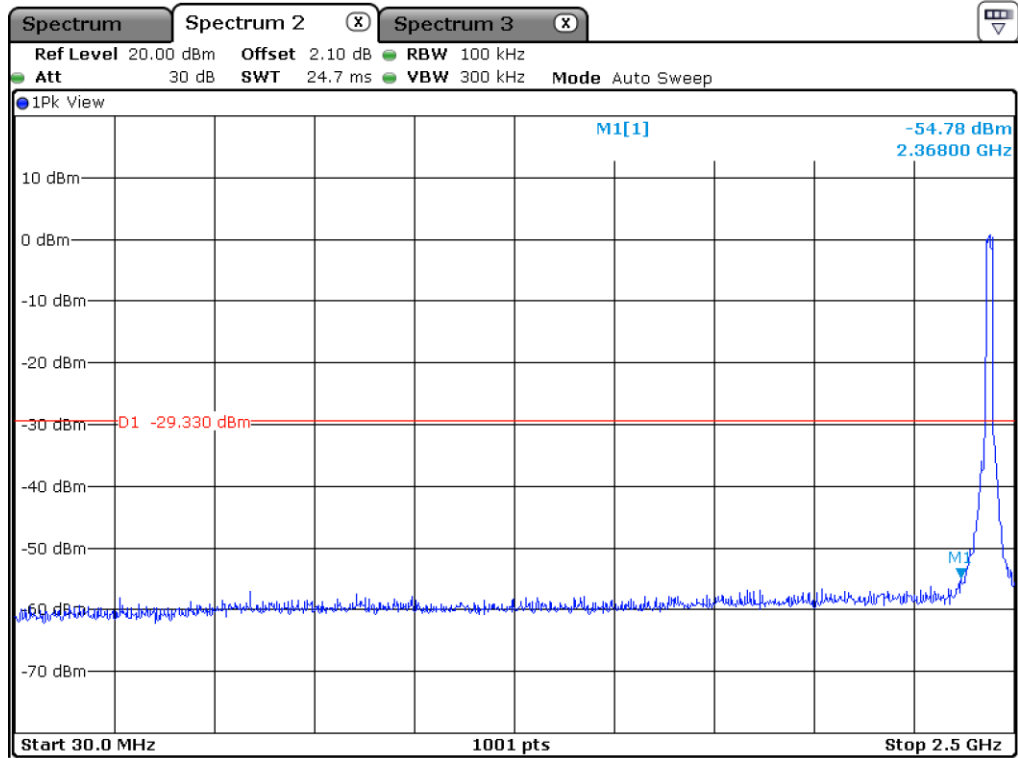




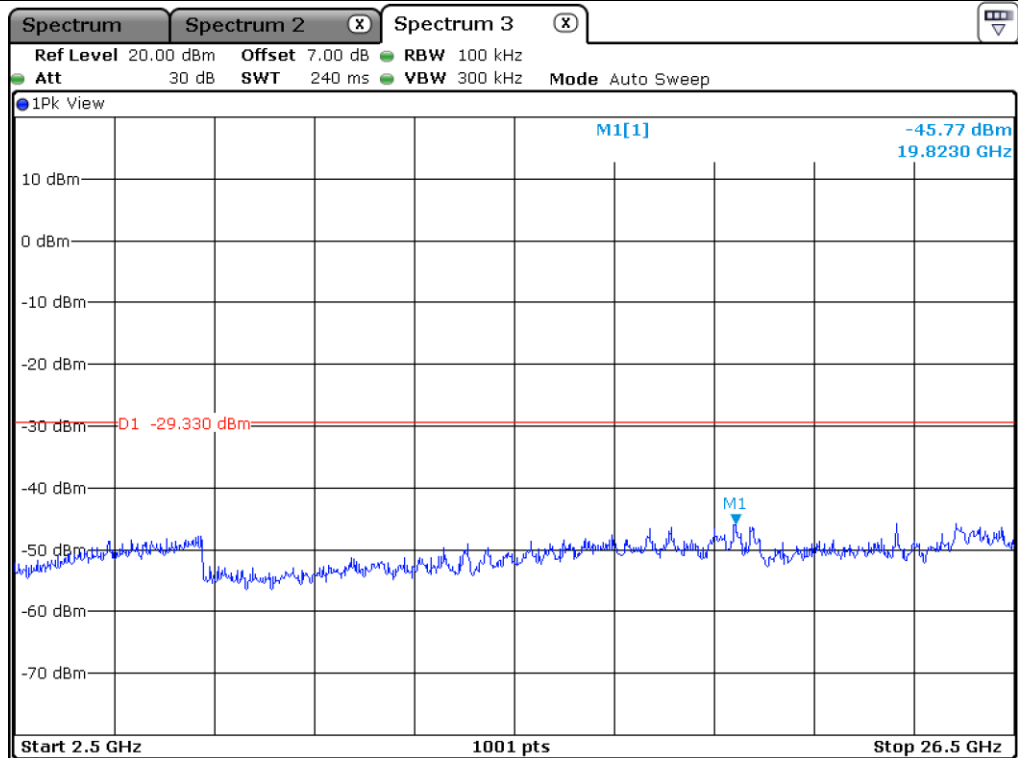
Low Channel



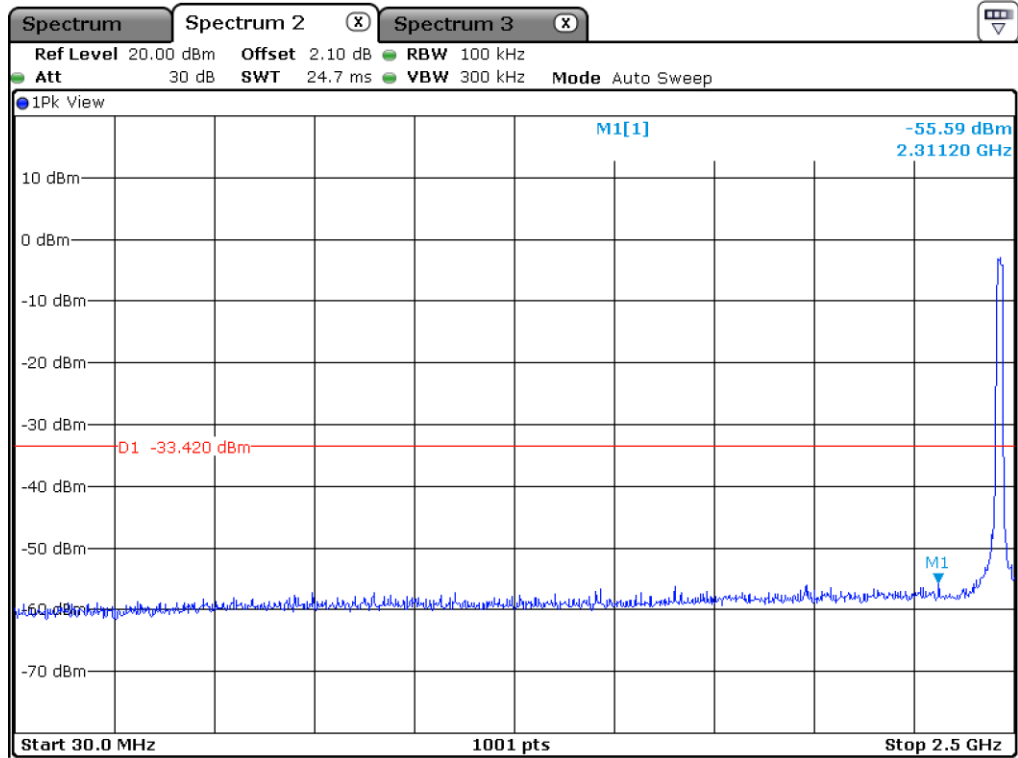
Low Channel



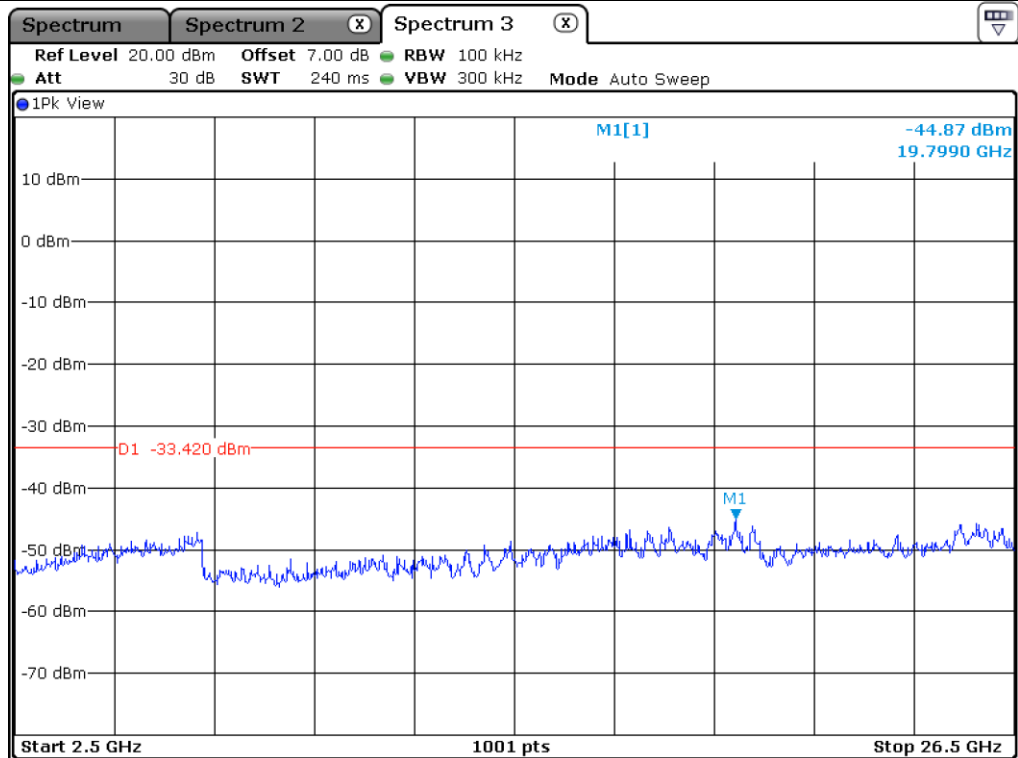
Middle Channel



Middle Channel

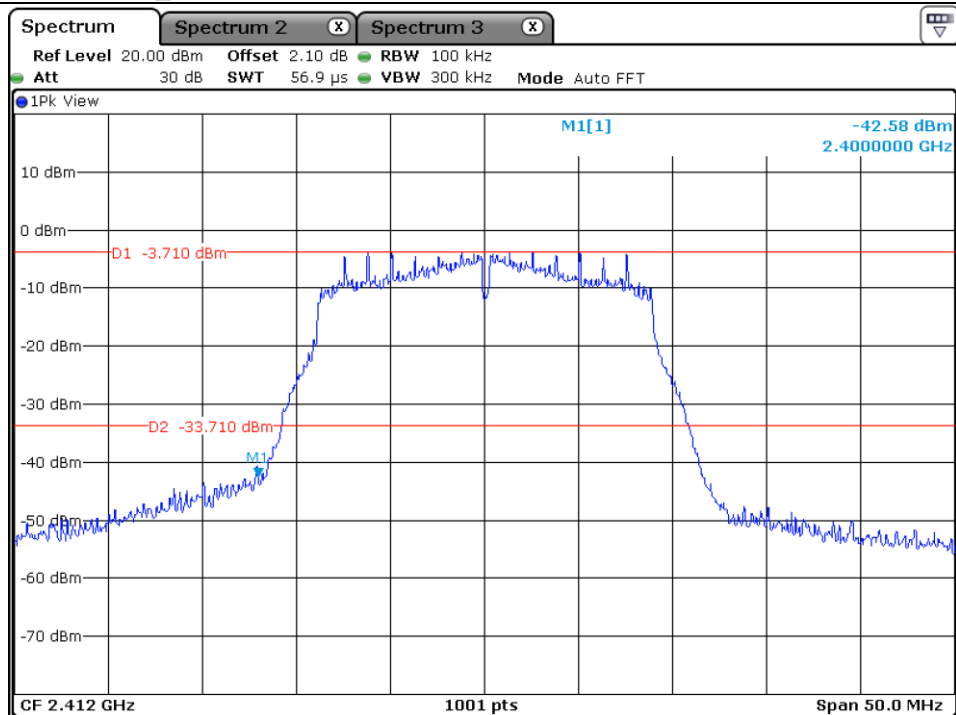


High Channel

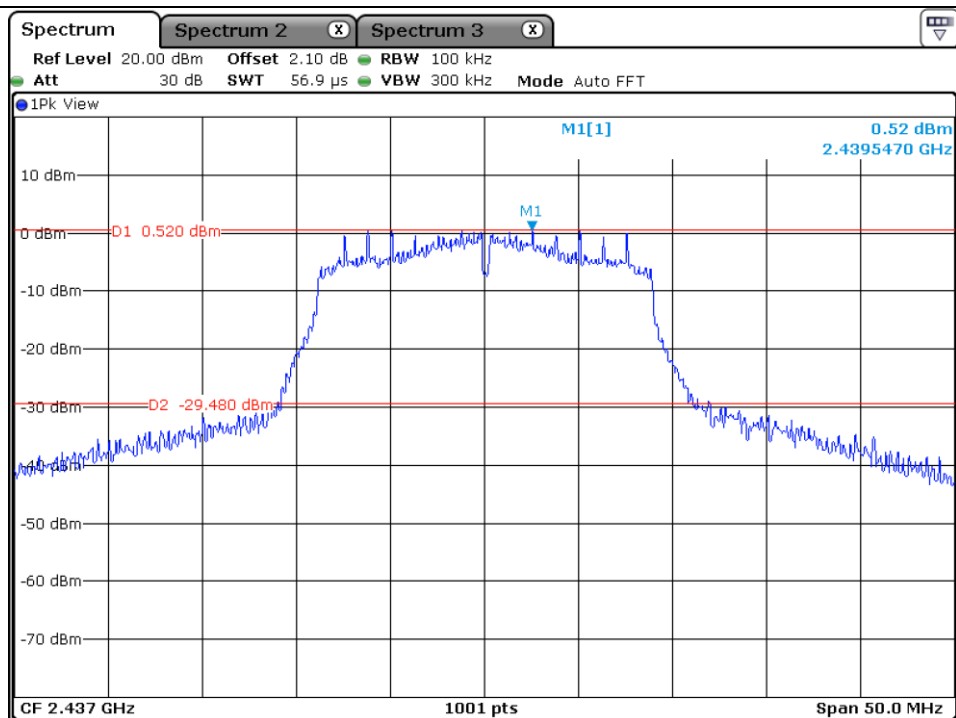


High Channel

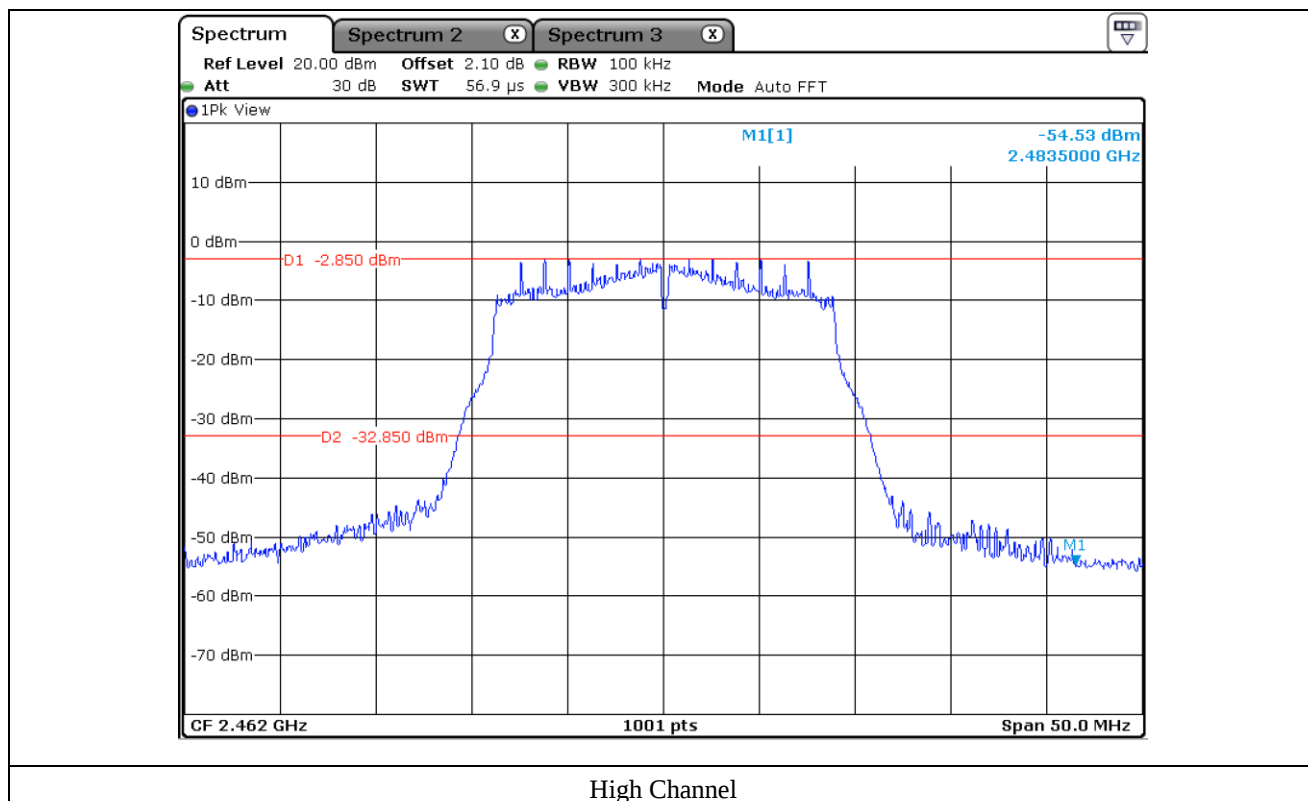
9.5.3 Test data for 802.11n_HT20 WLAN Mode

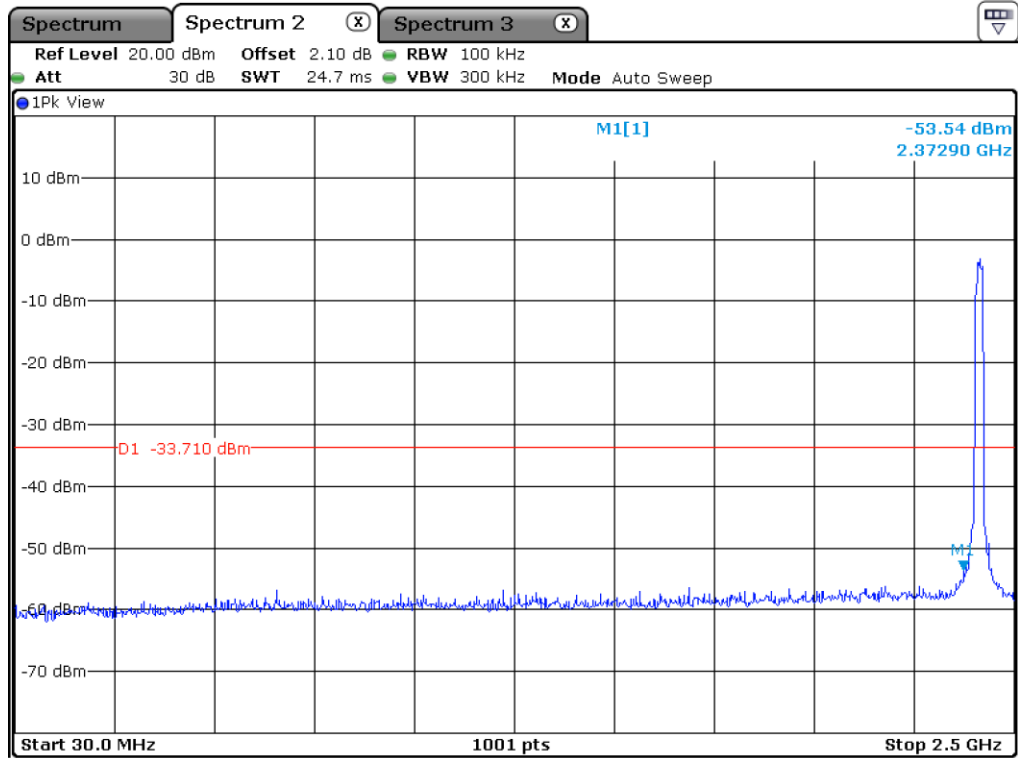


Low Channel

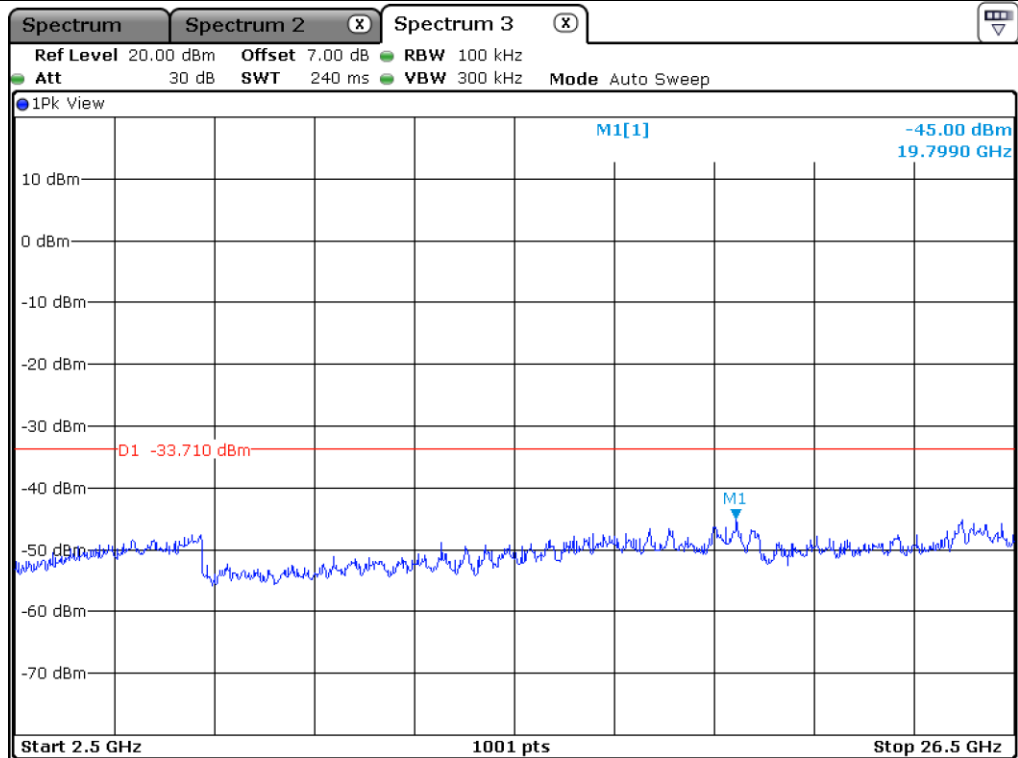


Middle Channel

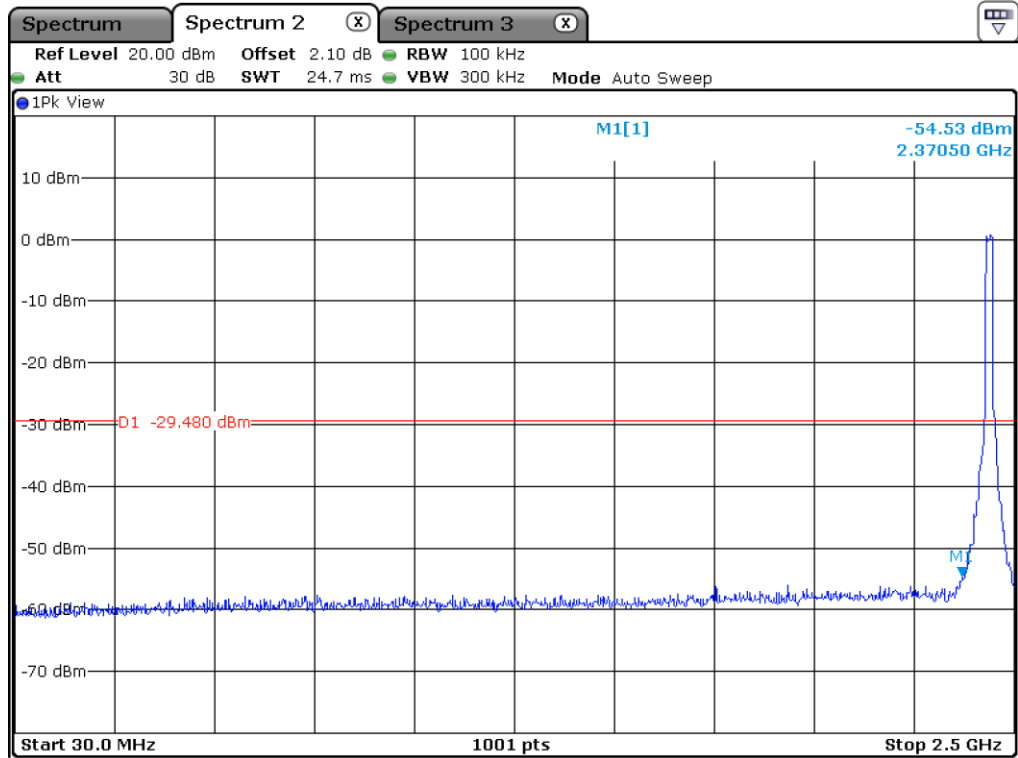




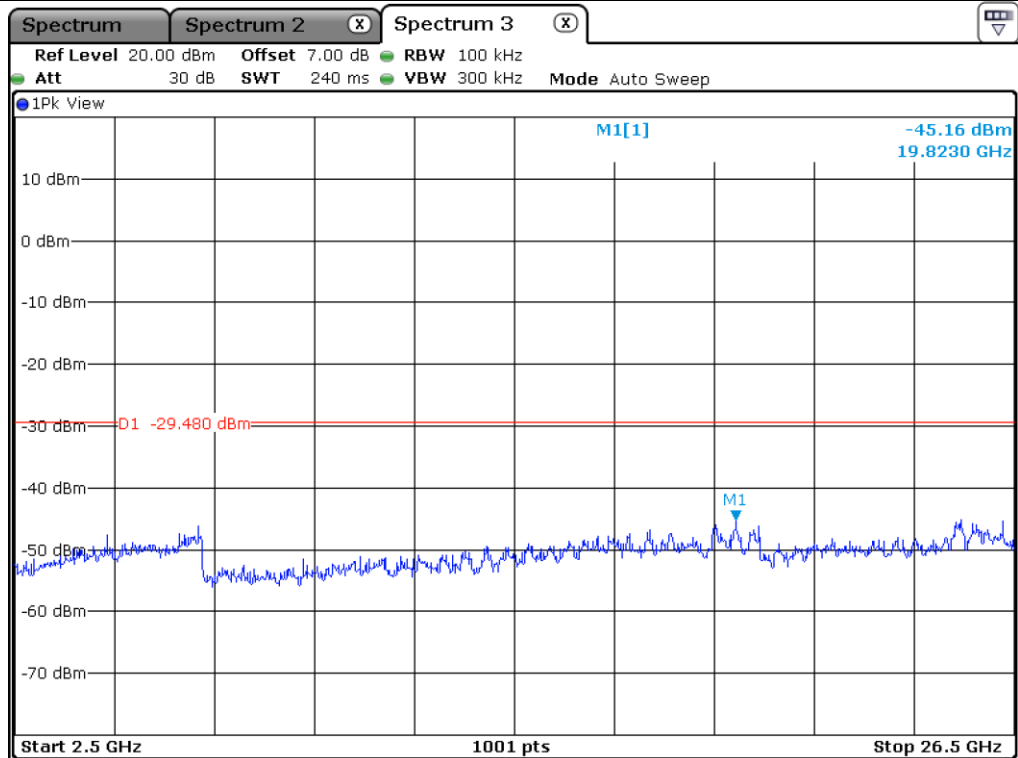
Low Channel



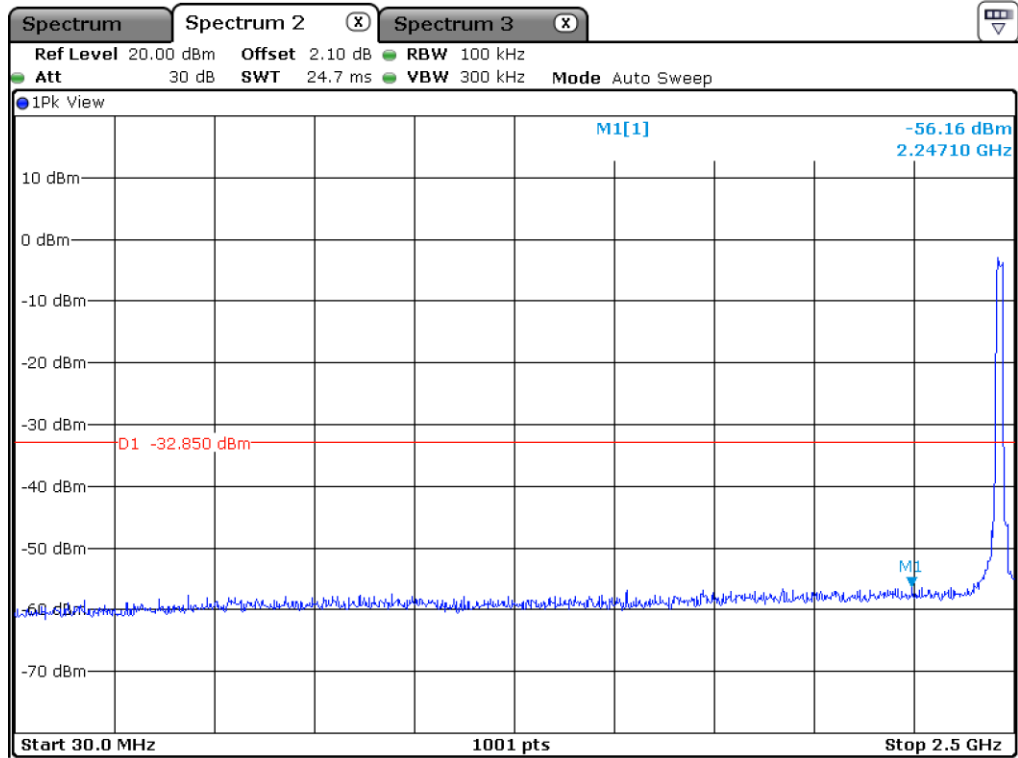
Low Channel



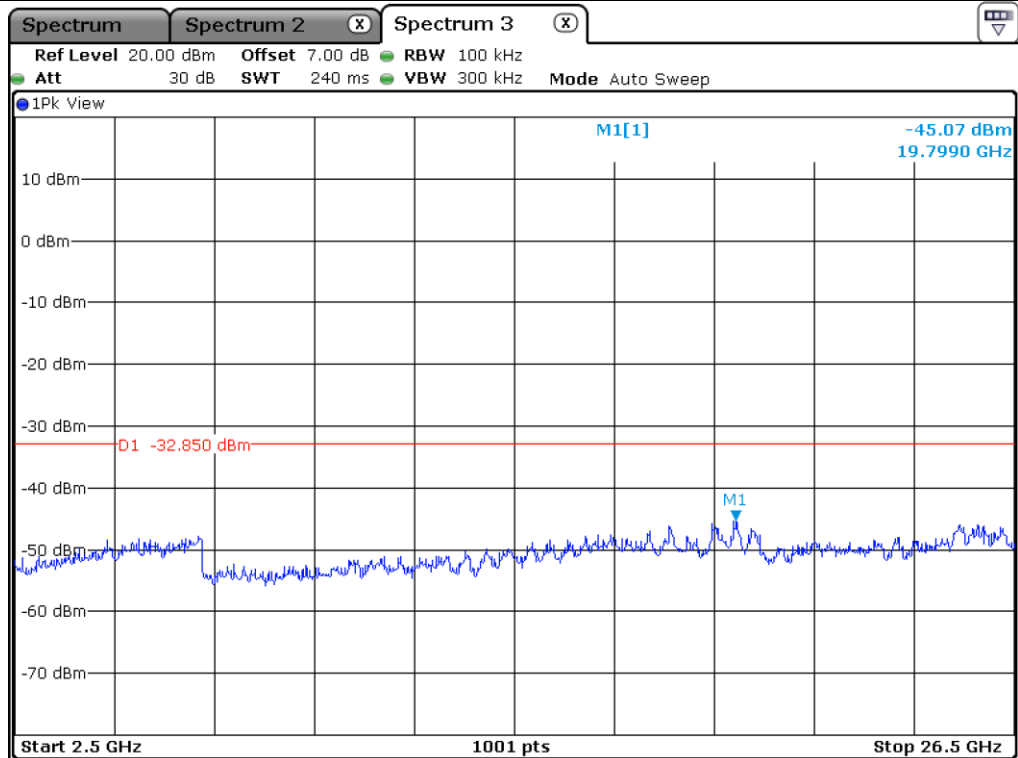
Middle Channel



Middle Channel



High Channel



High Channel

9.6 Test data for radiated emission

9.6.1 Radiated Emission which fall in the Restricted Band

9.6.1.1 Test data for 802.11b WLAN Mode

- . Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Measurement distance : 3 m
- . Duty Cycle : 98.84 %
- . Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	AMP Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
2 387.290	60.11	Peak	H	28.30	8.20	-	45.30	51.31	74.00	22.69
2 387.490	55.08	Average	H	28.30	8.20	0.05	45.30	46.33	54.00	7.67
2 384.440	60.49	Peak	V	28.30	8.20	-	45.30	51.69	74.00	22.31
2 387.450	56.76	Average	V	28.30	8.20	0.05	45.30	48.01	54.00	5.99
Test Data for High Channel										
2 487.594	61.74	Peak	H	28.70	8.23	-	45.50	53.17	74.00	20.83
2 486.549	57.13	Average	H	28.70	8.23	0.05	45.50	48.61	54.00	5.39
2 487.790	61.08	Peak	V	28.70	8.23	-	45.50	52.51	74.00	21.49
2 488.479	56.43	Average	V	28.70	8.23	0.05	45.50	47.91	54.00	6.09

Remark: "H": Horizontal, "V": Vertical

Margin (dB) = Limits (dBμV/m) - Total Level (dBμV/m)

Total Level = Reading + Antenna Factor + Cable Loss - Amp Gain + Correction Factor

9.6.1.2 Test data for 802.11g WLAN Mode

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Measurement distance : 3 m
- Duty Cycle : 95.36 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	AMP Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
2 388.570	64.35	Peak	H	28.30	8.20	-	45.30	55.55	74.00	18.45
2 390.000	54.12	Average	H	28.30	8.20	0.21	45.30	45.53	54.00	8.47
2 390.000	64.79	Peak	V	28.30	8.20	-	45.30	55.99	74.00	18.01
2 390.000	55.98	Average	V	28.30	8.20	0.21	45.30	47.39	54.00	6.61
Test Data for High Channel										
2 483.500	70.84	Peak	H	28.70	8.23	-	45.50	62.27	74.00	11.73
2 483.500	58.17	Average	H	28.70	8.23	0.21	45.50	49.81	54.00	4.19
2 483.500	71.08	Peak	V	28.70	8.23	-	45.50	62.51	74.00	11.49
2 483.500	59.02	Average	V	28.70	8.23	0.21	45.50	50.66	54.00	3.34

Remark: "H": Horizontal, "V": Vertical

Margin (dB) = Limits (dBμV/m) - Total Level (dBμV/m)

Total Level = Reading + Antenna Factor + Cable Loss - Amp Gain + Correction Factor

9.6.1.3 Test data for 802.11n_HT20 WLAN Mode

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Measurement distance : 3 m
- Duty Cycle : 95.31 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	AMP Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
2 390.000	69.15	Peak	H	28.30	8.20	-	45.30	60.35	74.00	13.65
2 390.000	56.36	Average	H	28.30	8.20	0.21	45.30	47.77	54.00	6.23
2 390.000	68.92	Peak	V	28.30	8.20	-	45.30	60.12	74.00	13.88
2 390.000	57.49	Average	V	28.30	8.20	0.21	45.30	48.90	54.00	5.10
Test Data for High Channel										
2 484.003	70.95	Peak	H	28.70	8.23	-	45.50	62.38	74.00	11.62
2 483.500	59.56	Average	H	28.70	8.23	0.21	45.50	51.20	54.00	2.80
2 484.955	71.63	Peak	V	28.70	8.23	-	45.50	63.06	74.00	10.94
2 483.500	58.77	Average	V	28.70	8.23	0.21	45.50	50.41	54.00	3.59

Remark: "H": Horizontal, "V": Vertical

Margin (dB) = Limits (dBμV/m) - Total Level (dBμV/m)

Total Level = Reading + Antenna Factor + Cable Loss - Amp Gain + Correction Factor

9.6.2 Spurious & Harmonic Radiated Emission

9.6.2.1 Test data for 802.11b WLAN Mode

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Duty Cycle : 98.84 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	AMP Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 824.00	51.06	Peak	H	33.40	11.21	-	46.30	49.37	74.00	24.63
4 824.00	40.11	Average	H	33.40	11.21	0.05	46.30	38.47	54.00	15.53
4 824.00	51.05	Peak	V	33.40	11.21	-	46.30	49.36	74.00	24.64
4 824.00	40.15	Average	V	33.40	11.21	0.05	46.30	38.51	54.00	15.49
Test Data for Middle Channel										
4 874.00	49.88	Peak	H	33.50	11.23	-	46.33	48.28	74.00	25.72
4 874.00	40.10	Average	H	33.50	11.23	0.05	46.33	38.55	54.00	15.45
4 874.00	50.68	Peak	V	33.50	11.23	-	46.33	49.08	74.00	24.92
4 874.00	40.22	Average	V	33.50	11.23	0.05	46.33	38.67	54.00	15.33
Test Data for High Channel										
4 924.00	50.10	Peak	H	33.30	11.25	-	46.35	48.30	74.00	25.70
4 924.00	40.30	Average	H	33.30	11.25	0.05	46.35	38.55	54.00	15.45
4 924.00	50.13	Peak	V	33.30	11.25	-	46.35	48.33	74.00	25.67
4 924.00	40.16	Average	V	33.30	11.25	0.05	46.35	38.41	54.00	15.59

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dBμV/m)} - \text{Total Level (dBμV/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amp Gain} + \text{Correction Factor}$$

9.6.2.2 Test data for 802.11g WLAN Mode

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Duty Cycle : 95.36 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	AMP Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 824.00	49.37	Peak	H	33.40	11.21	-	46.30	47.68	74.00	26.32
4 824.00	39.98	Average	H	33.40	11.21	0.21	46.30	38.50	54.00	15.50
4 824.00	50.17	Peak	V	33.40	11.21	-	46.30	48.48	74.00	25.52
4 824.00	40.03	Average	V	33.40	11.21	0.21	46.30	38.55	54.00	15.45
Test Data for Middle Channel										
4 874.00	49.17	Peak	H	33.50	11.23	-	46.33	47.57	74.00	26.43
4 874.00	39.95	Average	H	33.50	11.23	0.21	46.33	38.56	54.00	15.44
4 874.00	49.52	Peak	V	33.50	11.23	-	46.33	47.92	74.00	26.08
4 874.00	40.18	Average	V	33.50	11.23	0.21	46.33	38.79	54.00	15.21
Test Data for High Channel										
4 924.00	51.86	Peak	H	33.30	11.25	-	46.35	50.06	74.00	23.94
4 924.00	39.84	Average	H	33.30	11.25	0.21	46.35	38.25	54.00	15.75
4 924.00	50.81	Peak	V	33.30	11.25	-	46.35	49.01	74.00	24.99
4 924.00	40.34	Average	V	33.30	11.25	0.21	46.35	38.75	54.00	15.25

Remark: "H": Horizontal, "V": Vertical

Margin (dB) = Limits (dBμV/m) - Total Level (dBμV/m)

Total Level = Reading + Antenna Factor + Cable Loss - Amp Gain + Correction Factor

9.6.2.3 Test data for 802.11n_HT20 WLAN Mode

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Duty Cycle : 95.31 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	C.F (dB)	AMP Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 824.00	51.05	Peak	H	33.40	11.21	-	46.30	49.36	74.00	24.64
4 824.00	40.15	Average	H	33.40	11.21	0.21	46.30	38.67	54.00	15.33
4 824.00	49.10	Peak	V	33.40	11.21	-	46.30	47.41	74.00	26.59
4 824.00	40.27	Average	V	33.40	11.21	0.21	46.30	38.79	54.00	15.21
Test Data for Middle Channel										
4 874.00	49.91	Peak	H	33.50	11.23	-	46.33	48.31	74.00	25.69
4 874.00	40.19	Average	H	33.50	11.23	0.21	46.33	38.80	54.00	15.20
4 874.00	50.77	Peak	V	33.50	11.23	-	46.33	49.17	74.00	24.83
4 874.00	40.03	Average	V	33.50	11.23	0.21	46.33	38.64	54.00	15.36
Test Data for High Channel										
4 924.00	50.30	Peak	H	33.30	11.25	-	46.35	48.50	74.00	25.50
4 924.00	40.33	Average	H	33.30	11.25	0.21	46.35	38.74	54.00	15.26
4 924.00	51.15	Peak	V	33.30	11.25	-	46.35	49.35	74.00	24.65
4 924.00	40.34	Average	V	33.30	11.25	0.21	46.35	38.75	54.00	15.25

Remark: "H": Horizontal, "V": Vertical

Margin (dB) = Limits (dBμV/m) - Total Level (dBμV/m)

Total Level = Reading + Antenna Factor + Cable Loss - Amp Gain + Correction Factor

10. PEAK POWER SPECTRAL DENSITY

10.1 Operating environment

Temperature : 23 °C

Relative humidity : 41 % R.H.

10.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer.

The resolution bandwidth is set to $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$, the video bandwidth is set to 3 times the resolution bandwidth.



10.3 Test Date

November 25, 2021 ~ January 18, 2022

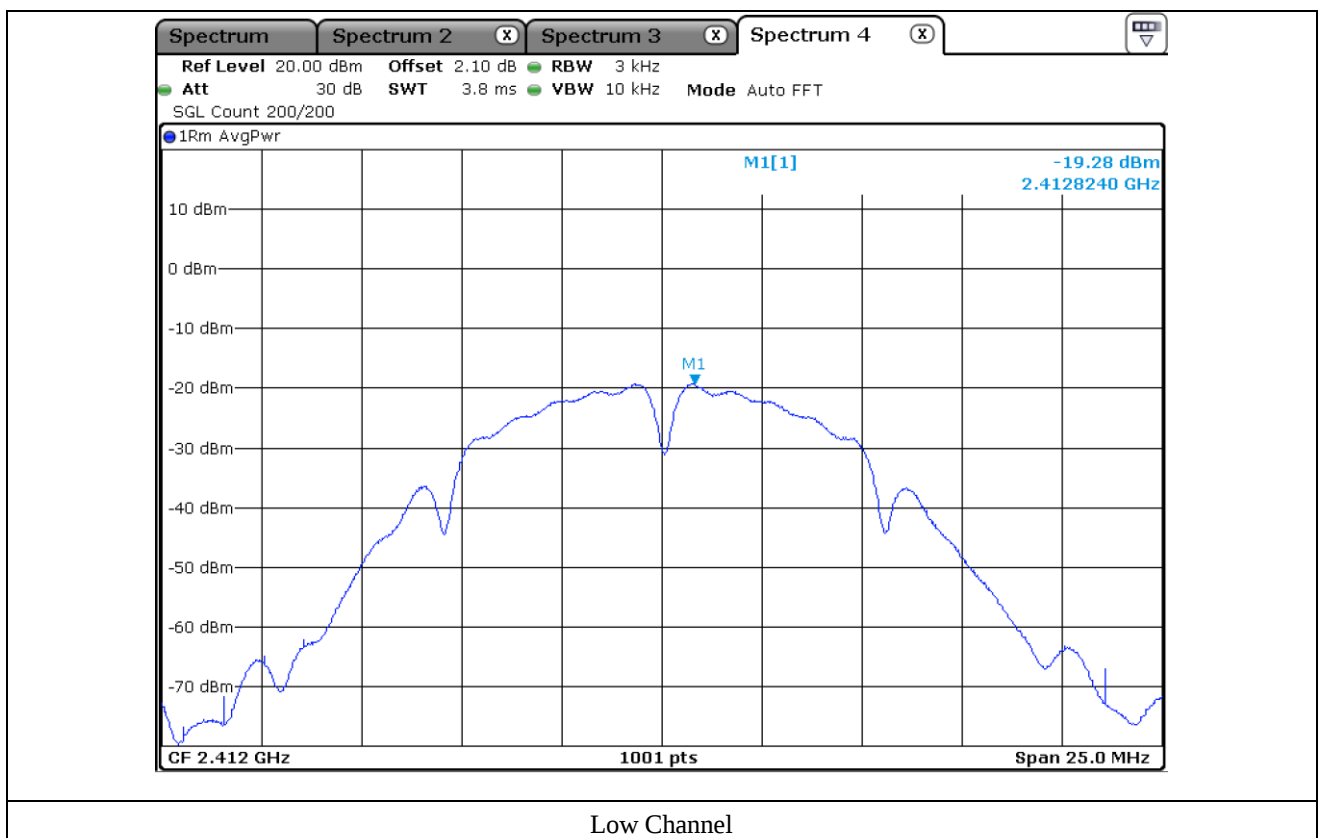
10.4 Test data for 802.11b WLAN Mode

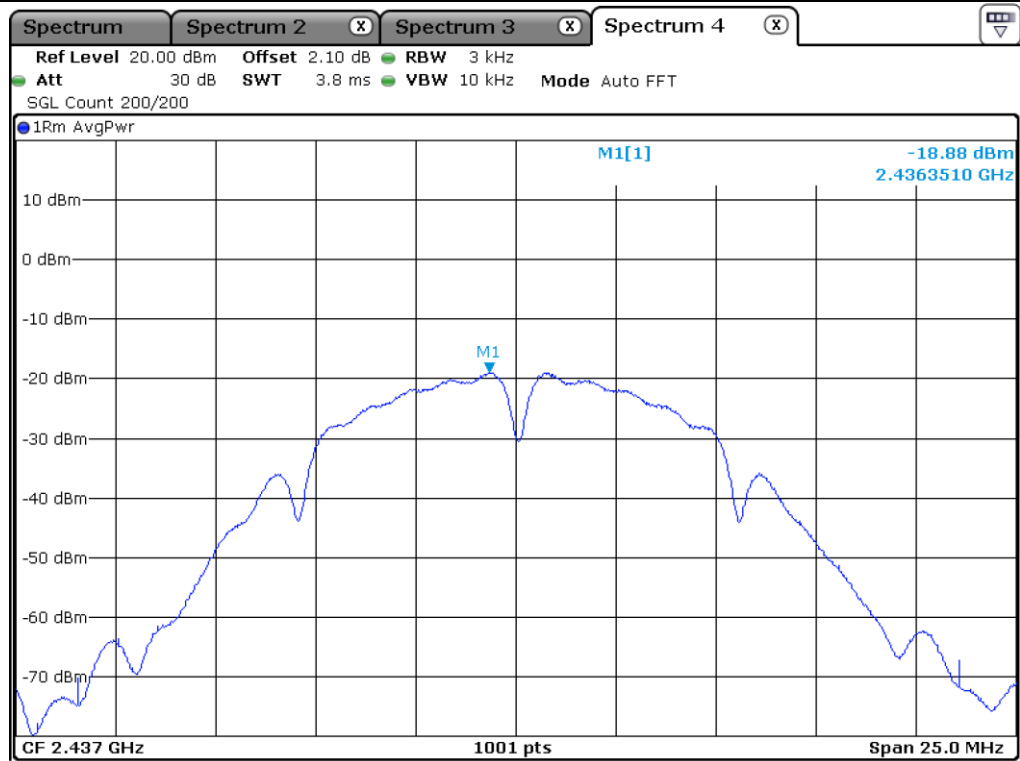
-. Test Result : Pass

-. Duty Cycle : 98.84 %

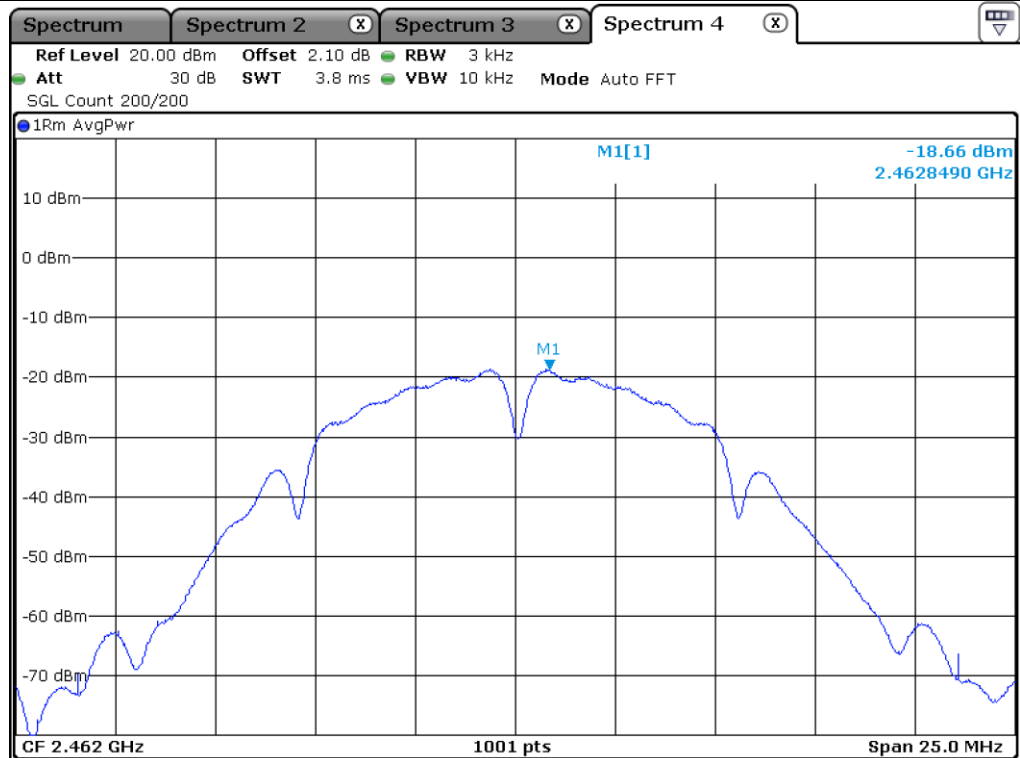
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	C.F (dB)	RESULT (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	-19.28	0.05	-19.23	8.00	27.23
MIDDLE	2 442.00	-18.88	0.05	-18.83	8.00	26.83
HIGH	2 462.00	-18.66	0.05	-18.61	8.00	26.61

Remark. Margin = Limit – Result (=Measured Value + C.F.)





Middle Channel



High Channel

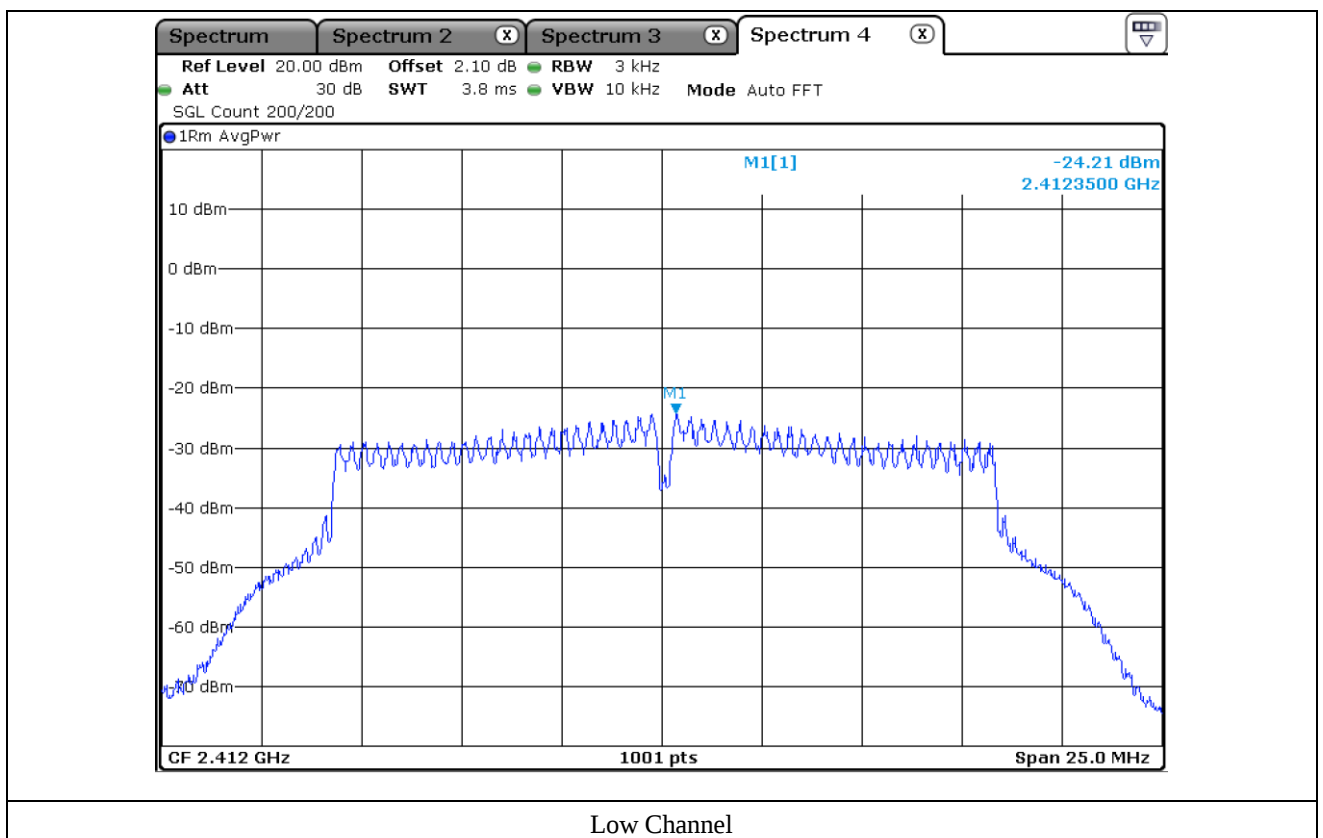
10.5 Test data for 802.11g WLAN Mode

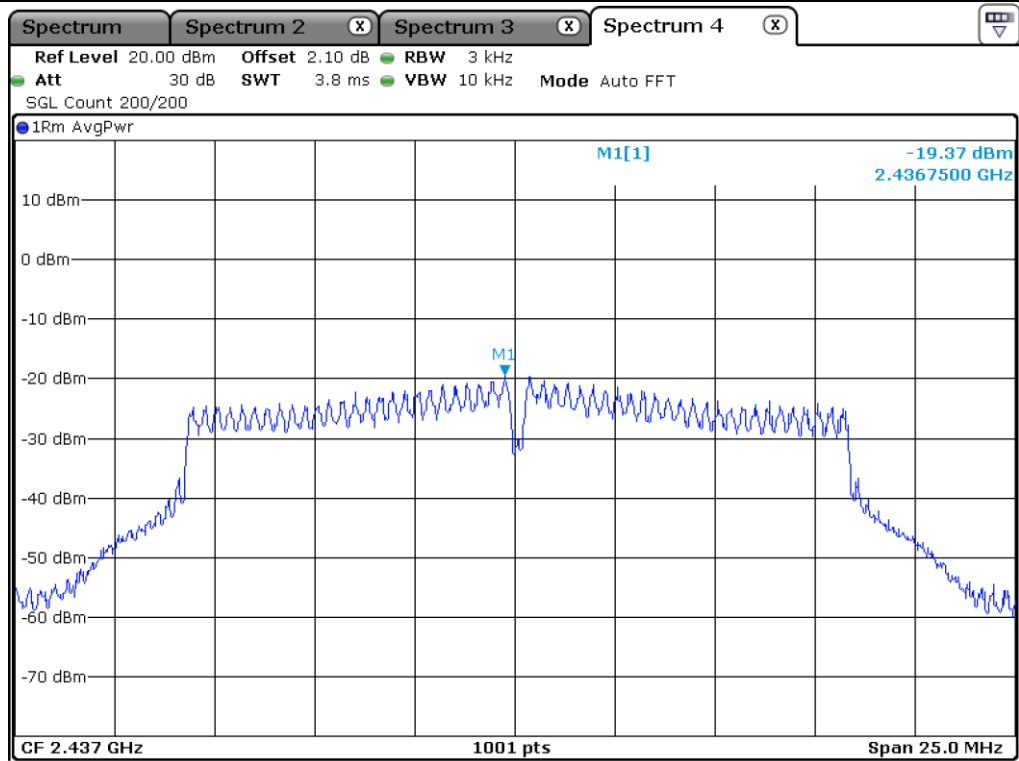
-. Test Result : Pass

-. Duty Cycle : 95.36 %

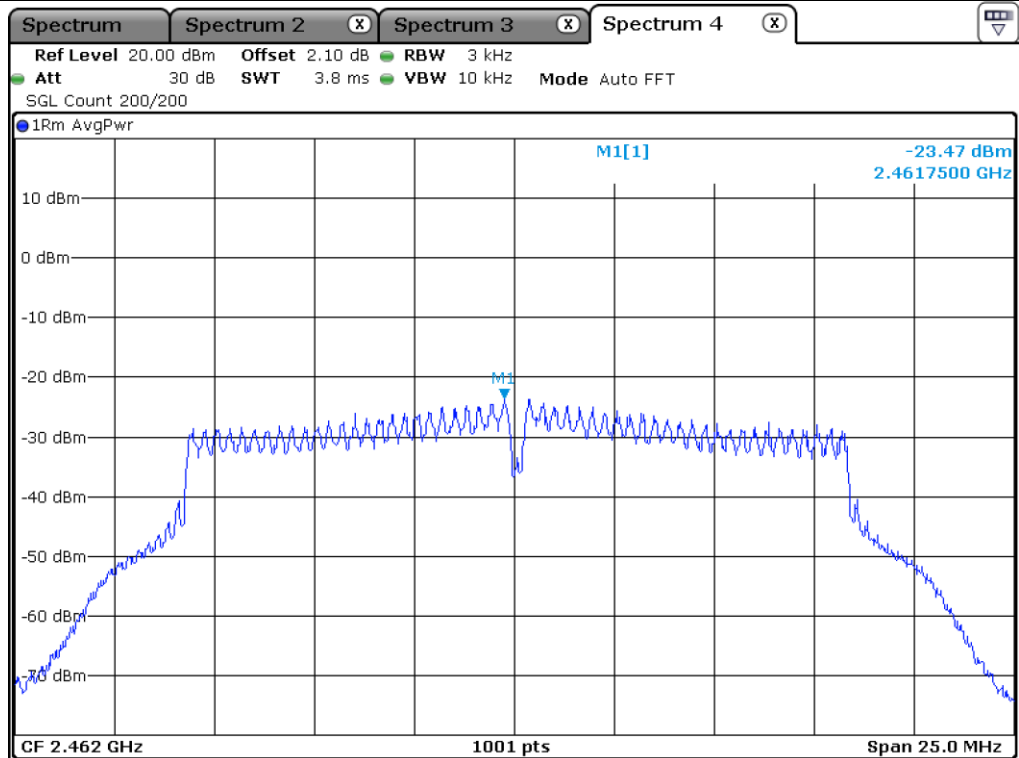
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	C.F (dB)	RESULT (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	-24.21	0.21	-24.00	8.00	32.00
MIDDLE	2 442.00	-19.37	0.21	-19.16	8.00	27.16
HIGH	2 462.00	-23.47	0.21	-23.26	8.00	31.26

Remark. Margin = Limit – Result (=Measured Value + C.F.)





Middle Channel



High Channel

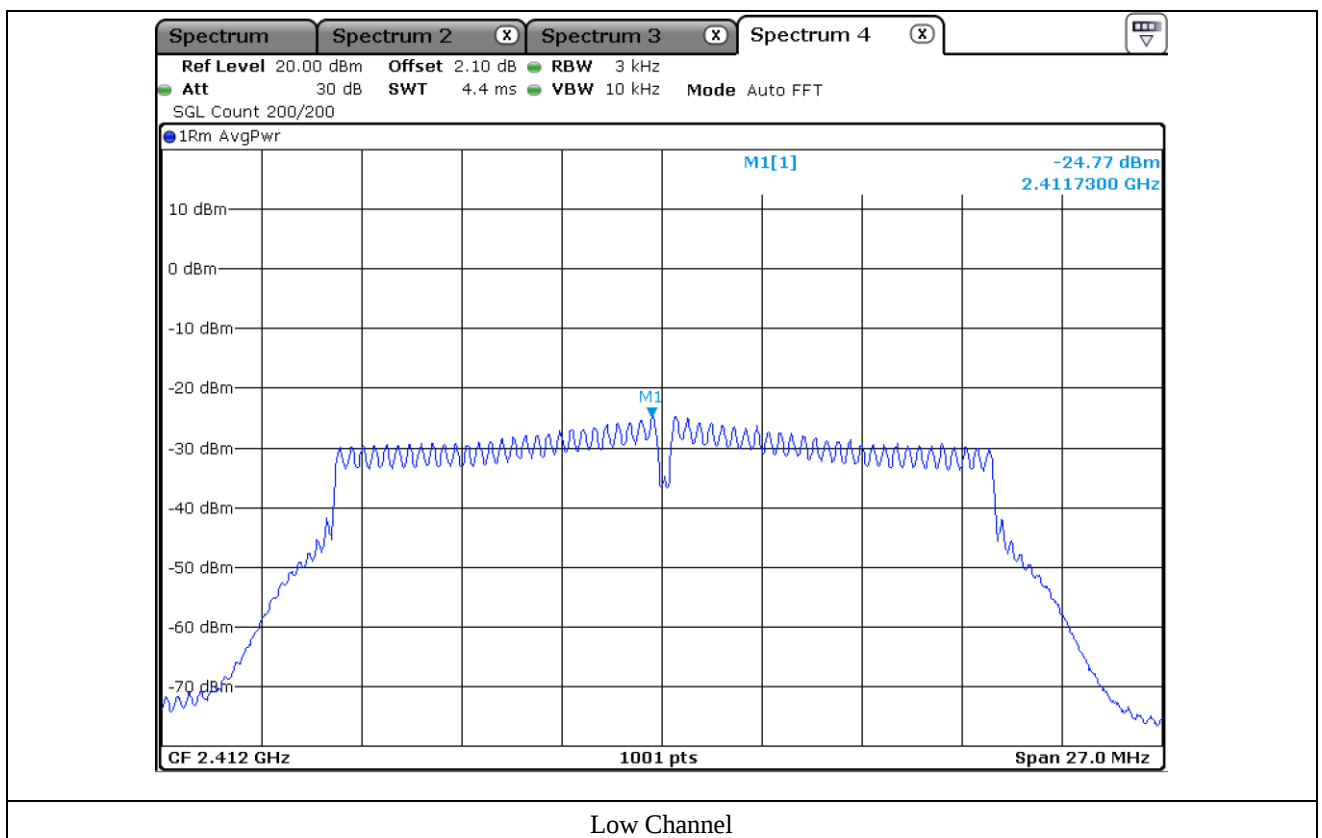
10.6 Test data for 802.11n_HT20 WLAN Mode

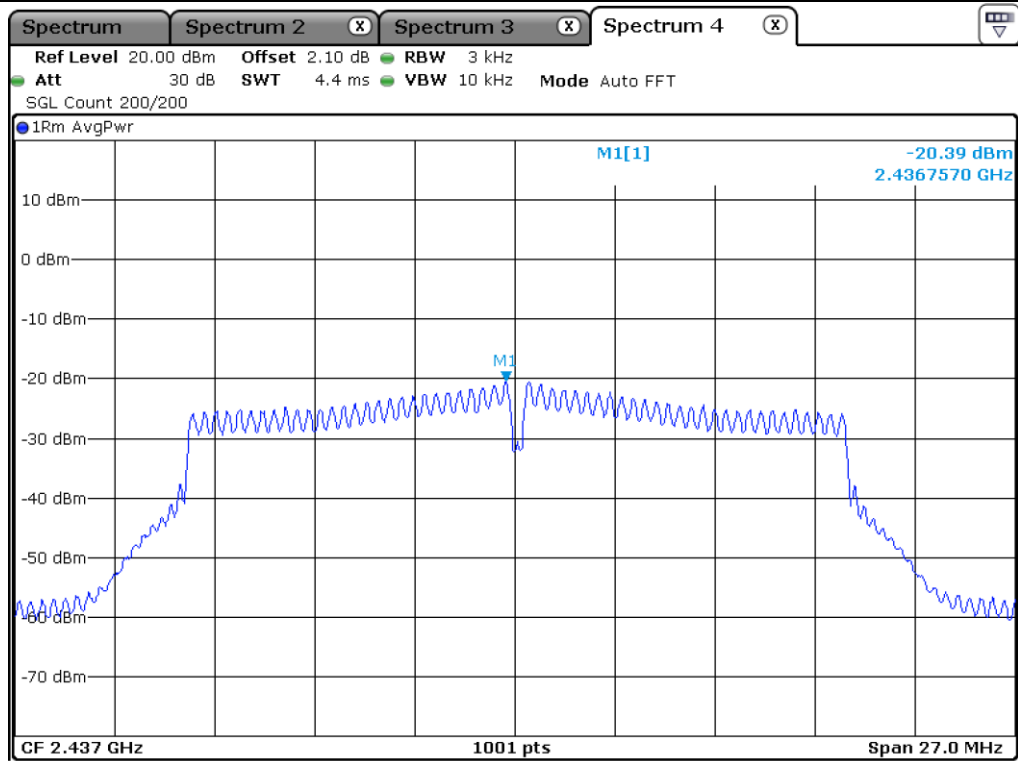
-. Test Result : Pass

-. Duty Cycle : 95.31 %

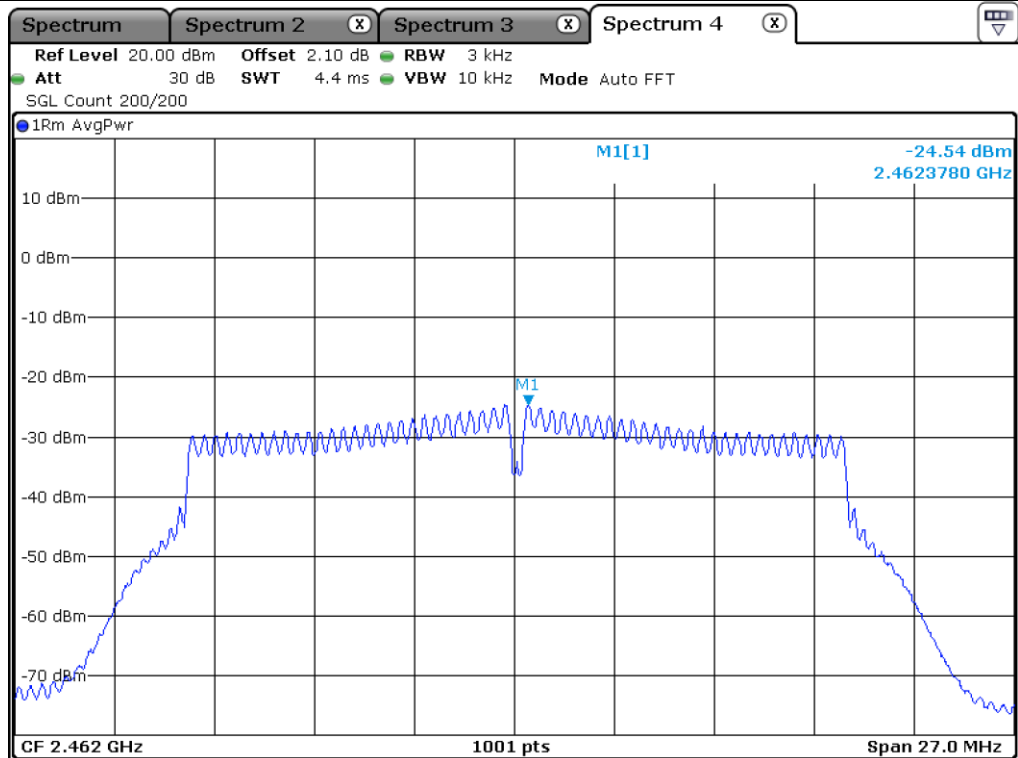
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	C.F (dB)	RESULT (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	-24.77	0.21	-24.56	8.00	32.56
MIDDLE	2 442.00	-20.39	0.21	-20.18	8.00	28.18
HIGH	2 462.00	-24.54	0.21	-24.33	8.00	32.33

Remark. Margin = Limit – Result (=Measured Value + C.F.)





Middle Channel



High Channel

11. RADIATED EMISSION TEST

11.1 Operating environment

Temperature : 23 °C

Relative humidity : 41 % R.H.

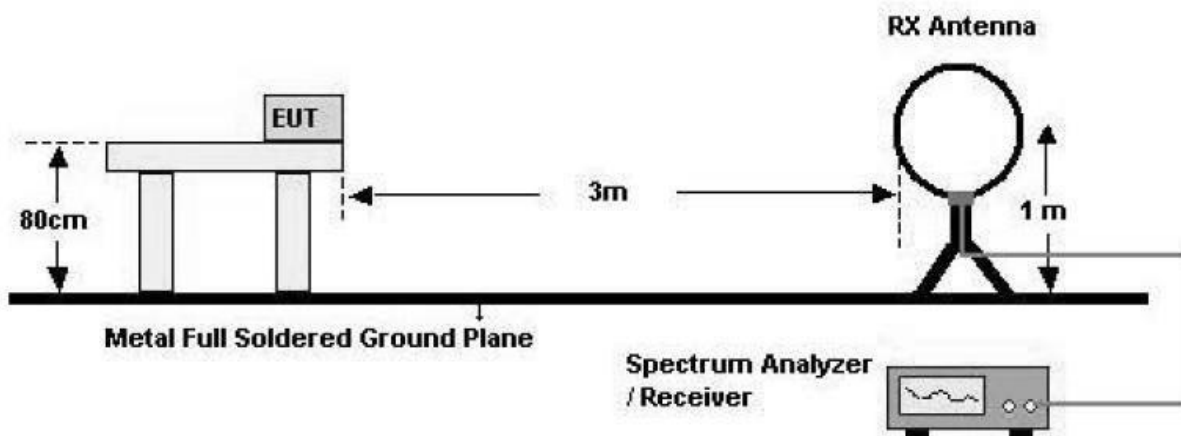
11.2 Test set-up

The radiated emissions measurements were on the 3 m semi anechoic chamber. The EUT and other support equipment were placed on a non-conductive turntable above the ground plane. The interconnecting cables from outside test site were inserted into ferrite clamps at the point where the cables reach the turntable.

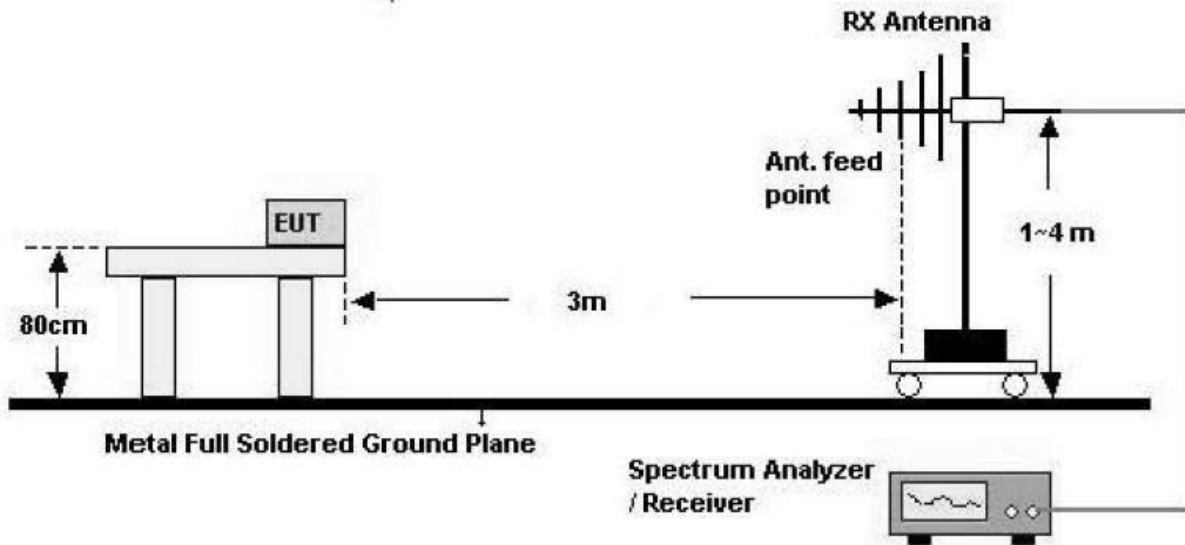
The frequency spectrum from 30 MHz to 26.5 GHz was scanned and emission levels maximized at each frequency recorded. The system was rotated 360°, and the antenna was varied in height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for both horizontal and vertical polarization of the receiving antenna.

- Test Configuration

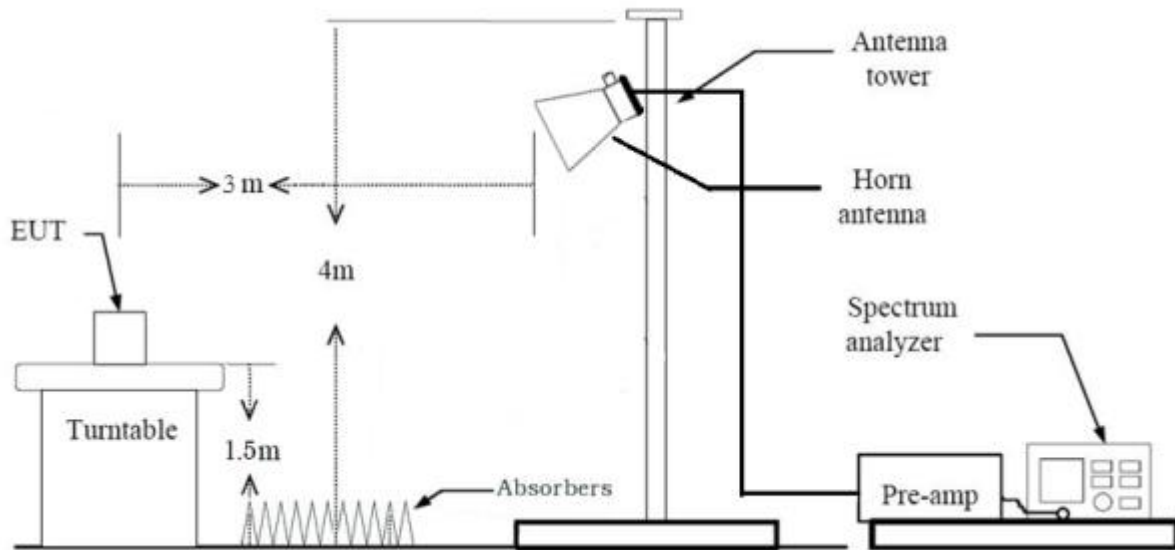
1. Below 30 MHz



2. 30 MHz - 1 GHz



3. Above 1 GHz



11.3 Test Date

November 25, 2021 ~ January 18, 2022

11.4 Test data for 30 MHz ~ 1 000 MHz

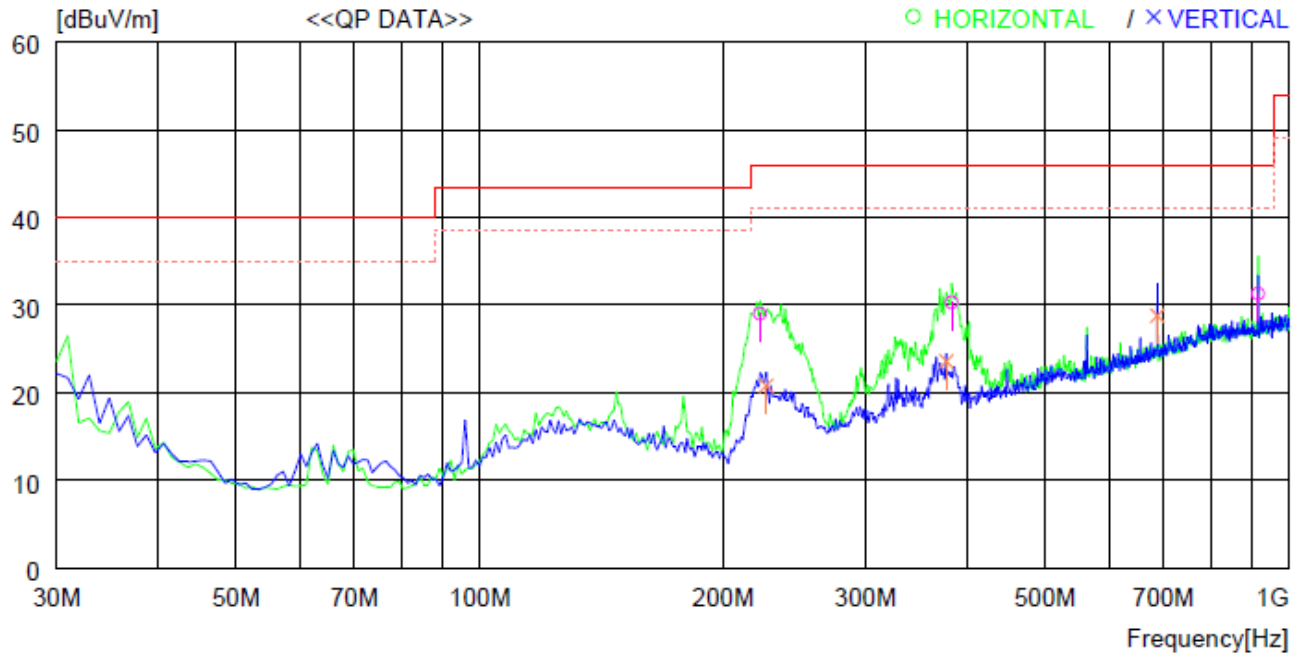
11.4.1 Test data for WLAN 2.4 GHz_External Antenna

Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

Result : PASSED

EUT : Silverbox RADIO ASM-RECEIVER

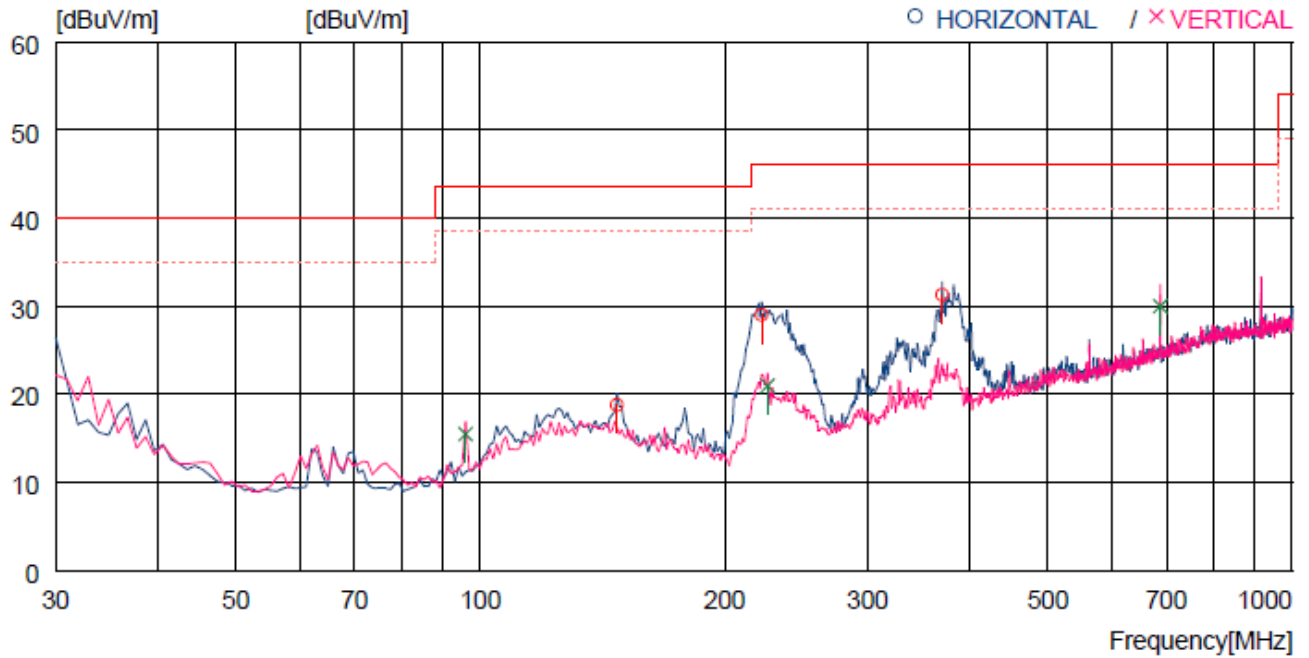
Detector : CISPR Quasi-Peak (6 dB Bandwidth: 120 kHz)



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	QF	FACTOR	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	222.060	41.9	16.6	2.6	32.1	29.0	46.0	17.0	200	157
2	383.080	38.7	20.4	3.4	32.2	30.3	46.0	15.7	100	359
3	915.598	30.2	27.7	5.3	31.9	31.3	46.0	14.7	400	134
----- Vertical -----										
4	225.940	33.6	16.7	2.6	32.1	20.8	46.0	25.2	200	359
5	377.260	32.0	20.4	3.4	32.2	23.6	46.0	22.4	300	249
6	687.655	31.2	25.4	4.6	32.4	28.8	46.0	17.2	100	0

11.4.2 Test data for Intermodulation Mode(Bluetooth + WLAN 2.4 GHz)

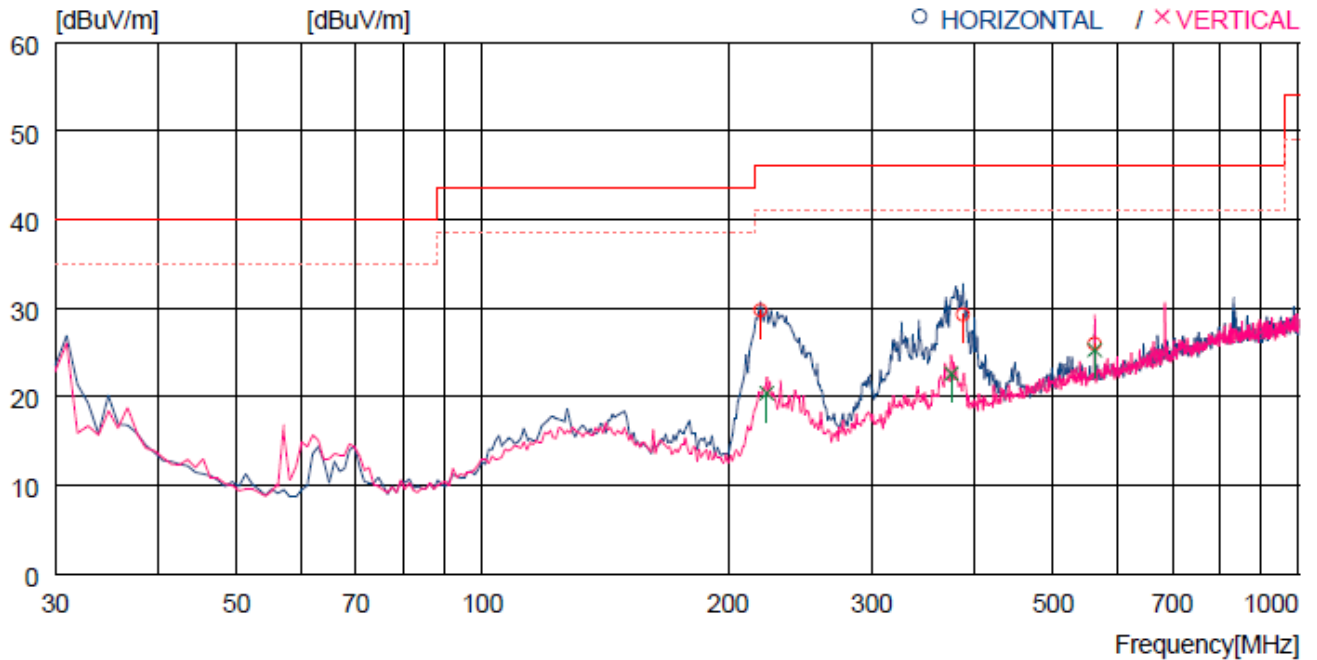
- Resolution bandwidth : 120 kHz
- Frequency range : 30 MHz ~ 1 000 MHz
- Measurement distance : 3 m



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	[dBuV]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
---- Horizontal ----										
1	147.370	29.9	18.9	2.1	32.1	18.8	43.5	24.7	200	0
2	222.060	41.9	16.6	2.6	32.1	29.0	46.0	17.0	200	157
3	370.470	39.9	20.3	3.3	32.2	31.3	46.0	14.7	100	359
---- Vertical ----										
4	95.960	31.2	14.6	1.8	32.1	15.5	43.5	28.0	400	359
5	225.940	33.8	16.7	2.6	32.1	21.0	46.0	25.0	200	359
6	687.655	32.4	25.4	4.6	32.4	30.0	46.0	16.0	100	0

11.4.3 Test data for Intermodulation Mode(WLAN 2.4 GHz + WLAN 5 GHz)

- Resolution bandwidth : 120 kHz
- Frequency range : 30 MHz ~ 1 000 MHz
- Measurement distance : 3 m



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	[dBuV]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
---- Horizontal ----										
1	219.150	42.9	16.4	2.6	32.1	29.8	46.0	16.2	200	0
2	387.930	37.6	20.5	3.4	32.2	29.3	46.0	16.7	100	318
3	562.529	30.5	23.8	4.1	32.4	26.0	46.0	20.0	300	232
---- Vertical ----										
4	223.030	33.3	16.6	2.6	32.1	20.4	46.0	25.6	300	207
5	375.320	31.1	20.3	3.4	32.2	22.6	46.0	23.4	300	0
6	562.529	29.8	23.8	4.1	32.4	25.3	46.0	20.7	100	172

11.5 Test data for Below 30 MHz

- . Resolution bandwidth : 200 Hz (from 9 kHz to 0.15 MHz), 9 kHz (from 0.15 MHz to 30 MHz)
- . Frequency range : 9 kHz ~ 30 MHz
- . Measurement distance : 3 m
- . Operating mode : Transmitting mode

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.									

11.6 Test data for above 1 GHz

- . Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Frequency range : 1 GHz ~ 26.5 GHz
- . Measurement distance : 3 m
- . Operating mode : Transmitting mode

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.									

12. LIST OF TEST EQUIPMENT

Model Number	Manufacturer	Description	Serial Number	Last Cal.(Interval)
FSV40-N	Rohde & Schwarz	Signal Analyzer	102177	Apr. 16, 2021 (1Y)
ESW	Rohde & Schwarz	EMI Test Receiver	101851	Mar. 22, 2021 (1Y)
GP-4303D	LG Precision Co.,Ltd	DC POWER SUPPLY	5071069	Jan. 03, 2022 (1Y)
HPF 3GHz	Rohde & Schwarz	High Pass Filter	N/A	Feb. 08, 2021 (1Y)
310N	Sonoma Instrument	Pre-Amplifier	392756	Oct. 14, 2021 (1Y)
SCU18	Rohde & Schwarz	Pre-Amplifier	102266	Jul. 14, 2021 (1Y)
SCU40A	Rohde & Schwarz	Signal Conditioning unit	100436	Feb. 08, 2021 (1Y)
DT2000-2t	Innco System	Turn Table	N/A	N/A
MA-4640-XPET	Innco System	Antenna Master	MA4640/652/43100318/P	N/A
HLP-2008	TDK	Hybrid Antenna	131316	Feb. 27, 2020 (2Y)
AH-118	Com-Power	Horn Antenna	10050061	Oct. 15, 2021 (1Y)
BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170178	Jan. 06, 2022 (1Y)
FMZB 1513	Schwarzbeck	Loop Antenna	1513-235	Mar. 24, 2020 (2Y)