

RADIO PERFORMANCE TEST REPORT

Test Report No. : OT-21N-RWD-057

Reception No. : 2110004459

Applicant : Hitachi-LG Data Storage Korea, Inc.

Address : (Gasam-dong), 189, Gasandigital1-ro, Geumcheon-gu, Seoul, Korea

Manufacturer : Hitachi-LG Data Storage Korea, Inc.

Address : (Gasam-dong), 189, Gasandigital1-ro, Geumcheon-gu, Seoul, Korea

Type of Equipment : Thermal Sensing Terminal

FCC ID. : 2AQ9F-HLT-SDBF1

Model Name : HLT-SDBF1

Multiple Model Name : 29KC5P2J-W

Serial number : N/A

Total page of Report : 78 pages (including this page)

Date of Incoming : October 11, 2021

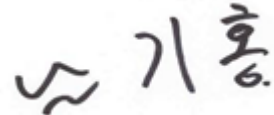
Date of issue : November 29, 2021

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.



Tested by	Reviewed by	Approved by
/Joon-Woo, Kim / Assistant Manager	/ Tae-Ho, Kim / Senior Manager	/ Ki-Hong, Nam / General Manager
ONETECH Corp.	ONETECH Corp.	ONETECH Corp.

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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-21N-RWD-057	November 29, 2021	Initial Release	All

1. VERIFICATION OF COMPLIANCE

Applicant : Hitachi-LG Data Storage Korea, Inc.
 Address : (Gasan-dong), 189, Gasandigital1-ro, Geumcheon-gu, Seoul, Korea
 Contact Person : Young-Jae Lee / Chief research engineer
 Telephone No. : +82-10-5295-2800
 FCC ID : 2AQ9F-HLT-SDBF1
 Model Name : HLT-SDBF1
 Brand Name : LG Electronics USA
 Serial Number : N/A
 Date : November 29, 2021

EQUIPMENT CLASS	DTS – DIGITAL TRNSMISSION SYSTEM
E.U.T. DESCRIPTION	Modular Transmitter, Thermal Sensing Terminal
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 Conducted(average) 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	Met the Limit / PASS
15.203	Antenna Requirement	Met requirement / PASS

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

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3. GENERAL INFORMATION

3.1 Product Description

The Hitachi-LG Data Storage Korea, Inc., Model HLT-SDBF1 (referred to as the EUT in this report) is a Thermal Sensing Terminal. The product specification described herein was obtained from product data sheet or user's manual.

Device Type	Thermal Sensing Terminal	
Operating Frequency	Bluetooth	2 402 MHz ~ 2 480 MHz
	Bluetooth LE	2 402 MHz ~ 2 480 MHz
	WLAN 2.4 GHz	2 412 MHz ~ 2 462 MHz (802.11b/g/n(HT20))
		2 422 MHz ~ 2 452 MHz (802.11n(HT40))
RF Output Power	Bluetooth	7.86 dBm
	Bluetooth LE	2.31 dBm
	WLAN 2.4 GHz	9.17 dBm(802.11b)
		5.30 dBm(802.11g)
Modulation Type	Bluetooth	GFSK for 1 Mbps, $\pi/4$ -DQPSK for 2 Mbps, 8-DPSK for 3 Mbps
	Bluetooth LE	GFSK
	WLAN 2.4 GHz	802.11b: DSSS Modulation(DBPSK/DQPSK/CCK)
		802.11g/n(HT20)/n(HT40): OFDM Modulation(BPSK/QPSK/16QAM/64QAM)
Antenna Type	PCB Antenna	
Antenna Gain	1.16 dBi	
Rated Supply Voltage	DC 12 V	
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)	24 MHz	

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

-. The following lists consist of the added model and their differences.

Model Name	Differences	Tested
HLT-SDBF1	Basic Model	☒
29KC5P2J-W	This model is identical to the basic model except for the difference of the Vendor (LG) [See Note 3]	☐

Note: 1. Applicant consigns only basic model to test. Therefore this test report just guarantees the units, which have been tested.

2. The Applicant/manufacturer is responsible for the compliance of all variants.

3. General product information and other remarks:

This product also included the stand as optional as follows;

- 1) Floor Stand(HLT-USBL2) for brand Hitachi-LG Data Storage
- 2) Floor Stand(ST-290FL(Stand Pole) & ST-290FP(Stand Plate)) for brand LG.

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	Hitachi-LG Data Storage Korea, Inc.	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
HLT-SDBF1	Hitachi-LG Data Storage Korea, Inc.	Thermal Sensing Terminal (EUT)	-
HP Probook	HP	Notebook PC	EUT
DZ048BHL120400V	KOORDA	AC Adapter	Notebook PC

5.3 Mode of operation during the test

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

-. Frequency / Channel Operations

Channel	Frequency
1	2 412
2	2 417
3	2 422
4	2 427
5	2 432
6	2 437
7	2 442
8	2 447
9	2 452
10	2 457
11	2 462

Modulation	DATA RATE	OUTPUT POWER[dBm]
802.11 b (Low Channel)	1 Mbps	9.83
	2 Mbps	9.80
	5.5 Mbps	9.72
	11 Mbps	9.66
802.11 g (Low Channel)	6 Mbps	6.13
	9 Mbps	6.05
	12 Mbps	6.00
	18 Mbps	5.99
	24 Mbps	5.87
	36 Mbps	5.85
	48 Mbps	5.80
	54 Mbps	5.66
802.11 HT 20 (Low Channel)	6.5 Mbps	5.61
	13 Mbps	5.55
	19.5 Mbps	5.50
	26 Mbps	5.46
	39 Mbps	5.40
	52 Mbps	5.28
	58.5 Mbps	5.15
	65 Mbps	5.11
802.11 HT 40 (Low Channel)	13.5 Mbps	3.80
	27 Mbps	3.73
	40.5 Mbps	3.66
	54 Mbps	3.61
	81 Mbps	3.50
	108 Mbps	3.43
	121.5 Mbps	3.40
	135 Mbps	3.29

-. 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, 13.5 Mbps for HT40.

-. 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.

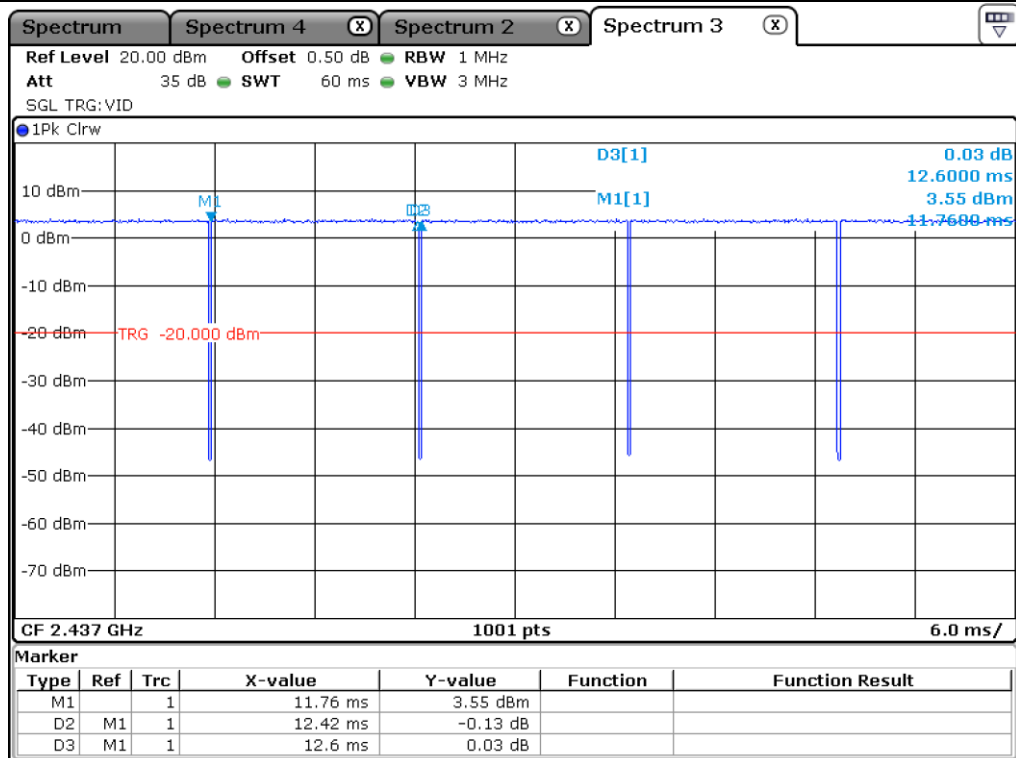
- Duty Cycle

Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
802.11 b	12.42	12.60	98.57	0.06
802.11 g	2.04	2.232	91.40	0.39
802.11 HT 20	1.9056	2.0464	93.12	0.31
802.11 HT 40	0.9066	1.0159	89.24	0.49

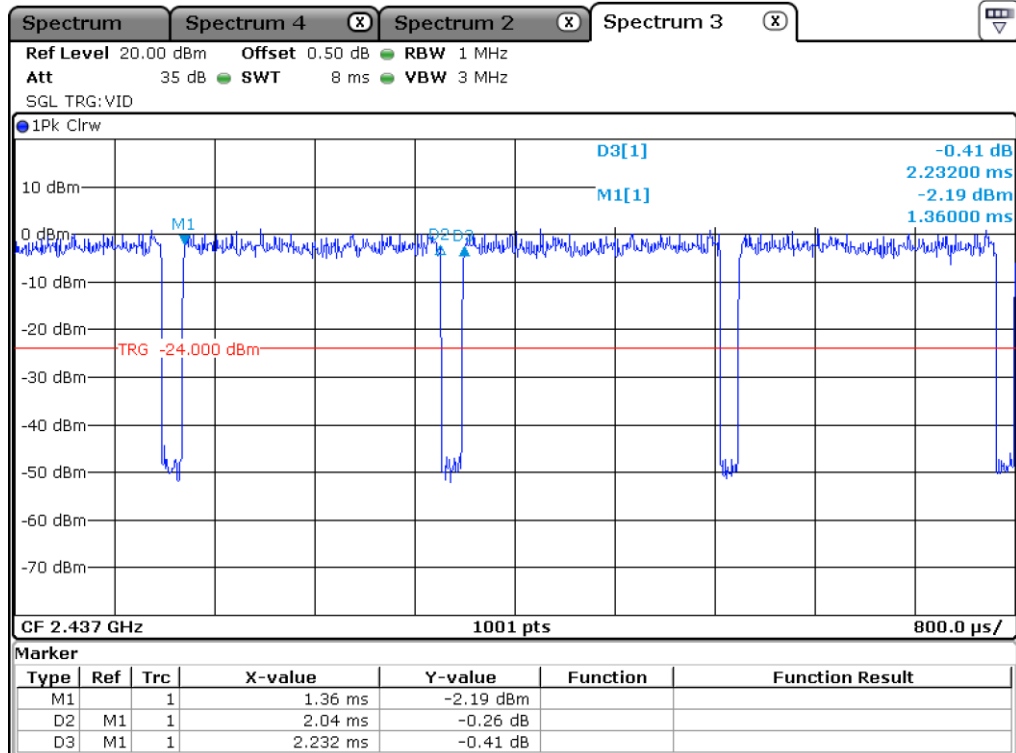
Note – Duty Cycle : (Tx On Time / (Tx On Time + Tx Off Time)) * 100

Correction Factor : $10 * \text{Log}(1 / (\text{Duty Cycle} / 100))$

- Test Plot



802.11 b



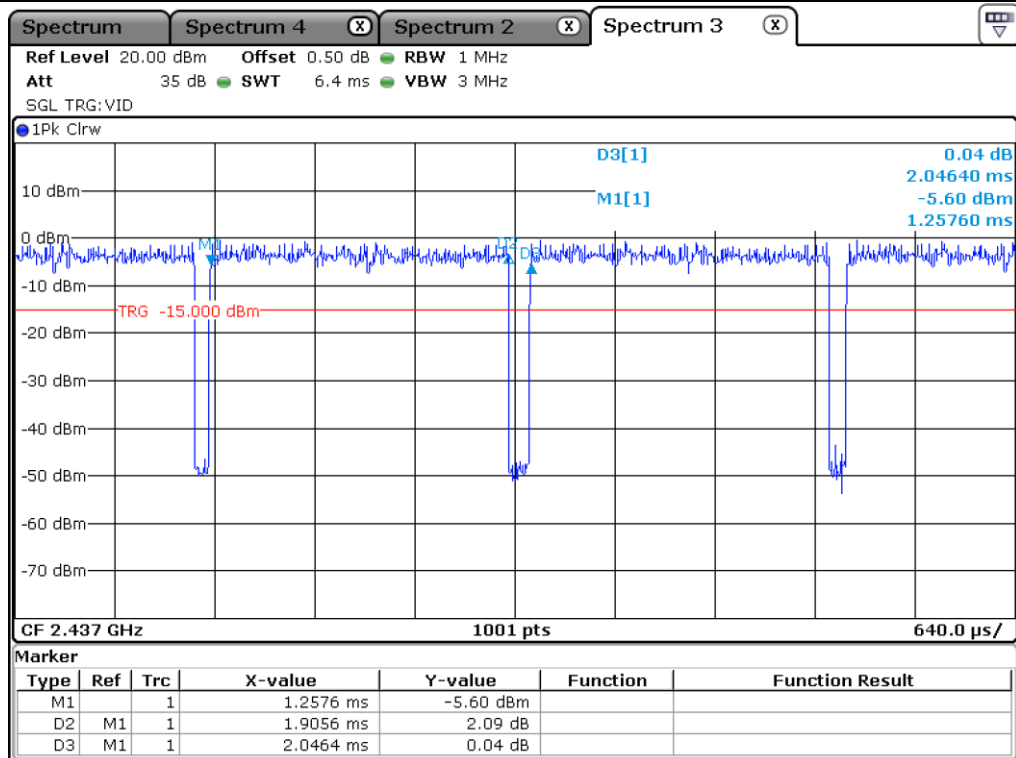
802.11 g

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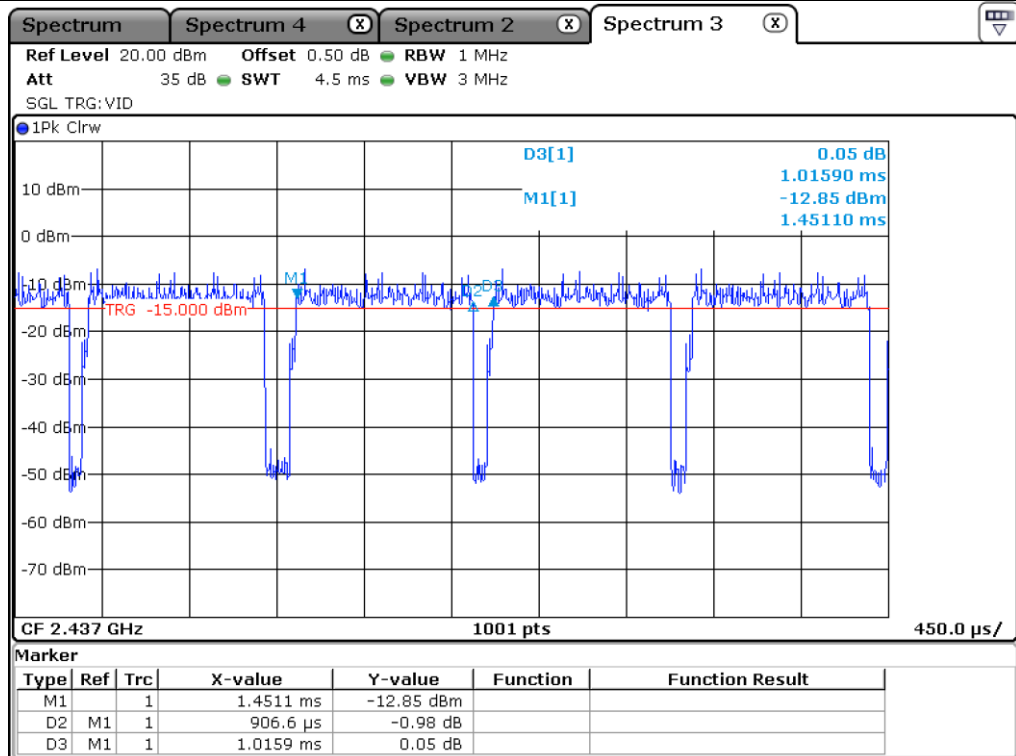
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802.11 HT 20



802.11 HT 40

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5.4 Configuration of Test System

Line Conducted Test: The EUT was tested in the Transmitting mode. All supporting equipment were connected to another LISN. Preliminary Power line Conducted Emission test was performed by using the procedure in ANSI C63.10: 2020 to determine the worse operating conditions.

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 PCB Antenna on the main board in the EUT, 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)
Transmitting Mode	X

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

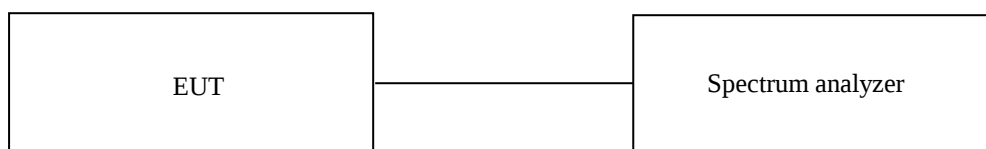
7. MINIMUM 6 dB BANDWIDTH

7.1 Operating environment

Temperature : 22.5 °C
Relative humidity : 46.7 % 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

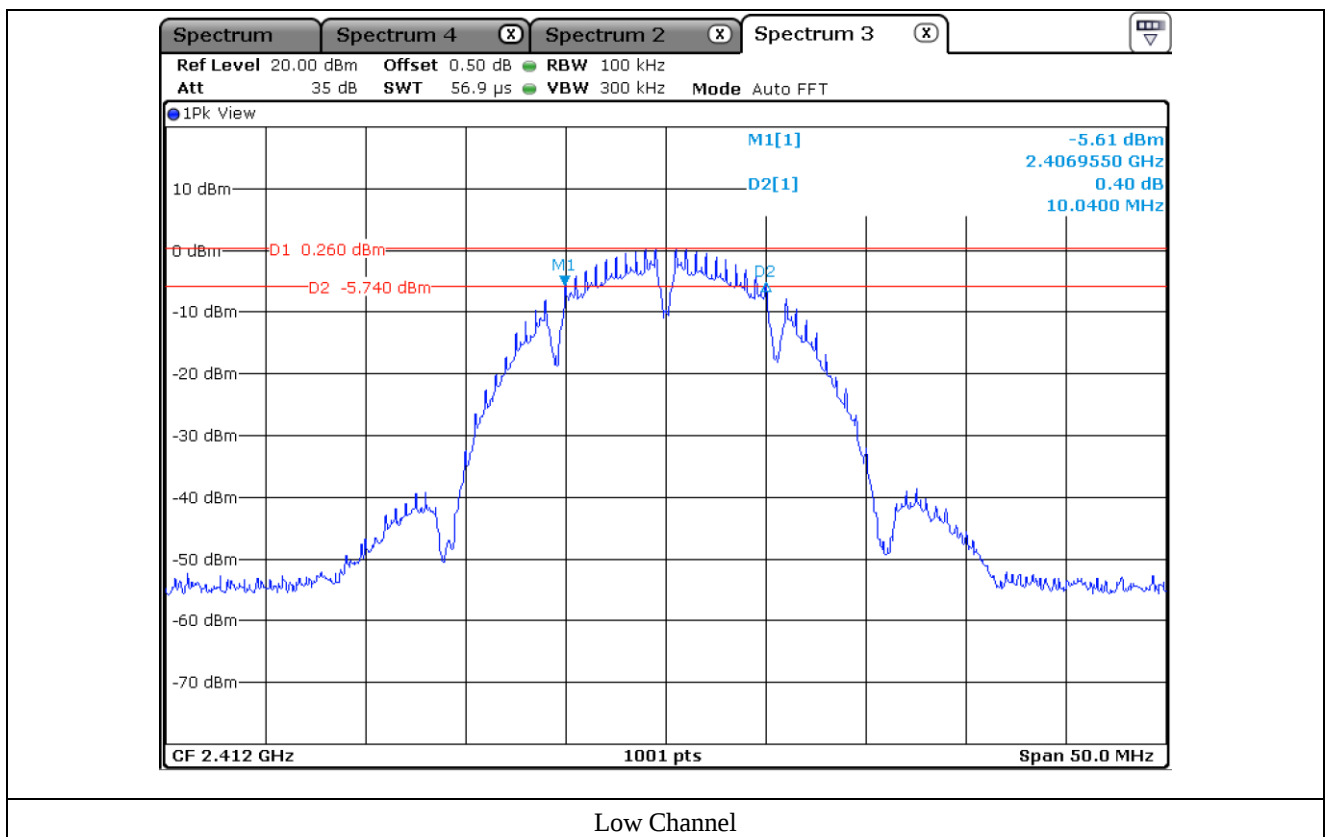
November 26, 2021

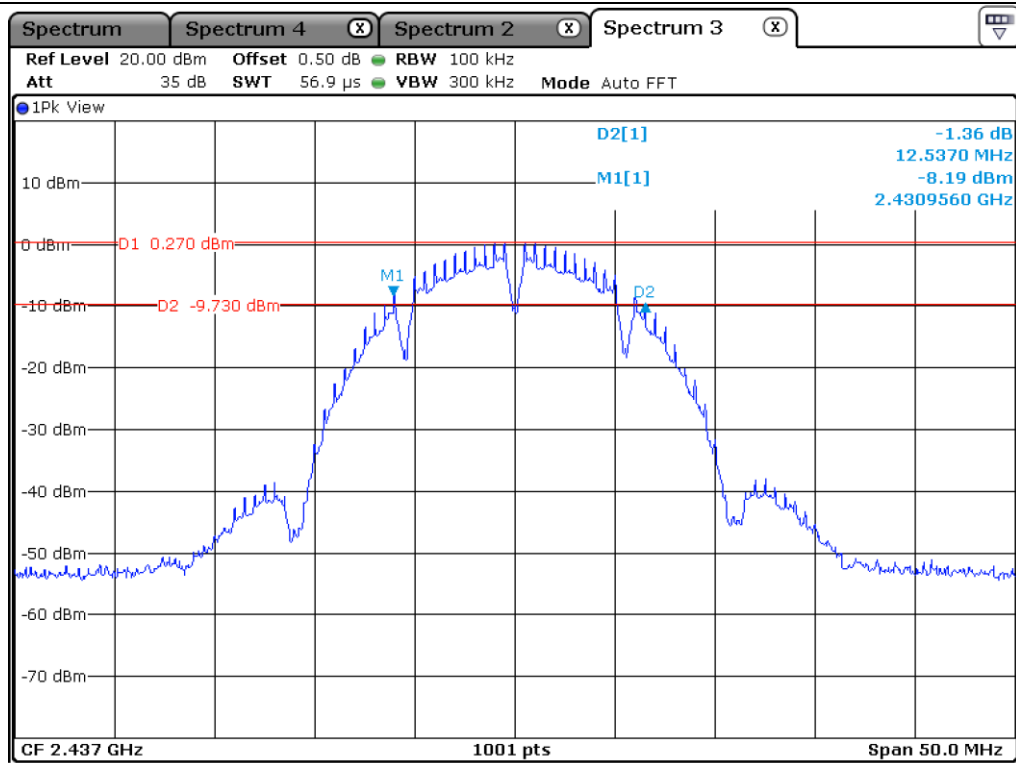
7.4 Test data for 802.11b WLAN Mode

-. Test Result : Pass

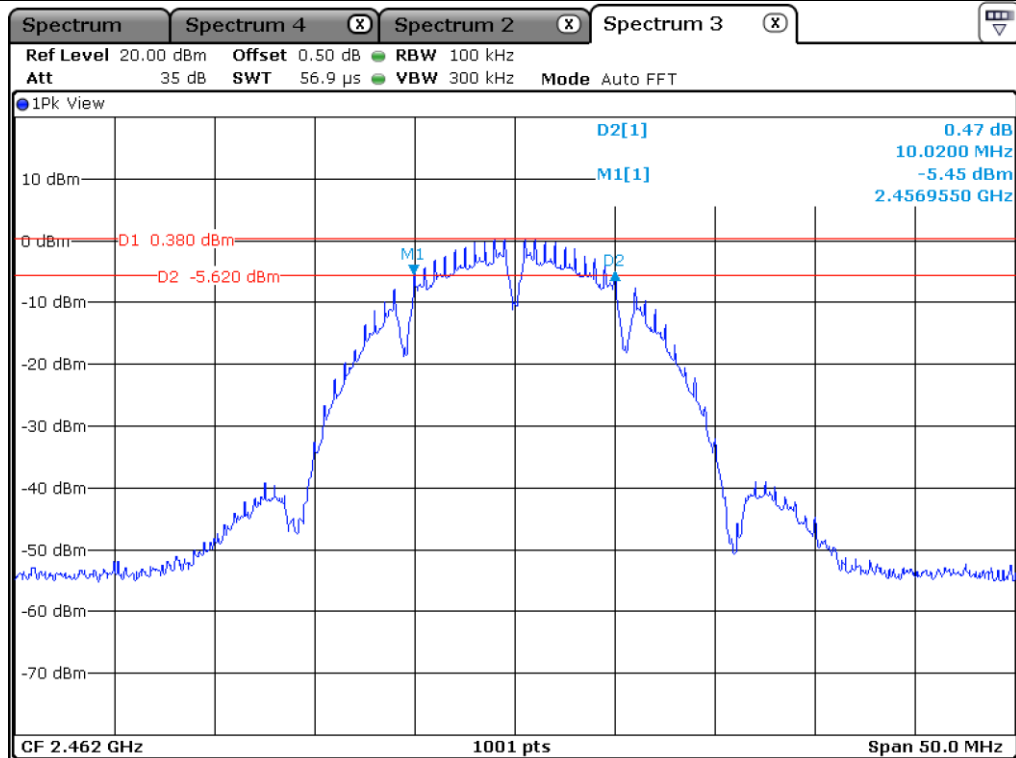
CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412.00	10.04	0.50	9.54
Middle	2 437.00	12.54	0.50	12.04
High	2 462.00	10.02	0.50	9.52

Remark. Margin = Measured Value - Limit





Middle Channel



High Channel

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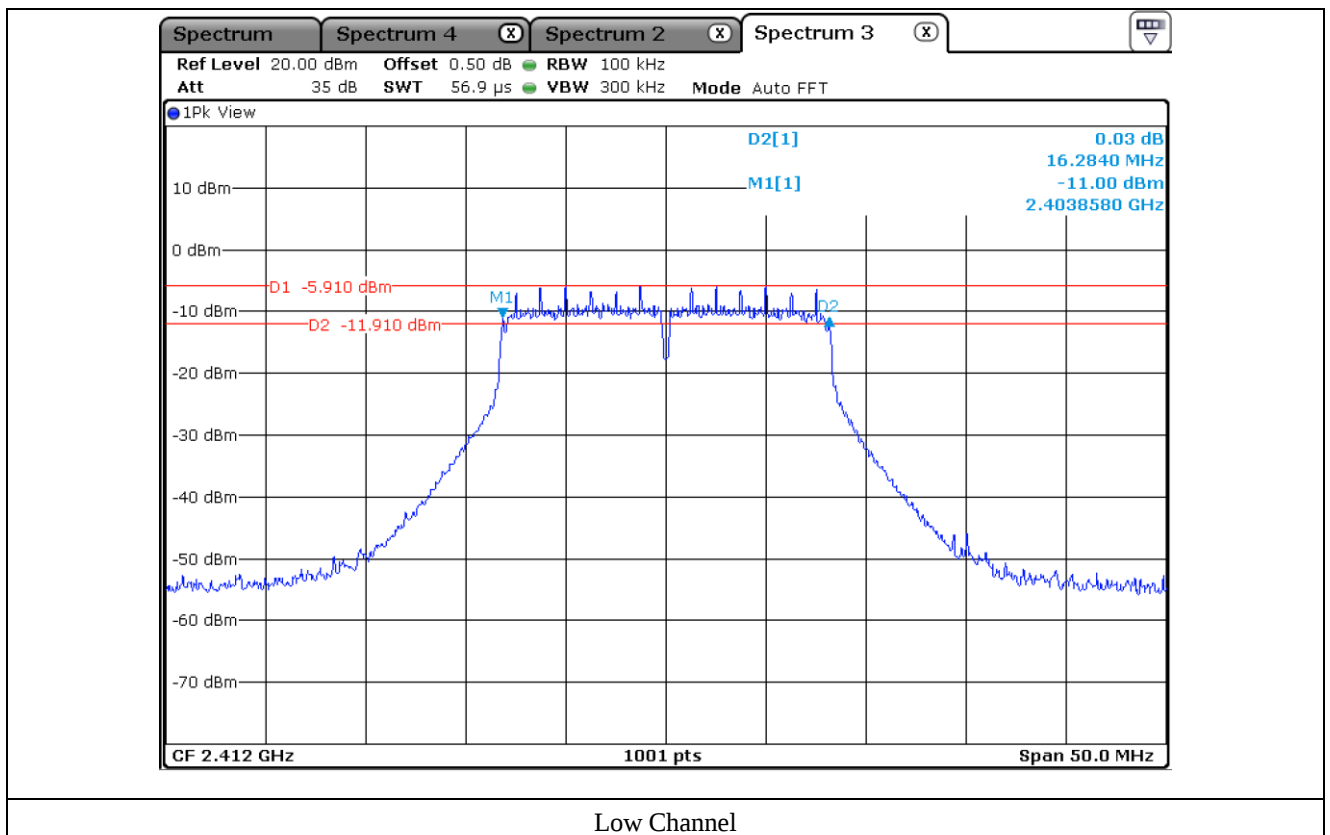
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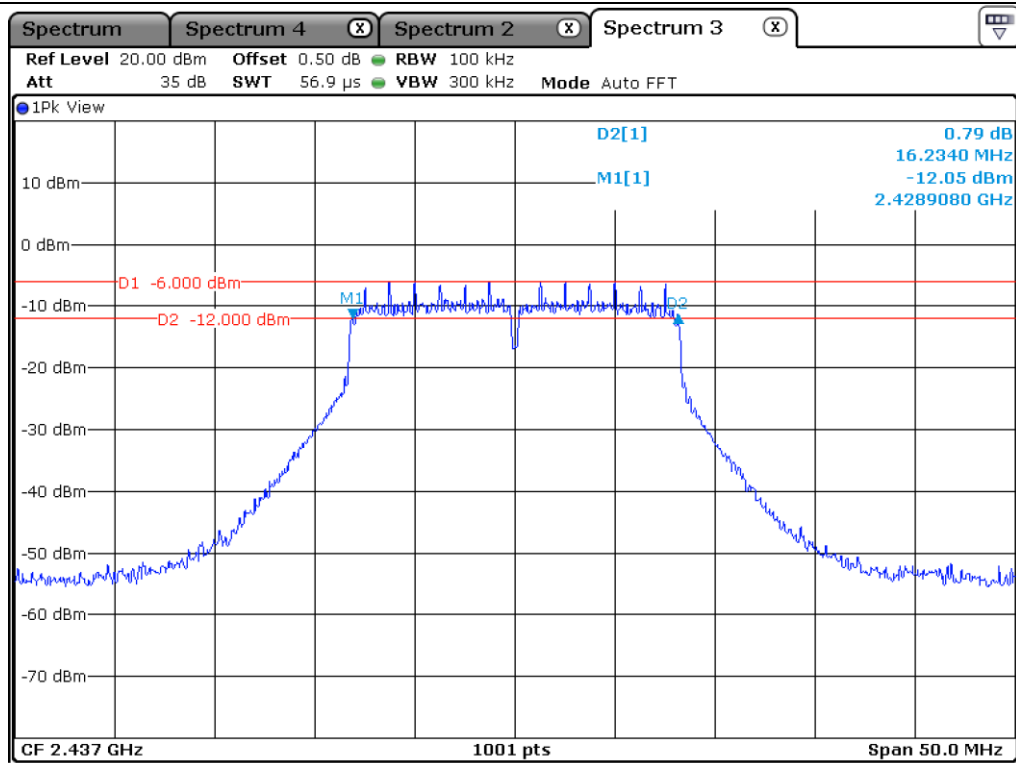
7.5 Test data for 802.11g WLAN Mode

-. Test Result : Pass

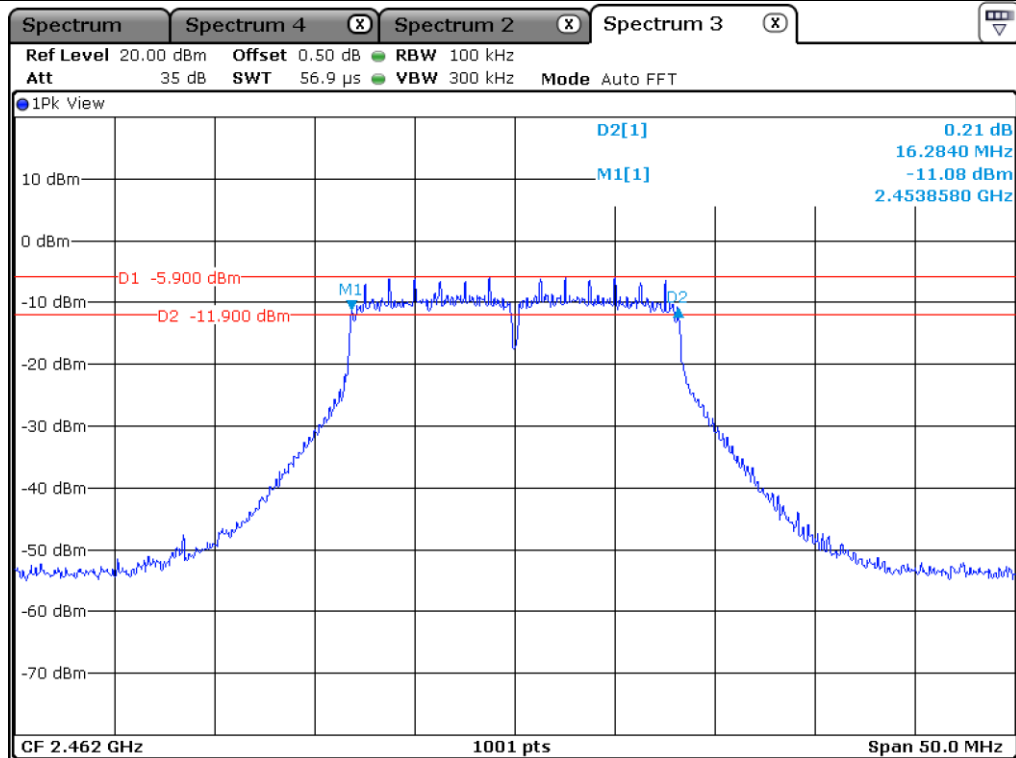
CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412.00	16.28	0.50	15.78
Middle	2 437.00	16.23	0.50	15.73
High	2 462.00	16.28	0.50	15.78

Remark. Margin = Measured Value - Limit





Middle Channel



High Channel

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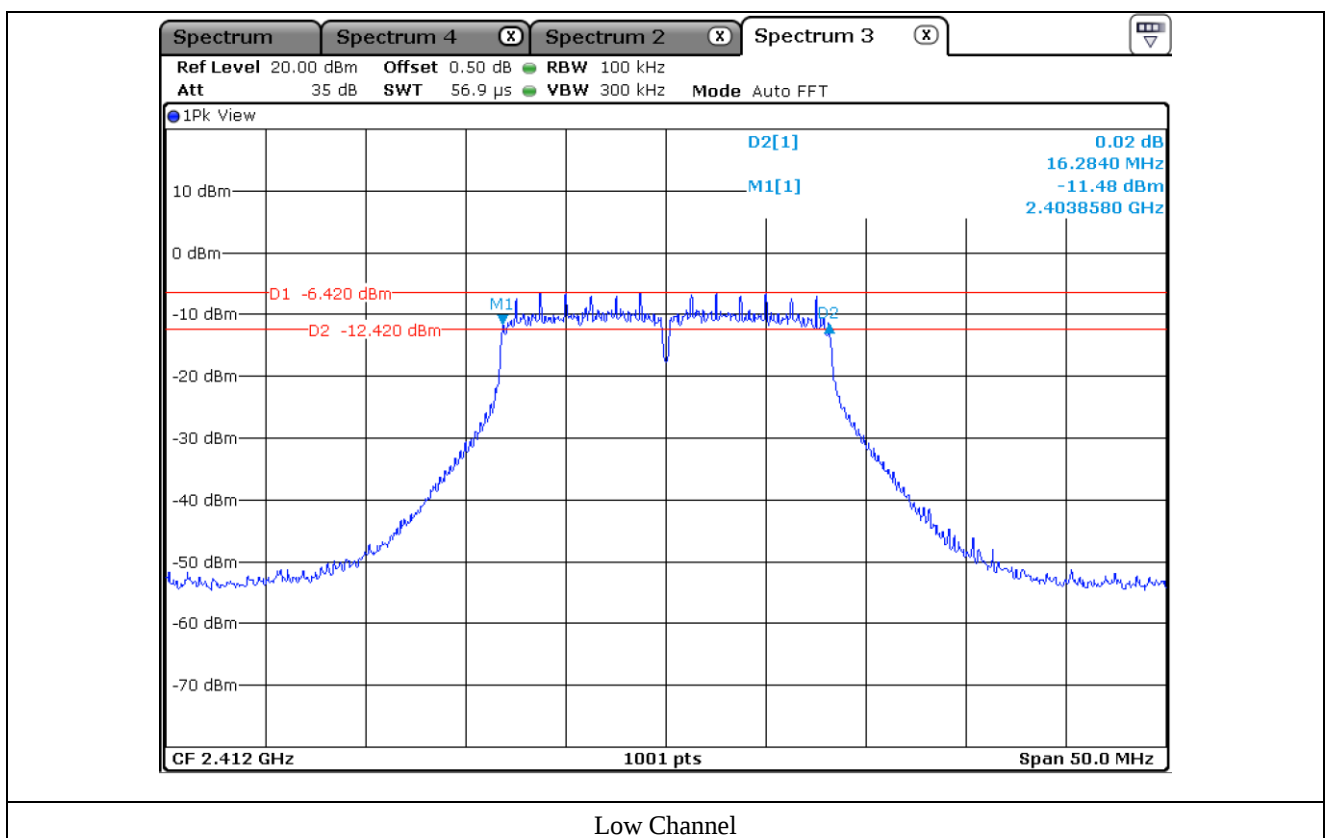
ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

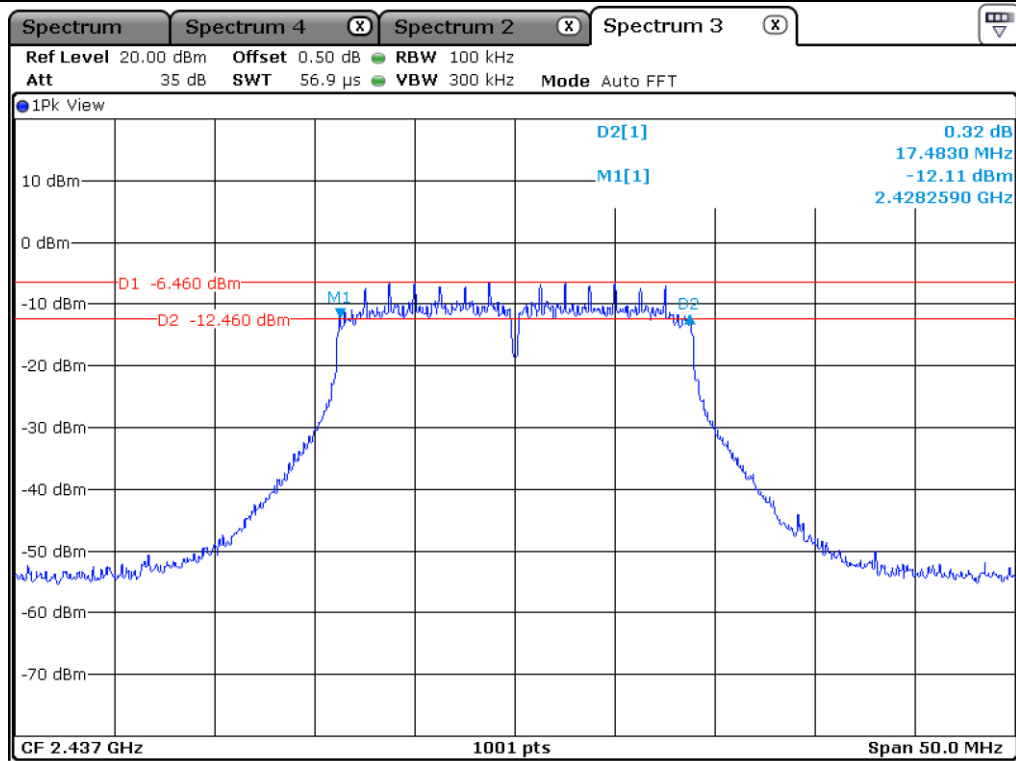
7.6 Test data for 802.11n_HT20 WLAN Mode

-. Test Result : Pass

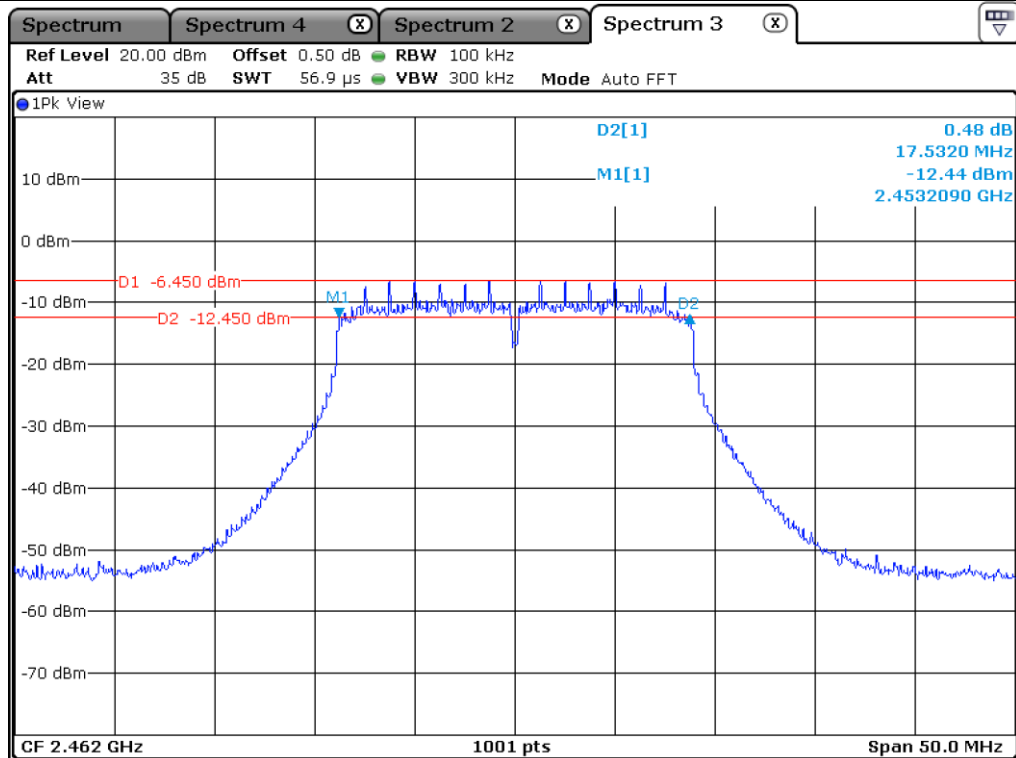
CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412.00	16.28	0.50	15.78
Middle	2 437.00	17.48	0.50	16.98
High	2 462.00	17.53	0.50	17.03

Remark. Margin = Measured Value - Limit





Middle Channel



High Channel

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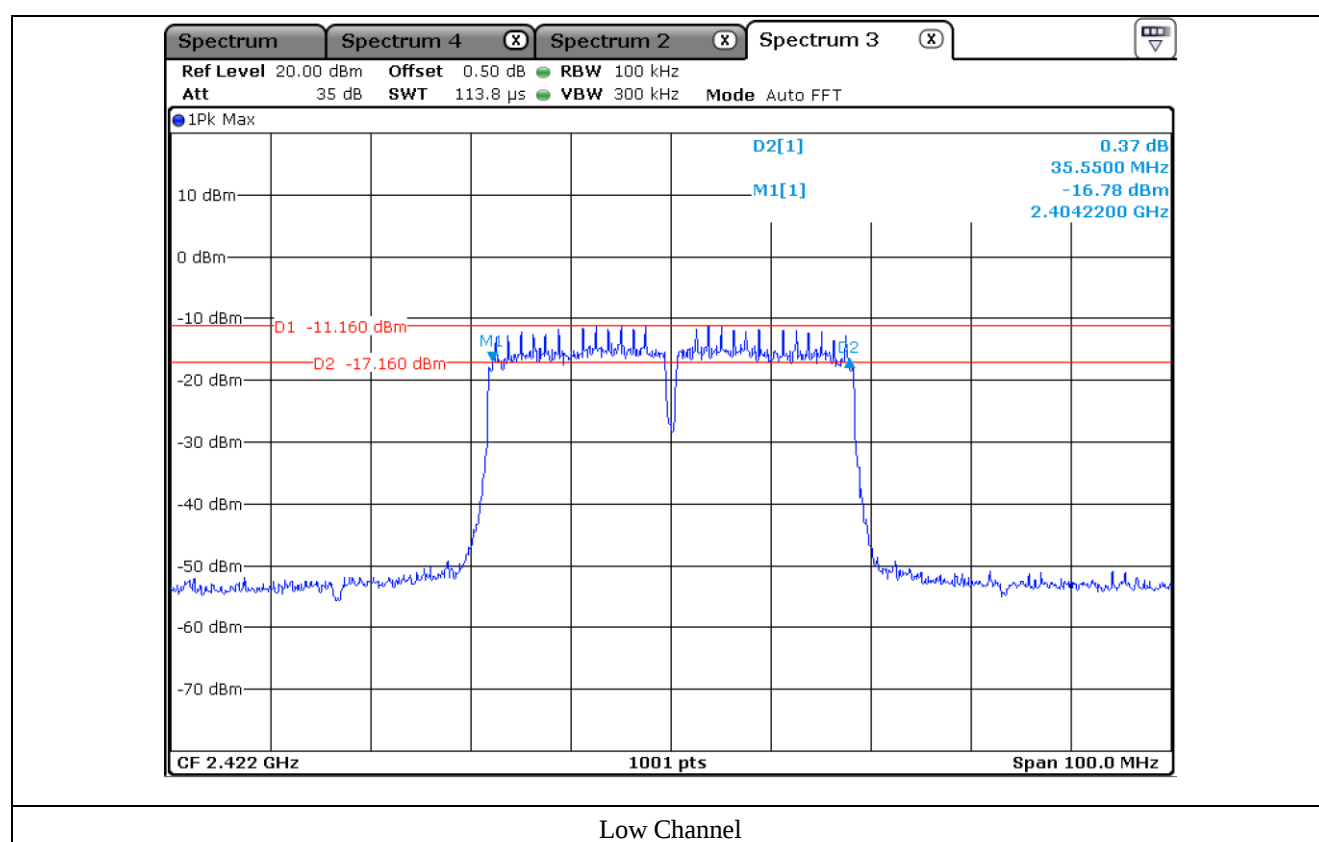
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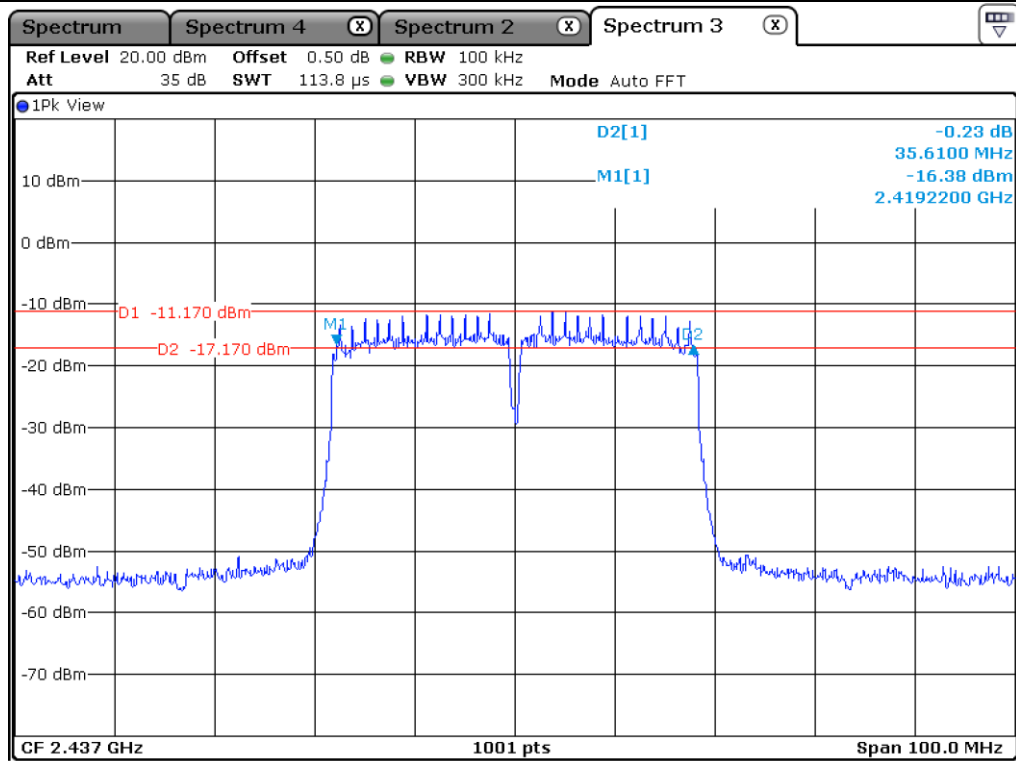
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-. Test Result : Pass

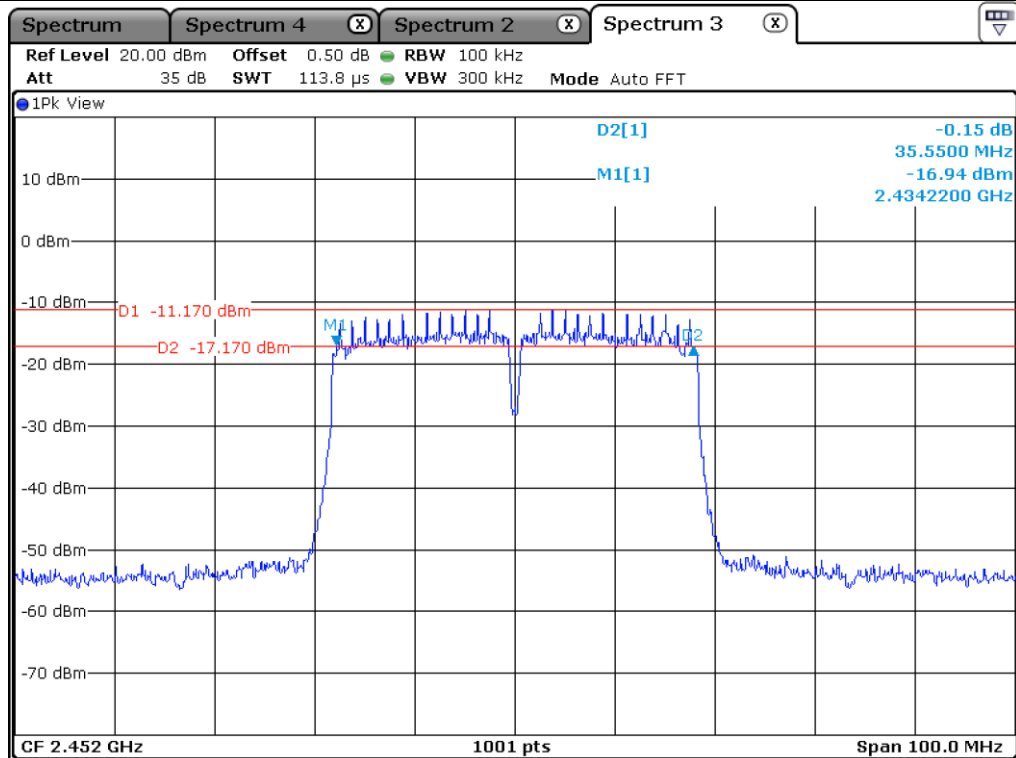
CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412.00	35.55	0.50	35.05
Middle	2 437.00	35.61	0.50	35.11
High	2 452.00	35.55	0.50	35.05

Remark. Margin = Measured Value - Limit





Middle Channel



High Channel

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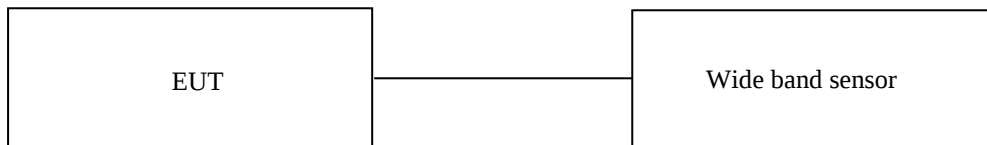
8. MAXIMUM CONDUCTED (AVERAGE) OUTPUT POWER

8.1 Operating environment

Temperature : 22.5 ° C
Relative humidity : 46.7 % R.H.

8.2 Test set-up

The maximum peak output power was measured with the wide band sensor connected to the antenna output of the EUT.
The Wide Band Sensor is measured when the EUT is transmitting at the appropriate center frequency its maximum power control level as described in Section 8.3(558074 D01 15.247 Meas Guidance v05r02).
Since this measurement is made only during the ON time of the transmitter, no duty cycle correction is required.



8.3 Test Date

November 26, 2021

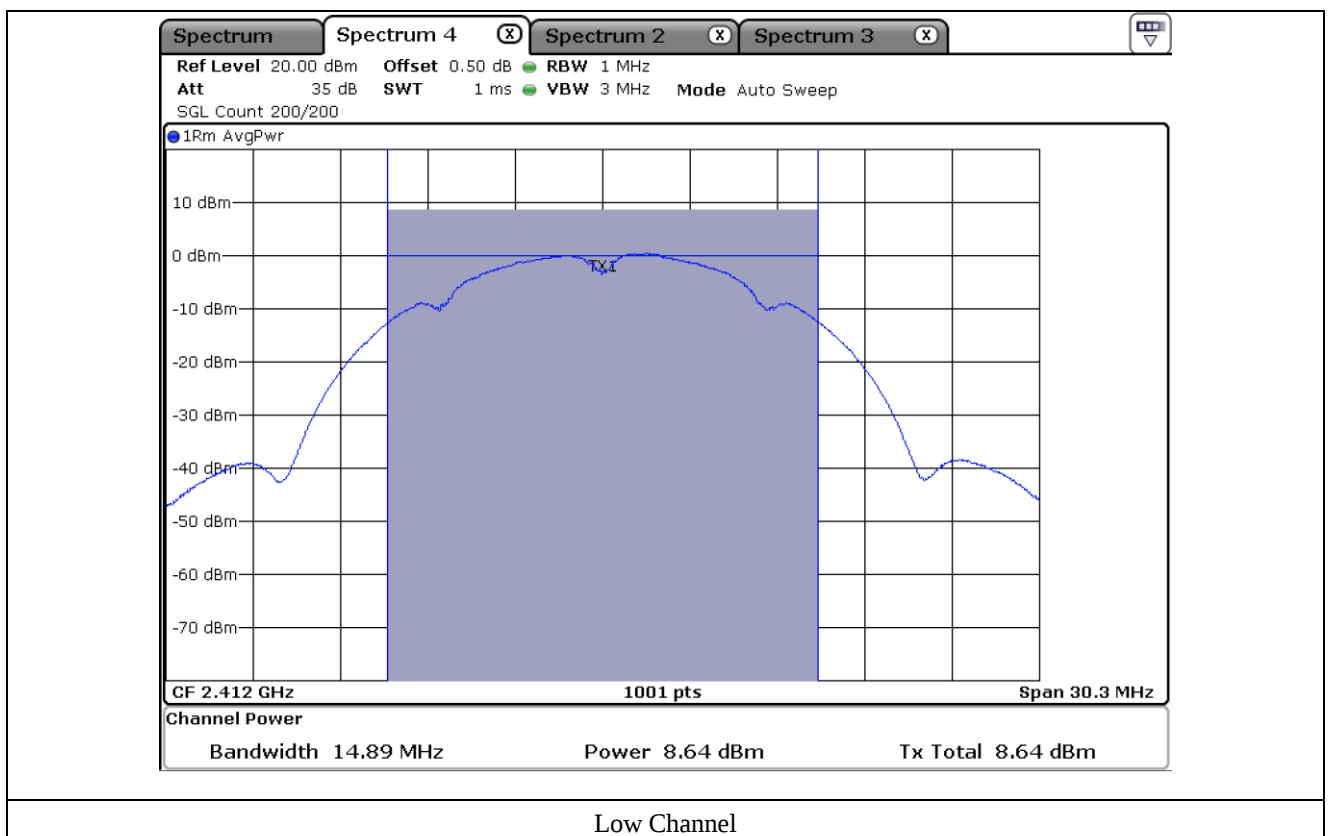
8.4 Test data for 802.11b WLAN Mode

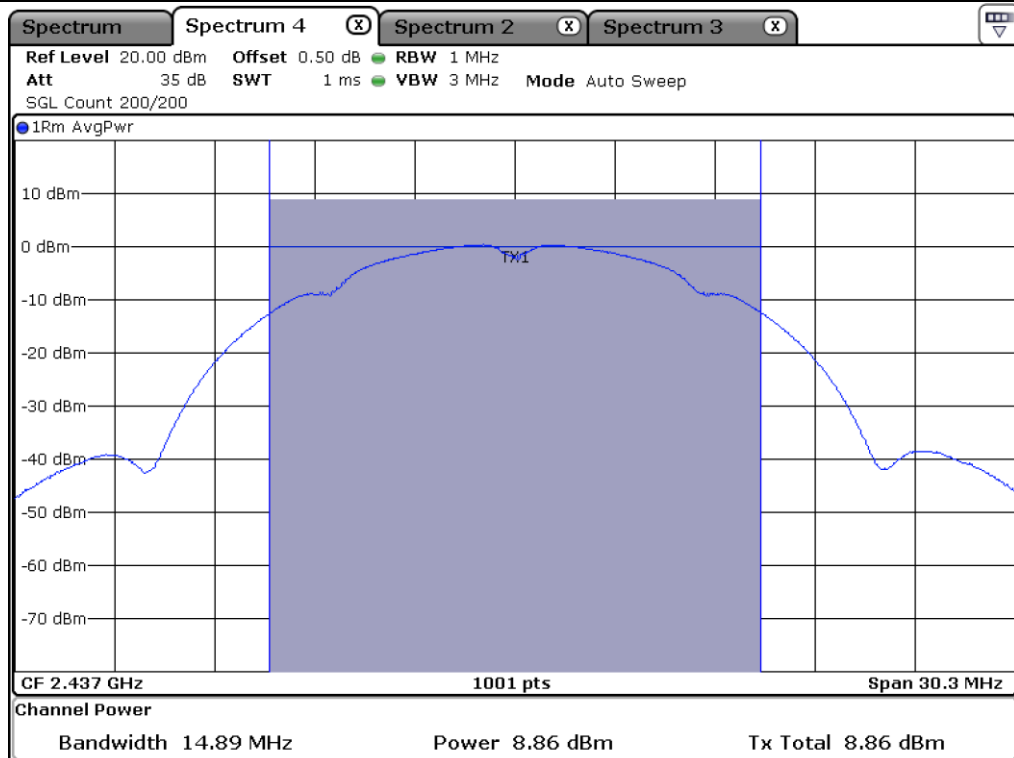
-. Test Result : Pass

-. Duty Cycle : 98.57 %

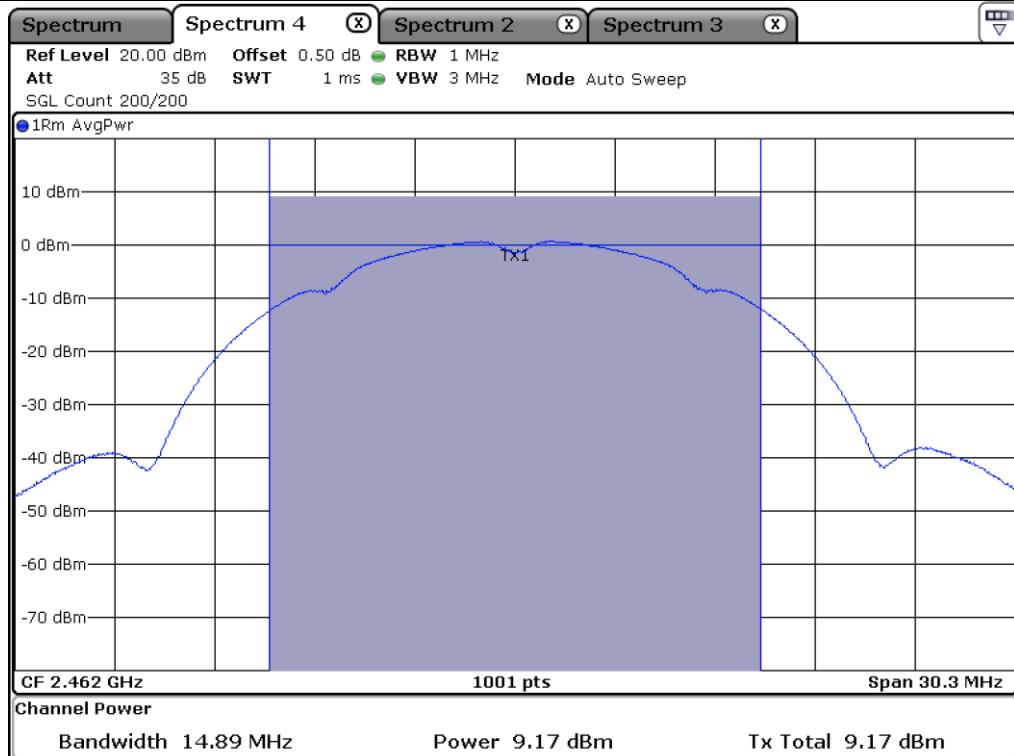
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	8.64	30.00	21.36
MIDDLE	2 437.00	8.86	30.00	21.14
HIGH	2 462.00	9.17	30.00	20.83

Remark : Margin = Limit – Measured Value (=Power Sensor Reading + Cable Loss)





Middle Channel



High Channel

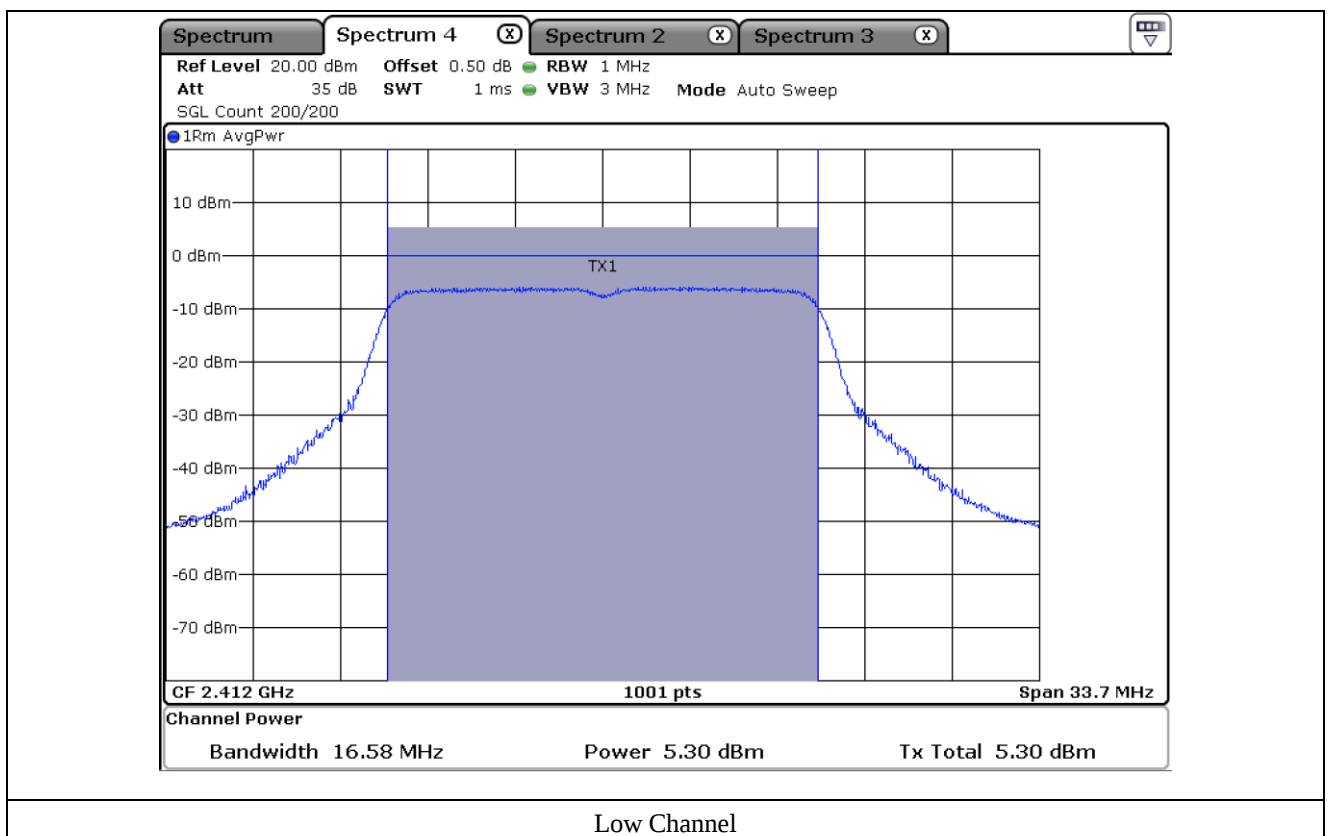
8.5 Test data for 802.11g WLAN Mode

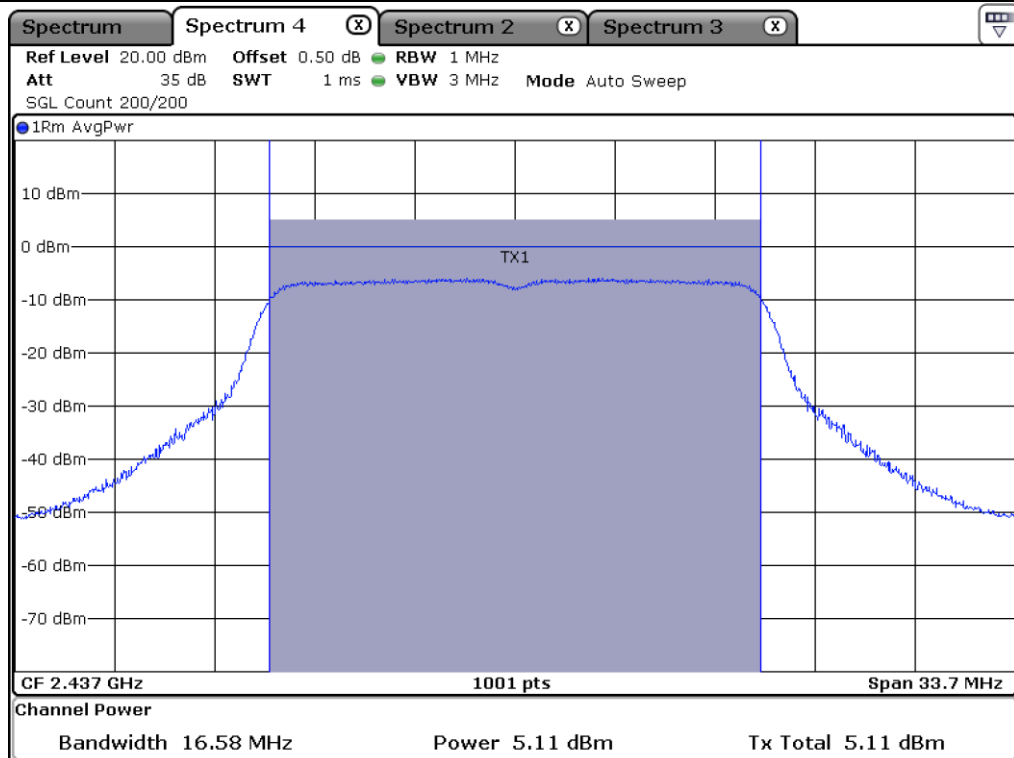
-. Test Result : Pass

-. Duty Cycle : 91.40 %

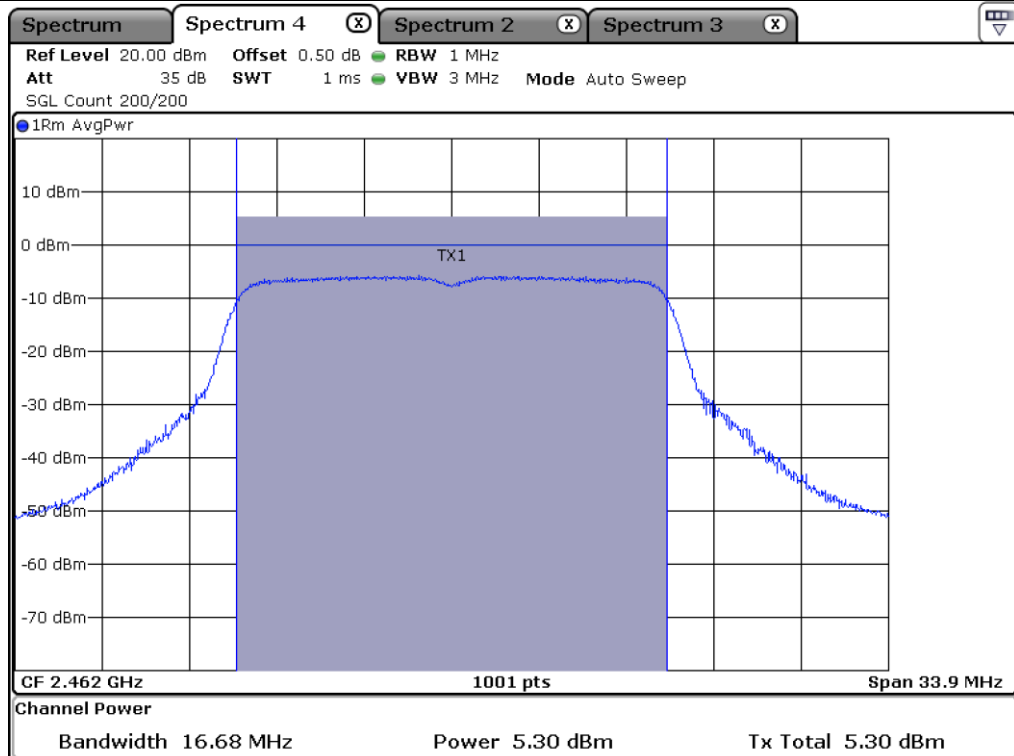
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	5.30	30.00	24.70
MIDDLE	2 437.00	5.11	30.00	24.89
HIGH	2 462.00	5.30	30.00	24.70

Remark : Margin = Limit – Measured Value (=Power Sensor Reading + Cable Loss)





Middle Channel



High Channel

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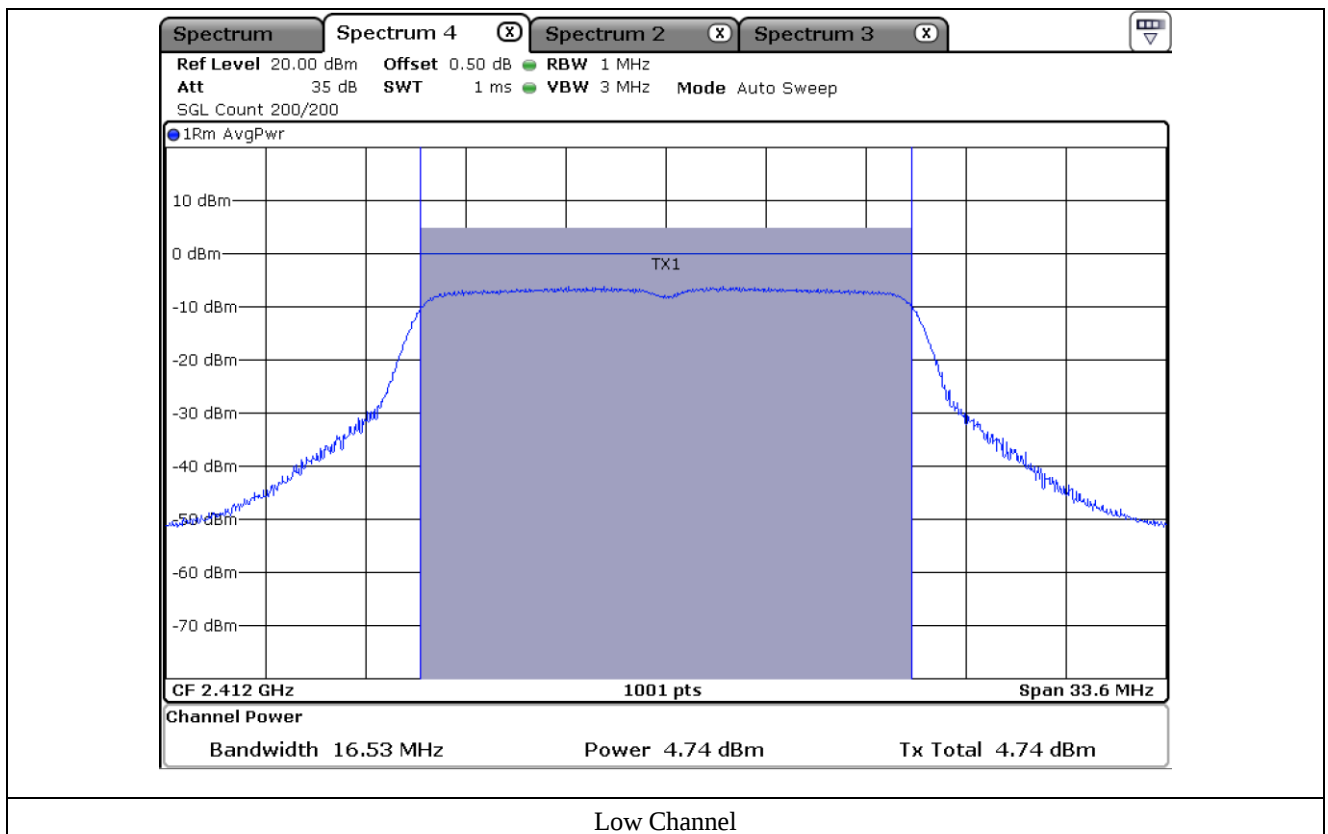
8.6 Test data for 802.11n_HT20 WLAN Mode

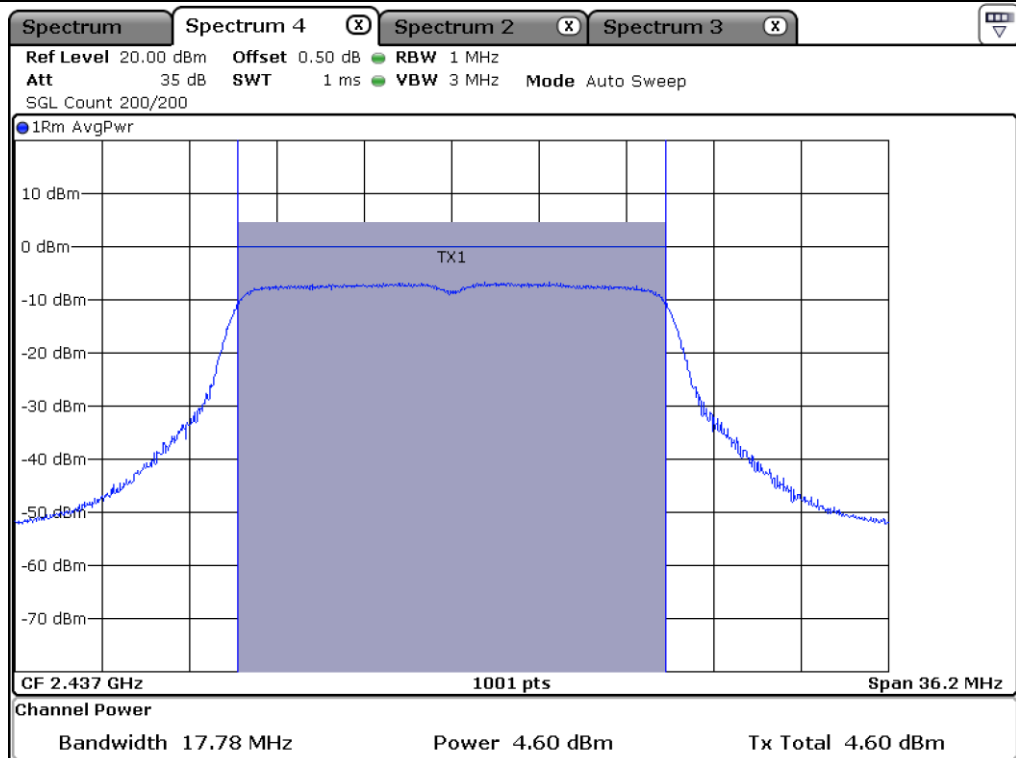
-. Test Result : Pass

-. Duty Cycle : 93.12 %

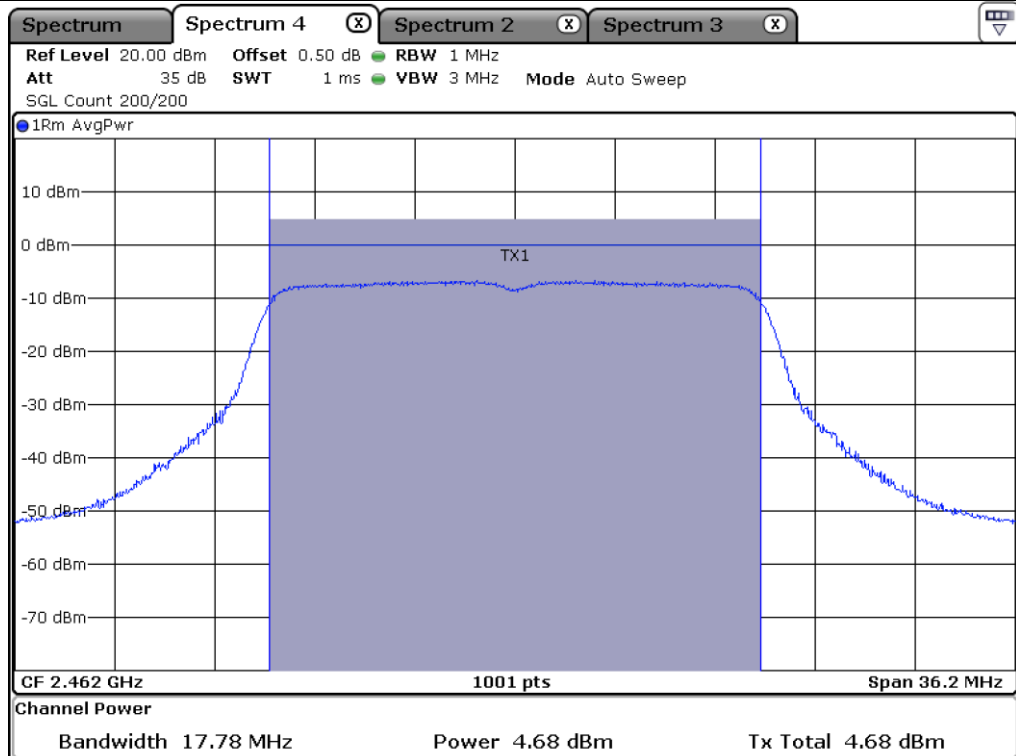
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	4.74	30.00	25.26
MIDDLE	2 437.00	4.60	30.00	25.40
HIGH	2 462.00	4.68	30.00	25.32

Remark : Margin = Limit – Measured Value (=Power Sensor Reading + Cable Loss)





Middle Channel



High Channel

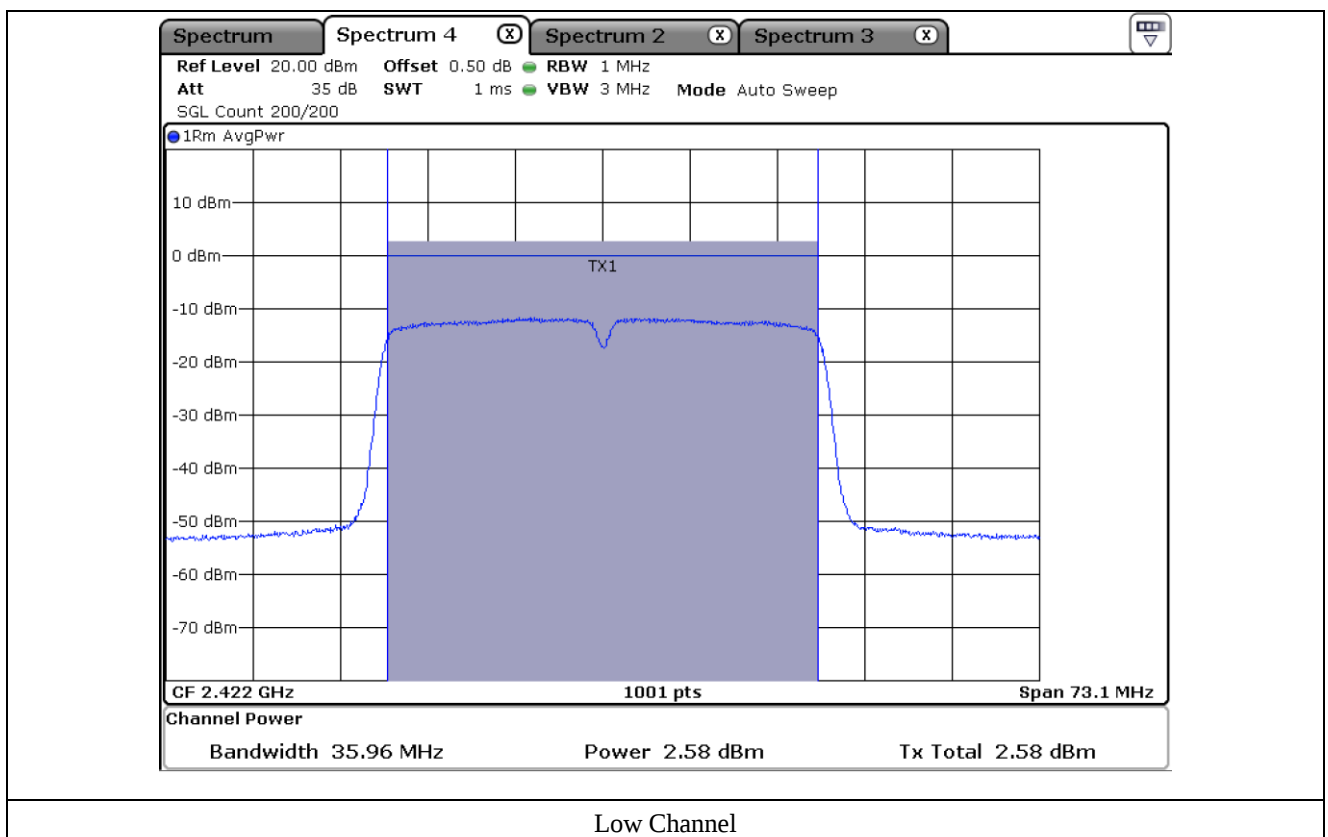
8.7 Test data for 802.11n_HT40 WLAN Mode

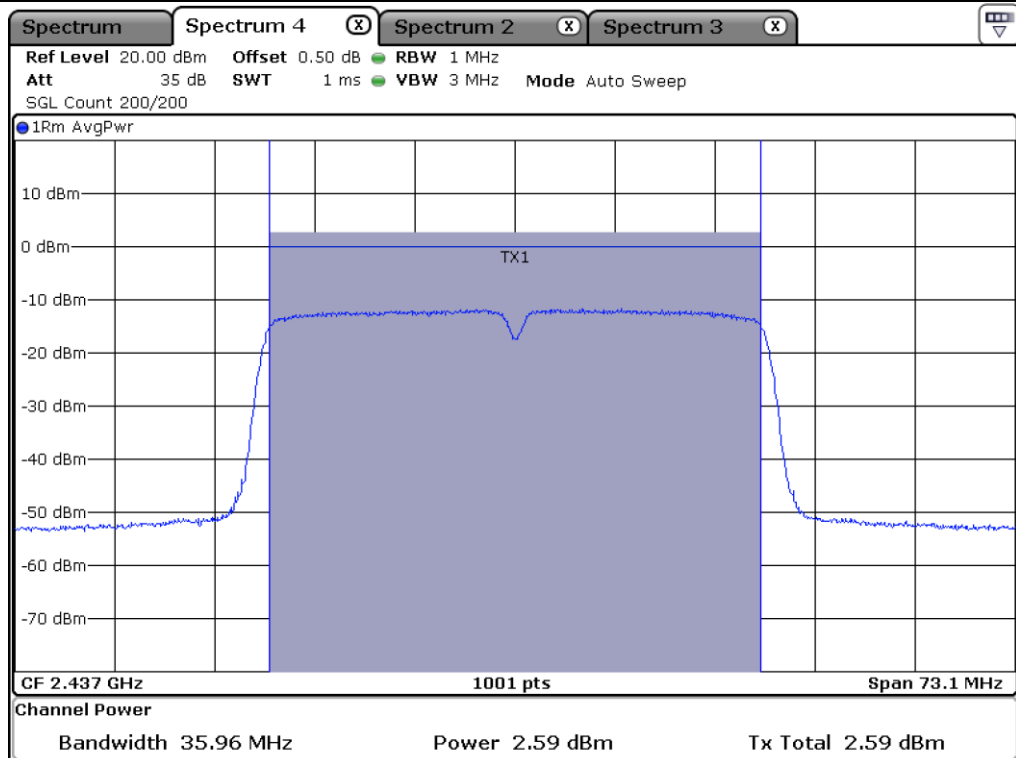
-. Test Result : Pass

-. Duty Cycle : 89.24 %

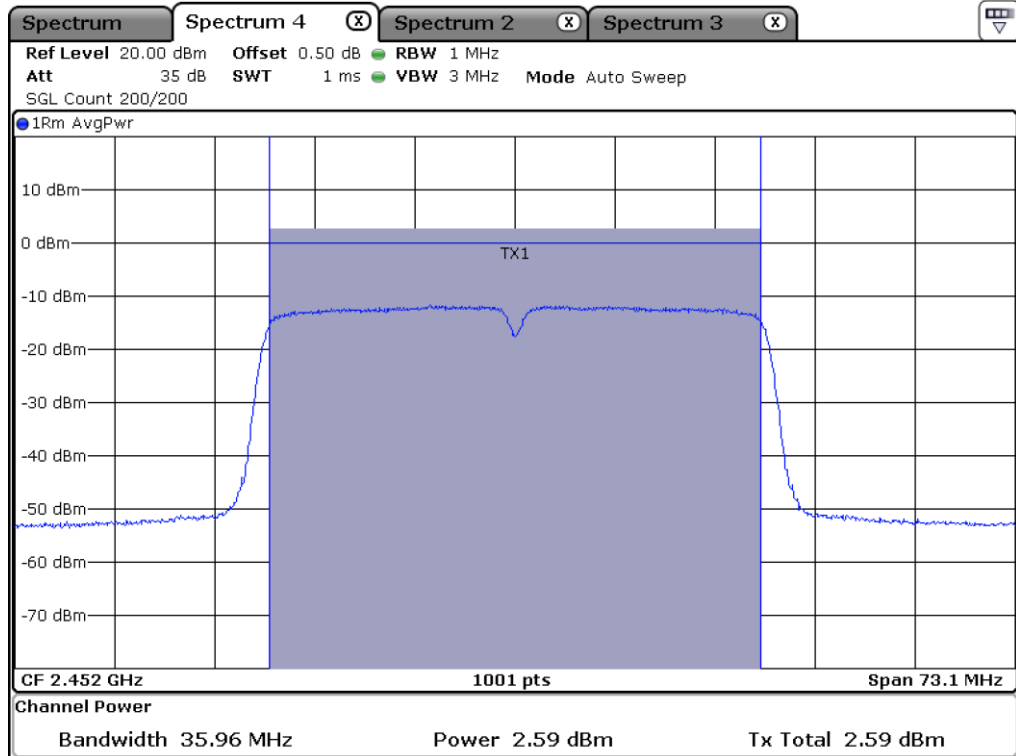
CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 422.00	2.58	30.00	27.42
MIDDLE	2 437.00	2.59	30.00	27.41
HIGH	2 452.00	2.59	30.00	27.41

Remark : Margin = Limit – Measured Value (=Power Sensor Reading + Cable Loss)





Middle Channel



High Channel

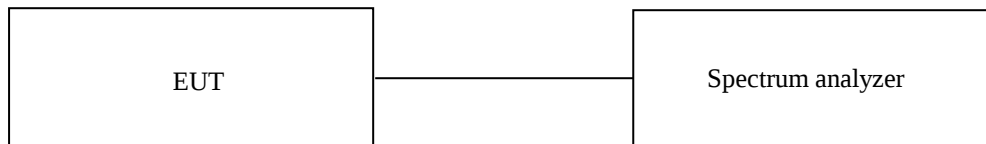
9. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

9.1 Operating environment

Temperature : 22.5 ° C
Relative humidity : 46.7 % R.H.

9.2 Test set-up for conducted measurement

The antenna output of the EUT was connected to the spectrum analyzer. The resolution and video bandwidth is set to 100 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.

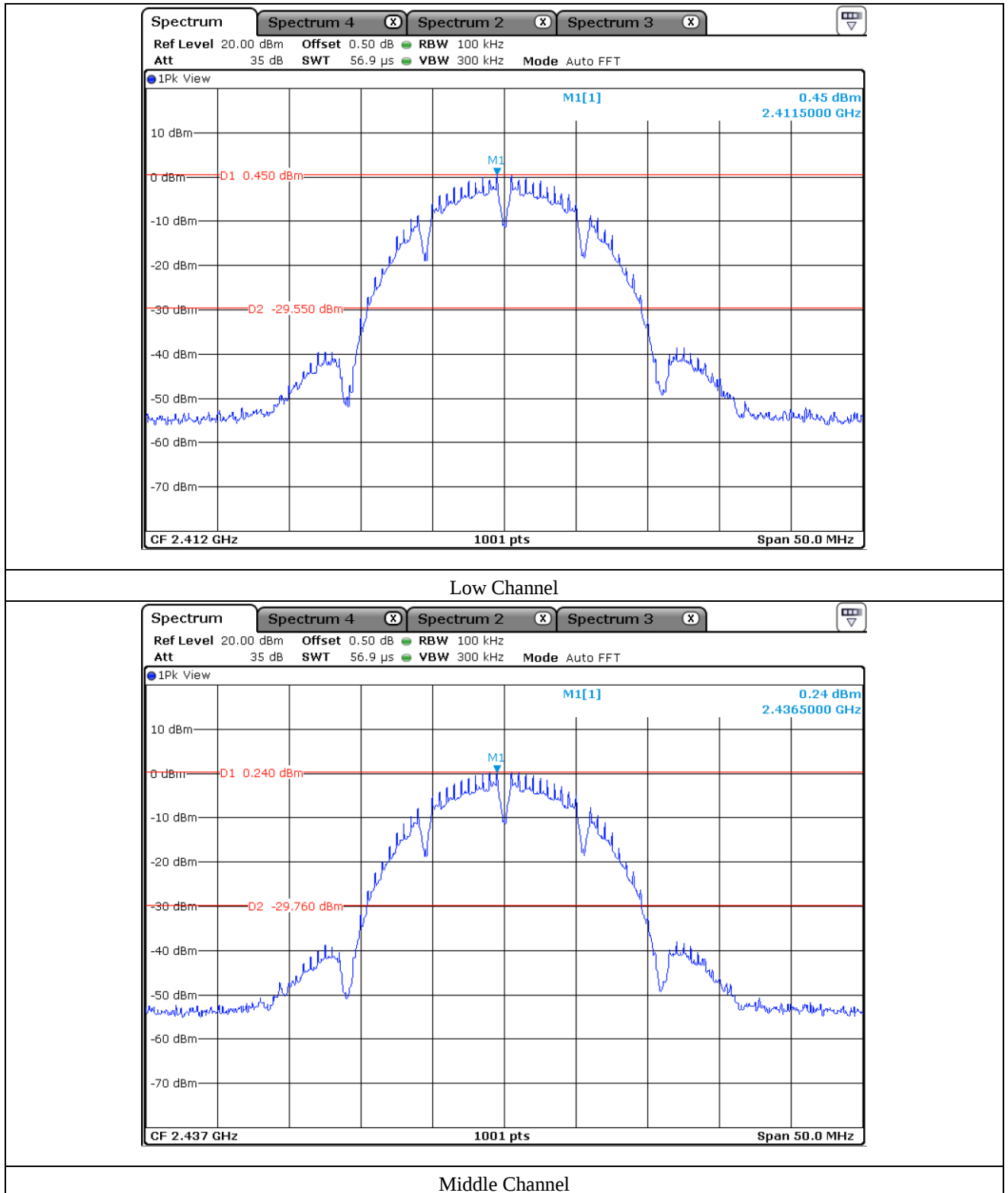
The frequency spectrum from 30 MHz to 26.5 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for horizontal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

9.4 Test Date

November 26, 2021

9.5 Test data for conducted emission

9.5.1 Test data for 802.11b WLAN Mode

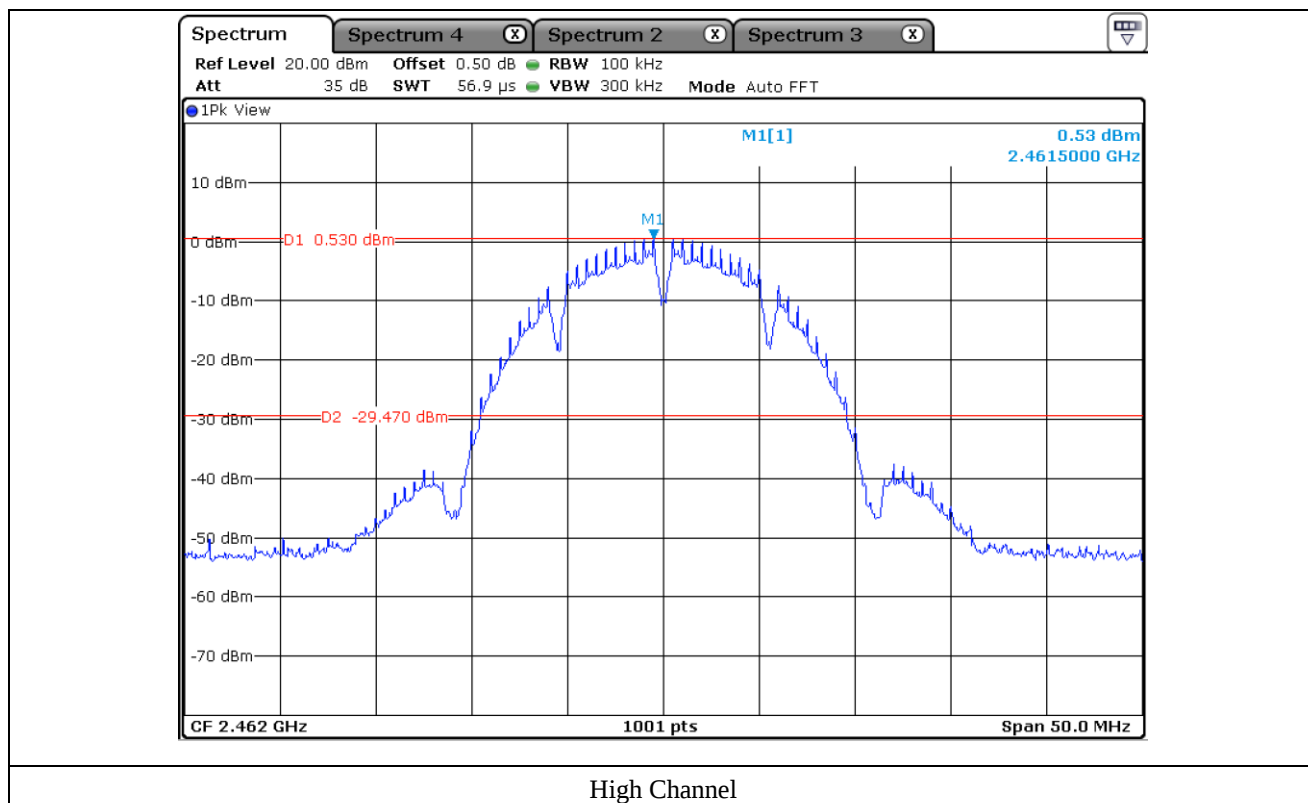


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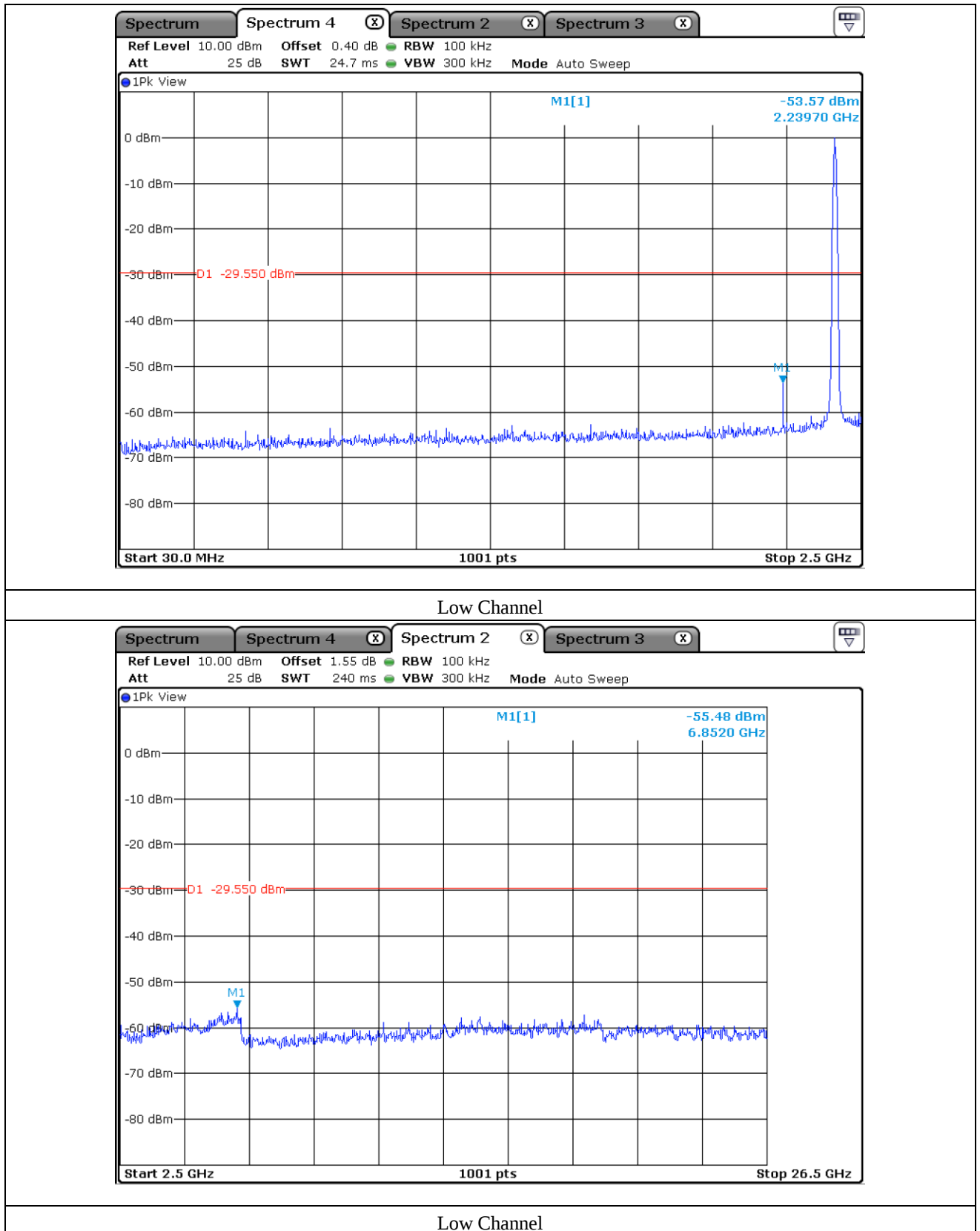


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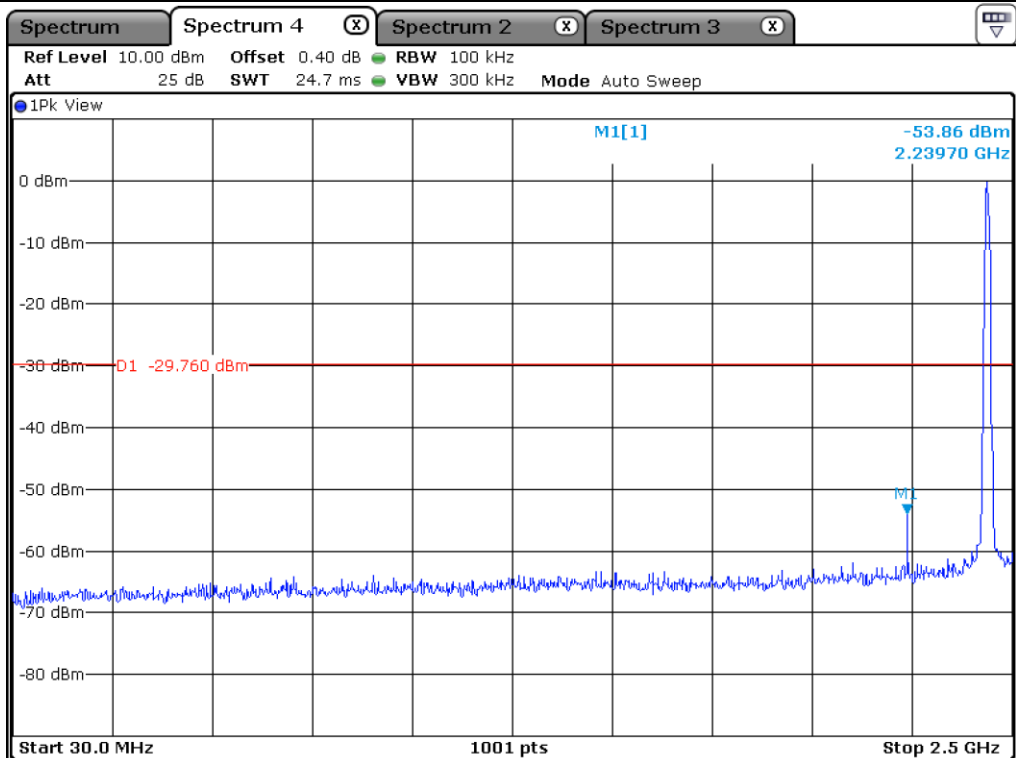


This Report is not correlated with the authentication of KOLAS

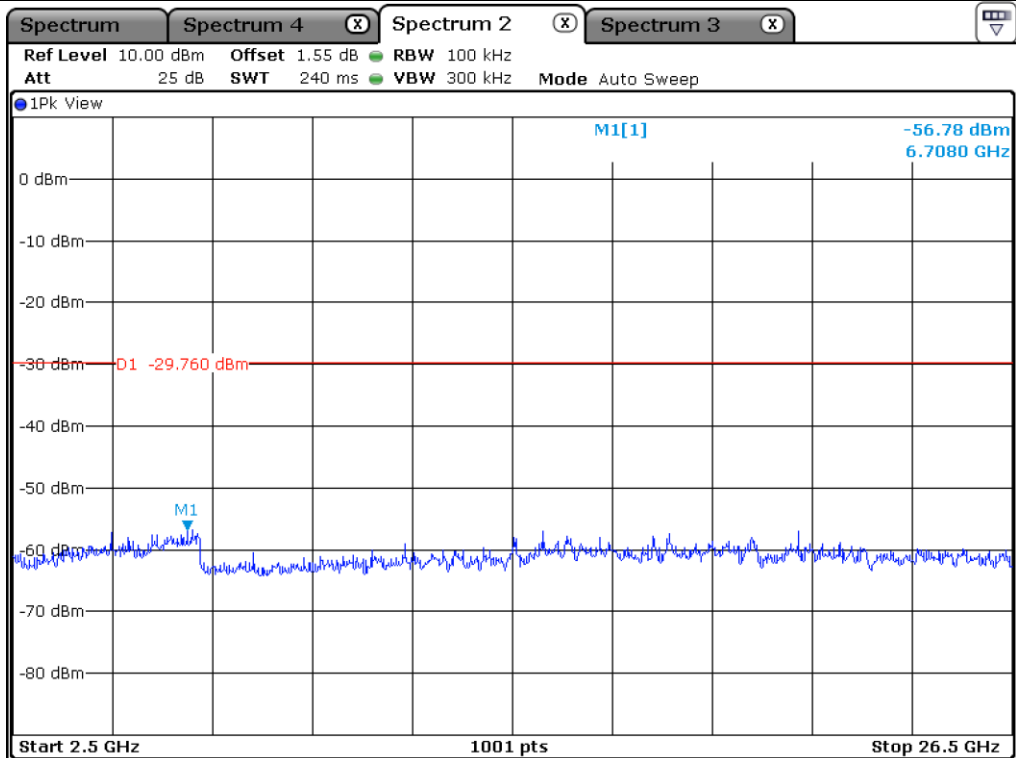
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Middle Channel



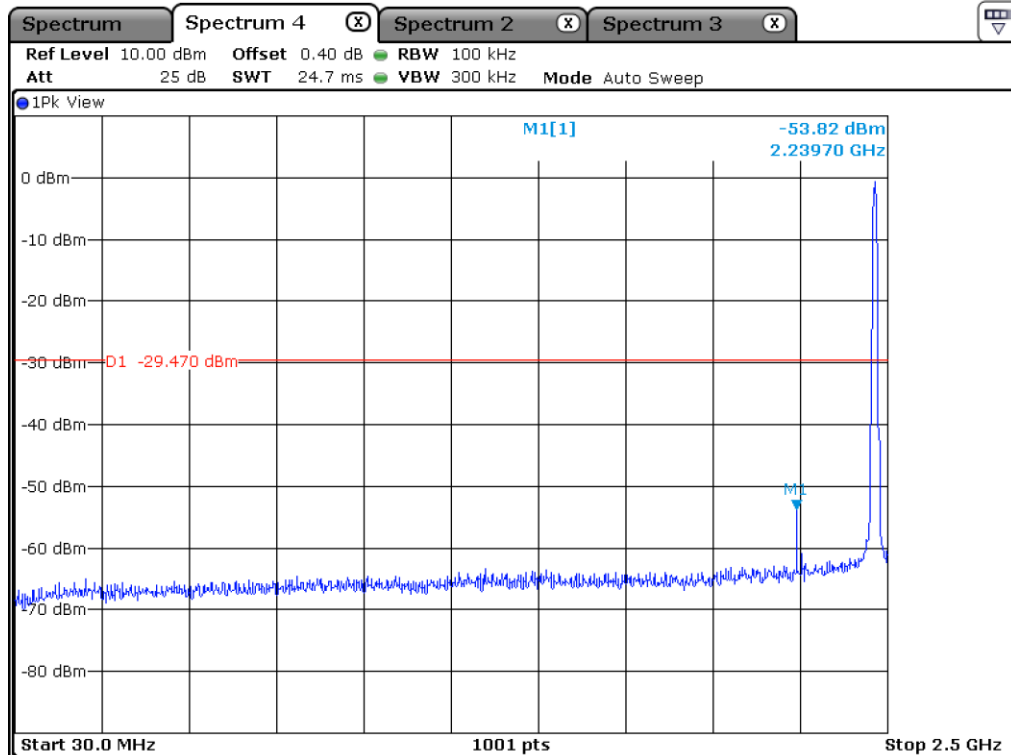
Middle Channel

This Report is not correlated with the authentication of KOLAS

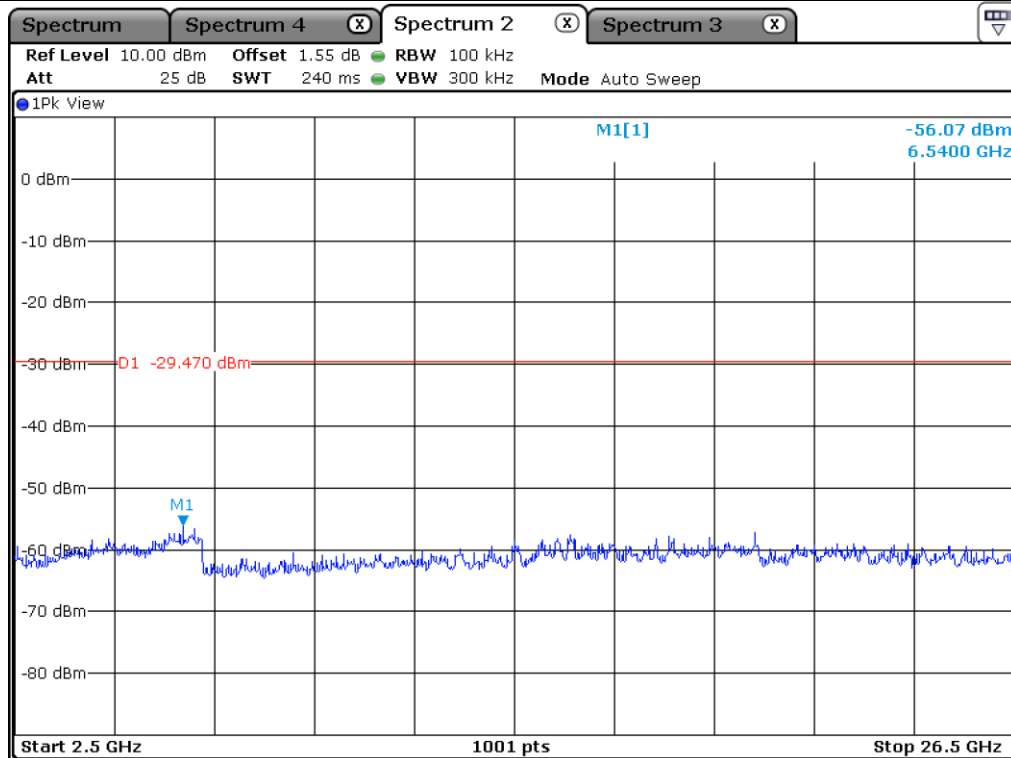
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High Channel



High Channel

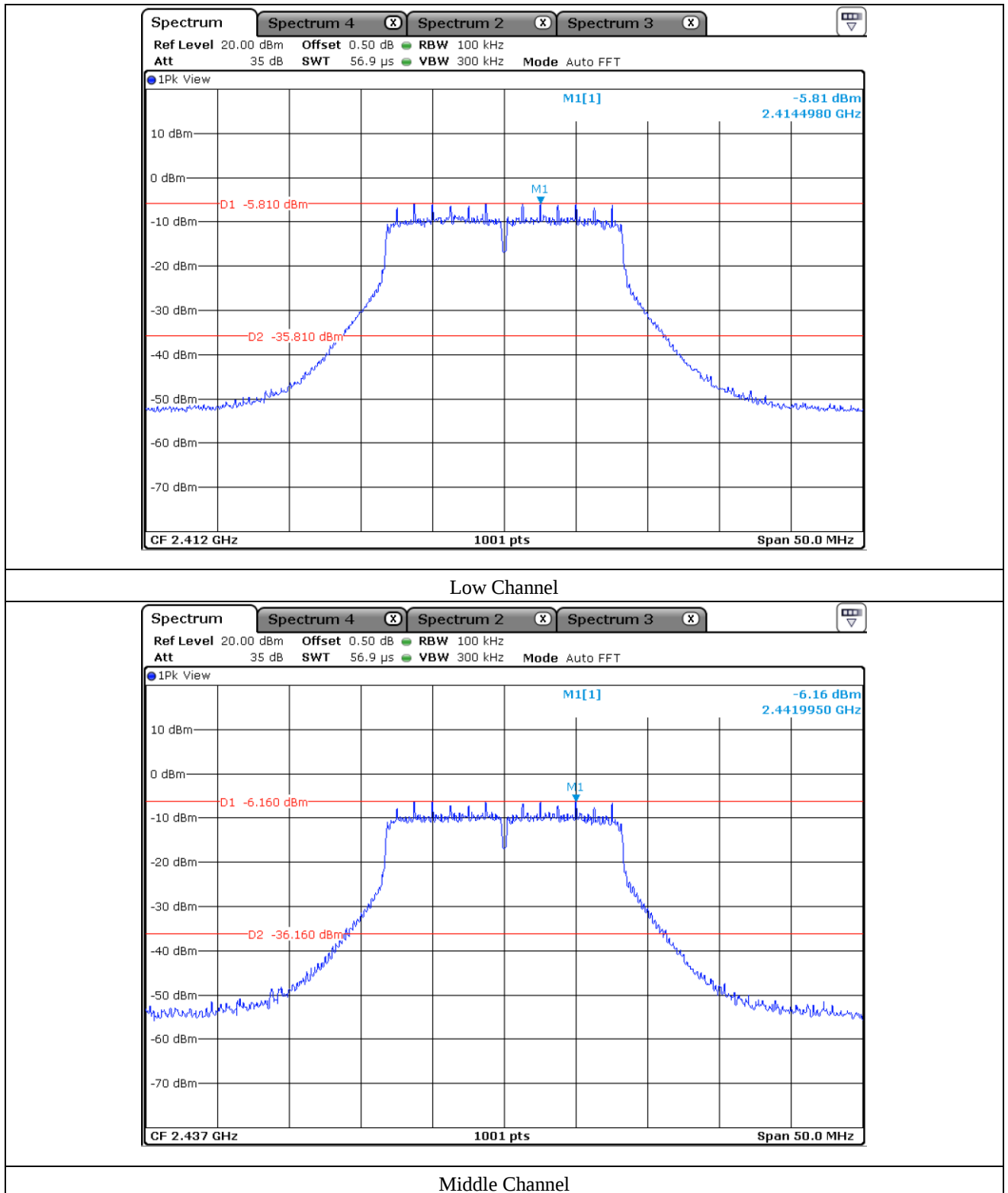
This Report is not correlated with the authentication of KOLAS

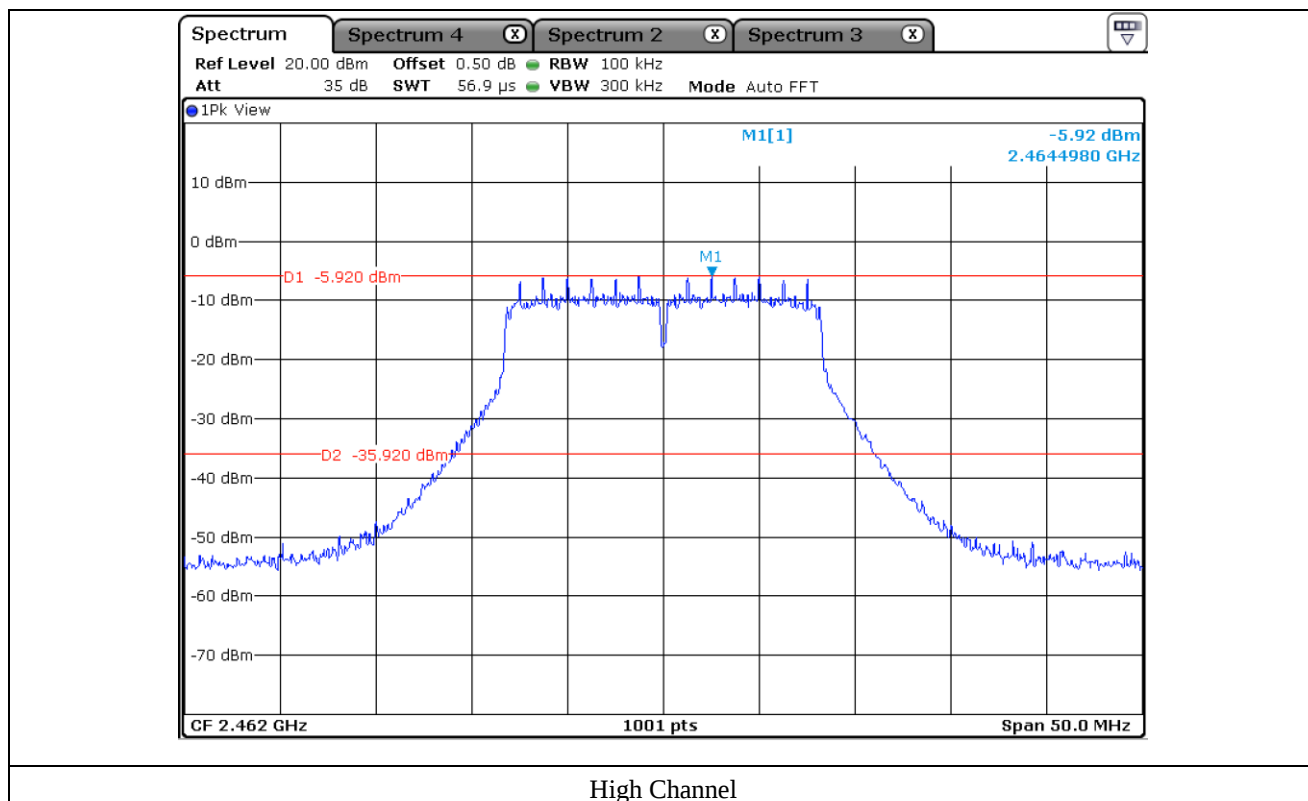
It should not be reproduced except in full, without the written approval of ONETECH Corp.

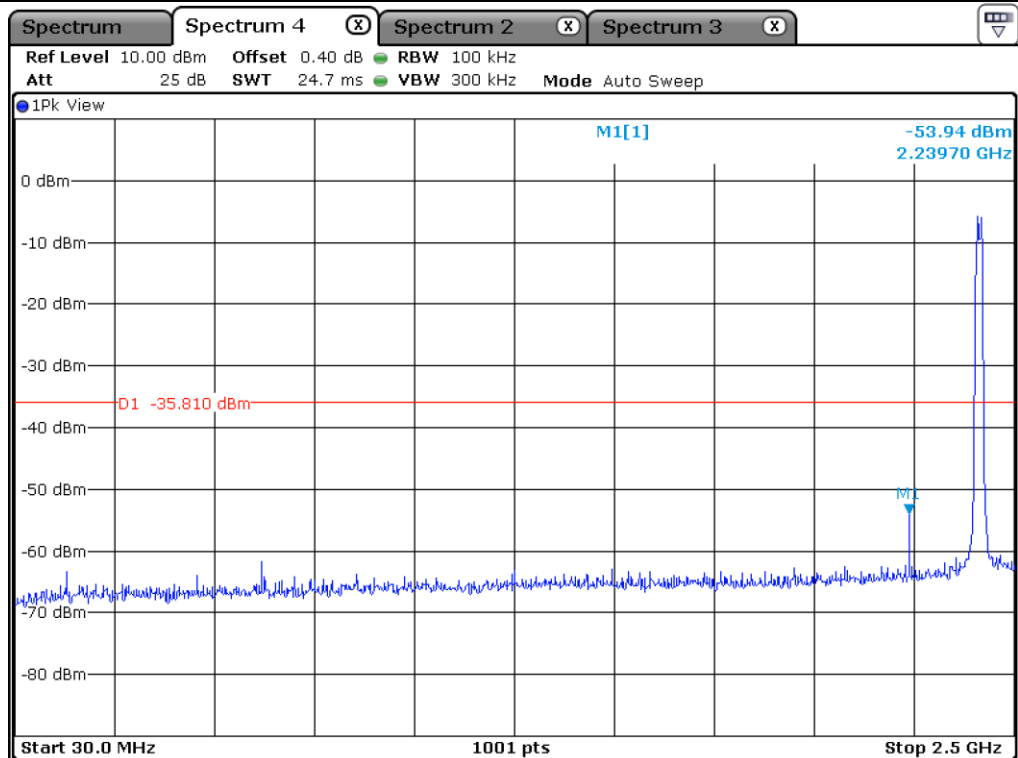
OTC-TRF-RF-001(0)

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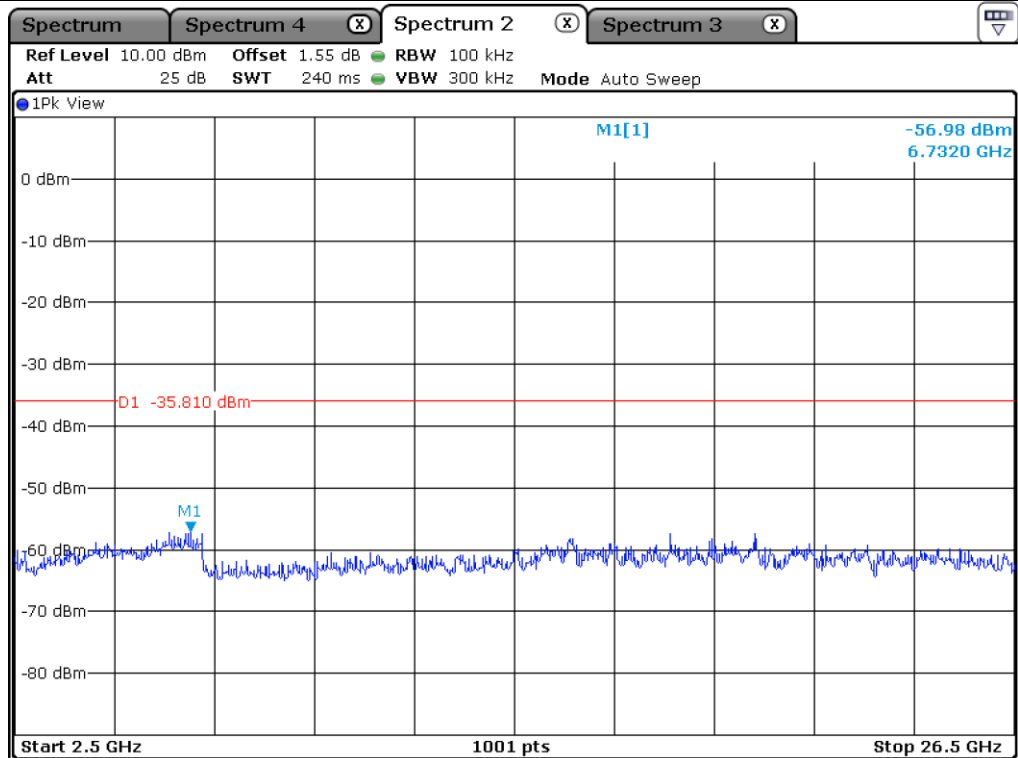
9.5.2 Test data for 802.11g WLAN Mode







Low Channel



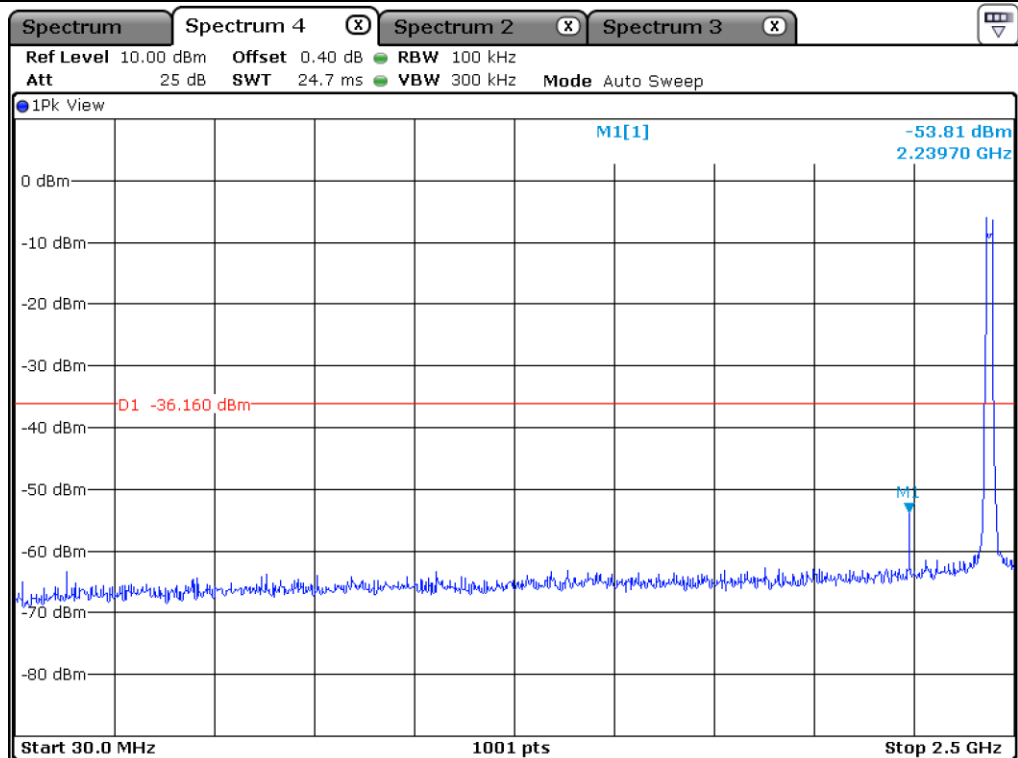
Low Channel

This Report is not correlated with the authentication of KOLAS

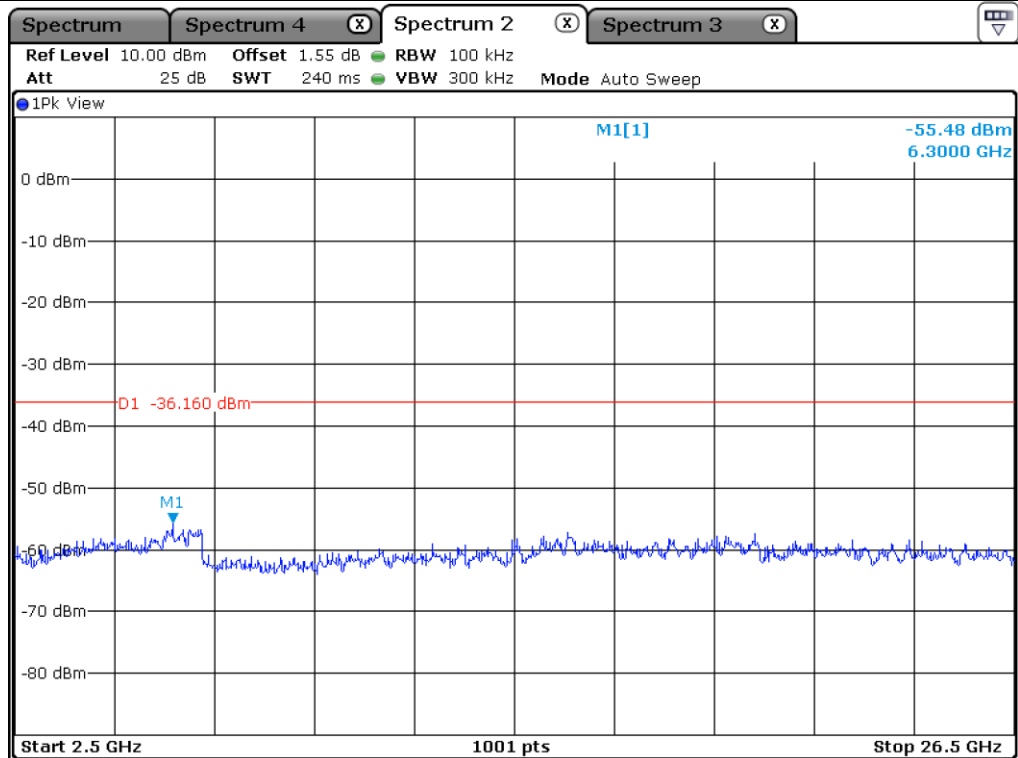
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Middle Channel



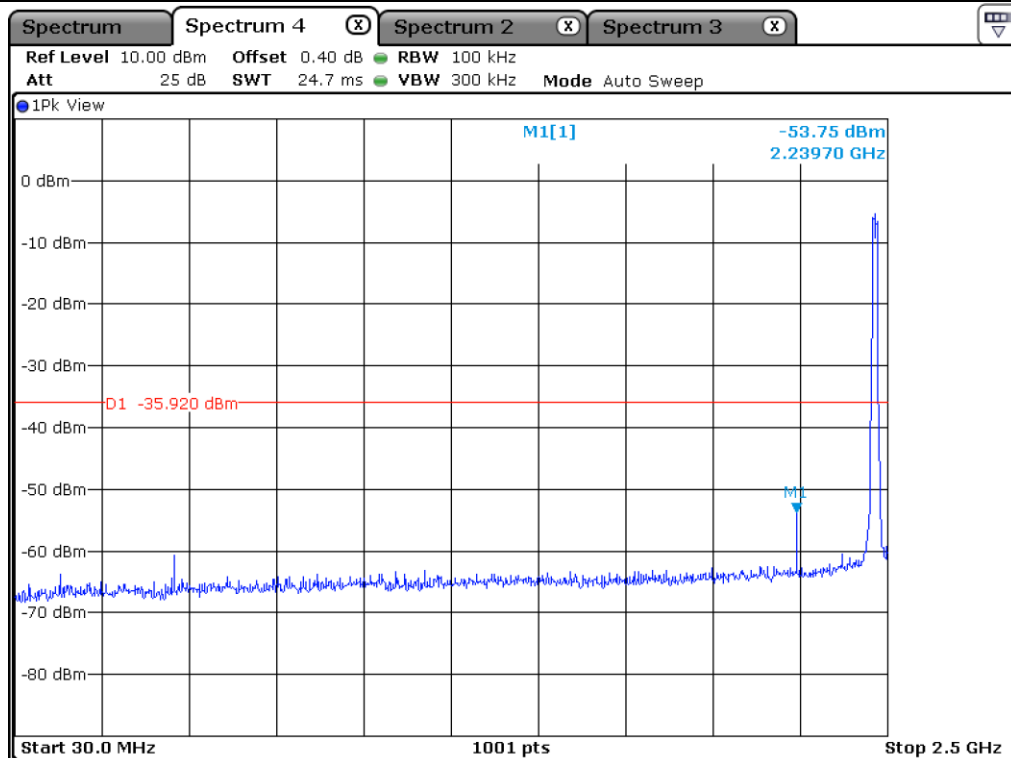
Middle Channel

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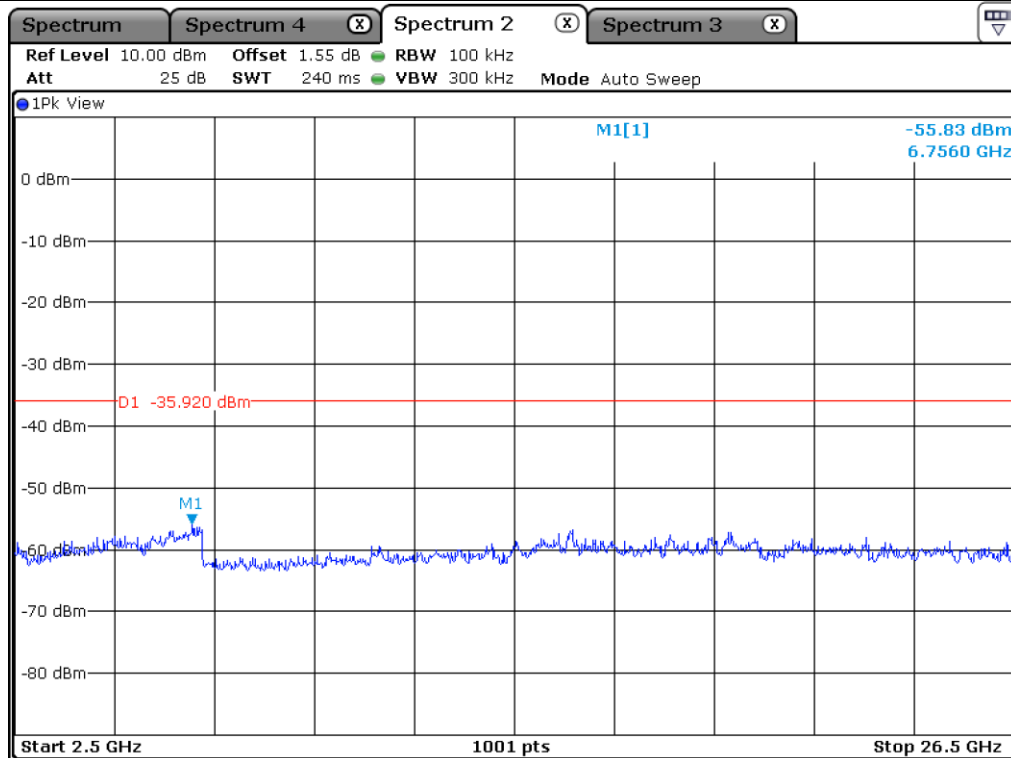
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High Channel



High Channel

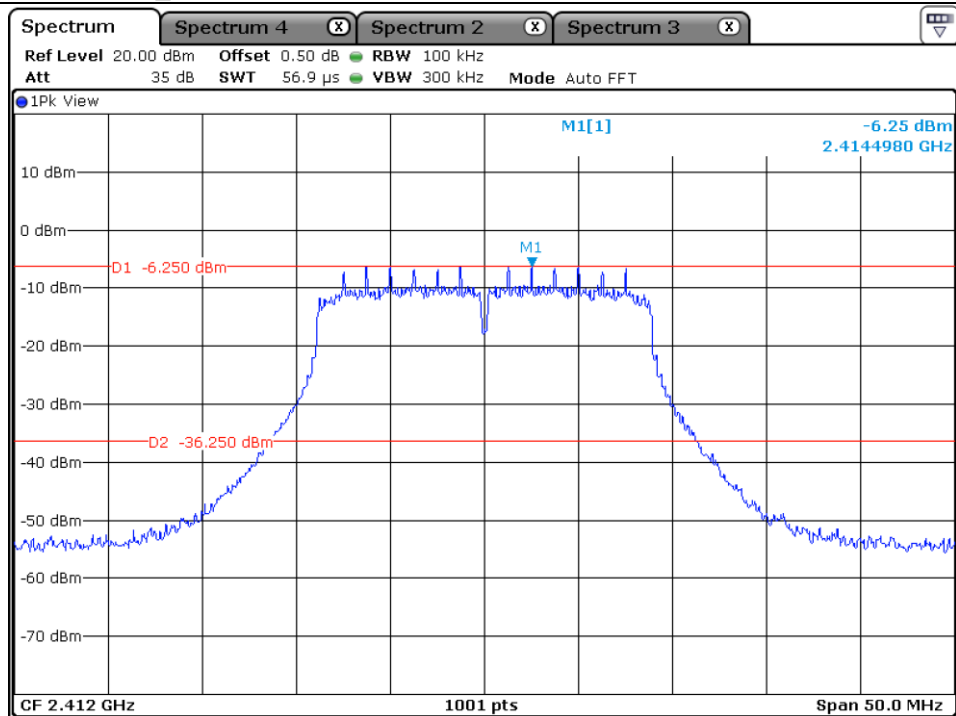
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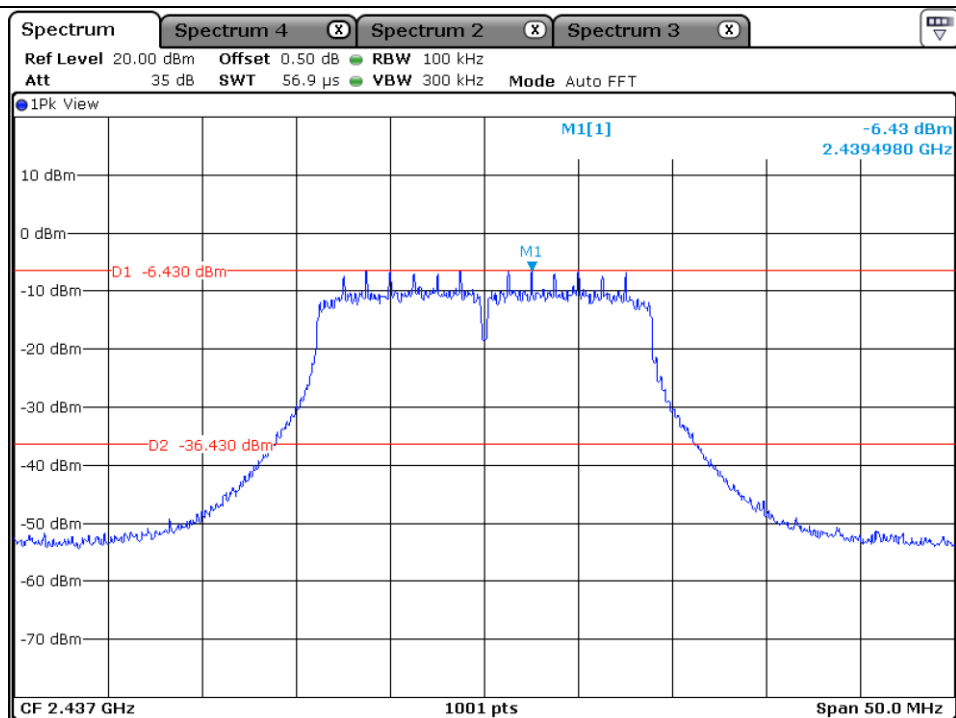
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9.5.3 Test data for 802.11n_HT20 WLAN Mode



Low Channel



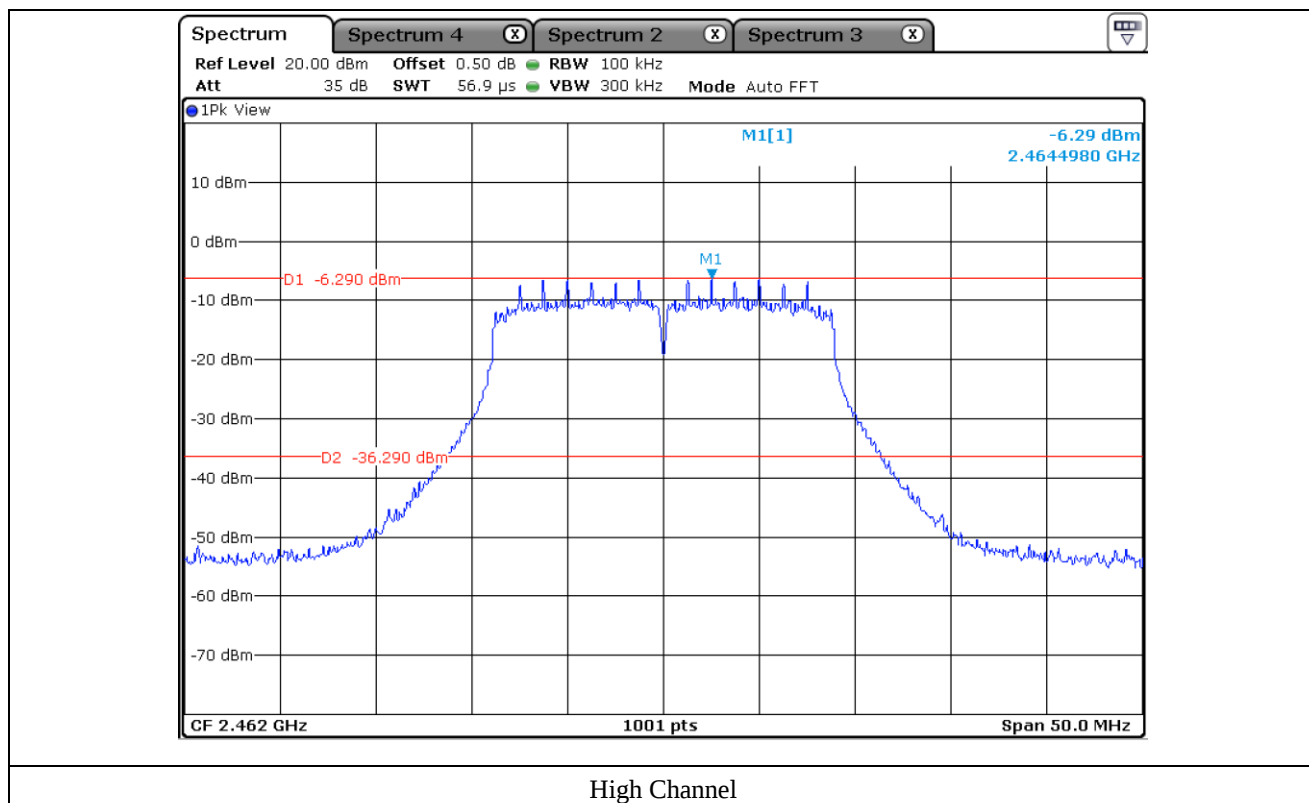
Middle Channel

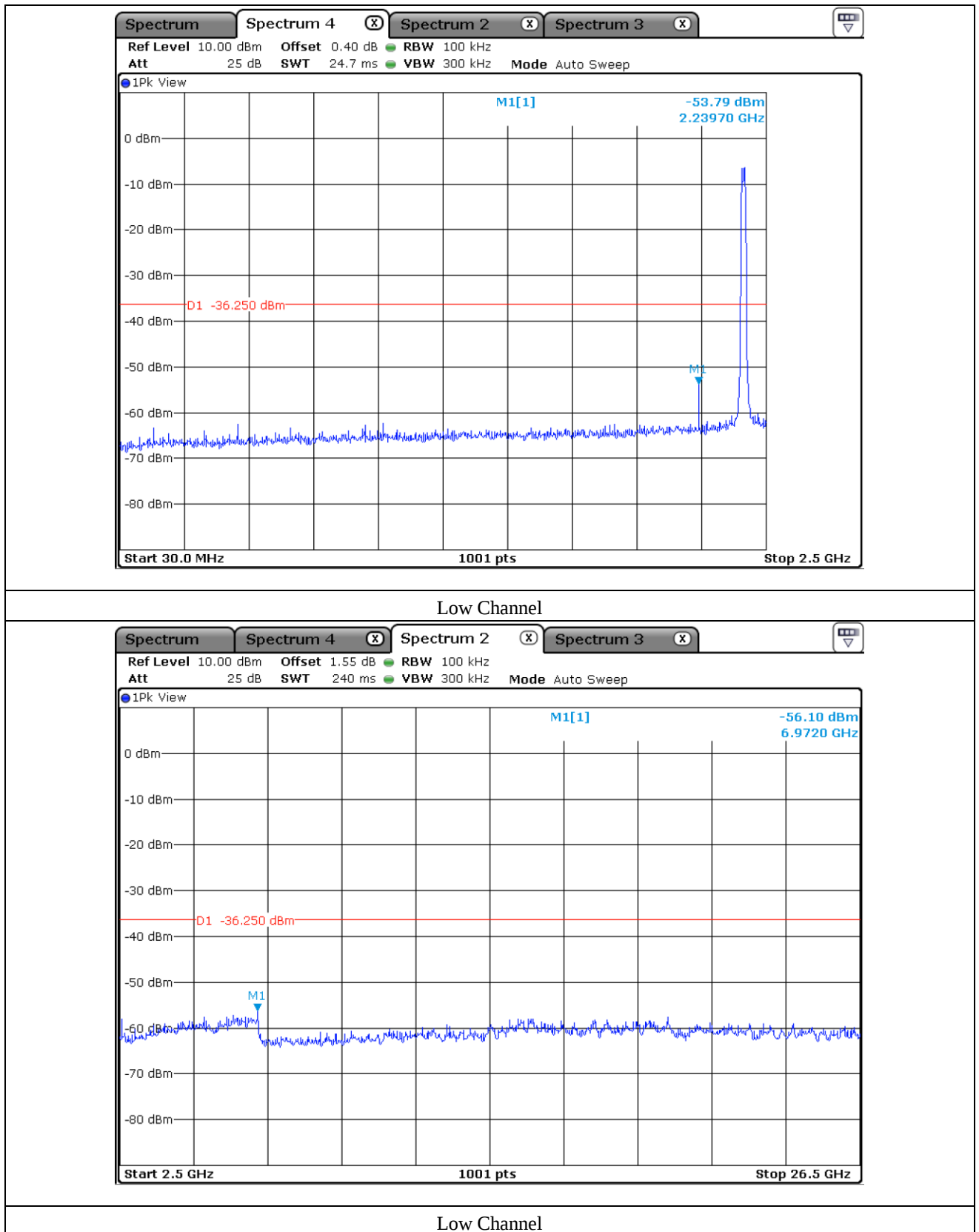
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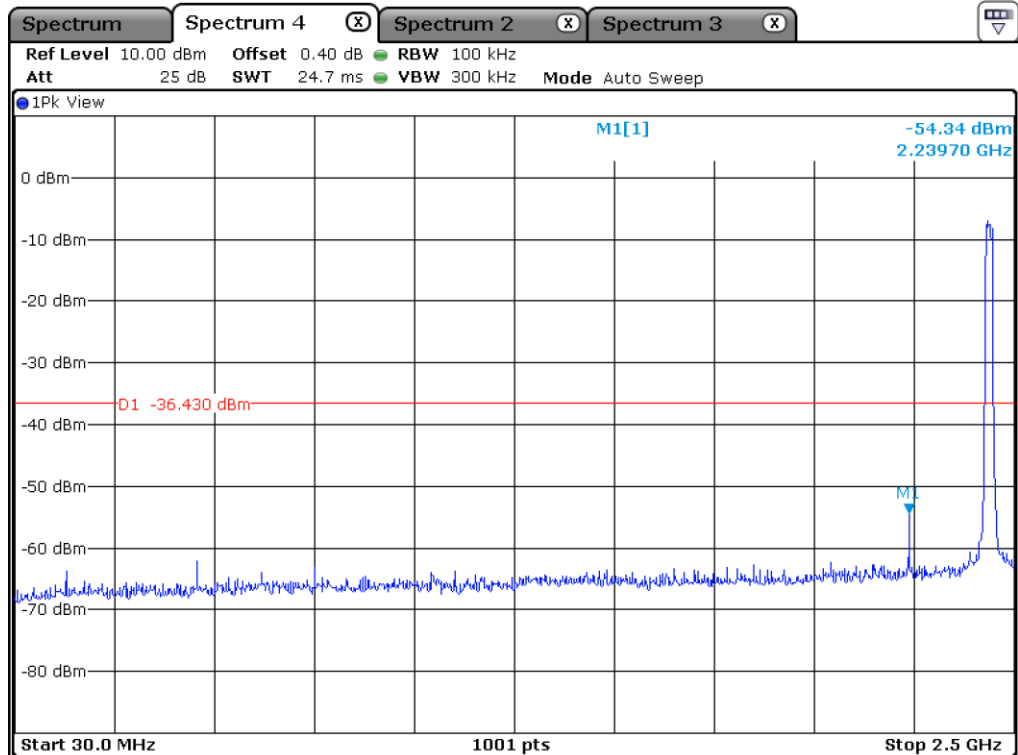


This Report is not correlated with the authentication of KOLAS

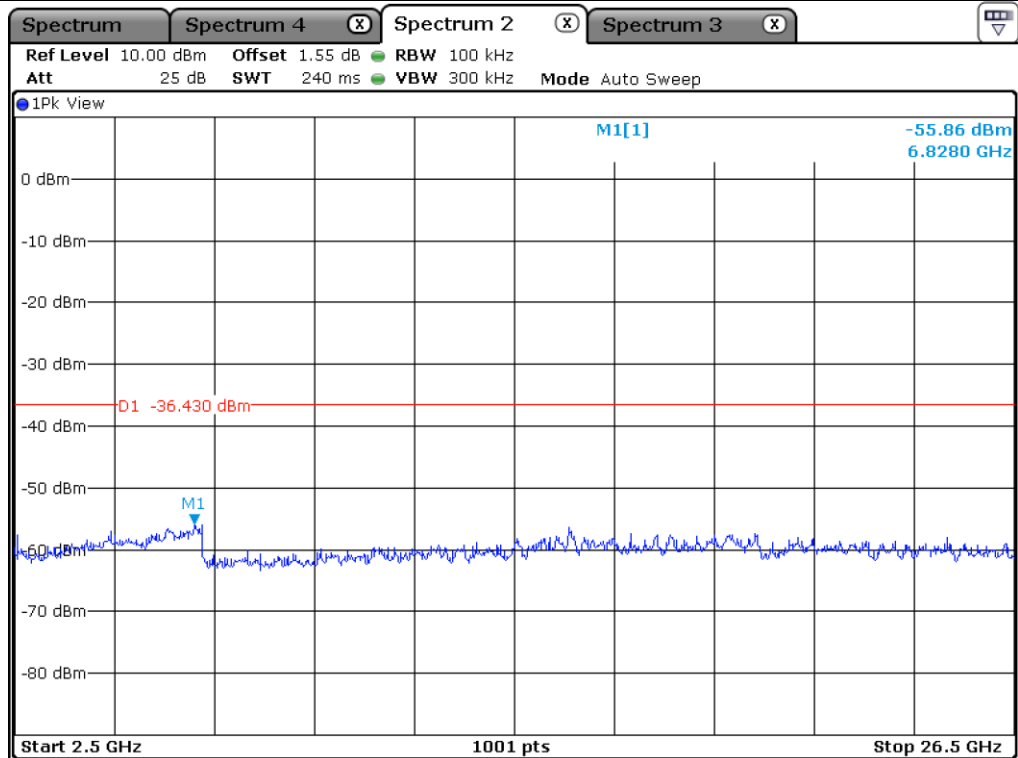
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Middle Channel



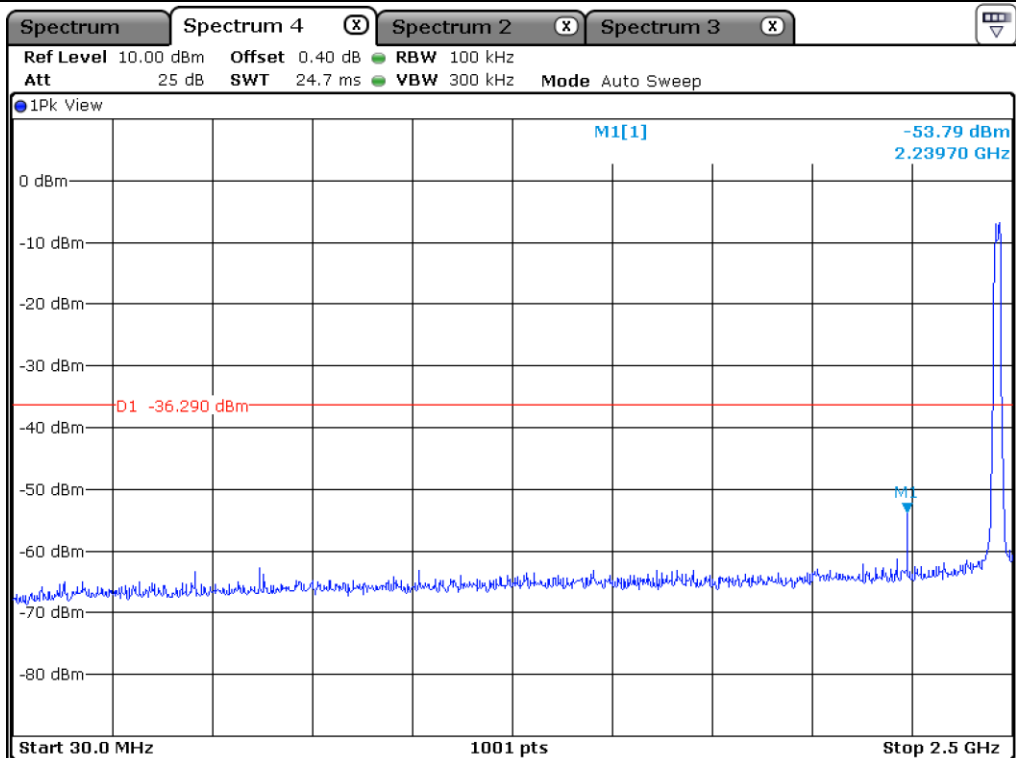
Middle Channel

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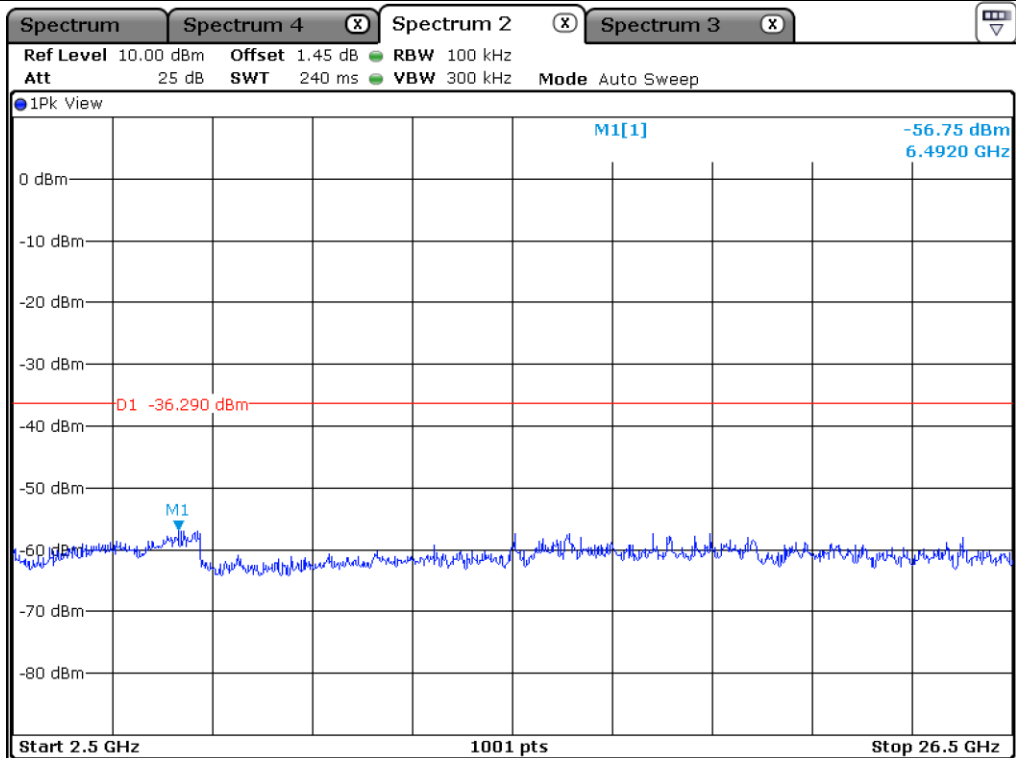
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High Channel



High Channel

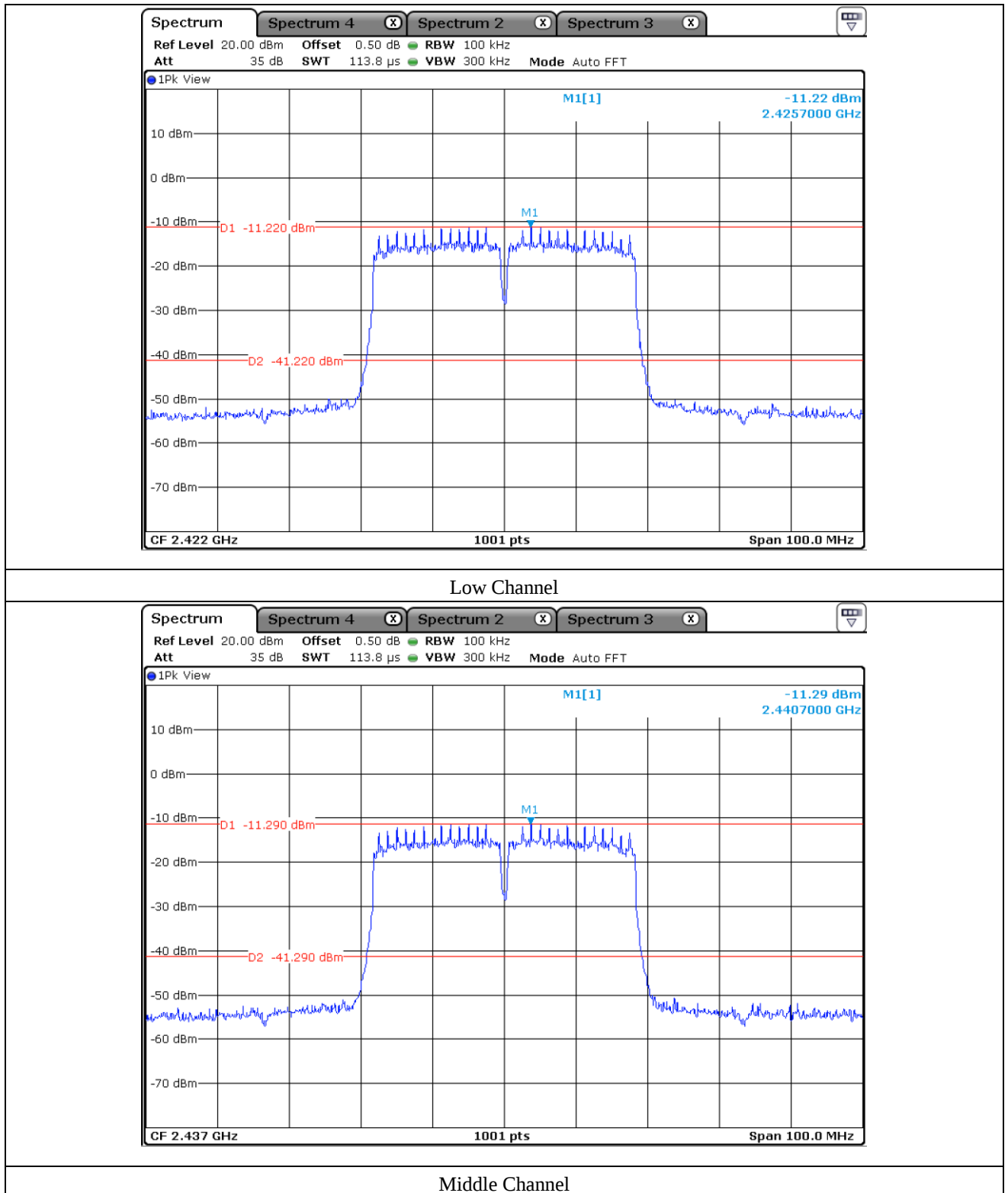
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9.5.4 Test data for 802.11n_HT40 WLAN Mode

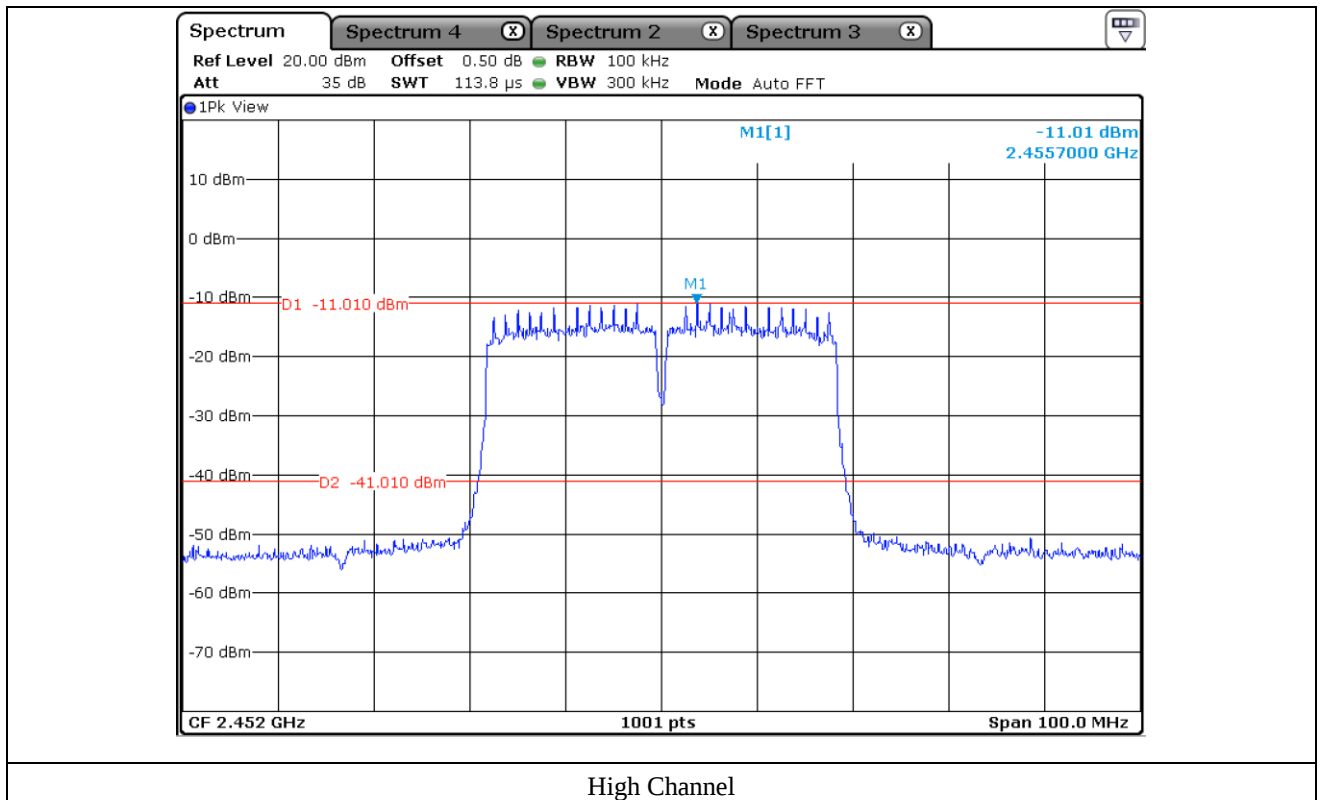


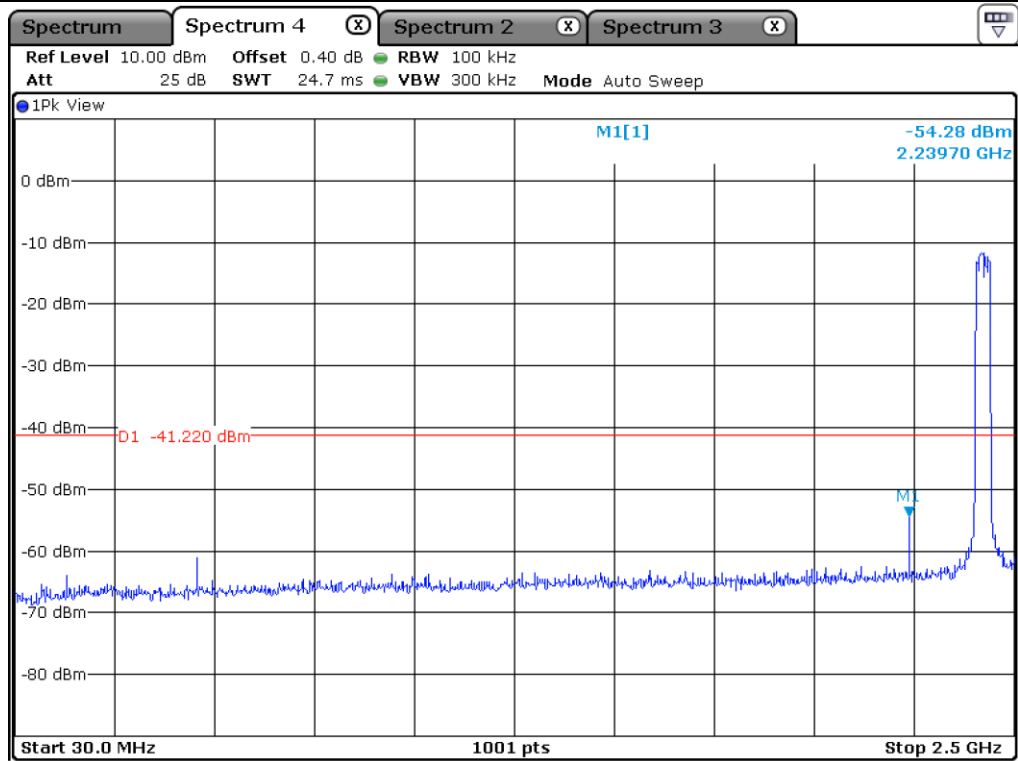
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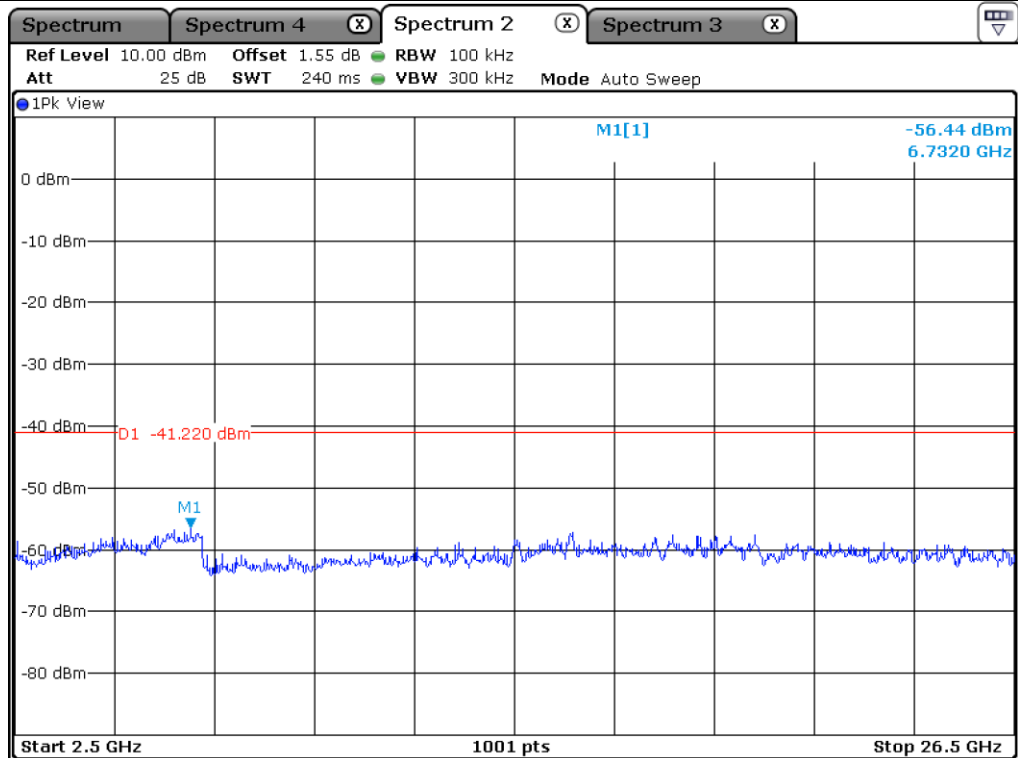
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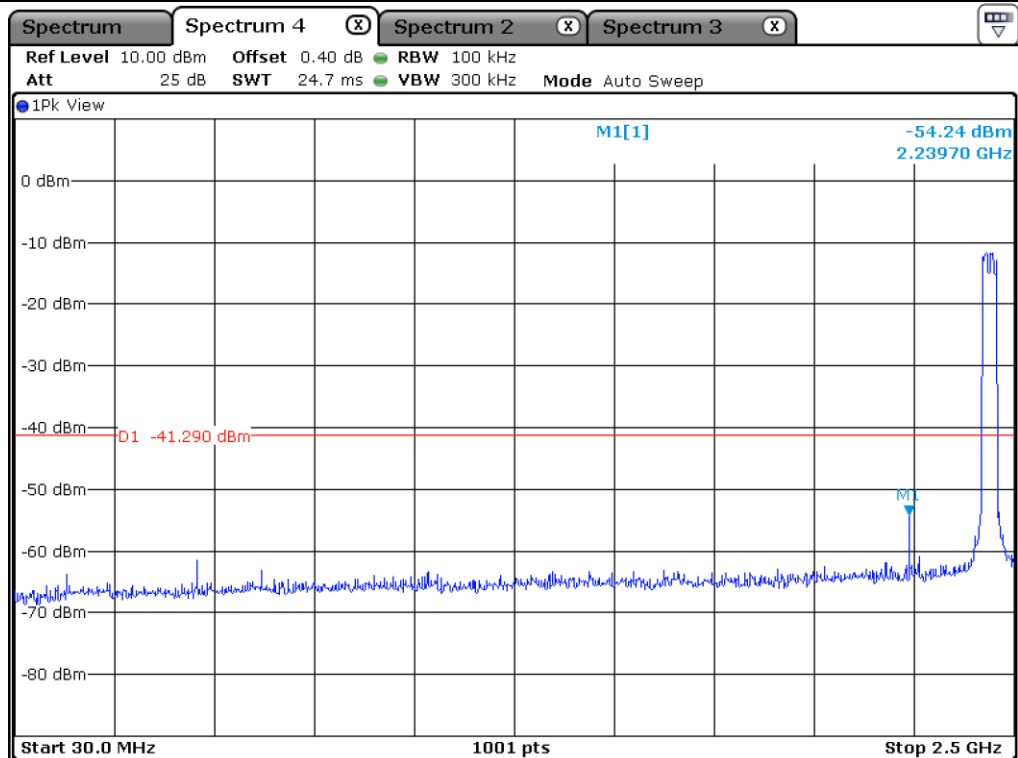




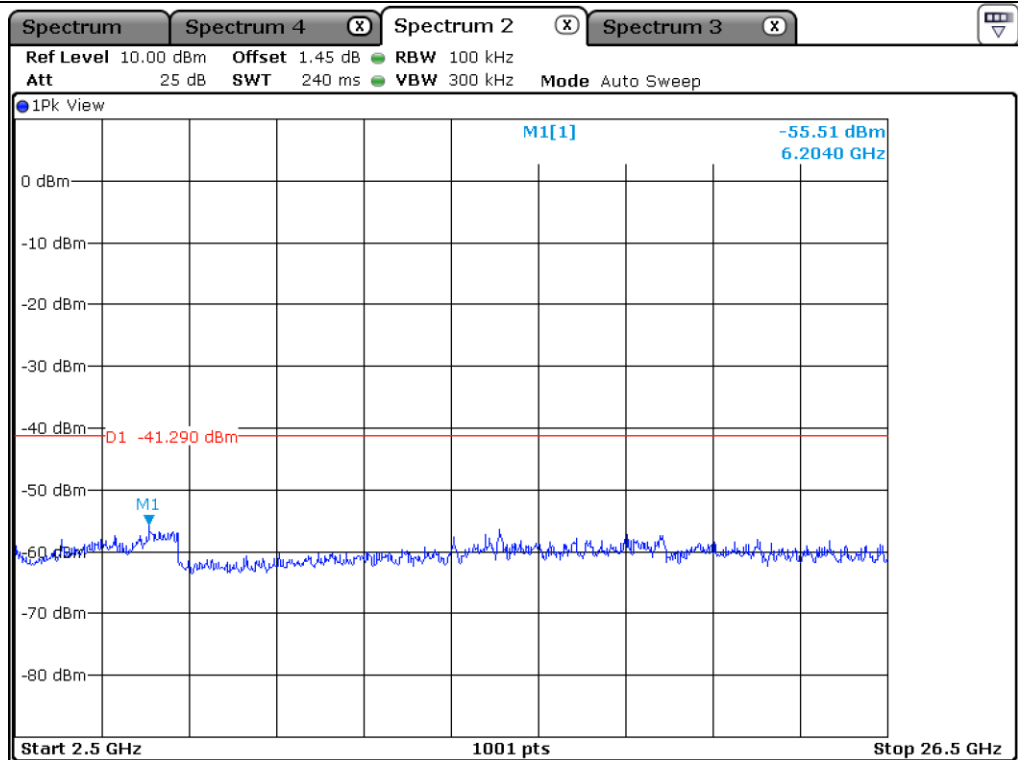
Low Channel



Low Channel



Middle Channel



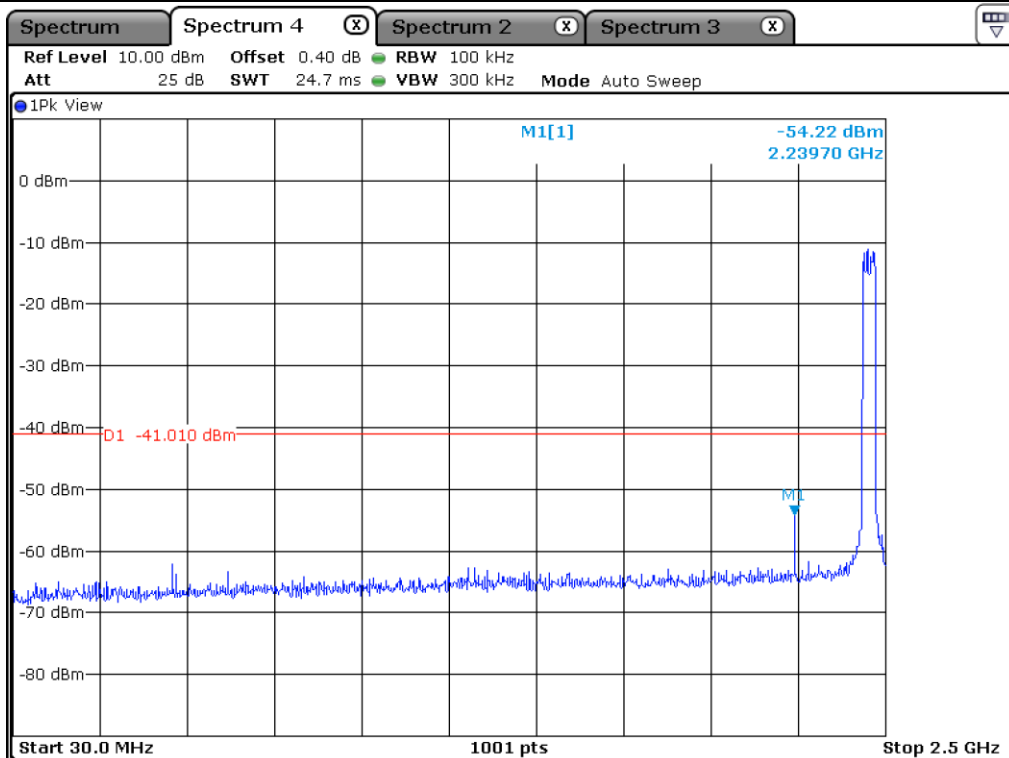
Middle Channel

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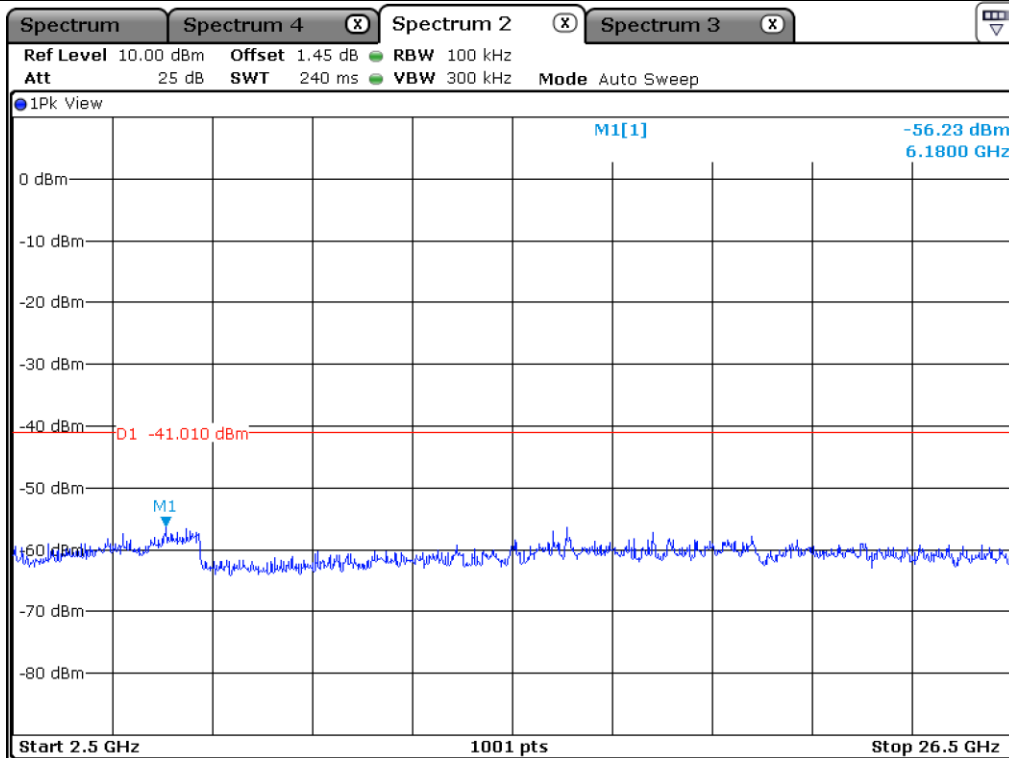
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High Channel



High Channel

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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 : 98.57 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Attenuator (dB)	AMP Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel											
2 380.085	52.02	Peak	H	28.30	6.71	9.93	45.14	-	51.82	74.00	22.18
2 387.368	44.40	Average	H	28.30	6.71	9.93	45.14	0.06	44.26	54.00	9.74
2 356.349	51.91	Peak	V	28.30	6.71	9.93	45.14	-	51.71	74.00	22.29
2 336.658	43.17	Average	V	28.20	6.71	9.93	45.14	0.06	42.93	54.00	11.07
Test Data for High Channel											
2 488.182	52.00	Peak	H	27.70	6.87	9.93	45.14	-	51.36	74.00	22.64
2 485.624	43.71	Average	H	27.70	6.87	9.93	45.14	0.06	43.13	54.00	10.87
2 490.999	52.44	Peak	V	27.70	6.87	9.93	45.14	-	51.80	74.00	22.20
2 487.542	42.97	Average	V	27.70	6.87	9.93	45.14	0.06	42.39	54.00	11.61

Tabulated test data for Restricted Band

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

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

Total Level = Reading + Antenna Factor + Cable Loss + ATT + Duty Factor – AMP Gain

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 : 91.40 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Attenuator (dB)	AMP Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel											
2 334.411	53.16	Peak	H	28.20	6.71	9.93	45.14	-	52.86	74.00	21.14
2 363.272	43.53	Average	H	28.30	6.71	9.93	45.14	0.39	43.72	54.00	10.28
2 341.154	52.15	Peak	V	28.20	6.71	9.93	45.14	-	51.85	74.00	22.15
2 364.351	43.33	Average	V	28.30	6.71	9.93	45.14	0.39	43.52	54.00	10.48
Test Data for High Channel											
2 488.082	52.63	Peak	H	27.70	6.87	9.93	45.14	-	51.99	74.00	22.01
2 489.700	43.22	Average	H	27.70	6.87	9.93	45.14	0.39	42.97	54.00	11.03
2 491.079	52.47	Peak	V	27.70	6.87	9.93	45.14	-	51.83	74.00	22.17
2 497.512	42.98	Average	V	27.70	6.87	9.93	45.14	0.39	42.73	54.00	11.27

Tabulated test data for Restricted Band

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

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

Total Level = Reading + Antenna Factor + Cable Loss + ATT + Duty Factor – AMP Gain

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 : 93.12 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Attenuator (dB)	AMP Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel											
2 389.975	52.30	Peak	H	28.30	6.71	9.93	45.14	-	52.10	74.00	21.90
2 389.705	44.36	Average	H	28.30	6.71	9.93	45.14	0.31	44.47	54.00	9.53
2 367.048	52.03	Peak	V	28.30	6.71	9.93	45.14	-	51.83	74.00	22.17
2 382.602	42.95	Average	V	28.00	6.71	9.93	45.14	0.31	42.76	54.00	11.24
Test Data for High Channel											
2 493.237	51.79	Peak	H	27.70	6.87	9.93	45.14	-	51.15	74.00	22.85
2 492.178	43.36	Average	H	27.70	6.87	9.93	45.14	0.31	43.03	54.00	10.97
2 490.420	52.10	Peak	V	27.70	6.87	9.93	45.14	-	51.46	74.00	22.54
2 490.859	43.92	Average	V	27.70	6.87	9.93	45.14	0.31	43.59	54.00	10.41

Tabulated test data for Restricted Band

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

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

Total Level = Reading + Antenna Factor + Cable Loss + ATT + Duty Factor – AMP Gain

9.6.1.4 Test data for 802.11n_HT40 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 : 89.24 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Attenuator (dB)	AMP Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel											
2 385.030	53.16	Peak	H	28.30	6.71	9.93	45.14	-	52.96	74.00	21.04
2384.131	44.92	Average	H	28.30	6.71	9.93	45.14	0.49	45.21	54.00	8.79
2 359.136	52.33	Peak	V	28.30	6.71	9.93	45.14	-	52.13	74.00	21.87
2352.213	43.21	Average	V	28.30	6.71	9.93	45.14	0.49	43.50	54.00	10.50
Test Data for High Channel											
2 484.286	52.34	Peak	H	27.70	6.87	9.93	45.14	-	51.70	74.00	22.30
2491.179	43.33	Average	H	27.70	6.87	9.93	45.14	0.49	43.18	54.00	10.82
2 491.778	52.51	Peak	V	27.70	6.87	9.93	45.14	-	51.87	74.00	22.13
2491.419	43.10	Average	V	27.70	6.87	9.93	45.14	0.49	42.95	54.00	11.05

Tabulated test data for Restricted Band

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

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

Total Level = Reading + Antenna Factor + Cable Loss + ATT + Duty Factor – AMP Gain

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 : 98.57 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 824.00	52.31	Peak	H	31.30	9.39	45.10	-	47.90	74.00	26.10
4 824.00	43.43	Average	H	31.30	9.39	45.10	0.06	39.08	54.00	14.92
4 824.00	52.95	Peak	V	31.30	9.39	45.10	-	48.54	74.00	25.46
4 824.00	43.70	Average	V	31.30	9.39	45.10	0.06	39.35	54.00	14.65
Test Data for Middle Channel										
4 874.00	51.79	Peak	H	31.20	9.39	45.10	-	47.28	74.00	26.72
4 874.00	43.55	Average	H	31.20	9.39	45.10	0.06	39.10	54.00	14.90
4 874.00	51.00	Peak	V	31.20	9.39	45.10	-	46.49	74.00	27.51
4 874.00	43.33	Average	V	31.20	9.39	45.10	0.06	38.88	54.00	15.12
Test Data for High Channel										
4 924.00	51.51	Peak	H	31.10	9.39	45.10	-	46.90	74.00	27.10
4 924.00	43.26	Average	H	31.10	9.39	45.10	0.06	38.71	54.00	15.29
4 924.00	50.84	Peak	V	31.10	9.39	45.10	-	46.23	74.00	27.77
4 924.00	43.27	Average	V	31.10	9.39	45.10	0.06	38.72	54.00	15.28

Tabulated test data for Restricted Band

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

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

Total Level = Reading + Antenna Factor + Cable Loss + Duty Factor – AMP Gain

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 : 91.40 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 824.00	52.55	Peak	H	31.30	9.39	45.10	-	48.14	74.00	25.86
4 824.00	43.39	Average	H	31.30	9.39	45.10	0.39	39.37	54.00	14.63
4 824.00	51.78	Peak	V	31.30	9.39	45.10	-	47.37	74.00	26.63
4 824.00	43.34	Average	V	31.30	9.39	45.10	0.39	39.32	54.00	14.68
Test Data for Middle Channel										
4 874.00	50.80	Peak	H	31.20	9.39	45.10	-	46.29	74.00	27.71
4 874.00	43.12	Average	H	31.20	9.39	45.10	0.39	39.00	54.00	15.00
4 874.00	50.34	Peak	V	31.20	9.39	45.10	-	45.83	74.00	28.17
4 874.00	43.47	Average	V	31.20	9.39	45.10	0.39	39.35	54.00	14.65
Test Data for High Channel										
4 924.00	50.76	Peak	H	31.10	9.39	45.10	-	46.15	74.00	27.85
4 924.00	43.58	Average	H	31.10	9.39	45.10	0.39	39.36	54.00	14.64
4 924.00	51.15	Peak	V	31.10	9.39	45.10	-	46.54	74.00	27.46
4 924.00	43.45	Average	V	31.10	9.39	45.10	0.39	39.23	54.00	14.77

Tabulated test data for Restricted Band

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

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

Total Level = Reading + Antenna Factor + Cable Loss + Duty Factor – AMP Gain

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 : 93.12 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 824.00	52.39	Peak	H	31.30	9.39	45.10	-	47.98	74.00	26.02
4 824.00	43.49	Average	H	31.30	9.39	45.10	0.31	39.39	54.00	14.61
4 824.00	51.83	Peak	V	31.30	9.39	45.10	-	47.42	74.00	26.58
4 824.00	43.39	Average	V	31.30	9.39	45.10	0.31	39.29	54.00	14.71
Test Data for Middle Channel										
4 874.00	51.60	Peak	H	31.20	9.39	45.10	-	47.09	74.00	26.91
4 874.00	44.02	Average	H	31.20	9.39	45.10	0.31	39.82	54.00	14.18
4 874.00	50.61	Peak	V	31.20	9.39	45.10	-	46.10	74.00	27.90
4 874.00	43.49	Average	V	31.20	9.39	45.10	0.31	39.29	54.00	14.71
Test Data for High Channel										
4 924.00	50.79	Peak	H	31.10	9.39	45.10	-	46.18	74.00	27.82
4 924.00	43.61	Average	H	31.10	9.39	45.10	0.31	39.31	54.00	14.69
4 924.00	50.66	Peak	V	31.10	9.39	45.10	-	46.05	74.00	27.95
4 924.00	43.51	Average	V	31.10	9.39	45.10	0.31	39.21	54.00	14.79

Tabulated test data for Restricted Band

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

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

Total Level = Reading + Antenna Factor + Cable Loss + Duty Factor – AMP Gain

9.6.2.4 Test data for 802.11n_HT40 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 : 89.24 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Gain	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 844.00	52.81	Peak	H	31.30	9.39	45.10	-	48.40	74.00	25.60
4 844.00	43.40	Average	H	31.30	9.39	45.10	0.49	39.48	54.00	14.52
4 844.00	52.15	Peak	V	31.30	9.39	45.10	-	47.74	74.00	26.26
4 844.00	43.56	Average	V	31.30	9.39	45.10	0.49	39.64	54.00	14.36
Test Data for Middle Channel										
4 874.00	52.68	Peak	H	31.20	9.39	45.10	-	48.17	74.00	25.83
4 874.00	43.87	Average	H	31.20	9.39	45.10	0.49	39.85	54.00	14.15
4 874.00	50.83	Peak	V	31.20	9.39	45.10	-	46.32	74.00	27.68
4 874.00	43.19	Average	V	31.20	9.39	45.10	0.49	39.17	54.00	14.83
Test Data for High Channel										
4 904.00	51.40	Peak	H	31.10	9.39	45.10	-	46.79	74.00	27.21
4 904.00	44.75	Average	H	31.10	9.39	45.10	0.49	40.63	54.00	13.37
4 904.00	50.97	Peak	V	31.10	9.39	45.10	-	46.36	74.00	27.64
4 904.00	44.52	Average	V	31.10	9.39	45.10	0.49	40.40	54.00	13.60

Tabulated test data for Restricted Band

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

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

Total Level = Reading + Antenna Factor + Cable Loss + Duty Factor – AMP Gain

10. PEAK POWER SPECTRUL DENSITY

10.1 Operating environment

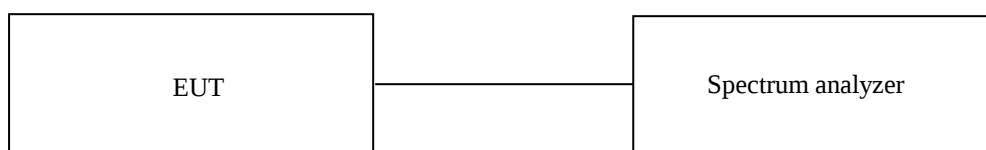
Temperature : 22.5 ° C

Relative humidity : 46.7 % 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 26, 2021

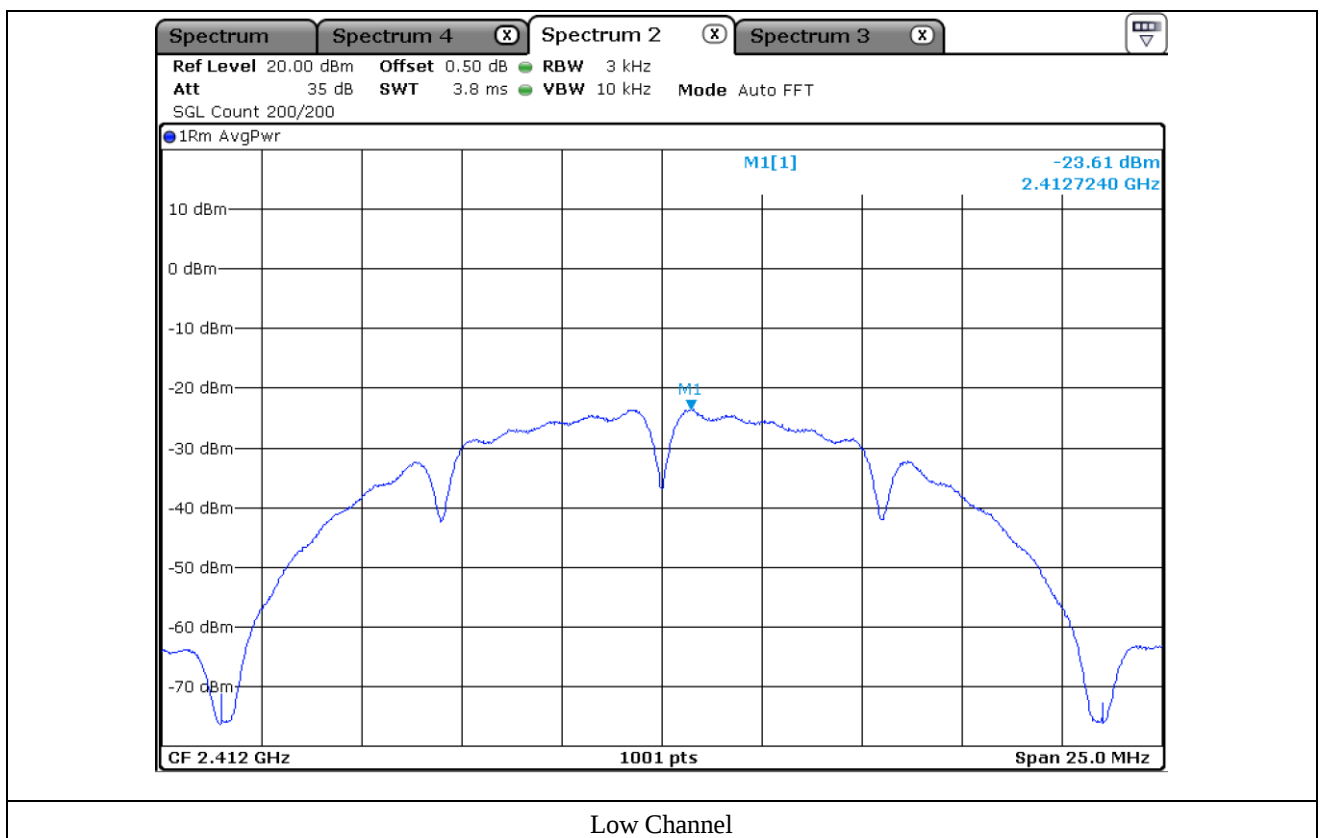
10.4 Test data for 802.11b WLAN Mode

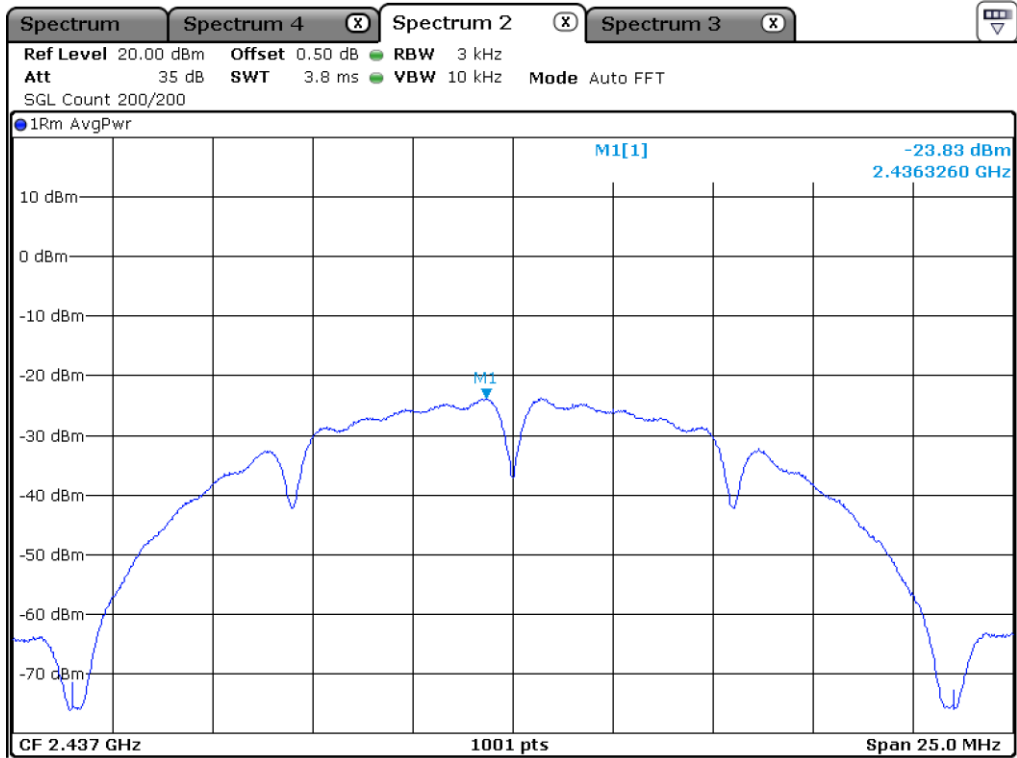
-. Test Result : Pass

-. Operating Condition : Continuous transmitting mode

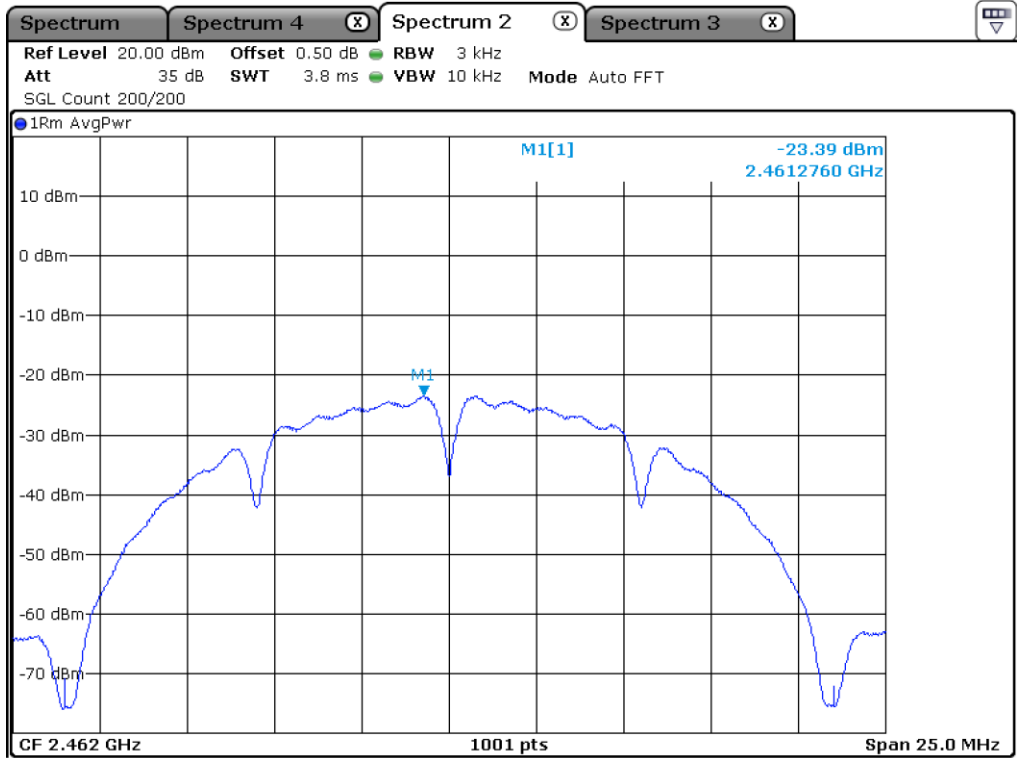
Channel	Frequency (MHz)	Measured Value (dBm)	Limit (dBm)	Margin (dB)
Low	2 412.00	-23.61	8.00	31.61
Middle	2 437.00	-23.83	8.00	31.83
High	2 462.00	-23.39	8.00	31.39

Remark. Margin = Limit – Measured Value





Middle Channel



High Channel

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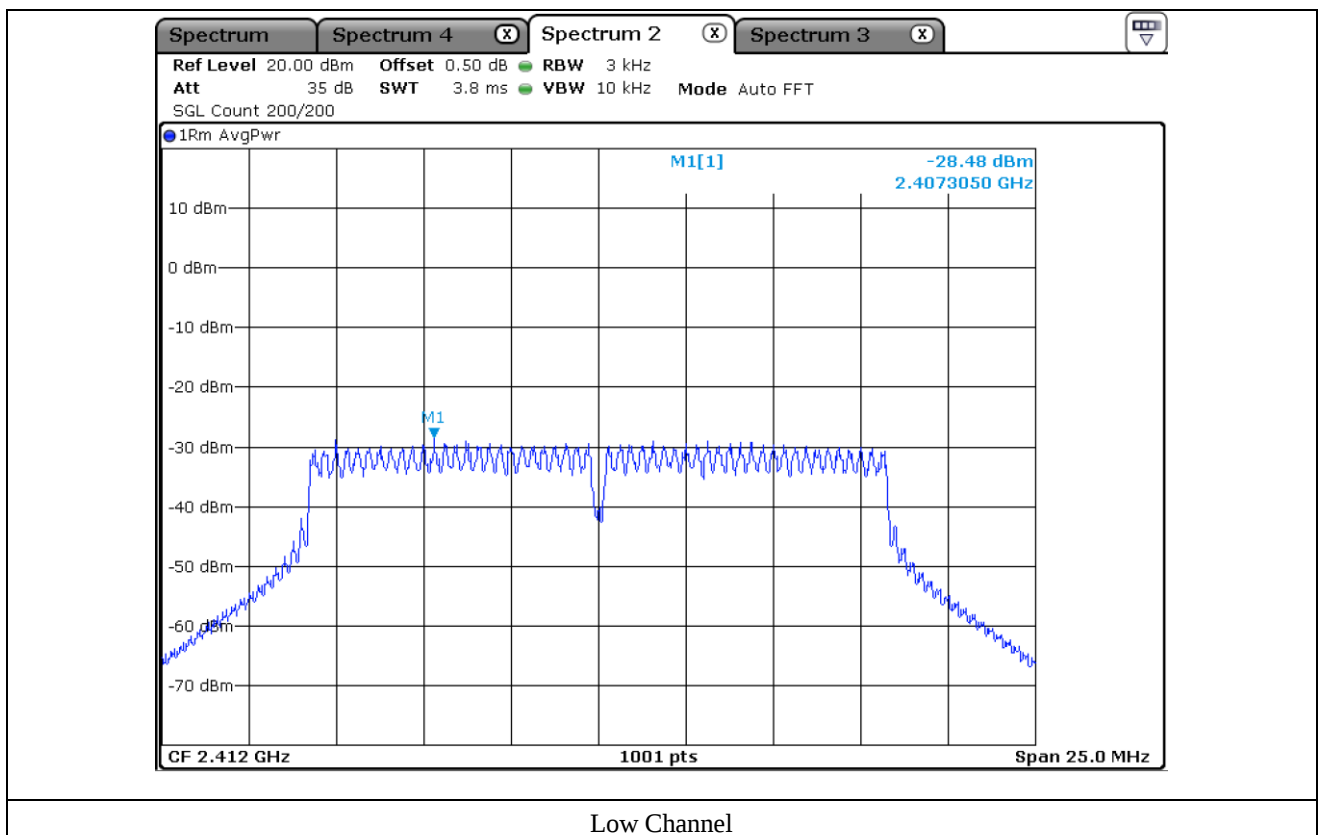
10.5 Test data for 802.11g WLAN Mode

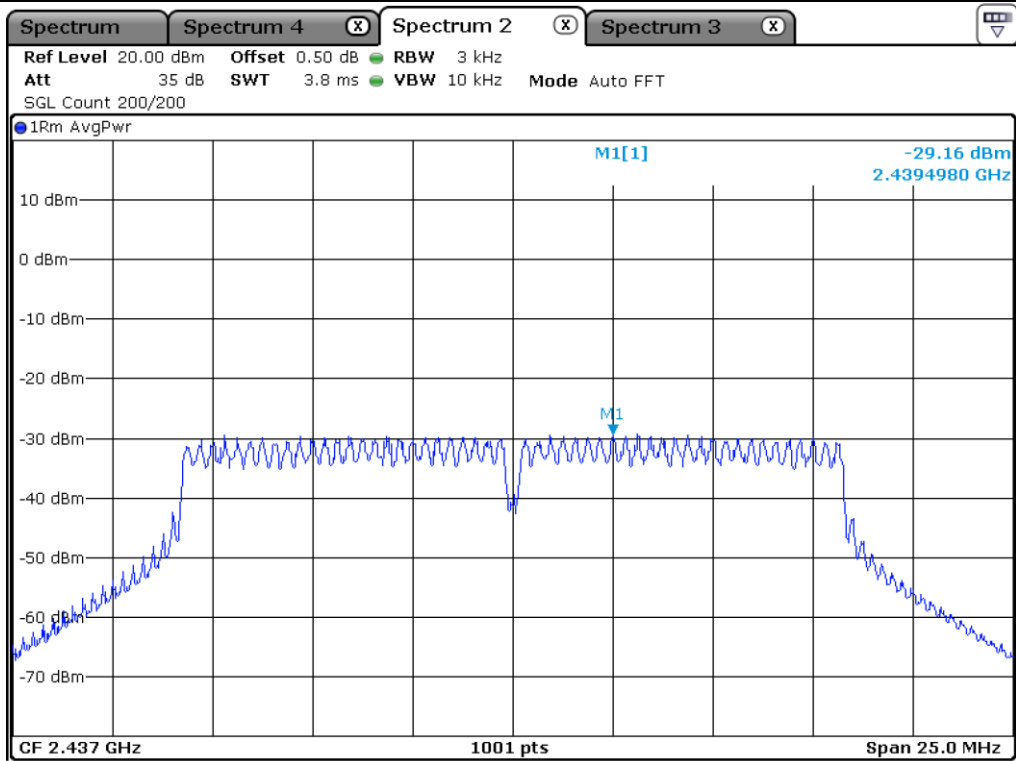
-. Test Result : Pass

-. Operating Condition : Continuous transmitting mode

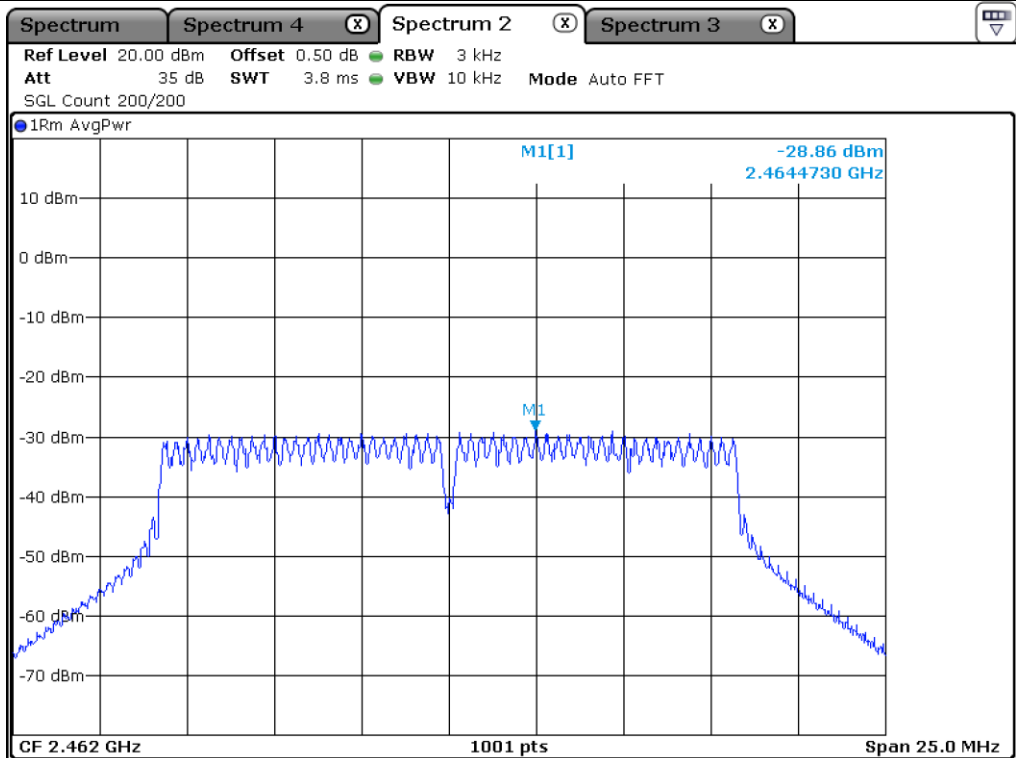
Channel	Frequency (MHz)	Measured Value (dBm)	Limit (dBm)	Margin (dB)
Low	2 412.00	-28.48	8.00	36.48
Middle	2 437.00	-29.16	8.00	37.16
High	2 462.00	-28.86	8.00	36.86

Remark. Margin = Limit – Measured Value





Middle Channel



High Channel

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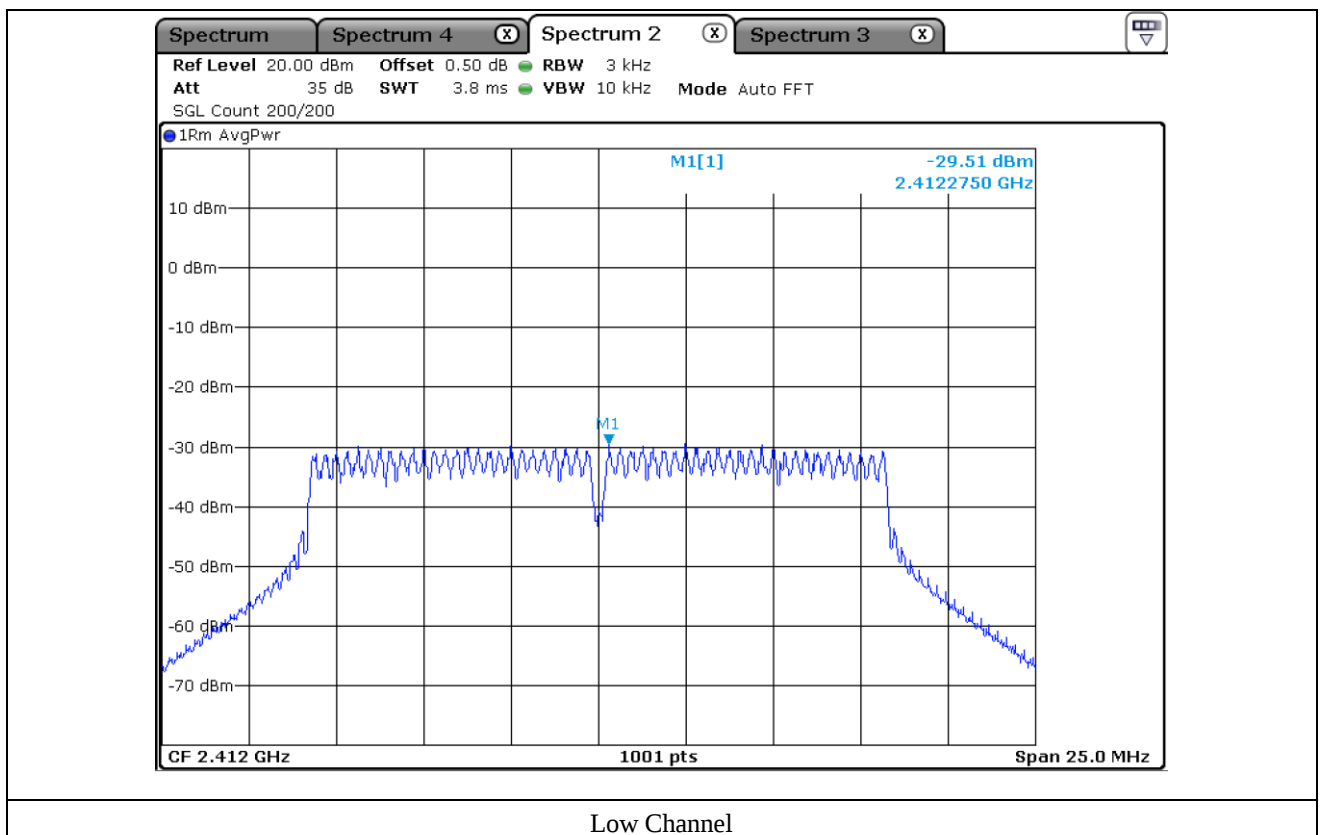
10.6 Test data for 802.11n_HT20 WLAN Mode

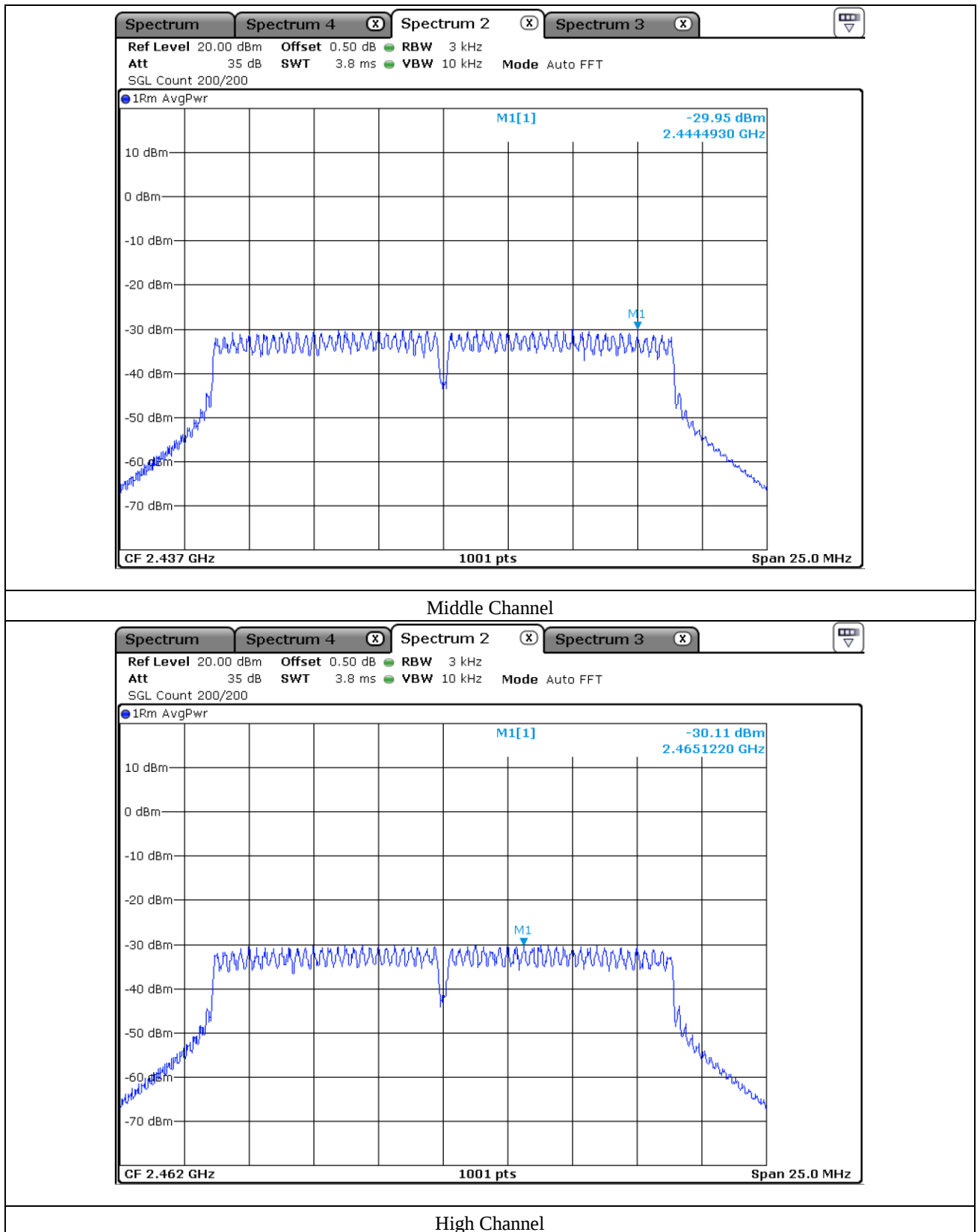
-. Test Result : Pass

-. Operating Condition : Continuous transmitting mode

Channel	Frequency (MHz)	Measured Value (dBm)	Limit (dBm)	Margin (dB)
Low	2 412.00	-29.51	8.00	37.51
Middle	2 437.00	-29.95	8.00	37.95
High	2 462.00	-30.11	8.00	38.11

Remark. Margin = Limit – Measured Value





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10.7 Test data for 802.11n_HT40 WLAN Mode

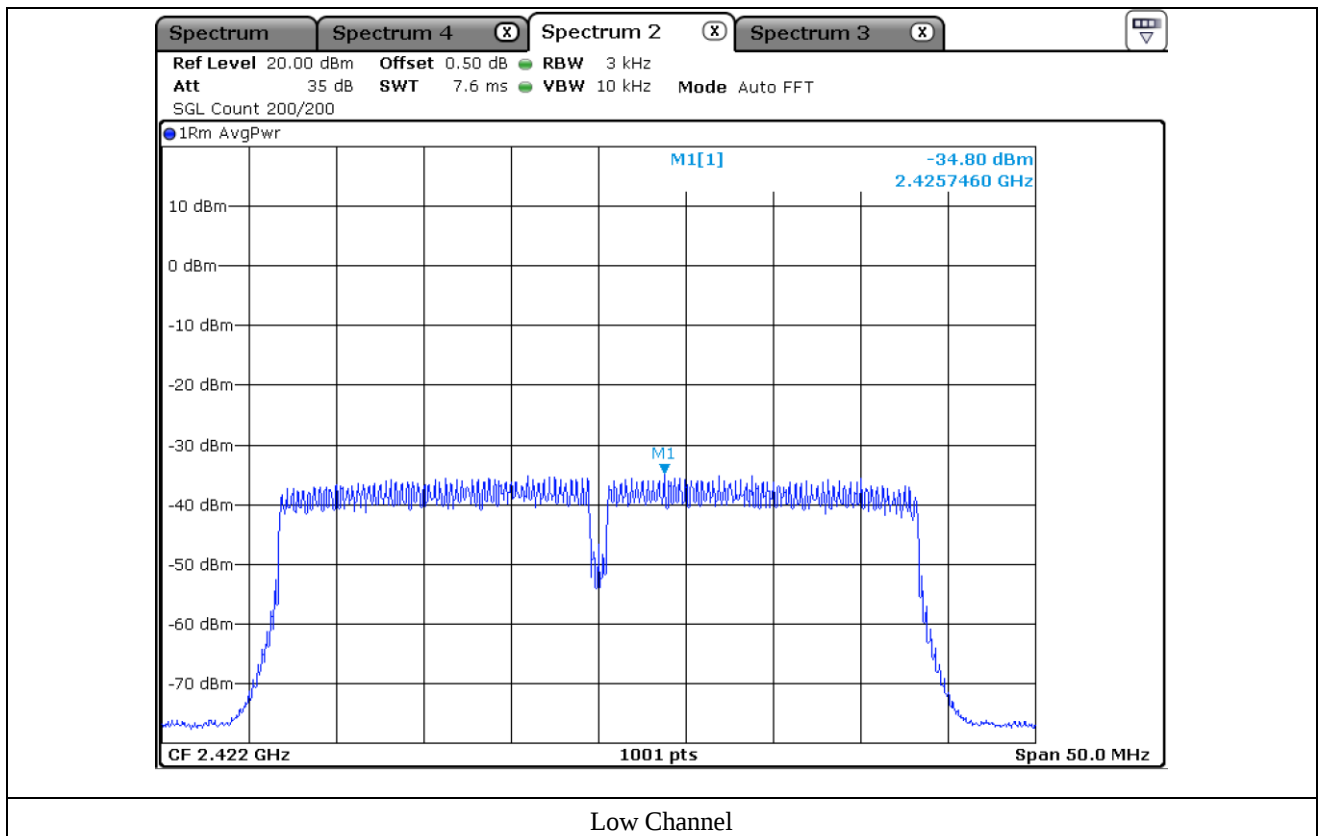
10.7.1 Test data for Antenna 0

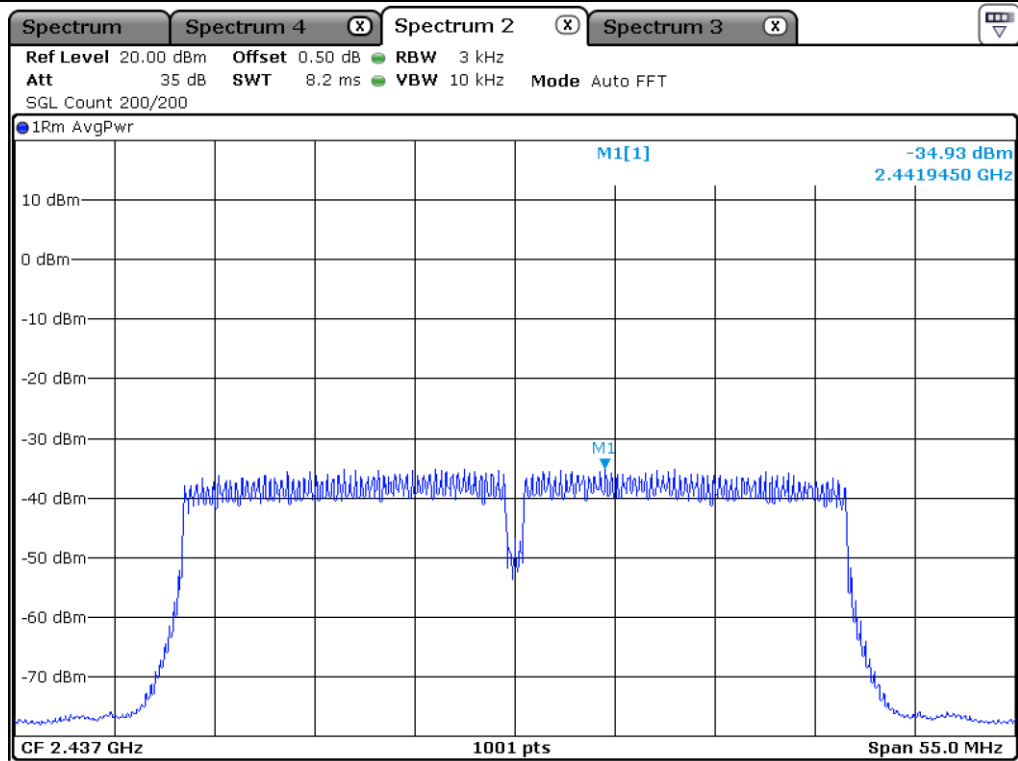
-. Test Result : Pass

-. Operating Condition : Continuous transmitting mode

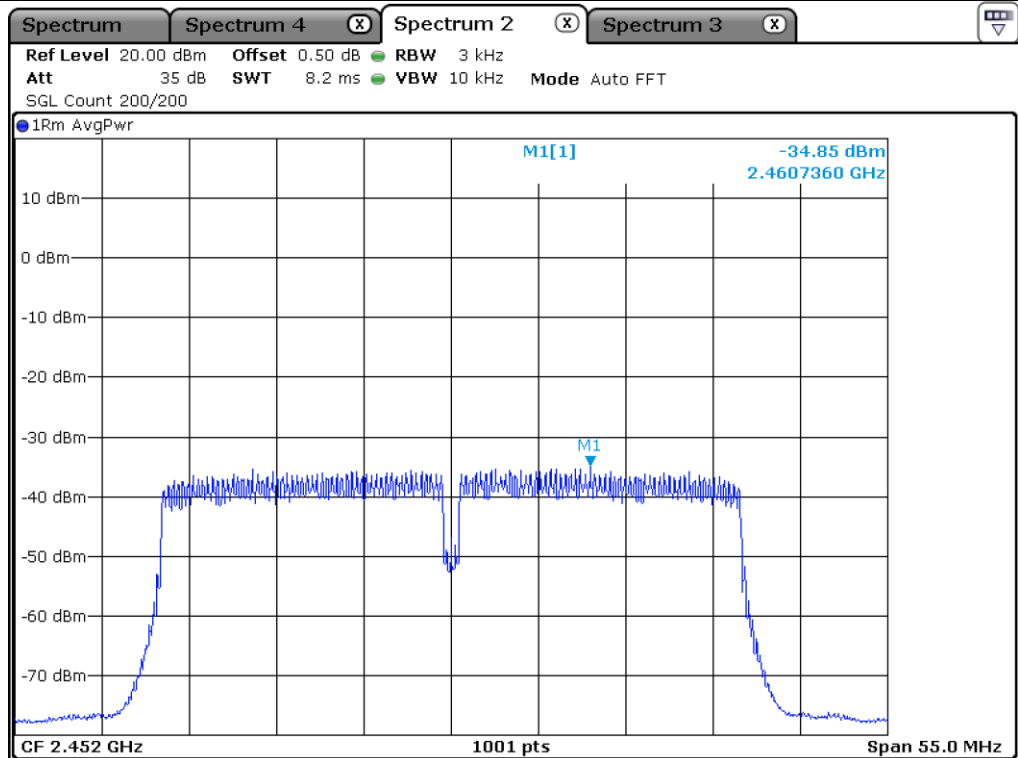
Channel	Frequency (MHz)	Measured Value (dBm)	Limit (dBm)	Margin (dB)
Low	2 422.00	-34.80	8.00	42.80
Middle	2 437.00	-34.93	8.00	42.93
High	2 452.00	-34.85	8.00	42.85

Remark. Margin = Limit – Measured Value





Middle Channel



High 9 Channel

11. RADIATED EMISSION TEST

11.1 Operating environment

Temperature : 22.5 °C
Relative humidity : 46.7 % 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 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.

11.3 Test Date

November 26, 2021

11.4 Test data for 30 MHz ~ 1 000 MHz

11.4.1 Test data for WLAN 2.4 GHz

Humidity Level : 46.7 % R.H.

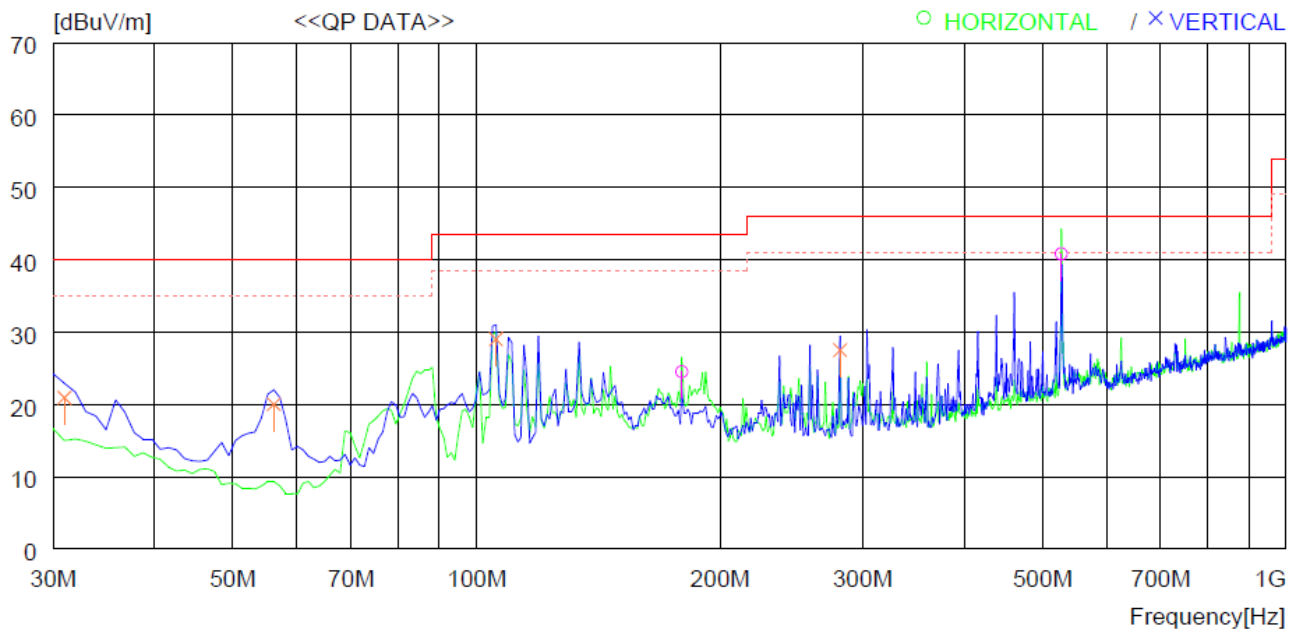
Temperature: 22.5 ° C

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

Result : PASSED

EUT : Thermal Sensing Terminal

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



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	[dBuV]	FACTOR	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	179.380	37.7	16.6	3.2	33.0	24.5	43.5	19.0	100	0
2	527.610	45.0	23.5	5.5	33.2	40.8	46.0	5.2	200	359
----- Vertical -----										
3	30.970	32.1	20.6	1.3	33.1	20.9	40.0	19.1	100	359
4	56.190	39.2	12.1	1.8	33.1	20.0	40.0	20.0	100	359
5	105.660	43.4	16.3	2.4	33.1	29.0	43.5	14.5	100	359
6	281.230	37.6	18.9	4.0	33.0	27.5	46.0	18.5	200	0

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. CONDUCTED EMISSION TEST

12.1 Operating environment

Temperature : 22.5 ° C
Relative humidity : 46.7 % R.H.

12.2 Test set-up

The EUT was placed on a wooden table, 0.8 m height above the floor. Power was fed to the EUT through a 50 Ω / 50 μ H + 5 Ω Artificial Mains Network (AMN). The ground plane was electrically bonded to the reference ground system and all power lines were filtered from ambient.

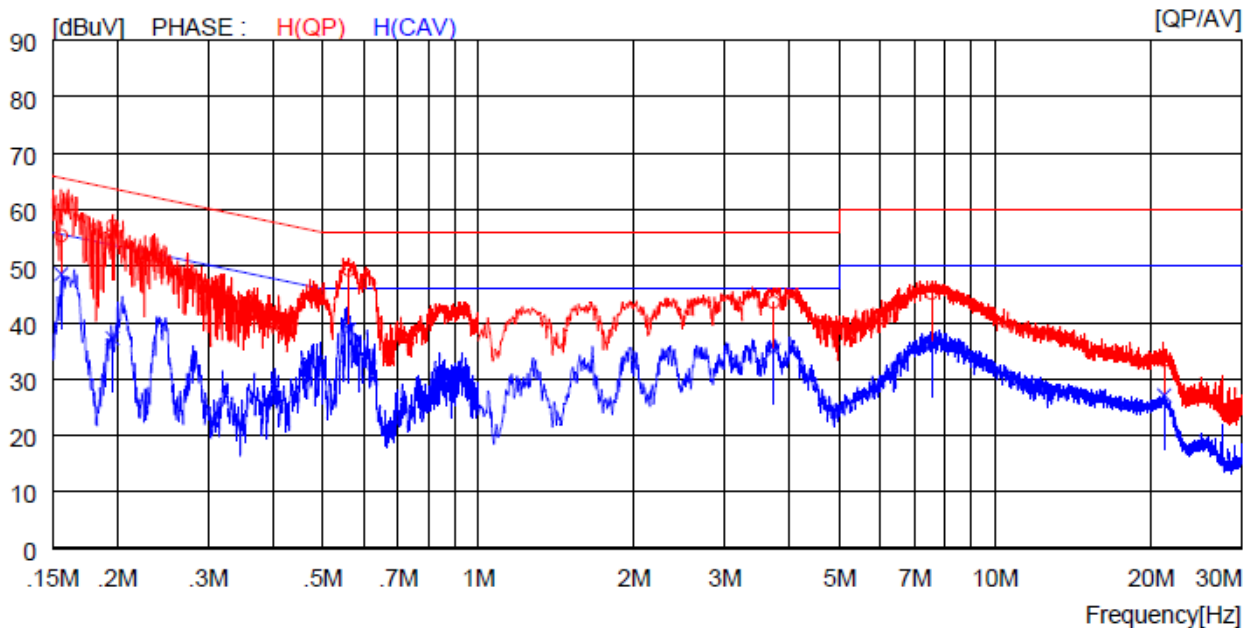
12.3 Test Date

November 26, 2021

12.4 Test data

12.4.1 Test data for WLAN 2.4 GHz

- Resolution bandwidth : 9 kHz
- Frequency range : 0.15 MHz ~ 30 MHz
- Tested Line : LIVE LINE



NO	FREQ [MHz]	READING		C.FACTOR [dB]	RESULT		LIMIT		MARGIN		PHASE
		QP [dBuV]	AV [dBuV]		QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	
1	0.15600	45.4	----	10.0	55.4	----	65.7	----	10.3	----	H (QP)
2	0.19600	47.2	----	10.0	57.2	----	63.8	----	6.6	----	H (QP)
3	0.56200	39.3	----	10.0	49.3	----	56.0	----	6.7	----	H (QP)
4	3.72800	33.5	----	10.1	43.6	----	56.0	----	12.4	----	H (QP)
5	7.52500	35.0	----	10.2	45.2	----	60.0	----	14.8	----	H (QP)
6	21.23000	22.9	----	10.4	33.3	----	60.0	----	26.7	----	H (QP)
7	0.15600	----	38.6	10.0	----	48.6	----	55.7	----	7.1	H (CAV)
8	0.19600	----	27.2	10.0	----	37.2	----	53.8	----	16.6	H (CAV)
9	0.56200	----	28.8	10.0	----	38.8	----	46.0	----	7.2	H (CAV)
10	3.72800	----	25.1	10.1	----	35.2	----	46.0	----	10.8	H (CAV)
11	7.52500	----	26.1	10.2	----	36.3	----	50.0	----	13.7	H (CAV)
12	21.23000	----	16.7	10.4	----	27.1	----	50.0	----	22.9	H (CAV)

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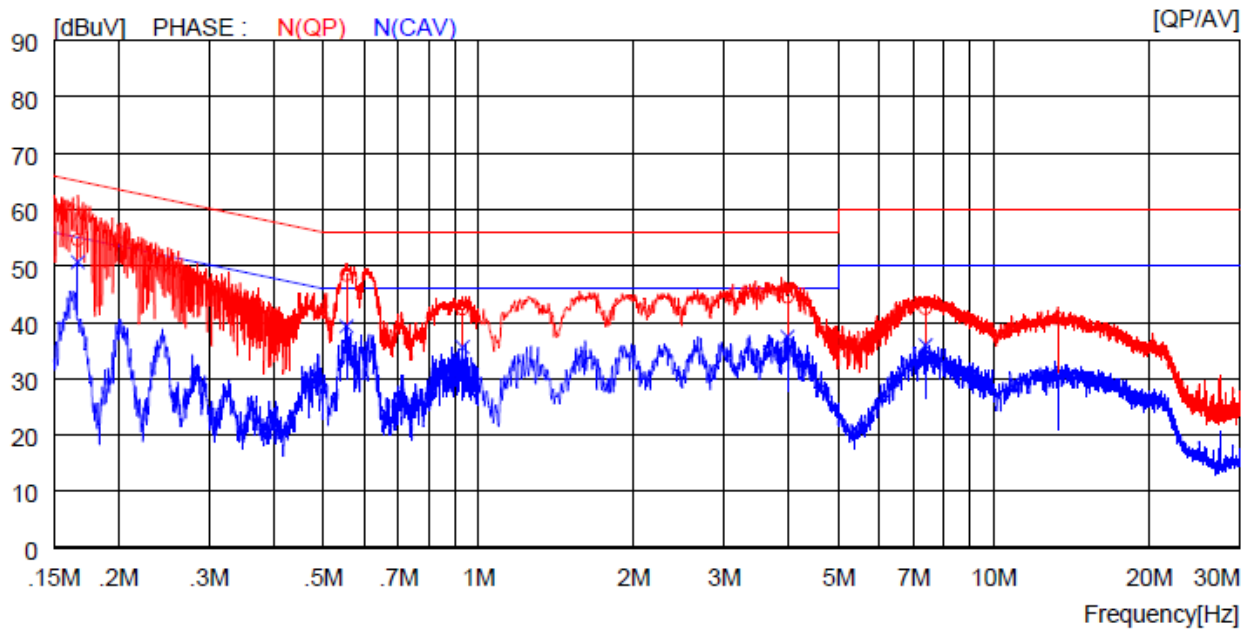
OTC-TRF-RF-001(0)

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

-. Tested Line : NEUTRAL LINE

Remark: Margin (dB) = Limit – Level (Result)

The emission level in above table is included the transducer factor that means insertion loss (LISN), cable loss and attenuator.



NO	FREQ [MHz]	READING		C.FACTOR [dB]	RESULT		LIMIT		MARGIN		PHASE
		QP [dBuV]	AV [dBuV]		QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	
1	0.16700	44.6	----	10.0	54.6	----	65.1	----	10.5	----	N(QP)
2	0.55500	38.4	----	10.0	48.4	----	56.0	----	7.6	----	N(QP)
3	0.93100	32.4	----	10.0	42.4	----	56.0	----	13.6	----	N(QP)
4	3.98000	34.4	----	10.1	44.5	----	56.0	----	11.5	----	N(QP)
5	7.37000	32.3	----	10.2	42.5	----	60.0	----	17.5	----	N(QP)
6	13.31000	30.4	----	10.3	40.7	----	60.0	----	19.3	----	N(QP)
7	0.16700	----	40.7	10.0	----	50.7	----	55.1	----	4.4	N(CAV)
8	0.55500	----	29.3	10.0	----	39.3	----	46.0	----	6.7	N(CAV)
9	0.93100	----	25.6	10.0	----	35.6	----	46.0	----	10.4	N(CAV)
10	3.98000	----	27.3	10.1	----	37.4	----	46.0	----	8.6	N(CAV)
11	7.37000	----	25.7	10.2	----	35.9	----	50.0	----	14.1	N(CAV)
12	13.31000	----	20.2	10.3	----	30.5	----	50.0	----	19.5	N(CAV)

13. LIST OF TEST EQUIPMENT

Model Number	Manufacturer	Description	Serial Number	Last Cal.(Interval)
FSV40-N	Rohde & Schwarz	Signal Analyzer	102177	Apr. 16, 2021 (1Y)
ESR	Rohde & Schwarz	EMI TEST RECEIVER	101470	Oct. 18, 2021 (1Y)
ESCI	Rohde & Schwarz	EMI Test RECEIVER	101012	Oct. 20, 2021 (1Y)
ESH3-Z2	Rohde & Schwarz	Pulse Limiter	100655	Mar. 15, 2021 (1Y)
NSLK8128	Schwarzbeck	V - LISN (4*32/50A)	8128216	Mar. 16, 2021 (1Y)
310N	Sonoma Instrument	Pre-Amplifier	312544	Mar. 16, 2021 (1Y)
DT3000-3t	Innco System	Turn Table	DT3000/093	N/A
MA-4000XPET	Innco System	Antenna Master	MA4000/509	N/A
BBHA9120D	Schwarzbeck	Horn Antenna	295	Mar. 04, 2021(1Y)
TC-3000C	TESCOM	BLUETOOTH TESTER	3000C000634	Feb. 09, 2021 (1Y)