

ELECTROMAGNETIC EMISSION COMPLIANCE REPORT FOR LOW-POWER, NON-LICENSED TRANSMITTER

Test Report No. : OT-189-RWD-004
AGR No. : A187A-312
Applicant : Humax Co., Ltd.
Address : HUMAX BLDG., 2, Yeongmun-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, 17040, South Korea
Manufacturer : Humax Co., Ltd.
Address : HUMAX BLDG., 2, Yeongmun-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, 17040, South Korea
Type of Equipment : Beam Projector
FCC ID. : O6ZW1
Model Name : W1
Multiple Model Name : N/A
Serial number : N/A
Total page of Report : 123 pages (including this page)
Date of Incoming : August 02, 2018
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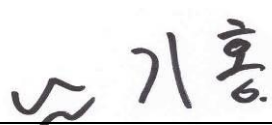
SUMMARY

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.

Reviewed by:


Ki-Hong, Nam / Chief Engineer
ONETECH Corp.

Approved by:


Keun-Young, Choi / Vice President
ONETECH Corp.

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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-189-RWD-004	2018.09.05	Initial Release	All

1. VERIFICATION OF COMPLIANCE

Applicant : Humax Co., Ltd.
 Address : HUMAX BLDG., 2, Yeongmun-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, 17040, South Korea
 Contact Person : Nak Yool Sung / Engineer
 Telephone No. : +82-31-776-6448
 FCC ID : O6ZW1
 Model Name : W1
 Brand Name : -
 Serial Number : N/A
 Date : September 05, 2018

EQUIPMENT CLASS	DTS – DIGITAL TRNSMISSION SYSTEM
E.U.T. DESCRIPTION	Modular Transmitter, Beam Projector
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2013
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 DTS Meas Guidance v04
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	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: 2013. 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-4112/ C-14617/ G-10666 / T-1842

IC (Industry Canada) – Registration No. Site# 3736A-3

-. Site Accreditation:

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 Humax Co., Ltd., Model W1 (referred to as the EUT in this report) is a Beam Projector. Product specification information described herein was obtained from product data sheet or user’s manual.

DEVICE TYPE	Beam Projector		
Operating Frequency	Bluetooth LE	2 402 MHz ~ 2 480 MHz	
	Bluetooth	2 402 MHz ~ 2 480 MHz	
	WLAN	2 412 MHz ~ 2 462 MHz (802.11b/g/n(HT20))	
	2.4 GHz Band	2 422 MHz ~ 2 452 MHz (802.11n(HT40))	
	WLAN 5 GHz Band	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))			
RF Output Power	Bluetooth LE	1.91 dBm	
	Bluetooth	1 Mbps (-5.49 dBm)	
		2 Mbps (-7.21 dBm)	
		3 Mbps (-6.73 dBm)	
	WLAN 2.4 GHz Band	Antenna 0	Wi-Fi 802.11b (17.70 dBm)
			Wi-Fi 802.11g (21.34 dBm)
			Wi-Fi 802.11n(HT20) (21.53 dBm)
Antenna 1		Wi-Fi 802.11n(HT40) (22.44 dBm)	
		Wi-Fi 802.11b (17.62 dBm)	
		Wi-Fi 802.11g (20.99 dBm)	
Antenna 0 + Antenna 1	Wi-Fi 802.11n(HT20) (21.47 dBm)		
	Wi-Fi 802.11n(HT40) (22.44 dBm)		
		Wi-Fi 802.11n(HT20) (21.20 dBm)	
		Wi-Fi 802.11n(HT40) (22.09 dBm)	

RF Output Power	WLAN 5 GHz Band	5 150 MHz ~ 5 250 MHz Band	Antenna 0	Wi-Fi 802.11a (14.72 dBm) Wi-Fi 802.11n(HT20) (14.66 dBm) Wi-Fi 802.11n(HT40) (16.49 dBm) Wi-Fi 802.11ac(HT80) (14.99 dBm)
			Antenna 1	Wi-Fi 802.11a (14.74 dBm) Wi-Fi 802.11n(HT20) (14.74 dBm) Wi-Fi 802.11n(HT40) (16.38 dBm) Wi-Fi 802.11ac(HT80) (14.78 dBm)
			Antenna 0 + Antenna 1	Wi-Fi 802.11n(HT20) (14.69 dBm) Wi-Fi 802.11n(HT40) (16.23 dBm) Wi-Fi 802.11ac(HT80) (14.95 dBm)
		5 725 MHz ~ 5 850 MHz Band	Antenna 0	Wi-Fi 802.11a (15.18 dBm) Wi-Fi 802.11n(HT20) (14.88 dBm) Wi-Fi 802.11n(HT40) (16.55 dBm) Wi-Fi 802.11ac(HT80) (15.21 dBm)
			Antenna 1	Wi-Fi 802.11a (15.11 dBm) Wi-Fi 802.11n(HT20) (14.94 dBm) Wi-Fi 802.11n(HT40) (16.48 dBm) Wi-Fi 802.11ac(HT80) (15.03 dBm)
			Antenna 0 + Antenna 1	Wi-Fi 802.11n(HT20) (14.94 dBm) Wi-Fi 802.11n(HT40) (16.46 dBm) Wi-Fi 802.11ac(HT80) (15.10 dBm)

Modulation Type	Bluetooth LE	DSSS Modulation(GFSK)	
	Bluetooth	GFSK (1 Mbps), $\pi/4$ -QPSK (2 Mbps), 8-DPSK (3 Mbp)	
	WLAN 2.4 GHz Band	DSSS Modulation(DBPSK/DQPSK/CCK) OFDM Modulation(BPSK/QPSK/16QAM/64QAM)	
	WLAN 5 GHz Band	OFDM Modulation(BPSK/QPSK/16QAM/64QAM)	
Antenna Type	Bluetooth LE	Antenna 1	5.60 dBi
	Bluetooth		
	WLAN 2.4 GHz Band	Antenna 0	5.50 dBi
		Antenna 1	5.60 dBi
		Antenna 0 + Antenna 1	8.56 dBi
	5 150 MHz ~ 5 250 MHz Band	Antenna 0	6.90 dBi
		Antenna 1	5.90 dBi
		Antenna 0 + Antenna 1	9.44 dBi
	5 725 MHz ~ 5 850 MHz Band	Antenna 0	6.90 dBi
		Antenna 1	5.90 dBi
		Antenna 0 + Antenna 1	9.44 dBi
	Antenna Type	FPCB Antenna	
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)	24 MHz, 37.4 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	Humax Co., Ltd.	CPU B/D REV 0.4	N/A
Button Board	Humax Co., Ltd.	W1 MIC B/D REV 0.4	N/A
AMP Board	Humax Co., Ltd.	W1 AMP B/D REV 0.4	N/A
Module	Humax Co., Ltd.	N/A	N/A
Adapter	Humax Co., Ltd.	ADS-48PI-12N-2 12048E	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
ThinBe	Hironic Co., Ltd	Beam Projector (EUT)	-
JIG	N/A	TEST JIG	EUT
ProBook 650 G2	H.P.	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.

Modulation	DATA RATE	OUTPUT POWER[dBm]	
		Antenna 0	Antenna 1
802.11 b (Middle Channel)	1 Mbps	17.70	17.62
	2 Mbps	17.42	17.35
	5.5 Mbps	17.26	16.98
	11 Mbps	17.00	16.83
802.11g (Middle Channel)	6 Mbps	21.34	20.99
	9 Mbps	21.05	20.76
	12 Mbps	20.82	20.63
	18 Mbps	20.69	20.28
	24 Mbps	20.57	19.95
	36 Mbps	20.26	19.62
	48 Mbps	20.09	19.25
	54 Mbps	19.78	19.02
HT 20 (Middle Channel)	6.5 Mbps	21.53	21.47
	13 Mbps	21.19	21.27
	19.5 Mbps	20.85	21.10
	26 Mbps	20.59	20.74
	39 Mbps	20.28	20.47
	52 Mbps	20.17	20.10
	58.5 Mbps	20.00	19.78
	65 Mbps	19.83	19.52
HT 40 (Middle Channel)	13.5 Mbps	22.44	22.44
	27 Mbps	22.24	22.17
	40.5 Mbps	22.12	21.83
	54 Mbps	21.76	21.70
	81 Mbps	21.54	21.31
	108 Mbps	21.15	20.97
	121.5 Mbps	21.03	20.59
	135 Mbps	20.86	20.32

-. The worse case data rate for each modulation is determined 1 Mbps(Ant.0/Ant.1) for IEEE 802.11b, 6 Mbps(Ant.0/Ant.1) for IEEE 802.11g, 6.5 Mbps(Ant.0/Ant.1) for HT20, 13.5 Mbps(Ant.0/Ant.1) 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.

5.4 Configuration of Test System

Line Conducted Test: The EUT was connected to LISN. All supporting equipments were connected to another LISN. Preliminary Power line Conducted Emission test was performed by using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions.

Radiated Emission Test: Preliminary radiated emissions test were conducted using the procedure in ANSI C63.10: 2013 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 FPCB 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

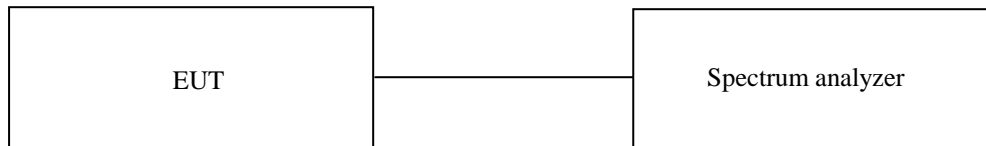
7. MIMIMUM 6 dB BANDWIDTH

7.1 Operating environment

Temperature : 24.3 °C
 Relative humidity : 43.9 % 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 equipment used

Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ - FSV40	Rohde & Schwarz	Signal Analyzer	101009	Mar. 14, 2018 (1Y)

All test equipment used is calibrated on a regular basis.

7.4 Test data for 802.11b WLAN Mode

7.4.1 Test data for Antenna 0

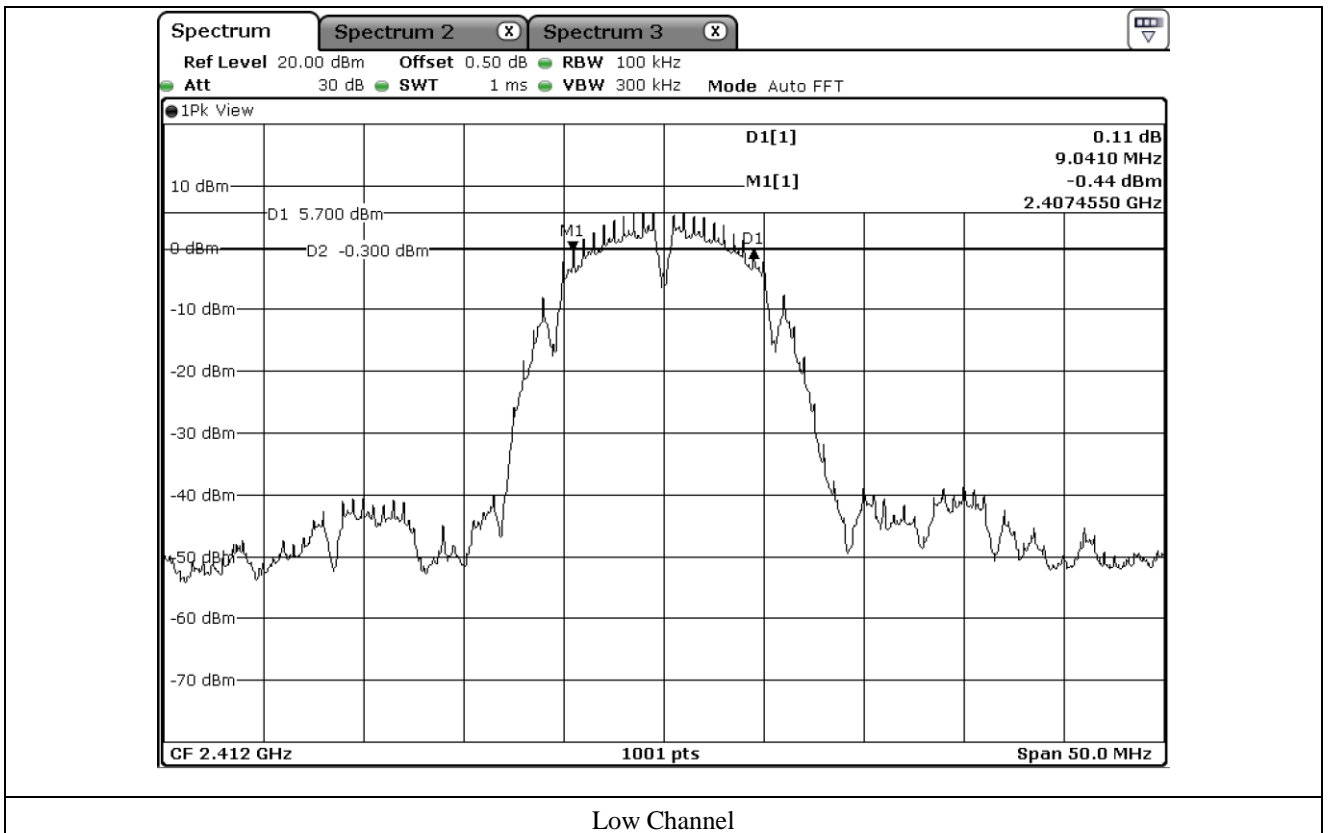
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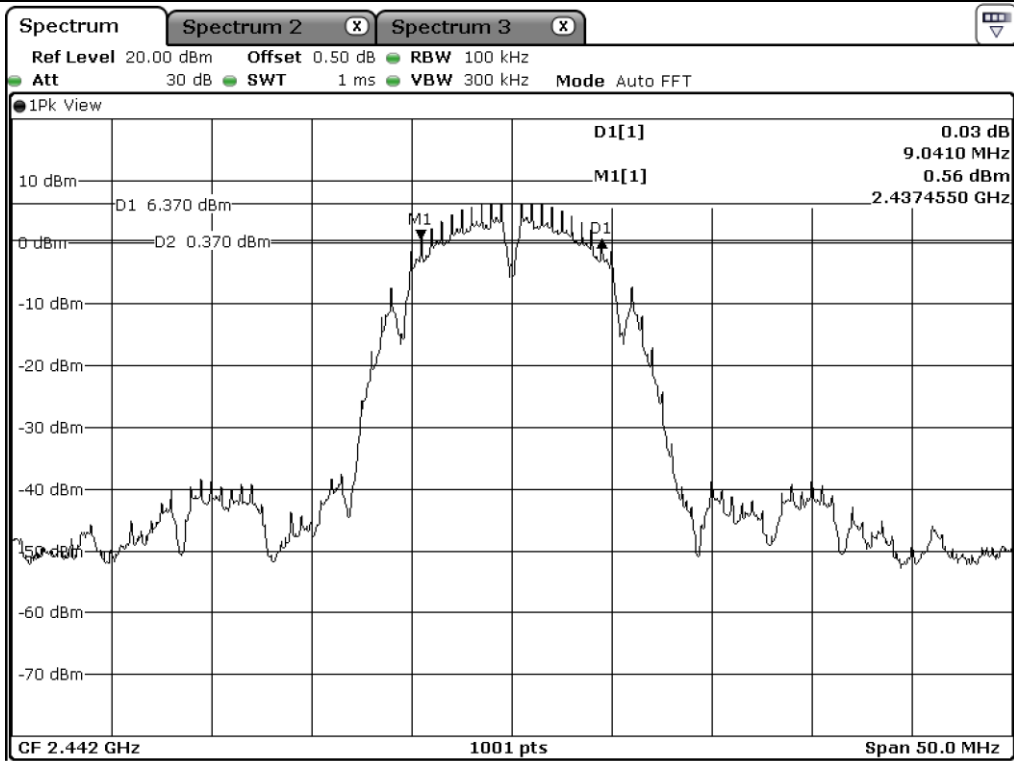
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412.00	9.04	0.50	8.54
Middle	2 442.00	9.04	0.50	8.54
High	2 462.00	9.04	0.50	8.54

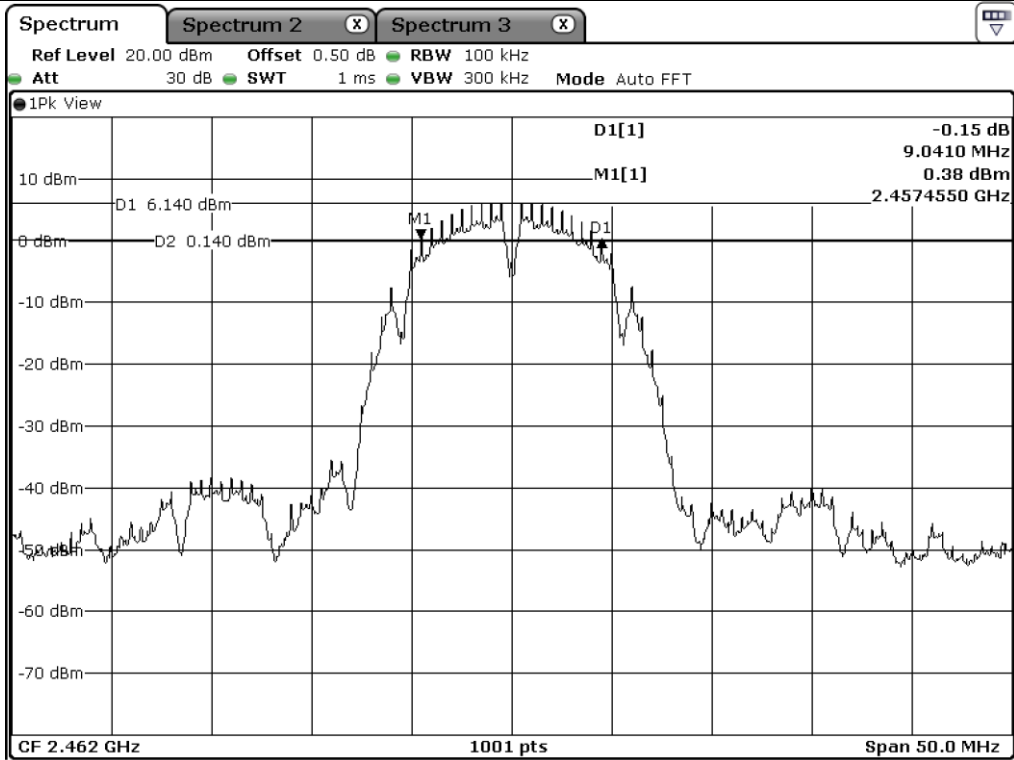
Remark. Margin = Measured Value - Limit

Tested by: Tae-Ho, Kim / Senior Manager





Middle Channel



High Channel

7.4.2 Test data for Antenna 1

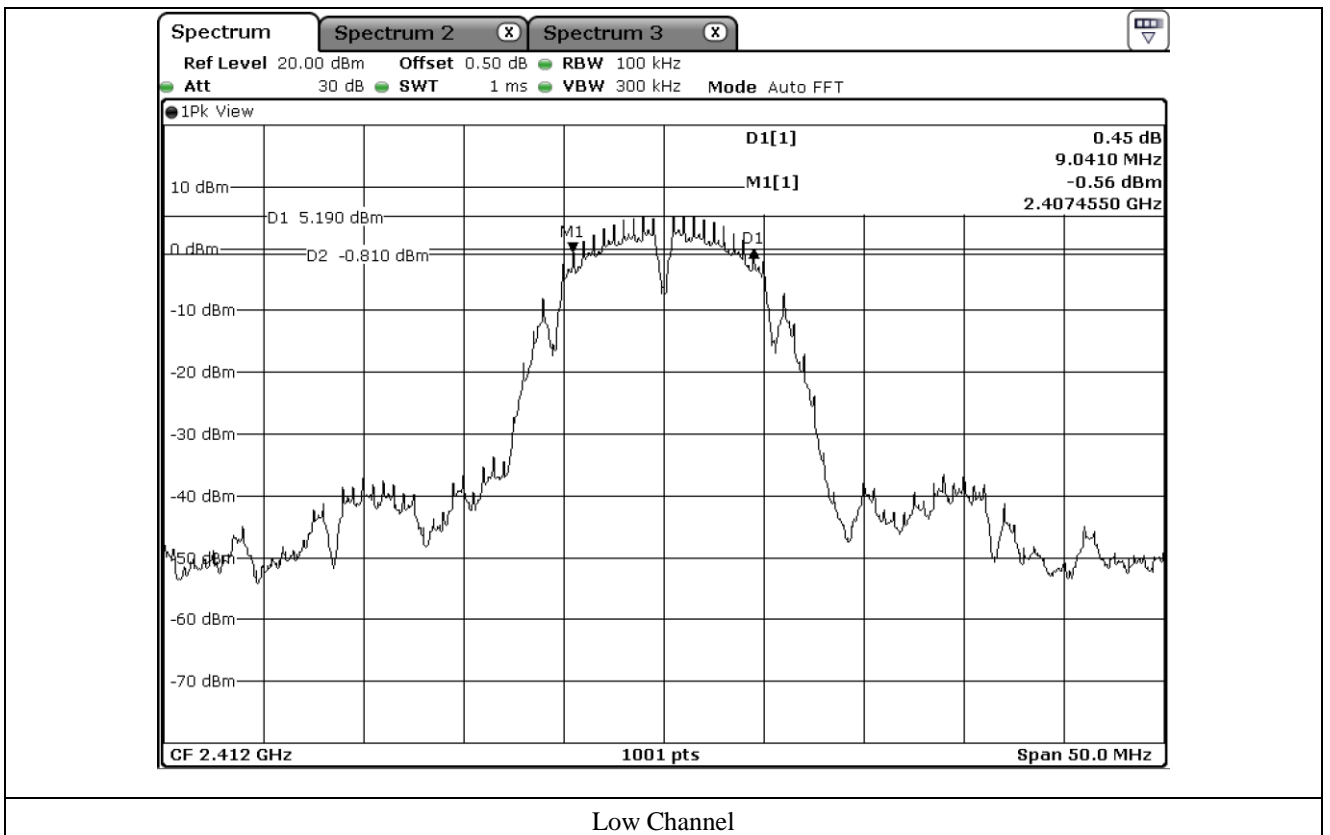
- Test Date : August 16, 2018 ~ August 28, 2018
- Test Result : Pass

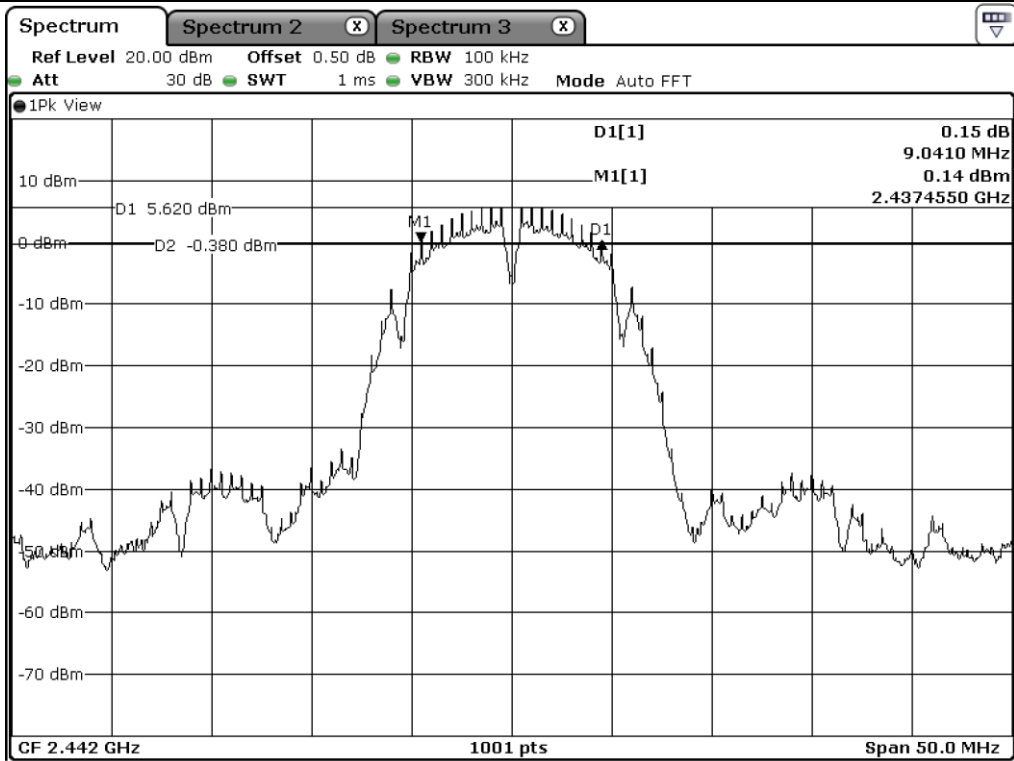
CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412.00	9.04	0.50	8.54
Middle	2 442.00	9.04	0.50	8.54
High	2 462.00	9.04	0.50	8.54

Remark. Margin = Measured Value - Limit

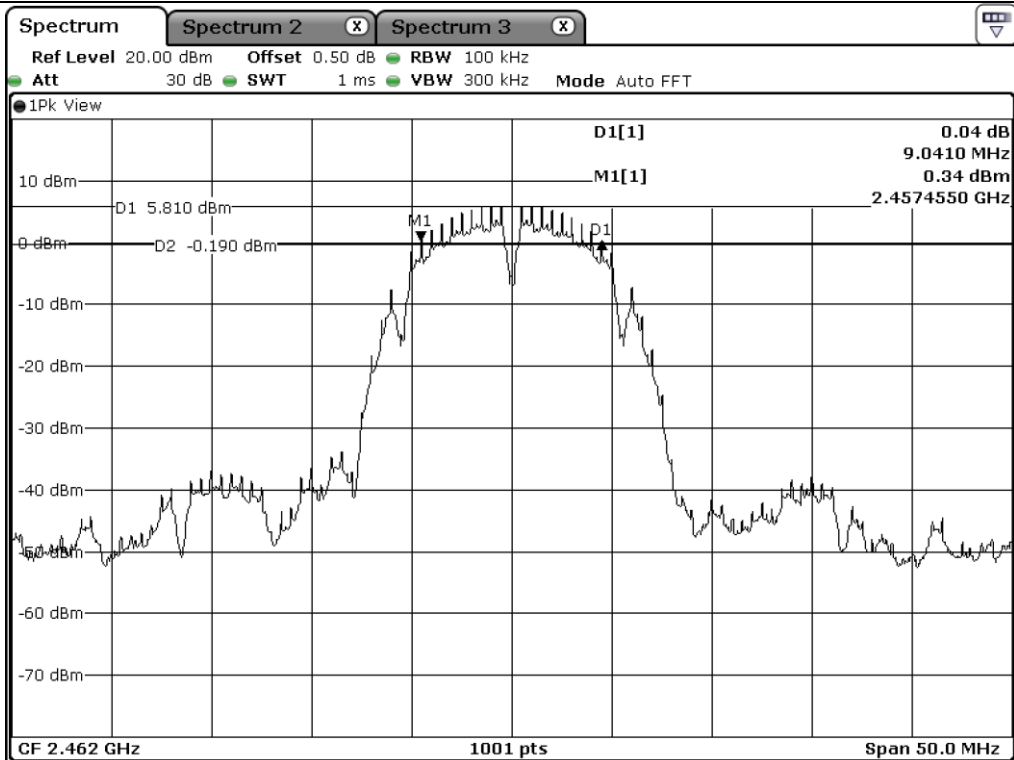


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Middle Channel



High Channel

7.5 Test data for 802.11g WLAN Mode

7.5.1 Test data for Antenna 0

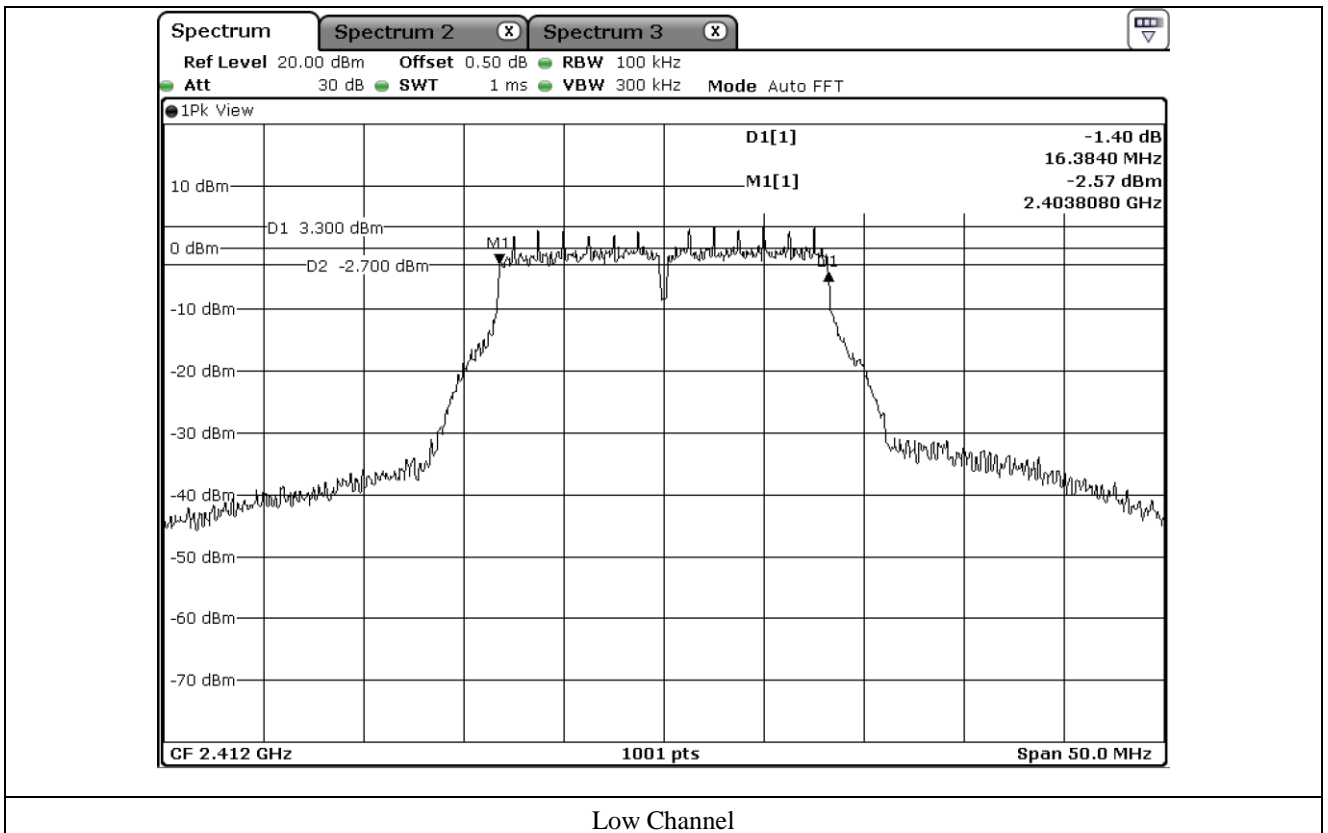
- Test Date : August 16, 2018 ~ August 28, 2018

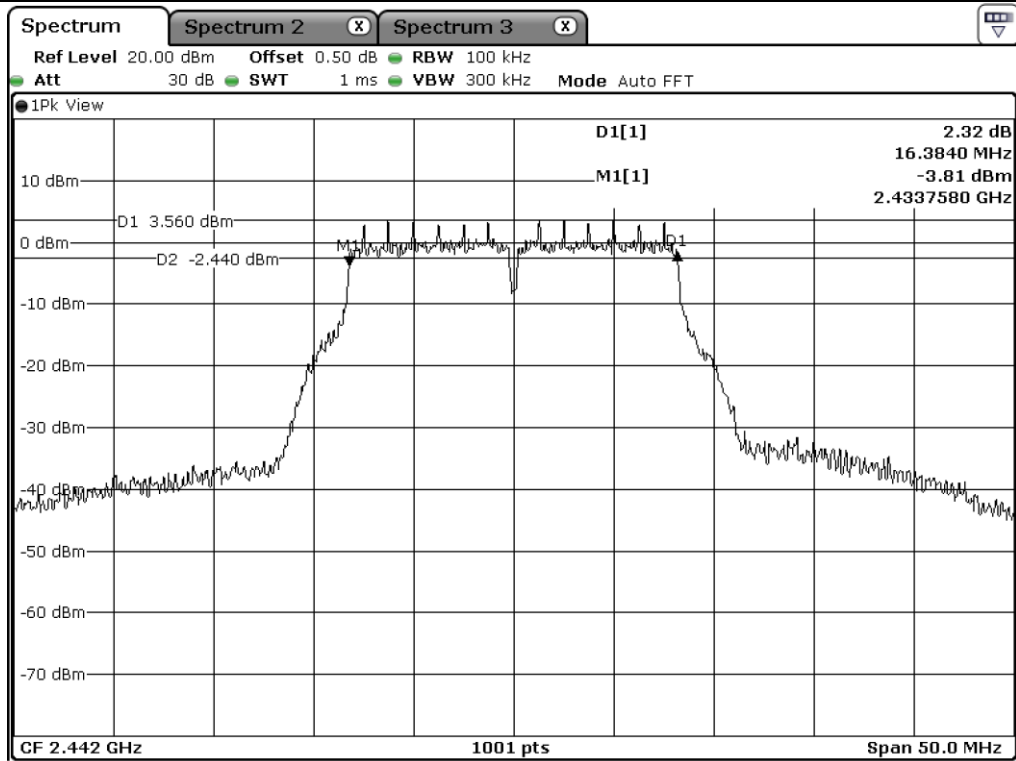
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412.00	16.38	0.50	15.88
Middle	2 442.00	16.38	0.50	15.88
High	2 462.00	16.38	0.50	15.88

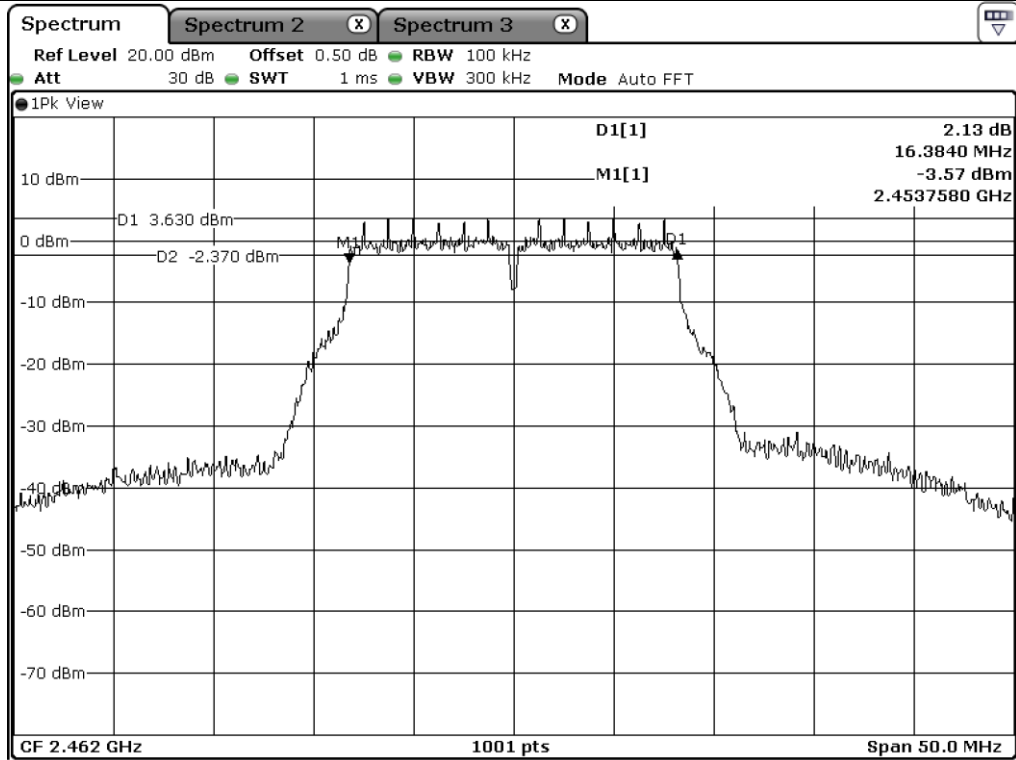
Remark. Margin = Measured Value - Limit

Tested by: Tae-Ho, Kim / Senior Manager





Middle Channel



High Channel

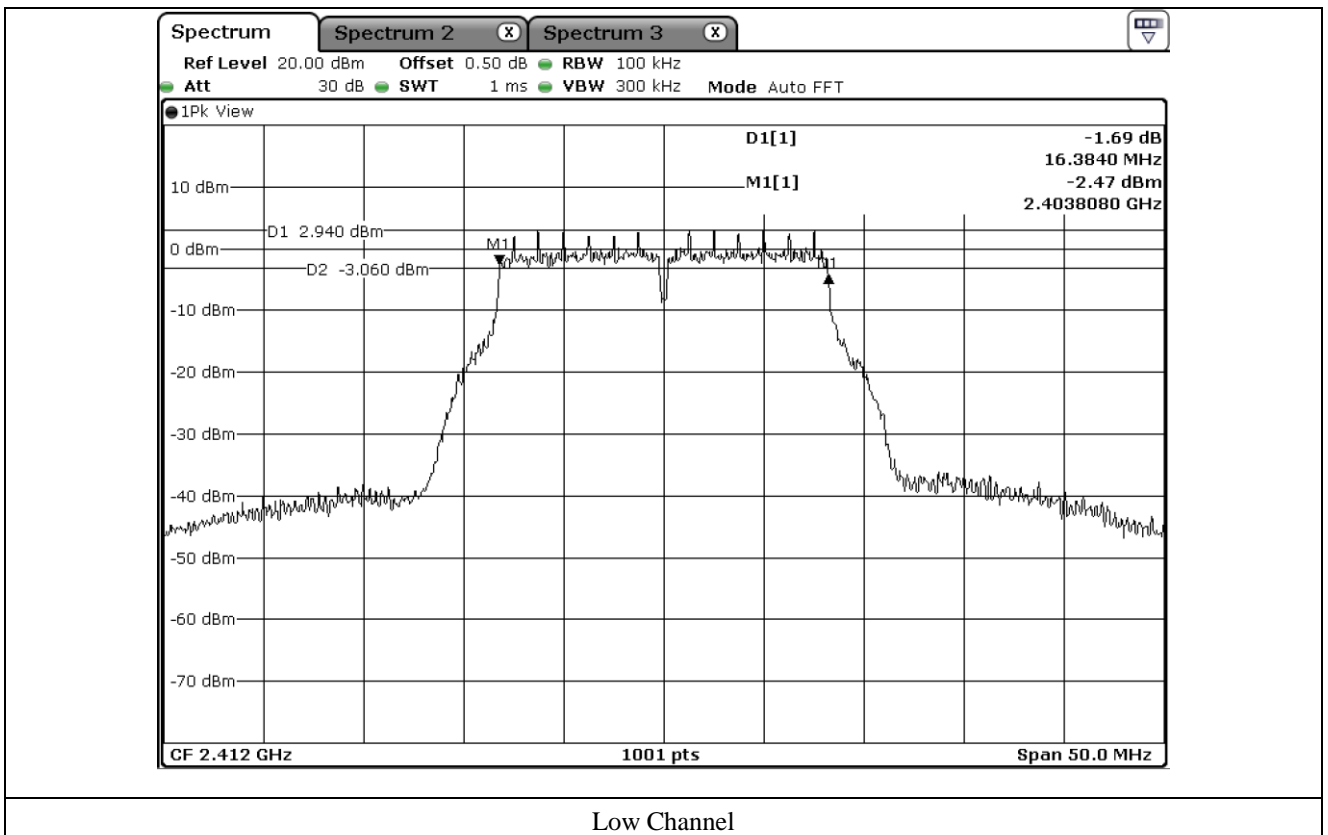
7.5.2 Test data for Antenna 1

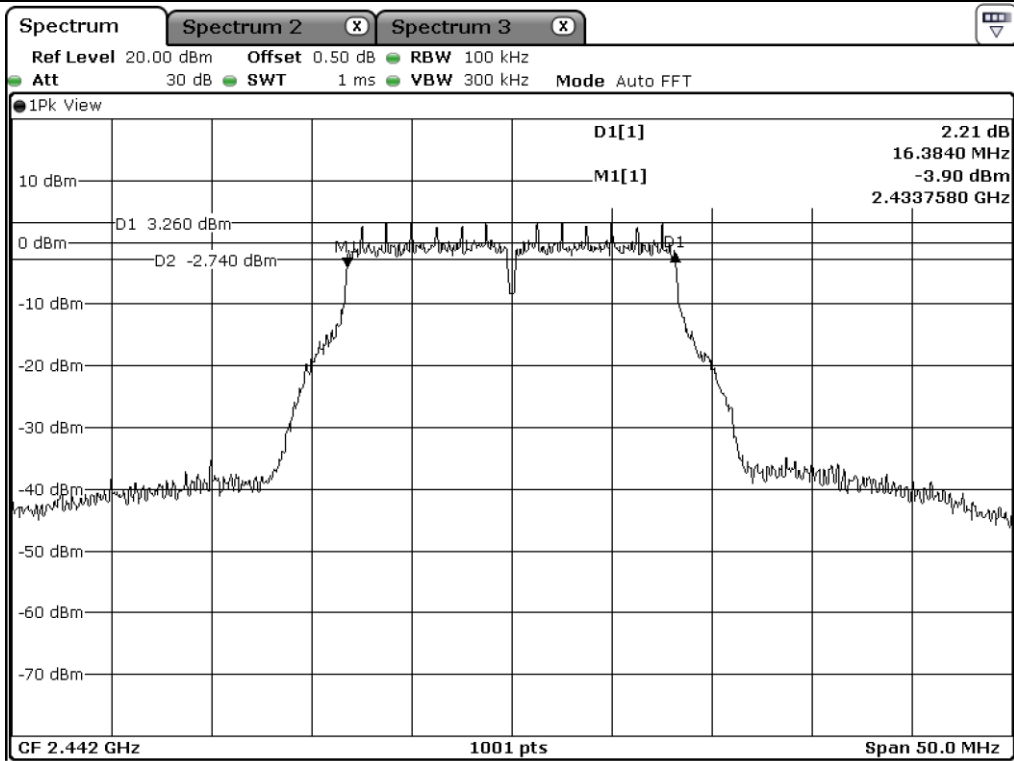
- Test Date : August 16, 2018 ~ August 28, 2018
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412.00	16.38	0.50	15.88
Middle	2 442.00	16.38	0.50	15.88
High	2 462.00	16.38	0.50	15.88

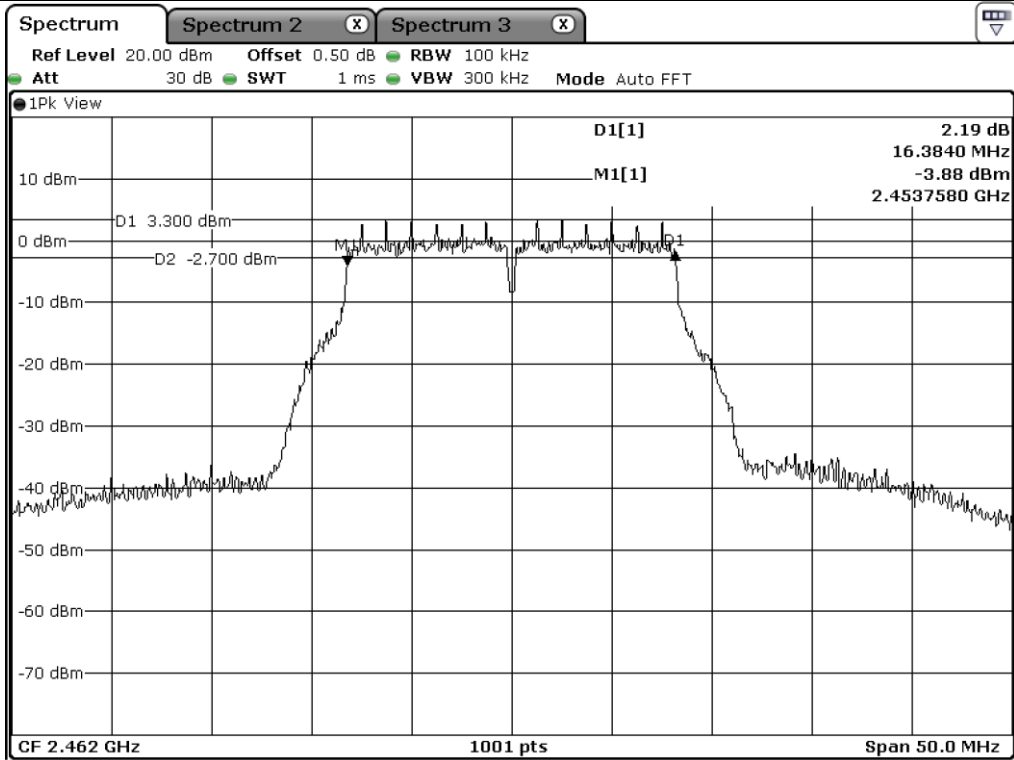
Remark. Margin = Measured Value - Limit

Tested by: Tae-Ho, Kim / Senior Manager





Middle Channel



High Channel

7.6 Test data for 802.11n_HT20 WLAN Mode

7.6.1 Test data for Antenna 0

-. Test Date : August 16, 2018 ~ August 28, 2018

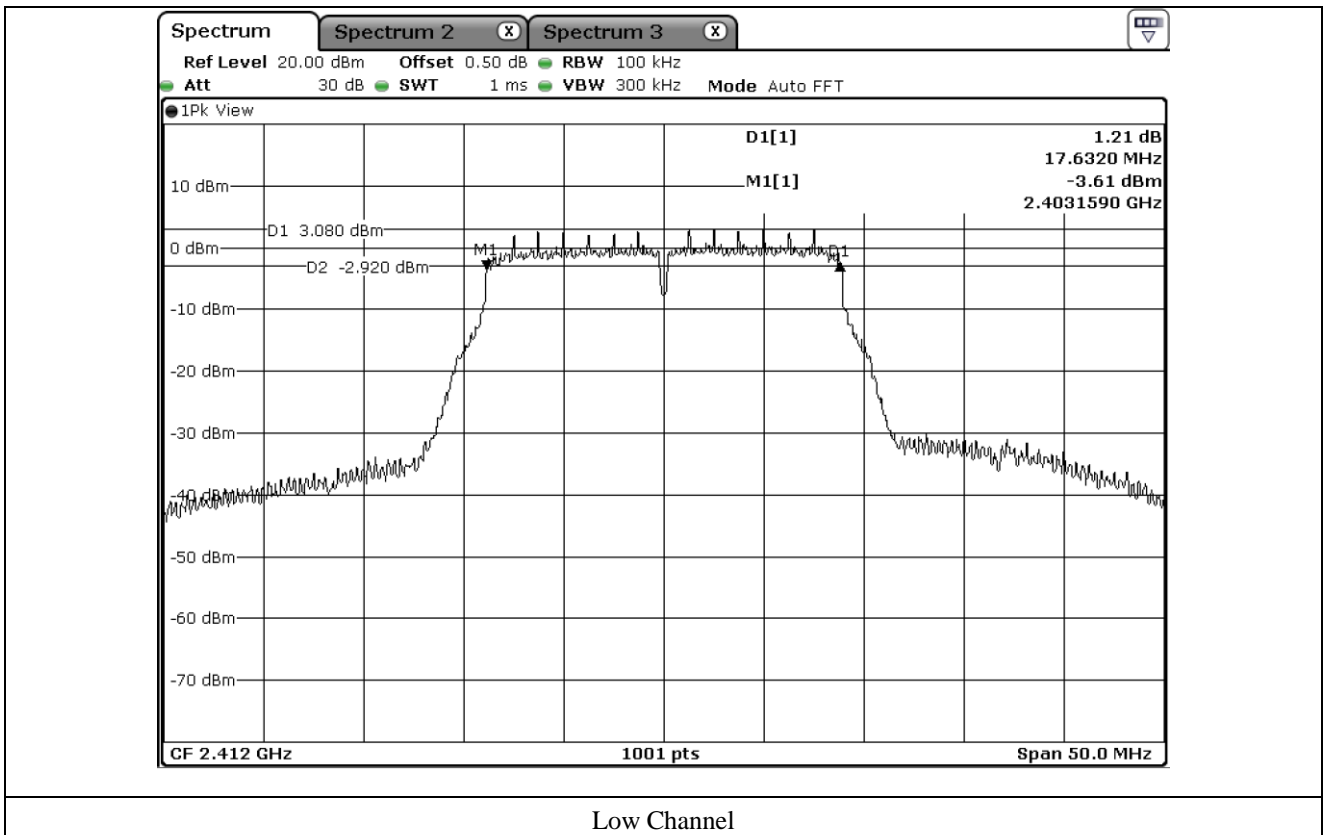
-. Test Result : Pass

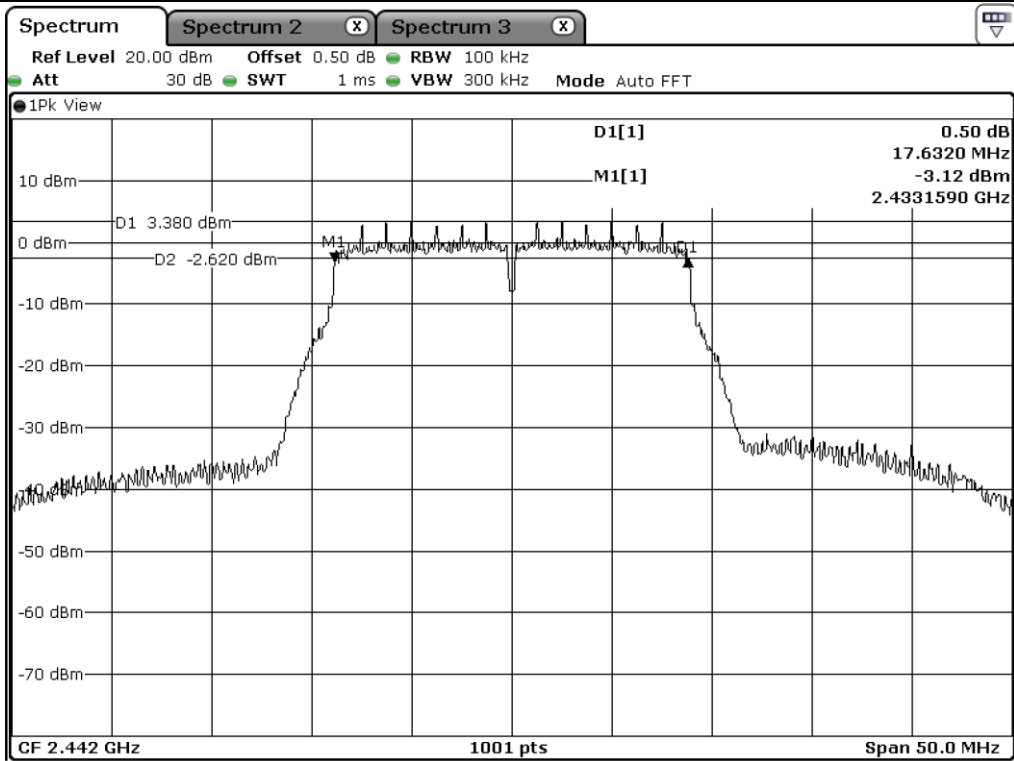
CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412.00	17.63	0.50	17.13
Middle	2 442.00	17.63	0.50	17.13
High	2 462.00	17.63	0.50	17.13

Remark. Margin = Measured Value - Limit

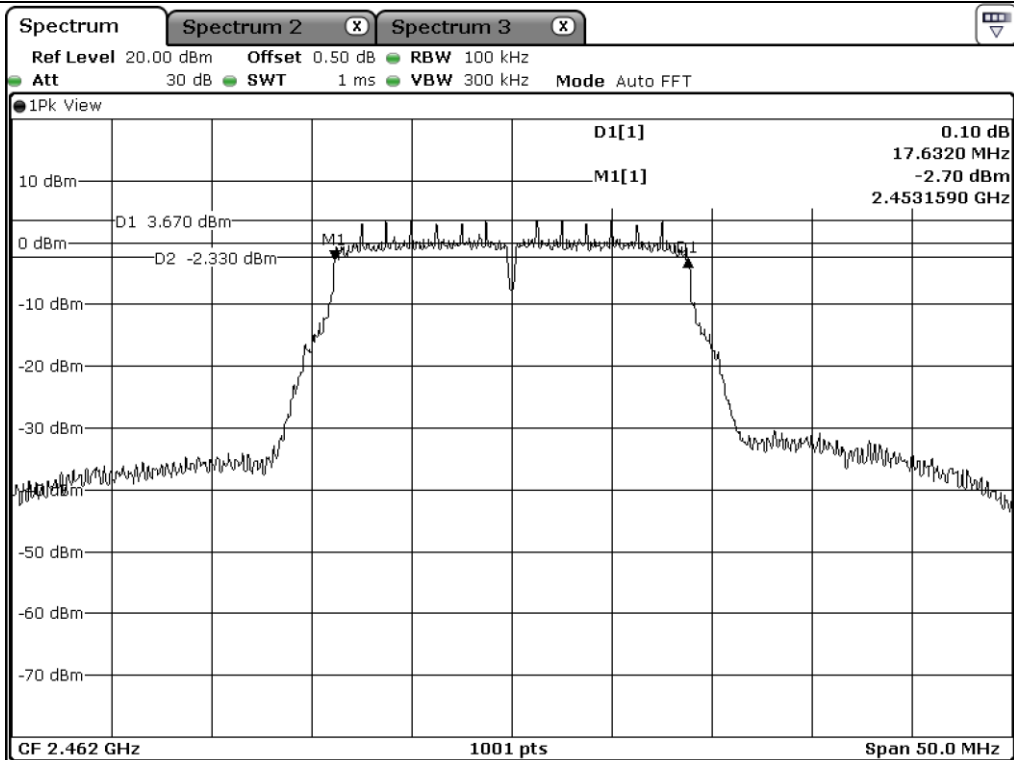


Tested by: Tae-Ho, Kim / Senior Manager





Middle Channel



High Channel

7.6.2 Test data for Antenna 1

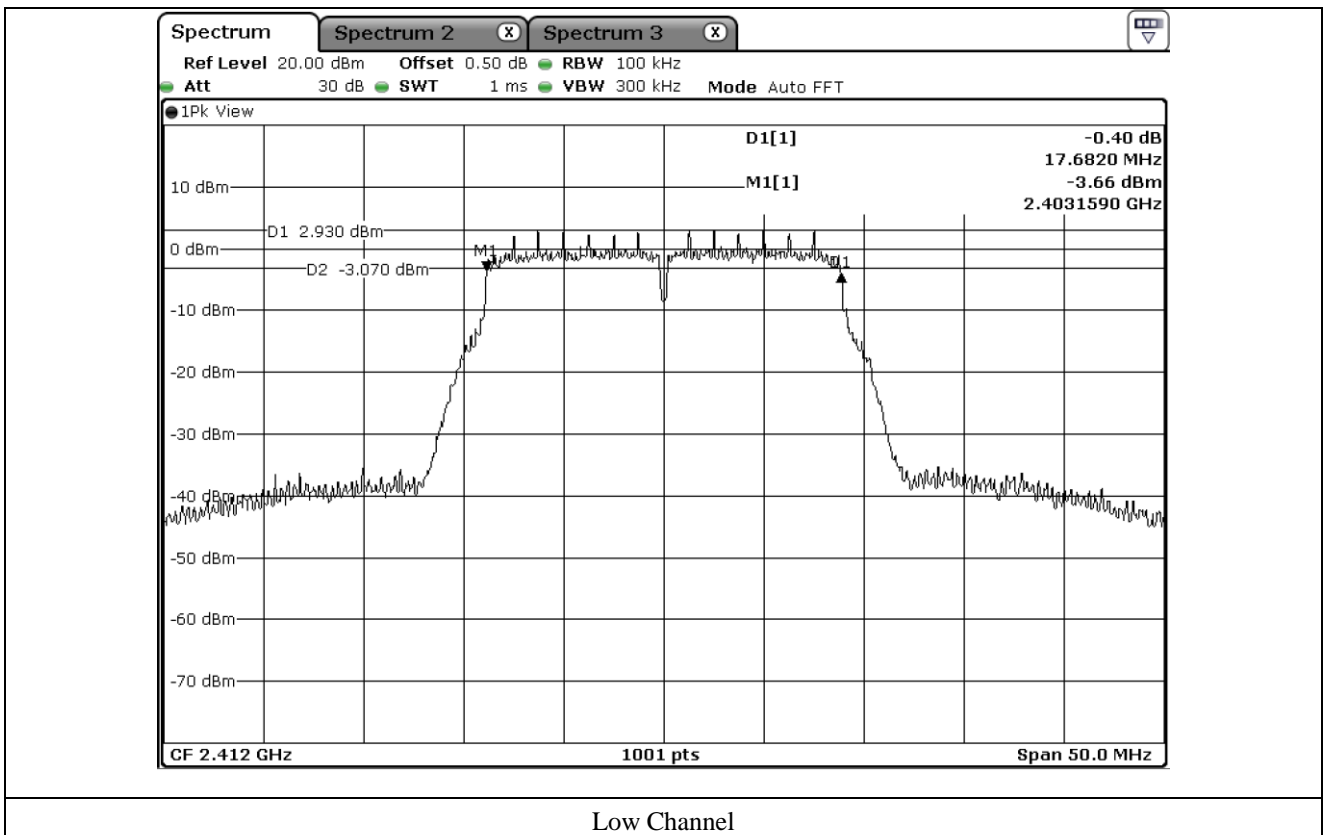
- Test Date : August 16, 2018 ~ August 28, 2018
 - Test Result : Pass

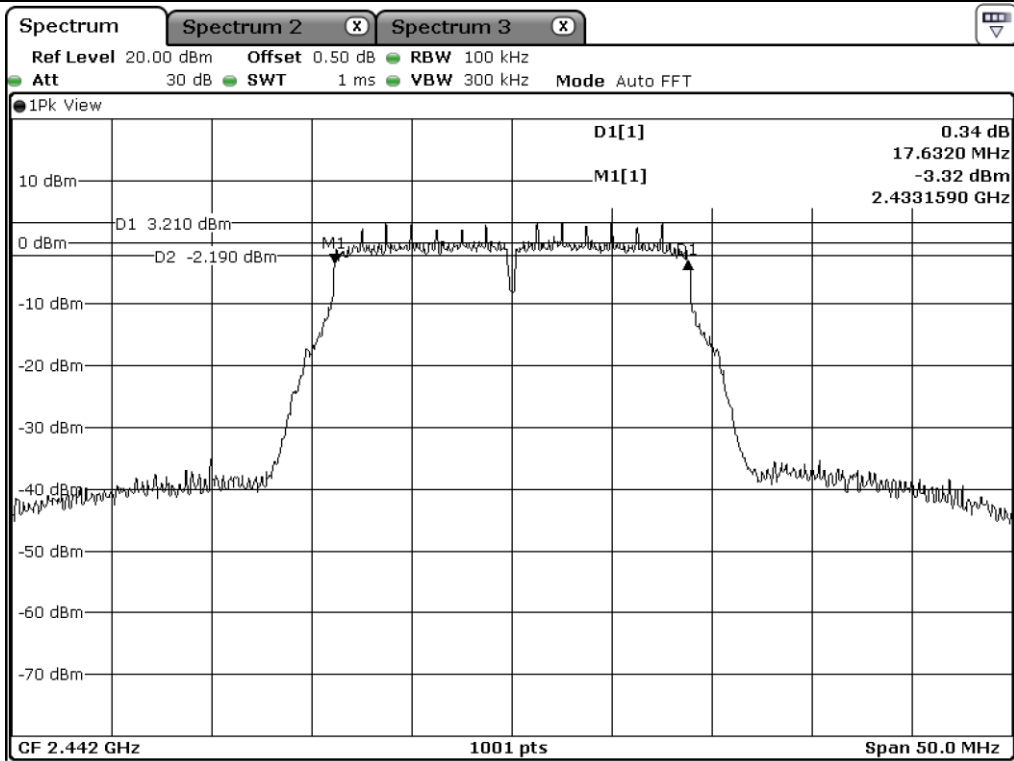
CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412.00	17.68	0.50	17.18
Middle	2 442.00	17.63	0.50	17.13
High	2 462.00	17.63	0.50	17.13

Remark. Margin = Measured Value - Limit

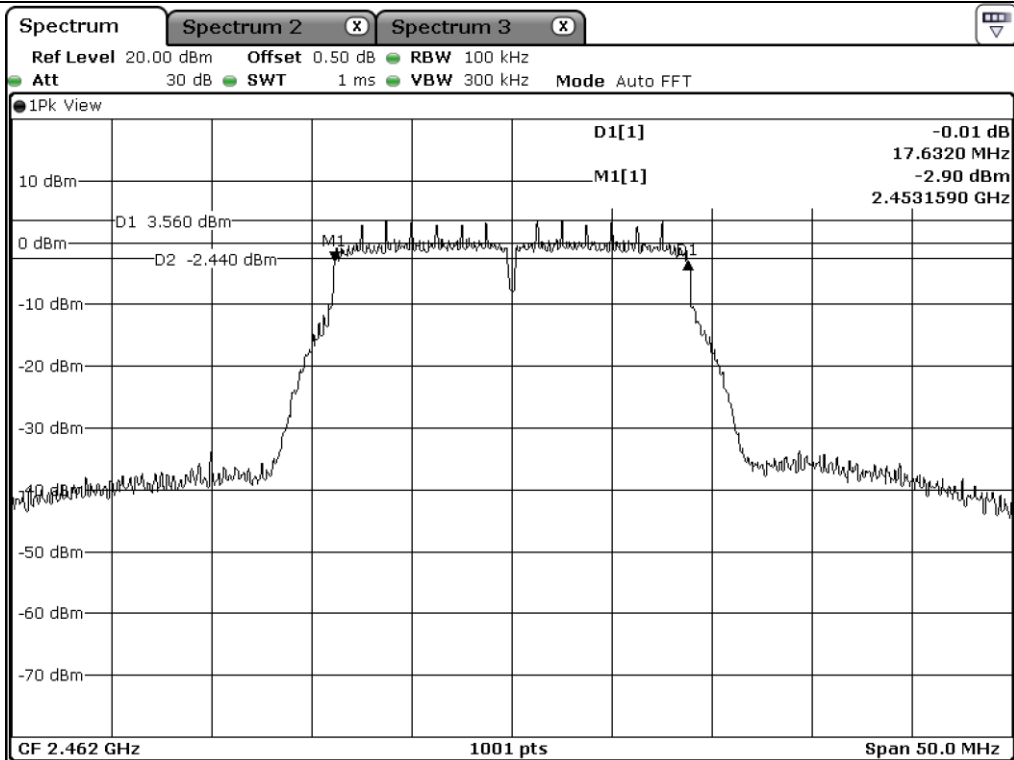


Tested by: Tae-Ho, Kim / Senior Manager





Middle Channel



High Channel

7.7 Test data for 802.11n_HT40 WLAN Mode

7.7.1 Test data for Antenna 0

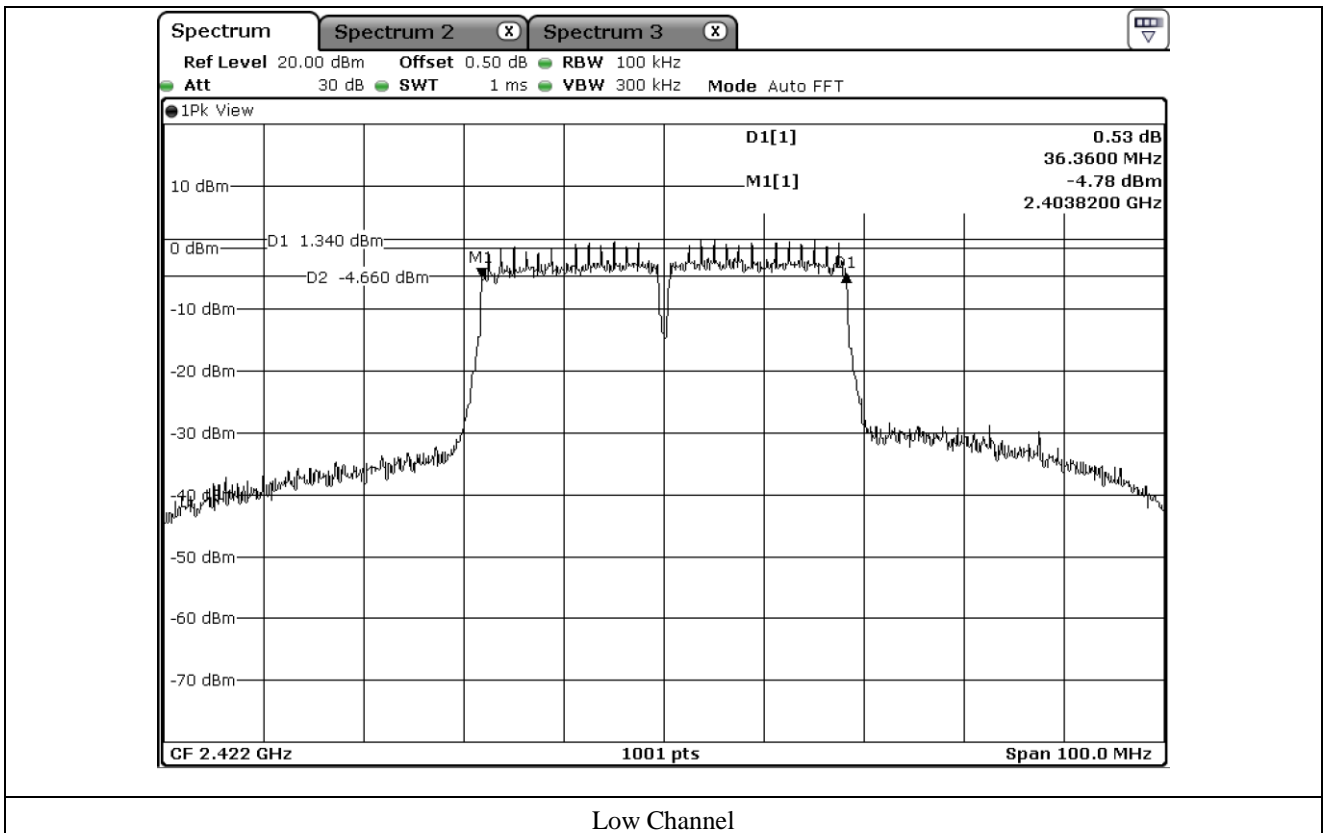
- Test Date : August 16, 2018 ~ August 28, 2018

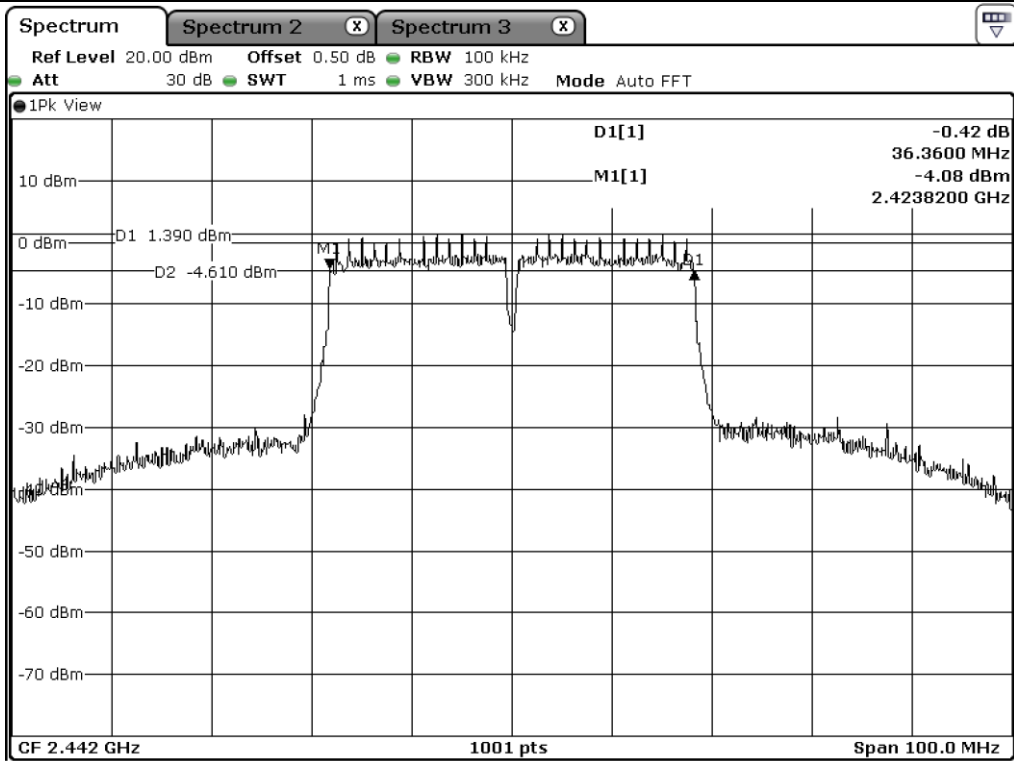
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 422.00	36.36	0.50	35.86
Middle	2 442.00	36.36	0.50	35.86
High	2 452.00	36.36	0.50	35.86

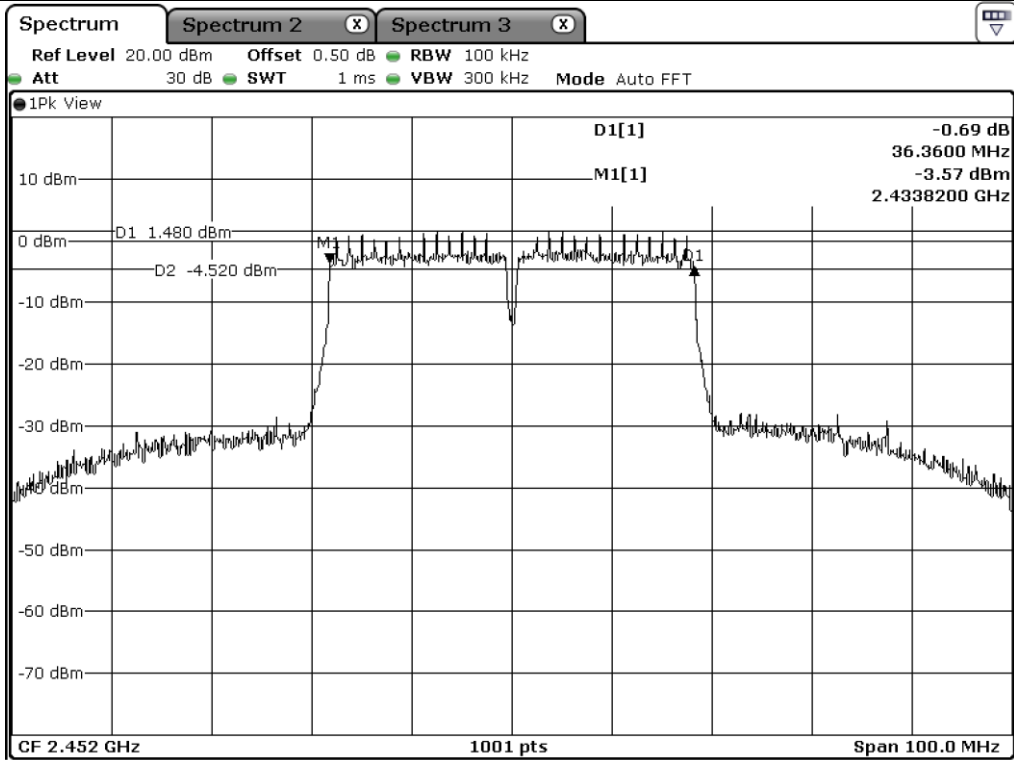
Remark. Margin = Measured Value - Limit

Tested by: Tae-Ho, Kim / Senior Manager





Middle Channel



High Channel

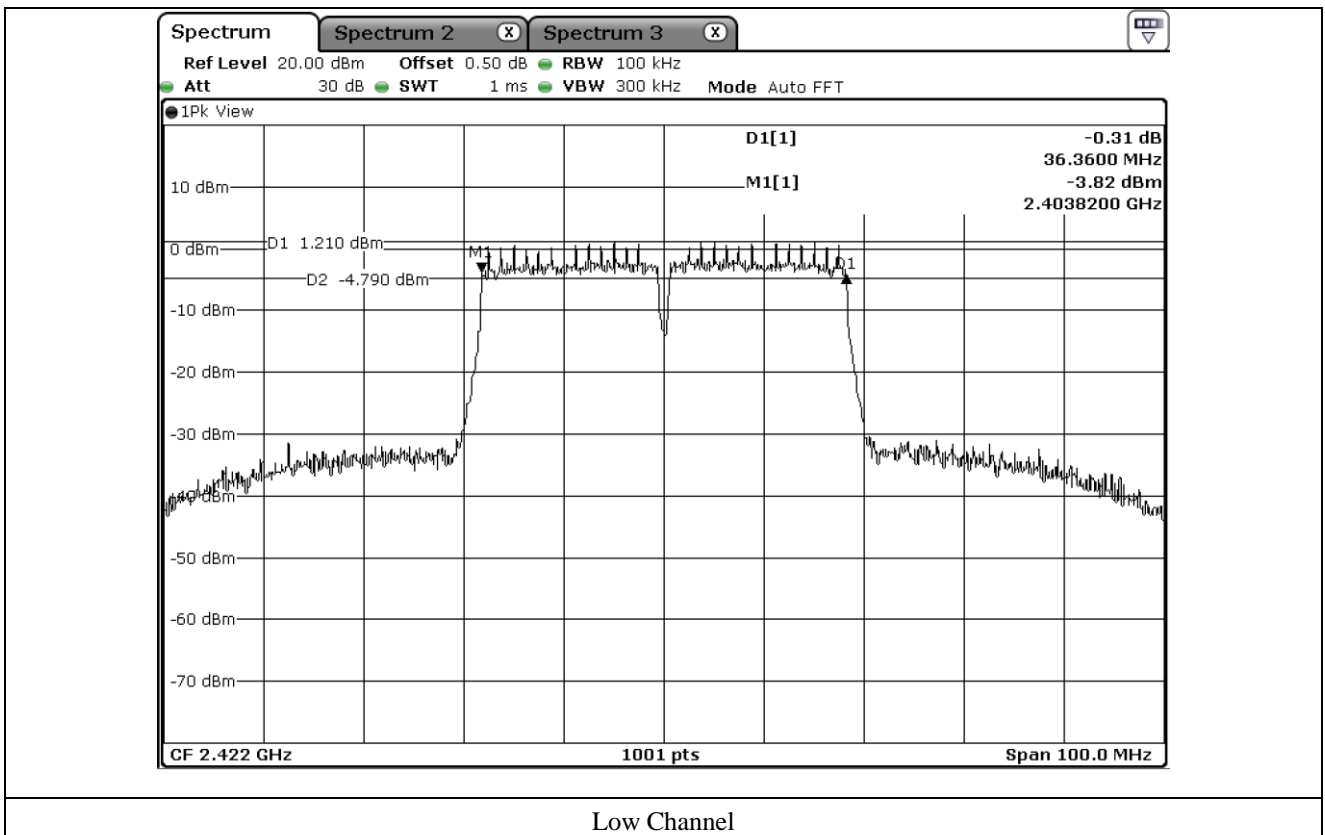
7.7.2 Test data for Antenna 1

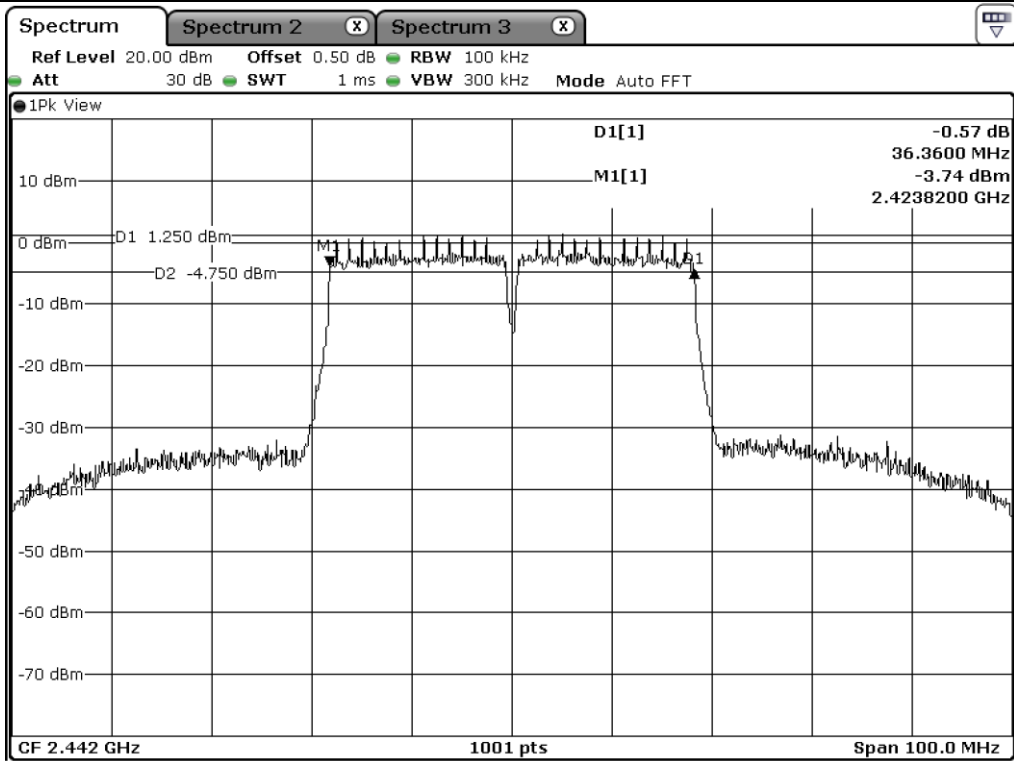
- Test Date : August 16, 2018 ~ August 28, 2018
- Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 422.00	36.36	0.50	35.86
Middle	2 442.00	36.36	0.50	35.86
High	2 452.00	36.36	0.50	35.86

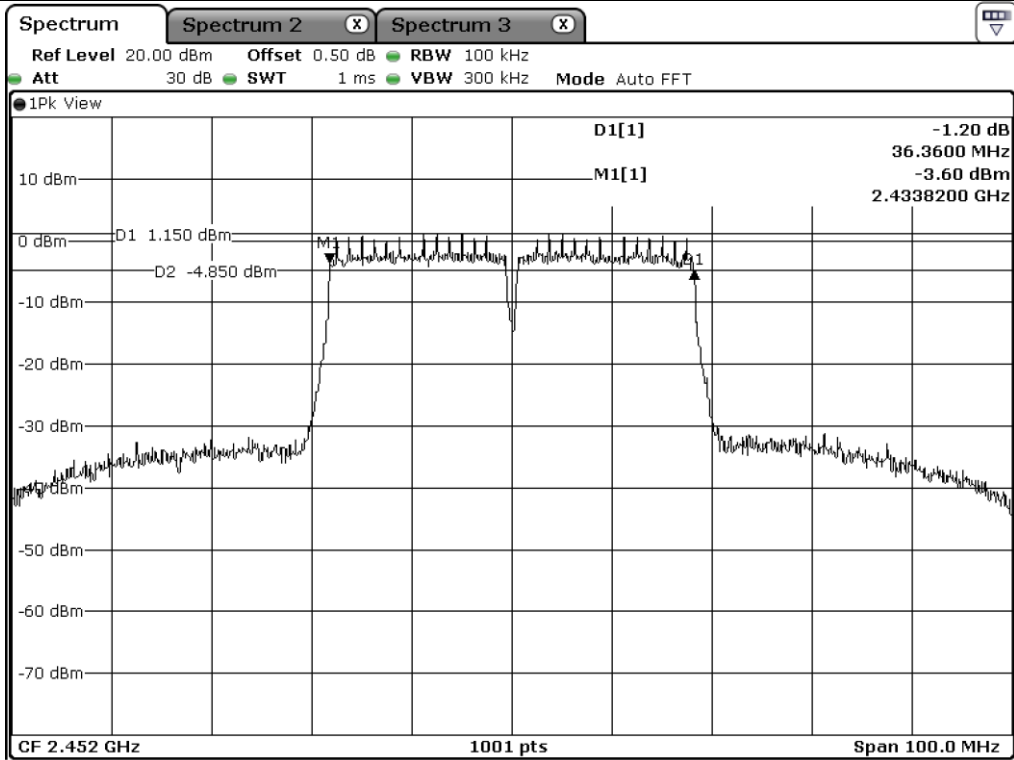
Remark. Margin = Measured Value - Limit

Tested by: Tae-Ho, Kim / Senior Manager





Middle Channel



High Channel

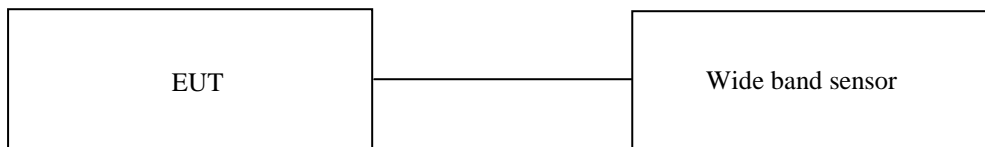
8. MAXIMUM PEAK OUTPUT POWER

8.1 Operating environment

Temperature : 24.3 °C
 Relative humidity : 43.9 % 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 9.2.3(KDB 558074 D01 DTS Meas Guidance V04). Since this measurement is made only during the ON time of the transmitter, no duty cycle correction is required.



8.3 Test equipment used

Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ - NRP-Z81	Rohde & Schwarz	Wide band Sensor	101975	Mar. 15, 2018 (1Y)

All test equipment used is calibrated on a regular basis.

8.4 Test data for 802.11b WLAN Mode

8.4.1 Test data for Antenna 0

- Test Date : August 16, 2018 ~ August 28, 2018
- Test Result : Pass
- Duty Cycle : 100 %

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	Duty Cycle Factor (dB)	Result (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	17.39	0.00	17.39	30.00	12.61
MIDDLE	2 442.00	17.66	0.00	17.66	30.00	12.34
HIGH	2 462.00	17.70	0.00	17.70	30.00	12.30

Remark : Result = MEASURED VALUE (dBm) + Duty Cycle Factor(dB)

The output is low when MIMO is operating. This product has different output values for SISO and MIMO


8.4.2 Test data for Antenna 1

- Test Date : August 16, 2018 ~ August 28, 2018
- Test Result : Pass
- Duty Cycle : 100 %

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	Duty Cycle Factor (dB)	Result (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	17.09	0.00	17.09	30.00	12.91
MIDDLE	2 442.00	17.51	0.00	17.51	30.00	12.49
HIGH	2 462.00	17.62	0.00	17.62	30.00	12.38

Remark : Result = MEASURED VALUE (dBm) + Duty Cycle Factor(dB)

The output is low when MIMO is operating. This product has different output values for SISO and MIMO



Tested by: Tae-Ho, Kim / Senior Manager

8.5 Test data for 802.11g WLAN Mode

8.5.1 Test data for Antenna 0

- Test Date : August 16, 2018 ~ August 28, 2018
- Test Result : Pass
- Duty Cycle : 94 %

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	Duty Cycle Factor (dB)	Result (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	20.67	0.27	20.94	30.00	9.06
MIDDLE	2 442.00	20.95	0.27	21.22	30.00	8.78
HIGH	2 462.00	21.07	0.27	21.34	30.00	8.66

Remark : Result = MEASURED VALUE (dBm) + Duty Cycle Factor(dB)

The output is low when MIMO is operating. This product has different output values for SISO and MIMO


8.5.2 Test data for Antenna 1

- Test Date : August 16, 2018 ~ August 28, 2018
- Test Result : Pass
- Duty Cycle : 94 %

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	Duty Cycle Factor (dB)	Result (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	20.51	0.27	20.78	30.00	9.22
MIDDLE	2 442.00	20.59	0.27	20.86	30.00	9.14
HIGH	2 462.00	20.72	0.27	20.99	30.00	9.01

Remark : Result = MEASURED VALUE (dBm) + Duty Cycle Factor(dB)

The output is low when MIMO is operating. This product has different output values for SISO and MIMO



Tested by: Tae-Ho, Kim / Senior Manager

8.6 Test data for 802.11n_HT20 WLAN Mode

8.6.1 Test data for Antenna 0

- Test Date : August 16, 2018 ~ August 28, 2018
- Test Result : Pass
- Duty Cycle : 93 %

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	Duty Cycle Factor (dB)	Result (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	21.07	0.32	21.39	30.00	8.61
MIDDLE	2 442.00	21.14	0.32	21.46	30.00	8.54
HIGH	2 462.00	21.21	0.32	21.53	30.00	8.47

Remark : Result = MEASURED VALUE (dBm) + Duty Cycle Factor(dB)

The output is low when MIMO is operating. This product has different output values for SISO and MIMO


8.6.2 Test data for Antenna 1

- Test Date : August 16, 2018 ~ August 28, 2018
- Test Result : Pass
- Duty Cycle : 93 %

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	Duty Cycle Factor (dB)	Result (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	20.84	0.32	21.16	30.00	8.84
MIDDLE	2 442.00	20.94	0.32	21.26	30.00	8.74
HIGH	2 462.00	21.15	0.32	21.47	30.00	8.53

Remark : Result = MEASURED VALUE (dBm) + Duty Cycle Factor(dB)

The output is low when MIMO is operating. This product has different output values for SISO and MIMO



Tested by: Tae-Ho, Kim / Senior Manager

8.6.3 Test data for Multiple Transmit

-. Test Date : August 16, 2018 ~ August 28, 2018

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	Antenna 0 MEASURED VLAUE (dBm)	Antenna 1 MEASURED VLAUE (dBm)	COMBINED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	17.51	17.62	20.90	27.44	6.54
MIDDLE	2 442.00	17.66	17.84	21.08	27.44	6.36
HIGH	2 462.00	17.84	17.90	21.20	27.44	6.24

Remark 1 : Margin = Limit – Combined value

Remark 2 : Calculated Output Power= $10\log (10^{(\text{Antenna0 Output Power}/10)}+10^{(\text{Antenna1 Output Power}/10)})$

Remark 3 : Directional gain = $10*\log[(10^{G0/20}+10^{G1/20})^2/N]$ dBi

Remark 4 : Limit = 30 dBm – Exceeds Antenna gain

Remark 5 : Exceeds Antenna gain = Above the limits is calculated according to antenna gain.

Because antenna gain is higher than 6 dBi.

The output is low when MIMO is operating. This product has different output values for SISO and MIMO



Tested by: Tae-Ho, Kim / Senior Manager

8.7 Test data for 802.11n_HT40 WLAN Mode

8.7.1 Test data for Antenna 0

- Test Date : August 16, 2018 ~ August 28, 2018
- Test Result : Pass
- Duty Cycle : 87 %

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	Duty Cycle Factor (dB)	Result (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 422.00	21.77	0.60	22.37	30.00	7.63
MIDDLE	2 442.00	21.80	0.60	22.40	30.00	7.60
HIGH	2 452.00	21.84	0.60	22.44	30.00	7.56

Remark : Result = MEASURED VALUE (dBm) + Duty Cycle Factor(dB)

The output is low when MIMO is operating. This product has different output values for SISO and MIMO

8.7.2 Test data for Antenna 1

- Test Date : August 16, 2018 ~ August 28, 2018
- Test Result : Pass
- Duty Cycle : 87 %

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	Duty Cycle Factor (dB)	Result (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 422.00	21.52	0.60	22.12	30.00	7.88
MIDDLE	2 442.00	21.84	0.60	22.44	30.00	7.56
HIGH	2 452.00	21.83	0.60	22.43	30.00	7.57

Remark : Result = MEASURED VALUE (dBm) + Duty Cycle Factor(dB)

The output is low when MIMO is operating. This product has different output values for SISO and MIMO



Tested by: Tae-Ho, Kim / Senior Manager

8.7.3 Test data for Multiple Transmit

-. Test Date : August 16, 2018 ~ August 28, 2018

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	Antenna 0 MEASURED VLAUE (dBm)	Antenna 1 MEASURED VLAUE (dBm)	COMBINED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 412.00	18.26	18.15	21.82	27.44	5.62
MIDDLE	2 442.00	18.21	18.21	21.82	27.44	5.62
HIGH	2 462.00	18.62	18.33	22.09	27.44	5.35

Remark 1 : Margin = Limit – Combined value

Remark 2 : Calculated Output Power= $10\log (10^{(\text{Antenna0 Output Power}/10)}+10^{(\text{Antenna1 Output Power}/10)})$

Remark 3 : Directional gain = $10*\log[(10^{G0/20}+10^{G1/20})^2/N]$ dBi

Remark 4 : Limit = 30 dBm – Exceeds Antenna gain

Remark 5 : Exceeds Antenna gain = Above the limits is calculated according to antenna gain.

Because antenna gain is higher than 6 dBi.

The output is low when MIMO is operating. This product has different output values for SISO and MIMO



Tested by: Tae-Ho, Kim / Senior Manager

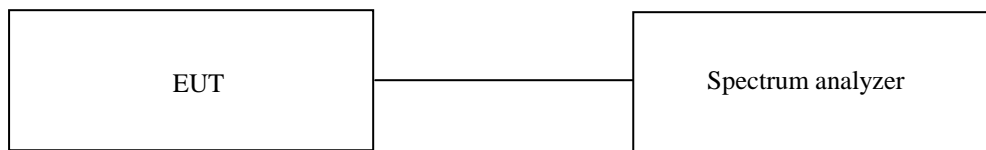
9. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

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 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 equipment used

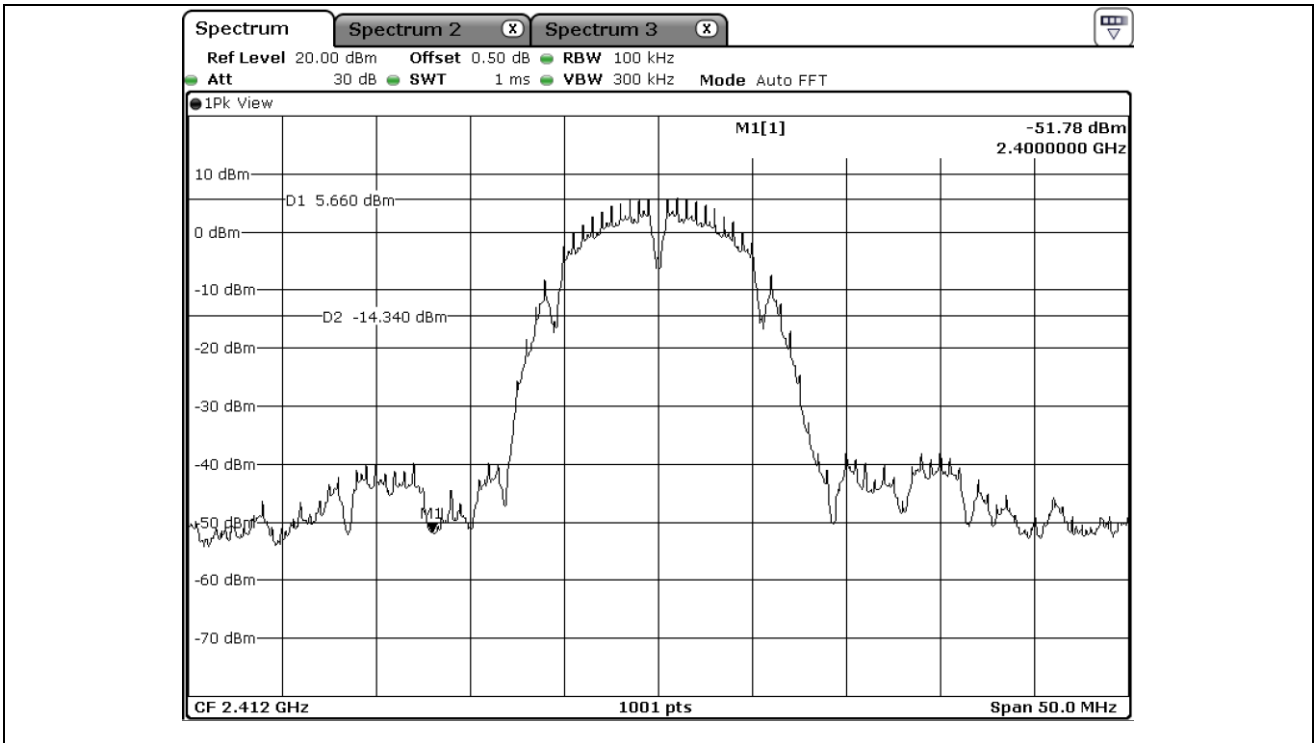
Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ - FSV40	Rohde & Schwarz	Signal Analyzer	101009	Mar. 14, 2018 (1Y)
■ - ESU	Rohde & Schwarz	EMI Test Receiver	100261	Mar. 29, 2018 (1Y)
■ - 310N	Sonoma Instrument	Pre-Amplifier	312544	Mar. 28, 2018 (1Y)
■ - BBV9718	Schwarzbeck	Amplifier	310	Mar. 30, 2018 (1Y)
■ - SCU40A	Rohde & Schwarz	Signal Conditioning unit	100436	Mar. 15, 2018 (1Y)
■ - DT3000-3t	Innco System	Turn Table	DT3000/093	N/A
■ - MA-4000XPET	Innco System	Antenna Master	MA4000/509	N/A
■ - VULB9163	Schwarzbeck	TRILOG Broadband Antenna	777	Apr. 13, 2018 (2Y)
■ - BBHA9120D	Schwarzbeck	Horn Antenna	BBHA9120D295	Aug. 16, 2017 (2Y)
■ - BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170179	Jul. 28, 2017 (2Y)

All test equipment used is calibrated on a regular basis.

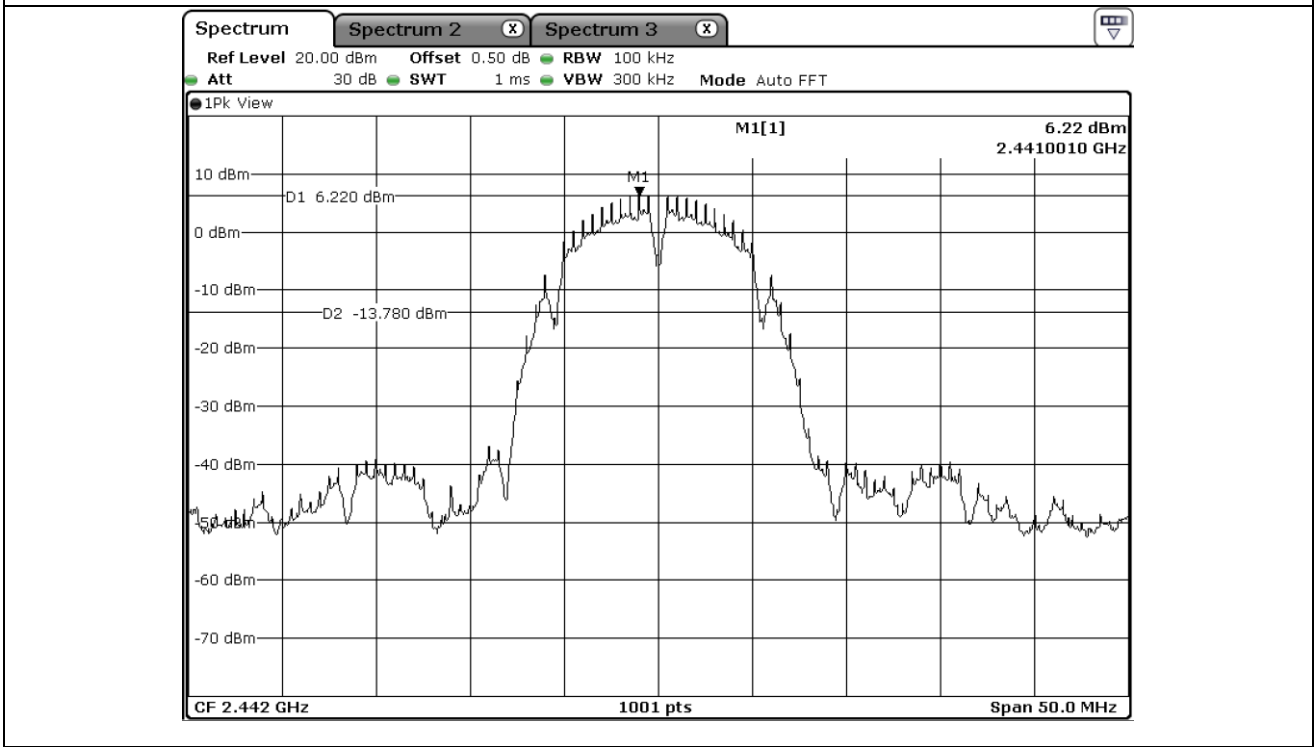
9.5 Test data for conducted emission

9.5.1 Test data for 802.11b WLAN Mode

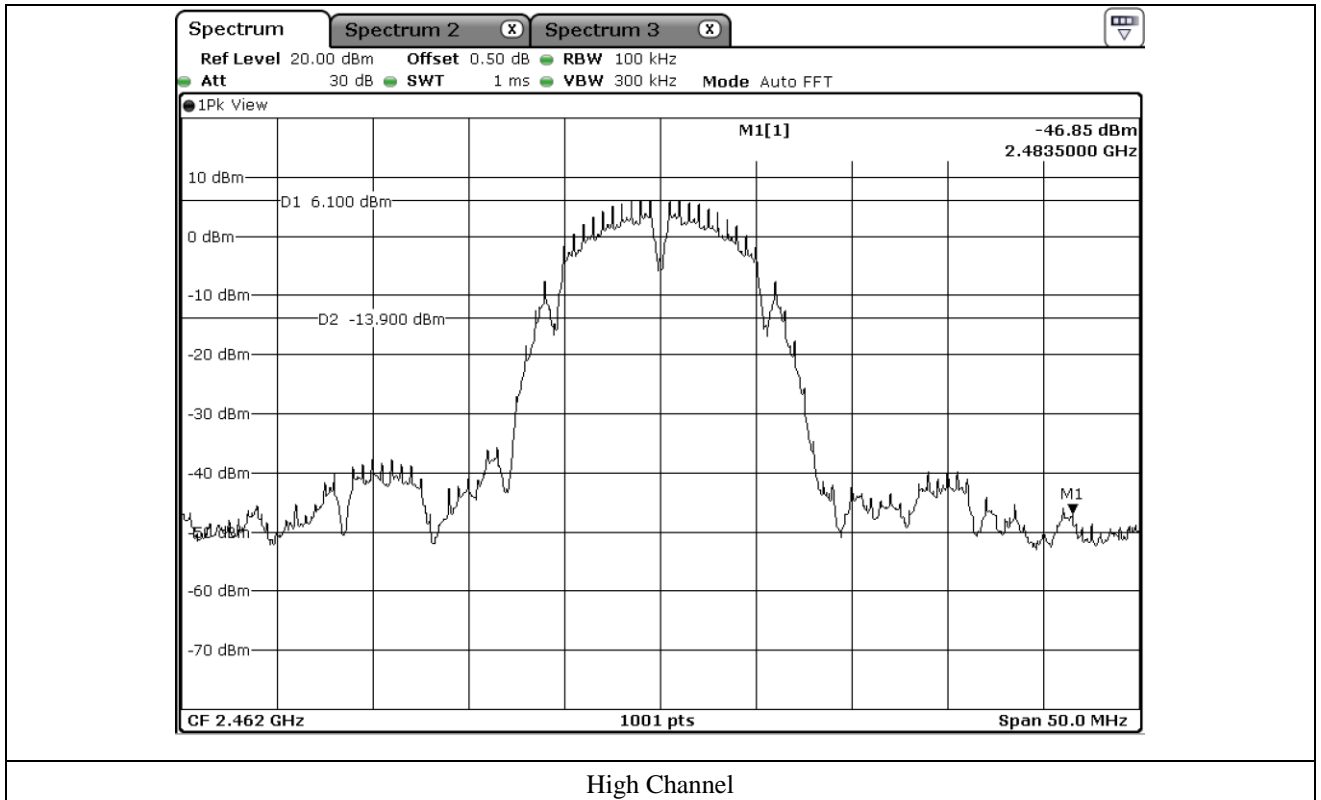
9.5.1.1 Test data for Antenna 0

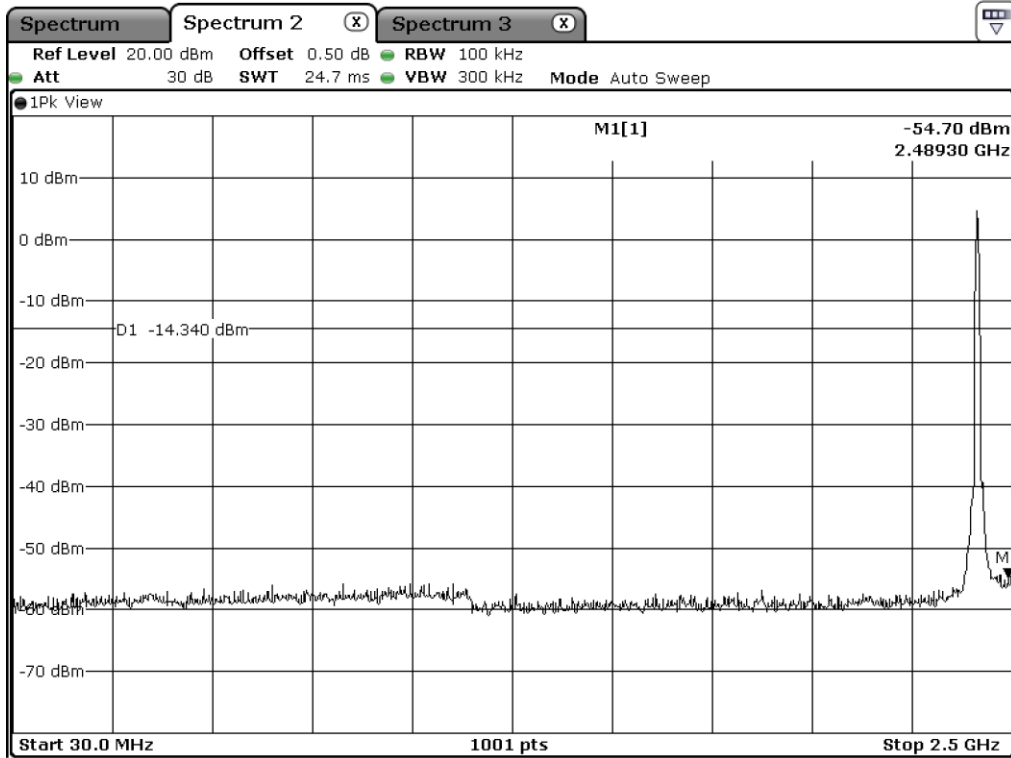


Low Channel

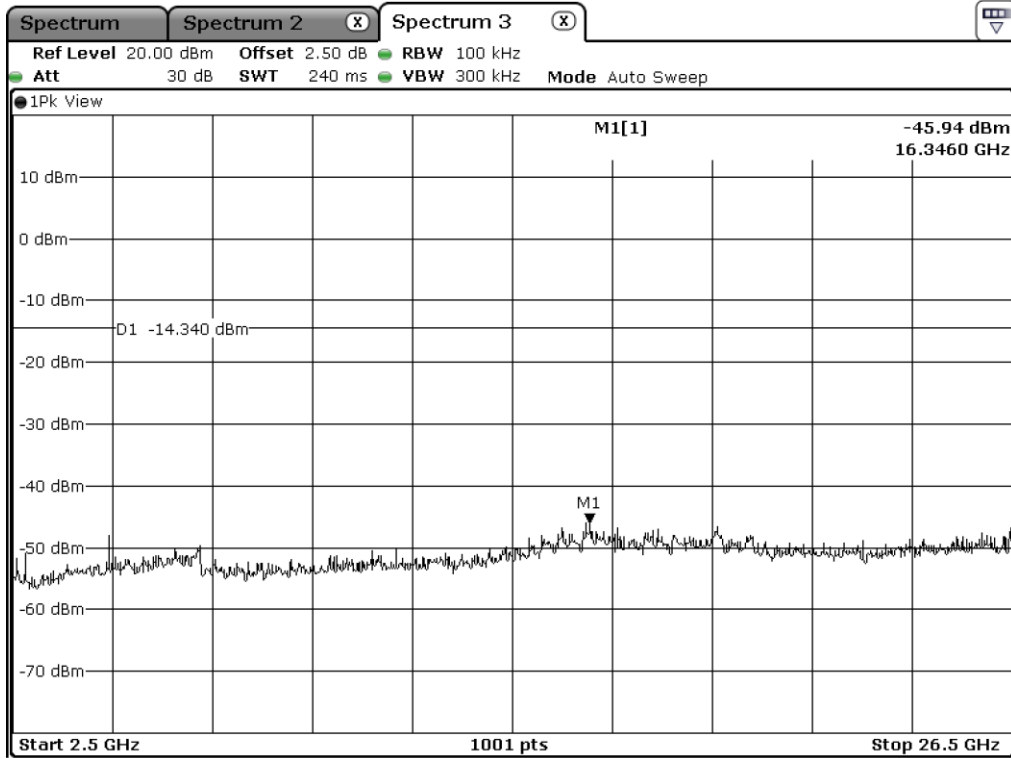


Middle Channel

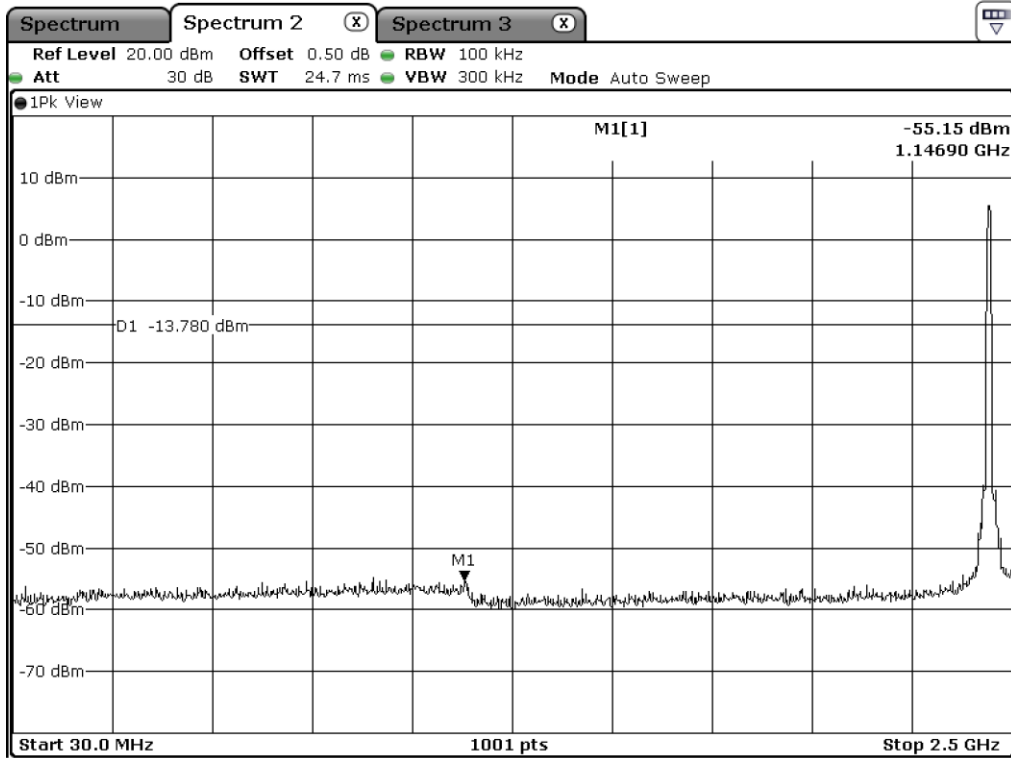




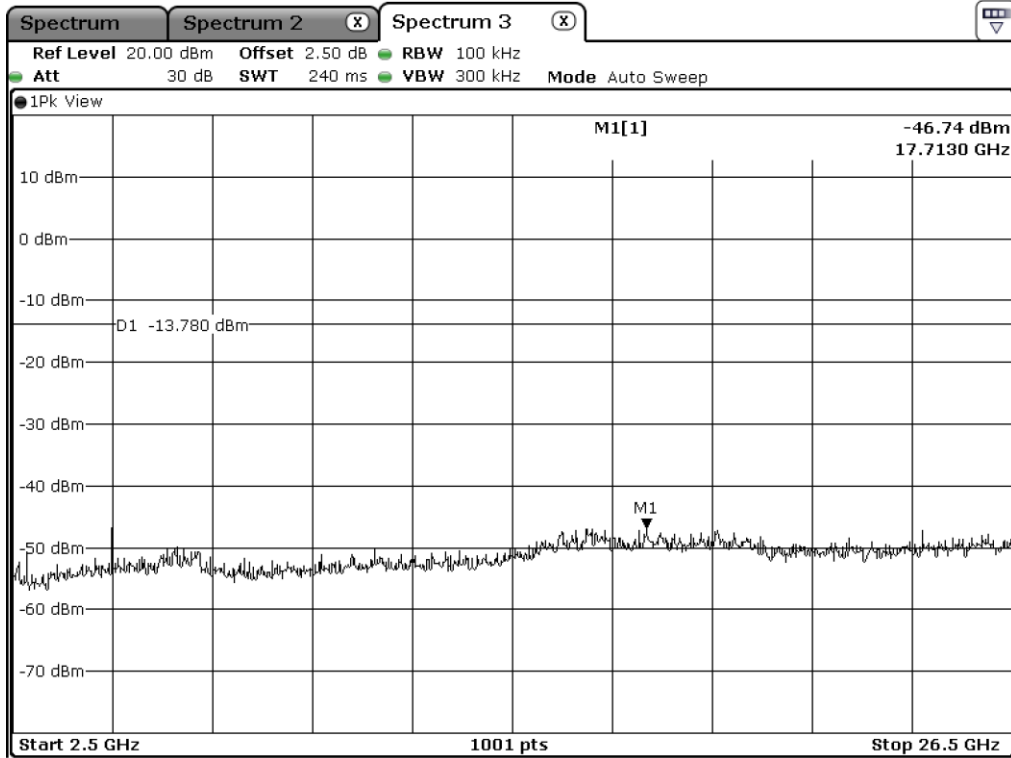
Low Channel



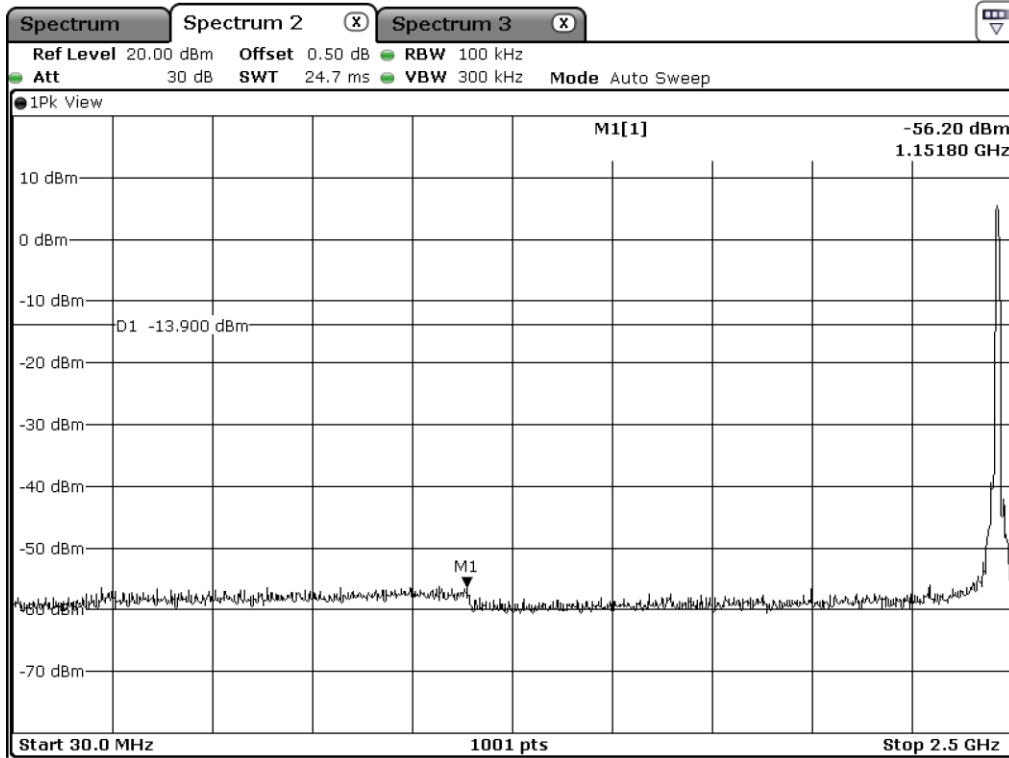
Low Channel



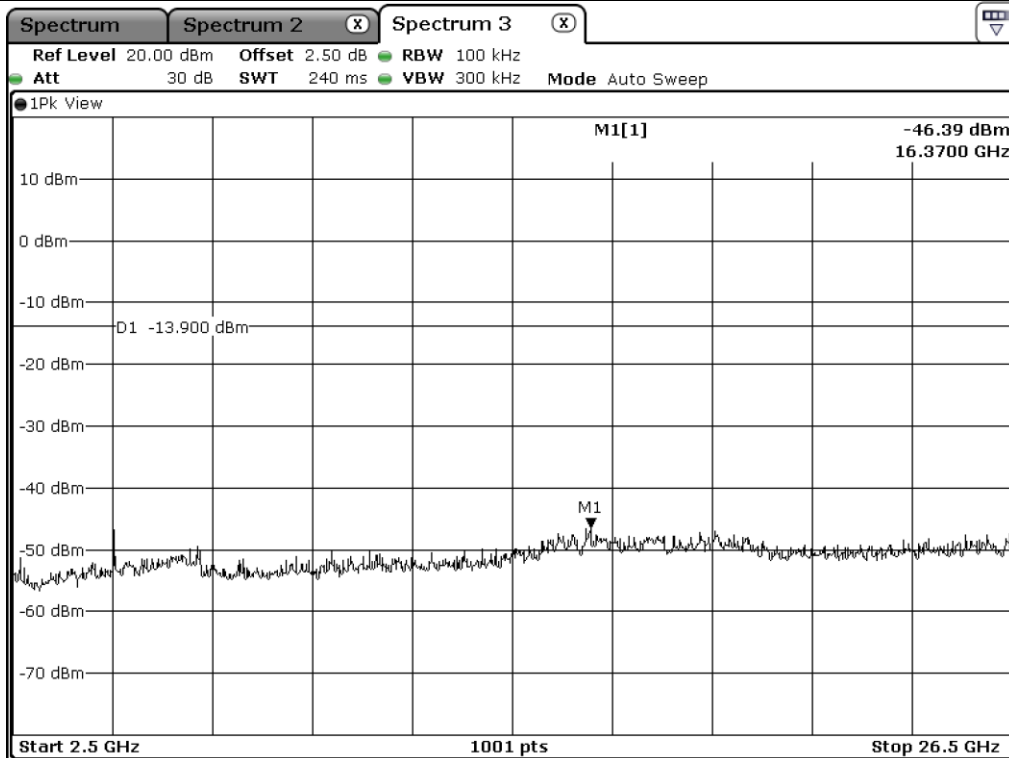
Middle Channel



Middle Channel

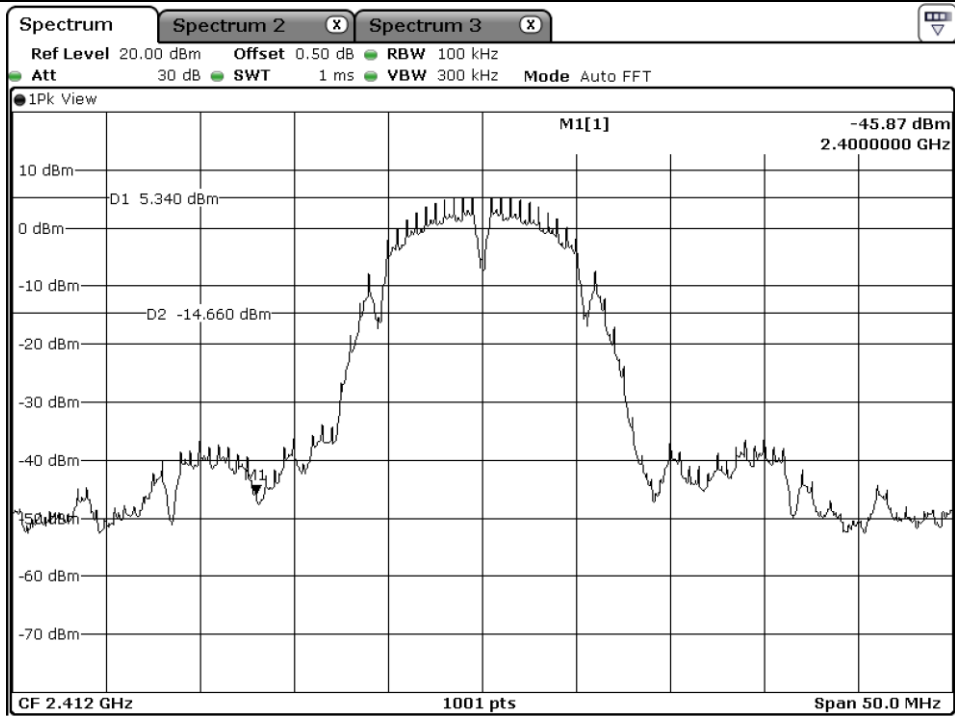


High Channel

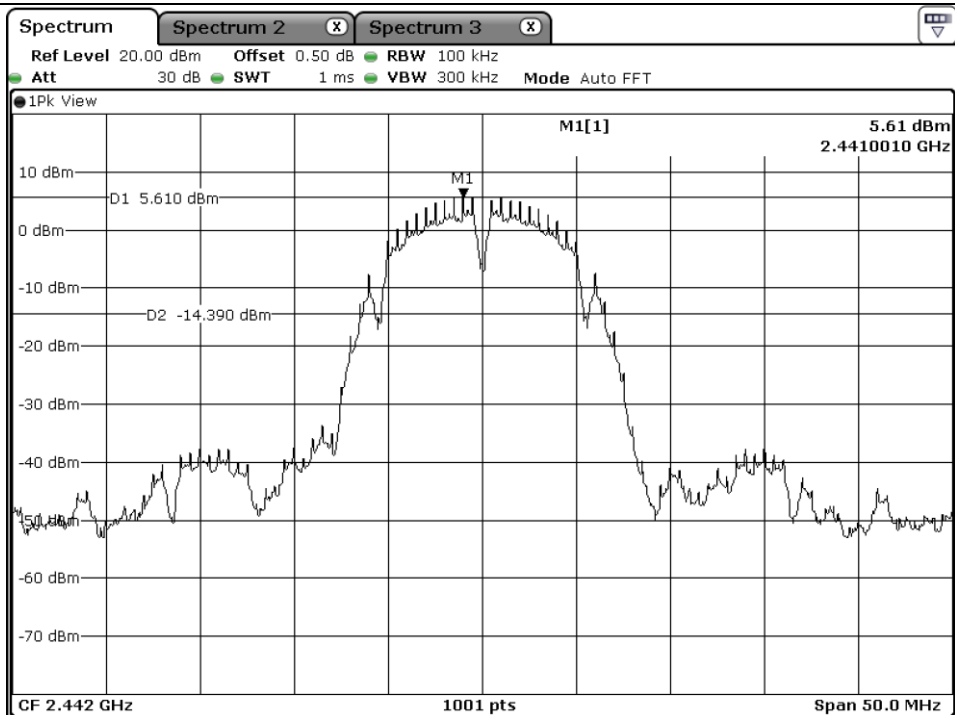


High Channel

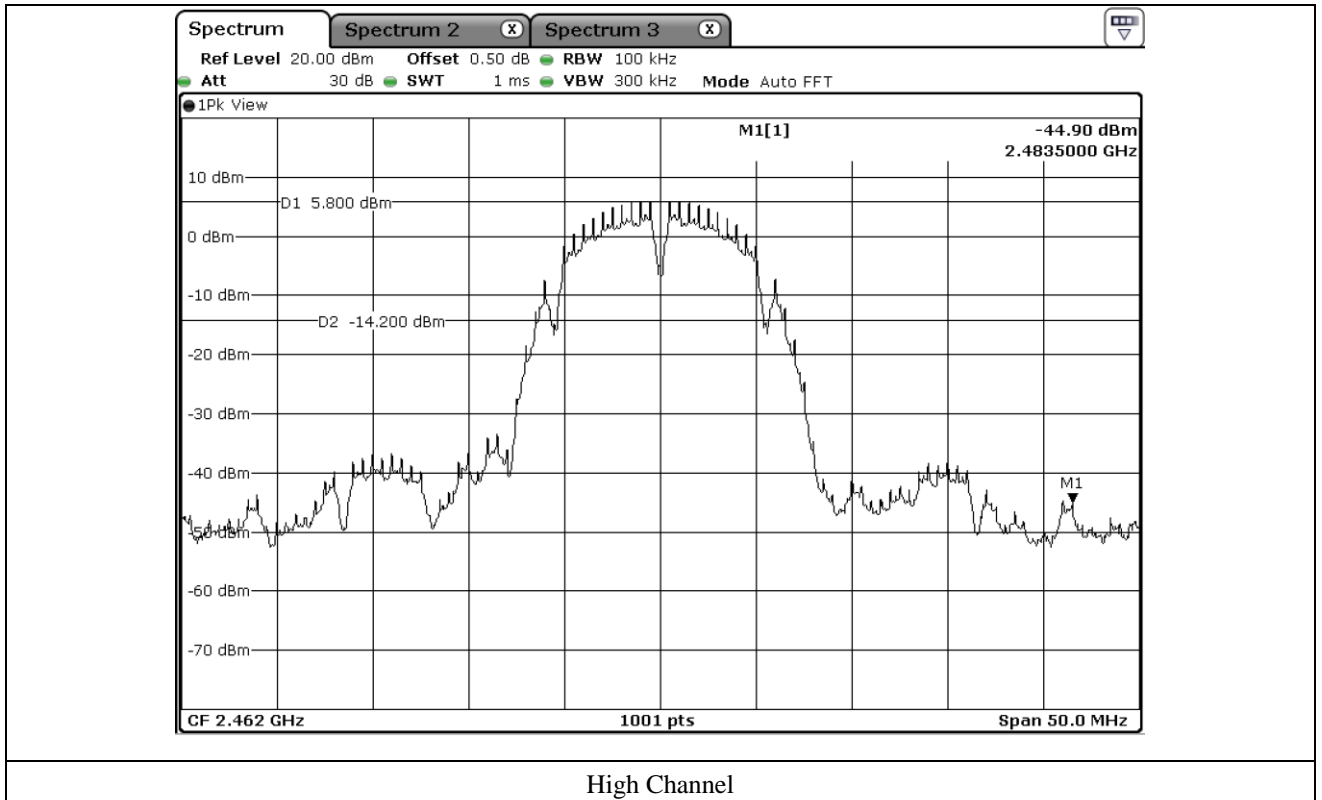
9.5.1.2 Test data for Antenna 1

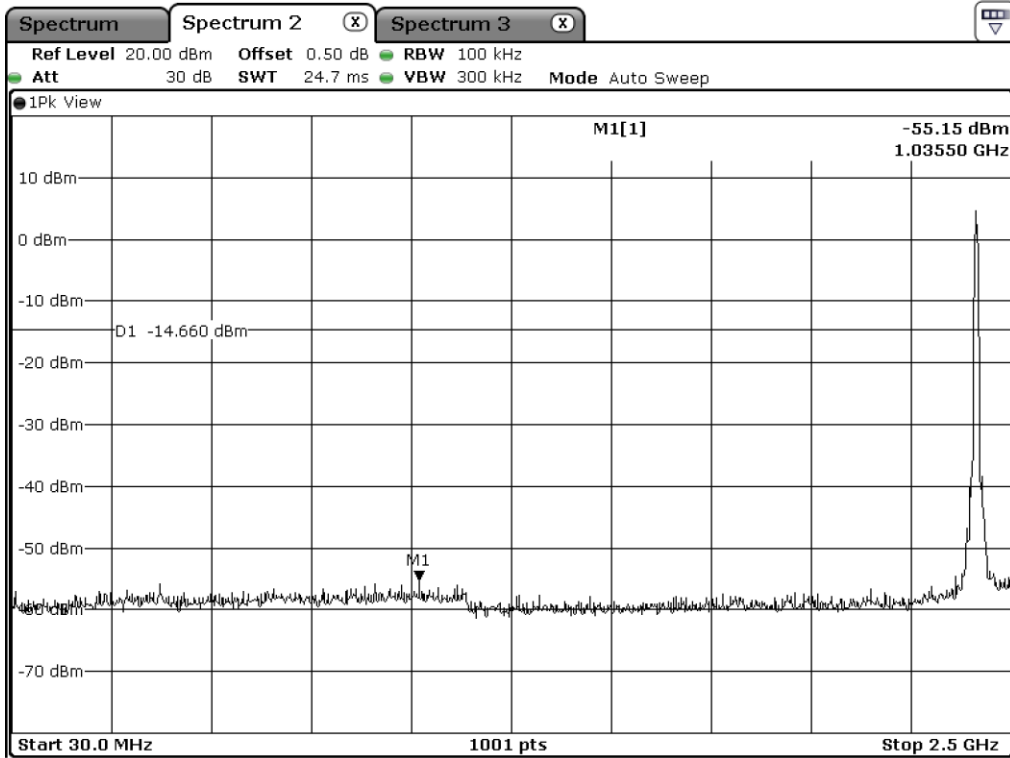


Low Channel

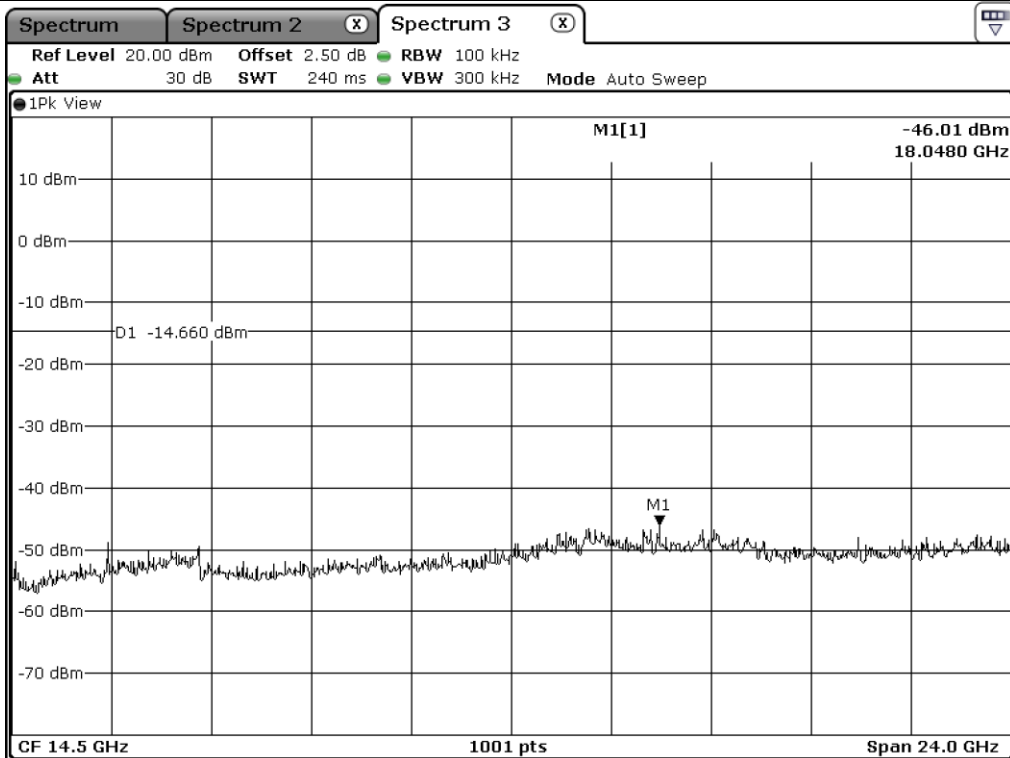


Middle Channel

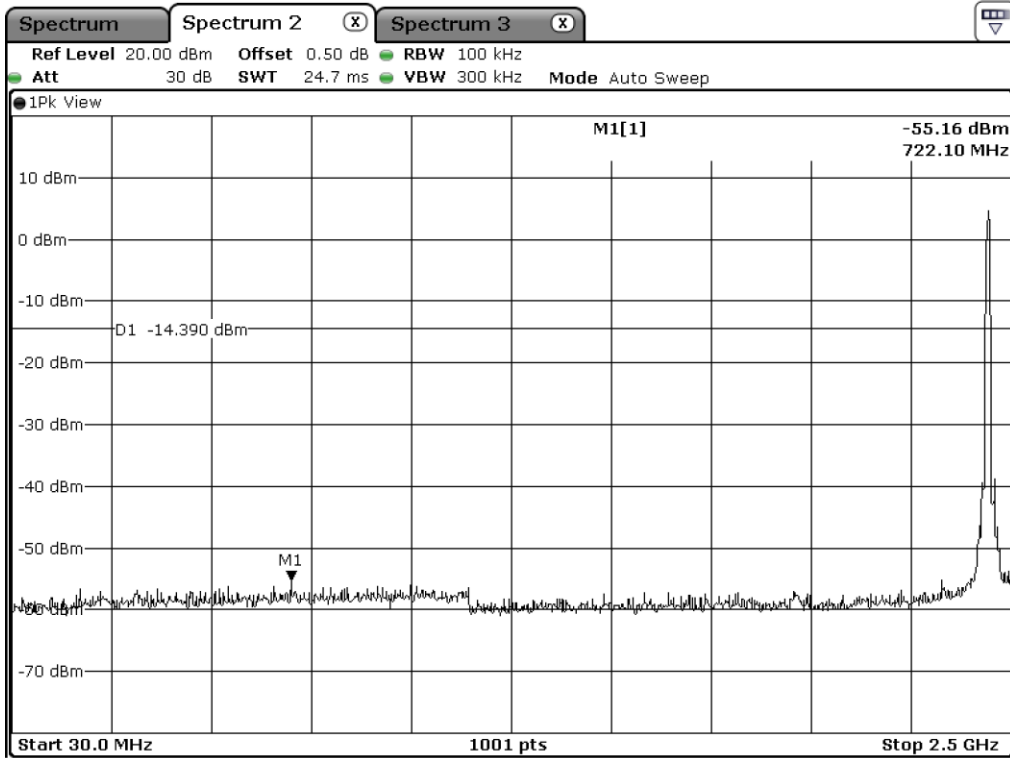




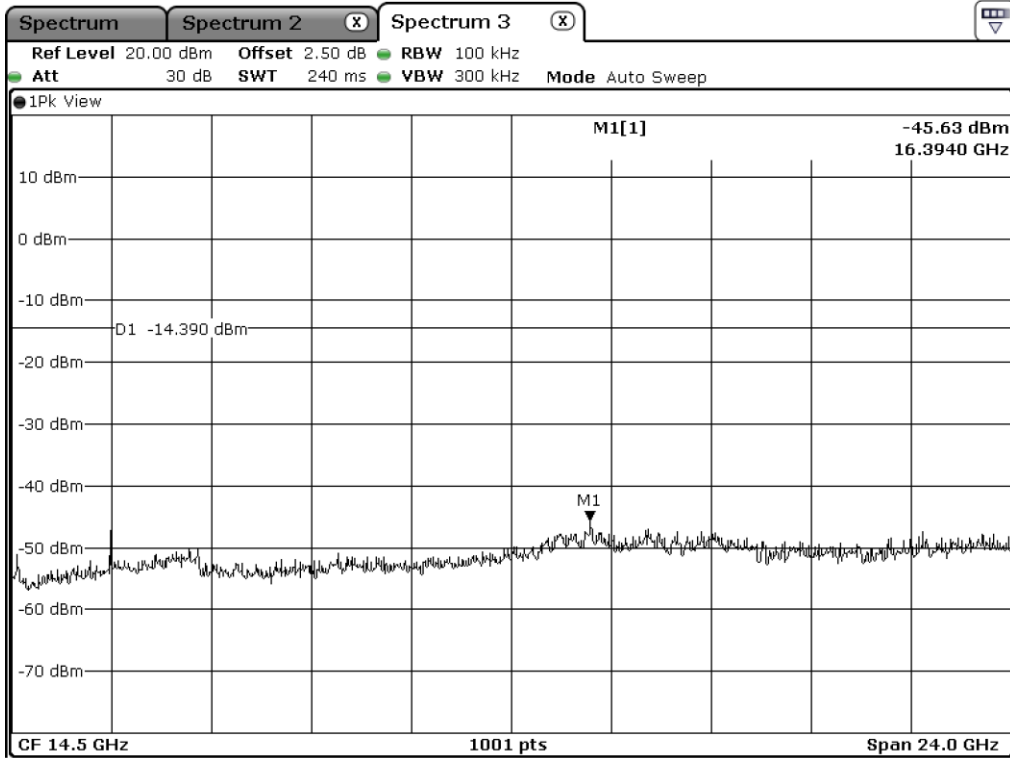
Low Channel



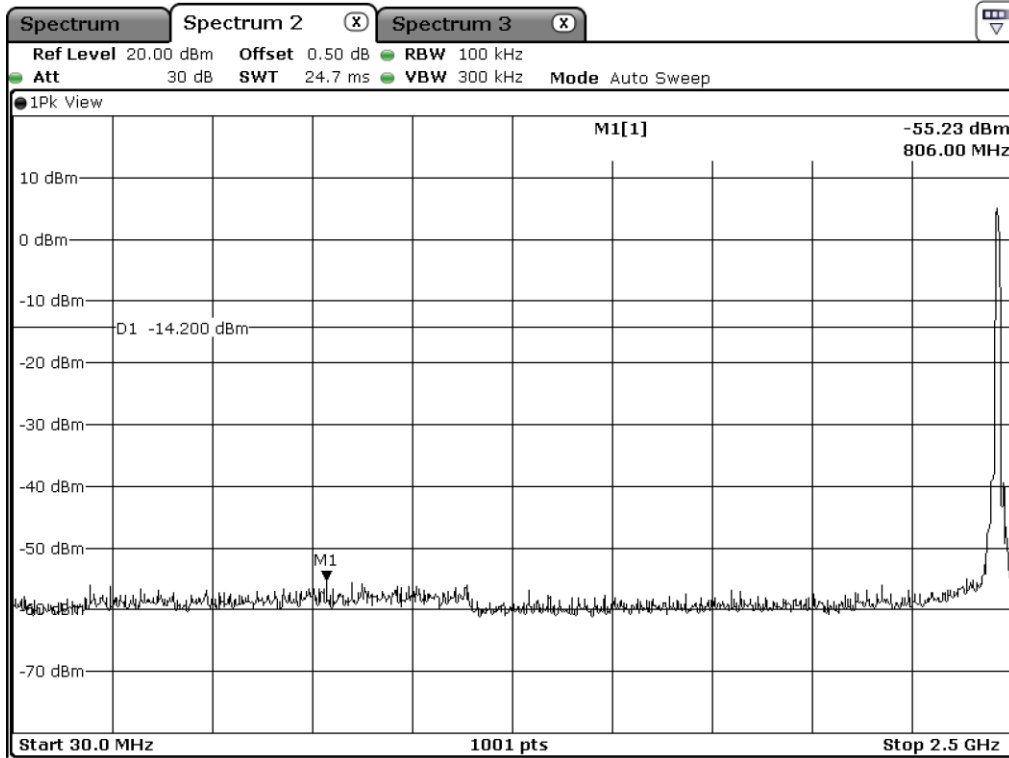
Low Channel



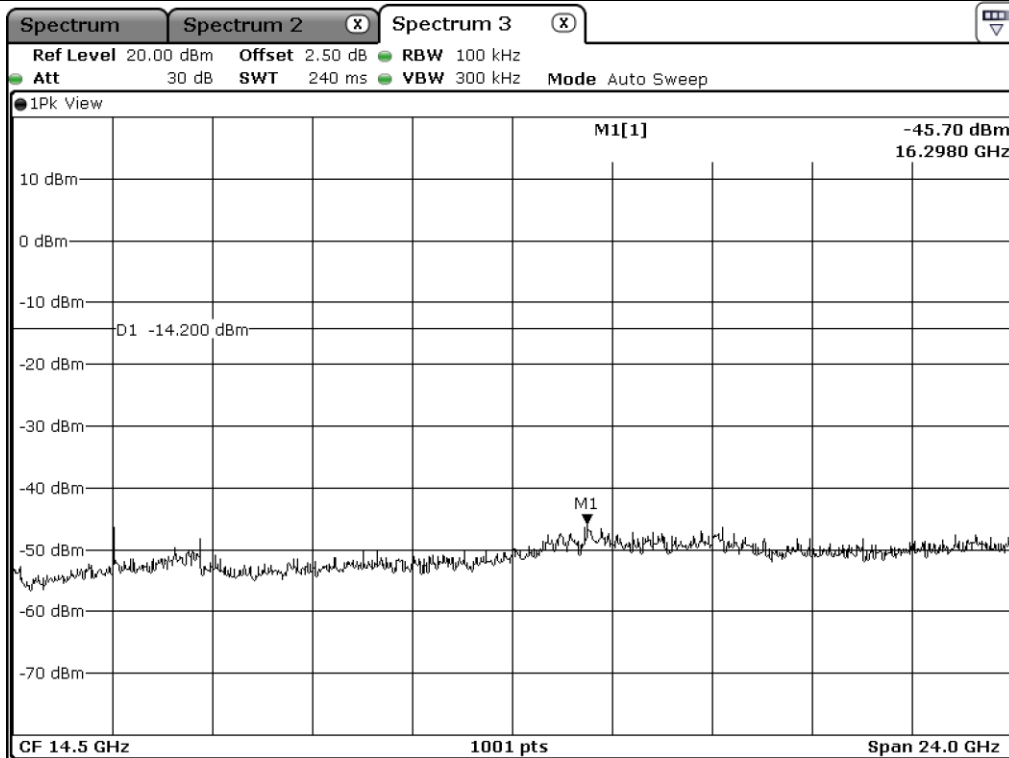
Middle Channel



Middle Channel



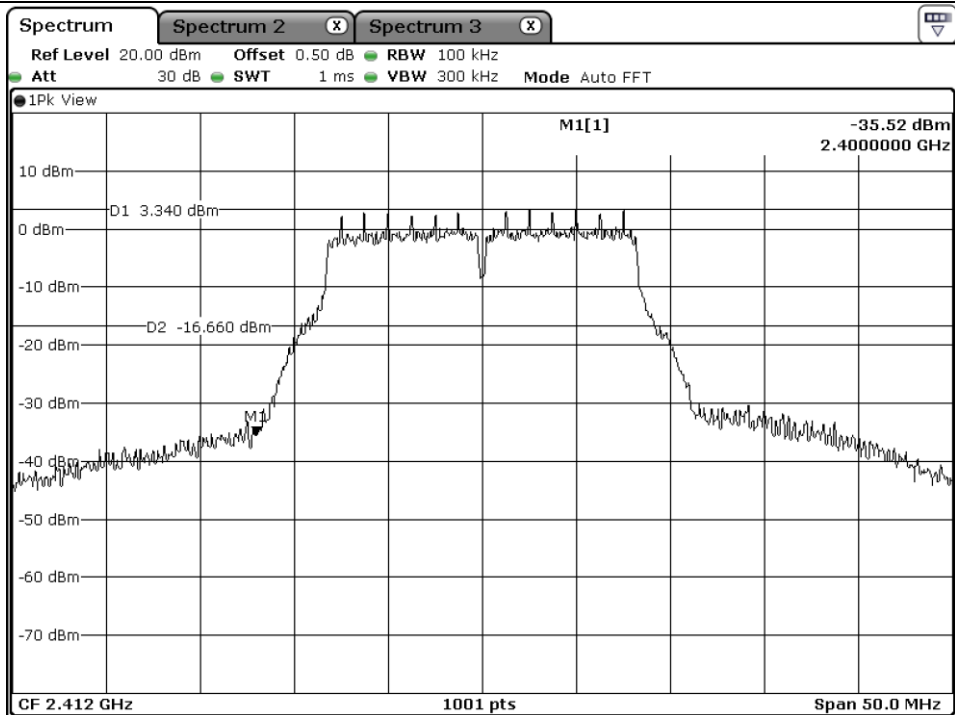
High Channel



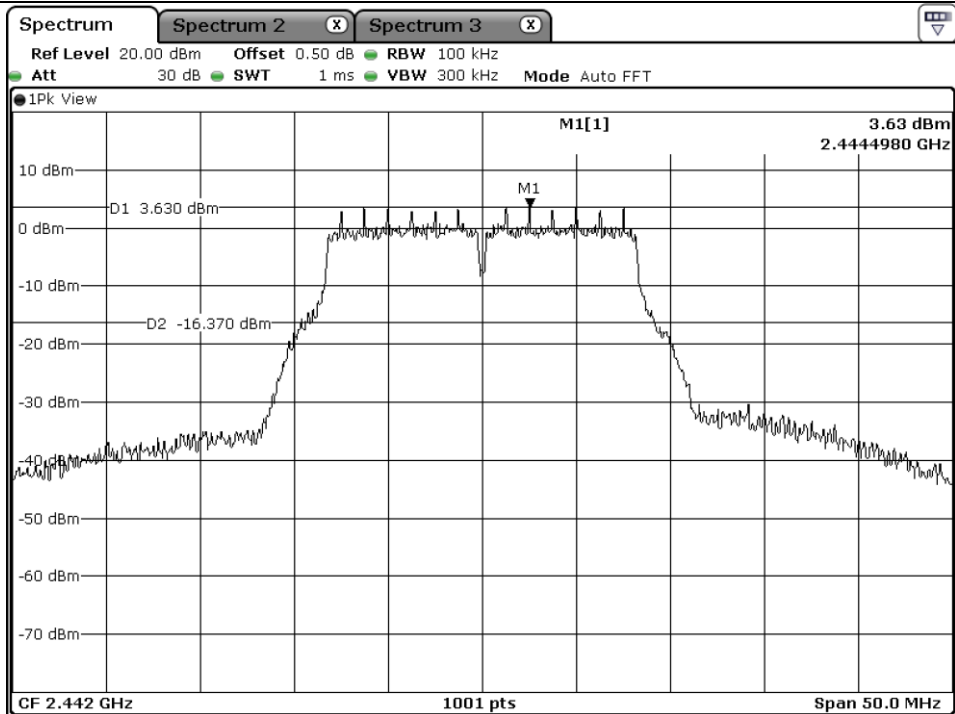
High Channel

9.5.2 Test data for 802.11g WLAN Mode

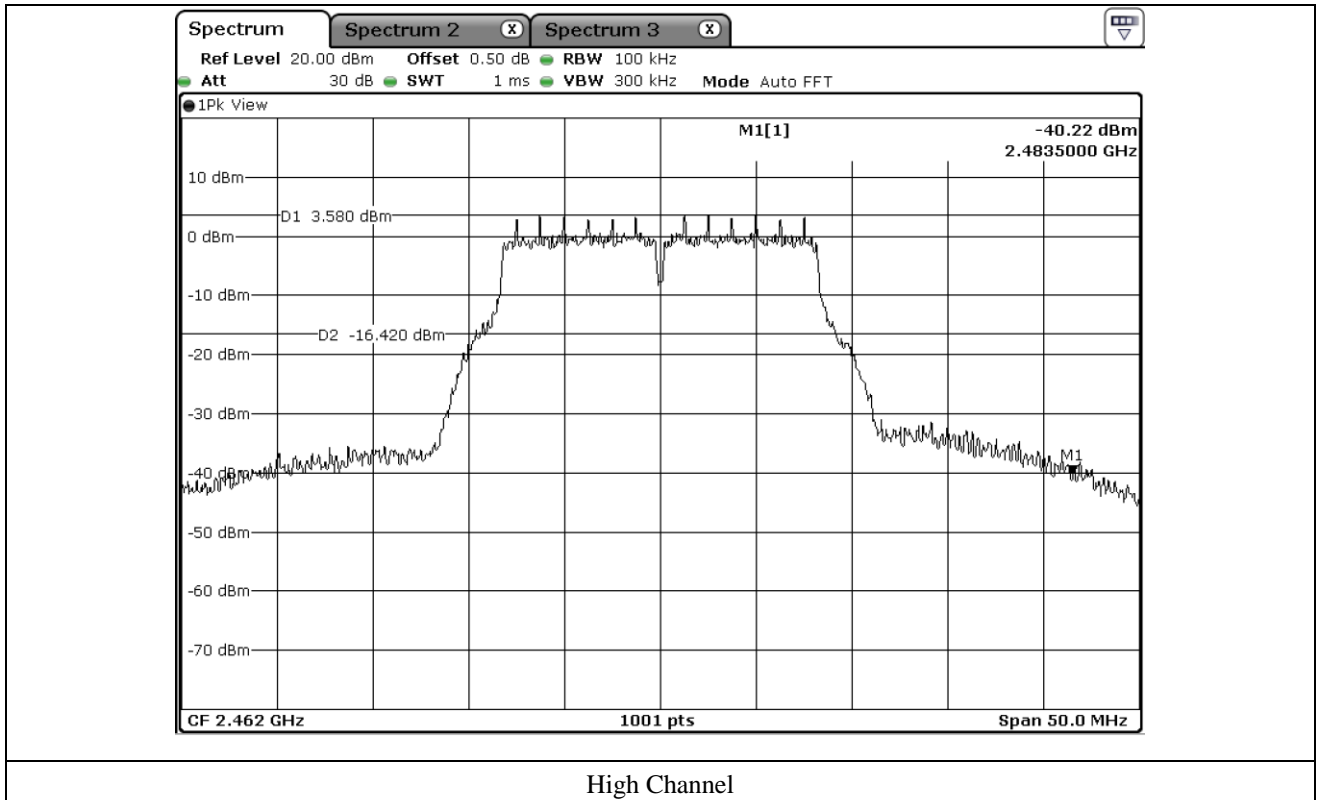
9.5.2.1 Test data for Antenna 0

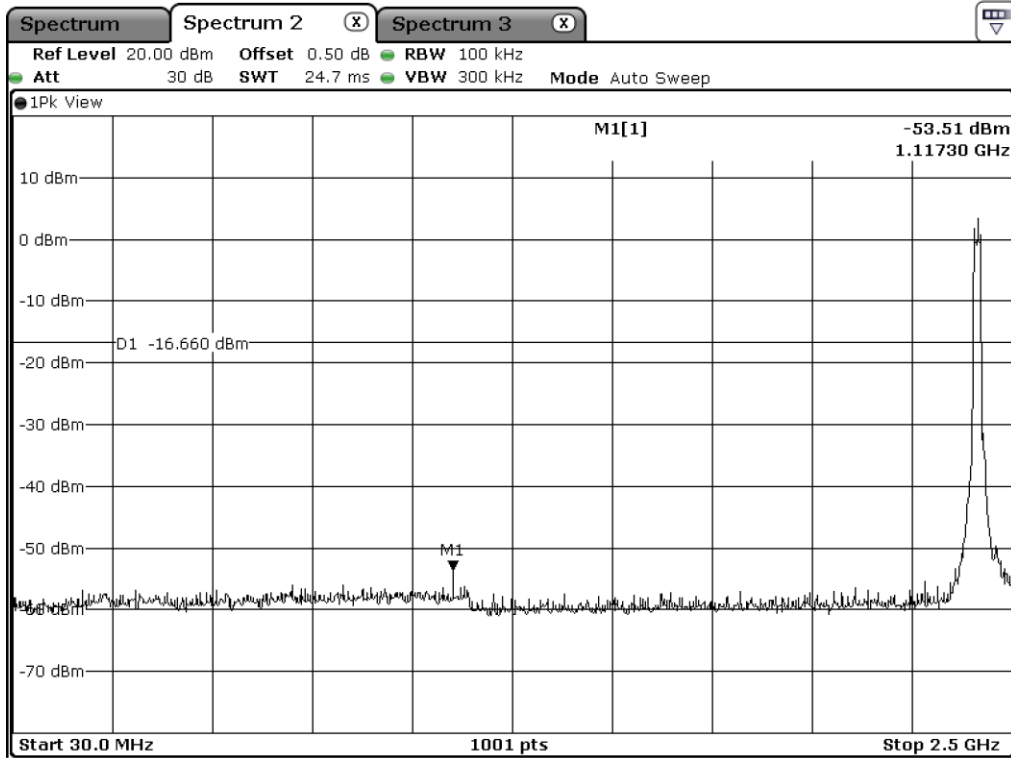


Low Channel

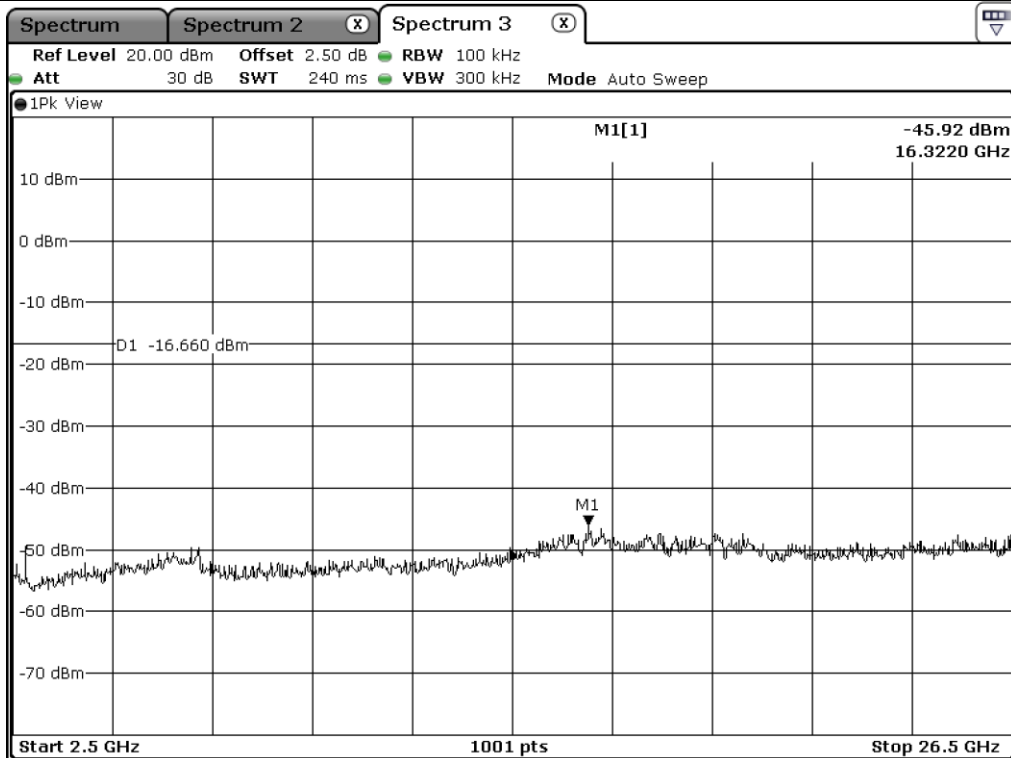


Middle Channel

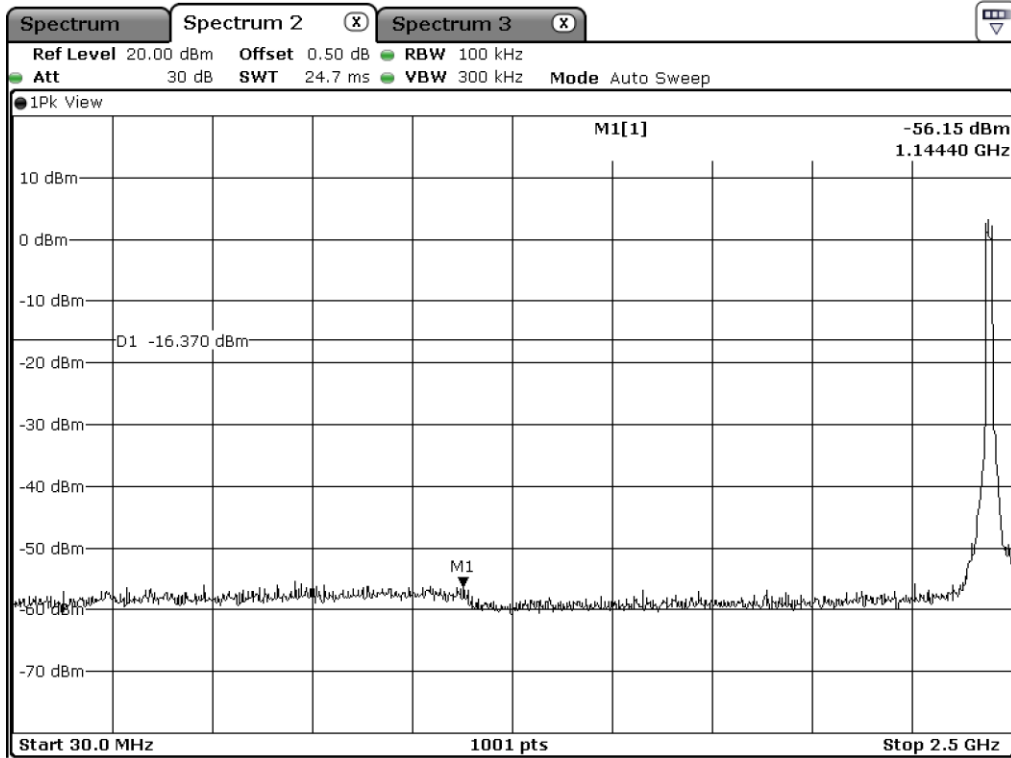




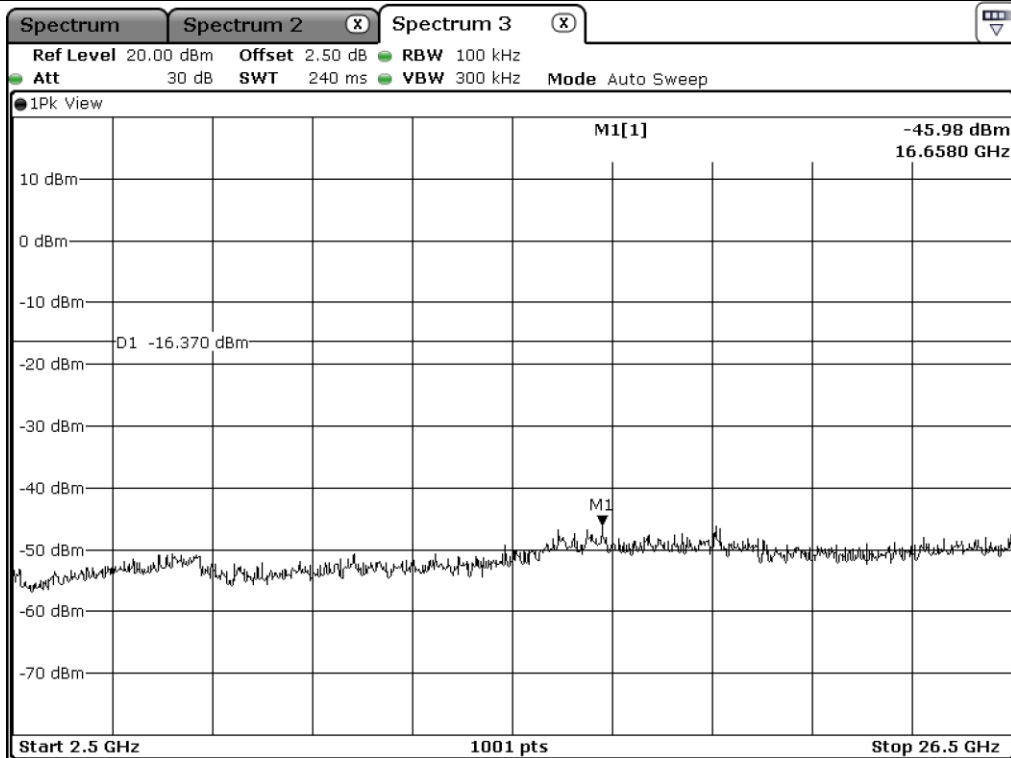
Low Channel



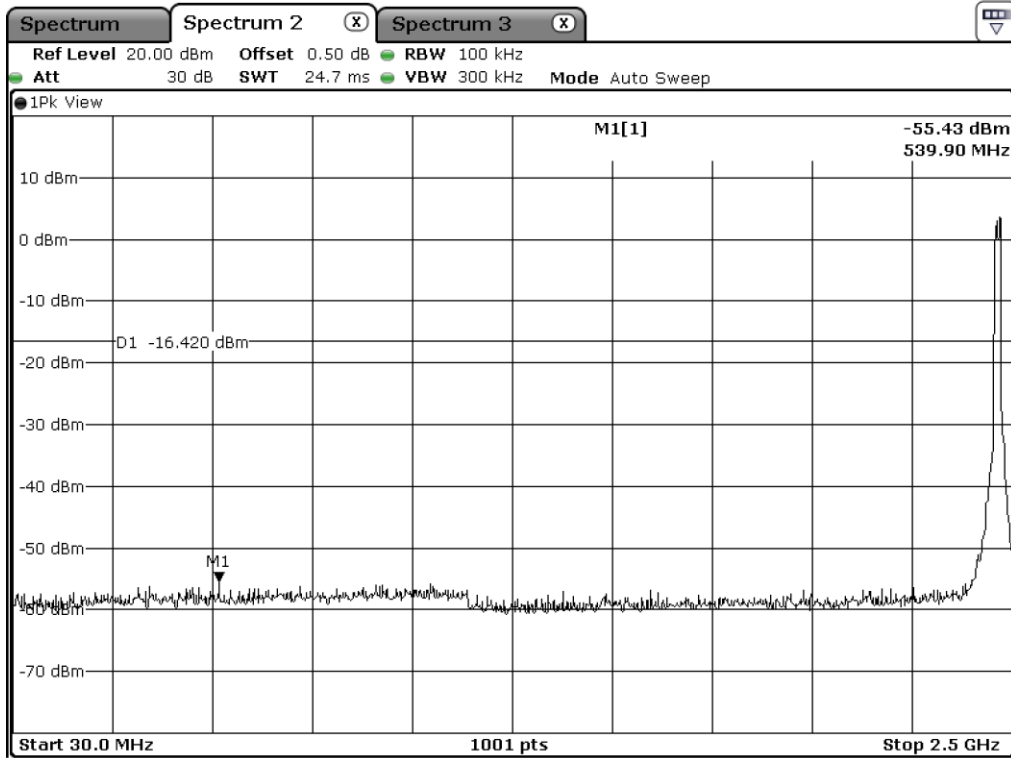
Low Channel



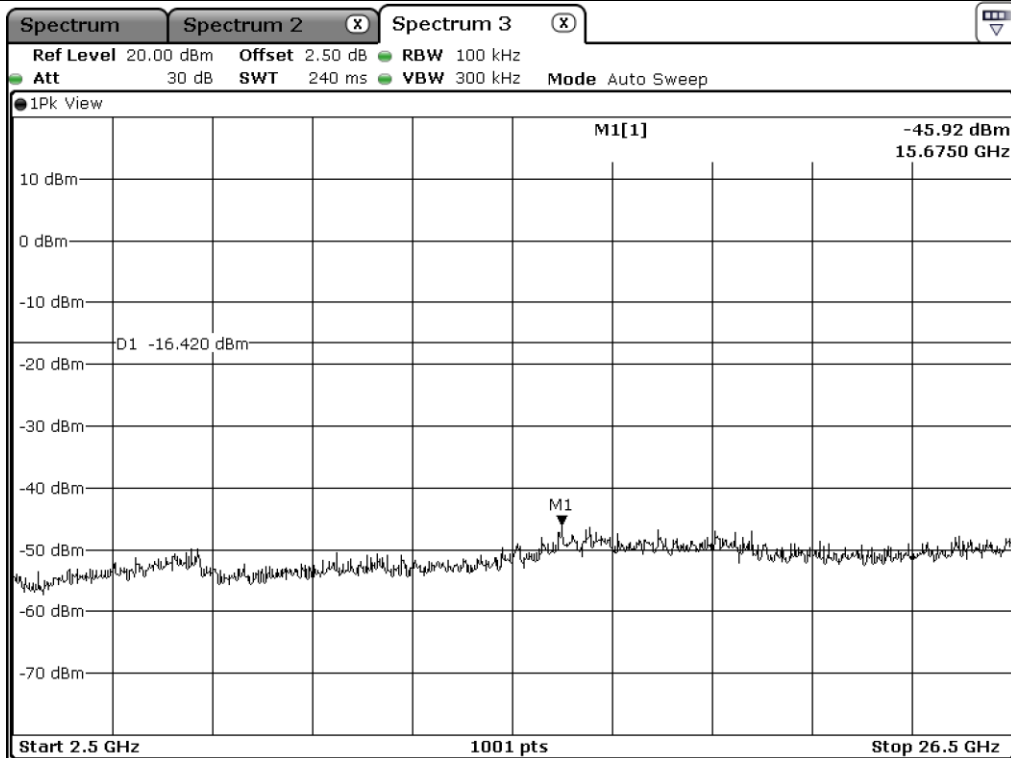
Middle Channel



Middle Channel

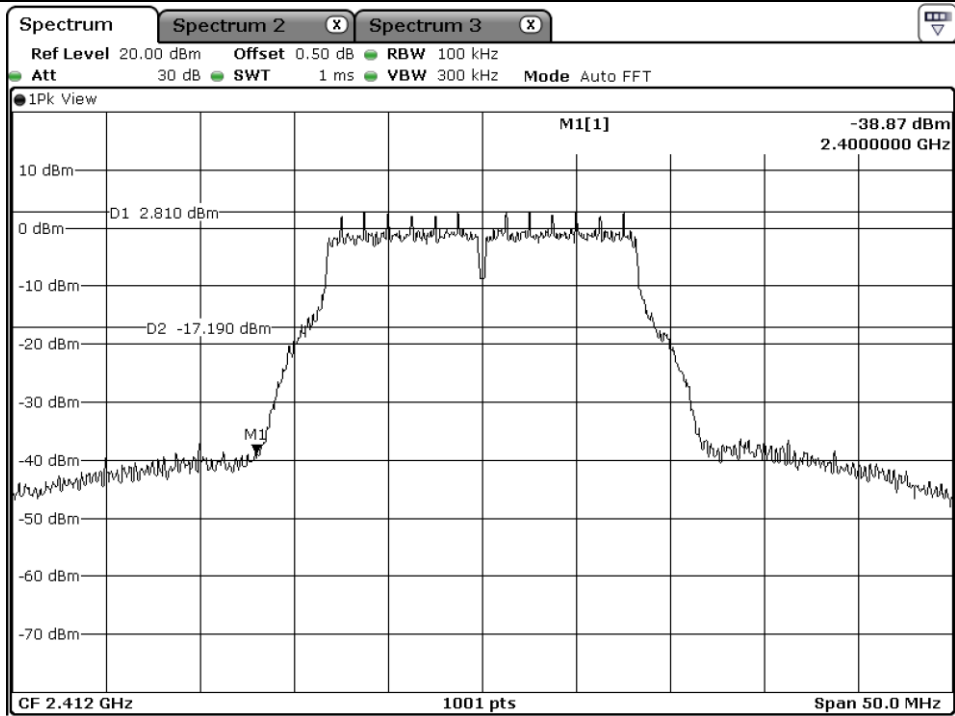


High Channel

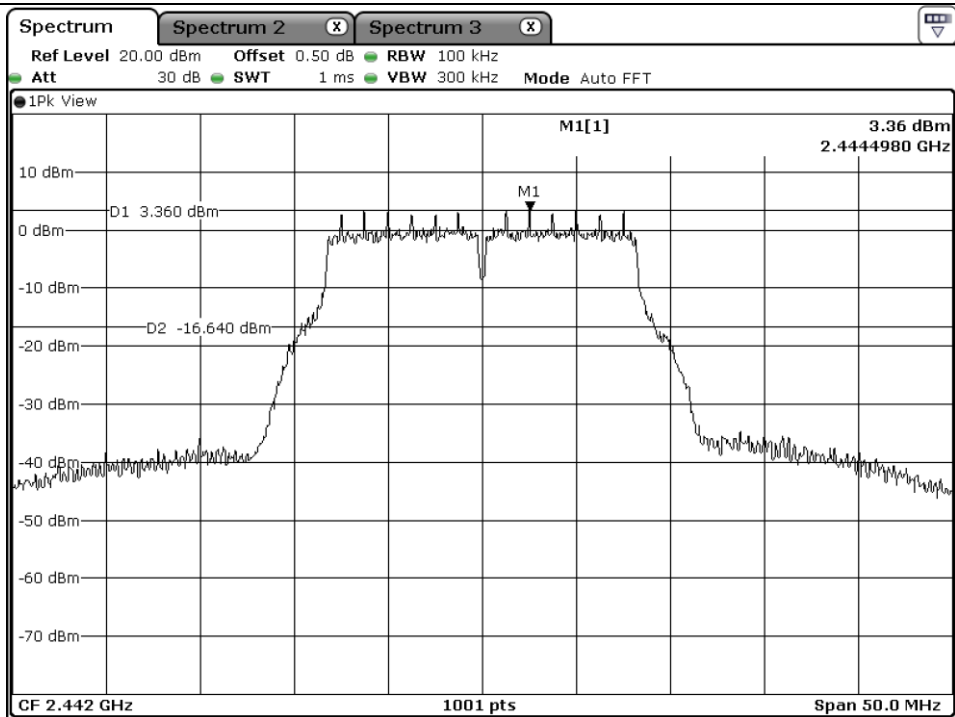


High Channel

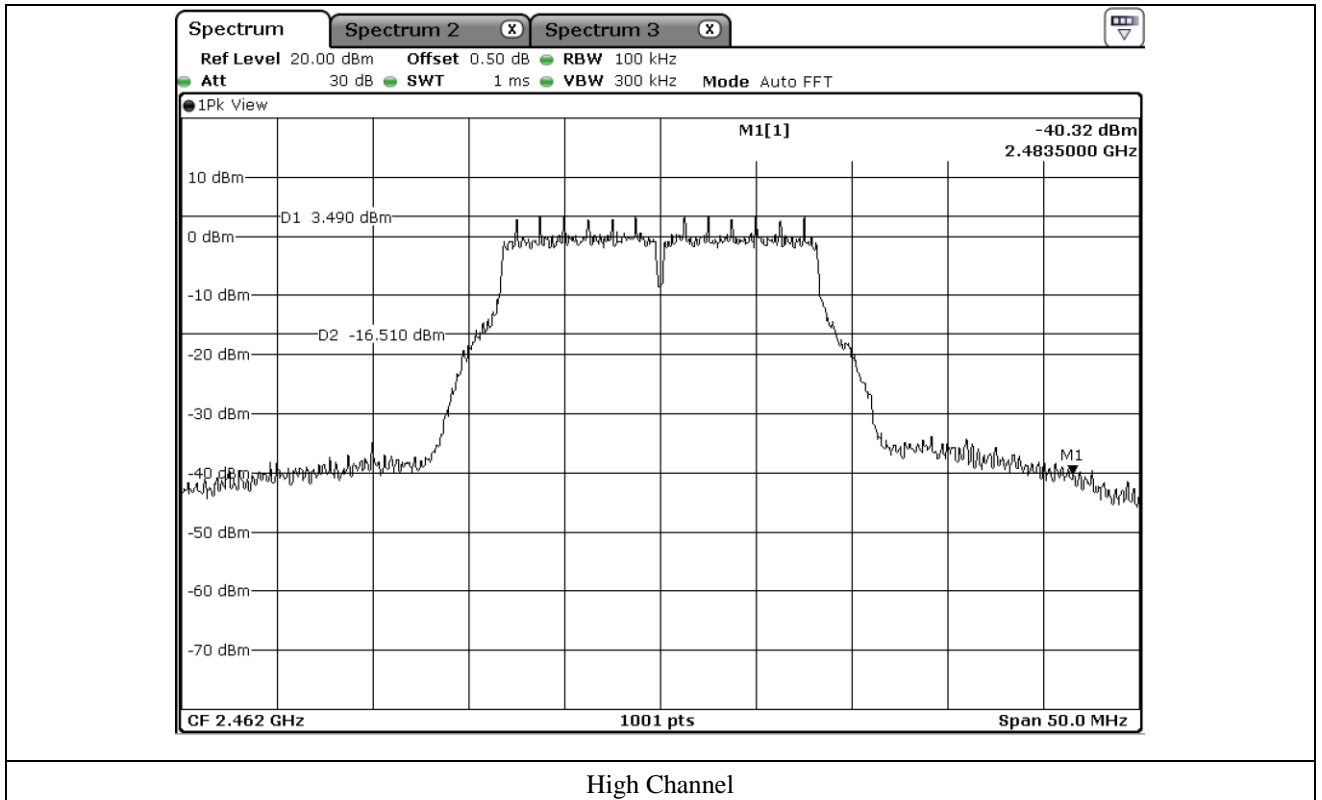
9.5.2.2 Test data for Antenna 1

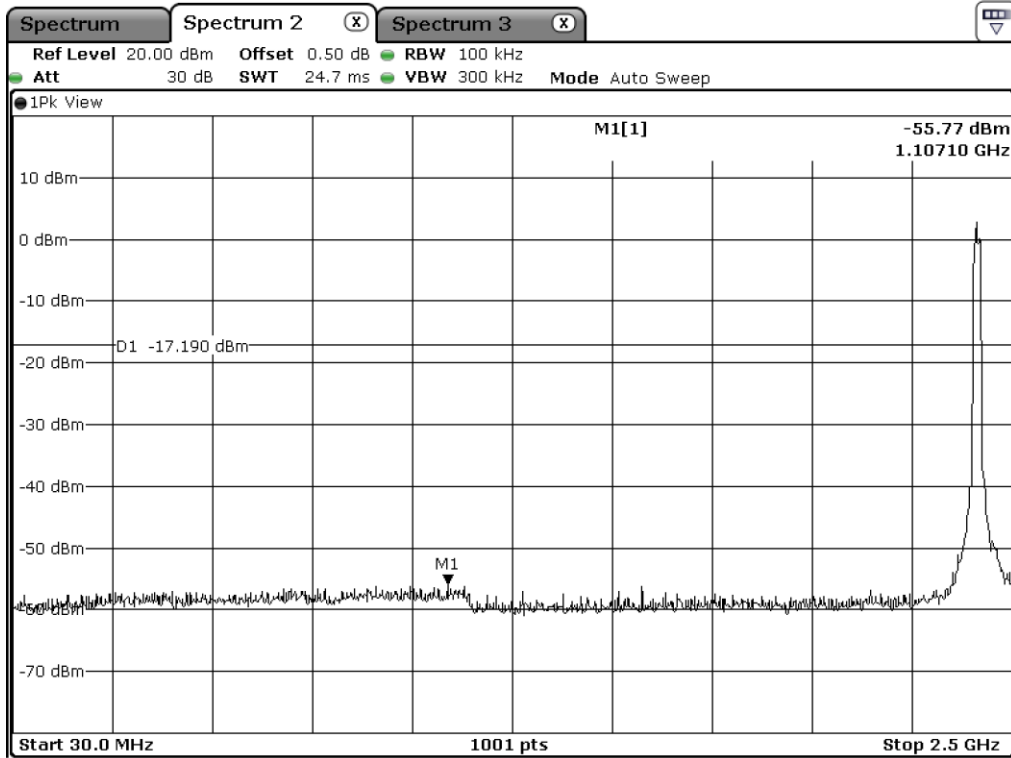


Low Channel

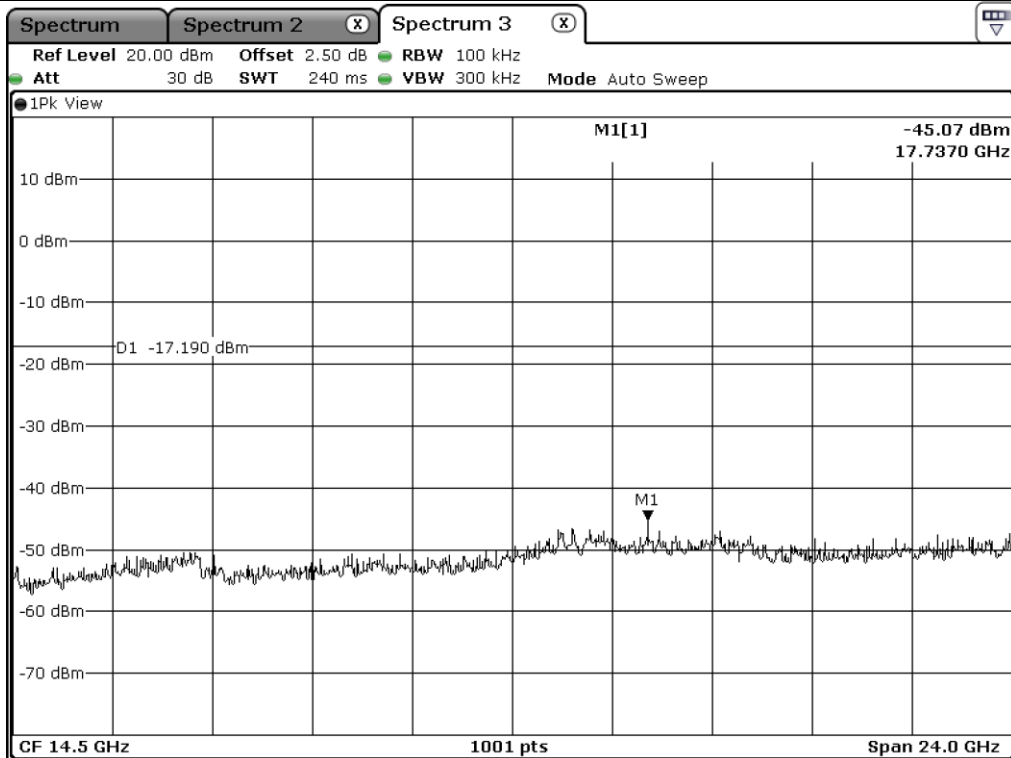


Middle Channel

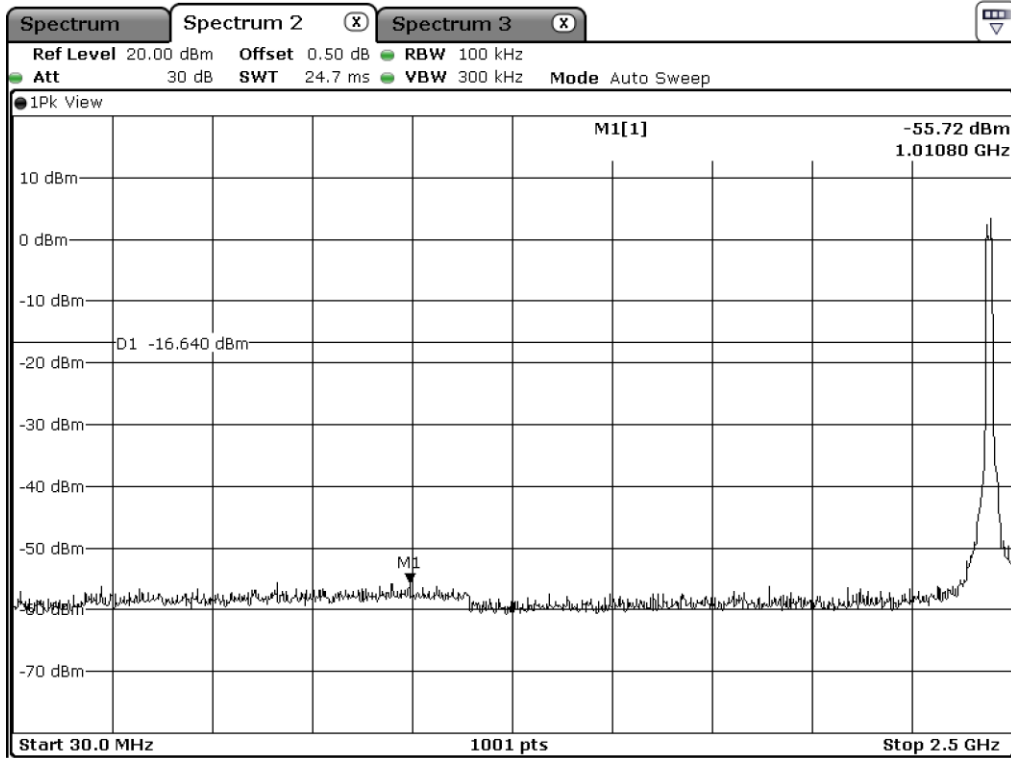




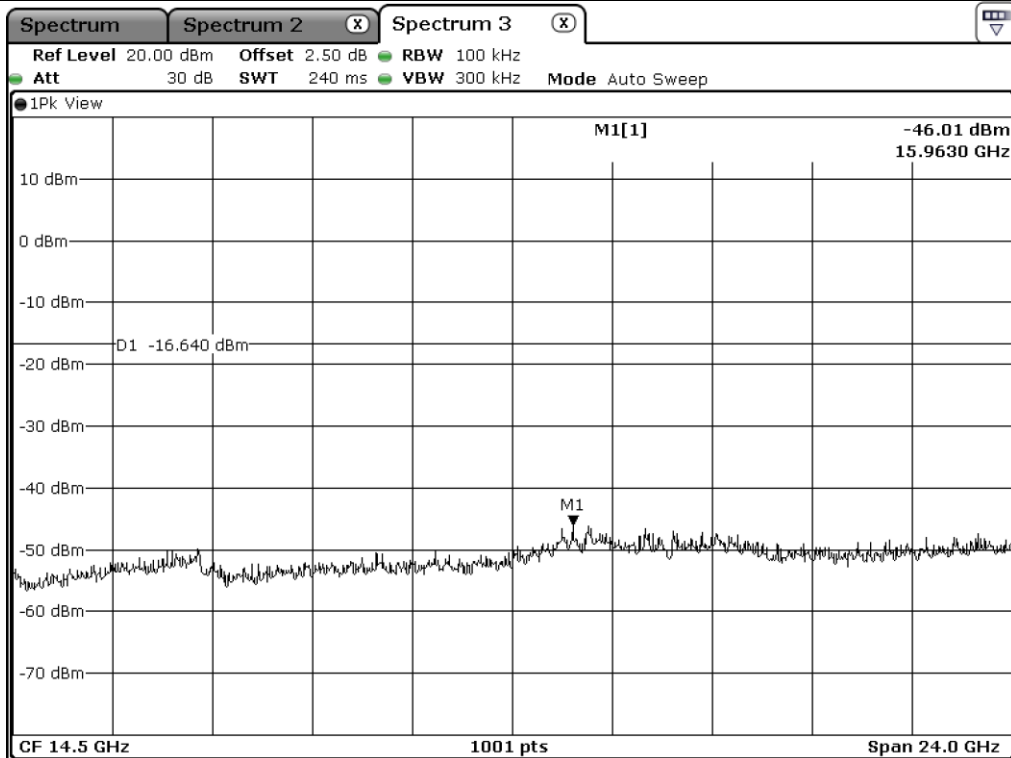
Low Channel



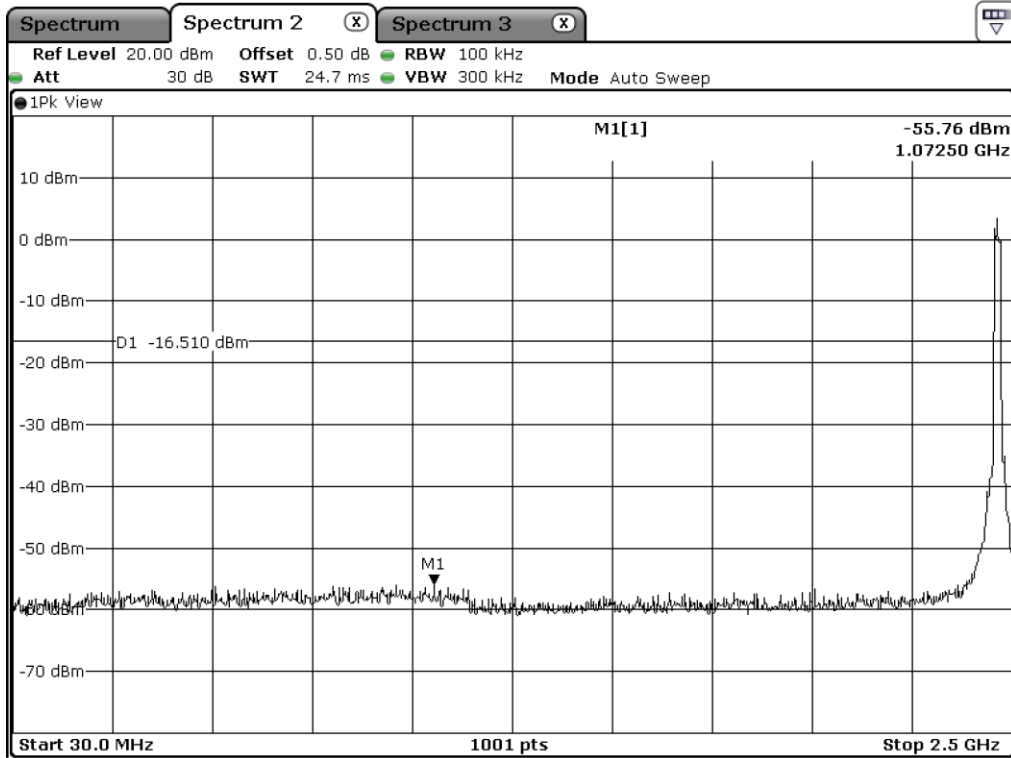
Low Channel



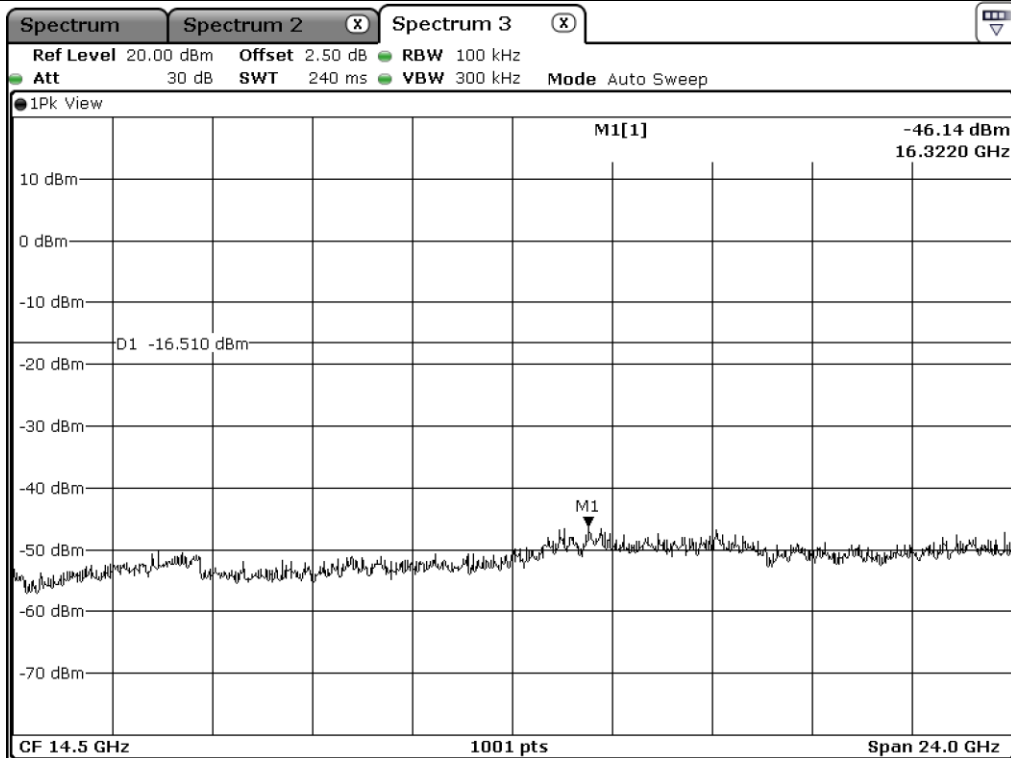
Middle Channel



Middle Channel



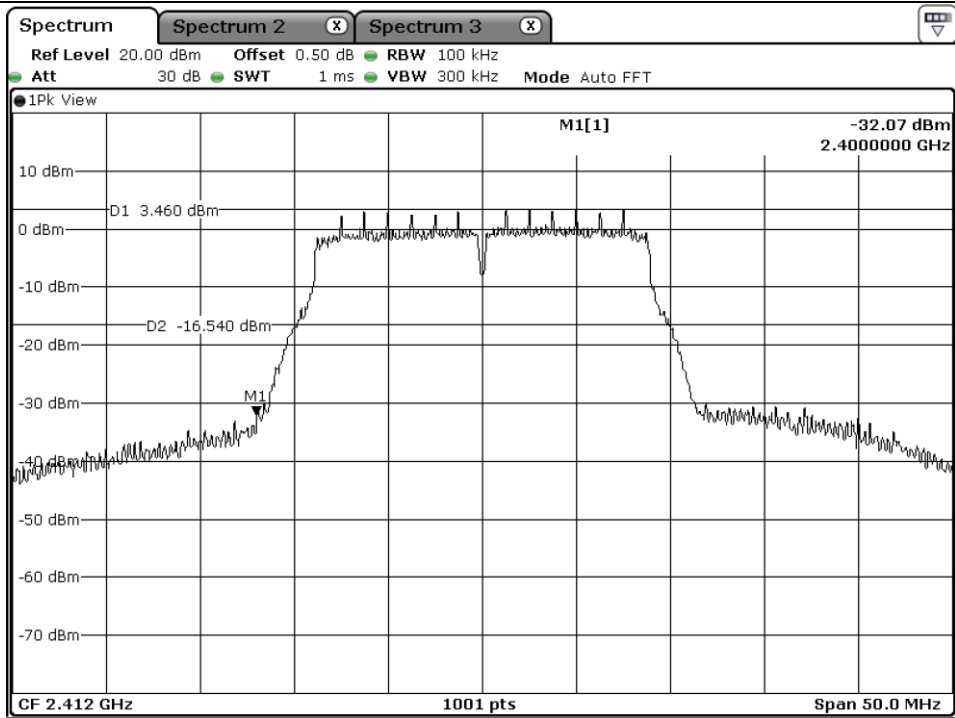
High Channel



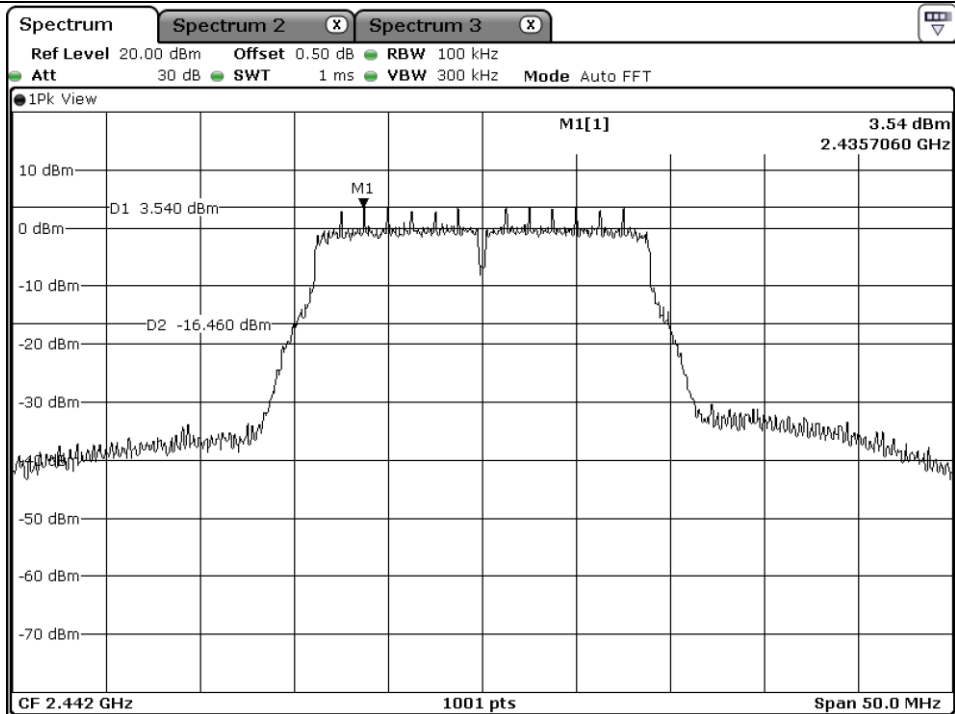
High Channel

9.5.3 Test data for 802.11n_HT20 WLAN Mode

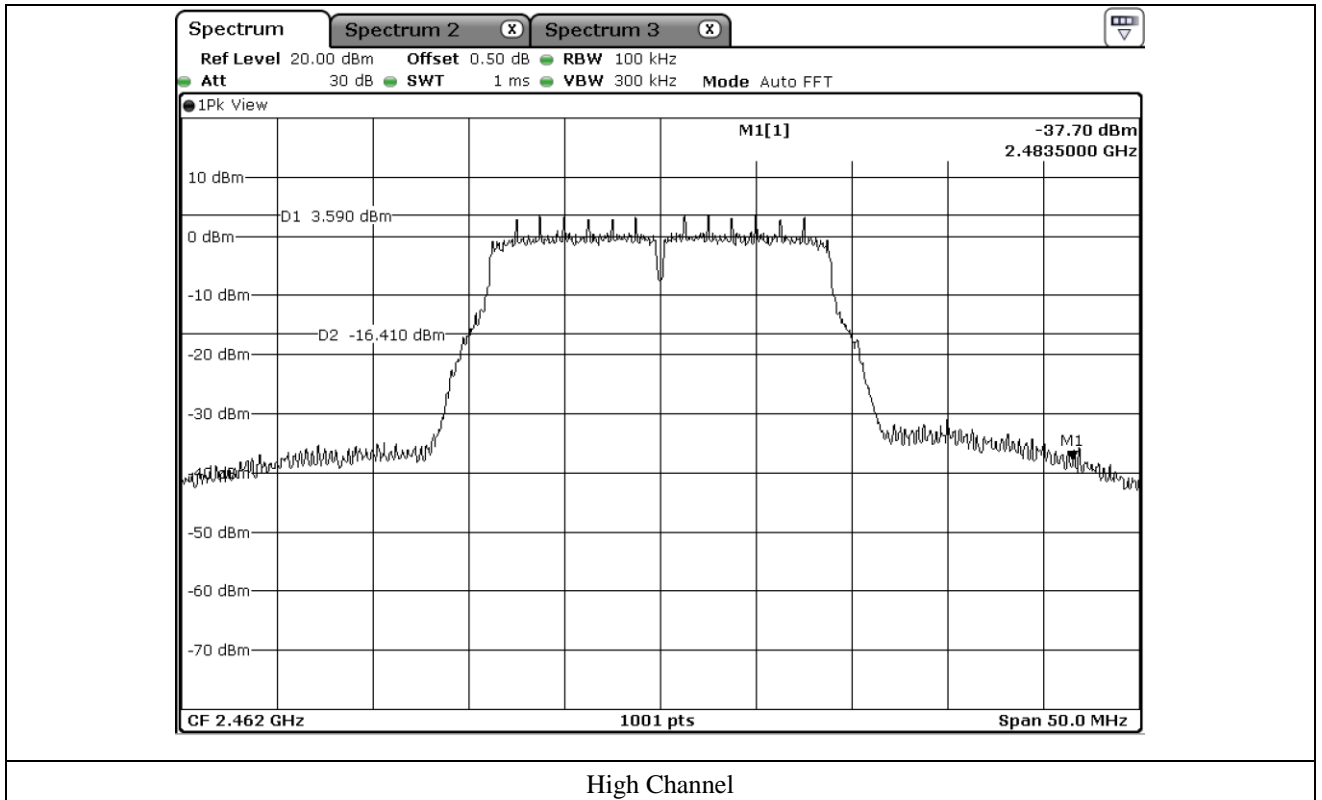
9.5.3.1 Test data for Antenna 0

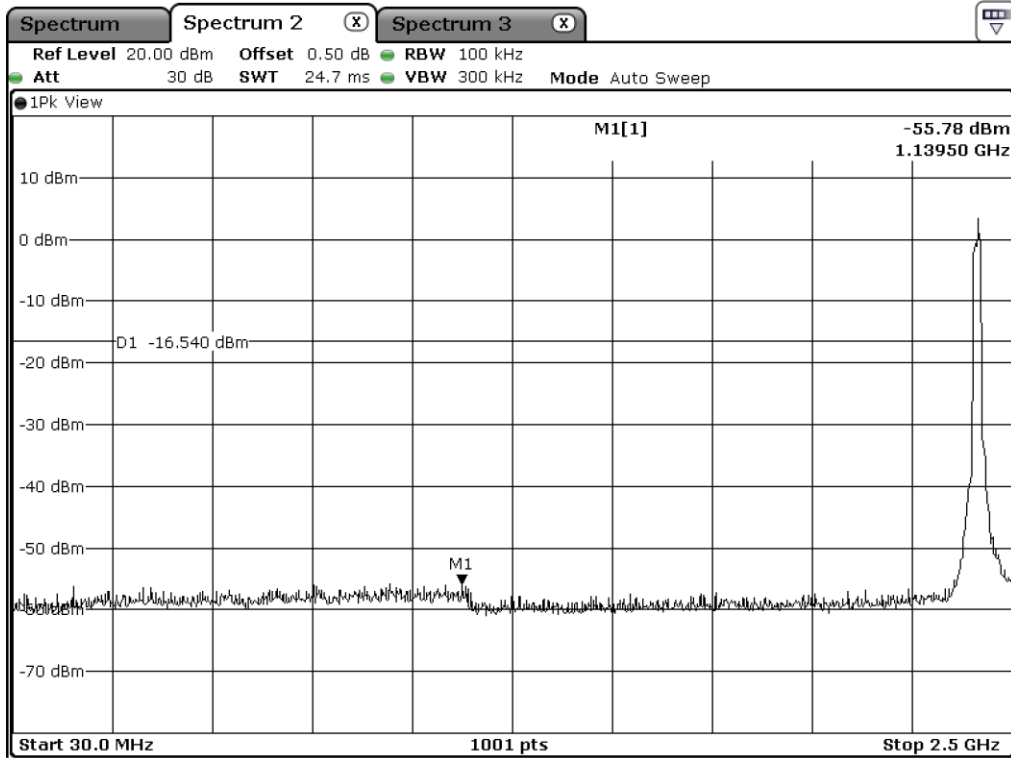


Low Channel

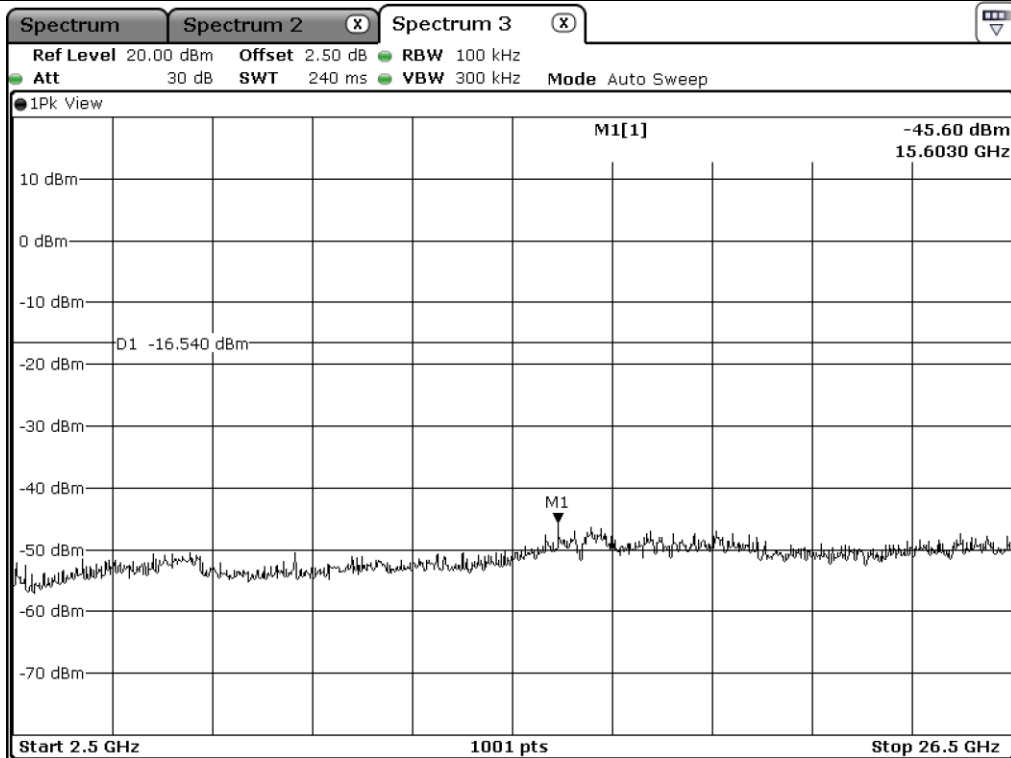


Middle Channel

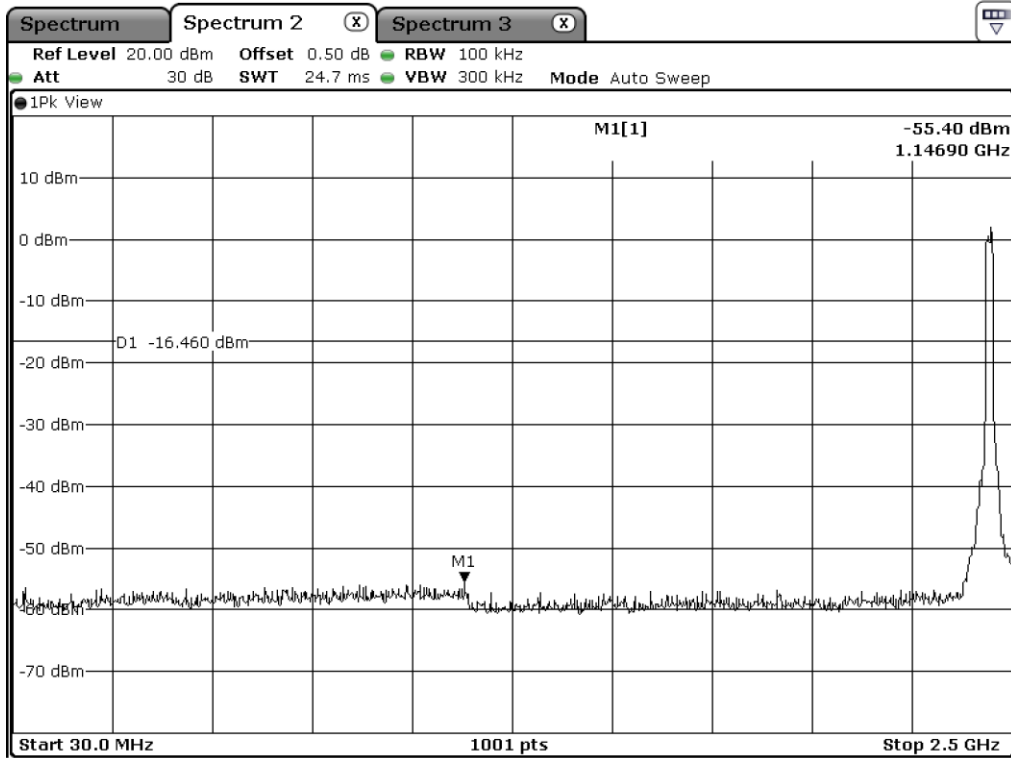




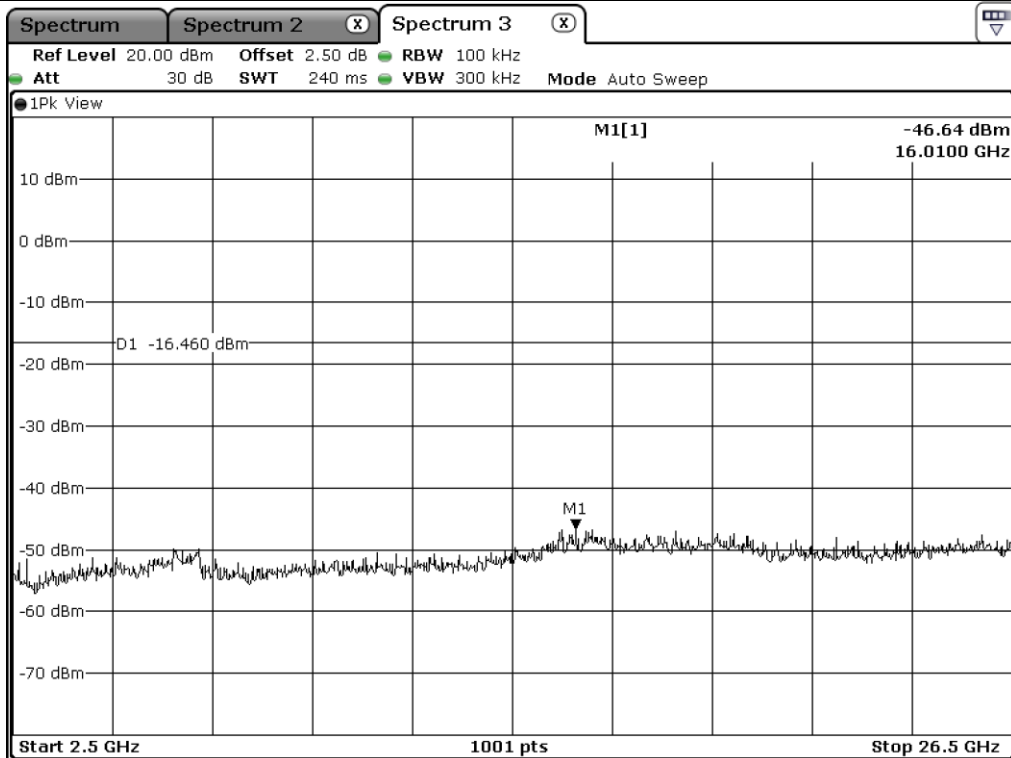
Low Channel



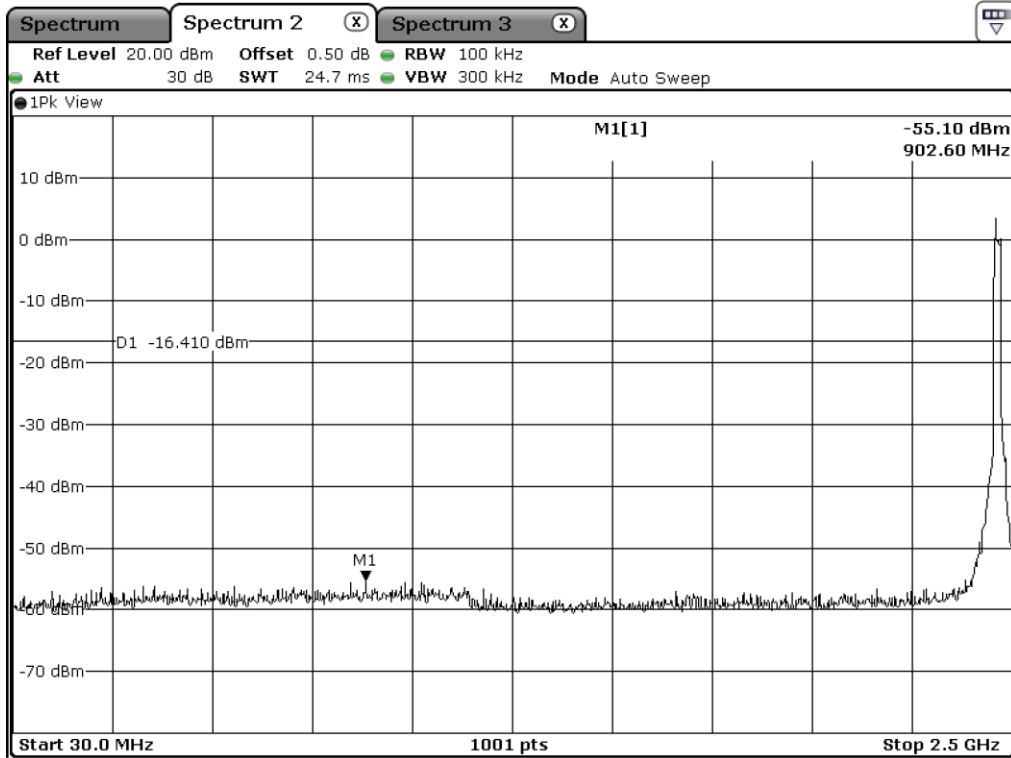
Low Channel



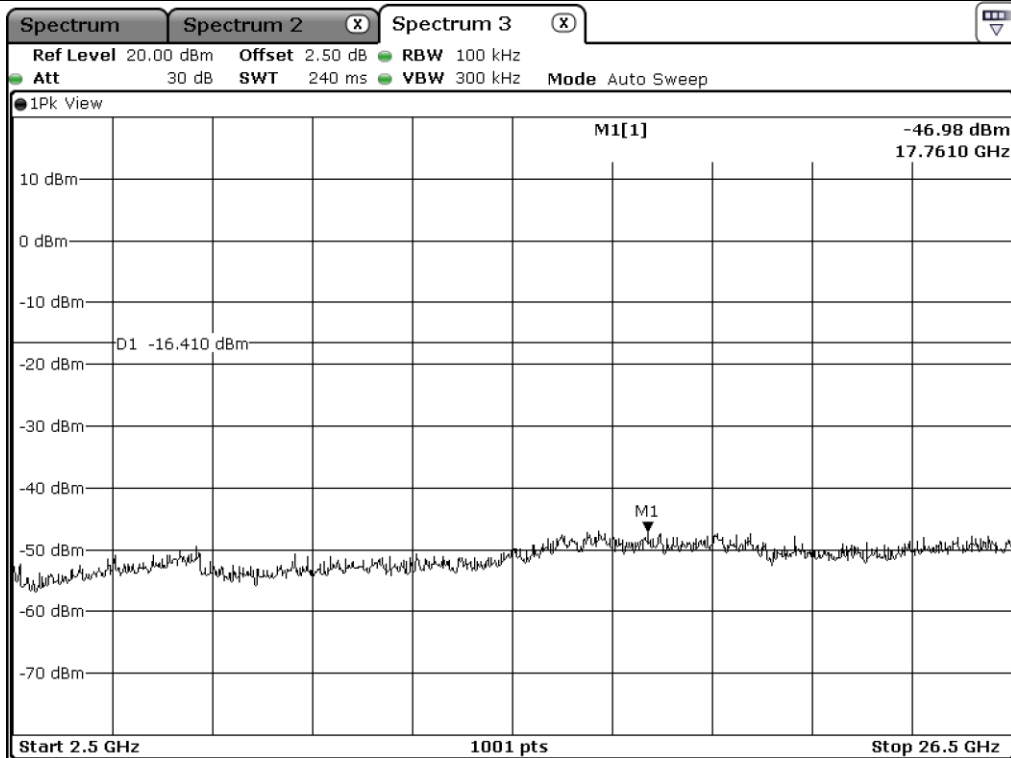
Middle Channel



Middle Channel

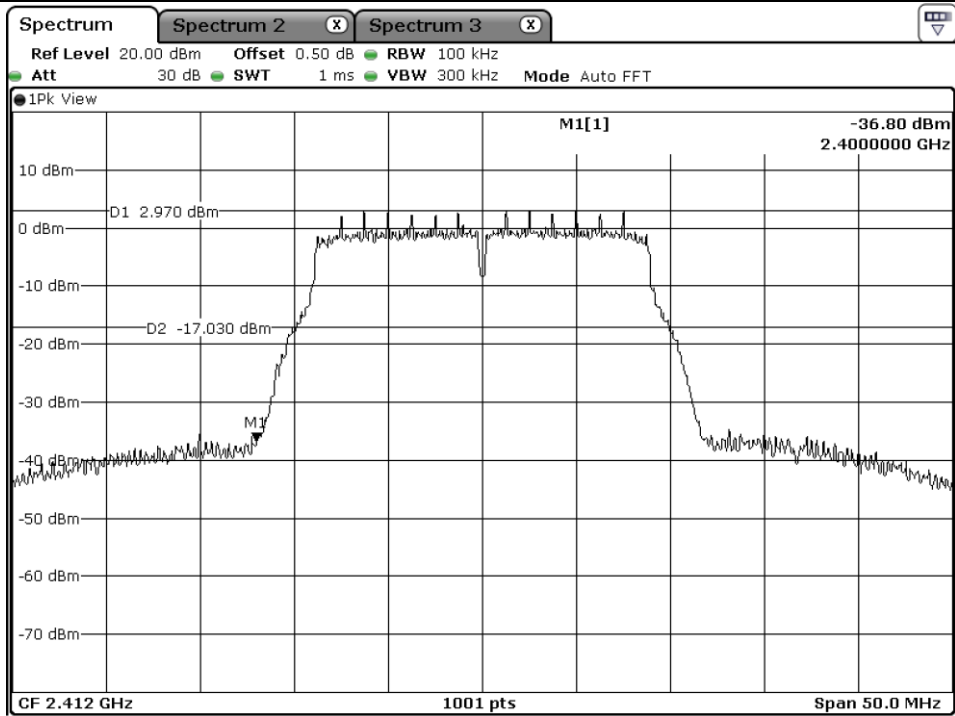


High Channel

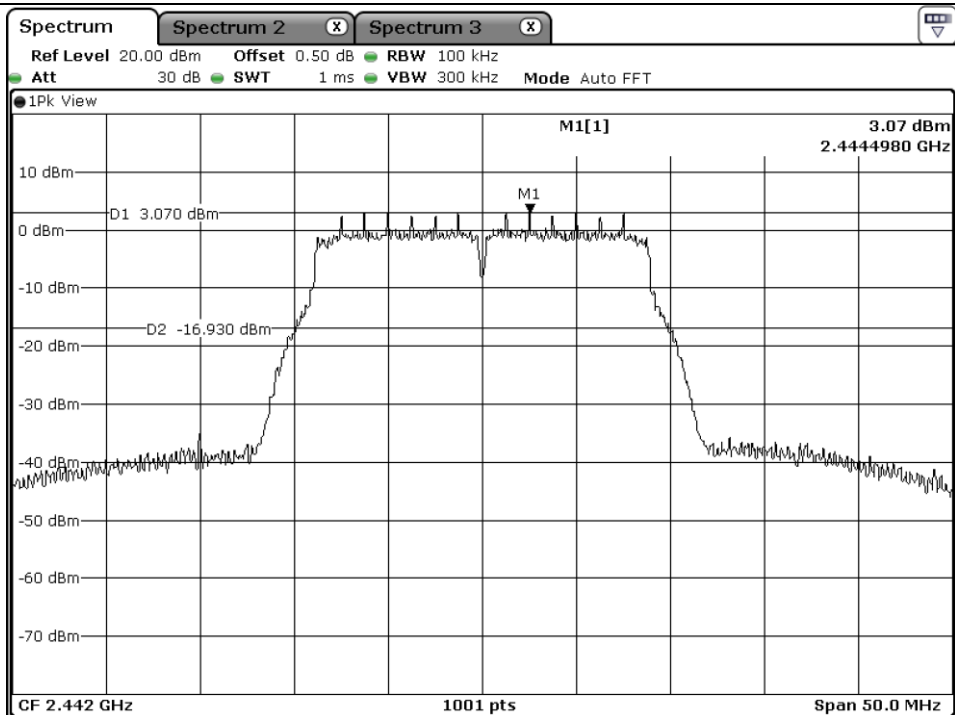


High Channel

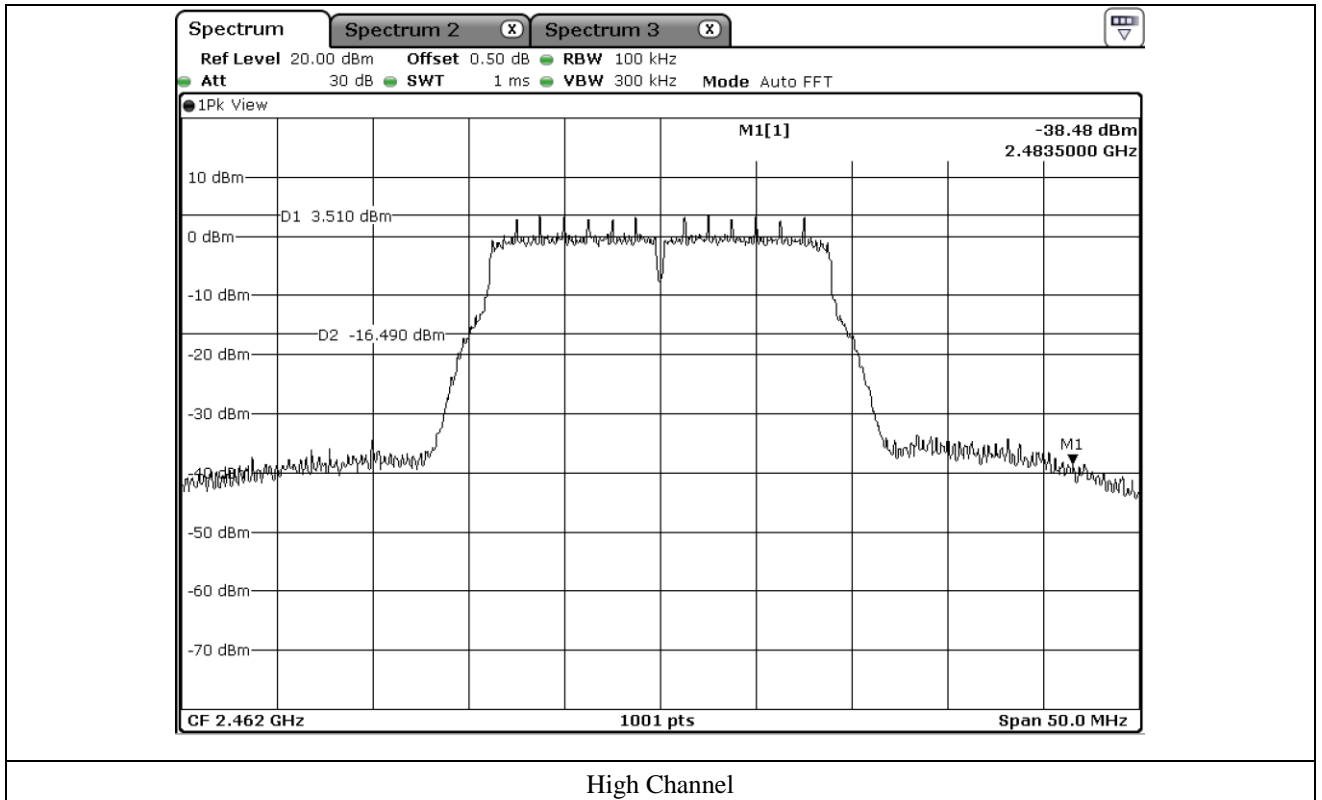
9.5.3.2 Test data for Antenna 1



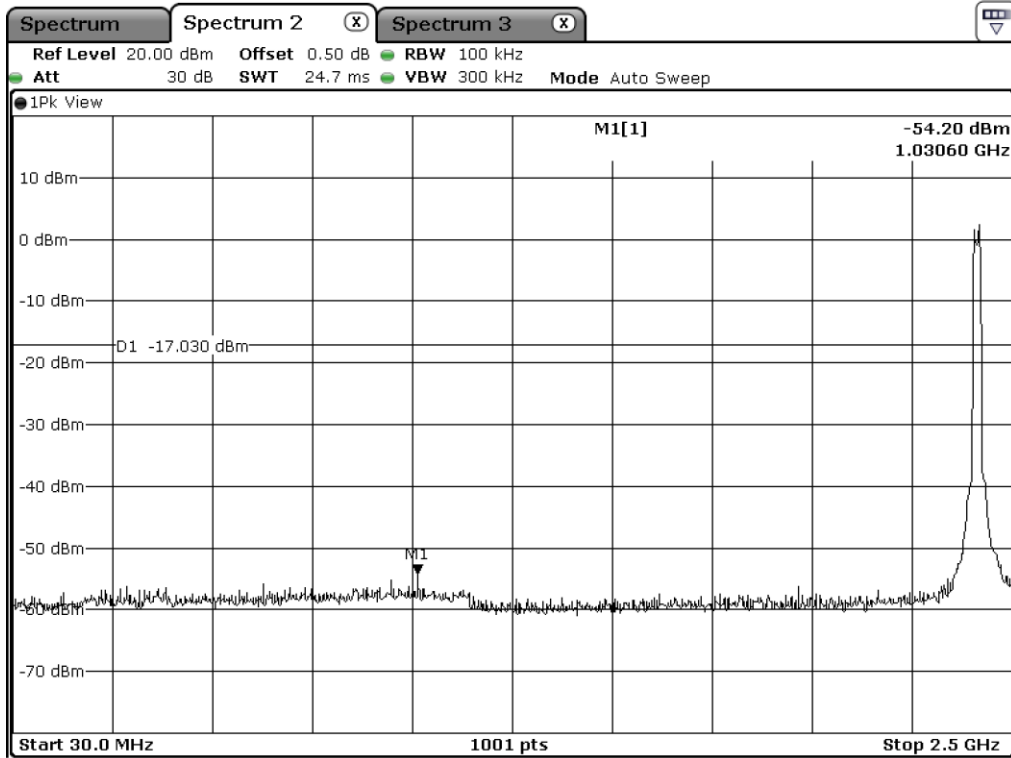
Low Channel



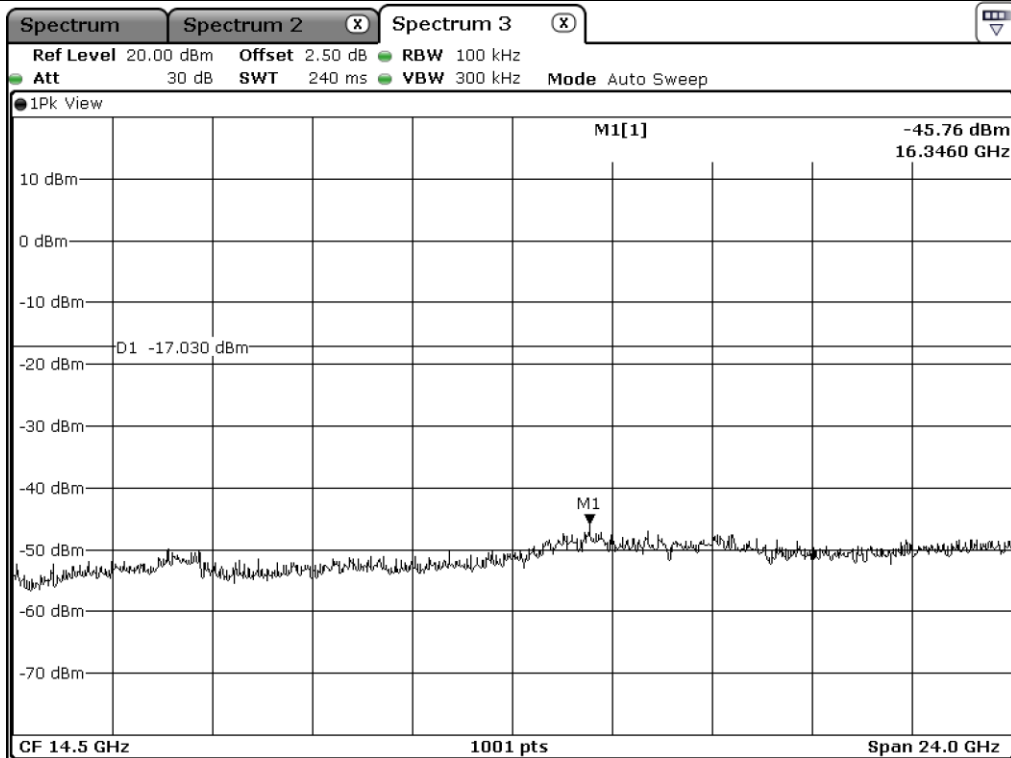
Middle Channel



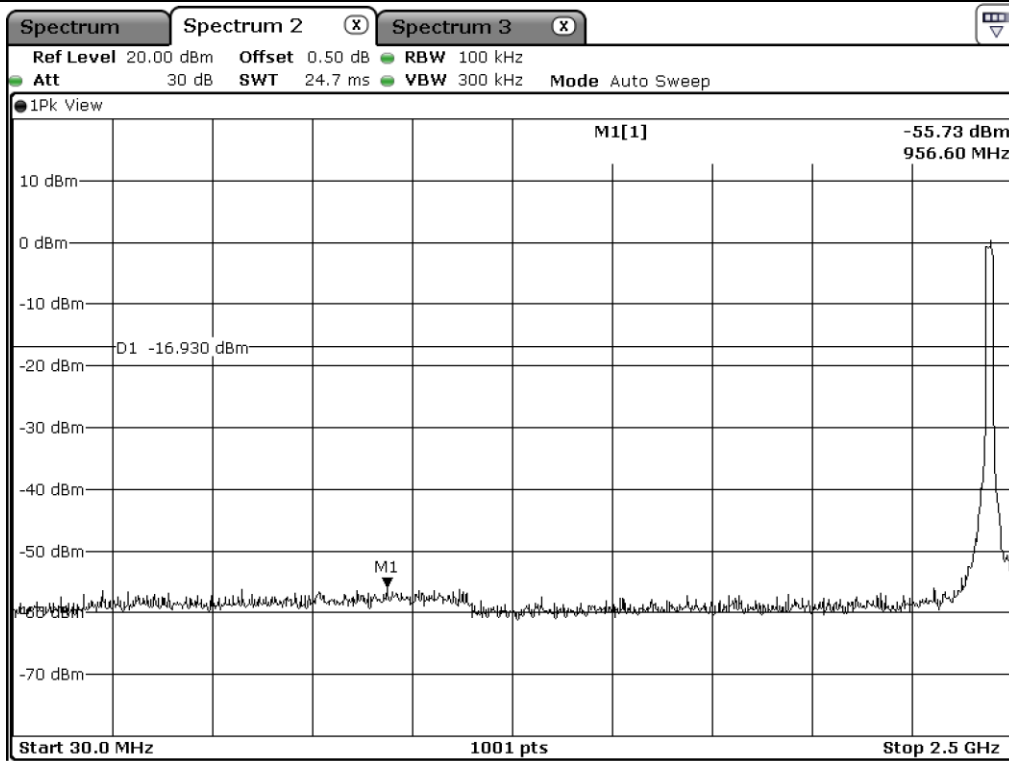
High Channel



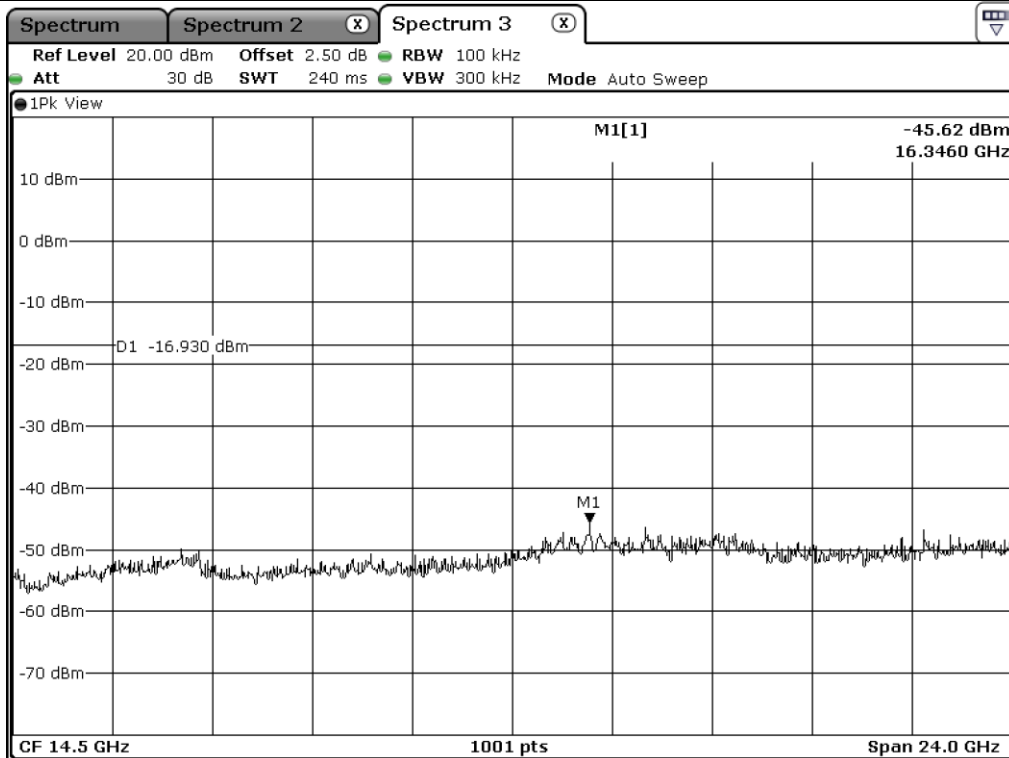
Low Channel



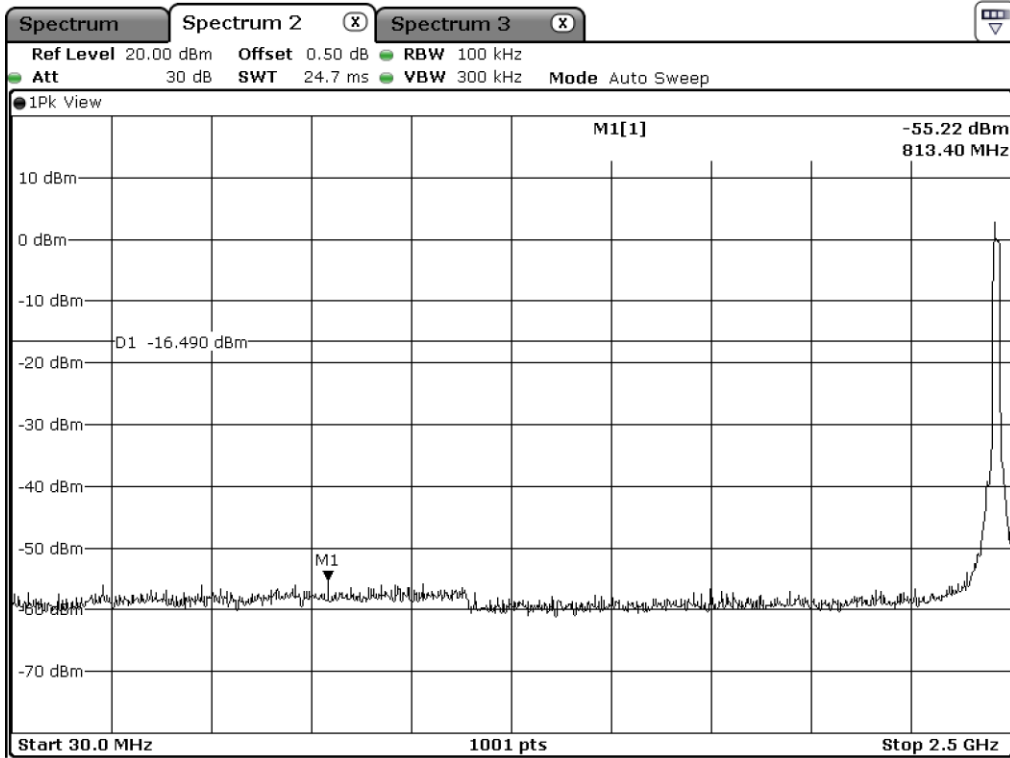
Low Channel



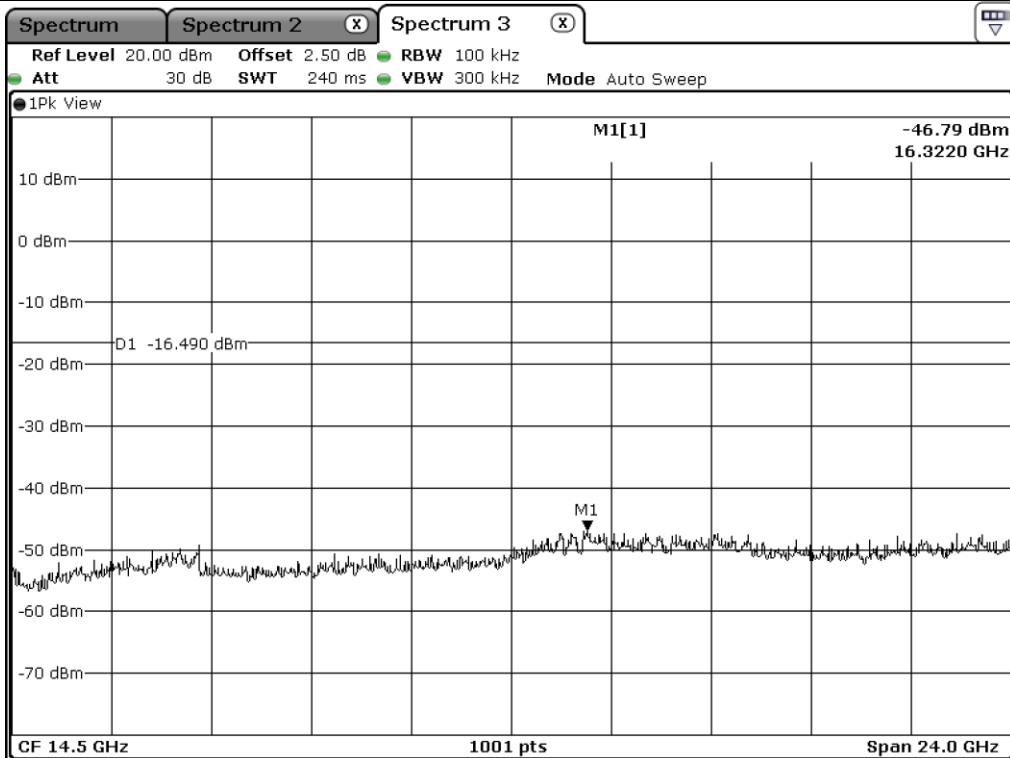
Middle Channel



Middle Channel



High Channel



High Channel