

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

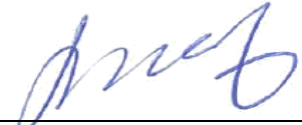
Test Report No. : OT-189-RWD-005
AGR No. : A187A-312
Applicant : Humax Co., Ltd.
Address : HUMAX BLDG., 2, Yeongmun-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, 17040, South Korea
Manufacturer : Humax Co., Ltd.
Address : HUMAX BLDG., 2, Yeongmun-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, 17040, South Korea
Type of Equipment : Beam Projector
FCC ID. : O6ZW1
Model Name : W1
Multiple Model Name : N/A
Serial number : N/A
Total page of Report : 167 pages (including this page)
Date of Incoming : August 02, 2018
Date of issue : September 05, 2018

SUMMARY

The equipment complies with the regulation; *FCC PART 15 SUBPART E Section 15.407*
 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: 

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 ONETECH Corp.

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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-189-RWD-005	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. : +82-31-776-6748
 FCC ID : O6ZW1
 Model Name : W1
 Brand Name : -
 Serial Number : N/A
 Date : September 05, 2018

EQUIPMENT CLASS	Unlicensed National Information infrastructure(UNII)
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 E Section 15.407 KDB 789033 D02 General UNII Test Procedures New Rules V02r01
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
15.407(a)	26 dB Bandwidth	PASS
15.407(a)	Maximum Conducted Output Power	Met the Limit / PASS
15.407(a)	Peak Power Spectral Density	Met the Limit / PASS
15.407(a)	Peak Excursion	Met the Limit / PASS
15.407(g)	Frequency Stability	Met the Limit / PASS
15.407(b)	Undesirable Emissions	Met the Limit / PASS
15.205, 15.407(b)	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Met the Limit / PASS
15.207	AC Conducted Emissions 150 kHz-30 MHz	Met the Limit / 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 E Section 15.407

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) Wi-Fi 802.11n(HT40) (22.44 dBm)	
		Antenna 1	Wi-Fi 802.11b (17.62 dBm) Wi-Fi 802.11g (20.99 dBm) Wi-Fi 802.11n(HT20) (21.47 dBm) Wi-Fi 802.11n(HT40) (22.44 dBm)	
		Antenna 0 + Antenna 1	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
W1	Humax Co., Ltd.	Beam Projector (EUT)	-
N/A	N/A	Jig Board	EUT
Ideapad 110	Lenovo	Notebook	-

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.

UNII 1

Modulation	DATA RATE	OUTPUT POWER[dBm]	
		Antenna 0	Antenna 1
802.11 a (Middle Channel)	6 Mbps	14.72	14.74
	9 Mbps	14.35	14.44
	12 Mbps	14.17	14.04
	18 Mbps	13.86	13.87
	24 Mbps	13.51	13.74
	36 Mbps	13.12	13.44
	48 Mbps	12.79	13.06
	54 Mbps	12.68	12.72
HT 20 (Middle Channel)	6.5 Mbps	14.66	14.74
	13 Mbps	14.30	14.42
	19.5 Mbps	14.16	14.12
	26 Mbps	13.82	13.94
	39 Mbps	13.50	13.68
	52 Mbps	13.12	13.40
	58.5 Mbps	12.80	13.05
	65 Mbps	12.66	12.83
HT 40 (Low Channel)	13.5 Mbps	16.49	16.38
	27 Mbps	16.26	16.12
	40.5 Mbps	16.06	15.99
	54 Mbps	15.75	15.85
	81 Mbps	15.43	15.57
	108 Mbps	15.07	15.29
	121.5 Mbps	14.82	15.03
	135 Mbps	14.59	14.68

VHT80 (Middle Channel)	29.3 Mbps	14.99	14.78
	58.5 Mbps	14.82	14.53
	87.8 Mbps	14.59	14.14
	117 Mbps	14.19	13.79
	175.5 Mbps	13.99	13.69
	234 Mbps	13.73	13.54
	263.3 Mbps	13.47	13.29
	292.5 Mbps	13.18	13.04
	351 Mbps	12.83	12.65
	390 Mbps	12.51	12.49

- The worse case data rate for each modulation is determined 6 Mbps(Ant.0/Ant.1) for IEEE 802.11a, 6.5 Mbps(Ant.0/Ant.1) for HT20, 13.5 Mbps(Ant.0/Ant.1) for HT40, 29.3 Mbps(Ant.0/Ant.1) for VHT80.
- 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.

UNII 3

Modulation	DATA RATE	OUTPUT POWER[dBm]	
		Antenna 0	Antenna 1
802.11 a (Middle Channel)	6 Mbps	15.18	15.11
	9 Mbps	15.07	14.86
	12 Mbps	14.70	14.64
	18 Mbps	14.57	14.29
	24 Mbps	14.44	13.96
	36 Mbps	14.09	13.84
	48 Mbps	13.85	13.57
	54 Mbps	13.64	13.33
HT 20 (Middle Channel)	6.5 Mbps	14.88	14.94
	13 Mbps	14.72	14.82
	19.5 Mbps	14.54	14.60
	26 Mbps	14.19	14.34
	39 Mbps	14.05	14.13
	52 Mbps	13.72	13.95
	58.5 Mbps	13.36	13.74
	65 Mbps	13.26	13.53
HT 40 (Low Channel)	13.5 Mbps	16.55	16.48
	27 Mbps	16.43	16.37
	40.5 Mbps	16.30	15.97
	54 Mbps	16.11	15.73
	81 Mbps	16.01	15.33
	108 Mbps	15.72	15.04
	121.5 Mbps	15.39	14.70
	135 Mbps	15.21	14.37

VHT80 (Middle Channel)	29.3 Mbps	15.21	15.03
	58.5 Mbps	15.07	14.83
	87.8 Mbps	14.68	14.54
	117 Mbps	14.41	14.41
	175.5 Mbps	14.25	14.20
	234 Mbps	13.91	13.94
	263.3 Mbps	13.73	13.66
	292.5 Mbps	13.48	13.54
	351 Mbps	13.36	13.32
	390 Mbps	12.97	13.13

- The worse case data rate for each modulation is determined 6 Mbps(Ant.0/Ant.1) for IEEE 802.11a, 6.5 Mbps(Ant.0/Ant.1) for HT20, 13.5 Mbps(Ant.0/Ant.1) for HT40, 29.3 Mbps(Ant.0/Ant.1) for VHT80.
- 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

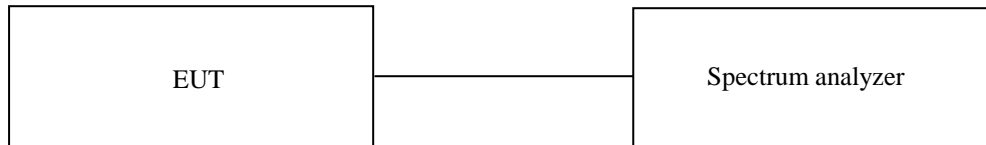
7. MIMIMUM 26 dB BANDWIDTH

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 26 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 26 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 802.11a RLAN Mode

7.4.1 Test data for Antenna 0

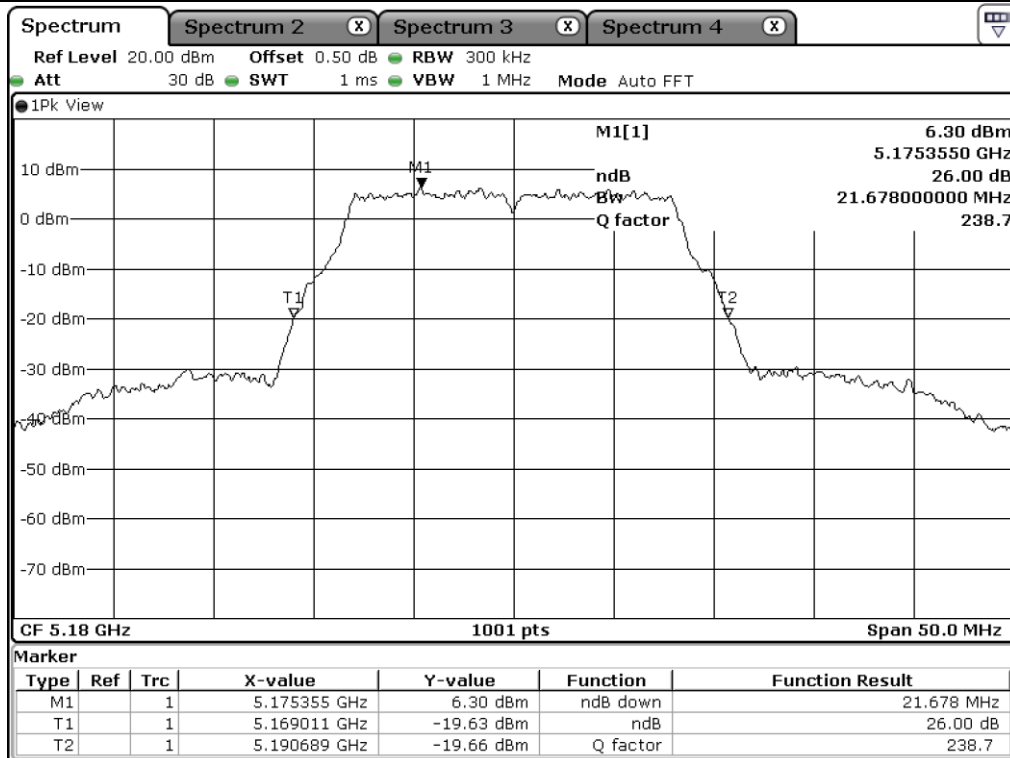
-. Test Date : August 16, 2018 ~ August 28, 2018

-. Test Result : Pass

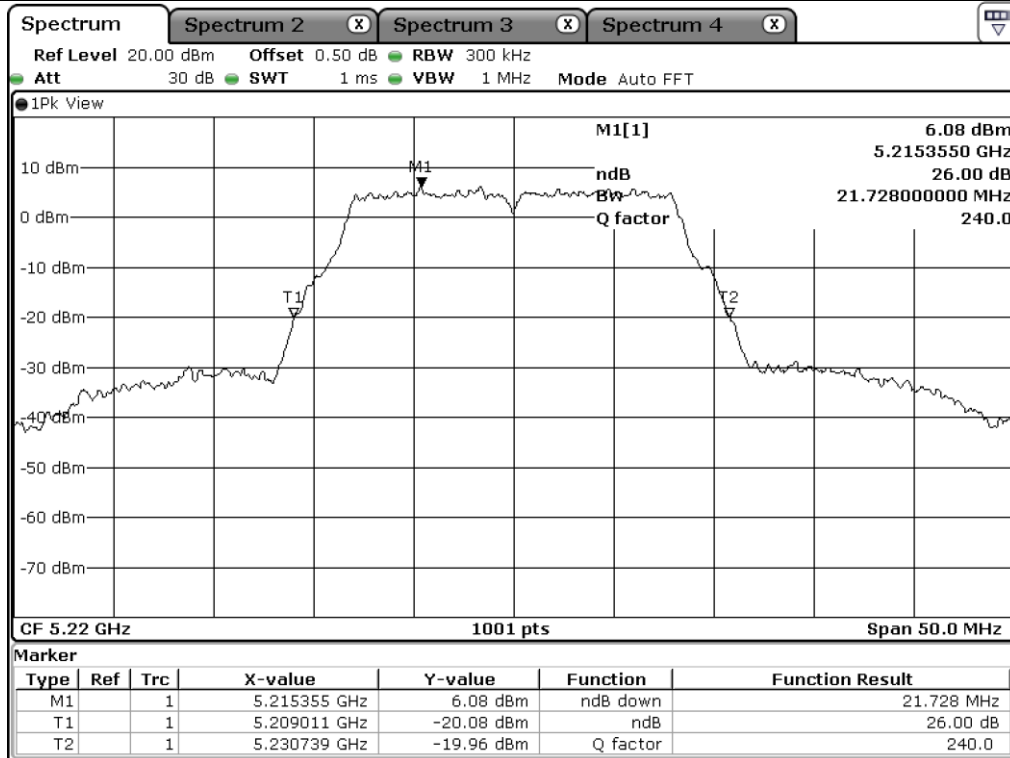
FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	26 dB Bandwidth (MHz)
5 150 ~ 5 250	Low	5 180.00	21.68
	Middle	5 220.00	21.73
	High	5 240.00	21.68
5 725 ~ 5 850	Low	5 745.00	21.23
	Middle	5 785.00	21.43
	High	5 825.00	21.28



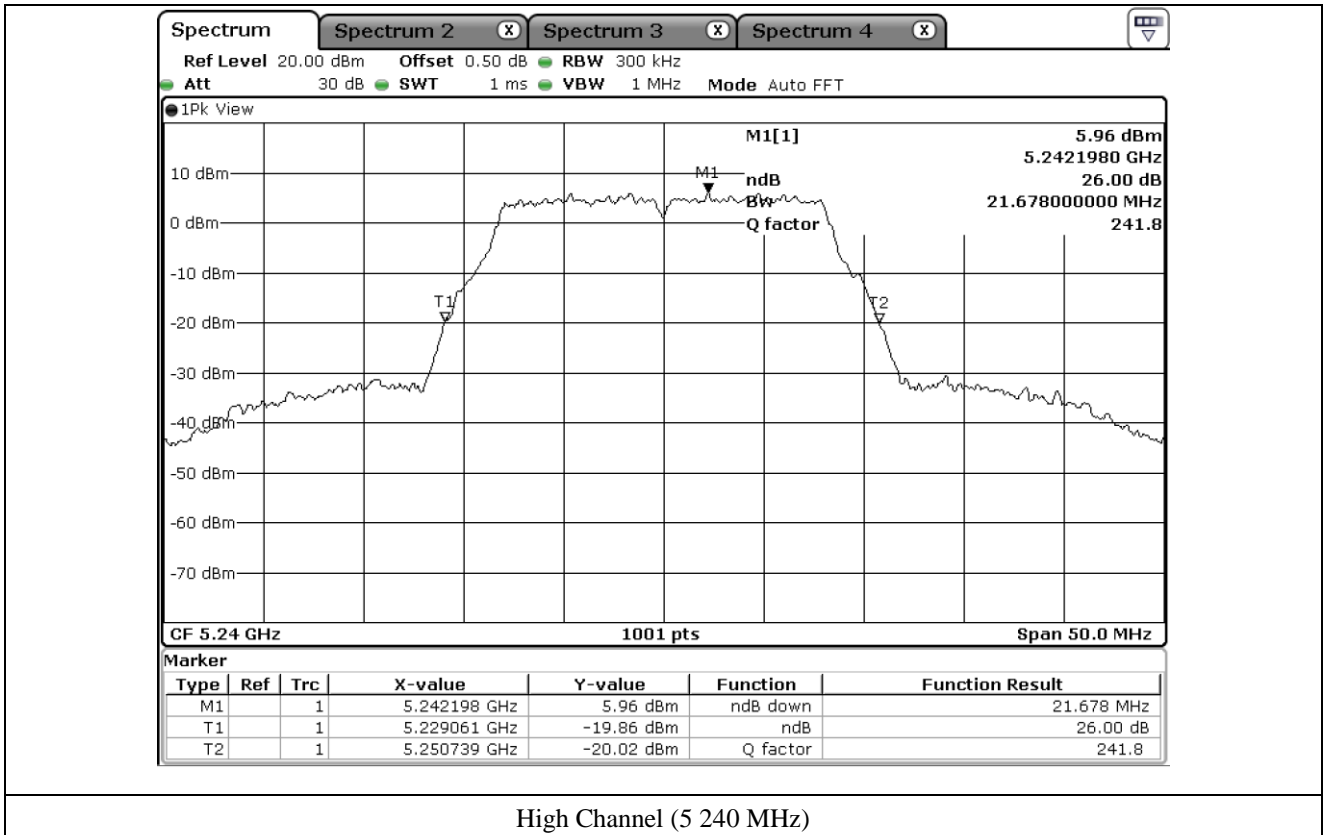
Tested by: **Tae-Ho, Kim / Senior Manager**

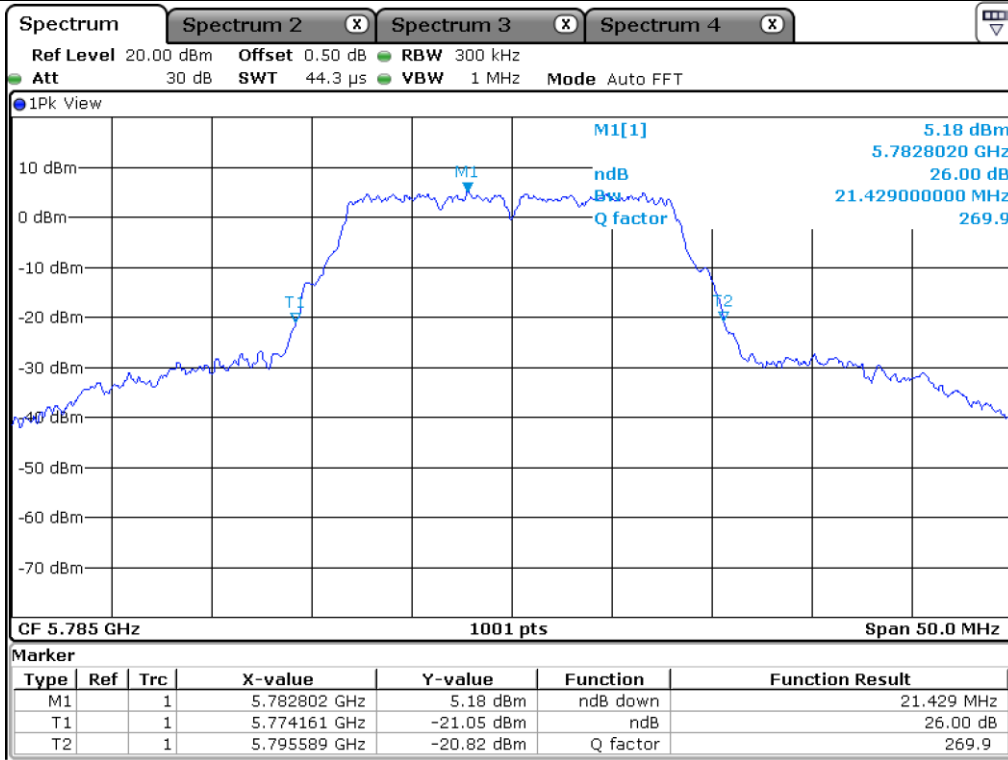
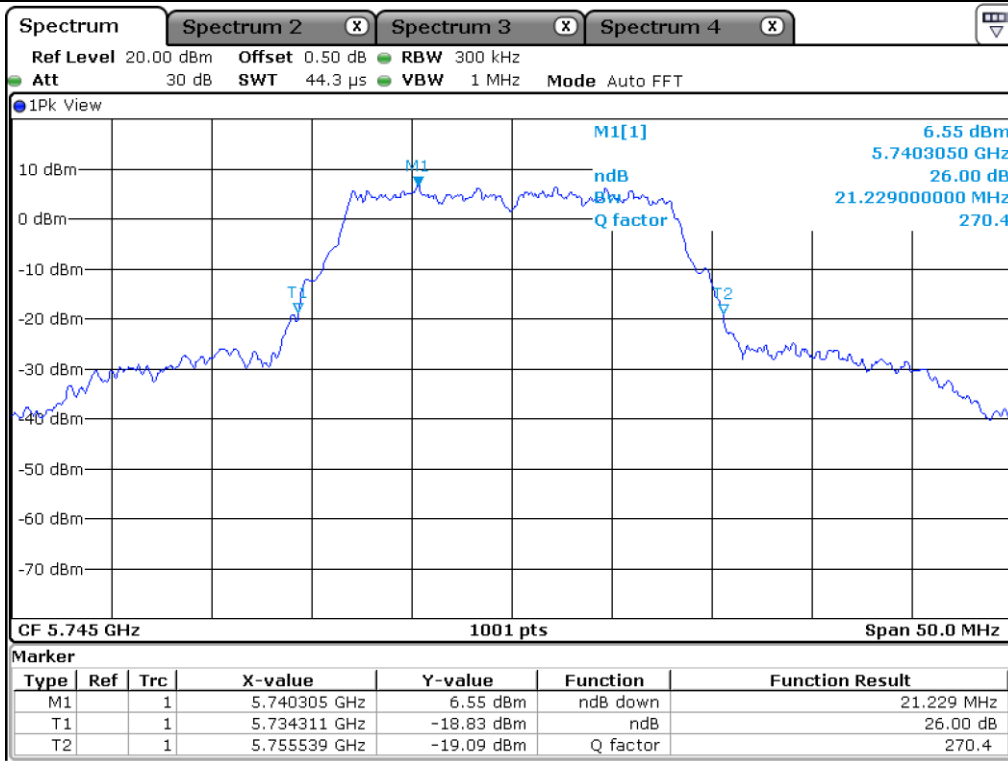


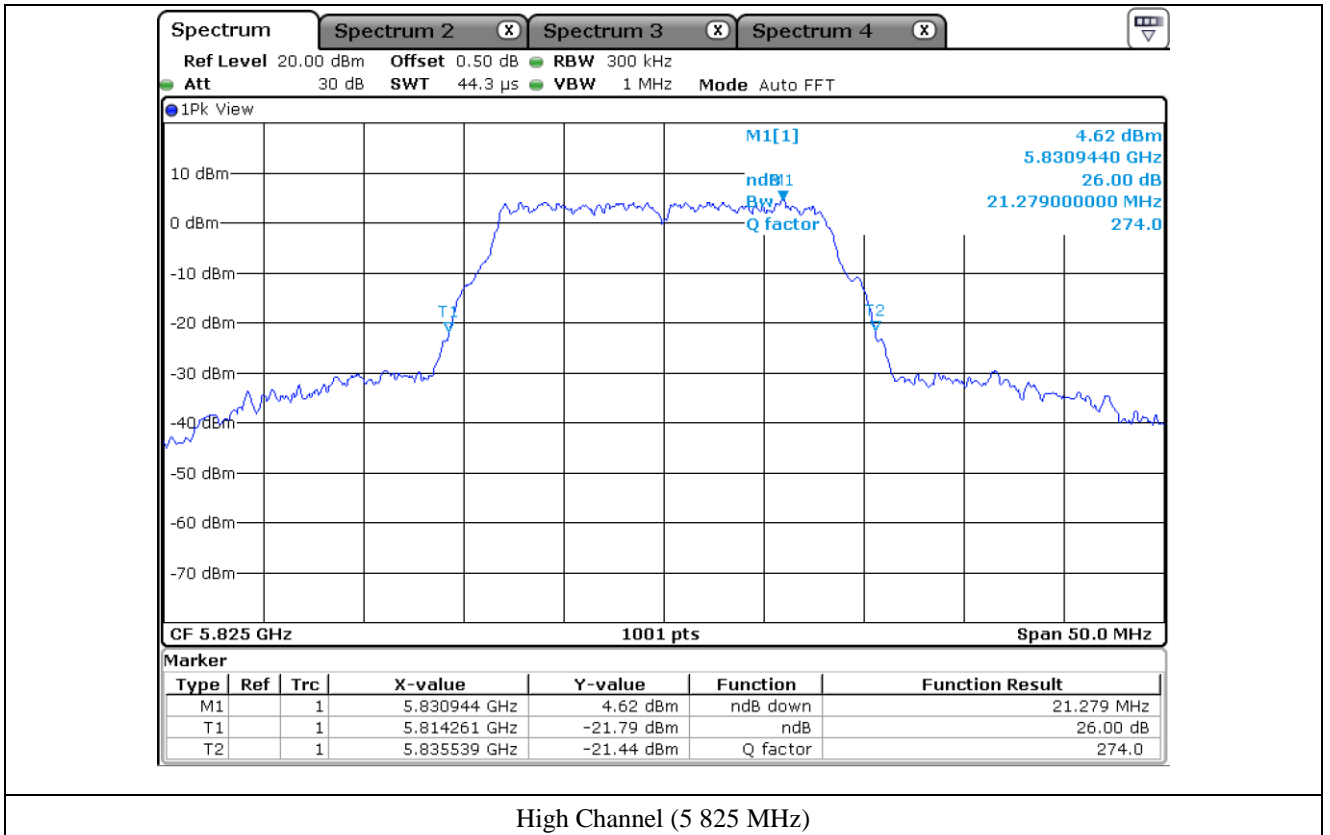
Low Channel (5 180 MHz)



Middle Channel (5 220 MHz)







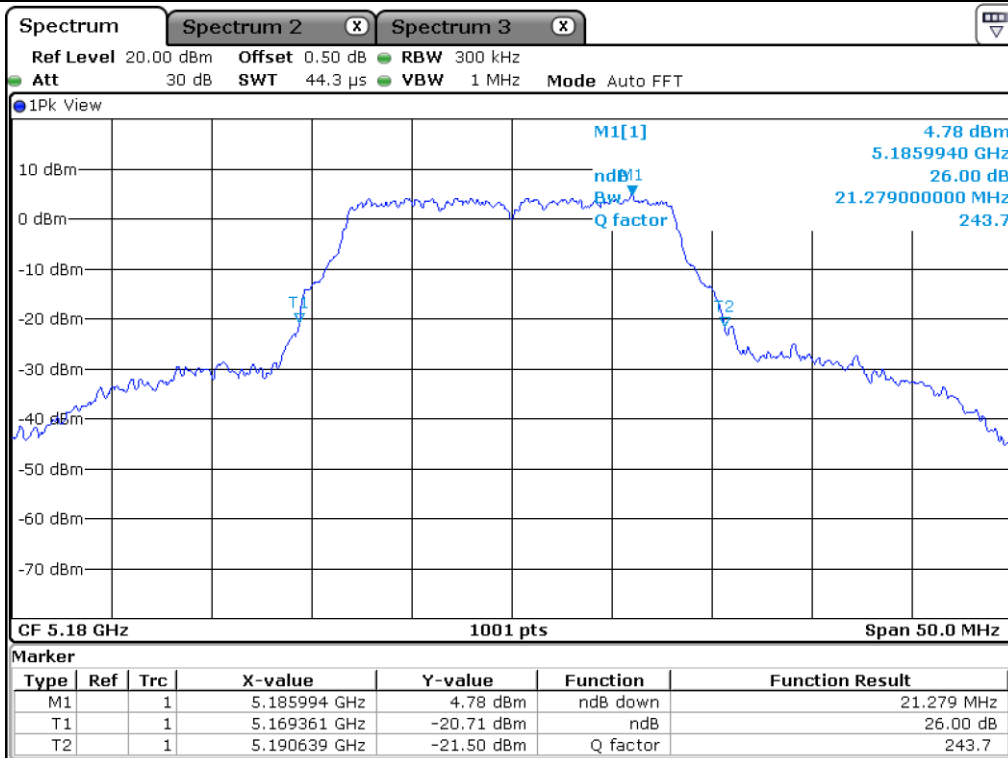
7.4.2 Test data for Antenna 1

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

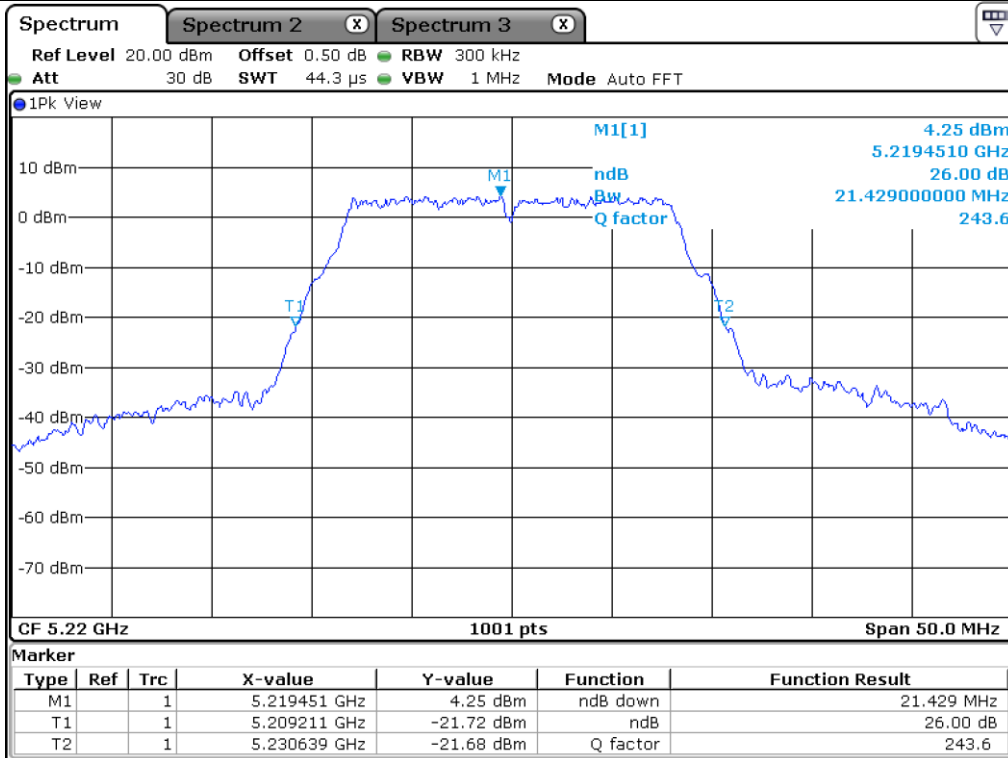
FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	26 dB Bandwidth (MHz)
5 150 ~ 5 250	Low	5 180.00	21.28
	Middle	5 220.00	21.43
	High	5 240.00	21.38
5 725 ~ 5 850	Low	5 745.00	21.68
	Middle	5 785.00	21.73
	High	5 825.00	21.18



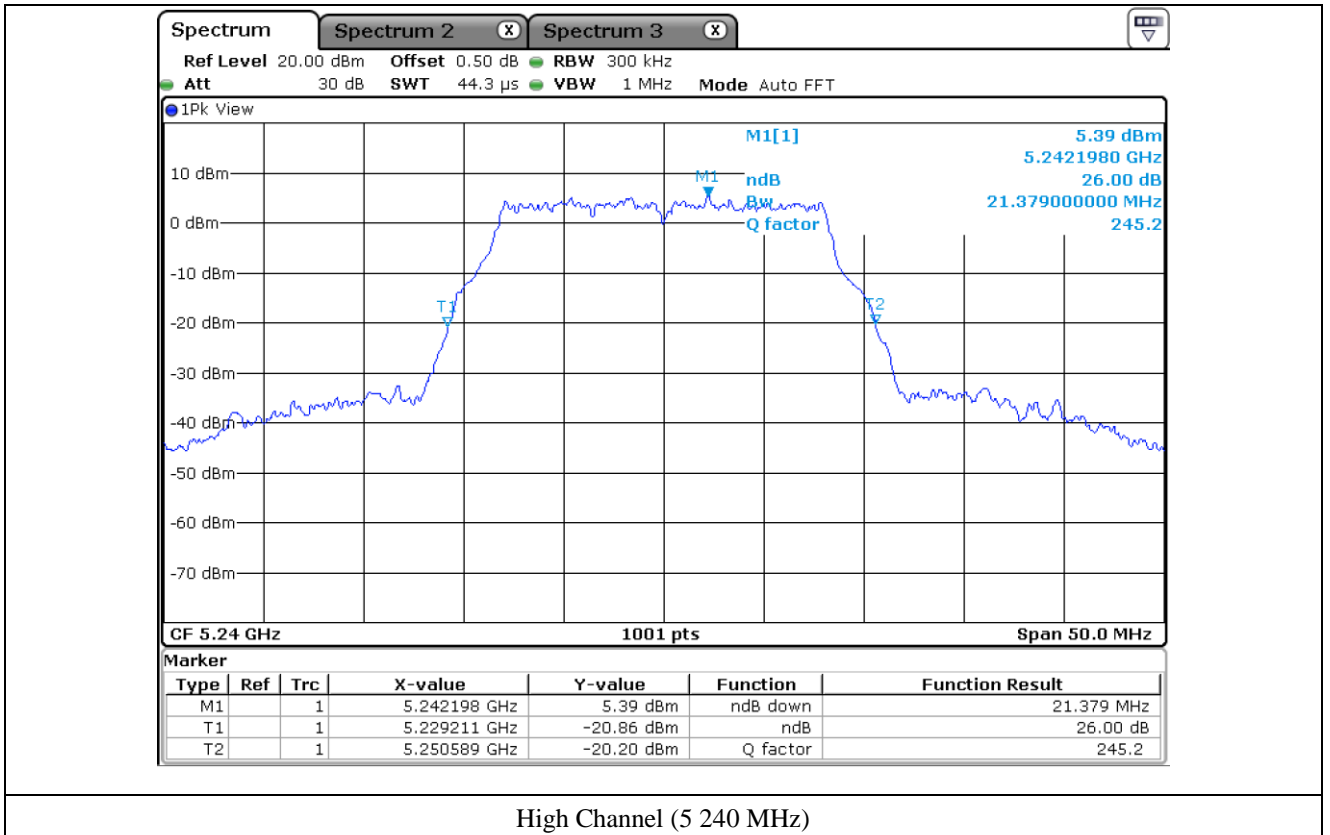
Tested by: Tae-Ho, Kim / Senior Manager

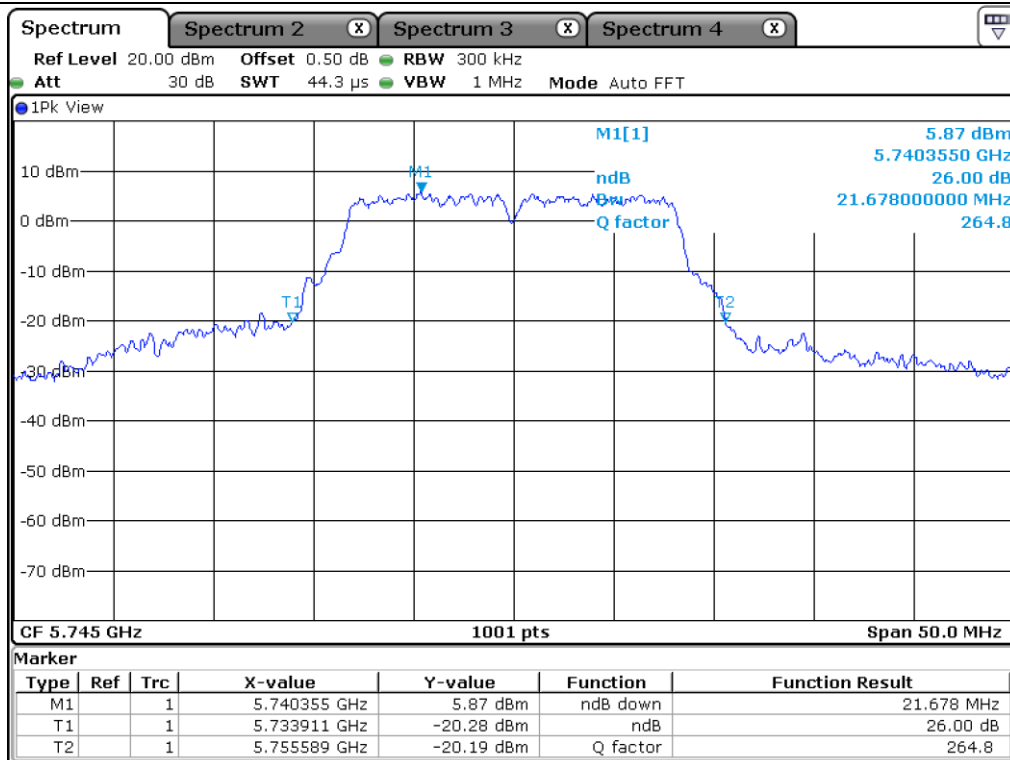


Low Channel (5 180 MHz)

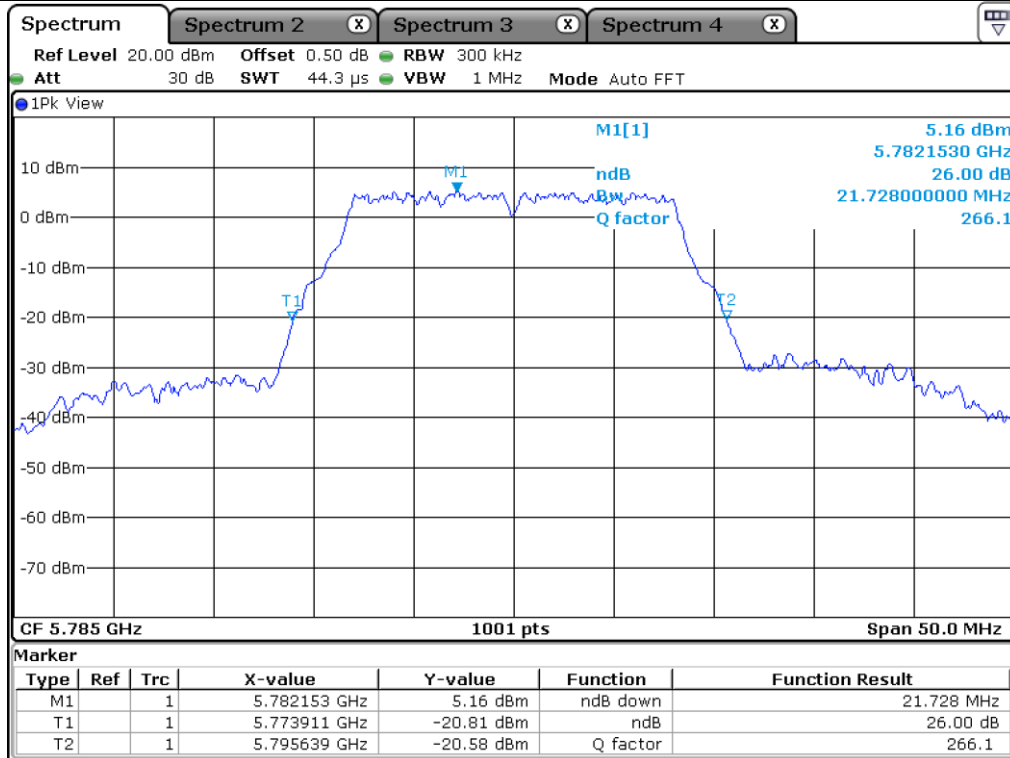


Middle Channel (5 220 MHz)

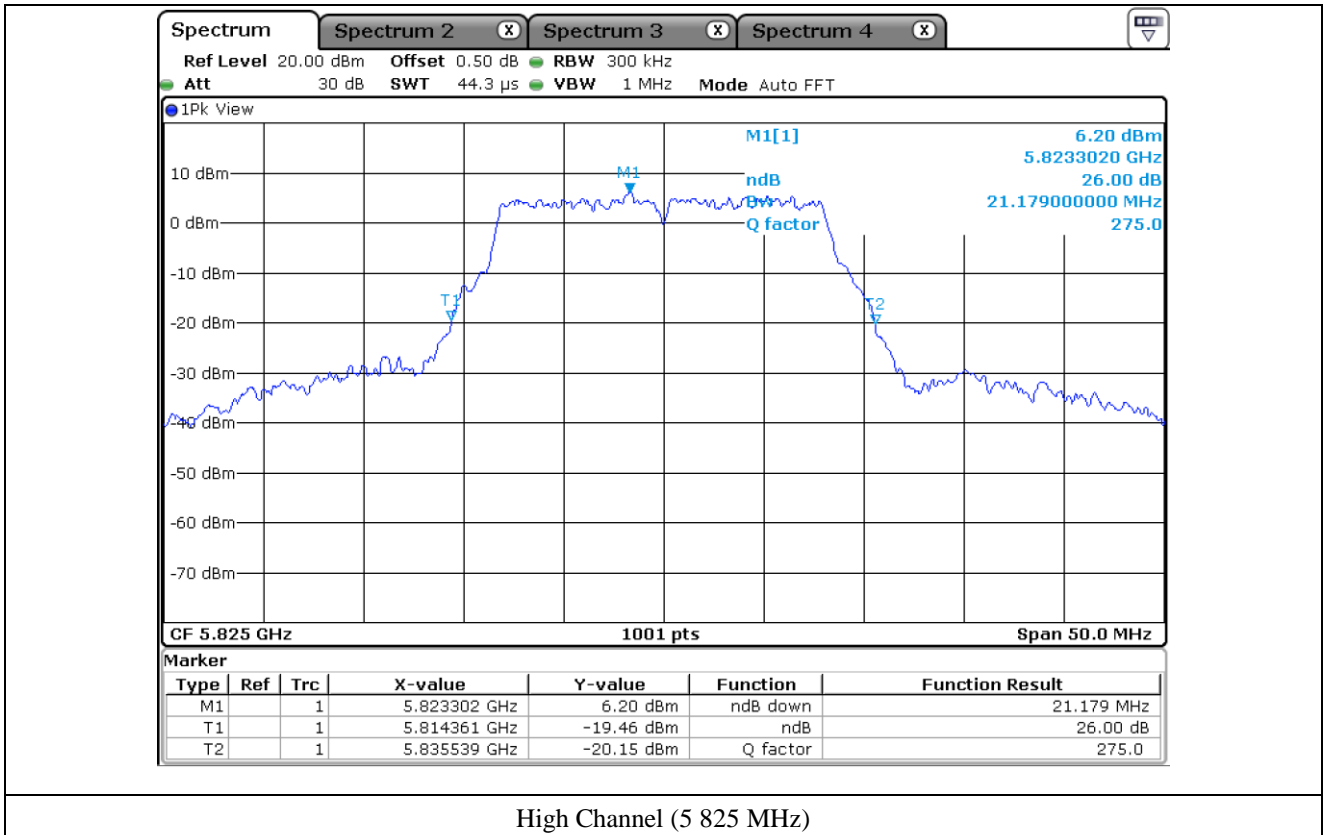




Low Channel (5 745 MHz)



Middle Channel (5 785 MHz)



7.5 Test data for 802.11n_HT20 RLAN Mode

7.5.1 Test data for Antenna 0

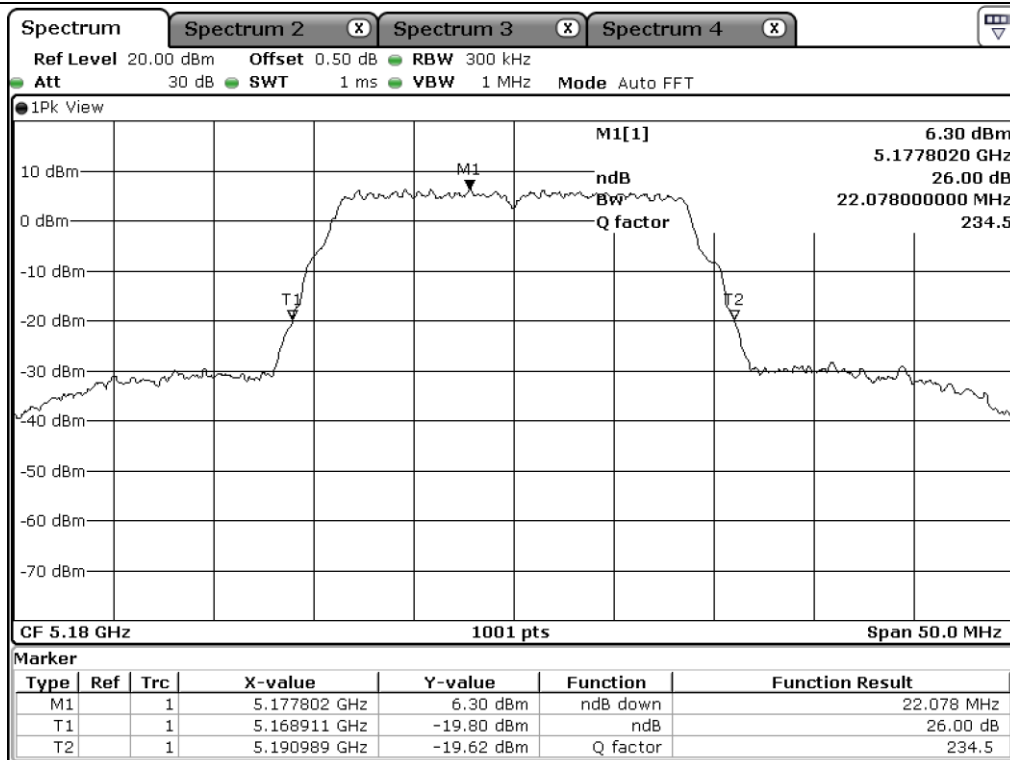
-. Test Date : August 16, 2018 ~ August 28, 2018

-. Test Result : Pass

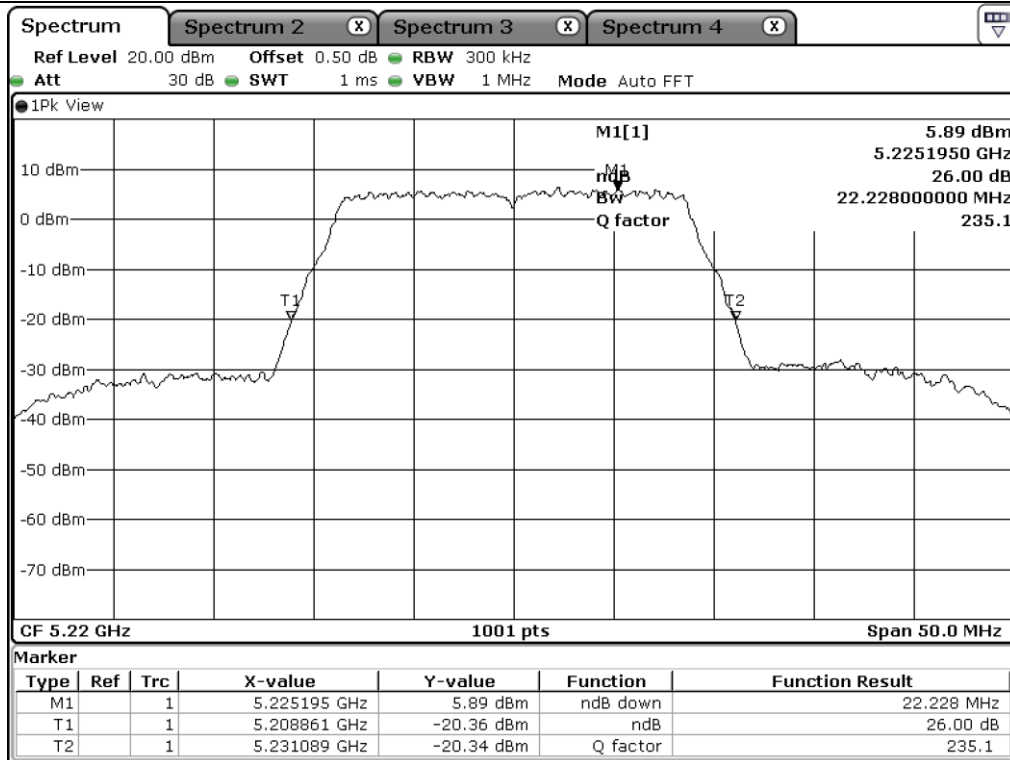
FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	26 dB Bandwidth (MHz)
5 150 ~ 5 250	Low	5 180.00	22.08
	Middle	5 220.00	22.23
	High	5 240.00	22.18
5 725 ~ 5 850	Low	5 745.00	21.48
	Middle	5 785.00	21.58
	High	5 825.00	21.28



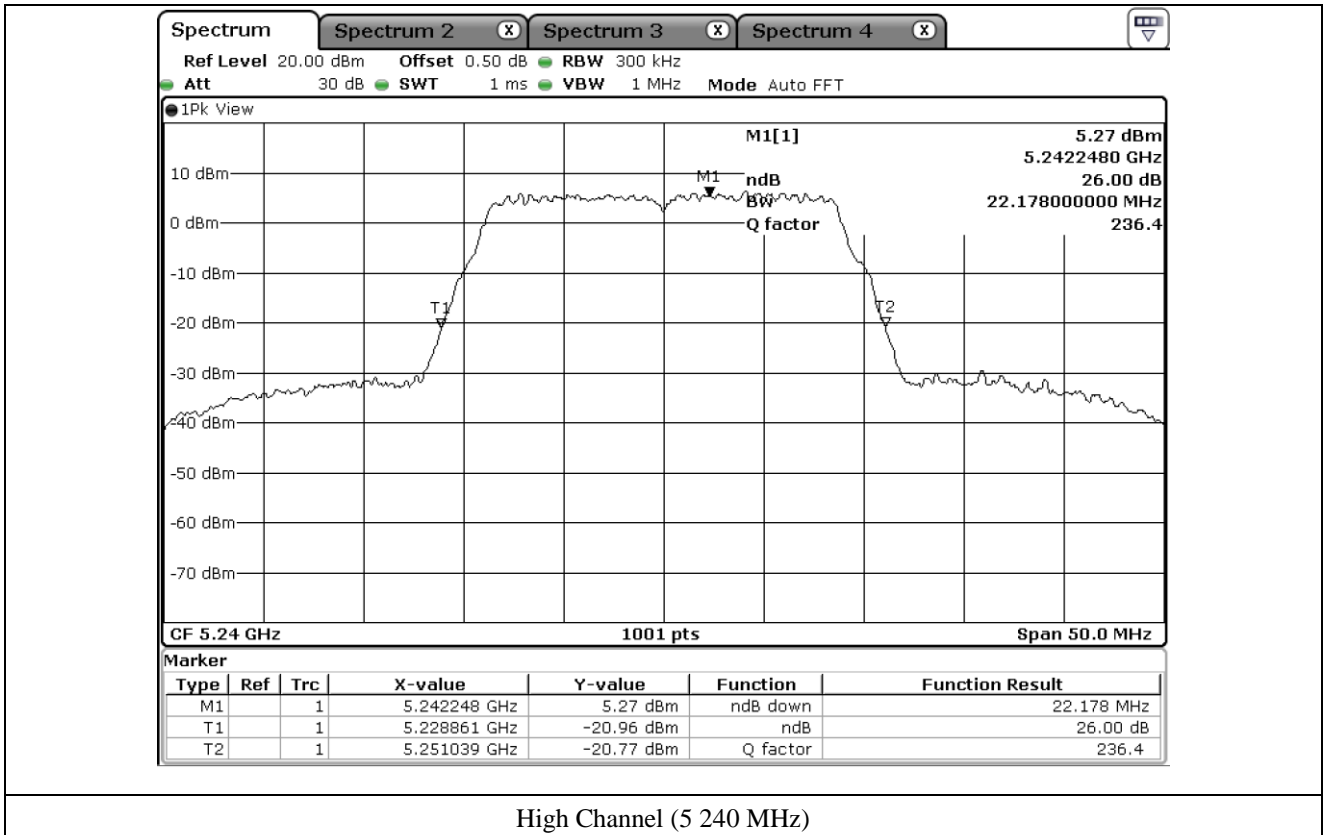
Tested by: **Tae-Ho, Kim / Senior Manager**

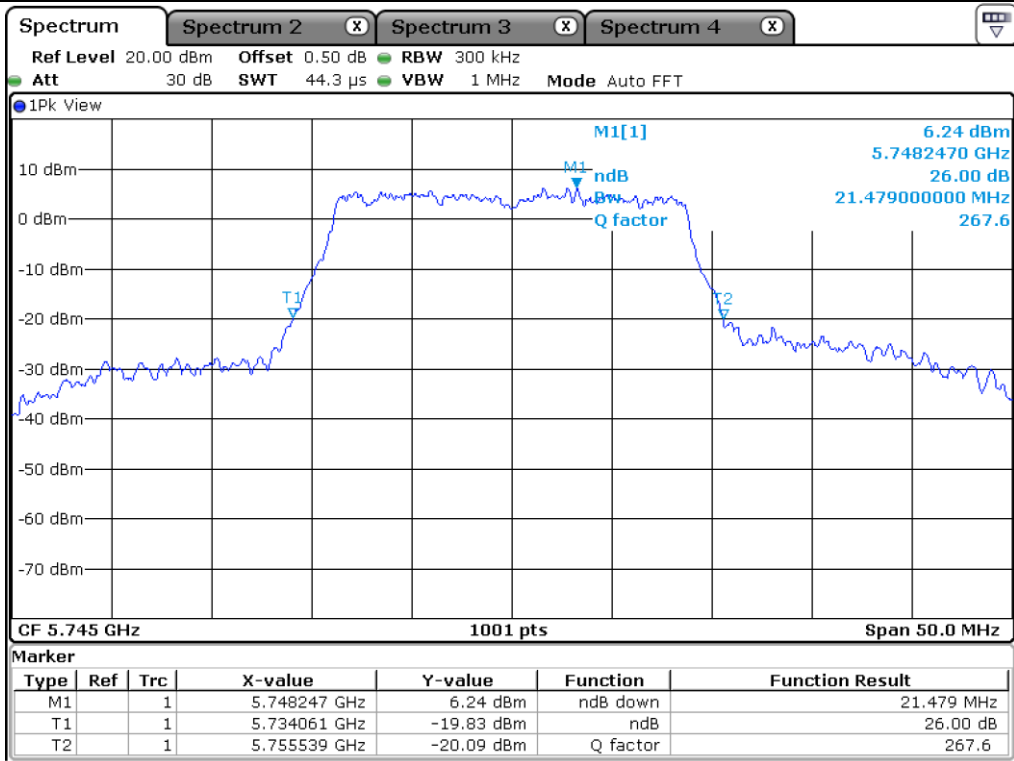


Low Channel (5 180 MHz)

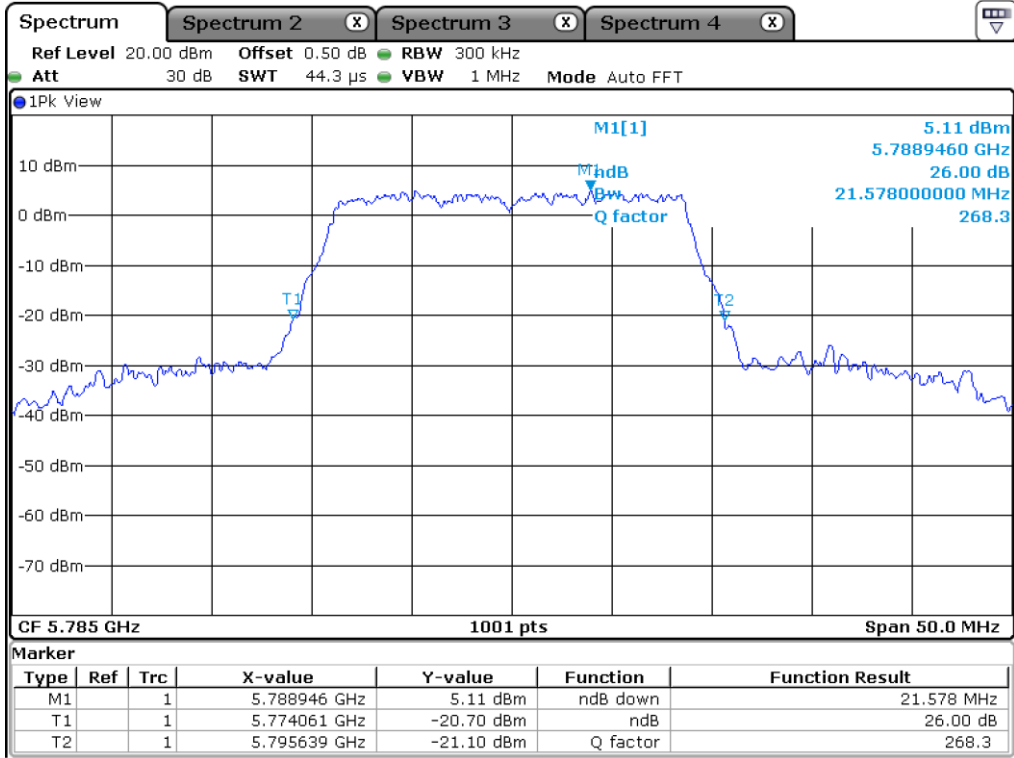


Middle Channel (5 220 MHz)

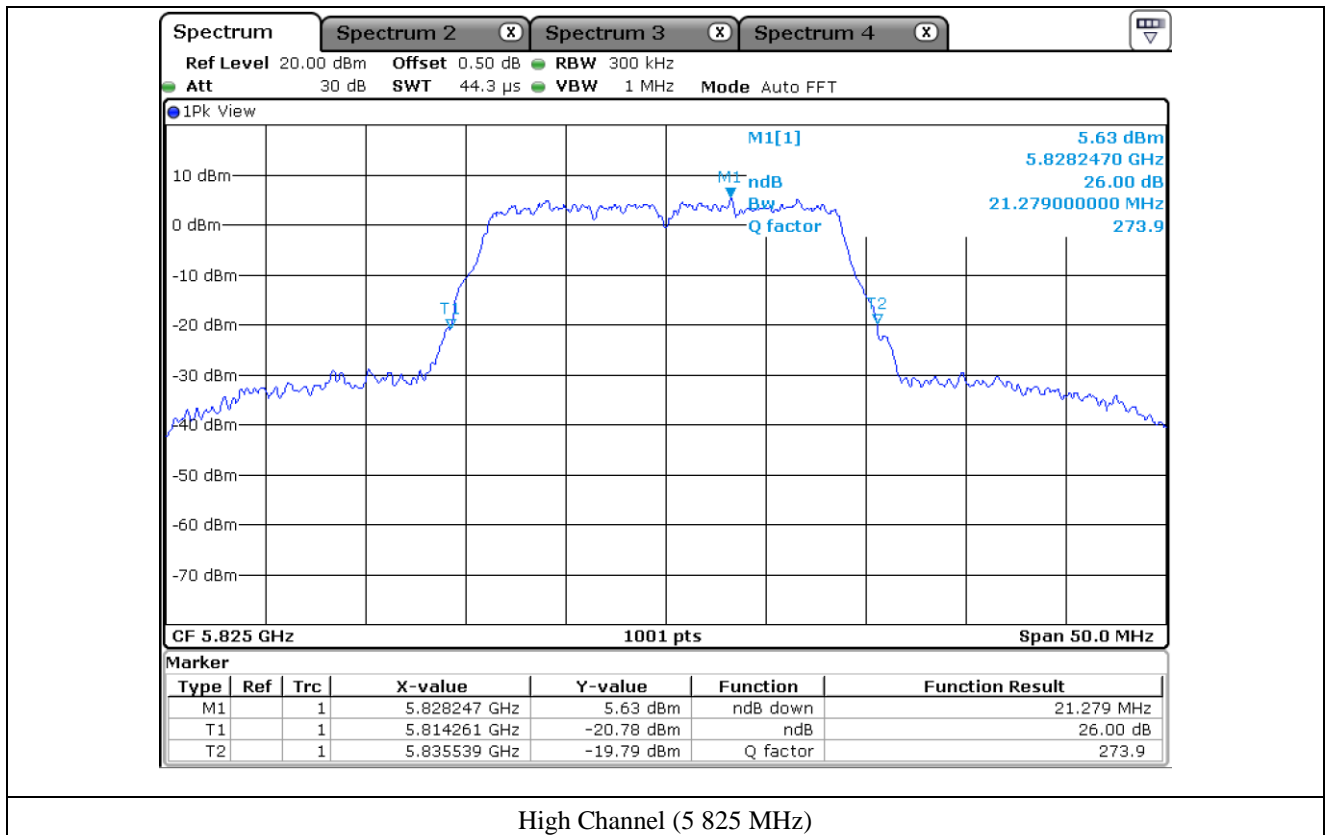




Low Channel (5 745 MHz)



Middle Channel (5 785 MHz)



High Channel (5 825 MHz)

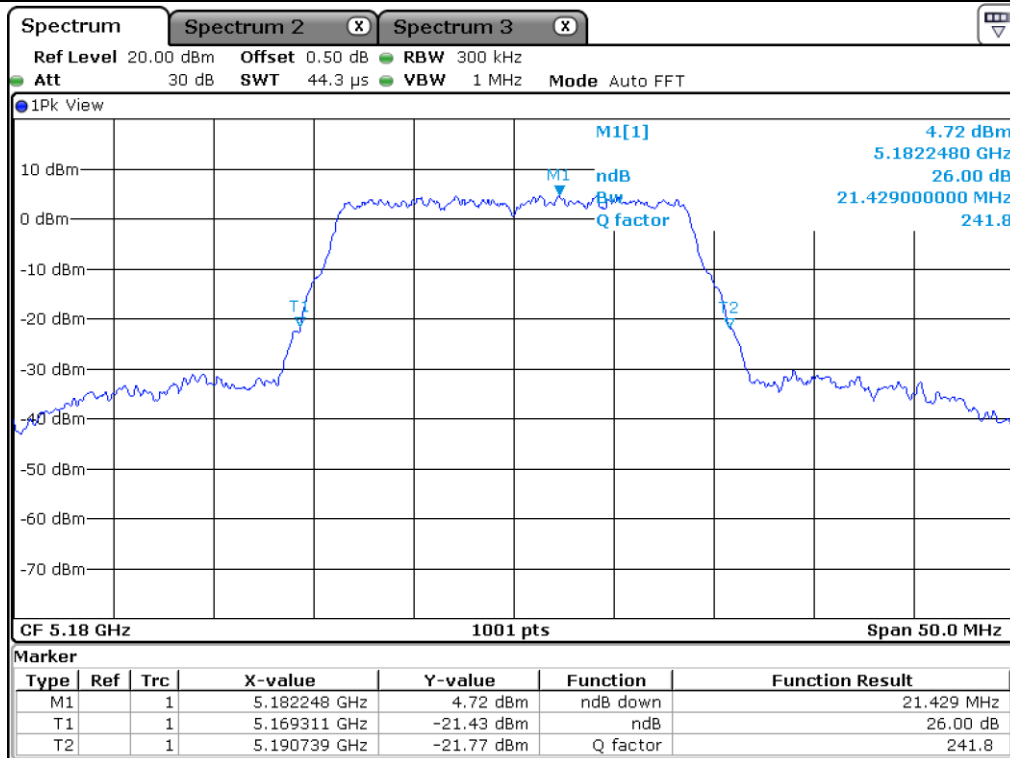
7.5.2 Test data for Antenna 1

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

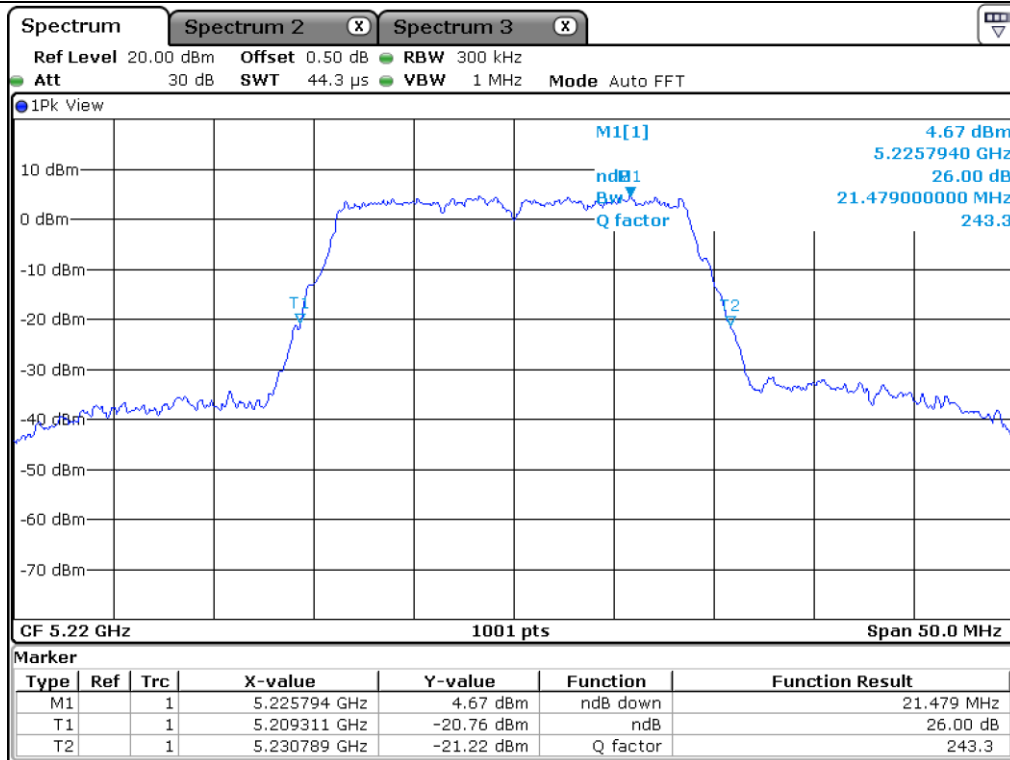
FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	26 dB Bandwidth (MHz)
5 150 ~ 5 250	Low	5 180.00	21.43
	Middle	5 220.00	21.48
	High	5 240.00	21.33
5 725 ~ 5 850	Low	5 745.00	21.43
	Middle	5 785.00	21.48
	High	5 825.00	21.43



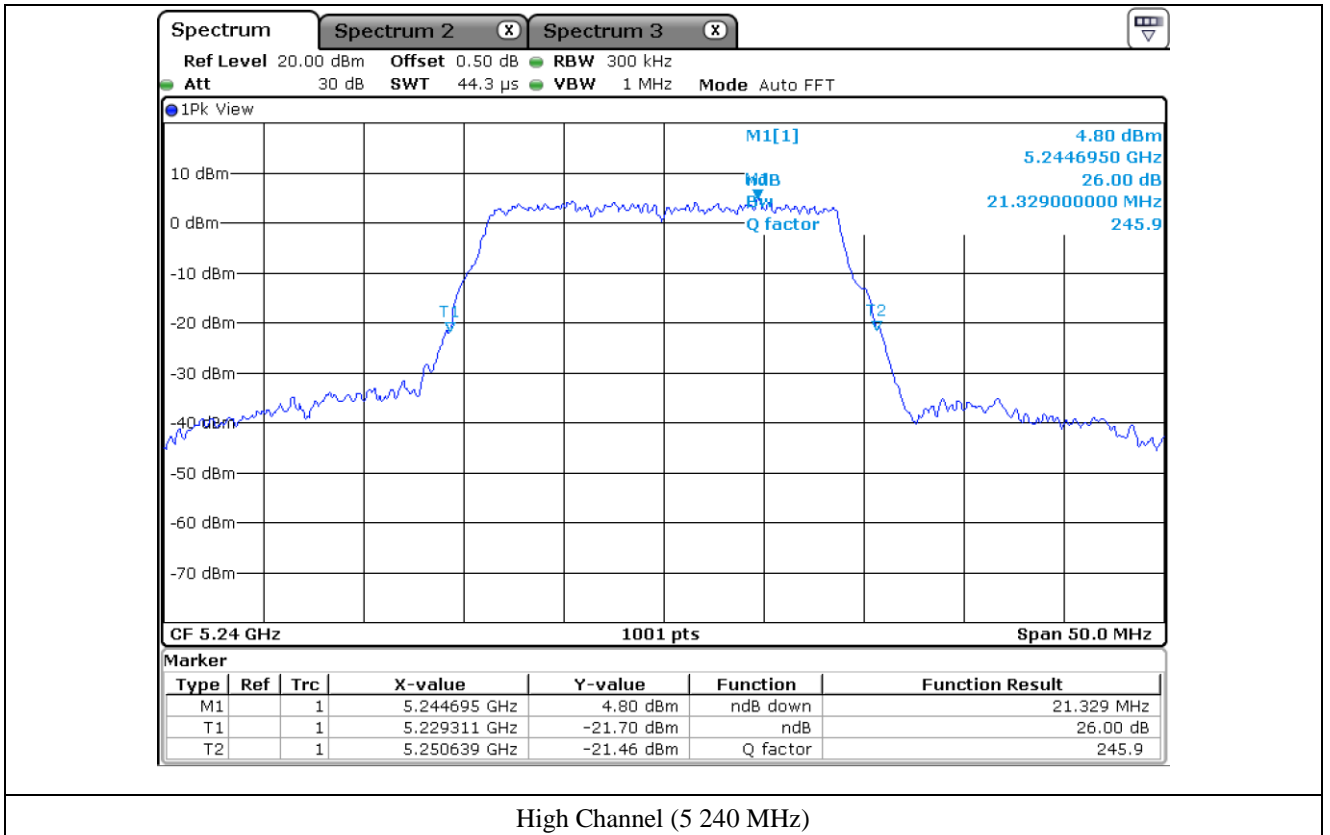
Tested by: Tae-Ho, Kim / Senior Manager

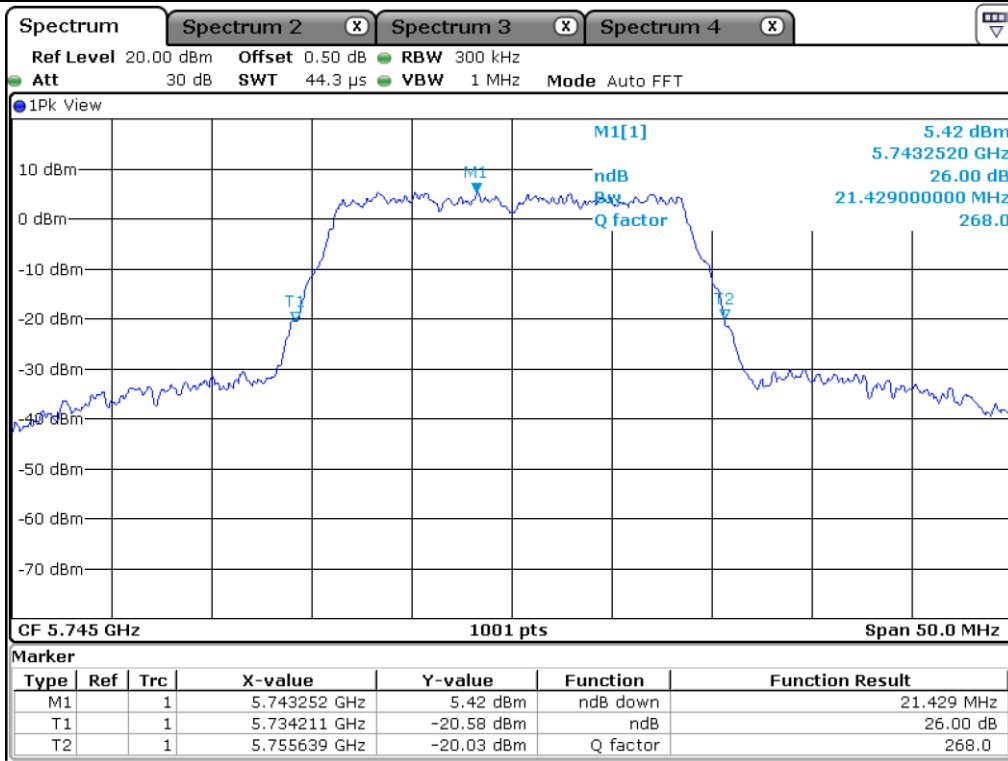


Low Channel (5 180 MHz)

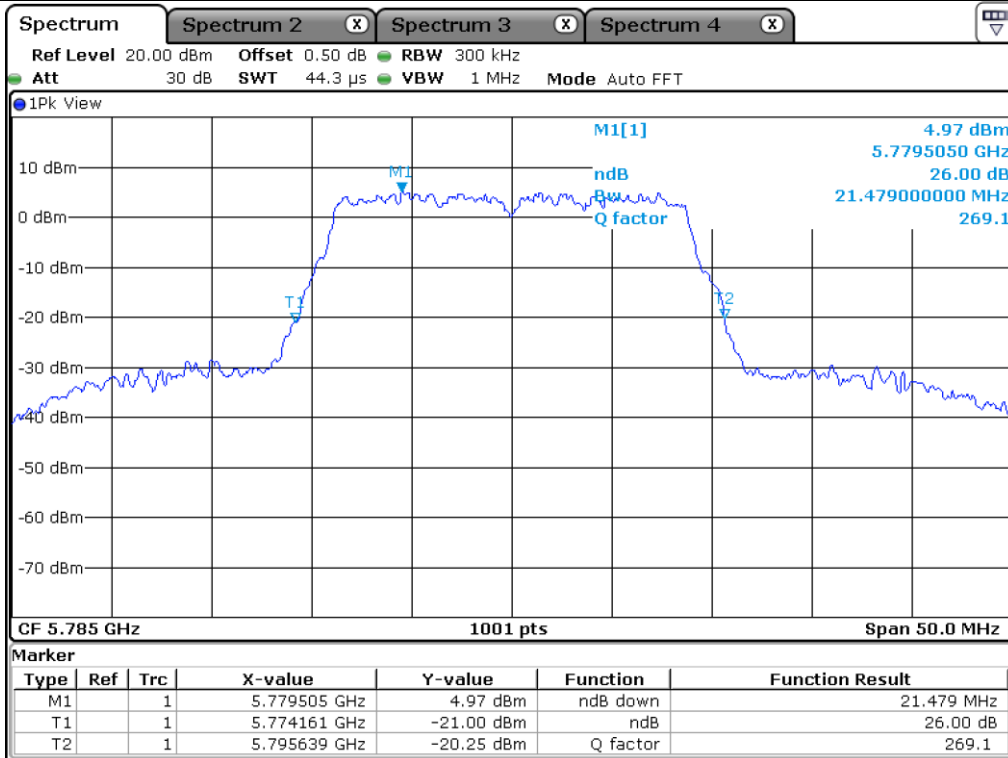


Middle Channel (5 220 MHz)

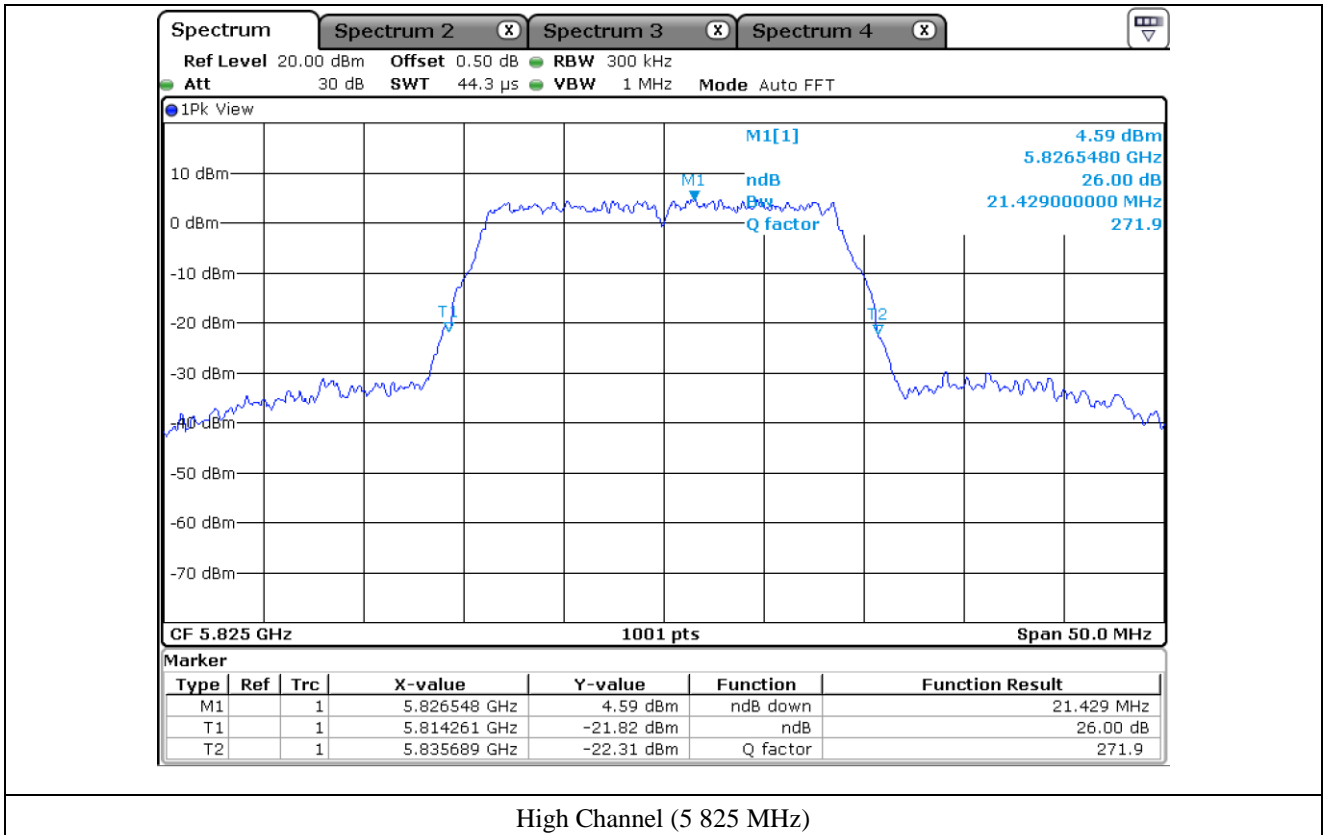




Low Channel (5 745 MHz)



Middle Channel (5 785 MHz)



High Channel (5 825 MHz)

7.6 Test data for 802.11n_HT40 RLAN Mode

7.6.1 Test data for Antenna 0

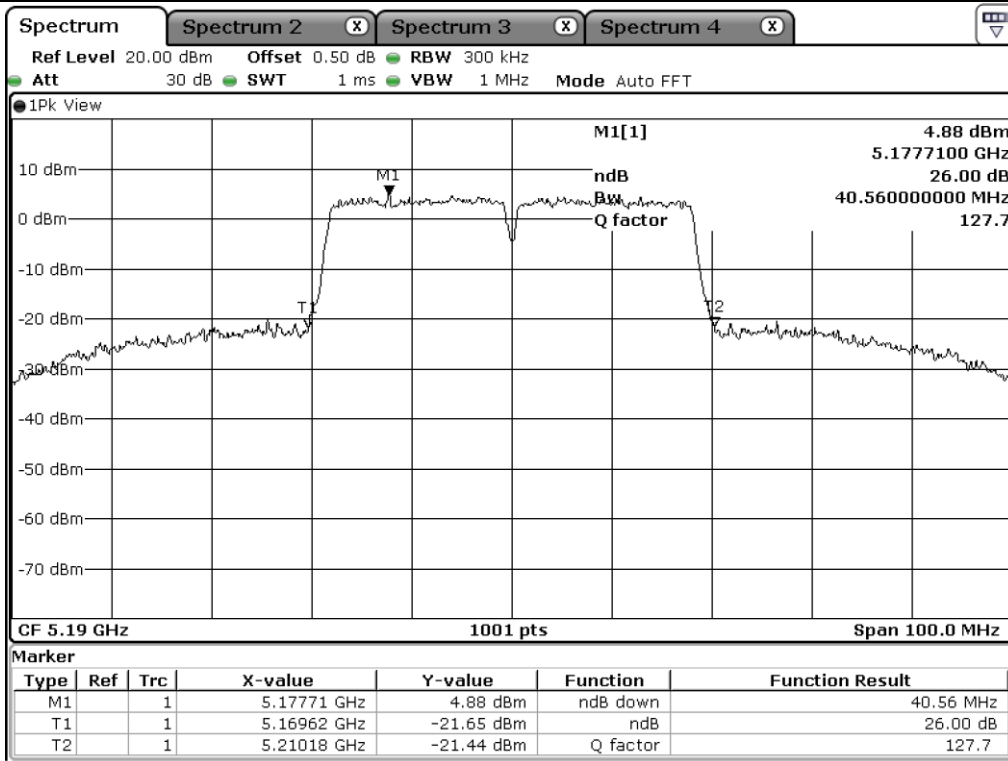
-. Test Date : August 16, 2018 ~ August 28, 2018

-. Test Result : Pass

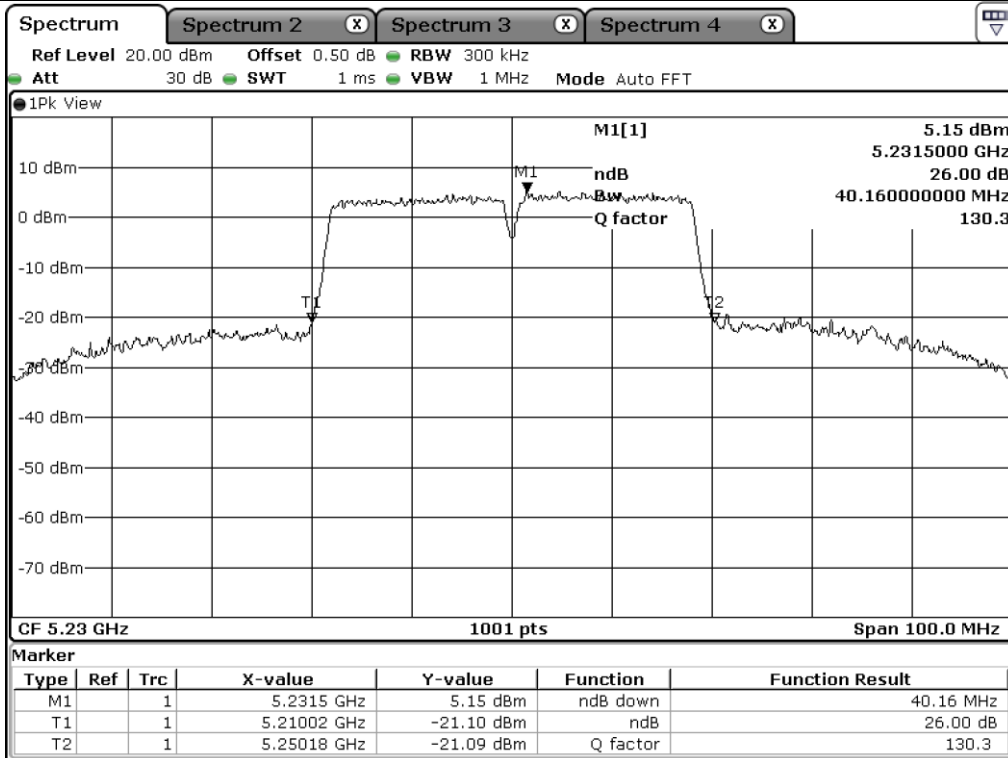
FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	26 dB Bandwidth (MHz)
5 150 ~ 5 250	Low	5 190.00	40.56
	High	5 230.00	40.16
5 725 ~ 5 850	Low	5 755.00	39.46
	High	5 795.00	39.86



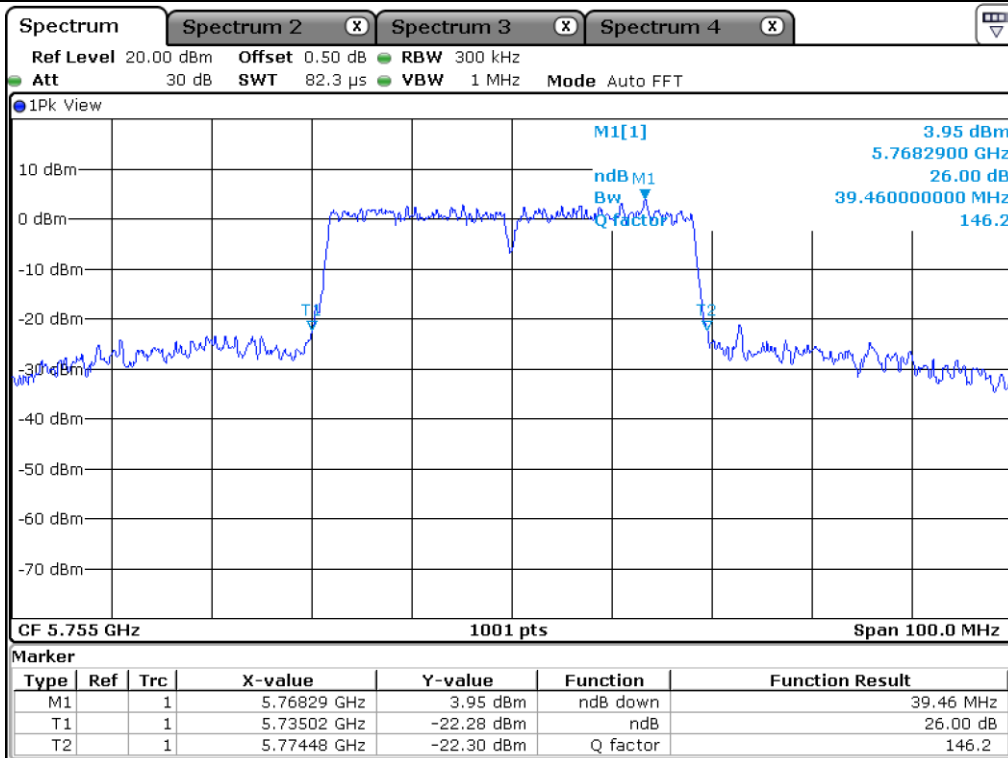
Tested by: **Tae-Ho, Kim / Senior Manager**



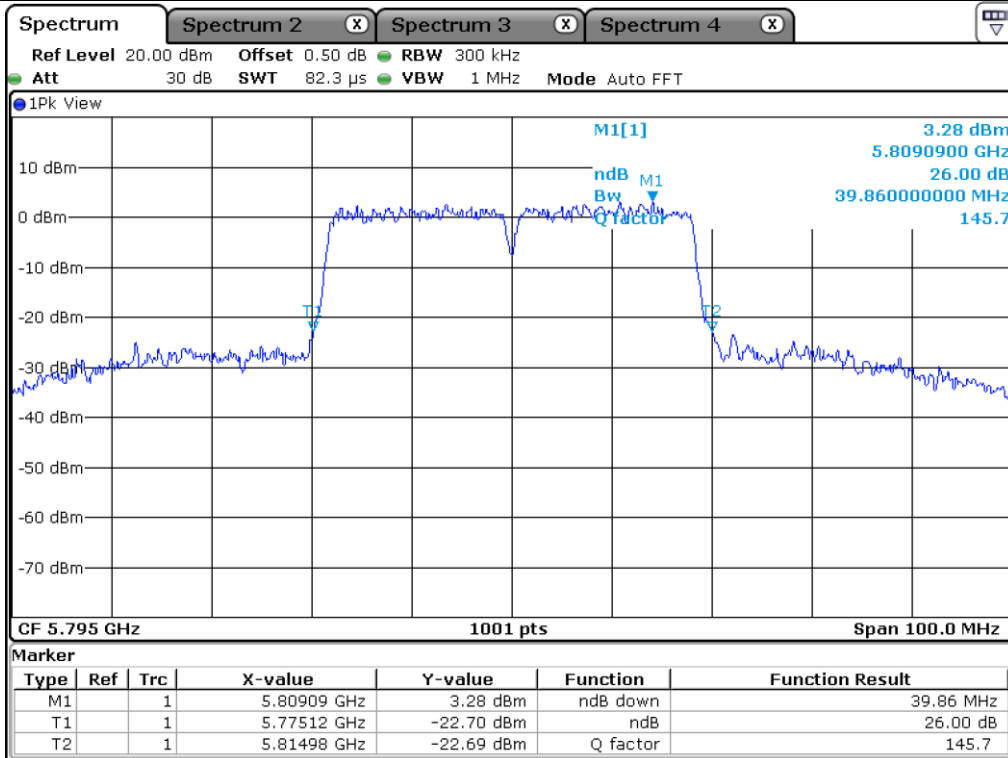
Low Channel (5 190 MHz)



High Channel (5 230 MHz)



Low Channel (5 755 MHz)



High Channel (5 795 MHz)

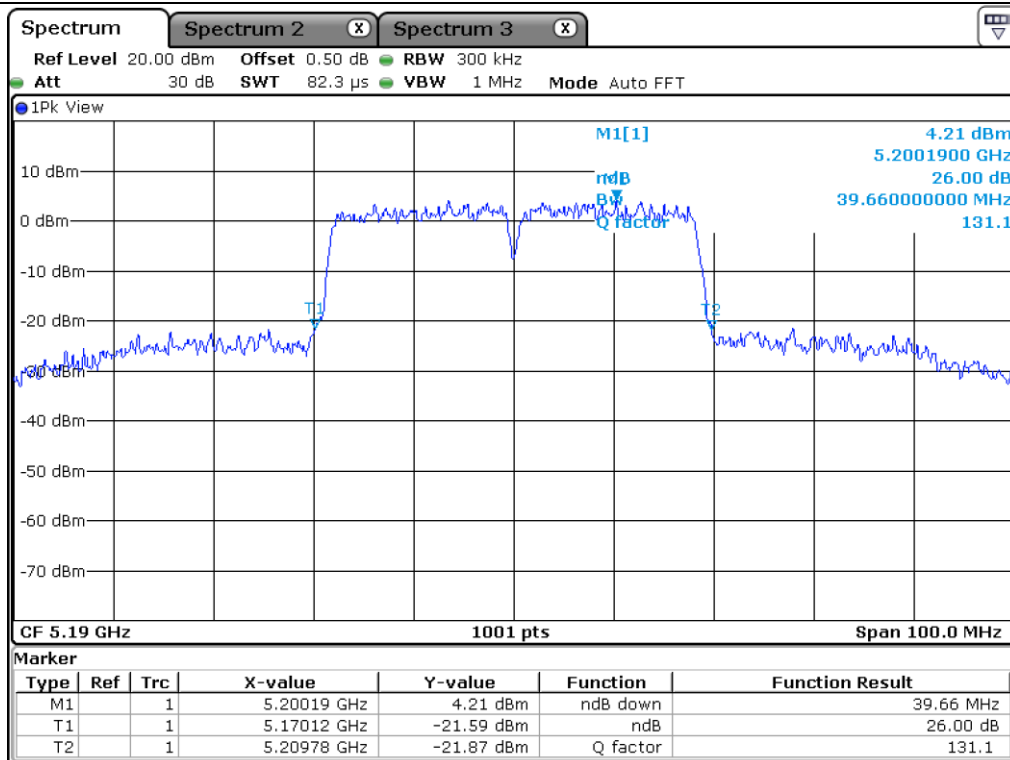
7.6.2 Test data for Antenna 1

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

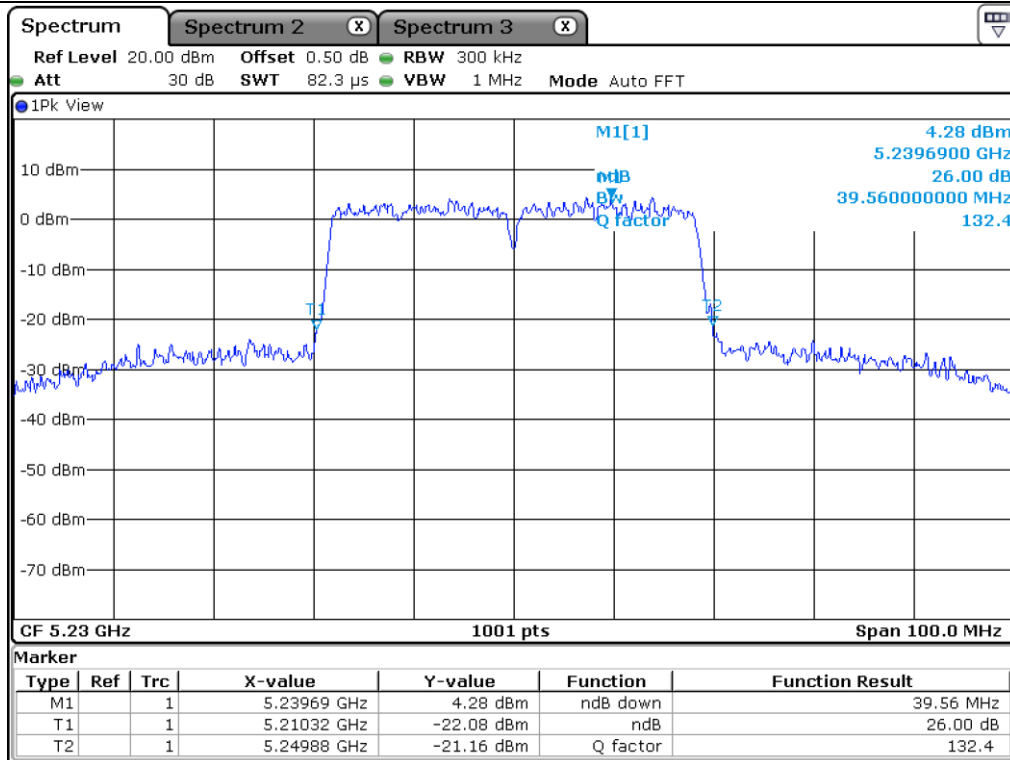
FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	26 dB Bandwidth (MHz)
5 150 ~ 5 250	Low	5 190.00	39.66
	High	5 230.00	39.56
5 725 ~ 5 850	Low	5 755.00	40.66
	High	5 795.00	39.76



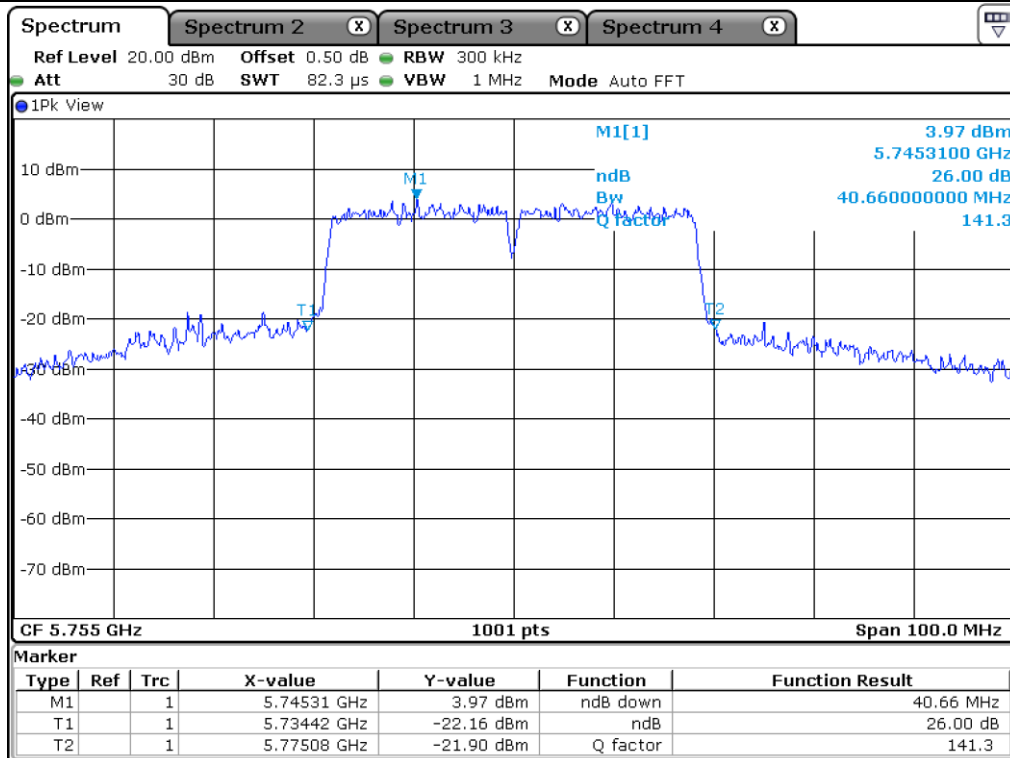
Tested by: Tae-Ho, Kim / Senior Manager



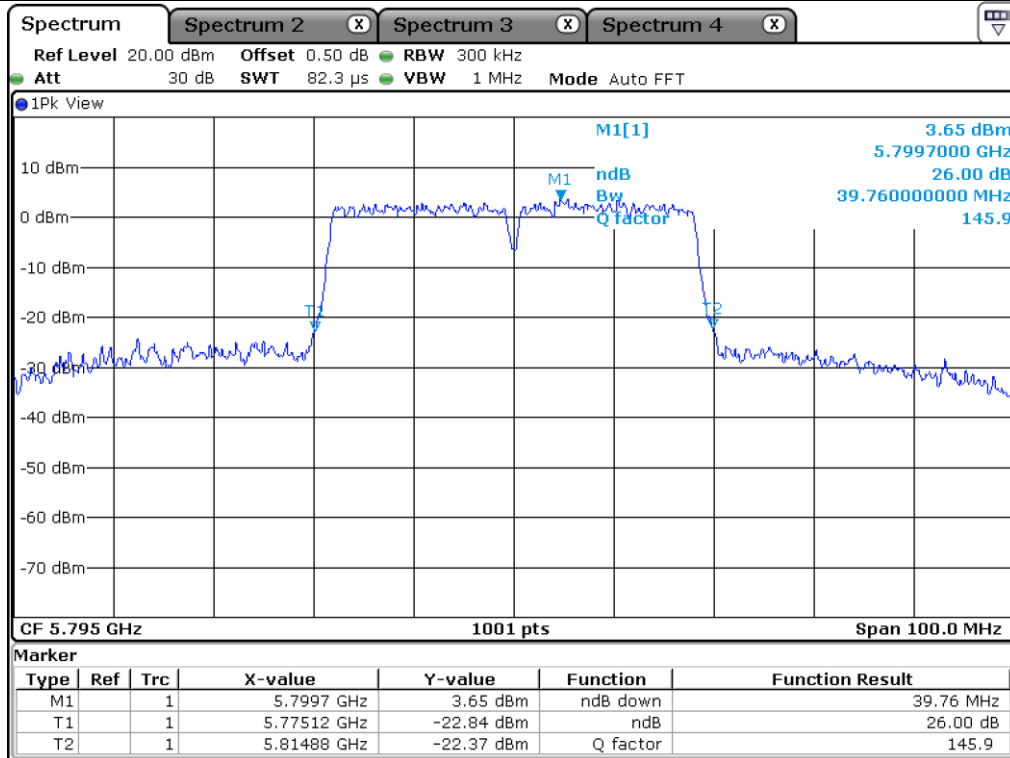
Low Channel (5 190 MHz)



High Channel (5 230 MHz)



Low Channel (5 755 MHz)



High Channel (5 795 MHz)

7.7 Test data for 802.11ac_VHT80 RLAN Mode

7.7.1 Test data for Antenna 0

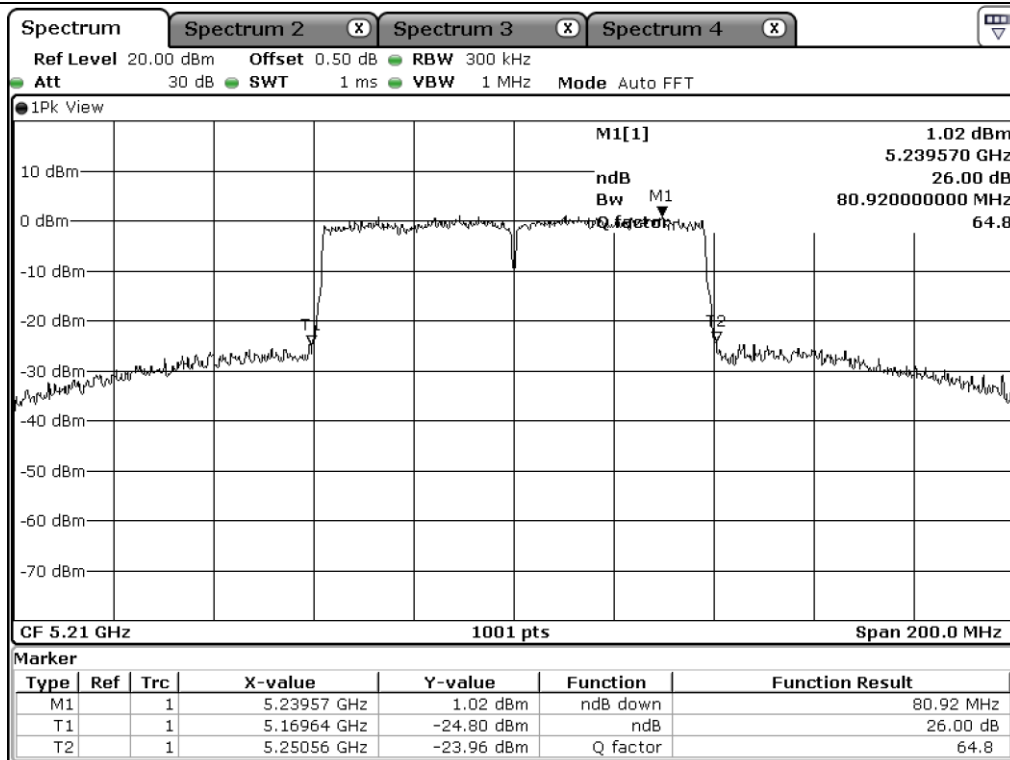
-. Test Date : August 16, 2018 ~ August 28, 2018

-. Test Result : Pass

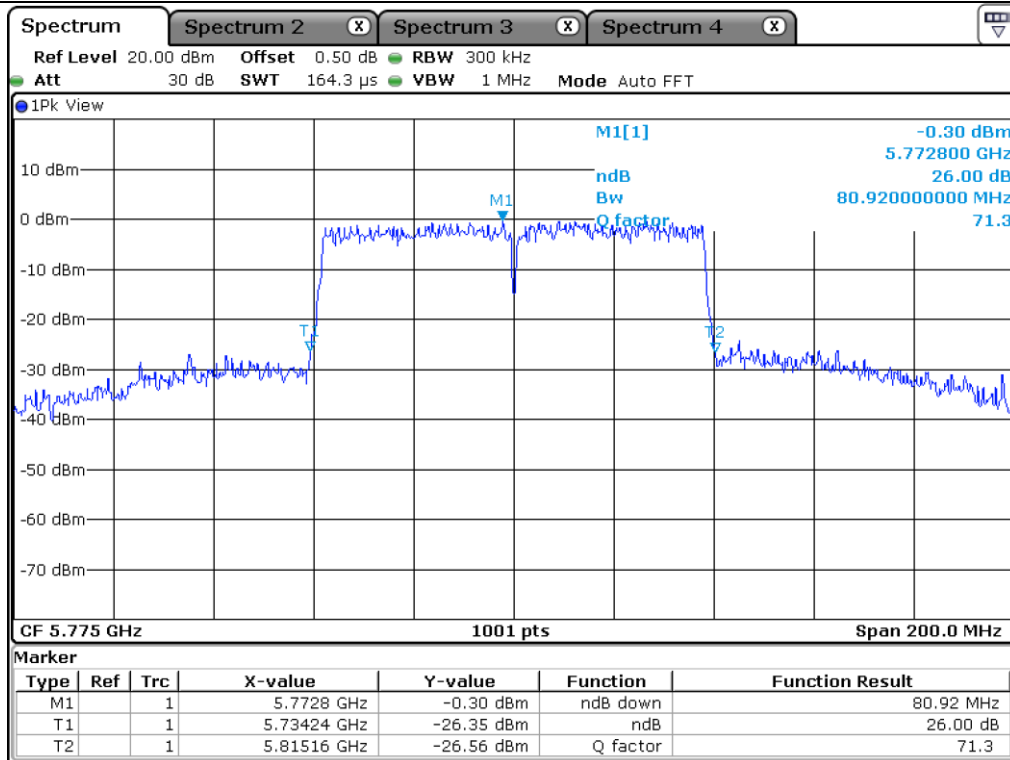
FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	26 dB Bandwidth (MHz)
5 150 ~ 5 250	Middle	5 210.00	80.92
5 725 ~ 5 850	Middle	5 775.00	80.92



Tested by: Tae-Ho, Kim / Senior Manager



Middle Channel (5 210 MHz)



Middle Channel (5 775 MHz)

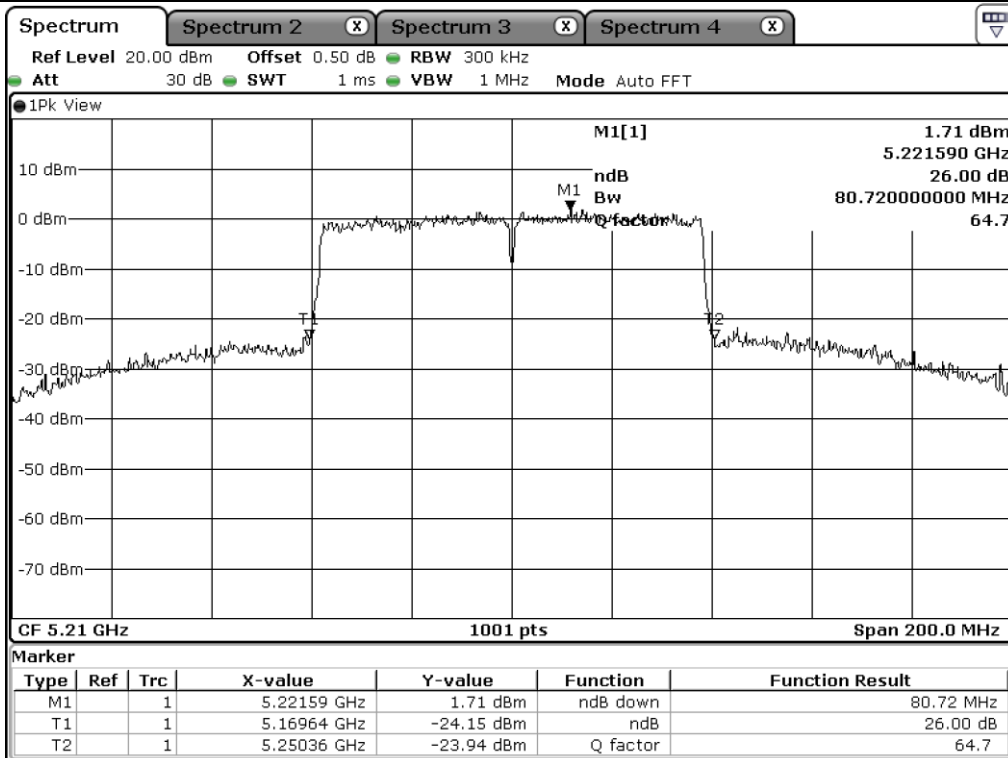
7.7.2 Test data for Antenna 1

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

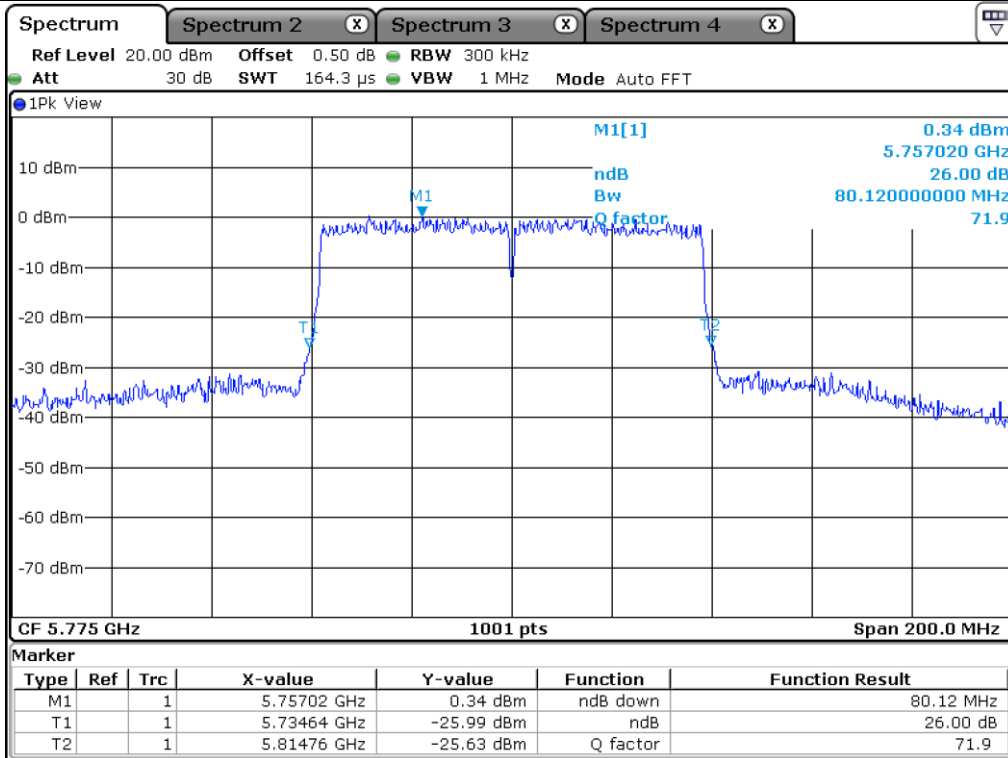
FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	26 dB Bandwidth (MHz)
5 150 ~ 5 250	Middle	5 210.00	80.72
5 725 ~ 5 850	Middle	5 775.00	80.12



Tested by: **Tae-Ho, Kim / Senior Manager**



Middle Channel (5 210 MHz)



Middle Channel (5 775 MHz)

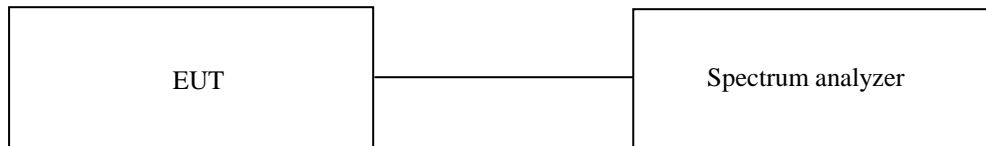
8. 6 dB BANDWIDTH

8.1 Operating environment

Temperature : 24.3 °C
 Relative humidity : 43.9 % R.H.

8.2 Test set-up

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



8.3 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.

8.4 Test data for 802.11a RLAN Mode

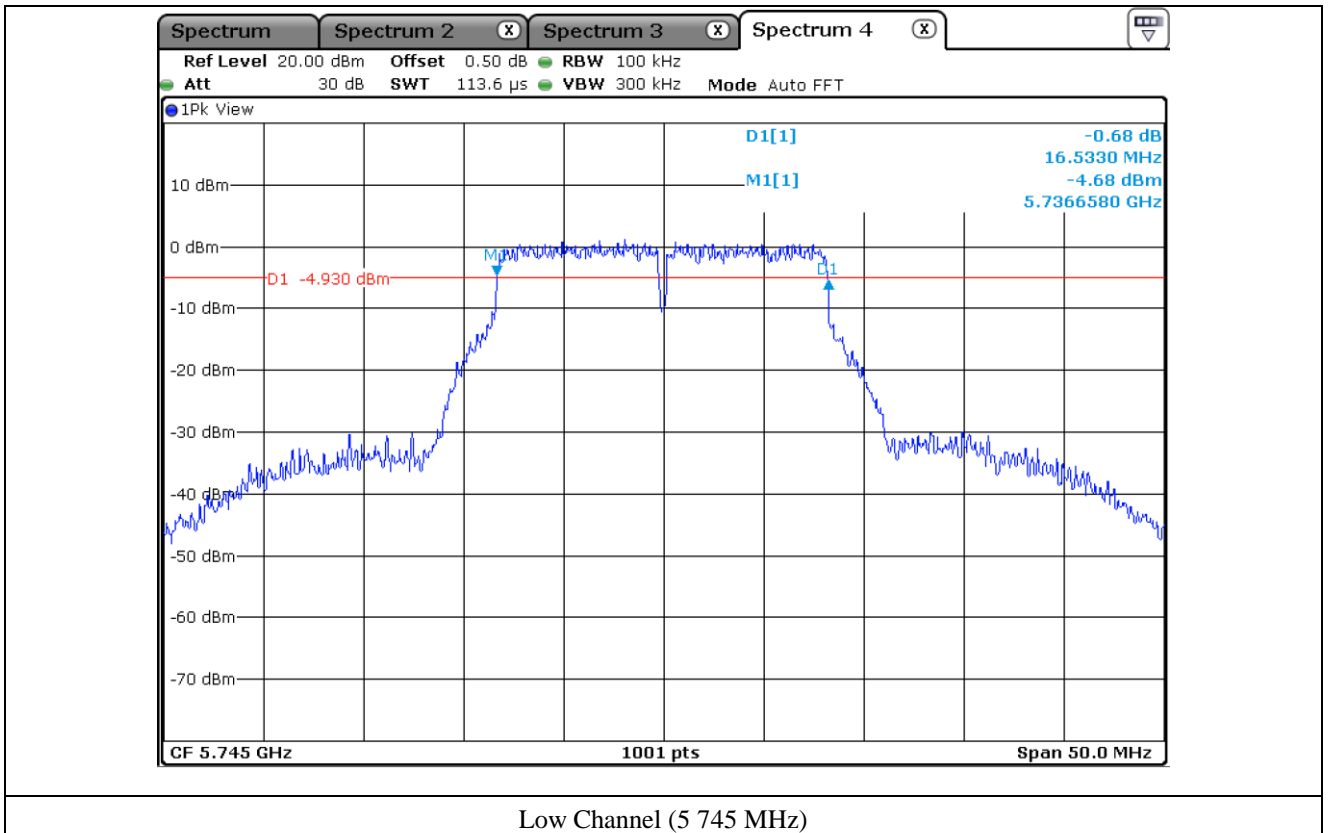
8.4.1 Test data for Antenna 0

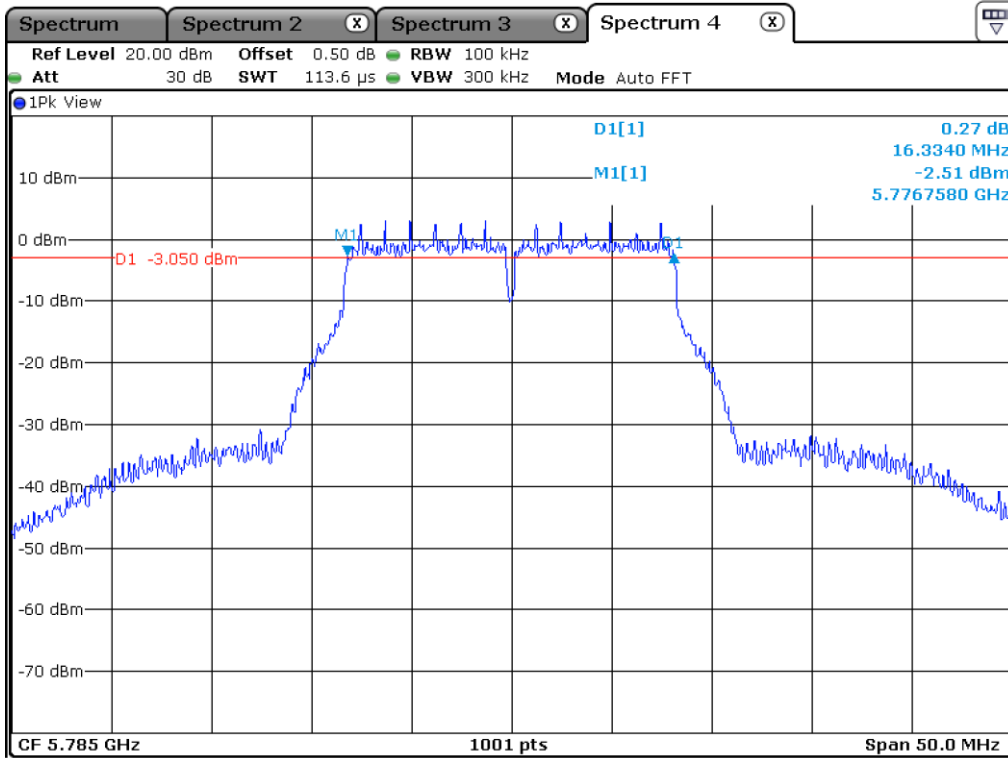
- Test Date : August 16, 2018 ~ August 28, 2018
- Test Result : Pass

FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)
5 725 ~ 5 850	Low	5 745.00	16.53
	Middle	5 785.00	16.33
	High	5 825.00	16.43

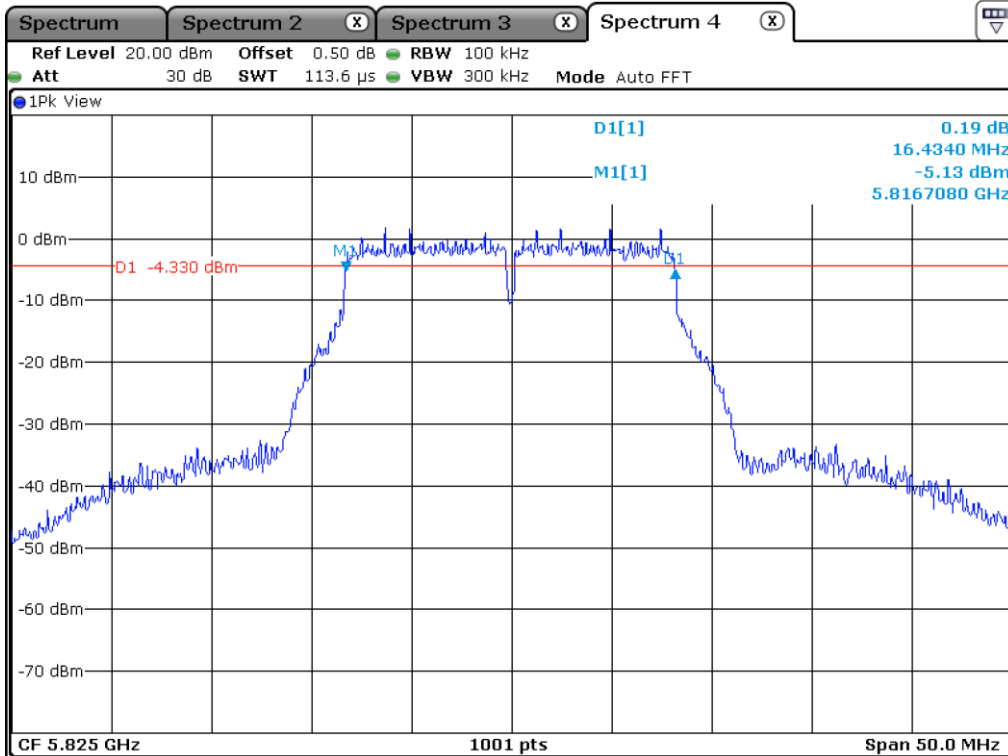


Tested by: Tae-Ho, Kim / Senior Manager





Middle Channel (5 785 MHz)



High Channel (5 825 MHz)

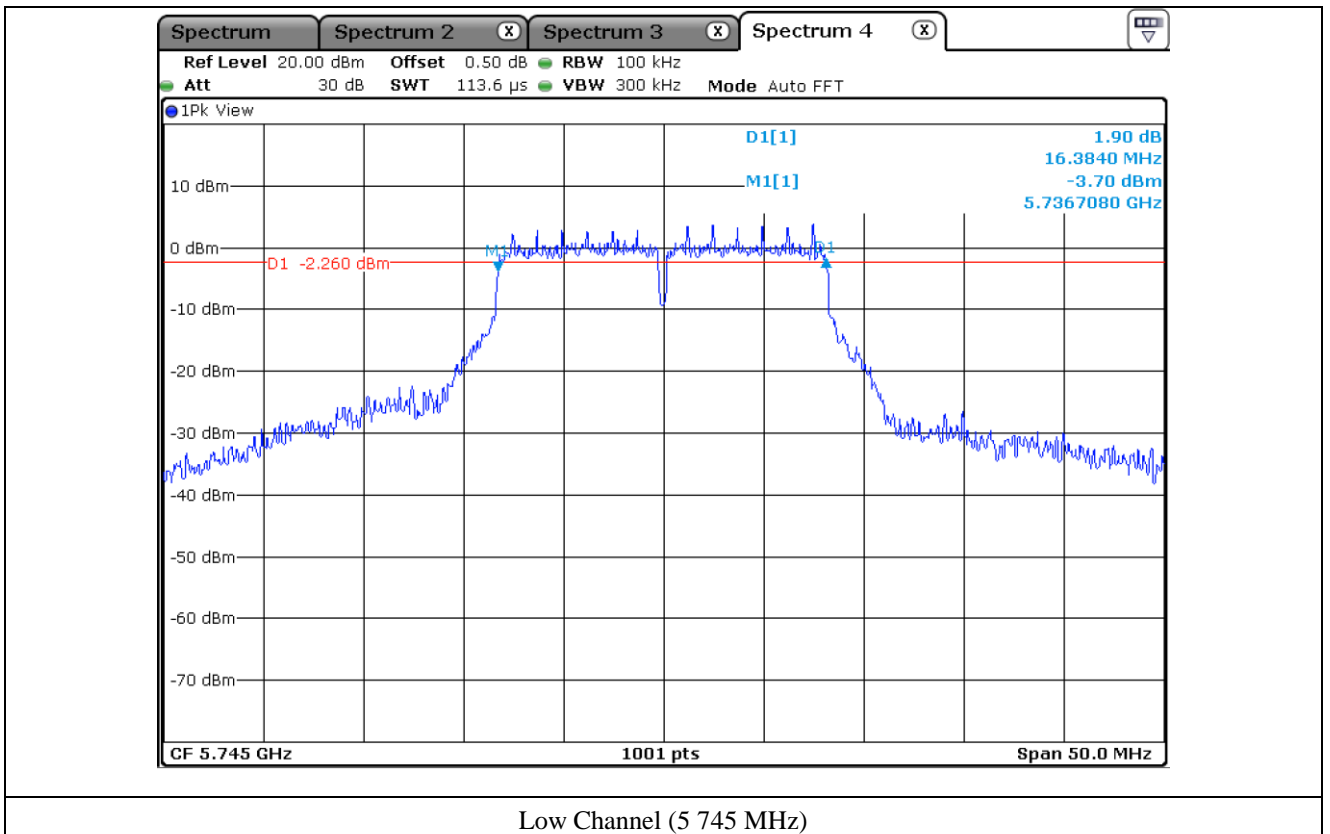
8.4.2 Test data for Antenna 1

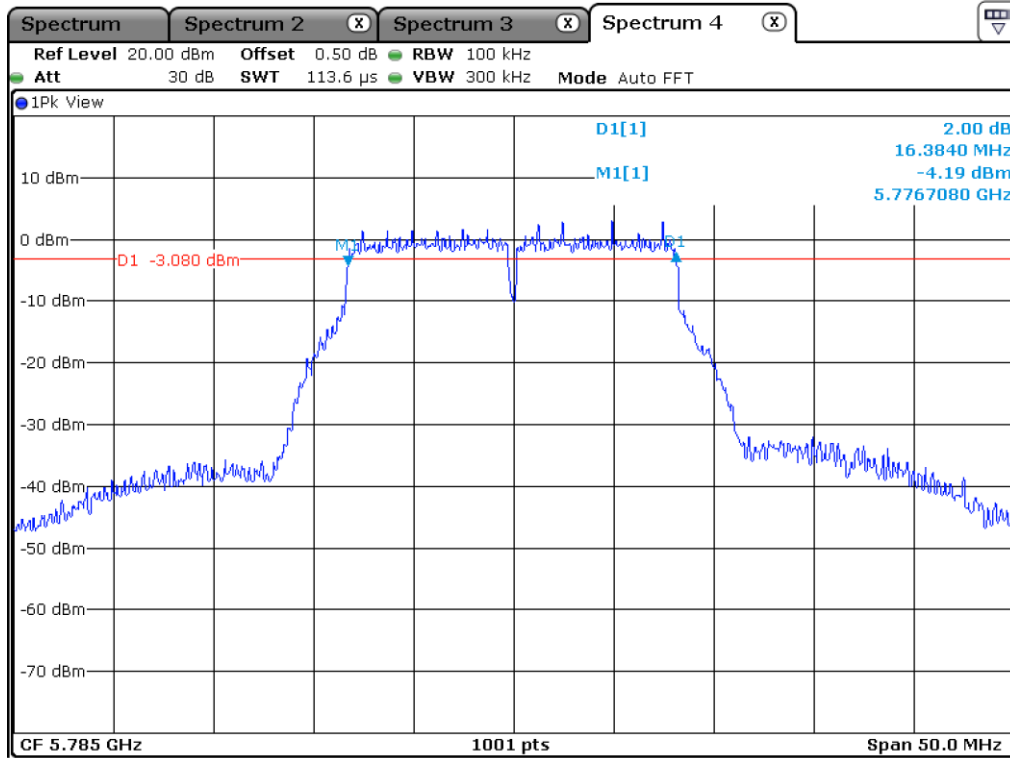
- Test Date : August 16, 2018 ~ August 28, 2018
- Test Result : Pass

FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)
5 725 ~ 5 850	Low	5 745.00	16.38
	Middle	5 785.00	16.38
	High	5 825.00	16.38

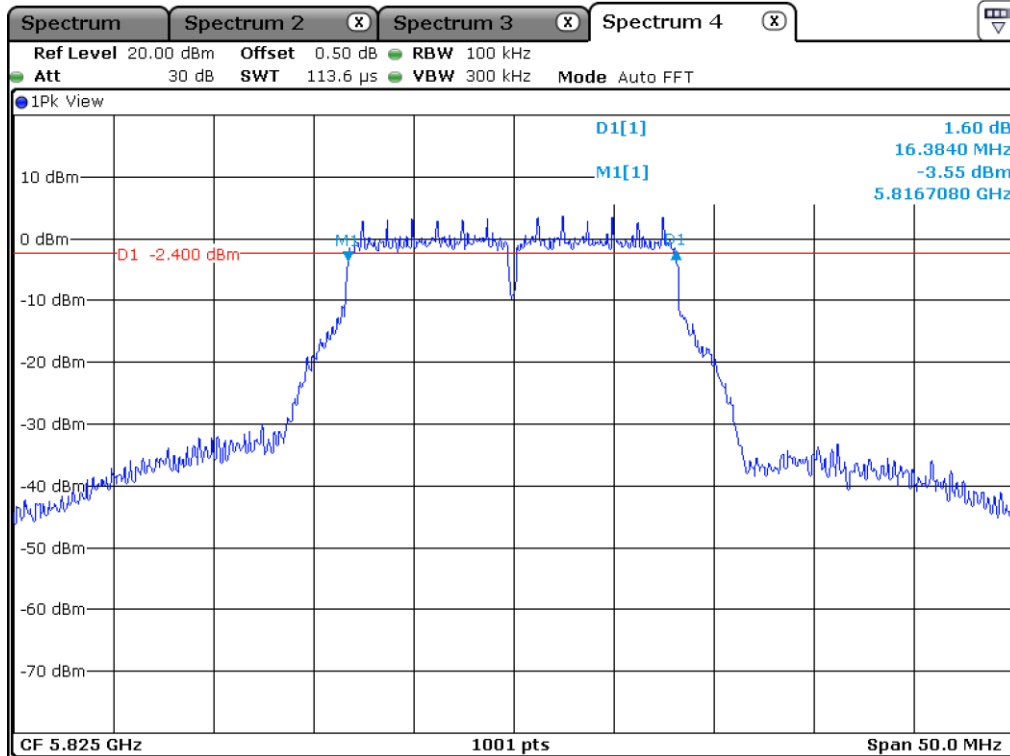


Tested by: Tae-Ho, Kim / Senior Manager





Middle Channel (5 785 MHz)



High Channel (5 825 MHz)

8.5 Test data for 802.11n_HT20 RLAN Mode

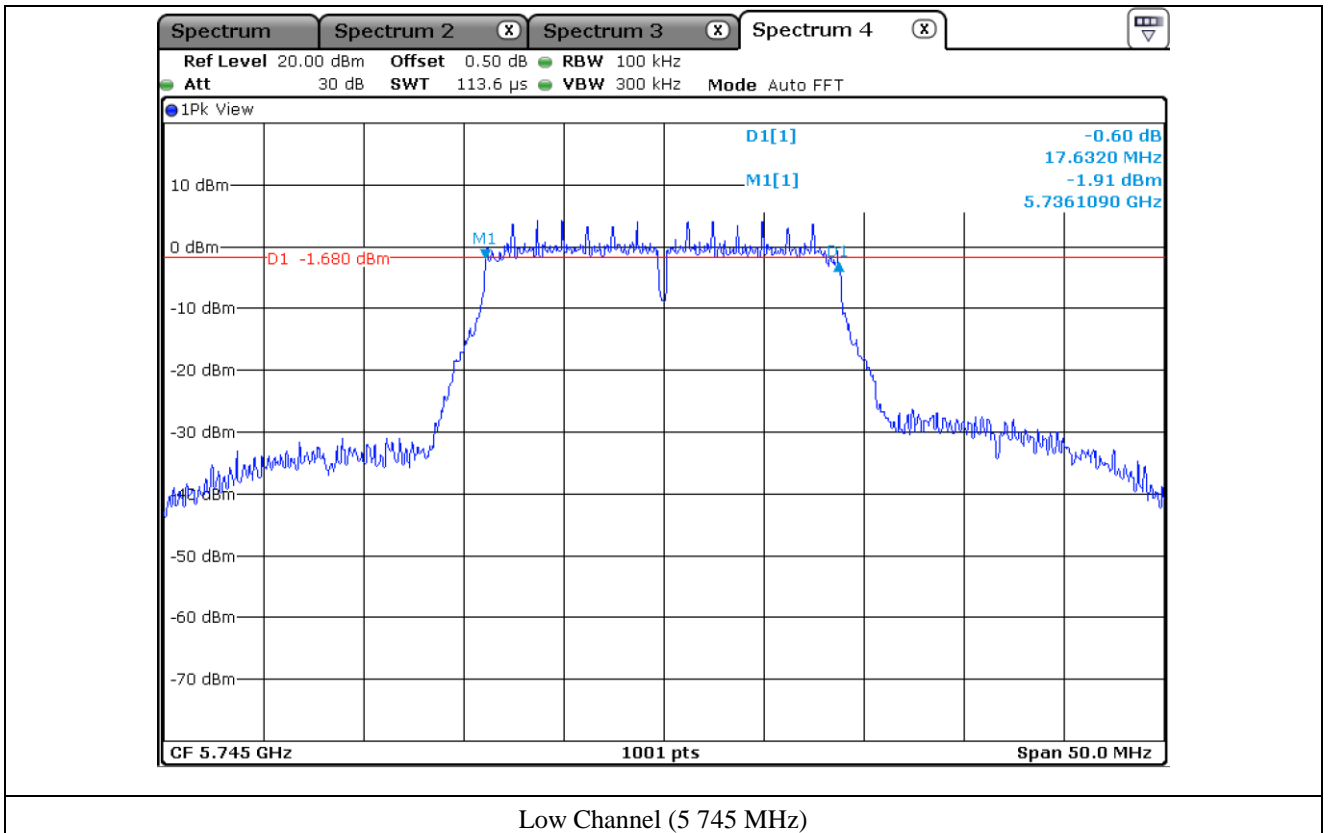
8.5.1 Test data for Antenna 0

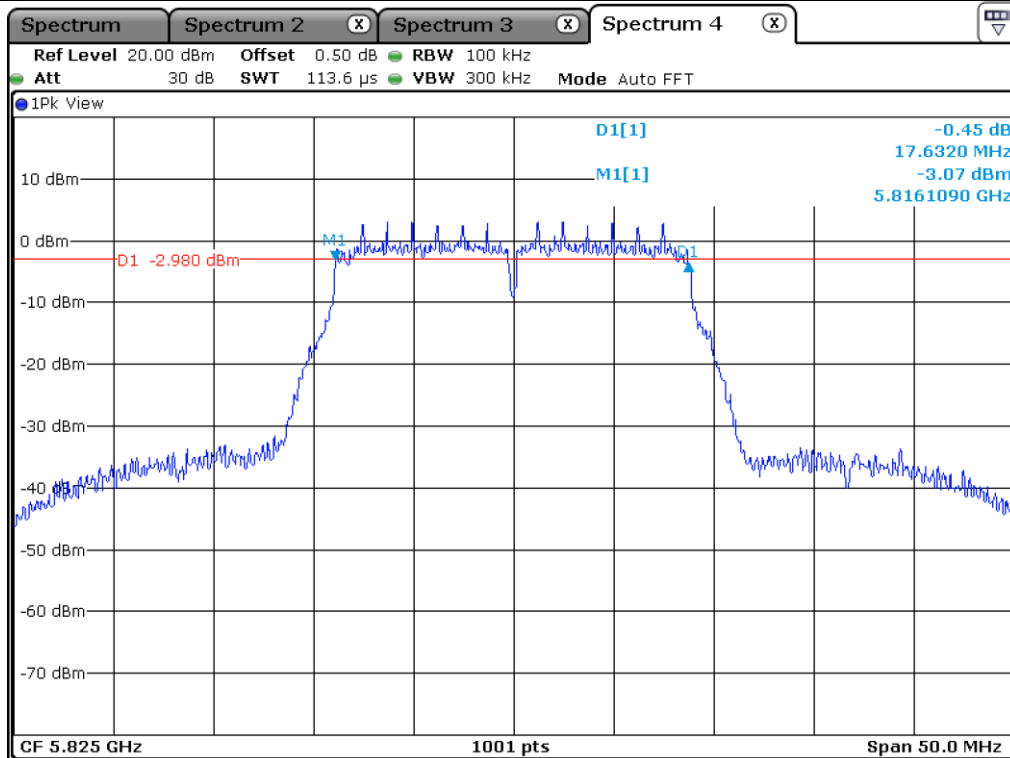
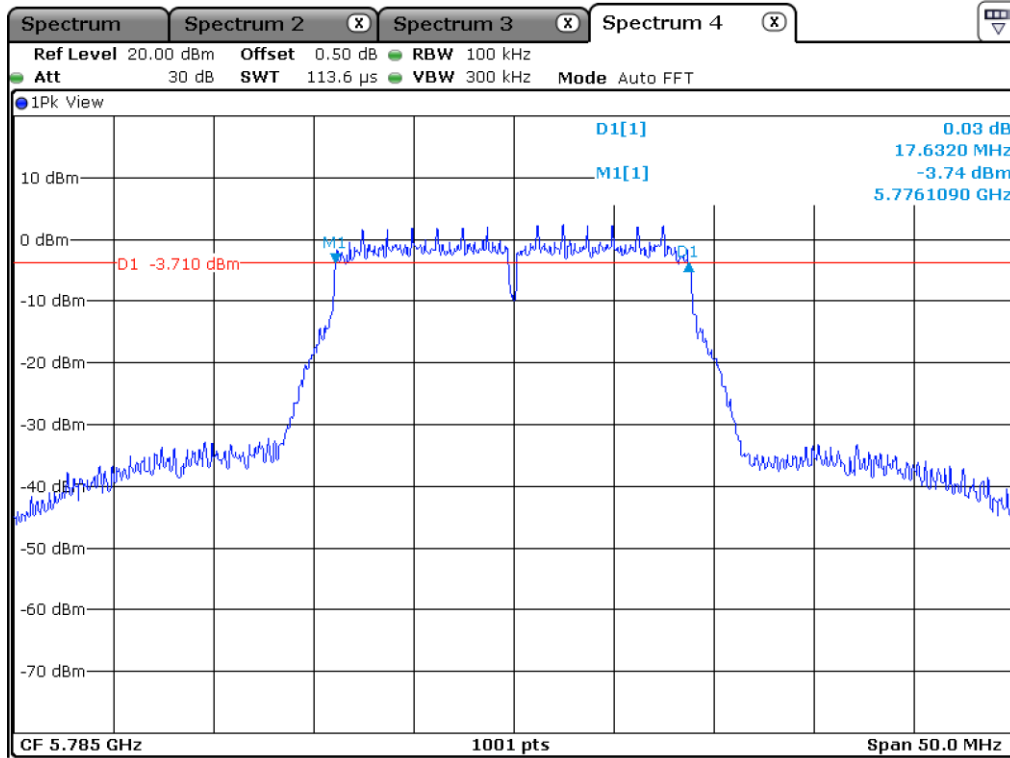
- Test Date : August 16, 2018 ~ August 28, 2018
- Test Result : Pass

FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)
5 725 ~ 5 850	Low	5 745.00	17.63
	Middle	5 785.00	17.63
	High	5 825.00	17.63



Tested by: Tae-Ho, Kim / Senior Manager





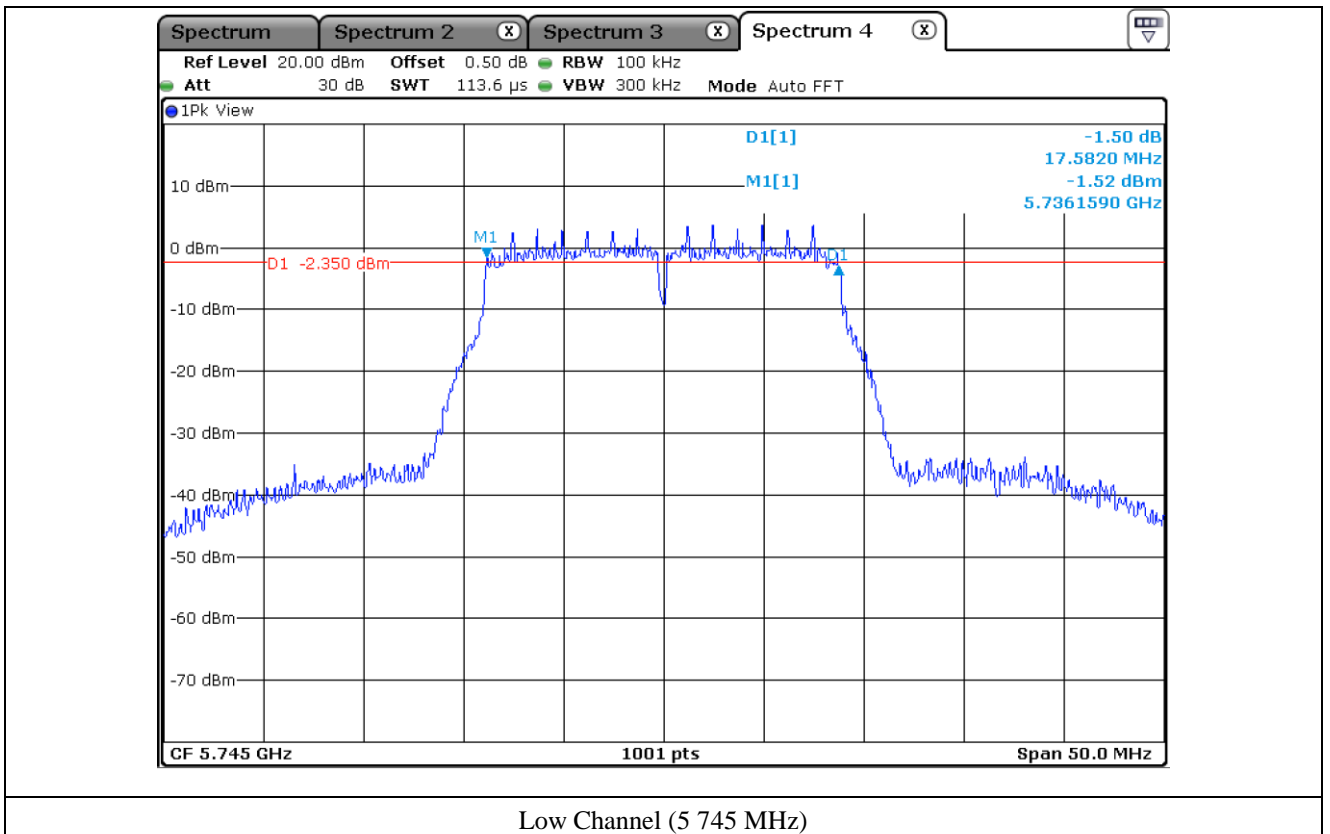
8.5.2 Test data for Antenna 1

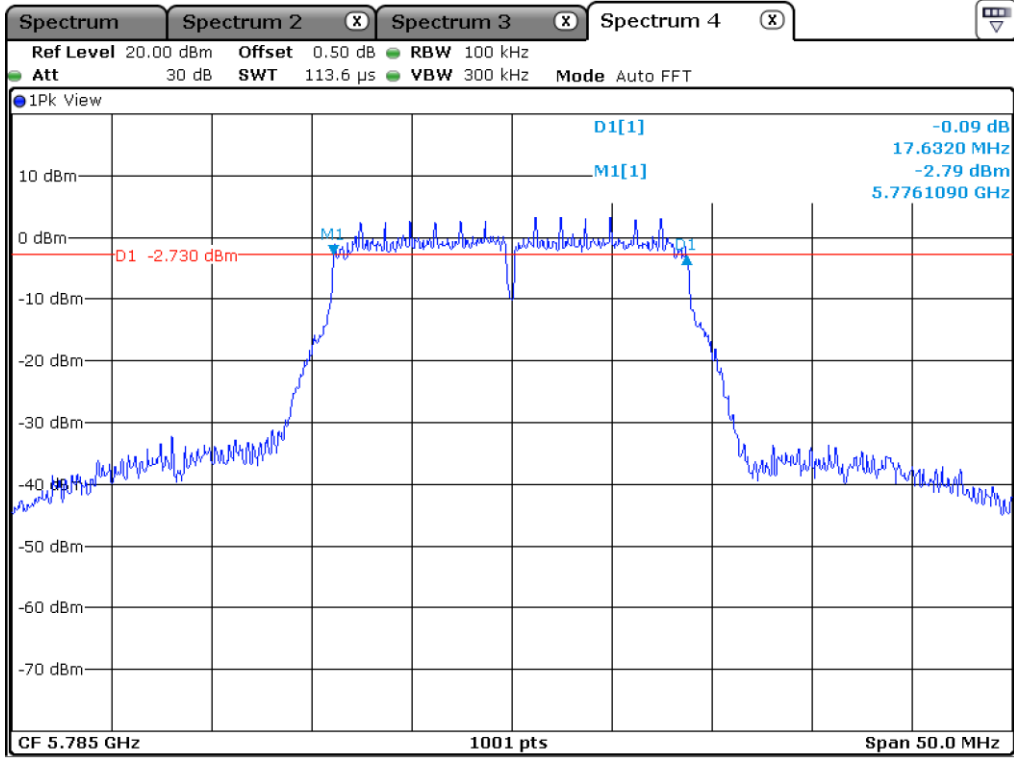
- Test Date : August 16, 2018 ~ August 28, 2018
- Test Result : Pass

FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)
5 725 ~ 5 850	Low	5 745.00	17.58
	Middle	5 785.00	17.63
	High	5 825.00	17.58

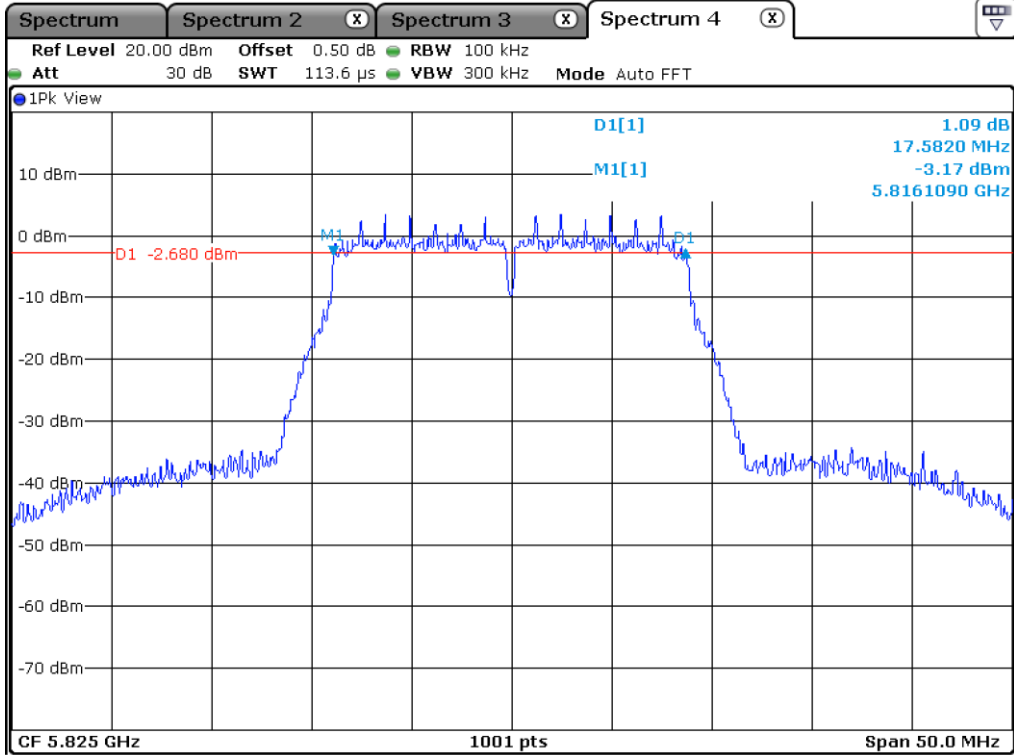


Tested by: Tae-Ho, Kim / Senior Manager





Middle Channel (5 785 MHz)



High Channel (5 825 MHz)

8.6 Test data for 802.11n_HT40 RLAN Mode

8.6.1 Test data for Antenna 0

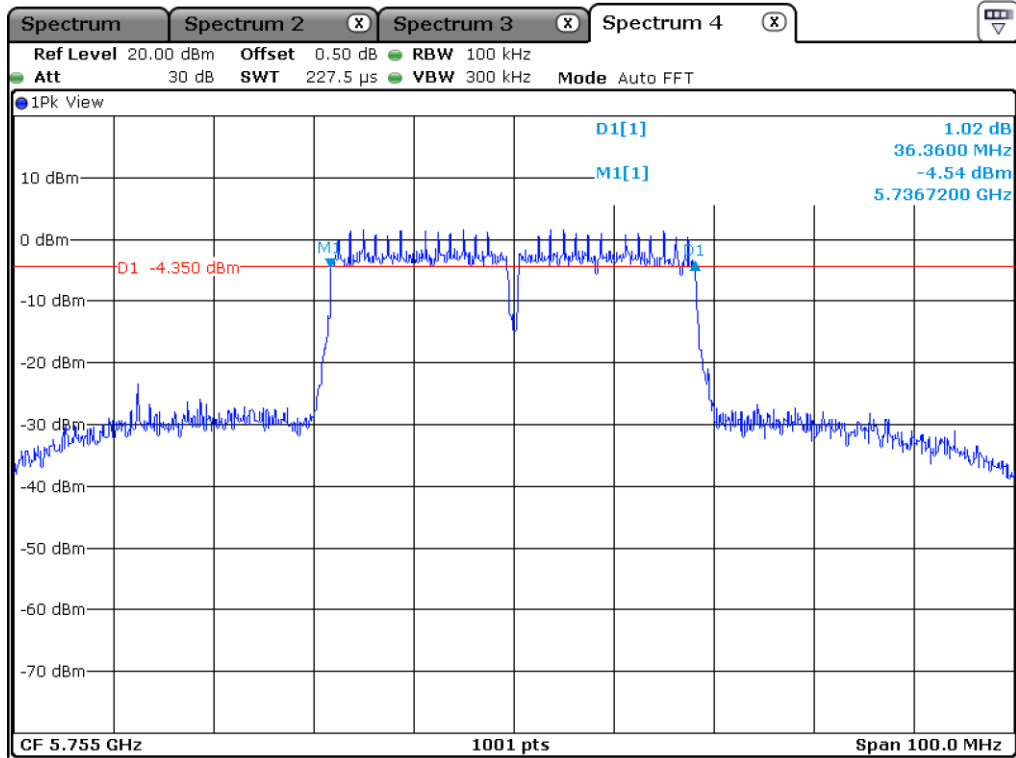
-. Test Date : August 16, 2018 ~ August 28, 2018

-. Test Result : Pass

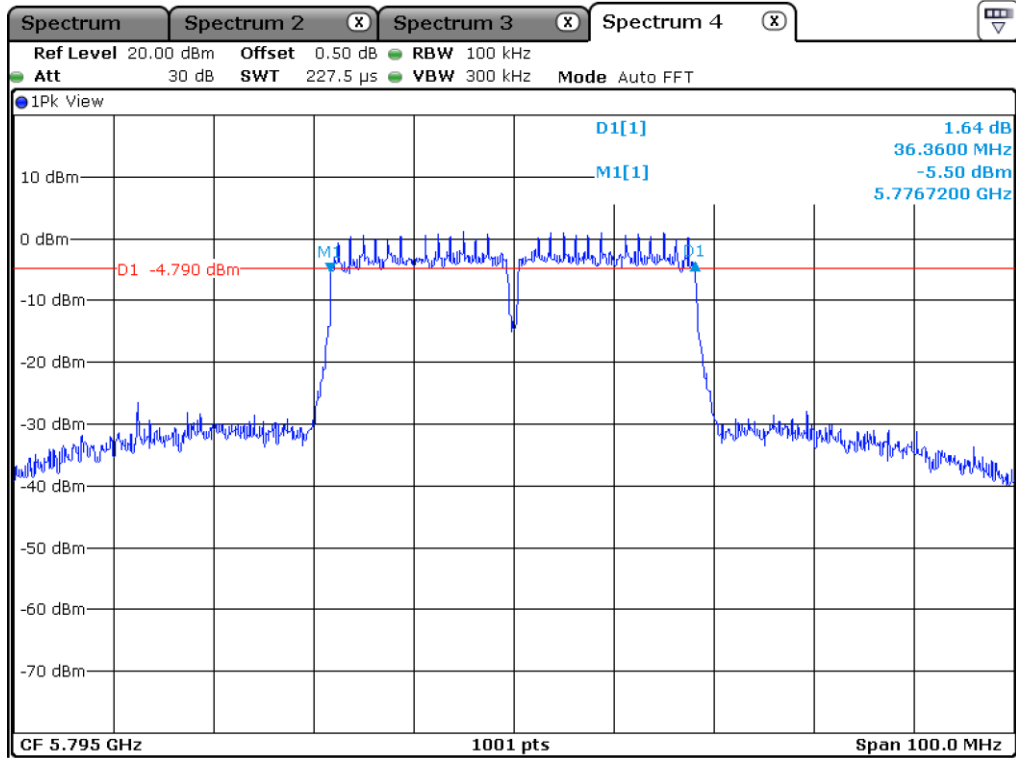
FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)
5 725 ~ 5 850	Low	5 755.00	36.36
	High	5 795.00	36.36



Tested by: **Tae-Ho, Kim / Senior Manager**



Low Channel (5 755 MHz)



High Channel (5 795 MHz)

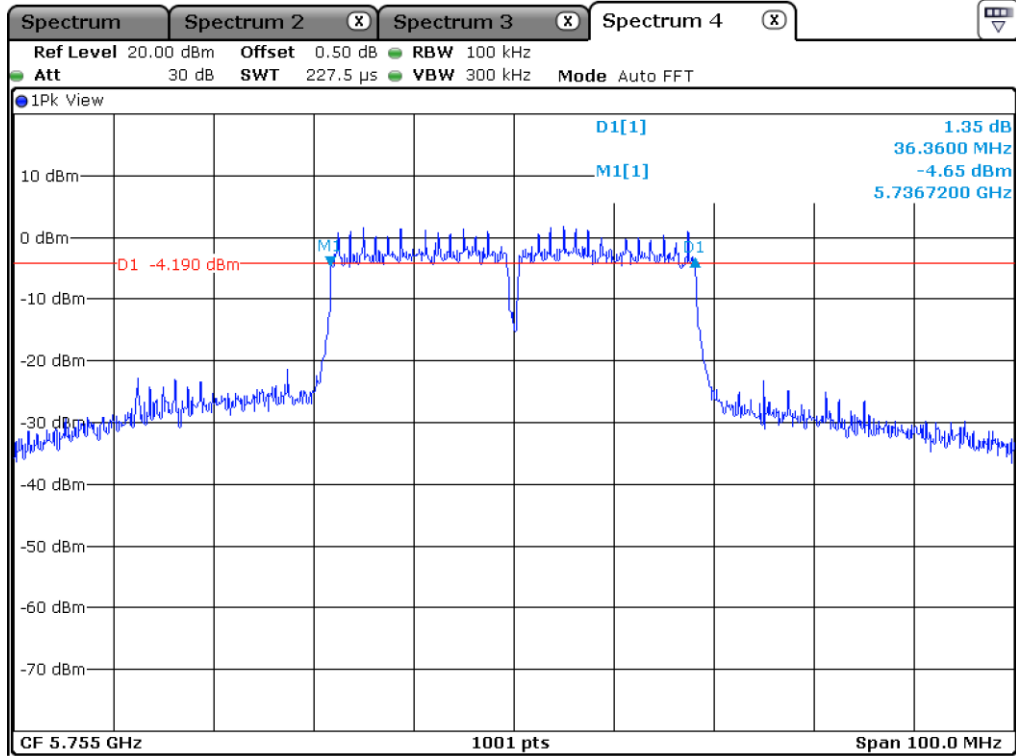
8.6.2 Test data for Antenna 1

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

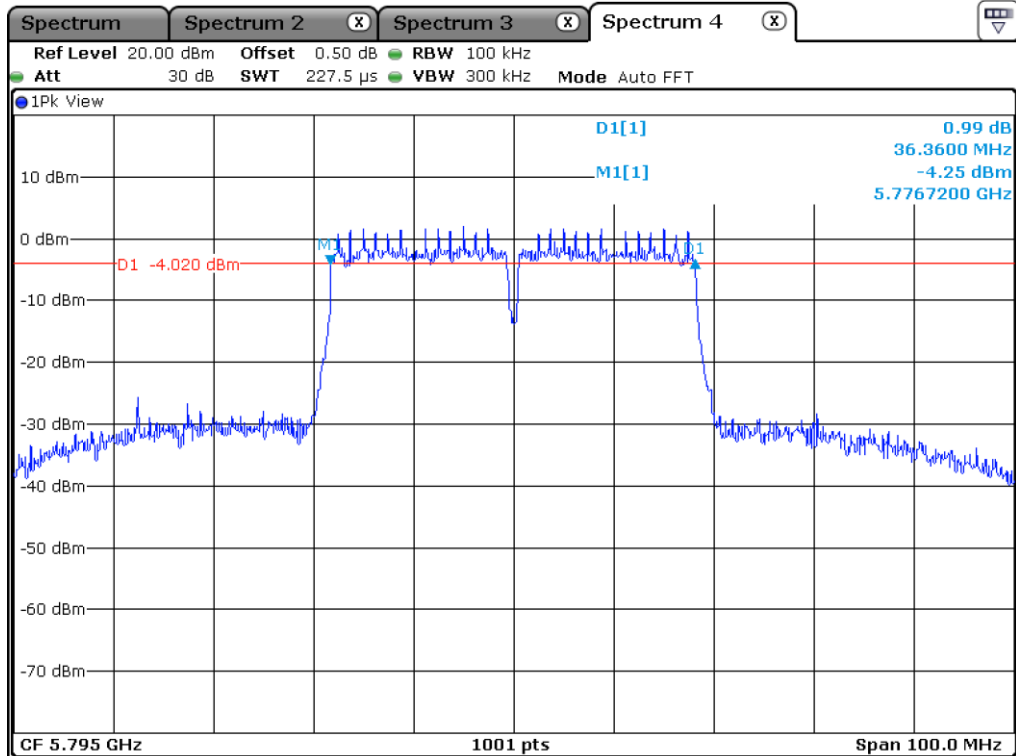
FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)
5 725 ~ 5 850	Low	5 755.00	36.36
	High	5 795.00	36.36



Tested by: Tae-Ho, Kim / Senior Manager



Low Channel (5 755 MHz)



High Channel (5 795 MHz)

8.7 Test data for 802.11ac_VHT80 RLAN Mode

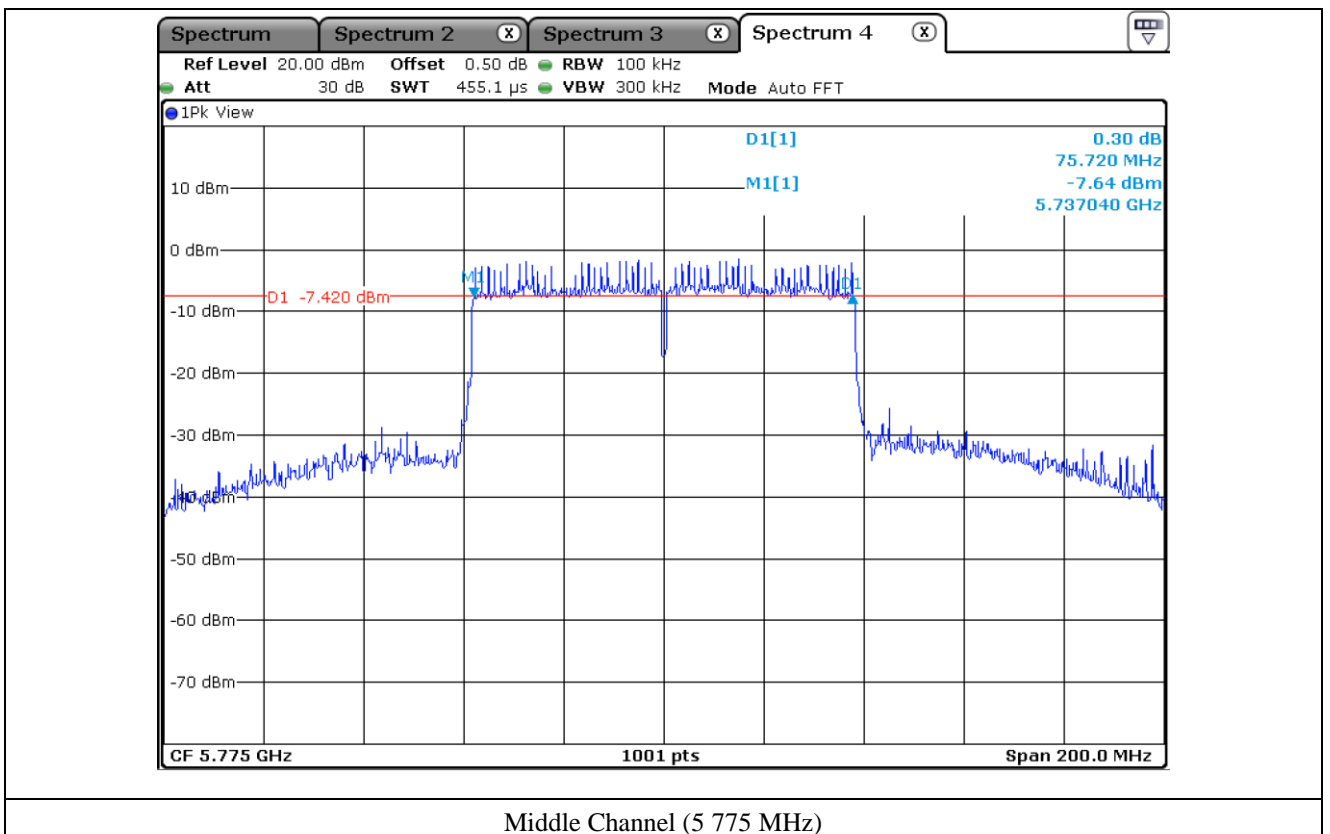
8.7.1 Test data for Antenna 0

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

FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)
5 725 ~ 5 850	Middle	5 775.00	75.72



Tested by: Tae-Ho, Kim / Senior Manager



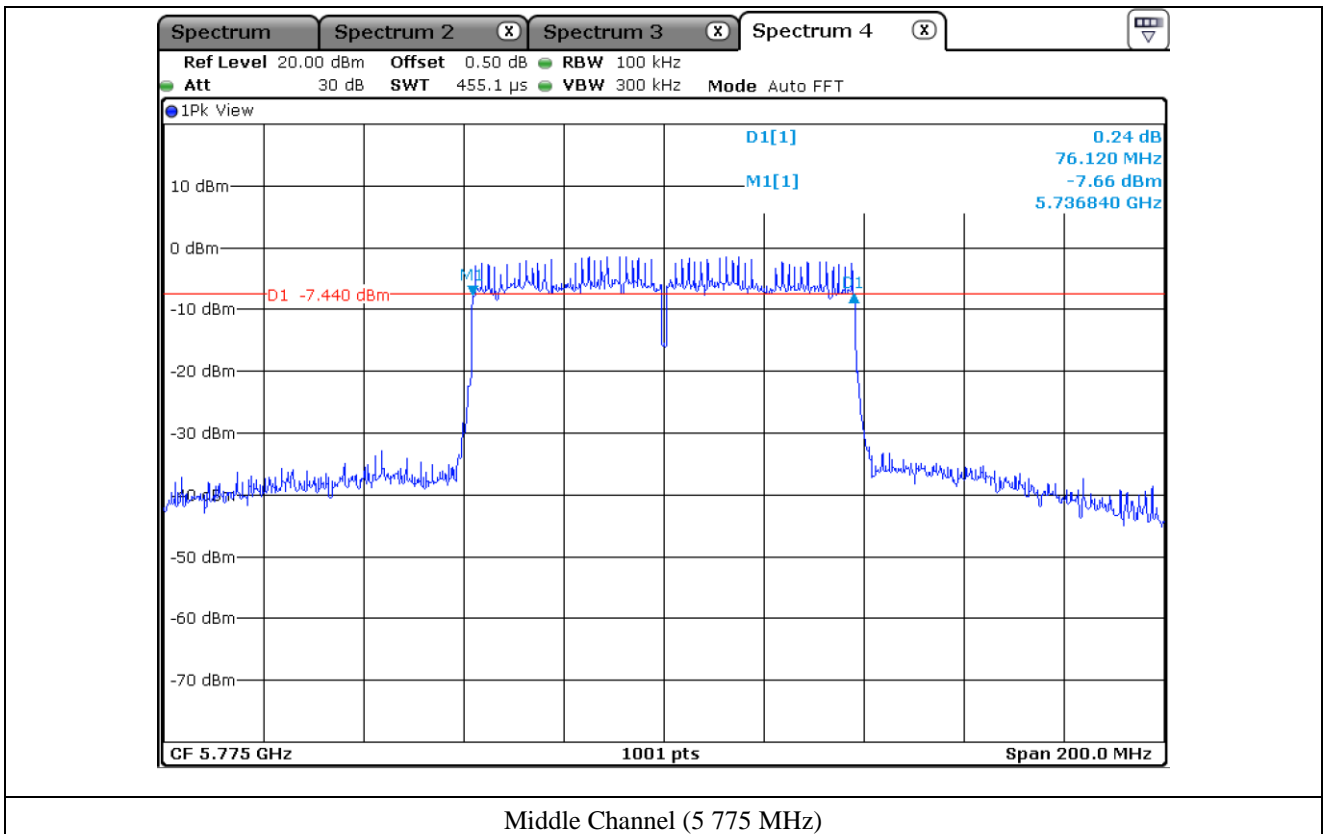
8.7.2 Test data for Antenna 1

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

FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)
5 725 ~ 5 850	Middle	5 775.00	76.12



Tested by: Tae-Ho, Kim / Senior Manager



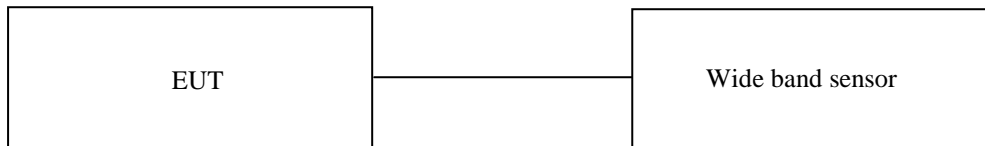
9. MAXIMUM PEAK OUTPUT POWER

9.1 Operating environment

Temperature : 24.3 °C
 Relative humidity : 43.9 % R.H.

9.2 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 E. 3.(KDB 789033 D02 General UNII Test Procedures New Rules v02r01). Since this measurement is made only during the ON time of the transmitter, no duty cycle correction is required.



9.3 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.

9.4 Test data for 802.11a RLAN Mode

9.4.1 Test data for Antenna 0

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

FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	Duty Correction Factor (dB)	Final Result (dBm)	LIMIT (dBm)	MARGIN (dB)
5 150 ~ 5 250	Low	5 180.00	14.45	0.27	14.72	23.10	8.38
	Middle	5 220.00	14.37	0.27	14.64	23.10	8.46
	High	5 240.00	14.44	0.27	14.71	23.10	8.39
5 725 ~ 5 850	Low	5 745.00	14.78	0.27	15.05	29.10	14.05
	Middle	5 785.00	14.88	0.27	15.15	29.10	13.95
	High	5 825.00	14.91	0.27	15.18	29.10	13.92

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


9.4.2 Test data for Antenna 1

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

FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	Duty Correction Factor (dB)	Final Result (dBm)	LIMIT (dBm)	MARGIN (dB)
5 150 ~ 5 250	Low	5 180.00	14.29	0.27	14.56	24.00	9.44
	Middle	5 220.00	14.33	0.27	14.60	24.00	9.40
	High	5 240.00	14.47	0.27	14.74	24.00	9.26
5 725 ~ 5 850	Low	5 745.00	14.51	0.27	14.78	30.00	15.22
	Middle	5 785.00	14.84	0.27	15.11	30.00	14.89
	High	5 825.00	14.73	0.27	15	30.00	15.00

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

9.5 Test data for 802.11n_HT20 RLAN Mode

9.5.1 Test data for Antenna 0

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

-. Test Result : Pass

-. Duty Cycle : 93 %

FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	Duty Correction Factor (dB)	Final Result (dBm)	LIMIT (dBm)	MARGIN (dB)
5 150 ~ 5 250	Low	5 180.00	14.34	0.32	14.66	23.10	8.44
	Middle	5 220.00	14.28	0.32	14.60	23.10	8.50
	High	5 240.00	14.21	0.32	14.53	23.10	8.57
5 725 ~ 5 850	Low	5 745.00	14.42	0.32	14.74	29.10	14.36
	Middle	5 785.00	14.56	0.32	14.88	29.10	14.22
	High	5 825.00	14.30	0.32	14.62	29.10	14.48

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

9.5.2 Test data for Antenna 1

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


-. Test Result : Pass

-. Duty Cycle : 93 %

FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	Duty Correction Factor (dB)	Final Result (dBm)	LIMIT (dBm)	MARGIN (dB)
5 150 ~ 5 250	Low	5 180.00	14.30	0.32	14.62	24.00	9.38
	Middle	5 220.00	14.38	0.32	14.70	24.00	9.30
	High	5 240.00	14.42	0.32	14.74	24.00	9.26
5 725 ~ 5 850	Low	5 745.00	14.55	0.32	14.87	30.00	15.13
	Middle	5 785.00	14.59	0.32	14.91	30.00	15.09
	High	5 825.00	14.62	0.32	14.94	30.00	15.06

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

9.5.3 Test data for Multiple Transmit

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

-. Test Result : Pass

FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	Antenna 0 MEASURED VLAUE (dBm)	Antenna 1 MEASURED VLAUE (dBm)	COMBINED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
5 150 ~ 5 250	Low	5 180.00	11.53	11.63	14.59	20.56	5.97
	Middle	5 220.00	11.51	11.60	14.57	20.56	5.99
	High	5 240.00	11.63	11.72	14.69	20.56	5.87
5 725 ~ 5 850	Low	5 745.00	11.70	11.64	14.68	26.56	11.88
	Middle	5 785.00	11.96	11.90	14.94	26.56	11.62
	High	5 825.00	11.83	11.81	14.83	26.56	11.73

Remark 1: Margin = Limit – Combined Value (=Power Sensor Reading - Cable Loss)

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

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

9.6 Test data for 802.11n_HT40 RLAN Mode

9.6.1 Test data for Antenna 0

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

FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	Duty Correction Factor (dB)	Final Result (dBm)	LIMIT (dBm)	MARGIN (dB)
5 150 ~ 5 250	Low	5 190.00	15.89	0.60	16.49	23.10	6.61
	High	5 230.00	15.81	0.60	16.41	23.10	6.69
5 725 ~ 5 850	Low	5 755.00	15.90	0.60	16.50	29.10	12.60
	High	5 795.00	15.95	0.60	16.55	29.10	12.55

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

9.6.2 Test data for Antenna 1

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

FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	Duty Correction Factor (dB)	Final Result (dBm)	LIMIT (dBm)	MARGIN (dB)
5 150 ~ 5 250	Low	5 190.00	15.69	0.60	16.29	24.00	7.71
	High	5 230.00	15.78	0.60	16.38	24.00	7.62
5 725 ~ 5 850	Low	5 755.00	15.81	0.60	16.41	30.00	13.59
	High	5 795.00	15.88	0.60	16.48	30.00	13.52

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

9.6.3 Test data for Multiple Transmit

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

-. Test Result : Pass

FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	Antenna 0 MEASURED VLAUE (dBm)	Antenna 1 MEASURED VLAUE (dBm)	COMBINED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
5 150 ~ 5 250	Low	5 190.00	13.28	13.16	16.23	20.56	4.33
	High	5 230.00	13.31	13.09	16.21	20.56	4.35
5 725 ~ 5 850	Low	5 755.00	13.44	13.44	16.45	26.56	10.11
	High	5 795.00	13.50	13.40	16.46	26.56	10.10

Remark 1: Margin = Limit – Combined Value (=Power Sensor Reading - Cable Loss)

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

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

9.7 Test data for 802.11ac_HT80 RLAN Mode

9.7.1 Test data for Antenna 0

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

-. Test Result : Pass

-. Duty Cycle : > 79 %

FREQUENCY RANGE (MHz)	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	Duty Correction Factor (dB)	Final Result (dBm)	LIMIT (dBm)	MARGIN (dB)
5 150 ~ 5 250	5 210.00	14.99	1.02	16.01	23.10	7.09
5 725 ~ 5 850	5 775.00	15.21	1.20	16.23	29.10	12.87

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

9.7.2 Test data for Antenna 1

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

-. Test Result : Pass

-. Duty Cycle : > 79 %

FREQUENCY RANGE (MHz)	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	Duty Correction Factor (dB)	Final Result (dBm)	LIMIT (dBm)	MARGIN (dB)
5 150 ~ 5 250	5 210.00	14.78	1.02	15.8	24.00	8.20
5 725 ~ 5 850	5 775.00	15.03	1.02	16.05	29.12	13.07

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

9.7.3 Test data for Multiple Transmit

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

-. Test Result : Pass

FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	Antenna 0 MEASURED VLAUE (dBm)	Antenna 1 MEASURED VLAUE (dBm)	COMBINED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
5 150 ~ 5 250	Middle	5 210.00	13.05	12.86	15.97	20.56	4.59
5 725 ~ 5 850	Middle	5 775.00	13.14	13.07	16.12	26.56	10.44

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 = 24 dBm – Exceeds Antenna gain (UNII I)

Limit = 30 dBm – Exceeds Antenna gain (UNII III)

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

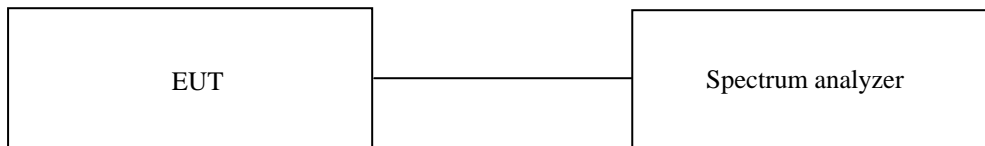
10. PEAK POWER SPECTRUL DENSITY

10.1 Operating environment

Temperature : 24.3 °C
 Relative humidity : 43.9 % 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 1 MHz, the video bandwidth is set to 3 times the resolution bandwidth. The maximum level form the EUT in 1 MHz bandwidth was measured with above condition.



10.3 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.

10.4 Test data for 802.11a RLAN Mode

10.4.1 Test data for Antenna 0

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

-. Test Result : Pass

-. Duty Cycle : 94 %

FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	RBW Converted Value(dB)	Duty Correction Factor(dB)	Result (dBm)	LIMIT (dBm)	MARGIN (dB)
5 150 ~ 5 250	Low	5 180.00	9.21	-	0.27	9.48	10.10	0.62
	Middle	5 220.00	9.15	-	0.27	9.42	10.10	0.68
	High	5 240.00	9.37	-	0.27	9.64	10.10	0.46
5 725 ~ 5 850	Low	5 745.00	10.05	-3	0.27	7.32	29.10	21.78
	Middle	5 785.00	9.93	-3	0.27	7.2	29.10	21.90
	High	5 825.00	9.07	-3	0.27	6.34	29.10	22.76

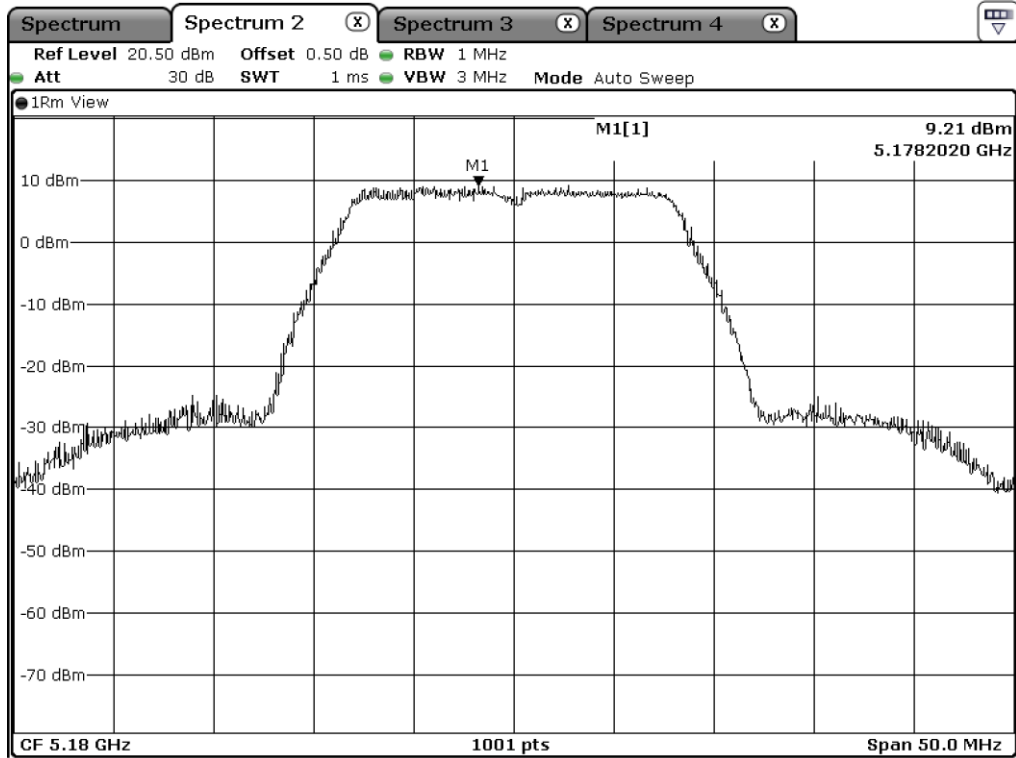
Remark 1: Calculated RBW Converted Value(dB)= 10Log(Measured RBW/Standard Set RBW)

Remark 2: Result(dBm) = MEASURED VALUE(dBm) + RBW Converted Value(dB)+ Duty Cycle Factor(dB)

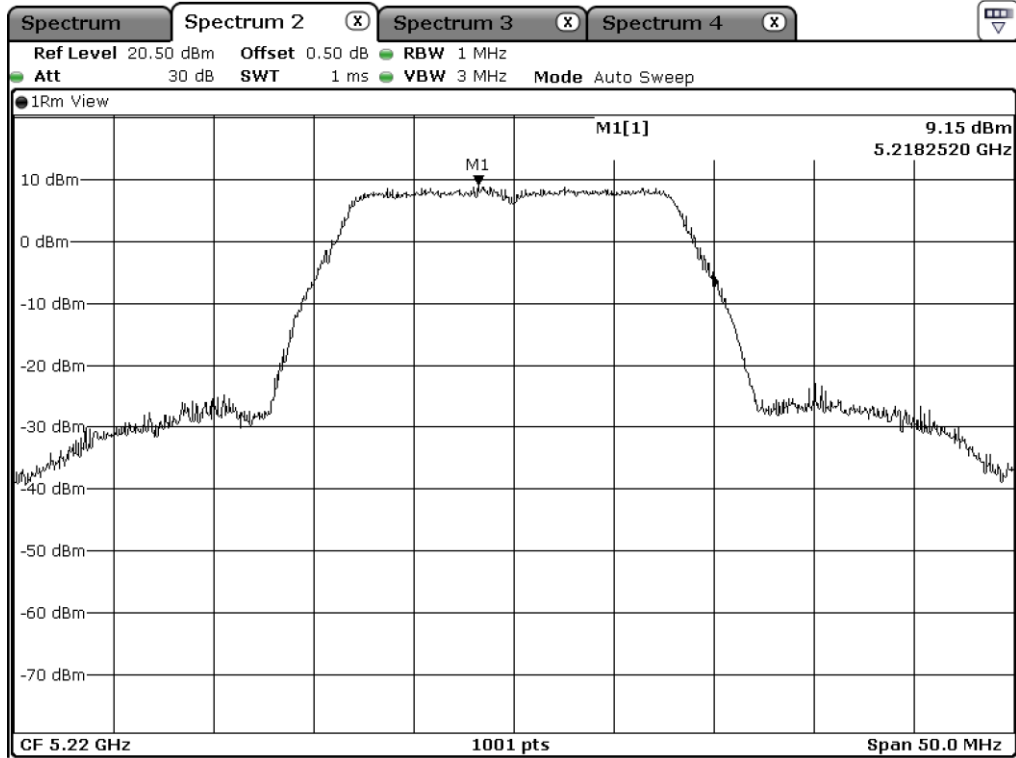
Remark 3: See next page for measurement data.



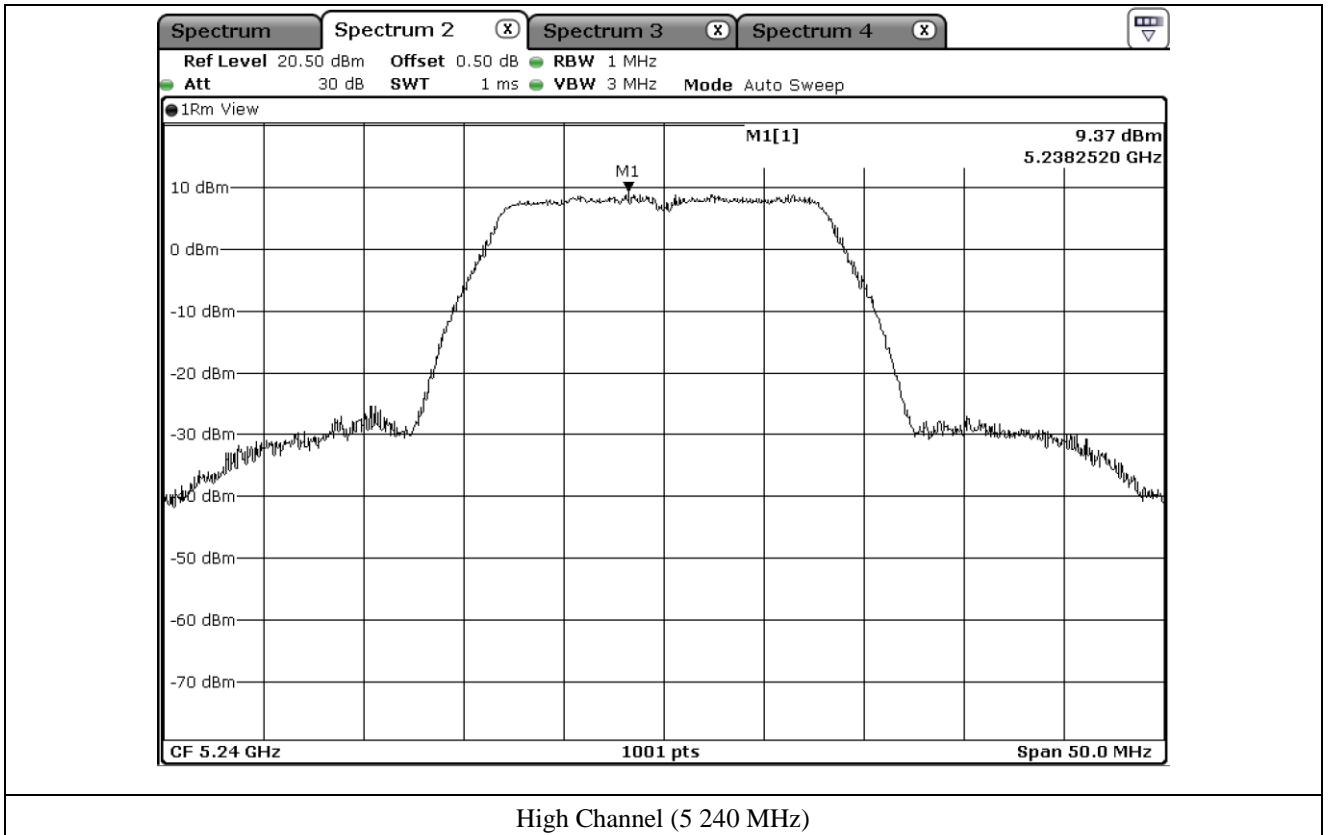
Tested by: Tae-Ho, Kim / Senior Manager



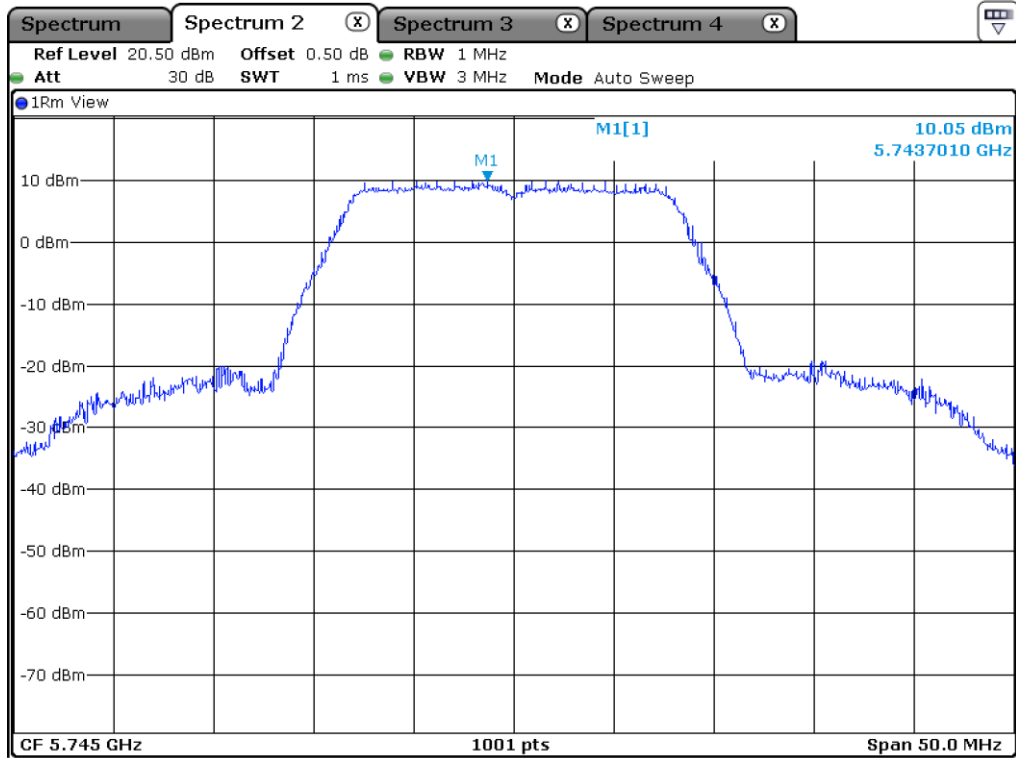
Low Channel (5 180 MHz)



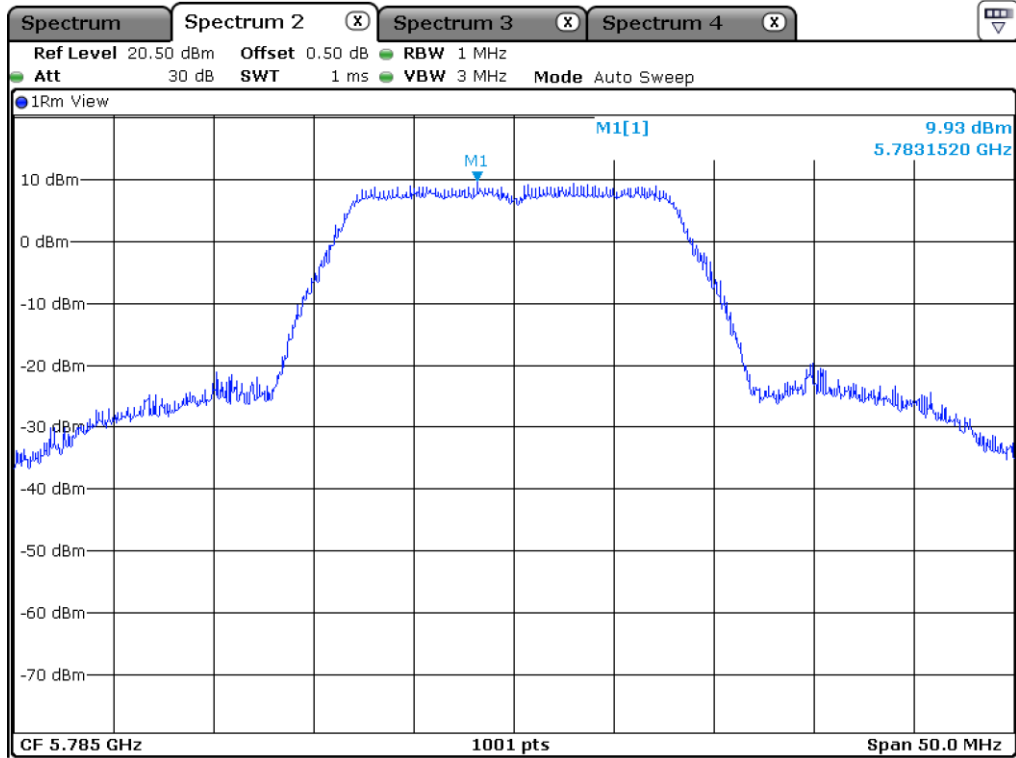
Middle Channel (5 220 MHz)



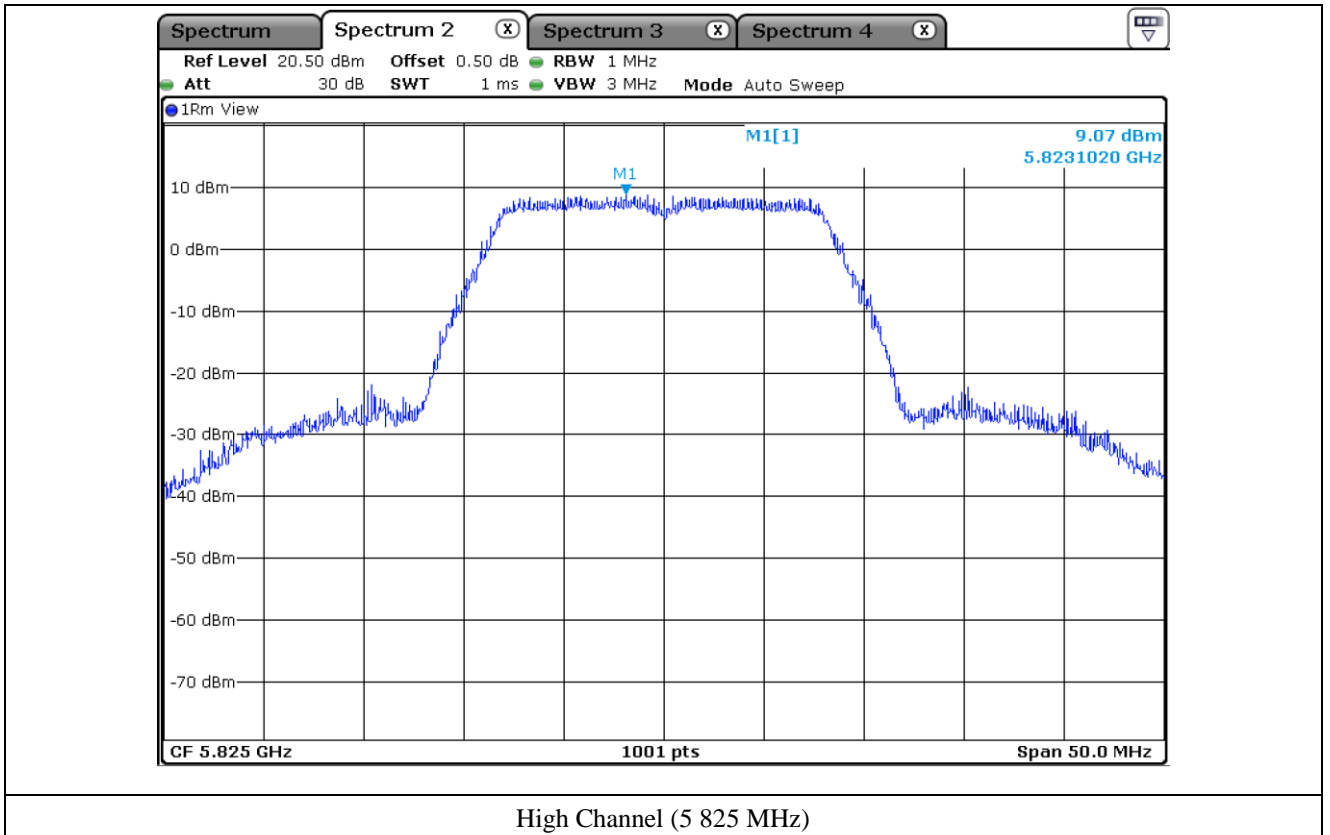
High Channel (5 240 MHz)



Low Channel (5 745 MHz)



Middle Channel (5 785 MHz)



10.4.2 Test data for Antenna 1

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

FREQUENCY RANGE (MHz)	CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	RBW Converted Value(dB)	Duty Correction Factor(dB)	Final Result (dBm)	LIMIT (dBm)	MARGIN (dB)
5 150 ~ 5 250	Low	5 180.00	8.74	-	0.27	9.01	11.00	1.99
	Middle	5 220.00	8.86	-	0.27	9.13	11.00	1.87
	High	5 240.00	8.50	-	0.27	8.77	11.00	2.23
5 725 ~ 5 850	Low	5 745.00	10.47	-3	0.27	7.74	30.00	22.26
	Middle	5 785.00	9.88	-3	0.27	7.15	30.00	22.85
	High	5 825.00	10.42	-3	0.27	7.69	30.00	22.31

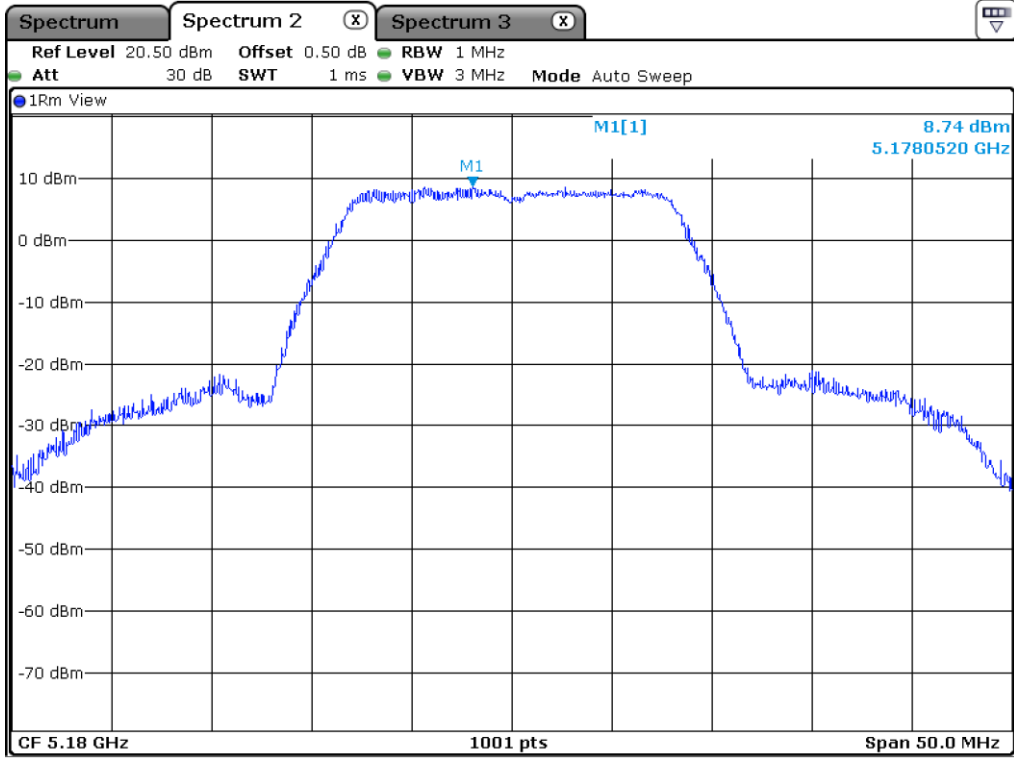
Remark 1: Calculated RBW Converted Value(dB)= 10Log(Measured RBW/Standard Set RBW)

Remark 2: Result(dBm) = MEASURED VALUE(dBm) + RBW Converted Value(dB)+ Duty Cycle Factor(dB)

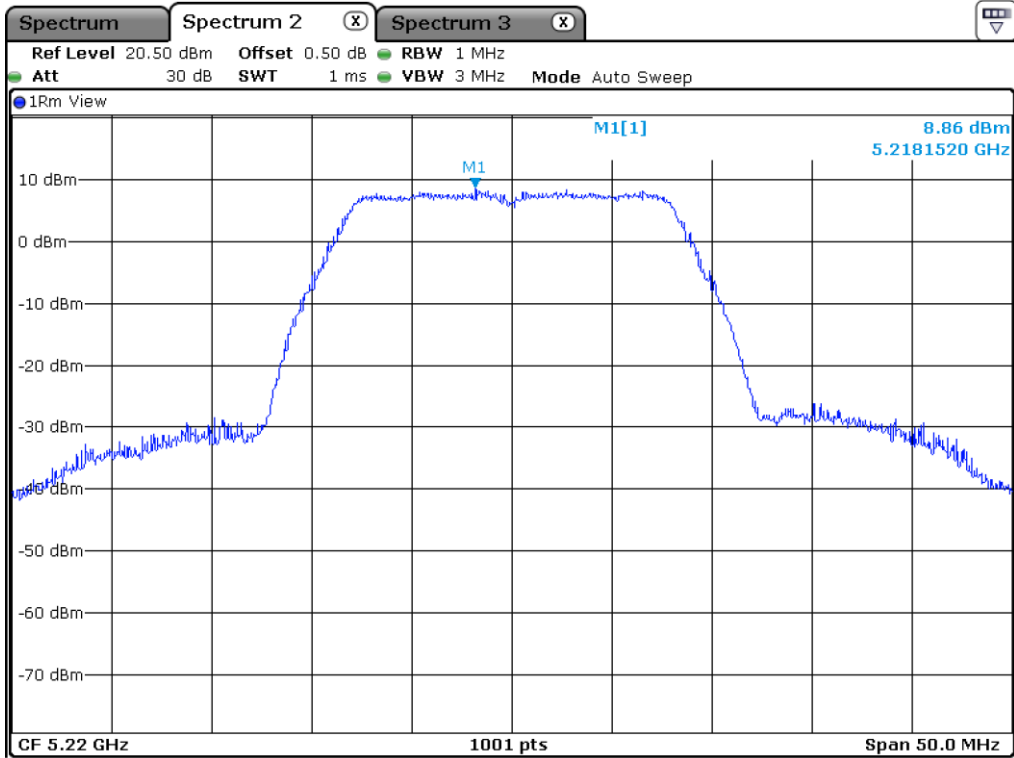
Remark 3: See next page for measurement data.



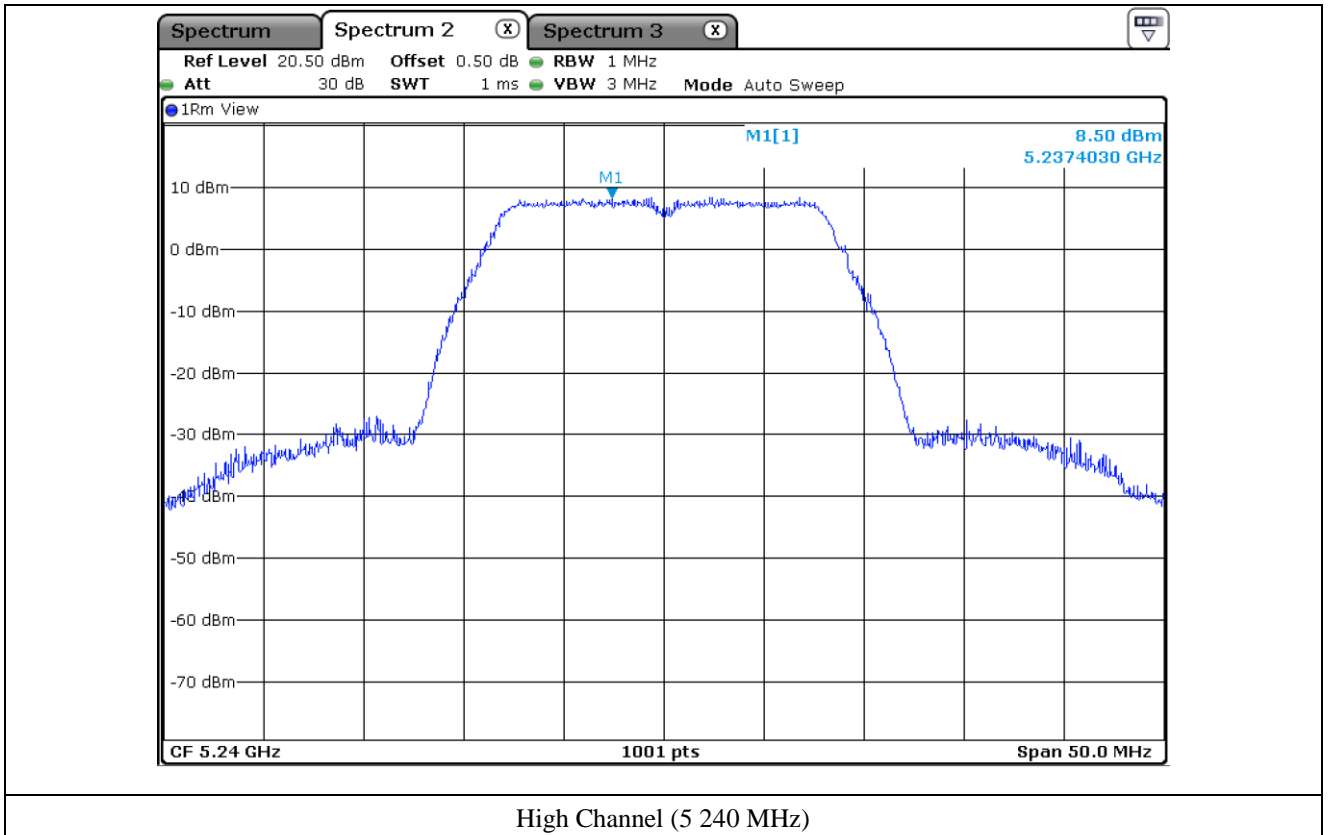
Tested by: Tae-Ho, Kim / Senior Manager



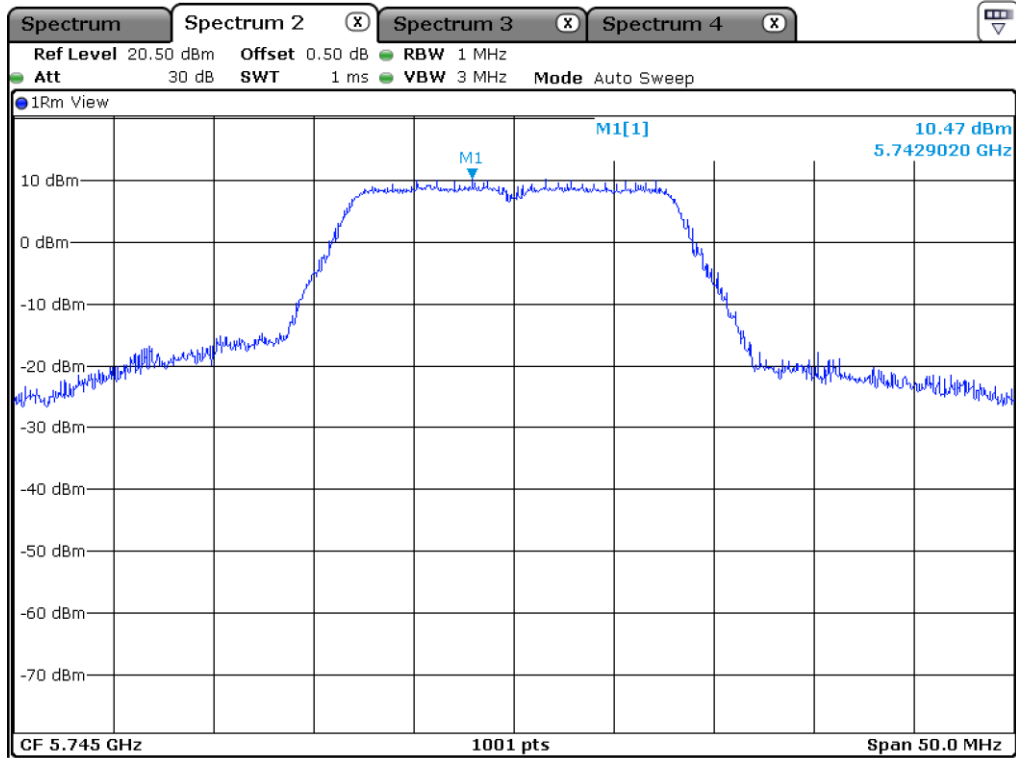
Low Channel (5 180 MHz)



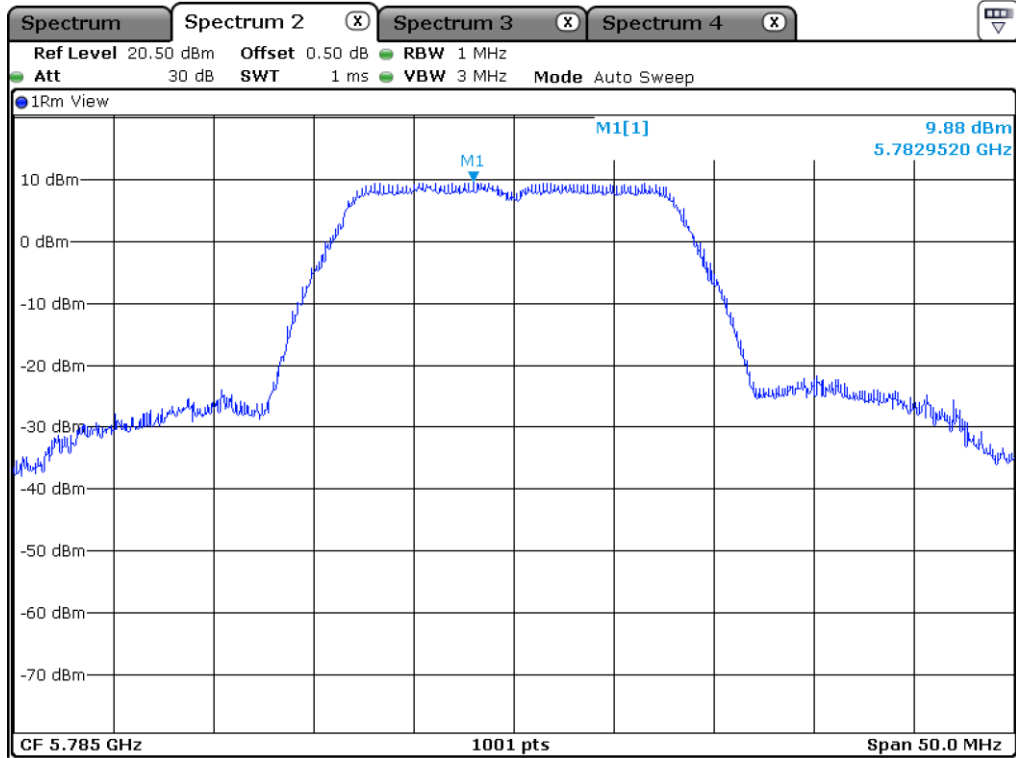
Middle Channel (5 220 MHz)



High Channel (5 240 MHz)



Low Channel (5 745 MHz)



Middle Channel (5 785 MHz)

