FCC RF Test Report

APPLICANT	:	Ring LLC
EQUIPMENT	:	Always Home Cam
BRAND NAME	:	ring
MODEL NAME	:	5E92E9
FCC ID	:	2AEUPBHAZU001
STANDARD	:	FCC Part 15 Subpart E § 15.407
CLASSIFICATION	:	(NII) Unlicensed National Information Infrastructure
TEST DATE(S)	:	Sep. 10, 2021 ~ Sep. 18, 2021

We, Sporton International (Kunshan) Inc., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International (Kunshan) Inc., the test report shall not be reproduced except in full.

Reviewed by: Jason Jia / Supervisor

Approved by: Alex Wang / Manager

Sporton International (Kunshan) Inc.
No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300
People's Republic of China

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REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR170120D	Rev. 01	Initial issue of report	Sep. 18, 2021

SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
3.1	2.1049 & 15.403(i)	26dB & 99% Bandwidth	-	Report only	-
3.2	15.407(a)	Maximum Conducted Output Power	⩽ 24 dBm	Pass	-
3.3	15.407(a)	Power Spectral Density	⩽ 11 dBm	Pass	-
3.4	15.407(b)	Unwanted Emissions	15.407(b) & 15.209(a)	Pass	Under limit 3.02 dB at 5149.98 MHz
3.5	15.207	AC Conducted Emission	15.207(a)	Pass	Under limit 9.86 dB at 0.158 MHz
3.6	15.203 & 15.407(a)	Antenna Requirement	15.203 & 15.407(a)	Pass	-

Declaration of Conformity:
The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.
Comments and Explanations:
The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

1 General Description

1.1 Applicant

Ring LLC
1523 26th St, Santa Monica, CA 90404, USA

1.2 Manufacturer

Goertek Inc.
No.8877 Yingqian Street, High-Tech Industrial Development District, Weifang, Shandong, 261031, P.R.China

1.3 Product Feature of Equipment Under Test

Product Feature	
Equipment	Always Home Cam
Brand Name	ring
Model Name	5E92E9
FCC ID	2AEUPBHAZU001
HW Version	DVT1.1C
SW Version	DVT1.1C
EUT Stage	Identical Prototype

Remark: The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

1.4 Product Specification of Equipment Under Test

Standards-related Product Specification	
Tx/Rx Frequency Range	5180 MHz ~ 5240 MHz 5260 MHz ~ 5320 MHz 5500 MHz ~ 5720 MHz
Maximum Output Power to Antenna	**<MIMO Ant.1+2>** **<5180 MHz ~ 5240 MHz>** 802.11a : 20.08 dBm / 0.1019 W 802.11n HT20 : 20.05 dBm / 0.1012 W 802.11n HT40 : 20.98 dBm / 0.1253 W 802.11ac VHT20 : 20.20 dBm / 0.1047 W 802.11ac VHT40 : 21.32 dBm / 0.1355 W 802.11ac VHT80 : 14.25 dBm / 0.0266 WZ **<5260 MHz ~ 5320 MHz>** 802.11a : 18.66 dBm / 0.0735 W 802.11n HT20 : 19.88 dBm / 0.0973 W 802.11n HT40 : 20.15 dBm / 0.1035 W 802.11ac VHT20 : 20.06 dBm / 0.1014 W 802.11ac VHT40 : 20.20 dBm / 0.1047 W 802.11ac VHT80 : 12.88 dBm / 0.0194 W **<5500 MHz ~ 5720 MHz >** 802.11a : 18.32 dBm / 0.0679 W

	802.11n HT20 : 19.01 dBm / 0.0796 W 802.11n HT40 : 19.26 dBm / 0.0843 W 802.11ac VHT20 : 19.25 dBm / 0.0841 W 802.11ac VHT40 : 19.47 dBm / 0.0885 W 802.11ac VHT80 : 19.12 dBm / 0.0817 W
99% Occupied Bandwidth	802.11a : 18.342 MHz 802.11ac VHT20 : 21.379 MHz 802.11ac VHT40 : 37.802 MHz 802.11ac VHT80 : 76.404 MHz
Antenna Type / Gain	**<5150 MHz ~ 5250 MHz>** <Ant. 1> : FPC Antenna with gain 3.46 dBi <Ant. 2> : FPC Antenna with gain 3.75 dBi **<5250 MHz ~ 5350 MHz>** <Ant. 1> : FPC Antenna with gain 5.59 dBi <Ant. 2> : FPC Antenna with gain 4.34 dBi **<5470 MHz ~ 5725 MHz>** <Ant. 1> : FPC Antenna with gain 6.69 dBi <Ant. 2> : FPC Antenna with gain 3.72 dBi
Type of Modulation	802.11a/n : OFDM (BPSK / QPSK / 16QAM / 64QAM) 802.11ac : OFDM (BPSK / QPSK / 16QAM / 64QAM / 256QAM)
Antenna Function Description	<table><tr><td></td><td>Ant. 1</td><td>Ant. 2</td></tr><tr><td>802.11 a/n/ac SISO</td><td>V</td><td>V</td></tr><tr><td>802.11 a/n/ac MIMO</td><td>V</td><td>V</td></tr></table>

Note:

1. For 802.11n HT20 / ac VHT20 and 802.11n HT40 / ac VHT40 mode, the whole testing have assessed only 802.11 ac VHT20/VHT40 by referring to their maximum conducted power.
2. For WLAN SISO & MIMO mode, the whole testing has assessed only MIMO mode by referring to their higher conducted power.

1.5 Modification of EUT

No modifications are made to the EUT during all test items.

1.6 Testing Location

Sporton International (Kunshan) Inc. is accredited to ISO/IEC 17025:2017 by American Association for Laboratory Accreditation with Certificate Number 5145.02.

Test Firm	Sporton International (Kunshan) Inc.		
Test Site Location	No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300 People's Republic of China TEL : +86-512-57900158 FAX : +86-512-57900958		
Test Site No.	**Sporton Site No.**	**FCC Designation No.**	**FCC Test Firm Registration No.**
	CO01-KS 03CH05-KS TH01-KS	CN1257	314309

1.7 Test Software

Item	Site	Manufacturer	Name	Version
1.	03CH05-KS	AUDIX	E3	6.2009-8-24al
2.	CO01-KS	AUDIX	E3	6.2009-8-24

1.8 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- 47 CFR Part 15 Subpart E
- FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01.
- FCC KDB 662911 D01 Multiple Transmitter Output v02r01.
- ANSI C63.10-2013

Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.

2 Test Configuration of Equipment Under Test

a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction emission (150 kHz to 30 MHz), radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower).

b. AC power line Conducted Emission was tested under maximum output power.

2.1 Carrier Frequency and Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
5150-5250 MHz U-NII-1	36	5180	44	5220
	38*	5190	46*	5230
	40	5200	48	5240
	42#	5210		

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
5250-5350 MHz U-NII-2A	52	5260	60	5300
	54*	5270	62*	5310
	56	5280	64	5320
	58#	5290		

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
5470-5725 MHz U-NII-2C	100	5500	112	5560
	102*	5510	116	5580
	104	5520	132	5660
	106#	5530	134*	5670
	108	5540	136	5680
	110*	5550	140	5700

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
TDWR Channel	118*	5590	124	5620
	120	5600	126*	5630
	122#	5610	128	5640

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
Straddle Channel	138#	5690	144	5720
	142*	5710		

Note:

1. The above Frequency and Channel in "*" were 802.11n HT40 and 802.11ac VHT40.
2. The above Frequency and Channel in "#" were 802.11ac VHT80.

2.2 Test Mode

Final test modes are considering the modulation and worse data rates as below table.

MIMO Mode

Modulation	Data Rate
802.11a	**6 Mbps**
802.11ac VHT20	**MCS0**
802.11ac VHT40	**MCS0**
802.11ac VHT80	**MCS0**

Test Cases	
AC Conducted Emission	Mode 1 : Bluetooth Link + WLAN Link(5G) + Adaptor + Charging base
Remark: For Radiated Test Cases, The tests were performance with Charging base and Adapter.	

Ch. #		U-NII-1：5150-5250 MHz	U-NII-2A：5250-5350 MHz	U-NII-2C：5470-5725MHz
		802.11a	802.11a	802.11a
L	Low	36	52	100
M	Middle	44	60	116
H	High	48	64	140
Straddle		-	-	144

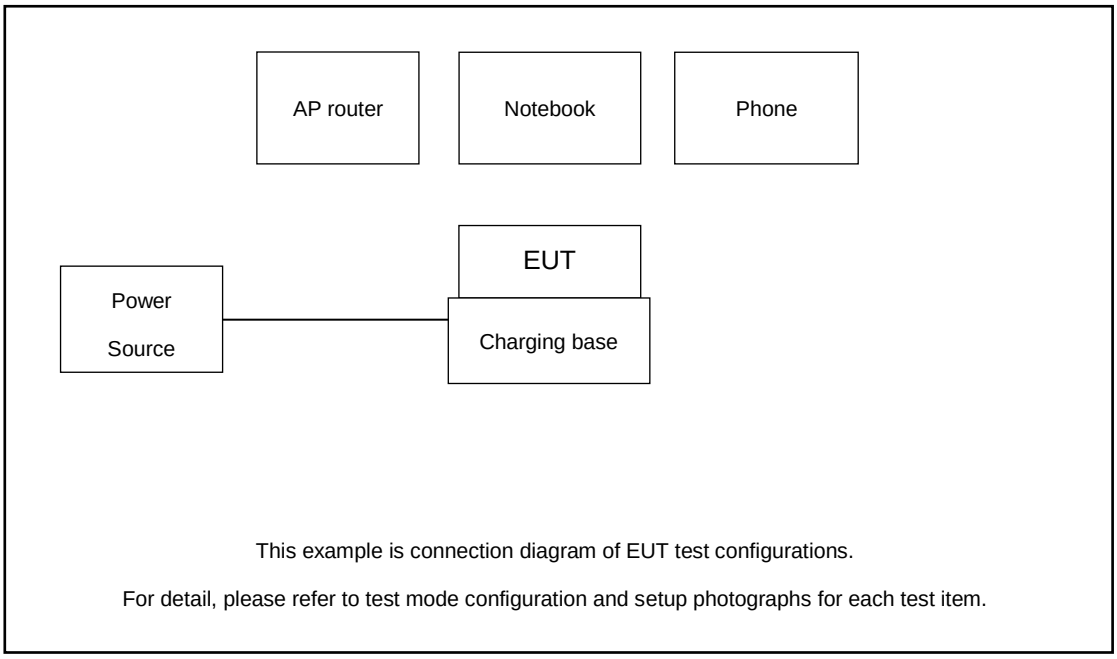
Ch. #		U-NII-1：5150-5250 MHz	U-NII-2A：5250-5350 MHz	U-NII-2C：5470-5725MHz
		802.11ac VHT20	802.11ac VHT20	802.11ac VHT20
L	Low	36	52	100
M	Middle	44	60	116
H	High	48	64	140
Straddle		-	-	144

Ch. #		U-NII-1：5150-5250 MHz	U-NII-2A：5250-5350 MHz	U-NII-2C：5470-5725MHz
		802.11ac VHT40	802.11ac VHT40	802.11ac VHT40
L	Low	38	54	102
M	Middle	-	-	110
H	High	46	62	134
Straddle		-	-	142

Ch. #		U-NII-1：5150-5250 MHz	U-NII-2A：5250-5350 MHz	U-NII-2C：5470-5725MHz
		802.11ac VHT80	802.11ac VHT80	802.11ac VHT80
L	Low	-	-	106
M	Middle	42	58	-
H	High	-	-	122
Straddle		-	-	138

2.3 Connection Diagram of Test System

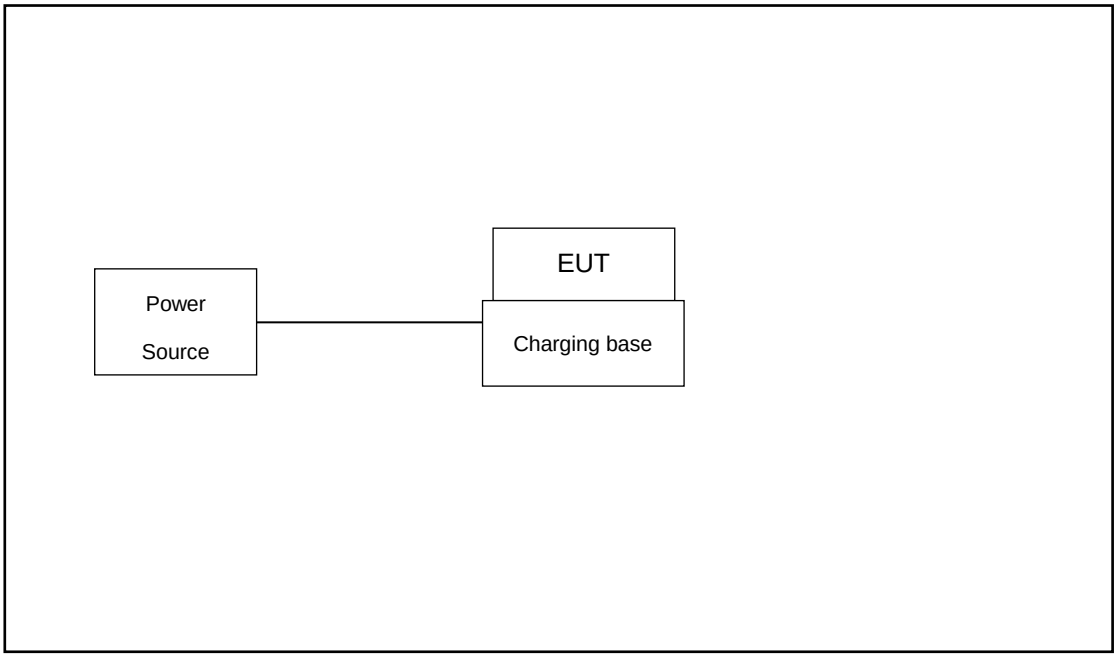
For Conducted Emission:



This example is connection diagram of EUT test configurations.

For detail, please refer to test mode configuration and setup photographs for each test item.

For Radiation:



2.4 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	WLAN AP	D-link	DIR-655	KA21R655B1	N/A	Unshielded, 1.8m
2.	Notebook	Lenovo	G480	QDS-BRCM1050I	N/A	AC I/P: Unshielded, 1.8 m DC O/P: Shielded, 1.8 m
3.	Mobile Phone	MOTO	N/A	N/A	N/A	N/A

2.5 EUT Operation Test Setup

For WLAN RF test items, an engineering test program was provided and enabled to make EUT continuously transmit/receive.

For AC power line conducted emissions, the EUT was set to connect with the WLAN AP under large package sizes transmission.

2.6 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Example :

The spectrum analyzer offset is derived from RF cable loss.

Offset = RF cable loss.

Following shows an offset computation example with cable loss 7.2 dB.

Offset(dB) = RF cable loss(dB).

= 7.2 (dB)

3 Test Result

3.1 26dB & 99% Occupied Bandwidth Measurement

3.1.1 Description of 26dB & 99% Occupied Bandwidth

This section is for reporting purpose only.

There is no restriction limits for bandwidth.

For Straddle Channel, According to KDB 789033 D02 General UNII Test Procedures New Rules v02r01, If the power and PSD of the devices are uniform and comply with the lower limits specified for the U-NII-2 bands, a single measurement over the entire emission bandwidth can be performed to show compliance.

3.1.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.1.3 Test Procedures

1. The testing follows FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01. Section C) Emission bandwidth
2. Set RBW = approximately 1% of the emission bandwidth.
3. Set the VBW > RBW.
4. Detector = Peak.
5. Trace mode = max hold
6. Measure the maximum width of the emission that is 26 dB down from the peak of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.
7. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) is set 1MHz and set the Video bandwidth (VBW) ≥ 3 * RBW.
8. Measure and record the results in the test report.

3.1.4 Test Setup

3.1.5 Test Result of 26dB & 99% Occupied Bandwidth

Please refer to Appendix A.

3.2 Maximum Conducted Output Power Measurement

3.2.1 Limit of Maximum Conducted Output Power

<FCC 14-30 CFR 15.407>

For mobile and portable client devices in the 5.15 – 5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW.

For the 5.25–5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or 11 dBm 10 log B, where B is the 26 dB emission bandwidth in megahertz.

For the 5.47–5.6 GHz and 5.65–5.725 GHz band, the maximum conducted output power shall not exceed 250 mW or 11 + 10 log10 B, dBm, whichever power is less. The maximum e.i.r.p. shall not exceed 1.0 W or 17 + 10 log10B, dBm, whichever is less. B is the 99% emission bandwidth in megahertz.

For Straddle Channel, According to KDB 789033 D02 General UNII Test Procedures New Rules v02r01, If the power and PSD of the devices are uniform and comply with the lower limits specified for the U-NII-2 bands, a single measurement over the entire emission bandwidth can be performed to show compliance.

If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Note that U-NII-2 band, devices with a maximum e.i.r.p. greater than 500 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

3.2.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.2.3 Test Procedures

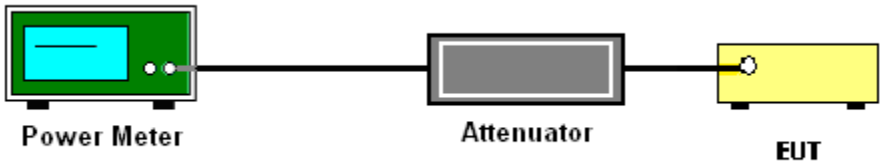
The testing follows Method PM of FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01.

Method PM (Measurement using an RF average power meter):

1. Measurement is performed using a wideband RF power meter.
2. The EUT is configured to transmit continuously with a consistent duty cycle at its maximum power control level.
3. Measure the average power of the transmitter, and the average power is corrected with duty factor, 10 log(1/x), where x is the duty cycle.

For Straddle Channel, According to KDB 789033 D02 General UNII Test Procedures New Rules v02r01, If the power and PSD of the devices are uniform and comply with the lower limits specified for the U-NII-2 bands, a single measurement over the entire emission bandwidth can be performed to show compliance.

3.2.4 Test Setup



3.2.5 Test Result of Maximum Conducted Output Power

FCC U-NII-1 MIMO												
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Average Conducted Power with duty factor (dBm)			FCC Conducted Power Limit (dBm)		DG (dBi)		Pass/Fail
					Ant 1	Ant 2	SUM	Ant 1	Ant 2	Ant 1	Ant 2	
11a	6Mbps	2	36	5180	14.26	15.06	17.69	23.98		3.75		Pass
11a	6Mbps	2	40	5200	16.79	17.33	20.08	23.98		3.75		Pass
11a	6Mbps	2	48	5240	16.59	17.45	20.05	23.98		3.75		Pass
HT20	MCS0	2	36	5180	14.50	15.58	18.08	23.98		3.75		Pass
HT20	MCS0	2	40	5200	16.62	17.42	20.05	23.98		3.75		Pass
HT20	MCS0	2	48	5240	16.21	17.27	19.78	23.98		3.75		Pass
HT40	MCS0	2	38	5190	12.74	13.88	16.36	23.98		3.75		Pass
HT40	MCS0	2	46	5230	17.44	18.45	20.98	23.98		3.75		Pass
VHT20	MCS0	2	36	5180	14.73	15.71	18.26	23.98		3.75		Pass
VHT20	MCS0	2	40	5200	16.76	17.59	20.20	23.98		3.75		Pass
VHT20	MCS0	2	48	5240	16.49	17.43	19.99	23.98		3.75		Pass
VHT40	MCS0	2	38	5190	13.02	14.16	16.64	23.98		3.75		Pass
VHT40	MCS0	2	46	5230	17.77	18.79	21.32	23.98		3.75		Pass
VHT80	MCS0	2	42	5210	10.68	11.74	14.25	23.98		3.75		Pass

FCC U-NII-2A MIMO													
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Average Conducted Power with duty factor (dBm)			FCC Conducted Power Limit (dBm)		DG (dBi)		EIRP Power Limit (dBm)	Pass/Fail
					Ant 1	Ant 2	SUM	Ant 1	Ant 2	Ant 1	Ant 2		
11a	6Mbps	2	52	5260	14.65	15.57	18.15	23.98		5.59		26.99	Pass
11a	6Mbps	2	56	5280	15.11	16.12	18.66	23.98		5.59		26.99	Pass
11a	6Mbps	2	64	5320	15.23	15.73	18.50	23.98		5.59		26.99	Pass
HT20	MCS0	2	52	5260	16.40	17.29	19.88	23.98		5.59		26.99	Pass
HT20	MCS0	2	56	5280	16.44	15.49	19.00	23.98		5.59		26.99	Pass
HT20	MCS0	2	64	5320	14.62	15.88	18.30	23.98		5.59		26.99	Pass
HT40	MCS0	2	54	5270	16.79	17.47	20.15	23.98		5.59		26.99	Pass
HT40	MCS0	2	62	5310	12.80	13.70	16.28	23.98		5.59		26.99	Pass
VHT20	MCS0	2	52	5260	16.55	17.50	20.06	23.98		5.59		26.99	Pass
VHT20	MCS0	2	56	5280	16.61	15.63	19.16	23.98		5.59		26.99	Pass
VHT20	MCS0	2	64	5320	14.76	16.01	18.44	23.98		5.59		26.99	Pass
VHT40	MCS0	2	54	5270	16.63	17.67	20.20	23.98		5.59		26.99	Pass
VHT40	MCS0	2	62	5310	13.13	13.98	16.59	23.98		5.59		26.99	Pass
VHT80	MCS0	2	58	5290	9.02	10.27	12.88	23.98		5.59		26.99	Pass

FCC U-NII-2C MIMO													
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Average Conducted Power with duty factor (dBm)			FCC Conducted Power Limit (dBm)		DG (dBi)		EIRP Power Limit (dBm)	Pass/Fail
					Ant 1	Ant 2	SUM	Ant 1	Ant 2	Ant 1	Ant 2		
11a	6Mbps	2	100	5500	15.64	14.93	18.31	23.29		6.69		26.99	Pass
11a	6Mbps	2	116	5580	15.55	15.06	18.32	23.29		6.69		26.99	Pass
11a	6Mbps	2	140	5700	13.19	13.18	16.20	23.29		6.69		26.99	Pass
11a	6Mbps	2	144	5720	15.01	14.97	18.00	23.29		6.69		26.99	Pass
HT20	MCS0	2	100	5500	15.64	15.11	18.39	23.29		6.69		26.99	Pass
HT20	MCS0	2	116	5580	16.20	15.58	18.91	23.29		6.69		26.99	Pass
HT20	MCS0	2	140	5700	14.80	15.16	17.99	23.29		6.69		26.99	Pass
HT20	MCS0	2	144	5720	15.95	16.05	19.01	23.29		6.69		26.99	Pass
HT40	MCS0	2	102	5510	15.05	14.25	17.68	23.29		6.69		26.99	Pass
HT40	MCS0	2	110	5550	16.00	15.72	18.87	23.29		6.69		26.99	Pass
HT40	MCS0	2	134	5670	16.40	16.10	19.26	23.29		6.69		26.99	Pass
HT40	MCS0	2	142	5710	15.80	16.06	18.94	23.29		6.69		26.99	Pass
VHT20	MCS0	2	100	5500	15.81	15.25	18.55	23.29		6.69		26.99	Pass
VHT20	MCS0	2	116	5580	16.33	15.81	19.09	23.29		6.69		26.99	Pass
VHT20	MCS0	2	140	5700	14.90	15.30	18.11	23.29		6.69		26.99	Pass
VHT20	MCS0	2	144	5720	16.21	16.28	19.25	23.29		6.69		26.99	Pass
VHT40	MCS0	2	102	5510	15.48	14.55	18.05	23.29		6.69		26.99	Pass
VHT40	MCS0	2	110	5550	16.34	16.03	19.20	23.29		6.69		26.99	Pass
VHT40	MCS0	2	134	5670	16.66	16.25	19.47	23.29		6.69		26.99	Pass
VHT40	MCS0	2	142	5710	16.13	16.41	19.29	23.29		6.69		26.99	Pass
VHT80	MCS0	2	106	5530	10.15	9.40	12.80	23.29		6.69		26.99	Pass
VHT80	MCS0	2	122	5610	16.07	15.74	18.92	23.29		6.69		26.99	Pass
VHT80	MCS0	2	138	5690	16.31	15.90	19.12	23.29		6.69		26.99	Pass

3.3 Power Spectral Density Measurement

3.3.1 Limit of Power Spectral Density

<FCC 14-30 CFR 15.407>

For mobile and portable client devices in the 5.15 – 5.25 GHz band, the maximum power spectral density shall not exceed 11dBm in any 1 megahertz band.

For the 5.25–5.725 GHz bands, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band.

For Straddle Channel, According to KDB 789033 D02 General UNII Test Procedures New Rules v02r01, If the power and PSD of the devices are uniform and comply with the lower limits specified for the U-NII-2 bands, a single measurement over the entire emission bandwidth can be performed to show compliance.

If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

3.3.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.3.3 Test Procedures

The testing follows FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01.

Section F) Maximum power spectral density.

 # Method SA-2 #

(trace averaging across on and off times of the EUT transmissions, followed by duty cycle correction).

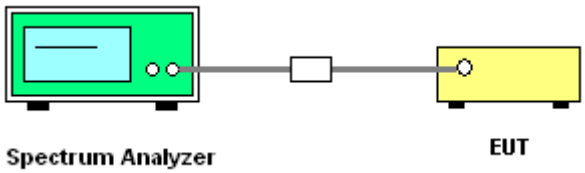
- Measure the duty cycle.
- Set span to encompass the entire emission bandwidth (EBW) of the signal.
- Set RBW = 1 MHz.
- Set VBW ≥ 3 MHz.
- Number of points in sweep ≥ 2 Span / RBW.
- Sweep time = auto.
- Detector = RMS
- Trace average at least 100 traces in power averaging mode.
- Add 10 log(1/x), where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times. For example, add 10 log(1/0.25) = 6 dB if the duty cycle is 25 percent.

1. The RF output of EUT was connected to the spectrum analyzer by a low loss cable.
2. Each plot has already offset with cable loss, and attenuator loss. Measure the PPSD and record it.
3. For MIMO mode, calculation method follows FCC KDB 662911 D01 Multiple Transmitter Output v02r01.

Method (a): Measure and sum the spectra across the outputs.

The total final Power Spectral Density is from a device with 2 transmitter outputs. The spectrum measurements of the individual outputs are all performed with the same span and number of points, the spectrum value in the first spectral bin of output 1 is summed with that in the first spectral bin of output 2 to obtain the value for the first frequency bin of the summed spectrum.

3.3.4 Test Setup



3.3.5 Test Result of Power Spectral Density

Please refer to Appendix A.

3.4 Unwanted Emissions Measurement

This section is to measure unwanted emissions through radiated measurement for band edge spurious emissions and out of band emissions measurement.

3.4.1 Limit of Unwanted Emissions

(1) For transmitters operating in the 5150-5250 MHz band: all emissions outside of the 5150-5350 MHz band shall not exceed an EIRP of –27dBm/MHz.

For transmitters operating in the 5250-5350 MHz band: all emissions outside of the 5150-5350 MHz band shall not exceed an EIRP of -27 dBm/MHz. Devices operating in the 5250-5350 MHz band that generate emissions in the 5150-5250 MHz band must meet all applicable technical requirements for operation in the 5150-5250 MHz band (including indoor use) or alternatively meet an out-of-band emission EIRP limit of -27 dBm/MHz in the 5150-5250 MHz band.

For transmitters operating in the 5470-5600 MHz and 5650-5725MHz band: all emissions outside of the 5470-5600 MHz and 5650-5725MHz band shall not exceed an EIRP of -27 dBm/MHz.

(2) Unwanted spurious emissions fallen in restricted bands shall comply with the general field strength limits as below table,

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 - 960	200	3
Above 960	500	3

EIRP (dBm)	Field Strength at 3m (dBμV/m)
- 27	68.3

Note: The following formula is used to convert the EIRP to field strength.

$$EIRP = E_{Meas} + 20\log(d_{Meas}) - 104.7$$

where

EIRP is the equivalent isotropically radiated power, in dBm

E_{Meas} is the field strength of the emission at the measurement distance, in dBμV/m

d_{Meas} is the measurement distance, in m

3.4.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.4.3 Test Procedures

1. The testing follows FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01. Section G) Unwanted emissions measurement.

   (1) Procedure for Unwanted Emissions Measurements Below 1000MHz

   - RBW = 120 kHz
   - VBW = 300 kHz
   - Detector = Peak
   - Trace mode = max hold

   (2) Procedure for Peak Unwanted Emissions Measurements Above 1000 MHz

   - RBW = 1 MHz
   - VBW ≥ 3 MHz
   - Detector = Peak
   - Sweep time = auto
   - Trace mode = max hold

   (3) Procedures for Average Unwanted Emissions Measurements Above 1000MHz

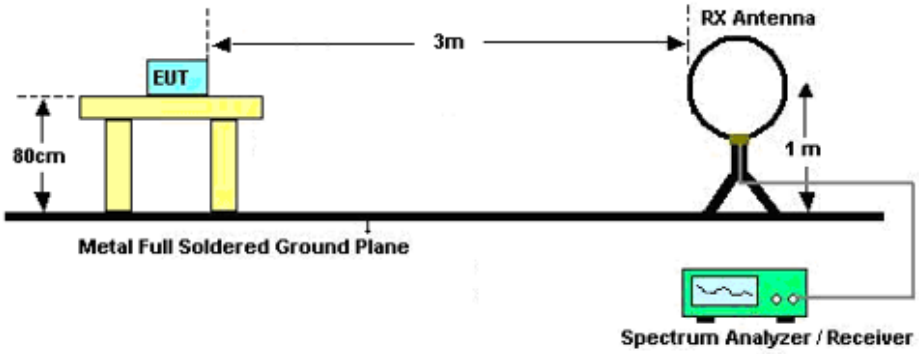
   - RBW = 1 MHz
   - VBW = 10 Hz, when duty cycle is no less than 98 percent.
   - VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

2. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
3. The EUT was set 3 meters from the interference receiving antenna which was mounted on the top of a variable height antenna tower.

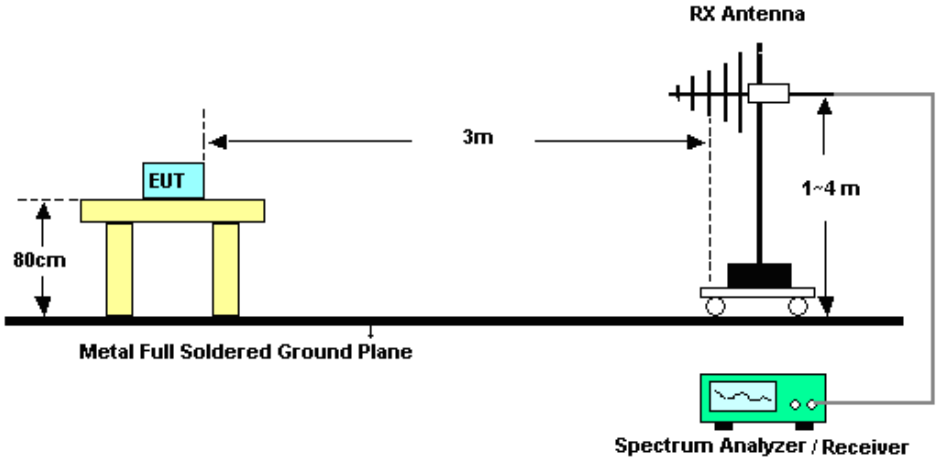
4. The antenna is a broadband antenna and its height is adjusted between one meter and four meters above ground to find the maximum value of the field strength for both horizontal polarization and vertical polarization of the antenna.
5. For each suspected emission, the EUT was arranged to its worst case and then adjust the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading.
6. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
7. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than peak limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.

3.4.4 Test Setup

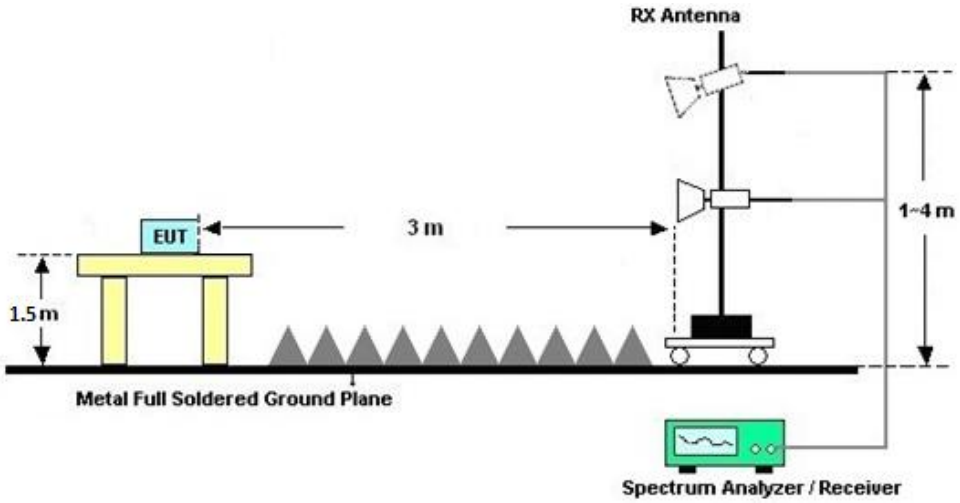
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



3.4.5 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line was not reported.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

3.4.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix C.

3.4.7 Duty Cycle

Please refer to Appendix D.

3.4.8 Test Result of Radiated Spurious Emissions (30MHz ~ 10th Harmonic or 40GHz, whichever is lower)

Please refer to Appendix C.

3.5 AC Conducted Emission Measurement

3.5.1 Limit of AC Conducted Emission

For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

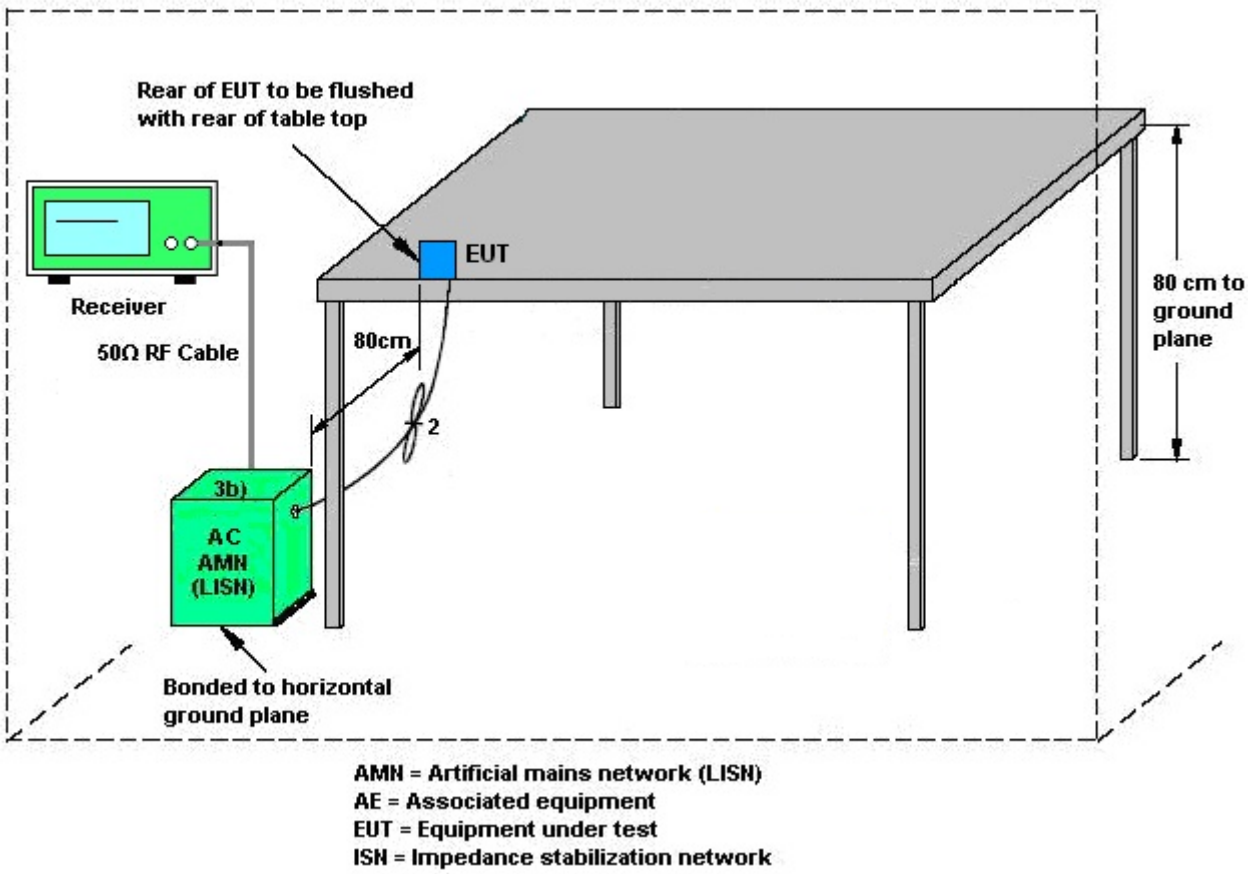
3.5.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.5.3 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth with Maximum Hold Mode.

3.5.4 Test Setup



3.5.5 Test Result of AC Conducted Emission

Please refer to Appendix B.

3.6 Antenna Requirements

3.6.1 Standard Applicable

If transmitting antenna directional gain is greater than 6 dBi, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

3.6.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.6.3 Antenna Gain

<MIMO Modes > for 802.11a

FCC KDB 662911 D01 Multiple Transmitter Output v02r01

The power and PSD limit should be modified if the directional gain of EUT is over 6 dBi,

The directional gain “DG” is calculated as following table.

	Ant. 1 (dBi)	Ant. 2 (dBi)	DG for Power (dBi)	DG for PSD (dBi)	Power Limit Reduction (dB)	PSD Limit Reduction (dB)
Band I	3.46	3.75	3.75	3.75	0.00	0.00
Band II	5.59	4.34	5.59	5.59	0.00	0.00
Band III	6.69	3.72	6.69	6.69	0.69	0.69

Power limit reduction = Composite gain – 6dBi, (min = 0)

PSD limit reduction = Composite gain + PSD Array gain – 6dBi, (min = 0)

<CDD Modes > for 802.11n/ac

FCC KDB 662911 D01 Multiple Transmitter Output v02r01

For CDD transmissions, directional gain is calculated as

Directional gain = GANT + Array Gain, where Array Gain is as follows.

For power spectral density (PSD) measurements on all devices,

Array Gain = 10 log(NANT/NSS=1) dB.

For power measurements on IEEE 802.11 devices,

Array Gain = 0 dB (i.e., no array gain) for NANT ≤ 4.

Directional gain may be calculated by using the formulas applicable to equal gain antennas with GANT set equal to the gain of the antenna having the highest gain;

The EUT supports CDD mode.

For power, the directional gain GANT is set equal to the antenna having the highest gain, i.e.,

F)2)f)i).

For PSD, the directional gain calculation is following F)2)f)ii) of KDB 662911 D01 v02r01.

The power and PSD limit should be modified if the directional gain of EUT is over 6 dBi,

The directional gain “DG” is calculated as following table.

<CDD Modes>

	Ant. 1 (dBi)	Ant. 2 (dBi)	DG for Power (dBi)	DG for PSD (dBi)	Power Limit Reduction (dB)	PSD Limit Reduction (dB)
Band I	3.46	3.75	3.75	6.62	0.00	0.62
Band II	5.59	4.34	5.59	8.00	0.00	2.00
Band III	6.69	3.72	6.69	8.34	0.69	2.34

Power limit reduction = Composite gain – 6dBi, (min = 0)

PSD limit reduction = Composite gain + PSD Array gain – 6dBi, (min = 0)

4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Spectrum Analyzer	R&S	FSV40	101040	10Hz~40GHz	Nov. 01, 2020	Sep. 15, 2021~ Sep. 18, 2021	Oct. 31, 2021	Conducted (TH01-KS)
Pulse Power Senor	Anritsu	MA2411B	0917070	300MHz~40GHz	Jan. 07, 2021	Sep. 15, 2021~ Sep. 18, 2021	Jan. 06, 2022	Conducted (TH01-KS)
Power Meter	Anritsu	ML2495A	1005002	50MHz Bandwidth	Jan. 07, 2021	Sep. 15, 2021~ Sep. 18, 2021	Jan. 06, 2022	Conducted (TH01-KS)
Temperature &hu midity chamber	Hongzhan	LP-150U	H2014011 440	-40~+150°C 20%~95%RH	Jul. 12, 2021	Sep. 15, 2021~ Sep. 18, 2021	Jul. 11, 2022	Conducted (TH01-KS)
EMI Test Receiver	Keysight	N9038A	MY564000 04	3Hz~8.5GHz;Ma x 30dBm	Oct. 17, 2020	Sep. 10, 2021	Oct. 16, 2021	Radiation (03CH05-KS)
EXA Spectrum Analyzer	Keysight	N9010A	MY551502 44	10Hz-44G,MAX 30dB	Apr. 13, 2021	Sep. 10, 2021	Apr. 12, 2022	Radiation (03CH05-KS)
Loop Antenna	R&S	HFH2-Z2	100321	9kHz~30MHz	Nov. 01, 2020	Sep. 10, 2021	Oct. 31, 2021	Radiation (03CH05-KS)
Bilog Antenna	TeseQ	CBL6111D	49922	30MHz-1GHz	Jun. 04, 2021	Sep. 10, 2021	Jun. 03, 2022	Radiation (03CH05-KS)
Double Ridge Horn Antenna	ETS-Lindgren	3117	00218652	1GHz~18GHz	Apr. 24, 2021	Sep. 10, 2021	Apr. 23, 2022	Radiation (03CH05-KS)
SHF-EHF Horn	Com-power	AH-840	101115	18GHz~40GHz	Nov. 10, 2020	Sep. 10, 2021	Nov. 09, 2021	Radiation (03CH05-KS)
Amplifier	SONOMA	310N	187289	9KHz-1GHz	Apr. 12, 2021	Sep. 10, 2021	Apr. 11, 2022	Radiation (03CH05-KS)
Amplifier	MITEQ	EM18G40GG A	060728	18~40GHz	Jan. 07, 2021	Sep. 10, 2021	Jan. 06, 2022	Radiation (03CH05-KS)
high gain Amplifier	MITEQ	AMF-7D-0010 1800-30-10P	2012228	1Ghz-18Ghz	Oct. 17, 2020	Sep. 10, 2021	Oct. 16, 2021	Radiation (03CH05-KS)
Amplifier	Keysight	83017A	MY532703 16	500MHz~26.5GH z	Oct. 17, 2020	Sep. 10, 2021	Oct. 16, 2021	Radiation (03CH05-KS)
AC Power Source	Chroma	61601	F1040900 04	N/A	NCR	Sep. 10, 2021	NCR	Radiation (03CH05-KS)
Turn Table	ChamPro	EM 1000-T	060762-T	0~360 degree	NCR	Sep. 10, 2021	NCR	Radiation (03CH05-KS)
Antenna Mast	ChamPro	EM 1000-A	060762-A	1 m~4 m	NCR	Sep. 10, 2021	NCR	Radiation (03CH05-KS)
EMI Receiver	R&S	ESCI7	100768	9kHz~7GHz;	Apr. 21, 2021	Sep. 15, 2021	Apr. 20, 2022	Conduction (CO01-KS)
AC LISN (for auxiliary equipment)	MessTec	AN3016	060103	9kHz~30MHz	Oct. 17, 2020	Sep. 15, 2021	Oct. 16, 2021	Conduction (CO01-KS)
AC LISN	R&S	ENV216	100334	9kHz~30MHz	Oct. 17, 2020	Sep. 15, 2021	Oct. 16, 2021	Conduction (CO01-KS)
AC Power Source	Chroma	61602	ABP00000 0811	AC 0V~300V, 45Hz~1000Hz	Oct. 17, 2020	Sep. 15, 2021	Oct. 16, 2021	Conduction (CO01-KS)

NCR: No Calibration Required.

5 Uncertainty of Evaluation

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI 63.10-2013. All the measurement uncertainty value were shown with a coverage K=2 to indicate 95% level of confidence. The measurement data show herein meets or exceeds the CISPR measurement uncertainty values specified in CISPR 16-4-2 and can be compared directly to specified limit to determine compliance.

Uncertainty of Conducted Emission Measurement (150kHz ~ 30MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**2.94dB**

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.0dB**

Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.0dB**

Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.0dB**

---------- THE END ----------

Appendix A. Conducted Test Results

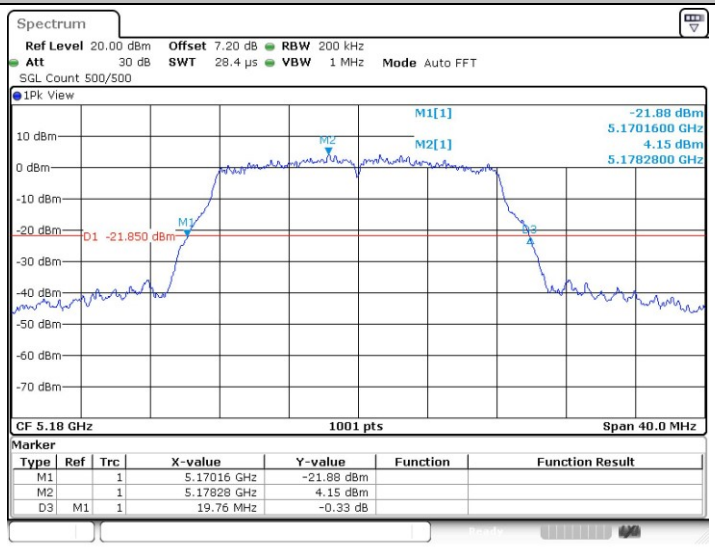
26dB Emission Bandwidth Test Result

TestMode	Antenna	FC[MHz]	26dB EBW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
11A-CDD	Ant1	5180	19.760	5170.160	5189.920	---	PASS
	Ant2	5180	19.640	5170.200	5189.840	---	PASS
	Ant1	5200	20.120	5189.920	5210.040	---	PASS
	Ant2	5200	19.840	5190.160	5210.000	---	PASS
	Ant1	5240	20.200	5229.760	5249.960	---	PASS
	Ant2	5240	19.960	5230.040	5250.000	---	PASS
	Ant1	5260	19.800	5250.080	5269.880	---	PASS
	Ant2	5260	20.000	5250.080	5270.080	---	PASS
	Ant1	5280	19.840	5270.000	5289.840	---	PASS
	Ant2	5280	20.080	5269.920	5290.000	---	PASS
	Ant1	5320	34.600	5302.720	5337.320	---	PASS
	Ant2	5320	19.840	5310.040	5329.880	---	PASS
	Ant1	5500	20.040	5489.960	5510.000	---	PASS
	Ant2	5500	19.920	5490.040	5509.960	---	PASS
	Ant1	5580	20.160	5570.000	5590.160	---	PASS
	Ant2	5580	20.000	5569.960	5589.960	---	PASS
	Ant1	5700	19.800	5690.200	5710.000	---	PASS
	Ant2	5700	19.720	5690.080	5709.800	---	PASS
	Ant1	5720	19.840	5710.080	5729.920	---	PASS
	Ant2	5720	19.600	5710.160	5729.760	---	PASS
11AC20MIMO	Ant1	5180	21.480	5168.960	5190.440	---	PASS
	Ant2	5180	20.240	5169.840	5190.080	---	PASS
	Ant1	5200	20.360	5189.840	5210.200	---	PASS
	Ant2	5200	20.320	5189.800	5210.120	---	PASS
	Ant1	5240	20.040	5229.960	5250.000	---	PASS
	Ant2	5240	20.320	5229.800	5250.120	---	PASS
	Ant1	5260	20.120	5249.880	5270.000	---	PASS
	Ant2	5260	20.200	5249.840	5270.040	---	PASS
	Ant1	5280	19.920	5270.040	5289.960	---	PASS
	Ant2	5280	20.120	5269.960	5290.080	---	PASS
	Ant1	5320	37.280	5301.360	5338.640	---	PASS
	Ant2	5320	20.080	5309.920	5330.000	---	PASS
	Ant1	5500	20.080	5489.960	5510.040	---	PASS

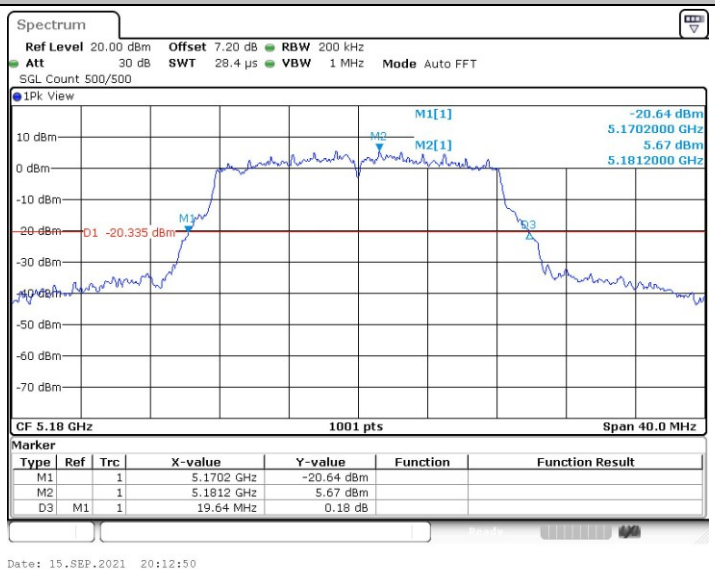
	Ant2	5500	20.280	5489.760	5510.040	---	PASS
	Ant1	5580	19.920	5570.000	5589.920	---	PASS
	Ant2	5580	20.280	5569.800	5590.080	---	PASS
	Ant1	5700	20.080	5689.920	5710.000	---	PASS
	Ant2	5700	20.000	5690.000	5710.000	---	PASS
	Ant1	5720	20.360	5709.840	5730.200	---	PASS
	Ant2	5720	20.360	5709.800	5730.160	---	PASS
11AC40MIMO	Ant1	5190	45.680	5169.360	5215.040	---	PASS
	Ant2	5190	39.920	5169.920	5209.840	---	PASS
	Ant1	5230	53.840	5196.960	5250.800	---	PASS
	Ant2	5230	40.640	5209.600	5250.240	---	PASS
	Ant1	5270	53.600	5237.120	5290.720	---	PASS
	Ant2	5270	40.240	5249.840	5290.080	---	PASS
	Ant1	5310	72.240	5274.640	5346.880	---	PASS
	Ant2	5310	39.920	5290.160	5330.080	---	PASS
	Ant1	5510	40.800	5489.440	5530.240	---	PASS
	Ant2	5510	39.680	5490.000	5529.680	---	PASS
	Ant1	5550	54.640	5528.240	5582.880	---	PASS
	Ant2	5550	40.000	5529.840	5569.840	---	PASS
	Ant1	5670	41.200	5649.360	5690.560	---	PASS
	Ant2	5670	40.160	5649.920	5690.080	---	PASS
	Ant1	5710	41.120	5689.360	5730.480	---	PASS
	Ant2	5710	40.160	5689.920	5730.080	---	PASS
11AC80MIMO	Ant1	5210	80.480	5169.360	5249.840	---	PASS
	Ant2	5210	80.320	5169.360	5249.680	---	PASS
	Ant1	5290	102.080	5233.360	5335.440	---	PASS
	Ant2	5290	79.680	5250.160	5329.840	---	PASS
	Ant1	5530	79.520	5490.320	5569.840	---	PASS
	Ant2	5530	79.840	5490.000	5569.840	---	PASS
	Ant1	5610	111.680	5552.880	5664.560	---	PASS
	Ant2	5610	116.160	5551.760	5667.920	---	PASS
	Ant1	5690	79.840	5650.160	5730.000	---	PASS
	Ant2	5690	92.000	5637.840	5729.840	---	PASS

Test Graphs

11A-CDD_Ant1_5180



11A-CDD_Ant2_5180



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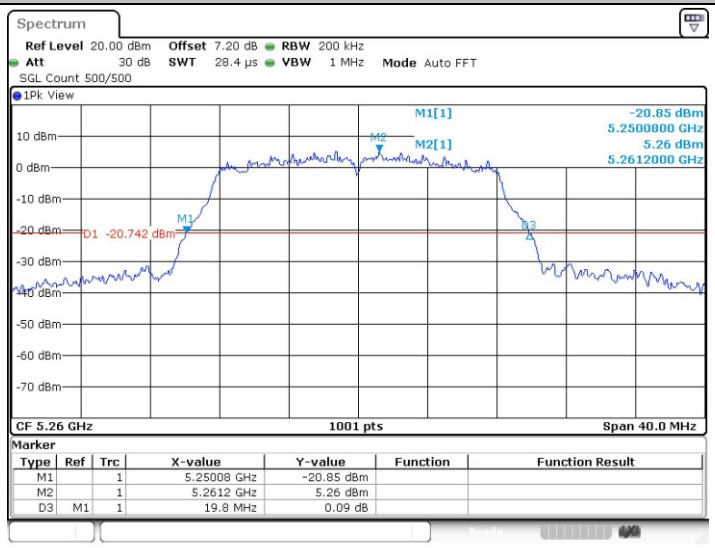
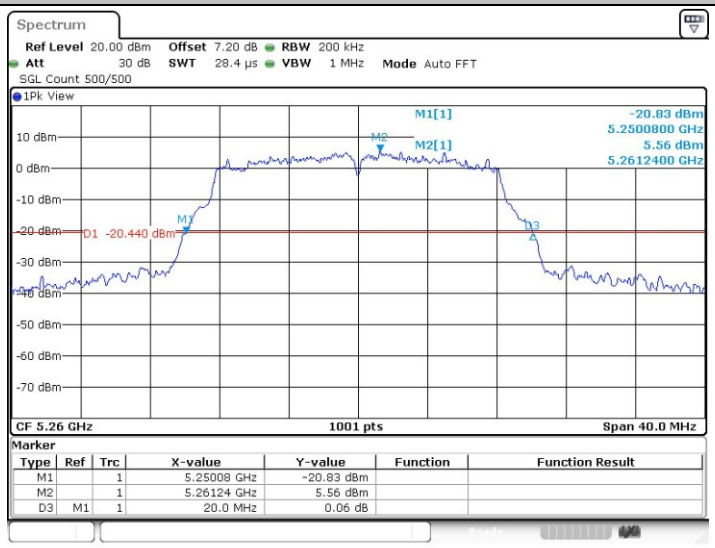


11A-CDD_Ant2_5260



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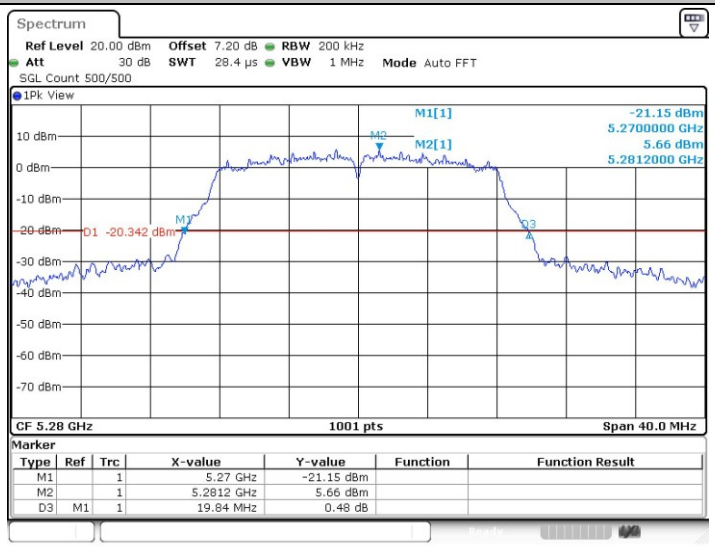
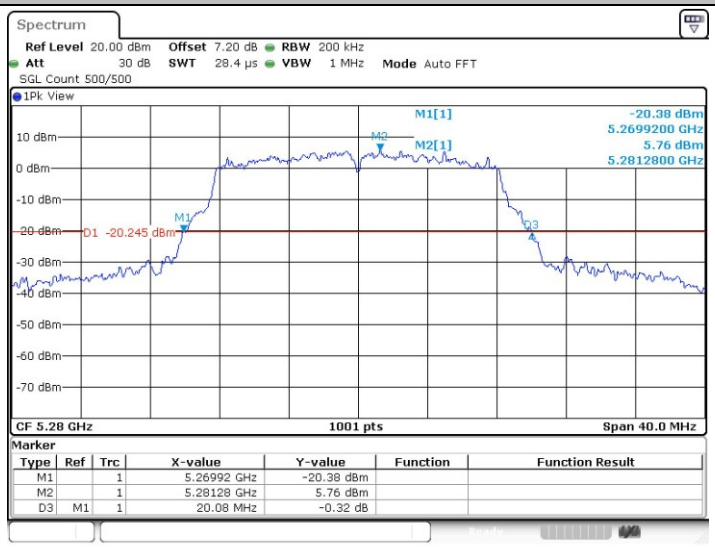


11A-CDD_Ant2_5280



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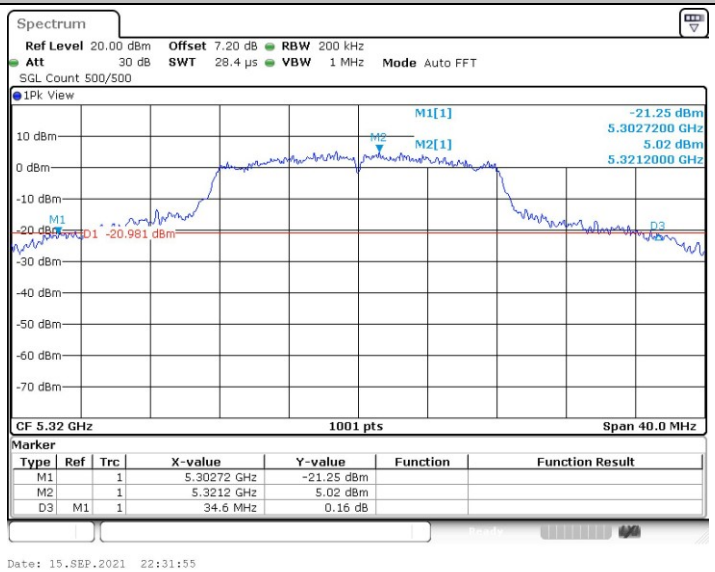

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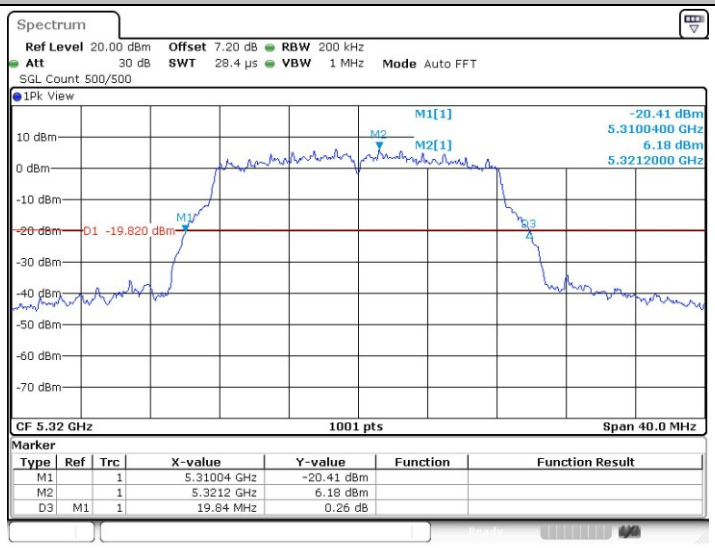

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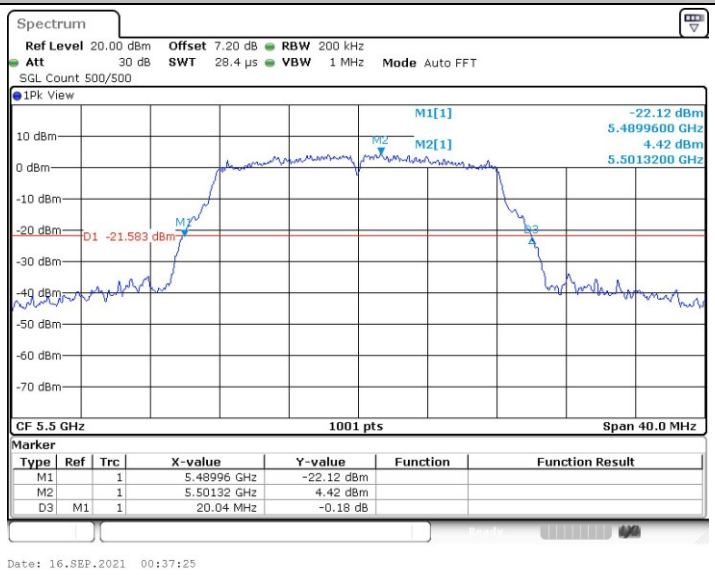

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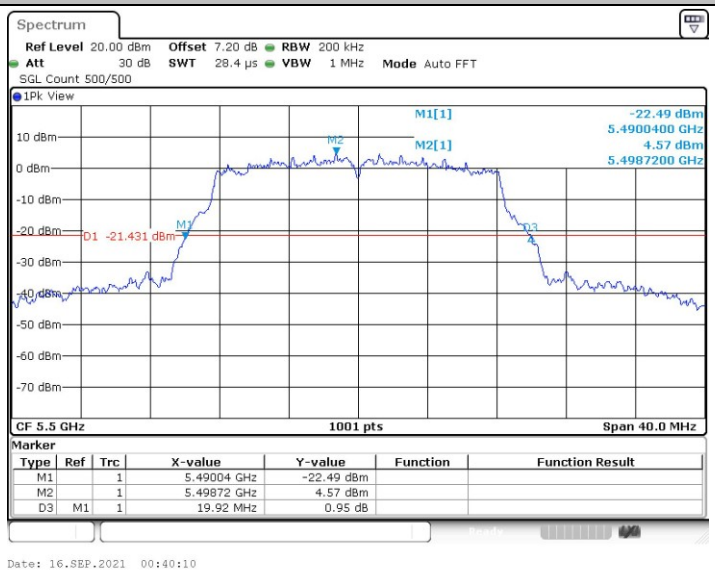
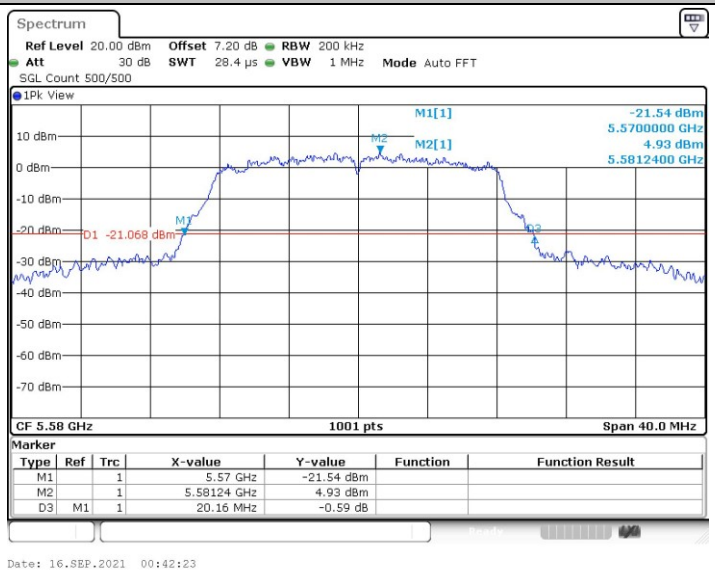


11A-CDD_Ant1_5580



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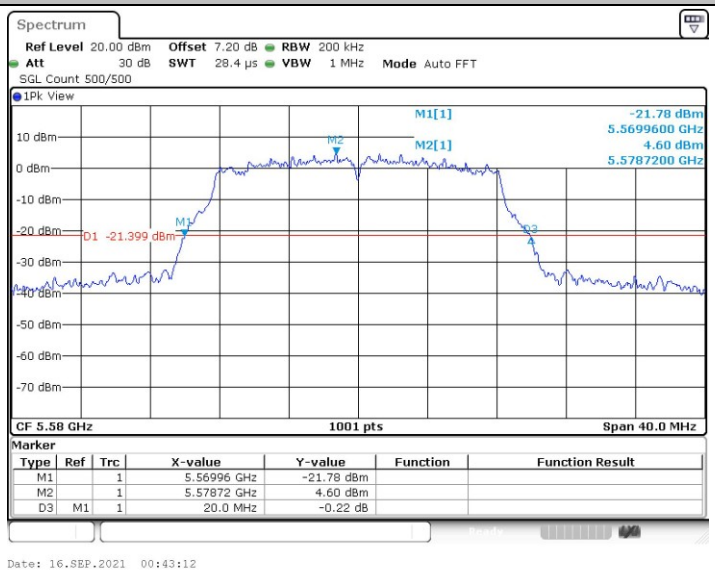

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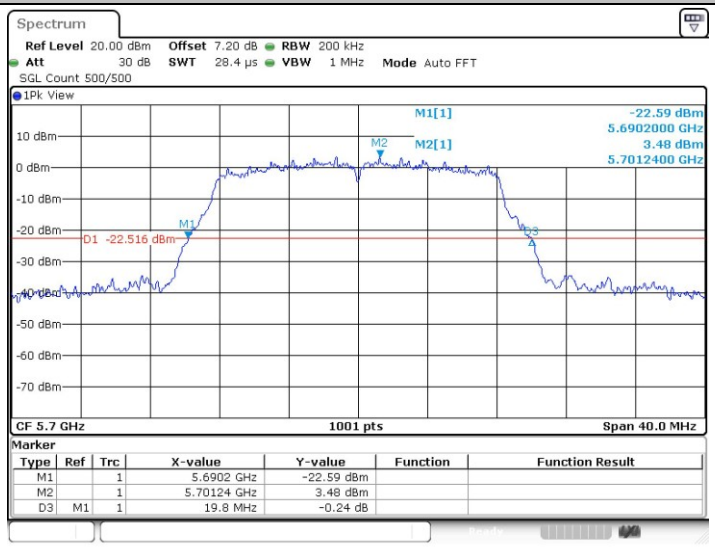

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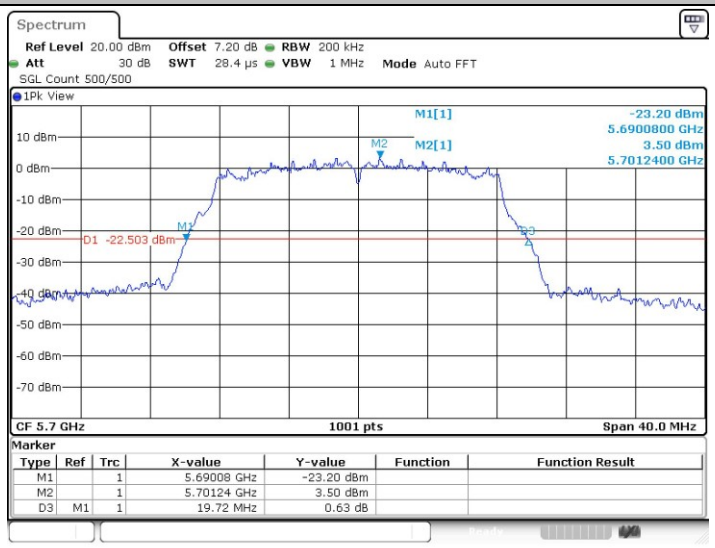

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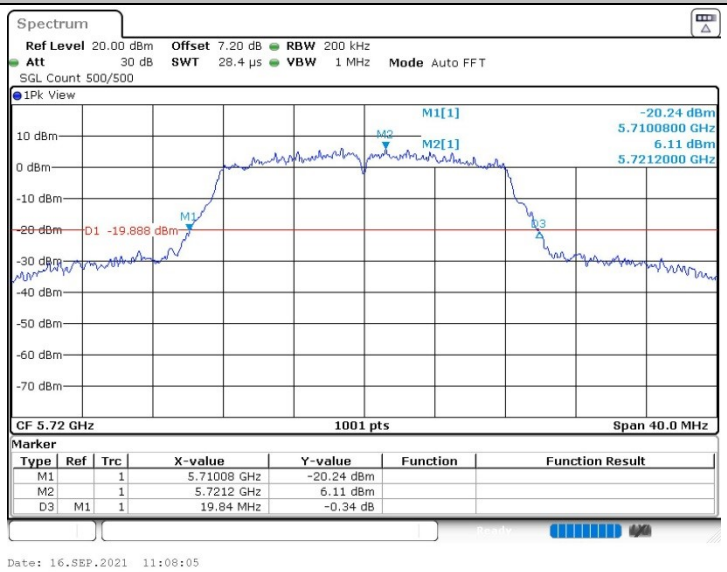

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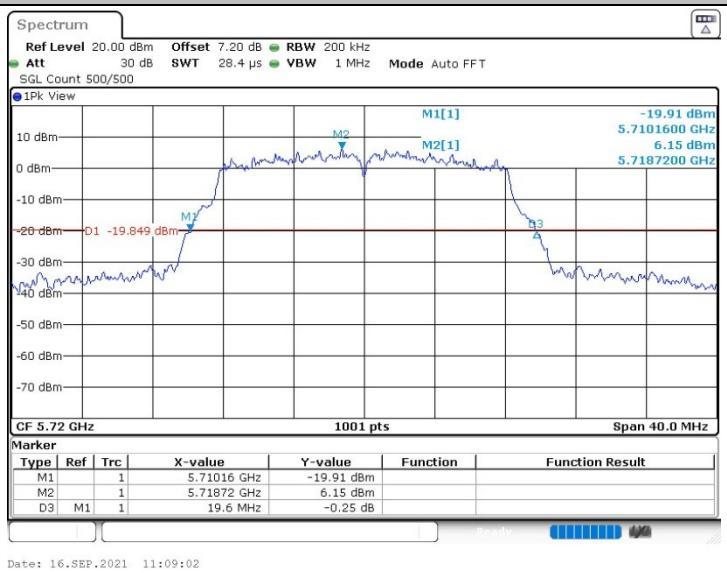

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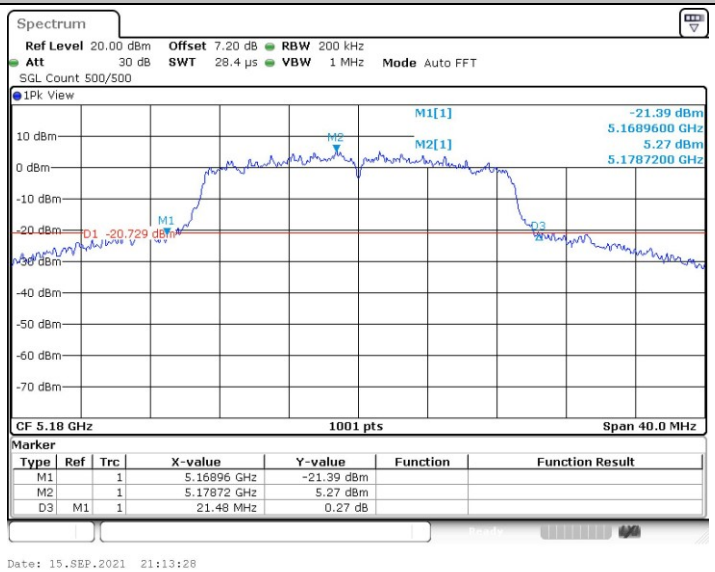

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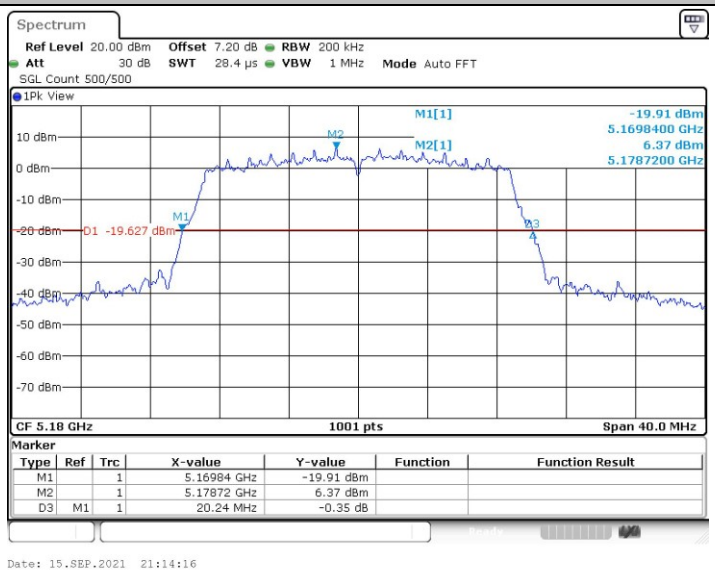

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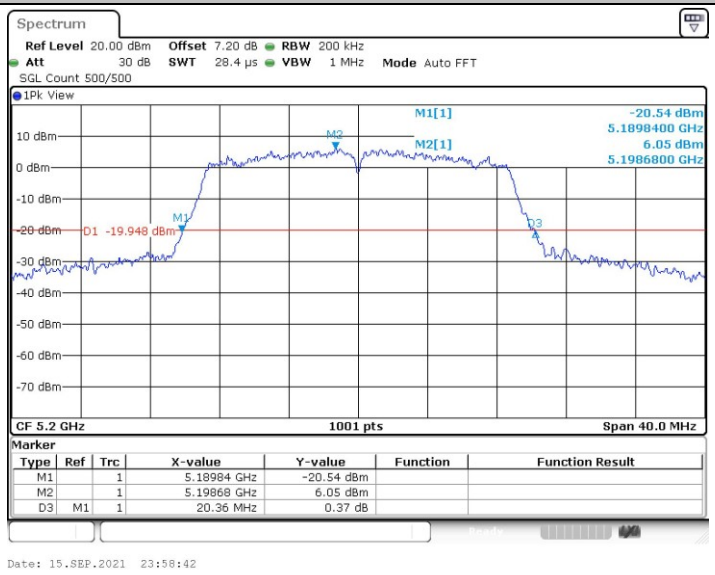

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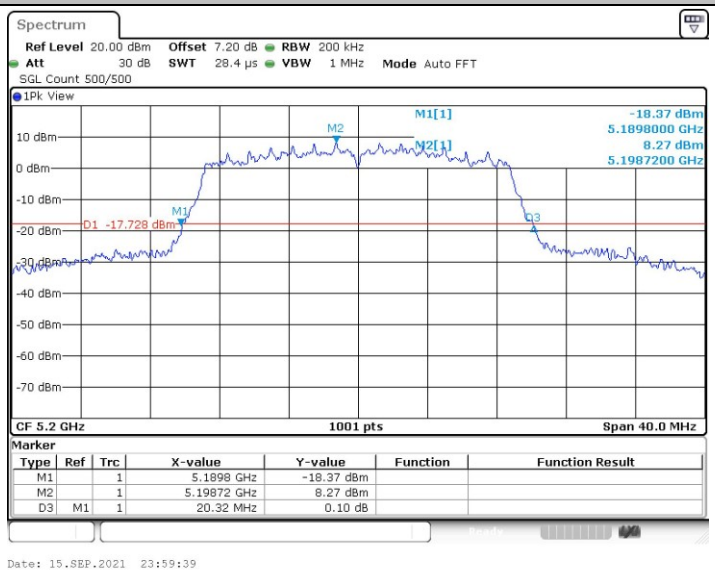

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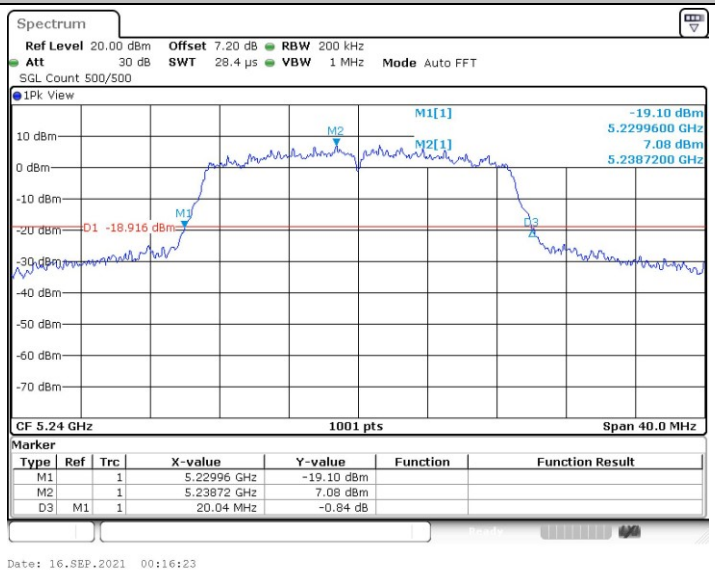

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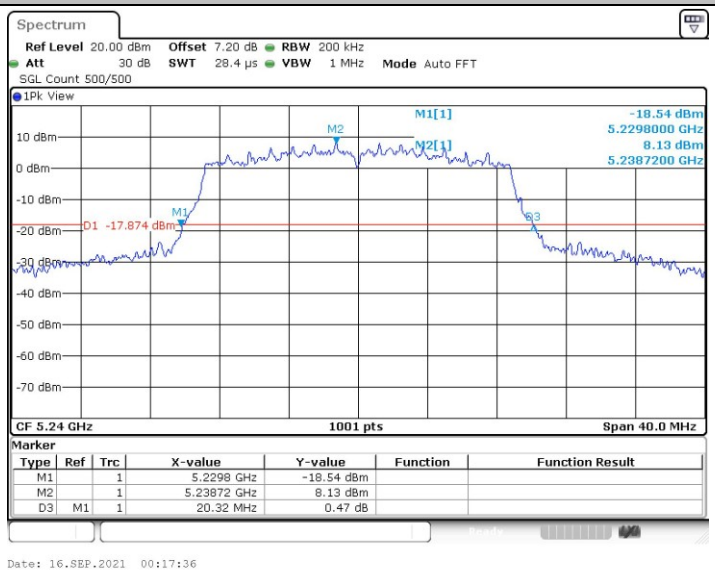

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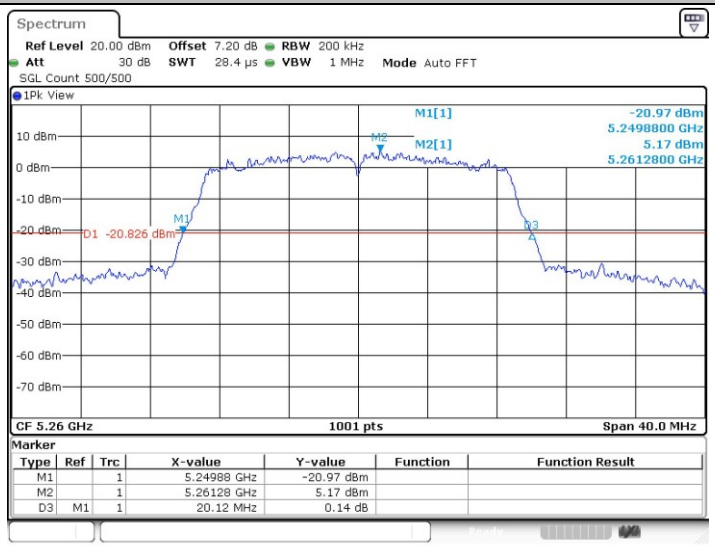

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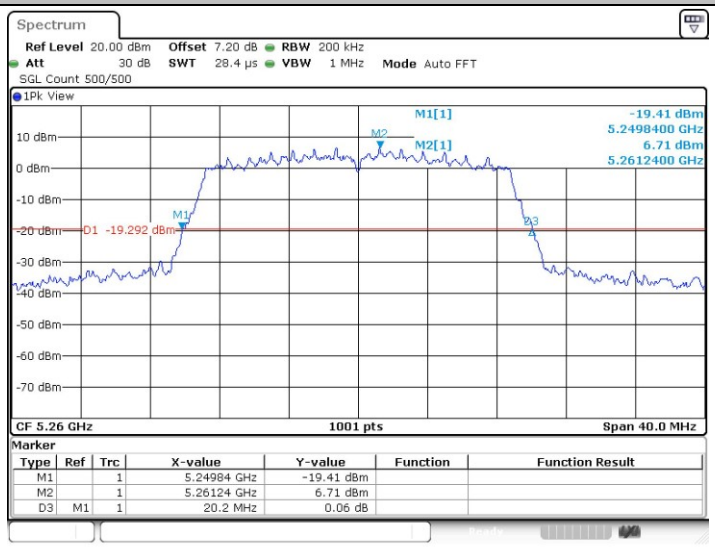
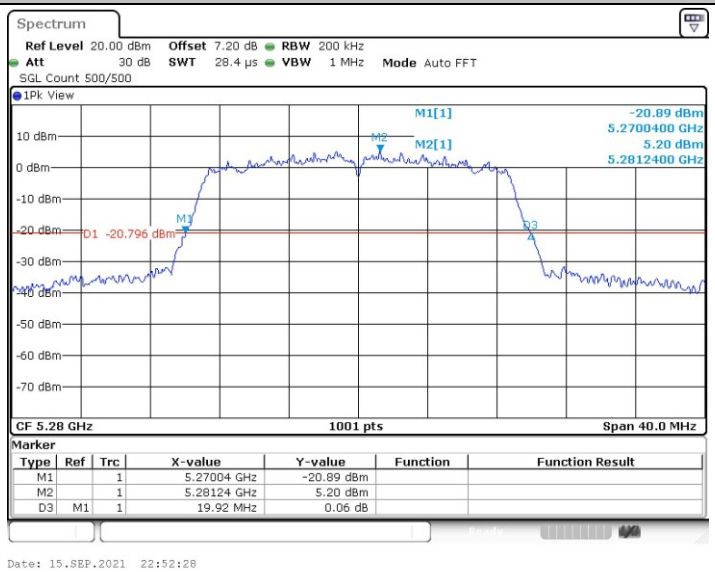


11AC20MIMO_Ant1_5280



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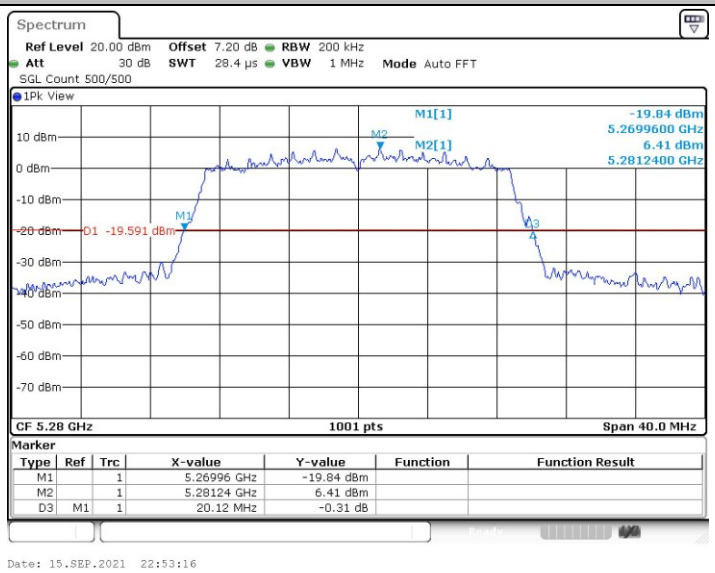

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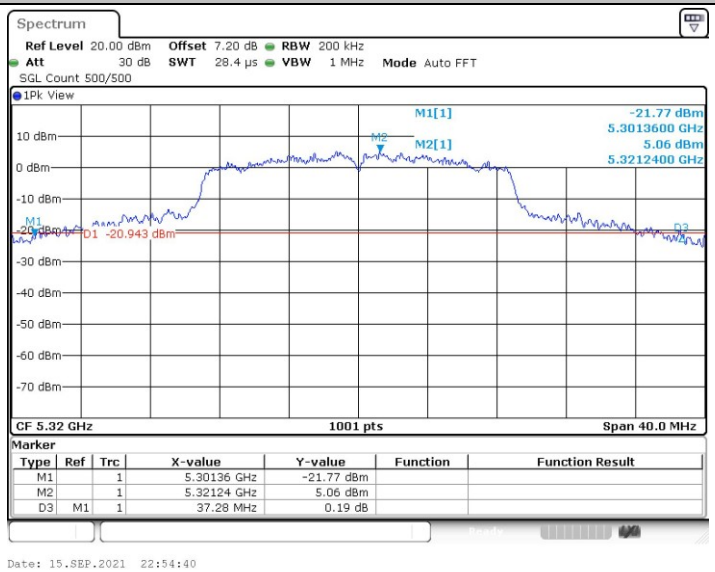

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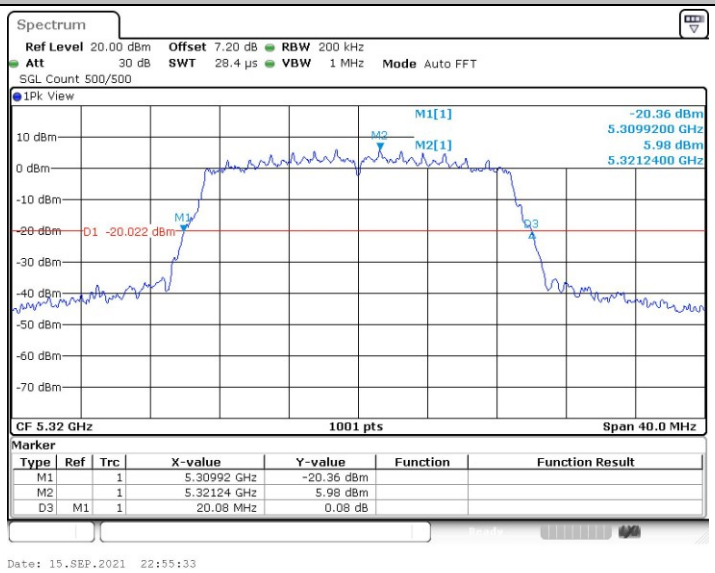

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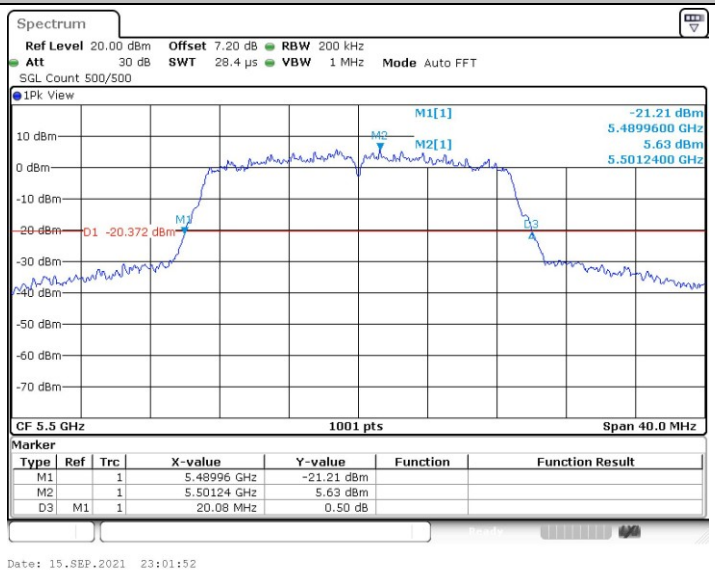

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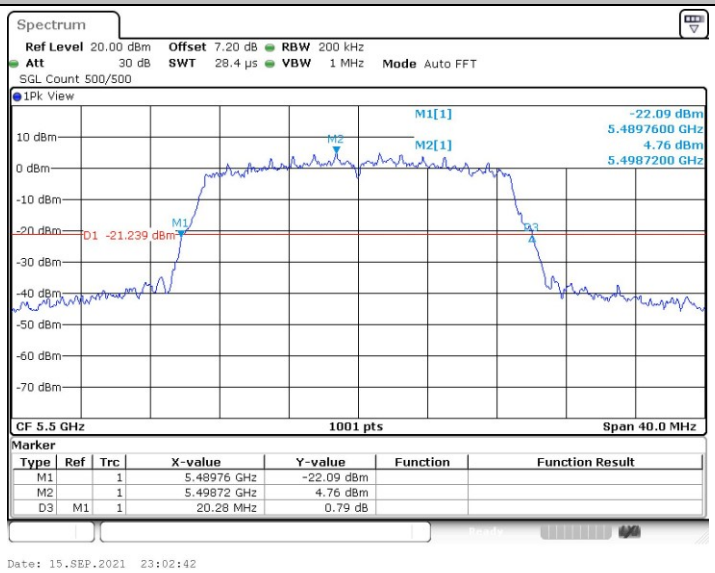

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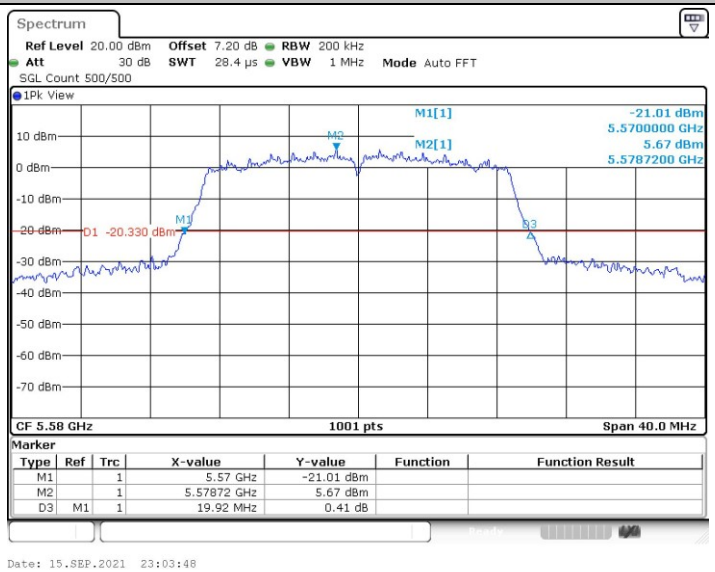

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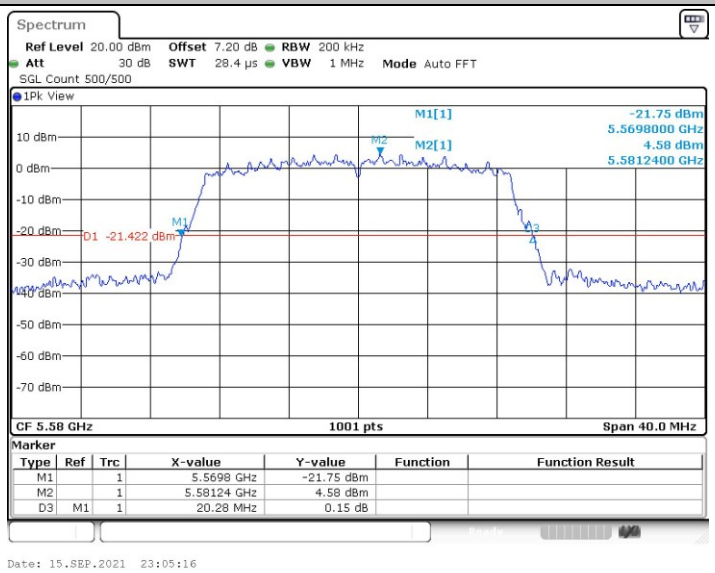

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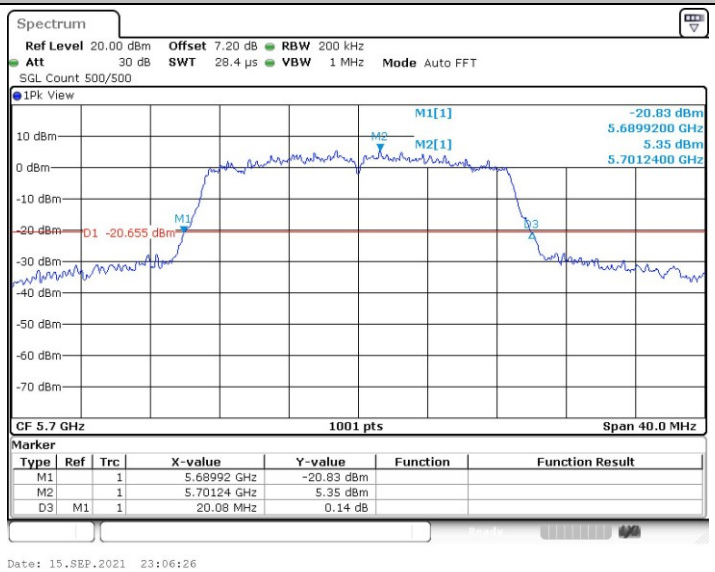

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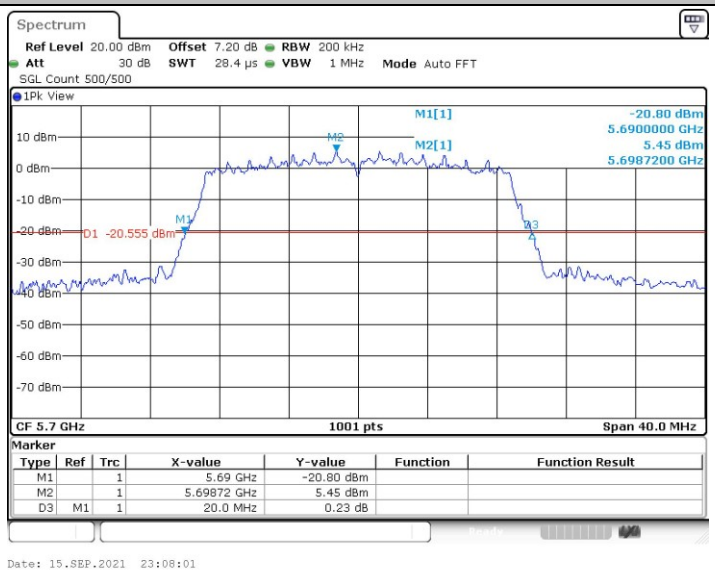

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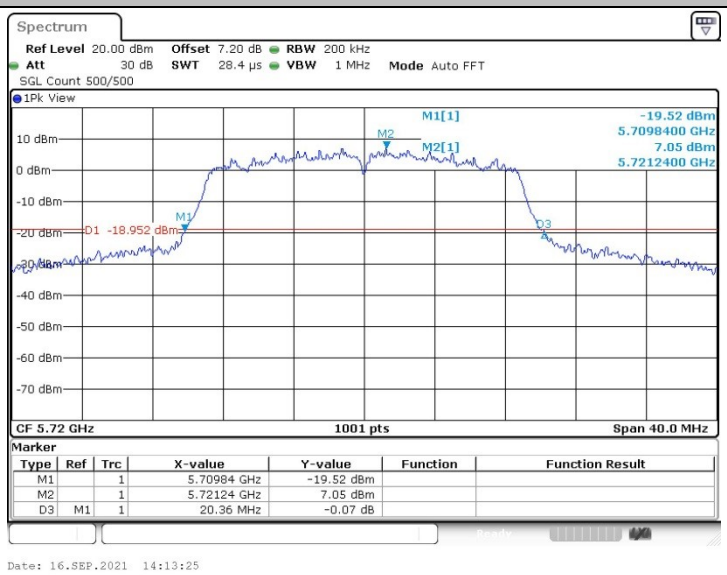

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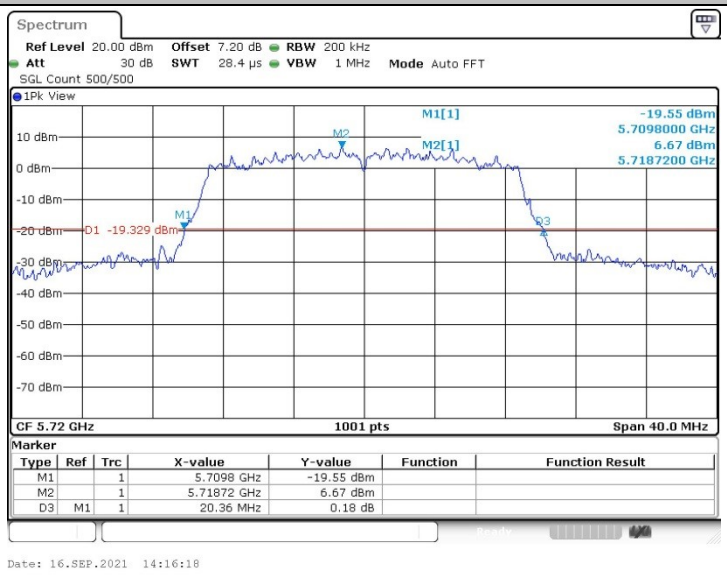

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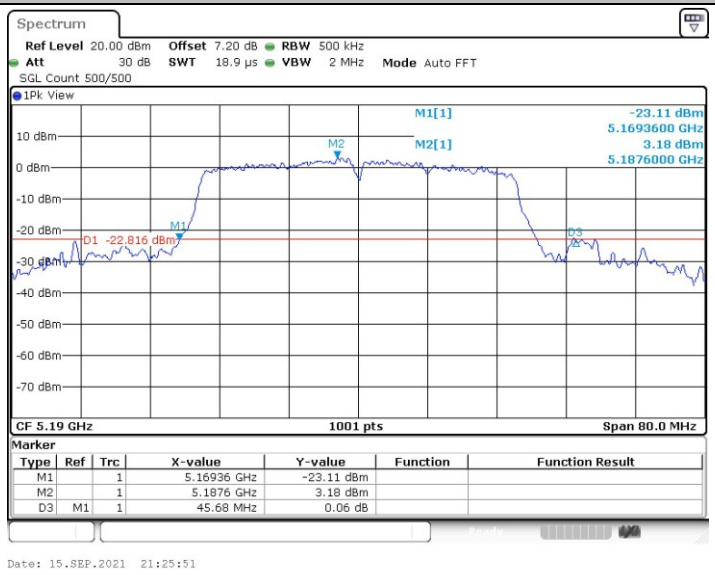

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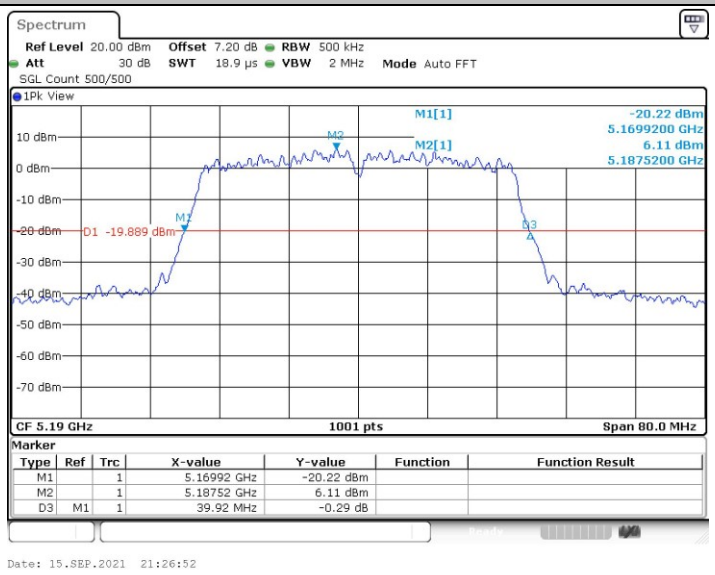

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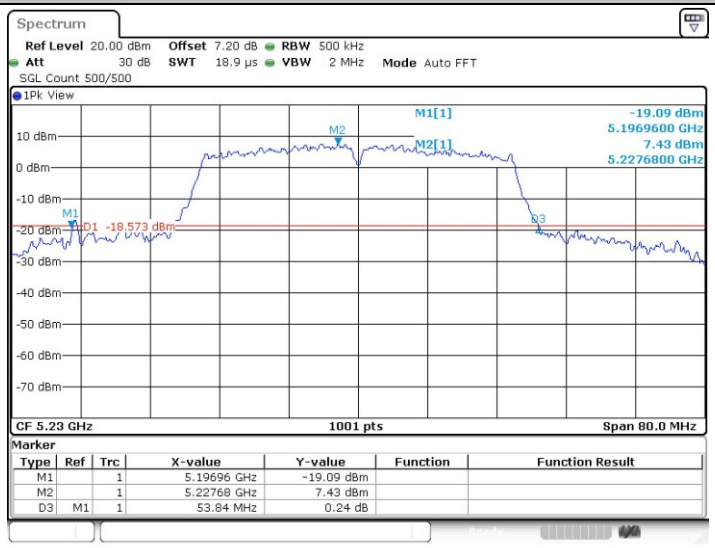

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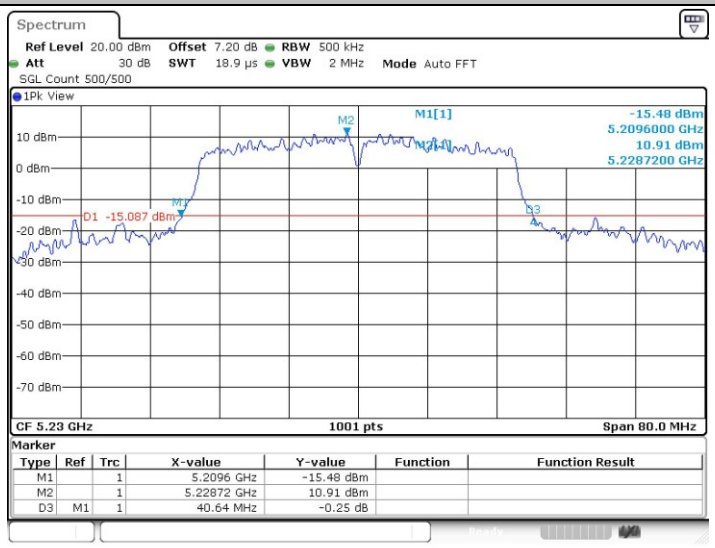

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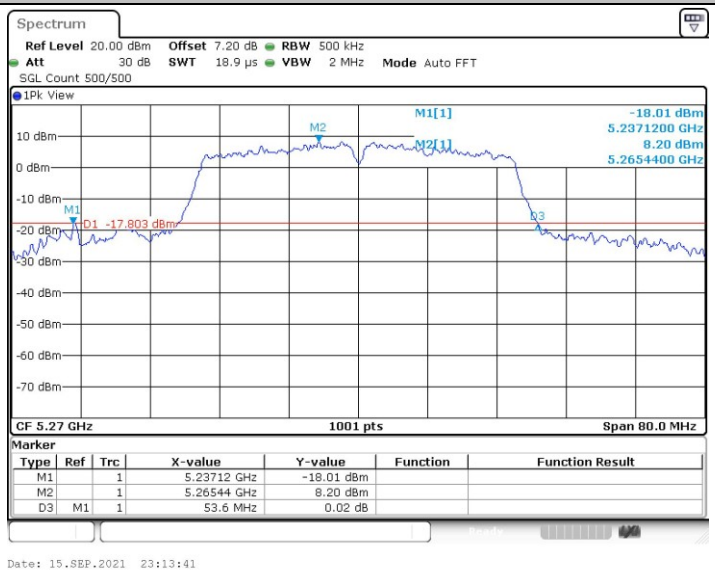

11AC40MIMO_Ant2_5270