

**Test Data**

**Environmental Conditions**

<b>Temperature:</b>	24 °C
<b>Relative Humidity:</b>	56 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Fan Yang from 2021-08-31 to 2021-10-29.*

*EUT operation mode: Transmitting*

**Test Result: Pass**

*Please refer to the Appendix.*

## FCC §15.407(a) – CONDUCTED TRANSMITTER OUTPUT POWER

### Applicable Standard

For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

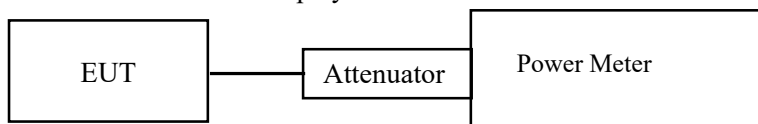
For client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or  $11 \text{ dBm} + 10 \log B$ , where B is the 26 dB emission bandwidth in megahertz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

### Test Procedure

- c. Place the EUT on a bench and set it in transmitting mode.
- d. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
- e. Add a correction factor to the display.



**Test Data**

**Environmental Conditions**

<b>Temperature:</b>	24 °C
<b>Relative Humidity:</b>	56 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Fan Yang from 2021-08-31 to 2021-10-29.*

*EUT operation mode: Transmitting*

**Test Result: Pass**

*Please refer to the Appendix.*

## **FCC §15.407(a) - POWER SPECTRAL DENSITY**

For 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 provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or  $11 \text{ dBm} + 10 \log B$ , where B is the 26 dB emission bandwidth in megahertz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

### **Test Procedure**

For devices operating in the bands 5.15-5.25 GHz, 5.25-5.35 GHz, and 5.47-5.725 GHz, the above procedures make use of 1 MHz RBW to satisfy directly the 1 MHz reference bandwidth specified in § 15.407(a)(5). For devices operating in the band 5.725-5.85 GHz, the rules specify a measurement bandwidth of 500 kHz. Many spectrum analyzers do not have 500 kHz RBW, thus a narrower RBW may need to be used. The rules permit the use of a RBWs less than 1 MHz, or 500 kHz, “provided that the measured power is integrated over the full reference bandwidth” to show the total power over the specified measurement bandwidth (i.e., 1 MHz, or 500 kHz). If measurements are performed using a reduced resolution bandwidth ( $< 1 \text{ MHz}$ , or  $< 500 \text{ kHz}$ ) and integrated over 1 MHz, or 500 kHz bandwidth, the following adjustments to the procedures apply:

- a) Set  $\text{RBW} \geq 1/T$ , where T is defined in section II.B.1.a).
- b) Set  $\text{VBW} \geq 3 \text{ RBW}$ .
- c) If measurement bandwidth of Maximum PSD is specified in 500 kHz, add  $10 \log (500 \text{ kHz/RBW})$  to the measured result, whereas RBW ( $< 500 \text{ kHz}$ ) is the reduced resolution bandwidth of the spectrum analyzer set during measurement.
- d) If measurement bandwidth of Maximum PSD is specified in 1 MHz, add  $10 \log (1\text{MHz/RBW})$  to the measured result, whereas RBW ( $< 1 \text{ MHz}$ ) is the reduced resolution bandwidth of spectrum analyzer set during measurement.
- e) Care must be taken to ensure that the measurements are performed during a period of continuous transmission or are corrected upward for duty cycle.

**Test Data****Environmental Conditions**

<b>Temperature:</b>	24 °C
<b>Relative Humidity:</b>	56 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Fan Yang from 2021-08-31 to 2021-10-29.*

*EUT operation mode: Transmitting*

**Test Result: Pass**

*Please refer to the Appendix.*

## **FCC §15.407(h) - DYNAMIC FREQUENCY SELECTION (DFS)**

### **Applicable Standard**

CFR §47 Part 15.407(h) and KDB 905462 D02 UNII DFS Compliance Procedures New Rules v02

**Table 1: Applicability of DFS Requirements Prior to Use of a Channel**

Requirement	Operational Mode		
	Master	Client Without Radar Detection	Client With Radar Detection
<i>Non-Occupancy Period</i>	Yes	Not required	Yes
<i>DFS Detection Threshold</i>	Yes	Not required	Yes
<i>Channel Availability Check Time</i>	Yes	Not required	Not required
<i>U-NII Detection Bandwidth</i>	Yes	Not required	Yes

**Table 2: Applicability of DFS requirements during normal operation**

Requirement	Operational Mode	
	Master Device or Client with Radar Detection	Client Without Radar Detection
<i>DFS Detection Threshold</i>	Yes	Not required
<i>Channel Closing Transmission Time</i>	Yes	Yes
<i>Channel Move Time</i>	Yes	Yes
<i>U-NII Detection Bandwidth</i>	Yes	Not required

Additional requirements for devices with multiple bandwidth modes	Master Device or Client with Radar Detection	Client Without Radar Detection
<i>U-NII Detection Bandwidth and Statistical Performance Check</i>	All BW modes must be tested	Not required
<i>Channel Move Time and Channel Closing Transmission Time</i>	Test using widest BW mode available	Test using the widest BW mode available for the link
<i>All other tests</i>	Any single BW mode	Not required
<b>Note:</b> Frequencies selected for statistical performance check (Section 7.8.4) should include several frequencies within the radar detection bandwidth and frequencies near the edge of the radar detection bandwidth. For 802.11 devices it is suggested to select frequencies in each of the bonded 20 MHz channels and the channel center frequency.		

**Table 3: DFS Detection Thresholds for Master Devices and Client Devices With Radar Detection**

Maximum Transmit Power	Value (See Notes 1, 2, and 3)
EIRP $\geq$ 200 milliwatt	-64 dBm
EIRP < 200 milliwatt and power spectral density < 10 dBm/MHz	-62 dBm
EIRP < 200 milliwatt that do not meet the power spectral density requirement	-64 dBm
<p><b>Note 1:</b> This is the level at the input of the receiver assuming a 0 dBi receive antenna.</p> <p><b>Note 2:</b> Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response.</p> <p><b>Note 3:</b> EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01.</p>	

**Table 4: DFS Response Requirement Values**

Parameter	Value
<i>Non-occupancy period</i>	Minimum 30 minutes
<i>Channel Availability Check Time</i>	60 seconds
<i>Channel Move Time</i>	10 seconds See Note 1.
<i>Channel Closing Transmission Time</i>	200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. See Notes 1 and 2.
<i>U-NII Detection Bandwidth</i>	Minimum 100% of the U- NII 99% transmission power bandwidth. See Note 3.
<p><b>Note 1:</b> <i>Channel Move Time</i> and the <i>Channel Closing Transmission Time</i> should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst.</p> <p><b>Note 2:</b> The <i>Channel Closing Transmission Time</i> is comprised of 200 milliseconds starting at the beginning of the <i>Channel Move Time</i> plus any additional intermittent control signals required to facilitate a <i>Channel</i> move (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.</p> <p><b>Note 3:</b> During the <i>U-NII Detection Bandwidth</i> detection test, radar type 0 should be used. For each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.</p>	

**Table 5 – Short Pulse Radar Test Waveforms**

Radar Type	Pulse Width (μsec)	PRI (μsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Number of Trials
0	1	1428	18	See Note 1	See Note 1
1	1	Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a	Roundup $\left\{ \left( \frac{1}{360} \right) \cdot \left( \frac{19 \cdot 10^6}{\text{PRI}_{\mu\text{sec}}} \right) \right\}$	60%	30
		Test B: 15 unique PRI values randomly selected within the range of 518-3066 μsec, with a minimum increment of 1 μsec, excluding PRI values selected in Test A			
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120
<b>Note 1:</b> Short Pulse Radar Type 0 should be used for the detection bandwidth test, channel move time, and channel closing time tests.					

A minimum of 30 unique waveforms are required for each of the Short Pulse Radar Types 2 through 4. If more than 30 waveforms are used for Short Pulse Radar Types 2 through 4, then each additional waveform must also be unique and not repeated from the previous waveforms. If more than 30 waveforms are used for Short Pulse Radar Type 1, then each additional waveform is generated with Test B and must also be unique and not repeated from the previous waveforms in Tests A or B.

For example if in Short Pulse Radar Type 1 Test B a PRI of 3066 usec is selected, the number of pulses

would be  $\text{Roundup} \left\{ \left( \frac{1}{360} \right) \cdot \left( \frac{19 \cdot 10^6}{3066} \right) \right\} = \text{Roundup} \{17.2\} = 18$ .



**Table 5a - Pulse Repetition Intervals Values for Test A**

<b>Pulse Repetition Frequency Number</b>	<b>Pulse Repetition Frequency (Pulses Per Second)</b>	<b>Pulse Repetition Interval (Microseconds)</b>
1	1930.5	518
2	1858.7	538
3	1792.1	558
4	1730.1	578
5	1672.2	598
6	1618.1	618
7	1567.4	638
8	1519.8	658
9	1474.9	678
10	1432.7	698
11	1392.8	718
12	1355	738
13	1319.3	758
14	1285.3	778
15	1253.1	798
16	1222.5	818
17	1193.3	838
18	1165.6	858
19	1139	878
20	1113.6	898
21	1089.3	918
22	1066.1	938
23	326.2	3066

The aggregate is the average of the percentage of successful detections of Short Pulse Radar Types 1-4. For example, the following table indicates how to compute the aggregate of percentage of successful detections.

<b>Radar Type</b>	<b>Number of Trials</b>	<b>Number of Successful Detections</b>	<b>Minimum Percentage of Successful Detection</b>
1	35	29	82.9%
2	30	18	60%
3	30	27	90%
4	50	44	88%
<b>Aggregate <math>(82.9\% + 60\% + 90\% + 88\%)/4 = 80.2\%</math></b>			

**Table 6 – Long Pulse Radar Test Waveform**

Radar Type	Pulse Width ( $\mu$ sec)	Chirp Width (MHz)	PRI ( $\mu$ sec)	Number of Pulses per <i>Burst</i>	Number of <i>Bursts</i>	Minimum Percentage of Successful Detection	Minimum Number of Trials
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

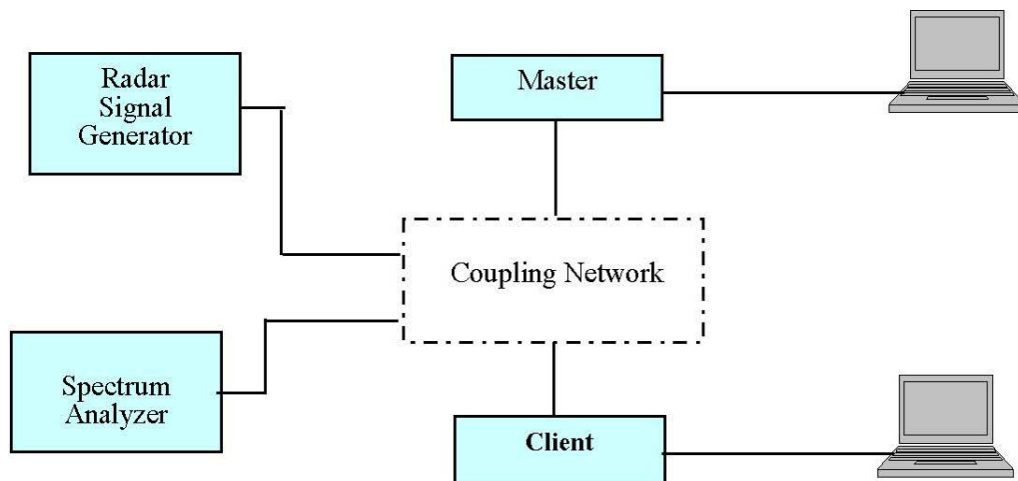
**Table 7 – Frequency Hopping Radar Test Waveform**

Radar Type	Pulse Width ( $\mu$ sec)	PRI ( $\mu$ sec)	Pulses per Hop	Hopping Rate (kHz)	Hopping Sequence Length (msec)	Minimum Percentage of Successful Detection	Minimum Number of Trials
6	1	333	9	0.333	300	70%	30

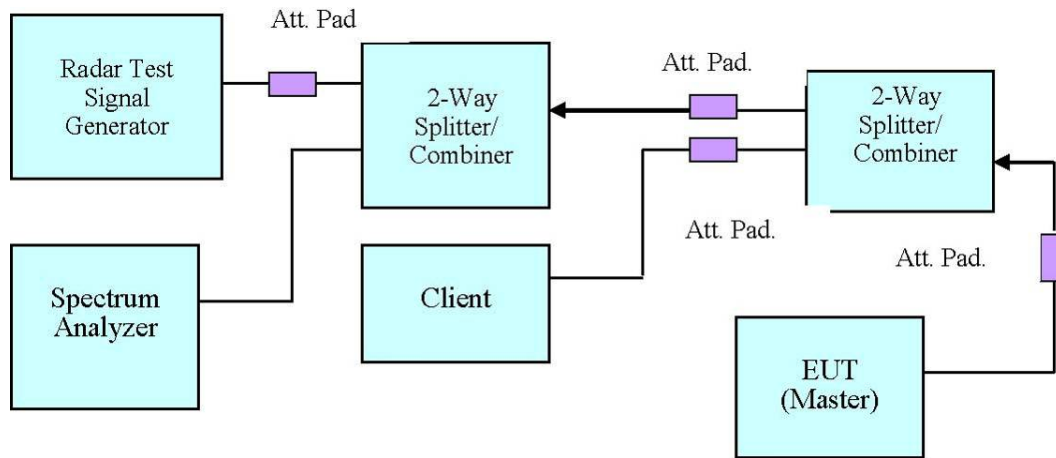
### DFS Measurement System

DFS measurement system consists of two subsystems: (1) The radar signal generating subsystem and (2) the traffic monitoring subsystem.

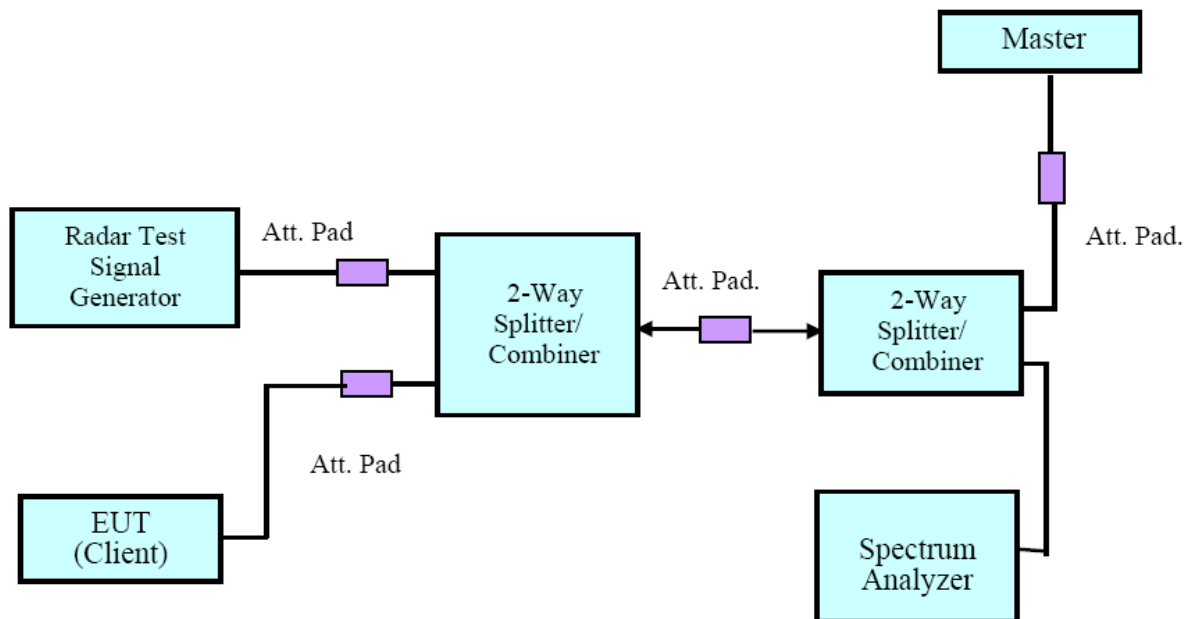
### System Block Diagram



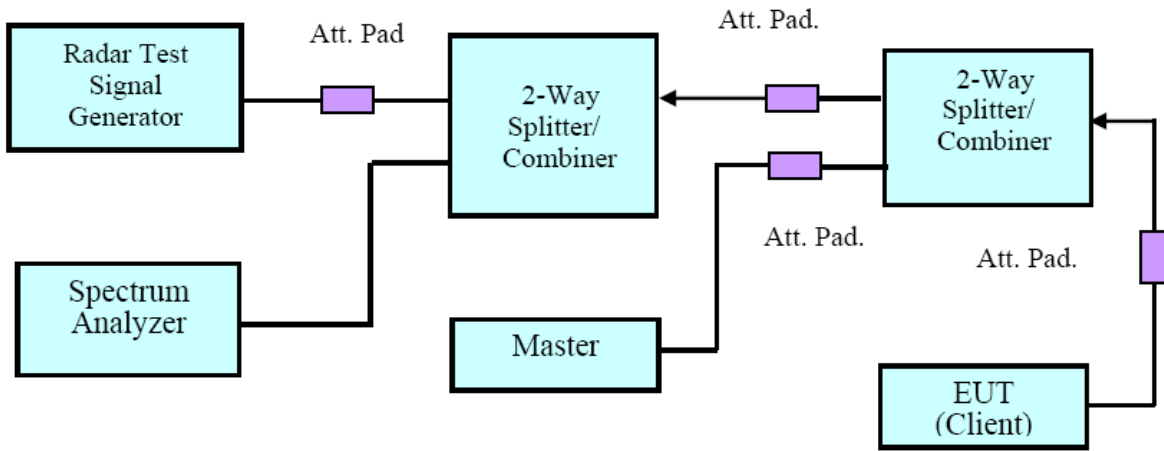
**Conducted Method**



**Setup for Master with injection at the Master**

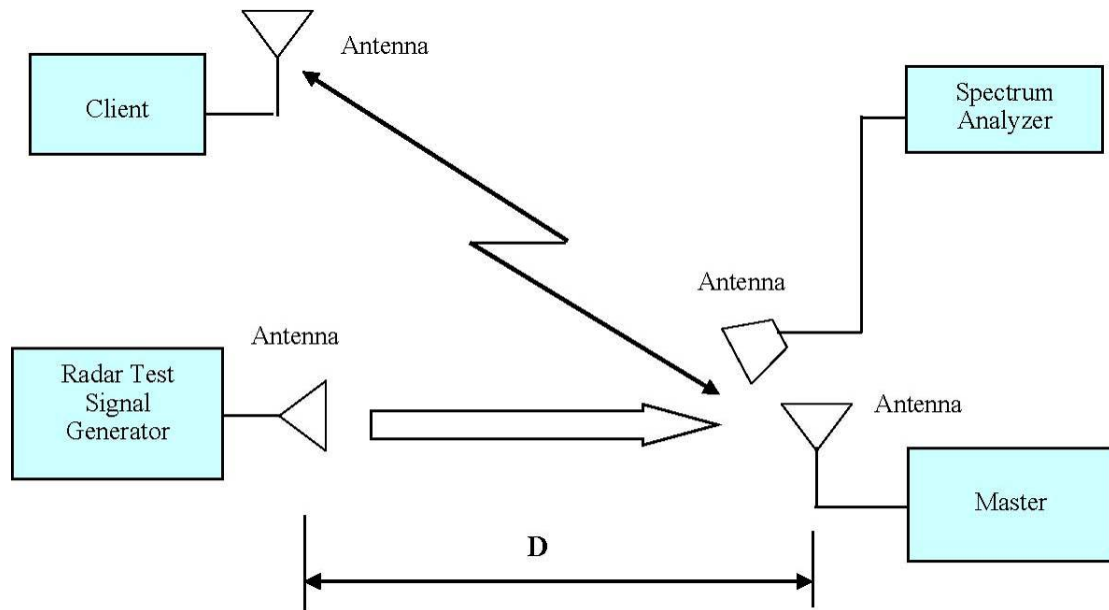


**Setup for Client with injection at the Master**



Setup for Client with injection at the Client

**Radiated Method**

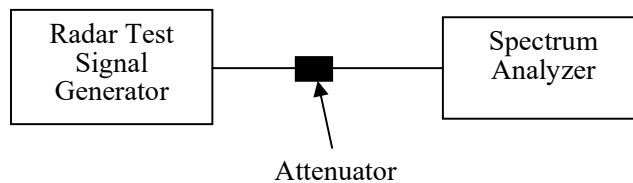


## Test Procedure

A spectrum analyzer is used as a monitor verifies that the EUT status including Channel Closing Transmission Time and Channel Move Time, and does not transmit on a Channel during the Non-Occupancy Period after the diction and Channel move. It is also used to monitor EUT transmissions during the Channel Availability Check Time.

### Radar Waveform Calibration

The calibrated radiated DFS detection threshold level is set to -62 dBm.



### Channel Move Time and Channel Closing Transmission Time

Channel Move Time and the Channel Closing Transmission Time should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst.

The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning of the Channel Move Time plus any additional intermittent control signals required to facilitate a Channel move (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.

The aggregate channel closing transmission time is calculated as follows:

$$\text{Aggregate Transmission Time} = N * \text{Dwell Time}$$

N is the number of spectrum analyzer bins showing a device transmission Dwell Time is the dwell time per bin (i.e.  $\text{Dwell Time} = S/B$ , S is the sweep time and B is the number of bin, i.e. 8192)

### Non-Occupancy Period

Measure the EUT for more than 30 minutes following the channel close/move time to very that the EUT does not resume any transmissions on this channel. Provide one plot to demonstrate no transmission on the channel for the non-occupancy period (30 minutes observation time)

**Test Data****Environmental Conditions**

<b>Temperature:</b>	24 °C
<b>Relative Humidity:</b>	56 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Fan Yang on 2021-10-12.*

*EUT operation mode: Transmitting*

**Test Result:**

<b>Items</b>	<b>Description of Test</b>	<b>Result</b>
Detection Bandwidth	UNII Detection Bandwidth	Not Applicable
Performance Requirements Check	Initial Channel Availability Check Time (CAC)	Not Applicable
	Radar Burst at the Beginning of the CAC	Not Applicable
	Radar Burst at the End of the CAC	Not Applicable
In-Service Monitoring	Channel Move Time	Compliant
	Channel Closing Transmission Time	Compliant
	Non-Occupancy Period	Compliant
Radar Detection	Statistical Performance Check	Not Applicable

Not Applicable: EUT is a client without Radar detection.

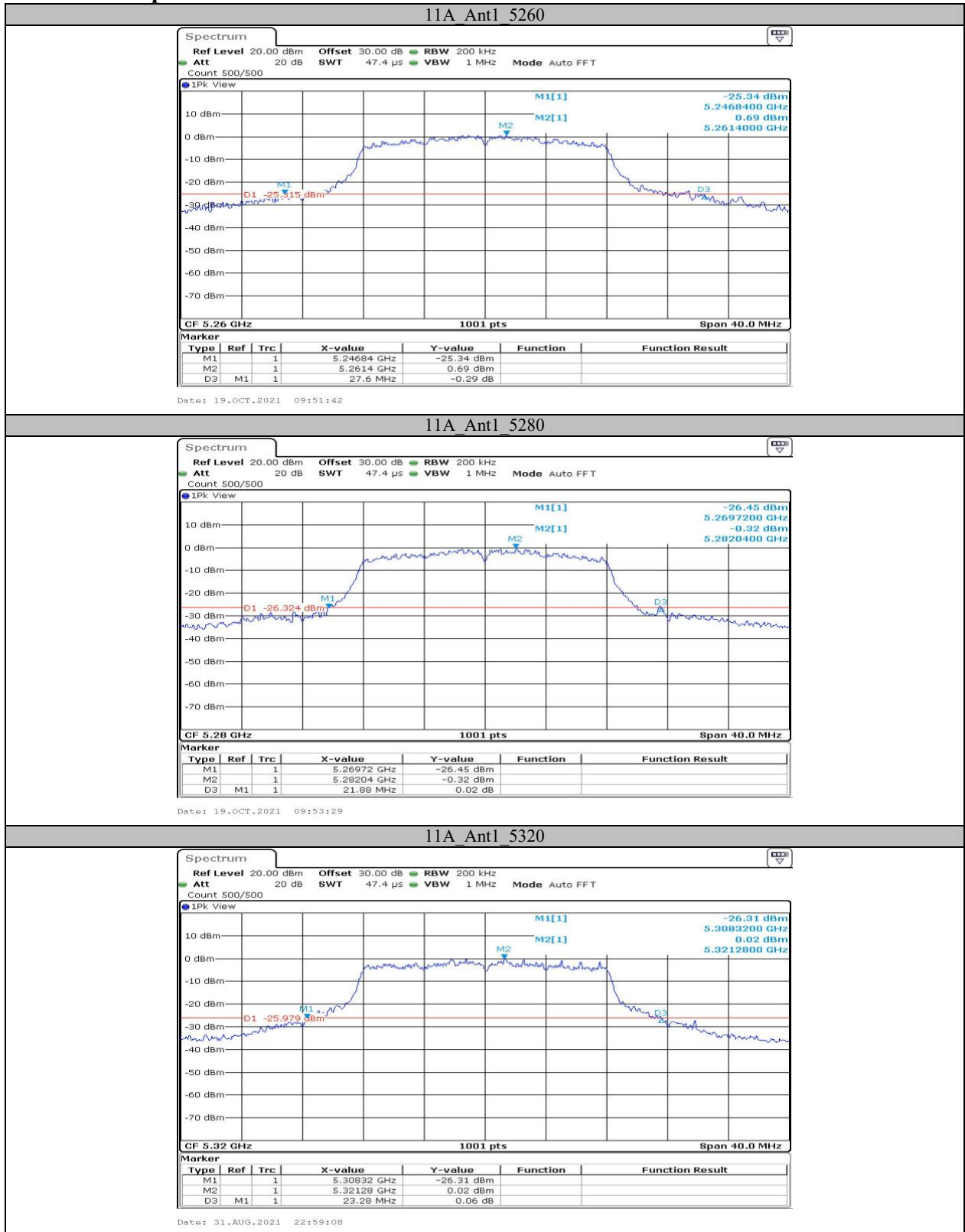
*Test data please refer to the Appendix DFS.*

## APPENDIX

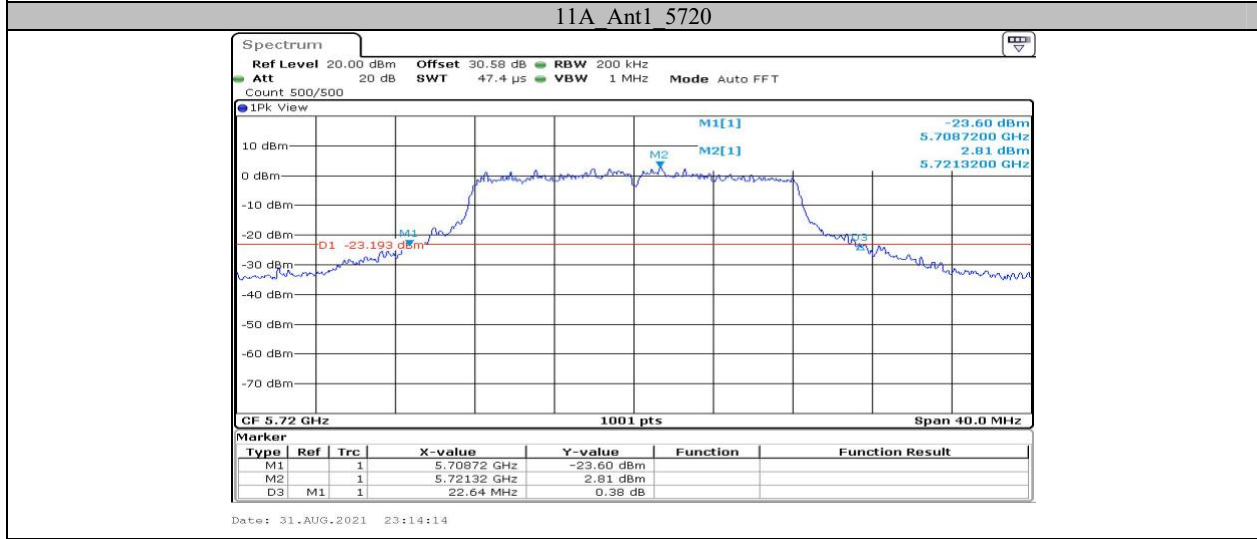
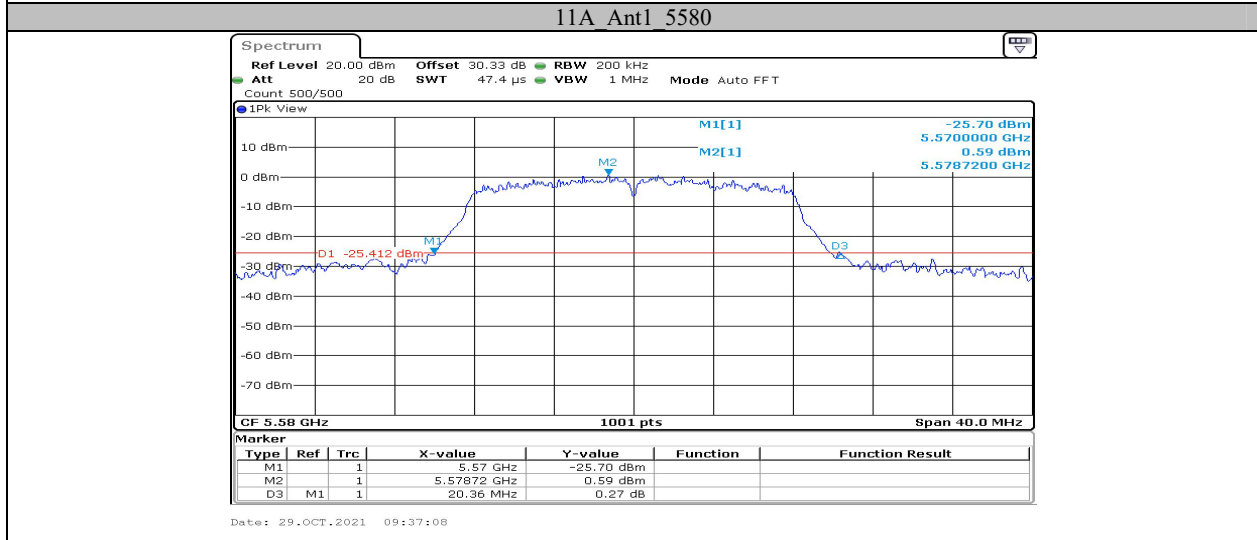
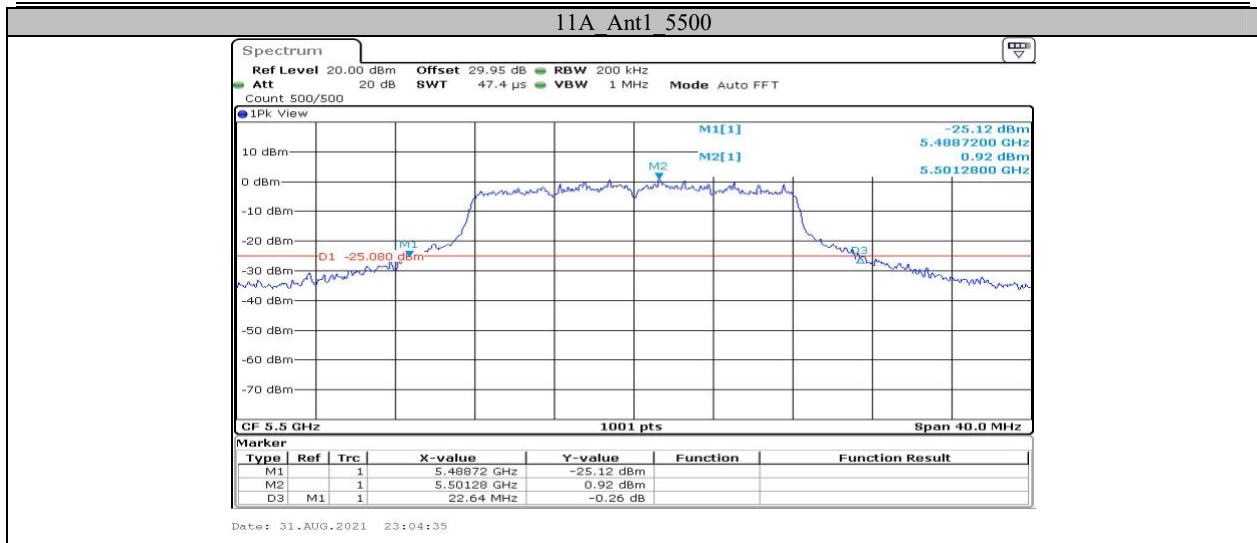
### Appendix A1: Emission Bandwidth Test Result

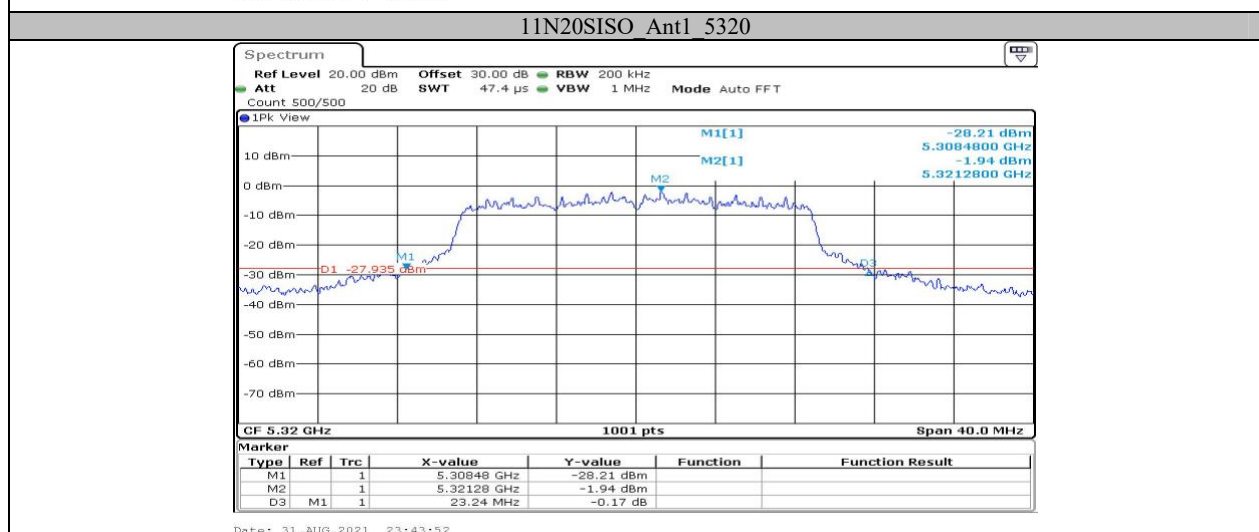
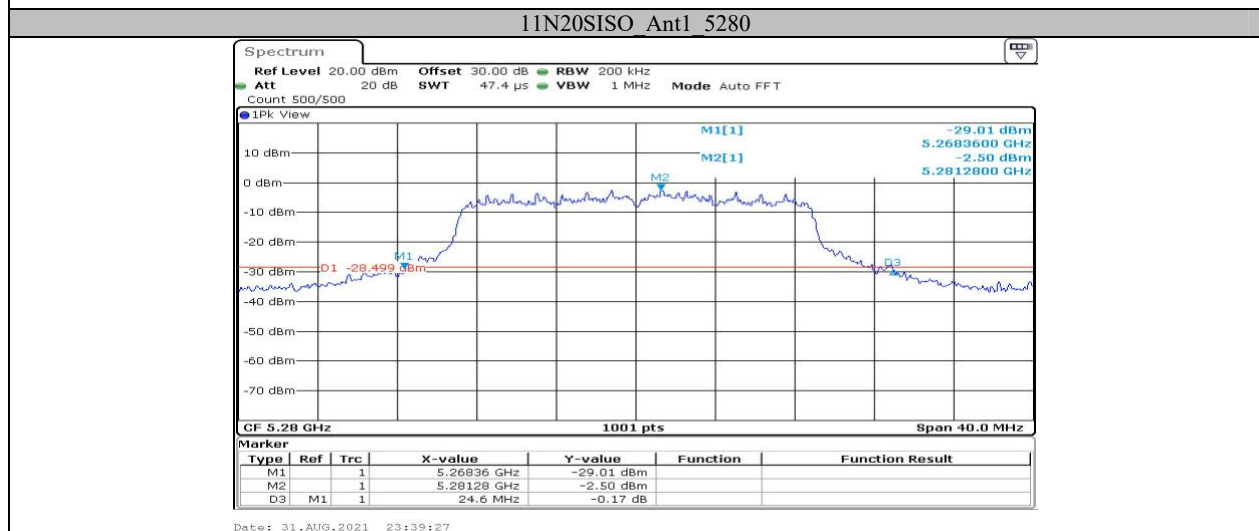
Test Mode	Antenna	Channel	26db EBW [MHz]	Limit[MHz]	Verdict
11A	Ant1	5260	27.600	---	PASS
		5280	21.880	---	PASS
		5320	23.280	---	PASS
		5500	22.640	---	PASS
		5580	20.360	---	PASS
		5720	22.640	---	PASS
		5720 UNII-2C	16.28	---	PASS
11N20SISO	Ant1	5260	21.840	---	PASS
		5280	24.600	---	PASS
		5320	23.240	---	PASS
		5500	20.160	---	PASS
		5580	23.880	---	PASS
		5720	22.880	---	PASS
		5720 UNII-2C	16.08	---	PASS
11N40SISO	Ant1	5270	46.640	---	PASS
		5310	48.960	---	PASS
		5510	41.920	---	PASS
		5550	42.480	---	PASS
		5710	42.480	---	PASS
		5710 UNII-2C	36.2	---	PASS
11AC20SISO	Ant1	5260	24.160	---	PASS
		5280	25.560	---	PASS
		5320	23.800	---	PASS
		5500	23.120	---	PASS
		5580	20.120	---	PASS
		5720	22.880	---	PASS
		5720 UNII-2C	16.32	---	PASS
11AC40SISO	Ant1	5270	43.120	---	PASS
		5310	42.960	---	PASS
		5510	42.000	---	PASS
		5550	42.080	---	PASS
		5710	42.400	---	PASS
		5710 UNII-2C	36.12	---	PASS
11AC80SISO	Ant1	5290	124.480	---	PASS
		5530	158.600	---	PASS
		5610	85.600	---	PASS
		5690	85.120	---	PASS
		5690 UNII-2C	77.56	---	PASS

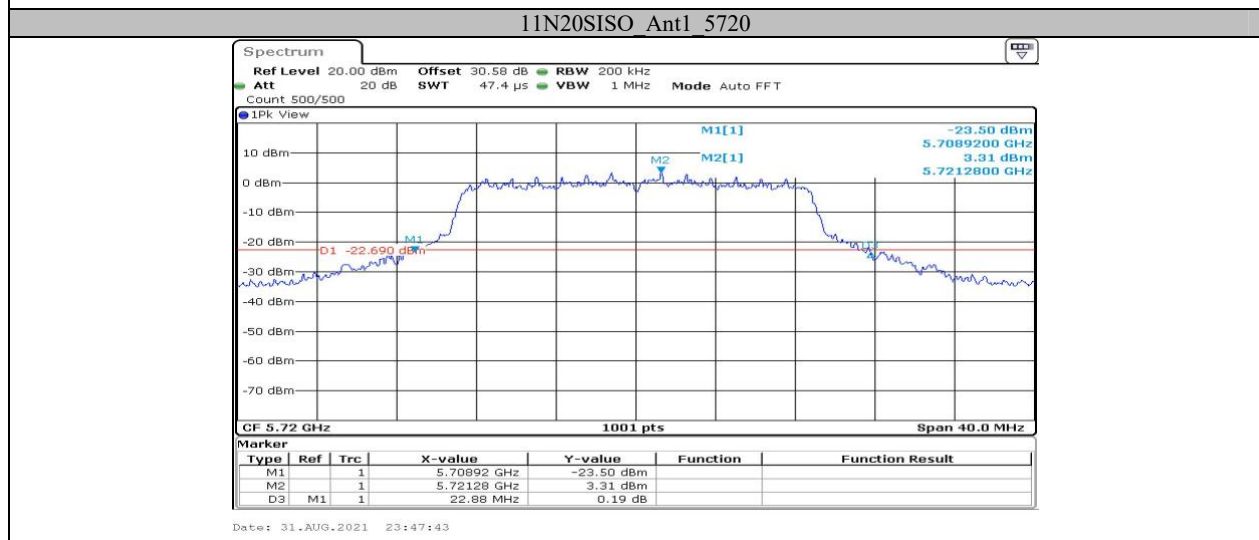
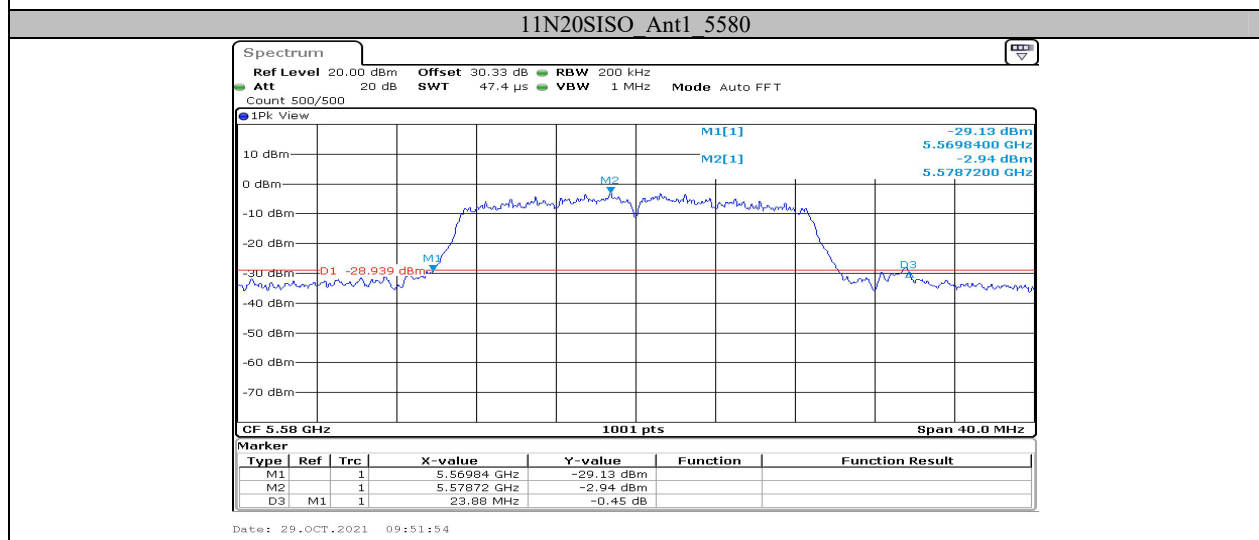
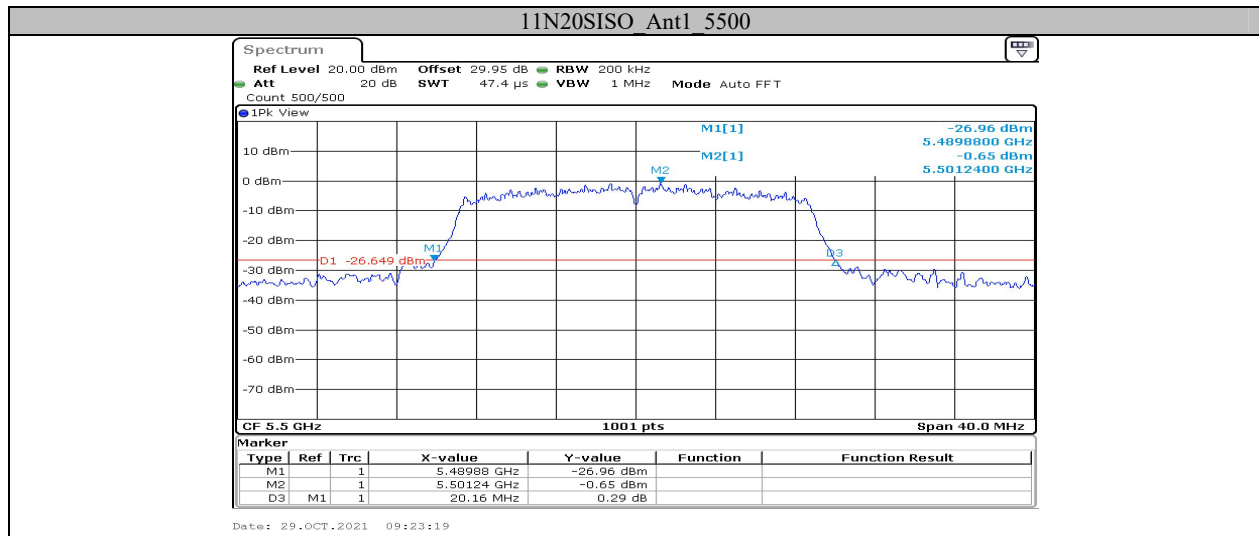
Test Graphs

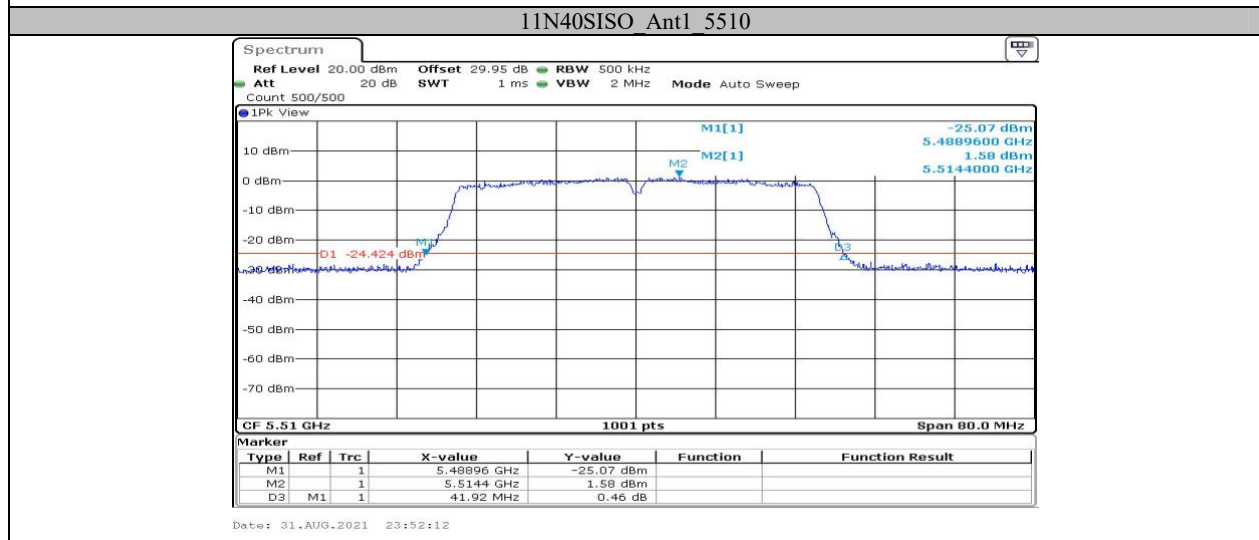
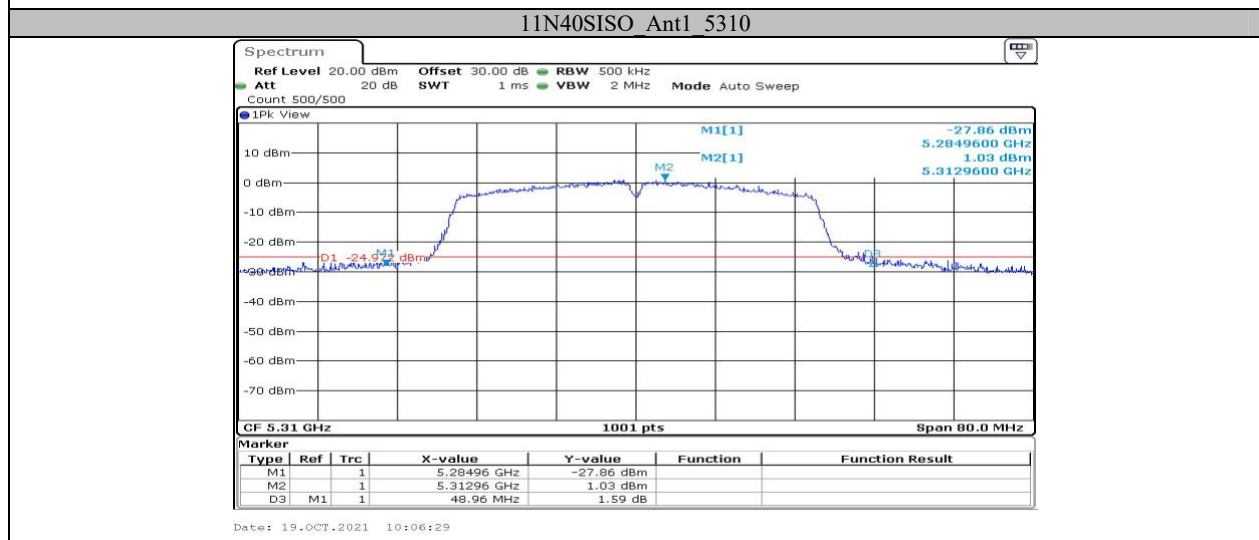
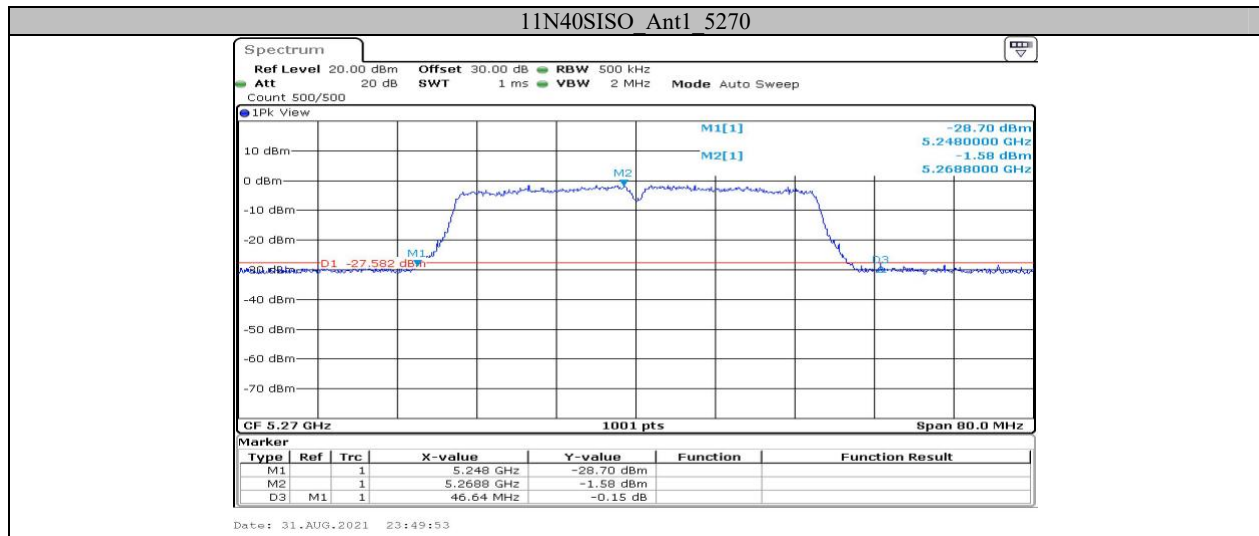


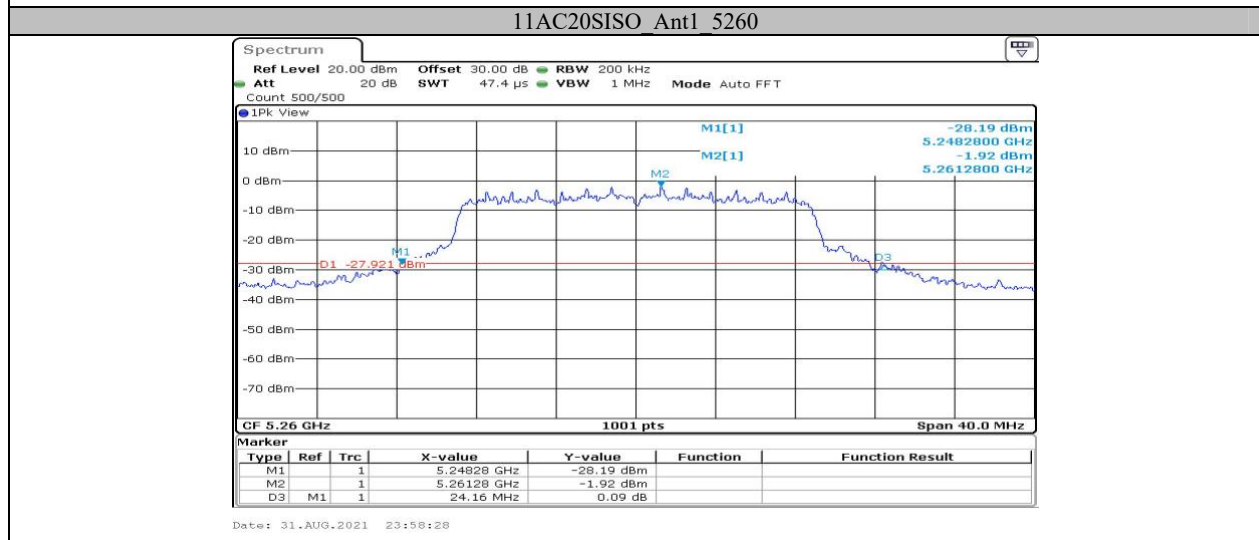
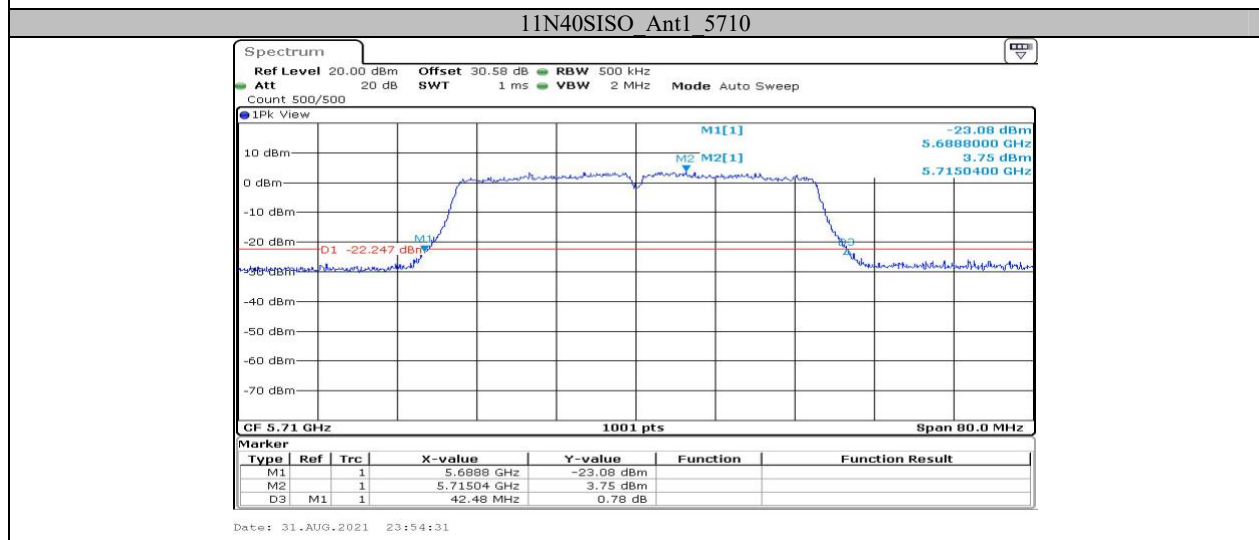
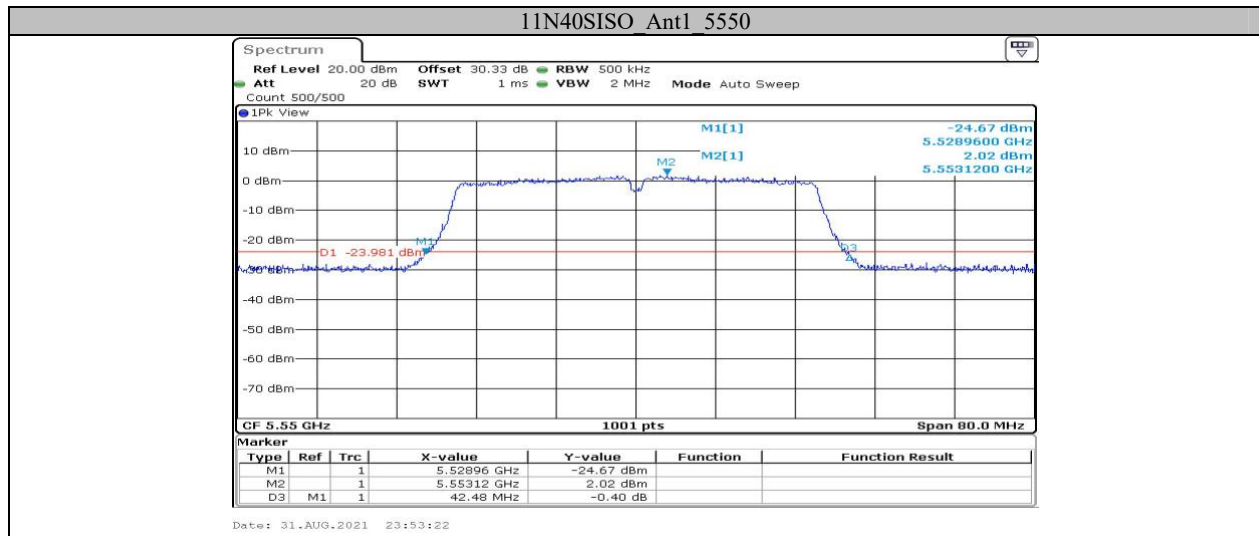




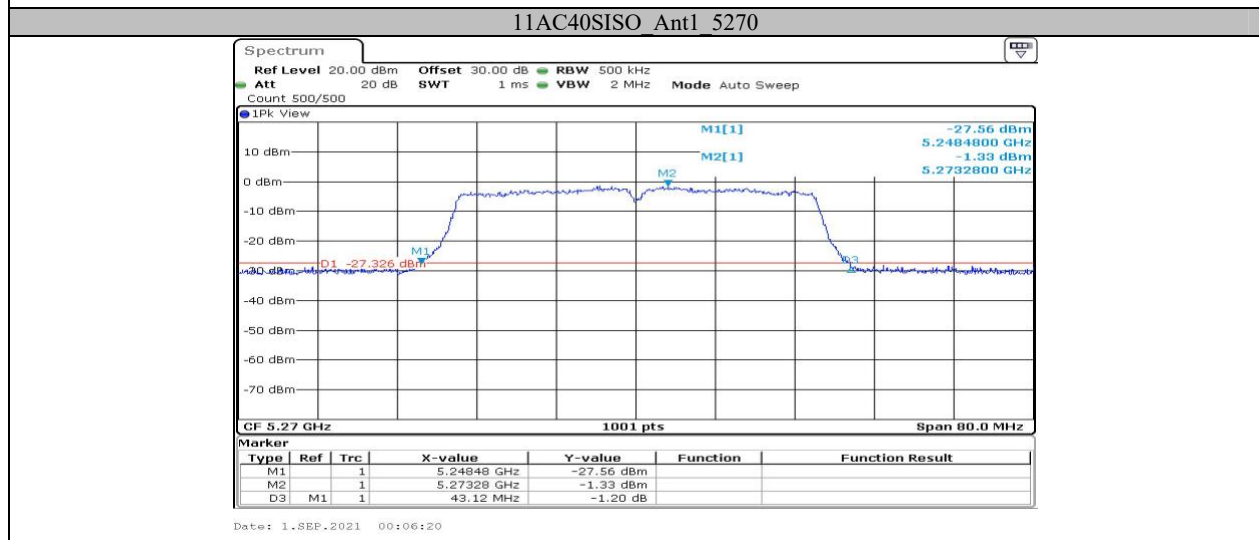
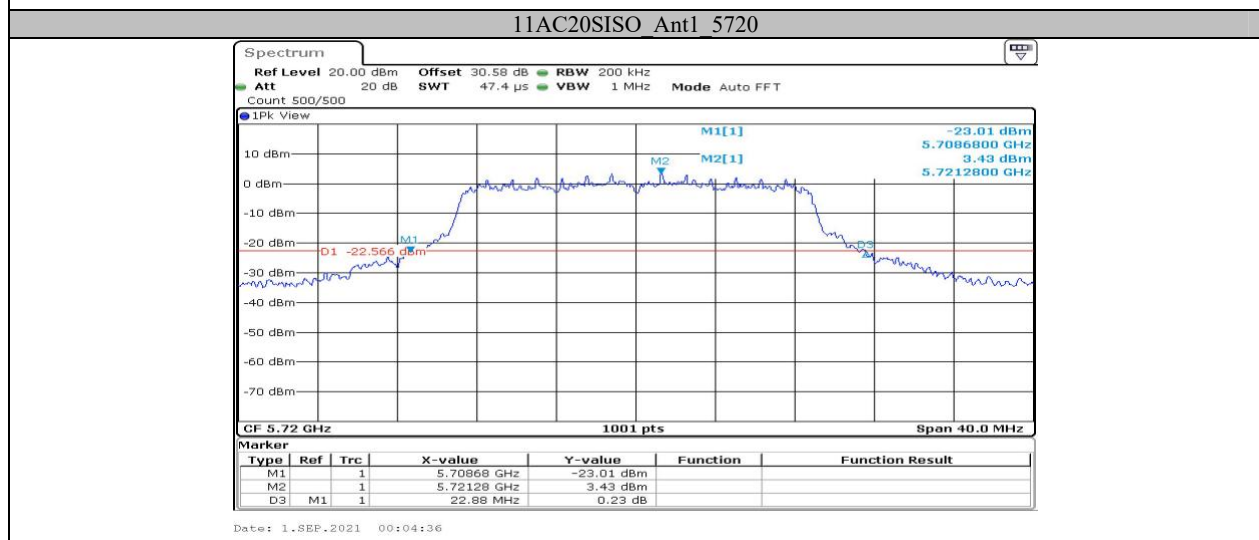
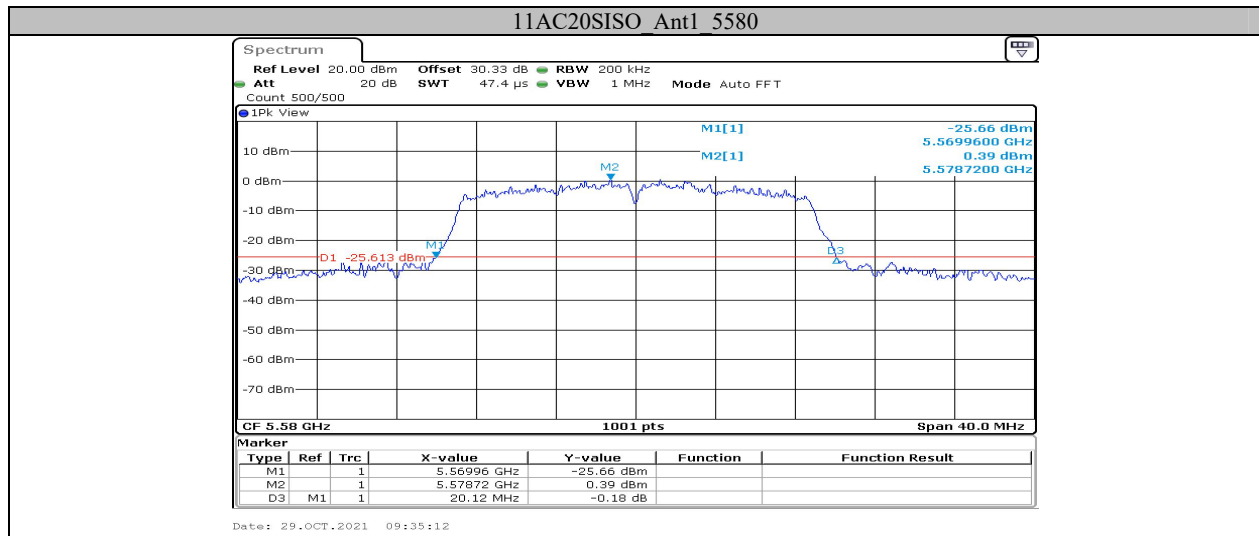


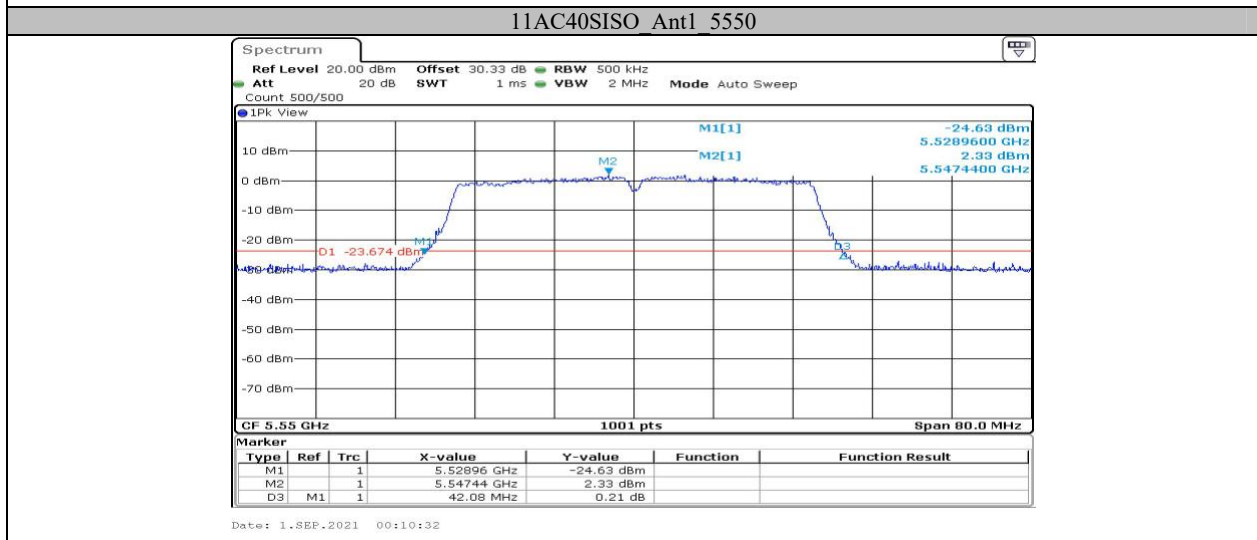
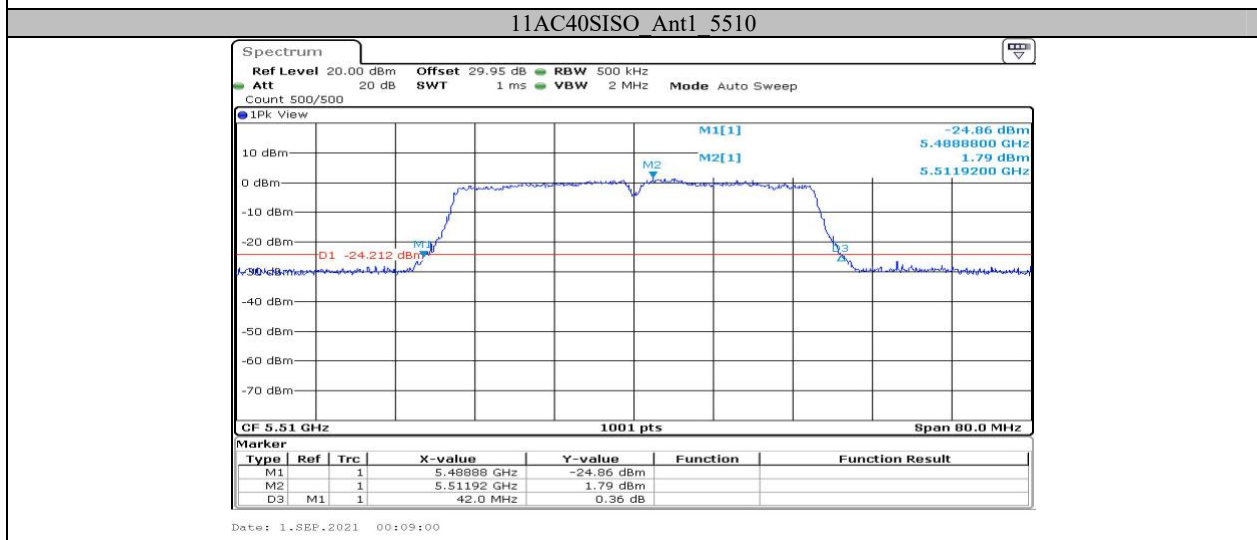
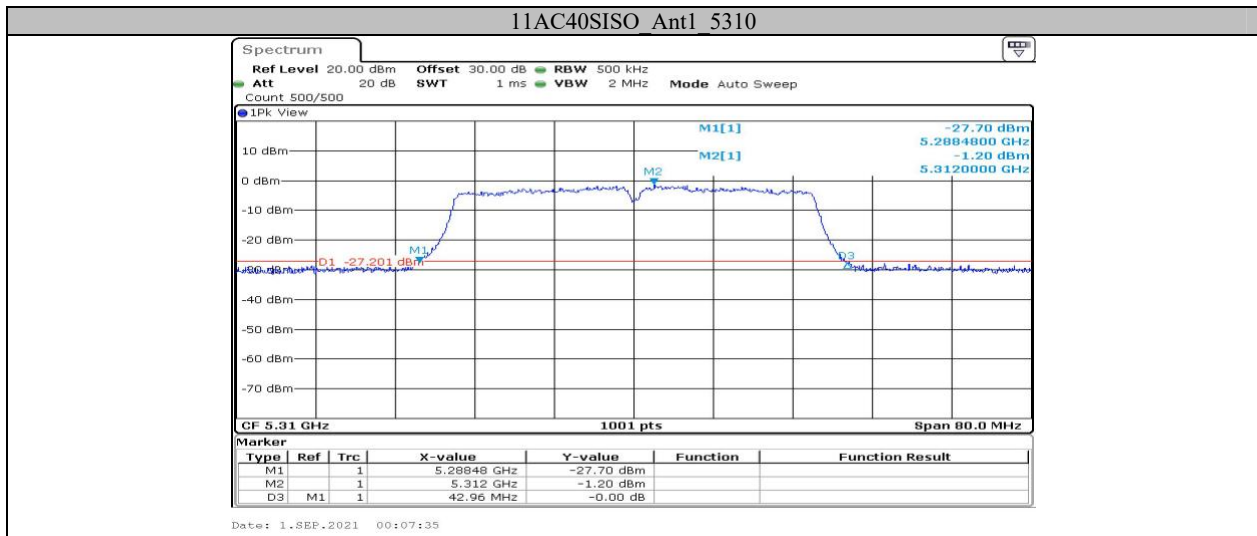




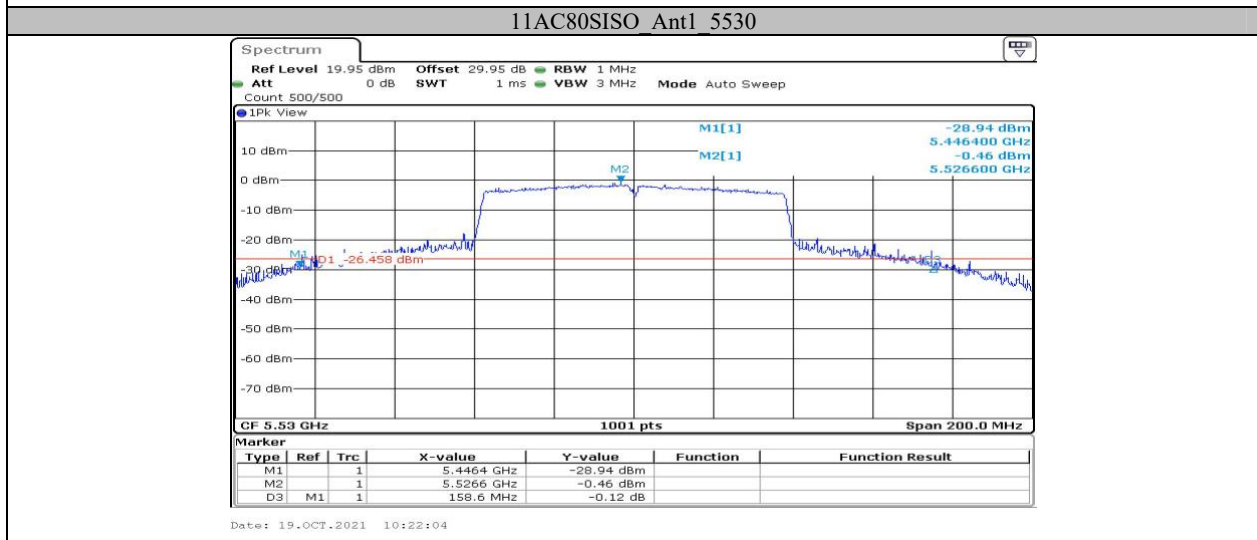
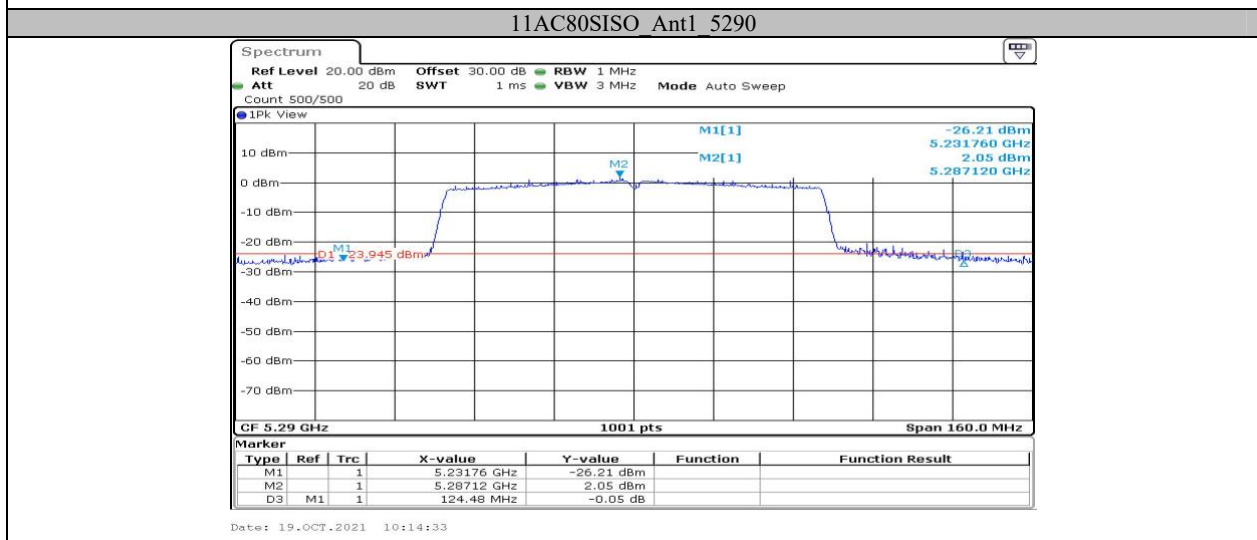
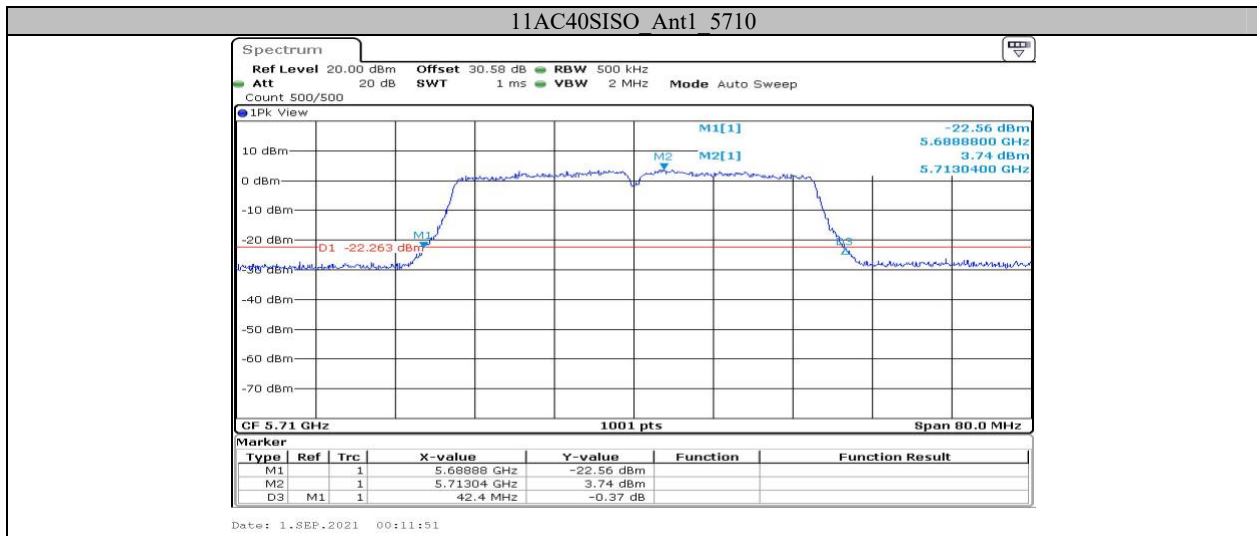


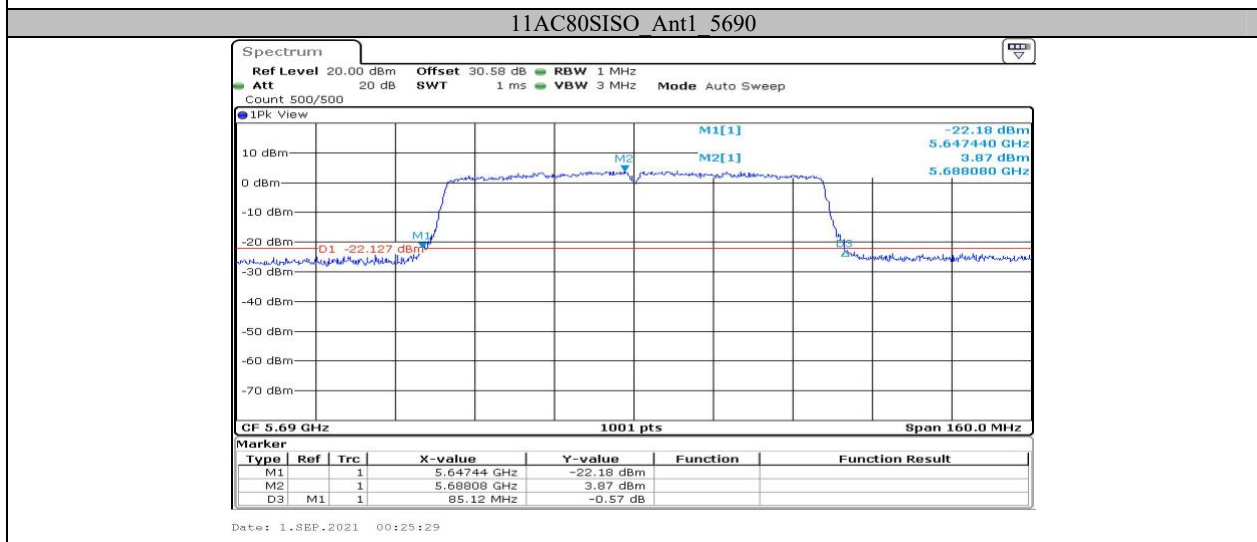
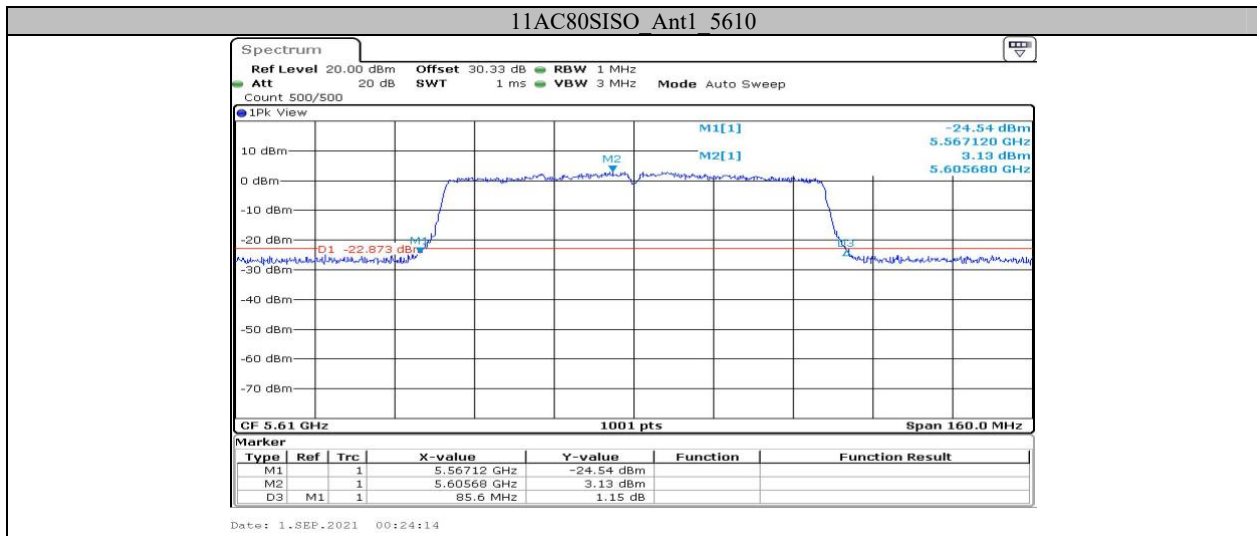












## Appendix A2: Occupied channel bandwidth Test Result

Test Mode	Antenna	Channel	OCB [MHz]	Limit[MHz]	Verdict
11A	Ant1	5260	17.423	---	PASS
		5280	17.343	---	PASS
		5320	17.423	---	PASS
		5500	17.463	---	PASS
		5580	17.662	---	PASS
		5720	17.343	---	PASS
		5720 UNII-2C	13.551	---	PASS
		5720 UNII-3	3.791	---	PASS
11N20SISO	Ant1	5260	18.661	---	PASS
		5280	18.541	---	PASS
		5320	18.621	---	PASS
		5500	18.501	---	PASS
		5580	18.661	---	PASS
		5720	18.422	---	PASS
		5720 UNII-2C	14.111	---	PASS
		5720 UNII-3	4.311	---	PASS
11N40SISO	Ant1	5270	36.843	---	PASS
		5310	36.923	---	PASS
		5510	36.683	---	PASS
		5550	36.683	---	PASS
		5710	36.683	---	PASS
		5710 UNII-2C	33.222	---	PASS
		5710 UNII-3	3.462	---	PASS
11AC20SISO	Ant1	5260	18.621	---	PASS
		5280	18.621	---	PASS
		5320	18.621	---	PASS
		5500	18.501	---	PASS
		5580	18.462	---	PASS
		5720	18.462	---	PASS
		5720 UNII-2C	14.151	---	PASS
		5720 UNII-3	4.311	---	PASS
11AC40SISO	Ant1	5270	36.763	---	PASS
		5310	36.843	---	PASS
		5510	36.683	---	PASS
		5550	36.763	---	PASS
		5710	36.683	---	PASS
		5710 UNII-2C	33.222	---	PASS
		5710 UNII-3	3.462	---	PASS
11AC80SISO	Ant1	5290	76.404	---	PASS
		5530	76.244	---	PASS
		5610	76.084	---	PASS
		5690	76.244	---	PASS
		5690 UNII-2C	72.882	---	PASS
		5690 UNII-3	3.362	---	PASS

Test Graphs

