TCT 通测检测 TESTING CENTRE TECHNOLOGY

TEST REPORT

FCC ID: 2AG87NM-915-2H

Product: Prism Wi-Fi® Radio Transceiver

Model No.: NM-915-2H

Additional Model: NO-915-2H, HM-915-2, HO-915-2

Trade Mark: N/A

Report No.: TCT180418E003

Issued Date: May 09, 2018

Issued for:

Doodle Labs (SG) Pte Ltd

150 Kampong Ampat, KA Center, Suite 05-03 Singapore, 368324 Singapore

Issued By:

Shenzhen Tongce Testing Lab.

1B/F., Building 1, Yibaolai Industrial Park, Qiaotou, Fuyong, Baoan District, Shenzhen, Guangdong, China

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Hotline: 400-6611-140 Tel: 86-755-27673339 Fax: 86-755-27673332 http://www.tct-lab.com

1. Test Certification

Product:	Prism Wi-Fi® Radio Transceiver
Model No.:	NM-915-2H
Additional Model No.:	NO-915-2H, HM-915-2, HO-915-2
Trade Mark:	**N/A**
Applicant:	Doodle Labs (SG) Pte Ltd
Address:	150 Kampong Ampat, KA Center, Suite 05-03 Singapore, 368324 Singapore
Manufacturer:	Doodle Labs (SG) Pte Ltd
Address:	150 Kampong Ampat, KA Center, Suite 05-03 Singapore, 368324 Singapore
Date of Test:	Apr.18. 2018 – May 08, 2018
Applicable Standards:	FCC CFR Title 47 Part 15 Subpart C Section 15.247 KDB 558074 D01 DTS Meas Guidance v04

The above equipment has been tested by Shenzhen Tongce Testing Lab. and found compliance with the requirements set forth in the technical standards mentioned above. The results of testing in this report apply only to the product/system, which was tested. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Tested By:	Garen	***Date:***	***May 08, 2018***
Reviewed By:	Beryl Zhao	***Date:***	***May 09, 2018***
Approved By:	Tomsin	***Date:***	***May 09, 2018***

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2. Test Result Summary

Requirement	CFR 47 Section	Result
Antenna requirement	§15.203/§15.247 (c)	PASS
AC Power Line Conducted Emission	§15.207	PASS
Conducted Peak Output Power	§15.247 (b)(3) §2.1046	PASS
6dB Emission Bandwidth	§15.247 (a)(2) §2.1049	PASS
Power Spectral Density	§15.247 (e)	PASS
Band Edge	1§5.247(d) §2.1051, §2.1057	PASS
Spurious Emission	§15.205/§15.209 §2.1053, §2.1057	PASS

Note:

1. PASS: Test item meets the requirement.

2. Fail: Test item does not meet the requirement.

3. N/A: Test case does not apply to the test object.

4. The test result judgment is decided by the limit of test standard.

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3. EUT Description

Product:	Prism Wi-Fi® Radio Transceiver
Product Type:	WLAN(2TX, 2RX)
Radio Type:	2x2 MIMO
Model No.:	NM-915-2H
Additional Model No.:	NO-915-2H, HM-915-2, HO-915-2
Trade Mark:	**N/A**
Hardware Version:	3
Software Version:	V1.0
Operation Frequency:	905MHz~920MHz
Channel Separation:	5MHz
Number of Channel:	905 MHz, 910 MHz, 915 MHz, 920 MHz,
Modulation Technology:	DSSS, OFDM
Antenna Type:	R-SMA antenna
Antenna Gain:	All are 2dBi
Power Supply:	DC 5V from adapter (voltage range: 5V up to 42V)
Remark:	All models above are identical in interior structure, electrical circuits and components, and just model names are different for the marketing requirement.

Operation Frequency each of channel For DSSS, OFDM.

Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
1	905MHz	2	910MHz	3	915MHz	4	920MHz
Remark: All the channels have been tested.							

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4. Genera Information

4.1. Test environment and mode

Operating Environment:	
Temperature:	25.0 °C
Humidity:	56 % RH
Atmospheric Pressure:	1010 mbar
Test Mode:	
Engineering mode:	Keep the EUT in continuous transmitting by above channel
The sample was placed (0.8m below 1GHz, 1.5m above 1GHz) above the ground plane of 3m chamber. Measurements in both horizontal and vertical polarities were performed. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, rotating the turntable, varying antenna height from 1m to 4m in both horizontal and vertical polarizations. The emissions worst-case are shown in Test Results of the following pages. For the full battery state and The output power to the maximum state.	

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4.2. Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

Equipment	Model No.	Serial No.	FCC ID	Trade Name
900MHz Dipole Antenna	001-0002	/	/	LSR
Adapter	EP-TA20CBC	R37HAEY0DT1RT3	/	SAMSUNG

Note:

1. All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.

2. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.

3. For conducted measurements (Output Power, 6dB Emission Bandwidth, Power Spectral Density, Spurious Emissions), the antenna is connected to the test equipment via temporary antenna connector, the antenna connector is soldered on the antenna port of EUT, and the temporary antenna connector is listed in the Test Instruments.

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5. Facilities and Accreditations

5.1. Facilities

The test facility is recognized, certified, or accredited by the following organizations:

- FCC - Registration No.: 645098

  Shenzhen Tongce Testing Lab

  The 3m Semi-anechoic chamber has been registered and fully described in a report with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files.

- IC - Registration No.: 10668A-1

  The 3m Semi-anechoic chamber of Shenzhen TCT Testing Technology Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing

5.2. Location

Shenzhen Tongce Testing Lab

Address: 1B/F., Building 1, Yibaolai Industrial Park, Qiaotou, Fuyong, Baoan District, Shenzhen, Guangdong, China

TEL: +86-755-27673339

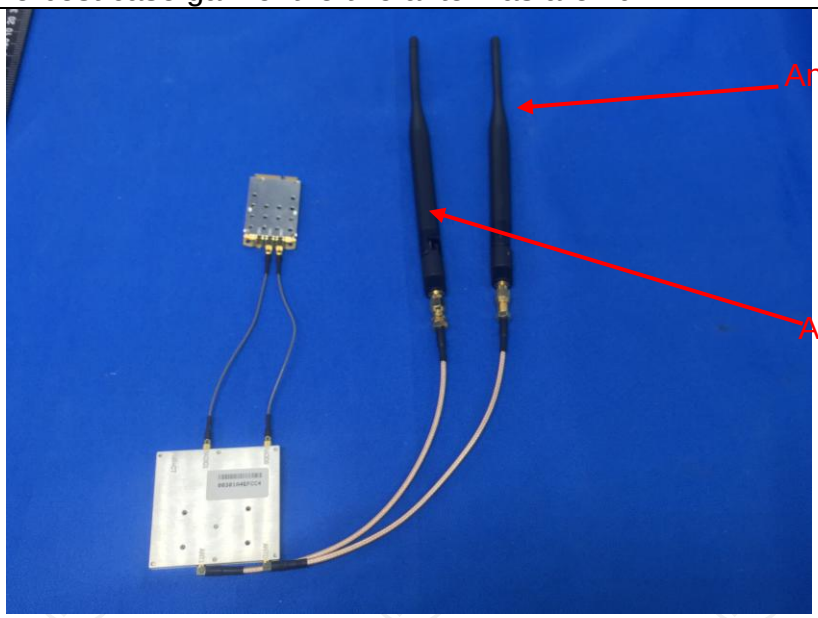
5.3. Measurement Uncertainty

The reported uncertainty of measurement y ± U, where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95 %.

No.	Item	MU
1	Conducted Emission	±2.56dB
2	RF power, conducted	±0.12dB
3	Spurious emissions, conducted	±0.11dB
4	All emissions, radiated(<1G)	±3.92dB
5	All emissions, radiated(>1G)	±4.28dB
6	Temperature	±0.1°C
7	Humidity	±1.0%

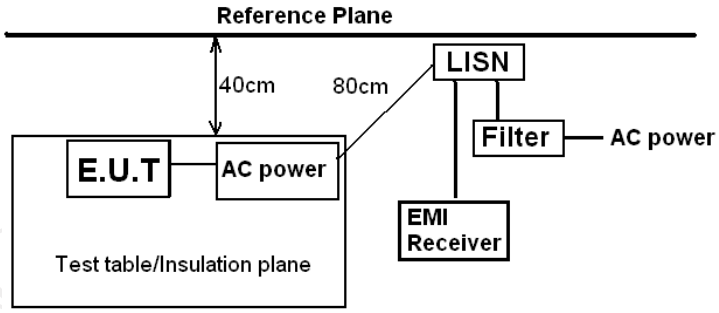
6. Test Results and Measurement Data

6.1. Antenna requirement

Standard requirement:	FCC Part15 C Section 15.203 /247(c)
15.203 requirement: 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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. 15.247(c) (1)(i) requirement: (i) Systems operating in the 902-928 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.	
E.U.T Antenna:	
The EUT has two R-SMA antennas that uses a unique coupling to the intentional radiator, and the best case gain of the two antennas are 2dBi.	
	

6.2. Conducted Emission

6.2.1. Test Specification

<table>
<tr><td>Test Requirement:</td><td>FCC Part15 C Section 15.207</td></tr>
<tr><td>Test Method:</td><td>ANSI C63.10:2013</td></tr>
<tr><td>Frequency Range:</td><td>150 kHz to 30 MHz</td></tr>
<tr><td>Receiver setup:</td><td>RBW=9 kHz, VBW=30 kHz, Sweep time=auto</td></tr>
<tr><td>Limits:</td><td>
<table>
<tr><td rowspan="2">Frequency range (MHz)</td><td colspan="2">Limit (dBuV)</td></tr>
<tr><td>Quasi-peak</td><td>Average</td></tr>
<tr><td>0.15-0.5</td><td>66 to 56*</td><td>56 to 46*</td></tr>
<tr><td>0.5-5</td><td>56</td><td>46</td></tr>
<tr><td>5-30</td><td>60</td><td>50</td></tr>
</table>
</td></tr>
<tr><td>Test Setup:</td><td>


Remark:
E.U.T: Equipment Under Test
LISN: Line Impedence Stabilization Network
Test table height=0.8m
</td></tr>
<tr><td>Test Mode:</td><td>Charging + transmitting with modulation</td></tr>
<tr><td>Test Procedure:</td><td>1. The E.U.T is connected to the main power through a line impedance stabilization network (L.I.S.N.). This provides a 50ohm/50uH coupling impedance for the measuring equipment.
2. The peripheral devices are also connected to the main power through a LISN that provides a 50ohm/50uH coupling impedance with 50ohm termination. (Please refer to the block diagram of the test setup and photographs).
3. Both sides of A.C. line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10: 2013 on conducted measurement.</td></tr>
<tr><td>Test Result:</td><td>PASS</td></tr>
</table>

6.2.2. Test Instruments

Conducted Emission Shielding Room Test Site (843)				
Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Due**
Test Receiver	R&S	ESPI	101401	Jun. 12, 2018
LISN	Schwarzbeck	NSLK 8126	8126453	Sep. 27, 2018
Coax cable (9KHz-30MHz)	TCT	CE-05	N/A	Sep. 27, 2018
EMI Test Software	Shurple Technology	EZ-EMC	N/A	N/A

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

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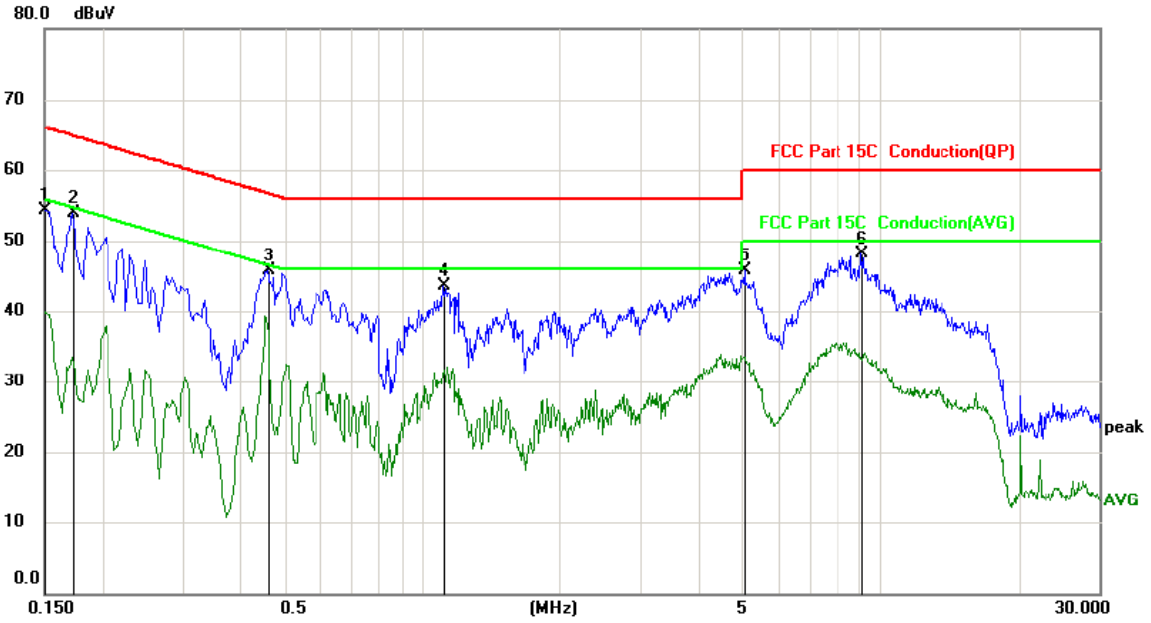
6.2.3. Test data

Please refer to following diagram for individual

Conducted Emission on Line Terminal of the power line (150 kHz to 30MHz)



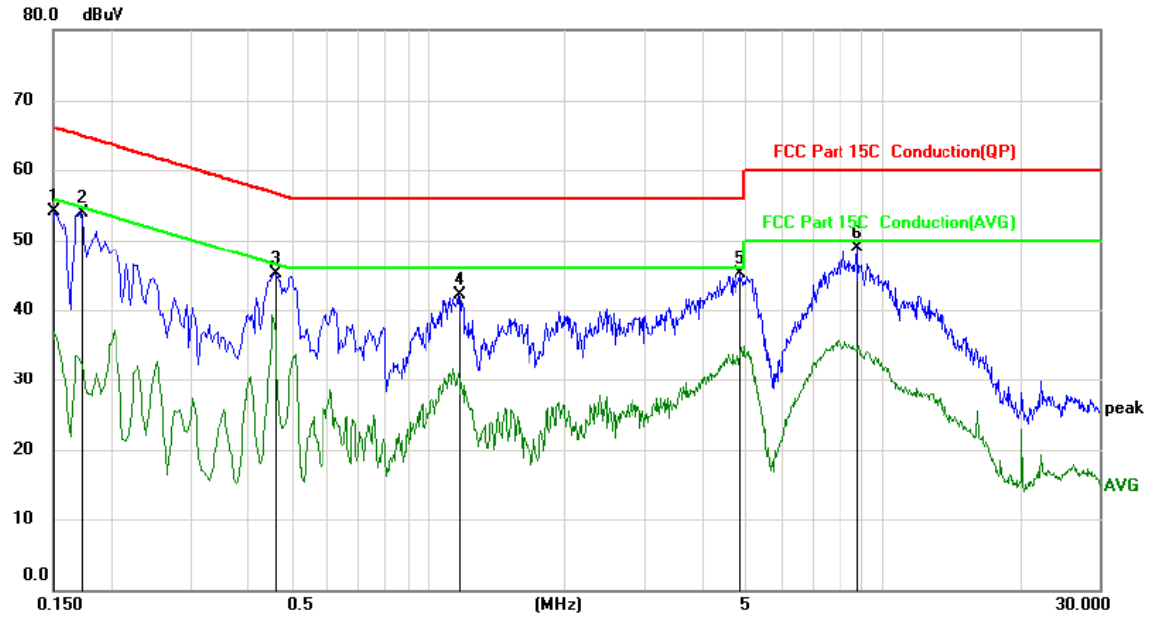
Site	Phase:	*L1*	Temperature: 25
Limit: FCC Part 15C Conduction(QP)	Power:	AC 120V/60Hz	Humidity: 55 %

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1500	42.97	11.39	54.36	66.00	-11.64	peak	
2	*	0.1725	42.47	11.38	53.85	64.84	-10.99	peak	
3		0.4605	34.43	11.24	45.67	56.68	-11.01	peak	
4		1.1129	32.57	11.01	43.58	56.00	-12.42	peak	
5		5.0640	35.35	10.28	45.63	60.00	-14.37	peak	
6		9.0960	37.26	10.84	48.10	60.00	-11.90	peak	

Note:

Freq. = Emission frequency in MHz
Reading level (dBµV) = Receiver reading
Corr. Factor (dB) = Antenna factor + Cable loss
Measurement (dBµV) = Reading level (dBµV) + Corr. Factor (dB)
Limit (dBµV) = Limit stated in standard
Margin (dB) = Measurement (dBµV) – Limits (dBµV)
Q.P. =Quasi-Peak
AVG =average
** is meaning the worst frequency has been tested in the frequency range 150 kHz to 30MHz.*

Conducted Emission on Neutral Terminal of the power line (150 kHz to 30MHz)



Site			Phase:	N		Temperature:	25
Limit: FCC Part 15C Conduction(QP)			Power:	AC 120V/60Hz		Humidity:	55 %

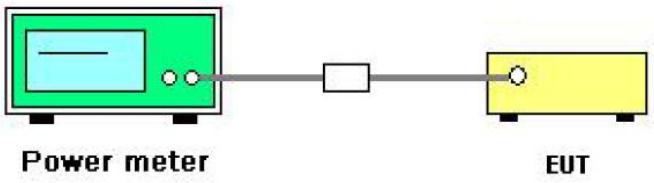
No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1508	42.76	11.39	54.15	65.96	-11.81	peak	
2	*	0.1725	42.52	11.38	53.90	64.84	-10.94	peak	
3		0.4605	33.95	11.24	45.19	56.68	-11.49	peak	
4		1.1670	31.11	11.04	42.15	56.00	-13.85	peak	
5		4.8615	34.69	10.32	45.01	56.00	-10.99	peak	
6		8.7944	38.05	10.80	48.85	60.00	-11.15	peak	

Note:

Freq. = Emission frequency in MHz
Reading level (dBµV) = Receiver reading
Corr. Factor (dB) = Antenna factor + Cable loss
Measurement (dBµV) = Reading level (dBµV) + Corr. Factor (dB)
Limit (dBµV) = Limit stated in standard
Margin (dB) = Measurement (dBµV) – Limits (dBµV)
Q.P. =Quasi-Peak
AVG =average
** is meaning the worst frequency has been tested in the frequency range 150 kHz to 30MHz.*

6.3. Maximum Conducted (Peak) Output Power

6.3.1. Test Specification

Test Requirement:	FCC Part15 C Section 15.247 (b)(3)
Test Method:	KDB 558074
Limit:	30dBm
Test Setup:	
Test Mode:	Transmitting mode with modulation
Test Procedure:	1. The testing follows the Measurement Procedure of FCC KDB No. 558074 DTS D01 Meas. Guidance v04. 2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement. 3. Set to the maximum power setting and enable the EUT transmit continuously. 4. Measure the Peak output power and record the results in the test report.
Test Result:	PASS

6.3.2. Test Instruments

Equipment	Manufacturer	Model	Serial Number	Calibration Due
Power Meter	Anritsu	ML2495A	1005002	Sep. 27, 2018
Pulse Power Senor	Anritsu	MA2411B	0917070	Sep. 27, 2018
RF Cable (9KHz-26.5GHz)	TCT	RE-06	N/A	Sep. 27, 2018
Antenna Connector	TCT	RFC-01	N/A	Sep. 27, 2018

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

6.3.3. Test Data

For DSSS / Antenna 0+Antenna 1					
Test channel	Maximum Conducted (Peak) Output Power (dBm)			Limit (dBm)	Result
	Ant0	Ant1	Total		
905MHz	25.13	25.83	28.50	30	PASS
910MHz	25.37	25.62	28.51	30	PASS
915MHz	25.22	25.48	28.36	30	PASS
920MHz	26.06	25.80	28.94	30	PASS

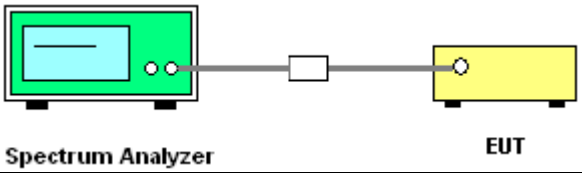
For OFDM / Antenna 0+Antenna 1					
Test channel	Maximum Conducted (Peak) Output Power (dBm)			Limit (dBm)	Result
	Ant0	Ant1	Total		
905MHz	23.52	23.52	26.53	30	PASS
910MHz	23.66	23.49	26.59	30	PASS
915MHz	23.61	23.72	26.68	30	PASS
920MHz	23.67	23.64	26.67	30	PASS

***Note*: G_{ANT} =2dBi, Array Gain=10log(N_{ANT}/N_{SS})=3.01dBi**

Directional Gain=G_{ANT} + Array Gain=5.01dBi<6dBi, So limit=30dBm

6.4. Emission Bandwidth

6.4.1. Test Specification

Test Requirement:	FCC Part15 C Section 15.247 (a)(2)
Test Method:	KDB 558074
Limit:	>500kHz
Test Setup:	
Test Mode:	Transmitting mode with modulation
Test Procedure:	1. The testing follows FCC KDB Publication No. 558074 DTS D01 Meas. Guidance v04. 2. Set to the maximum power setting and enable the EUT transmit continuously. 3. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6dB bandwidth must be greater than 500 kHz. 4. Measure and record the results in the test report.
Test Result:	PASS

6.4.2. Test Instruments

RF Test Room				
Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Due**
Spectrum Analyzer	Agilent	N9020A	MY49100060	Sep. 27, 2018
RF Cable (9KHz-26.5GHz)	TCT	RE-06	N/A	Sep. 27, 2018
Antenna Connector	TCT	RFC-01	N/A	Sep. 27, 2018

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

6.4.3. Test data

Antenna 0:

Test channel	6dB Emission Bandwidth (MHz)	
	For DSSS	For OFDM
905MHz	2.548	4.479
910MHz	2.477	4.471
915MHz	2.537	4.483
920MHz	2.461	4.471
Limit:	>500k	
Test Result:	PASS	

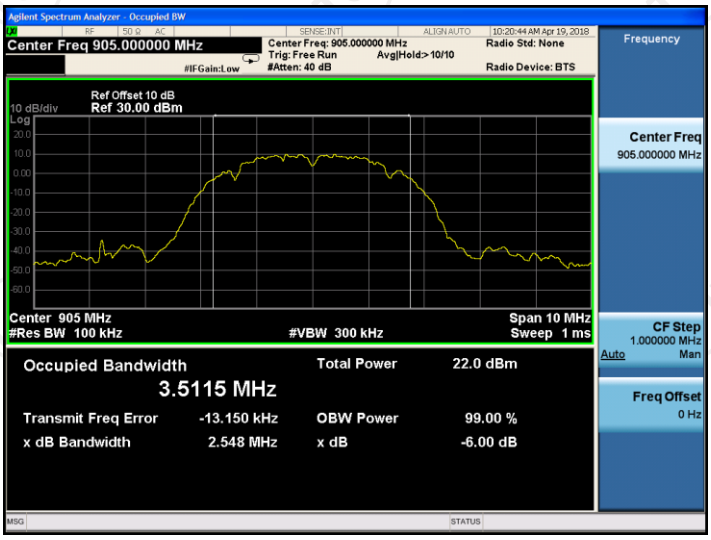
Antenna 1:

Test channel	6dB Emission Bandwidth (MHz)	
	For DSSS	For OFDM
905MHz	2.418	4.451
910MHz	2.458	4.444
915MHz	2.482	4.490
920MHz	2.457	4.490
Limit:	>500k	
Test Result:	PASS	

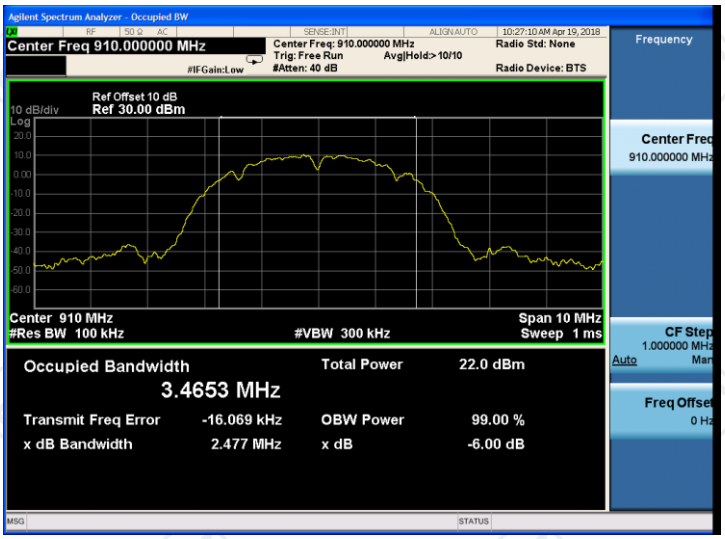
Test plots as follows:

Antenna 0:
For DSSS

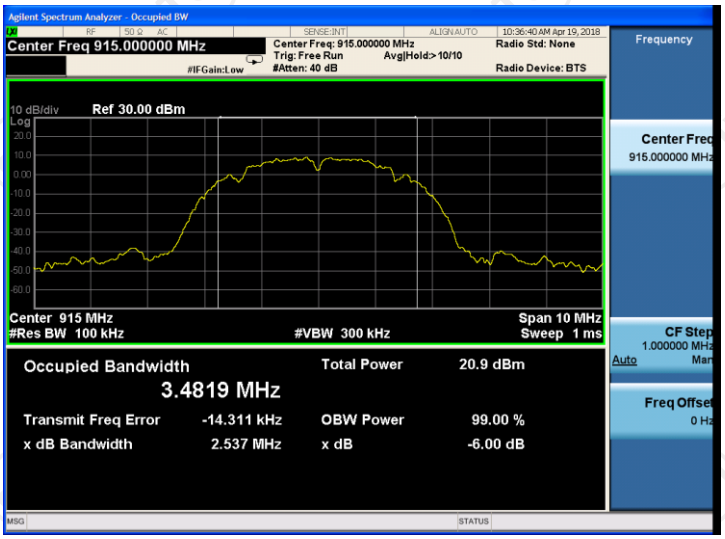
905MHz Modulation



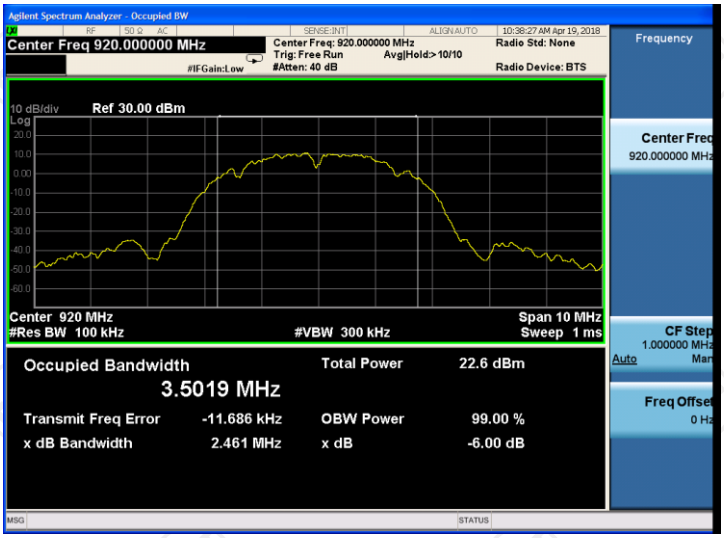
910MHz Modulation



915MHz Modulation

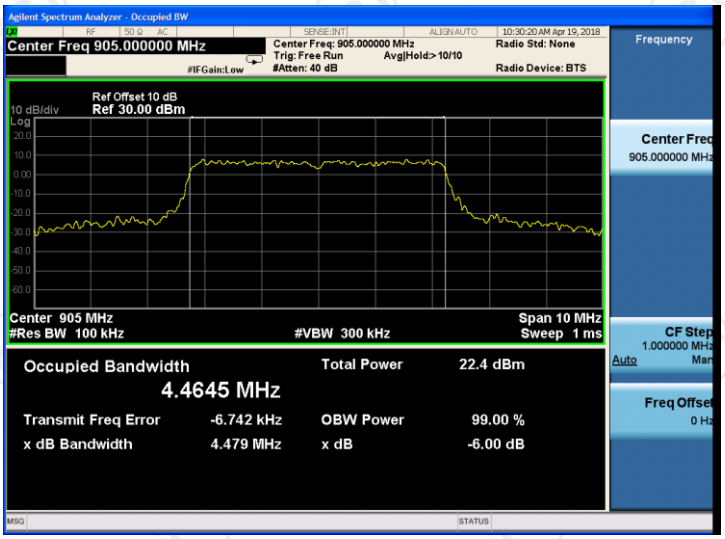


920MHz Modulation

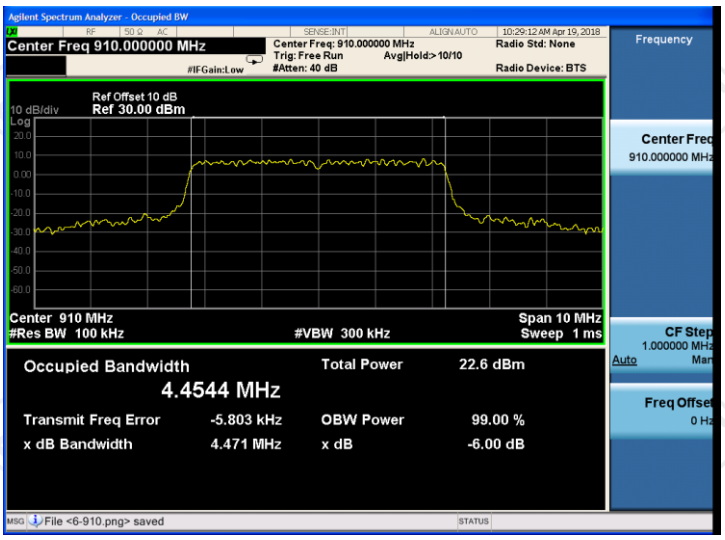


For OFDM

905MHz Modulation

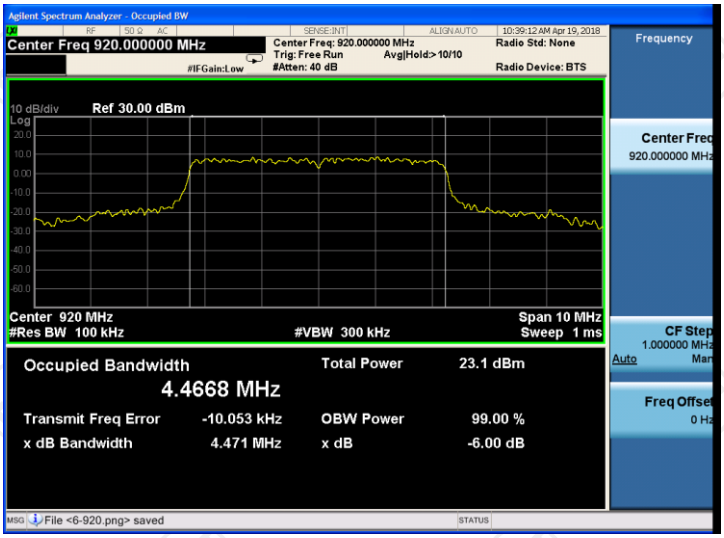


910MHz Modulation



915MHz Modulation

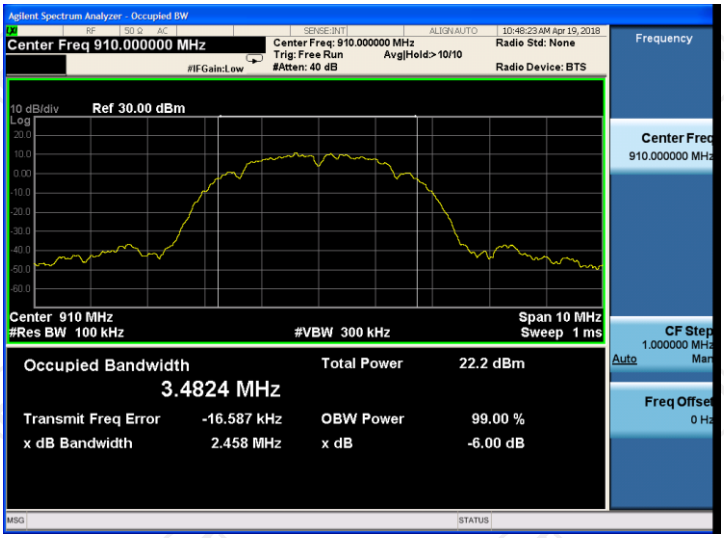
920MHz Modulation



Antenna 1:
For DSSS

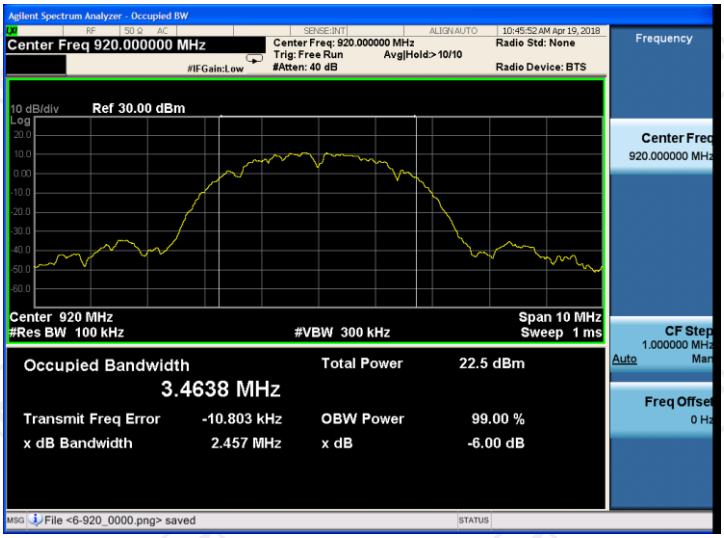
905MHz Modulation

910MHz Modulation



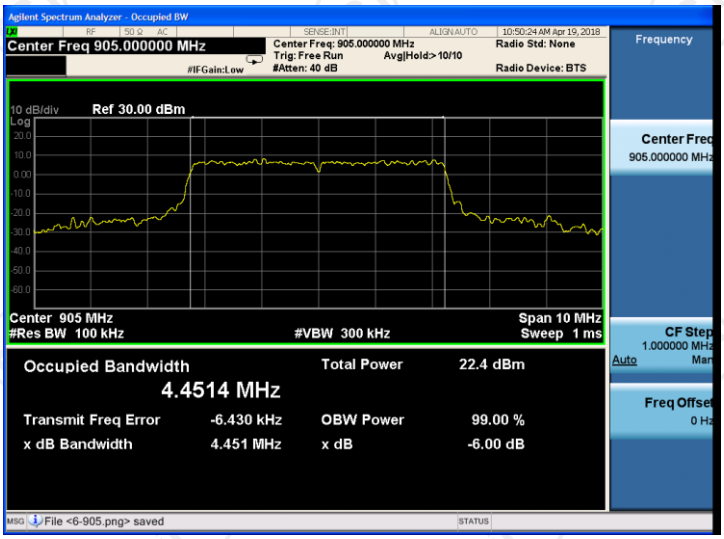
915MHz Modulation

920MHz Modulation

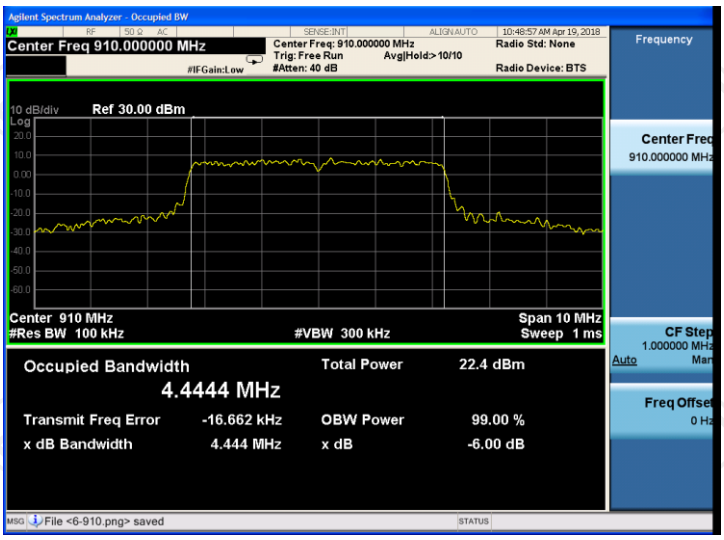


For OFDM

905MHz Modulation

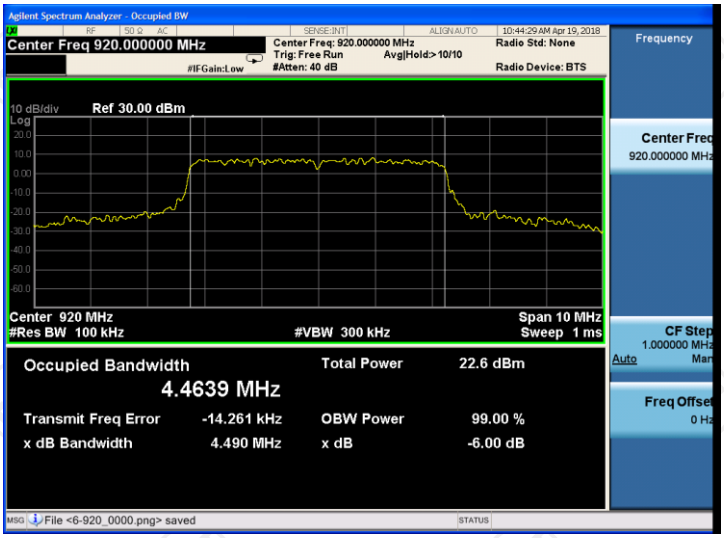


910MHz Modulation



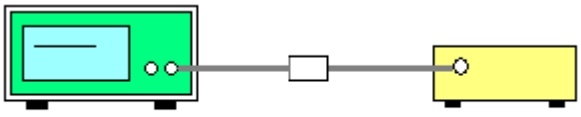
915MHz Modulation

920MHz Modulation



6.5. Power Spectral Density

6.5.1. Test Specification

Test Requirement:	FCC Part15 C Section 15.247 (e)
Test Method:	KDB 558074
Limit:	The average power spectral density shall not be greater than 8dBm in any 3kHz band at any time interval of continuous transmission.
Test Setup:	
Test Mode:	Transmitting mode with modulation
Test Procedure:	1. The testing follows Measurement Procedure 10.3 Method AVGPSD of FCC KDB Publication No.558074 D01 DTS Meas. Guidance v04 2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement. 3. Set to the maximum power setting and enable the EUT transmit continuously. 4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW): 3 kHz ≤ RBW ≤ 100 kHz. Video bandwidth VBW ≥ 3 x RBW. Set the span to at least 1.5 times the OBW. 5. Detector = RMS, Sweep time = auto couple. 6. Employ trace averaging (RMS) mode over a minimum of 100 traces. Use the peak marker function to determine the maximum power level. 6. Measure and record the results in the test report.
Test Result:	PASS

6.5.2. Test Instruments

RF Test Room				
Equipment	**Manufacturer**	**Model**	**Serial Number**	**Calibration Due**
Spectrum Analyzer	Agilent	N9020A	MY49100060	Sep. 27, 2018
RF Cable (9KHz-26.5GHz)	TCT	RE-06	N/A	Sep. 27, 2018
Antenna Connector	TCT	RFC-01	N/A	Sep. 27, 2018

Note: *The calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).*

6.5.3. Test data

For DSSS/ Antenna 0, Antenna 1					
Test channel	AVG Power Spectral Density (dBm/3kHz)			Limit (dBm)	Result
	Ant0	Ant1	Total		
905MHz	2.573	2.930	5.77	8dBm/3kHz	PASS
910MHz	2.437	1.267	4.90	8dBm/3kHz	PASS
915MHz	1.650	1.208	4.44	8dBm/3kHz	PASS
920MHz	3.820	2.994	6.44	8dBm/3kHz	PASS

For OFDM/ Antenna 0, Antenna 1					
Test channel	AVG Power Spectral Density (dBm/3kHz)			Limit (dBm)	Result
	Ant0	Ant1	Total		
905MHz	2.936	2.913	5.93	8dBm/3kHz	PASS
910MHz	3.433	1.068	5.42	8dBm/3kHz	PASS
915MHz	2.295	1.378	4.87	8dBm/3kHz	PASS
920MHz	3.258	2.830	6.06	8dBm/3kHz	PASS

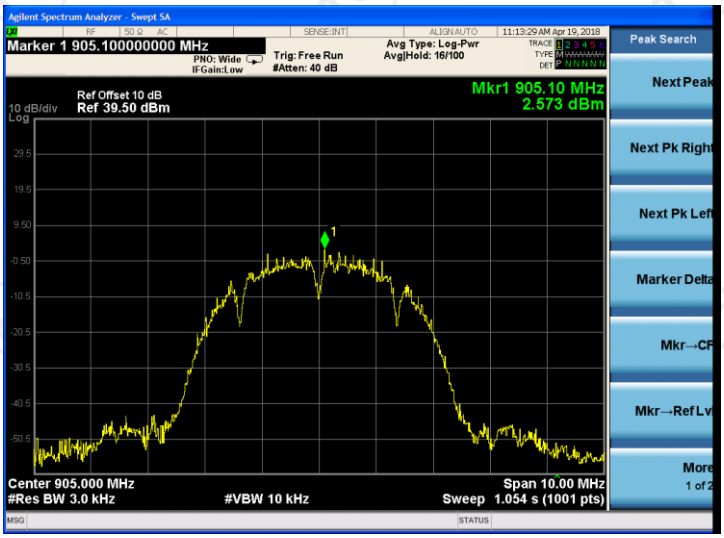
***Note*: G_{ANT} =3dBi, Array Gain=10log(N_{ANT}/N_{SS})=3.01dBi**

Directional Gain=G_{ANT} + Array Gain=5.01dBi<6dBi, So limit=8dBm/3kHz

Test plots as follows:

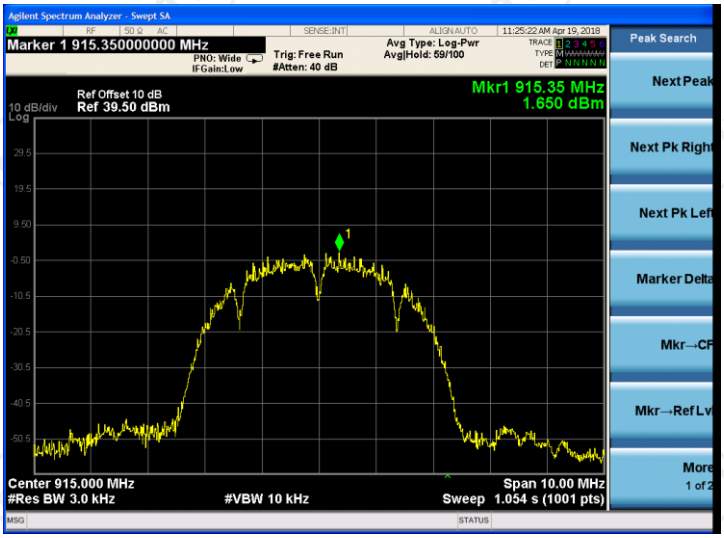
Antenna 0:
For DSSS

905MHz Modulation



910MHz Modulation

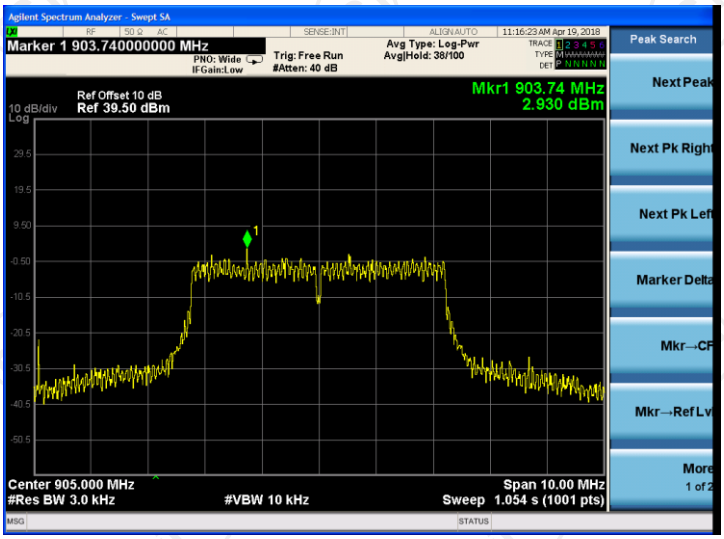
915MHz Modulation



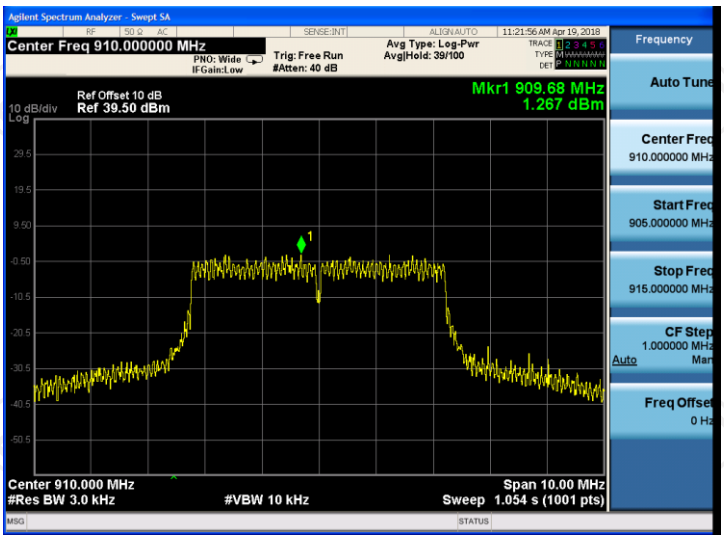
920MHz Modulation

For OFDM

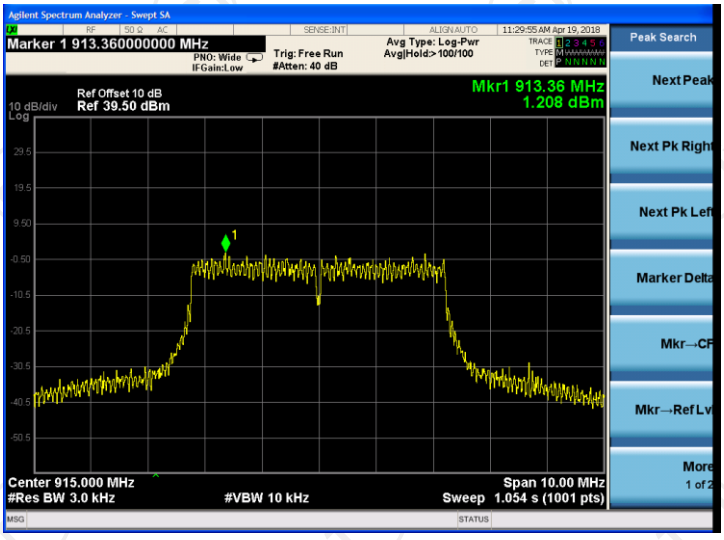
905MHz Modulation



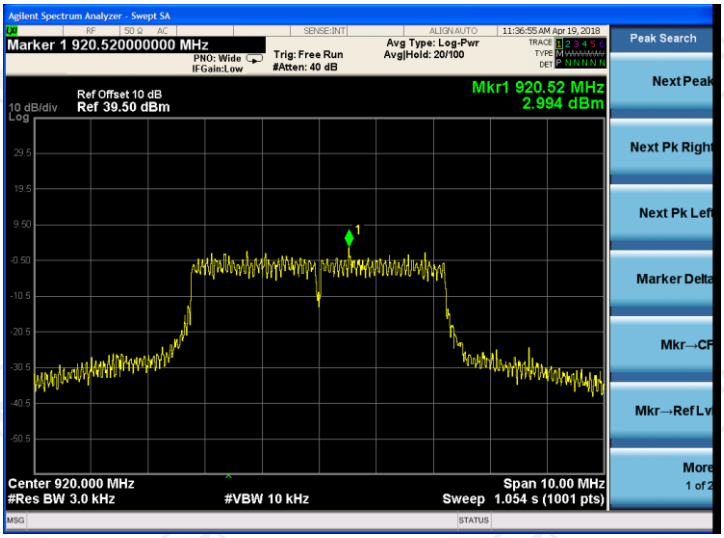
910MHz Modulation



915MHz Modulation

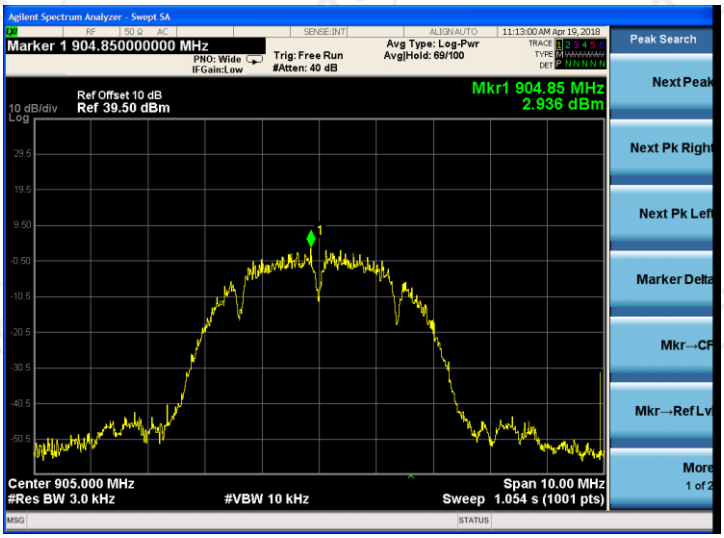


920MHz Modulation



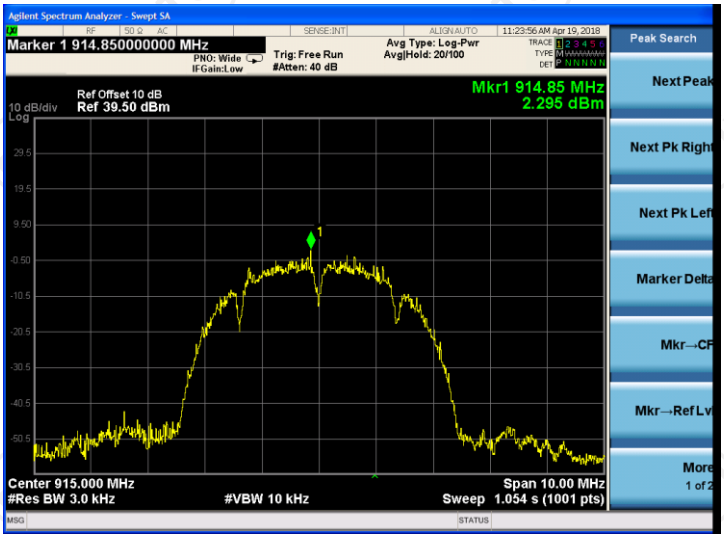
Antenna 1:
For DSSS

905MHz Modulation



910MHz Modulation

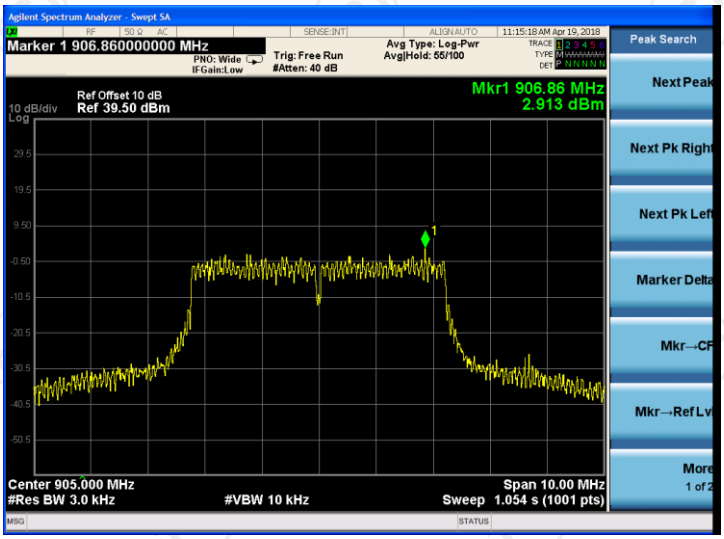
915MHz Modulation



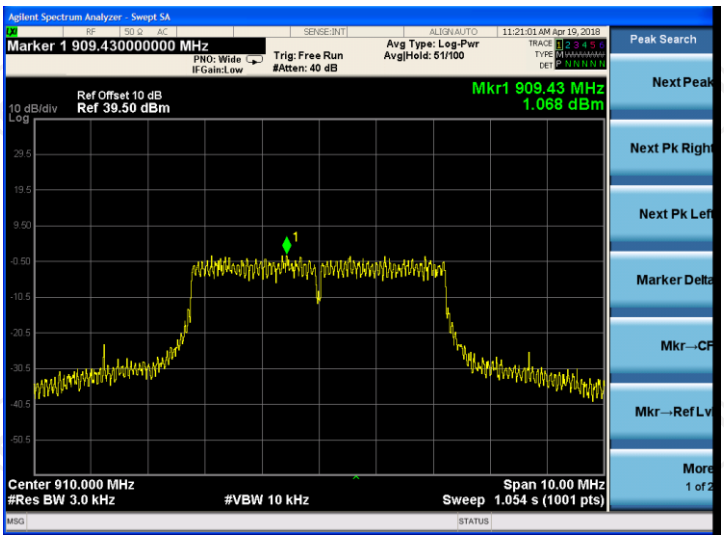
920MHz Modulation

For OFDM

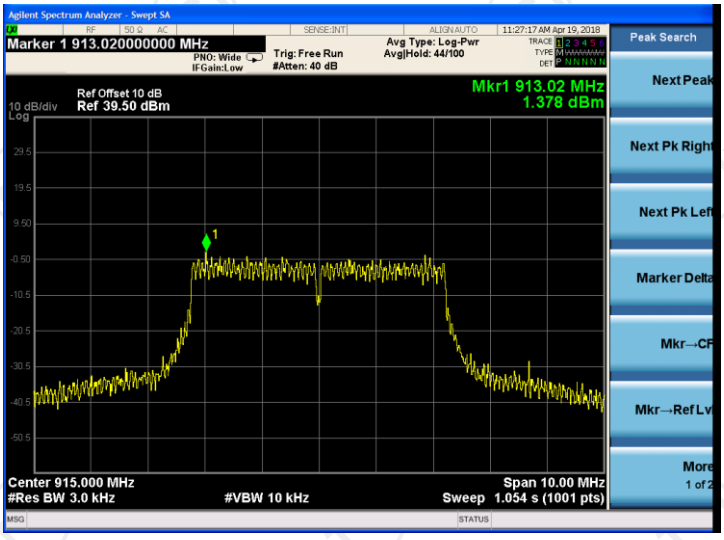
905MHz Modulation



910MHz Modulation



915MHz Modulation



920MHz Modulation