

5.7 DWELL TIME

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247(a)(1)

RSS-247 Issue 2, Section 5.1(d)

Test Method: ANSI C63.10-2013 Section 7.8.4

Limit: Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

Use the following spectrum analyzer settings:

- a) Span = zero span, centered on a hopping channel
- b) RBW shall be \leq channel spacing and where possible RBW should be set $>> 1 / T$, where T is the expected dwell time per channel.
- c) Sweep = As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
- d) Detector function = peak
- e) Trace = max hold
- f) Use the marker-delta function to determine the dwell time

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

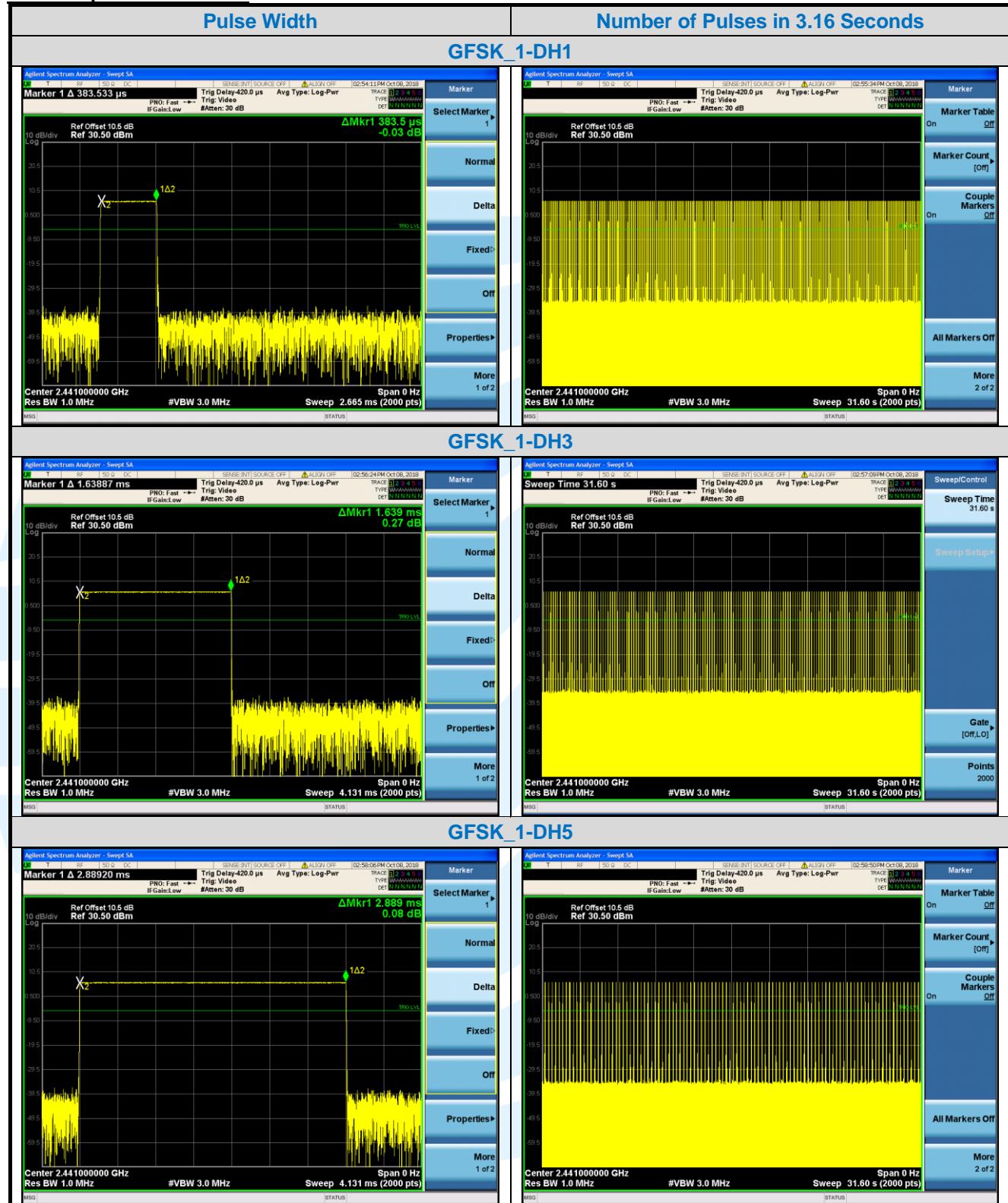
Test Setup: Refer to section 4.5.3 for details.

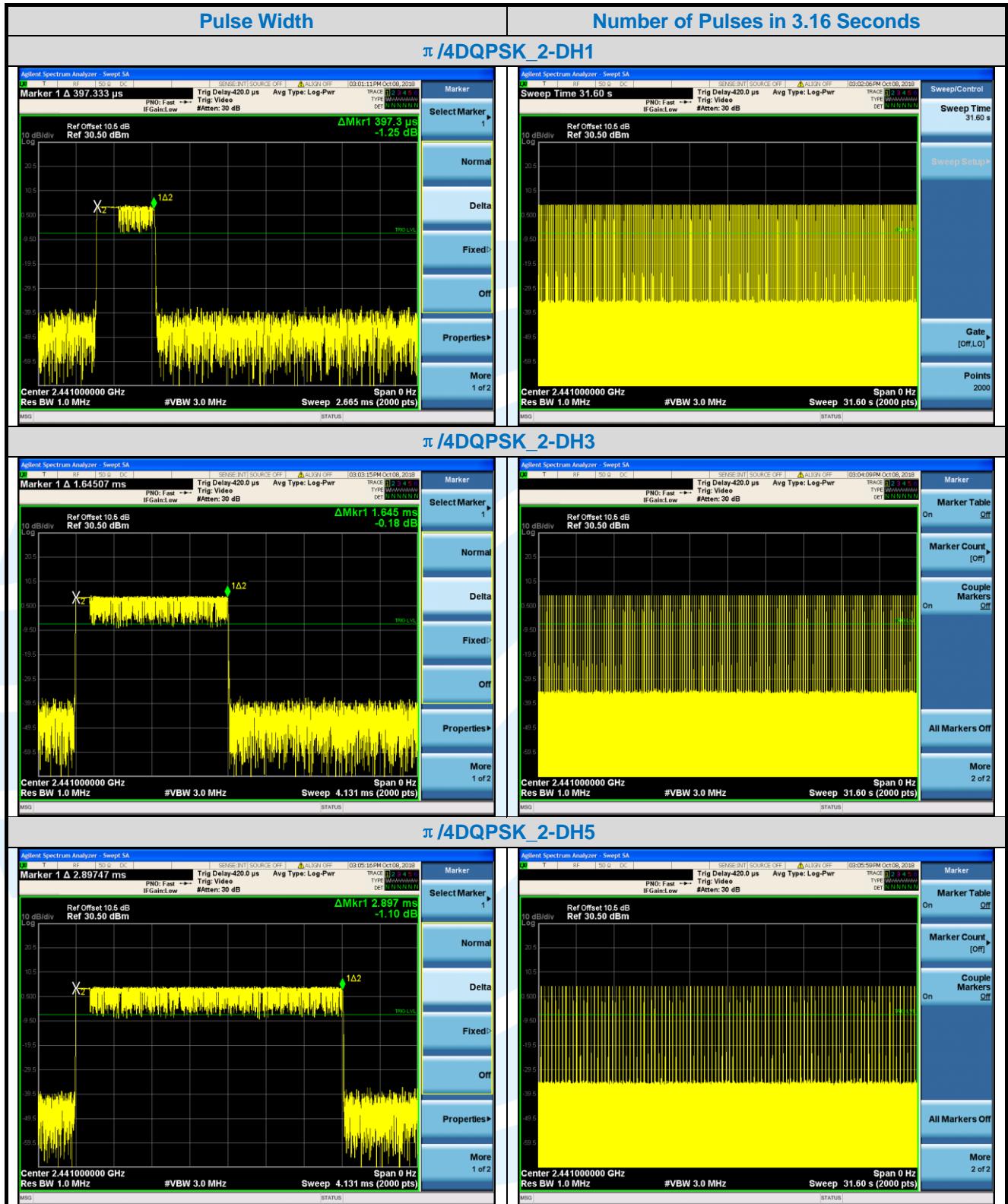
Instruments Used: Refer to section 3 for details

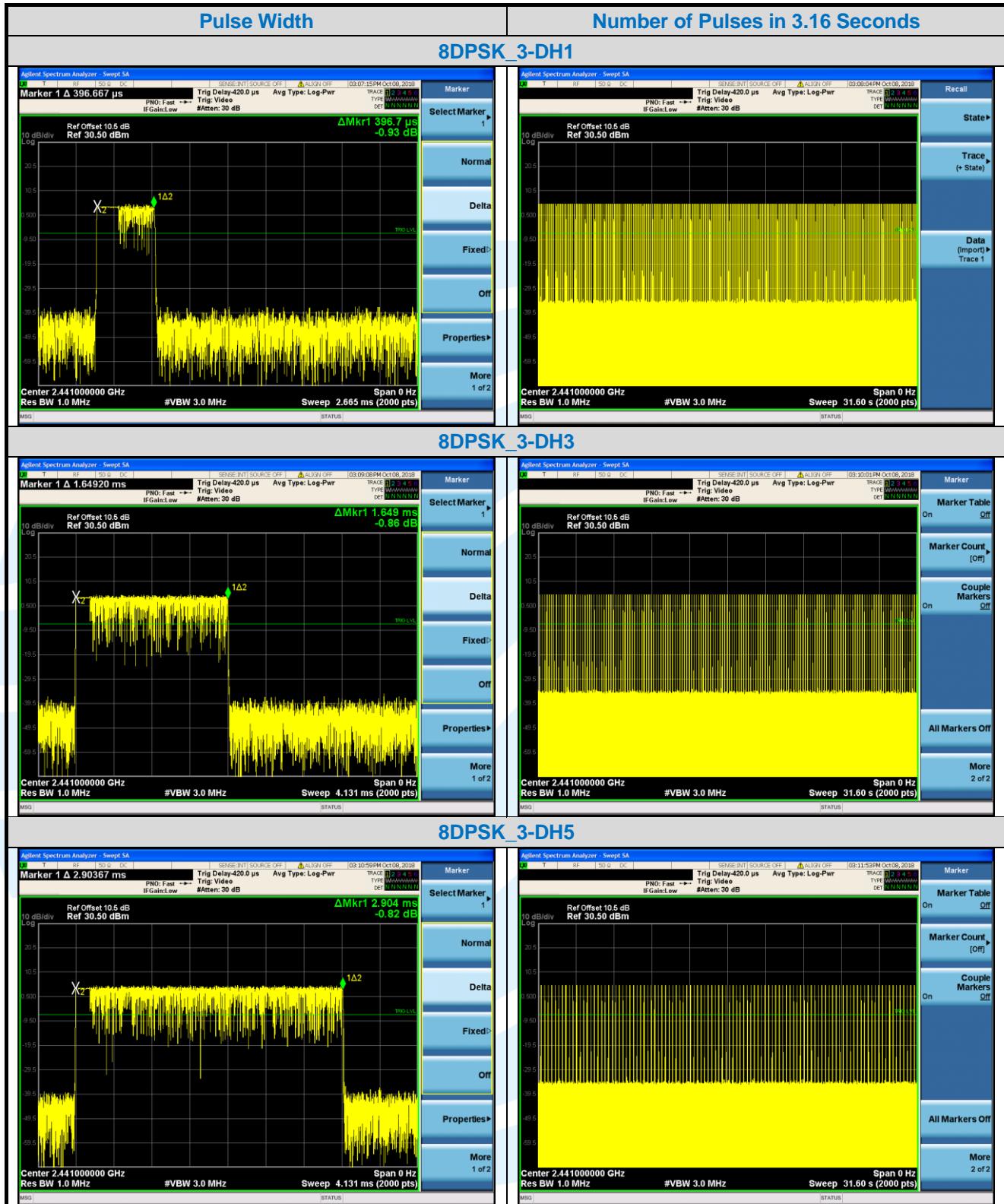
Test Results: Pass

Type of Modulation	Test Frequency	Packet	Pulse Width	Number of Pulses in 31.6 seconds	Dwell Time	Limit
			ms		ms	ms
GFSK	2441MHz	1-DH1	0.384	314.000	120.42	< 400
		1-DH3	1.639	160.000	262.24	< 400
		1-DH5	2.889	106.000	306.23	< 400
$\pi/4$ DQPSK	2441MHz	2-DH1	0.397	314.000	124.75	< 400
		2-DH3	1.645	160.000	263.20	< 400
		2-DH5	2.897	106.000	307.08	< 400
8DPSK	2441MHz	3-DH1	0.397	314.000	124.56	< 400
		3-DH3	1.649	160.000	263.84	< 400
		3-DH5	2.904	106.000	307.82	< 400

The test plots as follows:







5.8 CONDUCTED OUT OF BAND EMISSION

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247(d)
RSS-247 Issue 2, Section 5.5

Test Method: ANSI C63.10-2013 Section 6.10.4 & Section 7.8.8

Limit: In any 100kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power.

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Use the following spectrum analyzer settings:

Step 1:Measurement Procedure REF

- a) Set instrument center frequency to 2400 MHz or 2483.5 MHz.
- b) Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation.
- c) Set the RBW = 100 kHz.
- d) Set the VBW $\geq 3 \times$ RBW.
- e) Detector = peak.
- f) Sweep time = auto couple.
- g) Sweep points $\geq 2 \times$ Span/RBW
- h) Trace mode = max hold.
- i) Allow the trace to stabilize.
- j) Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.

Step 2:Measurement Procedure OOB

- a) Set RBW = 100 kHz.
- b) Set VBW ≥ 300 kHz.
- c) Detector = peak.
- d) Sweep = auto couple.
- e) Trace Mode = max hold.
- f) Allow trace to fully stabilize.
- g) Use the peak marker function to determine the maximum amplitude level.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

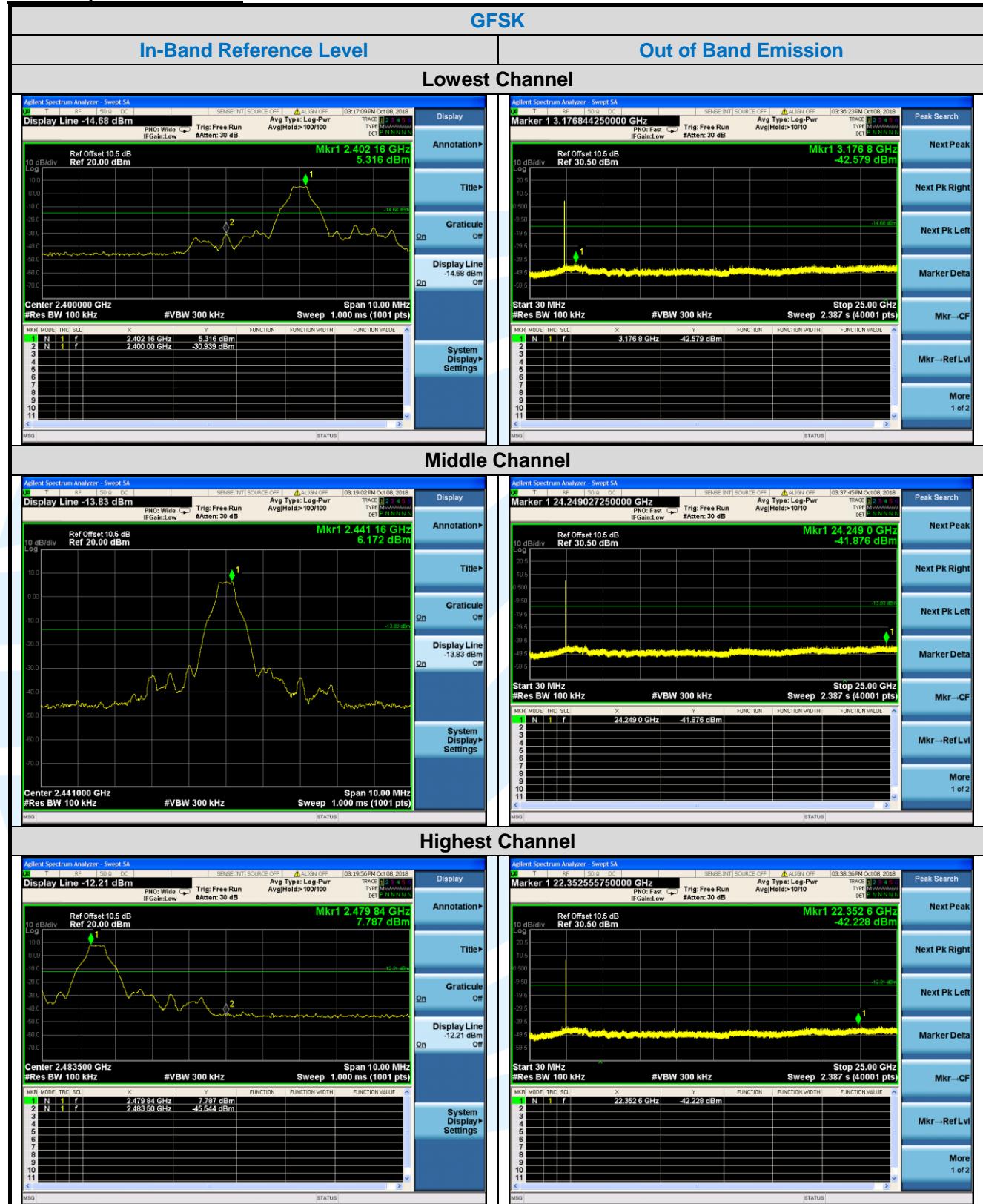
Instruments Used: Refer to section 3 for details

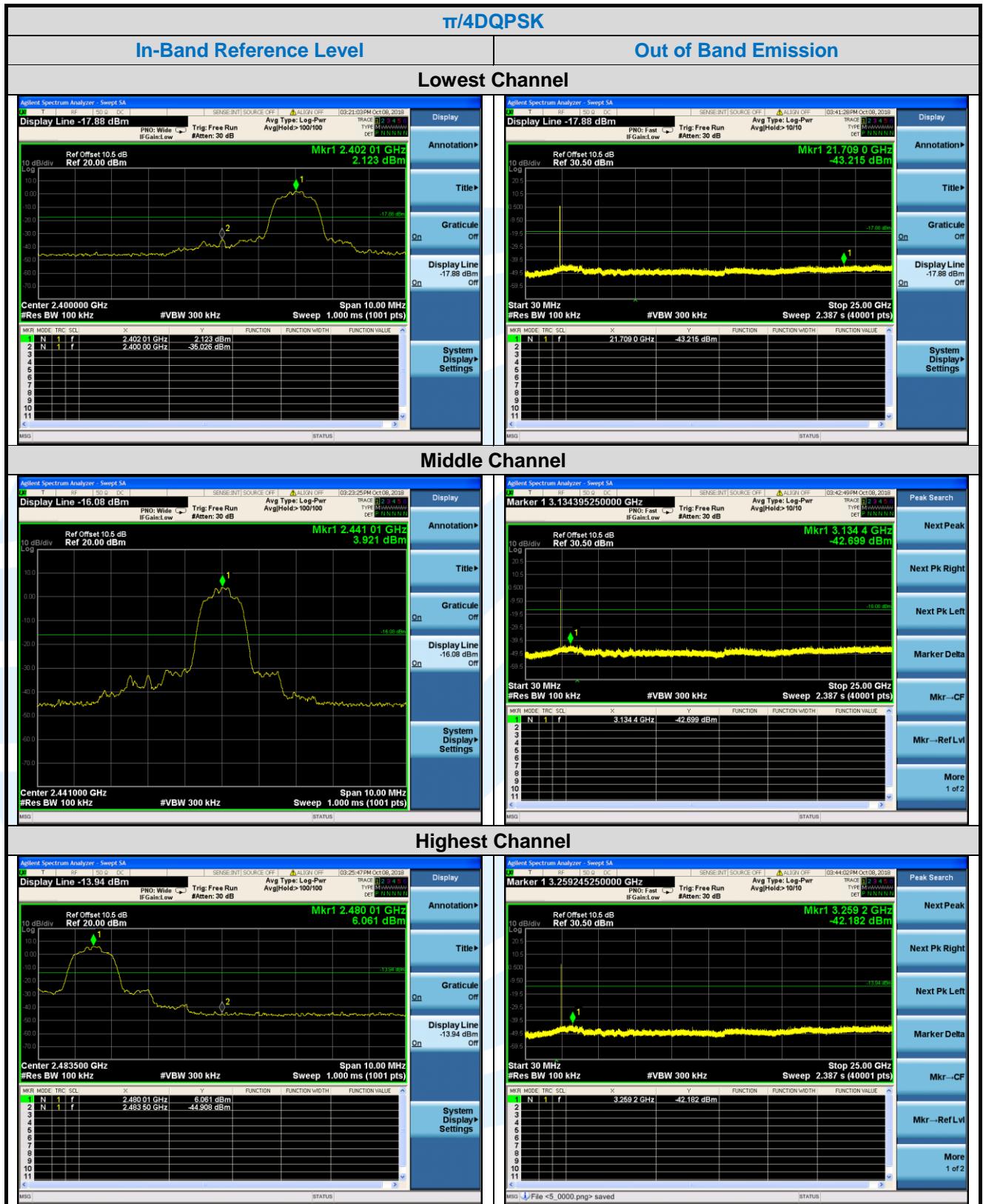
Test Mode: Hopping Frequencies Transmitter mode

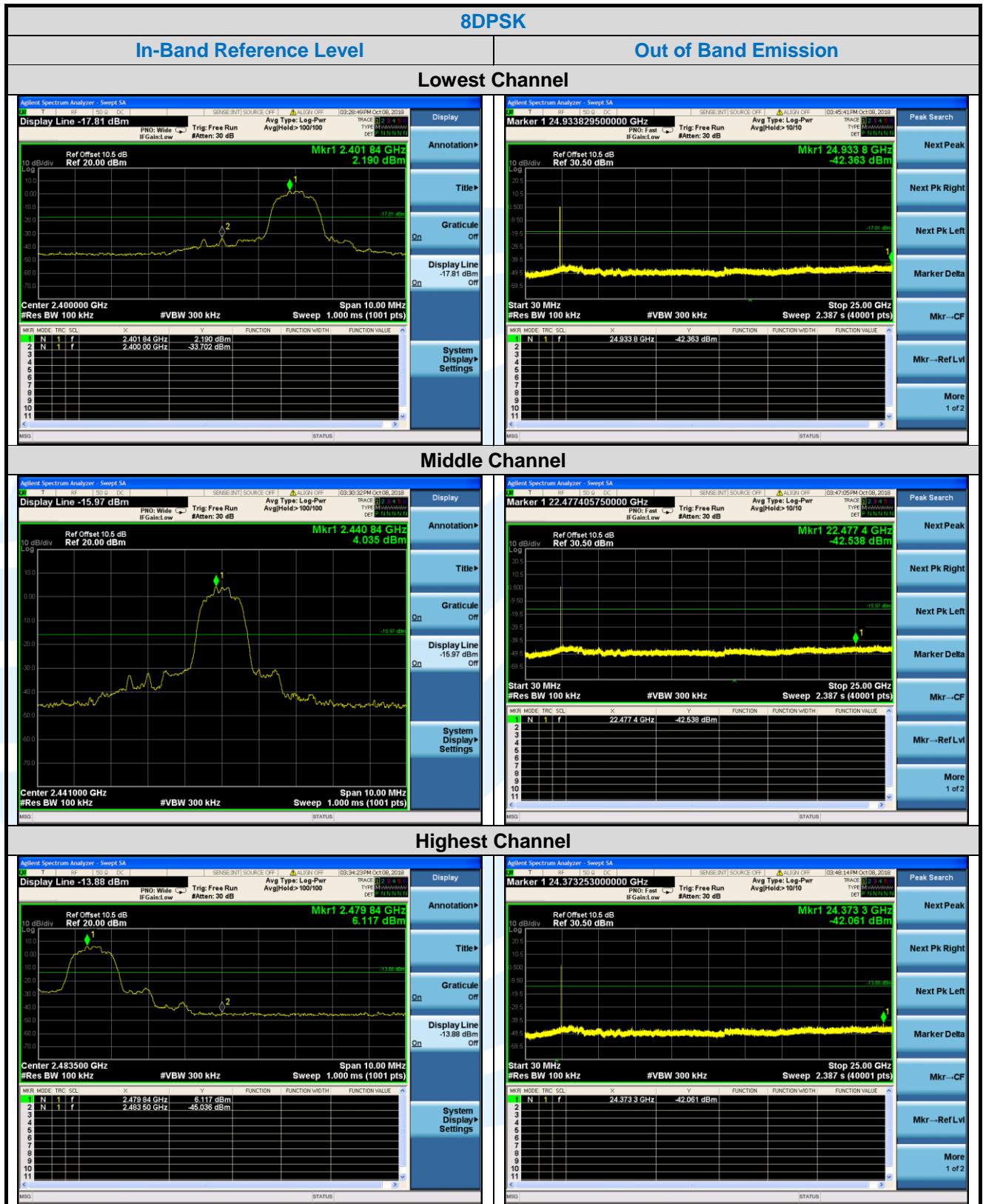
Test Results: Pass

Test Data:

The test plots as follows:









5.9 RADIATED SPURIOUS EMISSIONS

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.205/15.209

RSS-Gen Issue 5, Section 6.13/8.9/8.10

Test Method: ANSI C63.10-2013 Section 6.3 & 6.5 & 6.6

Receiver Setup:

Frequency	RBW
0.009 MHz-0.150 MHz	200/300 kHz
0.150 MHz -30 MHz	9/10 kHz
30 MHz-1 GHz	100/120 kHz
Above 1 GHz	1 MHz

Limits:

Spurious Emissions

Frequency	Field strength (microvolt/meter)	Limit (dB _u V/m)	Remark	Measurement distance (m)
0.009 MHz-0.490 MHz	2400/F(kHz)	--	--	300
0.490 MHz-1.705 MHz	24000/F(kHz)	--	--	30
1.705 MHz-30 MHz	30	--	--	30
30 MHz-88 MHz	100	40.0	Quasi-peak	3
88 MHz-216 MHz	150	43.5	Quasi-peak	3
216 MHz-960 MHz	200	46.0	Quasi-peak	3
960MHz-1GHz	500	54.0	Quasi-peak	3
Above 1 GHz	500	54.0	Average	3

Remark:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dB_uV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000 MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20 dB under any condition of modulation.

Test Setup: Refer to section 4.5.1 for details.

Test Procedures:

1. From 30 MHz to 1GHz test procedure as below:

- 1) The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- 2) The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- 3) The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- 4) For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rota table table was turned from 0 degrees to 360 degrees to find the maximum reading.
- 5) The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- 6) If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

2. Above 1GHz test procedure as below:

- 1) Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber and change form table 0.8 meter to 1.5 meter(Above 18GHz the distance is 1 meter and table is 1.5 meter).
- 2) Test the EUT in the lowest channel ,middle channel, the Highest channel

- 3) The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the Y axis positioning which it is worse case.
- 4) Repeat above procedures until all frequencies measured was complete.

Equipment Used: Refer to section 3 for details.

Test Result: Pass

The measurement data as follows:

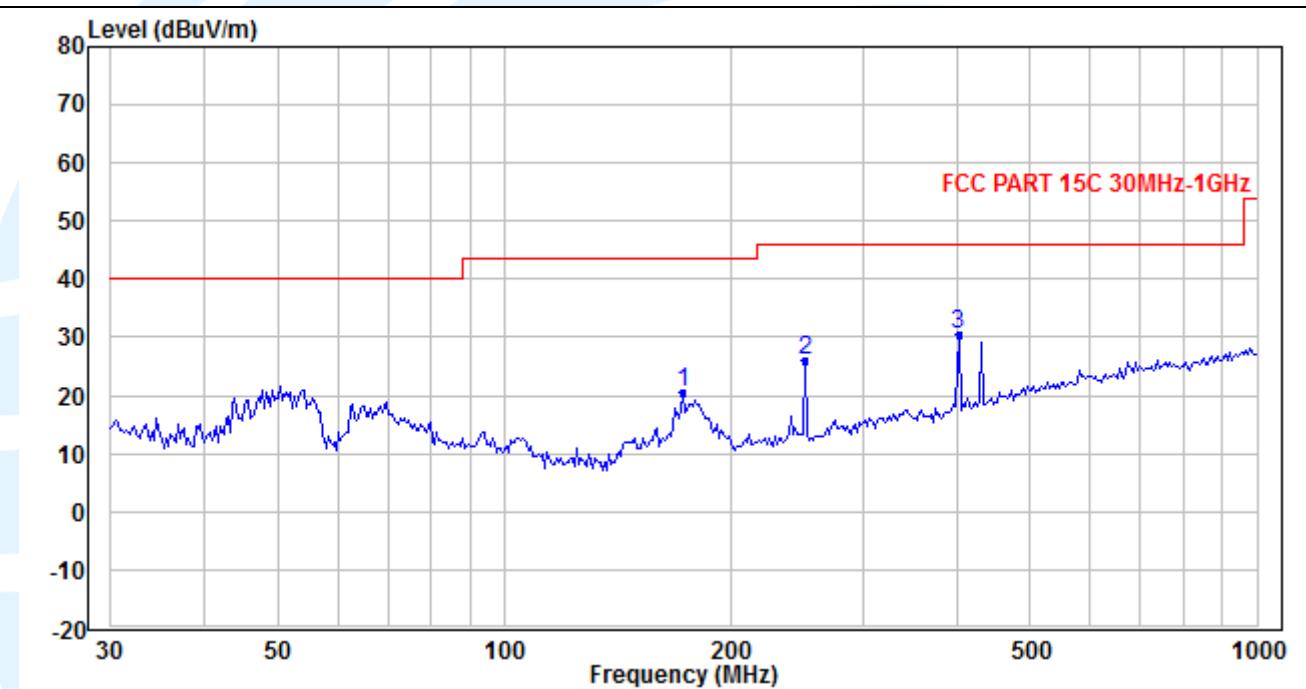
Radiated Emission Test Data (9 KHz ~ 30 MHz):

The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.

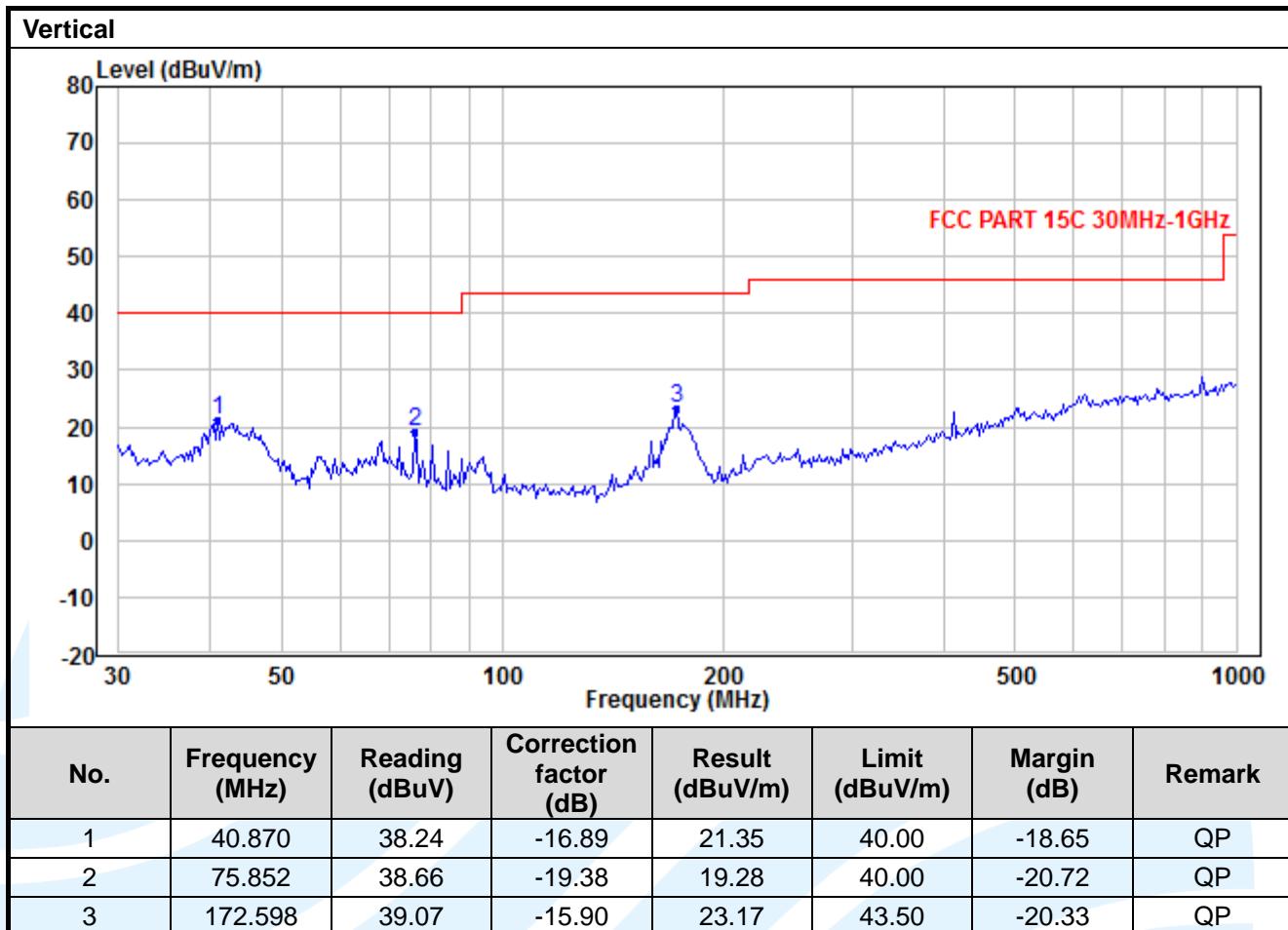
Radiated Emission Test Data (30 MHz ~ 1 GHz):

Worst-Case Configuration

Horizontal



No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	172.598	36.33	-15.90	20.43	43.50	-23.07	QP
2	250.486	38.29	-12.37	25.92	46.00	-20.08	QP
3	401.105	38.38	-7.91	30.47	46.00	-15.53	QP



Radiated Emission Test Data (Above 1GHz):
Lowest Channel:

No.	Frequency (MHz)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna Polaxis
1	4804.00	51.36	74.00	-22.64	Peak	Horizontal
2	4804.00	34.36	54.00	-19.64	Average	Horizontal
3	7206.00	50.08	74.00	-23.92	Peak	Horizontal
4	7206.00	37.08	54.00	-16.92	Average	Horizontal
5	4804.00	46.79	74.00	-27.21	Peak	Vertical
6	4804.00	32.79	54.00	-21.21	Average	Vertical
7	7206.00	51.15	74.00	-22.85	Peak	Vertical
8	7206.00	38.15	54.00	-15.85	Average	Vertical

Middle Channel:

No.	Frequency (MHz)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna Polaxis
1	4882.00	48.85	74.00	-25.15	Peak	Horizontal
2	4882.00	33.73	54.00	-20.27	Average	Horizontal
3	7323.00	51.34	74.00	-22.66	Peak	Horizontal
4	7323.00	37.57	54.00	-16.43	Average	Horizontal
5	4882.00	45.73	74.00	-28.27	Peak	Vertical
6	4882.00	33.35	54.00	-20.65	Average	Vertical
7	7323.00	53.57	74.00	-20.43	Peak	Vertical
8	7323.00	38.59	54.00	-15.41	Average	Vertical

Highest Channel:

No.	Frequency (MHz)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna Polaxis
1	4960.00	50.51	74.00	-23.49	Peak	Horizontal
2	4960.00	33.64	54.00	-20.36	Average	Horizontal
3	7440.00	51.02	74.00	-22.98	Peak	Horizontal
4	7440.00	37.53	54.00	-16.47	Average	Horizontal
5	4960.00	46.60	74.00	-27.40	Peak	Vertical
6	4960.00	32.64	54.00	-21.36	Average	Vertical
7	7440.00	53.10	74.00	-20.90	Peak	Vertical
8	7440.00	37.53	54.00	-16.47	Average	Vertical

5.10 BAND EDGE MEASUREMENTS (RADIATED)

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.205/15.209
RSS-247 Issue 2, Section 5.5

Test Method: ANSI C63.10-2013 Section 6.10.5

Limits:

Radiated emissions which fall in the restricted bands, as defined in section 15.205(a), must also comply with the radiated emission limits specified in section 15.209(a).

Frequency	Limit (dB μ V/m @3m)	Remark
30 MHz-88 MHz	40.0	Quasi-peak Value
88 MHz-216 MHz	43.5	Quasi-peak Value
216 MHz-960 MHz	46.0	Quasi-peak Value
960 MHz-1 GHz	54.0	Quasi-peak Value
Above 1 GHz	54.0	Average Value
	74.0	Peak Value

Test Setup: Refer to section 4.5.1 for details.

Test Procedures:

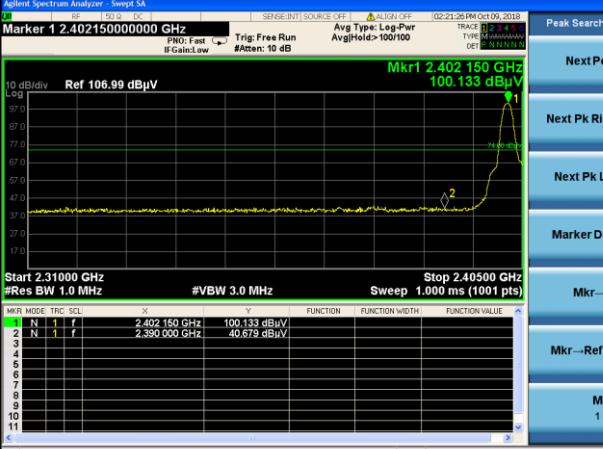
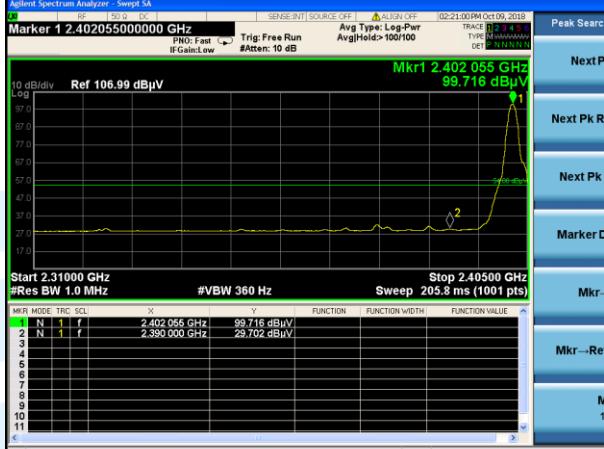
Radiated band edge measurements at 2390 MHz and 2483.5 MHz were made with the unit transmitting in the low end of the channel range and the high end closest to the restricted bands respectively. The emissions were made on the 966 Semi-Chamber. Use (resolution bandwidth (RBW) = 1 MHz, video bandwidth (VBW) = 3 MHz for peak levels and RBW = 1 MHz and VBW = 10 Hz or 1/T for average levels).

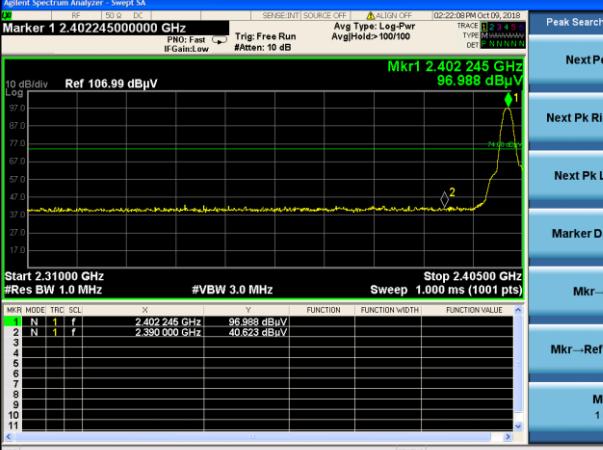
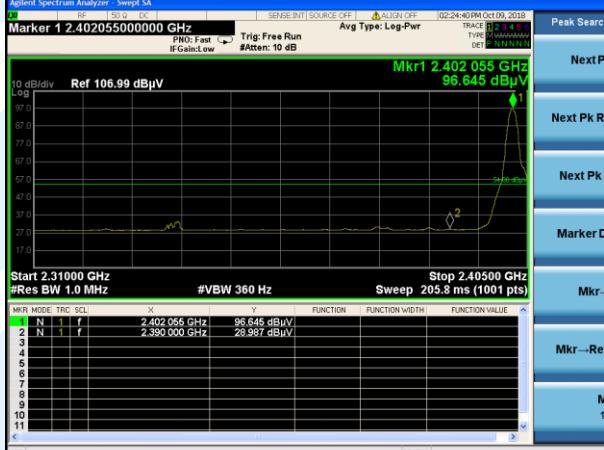
1. Use radiated spurious emission test procedure described in clause 5.10. The transmitter output (antenna port) was connected to the test receiver.
2. Set the PK and AV limit line.
3. Record the fundamental emission and emissions out of the band-edge.
4. Determine band-edge compliance as required.

Equipment Used: Refer to section 3 for details.

Test Result: Pass

The measurement data as follows:

Test Channel:	Lowest Channel	Ant. Polar. :	Horizontal
Peak		AV	
			
Frequency (MHz)	Peak level (dBuv/m)	AV level (dBuv/m)	Conclusion
2390.0000	40.68	29.70	Pass

Test Channel:	Lowest Channel	Ant. Polar. :	Vertical
Peak		AV	
			
Frequency (MHz)	Peak level (dBuv/m)	AV level (dBuv/m)	Conclusion
2390.0000	40.62	28.99	Pass

Test Channel:	Highest Channel	Ant. Polar. :	Horizontal
Peak		AV	
		Peak Search	Peak Search
		Next Peak	Next Peak
		Next Pk Right	Next Pk Right
		Next Pk Left	Next Pk Left
		Marker Delta	Marker Delta
		Mkr--CF	Mkr--CF
		Mkr--Ref Lvl	Mkr--Ref Lvl
		More 1 of 2	More 1 of 2
Frequency (MHz)	Peak level (dBuv/m)	Peak Limit (dBuv/m)	AV level (dBuv/m)
2483.5000	60.19	74.00	49.97
			AV Limit (dBuv/m)
			54.00
			Conclusion
			Pass

Test Channel:	Highest Channel	Ant. Polar. :	Vertical
Peak		AV	
		Peak Search	Peak Search
		Next Peak	Next Peak
		Next Pk Right	Next Pk Right
		Next Pk Left	Next Pk Left
		Marker Delta	Marker Delta
		Mkr--CF	Mkr--CF
		Mkr--Ref Lvl	Mkr--Ref Lvl
		More 1 of 2	More 1 of 2
Frequency (MHz)	Peak level (dBuv/m)	Peak Limit (dBuv/m)	AV level (dBuv/m)
2483.5000	61.47	74.00	51.04
			AV Limit (dBuv/m)
			54.00
			Conclusion
			Pass

APPENDIX 1 PHOTOS OF TEST SETUP

See test photos attached in Appendix 1 for the actual connections between Product and support equipment.

APPENDIX 2 PHOTOS OF EUT CONSTRUCTIONAL DETAILS

Refer to Appendix 2 for EUT external and internal photos.

*** End of Report ***

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