6. Radiated Spurious Emissions

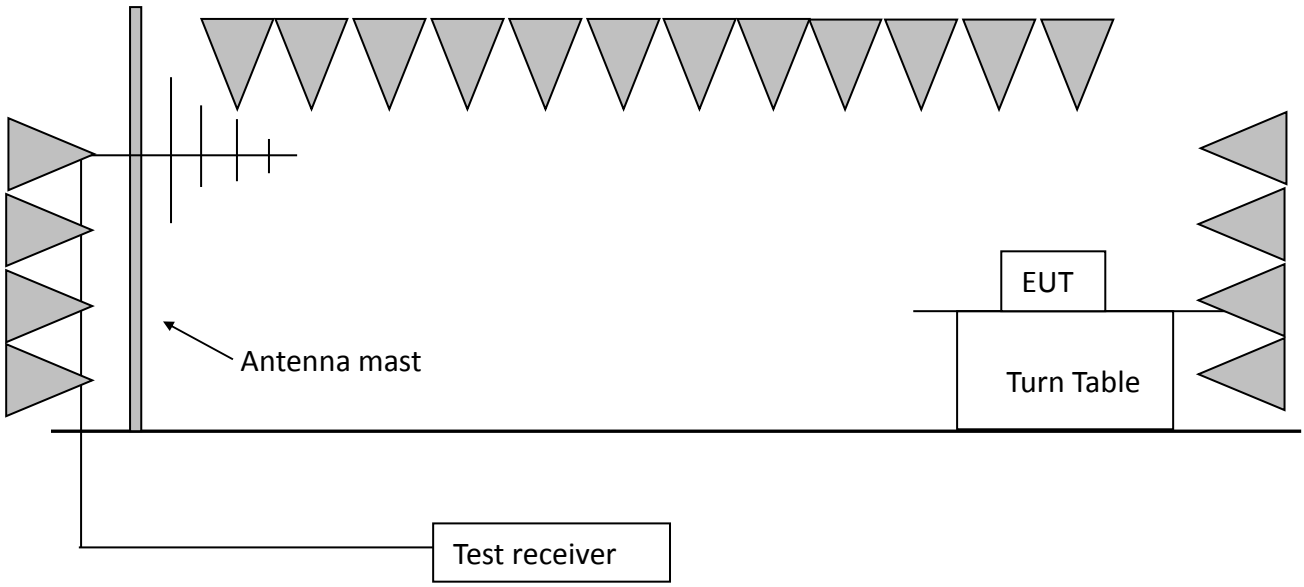
Test result: Pass

6.1 Test limit

The radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) showed as below:

Frequency (MHz)	Field Strength (dBuV/m)	Measurement Distance (m)
30 - 88	40.0	3
88 - 216	43.5	3
216 - 960	46.0	3
Above 960	54.0	3

6.2 Test Configuration



6.3 Test procedure and test setup

The measurement was applied in a semi-anechoic chamber. While testing for spurious emission higher than 1GHz, if applied, the pre-amplifier would be equipped just at the output terminal of the antenna.

Tabletop devices shall be placed on a nonconducting platform with nominal top surface dimensions 1 m by 1.5 m. For emissions testing at or below 1 GHz, the table height shall be 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m.

The turn table rotated 360 degrees to determine the position of the maximum emission level. The EUT was set 3 meters away from the receiving antenna which was mounted on an antenna mast. The antenna moved up and down between from 1meter to 4 meters to find out the maximum emission level.

The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems)

The radiated emission was measured using the Spectrum Analyzer with the resolutions bandwidth set as:

RBW = 100 kHz, VBW = 300 kHz (30MHz~1GHz)
RBW = 1MHz, VBW = 3MHz (>1GHz for PK);

Remark: 1. For fundamental emission, no amplifier is employed.
2. Correct Factor = Antenna Factor + Cable Loss (-Amplifier, is employed)
3. Corrected Reading = Original Receiver Reading + Correct Factor
4. Margin = limit – Corrected Reading
5. If the PK reading is lower than AV limit, the AV test can be elided.
6. The emission was conducted from 30MHz to 25GHz.

Example: Assuming Antenna Factor = 30.20dB/m, Cable Loss = 2.00dB,
Gain of Preamplifier = 32.00dB, Original Receiver Reading = 10dBuV.
Then Correct Factor = 30.20 + 2.00 – 32.00 = 0.20dB/m; Corrected Reading = 10dBuV + 0.20dB/m = 10.20dBuV/m
Assuming limit = 54dBuV/m, Corrected Reading = 10.20dBuV/m, then Margin = 54 - 10.20 = 43.80dBuV/m

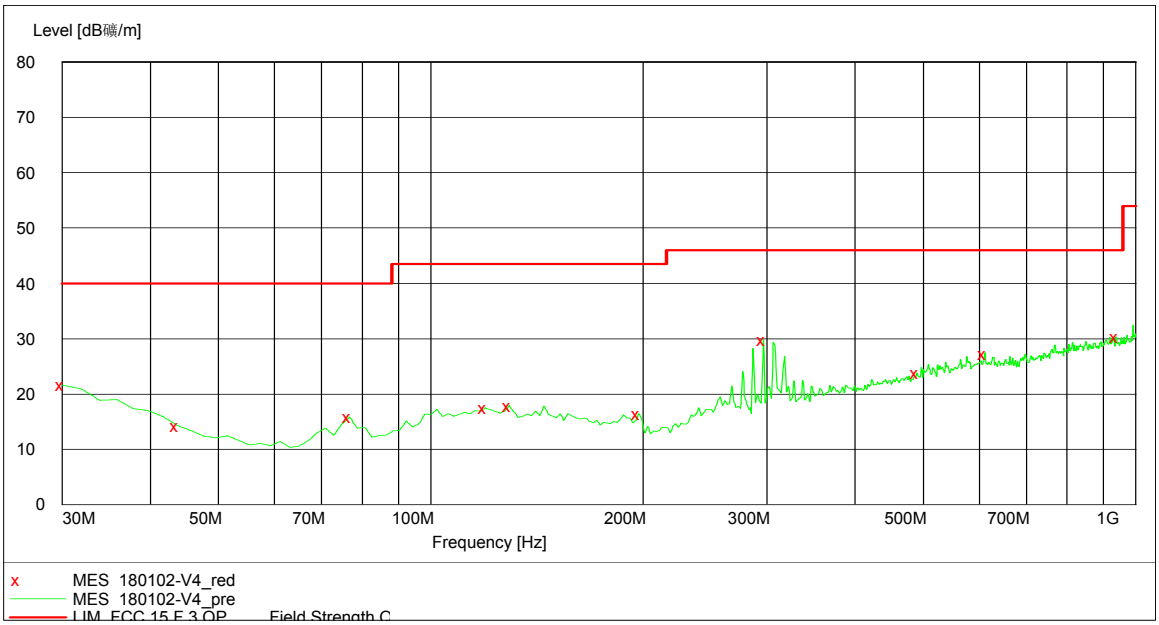
6.4 Test protocol

Temperature	:	25 °C
Relative Humidity	:	55 %

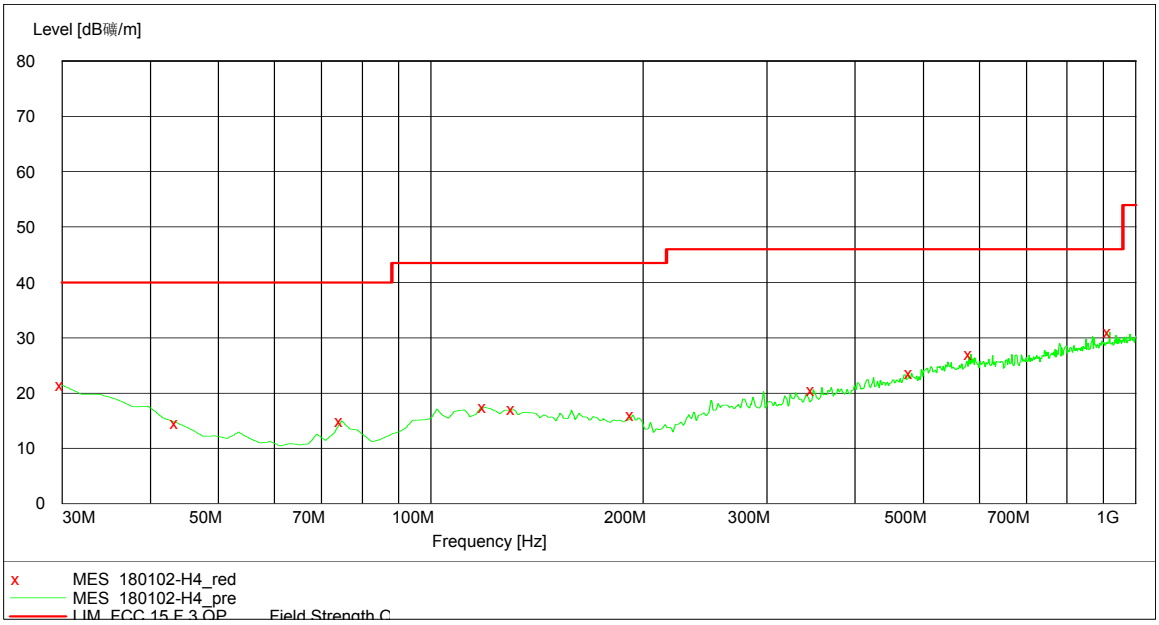
The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.

The worst waveform from 30MHz to 1000MHz is listed as below:

Horizontal



Vertical



Test data 30MHz~1GHz:

Polarization	Frequency (MHz)	Measured level (dBμV/m)	Correct Factor (dB/m)	Limits (dBμV/m)	Margin (dB)	Detector
H	30.00	21.6	19.2	40.0	18.4	PK
	43.61	14.3	11.6	40.0	25.7	PK
	76.65	15.8	7.6	40.0	24.2	PK
	119.42	17.5	13.3	43.5	26.0	PK
	129.14	17.9	12.9	43.5	25.6	PK
	197.17	16.4	10.7	43.5	27.1	PK
	296.31	29.7	14.6	46.0	16.3	PK
	488.76	23.8	19.1	46.0	22.2	PK
	611.22	27.3	20.6	46.0	18.7	PK
	939.74	30.3	23.4	46.0	15.7	PK
V	30.00	21.4	19.2	40.0	18.6	PK
	43.61	14.6	11.6	40.0	25.4	PK
	74.71	14.9	7.5	40.0	25.1	PK
	119.42	17.4	13.3	43.5	26.1	PK
	131.08	17.0	12.8	43.5	26.5	PK
	193.29	16.0	10.6	43.5	27.5	PK
	348.80	20.5	16.0	46.0	25.5	PK
	480.98	23.6	18.9	46.0	22.4	PK
	584.01	27.0	20.4	46.0	19.0	PK
	918.36	31.0	23.2	46.0	15.0	PK

Test Data (>1GHz):

GFSK (DH5) Modulation:

CH	Antenna	Frequency (MHz)	Correct Factor (dB/m)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
L	H	2402.00	30.70	100.10	Fundamental	/	PK
	H	2390.00	30.20	50.10	74.00	23.90	PK
	H	2390.00	30.20	39.50	54.00	14.50	AV
	H	4804.00	-1.50	45.50	74.00	28.50	PK
M	V	2441.00	30.70	99.60	Fundamental	/	PK
	V	4882.00	-1.10	44.60	74.00	29.40	PK
H	H	2480.00	30.70	99.40	Fundamental	/	PK
	V	2483.50	31.52	48.60	74.00	25.40	PK
	V	2483.50	31.52	40.30	54.00	13.70	AV
	V	4960.00	-0.80	45.60	74.00	28.40	PK

π/4DQPSK (2DH5) Modulation:

CH	Antenna	Frequency (MHz)	Correct Factor (dB/m)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
L	H	2402.00	30.70	98.30	Fundamental	/	PK
	H	2390.00	30.20	48.50	74.00	25.50	PK
	H	2390.00	30.20	38.80	54.00	15.20	AV
	H	4804.00	-1.50	44.70	74.00	29.30	PK
M	V	2441.00	30.70	98.10	Fundamental	/	PK
	V	4882.00	-1.10	44.20	74.00	29.80	PK
H	H	2480.00	30.70	97.90	Fundamental	/	PK
	V	2483.50	31.52	47.90	74.00	26.10	PK
	V	2483.50	31.52	39.70	54.00	14.30	AV
	V	4960.00	-0.80	44.50	74.00	29.50	PK

8DPSK (3DH5) Modulation:

CH	Antenna	Frequency (MHz)	Correct Factor (dB/m)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
L	H	2402.00	30.70	97.70	Fundamental	/	PK
	H	2390.00	30.20	46.50	74.00	27.50	PK
	H	2390.00	30.20	38.70	54.00	15.30	AV
	H	4804.00	-1.50	44.40	74.00	29.60	PK
M	V	2441.00	30.70	97.40	Fundamental	/	PK
	V	4882.00	-1.10	44.60	74.00	29.40	PK
H	H	2480.00	30.70	96.50	Fundamental	/	PK
	V	2483.50	31.52	46.40	74.00	27.60	PK
	V	2483.50	31.52	39.20	54.00	14.80	AV
	V	4960.00	-0.80	44.20	74.00	29.80	PK

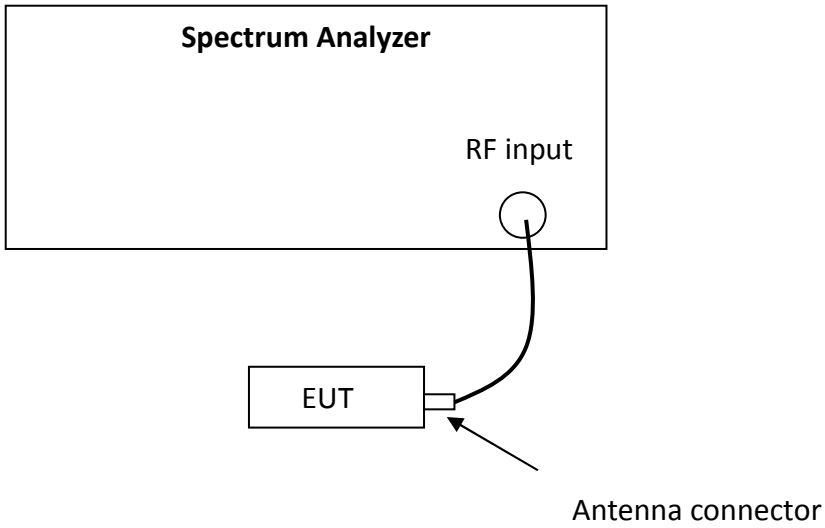
7. Conducted Spurious Emissions & Band Edge

Test result: Pass

7.1 Limit

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

7.2 Test Configuration



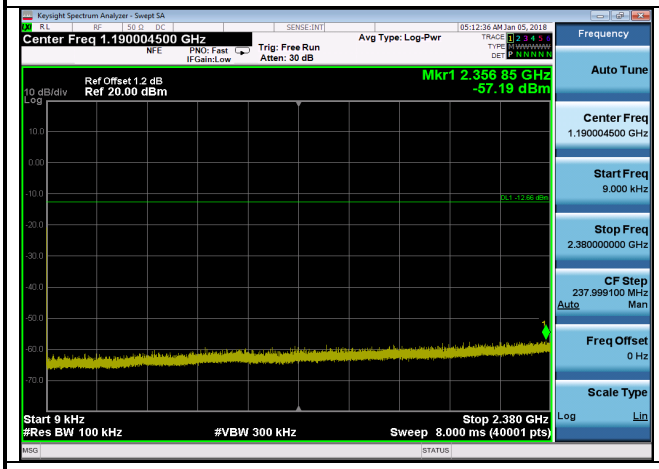
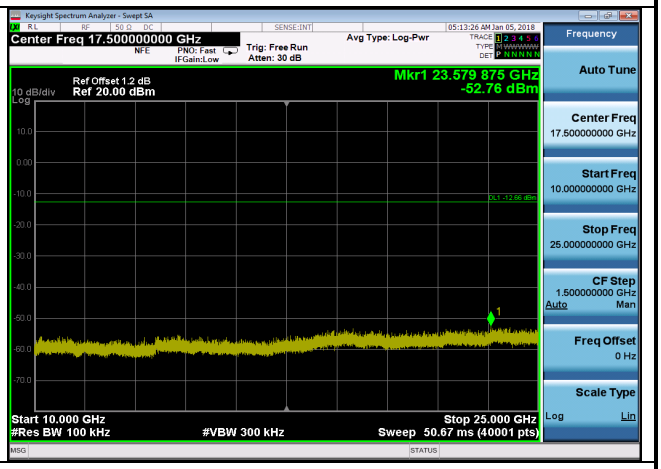
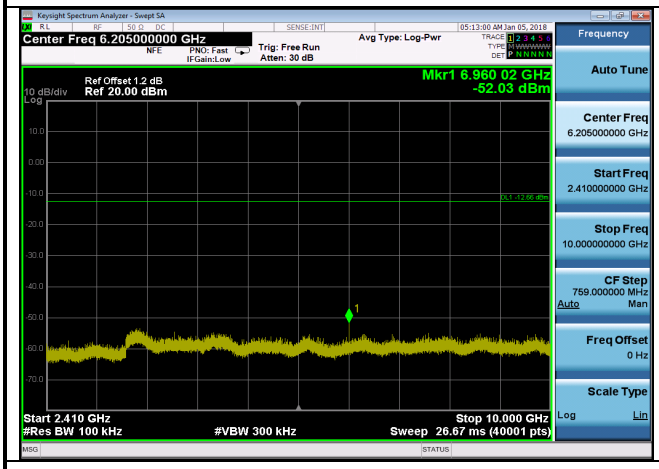
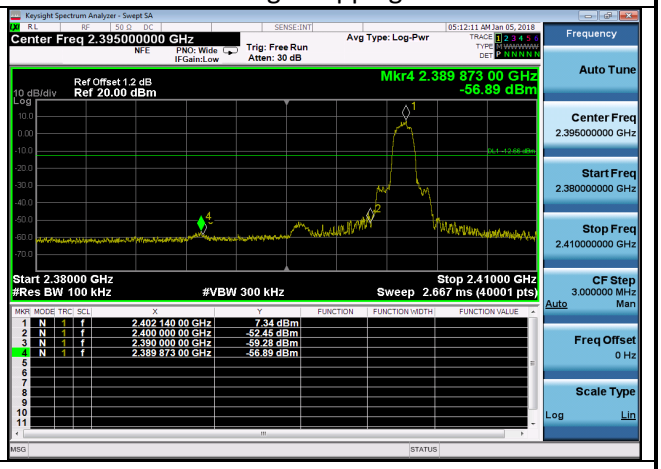
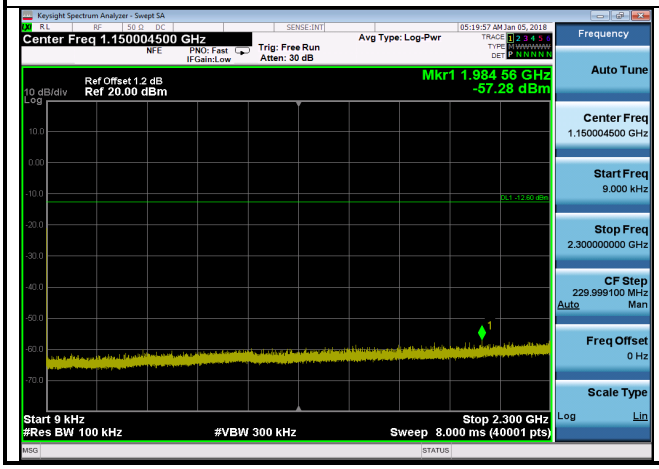
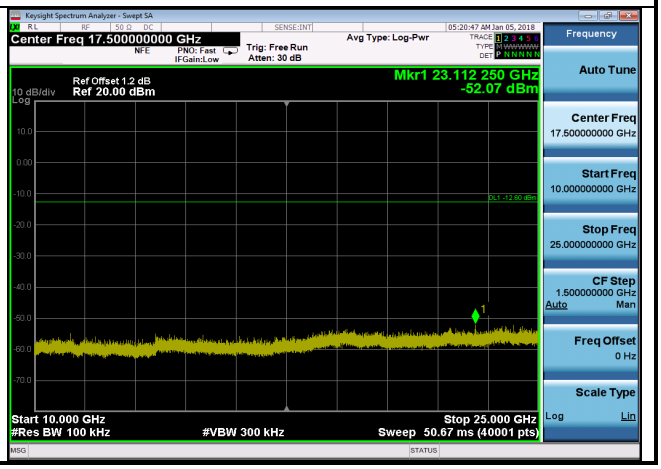
7.3 Test procedure and test setup

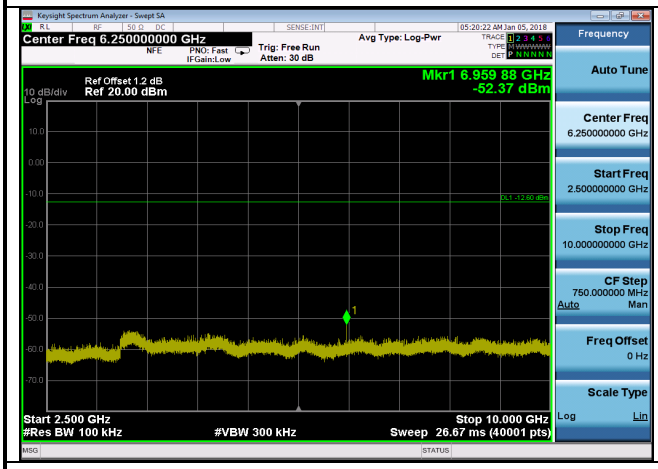
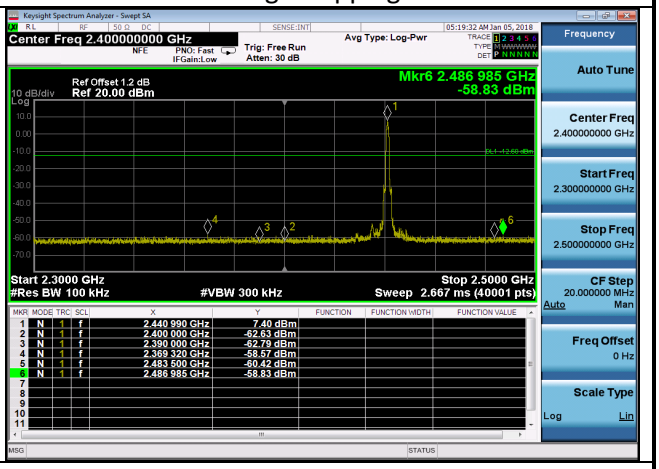
The Conducted Spurious Emissions per FCC §15.247(d) is measured using the Spectrum Analyzer with Span wide enough capturing all spurious from the lowest emission frequency of the EUT up to 10th harmonics, RBW = 100kHz, VBW≥RBW, Sweep = auto, Detector = peak, Trace = max hold.
The test was performed at 3 channels (lowest, middle and highest channel).
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems)

7.4 Test protocol

Temperature : 25 °C

Relative Humidity : 55 %

Conducted Emission：8DPSK,2402,3DH5,0.009Mhz~2380Mhz	Conducted Emission：8DPSK,2402,3DH5,10000Mhz~25000Mhz
	
Conducted Emission：8DPSK,2402,3DH5,2410Mhz~10000Mhz	Conducted Emission：8DPSK,2402,3DH5,Band Edge HoppingOFF
	
Conducted Emission：8DPSK,2441,3DH5,0.009Mhz~2300Mhz	Conducted Emission：8DPSK,2441,3DH5,10000Mhz~25000Mhz
	

Conducted Emission：8DPSK,2441,3DH5,2500Mhz~10000Mhz	Conducted Emission：8DPSK,2441,3DH5,Band Edge HoppingOFF
	
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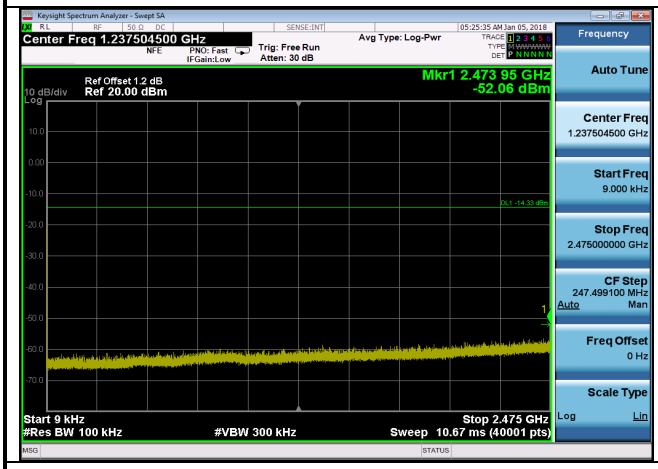
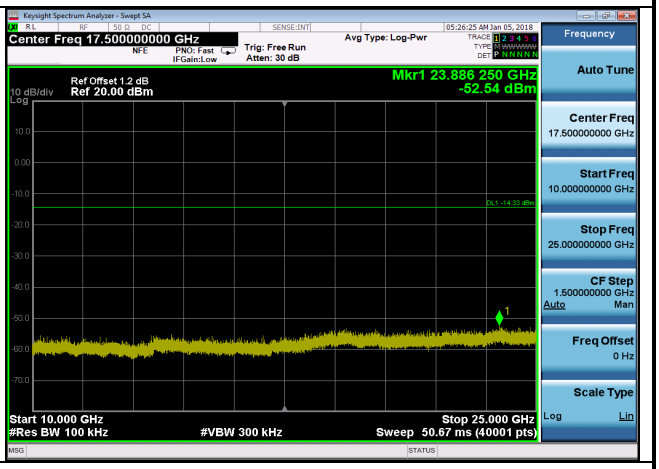
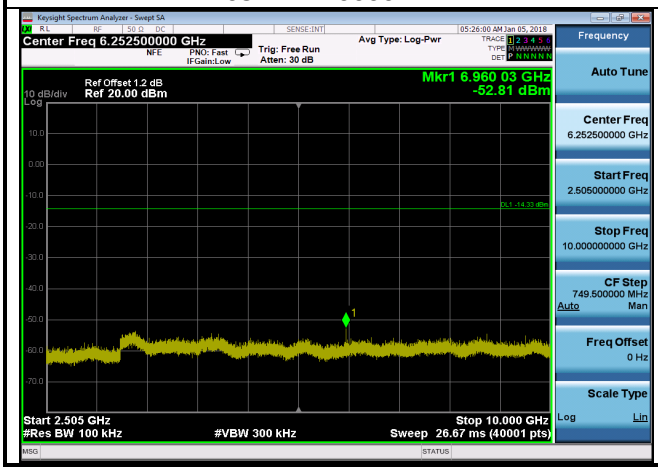
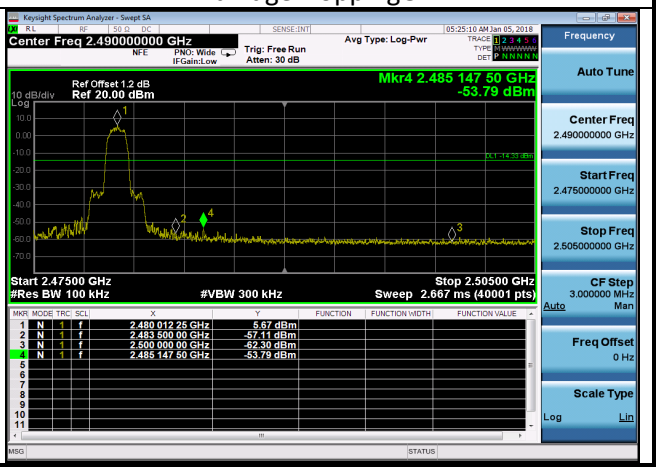
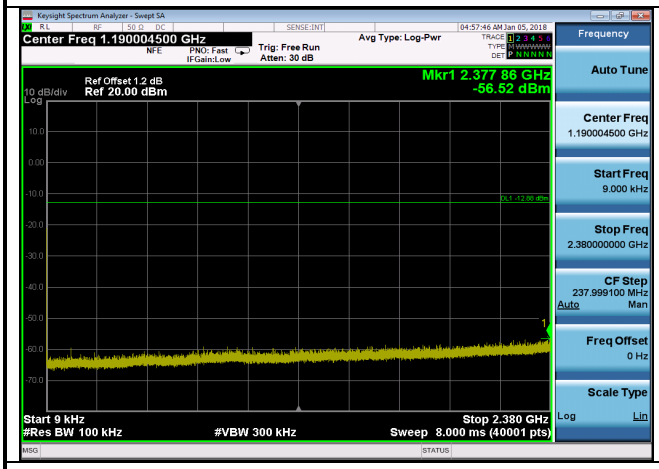
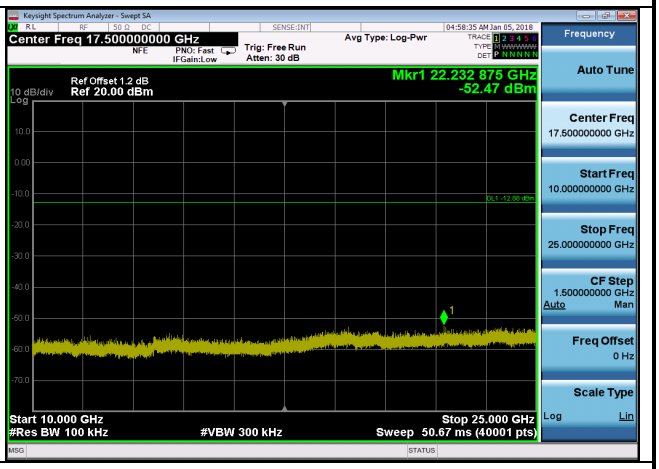
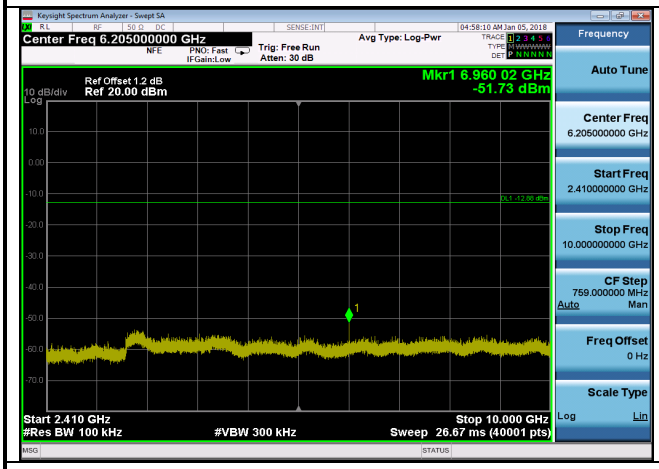
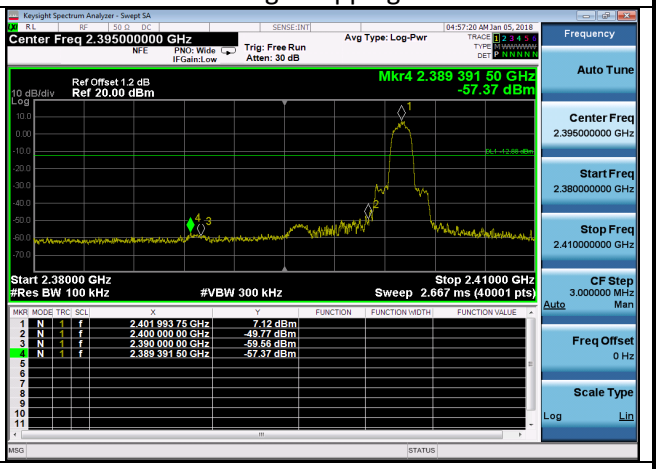
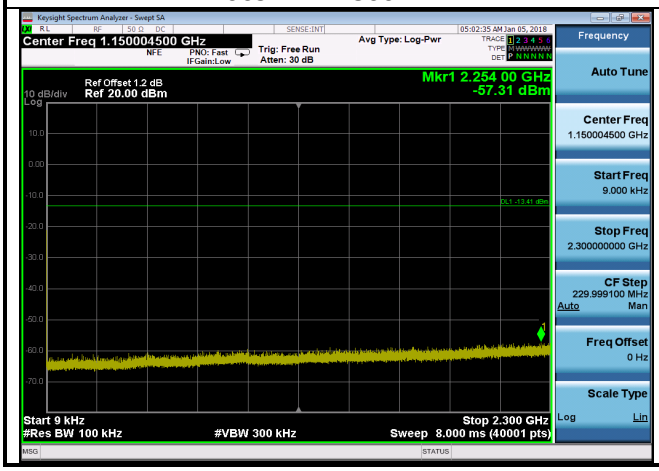
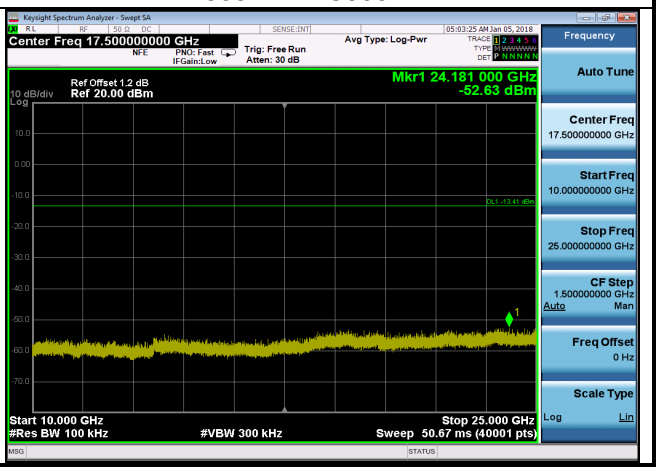
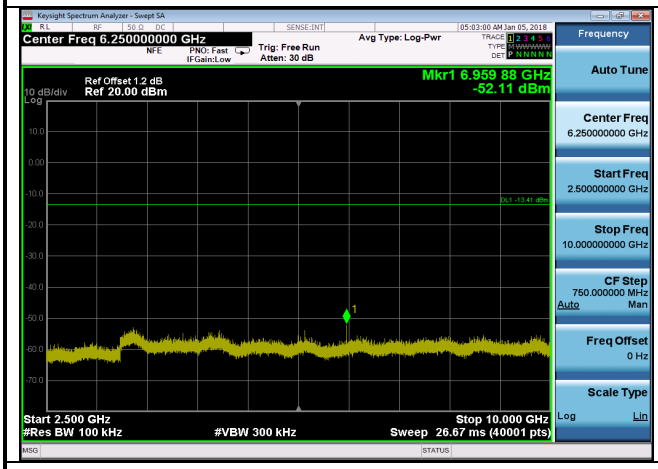
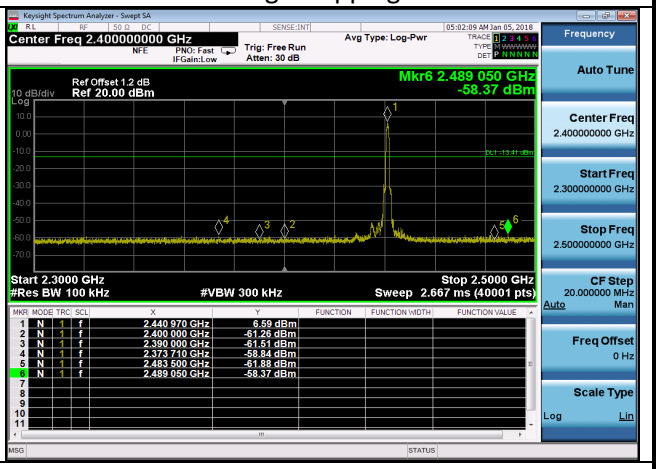
	
Conducted Emission：8DPSK,2480,3DH5,2505Mhz~10000Mhz	Conducted Emission：8DPSK,2480,3DH5,Band Edge HoppingOFF
	

Conducted Emission：DQPSK,2402,2DH5,0.009Mhz~2380Mhz	Conducted Emission：DQPSK,2402,2DH5,10000Mhz~25000Mhz
	
Conducted Emission：DQPSK,2402,2DH5,2410Mhz~10000Mhz	Conducted Emission：DQPSK,2402,2DH5,Band Edge HoppingOFF
	
Conducted Emission：DQPSK,2441,2DH5,0.009Mhz~2300Mhz	Conducted Emission：DQPSK,2441,2DH5,10000Mhz~25000Mhz
	

Conducted Emission：DQPSK,2441,2DH5,2500Mhz~10000Mhz	Conducted Emission：DQPSK,2441,2DH5,Band Edge HoppingOFF
	
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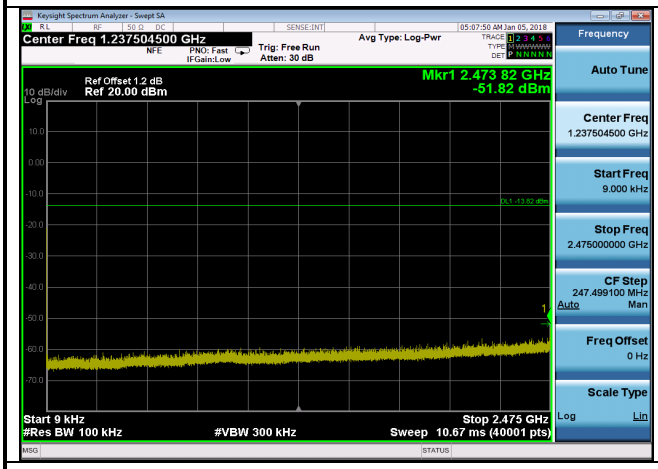
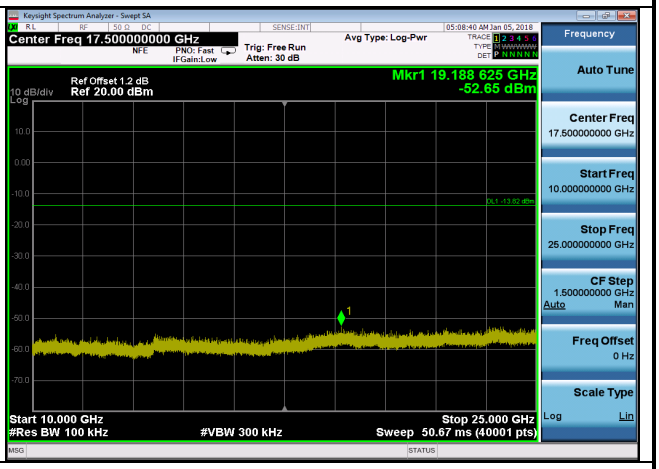
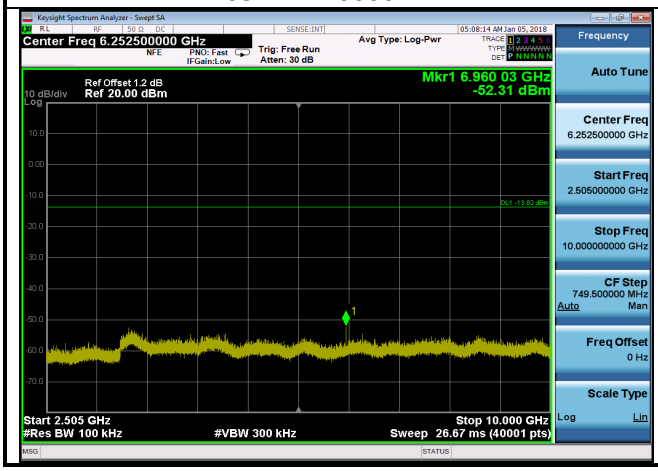
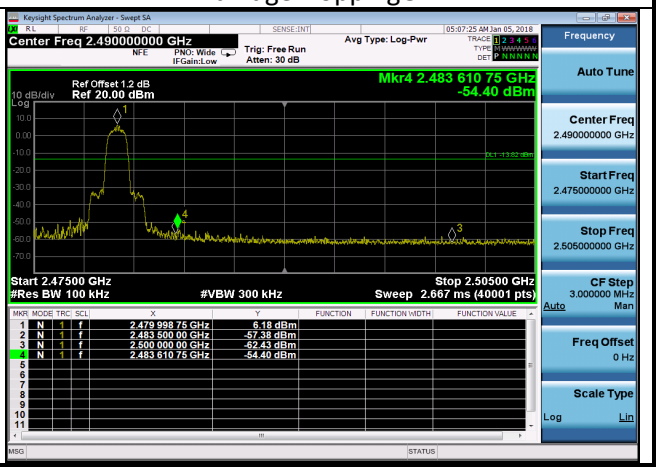
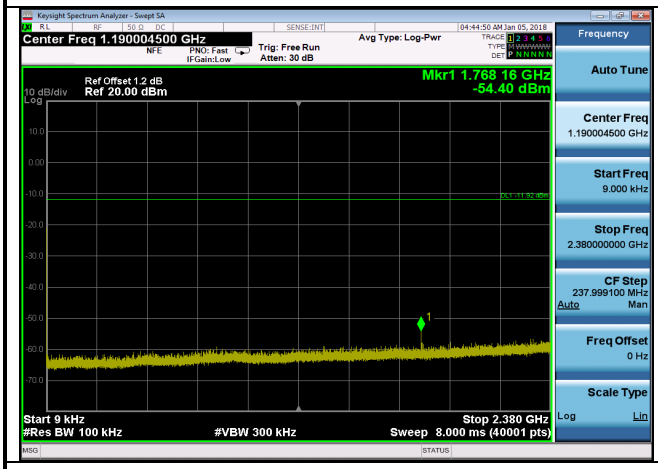
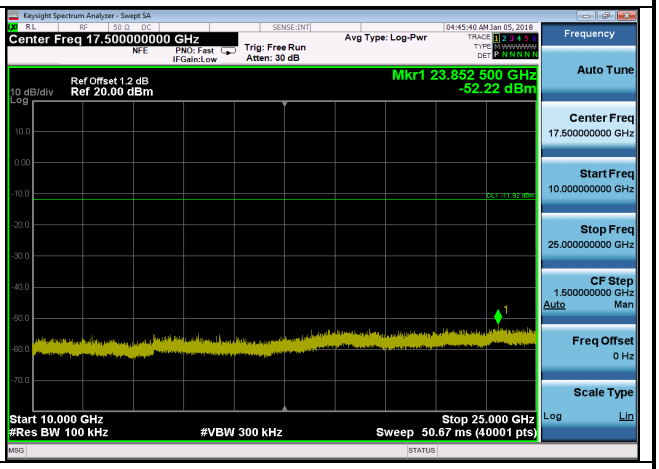
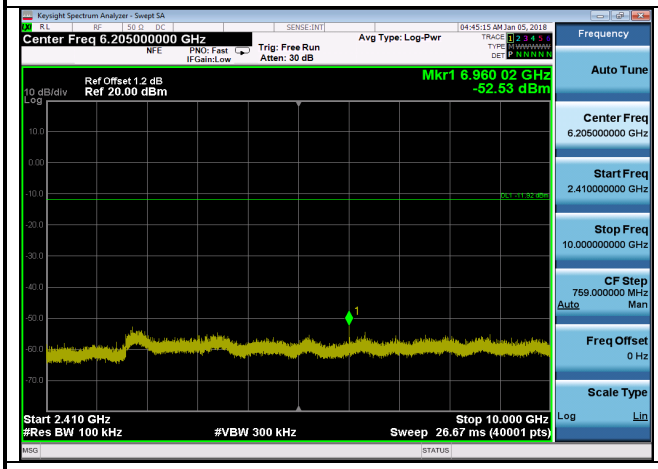
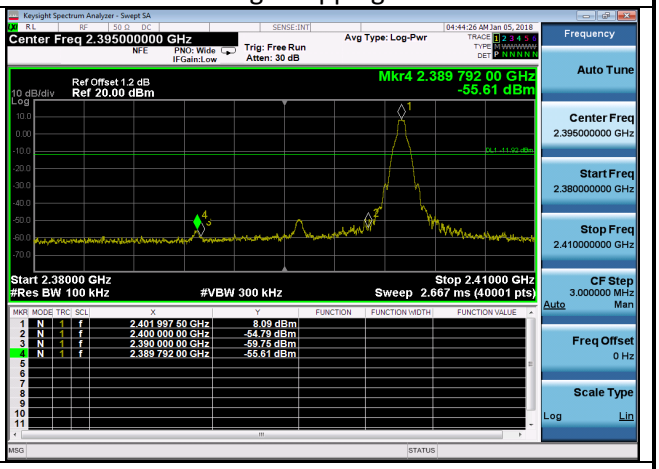
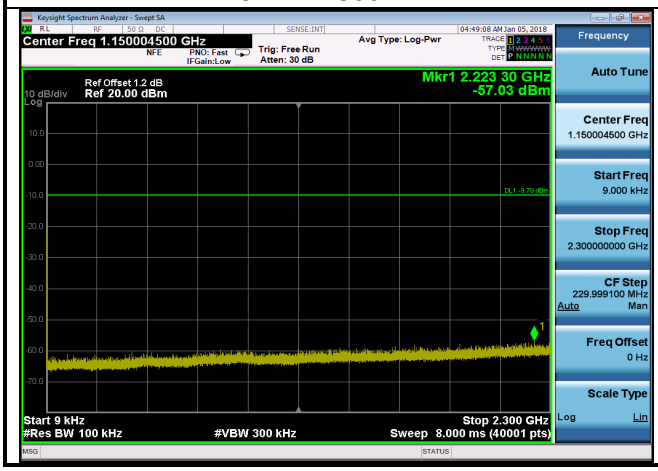
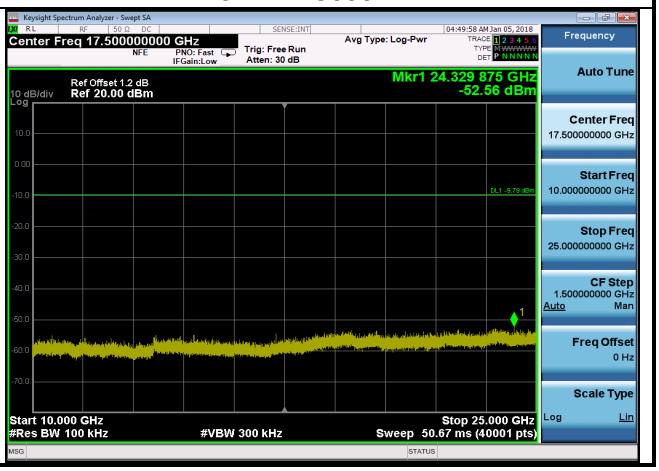
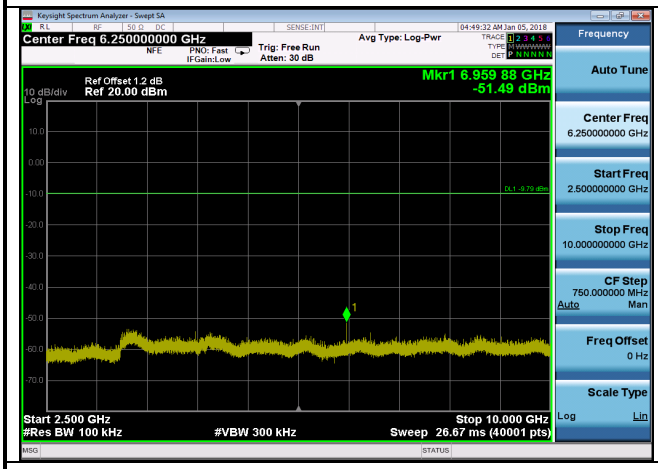
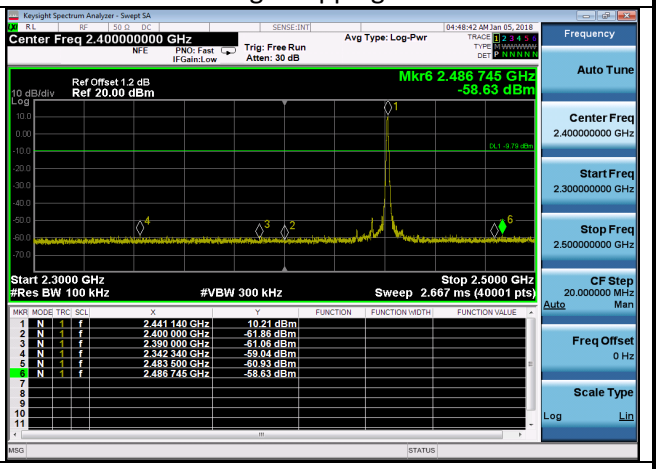
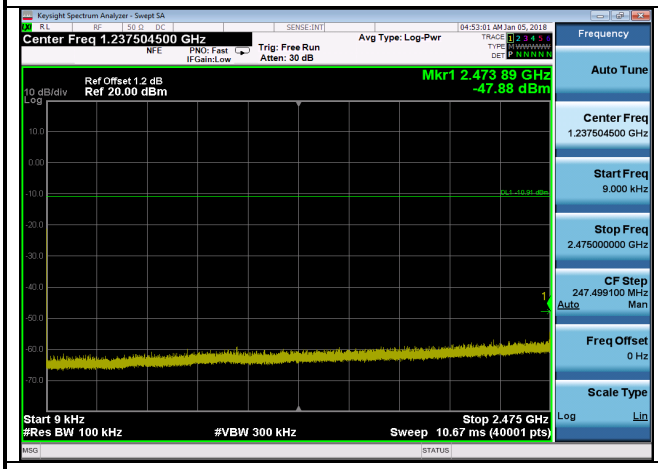
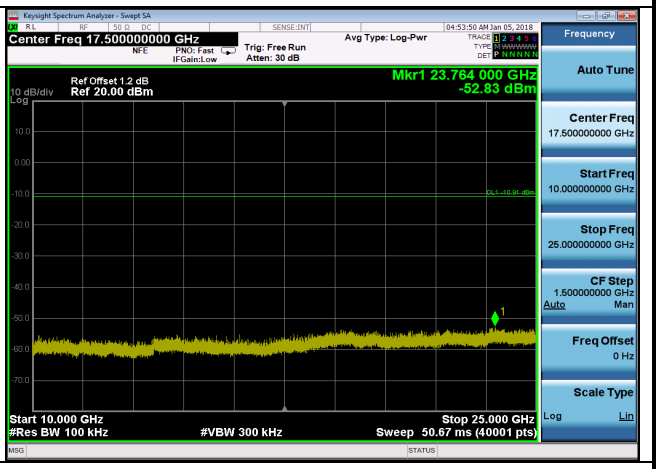
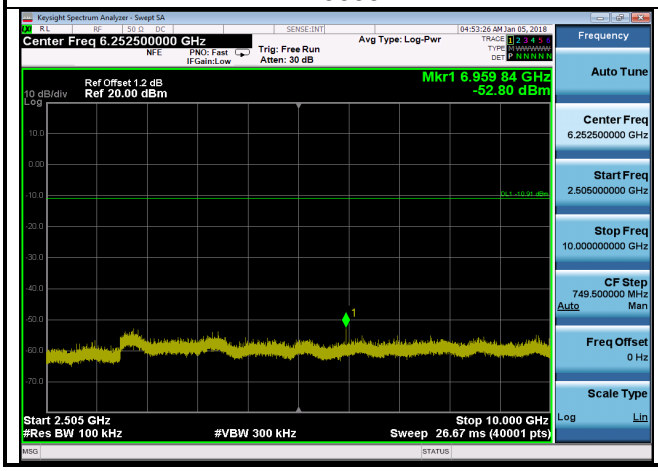
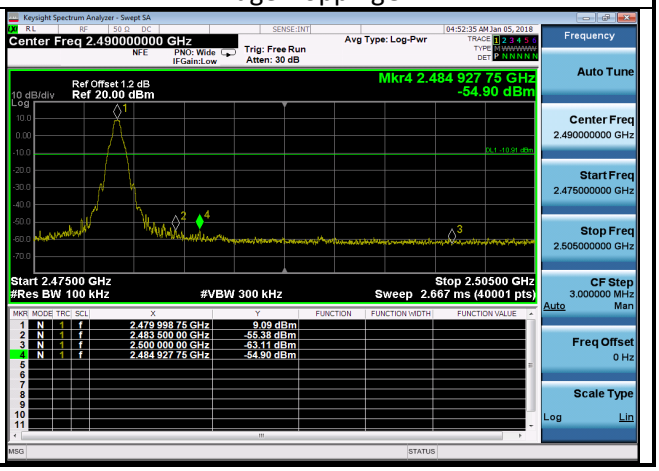
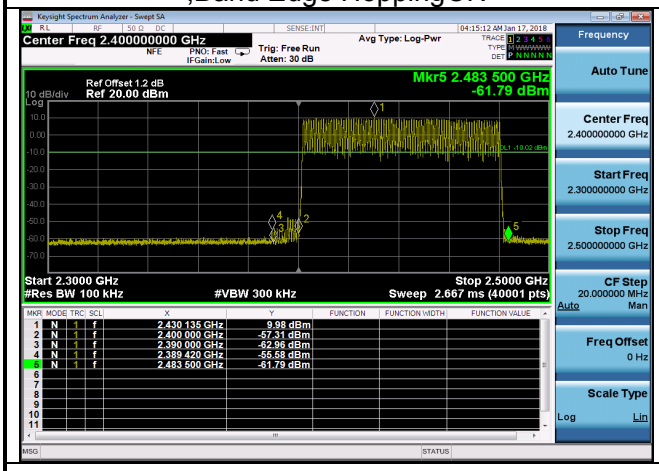
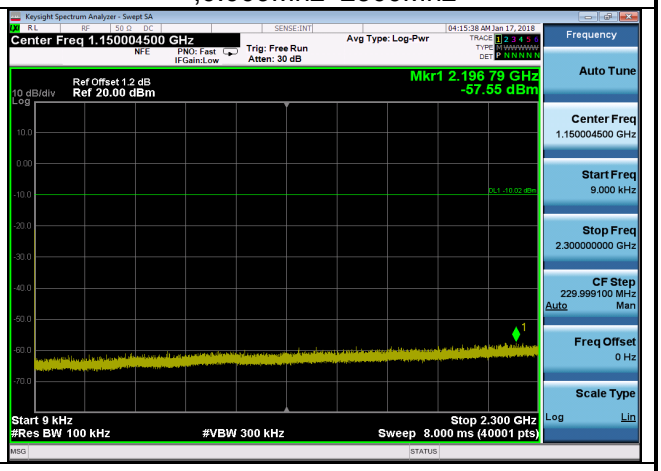
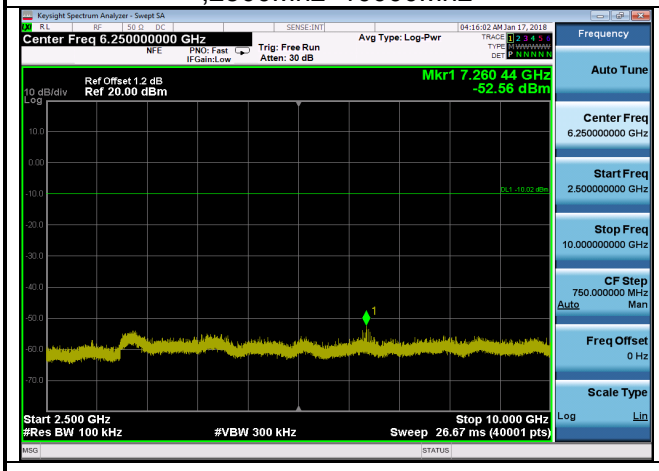
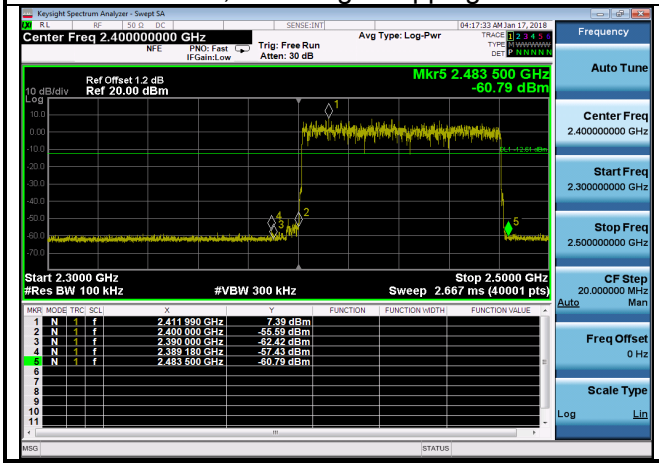
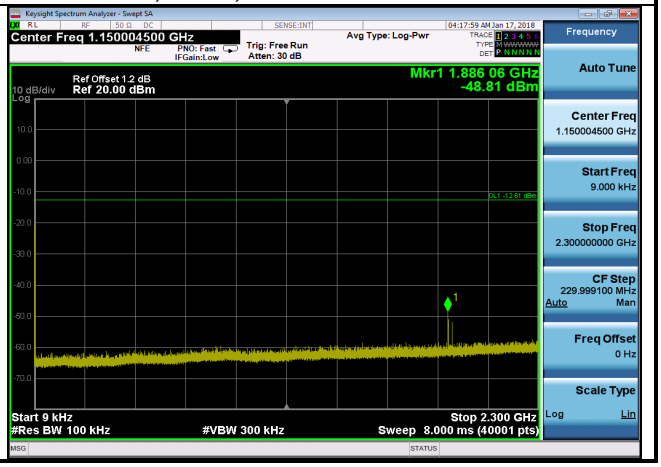
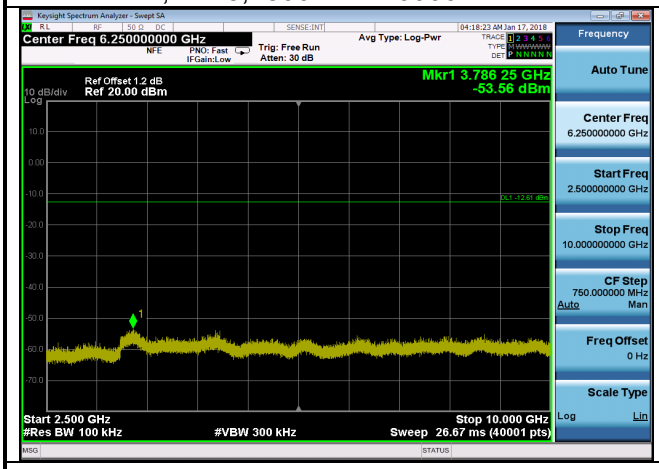
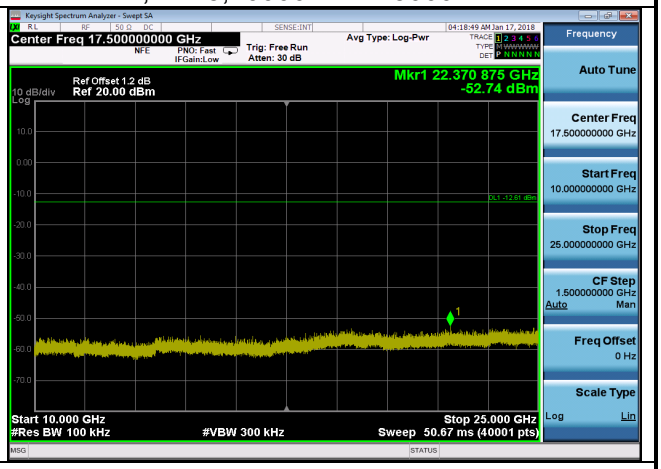
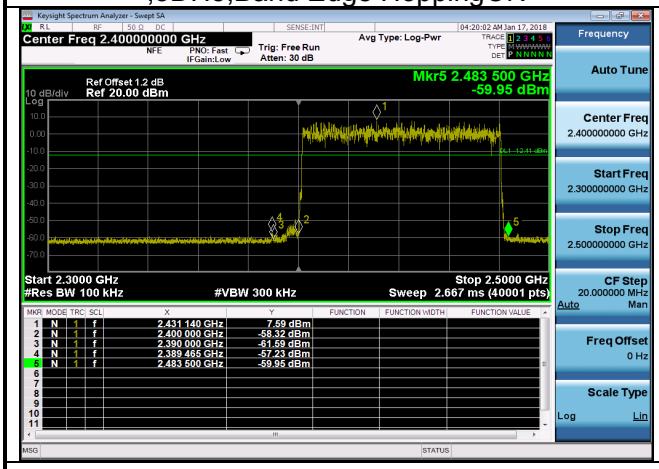
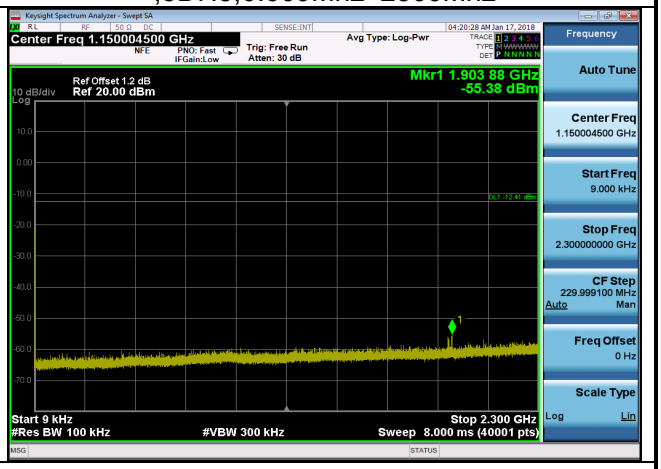
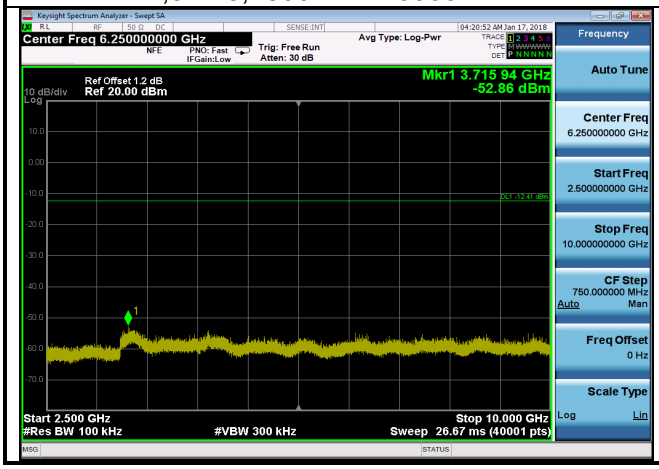
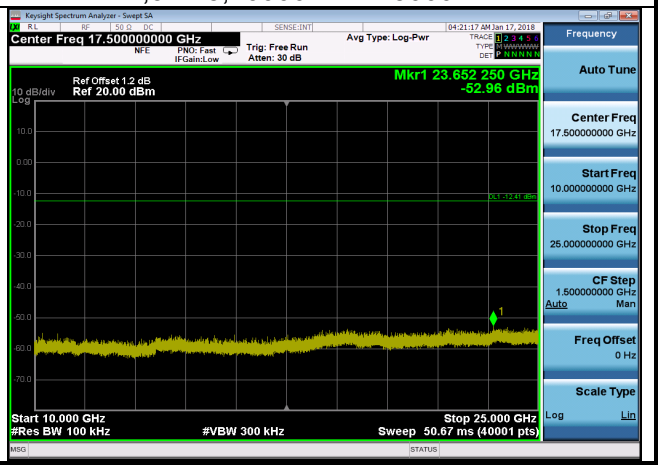
	
Conducted Emission：DQPSK,2480,2DH5,2505Mhz~10000Mhz	Conducted Emission：DQPSK,2480,2DH5,Band Edge HoppingOFF
	

Conducted Emission：GFSK,2402,DH5,0.009Mhz~2380Mhz	Conducted Emission：GFSK,2402,DH5,10000Mhz~25000Mhz
	
Conducted Emission：GFSK,2402,DH5,2410Mhz~10000Mhz	Conducted Emission：GFSK,2402,DH5,Band Edge HoppingOFF
	
Conducted Emission：GFSK,2441,DH5,0.009Mhz~2300Mhz	Conducted Emission：GFSK,2441,DH5,10000Mhz~25000Mhz
	

Conducted Emission：GFSK,2441,DH5,2500 Mhz~10000Mhz	Conducted Emission：GFSK,2441,DH5,Band Edge HoppingOFF
	
Conducted Emission：GFSK,2480,DH5,0.009Mhz~2475Mhz	Conducted Emission：GFSK,2480,DH5,10000Mhz~25000Mhz
	
Conducted Emission：GFSK,2480,DH5,2505 Mhz~10000Mhz	Conducted Emission：GFSK,2480,DH5,Band Edge HoppingOFF
	

1Conducted Emission：GFSK, DH5 ,Band Edge HoppingON	2Conducted Emission：GFSK, DH5 ,0.009Mhz~2300Mhz
	
3Conducted Emission：GFSK, DH5 ,2500Mhz~10000Mhz	4Conducted Emission：GFSK,DH5 ,10000Mhz~25000Mhz
	
1Conducted Emission：DQPSK, 2DH5,Band Edge HoppingON	2Conducted Emission：DQPSK ,2DH5,0.009Mhz~2300Mhz
	

3Conducted Emission：DQPSK ,2DH5,2500Mhz~10000Mhz	4Conducted Emission：DQPSK ,2DH5,10000Mhz~25000Mhz
	
1Conducted Emission：8DPSK ,3DH5,Band Edge HoppingON	2Conducted Emission：8DPSK ,3DH5,0.009Mhz~2300Mhz
	
3Conducted Emission：8DPSK ,3DH5,2500Mhz~10000Mhz	4Conducted Emission：8DPSK ,3DH5,10000Mhz~25000Mhz
	

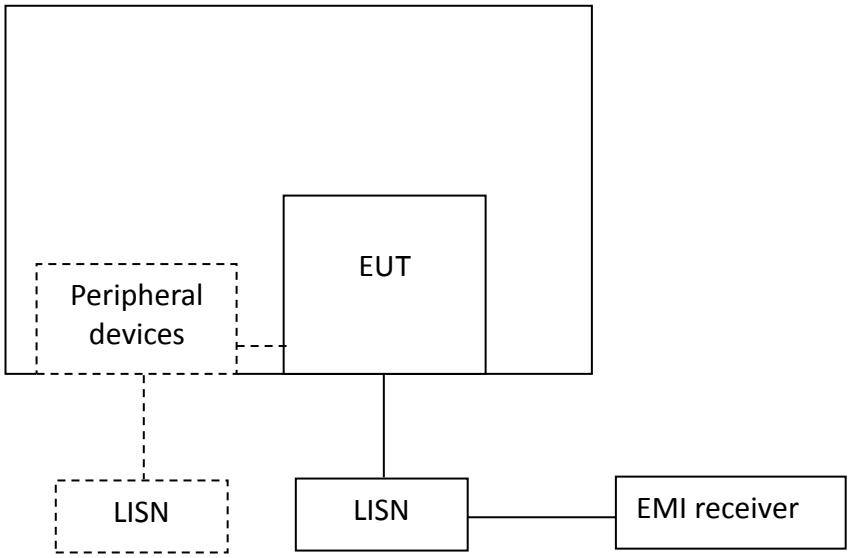
8. Power line conducted emission

Test result:Pass

8.1 Limit

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	QP	AV
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.		

8.2 Test configuration



☒ For table top equipment, wooden support is 0.8m height table

☐ For floor standing equipment, wooden support is 0.12m height rack.

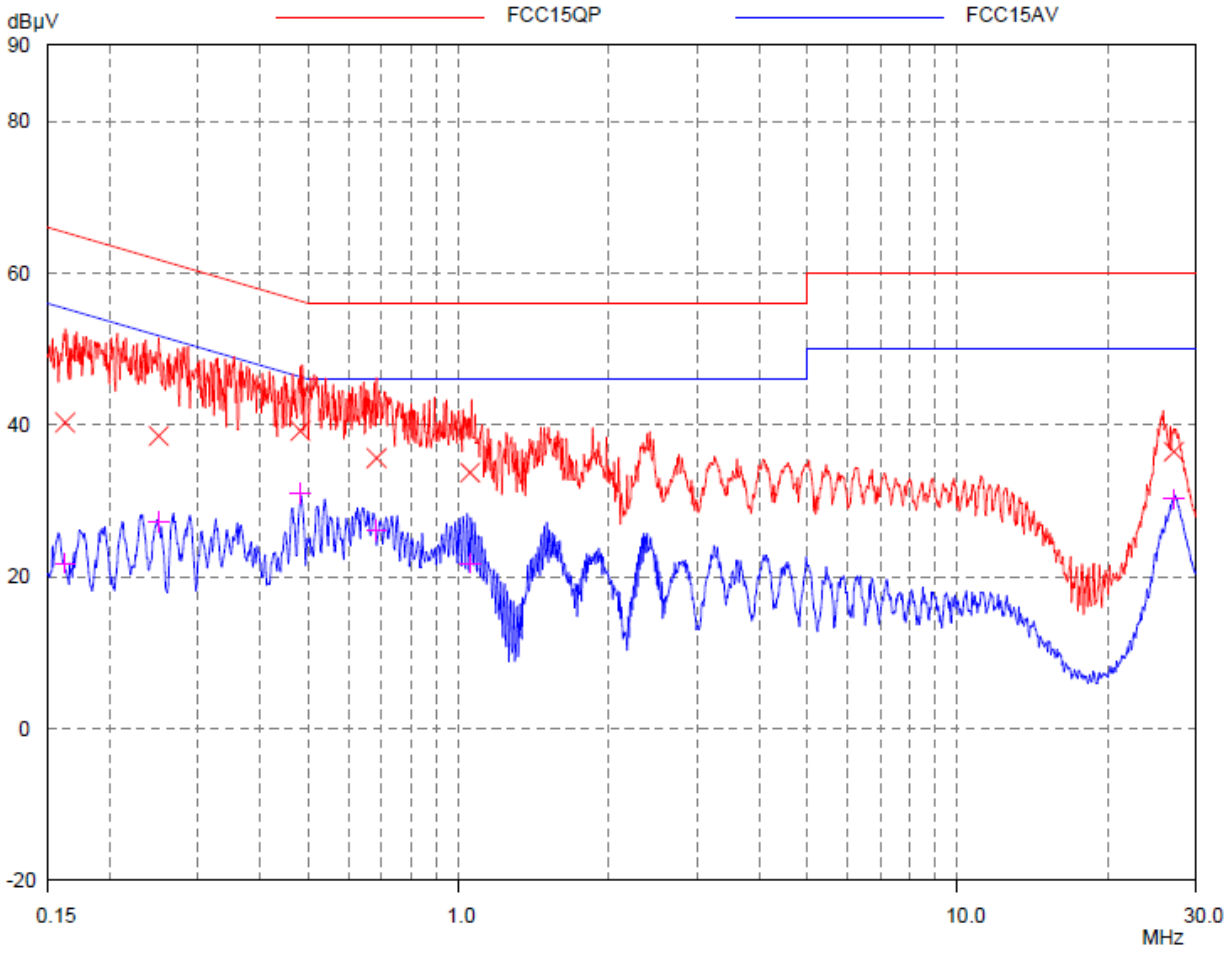
8.3 Test procedure and test set up

The EUT are connected to the main power through a line impedance stabilization network (LISN). This provides a 50Ω/50uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a 50Ω/50uH coupling impedance with 50Ω termination.
Both sides (Line and Neutral) of AC 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 C63.4 on conducted measurement.
The bandwidth of the test receiver is set at 9 kHz.
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems)

8.4 Test protocol

Temperature : 25 °C
Relative Humidity : 55 %

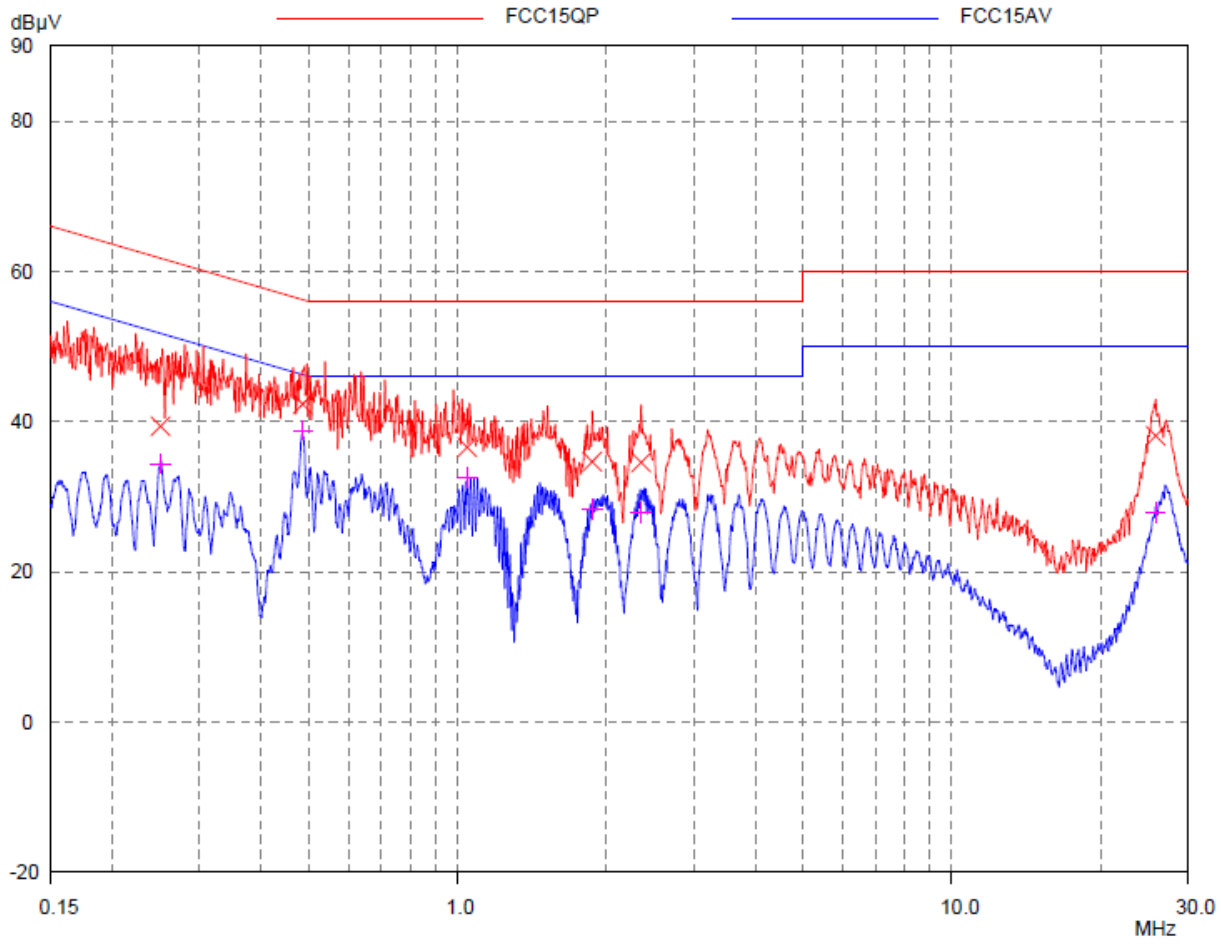
L Line



Test Data:

Frequency (MHz)	Quasi-peak			Average		
	level dB(µV)	Limit dB(µV)	Margin (dB)	level dB(µV)	limit dB(µV)	Margin (dB)
0.162	40.33	65.34	25.01	21.76	55.34	33.58
0.250	38.55	61.76	23.21	27.27	51.76	24.49
0.481	39.23	56.32	17.09	31.05	46.32	15.27
0.684	35.62	56.00	20.38	26.19	46.00	19.81
1.052	33.72	56.00	22.28	21.75	46.00	24.25
27.126	36.48	60.00	23.52	30.28	50.00	19.72

N Line



Test Data:

Frequency (MHz)	Quasi-peak			Average		
	level dB(µV)	Limit dB(µV)	Margin (dB)	level dB(µV)	limit dB(µV)	Margin (dB)
0.250	39.40	61.76	22.36	34.40	51.76	17.36
0.485	42.36	56.25	13.89	38.79	46.25	7.46
1.044	36.61	56.00	19.39	32.57	46.00	13.43
1.870	34.68	56.00	21.32	28.33	46.00	17.67
2.348	34.58	56.00	21.42	27.87	46.00	18.13
25.857	38.11	60.00	21.89	27.92	50.00	22.08

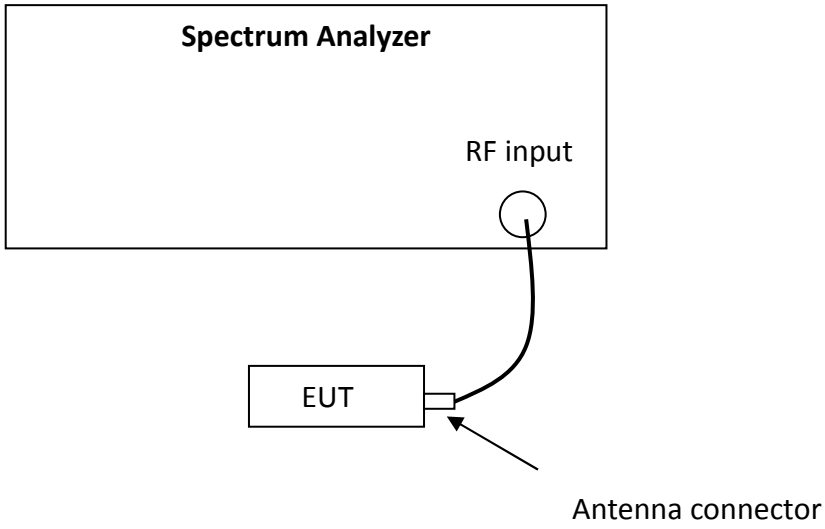
9. Number of Hopping Frequencies

Test result:Pass

9.1 Limit

Number of Hopping Frequencies in the 2400-2483.5 MHz band shall use at least 15 channels.

9.2 Test Configuration



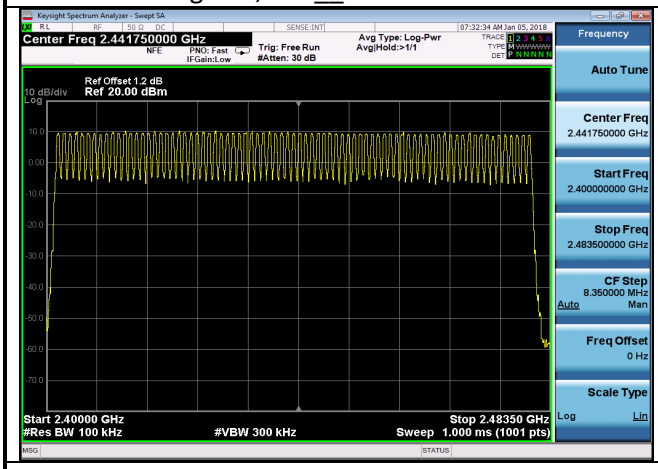
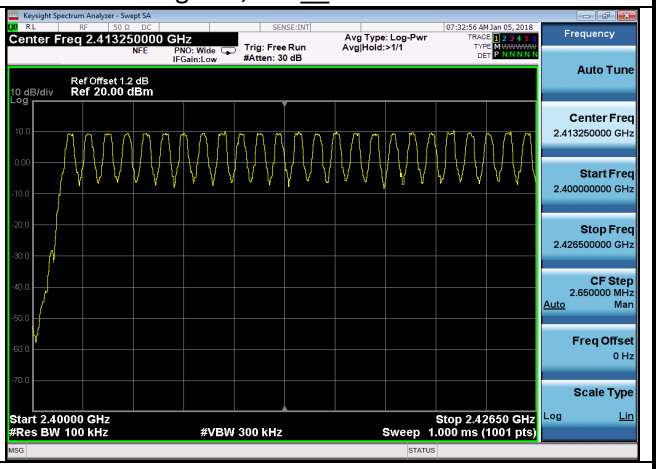
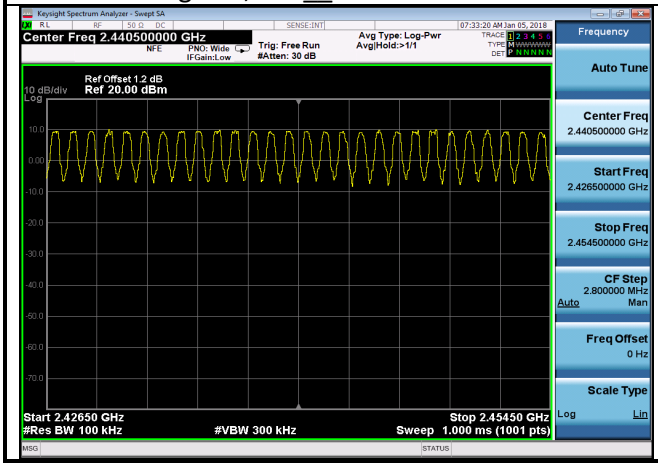
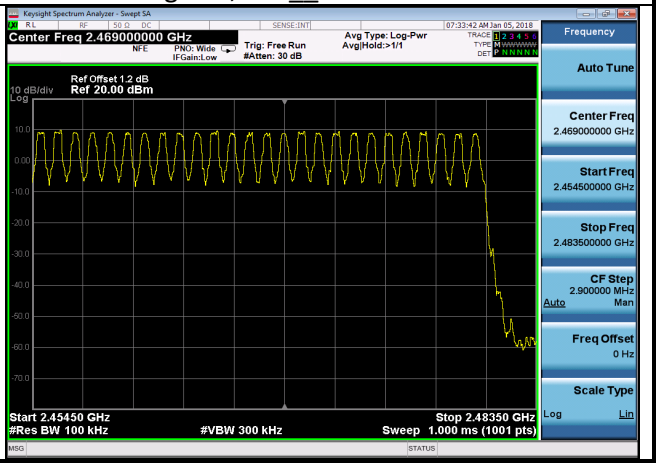
9.3 Test procedure and test setup

The channel number per FCC §15.247(a)(1)(iii) is measured using the Spectrum Analyzer with RBW=100kHz, VBW≥RBW, Sweep = auto, Detector = peak, Trace = max hold.
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems).

9.4 Test protocol

Temperature : 25 °C
Relative Humidity : 55 %

Channel Number	Limit
79	≥15

Number Of Hopping Channels：GFSK,Hoppi ngMhz,DH5__2400~2483.5	Number Of Hopping Channels：GFSK,Hoppi ngMhz,DH5__2400~2426.5
	
Number Of Hopping Channels：GFSK,Hoppi ngMhz,DH5__2426.5~2454.5	**Number Of Hopping Channels：GFSK,Hoppi ngMhz,DH5__2454.5~2483.5**
	

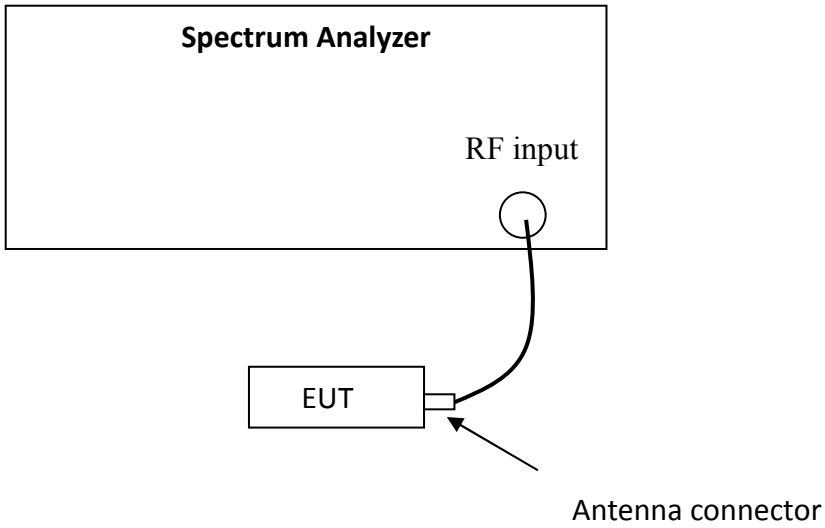
10. Dwell Time

Test result:Pass

10.1 Limit

The dwell time 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

10.2 Test Configuration



10.3 Test procedure and test setup

Dwell time per FCC §15.247(a)(1)(iii) is measured using the Spectrum Analyzer with Span = 0, RBW=1MHz, VBW≥RBW, Sweep can capture the entire dwell time, Detector = peak, Trace = max hold.
The EUT was tested according to DA 00-705 (Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems).

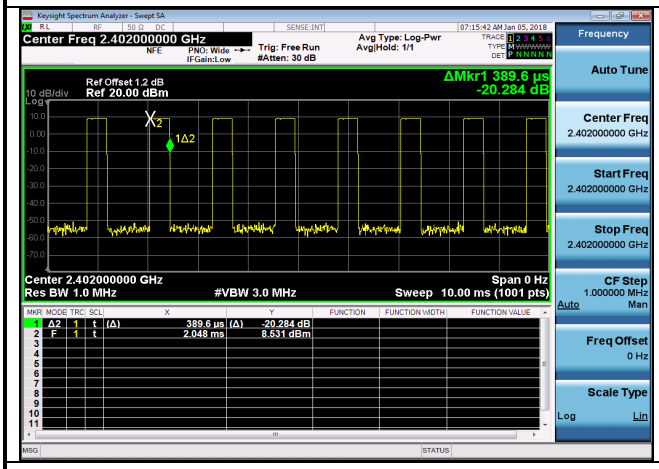
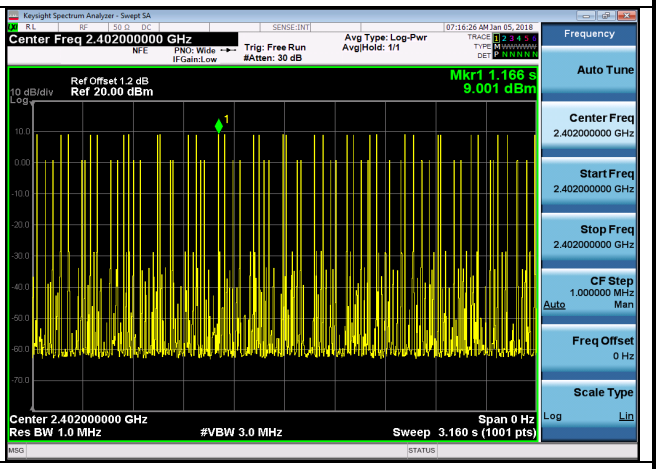
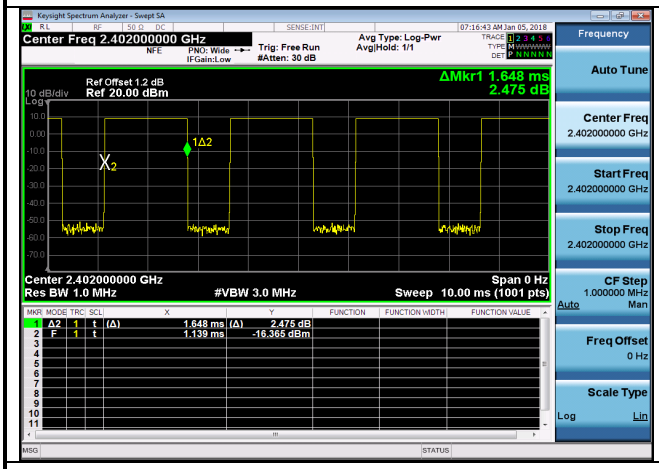
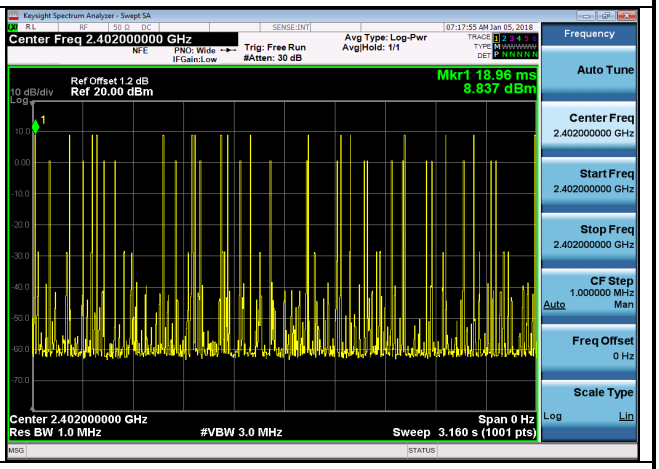
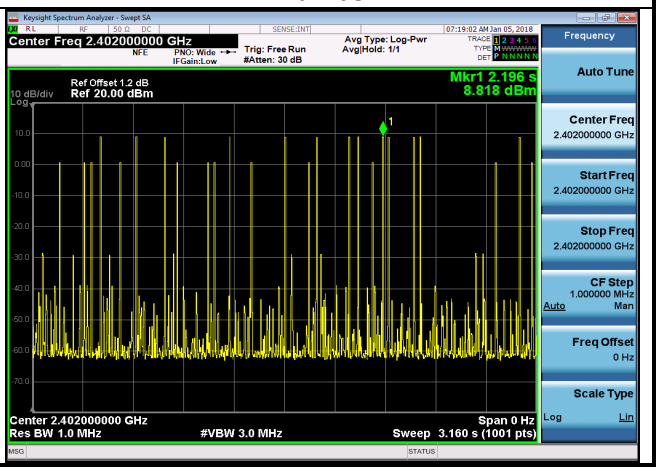
10.4 Test protocol

Temperature : 25 °C
Relative Humidity : 55 %

8DPSK Modulation:

Packet	Occupancy time for single hop (ms) **O**	CH	Real observed period (s) **P**	Hops among Observed period **I**	Dwell time (ms) **T**	Limit (s)
DH1	0.3896	L	3.16	32	124.67	≤0.4
		M	3.16	32	124.67	
		H	3.16	32	124.67	
DH3	1.648	L	3.16	17	280.16	
		M	3.16	17	280.16	
		H	3.16	17	280.16	
DH5	2.897	L	3.16	13	376.61	
		M	3.16	13	376.61	
		H	3.16	13	376.61	

Remark: 1. There are 79 channels in all. So the complete observed period P = 0.4 * 79 = 31.6 s.
2. Average time of occupancy **T = O *I * 31.6 / P**

Dwell Time：GFSK,2402,DH1,Transmission Time	Dwell Time：GFSK,2402,DH1,Transmission Number
	
Dwell Time：GFSK,2402,DH3,Transmission Time	Dwell Time：GFSK,2402,DH3,Transmission Number
	
Dwell Time：GFSK,2402,DH5,Transmission Time	Dwell Time：GFSK,2402,DH5,Transmission Number
	

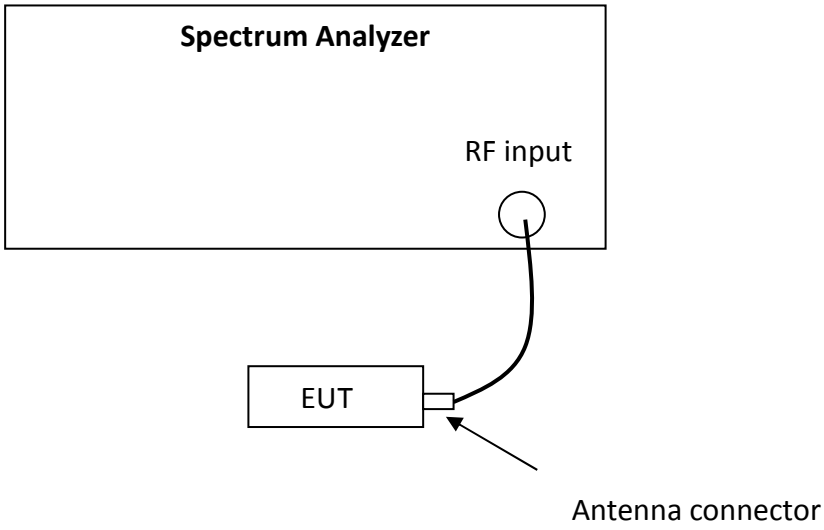
11. Occupied Bandwidth

Test result:Tested

11.1 Test limit

None

11.2 Test Configuration



11.3 Test procedure and test setup

The occupied bandwidth per RSS-Gen Issue 4 Clause 6.6 was measured using the Spectrum Analyzer with the RBW close to 1% of the selected span, VBW = 3 * RBW
Detector = Sample, Sweep = Auto.

11.4 Test protocol

Temperature : 25 °C
Relative Humidity : 55 %

Modulation	Channel	99% Occupied Bandwidth (kHz)
GFSK	L	903.80
	M	904.40
	H	903.93

Modulation	Channel	99% Occupied Bandwidth (kHz)
π/4 DQPSK	L	1178.70
	M	1179.60
	H	1179.20

Modulation	Channel	99% Occupied Bandwidth (kHz)
8DPSK	L	1183.50
	M	1183.60
	H	1183.90

Note: The test plots please see Section 3 in this report.