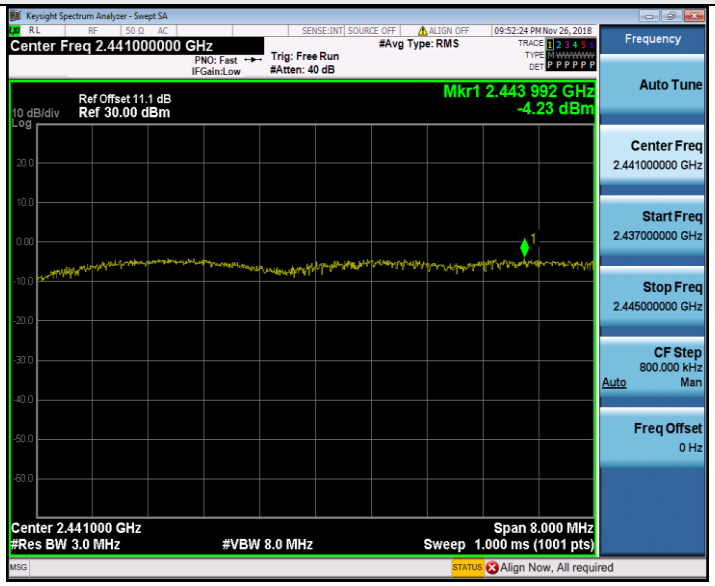
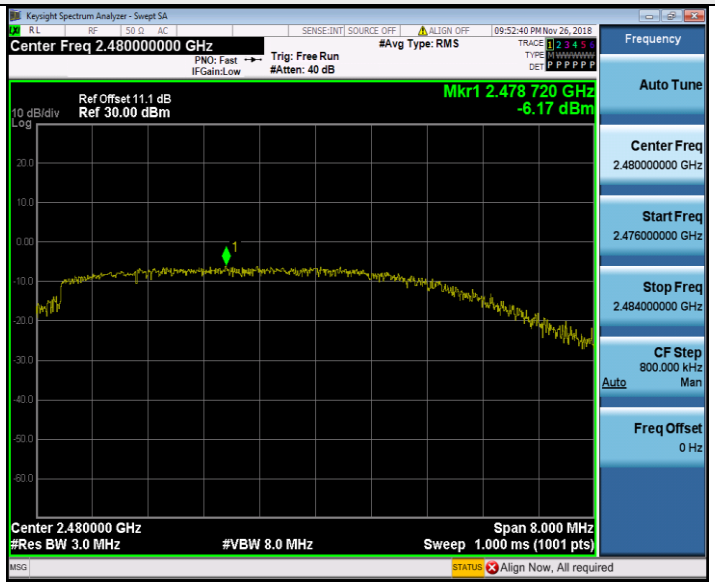
π/4DQPSK / CH 39



π/4DQPSK / CH 78



4.7 Conducted Out of Band Emission Measurement

4.7.1 Limit

Below –20dB of the highest emission level of operating band (in 100kHz RBW).

4.7.2 Test Procedures

The transmitter output was connected to the spectrum analyzer via a low lose cable. Set both RBW and VBW of spectrum analyzer to 100 kHz and 300 kHz with suitable frequency span including 100 MHz bandwidth from band edge. The band edges was measured and recorded.

4.7.3 Deviation of Test Standard

No deviation.

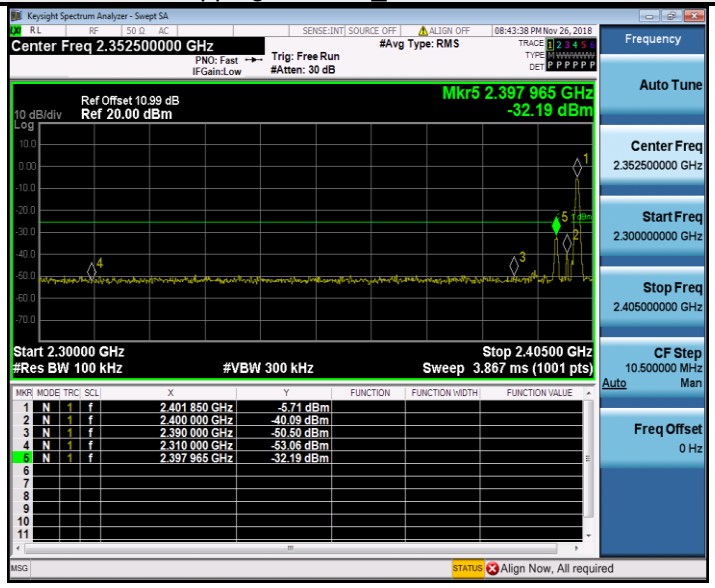
4.7.4 Test Results

The spectrum plots are attached on the following images. D1 line indicates the highest level, D2 line indicates the 20dB offset below D1. It shows compliance with the requirement.

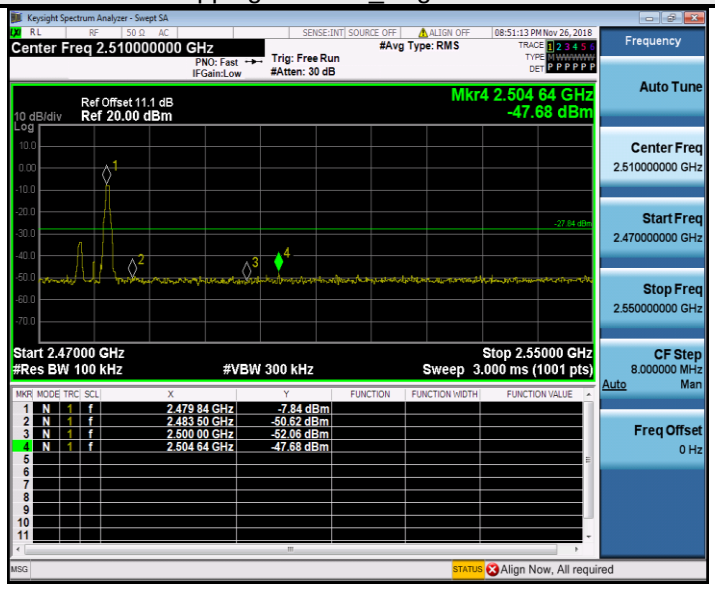
TestMode	ChName	Channel	Max. Level	Result	Limit	Verdict
DH5	Low	2402	-5.71	-32.19	-25.71	PASS
DH5	High	2480	-7.84	-47.68	-27.84	PASS
DH5	Low	HOP	-6.12	-33.06	-26.12	PASS
DH5	High	HOP	-8.24	-49.09	-28.24	PASS
2DH5	Low	2402	-5.90	-35.23	-25.9	PASS
2DH5	High	2480	-7.72	-49.25	-27.72	PASS
2DH5	Low	HOP	-10.09	-37.51	-30.09	PASS
2DH5	High	HOP	-8.96	-48.88	-28.96	PASS

GFSK

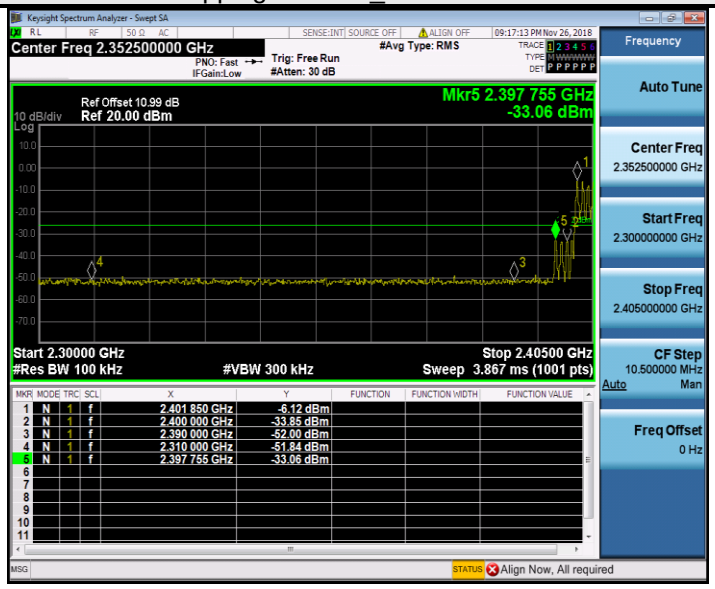
Hopping disabled_ Low Channel

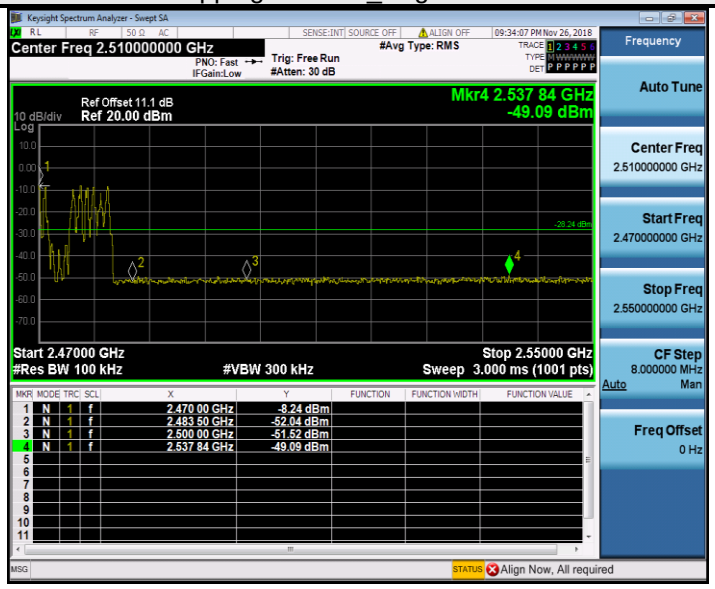


Hopping disabled_ High Channel

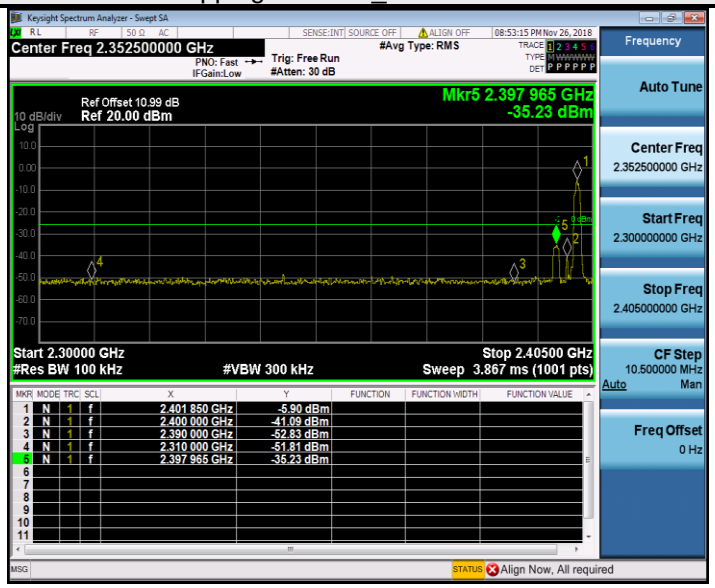


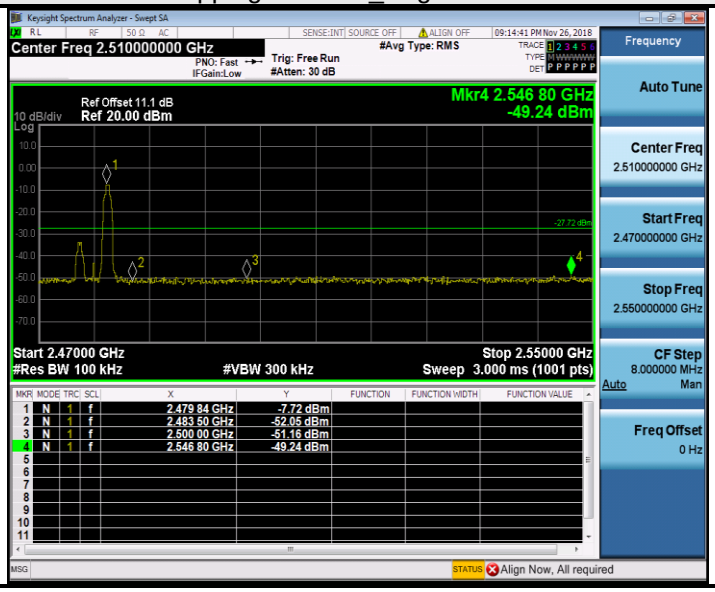
Hopping enabled_ Low Channel

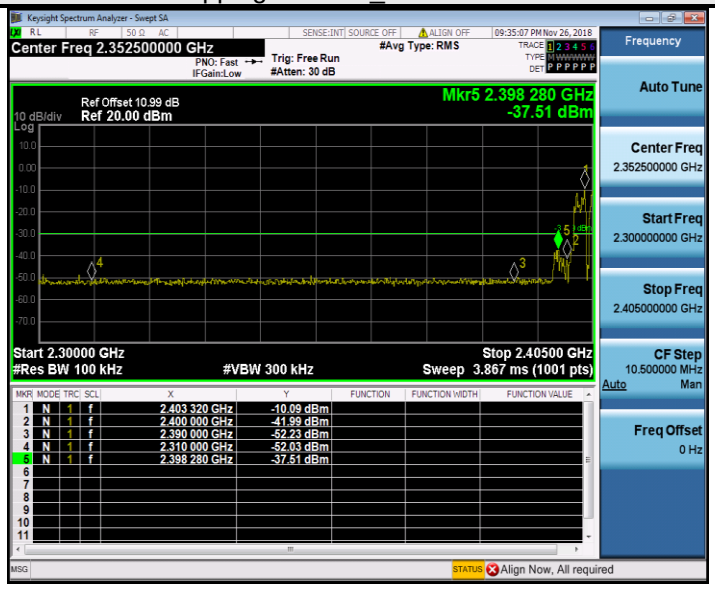


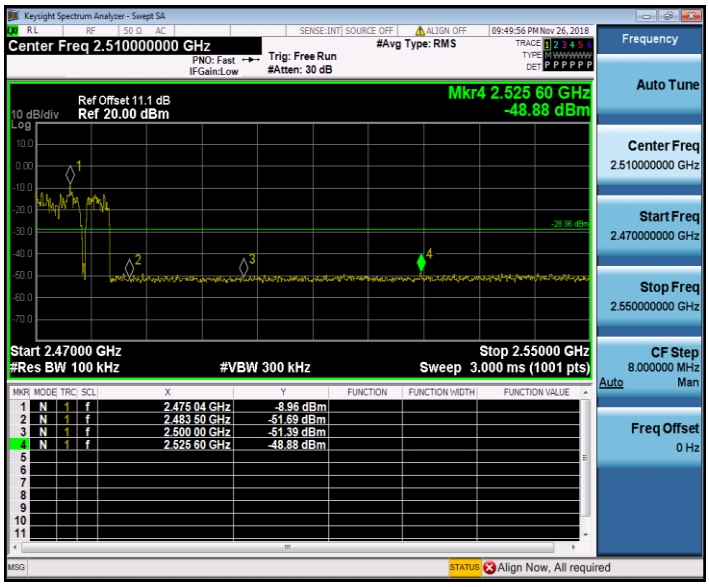
Hopping enabled_ High Channel


π/4DQPSK

Hopping disabled_ Low Channel


Hopping disabled_ High Channel


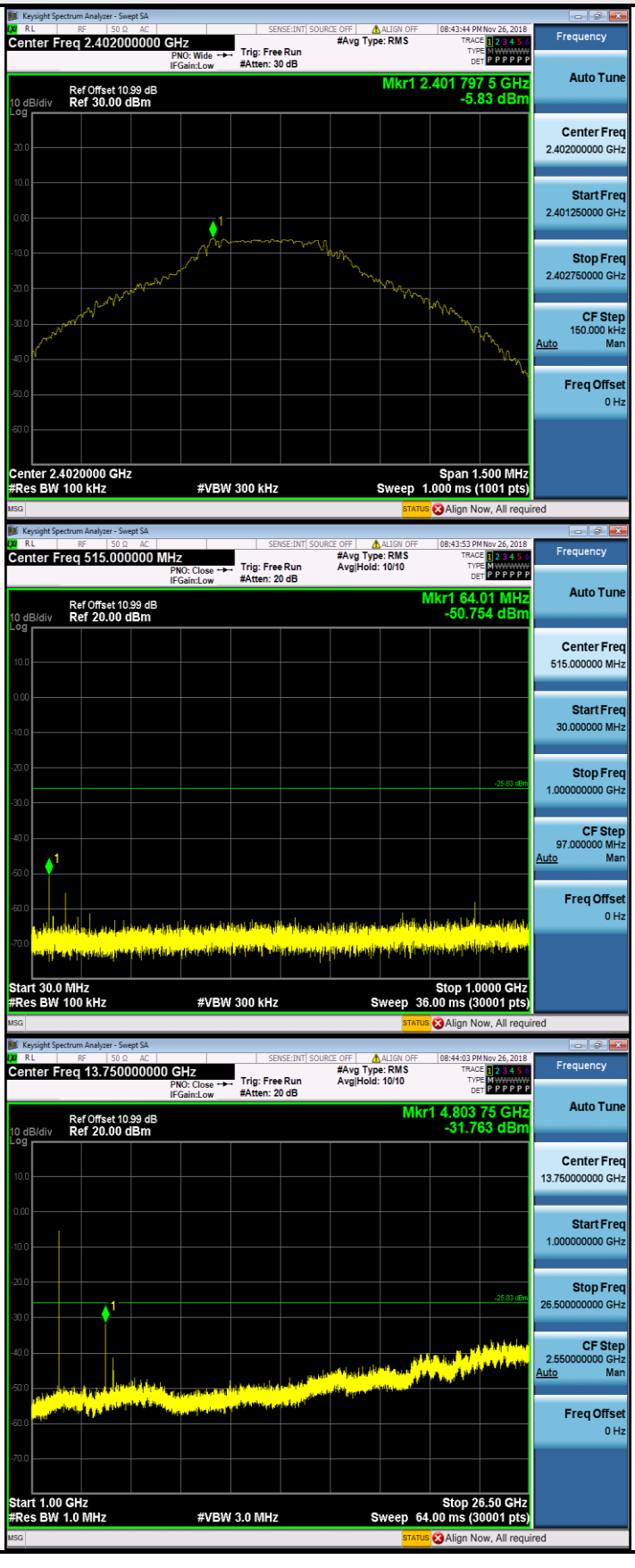
Hopping enabled_ Low Channel


Hopping enabled_ High Channel


Out of Band Emission

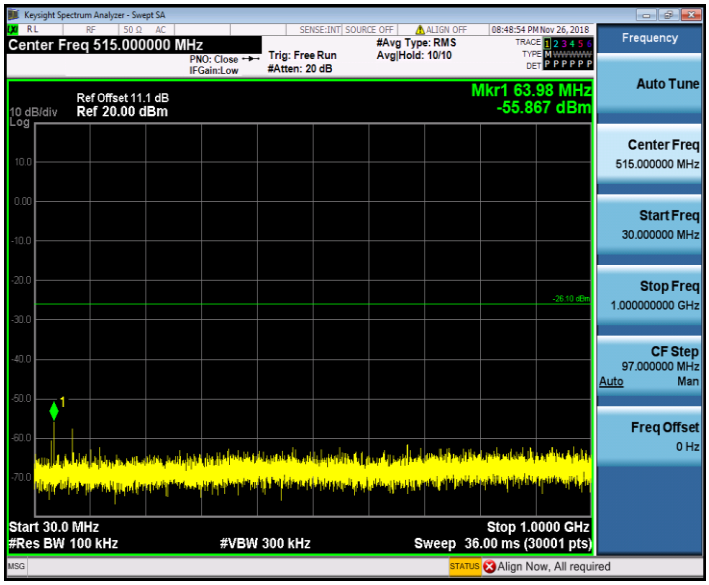
GFSK

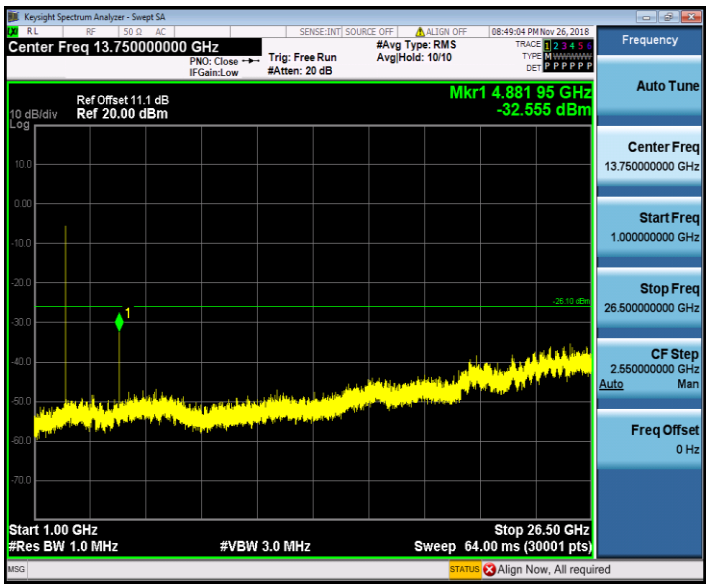
2402MHz



2441MHz

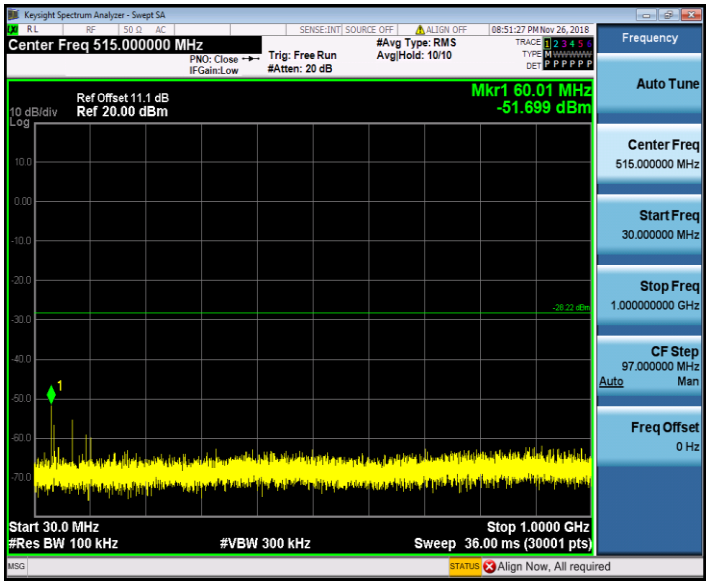

Keysight Spectrum Analyzer - Swept SA
Center Freq 2.441000000 GHz
PNO: Wide
IFGain:Low
Trig: Free Run
#Atten: 30 dB
#Avg Type: RMS
08:48:46 PM Nov 26, 2018
Frequency
Ref Offset 11.1 dB
10 dB/div
Ref 30.00 dBm
Log
Mkr1 2.440 970 0 GHz
-6.10 dBm
Auto Tune
Center Freq
2.441000000 GHz
Start Freq
2.440250000 GHz
Stop Freq
2.441750000 GHz
CF Step
150.000 kHz
Auto
Man
Freq Offset
0 Hz
Center 2.4410000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Span 1.500 MHz
Sweep 1.000 ms (1001 pts)
Align Now, All required

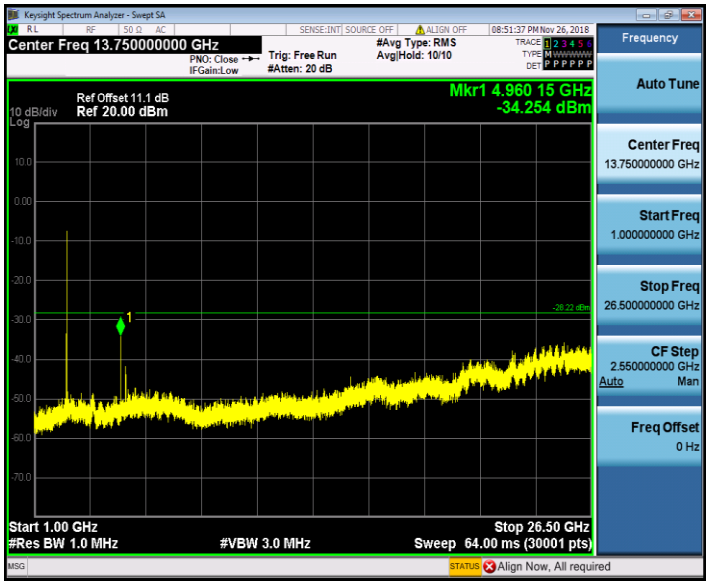

Keysight Spectrum Analyzer - Swept SA
Center Freq 515.000000 MHz
PNO: Close
IFGain:Low
Trig: Free Run
#Atten: 20 dB
#Avg Type: RMS
Avg|Hold: 10/10
08:48:54 PM Nov 26, 2018
Frequency
Ref Offset 11.1 dB
10 dB/div
Ref 20.00 dBm
Log
Mkr1 63.98 MHz
-55.867 dBm
Auto Tune
Center Freq
515.000000 MHz
Start Freq
30.000000 MHz
Stop Freq
1.000000000 GHz
CF Step
97.000000 MHz
Auto
Man
Freq Offset
0 Hz
Start 30.0 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 1.0000 GHz
Sweep 36.00 ms (30001 pts)
Align Now, All required


Keysight Spectrum Analyzer - Swept SA
Center Freq 13.750000000 GHz
PNO: Close
IFGain:Low
Trig: Free Run
#Atten: 20 dB
#Avg Type: RMS
Avg|Hold: 10/10
08:49:04 PM Nov 26, 2018
Frequency
Ref Offset 11.1 dB
10 dB/div
Ref 20.00 dBm
Log
Mkr1 4.881 95 GHz
-32.555 dBm
Auto Tune
Center Freq
13.750000000 GHz
Start Freq
1.000000000 GHz
Stop Freq
26.500000000 GHz
CF Step
2.550000000 GHz
Auto
Man
Freq Offset
0 Hz
Start 1.00 GHz
#Res BW 1.0 MHz
#VBW 3.0 MHz
Stop 26.50 GHz
Sweep 64.00 ms (30001 pts)
Align Now, All required

2480MHz

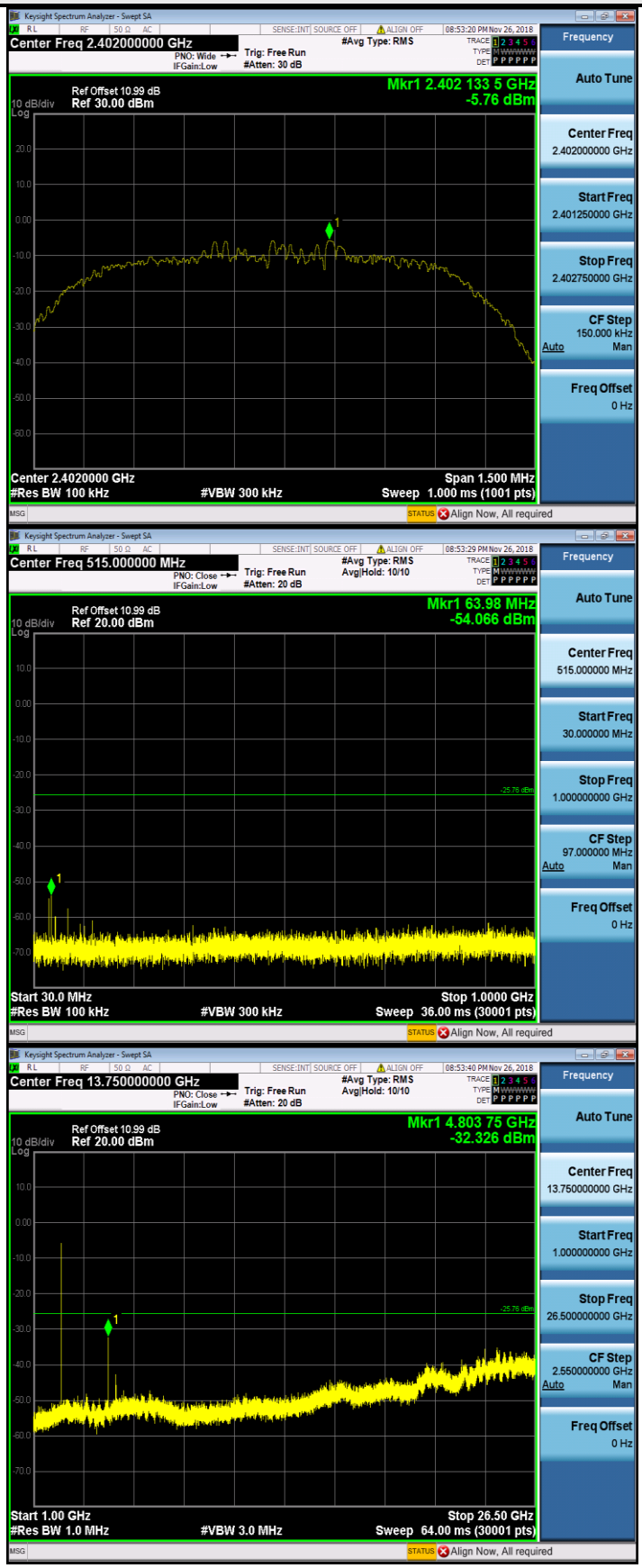

Keysight Spectrum Analyzer - Swept SA
Center Freq 2.480000000 GHz
PNO: Wide
IFGain:Low
Trig: Free Run
#Atten: 30 dB
#Avg Type: RMS
08:51:19 PM Nov 26, 2018
Frequency
Ref Offset 11.1 dB
10 dB/div
Ref 30.00 dBm
Log
Mkr1 2.479 832 0 GHz
-8.22 dBm
Auto Tune
Center Freq
2.480000000 GHz
Start Freq
2.479250000 GHz
Stop Freq
2.480750000 GHz
CF Step
150.000 kHz
Auto
Man
Freq Offset
0 Hz
Center 2.4800000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Span 1.500 MHz
Sweep 1.000 ms (1001 pts)
Align Now, All required


Keysight Spectrum Analyzer - Swept SA
Center Freq 515.000000 MHz
PNO: Close
IFGain:Low
Trig: Free Run
#Atten: 20 dB
#Avg Type: RMS
Avg|Hold: 10/10
08:51:27 PM Nov 26, 2018
Frequency
Ref Offset 11.1 dB
10 dB/div
Ref 20.00 dBm
Log
Mkr1 60.01 MHz
-51.699 dBm
Auto Tune
Center Freq
515.000000 MHz
Start Freq
30.000000 MHz
Stop Freq
1.000000000 GHz
CF Step
97.000000 MHz
Auto
Man
Freq Offset
0 Hz
Start 30.0 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 1.0000 GHz
Sweep 36.00 ms (30001 pts)
Align Now, All required


Keysight Spectrum Analyzer - Swept SA
Center Freq 13.750000000 GHz
PNO: Close
IFGain:Low
Trig: Free Run
#Atten: 20 dB
#Avg Type: RMS
Avg|Hold: 10/10
08:51:37 PM Nov 26, 2018
Frequency
Ref Offset 11.1 dB
10 dB/div
Ref 20.00 dBm
Log
Mkr1 4.960 15 GHz
-34.254 dBm
Auto Tune
Center Freq
13.750000000 GHz
Start Freq
1.000000000 GHz
Stop Freq
26.500000000 GHz
CF Step
2.550000000 GHz
Auto
Man
Freq Offset
0 Hz
Start 1.00 GHz
#Res BW 1.0 MHz
#VBW 3.0 MHz
Stop 26.50 GHz
Sweep 64.00 ms (30001 pts)
Align Now, All required

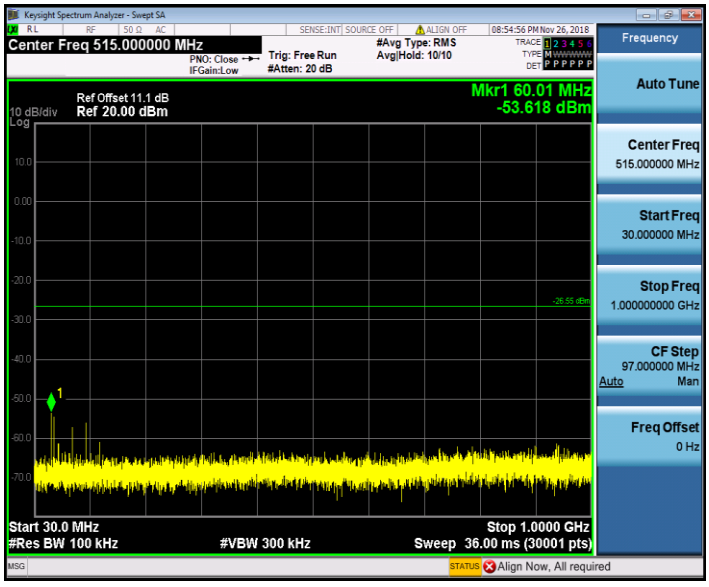
π/4DQPSK

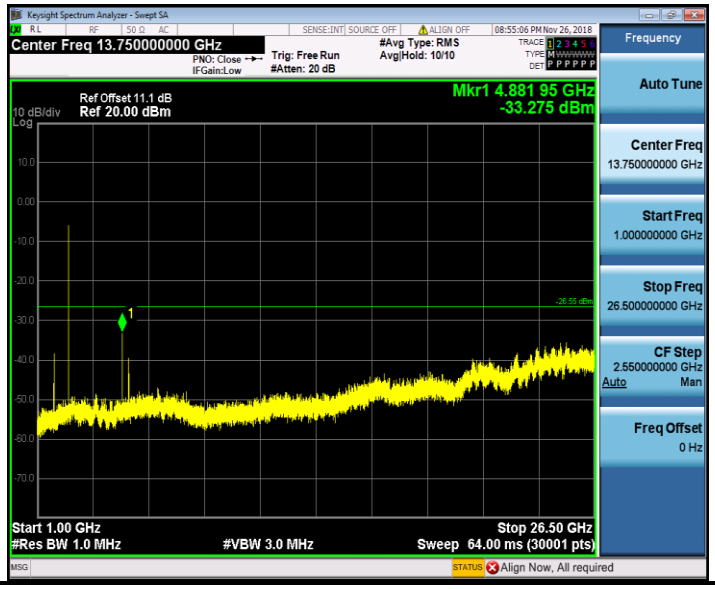
2402MHz



2441MHz

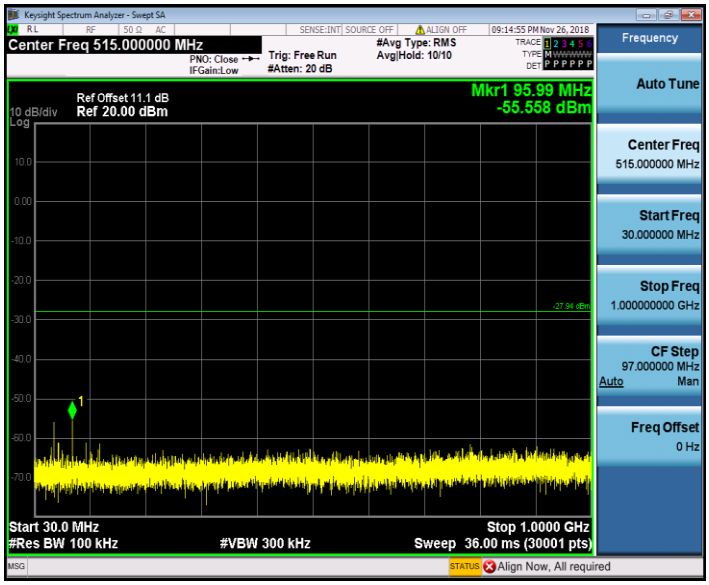

Keysight Spectrum Analyzer - Swept SA
Center Freq 2.441000000 GHz
PNO: Wide
IFGain:Low
Trig: Free Run
#Atten: 30 dB
#Avg Type: RMS
08:54:47 PM Nov 26, 2018
Ref Offset 11.1 dB
10 dB/div
Ref 30.00 dBm
Log
Mkr1 2.440 982 0 GHz
-6.55 dBm
Center 2.4410000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Span 1.500 MHz
Sweep 1.000 ms (1001 pts)
Frequency
Auto Tune
Center Freq
2.441000000 GHz
Start Freq
2.440250000 GHz
Stop Freq
2.441750000 GHz
CF Step
150.000 kHz
Auto
Man
Freq Offset
0 Hz
Align Now, All required

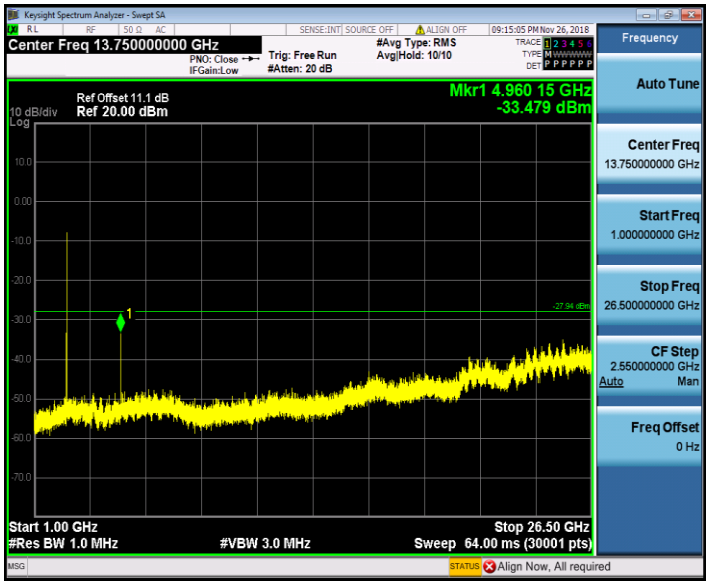

Keysight Spectrum Analyzer - Swept SA
Center Freq 515.000000 MHz
PNO: Close
IFGain:Low
Trig: Free Run
#Atten: 20 dB
#Avg Type: RMS
Avg|Hold: 10/10
08:54:56 PM Nov 26, 2018
Ref Offset 11.1 dB
10 dB/div
Ref 20.00 dBm
Log
Mkr1 60.01 MHz
-53.618 dBm
-26.55 dBm
Start 30.0 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 1.0000 GHz
Sweep 36.00 ms (30001 pts)
Frequency
Auto Tune
Center Freq
515.000000 MHz
Start Freq
30.000000 MHz
Stop Freq
1.000000000 GHz
CF Step
97.000000 MHz
Auto
Man
Freq Offset
0 Hz
Align Now, All required


Keysight Spectrum Analyzer - Swept SA
Center Freq 13.750000000 GHz
PNO: Close
IFGain:Low
Trig: Free Run
#Atten: 20 dB
#Avg Type: RMS
Avg|Hold: 10/10
08:55:06 PM Nov 26, 2018
Ref Offset 11.1 dB
10 dB/div
Ref 20.00 dBm
Log
Mkr1 4.881 95 GHz
-33.275 dBm
-26.55 dBm
Start 1.00 GHz
#Res BW 1.0 MHz
#VBW 3.0 MHz
Stop 26.50 GHz
Sweep 64.00 ms (30001 pts)
Frequency
Auto Tune
Center Freq
13.750000000 GHz
Start Freq
1.000000000 GHz
Stop Freq
26.500000000 GHz
CF Step
2.550000000 GHz
Auto
Man
Freq Offset
0 Hz
Align Now, All required

2480MHz


Keysight Spectrum Analyzer - Swept SA
Center Freq 2.480000000 GHz
PNO: Wide
IFGain:Low
Trig: Free Run
#Atten: 30 dB
#Avg Type: RMS
09:14:47 PM Nov 26, 2018
Frequency
Auto Tune
Ref Offset 11.1 dB
10 dB/div
Ref 30.00 dBm
Log
Mkr1 2.480 138 0 GHz
-7.94 dBm
Center Freq
2.480000000 GHz
Start Freq
2.479250000 GHz
Stop Freq
2.480750000 GHz
CF Step
150.000 kHz
Auto
Man
Freq Offset
0 Hz
Center 2.4800000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Span 1.500 MHz
Sweep 1.000 ms (1001 pts)
Align Now, All required


Keysight Spectrum Analyzer - Swept SA
Center Freq 515.000000 MHz
PNO: Close
IFGain:Low
Trig: Free Run
#Atten: 20 dB
#Avg Type: RMS
Avg|Hold: 10/10
09:14:55 PM Nov 26, 2018
Frequency
Auto Tune
Ref Offset 11.1 dB
10 dB/div
Ref 20.00 dBm
Log
Mkr1 95.99 MHz
-55.558 dBm
-27.94 dBm
Center Freq
515.000000 MHz
Start Freq
30.000000 MHz
Stop Freq
1.000000000 GHz
CF Step
97.000000 MHz
Auto
Man
Freq Offset
0 Hz
Start 30.0 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 1.0000 GHz
Sweep 36.00 ms (30001 pts)
Align Now, All required


Keysight Spectrum Analyzer - Swept SA
Center Freq 13.750000000 GHz
PNO: Close
IFGain:Low
Trig: Free Run
#Atten: 20 dB
#Avg Type: RMS
Avg|Hold: 10/10
09:15:05 PM Nov 26, 2018
Frequency
Auto Tune
Ref Offset 11.1 dB
10 dB/div
Ref 20.00 dBm
Log
Mkr1 4.960 15 GHz
-33.479 dBm
-27.94 dBm
Center Freq
13.750000000 GHz
Start Freq
1.000000000 GHz
Stop Freq
26.500000000 GHz
CF Step
2.550000000 GHz
Auto
Man
Freq Offset
0 Hz
Start 1.00 GHz
#Res BW 1.0 MHz
#VBW 3.0 MHz
Stop 26.50 GHz
Sweep 64.00 ms (30001 pts)
Align Now, All required

4.8 Radiated Emission Measurement

4.8.1 Limits

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table.

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

NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/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.

4.8.2 Test Procedures

For Radiated emission below 30MHz

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degree to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. Both X and Y axes of the antenna are set to make the measurement.

d. For each suspected emission, the EUT was arranged to its worst case and the rotate table was turned from 0 degree to 360 degree to find the maximum reading.

e. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

Note:

The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

For Radiated emission above 30MHz

a. The EUT was placed on the top of a rotating table 0.8 meters (for below 1 GHz) / 1.5 meters (for above 1 GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The height of antenna 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.

d. 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 and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.

f. The test-receiver system was set to peak and average detected function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

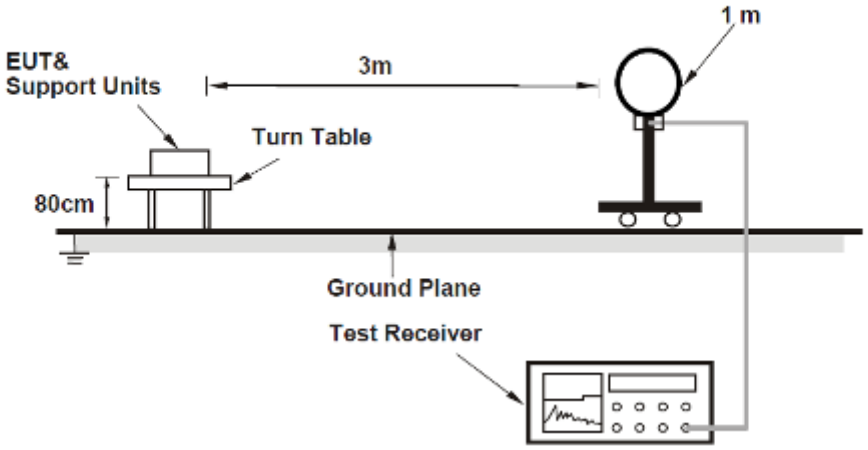
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz & 360 kHz for Quasi-peak detection (QP) at frequency below 1 GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1 GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 1/T for RMS Average (Duty cycle < 98 %) for Peak detection at frequency above 1 GHz.
4. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 10 Hz (Duty cycle $\geqslant$ 98 %) for Average detection (AV) at frequency above 1 GHz.
5. All modes of operation were investigated and the worst-case emissions are reported.

4.8.3 Deviation from Test Standard

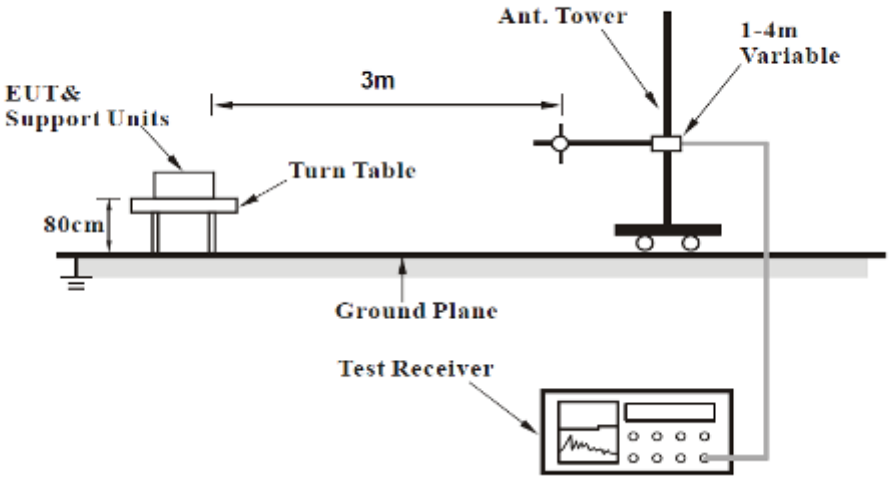
No deviation.

4.8.4 Test Setup

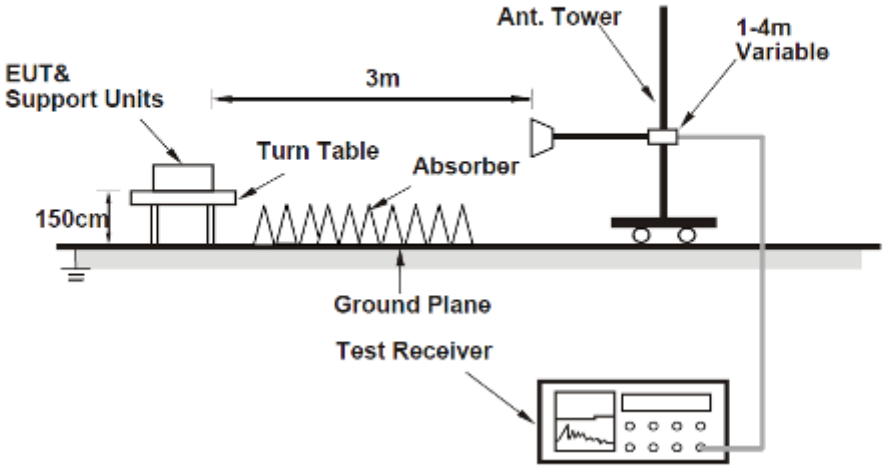
For Radiated emission below 30MHz



For Radiated emission 30MHz to 1GHz



For Radiated emission above 1GHz



For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.8.5 EUT Operating Conditions

a. Placed the EUT on a testing table.

b. Use the software to control the EUT under transmission condition continuously at specific channel frequency.

4.8.6 Test Results

Radiated Emissions Range 9kHz~30MHz

The amplitude of spurious emissions which are attenuated by more than 20 dB below the permissible value has no need to be reported.

Radiated Emissions Range 30MHz~1GHz

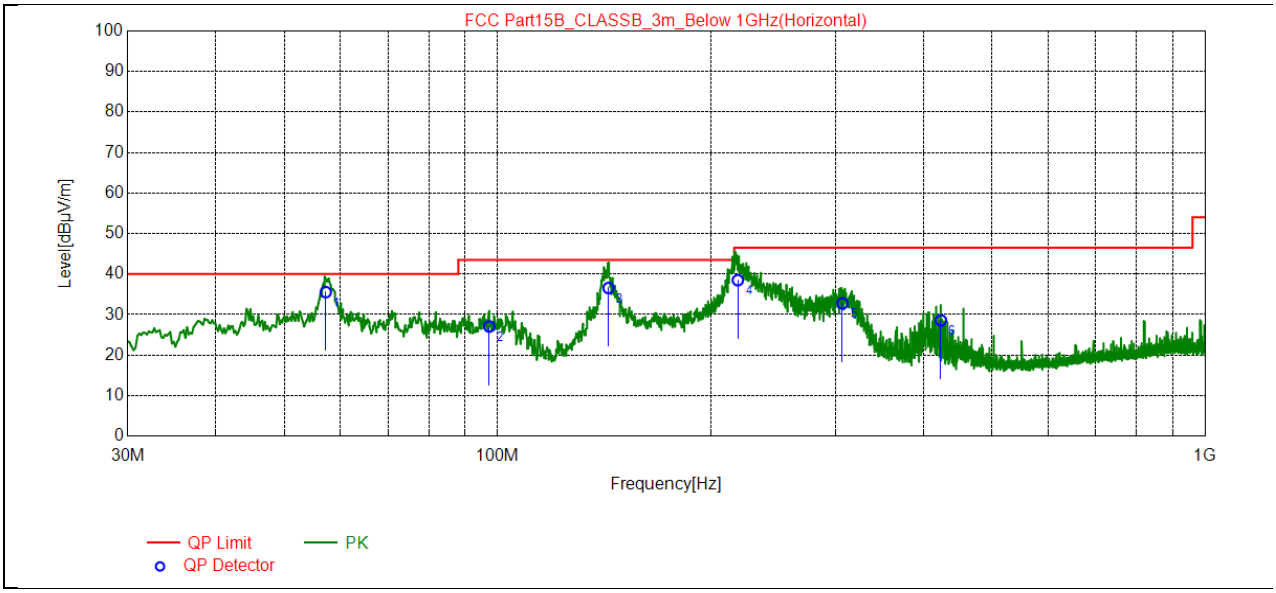
Channel	TX Channel 0	**Detector Function**	Quasi-Peak (QP)
Frequency Range	30MHz ~ 1GHz	**Antenna Polarity**	Horizontal

Spurious Emission Level					
No.	**Frequency (MHz)**	**Emission Level (dBuV/m)**	**Limit (dBuV/m)**	**Margin (dB)**	**Correction Factor (dB/m)**
1	57.1600	35.54	40.00	-4.46	-17.70
2	97.3180	27.06	43.50	-16.44	-20.31
3	143.4742	36.56	43.50	-6.94	-16.97
4	218.5658	38.49	46.50	-8.01	-18.46
5	307.2260	32.76	46.50	-13.74	-15.70
6	423.2380	28.56	46.50	-17.94	-12.82

REMARKS:

1. Emission Level(dBuV/m) = Spectrum reading (dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value

Test Plot:



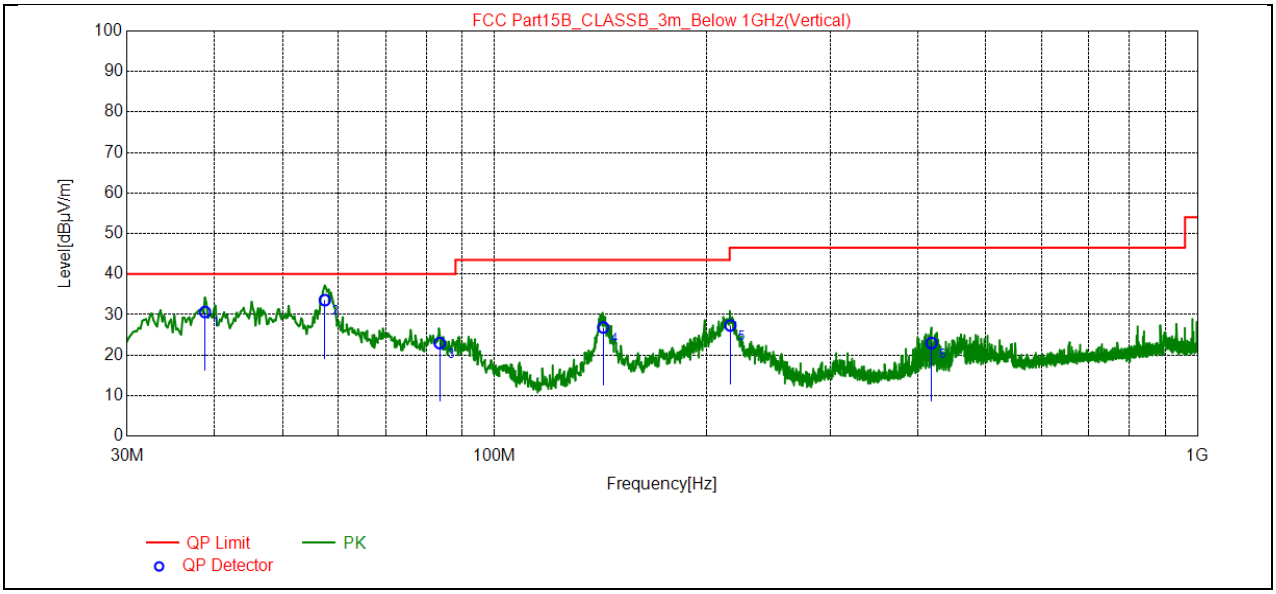
Channel	TX Channel 0	**Detector Function**	Quasi-Peak (QP)
Frequency Range	30MHz ~ 1GHz	**Antenna Polarity**	Vertical

Spurious Emission Level					
No.	**Frequency (MHz)**	**Emission Level (dBuV/m)**	**Limit (dBuV/m)**	**Margin (dB)**	**Correction Factor (dB/m)**
1	38.7300	30.64	40.00	-9.36	-17.47
2	57.3540	33.57	40.00	-6.43	-17.72
3	83.5440	22.95	40.00	-17.05	-20.70
4	142.7140	26.83	43.50	-16.67	-17.01
5	216.4340	27.30	46.50	-19.20	-18.53
6	418.3880	22.97	46.50	-23.53	-12.91

REMARKS:

1. Emission Level(dBuV/m) = Original Spectrum reading (dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value

Test Plot:



Radiated Emission Range 1GHz~10th Harmonic

GFSK

Channel	TX Channel 0	Detector Function	Peak (PK)
Frequency Range	1GHz ~ 25GHz		Average (AV)

Spurious Emission Level							
No.	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Correction Factor (dB/m)	Antenna Polarity	Detector
1	4803.7500	51.36	74.00	-22.64	-9.42	H	PK
2	4804.6000	50.22	54.00	-3.78	-9.42	H	AV
3	4803.7500	46.20	74.00	-27.80	-11.06	V	PK
4	4804.6000	41.44	54.00	-12.56	-11.06	V	AV

Channel	TX Channel 40	Detector Function	Peak (PK)
Frequency Range	1GHz ~ 25GHz		Average (AV)

Spurious Emission Level							
No.	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Correction Factor (dB/m)	Antenna Polarity	Detector
1	4881.9500	53.60	74.00	-20.40	-9.32	H	PK
2	4882.8000	51.05	54.00	-2.95	-9.32	H	AV
3	4881.9500	46.47	74.00	-27.53	-9.32	V	PK
4	4882.8000	44.14	54.00	-9.86	-9.32	V	AV

Channel	TX Channel 78	Detector Function	Peak (PK)
Frequency Range	1GHz ~ 25GHz		Average (AV)

Spurious Emission Level							
No.	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Correction Factor (dB/m)	Antenna Polarity	Detector
1	4959.3000	51.29	74.00	-22.71	-9.23	H	PK
2	4961.0000	48.29	54.00	-5.71	-9.22	H	AV
3	4960.1500	46.85	74.00	-27.15	-9.23	V	PK
4	4961.0000	43.52	54.00	-10.48	-9.22	V	AV

REMARKS:

1. Emission Level(dBuV/m) = Original Spectrum reading (dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value

π/4DQPSK

Channel	TX Channel 0	Detector Function	Peak (PK)
Frequency Range	1GHz ~ 25GHz		Average (AV)

Spurious Emission Level							
No.	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Correction Factor (dB/m)	Antenna Polarity	Detector
1	4803.7500	52.19	74.00	-21.81	-9.42	H	PK
2	4804.6000	49.09	54.00	-4.91	-9.42	H	AV
3	4803.7500	45.30	74.00	-28.70	-9.42	V	PK
4	4804.6000	40.67	54.00	-13.33	-9.42	V	AV

Channel	TX Channel 40	Detector Function	Peak (PK)
Frequency Range	1GHz ~ 25GHz		Average (AV)

Spurious Emission Level							
No.	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Correction Factor (dB/m)	Antenna Polarity	Detector
1	4881.1000	49.06	74.00	-24.94	-9.32	H	PK
2	4882.8000	46.08	54.00	-7.92	-9.32	H	AV
3	4882.8000	46.10	74.00	-27.90	-9.32	V	PK
4	4882.8000	42.55	54.00	-11.45	-9.32	V	AV

Channel	TX Channel 78	Detector Function	Peak (PK)
Frequency Range	1GHz ~ 25GHz		Average (AV)

Spurious Emission Level							
No.	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Correction Factor (dB/m)	Antenna Polarity	Detector
1	4960.1500	55.09	74.00	-18.91	-9.23	H	PK
2	4961.0000	50.76	54.00	-3.24	-9.22	H	AV
3	4959.3000	48.79	74.00	-25.21	-9.23	V	PK
4	4960.1500	44.64	54.00	-9.36	-9.23	V	AV

REMARKS:

1. Emission Level(dBuV/m) = Original Spectrum reading (dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value

5 Pictures of Test Arrangements

Please refer to the attached file (Test Setup Photo).

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