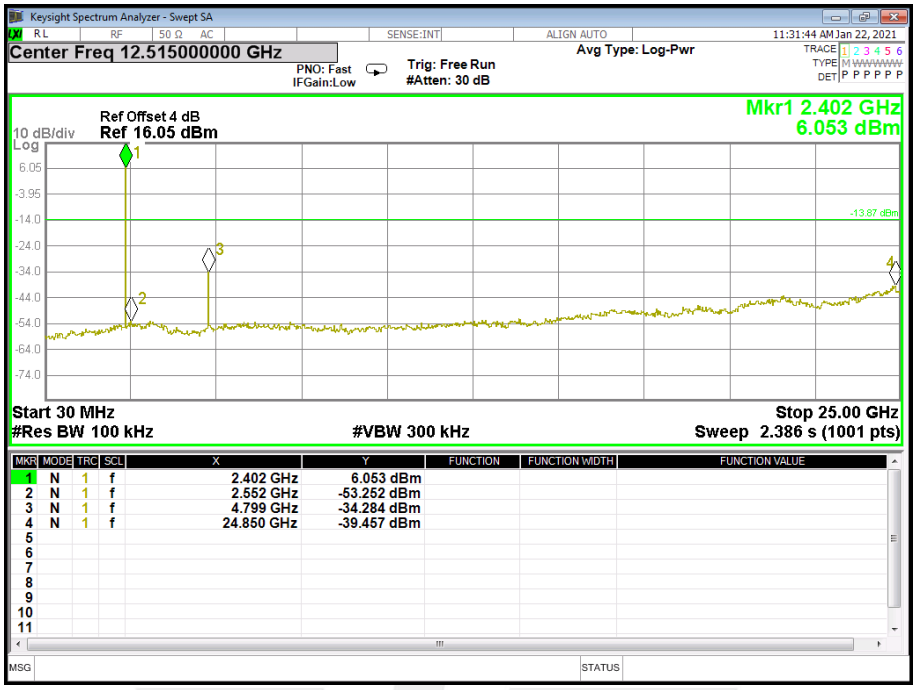
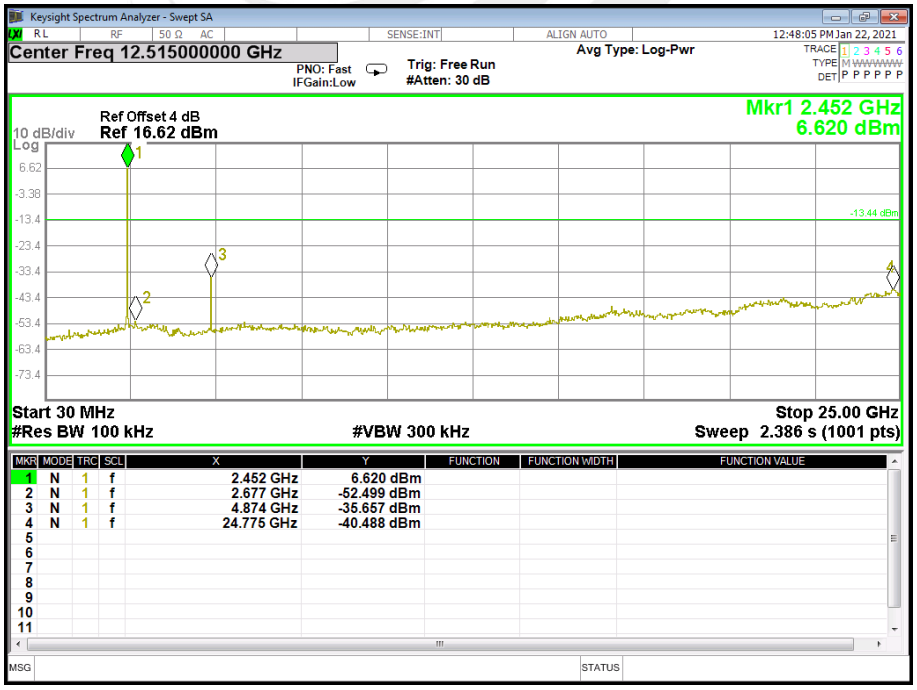
Temperature:	25℃	Relative Humidity:	50%
Test Mode:	π/4-DQPSK(2Mbps)–00/39/78 CH	Test Voltage:	DC 3.8V

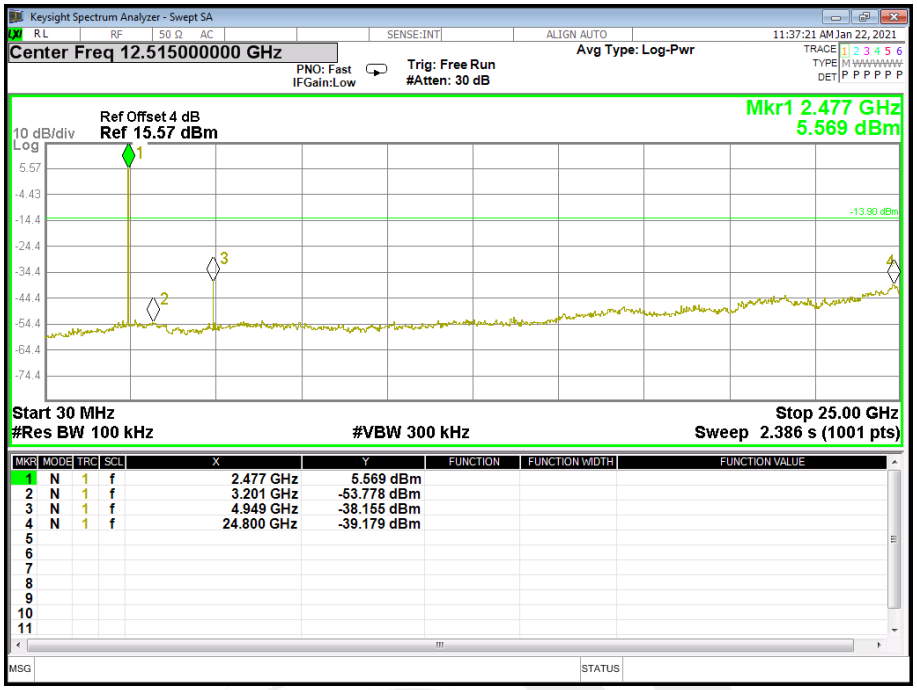
00 CH



39 CH

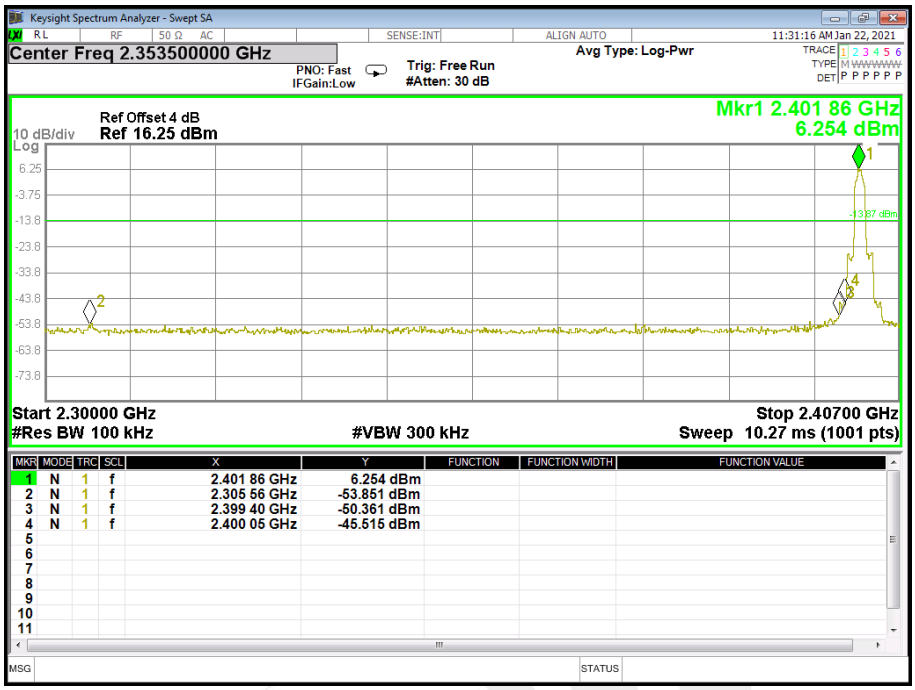


78 CH

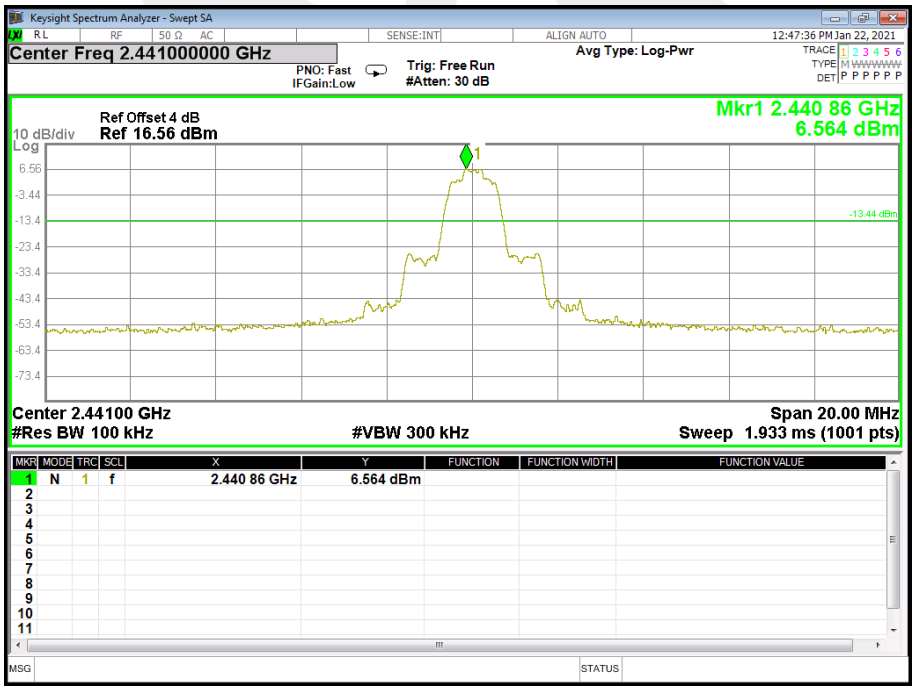

Keysight Spectrum Analyzer - Swept SA
RL
RF
50 Ω AC
SENSE:INT
ALIGN AUTO
11:37:21 AM Jan 22, 2021
Center Freq 12.515000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
TRACE 1 2 3 4 5 6
TYPE M WWWWW
DET P P P P P P
Ref Offset 4 dB
10 dB/div
Ref 15.57 dBm
Log
Mkr1 2.477 GHz
5.569 dBm
5.57
-4.43
-14.4
-24.4
-34.4
-44.4
-54.4
-64.4
-74.4
-13.90 dBm
Start 30 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.386 s (1001 pts)
MKR MODE TRC SCL X Y FUNCTION FUNCTION WIDTH FUNCTION VALUE
1 N 1 f 2.477 GHz 5.569 dBm
2 N 1 f 3.201 GHz -53.778 dBm
3 N 1 f 4.949 GHz -38.155 dBm
4 N 1 f 24.800 GHz -39.179 dBm
MSG
STATUS

For Band edge(it's also the reference level for conducted spurious emission)

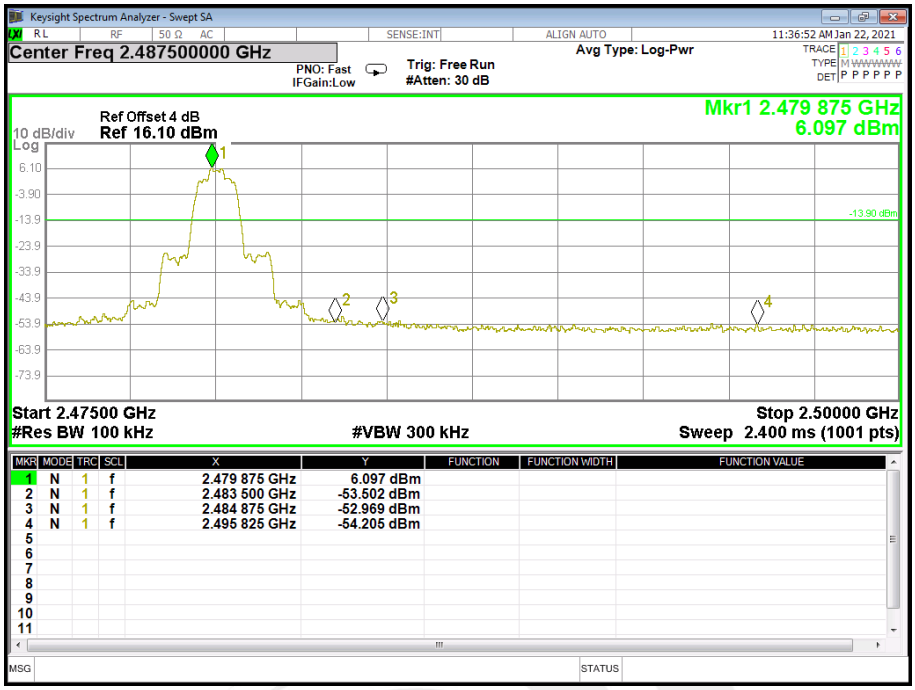
00 CH



39 CH

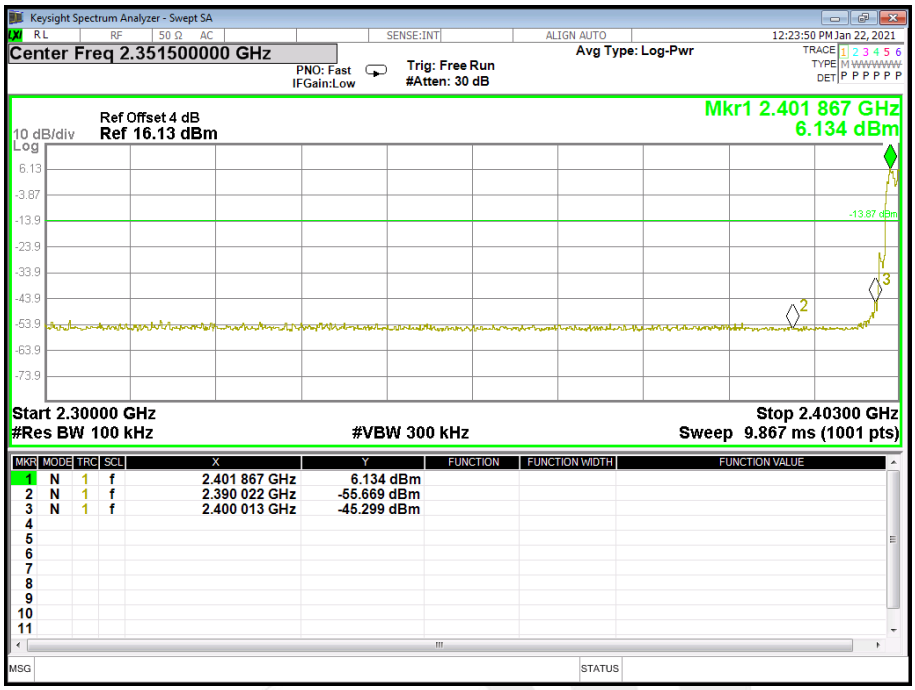


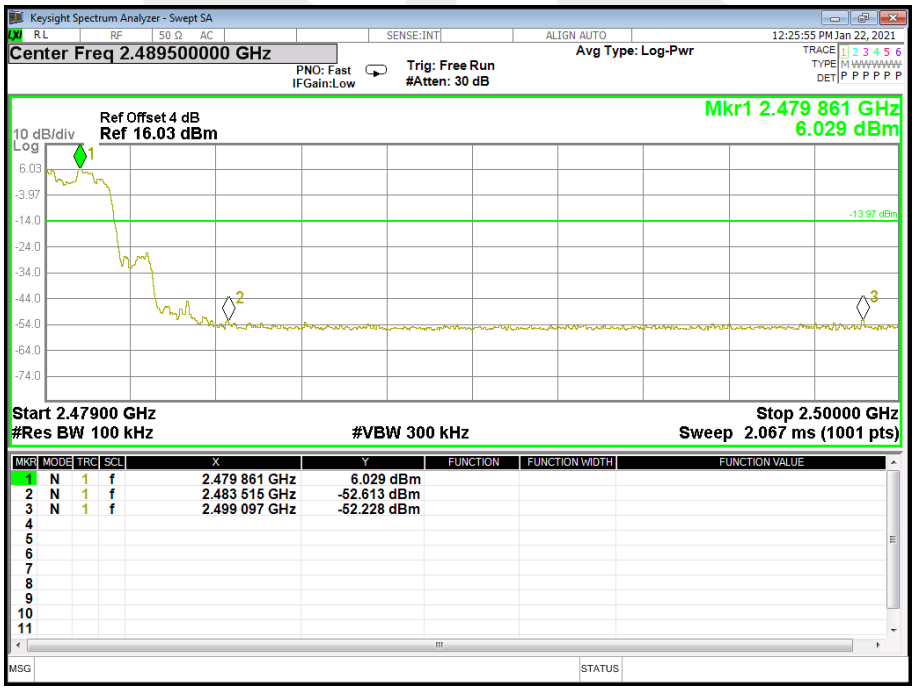
78 CH


Keysight Spectrum Analyzer - Swept SA
RL
RF
50 Ω AC
SENSE:INT
ALIGN AUTO
11:36:52 AM Jan 22, 2021
Center Freq 2.487500000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
TRACE 1 2 3 4 5 6
TYPE M WWWWW
DET P P P P P
Ref Offset 4 dB
10 dB/div
Log
Ref 16.10 dBm
Mkr1 2.479 875 GHz
6.097 dBm
6.10
-3.90
-13.9
-23.9
-33.9
-43.9
-53.9
-63.9
-73.9
-13.90 dBm
Start 2.47500 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 2.50000 GHz
Sweep 2.400 ms (1001 pts)
MKR MODE TRC SCL X Y FUNCTION FUNCTION WIDTH FUNCTION VALUE
1 N 1 f 2.479 875 GHz 6.097 dBm
2 N 1 f 2.483 500 GHz -53.502 dBm
3 N 1 f 2.484 875 GHz -52.969 dBm
4 N 1 f 2.495 825 GHz -54.205 dBm
MSG
STATUS

For Hopping Band edge

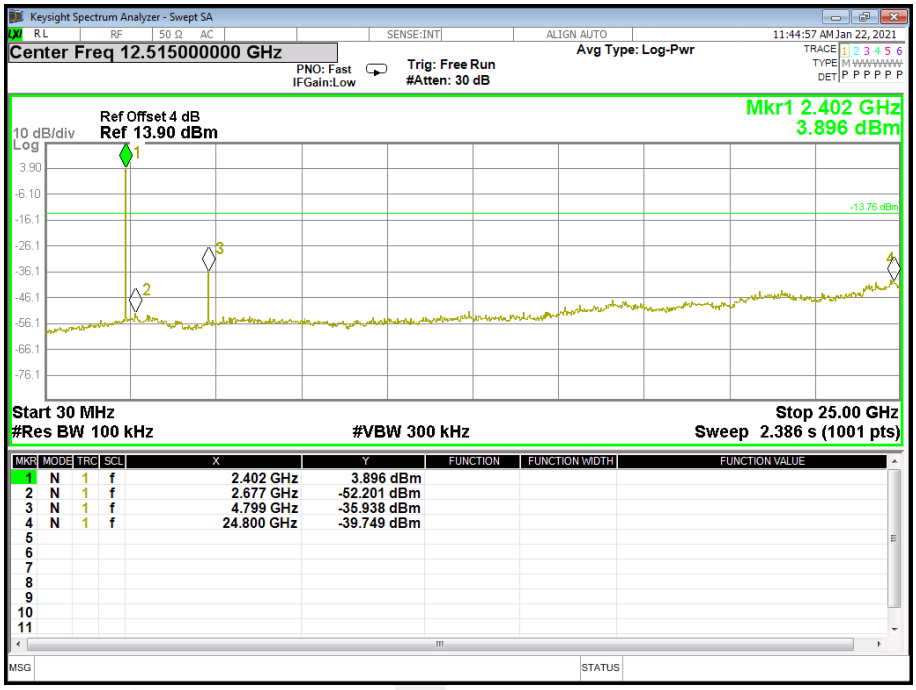
π/4-DQPSK



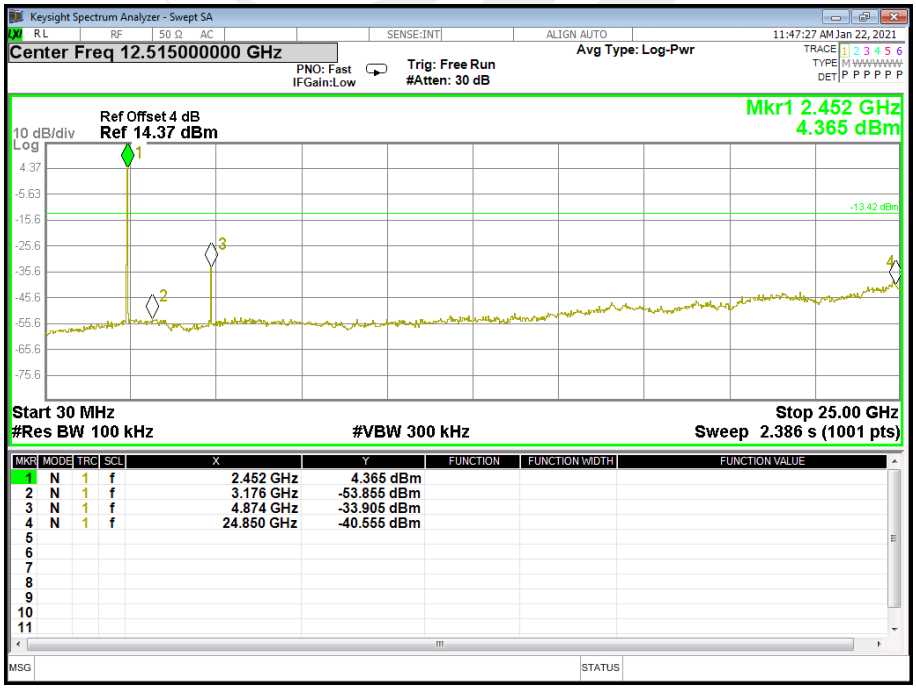


Temperature:	25℃	Relative Humidity:	50%
Test Mode:	8DPSK(3Mbps) -00/39/78 CH	Test Voltage:	DC 3.8V

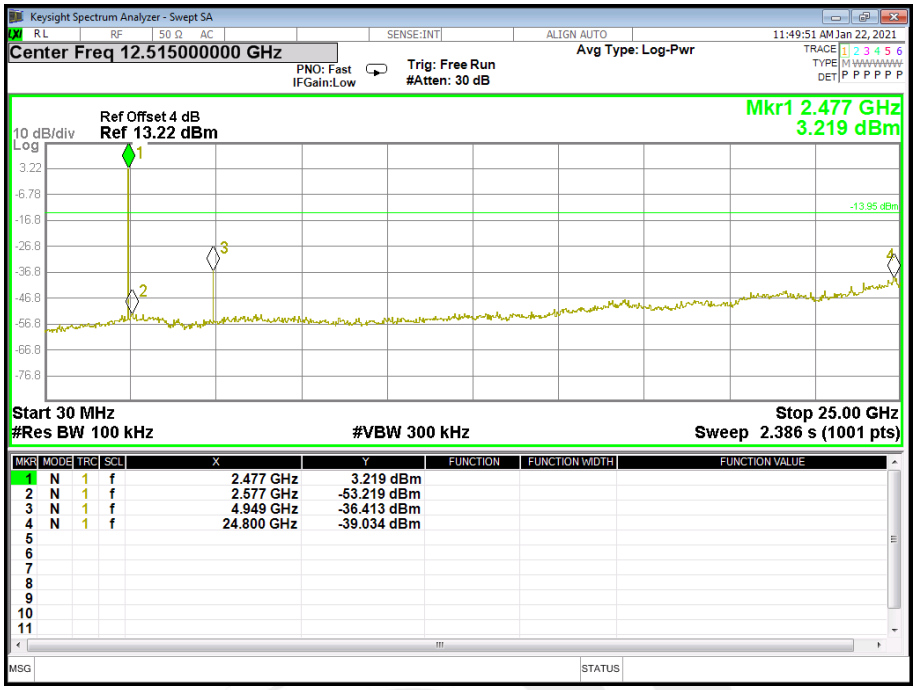
00 CH



39 CH

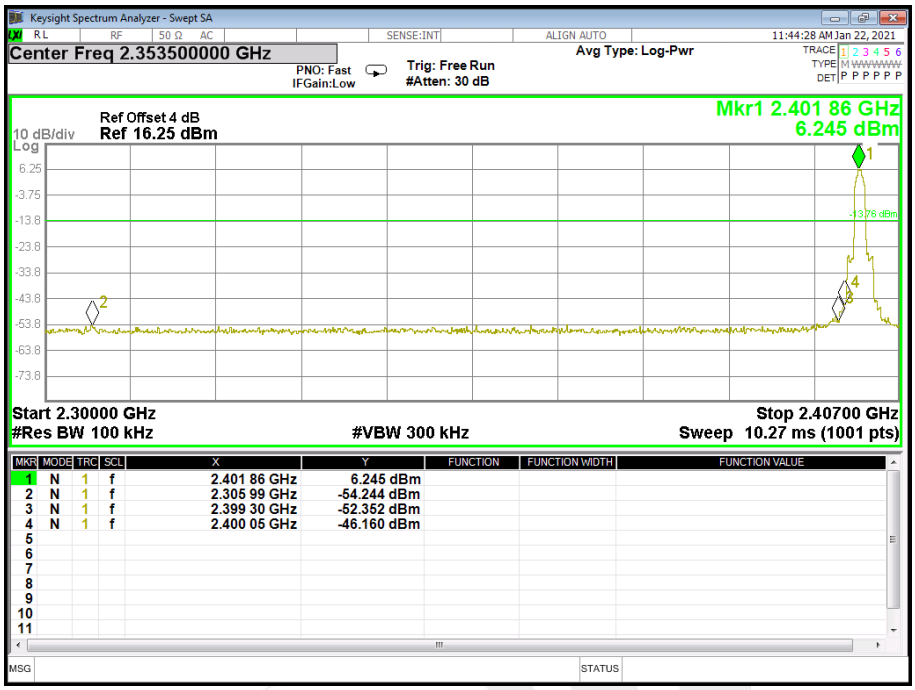


78 CH

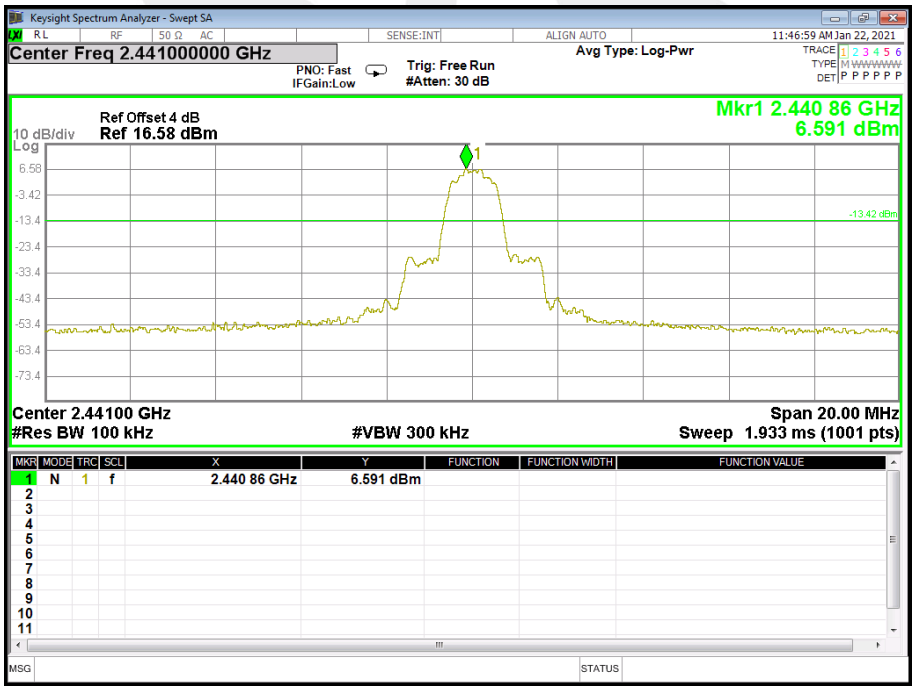

Keysight Spectrum Analyzer - Swept SA
RL
RF
50 Ω AC
SENSE:INT
ALIGN AUTO
11:49:51 AM Jan 22, 2021
Center Freq 12.515000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
TRACE 1 2 3 4 5 6
TYPE M WWWWW
DET P P P P P P
Ref Offset 4 dB
10 dB/div
Log
Ref 13.22 dBm
Mkr1 2.477 GHz
3.219 dBm
3.22
-6.78
-16.8
-26.8
-36.8
-46.8
-56.8
-66.8
-76.8
-13.95 dBm
Start 30 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 25.00 GHz
Sweep 2.386 s (1001 pts)
MKR MODE TRC SCL X Y FUNCTION FUNCTION WIDTH FUNCTION VALUE
1 N 1 f 2.477 GHz 3.219 dBm
2 N 1 f 2.577 GHz -53.219 dBm
3 N 1 f 4.949 GHz -36.413 dBm
4 N 1 f 24.800 GHz -39.034 dBm
5
6
7
8
9
10
11
MSG
STATUS

For Band edge(it's also the reference level for conducted spurious emission)

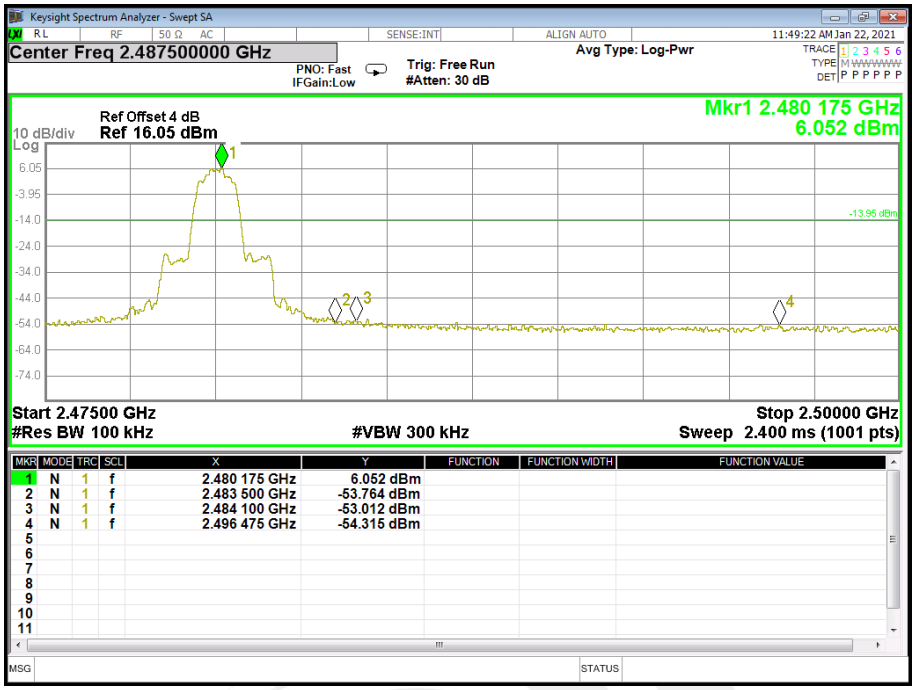
00 CH



39 CH

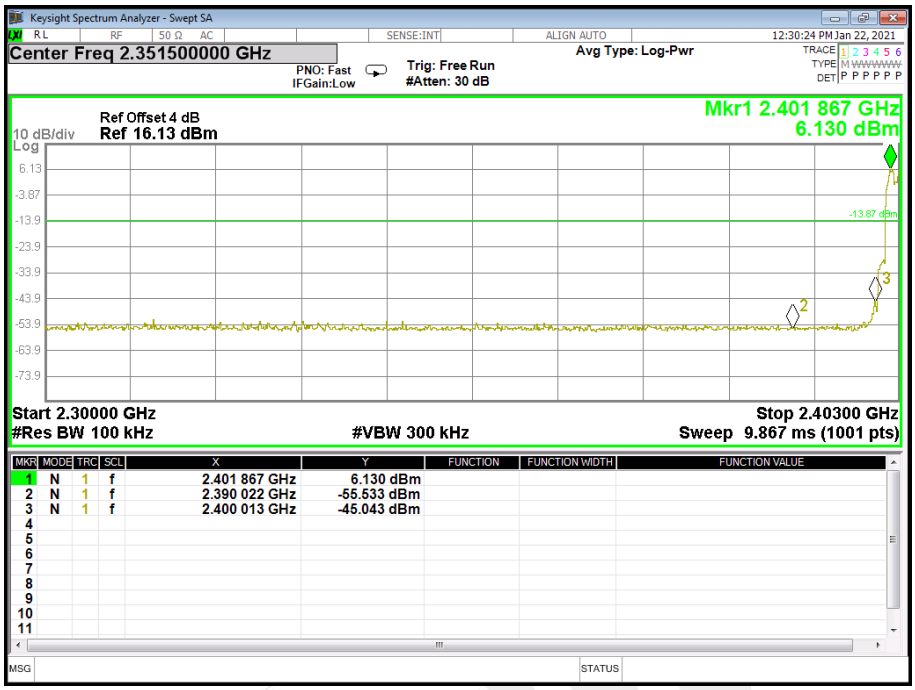


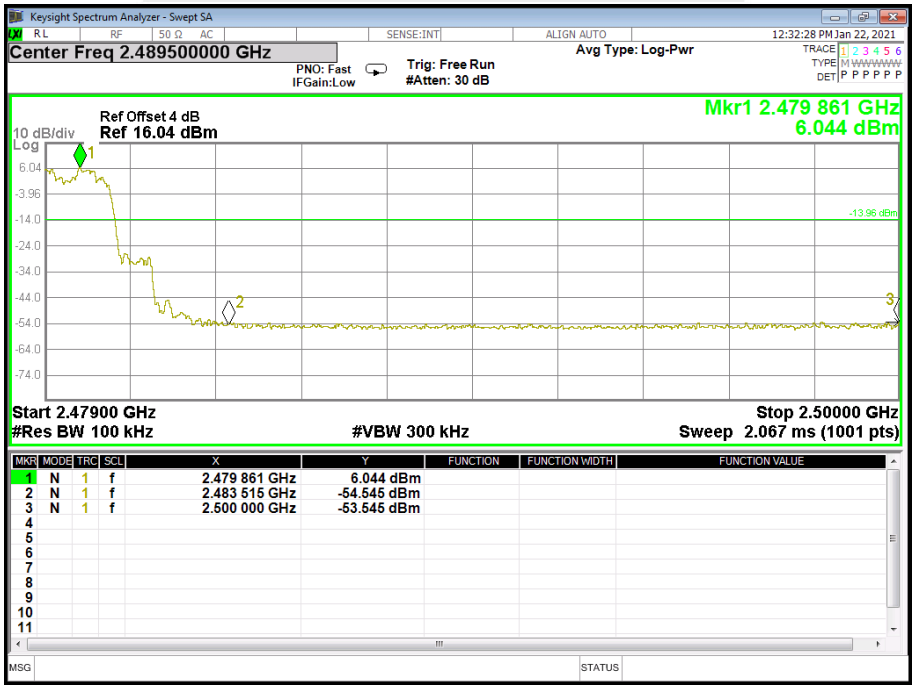
78 CH


Keysight Spectrum Analyzer - Swept SA
RL
RF
50 Ω AC
SENSE:INT
ALIGN AUTO
11:49:22 AM Jan 22, 2021
Center Freq 2.487500000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 30 dB
Avg Type: Log-Pwr
TRACE 1 2 3 4 5 6
TYPE M WWWWW
DET P P P P P
Ref Offset 4 dB
10 dB/div
Log
Ref 16.05 dBm
Mkr1 2.480 175 GHz
6.052 dBm
6.05
-3.95
-14.0
-24.0
-34.0
-44.0
-54.0
-64.0
-74.0
-13.95 dBm
Start 2.47500 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 2.50000 GHz
Sweep 2.400 ms (1001 pts)
MKR MODE TRC SCL X Y FUNCTION FUNCTION WIDTH FUNCTION VALUE
1 N 1 f 2.480 175 GHz 6.052 dBm
2 N 1 f 2.483 500 GHz -53.764 dBm
3 N 1 f 2.484 100 GHz -53.012 dBm
4 N 1 f 2.496 475 GHz -54.315 dBm
MSG
STATUS

For Hopping Band edge

8DPSK





5. NUMBER OF HOPPING CHANNEL

5.1 LIMIT

FCC Part 15.247,Subpart C				
Section	Test Item	Limit	FrequencyRange (MHz)	Result
15.247 (a)(1)(iii)	Number of Hopping Channel	≥15	2400-2483.5	PASS

Spectrum Parameters	Setting
Attenuation	Auto
Span Frequency	> Operating FrequencyRange
RB	300KHz
VB	300KHz
Detector	Peak
Trace	Max Hold
Sweep Time	Auto

5.2 TEST PROCEDURE

a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below.
b. Spectrum Setting: RBW= 300KHz, VBW=300KHz, Sweep time = Auto.

5.3 TEST SETUP

5.4 EUT OPERATION CONDITIONS

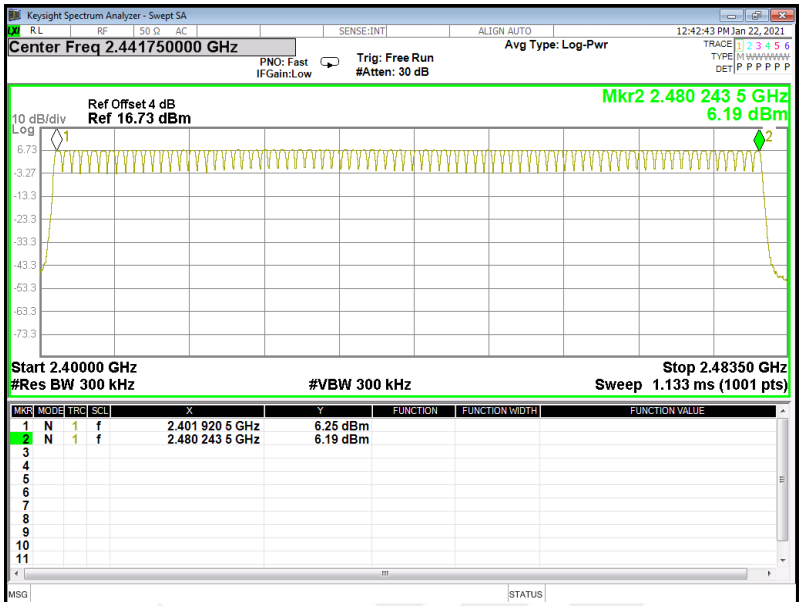
Please refer to section 3.1.4 of this report.

5.5 TEST RESULTS

Temperature:	25℃	Relative Humidity:	60%
Test Mode:	Hopping Mode -GFSK Mode	Test Voltage:	DC 3.8V

Number of Hopping Channel 79

Hopping channel



6. AVERAGE TIME OF OCCUPANCY

6.1 LIMIT

FCC Part 15.247,Subpart C				
Section	Test Item	Limit	FrequencyRange (MHz)	Result
15.247 (a)(1)(iii)	Average Time of Occupancy	0.4sec	2400-2483.5	PASS

6.2 TEST PROCEDURE

a. The transmitter output (antenna port) was connected to the spectrum analyzer.
b. Set RBW =1MHz/VBW =3MHz.
c. Use a video trigger with the trigger level set to enable triggering only on full pulses.
d. Sweep Time is more than once pulse time.
e. Set the center frequency on any frequency would be measure and set the frequency span to zero span.
f. Measure the maximum time duration of one single pulse.
g. Set the EUT for DH5, DH3 and DH1 packet transmitting.
h. Measure the maximum time duration of one single pulse.
i. DH5 Packet permit maximum 1600/ 79 / 6 = 3.37 hops per second in each channel (5 time slots RX, 1 time slot TX). So the number of pulses in the observation period of 31.6 seconds is 3.37 x 31.6 = 106.6.
j. DH3 Packet permit maximum 1600 / 79 / 4 = 5.06 hops per second in each channel (3 time slots RX, 1 time slot TX). So the number of pulses in the observation period of 31.6 seconds is 5.06 x 31.6 = 160.
k. DH1 Packet permit maximum 1600 / 79 / 2 = 10.12 hops per second in each channel (1 time slot RX, 1 time slot TX). So the number of pulses in the observation period of 31.6 seconds is 10.12 x 31.6 = 320.

6.3 TEST SETUP

6.4 EUT OPERATION CONDITIONS

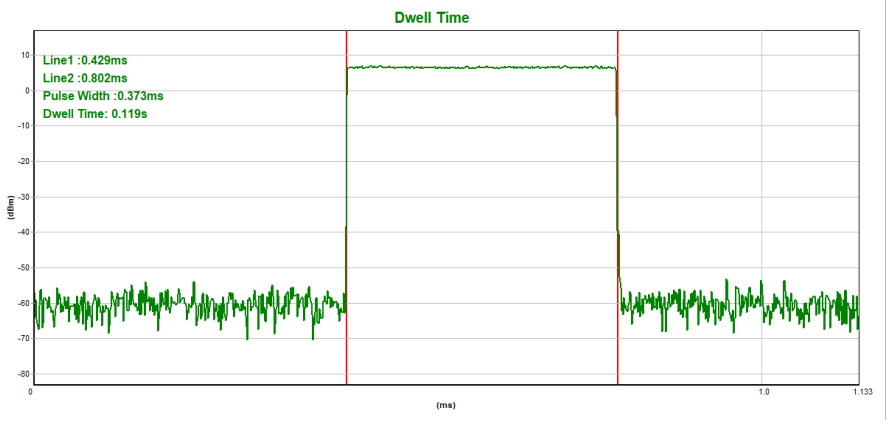
Please refer to section 3.1.4 of this report.

6.5 TEST RESULTS

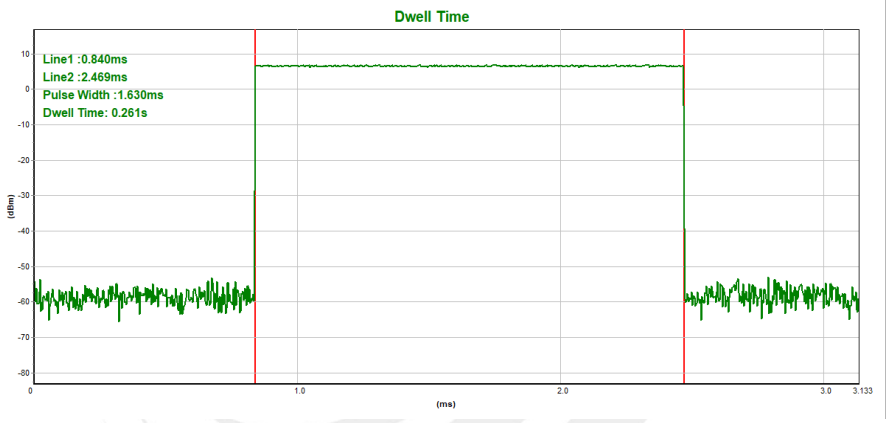
Temperature:	25℃	Relative Humidity:	50%
Test Mode:	GFSK(1Mbps)-DH1/DH3/DH5	Test Voltage:	DC 3.8V

Data Packet	Channel	pulse time(ms)	Dwell Time(s)	Limits(s)
DH1	middle	0.373	0.119	0.4
DH3	middle	1.630	0.261	0.4
DH5	middle	2.878	0.307	0.4

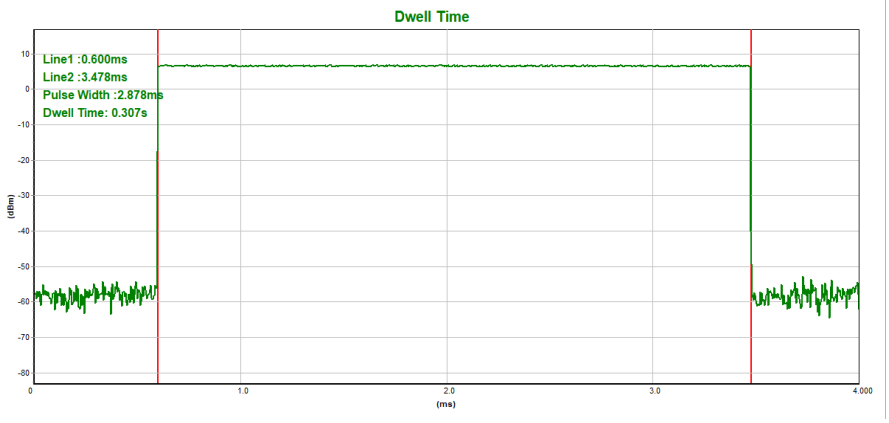
CH39-DH1



CH39-DH3



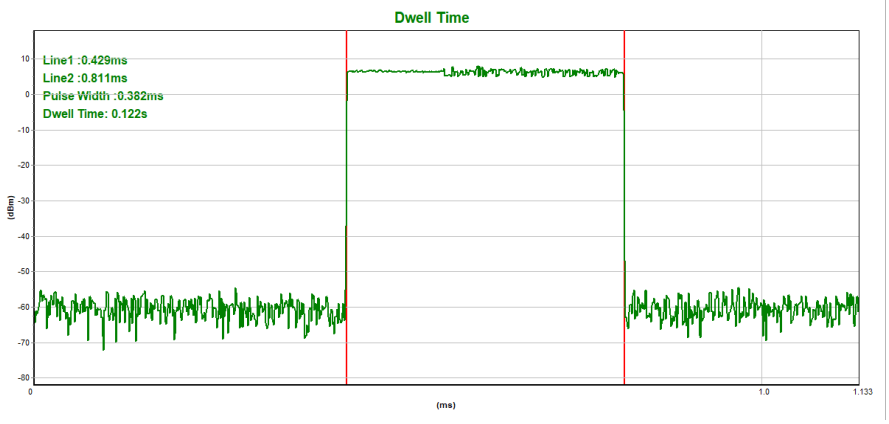
CH39-DH5



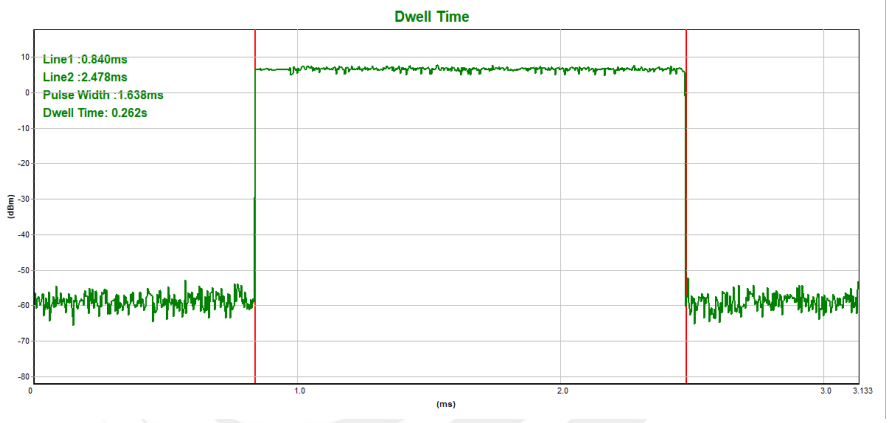
Temperature:	25℃	Relative Humidity:	50%
Test Mode:	π/4-DQPSK(2Mbps)–2DH1/2DH3/2DH5	Test Voltage:	DC 3.8V

Data Packet	Channel	pulse time(ms)	Dwell Time(s)	Limits(s)
2DH1	middle	0.382	0.122	0.4
2DH3	middle	1.638	0.262	0.4
2DH5	middle	2.888	0.308	0.4

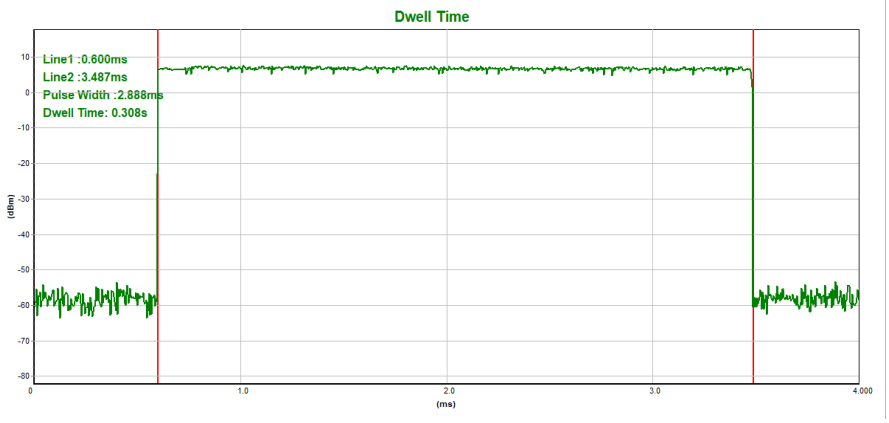
CH39-2DH1



CH39-2DH3



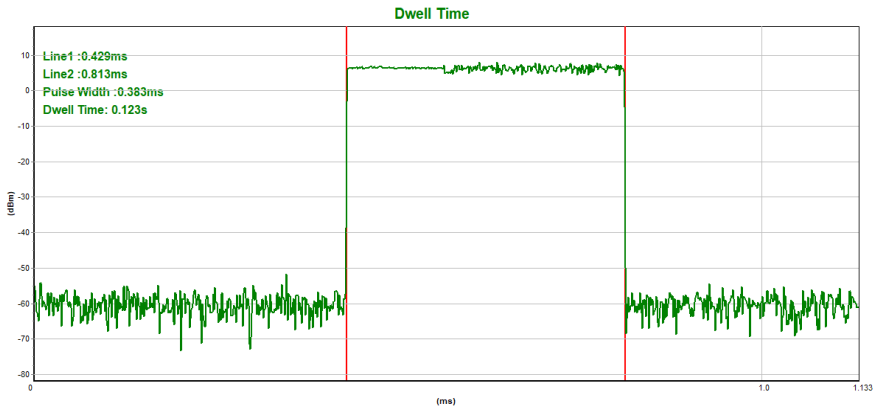
CH39-2DH5



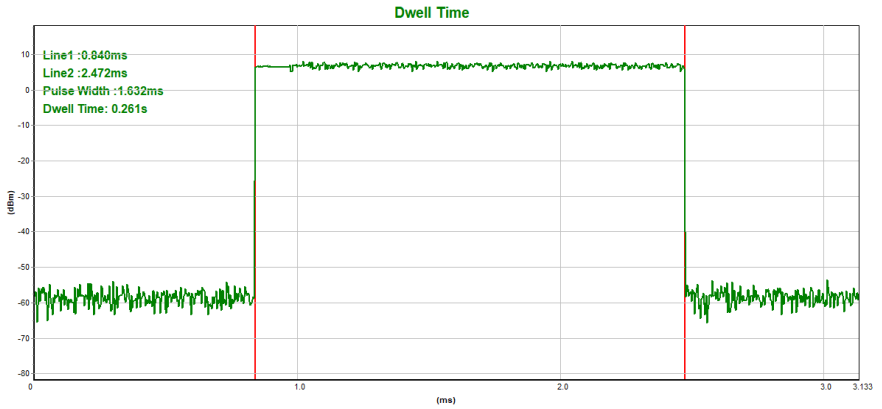
Temperature:	25℃	Relative Humidity:	50%
Test Mode:	8DPSK(3Mbps)–3DH1/3DH3/3DH5	Test Voltage:	DC 3.8V

Data Packet	Channel	pulse time(ms)	Dwell Time(s)	Limits(s)
3DH1	middle	0.383	0.123	0.4
3DH3	middle	1.632	0.261	0.4
3DH5	middle	2.887	0.308	0.4

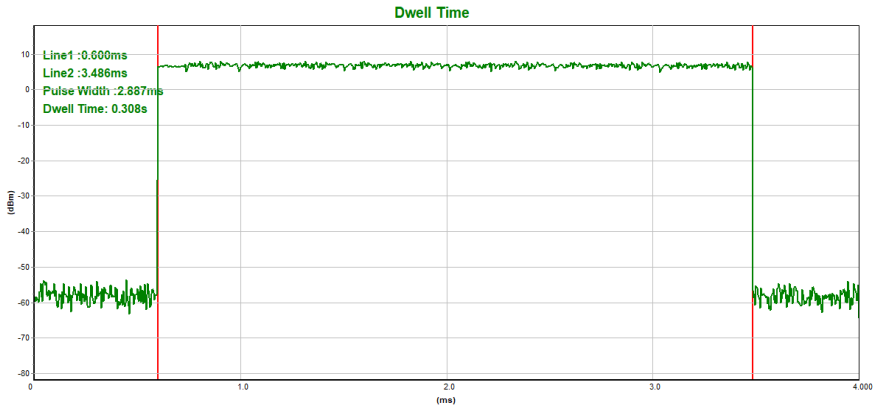
CH39-3DH1



CH39-3DH3



CH39-3DH5



7. HOPPING CHANNEL SEPARATION MEASUREMEN

7.1 LIMIT

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	> 20 dB Bandwidth or Channel Separation
RB	30 kHz (20dB Bandwidth) / 30 kHz (Channel Separation)
VB	100 kHz (20dB Bandwidth) / 100 kHz (Channel Separation)
Detector	Peak
Trace	Max Hold
Sweep Time	Auto

7.2 TEST PROCEDURE

a. The transmitter output (antenna port) was connected to the spectrum analyser in peak hold mode.
b. The resolution bandwidth of 30 kHz and the video bandwidth of 100 kHz were utilised for 20 dB bandwidth measurement.
c. The resolution bandwidth of 30 kHz and the video bandwidth of 100 kHz were utilised for channel separation measurement.

7.3 TEST SETUP

7.4 EUT OPERATION CONDITIONS

The EUT was programmed to be in continuously transmitting mode.

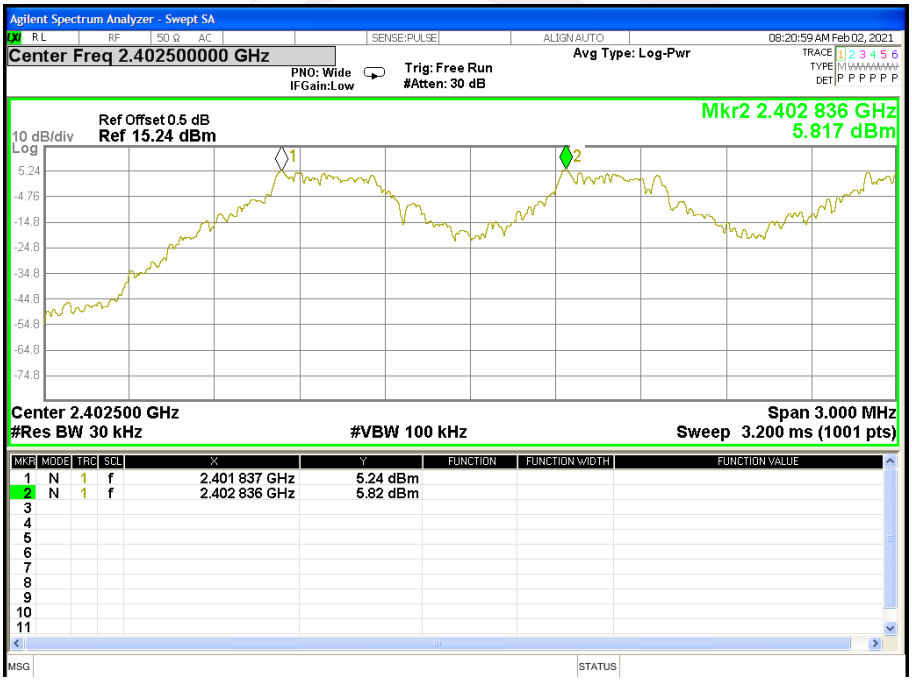
7.5 TEST RESULTS

Temperature:	25℃	Relative Humidity:	50%
Test Mode:	CH00 / CH39 / CH78 (GFSK(1Mbps) Mode)	Test Voltage:	DC 3.8V

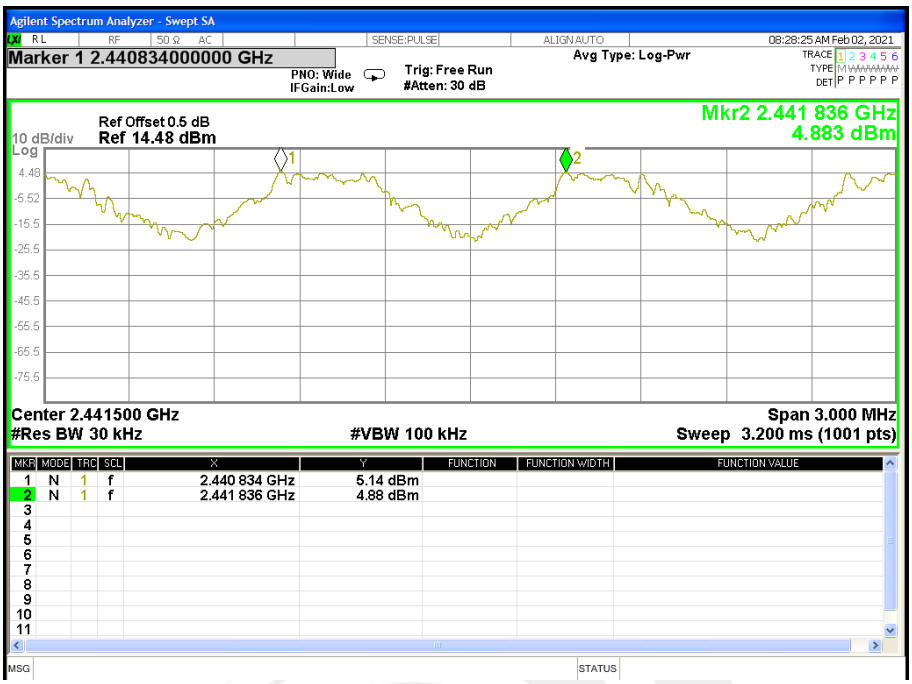
Frequency	Mark1 Frequency （MHz）	Mark2 Frequency （MHz）	Ch. Separation (MHz)	Limit (MHz)	Result
2402 MHz	2401.837	2402.836	0.999	0.887	Complies
2441 MHz	2440.834	2441.836	1.002	0.885	Complies
2480 MHz	2478.984	2479.899	0.915	0.887	Complies

For GFSK: Ch. Separation Limits: > 20dB bandwidth

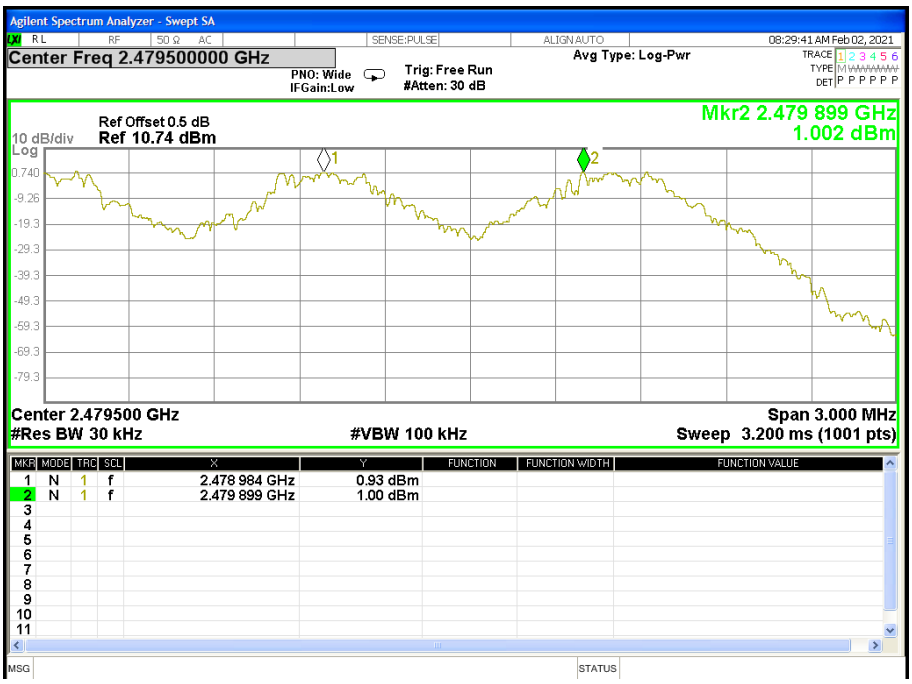
CH00 -1Mbps



CH39 -1Mbps



CH78 -1Mbps

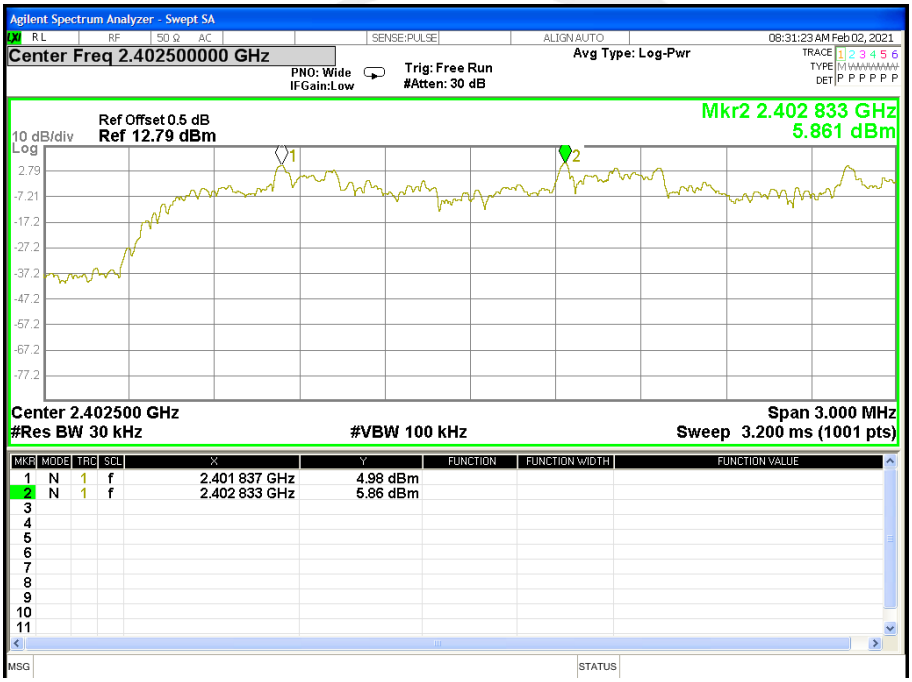


Temperature:	25℃	Relative Humidity:	50%
Test Mode:	CH00 / CH39 / CH78 (π/4-DQPSK(2Mbps) Mode)	Test Voltage:	DC 3.8V

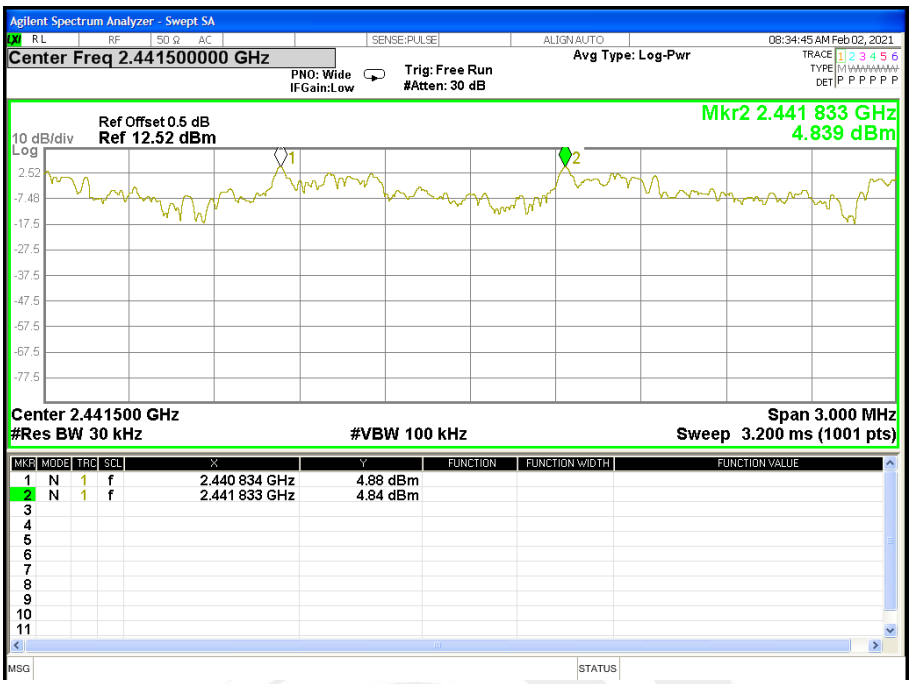
Frequency	Mark1 Frequency （MHz）	Mark2 Frequency （MHz）	Ch. Separation (MHz)	Limit (MHz)	Result
2402 MHz	2401.837	2402.833	0.996	0.839	Complies
2441 MHz	2440.834	2441.833	0.999	0.837	Complies
2480 MHz	2478.834	2479.833	0.999	0.837	Complies

For π/4-DQPSK(2Mbps): Ch. Separation Limits: > two-thirds 20dB bandwidth

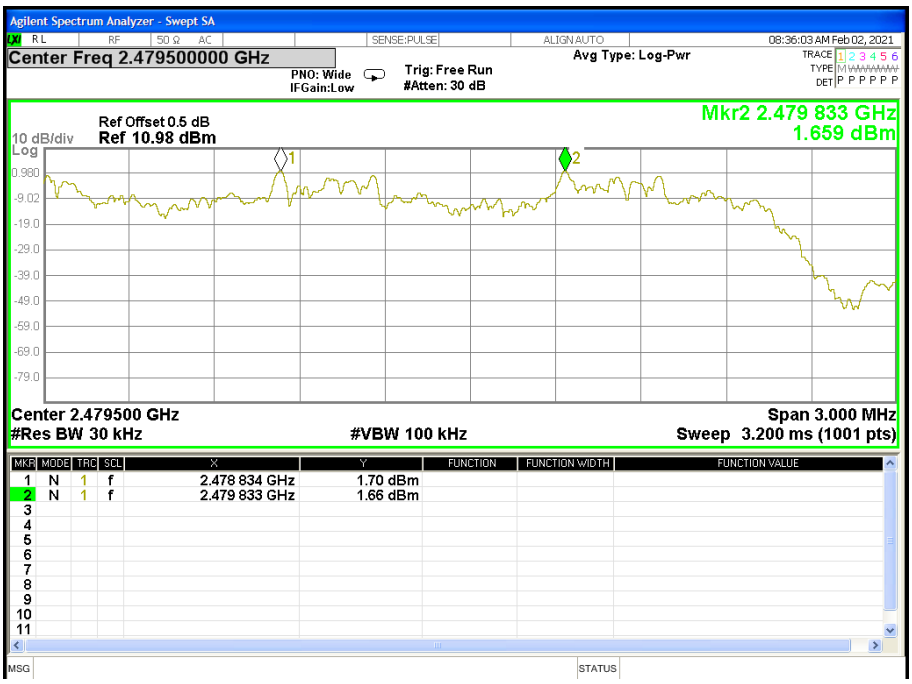
CH00 -2Mbps



CH39 -2Mbps



CH78 -2Mbps

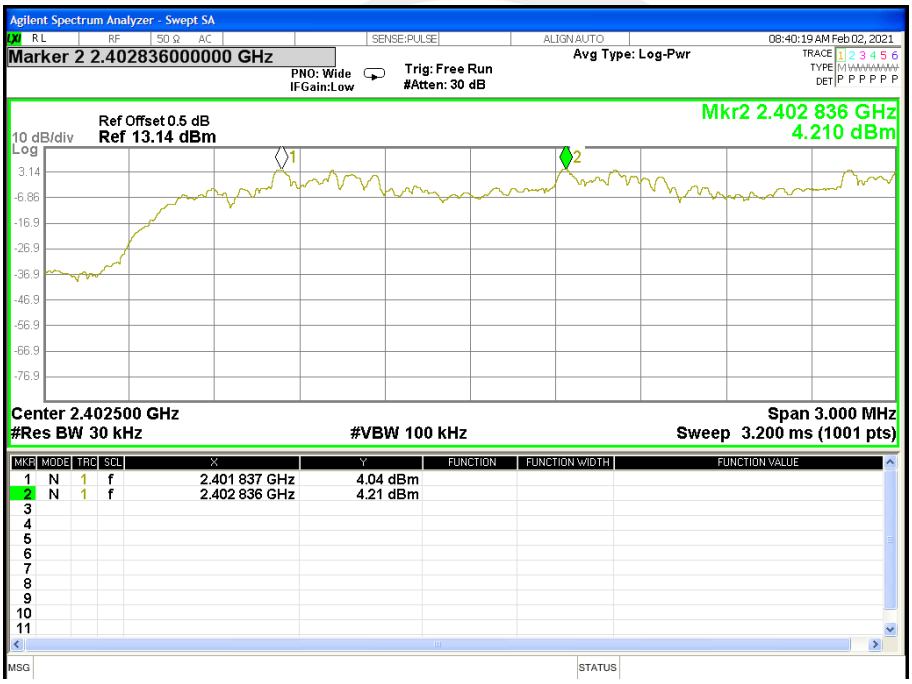


Temperature:	25℃	Relative Humidity:	50%
Test Mode:	CH00 / CH39 / CH78 (8DPSK(3Mbps)Mode)	Test Voltage:	DC 3.8V

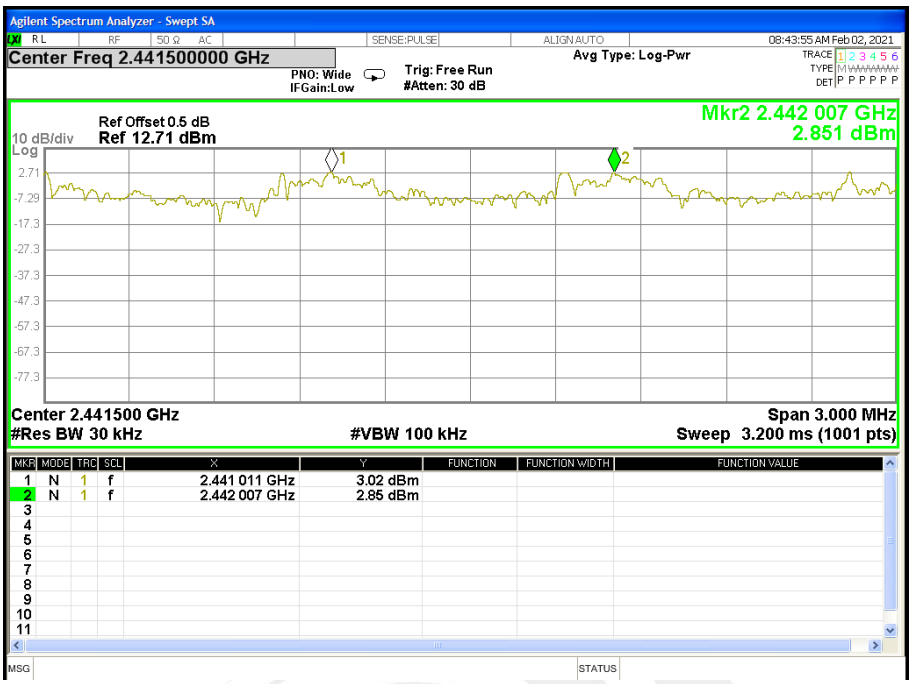
Frequency	Mark1 Frequency （MHz）	Mark2 Frequency （MHz）	Ch. Separation (MHz)	Limit (MHz)	Result
2402 MHz	2401.837	2402.836	0.999	0.841	Complies
2441 MHz	2441.011	2442.007	0.996	0.841	Complies
2480 MHz	2478.831	2479.848	1.017	0.843	Complies

For 8DPSK(3Mbps):Ch. Separation Limits: > two-thirds 20dB bandwidth

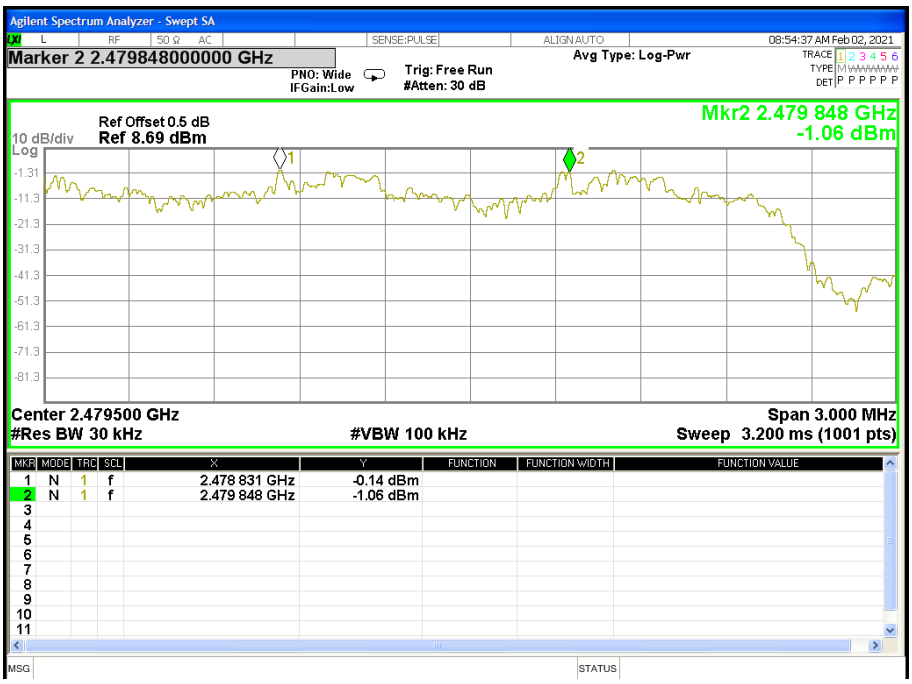
CH00 -3Mbps



CH39 -3Mbps



CH78 -3Mbps



8. BANDWIDTH TEST

8.1 LIMIT

FCC Part15 15.247,Subpart C				
Section	Test Item	Limit	FrequencyRange (MHz)	Result
15.247 (a)(1)	Bandwidth	N/A	2400-2483.5	PASS

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	> Measurement Bandwidth or Channel Separation
RB	30 kHz (20dB Bandwidth) / 30 kHz (Channel Separation)
VB	100 kHz (20dB Bandwidth) / 100 kHz (Channel Separation)
Detector	Peak
Trace	Max Hold
Sweep Time	Auto

8.2 TEST PROCEDURE

a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below.
b. Spectrum Setting: RBW= 30KHz, VBW=100KHz, Sweep time = Auto.

8.3 TEST SETUP

8.4 EUT OPERATION CONDITIONS

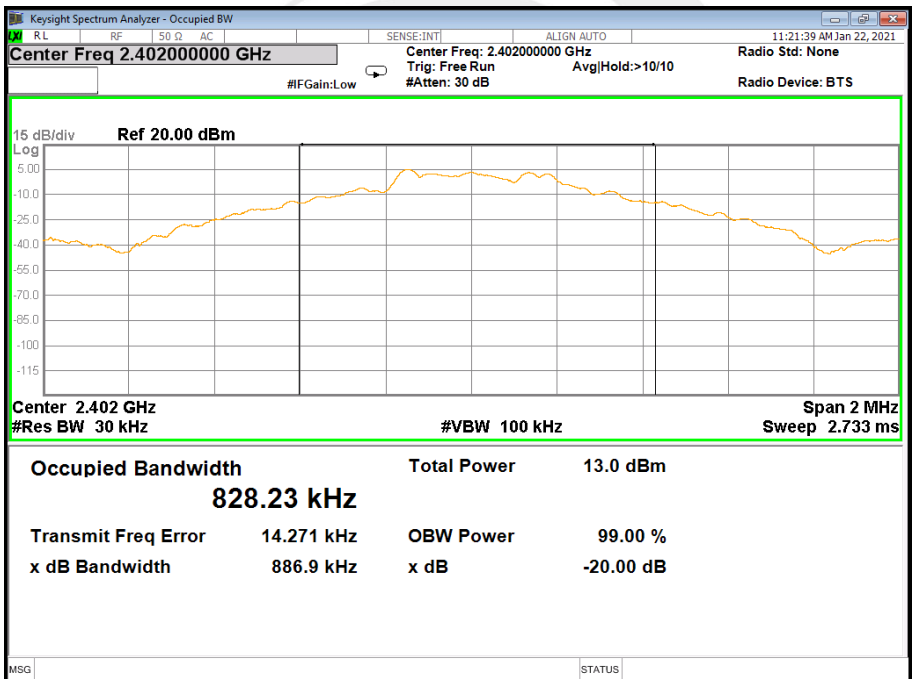
Please refer to section 3.1.4 of this report.

8.5 TEST RESULTS

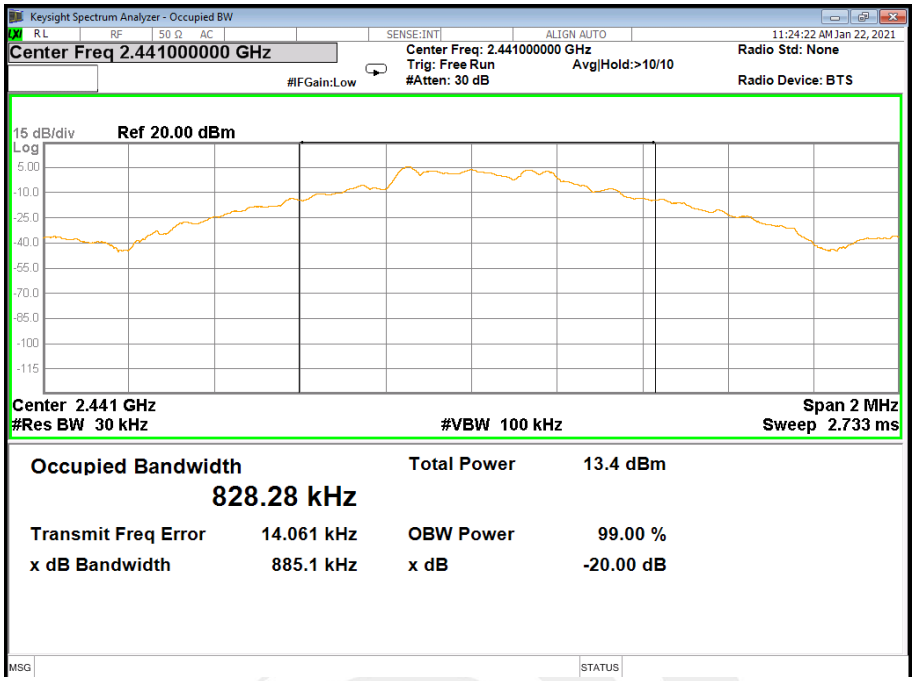
Temperature:	25℃	Relative Humidity:	50%
Test Mode:	GFSK(1Mbps) CH00 / CH39 / C78	Test Voltage:	DC 3.8V

Frequency	20dB Bandwidth (MHz)	Result
2402 MHz	0.8869	PASS
2441 MHz	0.8851	PASS
2480 MHz	0.8865	PASS

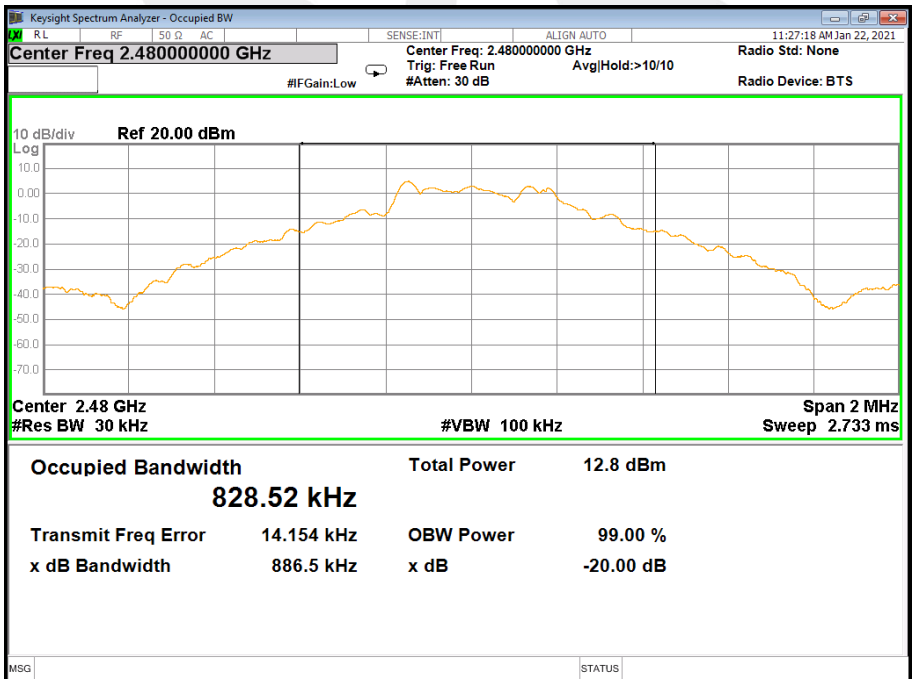
CH00 -1Mbps



CH39 -1Mbps



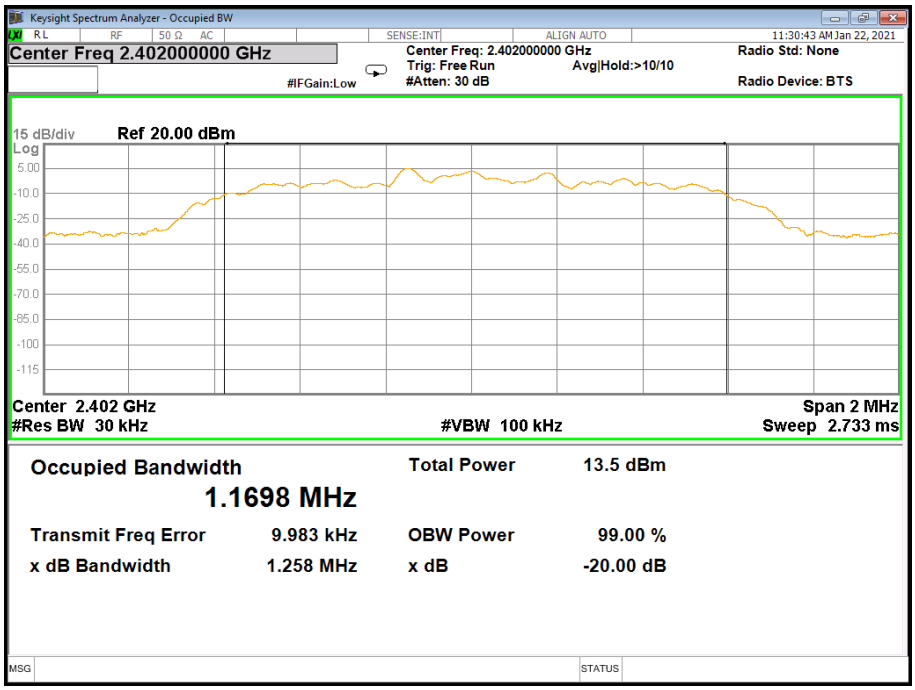
CH78 -1Mbps



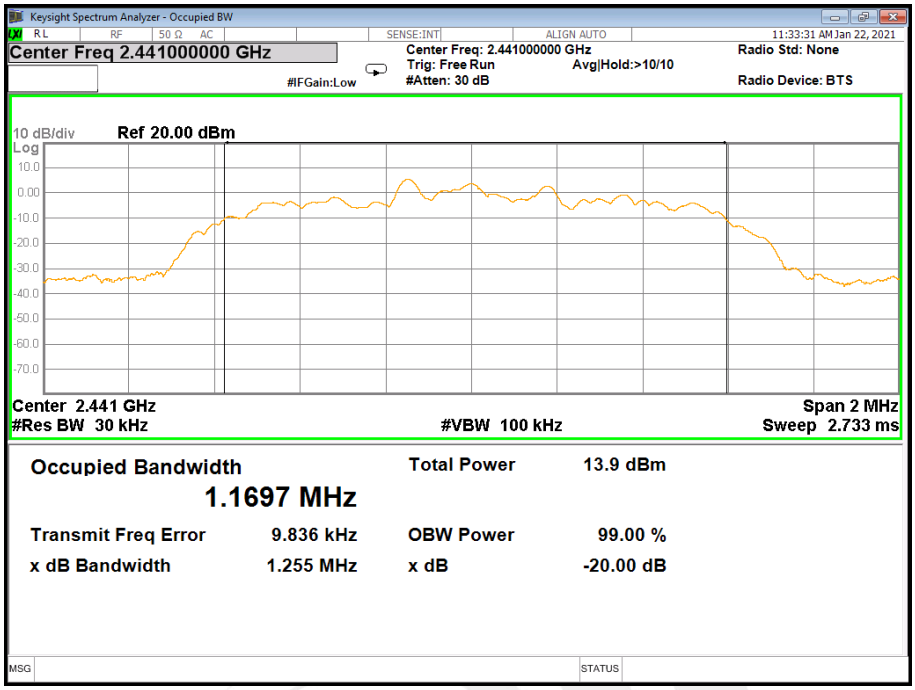
Temperature:	25℃	Relative Humidity:	50%
Test Mode:	π/4-DQPSK(2Mbps) CH00 / CH39 / C78	Test Voltage:	DC 3.8V

Frequency	20dB Bandwidth (MHz)	Result
2402 MHz	1.258	PASS
2441 MHz	1.255	PASS
2480 MHz	1.256	PASS

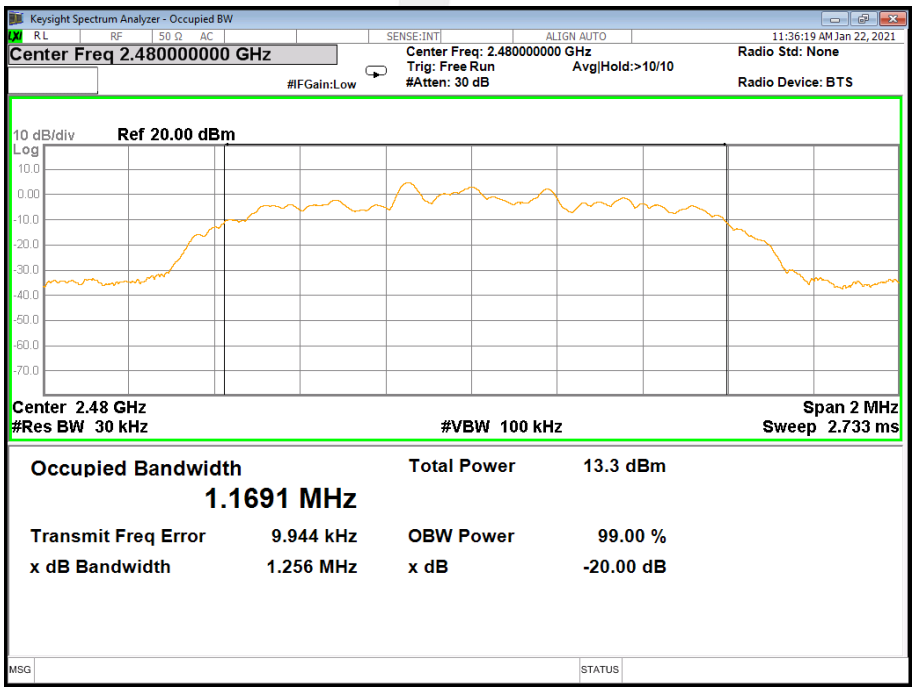
CH00 -2Mbps



CH39 -2Mbps



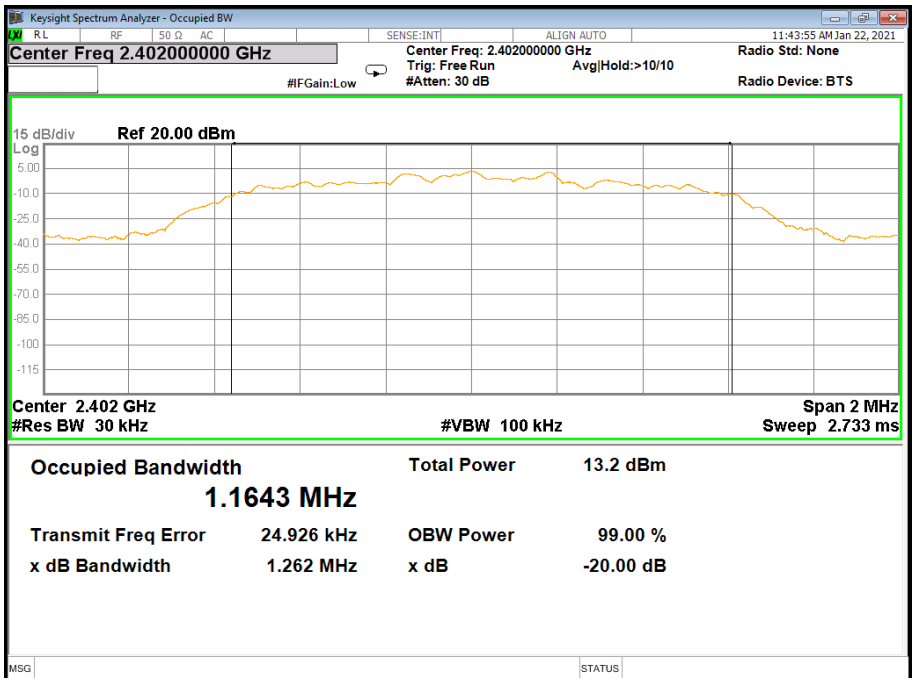
CH78 -2Mbps



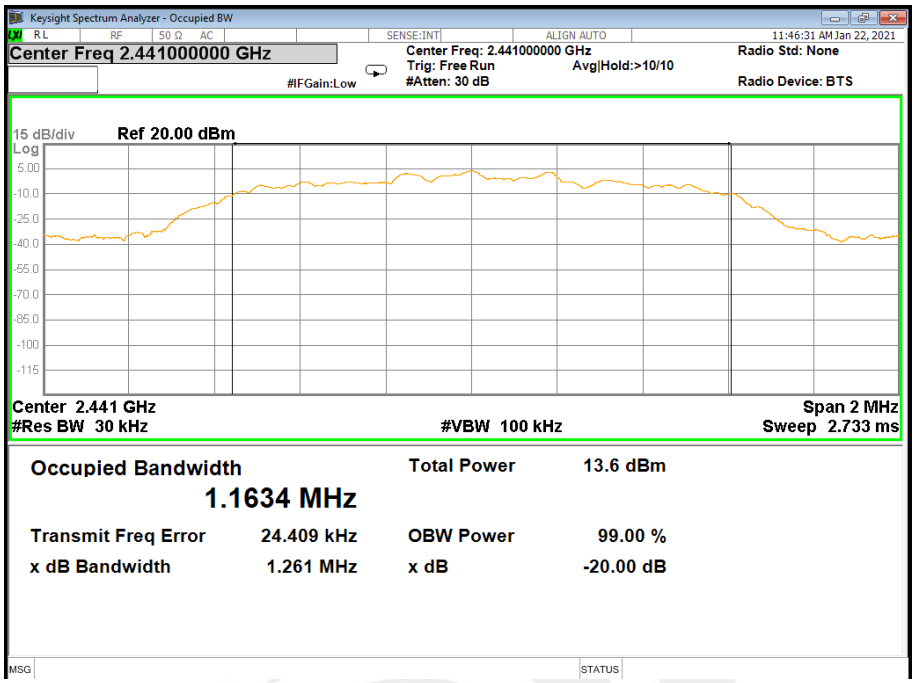
Temperature:	25℃	Relative Humidity:	50%
Test Mode:	8DPSK(3Mbps) CH00 / CH39 / CH78	Test Voltage:	DC 3.8V

Frequency	20dB Bandwidth (MHz)	Result
2402 MHz	1.262	PASS
2441 MHz	1.261	PASS
2480 MHz	1.264	PASS

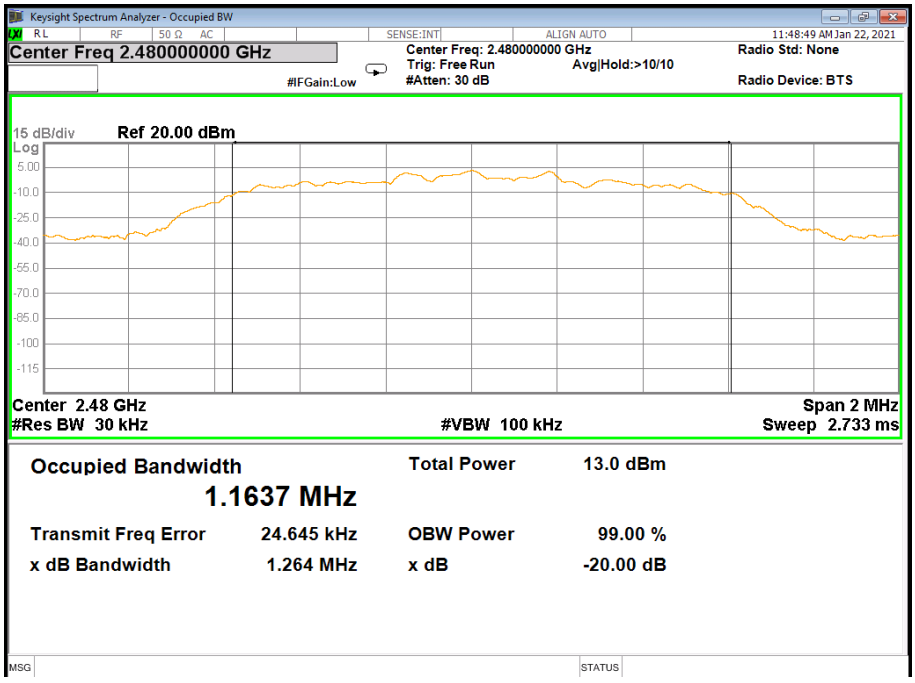
CH00 -3Mbps



CH39 -3Mbps



CH78 -3Mbps



9. OUTPUT POWER TEST

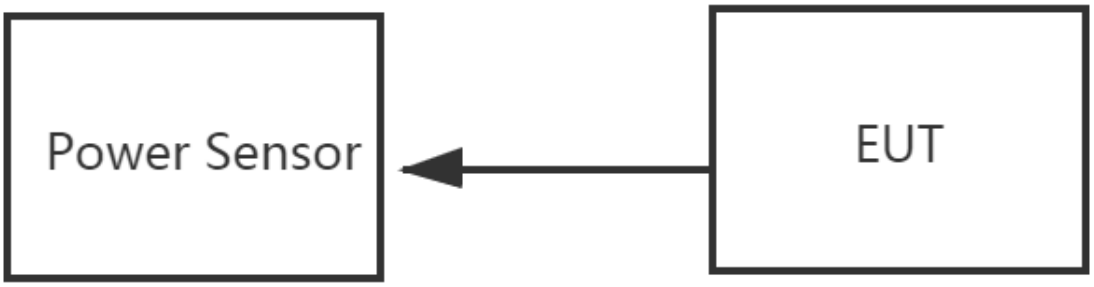
9.1 LIMIT

FCC Part 15.247,Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247 (a)(1)&(b)(1)	Output Power	1 W or 0.125W if channel separation > 2/3 bandwidthprovided thesystems operatewith an output power no greater than125 mW(20.97dBm)	2400-2483.5	PASS

9.2 TEST PROCEDURE

This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test:
a) Use the following spectrum analyzer settings:
1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
2) RBW > 20 dB bandwidth of the emission being measured.
3) VBW ≥ RBW.
4) Sweep: Auto.
5) Detector function: Peak.
6) Trace: Max hold.
b) Allow trace to stabilize.
c) Use the marker-to-peak function to set the marker to the peak of the emission.
d) The indicated level is the peak output power, after any corrections for external attenuators and cables.
e) A plot of the test results and setup description shall be included in the test report.
NOTE—A peak responding power meter may be used, where the power meter and sensor system video bandwidth is greater than the occupied bandwidth of the unlicensed wireless device, rather than a spectrum analyzer.
PKPM1 Peak power meter method:
The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DSS bandwidth and shall use a fast-responding diode detector.

9.3 TEST SETUP



9.4 EUT OPERATION CONDITIONS

Please refer to section 3.1.4 of this report.

9.5 TEST RESULTS

Temperature:	25℃	Relative Humidity:	60%
Test Voltage:	DC 3.8V		

Mode	Channel Number	Frequency (MHz)	Peak Power (dBm)	Average Power (dBm)	Limit (dBm)
GFSK(1M)	0	2402	6.77	2.81	30.00
	39	2441	6.86	2.76	30.00
	78	2480	6.80	2.89	30.00

Note: the channel separation >20dB bandwidth

Mode	Channel Number	Frequency (MHz)	Peak Power (dBm)	Average Power (dBm)	Limit (dBm)
π/4-DQPSK(2M)	0	2402	6.65	2.23	20.97
	39	2441	6.75	2.77	20.97
	78	2480	6.70	2.64	20.97

Note: the channel separation >2/3 20dB bandwidth

Mode	Channel Number	Frequency (MHz)	Peak Power (dBm)	Average Power (dBm)	Limit (dBm)
8-DPSK(3M)	0	2402	6.65	2.59	20.97
	39	2441	6.73	2.77	20.97
	78	2480	6.67	2.78	20.97

Note: the channel separation >2/3 20dB bandwidth

10. ANTENNA REQUIREMENT

10.1 STANDARD REQUIREMENT

15.203 requirement: For intentional device, according to 15.203: 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.

10.2 EUT ANTENNA

The EUT antenna is PIFA Antenna. It comply with the standard requirement.

APPENDIX-PHOTOS OF TEST SETUP

Note: See test photos in setup photo document for the actual connections between Product and support equipment.

※※※※※END OF THE REPORT※※※※※