For Hopping Band edge

00 CH

78 CH

Right earphone

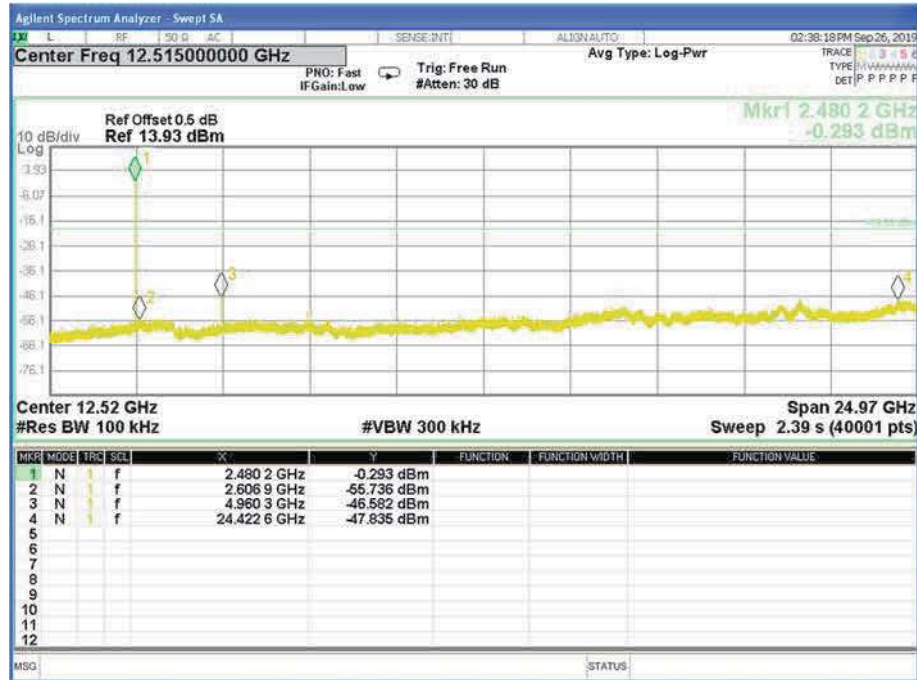00 CH
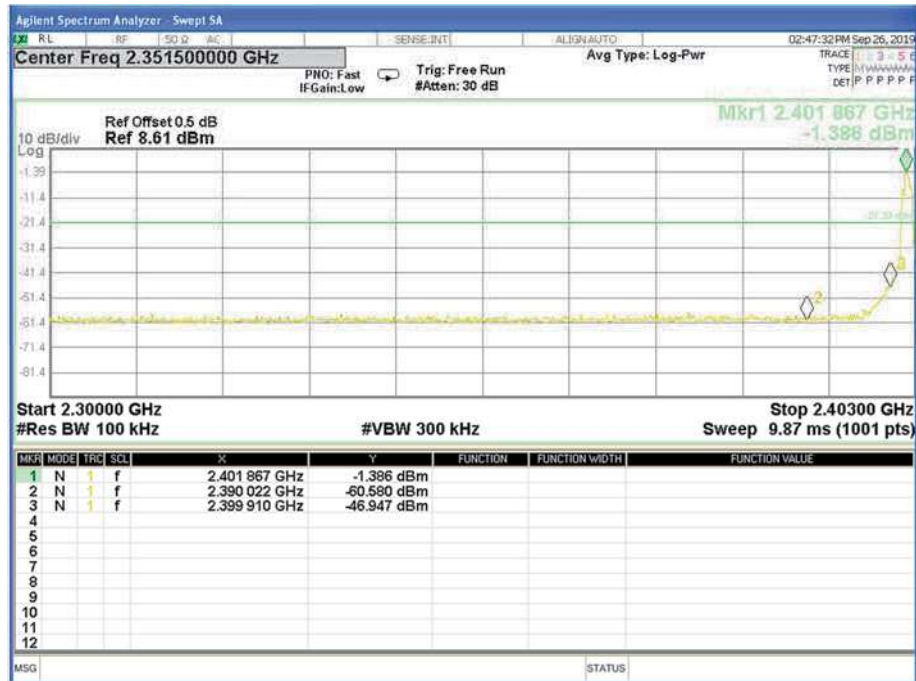

39 CH

78 CH

For Band edge

00 CH

39 CH

78 CH

For Hopping Band edge

00 CH

78 CH

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
The EUT tested system was configured as the statements of 2.4 Unless otherwise a special operating condition is specified in the follows during the testing.

5.5 TEST RESULTS

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

Left

Number of Hopping Channel   79
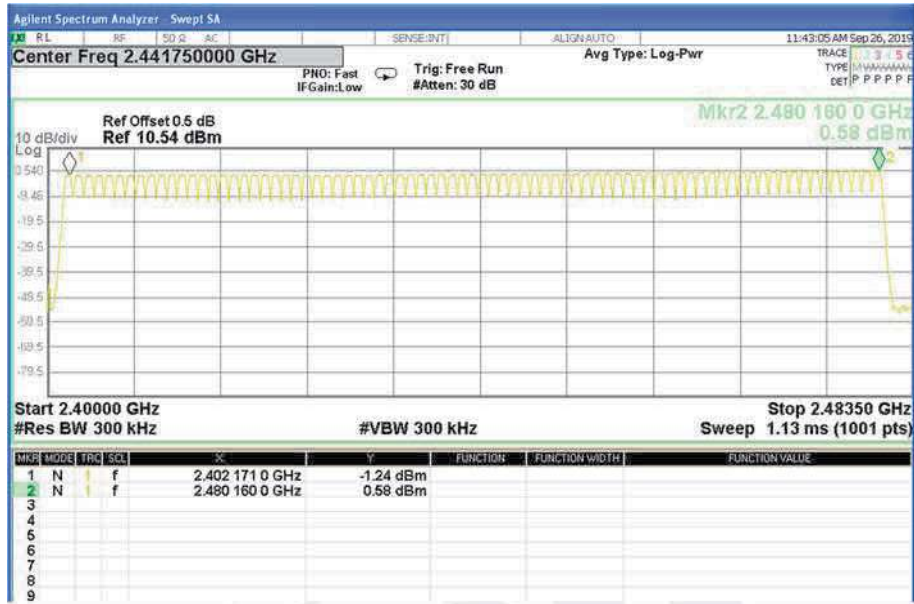
Hopping channel

Right

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). Sothe dwell time is the time duration of the pulse times 3.37 x 31.6 = 106.6 within 31.6 seconds.

j. DH3 Packet permit maximum 1600 / 79 / 4 = 5.06 hops per second in each channel (3 time slots RX, 1 time slot TX). Sothe dwell time is the time duration of the pulse times 5.06 x 31.6 = 160 within 31.6 seconds.

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 dwell time is the time duration of the pulse times 10.12 x 31.6 = 320 within 31.6 seconds.

6.3 TEST SETUP

6.4 EUT OPERATION CONDITIONS

The EUT tested system was configured as the statements of 2.4 Unless otherwise a special operating condition is specified in the follows during the testing.

6.5 TEST RESULTS

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

Left

Data Packet	Channel	pulse time(ms)	Dwell Time(s)	Limits(s)
DH1	middle	0.397	0.127	0.4
DH3	middle	1.654	0.265	0.4
DH5	middle	2.904	0.310	0.4

CH39-DH1
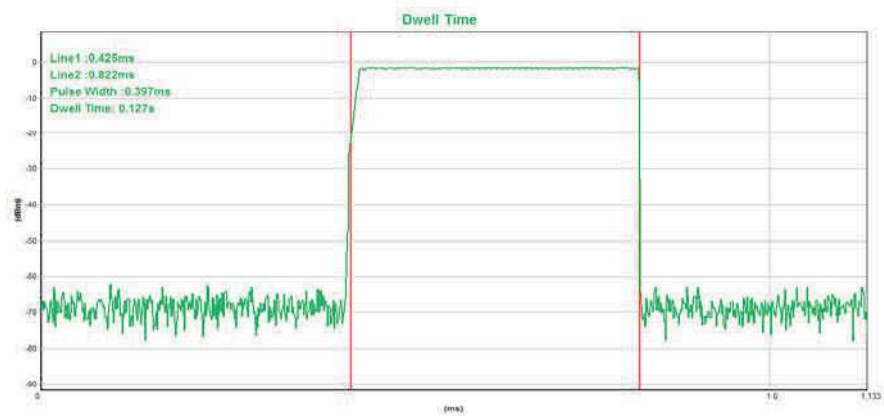
CH39-DH3
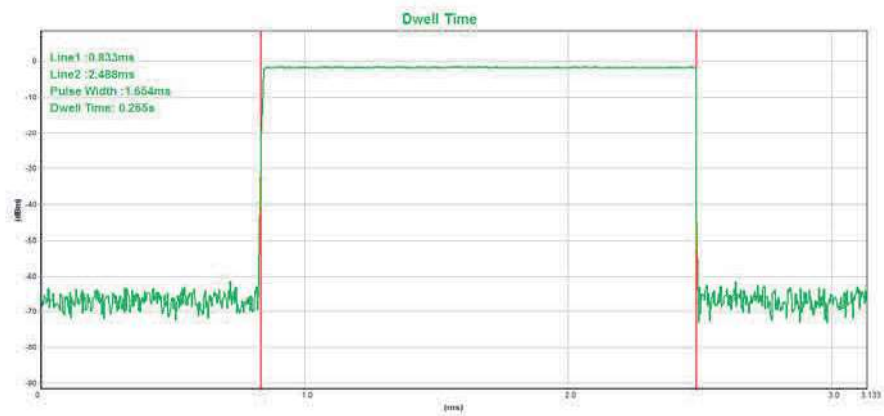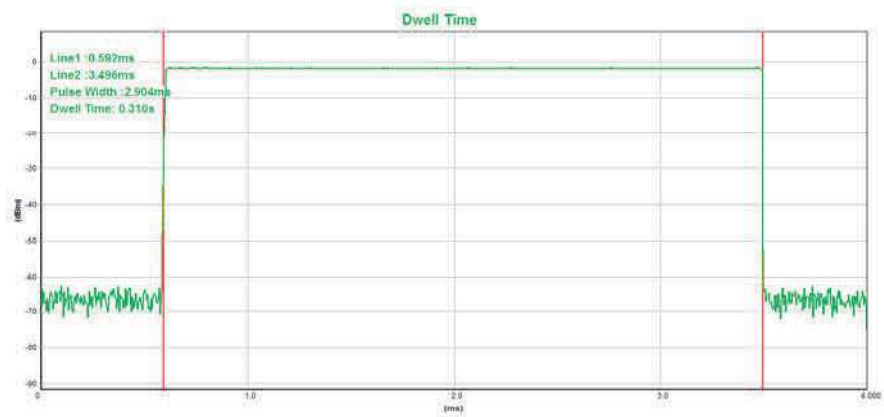
CH39-DH5

Right

Data Packet	Channel	pulse time(ms)	Dwell Time(s)	Limits(s)
DH1	middle	0.396	0.127	0.4
DH3	middle	1.654	0.265	0.4
DH5	middle	2.907	0.310	0.4

CH39-DH1
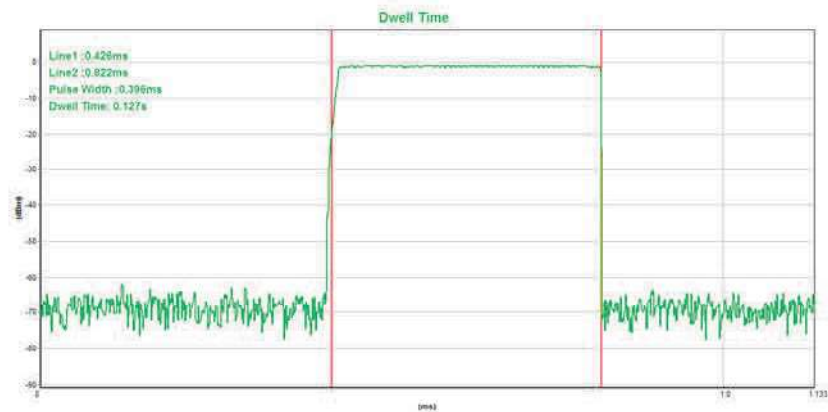
CH39-DH3
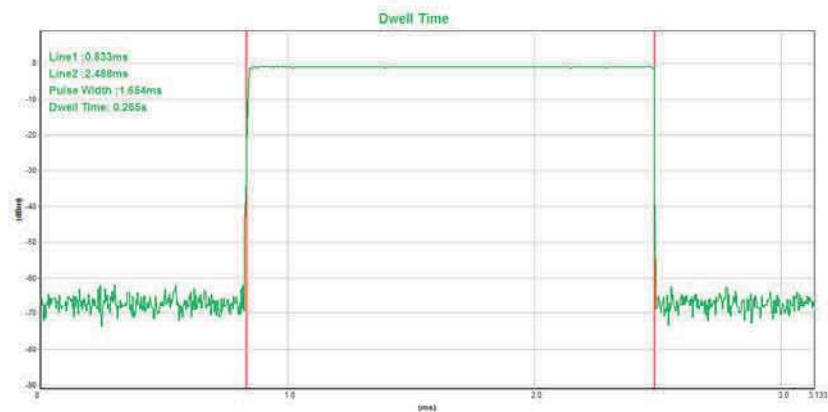
CH39-DH5
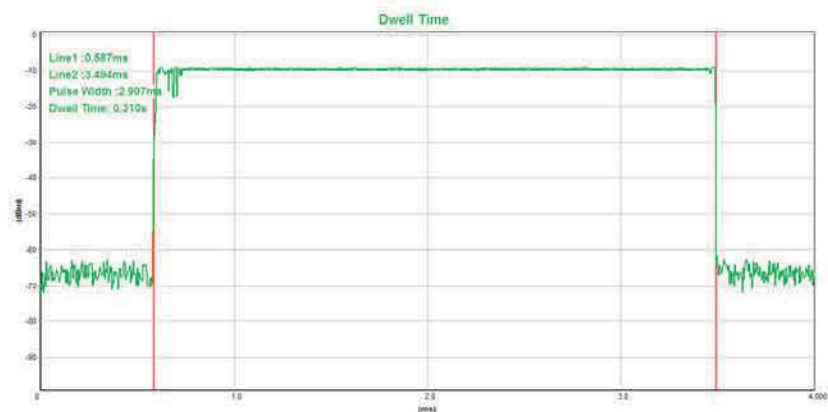
Temperature:	25℃	Relative Humidity:	50%
Test Mode:	π/4-DQPSK(2Mbps)–2DH1/2DH3/2DH5	Test Voltage:	DC 3.8V from battery

Left

Data Packet	Channel	pulse time(ms)	Dwell Time(s)	Limits(s)
2DH1	middle	0.407	0.130	0.4
2DH3	middle	1.659	0.265	0.4
2DH5	middle	2.652	0.283	0.4

CH39-2DH1
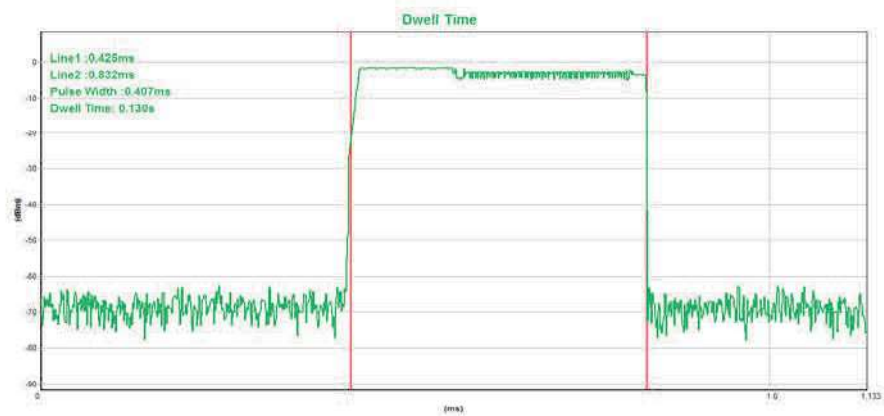
CH39-2DH3
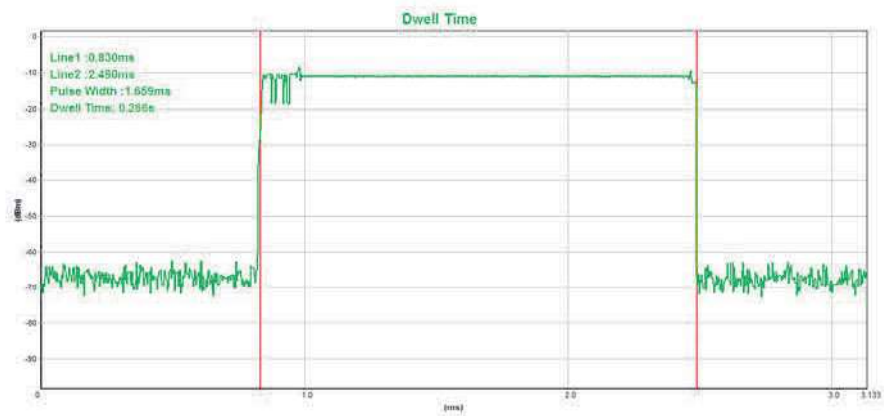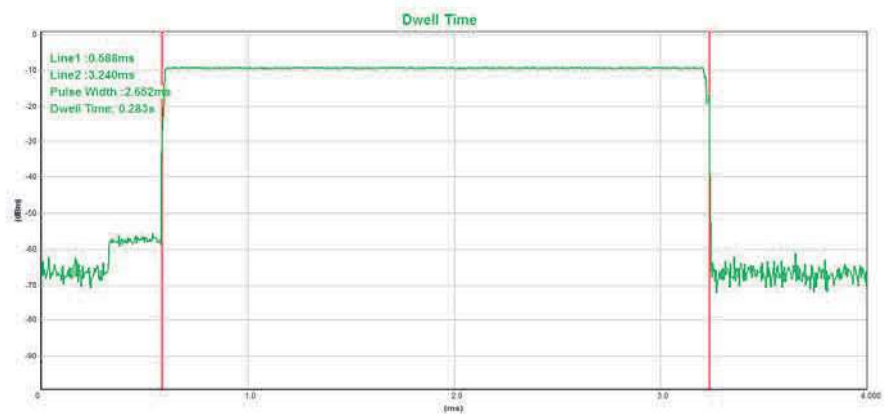
CH39-2DH5

Right

Data Packet	Channel	pulse time(ms)	Dwell Time(s)	Limits(s)
2DH1	middle	0.404	0.129	0.4
2DH3	middle	1.658	0.265	0.4
2DH5	middle	2.906	0.310	0.4

CH39-2DH1
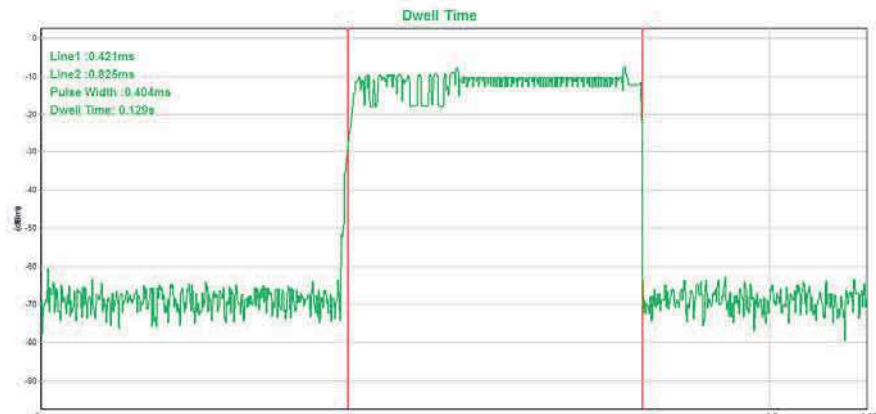
CH39-2DH3
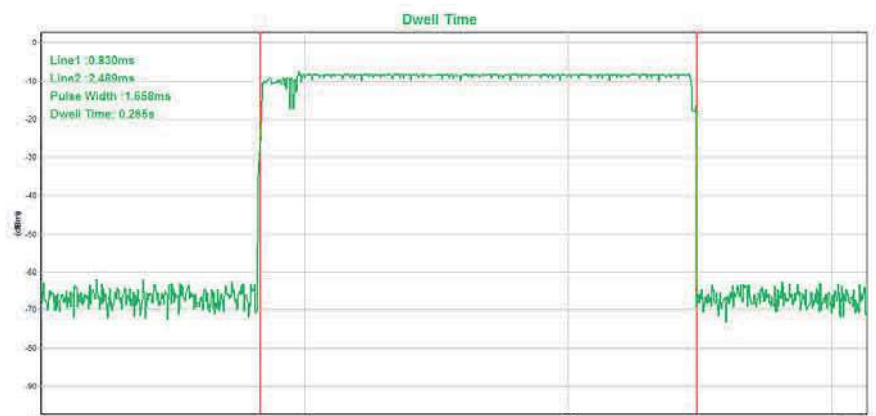
CH39-2DH5

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

Left

Data Packet	Channel	pulse time(ms)	Dwell Time(s)	Limits(s)
3DH1	middle	0.409	0.131	0.4
3DH3	middle	1.659	0.265	0.4
3DH5	middle	2.917	0.311	0.4

CH39-3DH1
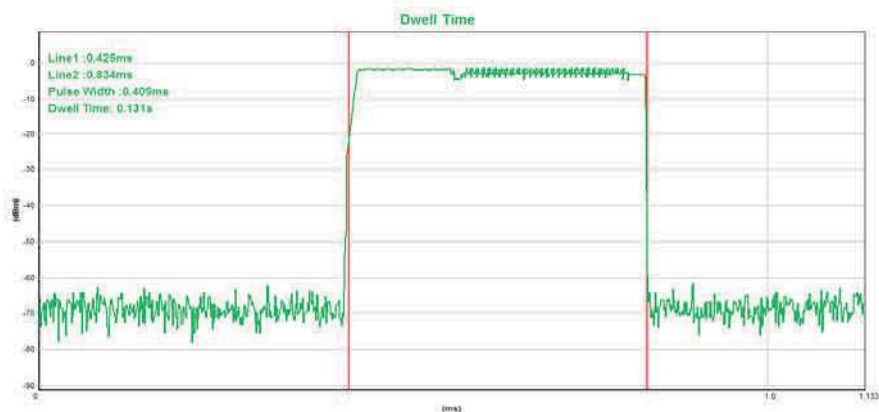
CH39-3DH3
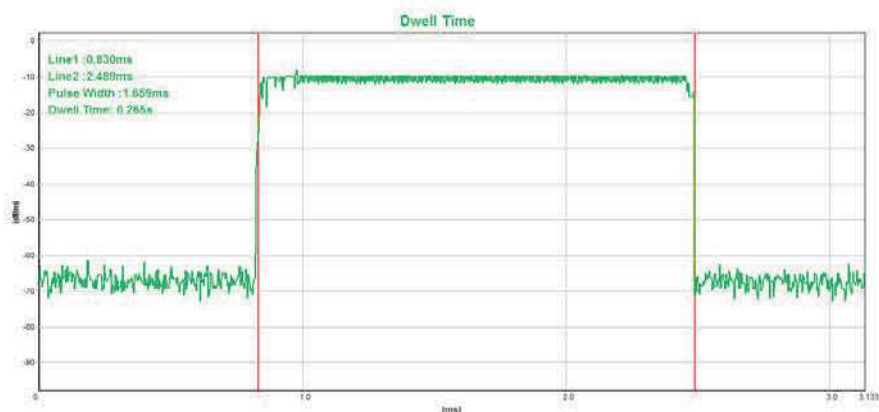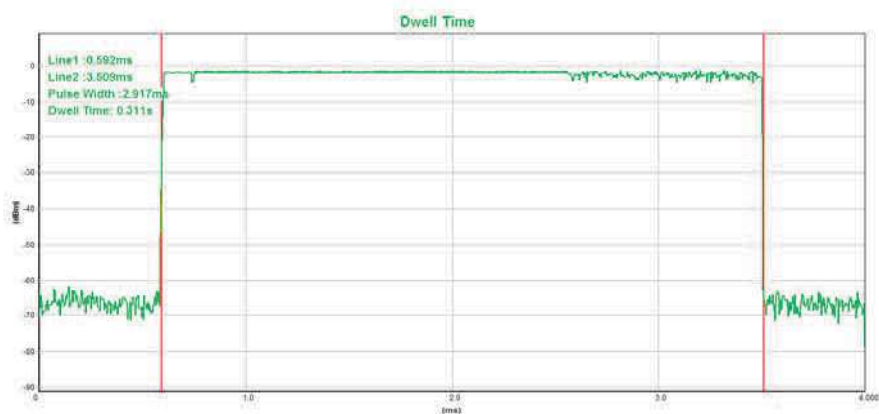
CH39-3DH5

Right

Data Packet	Channel	pulse time(ms)	Dwell Time(s)	Limits(s)
3DH1	middle	0.408	0.131	0.4
3DH3	middle	1.660	0.266	0.4
3DH5	middle	2.908	0.310	0.4

CH39-3DH1
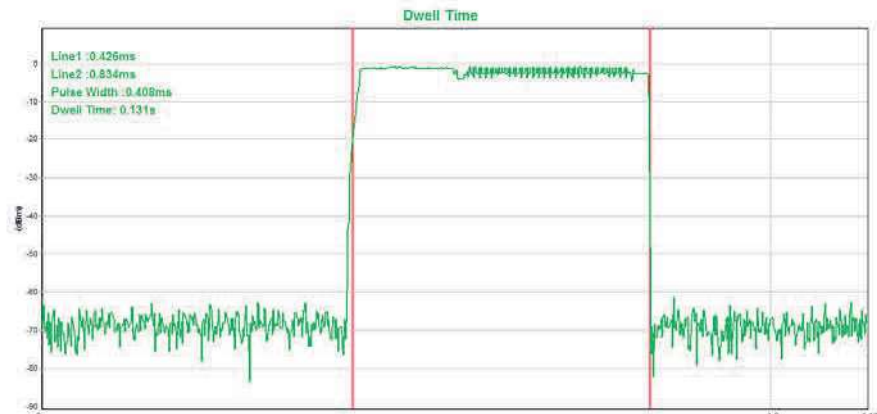
CH39-3DH3
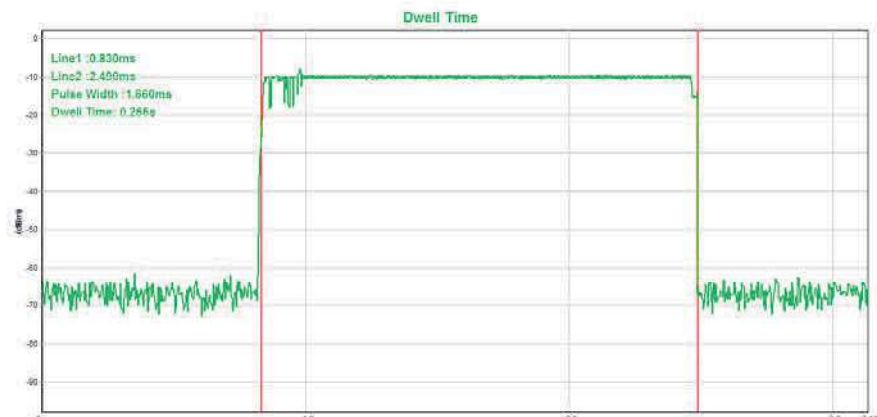
CH39-3DH5
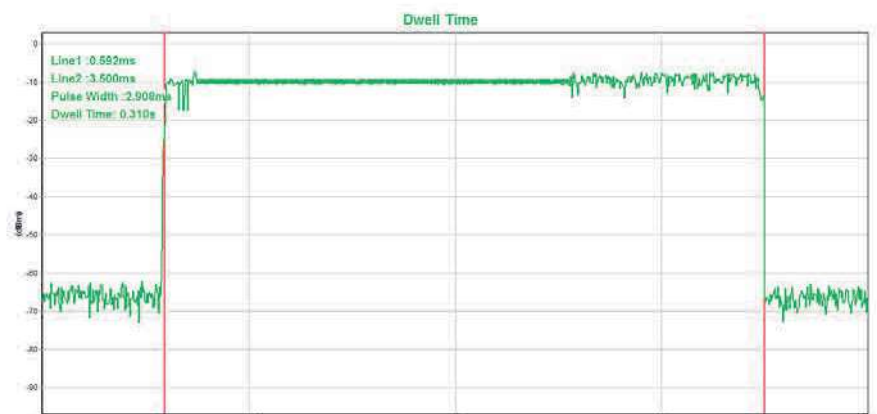
7. HOPPING CHANNEL SEPARATION MEASUREMEN

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

Spectrum Analayzer   EUT
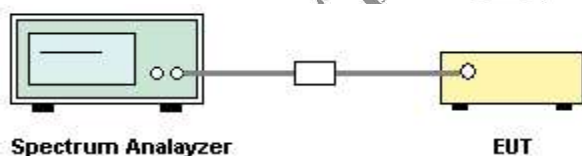
7.4 EUT OPERATION CONDITIONS

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 from battery

Left

Frequency	Mark1 Frequency （MHz）	Mark2 Frequency （MHz）	Ch. Separation (MHz)	Limit (MHz)	Result
2402 MHz	2401.846	2402.842	0.996	0.758	Complies
2441 MHz	2440.843	2441.845	1.002	0.757	Complies
2480 MHz	2478.843	2479.842	0.999	0.757	Complies

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

CH00 -1Mbps

CH39 -1Mbps

CH78 -1Mbps

Right

Frequency	Mark1 Frequency（MHz）	Mark2 Frequency（MHz）	Ch. Separation (MHz)	Limit (MHz)	Result
2402 MHz	2401.837	2402.836	0.999	0.851	Complies
2441 MHz	2440.837	2441.839	1.002	0.852	Complies
2480 MHz	2478.837	2479.836	0.999	0.850	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 from battery

Left

Frequency	Mark1 Frequency（MHz）	Mark2 Frequency（MHz）	Ch. Separation (MHz)	Limit (MHz)	Result
2402 MHz	2401.846	2402.845	0.999	0.849	Complies
2441 MHz	2440.843	2441.845	1.002	0.881	Complies
2480 MHz	2478.846	2479.845	0.999	0.882	Complies

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

CH00 -2Mbps

CH39 -2Mbps

CH78 -2Mbps

Right

Frequency	Mark1 Frequency （MHz）	Mark2 Frequency （MHz）	Ch. Separation (MHz)	Limit (MHz)	Result
2402 MHz	2401.837	2402.836	0.999	0.855	Complies
2441 MHz	2440.837	2441.836	0.999	0.853	Complies
2480 MHz	2478.837	2479.836	0.999	0.854	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 from battery

Left

Frequency	Mark1 Frequency （MHz）	Mark2 Frequency （MHz）	Ch. Separation (MHz)	Limit (MHz)	Result
2402 MHz	2401.840	2402.842	1.002	0.805	Complies
2441 MHz	2440.840	2441.842	1.002	0.802	Complies
2480 MHz	2478.843	2479.842	0.999	0.803	Complies

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

CH00 -3Mbps

CH39 -3Mbps

CH78 -3Mbps

Right

Frequency	Mark1 Frequency （MHz）	Mark2 Frequency （MHz）	Ch. Separation (MHz)	Limit (MHz)	Result
2402 MHz	2401.837	2402.839	1.002	0.797	Complies
2441 MHz	2440.837	2441.839	1.002	0.769	Complies
2480 MHz	2478.837	2479.836	0.999	0.799	Complies

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

CH00 -3Mbps

CH39 -3Mbps
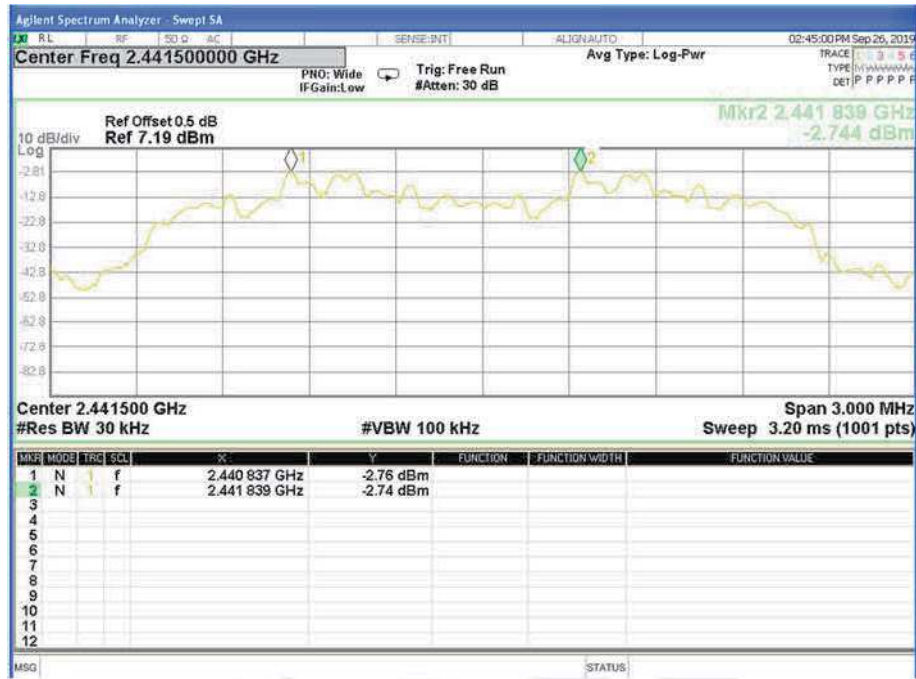
CH78 -3Mbps

8. BANDWIDTH TEST

8.1 LIMIT

FCC Part15 15.247,Subpart C				
Section	Test Item	Limit	FrequencyRange (MHz)	Result
15.247 (a)(1)	Bandwidth	(20dB bandwidth)	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

The EUT tested system was configured as the statements of 2.4 Unless otherwise a special operating condition is specified in the follows during the testing.

8.5 TEST RESULTS

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

Left

Frequency	20dB Bandwidth (MHz)	Result
2402 MHz	0.758	PASS
2441 MHz	0.757	PASS
2480 MHz	0.757	PASS

CH00 -1Mbps

CH39 -1Mbps

Occupied Bandwidth		Total Power	3.72 dBm
765.20 kHz			
Transmit Freq Error	-1.914 kHz	OBW Power	99.00 %
x dB Bandwidth	756.6 kHz	x dB	-20.00 dB

CH78 -1Mbps

Occupied Bandwidth		Total Power	5.33 dBm
765.65 kHz			
Transmit Freq Error	-1.182 kHz	OBW Power	99.00 %
x dB Bandwidth	756.7 kHz	x dB	-20.00 dB
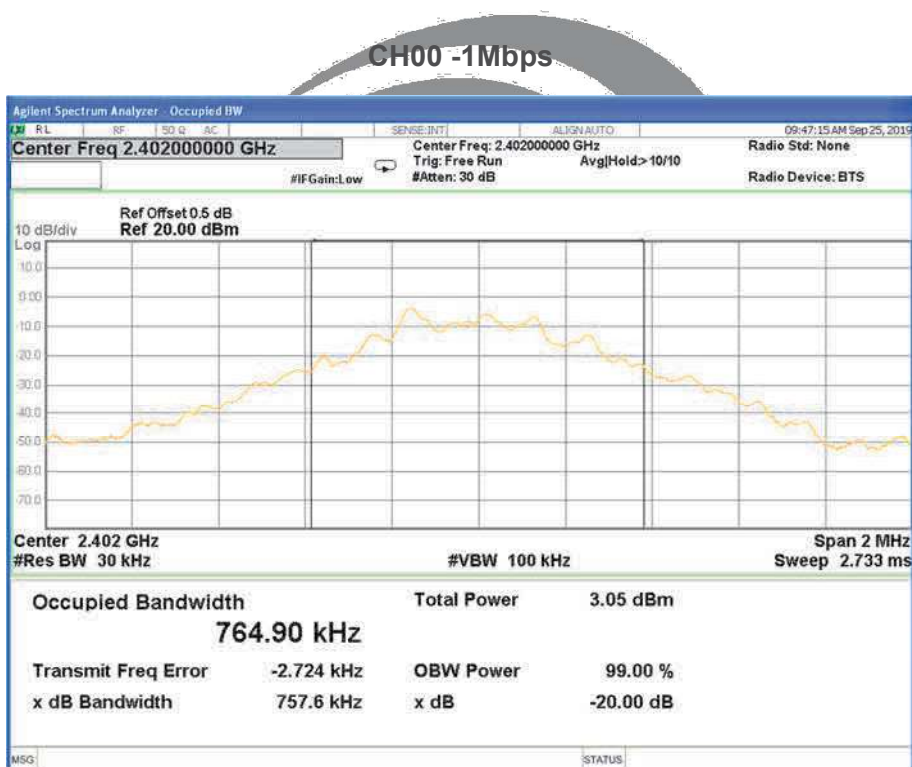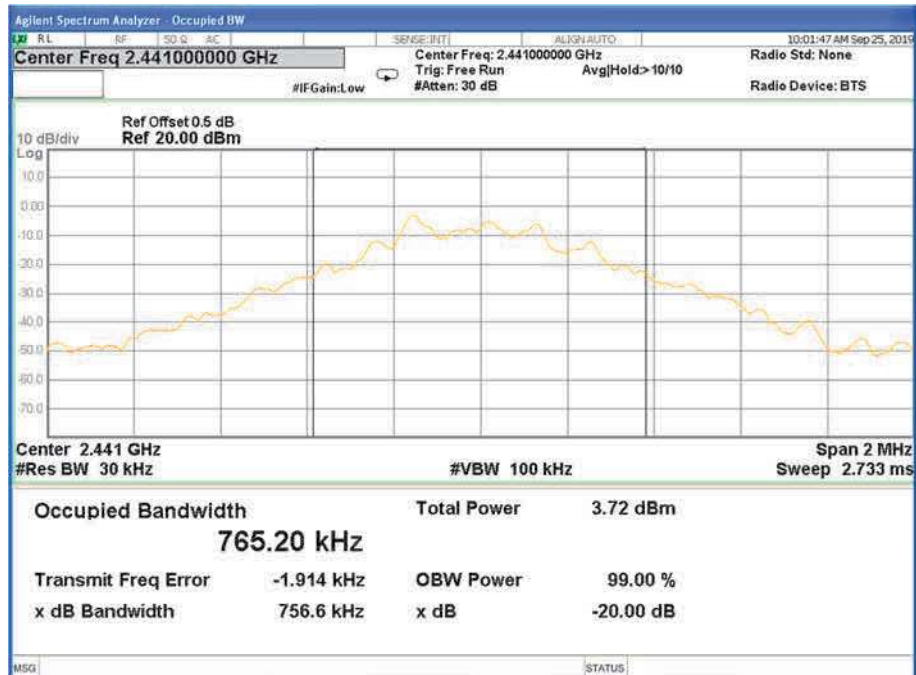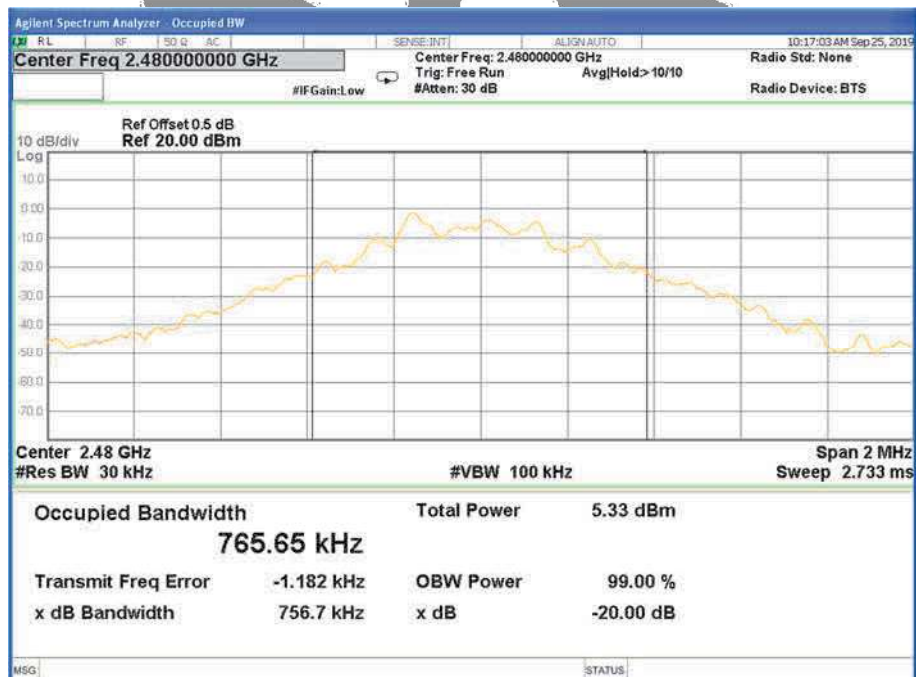
Right

Frequency	20dB Bandwidth (MHz)	Result
2402 MHz	0.851	PASS
2441 MHz	0.852	PASS
2480 MHz	0.850	PASS

CH00 -1Mbps

CH39 -1Mbps

Occupied Bandwidth		Total Power	4.89 dBm
797.66 kHz			
Transmit Freq Error	9.920 kHz	OBW Power	99.00 %
x dB Bandwidth	851.8 kHz	x dB	-20.00 dB

CH78 -1Mbps

Occupied Bandwidth		Total Power	6.31 dBm
804.08 kHz			
Transmit Freq Error	11.083 kHz	OBW Power	99.00 %
x dB Bandwidth	850.1 kHz	x dB	-20.00 dB
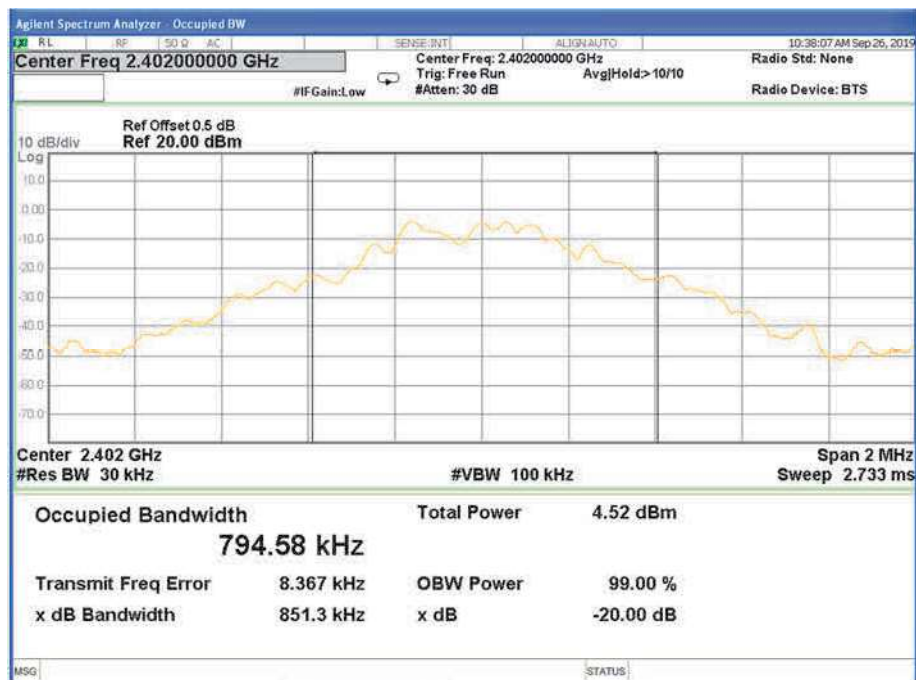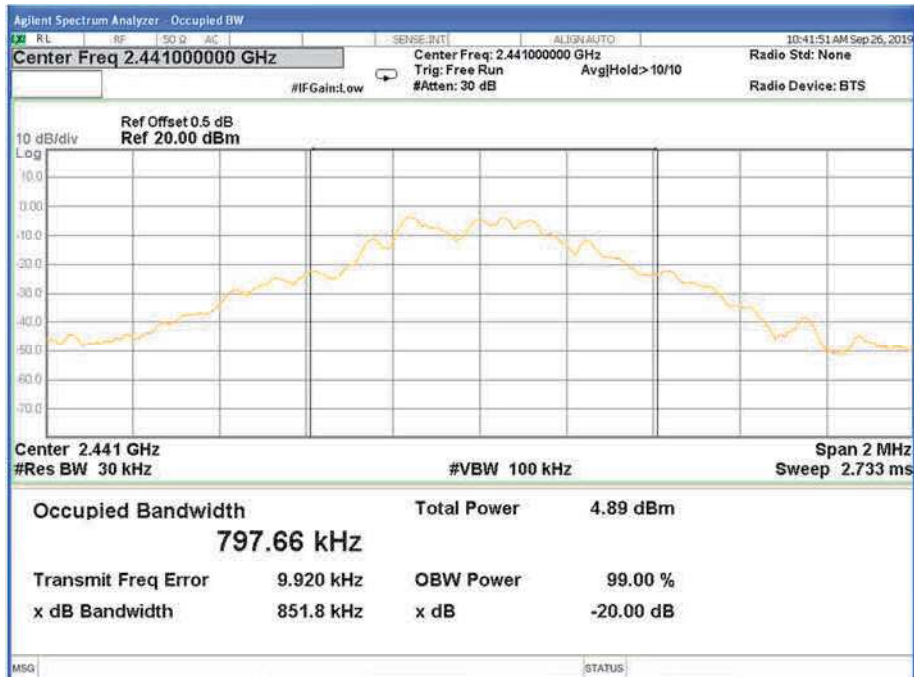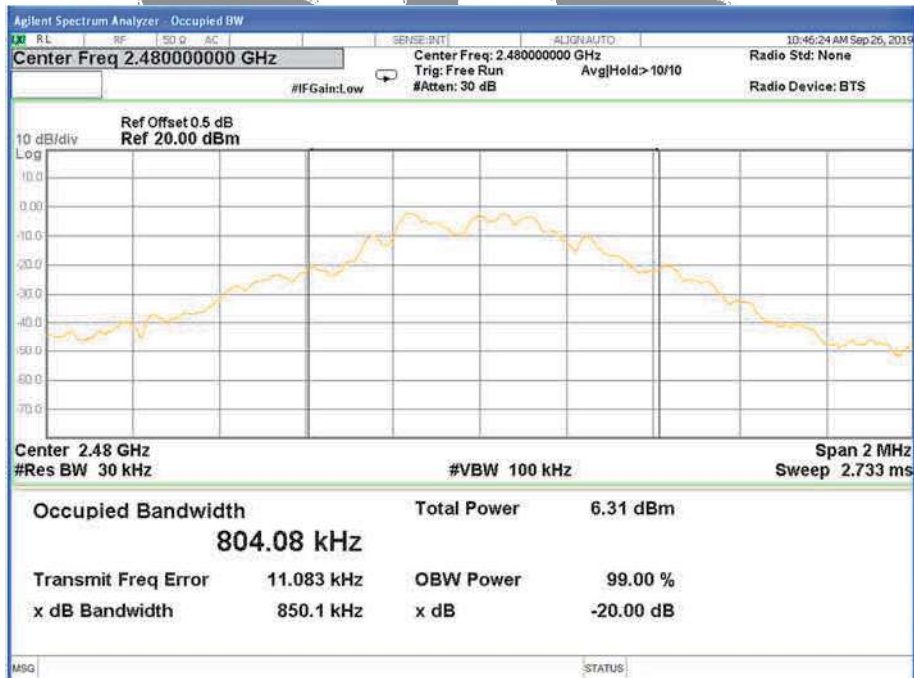
Temperature:	25℃	Relative Humidity:	50%
Test Mode:	π/4-DQPSK(2Mbps) CH00 / CH39 / C78	Test Voltage:	DC 3.8V from battery

Left

Frequency	20dB Bandwidth (MHz)	Result
2402 MHz	1.274	PASS
2441 MHz	1.273	PASS
2480 MHz	1.280	PASS

CH00 -2Mbps

CH39 -2Mbps

Agilent Spectrum Analyzer - Occupied BW

LXI R L   RF   50 Ω   AC   SENSE:INT   ALIGN AUTO   11:02:30 AM Oct 25, 2019
Center Freq 2.441000000 GHz   Center Freq: 2.441000000 GHz   Radio Std: None
                                                    Trig: Free Run   Avg|Hold:>10/10
                        #IFGain:Low   #Atten: 30 dB   Radio Device: BTS

Ref Offset 0.5 dB
10 dB/div   **Ref 20.00 dBm**
Log
  10.0
  0.00
 -10.0
 -20.0
 -30.0
 -40.0
 -50.0
 -60.0
 -70.0

Center 2.441 GHz   Span 2 MHz
#Res BW 30 kHz   #VBW 100 kHz   Sweep 2.733 ms

Occupied Bandwidth		Total Power	5.60 dBm
1.1261 MHz			
Transmit Freq Error	17.094 kHz	OBW Power	99.00 %
x dB Bandwidth	1.273 MHz	x dB	-20.00 dB

MSG   STATUS

CH78 -2Mbps

Agilent Spectrum Analyzer - Occupied BW

LXI R L   RF   50 Ω   AC   SENSE:INT   ALIGN AUTO   11:07:24 AM Oct 25, 2019
Center Freq 2.480000000 GHz   Center Freq: 2.480000000 GHz   Radio Std: None
                                                    Trig: Free Run   Avg|Hold:>10/10
                        #IFGain:Low   #Atten: 30 dB   Radio Device: BTS

Ref Offset 0.5 dB
10 dB/div   **Ref 20.00 dBm**
Log
  10.0
  0.00
 -10.0
 -20.0
 -30.0
 -40.0
 -50.0
 -60.0
 -70.0

Center 2.48 GHz   Span 2 MHz
#Res BW 30 kHz   #VBW 100 kHz   Sweep 2.733 ms

Occupied Bandwidth		Total Power	6.70 dBm
1.1266 MHz			
Transmit Freq Error	20.238 kHz	OBW Power	99.00 %
x dB Bandwidth	1.280 MHz	x dB	-20.00 dB

MSG   STATUS

Right

Frequency	20dB Bandwidth (MHz)	Result
2402 MHz	1.282	PASS
2441 MHz	1.279	PASS
2480 MHz	1.281	PASS

CH00 -2Mbps

CH39 -2Mbps

Agilent Spectrum Analyzer - Occupied BW

R L	RF	50 Ω AC	SENSE:INT	ALIGN AUTO	02:19:36 PM Sep 26, 2019

Center Freq 2.441000000 GHz

Center Freq: 2.441000000 GHz   Radio Std: None
Trig: Free Run   Avg|Hold:>10/10
#IFGain:Low   #Atten: 30 dB   Radio Device: BTS

Ref Offset 0.5 dB
10 dB/div   **Ref 20.00 dBm**
Log

Center 2.441 GHz   Span 2 MHz
#Res BW 30 kHz   #VBW 100 kHz   Sweep 2.733 ms

Occupied Bandwidth		Total Power	5.07 dBm
1.1153 MHz			
Transmit Freq Error	-5.702 kHz	OBW Power	99.00 %
x dB Bandwidth	1.279 MHz	x dB	-20.00 dB

MSG   STATUS

CH78 -2Mbps

Agilent Spectrum Analyzer - Occupied BW

R L	RF	50 Ω AC	SENSE:INT	ALIGN AUTO	02:27:50 PM Sep 26, 2019

Center Freq 2.480000000 GHz

Center Freq: 2.480000000 GHz   Radio Std: None
Trig: Free Run   Avg|Hold:>10/10
#IFGain:Low   #Atten: 30 dB   Radio Device: BTS

Ref Offset 0.5 dB
10 dB/div   **Ref 20.00 dBm**
Log

Center 2.48 GHz   Span 2 MHz
#Res BW 30 kHz   #VBW 100 kHz   Sweep 2.733 ms

Occupied Bandwidth		Total Power	6.54 dBm
1.1209 MHz			
Transmit Freq Error	-4.940 kHz	OBW Power	99.00 %
x dB Bandwidth	1.281 MHz	x dB	-20.00 dB

MSG   STATUS

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

Left

Frequency	20dB Bandwidth (MHz)	Result
2402 MHz	1.207	PASS
2441 MHz	1.203	PASS
2480 MHz	1.205	PASS

CH00 -3Mbps

CH39 -3Mbps

Occupied Bandwidth	Total Power 5.24 dBm
1.1121 MHz	
Transmit Freq Error 1.763 kHz	OBW Power 99.00 %
x dB Bandwidth 1.203 MHz	x dB -20.00 dB

CH78 -3Mbps

Occupied Bandwidth	Total Power 6.34 dBm
1.1114 MHz	
Transmit Freq Error -2 Hz	OBW Power 99.00 %
x dB Bandwidth 1.205 MHz	x dB -20.00 dB
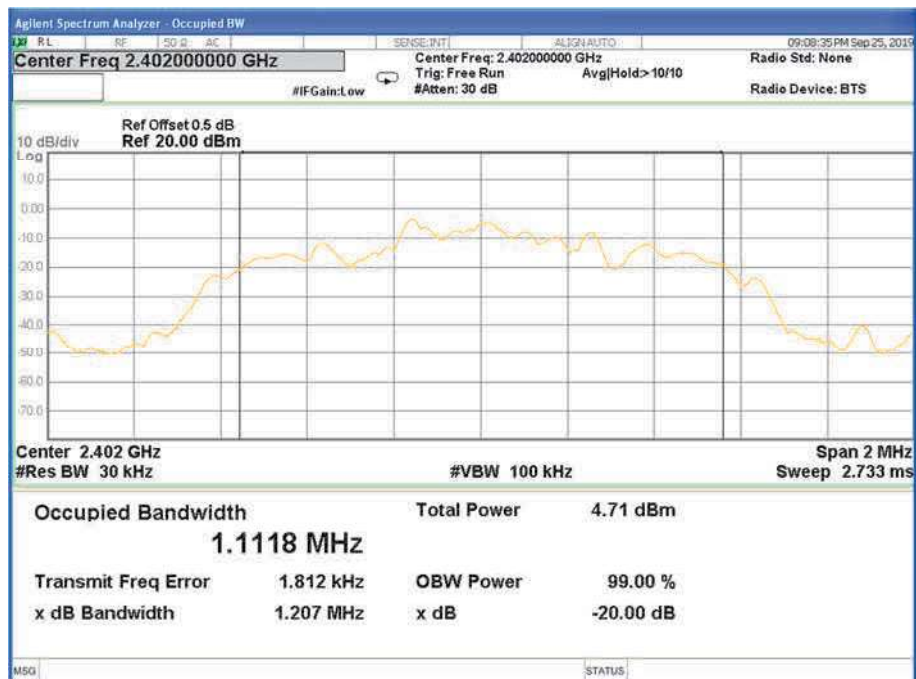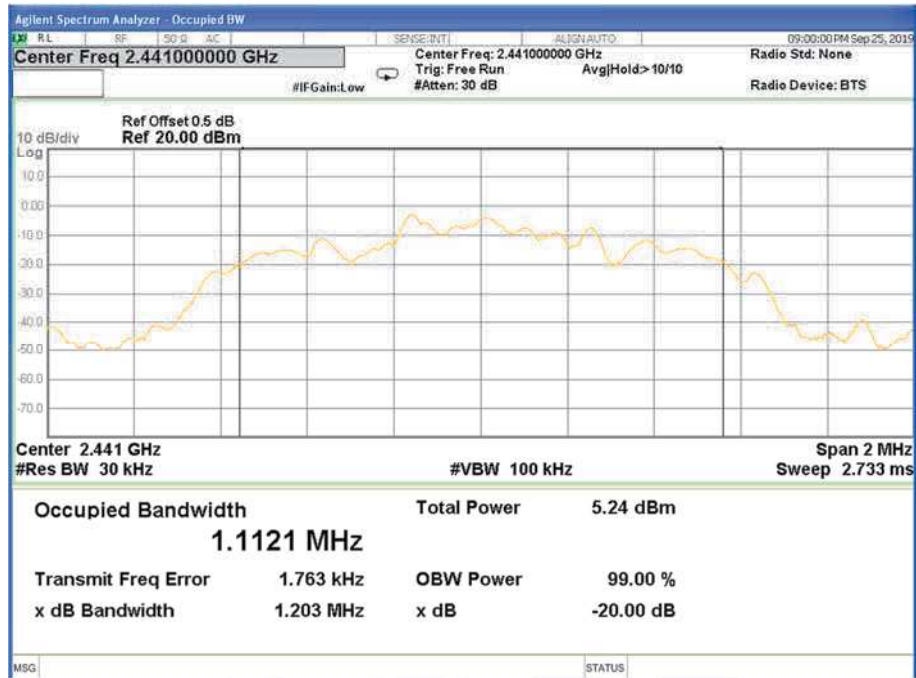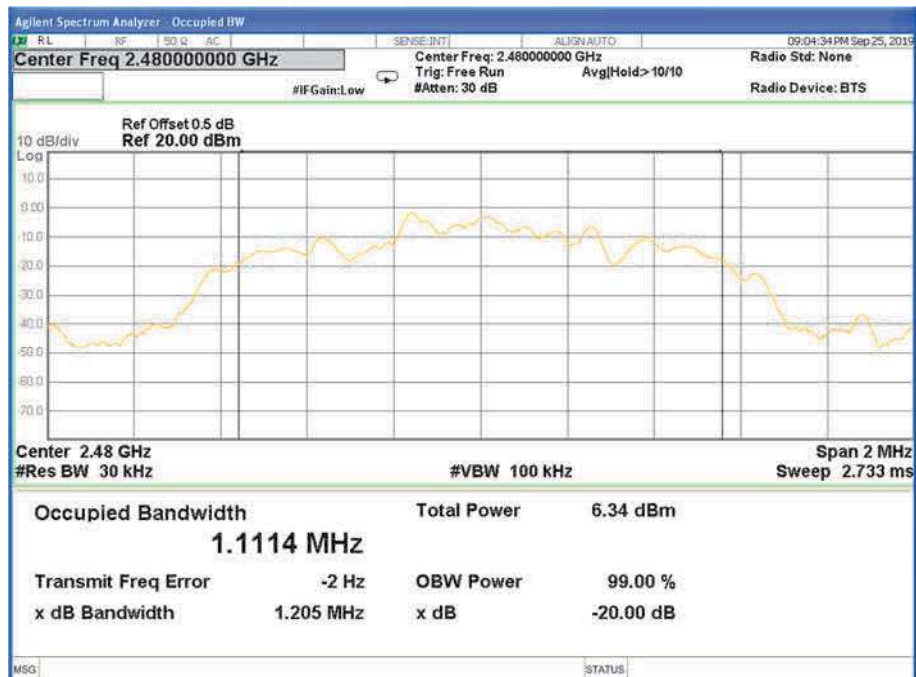
Right

Frequency	20dB Bandwidth (MHz)	Result
2402 MHz	1.196	PASS
2441 MHz	1.154	PASS
2480 MHz	1.198	PASS

CH00 -3Mbps

CH39 -3Mbps

Agilent Spectrum Analyzer - Occupied BW		
Center Freq 2.441000000 GHz	Center Freq: 2.441000000 GHz Trig: Free Run Avg|Hold:>10/10 #IFGain:Low #Atten: 30 dB	Radio Std: None 02:42:14 PM Sep 26, 2019 Radio Device: BTS

Ref Offset 0.5 dB
10 dB/div **Ref 20.00 dBm**
Log

Center 2.441 GHz   Span 2 MHz
#Res BW 30 kHz   #VBW 100 kHz   Sweep 2.733 ms

Occupied Bandwidth		Total Power	4.69 dBm
1.1065 MHz			
Transmit Freq Error	-6.522 kHz	OBW Power	99.00 %
x dB Bandwidth	1.154 MHz	x dB	-20.00 dB

CH78 -3Mbps

Agilent Spectrum Analyzer - Occupied BW		
Center Freq 2.480000000 GHz	Center Freq: 2.480000000 GHz Trig: Free Run Avg|Hold:>10/10 #IFGain:Low #Atten: 30 dB	Radio Std: None 02:34:35 PM Sep 26, 2019 Radio Device: BTS

Ref Offset 0.5 dB
10 dB/div **Ref 20.00 dBm**
Log

Center 2.48 GHz   Span 2 MHz
#Res BW 30 kHz   #VBW 100 kHz   Sweep 2.733 ms

Occupied Bandwidth		Total Power	6.18 dBm
1.1055 MHz			
Transmit Freq Error	-8.811 kHz	OBW Power	99.00 %
x dB Bandwidth	1.198 MHz	x dB	-20.00 dB

9. OUTPUT POWER TEST

9.1 LIMIT

FCC Part 15.247,Subpart C				
Section	Test Item	Limit	FrequencyRange (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
a. The EUT was directly connected to the Power Sensor&PC

9.3 TEST SETUP

EUT	Power sensor	PC
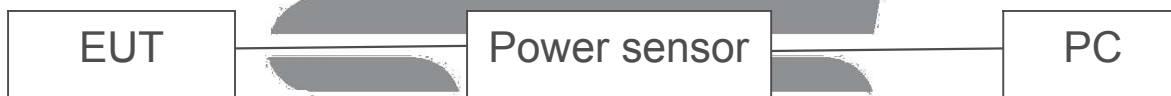
9.4 EUT OPERATION CONDITIONS
The EUT tested system was configured as the statements of 2.4 Unless otherwise a special operating condition is specified in the follows during the testing.

9.5 TEST RESULTS

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

Left

Mode	Channel Number	Frequency (MHz)	Peak Power (dBm)	Average Power (dBm)	Limit (dBm)
GFSK(1M)	0	2402	-2.01	-3.33	30.00
	39	2441	-0.34	-1.65	30.00
	78	2480	0.24	-1.15	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	-1.49	-5.23	20.97
	39	2441	-0.39	-3.29	20.97
	78	2480	0.80	-3.06	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	-0.61	-5.19	20.97
	39	2441	0.85	-3.81	20.97
	78	2480	1.80	-2.98	20.97

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

Right

Mode	Channel Number	Frequency (MHz)	Peak Power (dBm)	Average Power (dBm)	Limit (dBm)
GFSK(1M)	0	2402	-1.04	-2.51	30.00
	39	2441	0.49	-0.94	30.00
	78	2480	1.35	-0.13	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	-0.51	-4.11	20.97
	39	2441	1.22	-2.66	20.97
	78	2480	2.06	-1.89	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	0.73	-4.09	20.97
	39	2441	2.23	-2.69	20.97
	78	2480	3.04	-1.93	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 Onboard antenna 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※ ※ ※ ※ ※