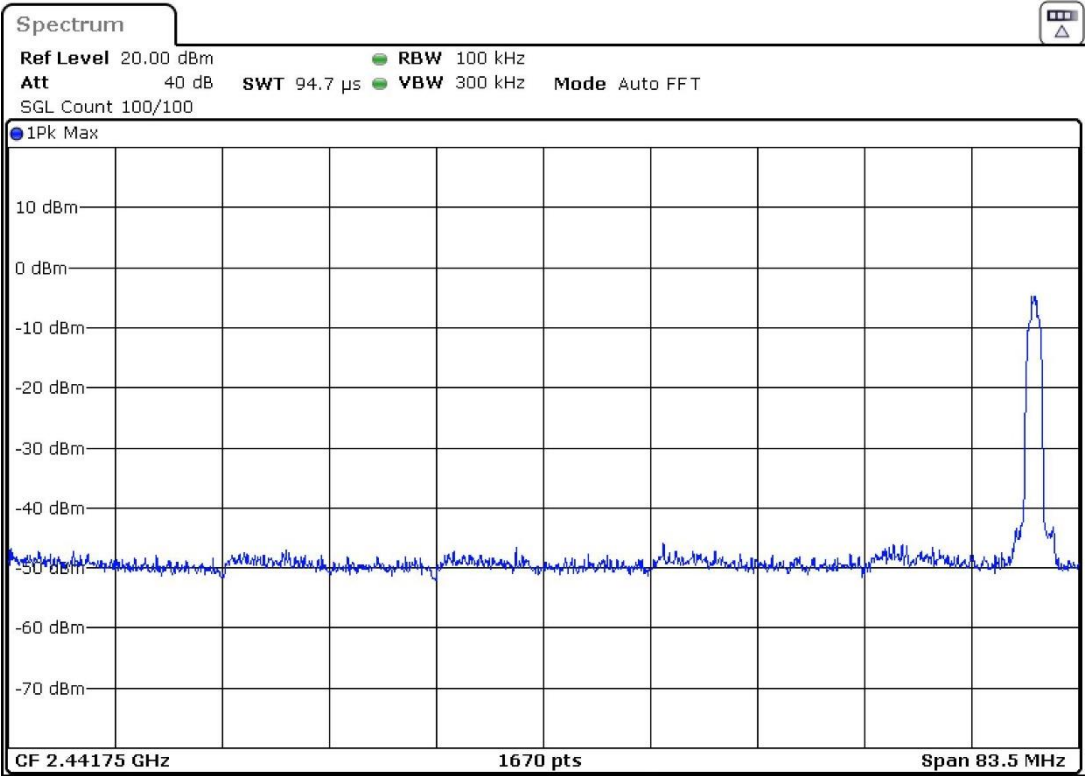
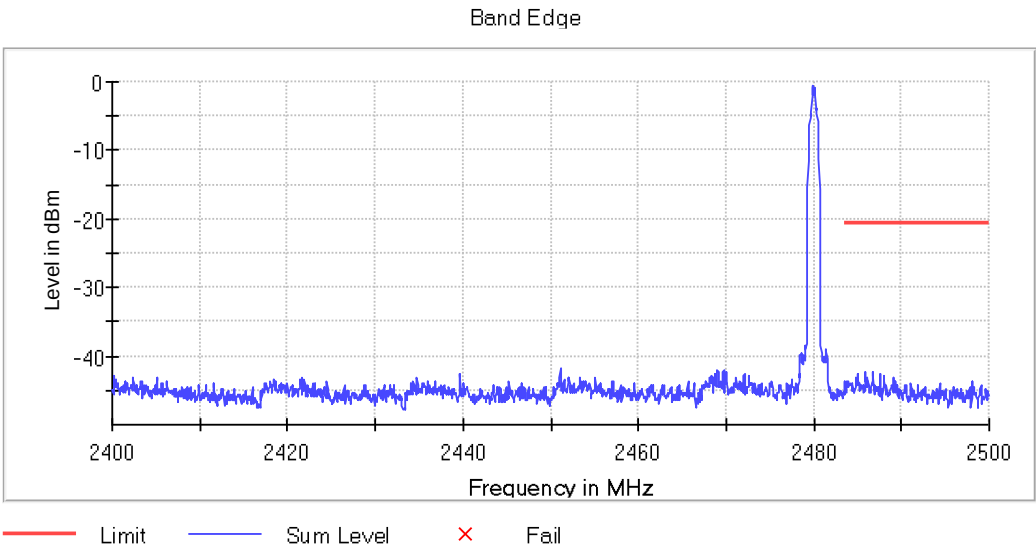
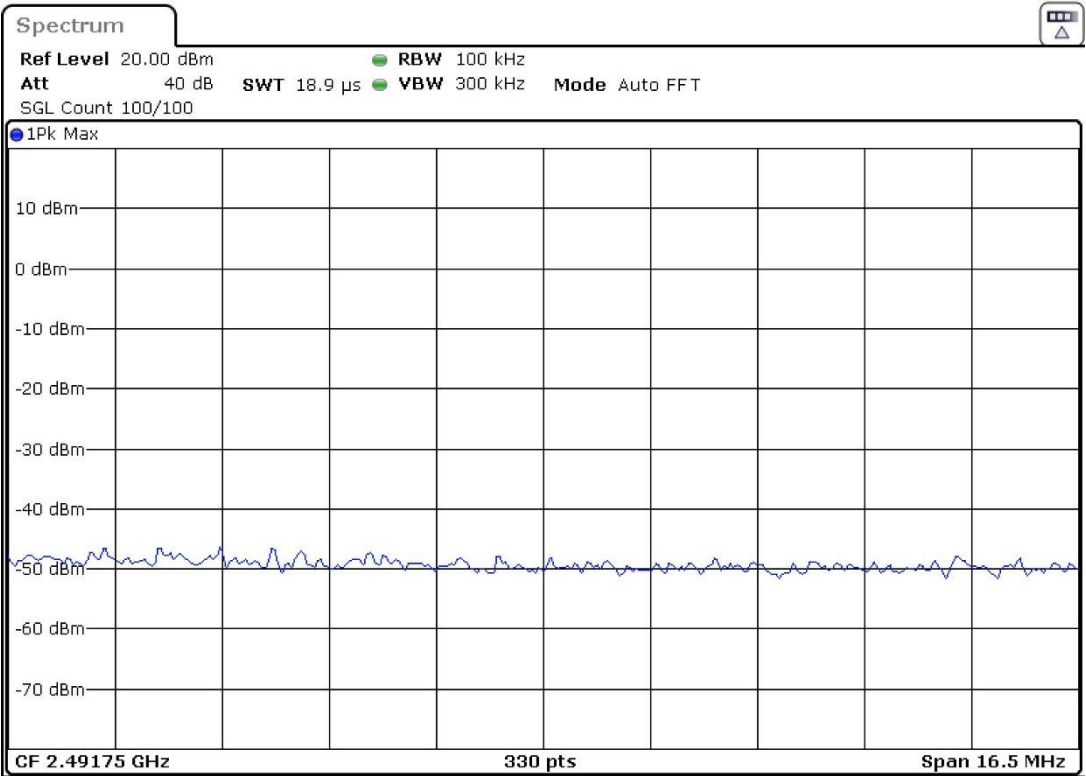


Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00, Hopping Mode: OFF, Modulation: BT (Pi/4 DQPSK 2-DH5), Number of Transmission Chains = 1

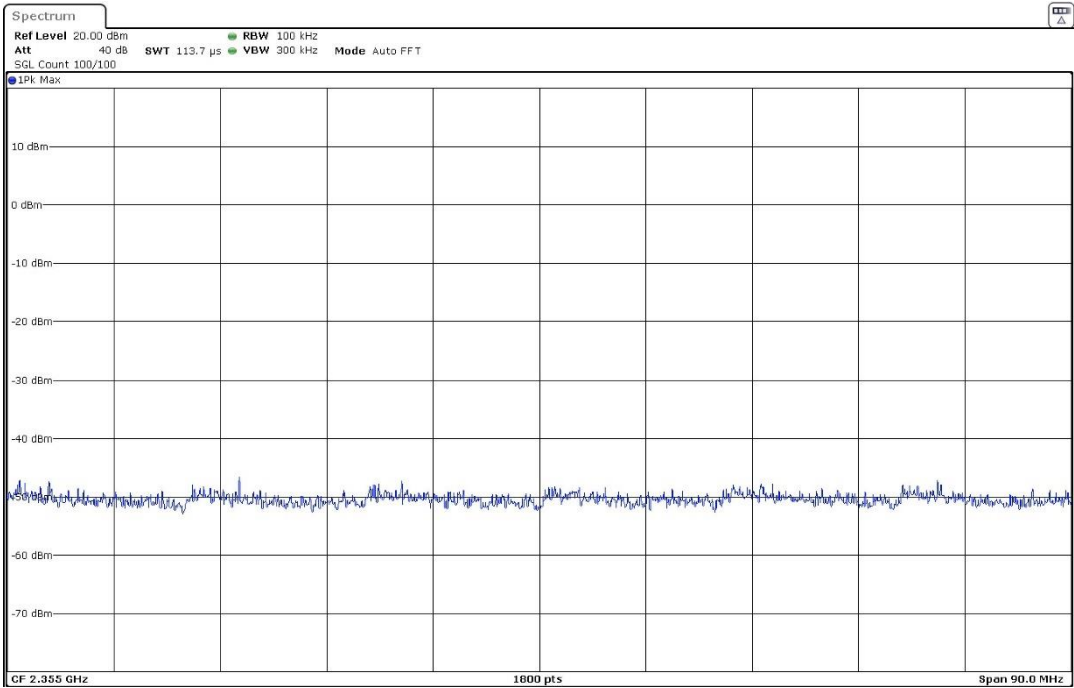
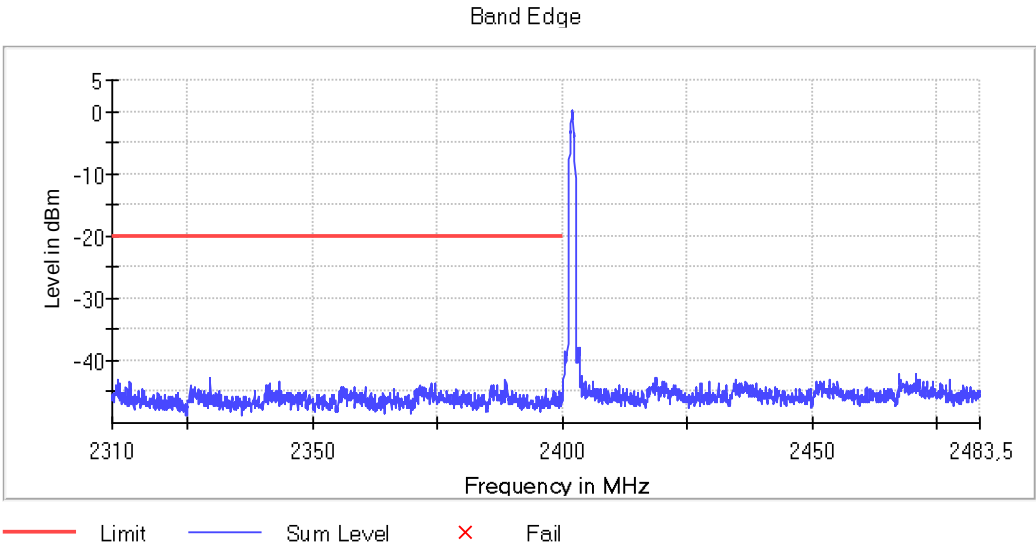
Plots:

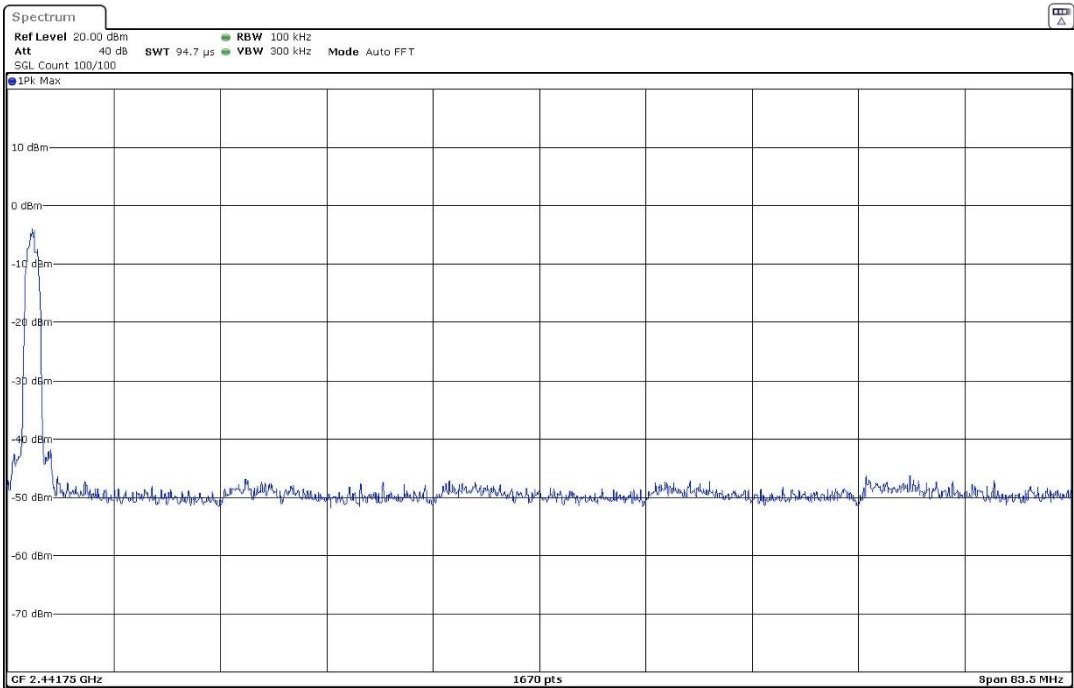




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00, Hopping Mode: OFF, Modulation: BT (8DPSK 3-DH5), Number of Transmission Chains = 1

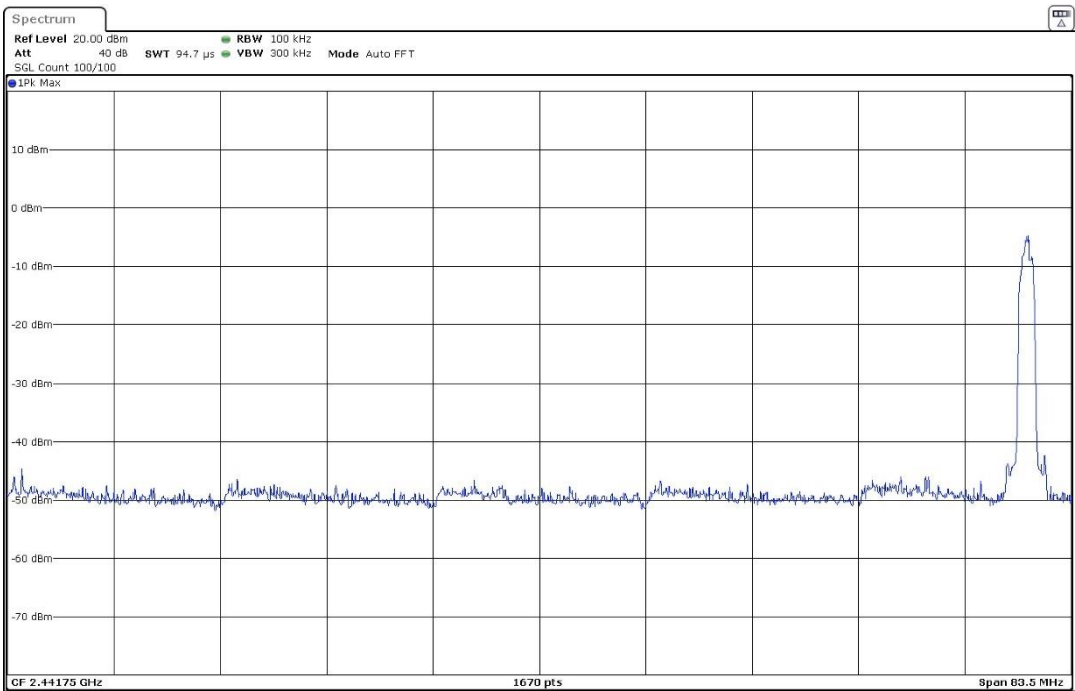
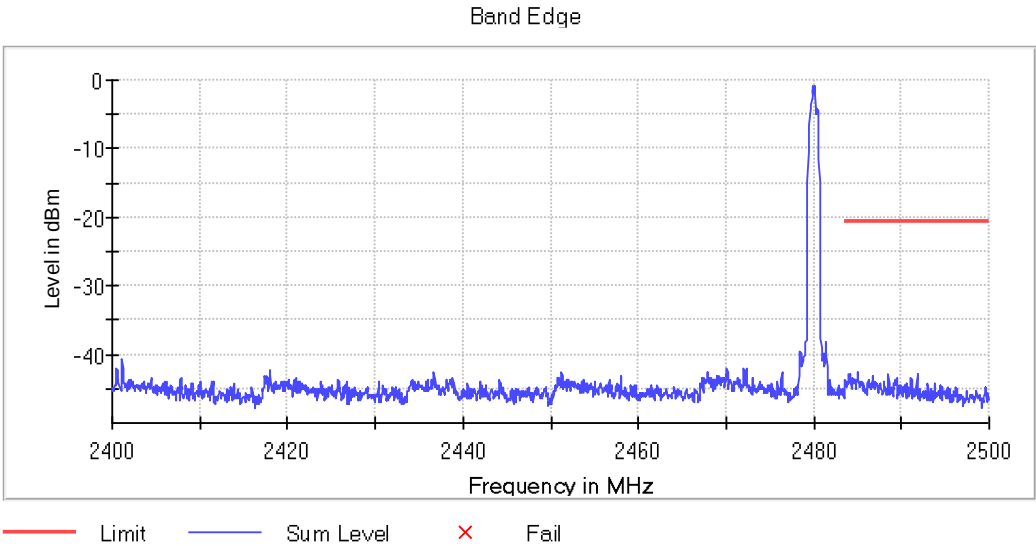
Plots:

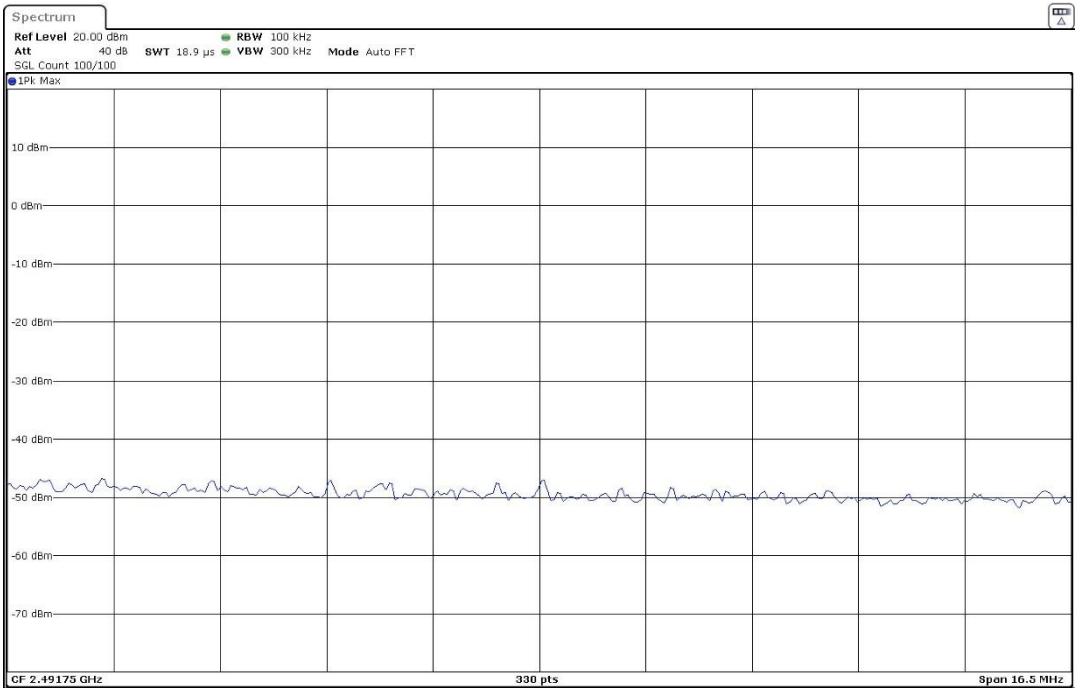




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00, Hopping Mode: OFF, Modulation: BT (8DPSK 3-DH5), Number of Transmission Chains = 1

Plots:





FCC 15.247 (d) Emission limitations radiated (Transmitter)

Limits

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

Frequency Range (MHz)	Field strength (μV/m)	Field strength (dBμV/m)	Measurement distance (m)
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	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

Results

Frequency range 30 MHz – 1 GHz:

The spurious frequencies detected do not depend on either the modulation or the operating channel.

Spurious frequencies detected at less than 20 dB below the limit:

Freq Rng (GHz)	Unwanted Freq (MHz)	Unwanted Lvl (dBμV/m)	Pol	Detector
[0.03, 1]	874.9913	43.76	V	QP

Frequency range 1 GHz – 26 GHz:

Modulation: BT (GFSK 1-DH5)

Spurious frequencies detected at less than 20 dB below the limit:

Freq (MHz)	Freq Rng (GHz)	Unwanted Freq (GHz)	Unwanted Lvl (dBμV/m)	Pol	Detector
2402.0000	[3, 17]	4.9636	46.40	H	Peak
		5.0216	48.24	V	Peak
		5.0693	51.33	V	Peak
2441.0000		4.2334	46.22	V	Peak
		5.3702	41.80	V	Peak
		5.4434	43.88	V	Peak
2480.0000		4.9733	45.70	H	Peak
		5.3605	48.92	V	Peak
		5.4433	49.87	V	Peak

Modulation: BT (Pi/4 DQPSK 2-DH5)

Spurious frequencies detected at less than 20 dB below the limit:

Freq (MHz)	Freq Rng (GHz)	Unwanted Freq (GHz)	Unwanted Lvl (dBμV/m)	Pol	Detector
2402.0000	[3, 17]	4.2335	45.15	V	Peak
		5.0149	47.50	V	Peak
		5.3533	47.69	V	Peak
2441.0000		4.8963	45.87	V	Peak
		5.0019	48.31	V	Peak
		5.0199	50.17	V	Peak
2480.0000		4.9639	46.17	V	Peak
		5.0595	47.47	V	Peak
		5.1076	49.68	V	Peak

Modulation: BT (8DPSK 3-DH5)

Spurious frequencies detected at less than 20 dB below the limit:

Freq (MHz)	Freq Rng (GHz)	Unwanted Freq (GHz)	Unwanted Lvl (dBμV/m)	Pol	Detector
2402.0000	[3, 17]	4.2331	45.80	V	Peak
		4.8679	43.53	V	Peak
		5.4431	48.25	H	Peak
2441.0000		5.0786	48.03	V	Peak
		5.3951	47.78	V	Peak
		5.4220	47.16	V	Peak
2480.0000		4.2328	43.38	V	Peak

Verdict

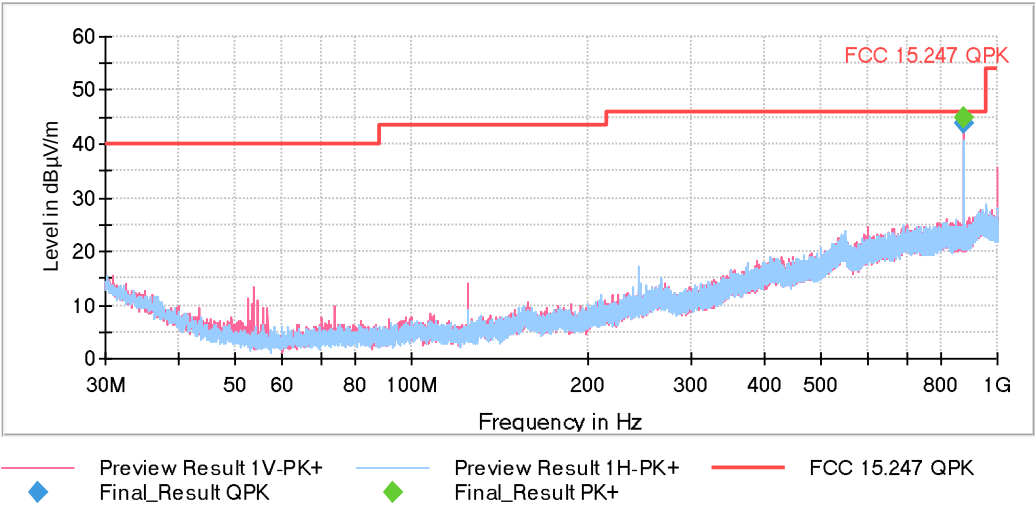
Pass

The setting for each range of frequency is indicated in the following tables:

Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
Receiver: [ESW 44] 30 MHz - 1 GHz	30,312 kHz	PK+	100 kHz	1 s	0 dB
Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
Receiver: [ESW 44] 1 GHz - 3 GHz	30,769 kHz	PK+ ; AVG	1 MHz	1 s	0 dB
Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
Receiver: [ESW 44] 3 GHz - 17 GHz	140 kHz	PK+ ; AVG	1 MHz	1 s	30 dB
Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
Receiver: [FSV 40] 17 GHz - 26 GHz	300 kHz	PK+ ; AVG	1 MHz	1 s	0 dB

Equipment Type = Digital Transmission System (DTS), Frequency Range GHz = [0.03, 1], Number of Transmission Chains = 1, Measurement Point = 1

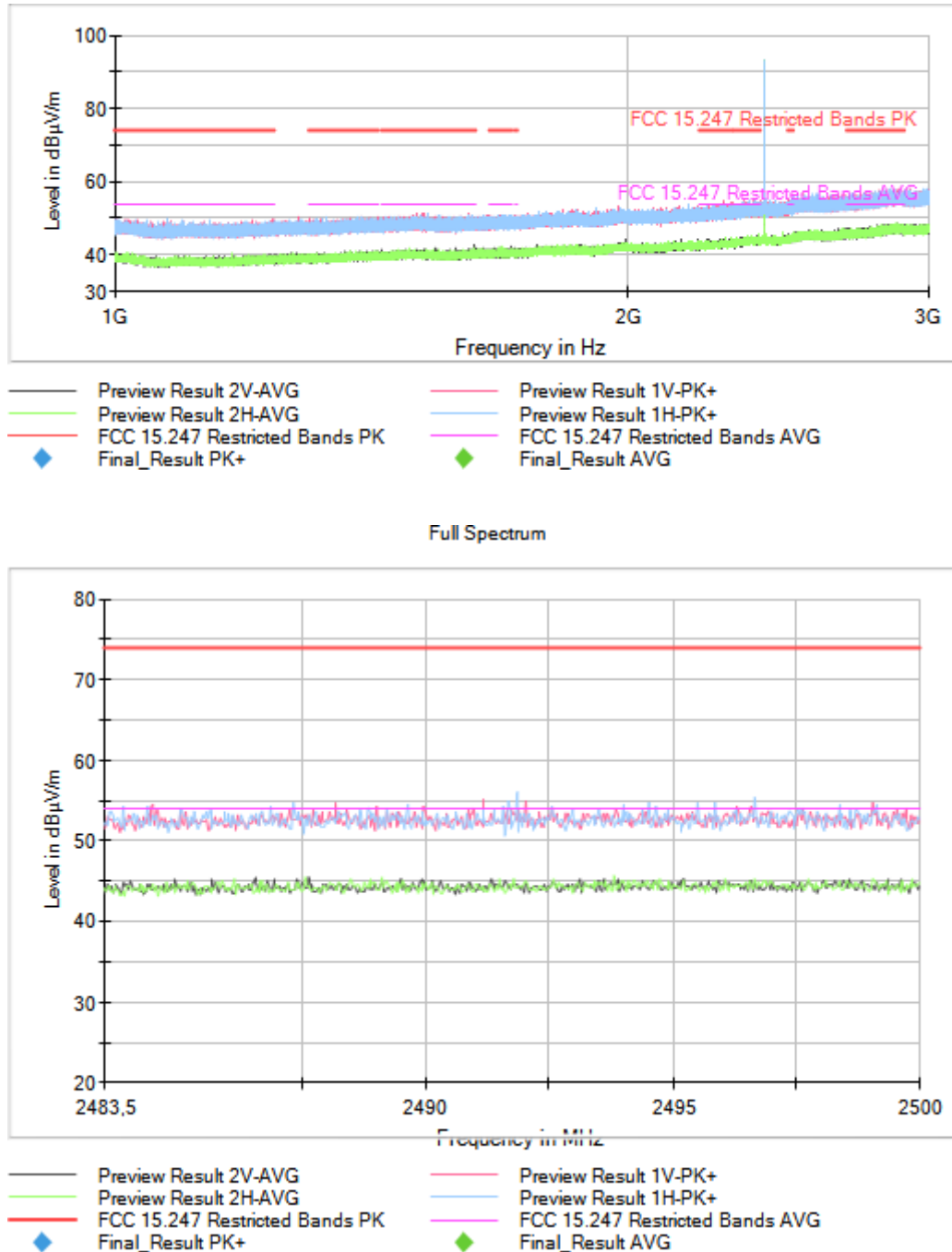
Images:

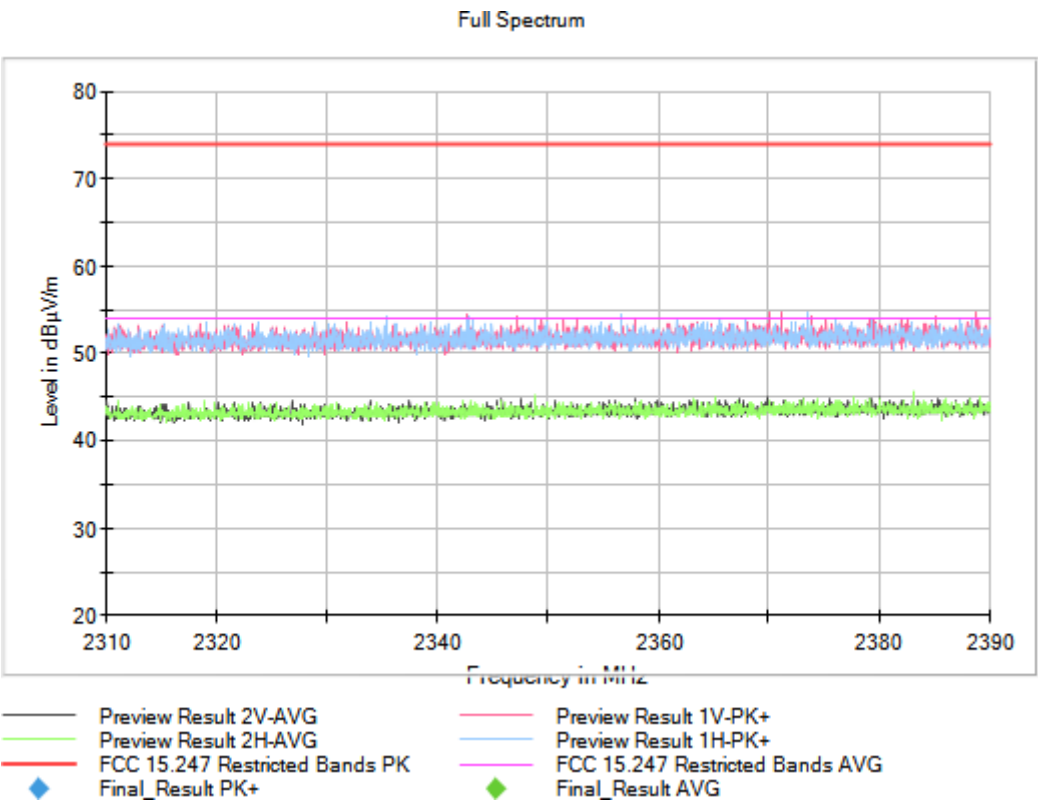


This plot is valid for all channel and all modulations

**Frequency MHz = 2402.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS),
Modulation = BT (GFSK 1-DH5), Frequency Range GHz = [1, 3], Number of Transmission Chains = 1,
Measurement Point = 1**

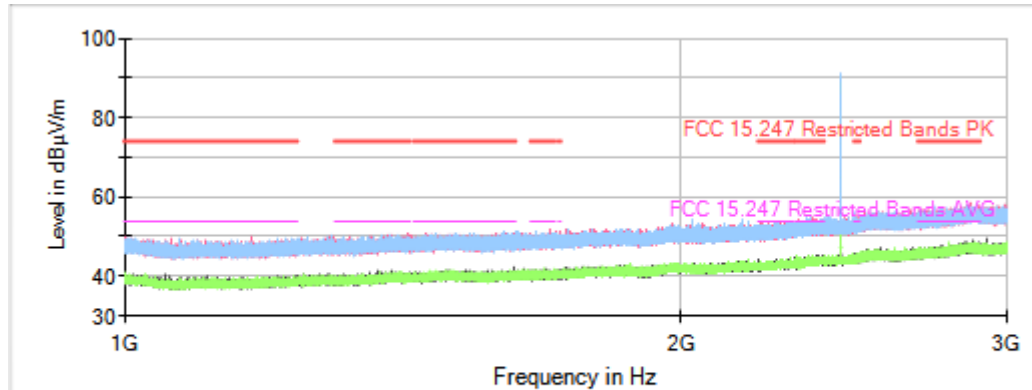
Images:



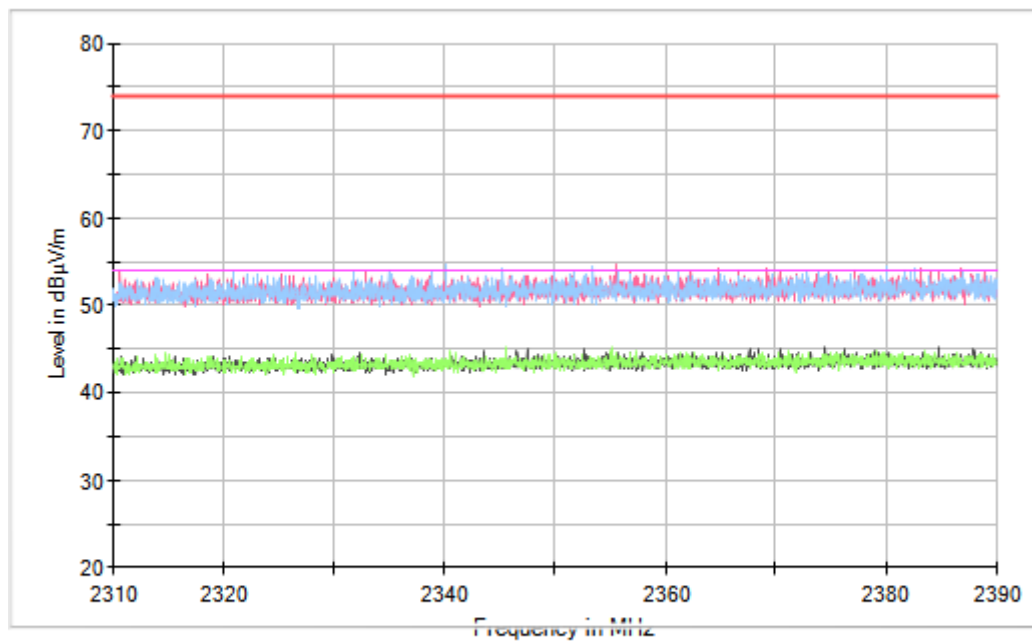


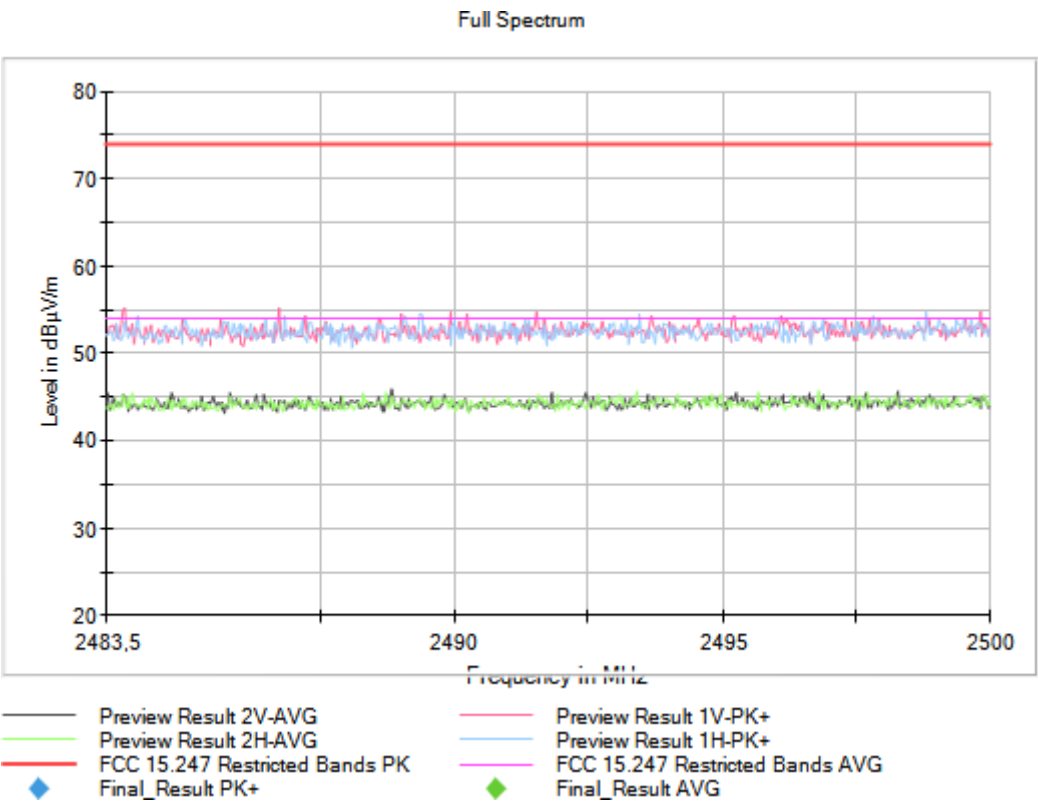
**Frequency MHz = 2441.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS),
Modulation = BT (GFSK 1-DH5), Frequency Range GHz = [1, 3], Number of Transmission Chains = 1,
Measurement Point = 1**

Images:



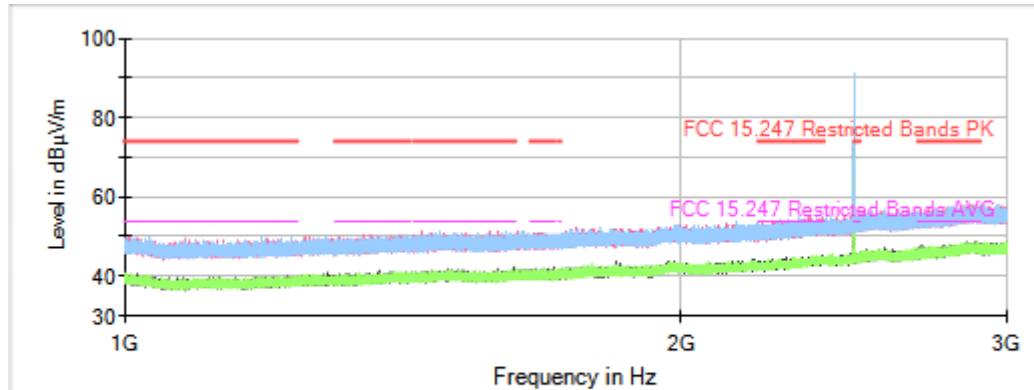
Full Spectrum





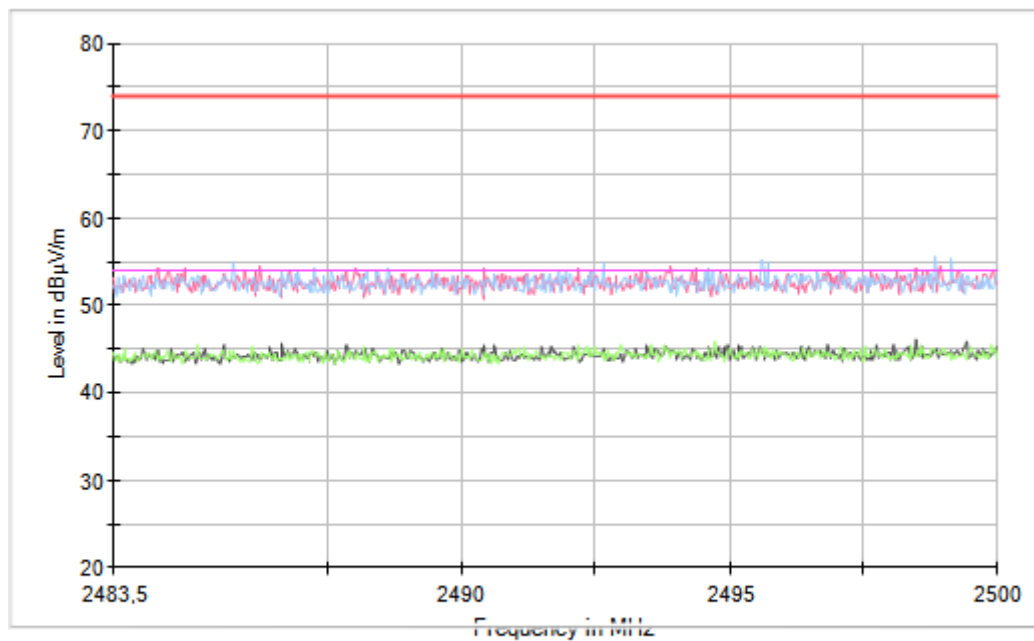
**Frequency MHz = 2480.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS),
Modulation = BT (GFSK 1-DH5), Frequency Range GHz = [1, 3], Number of Transmission Chains = 1,
Measurement Point = 1**

Images:

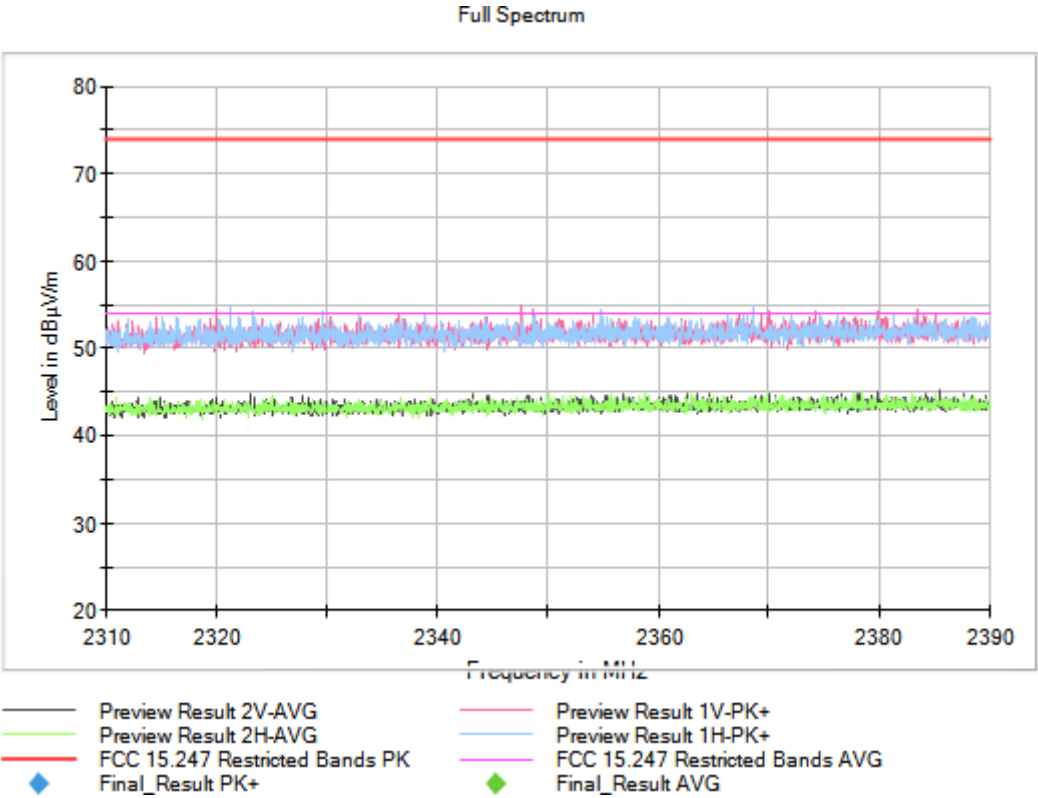


— Preview Result 2V-AVG	— Preview Result 1V-PK+
— Preview Result 2H-AVG	— Preview Result 1H-PK+
— FCC 15.247 Restricted Bands PK	— FCC 15.247 Restricted Bands AVG
◆ Final_Result PK+	◆ Final_Result AVG

Full Spectrum

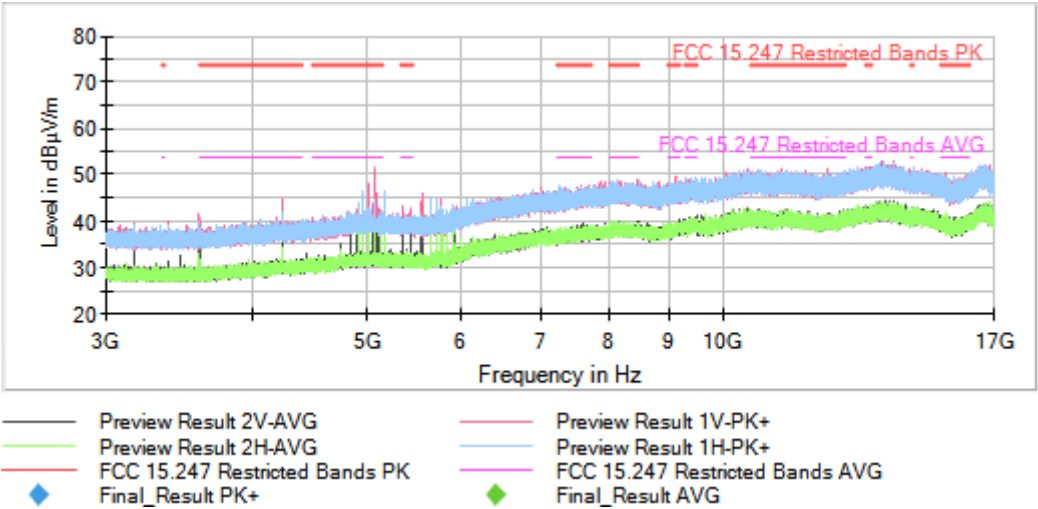


— Preview Result 2V-AVG	— Preview Result 1V-PK+
— Preview Result 2H-AVG	— Preview Result 1H-PK+
— FCC 15.247 Restricted Bands PK	— FCC 15.247 Restricted Bands AVG
◆ Final_Result PK+	◆ Final_Result AVG



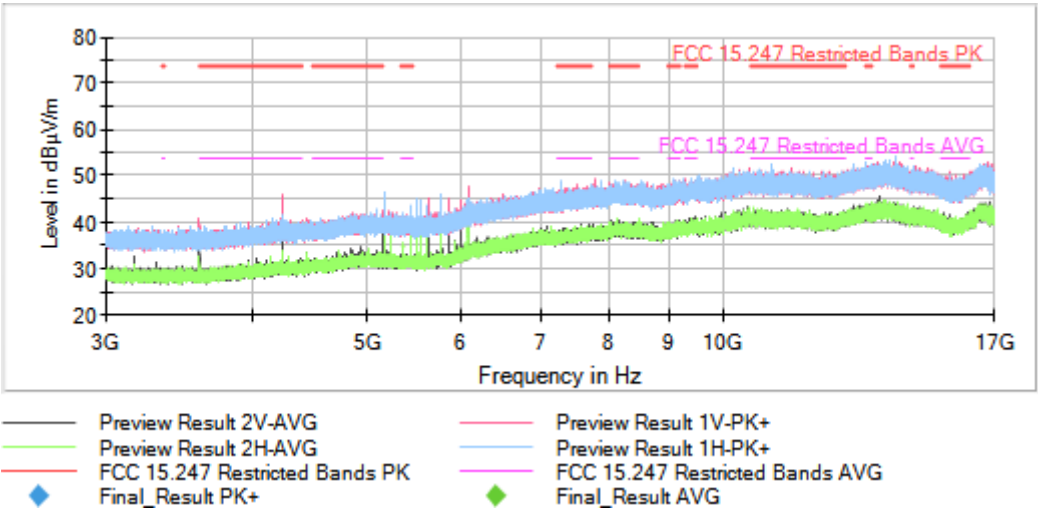
Frequency MHz = 2402.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS),
Modulation = BT (GFSK 1-DH5), Frequency Range GHz = [3, 17], Number of Transmission Chains = 1,
Measurement Point = 1

Images:



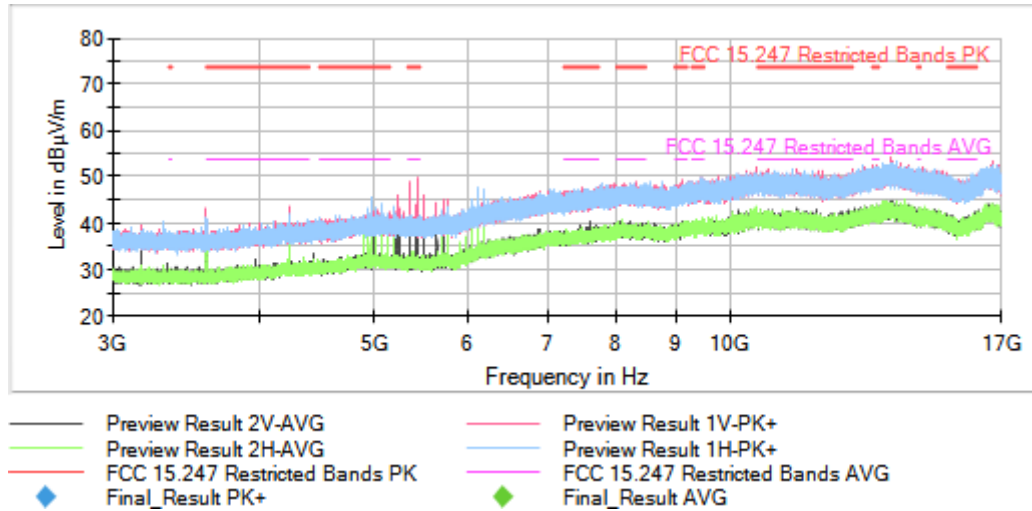
Frequency MHz = 2441.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS),
Modulation = BT (GFSK 1-DH5), Frequency Range GHz = [3, 17], Number of Transmission Chains = 1,
Measurement Point = 1

Images:



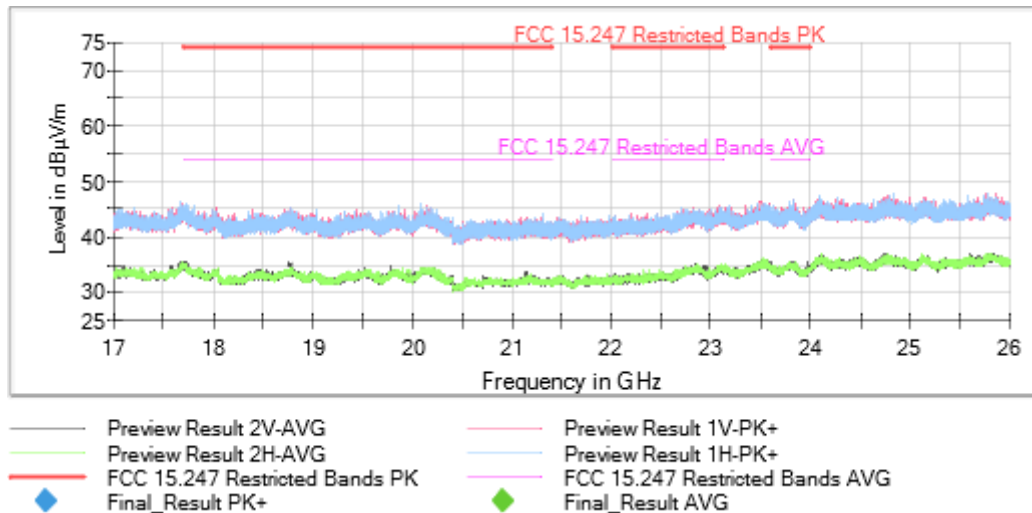
Frequency MHz = 2480.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS),
Modulation = BT (GFSK 1-DH5), Frequency Range GHz = [3, 17], Number of Transmission Chains = 1,
Measurement Point = 1

Images:



Equipment Type = Digital Transmission System (DTS), Frequency Range GHz = [17, 26], Number of
Transmission Chains = 1, Measurement Point = 1

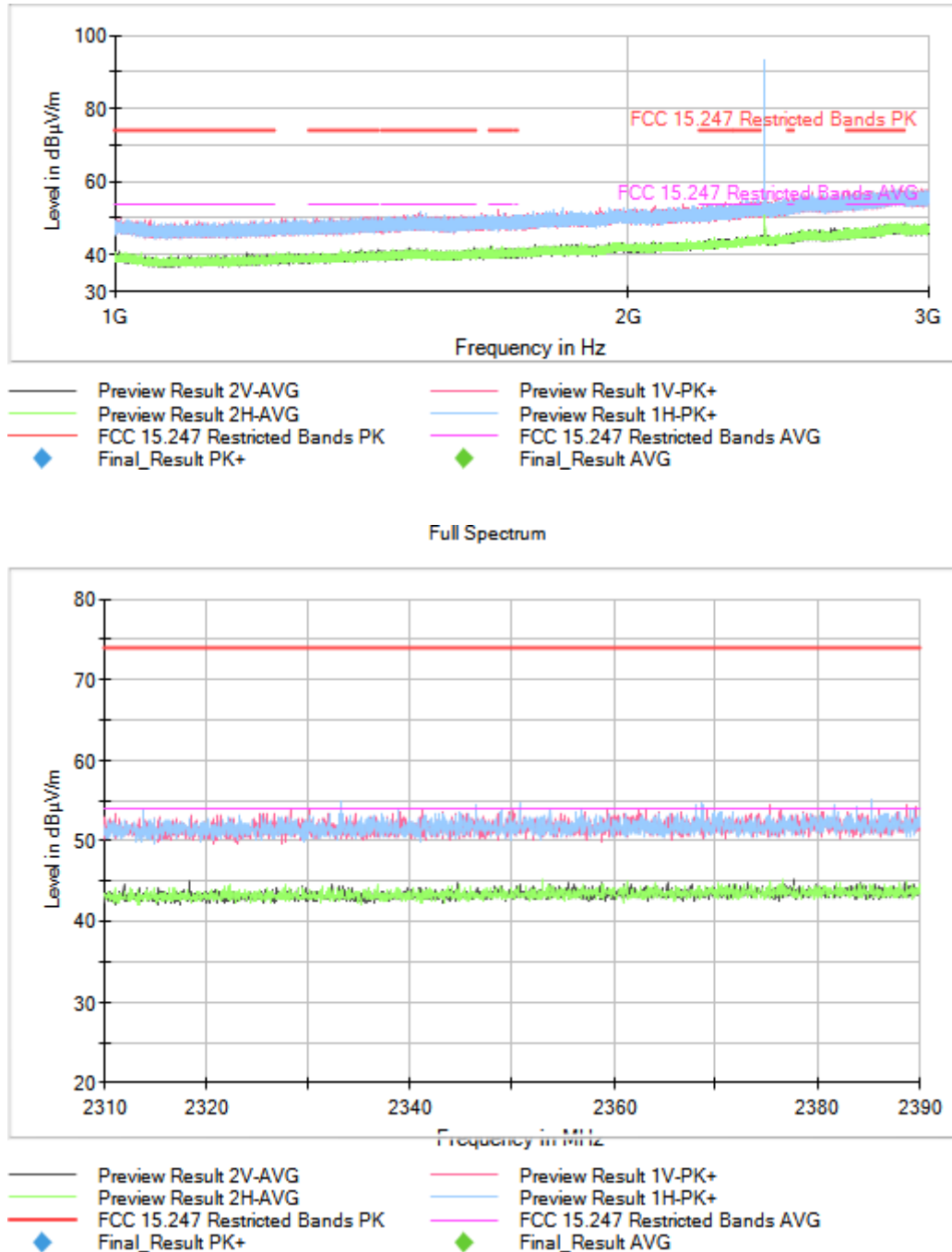
Images:

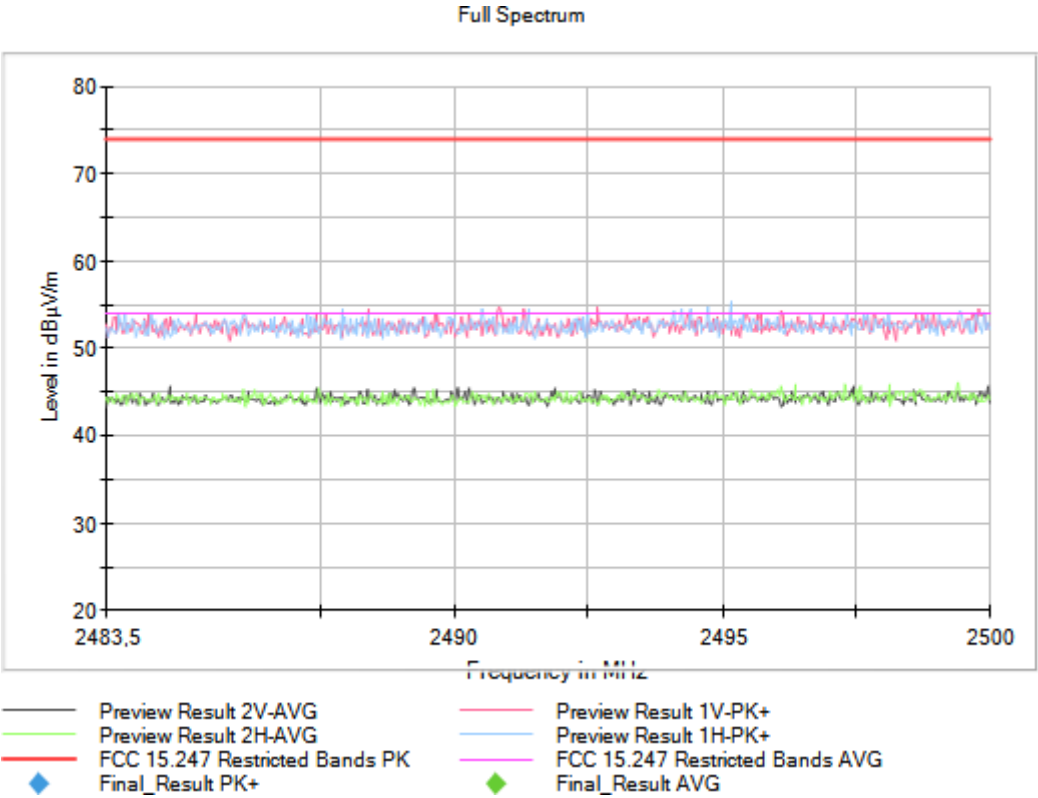


This plot is valid for all channel and all modulations

**Frequency MHz = 2402.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS),
Modulation = BT (Pi/4 DQPSK 2-DH5), Frequency Range GHz = [1, 3], Number of Transmission Chains = 1,
Measurement Point = 1**

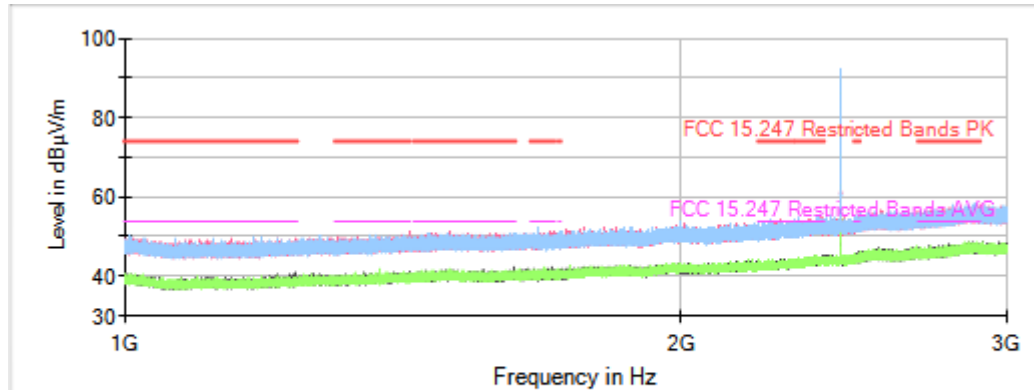
Images:



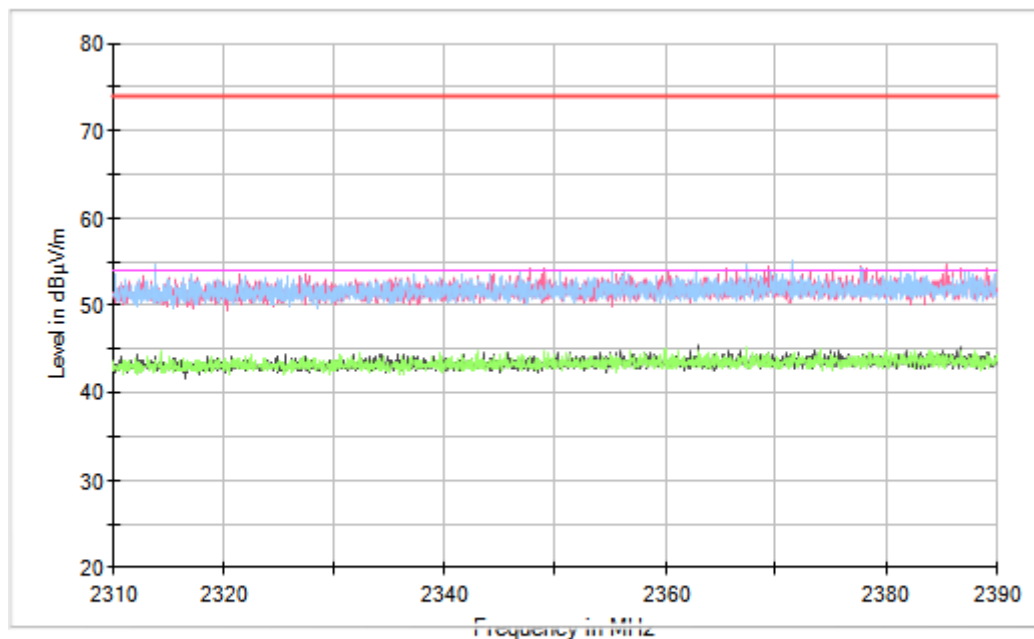


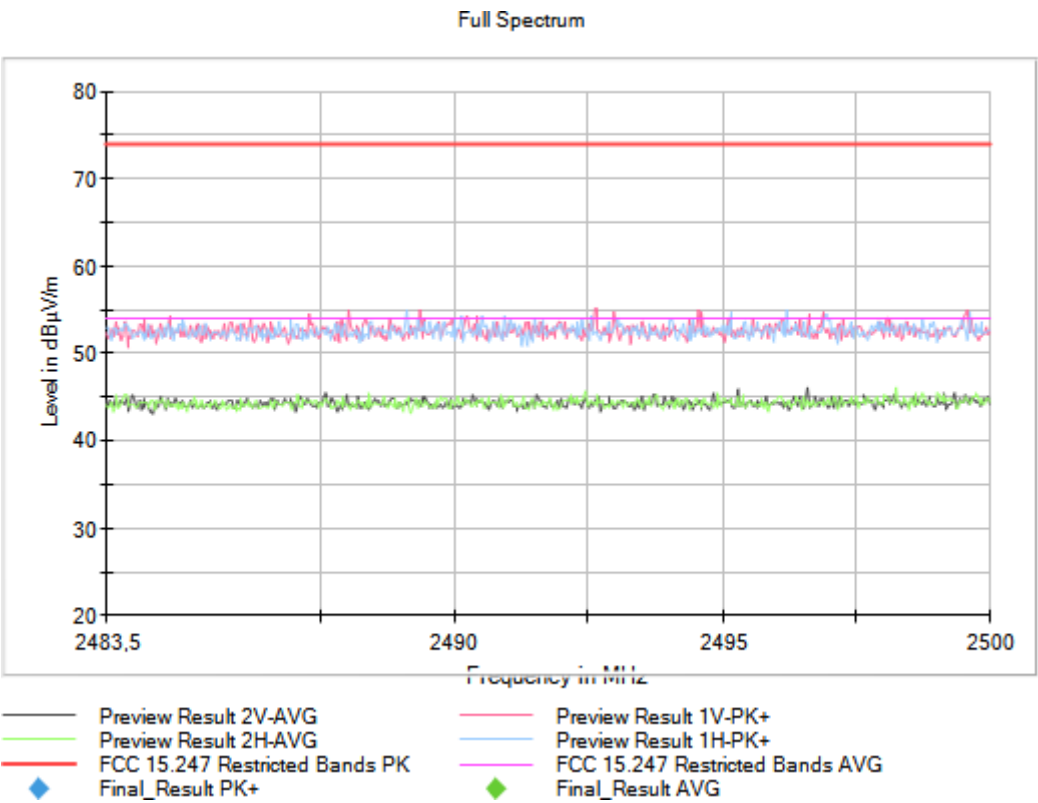
**Frequency MHz = 2441.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS),
 Modulation = BT (Pi/4 DQPSK 2-DH5), Frequency Range GHz = [1, 3], Number of Transmission Chains = 1,
 Measurement Point = 1**

Images:



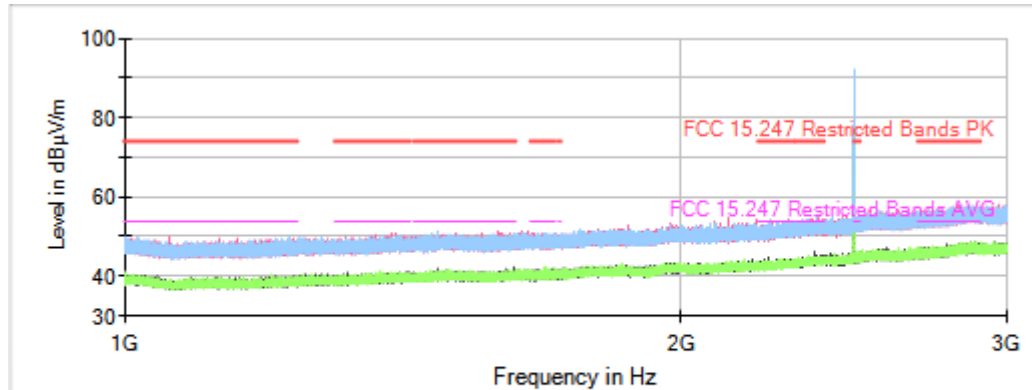
Full Spectrum





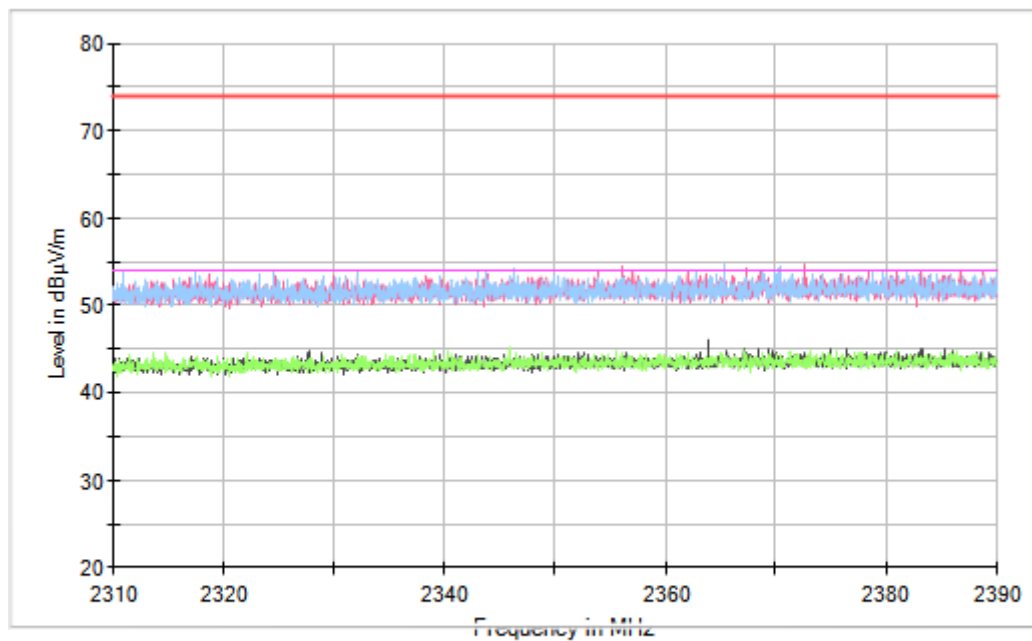
Frequency MHz = 2480.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS),
Modulation = BT (Pi/4 DQPSK 2-DH5), Frequency Range GHz = [1, 3], Number of Transmission Chains = 1,
Measurement Point = 1

Images:

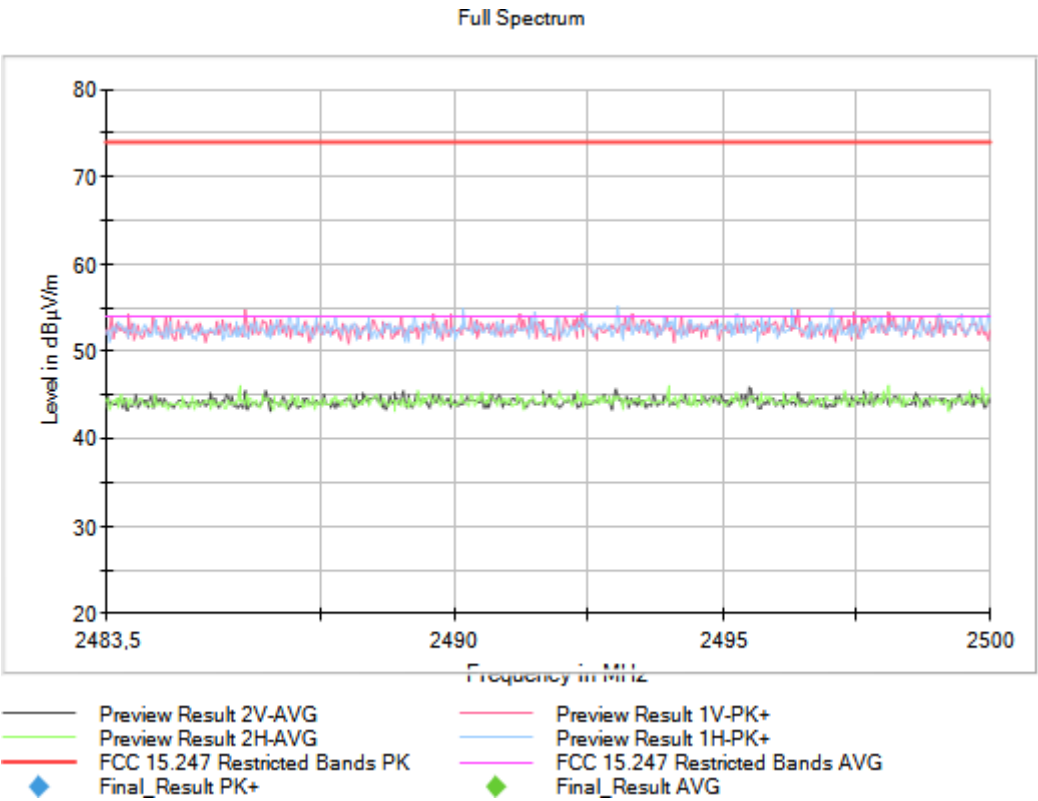


Preview Result 2V-AVG	Preview Result 1V-PK+
Preview Result 2H-AVG	Preview Result 1H-PK+
FCC 15.247 Restricted Bands PK	FCC 15.247 Restricted Bands AVG
Final_Result PK+	Final_Result AVG

Full Spectrum

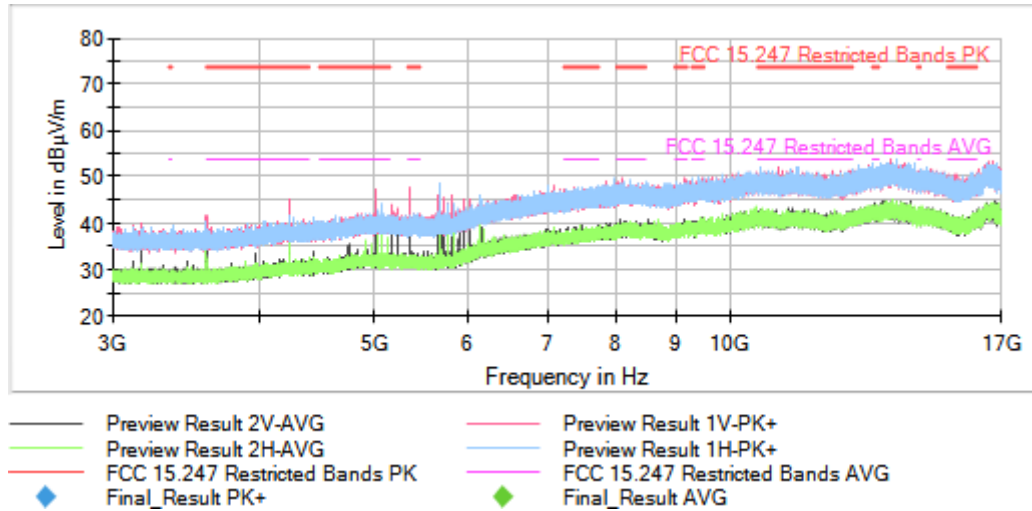


Preview Result 2V-AVG	Preview Result 1V-PK+
Preview Result 2H-AVG	Preview Result 1H-PK+
FCC 15.247 Restricted Bands PK	FCC 15.247 Restricted Bands AVG
Final_Result PK+	Final_Result AVG



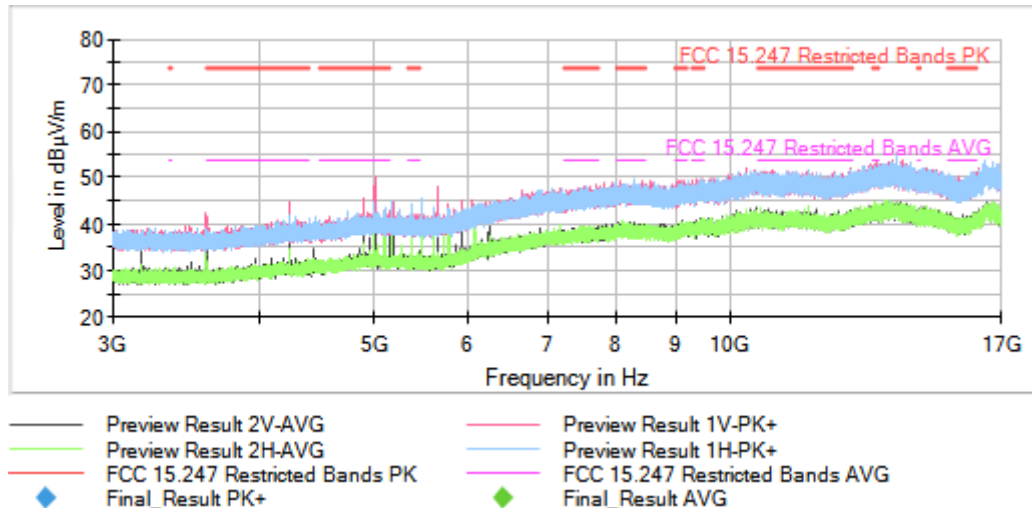
Frequency MHz = 2402.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS),
Modulation = BT (Pi/4 DQPSK 2-DH5), Frequency Range GHz = [3, 17], Number of Transmission Chains =
1, Measurement Point = 1

Images:



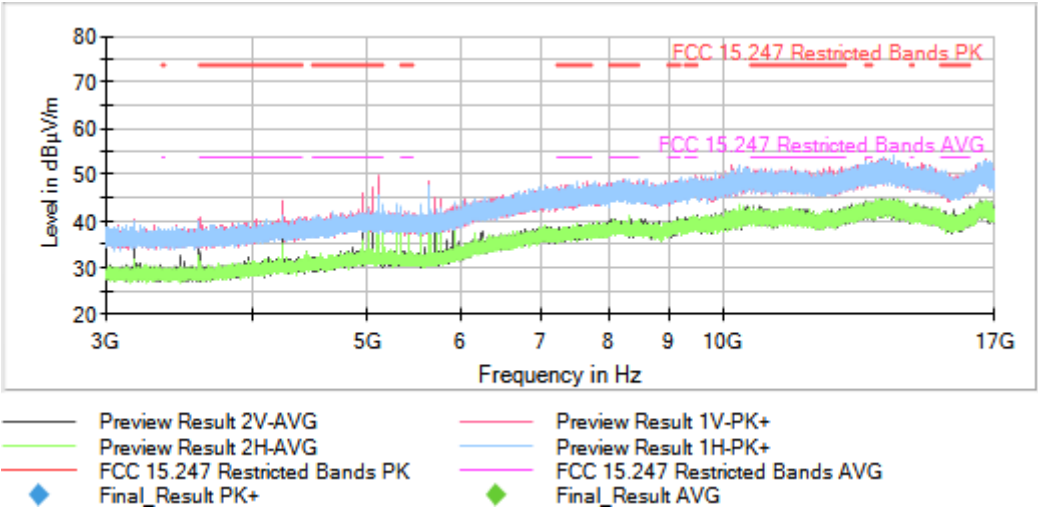
Frequency MHz = 2441.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS),
Modulation = BT (Pi/4 DQPSK 2-DH5), Frequency Range GHz = [3, 17], Number of Transmission Chains =
1, Measurement Point = 1

Images:



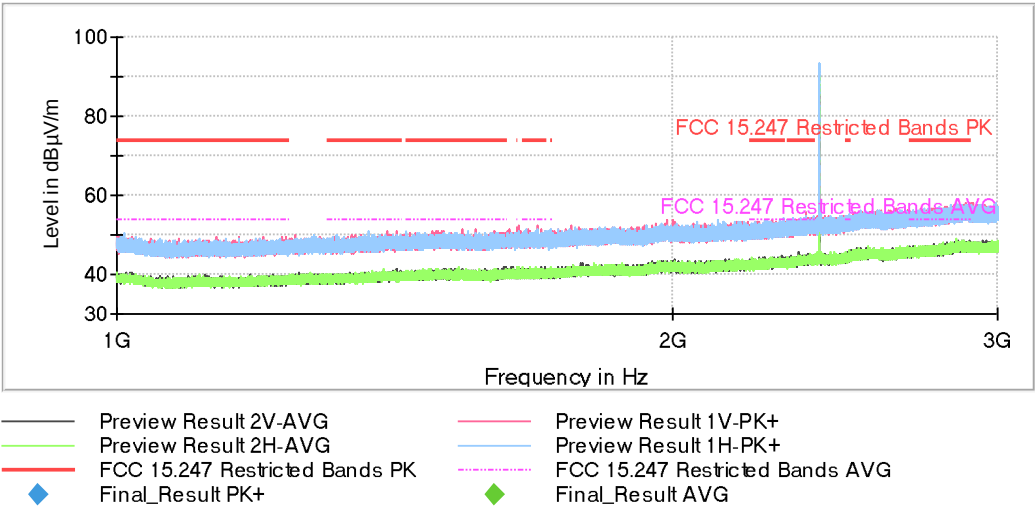
Frequency MHz = 2480.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS),
Modulation = BT (Pi/4 DQPSK 2-DH5), Frequency Range GHz = [3, 17], Number of Transmission Chains =
1, Measurement Point = 1

Images:

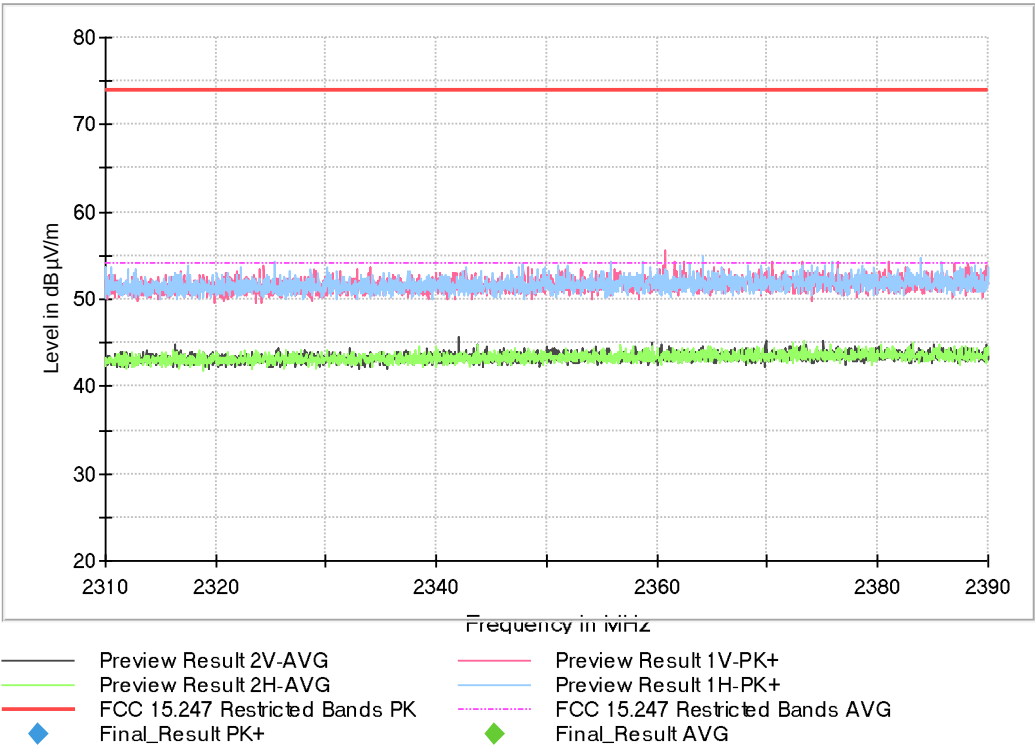


Frequency MHz = 2402.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS),
Modulation = BT (8DPSK 3-DH5), Frequency Range GHz = [1, 3], Number of Transmission Chains = 1,
Measurement Point = 1

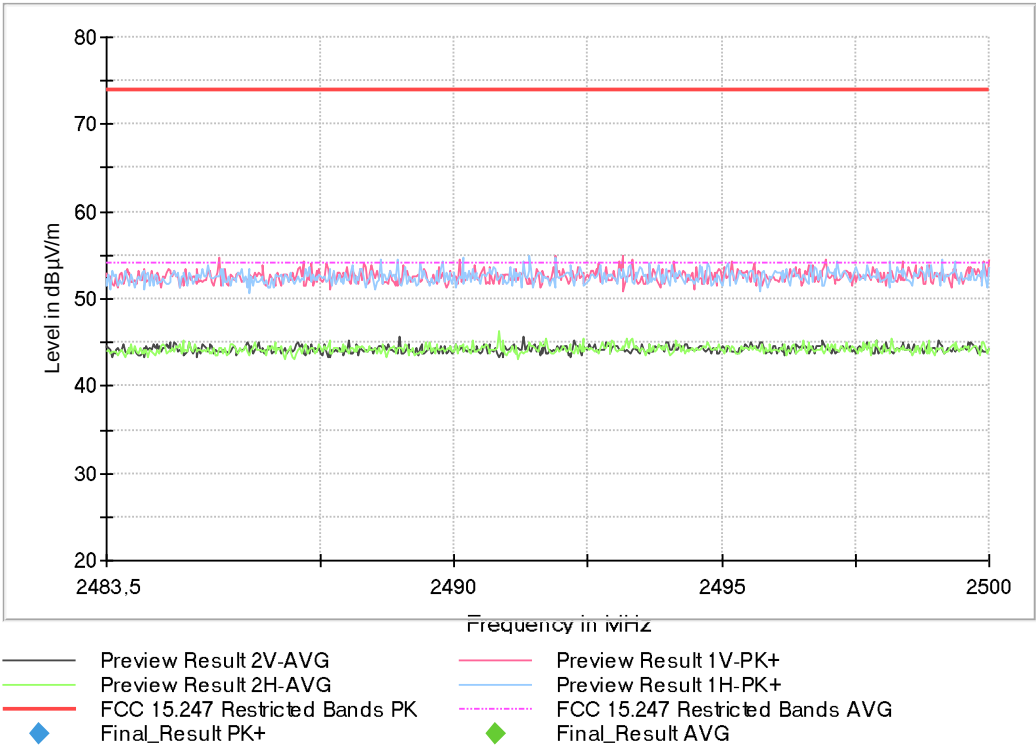
Images:



Full Spectrum

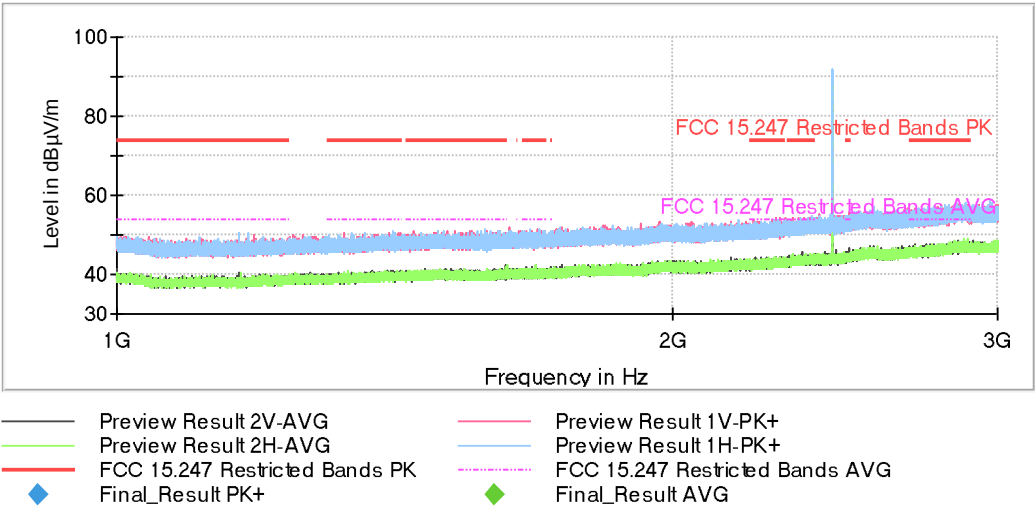


Full Spectrum

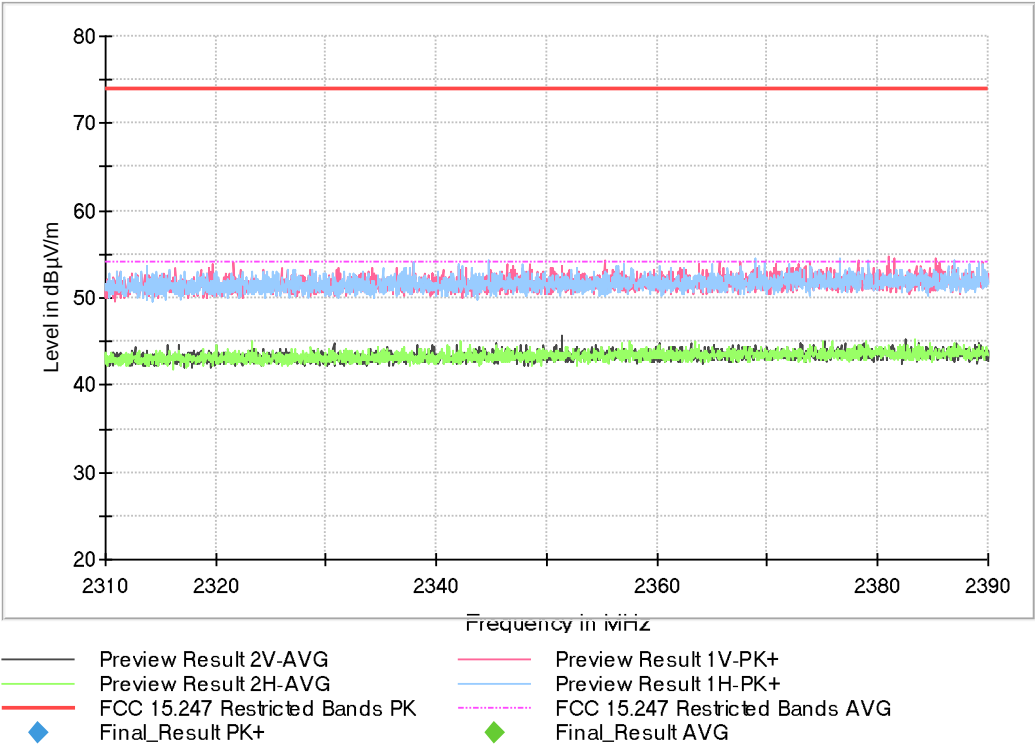


Frequency MHz = 2441.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS),
Modulation = BT (8DPSK 3-DH5), Frequency Range GHz = [1, 3], Number of Transmission Chains = 1,
Measurement Point = 1

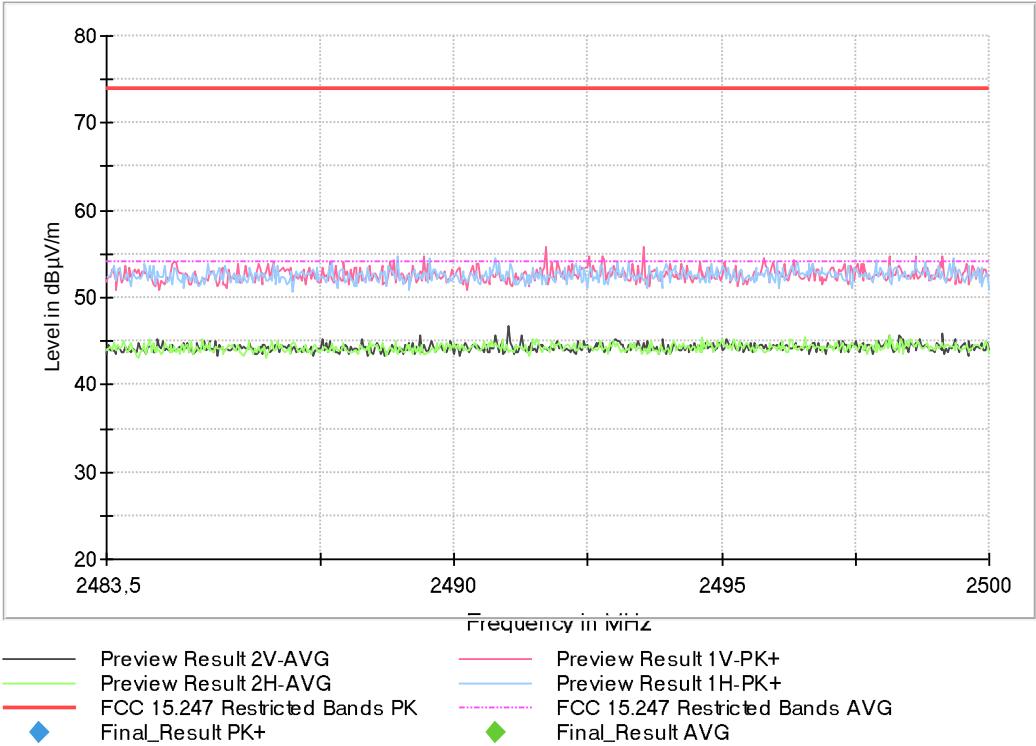
Images:



Full Spectrum

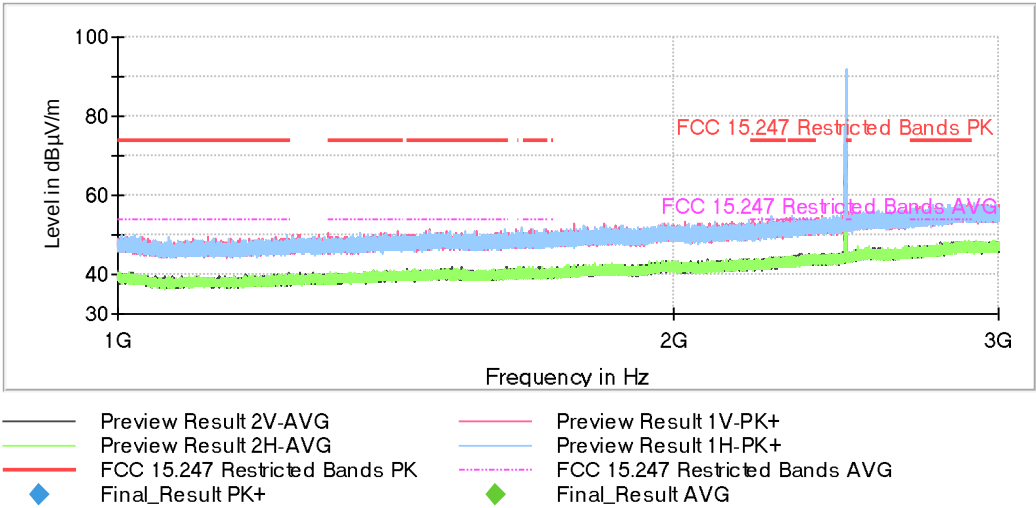


Full Spectrum

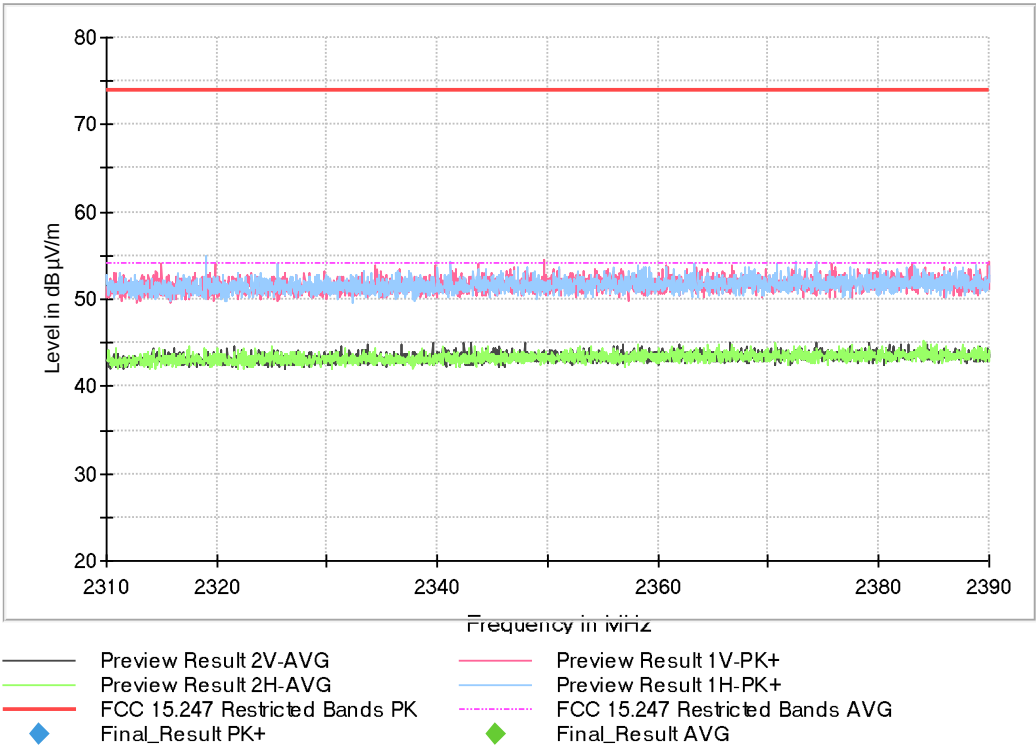


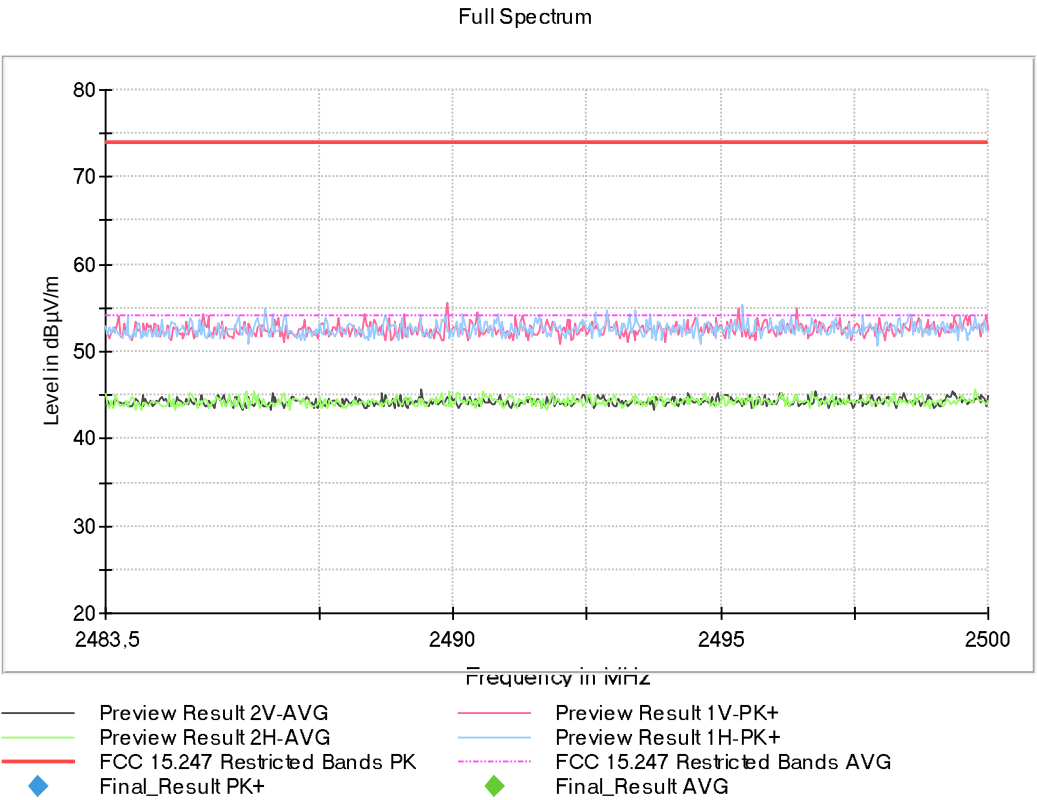
Frequency MHz = 2480.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS),
Modulation = BT (8DPSK 3-DH5), Frequency Range GHz = [1, 3], Number of Transmission Chains = 1,
Measurement Point = 1

Images:



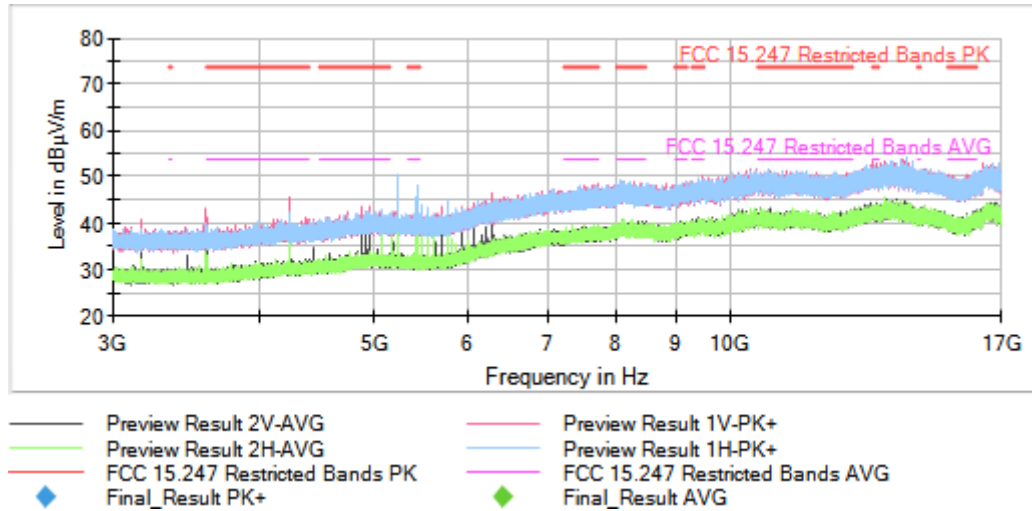
Full Spectrum





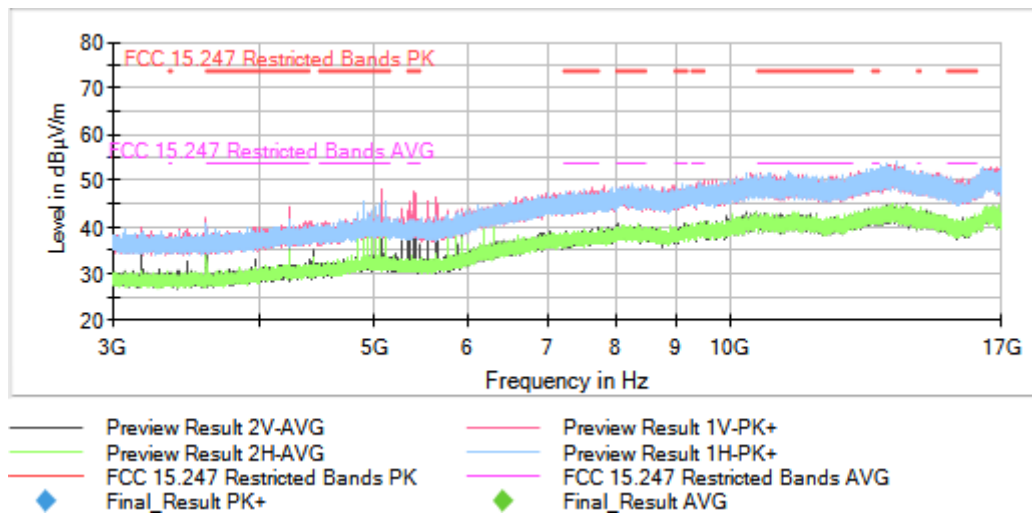
Frequency MHz = 2402.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS),
 Modulation = BT (8DPSK 3-DH5), Frequency Range GHz = [3, 17], Number of Transmission Chains = 1,
 Measurement Point = 1

Images:



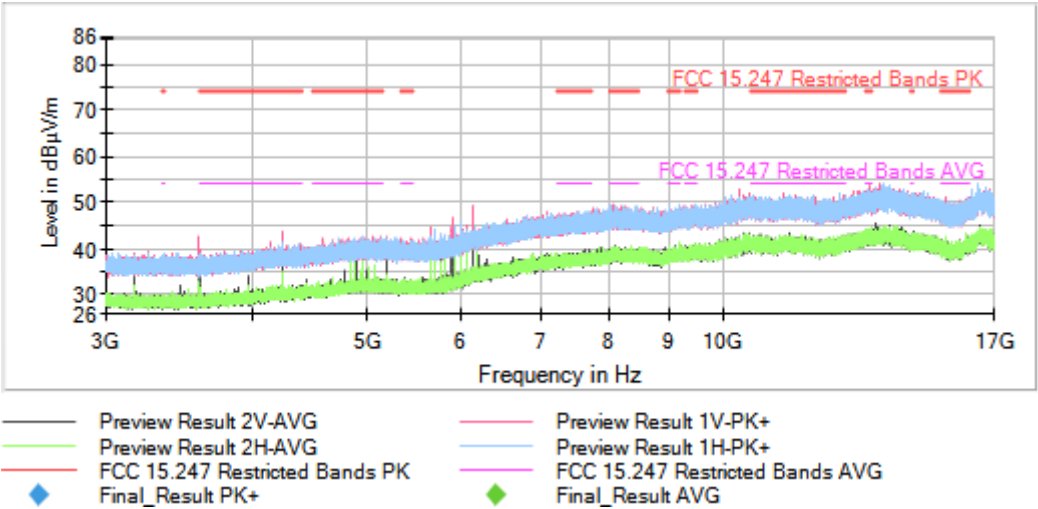
Frequency MHz = 2441.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS),
 Modulation = BT (8DPSK 3-DH5), Frequency Range GHz = [3, 17], Number of Transmission Chains = 1,
 Measurement Point = 1

Images:



Frequency MHz = 2480.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS),
Modulation = BT (8DPSK 3-DH5), Frequency Range GHz = [3, 17], Number of Transmission Chains = 1,
Measurement Point = 1

Images:



Appendix C: Test results. Bluetooth Low Energy 5.1 (2M, 1M). Chipset 1

TEST CONDITIONS	217
TEST CASES DETAILS	220
<i>99dBw Occupied Channel Bandwidth 99%</i>	220
<i>FCC 15.247 (a) (2) 6 dB Bandwidth</i>	227
<i>FCC 15.247 (e) Power spectral density</i>	234
<i>FCC 15.247 (b) Maximum output power and antenna gain</i>	241
<i>FCC 15.247 (d) Band-edge emissions compliance (Transmitter)</i>	248
<i>FCC 15.247 (d) Emission limitations radiated (Transmitter)</i>	257

TEST CONDITIONS

(*): Data provided by the client.

POWER SUPPLY (*):

Vnominal:	12Vdc
Type of Power Supply:	Battery

ANTENNA (*):

Type of Antenna:	External antenna
Maximum Declared Antenna Gain:	2dBi

TEST FREQUENCIES (*):

Low Channel:	2402 MHz
Middle Channel:	2440 MHz
High Channel:	2480 MHz

CONDUCTED MEASUREMENTS:

The equipment under test was set up in a shielded room and it is connected to the TS8997 using a low loss RF cable. The reading of the spectrum analyser is corrected taking into account the cable loss.



RADIATED MEASUREMENTS:

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz and 1 GHz-17 GHz Double ridge horn antenna) is situated at a distance of 3 m and at a distance of 1.5 m for the frequency range 17 GHz-26 GHz (17 GHz-40 GHz horn antenna).

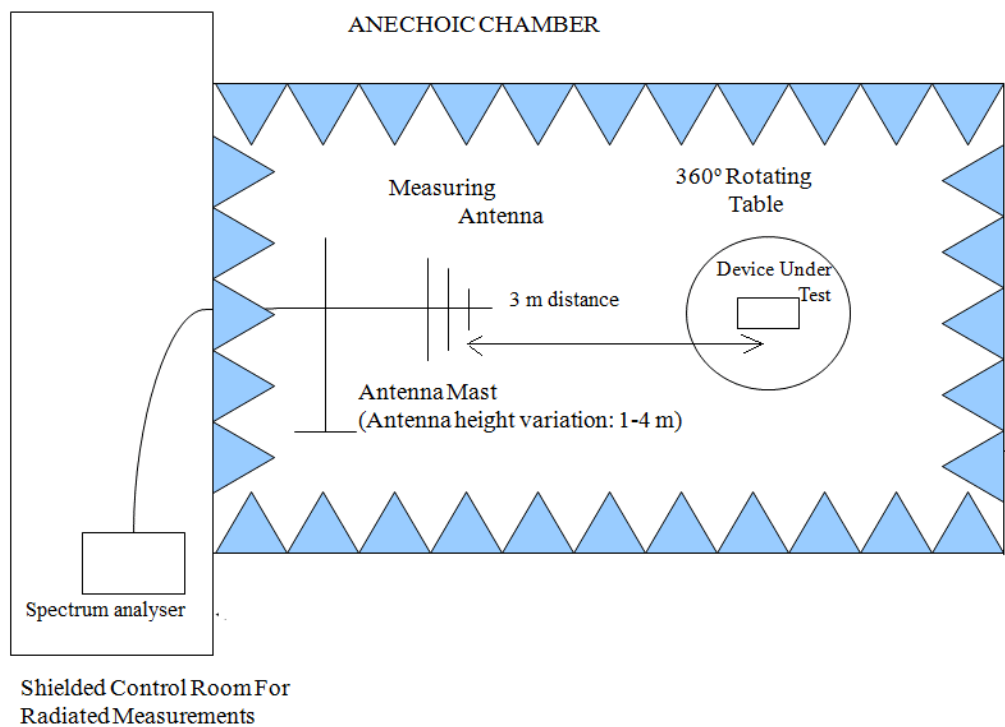
For radiated emissions in the range 17 GHz-26 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find the maximum radiated emission.

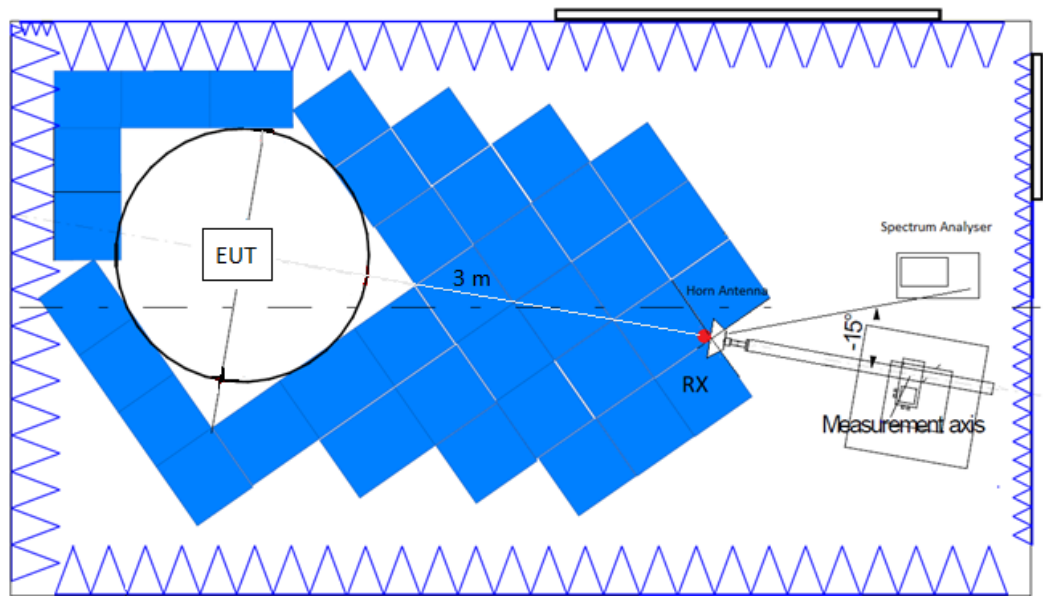
Measurements were made in both horizontal and vertical planes of polarization.

A resolution bandwidth/video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

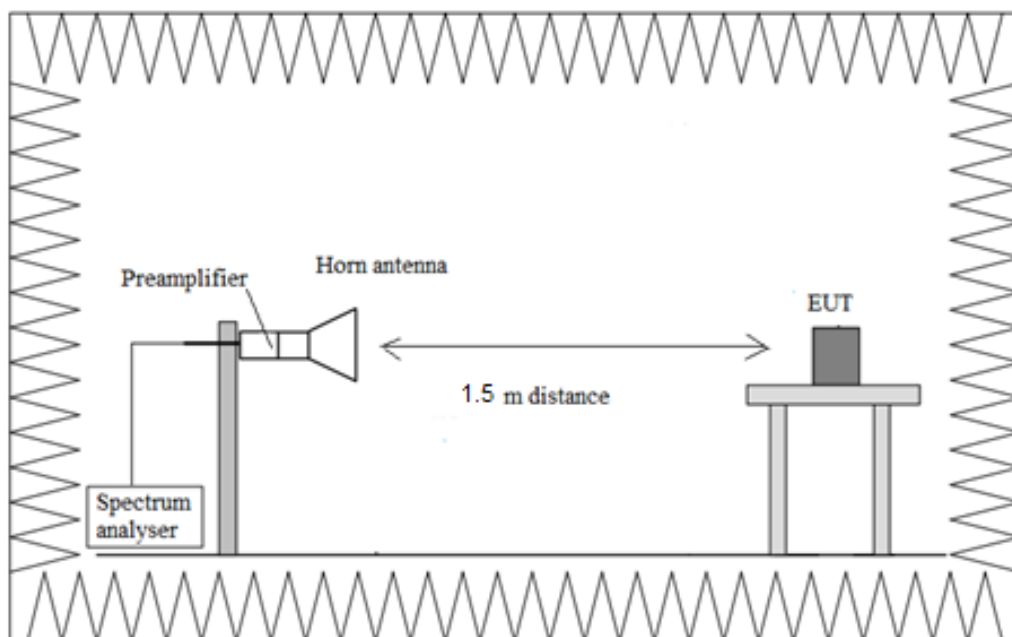
Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup $f > 17$ GHz:



TEST CASES DETAILS

Occupied Channel Bandwidth 99%

Modulation: BTLE 5.1 (GFSK 2 Mbit/s)

Results

Freq (MHz)	Occ Ch BW (MHz)
2402.00000	1.990
2440.00000	1.980
2480.00000	1.980

Modulation: BTLE 5.1 (GFSK 1 Mbit/s)

Results

Freq (MHz)	Occ Ch BW (MHz)
2402.00000	1.020
2440.00000	1.020
2480.00000	1.020

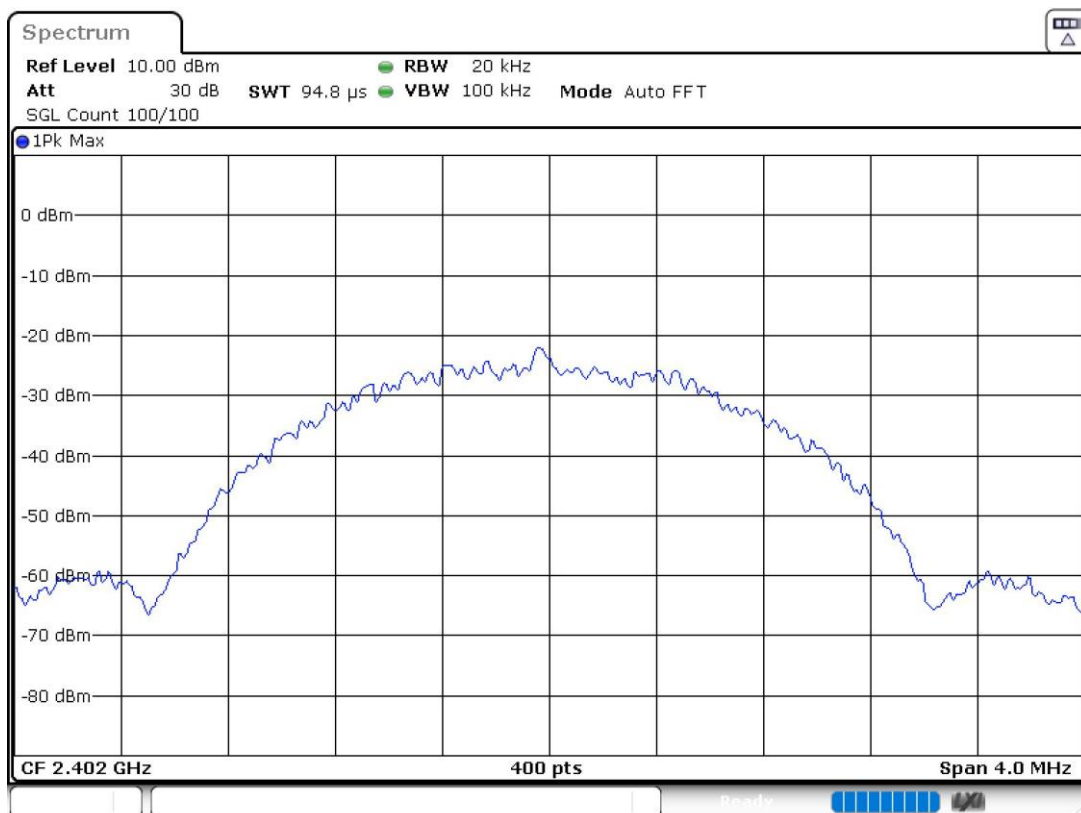
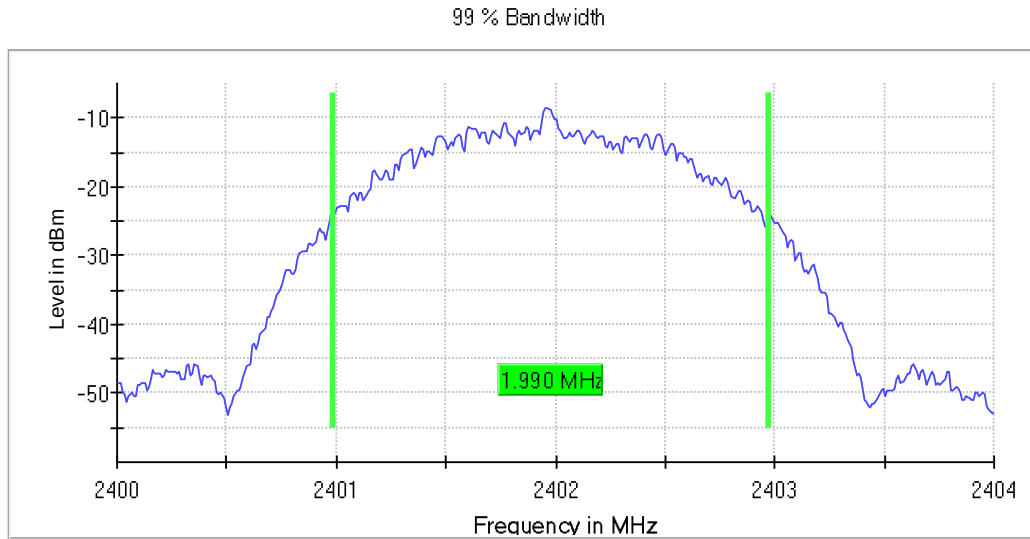
Verdict

Pass

Attachments

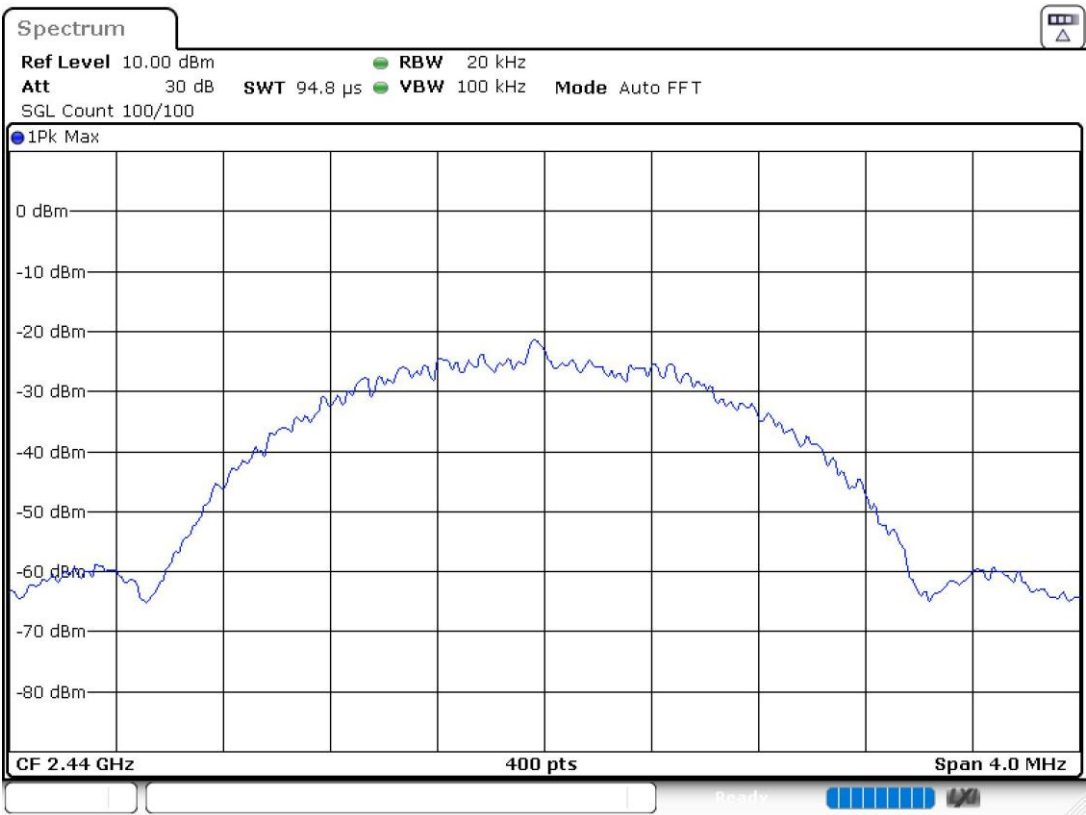
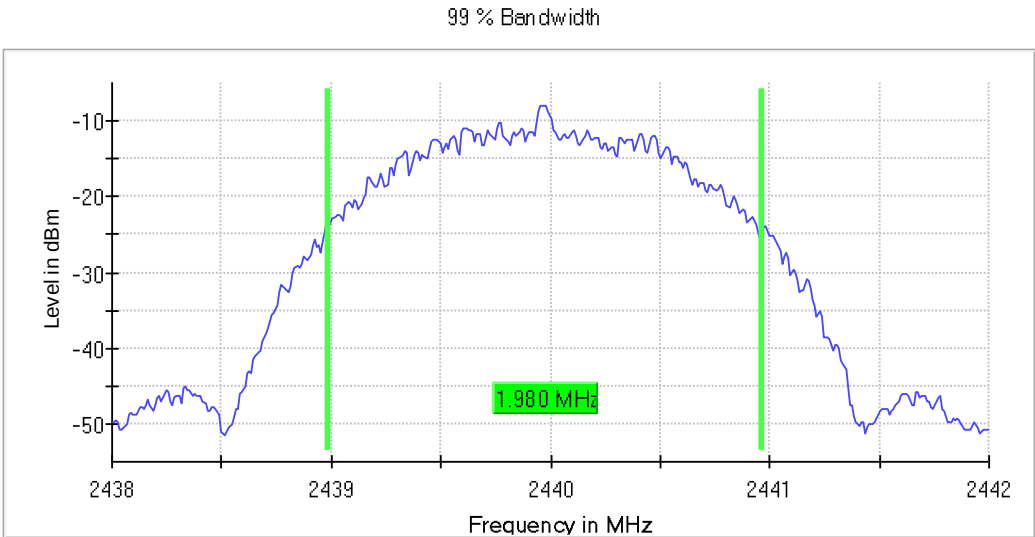
Operation Band MHz = [2400, 2483.5], Frequency MHz = 2402.00000, Equipment Type = Digital Transmission System (DTS), Modulation = BTLE 5.1 (GFSK 2 Mbit/s)

Images:



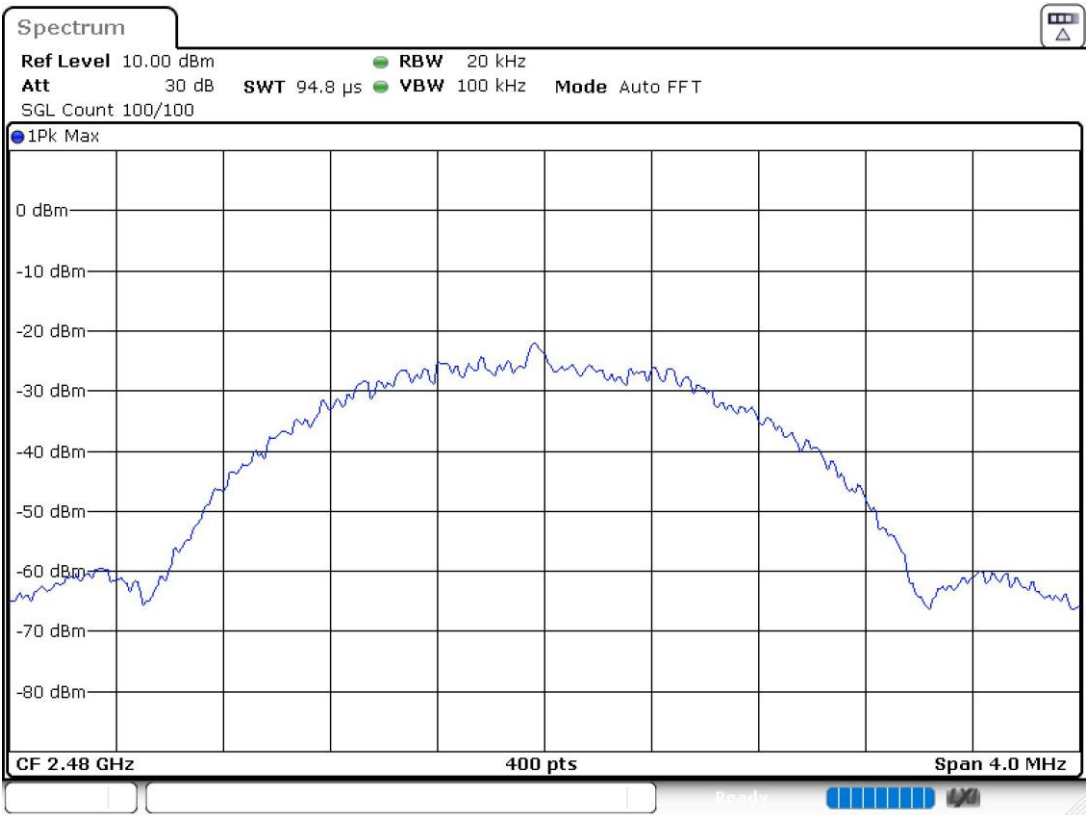
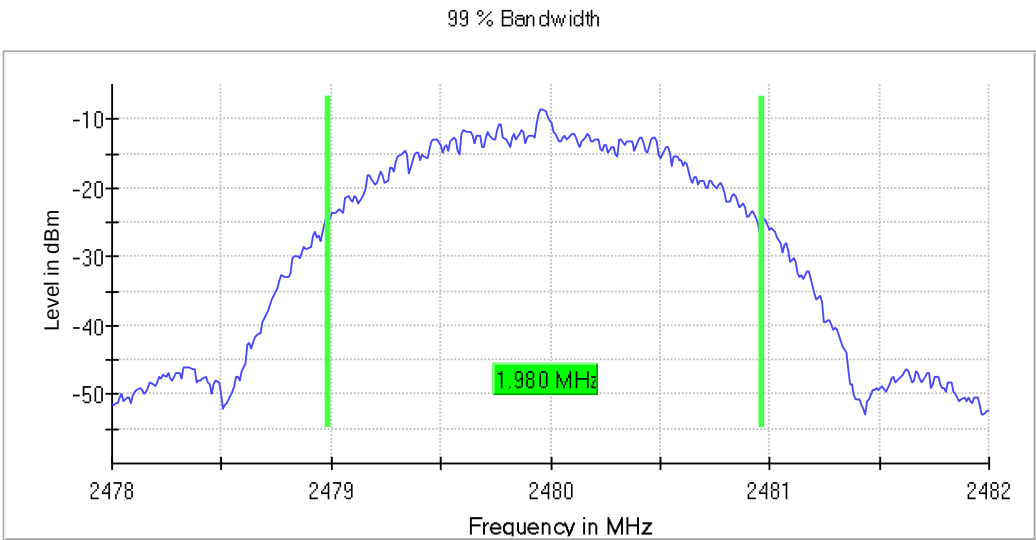
Operation Band MHz = [2400, 2483.5], Frequency MHz = 2440.00000, Equipment Type = Digital Transmission System (DTS), Modulation = BTLE 5.1 (GFSK 2 Mbit/s)

Images:



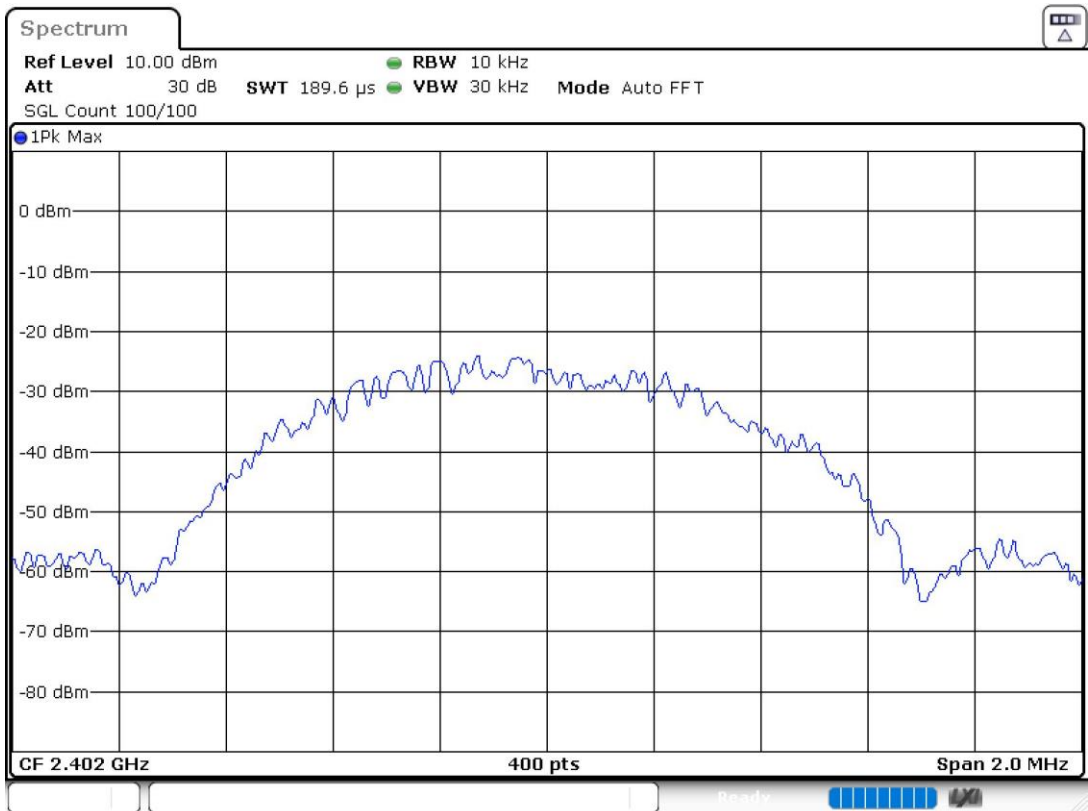
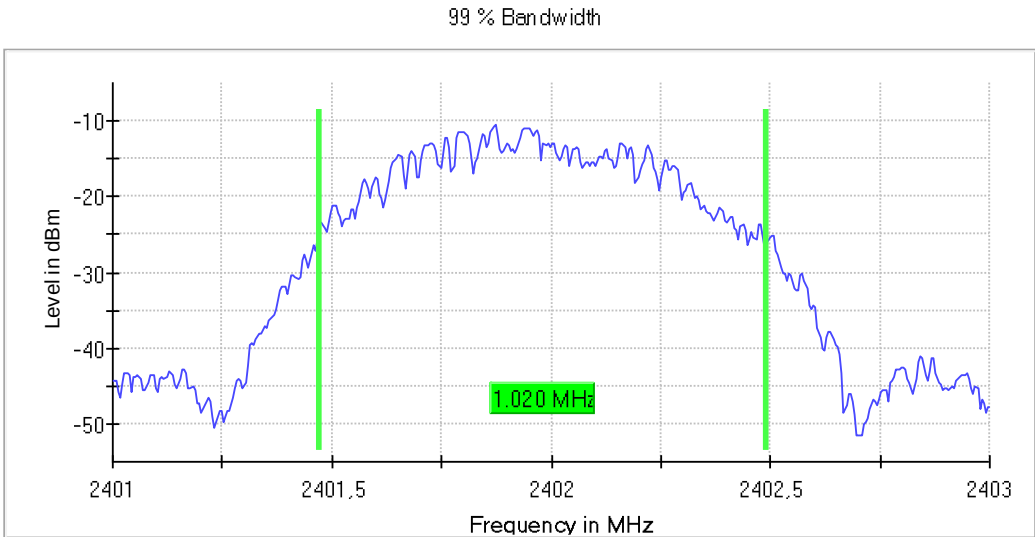
Operation Band MHz = [2400, 2483.5], Frequency MHz = 2480.00000, Equipment Type = Digital Transmission System (DTS), Modulation = BTLE 5.1 (GFSK 2 Mbit/s)

Images:



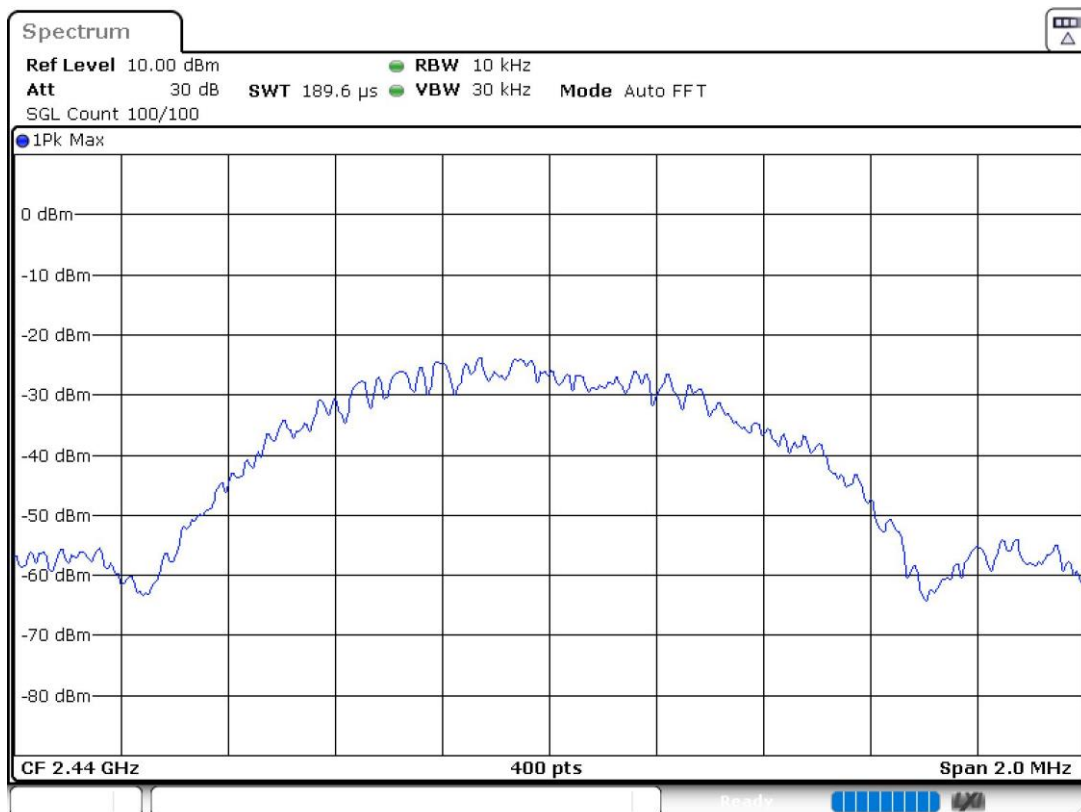
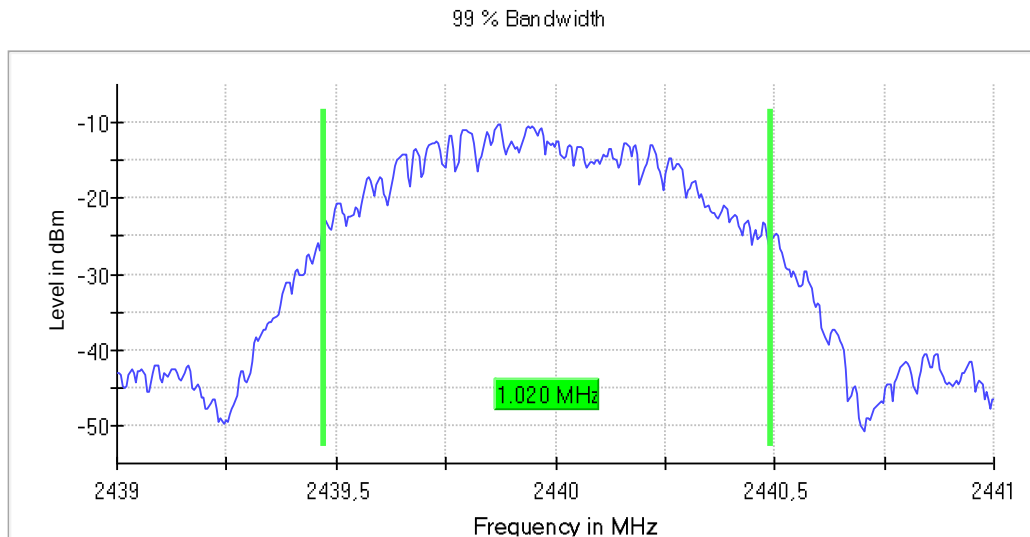
Operation Band MHz = [2400, 2483.5], Frequency MHz = 2402.00000, Equipment Type = Digital Transmission System (DTS), Modulation = BTLE 5.1 (GFSK 1 Mbit/s)

Images:



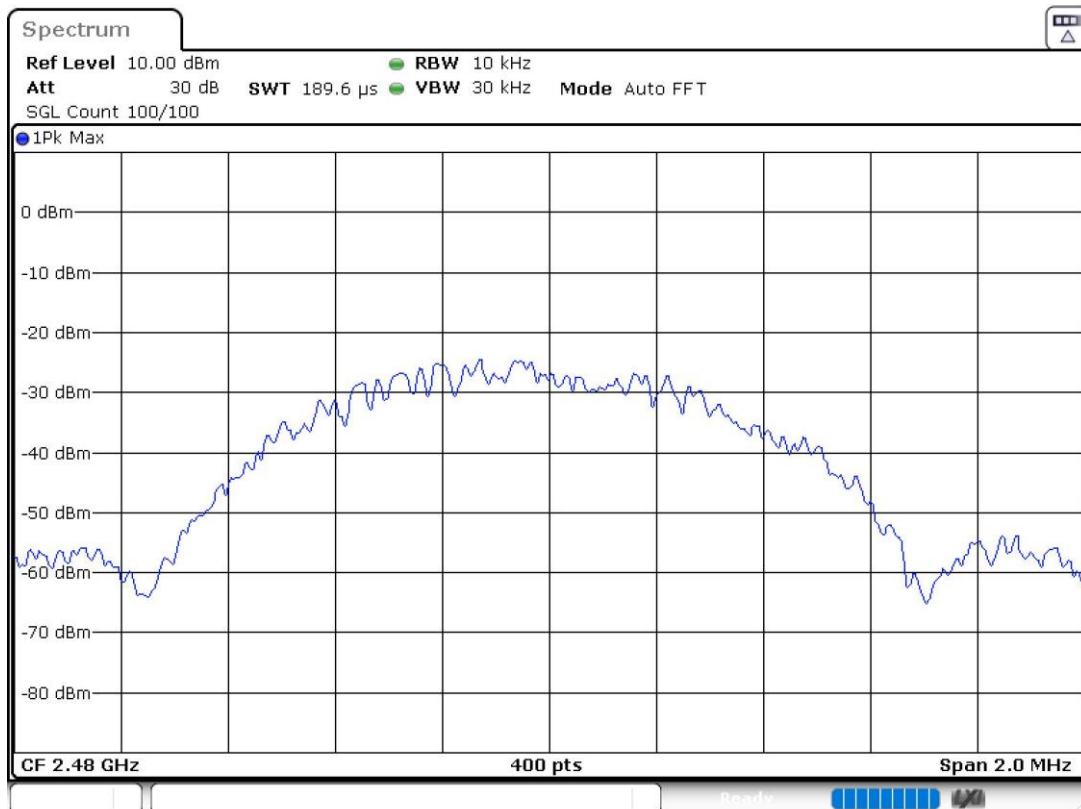
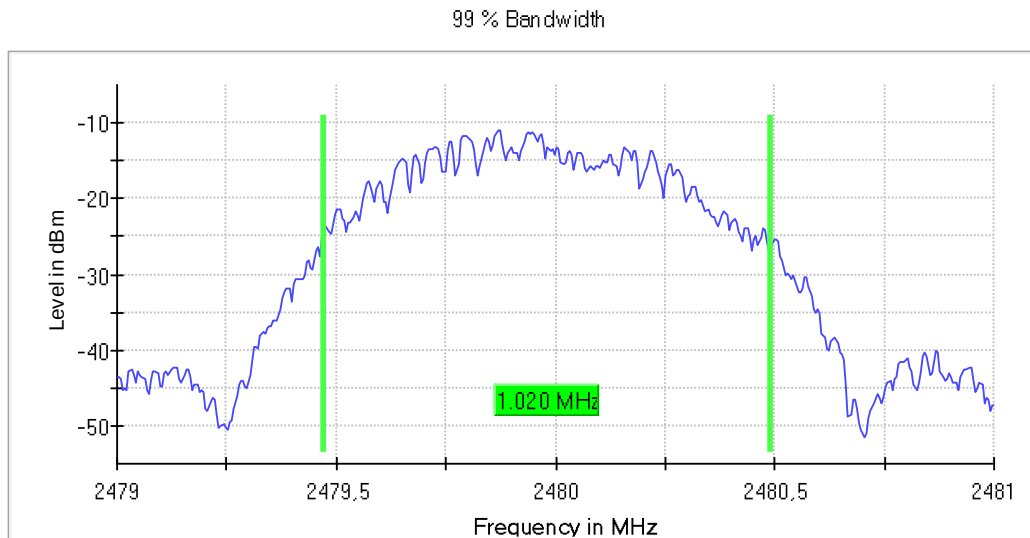
Operation Band MHz = [2400, 2483.5], Frequency MHz = 2440.00000, Equipment Type = Digital Transmission System (DTS), Modulation = BTLE 5.1 (GFSK 1 Mbit/s)

Images:



Operation Band MHz = [2400, 2483.5], Frequency MHz = 2480.00000, Equipment Type = Digital Transmission System (DTS), Modulation = BTLE 5.1 (GFSK 1 Mbit/s)

Images:



FCC 15.247 (a) (2) 6 dB Bandwidth

Limits

The minimum 6 dB bandwidth shall be at least 500 kHz.

Modulation: BTLE 5.1 (GFSK 2 Mbit/s)

Results

Freq (MHz)	6 dB Bandwidth (MHz)
2402.00000	1.2277
2440.00000	1.2277
2480.00000	1.2277

Modulation: BTLE 5.1 (GFSK 1 Mbit/s)

Results

Freq (MHz)	6 dB Bandwidth (MHz)
2402.00000	0.6931
2440.00000	0.6931
2480.00000	0.6931

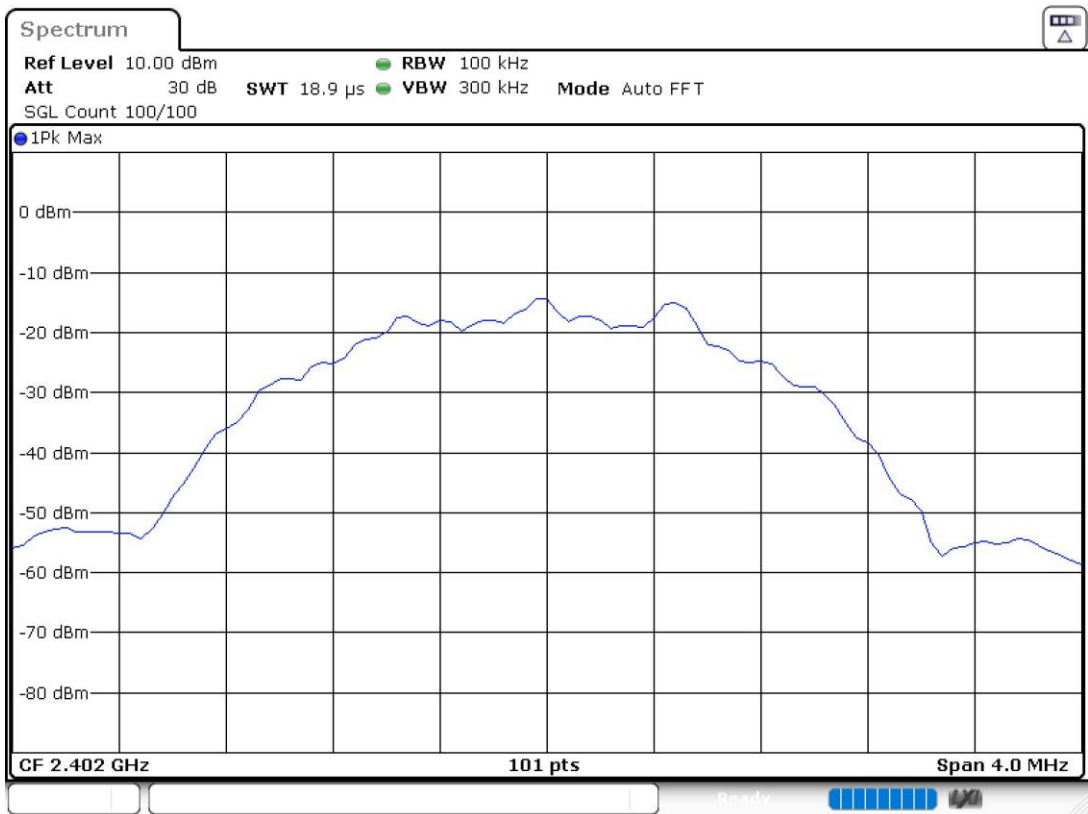
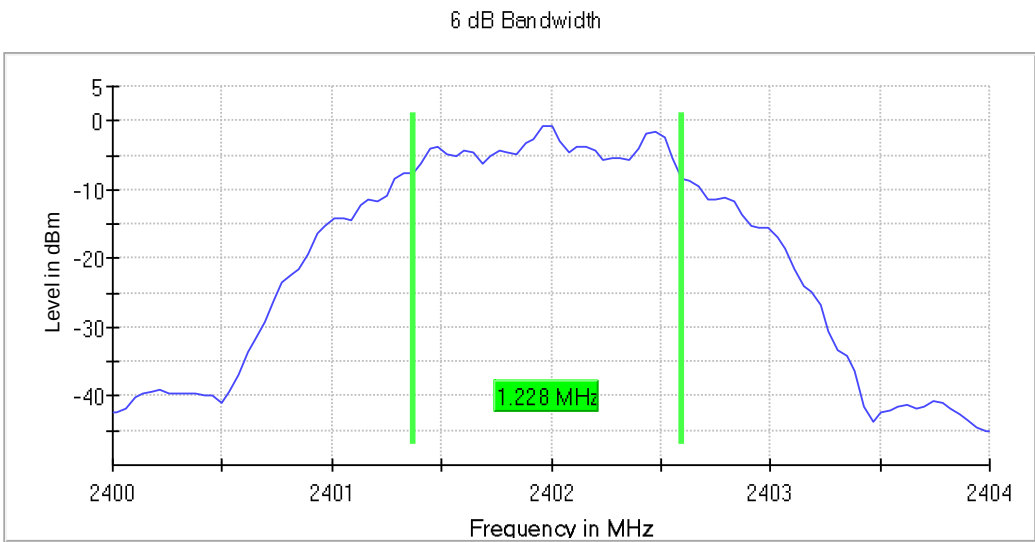
Verdict

Pass

Attachments

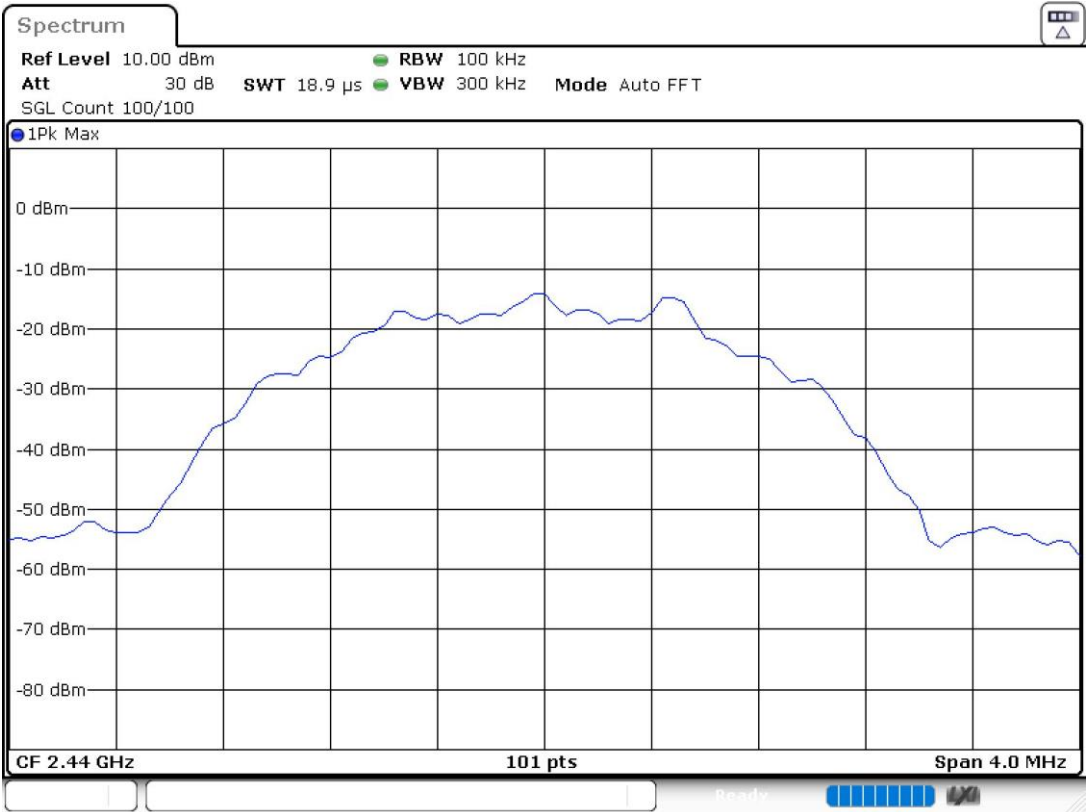
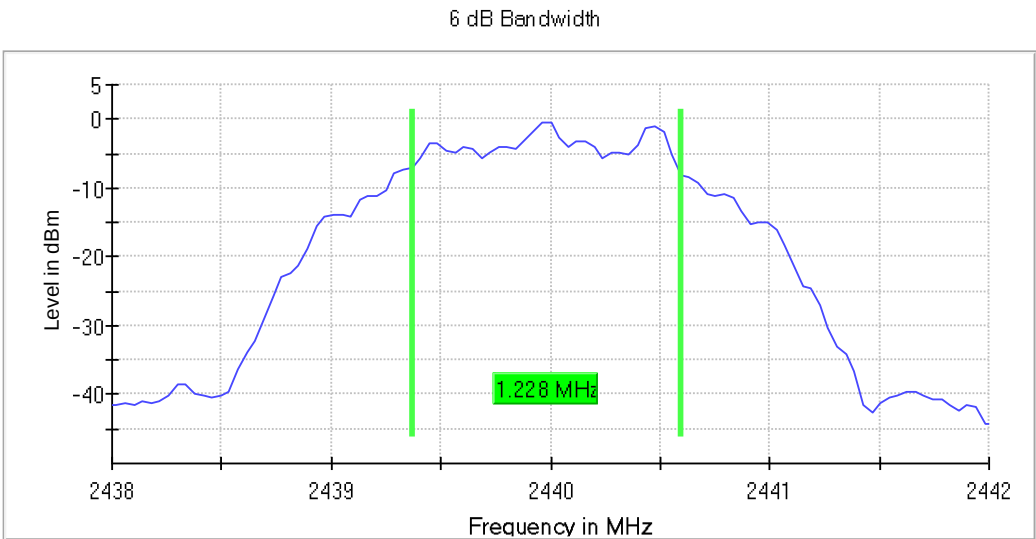
Frequency MHz = 2402.00000, Modulation = BTLE 5.1 (GFSK 2 Mbit/s)

Images:



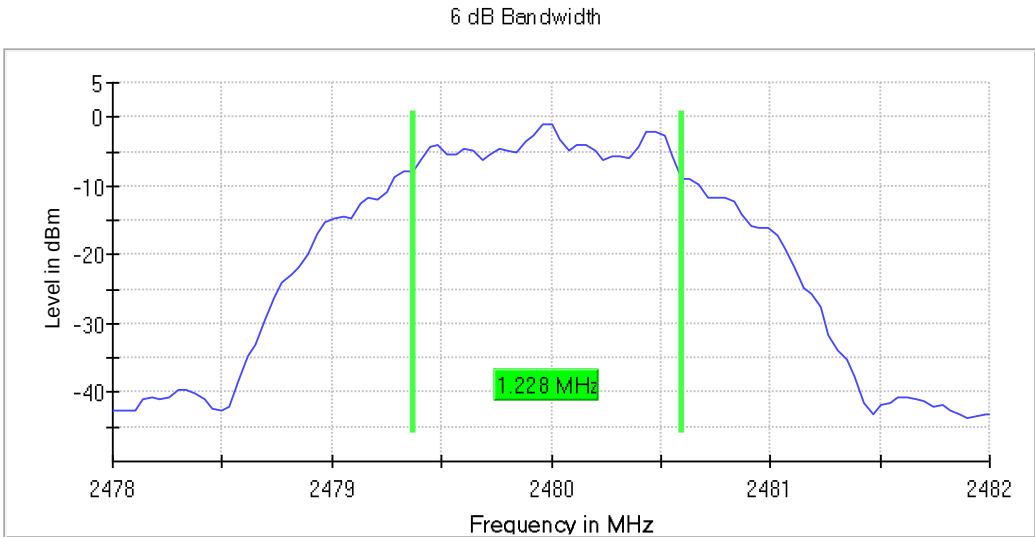
Frequency MHz = 2440.00000, Modulation = BTLE 5.1 (GFSK 2 Mbit/s)

Images:



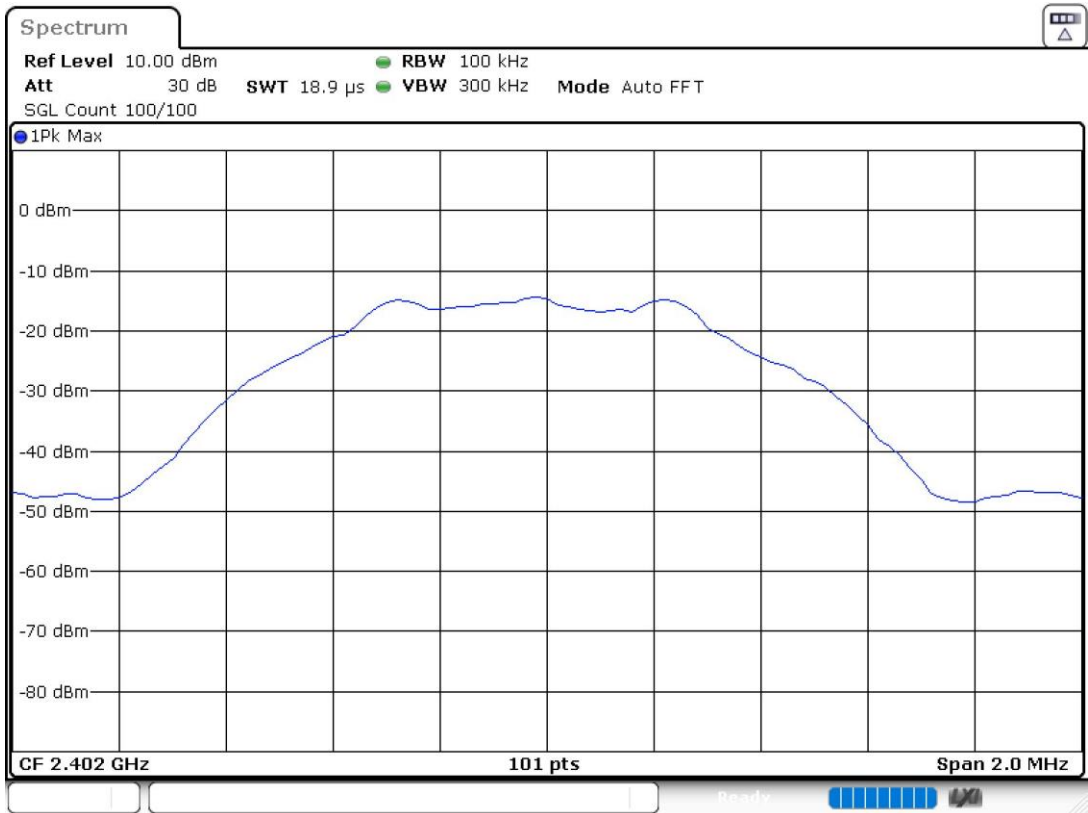
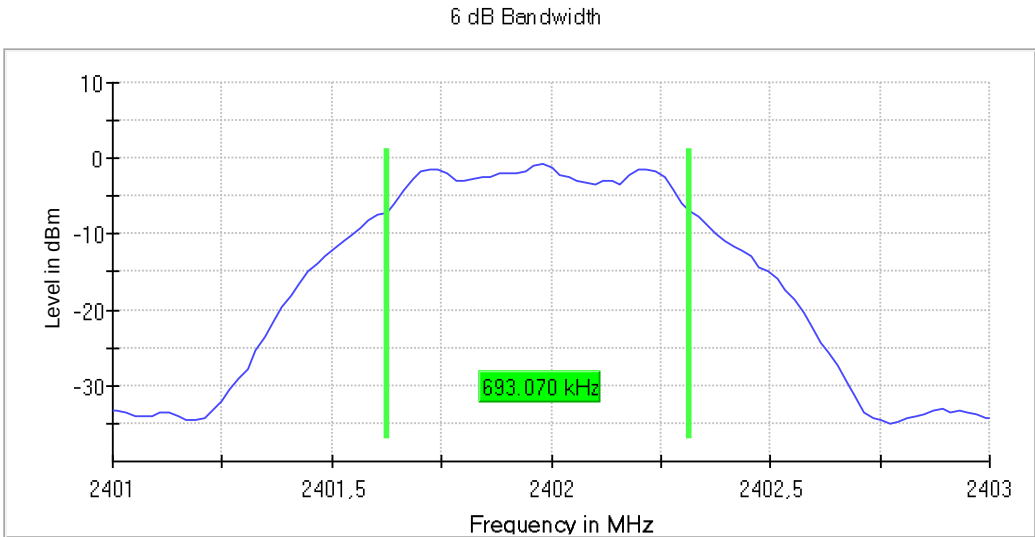
Frequency MHz = 2480.00000, Modulation = BTLE 5.1 (GFSK 2 Mbit/s)

Images:



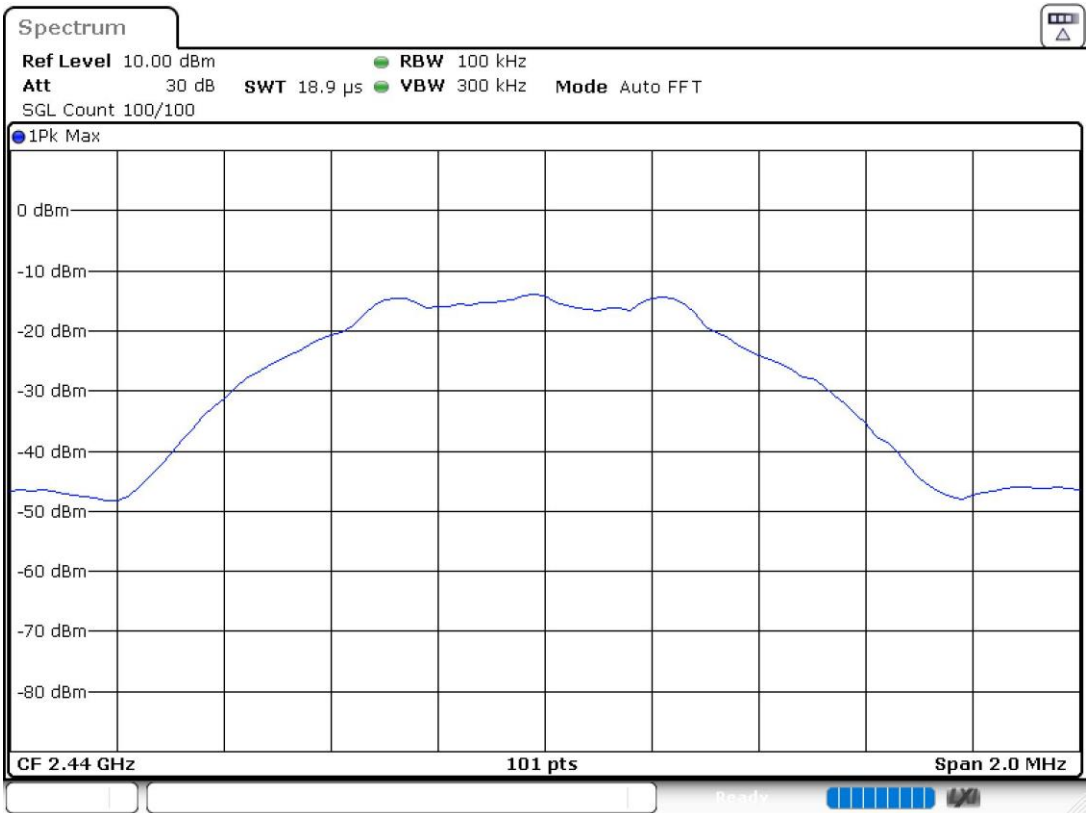
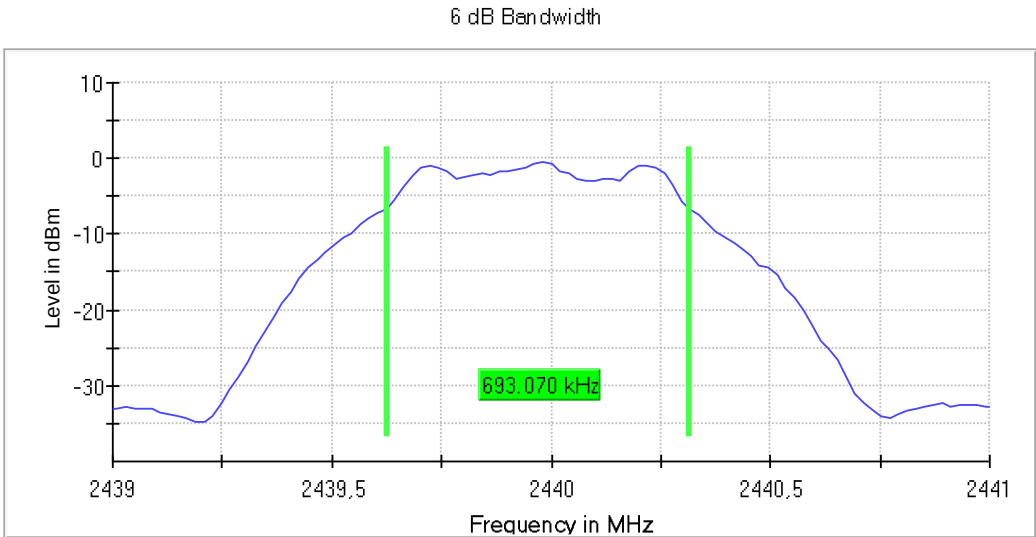
Frequency MHz = 2402.00000, Modulation = BTLE 5.1 (GFSK 1 Mbit/s)

Images:



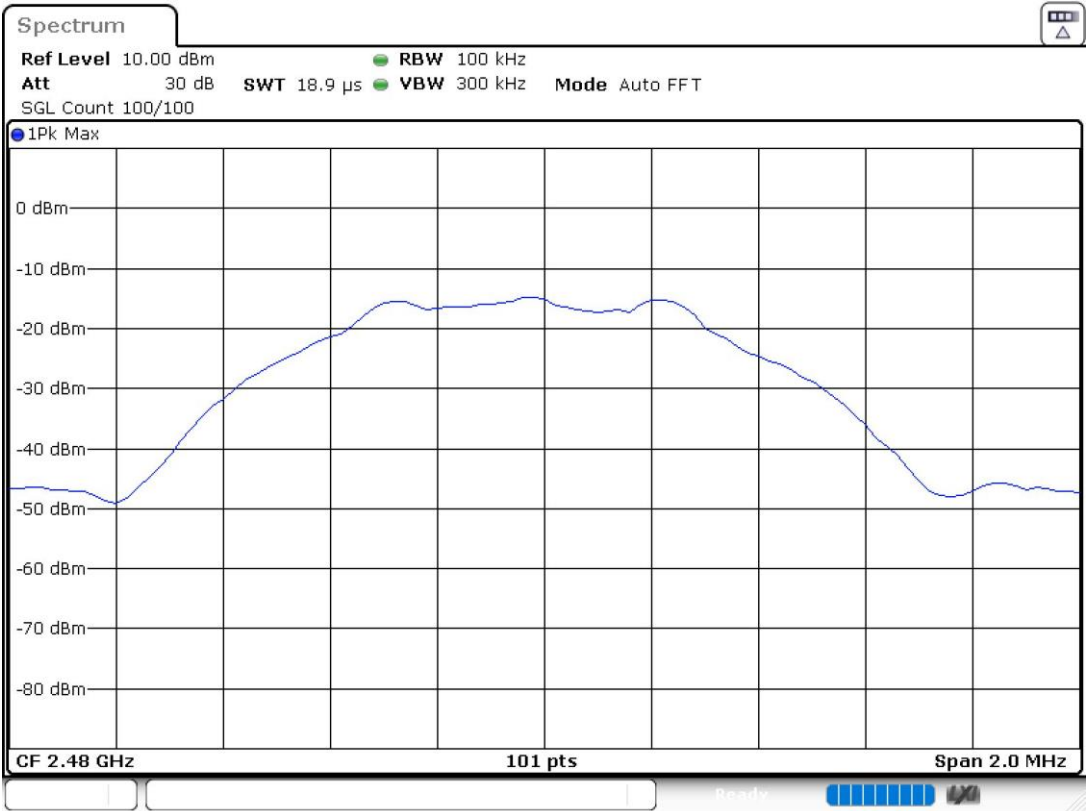
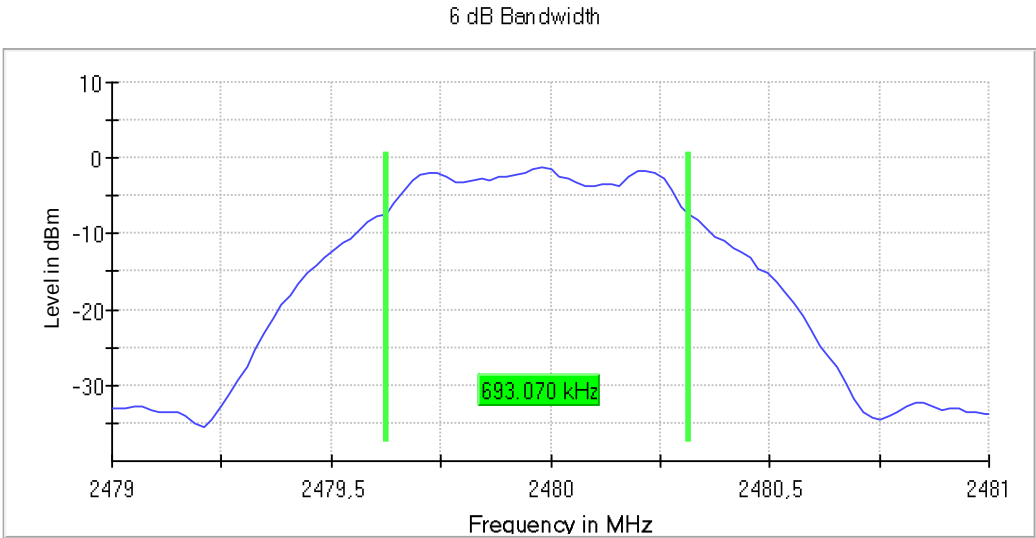
Frequency MHz = 2440.00000, Modulation = BTLE 5.1 (GFSK 1 Mbit/s)

Images:



Frequency MHz = 2480.00000, Modulation = BTLE 5.1 (GFSK 1 Mbit/s)

Images:



FCC 15.247 (e) Power spectral density

Limits

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Operation Band: [2400, 2483.5]

Modulation: BTLE 5.1 (GFSK 2 Mbit/s)

Results

Freq (MHz)	PSD (dBm)
2402.00000	-13.022
2440.00000	-12.595
2480.00000	-13.295

Modulation: BTLE 5.1 (GFSK 1 Mbit/s)

Results

Freq (MHz)	PSD (dBm)
2402.00000	-10.529
2440.00000	-10.110
2480.00000	-10.812

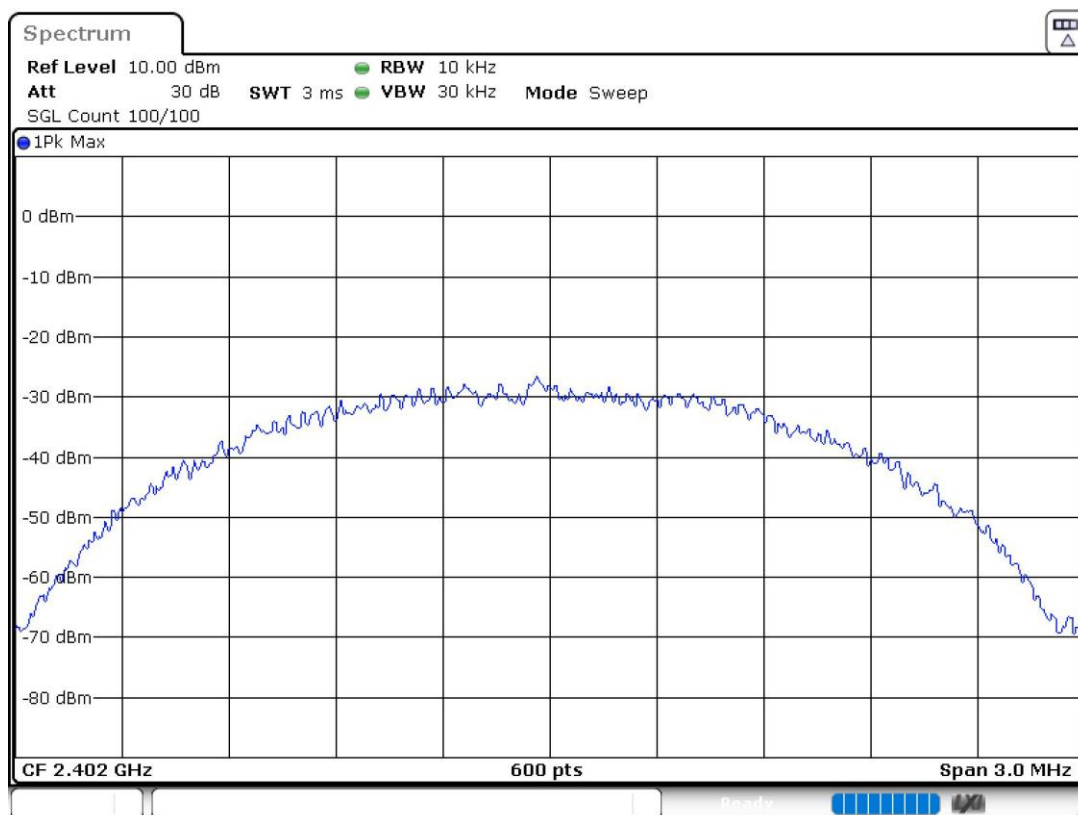
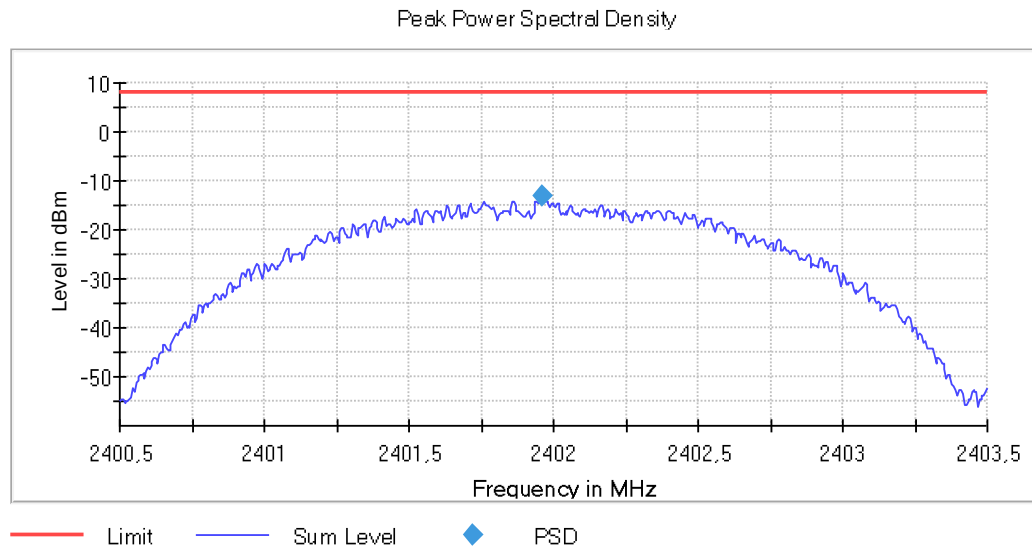
Verdict

Pass

Attachments

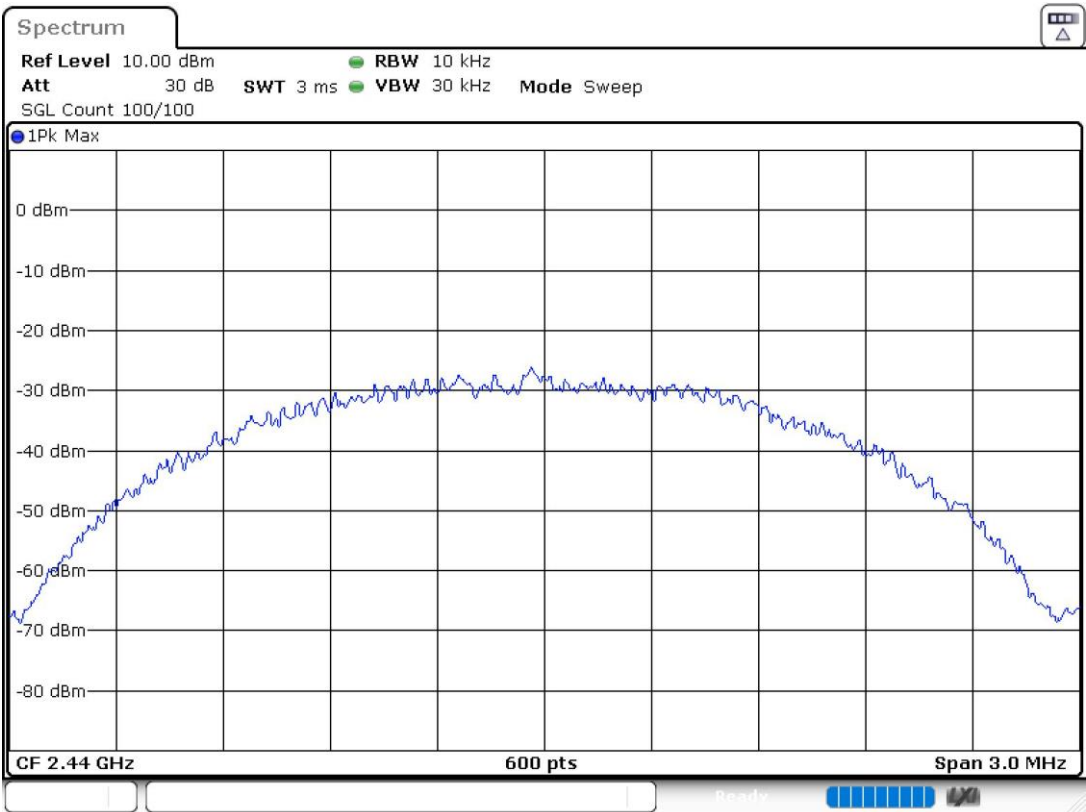
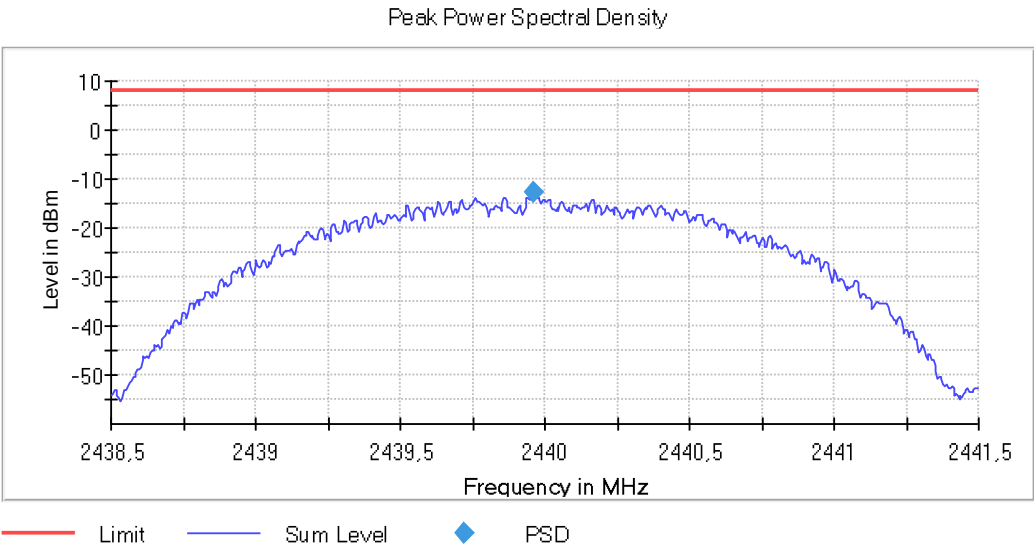
Operation Band MHz = [2400, 2483.5], Frequency MHz = 2402.00000, Equipment Type = Digital Transmission System (DTS), Modulation = BTLE 5.1 (GFSK 2 Mbit/s)

Images:



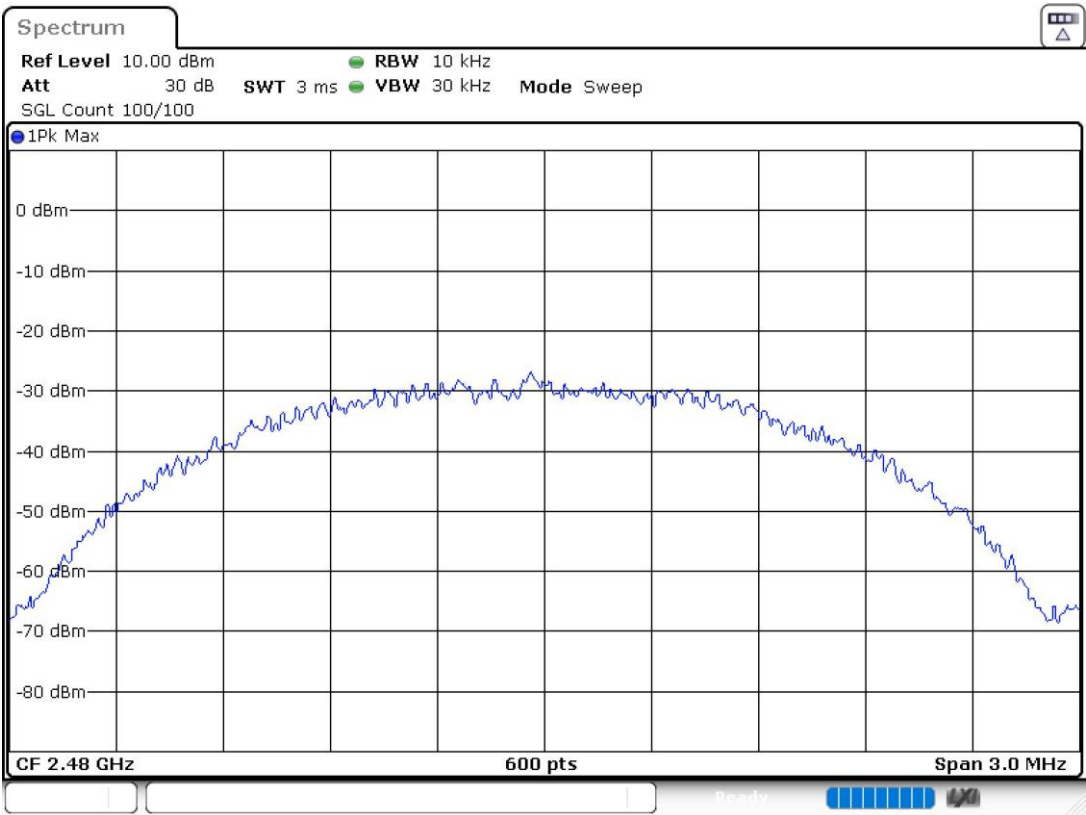
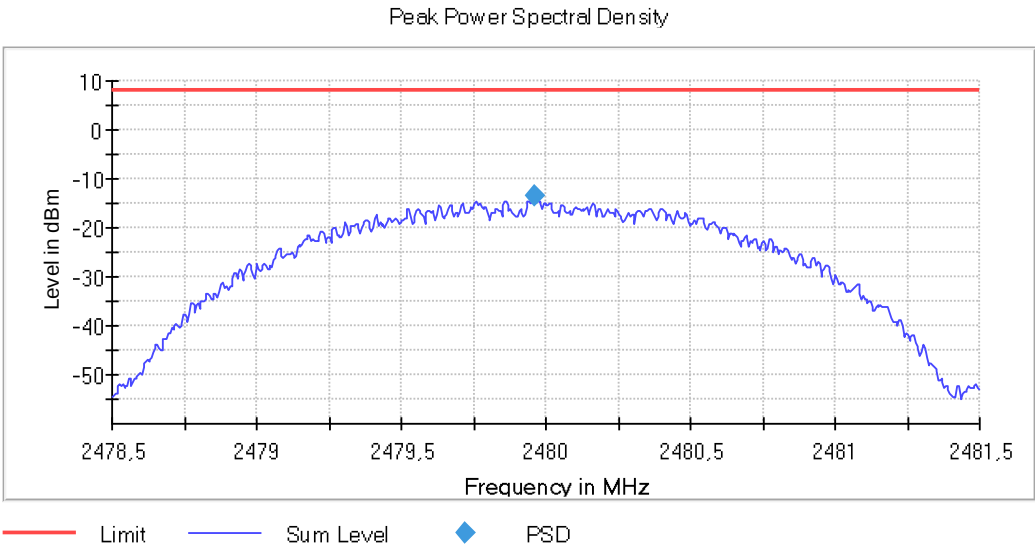
Operation Band MHz = [2400, 2483.5], Frequency MHz = 2440.00000, Equipment Type = Digital Transmission System (DTS), Modulation = BTLE 5.1 (GFSK 2 Mbit/s)

Images:



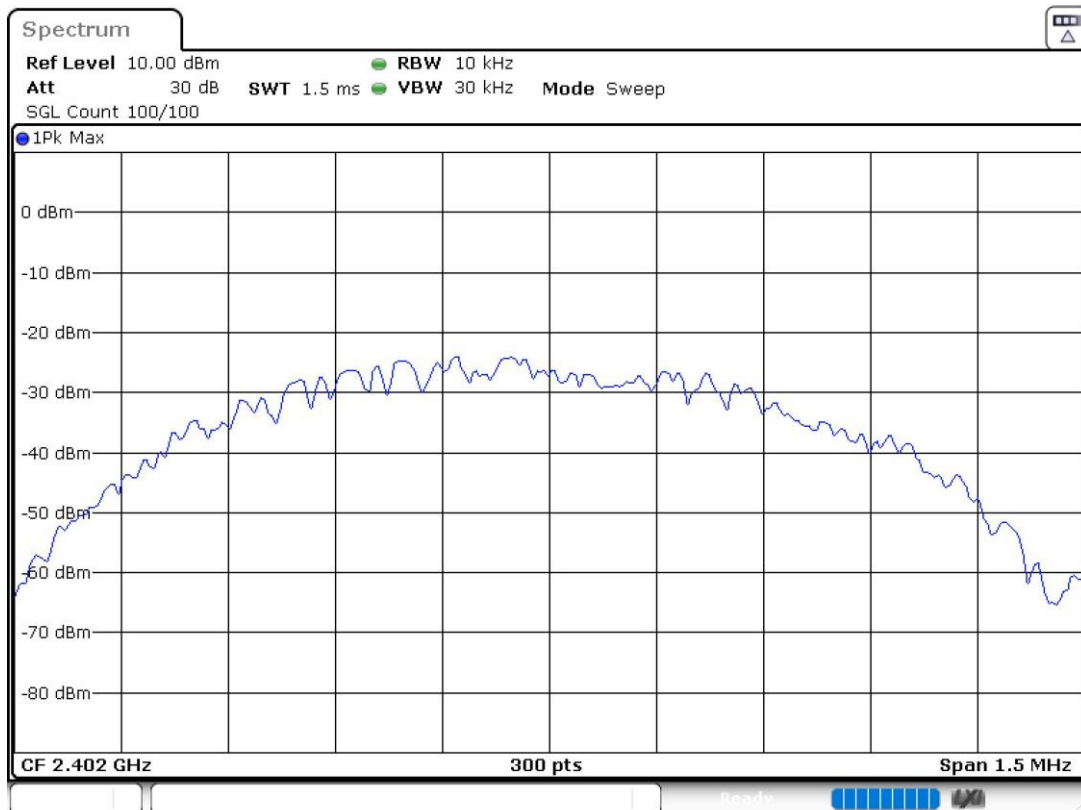
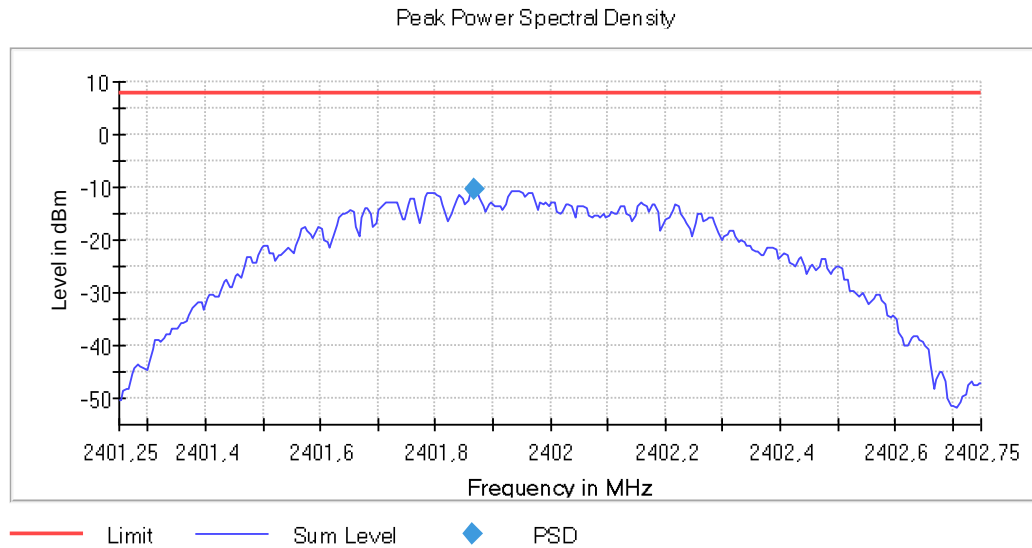
Operation Band MHz = [2400, 2483.5], Frequency MHz = 2480.00000, Equipment Type = Digital Transmission System (DTS), Modulation = BTLE 5.1 (GFSK 2 Mbit/s)

Images:



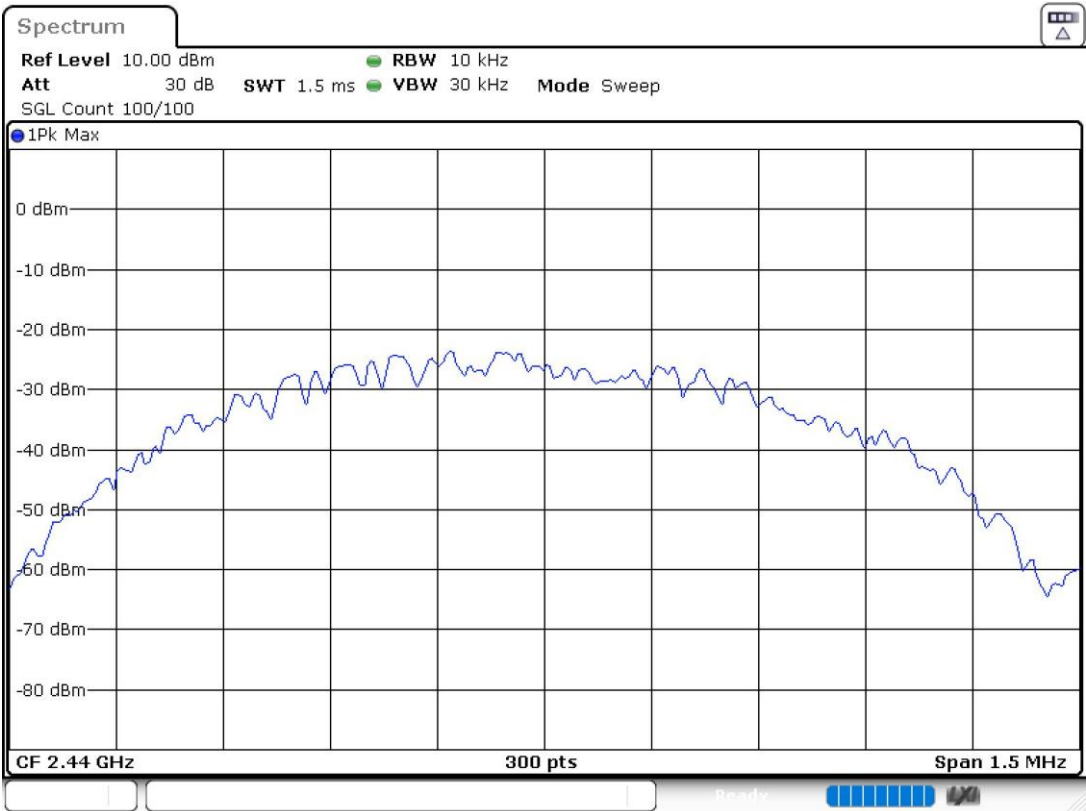
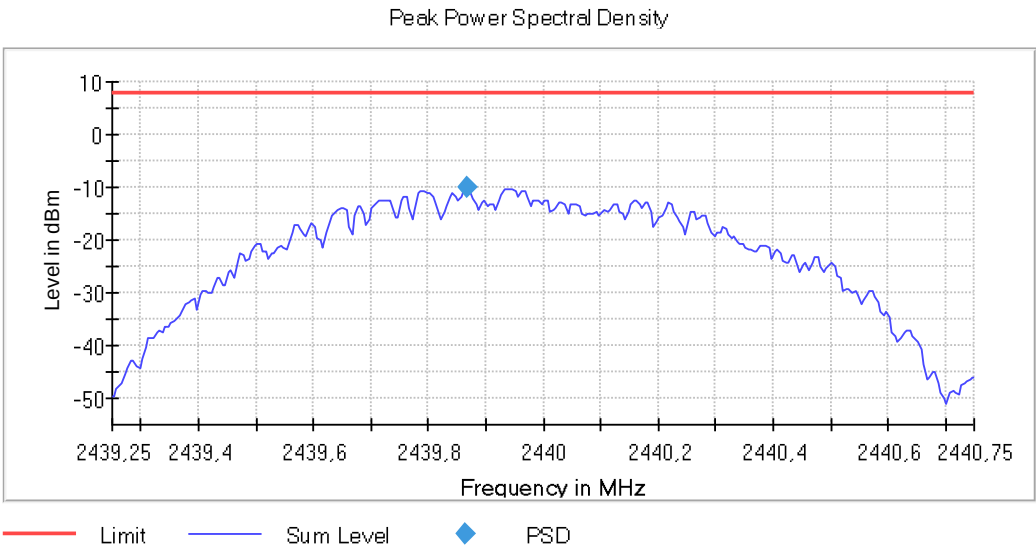
Operation Band MHz = [2400, 2483.5], Frequency MHz = 2402.00000, Equipment Type = Digital Transmission System (DTS), Modulation = BTLE 5.1 (GFSK 1 Mbit/s)

Images:



Operation Band MHz = [2400, 2483.5], Frequency MHz = 2440.00000, Equipment Type = Digital Transmission System (DTS), Modulation = BTLE 5.1 (GFSK 1 Mbit/s)

Images:



Operation Band MHz = [2400, 2483.5], Frequency MHz = 2480.00000, Equipment Type = Digital Transmission System (DTS), Modulation = BTLE 5.1 (GFSK 1 Mbit/s)

Images:

