9 TRANSMITTER OUTPUT POWER

9.1 Test Equipment

The following test equipment was used during the maximum peak output power measurement:

Item	Type	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
1.	Spectrum Analyzer	Agilent	N9010A	MY52221182	2023.08.09	1 Year
2.	RF Cable	Mini-Circuits	FLC-3FT-SM SM+	22022838	2023.08.09	1 Year
3.	10 dB Attenuator	Mini-Circuits	BW-S10W2+	001	2023.08.09	1 Year

9.2 Block Diagram of Test Setup

Same as section 5.2.

9.3 Specification Limits (§15.247(b)(1))

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

9.4 Operating Condition of EUT

The software as section 2.3 was used to enable the EUT to change the test mode one by one.

9.5 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.

The test procedure is defined in ANSI C63.10-2013 (7.8.5 Measurement Procedure " Output power test procedure for frequency-hopping spread-spectrum (FHSS) devices" was used).

9.6 Test Results

PASSED.

All the test results are listed below.

(Test Date: 2024.05.30 Temperature: 23℃ Humidity: 51 %)

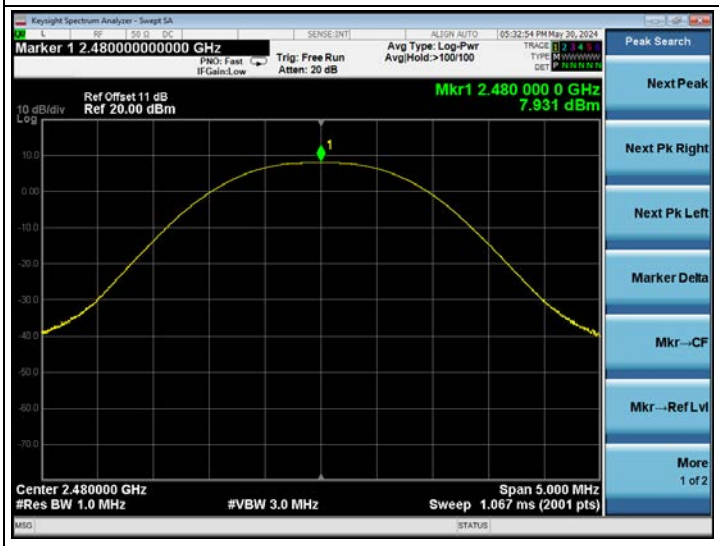
Mode	Channel	Frequency (MHz)	**Maximum Conducted Output Power (dBm)**	Limit (dBm)
BT DH1	00	2402	**8.051**	30
	39	2441	**7.563**	30
	78	2480	**7.931**	30
BT DH3	00	2402	**8.097**	30
	39	2441	**7.589**	30
	78	2480	**7.924**	30
BT DH5	00	2402	**8.128**	30
	39	2441	**7.606**	30
	78	2480	**7.931**	30
BT 3DH1	00	2402	**10.04**	30
	39	2441	**9.505**	30
	78	2480	**9.824**	30
BT 3DH3	00	2402	**10.199**	30
	39	2441	**9.62**	30
	78	2480	**9.904**	30
BT 3DH5	00	2402	**10.18**	30
	39	2441	**9.613**	30
	78	2480	**9.879**	30

DH1

CH2402

CH2441

CH2480



DH3

CH2402

CH2441

CH2480

DH5

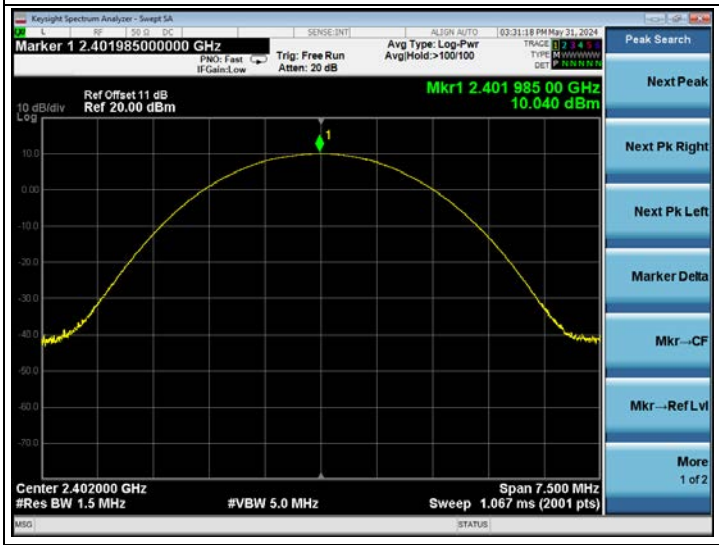
CH2402

CH2441

CH2480

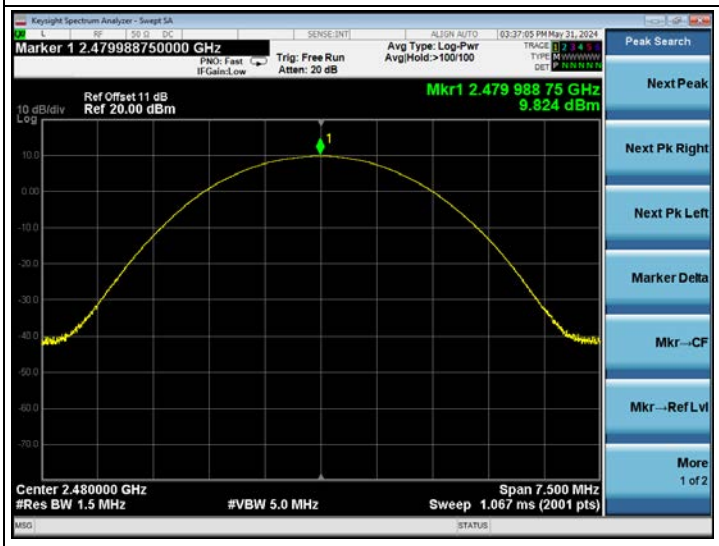
3DH1

CH2402



CH2441

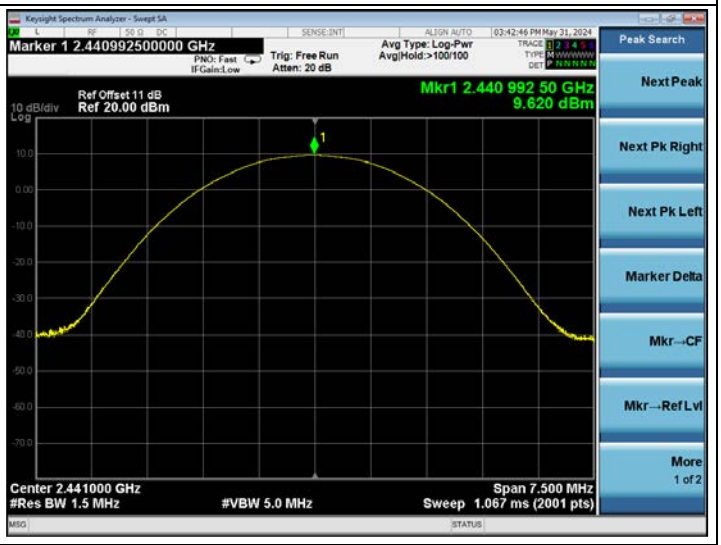
CH2480



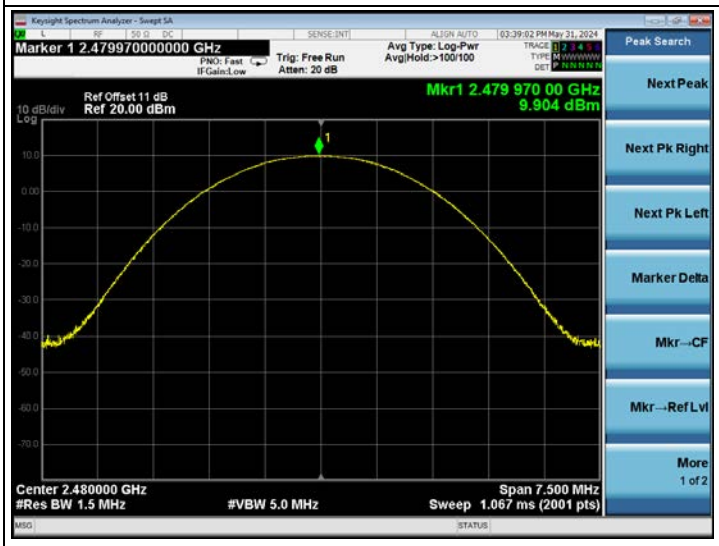
3DH3

CH2402

CH2441



CH2480

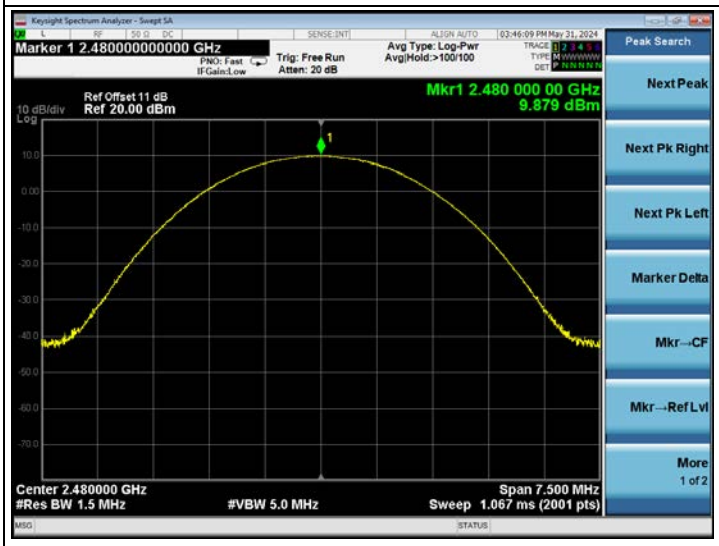


3DH5

CH2402

CH2441

CH2480



10 BAND EDGE MEASUREMENT

10.1 Test Equipment

The following test equipment was used during the maximum peak output power measurement:

Item	Type	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
1.	Spectrum Analyzer	Agilent	N9010A	MY52221182	2023.08.09	1 Year
2.	RF Cable	Mini-Circuits	FLC-3FT-SM SM+	22022838	2023.08.09	1 Year
3.	10 dB Attenuator	Mini-Circuits	BW-S10W2+	001	2023.08.09	1 Year

10.2 Block Diagram of Test Setup

The Same as Section. 5.2

10.3 Specification Limits (§15.247(d))

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.
In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see§15.205(c)). (※This test result attaching to §4.7).

10.4 Operating Condition of EUT

The software as section 2.3 was used to enable the EUT to change the test mode one by one and have its hopping function enabled.

10.5 Test Procedure

The transmitter output was connected to the spectrum analyzer.
a) Set the EUT to the lowest frequency channel (for the hopping on test, the hopping sequence shall include the lowest frequency channel).
b) Set the EUT to operate at maximum output power and 100% duty cycle, or equivalent “normal mode of operation” as specified in 6.10.3 of ANSI C63.10.
c) Perform the test as follows:

1) Span: wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation.
2) Attenuation: Auto
3) Sweep time: Coupled.

4) Resolution bandwidth: 100kHz.
5) Video bandwidth: 300kHz.
6) Detector: peak
7) Trace: max hold.

d) Allow the trace to stabilize. For the test with the hopping function turned ON, this can take several minutes to achieve a reasonable probability of intercepting any emissions due to oscillator overshoot.
e) Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.
f) Repeat step b) through step e) for every applicable modulation.
k) Set the EUT to the highest frequency channel (for the hopping on test, the hopping sequence shall include the highest frequency channel and repeat step b) through step f).

Band-edge measurements shall be tested both on single channels, and with the EUT hopping.

The test procedure is defined in ANSI C63.10-2013 (7.8.6 " Band-edge measurements for RF conducted emissions", 6.10.4 Measurement Procedure " Authorized-band band-edge measurements (relative method)" was used).

10.6 Test Results

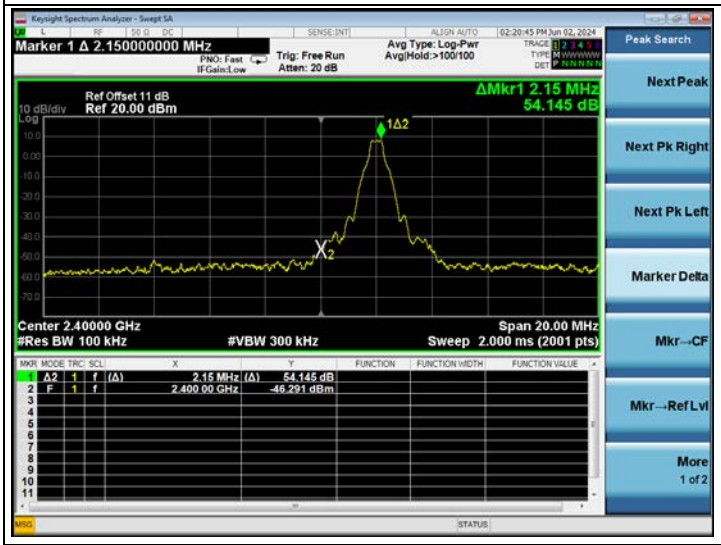
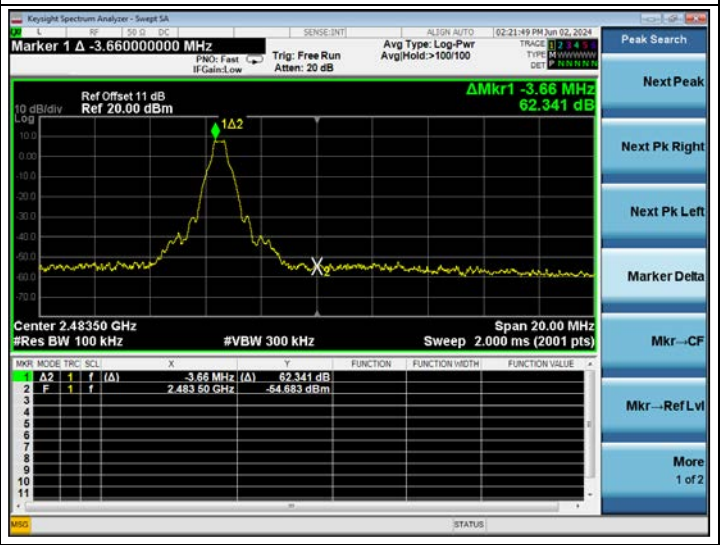
PASSED.

All the test results are attached in next pages.

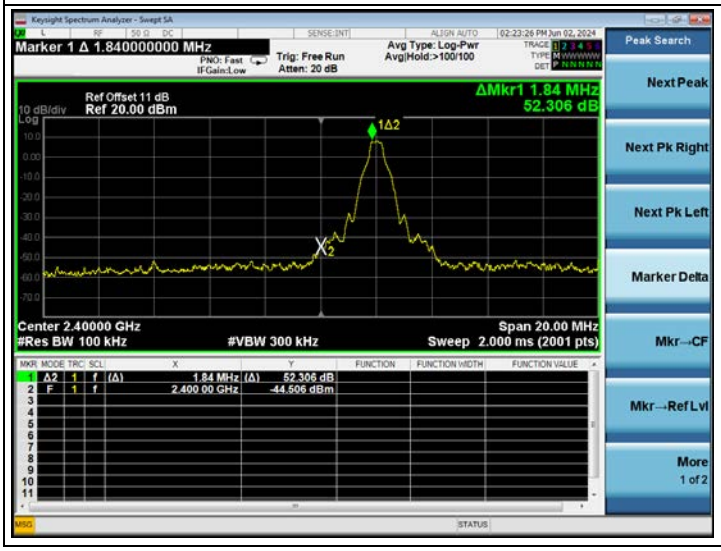
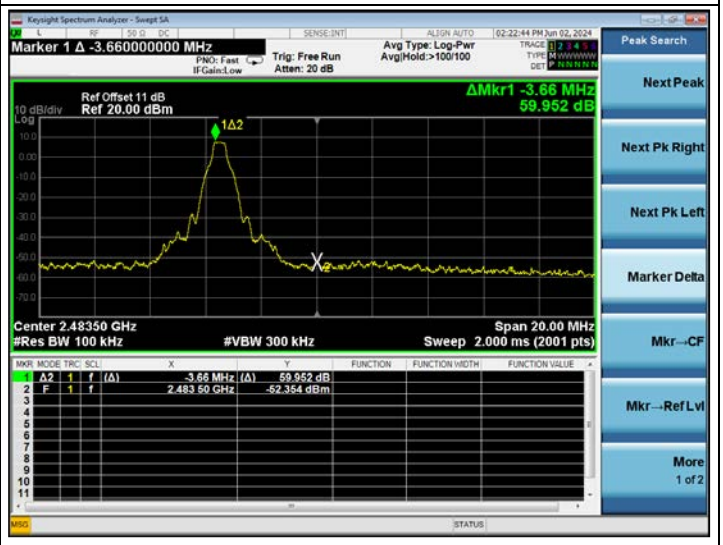
(Test Date: 2024.06.02 Temperature: 23℃ Humidity: 51 %)

Mode	Location	Channel	Frequency (MHz)	**Delta Marker (dB)**	Limit (dB)
BT DH1	Lower Edge	00	2402	**54.145**	20
	Upper Edge	78	2480	**62.341**	20
BT DH3	Lower Edge	00	2402	**52.306**	20
	Upper Edge	78	2480	**59.952**	20
BT DH5	Lower Edge	00	2402	**51.87**	20
	Upper Edge	78	2480	**59.343**	20
BT 3DH1	Lower Edge	00	2402	**56.094**	20
	Upper Edge	78	2480	**62.155**	20
BT 3DH3	Lower Edge	00	2402	**56.387**	20
	Upper Edge	78	2480	**62.33**	20
BT 3DH5	Lower Edge	00	2402	**56.12**	20
	Upper Edge	78	2480	**61.238**	20
BT DH1 Hopping	Lower Edge	Hopping		**53.579**	20
	Upper Edge	Hopping		**61.678**	20
BT DH3 Hopping	Lower Edge	Hopping		**53.73**	20
	Upper Edge	Hopping		**62.017**	20
BT DH5 Hopping	Lower Edge	Hopping		**57.01**	20
	Upper Edge	Hopping		**62.239**	20
BT 3DH1 Hopping	Lower Edge	Hopping		**57.408**	20
	Upper Edge	Hopping		**62.148**	20
BT 3DH3 Hopping	Lower Edge	Hopping		**58.002**	20
	Upper Edge	Hopping		**62.887**	20
BT 3DH5 Hopping	Lower Edge	Hopping		**56.435**	20
	Upper Edge	Hopping		**62.831**	20

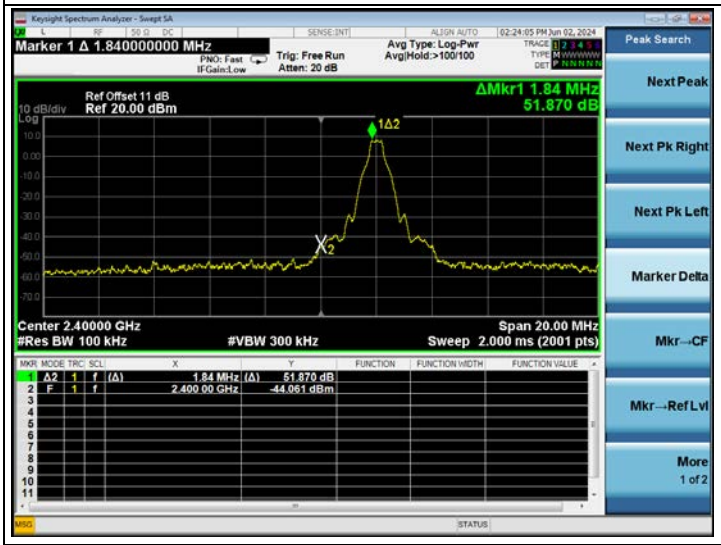
DH1

CH2402	CH2480
	

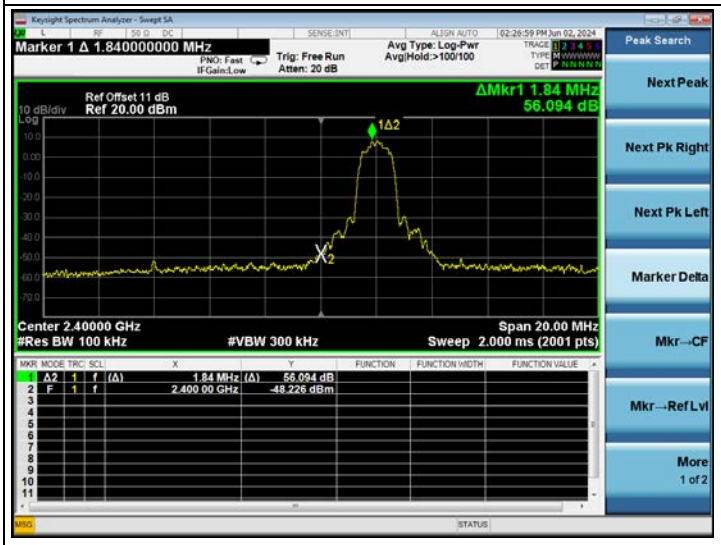
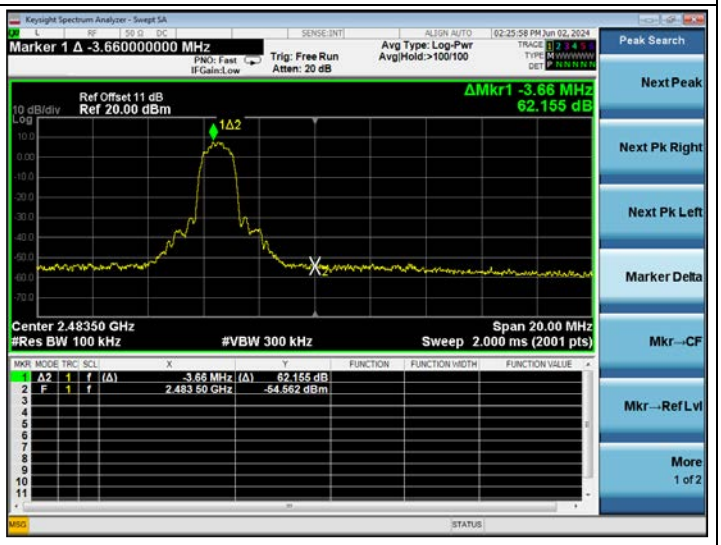
DH3

CH2402	CH2480
	

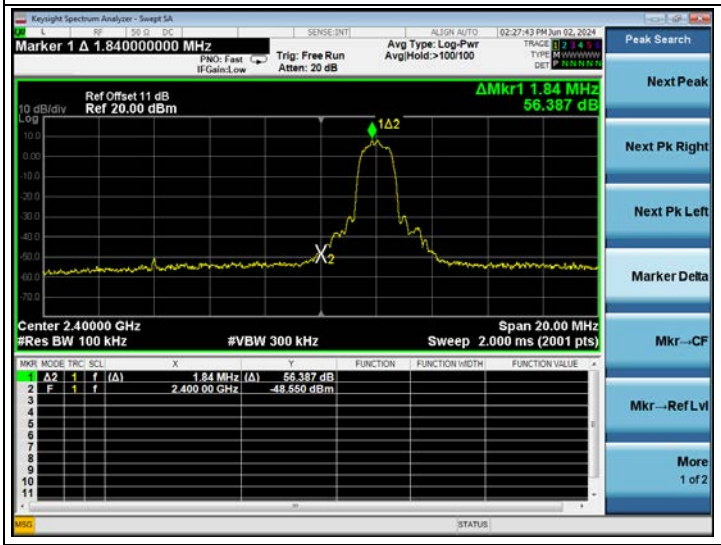
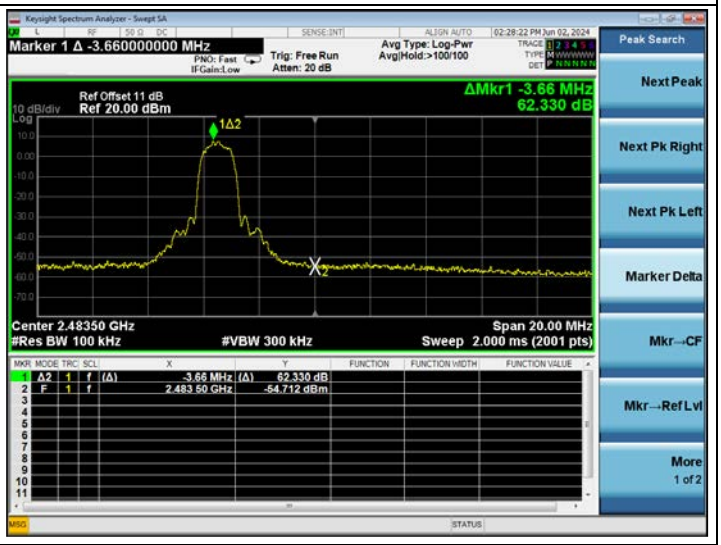
DH5

CH2402	CH2480
	

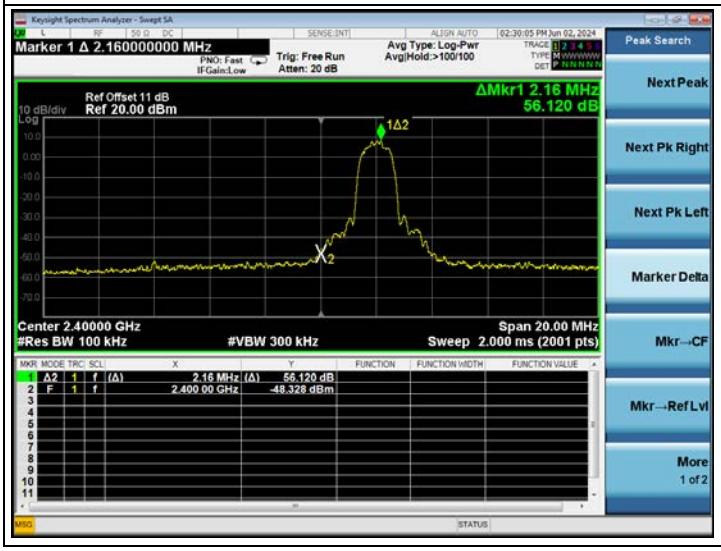
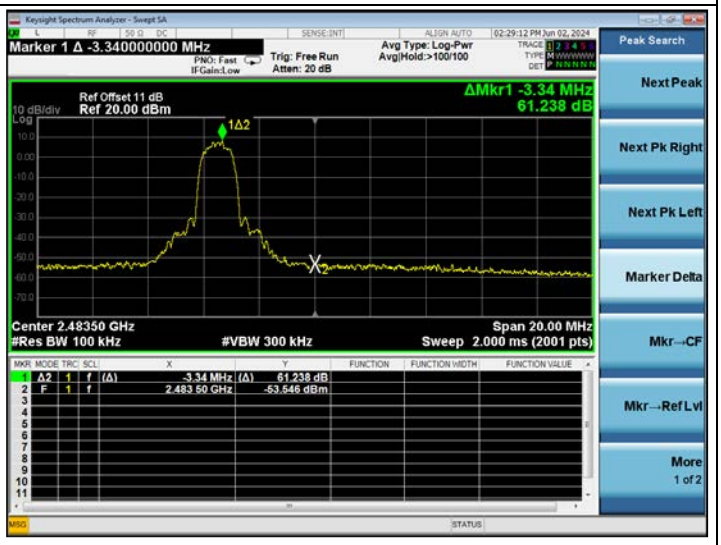
3DH1

CH2402	CH2480
	

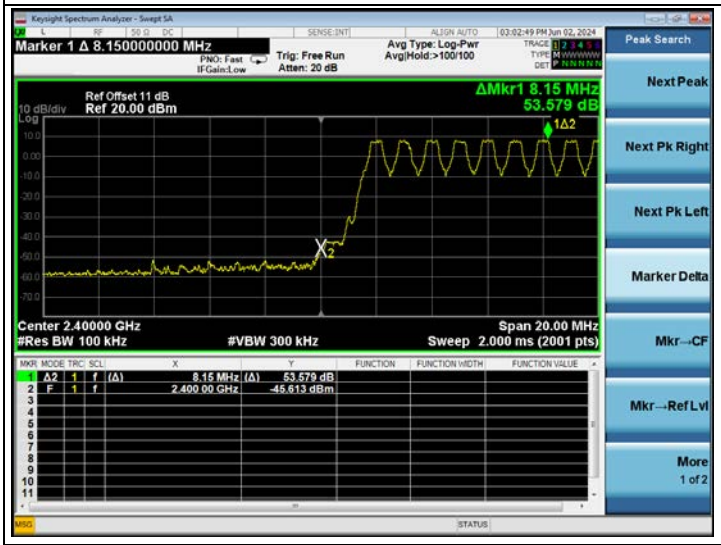
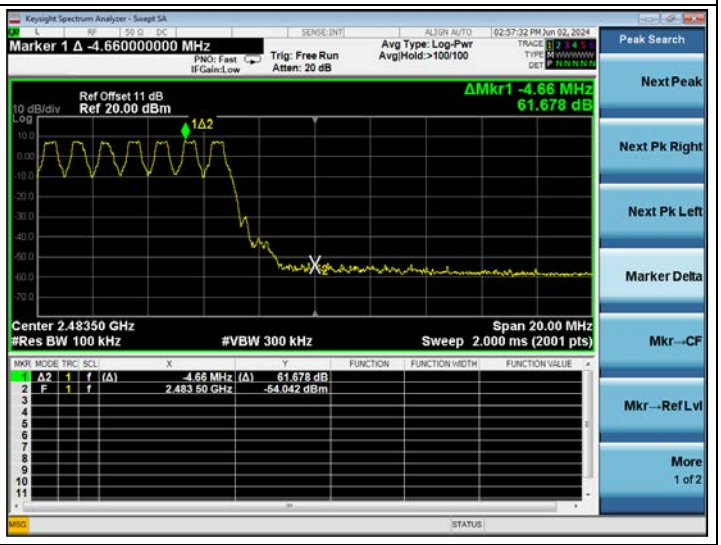
3DH3

CH2402	CH2480
	

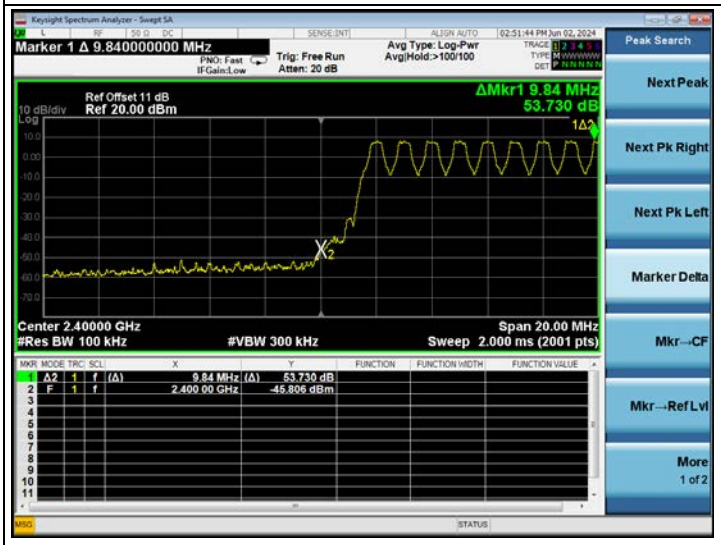
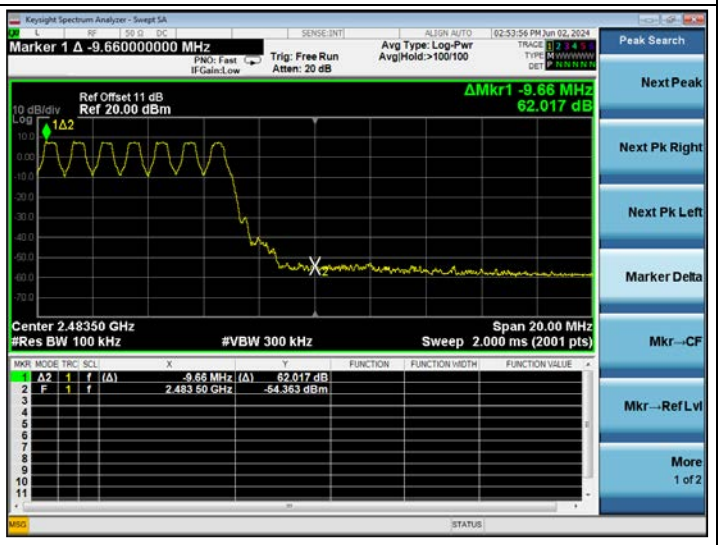
3DH5

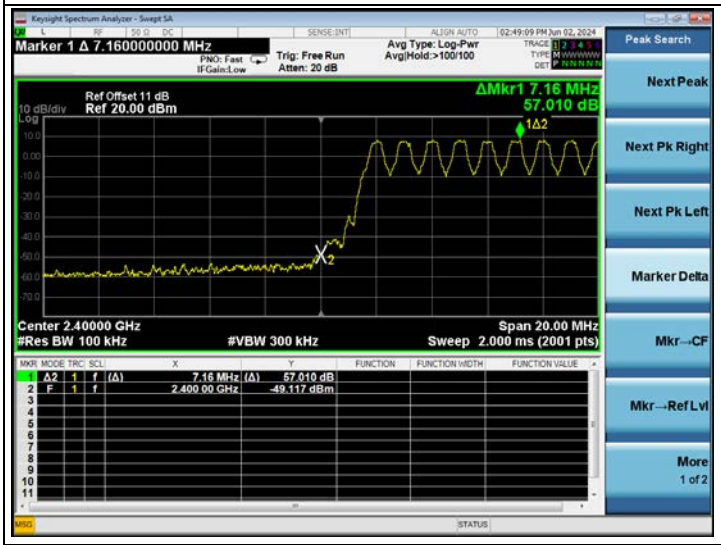
CH2402	CH2480
	

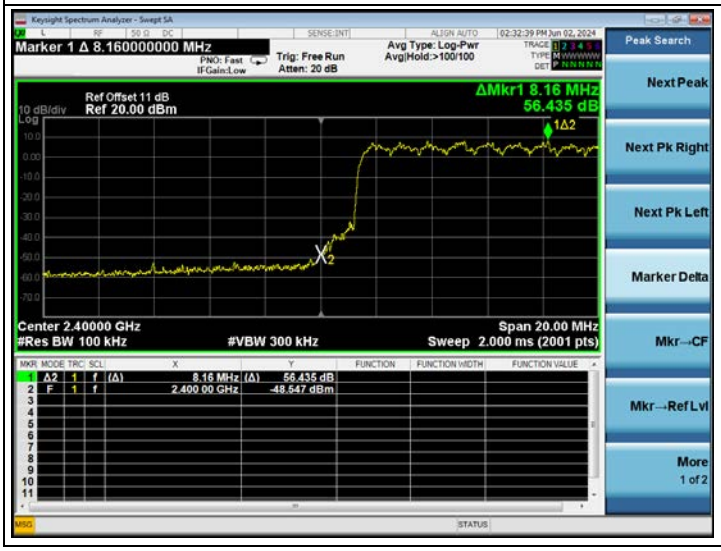
DH1

Hopping	Hopping
	

DH3

Hopping	Hopping
	

DH5	
Hopping	Hopping
	
3DH1	
Hopping	Hopping
	

3DH3	
Hopping	Hopping
	
3DH5	
Hopping	Hopping
	

11 UNWANTED EMISSIONS MEASUREMENT

11.1Test Equipment

The following test equipment was used during the emission limitations test：

Item	Type	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
1.	Spectrum Analyzer	Agilent	N9010A	MY52221182	2023.08.09	1 Year
2.	RF Cable	Mini-Circuits	FLC-3FT-SM SM+	22022838	2023.08.09	1 Year
3.	10 dB Attenuator	Mini-Circuits	BW-S10W2+	001	2023.08.09	1 Year

11.2Block Diagram of Test Setup

Same as Section. 5.2.

11.3Specification Limits (§15.247(d))

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.
In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see§15.205(c)). (※This test result attaching to §4.7).

11.4Operating Condition of EUT

The software as section 2.3 was used to enable the EUT to change the test mode one by one.

11.5Test Procedure

The transmitter output was connected to the spectrum analyzer.

Establish a reference level by using the following procedure:
Connect the primary antenna port through an attenuator to the spectrum analyzer input; in the results, account for all losses between the unlicensed wireless device output and the spectrum analyzer. The instrument shall span 30 MHz to 10 times the operating frequency in GHz, with a resolution bandwidth of 100 kHz, video bandwidth of 300 kHz, and a coupled sweep time with a peak detector. The band 30 MHz to the highest frequency may be split into smaller spans, as long as the entire spectrum is covered.

The test procedure is defined in ANSI C63.10-2013 (7.8.8 “ Conducted spurious emissions test methodology” was used).

11.6 Test Results

PASSED.

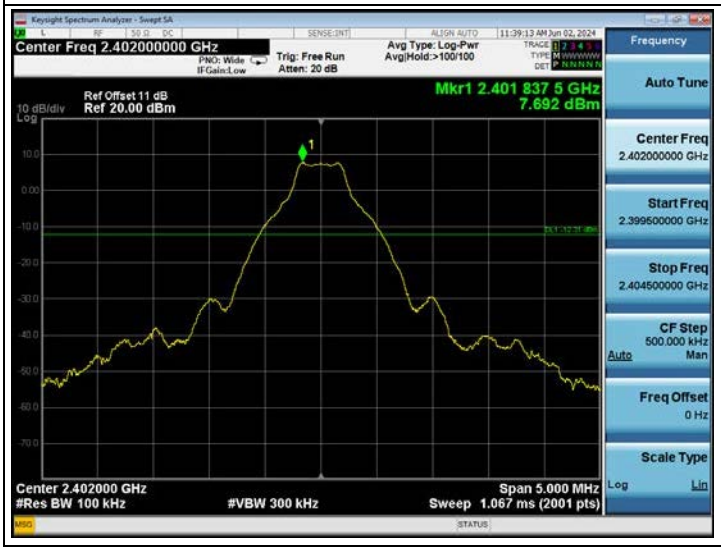
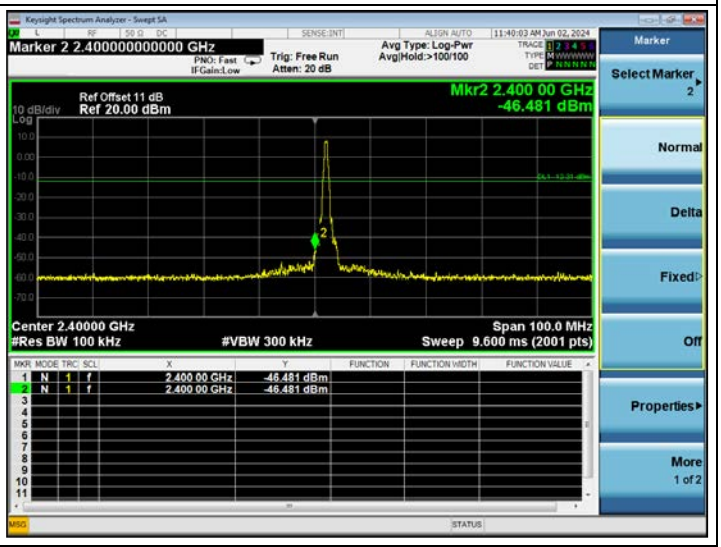
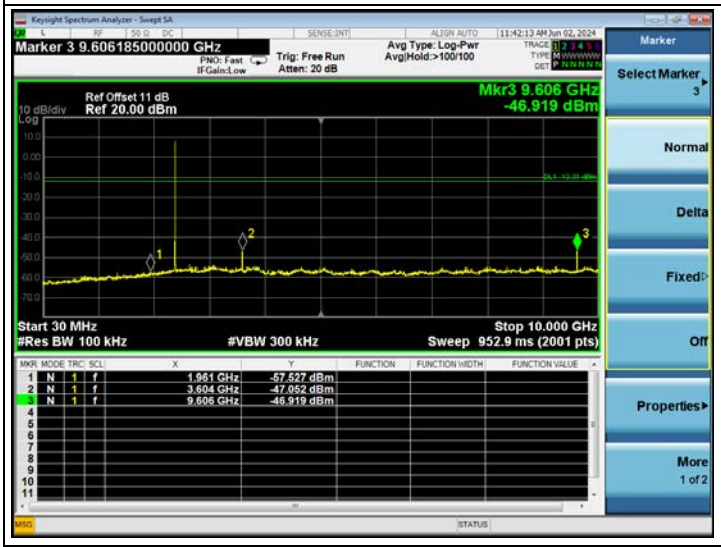
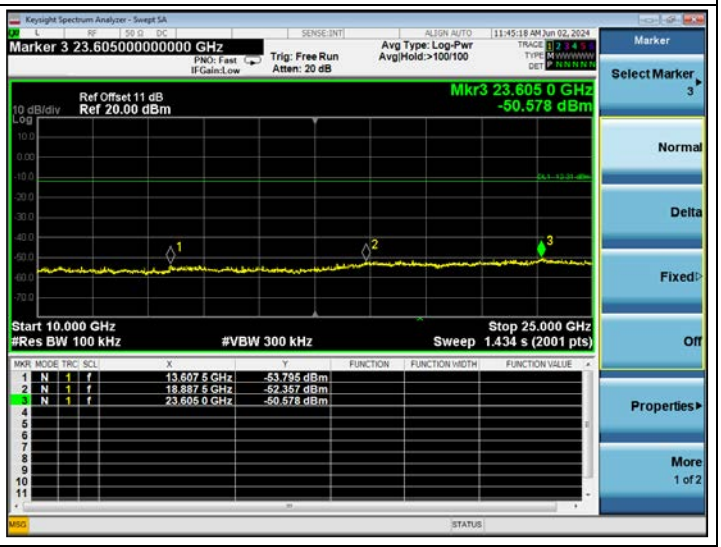
The test data was attached in the next pages.

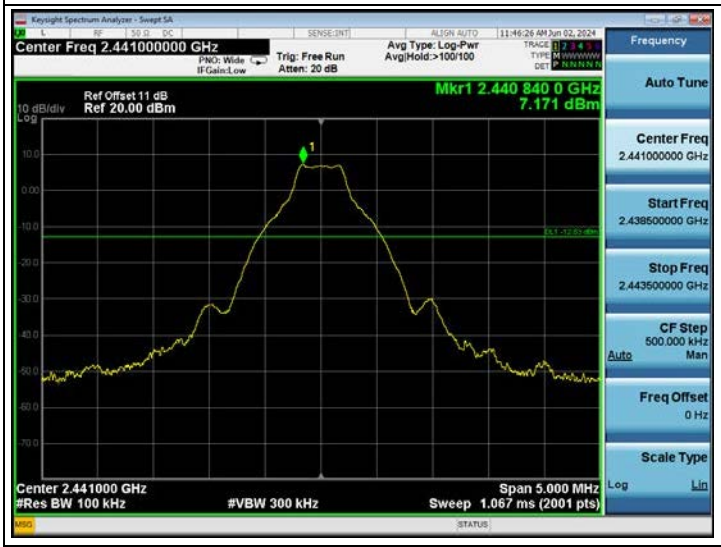
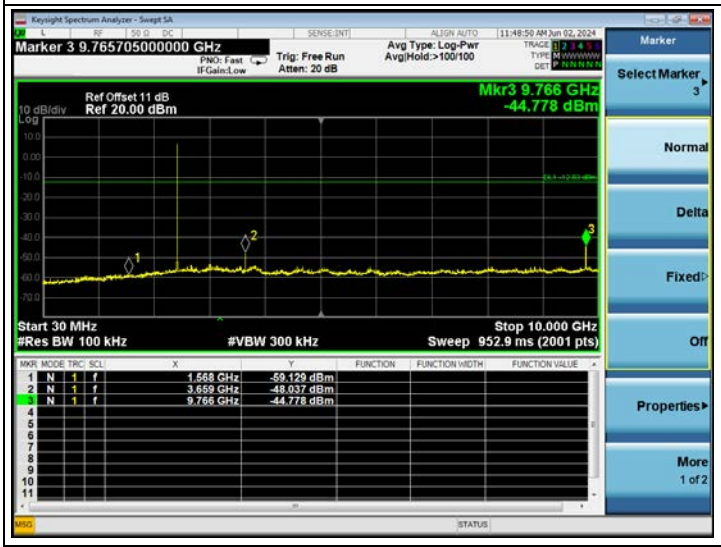
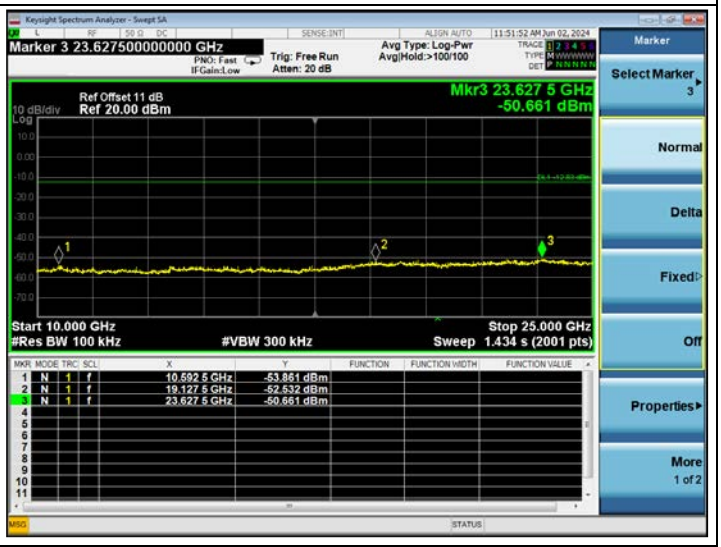
(Test Date: 2024.06.02 Temperature: 23℃ Humidity: 51 %)

Mode	Channel	Frequency (MHz)	Data Page
BT DH1	00	2402	P111
	39	2441	P112
	78	2480	P113
BT DH3	00	2402	P114
	39	2441	P115
	78	2480	P116
BT DH5	00	2402	P117
	39	2441	P118
	78	2480	P119
BT 3DH1	00	2402	P120
	39	2441	P121
	78	2480	P122
BT 3DH3	00	2402	P123
	39	2441	P124
	78	2480	P125
BT 3DH5	00	2402	P126
	39	2441	P127
	78	2480	P128

DH1

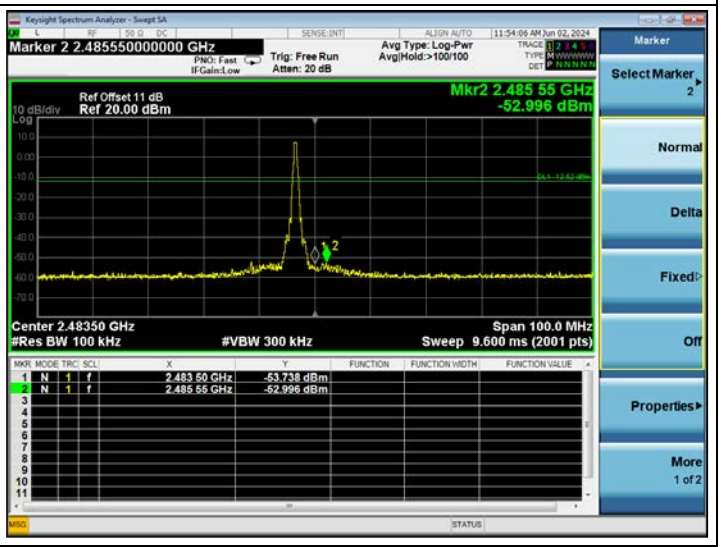
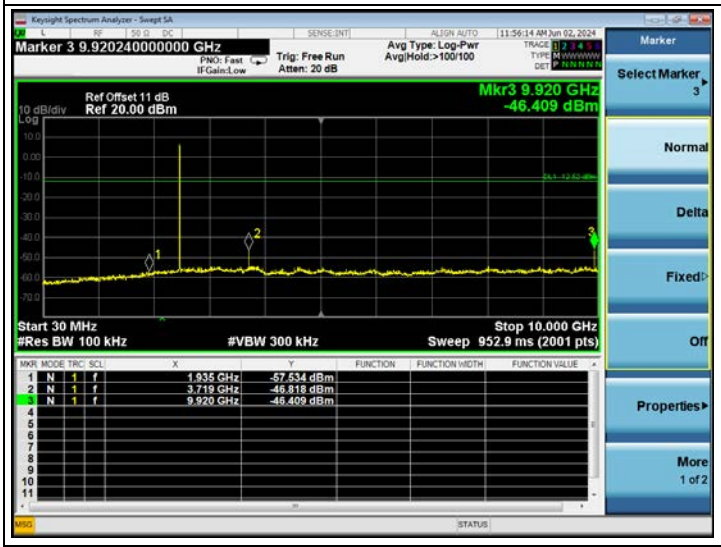
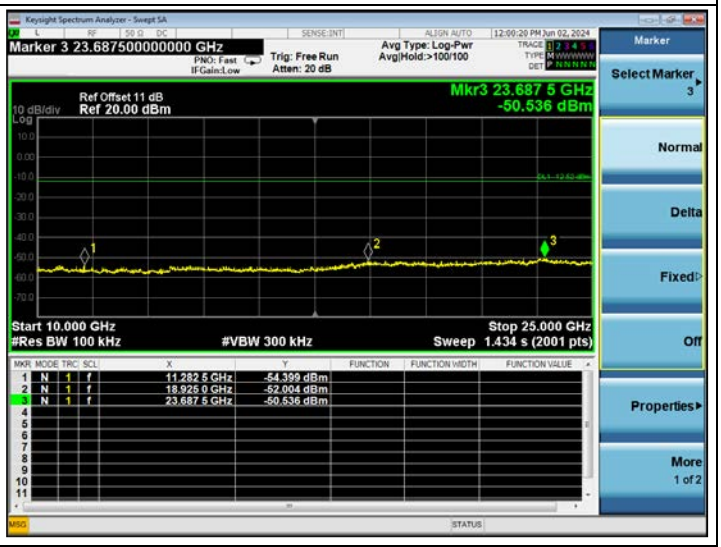
CH2402

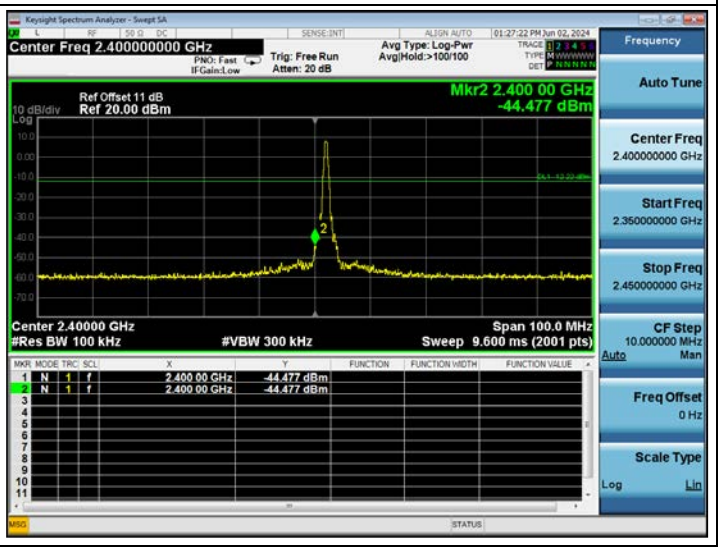
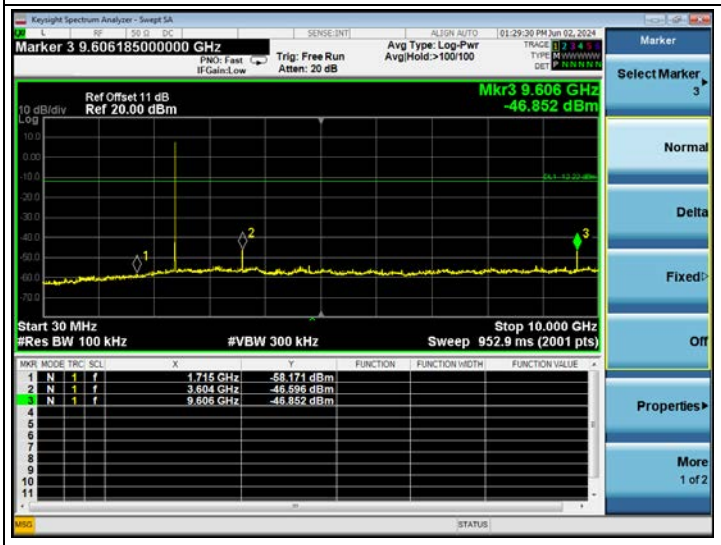
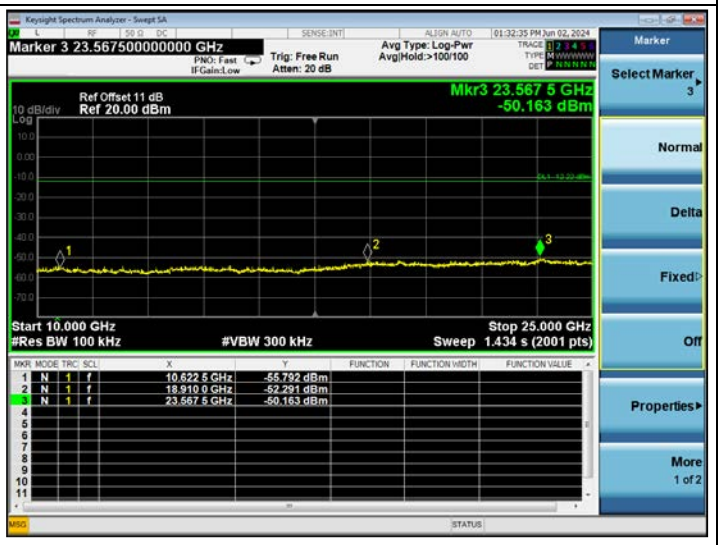
Reference Level	Lower Edge
	
Emission Level	
	

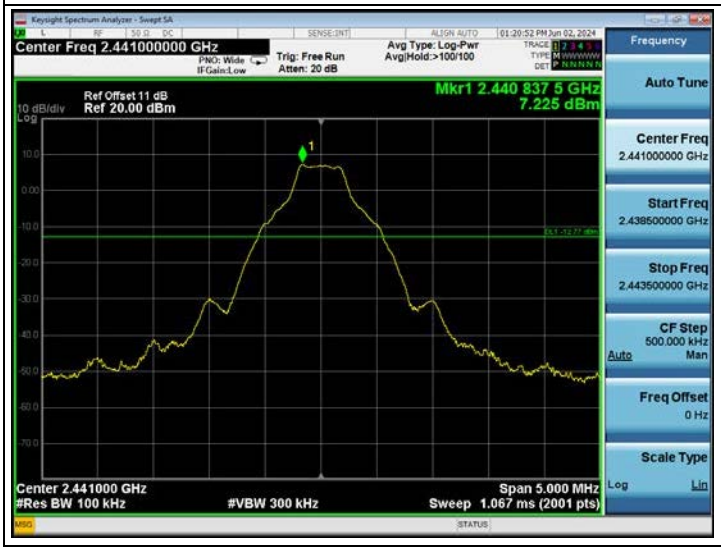
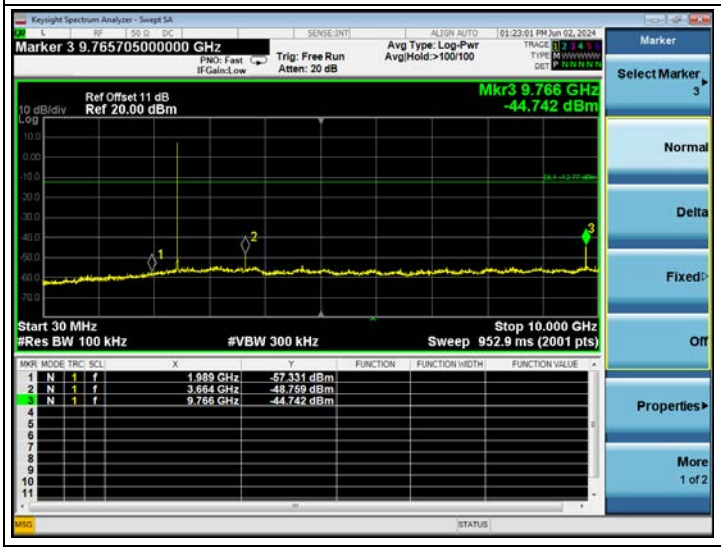
DH1
CH2441
Reference Level

Emission Level
 

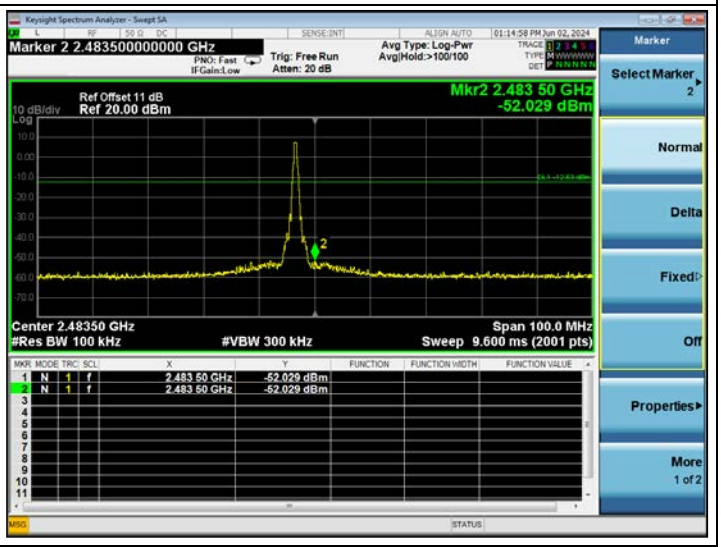
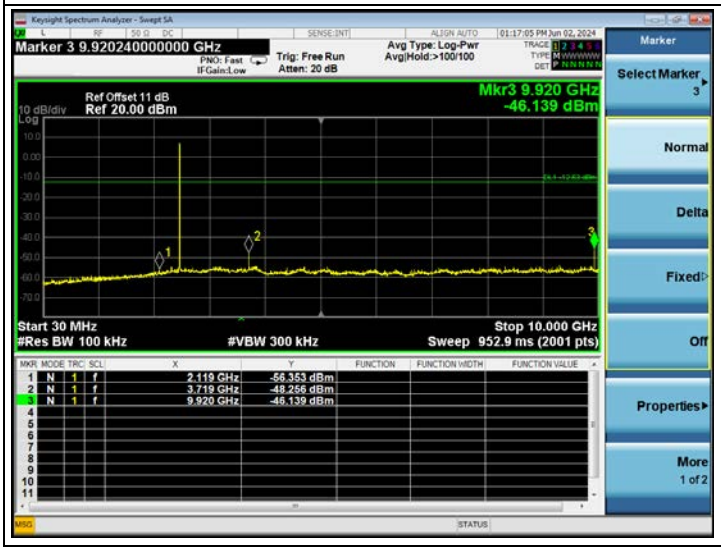
DH1

CH2480

Reference Level	Higher Edge
	
Emission Level	
	

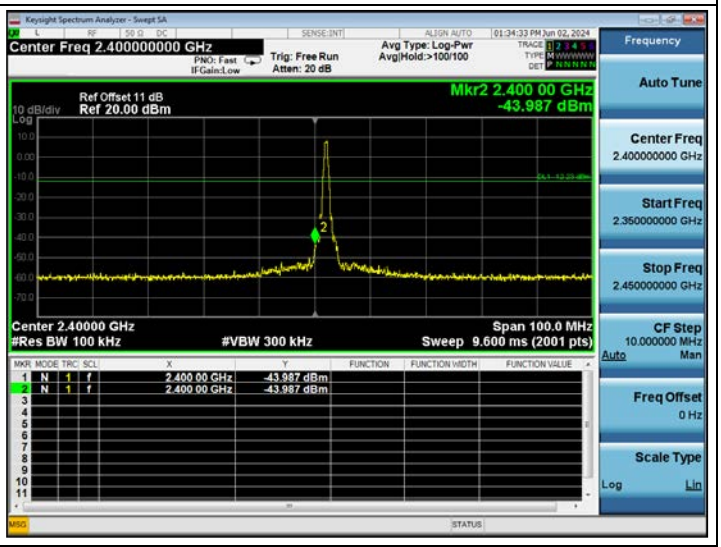
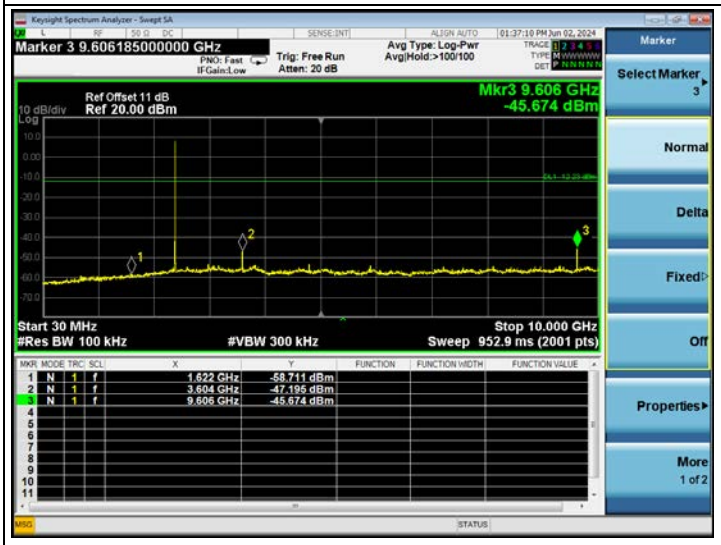
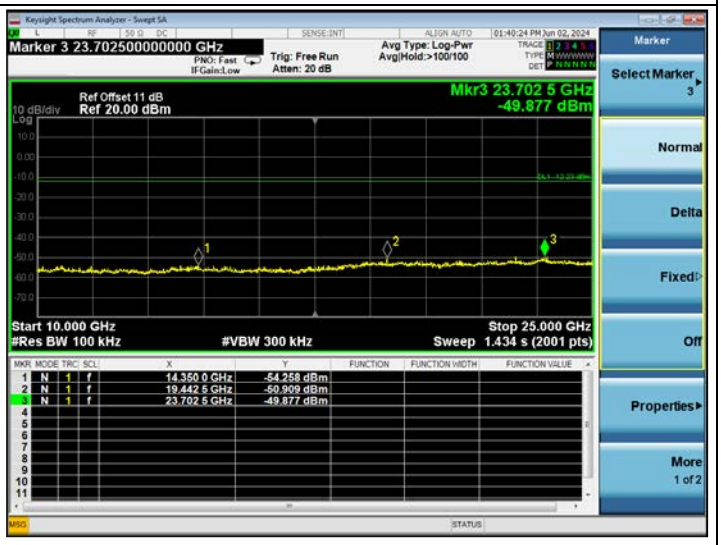
DH3	
CH2402	
Reference Level	Lower Edge
	
Emission Level	
	

DH3
CH2441
Reference Level

Emission Level
 

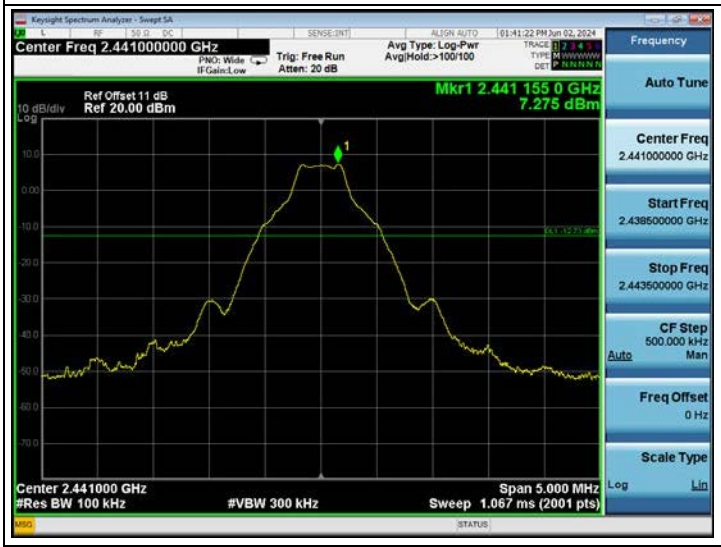
DH3	
CH2480	
Reference Level	Higher Edge
	
Emission Level	
	

DH5

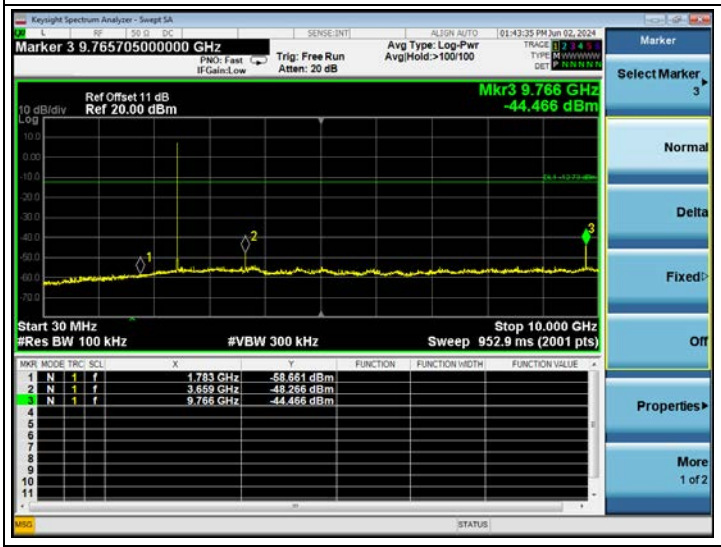
CH2402

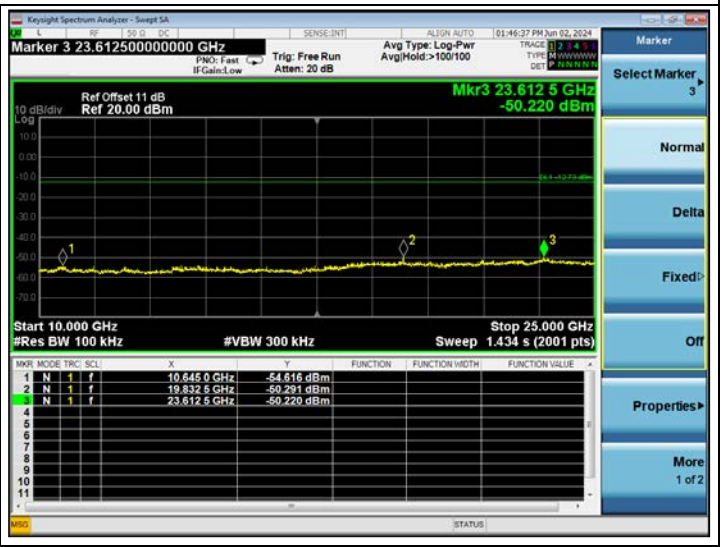
Reference Level	Lower Edge
	
Emission Level	
	

DH5
CH2441
Reference Level



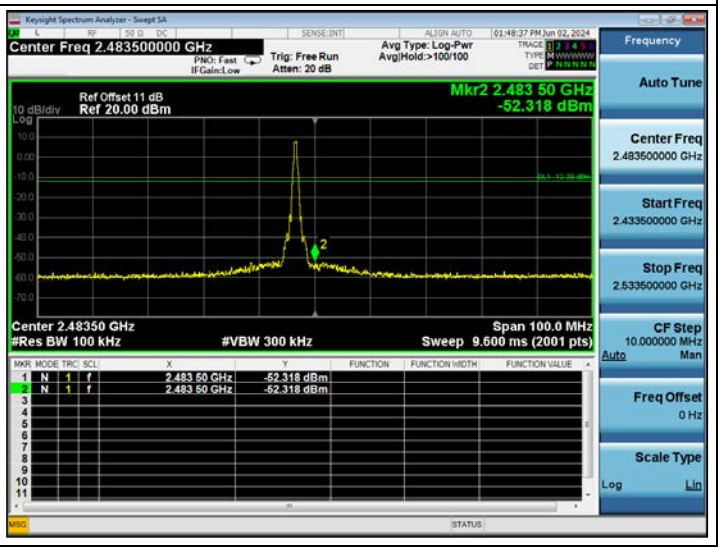
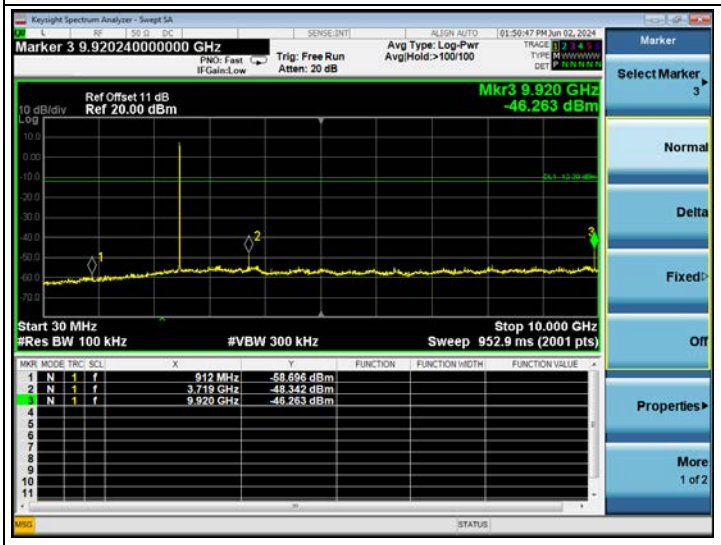
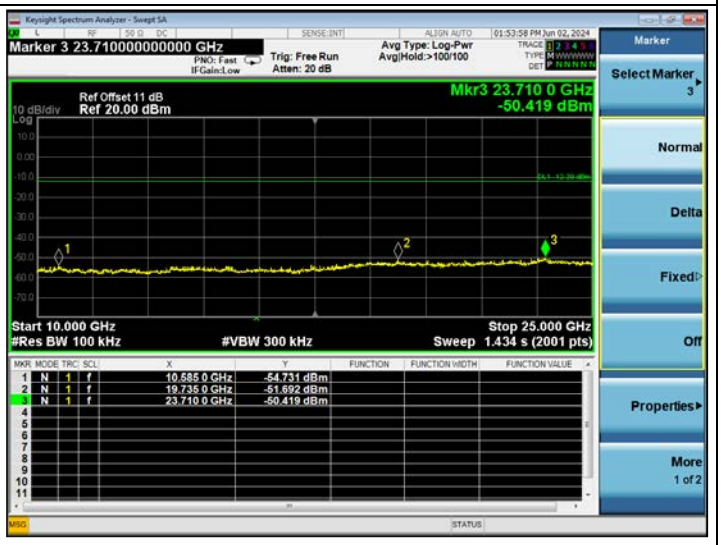
Emission Level

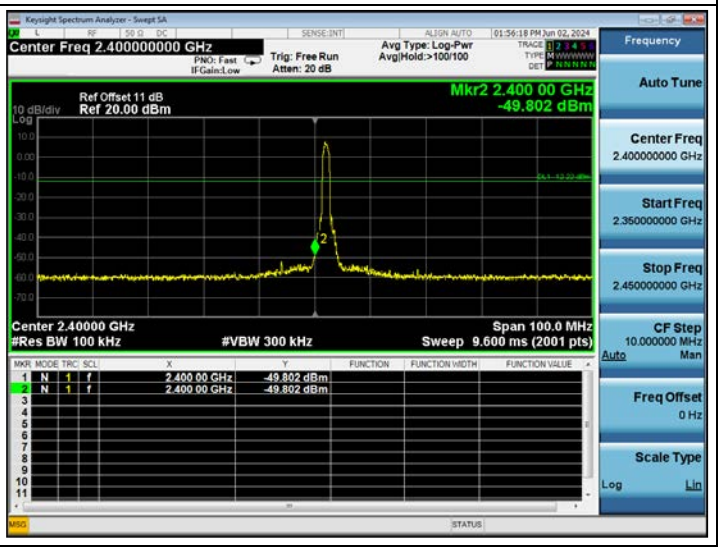
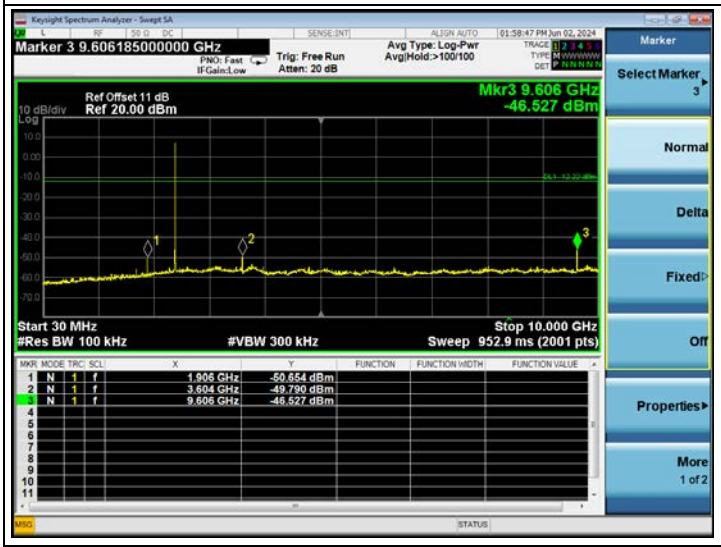
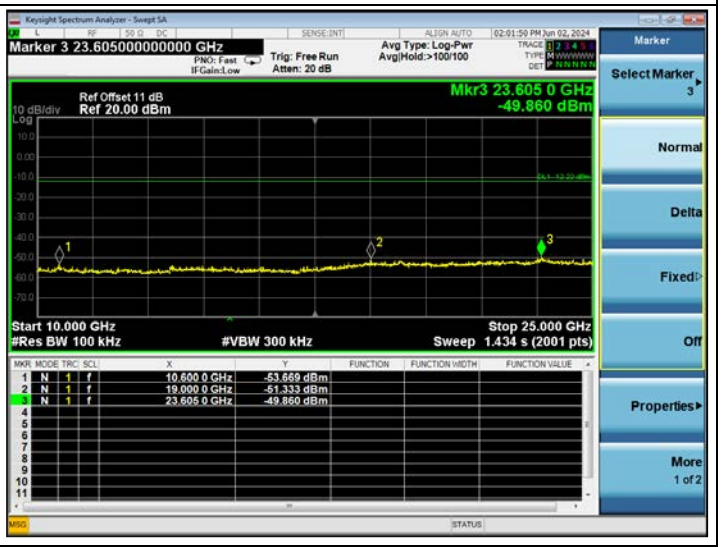




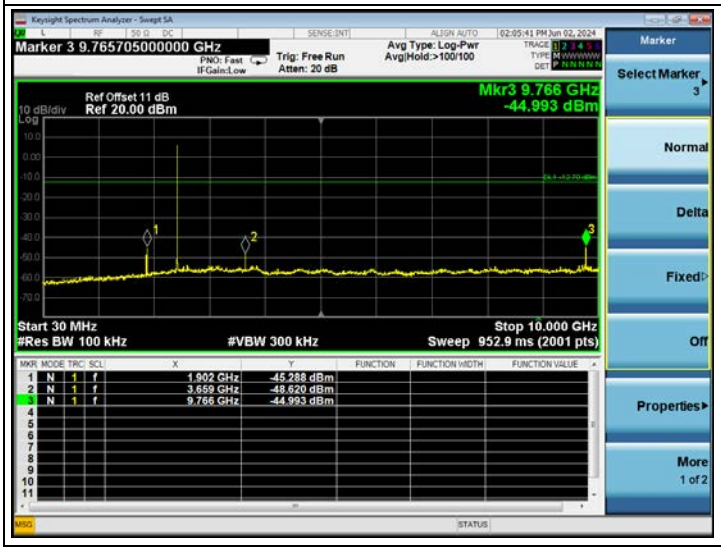
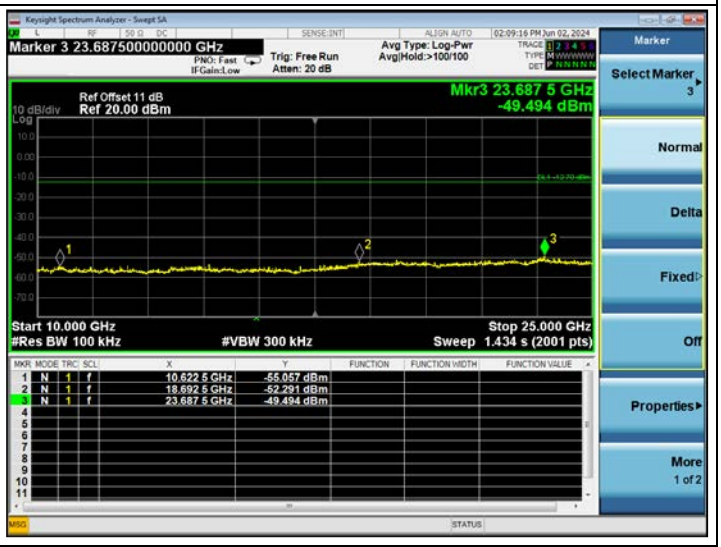
DH5

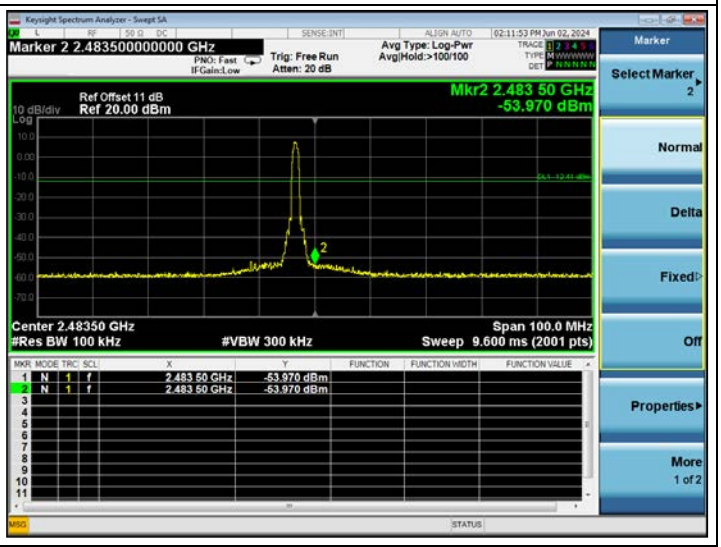
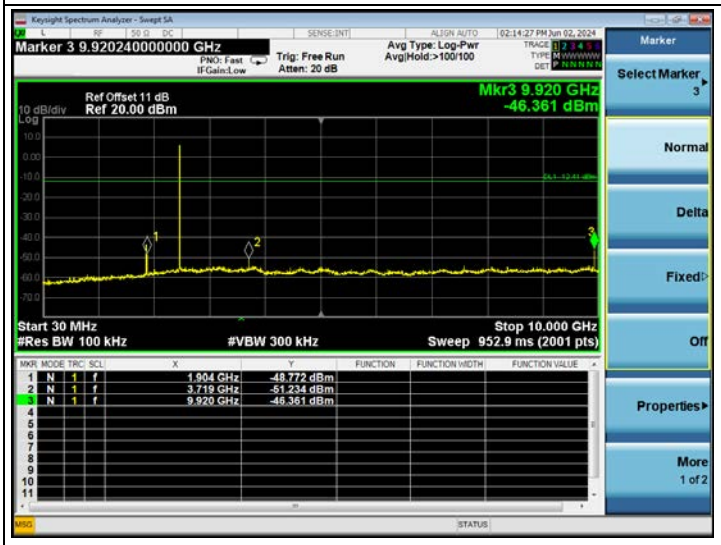
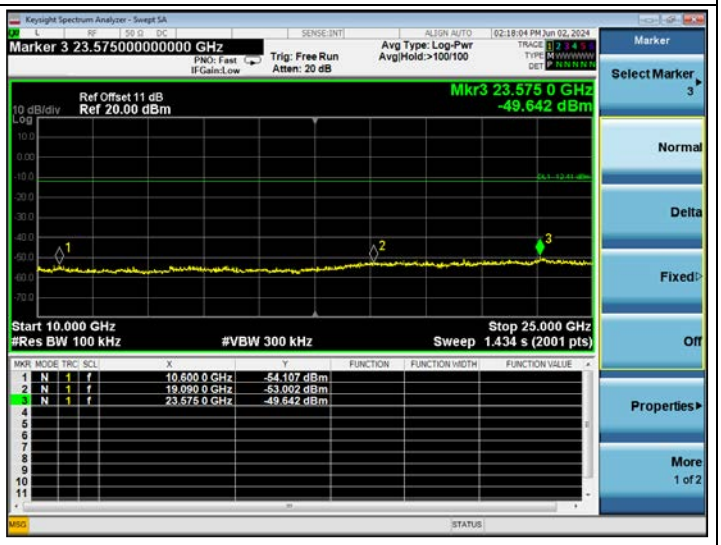
CH2480

Reference Level	Higher Edge
	
Emission Level	
	

3DH1	
CH2402	
Reference Level	Lower Edge
	
Emission Level	
	

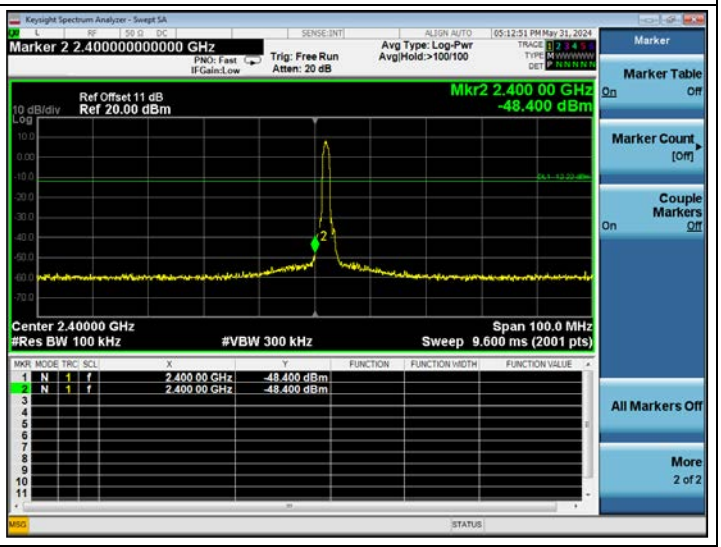
3DH1
CH2441
Reference Level

Emission Level
 

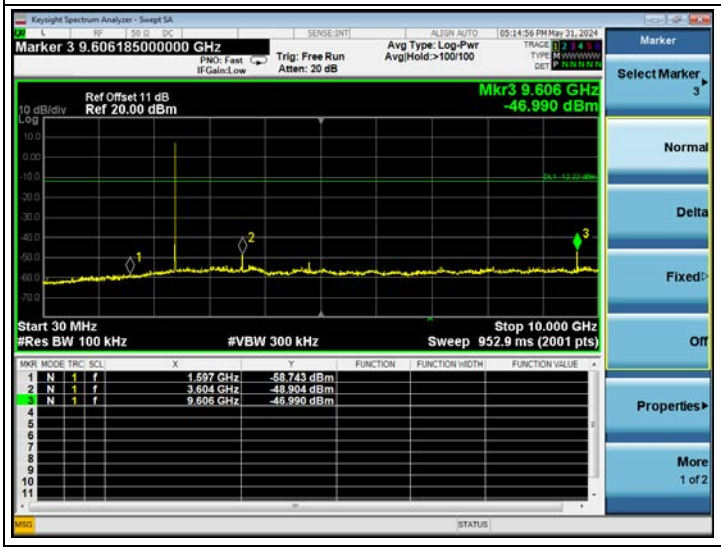
3DH1	
CH2480	
Reference Level	Higher Edge
	
Emission Level	
	

3DH3

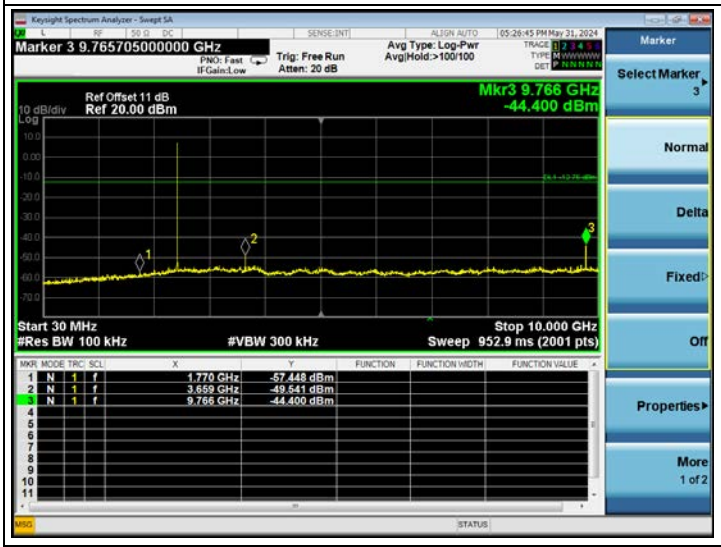
CH2402

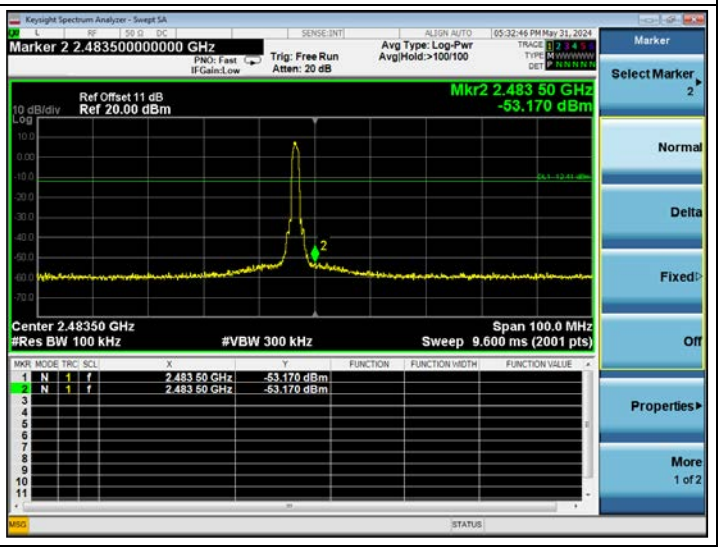
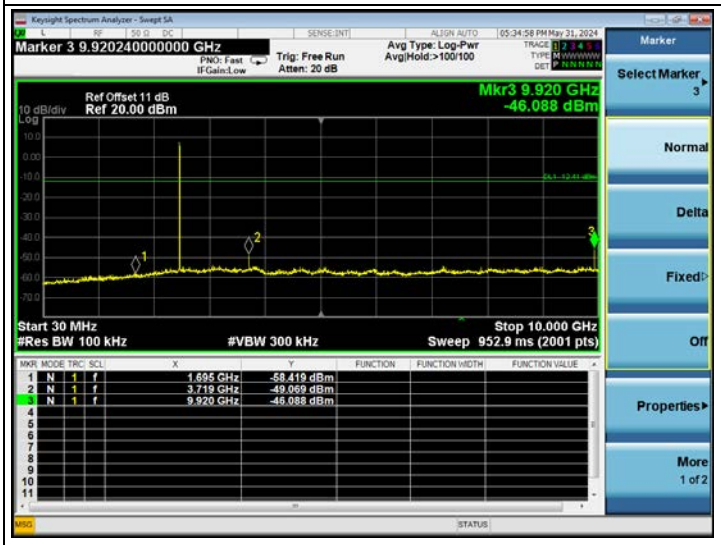
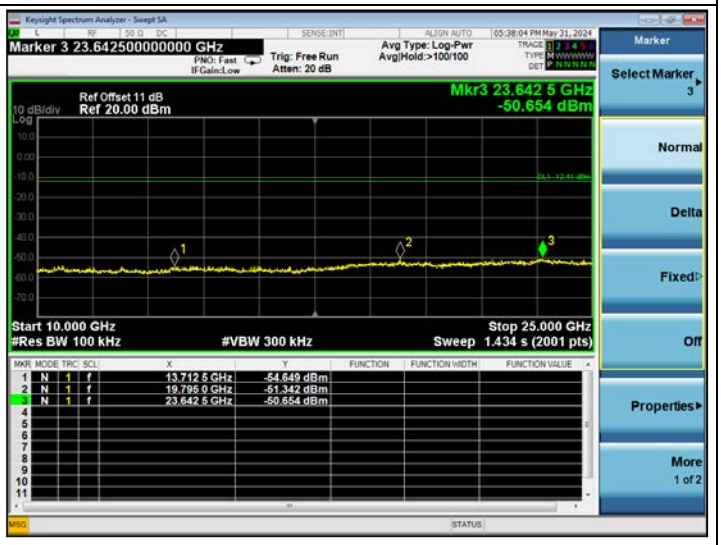
Reference Level	Lower Edge
	

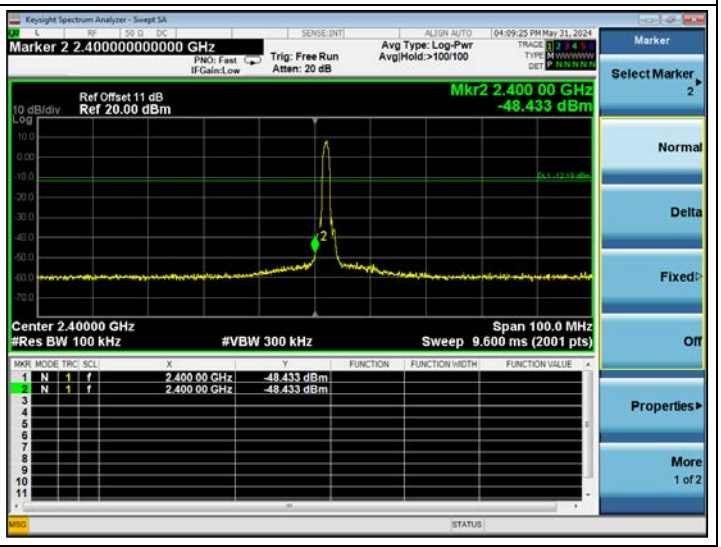
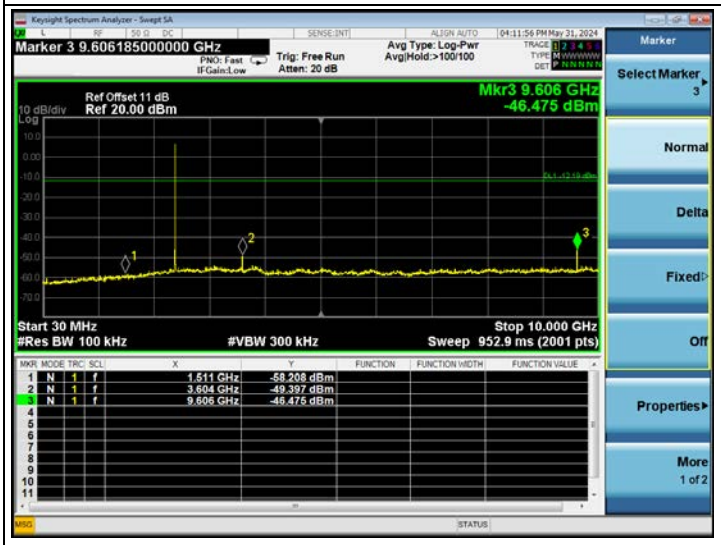
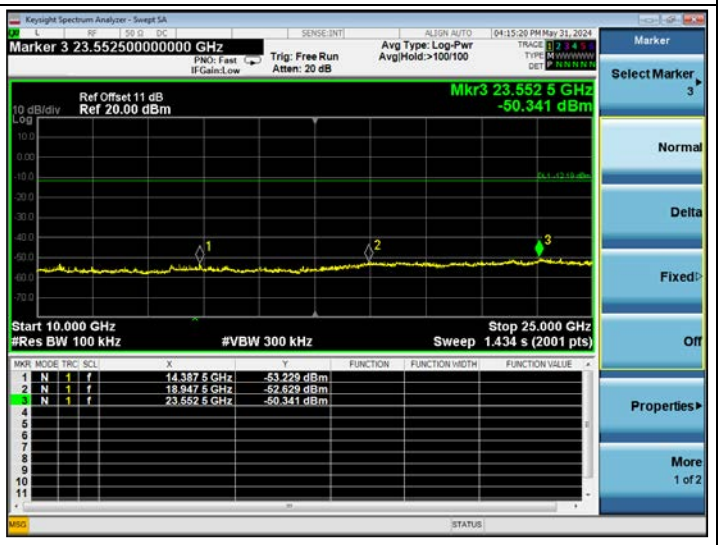
Emission Level



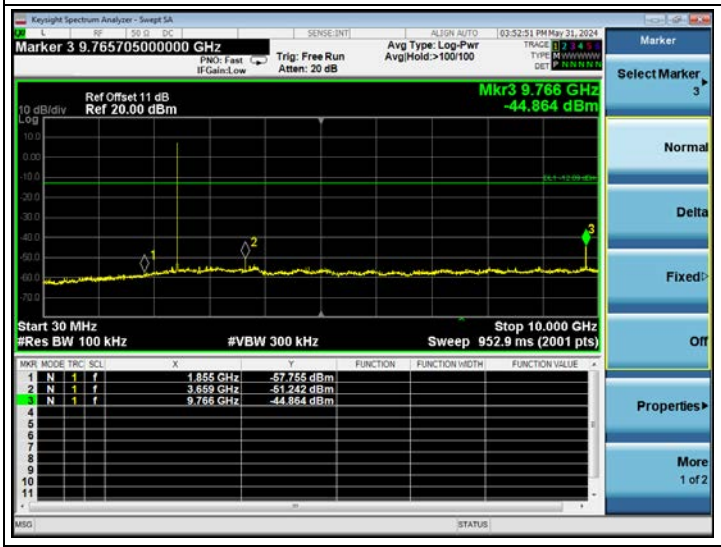
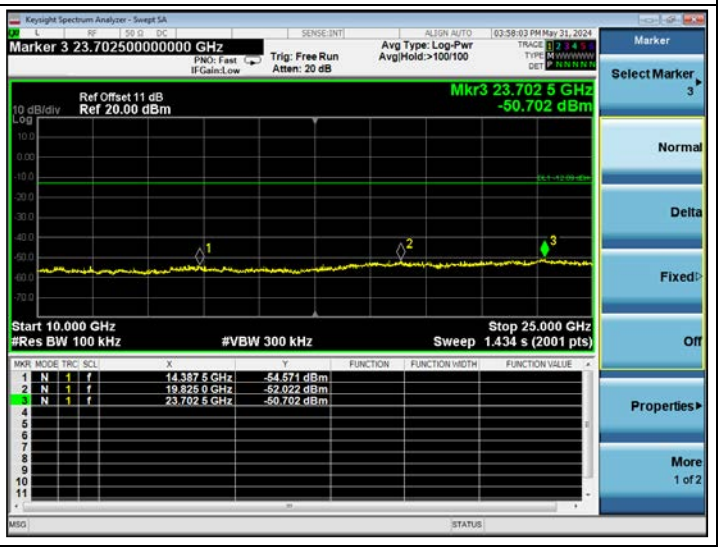
3DH3
CH2441
Reference Level

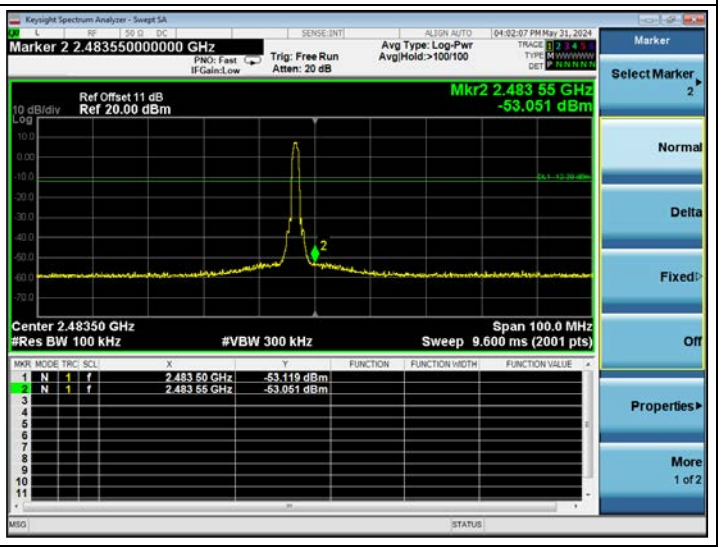
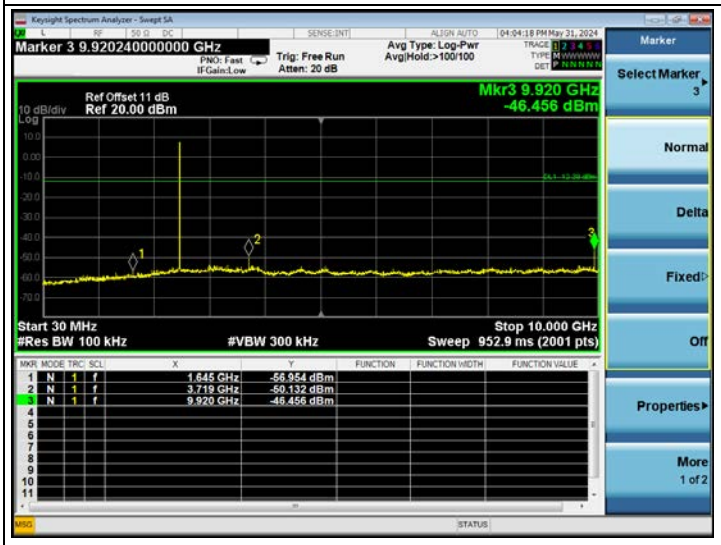
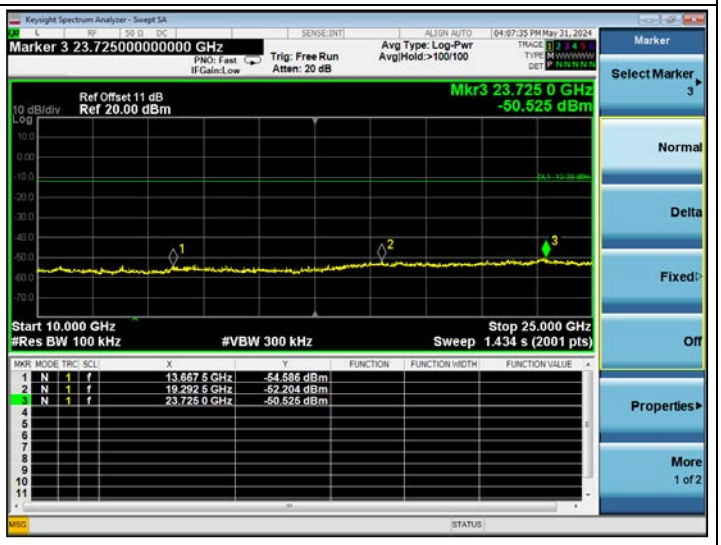
Emission Level
 

3DH3	
CH2480	
Reference Level	Higher Edge
	
Emission Level	
	

3DH5	
CH2402	
Reference Level	Lower Edge
	
Emission Level	
	

3DH5
CH2441
Reference Level

Emission Level
 

3DH5	
CH2480	
Reference Level	Higher Edge
	
Emission Level	
	

12 ANTENNA REQUIREMENT

12.1 Specification Limits (§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.

12.2 Result

According to KDB 353028 D1, the following describes the three ways that can be used to demonstrate compliance to Section 15.203: a) Antenna permanently attached. b) Unique (non-standard) antenna connector. c) Professional installation.
For this product, the antenna is: ☐ Antenna permanently attached ☑ Unique (non-standard) antenna connector ☐ Professional installation ☐ not meet any of ways list above that ☑ compliant ☐ not compliant with the requirement of Section 15.203.

13 DEVIATION TO TEST SPECIFICATIONS

None.

14 MEASUREMENT UNCERTAINTY LIST

The measurement uncertainty was estimated for test on the EUT according to CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage of K=2.
The uncertainties value is not used in determining the PASS/FAIL results.

Test Items/Facilities	Frequency/Equipment/Unit	Uncertainty
Conducted Emission No.1 Shielded Room	9kHz~150kHz	±3.1 dB
	150kHz~30MHz	±2.6 dB
Conducted Emission No.3 Shielded Room	9kHz~150kHz	±3.1 dB
	150kHz~30MHz	±2.6 dB
Radiated Emission	30MHz~200MHz, Horizontal	±3.8 dB
	30MHz~200MHz, Vertical	±4.1 dB
	200MHz~1000MHz, Horizontal	±3.6 dB
	200MHz~1000MHz, Vertical	±5.1 dB
	1GHz~6GHz	±5.3 dB
	6GHz~18GHz	±5.3 dB
	18GHz~40GHz	±3.5 dB
Output Power Test	50MHz~18GHz	0.77 dB
Power Density Test	9kHz~6GHz	1.08 dB
RF Frequency Test	9kHz~40GHz	$6*10^{-4}$
Bandwidth Test	9kHz~6GHz	$1.5*10^{-3}$
RF Radiated Power Test	30MHz~1000MHz	3.06 dB
Conducted Output Power Test	50MHz~18GHz	0.83 dB
AC Voltage(<10kHz) Test	120V~230V	0.04 %
DC Power Test	0V~30V	0.4 %
Temperature	-40℃~+100℃	0.52 ℃
Humidity	30%~95%	2.6 %