



REPORT No.: SZ25010004W01

TEST REPORT

APPLICANT : Lierda Science & Technology Group Co.,Ltd

PRODUCT NAME : WB99 BluetoothLE module

MODEL NAME : L-BTOWB99-G0NN4, L-BTOWB99-07014

BRAND NAME : Lierda

FCC ID : N8N-WB99

STANDARD(S) : 47 CFR Part 15 Subpart C

RECEIPT DATE : 2025-01-10

TEST DATE : 2025-01-18 to 2025-01-23

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Change History		
Version	Date	Reason for change
1.0	2025-03-14	First edition



1. Summary of Test Result

No.	Section	Description	Test Date	Test Engineer	Result	Method Determination /Remark
1	15.203	Antenna Requirement	N/A	N/A	PASS	No deviation
2	N/A	Duty Cycle of Test Signal	Jan. 23, 2025	Li Zikai	PASS	No deviation
3	15.247(b)	Maximum Peak Conducted Output Power	Jan. 23, 2025	Li Zikai	PASS	No deviation
4	15.247(b)	Maximum Average Conducted Output Power	Jan. 23, 2025	Li Zikai	PASS	No deviation
5	15.247(a)	Bandwidth	Jan. 23, 2025	Li Zikai	PASS	No deviation
6	15.247(d)	Conducted Spurious Emission and Band Edge	Jan. 23, 2025	Li Zikai	PASS	No deviation
7	15.247(e)	Power Spectral Density	Jan. 23, 2025	Li Zikai	PASS	No deviation
8	15.207	Conducted Emission	Jan. 21, 2025	Fan Shengquan	PASS	No deviation
9	15.247(d)	Restricted Frequency Bands	Jan. 18, 2025	Li Hanbin	PASS	No deviation
10	15.209, 15.247(d)	Radiated Emission	Jan. 18, 2025	Li Hanbin	PASS	No deviation

Note 1: The tests were performed according to the method of measurements prescribed in ANSI C63.10-2013 and KDB 558074 D01 v05r02.

Note 2: Additions to, deviation, or exclusions from the method shall be judged in the "method determination" column of add, deviate or exclude from the specific method shall be explained in the "Remark" of the above table.

Note 3: When the test result is a critical value, we will use the measurement uncertainty give the judgment result based on the 95% confidence intervals.



1.1. Testing Applied Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- 47 CFR Part 15 Subpart C Radio Frequency Devices



1.2. Test Equipment List

1.2.1 Conducted Test Equipment

Equipment	Serial No.	Type	Manufacturer	Cal. Date	Due Date
EXA Signal Analyzer	MY53470836	N9010A	Agilent	2025.01.15	2026.01.16
RF Cable (30MHz-26GHz)	CB01	RF01	Morlab	N/A	N/A
SMA Connector	CN01	RF03	HUBER-SUHNER	N/A	N/A

1.2.2 Conducted Emission Test Equipment

Equipment	Serial No.	Type	Manufacturer	Cal. Date	Due Date
Receiver	MY56400093	N9038A	KEYSIGHT	2025.01.06	2026.01.05
LISN	8127449	NSLK 8127	Schwarzbeck	2024.02.02	2025.02.01
Pulse Limiter (10dB)	VTSD 9561 F- B #206	VTSD 9561-F	Schwarzbeck	2024.05.30	2025.05.29
RF Coaxial Cable (DC-100MHz)	BNC	MRE04	Qualwave	2024.07.02	2025.07.01

1.2.3 List of Software Used

Description	Manufacturer	Software Version
Test System	MaiWei	V2.0.0.0
TS+ -[JS36-RSE]	Tonscend	V3.0.0.0
TS+ -[JS32-CE]	Tonscend	V2.5.0.0
TS+	Tonscend	V5.0.0

**1.2.4 Radiated Test Equipment**

Equipment	Serial No.	Type	Manufacturer	Cal. Date	Due Date
Signal Analyzer	MY56060145	N9020A	Agilent	2024.05.30	2025.05.29
Test Antenna - Bi-Log	9163-519	VULB 9163	Schwarzbeck	2024.06.22	2025.06.21
Test Antenna - Loop	1519-022	FMZB1519	Schwarzbeck	2024.06.03	2025.06.02
Test Antenna – Horn	01774	BBHA 9120D	Schwarzbeck	2024.06.22	2025.06.21
Test Antenna – Horn	BBHA9170 #773	BBHA9170	Schwarzbeck	2024.06.22	2025.06.21
Preamplifier (10MHz-6GHz)	46732	S10M100L38 02	LUCIX CORP.	2024.05.30	2025.05.29
Preamplifier (2GHz-18GHz)	61171/61172	S020180L32 03	LUCIX CORP.	2024.05.30	2025.05.29
Preamplifier (18GHz-40GHz)	DS77209	DCLNA0118-40C-S	Decentest	2024.05.30	2025.05.29
RF Coaxial Cable (DC-18GHz)	MRE001	PE330	Pasternack	2024.05.30	2025.05.29
RF Coaxial Cable (DC-18GHz)	MRE002	CLU18	Pasternack	2024.05.30	2025.05.29
RF Coaxial Cable (DC-18GHz)	MRE003	CLU18	Pasternack	2024.05.30	2025.05.29
RF Coaxial Cable (DC-40GHz)	22290045	QA360-40-KK-0.5	Qualwave	2024.07.03	2025.07.02
RF Coaxial Cable (DC-40GHz)	22290046	QA360-40-KKF-2	Qualwave	2024.07.03	2025.07.02
RF Coaxial Cable (DC-18GHz)	22120181	QA500-18-NN-5	Qualwave	2024.07.03	2025.07.02
Notch Filter	N/A	WRCG-2400-2483.5-60SS	Wainwright	N/A	N/A
Anechoic Chamber	N/A	9m*6m*6m	CRT	2022.05.10	2025.05.09



1.3. Measurement Uncertainty

Test Items	Uncertainty	Remark
Peak Output Power	$\pm 2.22\text{dB}$	Confidence levels of 95%
Power Spectral Density	$\pm 2.22\text{dB}$	Confidence levels of 95%
Bandwidth	$\pm 5\%$	Confidence levels of 95%
Conducted Spurious Emission	$\pm 2.77\text{dB}$	Confidence levels of 95%
Restricted Frequency Bands	$\pm 5\%$	Confidence levels of 95%
Radiated Emission	$\pm 2.95\text{dB}$	Confidence levels of 95%
Conducted Emission	$\pm 2.44\text{dB}$	Confidence levels of 95%

1.4. Testing Laboratory

Laboratory Name:	Shenzhen Morlab Communications Technology Co., Ltd.
Laboratory Address:	FL.3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, GuangDong Province, P. R. China
Telephone:	+86 755 36698555
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FCC Designation Number:	CN1192
FCC Test Firm Registration Number:	226174



2. General Description

2.1. Information of Applicant and Manufacturer

Applicant:	Lierda Science & Technology Group Co.,Ltd
Applicant Address:	Building 1#, Lierda IOT park, No.1326 Wenyi Xi Rd, Hangzhou, China
Manufacturer:	Lierda Science & Technology Group Co.,Ltd
Manufacturer Address:	Building 1#, Lierda IOT park, No.1326 Wenyi Xi Rd, Hangzhou, China

2.2. Information of EUT

Product Name:	WB99 BluetoothLE module
Sample No.:	2#, 4#
Hardware Version:	V01
Software Version:	radio_test_CE&DTM_52840 V01.00
Equipment Type:	Bluetooth LE
Bluetooth Version:	5.4
Modulation Type:	GFSK
Data Rate:	1Mbps, 2Mbps
Operating Frequency Range:	2402MHz-2480MHz
Antenna Type:	FPC Antenna
Antenna Gain:	3.0dBi

Note 1: According to the certificate holder, they declared that the models L-BTOWB99-G0NN4, L-BTOWB99-07014 are accordant in both hardware and software. These two models only differ in model name and color. Their electrical circuit design, layout, components used and internal wiring are identical. The main measuring model is L-BTOWB99-G0NN4, only the results for L-BTOWB99-G0NN4 were recorded in this report.

Note 2: For a more detailed description, please refer to Specification or User's Manual supplied by the applicant and/or manufacturer.



2.3.Channel List of EUT

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	10	2422	20	2442	30	2462
1	2404	11	2424	21	2444	31	2464
2	2406	12	2426	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476
8	2418	18	2438	28	2458	38	2478
9	2420	19	2440	29	2460	39	2480

Note 1: The black bold channels were selected for test.

2.4. Test Configuration of EUT

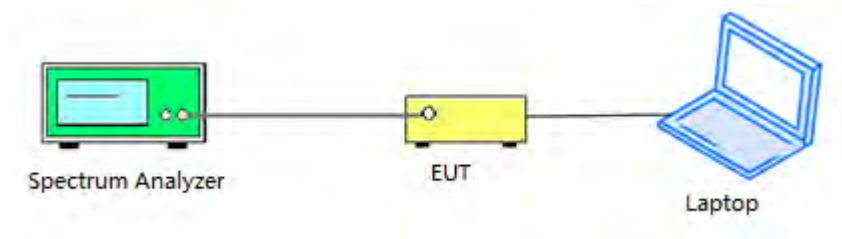
The EUT is controlled by dedicated software to transmit at the default maximum power level.

2.5. Test Conditions

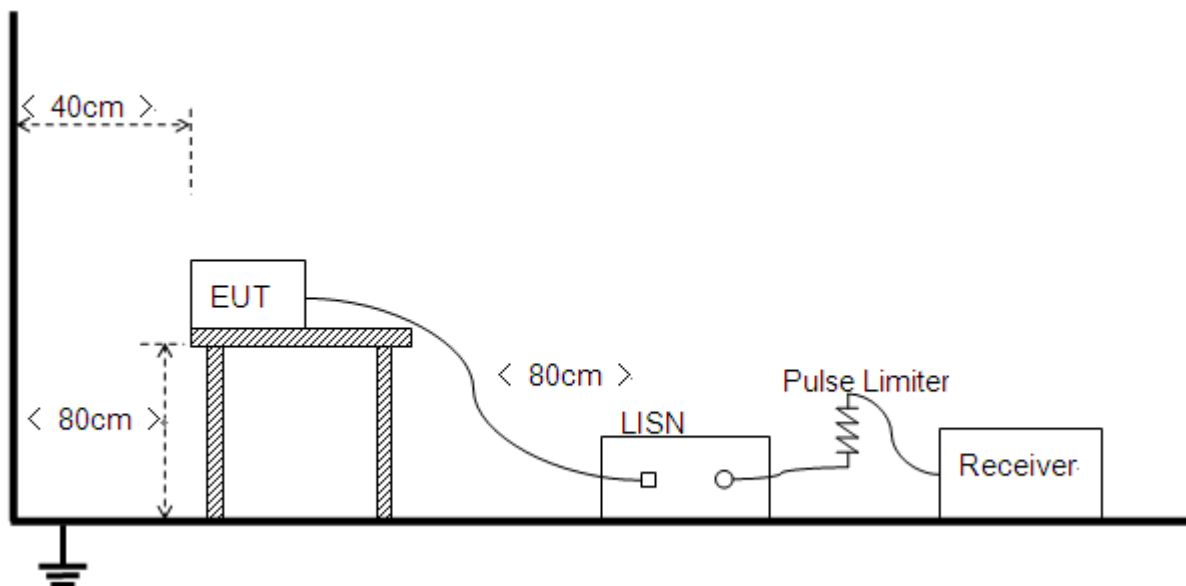
Temperature (°C):	15-35
Relative Humidity (%):	30-60
Atmospheric Pressure (kPa):	86-106

2.6. Test Setup Layout Diagram

2.6.1. Conducted Measurement

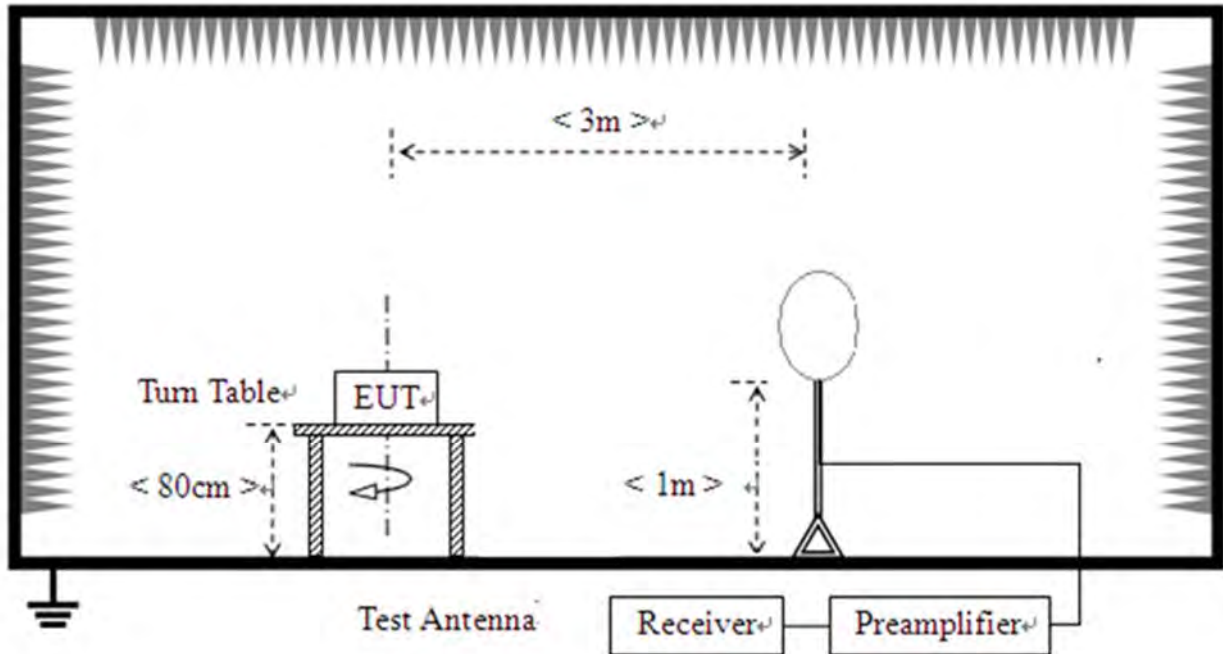


2.6.2. Conducted Emission Measurement

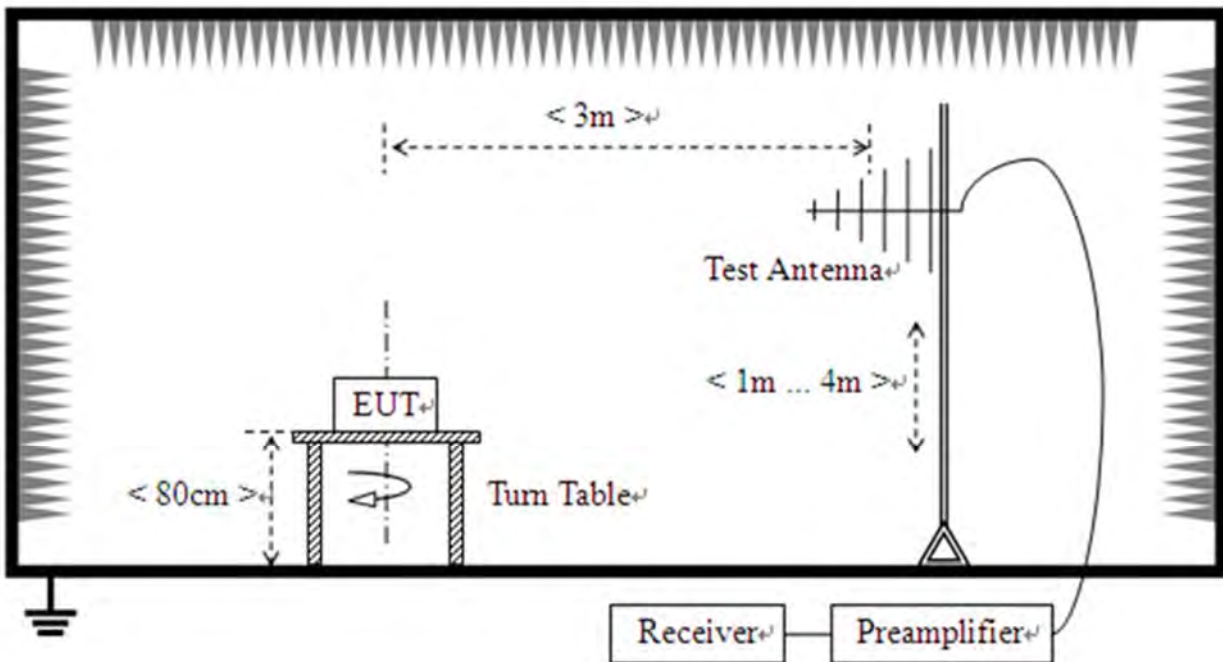


2.6.3.Radiation Measurement

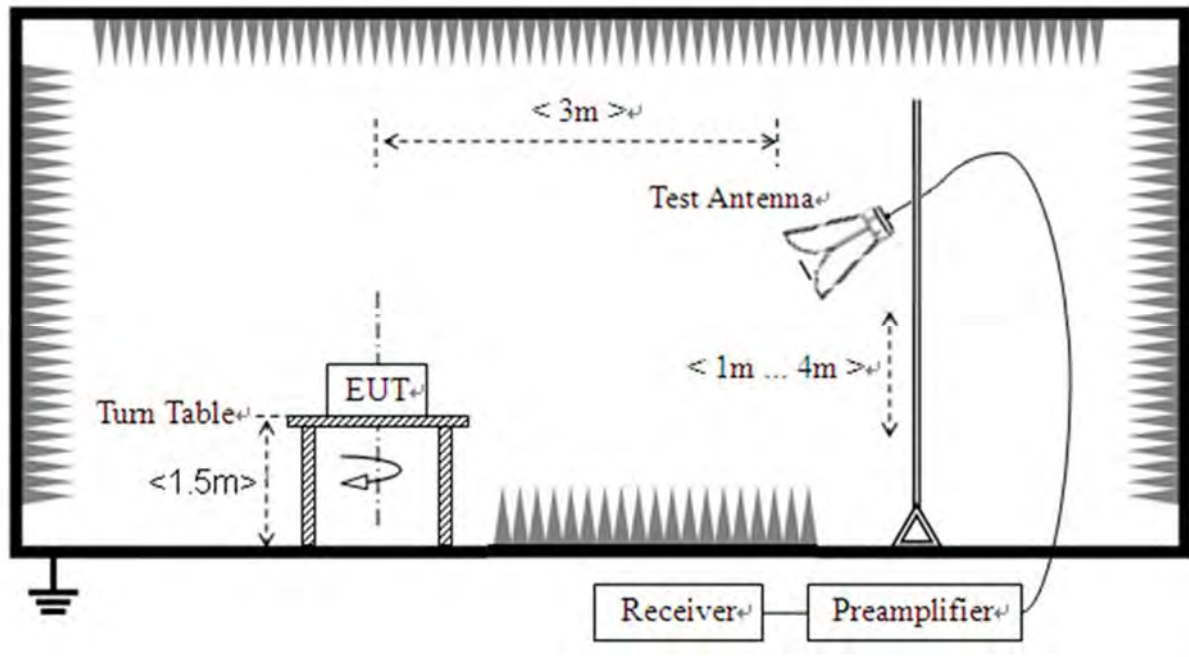
1) For radiated emissions from 9kHz to 30MHz



2) For radiated emissions from 30MHz to 1GHz



3) For radiated emissions above 1GHz





3. Test Results

3.1. Antenna Requirement

3.1.1. Requirement

According to FCC 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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

3.1.2. Test Result

Antenna location	Antenna Type	Coupling Method
☒ Internal ☐ External	☒ FPC Antenna ☐ Spring Antenna ☐ Ceramic Antenna ☐ Integrated Antenna ☐ Dipole Antenna ☐ PCB Antenna ☐ PIFA Antenna ☐ On-board Antenna	☒ I-PEX Connector ☐ SMA Connector ☐ RP-SMA Connector ☐ Metal Shrapnel ☐ Layout

3.2. Duty Cycle of Test Signal

3.2.1. Requirement

Preferably, all measurements of maximum conducted (average) output power will be performed with the EUT transmitting continuously (i.e., with a duty cycle of greater than or equal to 98%). When continuous operation cannot be realized, then the use of sweep triggering/signal gating techniques can be used to ensure that measurements are made only during transmissions at the maximum power control level. Such sweep triggering/signal gating techniques will require knowledge of the minimum transmission duration(T) over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation. Sweep triggering/signal gating techniques can then be used if the measurement/sweep time of the analyzer can be set such that it does not exceed T at any time that data are being acquired (i.e.,no transmitter OFF-time is to be considered).

When continuous transmission cannot be achieved and sweep triggering/signal gating cannot be implemented, alternative procedures are provided that can be used to measure the average power; however, they will require an additional measurement of the transmitter duty cycle (D). Within this sub clause, the duty cycle refers to the fraction of time over which the transmitter is ON and is transmitting at its maximum power control level. The duty cycle is considered to be constant if variations are less than $\pm 2\%$; otherwise, the duty cycle is considered to be non constant.

3.2.2. Test Result

Refer to Annex A.1 in this report.



3.3. Maximum Peak Conducted Output Power

3.3.1. Requirement

According to FCC section 15.247(b)(3), For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: The maximum peak conducted output power of the intentional radiator shall not exceed 1 Watt.

3.3.2. Test Procedures

KDB 558074 Section 8.3.1 was used in order to prove compliance.

3.3.3. Test Setup Layout

Refer to chapter 2.6.1 in this report.

3.3.4. Test Result

Refer to Annex A.2 in this report.



3.4. Maximum Average Conducted Output Power

3.4.1. Requirement

According to FCC section 15.247(b)(3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: The maximum average conducted output power of the intentional radiator shall not exceed 1 Watt.

3.4.2. Test Procedures

KDB 558074 Section 8.3.2 was used in order to prove compliance.

3.4.3. Test Setup Layout

Refer to chapter 2.6.1 in this report.

3.4.4. Test Result

Refer to Annex A.3 in this report.



3.5.6 dB Bandwidth

3.5.1.Requirement

According to FCC section 15.247(a) (2), systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz bands. The minimum 6dB bandwidth shall be at least 500 kHz.

3.5.1.Test Procedures

The steps for the first option are as follows:

- a) Set analyzer center frequency to channel center frequency
- b) Set RBW to 100kHz
- c) Set VBW to 300kHz
- d) Detector = peak.
- e) Trace mode = max hold
- f) Sweep time = auto couple
- g) Allow the trace to fully stabilize
- h) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission

The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described in 11.8.1 (i.e., $RBW = 100\text{ kHz}$, $VBW \geq 3 \times RBW$, and peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be $\geq 6\text{ dB}$.

3.5.2.Test Setup Layout

Refer to chapter 2.6.1 in this report.

3.5.3.Test Result

Refer to Annex A.4 in this report.



3.6. Conducted Spurious Emissions and Band Edge

3.6.1. Requirement

According to FCC section 15.247(d), in any 100kHz 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 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

3.6.2. Test Procedures

KDB 558074 Section 8.5 and 8.7 was used in order to prove compliance.

3.6.3. Test Setup Layout

Refer to chapter 2.6.1 in this report.

3.6.4. Test Result

Refer to Annex A.5 and A.6 in this report.

3.7. Power Spectral Density

3.7.1. Requirement

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

3.7.2. Test Procedures

The measured power spectral density was calculated by the reading of the spectrum analyzer and calibration. Following is the test procedure for PSD test:

- a) Set analyzer center frequency to channel center frequency
- b) Set span to 1.5 times DTS
- c) Set RBW to 3kHz
- d) Set VBW to 10kHz
- e) Detector = peak
- f) Sweep time = auto couple
- g) Trace mode = max hold
- h) Allow trace to fully stabilize
- i) Use the peak marker function to determine the maximum amplitude level within the RBW

3.7.3. Test Setup Layout

Refer to chapter 2.6.1 in this report.

3.7.4. Test Result

Refer to Annex A.7 in this report.

3.8. Conducted Emission

3.8.1. Requirement

According to FCC section 15.207, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency within the band 150kHz to 30MHz shall not exceed the limits in the following table, as measured using a 50 μ H/50 Ω line impedance stabilization network (LISN).

Frequency Range (MHz)	Conducted Limit (dB μ V)	
	Quai-peak	Average
0.15 - 0.50	66 to 56	56 to 46
0.50 - 5	56	46
5 - 30	60	50

Note:

- (a) The lower limit shall apply at the band edges.
- (b) The limit decreases linearly with the logarithm of the frequency in the range 0.15 - 0.50MHz.

3.8.2. Test Procedures

The Table-top EUT was placed upon a non-metallic table 0.8m above the horizontal metal reference ground plane. EUT was connected to LISN and LISN was connected to reference Ground Plane. EUT was 80cm from LISN. The set-up and test methods were according to ANSI C63.10: 2013.

3.8.3. Test Setup Layout

Refer to chapter 2.6.2 in this report.

3.8.4. Test Result

Refer to Annex A.8 in this report.



3.9.Restricted Frequency Bands

3.9.1.Requirement

According to FCC section 15.247(d), in any 100kHz 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 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, 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).

3.9.2.Test Procedures

The EUT is located in a 3m Semi-Anechoic Chamber; the antenna factors, cable loss and so on of the site as factors are calculated to correct the reading.

For the Test Antenna:

Test Antenna is 3m away from the EUT. Test Antenna height is varied from 1m to 4m above the ground to determine the maximum value of the field strength.

Span = wide enough to fully capture the emission being measured

RBW = 1 MHz for $f \geq 1\text{GHz}$, 100 kHz for $f < 1\text{GHz}$

VBW = 3 MHz

Sweep = auto

Detector function = peak/average

Trace = max hold

Allow the trace to stabilize

3.9.3.Test Setup Layout

Refer to chapter 2.6.3 in this report.

3.9.4.Test Result

Refer to Annex A.9 in this report.

3.10. Radiated Emission

3.10.1.Requirement

According to FCC section 15.247(d), radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

According to FCC section 15.209 (a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength ($\mu\text{V/m}$)	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	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

Note1: For above 1000MHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20dB above the maximum permitted average limit.

Note2:For above 1000MHz, limit field strength of harmonics: 54dBuV/m@3m (AV) and 74dBuV/m@3m (PK).In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), also should comply with the radiated emission limits specified in Section 15.209(a)(above table).



3.10.2.Test Procedures

The EUT is placed on a non-conducting table 80 cm above the ground plane for measurement below 1GHz; 1.5 m above the ground plane for measurement above 1GHz. The antenna to EUT distance is 3meters. The EUT is configured in accordance with ANSI C63.10. The EUT is set to transmit in a continuous mode.

For measurements below 30MHz, the emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9kHz-90 kHz, 110kHz-490 kHz. Radiated emission limits in these two bands are based on measurements employing an average detector.

For measurements below 1GHz the resolution bandwidth is set to 100kHz for peak detection measurements or 120kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For measurements above 1GHz the resolution bandwidth is set to 1MHz, the video band width is set to 3MHz for peak measurements and as applicable for average measurements.

The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions. For measurements above 1 GHz, keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response.

3.10.3.Test Setup Layout

Refer to chapter 2.6.3 in this report.

3.10.4.Test Result

Refer to Annex A.10 in this report.



Annex A Test Data and Result

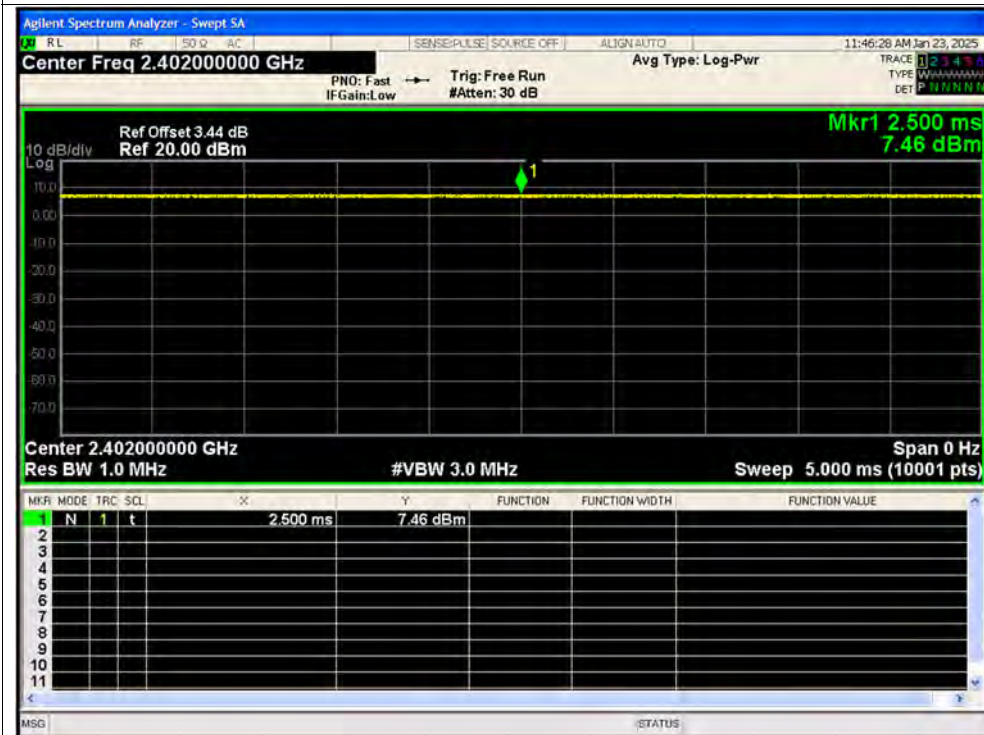
A.1. Duty Cycle of Test Signal

Condition	Mode	Frequency (MHz)	Antenna	Duty Cycle (%)	Correction Factor (dB)	1/T (kHz)
NVNT	BLE 1M	2402	Ant1	100	0	0
NVNT	BLE 1M	2440	Ant1	100	0	0
NVNT	BLE 1M	2480	Ant1	100	0	0
NVNT	BLE 2M	2402	Ant1	100	0	0
NVNT	BLE 2M	2440	Ant1	100	0	0
NVNT	BLE 2M	2480	Ant1	100	0	0

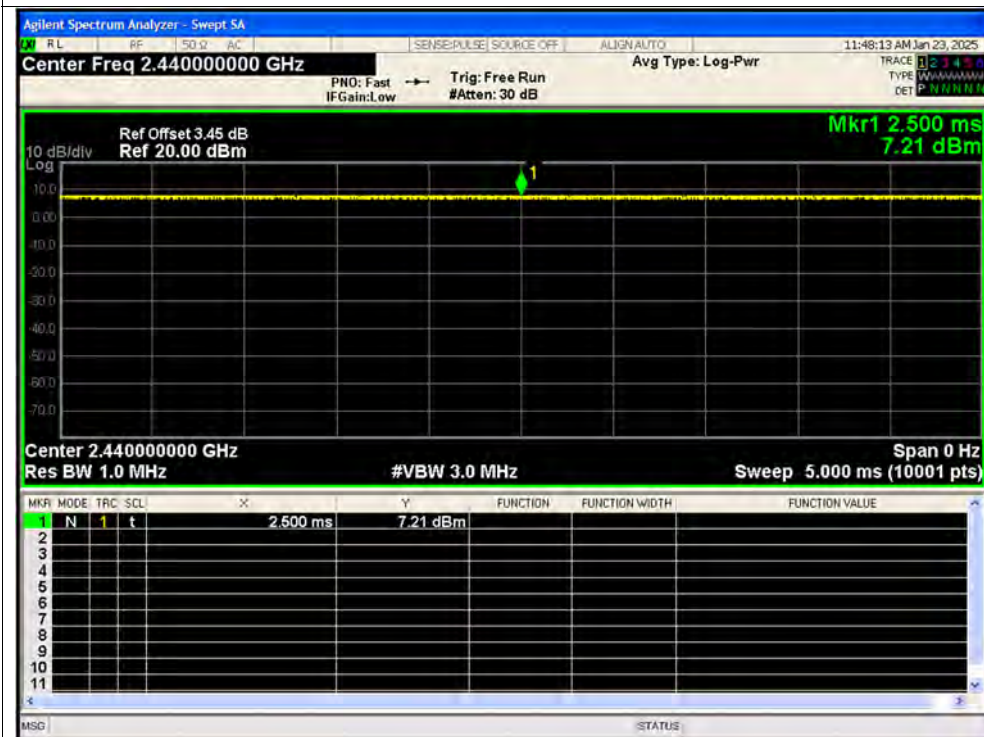


Test Graphs

Duty Cycle NVNT BLE 1M 2402MHz Ant1

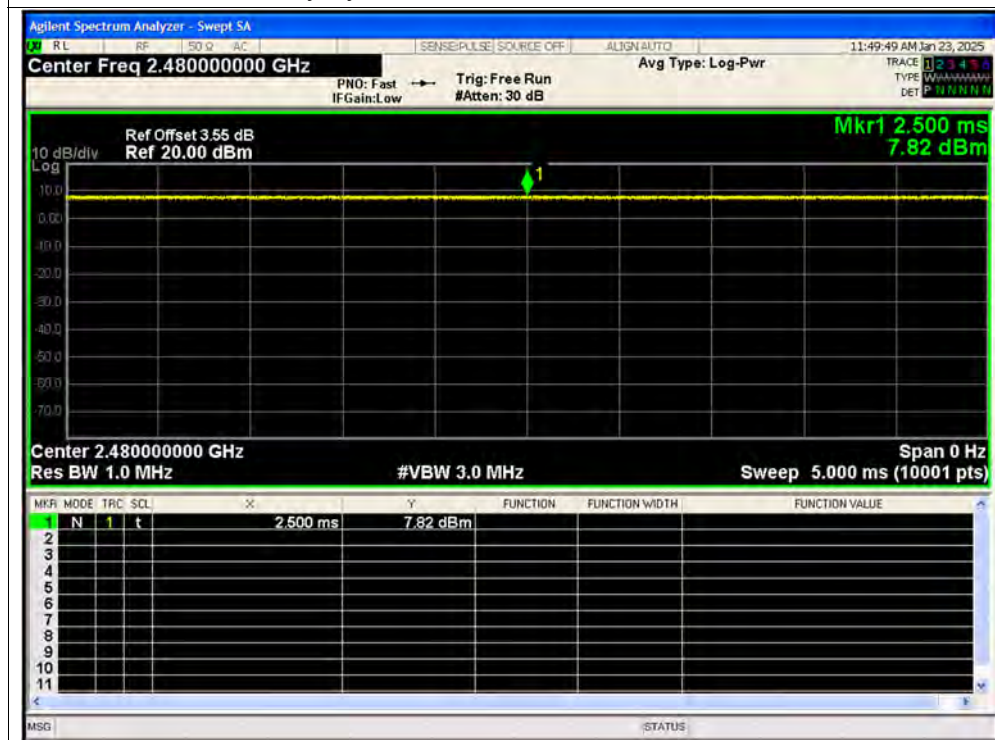


Duty Cycle NVNT BLE 1M 2440MHz Ant1

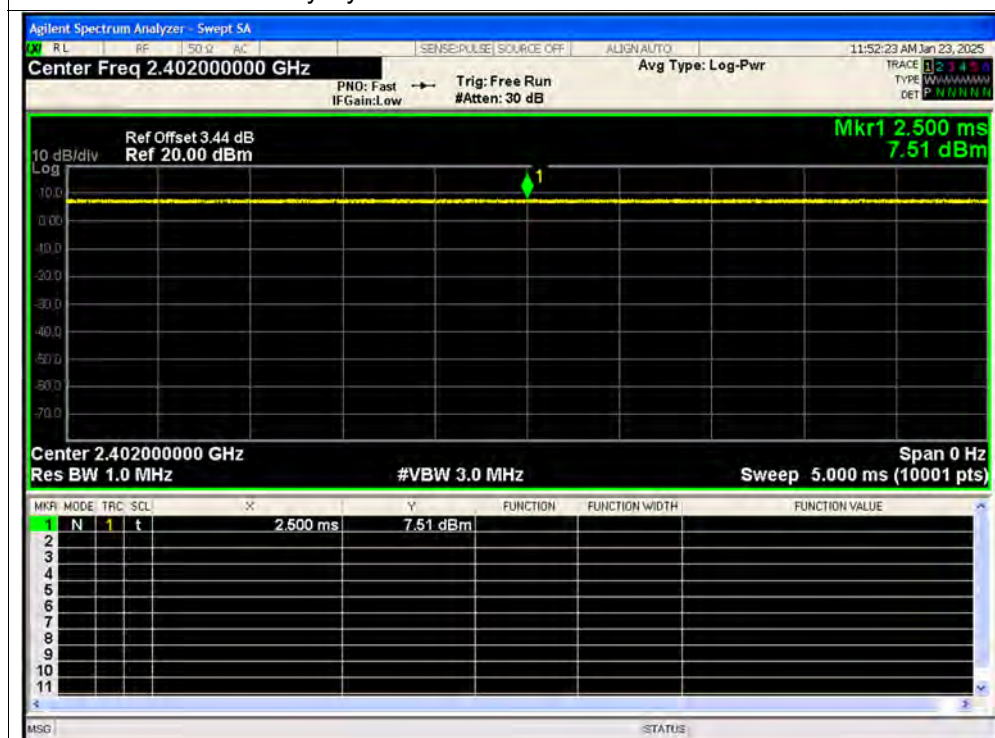




Duty Cycle NVNT BLE 1M 2480MHz Ant1

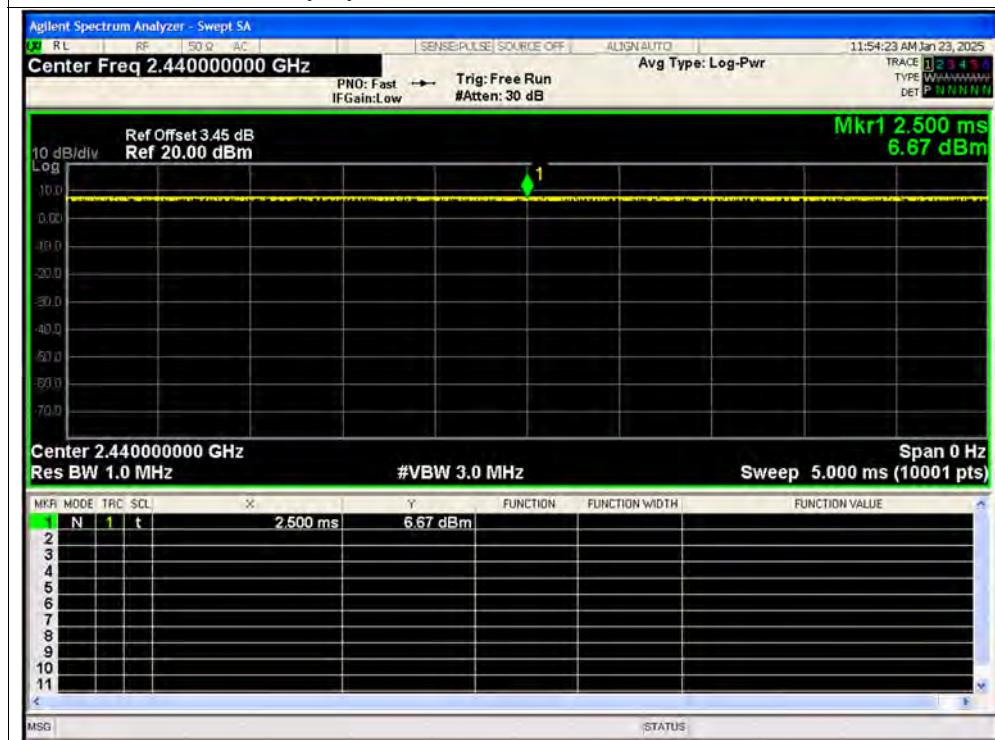


Duty Cycle NVNT BLE 2M 2402MHz Ant1

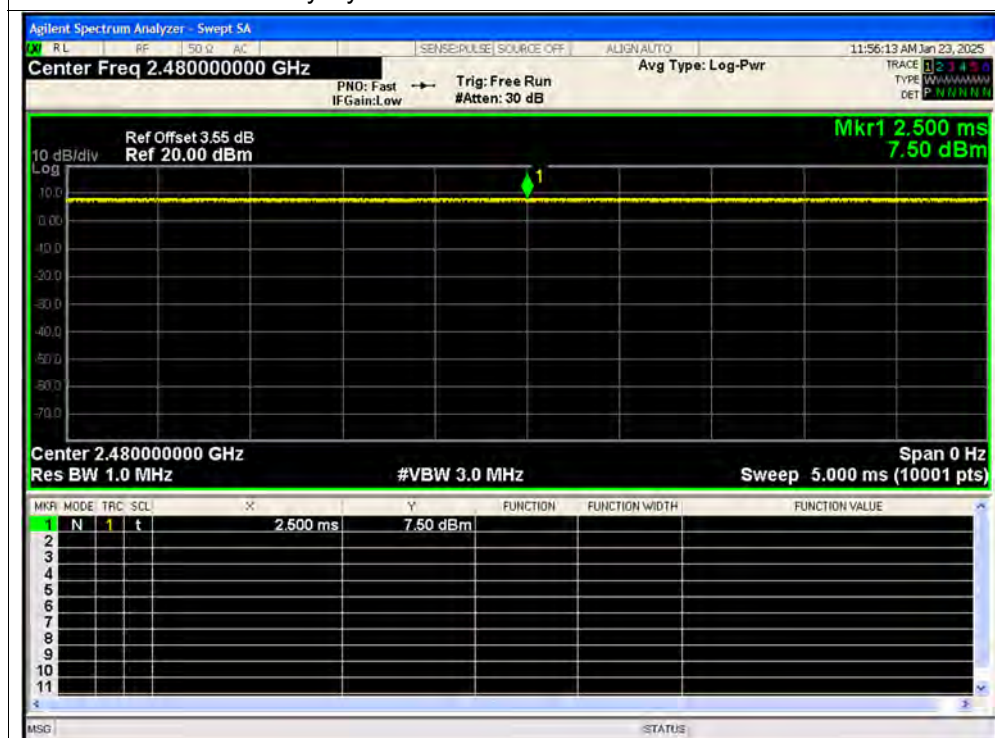




Duty Cycle NVNT BLE 2M 2440MHz Ant1



Duty Cycle NVNT BLE 2M 2480MHz Ant1

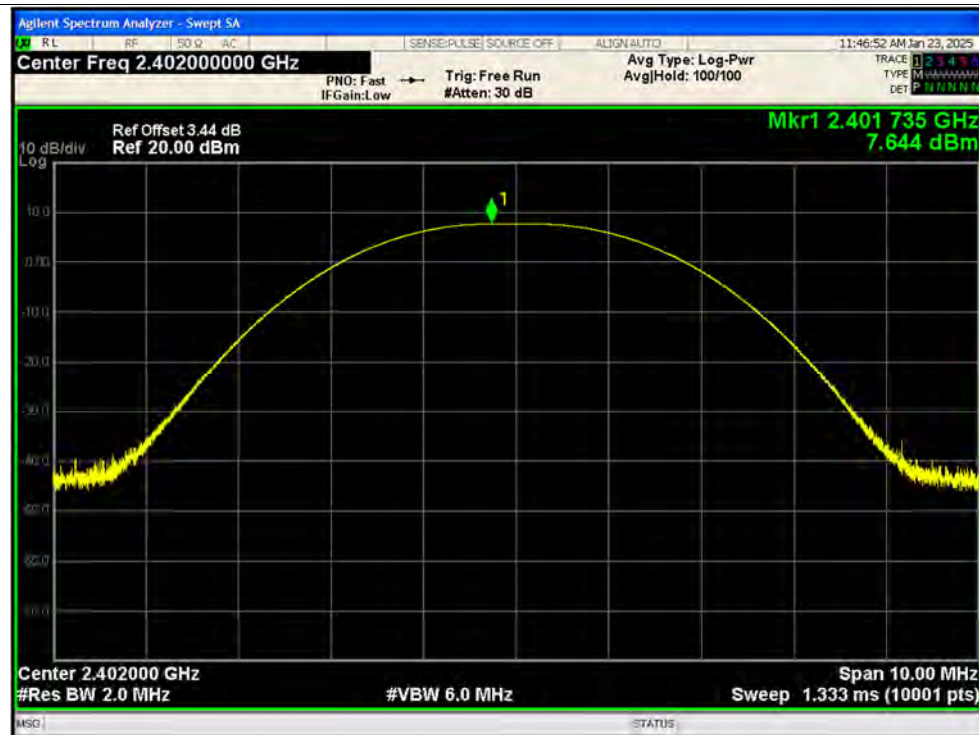


**A.2. Maximum Peak Conducted Output Power**

Condition	Mode	Frequency (MHz)	Antenna	Conducted Power (dBm)	Duty Factor (dB)	Total Conducted Power (dBm)	Total Conducted Power (W)	Limit Conducted (dBm)	Verdict
NVNT	BLE 1M	2402	Ant1	7.64	0	7.64	0.00581	30	Pass
NVNT	BLE 1M	2440	Ant1	7.77	0	7.77	0.00598	30	Pass
NVNT	BLE 1M	2480	Ant1	8.01	0	8.01	0.00632	30	Pass
NVNT	BLE 2M	2402	Ant1	7.65	0	7.65	0.00582	30	Pass
NVNT	BLE 2M	2440	Ant1	7.77	0	7.77	0.00598	30	Pass
NVNT	BLE 2M	2480	Ant1	8	0	8	0.00631	30	Pass

Test Graphs

Peak Power NVNT BLE 1M 2402MHz Ant1



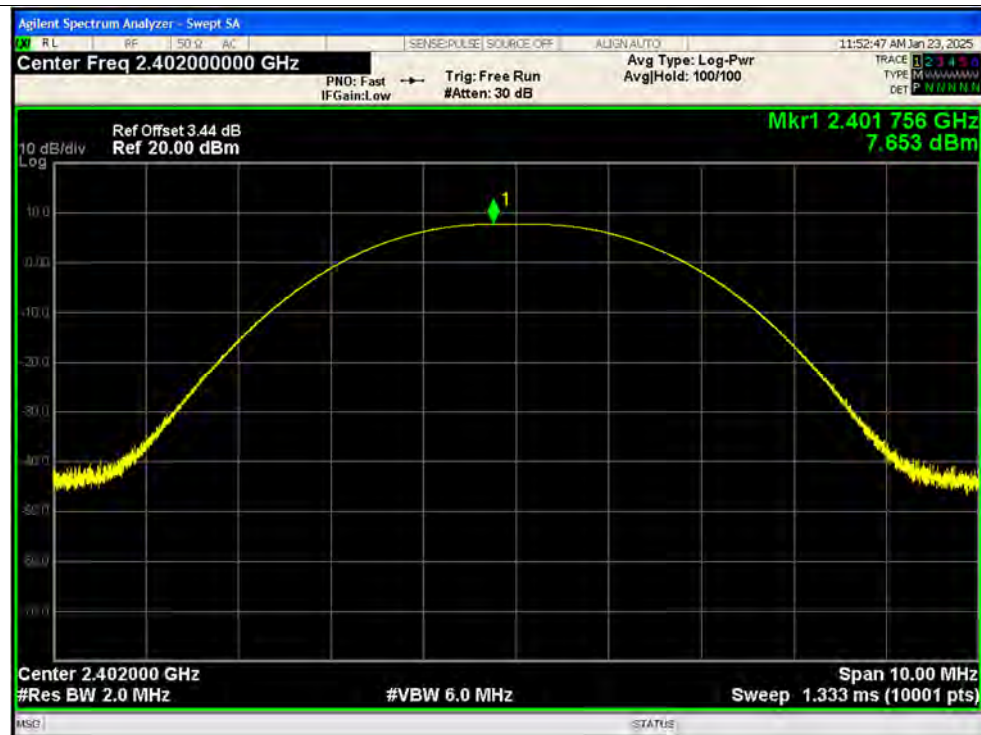
Peak Power NVNT BLE 1M 2440MHz Ant1



Peak Power NVNT BLE 1M 2480MHz Ant1



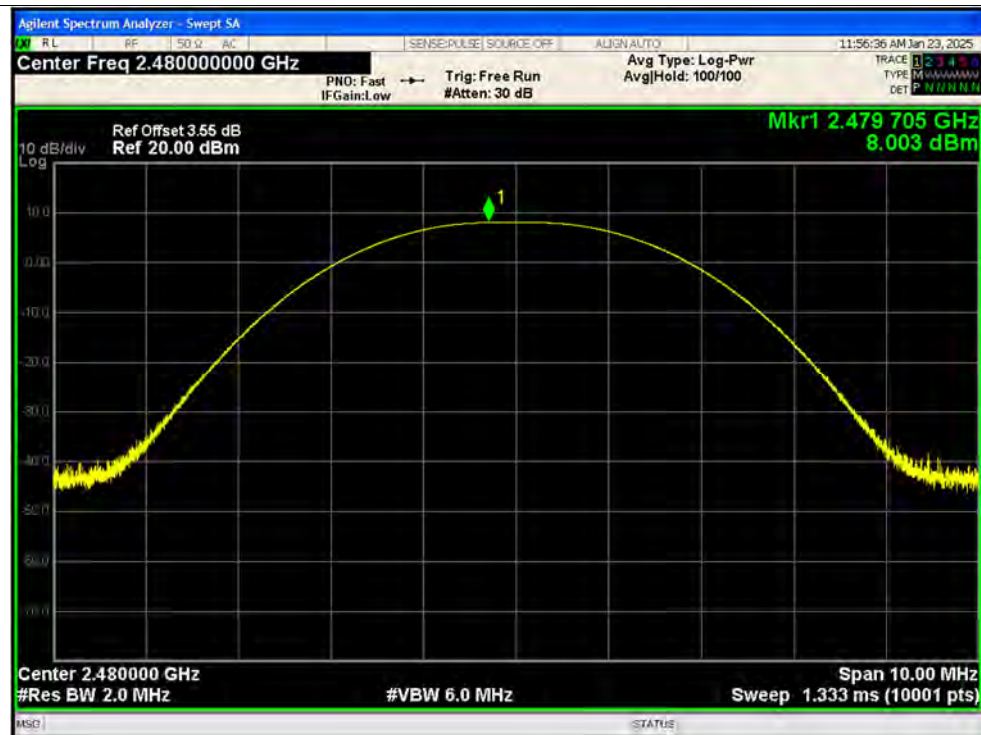
Peak Power NVNT BLE 2M 2402MHz Ant1



Peak Power NVNT BLE 2M 2440MHz Ant1



Peak Power NVNT BLE 2M 2480MHz Ant1



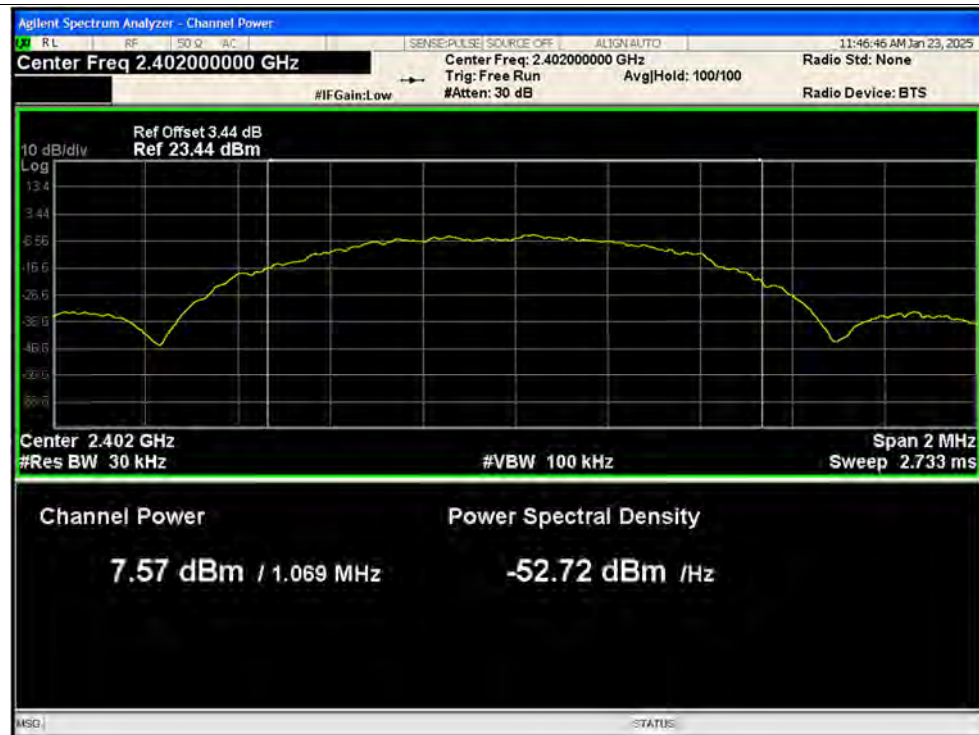
**A.3. Maximum Average Conducted Output Power**

Condition	Mode	Frequency (MHz)	Antenna	Conducted Power (dBm)	Duty Factor (dB)	Total Conducted Power (dBm)	Total Conducted Power (W)	Limit Conducted (dBm)	Verdict
NVNT	BLE 1M	2402	Ant1	7.57	0	7.57	0.00571	30	Pass
NVNT	BLE 1M	2440	Ant1	7.63	0	7.63	0.00579	30	Pass
NVNT	BLE 1M	2480	Ant1	7.8	0	7.8	0.00603	30	Pass
NVNT	BLE 2M	2402	Ant1	7.52	0	7.52	0.00565	30	Pass
NVNT	BLE 2M	2440	Ant1	7.64	0	7.64	0.00581	30	Pass
NVNT	BLE 2M	2480	Ant1	7.87	0	7.87	0.00612	30	Pass

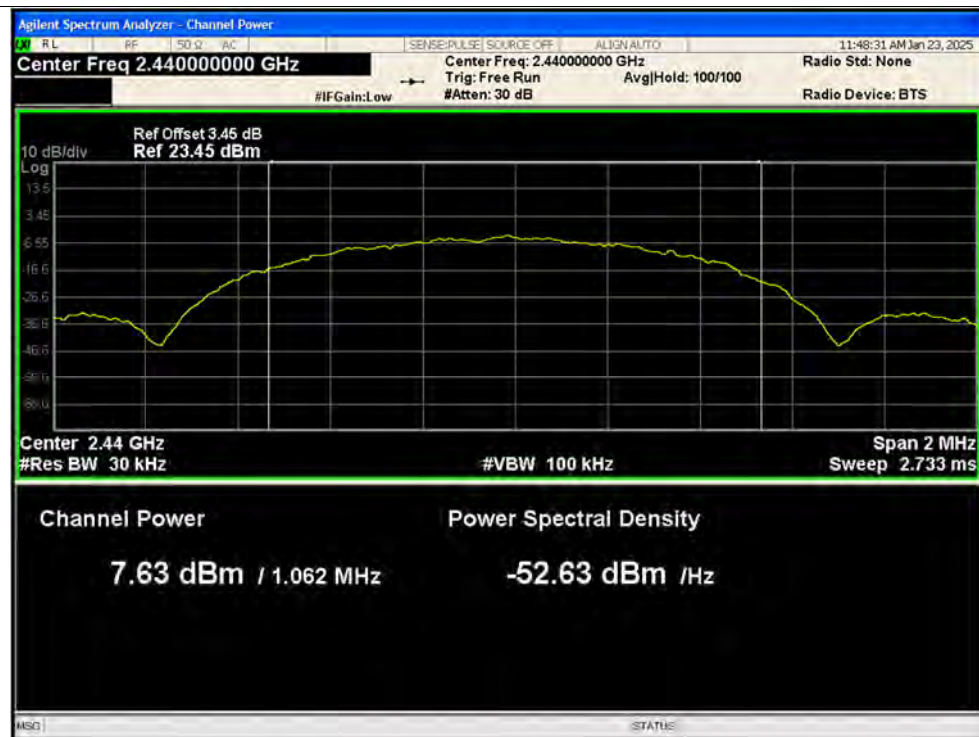


Test Graphs

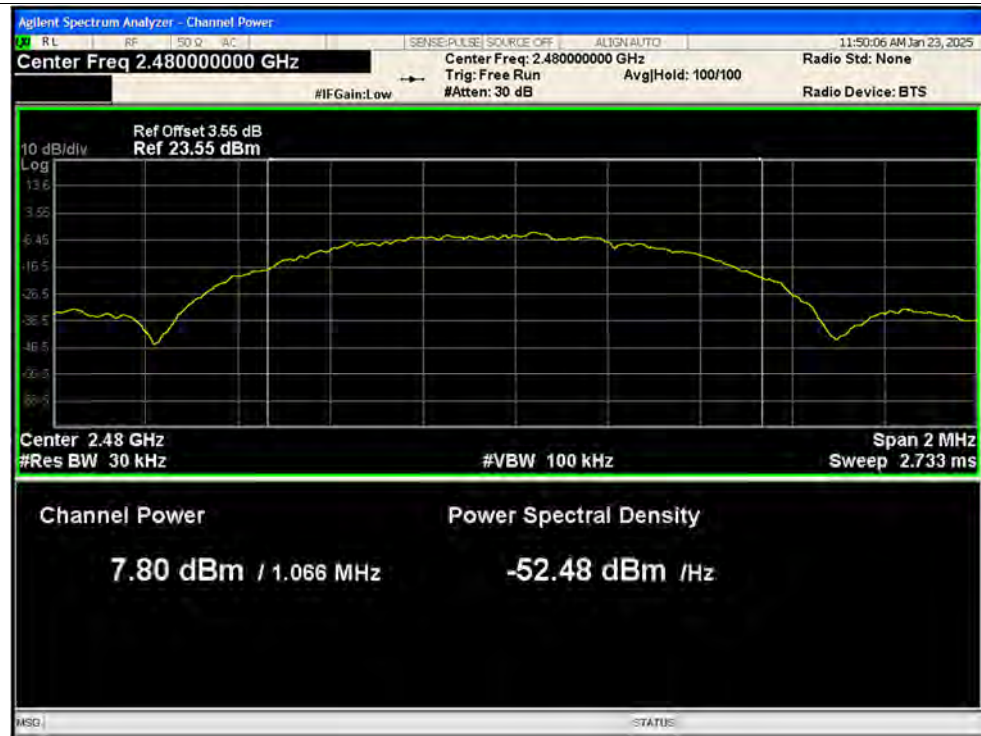
Average Power NVNT BLE 1M 2402MHz Ant1



Average Power NVNT BLE 1M 2440MHz Ant1



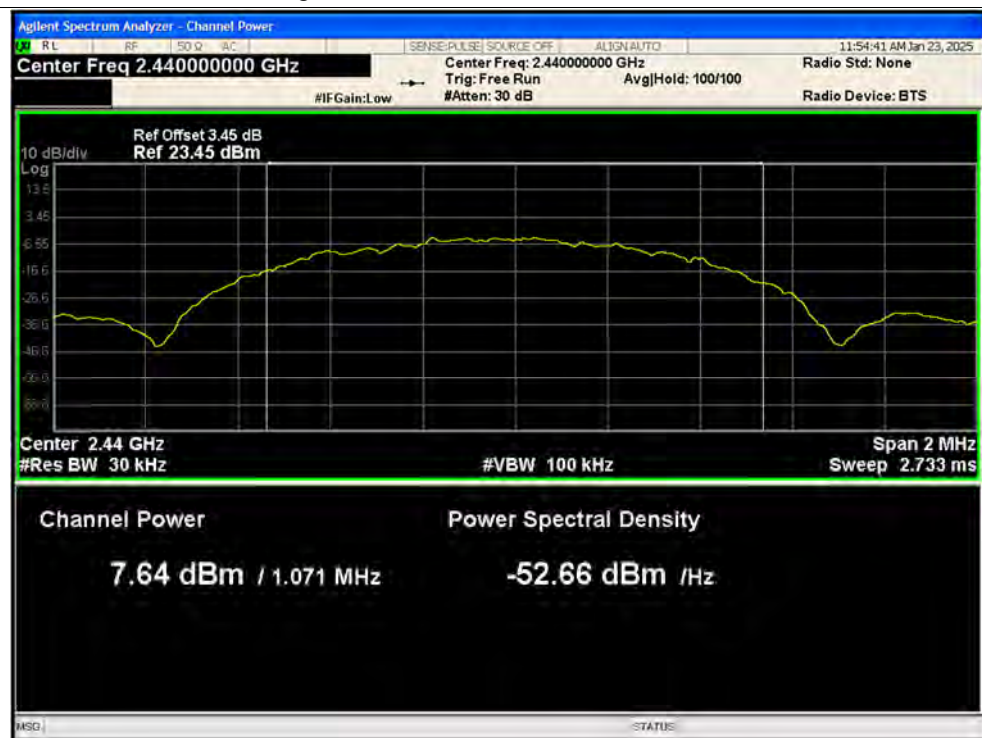
Average Power NVNT BLE 1M 2480MHz Ant1



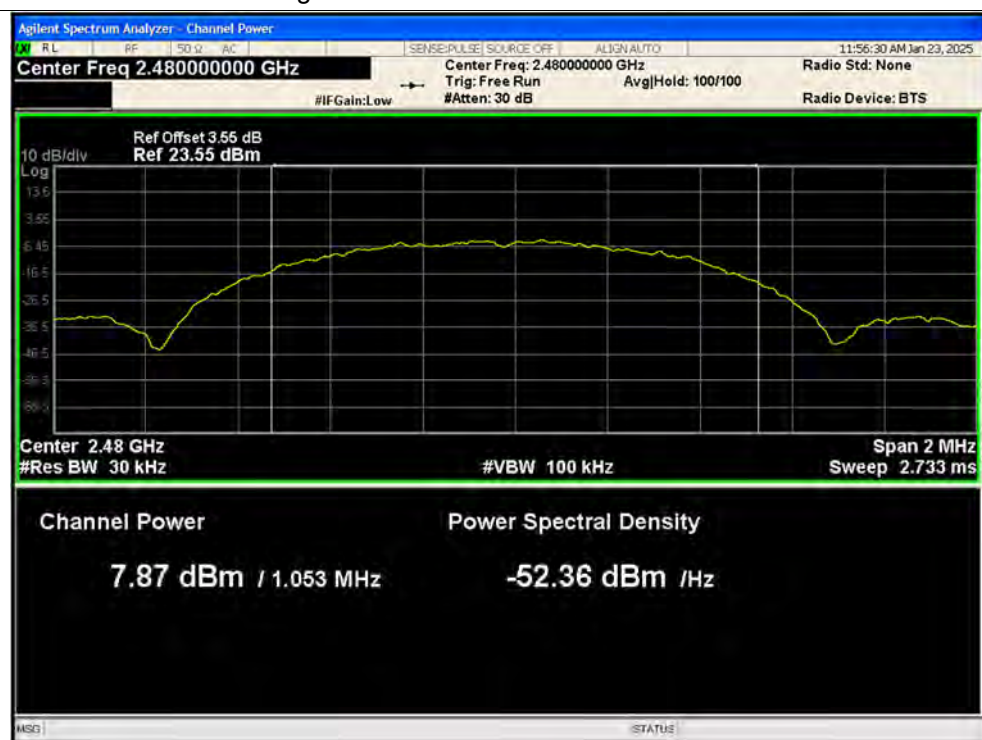
Average Power NVNT BLE 2M 2402MHz Ant1



Average Power NVNT BLE 2M 2440MHz Ant1



Average Power NVNT BLE 2M 2480MHz Ant1



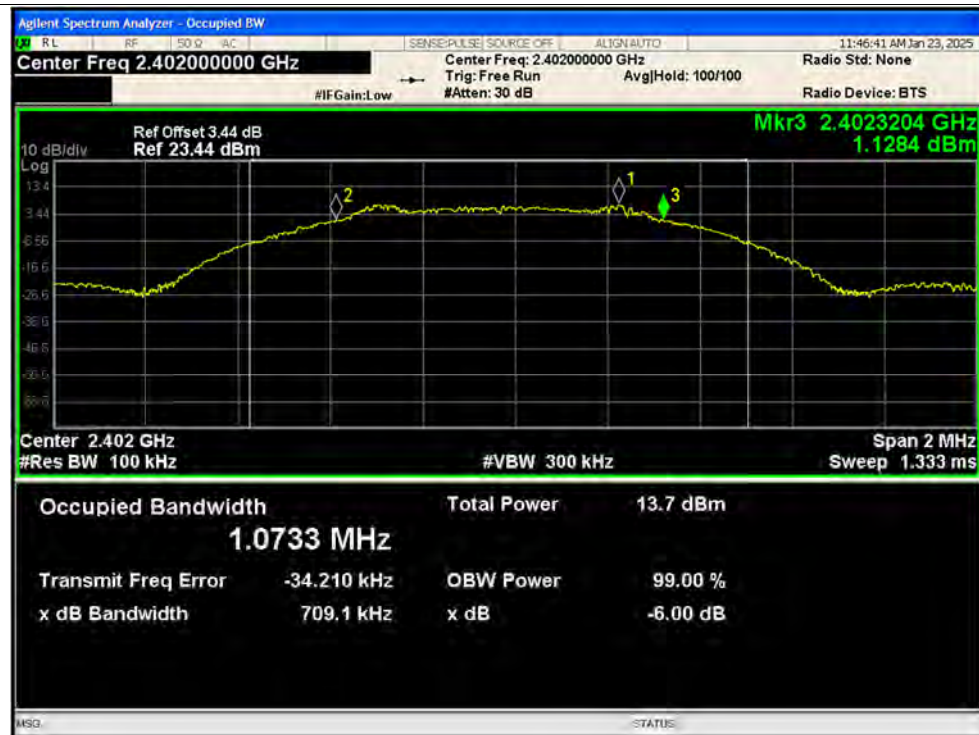
**A.4. 6 dB Bandwidth**

Condition	Mode	Frequency (MHz)	Antenna	-6 dB Bandwidth (MHz)	Limit -6 dB Bandwidth (MHz)	Verdict
NVNT	BLE 1M	2402	Ant1	0.7091	0.5	Pass
NVNT	BLE 1M	2440	Ant1	0.6898	0.5	Pass
NVNT	BLE 1M	2480	Ant1	0.7223	0.5	Pass
NVNT	BLE 2M	2402	Ant1	0.7437	0.5	Pass
NVNT	BLE 2M	2440	Ant1	0.7325	0.5	Pass
NVNT	BLE 2M	2480	Ant1	0.7013	0.5	Pass



Test Graphs

-6dB Bandwidth NVNT BLE 1M 2402MHz Ant1



-6dB Bandwidth NVNT BLE 1M 2440MHz Ant1



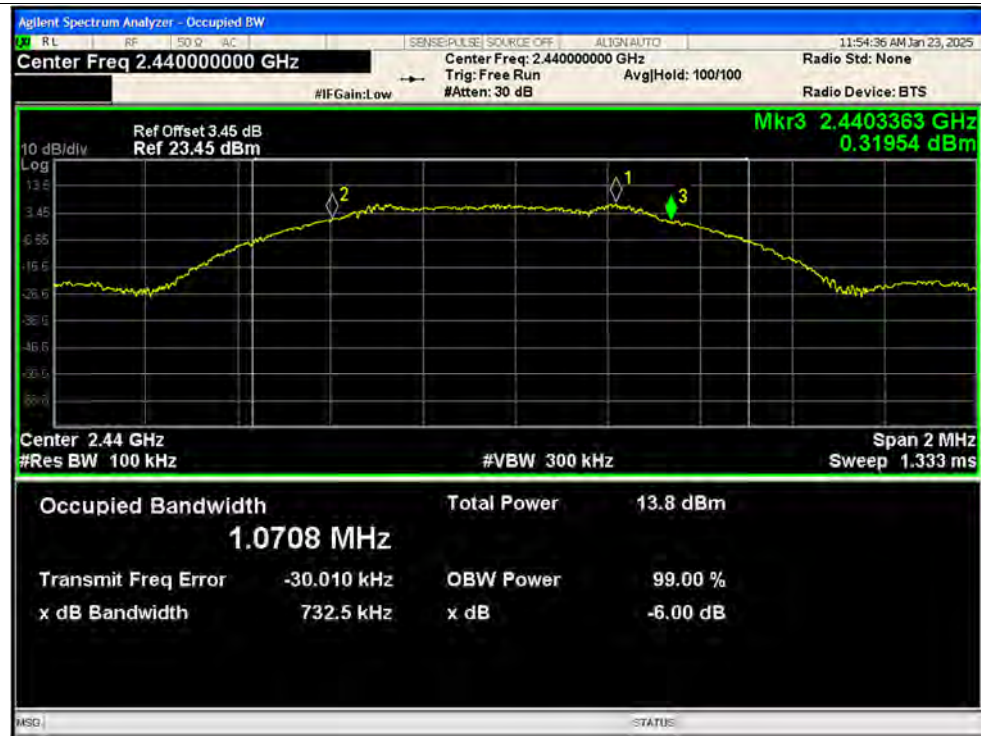
-6dB Bandwidth NVNT BLE 1M 2480MHz Ant1



-6dB Bandwidth NVNT BLE 2M 2402MHz Ant1



-6dB Bandwidth NVNT BLE 2M 2440MHz Ant1



-6dB Bandwidth NVNT BLE 2M 2480MHz Ant1



**A.5. Conducted Spurious Emissions**

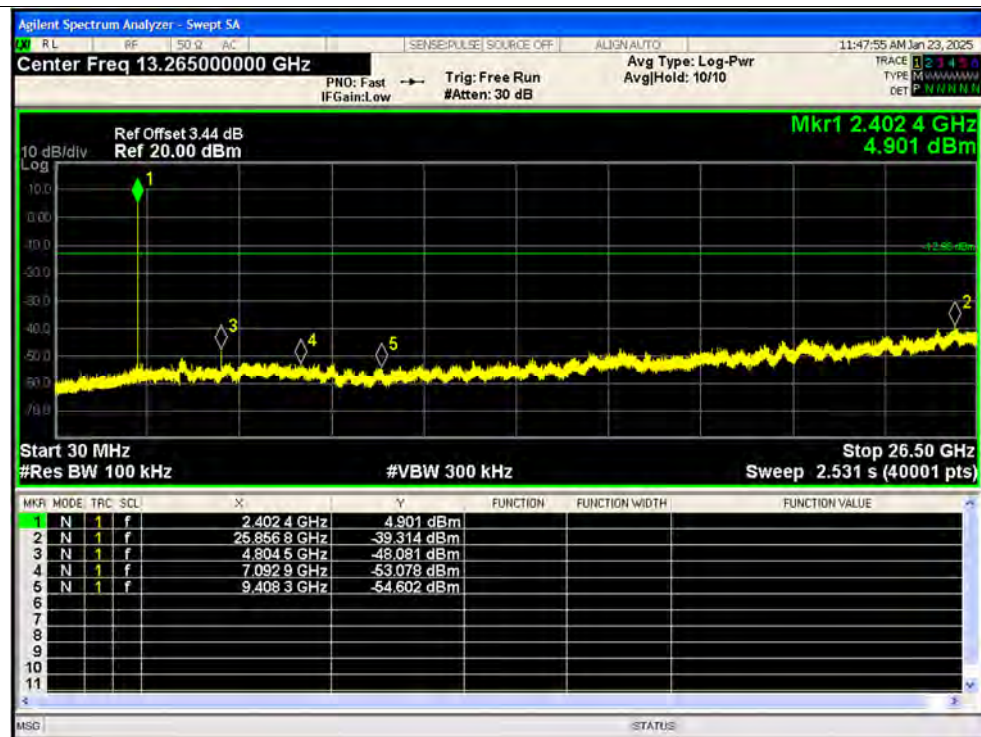
Condition	Mode	Frequency (MHz)	Antenna	Max Value (dBc)	Limit (dBc)	Verdict
NVNT	BLE 1M	2402	Ant1	-46.36	-20	Pass
NVNT	BLE 1M	2440	Ant1	-45.2	-20	Pass
NVNT	BLE 1M	2480	Ant1	-47.59	-20	Pass
NVNT	BLE 2M	2402	Ant1	-46.02	-20	Pass
NVNT	BLE 2M	2440	Ant1	-46.27	-20	Pass
NVNT	BLE 2M	2480	Ant1	-47.04	-20	Pass

Test Graphs

Tx. Spurious NVNT BLE 1M 2402MHz Ant1 Ref



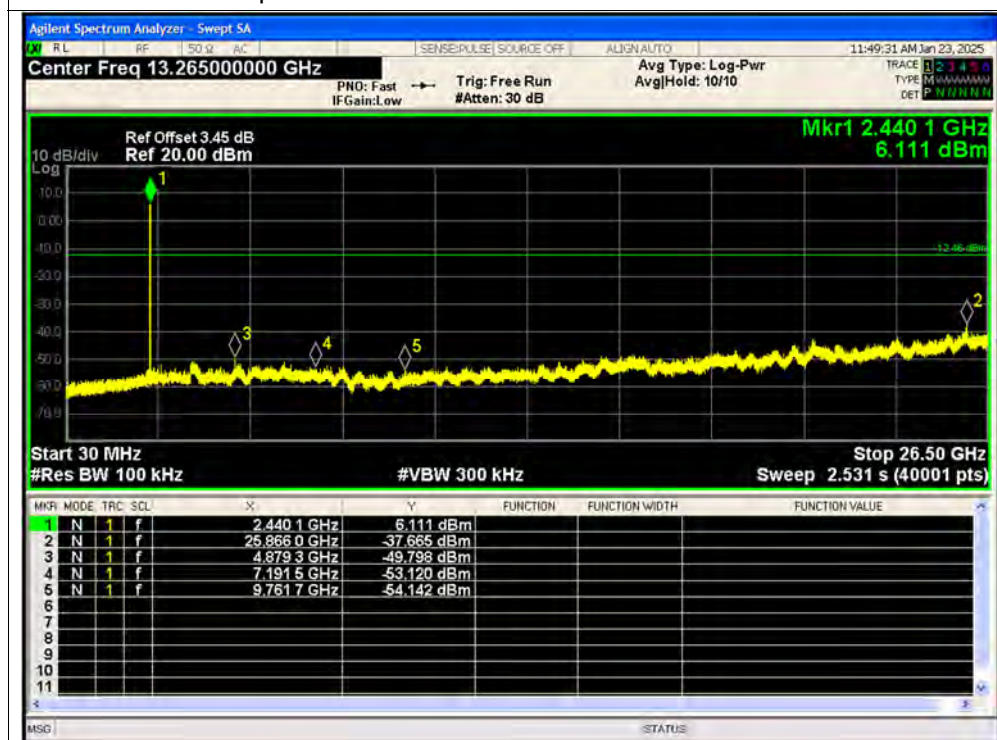
Tx. Spurious NVNT BLE 1M 2402MHz Ant1 Emission



Tx. Spurious NVNT BLE 1M 2440MHz Ant1 Ref



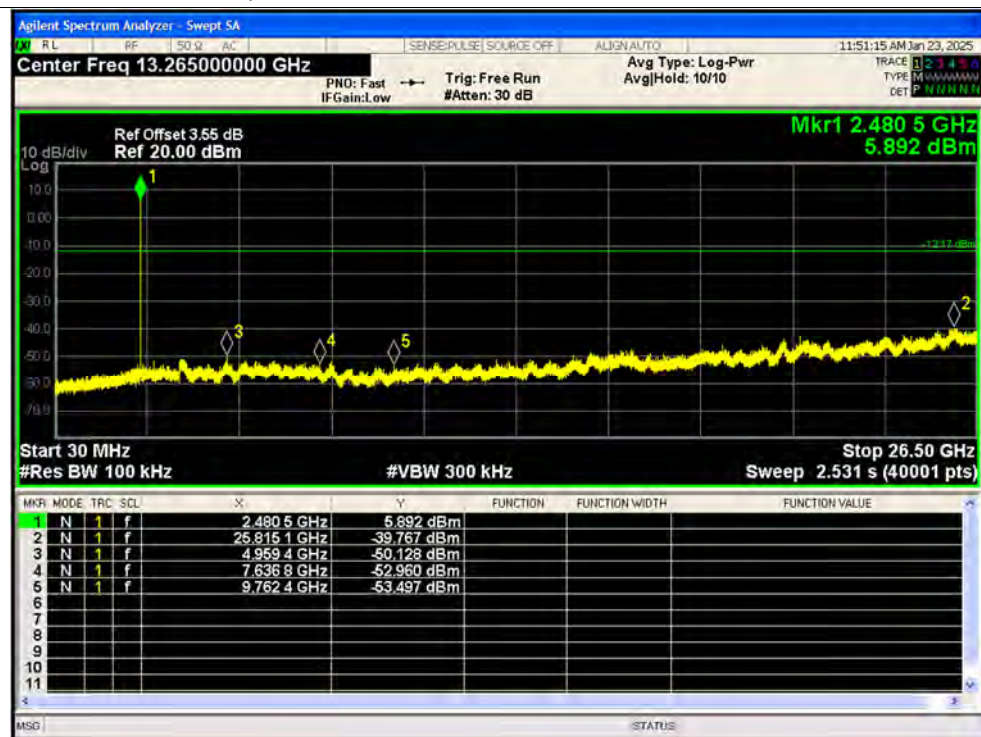
Tx. Spurious NVNT BLE 1M 2440MHz Ant1 Emission



Tx. Spurious NVNT BLE 1M 2480MHz Ant1 Ref



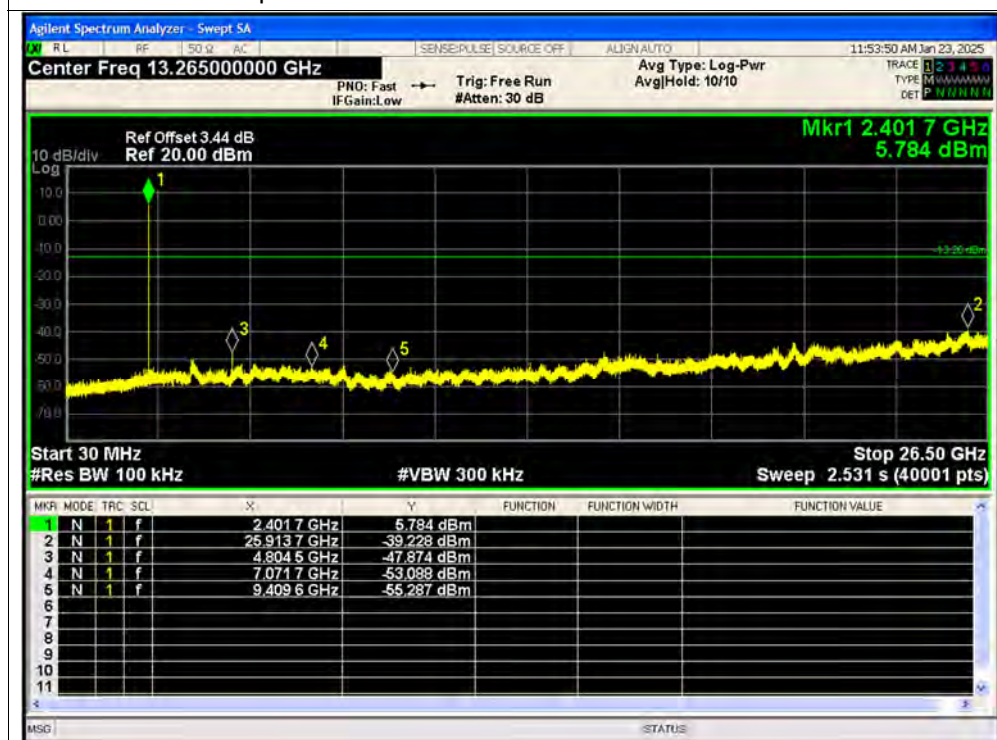
Tx. Spurious NVNT BLE 1M 2480MHz Ant1 Emission



Tx. Spurious NVNT BLE 2M 2402MHz Ant1 Ref



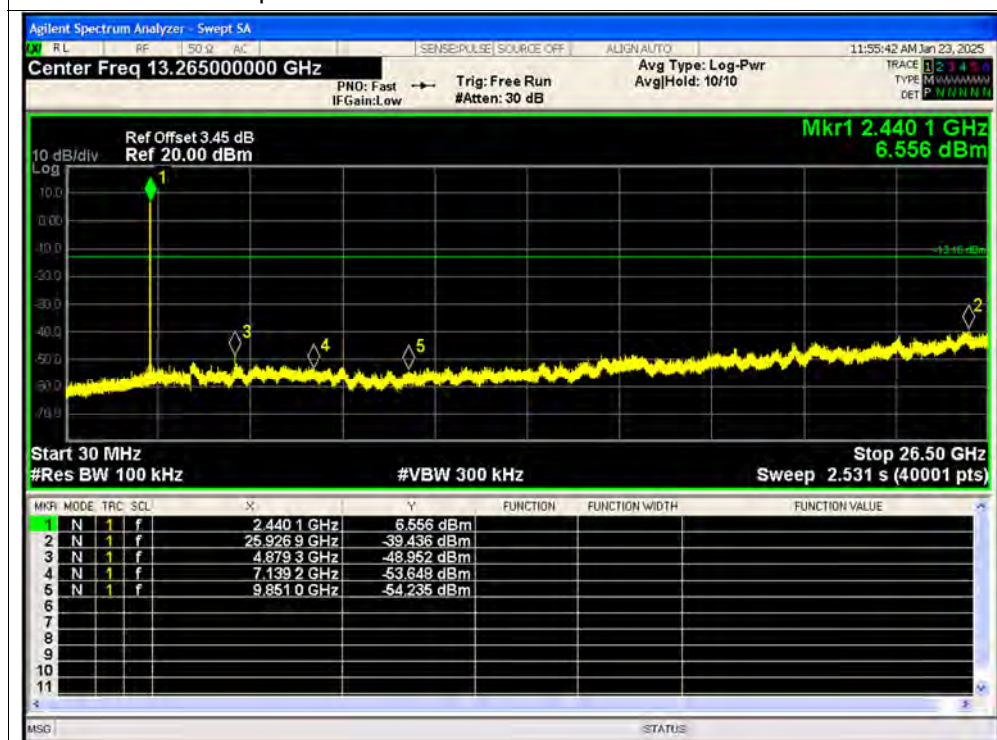
Tx. Spurious NVNT BLE 2M 2402MHz Ant1 Emission



Tx. Spurious NVNT BLE 2M 2440MHz Ant1 Ref



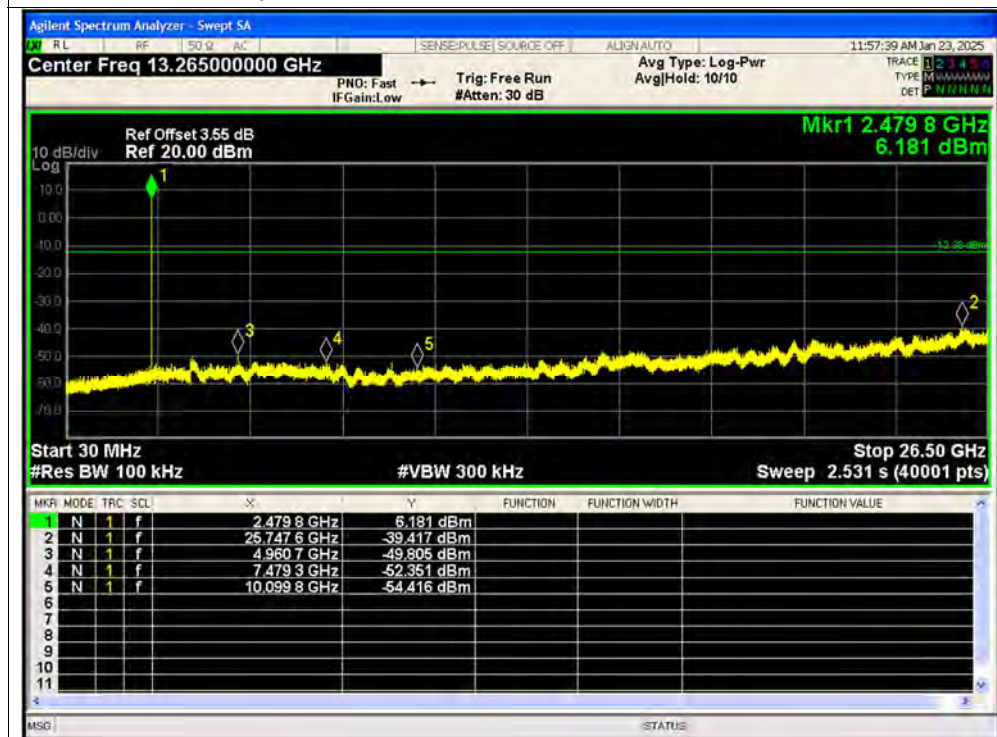
Tx. Spurious NVNT BLE 2M 2440MHz Ant1 Emission



Tx. Spurious NVNT BLE 2M 2480MHz Ant1 Ref



Tx. Spurious NVNT BLE 2M 2480MHz Ant1 Emission



**A.6. Band Edge**

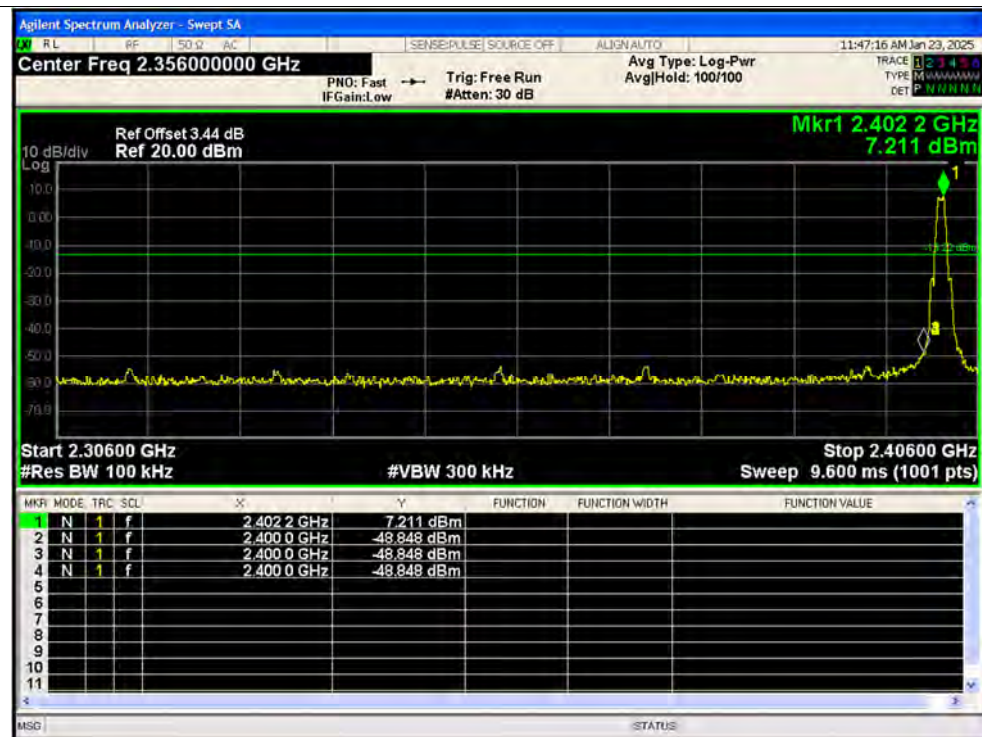
Condition	Mode	Frequency (MHz)	Antenna	Max Value (dBc)	Limit (dBc)	Verdict
NVNT	BLE 1M	2402	Ant1	-55.62	-20	Pass
NVNT	BLE 1M	2480	Ant1	-60.66	-20	Pass
NVNT	BLE 2M	2402	Ant1	-56.36	-20	Pass
NVNT	BLE 2M	2480	Ant1	-58.52	-20	Pass

Test Graphs

Band Edge NVNT BLE 1M 2402MHz Ant1 Ref



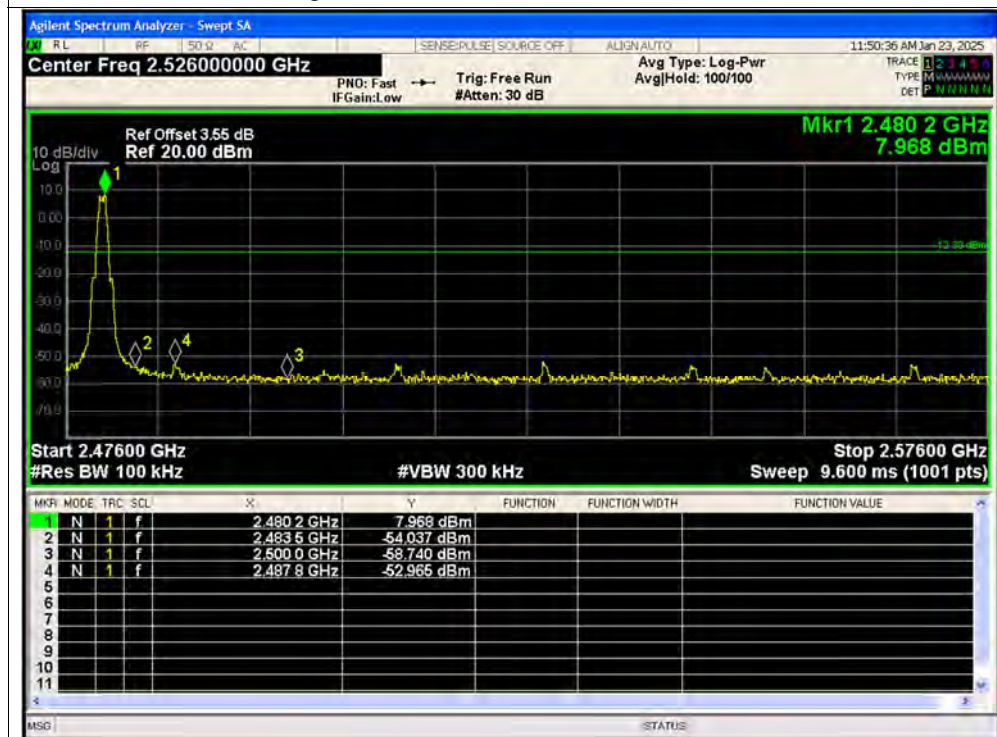
Band Edge NVNT BLE 1M 2402MHz Ant1 Emission



Band Edge NVNT BLE 1M 2480MHz Ant1 Ref



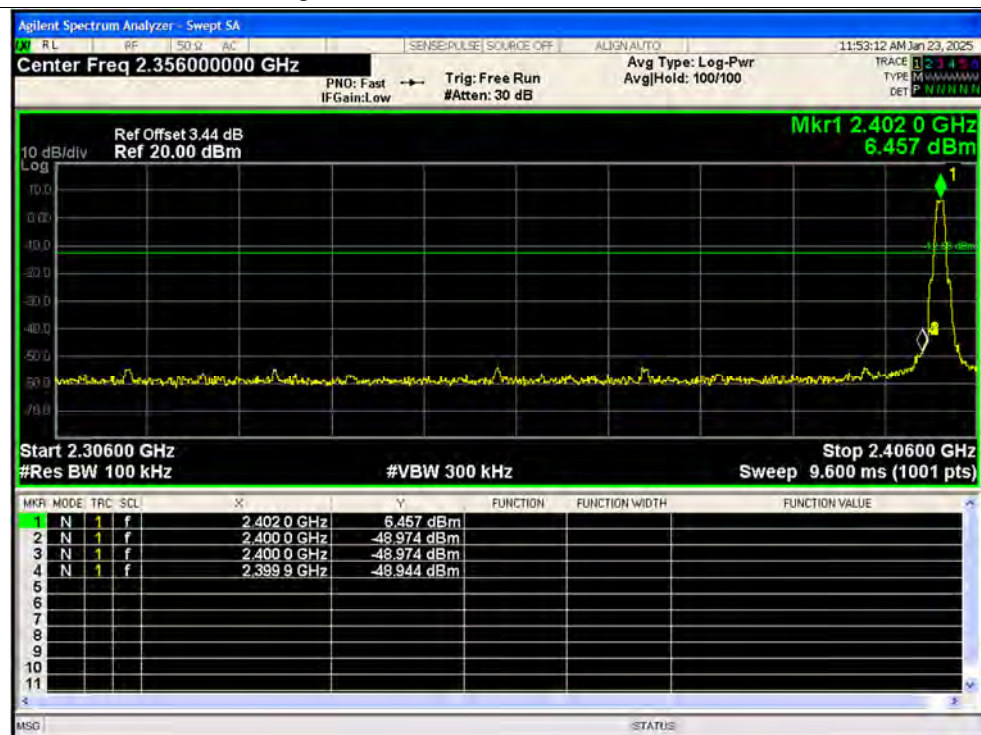
Band Edge NVNT BLE 1M 2480MHz Ant1 Emission



Band Edge NVNT BLE 2M 2402MHz Ant1 Ref



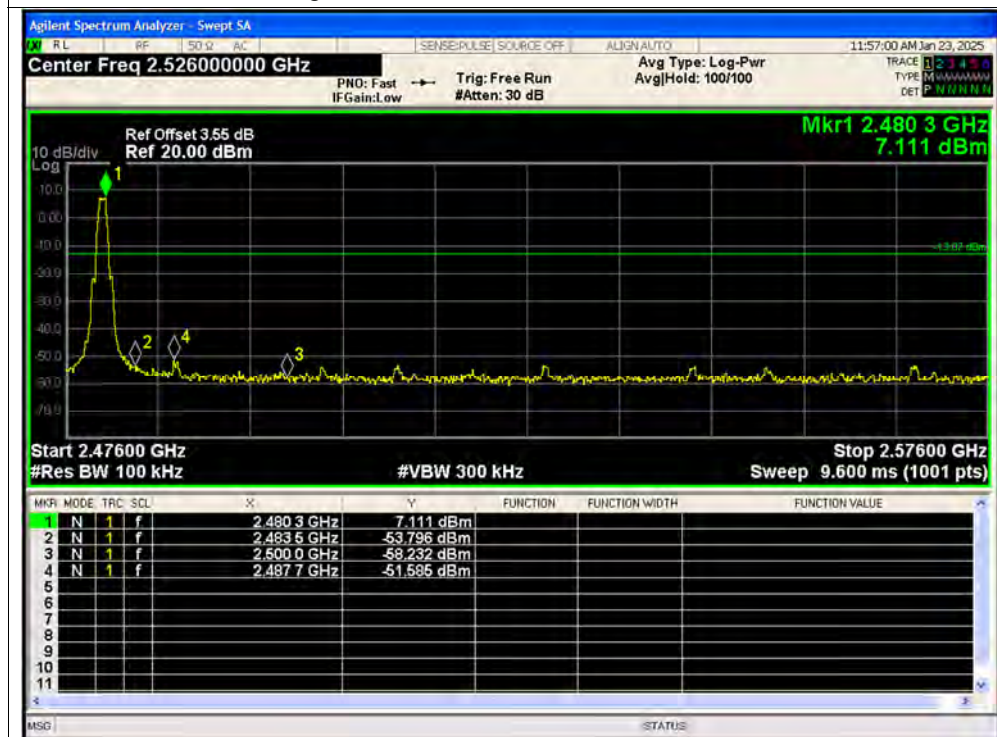
Band Edge NVNT BLE 2M 2402MHz Ant1 Emission



Band Edge NVNT BLE 2M 2480MHz Ant1 Ref



Band Edge NVNT BLE 2M 2480MHz Ant1 Emission



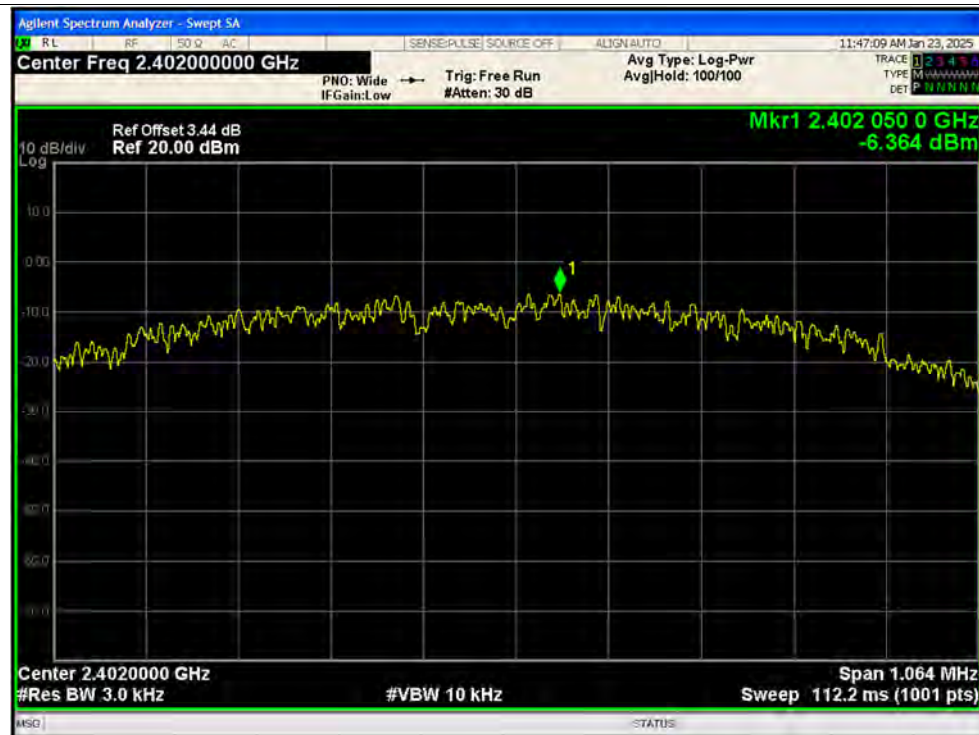
**A.7. Power Spectral Density**

Condition	Mode	Frequency (MHz)	Antenna	Conducted PSD (dBm/3kHz)	Duty Factor (dB)	Total PSD (dBm/3kHz)	Limit (dBm/3kHz)	Verdict
NVNT	BLE 1M	2402	Ant1	-6.36	0	-6.36	8	Pass
NVNT	BLE 1M	2440	Ant1	-5.3	0	-5.3	8	Pass
NVNT	BLE 1M	2480	Ant1	-5.53	0	-5.53	8	Pass
NVNT	BLE 2M	2402	Ant1	-5.63	0	-5.63	8	Pass
NVNT	BLE 2M	2440	Ant1	-5.16	0	-5.16	8	Pass
NVNT	BLE 2M	2480	Ant1	-5.54	0	-5.54	8	Pass



Test Graphs

PSD NVNT BLE 1M 2402MHz Ant1



PSD NVNT BLE 1M 2440MHz Ant1



PSD NVNT BLE 1M 2480MHz Ant1



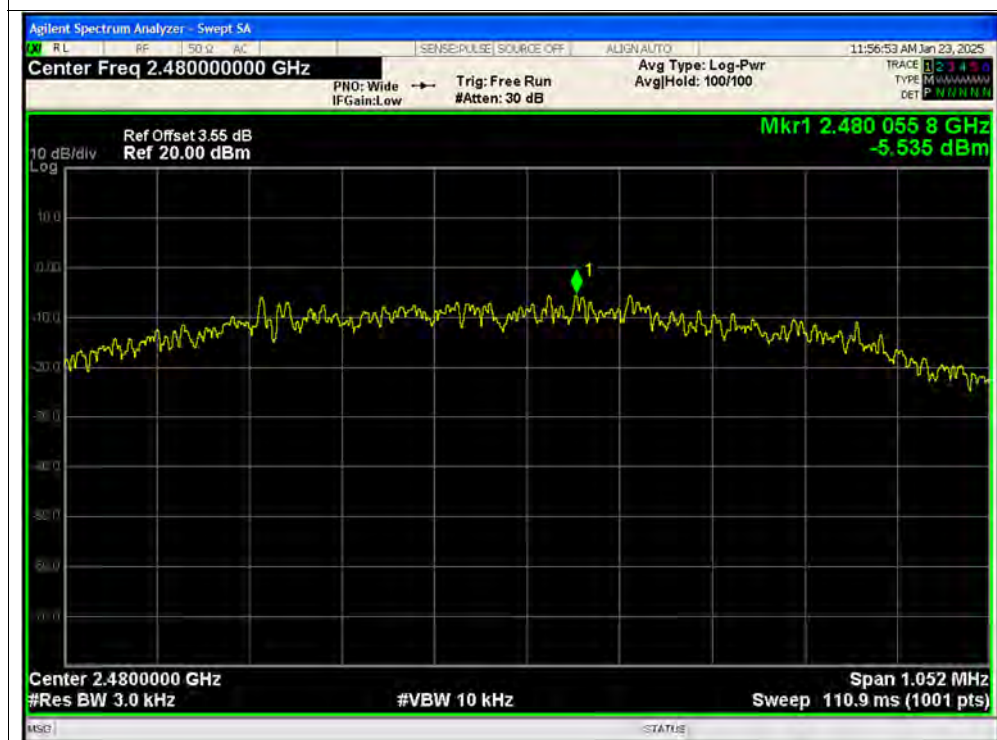
PSD NVNT BLE 2M 2402MHz Ant1



PSD NVNT BLE 2M 2440MHz Ant1



PSD NVNT BLE 2M 2480MHz Ant1





A.8. Conducted Emission

The maximum conducted interference is searched using Peak (PK), if the emission levels more than the AV and QP limits, and that have narrow margins from the AV and QP limits will be re-measured with AV and QP detectors. Tests for both L phase and N phase lines of the power mains connected to the EUT are performed. Set RBW=9kHz, VBW=30kHz. Refer to recorded points and plots below.

Note: Both of the test voltage AC 120V/60Hz and AC 230V/50Hz were considered and tested respectively, only the results of the worst case AC 120V/60Hz were recorded in this report.

A. Test Setup:

Test Mode: EUT+PC+PC adapter+Antenna+Serial port board+BLE TX

Test voltage: AC 120V/60Hz

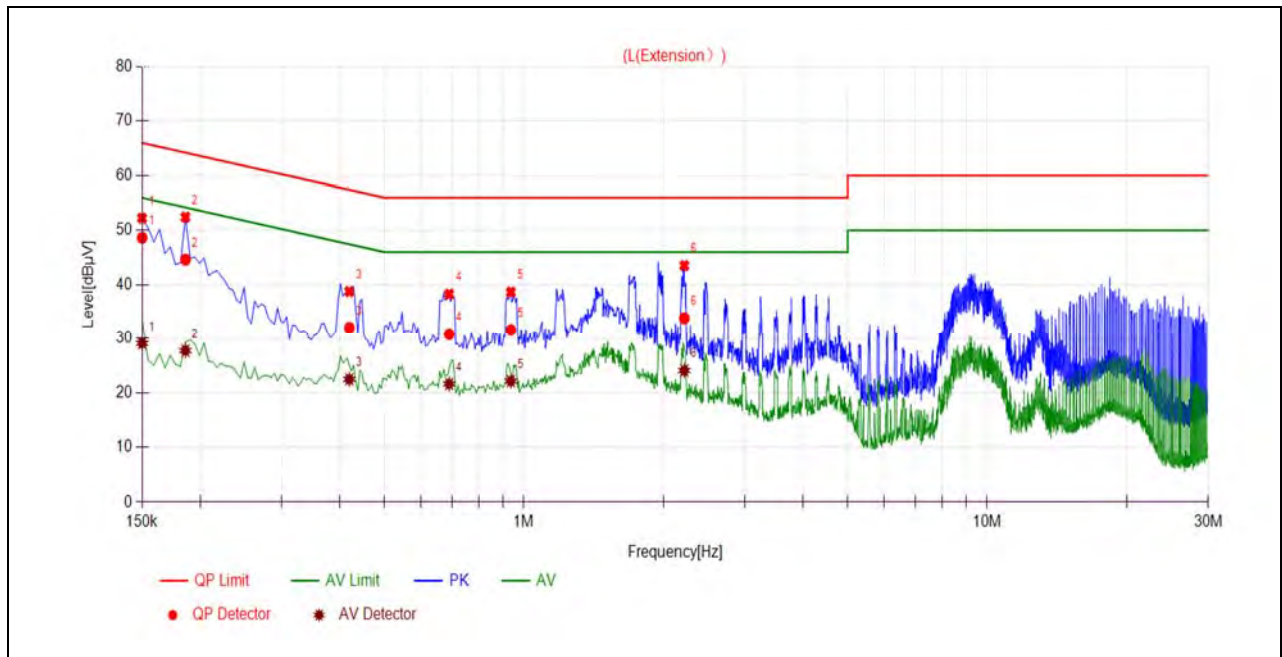
The measurement results are obtained as below:

$$E \text{ [dB}\mu\text{V]} = U_R + L_{\text{Cable loss [dB]} + A_{\text{Factor}}$$

U_R : Receiver Reading

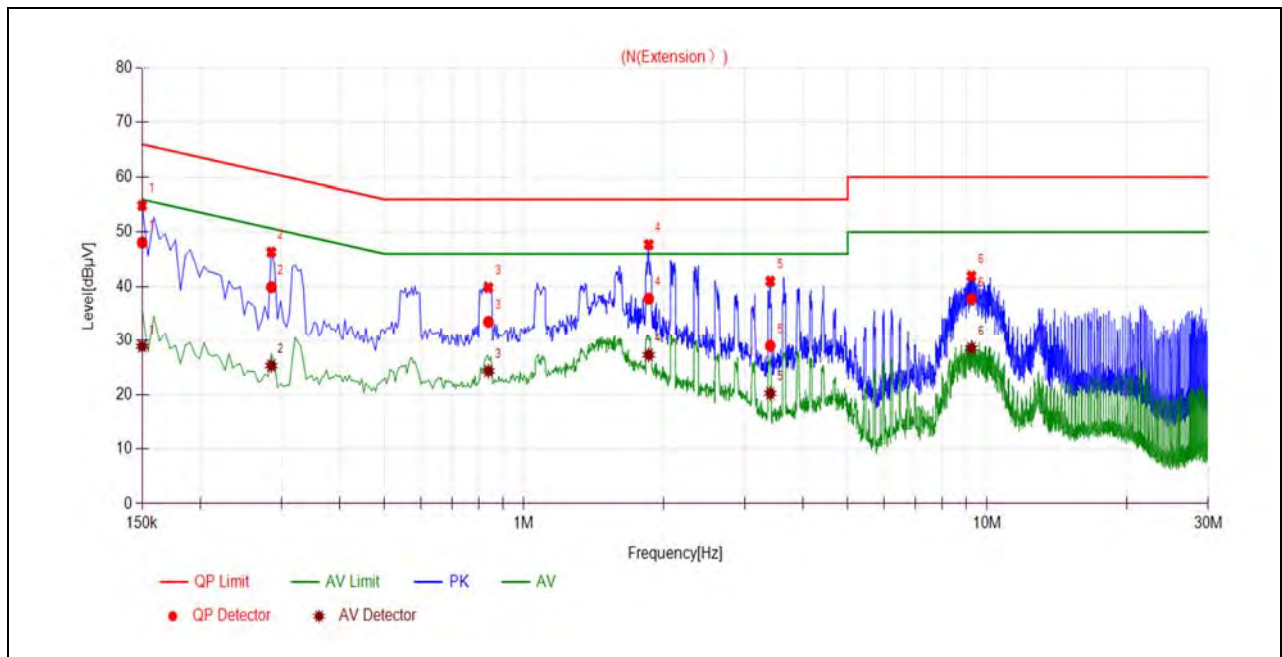
A_{Factor} : Voltage division factor of LISN

B. Test Plot:



(L Phase)

No.	Fre. (MHz)	Emission Level (dBμV)		Limit (dBμV)		Power-line	Verdict
		Quai-peak	Average	Quai-peak	Average		
1	0.1500	48.66	29.08	66.00	56.00	Line	PASS
2	0.1860	44.62	27.72	64.21	54.21		PASS
3	0.4200	32.04	22.44	57.45	47.45		PASS
4	0.6900	30.80	21.58	56.00	46.00		PASS
5	0.9375	31.60	22.10	56.00	46.00		PASS
6	2.2199	33.80	24.05	56.00	46.00		PASS



(N Phase)

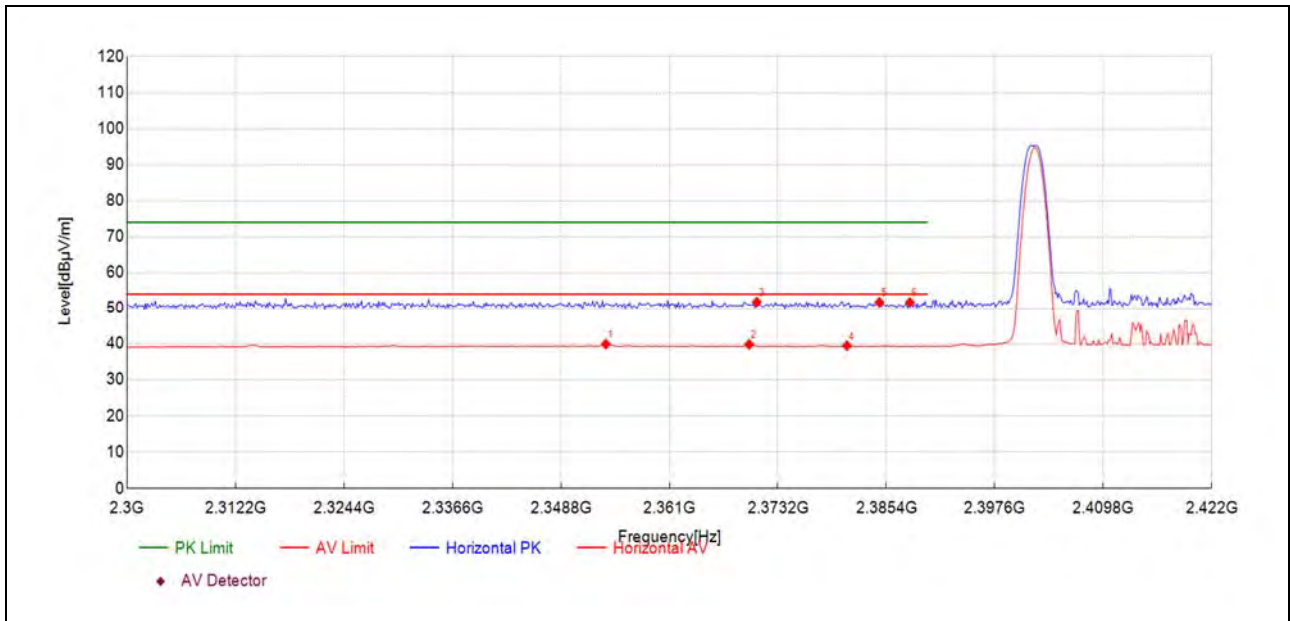
No.	Fre. (MHz)	Emission Level (dBμV)		Limit (dBμV)		Power-line	Verdict
		Quai-peak	Average	Quai-peak	Average		
1	0.1500	48.08	28.88	66.00	56.00	Neutral	PASS
2	0.2850	39.91	25.31	60.67	50.67		PASS
3	0.8385	33.52	24.32	56.00	46.00		PASS
4	1.8600	37.79	27.31	56.00	46.00		PASS
5	3.4033	28.97	20.22	56.00	46.00		PASS
6	9.2488	37.68	28.54	60.00	50.00		PASS

A.9. Restricted Frequency Bands

Note: Restricted Frequency Bands were performed when antenna was at vertical and horizontal polarity, and only the worse test condition (Horizontal) was recorded in this test report.

1Mbps

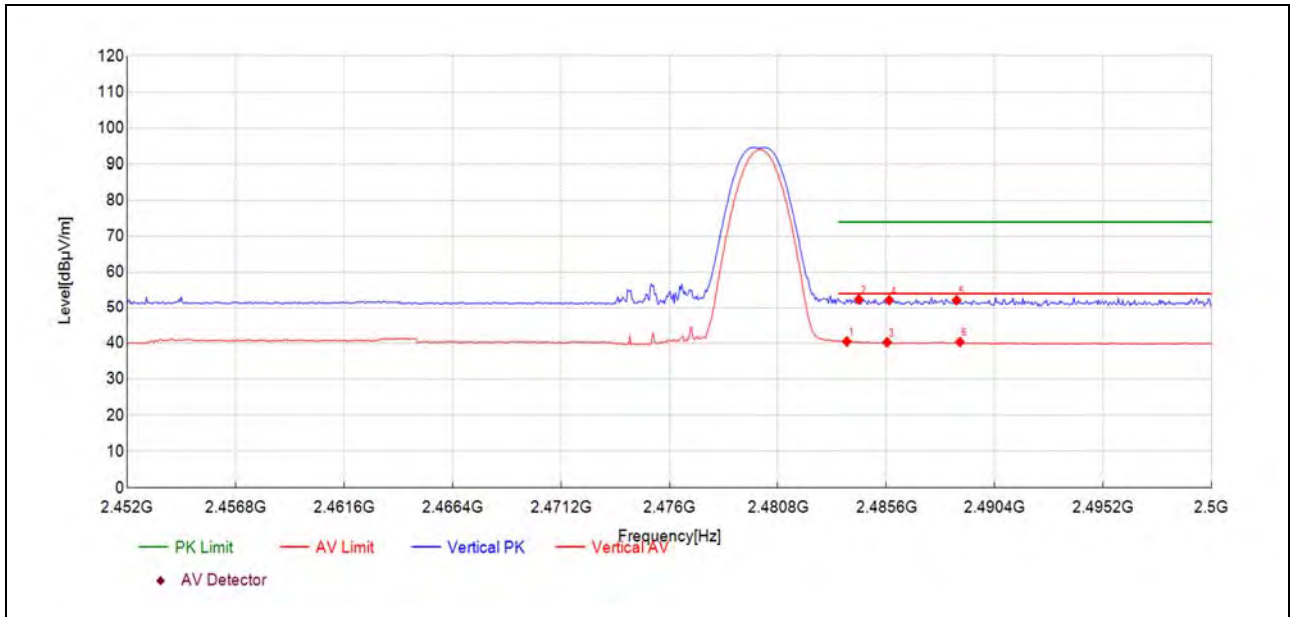
Plot for Channel 0



Fre. (MHz)	Reading [dBμV]	Level [dBμV/m]	Factor [dB/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Verdict
2353.86	2.5	39.92	37.460	54.00	14.08	150	134	AV	PASS
2369.98	2.4	39.83	37.470	54.00	14.17	150	125	AV	PASS
2370.83	14.4	51.84	37.470	74.00	22.16	150	31	PK	PASS
2380.97	2.0	39.48	37.480	54.00	14.52	150	195	AV	PASS
2384.63	14.3	51.79	37.490	74.00	22.21	150	307	PK	PASS
2388.05	14.3	51.74	37.490	74.00	22.26	150	138	PK	PASS



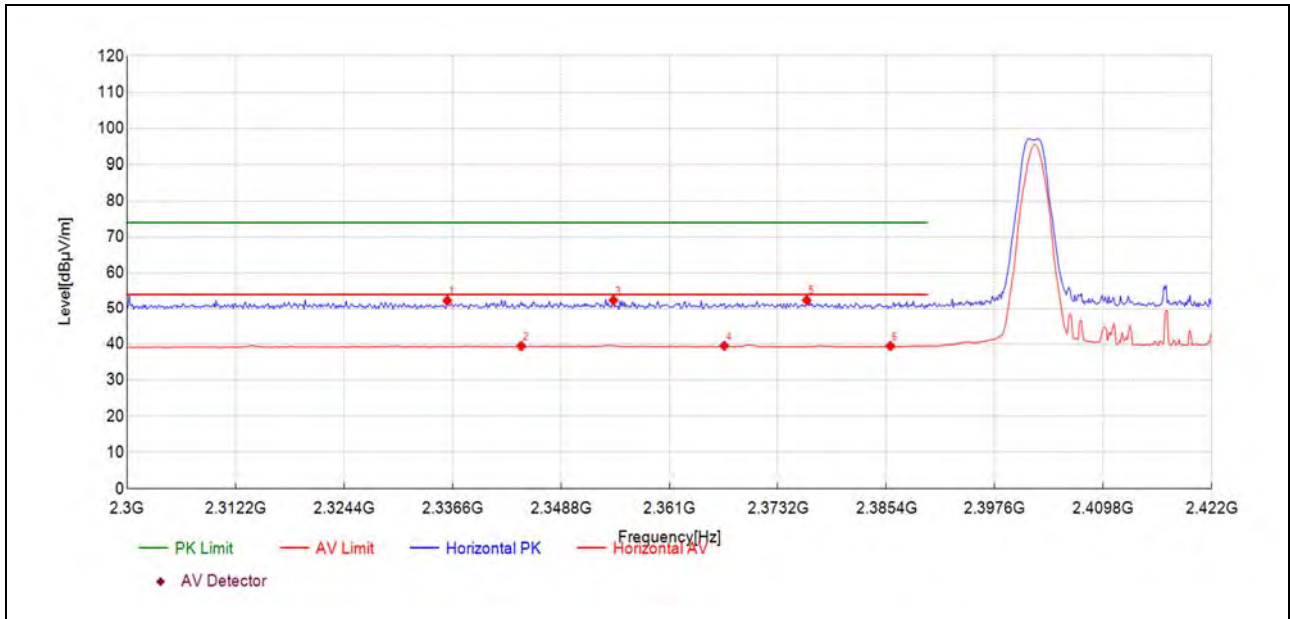
Plot for Channel 39



Fre. (MHz)	Reading [dBμV]	Level [dBμV/m]	Factor [dB/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Verdict
2483.86	2.2	40.47	38.270	54.00	13.53	150	143	AV	PASS
2484.38	14.2	52.42	38.270	74.00	21.58	150	339	PK	PASS
2485.63	2.0	40.23	38.270	54.00	13.77	150	169	AV	PASS
2485.73	14.0	52.22	38.270	74.00	21.78	150	223	PK	PASS
2488.71	13.9	52.20	38.270	74.00	21.80	150	98	PK	PASS
2488.85	2.1	40.33	38.260	54.00	13.67	150	143	AV	PASS

**2Mbps**

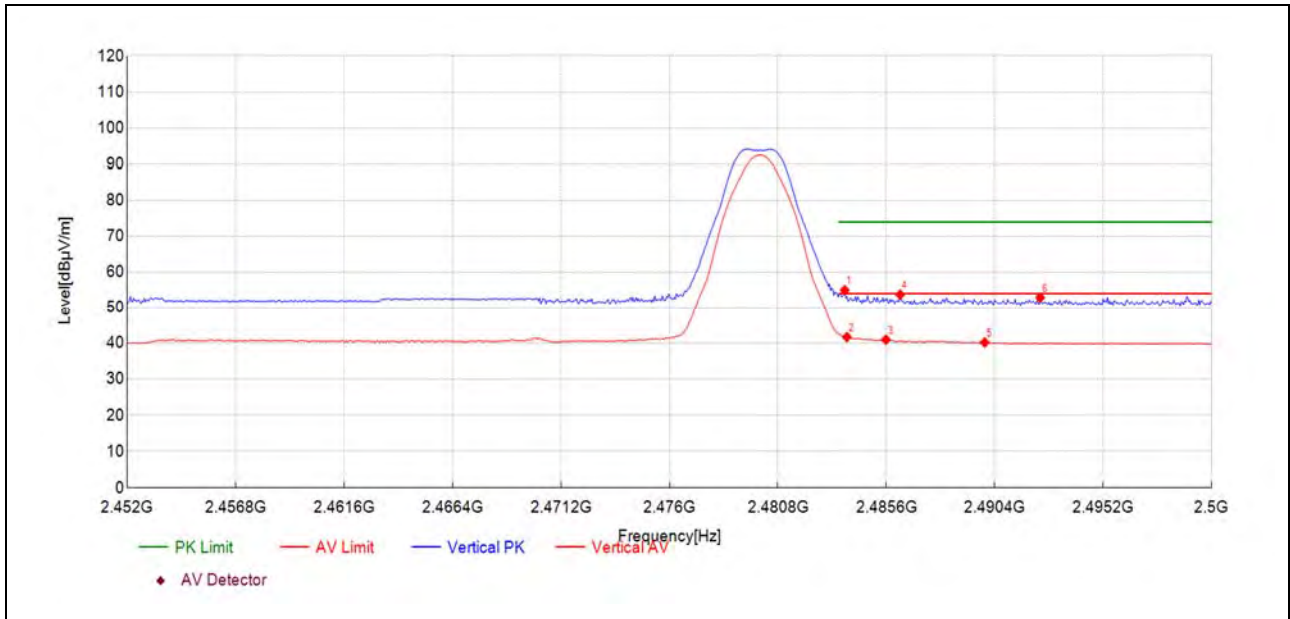
Plot for Channel 0



Fre. (MHz)	Reading [dBμV]	Level [dBμV/m]	Factor [dB/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Verdict
2336.03	15.0	52.36	37.330	74.00	21.64	150	281	PK	PASS
2344.33	2.1	39.47	37.400	54.00	14.53	150	107	AV	PASS
2354.71	15.0	52.45	37.460	74.00	21.55	150	294	PK	PASS
2367.17	2.1	39.53	37.470	54.00	14.47	150	330	AV	PASS
2376.45	15.0	52.47	37.480	74.00	21.53	150	80	PK	PASS
2385.85	2.0	39.48	37.490	54.00	14.52	150	303	AV	PASS



Plot for Channel 39



Fre. (MHz)	Reading [dBμV]	Level [dBμV/m]	Factor [dB/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Verdict
2483.76	16.7	55.00	38.270	74.00	19.00	150	31	PK	PASS
2483.86	3.4	41.69	38.270	54.00	12.31	150	147	AV	PASS
2485.59	2.7	40.97	38.270	54.00	13.03	150	147	AV	PASS
2486.21	15.5	53.75	38.280	74.00	20.25	150	80	PK	PASS
2489.96	1.9	40.20	38.260	54.00	13.80	150	315	AV	PASS
2492.41	14.7	52.91	38.260	74.00	21.09	150	151	PK	PASS



A.10. Radiated Emission

According to ANSI C63.10, because of peak detection will yield amplitudes equal to or greater than amplitudes measured with the quasi-peak (or average) detector, the measurement data from a spectrum analyzer peak detector will represent the worst-case results, if the peak measured value complies with the quasi-peak (or average) limit, it is unnecessary to perform an quasi-peak measurement (or average).

The measurement results are obtained as below:

$$E [\text{dB}\mu\text{V/m}] = U_R + A_T + A_{\text{Factor}} [\text{dB}]; A_T = L_{\text{Cable loss}} [\text{dB}] - G_{\text{preamp}} [\text{dB}]$$

A_T : Total correction Factor except Antenna

U_R : Receiver Reading

G_{preamp} : Preamplifier Gain

A_{Factor} : Antenna Factor at 3m

During the test, the total correction Factor A_T and A_{Factor} were built in test software.

Note1: All radiated emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

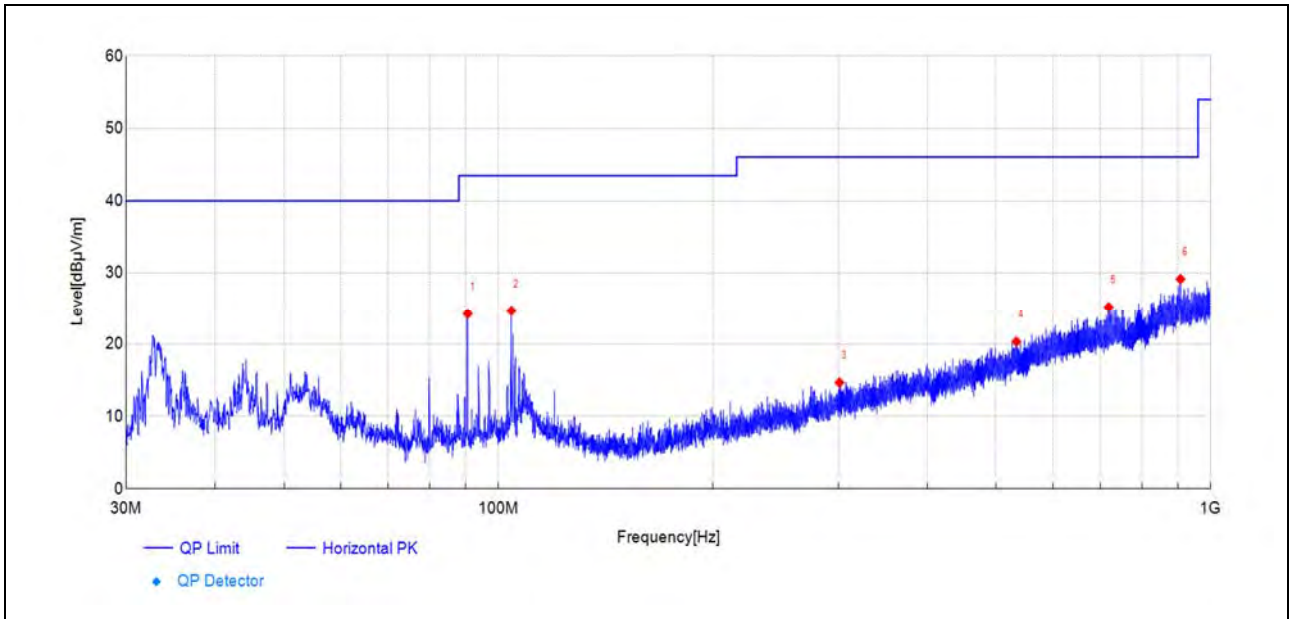
Note2: For the frequency, which started from 9kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit was not recorded.

Note3: For the frequency, which started from 18GHz to 10th harmonic of the highest frequency, was pre-scanned and the result which was 20dB lower than the limit was not recorded.



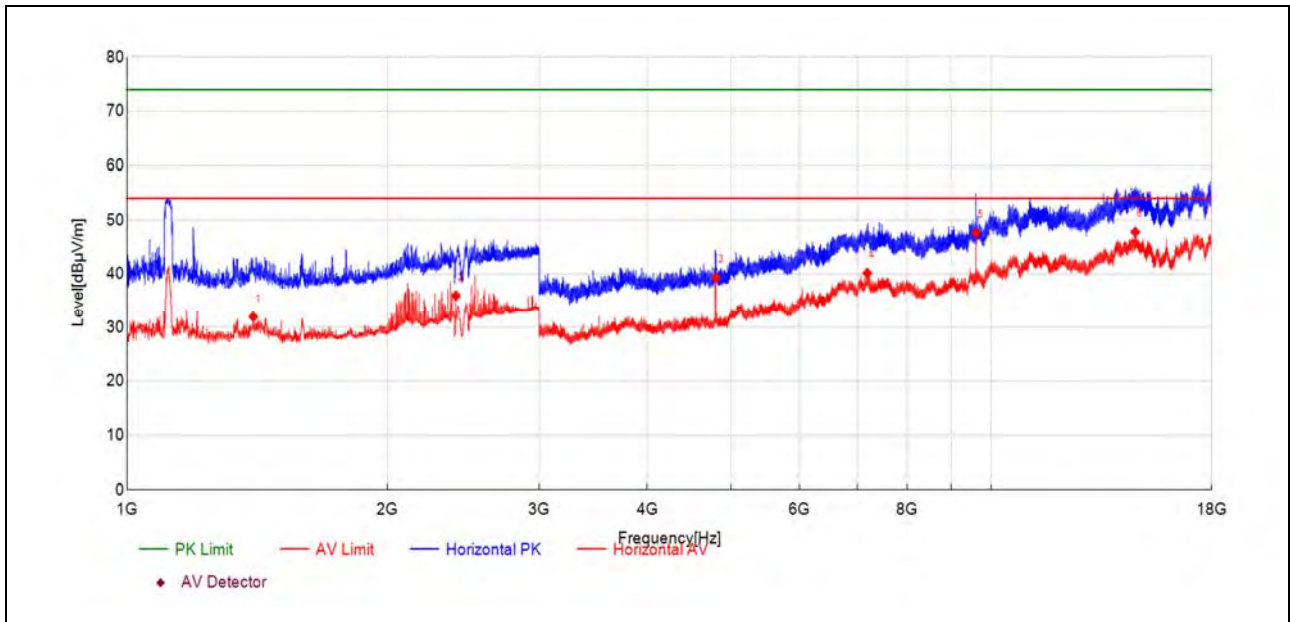
1Mbps

Plot for Channel 0



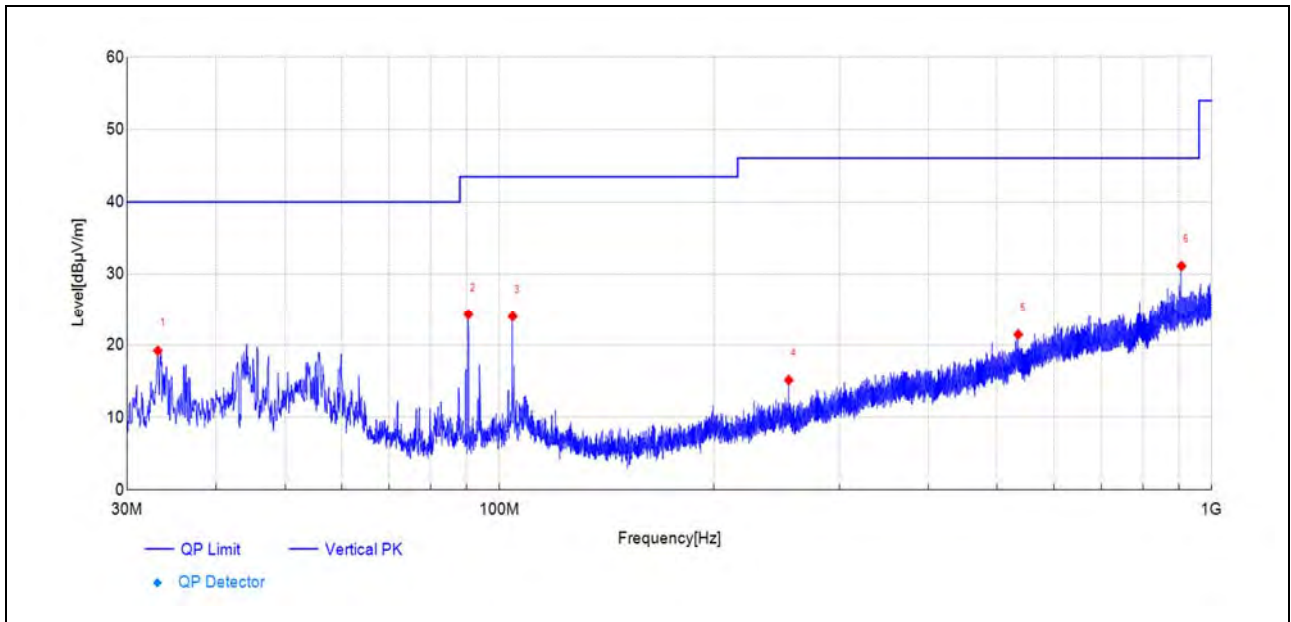
(Antenna Horizontal, 30MHz to 1GHz)

Fre. (MHz)	Reading [dBμV]	Level [dBμV/m]	Factor [dB/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Verdict
90.53	55.7	24.27	-31.450	43.50	19.23	150	359	PK	PASS
104.31	54.2	24.70	-29.520	43.50	18.80	150	339	PK	PASS
301.13	40.0	14.66	-25.370	46.00	31.34	150	61	PK	PASS
533.46	39.4	20.35	-19.030	46.00	25.65	150	313	PK	PASS
719.03	40.9	25.22	-15.660	46.00	20.78	150	163	PK	PASS
906.73	40.8	29.15	-11.620	46.00	16.85	150	324	PK	PASS



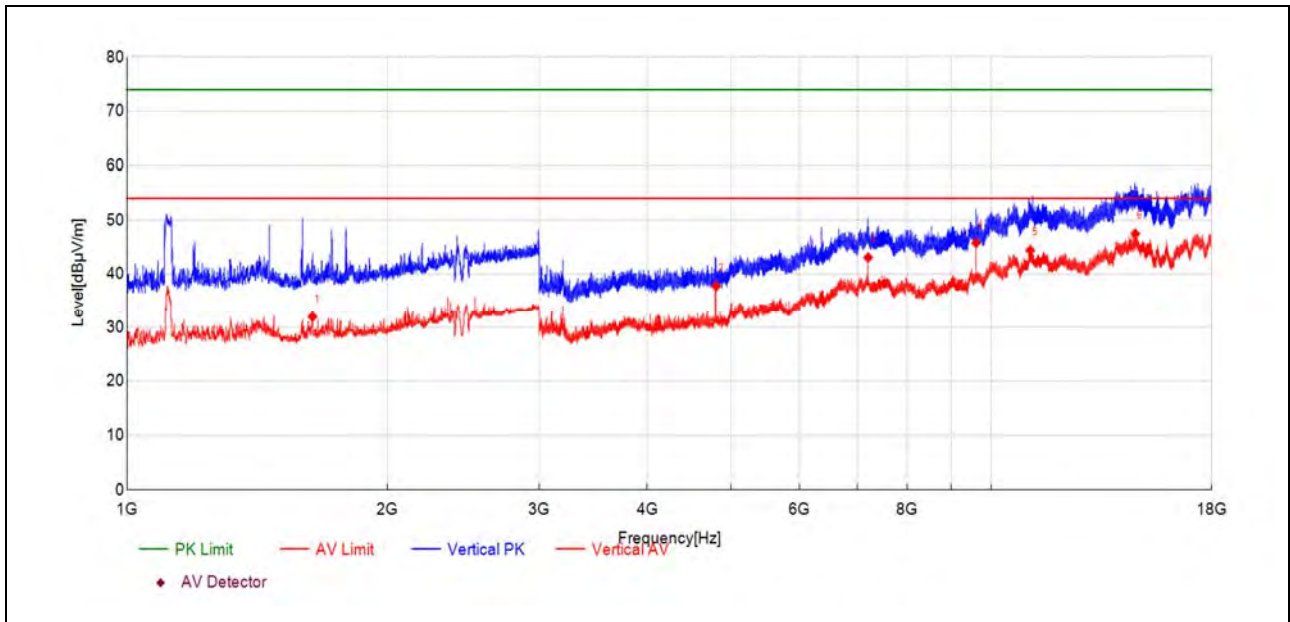
(Antenna Horizontal, 1GHz to 18GHz)

Fre. (MHz)	Reading [dBμV]	Level [dBμV/m]	Factor [dB/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Verdict
1400.09	32.2	31.97	-0.210	54.00	22.03	150	64	AV	PASS
2402.53	30.7	35.97	5.260	-	-	150	284	AV	NA
4803.91	44.5	39.39	-5.150	54.00	14.61	150	311	AV	PASS
7189.83	35.2	40.19	5.020	54.00	13.81	150	43	AV	PASS
9607.47	39.0	47.65	8.660	54.00	6.35	150	297	AV	PASS
14681.05	27.2	47.80	20.560	54.00	6.20	150	217	AV	PASS



(Antenna Vertical, 30MHz to 1GHz)

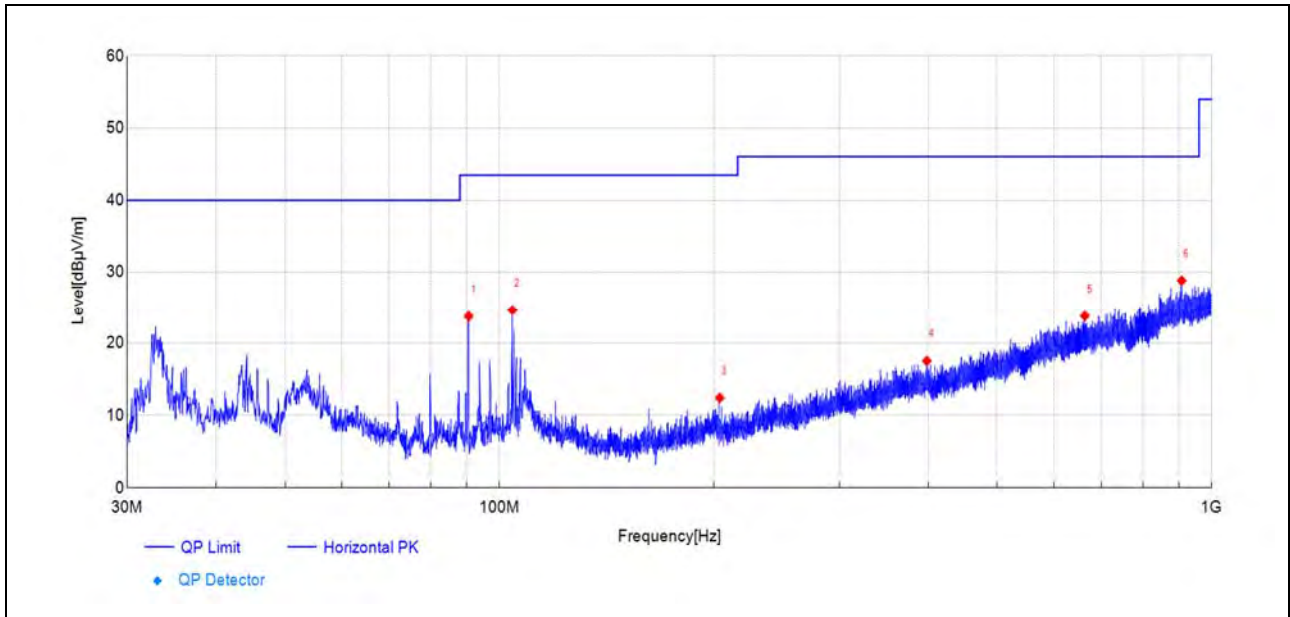
Fre. (MHz)	Reading [dBμV]	Level [dBμV/m]	Factor [dB/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Verdict
33.15	49.6	19.23	-30.370	40.00	20.77	150	125	PK	PASS
90.43	55.8	24.33	-31.480	43.50	19.17	150	254	PK	PASS
104.35	53.5	24.05	-29.490	43.50	19.45	150	85	PK	PASS
254.81	42.4	15.16	-27.220	46.00	30.84	150	85	PK	PASS
534.96	40.6	21.51	-19.100	46.00	24.49	150	95	PK	PASS
907.02	42.8	31.14	-11.650	46.00	14.86	150	341	PK	PASS



(Antenna Vertical, 1GHz to 18GHz)

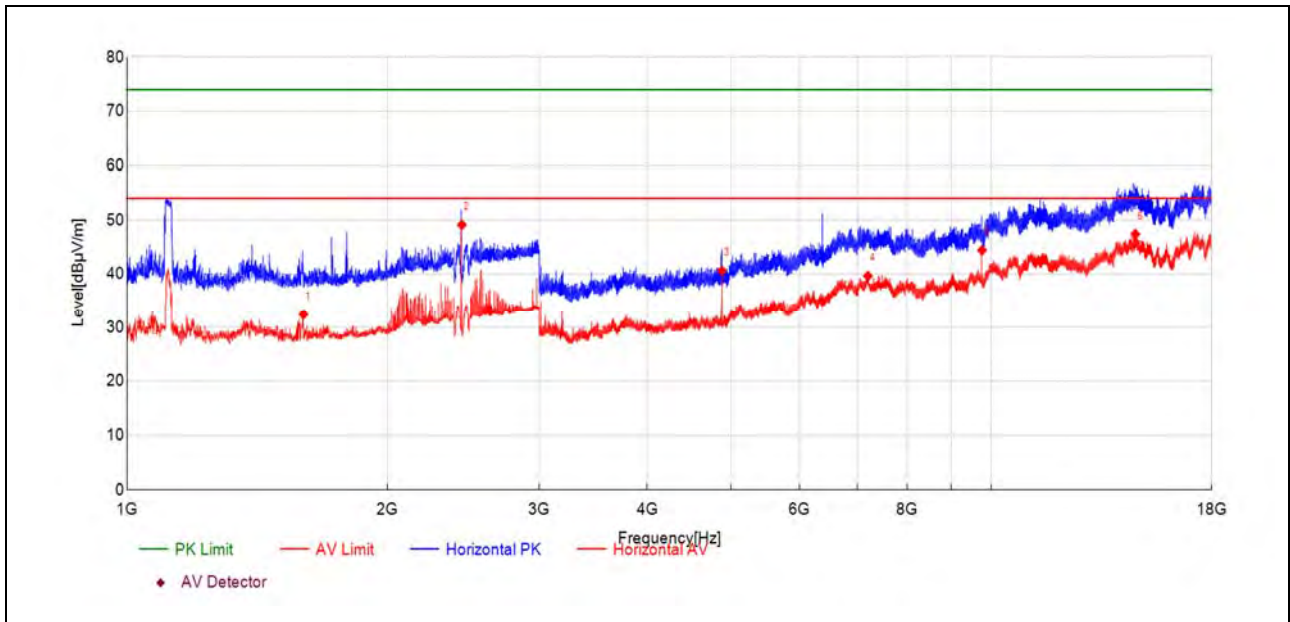
Fre. (MHz)	Reading [dBμV]	Level [dBμV/m]	Factor [dB/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Verdict
1639.25	32.1	32.00	-0.140	54.00	22.00	150	138	AV	PASS
4804.77	42.9	37.76	-5.140	54.00	16.24	150	218	AV	PASS
7206.98	38.1	43.08	5.020	54.00	10.92	150	297	AV	PASS
9607.47	37.1	45.78	8.660	54.00	8.22	150	324	AV	PASS
11101.95	30.3	44.41	14.070	54.00	9.59	150	297	AV	PASS
14679.76	26.9	47.46	20.550	54.00	6.54	150	285	AV	PASS

Plot for Channel 19



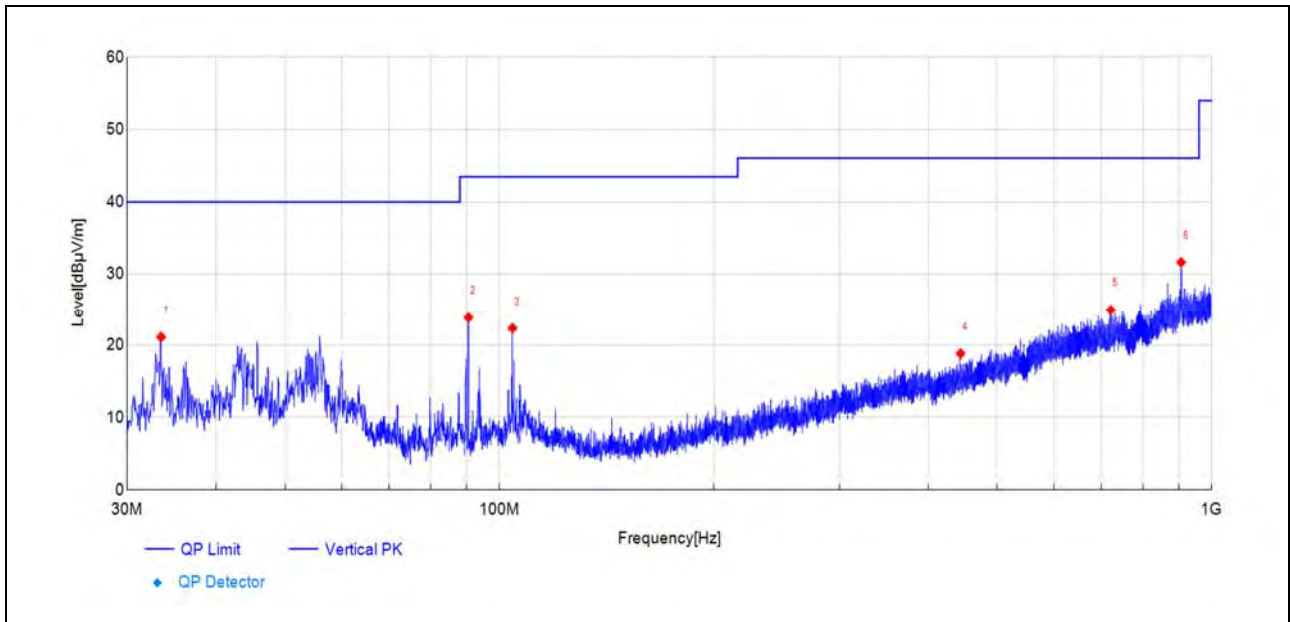
(Antenna Horizontal, 30MHz to 1GHz)

Fre. (MHz)	Reading [dBμV]	Level [dBμV/m]	Factor [dB/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Verdict
90.53	55.2	23.77	-31.450	43.50	19.73	150	341	PK	PASS
104.31	54.2	24.63	-29.520	43.50	18.87	150	161	PK	PASS
203.83	41.6	12.40	-29.230	43.50	31.10	150	283	PK	PASS
398.13	40.1	17.53	-22.550	46.00	28.47	150	14	PK	PASS
663.59	40.0	23.81	-16.180	46.00	22.19	150	303	PK	PASS
907.36	40.5	28.82	-11.700	46.00	17.18	150	192	PK	PASS



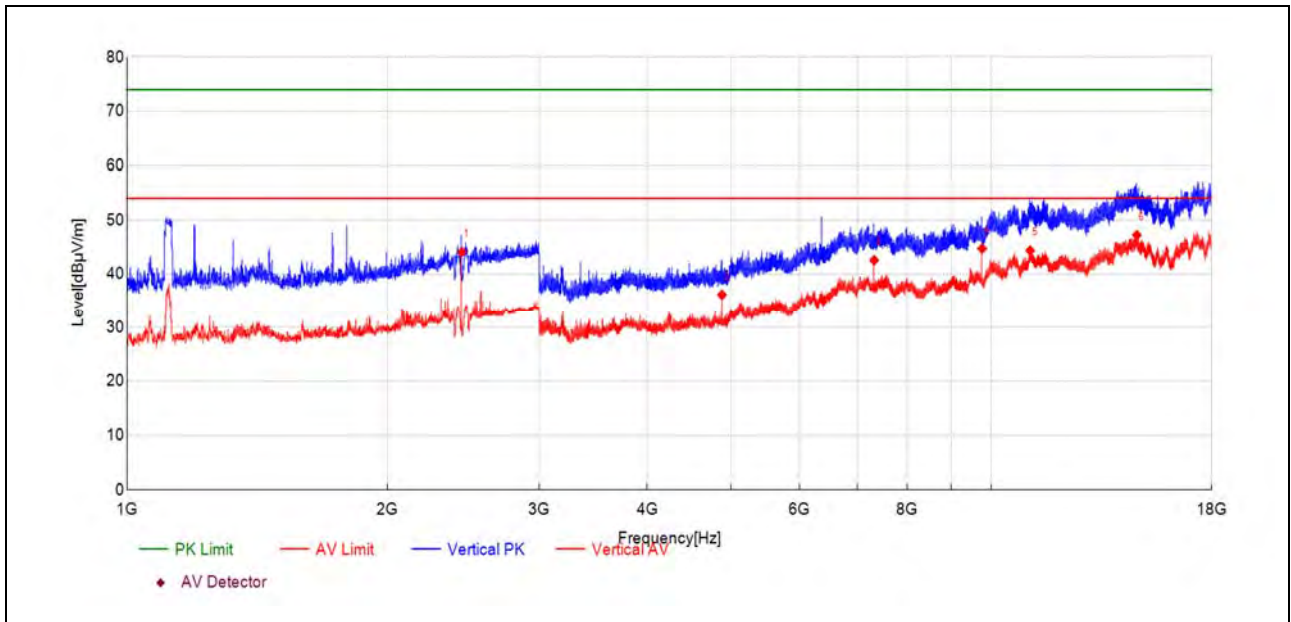
(Antenna Horizontal, 1GHz to 18GHz)

Fre. (MHz)	Reading [dBμV]	Level [dBμV/m]	Factor [dB/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Verdict
1600.13	32.8	32.41	-0.380	54.00	21.59	150	69	AV	PASS
2440.32	43.3	49.13	5.820	-	-	150	307	AV	N/A
4880.20	45.6	40.63	-5.000	54.00	13.37	150	268	AV	PASS
7201.41	34.6	39.66	5.100	54.00	14.34	150	118	AV	PASS
9761.34	35.4	44.42	9.020	54.00	9.58	150	9	AV	PASS
14684.91	26.9	47.41	20.560	54.00	6.59	150	171	AV	PASS



(Antenna Vertical, 30MHz to 1GHz)

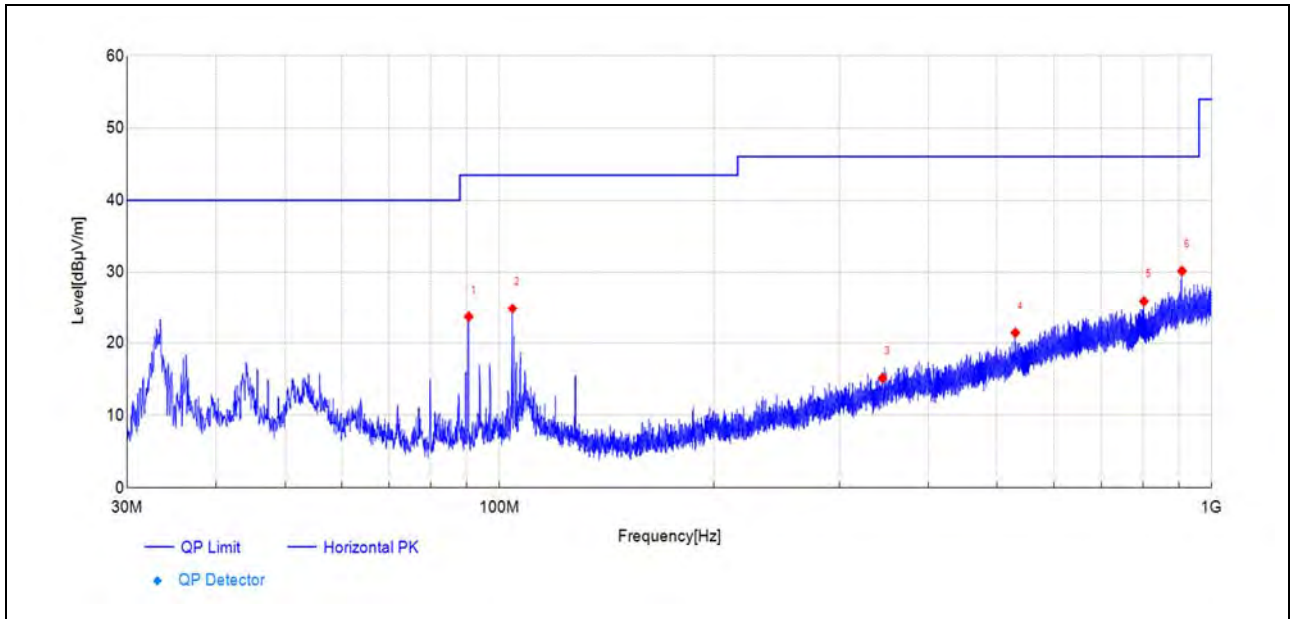
Fre. (MHz)	Reading [dBμV]	Level [dBμV/m]	Factor [dB/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Verdict
33.49	51.3	21.15	-30.150	40.00	18.85	150	312	PK	PASS
90.48	55.3	23.86	-31.470	43.50	19.64	150	360	PK	PASS
104.31	51.9	22.37	-29.520	43.50	21.13	150	14	PK	PASS
443.97	40.6	18.85	-21.770	46.00	27.15	150	359	PK	PASS
721.45	40.6	24.97	-15.600	46.00	21.03	150	71	PK	PASS
906.15	43.2	31.64	-11.550	46.00	14.36	150	347	PK	PASS



(Antenna Vertical, 1GHz to 18GHz)

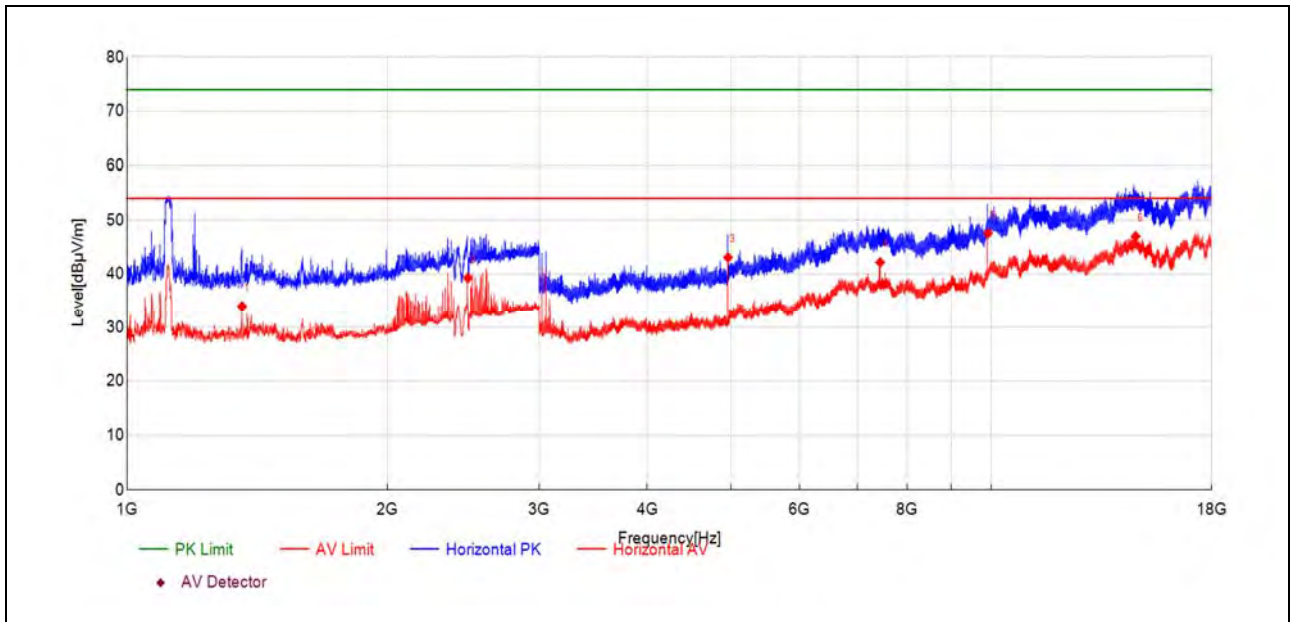
Fre. (MHz)	Reading [dBμV]	Level [dBμV/m]	Factor [dB/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Verdict
2440.32	38.3	44.08	5.820	-	-	150	3	AV	N/A
4880.63	41.2	36.15	-5.010	54.00	17.85	150	346	AV	PASS
7320.98	38.3	42.58	4.280	54.00	11.42	150	318	AV	PASS
9761.34	35.7	44.73	9.020	54.00	9.27	150	130	AV	PASS
11096.80	30.3	44.36	14.030	54.00	9.64	150	77	AV	PASS
14743.62	27.0	47.23	20.220	54.00	6.77	150	9	AV	PASS

Plot for Channel 39



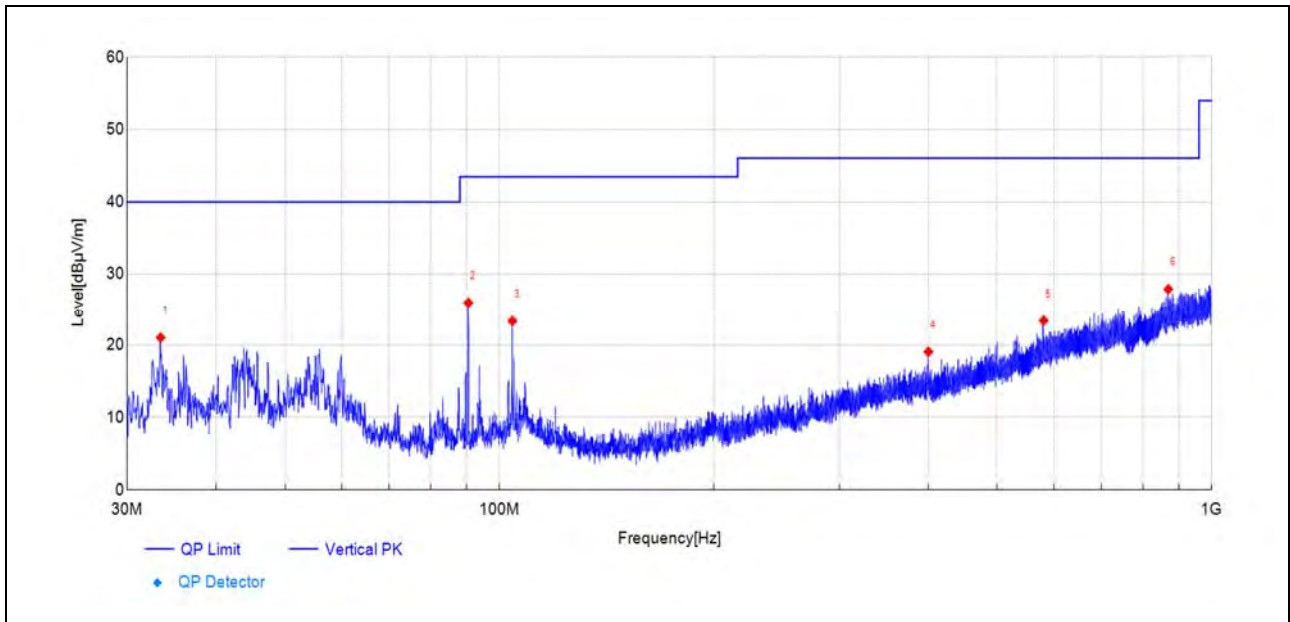
(Antenna Horizontal, 30MHz to 1GHz)

Fre. (MHz)	Reading [dBμV]	Level [dBμV/m]	Factor [dB/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Verdict
90.53	55.1	23.69	-31.450	43.50	19.81	150	112	PK	PASS
104.31	54.4	24.87	-29.520	43.50	18.63	150	148	PK	PASS
344.97	39.3	15.16	-24.120	46.00	30.84	150	272	PK	PASS
529.96	40.3	21.45	-18.890	46.00	24.55	150	352	PK	PASS
803.27	40.5	25.94	-14.560	46.00	20.06	150	200	PK	PASS
908.38	42.0	30.17	-11.830	46.00	15.83	150	332	PK	PASS



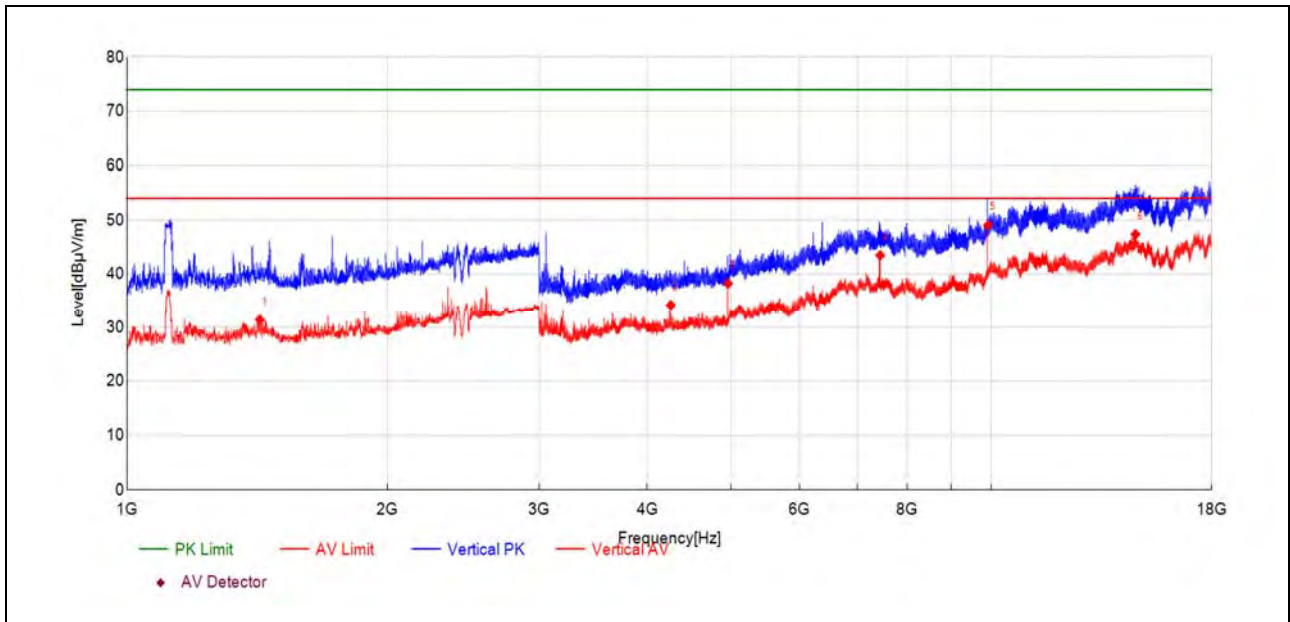
(Antenna Horizontal, 1GHz to 18GHz)

Fre. (MHz)	Reading [dBμV]	Level [dBμV/m]	Factor [dB/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Verdict
1358.75	34.7	33.99	-0.700	-	-	150	82	AV	NA
2480.33	33.4	39.29	5.890	-	-	150	297	AV	NA
4960.34	47.7	43.09	-4.610	54.00	10.91	150	279	AV	PASS
7440.13	37.6	42.18	4.630	54.00	11.82	150	128	AV	PASS
9919.48	38.2	47.57	9.360	54.00	6.43	150	320	AV	PASS
14694.76	26.4	46.99	20.580	54.00	7.01	150	157	AV	PASS



(Antenna Vertical, 30MHz to 1GHz)

Fre. (MHz)	Reading [dBμV]	Level [dBμV/m]	Factor [dB/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Verdict
33.44	51.3	21.07	-30.180	40.00	18.93	150	130	PK	PASS
90.43	57.5	26.00	-31.480	43.50	17.50	150	265	PK	PASS
104.31	52.9	23.38	-29.520	43.50	20.12	150	105	PK	PASS
400.12	41.4	19.09	-22.270	46.00	26.91	150	79	PK	PASS
580.89	41.1	23.44	-17.630	46.00	22.56	150	254	PK	PASS
869.09	40.3	27.90	-12.430	46.00	18.10	150	254	PK	PASS



(Antenna Vertical, 1GHz to 18GHz)

Fre. (MHz)	Reading [dBμV]	Level [dBμV/m]	Factor [dB/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Detector	Verdict
1424.54	31.4	31.41	0.000	54.00	22.59	150	136	AV	PASS
4258.75	41.4	34.21	-7.210	54.00	19.79	150	89	AV	PASS
4960.77	42.9	38.26	-4.600	54.00	15.74	150	89	AV	PASS
7440.13	38.9	43.49	4.630	54.00	10.51	150	304	AV	PASS
9919.48	39.7	49.09	9.360	54.00	4.91	150	264	AV	PASS
14692.62	26.8	47.38	20.580	54.00	6.62	150	37	AV	PASS

_____ END OF REPORT _____