

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT



EUT Description: LBMA0ZZ2NR
Applicant: Murata Electronics North America
3330 Cumberland Blvd SE #700, Atlanta, GA 30339
Manufacturer: Murata Electronics North America
3330 Cumberland Blvd SE #700, Atlanta, GA 30339
Brand Name: Murata Electronics North America
Model No./ISED HVIN: LBMA0ZZ2NR
ISED PMN: Type 2NR
Report Number: TERF2601000201ER
FCC ID HSW2NR
IC: 4492A-2NR
Date of EUT Received: January 20, 2026
Date of Test: January 21, 2026 ~ March 05, 2026
Issue Date: April 28, 2026

CHUN-CHIEH, CHEN

Approved By

Chun Chieh Chen

We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Central RF Lab. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10 and the energy emitted by the sample EUT comply with FCC rule part §15.247, ISSED RSS-247.

The results of this report relate only to the sample identified in this report.

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Revision History

Report Number	Revision	Description	Issue Date	Revised By	Remark
TERF2601000201ER	00	Original	March 26, 2026	Autumn Chiu	
TERF2601000201ER	01	Revised Chapter 3	April 27, 2026	Autumn Chiu	*
TERF2601000201ER	02	Revised Chapter 7.6.2	April 28, 2026	Autumn Chiu	*

Note:

- 1、The remark "*" indicates modification of the report upon requests from certification body.

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1 GENERAL INFORMATION

1.1 Equipment Under Test (EUT)

EUT Description	LBMA0ZZ2NR
Brand Name	Murata Electronics North America
Model No. /ISED HVIN	LBMA0ZZ2NR
Firmware Version	1
Power Supply	3.3 Vdc
Test Software (Name/Version)	Tera Term / 5.2 nRf Connect for Desktop / 5.2.1

1.2 RF Specification

Radio Technology	BLE
Frequency Range	2402 ~ 2480MHz
Channel number	40 channels
Modulation type	GFSK
Transmit Power	BLE 1M: 7.57 dBm BLE 2M: 7.57 dBm BLE 125k: 7.58 dBm BLE 500k: 7.57 dBm Proprietary mode: 7.72 dBm

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1.3 Antenna Designation

Ant. Type	Brand	Model No.	Freq. (MHz)	Peak Gain(dBi)
PCB	Inventek Systems, LLC.	W2.4-5P-U	2400~2484	3.73

Note:

- 1 Pre-scanned was done on the above antennas, measurements were demonstrated by using the antenna with the highest gain as the worst case scenarios.
- 2 The antenna information is provided by the applicant. The laboratory does not verify the accuracy of this information, and all test results related to antenna characteristics are based solely on the data supplied. Responsibility for the authenticity and accuracy of these specifications rests entirely with the party who provided the information.
- 3 The antenna complies with part 15.203 requirement and no consideration of replacement. Please see EUT photo for details.

1.4 Operating Frequencies

Channel List

2400~2483.5 MHz							
CH	Freq. (MHz)	CH	Freq. (MHz)	CH	Freq. (MHz)	CH	Freq. (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

Channel List(Proprietary mode)

2400~2483.5 MHz															
CH	Freq. (MHz)	CH	Freq. (MHz)	CH	Freq. (MHz)	CH	Freq. (MHz)	CH	Freq. (MHz)	CH	Freq. (MHz)	CH	Freq. (MHz)	CH	Freq. (MHz)
3	2403	13	2413	23	2423	33	2433	43	2443	53	2453	63	2463	73	2473
4	2404	14	2414	24	2424	34	2434	44	2444	54	2454	64	2464	74	2474
5	2405	15	2415	25	2425	35	2435	45	2445	55	2455	65	2465	75	2475
6	2406	16	2416	26	2426	36	2436	46	2446	56	2456	66	2466		
7	2407	17	2417	27	2427	37	2437	47	2447	57	2457	67	2467		
8	2408	18	2418	28	2428	38	2438	48	2448	58	2458	68	2468		
9	2409	19	2419	29	2429	39	2439	49	2449	59	2459	69	2469		
10	2410	20	2420	30	2430	40	2440	50	2450	60	2460	70	2470		
11	2411	21	2421	31	2431	41	2441	51	2451	61	2461	71	2471		
12	2412	22	2422	32	2432	42	2442	52	2452	62	2462	72	2472		

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1.5 EUT Availability and The Worst Test Modes

1. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.
2. The field strength of radiation emission was measured as the EUT positioned in different orthogonal planes (E1/E2/H) based on actual usage of the EUT to pre-scan the emissions for determining the worst case scenario.
3. Investigation has been done on all the possible configurations for searching the worst case. The given UE is pre-scanned among modes below.

MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)
CONDUCTED TEST				
Bluetooth LE_1M	0 to 39	0,20,39	GFSK	1
Bluetooth LE_2M	0 to 39	0,20,39	GFSK	2
Bluetooth LE_125k	0 to 39	0,20,39	GFSK	0.125
Bluetooth LE_500k	0 to 39	0,20,39	GFSK	0.5
Proprietary mode	3 to 75	3,39,75	GFSK	4

TRANSMIT RADIATED EMISSION TEST (BELOW 1 GHz)				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)
Bluetooth LE_1M	0 to 39	20	GFSK	1
TRANSMIT RADIATED EMISSION TEST (ABOVE 1 GHz)				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)
Bluetooth LE_1M	0 to 39	0,20,39	GFSK	1
Bluetooth LE_2M	0 to 39	0,20,39	GFSK	2
Bluetooth LE_125k	0 to 39	0,20,39	GFSK	0.125
Bluetooth LE_500k	0 to 39	0,20,39	GFSK	0.5
Proprietary mode	3 to 75	3,39,75	GFSK	4

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2 SUMMARY OF TEST RESULTS

FCC Rules	ISED Rules	Description Of Test	Result
§15.207(a)	RSS-Gen §8.8	AC Power Line Conducted Emission	Compliant
§15.247(b) (3)	RSS-247 §6.3.2	Peak Output Power	Compliant
§15.247(a)(2)	RSS-247 §6.3.1.a RSS-Gen §6.7	Emission Bandwidth	Compliant
§15.205 §15.209 §15.247(d)	RSS-247 §6.6 RSS-Gen §8.9 RSS-Gen §8.10	Out of Band Emission	Compliant
§15.205 §15.209 §15.247(d)	RSS-247 §6.6 RSS-Gen §8.9 RSS-Gen §8.10	Unwanted Emission	Compliant
§15.247(e)	RSS-247 §6.3.1.b	Power Spectral Density	Compliant
§15.203	N/A	Antenna Requirement	Compliant

2.1 Test Methodology of Applied Standards

- 1 FCC Part 15, Subpart C §15.247
- 2 ANSI C63.10:2020
- 3 ANSI C63.10-2020+Cor. 1-2023+C63.10a-2024 + Errata to C63.10a-2024
- 4 FCC KDB 558074 D01 15.247 Meas Guidance v05r02
- 5 ISED RSS-247 issue 4 July 2025
- 6 ISED RSS-Gen, Issue 5 April 2018, Amendment 2 (February 2021)

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2.2 Measurement Uncertainty

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 1.61 dB
Output Power measurement	+/- 0.97 dB
Emission Bandwidth	+/- 1.38 Hz
Conducted emission measurement	+/- 0.77 dB
Peak Power Density	+/- 0.61 dB
Temperature	+/- 0.60 °C
Humidity	+/- 3.00 %
DC / AC Power Source	+/- 1.00 %

Radiated Spurious Emission Measurement Uncertainty		
Polarization: Vertical	+/- 1.89 dB	9kHz - 30MHz
	+/- 4.10 dB	30MHz - 1000MHz
	+/- 3.41 dB	1GHz - 18GHz
	+/- 3.89 dB	18GHz - 40GHz
Polarization: Horizontal	+/- 1.89 dB	9kHz - 30MHz
	+/- 4.10 dB	30MHz - 1000MHz
	+/- 3.41 dB	1GHz - 18GHz
	+/- 3.89 dB	18GHz - 40GHz
Radiated Spurious Emission	+/- 2.00 dB	33GHz - 50GHz
	+/- 1.59 dB	50GHz - 60GHz
	+/- 1.71 dB	60GHz - 90GHz
	+/- 1.64 dB	90GHz - 140GHz
	+/- 3.84 dB	140GHz - 220GHz

Note

1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.
2. The conformity assessment statement in this report is based solely on the test results, measurement uncertainty is excluded.

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2.3 Test Facility

Laboratory	Test Site Address	Test Site Name	FCC Designation number / Registration Number	IC CAB identifier / Company Number
SGS Taiwan Ltd. Central RF Lab. (TAF code 3702)	No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan 24803	SAC 1 / SAC 2 / SAC 3 Conduction 1 / Conducted 1 Conducted 2 / Conducted 3 Conducted 4 / Conducted 5 Conducted 6	TW0027 / 891563	TW3702 / 4620A
SGS Taiwan Ltd. Central RF Lab. (TAF code 3702)	No.2, Keji 1st Rd, Guishan District, Taoyuan City, Taiwan 333	SAC C / SAC D / SAC G Conduction C/ Conducted A Conducted B / Conducted C Conducted D / Conducted E Conducted F / Conducted G	TW0028 / 200037	TW3702 / 4620E

Measurement	Test Site Name	Test Engineer	EUT S/N	Test Environment	Test Date
Conducted	Conducted 2	Bob Chao	N/A	21~23°C / 52~54%	2026/02/04 ~ 2026/03/05
Radiated	SAC 2	Bob Chao	N/A	22~26°C / 57~61%	2026/02/26 ~ 2026/03/04
Conduction	SAC 2	Bob Chao	N/A	25.6~25.6°C / 58~58%	2026/03/05 ~ 2026/03/05

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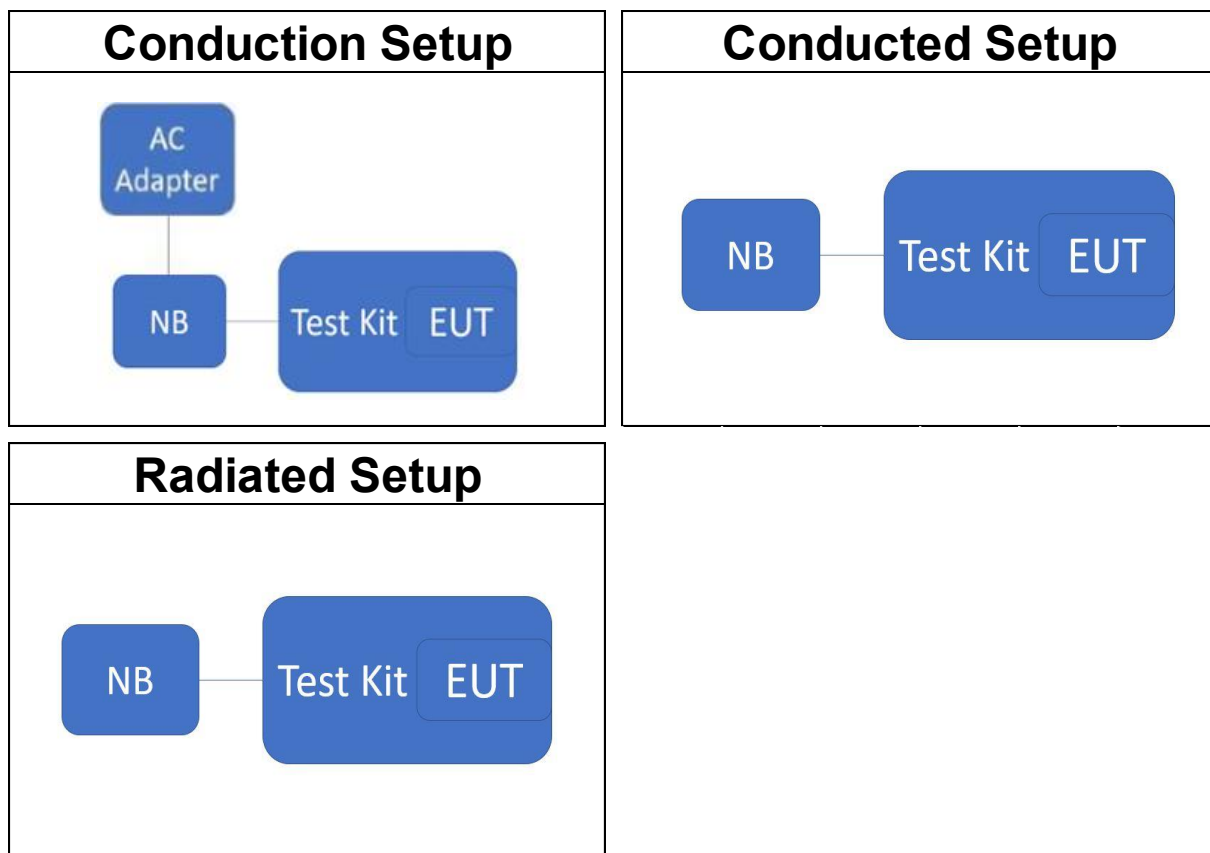
3 CONTROL UNIT(S) AND PERIPHERAL(S)

3.1 EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme.

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

3.2 Diagrams



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3.3 List

3.3.1 Conduction Setup

AC Power-Line Conducted Emission Test Site: Conduction 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
Test kit	Murata	P2MLZ454	N/A	N/A	N/A
AC Adapter	Lenovo	ADLX45YDC3D	N/A	N/A	N/A
Notebook	Lenovo	L490	PF-1DX6LZ 19/10	N/A	N/A
USB Cable	PowerSync	CUBCVARA0010	N/A	N/A	N/A

3.3.2 Conducted Setup

Conducted Emission Test Site: Conducted 2					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
Test kit	Murata	P2MLZ454	N/A	N/A	N/A
Notebook	Lenovo	L490	PF-1DX6LZ 19/10	N/A	N/A
USB Cable	PowerSync	CUBCVARA0010	N/A	N/A	N/A

3.3.3 Radiated Setup

Radiated Emission Test Site: SAC 2					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
Test kit	Murata	P2MLZ454	N/A	N/A	N/A
Notebook	Lenovo	L490	PF-1DX6LZ 19/10	N/A	N/A
USB Cable	PowerSync	CUBCVARA0010	N/A	N/A	N/A
USB Cable	UGREEN	10373	N/A	N/A	N/A

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4 TEST INSTRUMENT

4.1 Conducted Measurement

Conducted Emission Test Site: Conducted 2					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
Attenuator	Mini-Circuits	BW-S10W2+	1	12/07/2025	12/06/2026
DC Block	Mini-Circuits	BLK-18-S+	10	12/07/2025	12/06/2026
EXA Spectrum Analyzer	KEYSIGHT	N9010B	MY59071570	07/04/2025	07/03/2026
Power Meter	Anritsu	ML2496A	1242004	10/23/2025	10/22/2026
Power Sensor	Anritsu	MA2411B	1207365	11/06/2025	11/05/2026
Power Sensor	Anritsu	MA2411B	1207368	10/23/2025	10/22/2026
Test Software	SGS	Radio Test Software	Ver. 21	N.C.R	N.C.R

4.2 Radiated Measurement

Radiated Emission Test Site: SAC 2					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
3.2G High Pass Filter	Woken	WHKX10-2624	3	12/07/2025	12/06/2026
Attenuator	Mini-Circuits	BW-S10W2+	10	12/07/2025	12/06/2026
Band Reject Filter 2400-2483.5	Titan	T04N2400248350S0 1	23040703-10	12/07/2025	12/06/2026
Bi-log Antenna	SCHWARZBECK	VULB9168	9168-1278	03/10/2025	03/09/2026
Coaxial Cables	EMCI	EMC104-SM-SM-600 +EMC105-SM-SM-2000 +EMC105-SM-SM-1500 +EMC105-SM-SM-10000	RX Cable 9K-18G (220237+220909+220906+240801)	07/14/2025	07/13/2026
Coaxial Cables	Huber Suhner	SUCOFLEX 102	RX Cable 18G-40G MY2630/2+805062/2	07/14/2025	07/13/2026
EMI Test Receiver	R&S	ESR 7	102525	02/23/2026	02/22/2027
EXA Spectrum Analyzer	KEYSIGHT	N9010B	MY59071570	07/04/2025	07/03/2026
Horn Antenna	RF SPIN	DRH0844	LE2D05A0844	08/07/2025	08/06/2026
Horn Antenna	SCHWARZBECK	BBHA9120D	603	05/20/2025	05/19/2026
Loop Antenna	COM-POWER	AL-130R	10160104	12/30/2025	12/29/2026
Pre-Amplifier	EMCI	EMC118A45SEE	980867	07/14/2025	07/13/2026
Pre-Amplifier	EMCI	EMC184045SEE	980939	07/14/2025	07/13/2026
Pre-Amplifier	EMCI	EMC330N	980826	07/14/2025	07/13/2026
Site Cal	SGS	SAC 2	N/A	07/14/2025	07/13/2026
Test Software	Audix	e3	Ver. 9.210616	N.C.R	N.C.R

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4.3 Emission from AC power line

AC Power-Line Conducted Emission Test Site: Conduction 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
Coaxial Cables	EMC Instruments Corp.	EMCCFD300-BM-BM-3000	161207	06/22/2025	06/21/2026
EMI Test Receiver	R&S	ESCI 7	100759	09/02/2025	09/01/2026
LISN	SCHWARZBECK	NSLK 8127	1040	09/13/2025	09/12/2026
Pulse Limiter	SCHWARZBECK	VTSD 9561F-N	793	06/22/2025	06/21/2026
Test Software	Audix	e3	Ver. 9.210616	N.C.R	N.C.R

NOTE: N.C.R refers to Not Calibrated Required.

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5 REGULATORY REQUIREMENTS

5.1 Emission Bandwidth

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

5.2 Duty Cycle

Pre-analysis Check: While conducting average power measurement, duty cycle of each mode shall be checked to ensure its duty cycle in order to compensate for the loss due to insufficient ratio of duty cycle.

All duty cycle is pre-scanned, and result as obtained below shows only the most representative ones where duty cycle is conducted as the given transmission with given virtual operation that expresses the percentage.

5.3 Maximum Output Power

FCC

For systems using digital modulation in the 2400-2483.5 MHz bands, the limit for peak output power is 1Watt.

If the transmitting antenna of directional gain greater than 6dBi are used the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the Antenna exceeds 6dBi.

In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of Antenna exceeds 6dBi.

ISED

For systems using digital modulation in the 2400-2483.5 MHz bands, the limit for peak output power is 1Watt and the e.i.r.p. shall not exceed 4 W.

Note:

When the antenna gain is greater than 6 dBi, the power limit attenuated accordingly.

5.4 Maximum Power Spectral Density

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.

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5.5 Out of Band Emission

For emissions in non-restricted frequency bands, 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.

5.6 Unwanted Emissions

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.

In addition, radiated emissions which fall in the restricted bands must also comply with the applicable radiated emission limits as defined in the general emission limit tables.

Moreover, for an intentional radiator operating below 10 GHz, the frequency range of measurements shall extend up to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Frequency (MHz)	Field strength (microvolts/meter)	Distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3
Note: The lower limit shall apply at the transition frequencies.		

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5.7 AC Power Line Conducted Emission

Frequency range within 150kHz to 30MHz shall not exceed the Limit table as below.

Frequency range MHz	Limits (dBuV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50
Note 1.The lower limit shall apply at the transition frequencies 2.The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz		

5.8 Antenna Requirement

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. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of § 15.211, 15.213, 15.217, 15.219, 15.221, or § 15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

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6 TEST CONFIGURATION

6.1 Emission Bandwidth



1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. 6dB BW measurements
The testing is performed in accordance with the applicable regulatory measurement procedure.
Set the spectrum analyzer as
RBW= 1% to 5% of the OBW but not less than 100 kHz,
VBW $\geq 3 \times$ RBW,
Span= 2 to 5 times of the OBW,
Sweep=Auto, Detector = Peak, and Trace mode = Max Hold.
Use the X dB bandwidth mode function of the spectrum analyzer and set to 6dB.
Repeat above procedures until all test default channel is completed.
4. 99% BW measurements
The testing is performed in accordance with the applicable regulatory measurement procedure.
Set the spectrum analyzer as
RBW= 1 % to 5% of 99% without going below 10kHz,
VBW $\geq 3 \times$ RBW,
Span= 1.5 to 5 times of the OBW,
Sweep=Auto, Detector = Peak, and Trace mode = Max Hold,
Use the 99% power bandwidth function of the spectrum analyzer.
Repeat above procedures until all test default channel is completed.

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6.2 Maximum Output Power

6.2.1 Duty Cycle



Set the spectrum analyzer as

Center Frequency = fundamental frequency

Span = Zero,

RBW = 8 MHz,

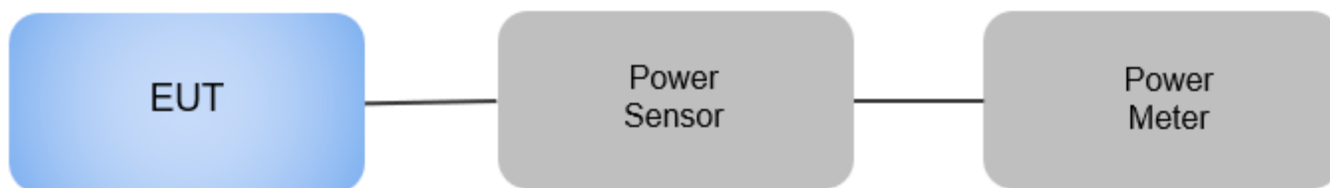
VBW = 8 MHz,

Detector = Peak,

Allow trace to fully stabilize.

Use the delta marker function to determine the ON and OFF times.

6.2.2 Output Power



1. Place the EUT on the table and set it to transmit mode.
2. The testing was performed in accordance with the applicable measurement procedure.
3. Remove the antenna from the EUT and connect a low-loss RF cable from the antenna port to the power meter.
4. Record the maximum reading as observed from the power meter.
5. Repeat the above procedures until all default test channels have been measured.

Note: The duty cycle factor is applied to obtain the average measurement corrected to its maximum equivalent.

Note: when the antenna gain is greater than 6 dBi, the power limit attenuated accordingly.

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6.3 Maximum Power Spectral Density



The test is conducted in accordance with the applicable regulatory measurement procedure.

Set spectrum analyzer center frequency to DTS channel center frequency.

Set the span > 1.5 times the DTS channel bandwidth.

Set the RBW = 3 kHz and VBW = 10 kHz.

Detector = Peak.

Sweep time = Auto Couple.

Trace mode = Max Hold.

Allow trace to fully stabilize.

Use the peak marker function to determine the maximum amplitude level.

Note: When the antenna gain is greater than 6 dBi, the power spectral density limit attenuated accordingly.

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6.4 Out of Band Emission



6.4.1 Reference Level of Emission Limit

The testing is performed in accordance with the applicable measurement procedure.

Set the analyzer center frequency to the DTS channel center frequency.

Set the span to 1.5 times the DTS channel bandwidth.

Set RBW = 100 kHz and VBW = 300 kHz.

Detector = Peak.

Sweep time = Auto Couple.

Trace mode = Max Hold.

Allow the trace to fully stabilize.

Use the peak marker function to determine the maximum amplitude level.

6.4.2 Conducted Band Edge

1. The testing is performed in accordance with the applicable measurement procedure.
2. Connect the antenna port of the EUT to the spectrum analyzer.
3. Remove the antenna from the EUT and connect a low-loss RF cable from the antenna port to the spectrum analyzer.
4. Set the start frequency and stop frequency of the spectrum analyzer to encompass the spectrum to be examined.

Configure the spectrum analyzer as follows:

RBW = 100 kHz

VBW = 300 kHz

Detector = Peak

Sweep = Auto

Mark the highest reading of the emission as the reference level.

Set DL as the limit = reading on marker of reference level measurement

Mark the highest emissions observed outside of the 2400 MHz to 2483.5 MHz band.

5. Repeat the above procedure for each default test channel (low, middle, and high).

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6.4.3 Conducted Spurious Emission

1. The testing is performed in accordance with the applicable measurement procedure.
2. Connect the antenna port of the EUT to the spectrum analyzer.

Configure the spectrum analyzer as follows:

RBW = 100 kHz

VBW = 300 kHz

Detector = Peak

Sweep = Auto.

Allow the trace to fully stabilize.

Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental emission bandwidth (EBW).

3. Repeat the above procedures until all default test channels (low, middle, and high) have been measured.

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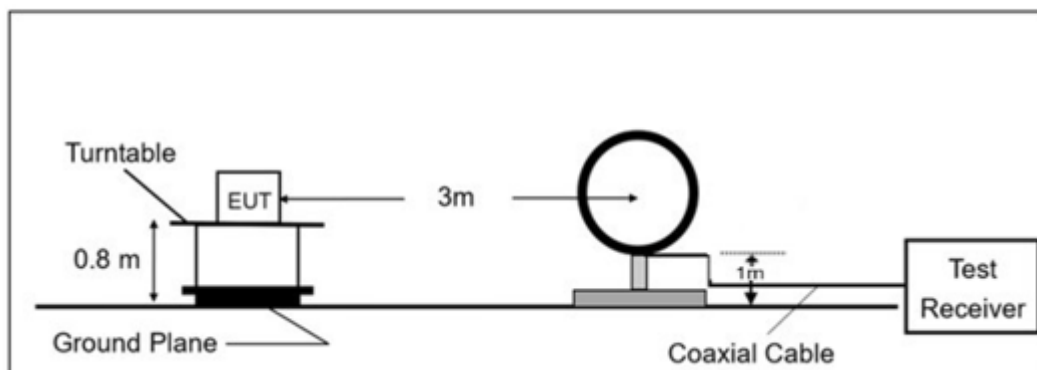
6.5 Unwanted Emissions

For Measurements From 9 kHz To 30 MHz

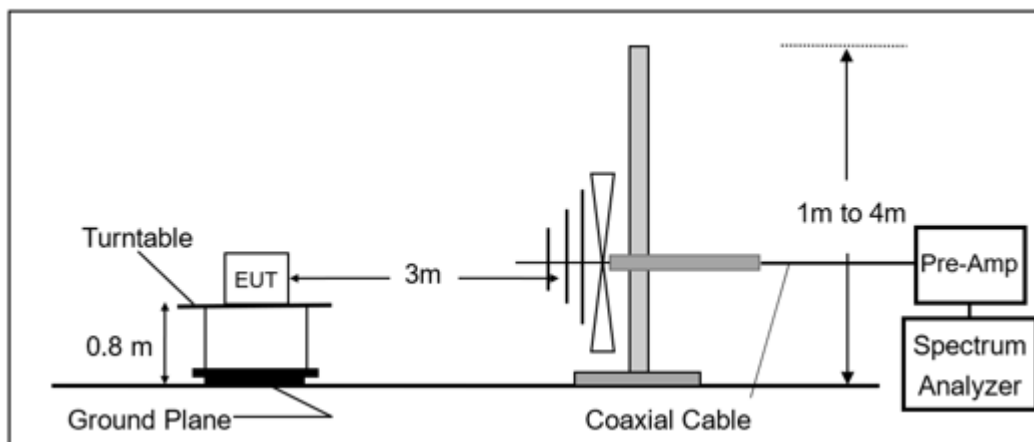
Radiated emission below 30MHz is measured in a 9m*6m*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

Radiated Emission Test Set-Up, Frequency Below 30MHz.



Radiated Emission Test Set-Up, Frequency From 30MHz to 1000MHz.



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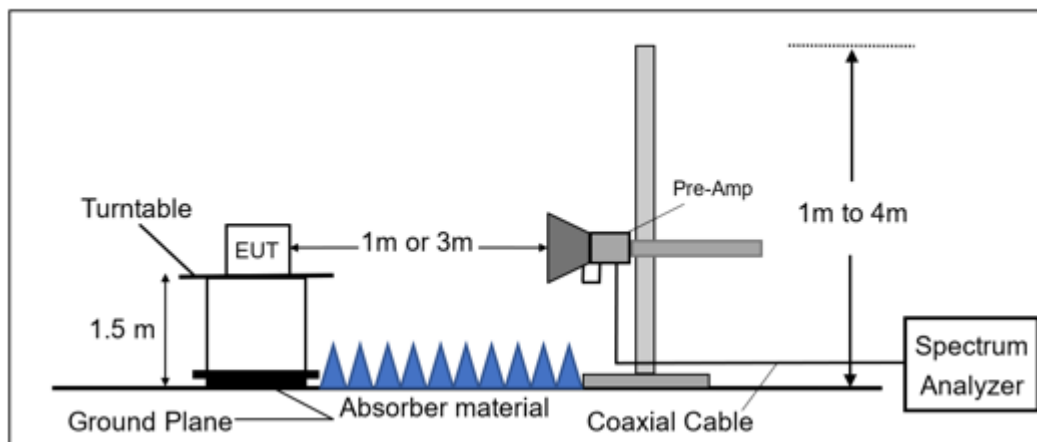
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Radiated Emission Test Set-Up, Frequency Above 1GHz.



1. The testing was performed in accordance with the applicable radiated emission measurement procedure.
2. The EUT was placed on a turntable at a height of 0.8 m for frequencies below 1 GHz and 1.5 m for frequencies above 1 GHz.
3. The turntable was rotated 360 degrees to determine the position of the maximum emission level.
4. The EUT was positioned 3 meters away from the receiving antenna, which was varied in height from 1 m to 4 m to locate the highest emissions.
5. The spectrum analyzer was set with RBW = 100 kHz and VBW = 300 kHz, using a Peak detector for frequencies between 30 MHz and 1 GHz.
6. A receiver mode with RBW = 120 kHz was used for Quasi-Peak (QP) measurements between 30 MHz and 1 GHz.
7. For frequencies above 1 GHz, the spectrum analyzer was set with RBW = 1 MHz, VBW = 3 MHz, and Detector = Peak for maximum emission measurements.
8. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz, Detector= RMS correction factor is $[10 \log (1 / D)]$ for Average Emission measurements at frequency above 1 GHz when $D \geq 98\%$. If a specific emission is demonstrated to be continuous ($D \geq 98\%$) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission, where D is the duty cycle.
9. Set the spectrum analyzer as RBW=1 MHz, VBW $\geq 1/T$, Detector= Peak when $D < 98\%$ for Average Emission Measurements at frequency above 1 GHz.
10. The average value of pulsed emissions is determined using the duty cycle correction method, applying a correction factor of $20 \times \log_{10} (T_{on} / 100 \text{ ms})$.
11. When measuring radiated emissions above 1 GHz, the receiving antenna was maintained within the "cone of radiation" and pointed at the emission source in both azimuth and elevation, with polarization oriented for maximum response, ensuring it remained within the 3 dB illumination beamwidth of the measurement antenna.
12. The six highest emissions were fully maximized using the above procedures to ensure EUT compliance.

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13. Each emission was further maximized by changing the receiving antenna polarization between horizontal and vertical.
14. Repeat the above procedures until all default test channels (low, middle, and high) are measured.

Note: Emissions from 9 kHz to 30 MHz were pre-scanned and found to be at least 20 dB below the applicable limits, and are therefore not reported.

6.5.1 Field Strength Calculation

The field strength is calculated by adding the antenna factor and cable loss, then subtracting the amplifier gain and any applicable duty cycle correction factor from the measured reading. The basic equation and an example calculation are as follows:

$$FS = RA + AF + CL - AG$$

Where:

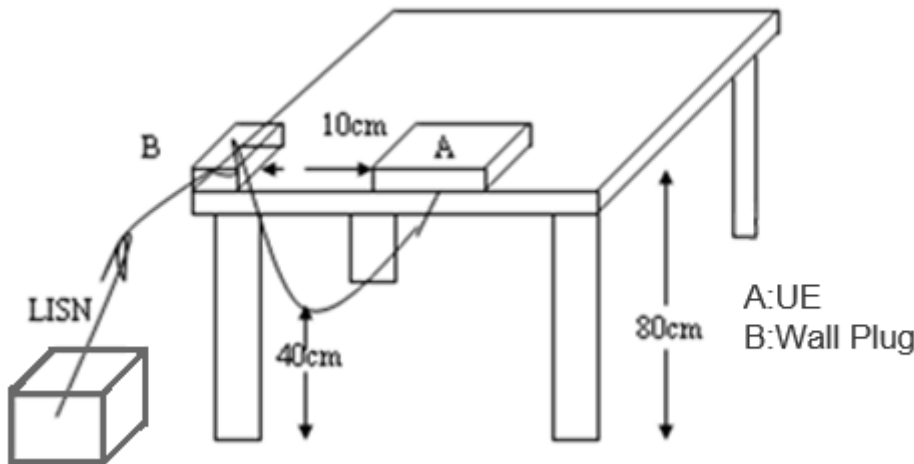
FS = Field Strength (dB μ V/m)
RA = Reading Amplitude (dB μ V)
AF = Antenna Factor (dB/m)
CL = Cable Loss (dB)
AG = Amplifier Gain (dB)

The emission limit is expressed in dB μ V/m, which corresponds to the logarithmic conversion of $20 \times \log_{10} (\mu\text{V/m})$.

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6.6 AC Power Line Conducted Emission



1. The conducted emission tests were performed at the designated test site using a setup in accordance with ANSI_C63.10
2. The EUT was placed on a non-conductive table that is 0.8 meters above the ground plane. Conducted emissions were measured in the frequency range from 0.15 MHz to 30 MHz using CISPR Quasi-Peak and Average detector modes. The two LISNs provided 50 μ H / 50 ohm coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
3. The AC/DC power adaptor of the EUT was connected to the LISN. The EUT was positioned flush with the rear edge of the table, with a minimum 0.4-meter distance from the shielding wall.
4. The LISNs were connected to the power source and configured according to the test requirements.
5. The maximum emission levels were investigated for each mode of operation. The six highest emissions were further maximized to ensure compliance.
6. The above procedures were repeated for all power supply configurations of the EUT.

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7 TEST RESULTS

7.1 Emission Bandwidth

7.1.1 6dB BW measurements

BLE 1M mode

Frequency (MHz)	6dB BW (MHz)	Required BW (MHz)	Result
2402	0.6794	≥ 0.5	PASS
2442	0.6782	≥ 0.5	PASS
2480	0.682	≥ 0.5	PASS

BLE 2M mode

Frequency (MHz)	6dB BW (MHz)	Required BW (MHz)	Result
2402	1.156	≥ 0.5	PASS
2442	1.154	≥ 0.5	PASS
2480	1.151	≥ 0.5	PASS

BLE 125k mode(Payload S=8)

Frequency (MHz)	6dB BW (MHz)	Required BW (MHz)	Result
2402	0.6137	≥ 0.5	PASS
2442	0.6155	≥ 0.5	PASS
2480	0.6133	≥ 0.5	PASS

BLE 500k mode(Payload S=2)

Frequency (MHz)	6dB BW (MHz)	Required BW (MHz)	Result
2402	0.672	≥ 0.5	PASS
2442	0.6714	≥ 0.5	PASS
2480	0.6844	≥ 0.5	PASS

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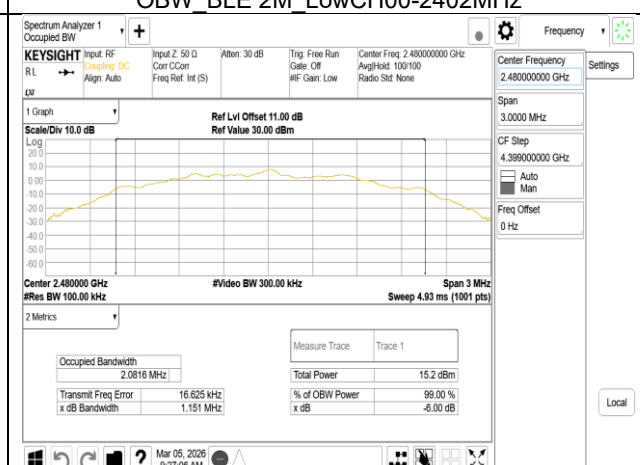
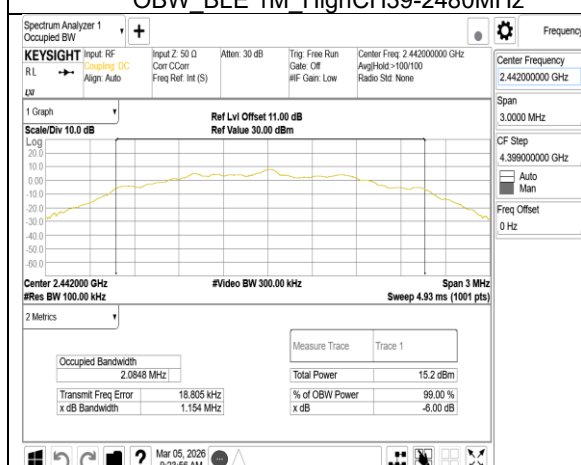
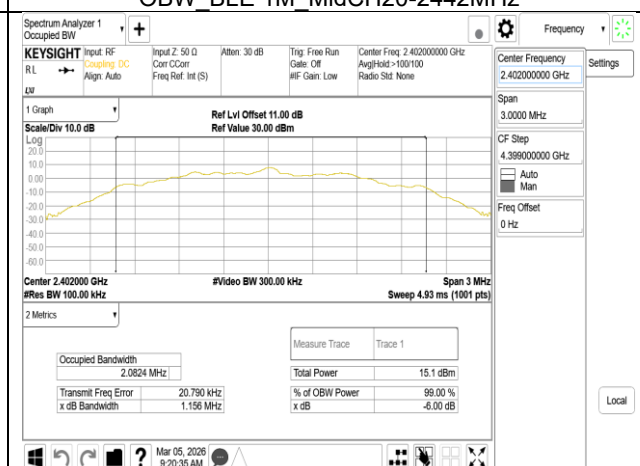
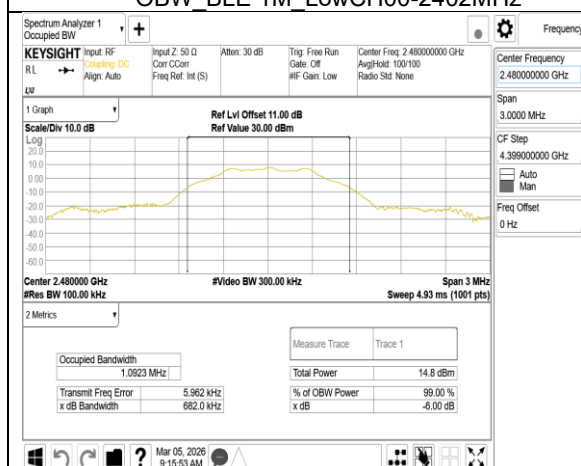
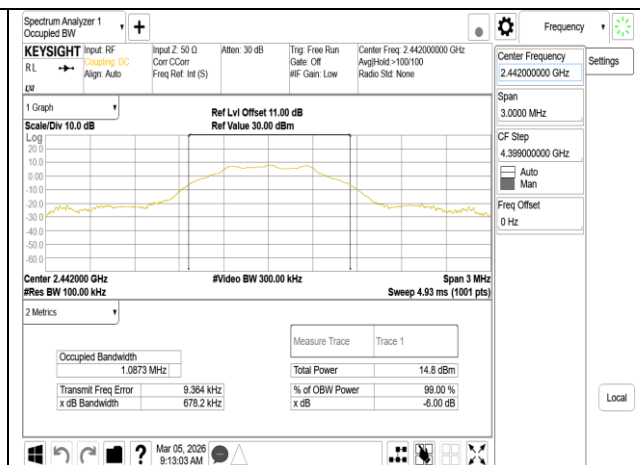
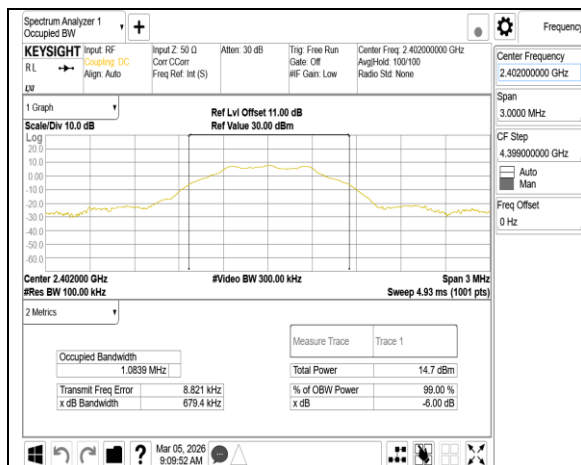
Proprietary mode

Frequency (MHz)	6dB BW (MHz)	Required BW (MHz)	Result
2403	2.116	≥ 0.5	PASS
2439	2.131	≥ 0.5	PASS
2475	2.123	≥ 0.5	PASS

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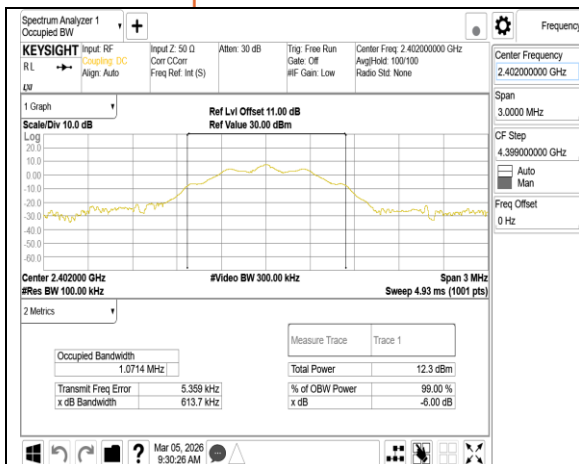
OBW_BLE 2M_MidCH20-2442MHz

OBW_BLE 2M_HighCH39-2480MHz

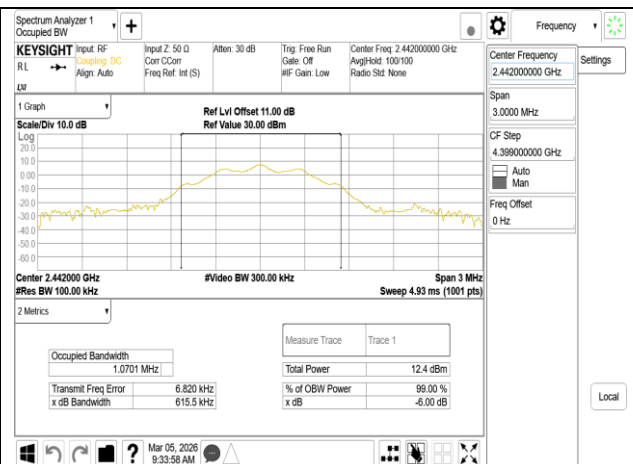
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OBW_BLE 125k_LowCH00-2402MHz



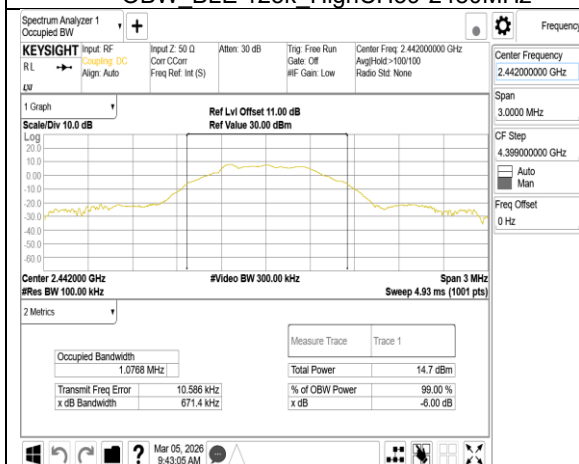
OBW_BLE 125k_MidCH20-2442MHz



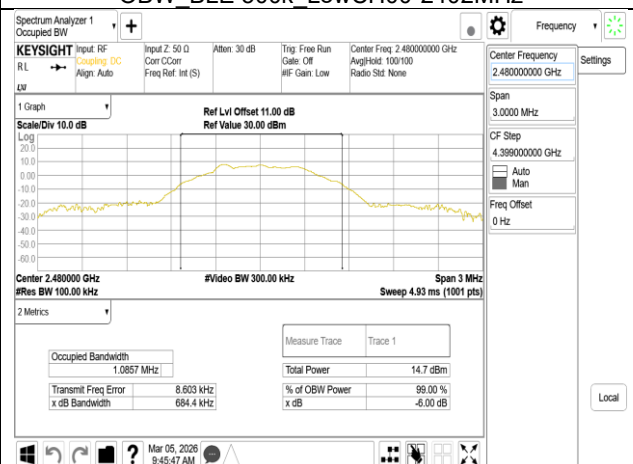
OBW_BLE 125k_HighCH39-2480MHz



OBW_BLE 500k_LowCH00-2402MHz



OBW_BLE 500k_MidCH20-2442MHz

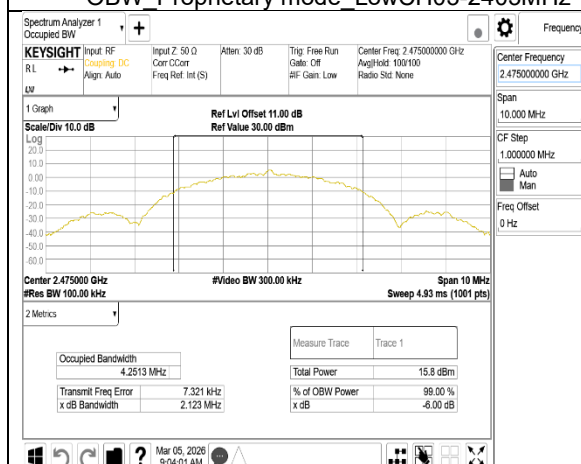
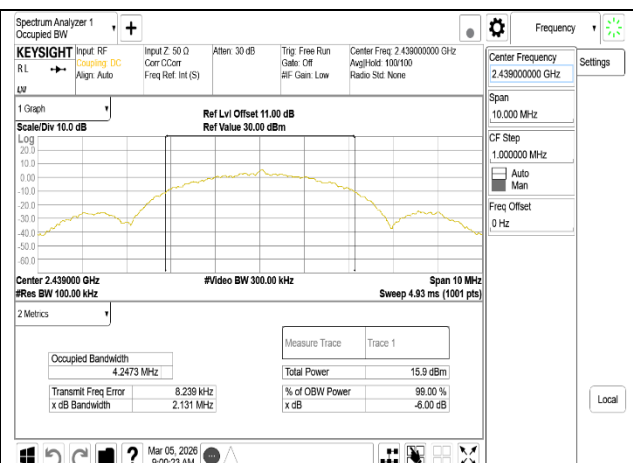
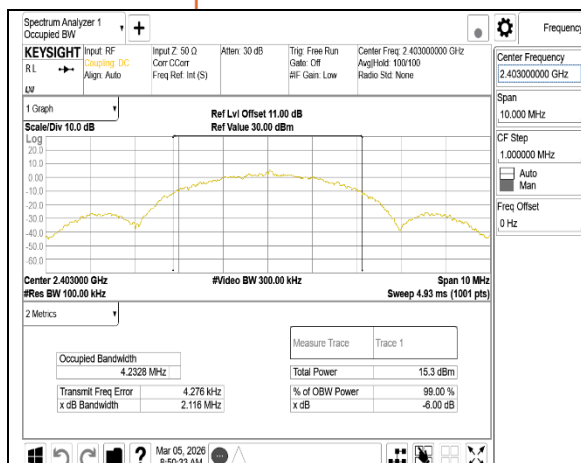


OBW_BLE 500k_HighCH39-2480MHz

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7.1.2 99% Bandwidth

BLE 1M mode

Frequency (MHz)	99%Bandwidth (MHz)
2402	1.0516
2442	1.0531
2480	1.0527

BLE 2M mode

Frequency (MHz)	99%Bandwidth (MHz)
2402	2.0841
2442	2.0862
2480	2.0834

BLE 125k mode(Payload S=8)

Frequency (MHz)	99%Bandwidth (MHz)
2402	1.073
2442	1.0753
2480	1.0795

BLE 500k mode(Payload S=2)

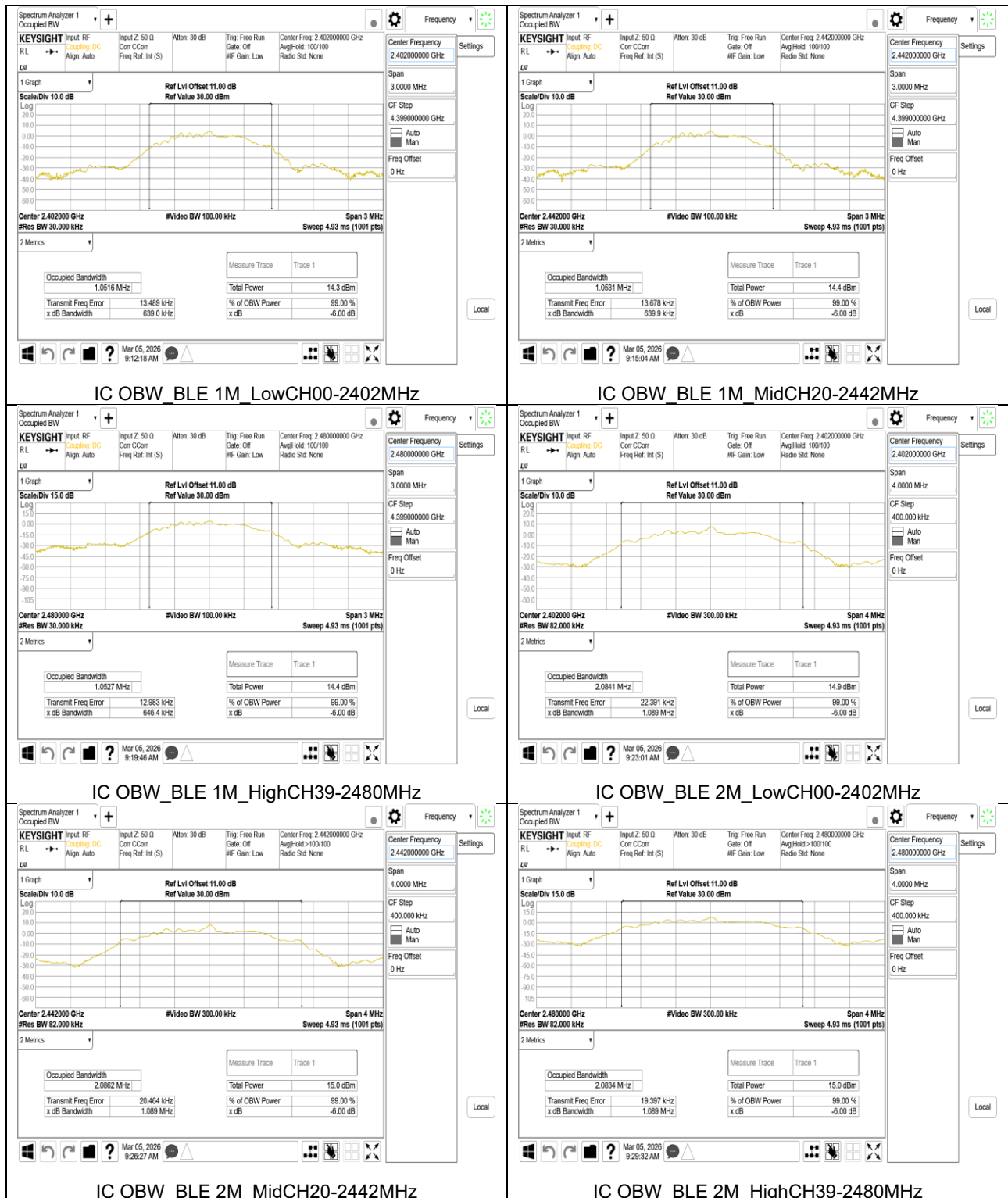
Frequency (MHz)	99%Bandwidth (MHz)
2402	1.0352
2442	1.0369
2480	1.0388

Proprietary mode

Frequency (MHz)	99%Bandwidth (MHz)
2403	4.2254
2439	4.2279
2475	4.2293

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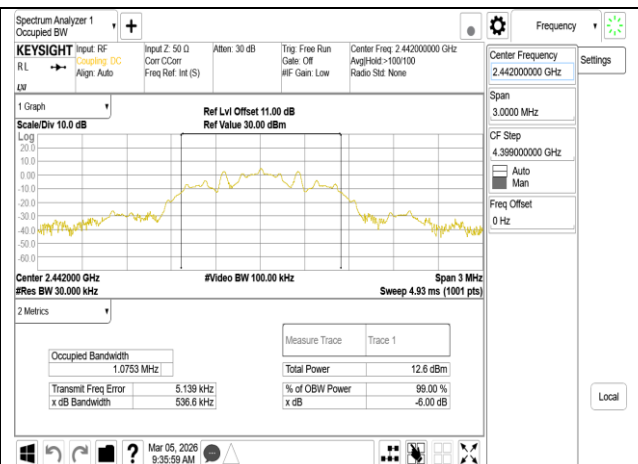
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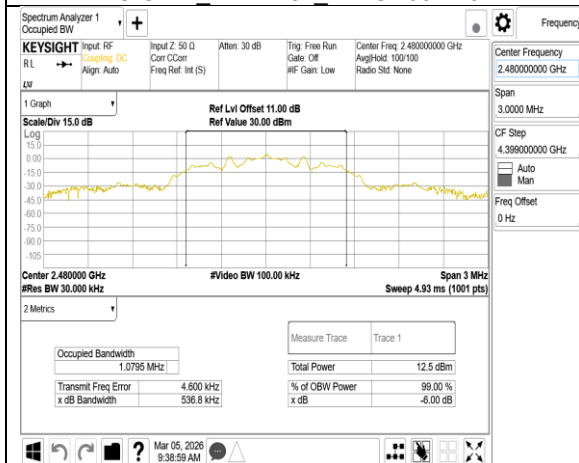
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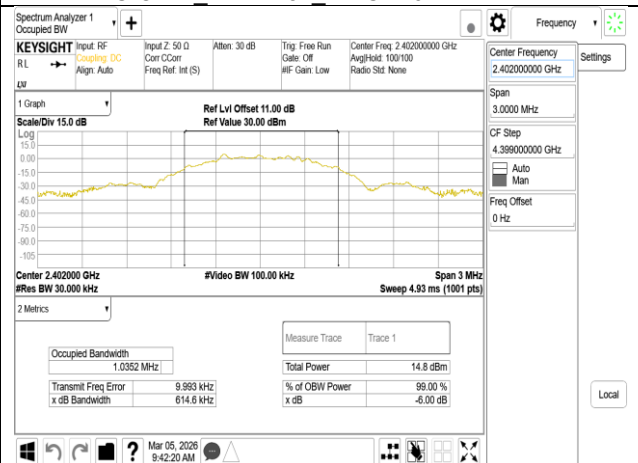
IC OBW_BLE 125k_LowCH00-2402MHz



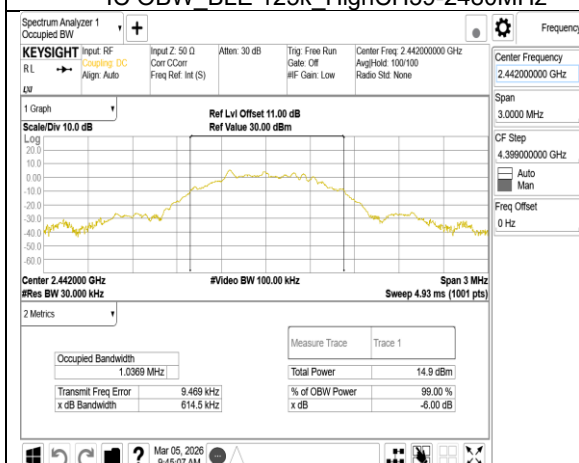
IC OBW_BLE 125k_MidCH20-2442MHz



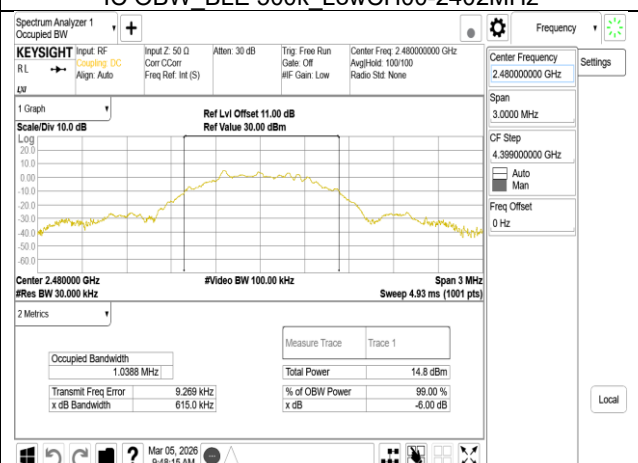
IC OBW_BLE 125k_HighCH39-2480MHz



IC OBW_BLE 500k_LowCH00-2402MHz



IC OBW_BLE 500k_MidCH20-2442MHz

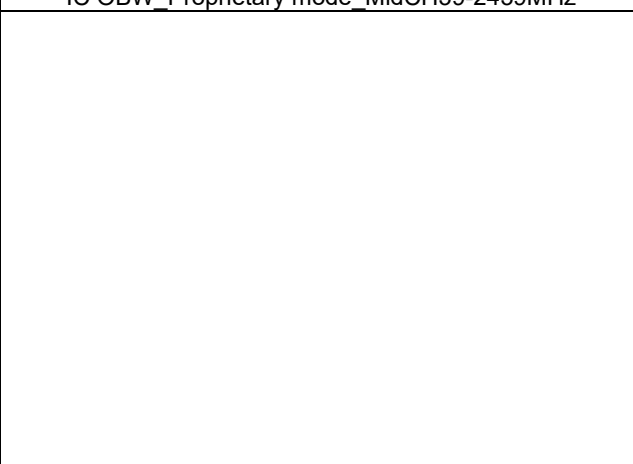
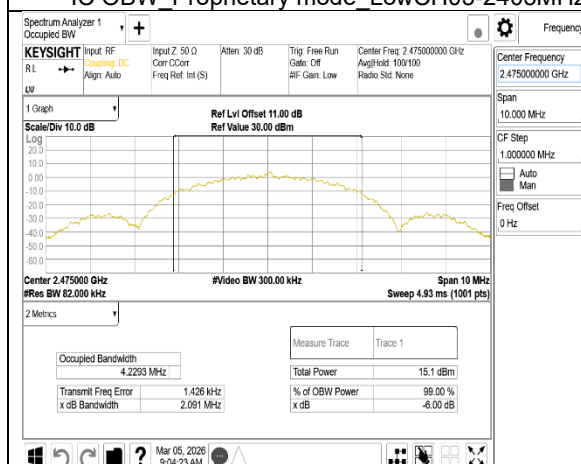
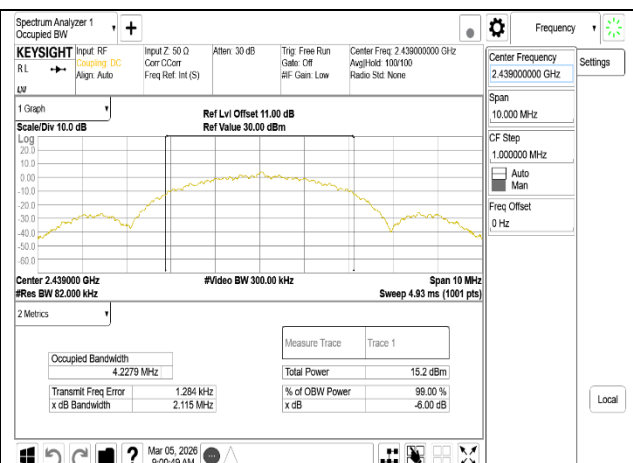
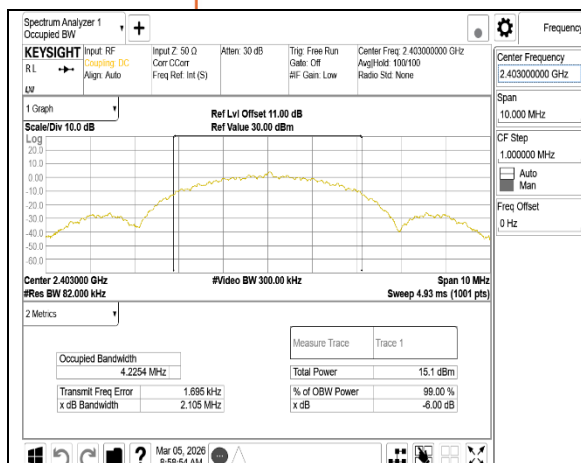


IC OBW_BLE 500k_HighCH39-2480MHz

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7.2 Duty Factor

Mode	Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log (1/Duty Cycle)	1/T (kHz)	VBW setting (kHz)
BLE 1M	62.40	2.05	2.56	3.00
BLE 2M	32.80	4.84	4.88	5.00
BLE 125k	82.80	0.82	0.32	1.00
BLE 500k	57.46	2.41	0.93	1.00
Proprietary mode (04)	100.00	0.00	0.00	0.01

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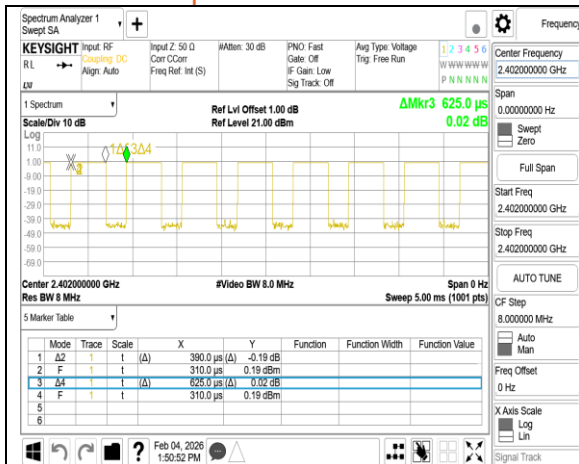
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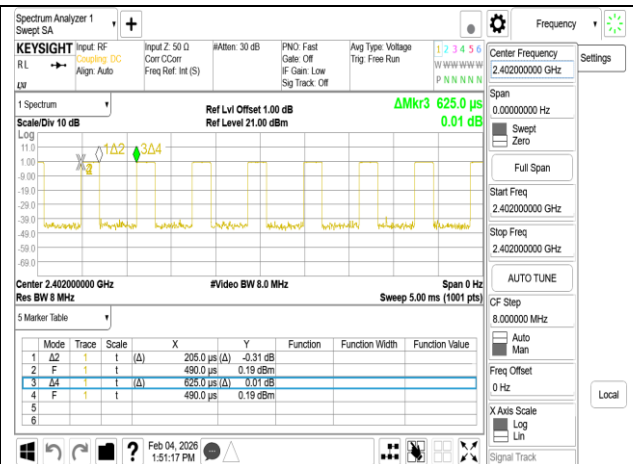
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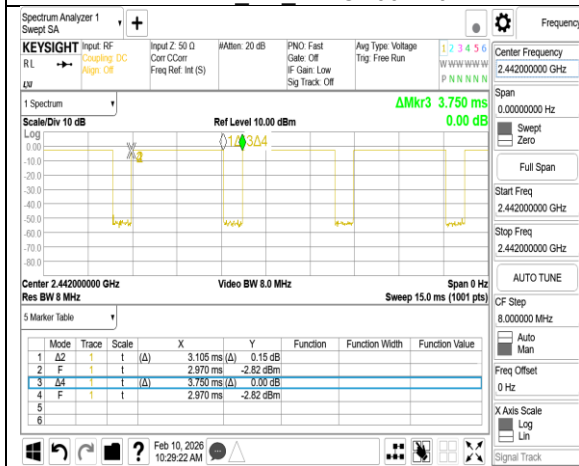
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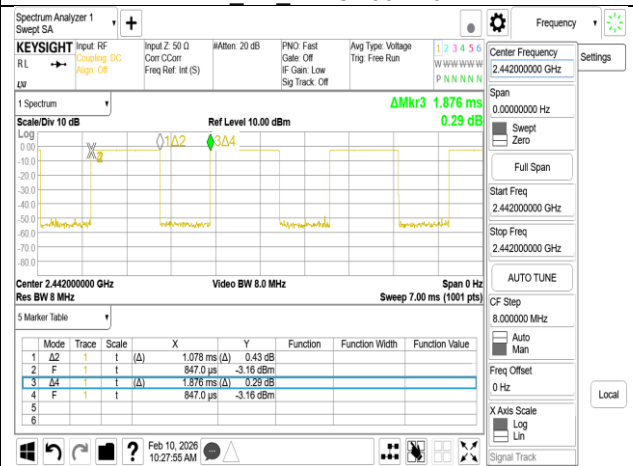
BLE_1M_LowCH00-2402



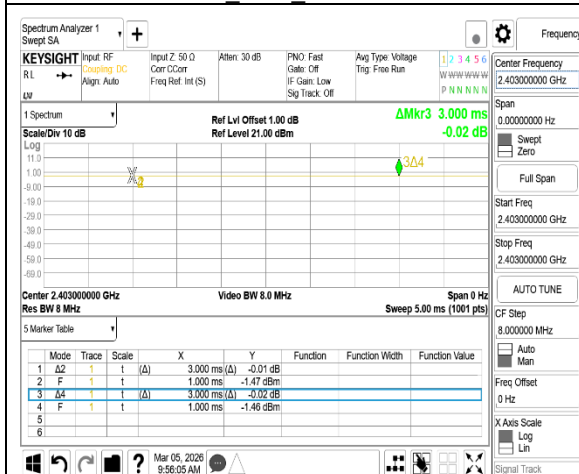
BLE_2M_LowCH00-2402



BLE_125k_LowCH00-2402



BLE_500k_LowCH00-2402



Proprietary mode_LowCH03-2403

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7.3 Maximum Output Power

7.3.1 Peak & Avg

BLE 1M mode:

CH	Frequency (MHz)	Power Setting	Peak Output Power (dBm)	Required Limit (dBm)
0	2402	8	7.57	30
20	2442	8	7.55	30
39	2480	8	7.54	30
CH	Frequency (MHz)	Power Setting	Avg. Output Power (dBm)	Required Limit (dBm)
0	2402	8	7.48	30
20	2442	8	7.53	30
39	2480	8	7.53	30

***Note:**

1.Measured by power meter, cable loss 11 dB + Duty cycle factor has been offseted to the power meter for Avg. power and cable loss has been offseted for Peak power measurement.

BLE 2M mode:

CH	Frequency (MHz)	Power Setting	Peak Output Power (dBm)	Required Limit (dBm)
0	2402	8	7.56	30
20	2442	8	7.57	30
39	2480	8	7.53	30
CH	Frequency (MHz)	Power Setting	Avg. Output Power (dBm)	Required Limit (dBm)
0	2402	8	7.52	30
20	2442	8	7.39	30
39	2480	8	7.38	30

***Note:**

1.Measured by power meter, cable loss 11 dB + Duty cycle factor has been offseted to the power meter for Avg. power and cable loss has been offseted for Peak power measurement.

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BLE 125k mode(Payload S=8):

CH	Frequency (MHz)	Power Setting	Peak Output Power (dBm)	Required Limit (dBm)
0	2402	8	7.58	30
20	2442	8	7.58	30
39	2480	8	7.54	30
CH	Frequency (MHz)	Power Setting	Avg. Output Power (dBm)	Required Limit (dBm)
0	2402	8	7.56	30
20	2442	8	7.49	30
39	2480	8	7.52	30

***Note:**

1.Measured by power meter, cable loss 11 dB + Duty cycle factor has been offseted to the power meter for Avg. power and cable loss has been offseted for Peak power measurement.

BLE 500k mode(Payload S=2):

CH	Frequency (MHz)	Power Setting	Peak Output Power (dBm)	Required Limit (dBm)
0	2402	8	7.54	30
20	2442	8	7.57	30
39	2480	8	7.54	30
CH	Frequency (MHz)	Power Setting	Avg. Output Power (dBm)	Required Limit (dBm)
0	2402	8	7.43	30
20	2442	8	7.51	30
39	2480	8	7.50	30

***Note:**

1.Measured by power meter, cable loss 11 dB + Duty cycle factor has been offseted to the power meter for Avg. power and cable loss has been offseted for Peak power measurement.

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Proprietary mode :

CH	Frequency (MHz)	Power Setting	Peak Output Power (dBm)	Required Limit (dBm)
3	2403	8	7.72	30
39	2439	8	7.70	30
75	2475	8	7.65	30
CH	Frequency (MHz)	Power Setting	Avg. Output Power (dBm)	Required Limit (dBm)
3	2403	8	7.69	30
39	2439	8	7.67	30
75	2475	8	7.62	30

***Note:**

1. Measured by power meter, cable loss 11 dB + Duty cycle factor has been offseted to the power meter for Avg. power and cable loss has been offseted for Peak power measurement.

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7.3.2 EIRP

EIRP BLE 1M mode

CH	Frequency (MHz)	Power Setting	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit
0	2402	8	7.48	3.73	11.21	4W= 36 dBm
20	2442	8	7.53	3.73	11.26	4W= 36 dBm
39	2480	8	7.53	3.73	11.26	4W= 36 dBm

* **Note:** EIRP = Average Power + Gain

EIRP BLE 2M mode

CH	Frequency (MHz)	Power Setting	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit
0	2402	8	7.52	3.73	11.25	4W= 36 dBm
20	2442	8	7.39	3.73	11.12	4W= 36 dBm
39	2480	8	7.38	3.73	11.11	4W= 36 dBm

* **Note:** EIRP = Average Power + Gain

EIRP BLE 125k mode(Payload S=8)

CH	Frequency (MHz)	Power Setting	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit
0	2402	8	7.56	3.73	11.29	4W= 36 dBm
20	2442	8	7.49	3.73	11.22	4W= 36 dBm
39	2480	8	7.52	3.73	11.25	4W= 36 dBm

* **Note:** EIRP = Average Power + Gain

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EIRP BLE 500k mode(Payload S=2)

CH	Frequency (MHz)	Power Setting	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit
0	2402	8	7.43	3.73	11.16	4W= 36 dBm
20	2442	8	7.51	3.73	11.24	4W= 36 dBm
39	2480	8	7.50	3.73	11.23	4W= 36 dBm

* **Note:** EIRP = Average Power + Gain

EIRP Proprietary mode

CH	Frequency (MHz)	Power Setting	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit
3	2403	8	7.69	3.73	11.42	4W= 36 dBm
39	2439	8	7.67	3.73	11.40	4W= 36 dBm
75	2475	8	7.62	3.73	11.35	4W= 36 dBm

* **Note:** EIRP = Average Power + Gain

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7.4 Maximum Power Spectral Density

BLE 1M mode

Frequency (MHz)	RF Power Density (dBm/3kHz)	Maximum Limit (dBm/3kHz)	Result
2402	-6.54	8	PASS
2442	-6.41	8	PASS
2480	-6.59	8	PASS

***Note:**

1.cable loss as 11 dB that offsets in the spectrum

BLE 2M mode

Frequency (MHz)	RF Power Density (dBm/3kHz)	Maximum Limit (dBm/3kHz)	Result
2402	-10.08	8	PASS
2442	-10.00	8	PASS
2480	-10.07	8	PASS

***Note:**

1.cable loss as 11 dB that offsets in the spectrum

BLE 125k mode(Payload S=8)

Frequency (MHz)	RF Power Density (dBm/3kHz)	Maximum Limit (dBm/3kHz)	Result
2402	1.93	8	PASS
2442	1.99	8	PASS
2480	1.95	8	PASS

***Note:**

1.cable loss as 11 dB that offsets in the spectrum

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BLE 500k mode(Payload S=2)

Frequency (MHz)	RF Power Density (dBm/3kHz)	Maximum Limit (dBm/3kHz)	Result
2402	1.83	8	PASS
2442	1.98	8	PASS
2480	1.83	8	PASS

Note:*1.cable loss as 11 dB that offsets in the spectrum**

Proprietary mode

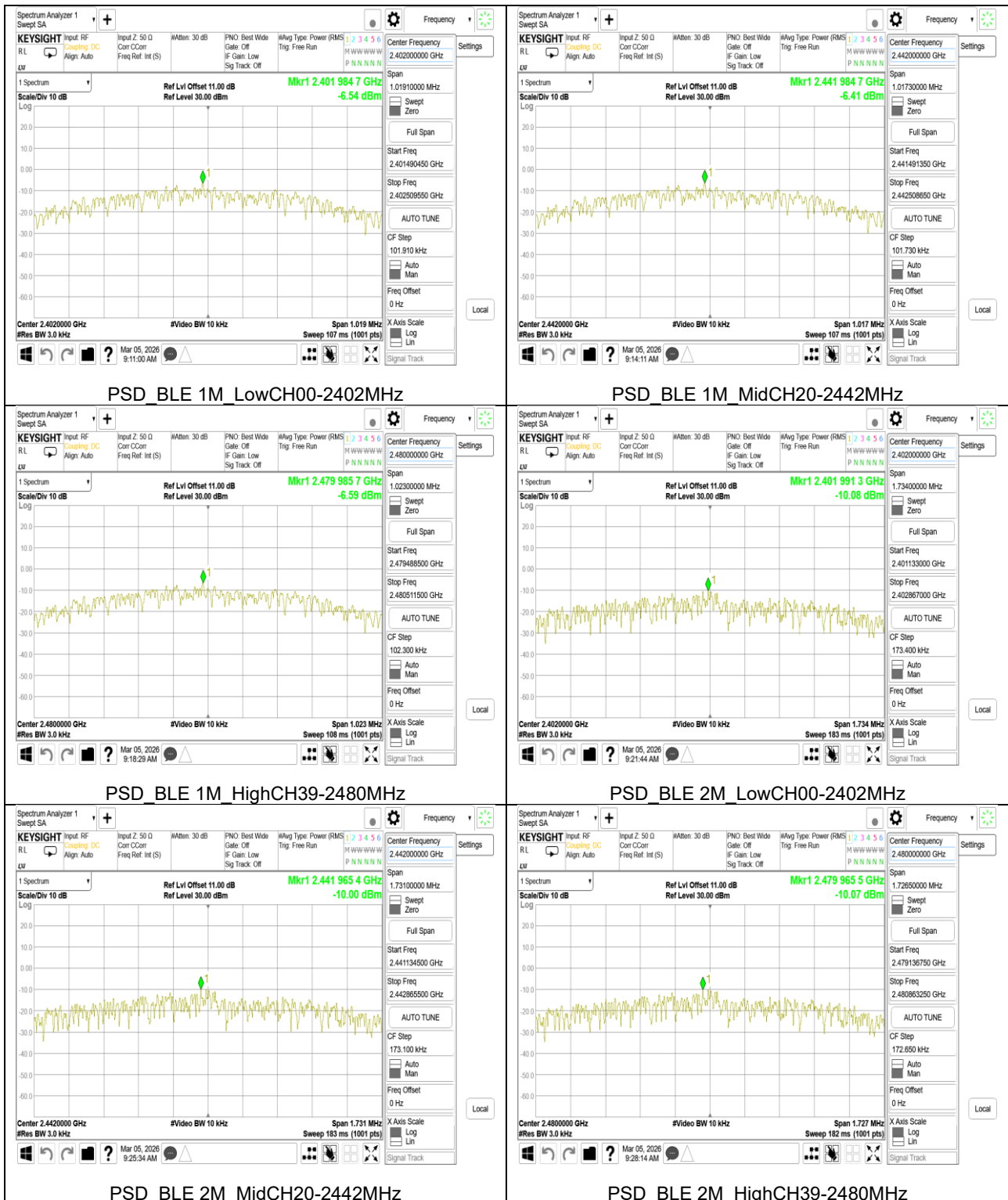
Frequency (MHz)	RF Power Density (dBm/3kHz)	Maximum Limit (dBm/3kHz)	Result
2403	-11.87	8	PASS
2439	-11.57	8	PASS
2475	-11.82	8	PASS

Note:*1.cable loss as 11 dB that offsets in the spectrum**

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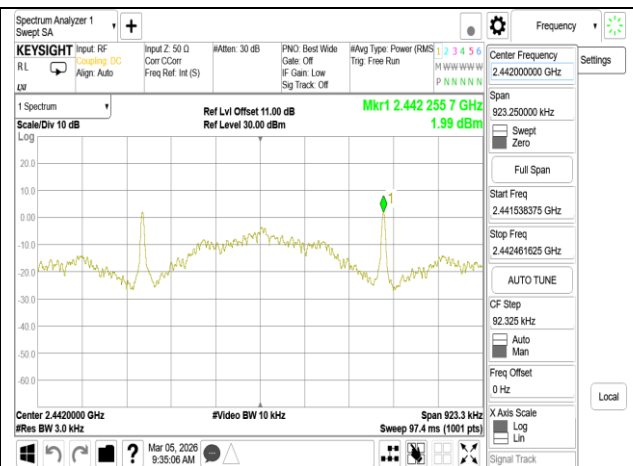
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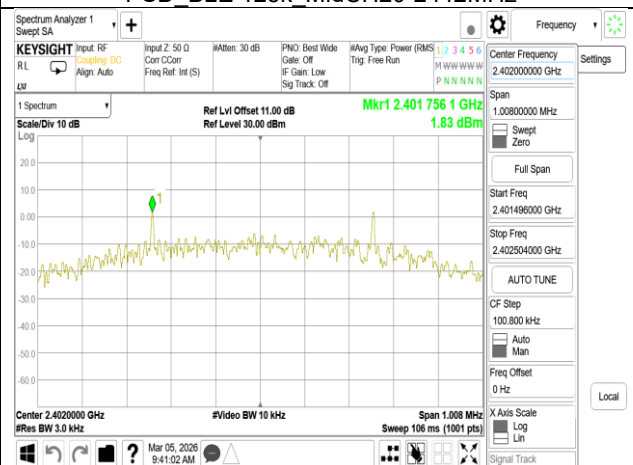
PSD_BLE 125k_LowCH00-2402MHz



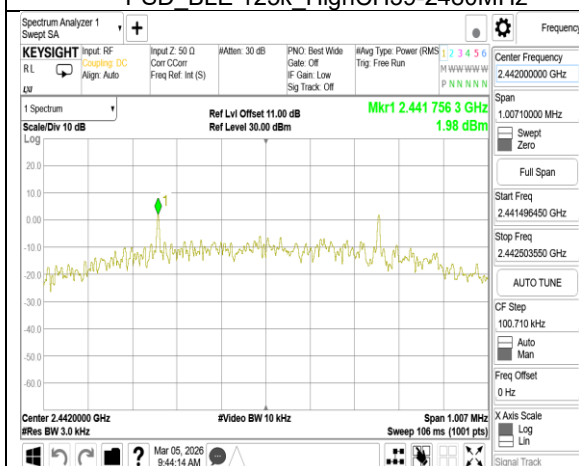
PSD_BLE 125k_MidCH20-2442MHz



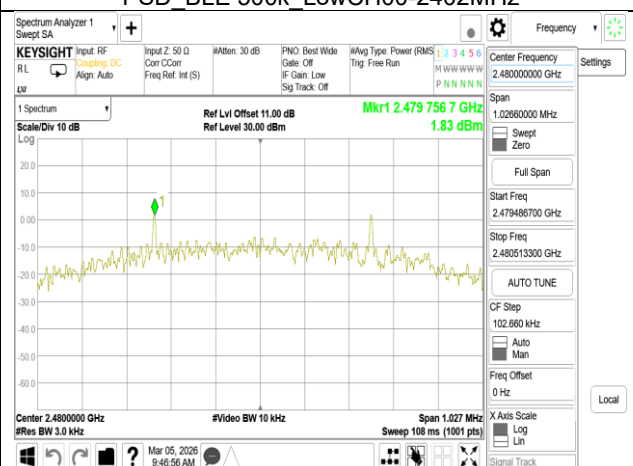
PSD_BLE 125k_HighCH39-2480MHz



PSD_BLE 500k_LowCH00-2402MHz



PSD_BLE 500k_MidCH20-2442MHz

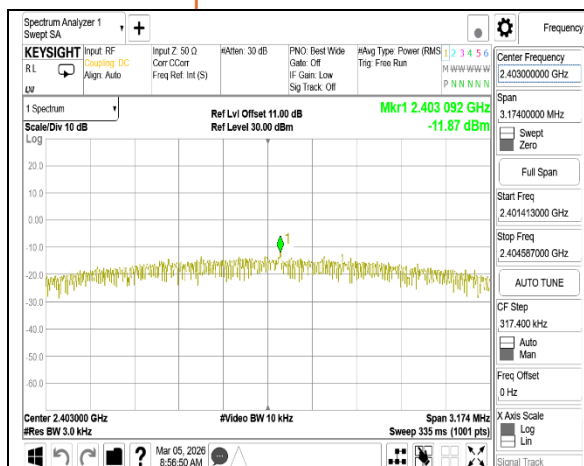


PSD_BLE 500k_HighCH39-2480MHz

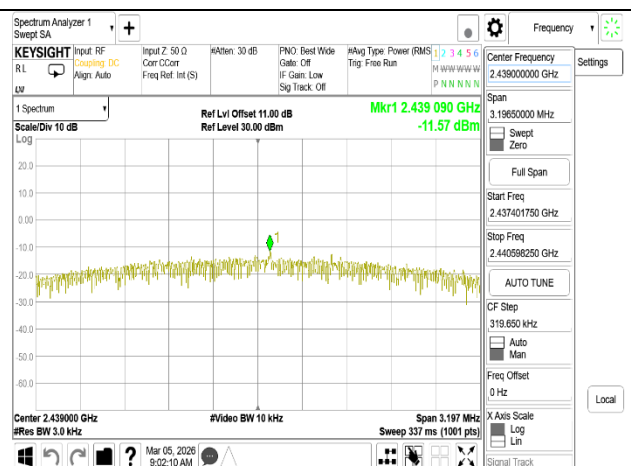
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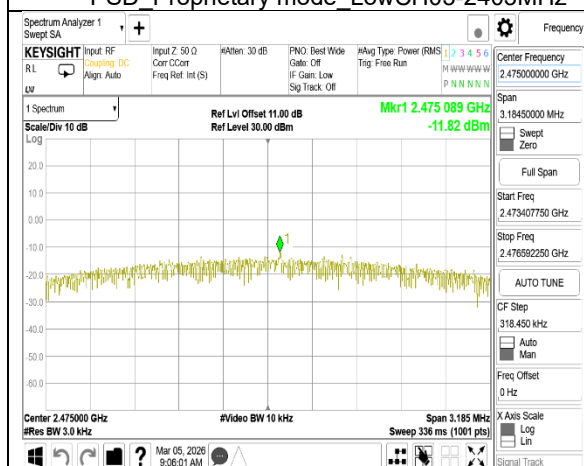
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PSD_Proprietary mode_LowCH03-2403MHz



PSD_Proprietary mode_MidCH39-2439MHz



PSD_Proprietary mode_HighCH75-2475MHz

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7.5 Out of Band Emission

BLE 1M_Reference Level of Limit

Frequency (MHz)	RF Power Density (dBm)	Reference Level of Limit = PSD - 20dB (dBm)
2402	7.79	-12.21
2442	7.94	-12.06
2480	7.87	-12.13

***Note:**

- 1.cable loss as 11 dB that offsets in the spectrum
- 2.Refer to next page for plots.

BLE 2M_Reference Level of Limit

Frequency (MHz)	RF Power Density (dBm)	Reference Level of Limit = PSD - 20dB (dBm)
2402	7.75	-12.25
2442	7.93	-12.07
2480	7.84	-12.16

***Note:**

- 1.cable loss as 11 dB that offsets in the spectrum
- 2.Refer to next page for plots.

BLE 125k(Payload S=8)_Reference Level of Limit

Frequency (MHz)	RF Power Density (dBm)	Reference Level of Limit = PSD - 20dB (dBm)
2402	7.56	-12.44
2442	7.62	-12.38
2480	7.58	-12.42

***Note:**

- 1.cable loss as 11 dB that offsets in the spectrum
- 2.Refer to next page for plots.

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BLE 500k(Payload S=2)_Reference Level of Limit

Frequency (MHz)	RF Power Density (dBm)	Reference Level of Limit = PSD - 20dB (dBm)
2402	7.99	-12.01
2442	8.14	-11.86
2480	8.06	-11.94

***Note:**

- 1.cable loss as 11 dB that offsets in the spectrum
- 2.Refer to next page for plots.

Proprietary mode_Reference Level of Limit

Frequency (MHz)	RF Power Density (dBm)	Reference Level of Limit = PSD - 20dB (dBm)
2403	5.19	-14.81
2439	5.36	-14.64
2475	5.30	-14.70

***Note:**

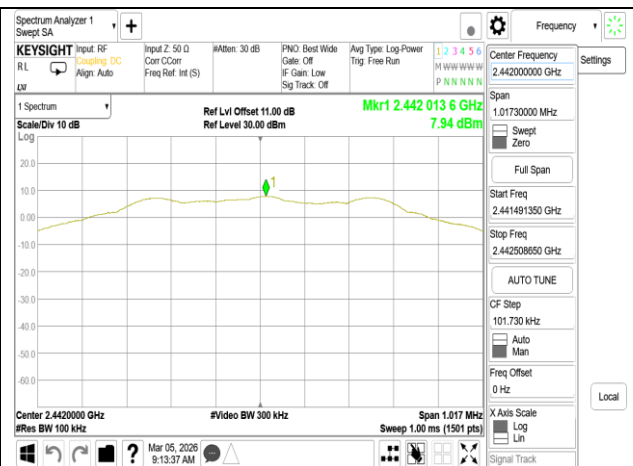
- 1.cable loss as 11 dB that offsets in the spectrum
- 2.Refer to next page for plots.

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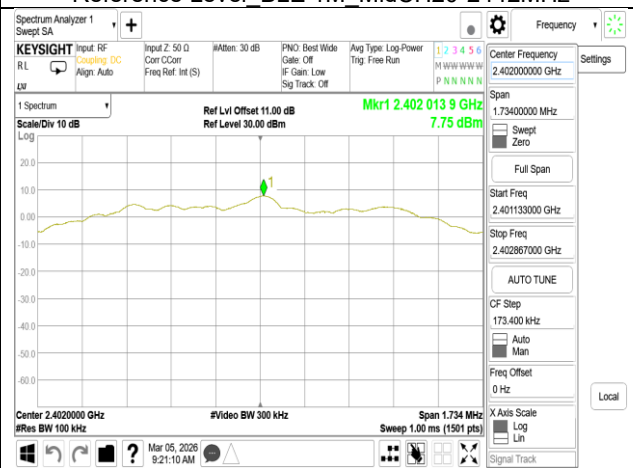
Reference Level_BLE 1M_LowCH00-2402MHz



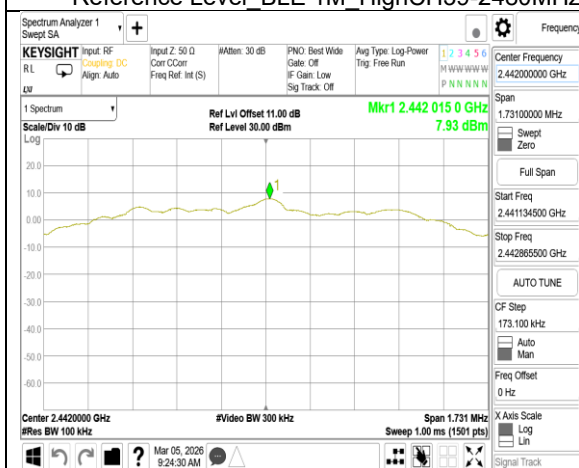
Reference Level_BLE 1M_MidCH20-2442MHz



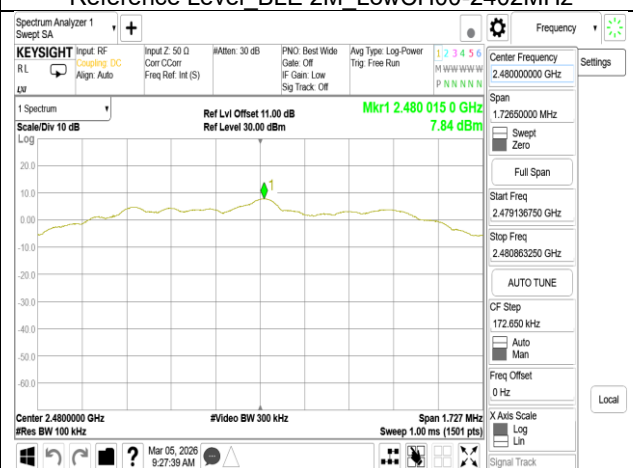
Reference Level_BLE 1M_HighCH39-2480MHz



Reference Level_BLE 2M_LowCH00-2402MHz



Reference Level_BLE 2M_MidCH20-2442MHz



Reference Level_BLE 2M_HighCH39-2480MHz

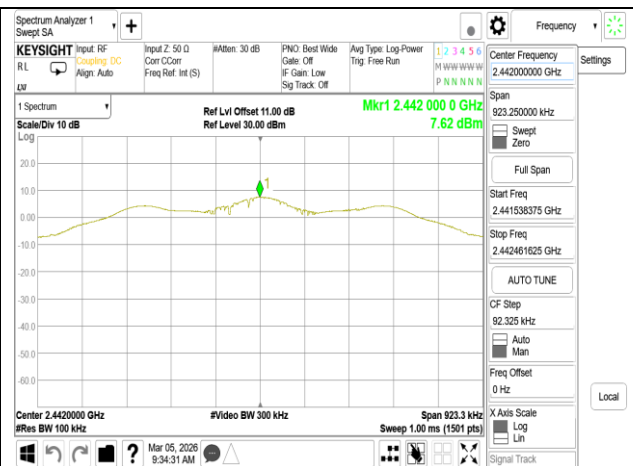
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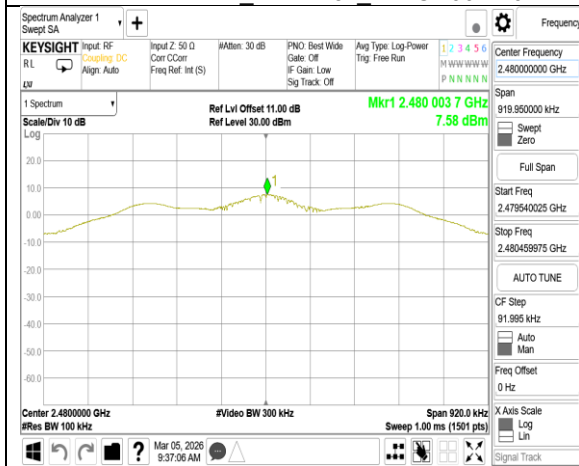
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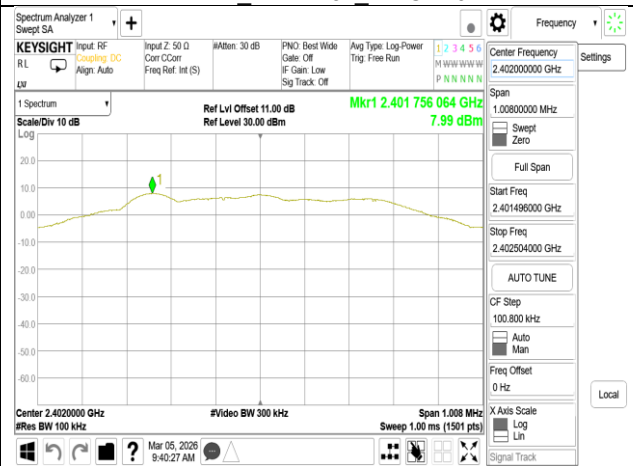
Reference Level_BLE 125k_LowCH00-2402MHz



Reference Level_BLE 125k_MidCH20-2442MHz



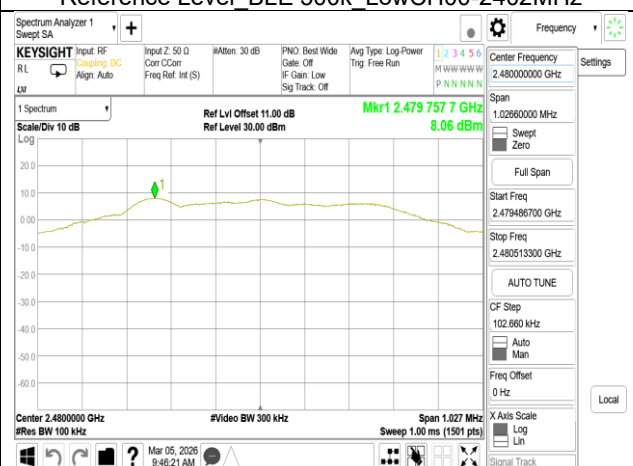
Reference Level_BLE 125k_HighCH39-2480MHz



Reference Level_BLE 500k_LowCH00-2402MHz



Reference Level_BLE 500k_MidCH20-2442MHz



Reference Level_BLE 500k_HighCH39-2480MHz

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