

CTC Laboratories, Inc.

2/F., Building 1 and 1-2/F., Building 2, Jiaquan Building, Guanlan High-Tech Park, Longhua District, Shenzhen, Guangdong, China

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TEST REPORT				
Report No: CTC20240747E05				
FCC ID:	2BFST-SANAGS3S			
Applicant:	Zhichuang All Technology Co. Ltd			
Address:	31st Floor, West Tower of Xinghe Twin Towers, No. 8 Yaxing Rd, Bantian St, Longgang Dist, Shenzhen			
Manufacturer	Zhichuang All Technology Co. Ltd			
Address:	31st Floor, West Tower of Xinghe Bantian St, Longgang Dist, Shenz			
Product Name:	OWS BLUETOOTH HEADSET			
Trade Mark:	/			
Model/Type reference:	sanag S3S			
Listed Model(s):	sanag S3S Al			
Standard:	Standard FCC CFR Title 47 Part 15 Subpart C Section 15.247			
Date of receipt of test sample:	Mar. 11, 2024			
Date of testing	Mar. 12, 2024 ~ Mar. 14, 2024			
Date of issue	Apr. 29, 2024			
Result:	PASS			
Compiled by:		lunge lann.		
(Printed name+signature)	Lucy Lan	Luey lan Zriz Zhang		
Supervised by:		Zic zhang		
(Printed name+signature)	Eric Zhang	~		
Approved by:		Johnas		
(Printed name+signature)	Totti Zhao	1		
Testing Laboratory Name:	CTC Laboratories, Inc.			
Address 2/F., Building 1 and 1-2/F., Building 2, Jiaquan Building, Guanlan High-Tech Park, Longhua District, Shenzhen, Guangdong, China				
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1. TEST SUMMARY

1.1. Test Standards

The tests were performed according to following standards:

FCC Rules Part 15.247: Operation within the bands 902–928MHz, 2400–2483.5MHz, and 5725-5850MHz.

ANSI C63.10-2013: American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

1.2. Report Version

Revised No.	Report No.	Date of issue	Description
01	CTC20240747E05	Apr. 29, 2024	Original

1.3. Test Description

FCC Part 15 Subpart C (15.247)					
Test Item	Standard Section	Result	Test Engineer		
Antenna Requirement	15.203	Pass	Kyrie		
Conducted Emission	15.207	Pass	Kyrie		
Conducted Band Edge and Spurious Emissions	15.247(d)	Pass	Kyrie		
Radiated Band Edge and Spurious Emissions	15.205&15.209& 15.247(d)	Pass	Kyrie		
6dB Bandwidth	15.247(a)(2)	Pass	Kyrie		
Conducted Max Output Power	15.247(b)(3)	Pass	Kyrie		
Power Spectral Density	15.247(e)	Pass	Kyrie		
Transmitter Radiated Spurious	15.209&15.247(d)	Pass	Kyrie		

Note:

1. The measurement uncertainty is not included in the test result.

N/A: means this test item is not applicable for this device according to the technology characteristic of 2. device.

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1.4. Test Facility

Address of the report laboratory

CTC Laboratories, Inc.

Add: 2/F., Building 1 and 1-2/F., Building 2, Jiaquan Building, Guanlan High-Tech Park, Longhua District, Shenzhen, Guangdong, China

Laboratory accreditation

The test facility is recognized, certified, or accredited by the following organizations:

A2LA-Lab Cert. No.: 4340.01

CTC Laboratories, Inc. EMC Laboratory has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025:2017 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

Industry Canada (Registration No.: 9783A, CAB Identifier: CN0029)

CTC Laboratories, Inc. EMC Laboratory has been registered by Certification and Engineer Bureau of Industry Canada for the performance of with Registration NO.: 9783A on Jan, 2016.

FCC (Registration No.: 951311, Designation Number CN1208)

CTC Laboratories, Inc. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration 951311, Aug 26, 2017.



1.5. Measurement Uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to TR-100028-01 "Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics; Part 1" and TR-100028-02 "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 2" and is documented in the CTC Laboratories, Inc. quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Test Items	Measurement Uncertainty	Notes
DTS Bandwidth	±0.0196%	(1)
Maximum Conducted Output Power	±0.686 dB	(1)
Maximum Power Spectral Density Level	±0.743 dB	(1)
Band-edge Compliance	±1.328 dB	(1)
Unwanted Emissions In Non-restricted Freq Bands	9kHz-1GHz: ±0.746dB 1GHz-26GHz: ±1.328dB	(1)
Conducted Emissions 9kHz~30MHz	±3.08 dB	(1)
Radiated Emissions 30~1000MHz	±4.51 dB	(1)
Radiated Emissions 1~18GHz	±5.84 dB	(1)
Radiated Emissions 18~40GHz	±6.12 dB	(1)

Below is the best measurement capability for CTC Laboratories, Inc.

Note (1): This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

1.6. Environmental Conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	15 °C to 35 °C
Relative Humidity:	20 % to 75 %
Air Pressure:	101 kPa

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2. GENERAL INFORMATION

2.1. Client Information

Applicant:	Zhichuang All Technology Co. Ltd
Address:	31st Floor, West Tower of Xinghe Twin Towers, No. 8 Yaxing Rd, Bantian St, Longgang Dist, Shenzhen
Manufacturer:	Zhichuang All Technology Co. Ltd
Address:	31st Floor, West Tower of Xinghe Twin Towers, No. 8 Yaxing Rd, Bantian St, Longgang Dist, Shenzhen

2.2. General Description of EUT

Product Name:	OWS BLUETOOTH HEADSET	
Trade Mark: /		
Model/Type reference:	sanag S3S	
Listed Model(s):	sanag S3S AI	
Model Difference:	Only the model name is different, the rest is the same	
	Charging bay:	
	DC 5V 1A from External adapter	
Power Supply:	400mAh from Battery	
	Earphone:	
	40mAh from Battery	
Hardware Version:	1	
Software Version:	/	
Bluetooth 5.3 / BLE		
Modulation:	GFSK	
Operation Frequency:	2402MHz~2480MHz	
Channel Number:	40	
Channel Separation: 2MHz		
Data Rate:	1Mbps, 2Mbps	
Antenna Type:	SMD Ceramic Antenna	
Antenna Gain:	2.71dBi	

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EN



2.3. Accessory Equipment Information

Equipment Information					
Name	Model	S/N	Manufacturer		
Adapter	PS06CA050K1000CU	/	/		
Cable Information	Cable Information				
Name	Shielded Type	Ferrite Core	Length		
USB Cable	Unshielded	NO	150cm		
Test Software Information					
Name	Version	/	/		
FCC_assist_1.0.2.2	1.0.2.2	/	/		



2.4. Operation State

Operation Frequency List: The EUT has been tested under typical operating condition. The Applicant provides communication tools software to control the EUT for staying in continuous transmitting and receiving mode for testing. BT BLE, 40 channels are provided to the EUT. Channels 00/19/39 were selected for testing.

Operation Frequency List:

Channel	Frequency (MHz)
00	2402
01	2404
÷	:
18	2438
19	2440
20	2442
:	:
38	2478
39	2480

Note: The display in grey were the channel selected for testing.

Test Mode:

For RF test items:

The engineering test program was provided and enabled to make EUT continuous transmit.

For AC power line conducted emissions:

The EUT was set to connect with the Bluetooth instrument under large package sizes transmission.

For Radiated spurious emissions test item:

The engineering test program was provided and enabled to make EUT continuous transmit. The EUT in each of three orthogonal axis emissions had been tested, but only the worst case (X axis) data recorded in the report.





2.5. Measurement Instruments List

RF Test System - SRD						
Item	Item Test Equipment Manufacturer Model No. Serial No. Calibrated U					
1	MXA Signal Analyzer Keysight		N9020A	MY46471737	Dec. 12, 2024	
2	Test Software	WCS	WCS-WCN	2023.08.04	/	

	Radiated emission					
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibrated Until	
1	Trilog-Broadband Antenna	Schwarzbeck	VULB 9168	9168-1013	Dec. 07, 2024	
2	Horn Antenna	Schwarzbeck	BBHA 9120D	9120D-648	Dec. 07, 2024	
3	Spectrum Analyzer	R&S	FSU26	100105	Dec. 12, 2024	
4	Spectrum Analyzer	R&S	FSV40-N	101331	Mar. 14 2024	
5	Pre-Amplifier	SONOMA	310	186194	Dec. 12, 2024	
6	Low Noise Pre-Amplifier	EMCI	EMC051835	980075	Dec. 12, 2024	
7	Test Receiver	R&S	ESCI7	100967	Dec. 12, 2024	
8	3m chamber 2	Frankonia	EE025	/	Oct. 23, 2024	
9	Test Software	FARA	EZ-EMC	FA-03A2	/	

	Conducted emission									
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibrated until					
1	LISN	R&S	ENV216	101112	Dec. 12, 2024					
2	LISN	R&S	ENV216	101113	Dec. 12, 2024					
3	EMI Test Receiver	R&S	ESCS30	100353	Dec. 12, 2024					
4	ISN CAT6	Schwarzbeck	NTFM 8158	CAT6-8158-0046	Dec. 12, 2024					
5	ISN CAT5	Schwarzbeck	NTFM 8158	CAT5-8158-0046	Dec. 12, 2024					
6	Test Software	R&S	EMC32	6.10.10	/					

Note: 1. The Cal. Interval was one year.

2. The Cal. Interval was three years of the antenna.

3. The cable loss has been calculated in test result which connection between each test instruments.

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3. TEST ITEM AND RESULTS

3.1. Conducted Emission

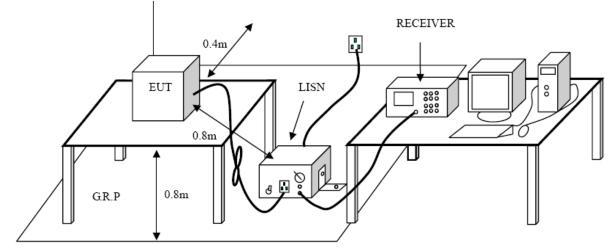
Limit

FCC CFR Title 47 Part 15 Subpart C Section 15.207

	Conducted Limit (dBµV)			
Frequency (MHz)	Quasi-peak Average 66 to 56 * 56 to 46 * 56 46	Average		
0.15 - 0.5	66 to 56 *	56 to 46 *		
0.5 - 5	56	46		
5 - 30	60	50		

* Decreases with the logarithm of the frequency.

Test Configuration



Test Procedure

1. The EUT was setup according to ANSI C63.10:2013 requirements.

The EUT was placed on a platform of nominal size, 1 m by 1.5 m, raised 80 cm above the conducting 2. ground plane. The vertical conducting plane was located 40 cm to the rear of the EUT. All other surfaces of EUT were at least 80 cm from any other grounded conducting surface.

The EUT and simulators are connected to the main power through a line impedance stabilization 3. network (LISN). The LISN provides a 50 ohm / 50 µH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN. (Please refer to the 4. block diagram of the test setup and photographs)

Each current-carrying conductor of the EUT power cord, except the ground (safety) conductor, was 5. individually connected through a LISN to the input power source.

The excess length of the power cord between the EUT and the LISN receptacle were folded back and 6. forth at the center of the lead to form a bundle not exceeding 40 cm in length.

Conducted emissions were investigated over the frequency range from 0.15MHz to 30MHz using a 7. receiver bandwidth of 9 kHz.

During the above scans, the emissions were maximized by cable manipulation. 8.

Test Mode

Please refer to the clause 2.4.

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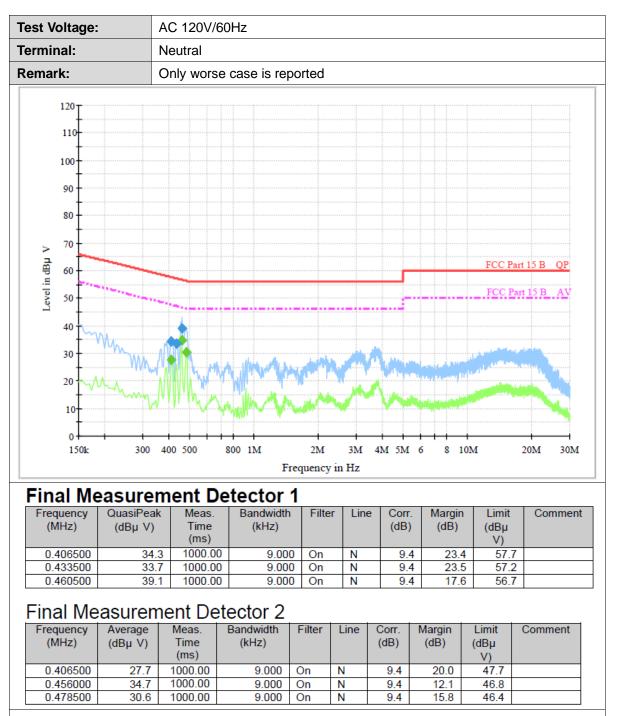


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Emission Level = Read Level + Correct Factor

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3.2. Radiated Emission

<u>Limit</u>

FCC CFR Title 47 Part 15 Subpart C Section 15.209

Frequency	Field Strength	Measurement Distance
(MHz)	(microvolts/meter)	(meters)
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
960~1000	500	3

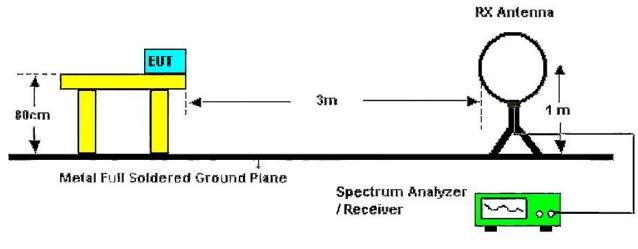
Frequency Range (MHz)	dBµV/m (at 3 meters)			
	Peak	Average		
Above 1000	74	54		

Note:

(1) The tighter limit applies at the band edges.

(2) Emission Level (dB μ V/m)=20log Emission Level (μ V/m).

Test Configuration



Below 30MHz Test Setup

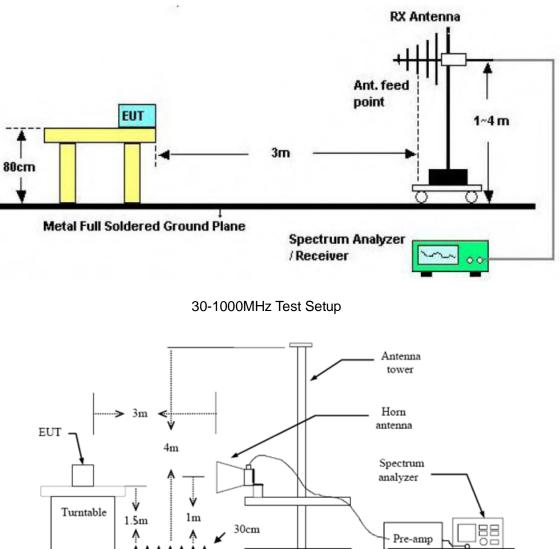
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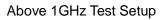
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Test Procedure

1. The EUT was setup and tested according to ANSI C63.10:2013.

2. The EUT is placed on a turn table which is 0.8 meter above ground for below 1 GHz, and 1.5 m for above 1 GHz. The turn table is rotated 360 degrees to determine the position of the maximum emission level.

3. The EUT was set 3 meters from the receiving antenna, which was mounted on the top of a variable height antenna tower.

4. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.

- 5. Set to the maximum power setting and enable the EUT transmit continuously.
- 6. Use the following spectrum analyzer settings
- (1) Span shall wide enough to fully capture the emission being measured;
- (2) 9k 150kHz:

RBW=300 Hz, VBW=1 kHz, Sweep=auto, Detector function=peak, Trace=max hold (3) 0.15M – 30MHz:

RBW=10 kHz, VBW=30 kHz, Sweep=auto, Detector function=peak, Trace=max hold (4) 30M - 1 GHz:

RBW=120 kHz, VBW=300 kHz, Sweep=auto, Detector function=peak, Trace=max hold If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the



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peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

(5) From 1 GHz to 10th harmonic:

RBW=1MHz, VBW=3MHz Peak detector for Peak value.

RBW=1MHz, VBW see note 1 with Peak Detector for Average Value.

Note 1: For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 3 MHz for peak measurements and 1 MHz resolution bandwidth with 1/T video bandwidth with peak detector for average measurements. For the Duty Cycle please refer to clause 3.8 Duty Cycle.

Test Mode

Please refer to the clause 2.4.

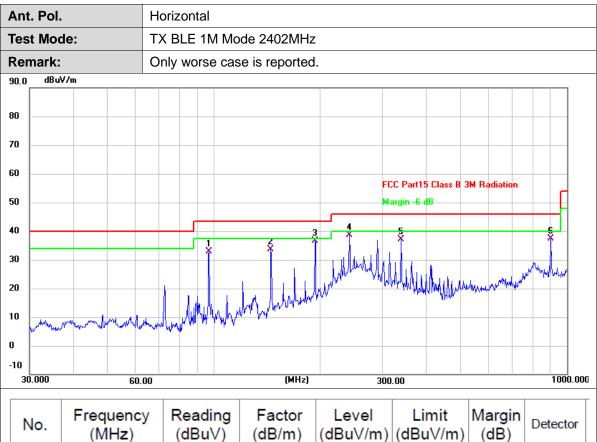
Test Result

9 kHz~30 MHz

From 9 kHz to 30 MHz: The conclusion is PASS.

Note: The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.





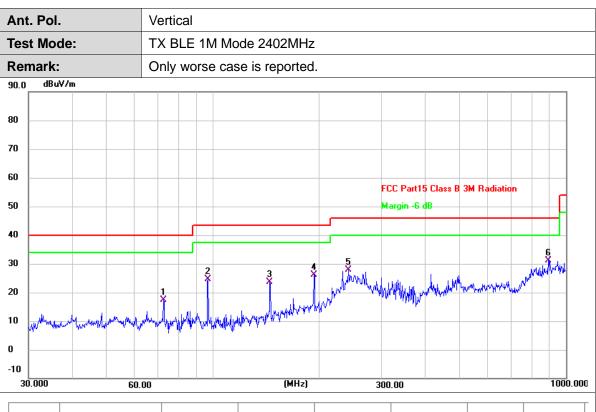
No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	96.7749	55.05	-22.10	32.95	43.50	-10.55	QP
2	144.8418	52.15	-18.53	33.62	43.50	-9.88	QP
3 *	193.0945	57.32	-20.77	36.55	43.50	-6.95	QP
4	241.6763	58.24	-19.73	38.51	46.00	-7.49	QP
5	338.4001	53.77	-16.55	37.22	46.00	-8.78	QP
6	900.1474	42.39	-4.92	37.47	46.00	-8.53	QP
							· · · · · ·

1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor

2.Margin value = Level -Limit value

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No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	72.3376	38.28	-20.81	17.47	40.00	-22.53	QP
2	96.7749	46.81	-22.10	24.71	43.50	-18.79	QP
3	144.8418	42.20	-18.53	23.67	43.50	-19.83	QP
4	193.0945	47.00	-20.77	26.23	43.50	-17.27	QP
5	241.6763	47.64	-19.73	27.91	46.00	-18.09	QP
6 *	890.7278	36.24	-5.01	31.23	46.00	-14.77	QP

1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor

2.Margin value = Level -Limit value

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Ant. Pol.	Horizontal
Test Mode:	TX BLE 1M Mode 2402MHz
Remark:	No report for the emission which more than 20 dB below the prescribed limit.

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)		Margin (dB)	Detector
1	4804.008	49.94	-3.40	46.54	74.00	-27.46	peak
2 *	4804.028	44.78	-3.40	41.38	54.00	-12.62	AVG

1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor

2.Margin value = Level -Limit value

Ant. Pol.	Vertical
Test Mode:	TX BLE 1M Mode 2402MHz
Remark:	No report for the emission which more than 20 dB below the prescribed limit.

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)		Margin (dB)	Detector
1	4804.002	51.12	-3.40	47.72	74.00	-26.28	peak
2 *	4804.066	46.51	-3.40	43.11	54.00	-10.89	AVG

Remarks:

1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor

2.Margin value = Level -Limit value

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Ant. Pol.		Horizontal	Horizontal					
Test Mode: TX BLE 1M Mode 2440MHz								
Remark:		No report for limit.	the emission	which more t	han 20 dB be	elow the p	rescribed	
No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	
1	4880.008	48.31	-3.26	45.05	74.00	-28.95	peak	
2 *	4880.036	40.07	-3.26	36.81	54.00	-17.19	AVG	
				•			· · · · ·	

1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor

2.Margin value = Level -Limit value

nt. Pol.		Vertical							
est Mod	de:	TX BLE 1M M	lode 2440M	Ηz					
emark:		No report for the emission which more than 20 dB below the prescribed limit.							
No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector		
1 *	4880.008	46.45	-3.26	43.19	54.00	-10.81	AVG		
2	4880.098	52.44	-3.26	49.18	74.00	-24.82	peak		

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Ant. Pol.		Horizontal					
Test Mod	de:	TX BLE 1M M	lode 2480MI	Hz			
Remark:		No report for limit.	the emission	which more t	han 20 dB be	elow the p	rescribed
No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1 *	4960.022	42.21	-3.10	39.11	54.00	-14.89	AVG
2	4960.138	48.94	-3.10	45.84	74.00	-28.16	peak
h	·			·	-	*	<u> </u>

1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor

2.Margin value = Level -Limit value

nt. Pol	-	Vertical								
est Mo	de:	TX BLE 1M M	/lode 2480MI	Hz						
emark:		No report for the emission which more than 20 dB below the prescribed limit.								
No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector			
1	4960.002	49.88	-3.10	46.78	74.00	-27.22	peak			
2 *	4960.054	43.35	-3.10	40.25	54.00	-13.75	AVG			



Ant. Po	l.	Horizontal						
Test Mo	est Mode: TX BLE 2M Mode 2402MHz emark: No report for the emission which more than 20 dB below the prescribed limit.							
Remarl	st Mode: TX BLE 2M Mode 2402MHz Imark: No report for the emission which more than 20 dB below the prescribed limit. Erequency Reading Eactor Level Limit Margin							
No.						-	Detector	
1 *	4804.050	44.37	-3.40	40.97	54.00	-13.03	AVG	
2	4804.062	50.03	-3.40	46.63	74.00	-27.37	peak	

1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor 2.Margin value = Level -Limit value

Ant. Pol.	Vertical
Test Mode:	TX BLE 2M Mode 2402MHz
Remark:	No report for the emission which more than 20 dB below the prescribed limit.

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)		Margin (dB)	Detector
1	4803.980	51.61	-3.40	48.21	74.00	-25.79	peak
2 *	4804.074	46.73	-3.40	43.33	54.00	-10.67	AVG

Remarks:

1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor

2.Margin value = Level -Limit value

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Ant. Pol.		Horizontal					
Test Mod	de:	TX BLE 2M N	lode 2440MI	Hz			
Remark:		No report for limit.	the emission	which more t	han 20 dB be	elow the p	rescribed
No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1 *	4880.068	40.32	-3.26	37.06	54.00	-16.94	AVG
2	4880.168	48.17	-3.26	44.91	74.00	-29.09	peak
-							<u> </u>
1							

1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor

2.Margin value = Level -Limit value

nt. Pol		Vertical								
est Mo	de:	TX BLE 2M M	/lode 2440MH	Ηz						
emark		No report for the emission which more than 20 dB below the prescribed limit.								
No.	Frequency (MHz)	Reading (dBu∀)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector			
1	4880.030	51.57	-3.26	48.31	74.00	-25.69	peak			
2 *	4880.044	46.64	-3.26	43.38	54.00	-10.62	AVG			

2.Margin value = Level -Limit value

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Ant. Pol.		Horizontal					
Test Mod	de:	TX BLE 2M M	lode 2480M	Hz			
Remark:		No report for limit.	the emissior	which more t	than 20 dB be	elow the p	rescribed
No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1 *	4960.050	42.44	-3.10	39.34	54.00	-14.66	AVG
2	4960.258	49.47	-3.10	46.37	74.00	-27.63	peak
							<u>_</u>
1							

1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor

2.Margin value = Level -Limit value

nt. Pol.		Vertical								
est Mod	le:	TX BLE 2M M	/lode 2480MI	Hz						
emark:		No report for the emission which more than 20 dB below the prescribed limit.								
No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector			
1	4959.964	49.66	-3.10	46.56	74.00	-27.44	peak			
2 *	4960.034	43.06	-3.10	39.96	54.00	-14.04	AVG			

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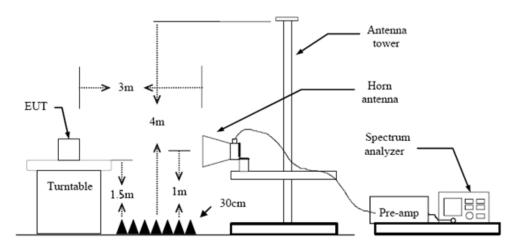
3.3. Band Edge Emissions (Radiated)

Limit

FCC CFR Title 47 Part 15 Subpart C Section 15.247 (d)

Restricted Frequency Band	(dBµV/m) (at 3m)				
(MHz)	Peak	Average			
2310 ~ 2390	74	54			
2483.5 ~ 2500	74	54			

Test Configuration



Test Procedure

1. The EUT was setup and tested according to ANSI C63.10:2013 requirements.

The EUT is placed on a turn table which is 1.5 meter above ground. The turn table is rotated 360 2. degrees to determine the position of the maximum emission level.

The EUT was positioned such that the distance from antenna to the EUT was 3 meters. 3.

4. The antenna is scanned from 1 meter to 4 meters to find out the maximum emission level. This is repeated for both horizontal and vertical polarization of the antenna. In order to find the maximum emission, all of the interface cables were manipulated according to ANSI C63.10:2013 on radiated measurement. The receiver set as follow: 5

RBW=1MHz, VBW=3MHz Peak detector for Peak value.

RBW=1MHz, VBW see note 1 with Peak Detector for Average Value.

Note 1: For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 3 MHz for peak measurements and 1 MHz resolution bandwidth with 1/T video bandwidth with peak detector for average measurements. For the Duty Cycle please refer to clause 3.8 Duty Cycle.

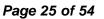
Test Mode

Please refer to the clause 2.4.

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0.0 230	05.000	2315.00	2325.	00 23	35.00 2	345.00 (M	Hz)	236	5.00	2375.00	2385	.00 23	395.00		2405
			uency		eading	Facto			vel		nit Ⅳ/m)	Marg		Dete	ecto
N	0.	(M	Hz)	(0	lBuV)	(dB/m)	(ави	V/m)	(ари	w/m)	(dB	/		
N 1			Hz) 0.000		18uV) 17.99	(dB/m 31.08			.07		.00	-24.9		pe	ak

1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor 2.Margin value = Level -Limit value

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est Mode			TX BLE	1M N	/lode 24	402MI	Ηz						
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2305.000	2315.00	2325.00	2335.00	23	\$45.00	(MHz)	236	5.00	2375.00	2385	.00 239	5.00	2405
No.	Freque (MHz		Readi (dBu		Fac (dB/			vel V/m)	Lin (dBu\		Margir (dB)	n _{De}	etecto
1	2390.0	000	18.0	9	31.	08	49	.17	74.	00	-24.83	3 p	eak
2 *	2390.0	000	7.36	6	31.	08	38	.44	54.	00	-15.56	3 A	٨VG

1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor 2.Margin value = Level -Limit value

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40	/ \	2		Anna			ana	
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10.0 24	77.000	2487.00 2497.0	0 2507.00 2	517.00 (MHz)	2537.00	2547.00 2557.	00 2567.0	0 2577.00
N	lo.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
	1	2483.500	19.87	31.43	51.30	74.00	-22.70	peak
	2 *	2483.500	8.21	31.43	39.64	54.00	-14.36	AVG

1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor 2.Margin value = Level -Limit value

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Ant.	Pol.			Ver	ical						
est	Mod	e:		TX	BLE 1M N	Node 2480	MHz				
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24	77.000	2487.00	2497.	<u>UU 2</u>	i07.00 2	517.00 (M	12] 2	537.00	2547.00 2557	.00 2567.	00 2577.1
N	o.		uency IHz)		eading dBuV)	Facto (dB/m		evel uV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	1	248	3.500		18.29	31.43	4	9.72	74.00	-24.28	peak
2	*	248	3.500		8.22	31.43	3	9.65	54.00	-14.35	AVG
Rem	narks:										

i (C II) ιų. 2.Margin value = Level -Limit value

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nt. Po	I.		Horizonta	I									
est Mo	ode:		TX BLE 2	M Mc	de 2402	2MF	Ηz						
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						-							
No.		uency Hz)	Readir (dBuV		Facto (dB/m			vel V/m)	Lin (dBu		Margir (dB)	Deteo	ctor
1	2390	0.000	17.73	•	31.08	}	48	.81	74.	00	-25.19	pea	ak
2 *	2390	0.000	7.38		31.08	}	38	.46	54.	00	-15.54	AV	G
1	2390	0.000	17.73	-	31.08		48	.81	(d	74.	IBuV/m) 74.00 54.00	74.00 -25.19	IBuV/m) (dB) 74.00 -25.19 pea

1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor 2.Margin value = Level -Limit value

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nt. Pol		Vertical					
est Mo	de:	TX BLE 2M	Mode 2402M	Ηz			
10.0 dBu	₩/m						
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					FCC Part 15C 3M /	Above-16 Pea	. A
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2306.000	2316.00 2326.	00 2336.00 2	346.00 (MHz)	2366.00	2376.00 2386.	00 2396.0	00 2406.0
No.	Frequency (MHz)	/ Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2390.000	18.93	31.08	50.01	74.00	-23.99	peak
1	2390.000	7.37	31.08	38.45	54.00	-15.55	AVG

1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor 2.Margin value = Level -Limit value

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nt. Pol.		1	Horizontal					
est Mod	de:	•	TX BLE 2M	Mode 2480M	Ηz			
10.0 dBu ^v	V/m							
00								
י ⊢						FCC Part 15C 3M /	Above-1G Pea	k
ידר								
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2476.000	2486.00	2496.00	2506.00	2516.00 (MHz)	2536.00	2546.00 2556.	.00 2566.0	0 2576.0
No.	Freque (MH		Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	2483.	500	19.21	31.43	50.64	74.00	-23.36	peak
	2483.		8.50	31.43	39.93	54.00	-14.07	AVG

1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor 2.Margin value = Level -Limit value

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nt.	Pol.			Vertical					
est	Mod	e:	-	TX BLE 2M I	Node 2480MI	Ηz			
10.0	dBu¥	/m							
)	\mathbb{A}						FCC Part 15C 3M /	Above-16 Pea	k
)	H								
)	\square						FCC Part 15C 3M /	Above-1G AV	
1	X	:							
•	X	L							
• -									
).0 247	77.000	2487.00	2497.00	2507.00 2	517.00 (MHz)	2537.00	2547.00 2557.	00 2567.0	00 2577.0
N	lo.		uency Hz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
	1	2483	3.500	19.14	31.43	50.57	74.00	-23.43	peak
2	2 *	2483	8.500	8.68	31.43	40.11	54.00	-13.89	AVG

1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor

2.Margin value = Level -Limit value

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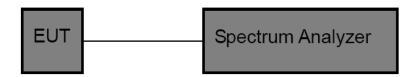
3.4. Band Edge and Spurious Emissions (Conducted)

<u>Limit</u>

FCC CFR Title 47 Part 15 Subpart C Section 15.247 (d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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.

Test Configuration



Test Procedure

- 1. The transmitter output was connected to the spectrum analyzer through an attenuator, the path loss was compensated to the results for each measurement.
- 2. Set to the maximum power setting and enable the EUT transmit continuously.
- Use the following spectrum analyzer settings: RBW = 100 kHz, VBW ≥ RBW, scan up through 10th harmonic. Sweep = auto, Detector function = peak, Trace = max hold.
- 4. Measure and record the results in the test report.

Test Mode

Please refer to the clause 2.4.

Test Result

Band Edge Conducted Test & Conducted Spurious Emissions Test

Mode	Channel	Frequency (MHz)	Level (dBm)	Limit (dBm)	Over Limit (dB)	Result
		2400.00	-60.363	-26.7	-33.663	PASS
	0	2381.16	-59.428	-26.7	-32.728	PASS
LE		24854.5	-52.487	-26.7	-25.787	PASS
LC	19	23536.1	-51.828	-25.16	-26.668	PASS
	39	2483.50	-62.148	-24.24	-37.908	PASS
		7440.03	-52.352	-24.24	-28.112	PASS
	0	2400.00	-40.777	-26.98	-13.797	PASS
	0	24831.5	-52.786	-26.98	-25.806	PASS
2LE	19	24830.8	-52.434	-25.22	-27.214	PASS
	20	2483.50	-59.736	-24.41	-35.326	PASS
	39	5237.62	-51.076	-24.41	-26.666	PASS

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Band Edge Conducted & Conducted Spurious Emissions Test plot as follows:

Band Edge Conducted & C			
	Addient Spectrum Analyzer - Swept SA SENSE:071 A U_R_R_TRFSO_QAC	AL2014.07.0 L 06-92.570.000 12: 2024 Avay Type: L 0.59.270.000 12: 2024 Avay Type: L 0.59.270.000 12: 2024 Avay Type: L L Avay Type: L L Avay Type: L L Avay Type: L L	
	IFGain:Low #Atten: 26 dB		
	Ref Offset 0.5 dB 10 dB/dlv Ref 15.00 dBm Log	Mkr3 2.402 243 0 GHz -6.702 dBm	
	500		
	.500	<u>3</u>	
	.15.0		
	-30		
	35.0		
	-45.0		
	-66.0		
	.75.0		
	Center 2.4020000 GHz #Res BW 100 kHz #VBW 300 kHz	Span 1.500 MHz Sweep 1.000 ms (1001 pts)	
	In-Band Reference	status	
	LE_Channel		
	Agtent Spectrum Analyzer Swept SA Of 6 T 87 87 500 AC Center Freq 2.3525000000 GHz PR0.Fast IFGold.cov Atten: 26 dB	Aug Type: Log-Pwr TRACE Display Log-Pwr Avg Type: Log-Pwr TRACE Display Display Display	
	10 dB/div Ref 05.0 dB	Mkr1 2.381 160 GHz -59.428 dBm	
	5.00		
	-15.0	and as a large state of the second state of th	
	-35.0		
	-55 0		
	-75.0		
	Start 2.30000 GHz #Res BW 100 kHz #VBW 300 kHz	Stop 2.40500 GHz Sweep 10.07 ms (1001 pts)	
	MKR, MDDE_TRC; SCL X Y FUNCTION FUN 1 N 1 f 2.381.160 GHz -69.428 dBm -69.353 dBm -60.353 dBm 2 N 1 f 2.400 000 GHz -60.353 dBm -60.353 dBm -60.353 dBm		
	2 N 1 f 2.400 000 GHz -60.363 dBm 3		
	5		
	8 9 10		
	11 < ₩50	STATUS	
	Out Of Band Emi		
	LE_Channel Agitent Spectrum Analyzer - Swept SA		
	Center Freq 12.515000000 GHz PN0: Fast →→ IFGsint.ow Fash.cow	Augusture 5000 Biologia 2001 Avgihele: 10/10 technologia 2001 Biologia 2	
	Ref Offset 0.5 dB	Mkr1 24.854 5 GHz	
	10 dB/div Ref 15.00 dBm Log 5.00		
	-500		
	-50		
	-45.0		
		Stan 25 98 Olla	
	Start 30 MHz #Res BW 100 kHz #VBW 300 kHz	Stop 25.00 GHz Sweep 2.387 s (40000 pts)	
	MKR MKR Y FUNCTION FUN 1 N 1 7 24.854.5 GHz -52.497 dBm FUNCTION FUN 2 2 -52.497 dBm FUNCTION FUN		
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	LE_Channel	0	

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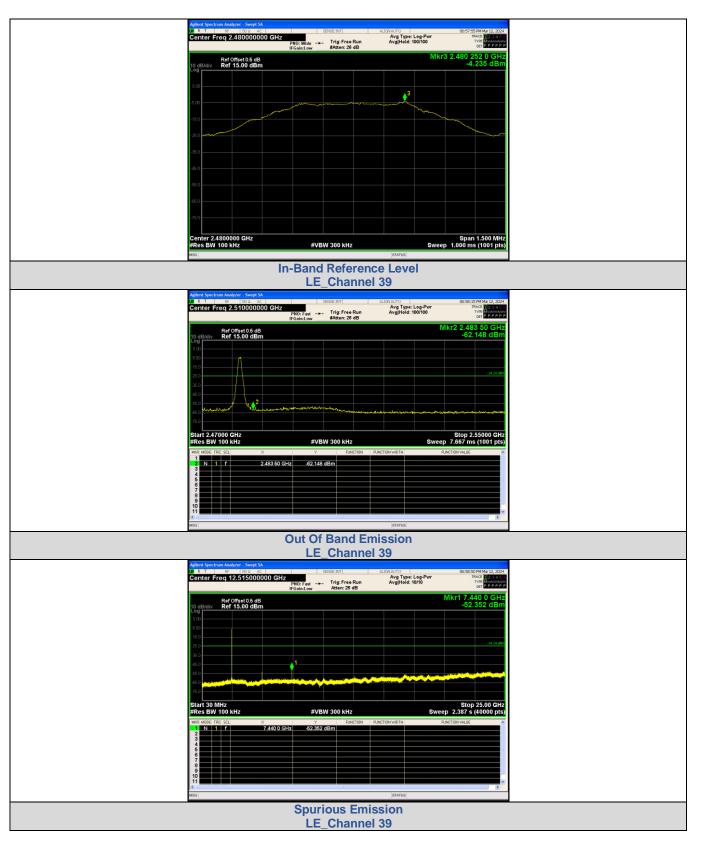
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	ant Spectrum Analyzer - Swoot SA			
Qui R	nt Spectrum Analyzer - Swept SA T RF 50 Q AC nter Freq 2.440000000 GHz	SENSE:INT	ALIGN AUTO	06:54:01 PM Mar 12, 2024 TRACE 12 3 4 5 6
Cer	nter Fred 2.440000000 GHz	PNO: Wide Trig: Free Run IFGain:Low #Atten: 26 dB	Avg Type: Log-Pwr Avg Hold: 100/100	TYPE MUMANUM DET PPPPP
		in Contector	Mk	r3 2.440 244 5 GHz -5.158 dBm
10 d Log	Ref Offset 0.5 dB IB/div Ref 15.00 dBm			-5.158 dBm
5.00				
			∮ ³	
-5.00				
-15.0				~~~~
26.0				- m
				~~~~
-36.0				
-45.0				
56 C				
-66.0				
-75.0	)			
Cer #Re	nter 2.4400000 GHz es BW 100 kHz	#VBW 300 kHz	Swee	Span 1.500 MHz ep 1.000 ms (1001 pts)
MSG			STATUS	
	In	-Band Reference	e Level	
		LE_Channel		
Agite	nt Spectrum Analyzer - Swept SA R T RF 50 Q AC		-	
Cer		SENSE:INT	ALIGN AUTO Avg Type: Log-Pwr Avg Hold: 10/10	06:54:38 PM Mar 12, 2024 TRACE 2 3 4 5 6 TYPE M
		PNO: Fast Trig: Free Run IFGain:Low Atten: 26 dB		
10 0	Ref Offset 0.5 dB dB/div Ref 15.00 dBm		I	Mkr1 23.536 1 GHz -51.828 dBm
Lõg				
-500				
-15.0	0			-25.16 obn
-25 0	1			425110 001
-45.0	, ,			1
-65.0			and the second	a la construction de la construction
-65 0		1 <b>1 1 1 1 1 1 1 1 1 1 1 1 1 1</b>		
Sta	1 30 MHz			Stop 25 00 CHz
#Re	urt 30 MHz es BW 100 kHz	#VBW 300 kHz	Swe	Stop 25.00 GHz ep 2.387 s (40000 pts)
MXR	MODE TRC SCL X N 1 f 23.536 1 GH	Y FUNCTION FUN z -51.828 dBm	CTION WIDTH	FUNCTION VALUE
2 3				
4				
7				
9 10				
11		1		>
MSG		0	STATUS	
		Spurious Emiss	lions	
		LE_Channel	19	
		-	-	

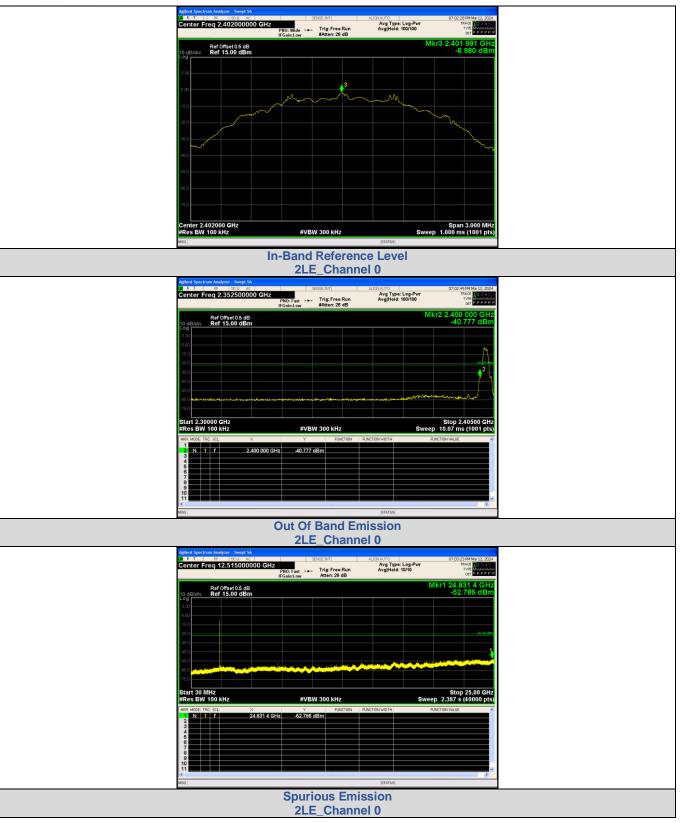




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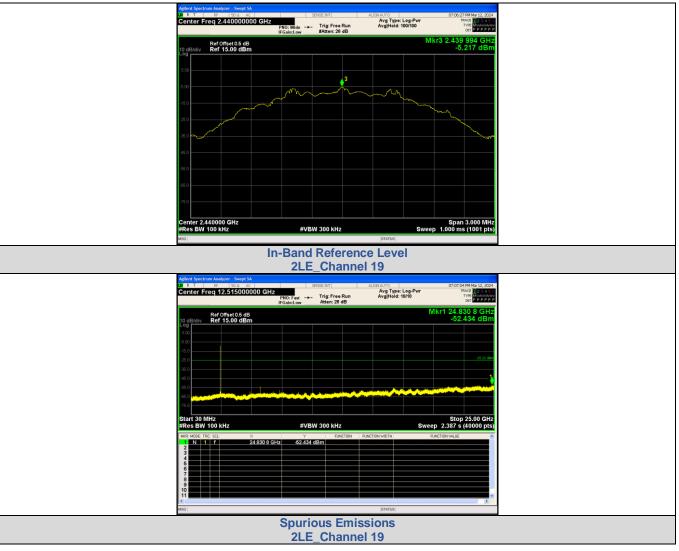
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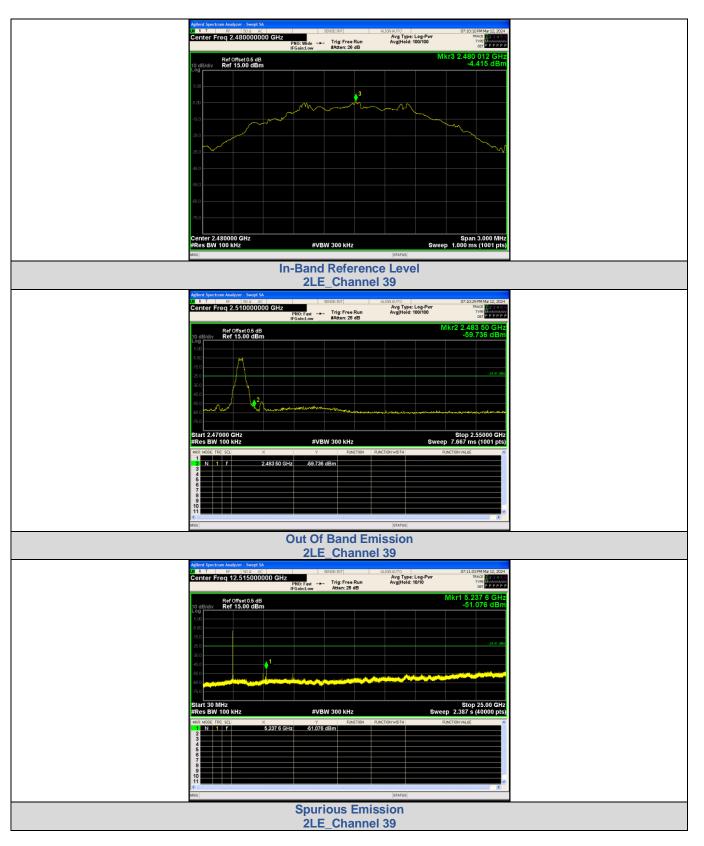
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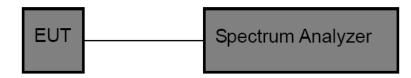
# 3.5. DTS Bandwidth

Limit

# FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(2)

Test Item	Limit	Frequency Range (MHz)
DTS Bandwidth	≥500 kHz (6dB bandwidth)	2400~2483.5

# **Test Configuration**



# **Test Procedure**

- 1. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.
- 2. DTS Spectrum Setting:
  - (1) Set RBW = 100 kHz.
  - (2) Set the video bandwidth (VBW)  $\ge$  3 RBW.
  - (3) Detector = Peak.
  - (4) Trace mode = Max hold.
  - (5) Sweep = Auto couple.
  - **OCB Spectrum Setting:**
  - (1) Set RBW =  $1\% \sim 5\%$  occupied bandwidth.
  - (2) Set the video bandwidth (VBW)  $\ge$  3 RBW.
  - (3) Detector = Peak.
  - (4) Trace mode = Max hold.
  - (5) Sweep = Auto couple.

NOTE: The EUT was set to continuously transmitting in each mode and low, Middle and high channel for the test.

### Test Mode

Please refer to the clause 2.4.

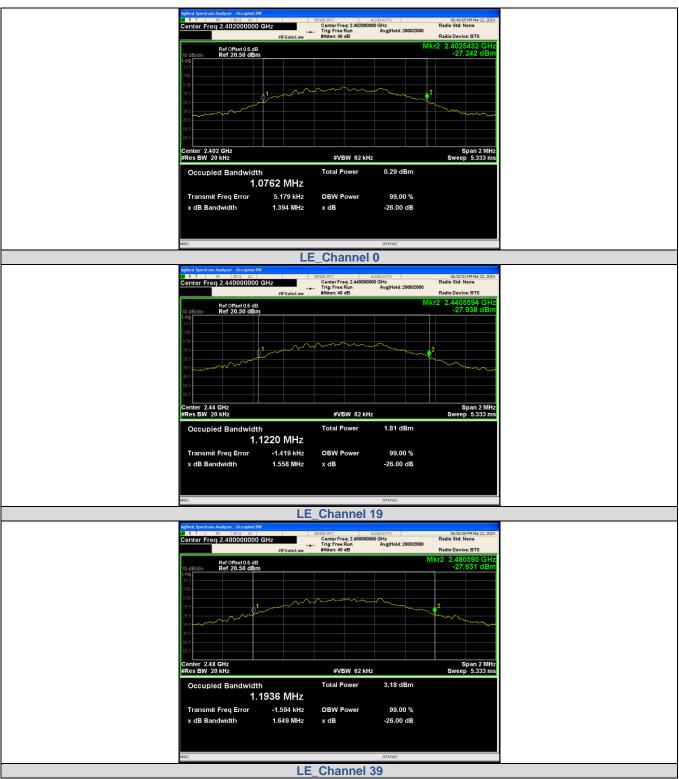
### **Test Result**

Mode	Channel	99% BW (MHz)	6 dB BW (MHz)	Limit (MHz)	Result
LE	0	1.0762	0.6969	0.5	PASS
LE	19	1.1220	0.7219		PASS
LE	39	1.1936	0.7601		PASS
2LE	0	2.0644	1.162		PASS
2LE	19	2.0787	1.152		PASS
2LE	39	2.1039	1.169		PASS

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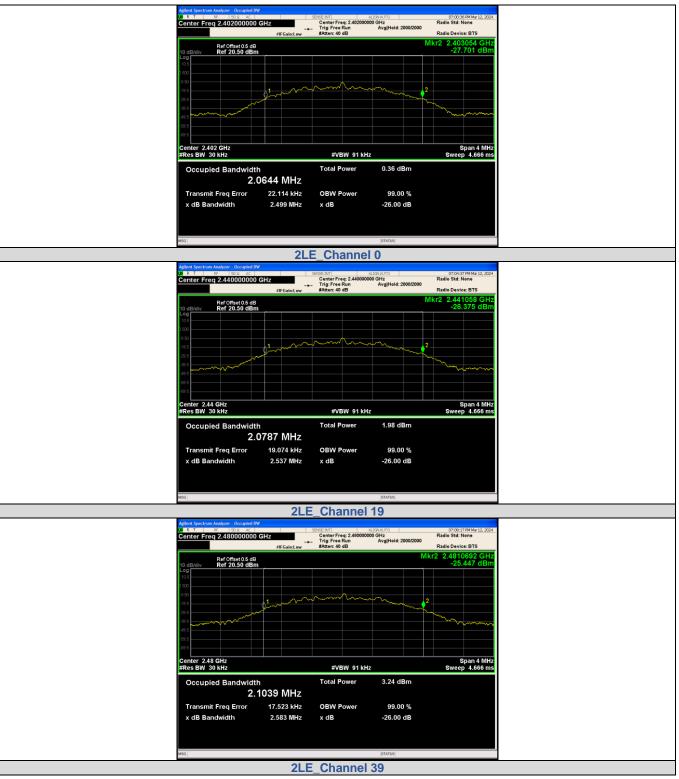




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#### DTS Bandwidth:

Agilent Spectrum Analyzer - Occupied BW	
10 R T RF 50 g AC SENSE:INT ALIGN AUTO 06:49:44 PM Mar 12, 2024	
Center Freq 2.402000000 GHz Center Freq: 2.402000000 GHz Radio Std: None #IFGaintow 40 B Radio Device: BTS	
Ref Offset0 5 dB Ref 1.5 0 dBm	
450	
14.5	
46	
515	
845	
Center 2.402 GHz Span 2 MHz #Res BW 100 kHz #VBW 300 kHz Sweep 1.333 ms	
Occupied Bandwidth Total Power 0.08 dBm 1.0659 MHz	
Transmit Freq Error 3.769 kHz OBW Power 99.00 %	
x dB Bandwidth 696.9 kHz x dB -6.00 dB	
MG STATUS	
LE_Channel 0	
Agilent Spectrum Analyzer - Occupied BW	
Center Freq: 2.44000000 GHz Center Freq: 2.440000000 GHz Radio Std: None	
CONTOT TO ANY DECOMPOSITION TO ANY TIME TO ANY	
Ref Offset 05 dB 10 dB/div Ref 15.50 dBm Log	
4.50	
345	
Center 2.44 GHz Span 2 MHz	
#Res BW 100 kHz #VBW 300 kHz Sweep 1.33 ms	
Occupied Bandwidth Total Power 1.65 dBm	
1.0981 MHz	
Transmit Freq Error 2.264 kHz OBW Power 99.00 %	
x dB Bandwidth 721.9 kHz x dB -6.00 dB	
MSG STATUS	
LE_Channel 19	
Agilent Spectrum Analyzer         Occupied BW           IR         T         RF         SD 0         AC         SERVEE.INT         ALIGNAUTO         0655647 PM Mr 12, 2024	
Center Freq 2.480000000 GHz Center Freq 2.48000000 GHz Radio Std: None Trid: Freq 2.480000000 GHz Radio Std: None	
#IFGaincl.ow #Atten: 40 dB Radio Device: BTS	
Ref Offset 0.5 dB 10 dB/div Ref 15.50 dBm	
to db/div Ref 15.50 dBm	
315	
Center 2.48 GHz Span 2 MHz #Res BW 100 kHz #VBW 300 kHz Sweep 1.333 ms	
Occupied Bandwidth Total Power 2.96 dBm	
1.1810 MHz	
Transmit Freq Error 1.820 kHz OBW Power 99.00 %	
x dB Bandwidth 760.1 kHz x dB -6.00 dB	
autara and an and a second and as	
LE_Channel 39	

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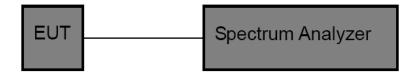
# 3.6. Peak Output Power

Limit

# FCC CFR Title 47 Part 15 Subpart C Section 15.247 (b)(3)

Section	Test Item	Limit	Frequency Range (MHz)
FCC CFR 47 Part15.247 (b)(3)	Maximum Conducted Output Power	1 Watt or 30dBm	2400~2483.5

# Test Configuration



# **Test Procedure**

1. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.

- Spectrum Setting: 2.
  - (1) Set RBW  $\geq$  DTS Bandwidth.
  - (2) Set VBW  $\geq$  3*RBW.
  - (3) Set Span  $\geq$  3*RBW.
  - (4) Sweep time = Auto couple.
  - (5) Detector = Peak.
  - (6) Trace mode = Max hold.

Allow trace to fully stabilize. Then use the peak marker function to determine the maximum amplitude level.

### **Test Mode**

Please refer to the clause 2.4.

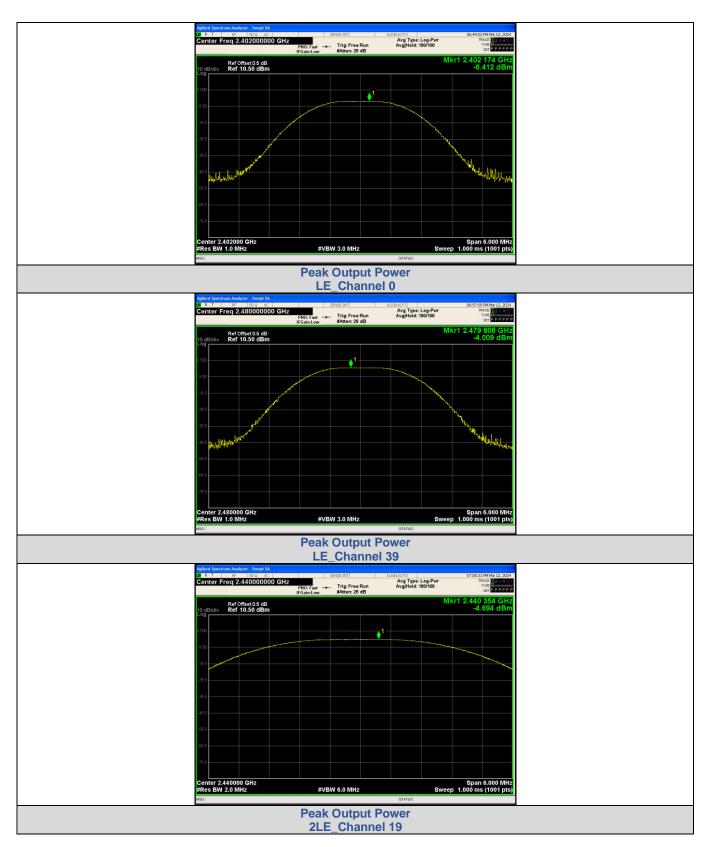
### Test Result

Test Mode	Frequency (MHz)	Conducted Output Power (dBm)	FCC Limit (dBm)	Verdict
	2402	-6.412	≤30	Pass
BLE_1M	2440	-4.868	≤30	Pass
	2480	-4.009	≤30	Pass
BLE_2M	2402	-6.303	≤30	Pass
	2440	-4.694	≤30	Pass
	2480	-3.844	≤30	Pass

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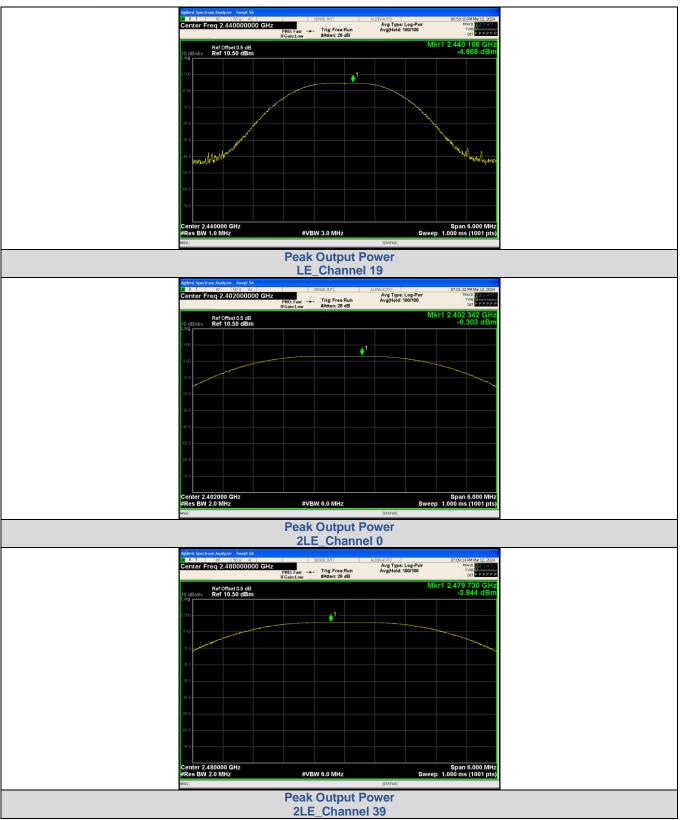




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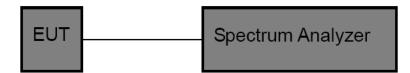
#### **Power Spectral Density** 3.7.

Limit

# FCC CFR Title 47 Part 15 Subpart C Section 15.247 (e)

Test Item	Limit	Frequency Range (MHz)	
Power Spectral Density	8 dBm (in any 3 kHz)	2400~2483.5	

# **Test Configuration**



### **Test Procedure**

1. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.

2. The EUT was directly connected to the Spectrum Analyzer and antenna output port as show in the block diagram above. The measurement according to section 10.2 of KDB 558074 D01 DTS Meas Guidance v05r02.

3. Spectrum Setting:

Set analyzer center frequency to DTS channel center frequency.

Set the span to 1.5 times the DTS bandwidth.

Set the RBW to: 3 kHz.

Set the VBW to: 10 kHz.

Detector: peak.

Sweep time: auto.

Allow trace to fully stabilize. Then use the peak marker function to determine the maximum amplitude level.

### **Test Mode**

Please refer to the clause 2.4.

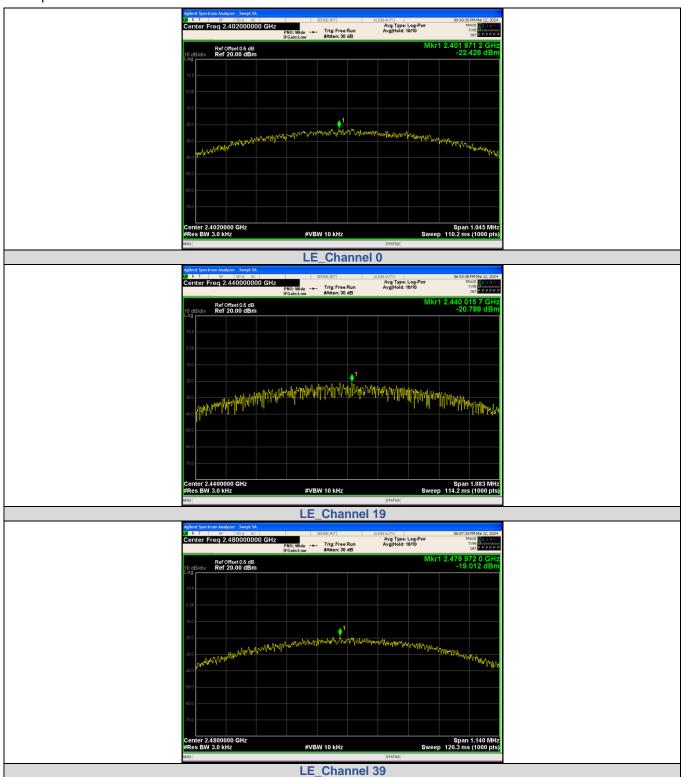
### **Test Result**

Mode	Channel	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Result
LE	0	-22.426	8	PASS
LE	19	-20.788	8	PASS
LE	39	-19.012	8	PASS
2LE	0	-25.630	8	PASS
2LE	19	-23.486	8	PASS
2LE	39	-22.217	8	PASS

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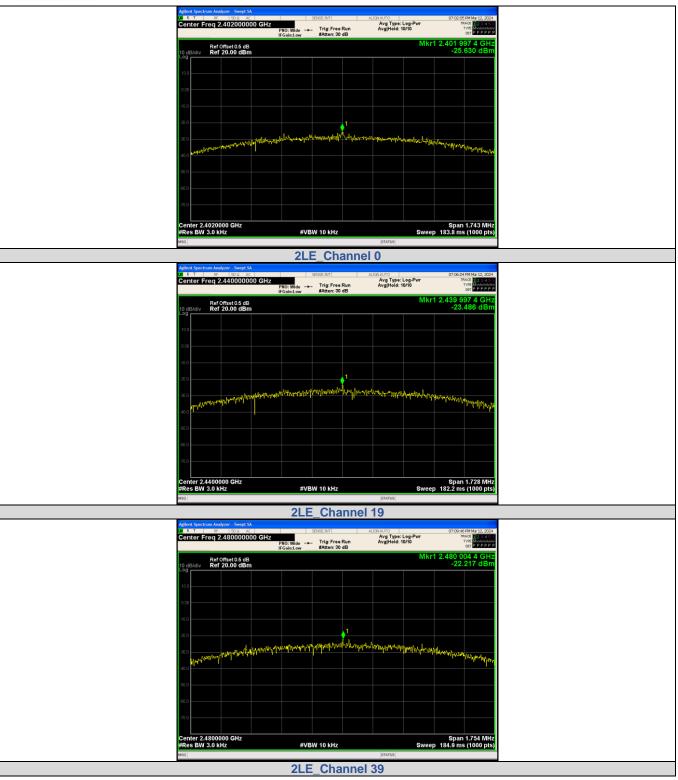
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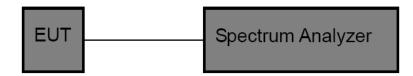


# 3.8. Duty Cycle

# <u>Limit</u>

None, for report purposes only.

# Test Configuration



# Test Procedure

- 1. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.
- 2. The EUT was directly connected to the Spectrum Analyzer and antenna output port as show in the block diagram above. The measurement according to section 10.2 of KDB 558074 D01 DTS Meas Guidance v05r02.

Spectrum Setting:
 Set analyzer center frequency to test channel center frequency.
 Set the span to 0Hz.
 Set the RBW to 10MHz.
 Set the VBW to 10MHz.
 Detector: Peak.
 Sweep time: Auto.

Allow trace to fully stabilize. Then use the peak marker function to determine the maximum amplitude level.

### Test Mode

Please refer to the clause 2.4.

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### Test Result

Test Mode	Frequency (MHz)	Transmission Duration (ms)	Transmission Period (ms)	Duty Cycle (%)	1/T Minimum VBW (kHz)	Final Setting for VBW (kHz)
	2402	2.129	2.479	85.91	0.47	1
BLE_1M	2440	2.129	2.490	85.52	0.47	1
	2480	2.129	2.479	85.91	0.47	1
	2402	1.082	2.490	43.44	0.92	1
BLE_2M	2440	1.082	2.490	43.44	0.92	1
	2480	1.082	2.490	43.44	0.92	1

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# 3.9. Antenna Requirement

# **Requirement**

### FCC CFR Title 47 Part 15 Subpart C Section 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 antenna that uses a unique coupling to the intentional radiator, 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.

#### FCC CFR Title 47 Part 15 Subpart C Section 15.247(c) (1)(i)

(i) Systems operating in the 2400~2483.5 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.

### Test Result

The directional gain of the antenna is less than 6dBi, please refer to the EUT internal photographs antenna photo.

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