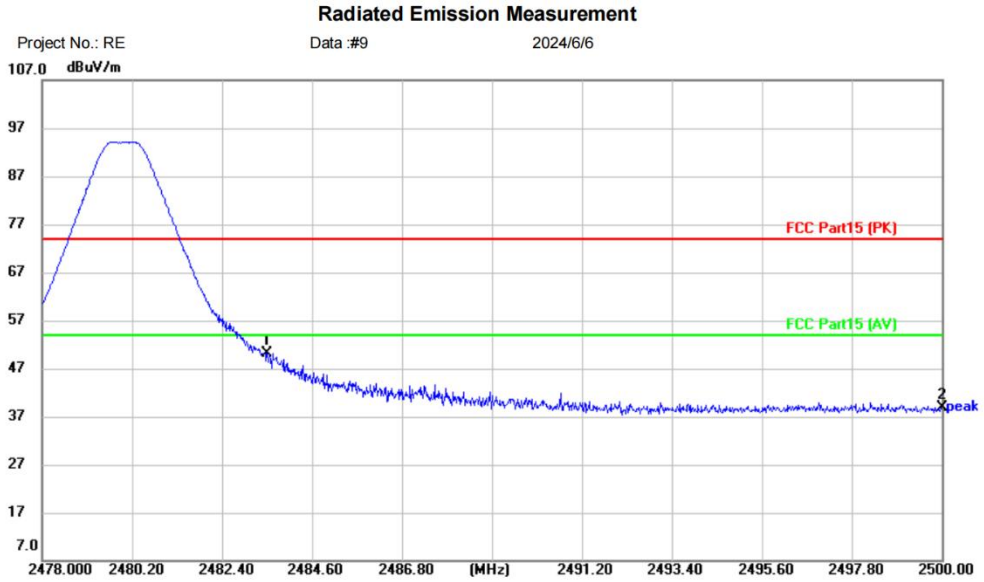
[Test mode: TX High channel]; [Polarity: Horizontal]



Site
Limit: FCC Part15 (PK)
EUT: Bluetooth low energy module
M/N: MS88SF3
Mode: BLE1M TX 2480
Note:

Polarization: ***Horizontal***
Power:

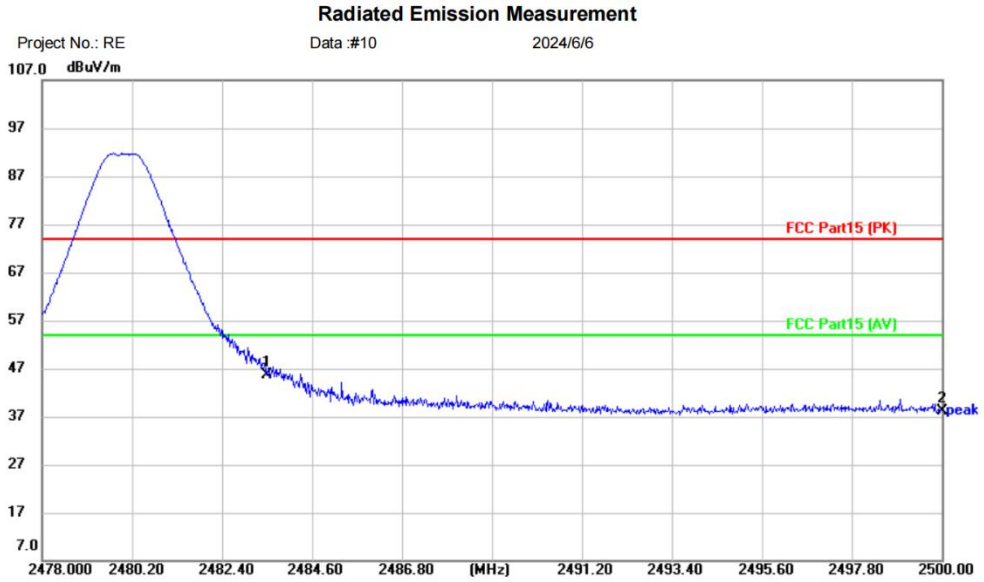
Temperature: (C)
Humidity: %RH

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1	*	2483.500	53.12	-2.91	50.21	74.00	-23.79	peak	
2		2500.000	41.94	-3.00	38.94	74.00	-35.06	peak	

*:Maximum data x:Over limit !:over margin 〈Reference Only
Receiver: ESR_1 Spectrum Analyzer: FSP40

Test Result: Pass

[Test mode:TX High channel]; [Polarity: Vertical]



Site
Limit: FCC Part15 (PK)
EUT: Bluetooth low energy module
M/N: MS88SF3
Mode: BLE1M TX 2480
Note:

Polarization: *Vertical*
Power:

Temperature: (C)
Humidity: %RH

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	Comment
1	*	2483.500	48.47	-2.91	45.56	74.00	-28.44	peak	
2		2500.000	41.16	-3.00	38.16	74.00	-35.84	peak	

*:Maximum data x:Over limit !:over margin 〈Reference Only
Receiver: ESR_1 Spectrum Analyzer: FSP40

Test Result: Pass

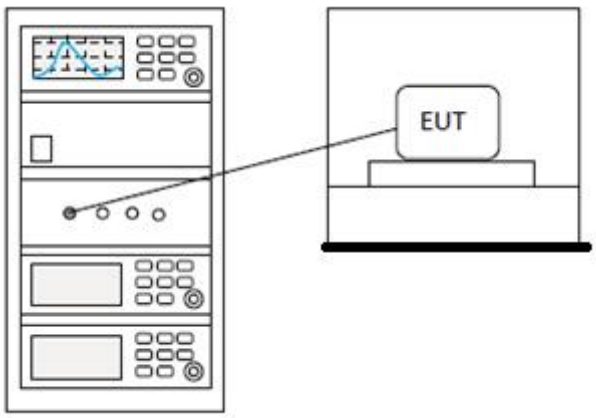
16 CONDUCTED SPURIOUS EMISSIONS

Test Standard	47 CFR Part 15, Subpart C 15.247
Test Method	ANSI C63.10 (2013) Section 7.8.6 & Section 11.11
Test Mode (Pre-Scan)	TX
Test Mode (Final Test)	TX
Tester	Jozu
Temperature	25℃
Humidity	56%

16.1 LIMITS

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

16.2 BLOCK DIAGRAM OF TEST SETUP



16.3 TEST DATA

Pass: Please Refer To Appendix: Appendix1 For Details

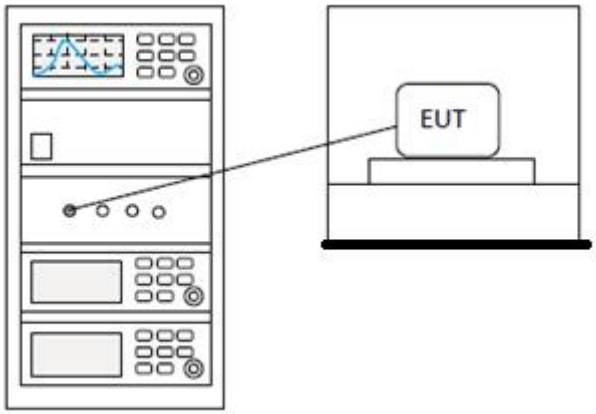
17 POWER SPECTRUM DENSITY

Test Standard	47 CFR Part 15, Subpart C 15.247
Test Method	ANSI C63.10 (2013) Section 11.10.2
Test Mode (Pre-Scan)	TX
Test Mode (Final Test)	TX
Tester	Jozu
Temperature	25℃
Humidity	60%

17.1 LIMITS

Limit:	≤8dBm in any 3 kHz band during any time interval of continuous transmission

17.2 BLOCK DIAGRAM OF TEST SETUP



17.3 TEST DATA

Pass: Please Refer To Appendix: Appendix1 For Details

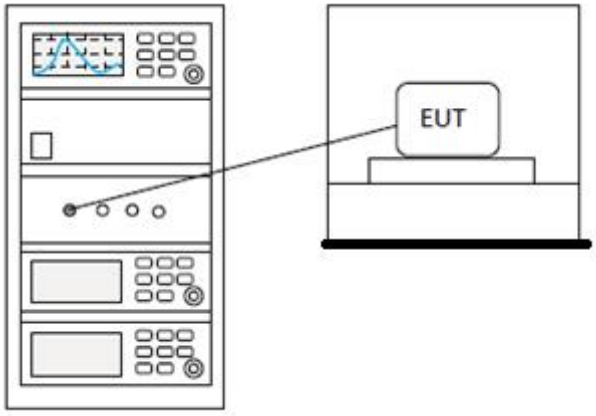
18 CONDUCTED PEAK OUTPUT POWER

Test Standard	47 CFR Part 15, Subpart C 15.247
Test Method	ANSI C63.10 (2013) Section 7.8.5
Test Mode (Pre-Scan)	TX
Test Mode (Final Test)	TX
Tester	Jozu
Temperature	25℃
Humidity	60%

18.1 LIMITS

Frequency range(MHz)	Output power of the intentional radiator(watt)
902-928	1 for ≥50 hopping channels
	0.25 for 25≤ hopping channels <50
	1 for digital modulation
2400-2483.5	1 for ≥75 non-overlapping hopping channels
	0.125 for all other frequency hopping systems
	1 for digital modulation
5725-5850	1 for frequency hopping systems and digital modulation

18.2 BLOCK DIAGRAM OF TEST SETUP



18.3 TEST DATA

Pass: Please Refer To Appendix: Appendix1 For Details

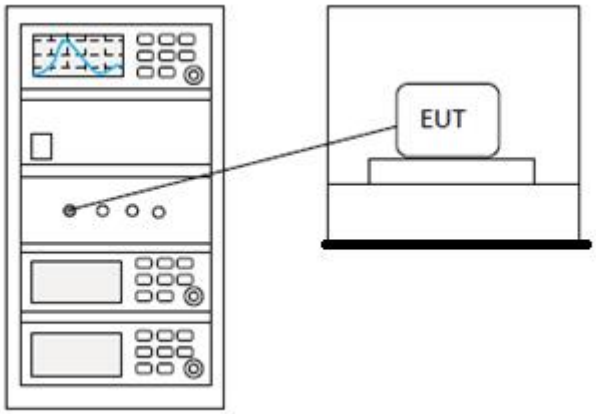
19 MINIMUM 6DB BANDWIDTH

Test Standard	47 CFR Part 15, Subpart C 15.247
Test Method	ANSI C63.10 (2013) Section 11.8.1
Test Mode (Pre-Scan)	TX
Test Mode (Final Test)	TX
Tester	Jozu
Temperature	25℃
Humidity	60%

19.1 LIMITS

Limit:	≥500 kHz

19.2 BLOCK DIAGRAM OF TEST SETUP



19.3 TEST DATA

Pass: Please Refer To Appendix: Appendix1 For Details

20 ANTENNA REQUIREMENT

Test Standard	47 CFR Part 15, Subpart C 15.247
Test Method	N/A

20.1 CONCLUSION

Standard 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 antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit permanently attached antenna or of an so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

EUT Antenna:
The antenna is integrated on the main PCB and no consideration of replacement. The best case gain of the antenna is 3.06dBi.

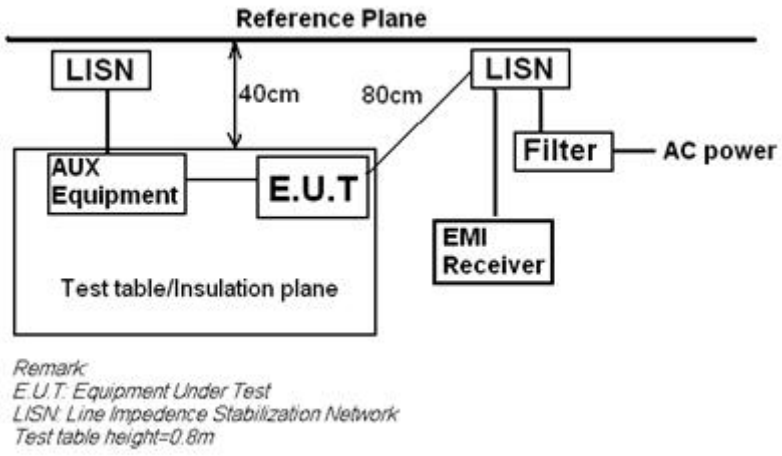
21 CONDUCTED EMISSIONS AT AC POWER LINE (150KHZ-30MHZ)

Test Standard	47 CFR Part 15, Subpart C 15.247
Test Method	ANSI C63.10 (2013) Section 6.2
Test Mode (Pre-Scan)	TX
Test Mode (Final Test)	TX
Tester	Jozu
Temperature	24℃
Humidity	55%

21.1 LIMITS

Frequency of emission(MHz)	Conducted limit(dBμV)	
	Quasi-peak	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.		

21.2 BLOCK DIAGRAM OF TEST SETUP



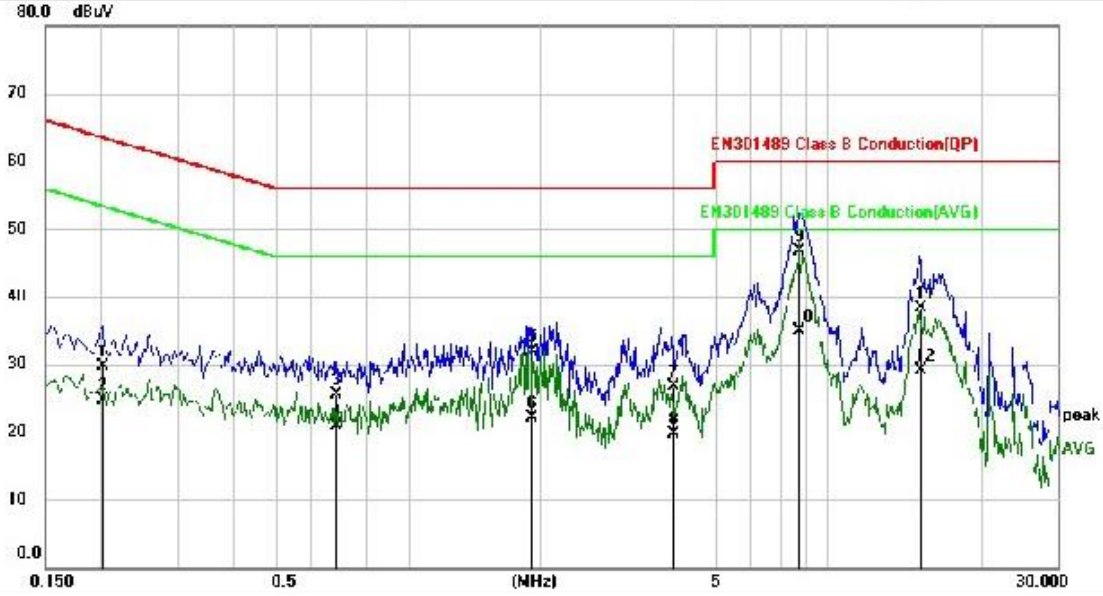
21.3 PROCEDURE

1) The mains terminal disturbance voltage test was conducted in a shielded room.
2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50ohm/50?H + 5ohm linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.

3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane,
4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2.
5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10 on conducted measurement.
Remark: LISN=Read Level+ Cable Loss+ LISN Factor

21.4 TEST DATA

[TestMode: TX]; [Line: Line]
Power:AC120V/60Hz



Site
Limit: EN301489 Class B Conduction(QP)
EUT: Blutetooth low energy module
M/N: MS88SF3
Mode: BT mode
Note:

Phase: L1
Power:

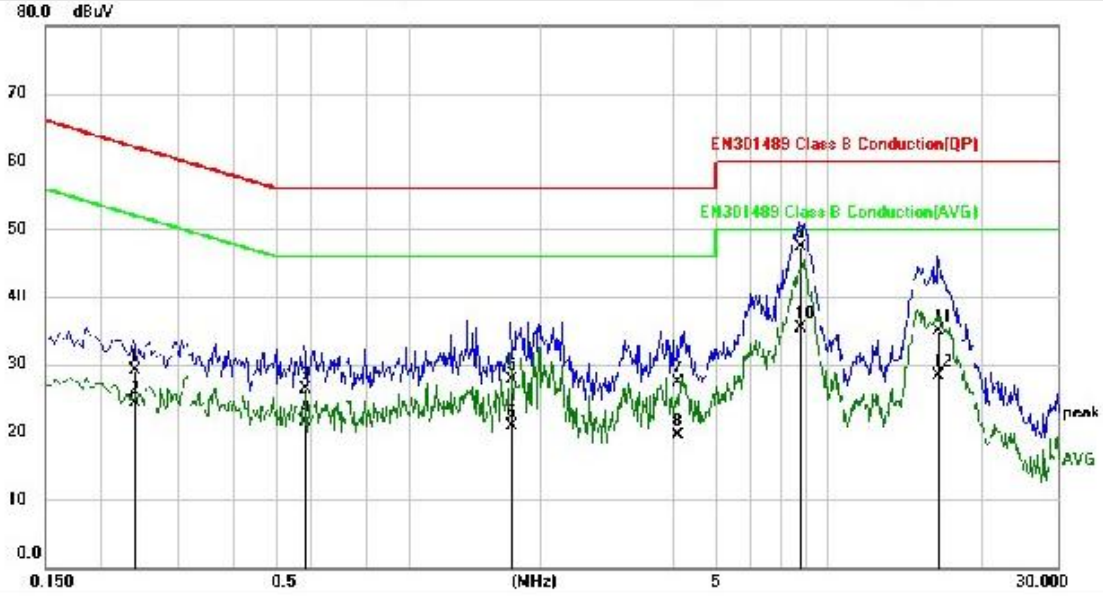
Temperature: 26
Humidity: 60 %

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.2020	19.89	9.87	29.76	63.53	-33.77	QP	
2		0.2020	14.92	9.87	24.79	53.53	-28.74	AVG	
3		0.6860	15.82	9.68	25.50	56.00	-30.50	QP	
4		0.6860	11.14	9.68	20.82	46.00	-25.18	AVG	
5		1.9060	22.16	9.82	31.98	56.00	-24.02	QP	
6		1.9060	12.32	9.82	22.14	46.00	-23.86	AVG	
7		4.0020	16.85	9.83	26.68	56.00	-29.32	QP	
8		4.0020	9.90	9.83	19.73	46.00	-26.27	AVG	
9	*	7.7420	36.84	9.87	46.71	60.00	-13.29	QP	
10		7.7420	24.96	9.87	34.83	50.00	-15.17	AVG	
11		14.5260	28.25	9.97	38.22	60.00	-21.78	QP	
12		14.5260	19.23	9.97	29.20	50.00	-20.80	AVG	

Test Result: Pass

[TestMode: TX]; [Line: Nutral]

Power:AC120V/60Hz



Site

Limit: EN301489 Class B Conduction(QP)

EUT: Blutetooth low energy module

M/N: MS88SF3

Mode: BT mode

Note:

Phase: N

Power:

Temperature: 26

Humidity: 60 %

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.2380	19.34	9.85	29.19	62.17	-32.98	QP	
2		0.2380	14.40	9.85	24.25	52.17	-27.92	AVG	
3		0.5820	16.59	9.74	26.33	56.00	-29.67	QP	
4		0.5820	11.77	9.74	21.51	46.00	-24.49	AVG	
5		1.7140	17.84	9.84	27.68	56.00	-28.32	QP	
6		1.7140	11.16	9.84	21.00	46.00	-25.00	AVG	
7		4.1100	17.38	9.84	27.22	56.00	-28.78	QP	
8		4.1100	9.66	9.84	19.50	46.00	-26.50	AVG	
9	*	7.8020	37.54	9.86	47.40	60.00	-12.60	QP	
10		7.8020	25.35	9.86	35.21	50.00	-14.79	AVG	
11		16.0419	24.91	10.00	34.91	60.00	-25.09	QP	
12		16.0419	18.39	10.00	28.39	50.00	-21.61	AVG	

Test Result: Pass

22 APPENDIX

Appendix1

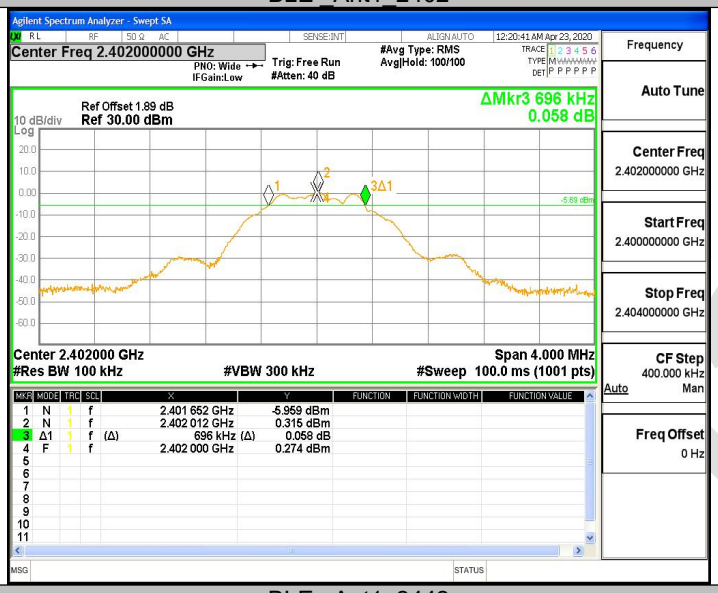
22.1 APPENDIXA: DTS BANDWIDTH

22.1.1 Test Result

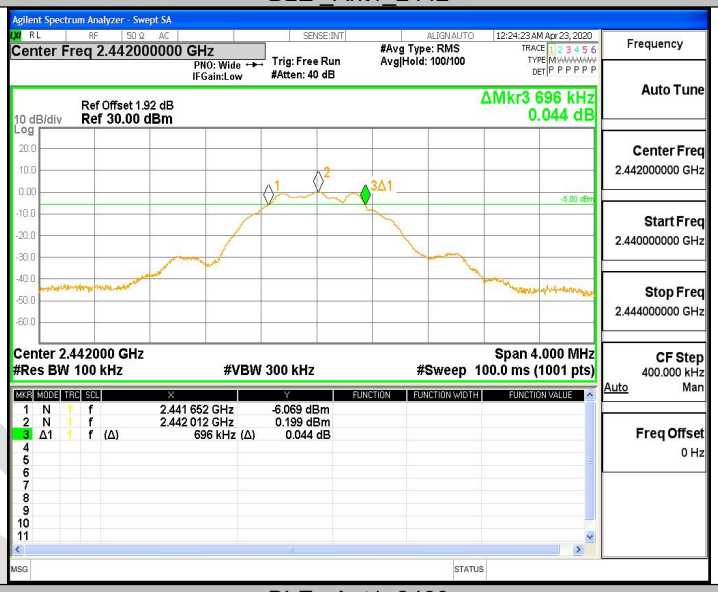
TestMode	Antenna	Channel	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE	Ant1	2402	0.696	2401.652	2402.348	>=0.5	PASS
		2442	0.696	2441.652	2442.348	>=0.5	PASS
		2480	0.692	2479.656	2480.348	>=0.5	PASS

22.1.2 Test Graphs

BLE _Ant1_2402



BLE _Ant1_2442



BLE _Ant1_2480


Agilent Spectrum Analyzer - Swept SA
Center Freq 2.480000000 GHz
PNO: Wide
IFGain:Low
Trig: Free Run
#Atten: 40 dB
#Avg Type: RMS
Avg|Hold: 100/100
12:26:49 AM Apr 23, 2020
Frequency
Auto Tune
Ref Offset 1.92 dB
10 dB/div
Ref 30.00 dBm
ΔMkr3 692 kHz
-0.252 dB
Center Freq
2.480000000 GHz
Start Freq
2.478000000 GHz
Stop Freq
2.482000000 GHz
Center 2.480000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Span 4.000 MHz
#Sweep 100.0 ms (1001 pts)
CF Step
400.000 kHz
Auto
Man
Freq Offset
0 Hz
1 N 1 f 2.479 656 GHz -5.856 dBm
2 N 1 f 2.480 004 GHz 0.148 dBm
3 Δ1 1 f (Δ) 692 kHz (Δ) -0.252 dB
MSG
STATUS

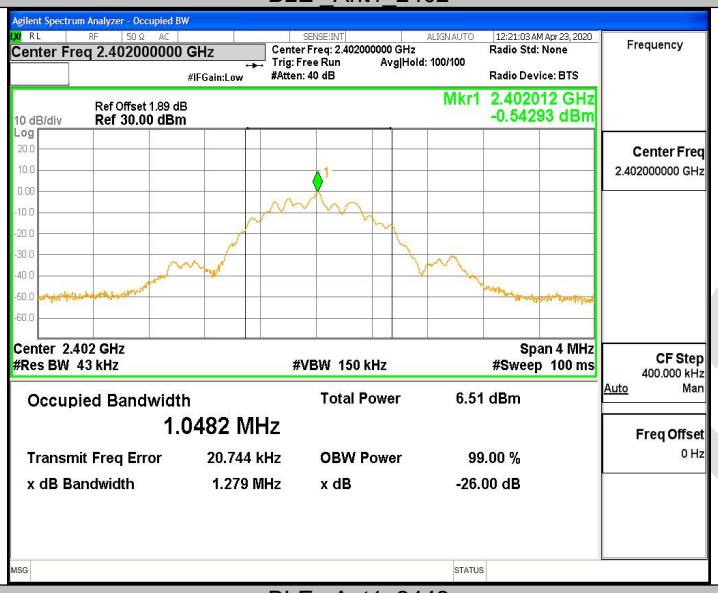
22.2 APPENDIXB: OCCUPIED CHANNEL BANDWIDTH

22.2.1 Test Result

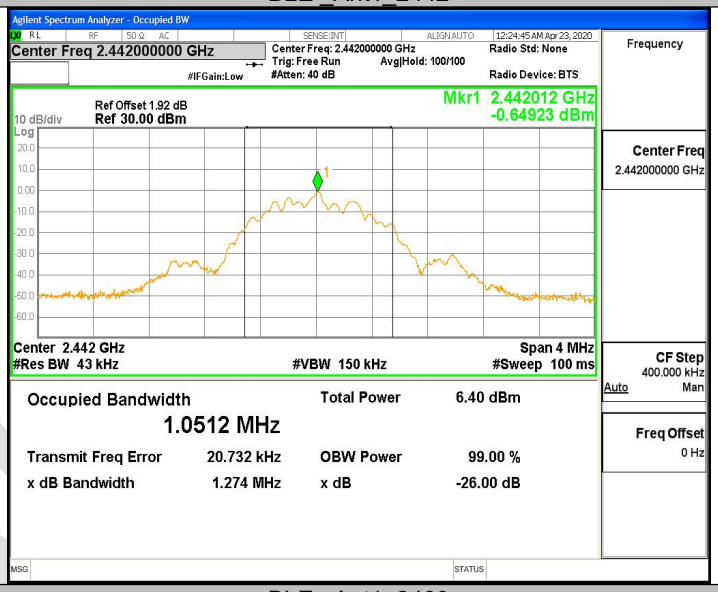
TestMode	Antenna	Channel	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE	Ant1	2402	1.0482	2401.497	2402.545	---	PASS
		2442	1.0512	2441.495	2442.546	---	PASS
		2480	1.0529	2479.494	2480.547	---	PASS

22.2.2 Test Graphs

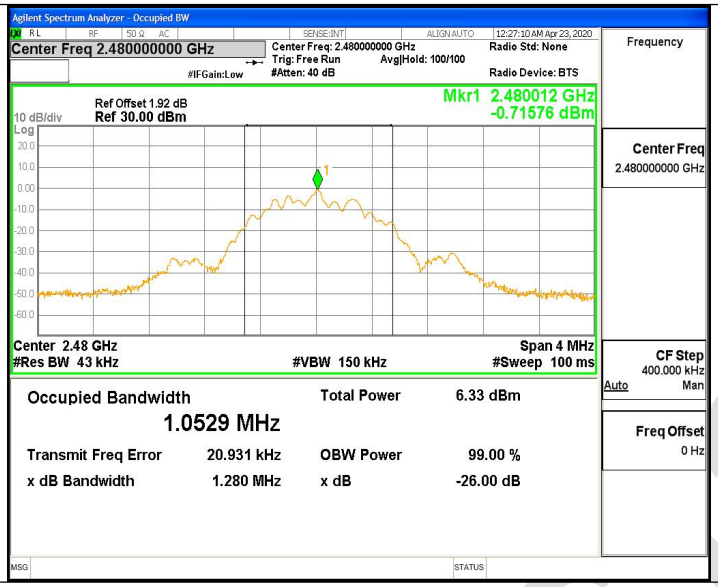
BLE _Ant1_2402



BLE _Ant1_2442



BLE _Ant1_2480


Agilent Spectrum Analyzer - Occupied BW
Center Freq 2.480000000 GHz
Center Freq: 2.480000000 GHz
Trig: Free Run
Avg|Hold: 100/100
#Atten: 40 dB
#IFGain:Low
Radio Std: None
Radio Device: BTS
12:27:10 AM Apr 23, 2020
Frequency
Ref Offset 1.92 dB
10 dB/div
Ref 30.00 dBm
Log
Mkr1 2.480012 GHz
-0.71576 dBm
Center 2.48 GHz
#Res BW 43 kHz
#VBW 150 kHz
Span 4 MHz
#Sweep 100 ms
Occupied Bandwidth
1.0529 MHz
Total Power 6.33 dBm
Transmit Freq Error 20.931 kHz
OBW Power 99.00 %
x dB Bandwidth 1.280 MHz
x dB -26.00 dB
Center Freq
2.480000000 GHz
CF Step
400.000 kHz
Auto
Man
Freq Offset
0 Hz
MSG
STATUS

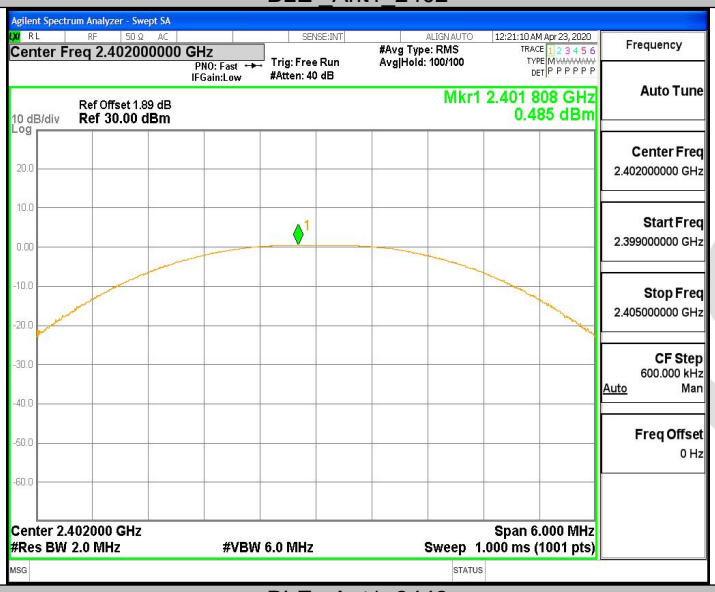
22.3 APPENDIXC: MAXIMUM CONDUCTED OUTPUT POWER

22.3.1 Test Result

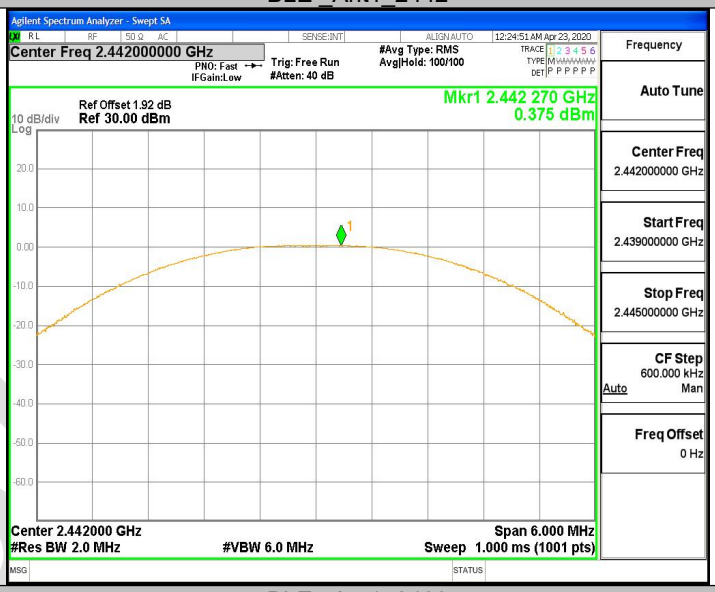
TestMode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
BLE	Ant1	2402	0.49	<=30	PASS
		2442	0.38	<=30	PASS
		2480	0.33	<=30	PASS

22.3.2 Test Graphs

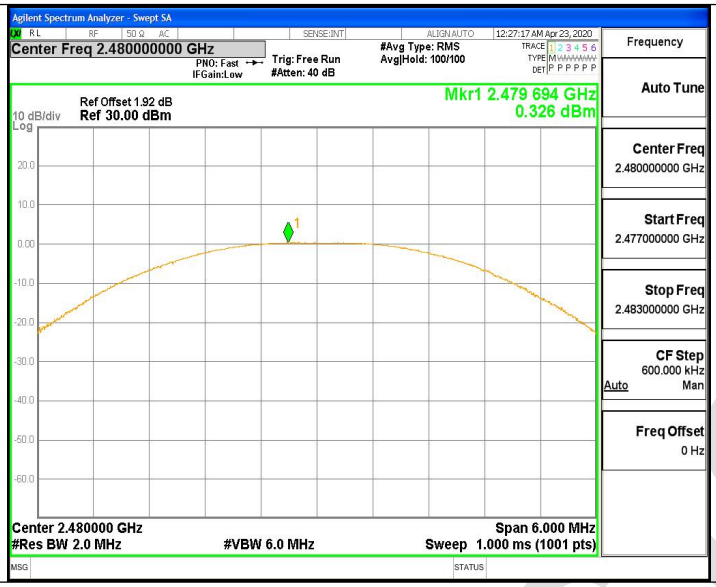
BLE _Ant1_2402



BLE _Ant1_2442



BLE _Ant1_2480


Agilent Spectrum Analyzer - Swept SA
Center Freq 2.480000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 40 dB
#Avg Type: RMS
Avg|Hold: 100/100
12:27:17 AM Apr 23, 2020
Frequency
Auto Tune
Ref Offset 1.92 dB
10 dB/div
Log
Ref 30.00 dBm
Mkr1 2.479 694 GHz
0.326 dBm
Center Freq
2.480000000 GHz
Start Freq
2.477000000 GHz
Stop Freq
2.483000000 GHz
CF Step
600.000 kHz
Auto
Man
Freq Offset
0 Hz
Center 2.480000 GHz
#Res BW 2.0 MHz
#VBW 6.0 MHz
Span 6.000 MHz
Sweep 1.000 ms (1001 pts)

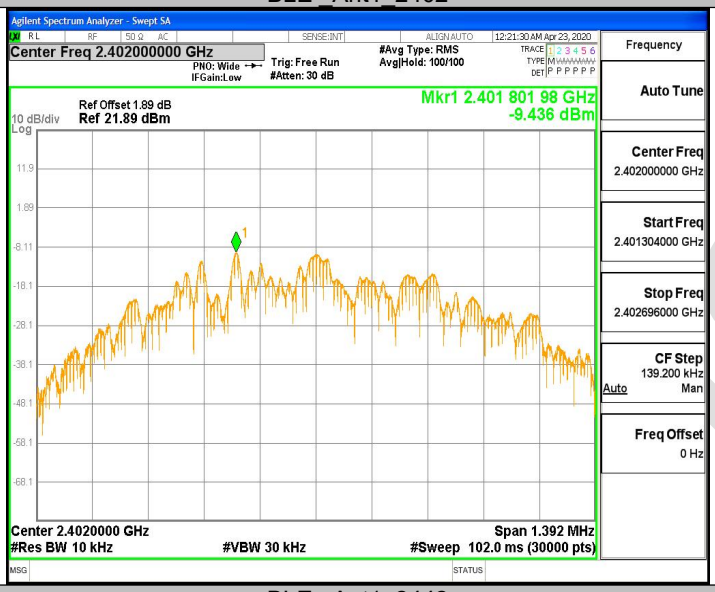
22.4 APPENDIXD: MAXIMUM POWER SPECTRAL DENSITY

22.4.1 Test Result

TestMode	Antenna	Channel	Result[dBm/3-100kHz]	Limit[dBm/3kHz]	Verdict
BLE	Ant1	2402	-9.44	<=8	PASS
		2442	-9.63	<=8	PASS
		2480	-9.7	<=8	PASS

22.4.2 Test Graphs

BLE _Ant1_2402



BLE _Ant1_2442

BLE _Ant1_2480


Agilent Spectrum Analyzer - Swept SA
Center Freq 2.480000000 GHz
PNO: Wide
IFGain:Low
Trig: Free Run
#Atten: 30 dB
#Avg Type: RMS
Avg|Hold: 100/100
12:27:38 AM Apr 23, 2020
Mkr1 2.479 801 41 GHz
-9.699 dBm
Ref Offset 1.92 dB
10 dB/div
Log
Ref 21.92 dBm
11.9
1.92
-8.08
-18.1
-28.1
-38.1
-48.1
-58.1
-68.1
Center 2.4800000 GHz
#Res BW 10 kHz
#VBW 30 kHz
Span 1.384 MHz
#Sweep 102.0 ms (30000 pts)
Frequency
Auto Tune
Center Freq
2.480000000 GHz
Start Freq
2.479308000 GHz
Stop Freq
2.480692000 GHz
CF Step
138.400 kHz
Auto
Man
Freq Offset
0 Hz
MSG
STATUS

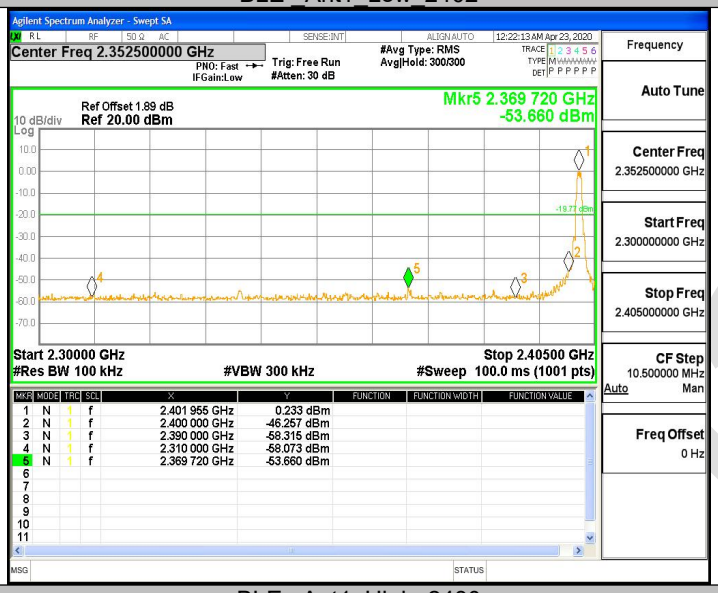
22.5 APPENDIXE:BAND EDGE MEASUREMENTS

22.5.1 Test Result

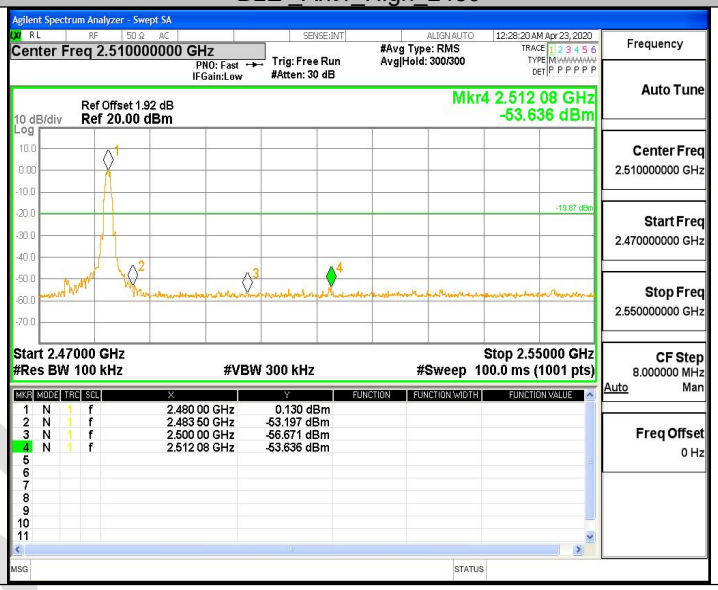
TestMode	Antenna	ChName	Channel	RefLevel[dBm]	Result[dBm]	Limit[dBm]	Verdict
BLE	Ant1	Low	2402	0.23	-53.66	<=-19.77	PASS
		High	2480	0.13	-53.64	<=-19.87	PASS

22.5.2 Test Graphs

BLE _Ant1_Low_2402



BLE _Ant1_High_2480



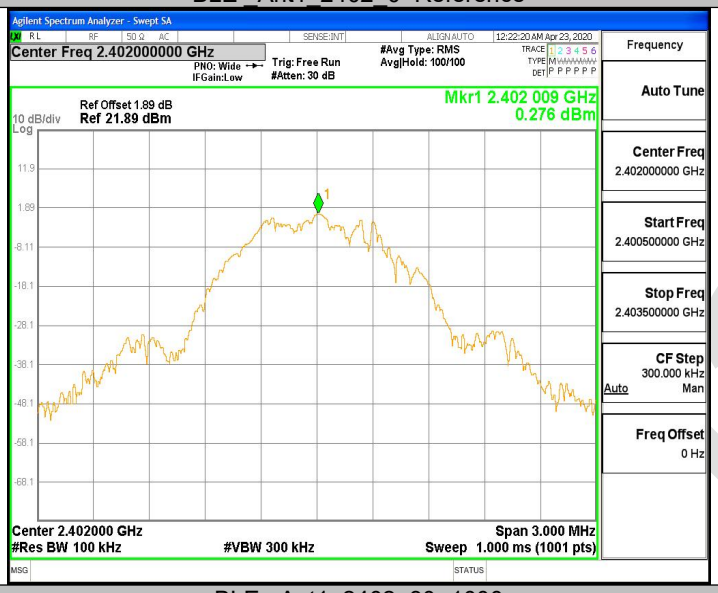
22.6 APPENDIXF:CONDUCTED SPURIOUSEMISSION

22.6.1 Test Result

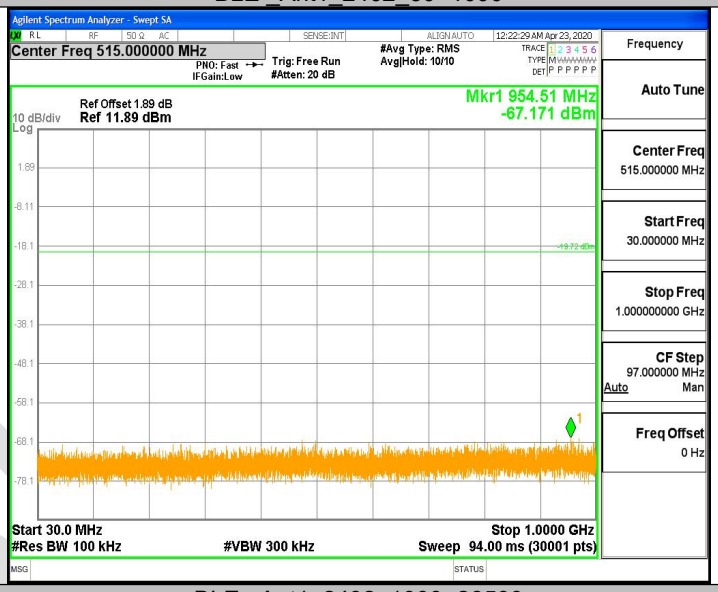
TestMode	Antenna	Channel	FreqRange [MHz]	RefLevel [dBm]	Result[dBm]	Limit[dBm]	Verdict
BLE	Ant1	2402	Reference	0.28	0.28	---	PASS
			30~1000	30~1000	-67.171	<=-19.724	PASS
			1000~26500	1000~26500	-52.431	<=-19.724	PASS
		2442	Reference	0.16	0.16	---	PASS
			30~1000	30~1000	-67.437	<=-19.843	PASS
			1000~26500	1000~26500	-53.327	<=-19.843	PASS
		2480	Reference	-0.43	-0.43	---	PASS
			30~1000	30~1000	-67.706	<=-20.43	PASS
			1000~26500	1000~26500	-53.502	<=-20.43	PASS

22.6.2 Test Graphs

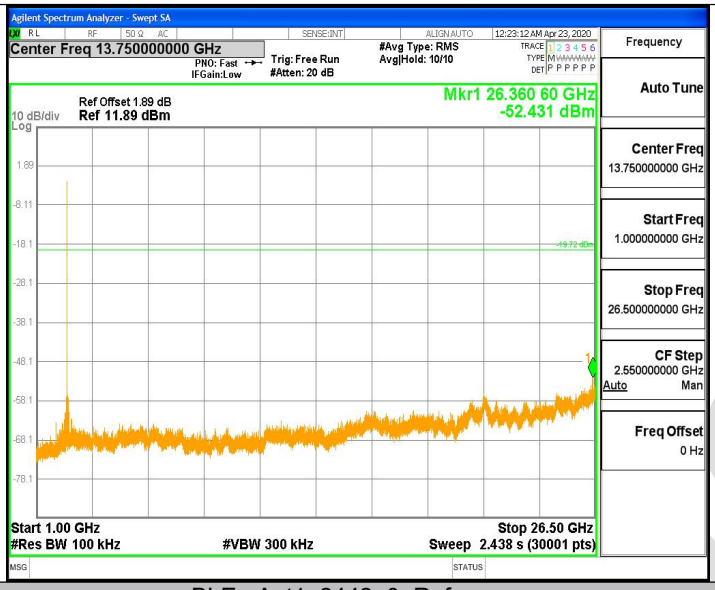
BLE _Ant1_2402_0~Reference



BLE _Ant1_2402_30~1000

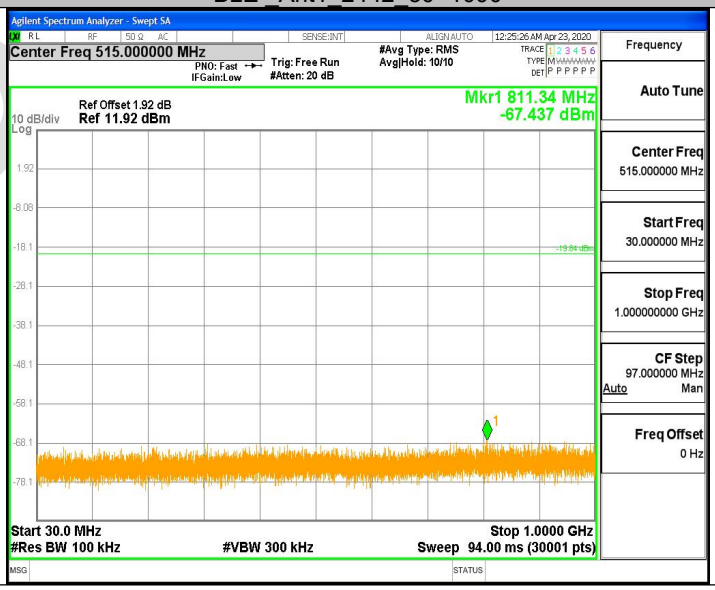


BLE _Ant1_2402_1000~26500

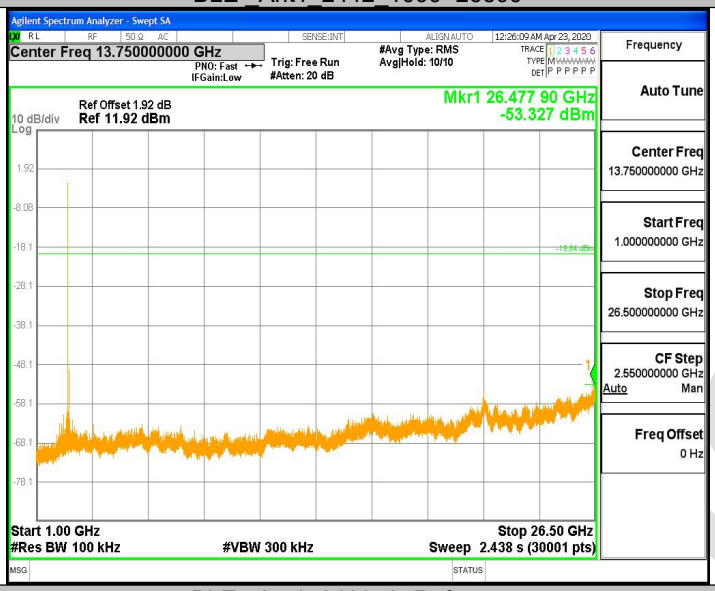


BLE _Ant1_2442_0~Reference

BLE _Ant1_2442_30~1000

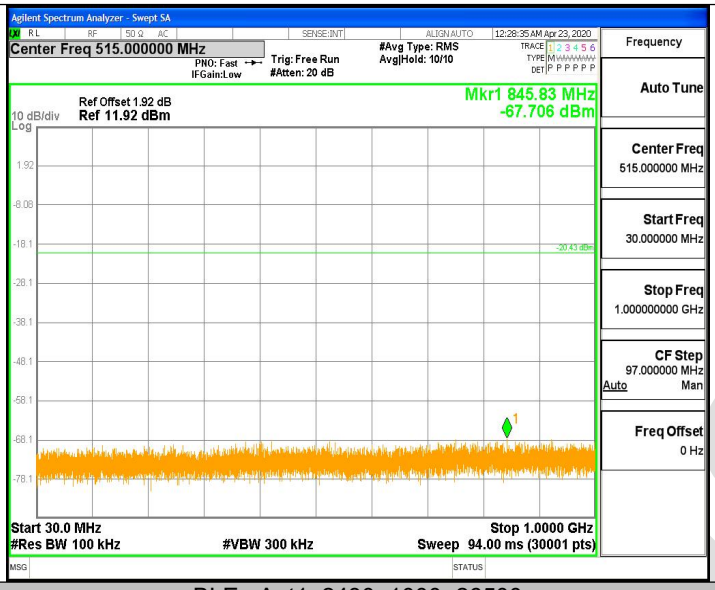


BLE _Ant1_2442_1000~26500

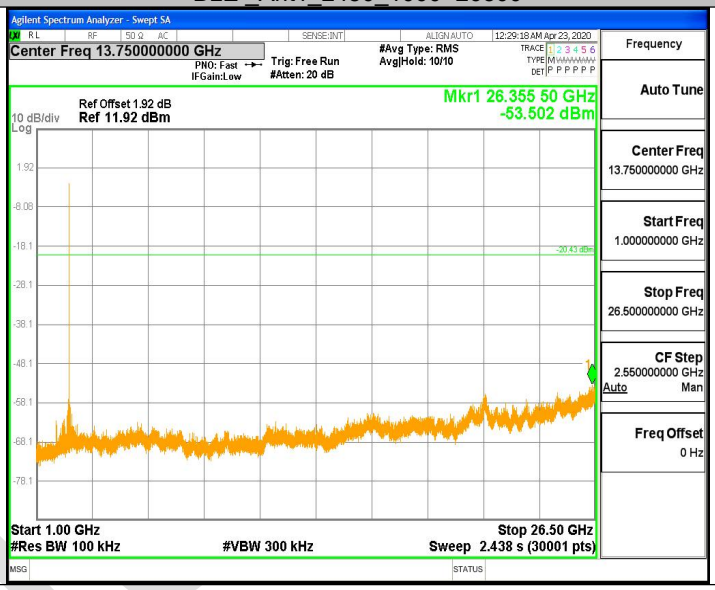


BLE _Ant1_2480_0~Reference

BLE _Ant1_2480_30~1000

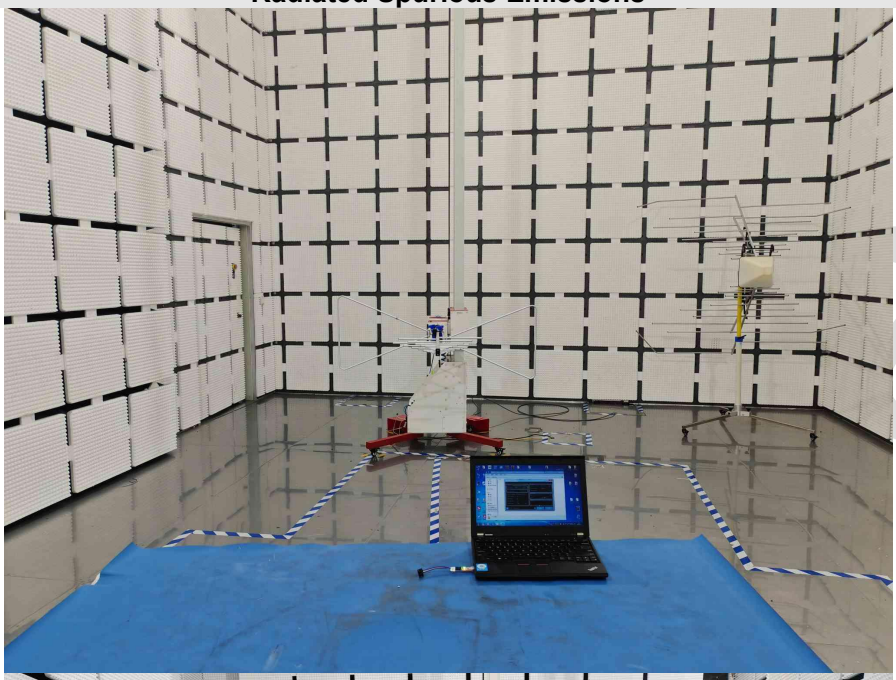


BLE _Ant1_2480_1000~26500

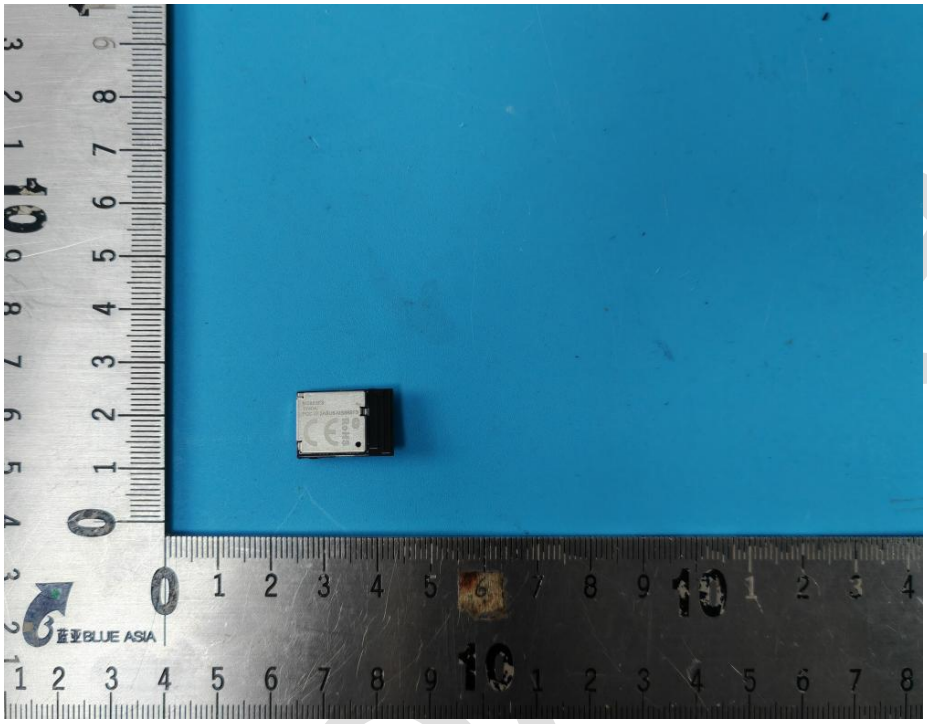


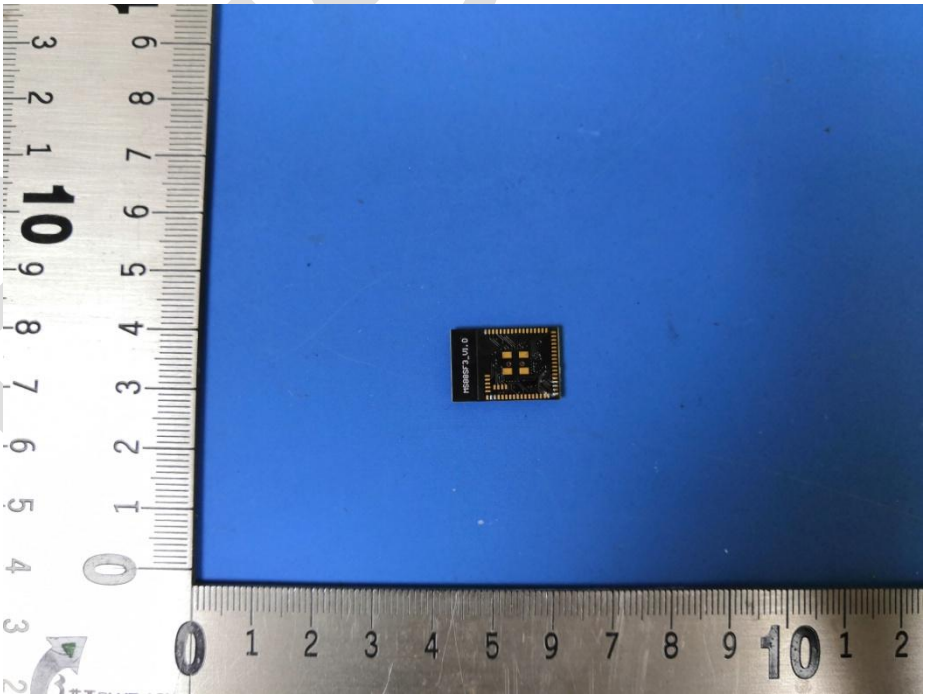
APPENDIX A: PHOTOGRAPHS OF TEST SETUP

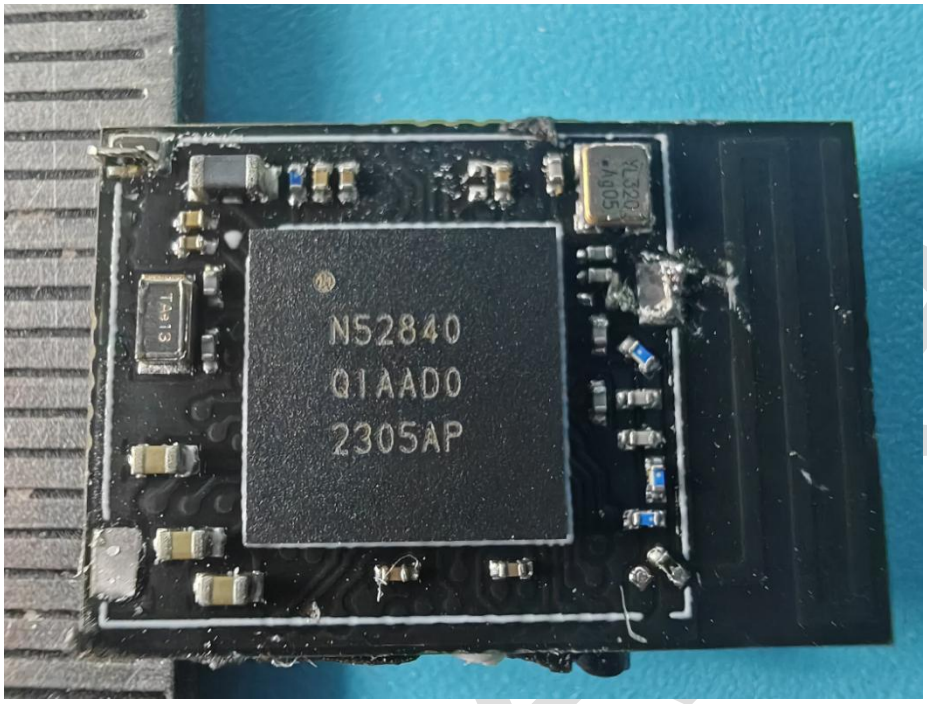
Radiated Spurious Emissions



APPENDIX B: PHOTOGRAPHS OF EUT







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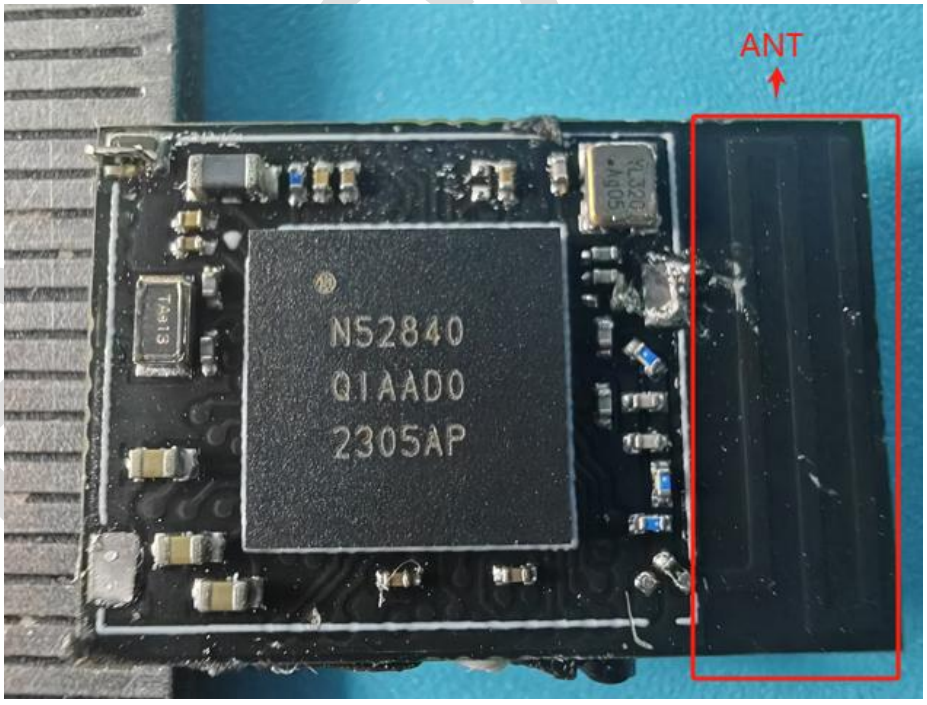

----END OF REPORT----

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