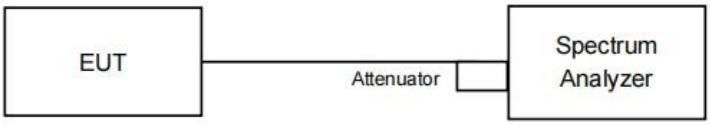
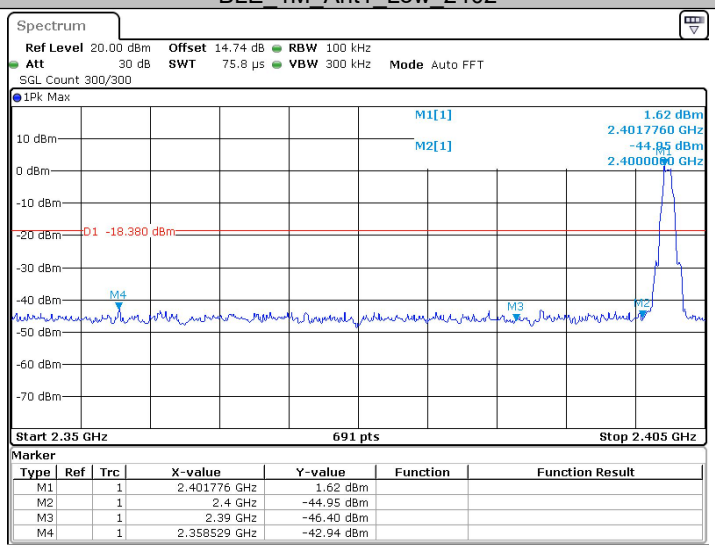
5.6 Band-edge for RF Conducted Emissions

Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10 2013
Test Setup:	 *Remark: Offset=Cable loss+ attenuation factor.*
Limit:	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.
Test Mode:	Transmitting with GFSK modulation.
Test Results:	Pass

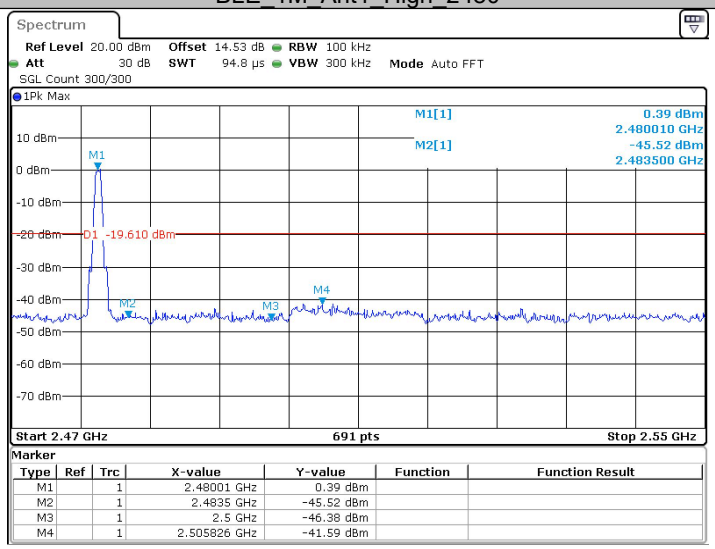
TestMode	ChName	Freq(MHz)	RefLevel[dBm]	Result[dBm]	Limit[dBm]	Verdict
BLE_1M	Low	2402	1.62	-42.94	≤-18.38	PASS
	High	2480	0.39	-41.59	≤-19.61	PASS
BLE_2M	Low	2402	1.02	-38.39	≤-18.98	PASS
	High	2480	0.14	-41.38	≤-19.86	PASS

Test plot as follows:

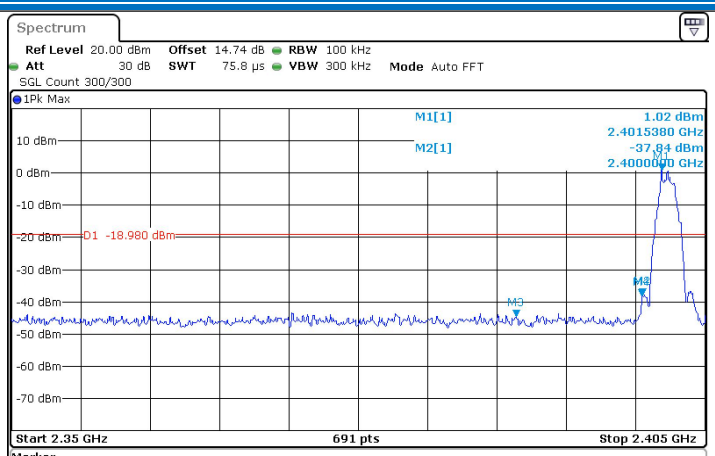
BLE_1M_Ant1_Low_2402



BLE_1M_Ant1_High_2480



BLE_2M_Ant1_Low_2402



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.401538 GHz	1.02 dBm		
M2		1	2.4 GHz	-37.84 dBm		
M3		1	2.39 GHz	-44.38 dBm		
M4		1	2.3999783 GHz	-38.39 dBm		

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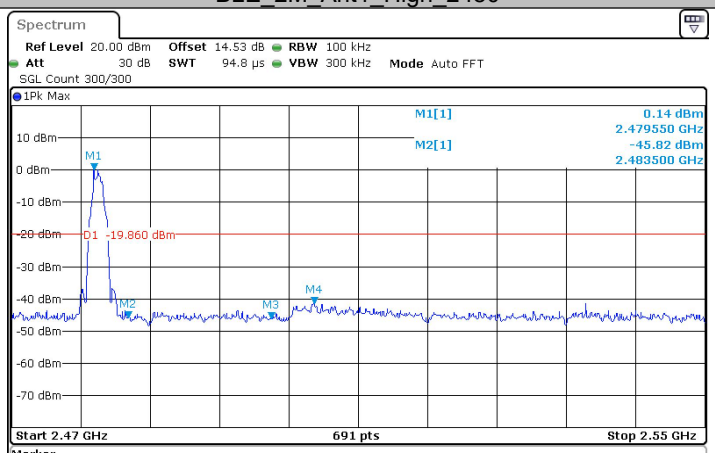
BLE_2M_Ant1_High_2480

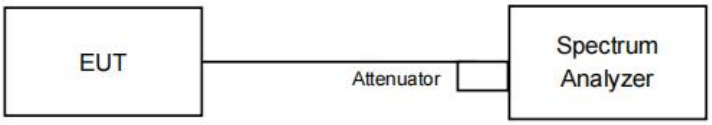


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47955 GHz	0.14 dBm		
M2		1	2.4835 GHz	-45.82 dBm		
M3		1	2.5 GHz	-46.24 dBm		
M4		1	2.504899 GHz	-41.38 dBm		

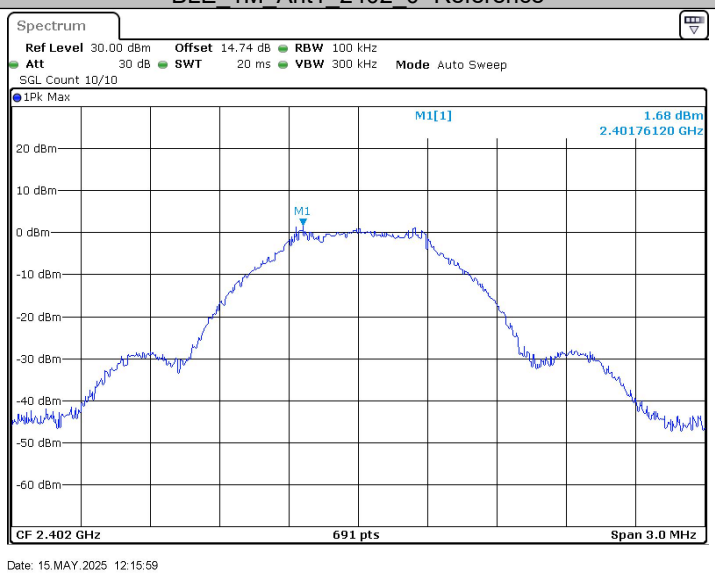
Date: 15.MAY.2025 12:30:31

5.7 Spurious RF Conducted Emissions

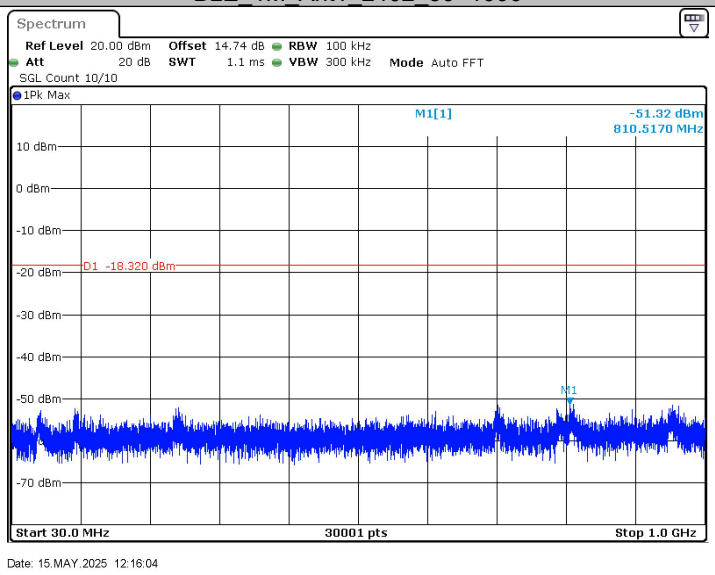
Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10 2013
Test Setup:	 *Remark: Offset=Cable loss+ attenuation factor.*
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is 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.
Test Mode:	Transmitting with GFSK modulation.
Test Results:	Pass

Test plot as follows:

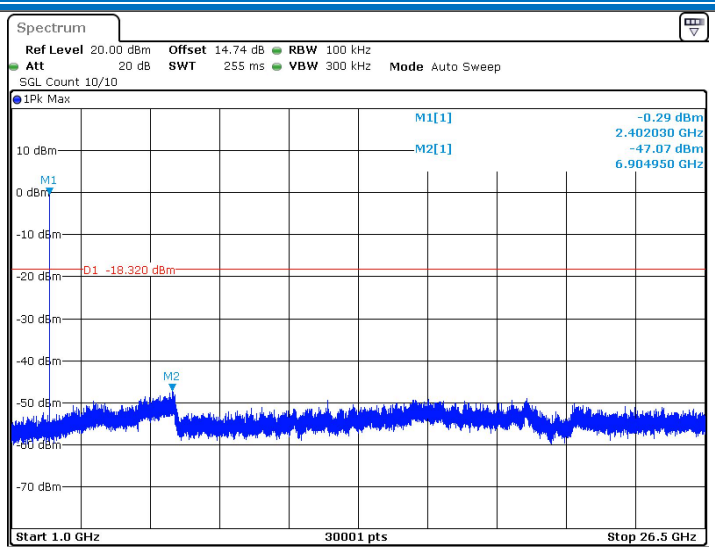
BLE_1M_Ant1_2402_0~Reference



BLE_1M_Ant1_2402_30~1000

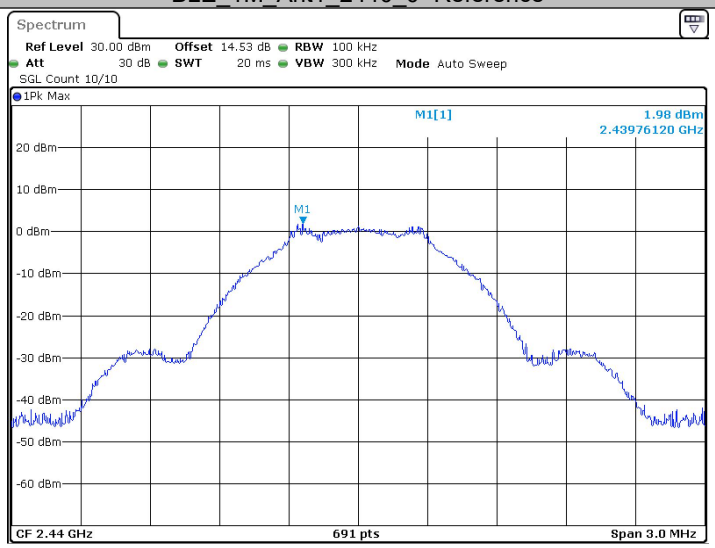


BLE_1M_Ant1_2402_1000~26500



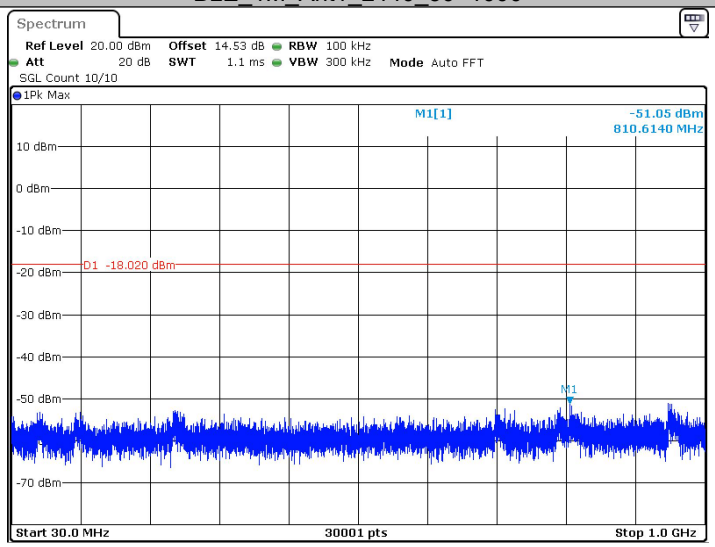
Date: 15.MAY.2025 12:16:14

BLE_1M_Ant1_2440_0~Reference



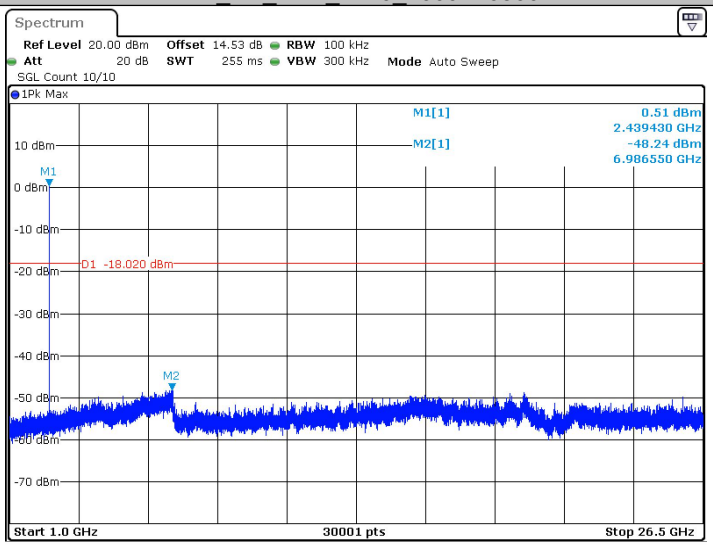
Date: 15.MAY.2025 12:18:59

BLE_1M_Ant1_2440_30~1000



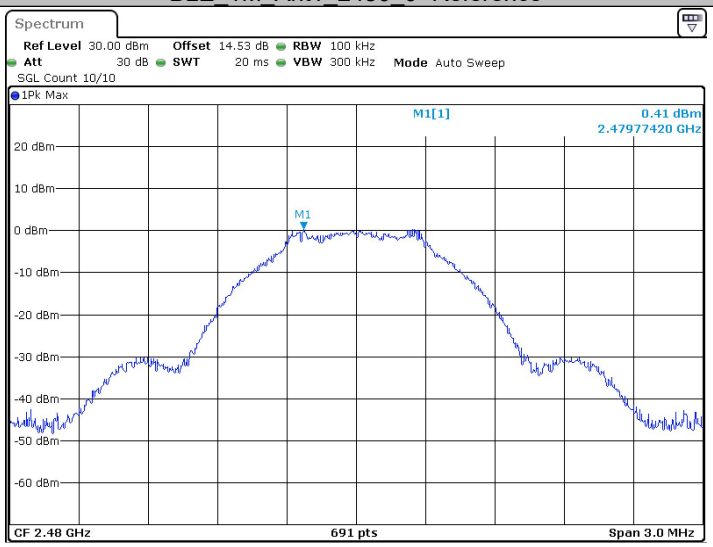
Date: 15.MAY.2025 12:19:03

BLE_1M_Ant1_2440_1000~26500



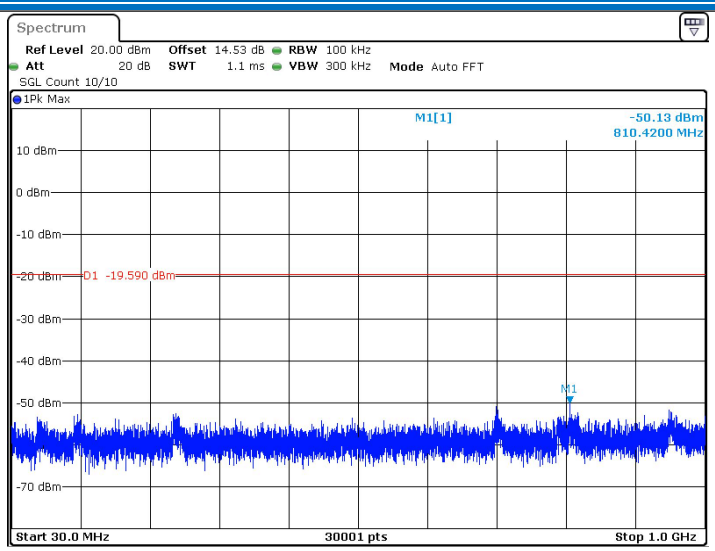
Date: 15.MAY.2025 12:19:14

BLE_1M_Ant1_2480_0~Reference



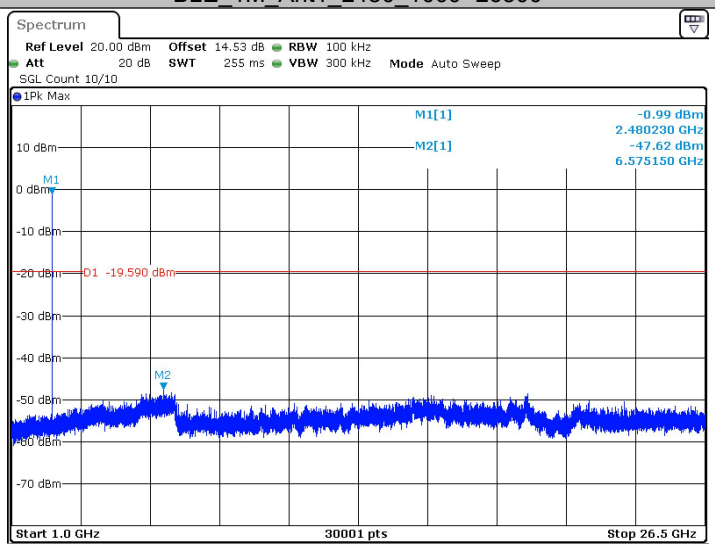
Date: 15.MAY.2025 12:21:24

BLE_1M_Ant1_2480_30~1000



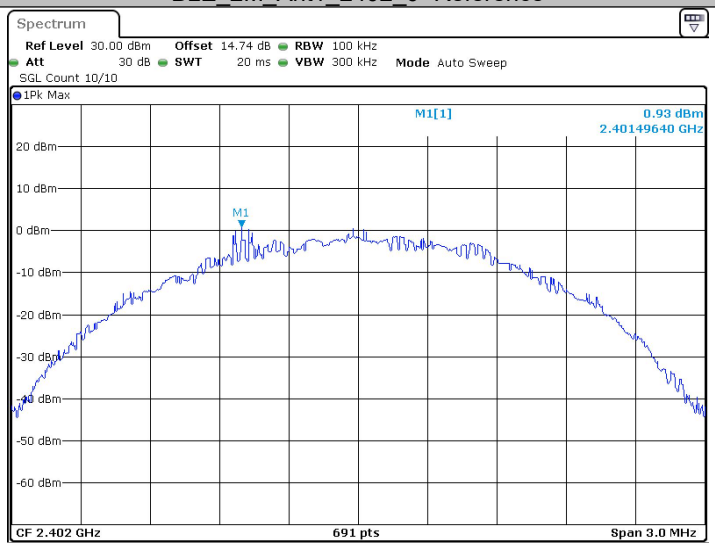
Date: 15.MAY.2025 12:21:29

BLE_1M_Ant1_2480_1000~26500



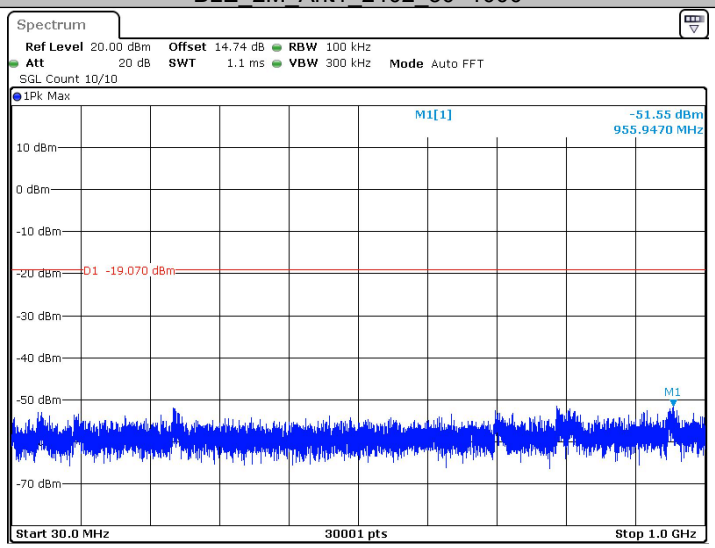
Date: 15.MAY.2025 12:21:39

BLE_2M_Ant1_2402_0~Reference



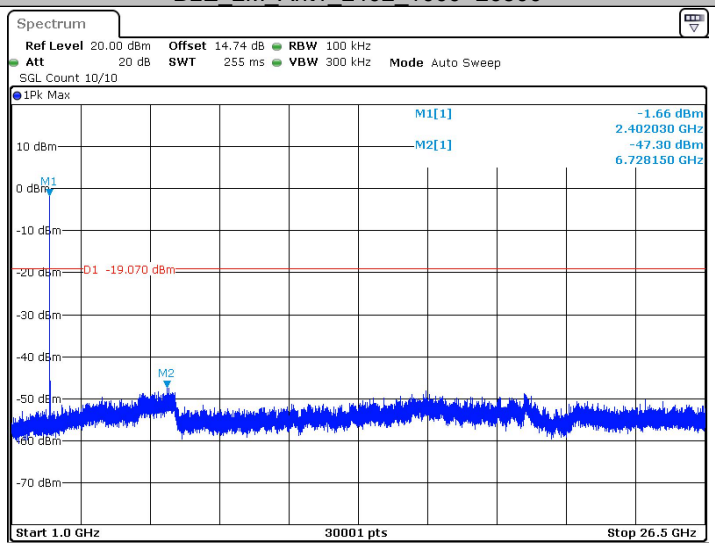
Date: 15.MAY.2025 12:27:19

BLE_2M_Ant1_2402_30~1000



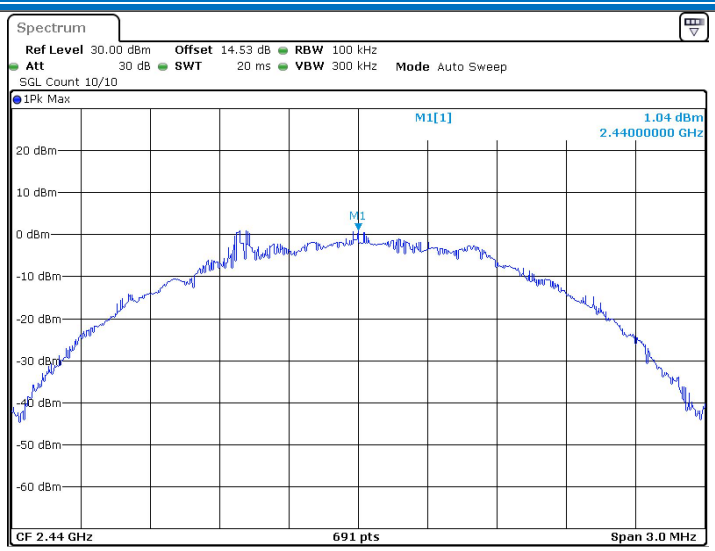
Date: 15.MAY.2025 12:27:23

BLE_2M_Ant1_2402_1000~26500



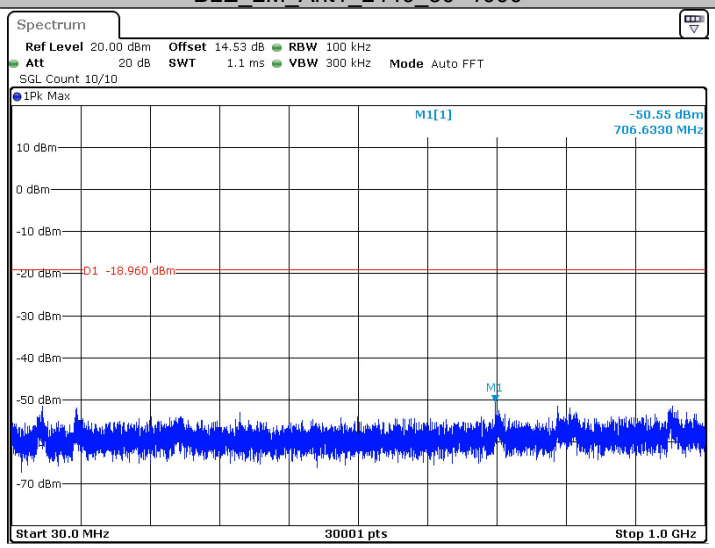
Date: 15.MAY.2025 12:27:34

BLE_2M_Ant1_2440_0~Reference



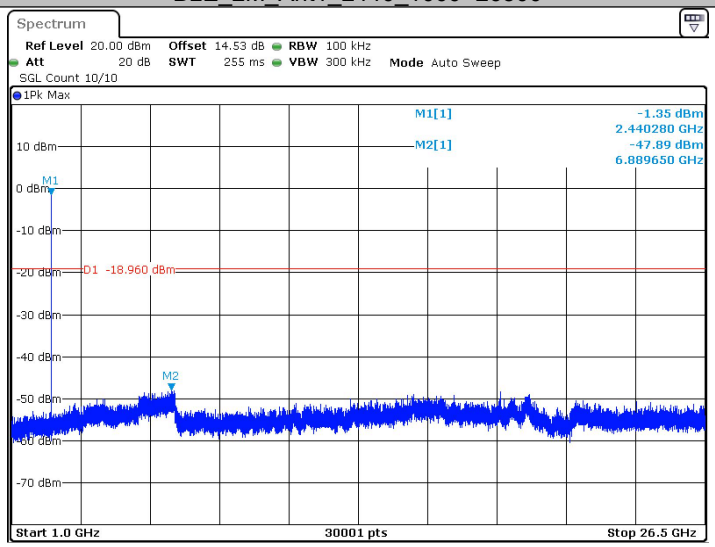
Date: 15.MAY.2025 12:28:35

BLE_2M_Ant1_2440_30~1000



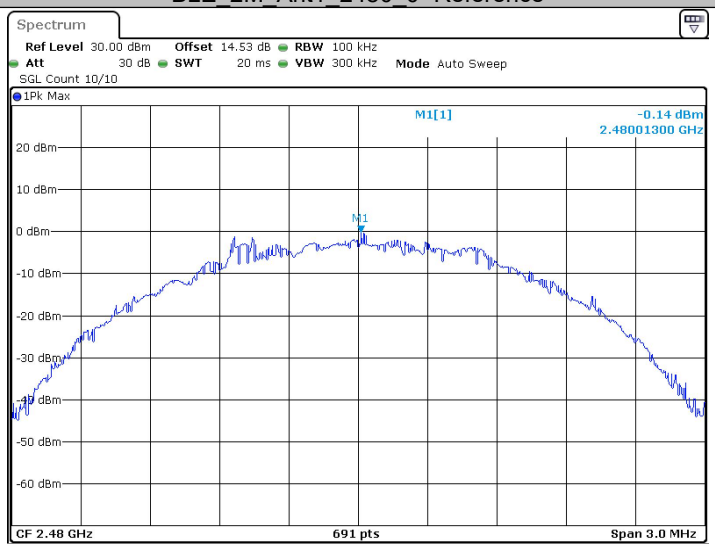
Date: 15.MAY.2025 12:28:39

BLE_2M_Ant1_2440_1000~26500



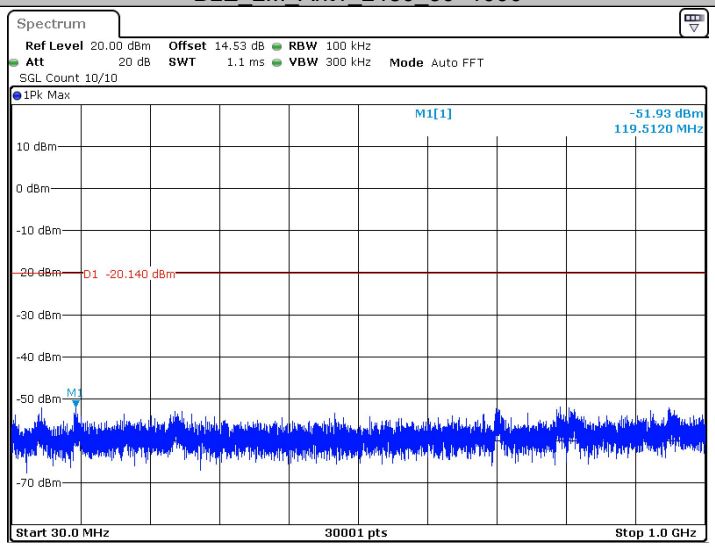
Date: 15.MAY.2025 12:28:50

BLE_2M_Ant1_2480_0~Reference



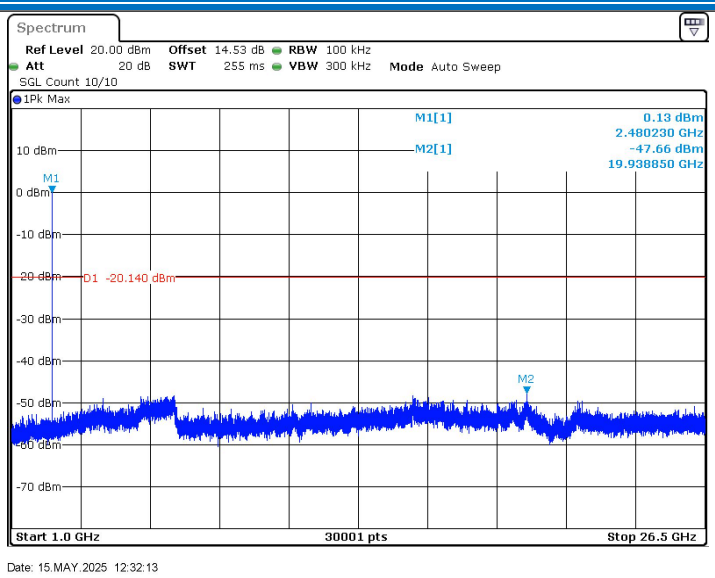
Date: 15.MAY.2025 12:31:58

BLE_2M_Ant1_2480_30~1000



Date: 15.MAY.2025 12:32:02

BLE_2M_Ant1_2480_1000~26500



Remark:

Pretest 9kHz to 25GHz, find the highest point when testing, so only the worst data were shown in the test report. Per FCC Part 15.33 (a) and 15.31 (o) ,The amplitude of spurious emissions from intentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

5.8 Radiated Spurious Emission & Restricted bands

5.8.1 Spurious Emissions

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205
Test Method:	ANSI C63.10 2013
Test Site:	Measurement Distance: 3m (Semi-Anechoic Chamber)

Receiver Setup:

Frequency	Detector	RBW	VBW	Remark
0.009MHz-0.090MHz	Peak	10kHz	30kHz	Peak
0.009MHz-0.090MHz	Average	10kHz	30kHz	Average
0.090MHz-0.110MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
0.110MHz-0.490MHz	Peak	10kHz	30kHz	Peak
0.110MHz-0.490MHz	Average	10kHz	30kHz	Average
0.490MHz -30MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
30MHz-1GHz	Quasi-peak	100 kHz	300kHz	Quasi-peak
Above 1GHz	Peak	1MHz	3MHz	Peak
	Peak	1MHz	10Hz	Average

Limit:

Frequency	Field strength (microvolt/meter)	Limit (dBuV/m)	Remark	Measurement distance (m)
0.009MHz-0.490MHz	2400/F(kHz)	-	-	300
0.490MHz-1.705MHz	24000/F(kHz)	-	-	30
1.705MHz-30MHz	30	-	-	30
30MHz-88MHz	100	40.0	Quasi-peak	3
88MHz-216MHz	150	43.5	Quasi-peak	3
216MHz-960MHz	200	46.0	Quasi-peak	3
960MHz-1GHz	500	54.0	Quasi-peak	3
Above 1GHz	500	54.0	Average	3

Note: 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.

Test Setup:	

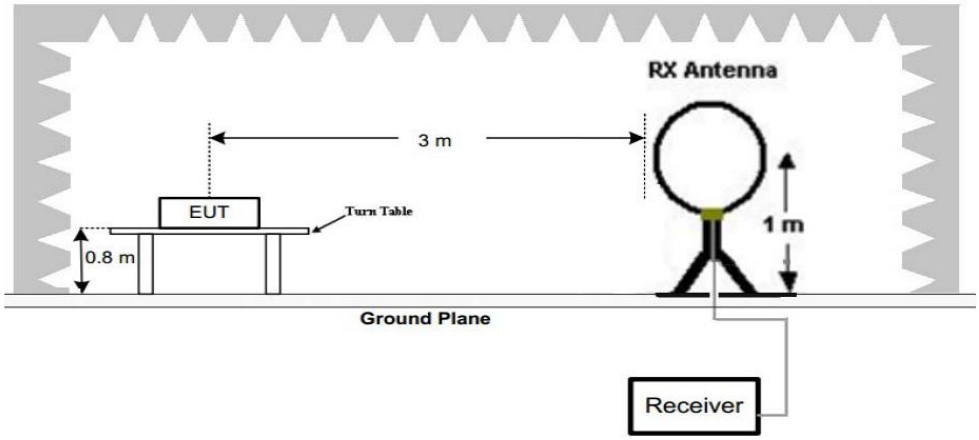


Figure 1. Below 30MHz

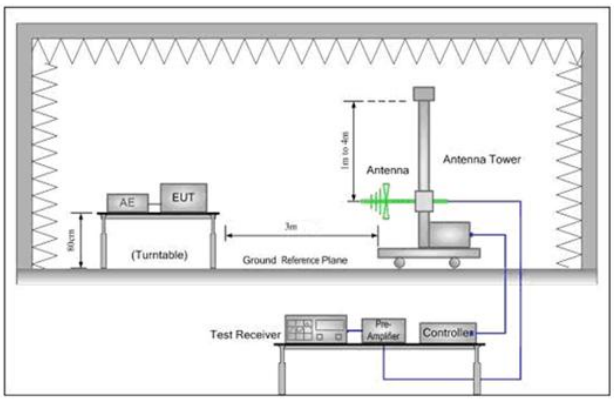


Figure 2. 30MHz to 1GHz

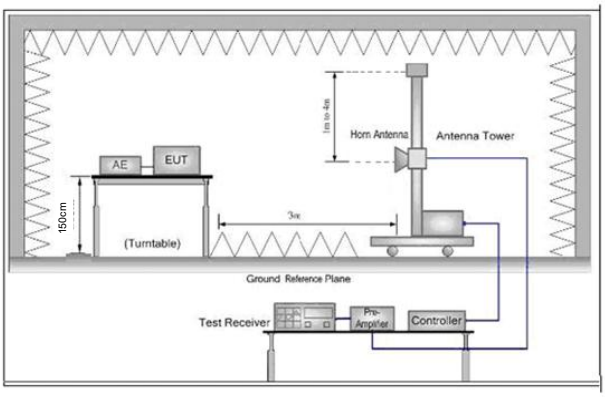
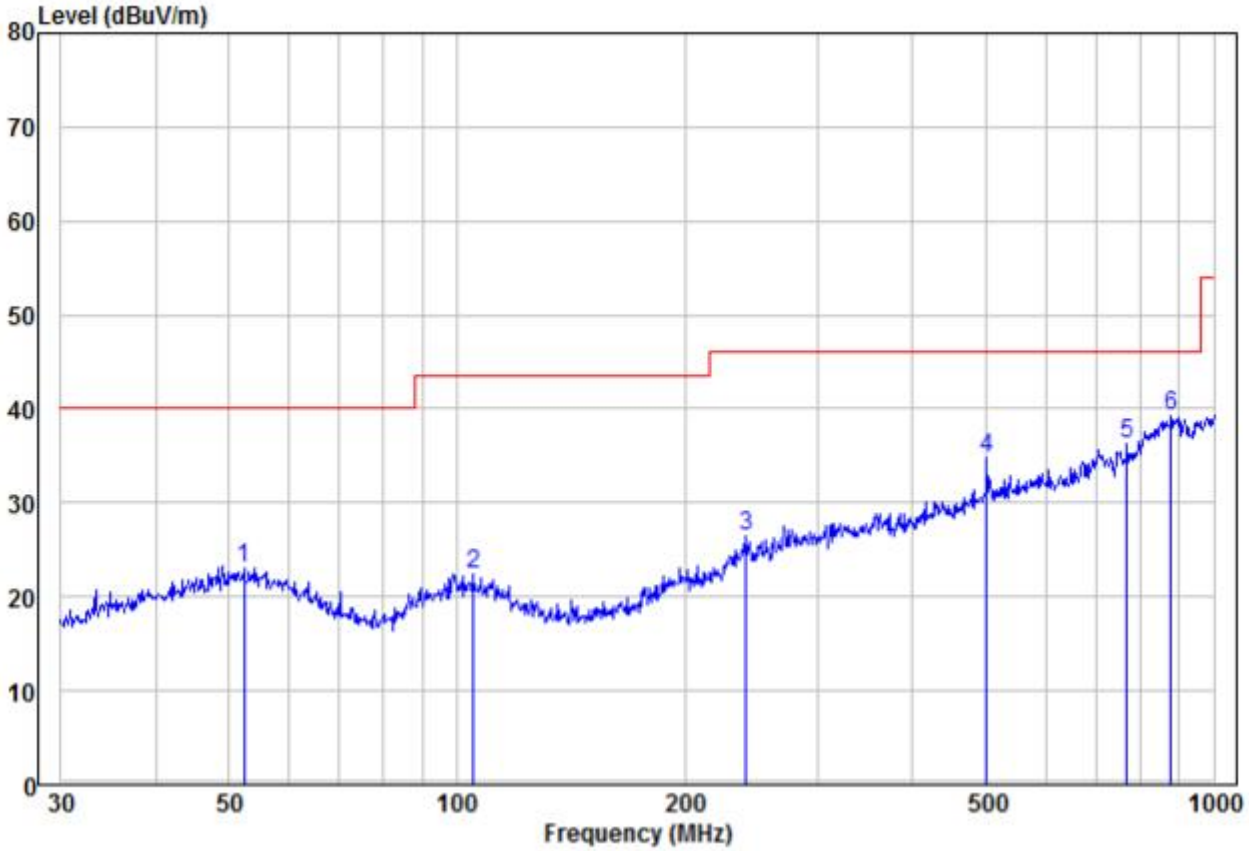


Figure 3. Above 1 GHz

Test Procedure:	a. 1) Below 1G: The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation. 2) Above 1G: The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation. Note: For the radiated emission test above 1GHz: Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane. b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower. c. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both

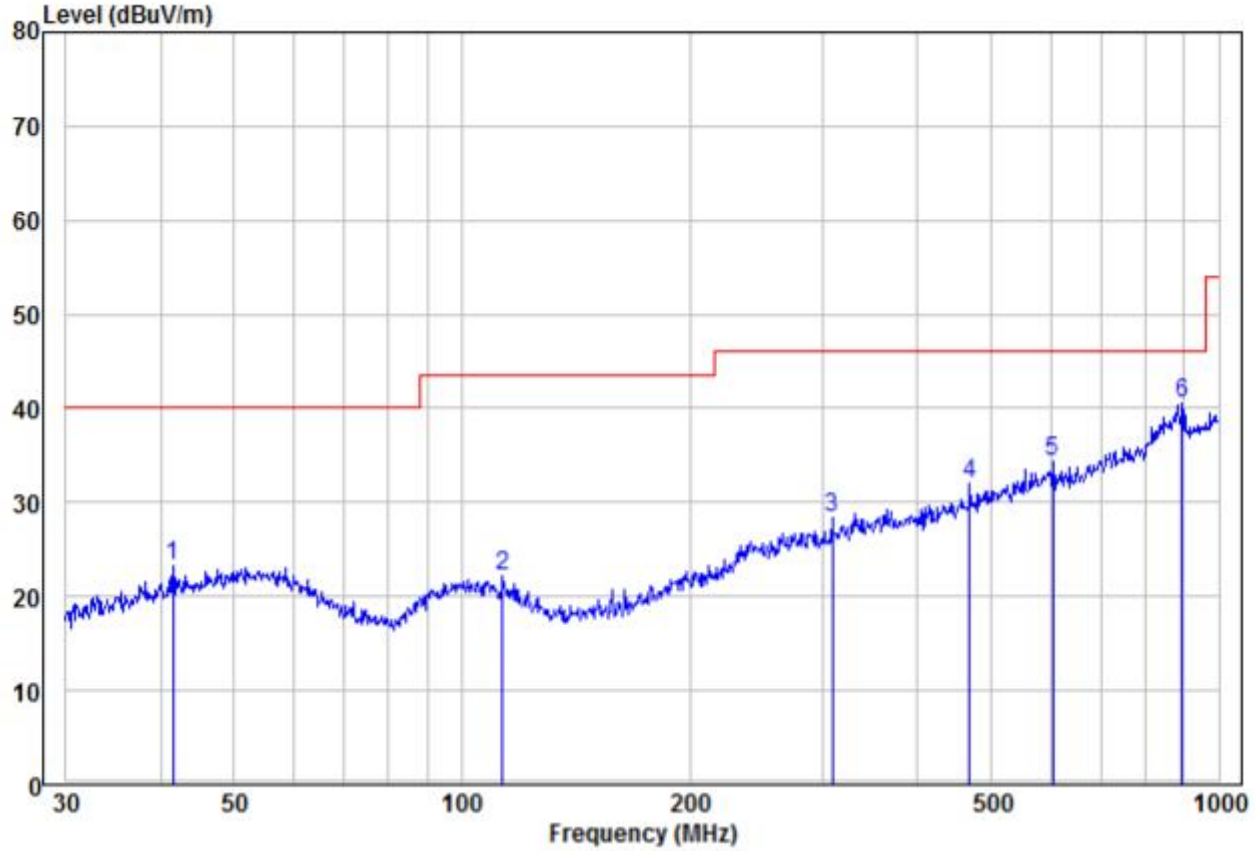
	horizontal and vertical polarizations of the antenna are set to make the measurement. d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading. e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet. g. Test the EUT in the lowest channel (2402MHz),the middle channel (2440MHz),the Highest channel (2480MHz) h. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case. i. Repeat above procedures until all frequencies measured was complete.
Exploratory Test Mode:	Transmitting with GFSK modulation. Transmitting mode.
Final Test Mode:	Through Pre-scan, find the 1Mbps of data type and GFSK modulation is the worst case. For below 1GHz part, through pre-scan, the worst case is the highest channel. Only the worst case is recorded in the report.
Test Results:	Pass

Radiated Emission below 1GHz		
30MHz~1GHz, the worst case		
Test mode:	Transmitting mode	Horizontal



	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark	Pol/Phase	APos	TPos
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB			cm	deg
1	52.39	9.20	13.80	23.00	40.00	-17.00	Peak	HORIZONTAL	100	245
2	105.27	9.56	12.86	22.42	43.50	-21.08	Peak	HORIZONTAL	100	214
3	240.83	10.44	15.95	26.39	46.00	-19.61	Peak	HORIZONTAL	100	169
4	501.18	12.91	21.84	34.75	46.00	-11.25	Peak	HORIZONTAL	100	133
5	768.75	10.48	25.76	36.24	46.00	-9.76	Peak	HORIZONTAL	100	101
6 pp	878.32	9.76	29.48	39.24	46.00	-6.76	Peak	HORIZONTAL	100	13

30MHz~1GHz, the worst case		
Test mode:	Transmitting mode	Vertical



	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark	Pol/Phase	APos	TPos
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB			cm	deg
1	41.57	11.01	12.32	23.33	40.00	-16.67	Peak	VERTICAL	100	360
2	113.32	9.94	12.24	22.18	43.50	-21.32	Peak	VERTICAL	100	60
3	308.91	10.31	17.99	28.30	46.00	-17.70	Peak	VERTICAL	100	93
4	468.88	11.18	20.86	32.04	46.00	-13.96	Peak	VERTICAL	100	12
5	603.54	11.41	22.84	34.25	46.00	-11.75	Peak	VERTICAL	100	32
6 pp	893.86	10.83	29.71	40.54	46.00	-5.46	Peak	VERTICAL	100	129

Transmitter Emission above 1GHz

Worse case mode:		GFSK(1Mbps)		Test channel:		Lowest			
Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Over (dB)	Detector Type	Ant. Pol. H/V	Antenna Height (m)	Table Angle (Degree)
2390	53.82	-9.2	44.62	74	-29.38	Peak	H	1.5	69
2400	54.35	-9.39	44.96	74	-29.04	Peak	H	1.5	230
4804	52.43	-4.33	48.10	74	-25.90	Peak	H	1.5	92
7206	50.82	1.01	51.83	74	-22.17	Peak	H	1.5	36
2390	53.82	-9.2	44.62	74	-29.38	Peak	V	1.5	295
2400	50.65	-9.39	41.26	74	-32.74	Peak	V	1.5	155
4804	53.63	-4.33	49.30	74	-24.70	Peak	V	1.5	356
7206	50.89	1.01	51.90	74	-22.10	Peak	V	1.5	343

Worse case mode:		GFSK(1Mbps)		Test channel:		Middle			
Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Over (dB)	Detector Type	Ant. Pol. H/V	Antenna Height (m)	Table Angle (Degree)
4880	52.24	-4.11	48.13	74	-25.87	peak	H	1.5	24
7320	51.22	1.51	52.73	74	-21.27	peak	H	1.5	218
4880	52.63	-4.11	48.52	74	-25.48	peak	V	1.5	17
7320	50.02	1.51	51.53	74	-22.47	peak	V	1.5	194

Worse case mode:		GFSK(1Mbps)		Test channel:		Highest			
Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Over (dB)	Detector Type	Ant. Pol. H/V	Antenna Height (m)	Table Angle (Degree)
2483.5	54.97	-9.29	45.68	74	-28.32	Peak	H	1.5	293
4960	51.33	-4.04	47.29	74	-26.71	Peak	H	1.5	192
7440	50.20	1.57	51.77	74	-22.23	Peak	H	1.5	102
2483.5	56.58	-9.29	47.29	74	-26.71	Peak	V	1.5	329
4960	50.96	-4.04	46.92	74	-27.08	Peak	V	1.5	101
7440	49.69	1.57	51.26	74	-22.74	Peak	V	1.5	348

Worse case mode:		GFSK(2Mbps)		Test channel:		Lowest			
Frequency	Meter Reading	Factor	Emission Level	Limits	Over	Detector Type	Ant. Pol.	Antenna Height	Table Angle
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)		H/V	(m)	(Degree)
2390	54.43	-9.2	45.23	74	-28.77	Peak	H	1.5	60
2400	54.80	-9.39	45.41	74	-28.59	Peak	H	1.5	324
4804	53.27	-4.33	48.94	74	-25.06	Peak	H	1.5	237
7206	49.38	1.01	50.39	74	-23.61	Peak	H	1.5	144
2390	53.06	-9.2	43.86	74	-30.14	Peak	V	1.5	308
2400	50.48	-9.39	41.09	74	-32.91	Peak	V	1.5	312
4804	55.16	-4.33	50.83	74	-23.17	Peak	V	1.5	299
7206	48.73	1.01	49.74	74	-24.26	Peak	V	1.5	42

Worse case mode:		GFSK(2Mbps)		Test channel:		Middle			
Frequency	Meter Reading	Factor	Emission Level	Limits	Over	Detector Type	Ant. Pol.	Antenna Height	Table Angle
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)		H/V	(m)	(Degree)
4880	52.94	-4.11	48.83	74	-25.17	peak	H	1.5	84
7320	50.69	1.51	52.20	74	-21.80	peak	H	1.5	118
4880	53.90	-4.11	49.79	74	-24.21	peak	V	1.5	89
7320	49.26	1.51	50.77	74	-23.23	peak	V	1.5	236

Worse case mode:		GFSK(2Mbps)		Test channel:		Highest			
Frequency	Meter Reading	Factor	Emission Level	Limits	Over	Detector Type	Ant. Pol.	Antenna Height	Table Angle
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)		H/V	(m)	(Degree)
2483.5	54.41	-9.29	45.12	74	-28.88	Peak	H	1.5	181
4960	51.38	-4.04	47.34	74	-26.66	Peak	H	1.5	210
7440	48.63	1.57	50.20	74	-23.80	Peak	H	1.5	196
2483.5	56.35	-9.29	47.06	74	-26.94	Peak	V	1.5	231
4960	52.02	-4.04	47.98	74	-26.02	Peak	V	1.5	31
7440	48.61	1.57	50.18	74	-23.82	Peak	V	1.5	36

Remark:

1) The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

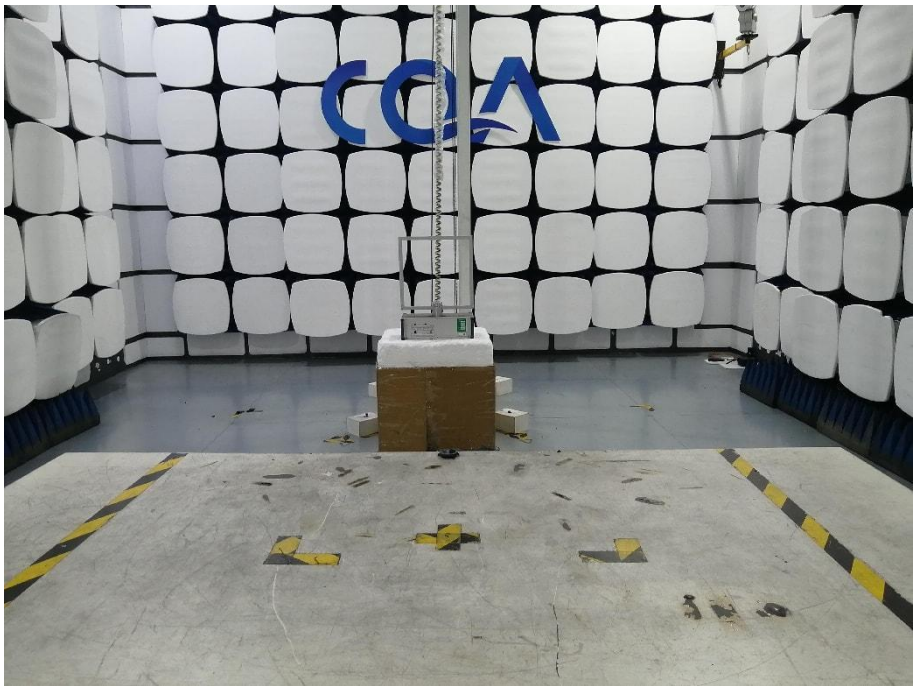
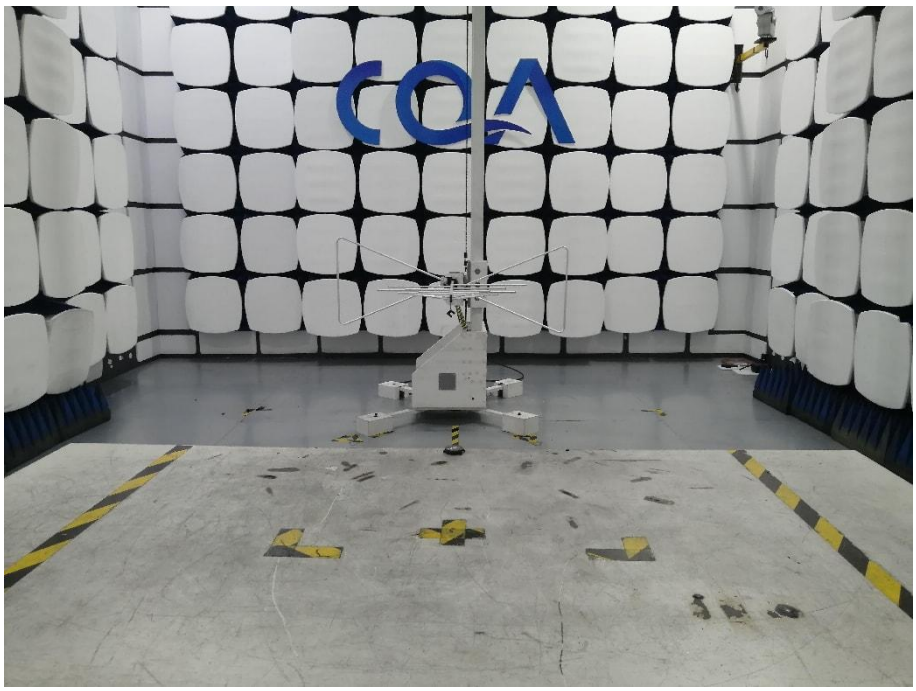
   Final Test Level =Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor

2) Scan from 9kHz to 25GHz, the disturbance above 10GHz and below 30MHz was very low. As shown in this section, for frequencies above 1GHz, the field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. So, only the peak measurements were shown in the report.

6 Photographs - EUT Test Setup

6.1 Radiated Spurious Emission

9kHz~30MHz:



30MHz~1GHz: