

### 13 RADIATED SPURIOUS EMISSIONS

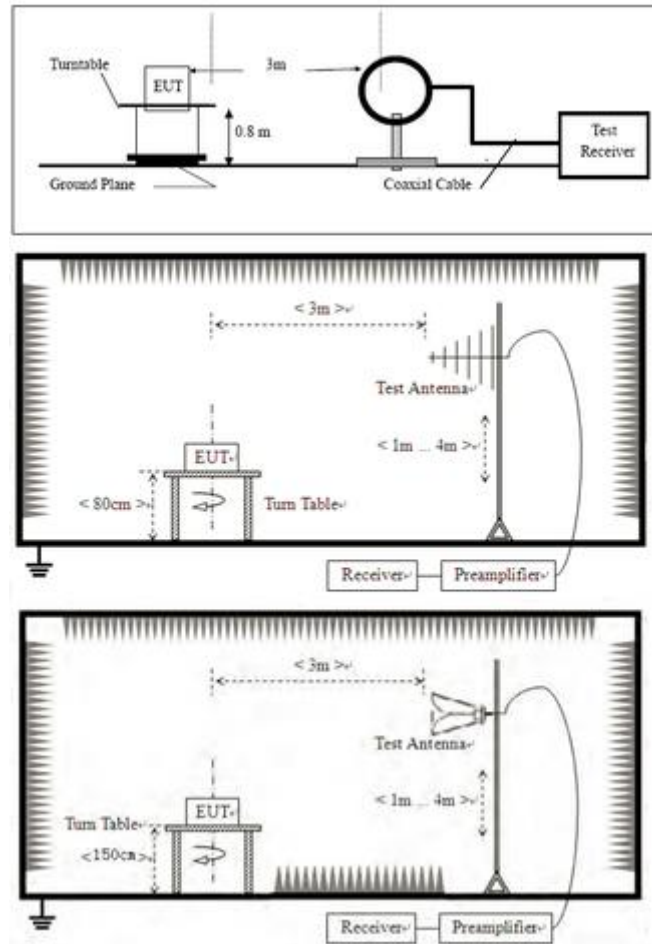
<b>Test Standard</b>	47 CFR Part 15, Subpart C 15.247
<b>Test Method</b>	ANSI C63.10 (2013) Section 6.4,6.5,6.6
<b>Test Mode (Pre-Scan)</b>	TX
<b>Test Mode (Final Test)</b>	TX
<b>Tester</b>	Charlie
<b>Temperature</b>	25℃
<b>Humidity</b>	60%

#### 13.1 LIMITS

<b>Frequency(MHz)</b>	<b>Field strength(microvolts/meter)</b>	<b>Measurement distance(meters)</b>
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Remark: The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90kHz, 110-490kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector, 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.

### 13.2 BLOCK DIAGRAM OF TEST SETUP



### 13.3 PROCEDURE

- For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter fully-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- 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.
- 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.
- The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- 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.

- h. Test the EUT in the lowest channel, the middle channel, the Highest channel.
- i. 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.
- j. Repeat above procedures until all frequencies measured was complete.

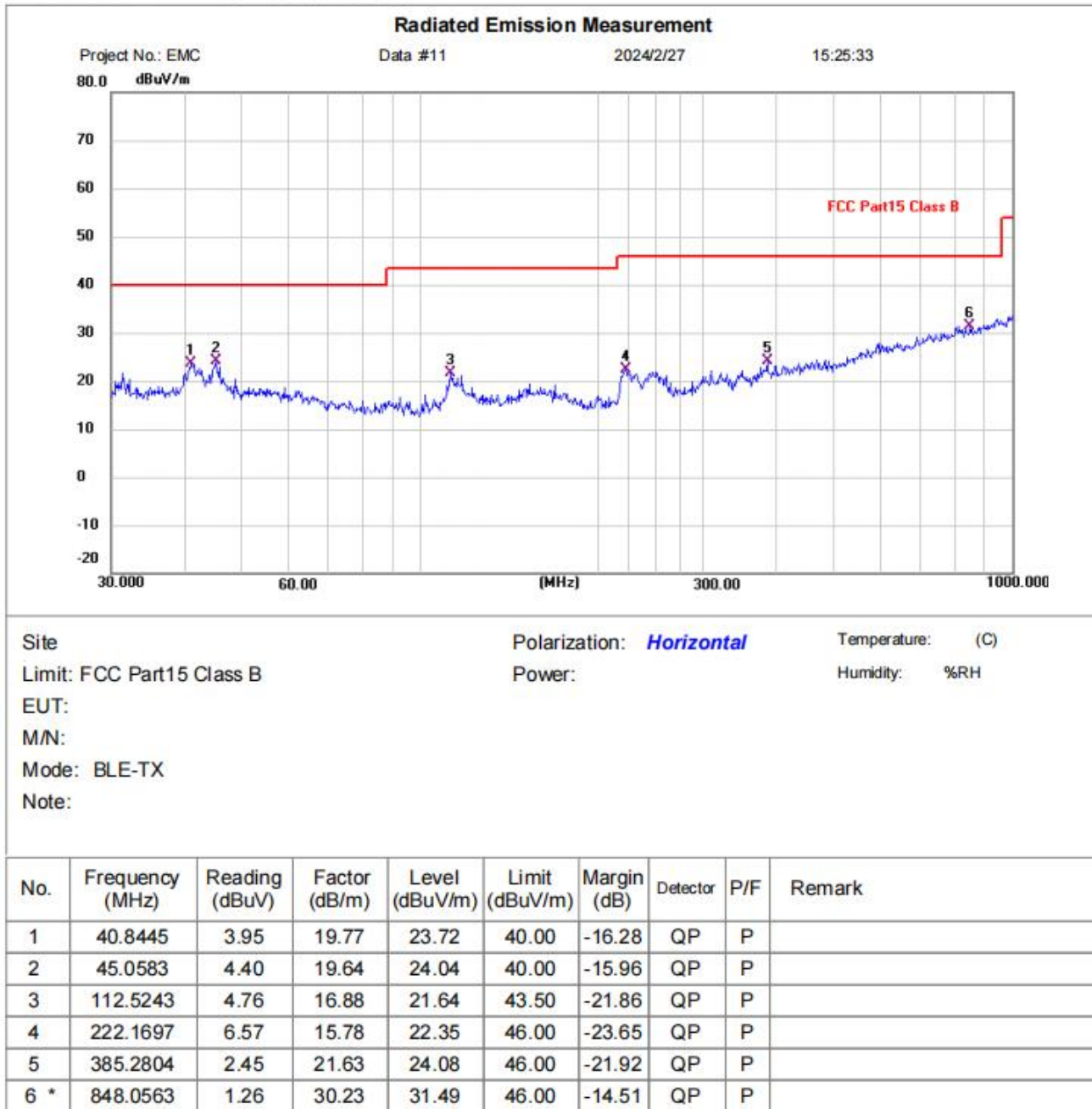
Remark:

- 1) For emission below 1GHz, through pre-scan found the worst case is the lowest channel. Only the worst case is recorded in the report.
- 2) 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
- 3) Scan from 9kHz to 25GHz, the disturbance above 12.75GHz and below 30MHz was very low. The points marked on above plots are the highest emissions could be found when testing, so only above points had been displayed. The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported. fundamental frequency is blocked by filter, and only spurious emission is shown.
- 4) 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. For the emissions whose peak level is lower than the average limit, only the peak measurement is shown in the report.

### 13.4 TEST DATA

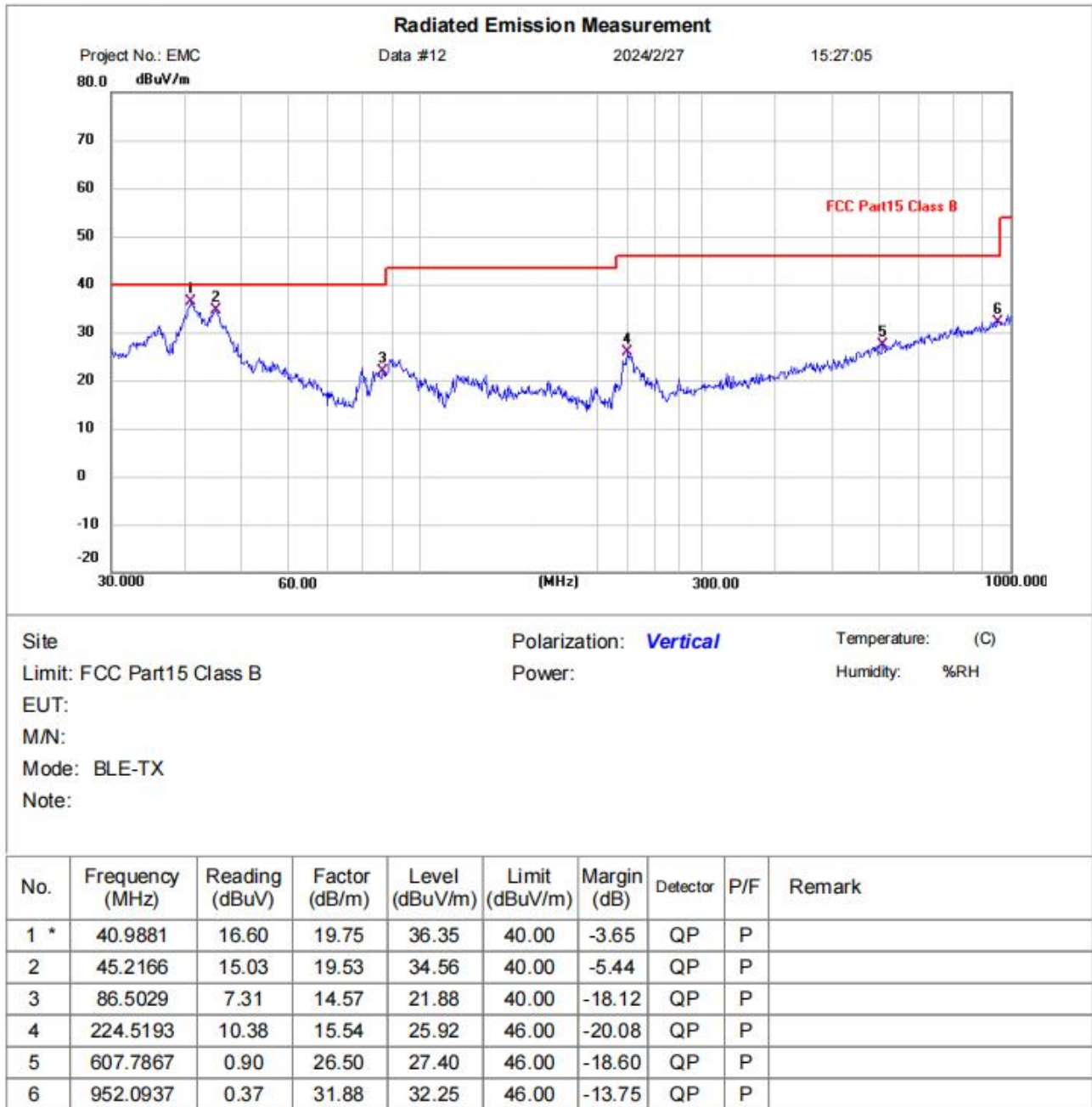
Below 1GHz

[TestMode: TX]; [Polarity: Horizontal]



**Test Result: Pass**

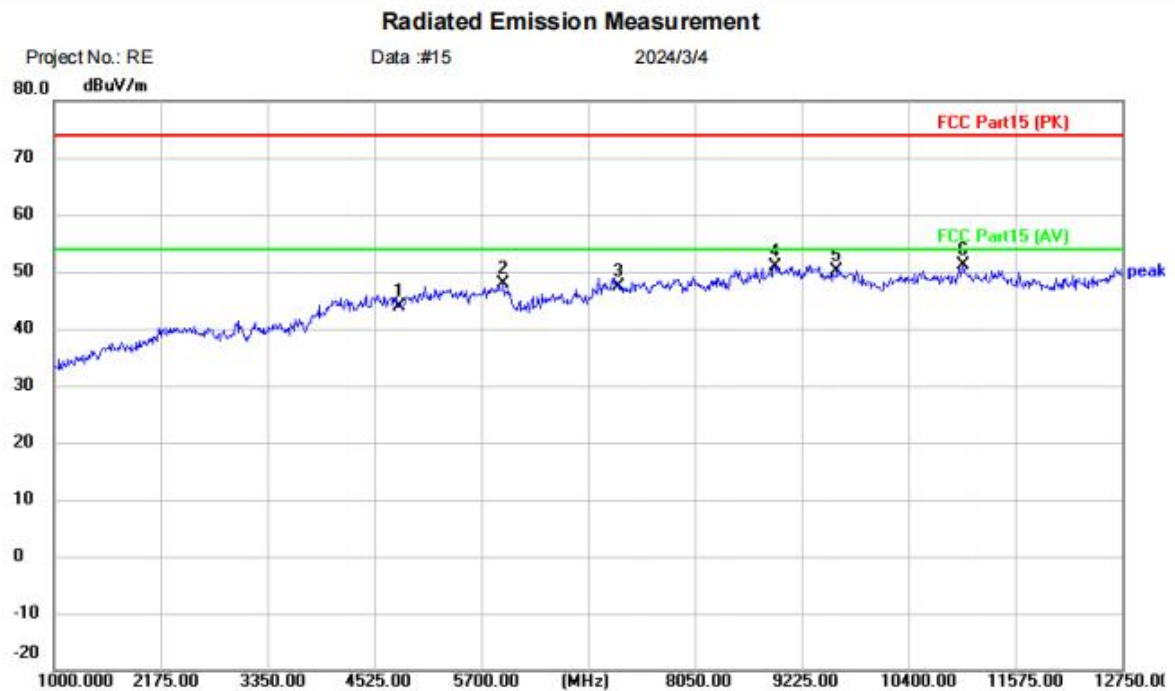
[TestMode: TX]; [Polarity: Vertical]



**Test Result: Pass**

Above 1GHz:

[TestMode: TX low channel]; [Polarity: Horizontal]



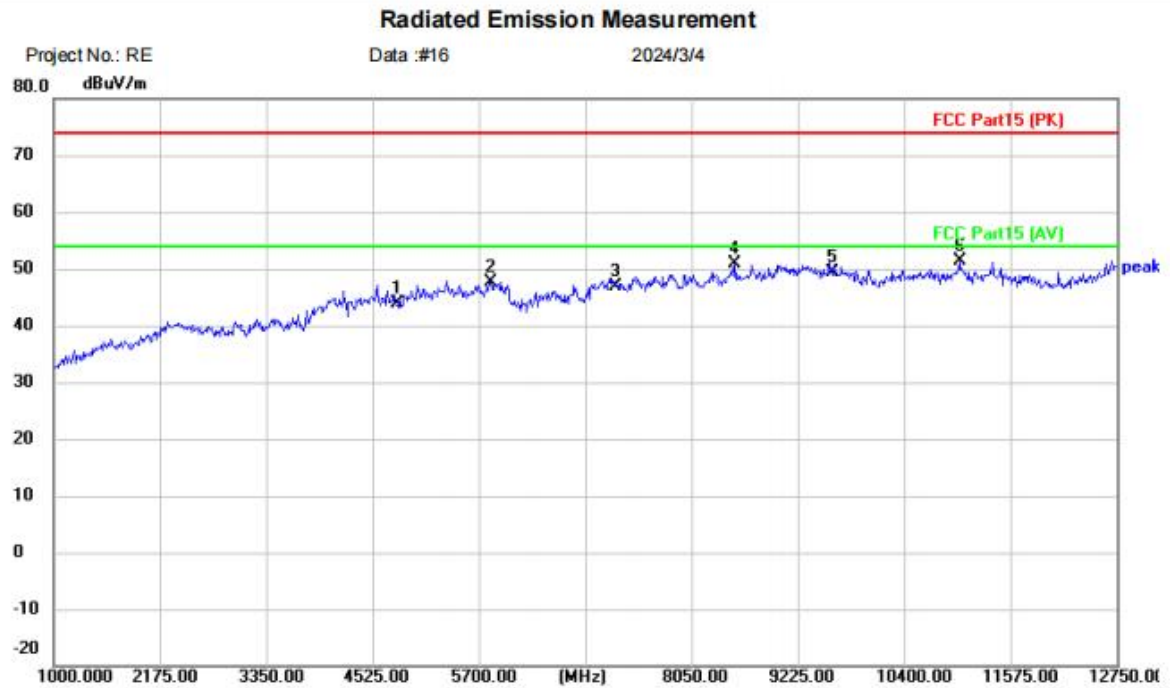
Site:      Polarization: **Horizontal**      Temperature: (C)  
Limit: FCC Part15 (PK)      Power:      Humidity: %RH  
EUT:  
M/N:  
Mode: BLE-TX-2402  
Note:

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Detector	Comment
1		4804.000	38.17	5.64	43.81	74.00	-30.19	peak	
2		5946.750	39.16	8.71	47.87	74.00	-26.13	peak	
3		7206.000	38.15	9.24	47.39	74.00	-26.61	peak	
4		8931.250	38.75	12.19	50.94	74.00	-23.06	peak	
5		9608.000	37.71	12.31	50.02	74.00	-23.98	peak	
6	*	10999.25	37.65	13.48	51.13	74.00	-22.87	peak	

**Test Result: Pass**



[TestMode: TX low channel]; [Polarity: Vertical]

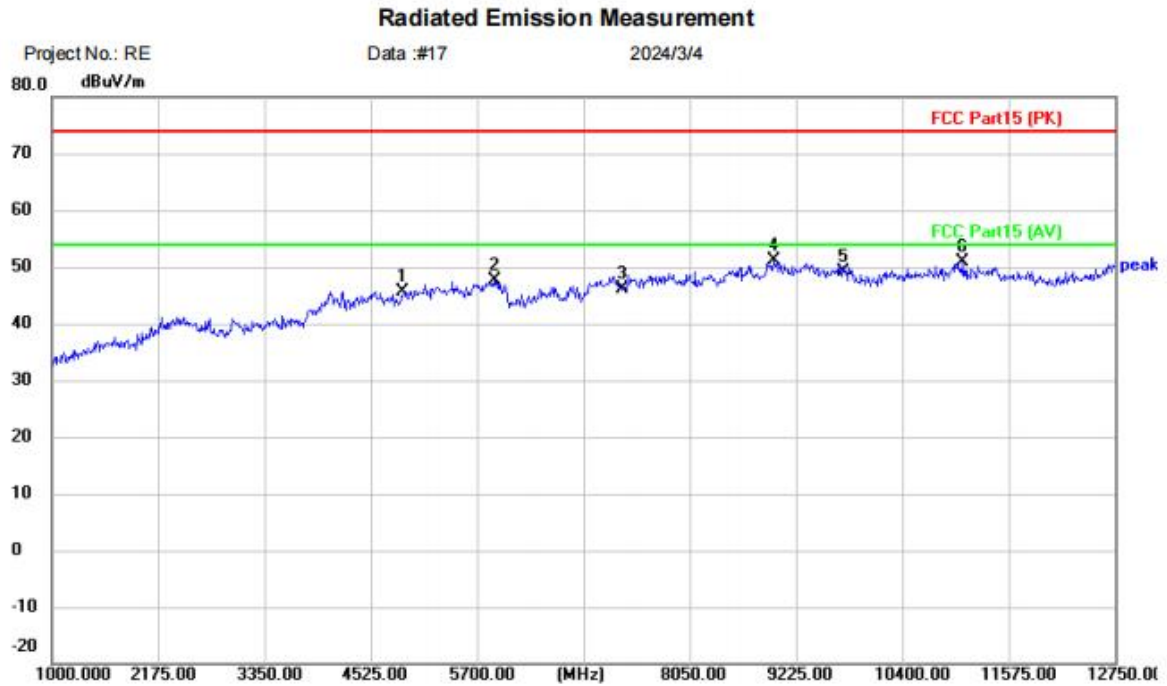


Site      Polarization: **Vertical**      Temperature: (C)  
Limit: FCC Part15 (PK)      Power:      Humidity: %RH  
EUT:  
M/N:  
Mode: BLE-TX-2402  
Note:

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Detector	Comment
1		4804.000	38.24	5.64	43.88	74.00	-30.12	peak	
2		5829.250	39.44	8.21	47.65	74.00	-26.35	peak	
3		7206.000	37.70	9.24	46.94	74.00	-27.06	peak	
4		8531.750	39.72	11.12	50.84	74.00	-23.16	peak	
5		9608.000	37.08	12.31	49.39	74.00	-24.61	peak	
6	*	11011.00	37.94	13.40	51.34	74.00	-22.66	peak	

**Test Result: Pass**

[TestMode: TX middle channel]; [Polarity: Horizontal]



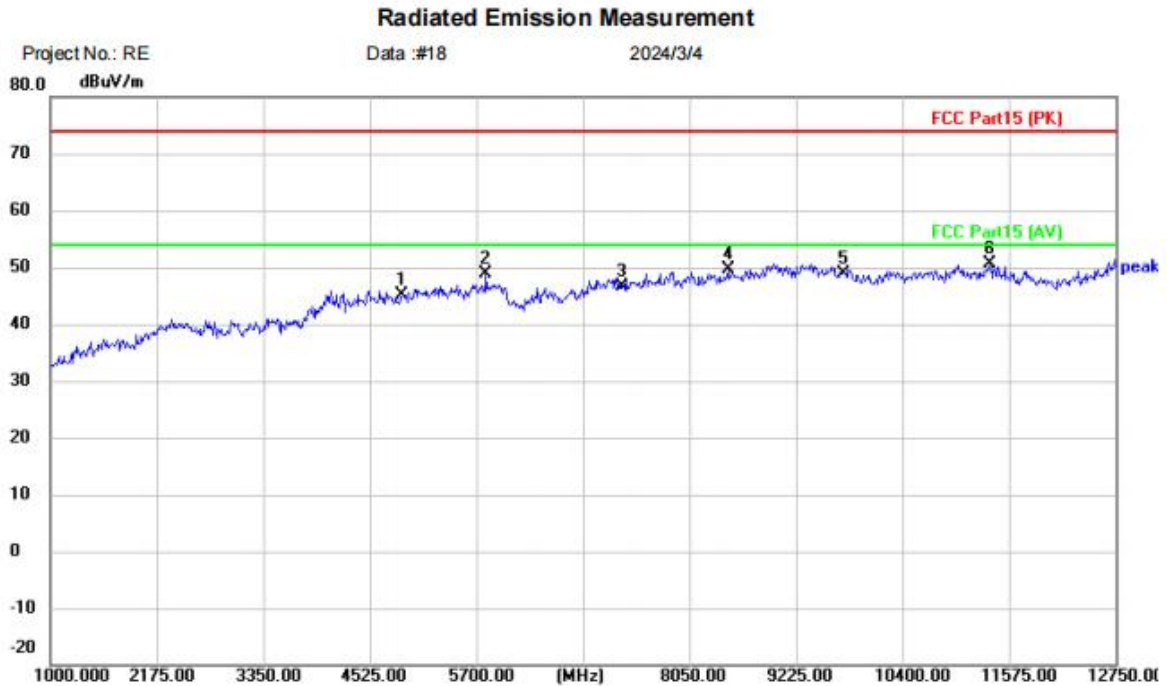
Site:      Polarization: **Horizontal**      Temperature: (C)  
Limit: FCC Part15 (PK)      Power:      Humidity: %RH  
EUT:  
M/N:  
Mode: BLE-TX-2440  
Note:

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Detector	Comment
1		4880.000	39.93	5.72	45.65	74.00	-28.35	peak	
2		5888.000	38.95	8.60	47.55	74.00	-26.45	peak	
3		7320.000	36.76	9.43	46.19	74.00	-27.81	peak	
4	*	8978.250	38.78	12.37	51.15	74.00	-22.85	peak	
5		9760.000	36.81	12.21	49.02	74.00	-24.98	peak	
6		11069.75	37.89	12.99	50.88	74.00	-23.12	peak	

**Test Result: Pass**



[TestMode: TX middle channel]; [Polarity: Vertical]



Site      Polarization: **Vertical**      Temperature: (C)

Limit: FCC Part15 (PK)      Power:      Humidity: %RH

EUT:

M/N:

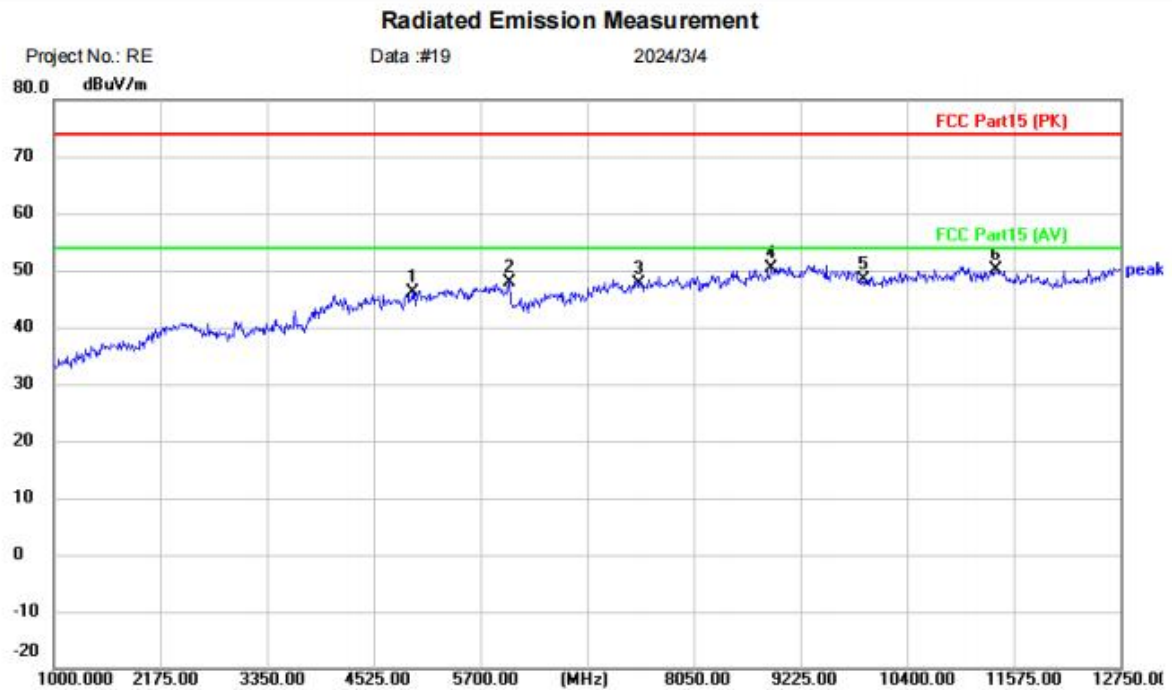
Mode: BLE-TX-2440

Note:

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Detector	Comment
1		4880.000	39.37	5.72	45.09	74.00	-28.91	peak	
2		5805.750	40.85	7.99	48.84	74.00	-25.16	peak	
3		7320.000	37.15	9.43	46.58	74.00	-27.42	peak	
4		8473.000	38.84	10.77	49.61	74.00	-24.39	peak	
5		9760.000	36.60	12.21	48.81	74.00	-25.19	peak	
6	*	11363.50	37.98	12.65	50.63	74.00	-23.37	peak	

**Test Result: Pass**

[TestMode: TX High channel]; [Polarity: Horizontal]



Site:      Polarization: **Horizontal**      Temperature: (C)

Limit: FCC Part15 (PK)      Power:      Humidity: %RH

EUT:

M/N:

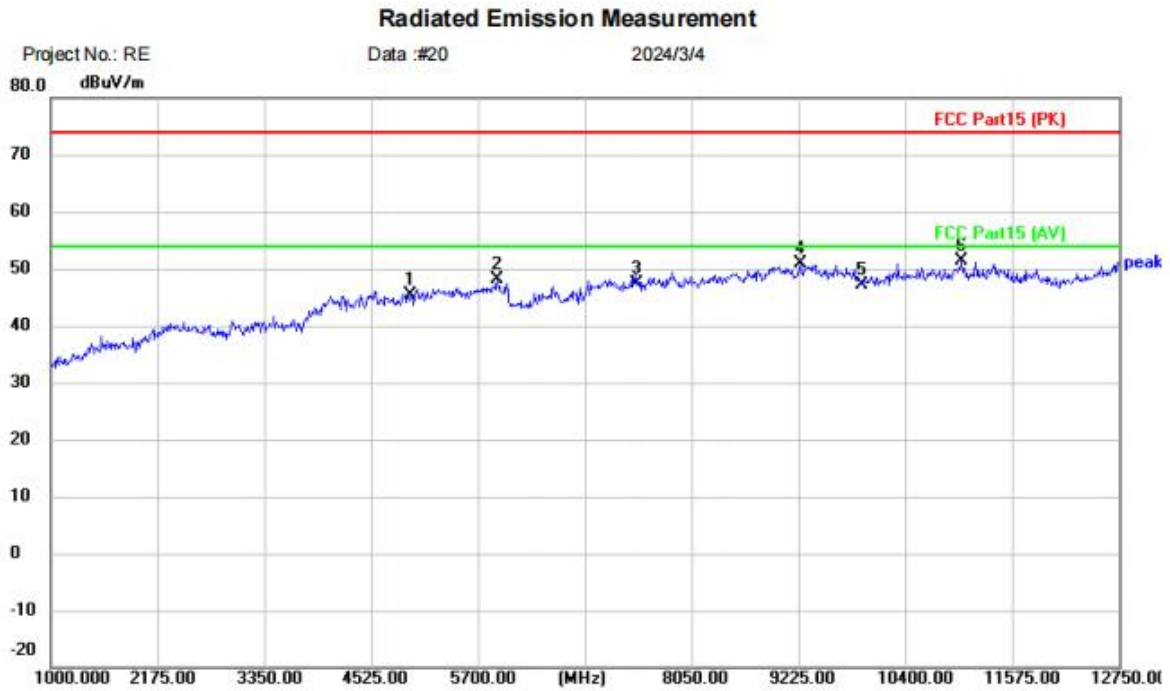
Mode: BLE-TX-2480

Note:

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Detector	Comment
1		4960.000	39.45	6.60	46.05	74.00	-27.95	peak	
2		6017.250	42.36	5.63	47.99	74.00	-26.01	peak	
3		7440.000	37.89	9.64	47.53	74.00	-26.47	peak	
4	*	8896.000	38.30	12.03	50.33	74.00	-23.67	peak	
5		9920.000	36.26	12.14	48.40	74.00	-25.60	peak	
6		11375.25	37.52	12.63	50.15	74.00	-23.85	peak	

**Test Result: Pass**

[TestMode: TX High channel]; [Polarity: Vertical]



Site      Polarization: **Vertical**      Temperature: (C)  
Limit: FCC Part15 (PK)      Power:      Humidity: %RH  
EUT:  
M/N:  
Mode: BLE-TX-2480  
Note:

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Detector	Comment
1		4960.000	38.70	6.60	45.30	74.00	-28.70	peak	
2		5911.500	39.35	8.68	48.03	74.00	-25.97	peak	
3		7440.000	37.86	9.64	47.50	74.00	-26.50	peak	
4		9248.500	38.19	12.73	50.92	74.00	-23.08	peak	
5		9920.000	35.03	12.14	47.17	74.00	-26.83	peak	
6	*	11022.75	37.99	13.32	51.31	74.00	-22.69	peak	

**Test Result: Pass**

## 14 ANTENNA REQUIREMENT

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

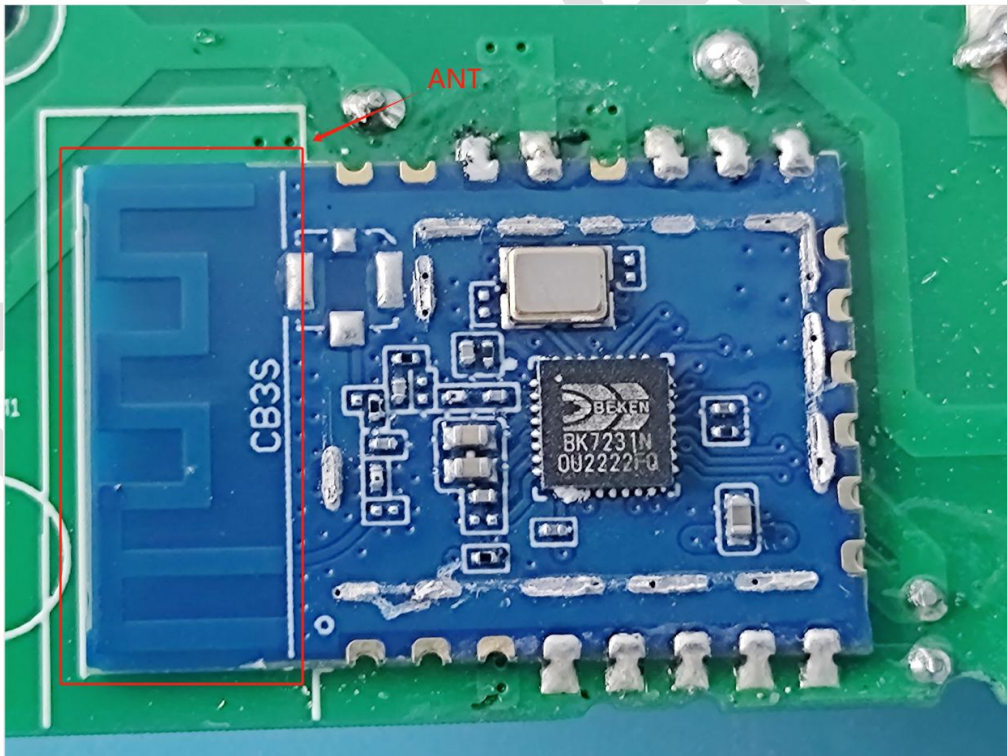
### 14.1 CONCLUSION

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 an 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 -15.36dBi.



## 15 RADIATED EMISSIONS WHICH FALL IN THE RESTRICTED BANDS

<b>Test Standard</b>	47 CFR Part 15, Subpart C 15.247
<b>Test Method</b>	ANSI C63.10 (2013) Section 6.10.5
<b>Test Mode (Pre-Scan)</b>	TX
<b>Test Mode (Final Test)</b>	TX
<b>Tester</b>	Charlie
<b>Temperature</b>	25°C
<b>Humidity</b>	60%

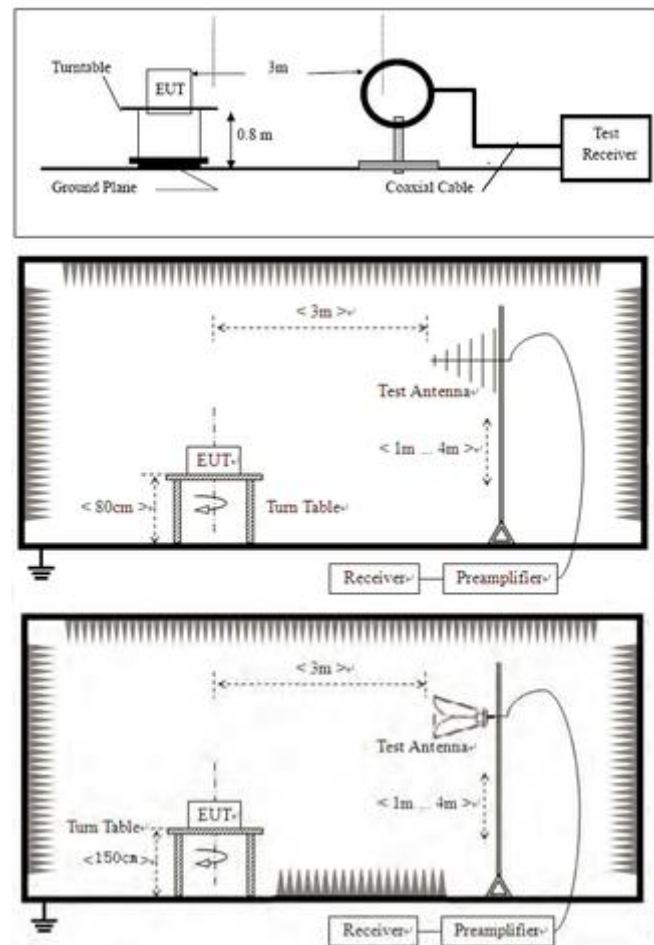
### 15.1 LIMITS

<b>Frequency(MHz)</b>	<b>Field strength(microvolts/meter)</b>	<b>Measurement distance(meters)</b>
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Remark: The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90kHz, 110-490kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector, 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.



## 15.2 BLOCK DIAGRAM OF TEST SETUP



## 15.3 PROCEDURE

- For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter fully-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- 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.
- 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.
- The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- 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.



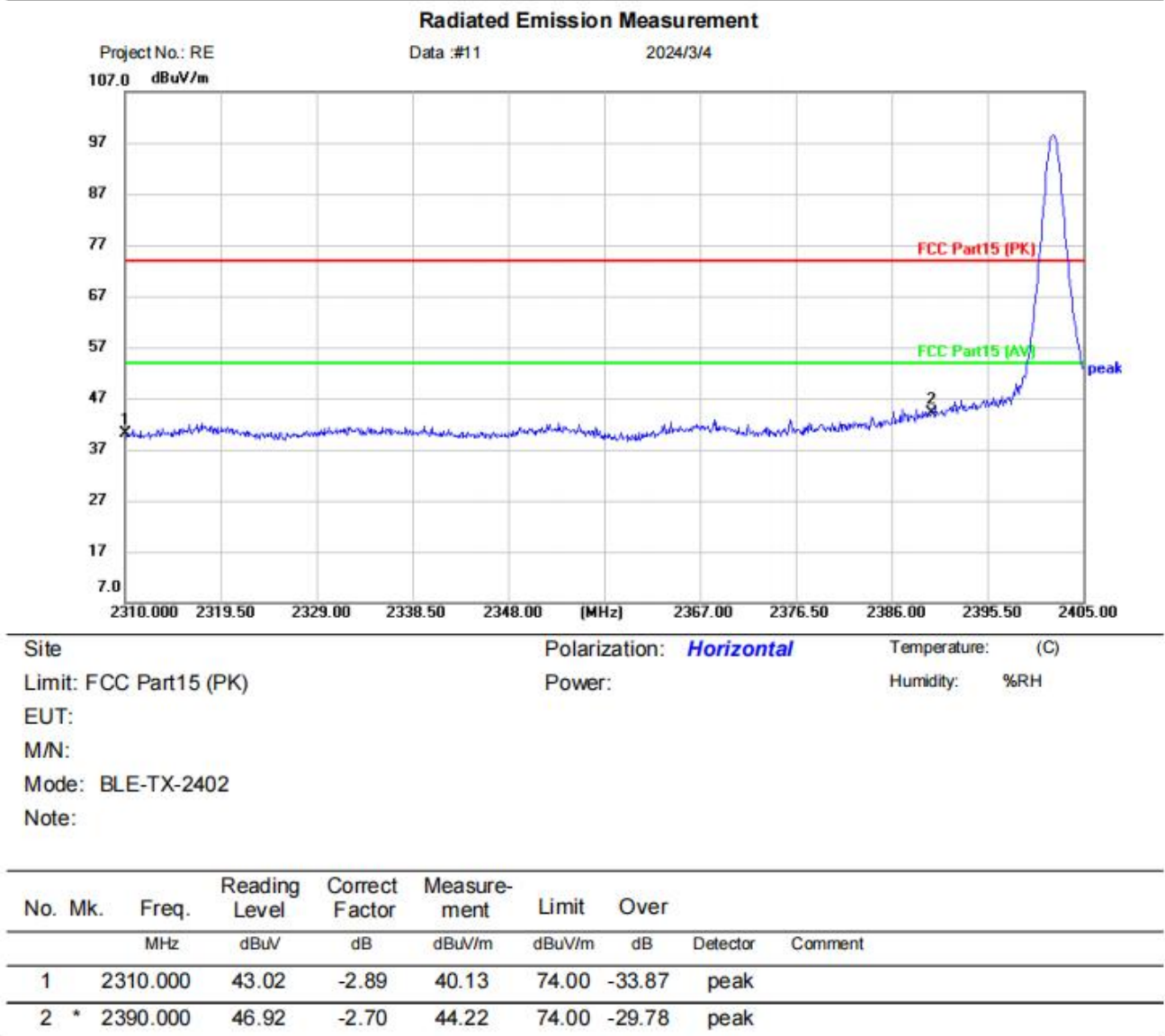
- h. Test the EUT in the lowest channel, the middle channel, the Highest channel.
- i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.
- j. Repeat above procedures until all frequencies measured was complete.

Remark 1:  $\text{Level} = \text{Read Level} + \text{Cable Loss} + \text{Antenna Factor} - \text{Preamp Factor}$

Remark 2: 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. For the emissions whose peak level is lower than the average limit, only the peak measurement is shown in the report.

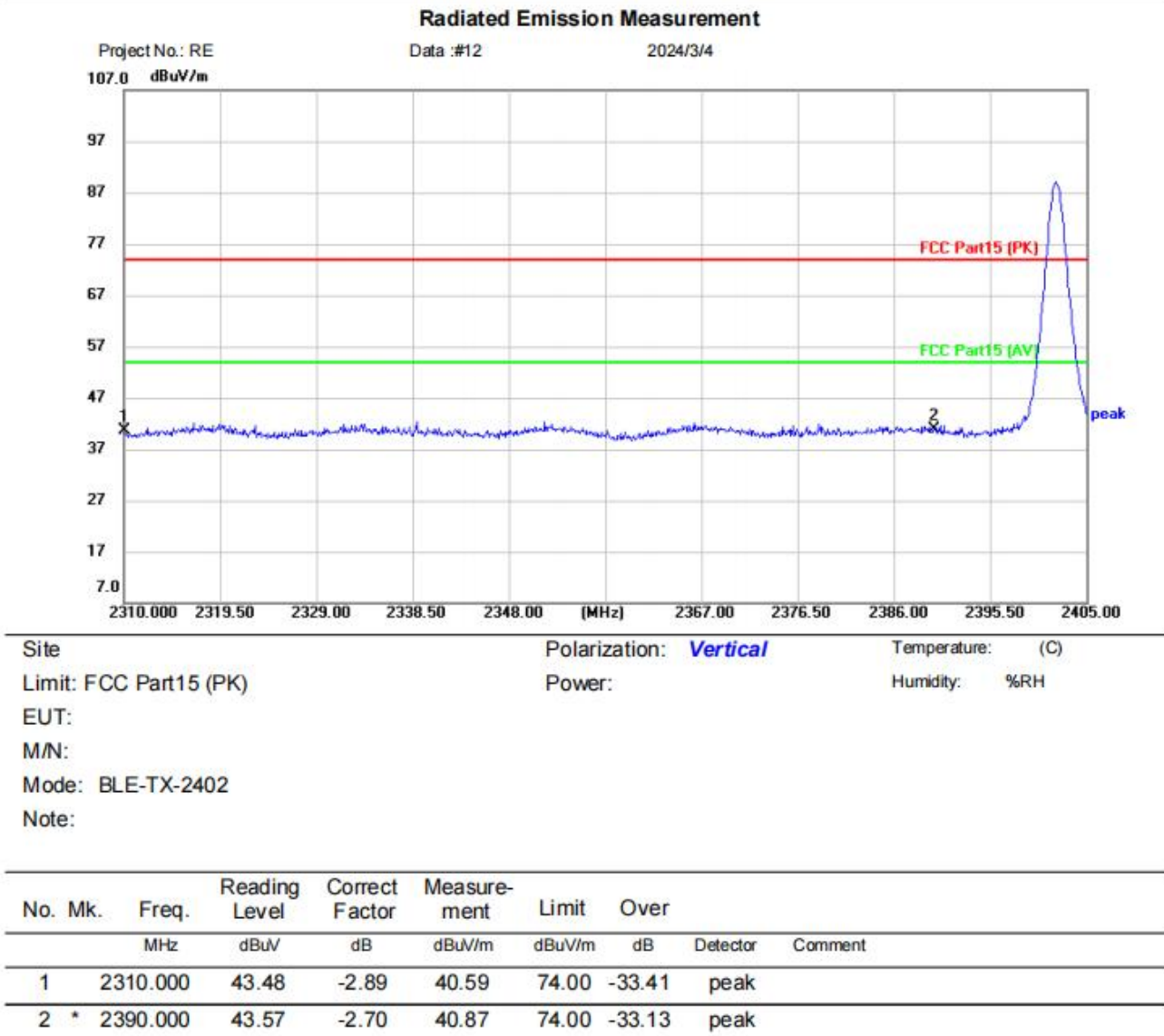
## 15.4 TEST DATA

[TestMode: TX low channel]; [Polarity: Horizontal]



**Test Result: Pass**

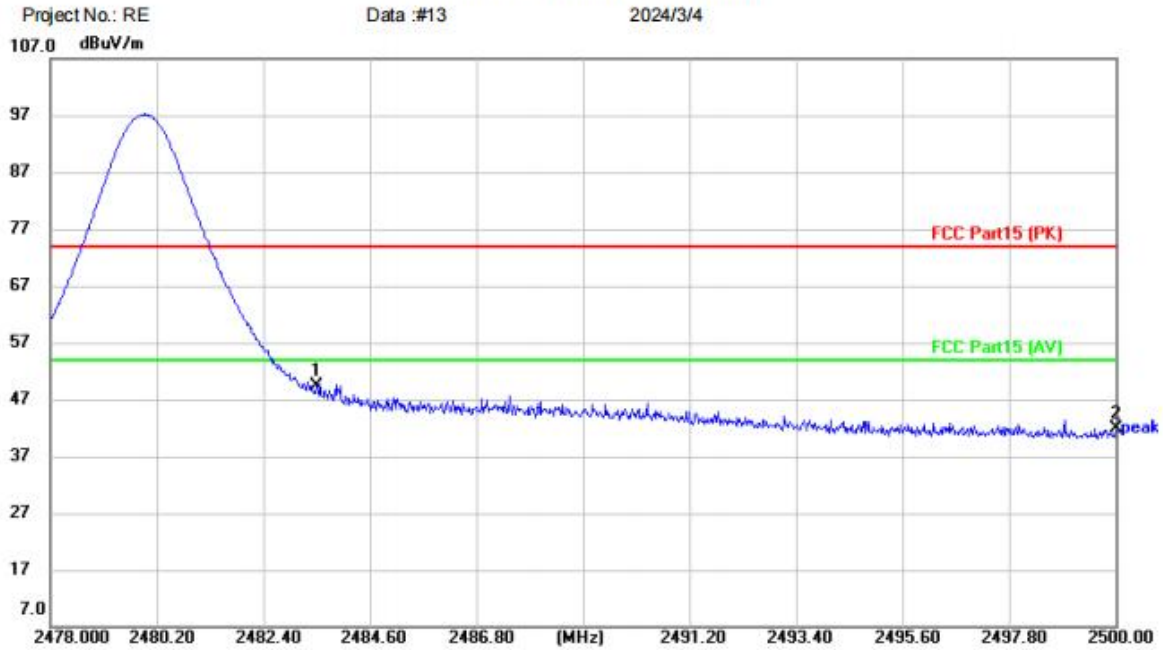
[TestMode:TX low channel]; [Polarity: Vertical]



**Test Result: Pass**

[TestMode: TX High channel]; [Polarity: Horizontal]

### Radiated Emission Measurement

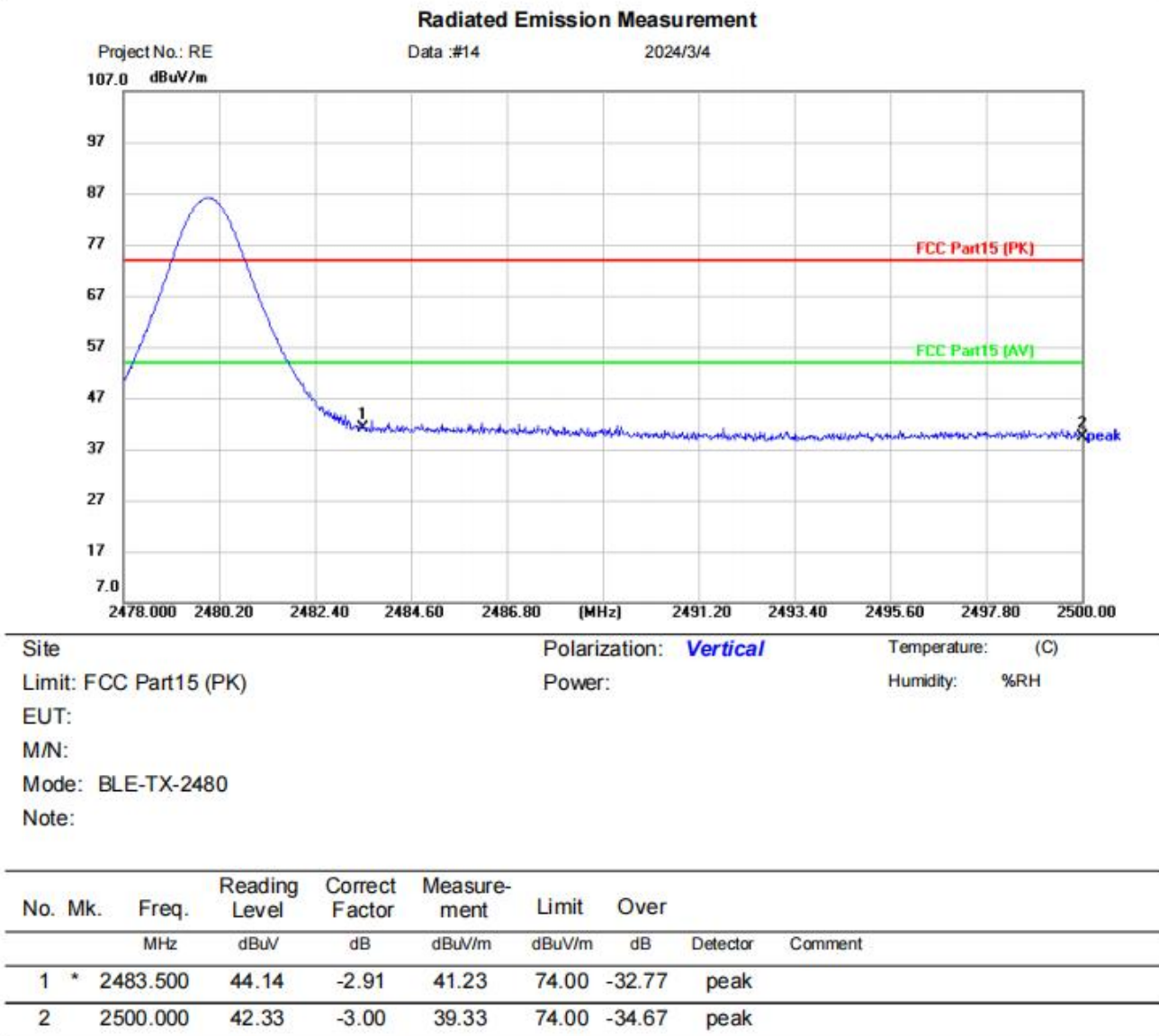


Site Polarization: **Horizontal** Temperature: (C)  
Limit: FCC Part15 (PK) Power: Humidity: %RH  
EUT:  
M/N:  
Mode: BLE-TX-2480  
Note:

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Detector	Comment
1	*	2483.500	52.28	-2.91	49.37	74.00	-24.63	peak	
2		2500.000	44.99	-3.00	41.99	74.00	-32.01	peak	

**Test Result: Pass**

[TestMode:TX High channel]; [Polarity: Vertical]



**Test Result: Pass**

## 16 CONDUCTED SPURIOUS EMISSIONS

<b>Test Standard</b>	47 CFR Part 15, Subpart C 15.247
<b>Test Method</b>	ANSI C63.10 (2013) Section 7.8.6 & Section 11.11
<b>Test Mode (Pre-Scan)</b>	TX
<b>Test Mode (Final Test)</b>	TX
<b>Tester</b>	Charlie
<b>Temperature</b>	25°C
<b>Humidity</b>	60%

### 16.1 LIMITS

<b>Limit:</b>	<p>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)).</p>
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