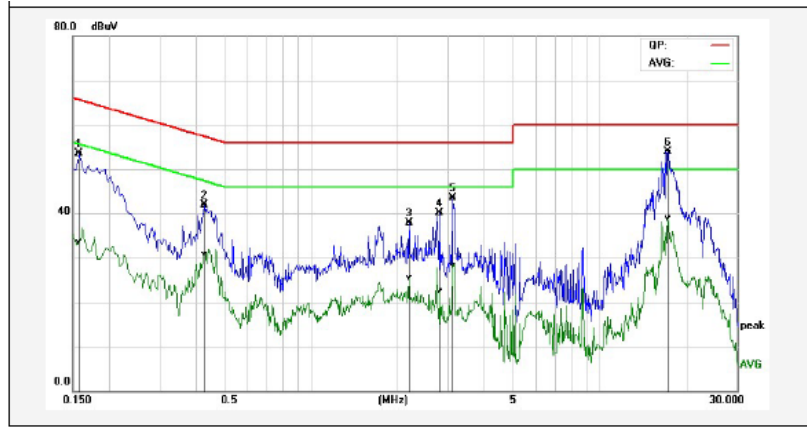
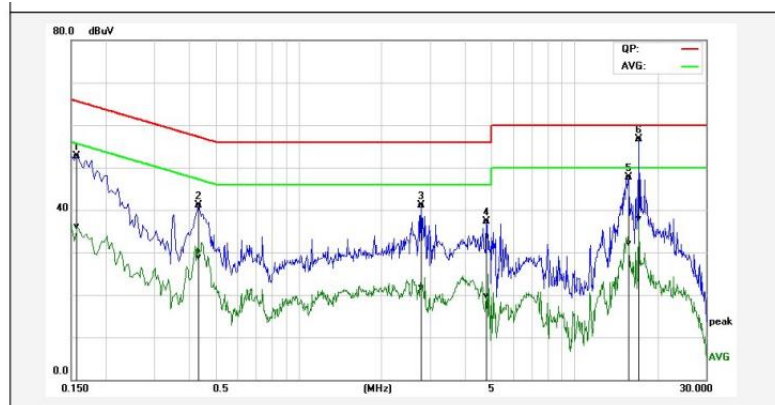


# Appendix A: Test Results of BLE

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## Appendix A.1 Test Results of Conducted Emission on AC Mains

Note: All modes have been tested, and the report only reflects the worst mode.

|                                                                                                 |           |                |         |            |           |         |           |         |           |         |        |
|-------------------------------------------------------------------------------------------------|-----------|----------------|---------|------------|-----------|---------|-----------|---------|-----------|---------|--------|
| Test Mode :                                                                                     | Mode 7    | Test Voltage : | DC 3.3V |            |           |         |           |         |           |         |        |
| L                                                                                               |           |                |         |            |           |         |           |         |           |         |        |
| <div></div>   |           |                |         |            |           |         |           |         |           |         |        |
| No.                                                                                             | Frequency | QuasiPeak      | Average | Correction | QuasiPeak | Average | QuasiPeak | Average | QuasiPeak | Average | Remark |
|                                                                                                 | (MHz)     | reading        | reading | factor     | result    | result  | limit     | limit   | margin    | margin  |        |
|                                                                                                 |           | (dBuV)         | (dBuV)  | (dB)       | (dBuV)    | (dBuV)  | (dBuV)    | (dBuV)  | (dB)      | (dB)    |        |
| 1P                                                                                              | 0.1580    | 43.99          | 24.01   | 9.50       | 53.49     | 33.51   | 65.56     | 55.57   | -12.07    | -22.06  | Pass   |
| 2P                                                                                              | 0.4300    | 32.48          | 21.28   | 9.50       | 41.98     | 30.78   | 57.25     | 47.25   | -15.27    | -16.47  | Pass   |
| 3P                                                                                              | 2.2100    | 28.62          | 16.21   | 9.28       | 37.90     | 25.49   | 56.00     | 46.00   | -18.10    | -20.51  | Pass   |
| 4P                                                                                              | 2.8179    | 30.82          | 13.30   | 9.22       | 40.04     | 22.52   | 56.00     | 46.00   | -15.96    | -23.48  | Pass   |
| 5P                                                                                              | 3.1220    | 34.41          | 19.21   | 9.19       | 43.60     | 28.40   | 56.00     | 46.00   | -12.40    | -17.60  | Pass   |
| 6*                                                                                              | 17.2099   | 44.51          | 29.53   | 9.44       | 53.95     | 38.97   | 60.00     | 50.00   | -6.05     | -11.03  | Pass   |
| N                                                                                               |           |                |         |            |           |         |           |         |           |         |        |
| <div></div> |           |                |         |            |           |         |           |         |           |         |        |
| No.                                                                                             | Frequency | QuasiPeak      | Average | Correction | QuasiPeak | Average | QuasiPeak | Average | QuasiPeak | Average | Remark |
|                                                                                                 | (MHz)     | reading        | reading | factor     | result    | result  | limit     | limit   | margin    | margin  |        |
|                                                                                                 |           | (dBuV)         | (dBuV)  | (dB)       | (dBuV)    | (dBuV)  | (dBuV)    | (dBuV)  | (dB)      | (dB)    |        |
| 1P                                                                                              | 0.1580    | 43.30          | 26.69   | 9.40       | 52.70     | 36.09   | 65.56     | 55.57   | -12.86    | -19.48  | Pass   |
| 2P                                                                                              | 0.4340    | 31.72          | 19.45   | 9.40       | 41.12     | 28.85   | 57.18     | 47.18   | -16.06    | -18.33  | Pass   |
| 3P                                                                                              | 2.7940    | 32.00          | 12.54   | 9.12       | 41.12     | 21.66   | 56.00     | 46.00   | -14.88    | -24.34  | Pass   |
| 4P                                                                                              | 4.7980    | 28.28          | 10.66   | 9.00       | 37.28     | 19.66   | 56.00     | 46.00   | -18.72    | -26.34  | Pass   |
| 5P                                                                                              | 15.7700   | 38.63          | 22.94   | 9.12       | 47.75     | 32.06   | 60.00     | 50.00   | -12.25    | -17.94  | Pass   |
| 6*                                                                                              | 17.1700   | 47.49          | 28.81   | 9.14       | 56.63     | 37.95   | 60.00     | 50.00   | -3.37     | -12.05  | Pass   |

Correction Factor = insertion loss of LISN + cable loss;

Reading = Reading Amplitude in the instrument;

Result = Correction Factor + Reading;

Margin = Result – Limit

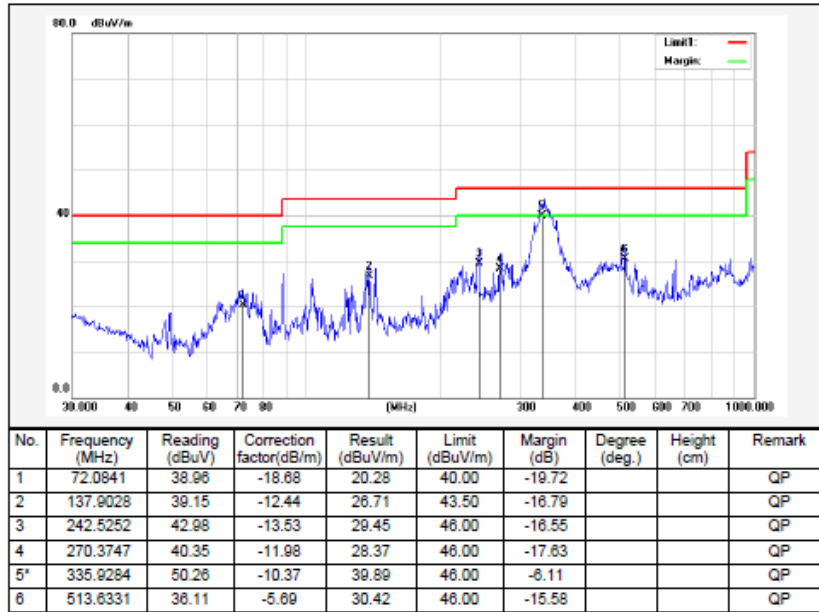
## Appendix A.2 Test Results of Radiated Spurious Emission

**Below 1GHz:**

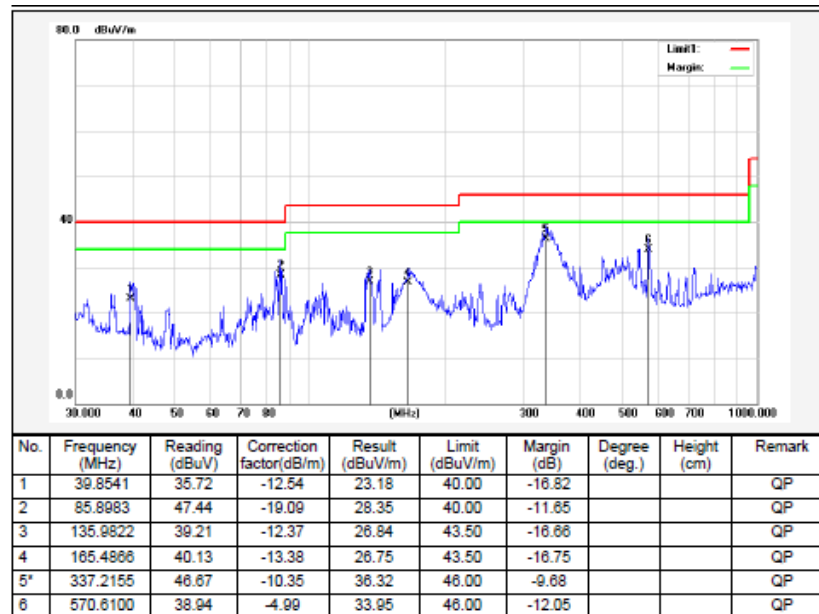
**All modes have been tested, and the report only reflects the worst mode.**

Test Mode: Mode 5

Horizontal



Vertical



Correction Factor = antenna factor + cable loss – amplifier gain;

Reading = Reading Amplitude in the instrument;

Result = Correction Factor + Reading;

Margin = Result – Limit.

**Above 1GHz:**

**Note: All modes have been tested, and the report only reflects the worst mode(1Mbps).**

**GFSK-Low Horizontal**

| No. | Frequency<br>(MHz) | Reading<br>(dBuV) | Correct<br>Factor(dB/m) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin<br>(dB) | Remark |
|-----|--------------------|-------------------|-------------------------|--------------------|-------------------|----------------|--------|
| 1   | 4808               | 59.6              | -13.33                  | 46.27              | 74                | -27.73         | peak   |
| 2   | 4808               | 50.75             | -13.33                  | 37.42              | 54                | -16.58         | AVG    |
| 3   | 7596               | 55.59             | -7.26                   | 48.33              | 74                | -25.67         | peak   |
| 4   | 7596               | 48.31             | -7.26                   | 41.05              | 54                | -12.95         | AVG    |
| 5   | 11132              | 54.16             | -2.48                   | 51.68              | 74                | -22.32         | peak   |
| 6   | 11132              | 45.33             | -2.48                   | 42.85              | 54                | -11.15         | AVG    |
| 7   | 13716              | 53.85             | 1.55                    | 55.4               | 74                | -18.6          | peak   |
| 8   | 13716              | 43.06             | 1.55                    | 44.61              | 54                | -9.39          | AVG    |
| 9   | 15382              | 52.92             | 7.02                    | 59.94              | 74                | -14.06         | peak   |
| 10  | 15382              | 39.7              | 7.02                    | 46.72              | 54                | -7.28          | AVG    |
| 11  | 17966              | 51.89             | 9.99                    | 61.88              | 74                | -12.12         | peak   |
| 12  | 17966              | 37.5              | 9.99                    | 47.49              | 54                | -6.51          | AVG    |

**GFSK-Low Vertical**

| No. | Frequency<br>(MHz) | Reading<br>(dBuV) | Correct<br>Factor(dB/m) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin<br>(dB) | Remark |
|-----|--------------------|-------------------|-------------------------|--------------------|-------------------|----------------|--------|
| 1   | 3958               | 61.69             | -15.09                  | 46.6               | 74                | -27.4          | peak   |
| 2   | 3958               | 51.68             | -15.09                  | 36.59              | 54                | -17.41         | AVG    |
| 3   | 7528               | 56.63             | -7.17                   | 49.46              | 74                | -24.54         | peak   |
| 4   | 7528               | 45.58             | -7.17                   | 38.41              | 54                | -15.59         | AVG    |
| 5   | 9704               | 56.55             | -6.65                   | 49.9               | 74                | -24.1          | peak   |
| 6   | 9704               | 48.11             | -6.65                   | 41.46              | 54                | -12.54         | AVG    |
| 7   | 11438              | 54.6              | -2.04                   | 52.56              | 74                | -21.44         | peak   |
| 8   | 11438              | 45.89             | -2.04                   | 43.85              | 54                | -10.15         | AVG    |
| 9   | 15212              | 53.6              | 6.63                    | 60.23              | 74                | -13.77         | peak   |
| 10  | 15212              | 39.59             | 6.63                    | 46.22              | 54                | -7.78          | AVG    |
| 11  | 17796              | 53.5              | 8.92                    | 62.42              | 74                | -11.58         | peak   |
| 12  | 17796              | 38.61             | 8.92                    | 47.53              | 54                | -6.47          | AVG    |

**GFSK- Middle Horizontal**

| No. | Frequency<br>(MHz) | Reading<br>(dBuV) | Correct<br>Factor(dB/m) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin<br>(dB) | Remark |
|-----|--------------------|-------------------|-------------------------|--------------------|-------------------|----------------|--------|
| 1   | 4876               | 58.29             | -13.00                  | 45.29              | 74                | -28.71         | peak   |
| 2   | 4876               | 49.59             | -13.00                  | 36.59              | 54                | -17.41         | AVG    |
| 3   | 5964               | 56.41             | -10.23                  | 46.18              | 74                | -27.82         | peak   |
| 4   | 5964               | 48.47             | -10.23                  | 38.24              | 54                | -15.76         | AVG    |
| 5   | 7528               | 56.89             | -7.17                   | 49.72              | 74                | -24.28         | peak   |
| 6   | 7528               | 47.68             | -7.17                   | 40.51              | 54                | -13.49         | AVG    |
| 7   | 11404              | 54.6              | -1.87                   | 52.73              | 74                | -21.27         | peak   |
| 8   | 11404              | 45.53             | -1.87                   | 43.66              | 54                | -10.34         | AVG    |
| 9   | 15382              | 53.28             | 7.02                    | 60.3               | 74                | -13.7          | peak   |
| 10  | 15382              | 38.8              | 7.02                    | 45.82              | 54                | -8.18          | AVG    |
| 11  | 17830              | 38.06             | 9.12                    | 47.18              | 54                | -6.82          | peak   |
| 12  | 17830              | 52.26             | 10.19                   | 62.45              | 74                | -11.55         | AVG    |

GFSK-Middle Vertical

| No. | Frequency<br>(MHz) | Reading<br>(dBuV) | Correct<br>Factor(dB/m) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin<br>(dB) | Remark |
|-----|--------------------|-------------------|-------------------------|--------------------|-------------------|----------------|--------|
| 1   | 4876               | 57.38             | -13.00                  | 44.38              | 74                | -29.62         | peak   |
| 2   | 4876               | 50.48             | -13.00                  | 37.48              | 54                | -16.52         | AVG    |
| 3   | 6134               | 55.9              | -9.98                   | 45.92              | 74                | -28.08         | peak   |
| 4   | 6134               | 48.57             | -9.98                   | 38.59              | 54                | -15.41         | AVG    |
| 5   | 8344               | 57                | -7.20                   | 49.8               | 74                | -24.2          | peak   |
| 6   | 8344               | 47.44             | -7.20                   | 40.24              | 54                | -13.76         | AVG    |
| 7   | 13784              | 52.99             | 1.80                    | 54.79              | 74                | -19.21         | peak   |
| 8   | 13784              | 41.39             | 1.80                    | 43.19              | 54                | -10.81         | AVG    |
| 9   | 15348              | 53.03             | 6.93                    | 59.96              | 74                | -14.04         | peak   |
| 10  | 15348              | 38.13             | 6.93                    | 45.06              | 54                | -8.94          | AVG    |
| 11  | 17524              | 52.21             | 9.07                    | 61.28              | 74                | -12.72         | peak   |
| 12  | 17524              | 37.72             | 9.07                    | 46.79              | 54                | -7.21          | AVG    |

GFSK-High Horizontal

| No. | Frequency<br>(MHz) | Reading<br>(dBuV) | Correct<br>Factor(dB/m) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin<br>(dB) | Remark |
|-----|--------------------|-------------------|-------------------------|--------------------|-------------------|----------------|--------|
| 1   | 2462               | 62.55             | -20.91                  | 41.64              | 74                | -32.36         | peak   |
| 2   | 2462               | 57.42             | -20.91                  | 36.51              | 54                | -17.49         | AVG    |
| 3   | 5964               | 55.32             | -10.23                  | 45.09              | 74                | -28.91         | peak   |
| 4   | 5964               | 48.52             | -10.23                  | 38.29              | 54                | -15.71         | AVG    |
| 5   | 8344               | 55.54             | -7.2                    | 48.34              | 74                | -25.66         | peak   |
| 6   | 8344               | 46.67             | -7.2                    | 39.47              | 54                | -14.53         | AVG    |
| 7   | 10316              | 55.05             | -4.06                   | 50.99              | 74                | -23.01         | peak   |
| 8   | 10316              | 46.64             | -4.06                   | 42.58              | 54                | -11.42         | AVG    |
| 9   | 15382              | 51.71             | 7.02                    | 58.73              | 74                | -15.27         | peak   |
| 10  | 15382              | 38.03             | 7.02                    | 45.05              | 54                | -8.95          | AVG    |
| 11  | 17456              | 52.54             | 9.05                    | 61.59              | 74                | -12.41         | peak   |
| 12  | 17456              | 38.14             | 9.05                    | 47.19              | 54                | -6.81          | AVG    |

GFSK-High Vertical

| No. | Frequency<br>(MHz) | Reading<br>(dBuV) | Correct<br>Factor(dB/m) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin<br>(dB) | Remark |
|-----|--------------------|-------------------|-------------------------|--------------------|-------------------|----------------|--------|
| 1   | 3958               | 59.84             | -15.09                  | 44.75              | 74                | -29.25         | peak   |
| 2   | 3958               | 52.54             | -15.09                  | 37.45              | 54                | -16.55         | AVG    |
| 3   | 4944               | 58.22             | -12.85                  | 45.37              | 74                | -28.63         | peak   |
| 4   | 4944               | 52.7              | -12.85                  | 39.85              | 54                | -14.15         | AVG    |
| 5   | 7426               | 56.49             | -7.09                   | 49.4               | 74                | -24.6          | peak   |
| 6   | 7426               | 46.71             | -7.09                   | 39.62              | 54                | -14.38         | AVG    |
| 7   | 10418              | 56.07             | -4.09                   | 51.98              | 74                | -22.02         | peak   |
| 8   | 10418              | 46.66             | -4.09                   | 42.57              | 54                | -11.43         | AVG    |
| 9   | 15348              | 53.18             | 6.93                    | 60.11              | 74                | -13.89         | peak   |
| 10  | 15348              | 39.1              | 6.93                    | 46.03              | 54                | -7.97          | AVG    |
| 11  | 17966              | 51.96             | 9.99                    | 61.95              | 74                | -12.05         | peak   |
| 12  | 18000              | 37.62             | 10.19                   | 47.81              | 54                | -6.19          | AVG    |

Node:

- 1、 Testing was carried out within frequency range 9kHz to the tenth harmonics. The measurement results below 30MHz and 18GHz - 26.5GHz were greater than 20dB below the limit, so only the radiated spurious emissions from 30MHz to 18GHz were reported..
- 2、 Radiated emissions measured in frequency above 1GHz were made with an instrument using peak/average detector mode.
- 3、 Average test would be performed if the peak result were greater than the average limit or as required by the applicant.
- 4、 Margin (dB), result in dBuV/m – limit in dBuV/m.

### Restricted band Requirements GFSK Low

All modes have been tested, and the report only reflects the worst mode(1Mbps)

#### Horizontal

| No. | Frequency<br>(MHz) | Reading<br>(dBuV) | Correct<br>Factor(dB/m) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin<br>(dB) | Remark |
|-----|--------------------|-------------------|-------------------------|--------------------|-------------------|----------------|--------|
| 1   | 2383.53            | 63.16             | -21.05                  | 42.11              | 74                | -31.89         | peak   |
| 2   | 2383.53            | 58.36             | -21.05                  | 37.31              | 54                | -16.69         | AVG    |
| 3   | 2390               | 61.93             | -21.03                  | 40.9               | 74                | -33.1          | peak   |
| 4   | 2390               | 56.74             | -21.03                  | 35.71              | 54                | -18.29         | AVG    |

#### Vertical

| No. | Frequency<br>(MHz) | Reading<br>(dBuV) | Correct<br>Factor(dB/m) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin<br>(dB) | Remark |
|-----|--------------------|-------------------|-------------------------|--------------------|-------------------|----------------|--------|
| 1   | 2387.14            | 65.12             | -21.04                  | 44.08              | 74                | -29.92         | peak   |
| 2   | 2387.14            | 61.22             | -21.04                  | 40.18              | 54                | -13.82         | AVG    |
| 3   | 2390               | 62.08             | -21.03                  | 41.05              | 74                | -32.95         | peak   |
| 4   | 2390               | 57.61             | -21.03                  | 36.58              | 54                | -17.42         | AVG    |

### GFSK-High

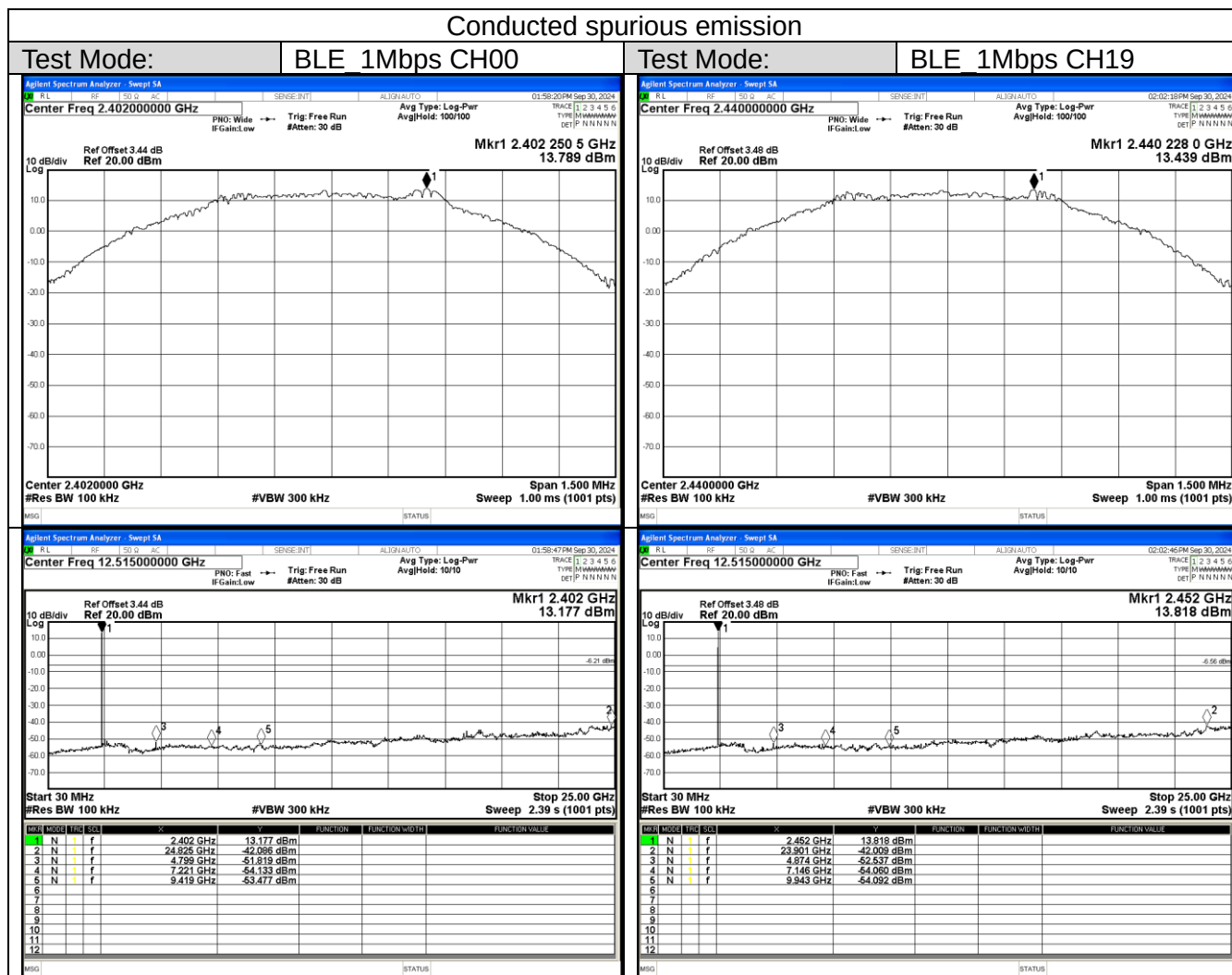
#### Horizontal

| No. | Frequency<br>(MHz) | Reading<br>(dBuV) | Correct<br>Factor(dB/m) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin<br>(dB) | Remark |
|-----|--------------------|-------------------|-------------------------|--------------------|-------------------|----------------|--------|
| 1   | 2483.5             | 69.09             | -20.91                  | 48.18              | 74                | -25.82         | peak   |
| 2   | 2483.5             | 64.92             | -20.91                  | 44.01              | 54                | -9.99          | AVG    |
| 3   | 2485.15            | 69.17             | -20.91                  | 48.26              | 74                | -25.74         | peak   |
| 4   | 2485.15            | 63.54             | -20.91                  | 42.63              | 54                | -11.37         | AVG    |

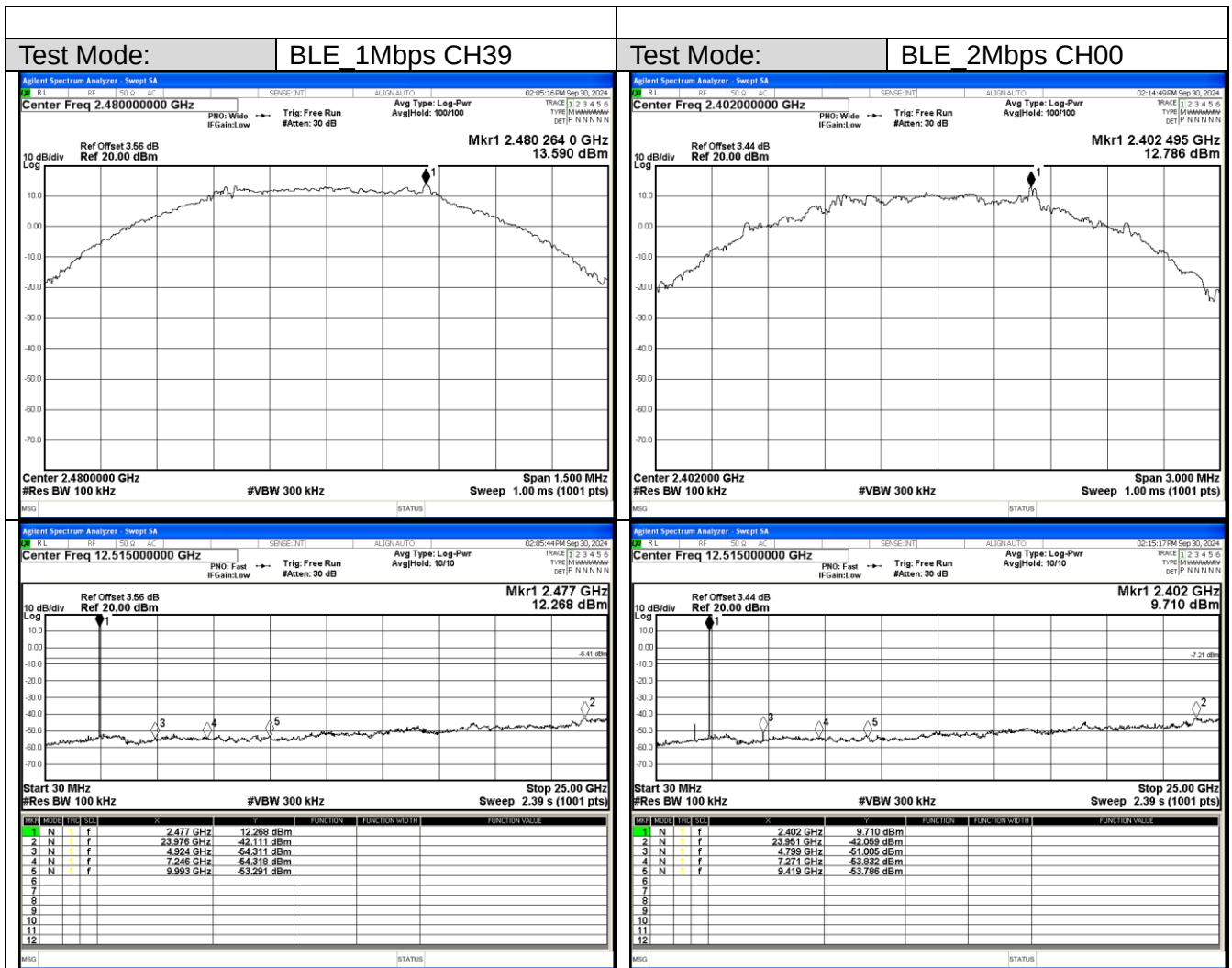
#### Vertical

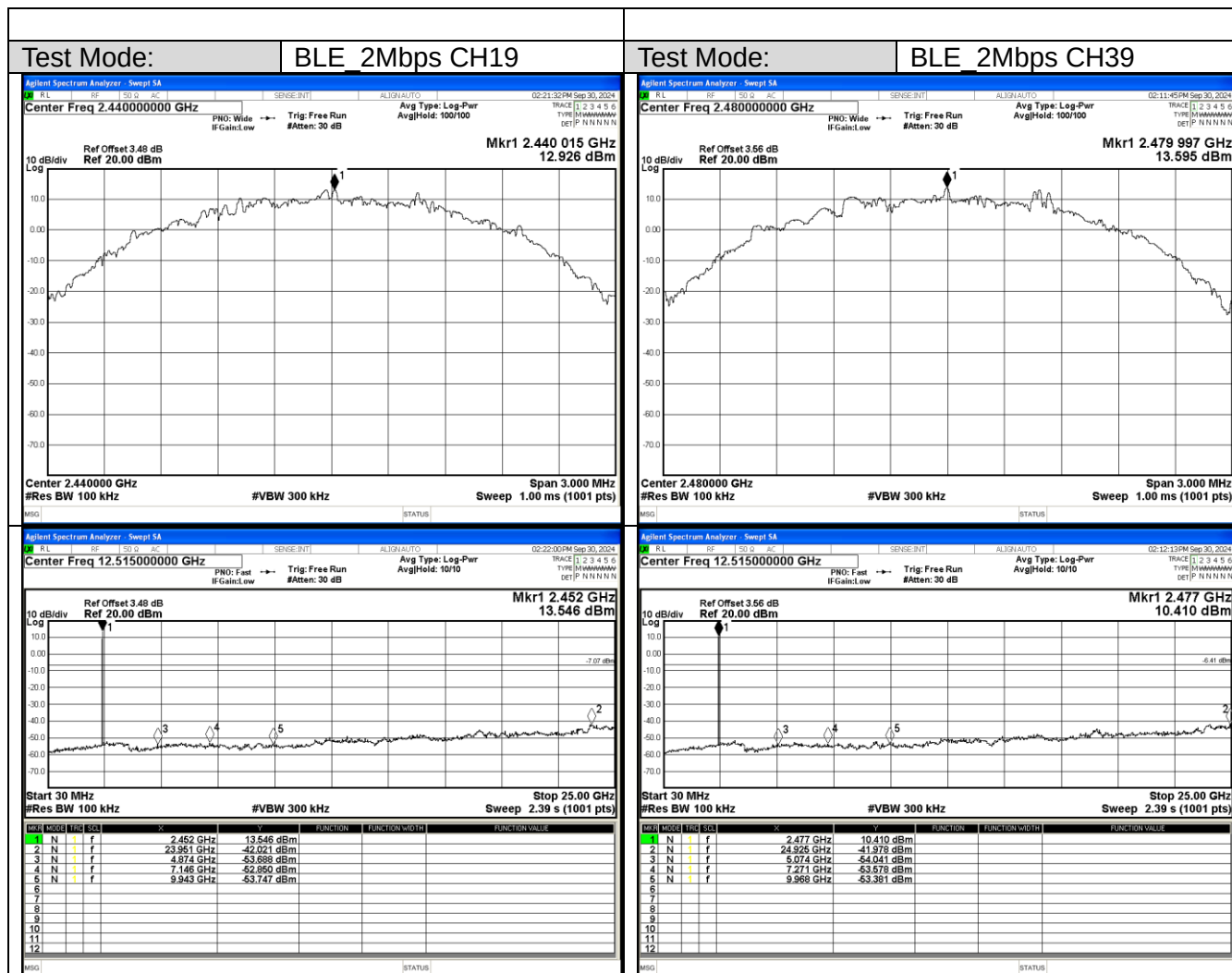
| No. | Frequency<br>(MHz) | Reading<br>(dBuV) | Correct<br>Factor(dB/m) | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin<br>(dB) | Remark |
|-----|--------------------|-------------------|-------------------------|--------------------|-------------------|----------------|--------|
| 1   | 2483.5             | 68.91             | -20.91                  | 48                 | 74                | -26            | peak   |
| 2   | 2483.5             | 63.7              | -20.91                  | 42.79              | 54                | -11.21         | AVG    |
| 3   | 2484.95            | 68.79             | -20.91                  | 47.88              | 74                | -26.12         | peak   |
| 4   | 2484.95            | 61.97             | -20.91                  | 41.06              | 54                | -12.94         | AVG    |

## Appendix A.3 Test Results of Conducted Spurious Emissions Measured in 100 kHz Bandwidth

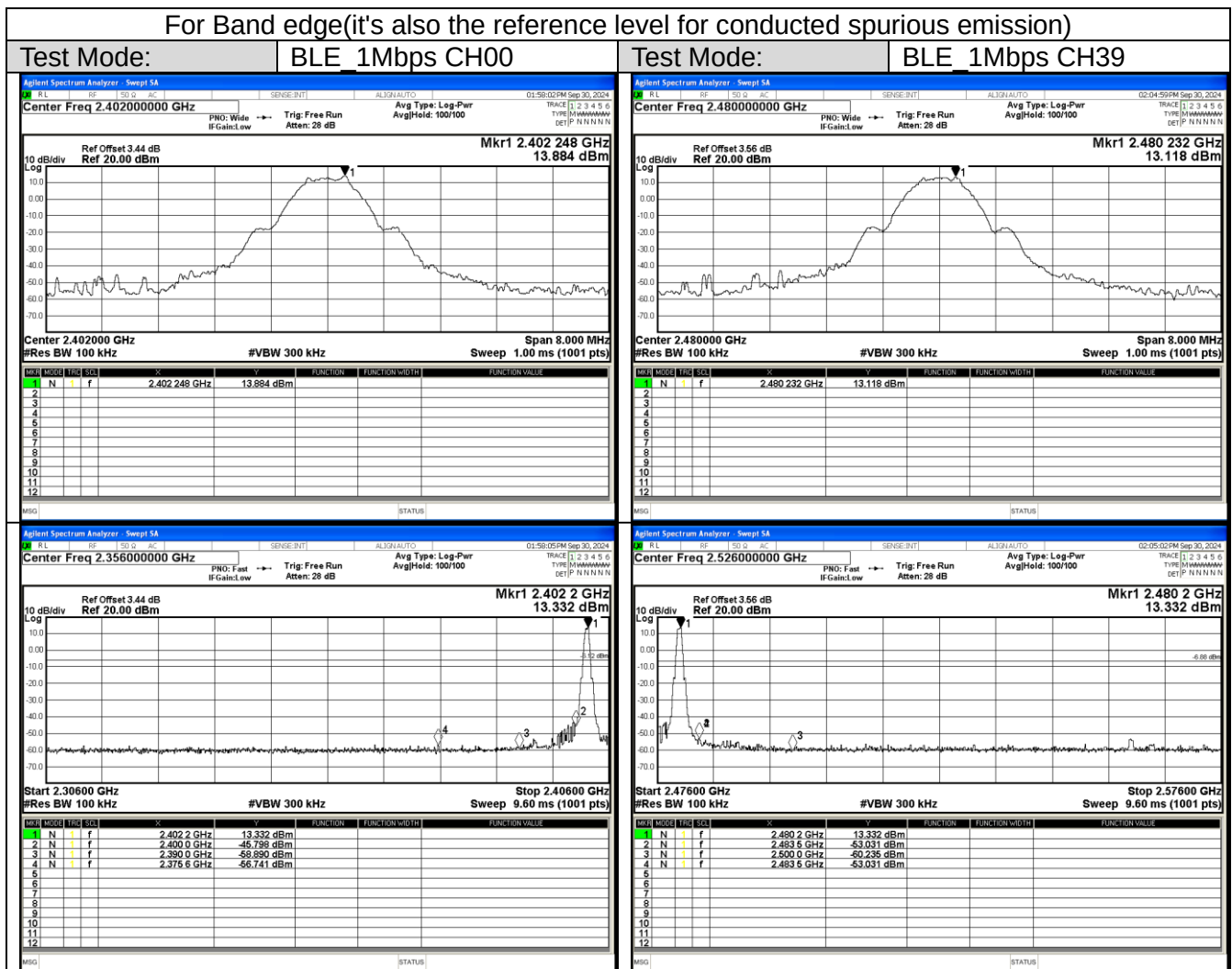


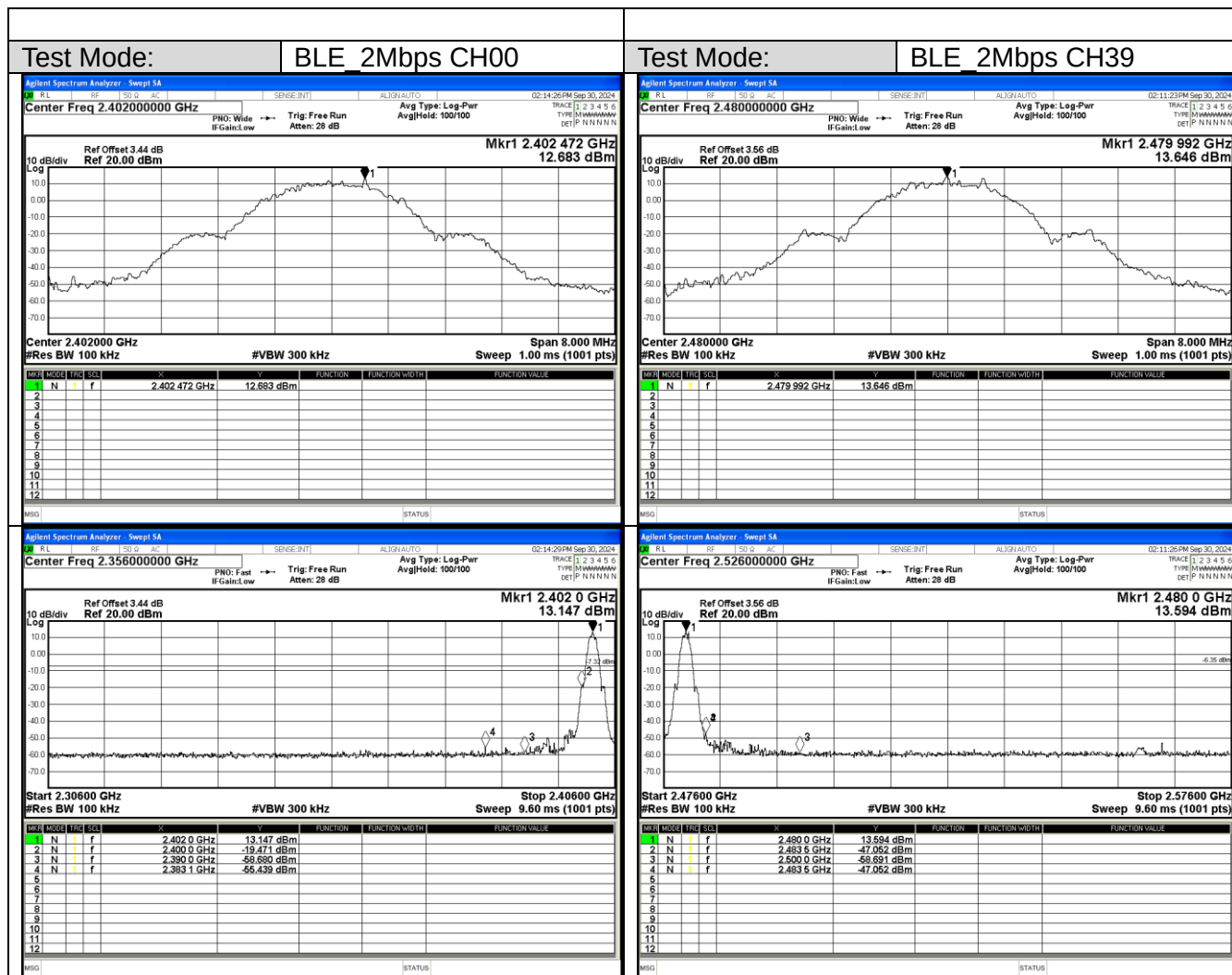






For Band edge(it's also the reference level for conducted spurious emission)

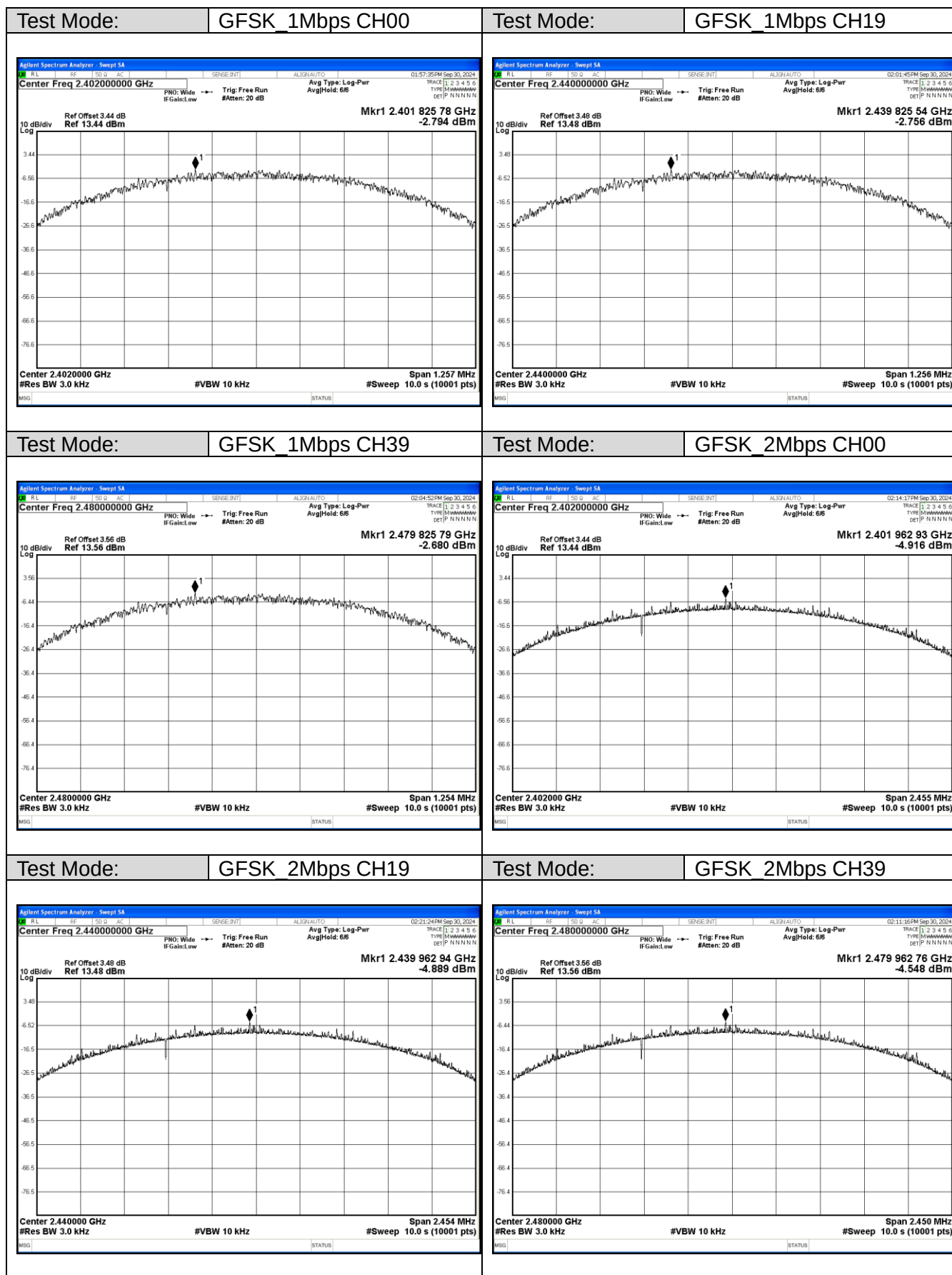




## Appendix A.4 Test Results of Conducted Power Spectral Density

| GFSK_1Mbps |               |                     |        |
|------------|---------------|---------------------|--------|
| Frequency  | Power Density | Limit<br>(dBm/3KHz) | Result |
|            | (dBm/3kHz)    |                     |        |
| CH00       | -2.794        | 8                   | Pass   |
| CH19       | -2.756        | 8                   | Pass   |
| CH39       | -2.68         | 8                   | Pass   |

| GFSK_2Mbps |               |                     |        |
|------------|---------------|---------------------|--------|
| Frequency  | Power Density | Limit<br>(dBm/3KHz) | Result |
|            | (dBm/3kHz)    |                     |        |
| CH00       | -4.916        | 8                   | Pass   |
| CH19       | -4.889        | 8                   | Pass   |
| CH39       | -4.548        | 8                   | Pass   |



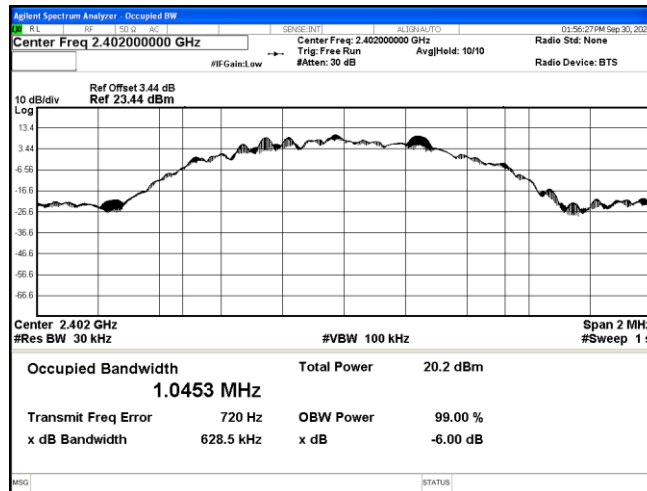
## Appendix A.5 Test Results of 6dB and 99% BANDWIDTH

| GFSK_1Mbps |                     |                     |                 |        |
|------------|---------------------|---------------------|-----------------|--------|
| Frequency  | 99% Bandwidth (MHz) | 6dB Bandwidth (MHz) | 6dB limit (MHz) | Result |
| CH00       | 1.0453              | 0.6639              | 0.5             | Pass   |
| CH19       | 1.0427              | 0.6676              | 0.5             | Pass   |
| CH39       | 1.0366              | 0.6621              | 0.5             | Pass   |

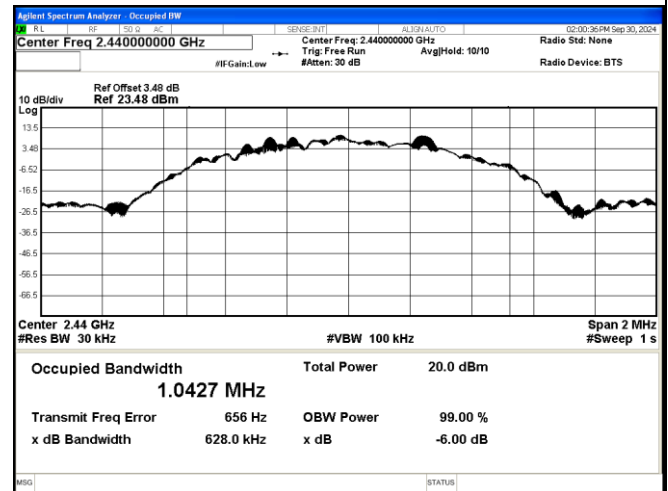
| GFSK_2Mbps |                     |                     |                 |        |
|------------|---------------------|---------------------|-----------------|--------|
| Frequency  | 99% Bandwidth (MHz) | 6dB Bandwidth (MHz) | 6dB limit (MHz) | Result |
| CH00       | 2.0823              | 1.155               | 0.5             | Pass   |
| CH19       | 2.0757              | 1.156               | 0.5             | Pass   |
| CH39       | 2.0656              | 1.160               | 0.5             | Pass   |

### 99% Bandwidth

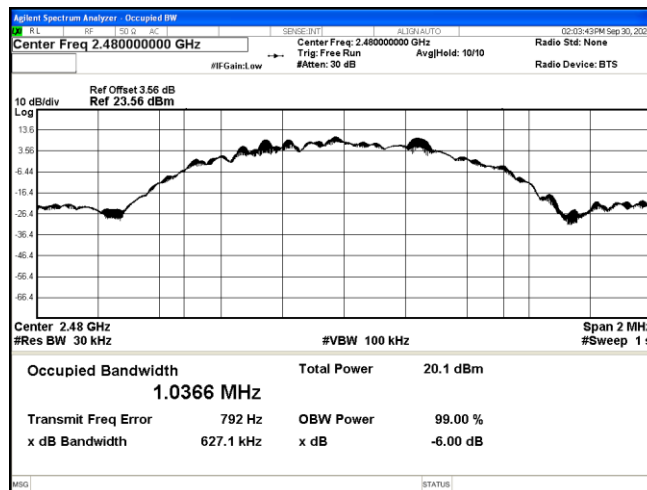
Test Mode: GFSK\_1Mbps CH00



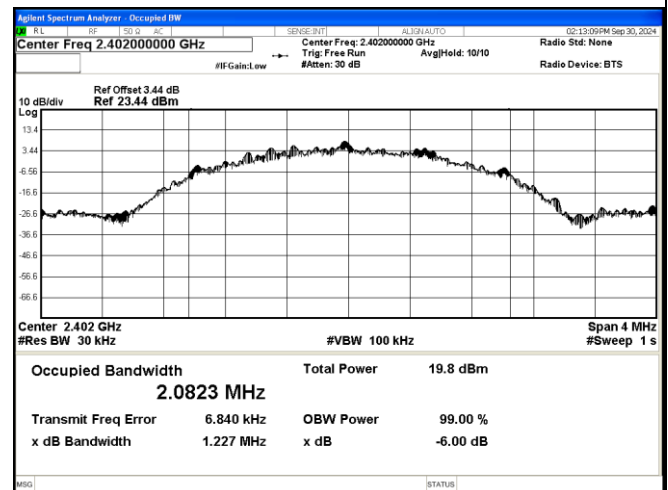
Test Mode: GFSK\_1Mbps CH19



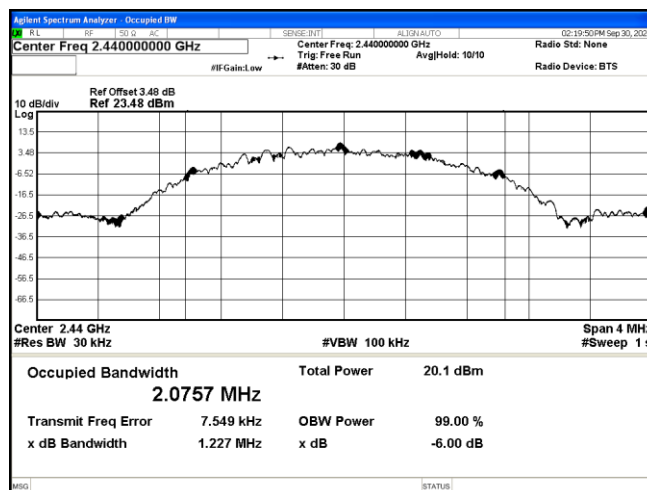
Test Mode: GFSK\_1Mbps CH39



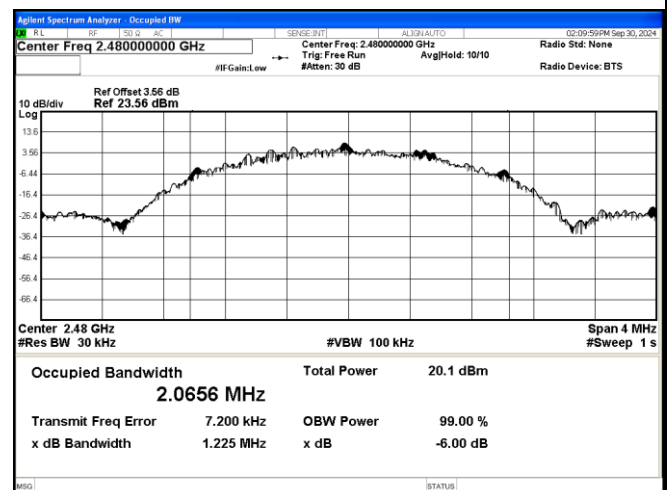
Test Mode: GFSK\_2Mbps CH00



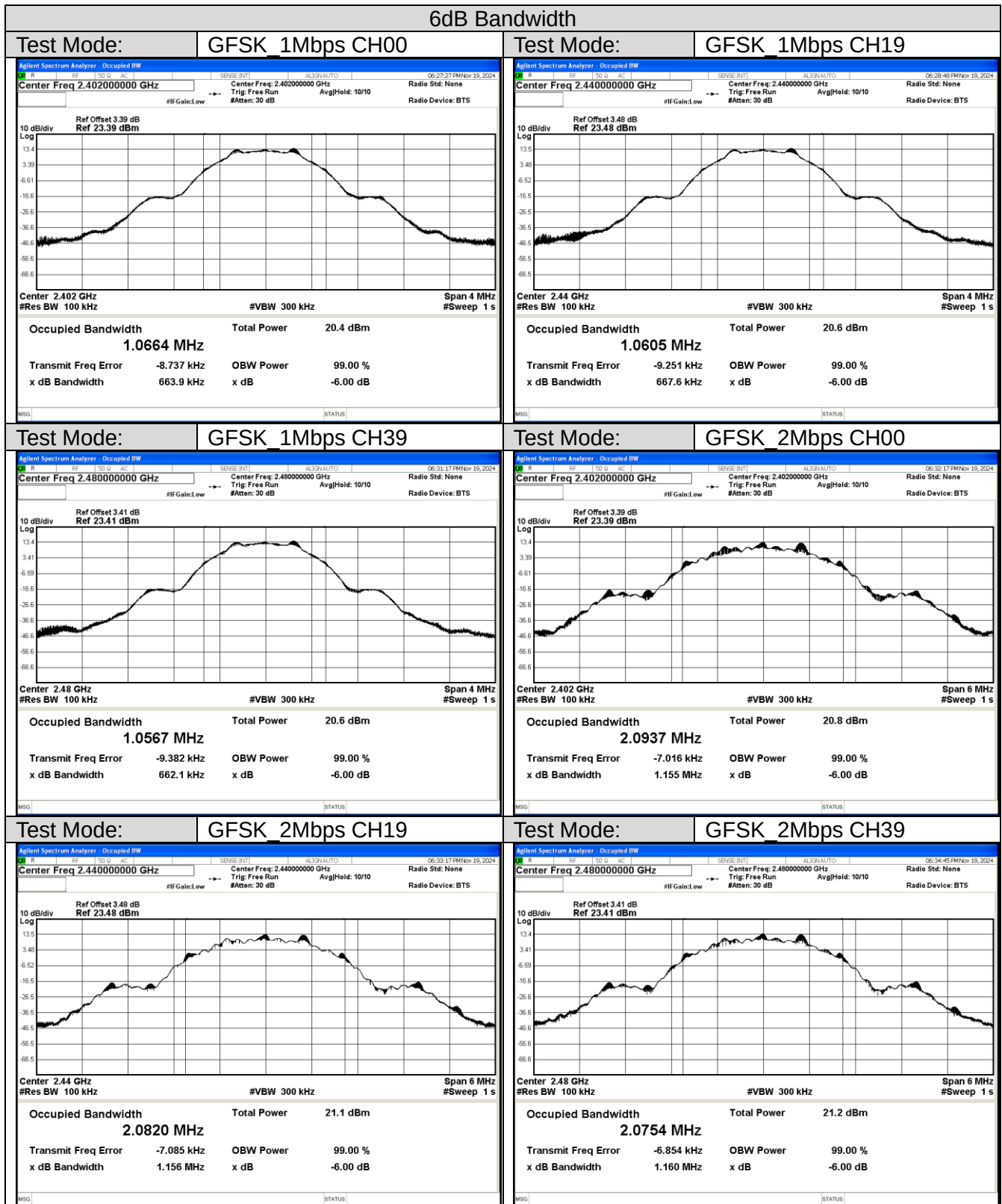
Test Mode: GFSK\_2Mbps CH19



Test Mode: GFSK\_2Mbps CH39







## Appendix A.6 Test Results of Maximum Conducted Power

For FCC:

| Mode      | Frequency [MHz] | Measured of Average Power | Limit [dBm] |
|-----------|-----------------|---------------------------|-------------|
|           |                 | Conducted [dBm]           |             |
| BLE_1Mbps | 2402            | 14.822                    | ≤ 30        |
|           | 2440            | 14.887                    | ≤ 30        |
|           | 2480            | 14.906                    | ≤ 30        |
| BLE_2Mbps | 2402            | 16.391                    | ≤ 30        |
|           | 2440            | 16.562                    | ≤ 30        |
|           | 2480            | 16.614                    | ≤ 30        |

**Note:**

- 1) The cable loss is taken into account in results.
- 2) Antenna gain(G) BLE: 3.01 dBi  
 $e.i.r.p.=P(AVG \text{ power})+ G$ , which is far below the 4 W

For IC:

| Mode      | Frequency [MHz] | Measured of Average Power |            | Limit [dBm] |
|-----------|-----------------|---------------------------|------------|-------------|
|           |                 | Conducted [dBm]           | EIRP [dBm] |             |
| BLE_1Mbps | 2402            | 14.822                    | 17.832     | ≤ 36        |
|           | 2440            | 14.887                    | 17.897     | ≤ 36        |
|           | 2480            | 14.906                    | 17.916     | ≤ 36        |
| BLE_2Mbps | 2402            | 16.391                    | 19.401     | ≤ 36        |
|           | 2440            | 16.562                    | 19.572     | ≤ 36        |
|           | 2480            | 16.614                    | 19.624     | ≤ 36        |

**Note:**

- 1) The cable loss is taken into account in results.
- 2) Antenna gain(G) BLE: 3.01 dBi.  
 $e.i.r.p.=P(AVG \text{ power})+ G$ , which is far below the 4 W.