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# FCC/ISED Test Report

**Prepared for:** Raven Applied Technologies, LLC

**Address:** 205 E 6th Street,
Sioux Falls, SD 57104

**Product:** RCU

**Test Report No:** R20250605-00-E1 **Rev: B**

**Approved by:**

Ethan Schmidt

**Ethan Schmidt,**
**EMC Test Engineer**

**DATE:** February 17, 2026

**Total Pages:** 35



ilac-MRA A2LA ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

## REVISION PAGE

| Rev. No. | Date | Description |
|---|---|---|
| 0 | 30 July 2025 | Issued by ESchmidt<br>Reviewed by KVepuri<br>Prepared by ESchmidt |
| A | 17 December 2025 | Corrected antenna information in §2.1 – ES |
| B | 17 February 2026 | Rephrased to an Original Equipment report, Removed references of internal module, Added lab registration numbers in §3.1, Added statement for radiated emissions up to 25GHz in §4.4 – ES |

## CONTENTS

## 1.0 SUMMARY OF TEST RESULTS

The worst-case measurements were reported in this report. The summary of test results presented in this report corresponds to the following section:

(1) US Code of Federal Regulations, Title 47, Part 15
(2) ISED RSS-Gen, Issue 5
(3) ISED RSS-247, Issue 4

| APPLIED STANDARDS AND REGULATIONS | | |
|---|---|---|
| **Standard Section** | **Test Type** | **Result** |
| FCC Part 15.35<br>RSS Gen, Issue 5, Section 6.10 | Duty Cycle | Pass |
| FCC Part 15.247(b)(3)<br>RSS-247 Issue 4 Section 5.4(d) | Peak output power | Pass |
| FCC Part 15.247(a)(2)<br>RSS-247 Issue 4 Section 5.2 (a) | Bandwidth | Pass |
| FCC Part 15.209<br>RSS-Gen Issue 5, Section 7.3 | Receiver Radiated Emissions | Pass |
| FCC Part 15.209 (restricted bands), 15.247 (unrestricted)<br>RSS-247 Issue 4 Section 5.5, RSS-Gen Issue 5, Section 8.9 | Transmitter Radiated Emissions | Pass |
| FCC Part 15.247(e)<br>RSS-247 Issue 4 Section 5.2 (b) | Power Spectral Density | Pass |
| FCC Part 15.209, 15.247(d)<br>RSS-247 Issue 4 Section 5.5 | Band Edge Measurement | Pass |
| FCC Part 15.207<br>RSS-Gen Issue 5, Section 8.8 | Conducted Emissions | N/A* |

*The EUT is powered only by DC and not connected to any AC line.

# 2.0 EUT DESCRIPTION

## 2.1 EQUIPMENT UNDER TEST

Summary and Operating Condition:

| | |
|---|---|
| **EUT** | RCU |
| **FCC ID** | 2BE68-RAV002 |
| **IC ID** | 2004B-RAV002 |
| **EUT Received** | 17 June 2025 |
| **EUT Tested** | 17 June 2025, 23 July 2025 - 24 June 2025 |
| **Serial No.** | 1193 |
| **Operating Band** | 2405 – 2470MHz |
| **Modulations** | O-QPSK |
| **Antenna Type** | SLPT2400/5900DMNW, with a peak gain of 4.78dBi |
| **Power Supply / Voltage** | 12VDC Lithium-Ion battery |

NOTE: For more detailed features description, please refer to the manufacturer's specifications or user's manual.

## 2.2 DESCRIPTION OF TEST MODES

The operating range of the EUT is dependent on the device type found in section 2.1:

Zigbee O-QPSK Transmissions:

| Channel | Frequency |
|---|---|
| Low | 2405 MHz |
| Mid | 2440 MHz |
| High | 2470 MHz |

Only Port 1 of the Zigbee module is utilized by the EUT, and the highest channel used is 2470MHz.

These are the only representative channels tested in the frequency range according to FCC Part 15.31 and RSS-Gen Table A1. See the operational description for a list of all channel frequencies and designations.

## 2.3 DESCRIPTION OF SUPPORT UNITS

None

# 3.0 LABORATORY AND GENERAL TEST DESCRIPTION

## 3.1 LABORATORY DESCRIPTION

All testing was performed at the following Facility:

The Nebraska Center for Excellence in Electronics (NCEE Labs)
4740 Discovery Drive
Lincoln, NE 68521

| | |
|---|---|
| A2LA Certificate Number: | 1953.01 |
| FCC Accredited Test Site Designation No: | US1060 |
| FCC Test Firm Registration Number: | 134067 |
| Industry Canada Test Site Registration No: | 4294A |
| NCC CAB Identification No: | US0177 |

Environmental conditions varied slightly throughout the tests:

Relative humidity of 35 ± 4%

Temperature of 22 ± 3° Celsius

## 3.2 TEST PERSONNEL

| No. | PERSONNEL | TITLE | ROLE |
|---|---|---|---|
| 1 | Fox Lane | Test Engineer | Testing |
| 2 | Blake Winter | Test Engineer | Testing |
| 4 | Ethan Schmidt | Test Engineer | Testing and Report |

Notes: All personnel are permanent staff members of NCEE Labs. No testing or review was sub-contracted or performed by sub-contracted personnel.

## 3.3 TEST EQUIPMENT

| DESCRIPTION AND MANUFACTURER | MODEL NO. | SERIAL NO. | LAST CALIBRATION DATE | CALIBRATION DUE DATE |
|---|---|---|---|---|
| Keysight MXE Signal Analyzer (26.5GHz) | N9038A | MY56400083 | July 17, 2024 | July 18, 2026 |
| Keysight MXE Signal Analyzer (26.5GHz) | N9038A | MY56400083 | July 15, 2025 | July 16, 2027** |
| SunAR RF Motion | JB1 | A082918-1 | July 17, 2024 | July 17, 2025*** |
| Com-Power Hybrid Antenna | ACL-6000 | 10350002 | April 29, 2024 | April 29, 2026*** |
| EMCO Horn Antenna | 3117 | 29616 | June 12, 2024 | June 12, 2026 |
| EMCO Horn Antenna | 3116 | 2576 | July 31, 2023 | July 30, 2025 |
| Com-Power LISN, Single Phase | LI-220C | 20070017 | July 17, 2023 | July 17, 2025 |
| Agilent Preamp* | 87405A | 3207A01475 | May 2, 2024 | May 2, 2026 |
| ETS Red Preamplifier (Orange)* | 3115-PA | 00218576 | January 22, 2024 | January 22, 2026 |
| Trilithic High Pass Filter* | 6HC330 | 23042 | June 5, 2023 | June 5, 2026 |
| ETS – Lindgren- VSWR on 10m Chamber | 10m Semi-anechoic chamber-VSWR | 4740 Discovery Drive | May 15, 2024 | May 15, 2027 |
| NCEE Labs-NSA on 10m Chamber* | 10m Semi-anechoic chamber-NSA | NCEE-001 | May 22, 2024 | May 22, 2026 |
| RF Cables (3m Ant. to Control room Bulkhead) | MFR-57500 | 1E3874 | January 20, 2024 | January 20, 2026 |
| RF Cable (antenna to 10m chamber bulkhead)* | FSCM 64639 | 01E3872 | January 21, 2024 | January 21, 2026 |
| RF Cable (10m chamber bulkhead to control room bulkhead)* | FSCM 64639 | 01E3874 | January 21, 2024 | January 21, 2026 |
| RF Cable (control room bulkhead to test receiver)* | FSCM 64639 | 01F1206 | January 21, 2024 | January 21, 2026 |
| N connector bulkhead (10m chamber)* | PE9128 | NCEEBH1 | January 21, 2024 | January 21, 2026 |
| N connector bulkhead (control room)* | PE9128 | NCEEBH2 | January 21, 2024 | January 21, 2026 |
| TDK Emissions Lab Software | V11.25 | 700307 | NA | NA |

*Internal Characterization

**Testing dates spanned two calibration cycles, so the most recent calibration date is shown.

***The SunAR antenna was only used prior to its calibration due date, the Com-Power antenna was used for the June test dates.

**Notes:**

All equipment is owned by NCEE Labs and stored permanently at NCEE Labs facilities.

## 3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO MEASUREMNTS

Measurement type presented in this report (Please see the checked box below):

**Conducted ☒**

The conducted measurements were performed by connecting the output of the transmitter directly into a spectrum analyzer using an impedance matched cable and connector soldered to the EUT in place of the antenna. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.


Figure 1 - Bandwidth Measurements Test Setup

**Radiated ☒**

All the radiated measurements were taken at a distance of 3m from the EUT. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

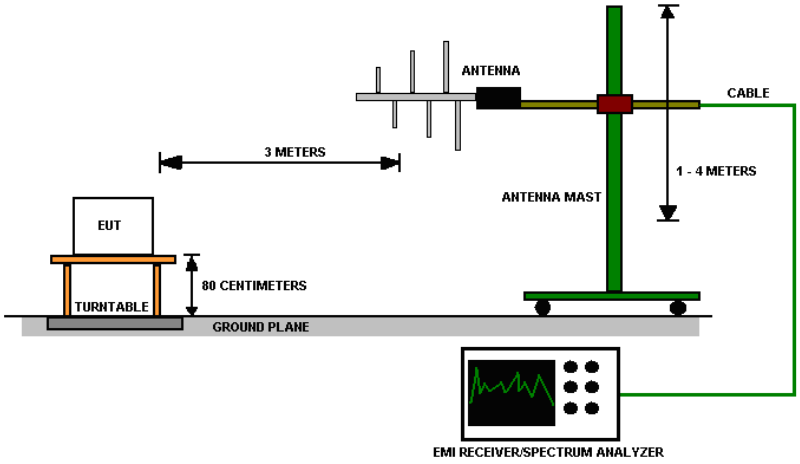



Figure 2 - Radiated Emissions Test Setup

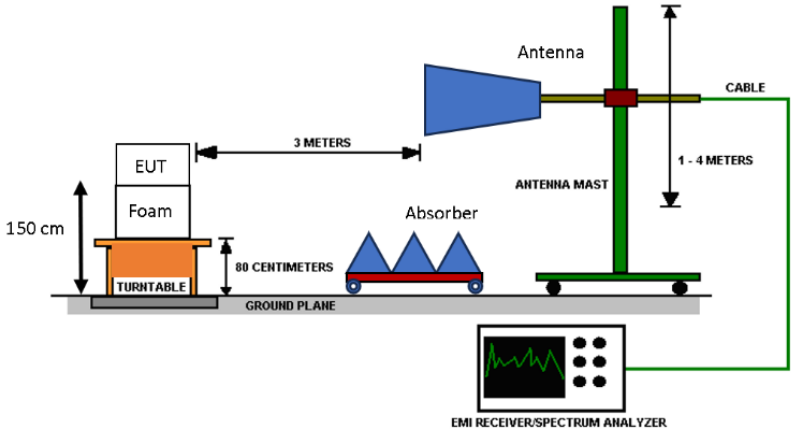



Figure 3 - Radiated Emissions Test Setup, >1GHz

## 4.0 RESULTS

| DTS Radio Measurements | | | | | | | |
|---|---|---|---|---|---|---|---|
| CHANNEL | Mode | Occupied BW (kHz) | 6 dB BW (kHz) | PSD (dBm) | PEAK OUTPUT POWER (dBm) | PEAK OUTPUT POWER (mW) | RESULT |
| Low | QPSK | 2258.9 | 1473 | 3.179 | 19.366 | 86.417 | PASS |
| Mid | QPSK | 2296.5 | 1506 | 1.371 | 19.101 | 81.302 | PASS |
| High | QPSK | 2310.9 | 1484 | 0.989 | 18.567 | 71.895 | PASS |
| Occupied Bandwidth Lim = N/A; 6dB Bandwidth Lim = N/A | | | | Peak Output Power Lim = 30dBm; PSD Lim = 8dBm | | | |

| Unrestricted Band-Edge | | | | | | | |
|---|---|---|---|---|---|---|---|
| CHANNEL | Mode | Band edge /Measurement Frequency (MHz) | Relative Highest out of band level (dBuV) | Relative Fundamental (dBuV) | Delta (dB) | Min Delta (dB) | Result |
| Low | QPSK | 2400.00 | 83.046 | 123.268 | 40.222 | 30.00 | PASS |
| High | QPSK | 2483.50 | 67.386 | 121.435 | 54.048 | 30.00 | PASS |
| | | | | | | | |
| **Peak Restricted Band-Edge** | | | | | | | |
| CHANNEL | Mode | Band edge /Measurement Frequency (MHz) | Highest out of band level (dBuV/m @ 3m) | Detector | Limit (dBuV/m @ 3m) | Margin | Result |
| Low | QPSK | 2390.00 | 59.989 | Peak | 73.98 | 13.991 | PASS |
| High | QPSK | 2483.50 | 60.678 | Peak | 73.98 | 13.302 | PASS |
| *Limit shown is the peak limit taken from FCC Part 15.209 | | | | | | | |

| Average Restricted Band-Edge, Low Data Rate | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Ch | Mode | Band edge /Measurement Frequency (MHz) | Peak Out of Band Level (dBuV/m @ 3m) | DCCF for Emissions (dB) | Corrected Out of band level (dBuV/m @ 3m) | Detector | Limit (dBuV/m @ 3m) | Margin | Result |
| Low | QPSK | 2390.00 | 59.989 | 17.016 | 42.97 | Peak | 53.98 | 11.01 | PASS |
| High | QPSK | 2483.50 | 60.678 | 17.016 | 43.66 | Peak | 53.98 | 10.32 | PASS |
| *Limit shown is the average limit taken from FCC Part 15.209 **Detector used was Peak, DCCF was subtracted from peak level to convert to true average | | | | | | | | | |

## 4.1 OUTPUT POWER

**Test Method:**
All measurements were performed using section 11.9.1.1 from ANSI C63.10.

**Limits of power measurements:**
For FCC Part 15.247 Device:
The maximum allowed output power is 30 dBm.

**Test procedures:**
Details can be found in section 3.4 of this report.

**Deviations from test standard:**
No deviation.

**Test setup:**
Details can be found in section 3.4 of this report.

**EUT operating conditions:**
Details can be found in section 2.1 of this report.

**Test results:**
Pass
Comments:
1. All the output power plots can be found in Appendix C.
2. All the measurements were found to be compliant.
3. Tabulated data is listed in section 4.0.

## 4.2 BANDWIDTH

**Test Method:**
All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

**Limits of bandwidth measurements:**
**For FCC Part 15.247 Device:**
The 99% occupied bandwidth is for informational/documentation purposes only. The 6dB bandwidth of the signal must be greater than 500 kHz.

**Test procedures:**
Details can be found in section 3.4 of this report.

**Deviations from test standard:**
No deviation.

**Test setup:**
Test setup details can be found in section 3.4 of this report.

**EUT operating conditions:**
Details can be found in section 2.1 of this report.

**Test results:**
Pass
Comments:
1. All the bandwidth plots can be found in Appendix C.
2. All the measurements were found to be compliant.
3. Tabulated data is listed in section 4.0.

## 4.3 DUTY CYCLE

The following duty cycle and duty cycle correction factors (DCCF) were used where applicable.

Duty Cycle correction factor (for emissions) = 20*log(Duty cycle)
Duty Cycle correction factor (for power) = 10*log(Duty Cycle)

Duty cycle for QPSK: 0.141
Duty cycle correction factor (for emissions): 17.016dB
Duty Cycle correction factor (for power): 8.508dB

*The 14.1% duty cycle is declared by the manufacturer based on the module report.

## 4.4 RADIATED EMISSIONS

**Test Method:**
ANSI C63.10-2020, Section 6.5, 6.6

**Limits for radiated emissions measurements:**
Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

| FREQUENCIES (MHz) | FIELD STRENGTH (μV/m) | MEASUREMENT DISTANCE (m) |
|---|---|---|
| 0.009-0.490 | 2400/F(kHz) | 300 |
| 0.490-1.705 | 24000/F(kHz) | 30 |
| 1.705-30.0 | 30 | 3 |
| 30-88 | 100 | 3 |
| 88-216 | 150 | 3 |
| 216-960 | 200 | 3 |
| Above 960 | 500 | 3 |

**NOTE:**
1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 * log * Emission level (μV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.

**Test procedures:**

a. The EUT was placed on the top of a rotating table above the ground plane in a 10-meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation. The table was 0.8m high for measurements from 30MHz-1Ghz and 1.5m for measurements from 1GHz and higher.

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 was a broadband antenna, and its height 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 used to make the measurement.

d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height varied from 1 meter to 4 meters, and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.

e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.

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 10 dB 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. The EUT was maximized in all 3 orthogonal positions. The results are presented for the axis that had the highest emissions.

**NOTE:**
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.

2. The resolution bandwidth 1 MHz for all measurements and at frequencies above 1GHz, A peak detector was used for all measurements above 1GHz. Measurements were made with an EMI Receiver.

**Deviations from test standard:**
No deviation.

**EUT operating conditions**
Details can be found in section 2.1 of this report.

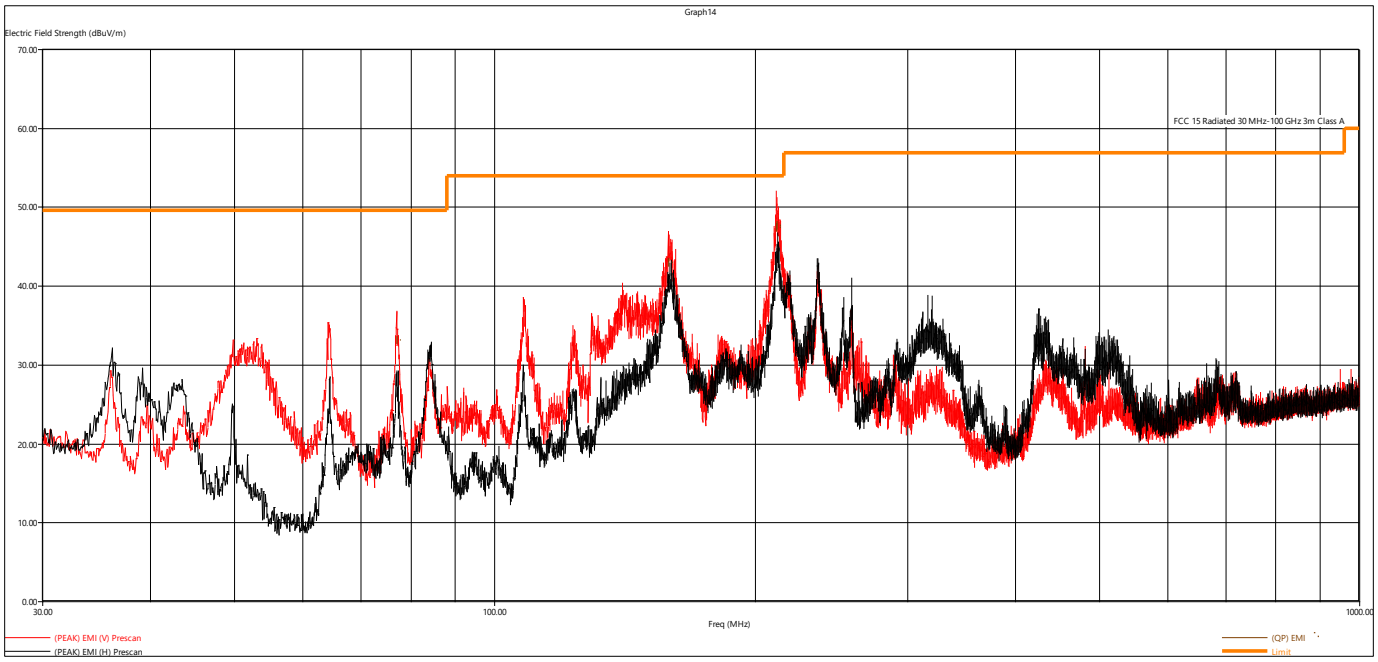



**Figure 4 - Radiated Emissions Plot, No TX, No Comms**

| Quasi-Peak Measurements, 30MHz – 1GHz | | | | | | |
|---|---|---|---|---|---|---|
| **Frequency** | **Level** | **Limit** | **Margin** | **Height** | **Angle** | **Pol** |
| **MHz** | **dBµV/m** | **dBµV/m** | **dB** | **cm.** | **deg.** | |
| 77.178480 | 33.09 | 49.54 | 16.45 | 129.44 | 95.00 | V |
| 158.649840 | 42.95 | 53.98 | 11.03 | 103.95 | 142.50 | V |
| 211.729200 | 47.28 | 53.98 | 6.70 | 106.16 | 121.25 | V |
| 211.787040 | 47.56 | 53.98 | 6.42 | 103.53 | 103.00 | V |

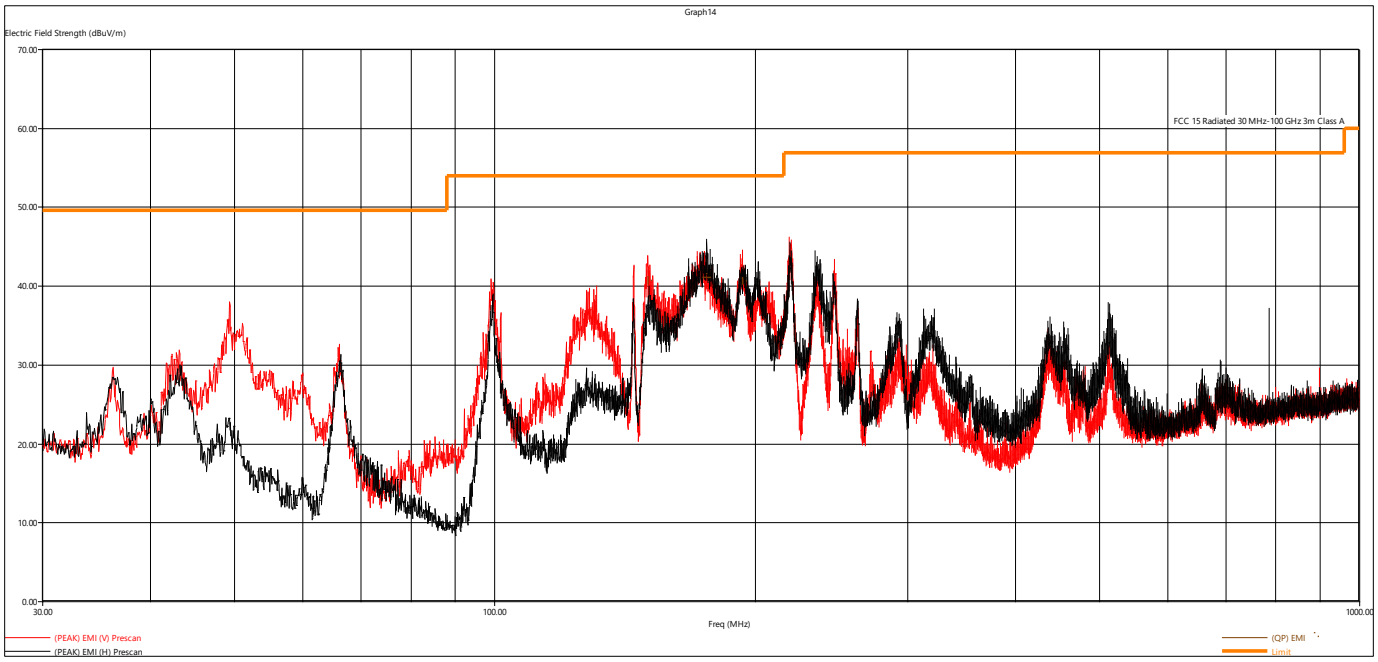



**Figure 5 - Radiated Emissions Plot, Receive, No TX, Comms on**

| Quasi-Peak Measurements, 30MHz – 1GHz | | | | | | |
|---|---|---|---|---|---|---|
| **Frequency** | **Level** | **Limit** | **Margin** | **Height** | **Angle** | **Pol** |
| **MHz** | **dBµV/m** | **dBµV/m** | **dB** | **cm.** | **deg.** | |
| 175.806000 | 41.01 | 53.98 | 12.97 | 220.43 | 4.00 | H |
| 150.250080 | 40.64 | 53.98 | 13.34 | 104.73 | 137.00 | V |
| 193.221840 | 40.55 | 53.98 | 13.43 | 124.31 | 13.25 | V |

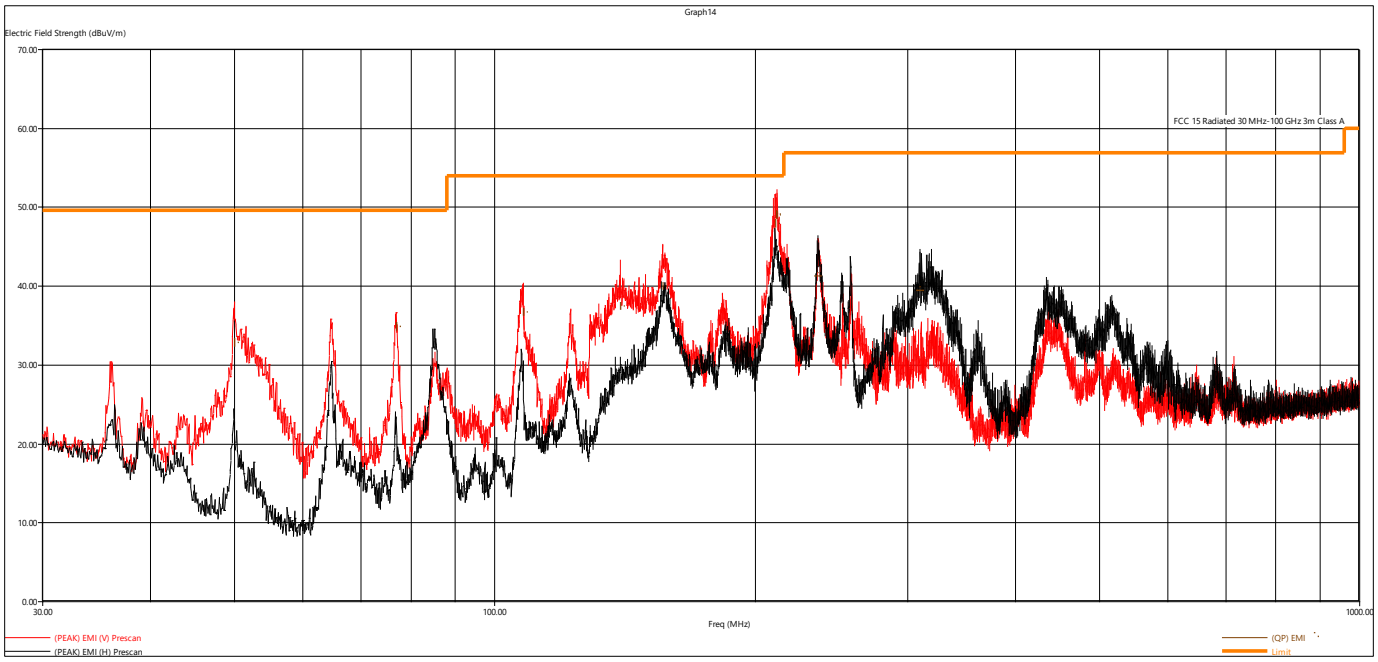



**Figure 6 - Radiated Emissions Plot, QPSK Low channel, No Comms**

| Quasi-Peak Measurements, 30MHz – 1GHz | | | | | | |
|---|---|---|---|---|---|---|
| **Frequency** | **Level** | **Limit** | **Margin** | **Height** | **Angle** | **Pol** |
| **MHz** | **dBµV/m** | **dBµV/m** | **dB** | **cm.** | **deg.** | |
| 236.404560 | 41.21 | 56.90 | 15.69 | 118.22 | 328.75 | H |
| 310.374480 | 39.42 | 56.90 | 17.48 | 120.61 | 21.00 | H |
| 50.094240 | 32.76 | 56.90 | 24.14 | 109.56 | 175.75 | V |
| 76.944240 | 34.83 | 56.90 | 22.07 | 104.55 | 109.50 | V |
| 107.997120 | 36.64 | 56.90 | 20.26 | 119.00 | 258.50 | V |
| 139.586400 | 37.37 | 56.90 | 19.53 | 105.44 | 136.25 | V |
| 156.213360 | 39.88 | 56.90 | 17.02 | 118.82 | 149.50 | V |
| 210.888480 | 47.81 | 56.90 | 9.09 | 103.89 | 104.00 | V |
| 211.460880 | 49.04 | 56.90 | 7.86 | 107.65 | 110.50 | V |
| 211.916640 | 48.91 | 56.90 | 7.99 | 103.59 | 88.50 | V |

**REMARKS:**

1. Emissions were investigated for the low, mid, and high transmitter channels. The worst case is shown above.
2. Emissions in excess of the Class B limits were found to not be caused by the transmitter.

| Peak Measurements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Frequency | Level | Limit | Margin | Height | Angle | Pol | Channel | Modulation |
| MHz | dBµV/m | dBµV/m | dB | cm. | deg. | | | |
| 4811.056000 | 50.91 | 73.98 | 23.07 | 526.95 | 142.25 | V | Low | QPSK |
| 12022.552000 | 62.61 | 73.98 | 11.37 | 253.40 | 44.00 | V | Low | QPSK |
| 7318.536000 | 67.84 | 73.98 | 6.14 | 257.58 | 82.00 | H | Mid | QPSK |
| 4879.132000 | 50.25 | 73.98 | 23.73 | 235.13 | 148.00 | V | Mid | QPSK |
| 12197.598000 | 60.05 | 73.98 | 13.93 | 198.95 | 299.50 | V | Mid | QPSK |
| 7411.572000 | 66.49 | 73.98 | 7.49 | 292.32 | 297.50 | H | High | QPSK |
| 4938.820000 | 47.79 | 73.98 | 26.19 | 180.26 | 158.25 | V | High | QPSK |
| 12352.498000 | 60.58 | 73.98 | 13.40 | 447.07 | 148.25 | V | High | QPSK |

| Average Measurements | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Freq. | Peak Level | DCCF | Average Level | Limit | Margin | Height | Angle | Pol | Channel | Modulation |
| MHz | dBµV/m | dB | dBµV/m | dBµV/m | dB | cm. | deg. | | | |
| 4811.056000 | 50.91 | 17.016 | 33.894 | 53.98 | 20.086 | 526.95 | 142.25 | V | Low | QPSK |
| 12022.552000 | 62.61 | 17.016 | 45.594 | 53.98 | 8.386 | 253.40 | 44.00 | V | Low | QPSK |
| 7318.536000 | 67.84 | 17.016 | 50.824 | 53.98 | 3.156 | 257.58 | 82.00 | H | Mid | QPSK |
| 4879.132000 | 50.25 | 17.016 | 33.234 | 53.98 | 20.746 | 235.13 | 148.00 | V | Mid | QPSK |
| 12197.598000 | 60.05 | 17.016 | 43.034 | 53.98 | 10.946 | 198.95 | 299.50 | V | Mid | QPSK |
| 7411.572000 | 66.49 | 17.016 | 49.474 | 53.98 | 4.506 | 292.32 | 297.50 | H | High | QPSK |
| 4938.820000 | 47.79 | 17.016 | 30.774 | 53.98 | 23.206 | 180.26 | 158.25 | V | High | QPSK |
| 12352.498000 | 60.58 | 17.016 | 43.564 | 53.98 | 10.416 | 447.07 | 148.25 | V | High | QPSK |

**REMARKS:**

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. Average Level = Peak Level – DCCF(emissions)
3. Margin value = Emission level - Limit value
4. No other levels, including frequencies from 30MHz – 25GHz, were found to be within 10dB of the applicable limits and therefore were not tabulated.

## 4.5 CONDUCTED SPURIOUS EMISSIONS

**Test Method:**
ANSI C63.10-2020, Section 6.7

**Limits of spurious emissions:**
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)).

**Test procedures:**
The highest emissions level was measured and recorded. All spurious measurements were evaluated to 30dB below the fundamental. More details can be found in section 3.4 of this report.

**Deviations from test standard:**
None.

**Test setup:**
Test setup details can be found in section 3.4 of this report.

**EUT operating conditions:**
Details can be found in section 2.1 of this report.

**Test results:**
Note that the limit shown on the plots does not apply. It is a line for reference.

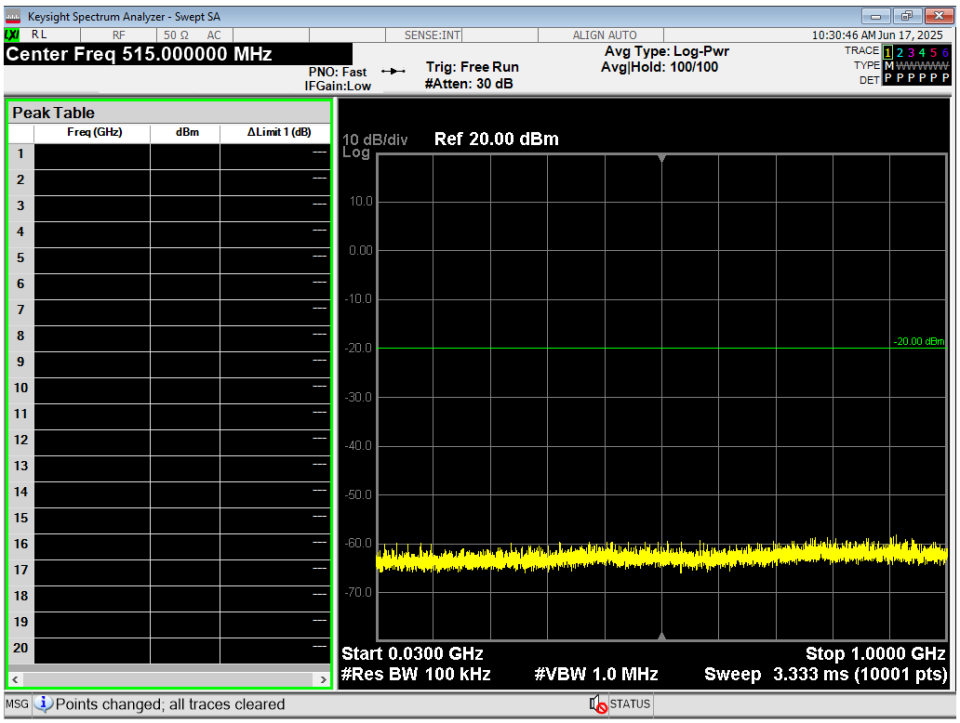



**Figure 7 - Conducted Spurious Plot, QPSK, 30MHz – 1GHz, Low**

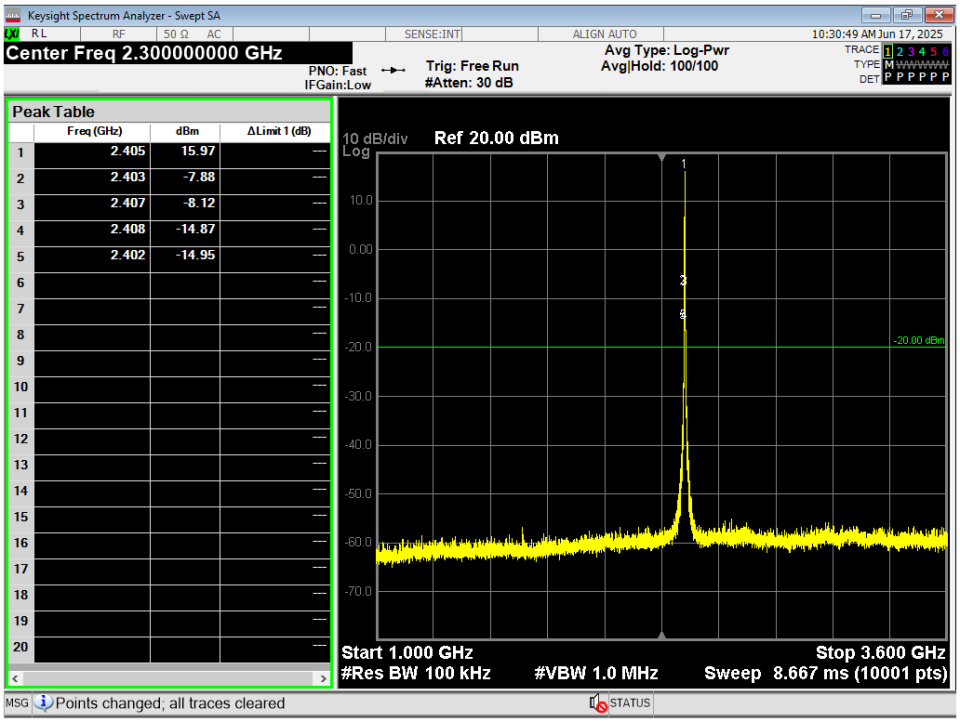



**Figure 8 - Conducted Spurious Plot, QPSK, 1GHz – 3.6GHz, Low**

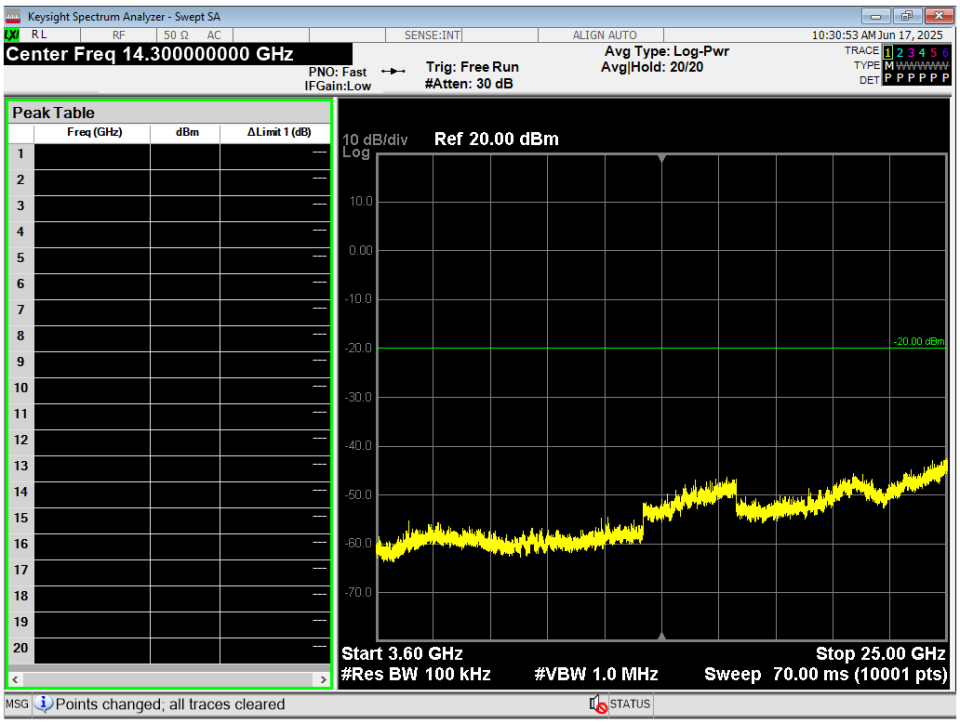



**Figure 9 - Conducted Spurious Plot, QPSK, 3.6GHz – 25GHz, Low**

## 4.6 BAND EDGES

**Test Method:**
All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

**Limits of band-edge measurements:**
**For FCC Part 15.247 Device:**
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))

**Test procedures:**
The highest emissions level beyond the band-edge was measured and recorded. All band edge measurements were evaluated to the general limits in Part 15.209. More details can be found in section 3.4 of this report.

**Deviations from test standard:**
No deviation.

**Test setup:**
Test setup details can be found in section 3.4 of this report.

**EUT operating conditions:**
Details can be found in section 2.1 of this report.

**Test results:**
Pass
Comments:
1. All the band edge plots can be found in Appendix C.
2. If the device falls under FCC Part 15.247 (Details can be found in summary of test results), compliance is shown in the unrestricted band edges by showing minimum delta of 20 dB between peak and the band edge.
3. The restricted band edge compliance is shown by comparing it to the general limit defined in Part 15.209.
4. Tabulated data is listed in section 4.0.

## 4.7 POWER SPECTRAL DENSITY

**Test Method:**
All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

**Limits of power measurements:**
For FCC Part 15.247 Device:
The maximum PSD allowed is 8 dBm.

**Test procedures:**
Details can be found in section 3.4 of this report.

**Deviations from test standard:**
No deviation.

**Test setup:**
Details can be found in section 3.4 of this report.

**EUT operating conditions:**
Details can be found in section 2.1 of this report.

**Test results:**
Pass
Comments:
1. All the Power Spectral Density (PSD) plots can be found in Appendix C.
2. All the measurements were found to be compliant.
3. Tabulated data is listed in section 4.0.

## APPENDIX A: SAMPLE CALCULATION

**Field Strength Calculation**

The field strength is calculated by adding the Antenna Factor, Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF – (-CF + AG) + AV

where FS = Field Strength
RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Attenuation Factor
AG = Amplifier Gain
AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dBμV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBμV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/m

AV is calculated by the taking the 20*log($T_{on}$/100) where $T_{on}$ is the maximum transmission time in any 100ms window.

**EIRP Calculations**

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

*EIRP (Watts) = [Field Strength (V/m) x antenna distance (m)]$^2$ / 30*
*Power (watts) = 10^[Power (dBm)/10] / 1000*
*Voltage (dBμV) = Power (dBm) + 107 (for 50Ω measurement systems)*
*Field Strength (V/m) = 10^[Field Strength (dBμV/m) / 20] / 10^6*
*Gain = 1 (numeric gain for isotropic radiator)*
*Conversion from 3m field strength to EIRP (d=3):*
*EIRP = [FS(V/m) x d^2]/30 = FS [0.3] for d = 3*
*EIRP(dBm) = FS(dBμV/m) – 10(log 10^9)+ 10log[0.3] = FS(dBμV/m) - 95.23*
*10log( 10^9) is the conversion from micro to milli*

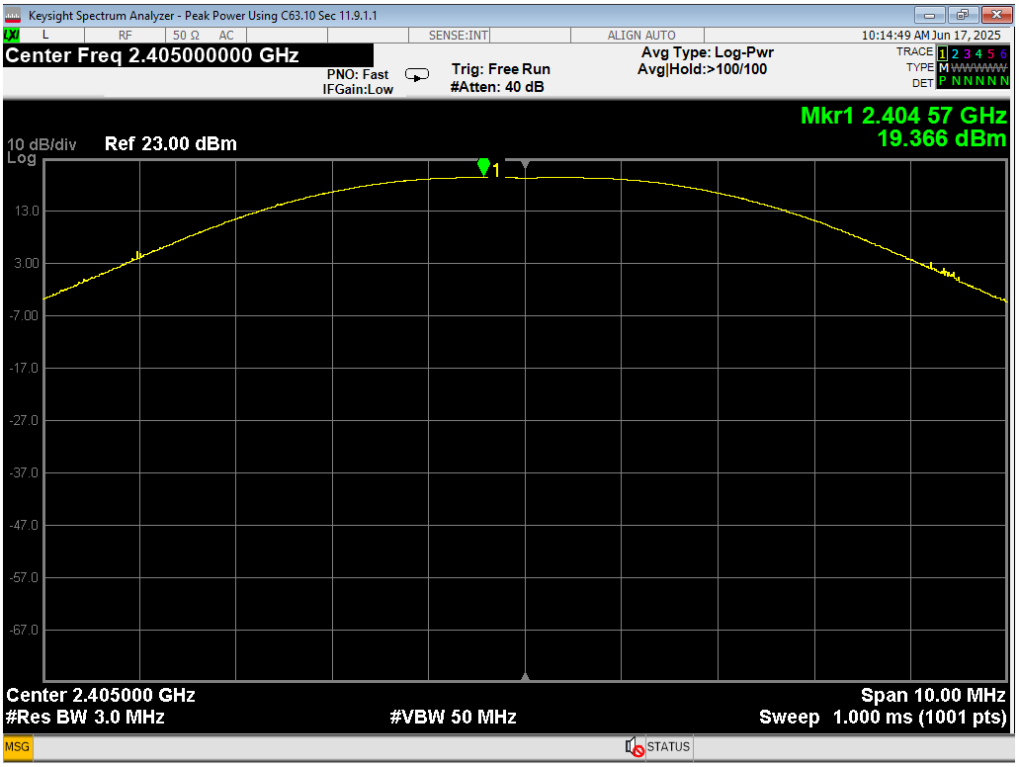
## APPENDIX B – MEASUREMENT UNCERTAINTY

NCEE Labs does not add uncertainty levels to measurement levels
Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

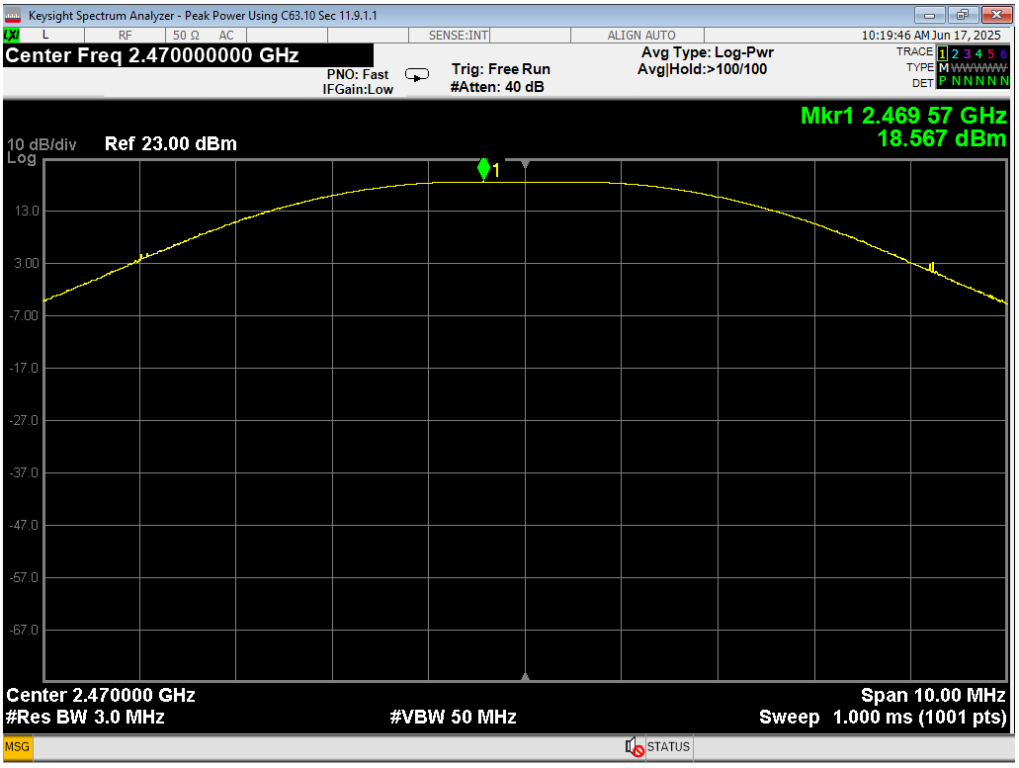
| Test | Frequency Range | Uncertainty Value (dB) |
|---|---|---|
| Radiated Emissions, 3m | 30MHz - 1GHz | ±4.31 |
| Radiated Emissions, 3m | 1GHz - 18GHz | ±5.08 |
| Emissions limits, conducted | 30MHz – 18GHz | ±3.03 |

Expanded uncertainty values are calculated to a confidence level of 95%.

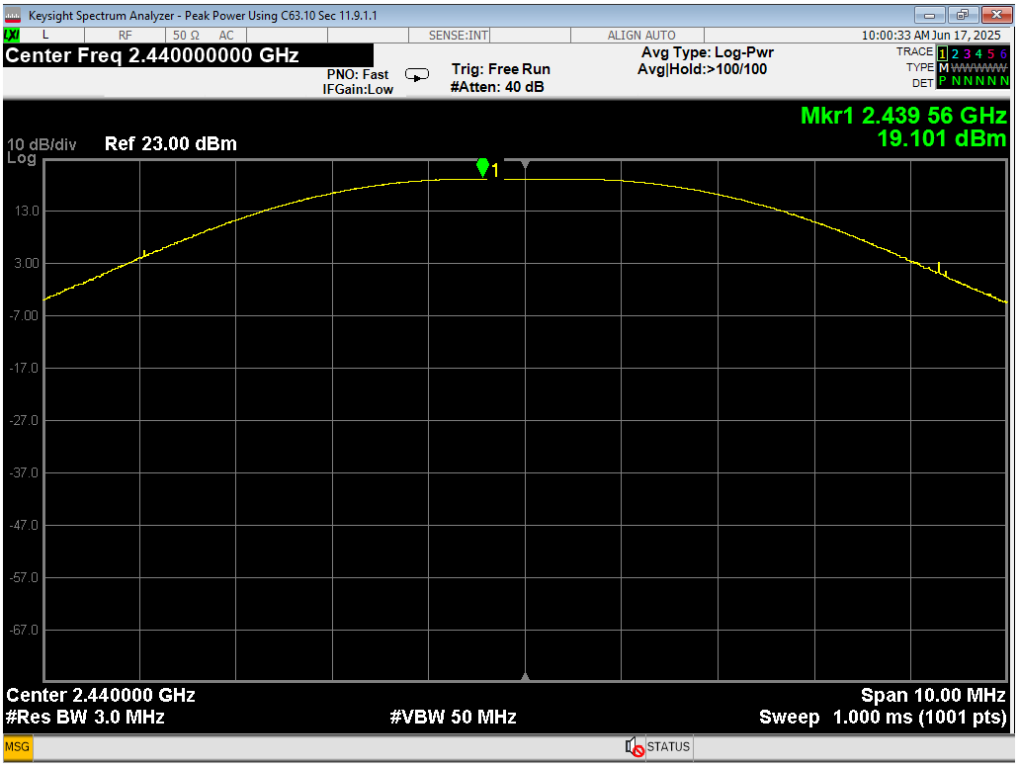
## APPENDIX C – GRAPHS AND TABLES



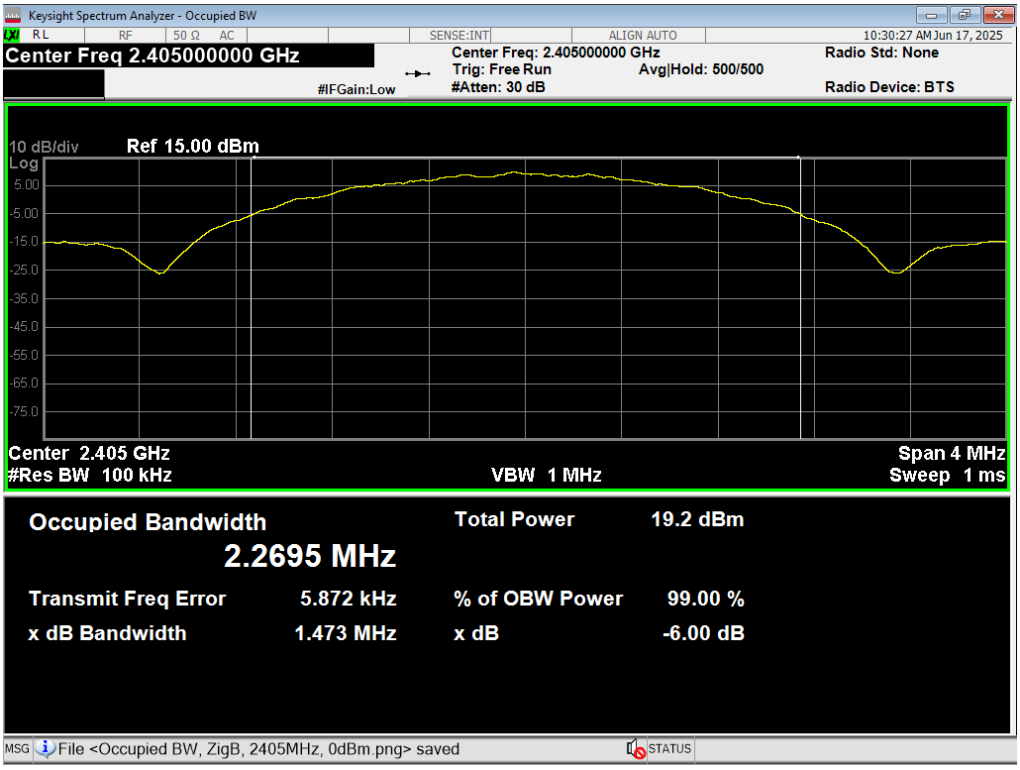

**01 Peak Power, Zigbee, Low**



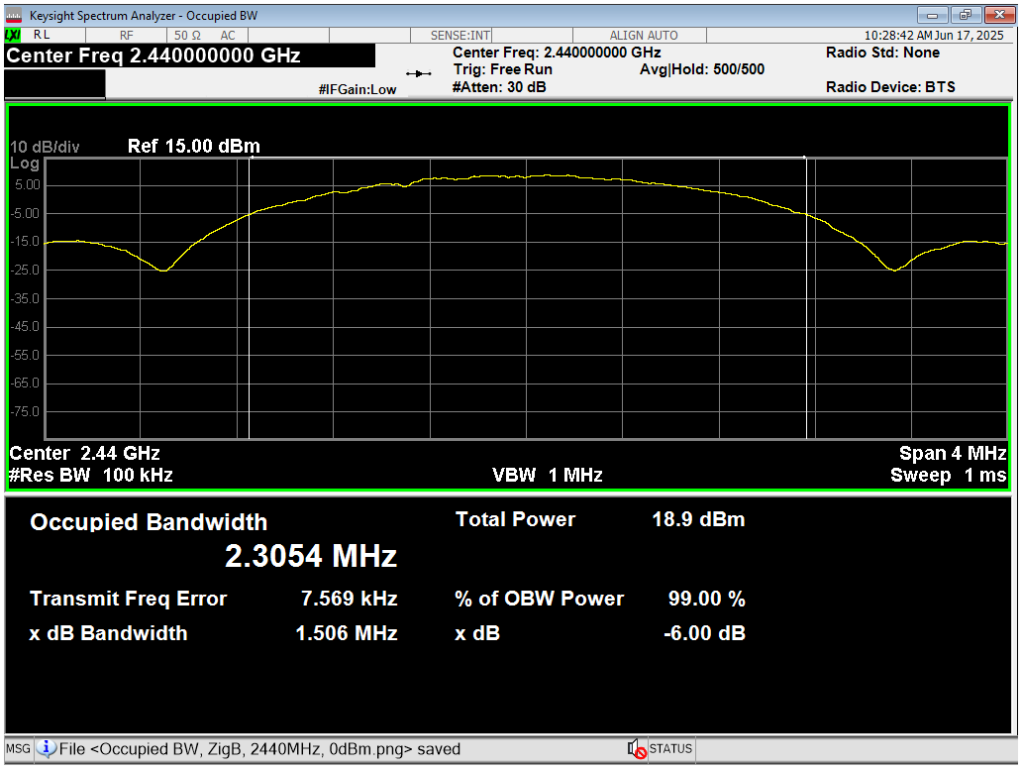

**02 Peak Power, Zigbee High**



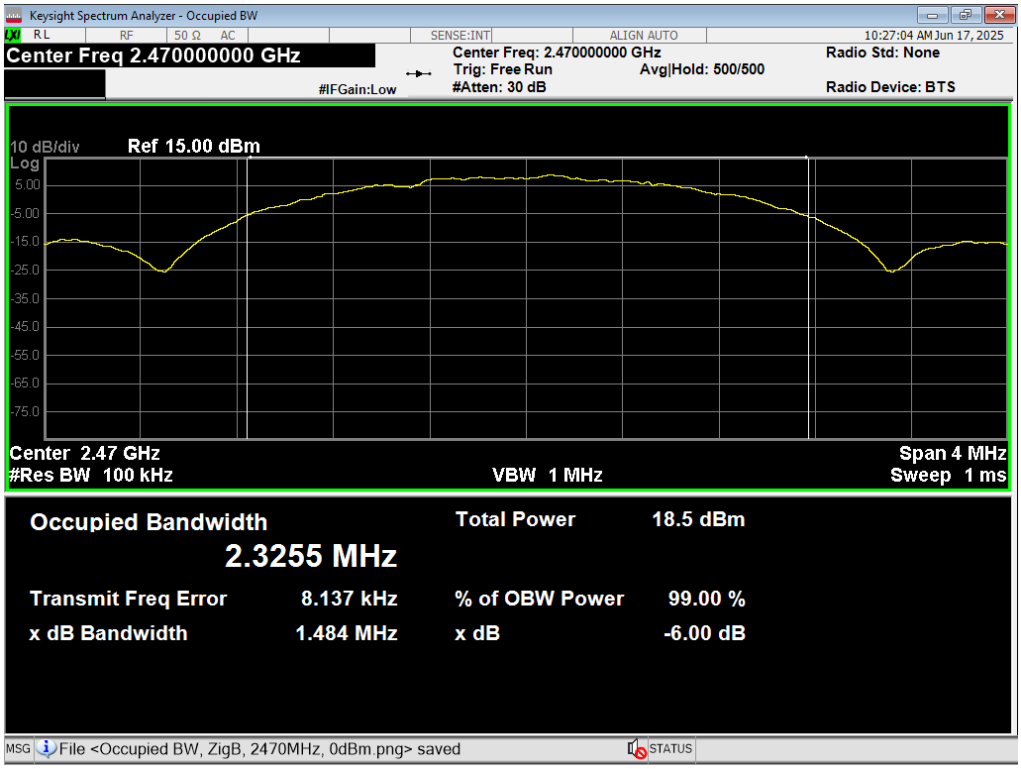

**03 Peak Power, Zigbee Mid**



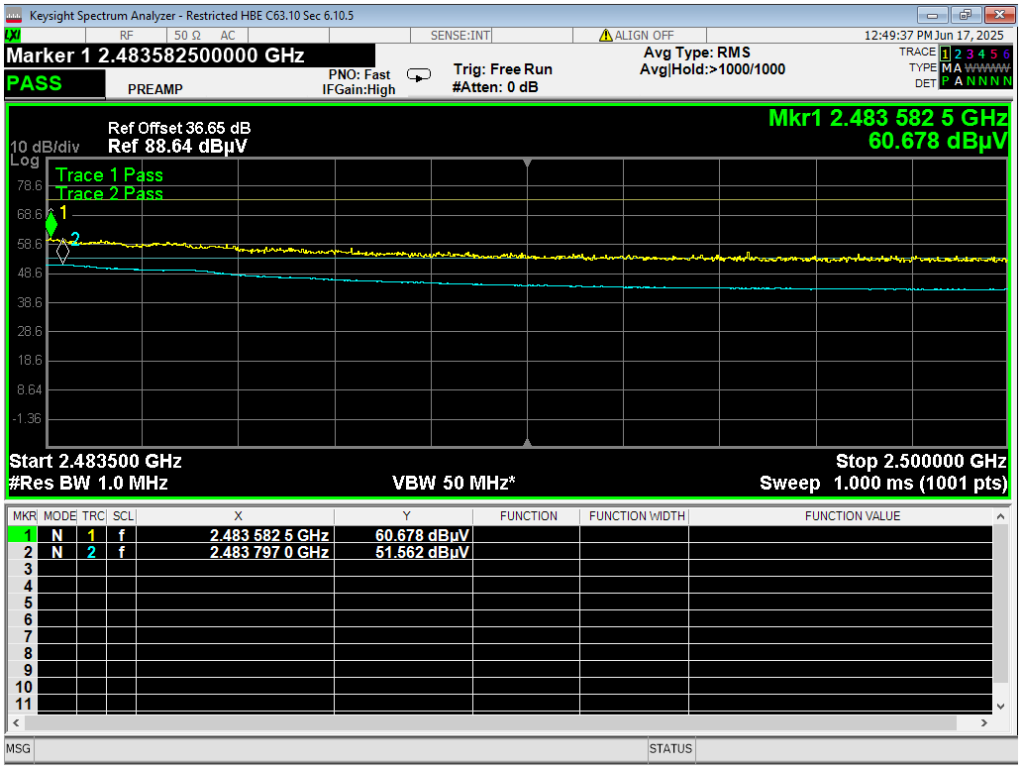

**04 6dB BW, Zigbee, 2405MHz**



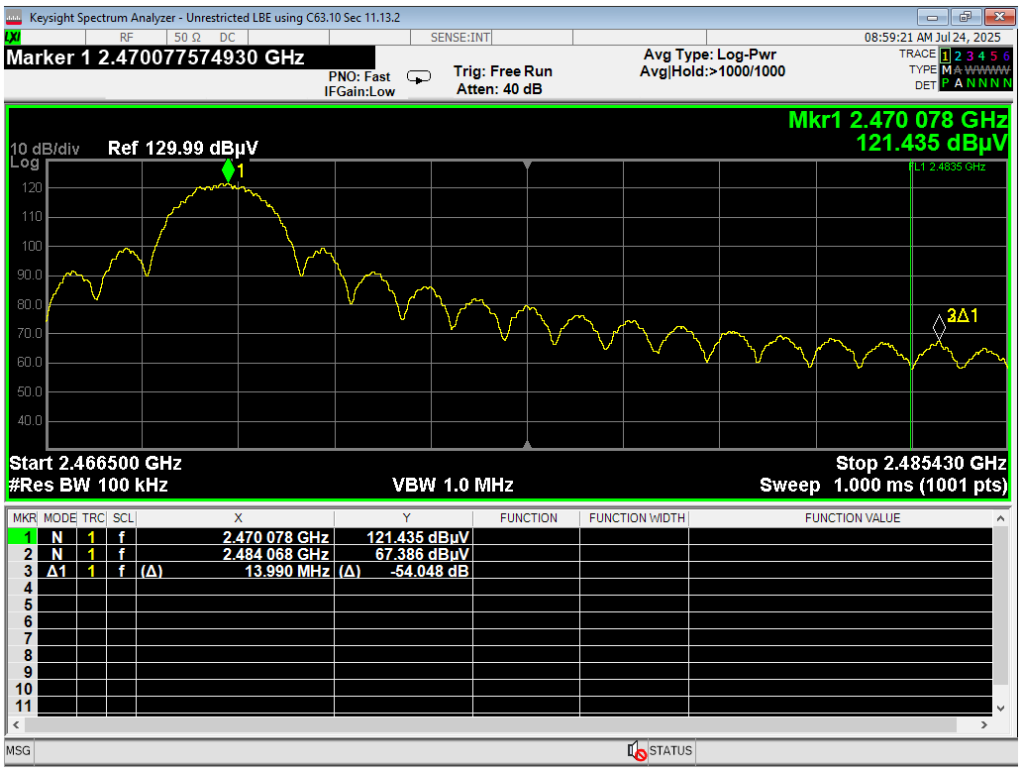

**05 6dB BW, Zigbee, 2440MHz**



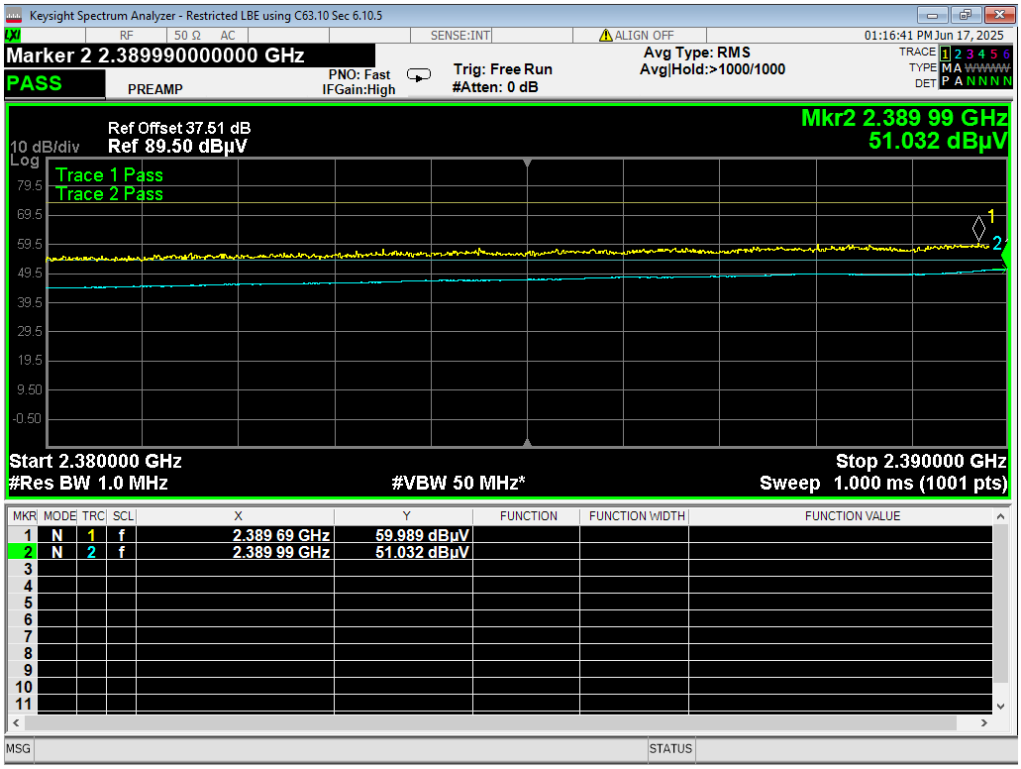

**06 6dB BW, Zigbee, 2470MHz**



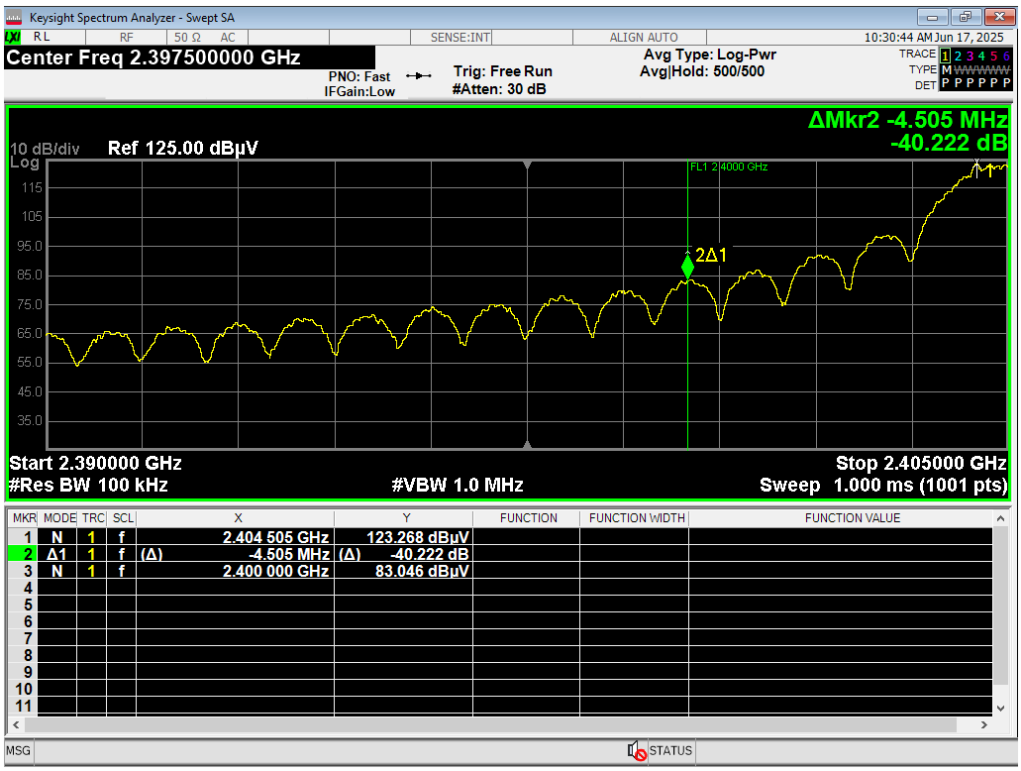

**07 HBE Restricted, Zigbee 2470MHz**



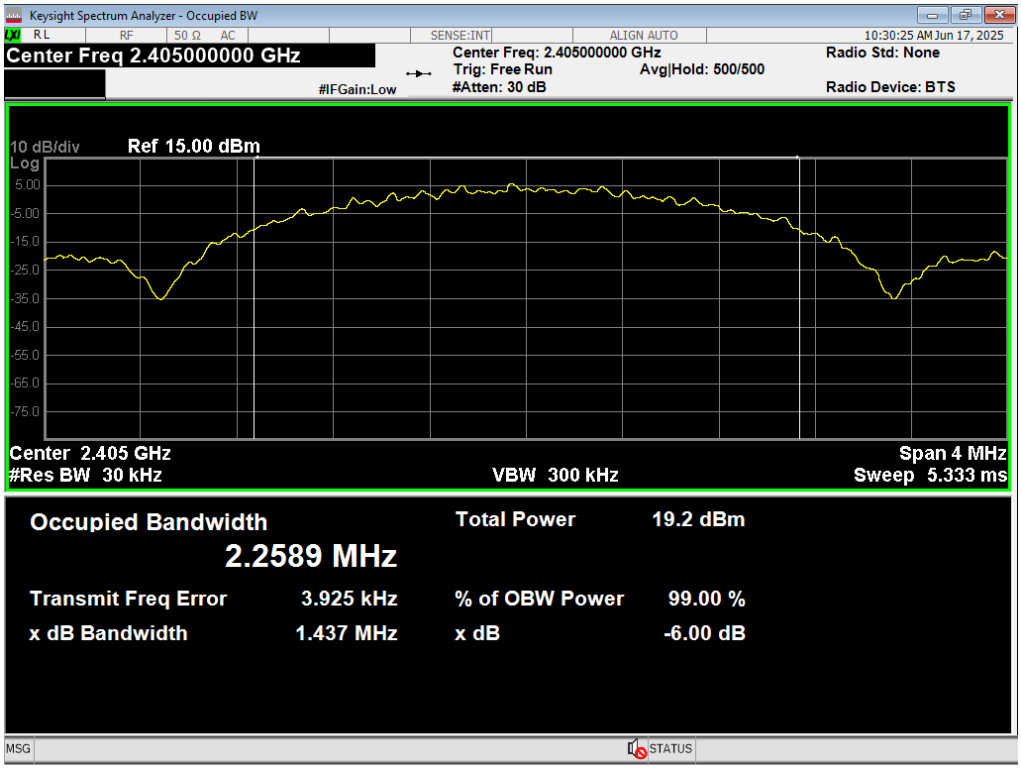

**08 HBE Unrestricted, Zigbee, 2470MHz**



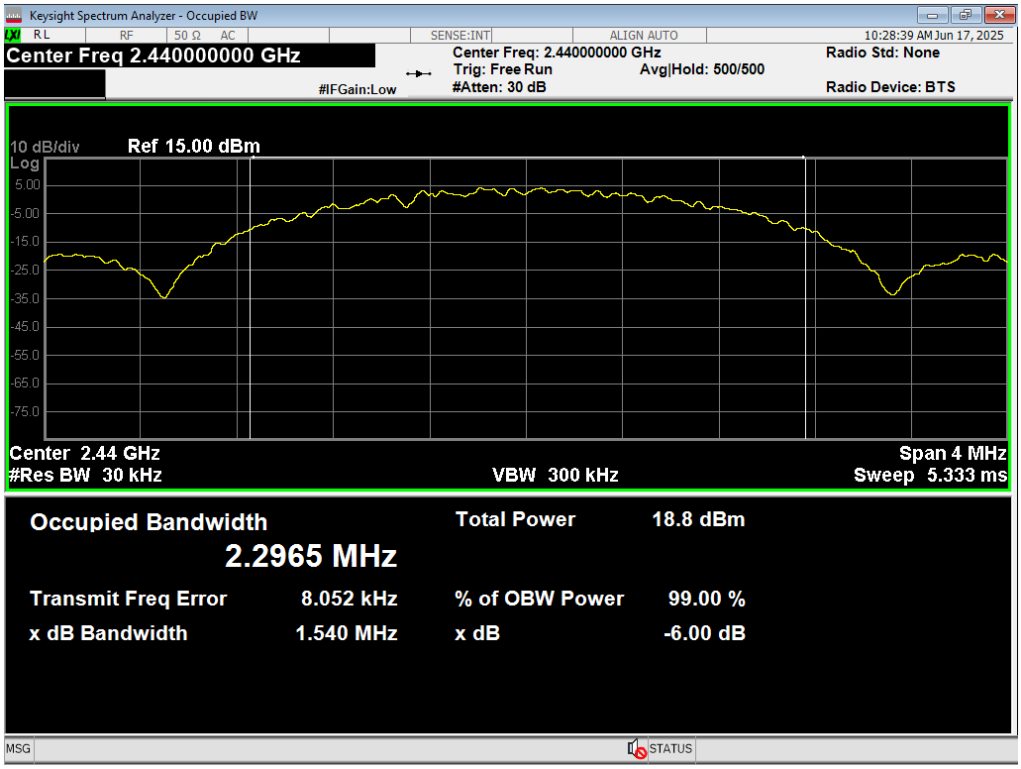

09 LBE Restricted, Zigbee 2405MHz



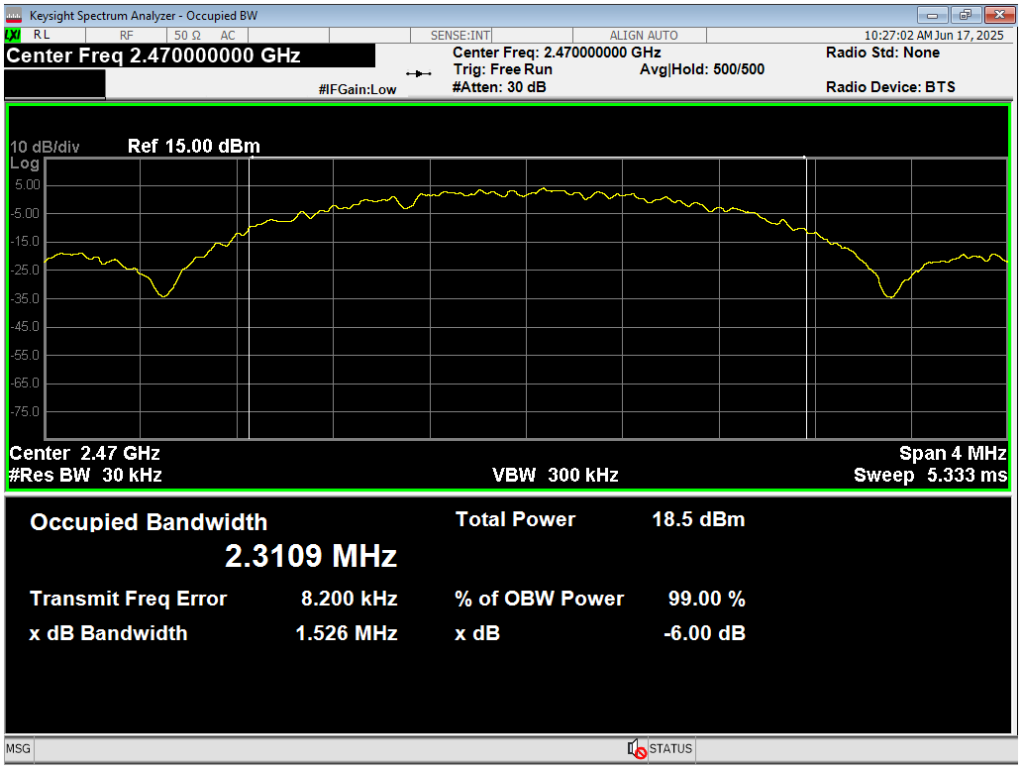

10 LBE Unrestricted, Zigbee, 2405MHz



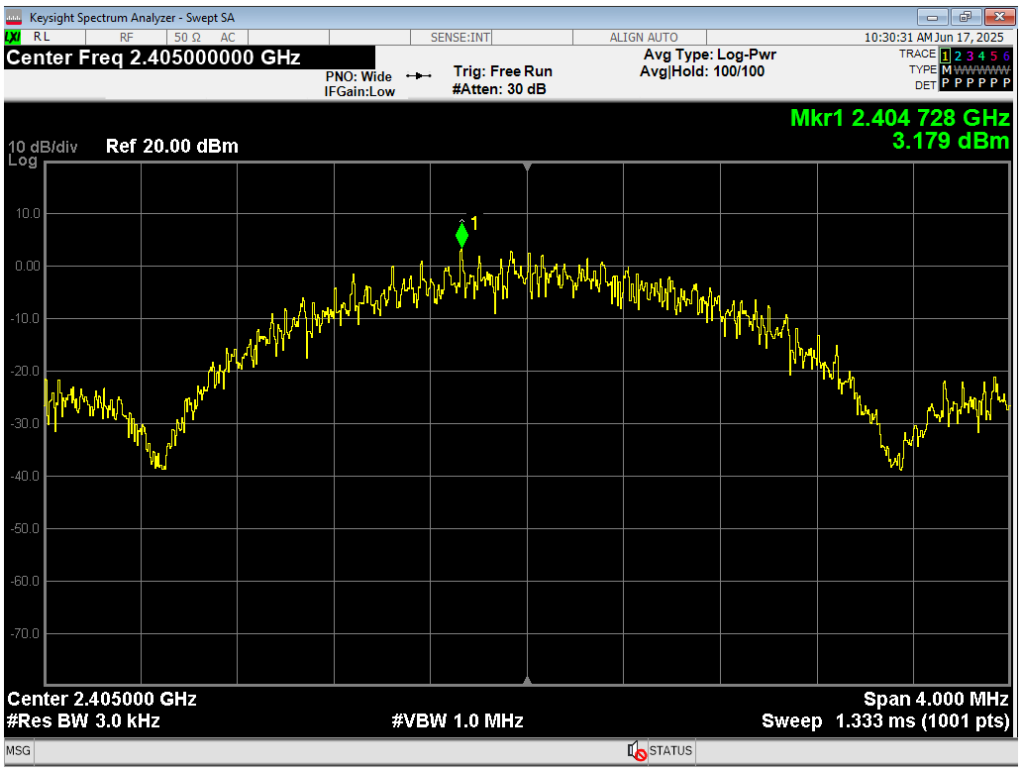

11 Occupied BW, Zigbee 2405MHz



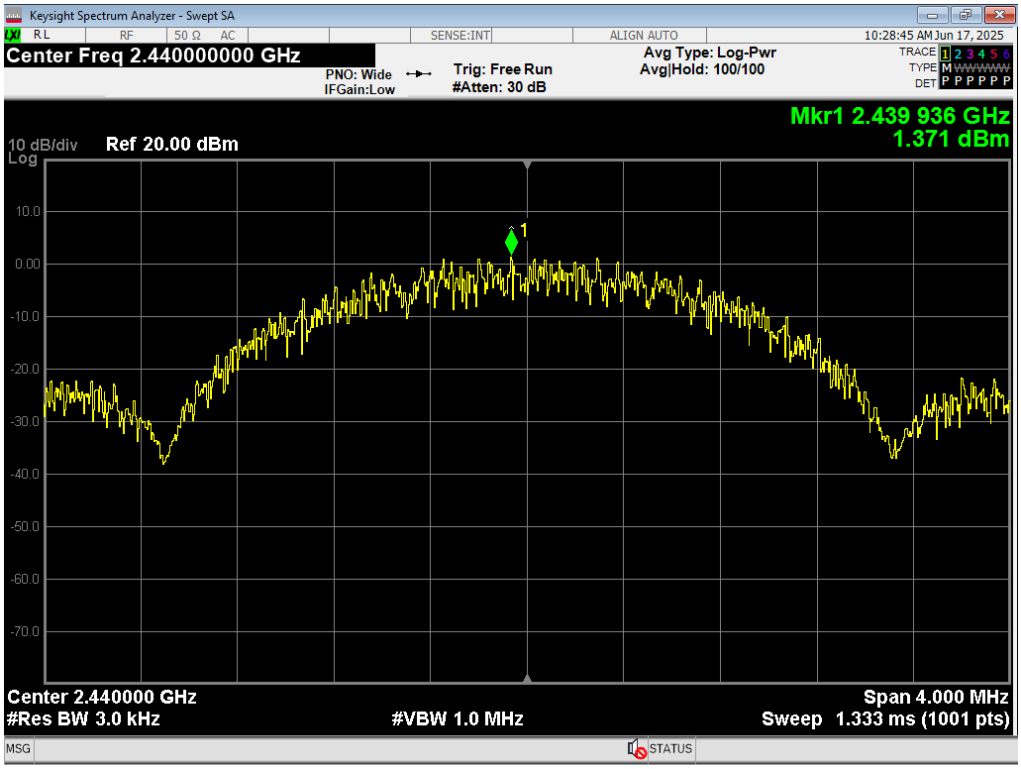

12 Occupied BW, Zigbee, 2440MHz



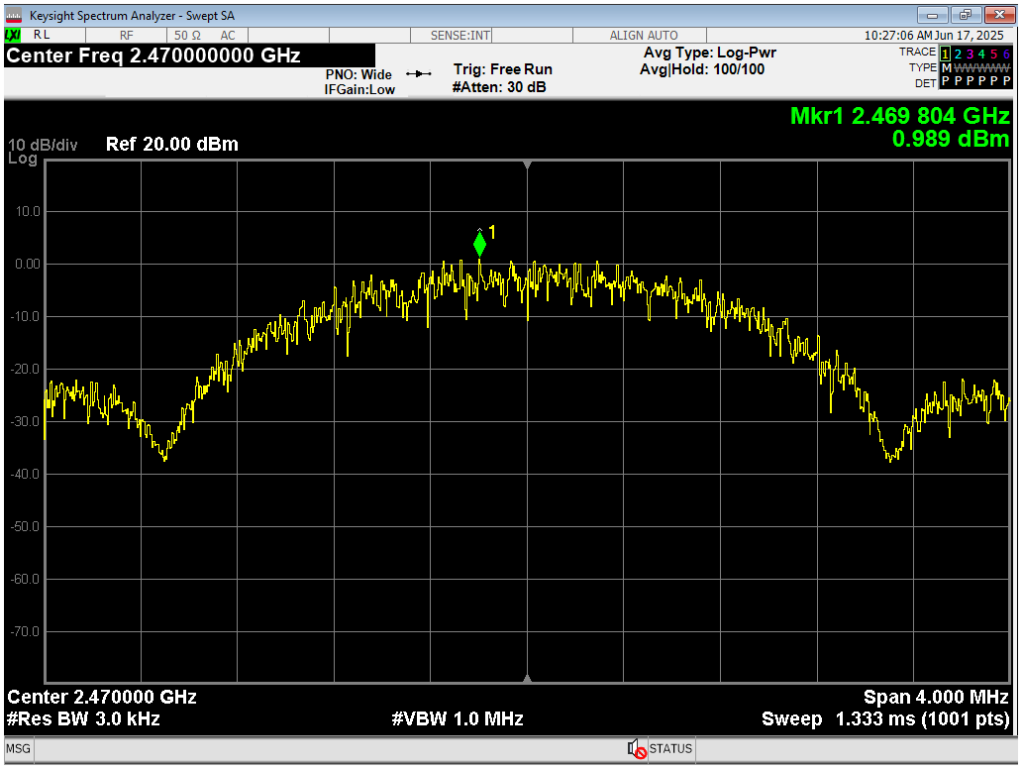

13 Occupied BW, Zigbee 2470MHz




14 PSD, Zigbee 2405MHz




15 PSD, Zigbee, 2440MHz




16 PSD, Zigbee, 2470MHz

REPORT END