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FCC/ISED Test Report

Prepared for: **Hunter Douglas**

Address: **2550 W. Midway Blvd.**
Broomfield, CO 80020

Product: **LBEE5HY1MW**

Test Report No: **R20200723-21-E7A**

Approved by:

Nic S. Johnson, NCE
Technical Manager
iNARTE Certified EMC Engineer #EMC-003337-NE

DATE: **June 16, 2022**

Total Pages: **22**

ACCREDITED
TESTING LABORATORY
CERTIFICATE NO. 1953.01

REVISION PAGE

Rev. No.	Date	Description
0	3 June 2022	Original - NJohnson Prepared by FLane
A	3 June 2022	Added comment to sec 4.2

CONTENTS

1.0 SUMMARY OF TEST RESULTS

The intention of this report is to determine, if the module in the EUT can be qualified as Class II permissive change. The EUT contains Murata module (with model number LBEE5HY1MW (FCC ID: VPYLBEE5HY1MW)). The manufacturer declared that they changed the antenna on the module. So, only the measurements that would be affected due to these changes are investigated in this report. The measurements that can be done in conducted manner are ignored as they won't be affected due to these changes. The worst-case measurements were reported in this report. Summary of test results presented in this report correspond to the following section:

FCC Part 15.247 ☒

The EUT has been tested according to the following specifications:

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

APPLIED STANDARDS AND REGULATIONS		
Standard Section	**Test Type**	**Result**
FCC Part 15.35 RSS Gen, Issue 5, Section 6.10	Duty Cycle	Pass
FCC Part 15.209 (restricted bands), RSS-247 Issue 2 Section 5.5, RSS-Gen Issue 4, Section 8.9 RSS-210 Issue 10 Section 7.1/7.2/7.3	Transmitter Radiated Emissions	Pass
FCC Part 15.209, 15.247(d) RSS-247 Issue 2 Section 11.13	Band Edge Measurement	Pass

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary and Operating Condition:

EUT	LBEE5HY1MW
EUT Received	20 November 2020
EUT Tested	2 June 2022- 3 June 2022
Serial No.	010409 (NCEE assigned serial number) (Radiated Unit)
Operating Band	2400 – 2483.5 MHz
Device Type	☒ GMSK ☐ GFSK ☐ BT BR ☐ BT EDR 2MB ☐ BT EDR 3MB ☐ 802.11x
Power Supply / Voltage	TP-POE-48 SN:139049622D RC03

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

This report is a class II permissive change;
see FCC ID: VPYLBEE5HY1MW

2.2 DESCRIPTION OF TEST MODES

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

For GMSK Transmissions:

Channel	Frequency
Low	2402 MHz
Mid	2440 MHz
High	2480 MHz

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 frequency 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
Industry Canada Test Site Registration No:	4294A-1
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	Nic Johnson	Technical Manager	Review/editing
2	Fox Lane	Test Engineer	Testing and report
3	Karthik Vepuri	Test Engineer	Report and review
4	Blake Winter	Test Engineer	Testing
5	Grace Larsen	Test Technician	Testing

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 (44GHz)**	N9038A	MY59050109	July 21, 2021	July 21, 2023^
Keysight MXE Signal Analyzer (26.5GHz)***	N9038A	MY56400083	May 5, 2020	May 5, 2023^
SunAR RF Motion	JB1	A091418	July 27, 2021	July 27, 2022^
EMCO Horn Antenna**	3115	6415	March 16, 2020	March 16, 2022
EMCO Horn Antenna	3115	6416	July 28, 2021	July 28, 2022
EMCO Horn Antenna**	3116	2576	March 9, 2020	March 9, 2022
Rohde & Schwarz Preamplifier**	TS-PR18	3545700803	March 21, 2022	March 21, 2024^
Trilithic High Pass Filter*	6HC330	23042	April 14, 2020	April 14, 2022
MiniCircuits 8400+ High Pass Filter	VHF-8400+	30807	May 30, 2022	May 30, 2024
RF Cable (preamplifier to antenna)*	MFR-57500	01-07-002	March 21, 2022	March 21, 2024
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	December 1, 2021	December 1, 2023^
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3874	December 1, 2021	December 1, 2023^
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	December 1, 2021	December 1, 2023^
N connector bulkhead (10m chamber)*	PE9128	NCEEBH1	December 1, 2021	December 1, 2023^
N connector bulkhead (control room)*	PE9128	NCEEBH2	December 1, 2021	December 1, 2023^
TDK Emissions Lab Software	V11.25	700307	NA	NA

* Internal Verification
**2 Year Cal Cycle
***3 Year Cal Cycle
^Most up to date calibration, testing was also performed before last calibration date and returned in tolerance.

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 the 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.

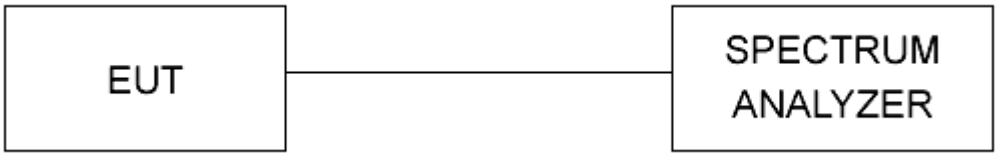


Figure 1 - Bandwidth Measurements Test Setup

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 the 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.

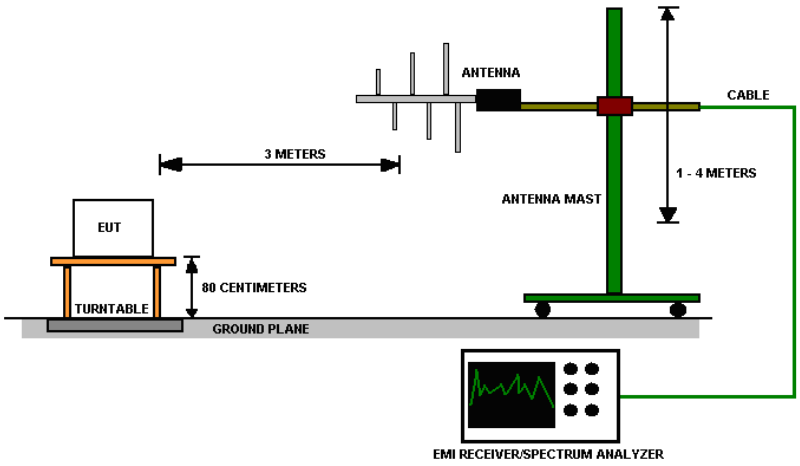


Figure 2 - Radiated Emissions Test Setup

4.0 RESULTS

Radiated Peak Restricted Band-Edge							
CH	**Mode**	**Band edge /Measurement Frequency (MHz)**	**Highest out of band level (dBuV/m @ 3m)**	**Measurement Type**	**Limit (dBuV/m @ 3m)**	**Margin**	**Result**
Low	GMSK	2390.00	54.646	Peak	73.98	19.334	PASS
High	GMSK	2483.50	54.205	Peak	73.98	19.775	PASS
*Limit shown is the peak limit taken from FCC Part 15.209							

Radiated Average Restricted Band-Edge								
CH	**Mode**	**Band edge /Measurement Frequency (MHz)**	**Raw Highest out of band level (dBuV/m @ 3m)**	**Corrected Highest out of band level (dBuV/m @ 3m)**	**Measurement Type**	**Limit (dBuV/m @ 3m)**	**Margin**	**Result**
Low	GMSK	2390.00	41.808	45.978	Average	53.98	8.132	PASS
High	GMSK	2483.50	42.544	46.714	Average	53.98	7.396	PASS
Corrected Highest out of band level (avg) = Raw Highest out of band level (avg) + DCCF See sec 4.1 for more information on DCCF *Limit shown is the average limit taken from FCC Part 15.209								

All conducted output power measurements were repeated and found to be within the same as the original grant within measurement tolerance.

4.1 DUTY CYCLE

Test Method:

Duty cycle from previous report (Report Number: 1802WSU008-U3) was 61.86%

Duty Cycle Correction Factor (DCCF) = 20 * Log (1 / DC)
DC = Duty Cycle
DCCF = 20 * Log (1/0.6186) = 4.17

4.2 RADIATED EMISSIONS

Test Method: ANSI C63.10-2013, 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.
4. The EUT was tested for spurious emissions. Emissions were produced while powered by POE device

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 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 used to make the measurement.

d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was 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.

Test setup:

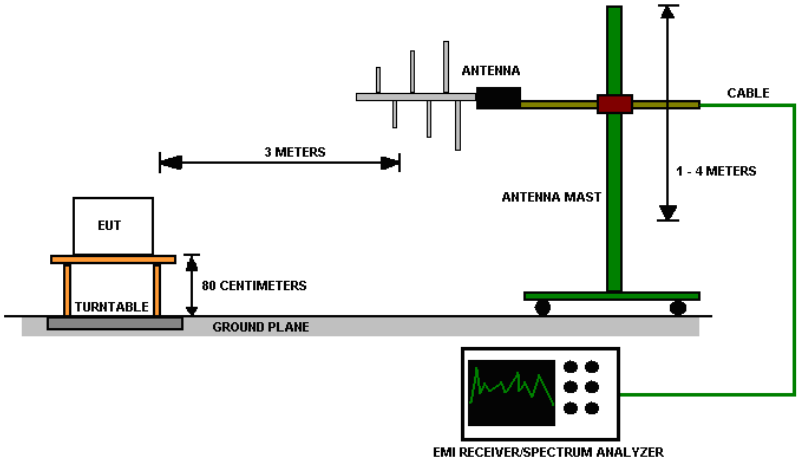


Figure 3 - Radiated Emissions Test Setup

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.

Test results:

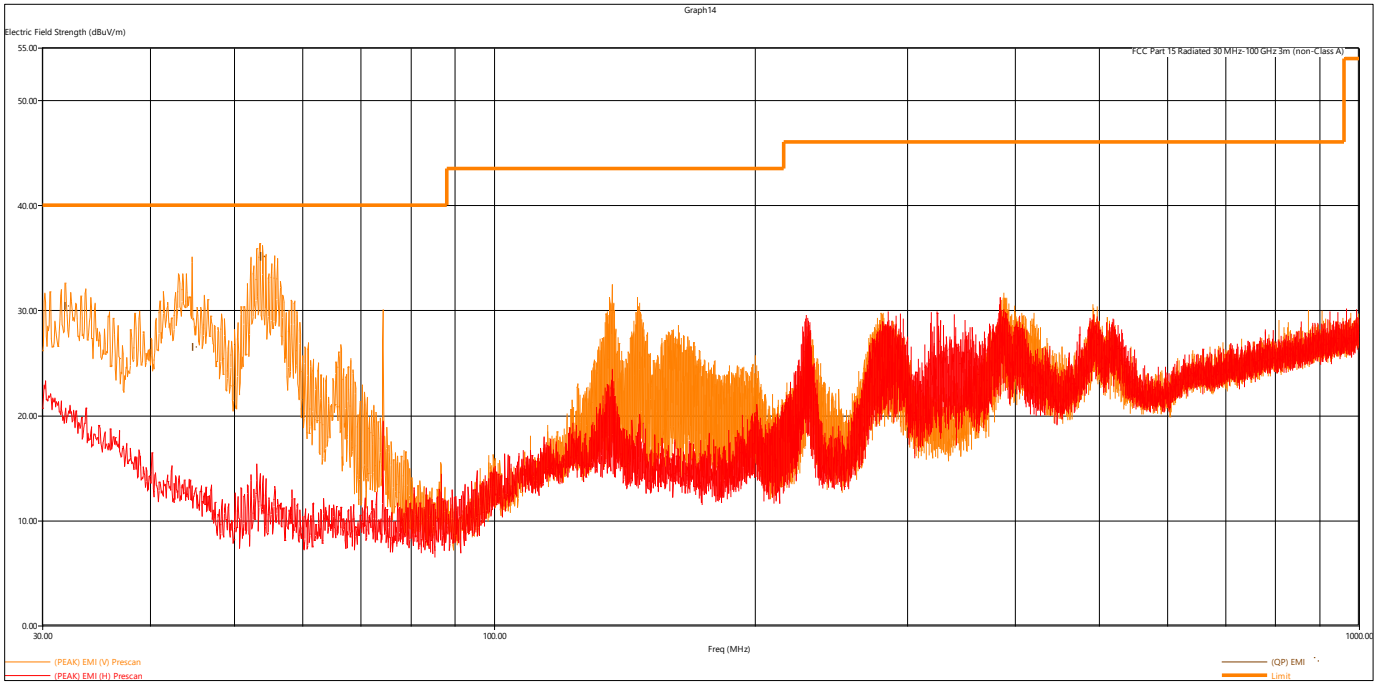


Figure 4 - Radiated Emissions Plot, GMSK, Low

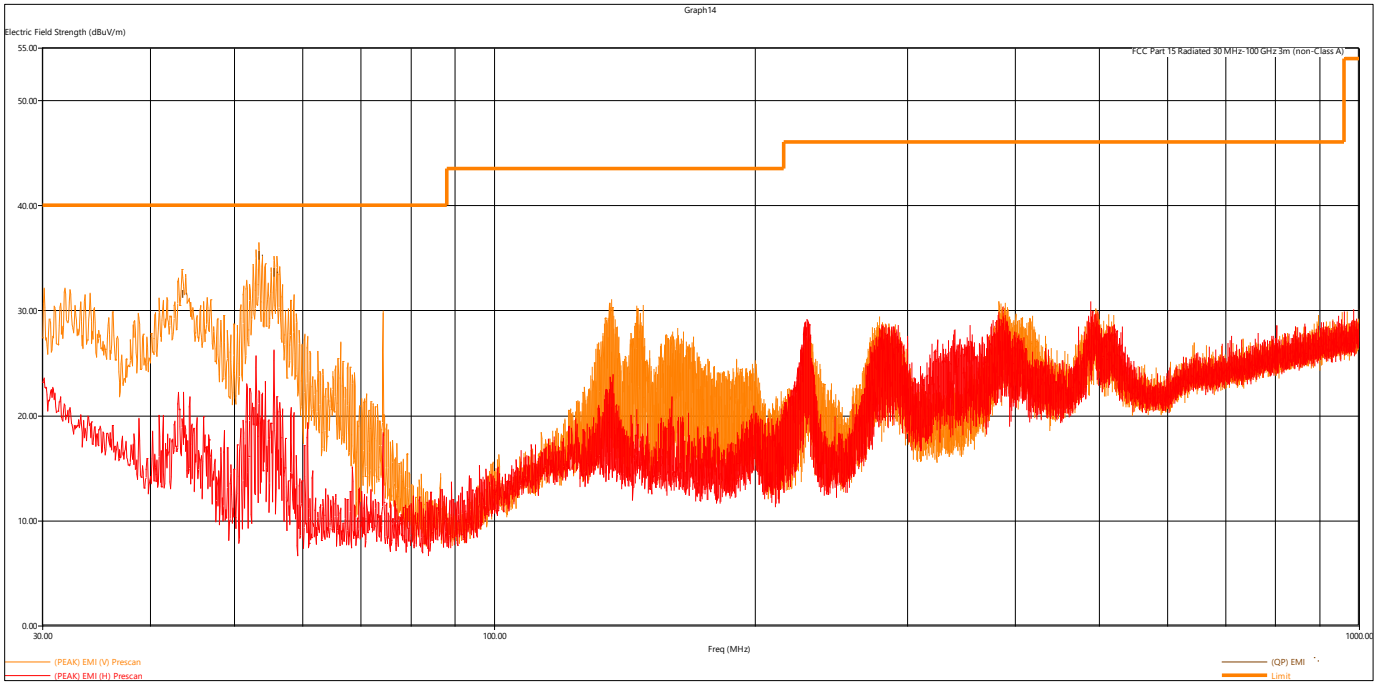


Figure 5 - Radiated Emissions Plot, GMSK, Mid

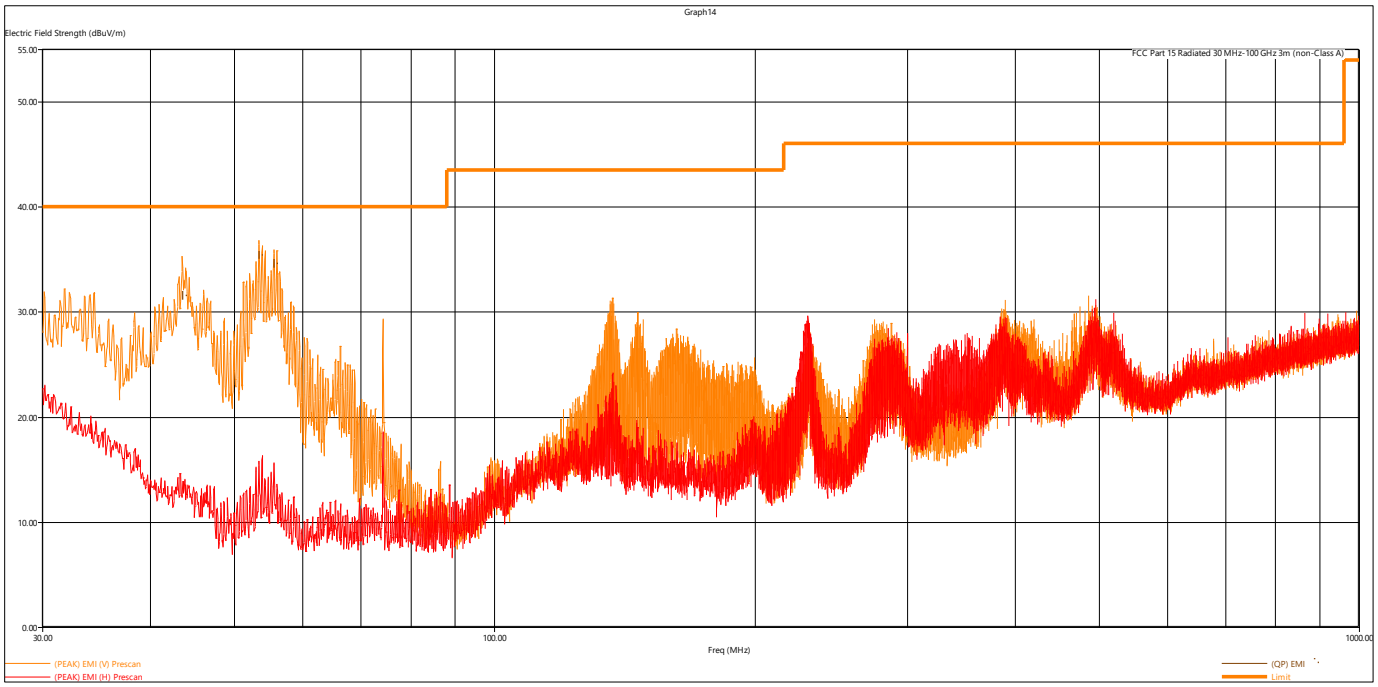


Figure 6 - Radiated Emissions Plot, GMSK, High

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. The other emission levels were very low against the limit.
4. Margin value = Limit value - Emission level

Quasi-Peak Measurements, GMSK							
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**Channel**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**		
31.901760	30.38	40.00	9.62	113.00	277.00	V	Low
44.514000	26.45	40.00	13.55	104.00	96.00	V	Low
53.431680	35.09	40.00	4.91	120.00	2.00	V	Low
43.494000	31.57	40.00	8.43	109.00	181.00	V	Mid
53.391360	35.18	40.00	4.82	112.00	0.00	V	Mid
55.512000	33.58	40.00	6.42	119.00	229.00	V	Mid
43.459200	31.52	40.00	8.48	114.00	157.00	V	High
53.363040	35.34	40.00	4.66	106.00	298.00	V	High
55.527120	34.56	40.00	5.44	105.00	267.00	V	High

Peak Measurements, GMSK-GFSK								
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**Channel**	**Modulation**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**			
2401.782000	99.88	NA	NA	290.00	109.00	H	Low	GMSK
2439.738000	99.37	NA	NA	290.00	109.00	H	Mid	GMSK
2479.702000	98.57	NA	NA	290.00	109.00	H	High	GMSK

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above.
Noise floor was at least 6dB below limit line and all other emissions found to be at least 6dB below the limit line

Average Measurements, GMSK-GFSK										
Frequency	**Peak Level**	**DCCF**	**Corrected AVG Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**Chan.**	**Mod.**
MHz	**dBµV/m**	**dB**	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**			
2401.782000	99.88	4.17	95.71	NA	NA	290.00	109.00	H	Low	GMSK
2439.738000	99.37	4.17	95.2	NA	NA	290.00	109.00	H	Mid	GMSK
2479.702000	98.57	4.17	94.4	NA	NA	290.00	109.00	H	High	GMSK
Corrected AVG Level = Peak Level – DCCF See Sec 4.1 for more information on DCCF										

The EUT was maximized in all 3 orthogonal axis. The worst-case is shown in the plot and table above.
Noise floor was at least 6dB below limit line and all other emissions found to be at least 6dB below the limit line

4.3 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 the 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 to the general limit defined in Part 15.209. The limit shown in the graph accounts for the antenna gain of the device.

APPENDIX A: SAMPLE CALCULATION

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and 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

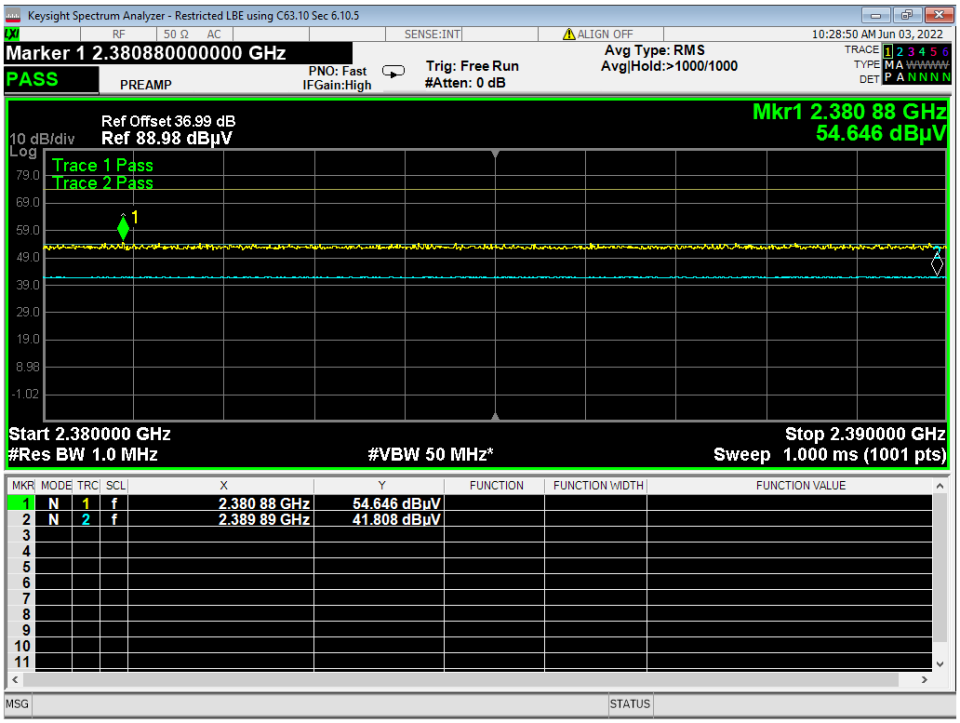
APPENDIX B – MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

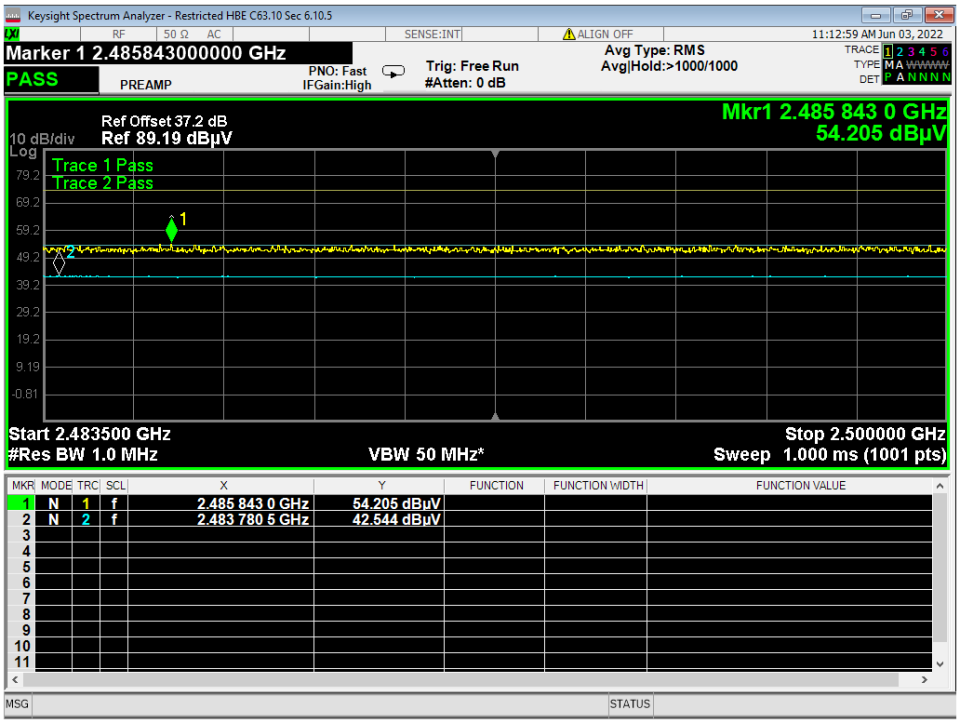
Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	±4.31
Radiated Emissions, 3m	1GHz - 18GHz	±5.08
Emissions limits, conducted	30MHz – 18GHz	±3.03

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

APPENDIX C – GRAPHS AND TABLES



Lower Band edge, GMSK



Higher Band edge, GMSK

REPORT END