TEST REPORT

Report Number. : R14147566-E1

Applicant	:	Dodge Industrial, Inc. 1061 Holland Rd, Simpsonville, SC, 29681, USA
Model	:	DPFSV1
Brand	:	Dodge Industrial, Inc.
FCC ID	:	2A6IE-DPFSV1
IC	:	28778-DPFSV1
EUT Description	:	OPTIFY™ Performance Sensor
Test Standard(s)	:	FCC 47 CFR PART 15 SUBPART C:2022 ISED RSS-247 ISSUE 2: 2017 ISED RSS-GEN ISSUE 5 + A2:2021

Date Of Issue:
2022-11-11

Prepared by:
UL LLC.
12 Laboratory Drive
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ACCREDITED
CERT #0751.06

REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	2022-07-15	Initial Issue	Noah Bennett
V2	2022-11-11	Corrected IC	Noah Bennett

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Dodge Industrial, Inc.
1061 Holland Rd,
Simpsonville, SC 29681, USA

EUT DESCRIPTION: Battery-powered, stand-alone measurement device which communicates through BLE to the cloud to monitor condition of industrial machines.

MODEL: DPFSV1

BRAND: Dodge Industrial, Inc.

SERIAL NUMBER: Non-Serialized

SAMPLE RECEIPT DATE: 2022-06-27

DATE TESTED: 2022-06-27 TO 2022-06-30

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart C	Complies
ISED RSS-247 Issue 2	Complies
ISED RSS-GEN Issue 5 + A2	Complies

UL LLC tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL LLC and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL LLC will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, any agency of the Federal Government, or any agency of the U.S. government.

Approved & Released For
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Consumer Technology Division
UL LLC

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2. TEST RESULTS SUMMARY

This report contains data provided by the applicant which can impact the validity of results. UL LLC is only responsible for the validity of results after the integration of the data provided by the customer.

FCC Clause	ISED Clause	Requirement	Result	Comment
See Comment		Duty Cycle	Reporting purposes only	ANSI C63.10 Section 11.6.
-	RSS-GEN 6.7	99% OBW	Reporting purposes only	ANSI C63.10 Section 6.9.3.
15.247 (a) (2)	RSS-247 5.2 (a)	6dB BW	Complies	None.
15.247 (b) (3)	RSS-247 5.4 (d)	Output Power	Complies	None.
See Comment		Average power	Reporting purposes only	Per ANSI C63.10, Section 11.9.2.3.2.
15.247 (e)	RSS-247 5.2 (b)	PSD	Complies	None.
15.247 (d)	RSS-247 5.5	Conducted Spurious Emissions	Complies	None.
15.209, 15.205	RSS-GEN 8.9, 8.10	Radiated Emissions	Complies	None.
15.207	RSS-Gen 8.8	AC Mains Conducted Emissions	N/A	None.

3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, ANSI C63.10-2013, KDB 558074 D01 15.247 Meas Guidance v05r02, KDB 414788 D01 Radiated Test Site v01r01, RSS-GEN Issue 5 + A1 + A2, and RSS-247 Issue 2.

4. FACILITIES AND ACCREDITATION

UL LLC is accredited by A2LA, Certificate Number 0751.06, for all testing performed within the scope of this report. Testing was performed at the locations noted below.

	Address	ISED CABID	ISED Company Number	FCC Registration
☒	Building 2800 Suite Perimeter Park Dr. Suite B Morrisville, NC 27560, U.S.A	US0067	27265	825374

5. DECISION RULES AND MEASUREMENT UNCERTAINTY

5.1. METROLOGICAL TRACEABILITY

All test and measuring equipment utilized to perform the tests documented in this report are calibrated on a regular basis, with a maximum time between calibrations of one year or the manufacturers' recommendation, whichever is less, and where applicable is traceable to recognized national standards.

5.2. DECISION RULES

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4:2012 Clause 8.2. (Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

5.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	U_{LAB}
Radio Frequency	±0.03 ppm
RF power, conducted	±0.45 dB
RF power, radiated	±6 dB
Spurious emissions, conducted	±1.94 dB
Spurious emissions, radiated (Substituted Power) Frequency < 180 MHz	±6.18 dB
Spurious emissions, radiated (Substituted Power) Frequency ≥ 180 MHz	±3.23 dB
Humidity	±3.39 % RH
Temperature	±0.57 deg C
Time.	±3.39 %

Uncertainty figures are valid to a confidence level of 95%.

5.4. SAMPLE CALCULATION

RADIATED EMISSIONS

Where relevant, the following sample calculation is provided:
Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)
36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

MAINS CONDUCTED EMISSIONS

Where relevant, the following sample calculation is provided:
Final Voltage (dBuV) = Measured Voltage (dBuV) + Cable Loss (dB) + Limiter Factor (dB) + LISN Insertion Loss.
36.5 dBuV + 0 dB +10.1 dB+ 0 dB = 46.6 dBuV

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6. EQUIPMENT UNDER TEST

6.1. EUT DESCRIPTION

The EUT is a Battery-powered, stand-alone measurement device which communicates through BLE to the cloud to monitor condition of industrial machines.

6.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum peak conducted output power as follows:

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
2402 - 2480	BLE	-1.23	0.75

6.3. DESCRIPTION OF AVAILABLE ANTENNAS

The antenna gain and type, as provided by the manufacturer' are as follows:

The radio utilizes a Chip antenna, with a maximum gain of 5.05 dBi.

6.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was v nRF5_SDK_DTM version 17.1.0_ddde560.

The test utility software used during testing was nRF Connect.

6.5. WORST-CASE CONFIGURATION AND MODE

Radiated emissions below 1GHz, and above 18GHz, were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

Band edge and radiated emissions between 1GHz and 18GHz were performed with the EUT set to transmit at the highest power on low, middle and high channels.

The fundamental of the EUT was investigated in three orthogonal orientations X,Y,Z, it was determined that Y orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in Y orientation.

The Worst-Case PSD mode was found to be 125Kbps, therefore, test reduction for radiated emissions was done to test 125Kbps only as a worst-case representative for the other supported data rates. Band Edge was done at 125Kbps and 2Mbps to account for the channel width differences between the 125Kbps Worst-Case mode, and the 2Mbps mode.

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6.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
Laptop	LG	16T90Q	204QCVU558327	-

I/O CABLES

N/A

TEST SETUP

The EUT is connected to a test laptop before the tests. Test software exercised the radio card.

SETUP DIAGRAMS

Please refer to R14147566-EP1 for setup diagrams

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7. MEASUREMENT METHOD

6 dB BW: ANSI C63.10 Subclause -11.8.1 RBW ≥ DTS BW

Occupied BW (99%): ANSI C63.10-2013 Section 6.9.3

Output Power: ANSI C63.10 Subclause -11.9.1.3 Method PKPM1 Peak-reading power meter
Output Power: ANSI C63.10 Subclause -11.9.2.3.2 Method AVGPM-G (Measurement using a gated RF average-reading power meter)

PSD: ANSI C63.10 Subclause -11.10.2 Method PKPSD (peak PSD)

Radiated emissions non-restricted frequency bands: ANSI C63.10 Subclause -11.11

Radiated emissions restricted frequency bands: ANSI C63.10 Subclause -11.12.1

Conducted emissions in restricted frequency bands: ANSI C63.10 Subclause -11.12.2

Band-edge: ANSI C63.10 Subclause -11.13.3.4 Integration method -Trace averaging across ON and OFF times DC correction

Radiated Spurious Emissions Below 30MHz: ANSI C63.10-2013 Section 6.3, 6.4 and 6.6

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8. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Test Equipment Used - Wireless Conducted Measurement Equipment

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	Conducted Room 2				
HI0090	Environmental Meter	Fischer Scientific	15-077-963	2021-07-12	2022-07-12
PWM004	RF Power Meter	Keysight Technologies	N1911A	2021-08-17	2022-08-17
PWS005	Peak and Avg Power Sensor, 50MHz – 18GHz	Keysight Technologies	N1921A	2022-06-15	2023-06-15
SA0027	Spectrum Analyzer	Keysight Technologies	N9030A	2022-05-24	2023-05-24
SOFTEMI	Antenna Port Software	UL	Version 2022.05.04		

Test Equipment Used - Radiated Disturbance Emissions Test Equipment (Morrisville – Chamber 1)

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	0.009-30MHz				
AT0079	Active Loop Antenna	ETS-Lindgren	6502	2021-08-19	2022-08-19
	30-1000 MHz				
AT0066	Hybrid Broadband Antenna	Sunol Sciences Corp.	JB1	2022-03-01	2023-03-01
	1-18 GHz				
AT0072)	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2022-05-11	2023-05-11
	18-40 GHz				
AT0063	Horn Antenna, 18-26.5GHz	ARA	MWH-1826/B	2021-11-04	2022-11-04
	Gain-Loss Chains				
C1-SAC01	Gain-loss string: 0.009-30MHz	Various	Various	2022-05-05	2023-05-05
C1-SAC02	Gain-loss string: 25-1000MHz	Various	Various	2022-05-05	2023-05-05
C1-SAC03	Gain-loss string: 1-18GHz	Various	Various	2022-05-05	2023-05-05
C1-SAC04	Gain-loss string: 18-40GHz	Various	Various	2022-05-05	2023-05-05
	Receiver & Software				
197954	Spectrum Analyzer	Rohde & Schwarz	ESW44	2022-04-14	2023-04-14
SOFTEMI	EMI Software	UL	Version 9.5 (18 Oct 2021)		
	Additional Equipment used				
s/n 181474341	Environmental Meter	Fisher Scientific	15-077-963	2021-09-27	2022-09-27

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Test Equipment Used - Radiated Disturbance Emissions Test Equipment (Morrisville – Chamber 4)

Equip. ID	Description	Manufacturer/Brand	Model Number	Last Cal.	Next Cal.
	1-18 GHz				
AT0069	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2021-06-29	2022-06-29
	Gain-Loss Chains				
C4-SAC03	Gain-loss string: 1-18GHz	Various	Various	2022-05-20	2023-05-20
	Receiver & Software				
206496	Spectrum Analyzer	Rohde & Schwarz	ESW44	2022-02-15	2023-02-15
SOFTEMI	EMI Software	UL	Version 9.5 (18 Oct 2021)		
	Additional Equipment used				
s/n 210701942	Environmental Meter	Fisher Scientific	15-077-963	2021-8-16	2023-08-16

9. ANTENNA PORT TEST RESULTS

9.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

PROCEDURE

KDB 558074 Zero-Span Spectrum Analyzer Method.

ON TIME AND DUTY CYCLE RESULTS

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (kHz)
2.4GHz Band						
BLE - 2Mbps	0.206	0.626	0.329	32.91%	9.65	4.854
BLE - 125Kbps	3.105	3.750	0.828	82.80%	1.64	0.322

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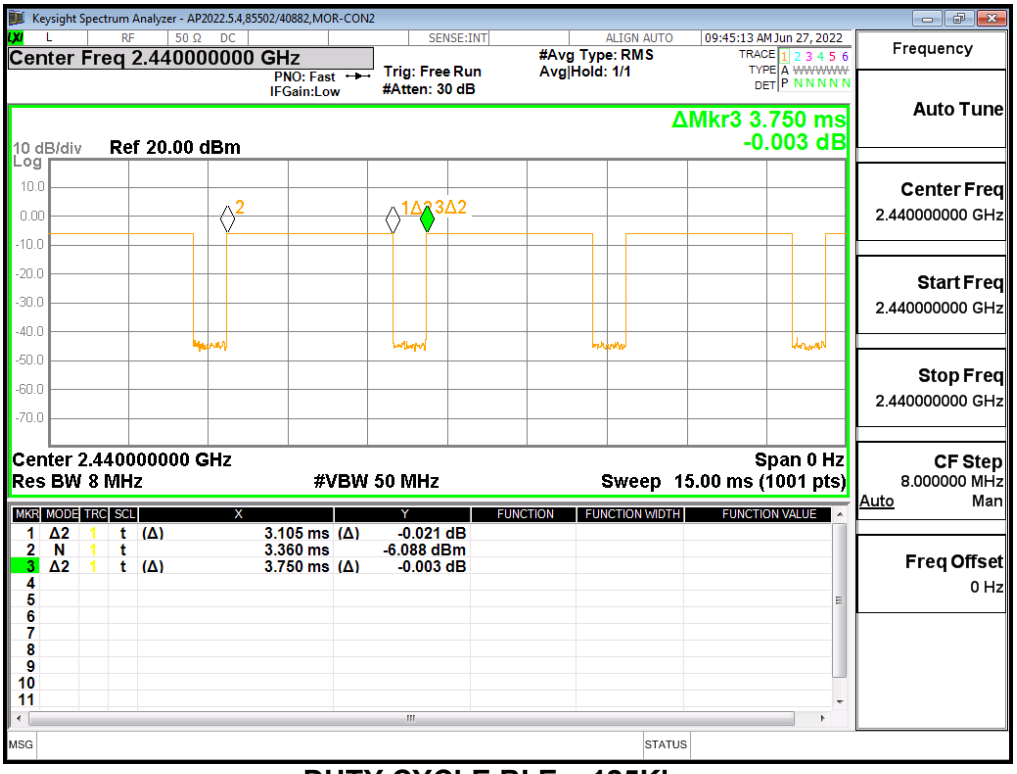
DUTY CYCLE PLOTS



DUTY CYCLE BLE – 125Kbps

DUTY CYCLE BLE – 2Mbps

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9.2. 99% BANDWIDTH

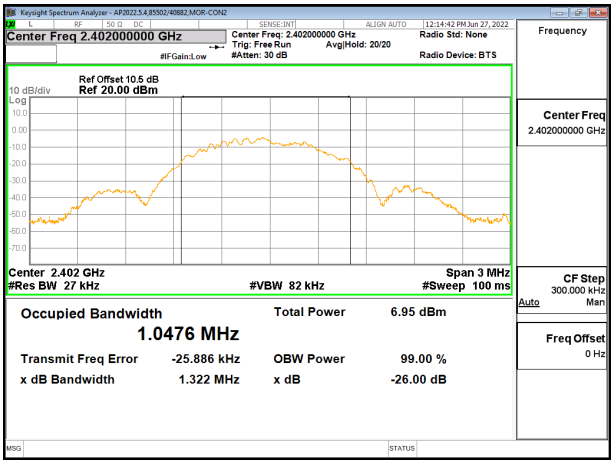
LIMITS

None; for reporting purposes only.

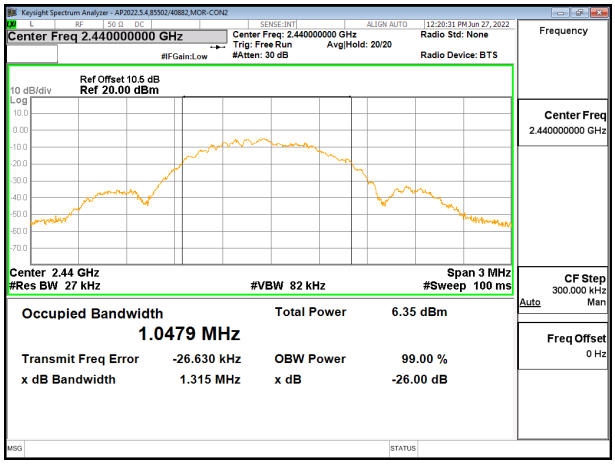
RESULTS

9.2.1. BLE (1Mbps)

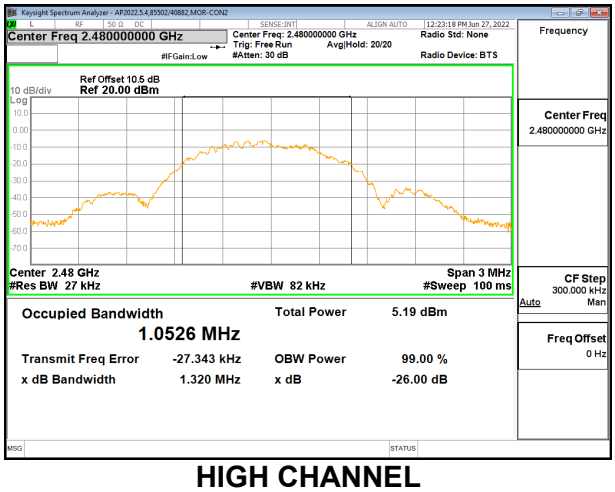
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0476
Middle	2440	1.0479
High	2480	1.0526



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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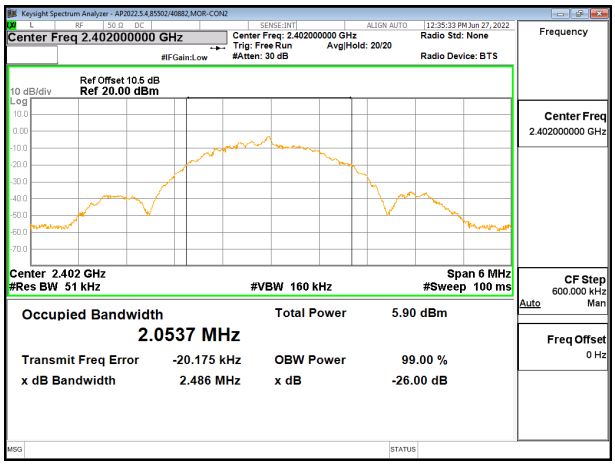
9.2.2. BLE (2Mbps)

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	2.0537
Middle	2440	2.0562
High	2480	2.0620



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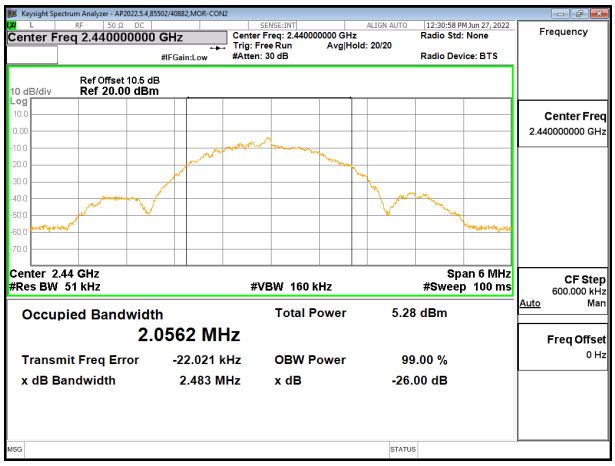

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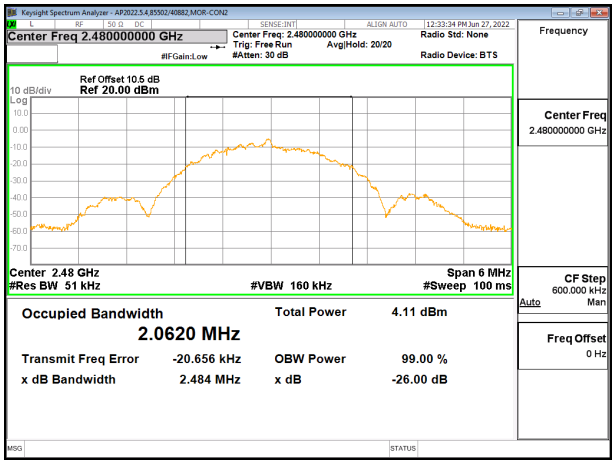
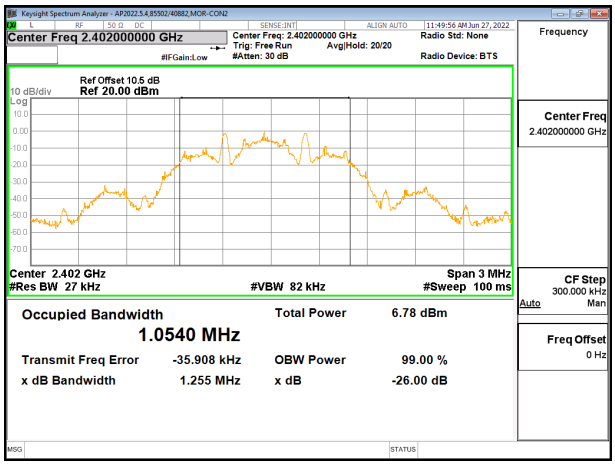


HIGH CHANNEL

9.2.3. BLE (125Kbps)

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0540
Middle	2440	1.0647
High	2480	1.0603



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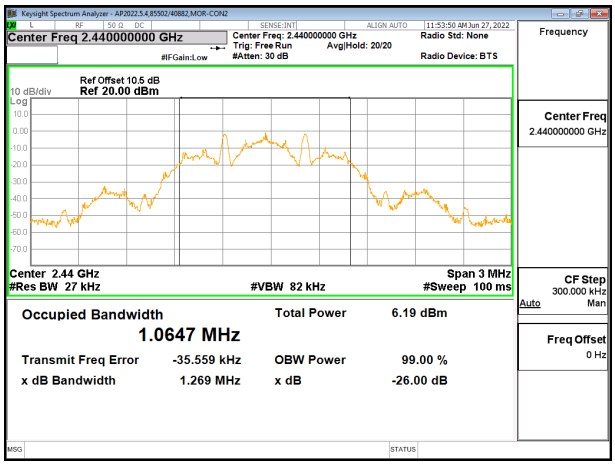

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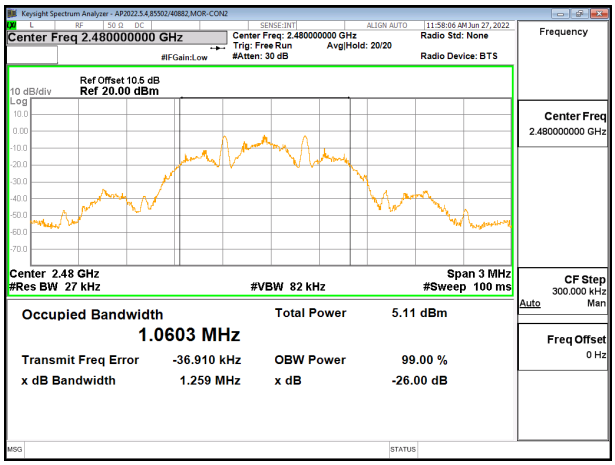
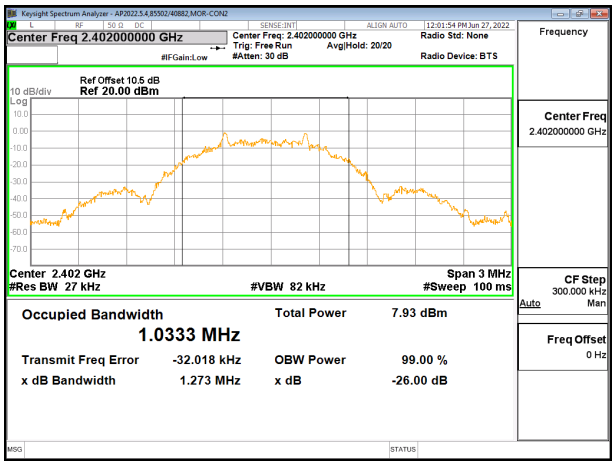


HIGH CHANNEL

9.2.4. BLE (500Kbps)

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0333
Middle	2440	1.0359
High	2480	1.0383



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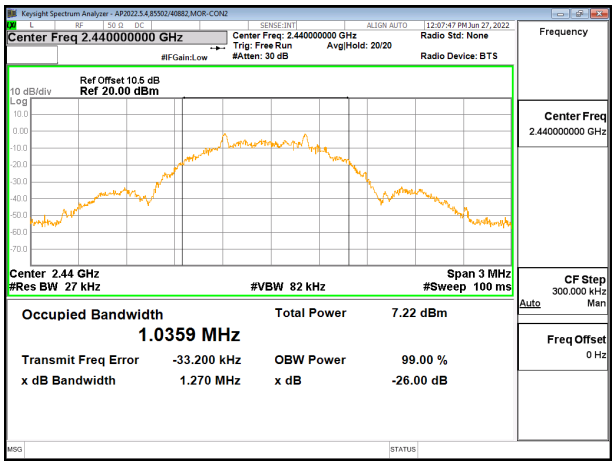

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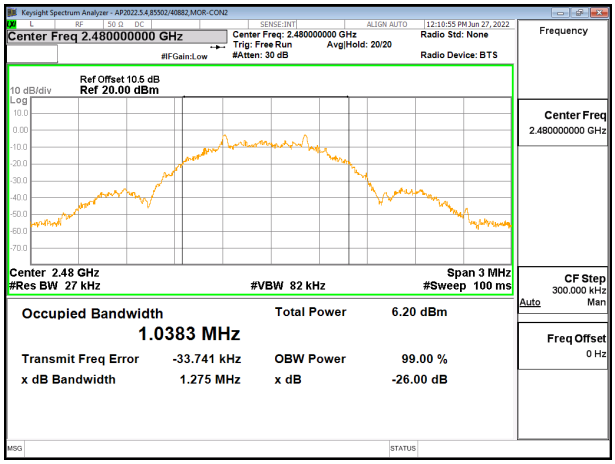


HIGH CHANNEL

9.3. 6 dB BANDWIDTH

LIMITS

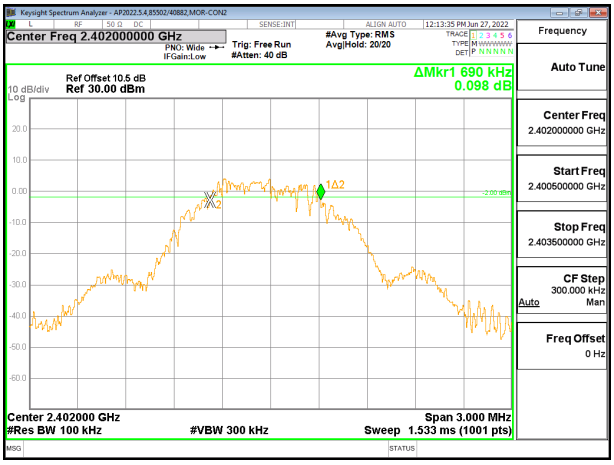
FCC §15.247 (a) (2)
RSS-247 5.2 (a)

The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS

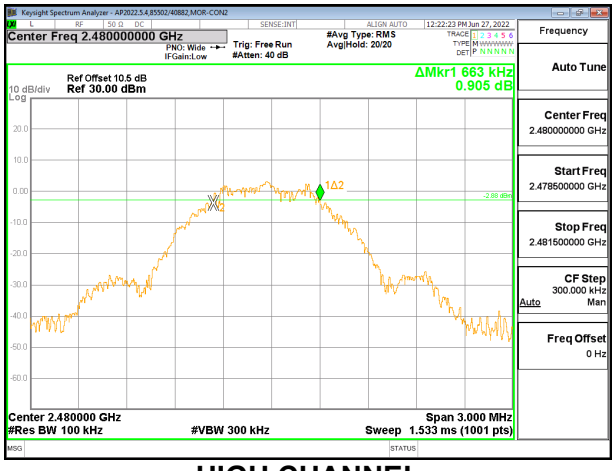
9.3.1. BLE (1Mbps)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.6900	0.5
Middle	2440	0.6720	0.5
High	2480	0.6630	0.5



LOW CHANNEL

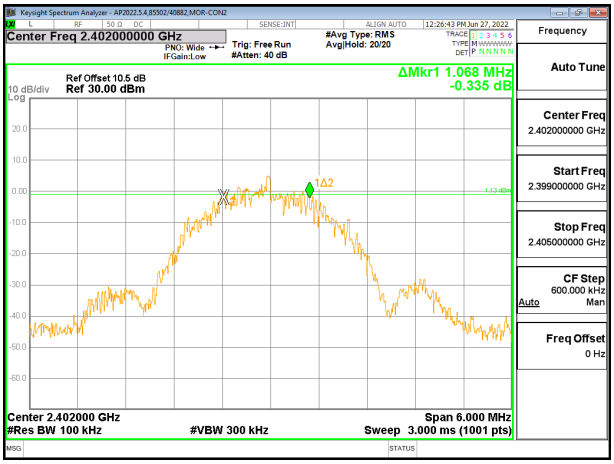
MID CHANNEL



HIGH CHANNEL

9.3.2. BLE (2Mbps)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	1.0680	0.5
Middle	2440	1.2720	0.5
High	2480	1.1220	0.5



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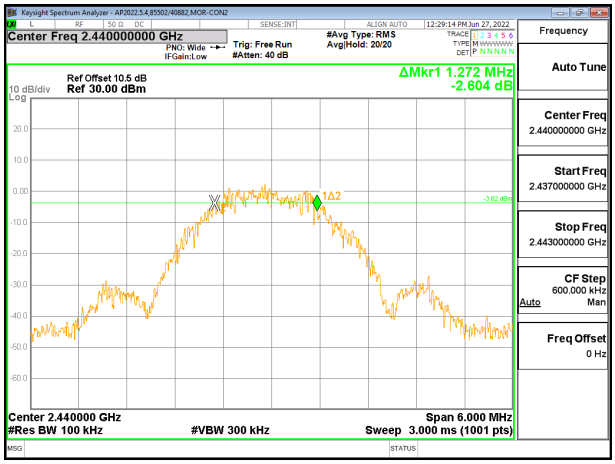

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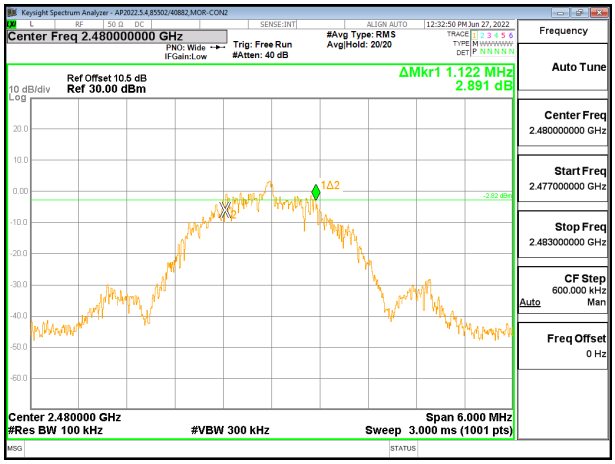

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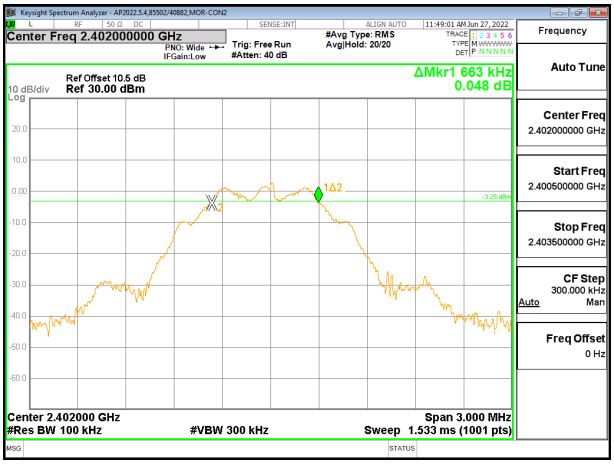
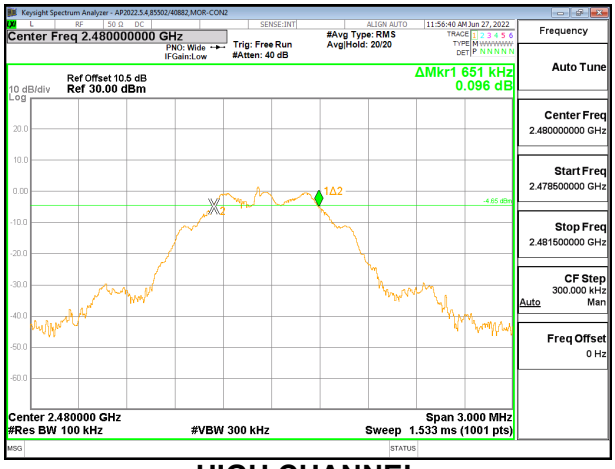
9.3.3. BLE (125Kbps)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.6630	0.5
Middle	2440	0.6840	0.5
High	2480	0.6510	0.5



LOW CHANNEL

MID CHANNEL



HIGH CHANNEL

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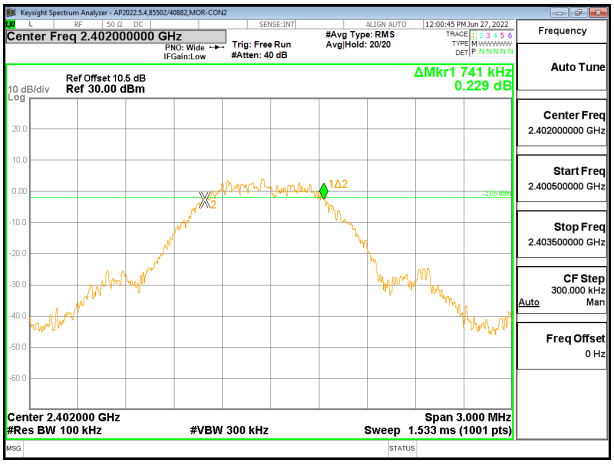
9.3.4. BLE (500Kbps)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.7410	0.5
Middle	2440	0.6690	0.5
High	2480	0.6750	0.5



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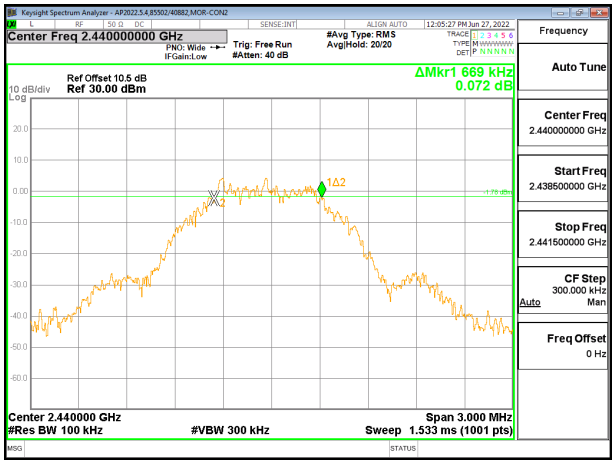

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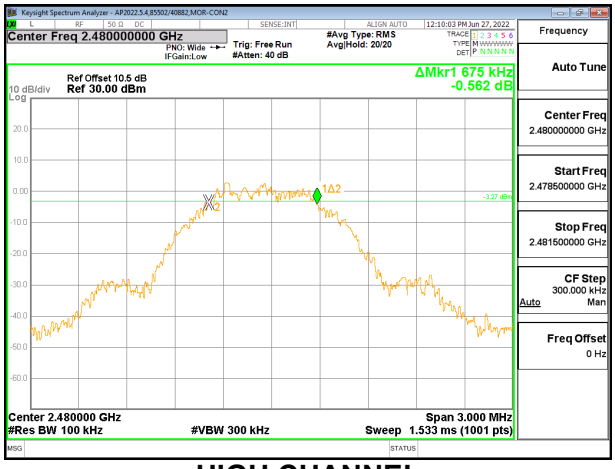

HIGH CHANNEL

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9.4. OUTPUT POWER

LIMITS

FCC §15.247 (b) (3)
RSS-247 5.4 (d)

The maximum antenna gain is less than or equal to 6 dBi, therefore the limit is 30 dBm.

TEST PROCEDURE
The transmitter output is connected to a power meter.

The cable assembly insertion loss of 10.5 dB (including 9.65 dB pad and 0.85 dB cable) was entered as an offset in the power meter to allow for a peak reading of power.

The power output was measured on the EUT antenna port using SMA cable with 10dB attenuator connected to a power meter via wideband average power sensor. Peak output power was read directly from power meter.

RESULTS

9.4.1. BLE (1Mbps)

Tested By:	85507/40882
Date:	6/27/2022

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	-1.280	30	-31.280
Middle	2440	-1.870	30	-31.870
High	2480	-2.490	30	-32.490

9.4.2. BLE (2Mbps)

Tested By:	85502/40882
Date:	6/27/2022

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	-1.280	30	-31.280
Middle	2440	-1.830	30	-31.830
High	2480	-2.480	30	-32.480

9.4.3. BLE (125Kbps)

Tested By:	85502/40882
Date:	6/27/2022

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	-1.230	30	-31.230
Middle	2440	-1.840	30	-31.840
High	2480	-2.530	30	-32.530

9.4.4. BLE (500Kbps)

Tested By:	85502/40882
Date:	6/27/2022

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	-1.260	30	-31.260
Middle	2440	-1.860	30	-31.860
High	2480	-2.470	30	-32.470

9.5. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 10.5 dB (including 9.65 dB pad and 0.85 dB cable) was entered as an offset in the power meter to allow for a gated average reading of power.

The power output was measured on the EUT antenna port using SMA cable with 10dB attenuator connected to a power meter via wideband average power sensor. Gated average output power was read directly from power meter.

RESULTS

9.5.1. BLE (1Mbps)

Tested By:	85502/40882
Date:	6/27/2022

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	-1.66
Middle	2440	-2.27
High	2480	-3

9.5.2. BLE (2Mbps)

Tested By:	85502/40882
Date:	6/27/2022

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	-1.65
Middle	2440	-2.26
High	2480	-3

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9.5.3. BLE (125Kbps)

Tested By:	85502/40882
Date:	6/27/2022

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	-1.69
Middle	2440	-2.3
High	2480	-3.04

9.5.4. BLE (500Kbps)

Tested By:	85502/40882
Date:	6/27/2022

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	-1.67
Middle	2440	-2.28
High	2480	-3.01

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9.6. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247 (e)

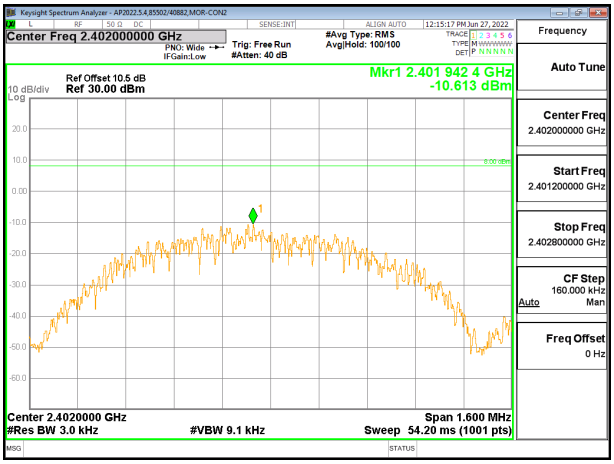
RSS-247 (5.2) (b)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

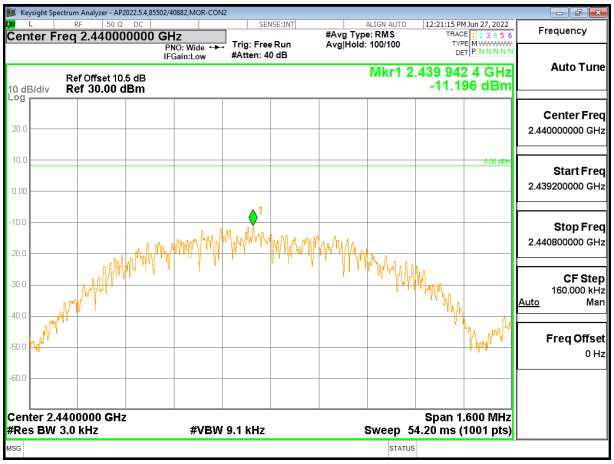
RESULTS

9.6.1. BLE (1Mbps)

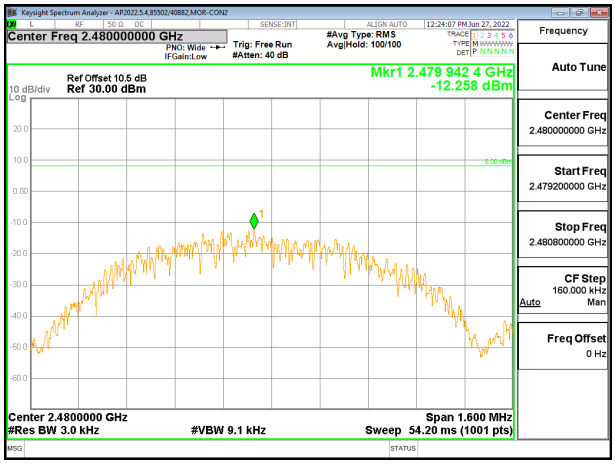
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	-10.613	8	-18.61
Middle	2440	-11.196	8	-19.20
High	2480	-12.258	8	-20.26



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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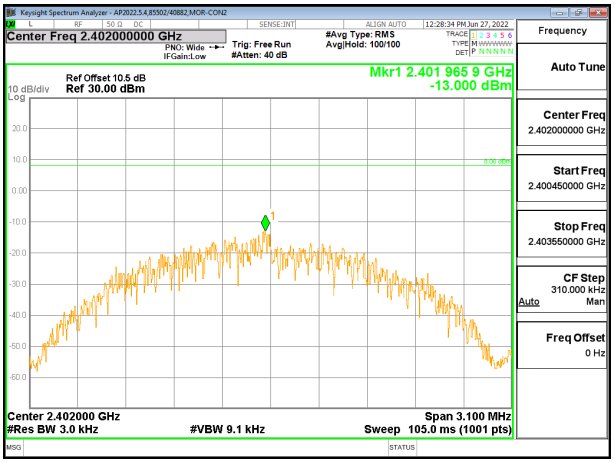
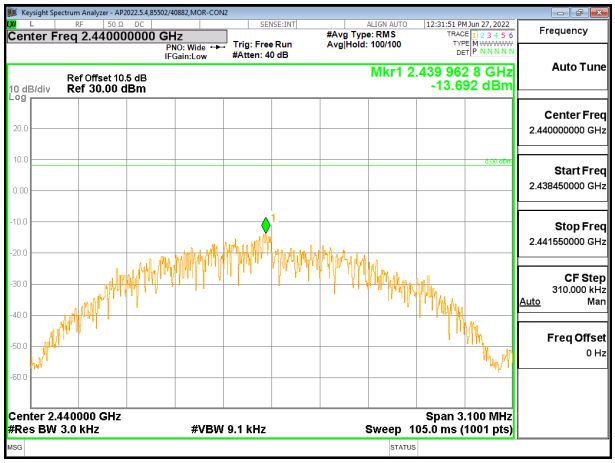
9.6.2. BLE (2Mbps)

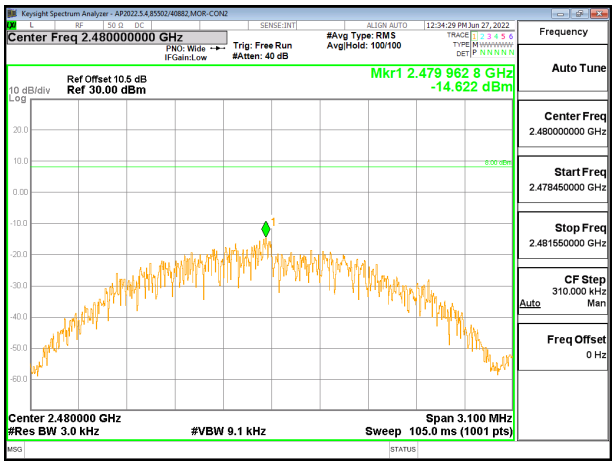
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	-13.000	8	-21.00
Middle	2440	-13.692	8	-21.69
High	2480	-14.622	8	-22.62



LOW CHANNEL



MID CHANNEL



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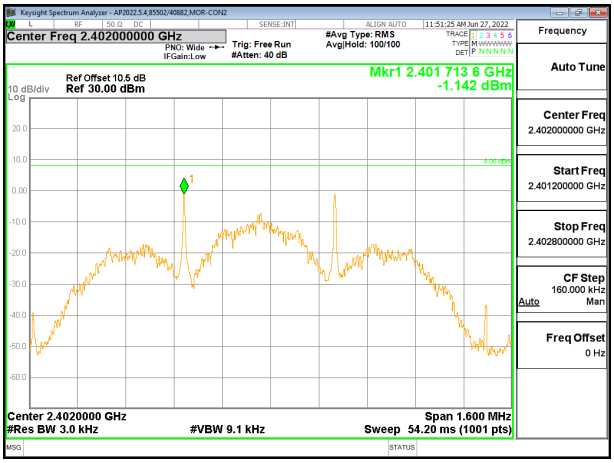
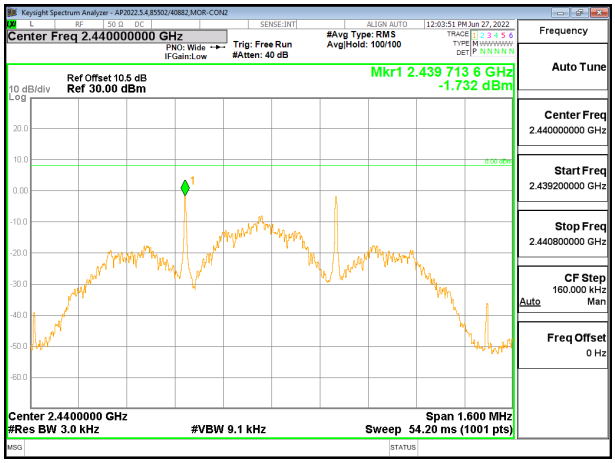
9.6.3. BLE (125Kbps)

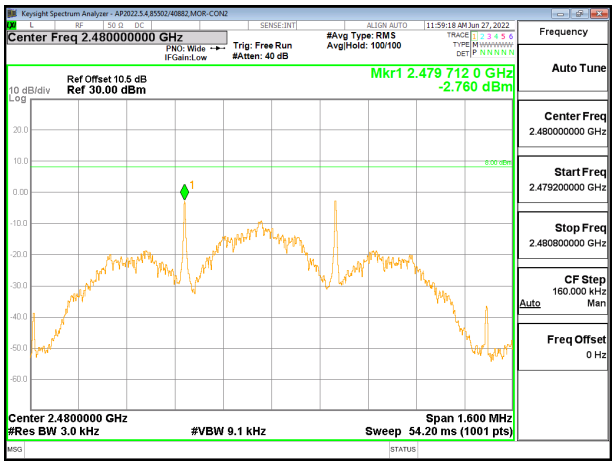
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	-1.142	8	-9.14
Middle	2440	-1.732	8	-9.73
High	2480	-2.760	8	-10.76



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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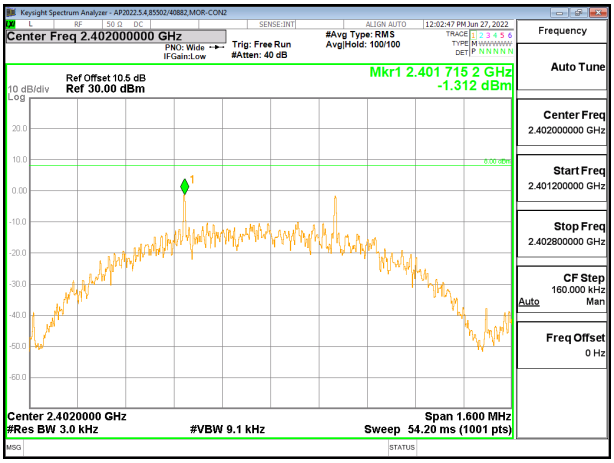
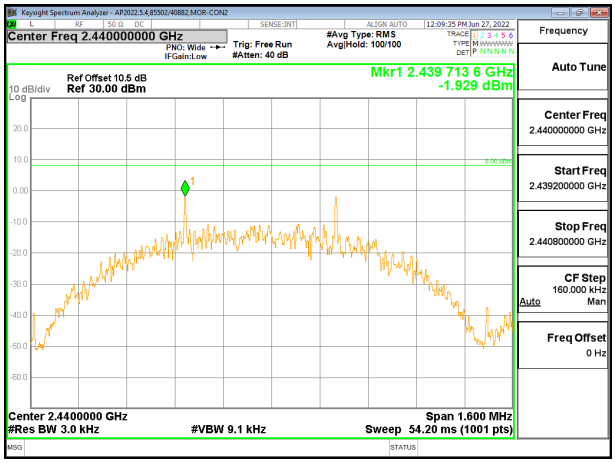
9.6.4. BLE (500Kbps)

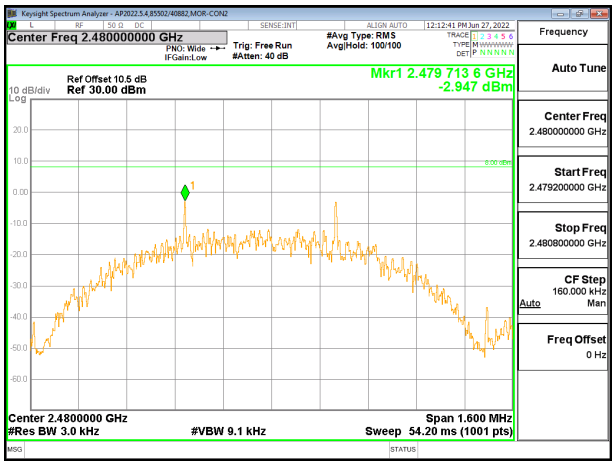
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	-1.312	8	-9.31
Middle	2440	-1.929	8	-9.93
High	2480	-2.947	8	-10.95



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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9.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)
RSS-247 5.5

Output power was measured based on the use of a peak measurement, therefore the required attenuation is >20 dB.

RESULTS

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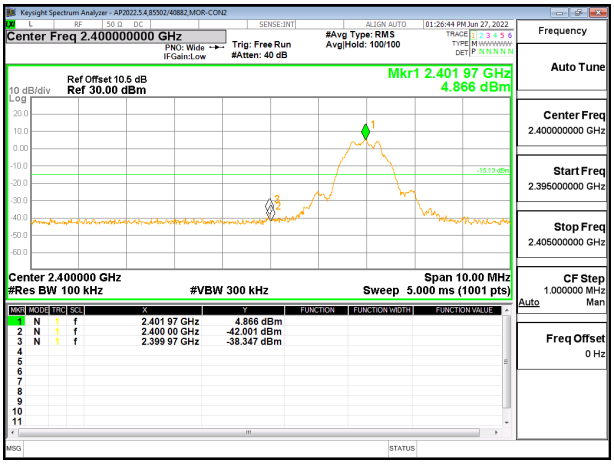
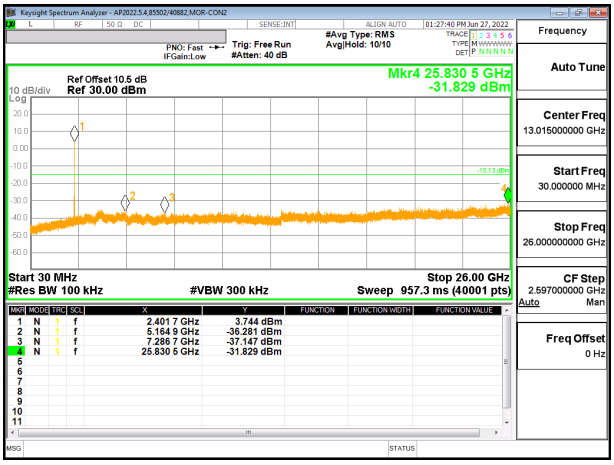
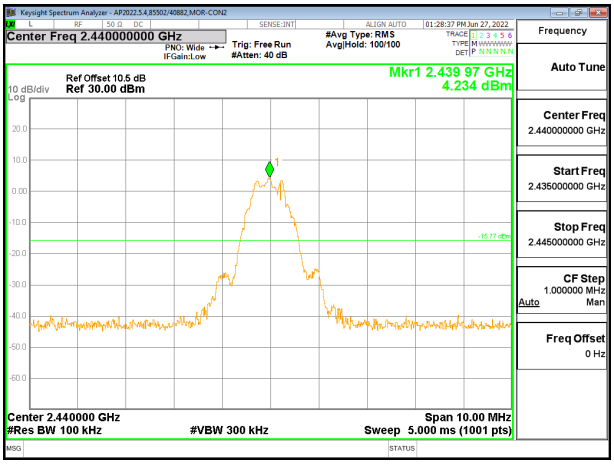
9.7.1. BLE (1Mbps)



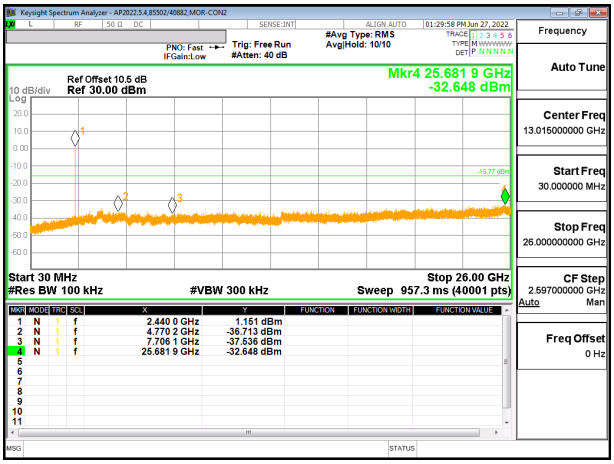
LOW CHANNEL BANDEDGE



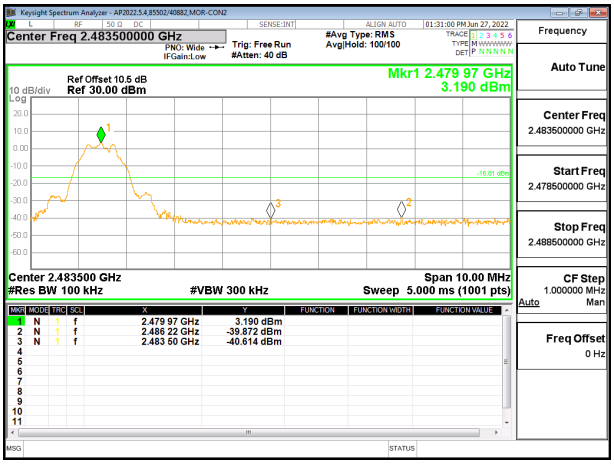
OUT-OF-BAND LOW CHANNEL



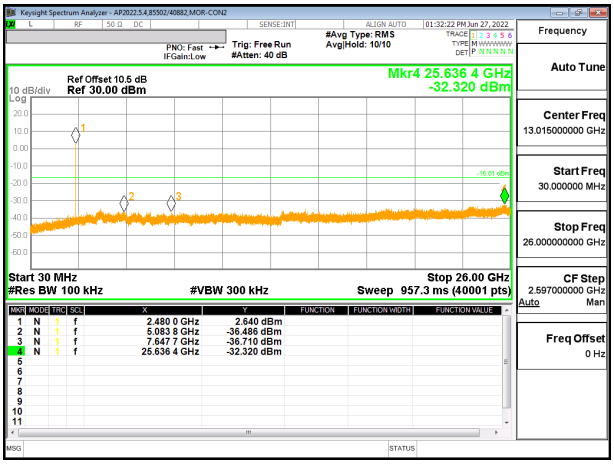
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

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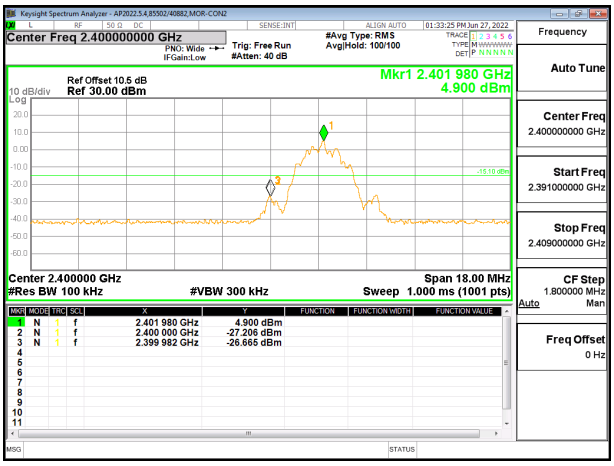
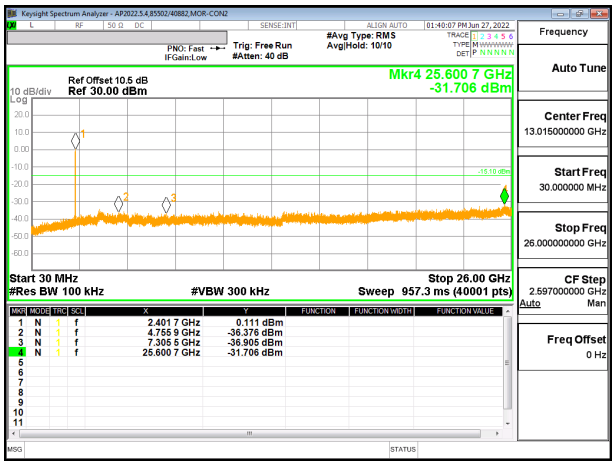
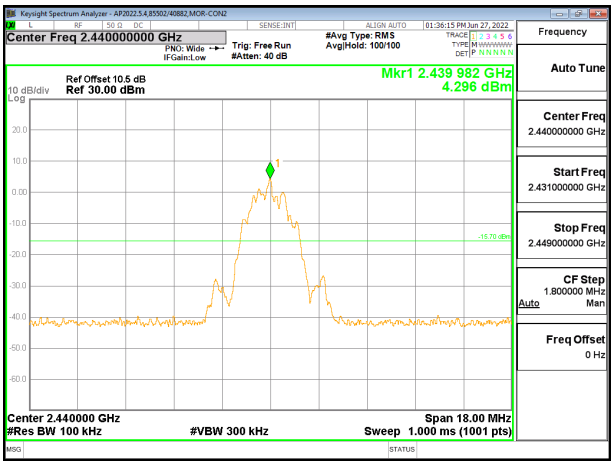
9.7.2. BLE (2Mbps)



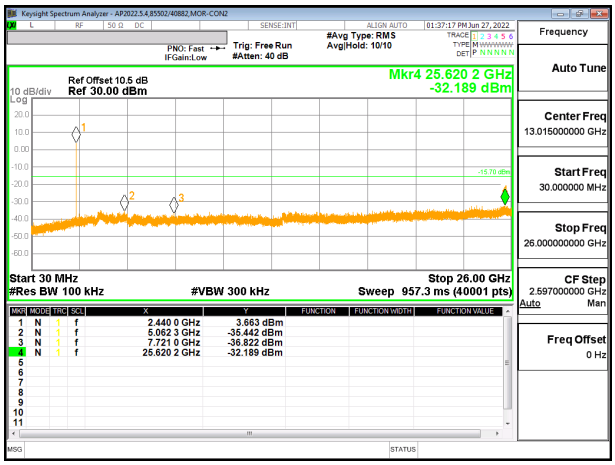
LOW CHANNEL BANDEDGE



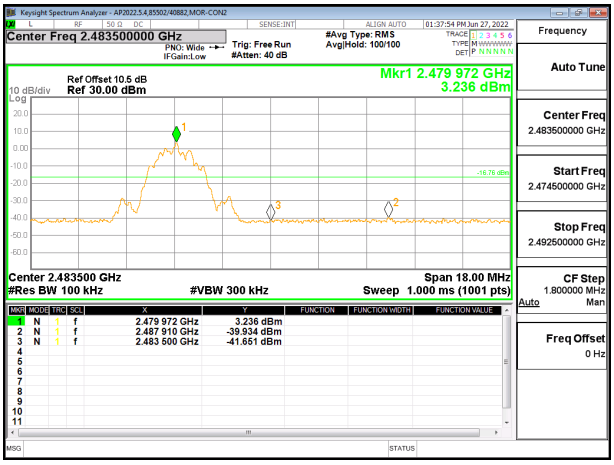
OUT-OF-BAND LOW CHANNEL



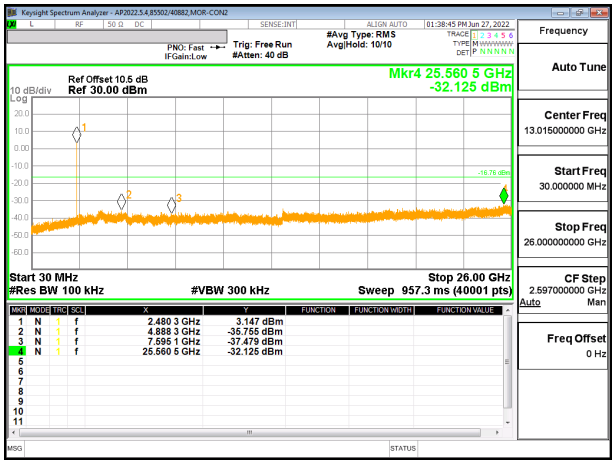
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

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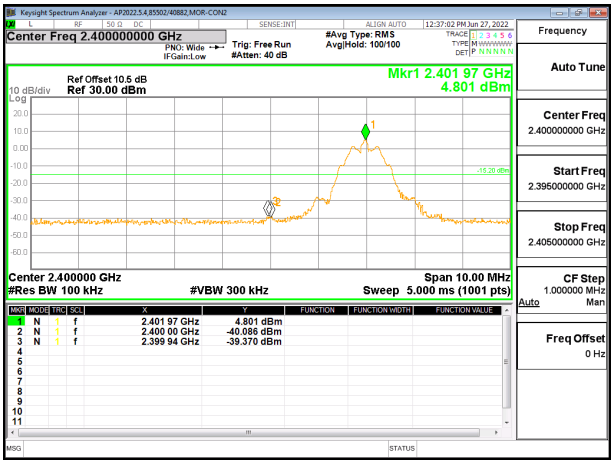
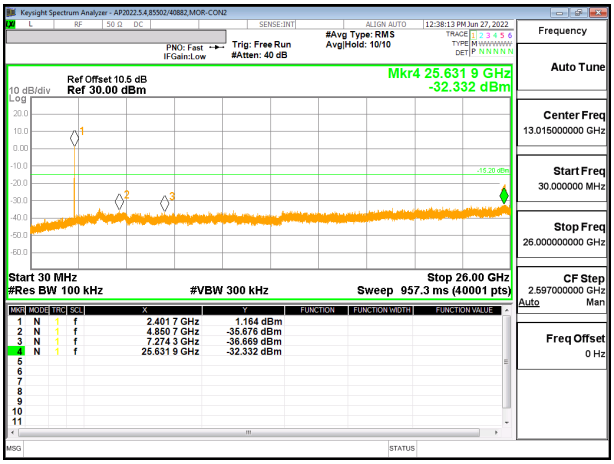
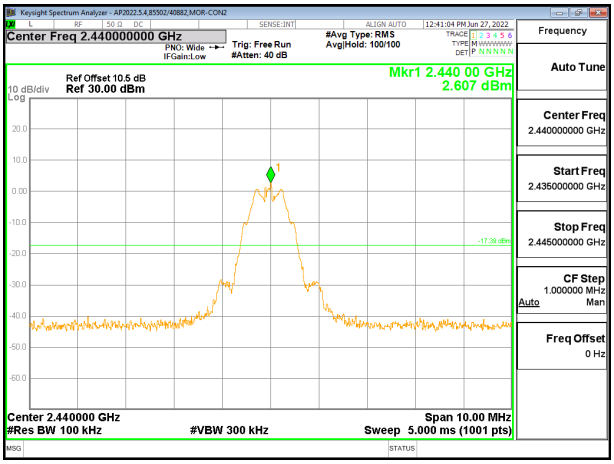
9.7.3. BLE (125Kbps)



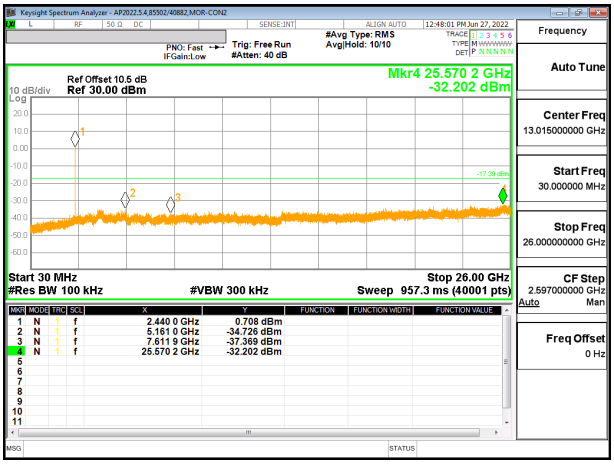
LOW CHANNEL BANDEDGE



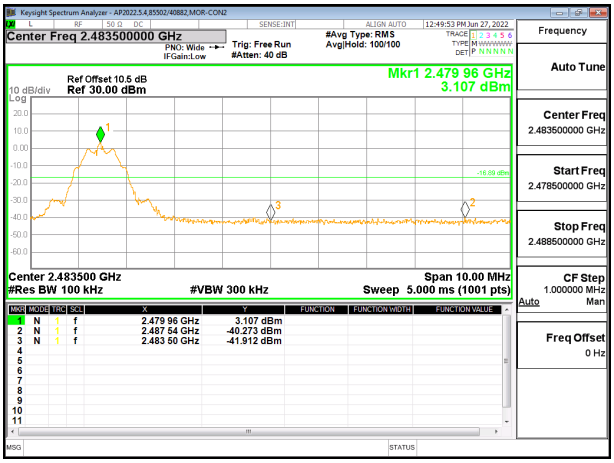
OUT-OF-BAND LOW CHANNEL



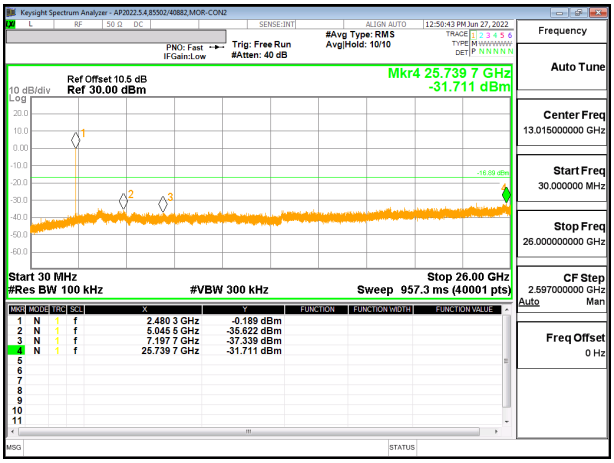
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

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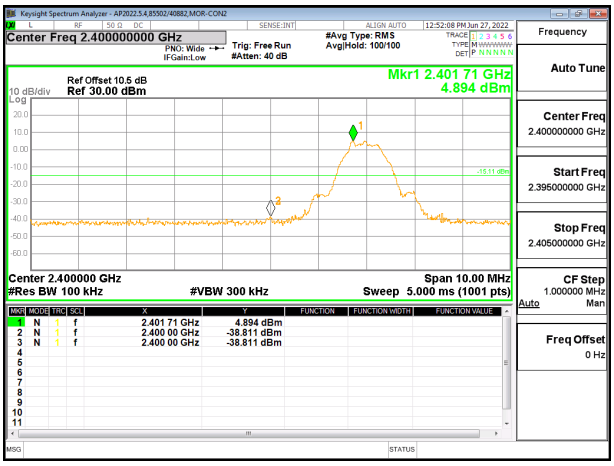
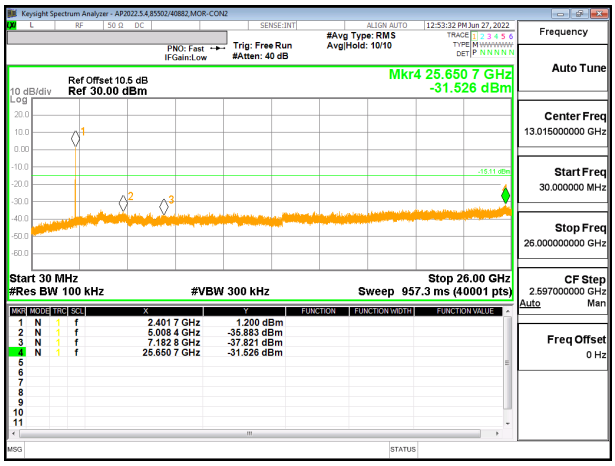
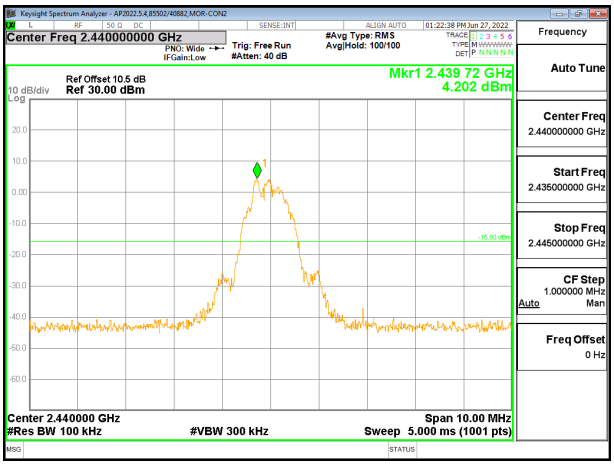
9.7.4. BLE (500Kbps)



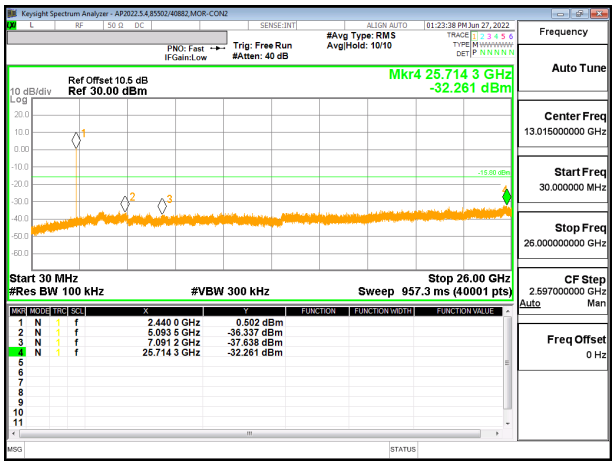
LOW CHANNEL BANDEDGE



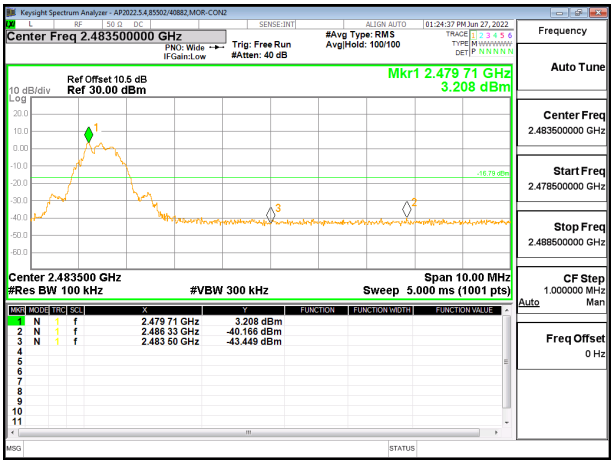
OUT-OF-BAND LOW CHANNEL



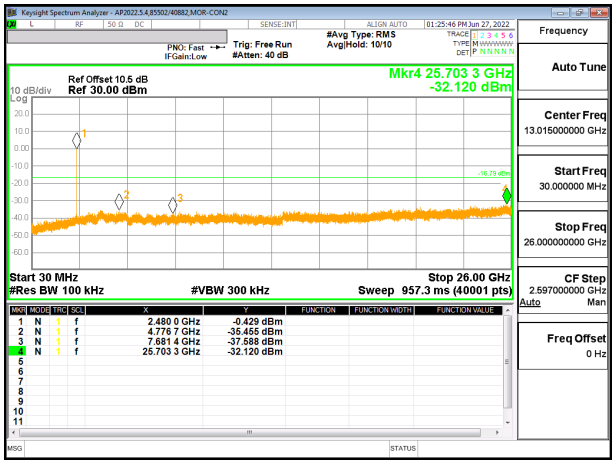
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

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10. RADIATED TEST RESULTS

10.1. LIMITS AND PROCEDURE

LIMITS

FCC §15.205 and §15.209

Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
0.009-0.490	2400/F(kHz) @ 300 m	-
0.490-1.705	24000/F(kHz) @ 30 m	-
1.705 - 30	30 @ 30m	-
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
Above 960	500	54

RSS-GEN, Section 8.9 and 8.10.

Frequency Range (MHz)	Field Strength Limit (uA/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
0.009-0.490	6.37/F(kHz) @ 300 m	-
0.490-1.705	63.7/F(kHz) @ 30 m	-
1.705 - 30	0.08 @ 30m	-
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
Above 960	500	54

TEST PROCEDURE

The EUT is placed on a non-conducting table 80 cm above the ground plane for measurement below 1GHz; 1.5 m above the ground plane for measurement above 1GHz. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.10. The EUT is set to transmit in a continuous mode.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements in the 30-1000MHz range, 9kHz for peak and/or quasi-peak detection measurements in the 0.15-30MHz range and 200Hz for peak and/or quasi-peak detection measurements in the 9 to 150kHz range. Peak detection is used unless otherwise noted as quasi-peak or average (9-90kHz and 110-490kHz).

For pre-scans above 10 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3MHz for peak measurements.

For final measurements above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3 MHz for peak measurements and as applicable for average measurements. Linear Voltage Averaging was used.

The spectrum from 1 GHz to 18 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each applicable band. Below 1GHz and above 18GHz emissions, the channel with the highest output power was tested.

The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

3D antenna use - For below 30MHz testing, investigation was done on three antenna orientations (parallel, perpendicular, and ground-parallel).

Base on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field.

KDB 414788 Open Field Site(OFS) and Chamber Correlation Justification

OFS and chamber correlation testing had been performed and chamber measured test result is the worst case test result.

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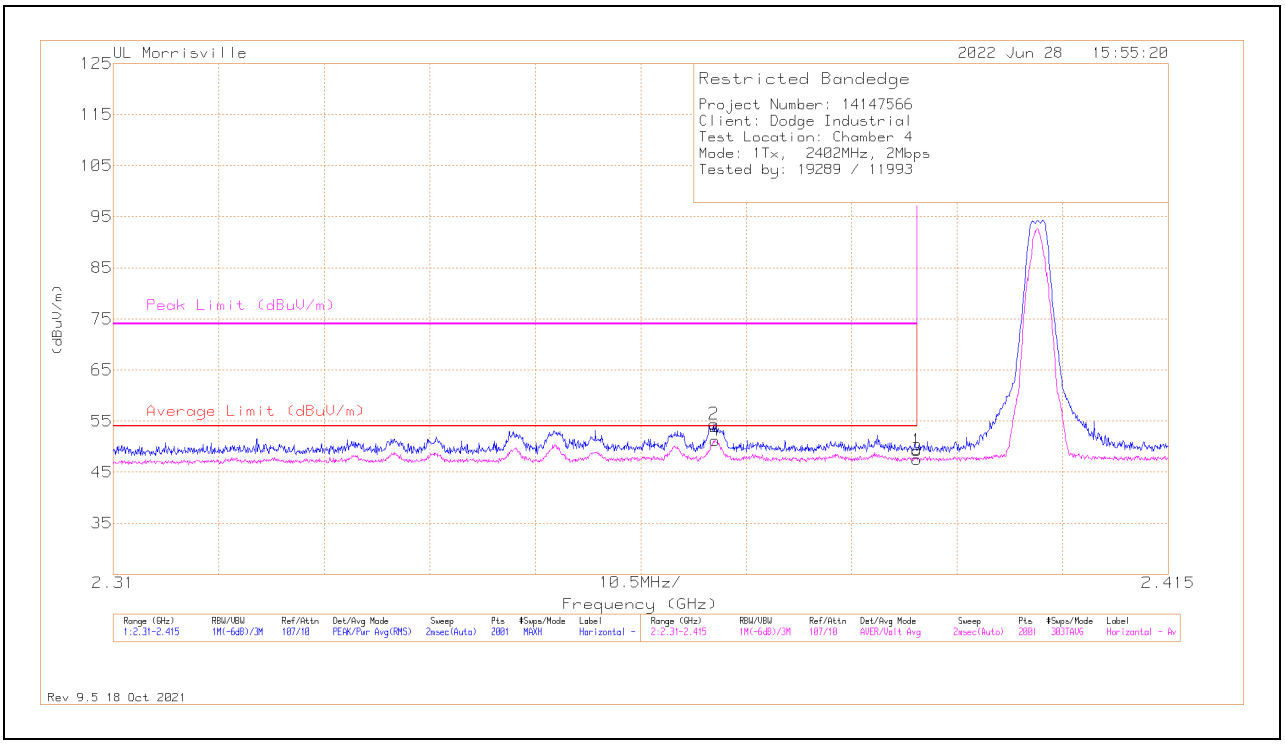
10.2. TRANSMITTER ABOVE 1 GHz

10.2.1. BLE (2Mbps)

Antenna 1

BANDEDGE (LOW CHANNEL)

HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0069 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.38996	30.98	Pk	31.9	-13.6	0	49.28	-	-	74	-24.72	258	103	H
2	* ** 2.3698	36.12	Pk	31.9	-13.6	0	54.42	-	-	74	-19.58	258	103	H
3	* ** 2.38996	19.6	ADV	31.9	-13.6	9.65	47.55	54	-6.45	-	-	258	103	H
4	* ** 2.3699	23.26	ADV	31.9	-13.6	9.65	51.21	54	-2.79	-	-	258	103	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
ADV -Linear Voltage Average

UL LLC
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VERTICAL RESULT

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0069 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.38996	30.69	Pk	31.9	-13.6	0	48.99	-	-	74	-25.01	210	351	V
2	* ** 2.37017	32.77	Pk	31.9	-13.6	0	51.07	-	-	74	-22.93	210	351	V
3	* ** 2.38996	19.36	ADV	31.9	-13.6	9.65	47.31	54	-6.69	-	-	210	351	V
4	* ** 2.37017	20.41	ADV	31.9	-13.6	9.65	48.36	54	-5.64	-	-	210	351	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
ADV - Linear Voltage Average

UL LLC
12 Laboratory Dr., RTP, NC 27709; USA TEL:(919) 549-1400

BANDEDGE (HIGH CHANNEL)

HORIZONTAL RESULT

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0069 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.48354	35.41	Pk	32.2	-13.7	0	53.91	-	-	74	-20.09	162	104	H
2	* ** 2.48364	35.66	Pk	32.2	-13.7	0	54.16	-	-	74	-19.84	162	104	H
3	* ** 2.48354	20.21	ADV	32.2	-13.7	9.66	48.37	54	-5.63	-	-	162	104	H
4	** 2.53205	20.53	ADV	32.4	-13.4	9.66	49.19	54	-4.81	-	-	162	104	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
ADV Linear Voltage Average

UL LLC
12 Laboratory Dr., RTP, NC 27709; USA TEL:(919) 549-1400

VERTICAL RESULT

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0069 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.48354	31.82	Pk	32.2	-13.7	0	50.32	-	-	74	-23.68	123	100	V
2	** 2.53684	33.37	Pk	32.4	-13.4	0	52.37	-	-	74	-21.63	123	100	V
3	* ** 2.48354	20.12	ADV	32.2	-13.7	9.66	48.28	54	-5.72	-	-	123	100	V
4	** 2.5285	20.56	ADV	32.4	-13.5	9.66	49.12	54	-4.88	-	-	123	100	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
ADV - Linear Voltage Average

UL LLC
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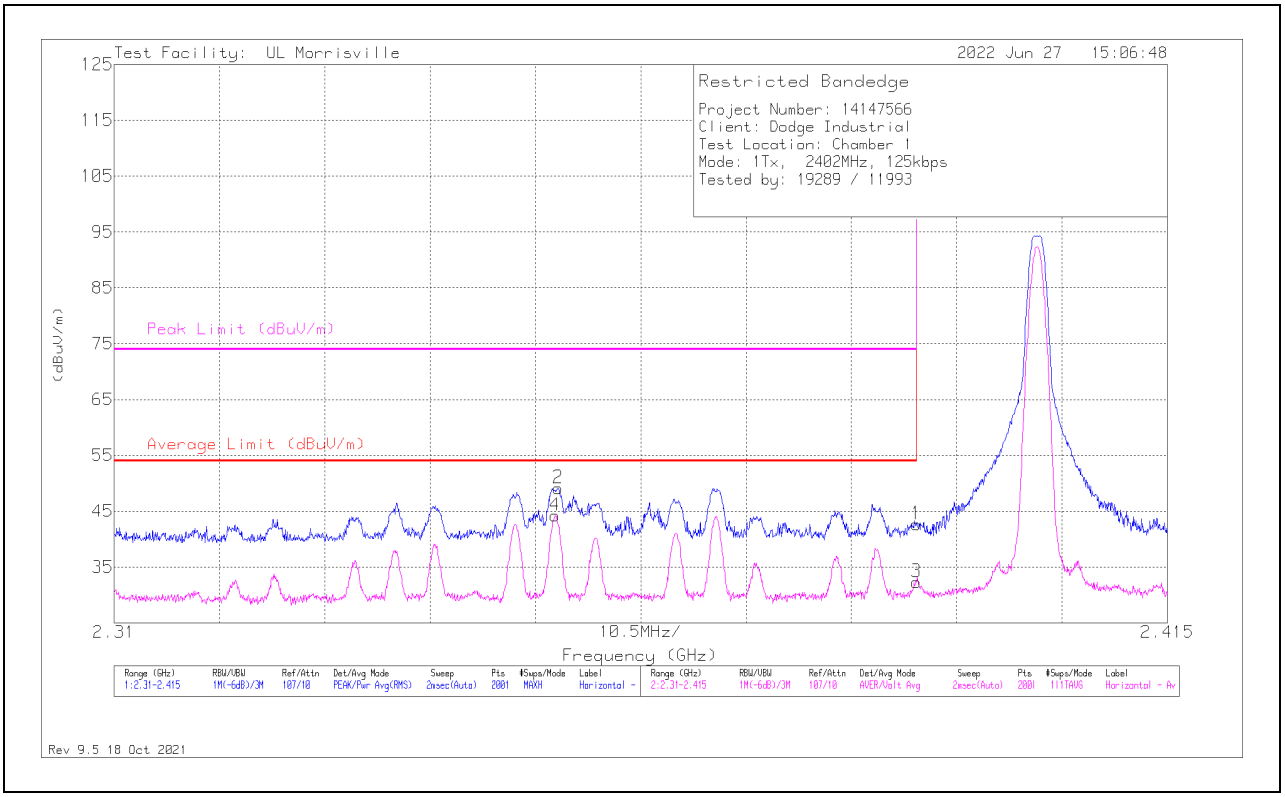
10.2.2. BLE (125Kbps)

Antenna 1

BANDEDGE (LOW CHANNEL)

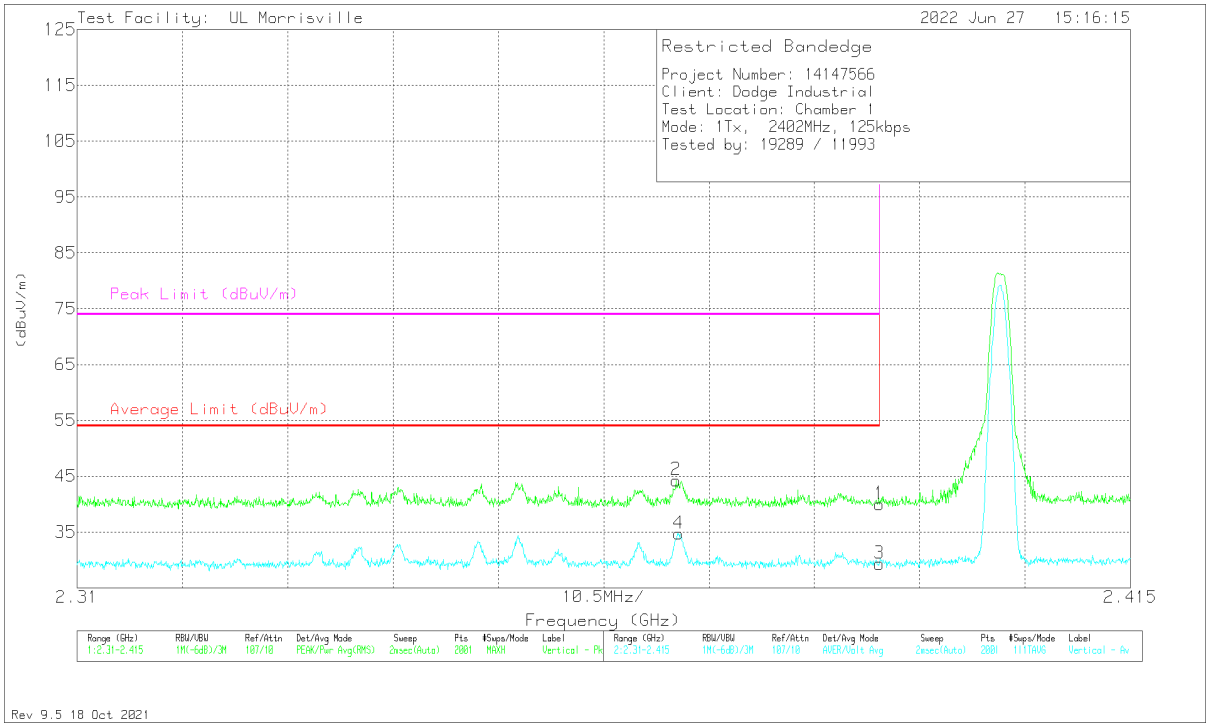
HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.38996	35.46	Pk	32	-24.8	0	42.66	-	-	74	-31.34	68	125	H
2	* ** 2.35426	41.72	Pk	31.9	-24.5	0	49.12	-	-	74	-24.88	68	125	H
3	* ** 2.38996	24.18	ADV	32	-24.8	1.64	33.02	54	-20.98	-	-	68	125	H
4	* ** 2.35394	35.85	ADV	31.9	-24.5	1.64	44.89	54	-9.11	-	-	68	125	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
ADV - Linear Voltage Average

VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.38996	32.77	Pk	32	-24.8	0	39.97	-	-	74	-34.03	269	113	V
2	* ** 2.36969	36.88	Pk	32	-24.6	0	44.28	-	-	74	-29.72	269	113	V
3	* ** 2.38996	21.17	ADV	32	-24.8	1.64	30.01	54	-23.99	-	-	269	113	V
4	* ** 2.36996	26.37	ADV	32	-24.6	1.64	35.41	54	-18.59	-	-	269	113	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
ADV - Linear Voltage Average

UL LLC
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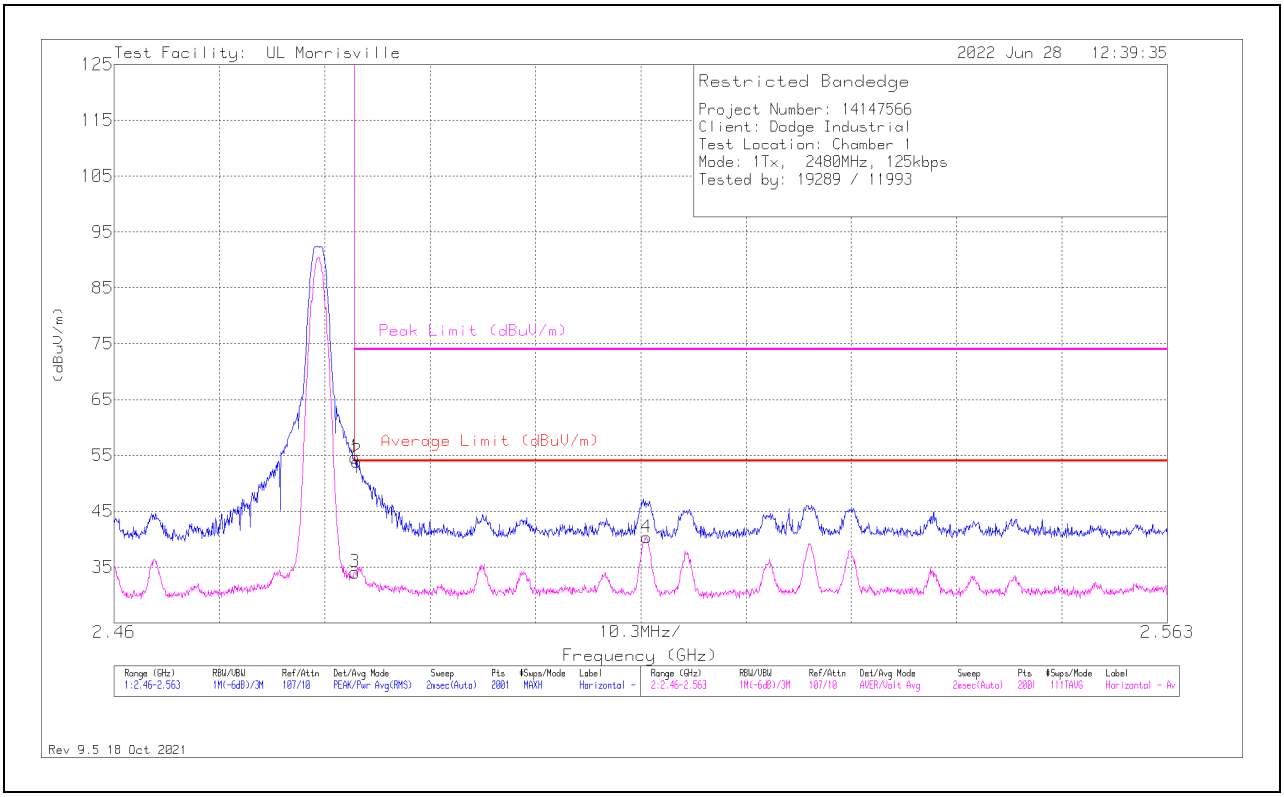
BANDEDGE (HIGH CHANNEL)

HORIZONTAL RESULT

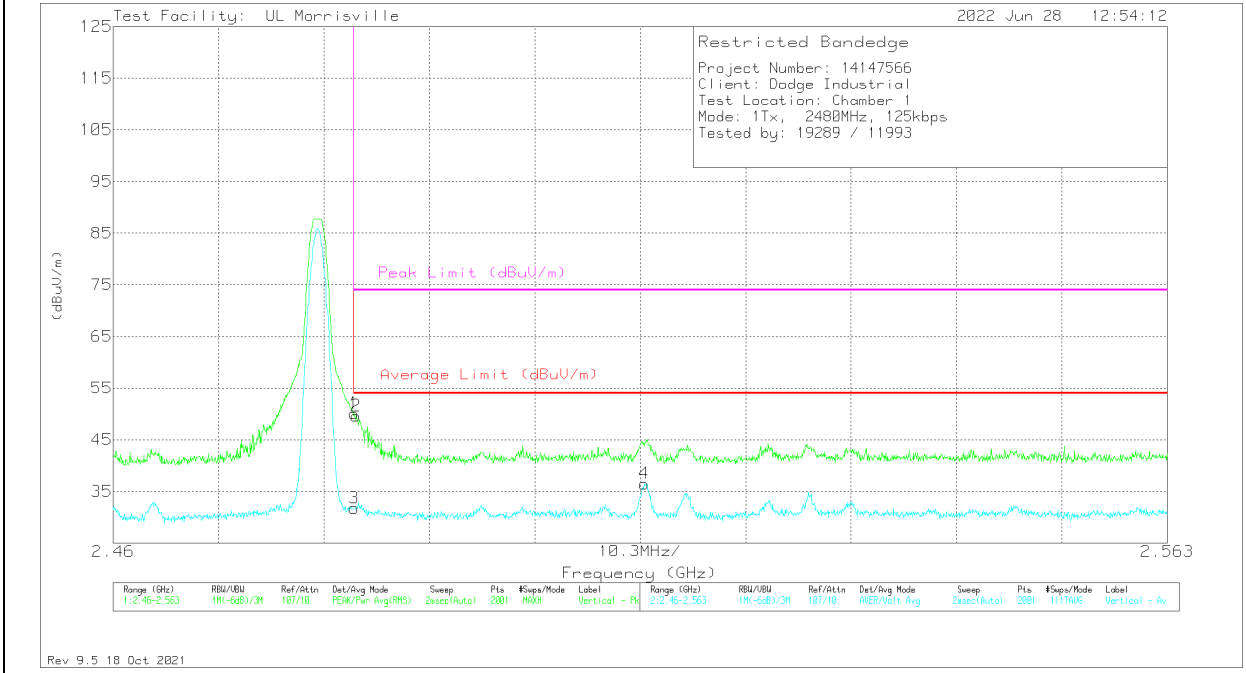


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.48354	46.55	Pk	32.5	-24.4	0	54.65	-	-	74	-19.35	90	320	H
2	* ** 2.48374	45.81	Pk	32.5	-24.4	0	53.91	-	-	74	-20.09	90	320	H
3	* ** 2.48354	25.03	ADV	32.5	-24.4	1.64	34.77	54	-19.23	-	-	90	320	H
4	** 2.51207	31.56	ADV	32.5	-24.7	1.64	41.00	54	-13.00	-	-	90	320	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
ADV - Linear Voltage Average

UL LLC
12 Laboratory Dr., RTP, NC 27709; USA TEL:(919) 549-1400

VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.48354	42	Pk	32.5	-24.4	0	50.1	-	-	74	-23.9	163	369	V
2	* ** 2.48374	41.5	Pk	32.5	-24.4	0	49.6	-	-	74	-24.4	163	369	V
3	* ** 2.48354	22.7	ADV	32.5	-24.4	1.64	32.44	54	-21.56	-	-	163	369	V
4	** 2.51191	27.74	ADV	32.5	-24.7	1.64	37.18	54	-16.82	-	-	163	369	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
ADV - Linear Voltage Average

UL LLC
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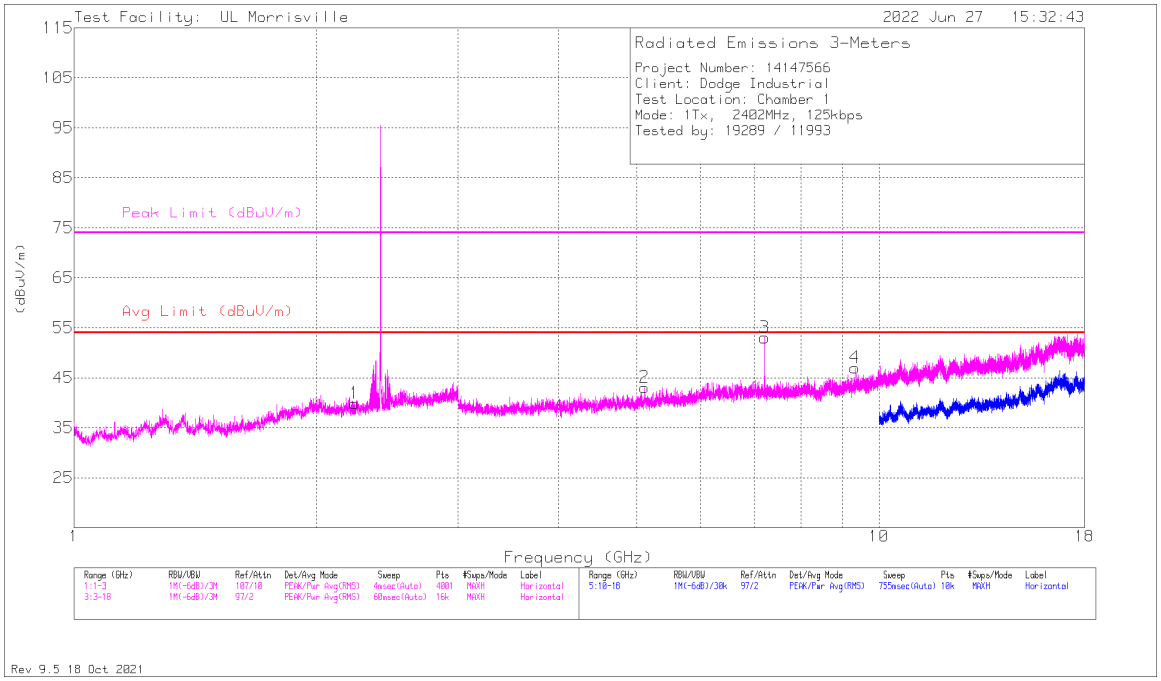
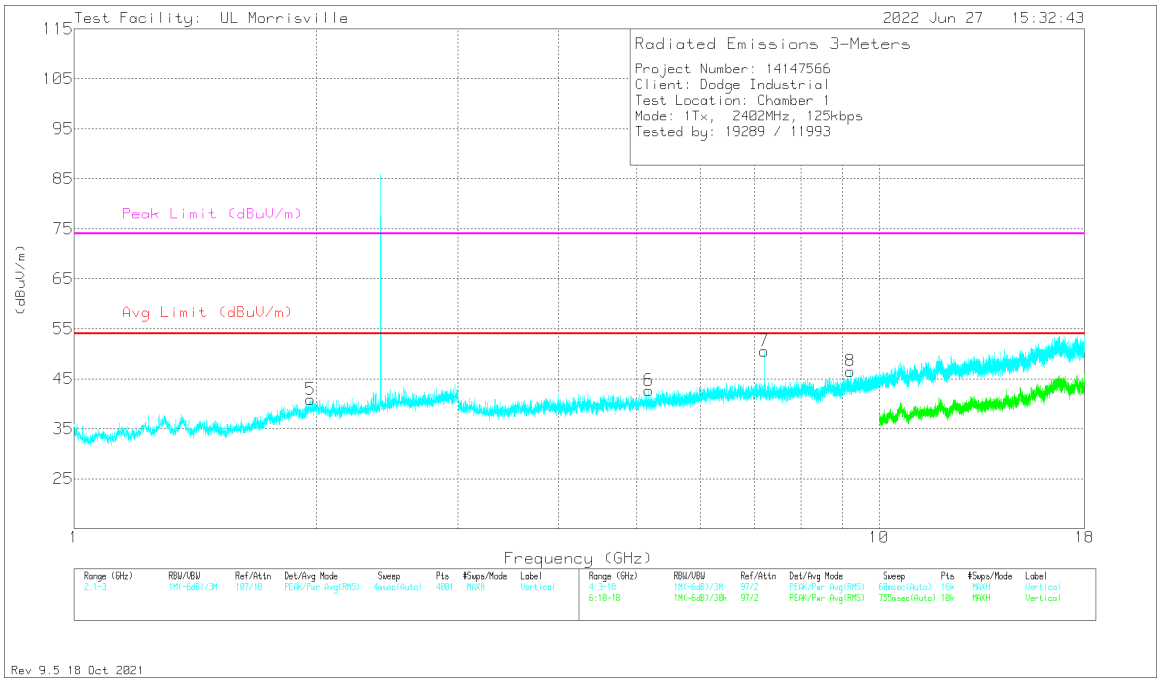
HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 2.23	33.04	Pk	31.6	-24.8	0	39.84	54	-14.16	74	-34.16	0-360	101	H
5	** 1.9655	33.96	Pk	31.8	-24.9	0	40.86	-	-	-	-	0-360	200	V
2	* ** 5.11594	40.05	Pk	34.2	-31.2	0	43.05	54	-10.95	74	-30.95	0-360	101	H
4	* ** 9.33375	39.21	Pk	36.5	-28.7	0	47.01	54	-6.99	74	-26.99	0-360	199	H
6	** 5.17688	40.87	Pk	34.3	-32.5	0	42.67	-	-	-	-	0-360	200	V
7	7.20469	45.27	Pk	35.7	-30.4	0	50.57	-	-	-	-	0-360	101	V
3	7.20656	47.64	Pk	35.7	-30.3	0	53.04	-	-	-	-	0-360	101	H
8	9.21281	38.91	Pk	36.3	-28.7	0	46.51	-	-	-	-	0-360	101	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector

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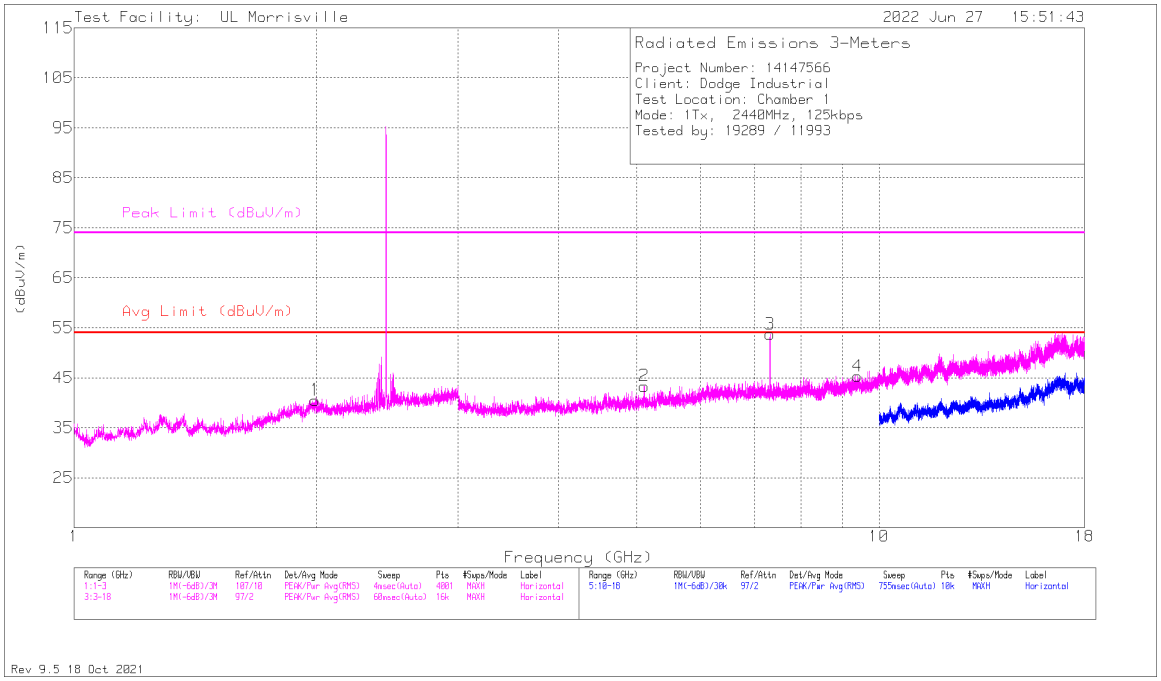
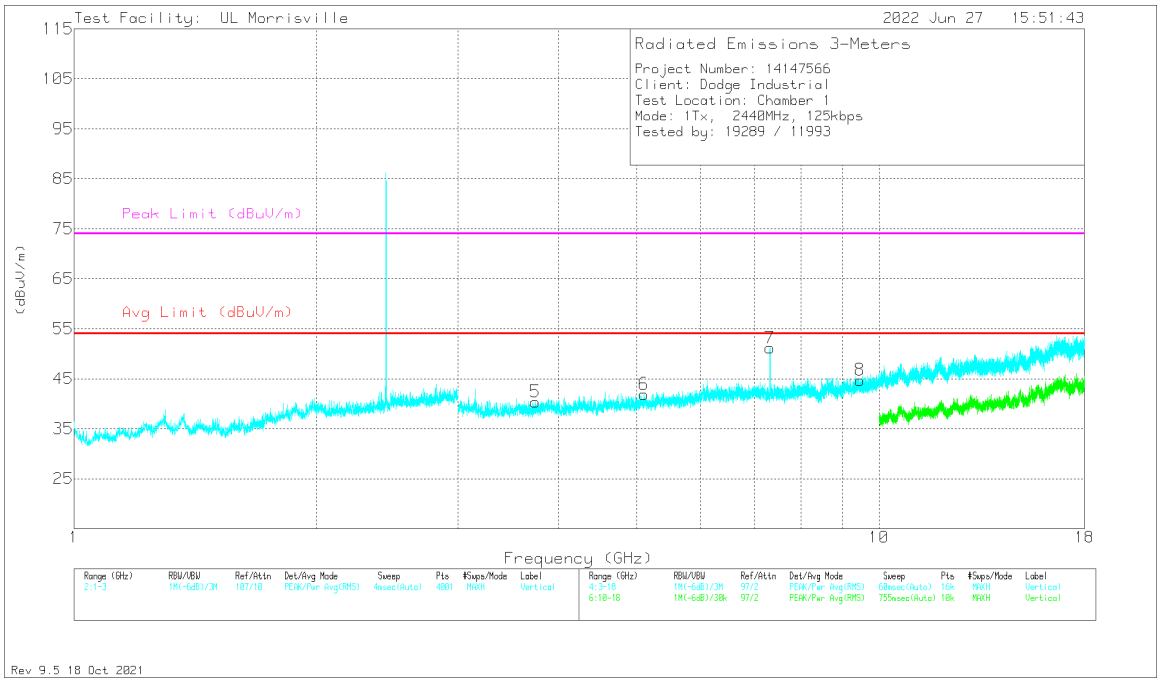
MID CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2	* ** 5.10844	40.33	Pk	34.2	-31.2	0	43.33	54	-10.67	74	-30.67	0-360	200	H
3	* ** 7.3207	49.19	PK2	35.6	-29.5	0	55.29	-	-	74	-18.71	23	107	H
	* ** 7.32039	41.45	ADV	35.6	-29.5	1.64	49.19	54	-4.81	-	-	23	107	H
4	* ** 9.40594	37.19	Pk	36.6	-28.5	0	45.29	54	-8.71	74	-28.71	0-360	101	H
5	* ** 3.74156	39.95	Pk	33.3	-32.9	0	40.35	54	-13.65	74	-33.65	0-360	101	V
6	* ** 5.10094	39.49	Pk	34.2	-31.8	0	41.89	54	-12.11	74	-32.11	0-360	200	V
7	* ** 7.31895	46.99	PK2	35.6	-29.5	0	53.09	-	-	74	-20.91	81	109	V
	* ** 7.31928	38.37	ADV	35.6	-29.5	1.64	46.11	54	-7.89	-	-	81	109	V
8	* ** 9.46875	36.5	Pk	36.7	-28.5	0	44.7	54	-9.3	74	-29.3	0-360	200	V
1	1.9925	32.99	Pk	32	-24.5	0	40.49	-	-	-	-	0-360	200	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
PK2 - Maximum Peak
ADV - Linear Voltage Average

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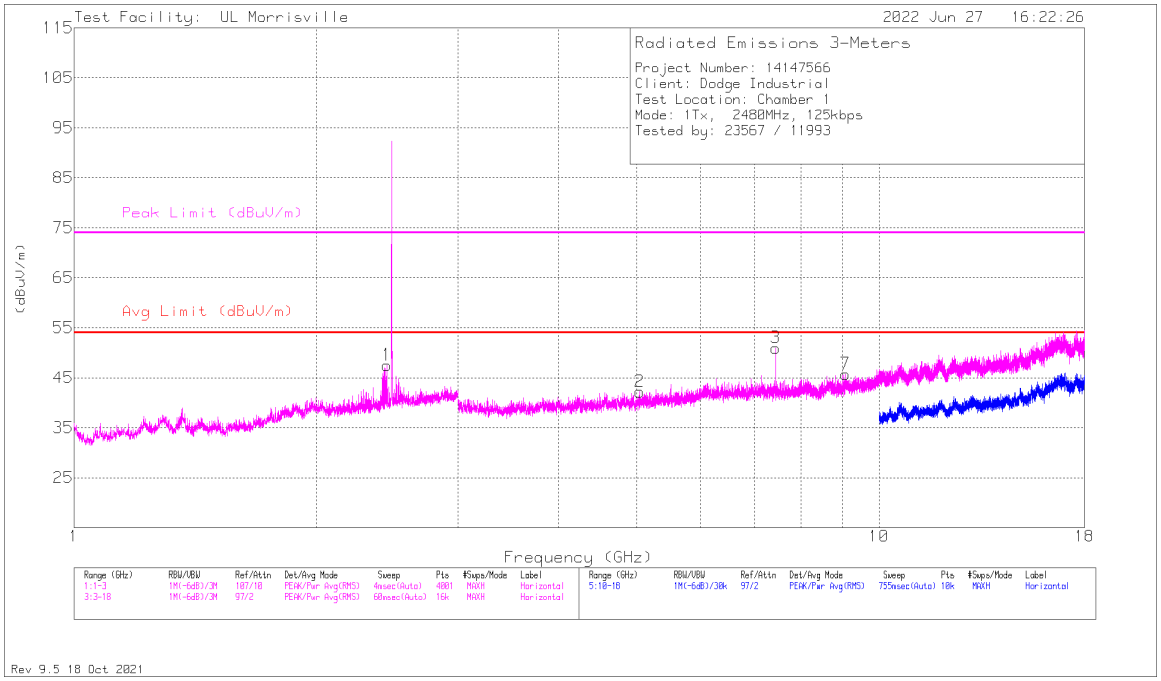
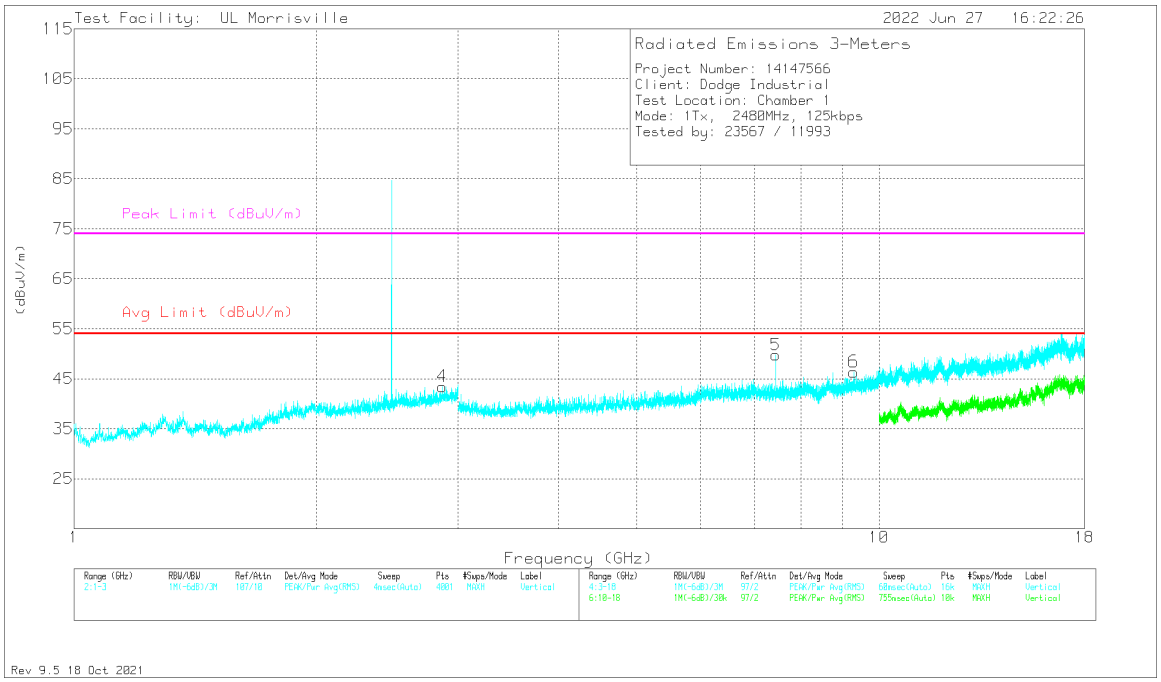
HIGH CHANNEL RESULTS



HORIZONTAL



VERTICAL

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RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Gain/Loss (dB)	DC Corr (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
4	* ** 2.866	34.62	Pk	32.6	-23.8	0	43.42	54	-10.58	74	-30.58	0-360	200	V
2	* ** 5.04188	40.11	Pk	34.1	-32	0	42.21	54	-11.79	74	-31.79	0-360	200	H
3	* ** 7.43903	47.92	PK2	35.6	-29.6	0	53.92	-	-	74	-20.08	117	109	H
	* ** 7.43927	39.81	ADV	35.6	-29.6	1.64	47.45	54	-6.55	-	-	117	109	H
7	* ** 9.0825	37.21	Pk	36.3	-27.8	0	45.71	54	-8.29	74	-28.29	0-360	101	H
5	* ** 7.44092	45.64	PK2	35.6	-29.5	0	51.74	-	-	74	-22.26	95	108	V
	* ** 7.43921	36.83	ADV	35.6	-29.6	1.64	44.47	54	-9.53	-	-	95	108	V
6	* ** 9.30094	38.56	Pk	36.5	-28.7	0	46.36	54	-7.64	74	-27.64	0-360	200	V
1	2.4485	39.9	Pk	32.2	-24.6	0	47.5	-	-	-	-	0-360	101	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector
PK2 - Maximum Peak
ADV - Linear Voltage Average

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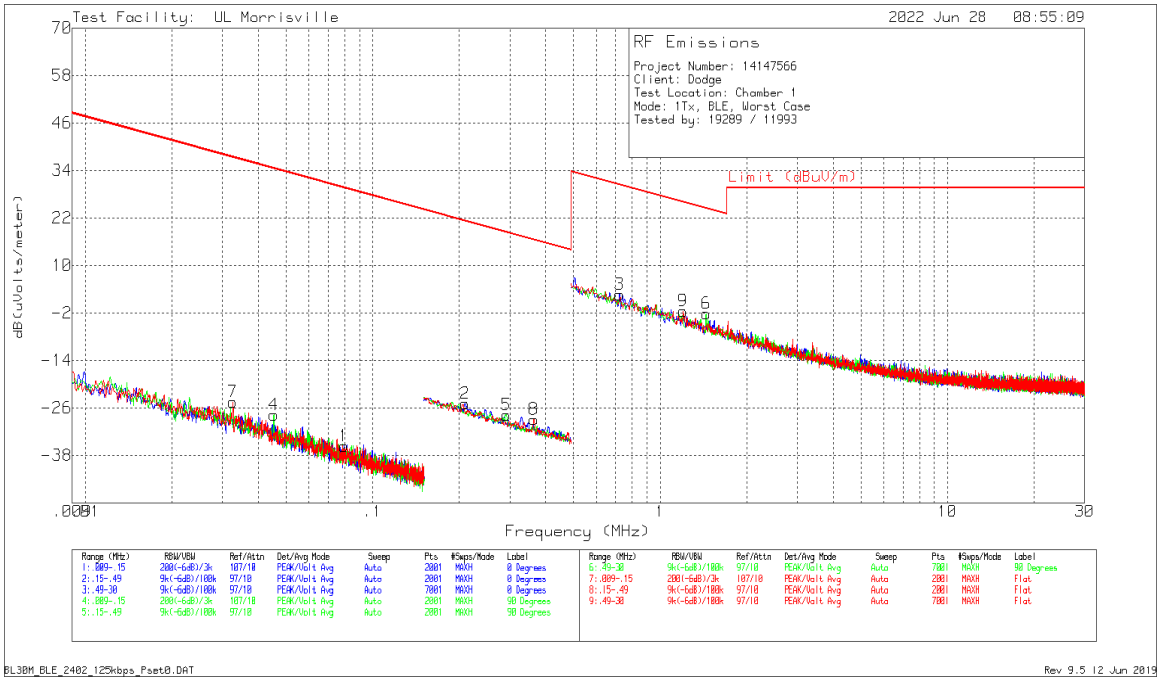
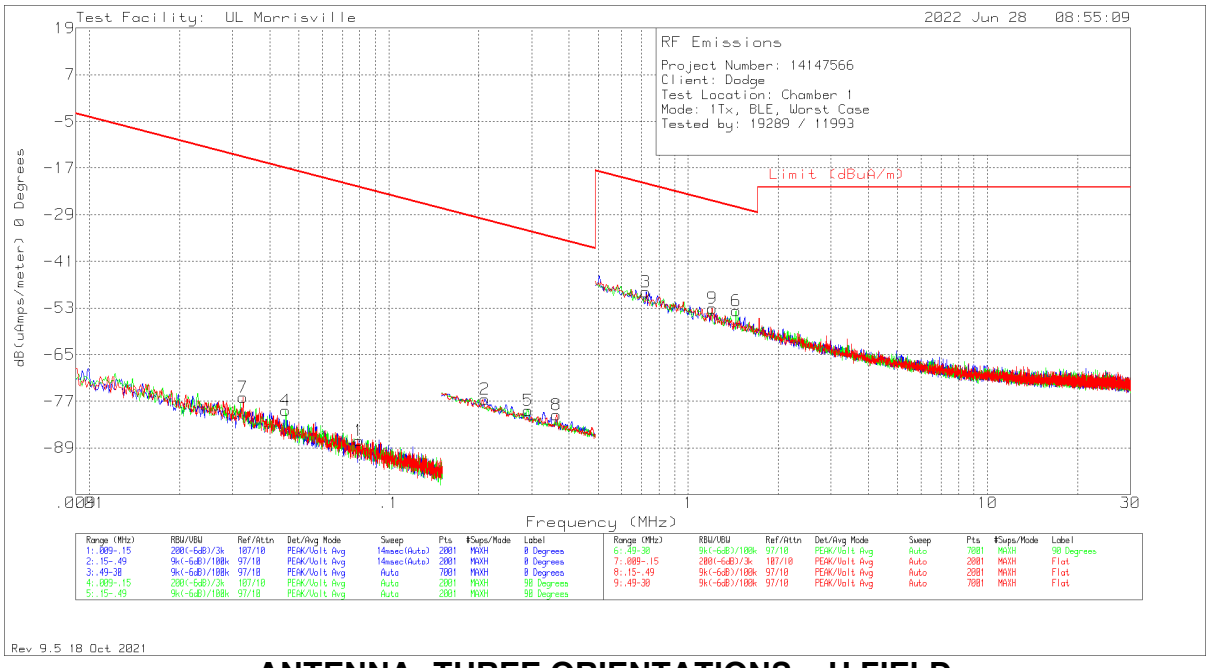
10.3. WORST CASE BELOW 30MHZ

SPURIOUS EMISSIONS BELOW 30 MHz (WORST-CASE CONFIGURATION)



ANTENNA- THREE ORIENTATIONS – E FIELD



ANTENNA- THREE ORIENTATIONS – H FIELD

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Below 30MHz Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AT0059 (dB/m)	Gain/Loss (dB)	Dist. Corr. Factor (dB)	Corrected Reading dB(uVolts/meter)	Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Loop Angle
1	.07943	33.62	Pk	10.6	.1	-80	-35.68	29.6	-65.28	0-360	0 degs
2	.2095	44.7	Pk	10.2	.1	-80	-25	21.18	-46.18	0-360	0 degs
3	.72188	32.25	Pk	10.2	.2	-40	2.65	30.43	-27.78	0-360	0 degs
4	.04528	40.49	Pk	11.6	.1	-80	-27.81	34.49	-62.3	0-360	90 degs
5	.29212	42.03	Pk	10	.1	-80	-27.87	18.29	-46.16	0-360	90 degs
6	1.44703	27.17	Pk	10.4	.2	-40	-2.23	24.39	-26.62	0-360	90 degs
7	.03257	42.34	Pk	13	.1	-80	-24.56	37.35	-61.91	0-360	Flat
8	.36318	40.91	Pk	10	.1	-80	-28.99	16.4	-45.39	0-360	Flat
9	1.2025	27.8	Pk	10.4	.2	-40	-1.6	26	-27.6	0-360	Flat

Pk - Peak detector

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AT0059 (dB/m)	Gain/Loss (dB)	Dist. Corr. Factor (dB)	Corrected Reading dB(uAmps/meter)	Limit (dBuA/m)	Margin (dB)	Azimuth (Degs)	Loop Angle
1	.07943	33.62	Pk	-40.9	.1	-80	-87.18	-21.9	-65.28	0-360	0 degs
2	.2095	44.7	Pk	-41.3	.1	-80	-76.5	-30.32	-46.18	0-360	0 degs
3	.72188	32.25	Pk	-41.3	.2	-40	-48.85	-21.07	-27.78	0-360	0 degs
4	.04528	40.49	Pk	-39.9	.1	-80	-79.31	-17.01	-62.3	0-360	90 degs
5	.29212	42.03	Pk	-41.5	.1	-80	-79.37	-33.21	-46.16	0-360	90 degs
6	1.44703	27.17	Pk	-41.1	.2	-40	-53.73	-27.11	-26.62	0-360	90 degs
7	.03257	42.34	Pk	-38.5	.1	-80	-76.06	-14.15	-61.91	0-360	Flat
8	.36318	40.91	Pk	-41.5	.1	-80	-80.49	-35.1	-45.39	0-360	Flat
9	1.2025	27.8	Pk	-41.1	.2	-40	-53.1	-25.5	-27.6	0-360	Flat

Pk - Peak detector

UL LLC
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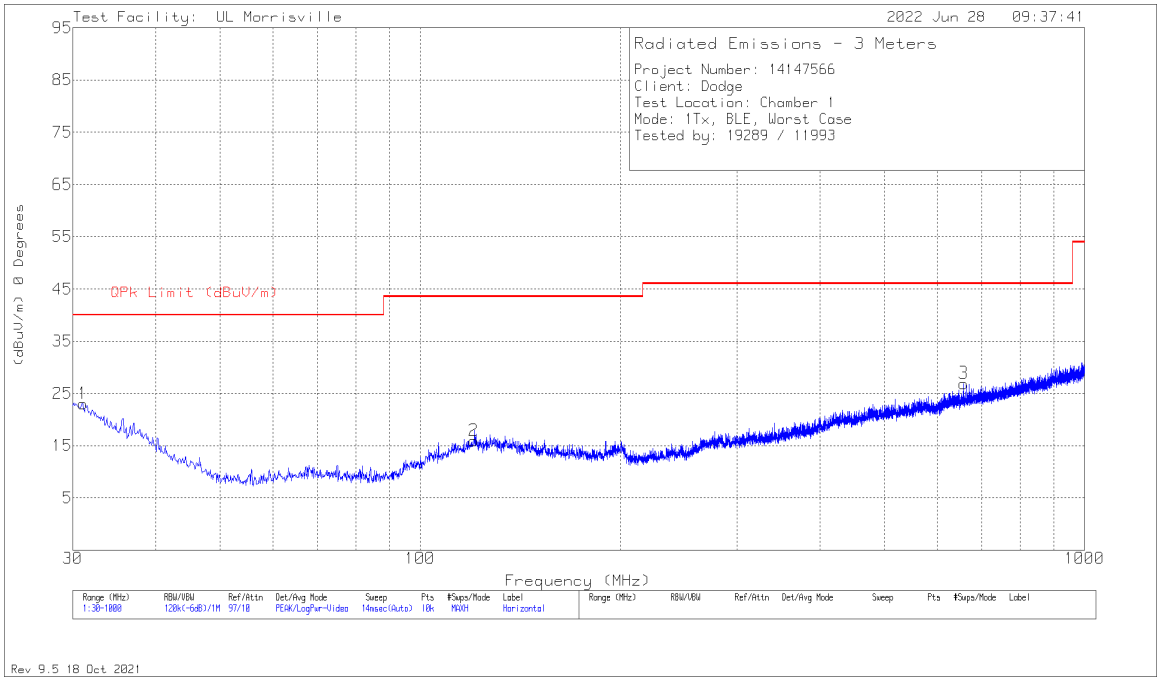
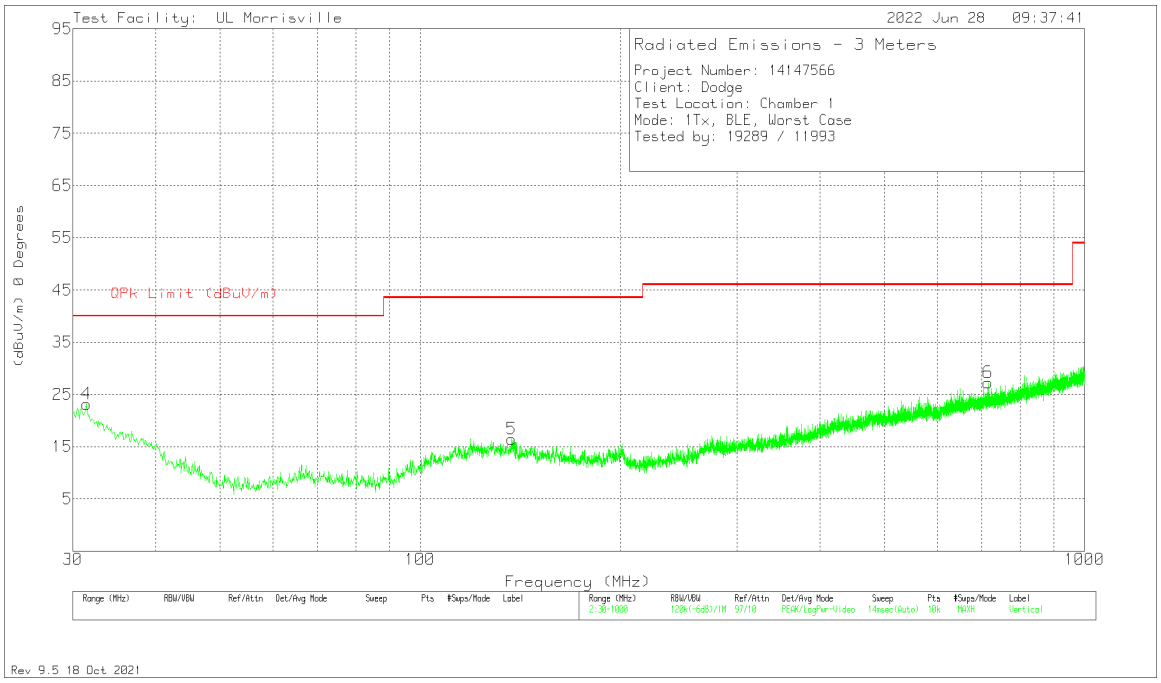
10.4. WORST CASE BELOW 1 GHZ

SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION)



HORIZONTAL



VERTICAL

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Below 1GHz Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AT0066 (dB/m)	Gain/Loss (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	31.067	27.73	Pk	26.5	-31.2	23.03	40	-16.97	0-360	200	H
4	31.455	28.14	Pk	26.2	-31.2	23.14	40	-16.86	0-360	100	V
2	120.307	26.59	Pk	19.4	-30	15.99	43.52	-27.53	0-360	100	H
5	137.185	27.15	Pk	19.2	-29.9	16.45	43.52	-27.07	0-360	100	V
3	657.202	28.13	Pk	25.5	-26.7	26.93	46.02	-19.09	0-360	300	H
6	715.693	27.29	Pk	26.2	-26.2	27.29	46.02	-18.73	0-360	100	V

Pk - Peak detector

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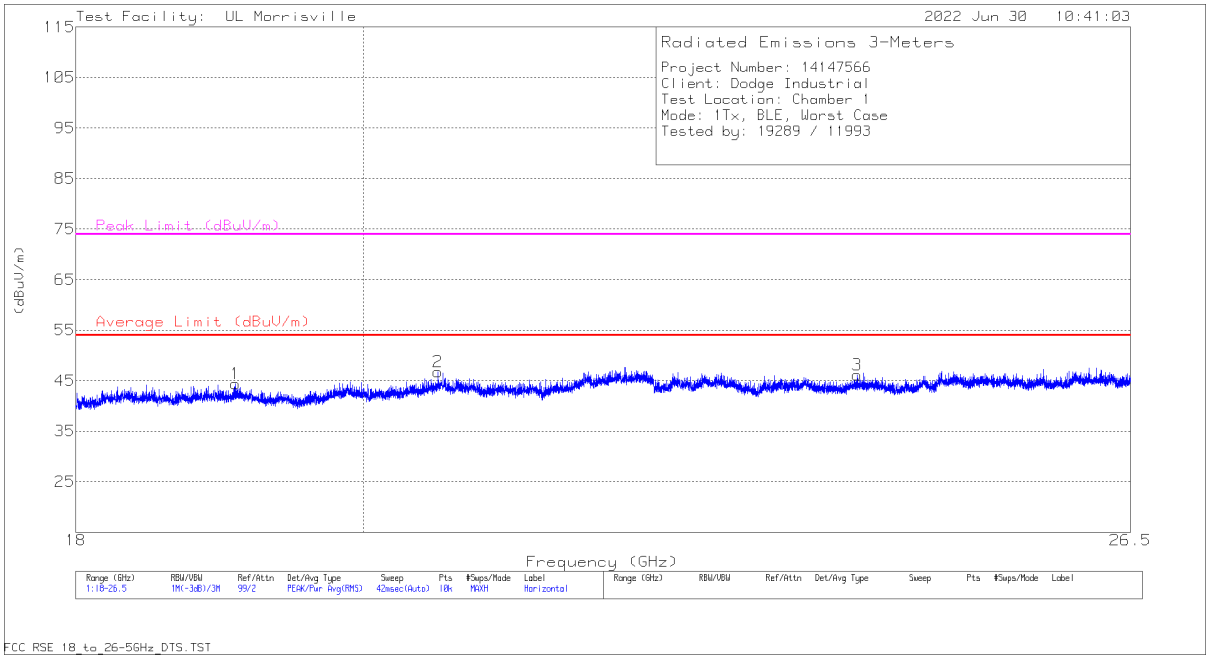
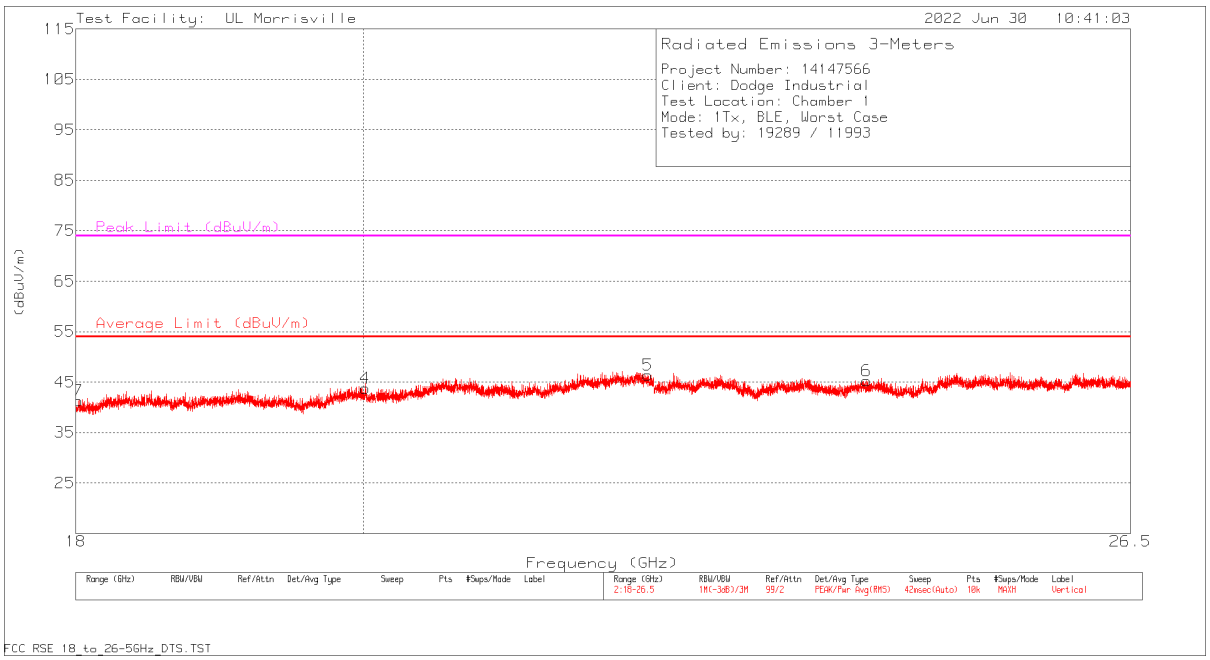
10.5. WORST CASE 18-26 GHZ

SPURIOUS EMISSIONS 18-26 GHz (WORST-CASE CONFIGURATION)



HORIZONTAL



VERTICAL

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18 – 26GHz Data

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	ANT (dB/m)	Gain/Loss (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 19.08449	50.4	Pk	33.4	-39.4	44.4	54	-9.6	74	-29.6	0-360	149	H
2	* ** 20.55654	52.03	Pk	33.9	-39.2	46.73	54	-7.27	74	-27.27	0-360	149	H
3	* ** 23.97575	49.85	Pk	35	-38.7	46.15	54	-7.85	74	-27.85	0-360	250	H
4	* ** 20.01515	49.18	Pk	33.6	-39	43.78	54	-10.22	74	-30.22	0-360	101	V
5	* ** 22.20198	49.11	Pk	36.9	-39.6	46.41	54	-7.59	74	-27.59	0-360	150	V
7	* ** 18.0153	46.96	Pk	33.2	-38.9	41.26	54	-12.74	74	-32.74	0-360	150	V
6	24.05479	49.14	Pk	35	-38.9	45.24	54	-8.76	74	-28.76	0-360	250	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
** - indicates frequency in Taiwan NCC LP0002 Restricted Band
Pk - Peak detector

11. SETUP PHOTOS

Please refer to R14147566-EP1 for setup photos

END OF TEST REPORT

UL LLC
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