

TEST REPORT

Report Number: R14964467-E3

Applicant : Alps Electric (Ireland) Ltd.
Clara Road, Millstreet Town, P51 XC56
Ireland

Model : Skoll

FCC ID : 2AT4VSKOLL

IC : 26629-SKOLL

EUT Description : Tracking Device

Test Standard(s) : FCC 47 CFR PART 15 SUBPART C: 2024
ISED RSS-247 ISSUE 3: 2023
ISED RSS-GEN ISSUE 5 + A1 + A2: 2021

Date Of Issue:
2024-11-06

Prepared by:
UL LLC
12 Laboratory Dr.
Research Triangle Park, NC 27709 U.S.A.
TEL: (919) 549-1400



REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	2024-04-12	Initial Issue	Charles Moody
V2	2024-10-17	Revised Technical Information, Test Methodology References, and Corrected Peak Power Measurement Typo	Charles Moody
V3	2024-11-06	Revised Technical Information	Charles Moody

TABLE OF CONTENTS

REPORT REVISION HISTORY	2
TABLE OF CONTENTS	3
1. ATTESTATION OF TEST RESULTS	5
2. TEST RESULTS SUMMARY	6
3. TEST METHODOLOGY	6
4. FACILITIES AND ACCREDITATION	6
5. DECISION RULES AND MEASUREMENT UNCERTAINTY	7
5.1. METROLOGICAL TRACEABILITY	7
5.2. DECISION RULES	7
5.3. MEASUREMENT UNCERTAINTY	7
5.4. SAMPLE CALCULATION	7
6. EQUIPMENT UNDER TEST	8
6.1. EUT DESCRIPTION	8
6.2. MAXIMUM OUTPUT POWER	8
6.3. DESCRIPTION OF AVAILABLE ANTENNAS	8
6.4. SOFTWARE AND FIRMWARE	8
6.5. WORST-CASE CONFIGURATION AND MODE	8
6.6. DESCRIPTION OF TEST SETUP	9
7. MEASUREMENT METHOD	10
8. TEST AND MEASUREMENT EQUIPMENT	11
9. ANTENNA PORT TEST RESULTS	13
9.1. ON TIME AND DUTY CYCLE	13
9.2. 99% BANDWIDTH	14
9.2.1. BLE (1Mbps)	14
9.2.2. BLE (2Mbps)	15
9.3. 6 dB BANDWIDTH	16
9.3.1. BLE (1Mbps)	16
9.3.2. BLE (2Mbps)	17
9.4. OUTPUT POWER	18
9.4.1. BLE (1Mbps)	19
9.4.2. BLE (2Mbps)	19
9.5. AVERAGE POWER	20
9.5.1. BLE (1Mbps)	21

9.5.2.	BLE (2Mbps).....	21
9.6.	<i>POWER SPECTRAL DENSITY</i>	22
9.6.1.	BLE (1Mbps).....	23
9.6.2.	BLE (2Mbps).....	24
9.7.	<i>CONDUCTED SPURIOUS EMISSIONS</i>	25
9.7.1.	BLE (1Mbps).....	26
9.7.2.	BLE (2Mbps).....	27
10.	RADIATED TEST RESULTS	28
10.1.	<i>LIMITS AND PROCEDURE</i>	28
10.2.	<i>TRANSMITTER ABOVE 1 GHz</i>	30
10.2.1.	BLE (1Mbps)	30
10.2.2.	BLE (2Mbps)	40
10.3.	<i>WORST CASE SPURIOUS BELOW 30MHZ</i>	44
10.4.	<i>WORST CASE SPURIOUS BELOW 1 GHZ</i>	46
10.5.	<i>WORST CASE SPURIOUS 18-26 GHZ</i>	48
11.	SETUP PHOTOS	50

1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Alps Electric (Ireland) Ltd.
Clara Road, Millstreet Town, P51 XC56
Ireland

EUT DESCRIPTION: Tracking Device

MODEL: Skoll

SERIAL NUMBER: CD:DF:C6:31:38:83, 6462529, 2EE-03029AA

SAMPLE RECEIPT DATE: 2023-11-27, 2024-03-21

DATE TESTED: 2023-12-26 TO 2024-04-08

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart C: 2024	Refer to Section 2
ISED RSS-247 Issue 3: 2023	Refer to Section 2
ISED RSS-GEN Issue 5 + A1 + A2: 2021	Refer to Section 2

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.

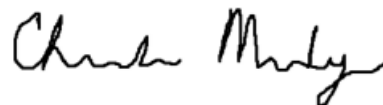
This document may not be altered or revised in any way unless done so by UL LLC and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL LLC will constitute fraud and shall nullify the document.

Approved & Released
For UL LLC By:



Mike Antola
Staff Engineer
Consumer, Medical and IT Segment
UL LLC

Prepared By:



Charles Moody
Engineer
Consumer, Medical and IT Segment
UL LLC

2. TEST RESULTS SUMMARY

This report contains info provided by the customer 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.

Below is a list of the data/info provided by the customer:

- 1) Antenna gain and type (see section 6.3)
- 2) Worst-case data rates (see section 6.5)

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	Compliant	None
15.247 (b) (3)	RSS-247 5.4 (d)	Output Power		
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	Compliant	None
15.247 (d)	RSS-247 5.5	Conducted Spurious Emissions		
15.209, 15.205	RSS-GEN 8.9, 8.10	Radiated Emissions		
15.207	RSS-Gen 8.8	AC Mains Conducted Emissions	N/A	EUT is Battery Powered

3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC 47 CFR Part 2, FCC 47 CFR Part 15, ANSI C63.10-2020, 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 3.

4. FACILITIES AND ACCREDITATION

UL LLC is accredited by A2LA, certification # 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: 12 Laboratory Dr RTP, NC 27709, U.S.A	US0067	2180C	825374
☒	Building: 2800 Perimeter Park Dr. Suite B Morrisville, NC 27560, U.S.A		27265	

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	UNCERTAINTY
Radio Frequency (Spectrum Analyzer)	141.2 Hz
Occupied Channel Bandwidth	1.22%
RF output power, conducted	1.3 dB (PK) 0.45 dB (AV)
Power Spectral Density, conducted	2.47 dB
Unwanted Emissions, conducted	1.94 dB
All emissions, radiated	6.01 dB
Conducted Emissions (0.150-30MHz) - LISN	3.40 dB
Temperature	0.57°C
Humidity	3.39%
DC Supply voltages	1.70%
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)
 $36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} = 28.9 \text{ dBuV/m}$

6. EQUIPMENT UNDER TEST

6.1. EUT DESCRIPTION

The EUT is a level tracking device that contains a BLE radio and a radar transmitter. This report covers the full emissions testing of the BLE radio.

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 1Mbps	5.43	3.49
2402-2480	BLE 2Mbps	5.43	3.49

6.3. DESCRIPTION OF AVAILABLE ANTENNAS

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

The radio utilizes an PCB antenna, with a maximum gain of -2.35 dBi.

6.4. SOFTWARE AND FIRMWARE

The EUT has an HVIN of 1AD-MA00055 and an FVIN of 2.0.0.

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 power spectral density 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 and high channels for band edge as well as middle channel for radiated spurious emissions. Band edge was performed on both supported data rates. For spurious emissions between 1 and 18GHz, only 1Mbps was tested as a worst case data rate, based on worst-case average power and PSD.

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

As provided by the client, the EUT only supports 1Mbps and 2Mbps data rates. Therefore only these data rates were used for testing.

6.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop	Lenovo	T14	PF4FKY5C	-

I/O CABLES

I/O Cable List						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	UART	1	6-Pin	Non-Shielded	<3m	Used to configure radio module

TEST SETUP

EUT was configured using the UART cable and support laptop, prior to testing. For final testing, the EUT was disconnected from the support laptop and debug cable.

SETUP DIAGRAMS

Please refer to R14964467-EP2 for setup diagrams

7. MEASUREMENT METHOD

On Time and Duty Cycle: ANSI C63.10-2020 Section 11.6

6 dB BW: ANSI C63.10-2020 Subclause -11.8.1

Occupied BW (99%): ANSI C63.10-2020 Section 6.9.3

Output Power: ANSI C63.10-2020 Subclause -11.9.1.2 Method PKPM1 Peak-reading power meter
ANSI C63.10-2020 Subclause -11.9.2.3.2 Method AVGPM-G (Measurement using a gated RF average-reading power meter)

PSD: ANSI C63.10-2020 Subclause -11.10.2 Method PKPSD (peak PSD)

Conducted emissions non-restricted frequency bands: ANSI C63.10-2020 Subclause -11.11 and 6.10.4

Radiated emissions restricted frequency bands: ANSI C63.10-2020 Subclause -11.12.1 and 6.10.5, 6.3 to 6.6.

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.
	Common Equipment				
	Conducted Room 2				
90410	Spectrum Analyzer	Keysight Technologies	N9030A	2023-06-14	2024-06-14
238710	Environmental Meter	Fisher Scientific	15-077-963	2023-06-27	2024-06-27
211057	Real-Time Peak Power Sensor 50MHz to 8GHz	Boonton	RTP5000	2023-08-01	2024-08-01
SOFTEMI	Antenna Port Software	UL	Version 2022.8.16	NA	NA
Power Software	Boonton Power Analyzer	Boonton	Version 3.0.13.0	NA	NA
Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	Common Equipment				
	Attenuators				
**226561	SMA Coaxial 10dB Attenuator 25MHz-18GHz	CentricRF	C18S2-10	2023-02-16	2024-02-16
	Cables				
CBL030	SMA Male to SMA Male Cable Using PE-P141 Coax - 12"	Pasternack	Sucoflex 104PEA	2023-06-27	2024-06-27

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

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	1-18 GHz				
**206211	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2023-04-06	2024-04-06
	Gain-Loss Chains				
91979	Gain-loss string: 1-18GHz	Various	Various	2023-05-16	2024-05-16
	Receiver & Software				
**206496	Spectrum Analyzer	Rohde & Schwarz	ESW44	2023-03-24	2024-03-24
SOFTEMI	EMI Software	UL	Version 9.5 (18 Oct 2021)		
	Additional Equipment used				
241205	Environmental Meter	Fisher Scientific	15-077-963	2023-09-05	2025-09-05

****Note:** Testing on this equipment was performed prior to the equipment's calibration expiring. Therefore, at the time of testing, all equipment was in calibration.

Test Equipment Used - Radiated Disturbance Emissions Test Equipment (Morrisville – Chamber 2)

Equip. ID	Description	Manufacturer/Brand	Model Number	Last Cal.	Next Cal.
	0.009-30MHz				
135144	Active Loop Antenna	ETS-Lindgren	6502	2024-01-24	2025-01-24
	30-1000 MHz				
159203	Hybrid Broadband Antenna	Sunol Sciences Corp.	JB3	2024-03-05	2026-03-05
	1-18 GHz				
86408	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2023-06-19	2025-06-19
	18-40 GHz				
204704	Horn Antenna, 18-26.5GHz	Com-Power	AH-826	2023-07-20	2025-07-20
	Gain-Loss Chains				
91975	Gain-loss string: 0.009-30MHz	Various	Various	2023-06-06	2024-06-06
91978	Gain-loss string: 25-1000MHz	Various	Various	2023-06-06	2024-06-06
91977	Gain-loss string: 1-18GHz	Various	Various	2023-06-06	2024-06-06
136042	Gain-loss string: 18-40GHz	Various	Various	2023-06-06	2024-06-06
	Receiver & Software				
197954	Spectrum Analyzer	Rohde & Schwarz	ESW44	2024-03-05	2025-03-05
72823	Spectrum Analyzer	Agilent	E4446A	2023-06-27	2024-06-30
SOFTEMI	EMI Software	UL	Version 9.5 (18 Oct 2021)		
	Additional Equipment used				
200540	Environmental Meter	Fisher Scientific	15-077-963	2023-07-19	2025-07-19

9. ANTENNA PORT TEST RESULTS

9.1. ON TIME AND DUTY CYCLE

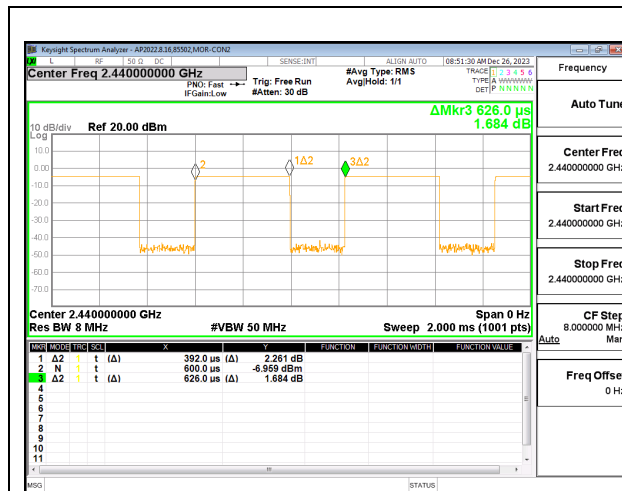
LIMITS

None; for reporting purposes only.

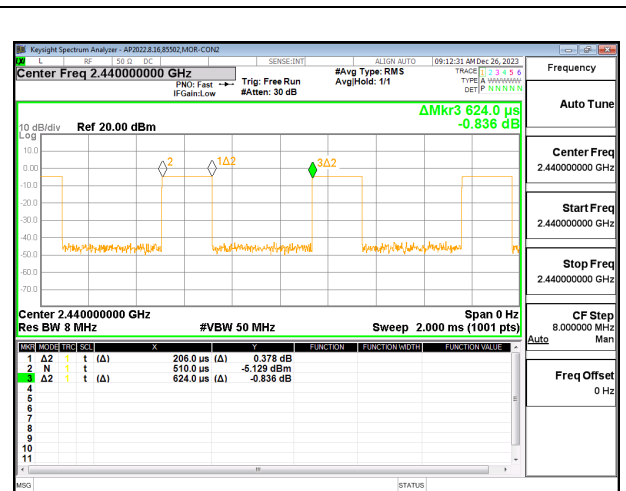
PROCEDURE

KDB 558074 Zero-Span Spectrum Analyzer Method.

Mode	ON Time B (ms)	Period (ms)	Duty Cycle x (linear)	Duty Cycle (%)	Voltage Duty Cycle Correction Factor (dB)	RMS Duty Cycle Correction Factor (dB)
BLE 1Mbps	0.392	0.626	0.626	62.62	4.07	2.03
BLE 2Mbps	0.206	0.624	0.330	33.01	9.63	4.81



DUTY CYCLE BLE 1Mbps MODE



DUTY CYCLE BLE 2Mbps MODE

9.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

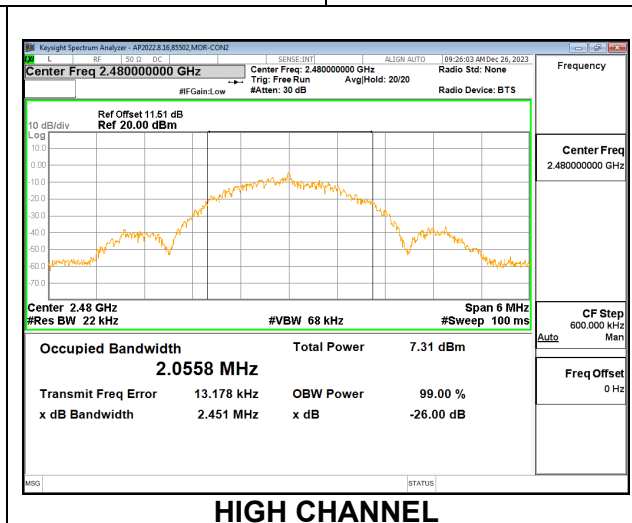
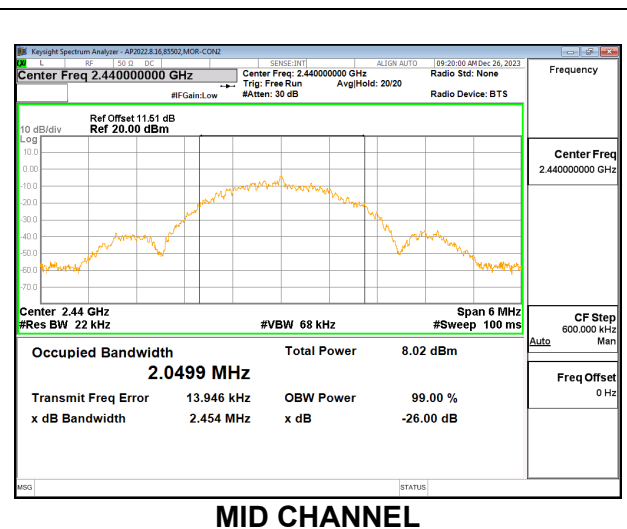
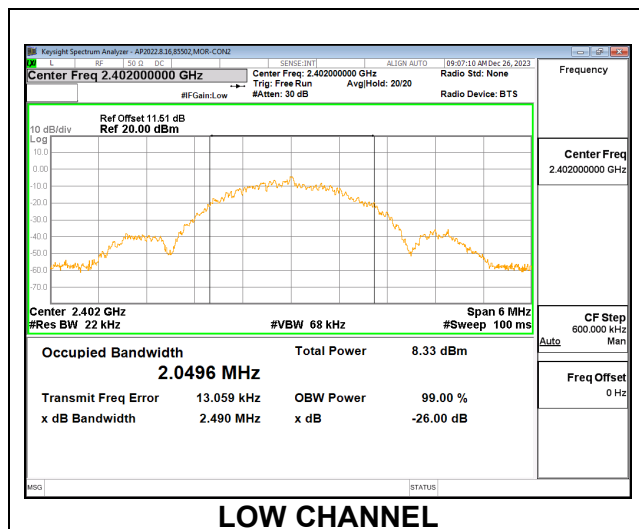
9.2.1. BLE (1Mbps)

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0512
Middle	2440	1.0529
High	2480	1.0506



9.2.2. BLE (2Mbps)

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	2.0496
Middle	2440	2.0499
High	2480	2.0558



9.3. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)

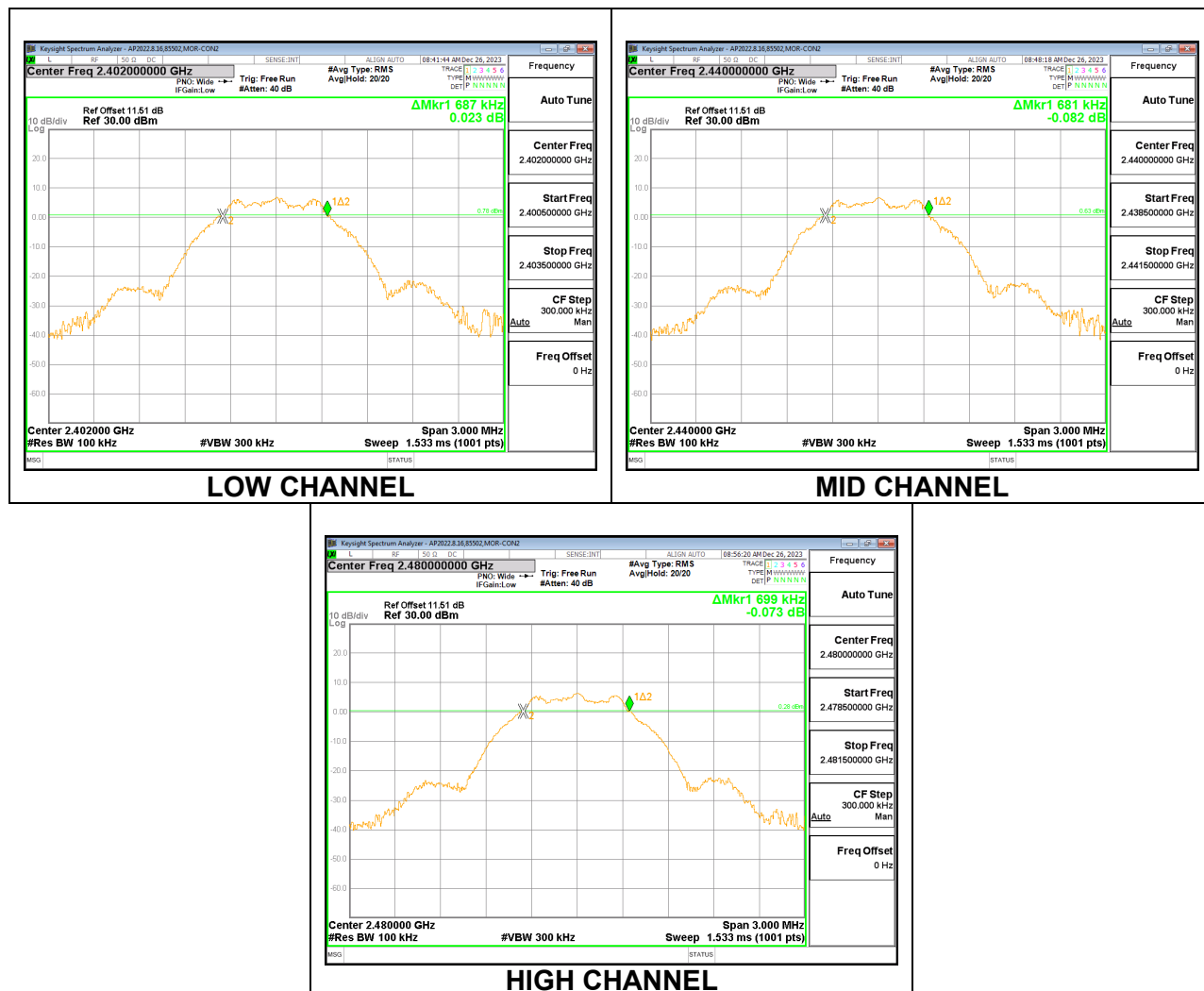
RSS-247 5.2 (a)

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

RESULTS

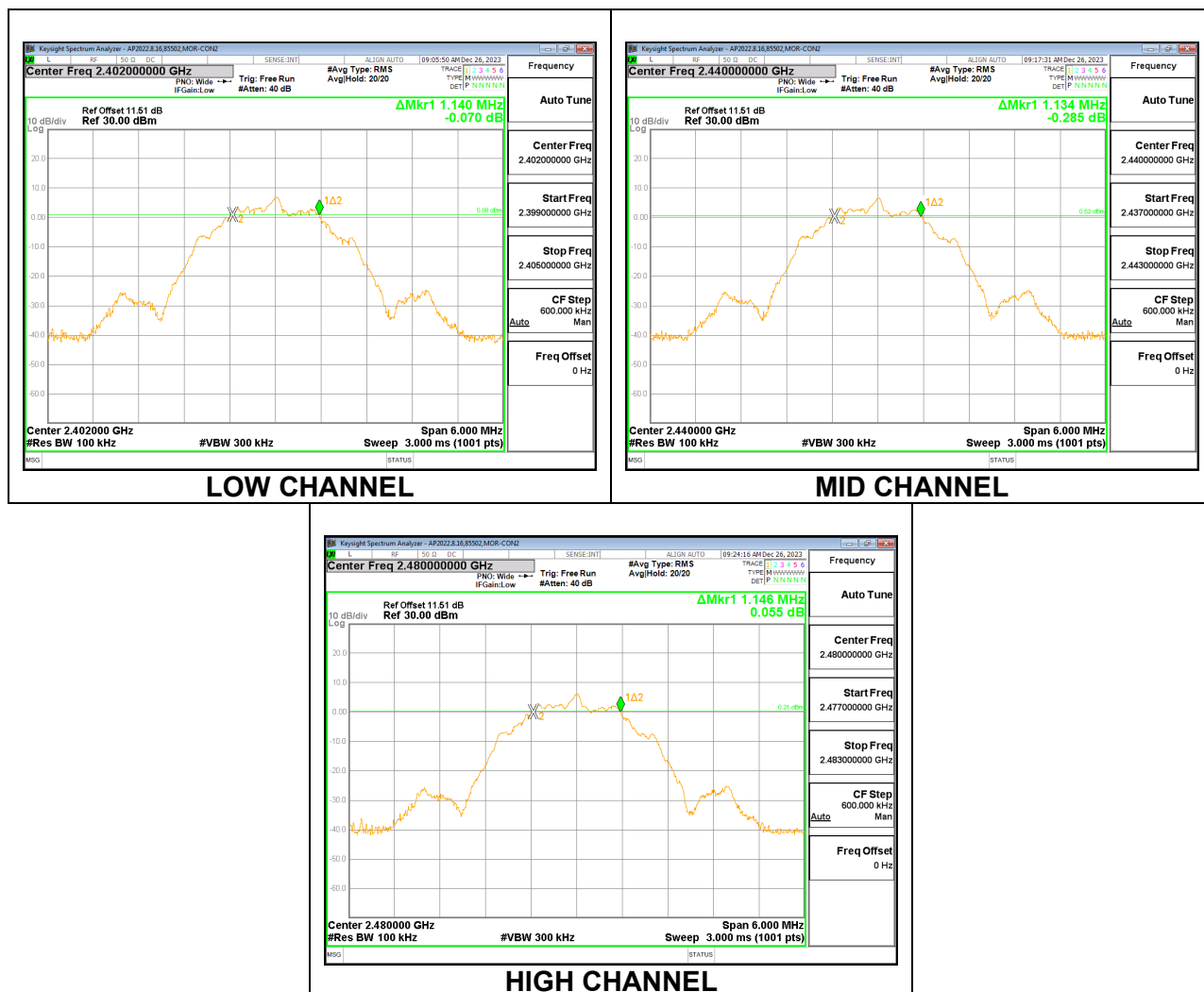
9.3.1. BLE (1Mbps)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.687	0.5
Middle	2440	0.681	0.5
High	2480	0.699	0.5



9.3.2. BLE (2Mbps)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	1.140	0.5
Middle	2440	1.134	0.5
High	2480	1.146	0.5



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 sensor.

The cable assembly insertion loss of 1.5 dB (including a 1.5 dB EUT cable) was entered as an offset in the power sensor software.

The power output was measured on the EUT antenna port using SMA cable connected to a wideband power sensor. Peak output power was read directly from the power sensor software.

RESULTS

9.4.1. BLE (1Mbps)

Tested By:	85502
Date:	2024-04-08

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	5.43	30	-24.570
Middle	2440	5.27	30	-24.730
High	2480	4.95	30	-25.050

9.4.2. BLE (2Mbps)

Tested By:	85502
Date:	2024-04-08

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	5.43	30	-24.570
Middle	2440	5.23	30	-24.770
High	2480	4.96	30	-25.040

9.5. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power sensor.

The cable assembly insertion loss of 1.5 dB (including a 1.5 dB EUT cable) was entered as an offset in the power sensor software.

The power output was measured on the EUT antenna port using SMA cable connected to a wideband power sensor. Gated average output power was read directly from power sensor software.

RESULTS

9.5.1. BLE (1Mbps)

Tested By:	85502
Date:	2024-04-08

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	5.23
Middle	2440	5.04
High	2480	4.76

9.5.2. BLE (2Mbps)

Tested By:	85502
Date:	2024-04-08

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	5.24
Middle	2440	5.04
High	2480	4.76

9.6. POWER SPECTRAL DENSITY

LIMITS

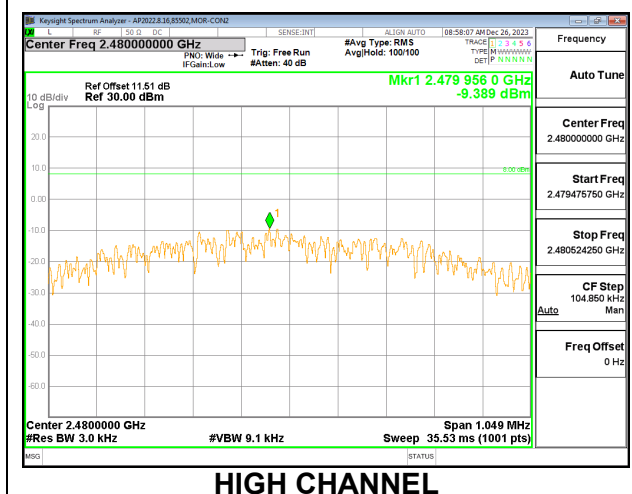
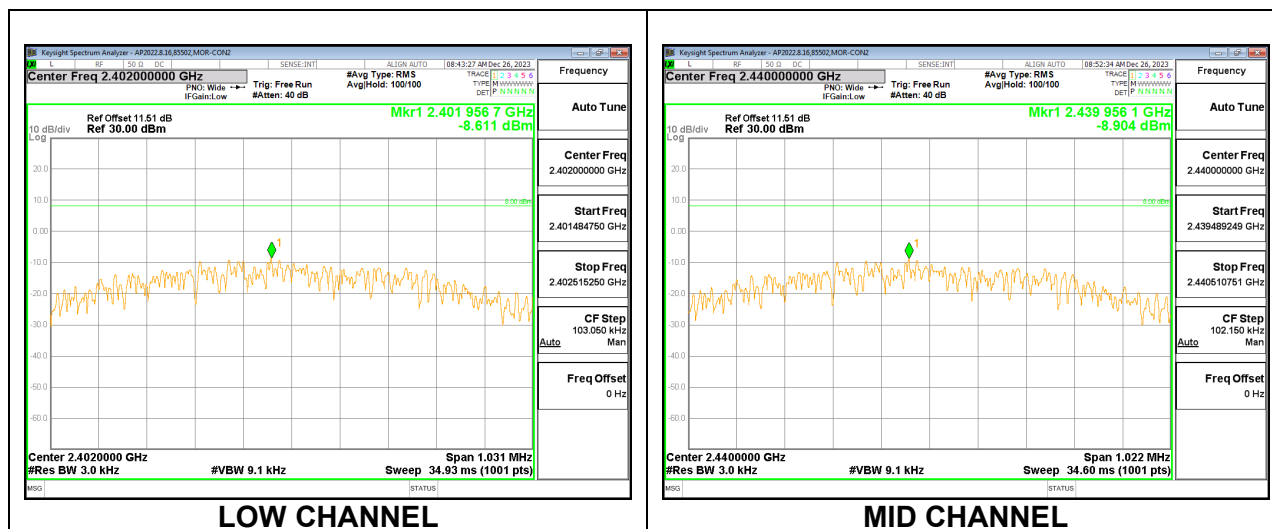
FCC §15.247 (e)
RSS-247 (5.2) (b)

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

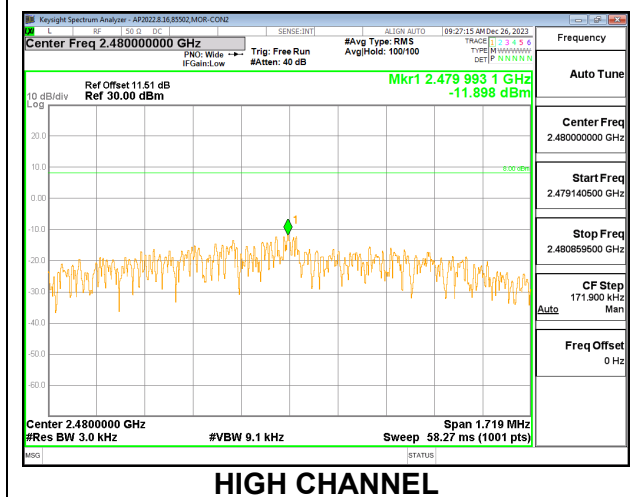
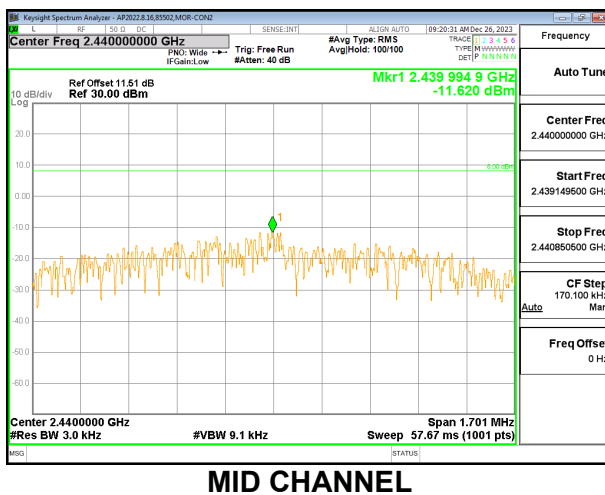
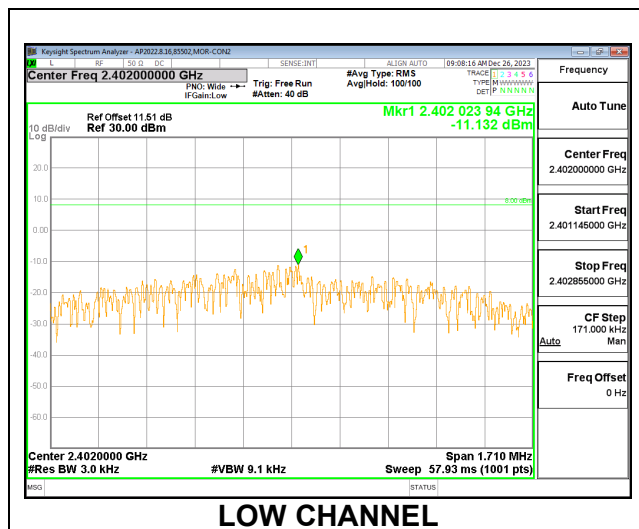
9.6.1. BLE (1Mbps)

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	-8.611	8	-16.61
Middle	2440	-8.904	8	-16.90
High	2480	-9.389	8	-17.39



9.6.2. BLE (2Mbps)

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	-11.132	8	-19.13
Middle	2440	-11.620	8	-19.62
High	2480	-11.898	8	-19.90



9.7. CONDUCTED SPURIOUS EMISSIONS

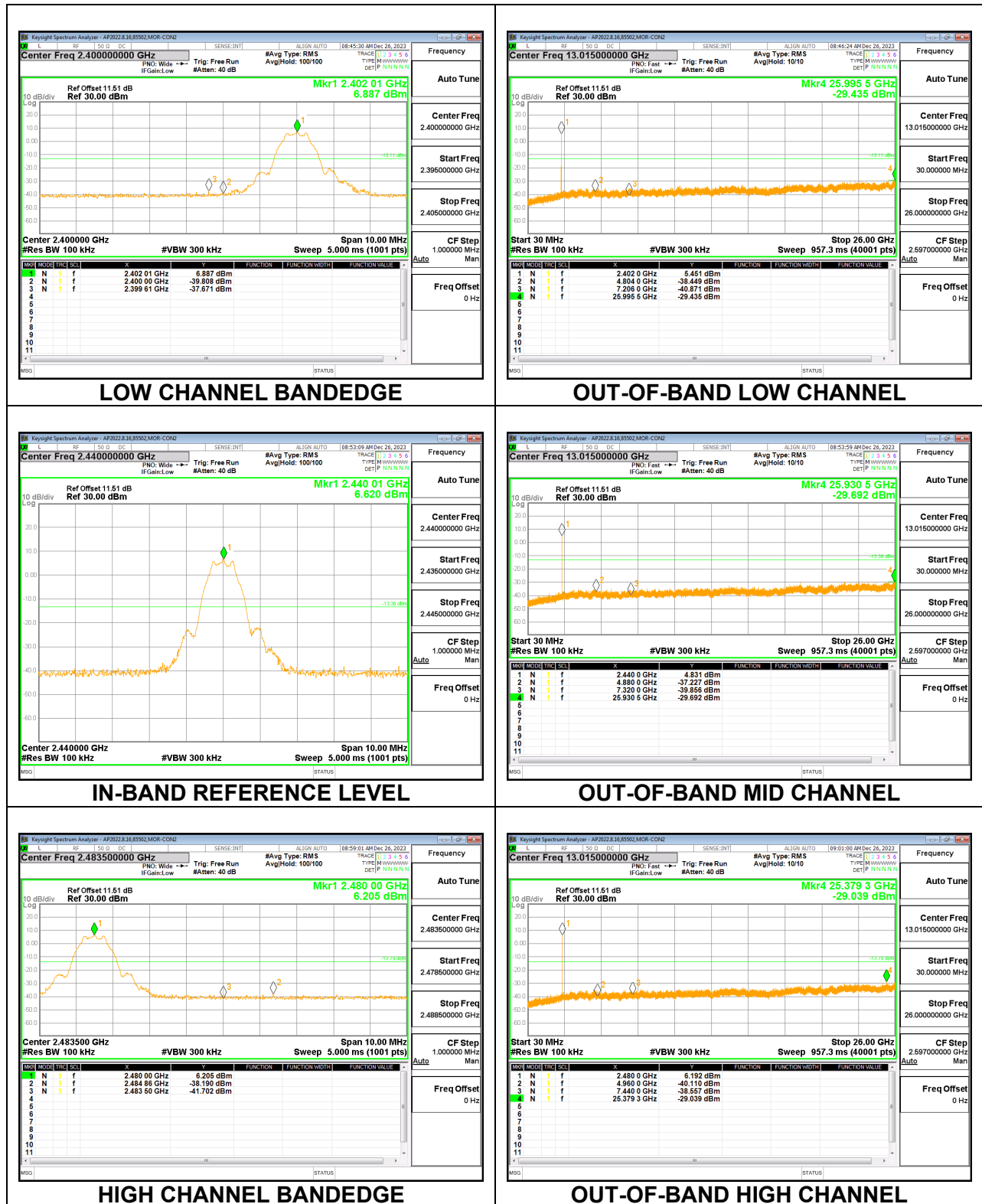
LIMITS

FCC §15.247 (d)
RSS-247 5.5

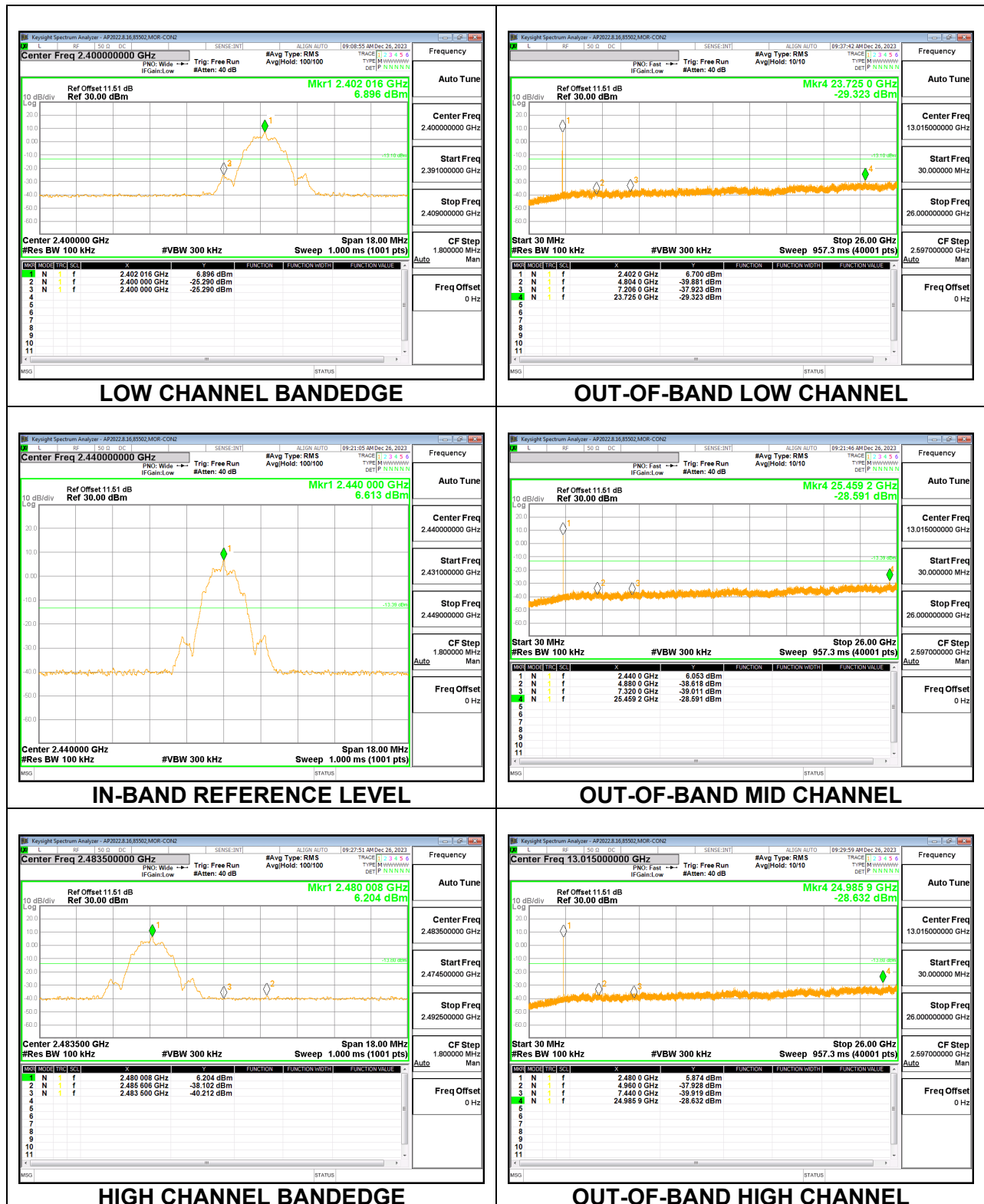
Output power was measured based on the use of a peak measurement, therefore the required attenuation is -20 dBc.

RESULTS

9.7.1. BLE (1Mbps)



9.7.2. BLE (2Mbps)



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

IC RSS-GEN Clause 8.9 and 8.10

Frequency Range (kHz)	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	-
Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
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 1 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 linear voltage average measurements.

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 power spectral density 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

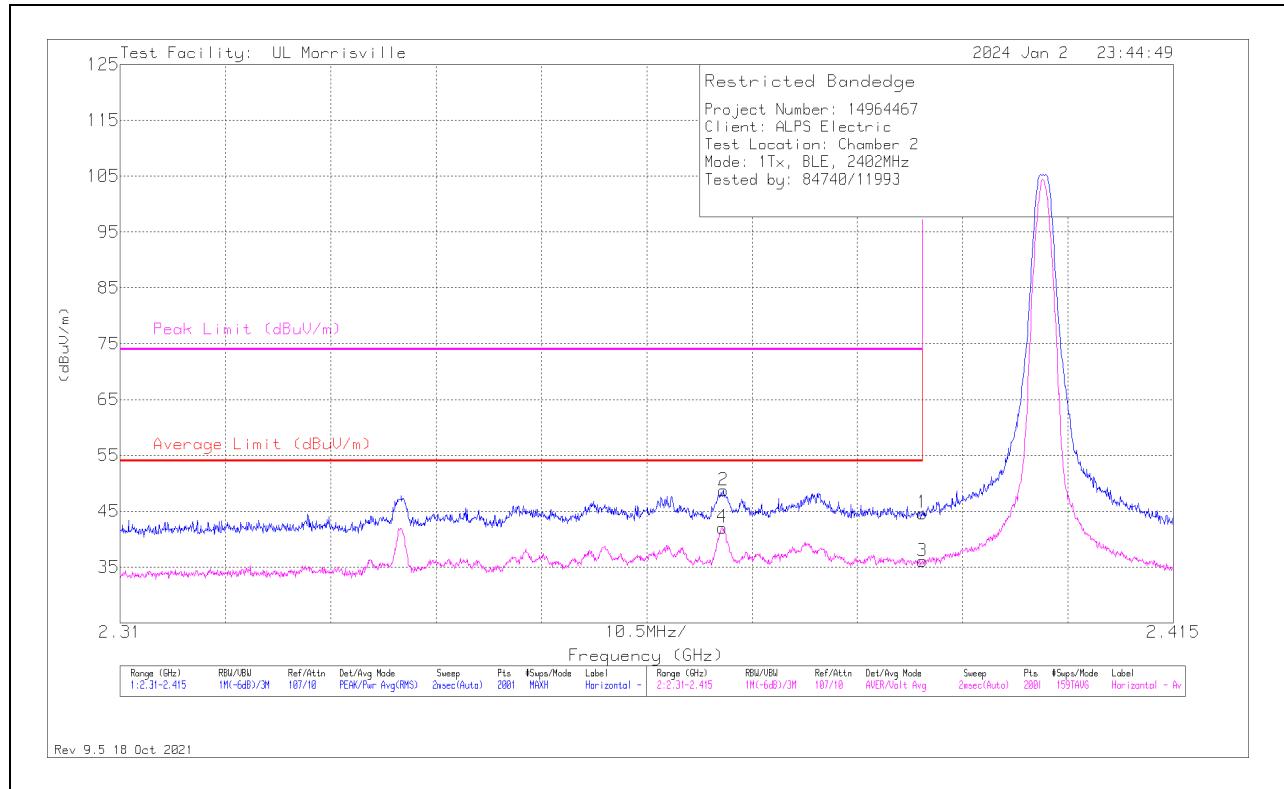
OFS and chamber correlation testing had been performed and chamber measured test result is the worst-case test result.

10.2. TRANSMITTER ABOVE 1 GHz

10.2.1. BLE (1Mbps)

BANDEDGE (LOW CHANNEL)

HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	86408 (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	36.55	Pk	32.3	-24.2	0	44.65	-	-	74	-29.35	320	120	H
2	* ** 2.37017	40.62	Pk	32.2	-24.1	0	48.72	-	-	74	-25.28	320	120	H
3	* ** 2.38996	23.87	ADV	32.3	-24.2	4.07	36.04	54	-17.96	-	-	320	120	H
4	* ** 2.37001	29.91	ADV	32.2	-24.1	4.07	42.08	54	-11.92	-	-	320	120	H

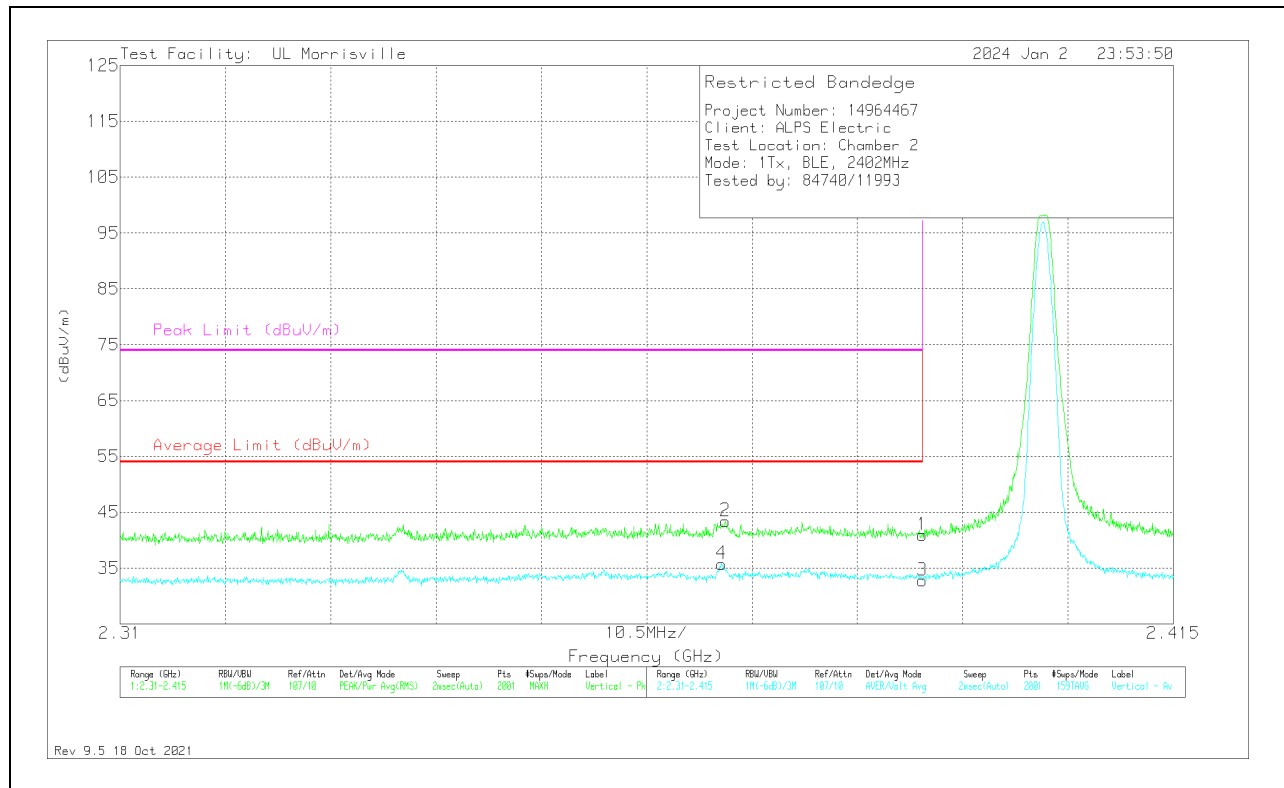
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

ADV - Linear Voltage Average

VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	86408 (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	32.82	Pk	32.3	-24.2	0	40.92	-	-	74	-33.08	292	392	V
2	* ** 2.37032	35.29	Pk	32.2	-24.1	0	43.39	-	-	74	-30.61	292	392	V
3	* ** 2.38996	20.6	ADV	32.3	-24.2	4.07	32.77	54	-21.23	-	-	292	391	V
4	* ** 2.36996	23.58	ADV	32.2	-24.1	4.07	35.75	54	-18.25	-	-	292	391	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

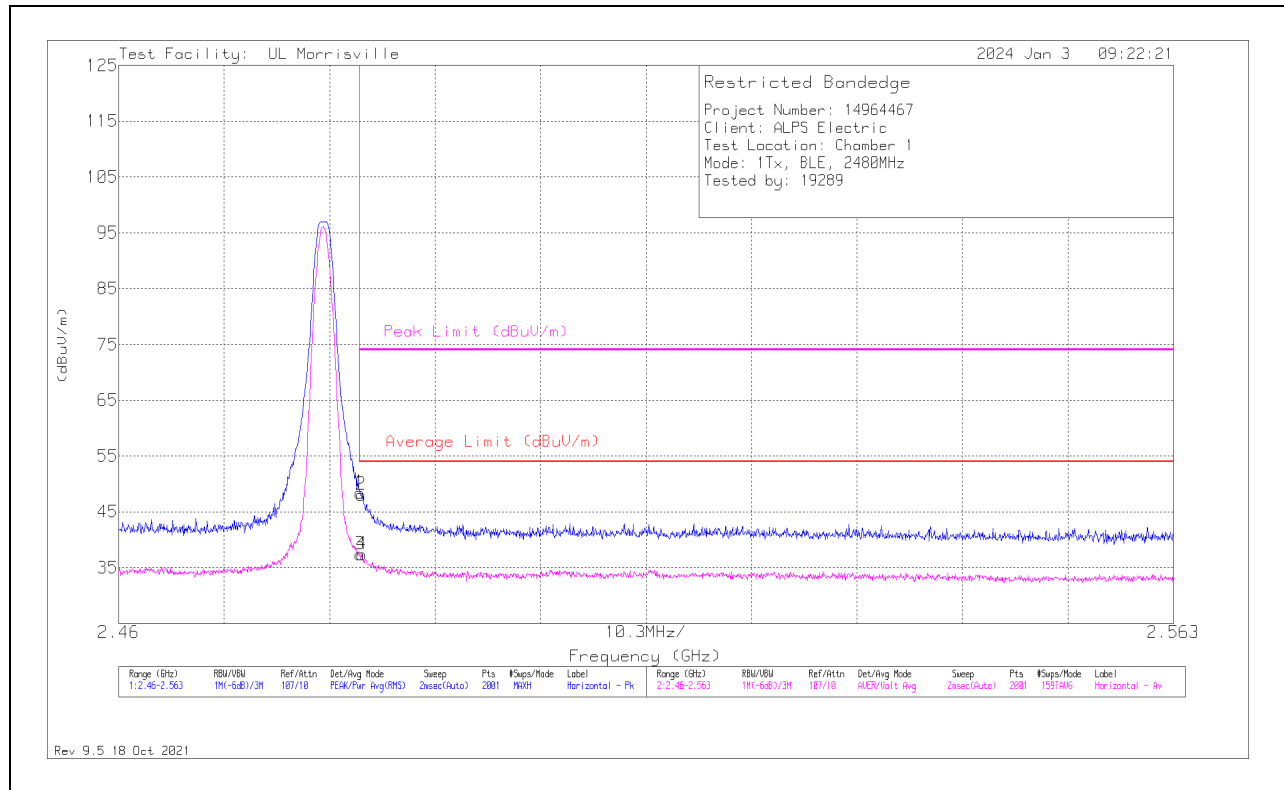
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

ADV - Linear Voltage Average

BANDEDGE (HIGH CHANNEL)

HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	206211 (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	40.68	Pk	32.3	-24.5	0	48.48	-	-	74	-25.52	35	111	H
2	* ** 2.48369	40.3	Pk	32.3	-24.5	0	48.1	-	-	74	-25.9	35	111	H
3	* ** 2.48354	25.48	ADV	32.3	-24.5	4.07	37.35	54	-16.65	-	-	35	111	H
4	* ** 2.48374	25.51	ADV	32.3	-24.5	4.07	37.38	54	-16.62	-	-	35	111	H

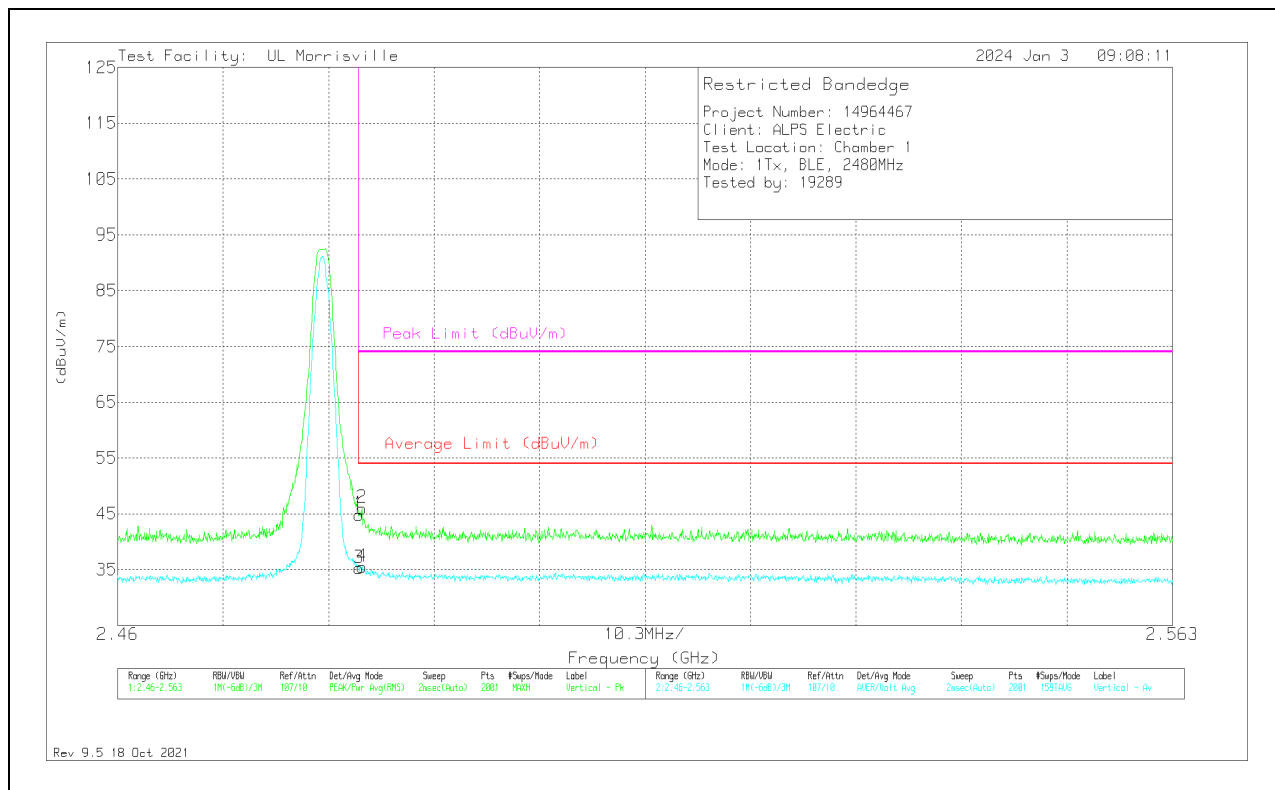
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

ADV - Linear Voltage Average

VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	206211 (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	37.09	Pk	32.3	-24.5	0	44.89	-	-	74	-29.11	133	264	V
2	* ** 2.48384	38.21	Pk	32.3	-24.5	0	46.01	-	-	74	-27.99	133	264	V
3	* ** 2.48354	23.41	ADV	32.3	-24.5	4.07	35.28	54	-18.72	-	-	133	264	V
4	* ** 2.48384	23.7	ADV	32.3	-24.5	4.07	35.57	54	-18.43	-	-	133	264	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

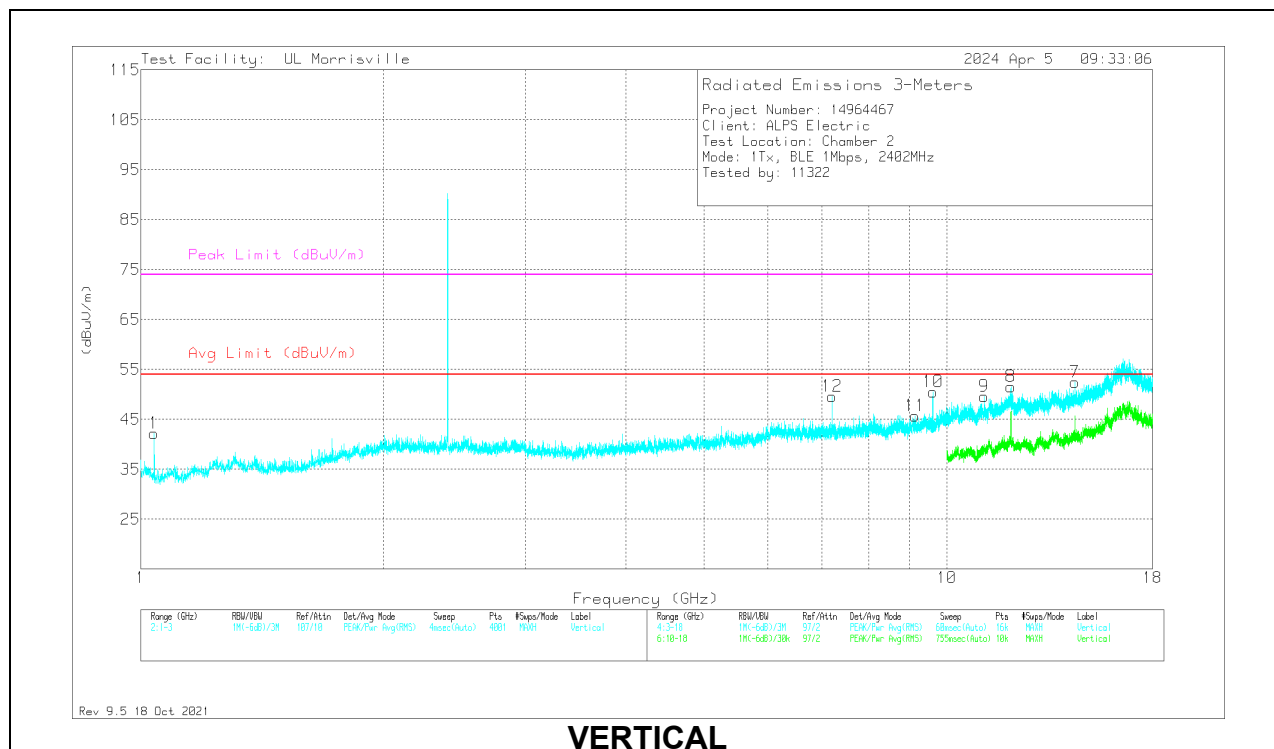
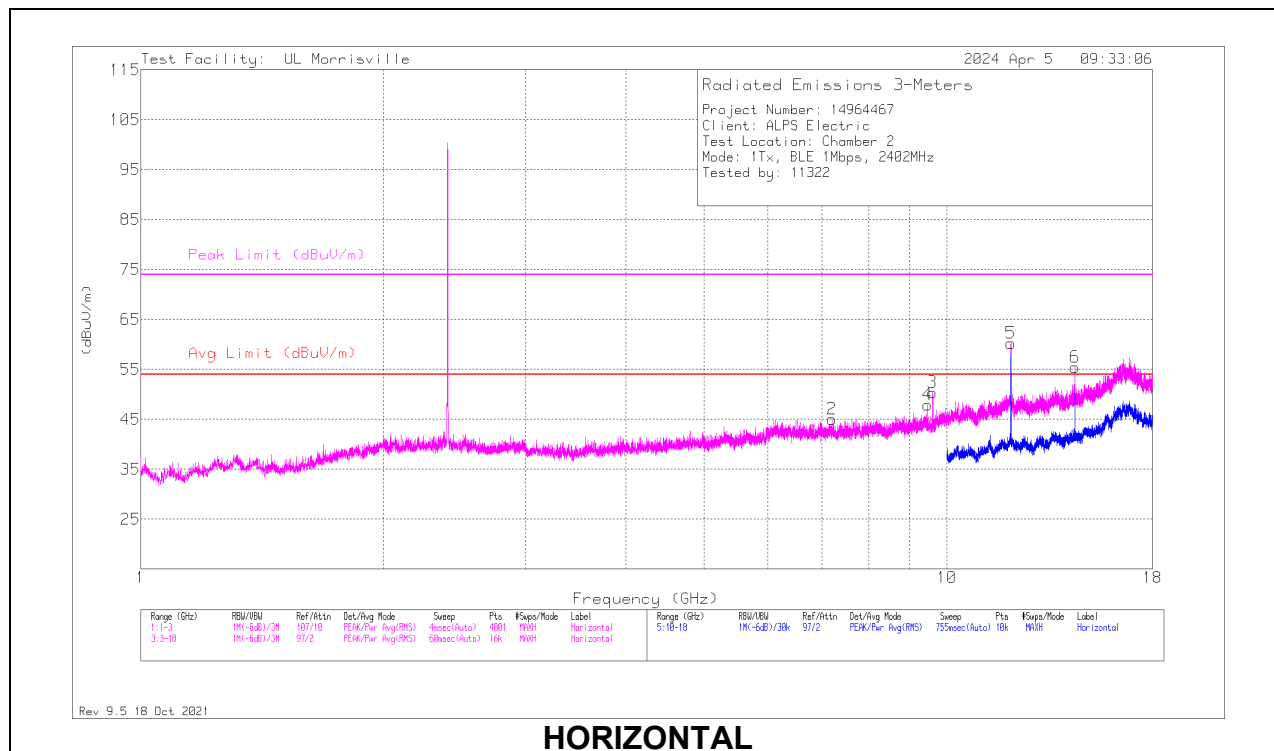
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

ADV - Linear Voltage Average

HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL RESULTS



RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	86408 (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	* ** 1.039	39.93	Pk	27.6	-25.3	0	42.23	54	-11.77	74	-31.77	0-360	200	V
4	* ** 9.46219	36.89	Pk	36.3	-25.3	0	47.89	54	-6.11	74	-26.11	0-360	101	H
5	* ** 12.0114	45.86	PK2	38.9	-22.7	0	62.06	-	-	74	-11.94	52	110	H
	* ** 12.00896	33.02	ADV	38.9	-22.7	4.07	53.29	54	-.71	-	-	53	110	H
8	* ** 12.00885	37.06	PK2	38.9	-22.7	0	53.26	-	-	74	-20.74	172	114	V
	* ** 12.00876	24.57	ADV	38.9	-22.7	4.07	44.84	54	-9.16	-	-	172	114	V
9	* ** 11.12713	35.03	PK2	37.7	-23.5	0	49.23	-	-	74	-24.77	350	238	V
	* ** 11.12656	22.48	ADV	37.7	-23.5	4.07	40.75	54	-13.25	-	-	350	238	V
11	* ** 9.12938	34.85	Pk	35.9	-25	0	45.75	54	-8.25	74	-28.25	0-360	200	V
2	7.20469	36.54	Pk	35.6	-27.1	0	45.04	-	-	-	-	0-360	101	H
12	7.20469	41.11	Pk	35.6	-27.1	0	49.61	-	-	-	-	0-360	200	V
3	9.60656	39.32	Pk	36.5	-25.4	0	50.42	-	-	-	-	0-360	101	H
10	9.60938	39.38	Pk	36.5	-25.4	0	50.48	-	-	-	-	0-360	101	V
6	14.41125	40.09	Pk	39.4	-24	0	55.49	-	-	-	-	0-360	101	H
7	14.41313	37.07	Pk	39.4	-24	0	52.47	-	-	-	-	0-360	101	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

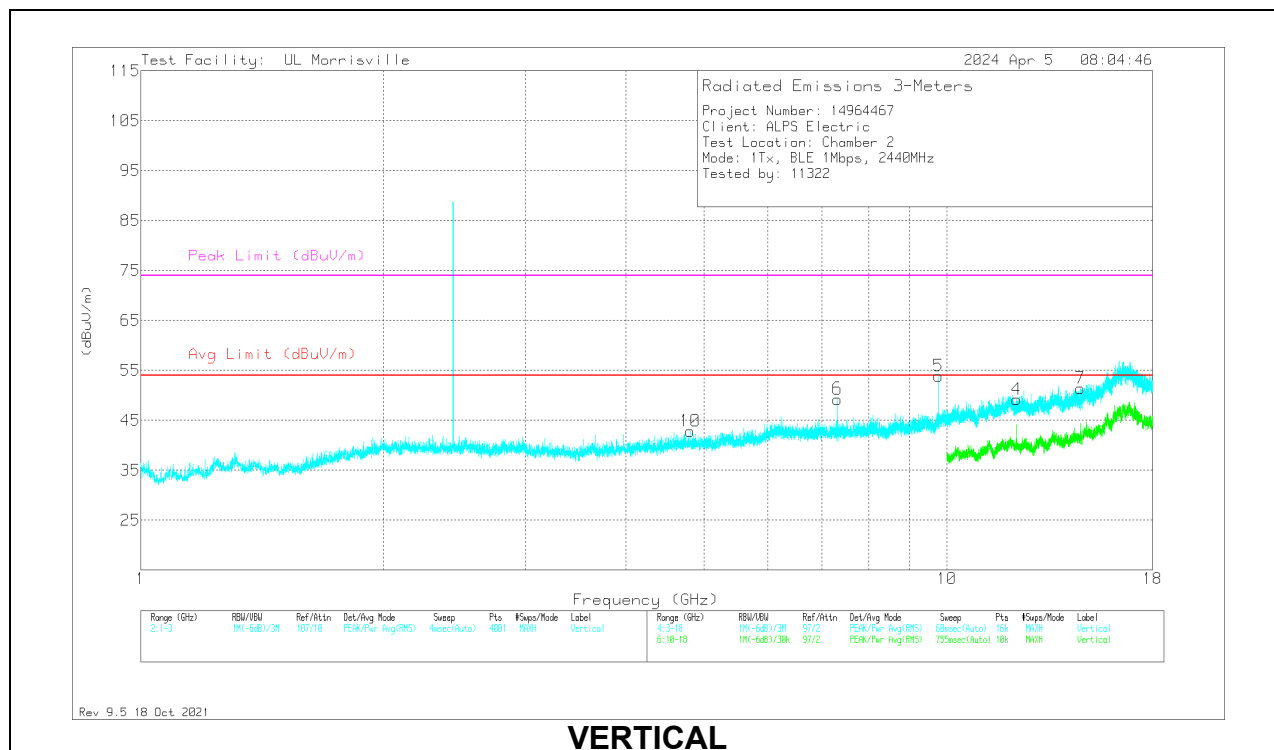
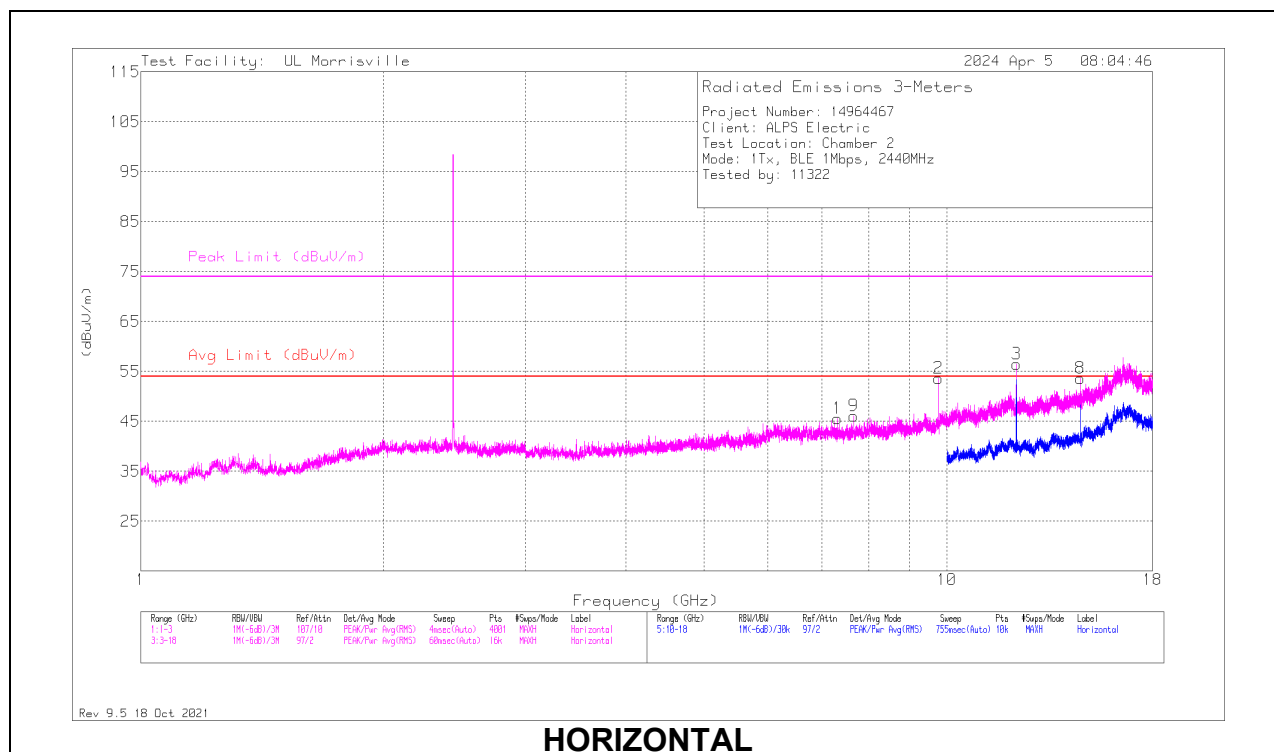
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

PK2 - Maximum Peak

ADV - Linear Voltage Average

MID CHANNEL RESULTS



RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	86408 (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	* ** 7.31906	36.69	Pk	35.6	-26.7	0	45.59	54	-8.41	74	-28.41	0-360	101	H
3	* ** 12.20002	43.84	PK2	38.9	-23.5	0	59.24	-	-	74	-14.76	47	118	H
	* ** 12.19882	33.21	ADV	38.9	-23.5	4.07	52.68	54	-1.32	-	-	47	118	H
9	* ** 7.66781	36.79	Pk	35.7	-26.4	0	46.09	54	-7.91	74	-27.91	0-360	101	H
4	* ** 12.20138	38.03	PK2	38.9	-23.4	0	53.53	-	-	74	-20.47	105	118	V
	* ** 12.19893	25.53	ADV	38.9	-23.5	4.07	45.00	54	-9.00	-	-	105	118	V
6	* ** 7.32077	43	PK2	35.6	-26.7	0	51.9	-	-	74	-22.1	355	249	V
	* ** 7.32055	32.39	ADV	35.6	-26.7	4.07	45.36	54	-8.64	-	-	355	249	V
10	* ** 4.80281	38.73	Pk	34.2	-30.1	0	42.83	54	-11.17	74	-31.17	0-360	101	V
2	9.76125	41.87	Pk	36.8	-25	0	53.67	-	-	-	-	0-360	101	H
5	9.76125	42.07	Pk	36.8	-25	0	53.87	-	-	-	-	0-360	101	V
8	14.63906	35.87	Pk	39.7	-21.9	0	53.67	-	-	-	-	0-360	101	H
7	14.63906	33.67	Pk	39.7	-21.9	0	51.47	-	-	-	-	0-360	199	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

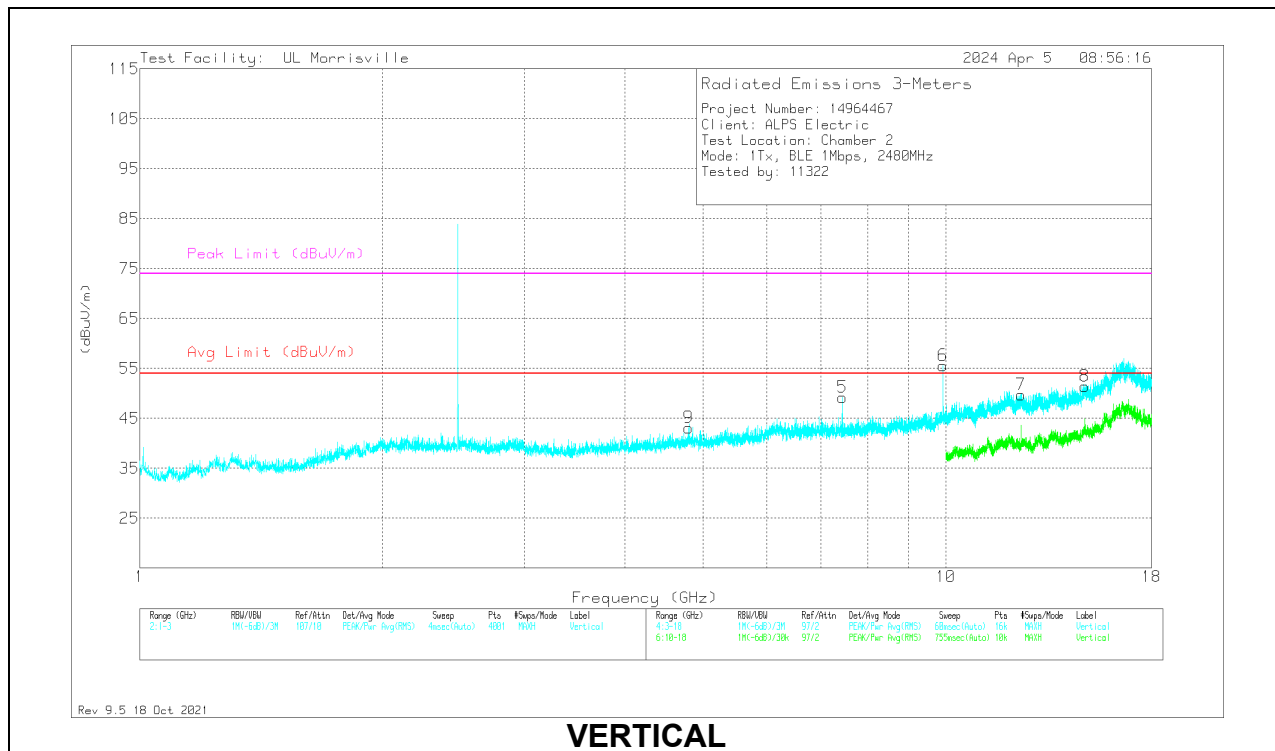
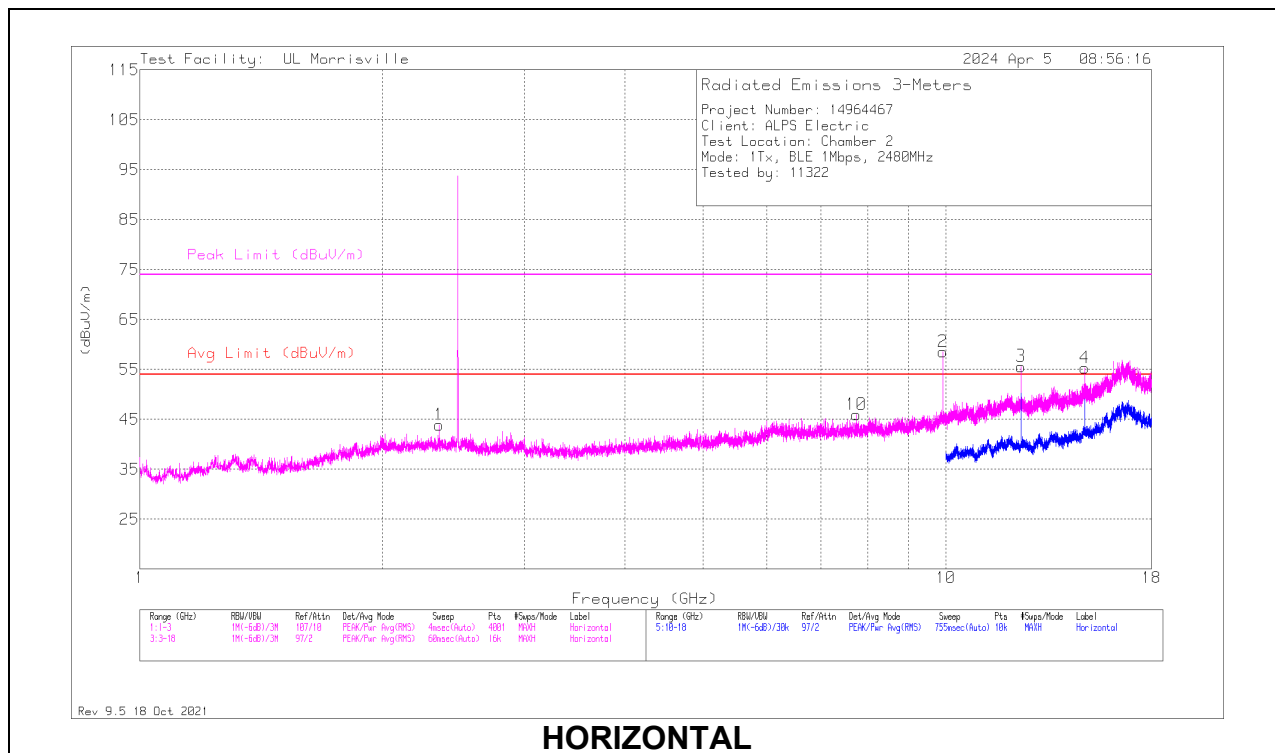
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

PK2 - Maximum Peak

ADV - Linear Voltage Average

HIGH CHANNEL RESULTS



RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	86408 (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	* ** 2.3525	35.72	Pk	32.1	-23.9	0	43.92	54	-10.08	74	-30.08	0-360	200	H
3	* ** 12.39874	41.3	PK2	38.8	-23.5	0	56.6	-	-	74	-17.4	51	106	H
	* ** 12.39892	30.57	ADV	38.8	-23.5	4.07	49.94	54	-4.06	-	-	51	106	H
10	* ** 7.74469	36.65	Pk	35.8	-26.5	0	45.95	54	-8.05	74	-28.05	0-360	199	H
5	* ** 7.44075	42.81	PK2	35.6	-27	0	51.41	-	-	74	-22.59	96	101	V
	* ** 7.43931	31.2	ADV	35.6	-26.9	4.07	43.97	54	-10.03	-	-	96	101	V
7	* ** 12.3989	36.42	PK2	38.8	-23.5	0	51.72	-	-	74	-22.28	103	108	V
	* ** 12.3989	24.39	ADV	38.8	-23.5	4.07	43.76	54	-10.24	-	-	103	108	V
9	* ** 4.79531	39.35	Pk	34.2	-30.4	0	43.15	54	-10.85	74	-30.85	0-360	101	V
2	9.91875	46.25	Pk	37.1	-24.8	0	58.55	-	-	-	-	0-360	101	H
6	9.92156	43.15	Pk	37.1	-24.7	0	55.55	-	-	-	-	0-360	101	V
8	14.87906	33.24	Pk	39.9	-21.7	0	51.44	-	-	-	-	0-360	199	V
4	14.88188	37.07	Pk	39.9	-21.7	0	55.27	-	-	-	-	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

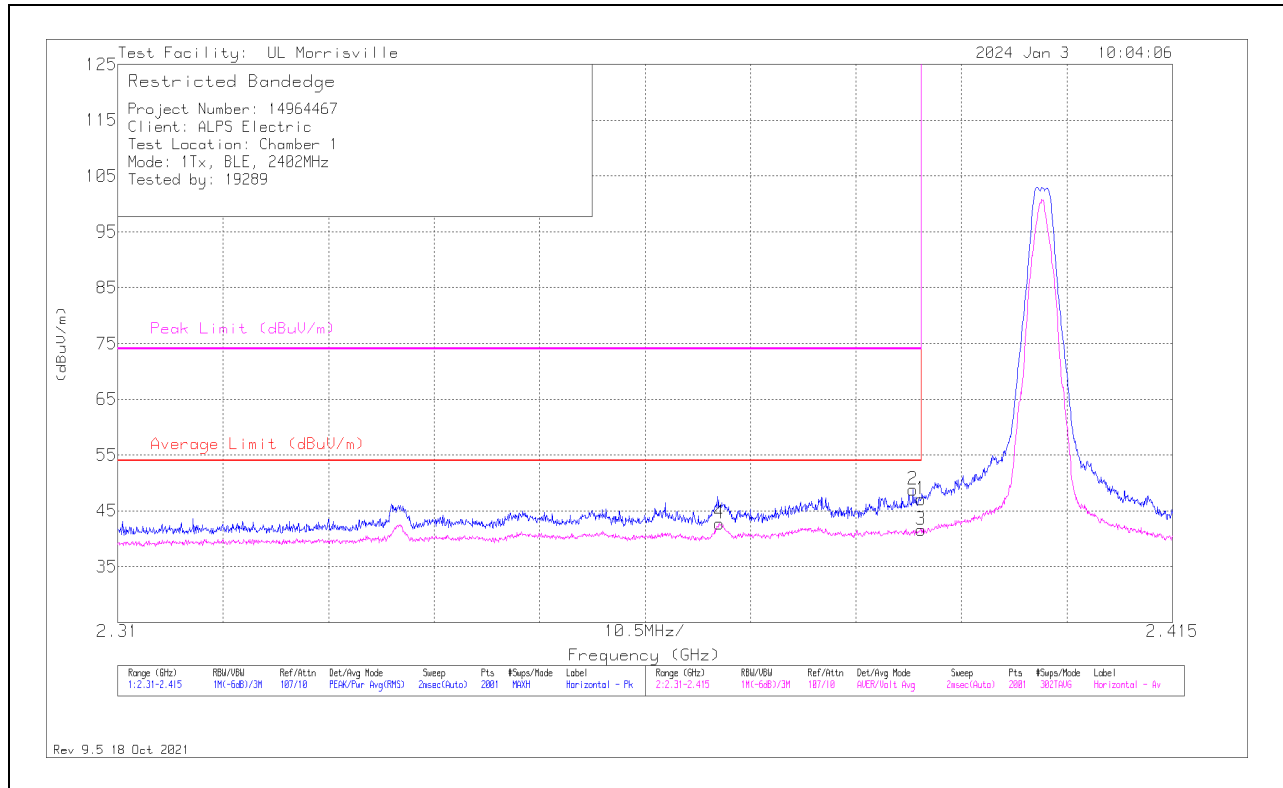
PK2 - Maximum Peak

ADV - Linear Voltage Average

10.2.2. BLE (2Mbps)

BANDEDGE (LOW CHANNEL)

HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	206211 (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	39.17	Pk	32.1	-24.2	0	47.07	-	-	74	-26.93	295	163	H
2	*** 2.38917	40.89	Pk	32.1	-24.2	0	48.79	-	-	74	-25.21	295	163	H
3	*** 2.38996	24.1	ADV	32.1	-24.2	9.63	41.63	54	-12.37	-	-	295	163	H
4	*** 2.3699	25.25	ADV	32	-24.1	9.63	42.78	54	-11.22	-	-	295	163	H

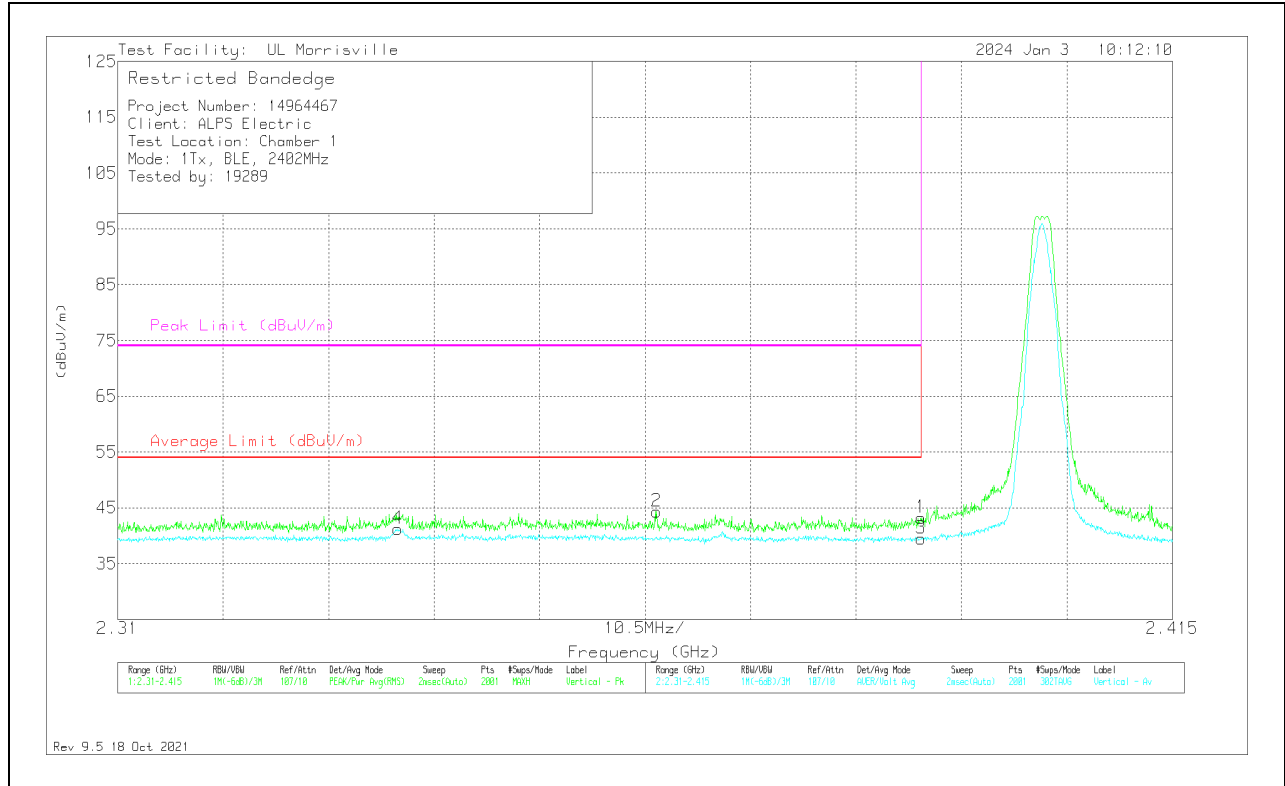
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

ADV - Linear Voltage Average

VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	206211 (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	35.37	Pk	32.1	-24.2	0	43.27	-	-	74	-30.73	128	199	V
2	* ** 2.36366	36.43	Pk	32	-24.1	0	44.33	-	-	74	-29.67	128	199	V
3	* ** 2.38996	21.93	ADV	32.1	-24.2	9.63	39.46	54	-14.54	-	-	128	199	V
4	* ** 2.33788	23.74	ADV	32	-24.1	9.63	41.27	54	-12.73	-	-	128	199	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

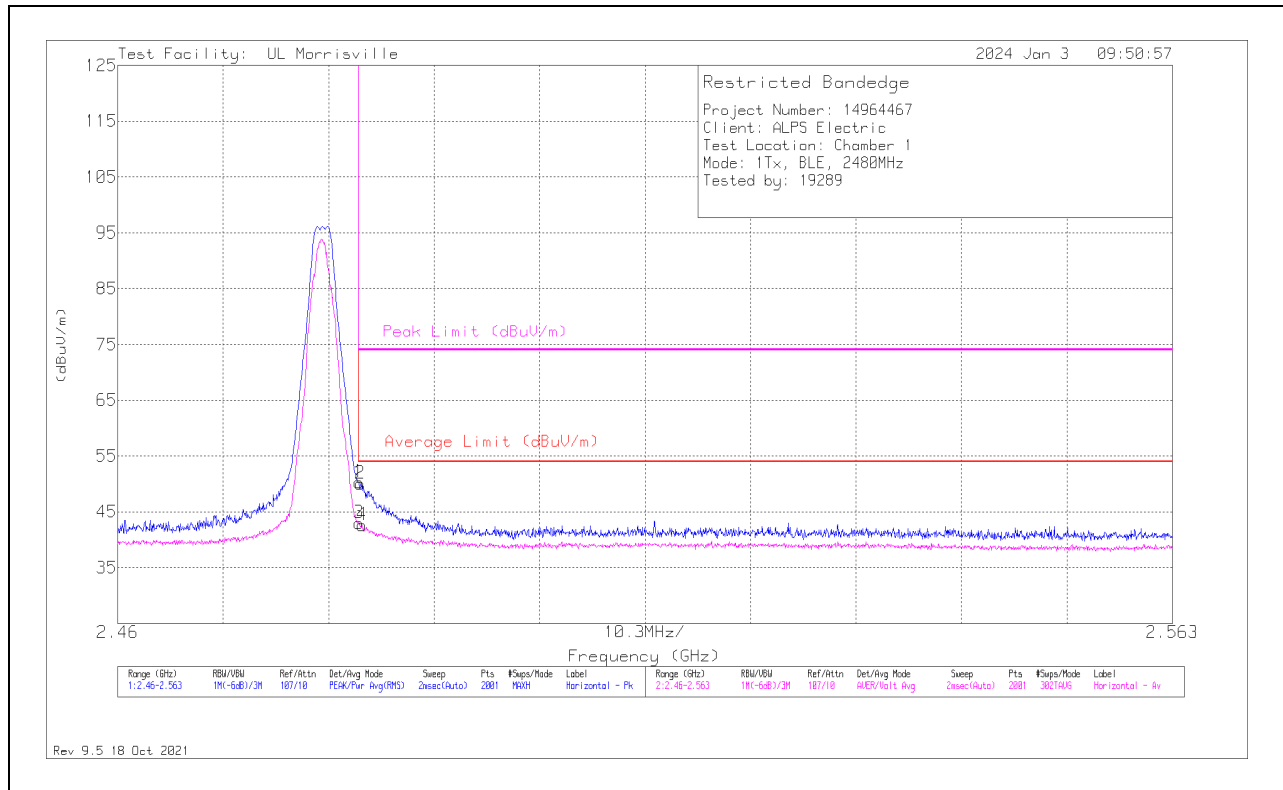
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

ADV - Linear Voltage Average

BANDEDGE (HIGH CHANNEL)

HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	206211 (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	42.46	Pk	32.3	-24.5	0	50.26	-	-	74	-23.74	39	206	H
2	* ** 2.48369	42.21	Pk	32.3	-24.5	0	50.01	-	-	74	-23.99	39	206	H
3	* ** 2.48354	25.56	ADV	32.3	-24.5	9.63	42.99	54	-11.01	-	-	39	206	H
4	* ** 2.48384	25.15	ADV	32.3	-24.5	9.63	42.58	54	-11.42	-	-	39	206	H

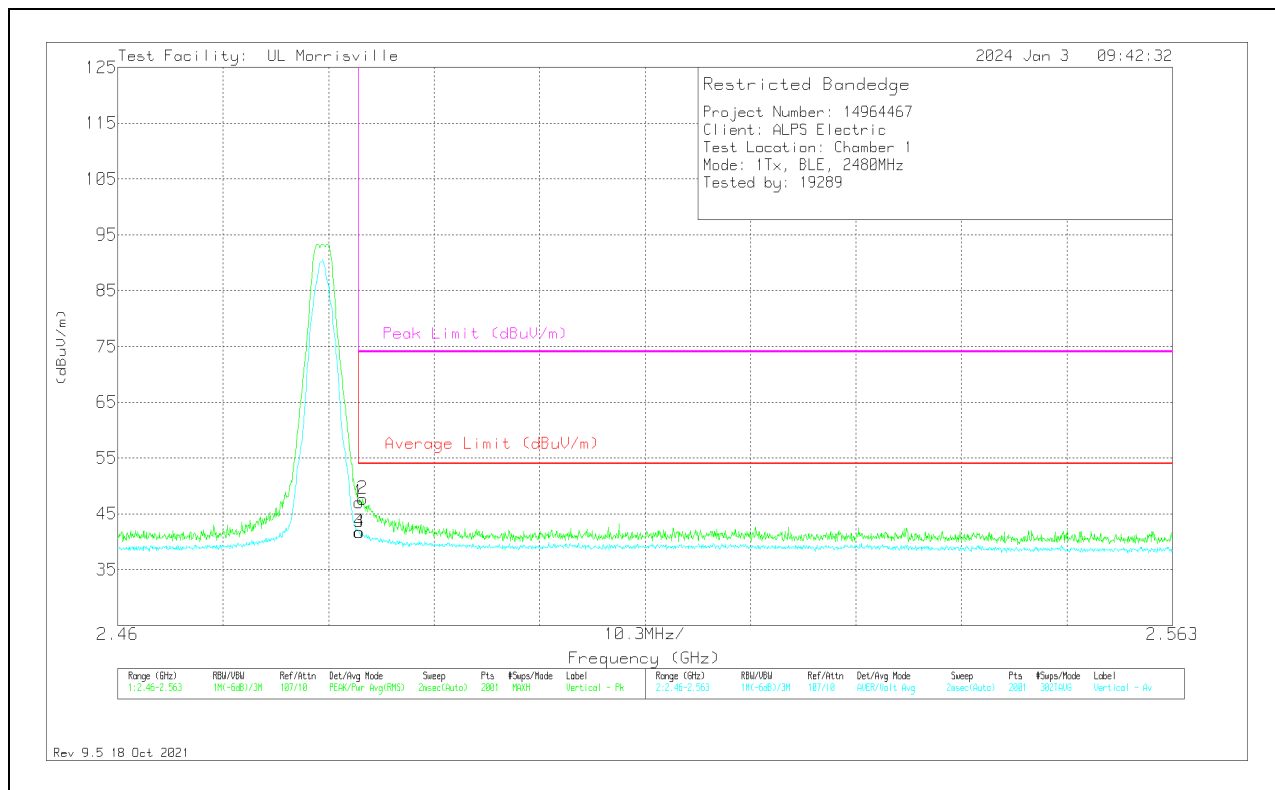
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

ADV - Linear Voltage Average

VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	206211 (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	39.32	Pk	32.3	-24.5	0	47.12	-	-	74	-26.88	131	239	V
2	* ** 2.4839	39.94	Pk	32.3	-24.5	0	47.74	-	-	74	-26.26	131	239	V
3	* ** 2.48354	24.35	ADV	32.3	-24.5	9.63	41.78	54	-12.22	-	-	131	239	V
4	* ** 2.48364	24.28	ADV	32.3	-24.5	9.63	41.71	54	-12.29	-	-	131	239	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

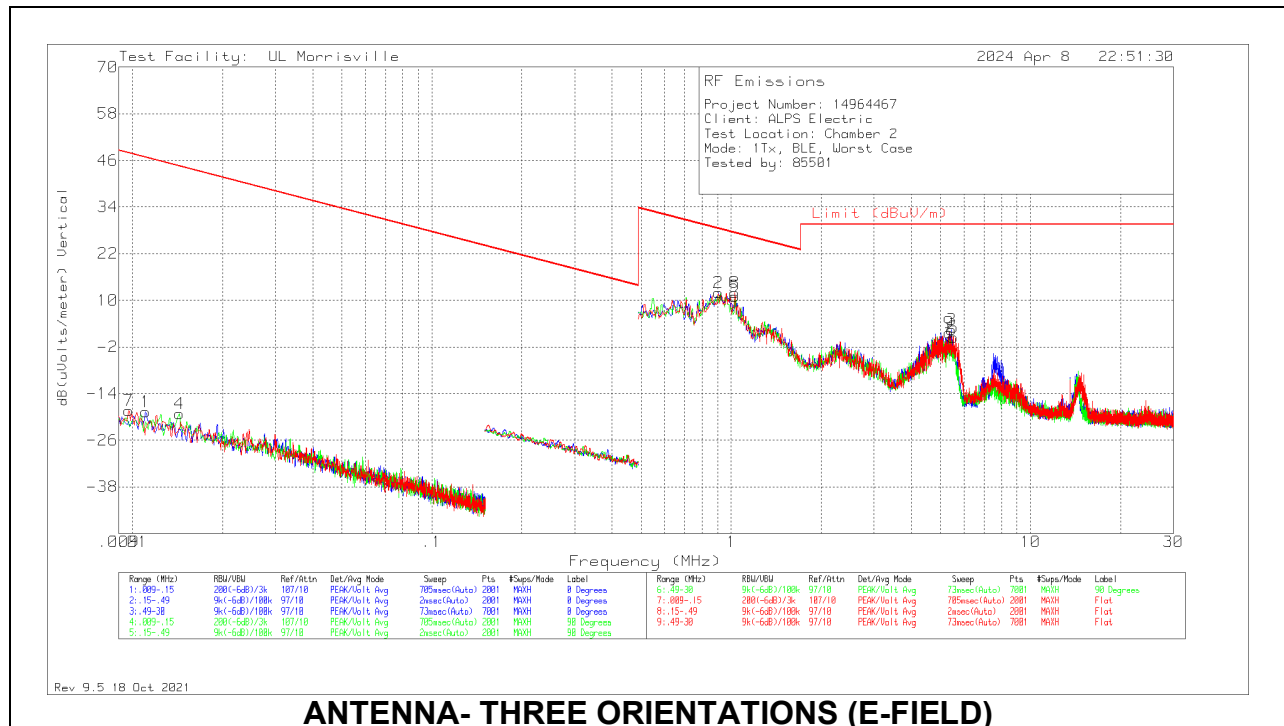
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

ADV - Linear Voltage Average

10.3. WORST CASE SPURIOUS BELOW 30MHZ

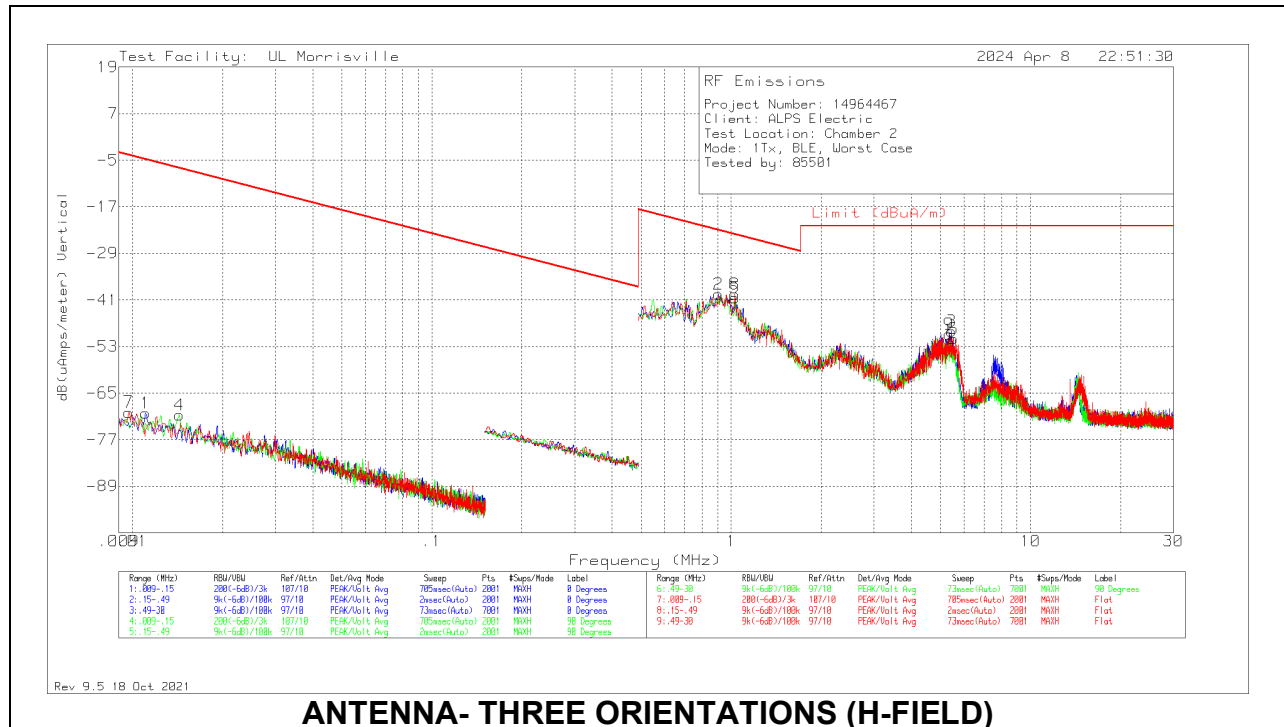
Note: All measurements were made at a test distance of 3 m. The measured data was extrapolated from the test distance (3m) to the specification distance (300 m from 9-490 kHz and 30 m from 490 kHz – 30 MHz) to clearly show the relative levels of fundamental and spurious emissions and demonstrate compliance with the requirement that the level of any spurious emissions be below the level of the intentionally transmitted signal. The extrapolation factor for the limits were $40 \cdot \log(\text{test distance} / \text{specification distance})$.



ANTENNA- THREE ORIENTATIONS (E-FIELD)

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	135144 (dBuV/m)	Gain/Loss (dB)	Dist. Corr. Factor (dB)	Corrected Reading dB(uVolts/meter)	QP/AV Limit (dBuV/m)	PK Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Loop Angle
7	.00971	42.86	Pk	18.6	.1	-80	-18.44	47.86	67.86	-66.3	0-360	Flat
1	.01106	43.26	Pk	18	.1	-80	-18.64	46.73	66.73	-65.37	0-360	0 degs
4	.01433	44.21	Pk	16.5	.1	-80	-19.19	44.48	64.48	-63.67	0-360	90 degs
2	.90738	40.63	Pk	11.1	.2	-40	11.93	28.45	-	-16.52	0-360	0 degs
5	1.02965	39.42	Pk	11.4	.2	-40	11.02	27.35	-	-16.33	0-360	90 degs
8	1.02965	40.37	Pk	11.4	.2	-40	11.97	27.35	-	-15.38	0-360	Flat
9	5.34683	29.95	Pk	11.3	.4	-40	1.65	29.54	-	-27.89	0-360	Flat
3	5.4438	30.73	Pk	11.3	.4	-40	2.43	29.54	-	-27.11	0-360	0 degs
6	5.51126	28.81	Pk	11.3	.4	-40	.51	29.54	-	-29.03	0-360	90 degs

Pk - Peak detector

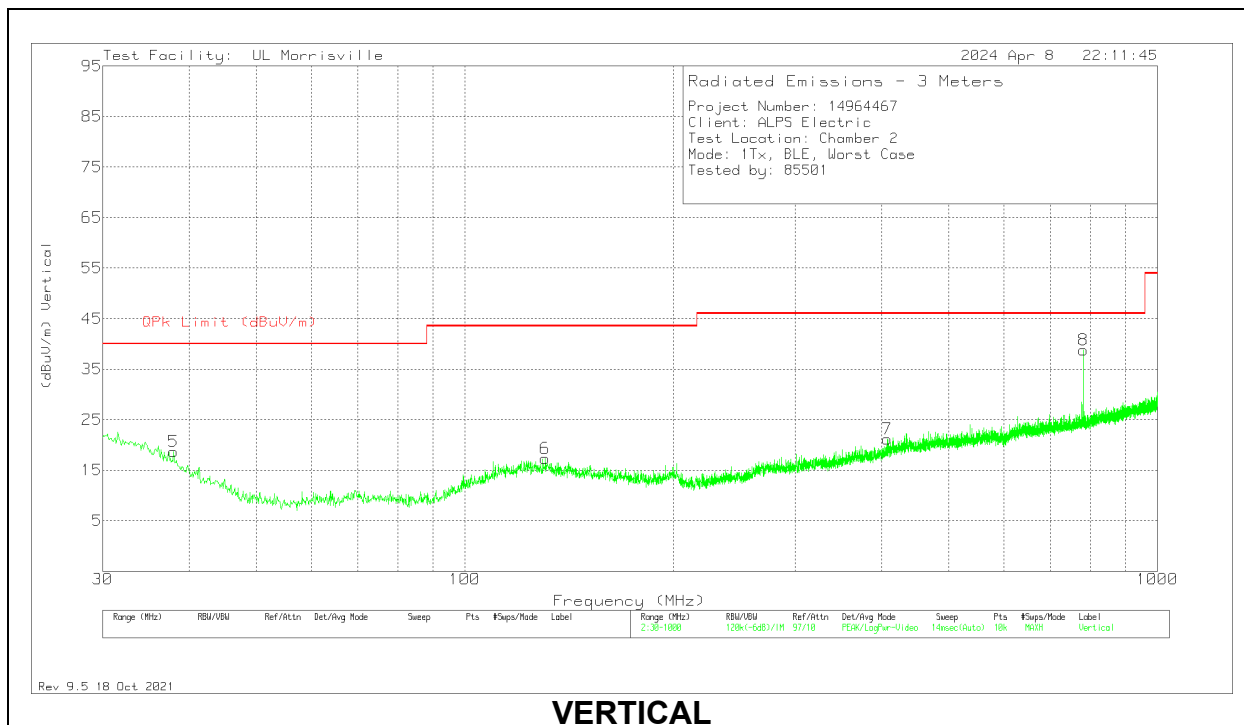
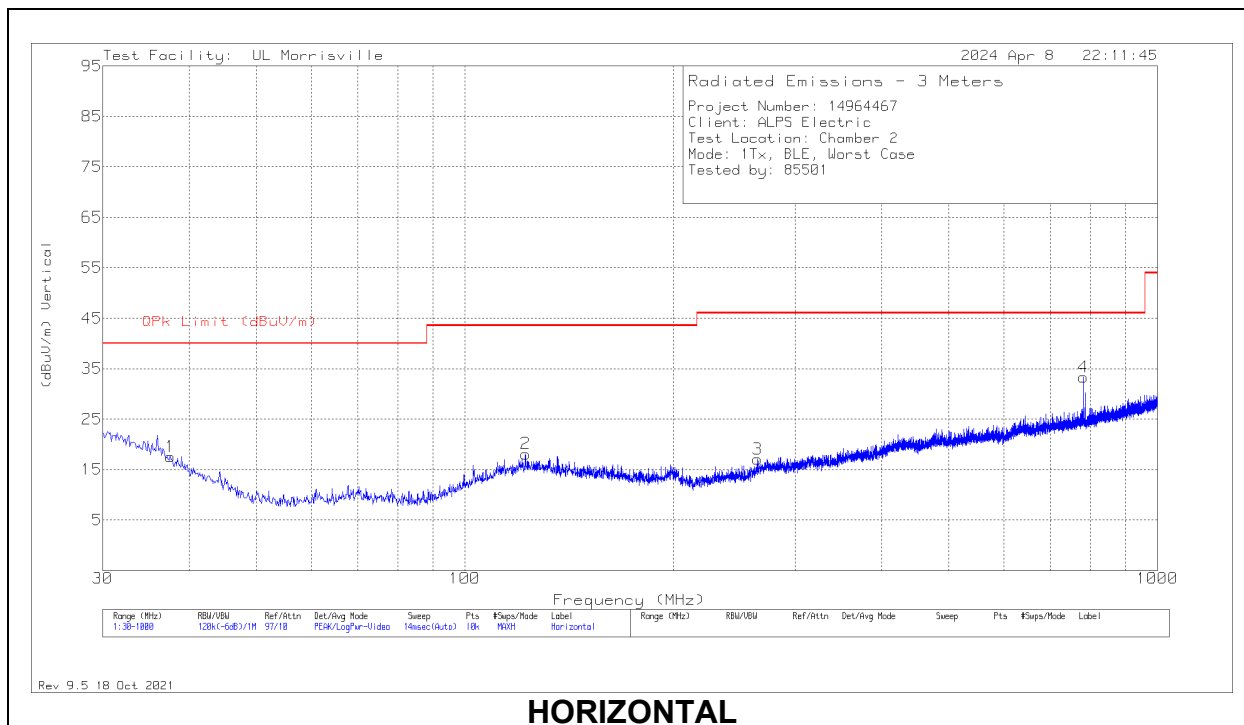


ANTENNA- THREE ORIENTATIONS (H-FIELD)

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	135144 (dBuV/m)	Gain/Loss (dB)	Dist. Corr. Factor (dB)	Corrected Reading dB(uAmps/meter)	QP/AV Limit (dBuA/m)	PK Limit (dBuA/m)	Margin (dB)	Azimuth (Degs)	Loop Angle
7	.00971	42.86	Pk	-32.9	.1	-80	-69.94	-3.64	16.36	-66.3	0-360	Flat
1	.01106	43.26	Pk	-33.5	.1	-80	-70.14	-4.77	15.23	-65.37	0-360	0 degs
4	.01433	44.21	Pk	-35	.1	-80	-70.69	-7.02	12.98	-63.67	0-360	90 degs
2	.90738	40.63	Pk	-40.4	.2	-40	-39.57	-23.05	-	-16.52	0-360	0 degs
5	1.02965	39.42	Pk	-40.1	.2	-40	-40.48	-24.15	-	-16.33	0-360	90 degs
8	1.02965	40.37	Pk	-40.1	.2	-40	-39.53	-24.15	-	-15.38	0-360	Flat
9	5.34683	29.95	Pk	-40.2	.4	-40	-49.85	-21.96	-	-27.89	0-360	Flat
3	5.4438	30.73	Pk	-40.2	.4	-40	-49.07	-21.96	-	-27.11	0-360	0 degs
6	5.51126	28.81	Pk	-40.2	.4	-40	-50.99	-21.96	-	-29.03	0-360	90 degs

Pk - Peak detector

10.4. WORST CASE SPURIOUS BELOW 1 GHZ



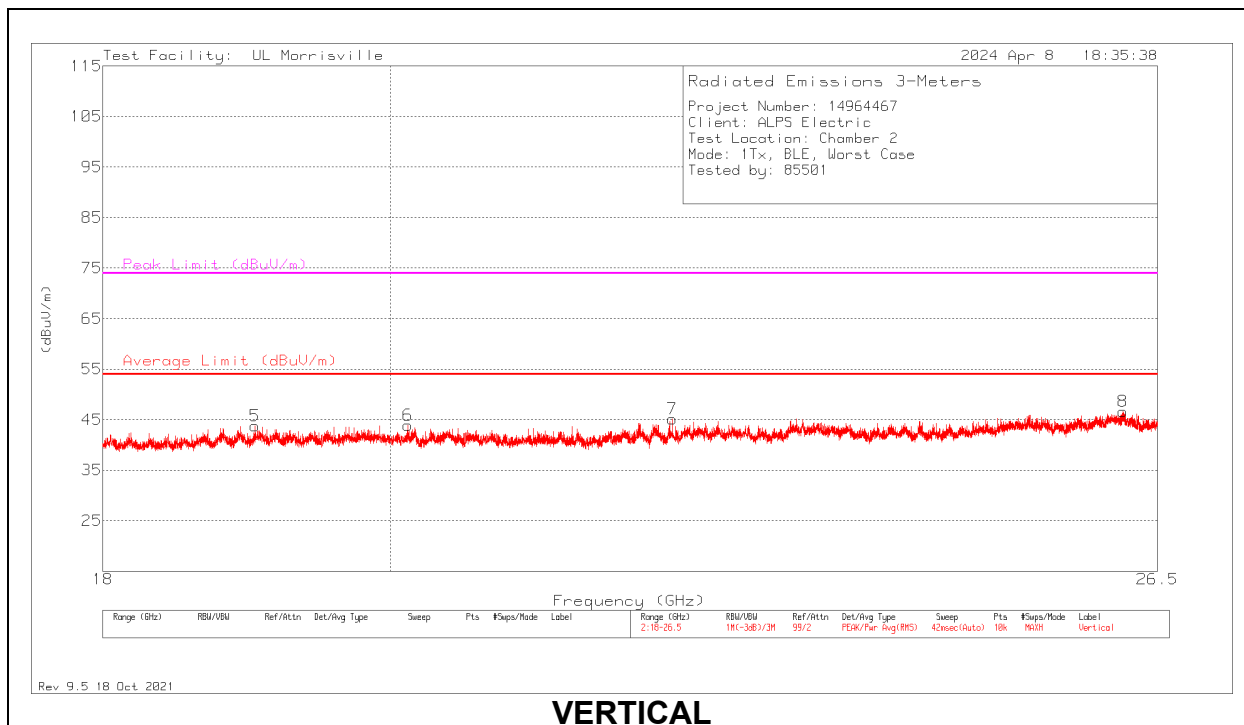
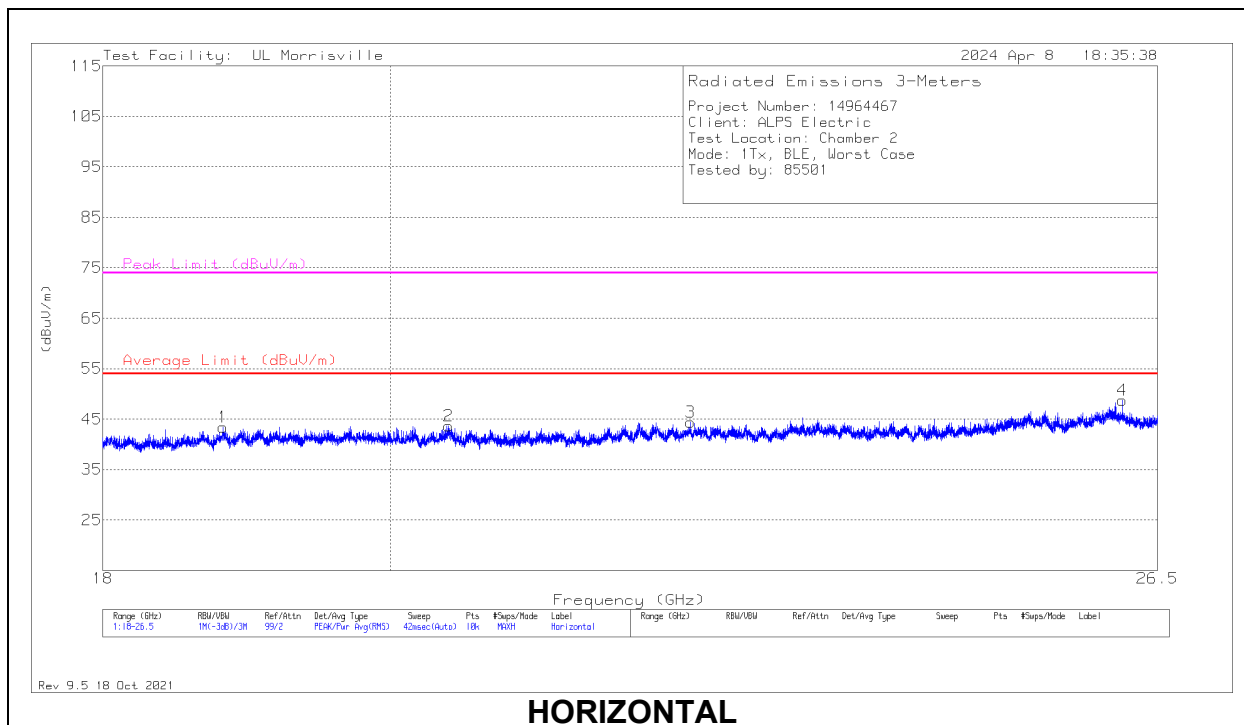
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	159203 (dB/m)	Gain/Loss (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 37.566	27.21	Pk	22.1	-31.7	17.61	40	-22.39	0-360	100	H
2	* ** 122.344	28.72	Pk	20.2	-30.8	18.12	43.52	-25.4	0-360	299	H
3	* ** 264.643	27.23	Pk	19.4	-29.6	17.03	46.02	-28.99	0-360	100	H
4	** 781.265	32.88	Pk	27.8	-27.3	33.38	46.02	-12.64	0-360	299	H
5	* ** 37.954	28.62	Pk	21.8	-31.7	18.72	40	-21.28	0-360	299	V
6	* ** 130.686	27.93	Pk	20.2	-30.8	17.33	43.52	-26.19	0-360	101	V
7	* ** 407.136	27.65	Pk	22.4	-28.9	21.15	46.02	-24.87	0-360	101	V
8	** 781.653	38.29	Pk	27.8	-27.3	38.79	46.02	-7.23	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

10.5. WORST CASE SPURIOUS 18-26 GHZ



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	204704 (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	* ** 18.81337	48.24	Pk	33.4	-38.2	43.44	54	-10.56	74	-30.56	0-360	250	H
2	* ** 20.43331	47.73	Pk	33.6	-37.7	43.63	54	-10.37	74	-30.37	0-360	149	H
3	* ** 22.32947	48.17	Pk	34.2	-38	44.37	54	-9.63	74	-29.63	0-360	250	H
5	* ** 19.0352	48.67	Pk	33.6	-38.5	43.77	54	-10.23	74	-30.23	0-360	250	V
6	* ** 20.12904	47.64	Pk	33.5	-37.3	43.84	54	-10.16	74	-30.16	0-360	250	V
7	* ** 22.18073	48.43	Pk	34.3	-37.6	45.13	54	-8.87	74	-28.87	0-360	300	V
4	26.16173	49.42	Pk	35.3	-36	48.72	-	-	74	-25.28	0-360	101	H
8	26.16853	47.24	Pk	35.3	-35.9	46.64	-	-	74	-27.36	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

11. SETUP PHOTOS

Please refer to R14964467-EP2 for setup photos

END OF TEST REPORT