Test Report

Prepared for: Sierzega Elektronik GmbH

Model: GRM-V22

Serial Number: 35082, 35226

Project No: p2440003

Test Results: Pass

To

FCC Part 15.245: 2024
and
RSS-210: Issue 10 (December 2019)

Date of Issue: August 1, 2024

On the behalf of the applicant:

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Attention of:

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Prepared By:

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ANAB Cert#: AT-2901
FCC Site Reg. #US2901
ISED Site Reg. #2044A-2

Reviewed / Authorized By:

Jeremiah Darden, Principal Engineer

Test Results Summary

Test Date Range: May 29 - Jun 25, 2024

Specification		Test Name	Pass, Fail, N/A	Comments
FCC	**RSS**			
15.245(b)	Annex F	Field Strength of Fundamental	Pass	
15.245(b)(1), 15.245(b)(1)(i), 15.245(b)(1)(ii), 15.245(b)(3), 15.209(a), 15.205	Annex F, Section 7.1, 7.2, 7.3 / RSS-GEN 8.9 and 8.10	General Field Strength Emissions, Spurious Harmonic Emission, Restricted Bands	Pass	
-	Section 5 / RSS-Gen 6.7	99% Occupied Bandwidth	Complete	
15.207	RSS-GEN Section 8.8	A/C Powerline Conducted Emissions	Pass	
Method Deviations/Additions: No				

Statements of conformity are reported as:

- Pass - the measured value is below the acceptance limit, *acceptance limit = test limit*.
- Fail - the measured value is above the acceptance limit, *acceptance limit = test limit*.

References/Methods	Description
ANSI C63.4-2014	Method and Measurements of Radio-Noise Emissions from low-Voltage Electrical and Electronic Equipment in the range 9kHz to 40GHz.
ANSI C63.10:2020	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
RSS-GEN Issue 5: 2018	General Requirements for Compliance of Radio Apparatus
ISO/IEC 17025:2017	General requirements for the Competence of Testing and Calibrations Laboratories

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Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	June 28, 2024	Jeremiah Darden	Original Document
2.0	August 1, 2024	Jeremiah Darden	Added IC numbers to EUT description

Current revision of the test report replaces any prior versions. Only the current version of the test report is valid.

EUT Description

Model:	**GRM-V22**
Serial:	**35082, 35226**
Firmware:	**V9.6**
Software:	**N/A**
Description:	**Module for monitoring Vehicle Traffic Speed on Roadways**
Additional Information:	**EUT operates at 12VDC.** **Radar 24GHz (24.075GHz-24.175GHz)** **FCC ID: S6P-GRM-V22** **IC: 5792A-GRMV22** **Contains FCC and IC ID's:** **BLE: QOQ-GM220P / 5123A-GM220P** **Cellular: XMR201910BG95M3 / 10224A-2019BG95M3** **Usage: Mounted near roads and streets**
Receipt of Sample(s):	**May 16, 2024** **June 13, 2024**
EUT Condition:	**Visual Damage** No **State of Development** Production/Production Equivalent

The applicant has been cautioned as to the following

15.21 - Information to User

The user's manual or instruction manual for an intentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

15.27(a) - Special Accessories

Equipment marked to a consumer must be capable of complying with the necessary regulations in the configuration in which the equipment is marketed. Where special accessories, such as shielded cables and/or special connectors are required to enable an unintentional or intentional radiator to comply with the emission limits in this part, the equipment must be marketed with, i.e. shipped and sold with, those special accessories. However, in lieu of shipping or packaging the special accessories with the unintentional or intentional radiator, the responsible party may employ other methods of ensuring that the special accessories are provided to the consumer without an additional charge.

Information detailing any alternative method used to supply the special accessories for a grant of equipment authorization or retained in the verification records, as appropriate. The party responsible for the equipment, as detailed in § 2.909 of this chapter, shall ensure that these special accessories are provided with the equipment. The instruction manual for such devices shall include appropriate instructions on the first page of text concerned with the installation of the device that these special accessories must be used with the device. It is the responsibility of the user to use the needed special accessories supplied with the equipment.

Authorization Requirements

Intentional Radios may require authorization covered under the following rule parts or standards:

-47 CFR Part 2 Subpart J

-RSS-Gen — General Requirements for Compliance of Radio Apparatus

Note: These notices are specific to the methods and standards related to the testing within this report. Customers should also consider and review additional legal regulations for import/export documentation and labeling for the countries and geographies under consideration by the manufacturer.

Test and Measurement Data

Subpart 2.1033(b)

All tests and measurement data shown were performed in accordance with FCC Rule Parts: 15.245.

All tests and measurement data shown are deemed satisfactory evidence of compliance with Industry Canada Radio Standards Specification RSS-Gen and RSS-210.

Standard Engineering Practices

Unless otherwise indicated, the procedures contained in ANSI C63.10 and ANSI C63.4 were observed during testing.

Prior to testing, the EUT was tuned up in accordance with the manufacturer's alignment procedures. All external gain controls were maintained at the position of maximum and/or optimum gain throughout the testing. Measurement results, unless otherwise noted, are worst case measurement.

Standard Test Conditions and Engineering Practices

Unless otherwise indicated in the specific measurement results, the ambient temperature was maintained within the range of 10º to 40ºC (50º to 104ºF) and the relative humidity levels were in the range of 10% to 90%.

Environmental Conditions		
Temperature (ºC)	**Humidity (%)**	**Barometric Pressure (mbar)**
25.67 – 25.89	24.2 – 44.0	966.0 – 969.3

Test Setup and Modes of Operation

EUT Operation during Tests
EUT was connected to power and operated with the installed firmware for typical operation. 24GHz radio is operated at it's highest duty cycle. EUT was powered by a 12VDC. Two EUTs were used for testing. S/N 35082 and S/N 35226 are identical except for FW operation that enables or disables the separate BLE and Cellular modules co-locate. Where applicable the 24GHz, BLE and cellular were all transmitting simultaneously to address co-location, host integration and single modular approval operation.

EUT:

Qty	Description	Manufacturer	Model	S/N
1	Traffic Radar Module	Sierzega	GRM_V22	35082
1	Traffic Radar Module	Sierzega	GRM_V22	35226

Accessories:

Qty	Description	Manufacturer	Model	S/N
1	Linear AC to 12VDC adapter	TamuraGroup	835AS12100	None

Cables:

Qty	Description	Length (M)	Ferrites (Y/N)	Shielding Y/N	Shielded Hood Y/N	Termination / Connection
1	Power Cable	1.8	N	N	N	EUT to 12VDC

Software/Firmware:

Name	Description	Version	Installation Info
GRM	System firmware	9.6	Installed on EUT

Modifications to EUT(s) (Y/N): N

15.203: Antenna Requirement:

X	The antenna is permanently attached to the EUT
	The antenna uses a unique coupling
	The EUT must be professionally installed
	The antenna requirement does not apply

Antenna type stated by the manufacturer: **The radar uses two identically designed antennas for Rx and TX. Each 4x4 patch, 17.1dBi**

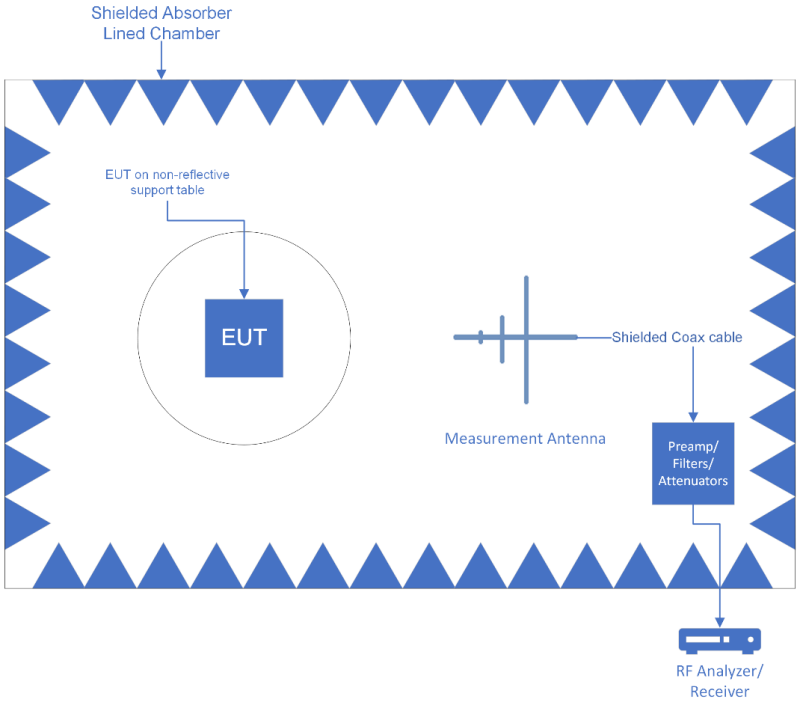
Field Strength of Fundamental

Engineer: Jeremiah Darden
Test Date: June 25, 2024

Test Procedure

RADIATED METHOD
The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was set to transmit on the lowest, middle and highest frequency of operation at the maximum power level. The EUT was tested, in 3 orthogonal axis, by rotating it 360° with the receive antenna in both the vertical and horizontal orientation while raised from 1 to 4 meters to ensure the TX signal levels were maximized. A spectrum analyzer was used to verify that the EUT met the requirements for Output Power.

Test Setup



The Spectrum Analyzer was set to the following for individual measurements:

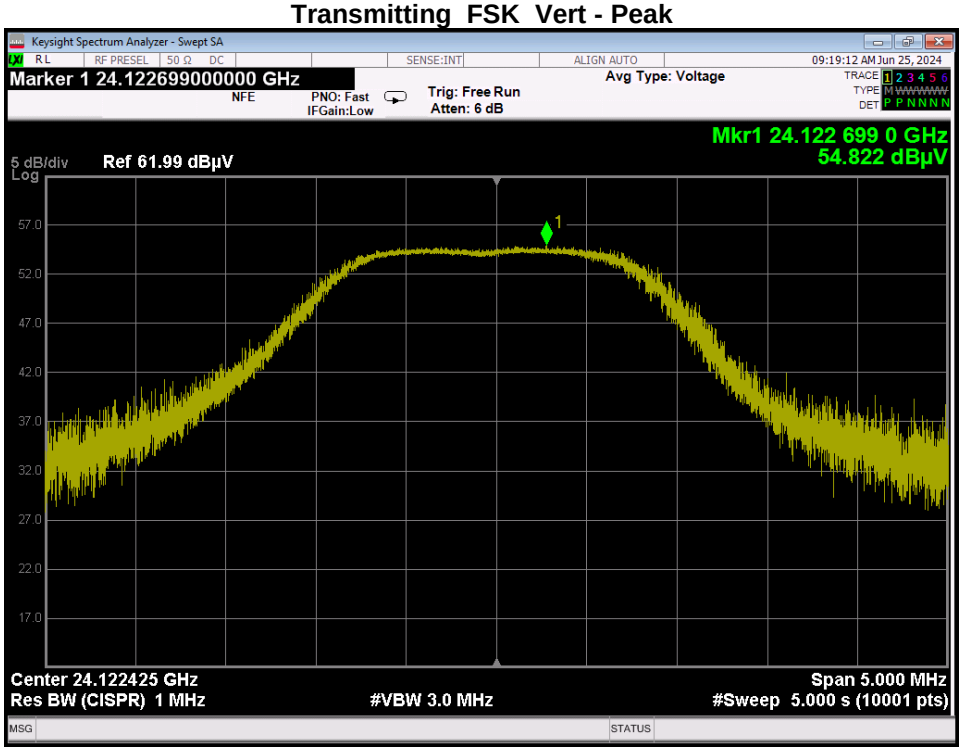
RBW ≥ 1MHz
VBW ≥ 3 x RBW
Span ≥ OBW
Sweep time > 2 × (Signal Period) × (Span) / (RBW)
Detector = peak
Trace Mode = max hold

Field Strength of Fundamental Summary Table (worse case axis and polarity)

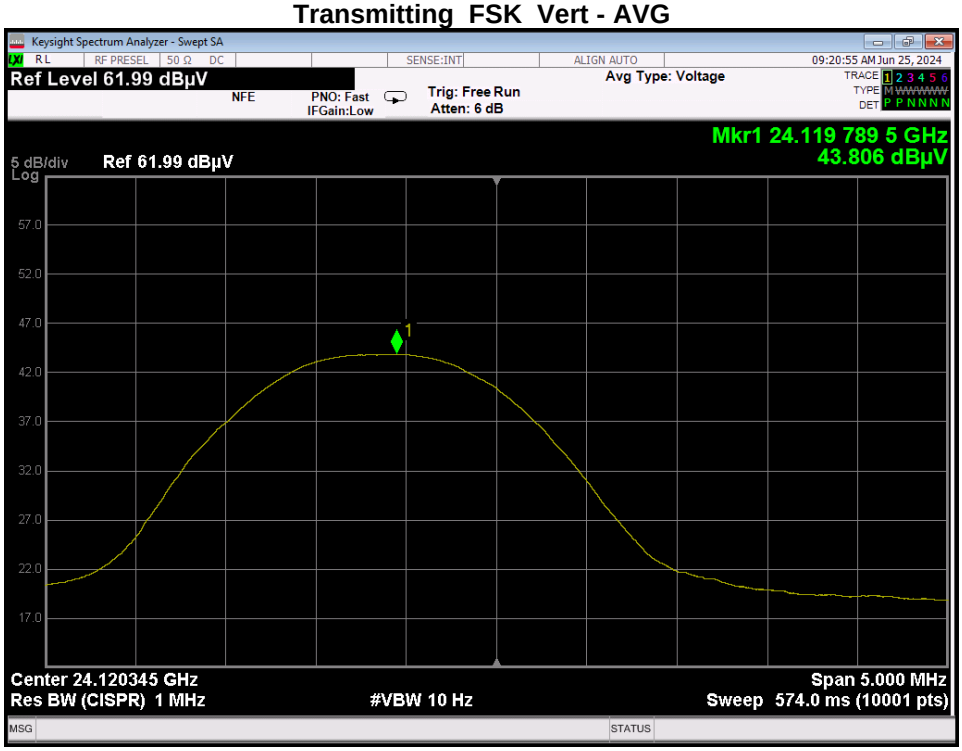
Tuned Frequency (GHz)	Mode of Operation	Measured (dBuV)	Factor (dB)	Final Value (dBuV/m)	Specification Limit (dBuV/m)	Result
24.123	Transmitting FSK - PK	54.822	63.58	118.4	147.95	Pass
24.119	Transmitting FSK - Avg	43.806	63.58	107.4	127.95	Pass

Field Strength of Fundamental Plots

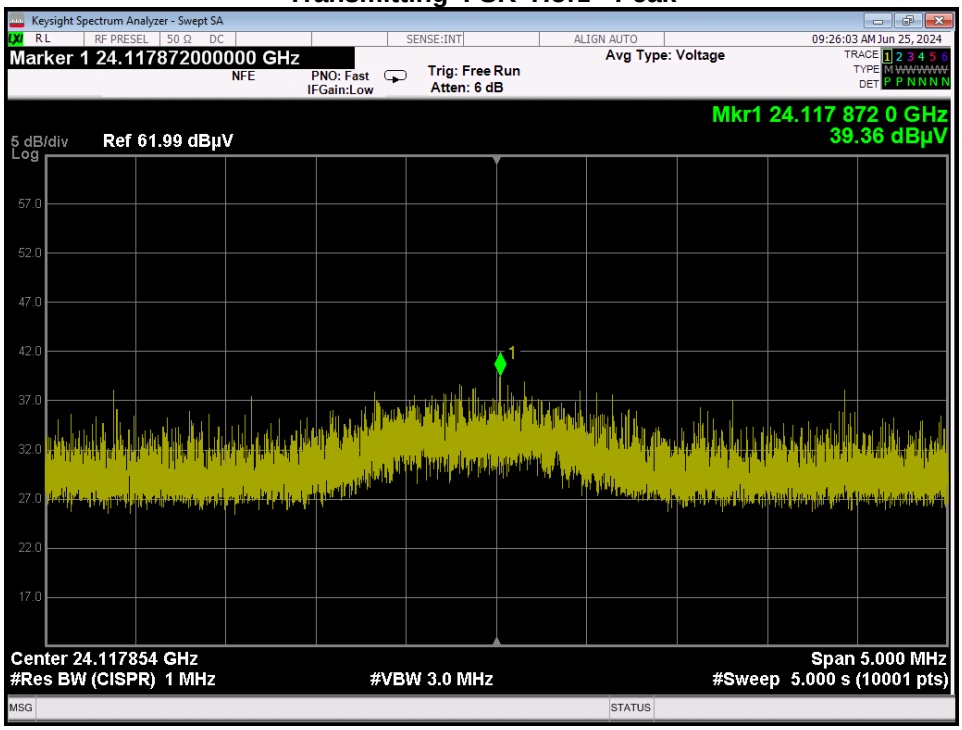
Transmitting FSK Vert - Peak



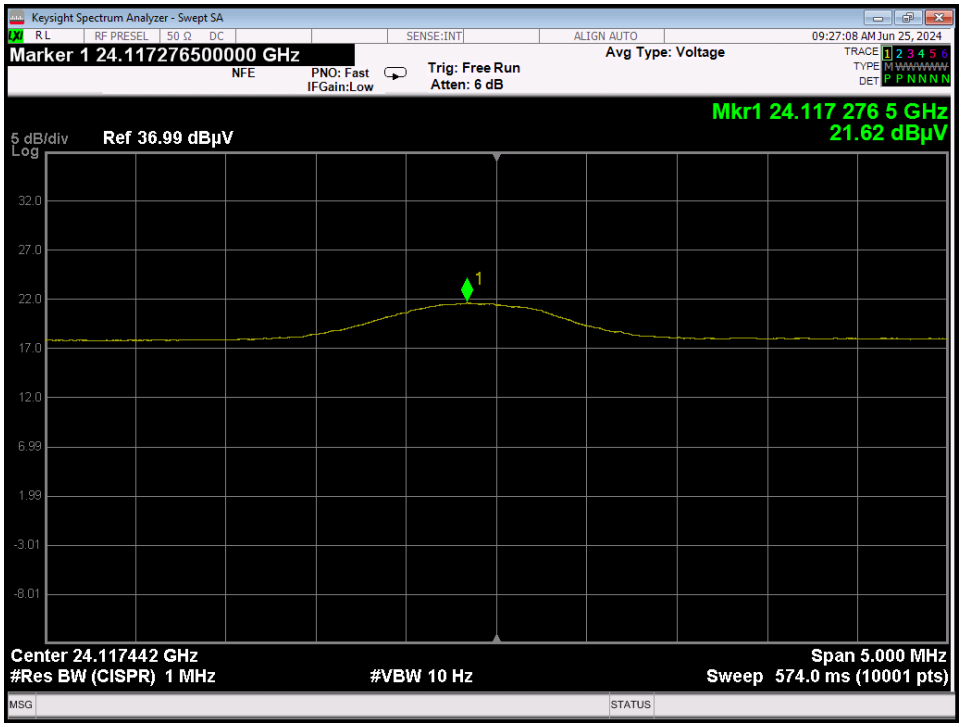
Transmitting FSK Vert - AVG



Transmitting FSK Horz - Peak



Transmitting FSK Horz - Avg



General Field Strength Emissions / Spurious Harmonic Emissions / Restricted Bands

Engineer: Jeremiah Darden

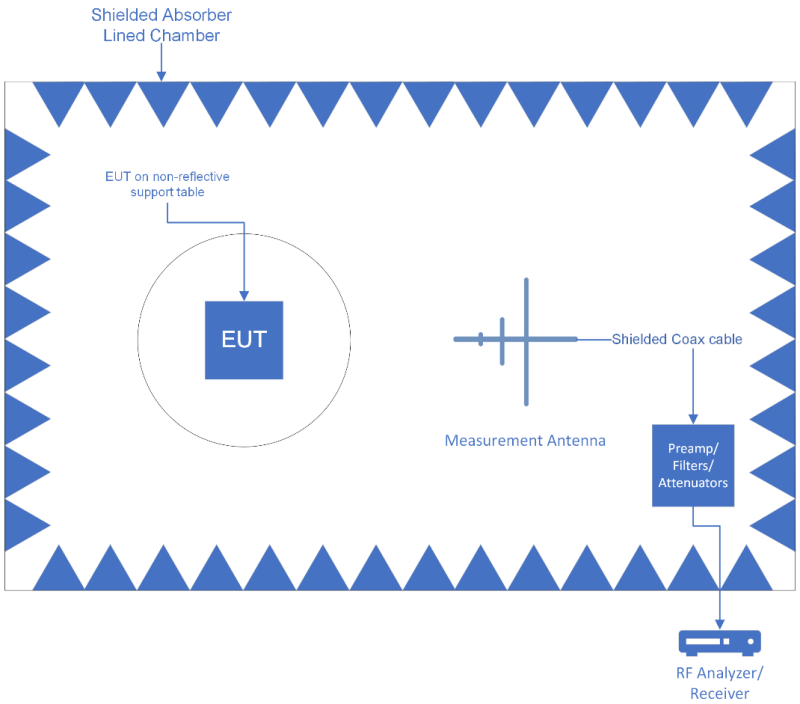
Test Date: May 30 – June 25, 2024

Test Procedure
Radiated Spurious Emissions: 9kHz – 1000 MHz and Above 1GHz

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was set to transmit on the lowest, middle and highest frequency of operation at the maximum power level into its permanently attached antenna. The EUT was tested, in 3 orthogonal axis, by rotating it 360° with the receive antenna in both the vertical and horizontal orientation while raised from 1 to 4 meters to ensure the TX signal levels were maximized. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Spurious Emissions. All emissions across the required range were evaluated.

Note: Data collected for both FCC 15.245 for Single Modular Approval for 24GHz module while being co-located and host integrated with existing certified BLE Module and Cellular Module for FCC 15.209, 15.205)

Basic Test Setup



	Settings Below 1GHz	Settings Above 1GHz
RBW	120 kHz	1 MHz
VBW	300 kHz	3 MHz
Detector	Quasi Peak	Peak / Average

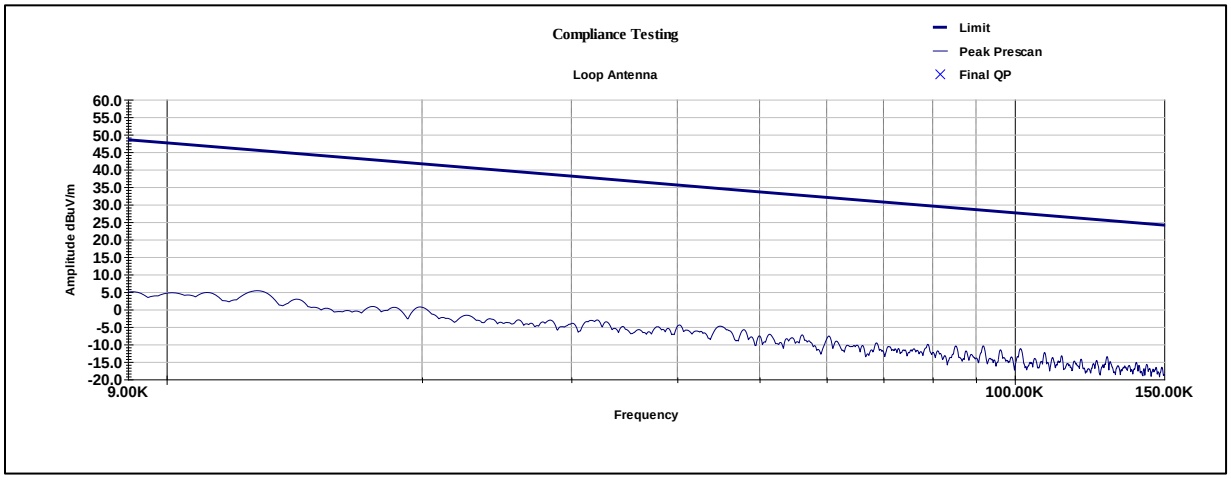
Sample Calculations
Corrected Value = Measured Value + Correction factor
Correction factor = Antenna Correction Factor + Cable loss + Preamp/Attenuator Factor

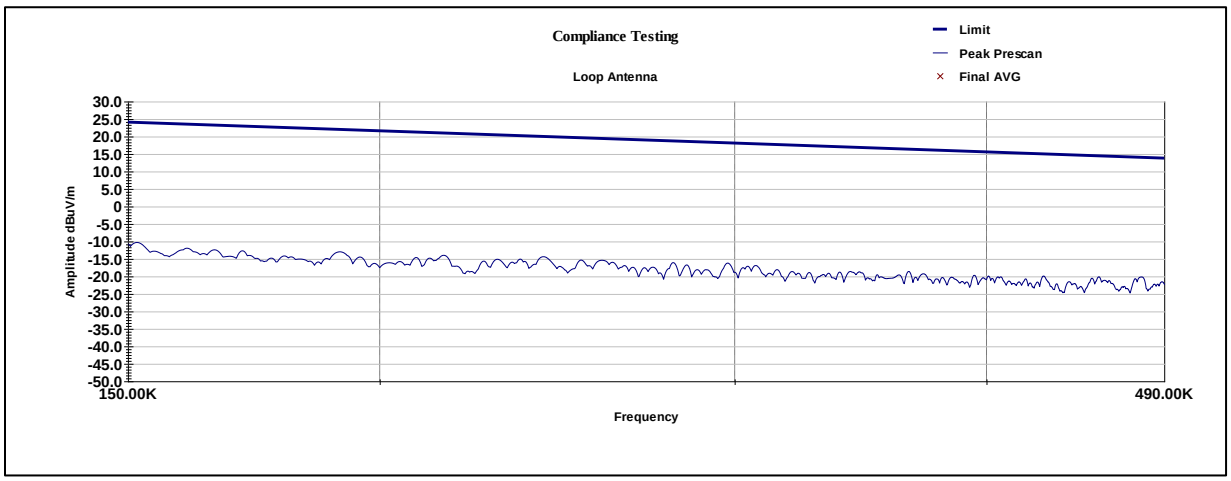
The Spectrum Analyzer was set to the following for individual measurements:
RBW ≥ 1MHz
VBW ≥ 3 x RBW
Span ≥ OBW BW
Sweep time > 2 × (Signal Period) × (Span) / (RBW)
Detector = peak
Trace Mode = max hold

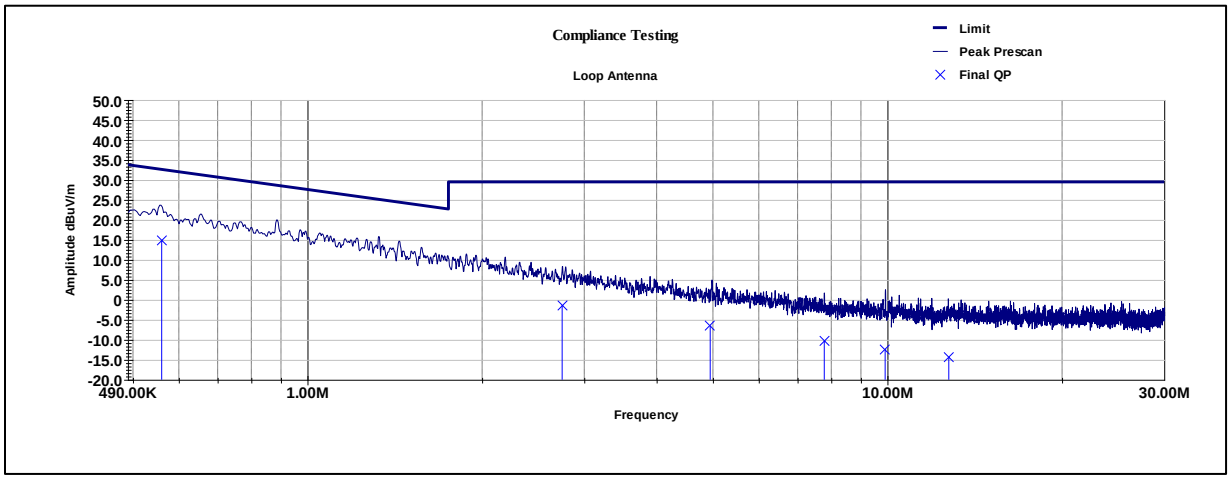
Radiated Spurious Emissions 9kHz-30MHz

Transmitting 24GHz, Cellular LTE 1.8GHz, BLE 2.4GHz

No Emissions to measure within scanned frequency range of 9kHz-490kHz



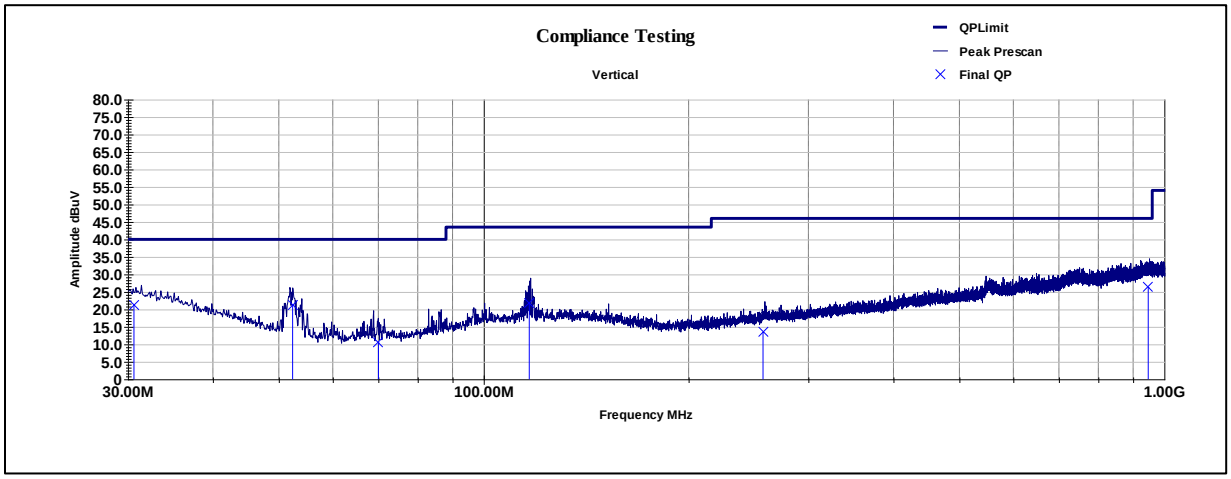




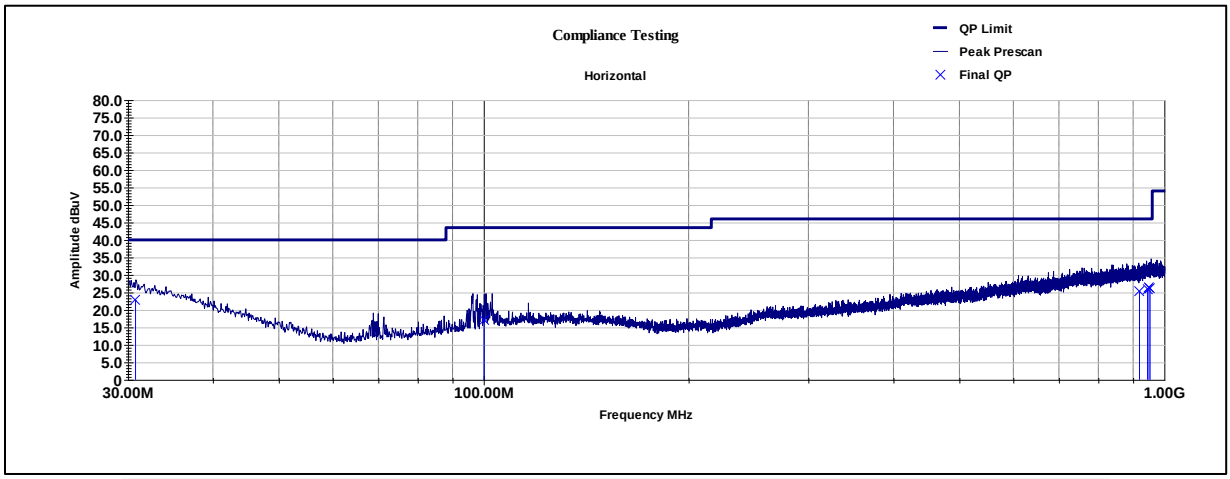
Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
0.56	67.00	197.00	37.42	-22.63	14.80	32.60	-17.80
2.748	242.00	197.00	21.25	-22.59	-1.30	29.50	-30.80
4.948	317.00	197.00	16.01	-22.51	-6.50	29.50	-36.00
7.779	197.00	143.00	11.94	-22.27	-10.30	29.50	-39.80
9.909	271.00	135.00	9.78	-22.21	-12.40	29.50	-41.90
12.758	146.00	243.00	7.67	-22.04	-14.40	29.50	-43.90
Final = Raw + Path Loss							
Margin = Final - Limit							

Radiated Spurious Emissions 30-1000MHz

Transmitting 24GHz, Cellular LTE 1.8GHz, BLE 2.4GHz



Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
30.621	173.00	393.00	38.40	-17.07	21.30	40.00	-18.70
52.38	41.00	100.00	49.32	-28.00	21.30	40.00	-18.70
70.028	228.00	167.00	38.67	-28.19	10.50	40.00	-29.50
116.646	205.00	105.00	44.52	-22.65	21.90	43.50	-21.60
257.208	30.00	351.00	34.61	-21.06	13.60	46.00	-32.40
946.91	253.00	389.00	33.46	-7.08	26.40	46.00	-19.60
Final = Raw + Path Loss							
Margin = Final - Limit							



Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
30.787	308.00	400.00	38.46	-15.63	22.80	40.00	-17.20
100.098	119.00	246.00	41.77	-24.53	17.20	43.50	-26.30
919.579	145.00	343.00	33.43	-8.14	25.30	46.00	-20.70
945.012	142.00	113.00	33.23	-7.27	26.00	46.00	-20.00
949.367	315.00	325.00	33.55	-7.17	26.40	46.00	-19.60
952.98	211.00	356.00	33.33	-7.17	26.20	46.00	-19.80
Final = Raw + Path Loss							
Margin = Final - Limit							

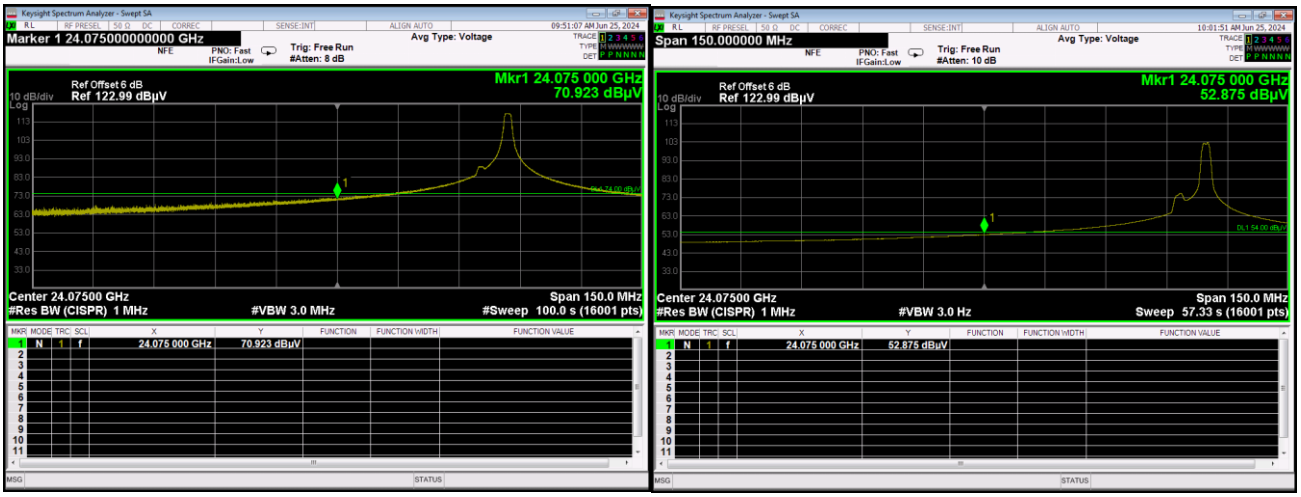
Radiated Emissions Above 1000MHz

Band Edge

Band Edge Summary Table

Tuned Frequency (MHz)	Mode of Operation	AVG Measured Value (dBuV/m)	PK Measured Value (dBuV/m)	AVG / PK Specification Limit (dBuV/m)	Result
24.075	Transmitting FSK	52.88	70.92	54 / 74	Pass
24.175	Transmitting FSK	53.38	68.64	54 / 74	Pass

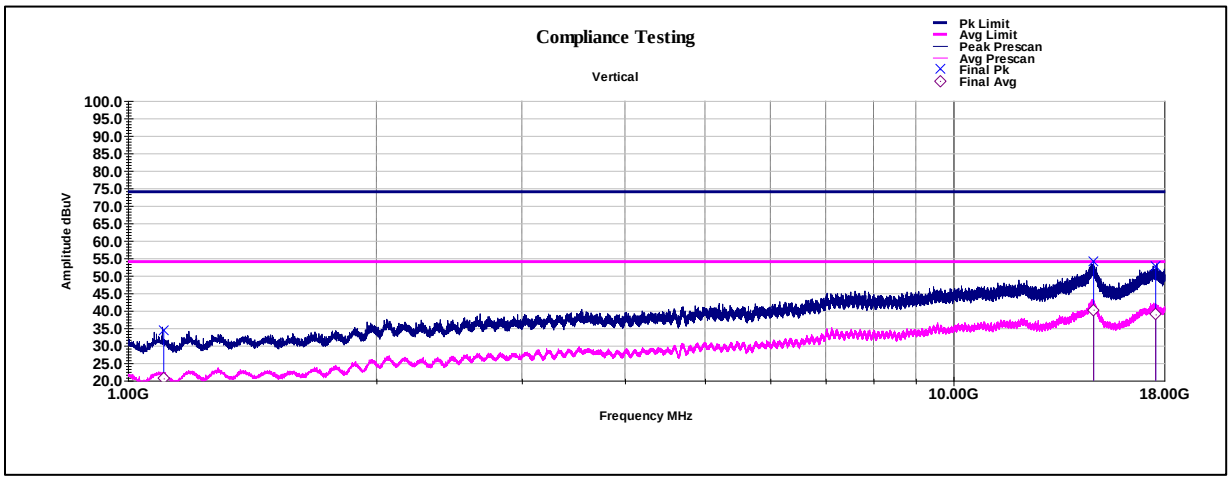
Band Edge – Transmitting FSK (Peak | AVG)



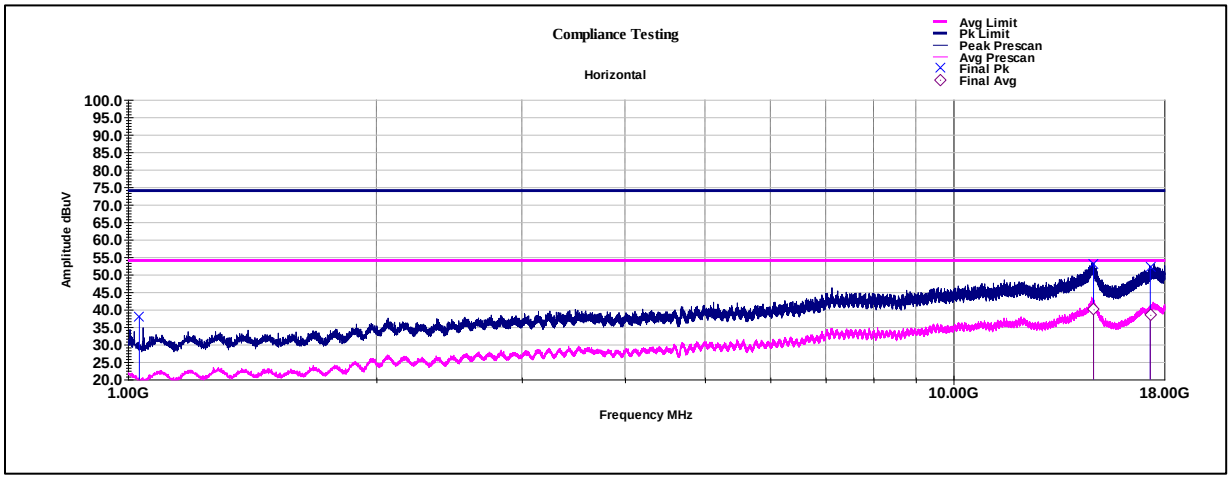
Band Edge – Transmitting FSK (Peak | AVG)

1-18GHz Spurious/Harmonics

Transmitting FSK 24GHz



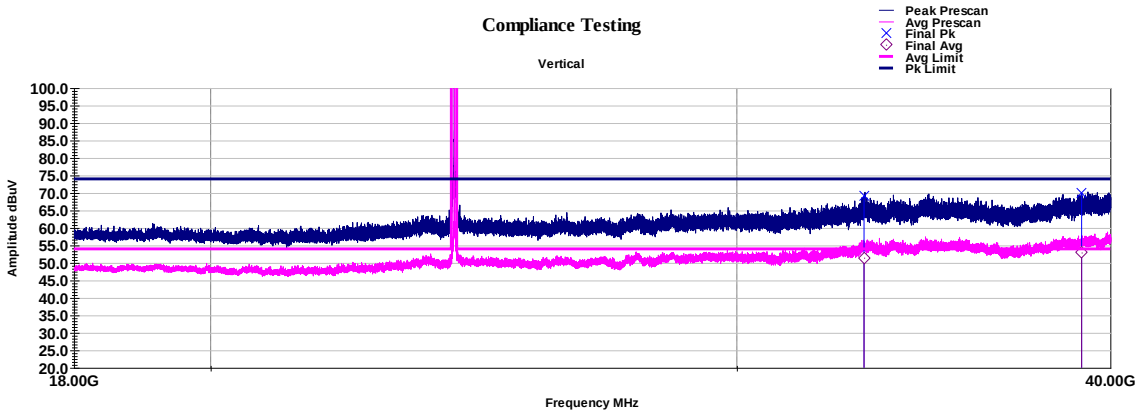
Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
GHz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
1.10529225	77.00	311.00	53.06	39.17	-18.55	34.51	74.00	-39.49	20.62	54	-33.38
14.7802815	150.00	395.00	48.03	34.20	6.05	54.08	74.00	-19.92	40.25	54	-13.75
17.57390375	253.00	395.00	44.78	30.92	8.01	52.78	74.00	-21.22	38.93	54	-15.07
Final = Raw + Path Loss											
Margin = Final - Limit											



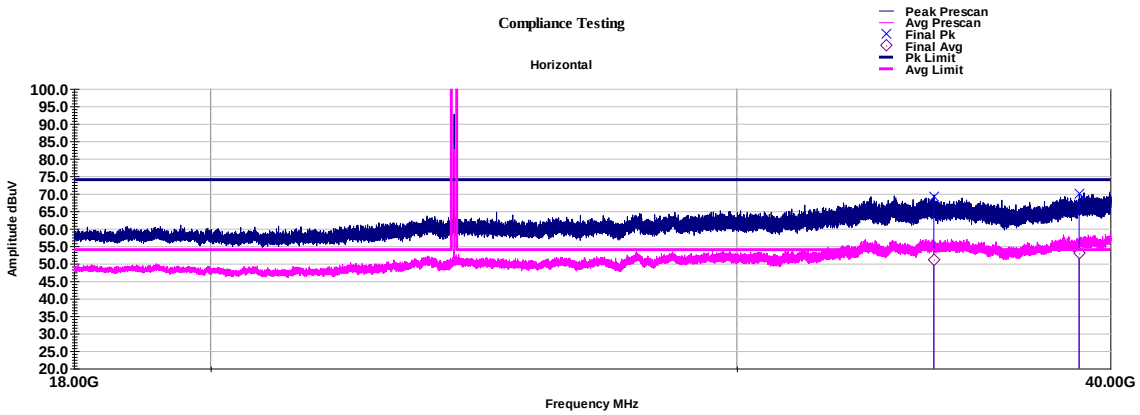
Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
GHz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
1.03249675	79.00	314.00	56.83	37.19	-18.85	37.98	74.00	-36.02	18.34	54	-35.66
14.77466775	353.00	159.00	47.01	33.92	6.12	53.13	74.00	-20.87	40.03	54	-13.97
17.30830575	5.00	105.00	45.08	31.29	7.17	52.25	74.00	-21.75	38.46	54	-15.54
Final = Raw + Path Loss											
Margin = Final - Limit											

18-40GHz Radiated Spurious/Harmonics

Transmitting FSK 24GHz



Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
GHz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
33.087952	193.00	372.00	42.46	24.86	26.61	69.07	74.00	-4.93	51.47	53.98	-2.51
39.12683	75.00	148.00	43.82	26.84	26.09	69.91	74.00	-4.09	52.93	53.98	-1.05
Final = Raw + Path Loss											
Margin = Final - Limit											



Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
GHz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
34.914084	134.00	252.00	43.79	25.76	25.39	69.18	74.00	-4.83	51.14	53.98	-2.84
39.050004	280.00	215.00	44.01	26.89	26.00	70.01	74.00	-3.99	52.89	53.98	-1.09
Final = Raw + Path Loss											
Margin = Final - Limit											

40-100GHz Radiated Spurious/Harmonics

Transmitting FSK 24GHz

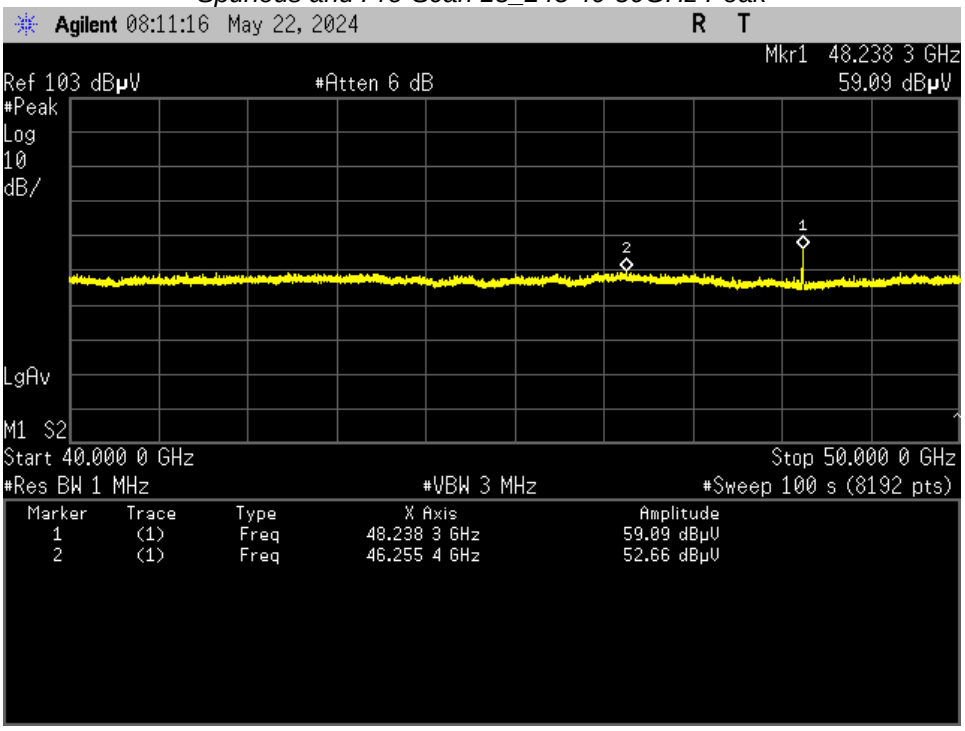
Signal Description	Detector	Range	Radiated Spurious (raw data)		Distance per standard	Distance used	Distance Correction factor	Cable Insertion Loss	Ext Amplifier Gain	Receive Mixer C/F	Receive Antenna C/F	Field Strength (calculated)	Limit	Margin	Pass / Fail
			Frequency	Amplitude											
			GHz	dBuV	meter	meter	dB	dB	dB	dB	dB	dBuV/m	dBuV/m	dB	
Spurious*	Peak	40 - 50	46.255	52.66	3.00	1.00	-9.54	15.64	42.6	0.00	40.14	56.30	74.00	-17.70	Pass
Spurious*	AVG	40 - 50	46.199	38.87	3.00	1.00	-9.54	15.64	42.6	0.00	40.14	42.51	54.00	-11.49	Pass
2nd Harm	Peak	40 - 50	48.255	60.39	3.00	1.00	-9.54	16.62	43.1	0.00	40.48	64.85	107.95	-43.10	Pass
2nd Harm	AVG	40 - 50	48.249	40.45	3.00	1.00	-9.54	16.62	43.1	0.00	40.48	44.91	87.95	-43.04	Pass
3rd Harm*	Peak	50 - 75	72.374	16.54	3.00	1.00	-9.54	0.50	33.393	46.90	44.01	65.01	107.95	-42.94	Pass
3rd Harm*	AVG	50 - 75	72.348	1.40	3.00	1.00	-9.54	0.50	33.393	46.90	44.01	49.87	87.95	-38.08	Pass
4th Harm*	Peak	75 - 100	96.27	16.89	3.00	1.00	-9.54	1.50	37.884	41.60	46.59	59.15	107.95	-48.80	Pass
4th Harm*	AVG	75 - 100	96.046	4.00	3.00	1.00	-9.54	1.50	37.884	41.60	46.59	46.26	87.95	-41.69	Pass

Notes:

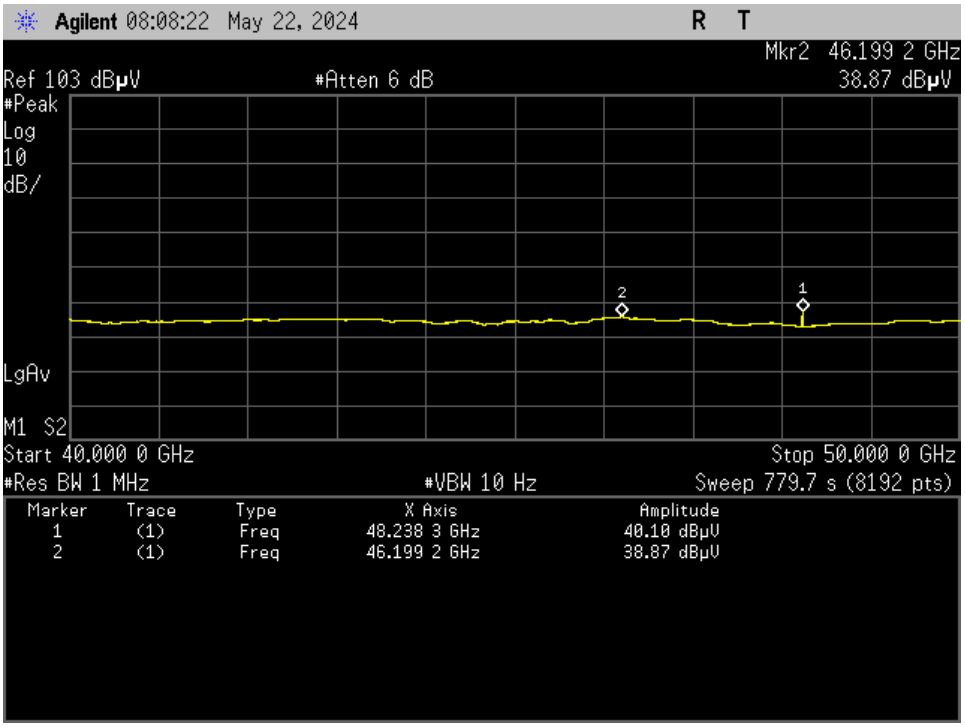
25 mV/m = 87.95 dBuV/m
*Noise Floor

40-100GHz Captures

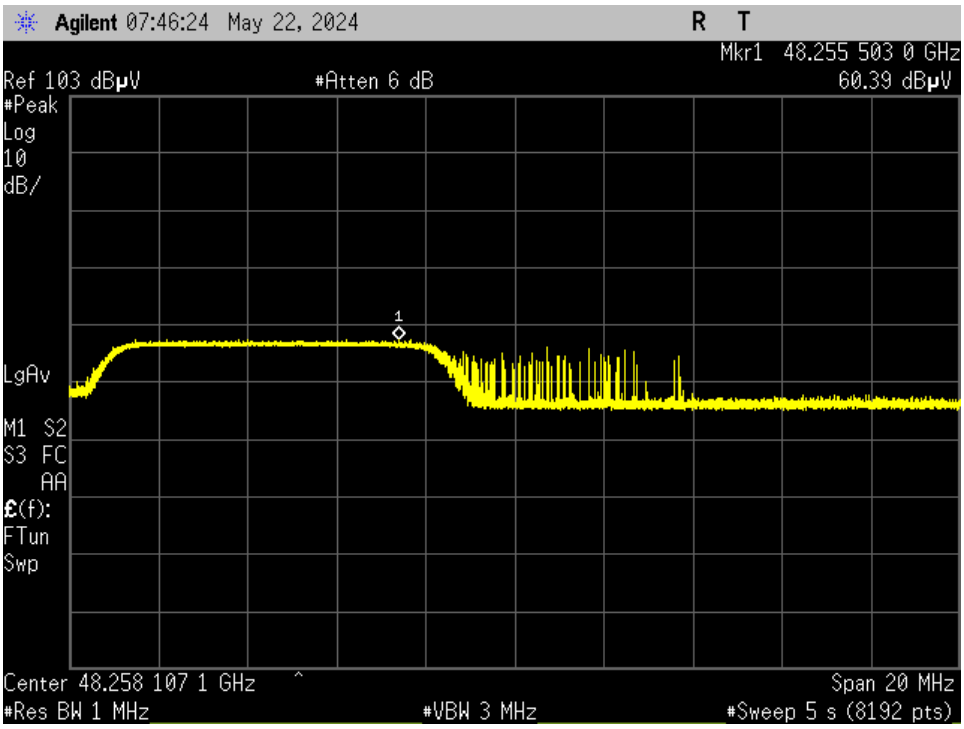
Spurious and Pre-Scan 15_245 40-50GHz Peak



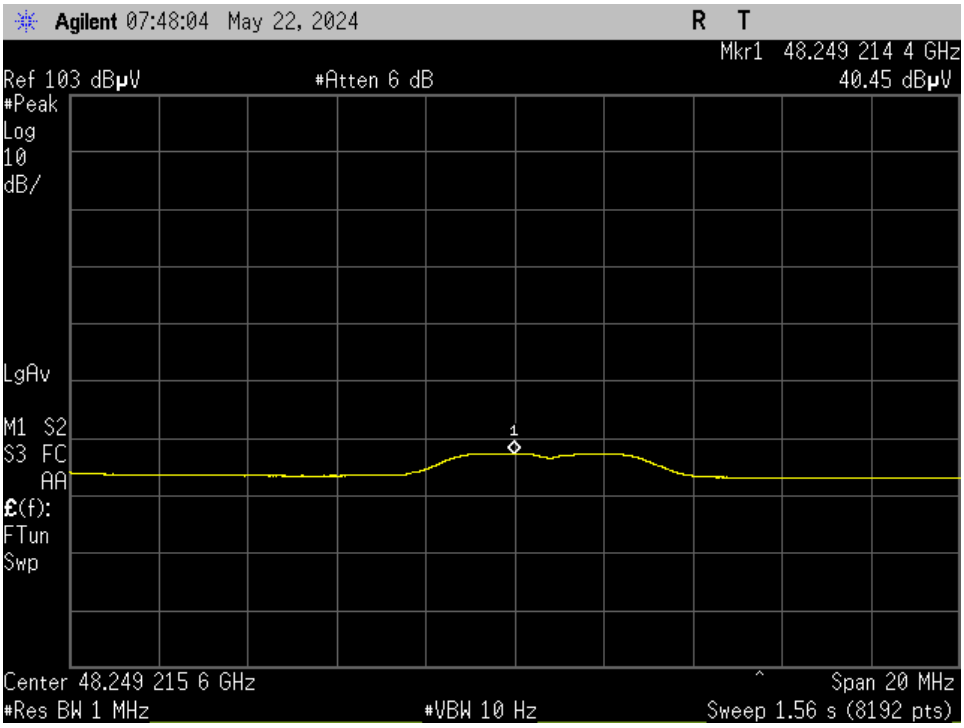
Spurious and Pre-Scan 15_245 40-50GHz AVG



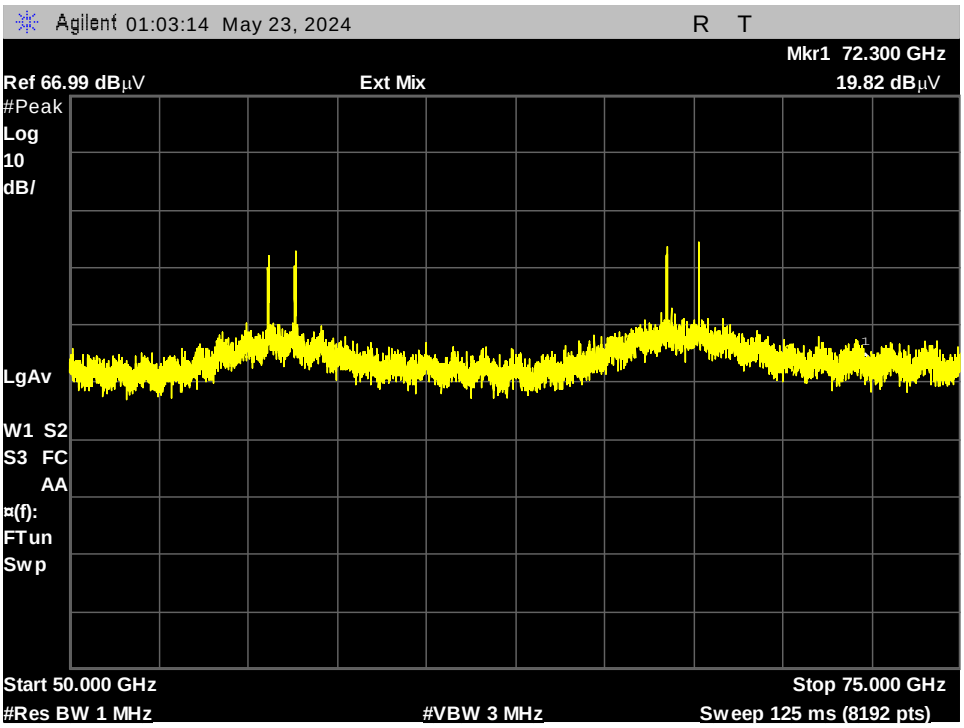
Harmonic 15_245 2nd harm Peak



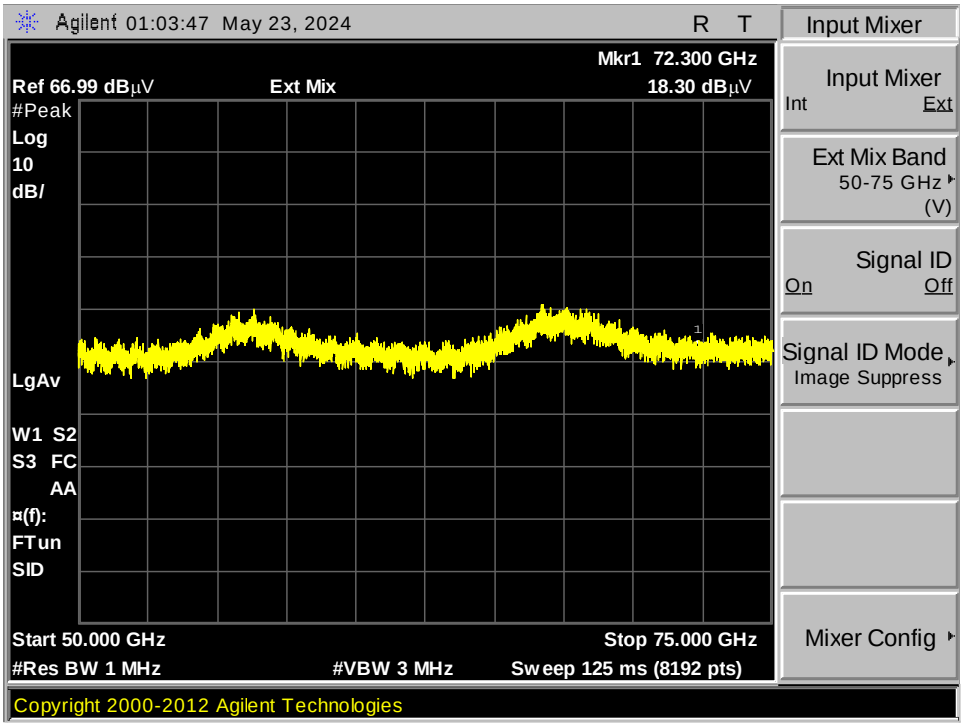
Harmonic 15_245 2nd harm AVG



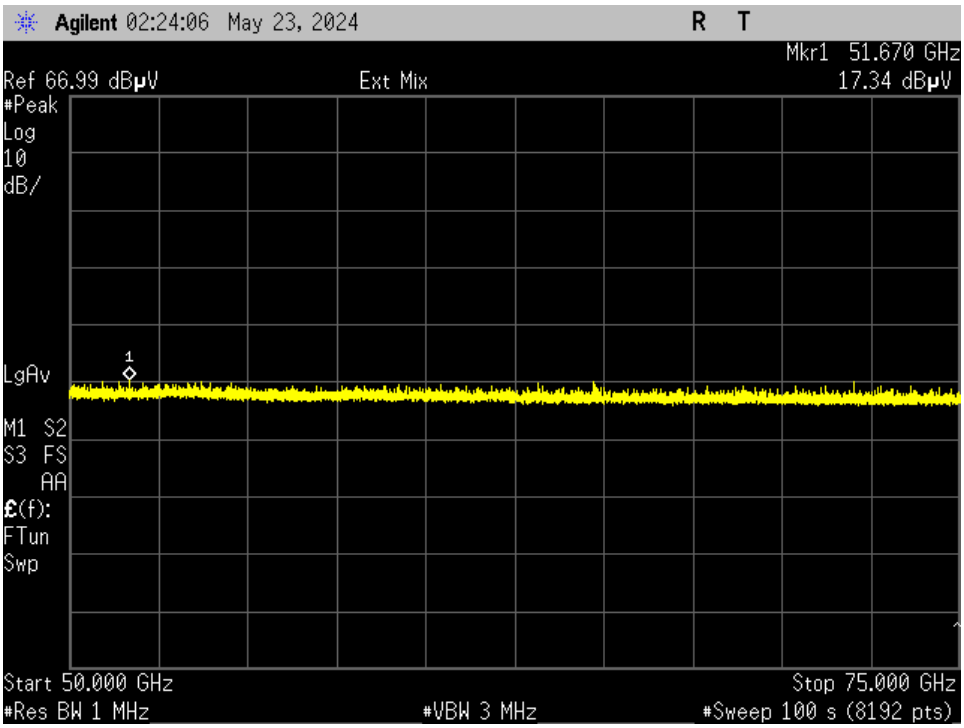
Pre-Scan Spurious Harmonic 15_245 50-75GHz w mixer check (no id)



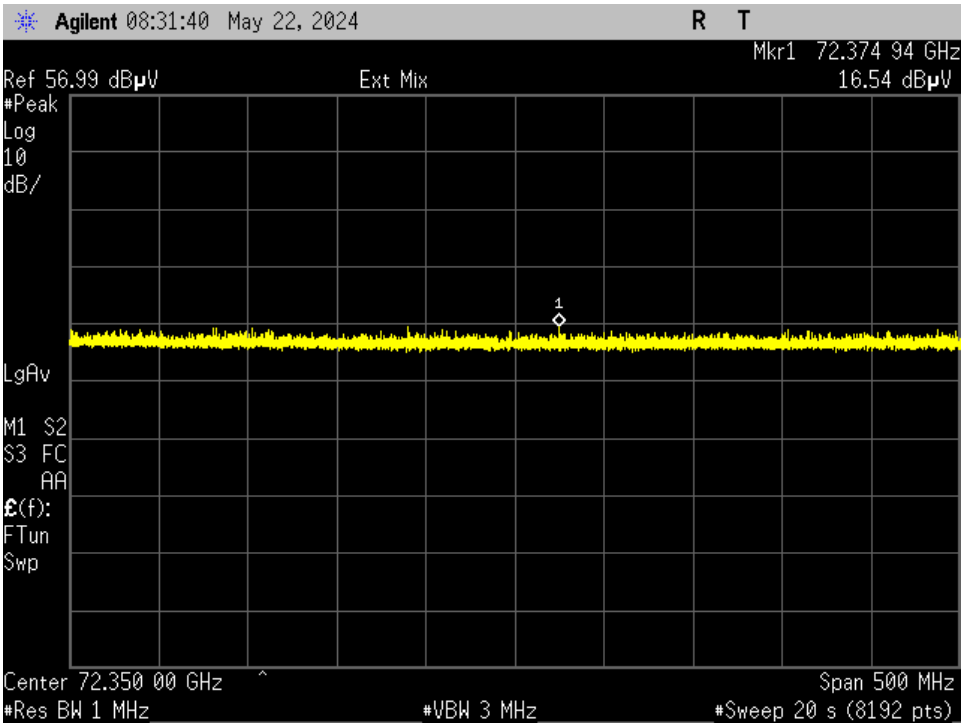
Pre-Scan Spurious Harmonic 15_245 50-75GHz w mixer check (signal id on)



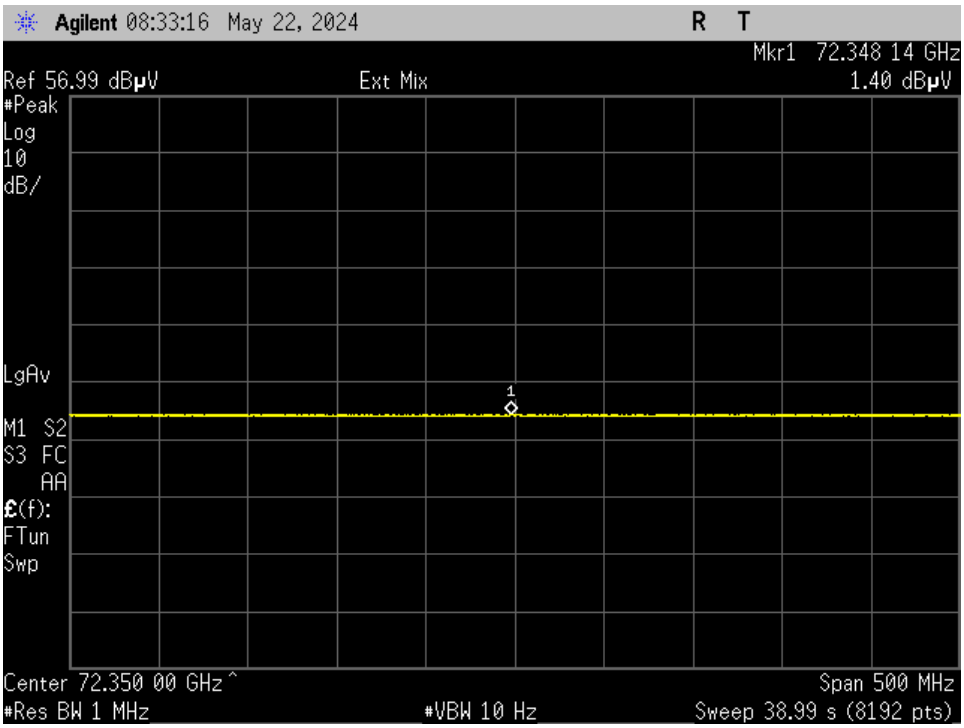
Pre-Scan Spurious Harmonic 15_245 50-75GHz w presel Peak



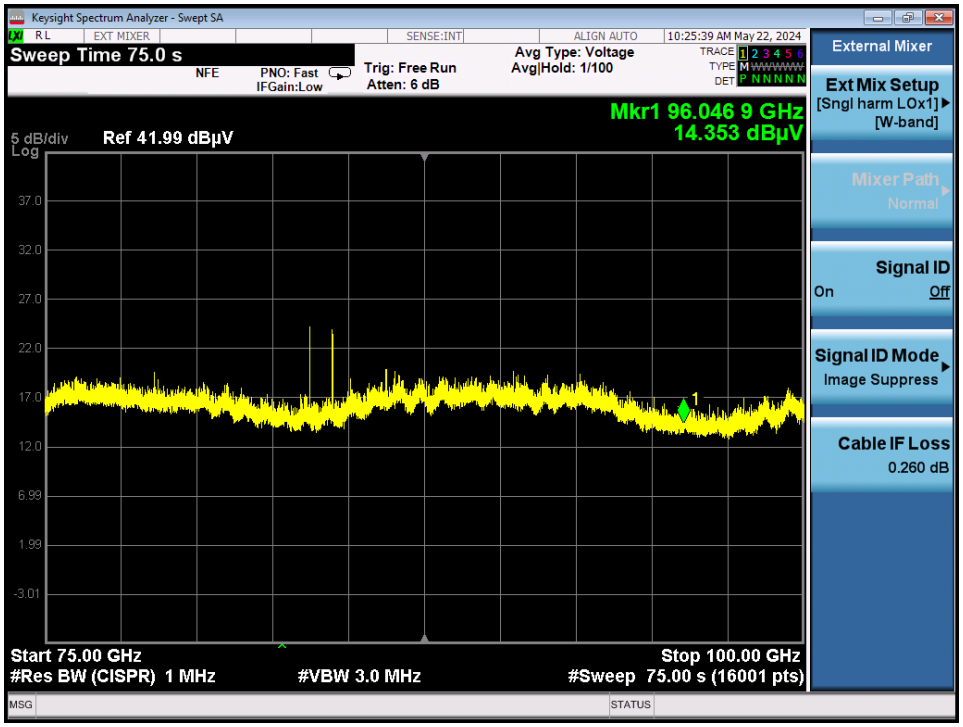
Harmonic 15_245 3rd harm w presel peak



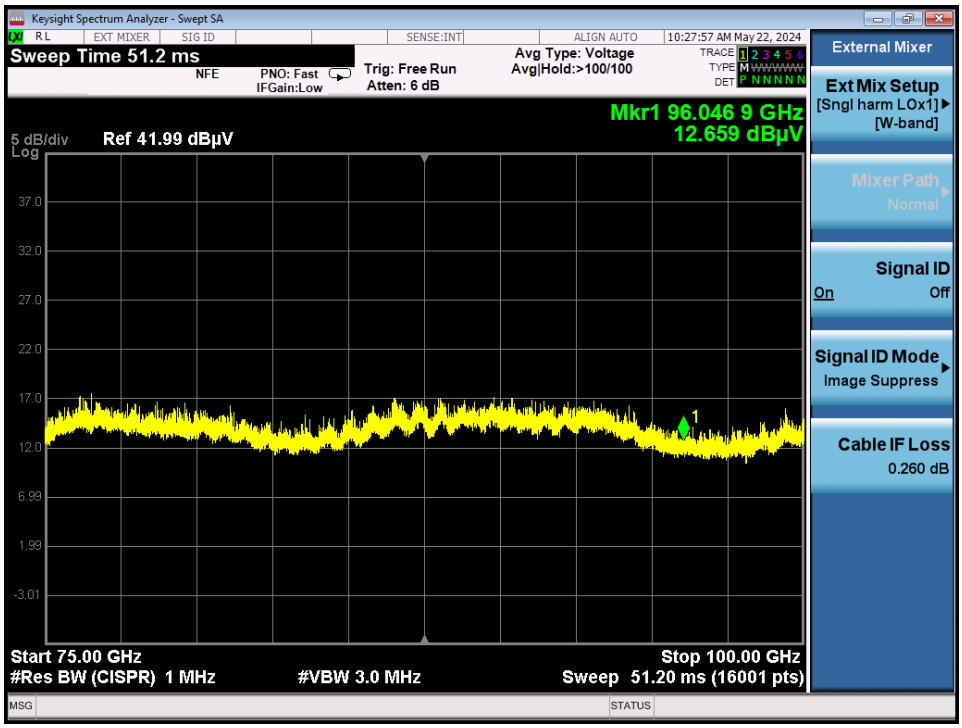
Harmonic 15_245 3rd harm w presel avg



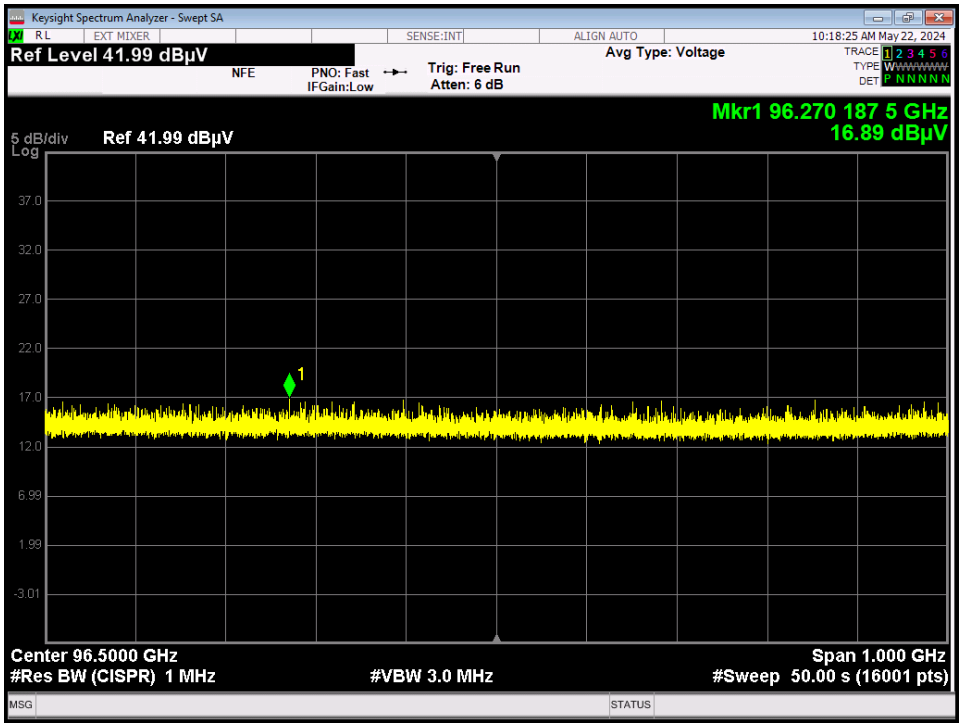
Pre-Scan Spurious Harmonic 15_245 75-100GHz (signal id off) peak



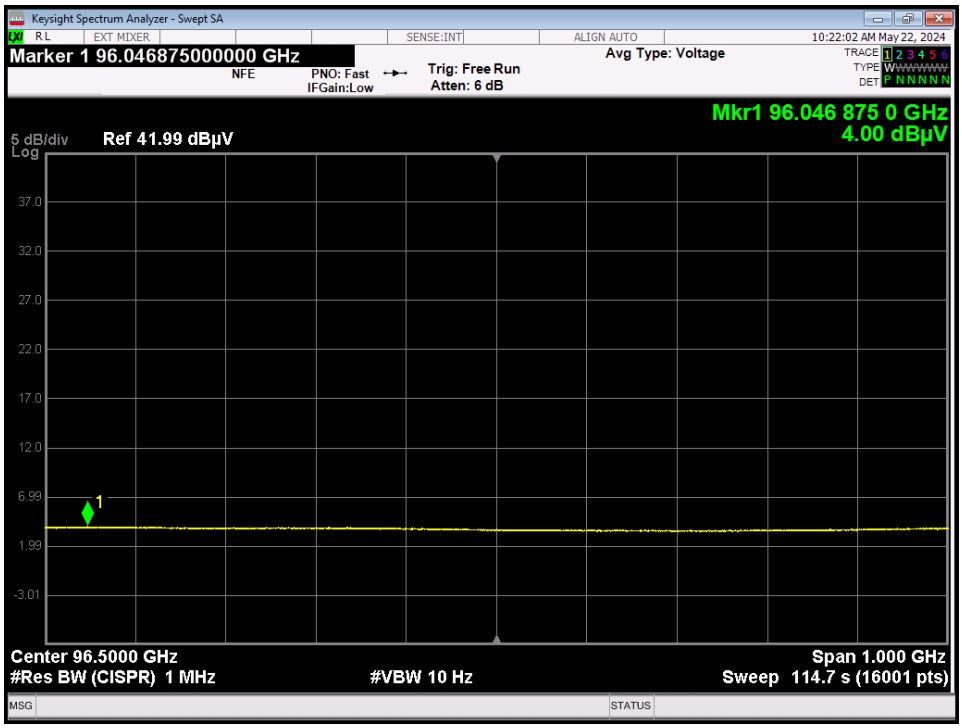
Pre-Scan Spurious Harmonic 15_245 75-100GHz (signal id on) peak



Harmonic 15_245 4th harm Peak



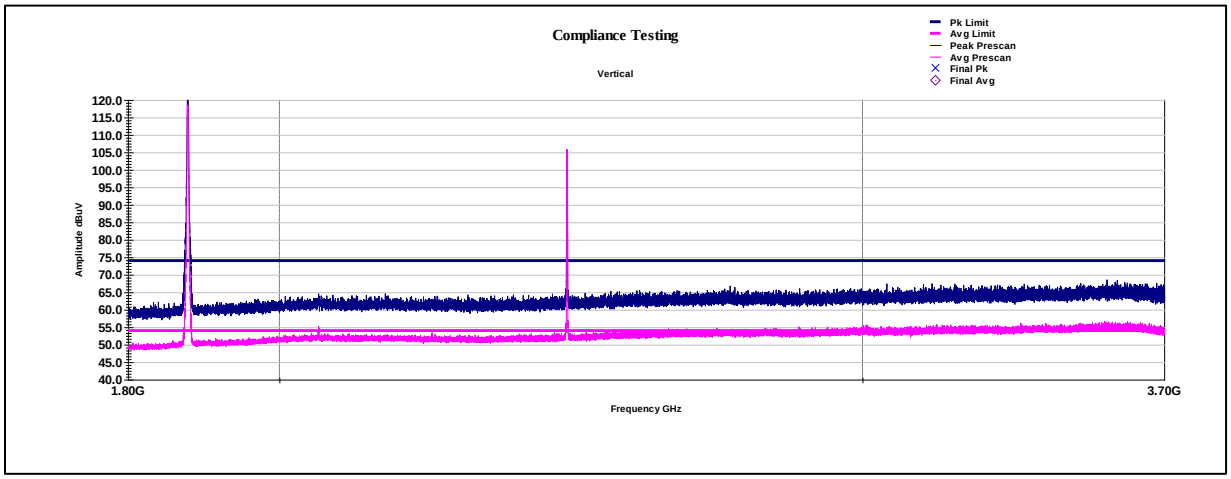
Harmonic 15_245 4th harm AVG

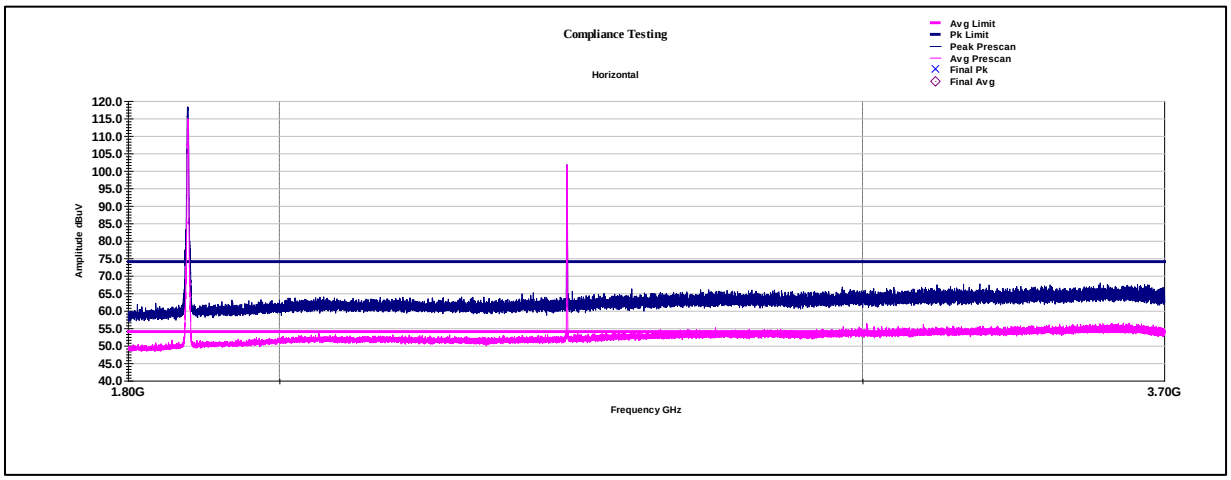


Transmitting 24GHz, Cellular LTE 1.8GHz, BLE 2.4GHz

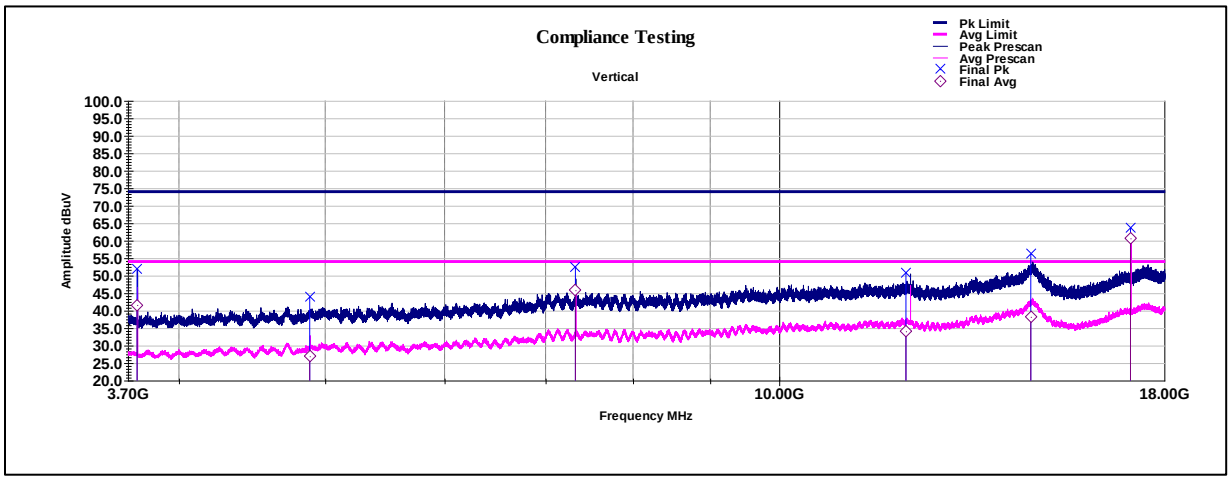
1-3.7GHz

Confirming operation of LTE 1.8GHz and BLE 2.4GHz



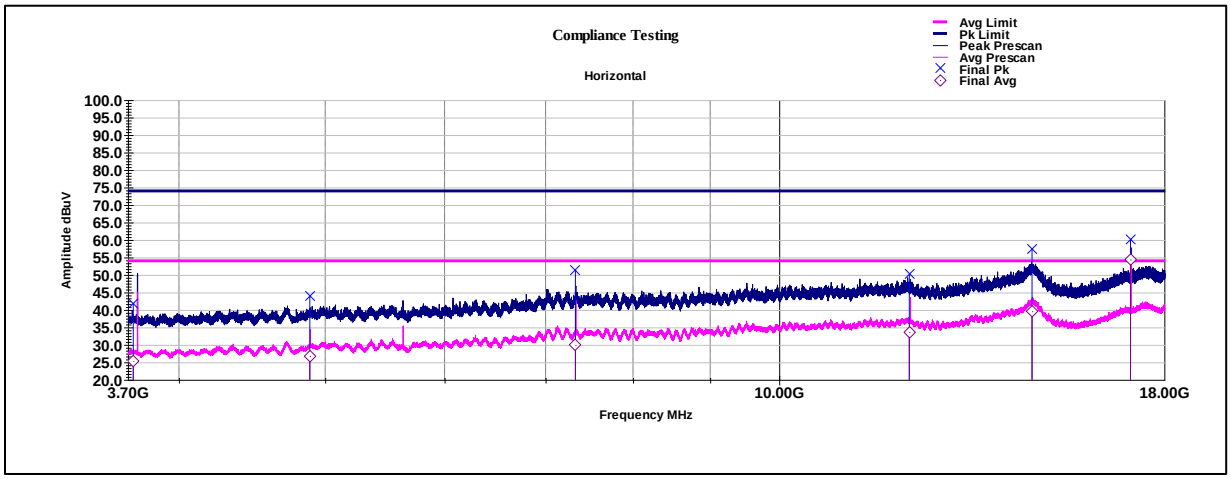


3.7-18GHz



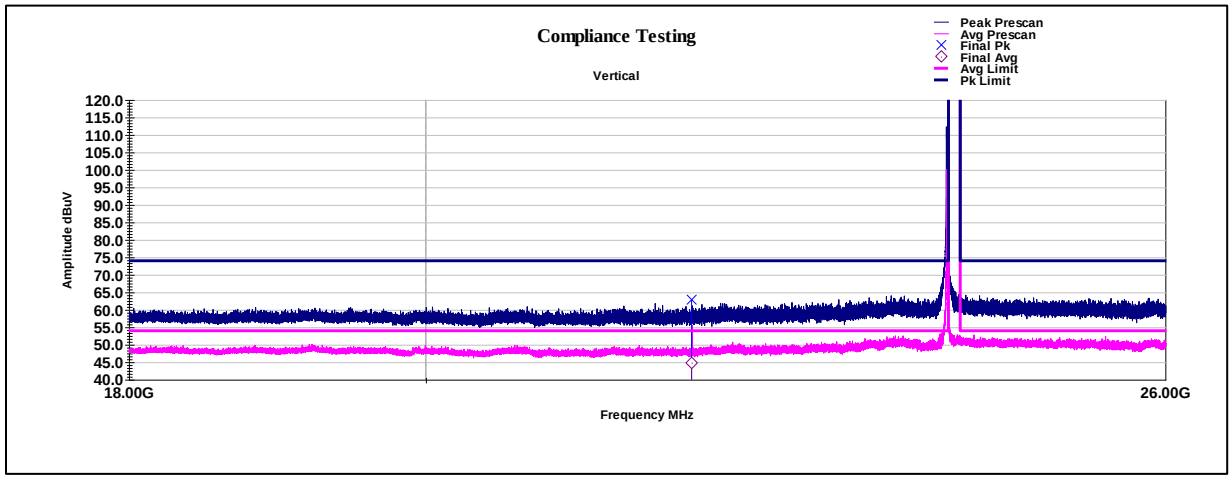
Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
GHz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
3.752752	47.00	100.00	61.30	51.03	-9.43	51.87	74.00	-22.13	41.60	54	-12.40
4.883738	128.00	105.00	51.07	34.04	-7.09	43.98	74.00	-30.02	26.95	54	-27.05
7.3262345	41.00	100.00	53.06	46.38	-0.56	52.50	74.00	-21.50	45.82	54	-8.18
12.133201	62.00	189.00	49.61	32.77	1.30	50.91	74.00	-23.09	34.08	54	-19.92
14.68032375	274.00	100.00	49.64	31.61	6.58	56.22	74.00	-17.78	38.19	54	-15.81
17.09412275	359.00	100.00	57.38	54.29	6.35	63.73	N/A	N/A	60.64	N/A	N/A
Final = Raw + Path Loss											
Margin = Final - Limit											

NOTE: FREQUENCY at 17.09GHz is not within the restricted band and was only measured for reference

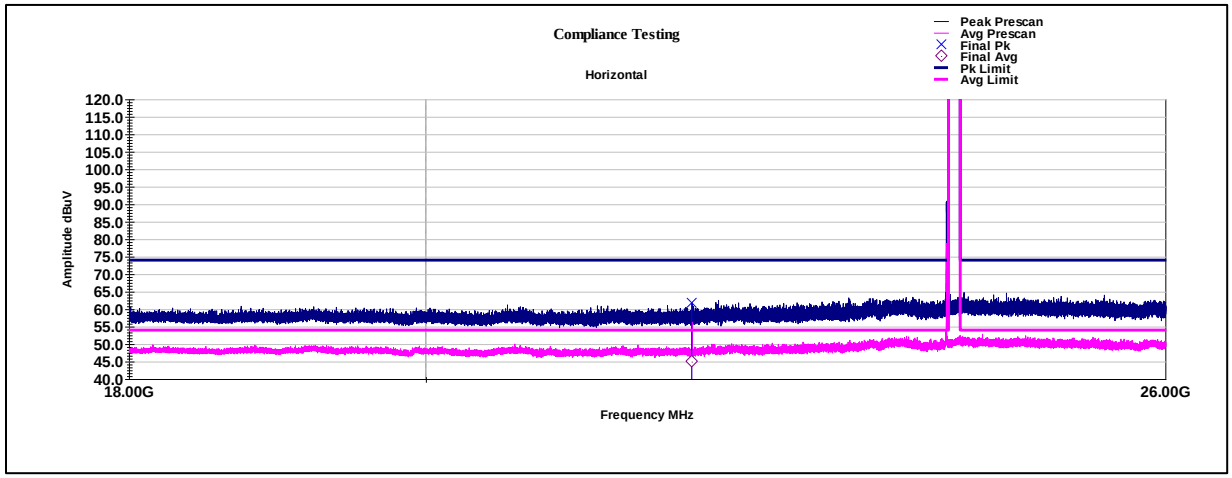


Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
GHz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
3.73052425	113.00	109.00	51.24	34.76	-9.37	41.87	74.00	-32.13	25.39	54	-28.61
4.88446775	0.00	235.00	50.94	33.86	-7.09	43.85	74.00	-30.15	26.77	54	-27.23
7.326038	10.00	100.00	51.82	30.51	-0.56	51.26	74.00	-22.74	29.94	54	-24.06
12.19657425	294.00	113.00	49.00	32.49	1.14	50.14	74.00	-23.86	33.63	54	-20.37
14.7086055	166.00	105.00	50.85	33.00	6.60	57.45	74.00	-16.56	39.60	54	-14.40
17.094069	136.00	394.00	53.88	48.03	6.35	60.23	N/A	N/A	54.39	N/A	N/A
Final = Raw + Path Loss											
Margin = Final - Limit											

18-26GHz



Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
GHz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
21.977716	344.00	325.00	43.24	25.24	19.61	62.84	73.98	-11.14	44.84	53.98	-9.14
Final = Raw + Path Loss											
Margin = Final - Limit											



Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
GHz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
21.97802	328.00	325.00	42.07	25.35	19.61	61.68	73.98	-12.30	44.96	53.98	-9.02
Final = Raw + Path Loss											
Margin = Final - Limit											

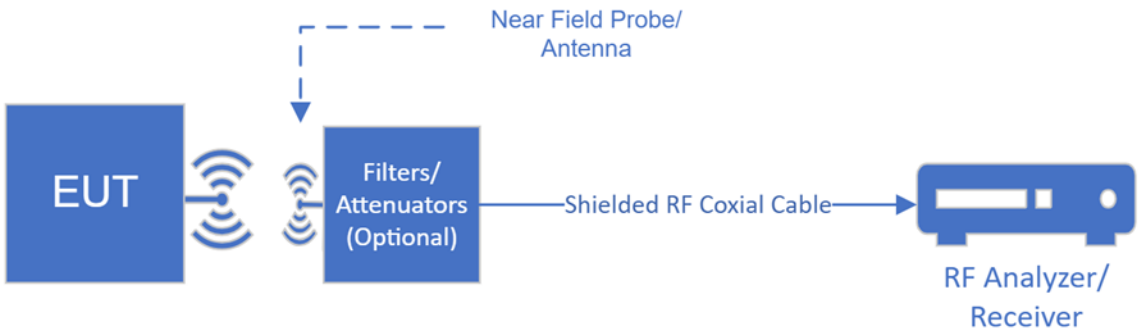
99% Occupied Bandwidth

Engineer: Jeremiah Darden
Test Date: June 25, 2024

Test Procedure

CONDUCTED METHOD
An antenna probe was placed next to the permanently attached antenna and then connected to a short shielded coax Cable. A spectrum analyzer was directly connected to this cable. The EUT was set to transmit at the full FMCW bandwidth at the maximum power level. The analyzer was offset to read the maximum power measured from radiated field strength measurements. A spectrum analyzer was used to verify that the EUT met the Bandwidth requirements.

Test Setup



The Spectrum Analyzer was set to the following:

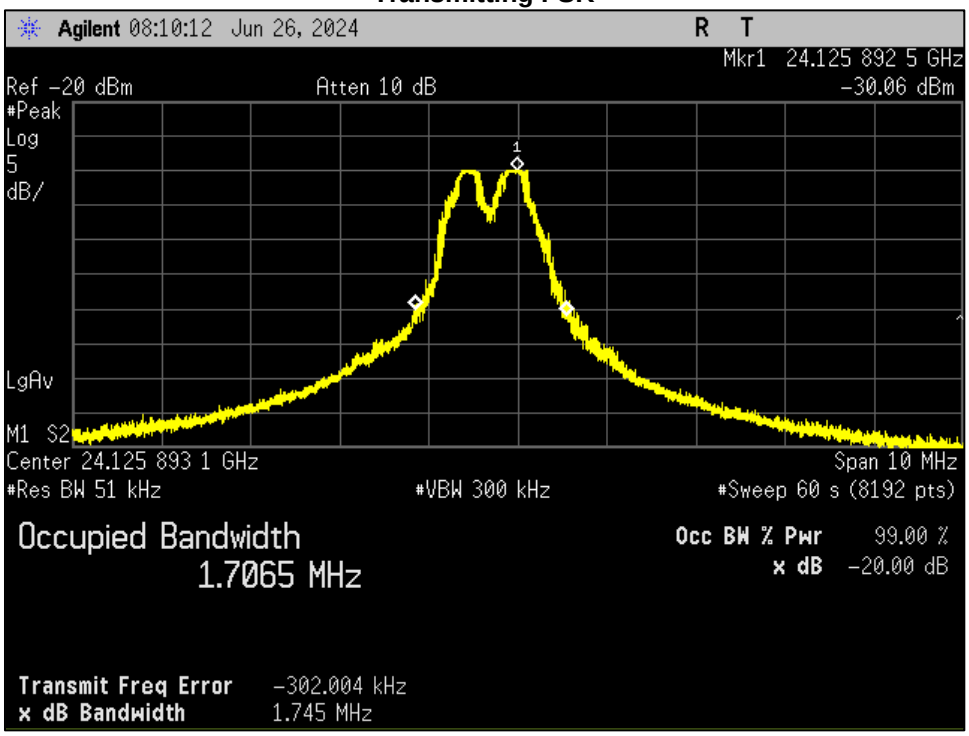
RBW = 1-3% of OBW
VBW ≥ 3 x RBW
Peak Detector
Trace mode = max hold
Sweep > 2 × (Signal Period) × (Span) / (RBW)
Span >= 1.5 x EBW

99% Bandwidth Summary

Frequency (GHz)	Mode of Operation	Measured Bandwidth (MHz)	Result
24.075-24.125	Transmitting FSK	1.7065	Complete

99% Bandwidth Plots

Transmitting FSK



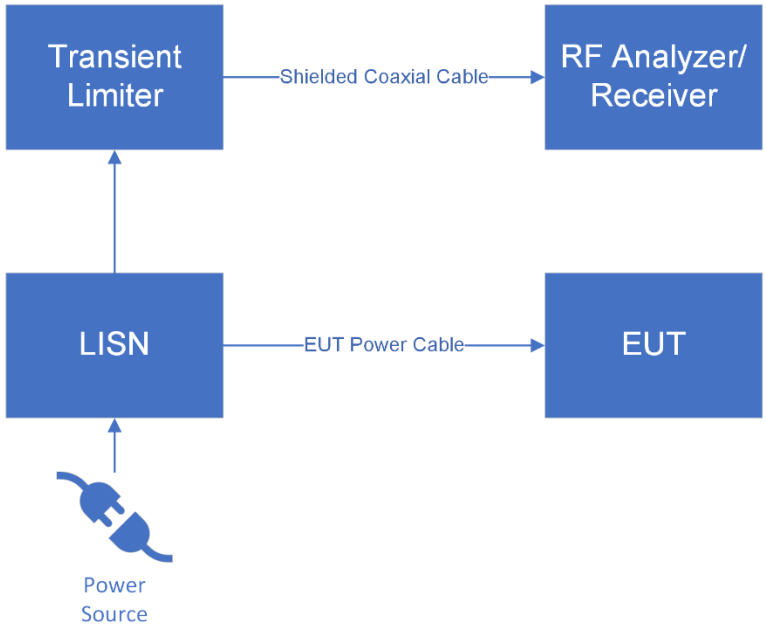
AC Powerline Conducted Emissions

Engineer: Jeremiah Darden
Test Date: May 31, 2024

Test Procedure

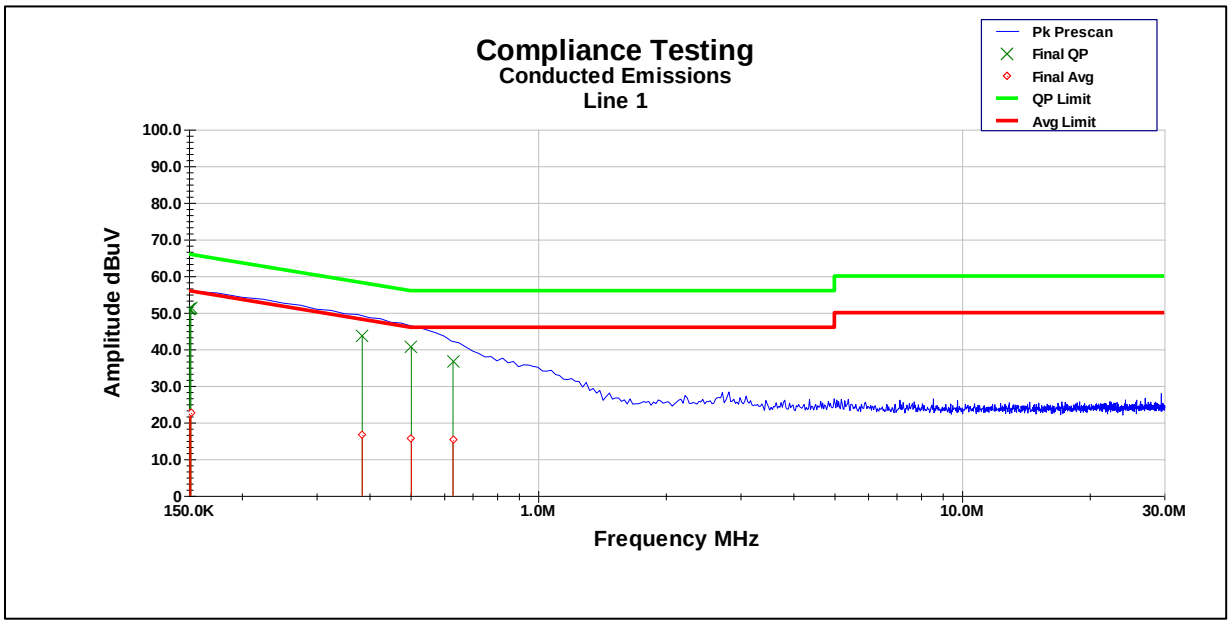
The EUT power cable was connected to a LISN and the monitored output of the LISN was connected to a transient limiter, which then connected directly to a spectrum analyzer. The conducted emissions from 150 kHz to 30 MHz were measured and compared to the specification limits.

Basic Test Setup

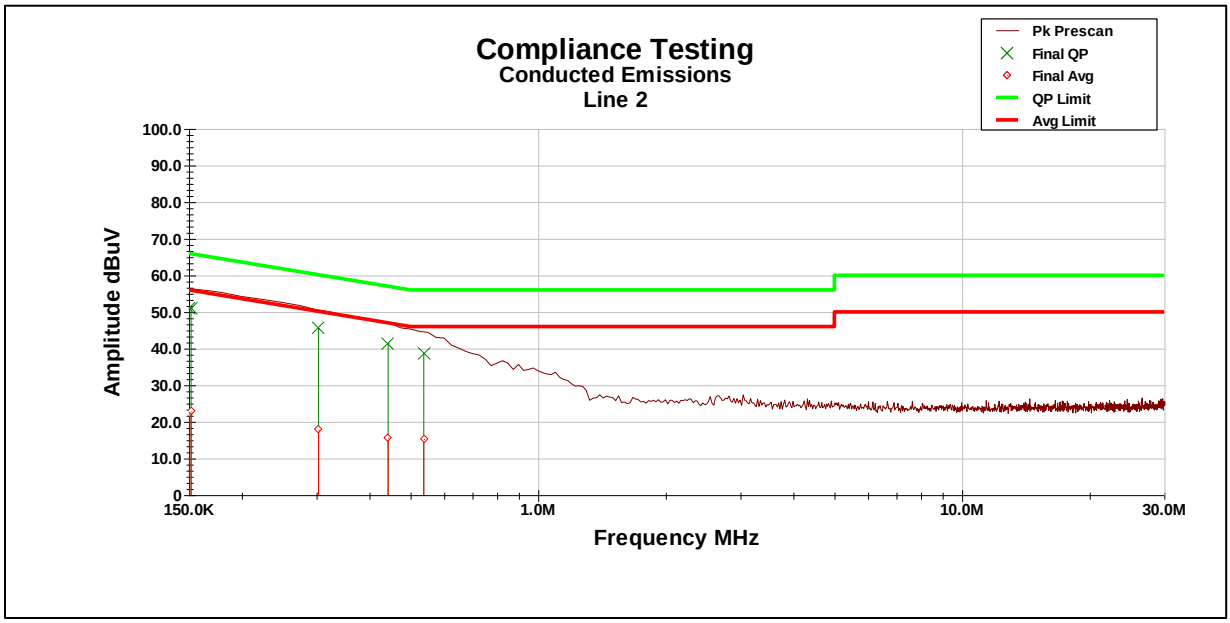


AC Powerline Conducted Emissions.

AC 120V/60Hz Linear Power Adapter(non filterted) to 12VDC. (FCC 15.207 for Single Modular Approval for 24GHz module while being co-located and host integrated with existing certified BLE Module and Cellular Module for FCC 15.207 and 15.109)



Frequency	Raw QP	Raw Avg	Path Loss	Final QP	Final Avg	QP Limit	QP Margin	Avg Limit	Avg Margin
-	dBuV	dBuV	dB	dBuV	dBuV	dBuV	dB	dBuV	dB
150.19 KHz	41.20	12.70	9.90	51.10	22.60	66.00	-14.90	56.00	-33.40
151.06 KHz	41.30	12.40	9.90	51.10	22.30	66.00	-14.80	56.00	-33.70
151.63 KHz	41.30	12.70	9.90	51.20	22.60	66.00	-14.80	56.00	-33.40
384.63 KHz	33.70	6.50	10.10	43.70	16.60	59.30	-15.60	49.30	-32.70
502.38 KHz	30.50	5.40	10.10	40.60	15.50	56.00	-15.40	46.00	-30.50
629.75 KHz	26.50	5.10	10.10	36.60	15.20	56.00	-19.40	46.00	-30.80
Final = Raw + Path Loss									
Margin = Final - Limit									



Frequency	Raw QP	Raw Avg	Path Loss	Final QP	Final Avg	QP Limit	QP Margin	Avg Limit	Avg Margin
-	dBuV	dBuV	dB	dBuV	dBuV	dBuV	dB	dBuV	dB
150.13 KHz	41.22	12.40	9.80	51.00	22.30	66.00	-15.00	56.00	-33.70
150.13 KHz	41.22	12.40	9.80	51.00	22.30	66.00	-15.00	56.00	-33.70
151.81 KHz	41.31	13.00	9.80	51.10	22.80	65.90	-14.80	55.90	-33.10
303.5 KHz	35.61	7.80	10.00	45.60	17.80	61.60	-16.00	51.60	-33.80
442.75 KHz	31.44	5.70	10.00	41.50	15.70	57.60	-16.20	47.60	-32.00
537.26 KHz	28.64	5.30	10.00	38.70	15.30	56.00	-17.30	46.00	-30.70
Final = Raw + Path Loss									
Margin = Final - Limit									

Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Horn Antenna	ARA	DRG-118/A	i00271	8/11/22	8/11/24
ultra wideband LNA 10MHz-45GHz	RF-Lambda USA	RLNA00M45GA	i00555	02/19/24	02/19/25
RF Amplifier 10MHz-50GHz, 40dB gain amp.	Eravant	SBB-0115034019-2F2F-E3	i00722	02/7/24	02/7/25
temperature/humidity/pressure probe	Omega Engineering, Inc.	iBTHX-W-5	i00629	01/25/23	01/24/25
temperature/humidity/pressure probe	Omega Engineering, Inc.	iBTHX-W	i00686	01/25/23	01/24/25
Bi-Log Antenna	Schaffner	CBL 6111D	i00349	2/7/23	2/7/25
Active Loop Antenna 1 kHz - 30 MHz	EMCO	6507	I00326	11/21/23	11/21/25
Harmonic Mixer	Hewlett Packard	11970V	00463	8/11/21	8/11/24
Harmonic Mixer	Hewlett Packard	11970W	00464	8/11/21	8/11/24
PSA Spectrum Analyzer	Agilent	E4445A	i00471	1/5/24	1/5/25
Horn Antenna standard gain	CMI	H06R	i00475	NR	NR
Horn Antenna, standard gain	CMI	H010R	i00476	NR	NR
Horn Antenna standard gain	CMI	Ho15R	i00477	NR	NR
Harmonic Mixer	OML	M06HWD	i00480	8/18/21	8/18/24
Harmonic Mixer	OML	M06HWD	i00480	8/18/21	8/18/24
Horn Antenna, standard gain	CMI	H022R	i00484	NR	NR
MXE EMI receiver	Keysight	N9038A	i00552	03/01/24	03/01/25
Network analyzer	HP	8753D	i00505	11/03/23	11/02/24
‘Antenna, Horn 18-40GHz	EMCO	3116	I00085	03/14/23	03/13/25
LNA (50-75GHz), 35 dB gain	Eravant	SBL-5037533550-1515-E1	I00588	Verified on: 5/15/24	
Horn, Pyramidal WR4	Omi	H04R	I00473	NR	
WR-04 harmonic Mixer	OML	M04HWD	I00481	Verified on: 5/15/24	
WR4.3 amplifier	Virginia Diodes	WR4.3AMP	I00682	Verified on: 5/15/24	
Preselector 50-75GHz	Agilent/HP	11974V	I00726	Verified on: 5/15/24	
LNA	Eravant	SBL-7531143550-1010-E1	i00589	Verified on: 5/15/24	

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Harmonic Mixer	Hewlett Packard	11970Q	i00621	8/10/21	8/10/24
ultra wideband LNA 10MHz-45GHz	RF-Lambda USA	RLNA00M45GA	I00555	Verified on: 4/9/24	
RF Amplifier 10MHz-50GHz, 40dB gain amp.	Eravant	SBB-0115034019-2F2F-E3	I00722	Verified on: 2/7/24	
LNA	Eravant	SBL-1141743065-0606-E1	i00658	Verified on: 5/15/24	

In addition to the above listed equipment standard RF connectors and cables were utilized in the testing of the described equipment. Prior to testing these components were tested to verify proper operation.

Measurement Uncertainty

Measurement Uncertainty for Compliance Testing is listed in the table below.

Measurement	U_{lab}
Radio Frequency	± 3.3 x 10^{-8}
RF Power, conducted	± 1.5 dB
RF Power Density, conducted	± 1.0 dB
Conducted Emissions	± 1.8 dB
Radiated Emissions 9kHz-30MHz	± 3.6 dB
Radiated Emissions 30MHz-1000MHz	± 4.25 dB
Radiated Emissions – 1GHz-18GHz	± 4.5 dB
Temperature	± 1.5 deg C
Humidity	± 4.3 %
DC voltage	± 0.20 VDC
AC Voltage	± 1.2 VAC

The reported expanded uncertainty +/- U_{lab}(dB) has been estimated at a 95% confidence level (k=2)
U_{lab} is less than or equal to U_{EMC} therefore;

- Compliance is deemed to occur if no measured disturbance exceeds the disturbance limit.
- Non-Compliance is deemed to occur if any measured disturbance exceeds the disturbance limit.

END OF TEST REPORT