

Test Report

Prepared for: Preferred Security Components Inc. of PA DBA Cartell

Model: CW-HUB

Serial Number: 260101-00808, 260101-00807

Project No: p2640011

FCC ID: 2AUXCCWHUB

IC ID: 25651-CWHUB

Test Results: Pass

To

FCC Part 15.247

&

RSS Gen Issue 5 (April 2018)

RSS-247 Issue 4 (July 2025)

Date of Issue: May 28, 2026

On behalf of the applicant:

Preferred Security Components Inc. of PA DBA Cartell
510 W King St
Shippensburg, PA 17257

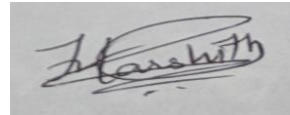
Attention of:

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CAB US-ID: US0122

Reviewed / Authorized By:



Harshith Devaraja, EMC Engineer

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Test Results Summary

Test Date Range: May 22, 2026 – May 28, 2026

Specification		Test Name	Pass, Fail, N/A	Comments
FCC	RSS			
15.247(a)(2)	RSS Gen 6.7 RSS 247 6.3.1(a)	Occupied Bandwidth	Pass	
15.247(b)(3)	RSS 247 6.3.2	Transmitter Output Power	Pass	
15.247(d)	RSS 247 6.6	Conducted Spurious Emissions	Pass	
15.247(d), 15.209(a), 15.205	RSS Gen 8.9/8.10 RSS 247 6.6	Spurious Emissions	Pass	
15.247(e)	RSS 247 6.3.1(b)	Power Spectral density	Pass	
15.207	RSS Gen 8.8	A/C Powerline Conducted Emissions	Pass	
15.203	RSS Gen 6.8	Antenna Requirement	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+ Cor. 1-2023+C63.10a-2024 + Errata to C63.10a-2024	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
558074 D01 15.247 Meas Guidance v05r02	Guidance for Compliance Measurements on DTS, FHSS, and Hybrid System Devices Operating Under Section 15.247 of the FCC Rules
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	May 28, 2026	Harshith Devaraja	Original Document
2.0	July 2, 2026	Harshith Devaraja	CAB US-ID updated Reference method updated IC HVIN, PMN updated BLE operating frequency updated Added EIRP table

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

EUT Description

Model:	CW-HUB
IC HVIN:	CWHUB
IC PMN:	CWHUB
Serial:	260101-00808 Simultaneous transmission sample: 260101-00807
Firmware:	1032/5019
Description:	Works with Cartell's wired and wireless device to enable notifications to the Cartell app.
Additional Information:	LoRa Radio Frequency Range and Operational Info: 903 – 927 MHz LoRa DTS – CSS Modulation (Spread factor 12) 1. EUT can simultaneously transmit BLE and LoRa DTS 2. EUT can simultaneously transmit 802.11b/g/n and LoRa DTS BLE Radio Frequency Range: 2.402 – 2.480 GHz Wi-Fi 802.11b/g/n Radio Frequency Range: 2.412 – 2.462 GHz Usage: Fixed/Mobile
Receipt of Sample(s):	May 8, 2026
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

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: 15.247.

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 measurements.

Standard Test Conditions and Engineering Practices

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

Environmental Conditions		
Temperature (°C)	Humidity (%)	Barometric Pressure (mbar)
22.33 - 25.56	28.3 - 31.5	962.5 - 969.8

Test Setup and Modes of Operation

EUT Operation during Tests

EUT was connected to a test laptop to control power and channel selection. The EUT was operated to control the continuous transmission of low, mid and high channels in the 903 – 927 MHz frequency range (LoRa).

In simultaneous transmission mode, the EUT was placed in the worst-case channel and mode for BLE and the LoRa transmission was set to its worst-case channel (middle channel). [17% duty cycle transmission]

In simultaneous transmission mode, the EUT was placed in the worst-case channel and mode for Wi-Fi 802.11 and the LoRa transmission was set to its worst-case channel (middle channel). [17% duty cycle transmission]

Accessories:

Qty	Description	Manufacturer	Model	S/N
1	Laptop	Dell	Latitude 7490	0VNCW A00
1	Wall power adapter	ShenZhen LuXiangYuan Technology Co, Ltd	LX050100	N/A

Cables:

Qty	Description	Length (M)	Ferrites (Y/N)	Shielding Y/N	Shielded Hood Y/N	Termination / Connection
1	USB Power Cable	0.8	N	N	N	Power adapter/ EUT

Software/Firmware:

Name	Description	Version	Installation Info
ESP RF Test Tool	Radio Control Software Application	v5.2	N/A
Tera term 5	Terminal Emulator	5.6.1	N/A

Modifications to EUT(s): N/A

15.203: Antenna Requirement:

LORA Antenna

- ☐ 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

The antenna gain stated by the manufacturer:

RF Antenna: 2.0 dBi

BLE/Wi-Fi Antenna

- ☒ 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

The antenna gain stated by the manufacturer:

RF Antenna: 3.96 dBi

Transmitter Output Power

Engineer: Harshith Devaraja

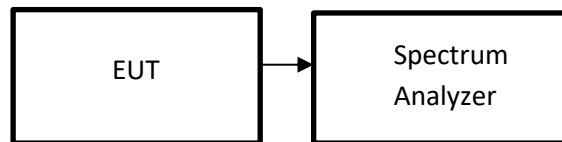
Test Date: 05/22/26

Test Procedure

Conducted Method

EUT, via a pigtail cable, was directly connected to the spectrum analyzer to verify that the EUT met the requirements for Output Power.

Test Setup



The Spectrum Analyzer was set to the following:

RBW = 1% - 5% times of OBW

VBW $\geq 3 \times$ RBW

Span $\geq 1.5 \times$ RBW

Sweep time = auto couple

Detector = Avg

Integrated Channel power measurement

Duty Cycle Calculation

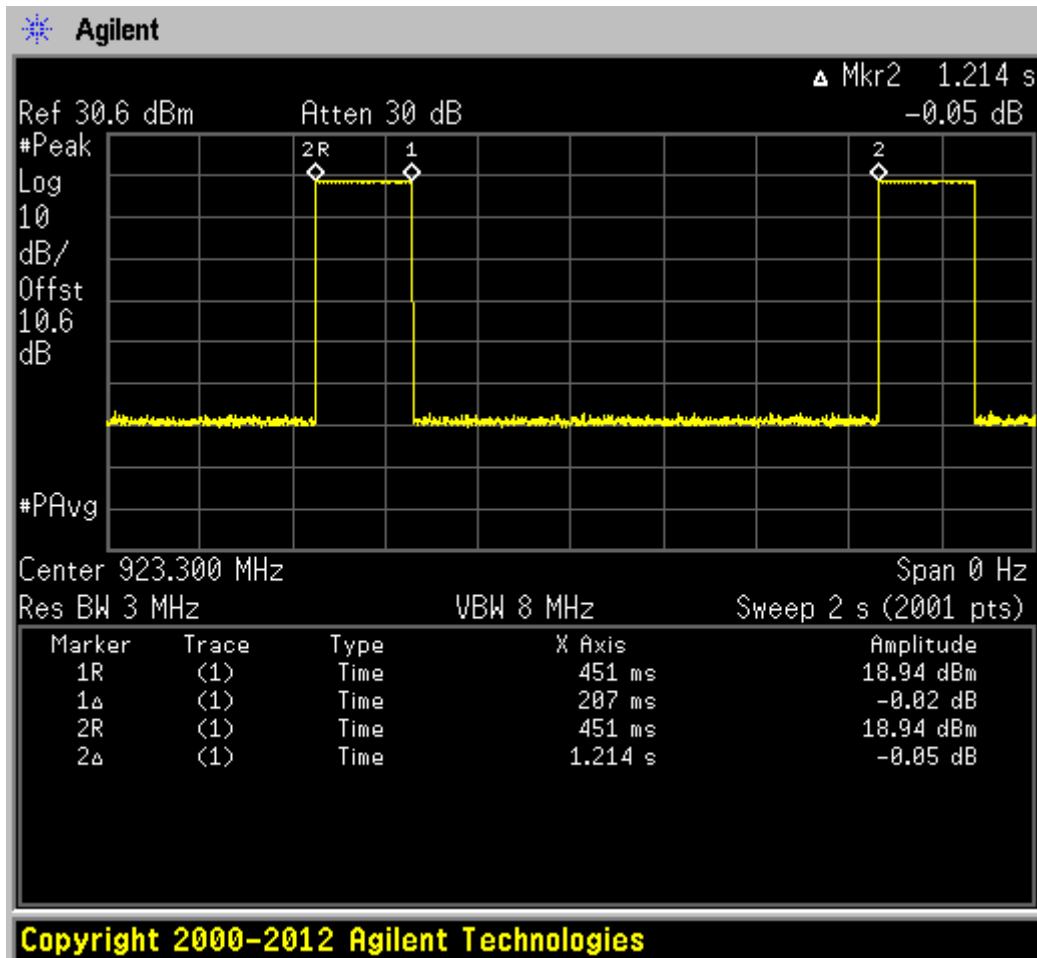
RBW $\geq$ OBW Bandwidth

VBW $\geq$ RBW

Span = Zero Span

Sweep time = 2s

Detector = peak



Ton = 207 ms
Ton+off = 1214 ms

Duty Cycle = $207/1214 = 0.17051 = 17.051\%$

Duty Cycle Correction factor = $10 \log (1/D) = 10 \log (1/0.17051) = 7.68 \text{ dB}$

Duty Cycle correction factor applied (approximating to a higher value) = 7.7 dB

Duty Cycle correction factor applied as External Gain in the spectrum analyzer

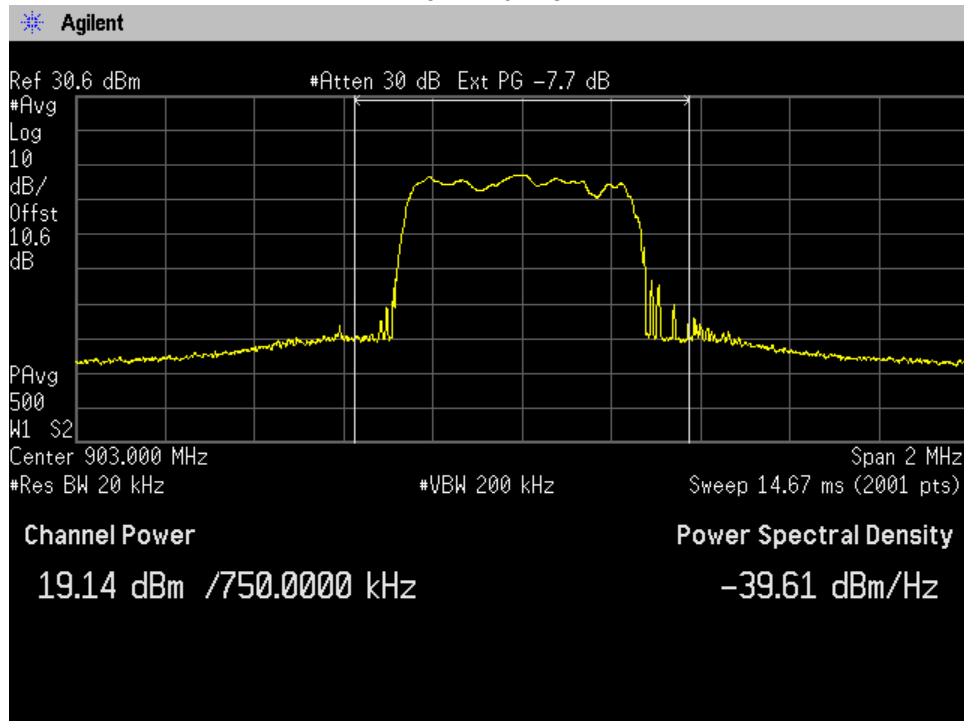
Transmitter Output Power Summary Table

Tuned Frequency (MHz)	Conducted power (dBm)	Conducted power (mW)	Specification Limit	Result
903	19.14	82	1 W (30 dBm)	Pass
915	19.47	88.5	1 W (30 dBm)	Pass
927	19.22	83.6	1 W (30 dBm)	Pass

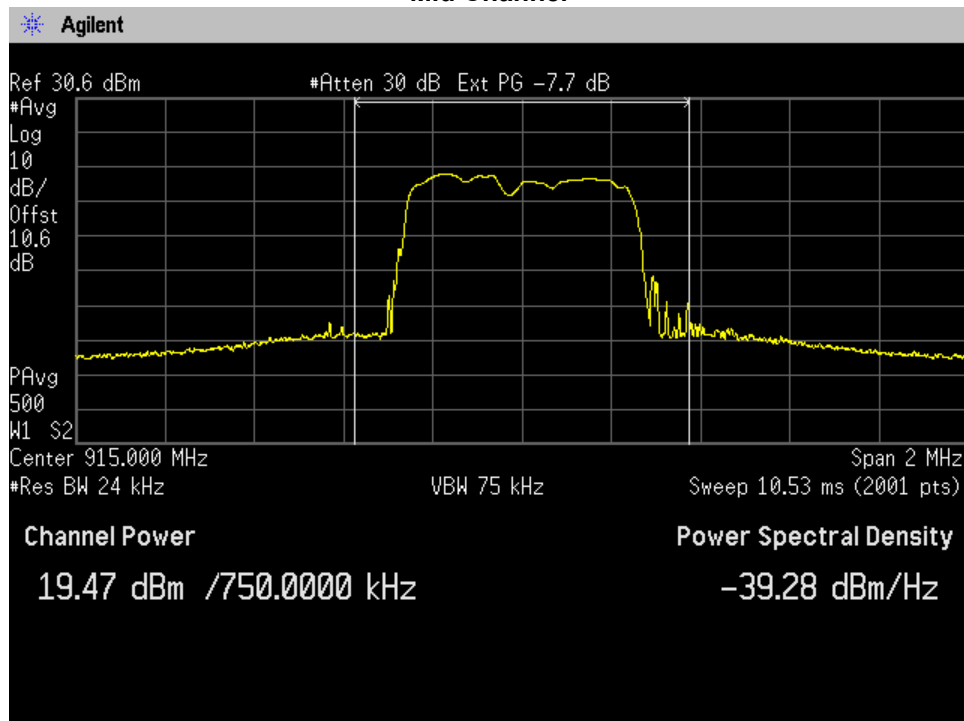
Tuned Frequency (MHz)	Conducted power (dBm)	Antenna Gain (dBi)	EIRP (W)	EIRP (dBm)	EIRP Limit	Result
903	19.14	2	0.13	21.14	4 W (36 dBm)	Pass
915	19.47	2	0.1403	21.47	4 W (36 dBm)	Pass
927	19.22	2	0.1324	21.22	4 W (36 dBm)	Pass

Output Power Plots

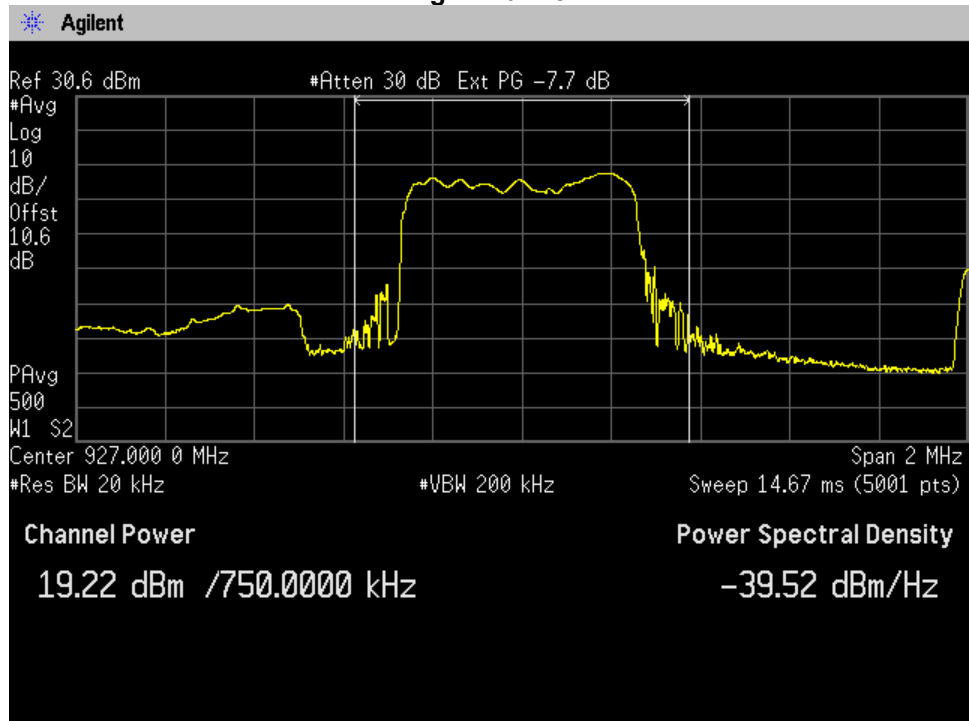
Low Channel



Mid Channel



High Channel



15.209/15.205 Spurious Emissions

Engineer: Harshith Devaraja

Test Date: 05/26/26 – 05/27/26

Test Procedure

Radiated Method

The EUT was set up 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 while the RF port was terminated to 50 Ω load. The EUT was tested, in 3 orthogonal axes, 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. EUT set in the X axis was determined as the worst-case position. 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 and emissions within 20dB margin are reported.

- Worst Case BLE 1 Mbps Low Channel and LoRa middle channel simultaneous transmission reported.
- Worst Case Wi-Fi 802.11b 1 Mbps Low Channel and LoRa middle channel simultaneous transmission reported.

Conducted Method

As per ANSI C63.10 Section 11.12.2

EUT, via a pigtail cable, were directly connected to the spectrum analyzer to verify that the EUT met the requirements for spurious emissions.

The conducted measurement plot reported below involves the resultant conversion from the EIRP to an equivalent electric field.

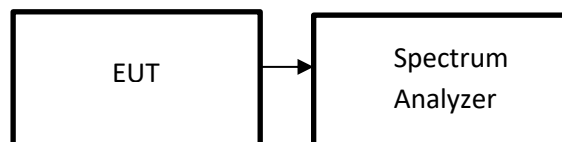
$$E = \text{EIRP} - 20 \log(3) + 104.8$$

The conversion is factored into the spectrum analyzer as the reference offset.

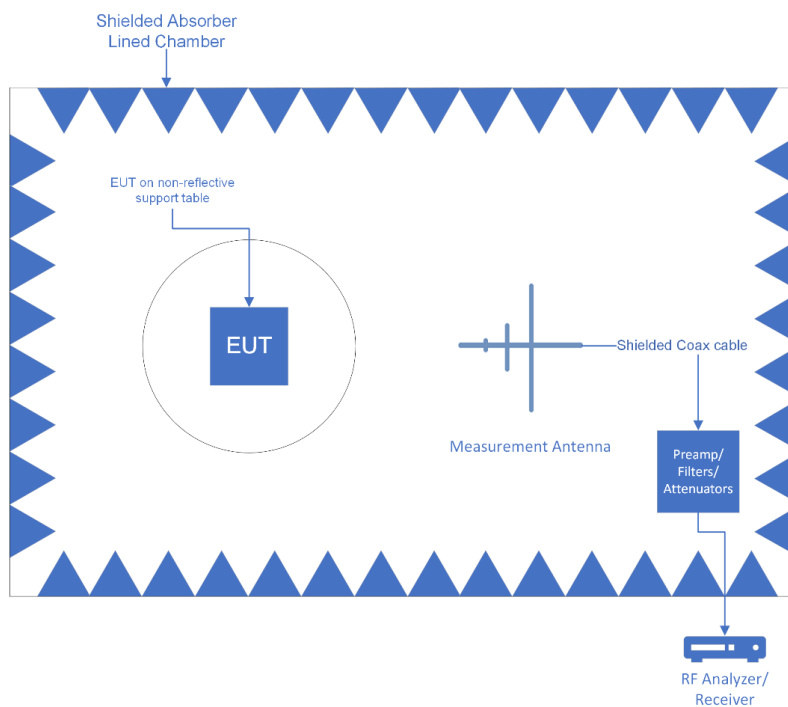
The maximum transmit antenna gain is set to 2.0 dB.as an offset on the analyzer.

The 10 dB attenuator and pigtail cable loss at 915 MHz is accommodated as the negative external gain while the pigtail cable loss in the rest of the frequency spectrum is accommodated via a correction factor included in the spectrum analyzer.

Conducted Test Setup



Radiated basic Test Setup



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

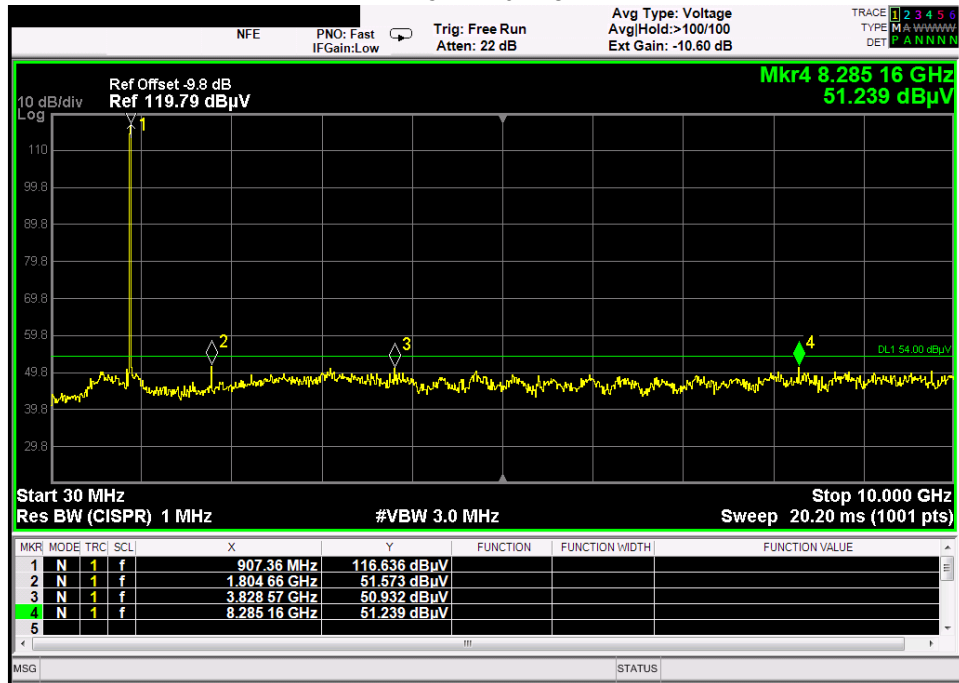
Sample Calculations

Corrected Value = Measured Value + Correction factor

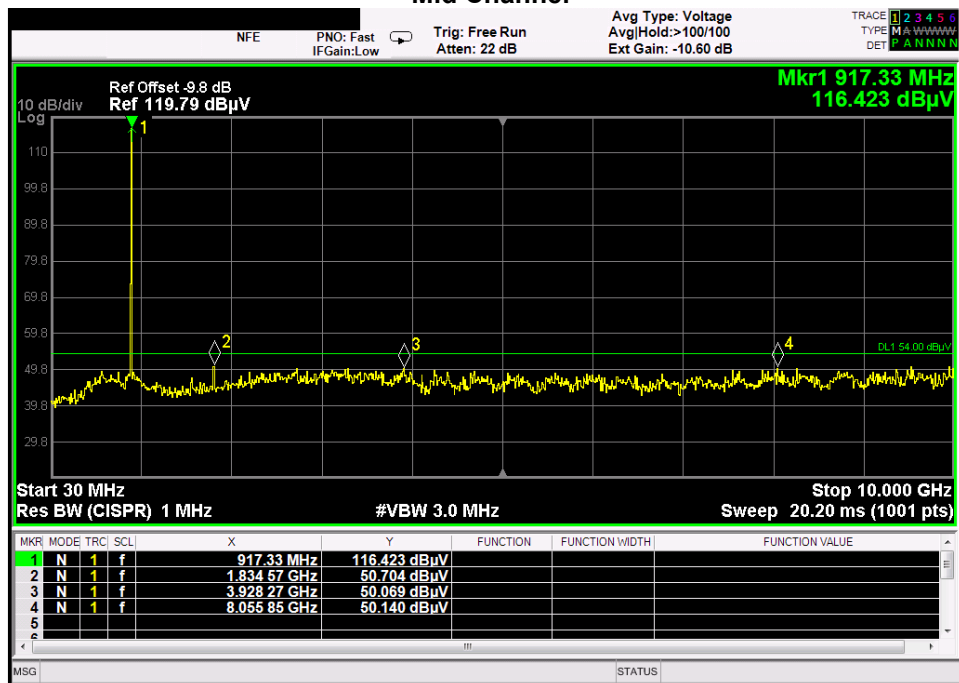
Correction factor = Antenna Correction Factor + Cable loss + Preamp/Attenuator Factor

Conducted Method Plots

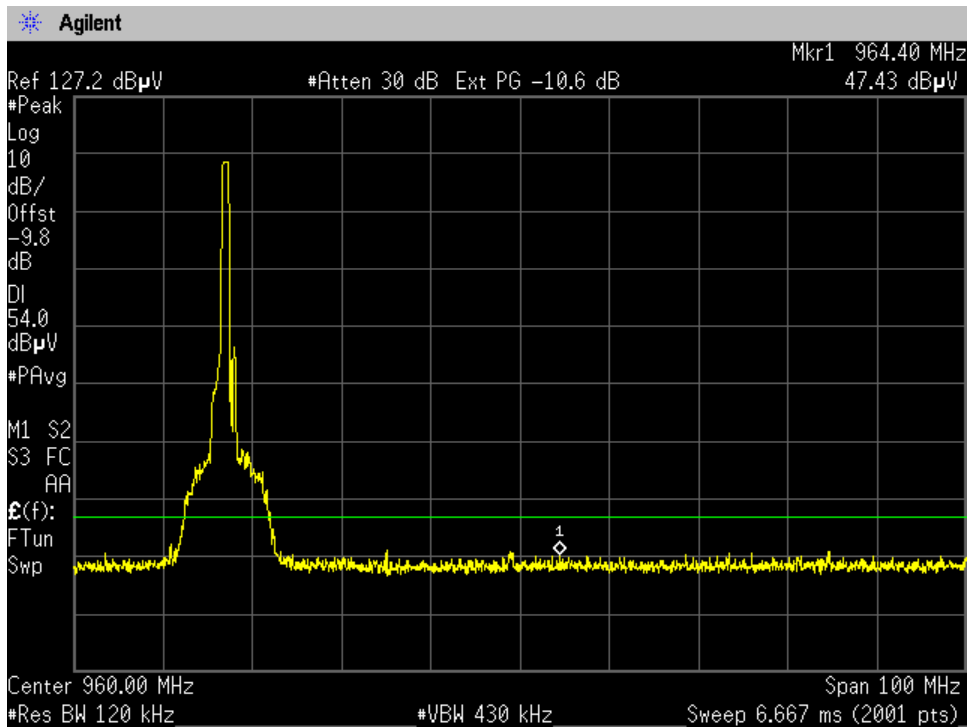
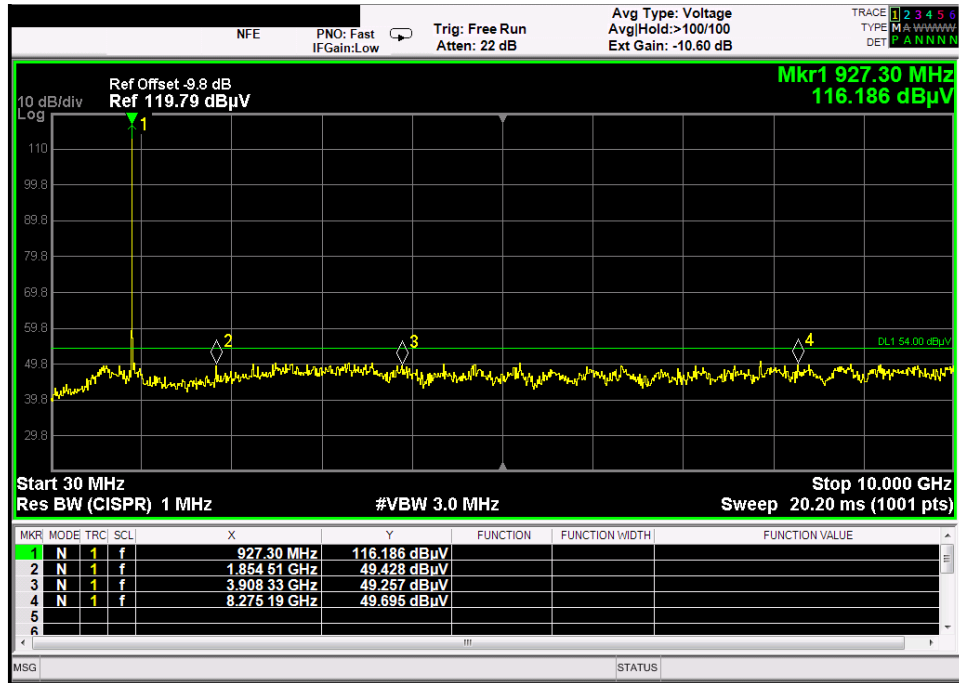
Low Channel



Mid Channel



High Channel



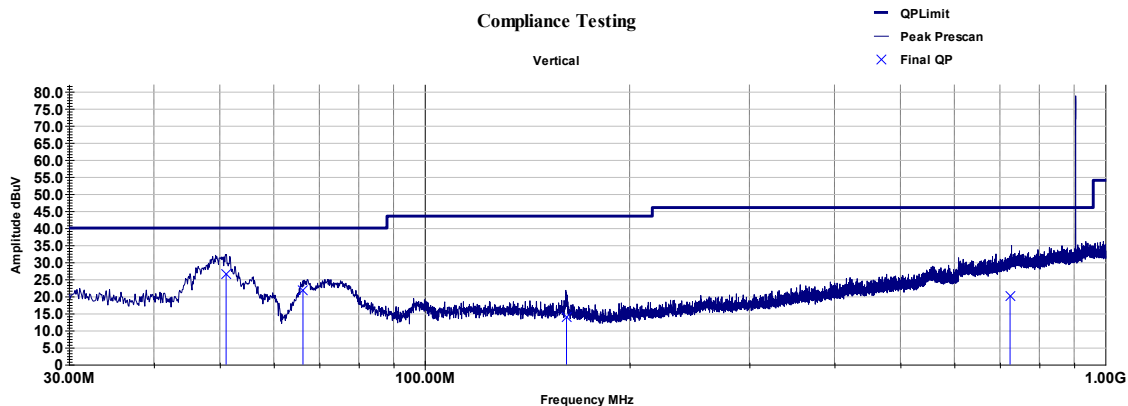
Frequency	Measured Value	Corrected Value
964.40 MHz	47.43	52.13

*Corrected value = Measured value + 4.7 dB (Appropriate maximum ground reflection factor added to the EIRP in 30 to 1000 MHz)

Radiated Plots

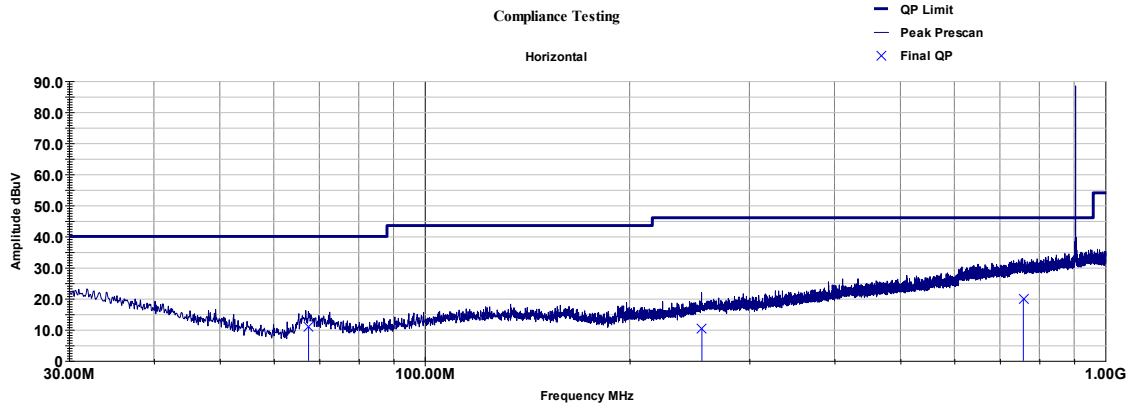
Low Channel

30-1000 MHz



Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
51.071	33.00	100.00	50.56	-24.09	26.50	40.00	-13.50
66.233	358.00	129.00	46.86	-25.10	21.80	40.00	-18.20
161.542	295.00	100.00	33.64	-19.65	14.00	43.50	-29.50
724.606	24.00	325.00	25.78	-5.71	20.10	46.00	-25.90
Final = Raw + Path Loss							
Margin = Final - Limit							

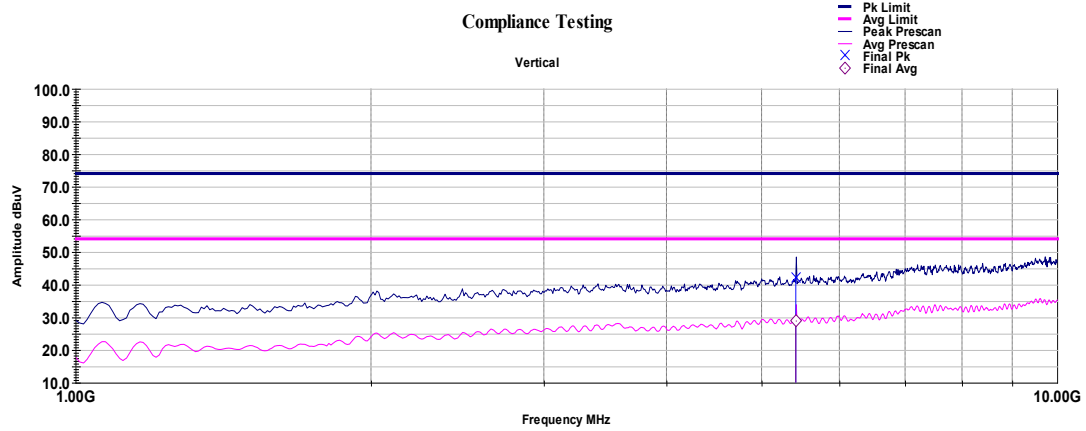
***903 MHz LoRa Low channel fundamental**



Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
67.495	282.00	315.00	35.96	-25.13	10.80	40.00	-29.20
255.433	284.00	219.00	27.48	-17.20	10.30	46.00	-35.70
757.916	335.00	394.00	25.24	-5.49	19.80	46.00	-26.20
Final = Raw + Path Loss							
Margin = Final - Limit							

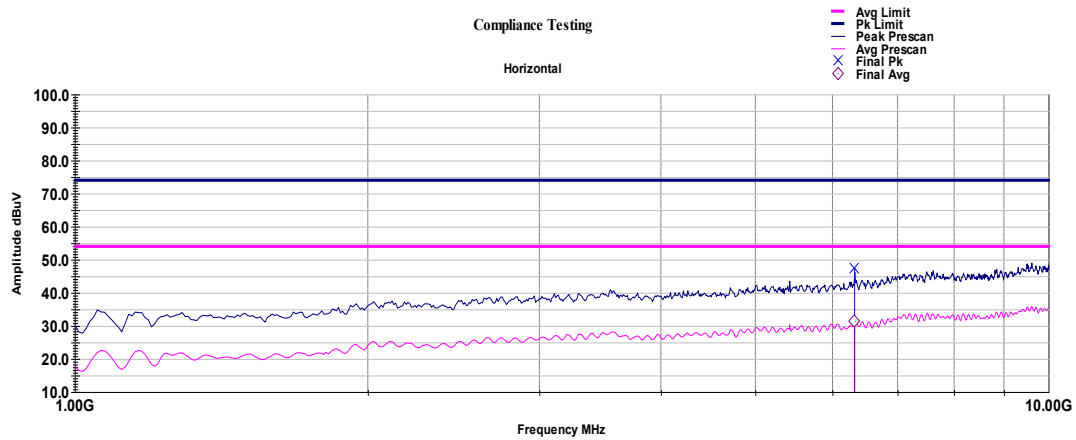
***903 MHz LoRa Low channel fundamental**

1 – 10 GHz Range



Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
Hz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
5417600000	180.00	325.00	45.89	32.55	-3.57	42.32	74.00	-31.68	36.68	54	-17.32
Final Pk = Raw + Path Loss											
Final Avg = Raw + Path Loss + DCCF											
Margin = Final - Limit											

*DCCF = 7.7 dB (17% duty cycle)

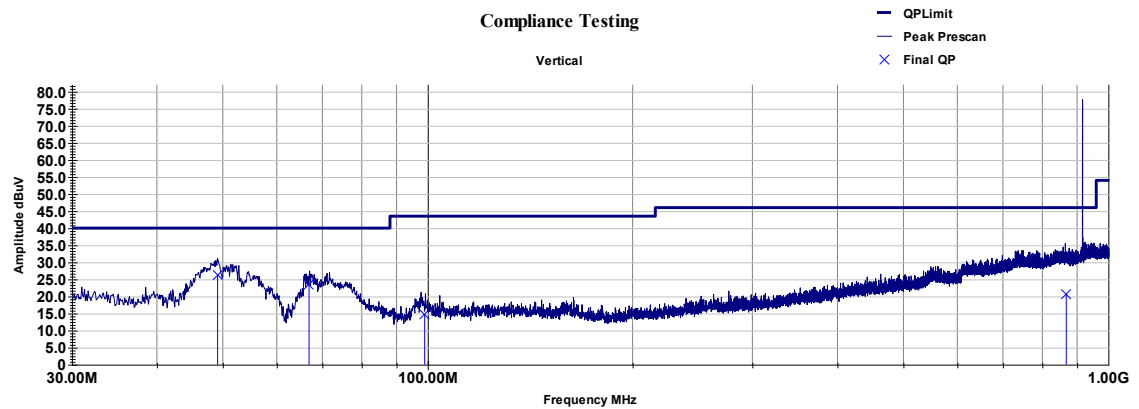


Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
Hz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
6322735000	78.00	100.00	47.74	31.82	-0.33	47.41	74.00	-26.59	39.19	54	-14.81
Final Pk = Raw + Path Loss											
Final Avg = Raw + Path Loss + DCCF											
Margin = Final - Limit											

*DCCF = 7.7 dB (17% duty cycle)

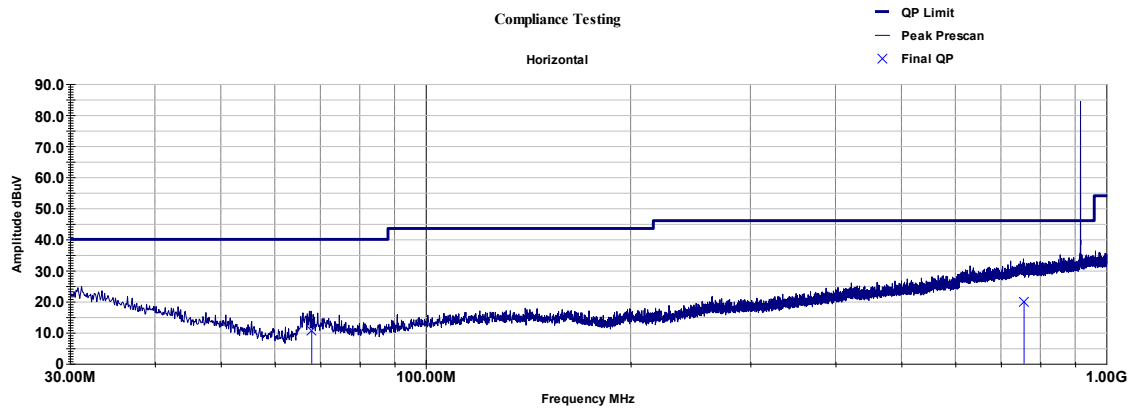
Mid Channel

30-1000 MHz



Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
49.123	51.00	105.00	49.59	-23.32	26.30	40.00	-13.70
66.924	224.00	105.00	48.59	-25.08	23.50	40.00	-16.50
98.961	194.00	133.00	34.53	-19.90	14.60	43.50	-28.90
867.281	128.00	395.00	24.41	-3.75	20.70	46.00	-25.30
Final = Raw + Path Loss							
Margin = Final - Limit							

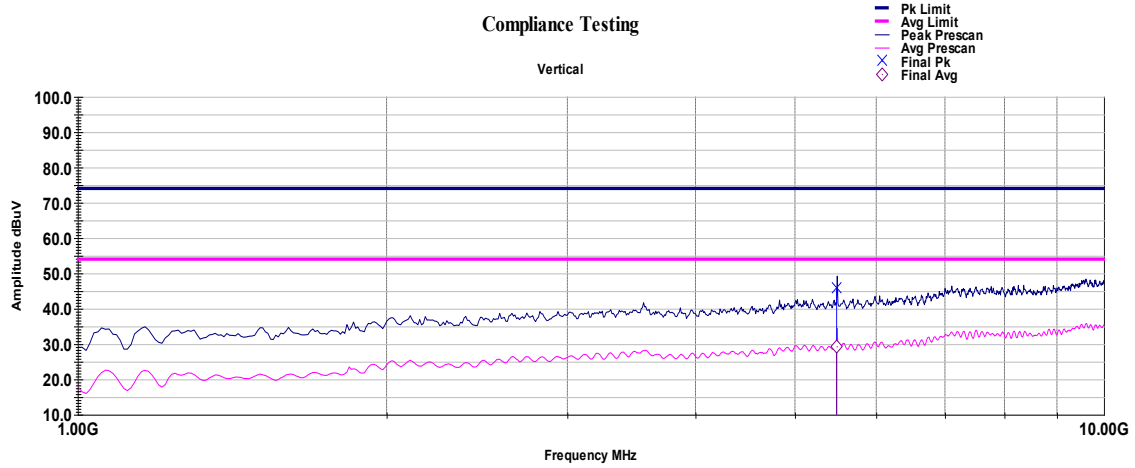
***915 MHz LoRa middle channel fundamental**



Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
67.992	269.00	263.00	35.60	-25.08	10.50	40.00	-29.50
757.209	313.00	381.00	25.27	-5.50	19.80	46.00	-26.20
Final = Raw + Path Loss							
Margin = Final - Limit							

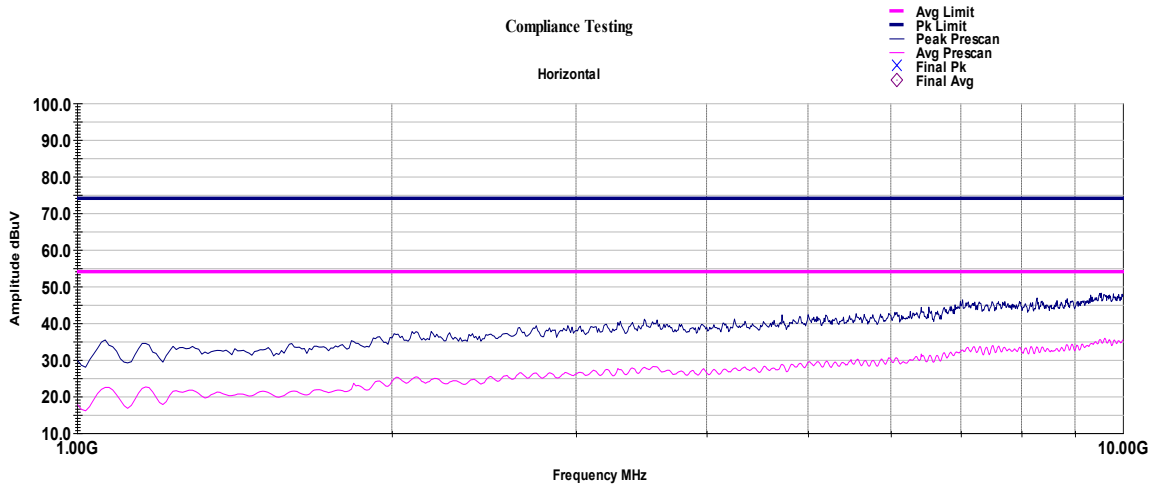
***915 MHz LoRa middle channel fundamental**

1 – 18 GHz Range



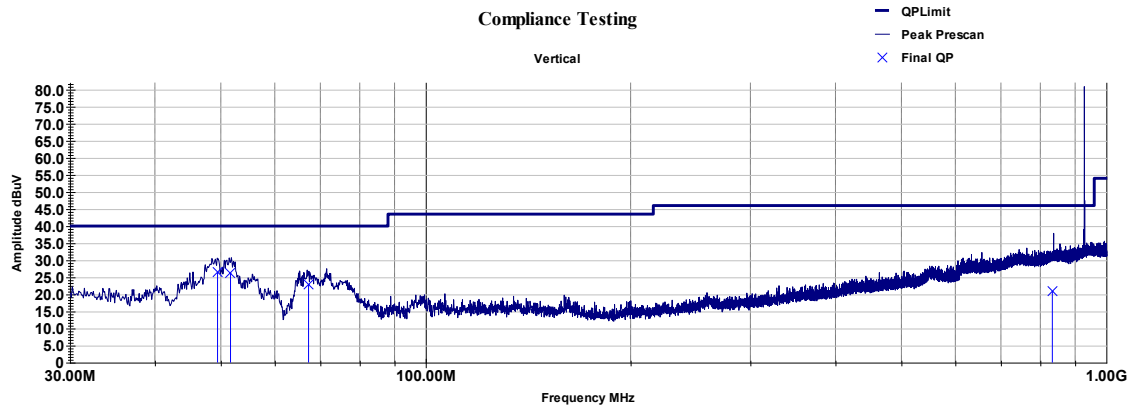
Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
Hz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
5490118000	344.00	157.00	49.28	32.66	-3.35	45.94	74.00	-28.06	37.01	54	-16.99
Final Pk = Raw + Path Loss											
Final Avg = Raw + Path Loss + DCCF											
Margin = Final - Limit											

*DCCF = 7.7 dB (17% duty cycle)



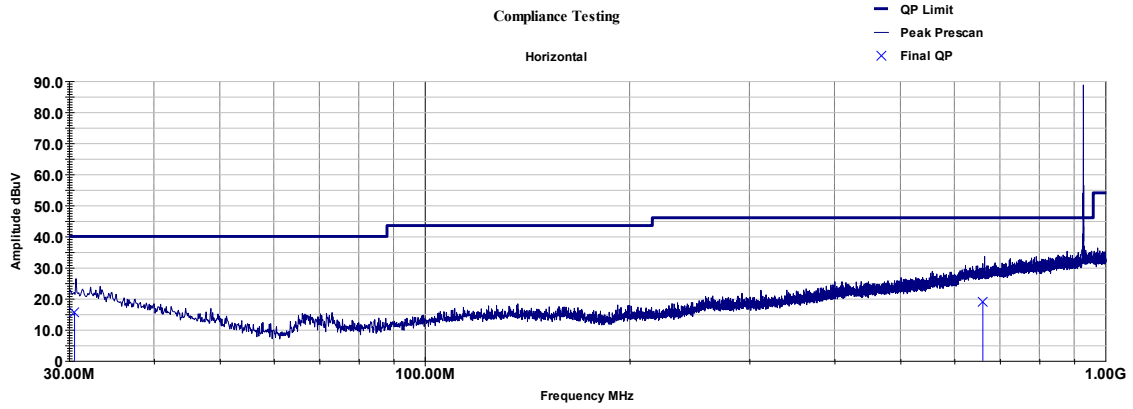
High Channel

30-1000 MHz



Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
49.451	19.00	100.00	49.89	-23.44	26.40	40.00	-13.60
51.658	8.00	105.00	50.64	-24.32	26.30	40.00	-13.70
67.268	288.00	117.00	48.08	-25.06	23.00	40.00	-17.00
833.13	201.00	227.00	24.74	-3.79	20.90	46.00	-25.10
Final = Raw + Path Loss							
Margin = Final - Limit							

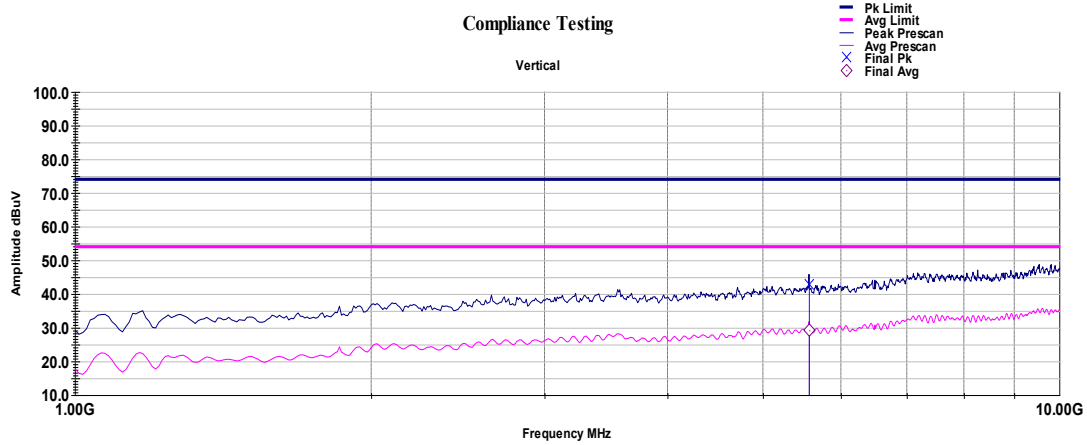
***927 MHz LoRa High channel fundamental**



Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
30.579	265.00	385.00	27.26	-11.84	15.40	40.00	-24.60
660.725	181.00	100.00	26.41	-7.60	18.80	46.00	-27.20
Final = Raw + Path Loss							
Margin = Final - Limit							

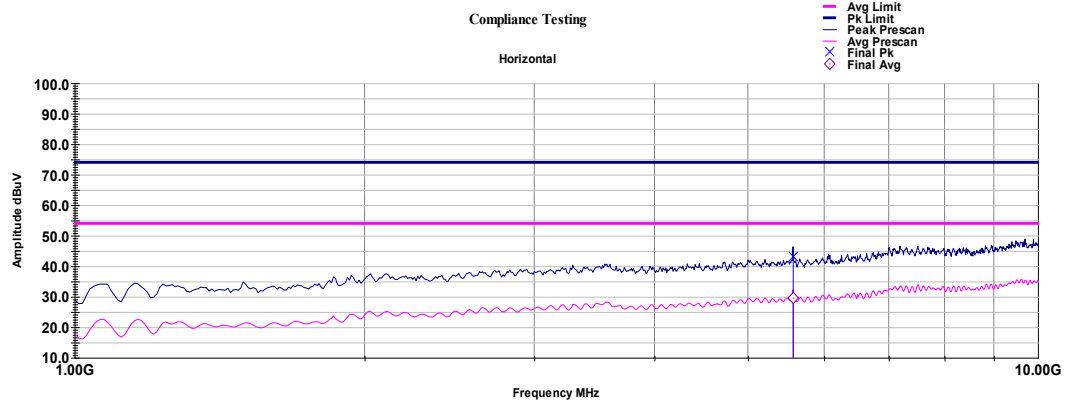
***927 MHz LoRa High channel fundamental**

1 – 18 GHz Range



Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
Hz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
5573406000	3.00	146.00	46.10	32.53	-3.32	42.79	74.00	-31.22	36.91	54	-17.09
Final Pk = Raw + Path Loss											
Final Avg = Raw + Path Loss + DCCF											
Margin = Final - Limit											

*DCCF = 7.7 dB (17% duty cycle)

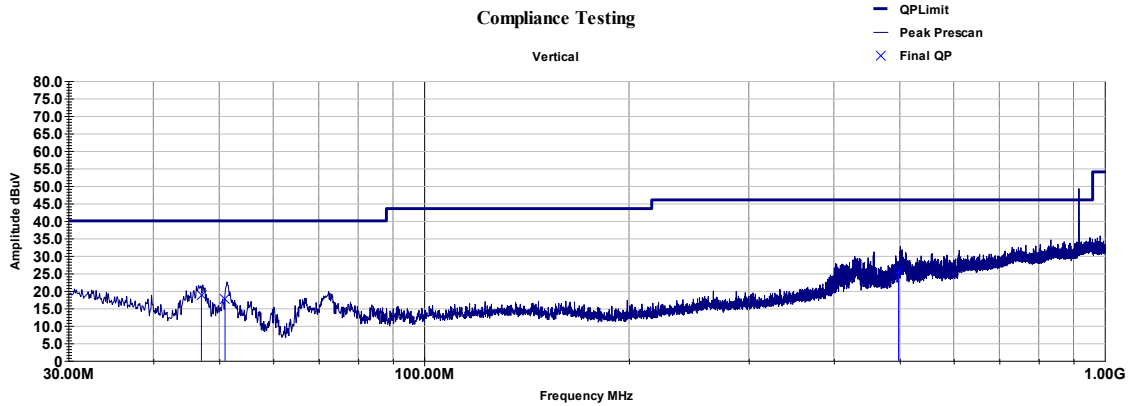


Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
Hz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
5571609000	323.00	151.00	46.36	32.99	-3.32	43.04	74.00	-30.96	37.37	54	-16.63
Final Pk = Raw + Path Loss											
Final Avg = Raw + Path Loss + DCCF											
Margin = Final - Limit											

*DCCF = 7.7 dB (17% duty cycle)

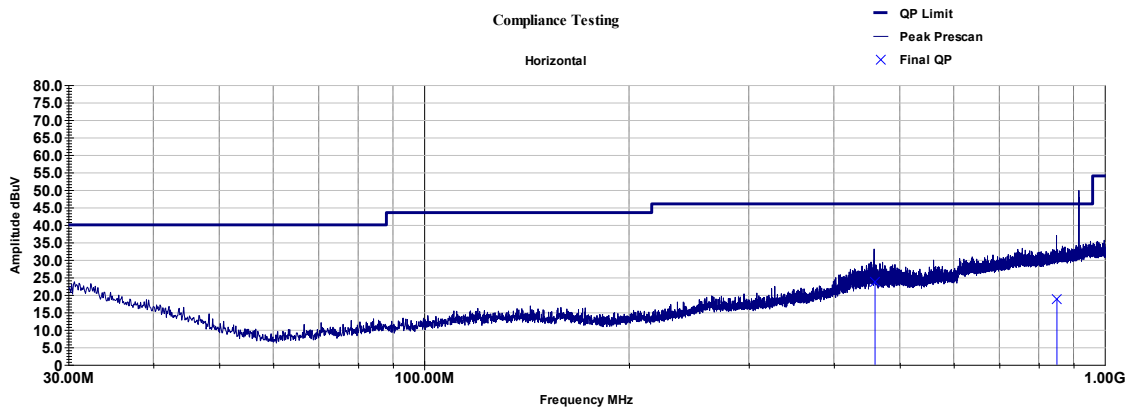
Worst Case BLE 1 Mbps Low Channel and LoRa middle channel simultaneous transmission plots

30-1000 MHz Range



Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
47.073	92.00	105.00	41.12	-22.30	18.80	40.00	-21.20
50.991	80.00	100.00	41.68	-24.05	17.60	40.00	-22.40
497.831	159.00	100.00	37.00	-11.22	25.80	46.00	-20.20
Final = Raw + Path Loss							
Margin = Final - Limit							

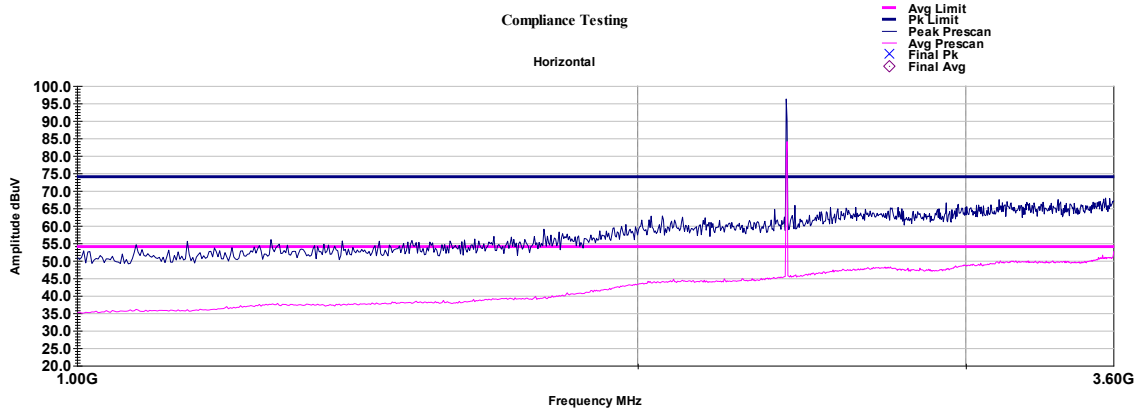
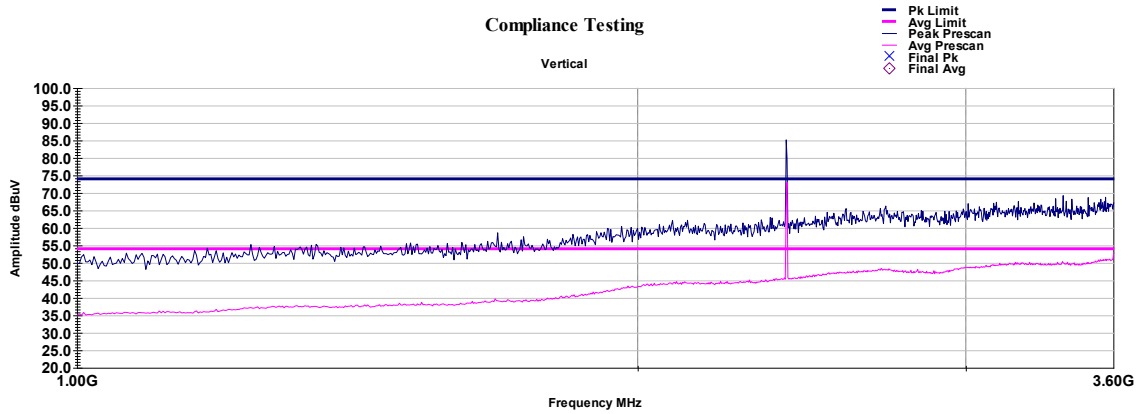
***915 MHz LoRa middle channel fundamental**



Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
459.816	100.00	109.00	35.76	-12.06	23.70	46.00	-22.30
850.64	97.00	394.00	22.60	-3.80	18.80	46.00	-27.20
Final = Raw + Path Loss							
Margin = Final - Limit							

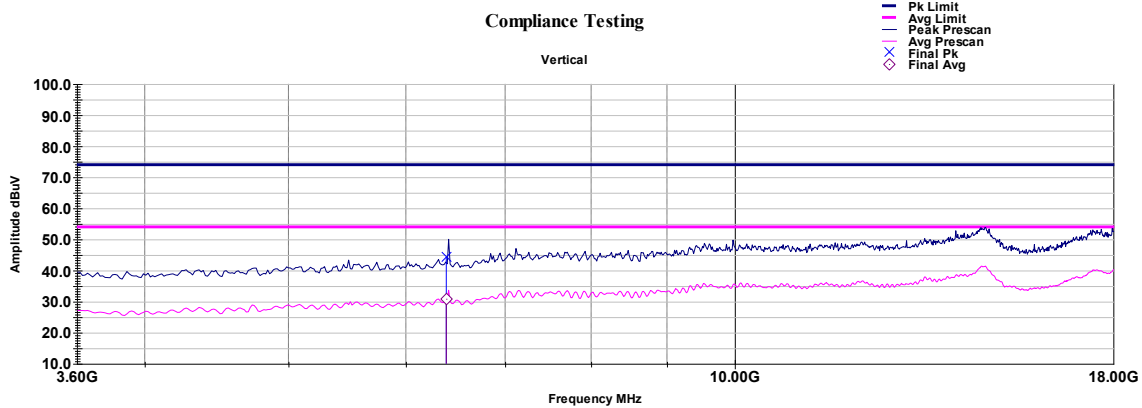
***915 MHz LoRa middle channel fundamental**

1 - 3.6 GHz Range



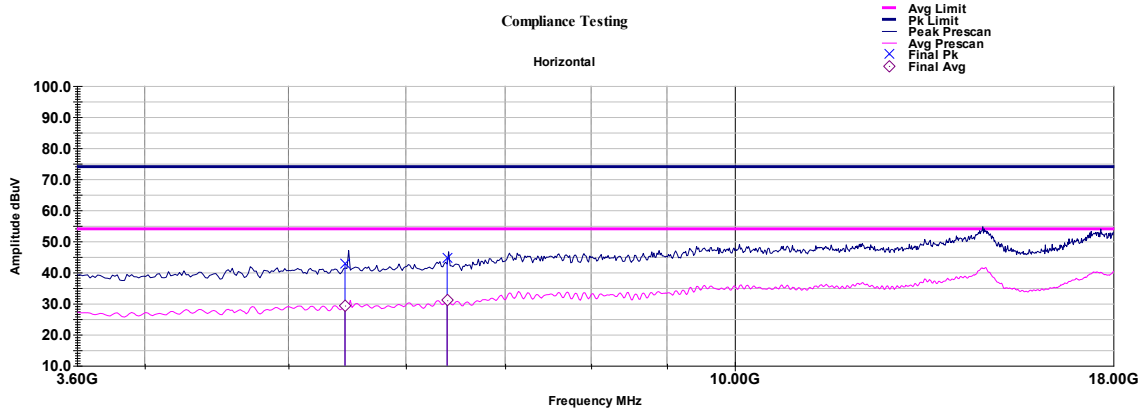
*BLE 2.402 GHz Fundamental

3.6 – 18 GHz Range



Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
Hz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
6389059000	228.00	105.00	44.44	30.98	-0.08	44.36	74.00	-29.64	38.60	54	-15.40
Final Pk = Raw + Path Loss											
Final Avg = Raw + Path Loss + DCCF											
Margin = Final - Limit											

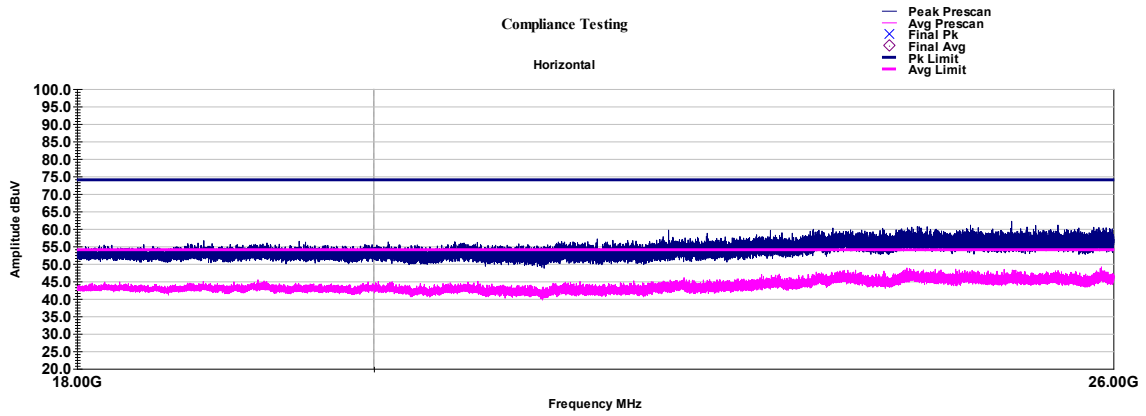
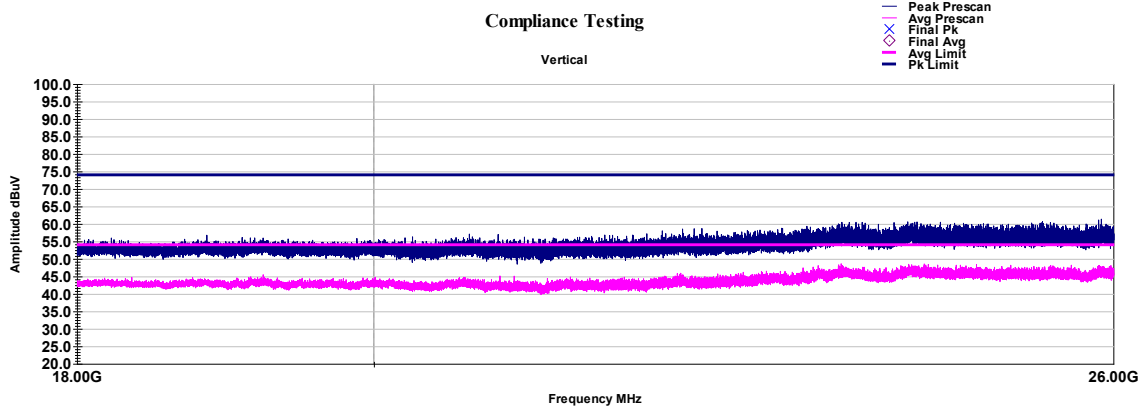
*DCCF = 7.7 dB (17% duty cycle)



Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
Hz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
5459058000	146.00	109.00	46.11	32.74	-3.43	42.68	74.00	-31.32	37.01	54	-16.99
6396983000	100.00	325.00	44.67	31.10	-0.06	44.62	74.00	-29.39	38.74	54	-15.26
Final Pk = Raw + Path Loss											
Final Avg = Raw + Path Loss + DCCF											
Margin = Final - Limit											

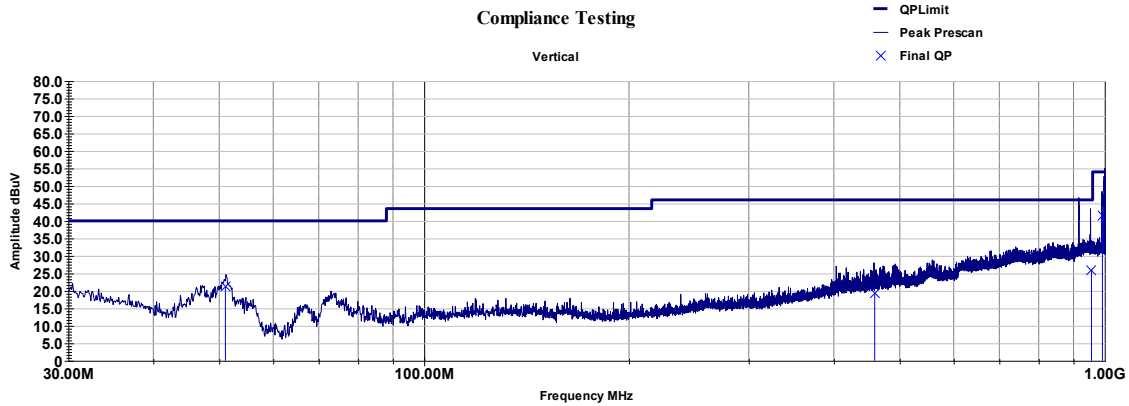
*DCCF = 7.7 dB (17% duty cycle)

18 - 26 GHz Range



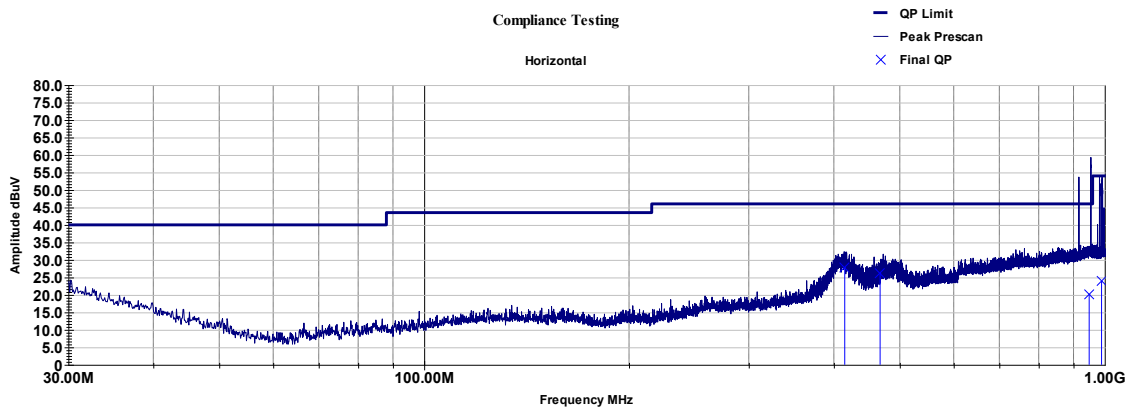
Worst Case BLE 1 Mbps Low Channel and LoRa middle channel simultaneous transmission plots

30-1000 MHz Range



Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
51.048	130.00	100.00	45.31	-24.08	21.20	40.00	-18.80
459.25	310.00	198.00	31.73	-12.36	19.40	46.00	-26.60
956.332	31.00	106.00	27.31	-1.54	25.80	46.00	-20.20
992.36	355.00	258.00	42.99	-1.54	41.50	54.00	-12.50
Final = Raw + Path Loss							
Margin = Final - Limit							

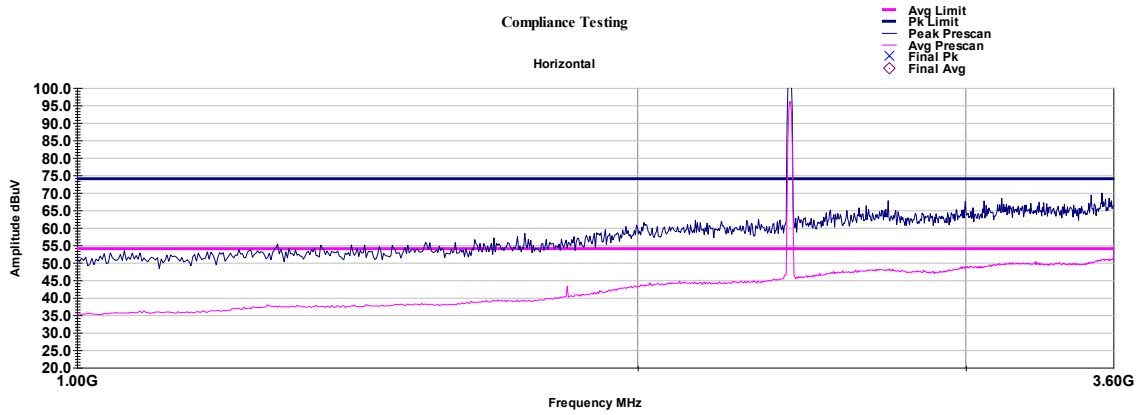
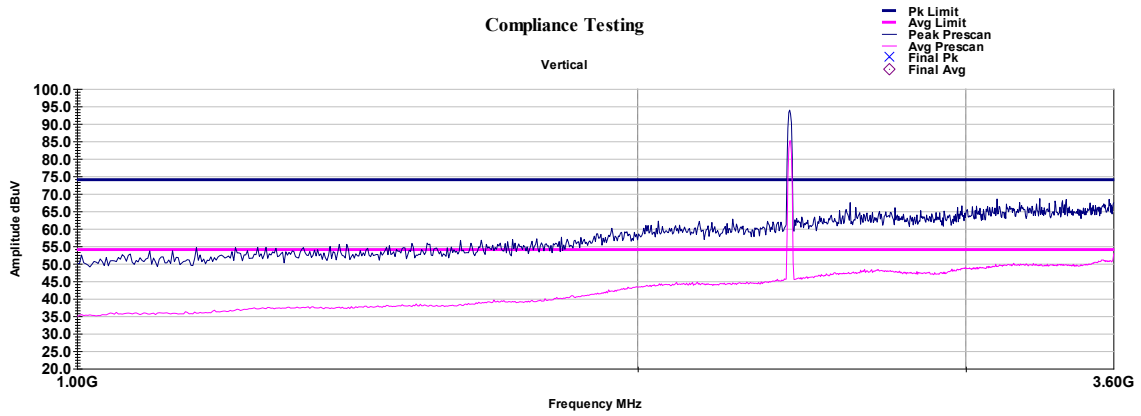
***915 MHz LoRa middle channel fundamental**



Frequency	Azimuth	Height	Raw QP	Correction	Final QP	Limit	QP Margin
MHz	deg	cm	dBuV	dB	dBuV/m	dBuV/m	dB
414.965	31.00	239.00	40.42	-12.51	27.90	46.00	-18.10
467.705	43.00	196.00	38.05	-11.83	26.20	46.00	-19.80
948.72	42.00	400.00	21.78	-1.58	20.20	46.00	-25.80
989.578	49.00	376.00	25.46	-1.54	23.90	54.00	-30.10
Final = Raw + Path Loss							
Margin = Final - Limit							

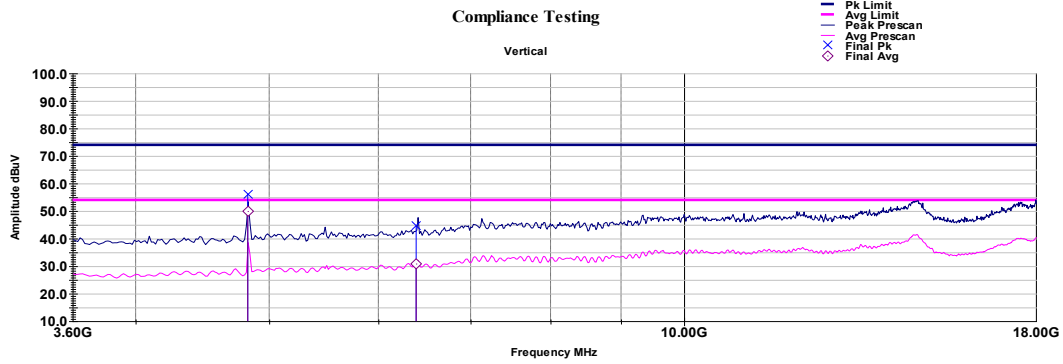
***915 MHz LoRa middle channel fundamental**

1 - 3.6 GHz Range



*Wi-Fi 802.11b 2412 MHz Fundamental

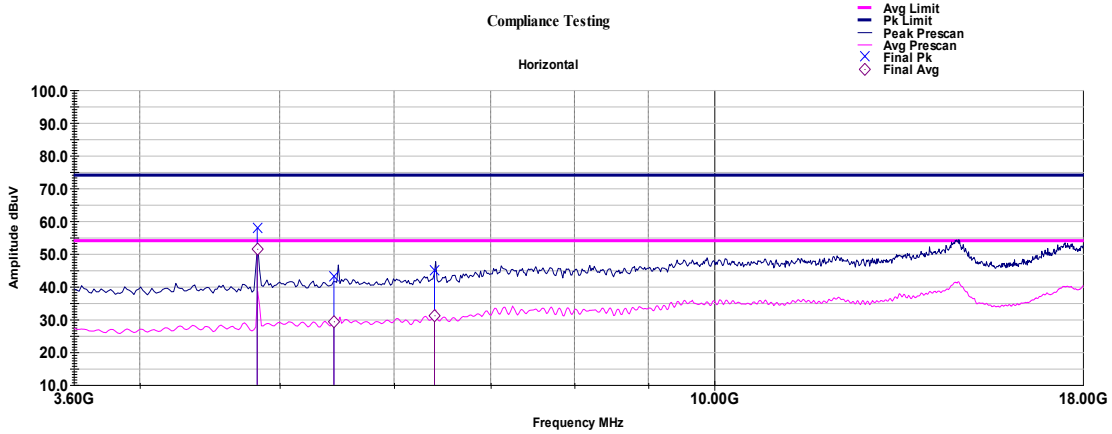
3.6 – 18 GHz Range



Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
Hz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
4824090000	324.00	100.00	60.23	54.10	-4.13	56.10	74.00	-17.90	49.97	54	-4.03
6391466000	72.00	362.00	44.66	30.97	-0.07	44.58	74.00	-29.42	38.6*	54	-15.40
Final = Raw + Path Loss											
Margin = Final - Limit											

*LoRa DCCF = 7.7 dB (17% duty cycle)

802.11b harmonic at 4.824 GHz unaffected by LoRa Transmission

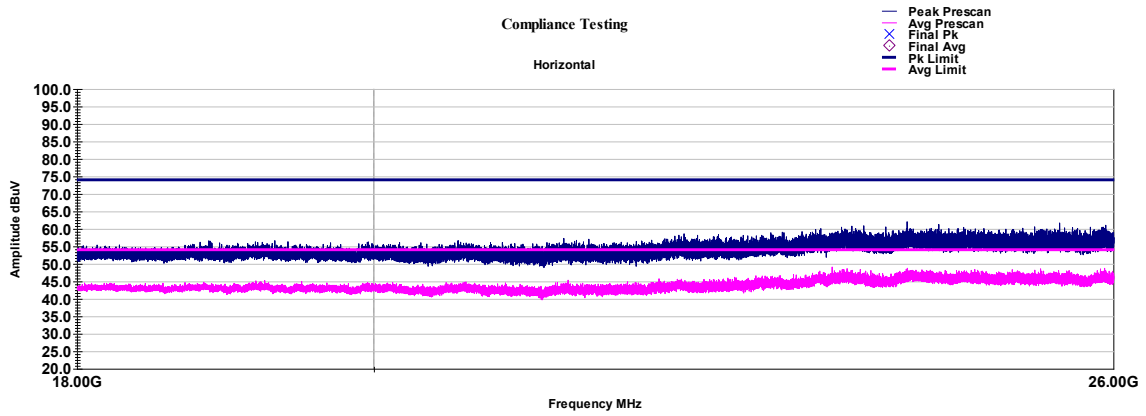
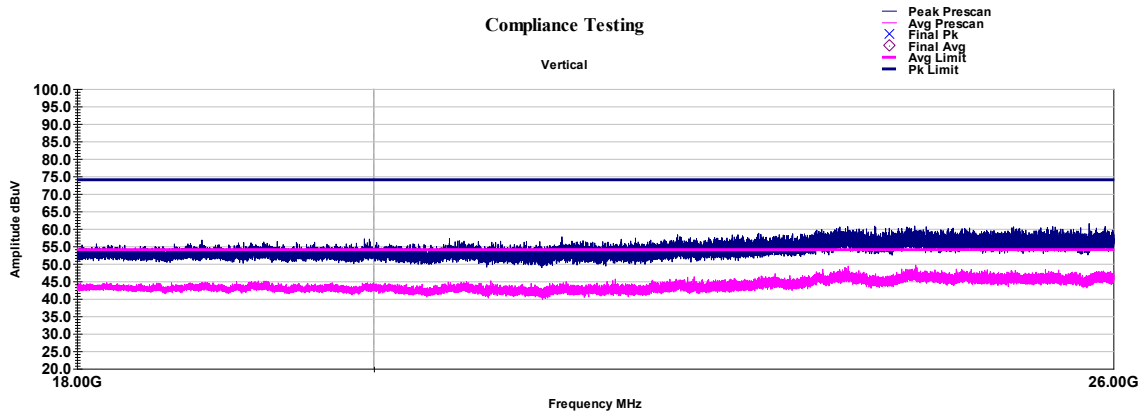


Frequency	Azimuth	Height	Raw Pk	Raw Avg	Correction	Final Pk	Pk Limit	Pk Margin	Final Avg	Avg Limit	Avg Margin
Hz	deg	cm	dBuV	dBuV	dB	dBuV/m	dBuV/m	dB	dBuV/m	dBuV/m	dB
4823965000	88.00	100.00	62.04	55.67	-4.13	57.91	74.00	-16.09	51.54	54	-2.46
5451527000	117.00	169.00	46.66	32.86	-3.46	43.20	74.00	-30.80	37.1*	54	-16.90
6400433000	60.00	113.00	45.07	31.30	-0.05	45.03	74.00	-28.97	38.96*	54	-15.04
Final = Raw + Path Loss											
Margin = Final - Limit											

*LoRa DCCF = 7.7 dB (17% duty cycle)

802.11b harmonic at 4.824 GHz unaffected by LoRa Transmission

18 - 26 GHz Range



Occupied Bandwidth

Engineer: Harshith Devaraja

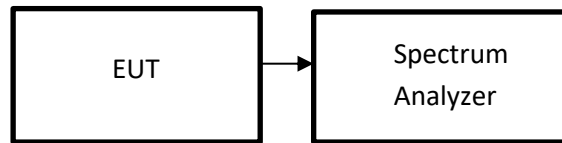
Test Date: 05/22/26

Test Procedure

Conducted Method

EUT, via a pigtail cable, were directly connected to the spectrum analyzer to verify that the EUT met the requirements for Occupied Bandwidth.

Test Setup



The Spectrum Analyzer was set to the following:

RBW = 1%-5% of the OWB but not less than 100 kHz

VBW $\geq 3 \times$ RBW

Peak Detector

Trace mode = max hold

Sweep = auto couple

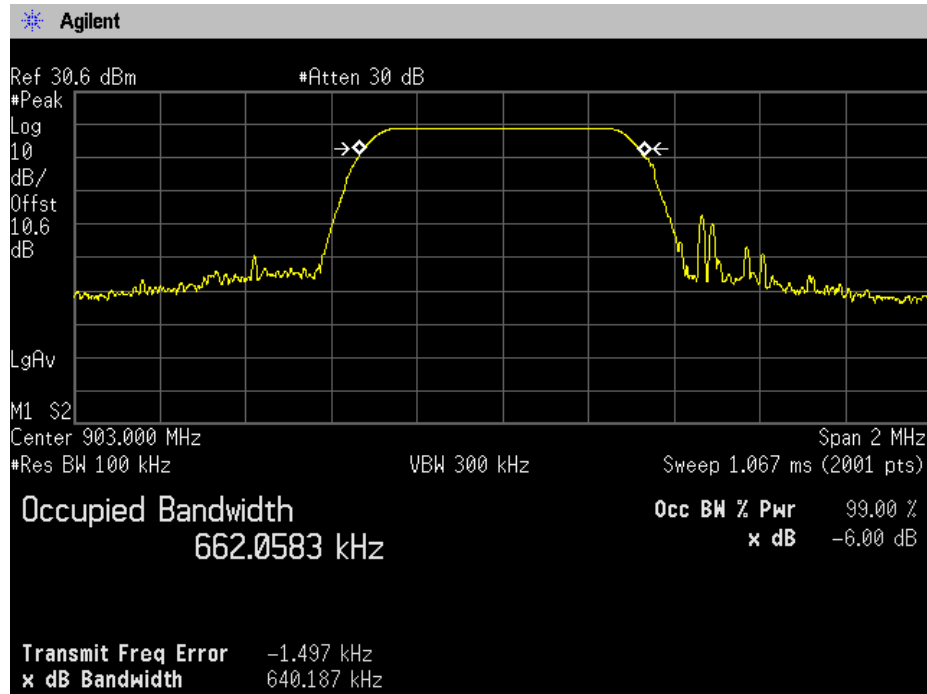
Span = $(1.5 - 5) \times$ OBW

-6 dB Occupied Bandwidth Summary

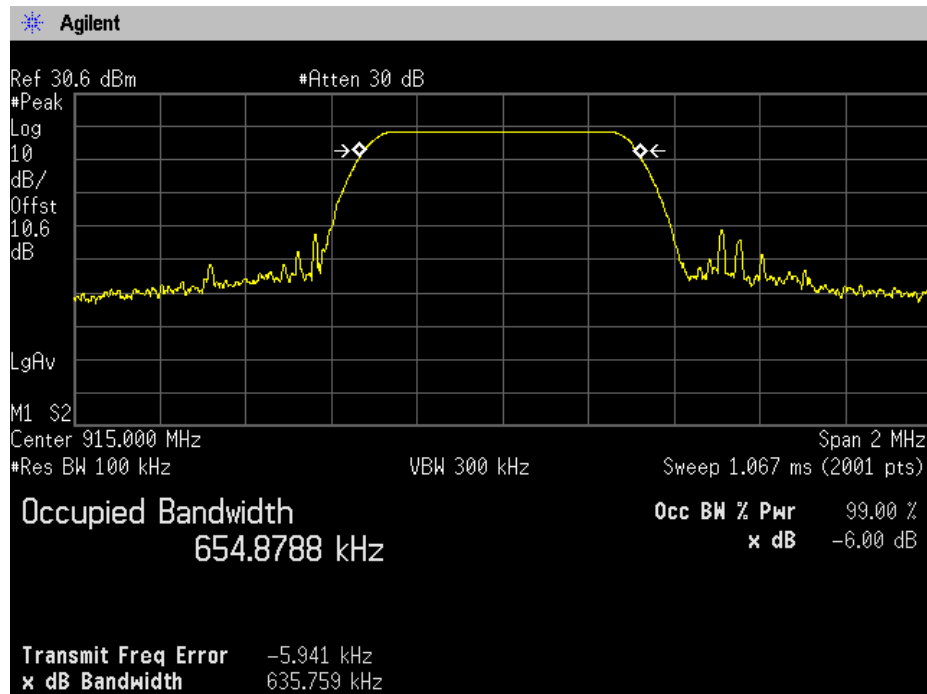
Frequency (MHz)	Measured Bandwidth (kHz)	Specification Limit (kHz)	Result
903	640.187	> 500	Pass
915	635.759	> 500	Pass
927	638.924	> 500	Pass

-6 dB and 99% Bandwidth Plots

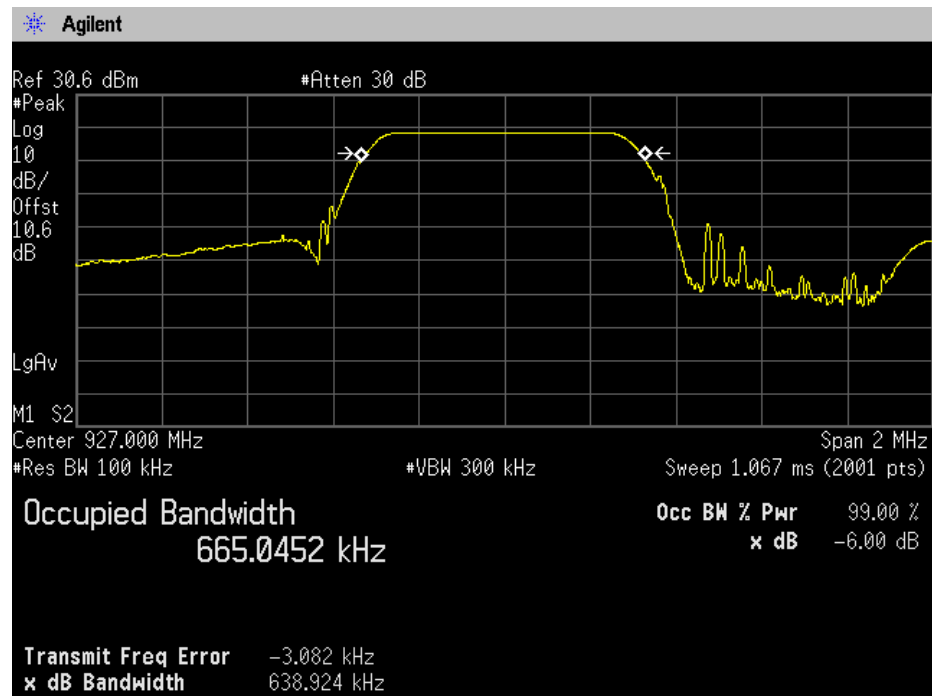
Low Channel



Mid channel



High channel



Power Spectral Density

Engineer: Harshith Devaraja

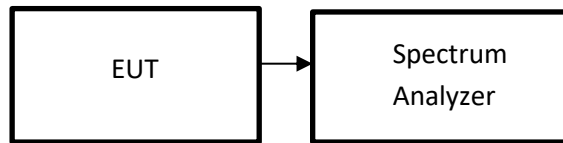
Test Date: 05/22/26

Test Procedure

Conducted Method

EUT, via a pigtail cable, were directly connected to the spectrum analyzer to verify that the EUT met the requirements for power spectral density.

Test Setup



The Spectrum Analyzer was set to the following:

RBW = 3 kHz

VBW $\geq 3 \times$ RBW

Average Detector

Trace Averaging = minimum 100

Sweep = auto couple

Span $> 1.5 \times$ OBW

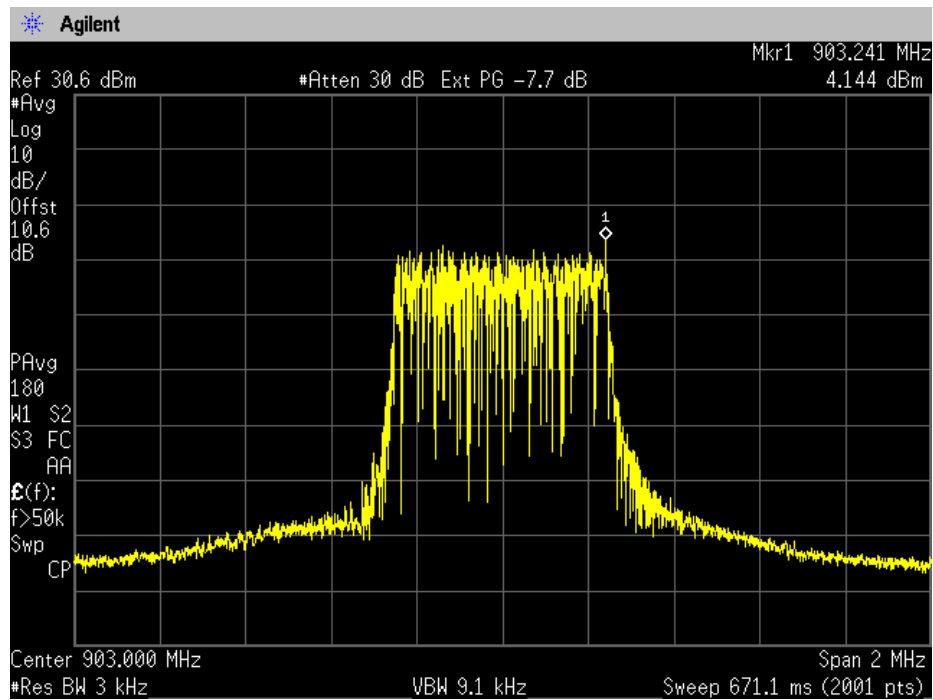
Duty Cycle correction factor = 7.7 dB (17% Duty cycle)

Power Spectral Density Summary

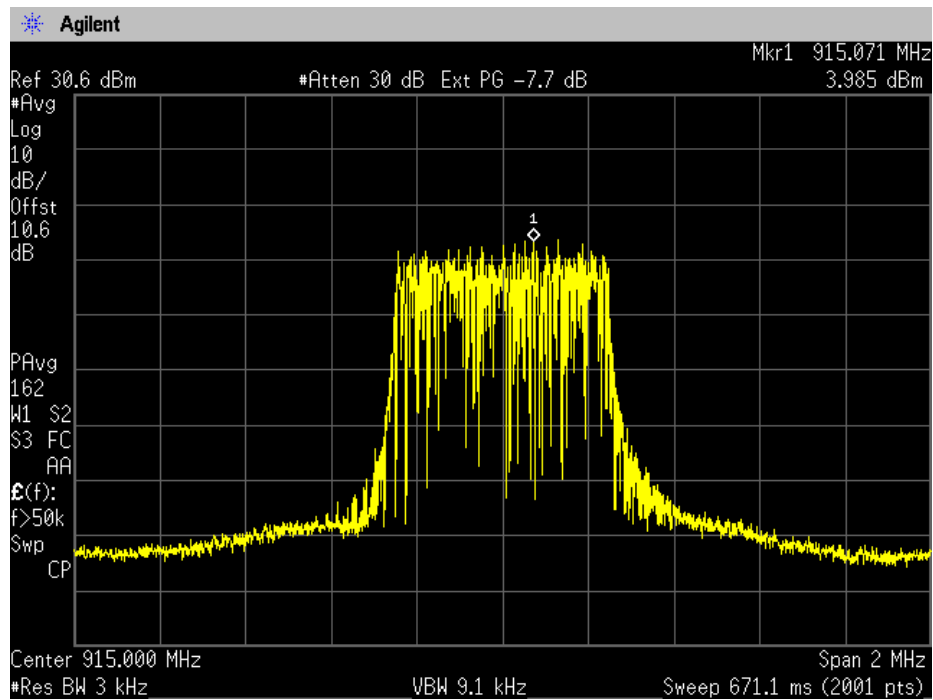
Frequency (MHz)	PSD (dBm/3kHz)	Specification Limit (dBm/3kHz)	Result
903	4.144	8	Pass
915	3.985	8	Pass
927	2.628	8	Pass

PSD Plots

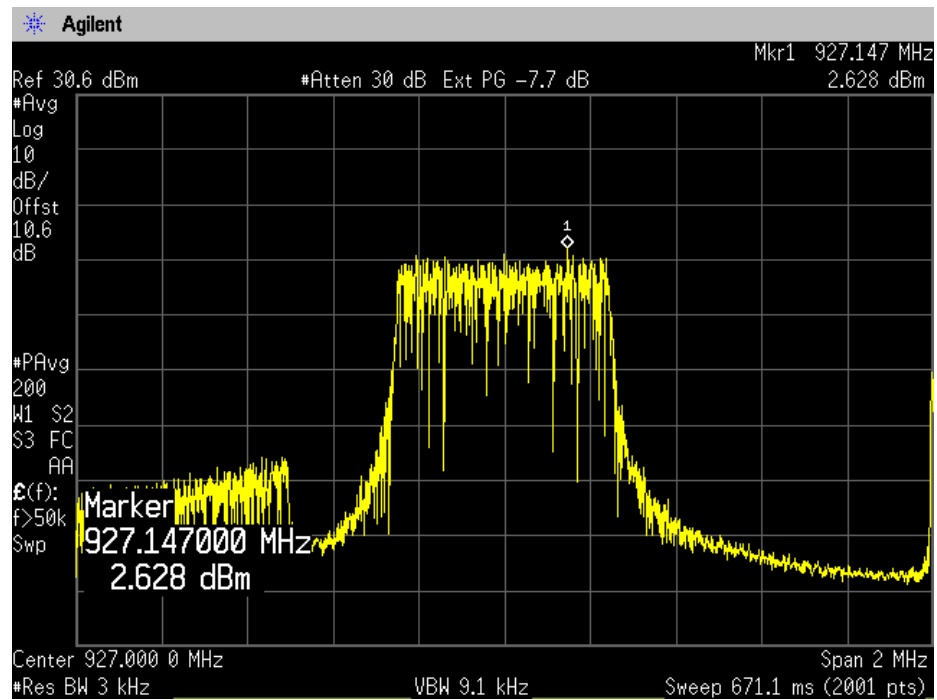
Low channel



Mid channel



High channel



Conducted Spurious Emissions

Engineer: Harshith Devaraja

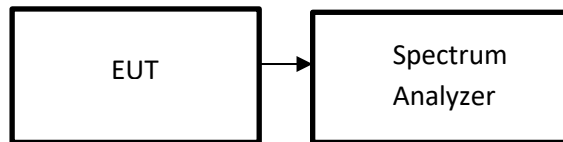
Test Date: 05/26/26

Test Procedure

Conducted Method

EUT, via a pigtail cable, were directly connected to the spectrum analyzer to verify that the EUT met the requirements for out of band emission in the 100 kHz bandwidth.

Test Setup



The Spectrum Analyzer was set to the following:

RBW = 100 kHz

VBW $\geq 3 \times$ RBW

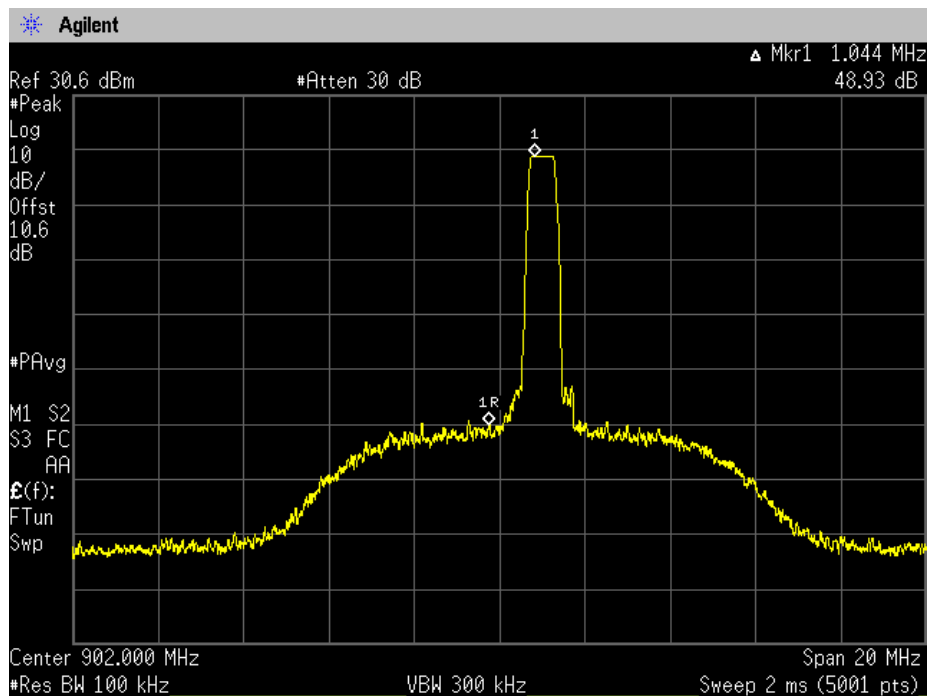
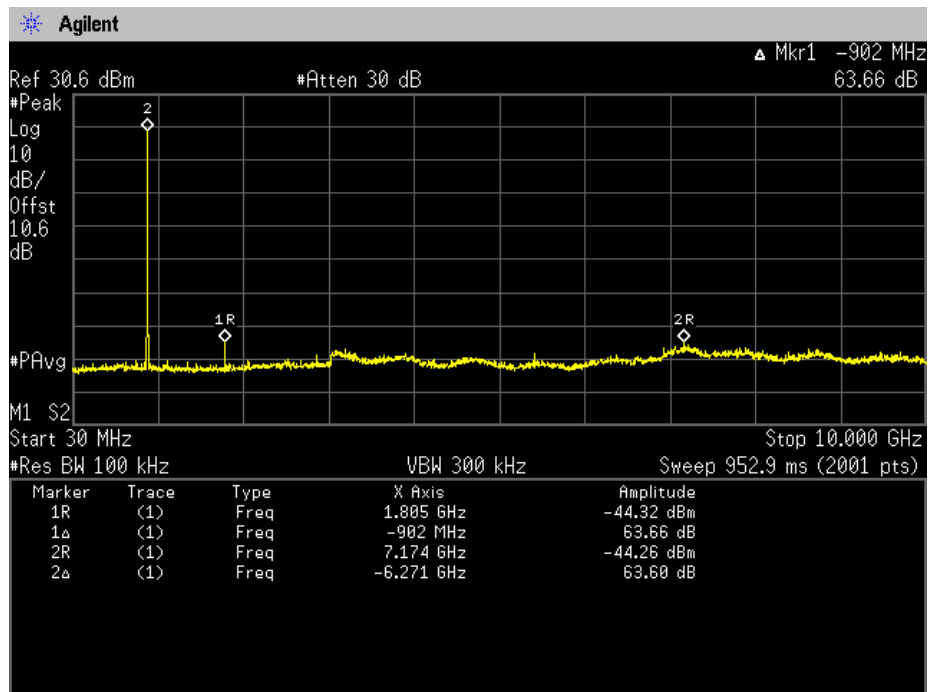
Peak Detector

Trace mode = max hold

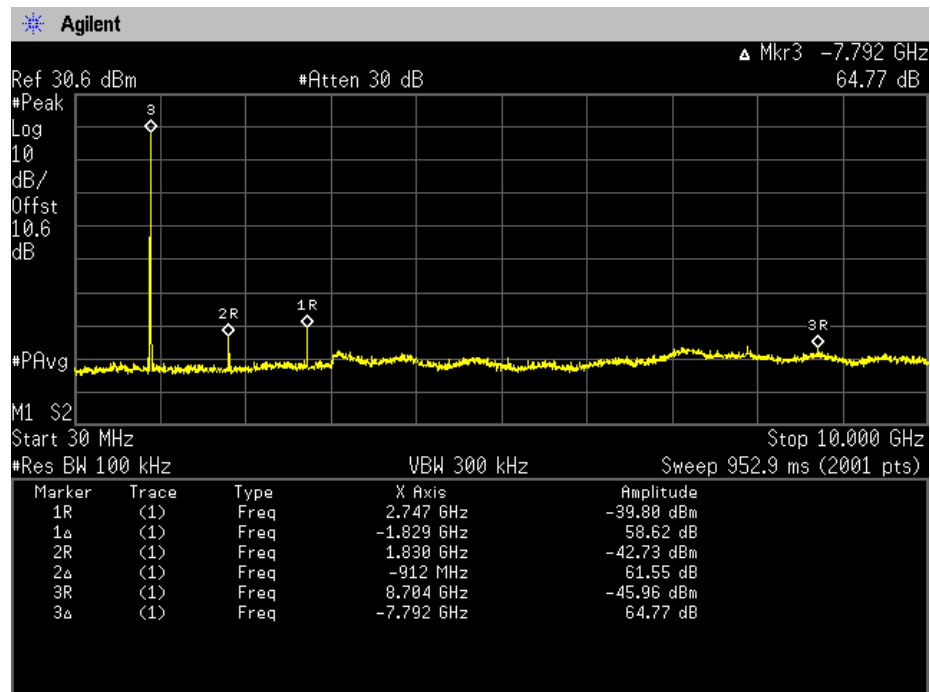
Sweep = auto couple

Conducted Spurious emission plots

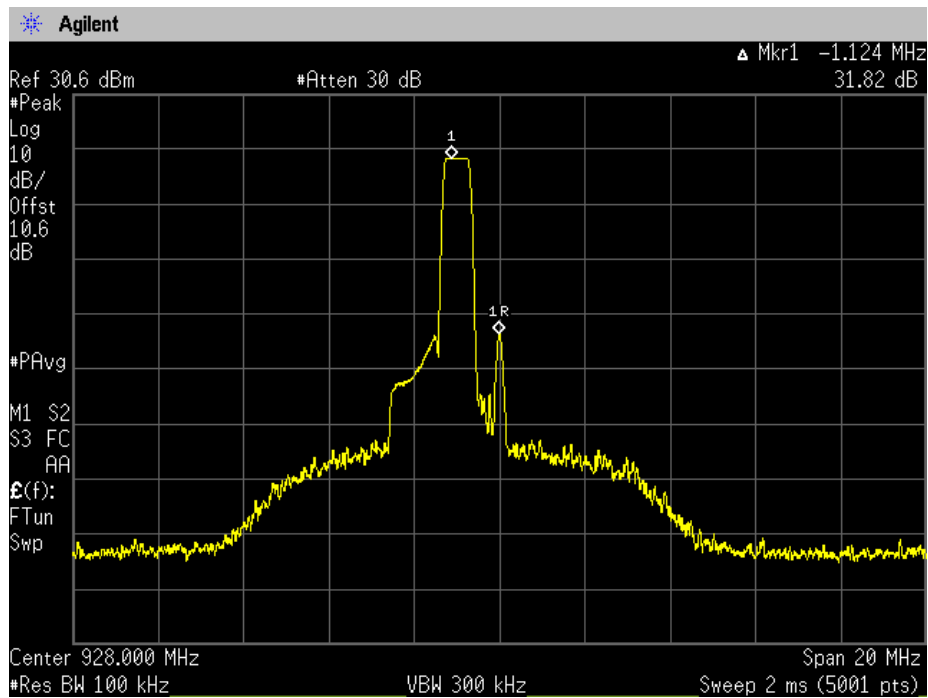
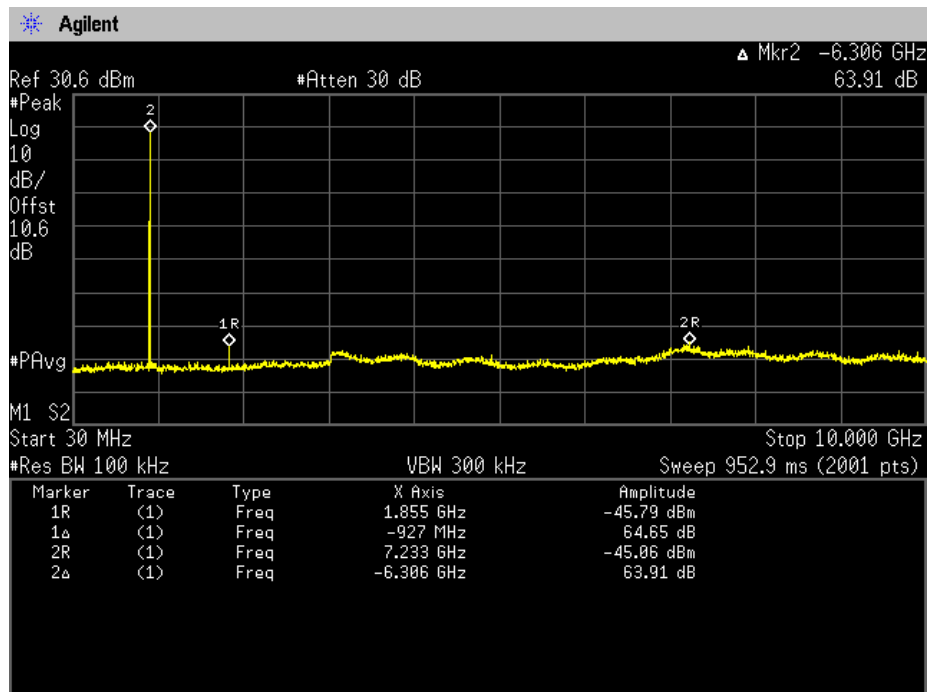
Low channel



Mid channel



High channel



A/C Powerline Conducted Emissions

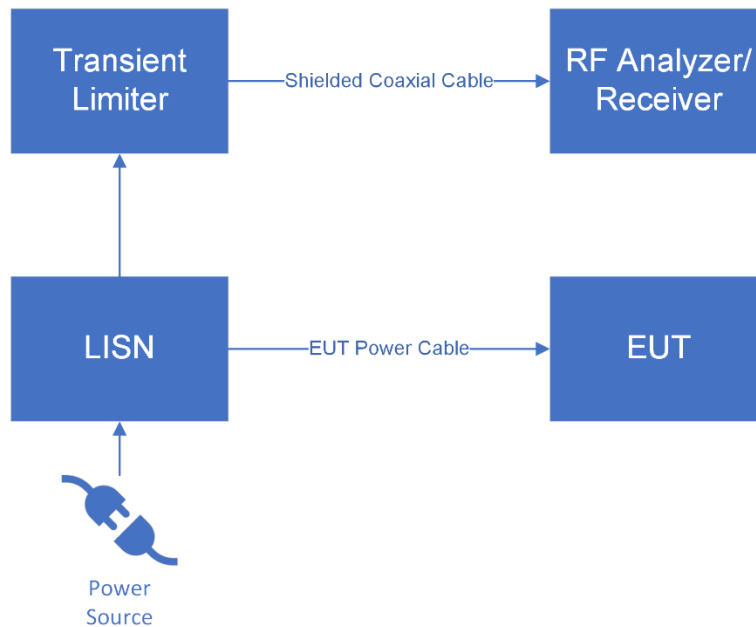
Engineer: Harshith Devaraja

Test Date: 05/28/2026

Test Procedure

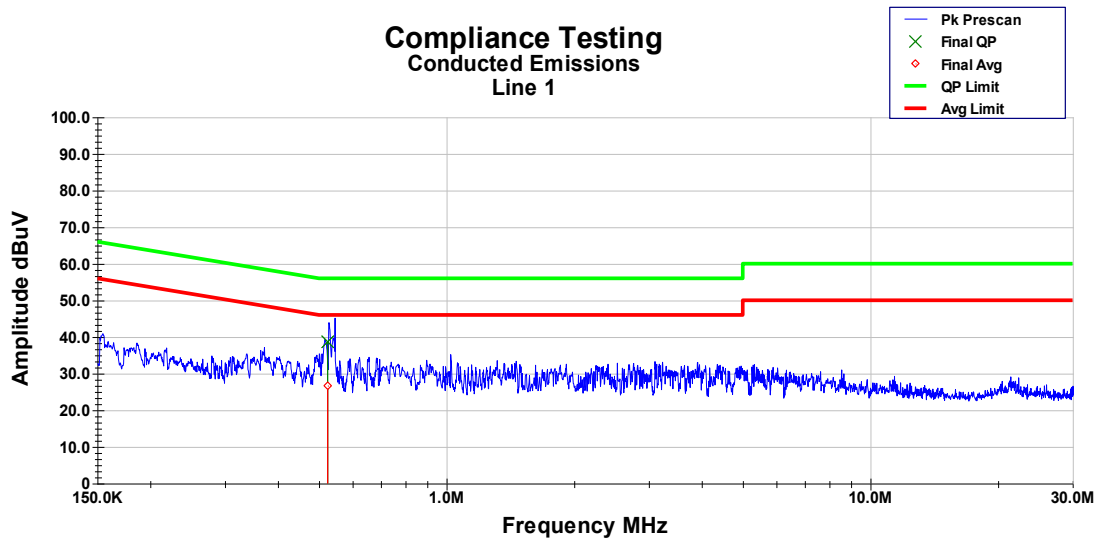
The EUT power cable was connected to a LISN and the monitored output of the LISN was connected to a transient limiter, which then connected directly to a spectrum analyzer. The conducted emissions from 150 kHz to 30 MHz were measured and compared to the specification limits.

Basic Test Setup



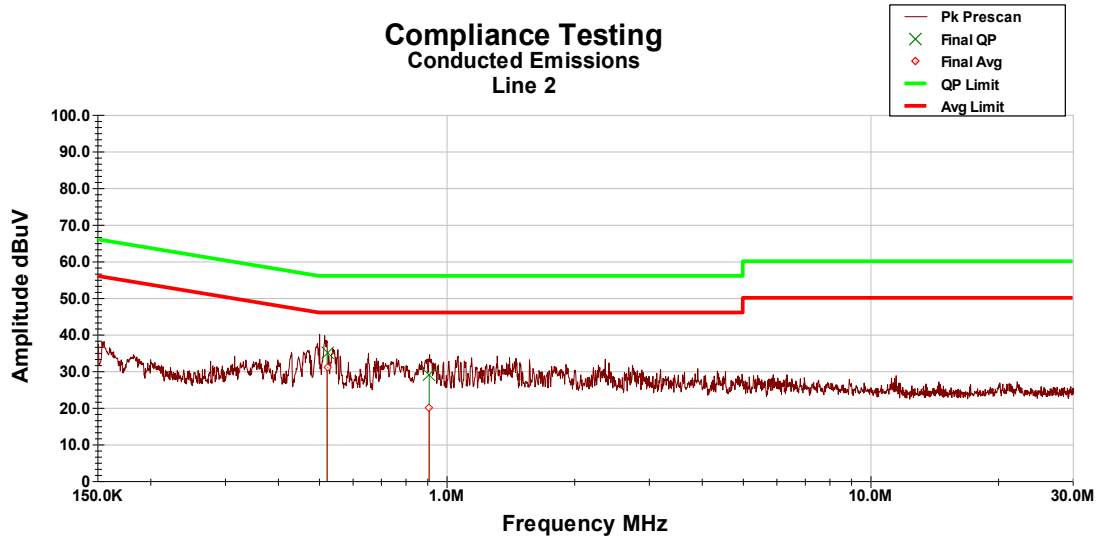
1. Worst Case LoRa Middle Channel reported.
2. Worst Case BLE 1 Mbps Low Channel and LoRa middle channel simultaneous transmission reported.
3. Worst case Wi-Fi 802.11b Low Channel and LoRa middle channel simultaneous transmission reported.

LoRa Middle Channel Plot



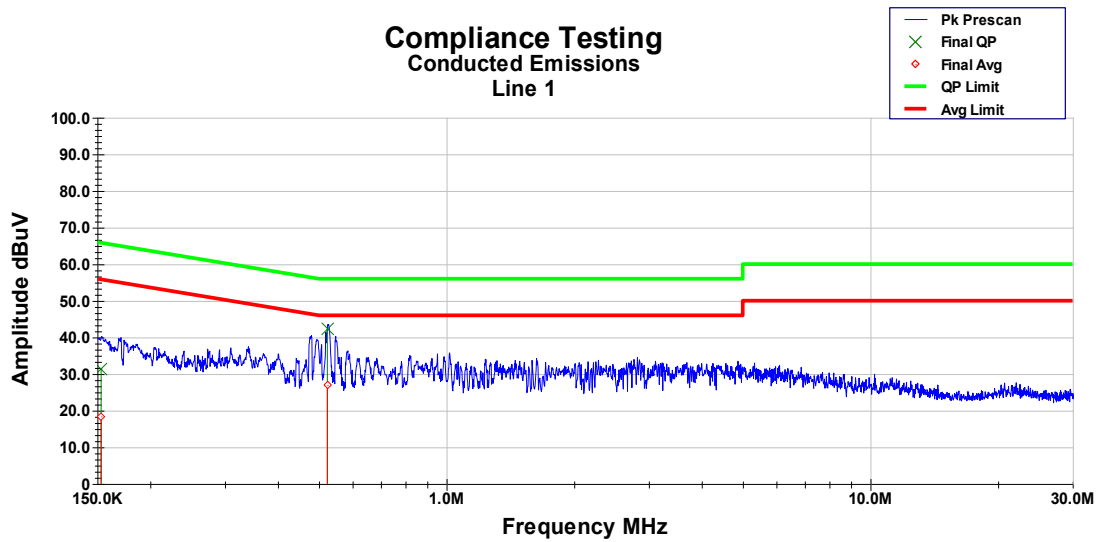
Frequency	Raw QP	Raw Avg	Path Loss	Final QP	Final Avg	QP Limit	QP Margin	Avg Limit	Avg Margin
(MHz)	dBuV	dBuV	dB	dBuV	dBuV	dBuV	dB	dBuV	dB
524.43 KHz	28.80	17.00	9.80	38.60	26.80	56.00	-17.40	46.00	-19.20
524.71 KHz	28.90	16.90	9.80	38.70	26.70	56.00	-17.30	46.00	-19.30
Final = Raw + Path Loss									
Margin = Final - Limit									

Compliance Testing Conducted Emissions Line 2



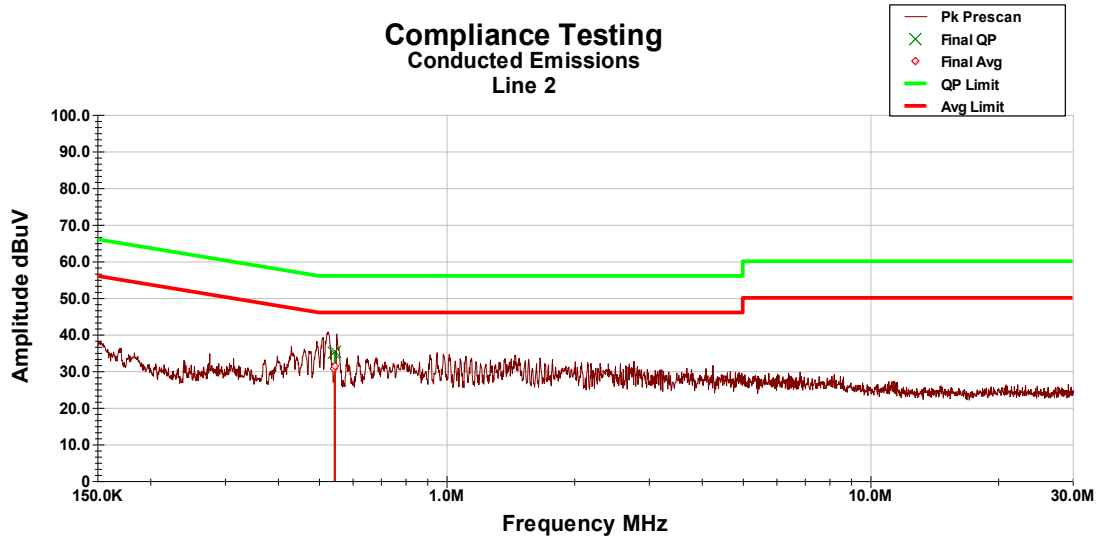
Frequency (MHz)	Raw QP dBuV	Raw Avg dBuV	Path Loss dB	Final QP dBuV	Final Avg dBuV	QP Limit dBuV	QP Margin dB	Avg Limit dBuV	Avg Margin dB
522.87 KHz	25.23	21.30	9.80	35.00	31.10	56.00	-21.00	46.00	-14.90
910.37 KHz	19.29	10.20	9.80	29.10	20.00	56.00	-26.90	46.00	-26.00
Final = Raw + Path Loss									
Margin = Final - Limit									

BLE 1 Mbps Low Channel and LoRa middle channel simultaneous transmission plot



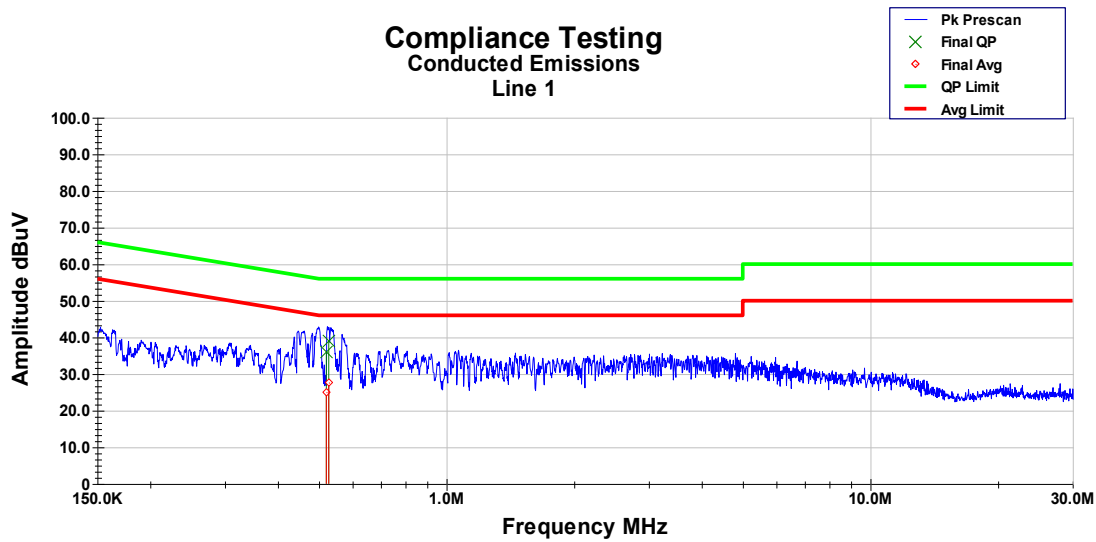
Frequency	Raw QP	Raw Avg	Path Loss	Final QP	Final Avg	QP Limit	QP Margin	Avg Limit	Avg Margin
(MHz)	dBuV	dBuV	dB	dBuV	dBuV	dBuV	dB	dBuV	dB
153.19 KHz	22.00	9.00	9.50	31.40	18.40	65.90	-34.50	55.90	-37.50
523.63 KHz	32.40	17.20	9.80	42.20	27.00	56.00	-13.80	46.00	-19.00
Final = Raw + Path Loss									
Margin = Final - Limit									

Compliance Testing Conducted Emissions Line 2

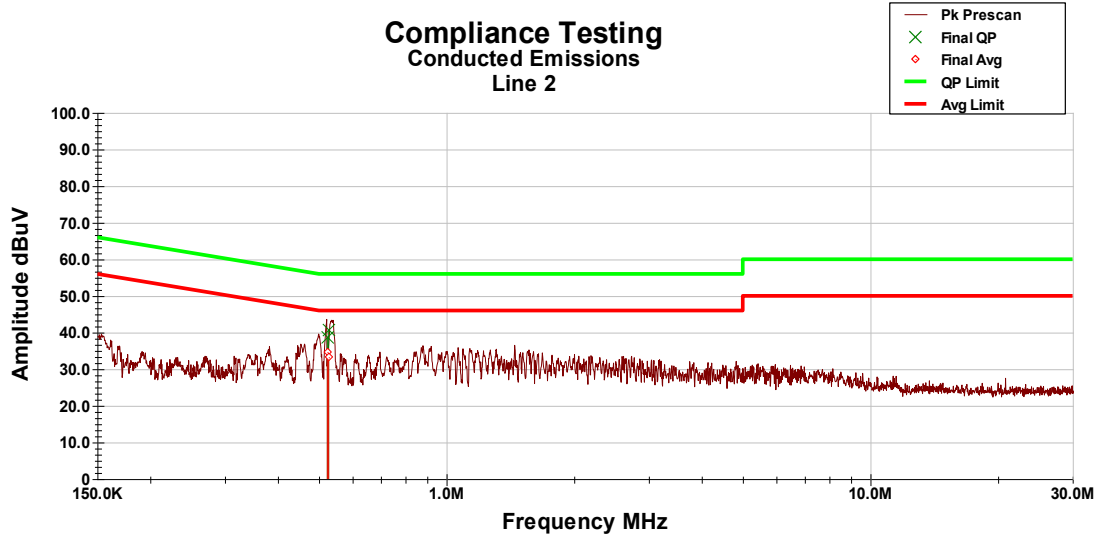


Frequency (MHz)	Raw QP dBuV	Raw Avg dBuV	Path Loss dB	Final QP dBuV	Final Avg dBuV	QP Limit dBuV	QP Margin dB	Avg Limit dBuV	Avg Margin dB
543.75 KHz	25.29	20.80	9.80	35.10	30.60	56.00	-20.90	46.00	-15.40
546.94 KHz	25.68	21.60	9.80	35.50	31.40	56.00	-20.50	46.00	-14.60
543.75 KHz	25.29	20.80	9.80	35.10	30.60	56.00	-20.90	46.00	-15.40
Final = Raw + Path Loss									
Margin = Final - Limit									

Wi-Fi 802.11b Low Channel and LoRa middle channel simultaneous transmission plot



Frequency	Raw QP	Raw Avg	Path Loss	Final QP	Final Avg	QP Limit	QP Margin	Avg Limit	Avg Margin
(MHz)	dBuV	dBuV	dB	dBuV	dBuV	dBuV	dB	dBuV	dB
520.51 KHz	26.10	15.20	9.80	35.90	25.00	56.00	-20.10	46.00	-21.00
527.58 KHz	29.30	17.90	9.80	39.10	27.70	56.00	-16.90	46.00	-18.30
Final = Raw + Path Loss									
Margin = Final - Limit									



Frequency (MHz)	Raw QP dBuV	Raw Avg dBuV	Path Loss dB	Final QP dBuV	Final Avg dBuV	QP Limit dBuV	QP Margin dB	Avg Limit dBuV	Avg Margin dB
523.59 KHz	28.88	24.90	9.80	38.70	34.70	56.00	-17.30	46.00	-11.30
527.25 KHz	30.80	23.50	9.80	40.60	33.20	56.00	-15.40	46.00	-12.80
Final = Raw + Path Loss									
Margin = Final - Limit									

Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Horn Antenna (1-18GHz)	ARA	DRG-118/A	i00271	8/9/24	8/9/26
Horn Antenna (18-40 Ghz)	EMCO	3116	I00085	3/18/25	3/18/27
Bi-Log Antenna	Schaffner	CBL 6111D	i00349	2/27/25	2/27/27
3 Meter Semi-Anechoic Chamber	Panashield	3 Meter Semi-Anechoic Chamber	i00428	7/13/23	7/13/26
44GHz EMI receiver	Keysight	N9038A	i00552	3/23/26	3/23/27
PSA Spectrum Analyzer	Agilent	E4448A	i00688	10/22/25	10/22/26
Temp./humidity/pressure monitor (Main Lab)	Omega Engineering	iBTHX-W-5	i00686	1/25/26	1/25/27
EMI Receiver	HP	85462A	i00033	6/25/25	6/25/26
Transient Limiter	Com-Power	LIT-153	i00123	Verified on: PTV	
AC Power Source	Behlman	BL 6000	i00362	NCR	
LISN	COM-Power	LI-125A	i00447	4/9/26	4/9/28
LISN	COM-Power	LI-125A	i00449	4/9/26	4/9/28
Preamplifier	COM-Power	PAM-103	i00734	Verified on: 04/23/26	
Preamplifier	Eravant	SBB-0115034019-2F2F-E3	i00756	Verified on: 04/23/26	

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	U_{lab}
Radio Frequency	$\pm 3.3 \times 10^{-8}$
RF Power, conducted	± 1.5 dB
RF Power Density, conducted	± 1.0 dB
Conducted Emissions	± 1.8 dB
Radiated Emissions	± 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 $\pm U_{lab}$ (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