Test Report

Prepared for: Trane Technologies

Model: TZM53040

Serial Number: NA
FCC ID: XVR-TZM5304-U

IC ID: 6178D-TZM5304U

Project No: p2460005

Test Results: Pass

To

FCC Part 15.249: 2024
and
RSS-210: Issue 10 (December 2019)

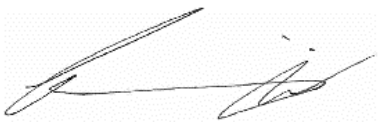
Date of Issue: July 16, 2024

On the behalf of the applicant:
Trane Technologies
6200 Troup Highway
Tyler, TX. 75707

Attention of:
Ronnie Tanner
Ph: +903-730-4575
E-Mail: Ronnie.Tanner@trane.com

Prepared By:
Compliance Testing, LLC
Mesa, AZ 85204
(480) 926-3100 phone / (480) 926-3598 fax
www.compliancetesting.com
ANAB Cert#: AT-2901
FCC Site Reg. #US2901
ISED Site Reg. #2044A-2

Reviewed / Authorized By:



John Michalowicz, Test Engineer

Test Results Summary

Test Date Range: May 1 – May 2, 2024

Specification		Test Name	Pass, Fail, N/A	Comments
FCC	**RSS**			
15.249(a)	Annex B.10	Field Strength of Fundamental	Pass	
15.249(a), 15.249(d), 15.209(a), 15.205	Annex B.10, 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
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
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

Table of Contents

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	July 16, 2024	John Michalowicz	Original Document

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

EUT Description

Model Tested:	**TZM53040**
Serial:	**NA**
Firmware:	**1.19**
Software:	**NA**
Description:	**900 MHz radio module**
Additional Information:	The TZM5304 Modem is a fully integrated Z-Wave modem module consisting of a baseband controller, sub-1 GHz radio transceiver, crystal, decoupling, SAW filter, matching, and antenna. It is intended to provide a complete Z-Wave controller solution to an application executing in an external host microcontroller. Power setting was set to 30 by the manufacturer. **Radio Frequency Range and Operational Info: 902-928MHz** **EUT is a module and operates off of 5vDC sourced from a evaluation board.** **Usage: Portable**
Receipt of Sample(s):	**June 28st 2024**
EUT Condition:	**Visual Damage** No **State of Development** Engineering Sample/Prototype

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: 15.249.

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)**
25.9 – 26.8	34 - 61	959.8 – 969.7

Test Setup and Modes of Operation

EUT Operation during Tests

EUT was tested by using radio test modes pre-programmed into the firmware of the EUT that allowed continuous >98% duty cycle at the low and high channel frequencies. The EUT is powered by an evaluation board. The channels selected for testing are as follows:
Channel 1 = 908.42 MHz with 9.6kbps
Channel 2 = 908.40 MHz with 40kbps
Channel 3 = 916.00 MHz with 100kbps

Accessories:

Qty	Description	Manufacturer	Model	S/N
1	Evaluation Board	Trane	D160372C	2415K5000X
1	AC/DC adaptor	CUI INC	SWI3-5-N	NA
1	Tablet	Amazon	Fire HD 8	G090 ME06 7152 0VRP

Cables: N/A

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

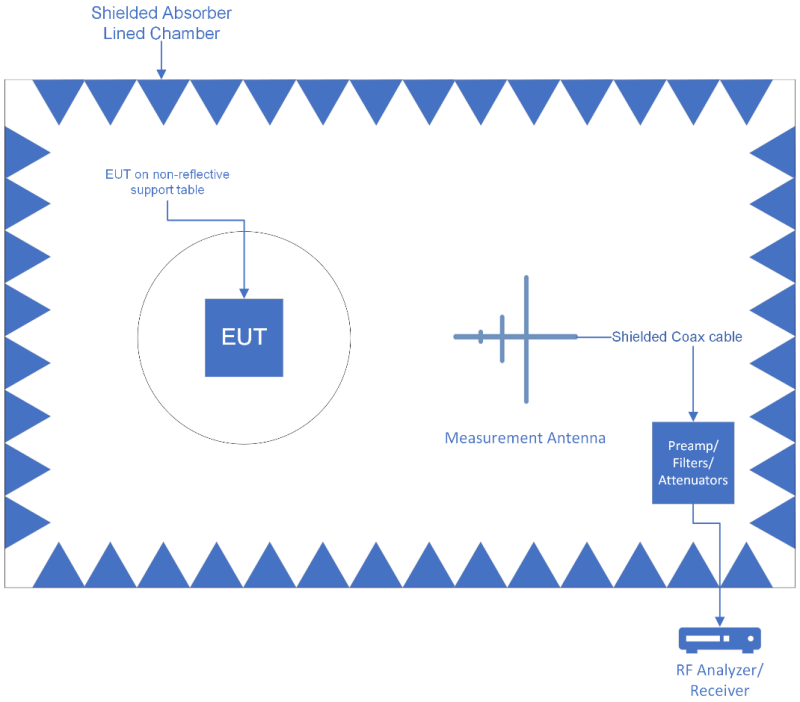
Field Strength of Fundamental

Engineer: John Michalowicz
Test Date: July 15th 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:

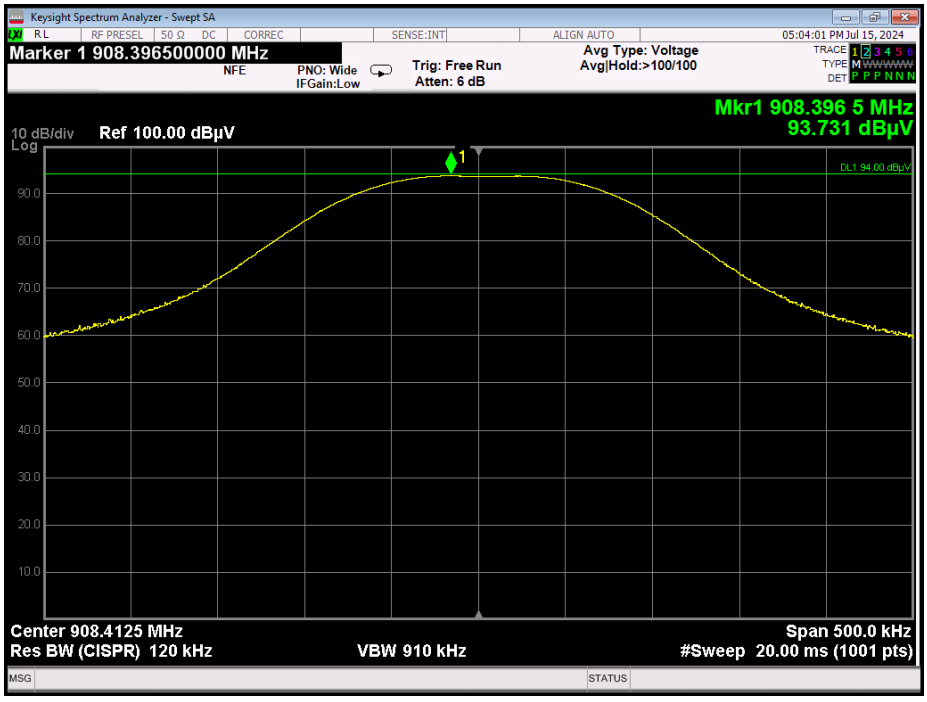
RBW ≥ DTS Bandwidth
VBW ≥ 3 x RBW
Span ≥ 3 x RBW
Sweep time = auto couple
Detector = peak
Trace Mode = max hold

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

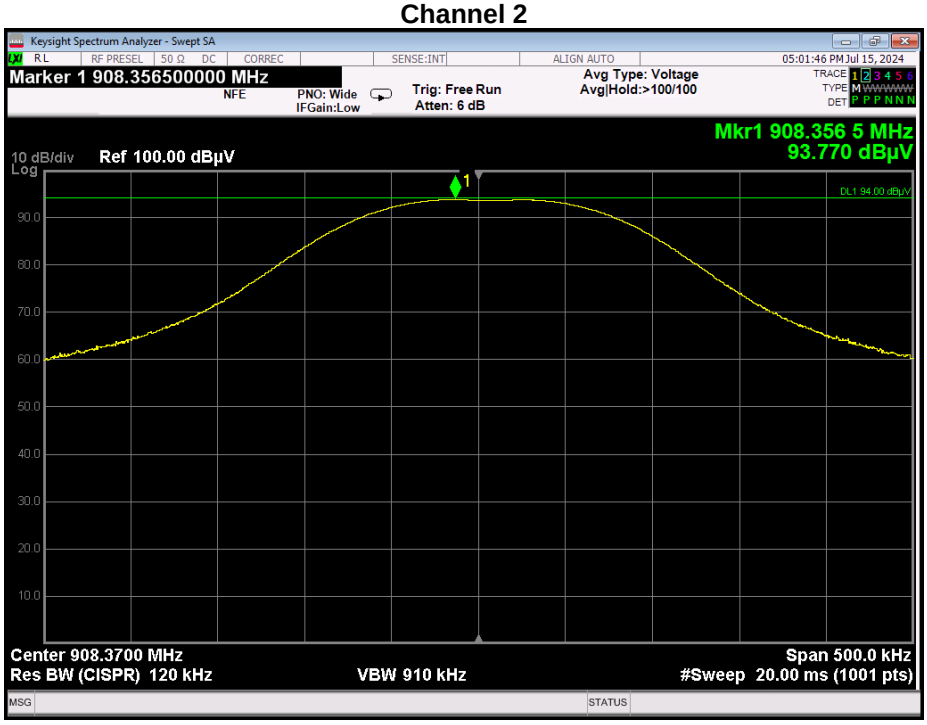
Tuned Frequency (MHz)	Mode of Operation	PK Measured Value (dBuV/m)	AVG /Specification Limit (dBuV/m)	Result
908.42	Continuous TX Low Ch	93.73	94	Pass
908.40	Continuous TX Mid Ch	93.77	94	Pass
916.0	Continuous TX High Ch	92.12	94	Pass

Field Strength of Fundamental Plots

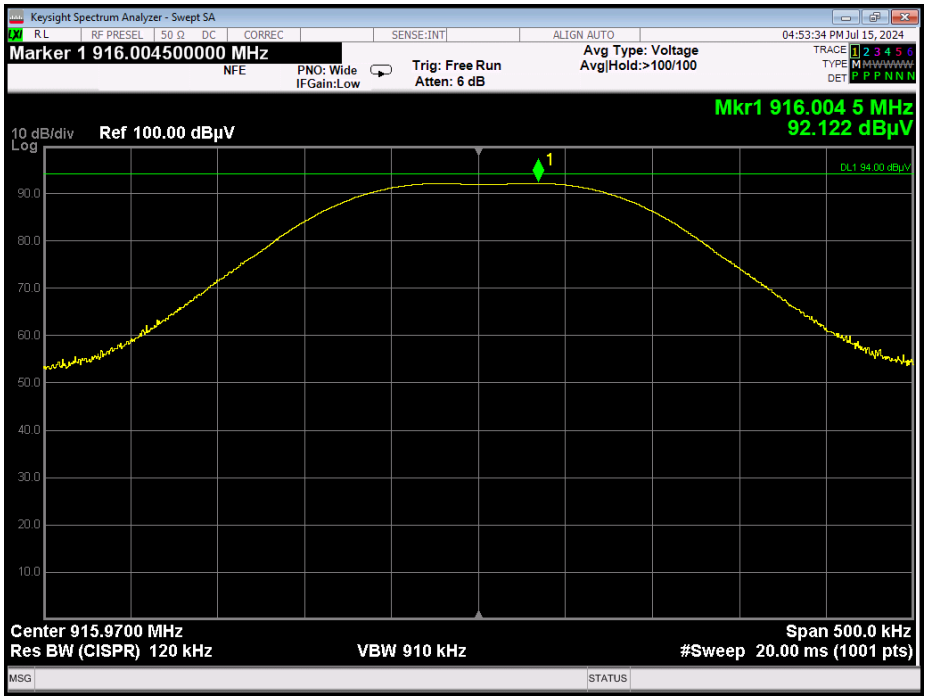
Channel 1



Channel 2



Channel 3


Keysight Spectrum Analyzer - Swept SA
RL
RF PRESEL
50 Ω
DC
CORREC
SENSE:INT
ALIGN AUTO
04:53:34 PM Jul 15, 2024
Marker 1 916.004500000 MHz
NFE
PNO: Wide
IFGain:Low
Trig: Free Run
Atten: 6 dB
Avg Type: Voltage
Avg|Hold:>100/100
TRACE 1 2 3 4 5 6
TYPE M WWWWW
DET P P P N N N
Mkr1 916.004 5 MHz
92.122 dBµV
10 dB/div
Log
Ref 100.00 dBµV
DL1 94.00 dBµV
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
Center 915.9700 MHz
Res BW (CISPR) 120 kHz
VBW 910 kHz
Span 500.0 kHz
#Sweep 20.00 ms (1001 pts)
MSG
STATUS

General Field Strength Emissions / Spurious Harmonic Emissions / Restricted Bands

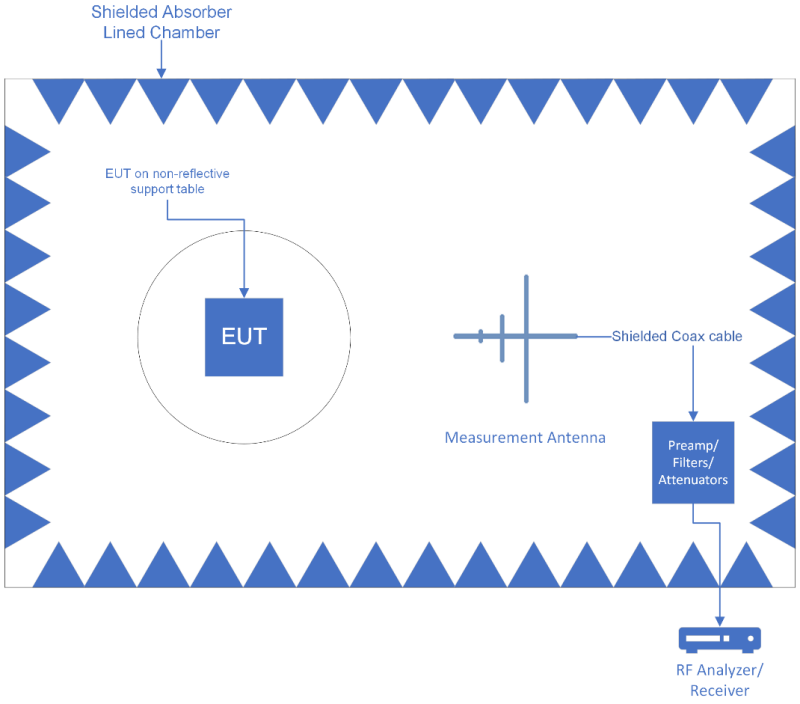
Engineer: John Michalowicz

Test Date: July 15, 2024

Test Procedure
Radiated Spurious Emissions: 30 – 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.

Basic Test Setup



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

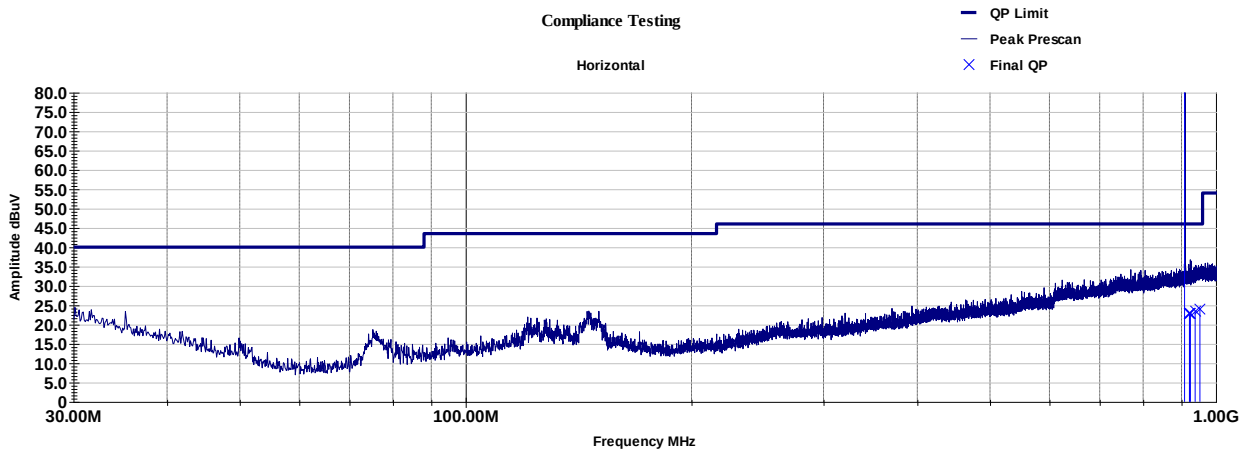
Sample Calculations

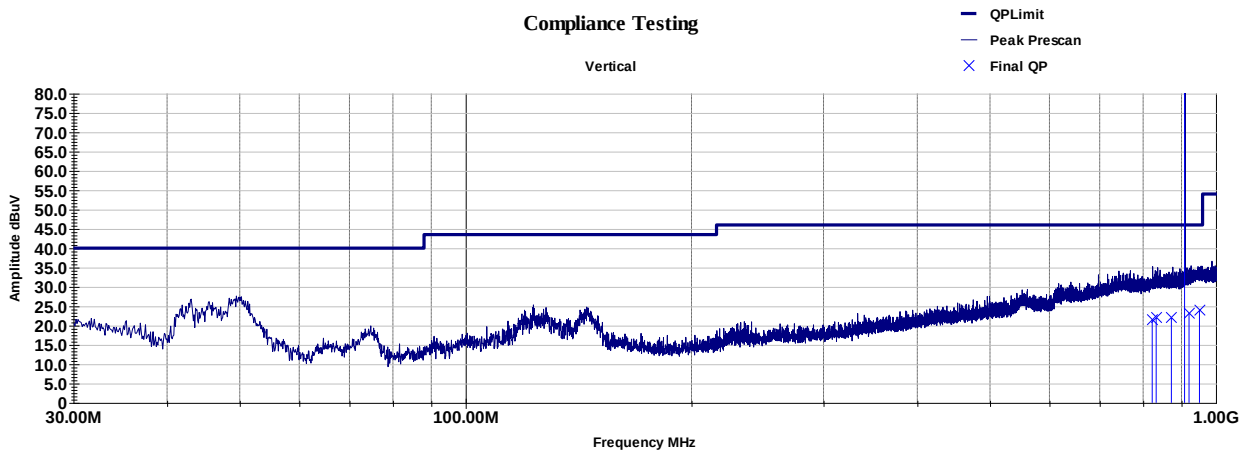
Corrected Value = Measured Value + Correction factor

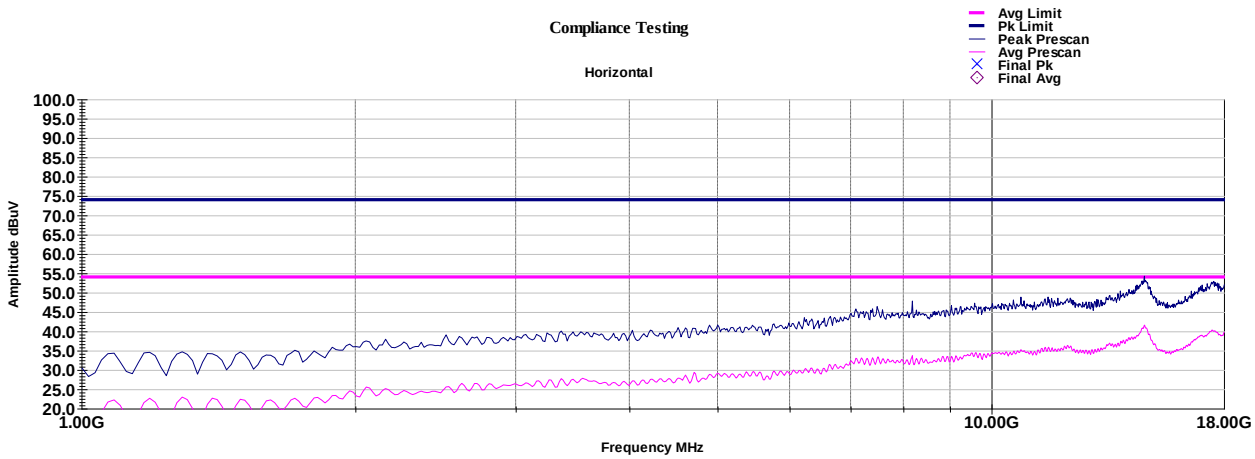
Correction factor = Antenna Correction Factor + Cable loss + Preamp/Attenuator Factor

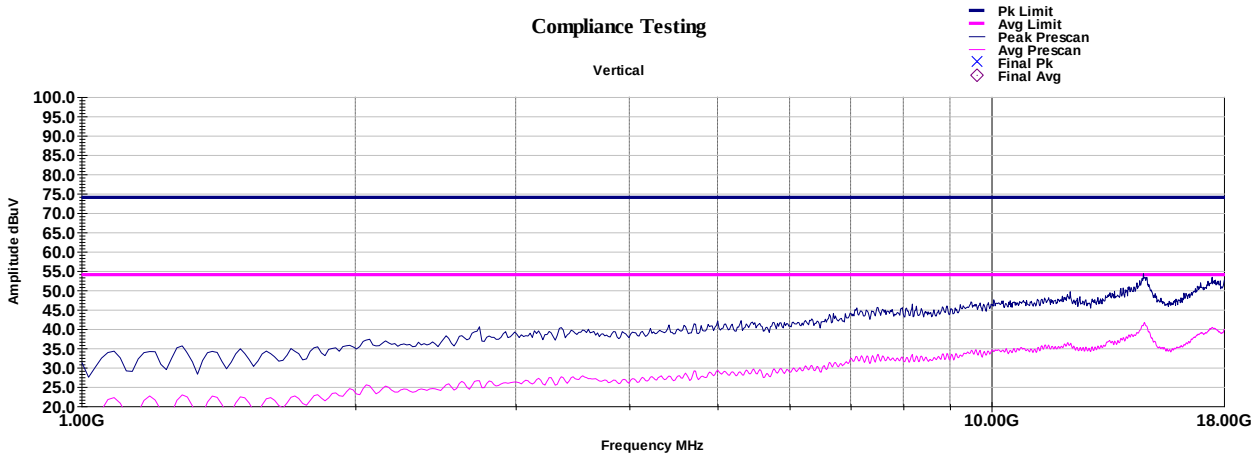
Radiated Emissions 30-1000MHz

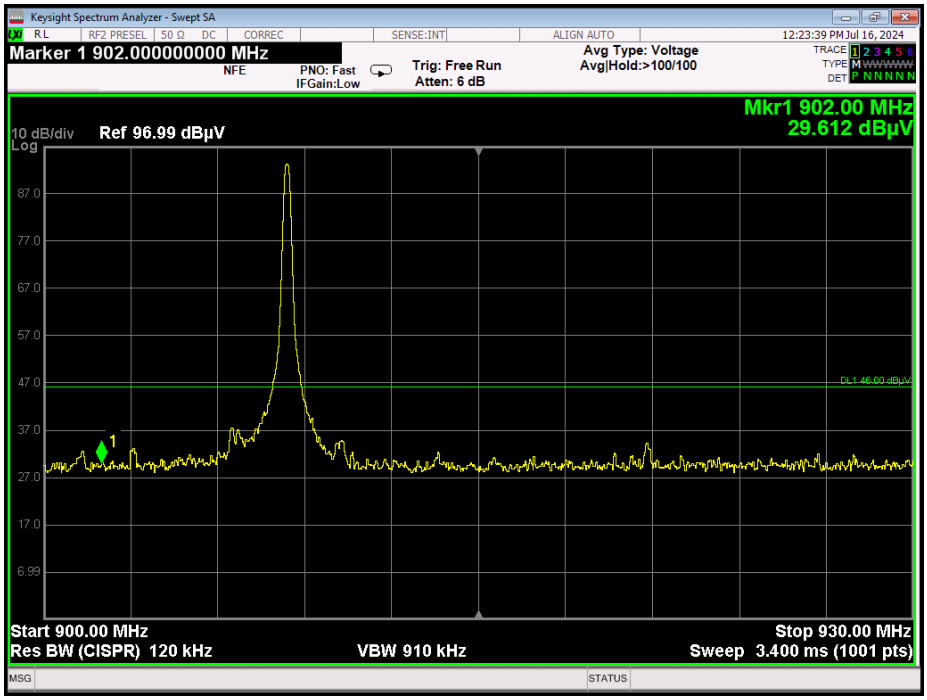
Channel 1



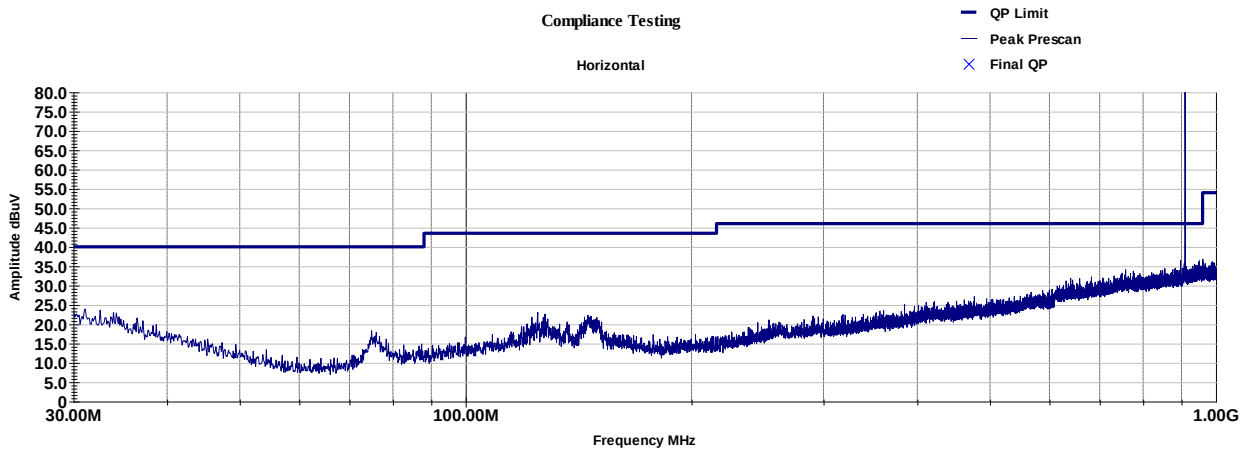


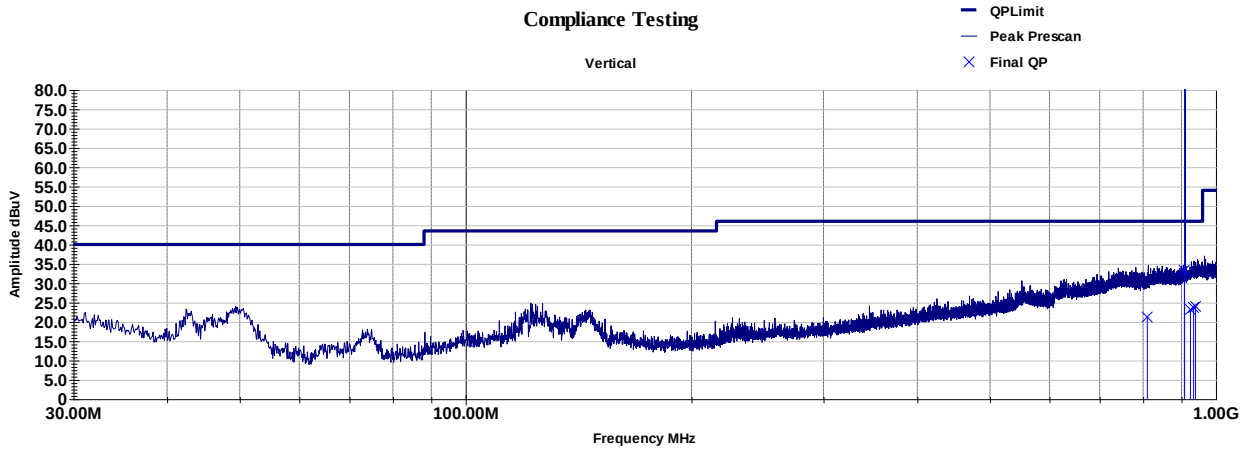


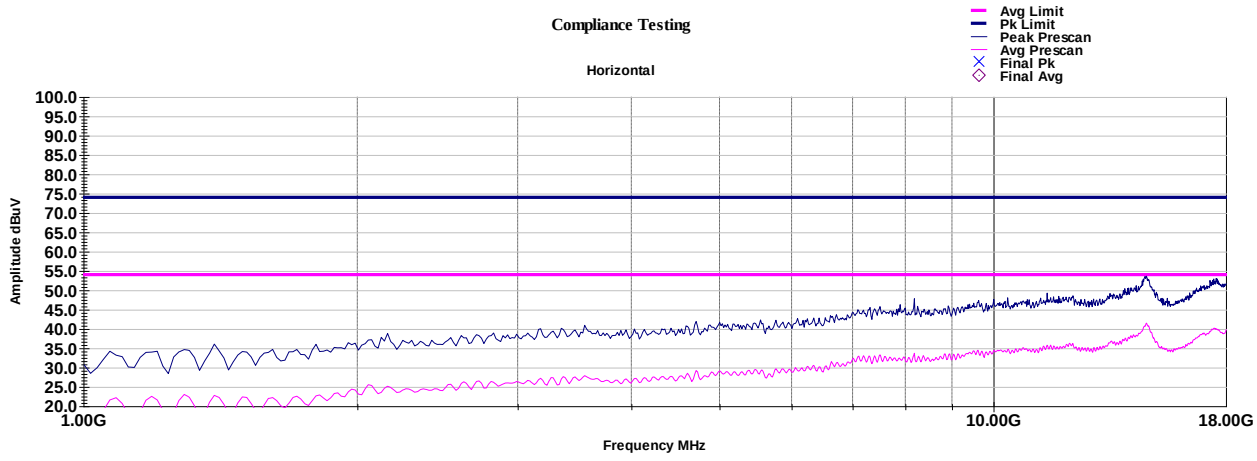

Compliance Testing
Vertical
Pk Limit
Avg Limit
Peak Prescan
Avg Prescan
Final Pk
Final Avg
Amplitude dBuV
100.0
95.0
90.0
85.0
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
1.00G
10.00G
18.00G
Frequency MHz

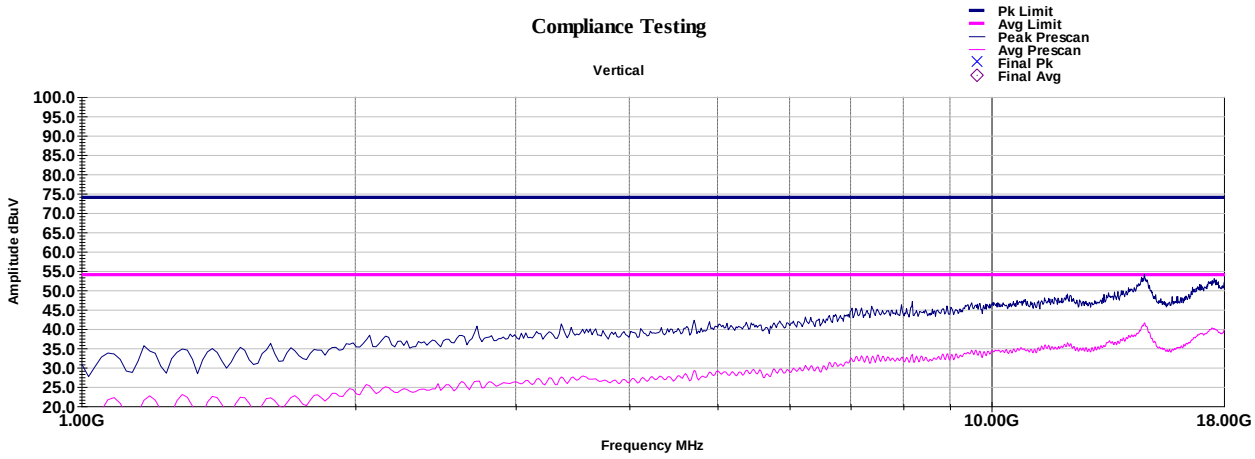

Keysight Spectrum Analyzer - Swept SA
RL
RF2 PRESEL
50 Ω
DC
CORREC
SENSE:INT
ALIGN AUTO
12:23:39 PM Jul 16, 2024
Marker 1 902.000000000 MHz
NFE
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 6 dB
Avg Type: Voltage
Avg|Hold:>100/100
TRACE 1 2 3 4 5 6
TYPE M WWWWW
DET P N N N N N
Mkr1 902.00 MHz
29.612 dBµV
10 dB/div
Log
Ref 96.99 dBµV
87.0
77.0
67.0
57.0
47.0
37.0
27.0
17.0
6.99
DL1 46.00 dBµV
1
Start 900.00 MHz
Res BW (CISPR) 120 kHz
VBW 910 kHz
Stop 930.00 MHz
Sweep 3.400 ms (1001 pts)
MSG
STATUS

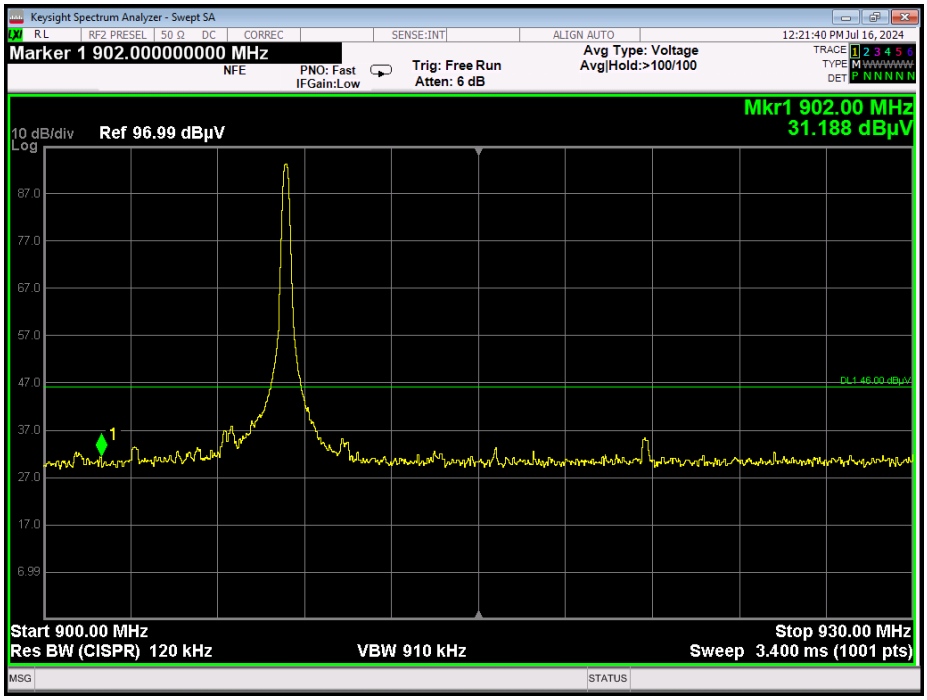
Channel 2


Compliance Testing
Horizontal
QP Limit
Peak Prescan
Final QP
Amplitude dBuV
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0
30.00M
100.00M
1.00G
Frequency MHz

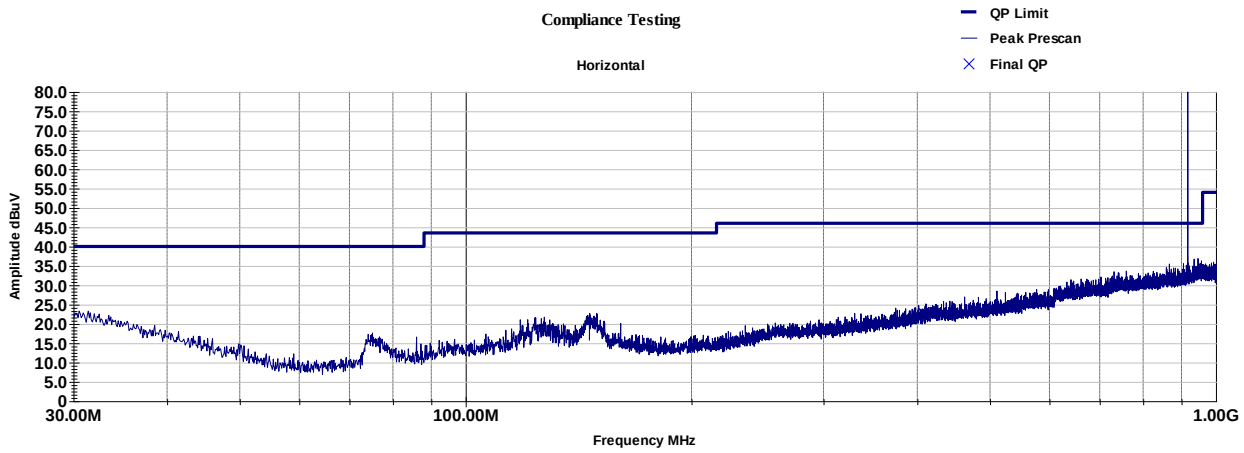

Compliance Testing
Vertical
QPLimit
Peak Prescan
Final QP
Amplitude dBuV
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0
30.00M
100.00M
1.00G
Frequency MHz

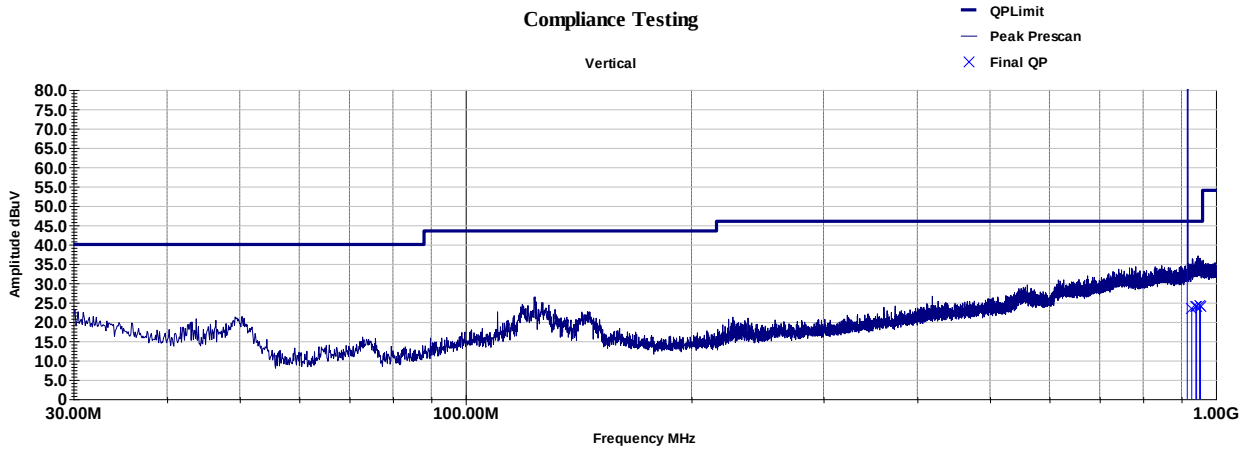

Compliance Testing
Horizontal
Avg Limit
Pk Limit
Peak Prescan
Avg Prescan
Final Pk
Final Avg
Amplitude dBuV
100.0
95.0
90.0
85.0
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
1.00G
10.00G
18.00G
Frequency MHz

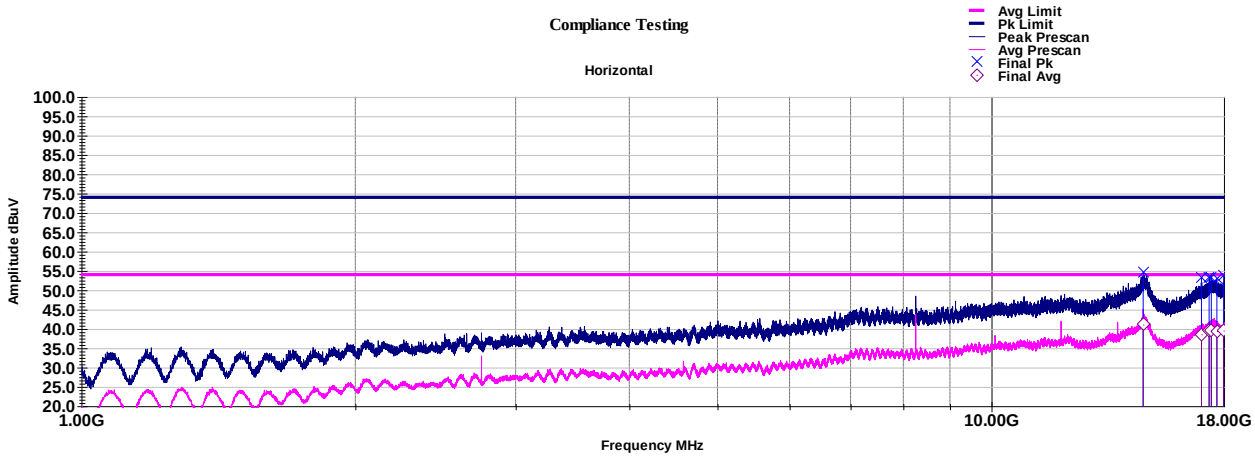

Compliance Testing
Vertical
Pk Limit
Avg Limit
Peak Prescan
Avg Prescan
Final Pk
Final Avg
Amplitude dBuV
100.0
95.0
90.0
85.0
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
1.00G
10.00G
18.00G
Frequency MHz

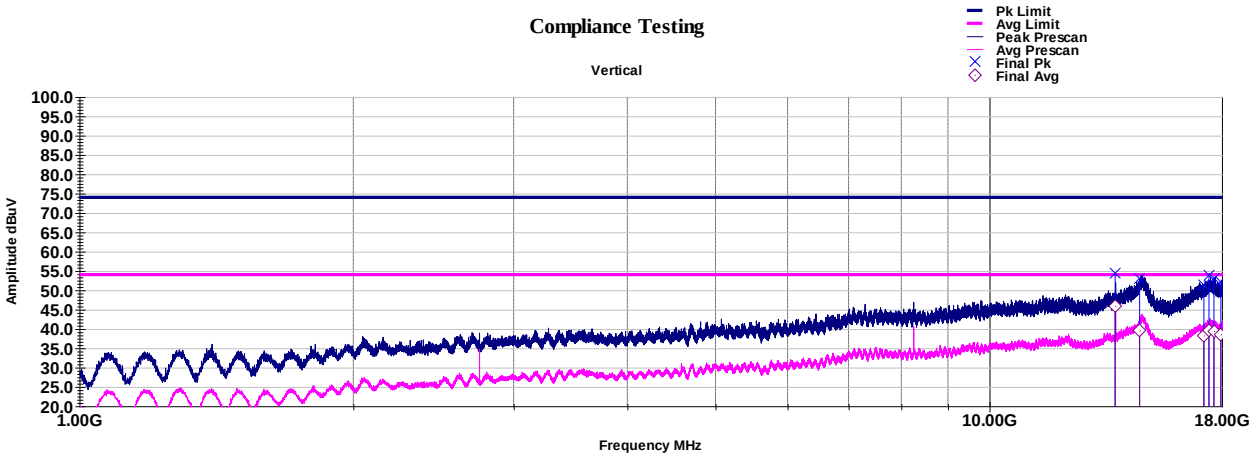

Keysight Spectrum Analyzer - Swept SA
RL
RF2 PRESEL
50 Ω
DC
CORREC
SENSE:INT
ALIGN AUTO
12:21:40 PM Jul 16, 2024
Marker 1 902.000000000 MHz
NFE
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 6 dB
Avg Type: Voltage
Avg|Hold:>100/100
TRACE 1 2 3 4 5 6
TYPE M WWWWW
DET P N N N N N
Mkr1 902.00 MHz
31.188 dBµV
10 dB/div
Log
Ref 96.99 dBµV
87.0
77.0
67.0
57.0
47.0
37.0
27.0
17.0
6.99
DL 46.00 dBµV
1
Start 900.00 MHz
Res BW (CISPR) 120 kHz
VBW 910 kHz
Stop 930.00 MHz
Sweep 3.400 ms (1001 pts)
MSG
STATUS

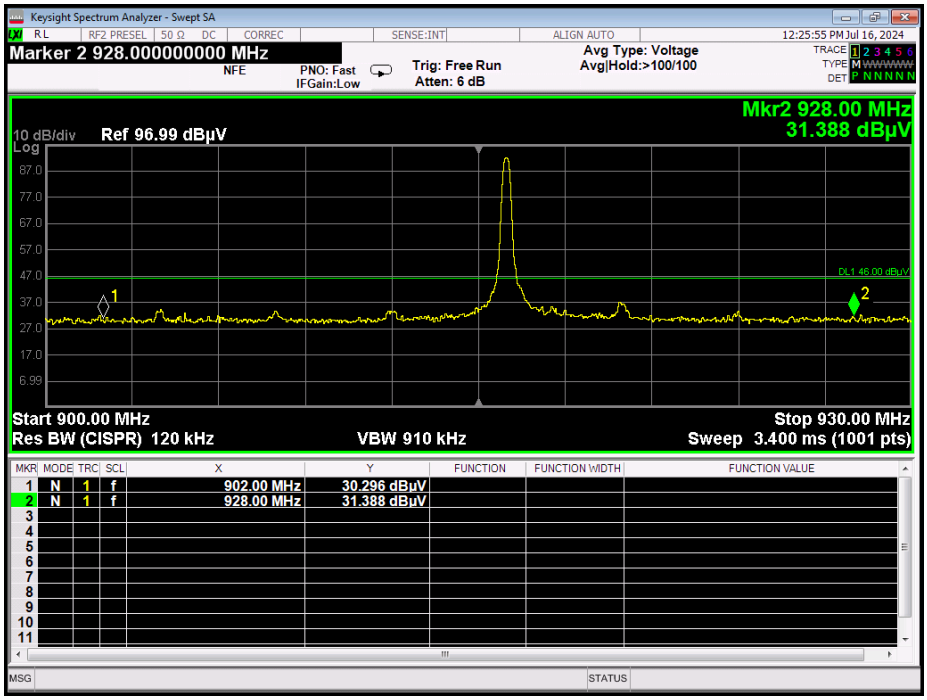
Channel 3


Compliance Testing
Horizontal
QP Limit
Peak Prescan
Final QP
Amplitude dBuV
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0
30.00M
100.00M
1.00G
Frequency MHz


Compliance Testing
Vertical
QPLimit
Peak Prescan
Final QP
Amplitude dBuV
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0
30.00M
100.00M
1.00G
Frequency MHz


Compliance Testing
Horizontal
Avg Limit
Pk Limit
Peak Prescan
Avg Prescan
Final Pk
Final Avg
Amplitude dBuV
100.0
95.0
90.0
85.0
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
1.00G
10.00G
18.00G
Frequency MHz





Band Edge Summary Table

Tuned Frequency (MHz)	Mode of Operation	PK Measured Value (dBuV/m)	AVG Specification Limit (dBuV/m)	Result
908.4	Continuous TX Low Ch	31.2	54	Pass
916.0	Continuous TX High Ch	31.4	54	Pass

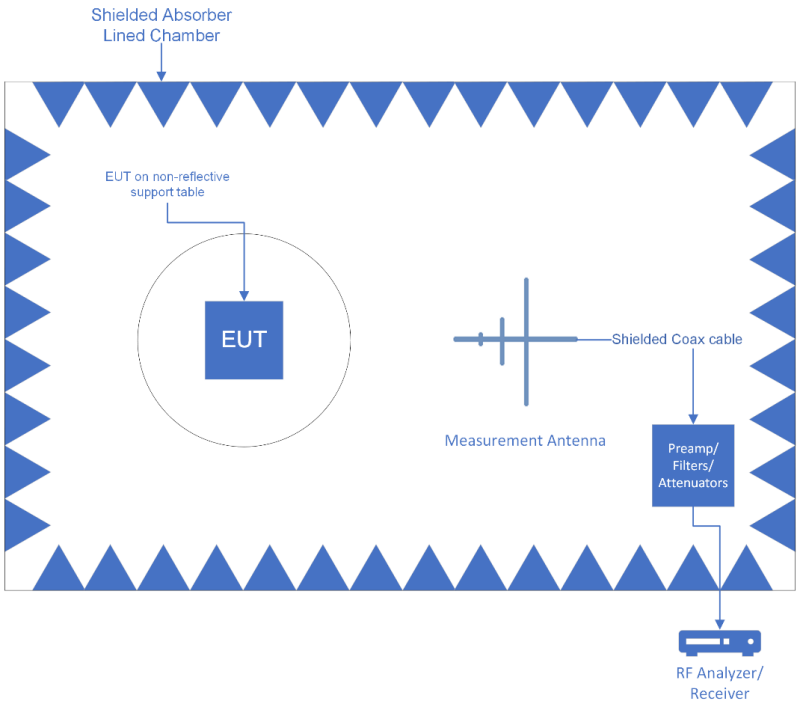
99% Occupied Bandwidth

Engineer: John Michalowicz
Test Date: June 15th 2024

Test Procedure

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.

Basic Test Setup

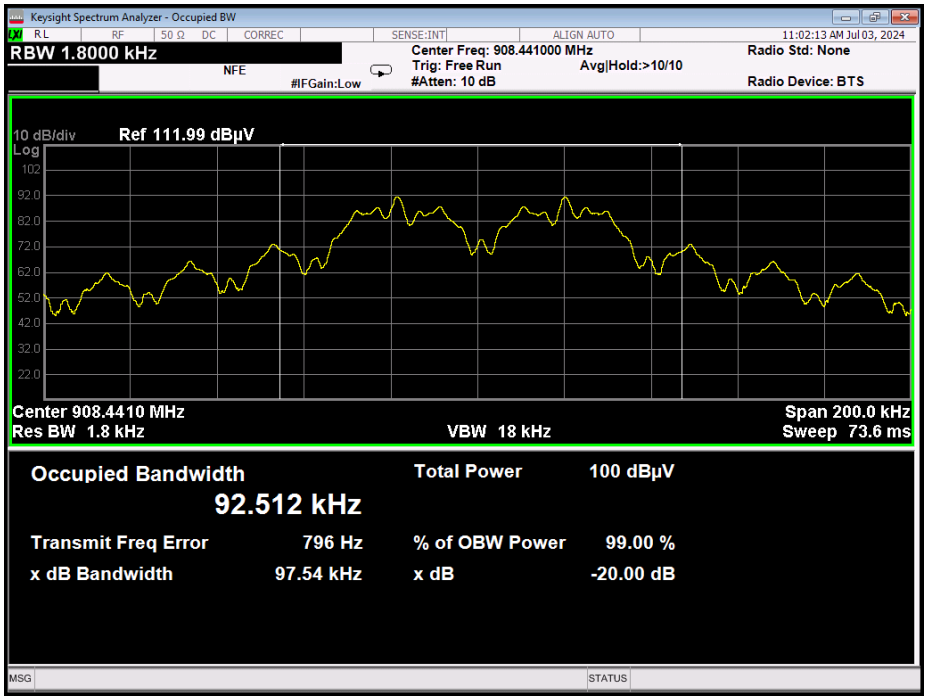


The Spectrum Analyzer was set to the following:
RBW = 1-3% of OBW
VBW ≥ 3 x RBW
Peak Detector
Trace mode = max hold
Sweep = auto couple
Span = 1.5 x EBW

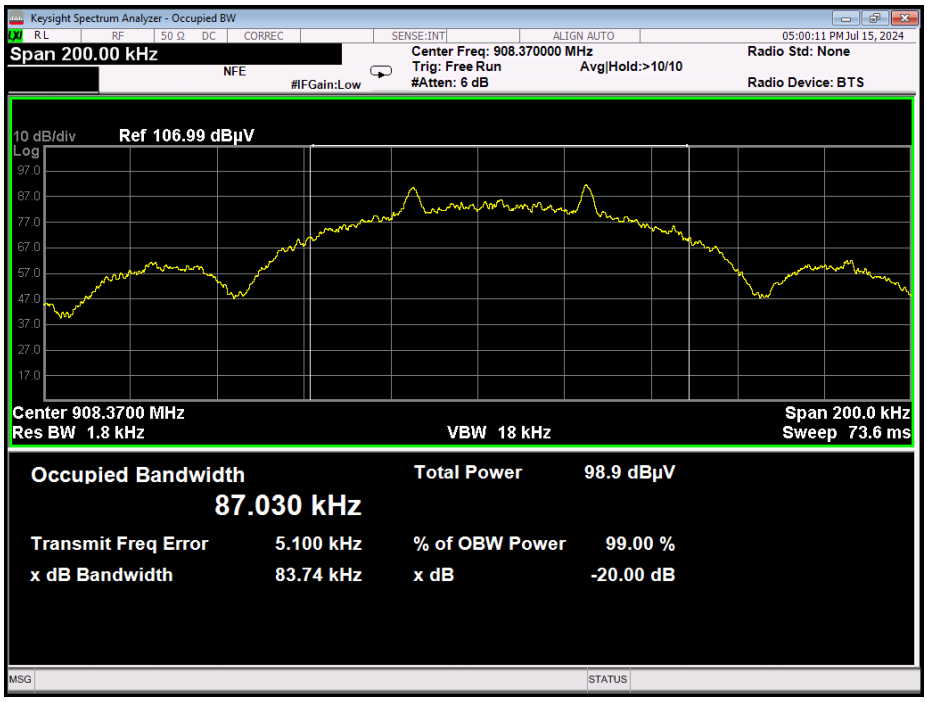
99% Bandwidth Summary

Frequency (MHz)	Mode of Operation	Measured Bandwidth (kHz)	Result
908.42	Continuous TX Ch 1	92.5	Complete
908.40	Continuous TX Ch 2	87.0	Complete
916.0	Continuous TX Ch 3	109.6	Complete

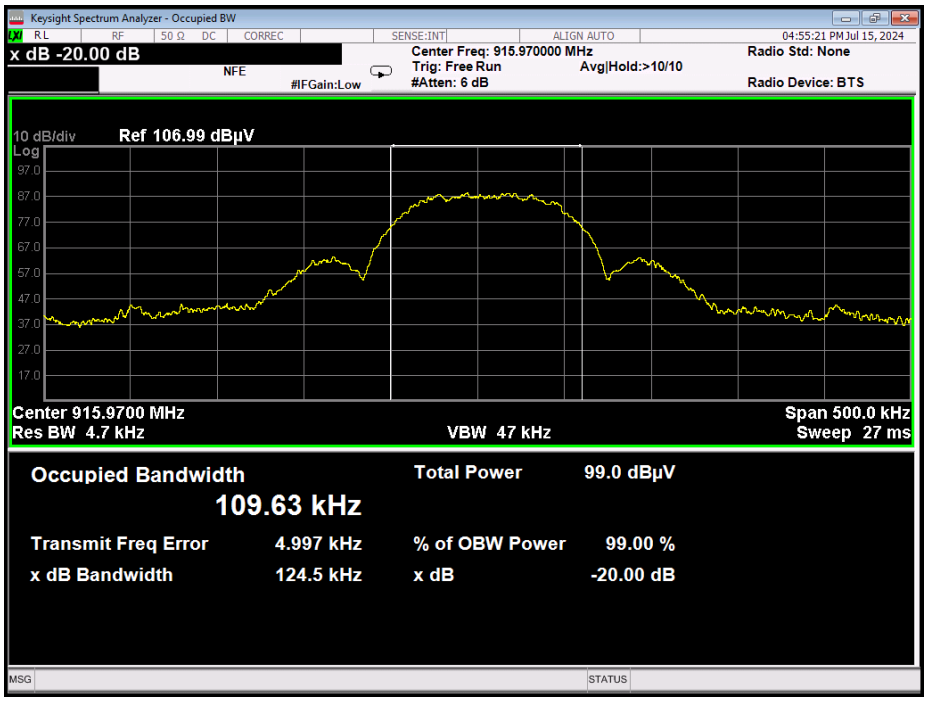
99% Bandwidth Plots



Low Channel



Mid Channel



High Channel

15.207 A/C Powerline Conducted Emissions

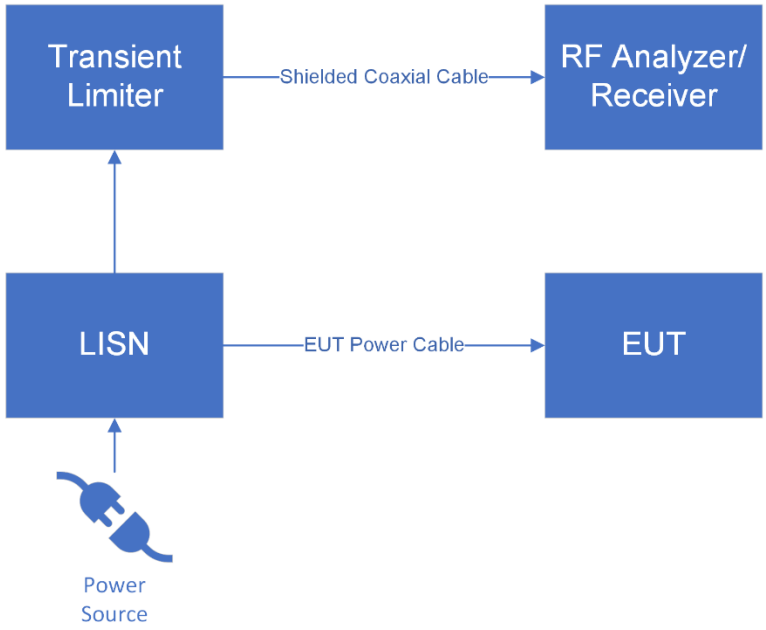
Engineer: John Michalowicz

Test Date: 7/16/24

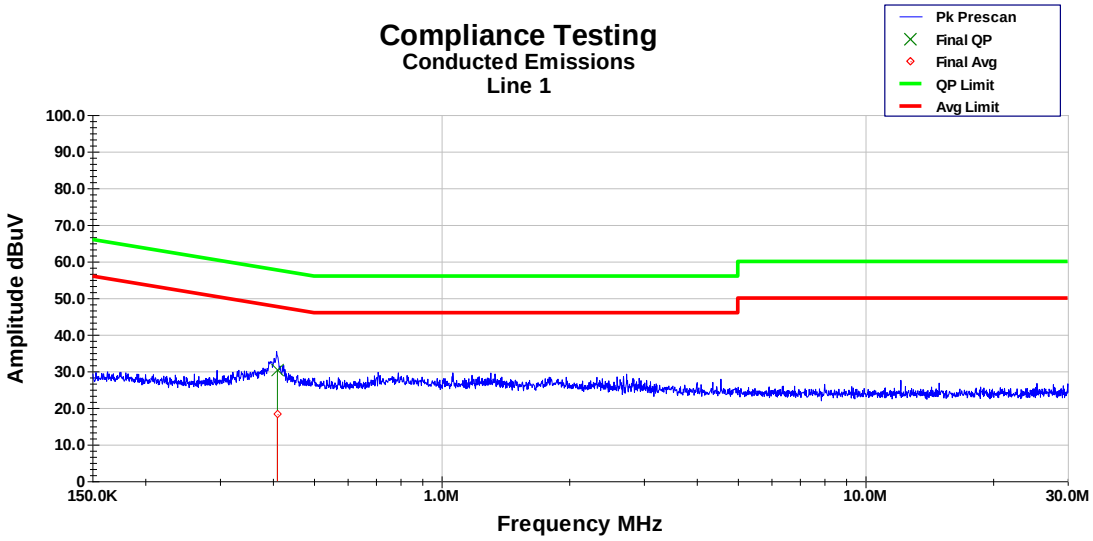
Test Procedure

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.

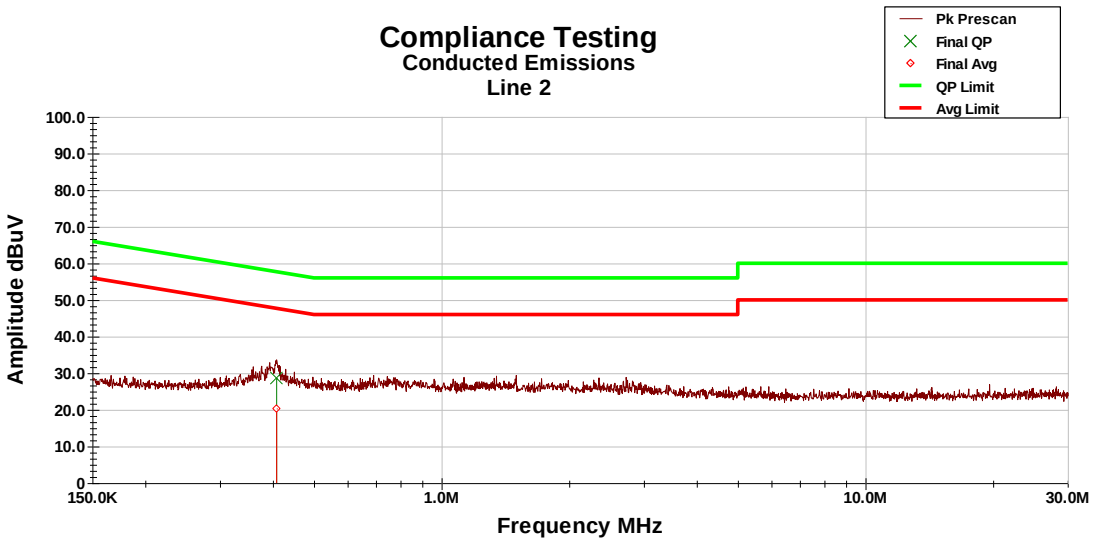
Basic Test Setup



120VAC_CE



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
410.24 KHz	20.30	8.20	10.10	30.30	18.30	58.60	-28.20	48.60	-30.30
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
(MHz)	dBuV	dBuV	dB	dBuV	dBuV	dBuV	dB	dBuV	dB
408.49 KHz	18.56	10.30	10.00	28.60	20.40	58.60	-30.00	48.60	-28.20
Final = Raw + Path Loss									
Margin = Final - Limit									

Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
EMI Receiver	Hewlett Packard	85462A	i00033	6/25/24	6/25/25
Bilog Antenna 0.030-1.0GHz	Schaffner	CBL6111C	i00349	02/07/23	02/06/25
LISN	COM-Power	LI-125A	i00446	3/18/24	3/18/26
LISN	COM-Power	LI-125A	i00448	3/18/24	3/18/26
ultra wideband LNA 10MHz-45GHz	RF-Lambda USA	RLNA00M45GA	i00555	02/19/24	02/19/25
9kHz-44GHz CISPR comp. receiver	Keysight	N9038A	i00552	03/01/24	03/01/25
Preamplifier	COM-Power	PAM-103	i00734	Verified on: 6/27/24	
1-18GHz Horn Antenna	Antenna Research Assoc	DRG-118/A	i00271	08/11/22	08/10/24
temperature/humidity/pressure probe	Omega Engineering, Inc.	iBTHX-W-5	i00629	01/25/23	01/24/25

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