
Project 22738-15

**Austin Devices, LLC
Kai Bridge**

Wireless Certification Report

Prepared for:

Austin Devices, LLC
5606 Shoalwood Avenue
Austin, TX 78756

By

Professional Testing (EMI), Inc.
1601 North A.W. Grimes Blvd., Suite B
Round Rock, Texas 78665

4 February 2022

Written by

A handwritten signature in black ink, appearing to read 'Larry Finn', with a stylized flourish at the end.

Larry Finn
Chief Technical Officer

Revision History

Revision Number	Description	Date
Draft01	Initial release for review	11 Nov 2021
Final01	Release to Agency	21 Jan 2022
Final02	Corrections to add details on WLAN radio module	4 Feb 2022

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Compliance Certificate

FCC MRA Designation Number: US5270 NVLAP Accreditation Number: 200062-0

Applicant	Device & Test Identification
Austin Devices, LLC 5606 Shoalwood Avenue Austin, TX 78756 Certificate Date: 21 Jan 2022	FCC ID: 2AO4VKB Industry Canada ID: 23667-KB Model(s): KB Laboratory Project ID: 22738-15

The device named above was tested utilizing the following standards and found to be in compliance with the required criteria:

Requirement	Reference	Detail
FCC 47 CFR Part 15 C	15.247	Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.
FCC 47 CFR Part 15 C	15.209	Radiated emission limits; general requirements.
FCC 47 CFR Part 15 C	15.205	Restricted Bands of Operation
KDB 558074 D01	DR01	DTS Measurement Guidance v03r02
KDB 412172	D01	Guidelines for Determining the ERP and EIRP of an RF Transmitting System
OET Bulletin 65*	Edition 97-01, and Supplement C, Ed. 01-01	Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields
RSS-247	Issue 2	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
RSS-Gen	Issue 5 Amd 1	General Requirements and Information for the Certification of Radio Apparatus
RSS-102	Issue 5	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

*MPE is reported separately from this document. **Corresponding RSS references are listed in the body of the report.

I, Larry Finn, for Professional Testing (EMI), Inc., being familiar with the above requirements and test procedures have reviewed the test setup, measured data, and this report. I believe them to be true and accurate.

Larry Finn
CTO



This report has been reviewed and accepted by the Applicant. The undersigned is responsible for ensuring that this device will continue to comply with the requirements listed above.

Representative of Applicant

1.0 Introduction

1.1 Scope

This report describes the extent to which the equipment under test (EUT) conformed to the intentional radiator requirements of the United States and Canada.

Professional Testing (EMI), Inc., (PTI) follows the guidelines of National Institute of Standards and Technology (NIST) for all uncertainty calculations, estimates, and expressions thereof for electromagnetic compatibility testing.

1.2 EUT Description

Table 1.2.1: Equipment Under Test		
Manufacturer / Model	Serial #	Description
Austin Devices, LLC Model: KB	none	Wireless valve controller base station

Table 1.2.2: Pre-certified WLAN Module Included		
Manufacturer / Model	Serial #	Description
Shenzhen Ai-Thinker Technology co., LTD Model: ESP-12F	none	WiFi module, 2.4 GHz, 802.11 b/g/n Power 16.39 dBm (43.55 dBm) FCC ID: 2AHMR-ESP12F IC ID: 23236-ESP12F Antenna Gain: 2dBi

Note: BLE and WLAN radios do not transmit simultaneously.

1.3 EUT Test Configuration

The EUT was exercised in a manner consistent with normal operations. The EUT is powered by +5VDC via an external AC/DC power adapter.



1.4 Modifications to Equipment

The PCB mounted chip antenna was removed, and a small coaxial cable was soldered in its place to facilitate conducted RF measurements.

1.5 Test Site

Measurements were made at the PTI semi-anechoic facility designated Site 45 (FCC 776781, IC 3036B-1) in Austin, Texas. The site is registered with the FCC under Section 2.948 and Industry Canada per RSS-GEN, and is subsequently confirmed by laboratory accreditation (NVLAP). The test site is located at 11400 Burnet Road, Austin, Texas 78758, while the main office is located at 1601 North A.W. Grimes Boulevard, Suite B, Round Rock, Texas, 78665. CAB Identifier: US 0123.

1.6 Radiated Measurements

Table 1.6 1 Measurement Corrections	
Parameter	From Sums Of
Radiated Field Strength	Raw Measured Level + Antenna Factor + Cable Losses – Amplifier Gain
Conducted Antenna Port	Raw Measured Level + Attenuator Factor + Cable Losses
Conducted Mains Port	Raw Measured Level + LISN Factor + Cable/Filter/Limiter Losses

Additionally, measurement distance extrapolation factors (such as $1/d$ above 30 MHz) are applied and documented where used.

1.7 Additional Documents Applied

Table 1.7.1: Additional Documents Applied	
Document	Title
ANSI C63.10:2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

2.0 AC Power Line Conducted Emissions

2.1 Conducted Emissions Test Data

2.1.1 Conducted Emissions Test Equipment List

Conducted Emissions Test Equipment List					
Tile! Software Version:		Version: 7.1.2.17 (Jan 08, 2016 - 02:12:48 PM) or 4.1.A.0, April 14, 2009, 11:01:00PM			
Test Profile:		2020_CE_TILE7_v4			
Asset #	Manufacturer	Model	Equipment Nomenclature	Serial Number	Calibration Due Date
1145	HP	8568B	Spectrum Analyzer 100Hz-1.5GHz	2517A01821	7/7/2022
2113	HP	85662A	Spec Anal Dsply for A/N 1842	2403A07470	N/A
990	HP	85685A	RF Preselector	3010A01119	7/9/2022
1279	HP	85650A	Quasi Peak Adapter	2521A00935	7/8/2022
C192	HP	none	Cable, RF, BNC-BNC, 0.2032m, Grey	None	1/20/2022
C303	Coleman Cable	RG-58A/U	Cable, BNC-BNC, 0.914m Black	None	2/24/2022
C107	Pomona	RG-223	Cable, BNC-BNC, 2.64m, RG-223 (black)	None	8/3/2022
1185	EMCO	3825/2	LISN, 10kHz-100MHz	1235	8/23/2022
1088	PTI	PTI-ALF4	Attenuator Limiter Filter	none	2/26/2023
1173	PTI	100k HPF	Filter, High Pass, 100kHz	none	2/11/2022

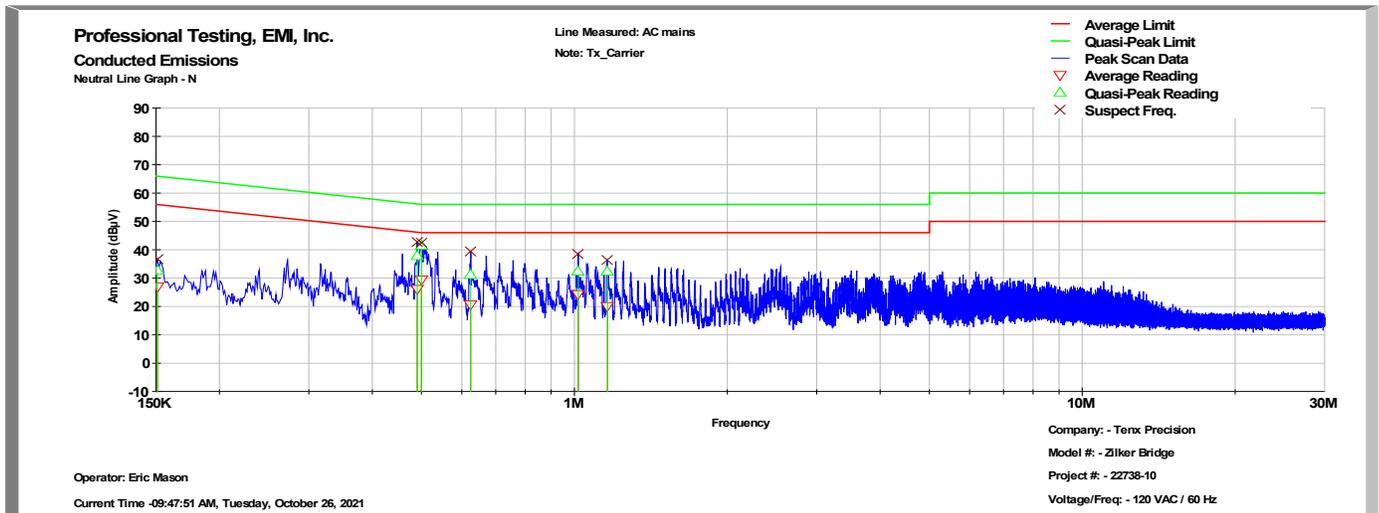
2.1.2 Conducted Emissions Test Results – AC Mains

Table 2.1.2.1: Conducted Emissions Test Results – AC Mains

EUT Name	Zilker Bridge		Model or Serial #	651867618	
EUT Line Voltage	120	VAC	Frequency	60	Hz
Emissions Limit Level	FCC Part 15 Class B		EUT Test Mode or Configuration	TX Carrier	
Frequency Range			Line Tested	Test Results	
150kHz to 30MHz			Neutral Line	PASS	
			Phase A (Line 1)	PASS	
Notes:					

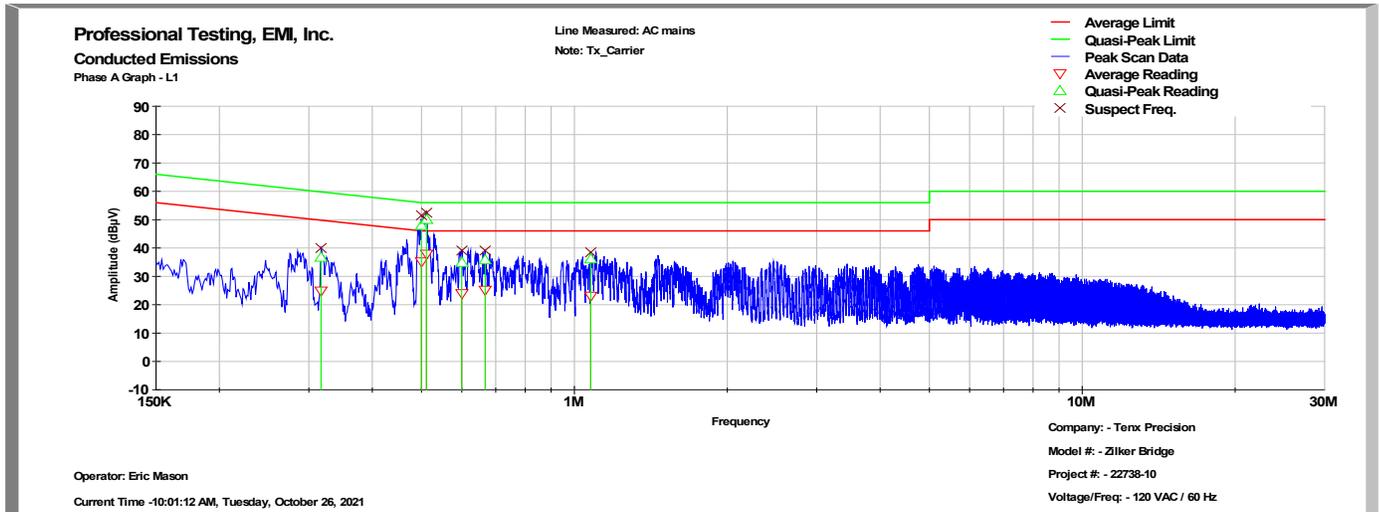
2.1.3 Conducted Emissions Test Data

Neutral Line Emissions Data



Frequency (MHz)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results (Pass/Fail)	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results (Pass/Fail)	Peak Reading (dBµV)
0.151	32.8	65.9	-33.1	PASS	27.0	55.9	-28.9	PASS	41.7
0.490	37.7	56.2	-18.4	PASS	26.0	46.2	-20.2	PASS	48.8
0.500	41.4	56.0	-14.6	PASS	29.3	46.0	-16.7	PASS	51.6
0.625	31.3	56.0	-24.7	PASS	20.5	46.0	-25.5	PASS	40.5
1.018	32.5	56.0	-23.5	PASS	24.1	46.0	-21.9	PASS	40.0
1.162	32.6	56.0	-23.4	PASS	20.1	46.0	-25.9	PASS	39.1

Line 1 Emissions Data



Frequency (MHz)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results (Pass/Fail)	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results (Pass/Fail)	Peak Reading (dBµV)
0.317	36.6	59.8	-23.2	PASS	24.9	49.8	-24.9	PASS	40.8
0.500	47.9	56.0	-8.1	PASS	35.3	46.0	-10.7	PASS	53.3
0.511	49.9	56.0	-6.1	PASS	37.7	46.0	-8.3	PASS	53.6
0.600	35.0	56.0	-21.0	PASS	23.8	46.0	-22.2	PASS	40.8
0.667	35.7	56.0	-20.3	PASS	25.2	46.0	-20.8	PASS	40.4
1.076	36.0	56.0	-20.0	PASS	23.1	46.0	-22.9	PASS	40.7

3.0 Fundamental Power; Clause 15.247(a)(3); RSS-247 5.2

3.1 Test Procedure

The radio was connected through a 20dB attenuator to the spectrum analyzer for measurement. Low, mid, and high channel output power was measured. Power measurements were made on 10/12/2021.

3.2 Test Criteria

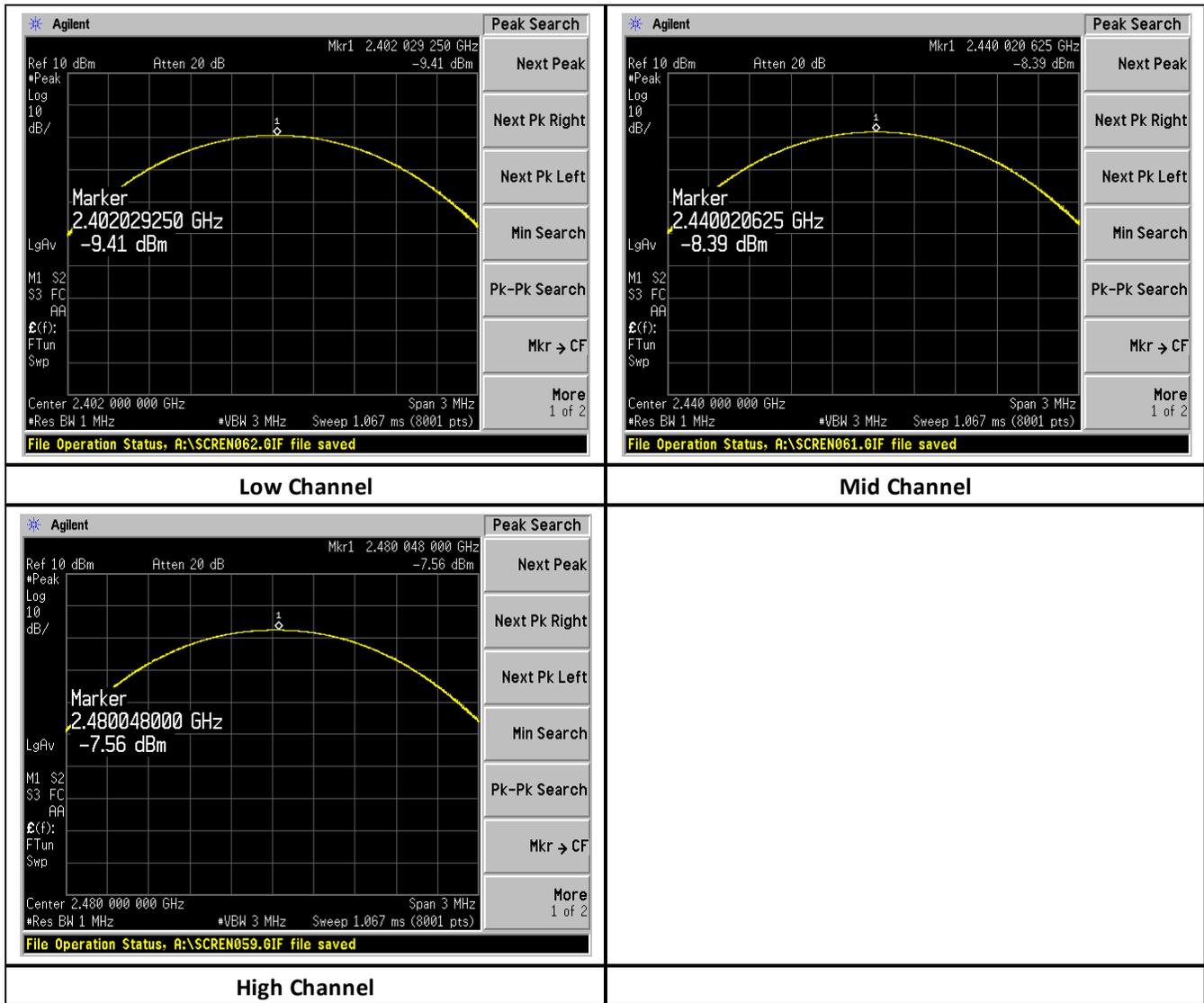
Conducted Power Limit	
1 W peak (+30dBm)	
Limit Restated as Field: 125.23 dB μ V/m @ 3 m	

3.3 Test Results, Peak Power (dBm)

Peak Output Power - Conducted Test Data												
Environmental Conditions:		Temperature	23	°C	Humidity	52	RH	Barometric Pressure	29.00	in Hg		
EUT (6 or 20 dB) Bandwidth:		0.70	MHz									
Measurement Parameters:		RBW	1	MHz	VBW	3	MHz	Span	3	MHz	Detector	Peak
Channel	Frequency	Measured Power	Attenuator Factor		Corrected Power		Limit		Test Result			
	(MHz)	(dBm)	(dB)		(dBm)		(dBm)					
2	2402	-9.41	20.12		10.71		30		Pass			
40	2440	-8.39	20.12		11.73		30		Pass			
80	2480	-7.56	20.12		12.56		30		Pass			

The requirements were satisfied.

Peak output power test data:



3.4 Test Results, Duty Cycle

Measurement is based on intervals not to exceed 100 msec. Maximum transmitter on time is divided by the lesser of 100 msec or the actual measured minimum transmitter interval time. The result is converted to dB and applied as needed to peak measurements of transmitter artifacts to determine average power. This is not a pass/fail measurement.

Continuous packet transmission mode was used for the duty cycle measurement, which would represent a worst-case operating scenario. Duty Cycle measurement was performed on 18 Oct, 2021.

Duty Cycle - Conducted Test Data									
Environmental Conditions:		Temperature	22 °C	Humidity	52 RH	Barometric Pressure		30.00	in Hg
Measurement Parameters:		RBW	1 MHz	VBW	3 MHz	Span	0 Hz	Detector	Peak
Measured On Time (ms)	Max On Time Allowed (ms)	On Time Result	Measured Time Interval (ms)	Duty Cycle Factor (dB) (20 * Log(On time/Interval))		Duty Cycle Factor Allowed (dB)			
2.113	100	N/A	4.226	-6.02		-6.02			
RF Exposure Allowable Duty Cycle Reduction (10*Log(On time/Interval):						-3.01			

<p>Agilent 15:33:38 Oct 18, 2021</p> <p>Ref 0 dBm Atten 10 dB</p> <p>Marker Δ 2.113 ms 0.97 dB</p> <p>Center 2.440 000 GHz Res BW 1 MHz #VBW 3 MHz Sweep 2.928 ms (8001 pts)</p> <p>File Operation Status: A:\SCREN017.GIF file saved</p>	<p>Agilent 16:01:19 Oct 18, 2021</p> <p>Ref 0 dBm Atten 10 dB</p> <p>Marker Δ 4.226 ms -0.01 dB</p> <p>Center 2.440 000 GHz Res BW 1 MHz #VBW 3 MHz Sweep 10.13 ms (8001 pts)</p> <p>File Operation Status: A:\SCREN019.GIF file saved</p>
Transmit Event Time	Transmit Interval

Duty Cycle Measurement

4.0 Power Spectral Density; 15.247(e); RSS-247, 5.2

4.1 Test Procedure

A spectrum analyzer is used to measure the power spectral density.

4.2 Test Criteria

Power Spectral Density, Conducted Limit	
8 dBm / 3 kHz	
Restated as field strength: 103.23 dB μ V/m at 3 m	

4.3 Test Results, Tabular

The radio was connected through a 20dB attenuator to the spectrum analyzer for measurement. Low, mid, and high channel output power was measured. PSD measurements were made on 10/7/2021.

Power Spectral Density - Conducted Test Data									
Environmental Conditions:		Temperature	22 °C	Humidity	52 RH	Barometric Pressure	29.00 in Hg		
EUT Channel Bandwidth:		0.75	MHz						
Measurement Parameters:		RBW	10 kHz	VBW	30 kHz	Span	1.5 MHz	Detector	Peak
Channel	Frequency (MHz)	Measured Power (dBm)	Attenuator Factor (dB)	Corrected Power (dBm)	Limit (dBm)	Test Result			
2	2402	-15.45	20.12	4.67	8	Pass			
40	2440	-14.88	20.12	5.24	8	Pass			
80	2480	-14.84	20.12	5.28	8	Pass			

<p>Agilent 16:24:57 Oct 7, 2021</p> <p>Mkr1 2.402 078 04 GHz -15.45 dBm</p> <p>Marker 2.402078040 GHz -15.45 dBm</p> <p>Center 2.402 020 62 GHz Span 1.5 MHz</p> <p>Res BW 10 kHz VBW 30 kHz Sweep 14.4 ms (8001 pts)</p> <p>File Operation Status: A:\SCREEN039.GIF file saved</p>	<p>Agilent 11:26:57 Oct 7, 2021</p> <p>Mkr1 2.439 767 18 GHz -14.88 dBm</p> <p>Marker 2.439767180 GHz -14.88 dBm</p> <p>Center 2.440 000 00 GHz Span 1.5 MHz</p> <p>Res BW 10 kHz VBW 30 kHz Sweep 14.4 ms (8001 pts)</p> <p>File Operation Status: A:\SCREEN035.GIF file saved</p>
<p>Low Channel</p> <p>Agilent 11:24:16 Oct 7, 2021</p> <p>Mkr1 2.480 079 87 GHz -14.84 dBm</p> <p>Marker 2.480079870 GHz -14.84 dBm</p> <p>Center 2.480 000 00 GHz Span 1.5 MHz</p> <p>Res BW 10 kHz VBW 30 kHz Sweep 14.4 ms (8001 pts)</p> <p>File Operation Status: A:\SCREEN034.GIF file saved</p>	<p>Mid Channel</p>
<p>High Channel</p>	

The requirements were satisfied.

5.0 Occupied Bandwidth; 15.247(a)(2), 2.1049; RSS-247, RSS-Gen 4.6

5.1 Test Procedure

Bandwidth is measured and recorded. The bandwidth measurement is used to verify DTS characteristics and/or for general reporting for agency application. Bandwidth measurements were made on 10/12/2021.

5.2 Test Criteria

Bandwidth
6 dB 500 kHz minimum 99% (all methods)

In cases where the software function fails to find/mark the correct edge of the modulated envelope, a manual measurement (marker-delta over display line) is taken with the same spectrum analyzer settings.

5.3 Test Results, Tabular

The requirements were satisfied.

Occupied Bandwidth - Conducted Test Data										
Environmental Conditions:		Temperature	23	°C	Humidity	52	RH	Barometric Pressure	29.00	in Hg
Measurement Parameters:		RBW	100	kHz	VBW	300	kHz	Span	3	MHz
Measurement Bandwidth:		- 6		dB						
Channel	Frequency	Measured Bandwidth		Reported Minimum Bandwidth						
	(MHz)	(kHz)		(kHz)						
2	2402	701.451		689.824						
40	2440	700.444								
80	2480	689.824								

The EUT met the requirements.

5.4 Test Results, Recorded: 6 dB, 99% BW



6.0 Band Edge; 15.247, 15.205; RSS-247 5.5; RSS-Gen 4.9

6.1 Test Procedure

EUT is placed into normal transmit operation on the nearest band edge channel. The spectrum analyzer is approximately centered on the band edge frequency with span sufficient to include the peak of the adjacent fundamental signal. Measurement includes at least two standard bandwidths from the respective band edge. If required, the band-edge marker-delta method is utilized. The radio was connected through a 20dB attenuator to the spectrum analyzer for measurement. Band Edge measurements were made on 10/7–8/2021.

6.2 Test Criteria

Unwanted Emissions
Emissions Adjacent to Authorized Band

6.3 Test Results

Measurements included fundamental and more than 2 standard bandwidths (standard bandwidth 1 MHz) beyond the band edges to provide a clear view of the fundamental and the declining emission levels. Beyond this point, the general emission limits are applied in the radiated emission tests reported elsewhere in the report.

This is a conducted measurement with limits derived from the general emission field strength limits. The far field path loss equation is utilized to convert the field strength limits to EIRP limits in dBm as follows:

$$\text{Given EIRP} = E_{\text{dB}\mu\text{V}/\text{m}} + 20\text{Log}_{10}(d) - 104.8$$

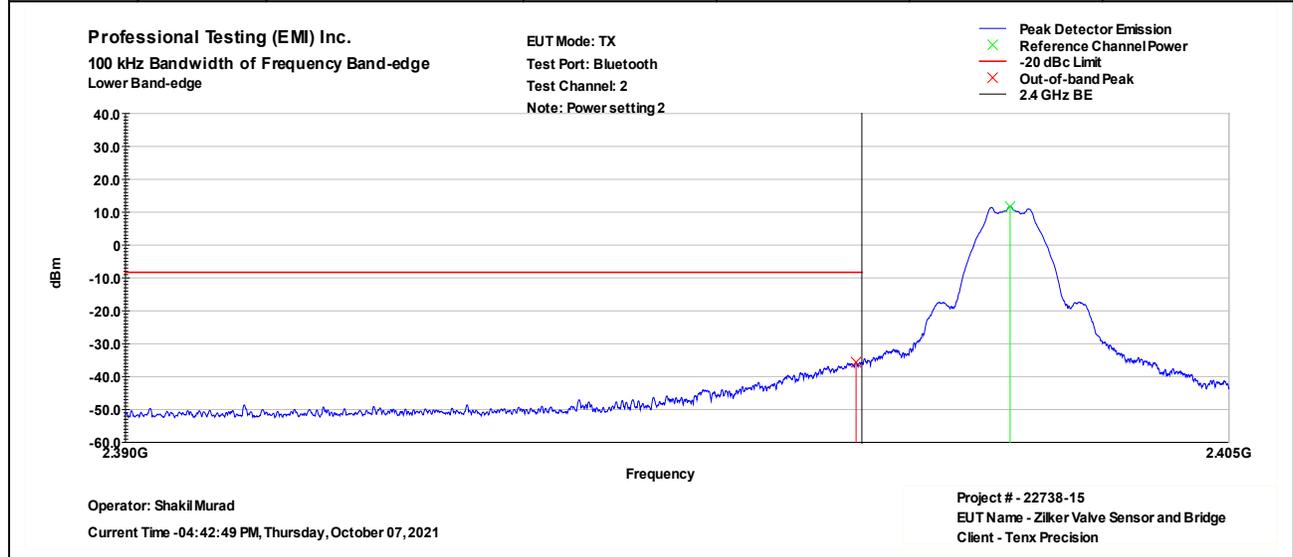
$$\text{EIRP} = 54 \text{ dB}\mu\text{V}/\text{m} + 20\text{Log}_{10}(3 \text{ m}) - 104.8 \text{ dB} = -41.25 \text{ dBm (commonly -41 dBm is applied)}$$

Emissions below band were measured with peak detection in 100 kHz RBW.

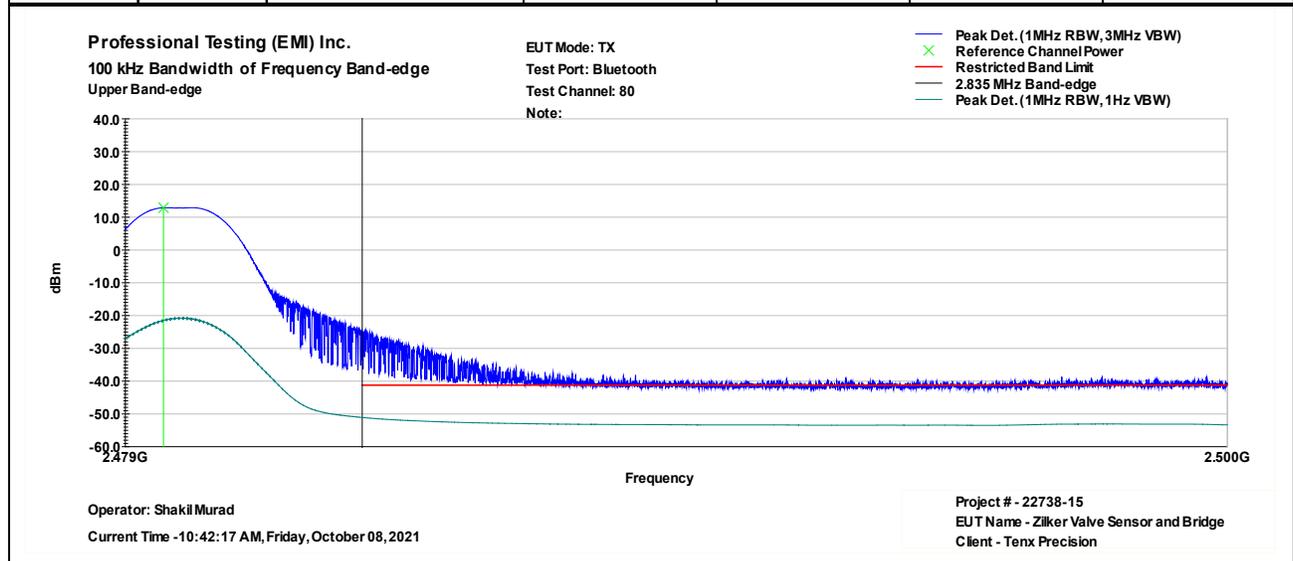
Emissions above band measured with peak detection and 1 Hz video average in 1 MHz RBW if the peak emission exceeds the average limit.

The requirement was satisfied. Plotted results appear on the following page.

Band-edge - Conducted Test Data							
Environmental Conditions:		Temperature	23 °C	Humidity	51 RH	Barometric Pressure	30.00 in Hg
Test Port:		Bluetooth					
Measurement Parameters:		RBW	0.1 MHz	VBW	0.3 MHz	Measurement Detector	Peak
Channel	Frequency (MHz)	Max Peak Band Emission (dBm)	Max Out-of-Band Emission (dBm)	Limit (-20 dBc)	Delta (dB)	Result	
2	2402	11.691	-35.628	-8.309	27.32	Pass	



Lower Band-edge							
Measurement Parameters:		RBW	1 MHz	VBW	3 MHz	Measurement Detector	Average
Channel	Frequency (MHz)	Max Peak Band Emission (dBm)	Max Out-of-Band Emission (dBm)	Limit (dBm)	Delta (dB)	Result	
80	2480	12.884	-51.13	-41.25	9.88	Pass	



Upper Band-edge						
-----------------	--	--	--	--	--	--

7.0 Conducted Antenna Port Spurious Emissions, Transmit Mode; 15.247, 15.209; RSS-247 5.5, RSS-Gen 4.9 & 4.10

7.1 Test Procedure

Conducted antenna port emissions are measured with the EUT transmitting on the required frequencies. Conducted antenna port measurements were made from 10/4/2021 – 10/5/2021.

7.1.1 Test Parameters		
30 MHz to 1 GHz	1 GHz to 18 GHz	18 GHz to 25 GHz
120kHz RBW / 300kHz VBW	1MHz RBW / 3MHz VBW	1MHz RBW / 3MHz VBW
Quasi-peak	Peak & Average	Peak & Average

7.2 Test Criteria

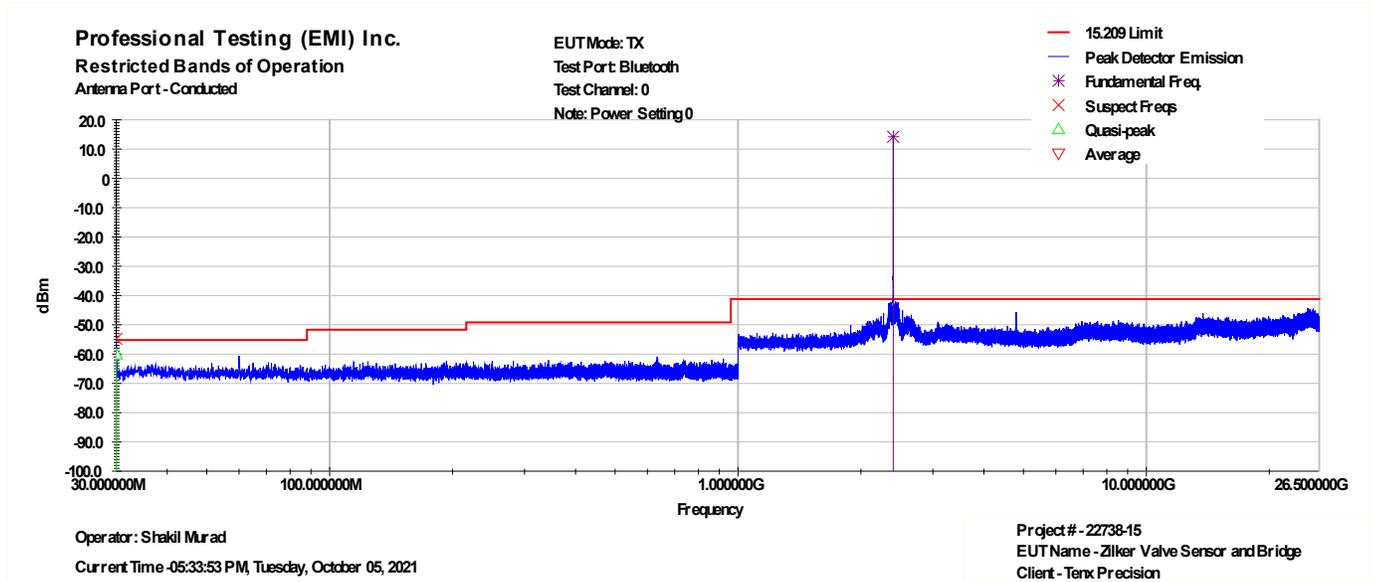
Unwanted Emissions
Antenna Port Conducted Spurious/Harmonic Emissions Transmit Mode

7.3 Test Results

Three channels were tested. EUT was transmitting continuously and unmodulated.

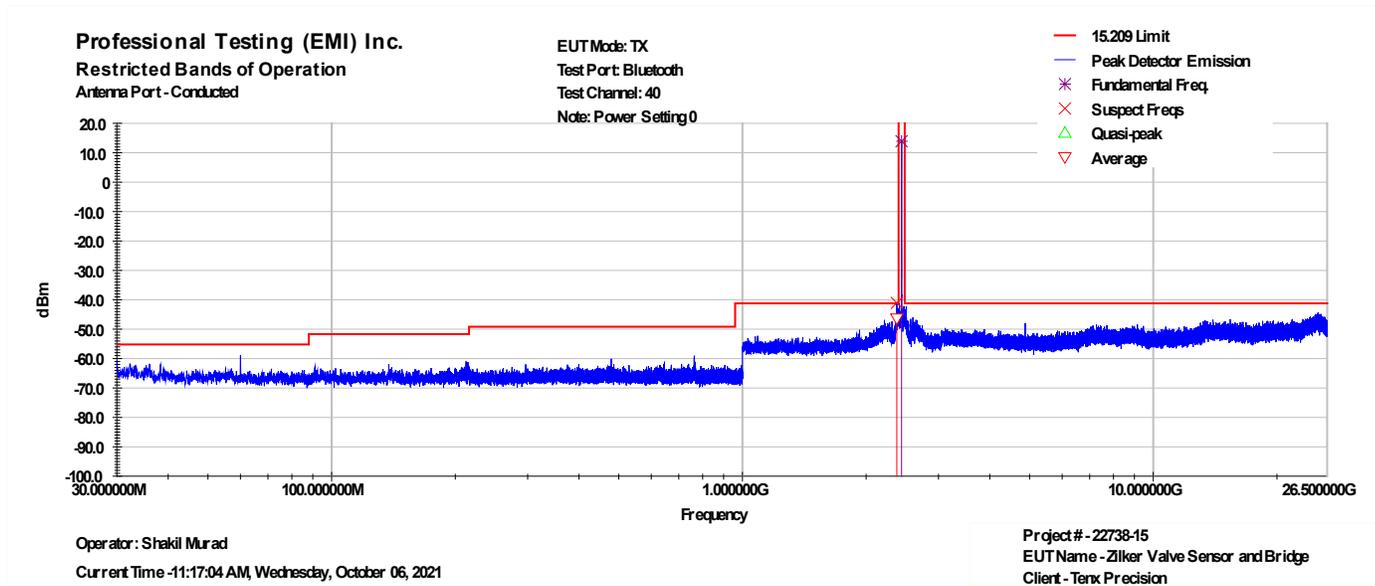
The top, middle and bottom channels were tested. 15.209 limits were applied to entire band for worst-case limits. The EUT satisfied the requirements.

Bottom Channel:



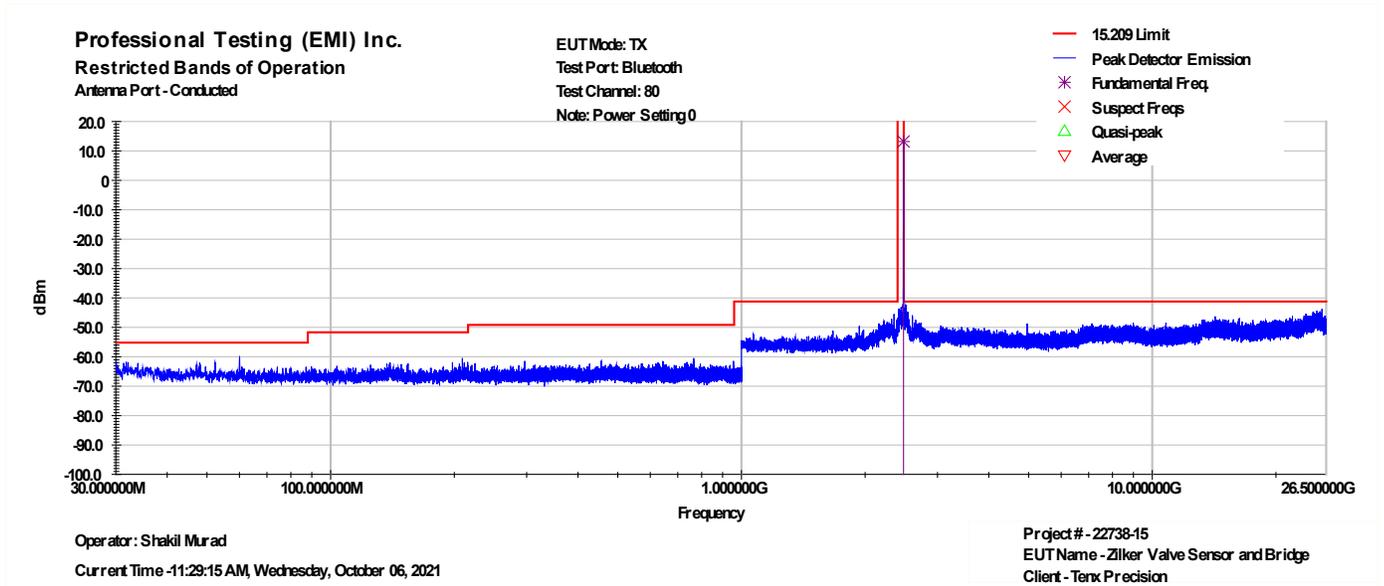
Frequency (MHz)	Corrected Level (dBm)	Limit (dBm)	Result
30.031MHz	-60.17	-55.23	PASS

Middle Channel:



Frequency (MHz)	Corrected Level (dBm)	Limit (dBm)	Result
2.376GHz	-46.371	-41.25	PASS

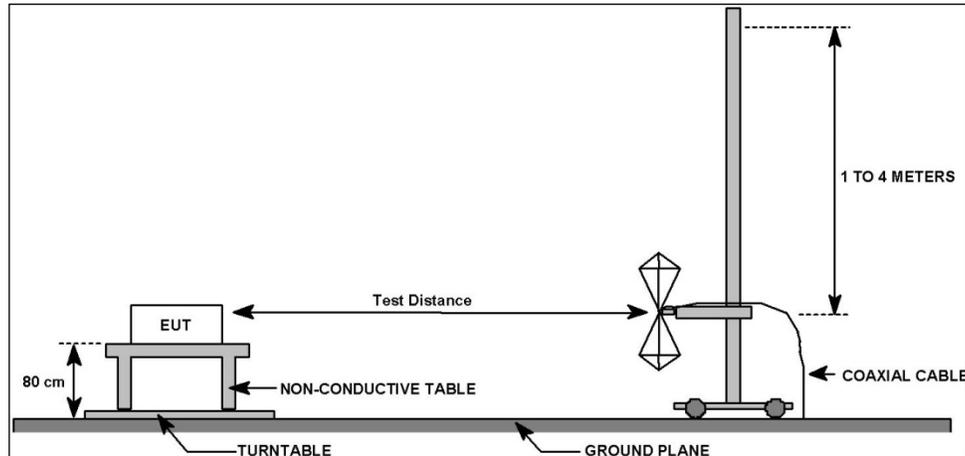
Top Channel:



8.0 Radiated Spurious Emissions, Transmit Mode; 15.247, 15.205; RSS-247 5.5; RSS-Gen 6.13 & 8.10

8.1 Test Procedure

Radiated emissions are measured with the EUT transmitting on the required frequencies.



6.1.1 Test Distance and Detection Method

30 MHz to 1 GHz	1 GHz to 18 GHz	18 GHz to 26.5 GHz
10 m	3 m	1 m
Quasi-peak	Peak & Average	Peak & Average

8.2 Test Criteria

47 CFR (USA) // IC (Canada)		
Section Reference	Parameter	Date(s)
15.247(d), 15.205 // RSS-247 5.5, RSS-Gen 6.13 & 8.10	Field Strength of Radiated Spurious/Harmonic Emissions Transmit Mode	12-14 Oct 2021

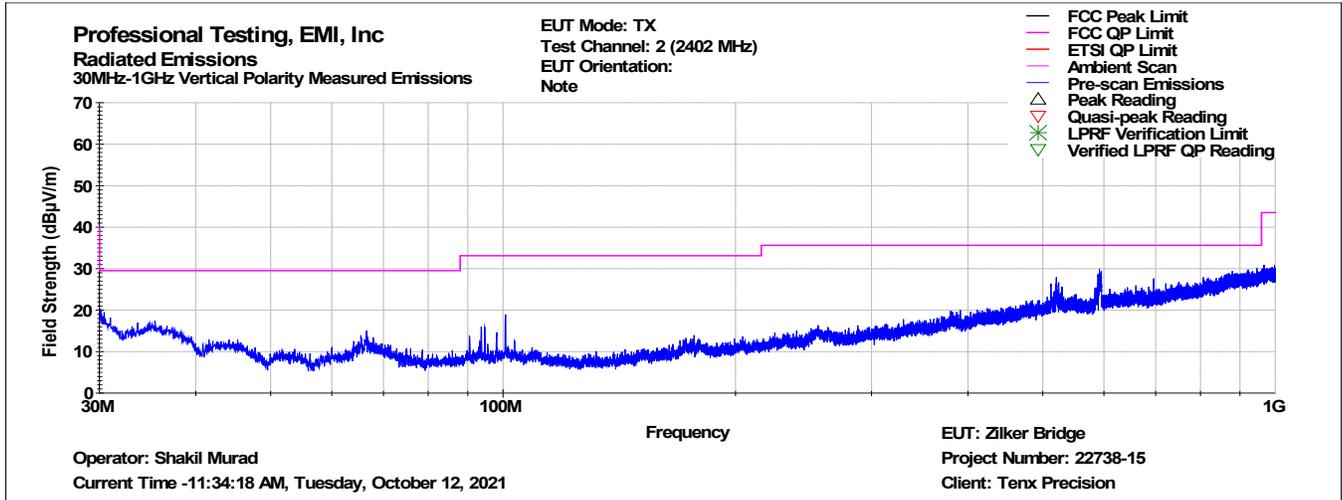
8.3 Test Results

Three channels were tested. EUT was transmitting continuously unmodulated. Device tested in normal operational orientation. Filters used to remove fundamental during testing.

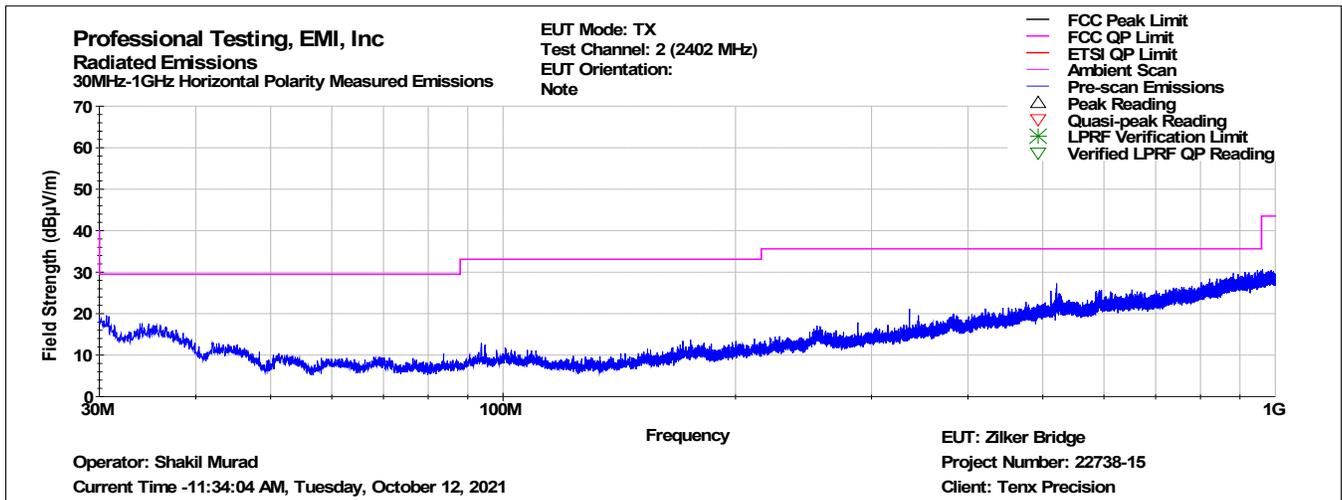
The EUT satisfied the requirement. Graphical and tabular data appears below.

8.3.1 Bottom Channel, 30 MHz to 26.5 GHz

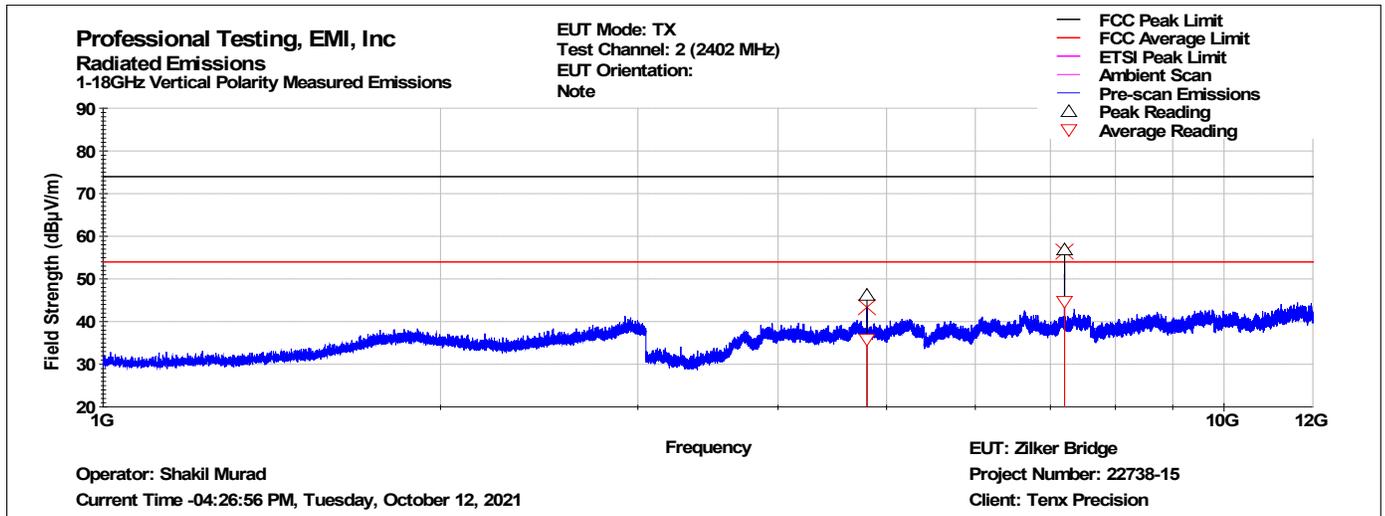
30MHz - 1GHz Vertical Polarity Measured Emissions Data



30MHz - 1GHz Horizontal Polarity Measured Emissions Data



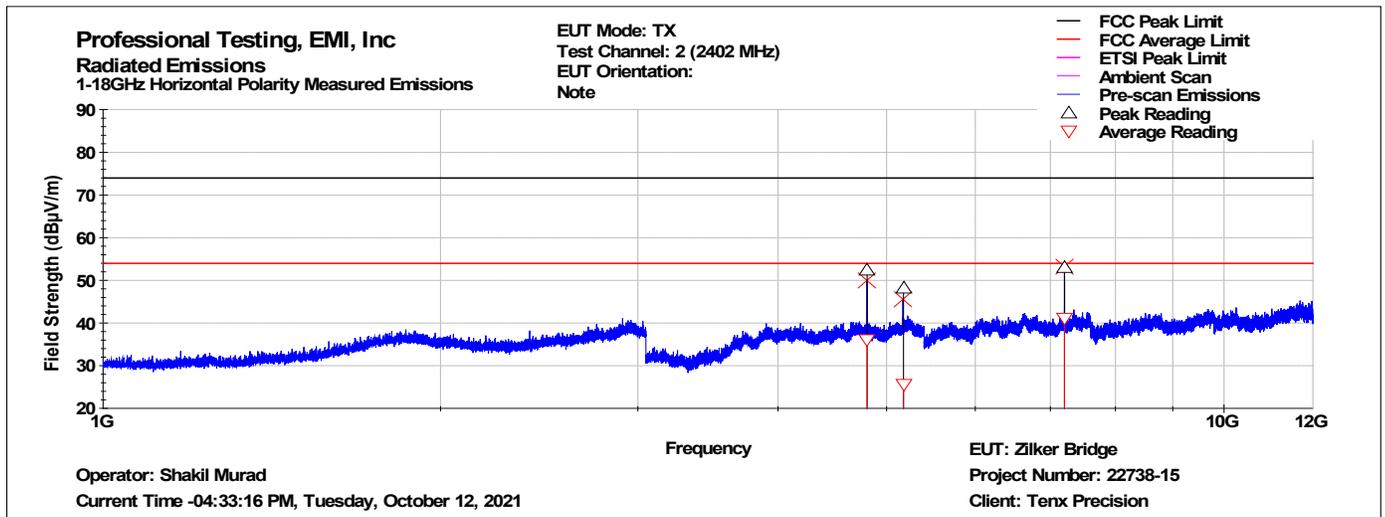
1GHz - 12GHz Vertical Polarity Measured Emissions Data



1GHz - 12GHz Vertical Polarity Measured Emissions Data - FCC

Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
4803.53	127	279	46.140	73.958	-27.818	PASS	35.861	53.958	-18.097	PASS
7206.75	175	187	56.750	73.958	-17.208	PASS	44.800	53.958	-9.158	PASS

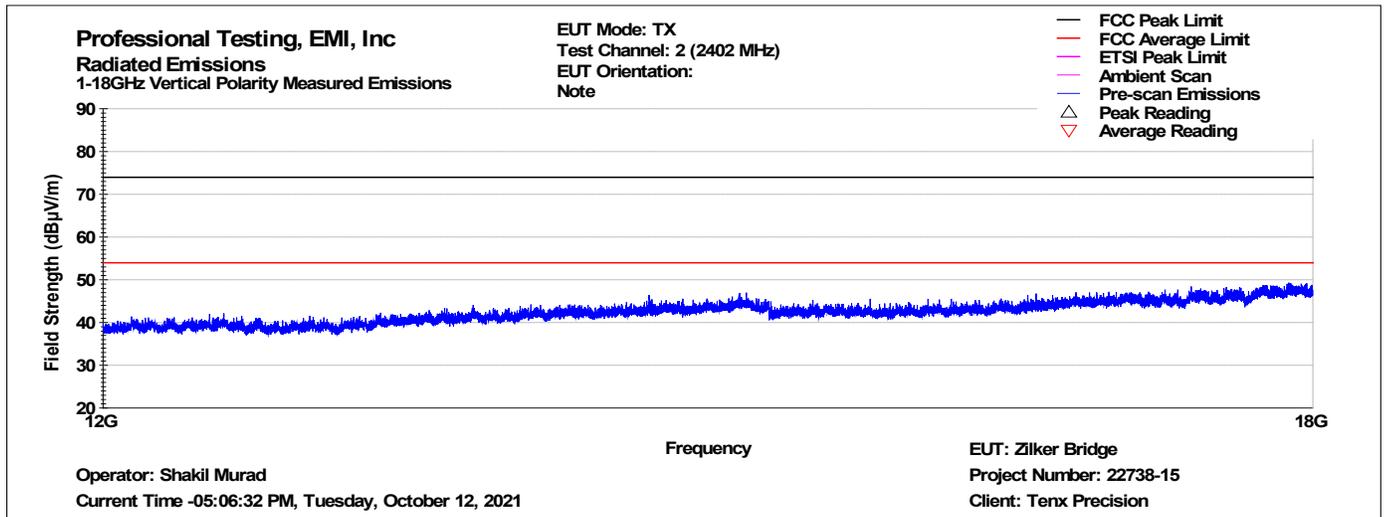
1GHz - 12GHz Horizontal Polarity Measured Emissions Data



1GHz - 12GHz Horizontal Polarity Measured Emissions Data - FCC

Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
4803.98	44	309	52.472	73.958	-21.486	PASS	36.018	53.958	-17.940	PASS
5176.50	230	397	48.091	73.958	-25.867	PASS	25.629	53.958	-28.329	PASS
7205.44	185	122	52.911	73.958	-21.047	PASS	41.112	53.958	-12.846	PASS

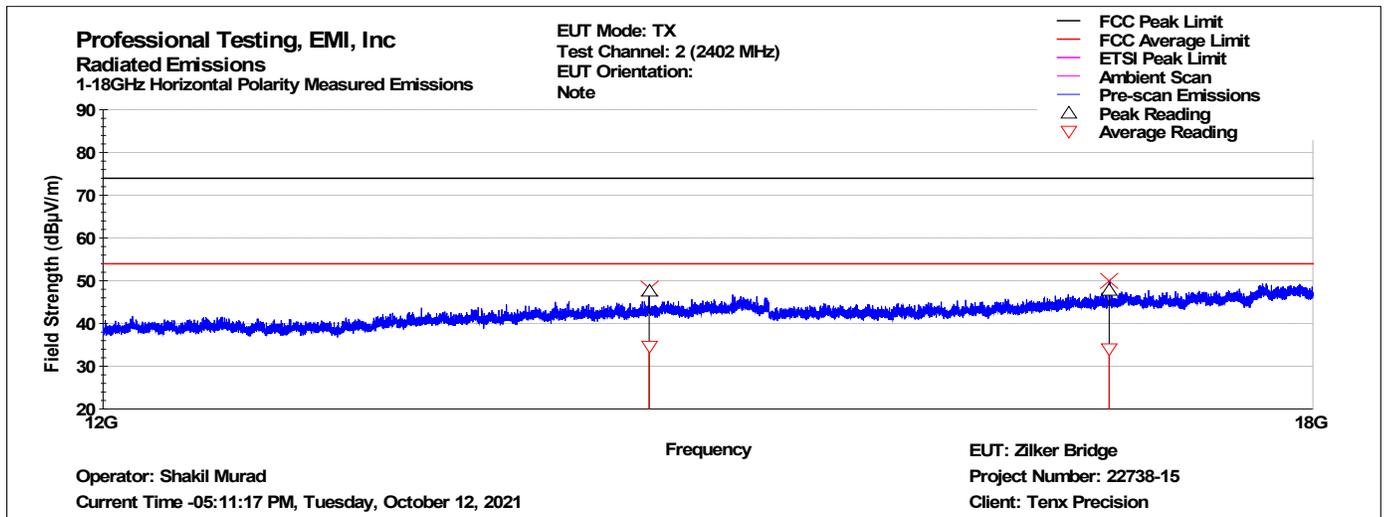
12GHz - 18GHz Vertical Polarity Measured Emissions Data



12GHz - 18GHz Vertical Polarity Measured Emissions Data - FCC

Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
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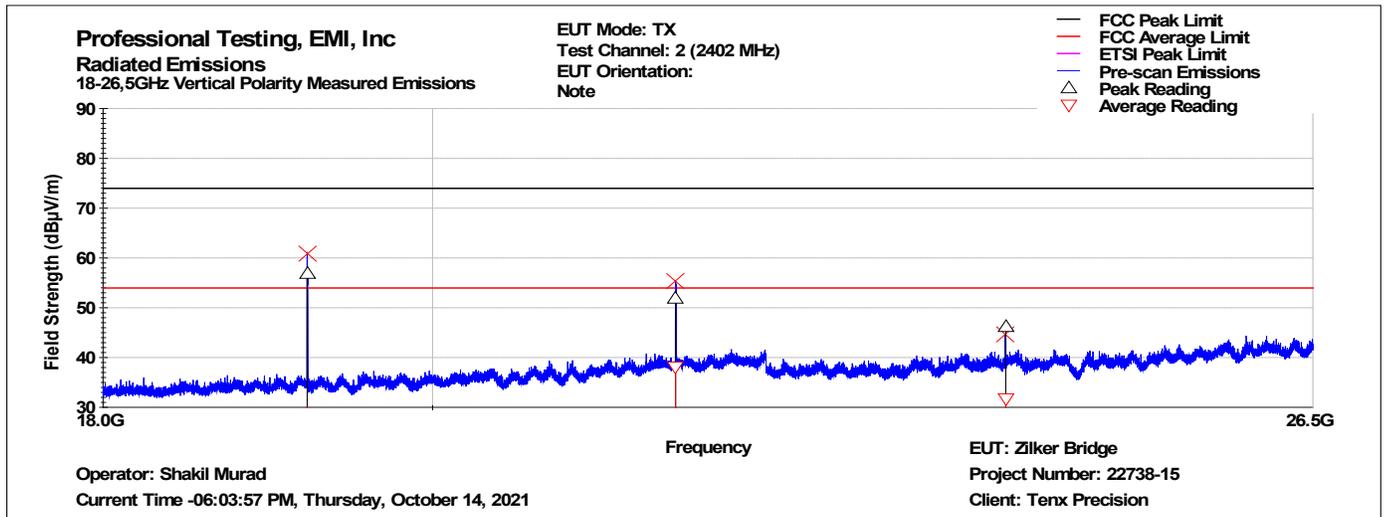
12GHz - 18GHz Horizontal Polarity Measured Emissions Data



12GHz - 18GHz Horizontal Polarity Measured Emissions Data - FCC

Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
14410.53	173	124	47.577	73.958	-26.381	PASS	34.757	53.958	-19.201	PASS
16812.52	66	99	47.680	73.958	-26.278	PASS	34.052	53.958	-19.906	PASS

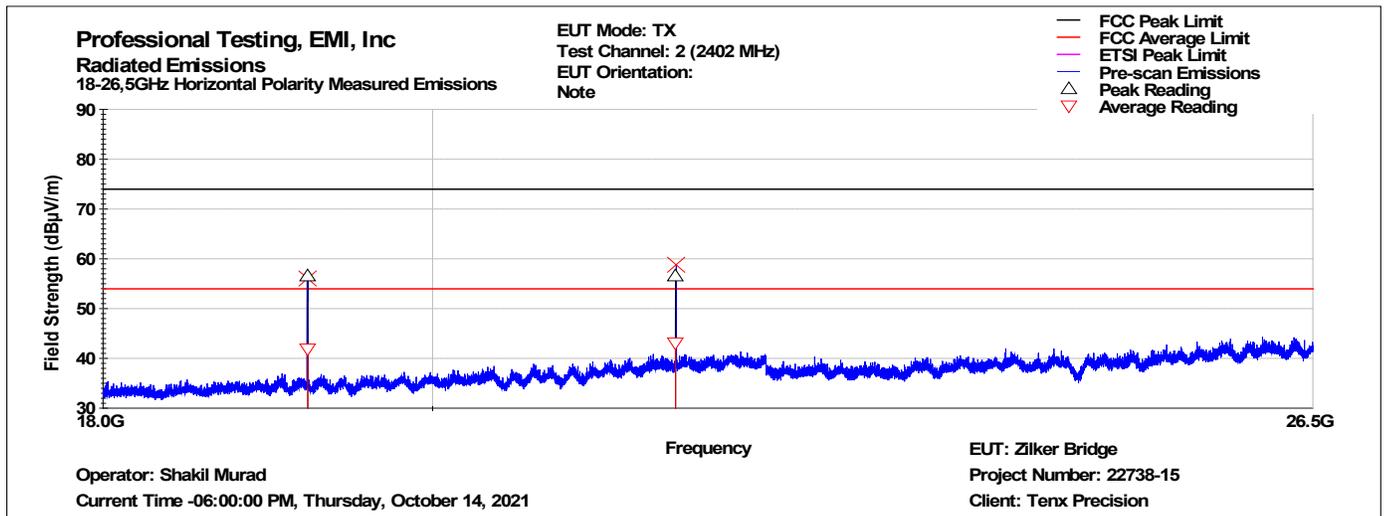
18GHz - 26.5GHz Vertical Polarity Measured Emissions Data



18GHz - 26.5GHz Vertical Polarity Measured Emissions Data - FCC

Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
19213.99	159	100.000	56.837	73.958	-17.121	PASS	27.285	53.958	-26.673	PASS
21615.90	76	100.000	51.977	73.958	-21.981	PASS	38.076	53.958	-15.882	PASS
24022.39	17	100.000	46.178	73.958	-27.780	PASS	31.701	53.958	-22.257	PASS

18GHz - 26.5GHz Horizontal Polarity Measured Emissions Data

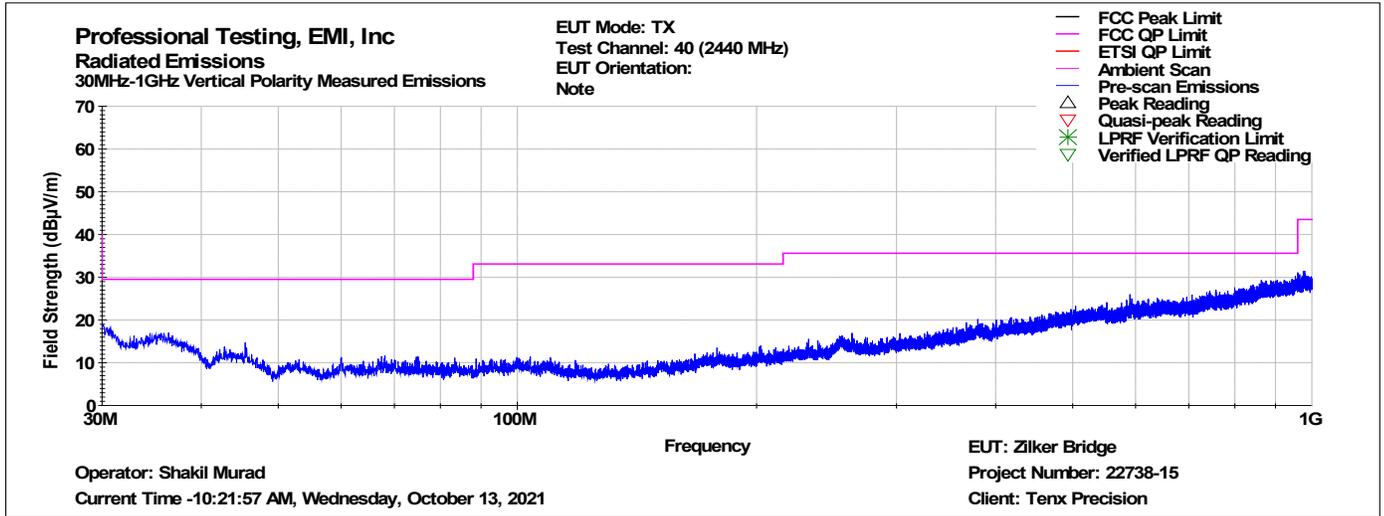


18GHz - 26.5GHz Horizontal Polarity Measured Emissions Data - FCC

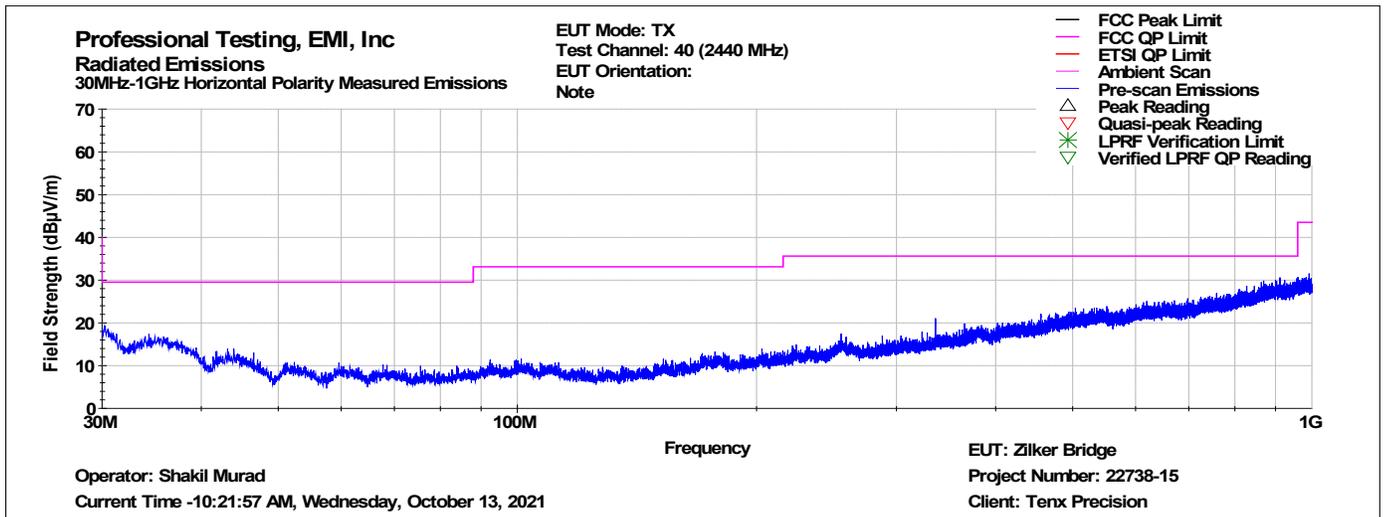
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
19218.12	225	100.000	56.533	73.958	-17.425	PASS	41.978	53.958	-11.980	PASS
21615.82	221	100.000	56.499	73.958	-17.459	PASS	43.093	53.958	-10.865	PASS

8.3.2 Middle Channel, 30 MHz to 26.5 GHz

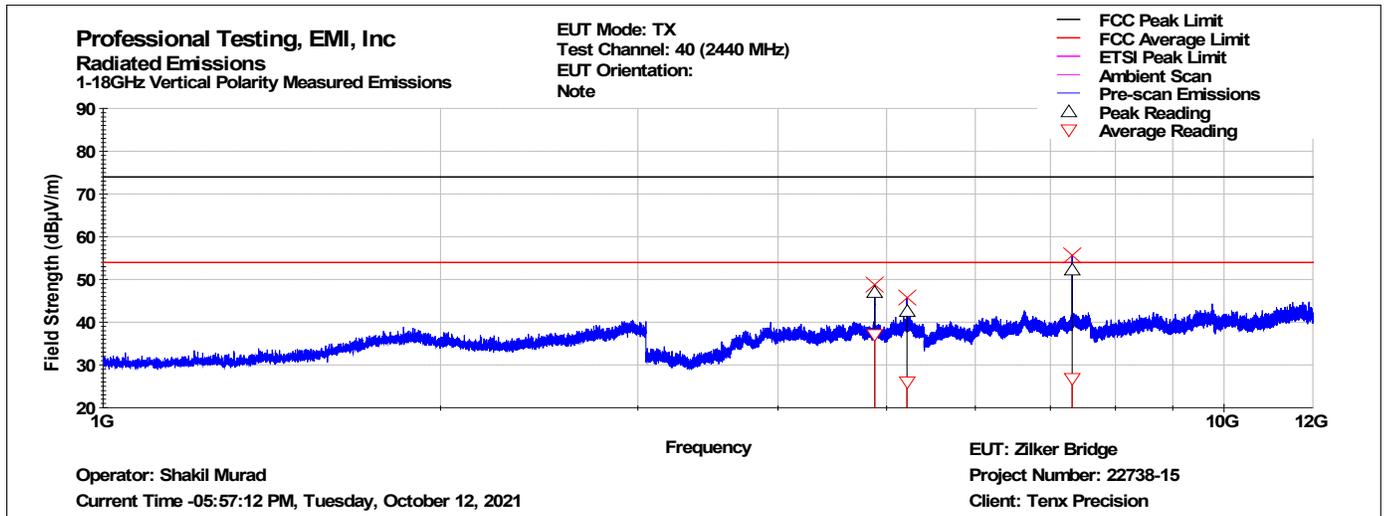
30MHz - 1GHz Vertical Polarity Measured Emissions Data



30MHz - 1GHz Horizontal Polarity Measured Emissions Data



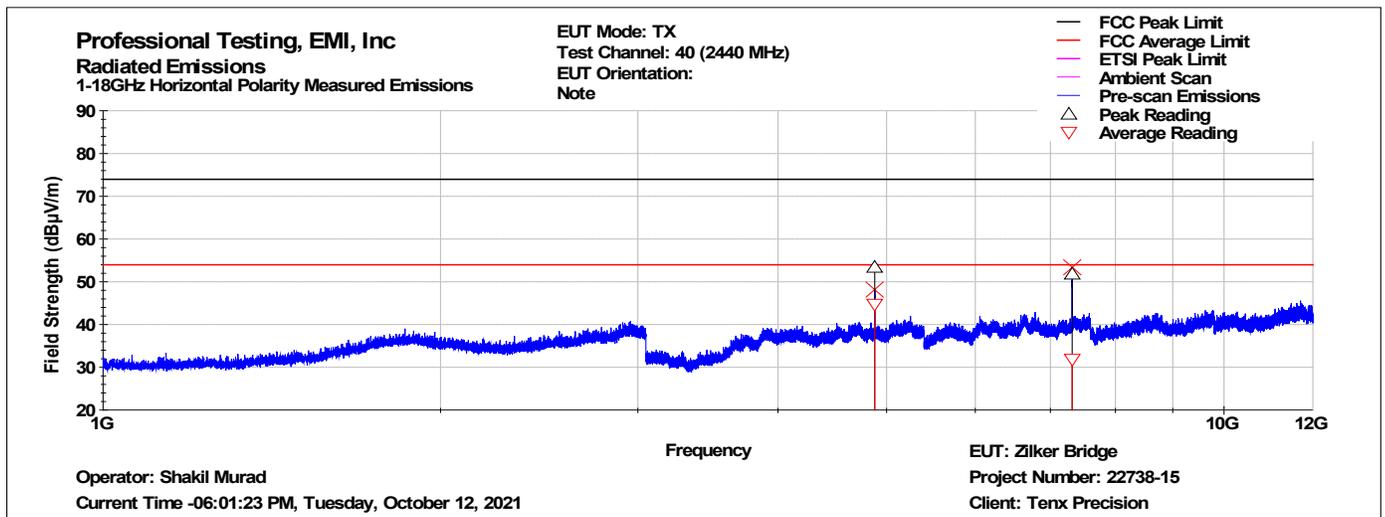
1GHz - 12GHz Vertical Polarity Measured Emissions Data



1GHz - 12GHz Vertical Polarity Measured Emissions Data - FCC

Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
4879.47	134	125	47.019	73.958	-26.939	PASS	37.174	53.958	-16.784	PASS
5214.43	95	271	42.612	73.958	-31.346	PASS	26.057	53.958	-27.901	PASS
7320.71	176	397	52.113	73.958	-21.845	PASS	26.906	53.958	-27.052	PASS

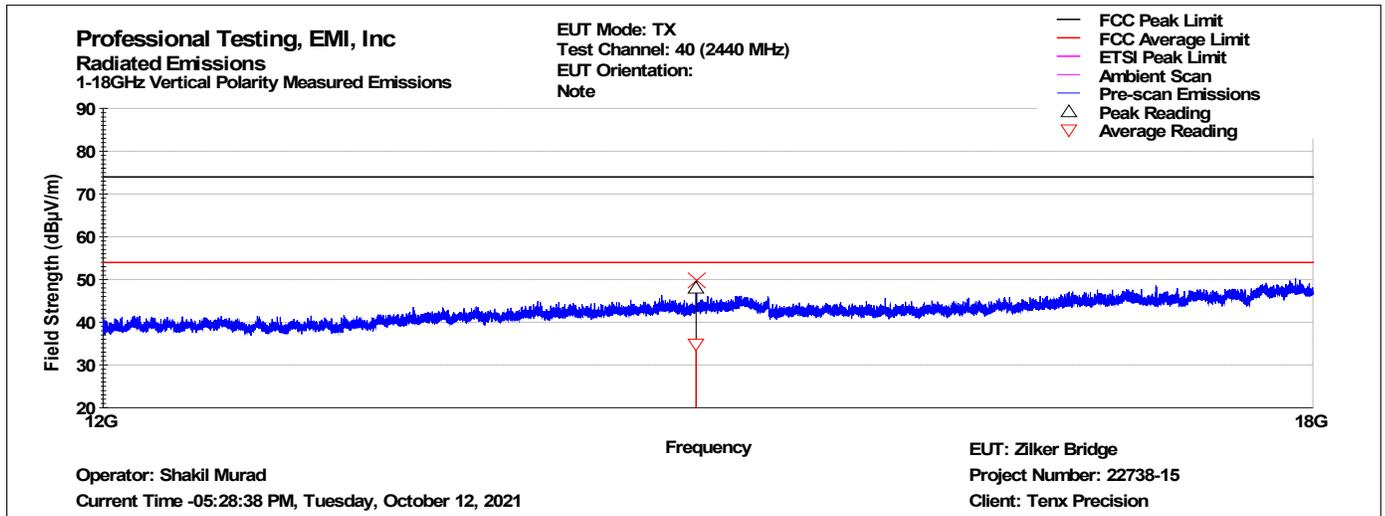
1GHz - 12GHz Horizontal Polarity Measured Emissions Data



1GHz - 12GHz Horizontal Polarity Measured Emissions Data - FCC

Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
4879.54	44	343	53.385	73.958	-20.573	PASS	44.696	53.958	-9.262	PASS
7319.49	183	122	51.837	73.958	-22.121	PASS	31.934	53.958	-22.024	PASS

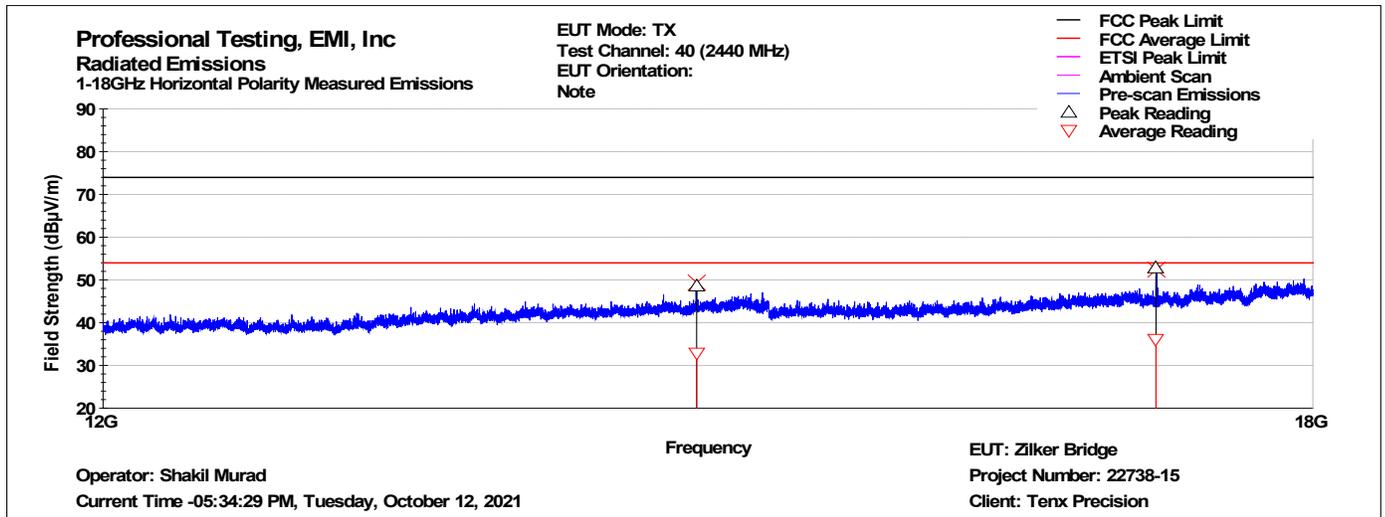
12GHz - 18GHz Vertical Polarity Measured Emissions Data



12GHz - 18GHz Vertical Polarity Measured Emissions Data - FCC

Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
14638.86	44	305	47.866	73.958	-26.092	PASS	34.920	53.958	-19.038	PASS

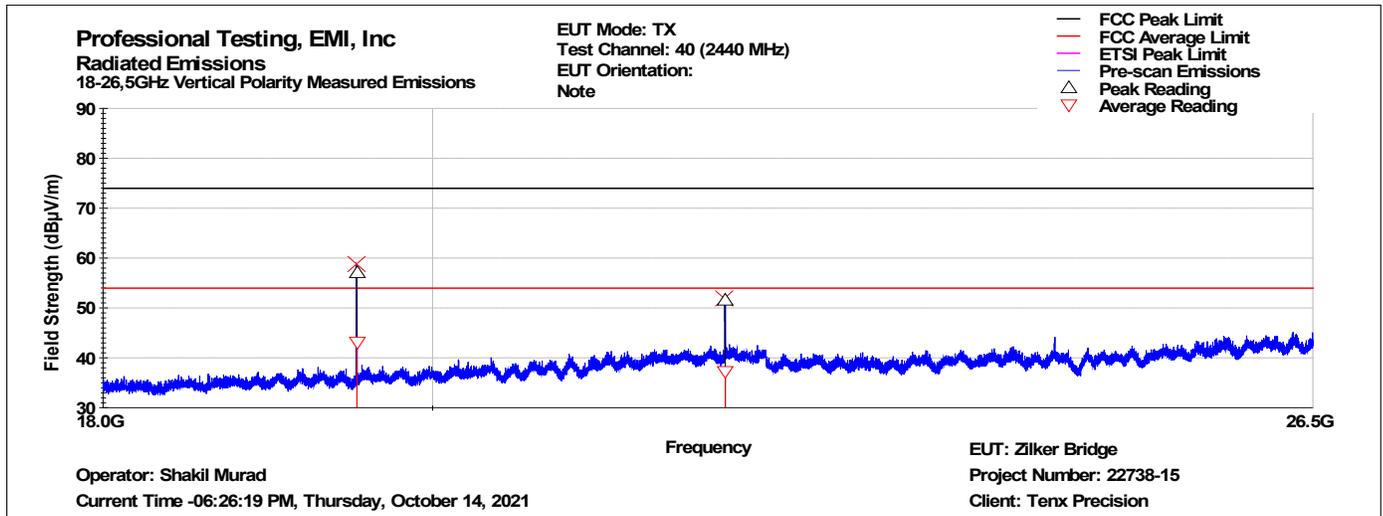
12GHz - 18GHz Horizontal Polarity Measured Emissions Data



12GHz - 18GHz Horizontal Polarity Measured Emissions Data - FCC

Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
14641.81	154	193	48.501	73.958	-25.457	PASS	32.911	53.958	-21.047	PASS
17078.33	138	359	52.802	73.958	-21.156	PASS	36.184	53.958	-17.774	PASS

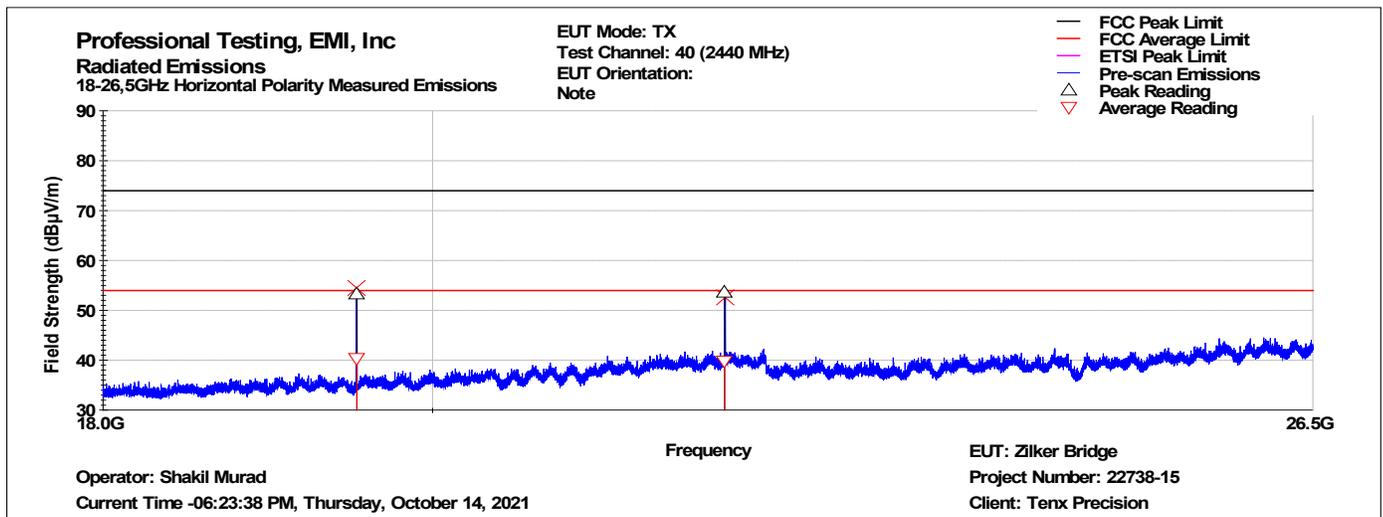
18GHz - 26.5GHz Vertical Polarity Measured Emissions Data



18GHz - 26.5GHz Vertical Polarity Measured Emissions Data - FCC

Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
19522.12	196	100.000	57.038	73.958	-16.920	PASS	43.147	53.958	-10.811	PASS
21962.46	179	100.000	51.573	73.958	-22.385	PASS	37.241	53.958	-16.717	PASS

18GHz - 26.5GHz Horizontal Polarity Measured Emissions Data

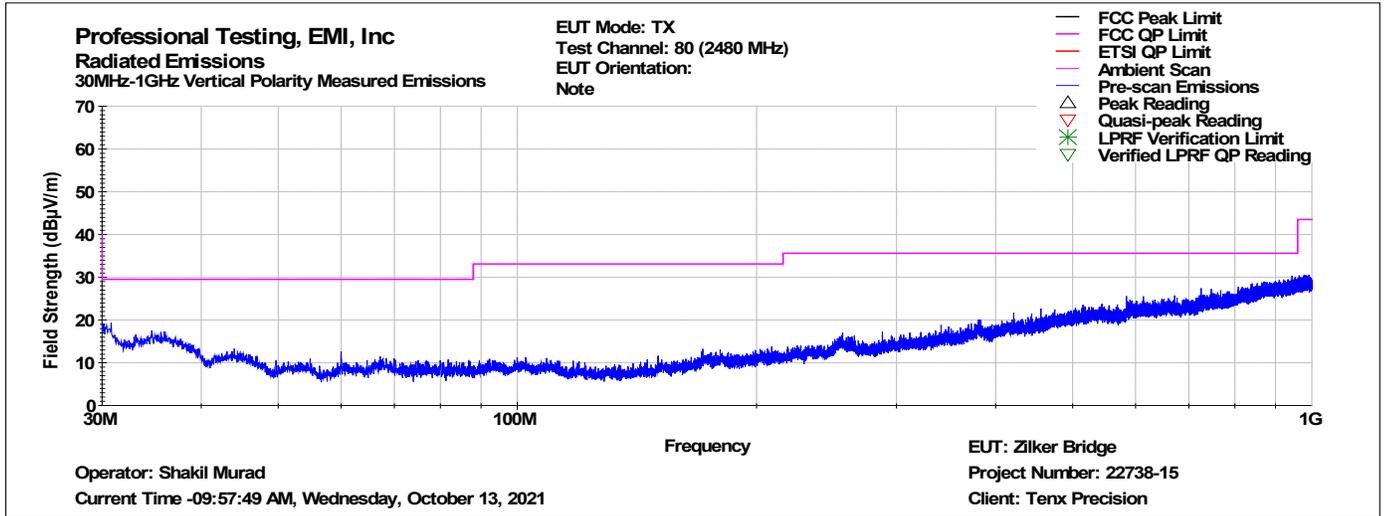


18GHz - 26.5GHz Horizontal Polarity Measured Emissions Data - FCC

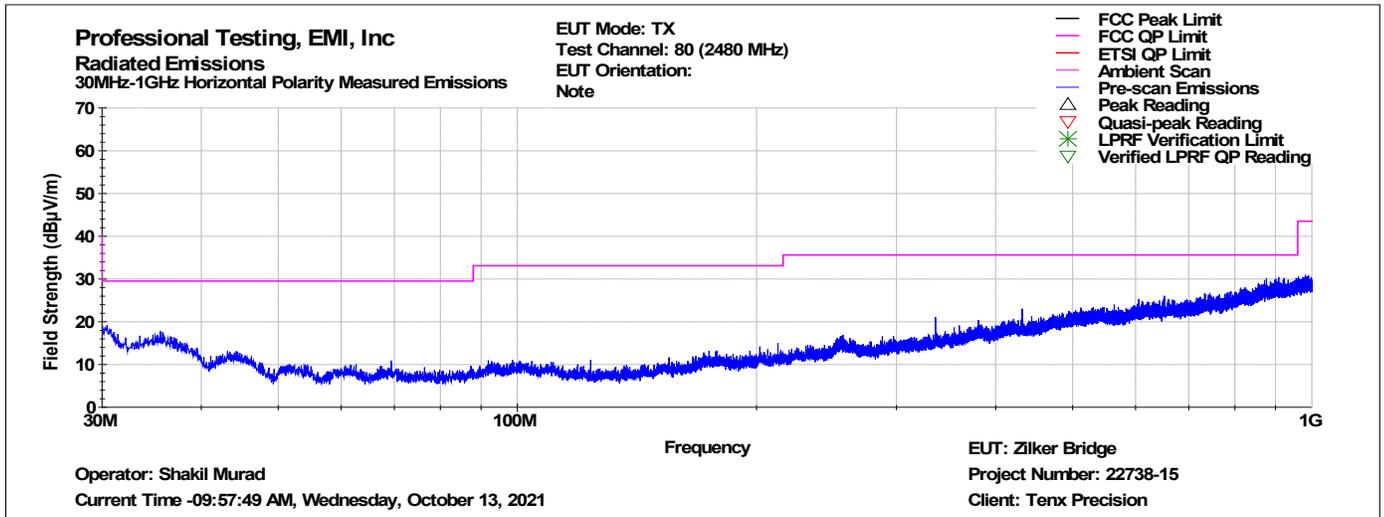
Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
19522.00	2	100.000	53.338	73.958	-20.620	PASS	40.260	53.958	-13.698	PASS
21957.92	210	100.000	53.617	73.958	-20.341	PASS	39.830	53.958	-14.128	PASS

8.3.3 Top Channel, 30 MHz to 26.5 GHz

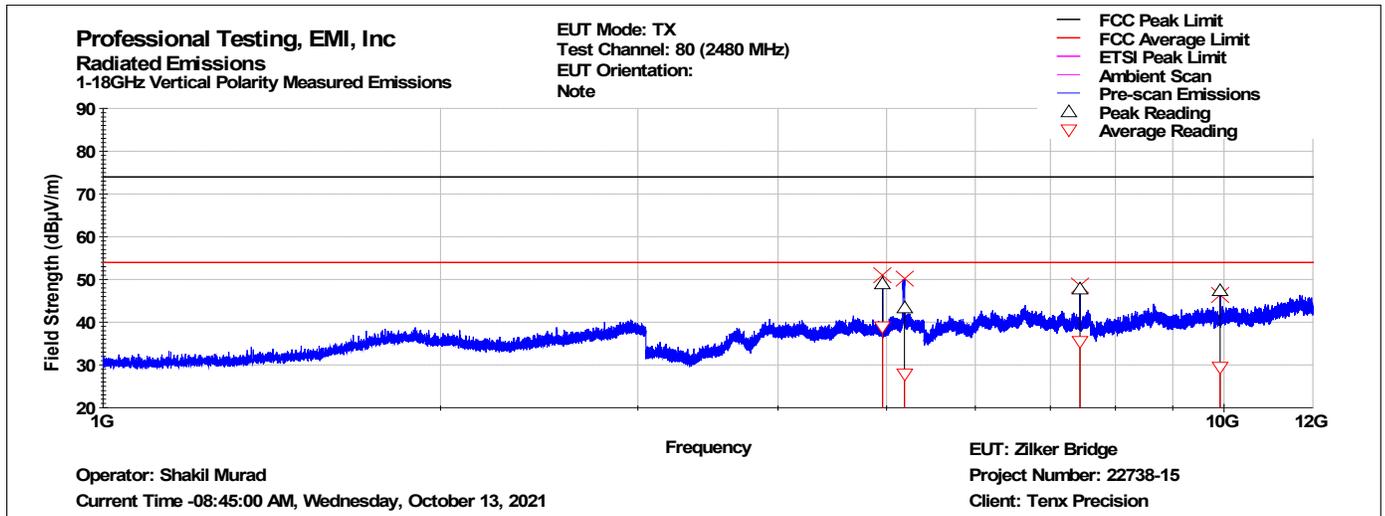
30MHz - 1GHz Vertical Polarity Measured Emissions Data



30MHz - 1GHz Horizontal Polarity Measured Emissions Data



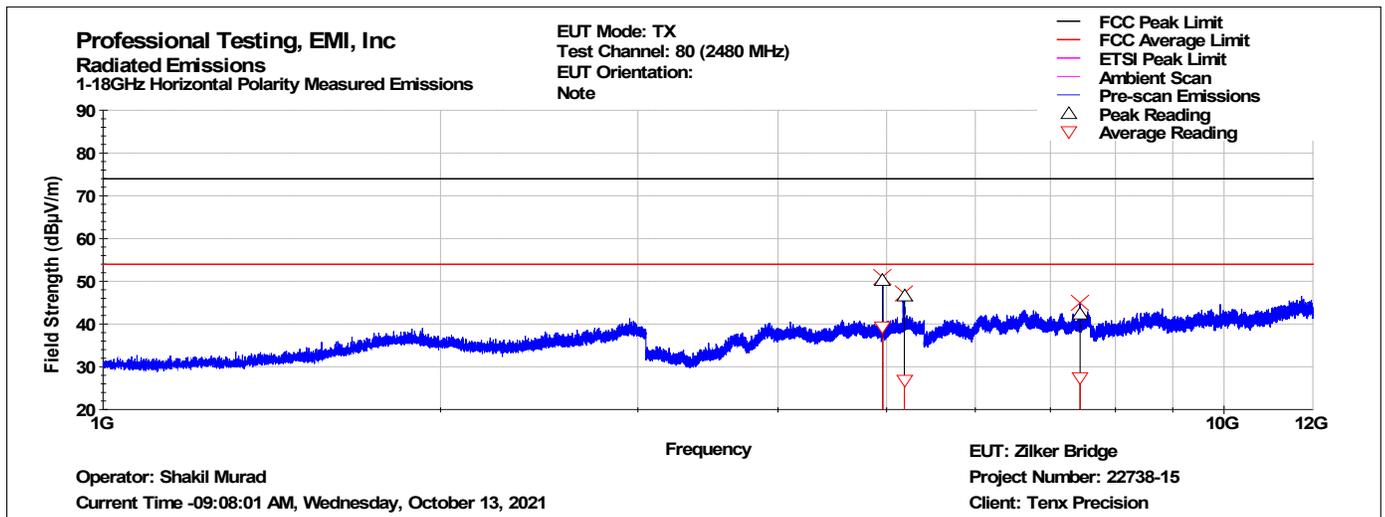
1GHz - 12GHz Vertical Polarity Measured Emissions Data



1GHz - 12GHz Vertical Polarity Measured Emissions Data - FCC

Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
4959.33	135	173	49.032	73.958	-24.926	PASS	38.848	53.958	-15.110	PASS
5187.04	208	102	43.294	73.958	-30.664	PASS	27.811	53.958	-26.147	PASS
7439.53	190	232	47.841	73.958	-26.117	PASS	35.489	53.958	-18.469	PASS
9919.35	206	375	47.247	73.958	-26.711	PASS	29.536	53.958	-24.422	PASS

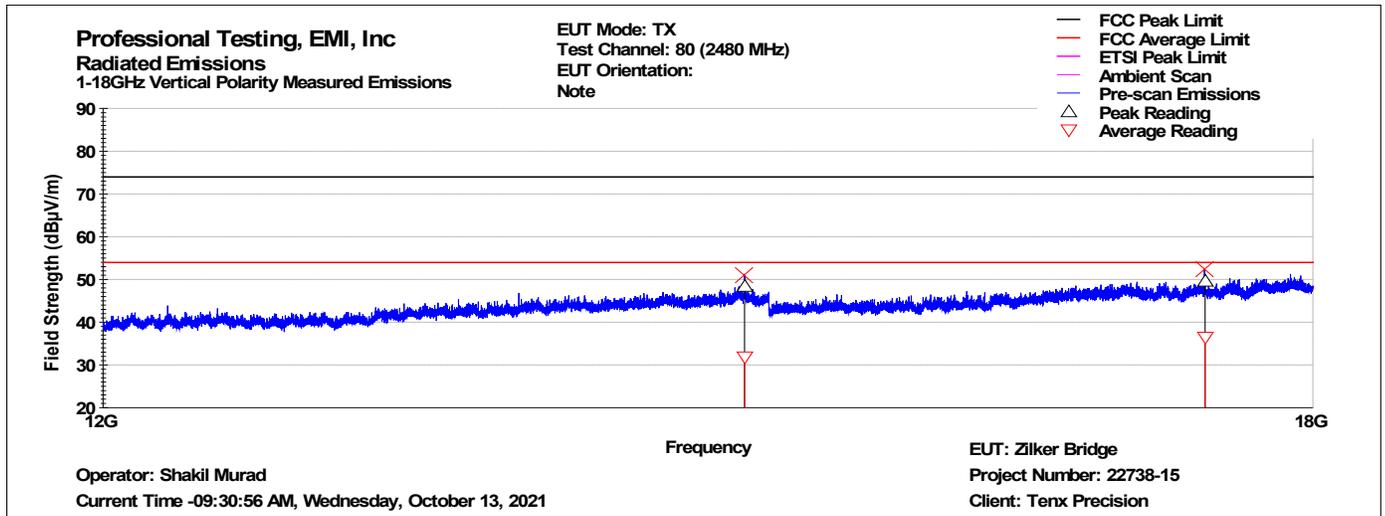
1GHz - 12GHz Horizontal Polarity Measured Emissions Data



1GHz - 12GHz Horizontal Polarity Measured Emissions Data - FCC

Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
4960.52	310	255	50.227	73.958	-23.731	PASS	39.312	53.958	-14.646	PASS
5185.78	180	321	46.499	73.958	-27.459	PASS	26.912	53.958	-27.046	PASS
7440.46	198	318	42.290	73.958	-31.668	PASS	27.503	53.958	-26.455	PASS
9921.00	0	0	NAN	73.958	NAN		NAN	53.958	NAN	

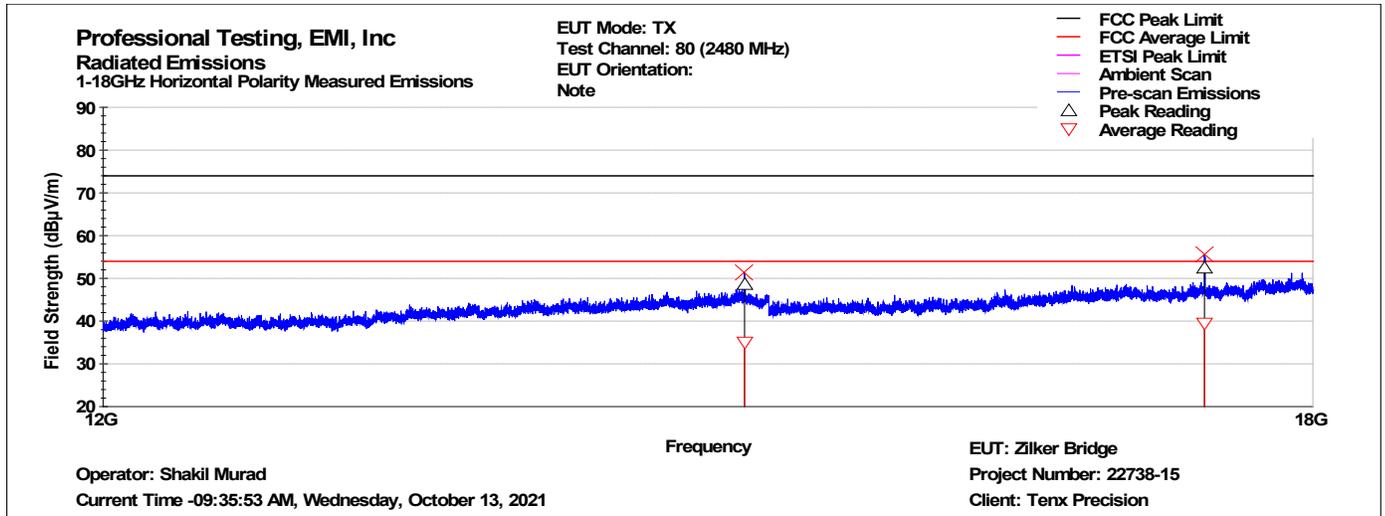
12GHz - 18GHz Vertical Polarity Measured Emissions Data



12GHz - 18GHz Vertical Polarity Measured Emissions Data - FCC

Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
14878.75	38	125	48.367	73.958	-25.591	PASS	31.798	53.958	-22.160	PASS
17361.77	156	376	49.552	73.958	-24.406	PASS	36.457	53.958	-17.501	PASS

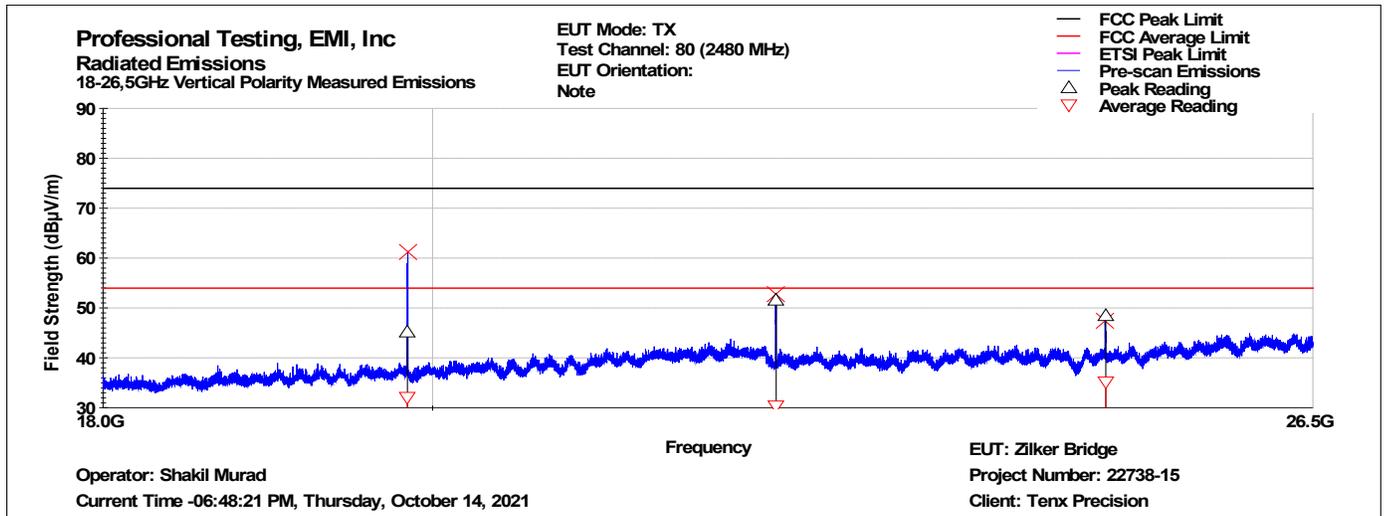
12GHz - 18GHz Horizontal Polarity Measured Emissions Data



12GHz - 18GHz Horizontal Polarity Measured Emissions Data - FCC

Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
14878.35	129	312	48.480	73.958	-25.478	PASS	35.182	53.958	-18.776	PASS
17358.38	218	372	52.294	73.958	-21.664	PASS	39.584	53.958	-14.374	PASS

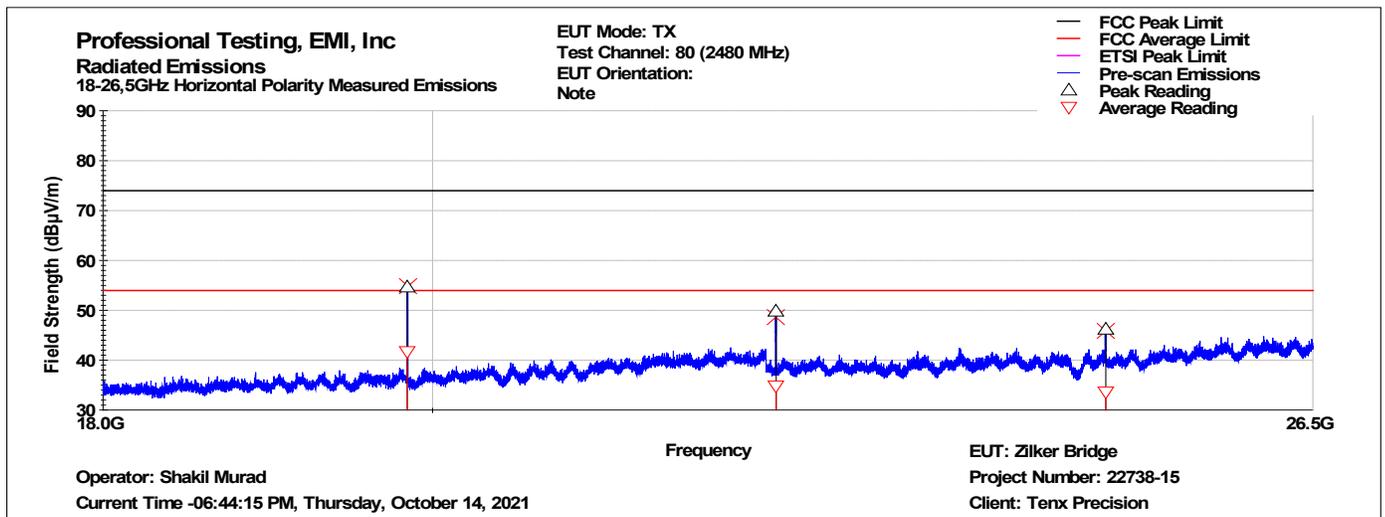
18GHz - 26.5GHz Vertical Polarity Measured Emissions Data



18GHz - 26.5GHz Vertical Polarity Measured Emissions Data - FCC

Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
19839.99	145	100.000	45.163	73.958	-28.795	PASS	31.998	53.958	-21.960	PASS
22322.29	21	100.000	51.529	73.958	-22.429	PASS	30.368	53.958	-23.590	PASS
24802.87	203	100.000	48.502	73.958	-25.456	PASS	35.176	53.958	-18.782	PASS

18GHz - 26.5GHz Horizontal Polarity Measured Emissions Data



18GHz - 26.5GHz Horizontal Polarity Measured Emissions Data - FCC

Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Peak Reading (dBµV)	Peak Limit (dBµV)	Peak Margin (dB)	Peak Results	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Average Results
19838.17	225	100.000	54.683	73.958	-19.275	PASS	41.671	53.958	-12.287	PASS
22322.29	277	100.000	49.831	73.958	-24.127	PASS	34.755	53.958	-19.203	PASS
24802.57	224	100.000	46.245	73.958	-27.713	PASS	33.542	53.958	-20.416	PASS

9.0 Radiated Spurious Emissions, Receive Mode; 15.247, 15.209; RSS-247 5.5, RSS-Gen 4.9 & 4.10

9.1 Test Procedure

Receive mode radiated emissions were measured with the EUT receiving on the center channel on 13 Oct 2021.

7.1.1 Test Distance, Table Height, and Detection Method		
30 MHz to 1 GHz	1 GHz to 18 GHz	18 GHz to 25 GHz
10 m, 80 cm	3 m, 80 cm	1 m, 80 cm
Quasi-peak	Peak & Average	Peak & Average

9.2 Test Criteria

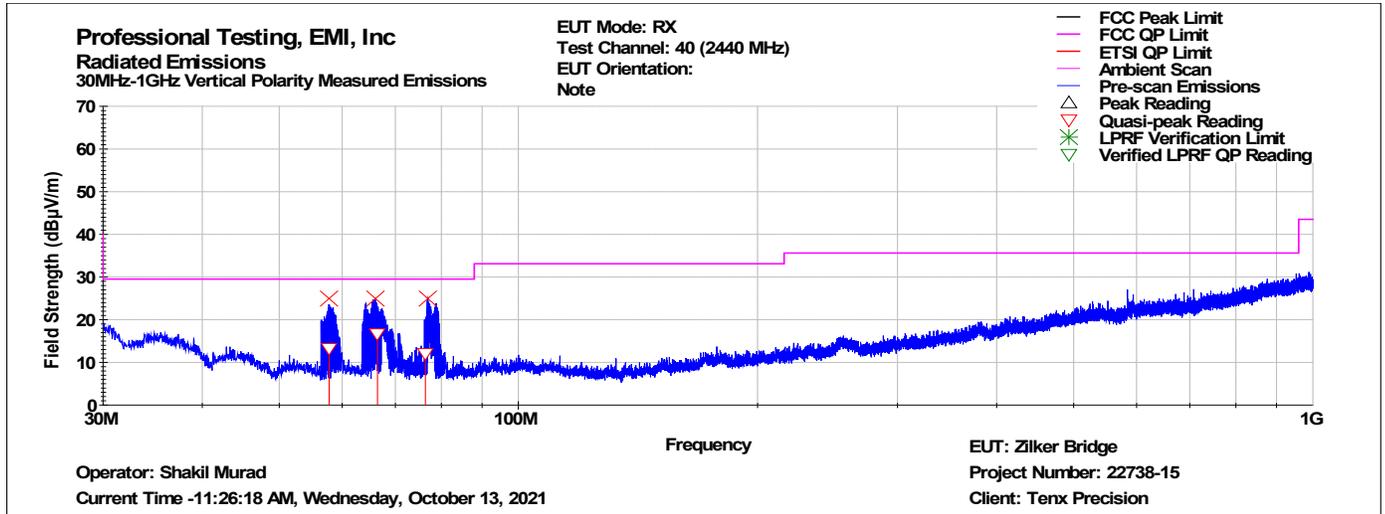
Unwanted Emissions
Field Strength of Radiated Spurious/Harmonic Emissions Receive Mode

9.3 Test Results

The requirement was satisfied.

9.3.1 Middle Channel, 30 MHz to 13 GHz

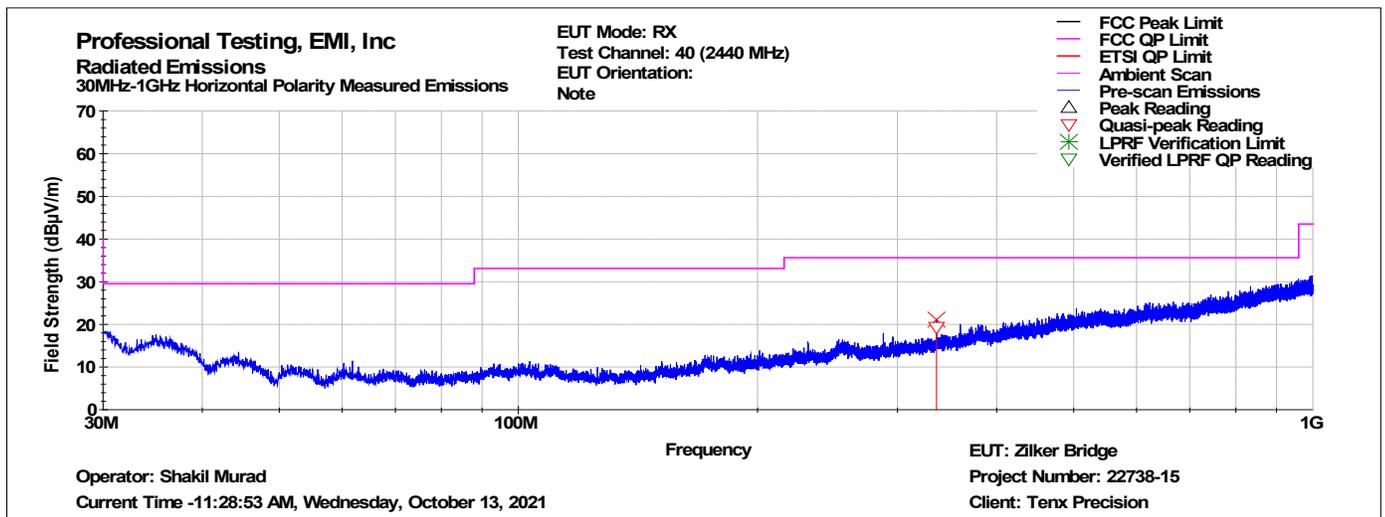
30MHz - 1GHz Vertical Polarity Measured Emissions Data



30MHz - 1GHz Vertical Polarity Measured Emissions Data - FCC

Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results
57.781	311.000	323.000	13.323	29.500	-16.177	PASS
66.481	174.000	262.000	16.791	29.500	-12.709	PASS
76.371	154.000	194.000	12.134	29.500	-17.366	PASS

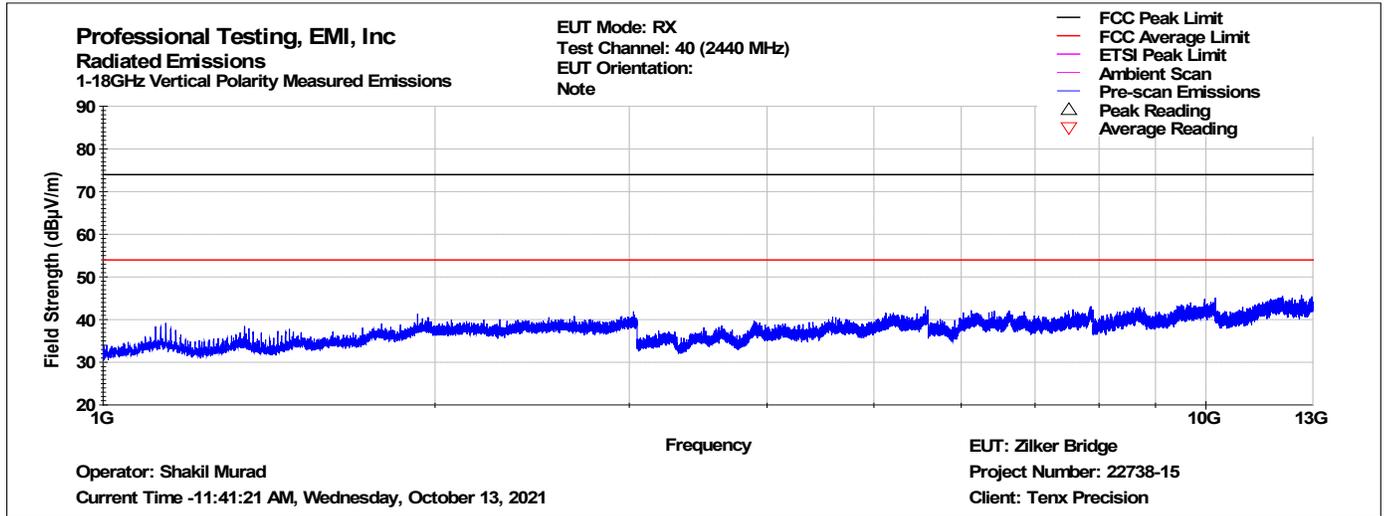
30MHz - 1GHz Horizontal Polarity Measured Emissions Data



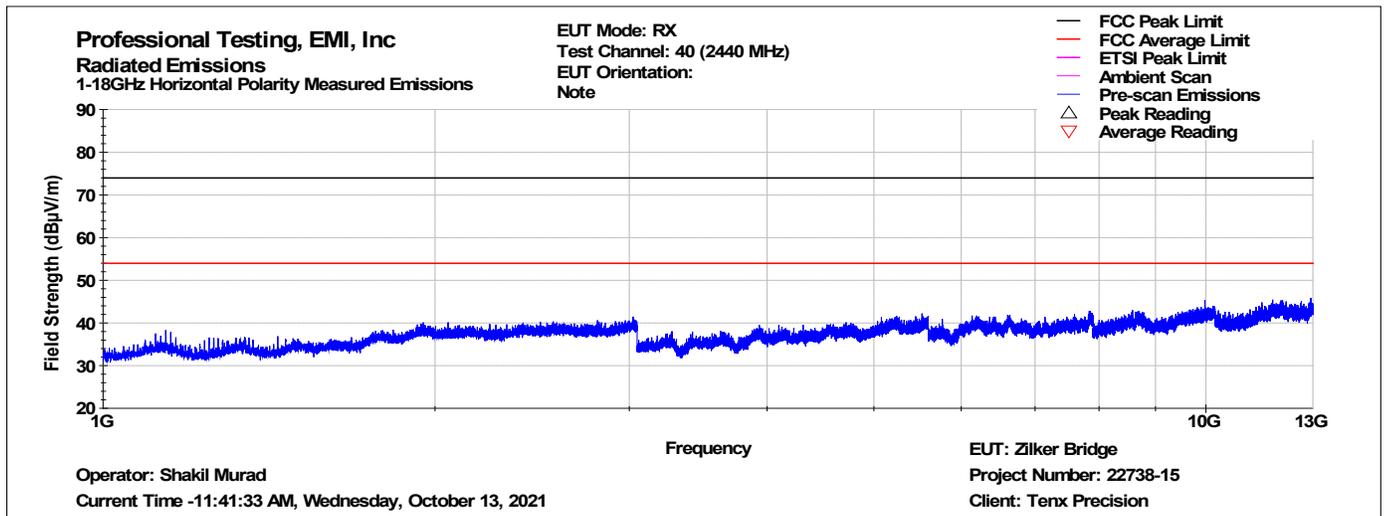
30MHz - 1GHz Horizontal Polarity Measured Emissions Data - FCC

Frequency (MHz)	EUT Direction (Degrees)	Antenna Height (cm)	Quasi-peak Reading (dBµV)	Quasi-peak Limit (dBµV)	Quasi-peak Margin (dB)	Quasi-peak Results
336.004	320.000	187.000	19.215	35.600	-16.385	PASS

1GHz - 13GHz Vertical Polarity Measured Emissions Data



1GHz - 13GHz Horizontal Polarity Measured Emissions Data



10.0 Antenna Construction; 15.203, 15.247; RSS-Gen 8.3

10.1 Procedure

A direct examination of the antenna construction is performed and compared to rule criteria that prevent wireless device antennas from being modified by end users.

10.2 Criteria

Antenna Construction
Type of Antenna(s)
Type of Connector
Gain

10.3 Results

Table 8.3.1 Antenna Construction Details
Chip Antenna
Manufacturer: Johanson Technology Model/PN: 2450AT18A100E Antenna peak gain 0.5 dBi. No connector. Chip is soldered to circuit board. https://www.johansontechnology.com/index.php?option=com_products&id=2450AT18A100E-AEC

User cannot substitute antenna.

Gain is under maximum limit of 6 dBi.

The requirement was satisfied.

11.0 Equipment

11.1 Transmitter Radiated Spurious Emissions 30 MHz to 26.5 GHz

Tile! Software Version:		Version: 7.1.2.17 (Jan 08, 2016 - 02:12:48 PM) or 4.1.A.0, April 14, 2009, 11:01:00PM			
Test Profile:		2020_RE_Unintentional_TILE7_v2.7.til			
Asset #	Manufacturer	Model	Equipment Nomenclature	Serial Number	Calibration Due Date
1425	Electro-Metrics	BPA-1000	Preamp, Broadband 10k-1GHz	123	3/13/2022
2295	Keysight	E4440A-AYZ	PSA Spectrum Analyzer	MY46186204	11/10/2021
1926	ETS-Lindgren	3142D	Antenna, Biconilog, 26 MHz - 6 GHz	135454	4/20/2022
C027	none	RG214	Cable Coax, N-N, 25m, 25MHz - 1GHz	None	9/14/2022
1327	EMCO	1050	Controller, Antenna Mast	none	N/A
942	EMCO	11968D	Turntable, 4ft.	9510-1835	N/A
1969	HP	11713A	Attenuator/Switch Driver	3748A04113	N/A
C030	none	none	Cable Coax, N-N, 30m, 1 - 18GHz	None	9/15/2022
1509B	Braden	TDK 10M	TDK 10M Chamber,sVSWR > 1 GHz	DAC-012915-005	4/9/2023
2004	Miteq	AFS44-00101800-2S-10P-44	Amplifier, 40dB, 100MHz-18GHz	None	1/9/2022
C030	none	none	Cable Coax, N-N, 30m, 1 - 18GHz	None	9/15/2022
1325	EMCO	1050	Controller, Antenna Mast	9003-1461	N/A
1780	ETS-Lindgren	3117	Antenna, Double Ridged Guide Horn, 1 - 18 GHz	110313	4/16/2023
1973	Agilent	83017A	Amplifier, Microwave 0.5-26.5 GHz	MY39500497	11/10/2022
1542	A.H. Systems	SAS-572	Antenna, Horn 18-26.5GHz, 20dB gain	225	N/A
1735	Pasternack	PE9850-20	Antenna, horn, WR28	N/A	N/A
2386	RF-Lambda	RLPF13G02	Low-pass Filter (DC-2GHz)	none	1/12/2022
2387	RF-Lambda	RHPF23G04G12	High-pass Filter (4-12GHz)	none	1/12/2022
2388	RF-Lambda	RHPF23G08G40	High-pass Filter (8-40GHz)	none	1/12/2022

11.2 Fundamental Power, Bandwidth, Duty Cycle, Band Edge, Conducted Spurious Emissions

Asset#	Manufacturer	Model	Equipment Nomenclature	Serial Number	Calibration Due Date
1937	Agilent	E4440A - AYZ	PSA , 3 Hz - 26.5 GHz, Opt. AYZ	MY44808298	11/11/2021
A118	Narda	768A-20	20 dB 20 W Attenuator, DC - 11GHz	105357	12/10/2022

11.3 Receiver Spurious Emissions (30MHz – 13GHz)

Tile! Software Version:		Version: 7.1.2.17 (Jan 08, 2016 - 02:12:48 PM) or 4.1.A.0, April 14, 2009, 11:01:00PM			
Test Profile:		2020_RE_Unintentional_TILE7_v2.7.til			
Asset #	Manufacturer	Model	Equipment Nomenclature	Serial Number	Calibration Due Date
1425	Electro-Metrics	BPA-1000	Preamp, Broadband 10k-1GHz	123	3/13/2022
2295	Keysight	E4440A-AYZ	PSA Spectrum Analyzer	MY46186204	11/10/2021
1926	ETS-Lindgren	3142D	Antenna, Biconilog, 26 MHz - 6 GHz	135454	4/20/2022
C027	none	RG214	Cable Coax, N-N, 25m, 25MHz - 1GHz	None	9/14/2022
1327	EMCO	1050	Controller, Antenna Mast	none	N/A
942	EMCO	11968D	Turntable, 4ft.	9510-1835	N/A
1969	HP	11713A	Attenuator/Switch Driver	3748A04113	N/A
C030	none	none	Cable Coax, N-N, 30m, 1 - 18GHz	None	9/15/2022
1509B	Braden	TDK 10M	TDK 10M Chamber,sVSWR > 1 GHz	DAC-012915-005	4/9/2023
2004	Miteq	AFS44-00101800-2S-10P-44	Amplifier, 40dB, 100MHz-18GHz	None	1/9/2022
C030	none	none	Cable Coax, N-N, 30m, 1 - 18GHz	None	9/15/2022
1325	EMCO	1050	Controller, Antenna Mast	9003-1461	N/A
1780	ETS-Lindgren	3117	Antenna, Double Ridged Guide Horn, 1 - 18 GHz	110313	4/16/2023
1973	Agilent	83017A	Amplifier, Microwave 0.5-26.5 GHz	MY39500497	11/10/2022

12.0 Measurement Bandwidths

Radiated Emissions Spectrum Analyzer Bandwidth and Measurement Time - Peak Scan				
Frequency Band Start (MHz)	Frequency Band Stop (MHz)	6 dB Bandwidth (kHz)	Number of Ranges Used	Measurement Time per Range
0.009	0.15	0.3	2	Multiple Sweeps
0.15	30	9	6	Multiple Sweeps
30	1000	120	2	Multiple 800 mS Sweeps
1000	6000	1000	2	Multiple Sweeps
6000	18000	1000	2	Multiple Sweeps
18000	26500	1000	2	Multiple Sweeps

*Notes:

1. The settings above are specifically calculated for the E4440A series of spectrum analyzers, which have 8,000 data points per range.
2. The measurement receiver resolution bandwidth setting was 300 Hz for quasi-peak measurements from 9-150 kHz.
3. The measurement receiver resolution bandwidth setting was 9 kHz for quasi-peak measurements from 0.15-30 MHz.
4. The measurement receiver resolution bandwidth setting was 120 kHz for quasi-peak measurements from 30-1000 MHz.
5. The measurement receiver resolution bandwidth setting was 1 MHz for average measurements from 1-18 GHz.

Appendix: Policy, Rationale, and Evaluation of EMC Measurement Uncertainty

All uncertainty calculations, estimates and expressions thereof shall be in accordance with NIST policy. Since PTI operates in accordance with NIST (NVLAP) Handbook 150-11: 2007, all instrumentation having an effect on the accuracy or validity of tests shall be periodically calibrated or verified traceable to national standards by a competent calibration laboratory. The certificates of calibration or verification on this instrumentation shall include estimates of uncertainty as required by NIST Handbook 150-11.

1. Rationale and Summary of Expanded Uncertainty.

Each piece of instrumentation at PTI that is used in making measurements for determining conformance to a standard (or limit), shall be assessed to evaluate its contribution to the overall uncertainty of the measurement in which it is used. The assessment of each item will be based on either a type A evaluation or a type B evaluation. Most of the evaluations will be type B, since they will be based on the manufacturer's statements or specifications of the calibration tolerances, or uncertainty will be stated along with a brief rationale for the type of evaluation and the resulting stated uncertainties.

The individual uncertainties included in the combined standard uncertainty for a specific test result will depend on the configuration in which the item of instrumentation is used. The combination will always be based on the law of propagation of uncertainty. Any systematic effects will be accommodated by including their uncertainties, in the calculation of the combined standard uncertainty; except that if the direction and amount of the systematic effect cannot be determined and separated from its uncertainty, the whole effect will be treated as uncertainty and combined along with the other elements of the test setup.

Type A evaluations of standard uncertainty will usually be based on calculating the standard deviation of the mean of a series of independent observations, but may be based on a least-squares curve fit or the analysis of variance for unusual situations. Type B evaluations of standard uncertainty will usually be based on manufacturer's specifications, data provided in calibration reports, and experience. The type of probability distribution used (normal, rectangular, a priori, or u-shaped) will be stated for each Type B evaluation.

In the evaluation of the uncertainty of each type of measurement, the uncertainty caused by the operator will be estimated. One notable operator contribution to measurement uncertainty is the manipulation of cables to maximize the measured values of radiated emissions. The operator contribution to measurement uncertainty is evaluated by having several operators independently repeat the same test. This results in a Type A evaluation of operator-contributed measurement uncertainty.

A summary of the expanded uncertainties of PTI measurements is shown as Table 1. These are the worst-case uncertainties considering all operative influence factors.

Table 1: Summary of Measurement Uncertainties for Site 45

Type of Measurement	Frequency Range	Meas. Dist.	Expanded Uncertainty U, dB (k=2)
Mains Conducted Emissions	150 kHz to 30 MHz	N/A	2.9
Telecom Conducted Emissions	150 kHz to 30 MHz	N/A	2.8
Radiated Emissions	30 to 1,000 MHz	10 m	4.8
	1 to 18 GHz	3 m	5.7

End of Report