Project 22738-15

Austin Devices, LLC
Kai Valve

Wireless Certification Report

Prepared for:

Austin Devices, LLC
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Austin, TX 78756

By

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21 January 2022

Written by

Larry Finn
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Revision History

Revision Number	Description	Date
Draft01	Initial release for review	3 Dec 2021
Final01	Release to Agency	21 Jan 2022

Table of Contents

Revision History 2
Compliance Certificate 5
1.0 Introduction 6
1.1 Scope 6
1.2 EUT Description 6
1.3 EUT Test Configuration 6
1.4 Modifications to Equipment 6
1.5 Test Site 6
1.6 Radiated Measurements 7
1.7 Additional Documents Applied 7
2.0 Fundamental Power; Clause 15.247(a)(3); RSS-247 5.2 8
2.1 Test Procedure 8
2.2 Test Criteria 8
2.3 Test Results, Peak Power (dBm) 8
2.4 Test Results, Duty Cycle 10
3.0 Power Spectral Density; 15.247(e); RSS-247, 5.2 11
3.1 Test Procedure 11
3.2 Test Criteria 11
3.3 Test Results, Tabular 11
4.0 Occupied Bandwidth; 15.247(a)(2), 2.1049; RSS-247, RSS-Gen 4.6 12
4.1 Test Procedure 12
4.2 Test Criteria 12
4.3 Test Results, Tabular 12
4.4 Test Results, Recorded: 6 dB, 99% BW 13
5.0 Band Edge; 15.247, 15.205; RSS-247 5.5; RSS-Gen 4.9 14
5.1 Test Procedure 14
5.2 Test Criteria 14
5.3 Test Results 14
6.0 Conducted Antenna Port Spurious Emissions, Transmit Mode; 15.247, 15.209; RSS-247 5.5, RSS-Gen 4.9 & 4.10 17
6.1 Test Procedure 17
6.2 Test Criteria 17
6.3 Test Results 17
7.0 Radiated Spurious Emissions, Transmit Mode; 15.247, 15.205; RSS-247 5.5; RSS-Gen 6.13 & 8.10 19
7.1 Test Procedure 19
7.2 Test Criteria 19
7.3 Test Results 19
7.3.1 Bottom Channel, 30 MHz to 26.5 GHz 20
7.3.2 Middle Channel, 30 MHz to 26.5 GHz 23
7.3.3 Top Channel, 1GHz to 26.5 GHz 25
8.0 Radiated Spurious Emissions, Receive Mode; 15.247, 15.209; RSS-247 5.5, RSS-Gen 4.9 & 4.10 27
8.1 Test Procedure 27
8.2 Test Criteria 27
8.3 Test Results 27
8.3.1 Middle Channel, 30 MHz to 13 GHz 28
9.0 Antenna Construction; 15.203, 15.247; RSS-Gen 8.3 30
9.1 Procedure 30
9.2 Criteria 30
9.3 Results 30
10.0 Equipment 31
10.1 Transmitter Radiated Spurious Emissions 30 MHz to 26.5 GHz 31
10.2 Fundamental Power, Bandwidth, Duty Cycle, Band Edge, Conducted Spurious Emissions 32
10.3 Receiver Spurious Emissions (30MHz – 18GHz) 32
11.0 Measurement Bandwidths 33
Appendix: Policy, Rationale, and Evaluation of EMC Measurement Uncertainty 34
End of Report 34

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Compliance Certificate

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

Applicant	Device & Test Identification	
Austin Devices, LLC	FCC ID:	2AO4VKV
5606 Shoalwood Avenue	Industry Canada ID:	23667-KV
Austin, TX 78756	Model(s):	KV
Certificate Date: 21 Jan 2022	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.

TESTING
NVLAP LAB CODE 200062-0

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.

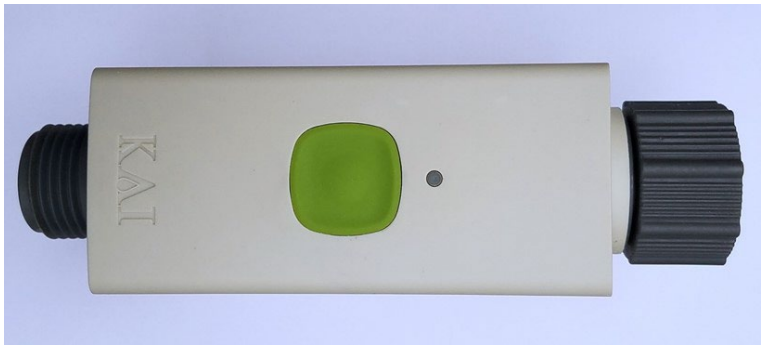
1.2 EUT Description

Table 1.2.1: Equipment Under Test

Manufacturer / Model	Serial #	Description
Austin Devices, LLC Model: KV	none	Remote control irrigation valve

1.3 EUT Test Configuration

The EUT was exercised in a manner consistent with normal operations. The EUT is battery powered only (No AC Mains derived power used). An external +3VDC supply was used for testing.



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

2.1 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 10/19/2021.

2.2 Test Criteria

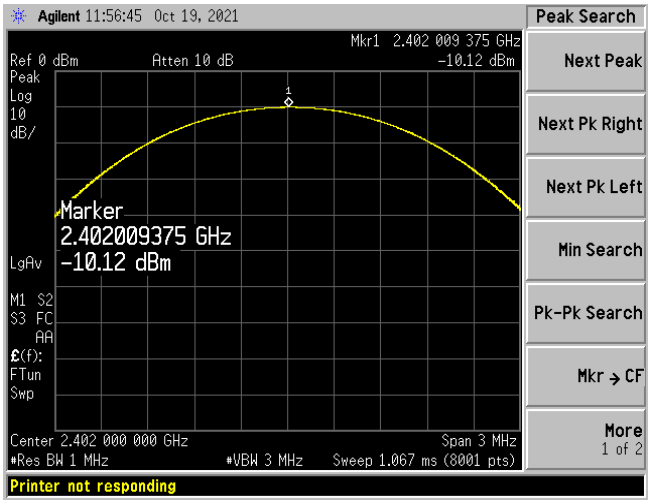
Conducted Power Limit
1 W peak (+30dBm) Limit Restated as Field: 125.23 dBµV/m @ 3 m

2.3 Test Results, Peak Power (dBm)

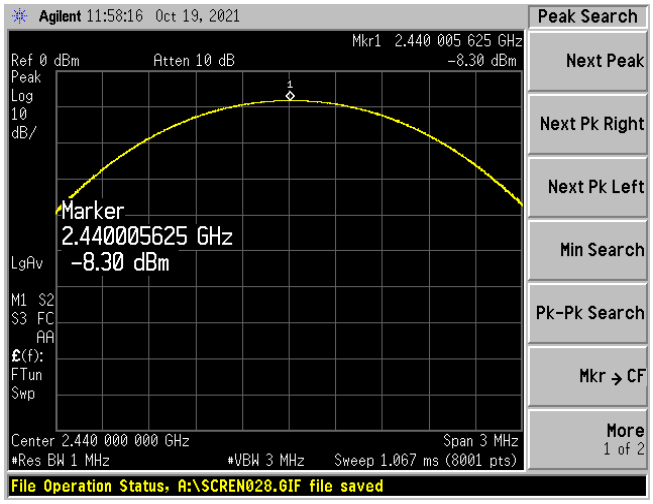
Peak Output Power - Conducted Test Data													
Environmental Conditions:	Temperature	22	°C	Humidity	53	RH	Barometric Pressure	30.00	in Hg				
EUT (6 or 20 dB) Bandwidth:	0.70	MHz											
Measurement Parameters:	RBW	1	MHz	VBW	3	MHz	Span	3	MHz	Detector	Peak		
Channel	Frequency (MHz)	Measured Power (dBm)	Attenuator Factor (dB)	Corrected Power (dBm)	Limit (dBm)	Test Result							
2	2402	-10.12	20.12	10	30	Pass							
40	2440	-8.3	20.12	11.82	30	Pass							
80	2480	-7.12	20.12	13	30	Pass							

The requirements were satisfied.

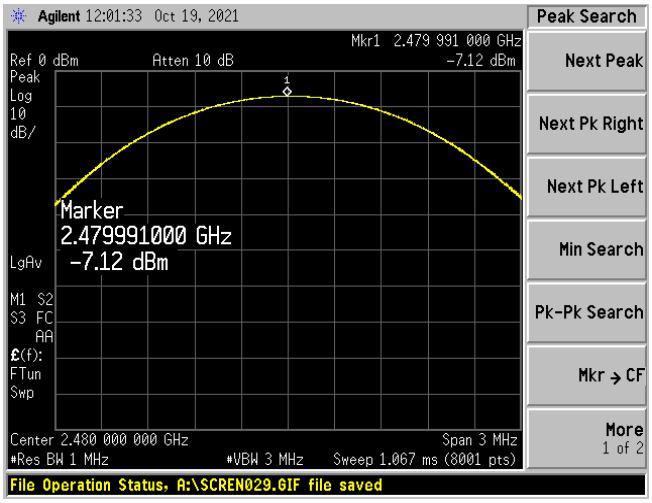
Peak output power test data:



Low Channel



Mid Channel



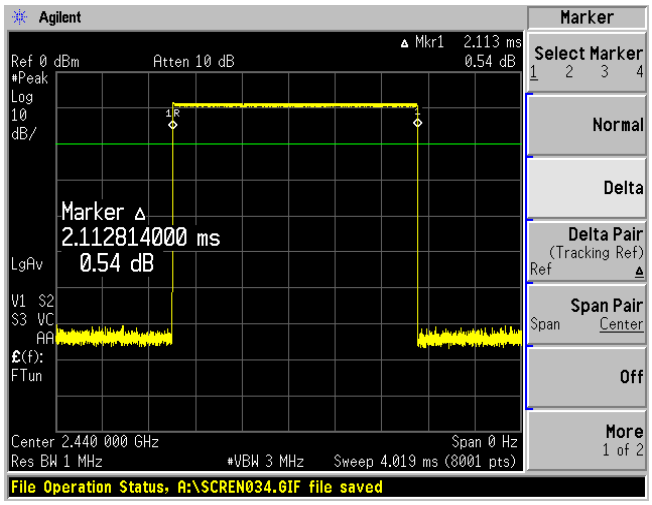
High Channel

2.4 Test Results, Duty Cycle

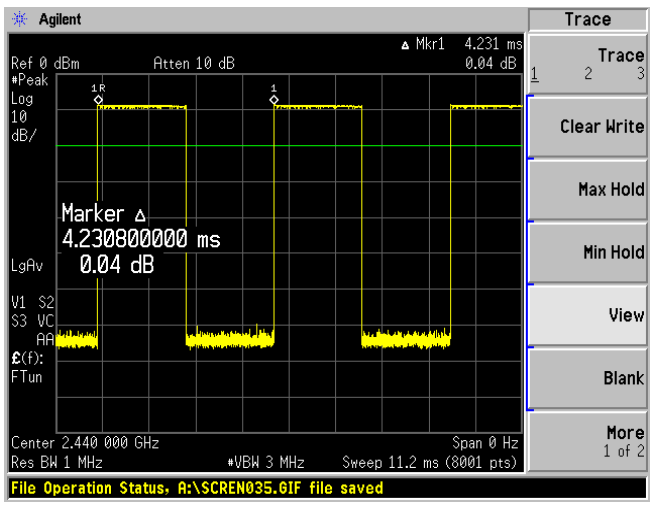
Measurement is based on intervals not to exceed 100 msec. Maximum transmitter on time is divided by the lesser of 100 msec or the actual measured minimum transmitter interval time. The result is converted to dB and applied as needed to peak measurements of transmitter artifacts to determine average power. 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 19 Oct, 2021.

Dyty Cycle - Conducted Test Data													
Environmental Conditions:	Temperature			°C	Humidity		RH	Barometric Pressure					in Hg
Measurement Parameters:	RBW	100	kHz	VBW	100	kHz	Span	1	MHz	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	Pass	4.231	-6.03						-6.03			
RF Exposure Allowable Duty Cycle Reduction (10*Log(On time/Interval):										-3.02			



Transmit Event Time



Time Interval (Return to channel time)

Duty Cycle Measurement

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

3.1 Test Procedure

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

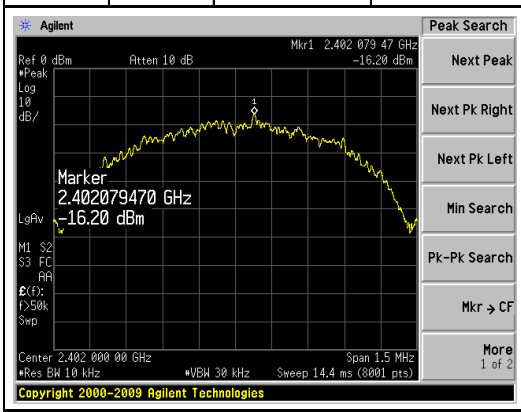
3.2 Test Criteria

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

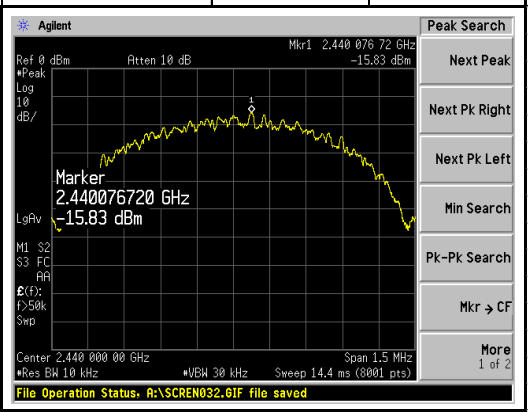
3.3 Test Results, Tabular

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 10/19/2021.

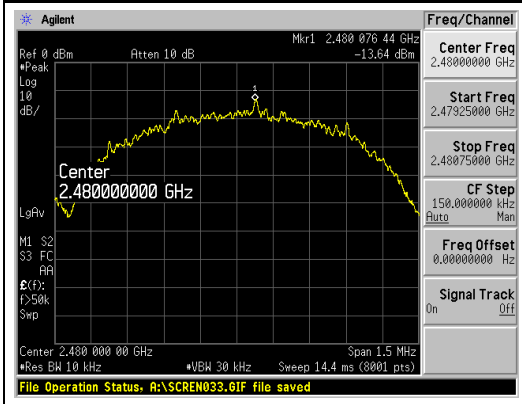
Power Spectral Density - Conducted Test Data														
Environmental Conditions:	Temperature	22	°C	Humidity	53	RH	Barometric Pressure	30.00	in Hg					
EUT Channel Bandwidth:	0.75	MHz												
Measurement Parameters:	RBW	10	kHz	VBW	30	kHz	Span	1.5	MHz	Detector	Peak			
Channel	Frequency (MHz)	Measured Power (dBm)	Attenuator Factor (dB)	Corrected Power (dBm)	Limit (dBm)	Test Result								
2	2402	-16.2	20.12	3.92	8	Pass								
40	2440	-13.83	20.12	6.29	8	Pass								
80	2480	-13.64	20.12	6.48	8	Pass								



Low Channel



Mid Channel



High Channel

The requirements were satisfied.

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

4.1 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 10/19/2021.

4.2 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.

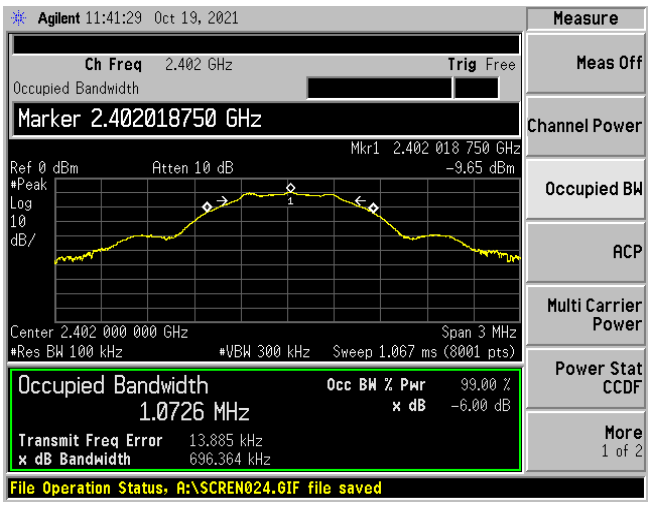
4.3 Test Results, Tabular

The requirements were satisfied.

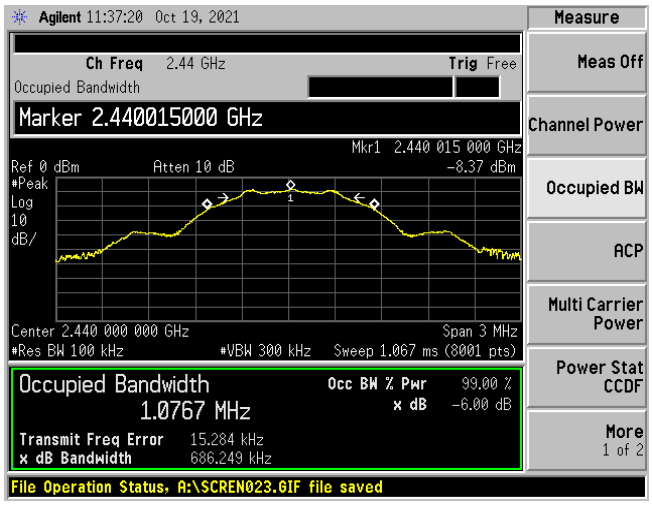
Occupied Bandwidth - Conducted Test Data													
Environmental Conditions:	Temperature	22	°C	Humidity	53	RH	Barometric Pressure	30.00	in Hg				
Measurement Parameters:	RBW	100	kHz	VBW	300	kHz	Span	3	MHz	Detector	Peak		
Measurement Bandwidth:	- 6	dB											
Channel	Frequency (MHz)	Measured Bandwidth (kHz)	Reported Minimum Bandwidth (kHz)										
2	2402	696.364	686.249										
40	2440	686.249											
80	2480	697.351											

The EUT met the requirements.

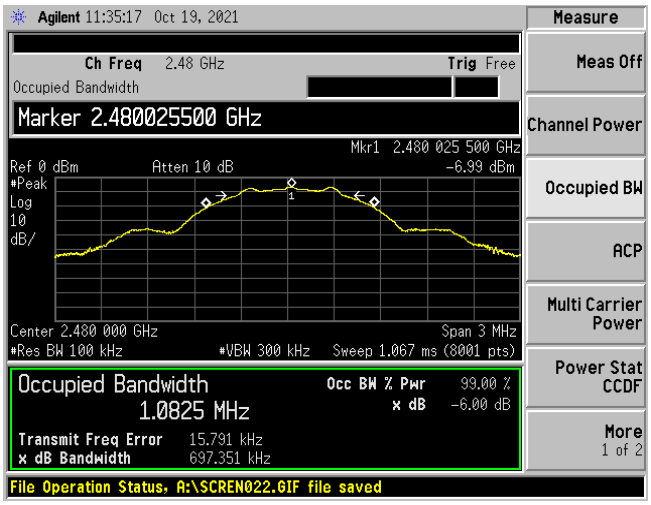
4.4 Test Results, Recorded: 6 dB, 99% BW



Low Channel



Mid Channel



High Channel

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

5.1 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 10/19/2021.

5.2 Test Criteria

Unwanted Emissions
Emissions Adjacent to Authorized Band

5.3 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:

Given EIRP = $E_{dB\mu V/m} + 20Log_{10}(d) – 104.8$

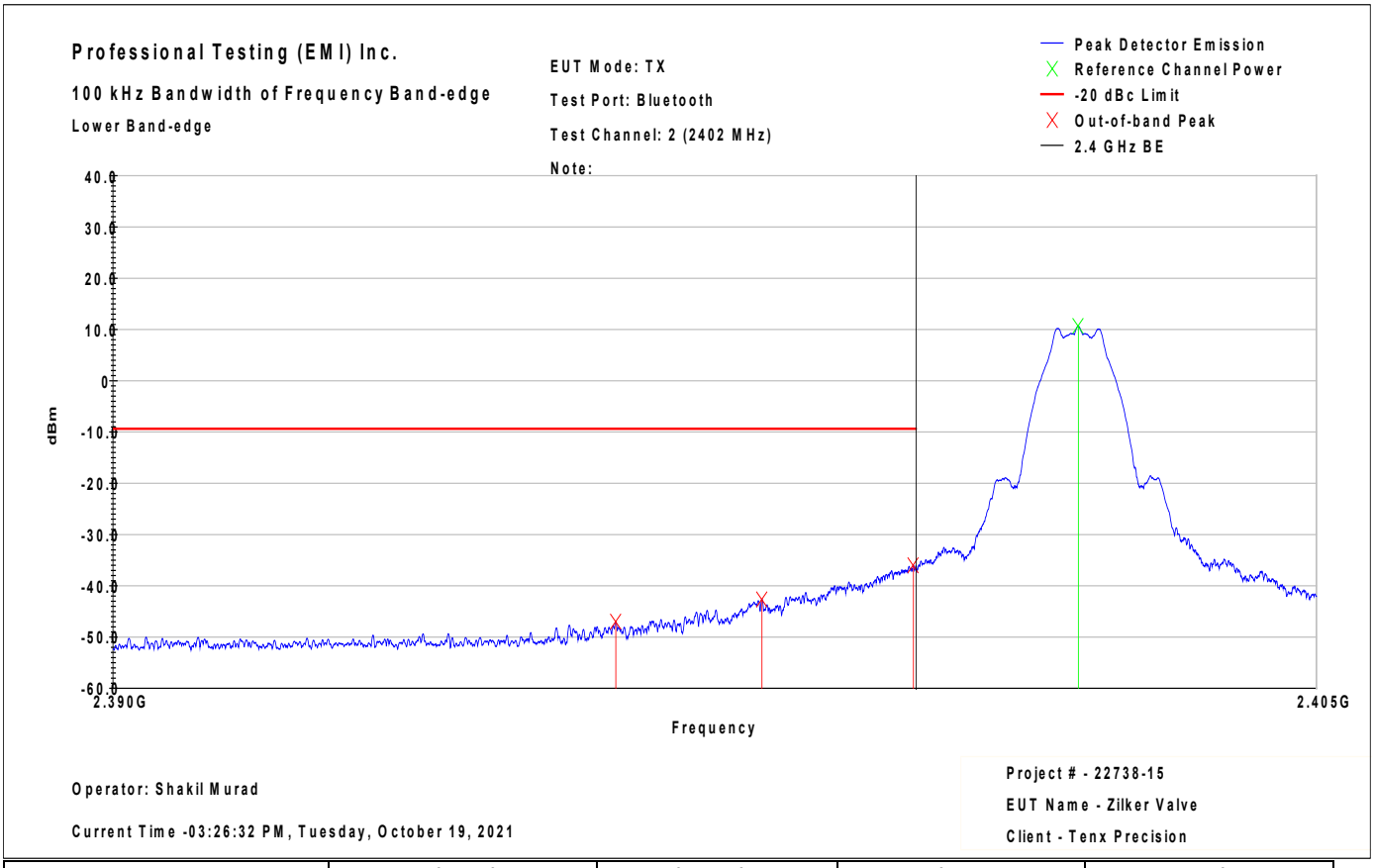
EIRP = 54 dBμV/m + $20Log_{10}$(3 m) – 104.8 dB = -41.25 dBm (commonly -41 dBm is applied)

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 pages.

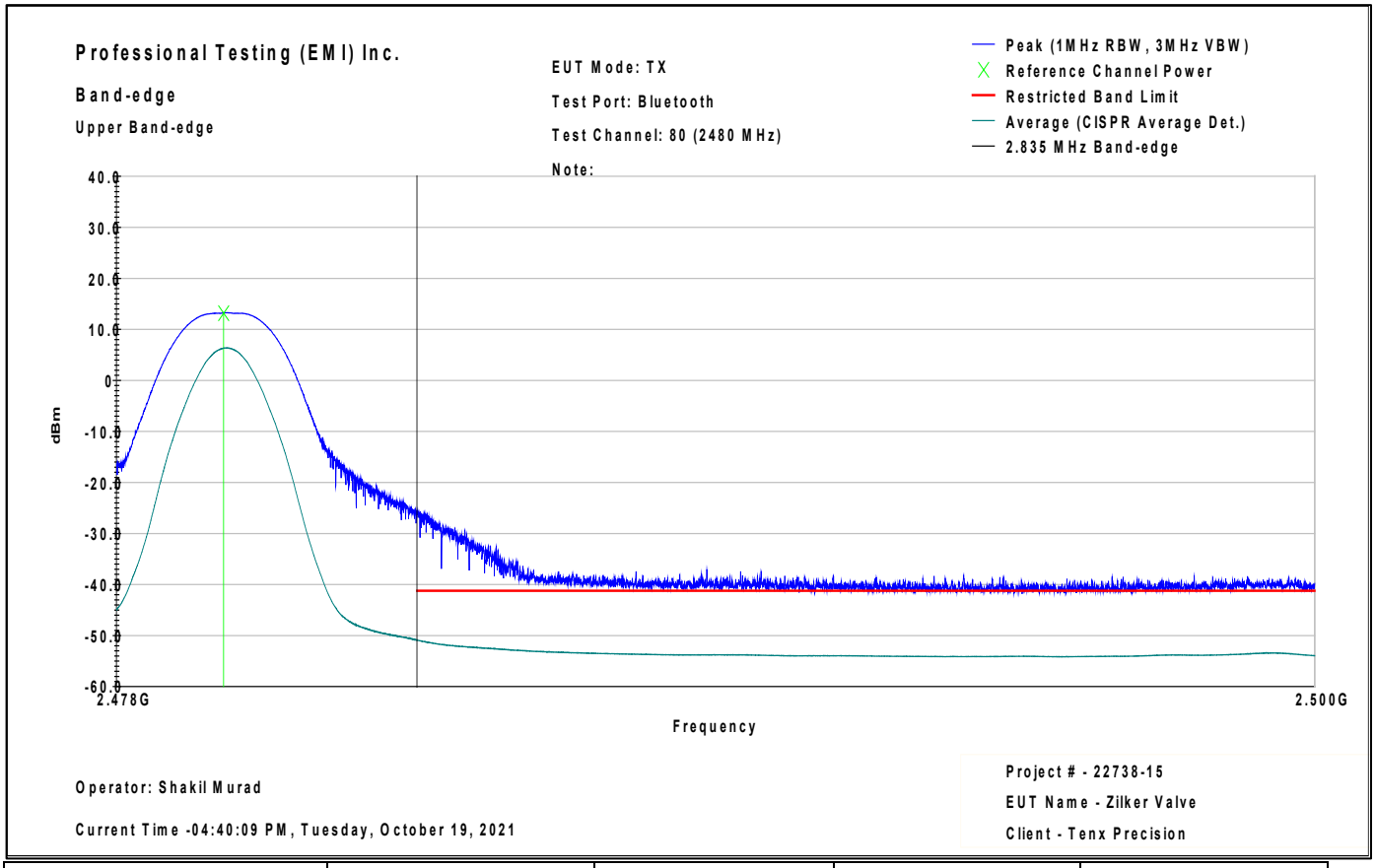
Lower Band Edge:



Frequency (MHz)	Peak Reading (dBm)	-20 dBc Peak Limit (dBm)	Peak Margin (dB)	Peak Results
2396.257	-47.056	-9.395	-37.661	PASS
2398.077	-42.643	-9.395	-33.248	PASS
2399.968	-36.027	-9.395	-26.632	PASS

100kHz RBW, 300kHz VBW

Upper Band Edge:



Frequency (MHz)	Average Reading (dBm)	Restricted Band Limit (dBm)	Average Margin (dB)	Average Results
2483.500	-50.864	-41.250	-9.614	PASS

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

6.1 Test Procedure

Conducted antenna port emissions are measured with the EUT transmitting on the required frequencies. Conducted antenna port measurements were made on 10/21/2021.

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

6.2 Test Criteria

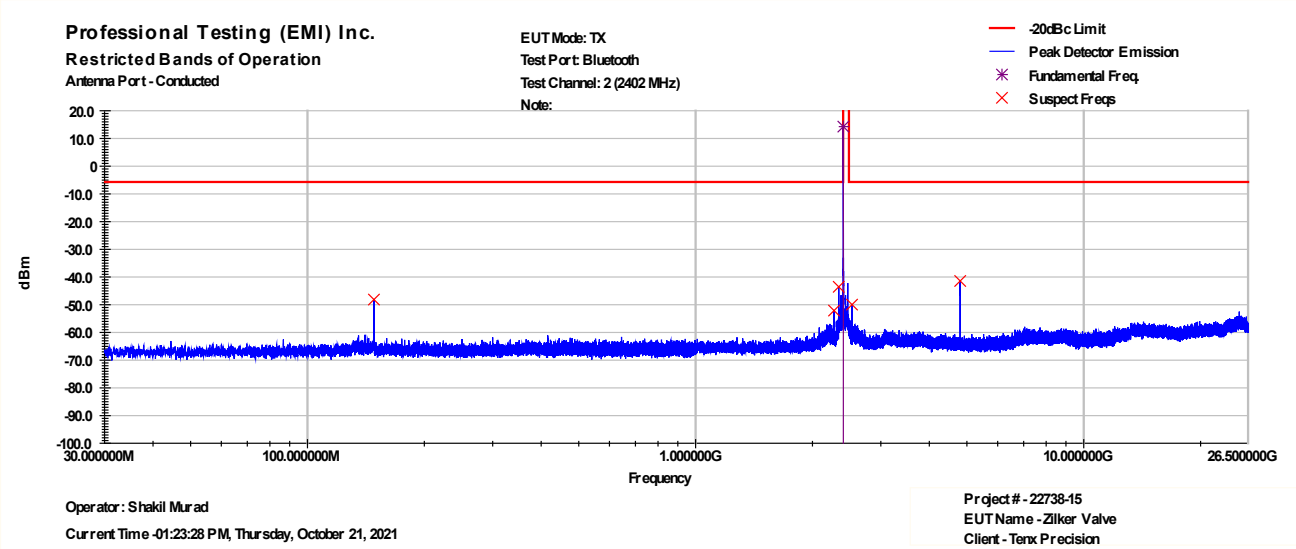
Unwanted Emissions
Antenna Port Conducted Spurious/Harmonic Emissions Transmit Mode

6.3 Test Results

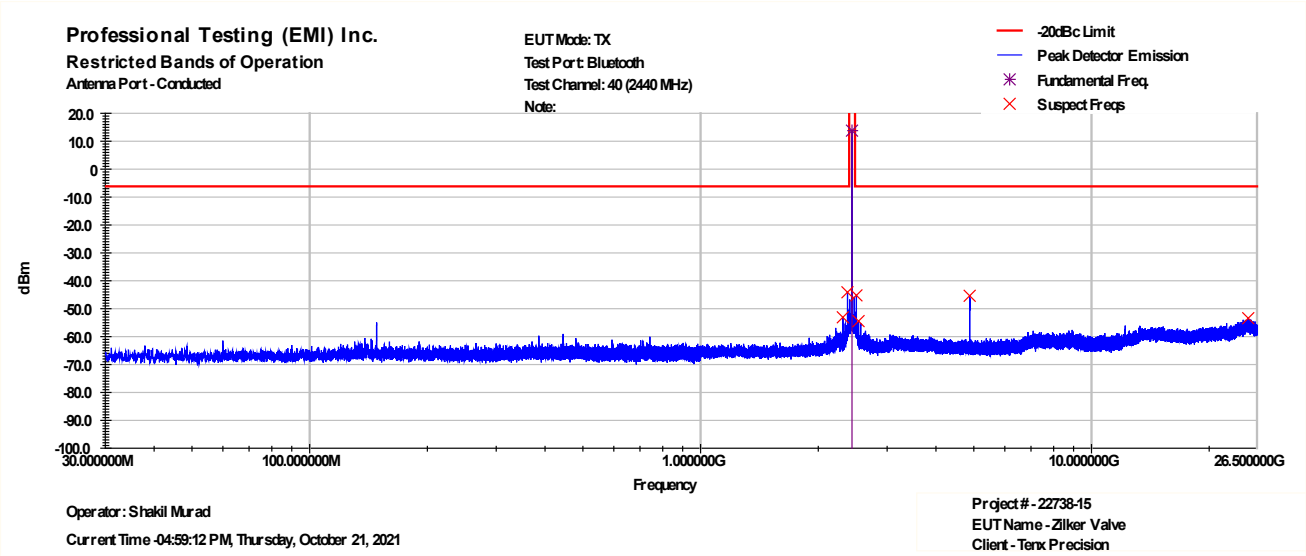
Three channels were tested. EUT was transmitting continuously and unmodulated.

The top, middle and bottom channels were tested. -20dBc limits were applied per 15.247(d). The EUT satisfied the requirements. Restricted band emissions evaluated in radiated transmitter spurious emissions section per 15.209. 100kHz RBW / 300kHz VBW used for measurements.

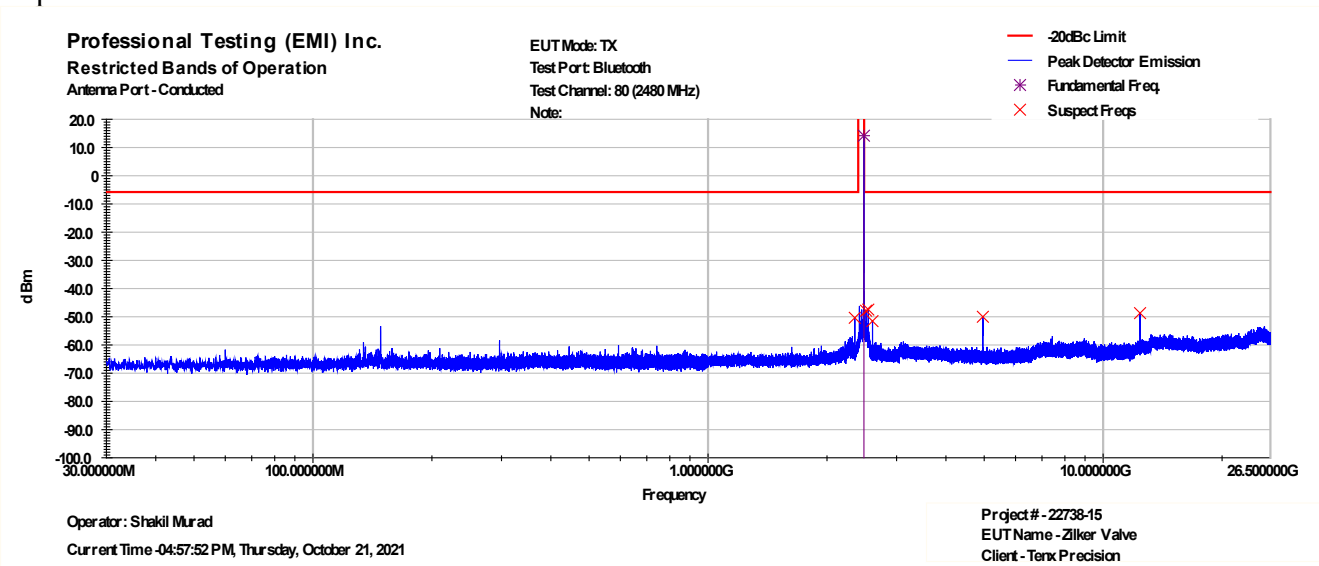
Bottom Channel:



Middle Channel:



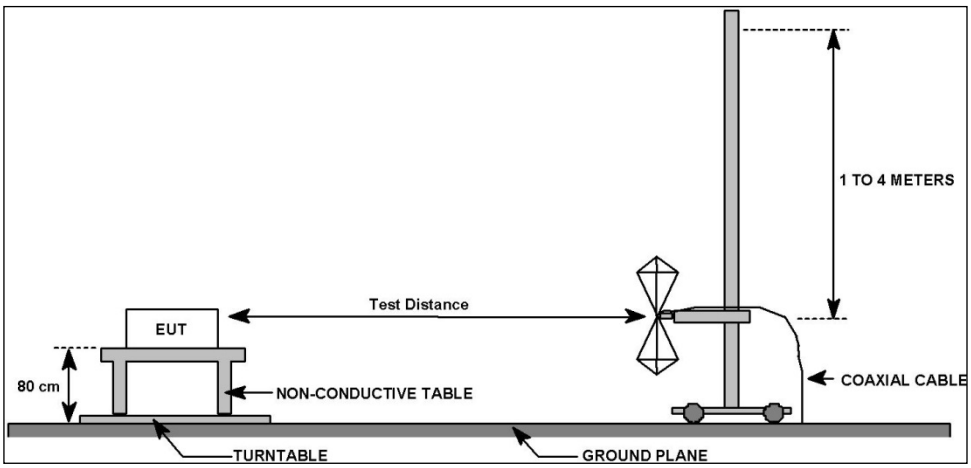
Top Channel:



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

7.1 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

7.2 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	14 Oct 2021

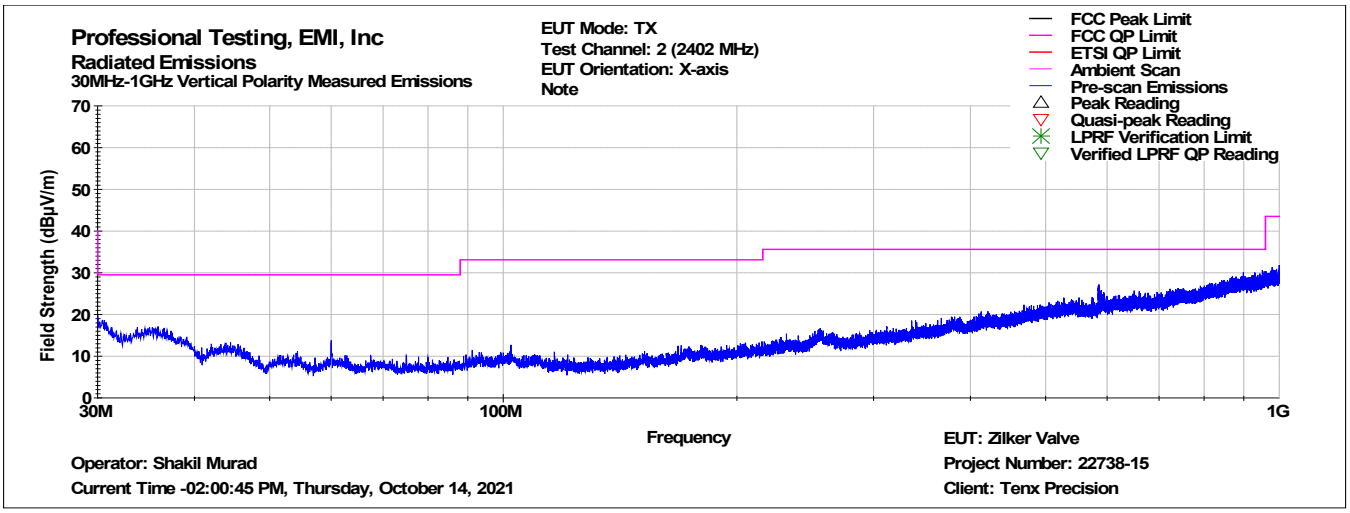
7.3 Test Results

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

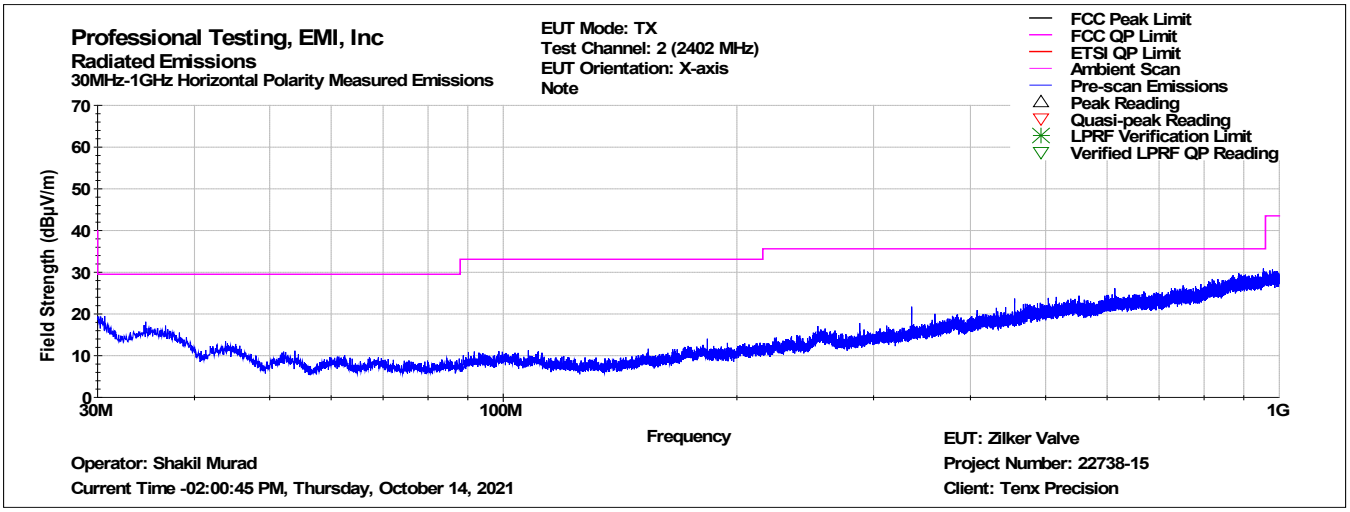
The EUT satisfied the requirement. Graphical and tabular data appears below.

7.3.1 Bottom Channel, 30 MHz to 26.5 GHz

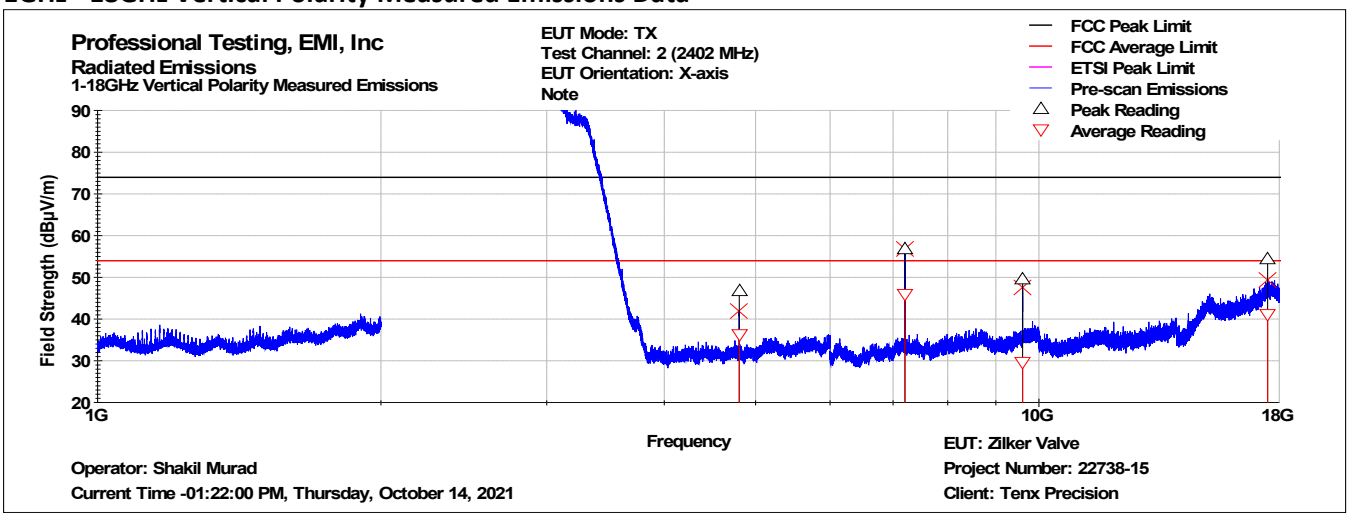
30MHz - 1GHz Vertical Polarity Measured Emissions Data



30MHz - 1GHz Horizontal Polarity Measured Emissions Data



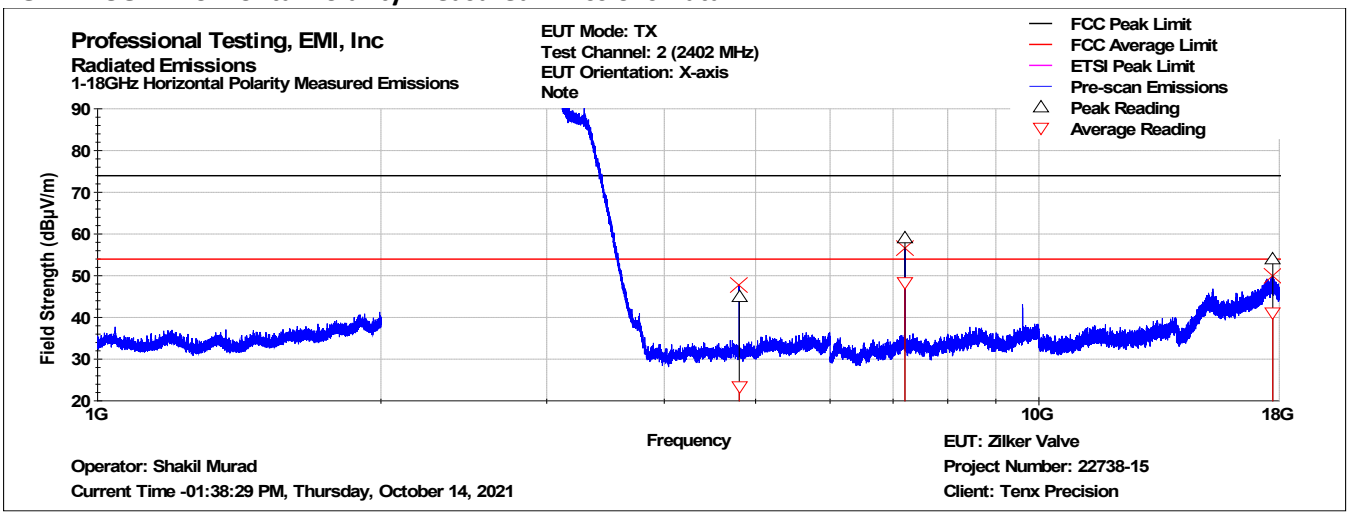
1GHz - 18GHz Vertical Polarity Measured Emissions Data



1GHz - 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
4804.37	93	102	46.814	73.958	-27.144	PASS	36.283	53.958	-17.675	PASS
7205.18	344	143	56.718	73.958	-17.240	PASS	45.925	53.958	-8.033	PASS
9609.07	223	101	49.629	73.958	-24.329	PASS	29.592	53.958	-24.366	PASS
17495.10	142	142	54.324	73.958	-19.634	PASS	41.106	53.958	-12.852	PASS

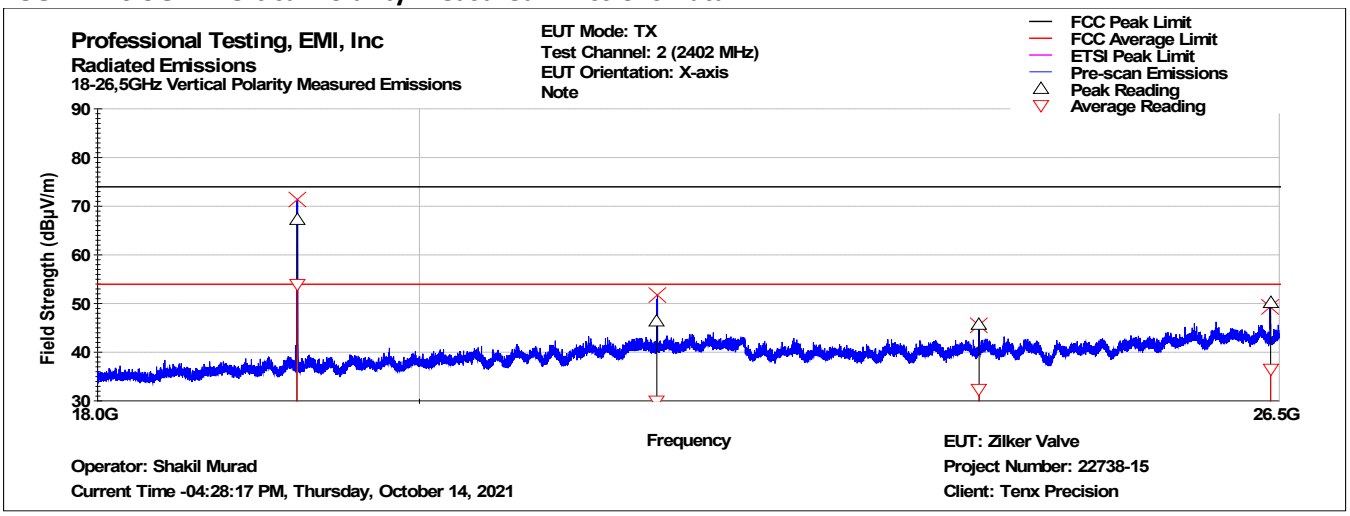
1GHz - 18GHz Horizontal Polarity Measured Emissions Data



1GHz - 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
4804.53	2	375	45.022	73.958	-28.936	PASS	23.327	53.958	-30.631	PASS
7205.23	315	102	59.001	73.958	-14.957	PASS	48.374	53.958	-5.584	PASS
17717.08	165	235	54.075	73.958	-19.883	PASS	41.159	53.958	-12.799	PASS

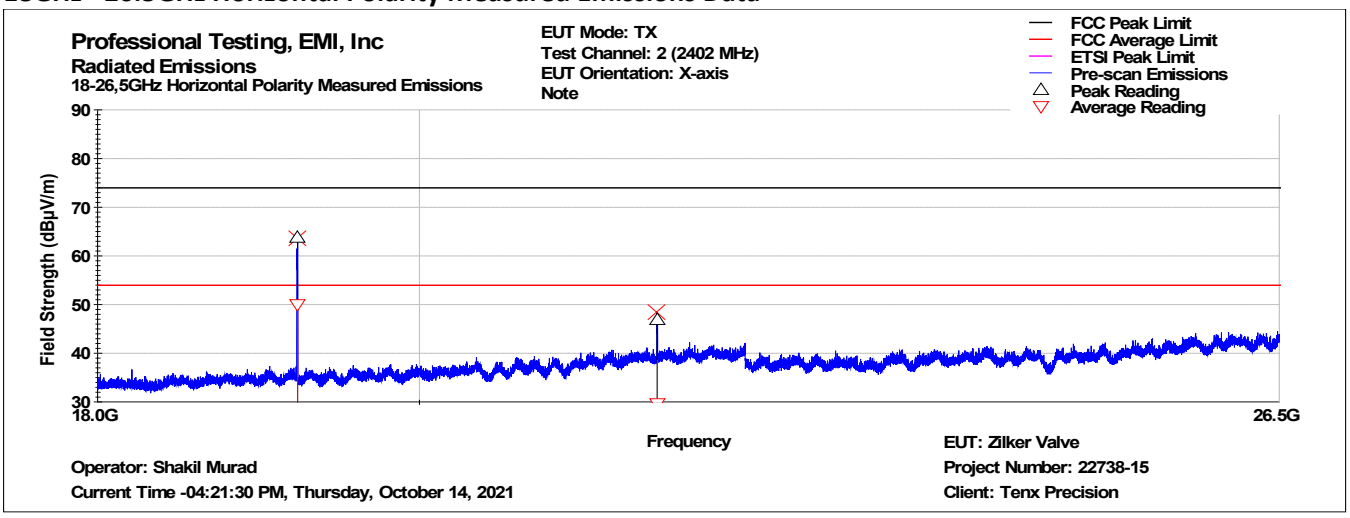
18GHz - 26.5GHz Vertical Polarity Measured Emissions Data



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
19214.18	1	100.000	67.278	73.958	-6.680	PASS	53.877	53.958	-0.081	PASS
21615.61	185	100.000	46.374	73.958	-27.584	PASS	30.007	53.958	-23.951	PASS
24020.35	145	100.000	45.662	73.958	-28.296	PASS	32.483	53.958	-21.475	PASS
26425.00	22	100.000	50.141	73.958	-23.817	PASS	36.471	53.958	-17.487	PASS

18GHz - 26.5GHz Horizontal Polarity Measured Emissions Data

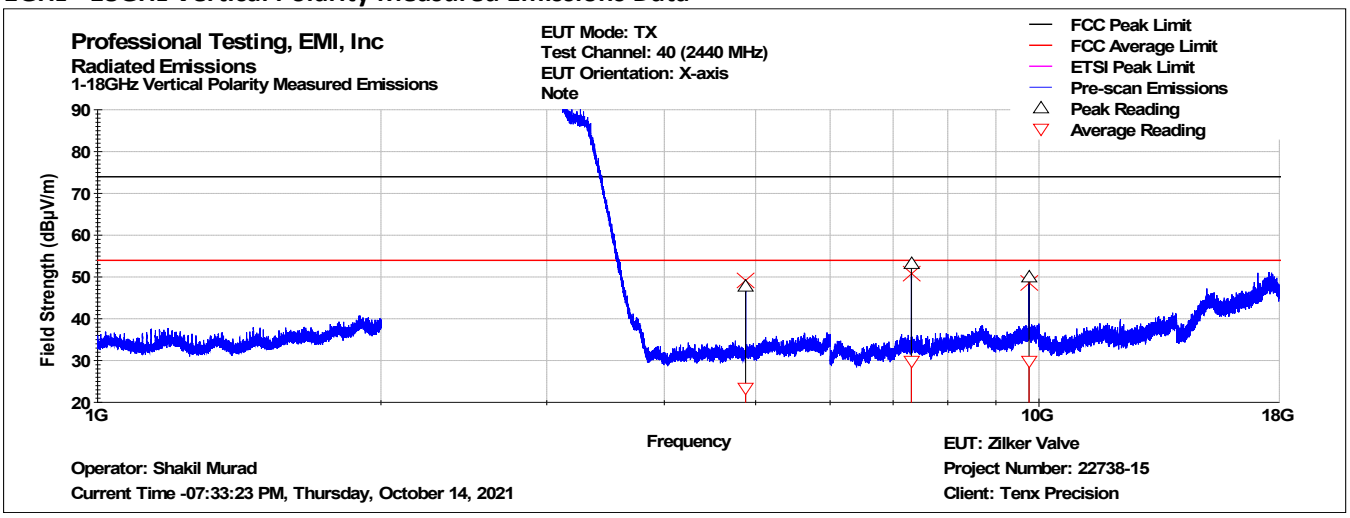


18GHz - 26.5GHz Horizontal Polarity Measured Emissions Data - FCC

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
19218.22	293	100.000	63.755	73.958	-10.203	PASS	49.945	53.958	-4.013	PASS
21618.14	313	100.000	46.820	73.958	-27.138	PASS	29.739	53.958	-24.219	PASS

7.3.2 Middle Channel, 30 MHz to 26.5 GHz

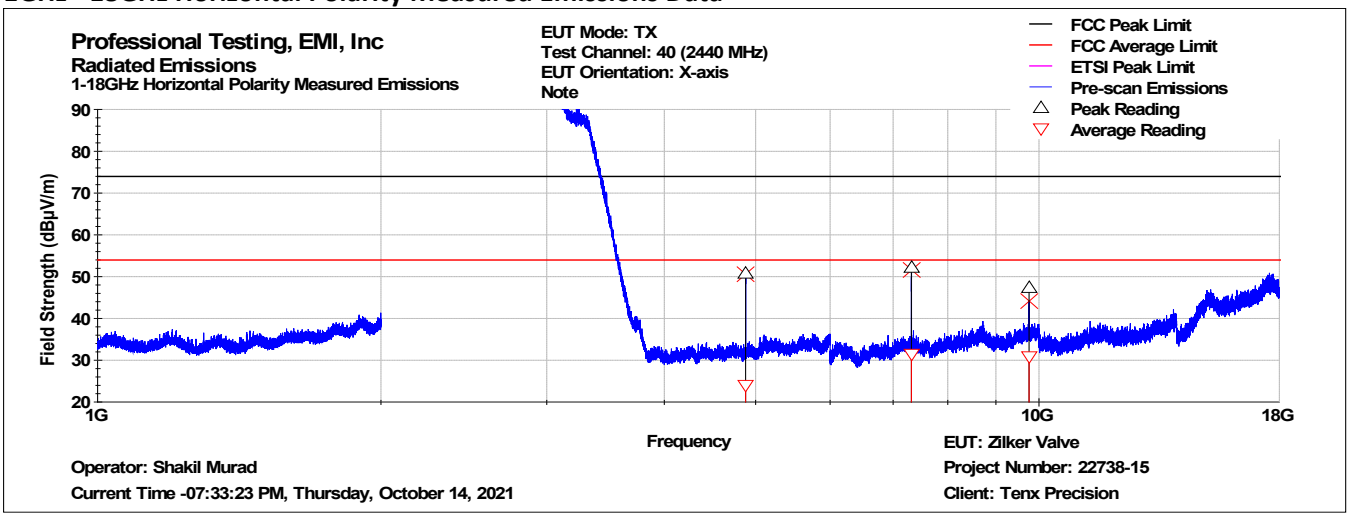
1GHz - 18GHz Vertical Polarity Measured Emissions Data



1GHz - 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
4879.44	224	102	47.671	73.958	-26.287	PASS	23.386	53.958	-30.572	PASS
7319.25	16	126	53.185	73.958	-20.773	PASS	29.842	53.958	-24.116	PASS
9761.11	227	174	50.002	73.958	-23.956	PASS	29.888	53.958	-24.070	PASS

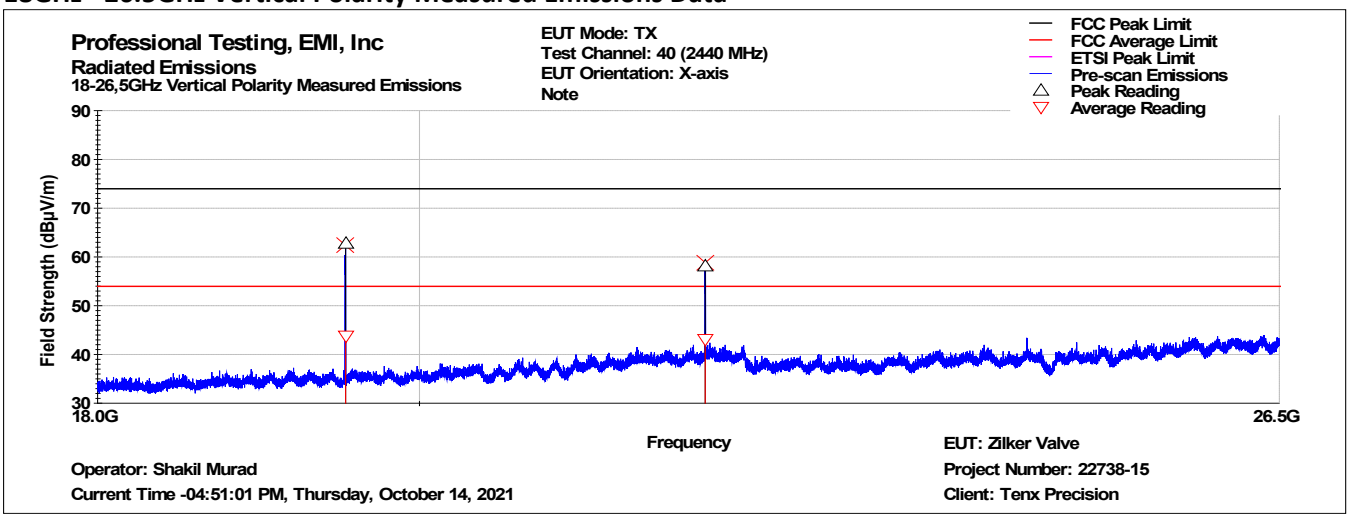
1GHz - 18GHz Horizontal Polarity Measured Emissions Data



1GHz - 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
4879.51	110	125	50.724	73.958	-23.234	PASS	24.009	53.958	-29.949	PASS
7319.20	316	149	52.073	73.958	-21.885	PASS	31.435	53.958	-22.523	PASS
9761.25	146	126	47.295	73.958	-26.663	PASS	30.861	53.958	-23.097	PASS

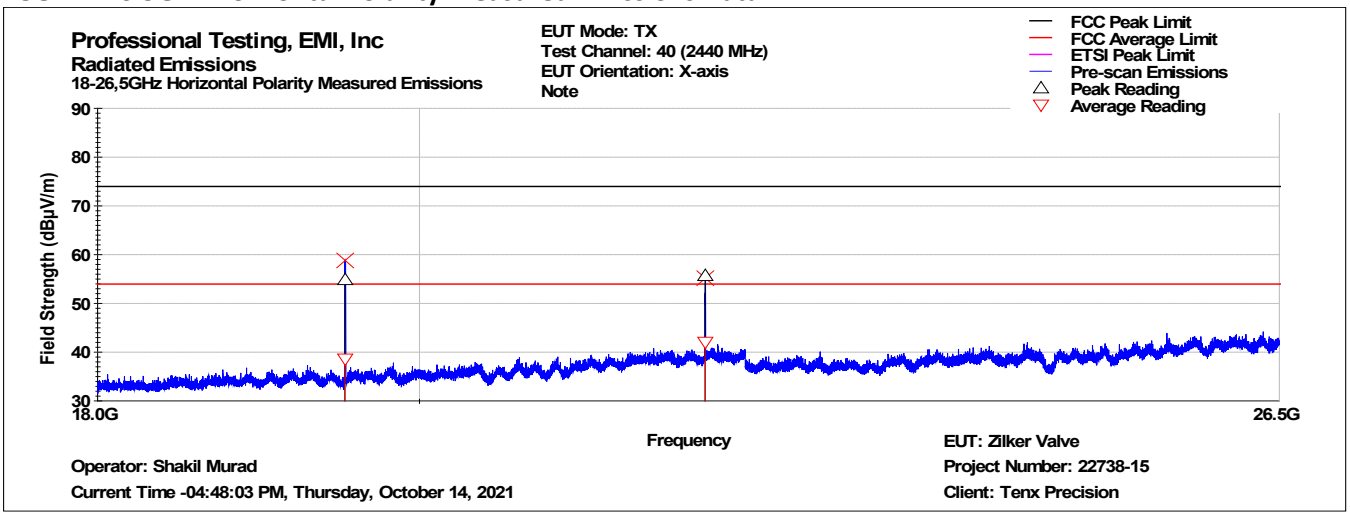
18GHz - 26.5GHz Vertical Polarity Measured Emissions Data



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
19522.22	0	100.000	62.672	73.958	-11.286	PASS	43.831	53.958	-10.127	PASS
21960.32	137	100.000	58.146	73.958	-15.812	PASS	43.118	53.958	-10.840	PASS

18GHz - 26.5GHz Horizontal Polarity Measured Emissions Data

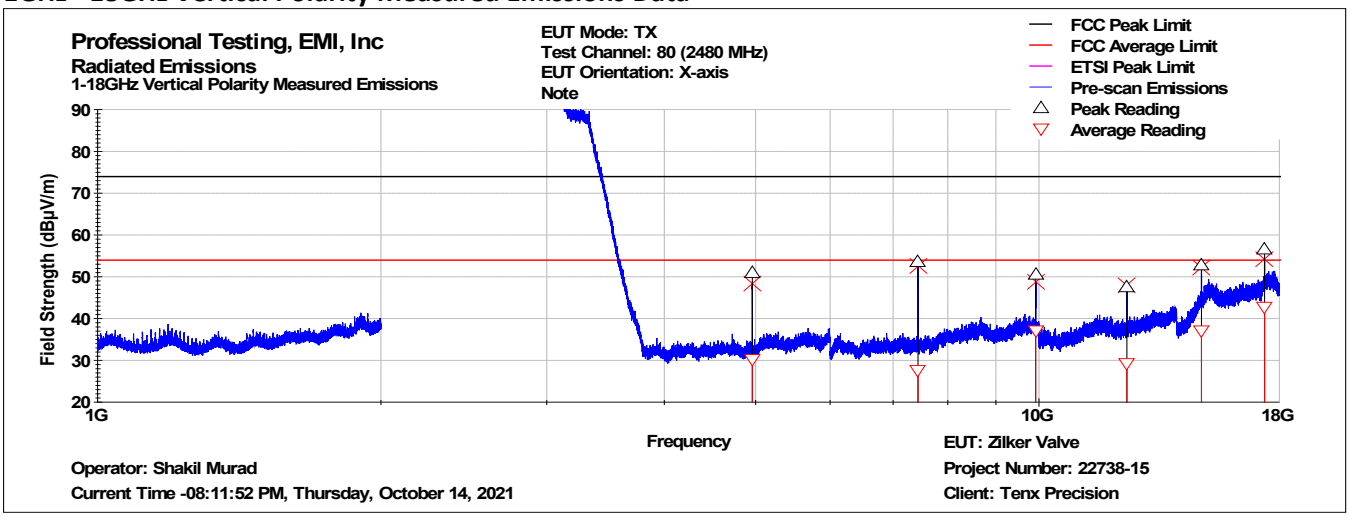


18GHz - 26.5GHz Horizontal Polarity Measured Emissions Data - FCC

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
19518.10	309	100.000	54.908	73.958	-19.050	PASS	38.576	53.958	-15.382	PASS
21960.20	0	100.000	55.623	73.958	-18.335	PASS	42.008	53.958	-11.950	PASS

7.3.3 Top Channel, 1GHz to 26.5 GHz

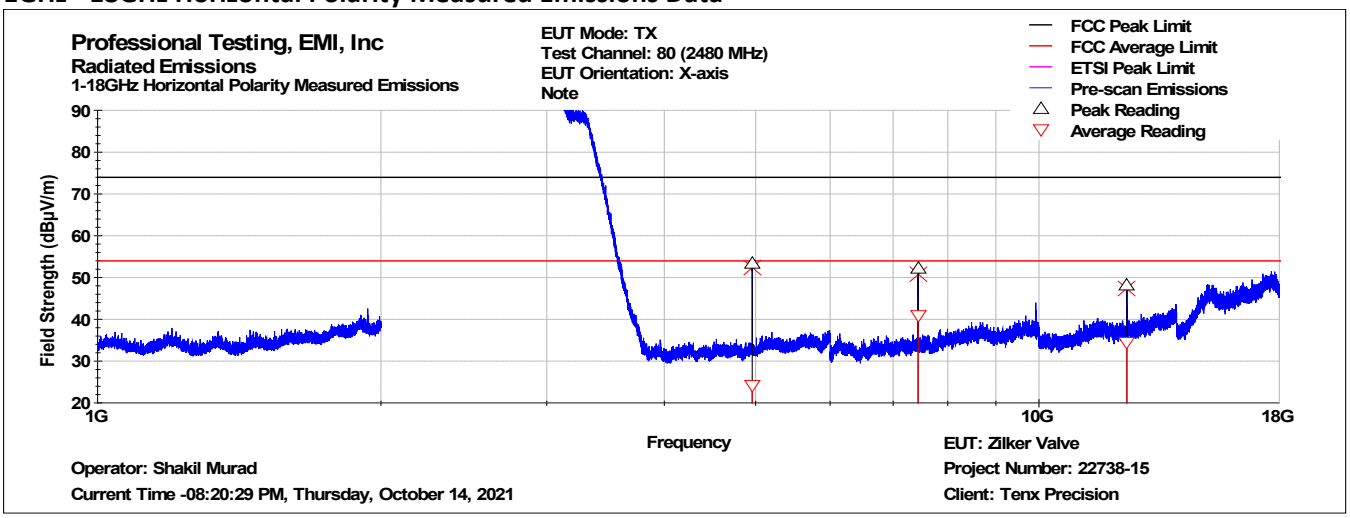
1GHz - 18GHz Vertical Polarity Measured Emissions Data



1GHz - 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
4960.51	225	154	51.025	73.958	-22.933	PASS	30.294	53.958	-23.664	PASS
7439.40	77	156	53.509	73.958	-20.449	PASS	27.723	53.958	-26.235	PASS
9920.16	229	204	50.561	73.958	-23.397	PASS	37.121	53.958	-16.837	PASS
12398.85	257	217	47.613	73.958	-26.345	PASS	29.197	53.958	-24.761	PASS
14879.97	51	257	52.688	73.958	-21.270	PASS	37.017	53.958	-16.941	PASS
17362.03	283	102	56.550	73.958	-17.408	PASS	42.728	53.958	-11.230	PASS

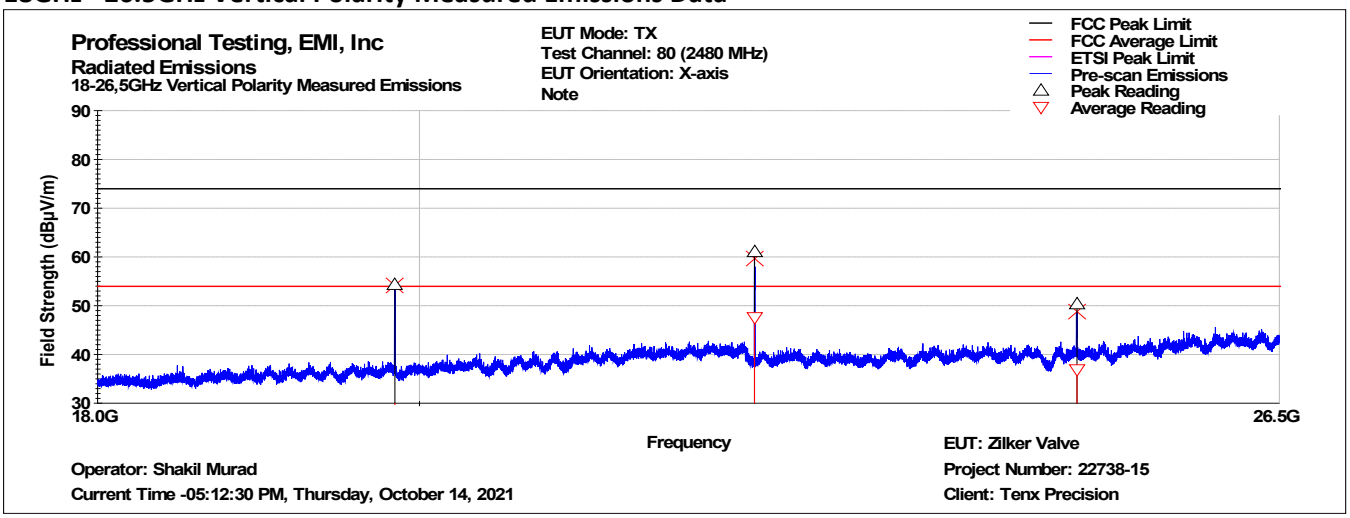
1GHz - 18GHz Horizontal Polarity Measured Emissions Data



1GHz - 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
4959.51	108	102	53.494	73.958	-20.464	PASS	24.142	53.958	-29.816	PASS
7440.78	124	151	52.128	73.958	-21.830	PASS	40.890	53.958	-13.068	PASS
12398.95	297	198	48.206	73.958	-25.752	PASS	34.579	53.958	-19.379	PASS

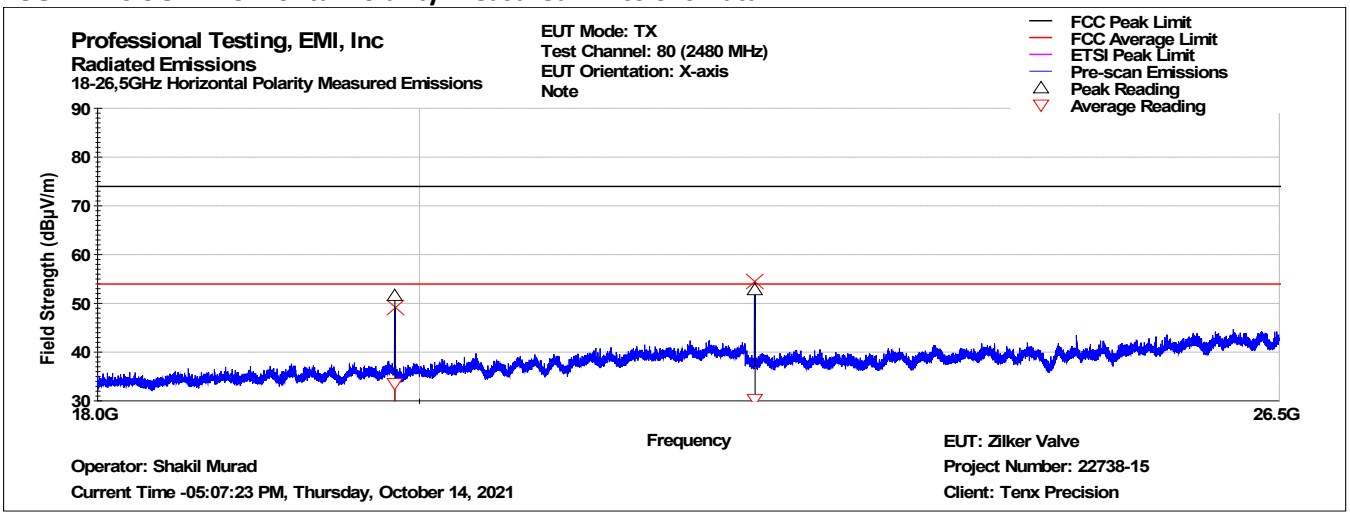
18GHz - 26.5GHz Vertical Polarity Measured Emissions Data



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
19839.84	44	100.000	54.268	73.958	-19.690	PASS	27.549	53.958	-26.409	PASS
22317.93	2	100.000	60.977	73.958	-12.981	PASS	47.580	53.958	-6.378	PASS
24802.42	38	100.000	50.297	73.958	-23.661	PASS	36.901	53.958	-17.057	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
19839.58	255	100.000	51.492	73.958	-22.466	PASS	33.708	53.958	-20.250	PASS
22322.26	309	100.000	52.701	73.958	-21.257	PASS	30.396	53.958	-23.562	PASS

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

8.1 Test Procedure

Receive mode radiated emissions were measured with the EUT receiving on the center channel on 22 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

8.2 Test Criteria

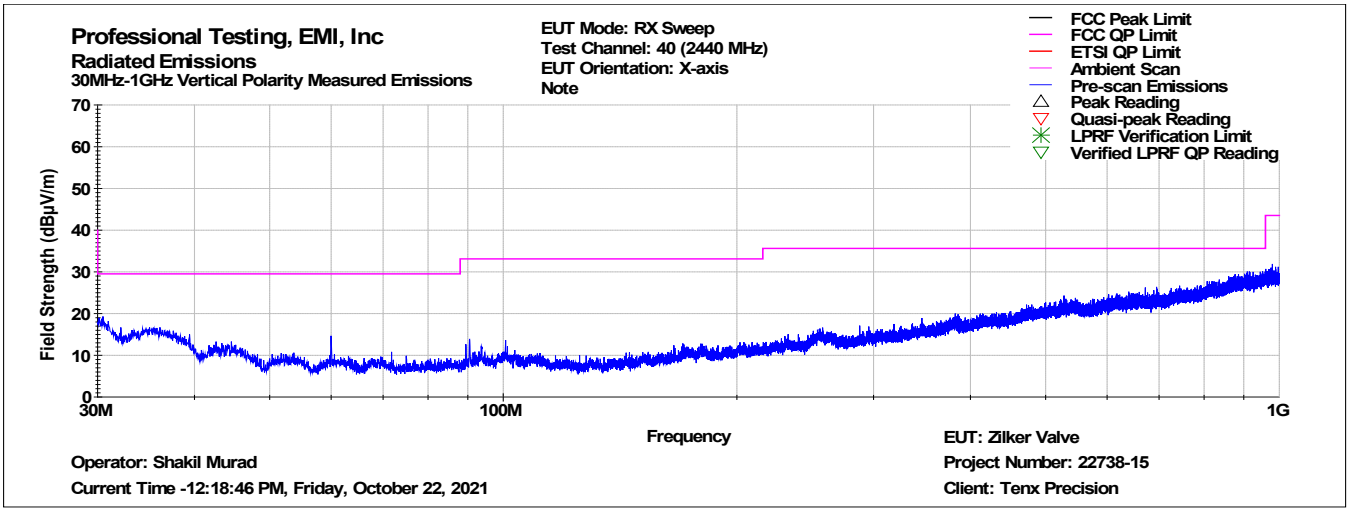
Unwanted Emissions
Field Strength of Radiated Spurious/Harmonic Emissions Receive Mode

8.3 Test Results

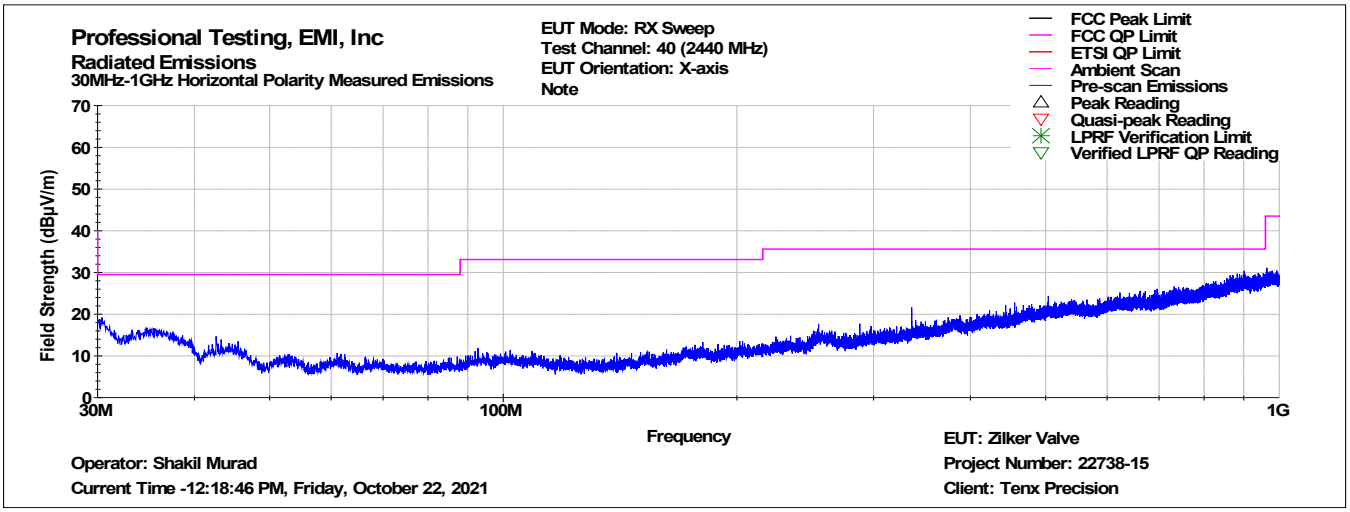
The requirement was satisfied.

8.3.1 Middle Channel, 30 MHz to 13 GHz

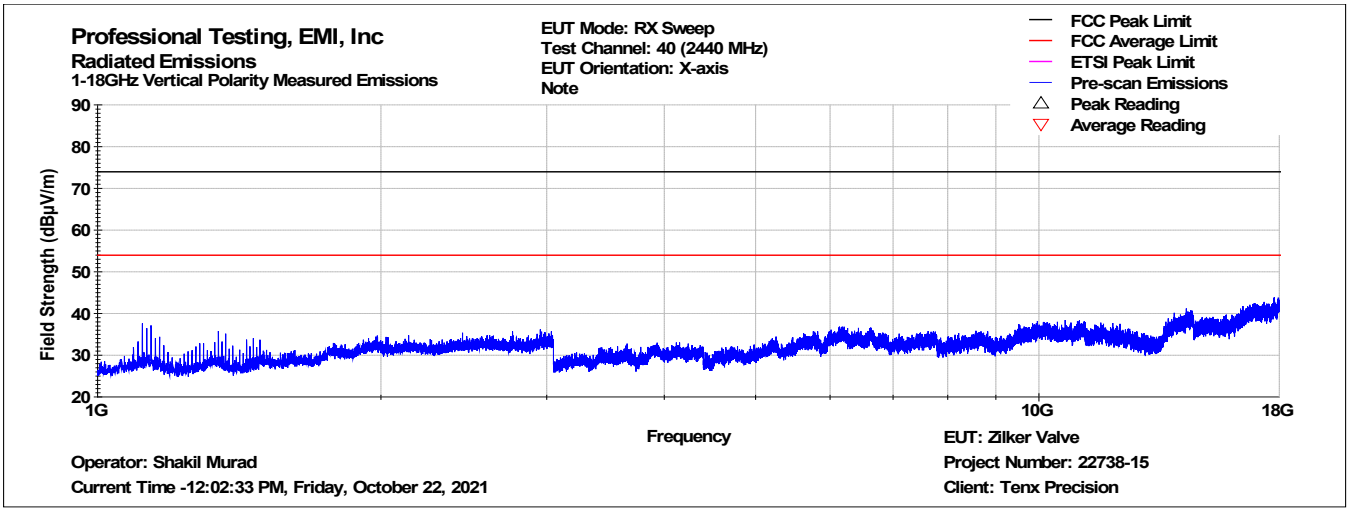
30MHz - 1GHz Vertical Polarity Measured Emissions Data



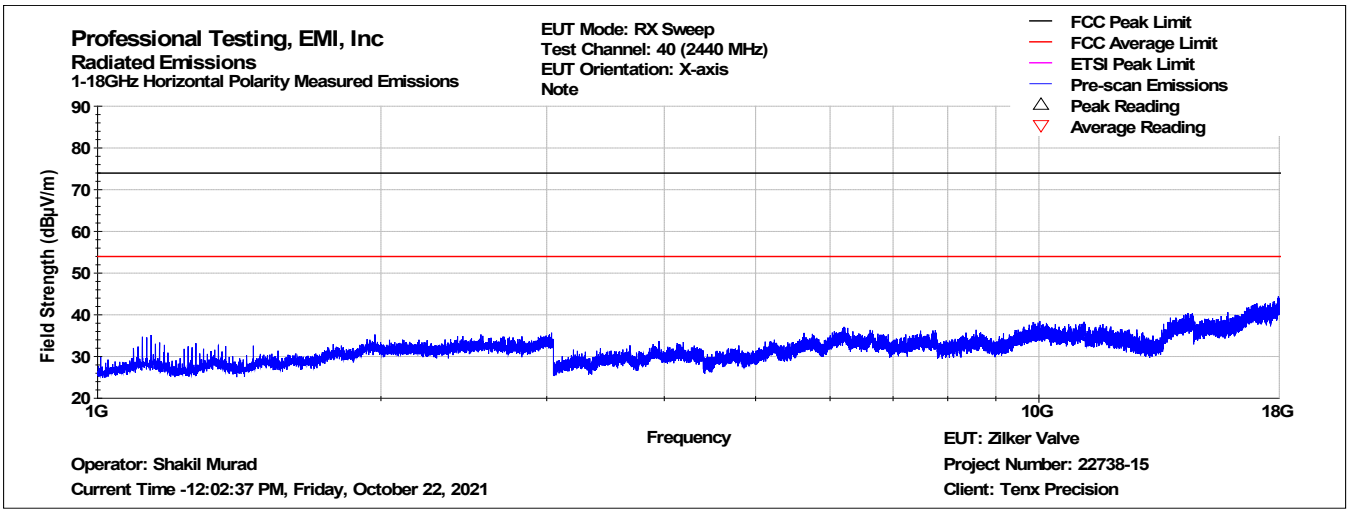
30MHz - 1GHz Horizontal Polarity Measured Emissions Data



1GHz - 18GHz Vertical Polarity Measured Emissions Data



1GHz - 18GHz Horizontal Polarity Measured Emissions Data



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

9.1 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.

9.2 Criteria

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

9.3 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.

10.0 Equipment

10.1 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

10.2 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

10.3 Receiver Spurious Emissions (30MHz – 18GHz)

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

11.0 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