TREX ENTERPRISES CORPORATION

TEST REPORT

SCOPE OF WORK
EMISSIONS TESTING – MODEL FODXFV2

REPORT NUMBER
104421478BOX-001

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EMISSIONS TEST REPORT

(FULL COMPLIANCE)

Report Number: 104421478BOX-001
Project Number: G104421478

Report Issue Date: 10/15/2020
Report Revision Date: 12/22/2020

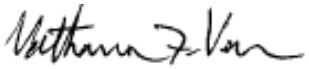
Model(s) Tested: FODXFV2
Model(s) Partially Tested: None
Model(s) Not Tested but declared equivalent by the client: None

Standards: FCC 47CFR Part 95, Subpart M:10/2020
KDB447498 D01 General RF Exposure Guidance v06

Tested by:
Intertek Testing Services NA, Inc.
70 Codman Hill Road
Boxborough, MA 01719
USA

Client:
Trex Enterprises Corporation
10455 Pacific Center Court
San Diego, CA 92121-4339
USA

Report prepared by



Vathana Ven/EMC Staff Engineer

Report reviewed by

Michael F Murphy / EMC Engineering Team Lead

Table of Contents

1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 4.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

2 Test Summary

Section	Test full name	Result
3	Client Information	--
4	Description of Equipment Under Test and Variant Models	--
5	System Setup and Method	---
6	Maximum Power and Human RF exposure FCC 47CFR Part 95, Subpart M:10/2020, KDB447498 D01 General RF Exposure Guidance v06	Pass
7	Occupied Bandwidth FCC 47CFR Part 95, Subpart M:10/2020	Pass
8	Unwanted Emissions FCC 47CFR Part 95, Subpart M:10/2020	Pass
9	Frequency Stability FCC 47CFR Part 95, Subpart M:10/2020	Pass
10	Appendix A – Mixer/Horn Calibration Certificates	--
11	Revision History	--

3 Client Information

This EUT was tested at the request of:

Client: Trex Enterprises Corporation
10455 Pacific Center Court
San Diego, CA 92121-4339
USA

Contact: Rich Chedester
Telephone: 858-646-5300
Email: rchedester@trexenterprises.com

4 Description of Equipment Under Test and Variant Models

Manufacturer: Trex Enterprises Corporation
10455 Pacific Center Court
San Diego, CA 92121-4339
USA

Equipment Under Test			
Description	Manufacturer	Model Number	Serial Number
FOD Finder XFV2 rada	Trex Enterprises Corporation	FODXFV2	003

Receive Date:	09/17/2020 & 10/07/2020
Received Condition:	Good
Type:	Production

Description of Equipment Under Test (provided by client)
Radar system operating between 76 – 81 GHz

Equipment Under Test Power Configuration			
Rated Voltage	Rated Current	Rated Frequency	Number of Phases
120 VAC	Not provided	50/60Hz	1

Operating modes of the EUT:

No.	Descriptions of EUT Exercising
1	Tx mode (run mode)

Software used by the EUT:

No.	Descriptions of EUT Exercising
1	Proprietary Software

Radio/Receiver Characteristics	
Frequency Band(s)	78 – 81 GHz
Modulation Type(s)	FMCW
Maximum Output Power	37.51 dBm or 5.636W (EIRP)
Test Channels/Sweep Ranges	Chirp frequency: 78.002 to 80.998 GHz
Maximum Bandwidth	2.960 GHz
Equipment Type	Radio
Number of Tx/Rx antennas	12/12
Antenna Type and Gain	Integrated antenna, Gain +20dBi

Variant Models:

The following variant models were not tested as part of this evaluation, but have been identified by the manufacturer as being electrically identical models, depopulated models, or with reasonable similarity to the model(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

None

5 System Setup and Method

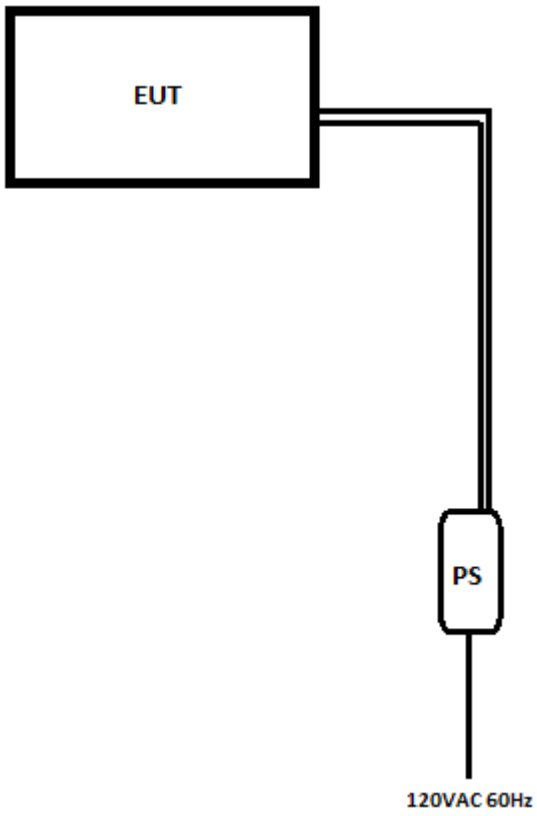
Cables					
ID	Description	Length (m)	Shielding	Ferrites	Termination
1	Power cable	3	None	None	-
2	Ethernet cable	3	None	None	-

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
Power supply	Trex Enterprises Corp.	N/A	N/A

5.1 Method:

Configuration as required by Configuration as required by FCC 47CFR Part 95, Subpart M:10/2020, ANSI C63.10:2013, ANSI C63.26:2015, KDB447498 D01 General RF Exposure Guidance v06, ANSI C63.26:2015, and FCC KDB 653005 D01 v01r01.

5.2 EUT Block Diagram:



6 Maximum Power and Human RF exposure

6.1 Method

The procedure described in Subclause 9.10 of ANSI C63.10-2013 and Subclause 5.5.4 (field strength method) of ANSI C63.26-2015 was utilized to determine maximum power and power density. Measurement was performed by using a radiated method. The EUT shall be transmitting at its maximum data rate.

- Connect the test antenna for the fundamental frequency band to a spectrum analyzer via an external mixer.
- Set spectrum analyzer RBW=1 MHz, VBW≥3 MHz.
- Set spectrum analyzer detector, span, and so on, to the proper values.
- Place the EUT 1.5 meters above the ground reference plane and in a continuous transmission mode.
- Perform handheld measurements by scanning the test antenna around all surfaces of the EUT.
- As the surfaces of the EUT are scanned, keep the test antenna pointed toward the EUT and slowly vary the test antenna polarization to cover all possible polarizations and orientations of the emission.
- Record the measured reading with the test antenna fixed at the maximized position, polarization, and orientation. Record the measurement distance.
- Repeat the preceding sequence for every operating configuration supported by the EUT (e.g., forward-looking, side-looking, and rear-looking configurations, with the vehicle at rest and in motion).

If necessary, the recorded reading(s) is adjusted by the conversion loss of the external mixer used at the frequency under investigation and the external mixer IF cable loss.

The maximum field strength of the emission at the measurement distance is calculated by using Equation (19) of ANSI C63.10-2013 and the adjusted/corrected power at the output of the test antenna.

The EIRP from the measured field strength is calculated by using Equation (22) of ANSI C63.10-2013 and convert to the linear form by using Equation (24) of ANSI C63.10-2013.

If measurements were made at any distance other than the distance specified by the limit, Equations (20) and (21) of ANSI C63.10-2013 were used to extrapolate the maximum measured field strength.

Far Field Distance (R_m) Calculation

$$R_m = 2D^2/\lambda$$

Where: D = largest dimension of the antenna aperture in meters
λ = wavelength of the emission under investigation [$300/f_{MHz}$] in meters

D = 0.031 (m), λ = 300 (m/s) / 77.0135*10^3 (MHz) = 0.003895 (m), R_m = ((2*0.031^2))/0.003895 = 0.49 (m)

Measurements was made at 0.5 meter distance.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	5.6 dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	4.9 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.4 dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	4.9 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	4.6 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	4.6 dB	5.5 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

6.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007	Weather Station	Davis Instruments	6250	MS191212003	03/12/2020	03/12/2021
OML3	Mixer / Antenna	Oleson Microwave Lab	M12HWD	E21011-1	06/18/2020	06/18/2021
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	10/10/2019	10/10/2020
CBL030	High Frequency Cable 40GHz	Megaphase	TM40 K1K1 80	CBL030	12/10/2019	12/10/2020

Software Utilized:

Name	Manufacturer	Version
None	--	--

6.3 Results:

The sample tested was found to Comply.

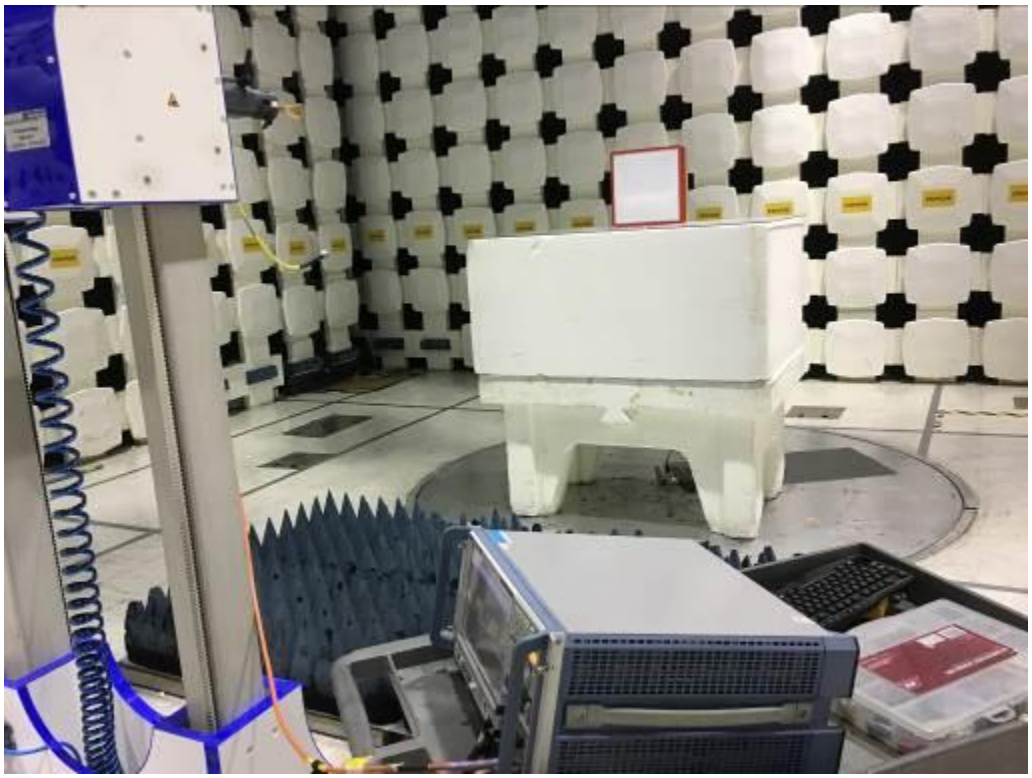
§95.3367 76-81 GHz Band Radar Service radiated power limits.

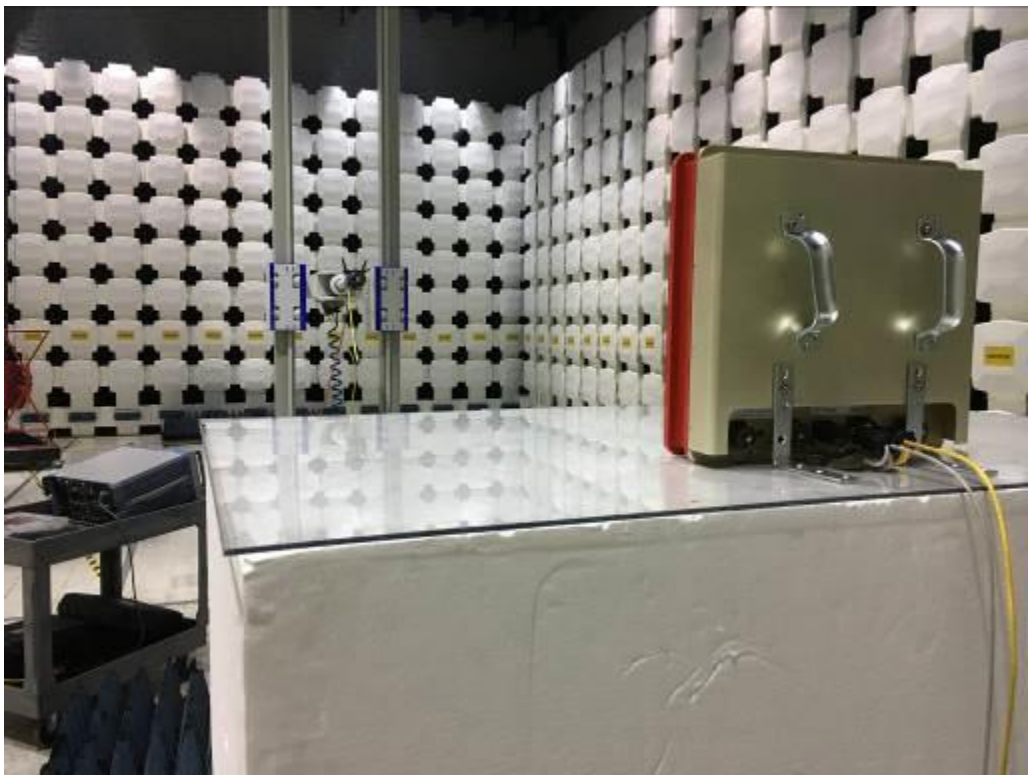
The fundamental radiated emission limits within the 76-81 GHz band are expressed in terms of Equivalent Isotropically Radiated Power (EIRP) and are as follows:

(a) The maximum power (EIRP) within the 76-81 GHz band shall not exceed 50 dBm based on measurements employing a power averaging detector with a 1 MHz Resolution Bandwidth (RBW).

(b) The maximum peak power (EIRP) within the 76-81 GHz band shall not exceed 55 dBm based on measurements employing a peak detector with a 1 MHz RBW.

6.4 Setup Photographs:



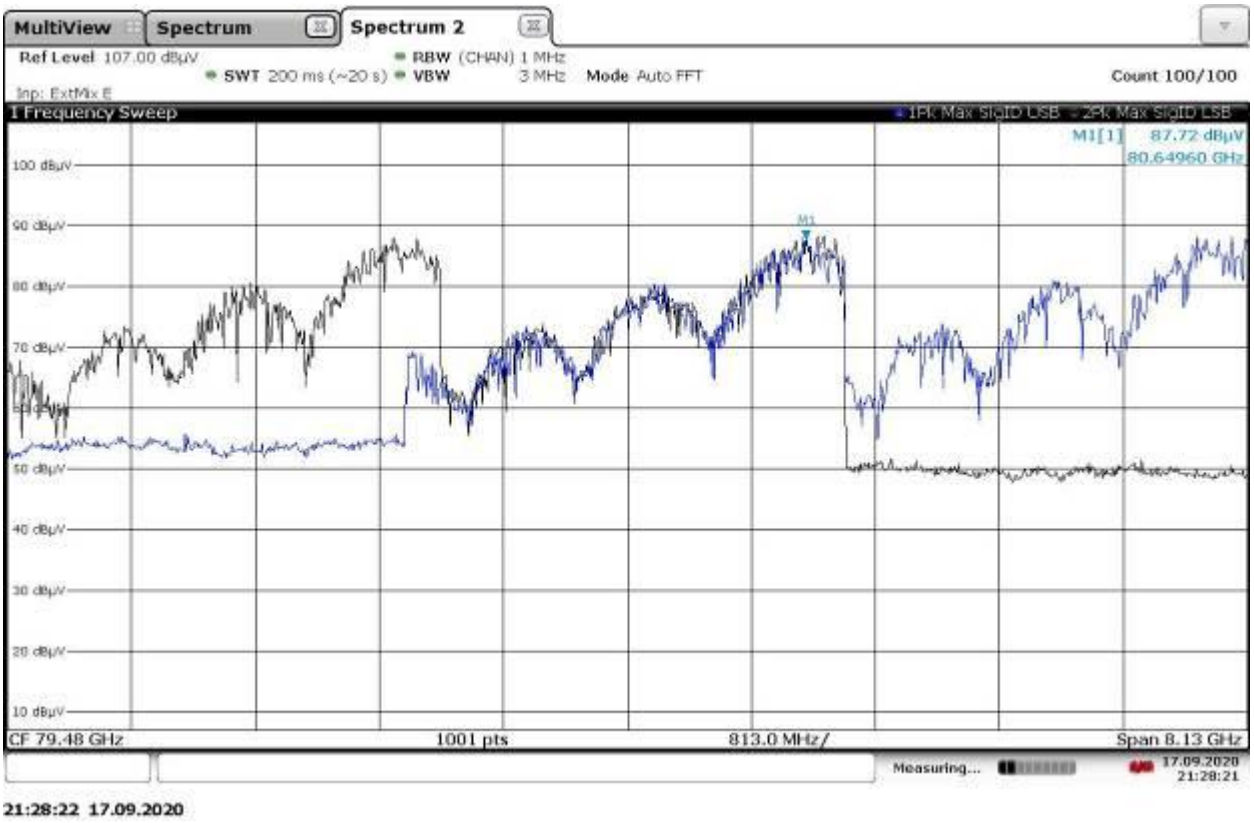


6.5 Test Data:

Antenna Pol.	Detection	Frequency (GHz)	Raw Reading* @3m (dBuV/m)	Receiving Antenna Gain (dBi)	Antenna Correction Factor, AF (dB/m)	Cable Loss (dB)	EIRP Level @3m (dBuV/m)	EIRP Level (dBm)	EIRP Limit (dBm)	Margin (dB)
V	Peak	80.6496	87.72	24	44.33	0.69	132.74	37.51	55	-17.49
Using integration method										
V	RMS	80.6496	77.39	24	44.33	0.69	122.41	27.18	50	-22.82
*: the mixer conversion losses were compensated for in the instrument: 33.77 (80.6496 GHz)										

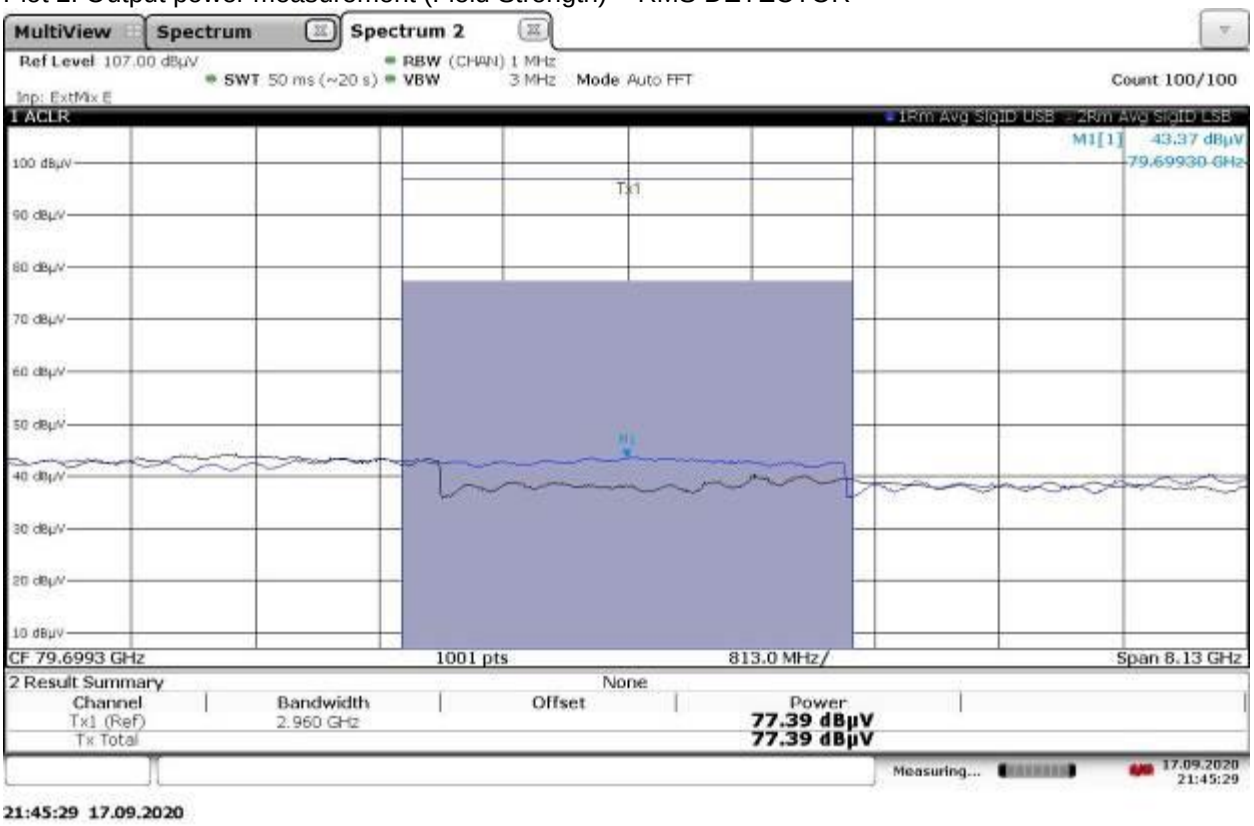
Note: Worst-case antenna polarization were recorded here.

Plot 1: Output power measurement (Field Strength) – PEAK DETECTOR



Note: Please see the sweep bandwidth in next section. Real signal and image are mixed in the above plot. This is the worst-case.

Plot 2: Output power measurement (Field Strength) – RMS DETECTOR



Note: Please see the sweep bandwidth in next section. Real signal and image are mixed in the above plot. This is the worst-case.

Sample calculations:

Peak Power of low channel

Calculate the field strength from the radiated measurement

$E = E_{Meas}$ (display on SA) + AF + Mixer Conversion Loss + Cable Loss

where
E is the field strength of the emission at the measurement distance, in dB(μV/m)
AF is Antenna correction factor, in dB
Mixer Conversion Loss is from datasheet and it was included in transducer factor of spectrum analyzer
Cable loss in dBi
E_{Meas} is the field strength of the emission at the measurement distance, in dB(μV/m)

NOTE—The measurements were taken at 3 meters.

AF = 20*Log (F) - G + 30.2

Where
AF is the antenna correction factor, in dB
F is the frequency in GHz
G is the gain of the test antenna, in dBi

F = 80.6496 GHz
G = 24.0
AF = 20*LOG(80.6496) - 24.0 + 30.2 = 44.33

AF = 44.33 dB/m
Cable loss = 0.69 dB
E_{Meas} = 87.72 dBμV/m

EIRP (dBm) = E (dBuV/m) – 104.77 + 20*LOG(d); where d is a distance of measurement in m
= 132.74 -104.77 + 9.54 = 37.51 dBm

MPE Calculation

§ 1.1310: The criteria listed in table 1 shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

Part 1.1310 Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f^2)	6
30–300	61.4	0.163	1.0	6
300–1500			f/300	6
1500–100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f^2)	30
30–300	27.5	0.073	0.2	30
300–1500			f/1500	30
1500–100,000			1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

1.1 Test Procedure

An MPE evaluation for was performed in order to show that the device was compliant with §2.1091. The maximum power density was calculated for each transmitter at a separation distance of 20cm.

$$S = \frac{PG}{4\pi R^2} \qquad 3)$$

where: S = power density (in appropriate units, e.g. mW/cm^2)
P = power input to the antenna (in appropriate units, e.g., mW)
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

or:

$$S = \frac{EIRP}{4\pi R^2} \qquad (4)$$

where: EIRP = equivalent (or effective) isotropically radiated power

Client specified safe distance of 3 m or 300 cm.

1.2 Results:

- EIRP = 37.51 dBm or 5.636W=5626mW

Power Density = 5626 / 1130500

Power Density = 0.004977 mW/cm^2

Limit at 80.6496GHz = 1mW/cm^2

The calculated maximum power density at 3m distance is less than the limit for general population / uncontrolled exposure.

Test Personnel:	Vathana Ven VSV	Test Date:	09/17/2020
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 95, Subpart M	Limit Applied:	See report section 6.3
Input Voltage:	120VAC 60Hz		
Pretest Verification w/ Ambient Signals or BB Source:	**N/A**	Ambient Temperature:	21 ºC
		Relative Humidity:	46 %
		Atmospheric Pressure:	1007 mbars

Deviations, Additions, or Exclusions: None

7 Occupied Bandwidth (26 dB)

7.1 Method

7.1 Method

The procedure described in Subclause 9.3 of ANSI C63.10-2013 and Subclause 5.4 of ANSI C63.26-2015 was utilized to determine occupied bandwidth. The EUT shall be transmitting at its maximum data rate.

a) Set the center frequency of the instrument to the center frequency of the transmission
b) Set span equal to approximately two times to three times the EBW, centered on the carrier frequency
c) Set RBW = (CHAN) 5 MHz
d) Set VBW = 10 MHz
e) Sweep = Auto
f) Detector = Peak
g) Trace = Max Hold
h) Allow the trace to stabilize
i) Use the Occupied Bandwidth function of the spectrum analyzer to measure occupied bandwidth

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	5.6 dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	4.9 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.4 dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	4.9 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	4.6 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	4.6 dB	5.5 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

7.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007	Weather Station	Davis Instruments	6250	MS191212003	03/12/2020	03/12/2021
OML3	Mixer / Antenna	Oleson Microwave Lab	M12HWD	E21011-1	06/18/2020	06/18/2021
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	10/10/2019	10/10/2020
CBL030	High Frequency Cable 40GHz	Megaphase	TM40 K1K1 80	CBL030	12/10/2019	12/10/2020

Software Utilized:

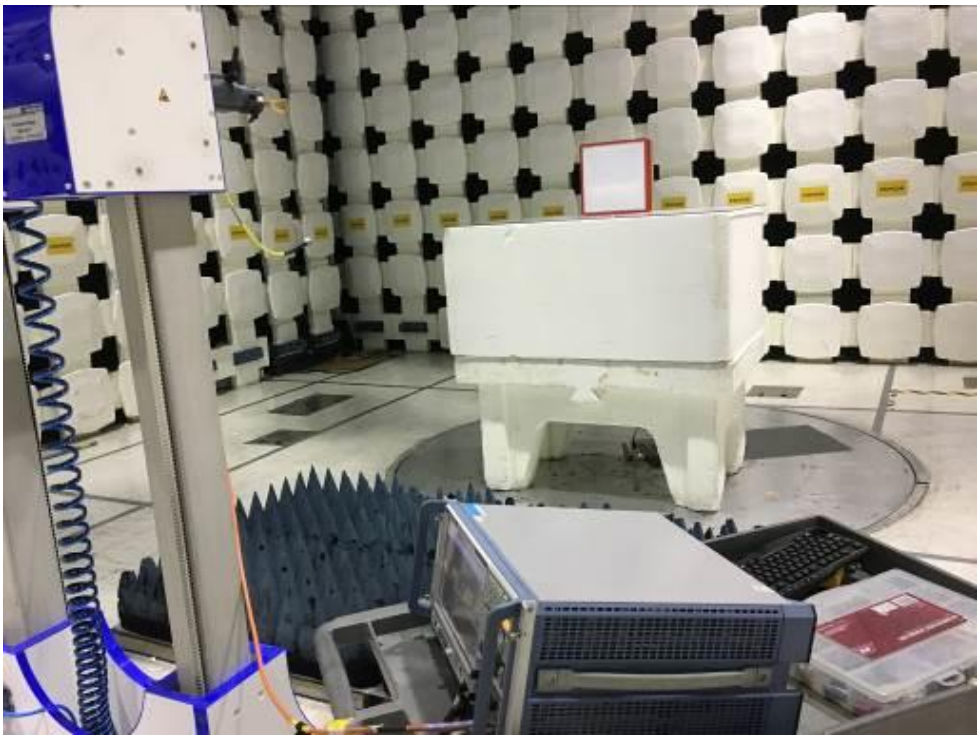
Name	Manufacturer	Version
None	--	--

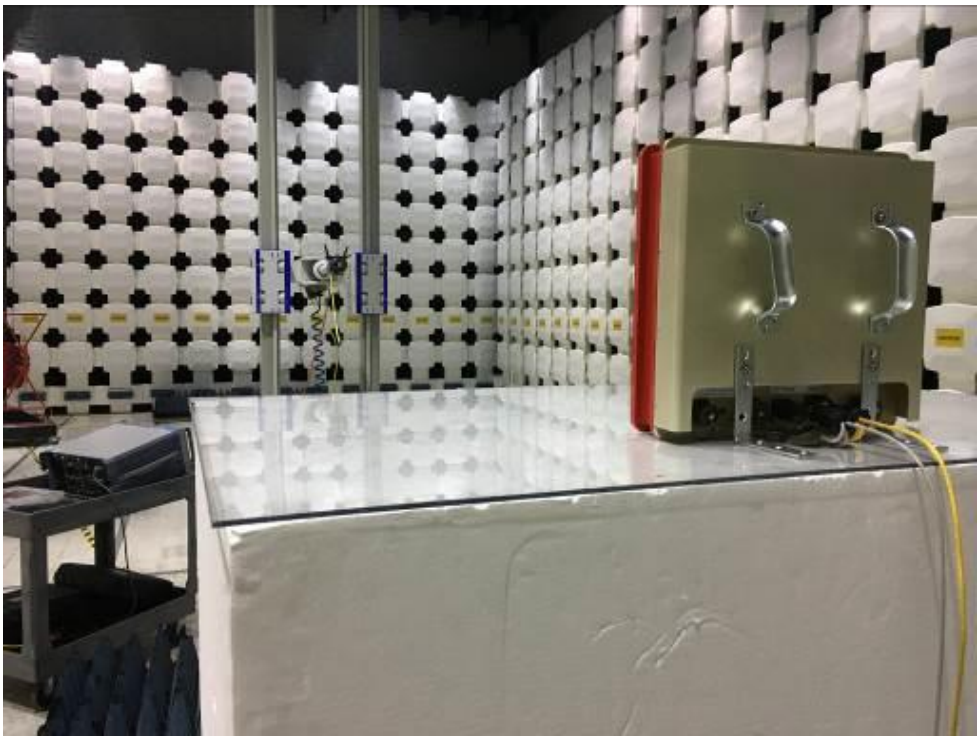
7.3 Results:

The sample tested was found to Comply.

The radar device's occupied bandwidth (i.e., 99% emission bandwidth) shall be contained in the 76-81 GHz frequency band. The measured occupied bandwidth data under extreme temperature conditions are reported in the Frequency Stability section.

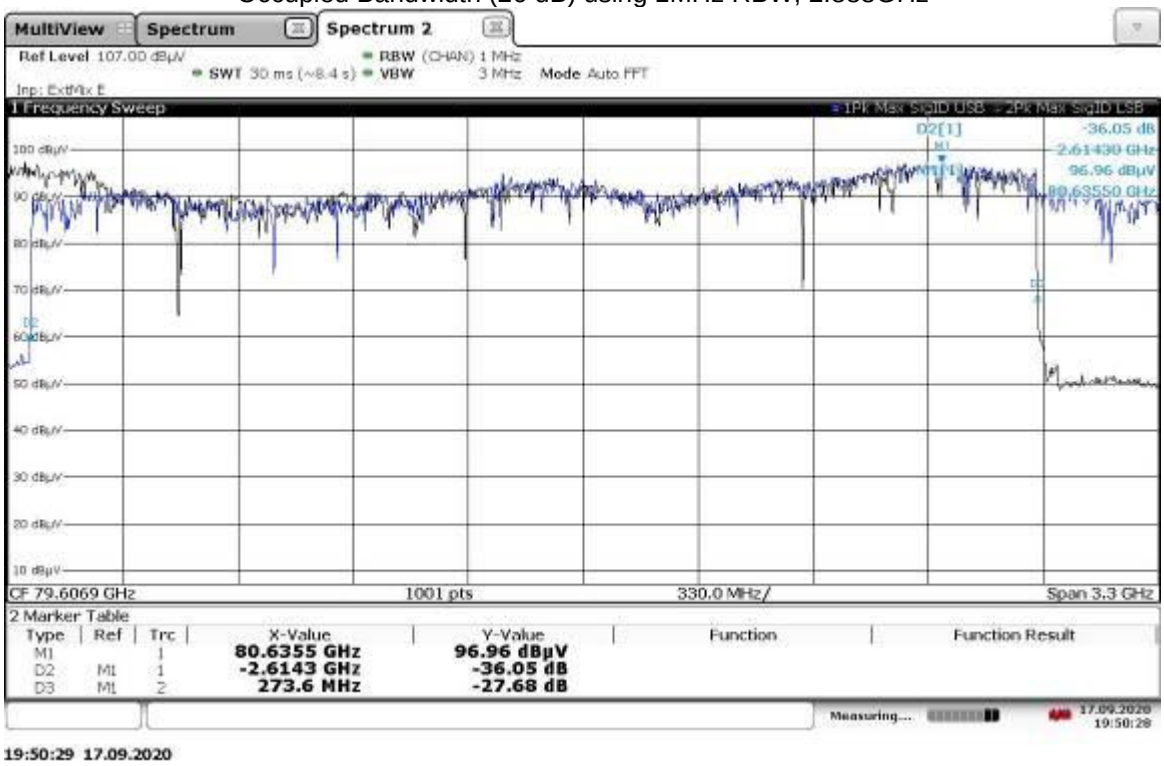
7.4 Setup Photograph:





7.5 Plots/Data:

Occupied Bandwidth (26 dB) using 1MHz RBW, 2.888GHz



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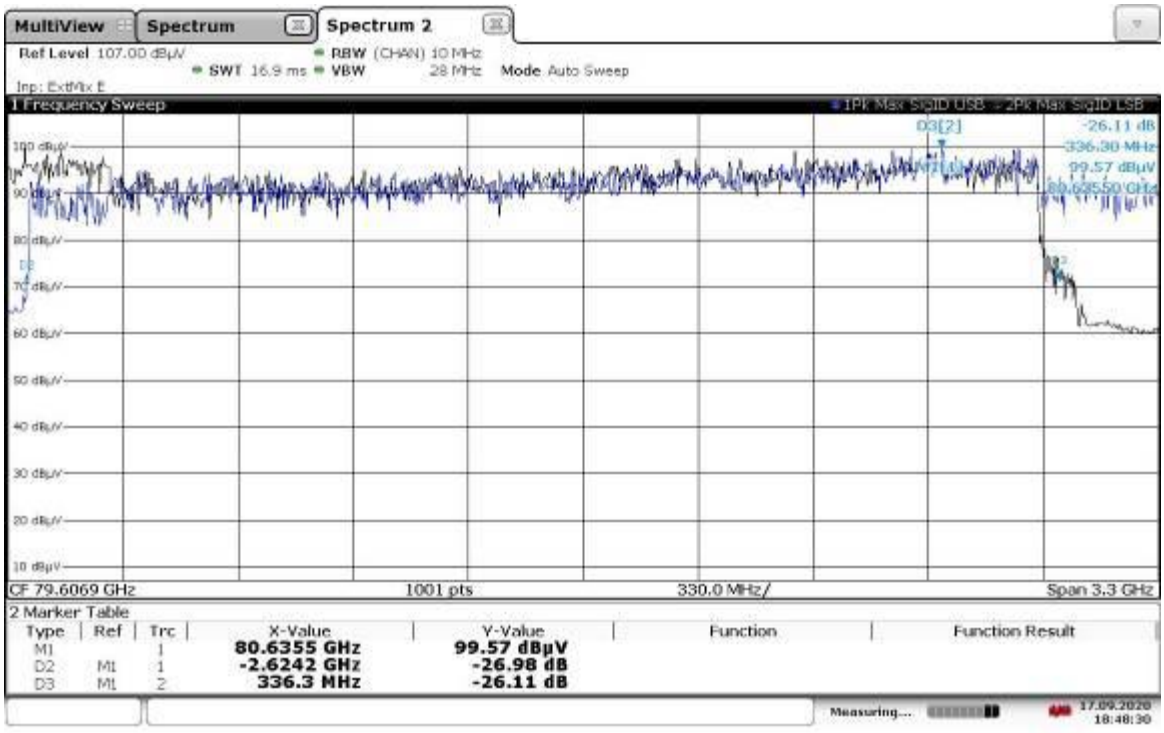
Occupied Bandwidth (26 dB) using 10MHz RBW, 2.960GHz



18:48:31 17.09.2020

Test Personnel:	Vathana Ven VSV	Test Date:	09/17/2020
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 95, Subpart M	Limit Applied:	See report section 7.3
Input Voltage:	120VAC 60Hz		
Pretest Verification w/ Ambient Signals or BB Source:	**N/A**	Ambient Temperature:	21 ºC
		Relative Humidity:	46 %
		Atmospheric Pressure:	1007 mbars

Deviations, Additions, or Exclusions: 26 dB bandwidth was used in place of occupied bandwidth. This is the worst-case.

8 Unwanted Emissions

8.1 Method

The procedure described in Subclauses 6.3-6.6 and 9.9 of ANSI C63.10-2013 and Subclause 5.5.4 (field strength method) of ANSI C63.26-2015 were utilized to determine unwanted emissions.

Radiated emission measurements are performed from 9 kHz to 231 GHz. Measurements for frequencies less than or equal to 1 GHz are made with an EMI receiver employing a CISPR quasi-peak detector. Measurements for frequencies above 1 GHz are made with an EMI receiver or a spectrum analyzer employing an average detector and a peak detector.

Quasi-peak measurements are performed for frequencies less than or equal to 1 GHz. The quasi-peak level of radiated emissions was measured with a resolution bandwidth (RBW) of 9 kHz for frequencies below 30 MHz and 120 kHz for frequencies between 30 MHz to 1 GHz.

Both Peak and Average measurements are performed for frequencies above 1 GHz. The peak level of radiated emissions was measured with a resolution bandwidth (RBW) of 1 MHz, a video bandwidth (VBW) of 3 MHz, and a peak detector. The average level of radiated emissions was measured with a resolution bandwidth (RBW) of 1 MHz, a video bandwidth (VBW) of 3 MHz, and an RMS detector with trace averaging.

Radiated emissions measurement is performed at 10 meters distance for frequencies below 1 GHz, 3 meters for frequency between 1 GHz and 18 GHz, and 1 meter for frequencies above 18 GHz. If the emission level is too low for measurement at that distance, a pre-amplifier is used and/or the test is performed at a closer distance.

The EUT is configured to transmit continuously at its maximum data rate. The EUT is placed 80 cm in height for frequencies below 1 GHz and 1.5 meters in height for frequency above 1 GHz. For portable or handheld devices, the EUT is manipulated through three orthogonal orientations.

For radiated emissions measurements Below 30 MHz, the measuring antenna is positioned with its plane perpendicular to the ground at the specified distance from the EUT. The lowest height of the measurement antenna is 1 m above the ground. During the test, the EUT is rotated 0° through 360° and the measuring antenna orientations are varied (parallel, perpendicular, and ground-parallel) during the search for maximum emission level. EMI receiver's resolution bandwidth is set at 9 kHz.

For radiated emissions measurements between 30 MHz to 18 GHz, measurements are performed with the EUT rotated from 0° to 360°, the measuring antenna height scanned between 1 to 4 meters, and the measuring antenna varied for both horizontal and vertical polarization, to determine the maximum emission level.

For radiated emissions measurements between 18 GHz to 231 GHz, handheld measurement is performed at a far field distance. As the surfaces of the EUT are scanned, the test antenna is kept pointed toward the EUT and the measuring antenna polarization is varied slowly to cover all possible polarizations and orientations of the emission(s).

Data included is representative of the worst-case configuration (the configuration which resulted in the highest emission levels). Plots below are corrected for distance, cables, preamp, filters, antenna factors, and conversion factors then compared to the limits.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the

entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
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Radiated Emissions, 3m	6-15 GHz	4.9 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	4.6 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	4.6 dB	5.5 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Far Field Distance (R_m) Calculation for harmonic mixer at 170GHz:

$$R_m = 2D^2/\lambda$$

Where: D = largest dimension of the antenna aperture in meters
λ = wavelength of the emission under investigation [300/f_{MHz}] in meters

D = 0.014 (m), λ = 300 (m/s) / 170*10^3 (MHz) = 0.0017647 (m), R_m = ((2*0.014^2))/0.0017647 = 0.22 (m)

Measurements was made at 0.22 meter distance.

8.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007'	Weather Station Vantage Vue	Davis	6250	MS191212003	03/12/2020	03/12/2021
145108'	EMI Test Receiver (20Hz - 40GHz)	Rohde & Schwarz	ESIB40	100209	06/08/2020	06/08/2021
IW001'	2 meter cable	Insulated Wire	2801-NPS	001	10/08/2019	10/08/2020
145-406'	10m Track A In-floor Cable #1	Huber + Suhner	sucoflex 160-19220mm	001	12/10/2019	12/10/2020
HS001'	DC-18GHz cable 1.5m long	Huber & Suhner	SucoFlex 106A	HS001	11/19/2019	11/19/2020
IW003'	8.4 meter cable	Insulated Wire	2800-NPS	003	10/08/2019	10/08/2020
145145'	Broadband Hybrid Antenna 30 MHz - 3 GHz	Sunol Sciences Corp.	JB3	A122313	05/07/2020	05/07/2021
PRE11'	50dB gain pre-amp	Pasternack	PRE11	PRE11	09/21/2020	09/21/2021
ETS002'	1-18GHz DRG Horn Antenna	ETS Lindgren	3117	00143260	01/21/2020	01/21/2021
EMC04'	ANTENNA, RIDGED GUIDE, 18-40 GHZ	EMCO	3116	2090	12/10/2019	12/10/2020
OML2'	Mixer / Antenna	Oleson Microwave Lab	M08HWA	F21011-1	06/18/2020	06/18/2021
OML1'	Mixer / Antenna	Oleson Microwave Lab	M05HWA	G21011-1	06/18/2020	06/18/2021
CBLHF2012-2M-1	2m 9kHz-40GHz Coaxial Cable - SET1	Sucoflex (Huber Suhn	SF102	252675001	02/17/2020	02/17/2021
PRE8'	PREAMPLFIER 1- 40 GHz	MITEQ	NSP4000-NF	507145	11/01/2019	11/01/2020
OML3'	Mixer / Antenna	Oleson Microwave Lab	M12HWD	E21011-1	06/18/2020	06/18/2021
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	10/10/2019	10/15/2020
CBL030	High Frequency Cable 40GHz	Megaphase	TM40 K1K1 80	CBL030	12/10/2019	12/10/2020
OML4'	Mixer / Antenna	Oleson Microwave Lab	M19HWA	U21011-1	06/18/2020	06/18/2021
OML5'	Millimeter Wave Harmonic Generator	Oleson Microwave Lab	40200WGS	21011-1	06/18/2020	06/18/2021
OML6'	WR-04 Horn antenna 22-24dBi, 170-260GHz	OML	M04RH	19042901	06/18/2020	06/18/2021
OML7'	WR-04 Harmonic Mixer, 170-260GHz	OML	M04HWD	190429-1	06/18/2020	06/18/2021
145-019'	Active Loop Antenna (9 KHz to 30 MHz)	EMCO	6502/1	9902-3267	12/11/2019	12/11/2020

Software Utilized:

Name	Manufacturer	Version
BAT-EMC	Nexio	3.17.0.3
EMI Boxborough.xls	Intertek	08/27/2010

8.3 Results:

The sample tested was found to Comply.

Modifications:

(1) Ferrite sleeve (Fair-Rite, Part: 0443167251) was externally installed around the ethernet cable as close to the EUT as possible with a full turn configuration.
(2) Ferrite sleeve (Fair-Rite, Part: 0443167251) was externally installed around the power cable as close to the EUT as possible with a full turn configuration.

Unwanted emissions Limits (FCC Part 95 Subpart M):

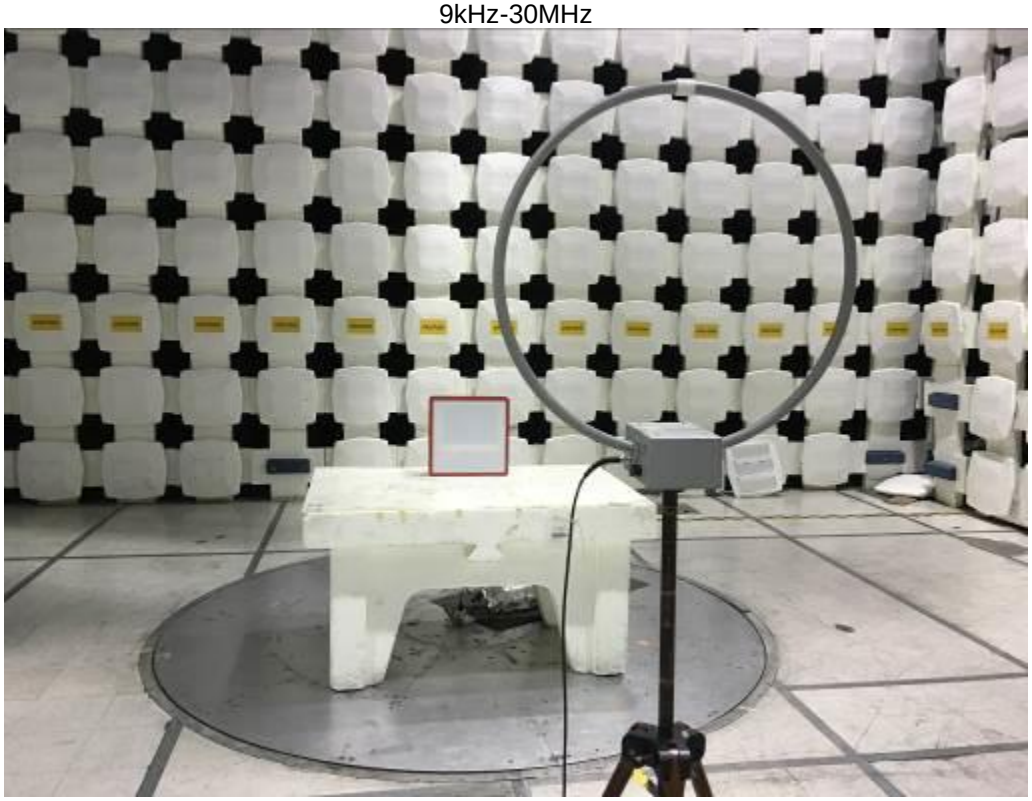
Frequency (MHz)	Field strength (µV/m)	Measurement distance (m)	Detector
0.009-0.490[1]	2400/F(kHz)	300	Quasi-peak [see Note 1]
0.490-1.705	24000/F(kHz)	30	Quasi-peak
1.705-30.0	30	30	Quasi-peak
30-88	100	3	Quasi-peak
88-216	150	3	Quasi-peak
216-960	200	3	Quasi-peak
960-40,000[2]	500	3	Quasi-peak [see Note 2]
Frequency (GHz)	**Power density (pW/cm^2)**	**Measurement distance (m)**	**Detector**
40-200	600	3	Average
Above 200	1000	3	Average

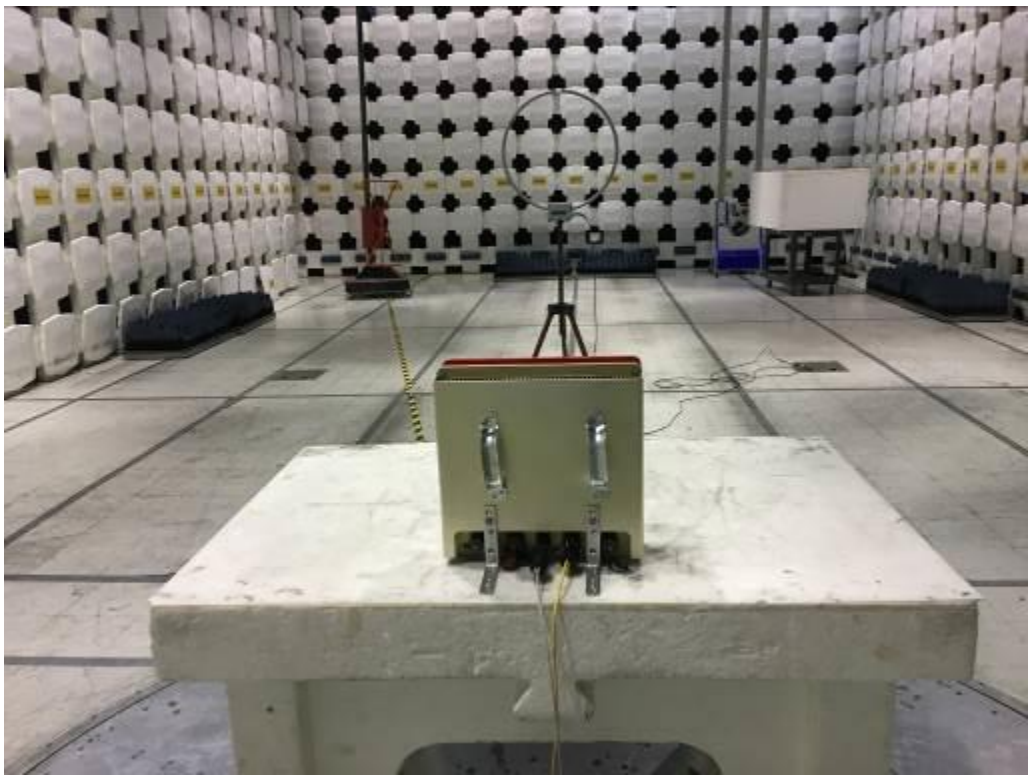
Note 1: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

Note 2: The emission limits for the frequencies above 1 GHz are based on measurements employing a linear average detector.

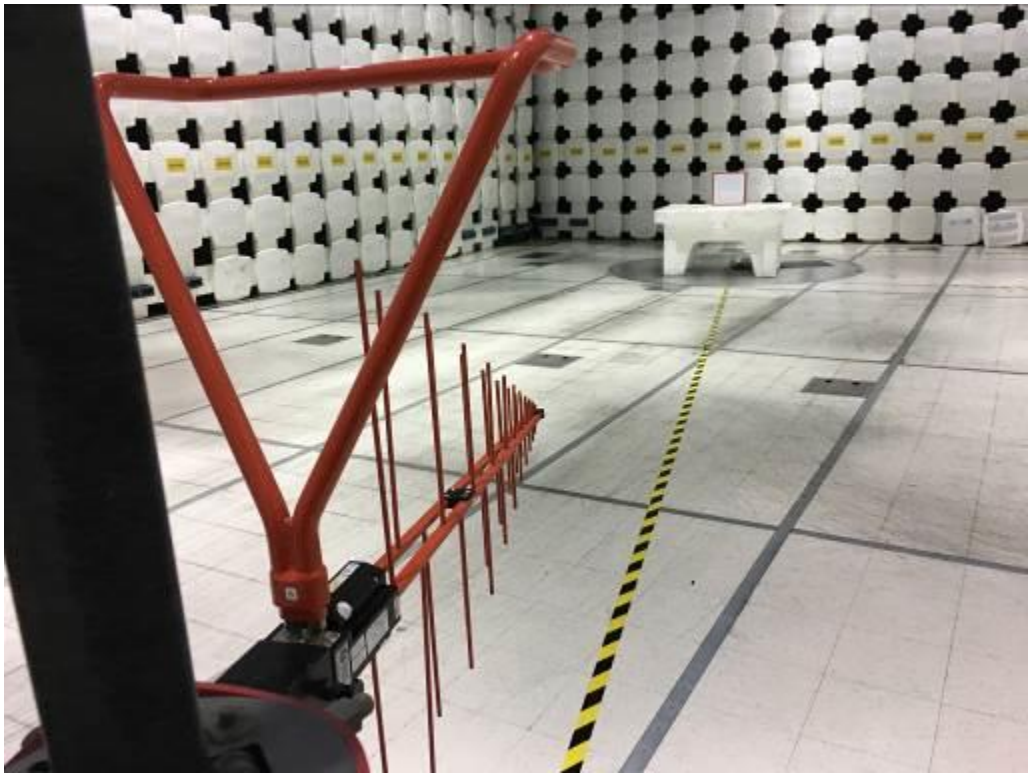
8.4 Setup Photograph:

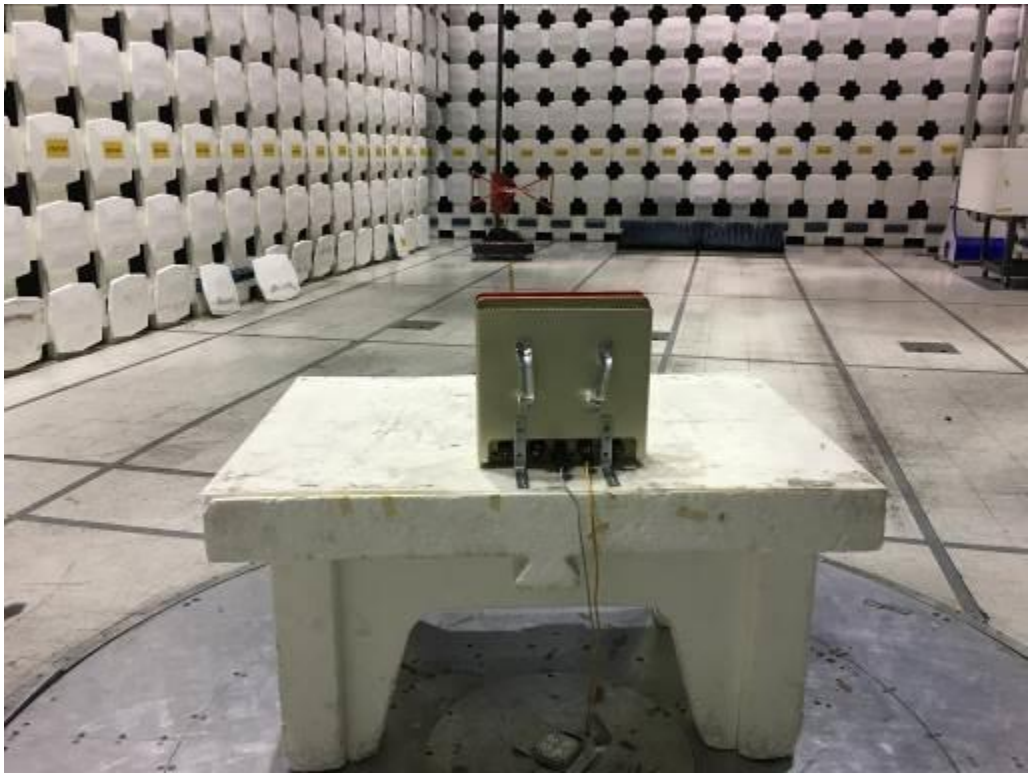
9kHz-30MHz



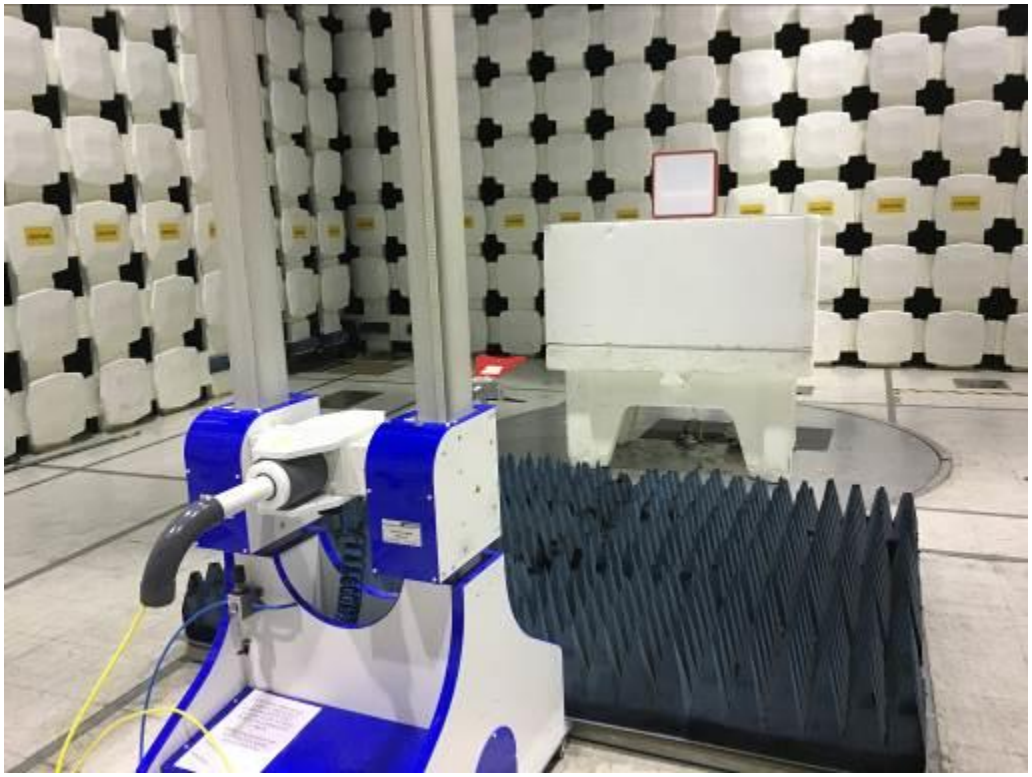


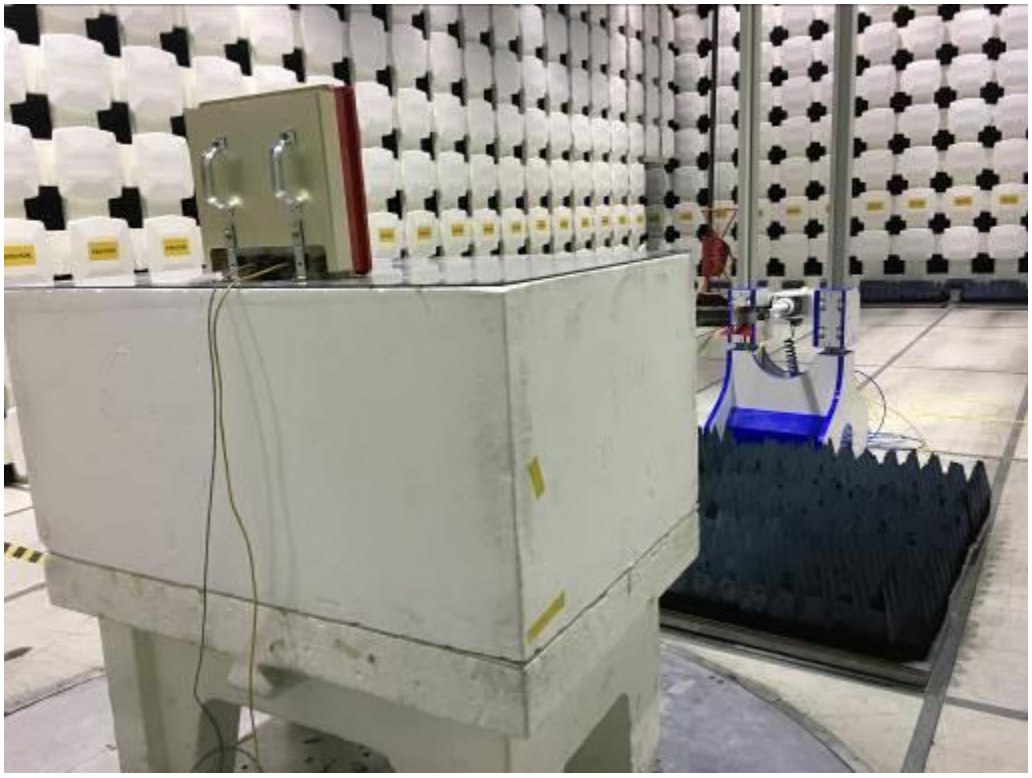
30-1000MHz



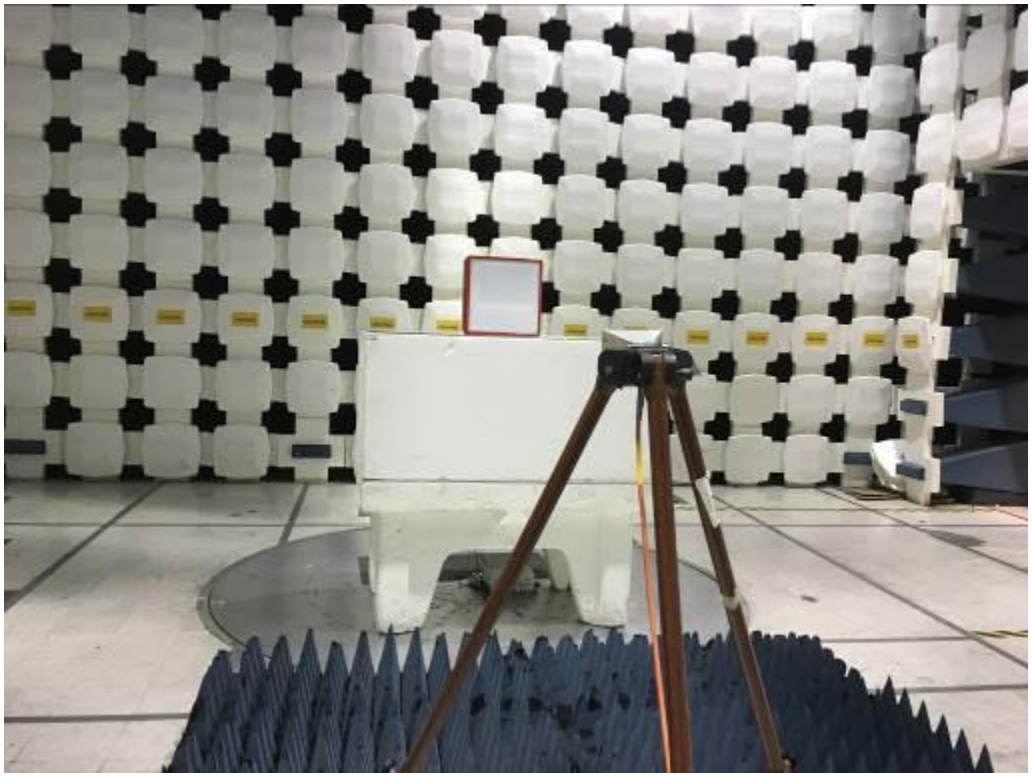


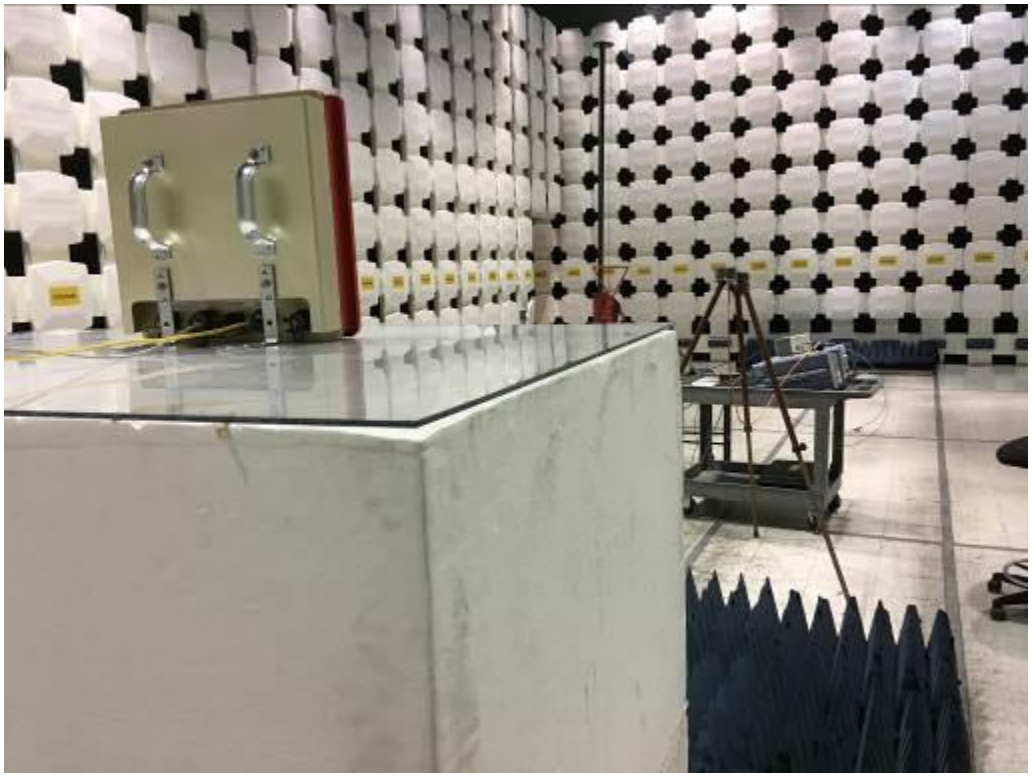
1-18 GHz



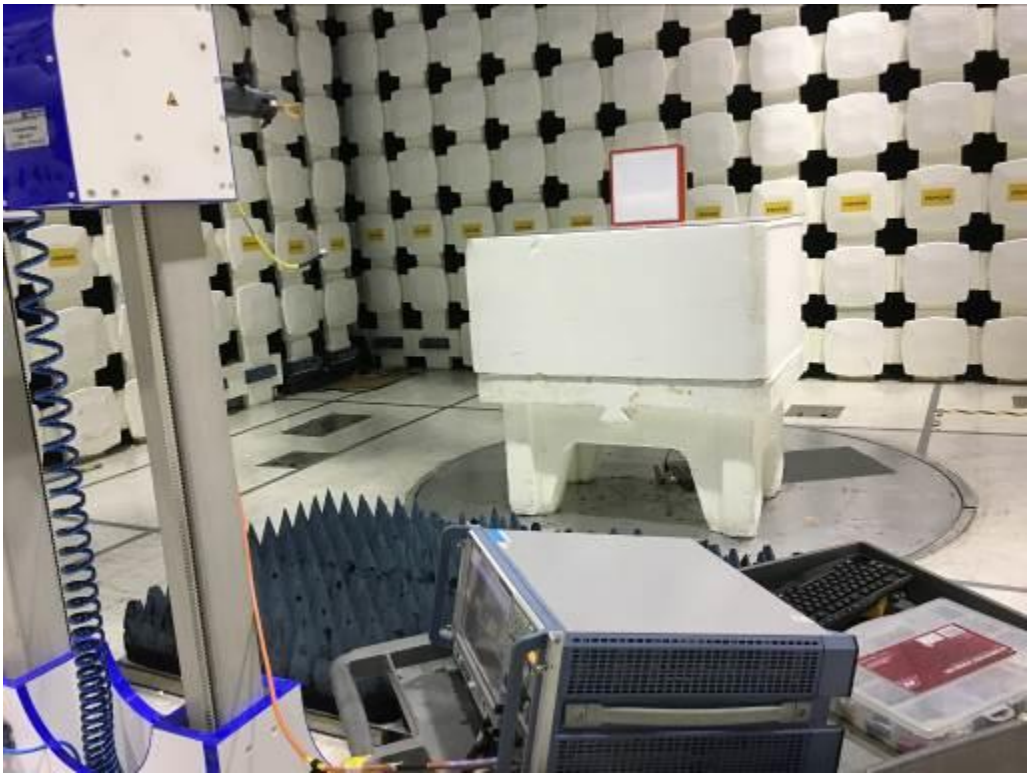


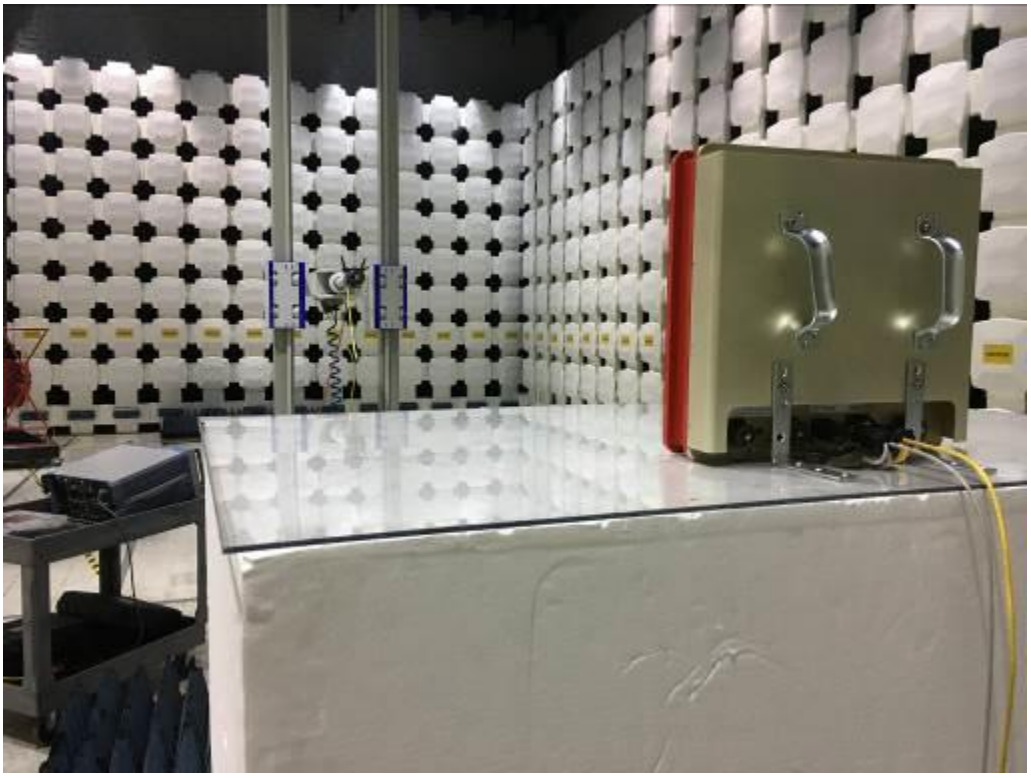
18-40 GHz





Above 40GHz





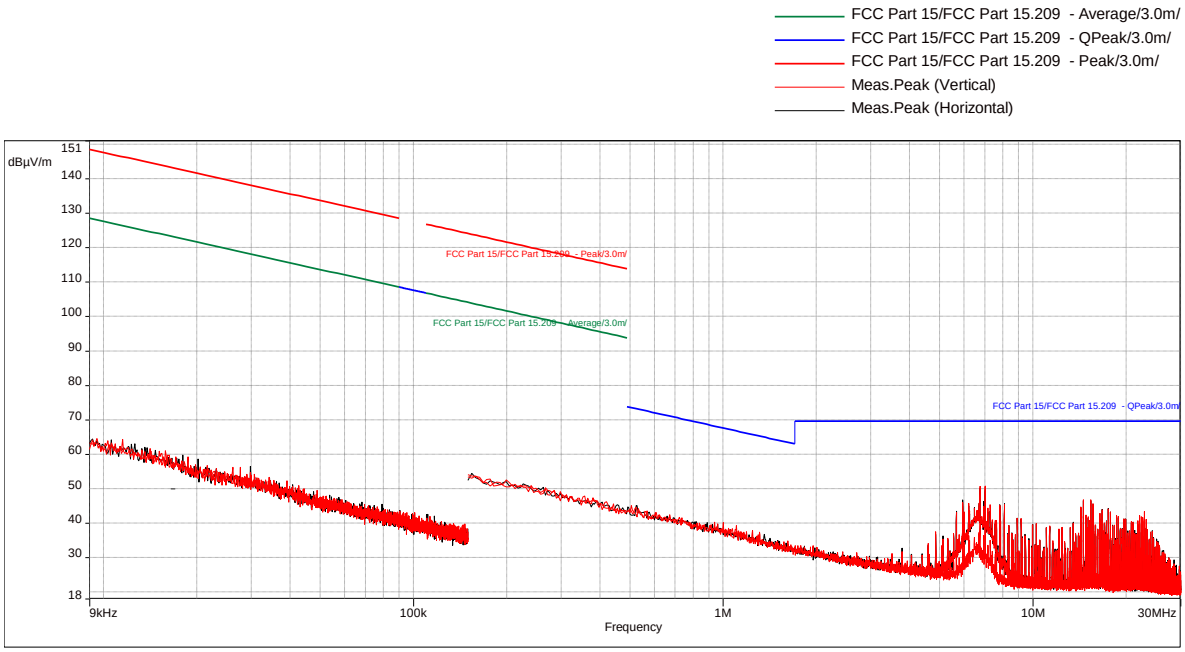
8.5 Plots/Data:

9kHz – 30MHz

Test Information:

Date and Time	9/18/2020 6:20:37 PM
Client and Project Number	Trex Enterprises_G104421478
Engineer	Vathana Ven
Temperature	23 deg C
Humidity	40%
Atmospheric Pressure	1005 mB
Comments	RE 9kHz-30MHz Loop antenna, Electric Field, 3M Location (FCC 15.209)_120VAC 60Hz

Graph:



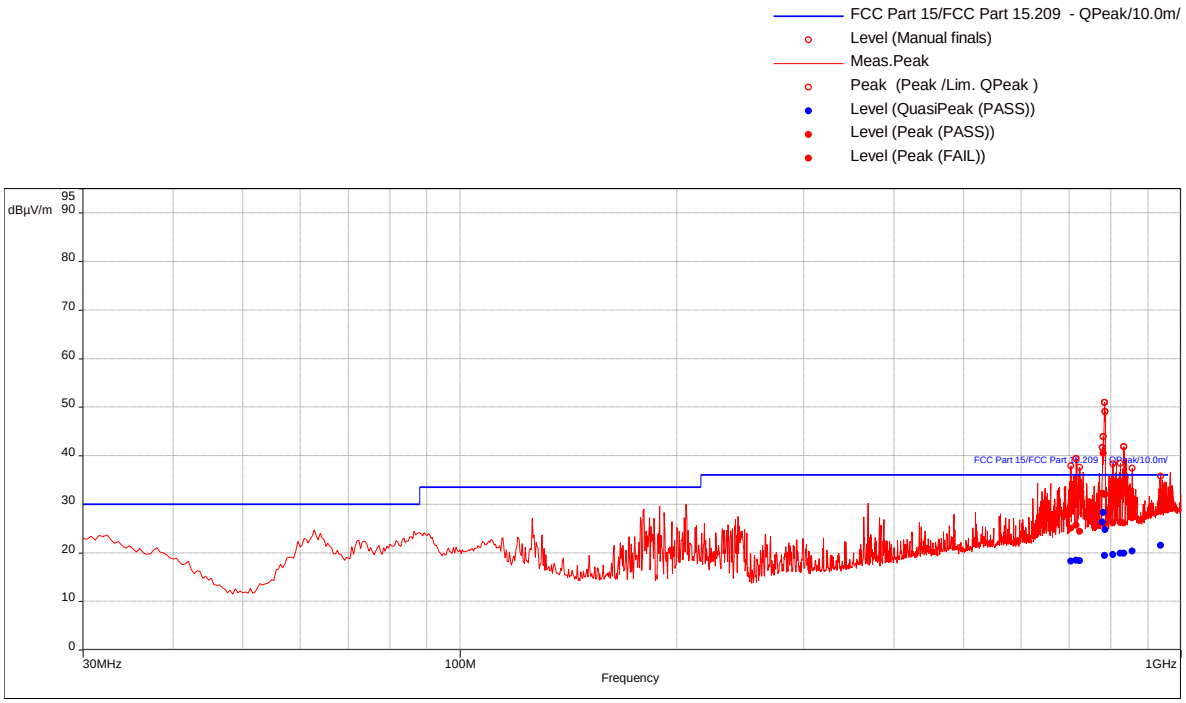
Results: Emissions were well below the limits.

Low Channel, 30-1000 MHz

Test Information:

Date and Time	10/7/2020 4:53:51 PM
Client and Project Number	Trex Enterprises_G104421478
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	40%
Atmospheric Pressure	988 mB
Comments	RE 30-1000MHz_120VAC 60Hz_Ferrites on power/ethernet cable with one loop, pn: 0443167251

Graph:



Results:

QuasiPeak (PASS) (12)

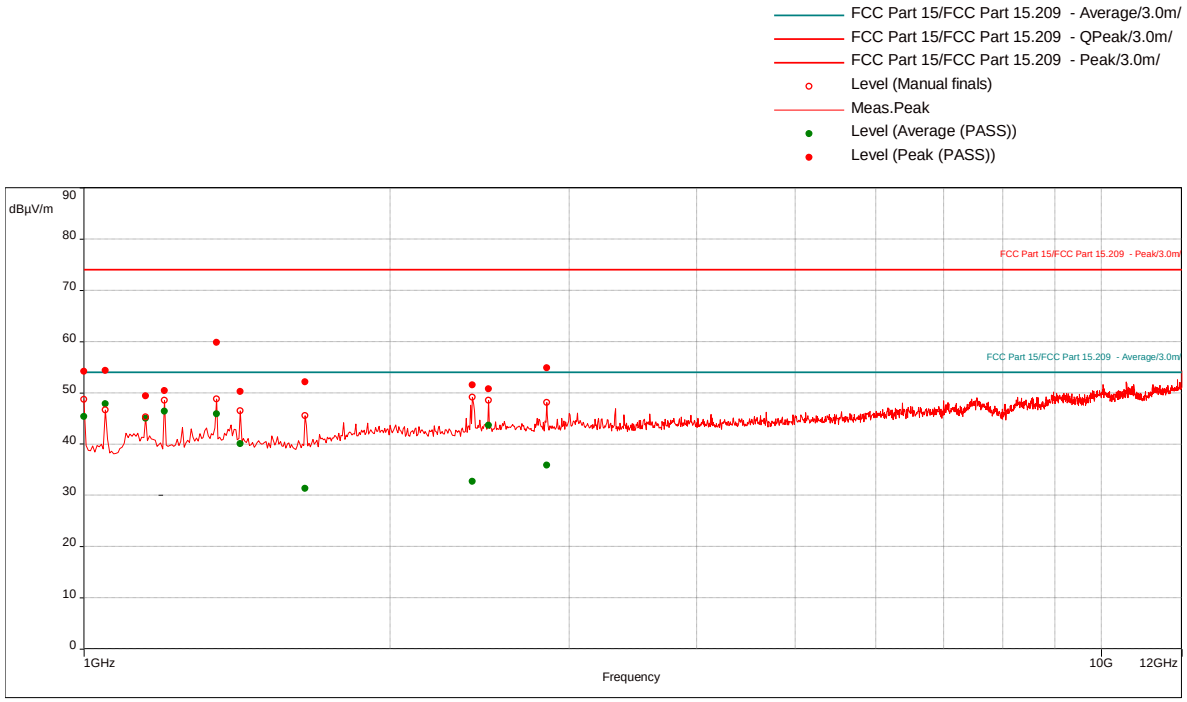
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (HZ)	Correction (dB)
703.6842105	18.23	36.00	-17.77	335.00	3.34	Vertical	120000.00	-8.82
715.8105263	18.39	36.00	-17.61	85.00	2.99	Vertical	120000.00	-8.59
724.0105263	18.30	36.00	-17.70	203.00	3.20	Vertical	120000.00	-8.54
778.1473684	26.28	36.00	-9.72	216.00	3.14	Vertical	120000.00	-7.58
780.9578947	28.29	36.00	-7.71	10.00	3.70	Vertical	120000.00	-7.55
784.2526316	19.46	36.00	-16.54	55.00	3.46	Horizontal	120000.00	-7.52
785.7263158	24.71	36.00	-11.29	39.00	1.60	Horizontal	120000.00	-7.50
804.8631579	19.57	36.00	-16.43	306.00	2.47	Vertical	120000.00	-7.15
823.9684211	19.85	36.00	-16.15	290.00	3.29	Vertical	120000.00	-6.73
834.3368421	19.86	36.00	-16.14	39.00	2.05	Vertical	120000.00	-6.72
856.5894737	20.34	36.00	-15.66	157.00	2.90	Vertical	120000.00	-6.24
938.4315789	21.46	36.00	-14.54	187.00	2.40	Vertical	120000.00	-4.77

1-18 GHz

Test Information:

Date and Time	9/18/2020 12:50:15 AM
Client and Project Number	Trex Enterprises_G104421478
Engineer	Vathana Ven
Temperature	23 deg C
Humidity	40%
Atmospheric Pressure	1005 mB
Comments	RE 1 to 12 GHz_120VAC 60Hz

Graph:



Results:

Peak (PASS) (10)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (HZ)	Correction (dB)
1000	54.14	74.00	-19.86	0.00	1.45	Vertical	1000000.00	-21.89
1050	54.37	74.00	-19.63	1.00	1.40	Vertical	1000000.00	-22.51
1150	49.36	74.00	-24.64	358.00	1.65	Vertical	1000000.00	-21.39
1200.263158	50.43	74.00	-23.57	32.00	1.65	Horizontal	1000000.00	-20.44
1350	59.80	74.00	-14.20	32.00	1.40	Vertical	1000000.00	-18.66
1423.157895	50.25	74.00	-23.75	337.00	1.00	Vertical	1000000.00	-18.76
1649.473684	52.10	74.00	-21.90	329.00	1.20	Vertical	1000000.00	-19.04
2410.263158	51.53	74.00	-22.47	158.00	1.00	Vertical	1000000.00	-15.12
2500	50.77	74.00	-23.23	357.00	1.00	Vertical	1000000.00	-14.47
2849.473684	54.87	74.00	-19.13	359.00	1.35	Vertical	1000000.00	-14.13

Average (PASS) (10)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (HZ)	Correction (dB)
1000	45.35	54.00	-8.65	0.00	1.45	Vertical	1000000.00	-21.89
1050	47.83	54.00	-6.17	1.00	1.40	Vertical	1000000.00	-22.51
1150	44.97	54.00	-9.03	358.00	1.65	Vertical	1000000.00	-21.39
1200.263158	46.34	54.00	-7.66	32.00	1.65	Horizontal	1000000.00	-20.44
1350	45.83	54.00	-8.17	32.00	1.40	Vertical	1000000.00	-18.66
1423.157895	40.07	54.00	-13.93	337.00	1.00	Vertical	1000000.00	-18.76
1649.473684	31.36	54.00	-22.64	329.00	1.20	Vertical	1000000.00	-19.04
2410.263158	32.70	54.00	-21.30	158.00	1.00	Vertical	1000000.00	-15.12
2500	43.63	54.00	-10.37	357.00	1.00	Vertical	1000000.00	-14.47
2849.473684	35.89	54.00	-18.11	359.00	1.35	Vertical	1000000.00	-14.13

Note: Scan from 12-18 GHz was performed manually, no emissions were detected above the measuring equipment's noise floor.

18-40 GHz

Radiated Emissions

Company: Trex Enterprises
Model #: FODXFV2
Serial #: 003
Engineers: Vathana Ven
Project #: G104421478
Standard: 15.209
Receiver: R&S ESI (145-128) 10-01-2014
PreAmp: PRE8 Data 2020.txt
PreAmp Used? (Y or N): Y

Location: 10M
Date(s): 09/17/20
Limit Distance (m): 3
Test Distance (m): 3
Voltage/Frequency: 120VAC 60Hz

Antenna & Cables: SHF
Antenna: EMC04_1M_Hor_12-10-2020.txt
Cable(s): CBLHF2012-2M-1_2020 cable factors.txt
Barometer: DAV007
Temp/Humidity/Pressure: 23 deg C

Bands: N, LF, HF, SHF
EMC04_1M_Hor_12-10-2020.txt
CBL030_12_10_2020.txt
Filter: NONE
40% 1005 mB
Frequency Range: 18-40 GHz

Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)

Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth	FCC	IC
AVG	V	19897.100	19.88	45.12	9.30	20.69	0.00	53.62	54.00	-0.38	1/3 MHz	RB	RB

40-231 GHz

Radiated Emissions

Company: Trex Enterprises
Model #: FODXFV2
Serial #: 3
Engineers: Vathana Ven
Project #: G104421478
Standard: FCC Part 95M
Receiver: R&S FSW (ROS005-1) 10-15-2019
PreAmp: PRE8
PreAmp Used? (Y or N): N

Location: 10M
Date(s): 09/17/20
Limit Distance (m): 3
Test Distance (m): 0.25
Voltage/Frequency: 120VAC 60Hz

Antenna & Cables: SHF
Antenna: M19HWD, M12HWD, M08HWD, M05HWD, M04HWD
Cable(s): CBL030
Barometer: DAV007
Temp/Humidity/Pressure: 23 deg C 40% 1005 mB

Bands: N, LF, HF, SHF
Filter: NONE
Frequency Range: 40-231 GHz

Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)

Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency GHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Distance Factor dB	Net EIRP dB(m)	Net Power Density (pw/cm2)	Limit Power Density (pw/cm2)	Margin (pw/cm2)	Bandwidth	
Tx mode, E(dBuV/m) = P(dBm) + 104.77 – 20*LOG(d); where d is the distance of measurement in meters												
RMS	V	46.643	31.93	39.56	0.69	0.00	-23.05	4.38074	600.00	-595.62	1/3 MHz	Test at 3m
RMS	V	100.415	50.20	46.22	0.69	6.02	-4.13	341.62341	600.00	-258.38	1/3 MHz	Test at 1.5m
RMS	V	159.000	62.81	50.21	0.84	21.58	-2.94	448.93673	600.00	-151.06	1/3 MHz	Test at 0.25

Note: Hand scans were performed at a close distance around the EUT.

Test Personnel: Vathana Ven VJV
Supervising/Reviewing Engineer: (Where Applicable) N/A

Test Date: 09/17/2020, 09/18/2020 10/07/2020

Product Standard: CFR47 FCC Part 95, Subpart M
Input Voltage: 120VAC 60Hz

Limit Applied: See report section 8.3

Pretest Verification w/ Ambient Signals or BB Source: BB Source

Ambient Temperature: 23, 23, 24 ºC
Relative Humidity: 40, 40, 40 %
Atmospheric Pressure: 1005, 1005, 988 mbars

Deviations, Additions, or Exclusions: None

9 Frequency Stability

9.1 Method

The procedure described in Subclause 9.14 of ANSI C63.10-2013 and Subclause 5.6 of ANSI C63.26-2015 was utilized. The EUT shall be transmitting at its maximum data rate.

TEST SITE: Safety Lab

9.2 Test Equipment Used:

Equipment Used For Radiated Measurement

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007'	Weather Station Vantage Vue	Davis	6250	MS191212003	03/12/2020	03/12/2021
OML3'	Mixer / Antenna	Oleson Microwave Lab	M12HWD	E21011-1	06/18/2020	06/18/2021
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	10/10/2019	10/15/2020
CBL030	High Frequency Cable 40GHz	Megaphase	TM40 K1K1 80	CBL030	12/10/2019	12/10/2020
SAF187'	Small Temperature/Humidity Chamber	Bryant Manufacturing	TH-5S	1207	12/17/2019	12/17/2020

Software Utilized:

Name	Manufacturer	Version
None	--	--

9.3 Results:

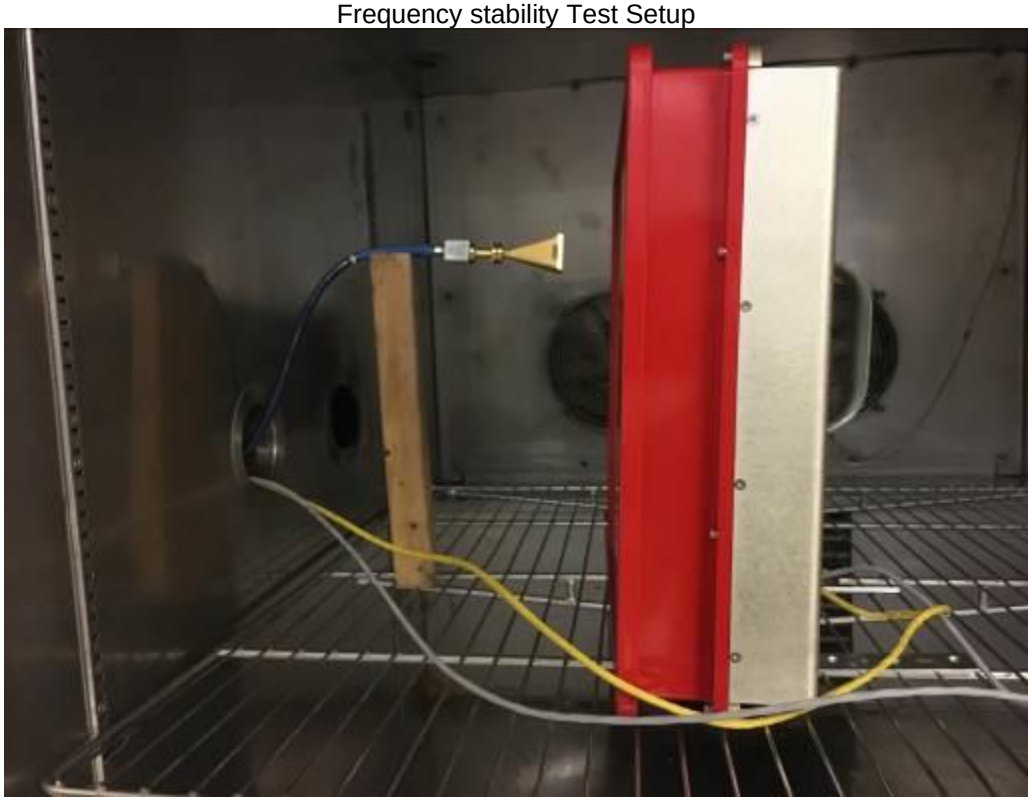
The sample tested was found to Comply.

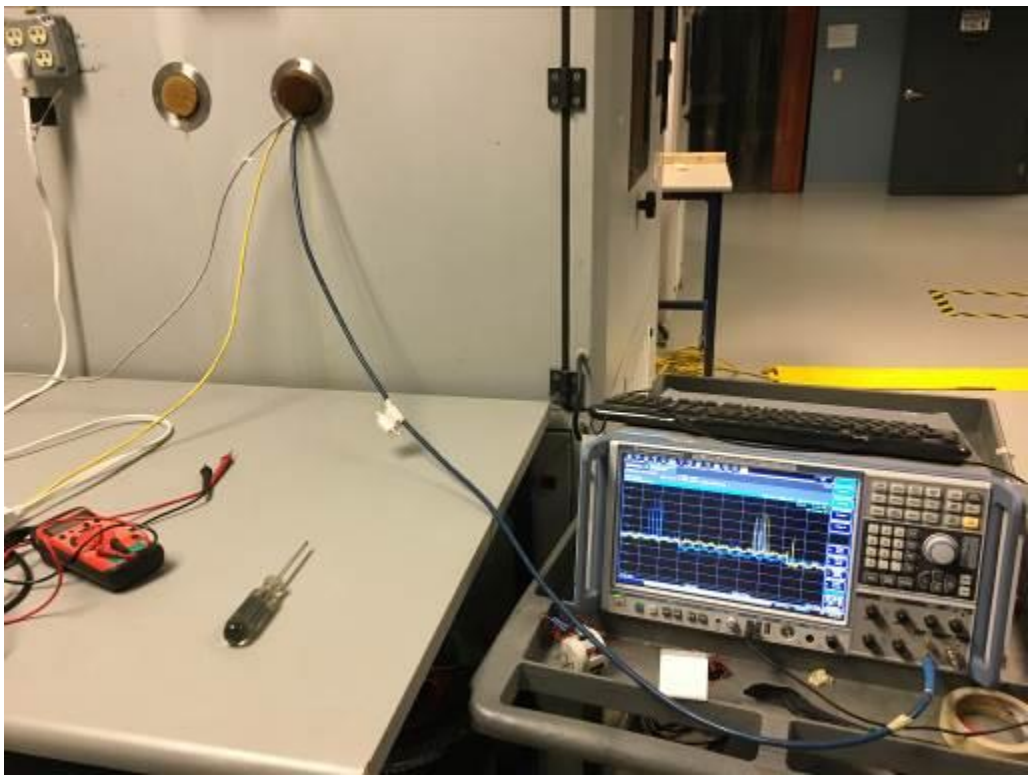
Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range −20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

The radar device's occupied bandwidth (i.e. 99% emission bandwidth) shall be maintained within the 76-81 GHz frequency band while subjected to all conditions of operation.

9.4 Setup Photograph:

Frequency stability Test Setup





9.5 Test Data:

Frequency Stability

Company: Trex Enterprises
Model #: FODXFV2
Serial #: 003
Engineer(s): Vathana Ven
Project #: G104421478 Date(s): 09/19/20
Standard: FCC PART 95M

Test Equipment Used:
ROS005-1 OML3 CBL030 DAV007
SAV187
Location: Safety

Nominal f: 78.002-80.998 GHz

Voltage: 120 VAC

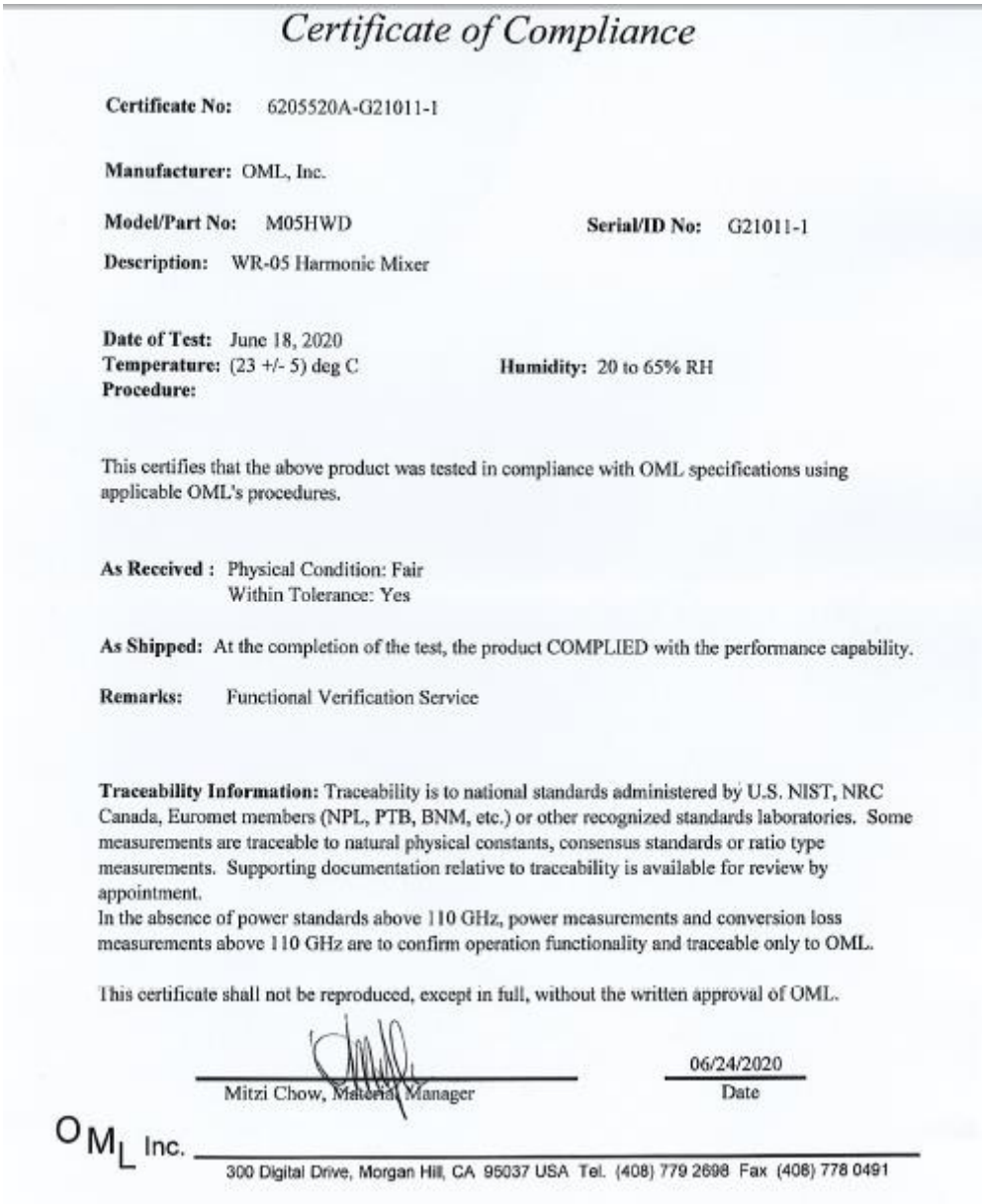
%	Voltage Volts	Frequency GHz
-15%	102	78.002-80.998
-10%	108	78.002-80.998
-5%	114	78.002-80.998
+0%	120	78.002-80.998
+5%	126	78.002-80.998
+10%	132	78.002-80.998
+15%	138	78.002-80.998

Temp Celsius	Lower Edge (GHz)	Upper Edge (GHz)	Limit GHz)
-20	78.021500	80.9186	76-81
-10	78.021500	80.9186	76-81
0	78.021500	80.9136	76-81
10	78.021600	80.7637	76-81
20	78.021600	80.7678	76-81
30	78.022600	80.7677	76-81
40	78.021500	80.9186	76-81
50	78.021500	80.9186	76-81

Test Personnel: Vathana Ven VSV
Test Date: 09/19/2020
Supervising/Reviewing Engineer: (Where Applicable) N/A
Product Standard: CFR47 FCC Part 95, Subpart M
Limit Applied: See report section 9.3
Input Voltage: 120VAC 60Hz
Pretest Verification w/ Ambient Signals or BB Source: BB Source
Ambient Temperature: 21 ºC
Relative Humidity: 57 %
Atmospheric Pressure: 1005 mbars

Deviations, Additions, or Exclusions: Testing was performed at normal and extreme temperature.

10 Appendix A – Mixer/Horn Calibration Certificates



Certificate of Compliance

Certificate No: 6205520A-G21011-1

Manufacturer: OML, Inc.

Model/Part No: M05HWD **Serial/ID No:** G21011-1

Description: WR-05 Harmonic Mixer

Date of Test: June 18, 2020
Temperature: (23 +/- 5) deg C **Humidity:** 20 to 65% RH
Procedure:

This certifies that the above product was tested in compliance with OML specifications using applicable OML's procedures.

As Received : Physical Condition: Fair
Within Tolerance: Yes

As Shipped: At the completion of the test, the product COMPLIED with the performance capability.

Remarks: Functional Verification Service

Traceability Information: Traceability is to national standards administered by U.S. NIST, NRC Canada, Euromet members (NPL, PTB, BNM, etc.) or other recognized standards laboratories. Some measurements are traceable to natural physical constants, consensus standards or ratio type measurements. Supporting documentation relative to traceability is available for review by appointment.
In the absence of power standards above 110 GHz, power measurements and conversion loss measurements above 110 GHz are to confirm operation functionality and traceable only to OML.

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Mitzi Chow, Material Manager — 06/24/2020 Date

OML Inc.
300 Digital Drive, Morgan Hill, CA 95037 USA Tel. (408) 779 2698 Fax (408) 778 0491

Certificate of Compliance

Certificate No: 6205520B-F21011-1

Manufacturer: OML, Inc.

Model/Part No: M08HWD **Serial/ID No:** F21011-1

Description: WR-08 Harmonic Mixer

Date of Test: June 18, 2020
Temperature: (23 +/- 5) deg C **Humidity:** 20 to 65% RH
Procedure:

This certifies that the above product was tested in compliance with OML specifications using applicable OML's procedures.

As Received : Physical Condition: Fair
Within Tolerance: Yes

As Shipped: At the completion of the test, the product COMPLIED with the performance capability.

Remarks: Functional Verification Service

Traceability Information: Traceability is to national standards administered by U.S. NIST, NRC Canada, Euromet members (NPL, PTB, BNM, etc.) or other recognized standards laboratories. Some measurements are traceable to natural physical constants, consensus standards or ratio type measurements. Supporting documentation relative to traceability is available for review by appointment.
In the absence of power standards above 110 GHz, power measurements and conversion loss measurements above 110 GHz are to confirm operation functionality and traceable only to OML.

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Mitzi Chow, Material Manager — 06/24/2020 Date

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Certificate of Compliance

Certificate No: 6205520C-E21011-1

Manufacturer: OML, Inc.

Model/Part No: M12HWD **Serial/ID No:** E21011-1

Description: WR-12 Harmonic Mixer

Date of Test: June 18, 2020
Temperature: (23 +/- 5) deg C **Humidity:** 20 to 65% RH
Procedure:

This certifies that the above product was tested in compliance with OML specifications using applicable OML's procedures.

As Received : Physical Condition: Good
Within Tolerance: Yes

As Shipped: At the completion of the test, the product COMPLIED with the performance capability.

Remarks: Functional Verification Service

Traceability Information: Traceability is to national standards administered by U.S. NIST, NRC Canada, Euromet members (NPL, PTB, BNM, etc.) or other recognized standards laboratories. Some measurements are traceable to natural physical constants, consensus standards or ratio type measurements. Supporting documentation relative to traceability is available for review by appointment.
In the absence of power standards above 110 GHz, power measurements and conversion loss measurements above 110 GHz are to confirm operation functionality and traceable only to OML.

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Mitzi Chow, Material Manager — 06/24/2020 Date

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Certificate No: 6205520D-U21011-1

Manufacturer: OML, Inc.

Model/Part No: M19HWD **Serial/ID No:** U21011-1

Description: WR-19 Harmonic Mixer

Date of Test: June 18, 2020
Temperature: (23 +/- 5) deg C **Humidity:** 20 to 65% RH
Procedure:

This certifies that the above product was tested in compliance with OML specifications using applicable OML's procedures.

As Received : Physical Condition: Good
Within Tolerance: Yes

As Shipped: At the completion of the test, the product COMPLIED with the performance capability.

Remarks: Functional Verification Service

Traceability Information: Traceability is to national standards administered by U.S. NIST, NRC Canada, Euromet members (NPL, PTB, BNM, etc.) or other recognized standards laboratories. Some measurements are traceable to natural physical constants, consensus standards or ratio type measurements. Supporting documentation relative to traceability is available for review by appointment.
In the absence of power standards above 110 GHz, power measurements and conversion loss measurements above 110 GHz are to confirm operation functionality and traceable only to OML.

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Mitzi Chow, Material Manager — 06/24/2020 Date

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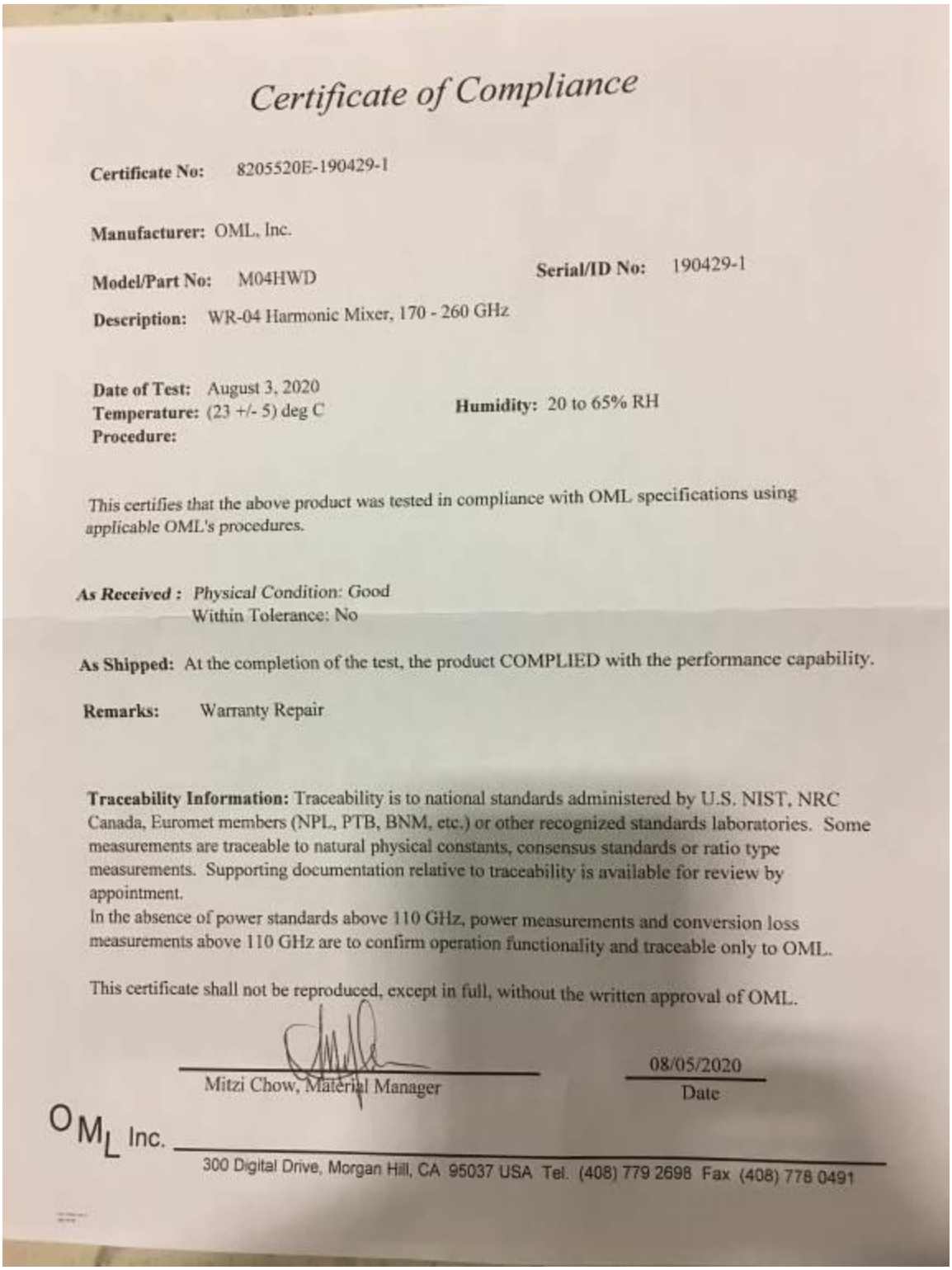

Certificate of Compliance

Certificate No: 8205520E-190429-1

Manufacturer: OML, Inc.

Model/Part No: M04HWD **Serial/ID No:** 190429-1

Description: WR-04 Harmonic Mixer, 170 - 260 GHz

Date of Test: August 3, 2020
Temperature: (23 +/- 5) deg C **Humidity:** 20 to 65% RH
Procedure:

This certifies that the above product was tested in compliance with OML specifications using applicable OML's procedures.

As Received : *Physical Condition: Good*
Within Tolerance: No

As Shipped: At the completion of the test, the product COMPLIED with the performance capability.

Remarks: Warranty Repair

Traceability Information: Traceability is to national standards administered by U.S. NIST, NRC Canada, Euromet members (NPL, PTB, BNM, etc.) or other recognized standards laboratories. Some measurements are traceable to natural physical constants, consensus standards or ratio type measurements. Supporting documentation relative to traceability is available for review by appointment.
In the absence of power standards above 110 GHz, power measurements and conversion loss measurements above 110 GHz are to confirm operation functionality and traceable only to OML.

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Mitzi Chow, Material Manager — 08/05/2020 Date

OML Inc.
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11 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	10/15/2020	104421478BOX-001	VFV	KPS	Original Issue
1	12/22/2020	104421478BOX-001	VFV	MFM	Corrected typo on page 18. Changed 20cm to 3m.