

FCC/ICES Test Report

Report No.: EMC_SL20072701-SIX-001_FCC

Product: 3G/4G & LTE Base HAT

Received Date: 9/10/2020

Test Date: 9/10/2020/, 9/11/2020

Issued Date: 9/15/2020

Applicant: Sixfab, Inc.

Address: 75 E. Santa Clara St., 6th Floor San Jose, CA 95113

Manufacturer: Sixfab, Inc.

Address: 75 E. Santa Clara St., 6th Floor San Jose, CA 95113

Issued By: Bureau Veritas Consumer Products Services, Inc.

Lab Address: 775 Montague Expressway, Milpitas, CA 95035, USA

Test Location(1): 775 Montague Expressway, Milpitas, CA 95035, USA

**FCC/ IC Test
Site Number:** 540430/4842D



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Release Control Record

Issue No.	Description	Date Issued
EMC_SL20072701-SIX-001_FCC	Original Release	9/15/2020

1 Certificate of Conformity

Product: 3G/4G & LTE Base HAT

Brand: Sixfab, Inc.

Test Model: N/A

Sample Status: Test Sample

Applicant: Sixfab, Inc.

Test Date: 9/10/2020/, 9/11/2020

Standards: 47 CFR FCC Part 15, Subpart B, Class B
ICES-003:2016 Issue 6, Class B
ANSI C63.4:2014

The above equipment has been tested by Bureau Veritas Consumer Products Services, Inc. Milpitas Branch, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

Prepared by : Alok Patel, **Date:** 9/15/2020
Alok Patel, Electrical Test Engineer

Approved by : George Hsu, **Date:** 9/21/2020
George Hsu, Lead EMC Test Engineer

2 Summary of Test Results

47 CFR FCC Part 15, Subpart B / ICES-003:2016 Issue 6, Class B

ANSI C63.4:2014

FCC Clause	ICES-003 Clause	Test Item	Result/Remarks	Verdict
15.107	6.1	AC Power Line Conducted Emissions	Minimum passing Class B margin is -15.87 dB at 0.502329 MHz	Pass
15.109	6.2.1	Radiated Emissions up to 1 GHz	Minimum passing Class B margin is 3.2 dB at 32.99 MHz	Pass
	6.2.2	Radiated Emissions above 1 GHz	Minimum passing Class B margin is 11.7 dB at 17386.84 MHz	Pass

Note:

1. There is no deviation to the applied test methods and requirements covered by the scope of this report
2. Please note for conducted emissions passing values are expressed as negative values while for radiated emissions passing values are expressed as positive values.

2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT:

Measurement	Frequency	Expanded Uncertainty (k=2) (±)
Conducted Emissions at mains ports	150kHz ~ 30MHz	3.856 dB
Radiated Emissions up to 1 GHz	30MHz ~ 1GHz	4.638 dB
Radiated Emissions above 1 GHz	Above 1GHz	4.580dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 Description of EUT

Product	3G/4G & LTE Base HAT
Brand	Sixfab, Inc.
Test Model	N/A
Identification No. of EUT	S121
Sample Status	Test Sample
Operating Software	Debian, Raspbian OS, Mendel Linux, Linux4Tegra, Linux
Power Supply Rating	5.1 Vdc, 3.0A via AC adapter

3.2 Features of EUT

The tests reported herein were performed according to the method specified by Sixfab, Inc., for detailed feature description, please refer to the manufacturer's specifications or user's manual.

3.3 Operating Modes of EUT and Determination of Worst Case Operating Mode

Mode	Test Condition
1	Normal Operation

Test modes are presented in the report as below.

Mode	Test Condition
All Tests	
1	Normal Operation

3.4 Test Program Used and Operational Description

The Sixfab 3G/4G & LTE Base HAT grants your Raspberry Pi or 40-pin Pi compatible single-board-computer a simple data interface bridge between mini PCIe cellular modems. With the modems you insert into Base HAT, your Raspberry Pi based projects will access data networks all around the world. This Base HAT enables high-bandwidth cellular connectivity on your remote devices. From low-power consumption LTE-M to ultra-high-speed LTE-Advanced mini PCIe cards supported by this HAT.

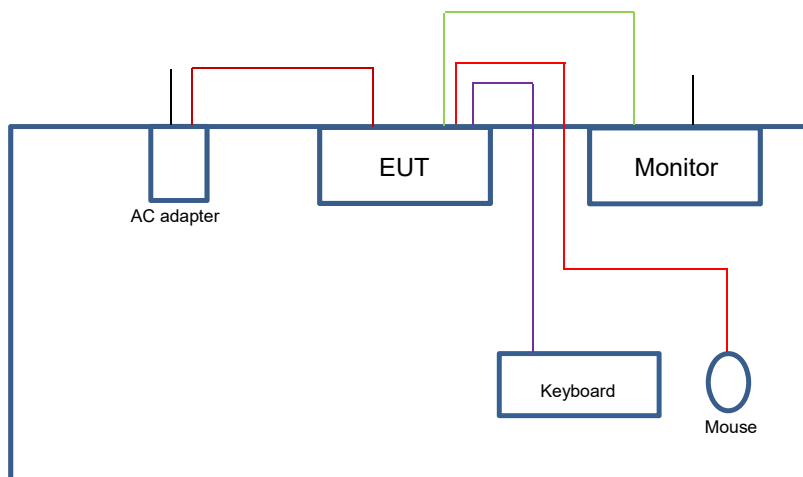
3.5 Primary Clock Frequencies of Internal Source

The highest frequency generated or used within the EUT or on which the EUT operates or tunes is 2400 MHz, provided by Sixfab, Inc., for detailed internal source, please refer to the manufacturer's specifications.

4 Configuration and Connections with EUT

4.1 Connection Diagram of EUT and Peripheral Devices

USB Keyboard ———
 USB Mouse ———
 Adapter cable ———
 Micro HDMI ———
 AC Power cable ———



4.2 Configuration of Peripheral Devices and Cable Connections

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Monitor	Acer	G276HL	MMLW9AA01394204B8B85C6	DOC	Provided by lab
B.	Monitor Power Supply	Liteon	PA-1450-26	ADT KP045030107201F23FPE01	N/A	Provided by lab
C.	Keyboard	Logitech	Y-U0011	N/A	DOC	Provided by lab
D.	Mouse	Microsoft	1088	N/A	N/A	Provided by lab

Note:

1. All power cords of the above support units are non-shielded (1.8m).

ID	Description	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	Keyboard Cable	1	1.82	Yes	0	Provided by lab
2.	Mouse Cable	1	1.82	Yes	0	Provided by lab
3.	Micro HDMI	1	1.82	Yes	0	Provided by lab
4.	Adapter Cable	1	1.5	Yes	0	Supplied by client

Note: The ferrite core(s) is(are) originally attached to the cable(s).

5 Conducted Emissions at Mains Ports

5.1 Limits

Frequency (MHz)	Class A (dBuV)		Class B (dBuV)	
	Quasi-peak	Average	Quasi-peak	Average
0.15 - 0.5	79	66	66 - 56	56 - 46
0.50 - 5.0	73	60	56	46
5.0 - 30.0	73	60	60	50

Notes: 1. The lower limit shall apply at the transition frequencies.

2. The limit decreases linearly with the logarithm of the frequency in the range of 0.15 to 0.50 MHz.

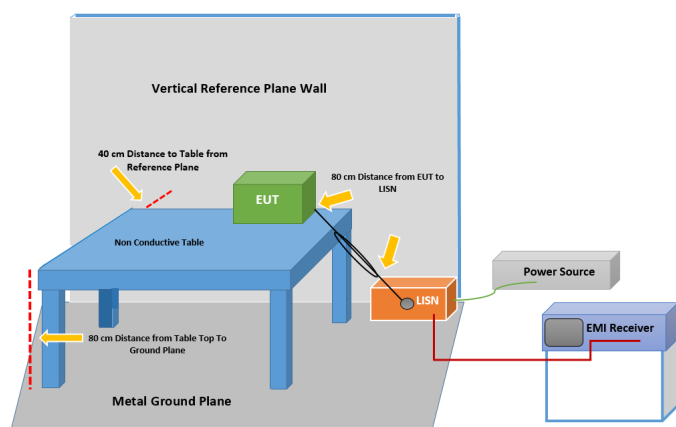
5.2 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due
EMI Test Receiver Rohde & Schwarz	ESIB 40	100179	11/01/2019	11/01/2020
Transient Limiter Electro-Metrics	EM-7600-5	106	12/31/2019	12/31/2020
LISN ETS-Lindgren	3816/2NM	214372	1/14/2020	1/14/2021

5.3 Test Arrangement

- The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
- Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
- The test results of conducted emissions at mains ports are recorded of six worst margins for quasi-peak (mandatory) [and average (if necessary)] values against the limits at frequencies of interest unless the margin is 20 dB or greater.

Note: The resolution bandwidth and video bandwidth of test receiver is 9 kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15MHz-30MHz.



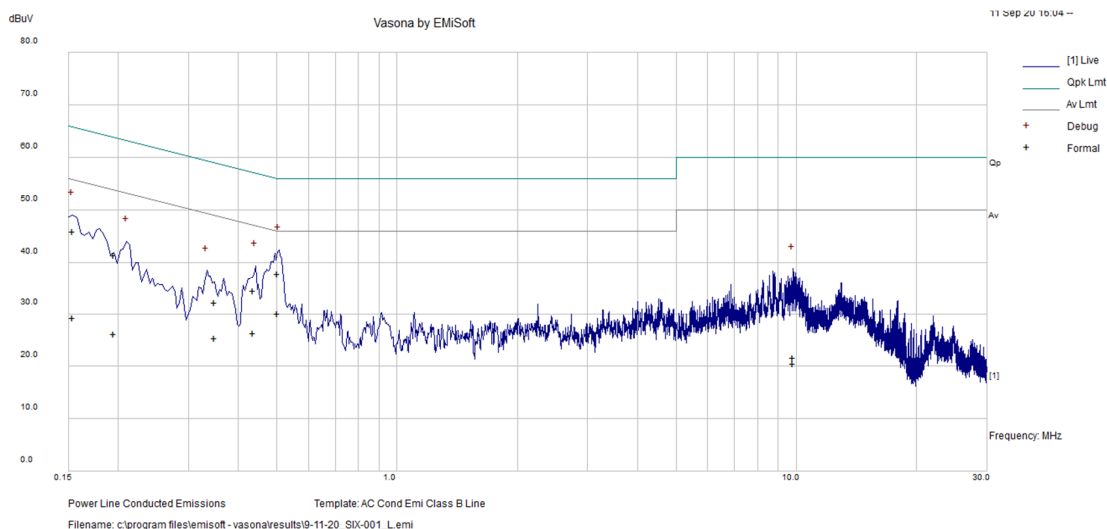
5.4 Test Results

Frequency Range	0.15-30 MHz	Phase	Line
Input Power	120 Vac, 60 Hz	Environmental Conditions	24 °C, 40% RH
Tested by	Alok Patel	Test Date	9/11/2020
Test Mode	Normal operation		

No	Frequency (MHz)	Reading Value (dBuV)	Cable Loss (dB)	Insertion Loss (dB)	Emission Level Corrected (dBuV)	Measurement Type	Line/Neutral	Limit (dBuV)	Margin (dB)	Pass/Fail
1	0.502329	28.3	9.45	0.04	37.79	Quasi Peak	Line	56	-18.21	Pass
2	0.154353	36.62	9.3	0.04	45.96	Quasi Peak	Line	65.76	-19.8	Pass
3	0.43717	24.9	9.45	0.04	34.38	Quasi Peak	Line	57.12	-22.73	Pass
4	0.195222	31.95	9.36	0.04	41.36	Quasi Peak	Line	63.81	-22.46	Pass
5	0.350297	22.69	9.44	0.04	32.17	Quasi Peak	Line	58.96	-26.79	Pass
6	9.823703	11.73	9.62	0.24	21.6	Quasi Peak	Line	60	-38.4	Pass
7	0.502329	20.64	9.45	0.04	30.13	Average	Line	46	-15.87	Pass
8	0.154353	19.94	9.3	0.04	29.28	Average	Line	55.76	-26.48	Pass
9	0.43717	16.92	9.45	0.04	26.41	Average	Line	47.12	-20.7	Pass
10	0.195222	16.84	9.36	0.04	26.24	Average	Line	53.81	-27.57	Pass
11	0.350297	15.96	9.44	0.04	25.45	Average	Line	48.96	-23.51	Pass
12	9.823703	10.59	9.62	0.24	20.46	Average	Line	50	-29.54	Pass

Remarks:

1. The emission levels of other frequencies were very low against the limit.
2. Margin value = Emission level – Limit value
3. Correction factor = Insertion loss + Cable loss
4. Emission Level = Correction Factor + Reading Value

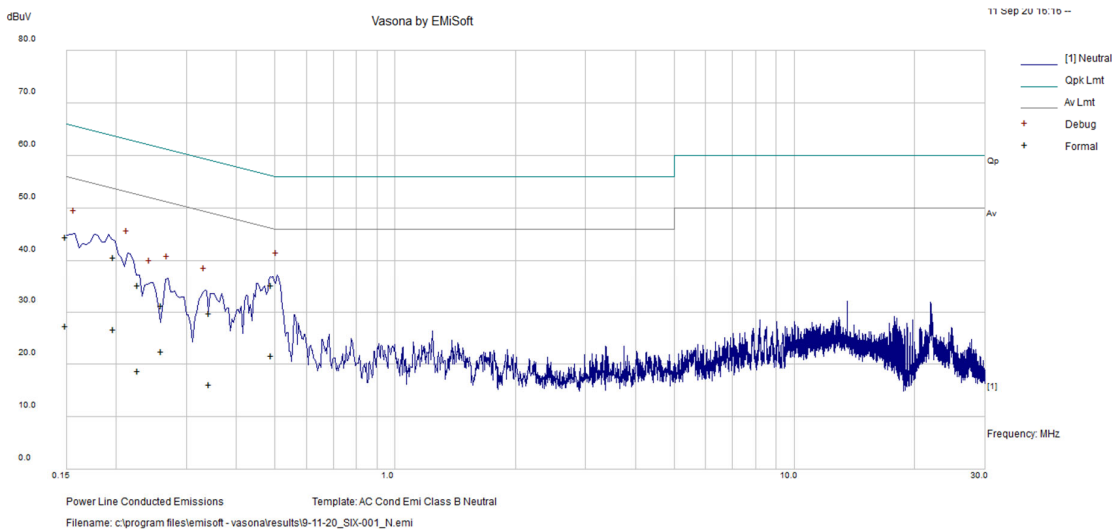


Frequency Range	0.15-30 MHz	Phase	Neutral
Input Power	120 Vac, 60 Hz	Environmental Conditions	24 °C, 40% RH
Tested by	Alok Patel	Test Date	9/11/2020
Test Mode	Normal operation		

No	Frequency (MHz)	Reading Value (dBuV)	Cable Loss (dB)	Insertion Loss (dB)	Emission Level Corrected (dBuV)	Measurement Type	Line/Neutral	Limit (dBuV)	Margin (dB)	Pass/Fail
1	0.490786	25.58	9.45	0.03	35.06	Quasi Peak	Neutral	56.15	-21.09	Pass
2	0.15	35.22	9.29	0.03	44.54	Quasi Peak	Neutral	66	-21.46	Pass
3	0.197375	31.16	9.37	0.03	40.56	Quasi Peak	Neutral	63.72	-23.16	Pass
4	0.259527	21.74	9.43	0.03	31.21	Quasi Peak	Neutral	61.45	-30.24	Pass
5	0.342938	20.35	9.44	0.03	29.82	Quasi Peak	Neutral	59.13	-29.31	Pass
6	0.226641	25.58	9.41	0.03	35.02	Quasi Peak	Neutral	62.57	-27.55	Pass
7	0.490786	12.18	9.45	0.03	21.66	Average	Neutral	46.15	-24.49	Pass
8	0.15	18.05	9.29	0.03	27.37	Average	Neutral	56	-28.63	Pass
9	0.197375	17.29	9.37	0.03	26.69	Average	Neutral	53.72	-27.03	Pass
10	0.259527	12.96	9.43	0.03	22.42	Average	Neutral	51.45	-29.03	Pass
11	0.342938	6.72	9.44	0.03	16.19	Average	Neutral	49.13	-32.94	Pass
12	0.226641	9.26	9.41	0.03	18.7	Average	Neutral	52.57	-33.87	Pass

Remarks:

1. The emission levels of other frequencies were very low against the limit.
2. Margin value = Emission level – Limit value
3. Correction factor = Insertion loss + Cable loss
4. Emission Level = Correction Factor + Reading Value



6 Radiated Emissions up to 1 GHz

6.1 Limits

Emissions radiated outside of the specified bands, shall be according to the general radiated limits as following:

Showing:

Radiated Emissions Limits at 10 meters (dBµV/m)				
Frequencies (MHz)	FCC 15B / ICES-003, Class A	FCC 15B / ICES-003, Class B	CISPR 22, Class A	CISPR 22, Class B
30-88	39	29.5	40	30
88-216	43.5	33		
216-230	46.4	35.5		
230-960			47	37
960-1000	49.5	43.5		

Radiated Emissions Limits at 3 meters (dBμV/m)				
Frequencies (MHz)	FCC 15B / ICES-003, Class A	FCC 15B / ICES-003, Class B	CISPR 22, Class A	CISPR 22, Class B
30-88	49.6	40	50.5	40.5
88-216	54	43.5		
216-230	56.9	46		
230-960			57.5	47.5
960-1000	60	54		

- Notes: 1. The lower limit shall apply at the transition frequencies.
2. Emission level (dB μ V/m) = 20 log Emission level (μ V/m).
3. QP detector shall be applied if not specified.

6.2 Test Instruments

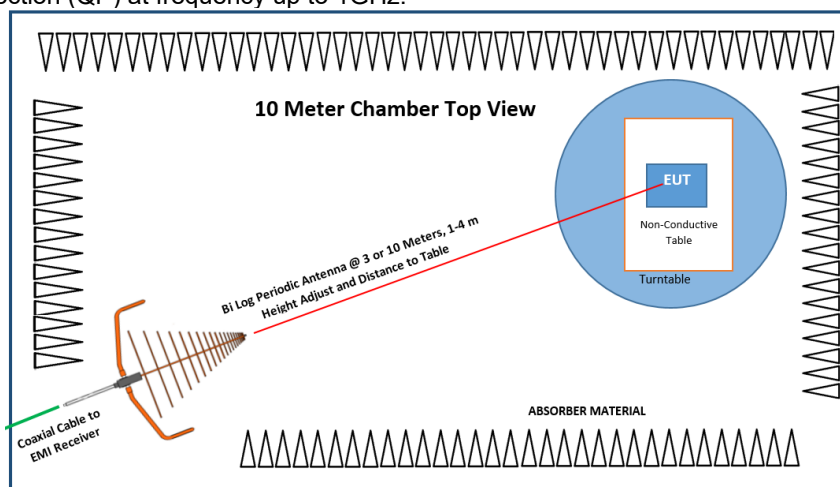
Description & Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due
EMI Receiver Keysight	N9038A	MY55330108	07/07/2020	07/07/2021
Biconilog Antenna Sunol	JB6	A111717	08/27/2019	11/27/2020*
Pre-Amplifier RF Bay, Inc.	LPA-6-30	11170601	4/27/2020	4/27/2021

*Calibration extended by three months.

6.3 Test Arrangement

- The EUT was placed on the top of a rotating table 0.8 meters above the ground at an accredited test facility. The table was rotated 360 degrees to determine the position of the highest radiation.
- The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is up to 1 GHz.

Note: The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for quasi-peak detection (QP) at frequency up to 1GHz.



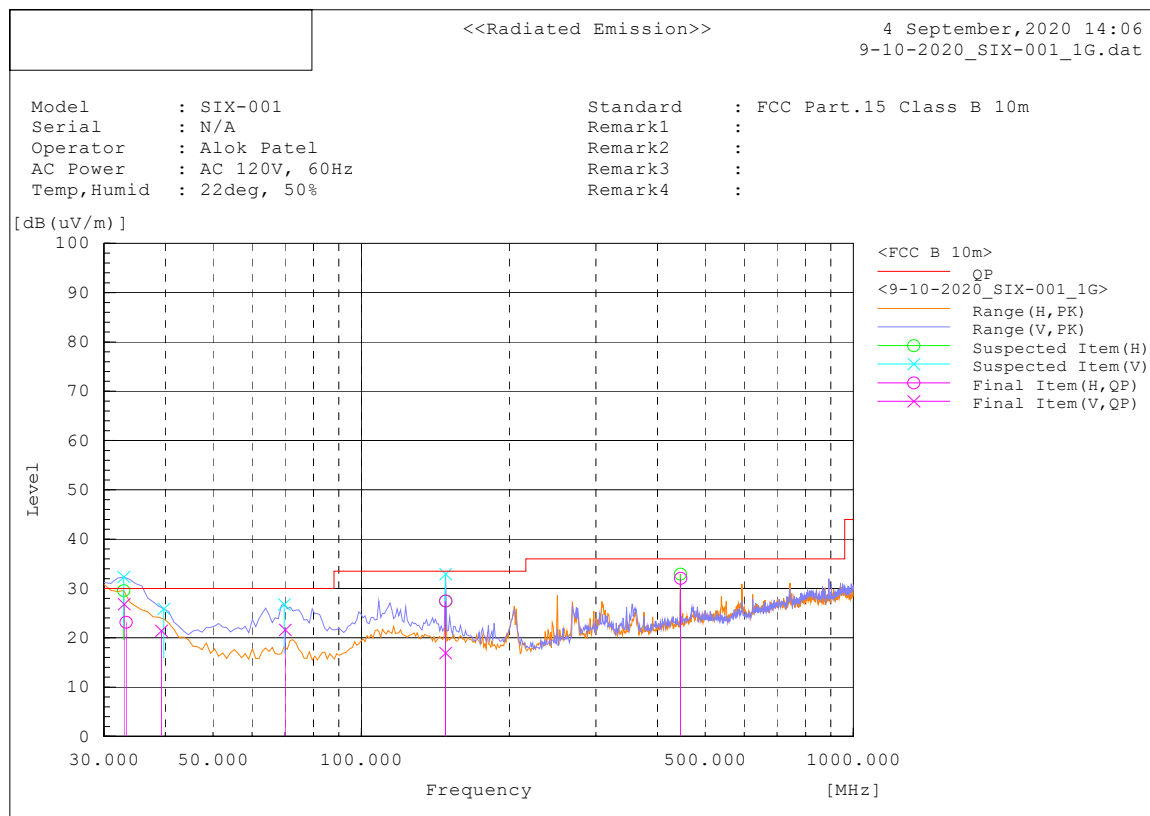
6.4 Test Results

Frequency Range	30-1000 MHz		
Input Power	120 Vac, 60 Hz	Environmental Conditions	22 °C, 50% RH
Tested by	Alok Patel	Test Date	9/10/2020
Test Mode	Normal Operation		

Antenna Polarity & Test Distance: Vertical and Horizontal at 10m										
No.	Frequency (MHz)	Polarization (H/V)	Reading QP [dB(uV)]	Factor [dB(1/m)]	Level QP [dB(uV/m)]	Limit\QP dB(uV/m)	Margin QP [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	32.99	V	41.4	-14.6	26.8	30	3.2	100	0	Pass
2	33.292	H	37.7	-14.6	23.1	30	6.9	379	0	Pass
3	39.258	V	40.4	-19	21.4	30	8.6	100	225.8	Pass
4	70.066	V	47.9	-26.3	21.6	30	8.4	255	83.1	Pass
5	148.42	V	39.5	-22.6	16.9	33.5	16.6	100	205.9	Pass
6	148.504	H	49.9	-22.4	27.5	33.5	6	399	281	Pass
7	445.512	H	49.3	-17.2	32.1	36	3.9	337	146.6	Pass

Remarks:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB)
3. Margin = Limit value(dBuV/m) - Level (dBuV/m)



7 Radiated Emissions above 1 GHz

7.1 Limits

Emissions radiated outside of the specified bands, shall be according to the general radiated limits as following:

Radiated Emissions Limits at 3 meters (dB μ V/m)				
Frequencies (MHz)	FCC 15B / ICES-003, Class A	FCC 15B / ICES-003, Class B	CISPR 22, Class A	CISPR 22, Class B
1000-3000	Avg: 60 Peak: 80	Avg: 54 Peak: 74	Avg: 56 Peak: 76	Avg: 50 Peak: 70
Above 3000			Avg: 60 Peak: 80	Avg: 54 Peak: 74

- Notes:
1. The lower limit shall apply at the transition frequencies.
 2. Emission level (dB μ V/m) = 20 log Emission level (μ V/m).
 3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

Frequency Range (For unintentional radiators)

Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	Upper frequency of measurement range (MHz)
Below 1.705	30
1.705-108	1000
108-500	2000
500-1000	5000
Above 1000	5th harmonic of the highest frequency or 40GHz, whichever is lower

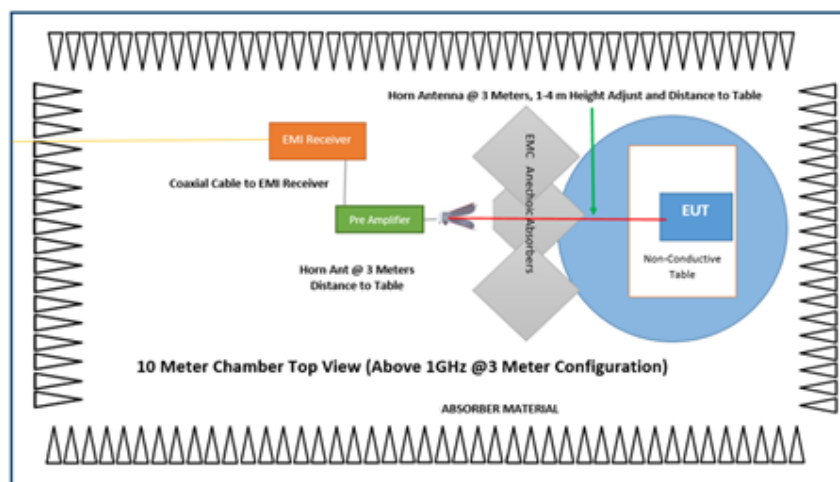
7.2 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due
EMI Receiver Keysight	N9038A	MY55330108	07/07/2020	07/07/2021
Horn Antenna ETS-Lindgren	3117	218553	11/20/2019	11/20/2020
Pre-Amplifier RF-Lambda	RAMP00M50GA	18040300055	10/01/2019	10/01/2020

7.3 Test Arrangement

- The EUT was placed on the top of a rotating table 0.8 meters above the ground at an accredited chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
- The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- The height of antenna can be varied from one meter to four meters, the height of adjustment depends on the EUT height and the antenna 3dB beamwidth both, to detect the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- The spectrum analyzer system was set to peak and average detects function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz.

Note: The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and video bandwidth is 3MHz for Peak detection (PK) at frequency above 1GHz. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz for Average detection (AV) at frequency above 1GHz.



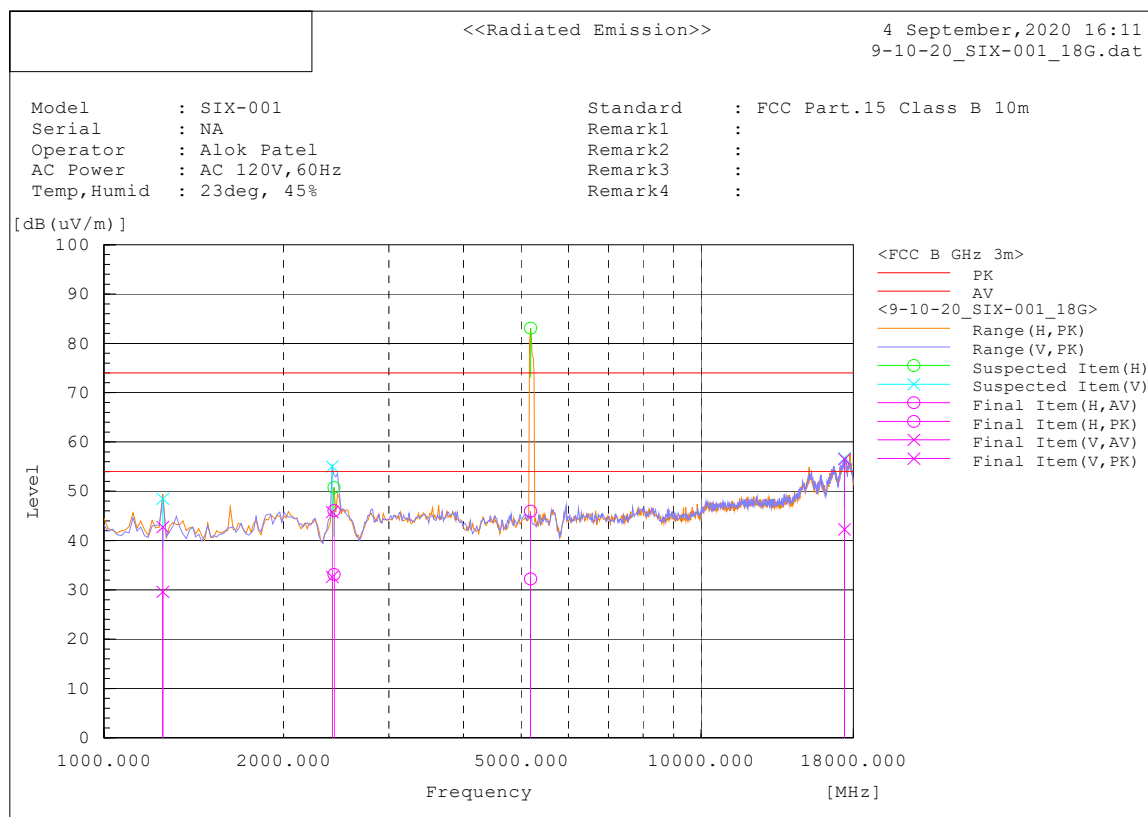
7.4 Test Results

Frequency Range	1000-18000 MHz		
Input Power	120 Vac, 60 Hz	Environmental Conditions	22 °C, 50% RH
Tested by	Alok Patel	Test Date	9/10/2020
Test Mode	Normal Operation		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	1254.941	V	39.3	52.5	-9.7	29.6	42.8	54	74	24.4	31.2	373	51.4	Pass
2	2412.272	V	38.3	51.5	-5.7	32.6	45.8	54	74	21.4	28.2	384	341.3	Pass
3	2429.213	H	38.9	51.8	-5.7	33.2	46.1	54	74	20.8	27.9	387	190.8	Pass
4	5181.929	H	33.7	47.5	-1.5	32.2	46	54	74	21.8	28	244	201.1	Pass
5	17386.84	V	22.4	36.6	19.9	42.3	56.5	54	74	11.7	17.5	100	79.6	Pass

Remarks:

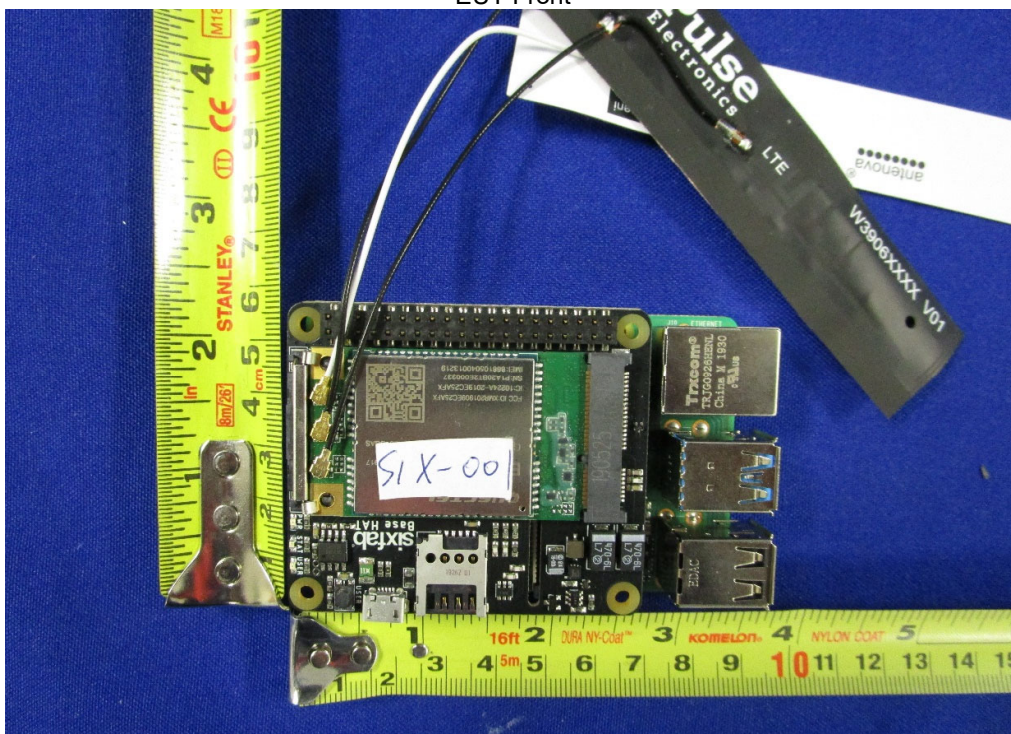
1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) -Preamplifier Gain (dB)
3. Margin = Limit value(dBuV/m) - Level (dBuV/m)



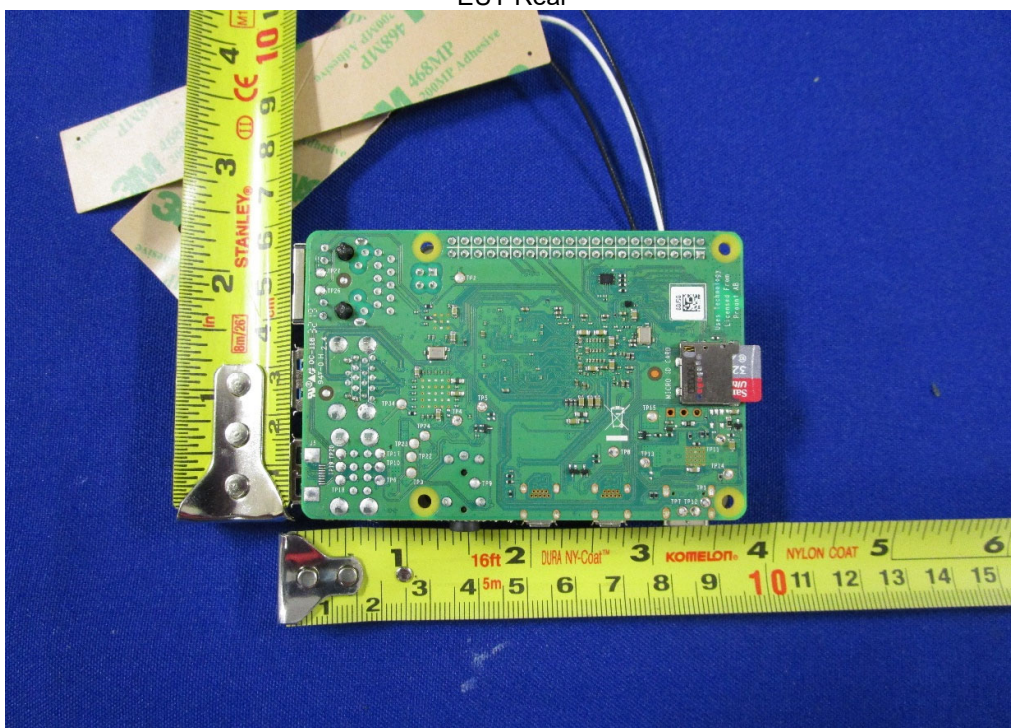
8 Pictures of Test Arrangements

8.1 EUT Photos

EUT Front

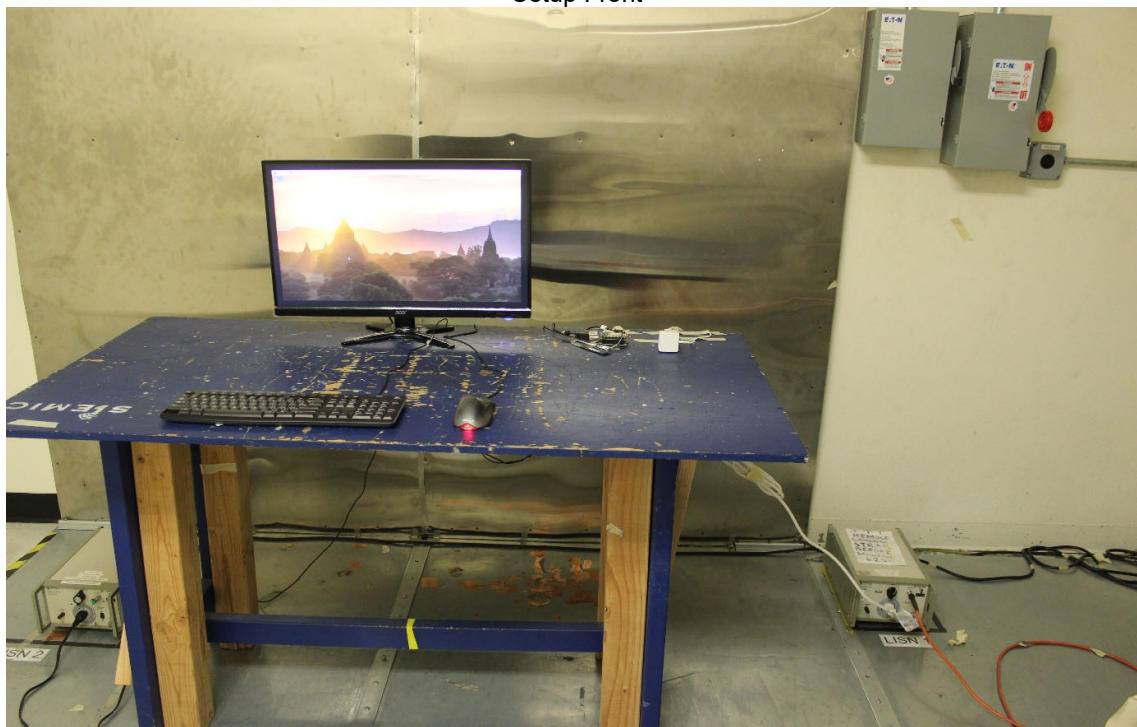


EUT Rear



8.2 Conducted Emissions at Mains Ports

Setup Front

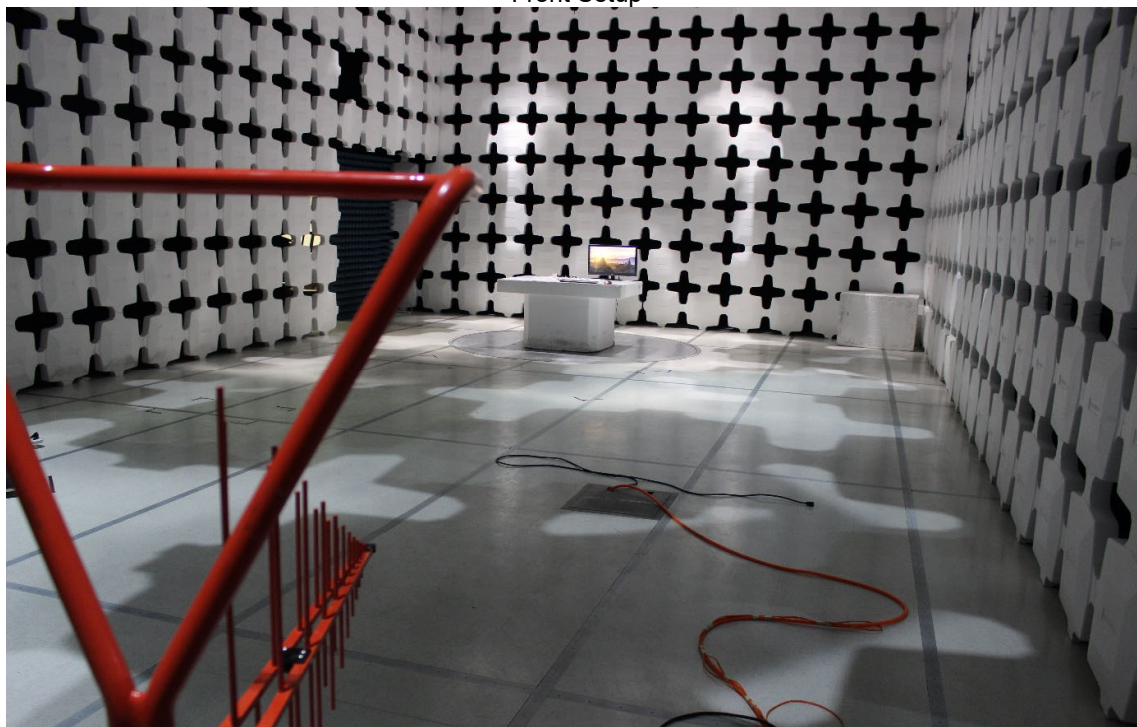


Setup Rear

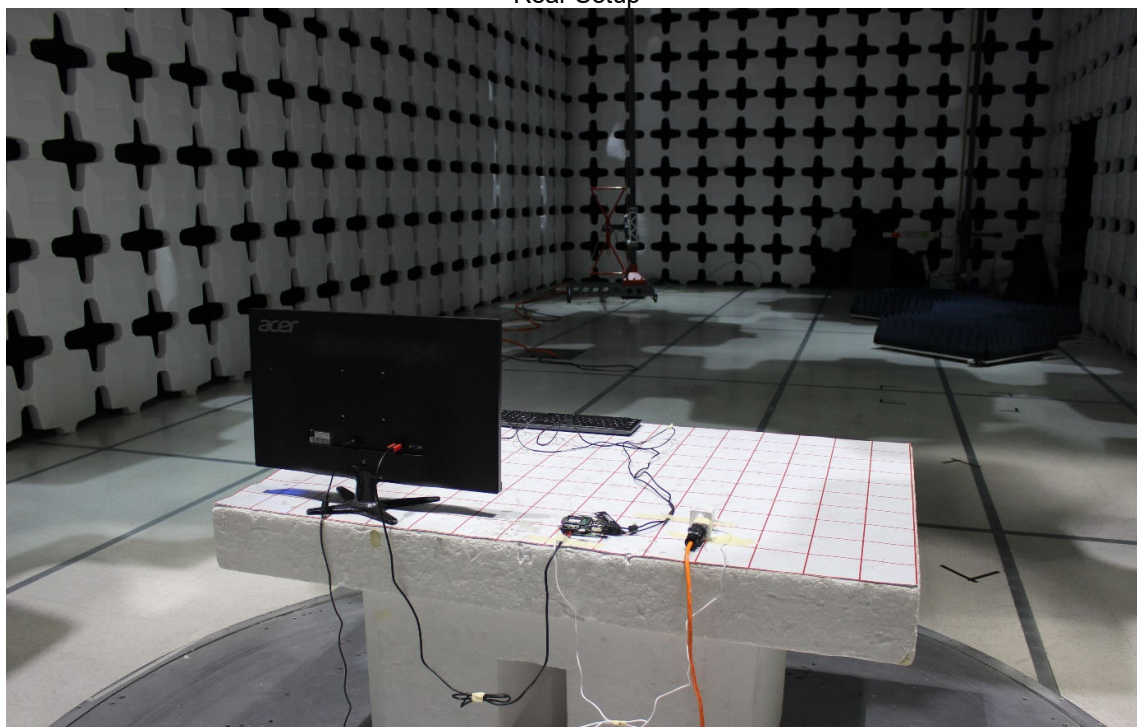


8.3 Radiated Emissions up to 1 GHz

Front Setup

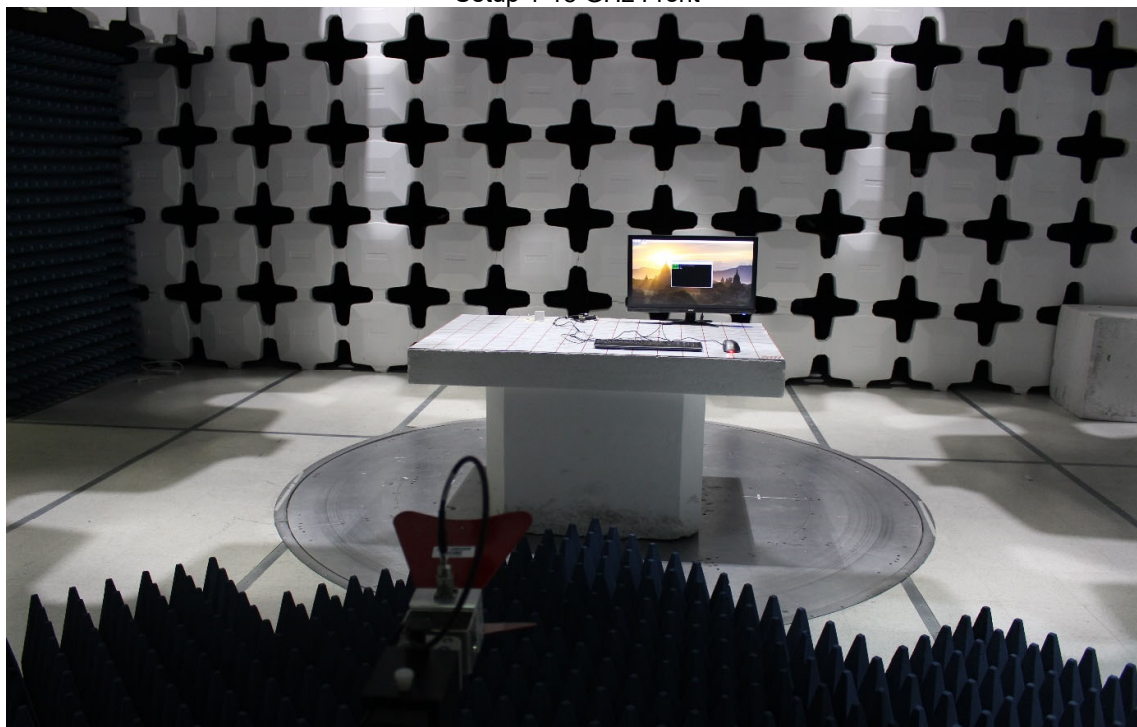


Rear Setup

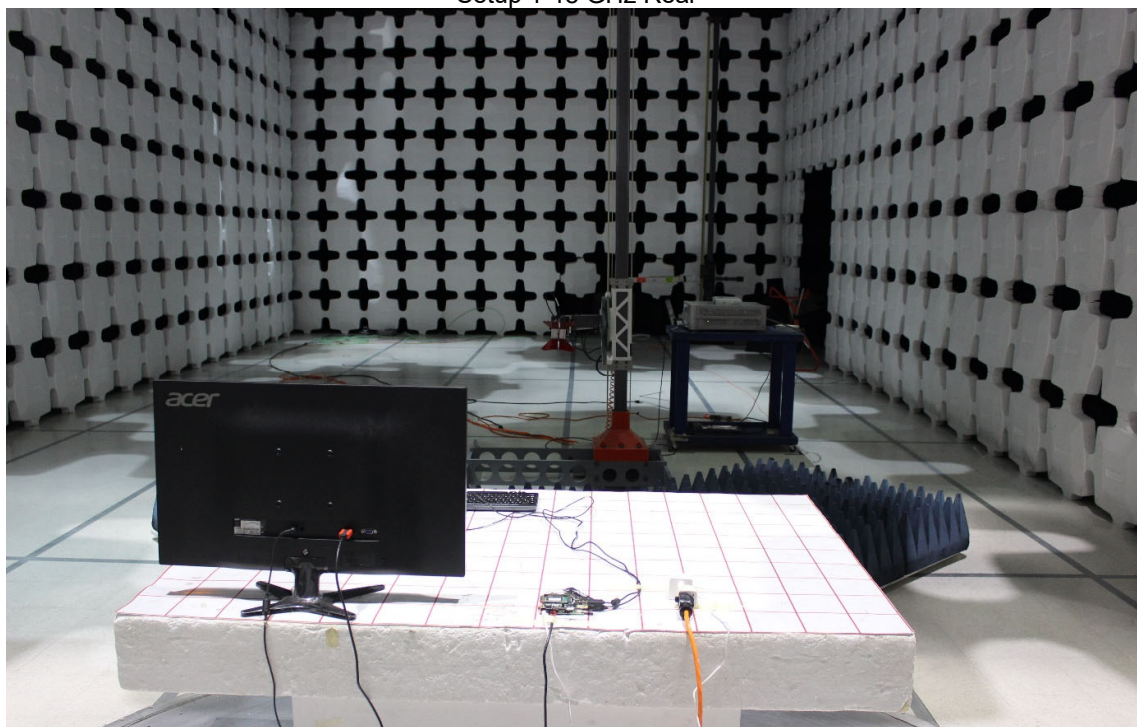


8.4 Radiated Emissions above 1 GHz

Setup 1-18 GHz Front



Setup 1-18 GHz Rear



Appendix – Information of the Testing Laboratories

Bureau Veritas is a global leader in testing, inspection and certification (TIC) services. We help businesses improve safety, sustainability and productivity; and our clients include the majority of leading brands in retail, manufacturing and other industries. With a presence in every major country around the world, our quality assurance and compliance solutions are vital in helping our customers enhance product quality and concept-to-consumer journeys. We also assist with increasing speed to market, profitability and brand equity throughout the supply chain. Bureau Veritas is a leading wireless/IoT testing, inspection, audit and certification provider, with a global network of test laboratories to support the IoT industry in areas of connectivity, security, interoperability as well as quality, health & safety, and environmental/chemical requirements.

If you have any comments, please feel free to contact us at the following:

Milpitas EMC/RF/Safety/Telecom Lab

775 Montague Expressway, Milpitas, CA 95035

Tel: +1 408 526 1188

Sunnyvale OTA/Bluetooth Lab

1293 Anvilwood Avenue, Sunnyvale, CA 94089

Tel: +1 669 600 5293

Littleton EMC/RF/Safety/Environmental Lab

1 Distribution Center Cir #1, Littleton, MA 01460

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The address and road map of all our labs can also be found on our web site.

--- End of Test Report ---