Patroness, LLC
TEST REPORT

SCOPE OF WORK
EMISSIONS TESTING – MODEL P003110

REPORT NUMBER
103842901BOX-013

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24-January-2020

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Non-Specific Radio Report Shell Rev. December 2017

EMISSIONS TEST REPORT

(FULL COMPLIANCE)

Report Number: 103842901BOX-013
Project Number: G103842901

Report Issue Date: 09/04/2019
Revised Date: 10/16/2019
Revision Date: 01/15/2020
Revision Date: 01/24/2020

Model(s) Tested: P003110
Model(s) Partially Tested: None
Model(s) Not Tested but declared equivalent by the client: None

Standards: FCC 47CFR Part 95, Subpart M:09/2019
RSS-251 Issue 2: 07/2018
RSS Gen Issue 5 March 2019 Amendment 1
RSS-102 Issue 5 March 2015

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

Client:
Patroness, LLC
101 Creekside Crossing
Suite 1700 #244
Brentwood, TX 37027
USA

Report prepared by

Vathana Ven/EMC Staff Engineer

Report reviewed by

Kouma Sinn/EMC Staff Engineer

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:09/2019 RSS-251 Issue 2: 07/2018, ANSI C63.10:2013, RSS-102 Issue 5 March 2015	Pass
7	Occupied Bandwidth FCC 47CFR Part 95, Subpart M:09/2019 RSS-251 Issue 2: 07/2018, RSS Gen Issue 5 March 2019 Amendment 1, ANSI C63.10:2013	Pass
8	Unwanted Emissions FCC 47CFR Part 95, Subpart M:09/2019 RSS-251 Issue 2: 07/2018, RSS Gen Issue 5 March 2019 Amendment 1 , ANSI C63.10:2013	Pass
9	Frequency Stability FCC 47CFR Part 95, Subpart M:09/2019 RSS-251 Issue 2: 07/2018, RSS Gen Issue 5 March 2019 Amendment 1, ANSI C63.10:2013	Pass
10	Appendix A – Mixer/Horn Calibration Certificates	--
11	Revision History	--

3 Client Information

This EUT was tested at the request of:

Client: Patroness, LLC
101 Creekside Crossing
Suite 1700 #244
Brentwood, TX 37027
USA

Contact: Jered Dean
Telephone: 781-535-4736
Email: jered@patroness.com

4 Description of Equipment Under Test and Variant Models

Manufacturer: Patroness, LLC
101 Creekside Crossing
Suite 1700 #244
Brentwood, TX 37027
USA

Equipment Under Test			
Description	Manufacturer	Model Number	Serial Number
Radar module operating between 76 – 81 GHz	Patroness, LLC	P003110	0003 LF (Tx mode) 0004 LF (Idle mode) 0005 LF (Tx mode) 0008 LF (Tx mode)

Receive Date:	08/27/2019, 01/23/2020
Received Condition:	Good
Type:	Production

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

Equipment Under Test Power Configuration			
Rated Voltage	Rated Current	Rated Frequency	Number of Phases
5 Volts DC	0.5 Amps	N/A	N/A

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)	77 – 81 GHz
Modulation Type(s)	FMCW
Maximum Output Power	15.69 dBm or 0.037068W (EIRP)
Test Channels/Sweep Ranges	79 GHz (Sweep Ranges: 77-81 GHz)
Maximum Bandwidth	3.9 GHz
Equipment Type	Radio
Number of Tx/Rx antennas	4/3
Antenna Type and Gain	Integrated antenna

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	UUT Interface Cable (P002-129)	13 in	See Dwg.	None	-
2	USB Cable	~2 m	Molex 887283402	Yes*	-

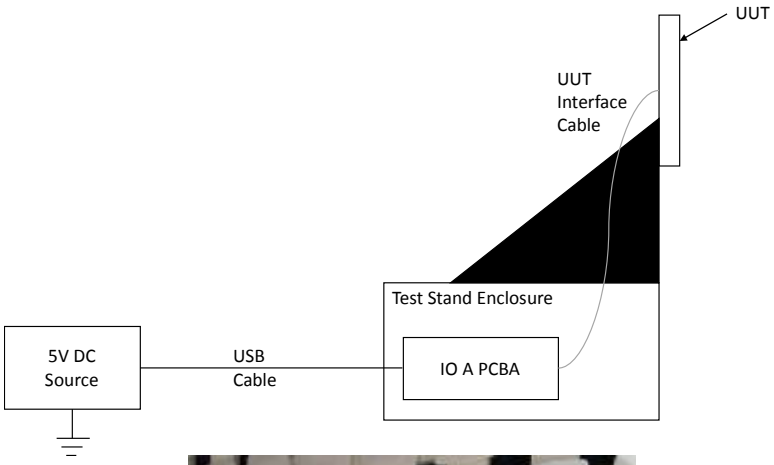
*Ferrite was placed at cable exit from AC/DC converter to isolate any converter noise from actual EUT.

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
Radar Test Stand	Patroness, LLC	P003-114	v 1.0
IO A PCBA	Patroness, LLC	P002-111	v 2.0
Battery pack	Belkin	F7U020 1INP11/66/110	N/A

5.1 Method:

Configuration as required by Configuration as required by FCC 47CFR Part 95, Subpart M:09/2019, RSS-251 Issue 2: 07/2018, RSS Gen Issue 5 March 2019 Amendment 1, RSS-102 Issue 5 March 2015, ANSI C63.10:2013, 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

$D = 0.031_{(m)}$, $\lambda = 300_{(m/s)} / 77.0135*10^3_{(MHz)} = 0.003895_{(m)}$, $R_m = ((2*0.031^2))/0.003895 = 0.49_{(m)}$

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.

Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV002'	Weather Station	Davis Instruments	7400	PE80519A93	06/13/2019	06/13/2020
OML3'	Mixer / Antenna	Oleson Microwave Lab	M12HWD	E21011-1	03/20/2019	03/20/2020
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	10/10/2019	10/10/2020
CBLHF2012-2M-2'	2m 9kHz-40GHz Coaxial Cable - SET2	Huber & Suhner	SF102	252675002	02/14/2019	02/14/2020

Software Utilized:

Name	Manufacturer	Version
None	--	--

6.2 Results:

The sample tested was found to Comply.

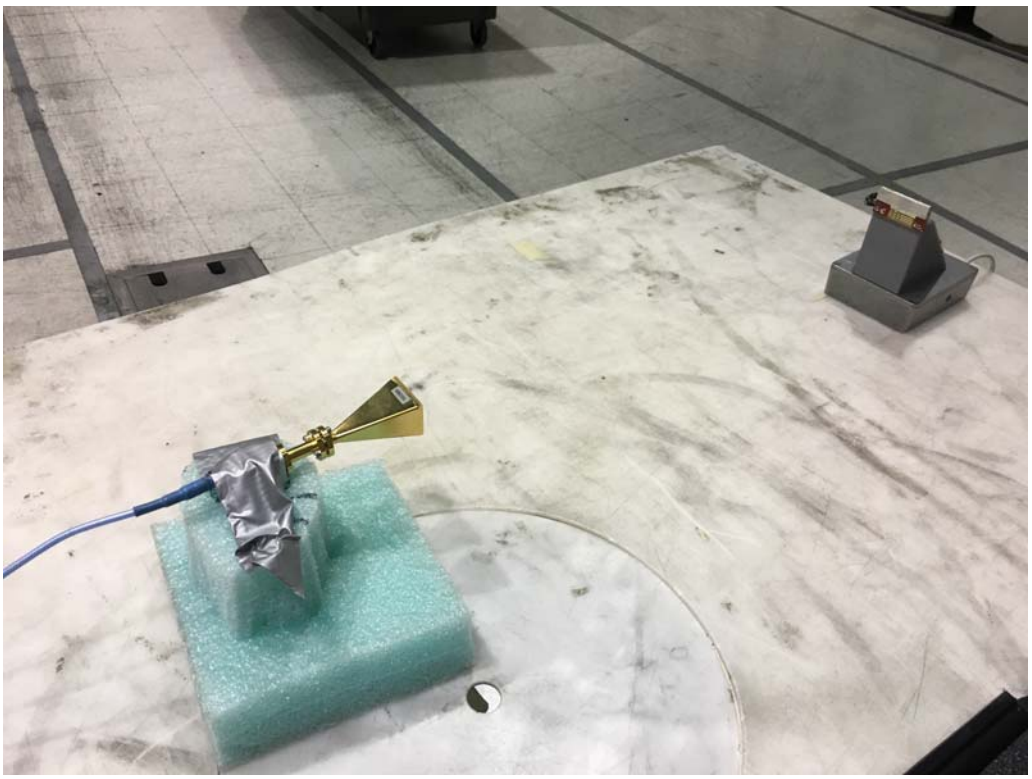
§95.3367 76-81 GHz Band Radar Service radiated power limits.

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.

6.3 Setup Photograph:

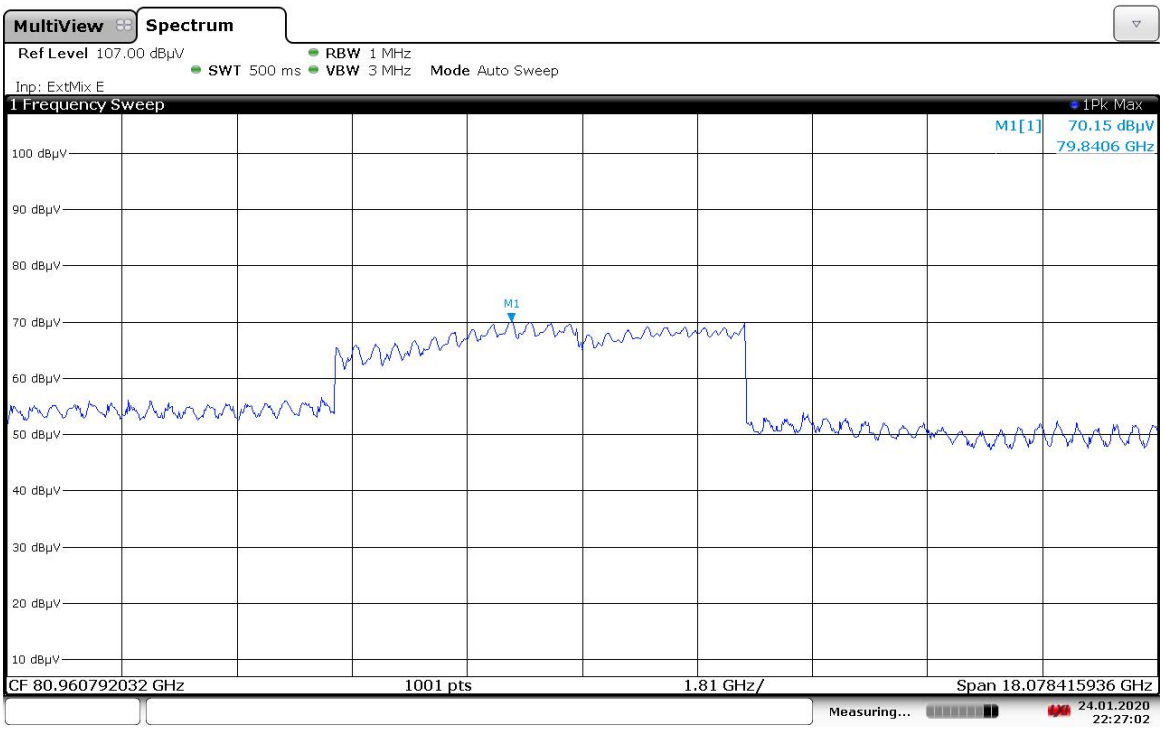


6.4 Test Data:

Antenna Pol.	Detection	Frequency (GHz)	Raw Reading* @0.5m (dBuV/m)	Receiving Antenna Gain (dBi)	Antenna Correction Factor, AF (dB/m)	Cable Loss (dB)	EIRP Level @0.5m (dBuV/m)	EIRP Level (dBm)	EIRP Limit (dBm)	Margin (dB)
V	Peak	79.84	70.51	24	44.24	2.08	116.83	6.04	55	-48.96
V	Average	79.84	44.76	24	44.24	2.08	91.08	-19.71	50	-69.71
V	RMS	79.84	46.89	24	44.24	2.08	93.21	-17.58	55	-72.58
Using integration method										
V	RMS	79.00	80.25	24	44.15	2.08	126.48	15.69	55	-39.31
*: the mixer conversion losses were compensated for in the instrument: 35.48 (79 GHz)										

Note: Worst-case antenna polarization were recorded here.

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



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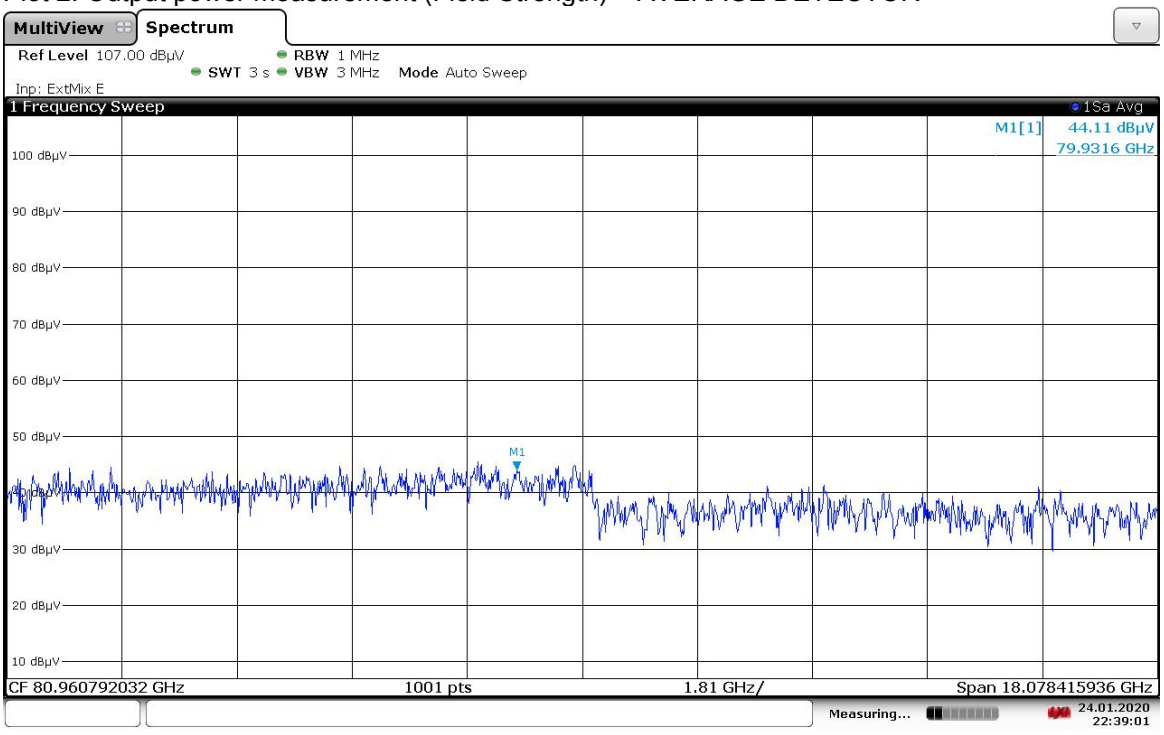
Note: Please see the sweep bandwidth in next section. Real signal and image are mixed in the above plot. This is the worst-case.

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



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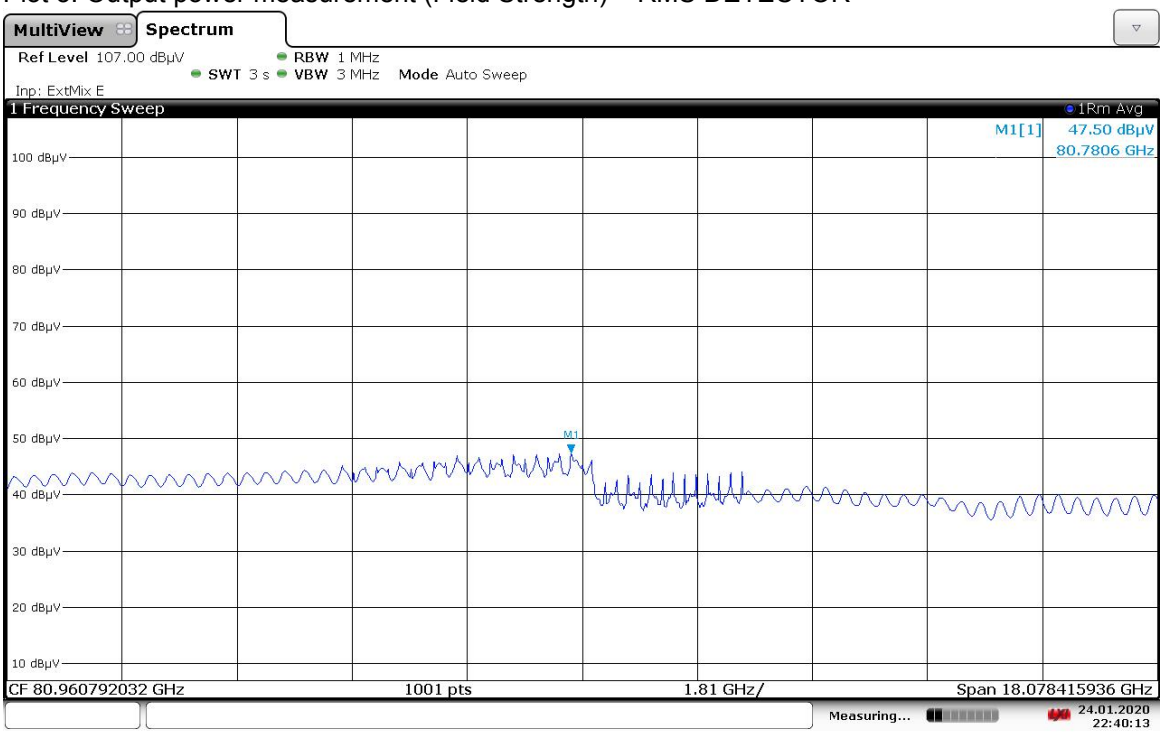
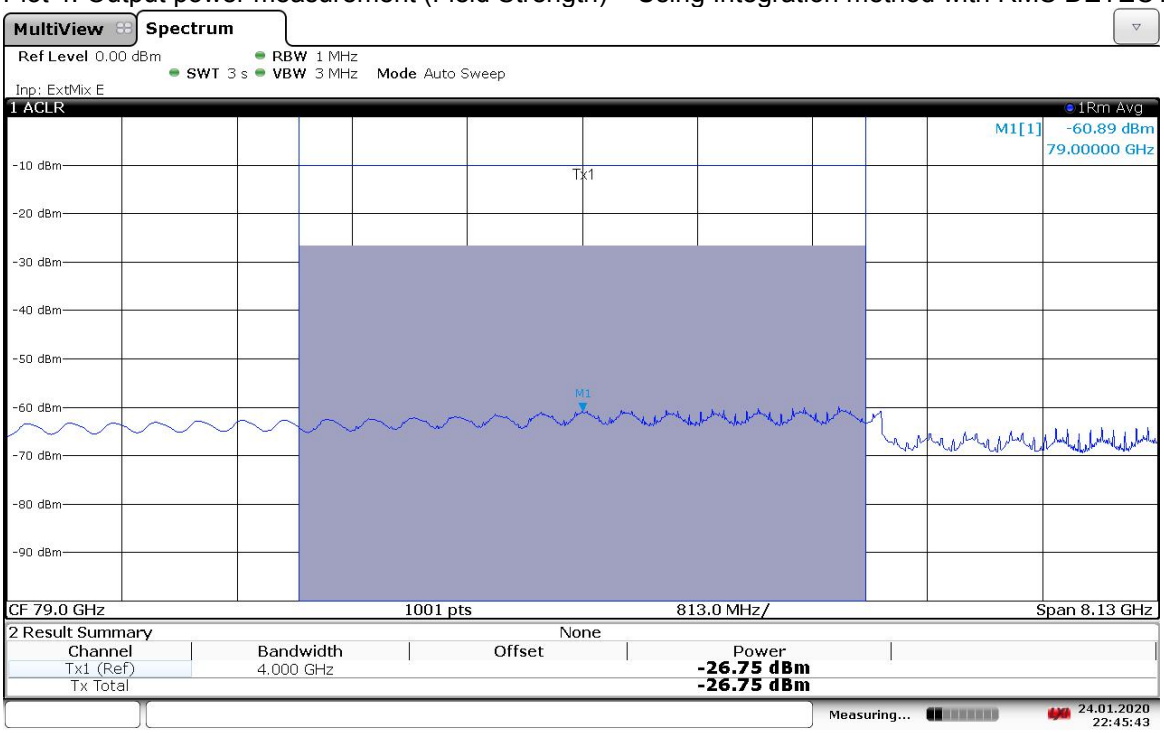
Plot 3: Output power measurement (Field Strength) – RMS DETECTOR



22:40:13 24.01.2020

Plot 4: Output power measurement (Field Strength) – Using Integration method with RMS DETECTOR



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Note: Worst-case bandwidth of 4GHz was used.

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 1 meter.

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 = 79.84 GHz
G = 24.0
AF = 20*LOG(79.84) - 24.0 + 30.2 = 44.24

AF = 44.24 dB/m
Cable loss = 2.08 dB
E_{Meas} = 70.51 dBμV/m

E (dBuV/m) = 70.51 + 43.93+2.08= 116.83 dB(μV/m) at 0.5 meter distance

EIRP (dBm) = E (dBuV/m) – 104.77 + 20*LOG(d); where d is a distance of measurement in m
= 116.83 -104.77 – 6.02 = 6.04 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.

RSS-102 Issue 5 Exposure Limits:

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[21]	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142f^{0.3417}$	$0.008335f^{0.3417}$	$0.02619f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158f^{0.5}$	$4.21 \times 10^{-4}f^{0.5}$	$6.67 \times 10^{-5}f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

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

1.2 Results:

- EIRP = 15.69 dBm = 15.69 dBm or 37.068 mW

Power Density = 37.068 / 5025.6

Power Density = 0.007376 mW/cm^2

Limit at 79GHz = 1mW/cm^2

RSS-102 Issue 5 Exposure Limit at 79GHz = 10 W/m^2

Power Density = 0.07376 W/m^2
The calculated maximum power density at 20cm distance is less than the limit for general population / uncontrolled exposure.

Test Personnel:	Vathana Ven VJV	Test Date:	01/25/2020
Supervising/Reviewing Engineer: (Where Applicable)			
Product Standard:	CFR47 FCC Part 95, Subpart M RSS-251, RSS-102	Limit Applied:	See report section 6.2
Input Voltage:	5 VDC		
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
DAV002'	Weather Station	Davis Instruments	7400	PE80519A93	06/13/2019	06/13/2020
OML3'	Mixer / Antenna	Oleson Microwave Lab	M12HWD	E21011-1	03/20/2019	03/20/2020
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	10/10/2019	10/10/2020
CBLHF2012-2M-2'	2m 9kHz-40GHz Coaxial Cable - SET2	Huber & Suhner	SF102	252675002	02/14/2019	02/14/2020

Software Utilized:

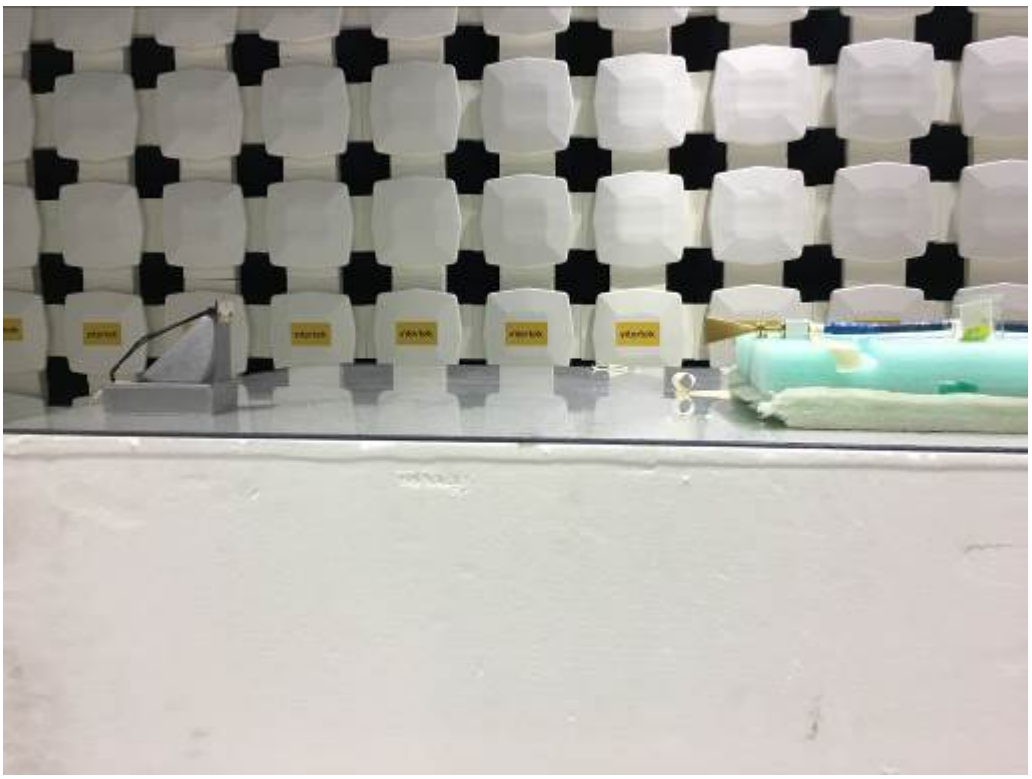
Name	Manufacturer	Version
None	--	--

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), 3.9GHz

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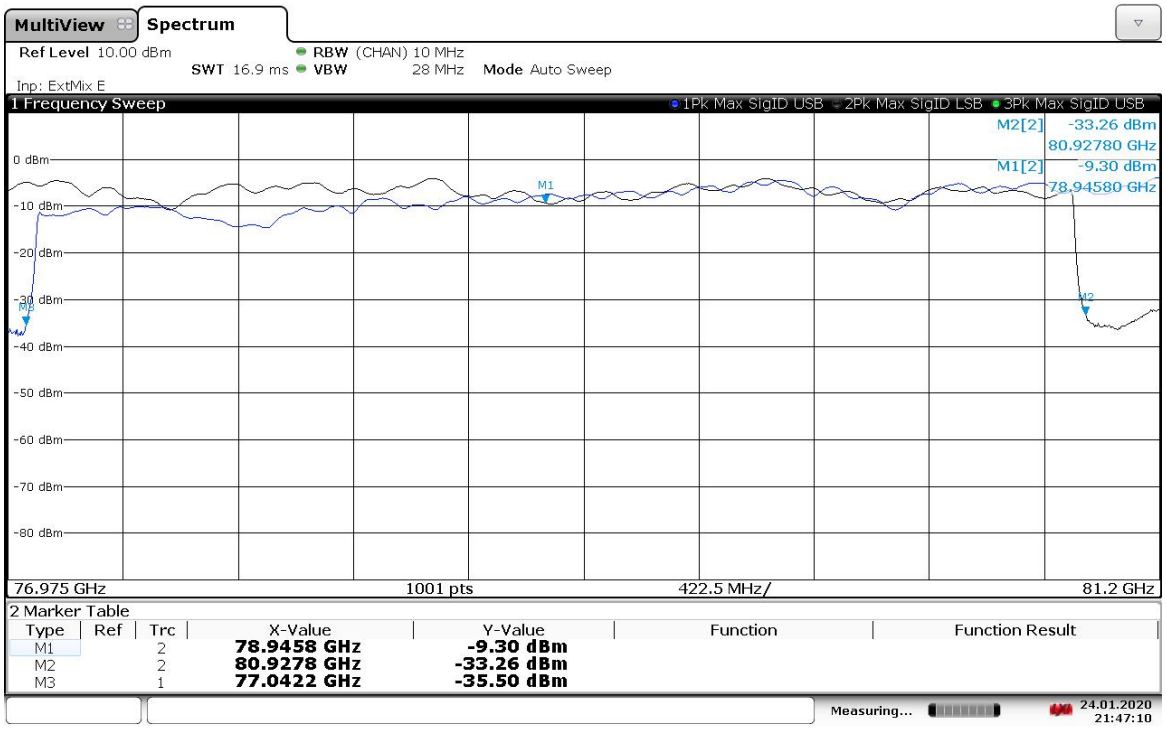


21:47:10 24.01.2020

Test Personnel:	Vathana Ven VSV	Test Date:	01/24/2020
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 95, Subpart M RSS-251, RSS-102	Limit Applied:	See report section 7.3
Input Voltage:	5 VDC	Ambient Temperature:	21 ºC
Pretest Verification w/ Ambient Signals or BB Source:	**N/A**	Relative Humidity:	46 %
		Atmospheric Pressure:	1007 mbars

Deviations, Additions, or Exclusions: None

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
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.

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

$D = 0.014_{(m)}$, $\lambda = 300_{(m/s)} / 170*10^3_{(MHz)} = 0.0017647_{(m)}$, $R_m = ((2*0.014^2))/0.0017647 = 0.22_{(m)}$

Measurements was made at 0.22 meter distance.

8.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV001'	Weather Station	Davis Instruments	7400	PE80519A61	01/23/2019	01/23/2020
145128'	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/28/2019	03/28/2020
145-410'	Cables 145-420 145-421 145-422 145-406	Huber + Suhner	10m Track A Cables	multiple	07/22/2019	07/22/2020
PRE11'	50dB gain pre-amp	Keith H	PRE11	PRE11	10/27/2018	10/27/2019
145145'	Broadband Hybrid Antenna 30 MHz - 3 GHz	Sunol Sciences Corp.	JB3	A122313	06/12/2019	06/12/2020
HORN3'	HORN ANTENNA	EMCO	3115	9610-4980	05/30/2019	05/30/2020
BON001'	METER, POWER	Boonton	4232A	55601	01/23/2019	01/23/2020
REA008'	band reject filter 2.4GHz	Reactel, Inc	12RX7-2441.75-x140 S	17-01	07/11/2019	07/11/2020
145-416'	Cables 145-420 145-423 145-425 145-408	Huber + Suhner	3m Track B cables	multiple	07/22/2019	07/22/2020
EMC04'	ANTENNA, RIDGED GUIDE, 18-40 GHZ	EMCO	3116	2090	10/26/2018	10/26/2019
OML2'	Mixer / Antenna	Oleson Microwave Lab	M08HWA	F21011-1	03/20/2019	03/27/2020
OML1'	Mixer / Antenna	Oleson Microwave Lab	M05HWA	G21011-1	03/20/2019	03/27/2020
CBLSHF102'	Cable, SMA - SMA, 9kHz-40GHz (Cable Kit 5)	Sucoflex (Huber Suhn	104PE	CBLSHF102	08/25/2017	10/25/2019
PRE8'	PREAMPLFIER 1- 40 GHz	MITEQ	NSP4000-NF	507145	10/25/2018	10/25/2019
OML3'	Mixer / Antenna	Oleson Microwave Lab	M12HWD	E21011-1	03/27/2019	03/27/2020
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	10/10/2019	10/15/2020
CBLSHF103'	Cable, SMA - SMA, < 18GHz	Sucoflex (Huber Suhn	104PE	CBLSHF103	11/15/2018	11/15/2019
OML4'	Mixer / Antenna	Oleson Microwave Lab	M19HWA	U21011-1	11/13/2016	04/29/2020
OML5'	Millimeter Wave Harmonic Generator	Oleson Microwave Lab	40200WGS	21011-1	03/27/2019	03/27/2020
OML6'	WR-04 Horn antenna 22-24dBi, 170-260GHz	OML	M04RH	19042901	04/29/2019	04/29/2020
OML7'	WR-04 Harmonic Mixer, 170-260GHz	OML	M04HWD	190429-1	04/29/2019	04/29/2020

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.

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.

Unwanted emissions Limits (ISED RSS-251 Issue 2):

Frequency (MHz)	Magnetic field strength (µA/m)	Measurement distance (m)	Detector
0.009-0.490[1]	6.37/F(kHz)	300	Quasi-peak [see Note 1]
0.490-1.705	63.7/F(kHz)	30	Quasi-peak
1.705-30.0	0.08	30	Quasi-peak
Frequency (MHz)	**Field strength (µV/m)**	**Measurement distance (m)**	**Detector**
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 (dBm/MHz eirp)**	**Measurement distance (m)**	**Detector**
40-162[3]	-30	3	RMS

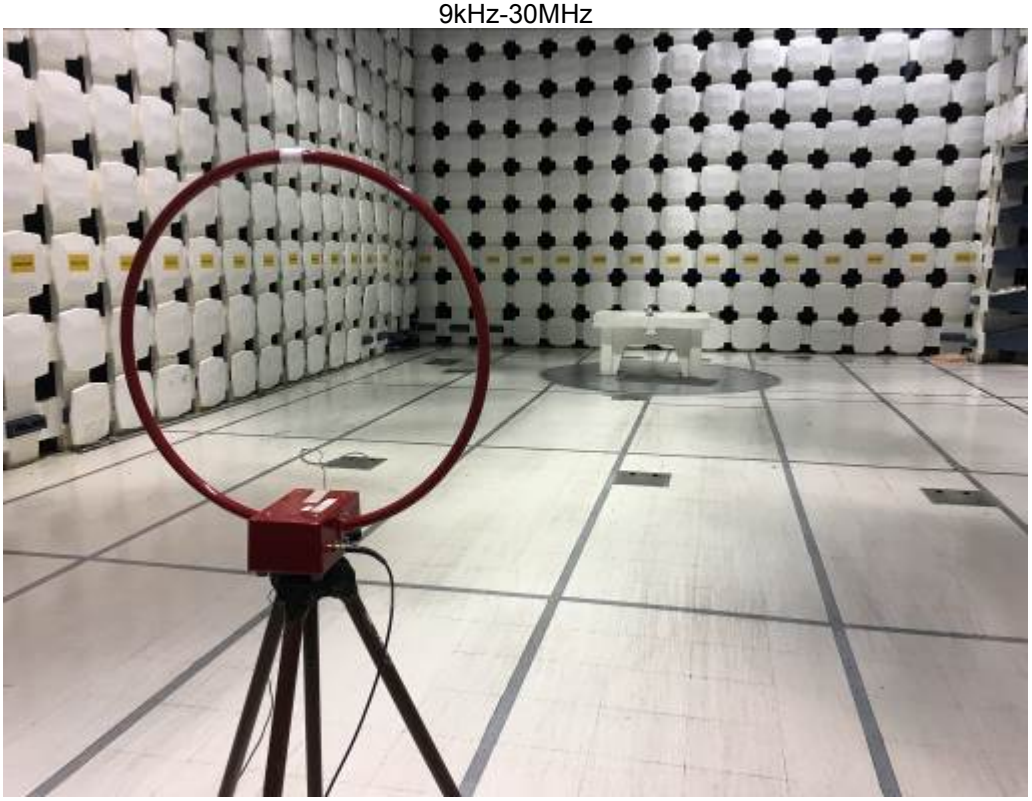
Note 1: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

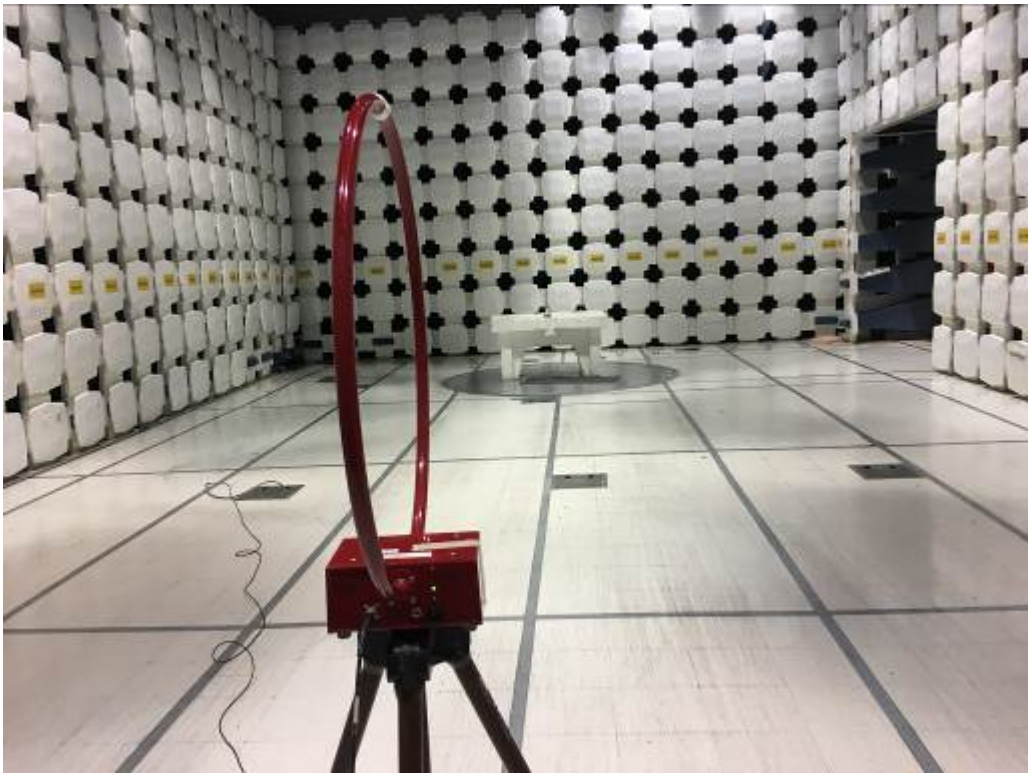
Note 2: The emission limits for the frequencies above 1 GHz are based on measurements employing a linear average detector.

Note 3: For radar devices that operate solely in the 76-77 GHz band (i.e., the occupied bandwidth is entirely contained in the 76-77 GHz band), an unwanted emissions limit of 0 dBm/MHz shall apply for the unwanted emission that fall in the 73.5-76 GHz band. Outside of the 73.5-76 GHz band, the unwanted emission limits prescribed in this table shall apply. The emission limits for the frequencies above 1 GHz are based on measurements employing a linear average detector.

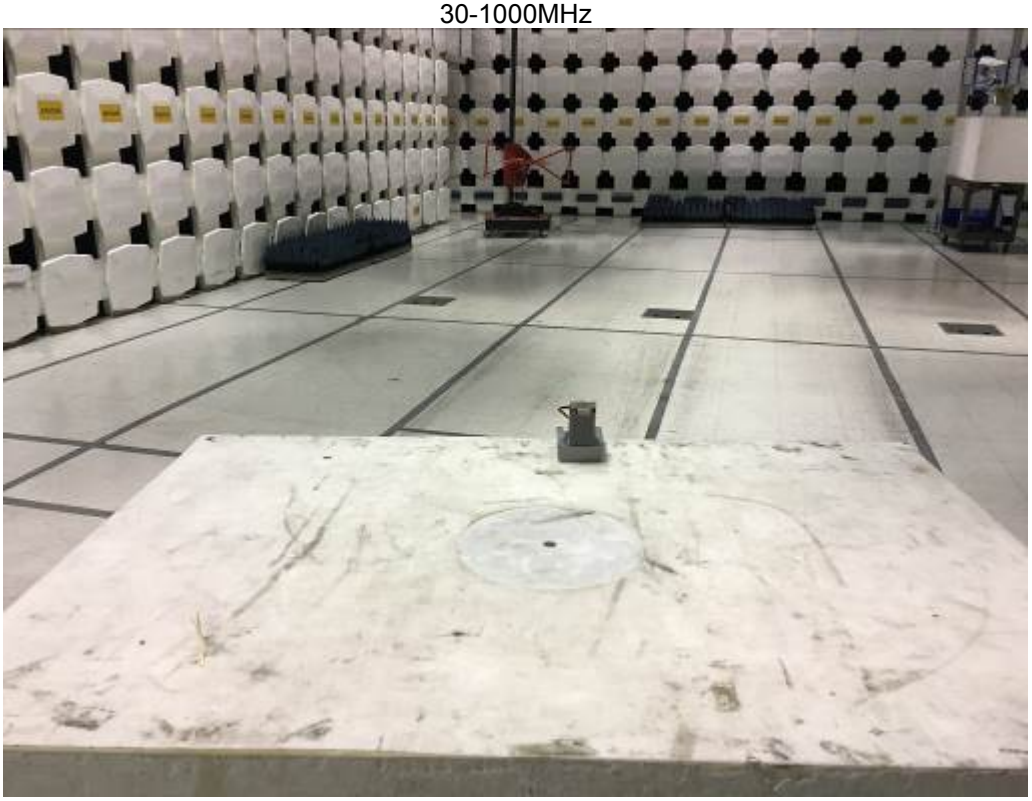
8.4 Setup Photograph:

9kHz-30MHz

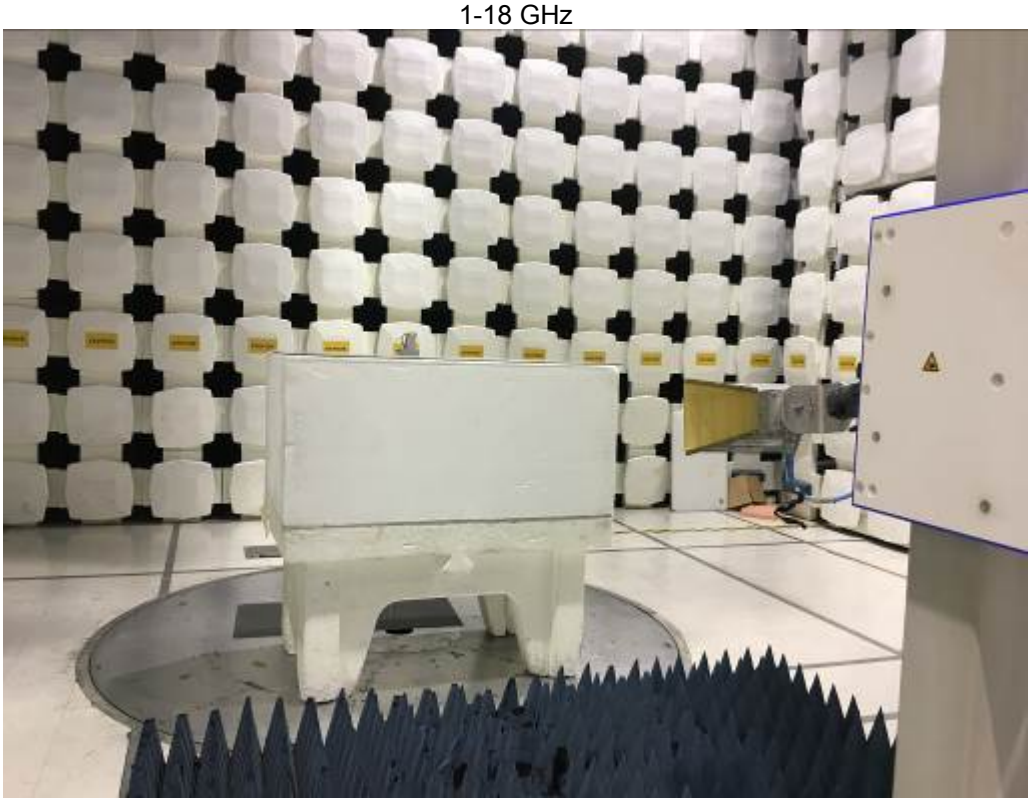


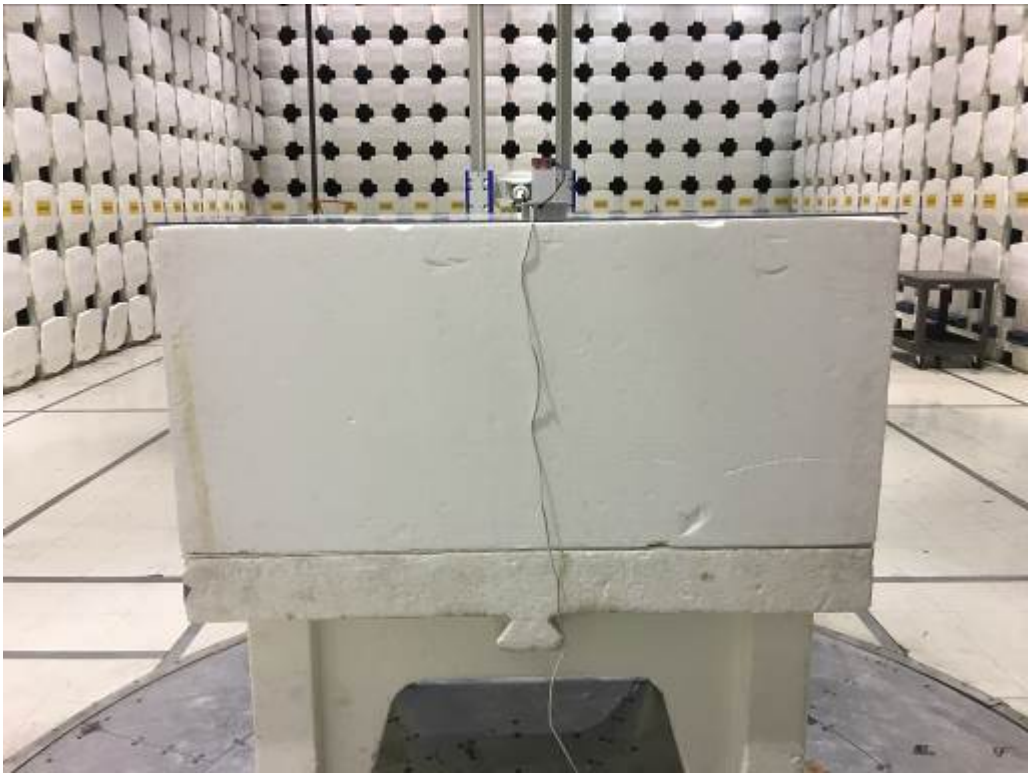


30-1000MHz

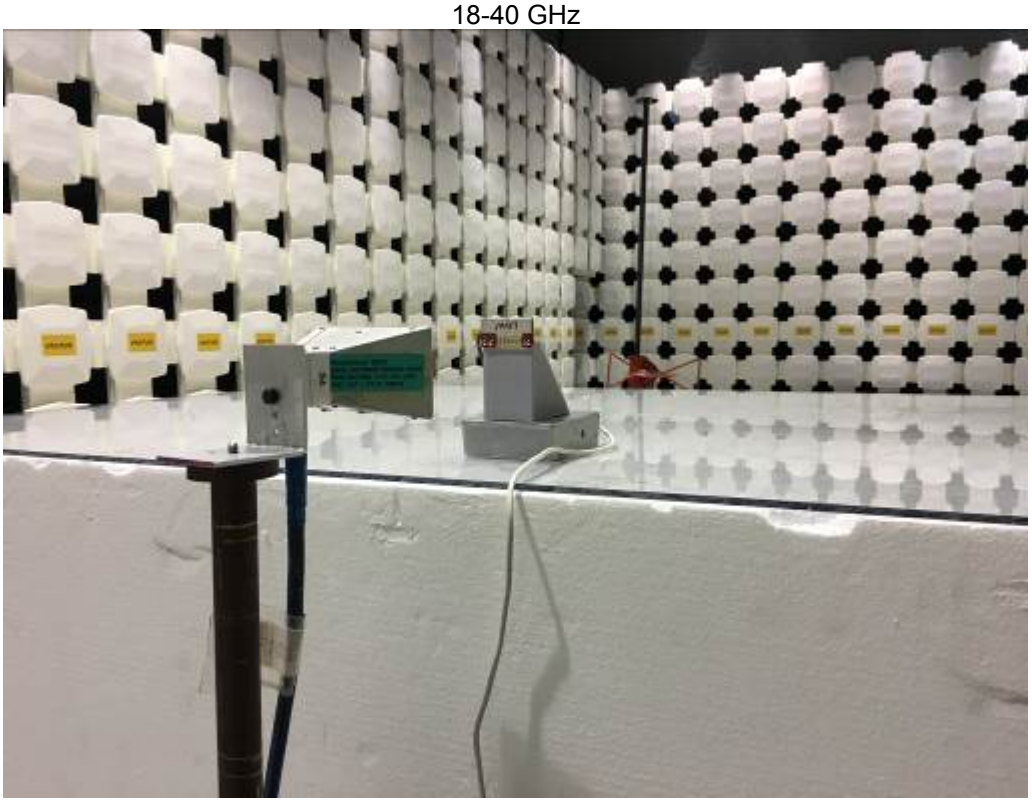


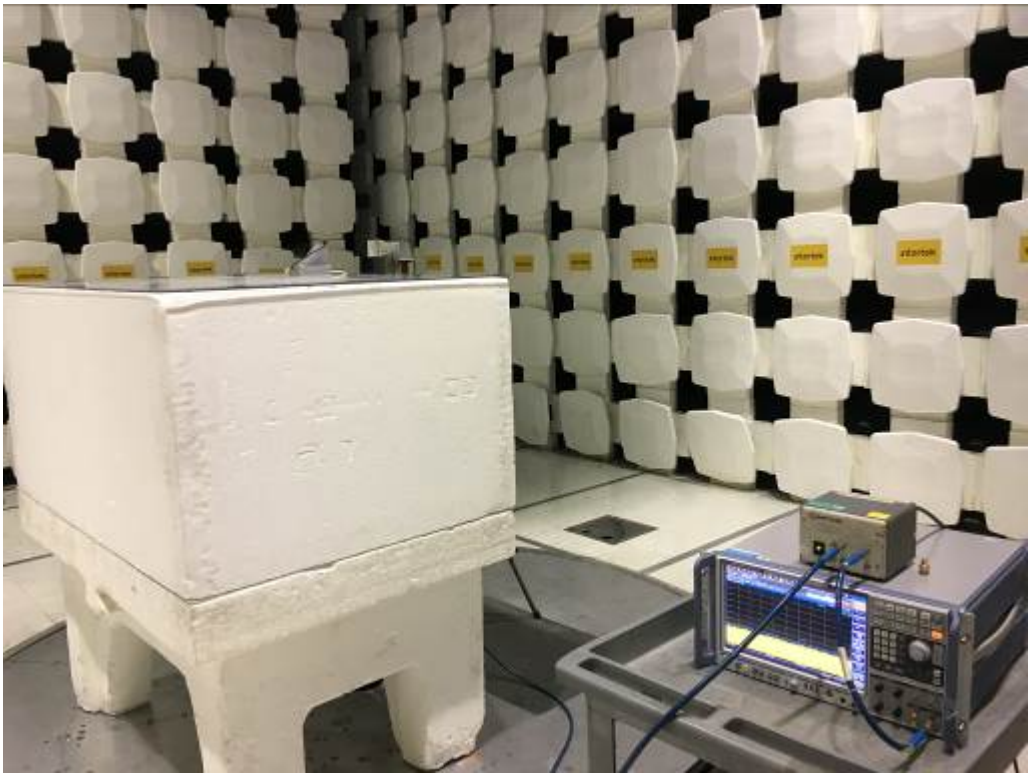
1-18 GHz





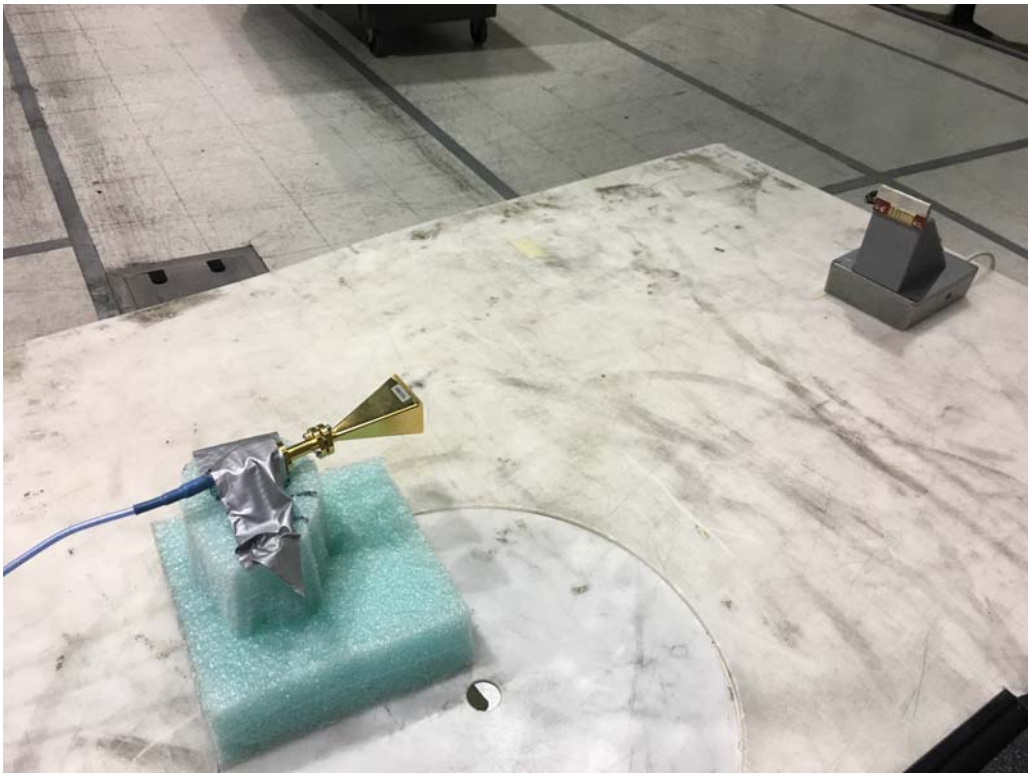
18-40 GHz





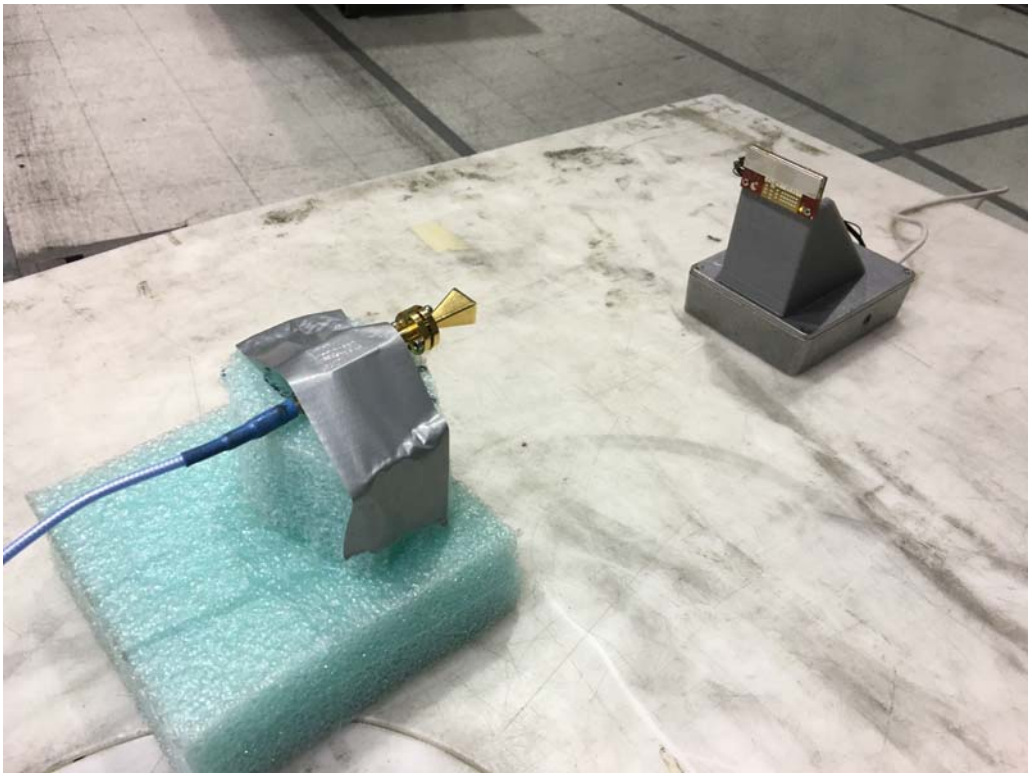
40-60 GHz

60-90 GHz



90-140 GHz

140-220 GHz



220-231 GHz

8.5 Plots/Data:

9kHz – 30MHz
Special Radiated Emissions

Company: Patroness | Antenna & Cables: LF | Bands: N, LF, HF, SHF
Model #: P003110 | Antenna: ETS003_06-17-2020.txt | ETS003_06-17-2020.txt
Serial #: 0 | Cable(s): 145-416__7-22-2020.txt | NONE.
Engineers: Vathana Ven | Location: 10M | Barometer: DAV001 | Filter: NONE
Project #: G103842901 | Date(s): 08/29/19
Standard: FCC Part 95, Subpart M/RSS-251 | Temp/Humidity/Pressure: 24 deg C | 41% | 755 mB
Receiver: R&S FSW (ROS005-1) 10-15-2019 | Limit Distance (m): 10
PreAmp: PRE8_10_25_2019.txt | Test Distance (m): 10
PreAmp Used? (Y or N): N | Voltage/Frequency: 5VDC | Frequency Range: 9kHz-30MHz
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

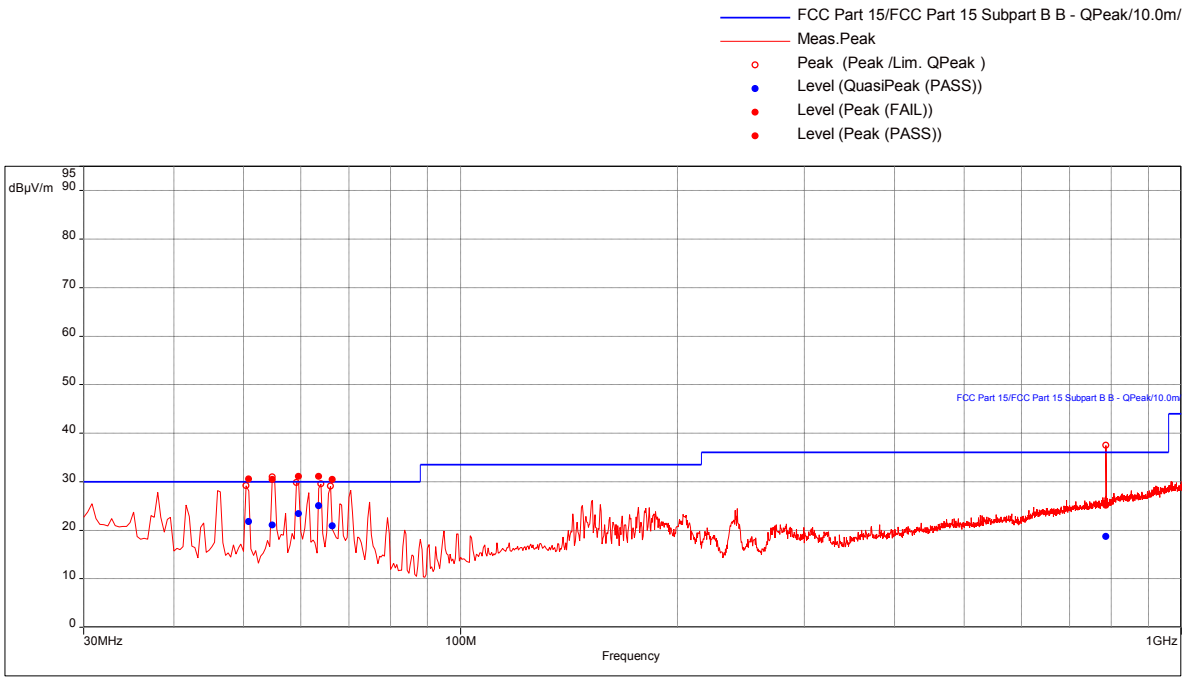
Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth	FCC	IC
No emissions were detected above the measuring equipment noise floor													

Low Channel, 30-1000 MHz

Test Information:

Date and Time	8/29/2019 6:38:19 PM
Client and Project Number	Patroness
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	41%
Atmospheric Pressure	755 mbar
Comments	30-1000MHz_Tx mode_Low Channel

Graph:



Results:

QuasiPeak (PASS) (6)

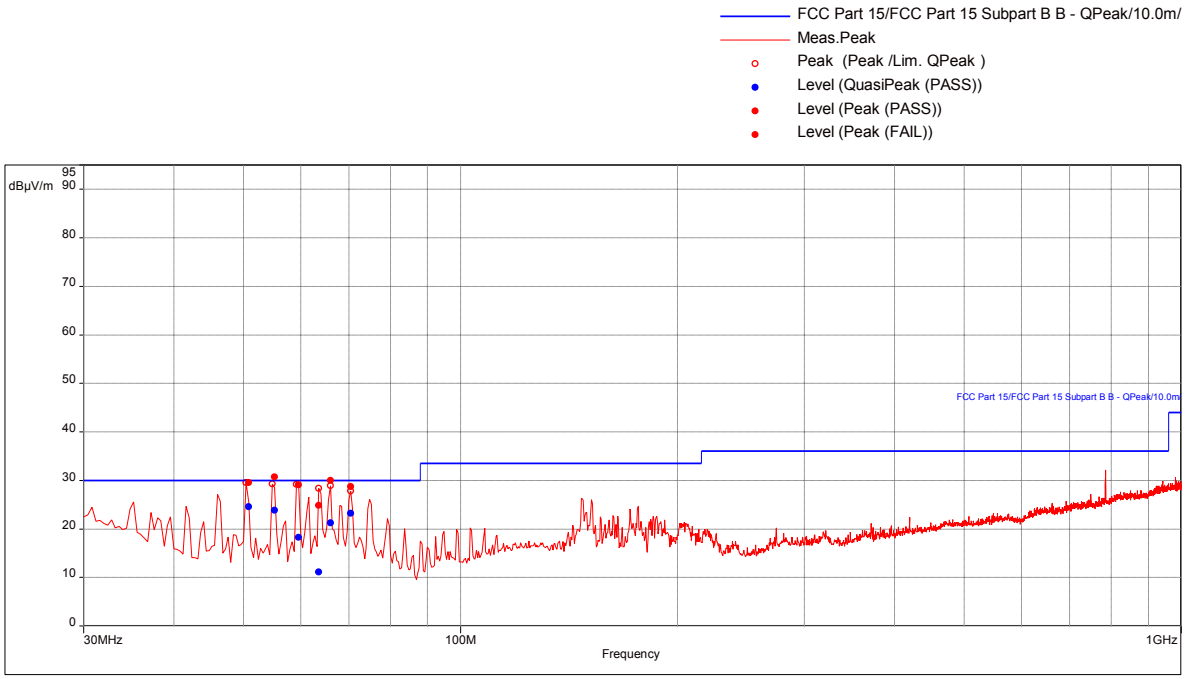
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
50.81052632	21.81	30.00	-8.19	342.00	2.35	Vertical	120000.00	-25.15
54.92631579	21.08	30.00	-8.92	305.00	3.70	Vertical	120000.00	-25.68
59.61052632	23.38	30.00	-6.62	321.00	2.25	Vertical	120000.00	-25.47
63.77894737	25.04	30.00	-4.96	355.00	1.74	Vertical	120000.00	-25.11
66.25263158	20.87	30.00	-9.13	305.00	2.34	Vertical	120000.00	-24.94
786.5894737	18.73	36.00	-17.27	77.00	2.53	Horizontal	120000.00	-7.98

Mid Channel, 30-1000 MHz

Test Information:

Date and Time	8/29/2019 6:33:50 PM
Client and Project Number	Patroness
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	41%
Atmospheric Pressure	755 mbar
Comments	30-1000MHz_Tx mode_Mid Channel

Graph:



Results:

QuasiPeak (PASS) (6)

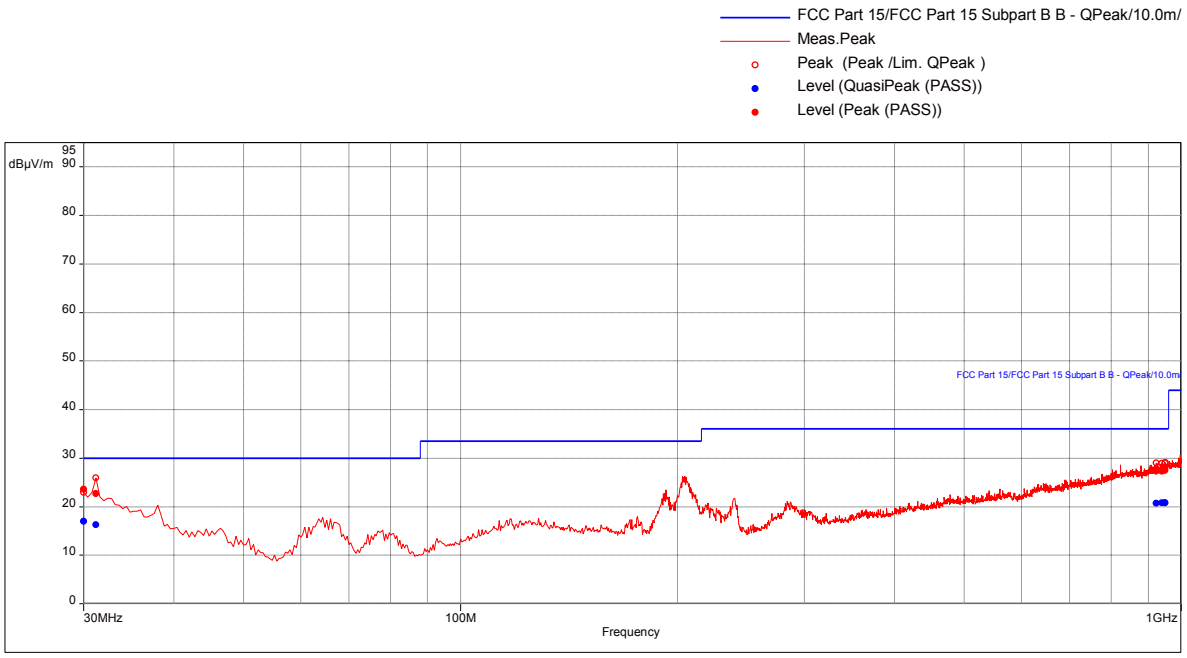
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
50.62105263	24.55	30.00	-5.45	284.00	2.02	Vertical	120000.00	-25.10
55.17894737	23.86	30.00	-6.14	253.00	1.96	Vertical	120000.00	-25.67
59.64210526	18.22	30.00	-11.78	290.00	3.95	Vertical	120000.00	-25.47
63.50526316	11.11	30.00	-18.89	349.00	2.28	Vertical	120000.00	-25.14
65.93684211	21.23	30.00	-8.77	282.00	1.61	Vertical	120000.00	-24.97
70.4	23.21	30.00	-6.79	40.00	2.26	Vertical	120000.00	-24.73

High Channel, 30-1000 MHz

Test Information:

Date and Time	8/29/2019 5:05:54 PM
Client and Project Number	Patroness
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	41%
Atmospheric Pressure	755 mbar
Comments	30-1000MHz_Tx mode_High Channel_Final scan

Graph:



Results:

QuasiPeak (PASS) (6)

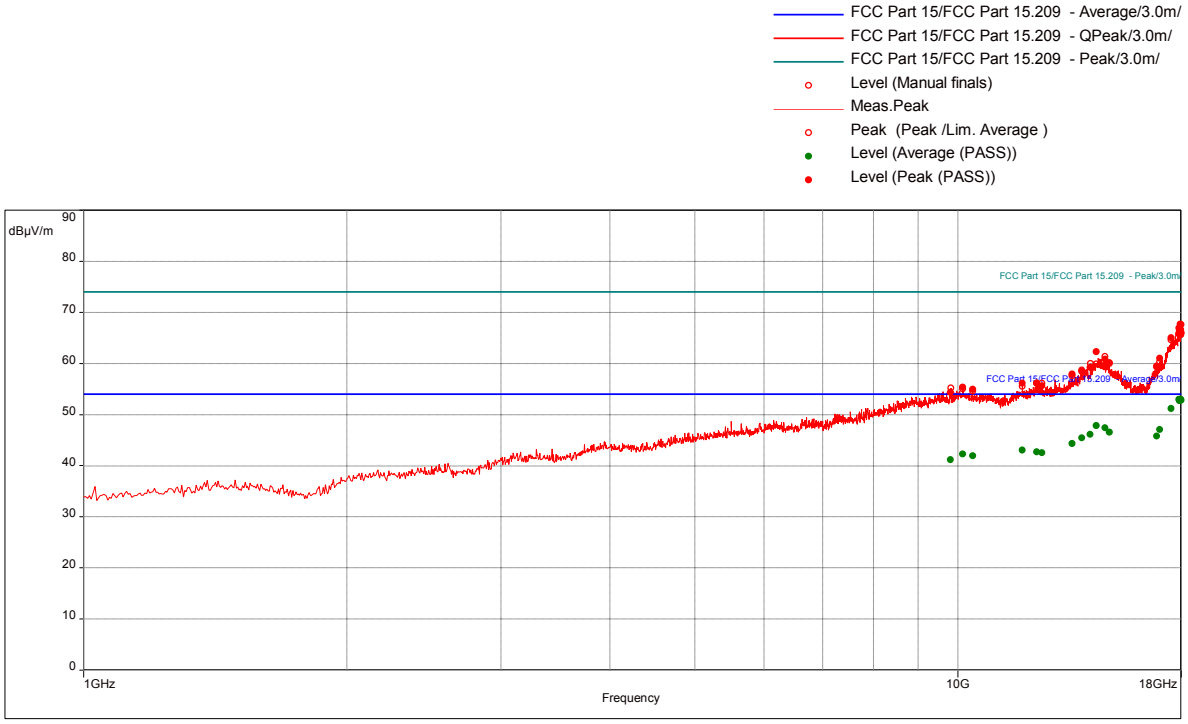
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
30	17.00	30.00	-13.00	32.00	1.59	Vertical	120000.00	-12.45
31.32631579	16.30	30.00	-13.70	128.00	2.05	Horizontal	120000.00	-13.15
923.2315789	20.70	36.00	-15.30	32.00	2.35	Vertical	120000.00	-5.53
940.7473684	20.77	36.00	-15.23	77.00	1.74	Vertical	120000.00	-5.47
949.0105263	20.78	36.00	-15.22	313.00	3.95	Vertical	120000.00	-5.24
950.0526316	20.78	36.00	-15.22	232.00	3.09	Vertical	120000.00	-5.23

Low Channel, 1-18 GHz

Test Information:

Date and Time	8/27/2019 9:11:18 PM
Client and Project Number	Patroness
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	41%
Atmospheric Pressure	755 mbar
Comments	1 to 18 GHz_Tx Low Channel

Graph:



Results:

Peak (PASS) (21)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
9807.105263	54.36	74.00	-19.64	341.00	1.40	Horizontal	1000000.00	-0.09
10127.89474	55.39	74.00	-18.61	231.00	3.30	Horizontal	1000000.00	0.68
10396.05263	54.89	74.00	-19.11	92.00	1.80	Vertical	1000000.00	0.70
11845	56.12	74.00	-17.88	25.00	2.15	Horizontal	1000000.00	2.96
12309.47368	56.13	74.00	-17.87	238.00	3.74	Vertical	1000000.00	3.38
12478.42105	55.61	74.00	-18.39	195.00	1.85	Vertical	1000000.00	3.41
13511.31579	57.94	74.00	-16.06	113.00	2.60	Horizontal	1000000.00	5.74
13861.57895	58.42	74.00	-15.58	268.00	1.65	Vertical	1000000.00	7.15
14171.57895	59.18	74.00	-14.82	92.00	2.10	Horizontal	1000000.00	8.69
14400.52632	62.25	74.00	-11.75	18.00	3.39	Horizontal	1000000.00	9.49
14725	60.80	74.00	-13.20	246.00	3.39	Vertical	1000000.00	9.39
14893.15789	60.14	74.00	-13.86	357.00	1.50	Vertical	1000000.00	8.86
16870.26316	59.43	74.00	-14.57	121.00	1.65	Horizontal	1000000.00	6.81
17019.47368	61.04	74.00	-12.96	47.00	2.40	Horizontal	1000000.00	8.15
17528.15789	65.03	74.00	-8.97	55.00	2.15	Vertical	1000000.00	12.14
17893.94737	66.91	74.00	-7.09	202.00	2.10	Vertical	1000000.00	14.16
17923.15789	66.33	74.00	-7.67	32.00	2.25	Vertical	1000000.00	14.27
17943.42105	66.96	74.00	-7.04	0.00	2.00	Vertical	1000000.00	14.35
17953.15789	67.68	74.00	-6.32	239.00	1.35	Horizontal	1000000.00	14.39
17980.78947	66.57	74.00	-7.43	157.00	1.70	Vertical	1000000.00	14.51
18000	67.62	74.00	-6.38	292.00	1.05	Vertical	1000000.00	14.59

Average (PASS) (21)

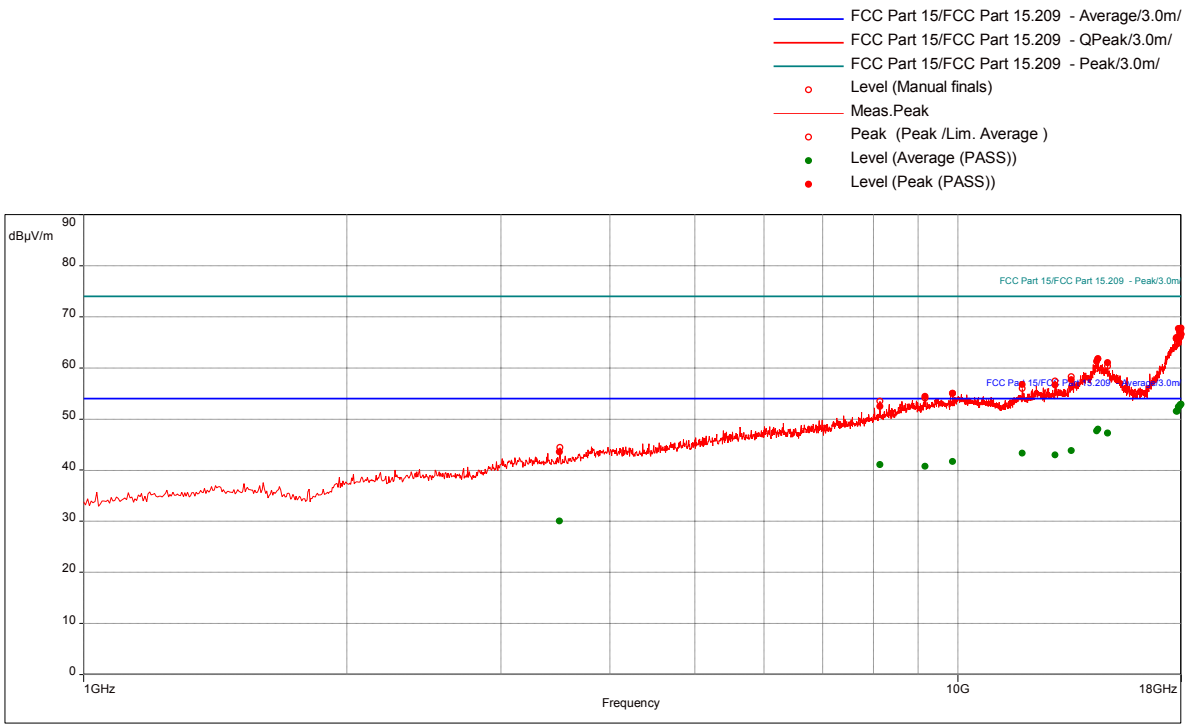
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
9807.105263	41.14	54.00	-12.86	341.00	1.40	Horizontal	1000000.00	-0.09
10127.89474	42.28	54.00	-11.72	231.00	3.30	Horizontal	1000000.00	0.68
10396.05263	41.94	54.00	-12.06	92.00	1.80	Vertical	1000000.00	0.70
11845	43.07	54.00	-10.93	25.00	2.15	Horizontal	1000000.00	2.96
12309.47368	42.71	54.00	-11.29	238.00	3.74	Vertical	1000000.00	3.38
12478.42105	42.52	54.00	-11.48	195.00	1.85	Vertical	1000000.00	3.41
13511.31579	44.36	54.00	-9.64	113.00	2.60	Horizontal	1000000.00	5.74
13861.57895	45.40	54.00	-8.60	268.00	1.65	Vertical	1000000.00	7.15
14171.57895	46.13	54.00	-7.87	92.00	2.10	Horizontal	1000000.00	8.69
14400.52632	47.85	54.00	-6.15	18.00	3.39	Horizontal	1000000.00	9.49
14725	47.43	54.00	-6.57	246.00	3.39	Vertical	1000000.00	9.39
14893.15789	46.57	54.00	-7.43	357.00	1.50	Vertical	1000000.00	8.86
16870.26316	45.80	54.00	-8.20	121.00	1.65	Horizontal	1000000.00	6.81
17019.47368	47.10	54.00	-6.90	47.00	2.40	Horizontal	1000000.00	8.15
17528.15789	51.13	54.00	-2.87	55.00	2.15	Vertical	1000000.00	12.14
17893.94737	52.93	54.00	-1.07	202.00	2.10	Vertical	1000000.00	14.16
17923.15789	52.68	54.00	-1.32	32.00	2.25	Vertical	1000000.00	14.27
17943.42105	52.88	54.00	-1.12	0.00	2.00	Vertical	1000000.00	14.35
17953.15789	52.96	54.00	-1.04	239.00	1.35	Horizontal	1000000.00	14.39
17980.78947	52.96	54.00	-1.04	157.00	1.70	Vertical	1000000.00	14.51
18000	52.83	54.00	-1.17	292.00	1.05	Vertical	1000000.00	14.59

Mid Channel, 1-18 GHz

Test Information:

Date and Time	8/27/2019 6:42:09 PM
Client and Project Number	Patroness
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	41%
Atmospheric Pressure	755 mbar
Comments	1 to 18 GHz_Trx @ Mid channel

Graph:



Results:

Peak (PASS) (16)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
3500.789474	43.52	74.00	-30.48	166.00	1.65	Horizontal	1000000.00	-15.91
8142.368421	52.43	74.00	-21.57	62.00	1.70	Horizontal	1000000.00	-3.96
9168.421053	54.42	74.00	-19.58	180.00	3.15	Vertical	1000000.00	-1.59
9863.421053	55.00	74.00	-19.00	26.00	2.25	Vertical	1000000.00	0.04
11838.94737	56.74	74.00	-17.26	39.00	1.85	Vertical	1000000.00	2.94
12915.26316	56.68	74.00	-17.32	320.00	2.85	Horizontal	1000000.00	3.93
13483.68421	57.71	74.00	-16.29	313.00	3.34	Horizontal	1000000.00	5.65
14403.15789	61.29	74.00	-12.71	172.00	2.80	Vertical	1000000.00	9.50
14460	61.80	74.00	-12.20	239.00	3.79	Horizontal	1000000.00	9.60
14828.15789	61.02	74.00	-12.98	54.00	2.40	Vertical	1000000.00	9.09
17764.73684	65.87	74.00	-8.13	277.00	2.00	Vertical	1000000.00	13.67
17819.73684	65.52	74.00	-8.48	99.00	3.00	Vertical	1000000.00	13.86
17885.26316	67.67	74.00	-6.33	39.00	3.34	Horizontal	1000000.00	14.12
17928.42105	67.32	74.00	-6.68	54.00	3.84	Vertical	1000000.00	14.29
17956.84211	67.16	74.00	-6.84	143.00	1.25	Vertical	1000000.00	14.40
17995.65789	67.73	74.00	-6.27	328.00	1.60	Vertical	1000000.00	14.57

Average (PASS) (16)

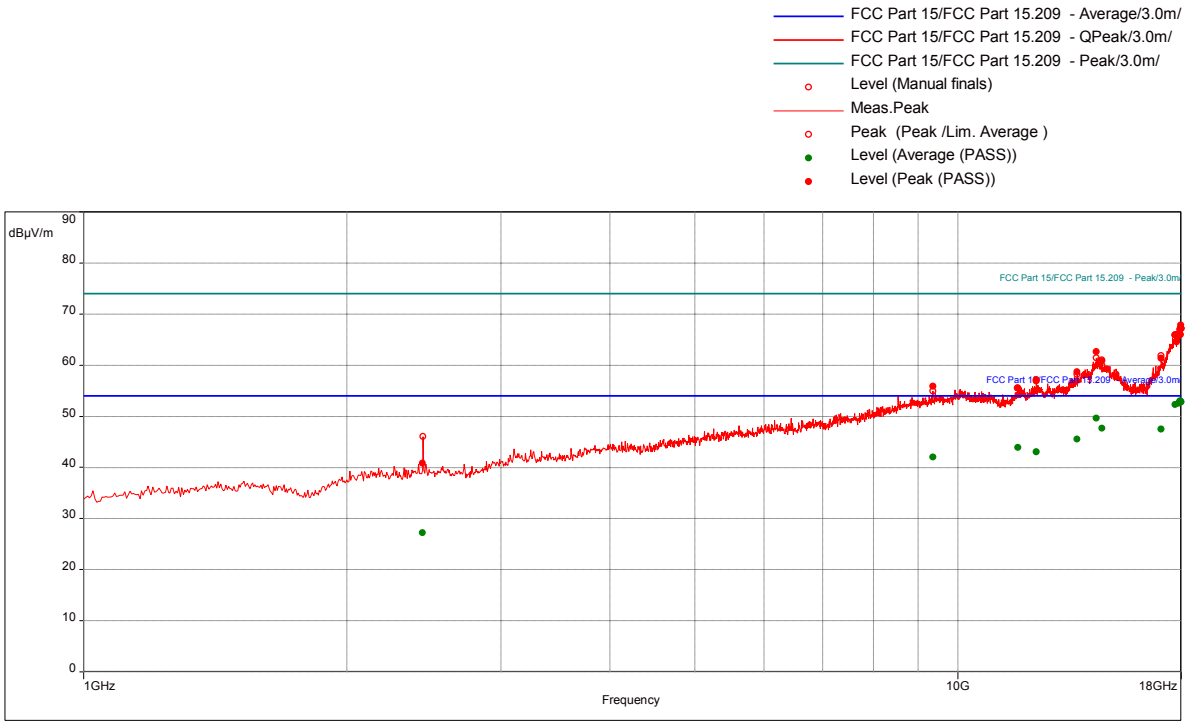
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
3500.789474	30.06	54.00	-23.94	166.00	1.65	Horizontal	1000000.00	-15.91
8142.368421	41.09	54.00	-12.91	62.00	1.70	Horizontal	1000000.00	-3.96
9168.421053	40.77	54.00	-13.23	180.00	3.15	Vertical	1000000.00	-1.59
9863.421053	41.65	54.00	-12.35	26.00	2.25	Vertical	1000000.00	0.04
11838.94737	43.31	54.00	-10.69	39.00	1.85	Vertical	1000000.00	2.94
12915.26316	42.91	54.00	-11.09	320.00	2.85	Horizontal	1000000.00	3.93
13483.68421	43.83	54.00	-10.17	313.00	3.34	Horizontal	1000000.00	5.65
14403.15789	47.68	54.00	-6.32	172.00	2.80	Vertical	1000000.00	9.50
14460	47.98	54.00	-6.02	239.00	3.79	Horizontal	1000000.00	9.60
14828.15789	47.27	54.00	-6.73	54.00	2.40	Vertical	1000000.00	9.09
17764.73684	51.53	54.00	-2.47	277.00	2.00	Vertical	1000000.00	13.67
17819.73684	51.55	54.00	-2.45	99.00	3.00	Vertical	1000000.00	13.86
17885.26316	52.33	54.00	-1.67	39.00	3.34	Horizontal	1000000.00	14.12
17928.42105	52.53	54.00	-1.47	54.00	3.84	Vertical	1000000.00	14.29
17956.84211	52.80	54.00	-1.20	143.00	1.25	Vertical	1000000.00	14.40
17995.65789	52.88	54.00	-1.12	328.00	1.60	Vertical	1000000.00	14.57

High Channel, 1-18 GHz

Test Information:

Date and Time	8/27/2019 5:40:01 PM
Client and Project Number	Patroness
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	41%
Atmospheric Pressure	755 mbar
Comments	1 to 18 GHz_Trx @ High channel

Graph:



Results:

Peak (PASS) (14)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m) (	Pol.	RBW (Hz)	Correction (dB)
2441.315789	40.82	74.00	-33.18	291.00	3.98	Vertical	1000000.00	-19.70
9358.684211	55.90	74.00	-18.10	349.00	1.00	Horizontal	1000000.00	-1.01
11705	55.53	74.00	-18.47	194.00	2.20	Horizontal	1000000.00	2.50
12291.31579	57.16	74.00	-16.84	246.00	2.15	Vertical	1000000.00	3.36
13683.15789	58.70	74.00	-15.30	0.00	3.49	Vertical	1000000.00	6.22
14399.73684	62.65	74.00	-11.35	269.00	1.05	Vertical	1000000.00	9.49
14610.52632	60.84	74.00	-13.16	32.00	3.15	Vertical	1000000.00	9.70
17072.36842	61.36	74.00	-12.64	99.00	2.75	Vertical	1000000.00	8.60
17706.31579	65.85	74.00	-8.15	25.00	2.60	Vertical	1000000.00	13.51
17881.84211	66.17	74.00	-7.83	224.00	1.90	Vertical	1000000.00	14.11
17944.47368	66.97	74.00	-7.03	267.00	1.50	Horizontal	1000000.00	14.35
17964.21053	67.05	74.00	-6.95	120.00	2.30	Vertical	1000000.00	14.44
17991.31579	67.84	74.00	-6.16	115.00	1.05	Vertical	1000000.00	14.55
17998.02632	67.20	74.00	-6.80	328.00	3.10	Vertical	1000000.00	14.58

Average (PASS) (14)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
2441.315789	27.22	54.00	-26.78	291.00	3.98	Vertical	1000000.00	-19.70
9358.684211	42.05	54.00	-11.95	349.00	1.00	Horizontal	1000000.00	-1.01
11705	43.89	54.00	-10.11	194.00	2.20	Horizontal	1000000.00	2.50
12291.31579	43.03	54.00	-10.97	246.00	2.15	Vertical	1000000.00	3.36
13683.15789	45.48	54.00	-8.52	0.00	3.49	Vertical	1000000.00	6.22
14399.73684	49.60	54.00	-4.40	269.00	1.05	Vertical	1000000.00	9.49
14610.52632	47.65	54.00	-6.35	32.00	3.15	Vertical	1000000.00	9.70
17072.36842	47.49	54.00	-6.51	99.00	2.75	Vertical	1000000.00	8.60
17706.31579	52.28	54.00	-1.72	25.00	2.60	Vertical	1000000.00	13.51
17881.84211	52.51	54.00	-1.49	224.00	1.90	Vertical	1000000.00	14.11
17944.47368	52.94	54.00	-1.06	267.00	1.50	Horizontal	1000000.00	14.35
17964.21053	52.94	54.00	-1.06	120.00	2.30	Vertical	1000000.00	14.44
17991.31579	52.90	54.00	-1.10	115.00	1.05	Vertical	1000000.00	14.55
17998.02632	52.77	54.00	-1.23	328.00	3.10	Vertical	1000000.00	14.58

18-231 GHz

Radiated Emissions

Company: Patroness
Model #: P003110
Serial #: 0003 LF, 0004 LF, 0005 LF, 0008 LF
Engineers: Vathana Ven Location: 10M
Project #: G103842901 Date(s): 08/28/19
Standard: FCC Part 95, Subpart M/RSS-251
Receiver: R&S FSW (ROS005-1) 10-15-2019 Limit Distance (m): 3
PreAmp: PRE8_10_25_2019.txt Test Distance (m): 0.2
PreAmp Used? (Y or N): Y (18-40GHz) Voltage/Frequency: 5VDC Frequency Range: 18-40 GHz

Antenna & Cables: SHF Bands: N, LF, HF, SHF
Antenna: EMC04_1MV_10-26-2019.txt EMC04_1MH_10-26-2019.txt OML-1 OML-2
Cable(s): CBLSHF102_9_13_19.txt CBLSHF103_11_15_2019.txt OML-3 OML-4, OM
Barometer: DAV001 Filter: NONE
Temp/Humidity/Pressure: 23 deg C 56% 1001 mB

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
Tx mode, Low Channel													
PK	V	19265.700	44.75	45.42	12.54	18.68	23.52	60.50	74.00	-13.50	1/3 MHz	RB	RB
AVG	V	19265.700	26.20	45.42	12.54	18.68	23.52	41.95	54.00	-12.05	1/3 MHz		
Tx mode, Mid Channel													
PK	V	19671.300	45.34	45.42	12.62	18.76	23.52	61.10	74.00	-12.90	1/3 MHz	RB	RB
AVG	V	19671.300	27.00	45.42	12.62	18.76	23.52	42.76	54.00	-11.24	1/3 MHz		
Tx mode, High Channel												RB	RB
PK	V	20240.800	41.90	45.23	12.91	18.28	23.52	58.24	74.00	-15.76	1/3 MHz	RB	RB
AVG	V	20240.800	26.90	45.23	12.91	18.28	23.52	43.24	54.00	-10.76	1/3 MHz		

No other emissions were detected above the measuring equipment noise floor.

Company: Patroness
Model #: P003110
Serial #: 0003 LF, 0004 LF, 0005 LF, 0008 LF
Engineers: Vathana Ven Location: 10M
Project #: G103842901 Date(s): 01/14/20
Standard: FCC Part 95M
Receiver: R&S FSW (ROS005-1) 10-10-2020 Limit Distance (m): 3
PreAmp: PRE8_10_25_2019.txt Test Distance (m): 0.22
PreAmp Used? (Y or N): N Voltage/Frequency: 5VDC Frequency Range: 40-231 GHz

Antenna & Cables: SHF Bands: N, LF, HF, SHF
Antenna: M05HWD M05HWD
Cable(s): CBLHF2012-2M-2_2-14-2020 Factors.txt
Barometer: DAV001 Filter: NONE
Temp/Humidity/Pressure: 23 deg C 30% 996 mB

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	154.020	51.20	49.94	0.84	22.69	-15.93	22.55020	600.00	-577.45	1/3 MHz	Noise Floor
Tx mode, E(dBuV/m) = P(dBm) + 104.77 – 20*LOG(d); where d is the distance of measurement in meters												
RMS	V	157.000	64.50	50.10	0.84	22.69	-2.47	500.20782	600.00	-99.79	1/3 MHz	Noise Floor
Tx mode, E(dBuV/m) = P(dBm) + 104.77 – 20*LOG(d); where d is the distance of measurement in meters												
RMS	V	161.580	64.30	50.35	0.84	22.69	-2.42	505.99996	600.00	-94.00	1/3 MHz	Noise Floor
Tx mode, E(dBuV/m) = P(dBm) + 104.77 – 20*LOG(d); where d is the distance of measurement in meters												
AVG	V	154.020	50.50	49.94	0.84	22.69	-16.63	19.19334	600.00	-580.81	1/3 MHz	Noise Floor
Tx mode, E(dBuV/m) = P(dBm) + 104.77 – 20*LOG(d); where d is the distance of measurement in meters												
AVG	V	157.000	62.50	50.10	0.84	22.69	-4.47	315.60980	600.00	-284.39	1/3 MHz	Noise Floor
Tx mode, E(dBuV/m) = P(dBm) + 104.77 – 20*LOG(d); where d is the distance of measurement in meters												
AVG	V	161.580	61.56	50.35	0.84	22.69	-5.16	269.24676	600.00	-330.75	1/3 MHz	Noise Floor

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

		Test Date:	08/28/2019 08/29/2019 11/18/2019 01/14/2020
Test Personnel:	Vathana Ven VJV		
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 95, Subpart M RSS-251, RSS-GEN	Limit Applied:	See report section 8.3
Input Voltage:	5 VDC		
Pretest Verification w/ Ambient Signals or BB Source:	N/A	Ambient Temperature:	23, 24, 30 ºC
		Relative Humidity:	56, 41, 30 %
		Atmospheric Pressure:	1001, 755, 996 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
DAV040'	Weather Station	Davis Instruments	7400	PE80519A61	01/23/2019	01/23/2020
OML3'	Mixer / Antenna	Oleson Microwave Lab	M12HWD	E21011-1	03/27/2019	03/27/2020
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	10/15/2018	10/15/2019
CBLSHF103'	Cable, SMA - SMA, < 18GHz	Sucoflex (Huber Suhn	104PE	CBLSHF103	11/15/2018	11/15/2019
SAF187'	Small Temperature/Humidity Chamber	Bryant Manufacturing	TH-5S	1207	01/29/2019	01/29/2020

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 specified in RSS-Gen.
Testing was performed at a nominal voltage of 5 Volts. The following is the client's justification.

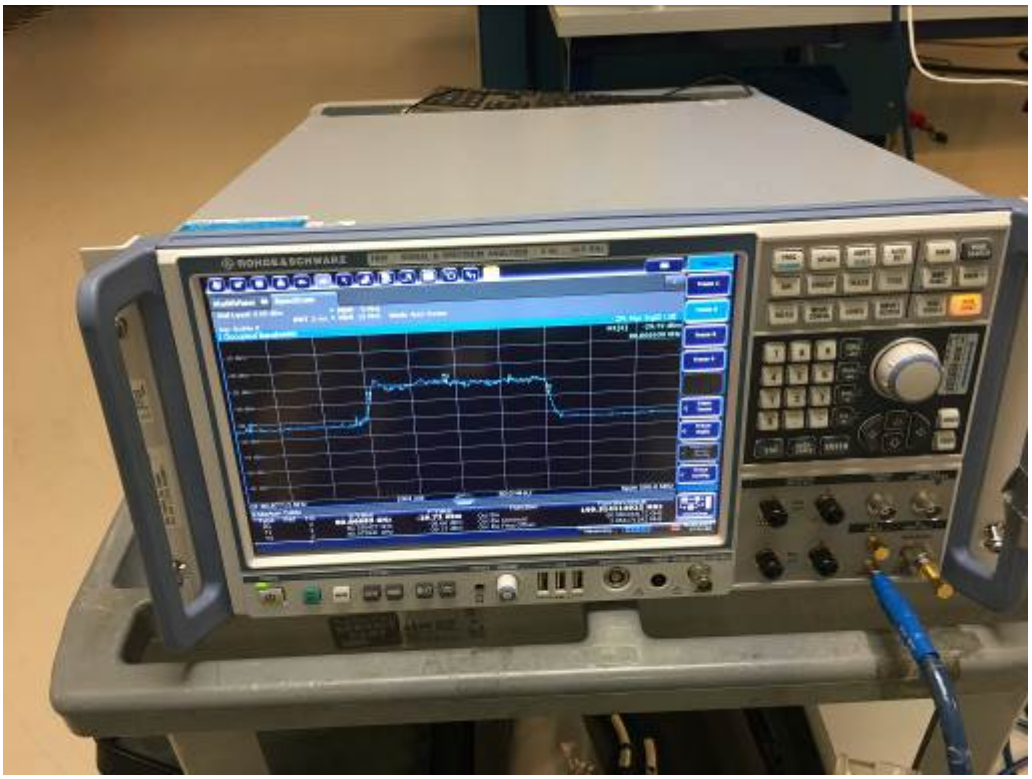
"The requirements for the frequency tolerance testing state that "an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise."

The following points summarize our justification for testing at a nominal 5 Volts:

- Our input voltage is based on the 5 Volt USB input spec. The stated range would equate to a voltage range of 4.25 Volts to 5.75 Volts which is outside the USB spec of 5 Volts +.25/-.6 Volts.
- Additionally, with our module construction, the LP87524JRNFRQ1 PMIC, which regulates voltage, maintains a constant voltage to the RF circuitry and will turn off or burn out if the input is under or over voltage to a point that it cannot maintain the correct output voltages. This blocks any variation of the digital and RF circuitry power input."

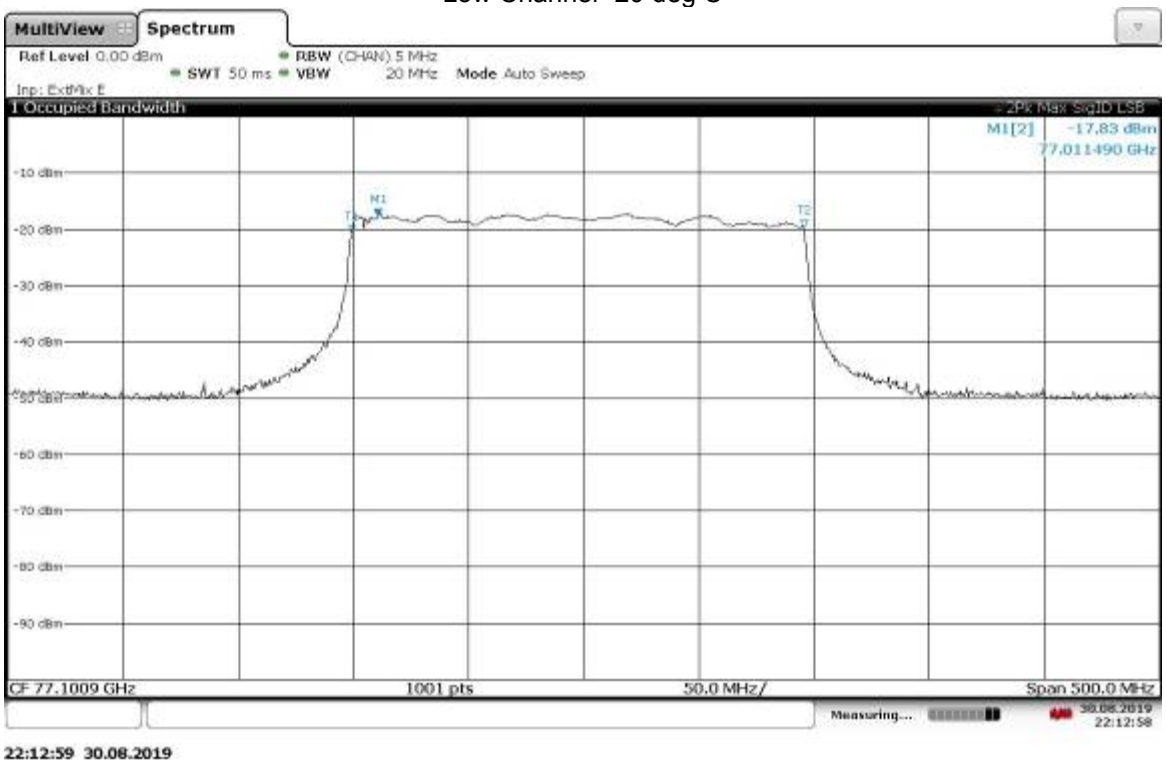
9.4 Setup Photograph:

Frequency stability Test Setup



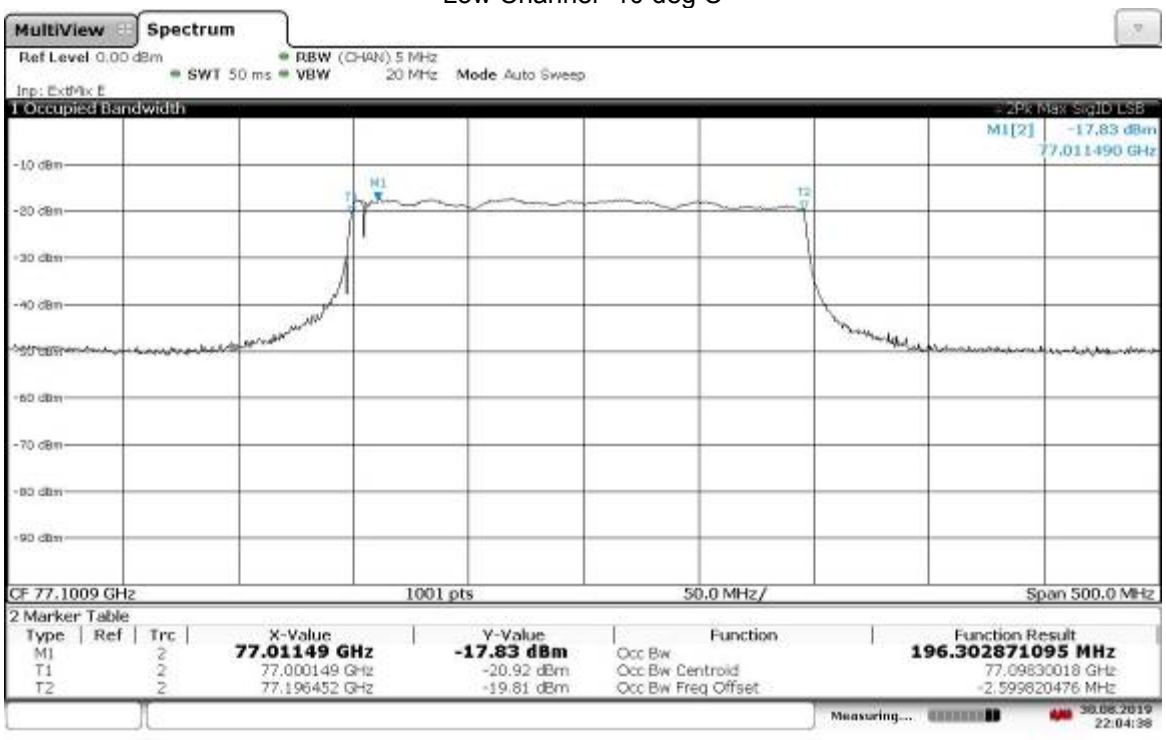
9.5 Plots/Data:

Low Channel -20 deg C



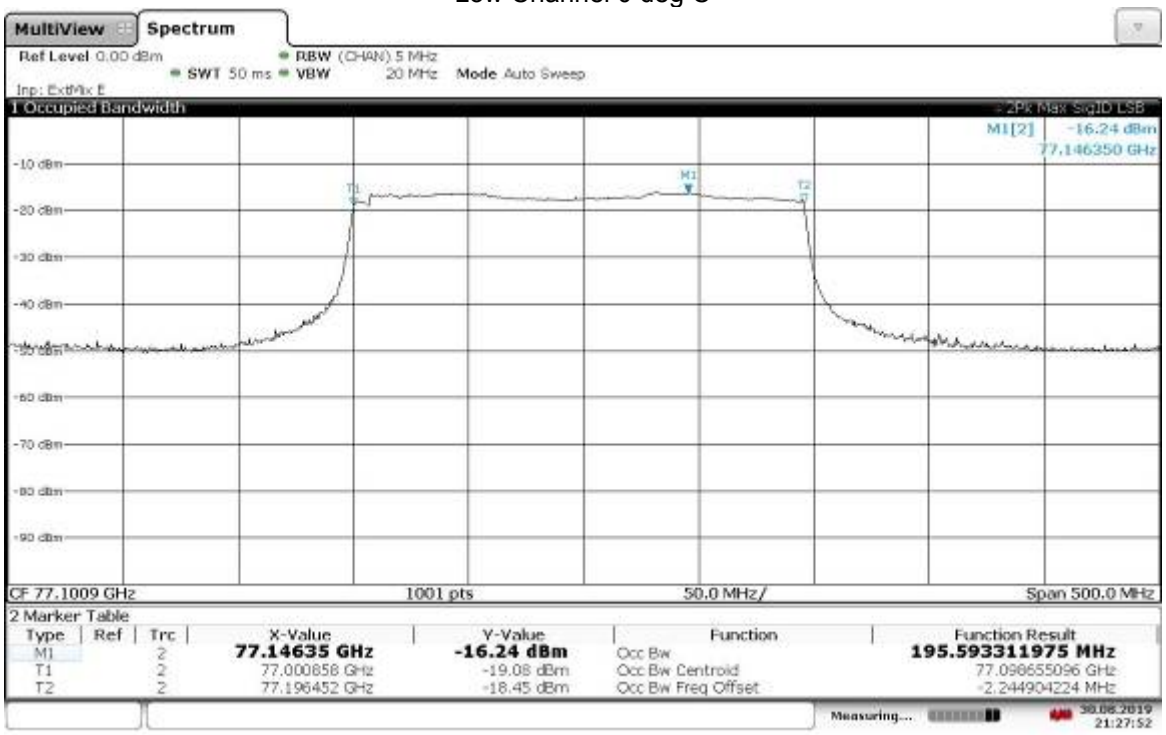
22:12:59 30.08.2019

Low Channel -10 deg C



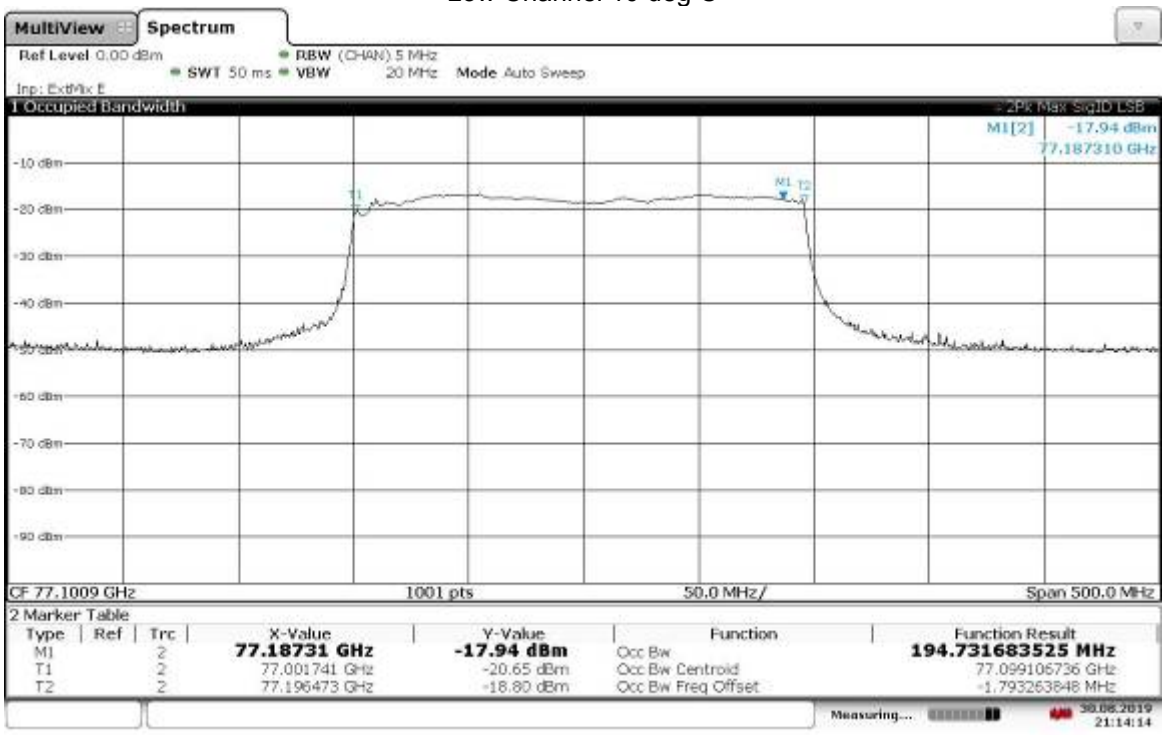
22:04:39 30.08.2019

Low Channel 0 deg C



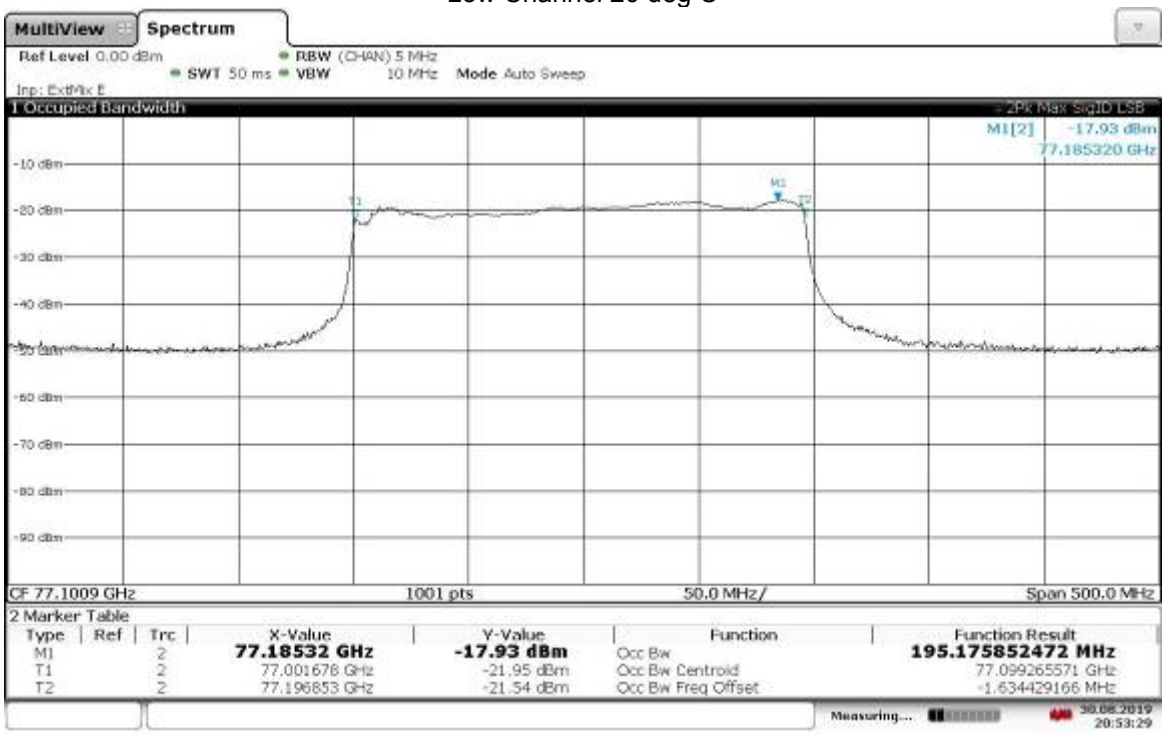
21:27:53 30.08.2019

Low Channel 10 deg C



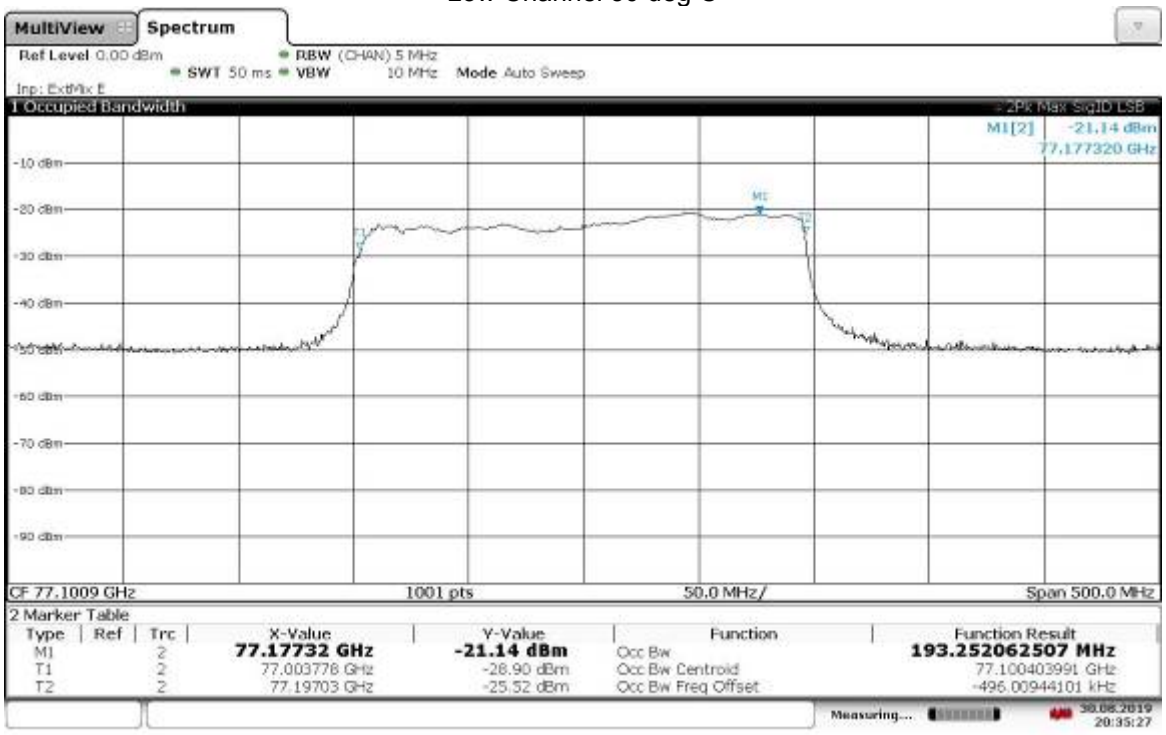
21:14:15 30.08.2019

Low Channel 20 deg C



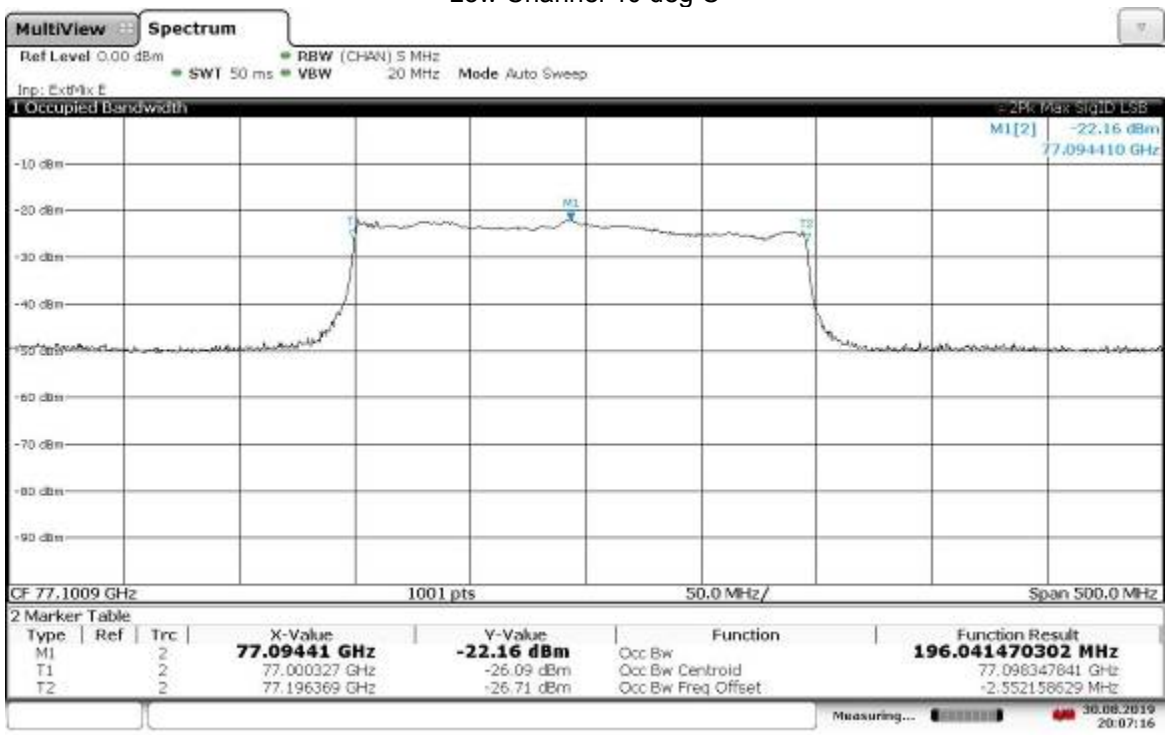
20:53:30 30.08.2019

Low Channel 30 deg C



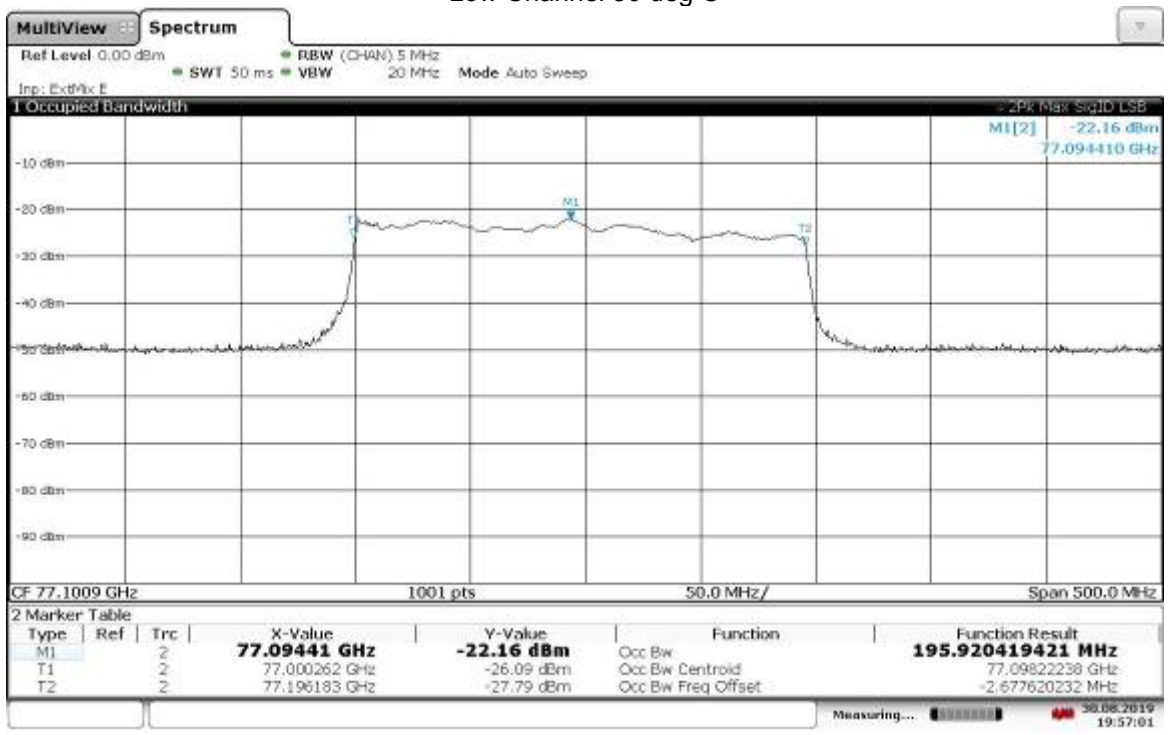
20:35:28 30.08.2019

Low Channel 40 deg C



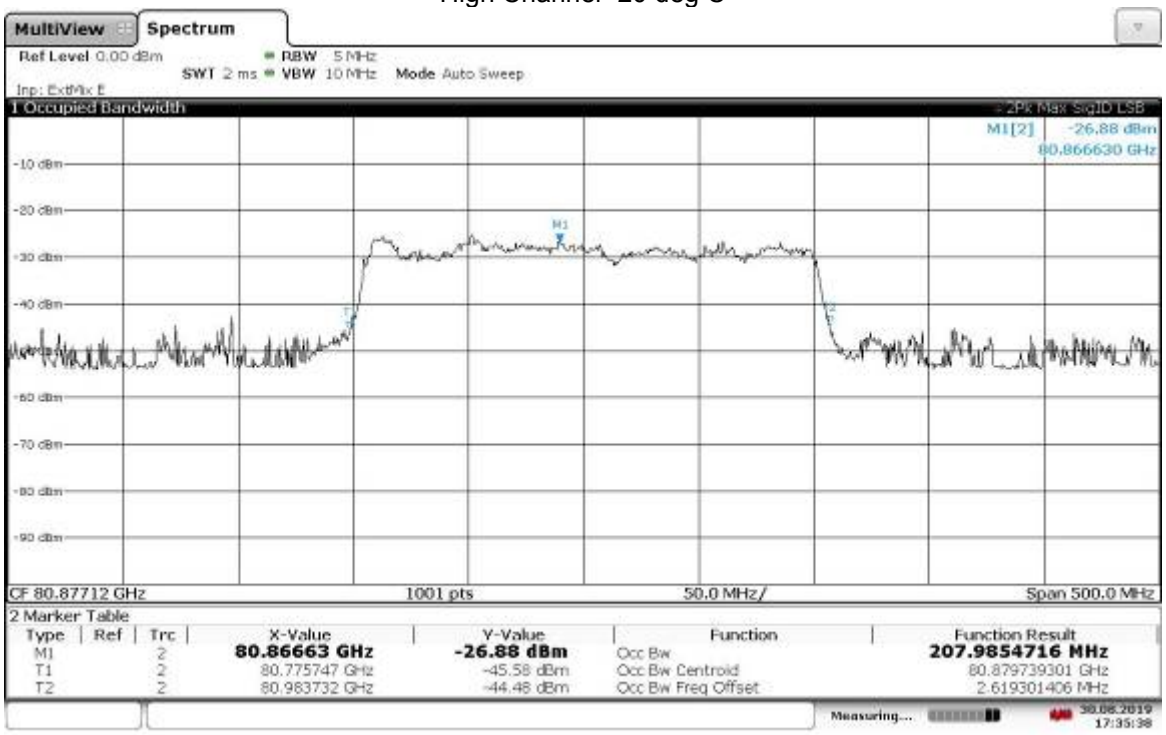
20:07:16 30.08.2019

Low Channel 50 deg C



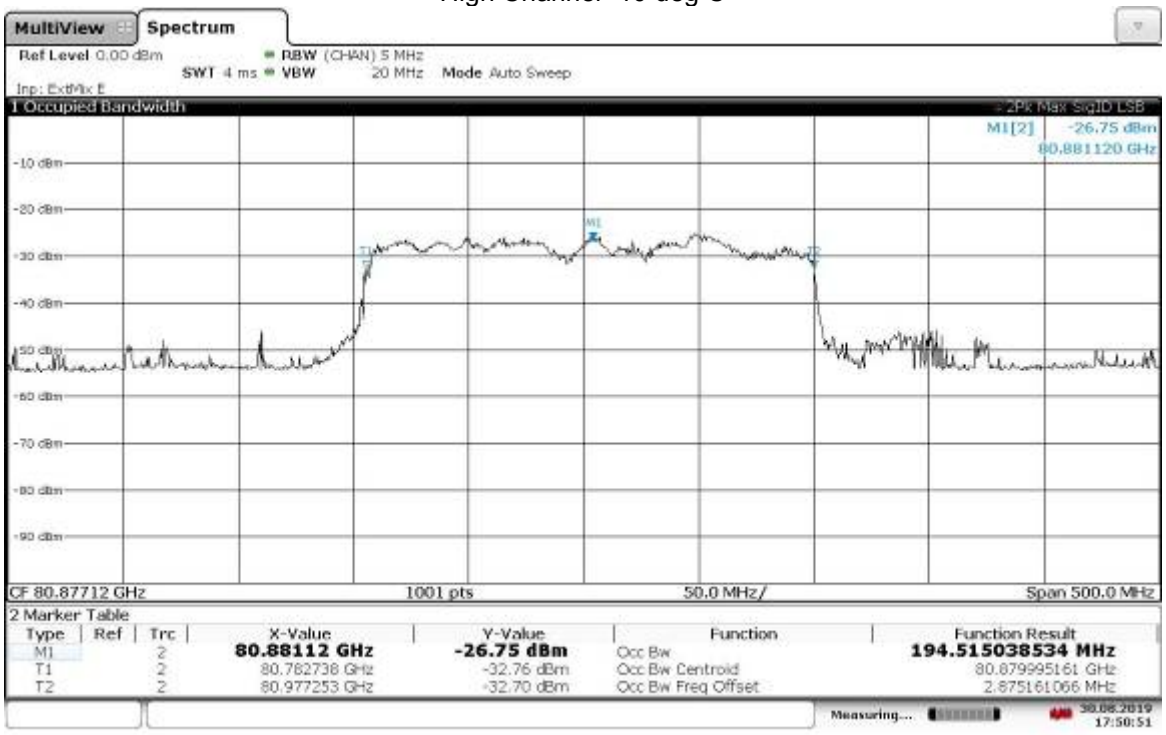
19:57:01 30.08.2019

High Channel -20 deg C



17:35:39 30.08.2019

High Channel -10 deg C

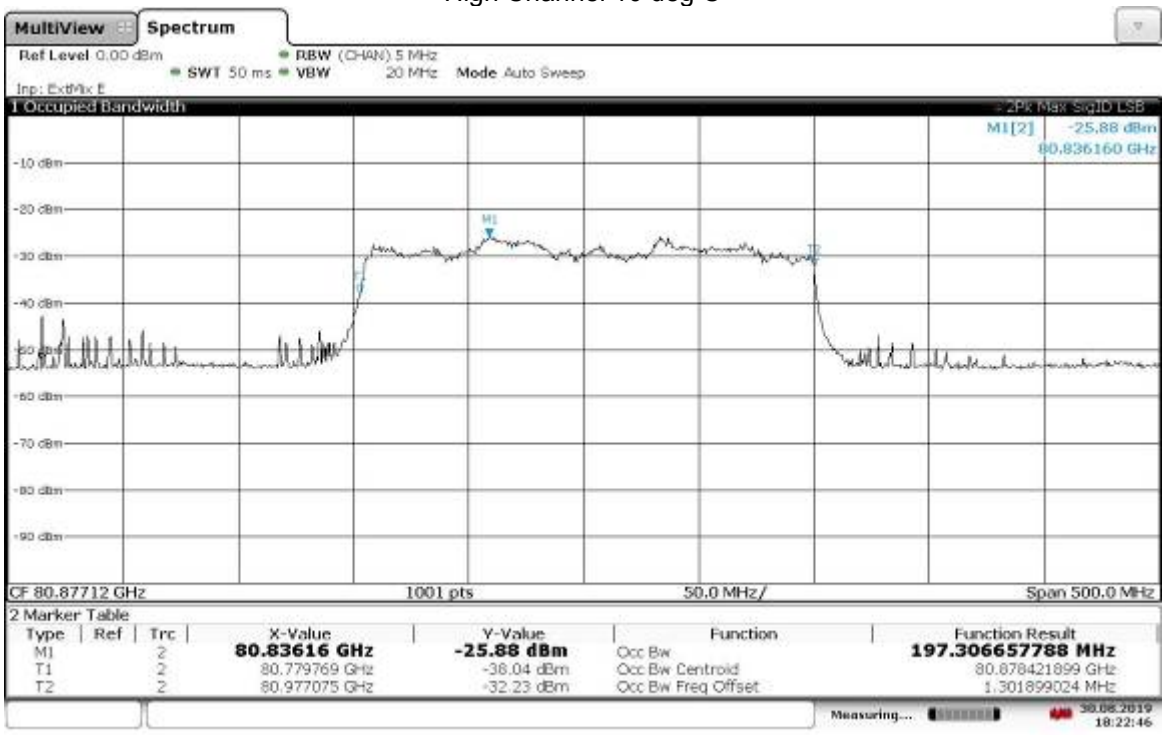


17:50:51 30.08.2019

High Channel 0 deg C

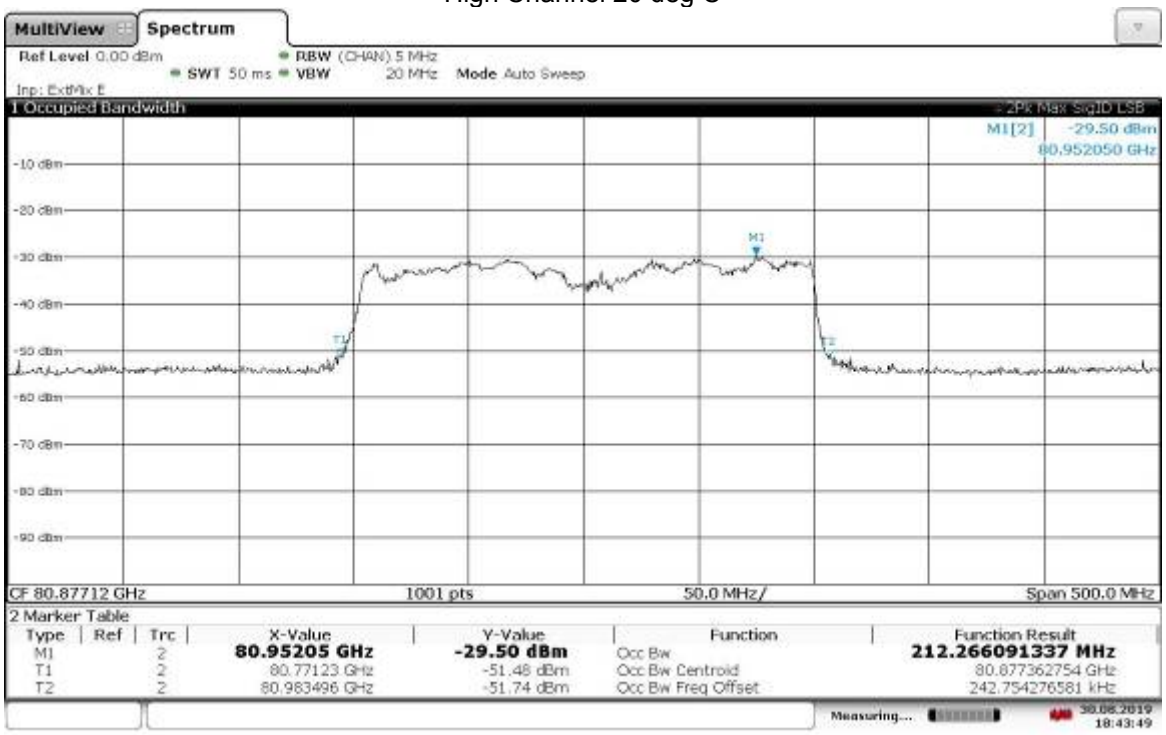
18:13:00 30.08.2019

High Channel 10 deg C



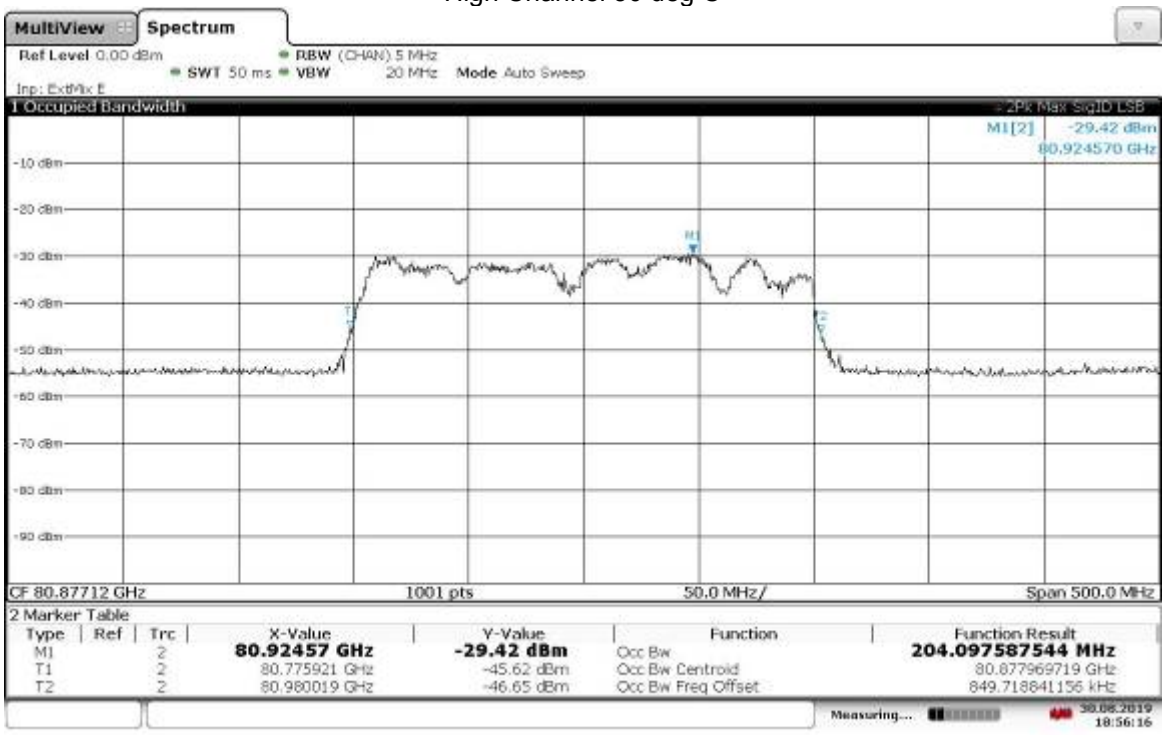
18:22:47 30.08.2019

High Channel 20 deg C



18:43:49 30.08.2019

High Channel 30 deg C

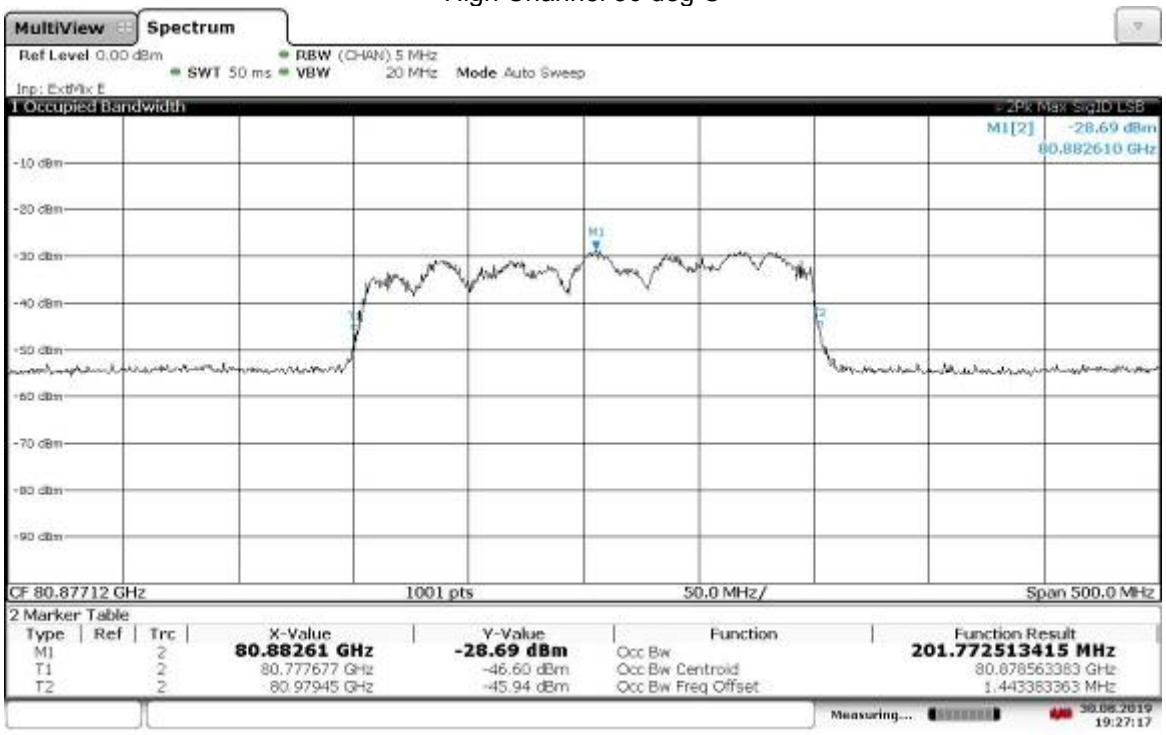


18:56:16 30.08.2019

High Channel 40 deg C

19:12:08 30.08.2019

High Channel 50 deg C



19:27:17 30.08.2019

Test Personnel:	Vathana Ven VSV	Test Date:	08/30/2019
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 95, Subpart M RSS-251	Limit Applied:	See report section 9.3
Input Voltage:	5VDC		
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: 6205419E-21011-1

Manufacturer: OML, Inc.

Model/Part No: 40200WGS **Serial/ID No:** 21011-1

Description: Harmonic Generator, 40 to 200+ GHz

Date of Test: March 25, 2019
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.

This certificate shall not be reproduced, except in full, without the written approval of OML.

Mitzi Chow, Material Manager — 03/27/2019 Date

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

Certificate of Compliance

Certificate No: 6205419A-U21011-1

Manufacturer: OML, Inc.

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

Description: WR-19 Harmonic Mixer, 40 to 60 GHz

Date of Test: March 20, 2019
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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Certificate of Compliance

Certificate No: 6205419B-E21011-1

Manufacturer: OML, Inc.

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

Description: WR-12 Harmonic Mixer, 60 to 90 GHz

Date of Test: March 20, 2019
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 — 03/27/2019 Date

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Certificate of Compliance

Certificate No: 6205419C-F21011-1

Manufacturer: OML, Inc.

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

Description: WR-08 Harmonic Mixer, 90 to 140 GHz

Date of Test: March 20, 2019
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 — 03/27/2019 Date

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Certificate of Compliance

Certificate No: 6205419D-G21011-1

Manufacturer: OML, Inc.

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

Description: WR-05 Harmonic Mixer, 140 to 220 GHz

Date of Test: March 20, 2019
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 — 03/27/2019 Date

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

Certificate of Compliance

Certificate No: 4207419A-190429-1

Manufacturer: OML, Inc.

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

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

Date of Test: April 29, 2019
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 : Factory Tested - No incoming data available.

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

Remarks:

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 — 05/01/2019 Date

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

11 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	09/04/2019	103842901BOX-013	VFV	KPS	Original Issue
1	10/16/2019	103842901BOX-013	VFV	KPS	Corrected typos, adding mixer calibration certificate
2	01/15/2020	103842901BOX-013	VFV	KPS	Added noise floor readings and fixed calculations
3	01/24/2020	103842901BOX-013	VFV	KPS	Remeasured output power, Emissions bandwidth, and rechecked spurious emissions