RF Test Report

Project Number: 4775973 **Offer Number:** SUW-202102000564 v2
Report Number: 4775973EMC01 **Revision Level:** 1

Client: Mueller Systems, LLC

Equipment Under Test: Mueller Cellular Node
Model: MS-CELLNODE
FCC ID: SM6-CELLNODE
IC: 9235A-CELLNODE

Applicable Standards: FCC Part 15 Subpart C, § 15.247
RSS-247, Issue 2, February 2017
RSS-GEN, Issue 5, February 2021, Amendment 2
ANSI C63.10:2013

Report issued on: 23 September 2021
Test Result: Compliant

FOR THE SCOPE OF ACCREDITATION UNDER CERTIFICATE NUMBER: 3212.01
This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the Federal Government.

Prepared by: Martin Taylor, Project Engineer

Reviewed by: Jeremy Pickens, RF Lab Manager

Remarks: This report details the results of the testing carried out on one sample; the results contained in this test report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.

Table of Contents

1 Summary of Test Results

Test Description	Test Specification		Test Result
Bandwidth	15.247(a)(2)	RSS-247 S5.2 (a) RSS-GEN S6.7	Compliant
Output Power	15.247(b)(3)	RSS-247 S5.4 (d)	Compliant
Power Spectral Density	15.247(e)	RSS-247 S5.2 (b)	Compliant
Conducted Spurious Emissions / Band Edge	15.247(d)	RSS-247 S5.5	Compliant
Emissions in Restricted Frequency Bands	15.247(d) 15.205, 15.209	RSS-247 S5.5 RSS-GEN S8.9, S8.10	Compliant
Band Edge Emissions in Restricted Frequency Bands	15.205, 15.209	RSS-GEN S8.9, S8.10	Compliant
AC Powerline Conducted Emissions	15.207	RSS-GEN S8.8	N/A (1)
Antenna Requirement	15.203	RSS-GEN S6.8	Compliant (2)

(1) The device does not connect to the AC Mains.
(2) The device uses an internal bent wire antenna which cannot be replaced by the end user.

1.1 *Modifications Required for Compliance*

None.

2 General Information

2.1 *Client Information*

Name:	Mueller Systems, LLC
Address:	1200 Abernathy Road, NE Suite 1200
City, State, Zip, Country:	Atlanta, Georgia 30328, USA

2.2 *Test Laboratory*

Name:	SGS North America, Inc.
Address:	620 Old Peachtree Road NW, Suite 100
City, State, Zip, Country:	Suwanee, GA 30024, USA
Accrediting Body:	A2LA
Type of lab:	Testing Laboratory
Certificate Number:	3212.01
CAB ID:	US0186

2.3 *General Information of EUT*

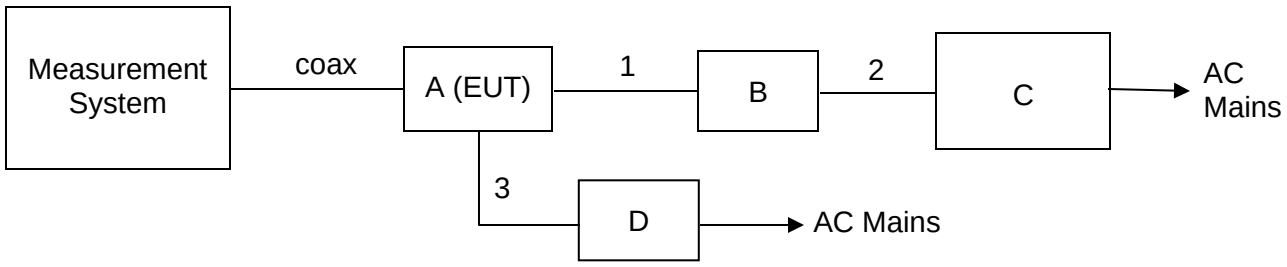
Equipment Under Test:	Mueller Cellular Node
Model:	MS-CELLNODE
Serial Numbers:	MC00000052 (conducted sample) MC00000055 (radiated sample)
FCC ID:	SM6-CELLNODE
IC:	9235A-CELLNODE
Frequency Range:	2402 – 2480 MHz
Data Modes:	Bluetooth Low Energy (GFSK)
Antenna:	Bent wire antenna (2dBi gain)
Rated Voltage:	3.6 Vdc (D Cell Lithium Battery)
Test Voltage:	3.6 Vdc from Lab Power Supply
Sample Received Date:	01 June 2021
Dates of testing:	21-22 July 2021

2.4 *Operating Modes and Conditions*

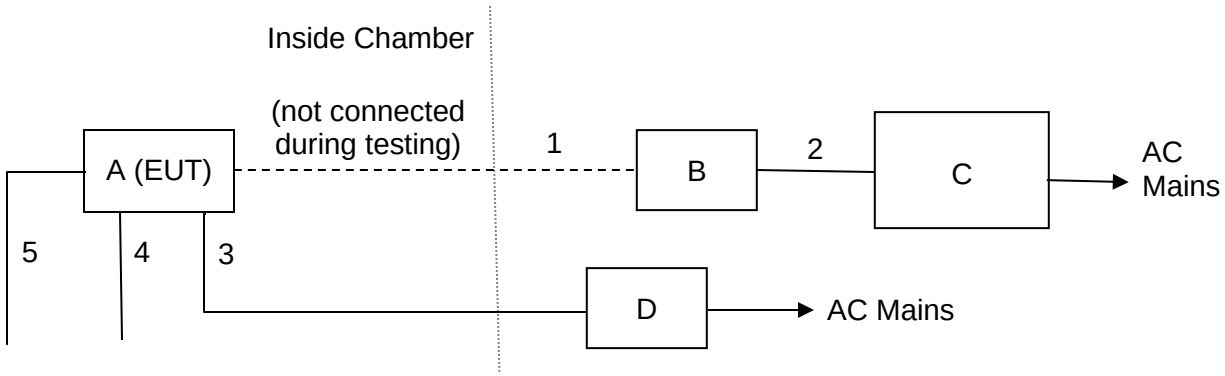
The EUT was connected to a Silicon Labs evaluation board with debug adapter to control the BLE radio. The software allowed the following:

1) selecting low, middle, and high BLE channels
2) selecting the modulation scheme as used in normal operation, but with 100% duty cycle
3) setting the power level. [The nominal power level of +4dBm was used for all tests.]

2.5 *EUT Connection Block Diagram – Conducted Measurements*



2.6 *EUT Connection Block Diagram – Radiated Measurements*



2.7 *System Configurations*

Device Reference	Manufacturer	Description	Model Number	Serial Number
A	Mueller Systems	Cellular Node (EUT)	MS-CELLNODE	MC00000052 MC00000055
B	Silicon Labs	Evaluation Board w/ Debug Adapter	PCB4001	200659879
C	HP	Laptop Computer	15-f233wm	5CD6415H9V
D	Rigol	DC Power Supply	DP711	Asset # 17004

2.8 *Cable List*

Cable reference	Port Name	Start	End	Cable Length (m)	Ferrite installed?	Shielded?
1	Ribbon	EUT	Debug Adapter	0.16	N	N
2	USB	Evaluation Board	Laptop Computer	0.92	N	N
3	DC Power	EUT	DC Power Supply	>1	N	N
4	Water Port	EUT	3-pin Connector	0.68	N	N
5	Valve Control	EUT	Valve Actuator	3.95	N	N

3 Bandwidth

3.1 *Test Result*

Test Description	Test Specification		Test Result
DTS Bandwidth (6dB)	15.247(a)(2)	RSS-247 S5.2 (a)	Compliant
Occupied Bandwidth (99%)	2.1049	RSS-GEN S6.7	Reported

3.2 *Test Methods*

The DTS 6dB bandwidth measurements were performed using the procedure from ANSI C63.10 clause 11.8.1, and the 99% occupied bandwidth measurements were performed using the procedure from ANSI C63.10 clause 6.9.3. These procedures are referenced in KDB 558074 D01 15.247 Meas Guidance v05r02.

Limit
The minimum 6dB bandwidth shall be at least 500 kHz.

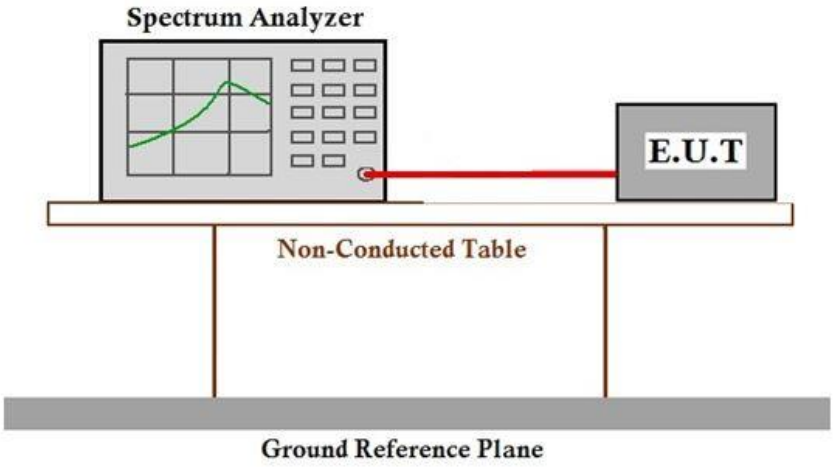
3.3 *Test Site*

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature:	24.9 °C
Relative Humidity:	50.6 %
Atmospheric Pressure:	98.2 kPa

3.4 *Test Setup*



3.5 *Test Equipment*

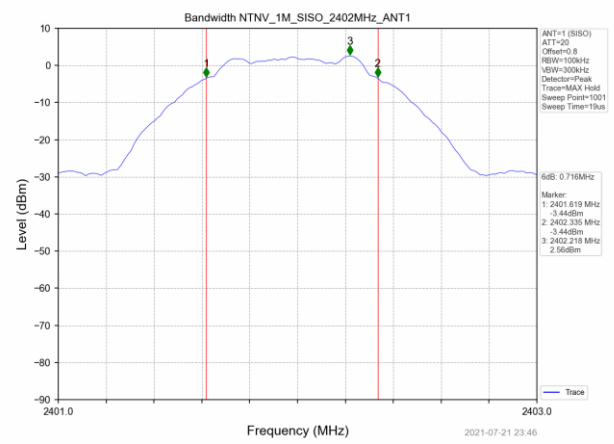
Test End Date: 21-Jul-2021 Tester: MT

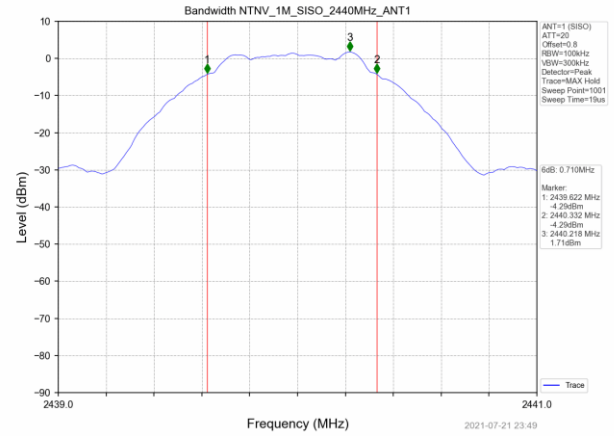
Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
RF Cable SMA to SMA, 0.01-40GHz	084-0505-059	TELEDYNE STORM MICROWAVE	20108	16-Mar-2021	16-Mar-2022
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	27-Dec-2019	27-Dec-2021

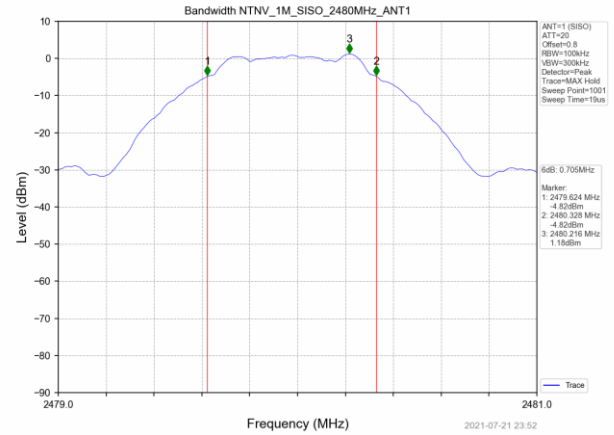
Note: The equipment calibration period is 1 year except for the FSV which is on a 2-year cycle.

3.6 *Test Data – DTS Bandwidth (6dB)*

Test Mode	Channel	Frequency (MHz)	6dB Bandwidth		Verdict
			Test Result (MHz)	Limits (MHz)	
BLE 1Mbps	0	2402	0.716	≥0.5	Pass
	19	2440	0.710	≥0.5	Pass
	39	2480	0.705	≥0.5	Pass

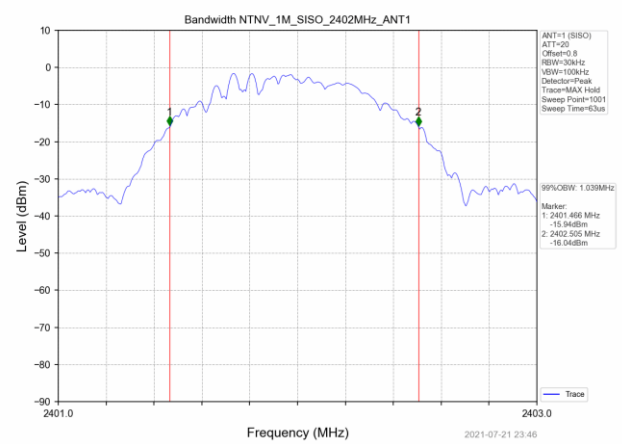


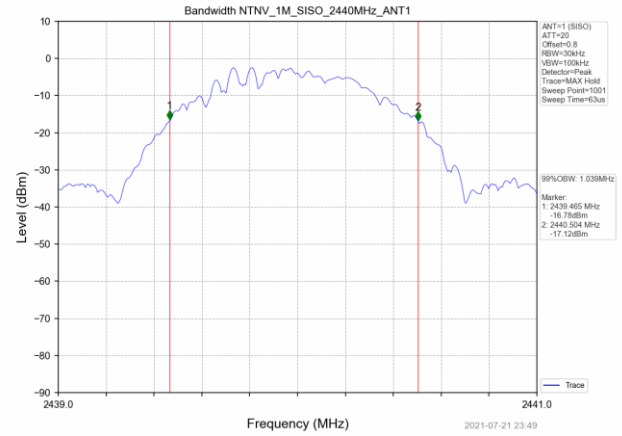


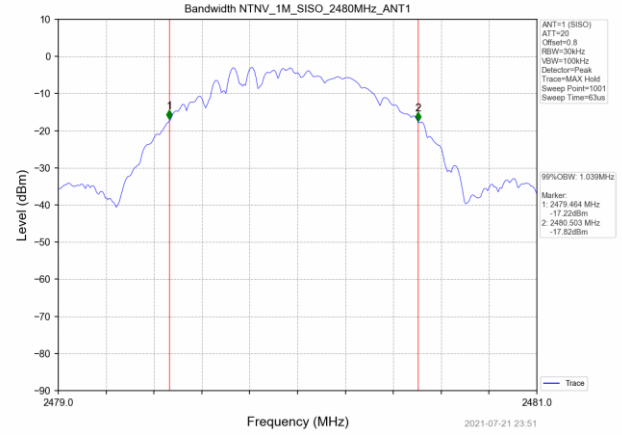


3.7 *Test Data – 99% Occupied Bandwidth*

Test Mode	Channel	Frequency (MHz)	99% Occupied Bandwidth Test Result (MHz)	Verdict
BLE 1Mbps	0	2402	1.039	Reported
	19	2440	1.039	Reported
	39	2480	1.039	Reported







4 Output Power

4.1 *Test Result*

Test Description	Test Specification		Test Result
Fundamental Emission Output Power	15.247(b)(3)	RSS-247 S5.4 (d)	Compliant

4.2 *Test Method*

Fundamental maximum peak conducted output power measurements were performed using the method described in ANSI C63.10:2013 clause 11.9.1.1. This procedure is referenced in KDB 558074 D01 15.247 Meas Guidance v05r02.

Limit

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. For using antennas with greater than 6dBi of gain, the limit is reduced in dB by the amount the gain exceeds 6dBi (e.g. for a 7.4dBi antenna, the limit is reduced from 30dBm to 28.6dBm). Also, the e.i.r.p. shall not exceed 4 Watts (36 dBm) based on RSS-247 S5.4 (d).

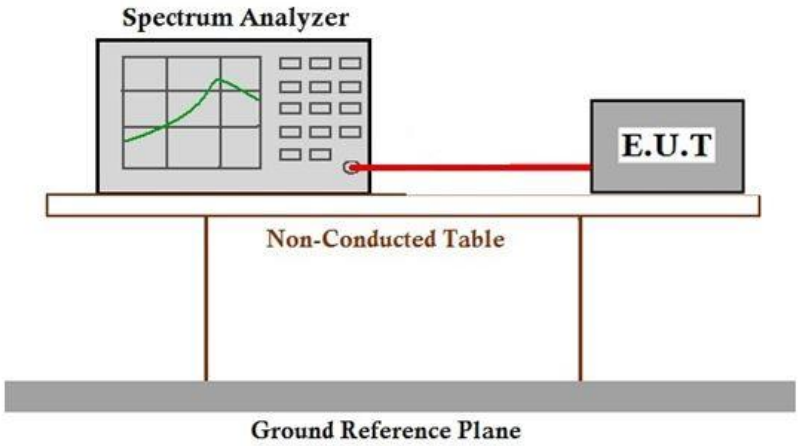
4.3 *Test Site*

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature:	24.9 °C
Relative Humidity:	50.6 %
Atmospheric Pressure:	98.2 kPa

4.4 *Test Setup*



4.5 *Test Equipment*

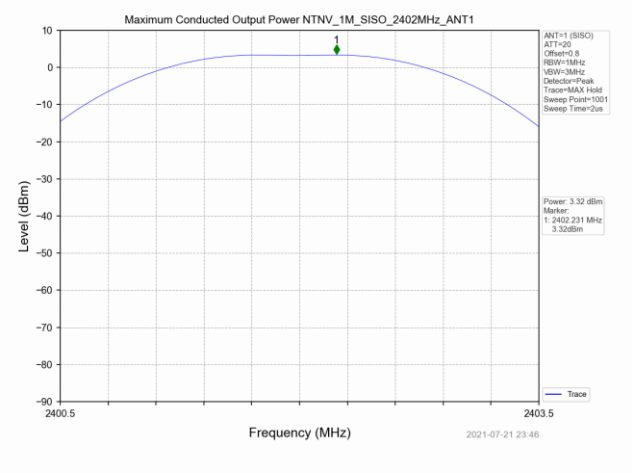
Test End Date: 21-Jul-2021 Tester: MT

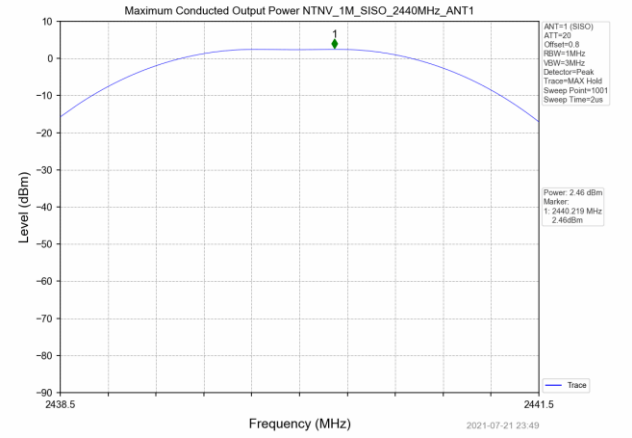
Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
RF Cable SMA to SMA, 0.01-40GHz	084-0505-059	TELEDYNE STORM MICROWAVE	20108	16-Mar-2021	16-Mar-2022
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	27-Dec-2019	27-Dec-2021

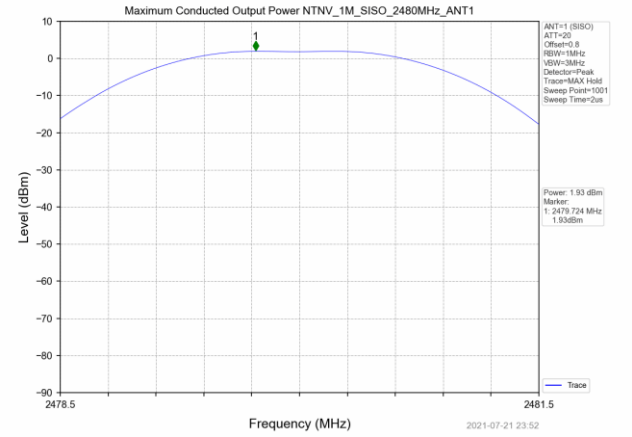
Note: The equipment calibration period is 1 year except for the FSV which is on a 2-year cycle.

4.6 *Test Data*

Channel	Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Peak EIRP (dBm)	Limit Max (dBm)	Verdict
0	2402	3.32	30	5.32	36	Pass
19	2440	2.46	30	4.46	36	Pass
39	2480	1.93	30	3.93	36	Pass







5 Power Spectral Density

5.1 *Test Result*

Test Description	Test Specification		Test Result
Power Spectral Density	15.247(e)	RSS-247 S5.2 (b)	Compliant

5.2 *Test Method*

Peak power spectral density measurements were performed using the procedures from ANSI C63.10: 2013 clause 11.10.2. These procedures are referenced in KDB 558074 D01 15.247 Meas Guidance v05r02.

Limit
The maximum limit is 8 dBm / 3 kHz.

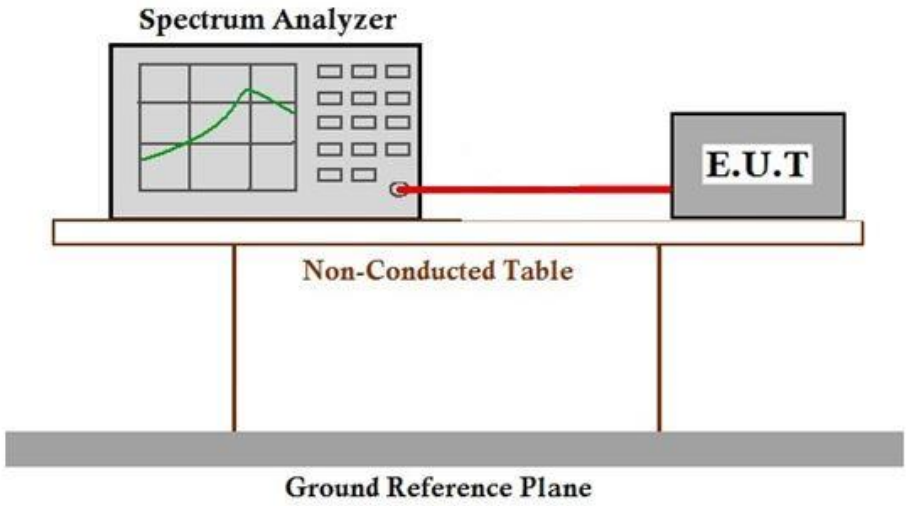
5.3 *Test Site*

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature:	24.9 °C
Relative Humidity:	50.6 %
Atmospheric Pressure:	98.2 kPa

5.4 *Test Setup*



5.5 *Test Equipment*

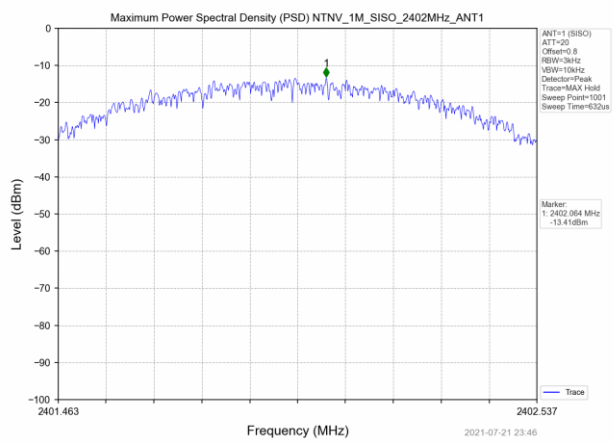
Test End Date: 21-Jul-2021 Tester: MT

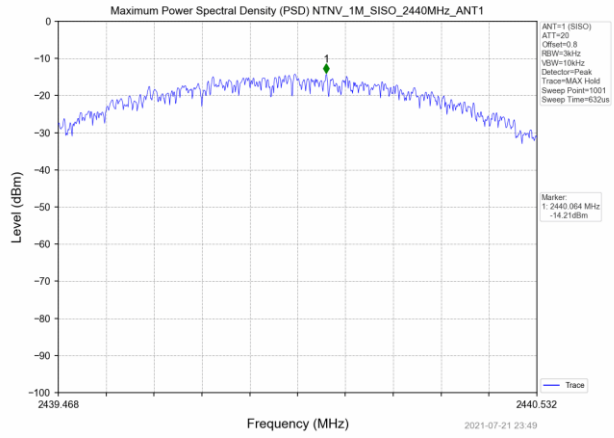
Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
RF Cable SMA to SMA, 0.01-40GHz	084-0505-059	TELEDYNE STORM MICROWAVE	20108	16-Mar-2021	16-Mar-2022
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	27-Dec-2019	27-Dec-2021

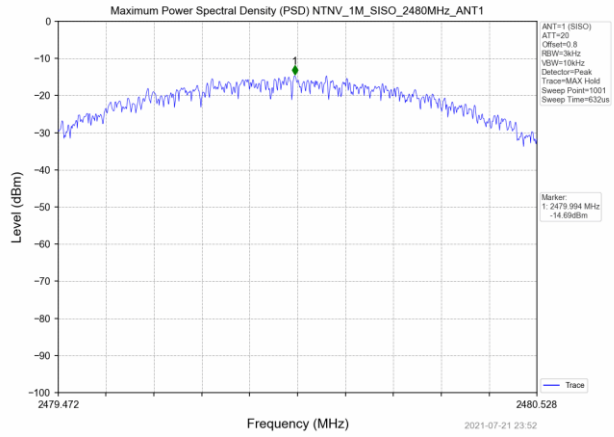
Note: The equipment calibration period is 1 year except for the FSV which is on a 2-year cycle.

5.6 *Test Data*

Channel	Frequency (MHz)	Peak PSD (dBm/3kHz)	Limit Max (dBm/3kHz)	Verdict
0	2402	-13.41	8	Pass
19	2440	-14.21	8	Pass
39	2480	-14.69	8	Pass







6 Conducted Spurious Emissions / Band Edge

6.1 *Test Result*

Test Description	Test Specification		Test Result
Conducted Spurious and Band Edge Emissions	15.247(d)	RSS-247 S5.5	Compliant

6.2 *Test Method*

Conducted band edge and spurious band emissions in non-restricted frequency bands were measured using the method defined in ANSI C63.10 clause 11.11. This procedure is referenced in KDB 558074 D01 15.247 Meas Guidance v05r02.

Limit

Because the maximum peak conducted output power was used to determine compliance with the output power limits, the limit in any 100 kHz band outside of the authorized band is 20 dB below the maximum in-band peak level.

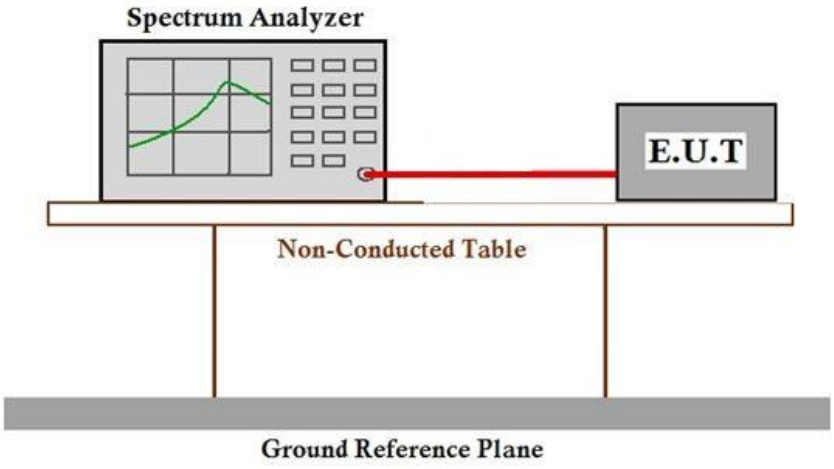
6.3 *Test Site*

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature:	24.9 °C
Relative Humidity:	50.6 %
Atmospheric Pressure:	98.2 kPa

6.4 *Test Setup*



6.5 *Test Equipment*

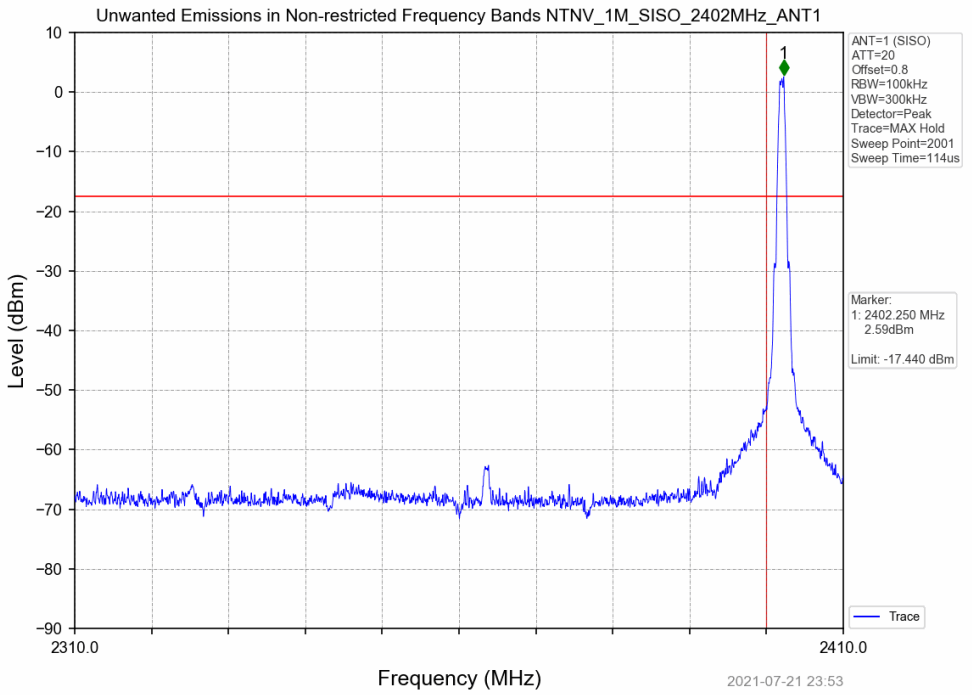
Test End Date: 21-Jul-2021 Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
RF Cable SMA to SMA, 0.01-40GHz	084-0505-059	TELEDYNE STORM MICROWAVE	20108	16-Mar-2021	16-Mar-2022
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	27-Dec-2019	27-Dec-2021

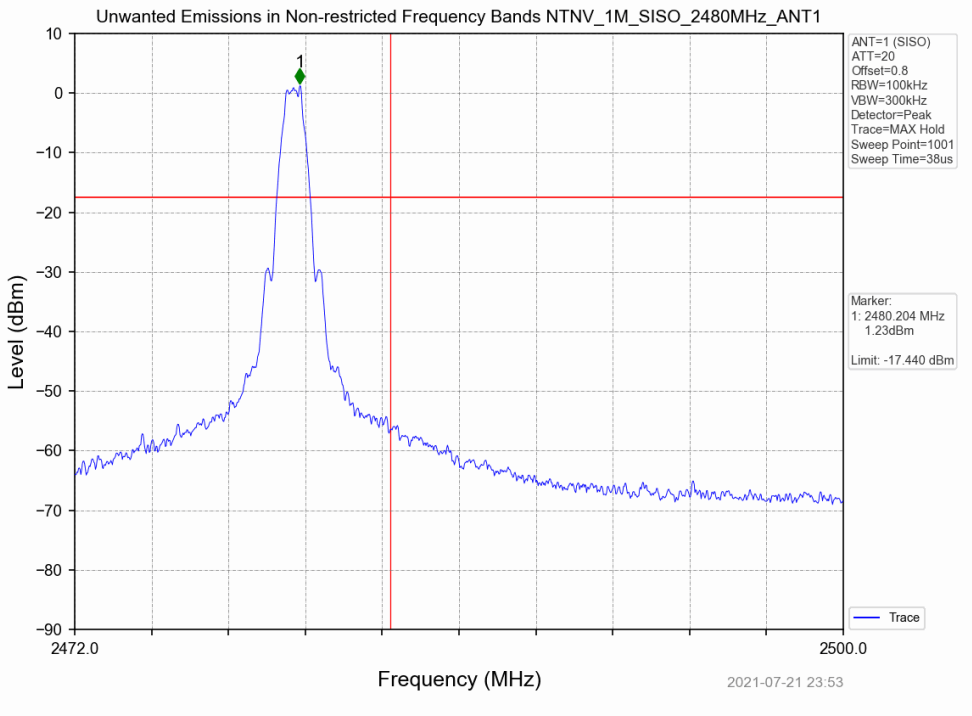
Note: The equipment calibration period is 1 year except for the FSV which is on a 2-year cycle.

6.6 *Test Data – DTS Band Edge*

BLE - Lower band edge

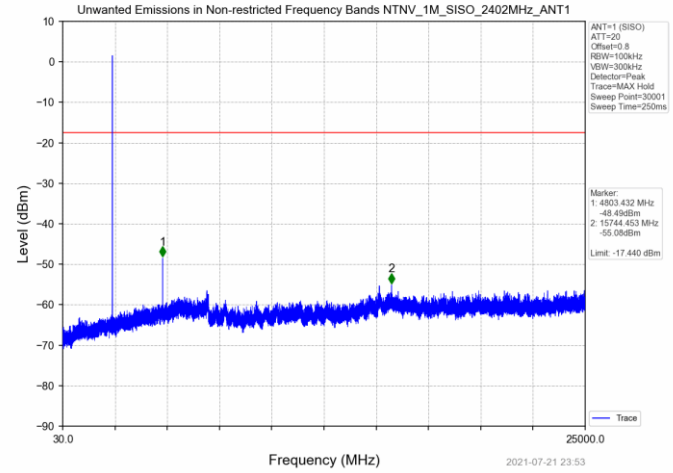


BLE - Upper band edge

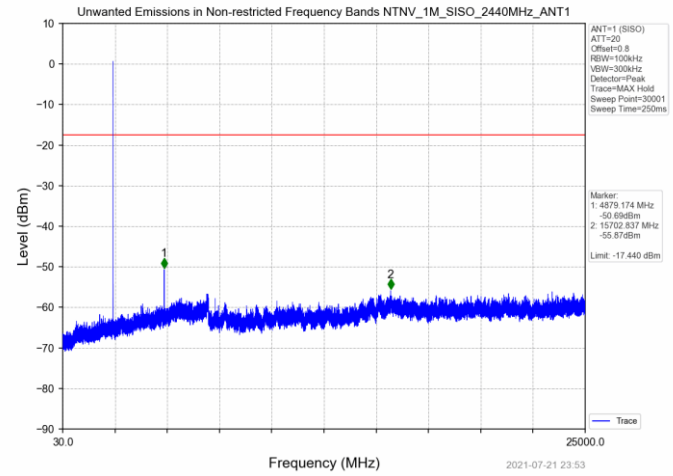


6.7 *Test Data – DTS Conducted Spurious Emissions*

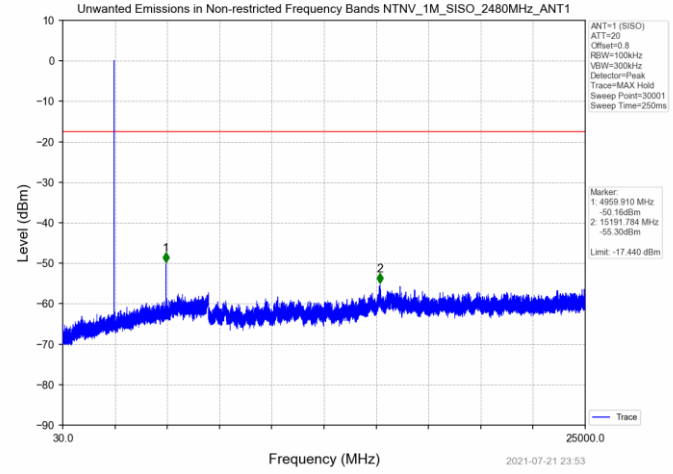
Conducted Spurs – BLE Channel 0



Conducted Spurs – BLE Channel 19



Conducted Spurs – BLE Channel 39



7 Emissions in Restricted Frequency Bands

7.1 *Test Result*

Test Description	Test Specification		Test Result
Emissions in Restricted Frequency Bands	15.247(d) 15.205, 15.209	RSS-247 S5.5 RSS-GEN S8.9, S8.10	Compliant

7.2 *Test Method*

Radiated emissions in restricted frequency bands were measured using methods defined in ANSI C63.10 clause 11.12. These procedures are referenced in KDB 558074 D01 15.247 Meas Guidance v05r02.

Lowest, middle and highest channels were investigated – the device was commanded to continuously transmit on channels 0, 19 and 39.

The EUT was testing in the vertical orientation since that is how it will be installed.

Test distances for radiated tests:

9k to 30 MHz – Near field prescan to determine if there were any emissions
30 to 1000 MHz - The EUT to measurement antenna distance was 3 meters
1 to 18 GHz - The EUT to measurement antenna distance was 3 meters
18 to 26 GHz - The EUT to measurement antenna distance was 3 meters

Limits within restricted bands of operation:

Frequency	Limits(1)		Peak Limits dBuV/m
	Microvolts/m	dBuV/m	
30 - 88 MHz	100	40 (2)	--
88 - 216 MHz	150	43.5 (2)	--
216 - 960 MHz	200	46 (2)	--
960 - 1000 MHz	500	54 (2)	--
1 - 40 GHz	500	54 (3)	74

(1) These limits are applicable to emissions outside of the intentional transmit frequency band.
(2) Quasi-peak limit
(3) Average limit

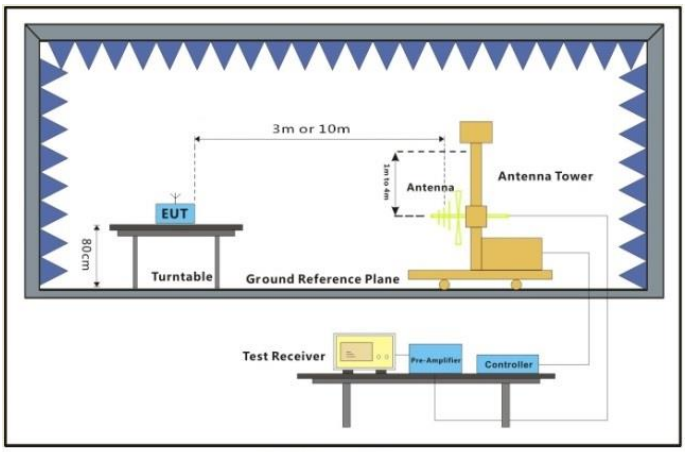
7.3 *Test Site*

3m Absorber Lined Shielded Enclosure (ALSE), Suwanee, GA

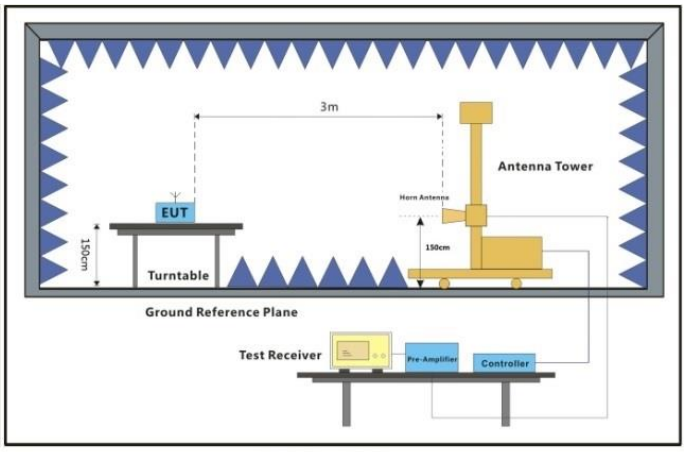
Environmental Conditions

Temperature:	23.3°C
Relative Humidity:	52.7 %
Atmospheric Pressure:	98.1 kPa

7.4 *Test Setup*



30MHz-1GHz



Above 1GHz

7.5 *Test Equipment*

30-1000MHz

Test End Date: 22-Jul-2021 Tester: PL

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
ANTENNA, BILOG	JB6	SUNOL	B079689	5-Nov-2020	5-Nov-2022
RF Cable Nm to Nm, 0.01-18GHz	90-195-354	TELEDYNE STORM MICROWAVE	20120	17-Feb-2021	17-Feb-2022
RF Cable Nm to Nf, 0.01-18GHz	90-213-118	TELEDYNE STORM MICROWAVE	20117	17-Feb-2021	17-Feb-2022
RF CABLE, Nm to Nm.	90-195-157	TELEDYNE STORM MICROWAVE	21019	26-Mar-2021	26-Mar-2022
RF CABLE	SUCOFLEX 100	Huber & Suhner	B108523	26-Aug-2021	26-Aug-2022
LOW NOISE AMPLIFIER	ZKL-2+	Mini-Circuits	B079800	7-Jul-2021	7-Jul-2022
EMI TEST RECEIVER	ESU8	ROHDE & SCHWARZ	B085759	9-Jul-2021	9-Jul-2022

Note: The equipment calibration period is 1 year, except for the antenna which is on a 2-year cycle.

1-18GHz

Test End Date: 22-Jul-2021 Tester: PL

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
ANTENNA, DRG HORN	3117	ETS Lindgren	B079691	10-Aug-2020	10-Aug-2022
RF Cable Nm to Nm, 0.01-18GHz	90-195-354	TELEDYNE STORM MICROWAVE	20120	17-Feb-2021	17-Feb-2022
RF CABLE	SUCOFLEX 100	Huber & Suhner	B108523	26-Aug-2021	26-Aug-2022
LOW NOISE AMPLIFIER	TS-PR18	ROHDE & SCHWARZ	B094463	7-Jul-2021	7-Jul-2022
EMI TEST RECEIVER	ESU40	ROHDE & SCHWARZ	100280	27-Dec-2020	27-Dec-2021

Note: The equipment calibration period is 1 year, except for the antenna which is on a 2-year cycle.

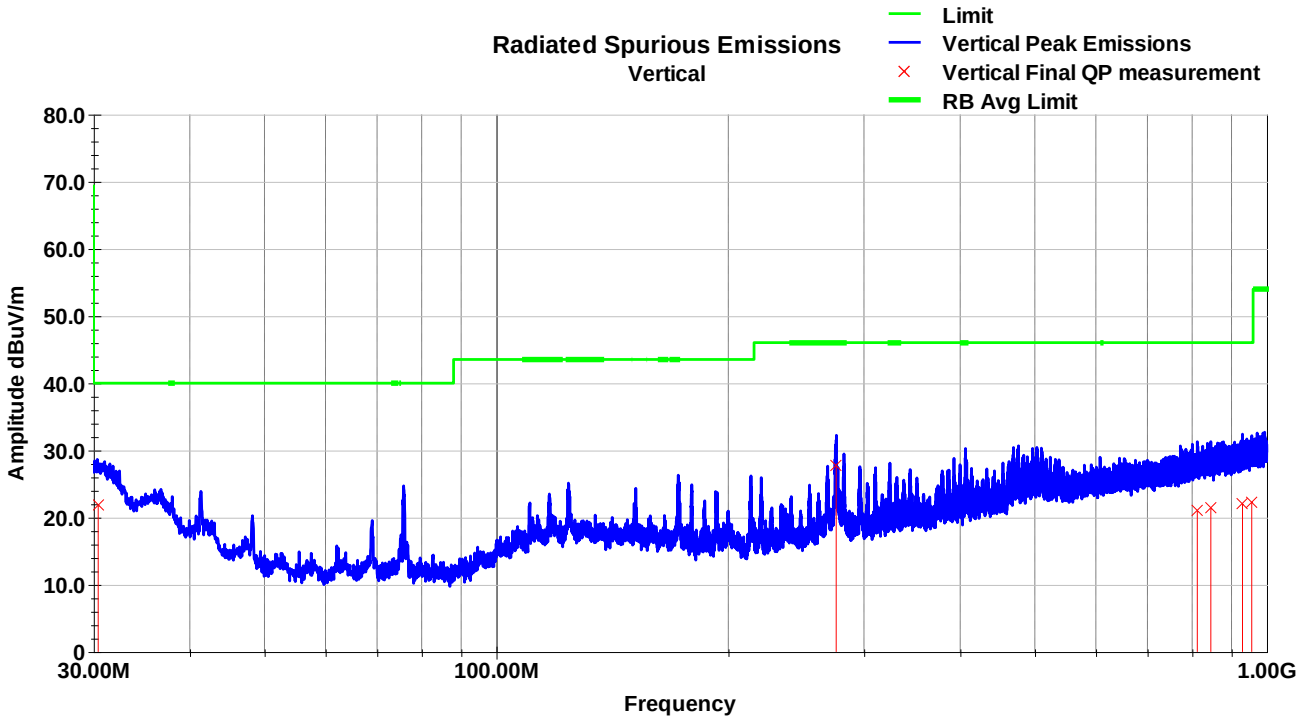
Software: "RSE 30-1000 MHz T7 201007" TILE 7! profile dated Oct 2020
"RSE 1-18 GHz T7 210212" TILE 7! profile dated Feb 2021

7.6 *Test Data*

No emissions were detected in the 9kHz to 30MHz frequency range.

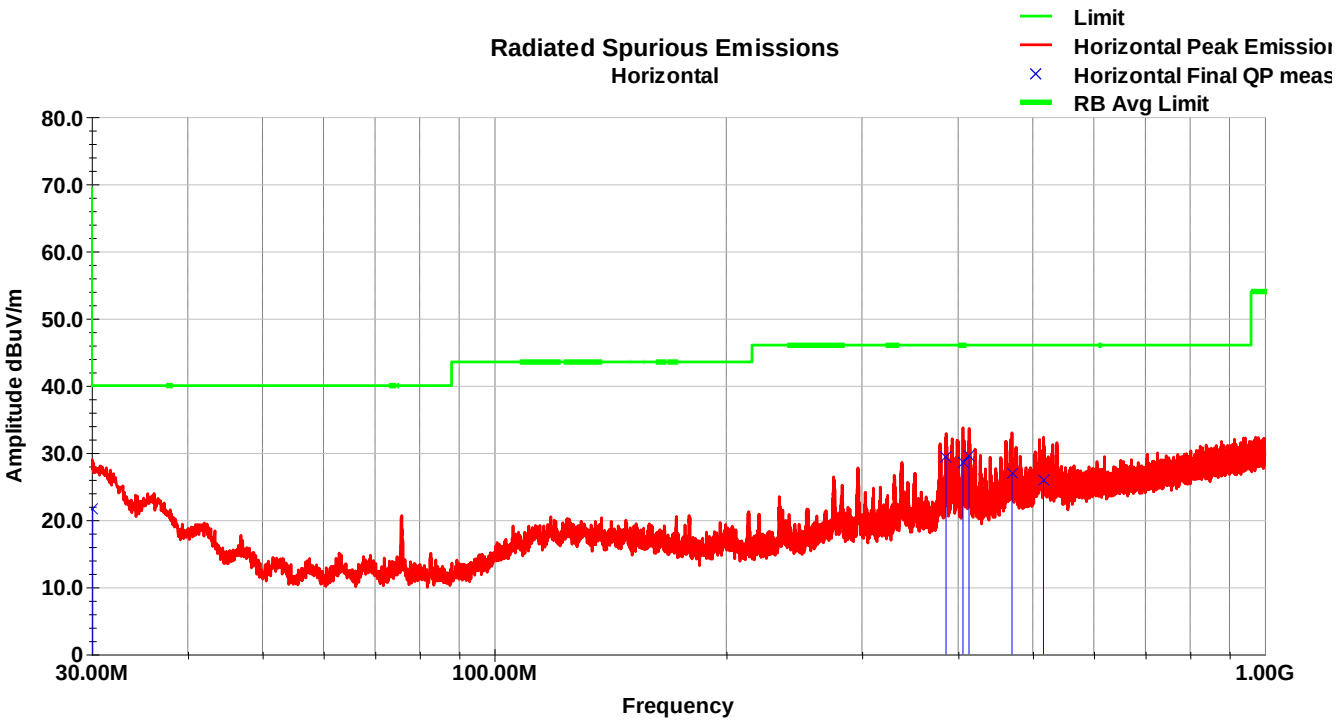
7.6.1 30-1000 MHz

30-1000MHz Vertical Low Channel



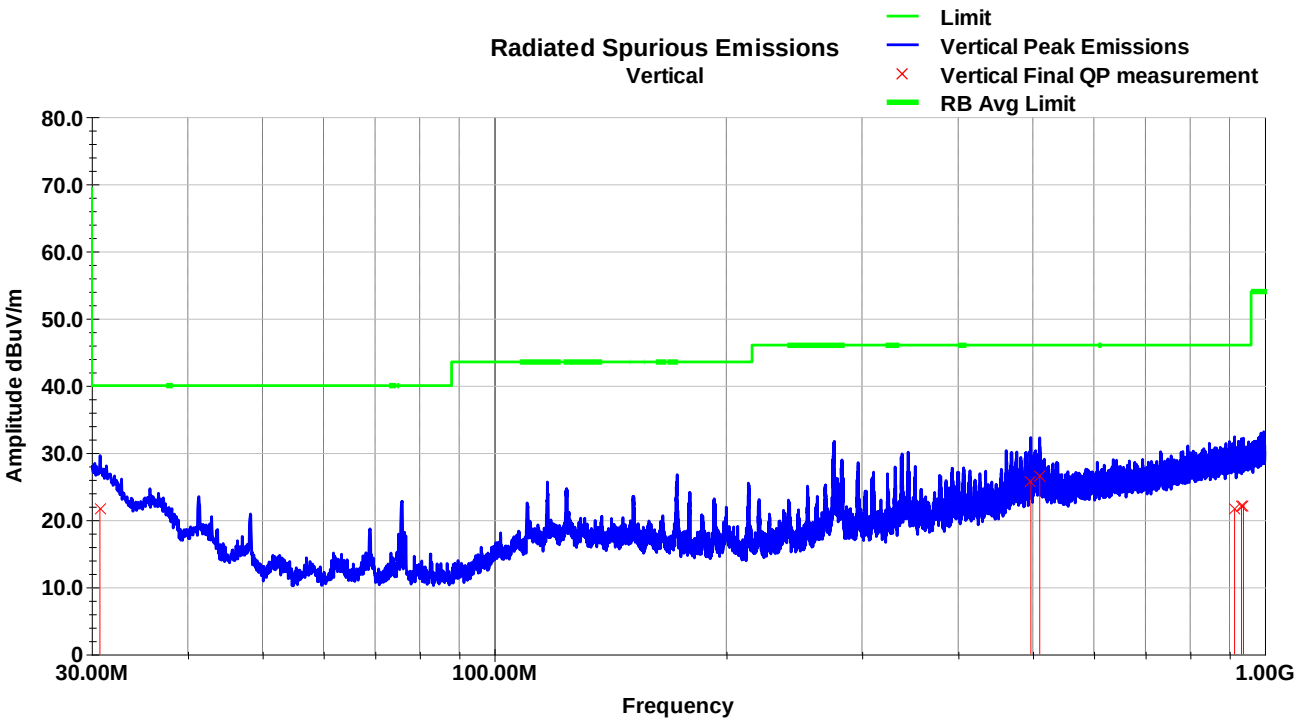
Frequency	Raw QP	Polarity	Azimuth	Height	AF	Loss	Amp	QP Value	Limit	Margin
MHz	(dBuV)	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	(dBuV/m)	(dBuV/m)	(dB)
30.42	30.6	V	216	271	22	0.5	31.3	21.8	40	-18.2
276.16	42.7	V	78	101	13.9	1.8	30.8	27.7	46	-18.3
812.48	25.4	V	71	278	22.3	3.1	29.9	21	46	-25.1
846.08	25.5	V	246	252	22.6	3.2	30	21.4	46	-24.6
930.04	25.3	V	68	127	23.2	3.3	29.8	22	46	-24
956.23	25.3	V	127	134	23.5	3.4	29.8	22.3	46	-23.7
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

30-1000MHz Horizontal Low Channel



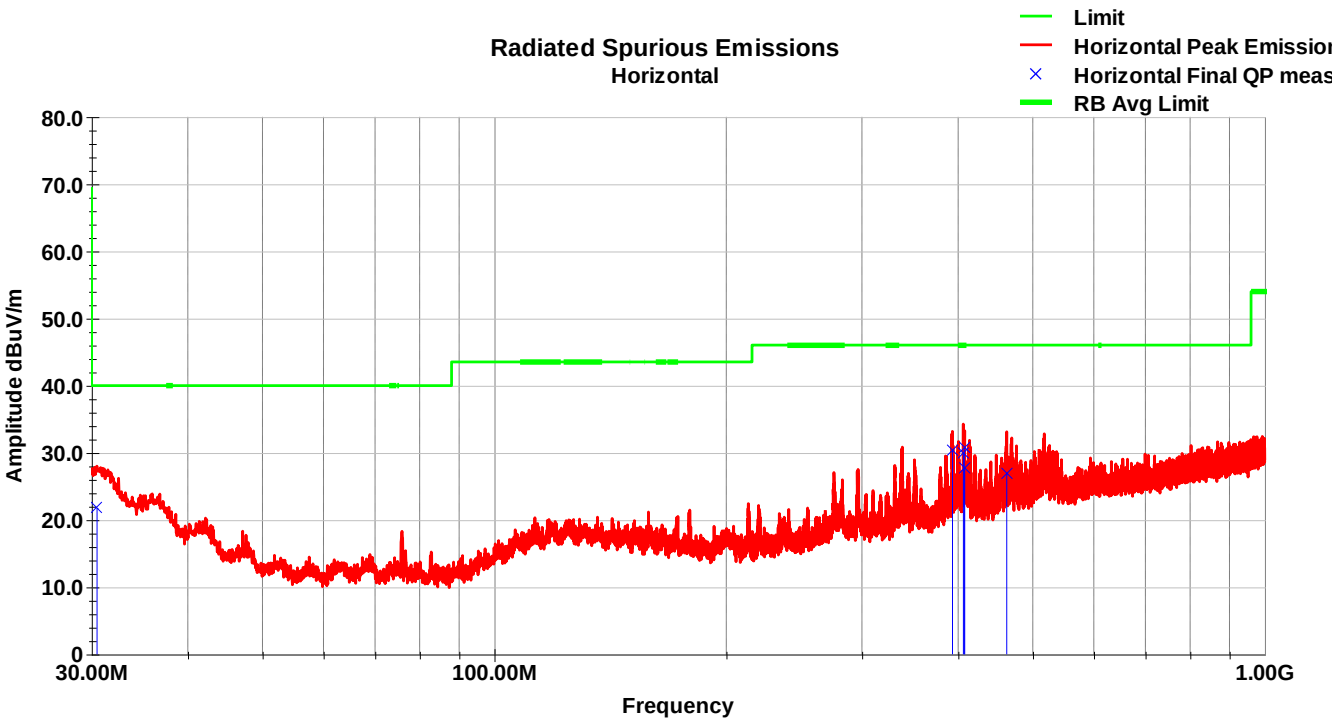
Frequency	Raw QP	Polarity	Azimuth	Height	AF	Loss	Amp	QP Value	Limit	Margin
MHz	(dBuV)	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	(dBuV/m)	(dBuV/m)	(dB)
30.11	30.3	H	131	314	22.2	0.5	31.3	21.7	40	-18.3
385.81	41.9	H	207	102	16	2.1	30.6	29.4	46	-16.6
405.79	40.5	H	203	102	16.4	2.2	30.6	28.5	46	-17.5
413.18	41.4	H	202	103	16.5	2.2	30.6	29.6	46	-16.4
469.88	37.2	H	185	104	17.8	2.4	30.4	27	46	-19
516.21	35.1	H	216	100	18.5	2.5	30.3	25.8	46	-20.2
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

30-1000MHz Vertical Mid Channel



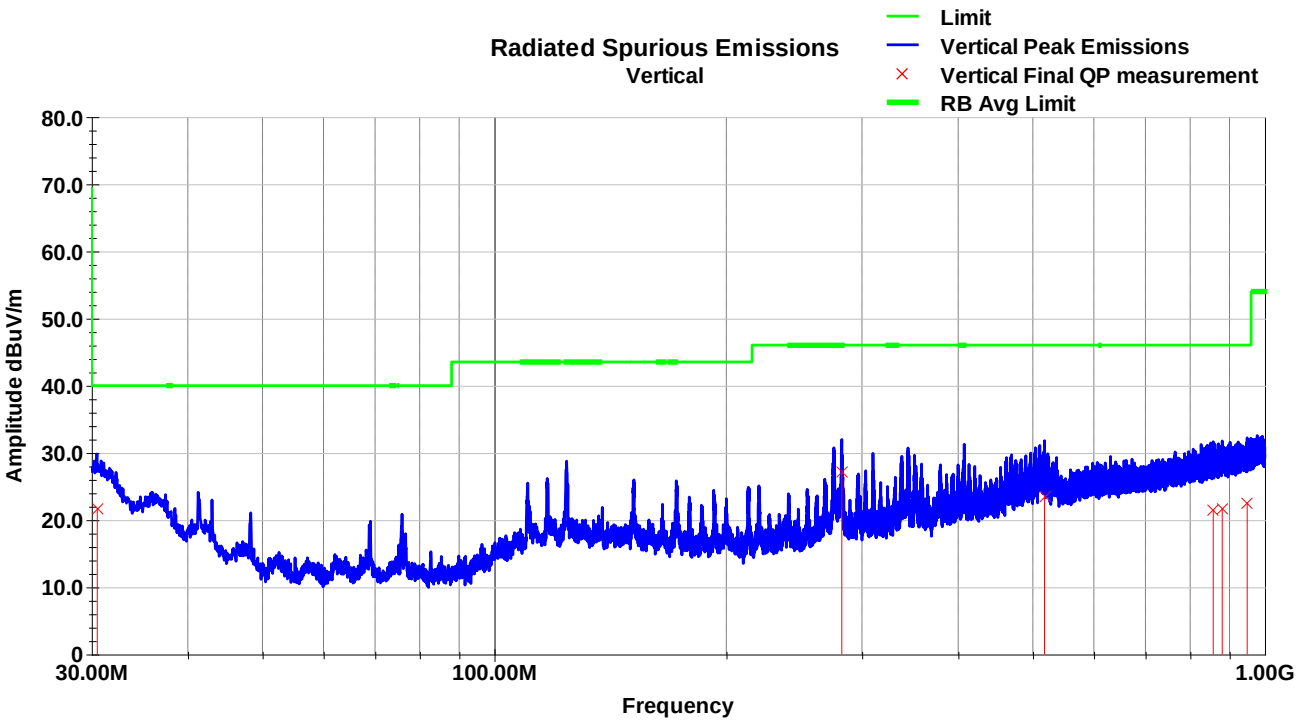
Frequency	Raw QP	Polarity	Azimuth	Height	AF	Loss	Amp	QP Value	Limit	Margin
MHz	(dBuV)	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	(dBuV/m)	(dBuV/m)	(dB)
30.76	30.8	V	96	389	21.7	0.5	31.3	21.8	40	-18.2
497.03	35.6	V	209	100	18.1	2.4	30.3	25.8	46	-20.2
510.32	35.9	V	180	100	18.4	2.5	30.3	26.5	46	-19.5
913.6	25.2	V	27	175	22.9	3.3	29.8	21.6	46	-24.4
932.85	25.3	V	159	135	23.3	3.3	29.8	22.1	46	-23.9
938.24	25.2	V	139	397	23.4	3.3	29.8	22.2	46	-23.9
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

30-1000MHz Horizontal Mid Channel



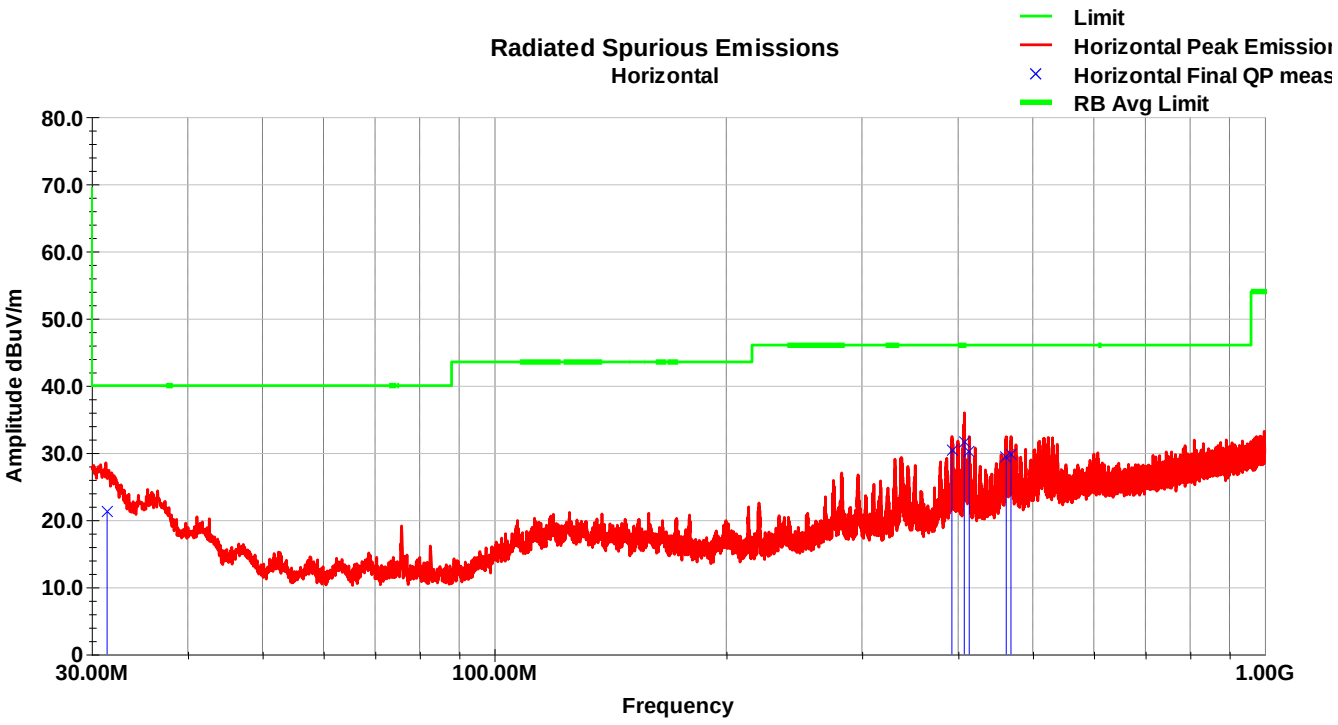
Frequency	Raw QP	Polarity	Azimuth	Height	AF	Loss	Amp	QP Value	Limit	Margin
MHz	(dBuV)	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	(dBuV/m)	(dBuV/m)	(dB)
30.5	30.6	H	207	325	21.9	0.5	31.3	21.8	40	-18.2
393.29	42.7	H	193	102	16.2	2.2	30.6	30.5	46	-15.6
406.23	41.9	H	208	102	16.4	2.2	30.6	30	46	-16
407.39	42.6	H	204	102	16.5	2.2	30.6	30.7	46	-15.3
407.86	39.7	H	215	102	16.5	2.2	30.6	27.8	46	-18.2
462.5	37.5	H	171	102	17.6	2.3	30.4	27	46	-19.1
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

30-1000MHz Vertical High Channel



Frequency	Raw QP	Polarity	Azimuth	Height	AF	Loss	Amp	QP Value	Limit	Margin
MHz	(dBuV)	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	(dBuV/m)	(dBuV/m)	(dB)
30.52	30.6	V	136	333	21.9	0.5	31.3	21.7	40	-18.3
282.42	42	V	14	100	14	1.8	30.8	27.1	46	-19
517.75	32.7	V	180	100	18.6	2.5	30.3	23.6	46	-22.5
857.34	25.6	V	1	163	22.7	3.2	29.9	21.5	46	-24.5
880.67	25.5	V	97	181	22.9	3.2	29.8	21.8	46	-24.3
948.86	25.4	V	187	181	23.5	3.4	29.8	22.5	46	-23.5
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

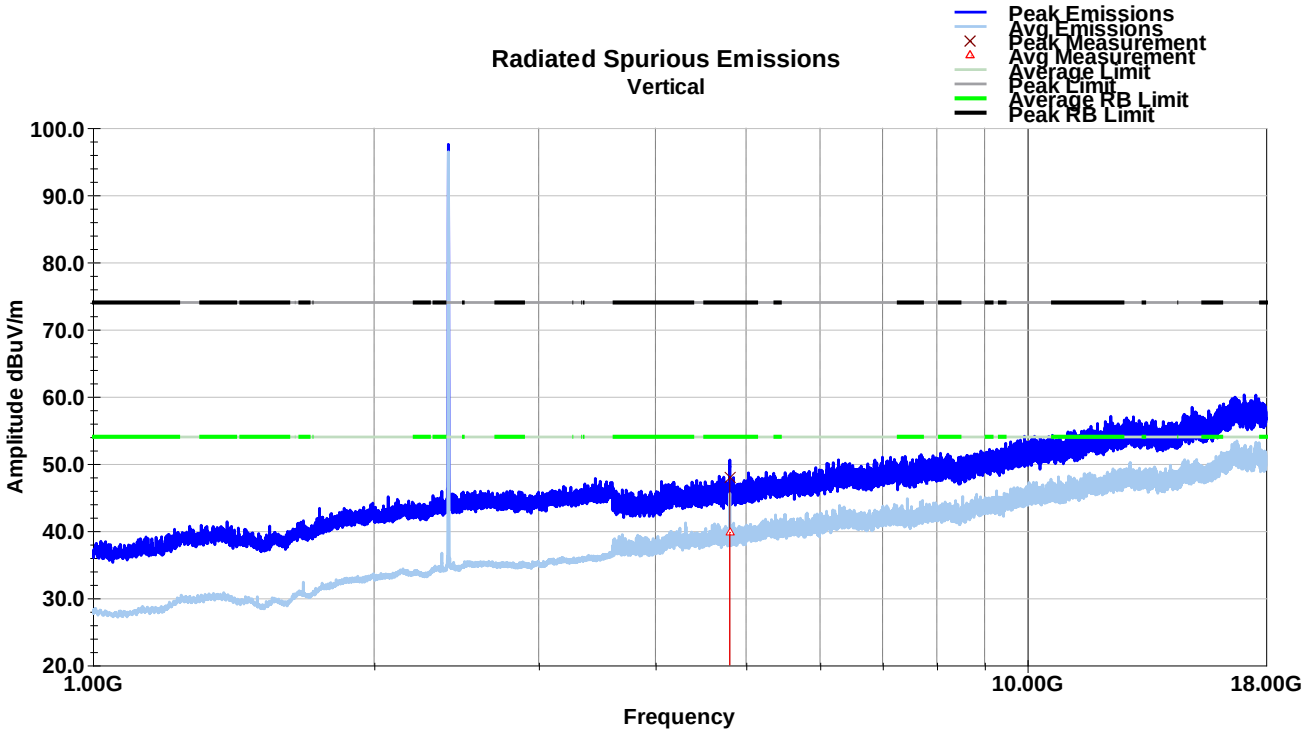
30-1000MHz Horizontal High Channel



Frequency	Raw QP	Polarity	Azimuth	Height	AF	Loss	Amp	QP Value	Limit	Margin
MHz	(dBuV)	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	(dBuV/m)	(dBuV/m)	(dB)
31.43	30.7	H	163	175	21.2	0.5	31.3	21.2	40	-18.8
392.51	42.5	H	194	100	16.2	2.2	30.6	30.3	46	-15.7
407.4	43.4	H	215	106	16.5	2.2	30.6	31.5	46	-14.5
413.47	42	H	210	100	16.5	2.2	30.6	30.2	46	-15.8
461.76	40	H	32	101	17.5	2.3	30.4	29.5	46	-16.6
468.41	40.1	H	42	102	17.8	2.4	30.4	29.8	46	-16.2
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

7.6.2 1-18 GHz

1-18 GHz Vertical Low Channel



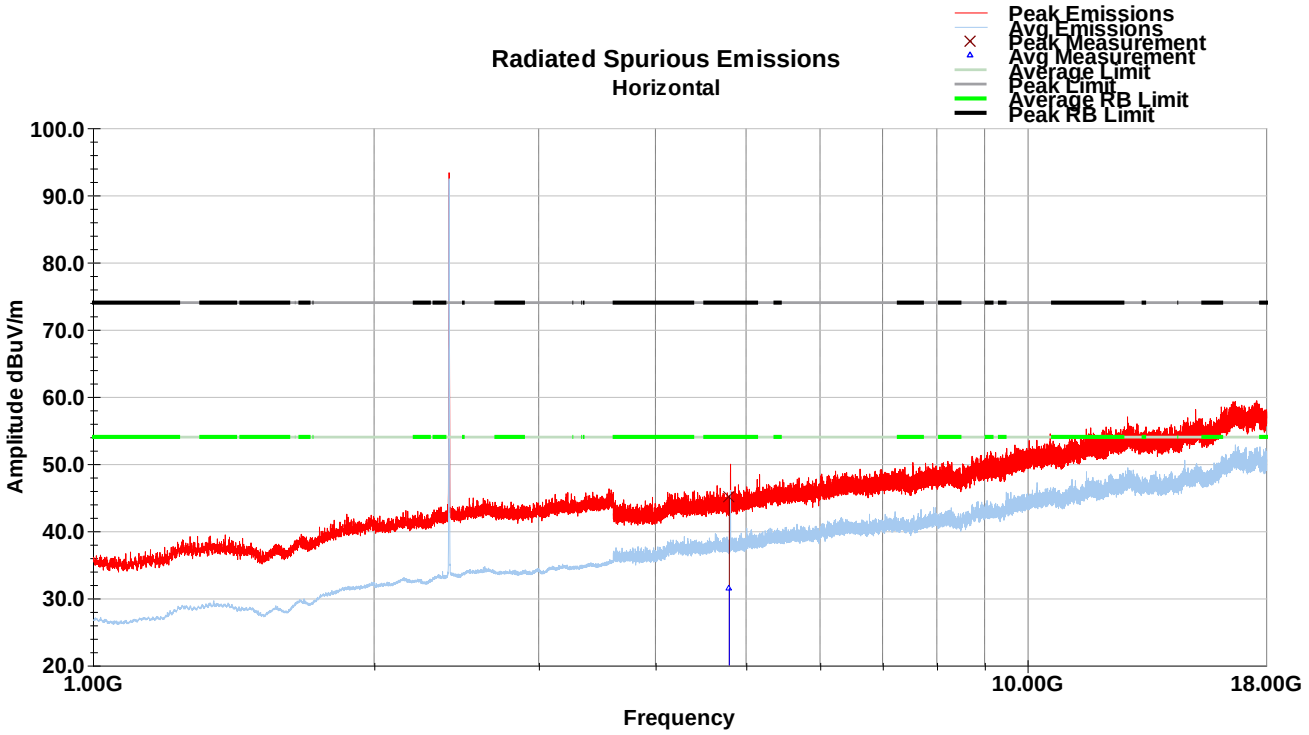
Peak Data

Frequency	Raw Pk	Polarity	Azimuth	Height	AF	Loss	Amp	Final Pk	Limit	Margin
MHz	dBuV	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	dBuV/m	dBuV/m	dB
4803.64	44.268	V	161	164	34.3	4.7	35.1	48.1	74	-25.9
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

Average Data

Frequency	Raw Avg	Polarity	Azimuth	Height	AF	Loss	Amp	Final Avg	Limit	Margin
MHz	dBuV	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	dBuV/m	(dBuV/m)	(dB)
4803.64	36.067	V	161	164	34.3	4.7	35.1	39.855	54	-14.1
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

1-18 GHz Horizontal Low Channel



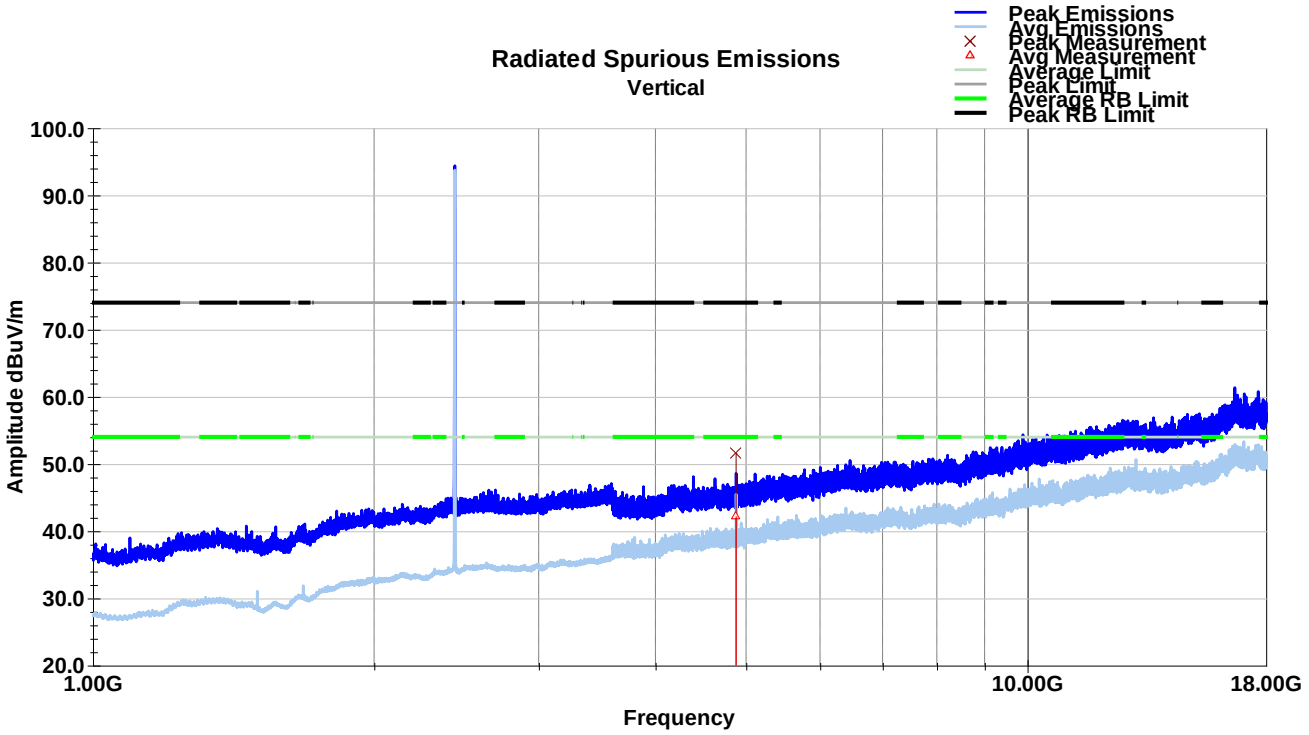
Peak Data

Frequency	Raw Pk	Polarity	Azimuth	Height	AF	Loss	Amp	Final Pk	Limit	Margin
MHz	dBuV	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	dBuV/m	dBuV/m	dB
4804.4	48.6	H	306	150	34.3	4.6	35.2	52.3	74	-21.7
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

Average Data

Frequency	Raw Avg	Polarity	Azimuth	Height	AF	Loss	Amp	Avg Value	Limit	Margin
MHz	dBuV	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	dBuV/m	(dBuV/m)	(dB)
4804.4	40.6	H	306	150	34.3	4.6	35.2	44.3	54	-9.7
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

1-18GHz Vertical Mid Channel



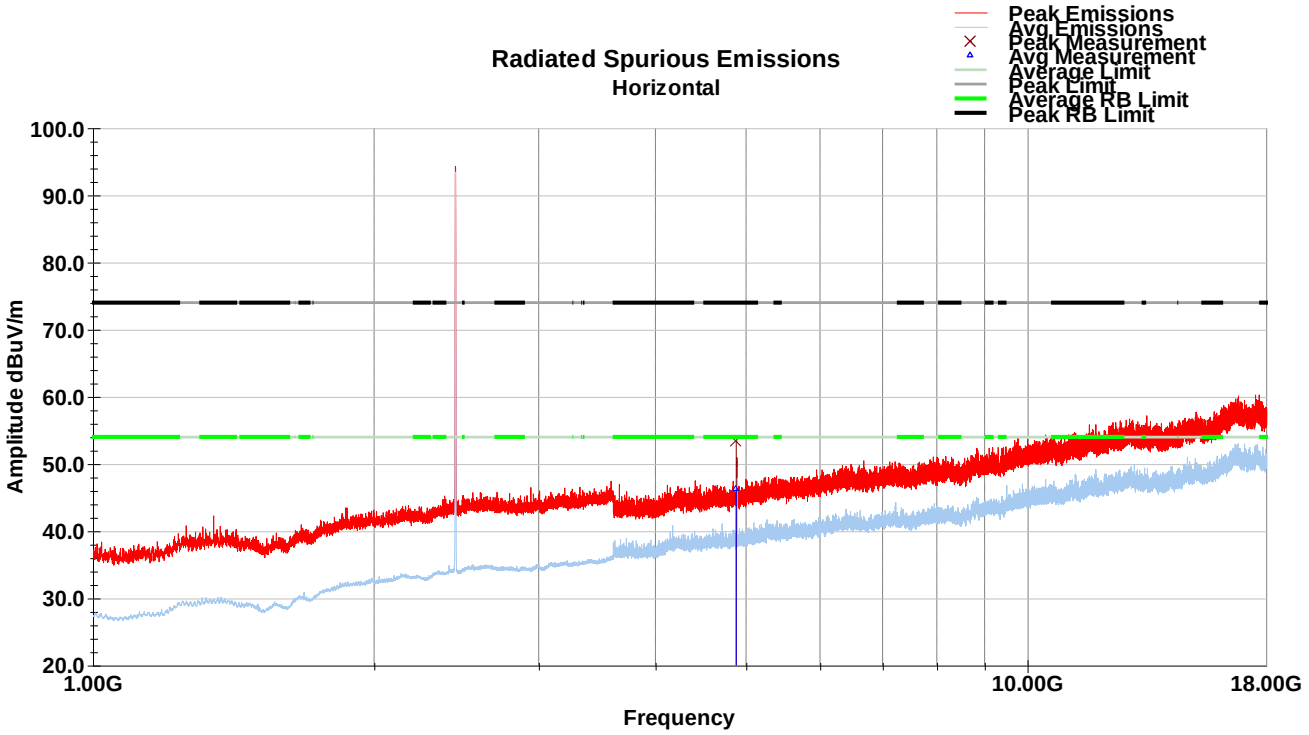
Peak Data

Frequency	Raw Pk	Polarity	Azimuth	Height	AF	Loss	Amp	Final Pk	Limit	Margin
MHz	dBuV	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	dBuV/m	dBuV/m	dB
4879.32	47.816	V	174	177	34.4	4.7	35.3	51.6	74	-22.4
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

Average Data

Frequency	Raw Avg	Polarity	Azimuth	Height	AF	Loss	Amp	Final Avg	Limit	Margin
MHz	dBuV	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	dBuV/m	(dBuV/m)	(dB)
4879.32	38.41	V	174	177	34.4	4.7	35.3	42.174	54	-11.8
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

1-18 GHz Horizontal Mid Channel



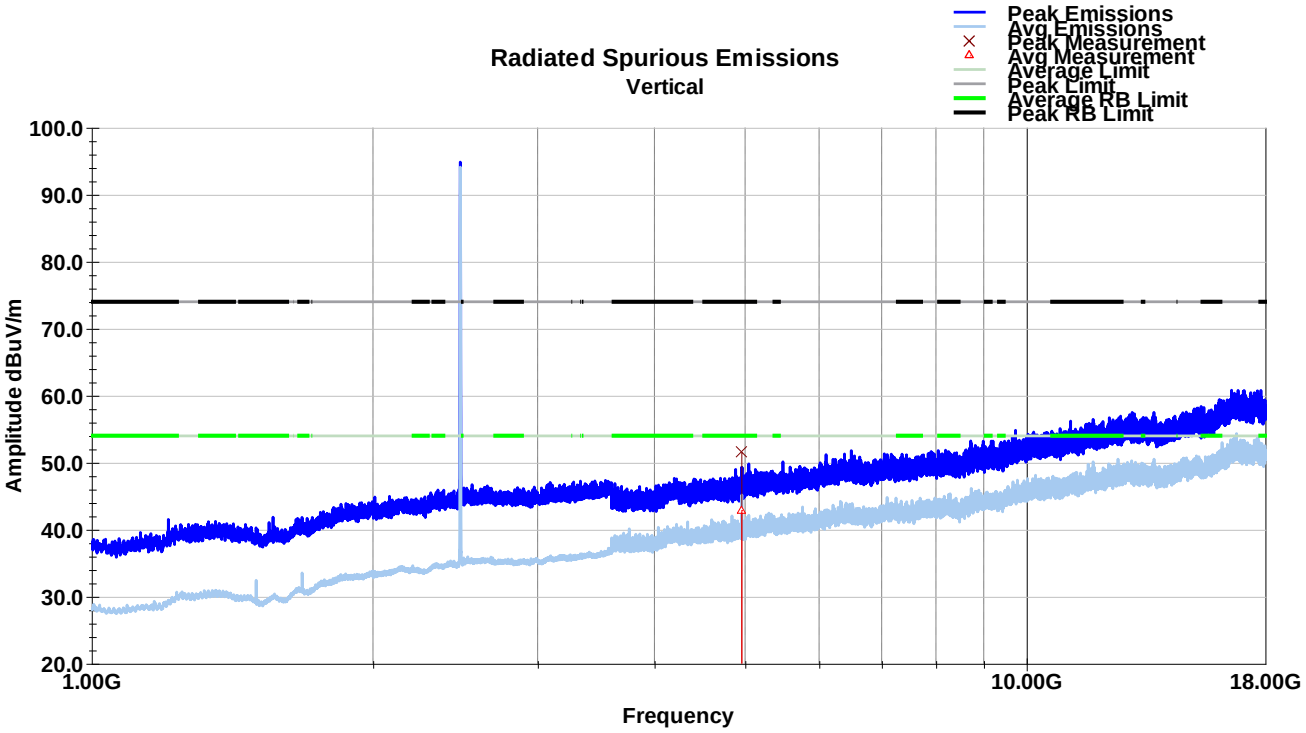
Peak Data

Frequency	Raw Pk	Polarity	Azimuth	Height	AF	Loss	Amp	Final Pk	Limit	Margin
MHz	dBuV	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	dBuV/m	dBuV/m	dB
4880.4	49.708	H	101	195	34.4	4.7	35.3	53.466	74	-20.5
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

Average Data

Frequency	Raw Avg	Polarity	Azimuth	Height	AF	Loss	Amp	Avg Value	Limit	Margin
MHz	dBuV	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	dBuV/m	(dBuV/m)	(dB)
4880.4	42.587	H	101	195	34.4	4.7	35.3	46.344	54	-7.6
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

1-18 GHz Vertical High Channel



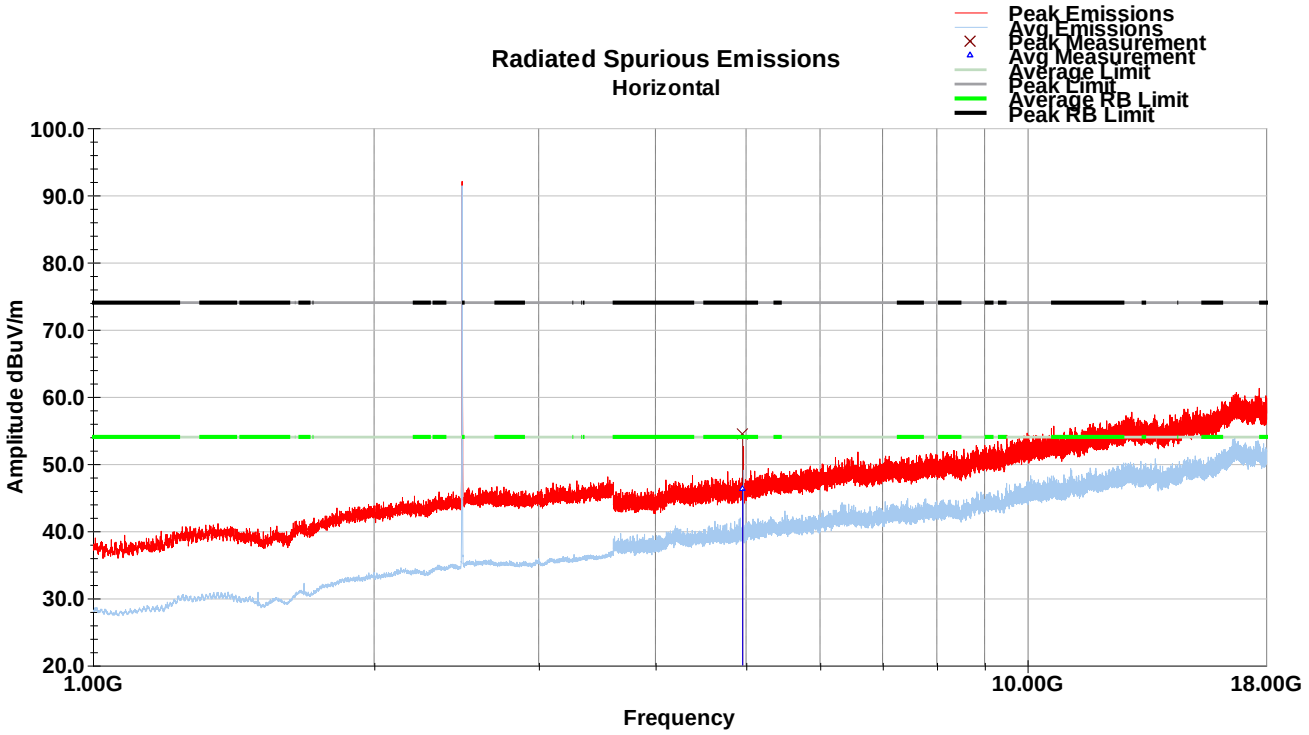
Peak Data

Frequency	Raw Pk	Polarity	Azimuth	Height	AF	Loss	Amp	Final Pk	Limit	Margin
MHz	dBuV	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	dBuV/m	dBuV/m	dB
4960.4	47.412	V	154	154	34.6	4.7	35.2	51.5	74	-22.5
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

Average Data

Frequency	Raw Avg	Polarity	Azimuth	Height	AF	Loss	Amp	Final Avg	Limit	Margin
MHz	dBuV	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	dBuV/m	(dBuV/m)	(dB)
4960.4	38.811	V	154	154	34.6	4.7	35.2	42.923	54	-11.1
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

1-18GHz Horizontal High Channel



Peak Data

Frequency	Raw Pk	Polarity	Azimuth	Height	AF	Loss	Amp	Final Pk	Limit	Margin
MHz	dBuV	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	dBuV/m	dBuV/m	dB
4959.32	50.242	H	104	208	34.6	4.7	35.2	54.357	74	-19.6
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

Average Data

Frequency	Raw Avg	Polarity	Azimuth	Height	AF	Loss	Amp	Avg Value	Limit	Margin
MHz	dBuV	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	dBuV/m	(dBuV/m)	(dB)
4959.32	42.125	H	104	208	34.6	4.7	35.2	46.24	54	-7.7
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

7.6.3 18-26 GHz

There were no emissions detected above 18GHz.

8 Band Edge Emissions in Restricted Frequency Bands

8.1 *Test Result*

Test Description	Test Specification		Test Result
Band Edge Emissions in Restricted Frequency Bands	15.205, 15.209	RSS-GEN S8.9, 8.10	Compliant

8.2 *Test Method*

Field strength measurements were performed at the restricted band edges of 2390MHz and 2483.5MHz. Measurements were made using the conducted methods defined in ANSI C63.10: 2013 clause 11.12.2. The measurements were converted to a radiated field strength equivalent using the equations defined in that section. Both peak and average measurements were performed at the antenna port. These procedures are referenced in KDB 558074 D01 15.247 Meas Guidance v05r02.

A reference level offset was applied to the spectrum analyzer so that conducted measurements represent field strength measurements in dBµV/m.

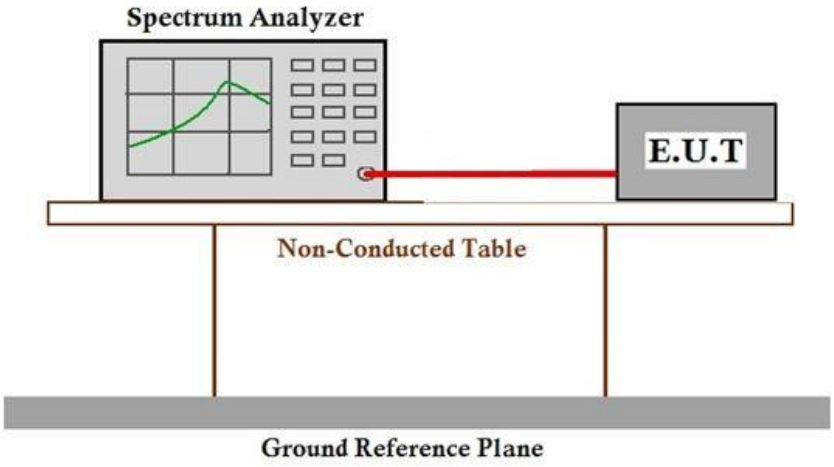
8.3 *Test Site*

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature:	24.9 °C
Relative Humidity:	50.6 %
Atmospheric Pressure:	98.2 kPa

8.4 *Test Setup*



8.5 *Test Equipment*

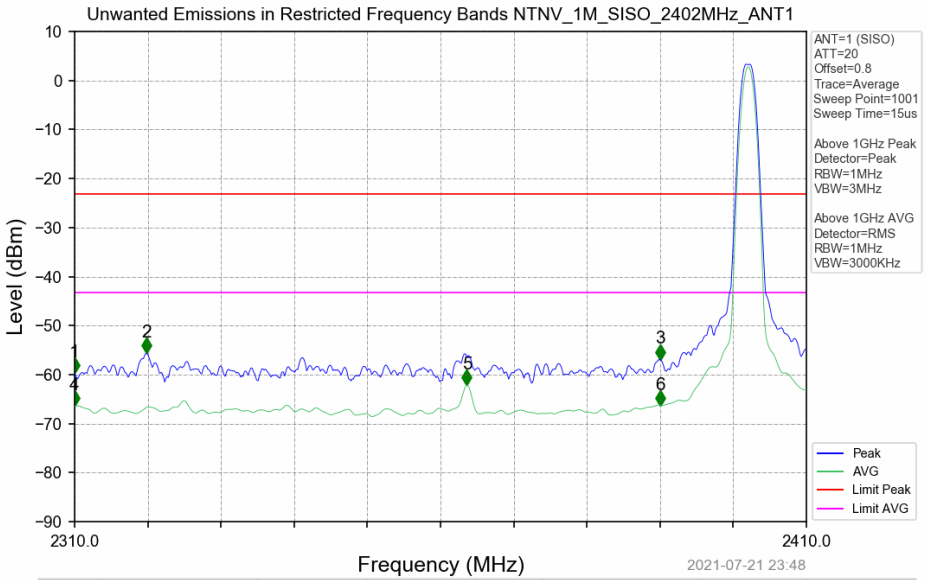
Test End Date: 21-Jul-2021 Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
RF Cable SMA to SMA, 0.01-40GHz	084-0505-059	TELEDYNE STORM MICROWAVE	20108	16-Mar-2021	16-Mar-2022
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	27-Dec-2019	27-Dec-2021

Note: The equipment calibration period is 1 year except for the FSV which is on a 2-year cycle.

8.6 *Test Data*

BLE – Low Channel – Plot

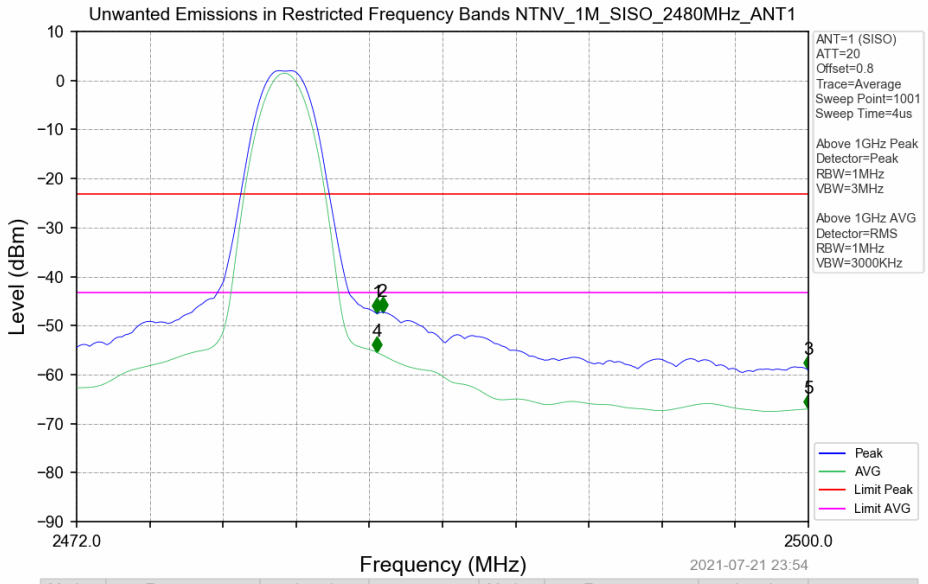


Marker No	Frequency (MHz)	Level (dBm)	Remark	Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2310.000	-59.678	Peak	4	2310.000	-66.447	AVG
2	2319.800	-55.661	Peak	5	2363.600	-62.148	AVG
3	2390.000	-56.935	Peak	6	2390.000	-66.311	AVG

BLE – Low Channel – Data

Frequency (MHz)	Reading Level (dBm)	Antenna Gain (dBi)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
2310.000	-66.45	2.00	30.75	54	-23.25	AVG
	-59.68	2.00	37.52	74	-36.48	Peak
2319.800	-55.66	2.00	41.54	74	-32.46	Peak
2363.600	-62.15	2.00	35.05	54	-18.95	AVG
2390.000	-66.31	2.00	30.89	54	-23.11	AVG
	-56.94	2.00	40.27	74	-33.73	Peak

BLE – High Channel – Plot



Marker No	Frequency (MHz)	Level (dBm)	Remark	Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2483.500	-47.560	Peak	4	2483.500	-55.445	AVG
2	2483.704	-47.291	Peak	5	2500.000	-67.033	AVG
3	2500.000	-59.095	Peak				

BLE – High Channel – Data

Frequency (MHz)	Reading Level (dBm)	Antenna Gain (dBi)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
2483.500	-55.45	2.00	41.76	54	-12.24	AVG
	-47.56	2.00	49.64	74	-24.36	Peak
2483.704	-47.29	2.00	49.91	74	-24.09	Peak
2500.000	-67.03	2.00	30.17	54	-23.83	AVG
	-59.09	2.00	38.10	74	-35.90	Peak

9 Measurement Uncertainty

The measurement uncertainty figures are calculated in accordance with TR 100 028-1 [2] and correspond to an expansion factor (coverage factor) k = 2 (which provides confidence levels of 95.45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)).

Parameter	Expanded Uncertainty for Normal k factor equal to 2	
	Required	Laboratory Actual
Radio Frequency	±1 x 10-5	±9.8 x 10-8
total RF power, conducted	±1.5 dB	±1.2 dB
RF power density, conducted	±3 dB	±0.7 dB
spurious emissions, conducted	±3 dB	±2.1 dB
all emissions, radiated	±6 dB	±4.8 dB
temperature	±1°C	±0.5°C
humidity	±5 %	±3.5%
DC and low frequency voltages	±3 %	±0.4%
Conducted disturbance at mains port using AMN	± 3.4 dB	± 2.5 dB

10 Revision History

Revision Level	Description of changes	Revision Date
0	Initial release	10 September 2021
1	- Added EUT power and accessory cables in sections 2.5 – 2.8 - Added test setup diagrams in new sections 3.4, 4.4, 5.4, 6.4, 7.4 and 8.4	23 September 2021