

RF Test Report

Project Number: 4681230**Proposal Number:** 11079**Report Number:** 4681230EMC09**Revision Level:** 1**Client:** ZEROKEY Inc.**Equipment Under Test:** 50V Ultrasonic Transducer**Model Name:** Anchor Node**Model Numbers:** AGISAN10 and ZKISAN10**FCC ID:** 2AX6LISAN10**IC:** 26679-ISAN10**Applicable Standards:** FCC Part 15 Subpart C, § 15.247

RSS-247, Issue 2, February 2017

RSS-GEN, Issue 5, March 2019, Amendment 1

ANSI C63.10:2013

Report issued on: 28 June 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:

A handwritten signature in blue ink, appearing to read 'Martin Taylor', is written over a horizontal line.

Martin Taylor, Project Engineer

Reviewed by:

A handwritten signature in blue ink, appearing to read 'Jeremy Pickens', is written over a horizontal line.

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.

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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 antenna which cannot be replaced by the end user.

1.1 Modifications Required for Compliance

None.

2 General Information

2.1 Client Information

Name: ZEROKEY Inc.
Address: 3120 12 Street NE
City, State, Zip, Country: Calgary, Alberta T2E 8T3 Canada

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: 50V Ultrasonic Transducer
Model Name: Anchor Node
Model Numbers: AGISAN10 and ZKISAN10
Sample ID: SUWES2012000108HZ
FCC ID: 2AX6LISAN10
IC: 26679-ISAN10

Frequency Range: 2402 – 2480 MHz (one BLE radio)
Data Modes: Bluetooth Low Energy (GFSK 1Mbps & 2Mbps)
Nordic Enhanced ShockBurst Protocol (GFSK 2Mbps)
Antenna: Surface Mount Stamped Metal Antenna (4.9 dBi max gain)

Rated Voltage: 3.6 Vdc Lithium Thionyl Chloride Battery
Test Voltage: 3.6 Vdc Lithium Thionyl Chloride Battery

Sample Received Date: 02 February 2021
Dates of testing: 17 February to 07 April 2021

2.4 Operating Modes and Conditions

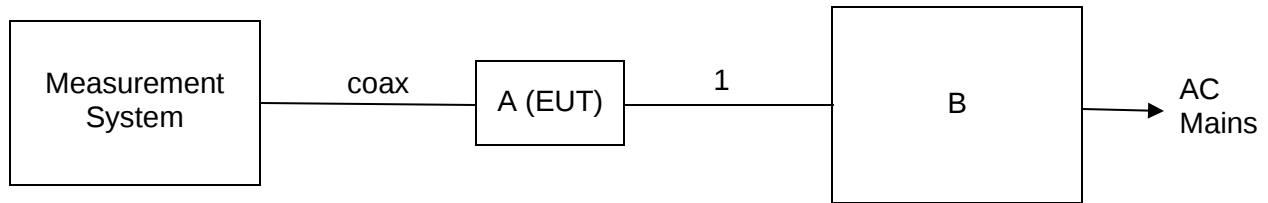
The EUT was running test mode firmware FCC Certification Version 1.0 that allowed control of the Bluetooth LE radio from Nordic Semiconductor. This firmware was based on Nordic SDK v15.2.0. This software allowed the following:

- 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 maximum nominal power level of +8dBm was used for all tests.]

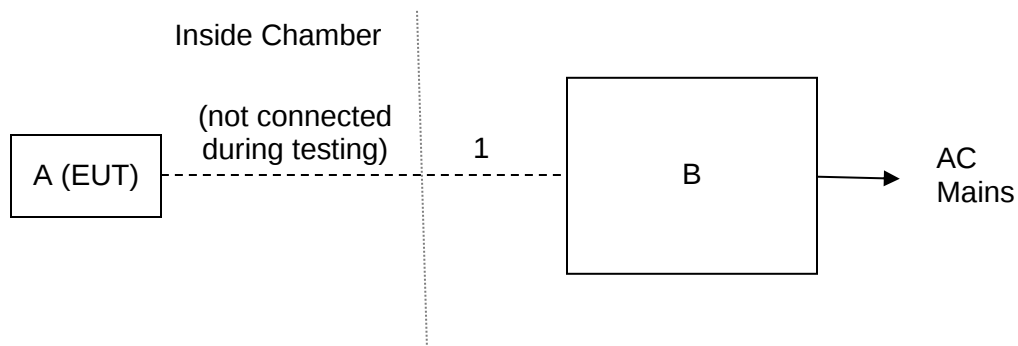
The following 3 data modes were tested and the worst-case results for each test were reported.

- Enhanced ShockBurst 2Mbps: Used for normal operation
- BLE 1Mbps: Used only for over-the-air firmware updates
- BLE 2Mbps: Used only for over-the-air firmware updates

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	ZEROKEY Inc.	50V Ultrasonic Transducer (EUT)	AGISAN10 ZKISAN10	Not labeled
B	Lenovo	Laptop Computer	T500	L3-ABV0N 08/12

2.8 Cable List

Cable reference	Port Name	Start	End	Cable Length (m)	Ferrite installed?	Shielded?
1	USB-Micro	EUT	Laptop Computer	1.0	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.

The BLE 1Mbps data mode was used for these tests since it produced the narrowest bandwidth.

Limit

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

3.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 24.2 °C
Relative Humidity: 34.8 %
Atmospheric Pressure: 97.8 kPa

3.4 Test Equipment

Test End Date: 7-Apr-2021

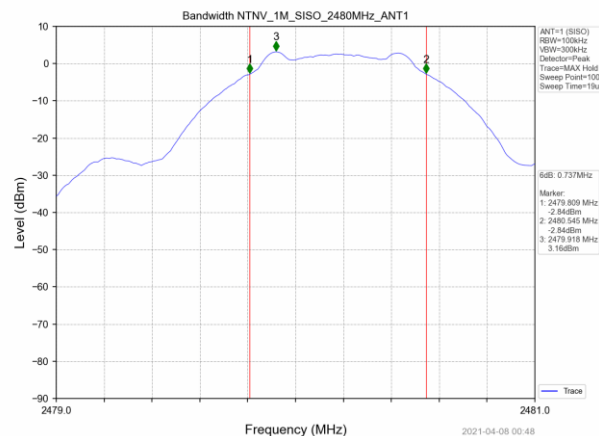
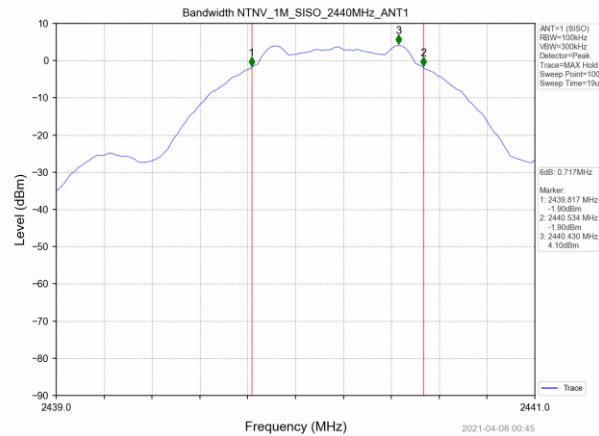
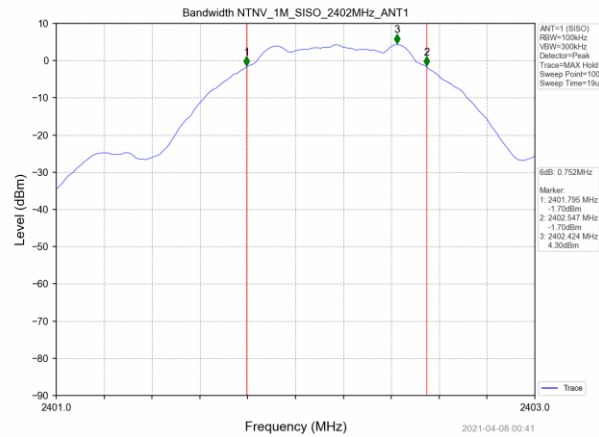
Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	27-Dec-2019	27-Dec-2021
ATTENUATOR, 10DB	BW-S10W2	Mini-Circuits	15032	28-Sep-2020	28-Sep-2021
RF Cable SMA to SMA, 0.01-40GHz	084-0505-059	TELEDYNE STORM MICROWAVE	20108	16-Mar-2021	16-Mar-2022

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

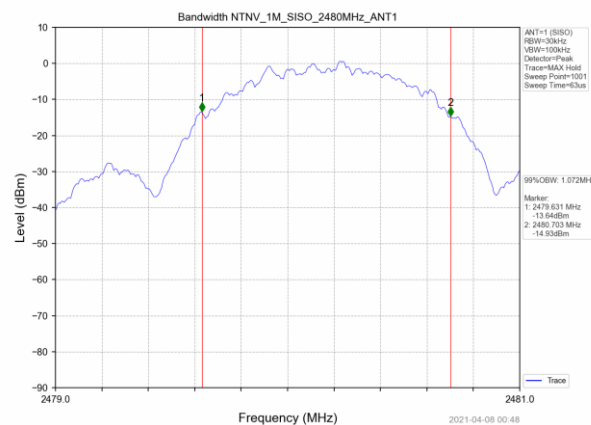
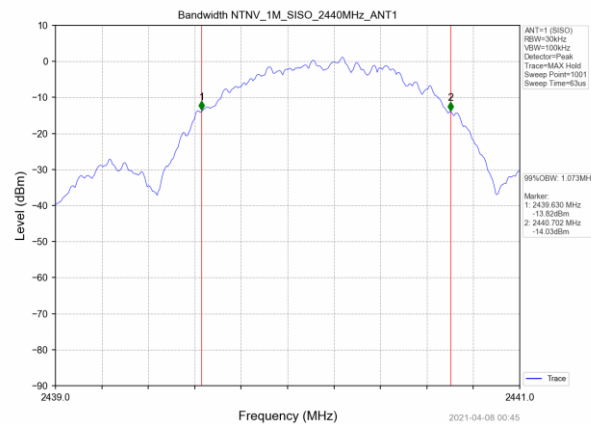
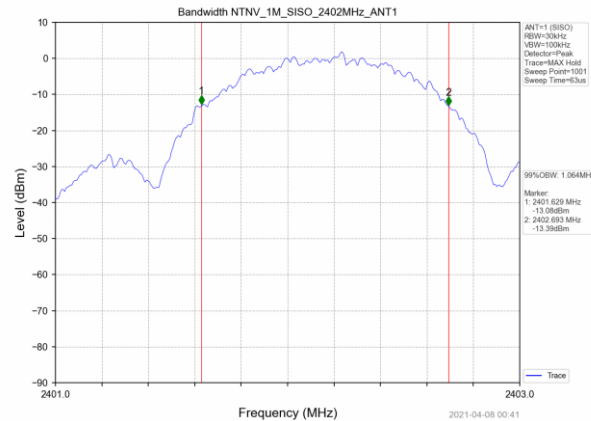
3.5 Test Data – DTS Bandwidth (6dB)

Test Mode	Channel	Frequency (MHz)	6dB Bandwidth		Verdict
			Test Result (MHz)	Limits (MHz)	
BLE 1Mbps	0	2402	0.752	≥0.5	Pass
	19	2440	0.717	≥0.5	Pass
	39	2480	0.737	≥0.5	Pass



3.6 Test Data – 99% Occupied Bandwidth

Test Mode	Channel	Frequency (MHz)	99% Occupied Bandwidth	Verdict
			Test Result (MHz)	
BLE 1Mbps	0	2402	1.064	Reported
	19	2440	1.073	Reported
	39	2480	1.072	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.

The ShockBurst 2Mbps data mode was used for this test since it produced the highest power.

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: 24.2 °C
Relative Humidity: 34.8 %
Atmospheric Pressure: 97.8 kPa

4.4 Test Equipment

Test End Date: 7-Apr-2021

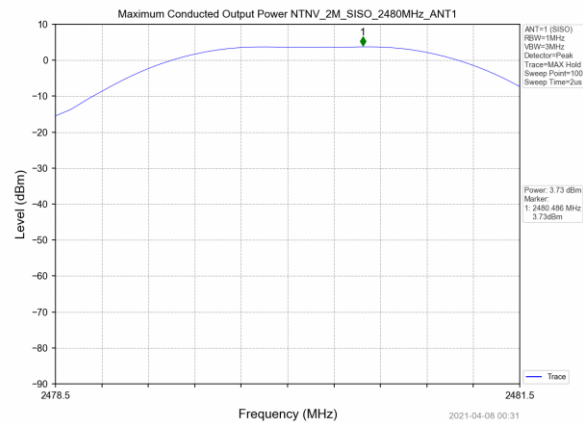
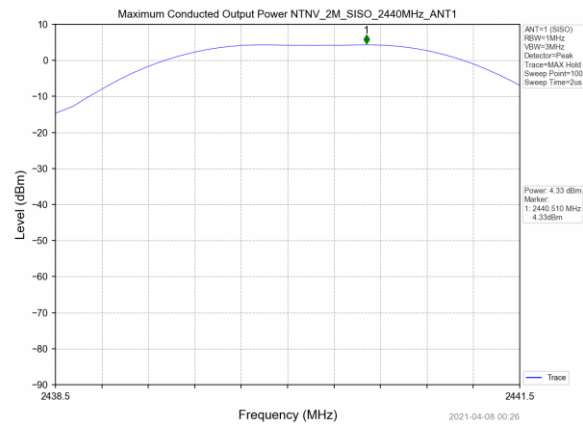
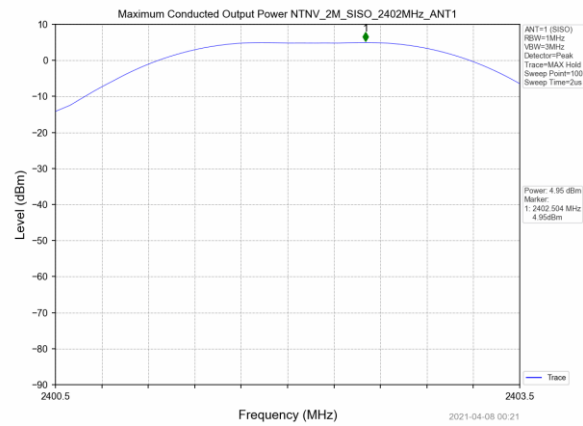
Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	27-Dec-2019	27-Dec-2021
ATTENUATOR, 10DB	BW-S10W2	Mini-Circuits	15032	28-Sep-2020	28-Sep-2021
RF Cable SMA to SMA, 0.01-40GHz	084-0505-059	TELEDYNE STORM MICROWAVE	20108	16-Mar-2021	16-Mar-2022

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

4.5 Test Data

Channel	Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Peak EIRP (dBm)	Limit Max (dBm)	Verdict
0	2402	4.95	30	9.85	36	Pass
19	2440	4.33	30	9.23	36	Pass
39	2480	3.73	30	8.63	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.

The BLE 1Mbps data mode was used for this test since it produced the highest Peak PSD.

Limit

The maximum limit is 8 dBm / 3 kHz.

5.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 24.2 °C

Relative Humidity: 34.8 %

Atmospheric Pressure: 97.8 kPa

5.4 Test Equipment

Test End Date: 7-Apr-2021

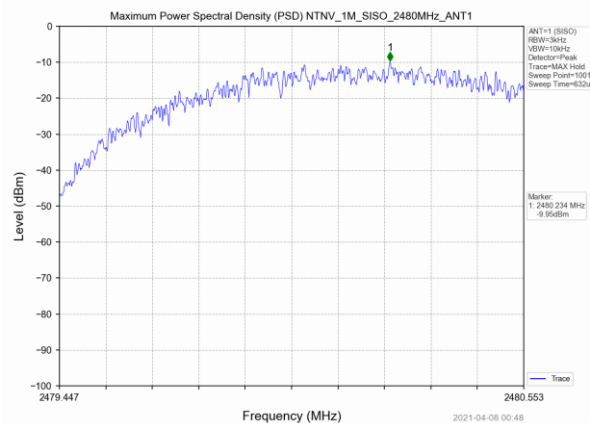
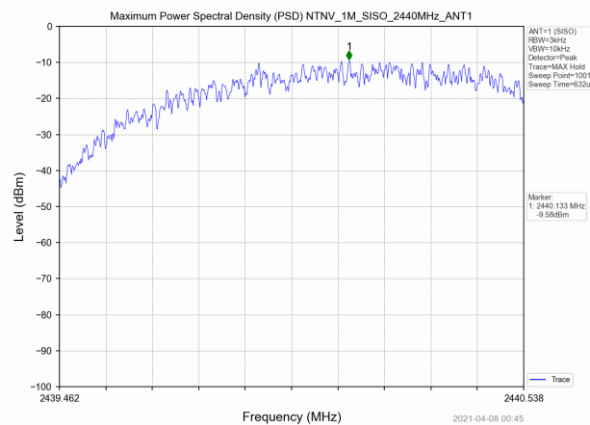
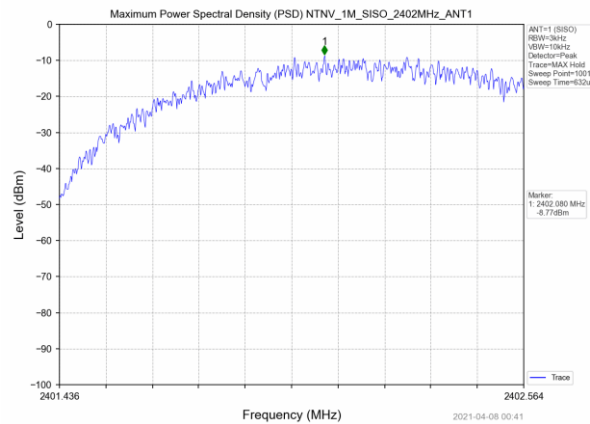
Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	27-Dec-2019	27-Dec-2021
ATTENUATOR, 10DB	BW-S10W2	Mini-Circuits	15032	28-Sep-2020	28-Sep-2021
RF Cable SMA to SMA, 0.01-40GHz	084-0505-059	TELEDYNE STORM MICROWAVE	20108	16-Mar-2021	16-Mar-2022

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

5.5 Test Data

Channel	Frequency (MHz)	Peak PSD (dBm/3kHz)	Limit Max (dBm/3kHz)	Verdict
0	2402	-8.77	8	Pass
19	2440	-9.58	8	Pass
39	2480	-9.95	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.

The BLE 2Mbps data mode was used for these tests since it produced emissions closest to the band edges.

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: 24.2 °C
Relative Humidity: 34.8 %
Atmospheric Pressure: 97.8 kPa

6.4 Test Equipment

Test End Date: 7-Apr-2021

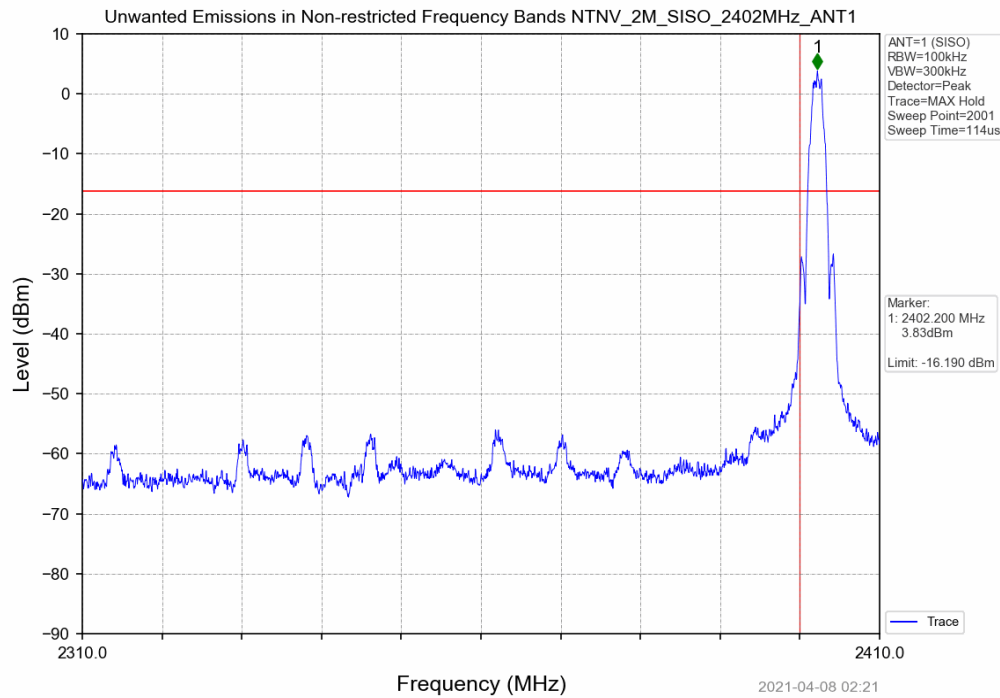
Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	27-Dec-2019	27-Dec-2021
ATTENUATOR, 10DB	BW-S10W2	Mini-Circuits	15032	28-Sep-2020	28-Sep-2021
RF Cable SMA to SMA, 0.01-40GHz	084-0505-059	TELEDYNE STORM MICROWAVE	20108	16-Mar-2021	16-Mar-2022

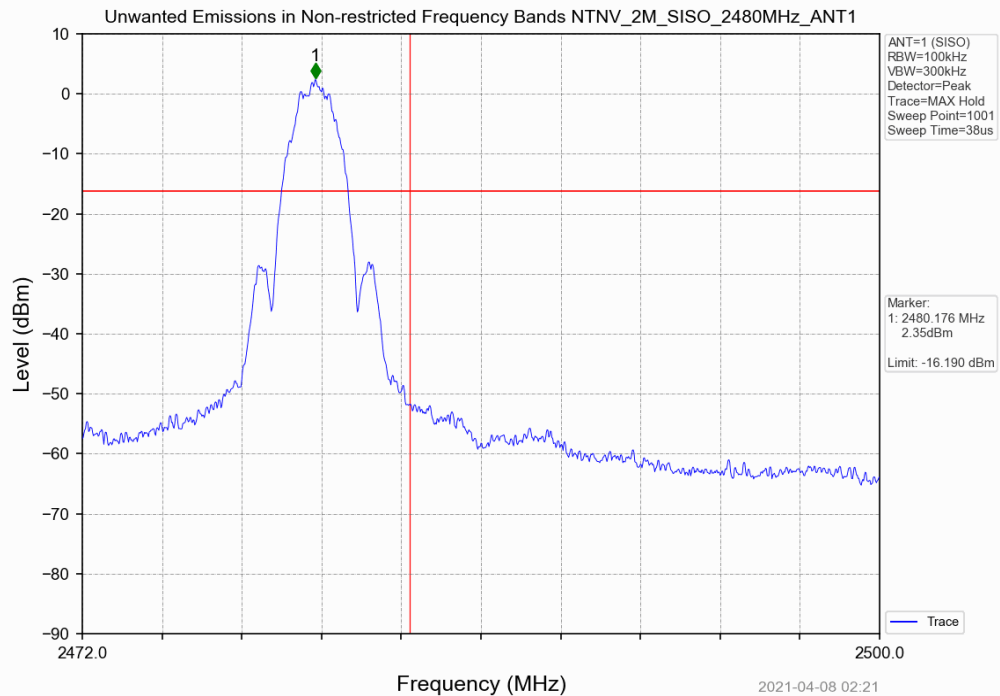
Note: The equipment calibration period is 1 year except for the FSV which is on a 2-year cycle.

6.5 Test Data – DTS Band Edge

BLE - Lower band edge

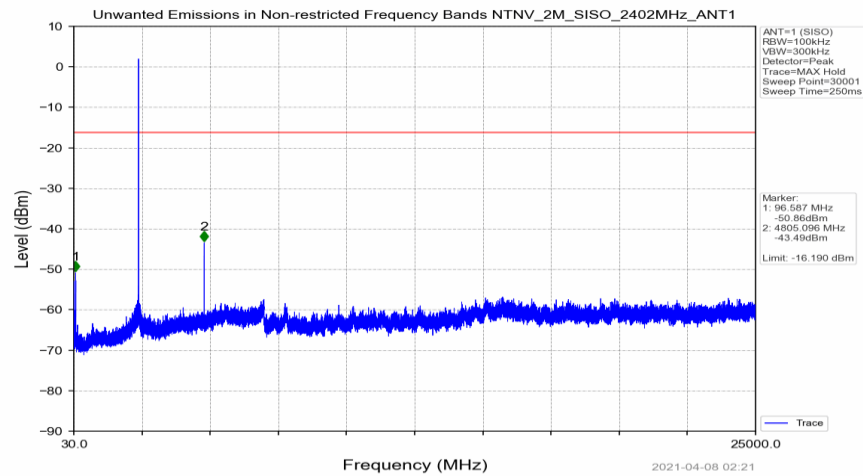


BLE - Upper band edge

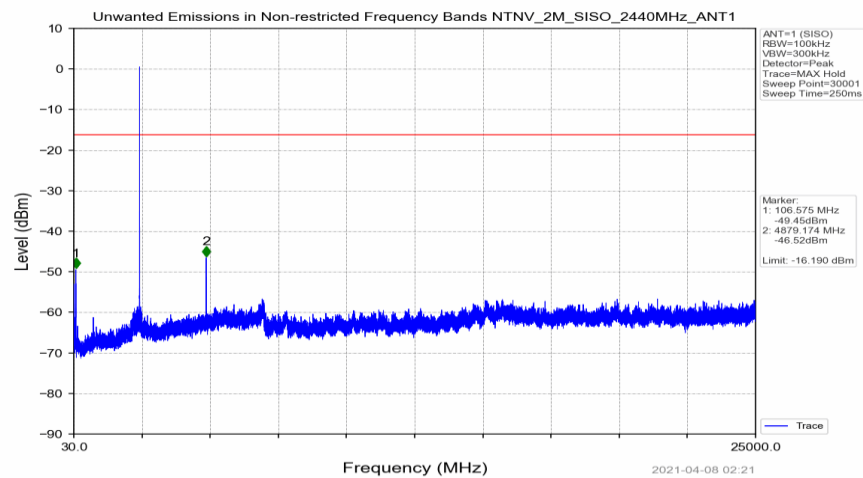


6.6 Test Data – DTS Conducted Spurious Emissions

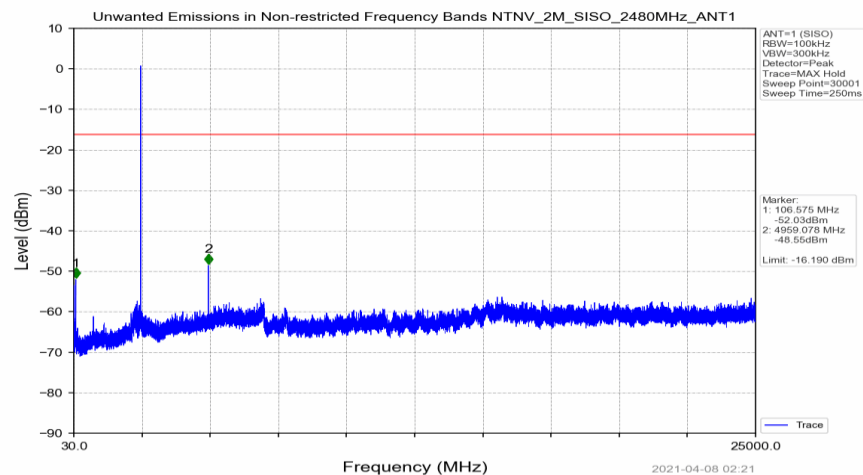
Conducted Spurs – BLE Channel 0



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.

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	30-1000MHz	1-18GHz	18-26GHz
Temperature:	23.8 °C	23.5 – 24.6 °C	23.8 °C
Relative Humidity:	22.7 %	19.4 – 25.7 %	22.7 %
Atmospheric Pressure:	98.0 kPa	97.5 – 97.7 kPa	98.0 kPa

7.4 Test Equipment

30-1000MHz

Test End Date: 19-Feb-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	2-Mar-2020	2-Mar-2021
RF Cable Nm to Nf, 0.01-18GHz	90-213-118	TELEDYNE STORM MICROWAVE	20117	2-Mar-2020	2-Mar-2021
RF Cable Nm to Nm, 0.01-18GHz	90-195-157	TELEDYNE STORM MICROWAVE	20122	2-Mar-2020	2-Mar-2021
RF CABLE	SUCOFLEX 100	Huber & Suhner	B108523	3-Sep-2020	3-Sep-2021
LOW NOISE AMPLIFIER	ZKL-2+	Mini-Circuits	B079817	28-Sep-2020	28-Sep-2021
EMI TEST RECEIVER	ESU40	ROHDE & SCHWARZ	B079629	6-Apr-2020	6-Apr-2021

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

1-18GHz

Test End Date: 17-Feb-2021

Tester: LM

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
ANTENNA, DRG HORN (MEDIUM)	3117	ETS Lindgren	B079699	15-Jul-2020	15-Jul-2022
RF Cable Nm to Nm, 0.01-18GHz	90-195-354	TELEDYNE STORM MICROWAVE	20120	2-Mar-2020	2-Mar-2021
RF CABLE	SUCOFLEX 100	Huber & Suhner	B108523	3-Sep-2020	3-Sep-2021
LOW NOISE AMPLIFIER	TS-PR18	ROHDE & SCHWARZ	B094463	24-Nov-2020	24-Nov-2021
EMI TEST RECEIVER	ESU8	ROHDE & SCHWARZ	B085759	7-May-2020	7-May-2021
FILTER, HIGH PASS, >2800MHz	HPM50111	MICRO-TRONICS	B085747	8-Sep-2020	8-Sep-2021

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

18-26GHz

Test End Date: 19-Feb-2021

Tester: PL

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
ANTENNA, HORN (SMALL)	LB-180400-20-C-KF	A-INFO	15007	6-Apr-2020	6-Apr-2022
LOW NOISE AMPLIFIER	NSP1840-HG	MITEQ	B087572	3-Nov-2020	3-Nov-2021
RF Cable SMA to SMA, 0.01-40GHz	084-0505-138	TELEDYNE STORM MICROWAVE	20112	6-Mar-2020	6-Mar-2021
RF Cable SMA to SMA, 0.01-40GHz	084-0505-020	TELEDYNE STORM MICROWAVE	20105	6-Mar-2020	6-Mar-2021
EMI TEST RECEIVER	ESU40	ROHDE & SCHWARZ	B079629	6-Apr-2020	6-Apr-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 201007" TILE 7! profile dated Oct 2020

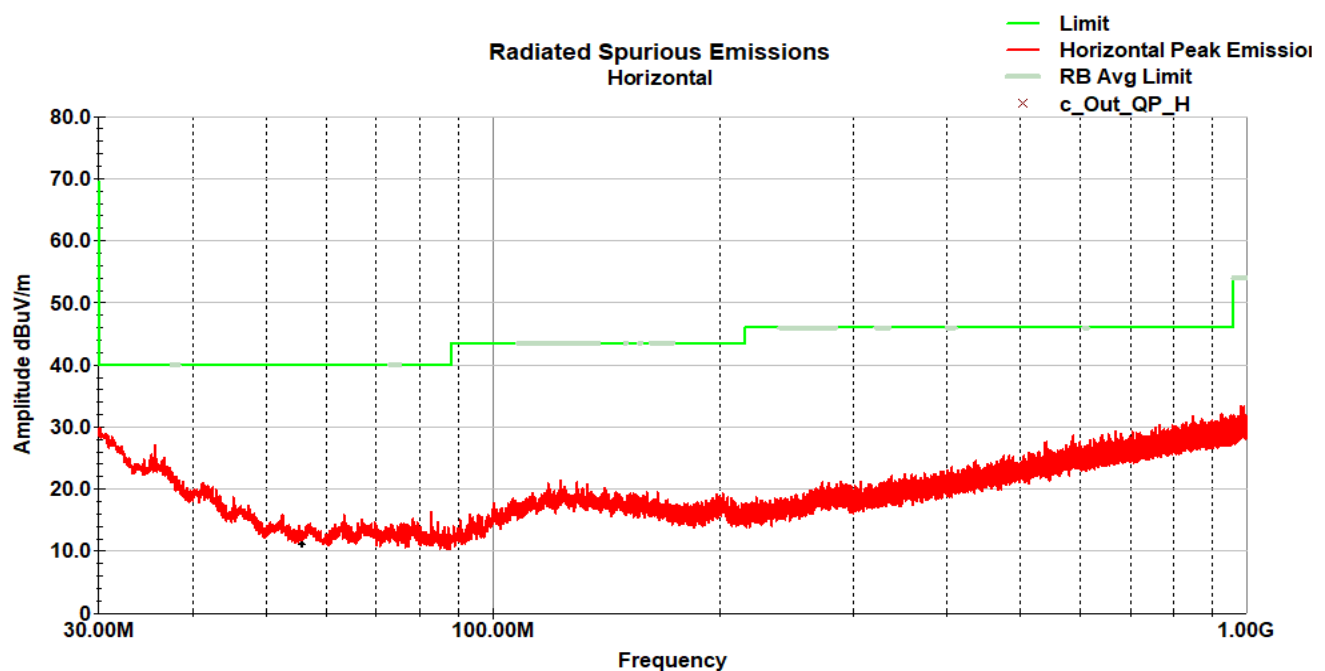
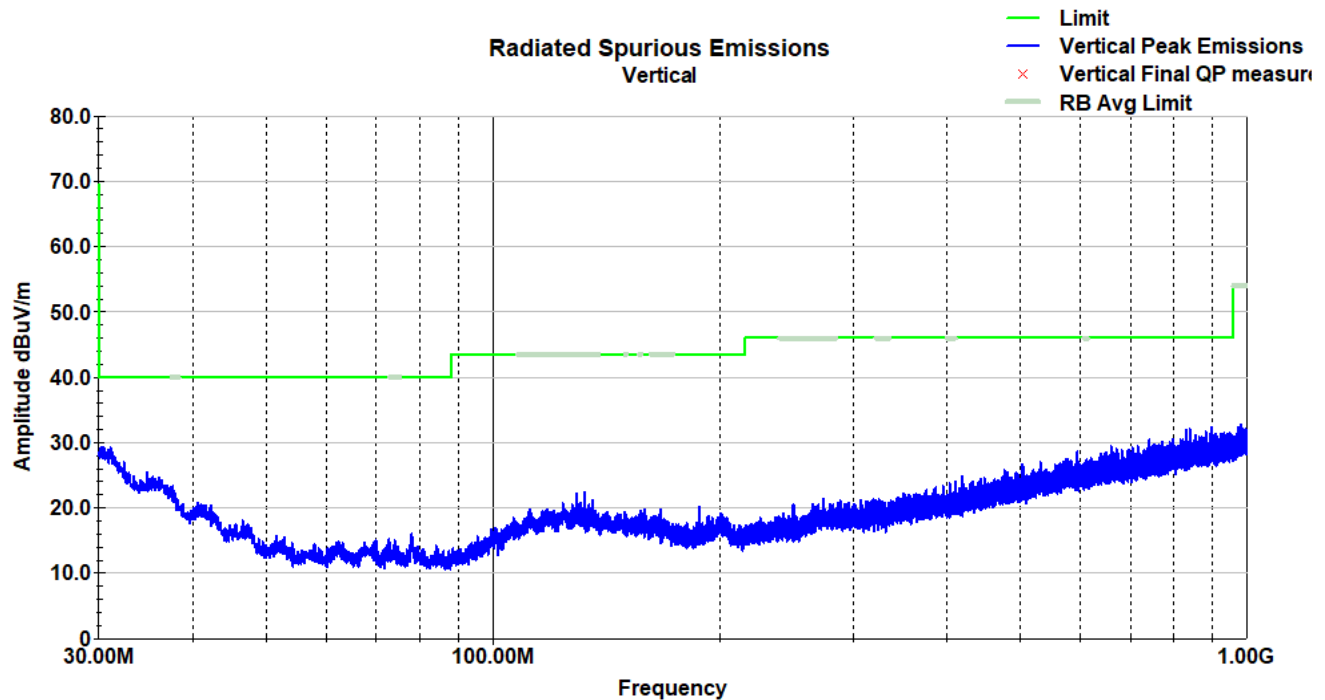
"RSE 18-40 GHz T7 190722" TILE 7! profile dated Jul 2019

7.5 Test Data

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

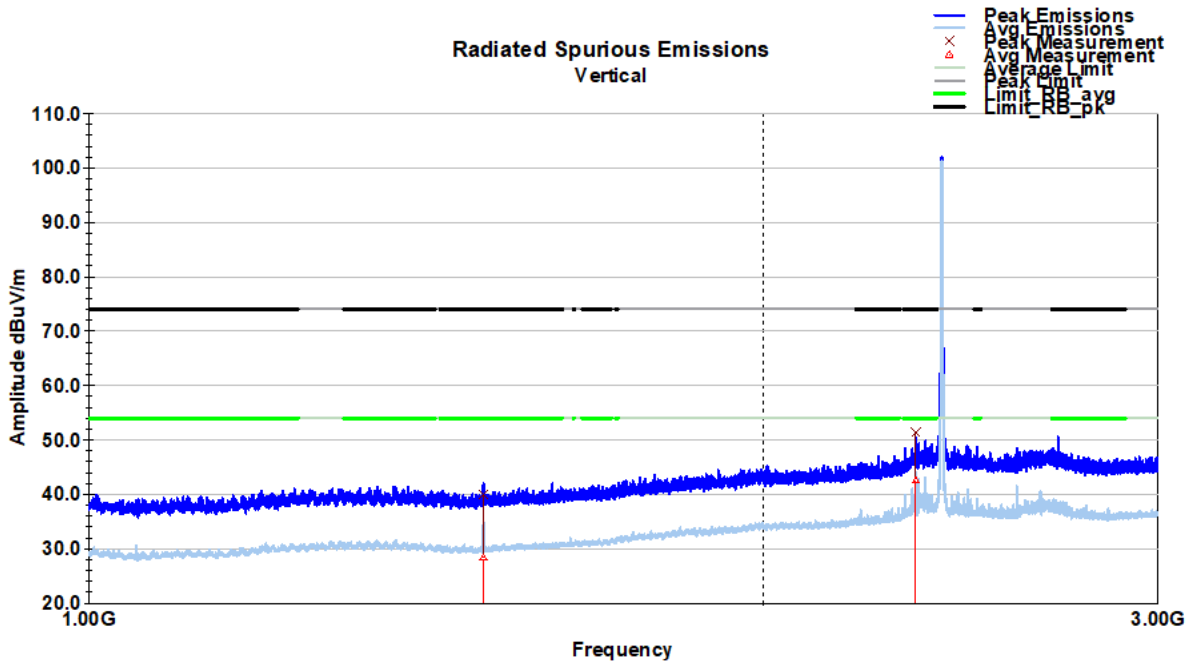
7.5.1 30-1000 MHz

There was no deviation based on axis or channel in the 30-1000 MHz spectrum.



7.5.2 1-3 GHz

1-3 GHz Vertical Low Channel



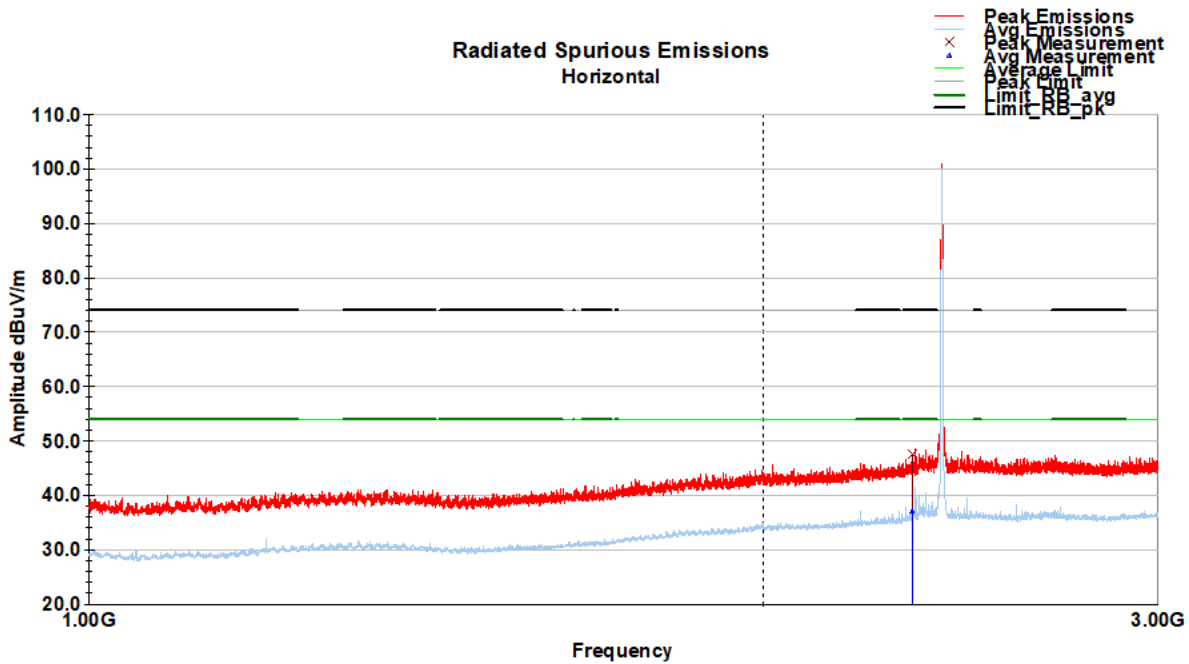
Peak Data

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
1500.28	44.558	V	170	103	27.7	2.4	34.7	40	74	-34
2338.44	51.12	V	0	221	31.8	3.1	34.5	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
1500.28	33.001	V	170	103	27.7	2.4	34.7	28.398	54	-25.6
2338.44	42.083	V	0	221	31.8	3.1	34.5	42.455	54	-11.5
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

1-3 GHz Horizontal Low Channel



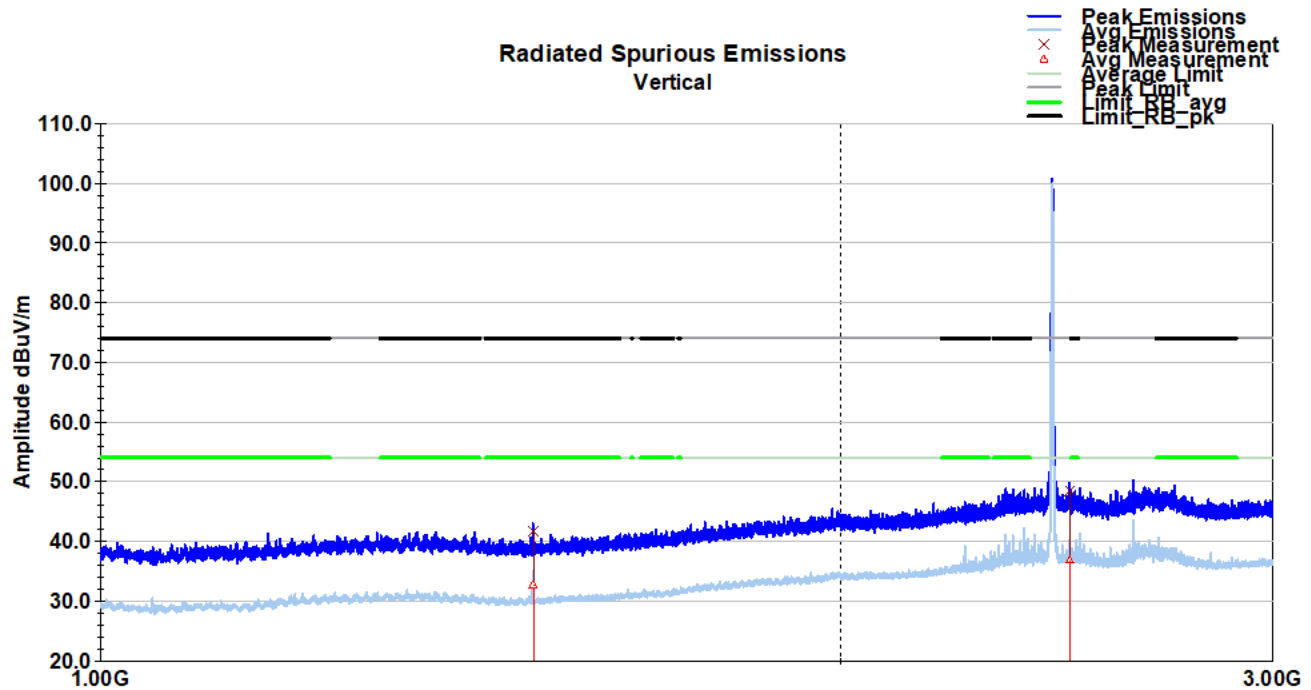
Peak Data

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
2330.28	47.121	H	333	248	31.8	3.1	34.5	47.478	74	-26.5
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)
2330.28	36.782	H	333	248	31.8	3.1	34.5	37.138	54	-16.8
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

1-3 GHz Vertical Mid Channel



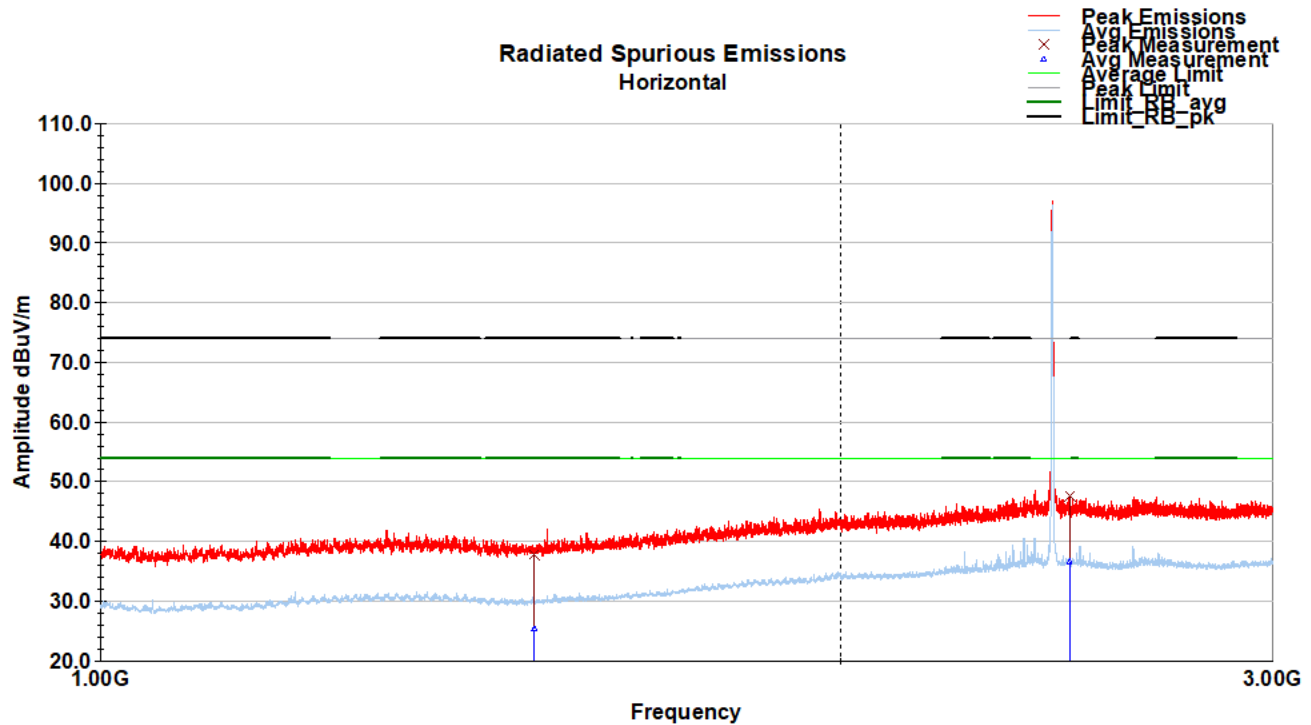
Peak Data

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
1500.28	46.13	V	74	203	27.7	2.4	34.7	41.5	74	-32.5
2480.64	47.381	V	329	186	32.4	3.2	34.5	48.4	74	-25.6
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
1500.28	37.335	V	74	203	27.7	2.4	34.7	32.732	54	-21.2
2480.64	35.744	V	329	186	32.4	3.2	34.5	36.753	54	-17.2
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

1-3 GHz Horizontal Mid Channel



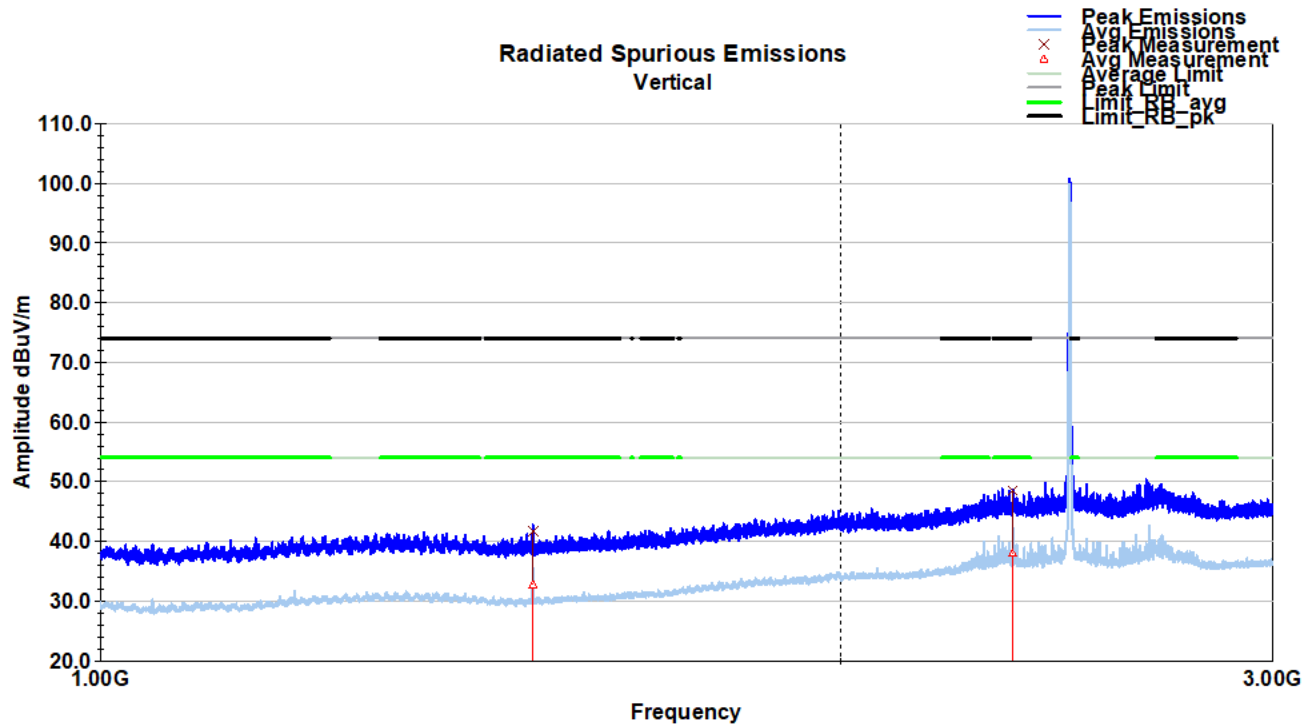
Peak Data

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
1501.6	42.406	H	18	198	27.7	2.4	34.7	37.817	74	-36.2
2480.16	46.572	H	275	126	32.4	3.2	34.5	47.577	74	-26.4
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)
1501.6	30.015	H	18	198	27.7	2.4	34.7	25.426	54	-28.6
2480.16	35.503	H	275	126	32.4	3.2	34.5	36.508	54	-17.5
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

1-3 GHz Vertical High Channel



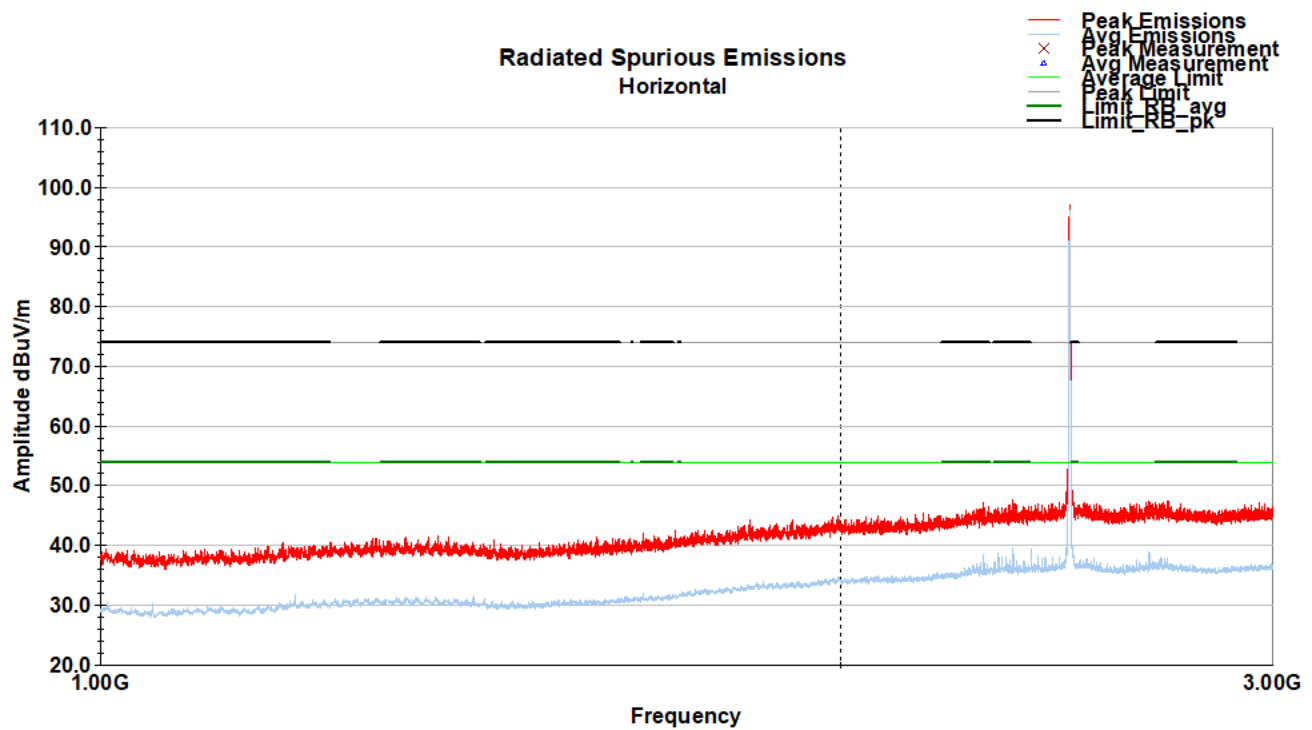
Peak Data

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
1499.92	46.313	V	330	180	27.7	2.4	34.7	41.7	74	-32.3
2351.8	48.052	V	330	229	31.8	3.1	34.5	48.4	74	-25.6
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

Average Data

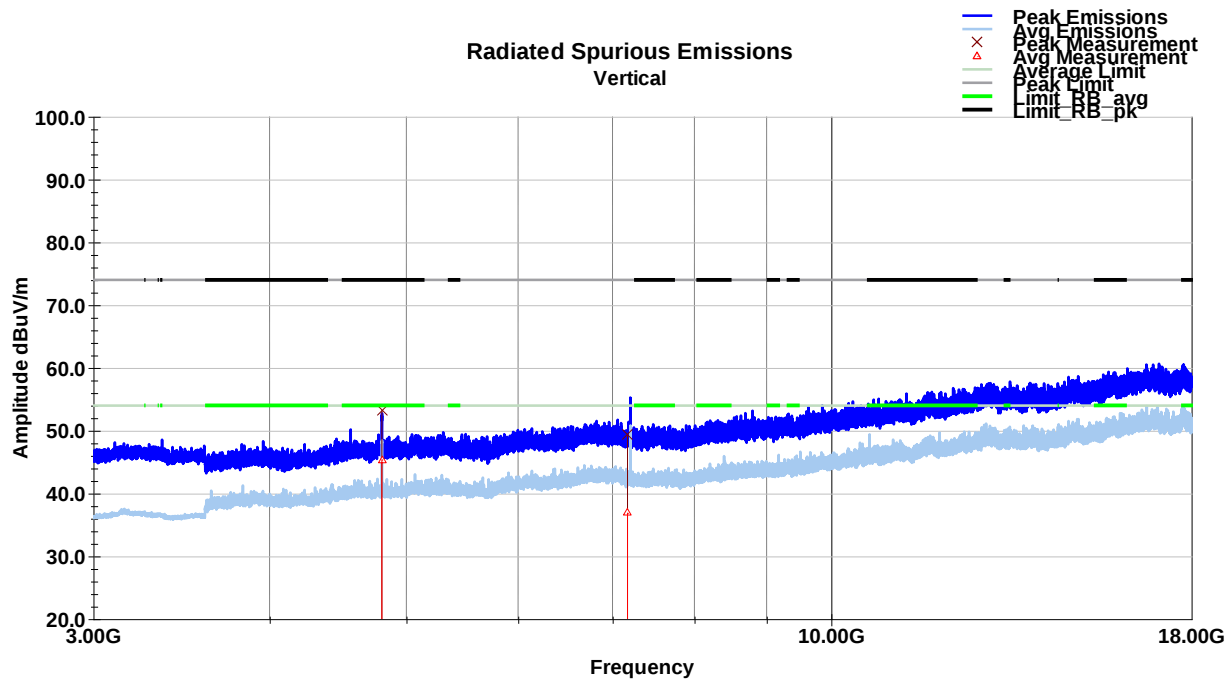
Frequency	Raw Avg	Polarity	Azimuth	Height	AF	Loss	Amp	Final Avg	Limit	Margin
MHz	dBuV	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	dBuV/m	dBuV/m	(dB)
1499.92	37.357	V	330	180	27.7	2.4	34.7	32.751	54	-21.2
2351.8	37.616	V	330	229	31.8	3.1	34.5	38.012	54	-16
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

1-3 GHz Horizontal High Channel



7.5.3 3-18 GHz

3-18 GHz Vertical Low Channel



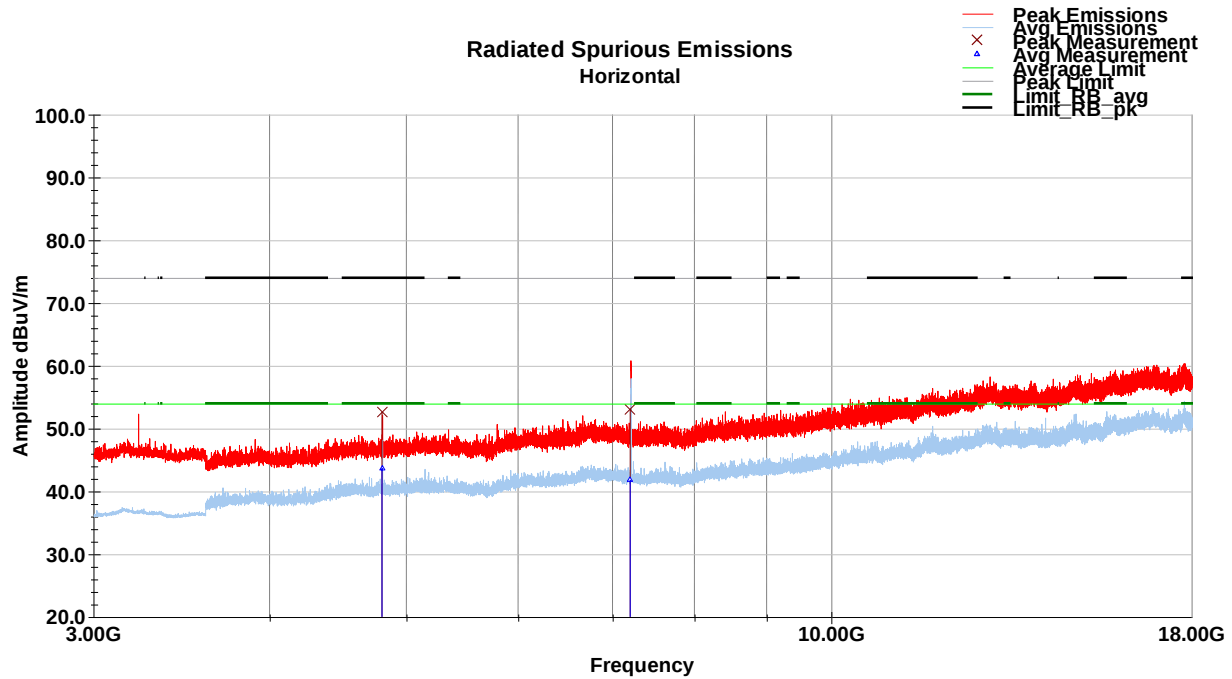
Peak Data

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
4804.48	48.314	V	101	222	34.6	4.9	34.6	53.2	74	-20.8
7172.44	42.5	V	227	210	35.8	6	35	49.3	74	-24.7
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
4804.48	40.49	V	101	222	34.6	4.9	34.6	45.412	54	-8.6
7172.44	30.09	V	227	210	35.8	6	35	36.92	54	-17.1
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

3-18 GHz Horizontal Low Channel



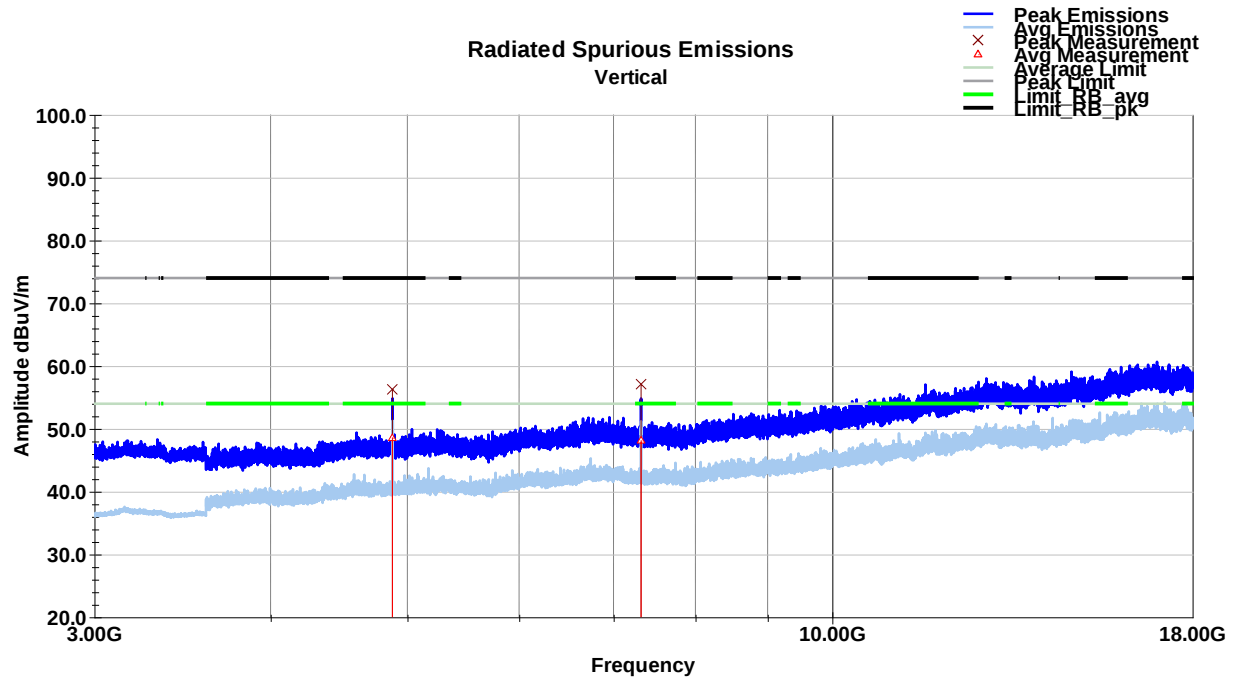
Peak Data

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
4804.84	47.696	H	281	247	34.6	4.9	34.6	52.618	74	-21.4
7204.84	46.269	H	164	229	35.7	6.1	35	53.056	74	-20.9
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)
4804.84	38.812	H	281	247	34.6	4.9	34.6	43.734	54	-10.2
7204.84	35.009	H	164	229	35.7	6.1	35	41.796	54	-12.2
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

3-18GHz Vertical Mid Channel



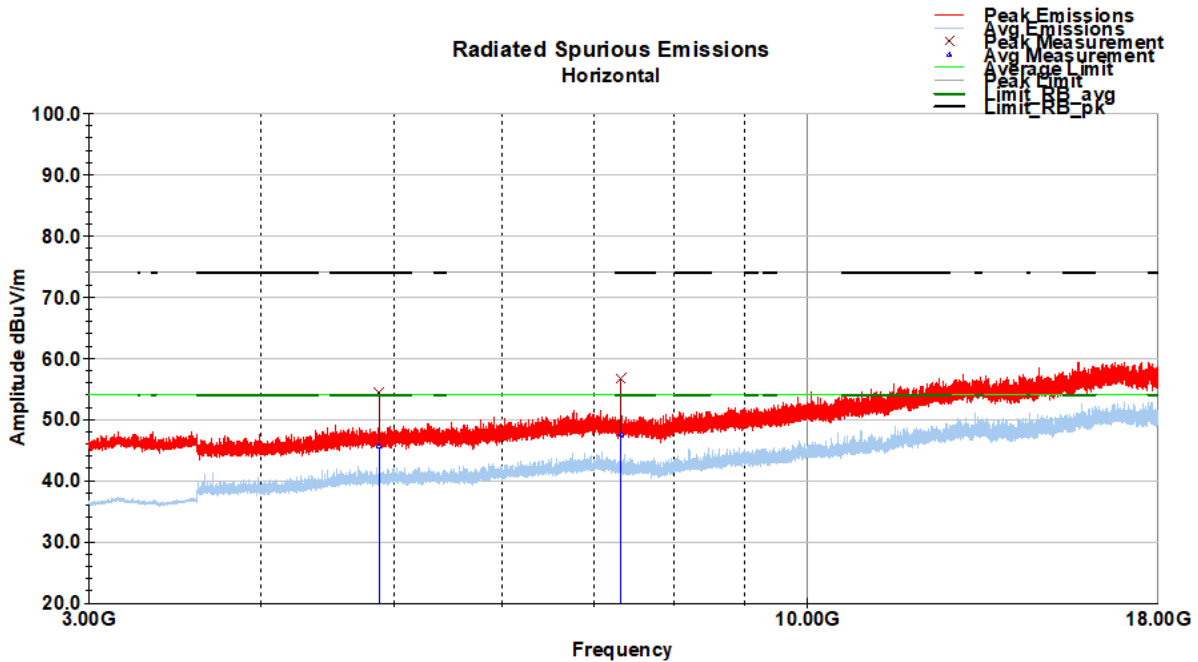
Peak Data

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
4879.68	51.496	V	180	249	34.5	4.9	34.6	56.3	74	-17.7
7321.32	50.275	V	3	243	35.7	6.1	35.1	57	74	-17
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)
4879.68	43.748	V	180	249	34.5	4.9	34.6	48.601	54	-5.4
7321.32	41.405	V	3	243	35.7	6.1	35.1	48.131	54	-5.8
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

3-18 GHz Horizontal Mid Channel



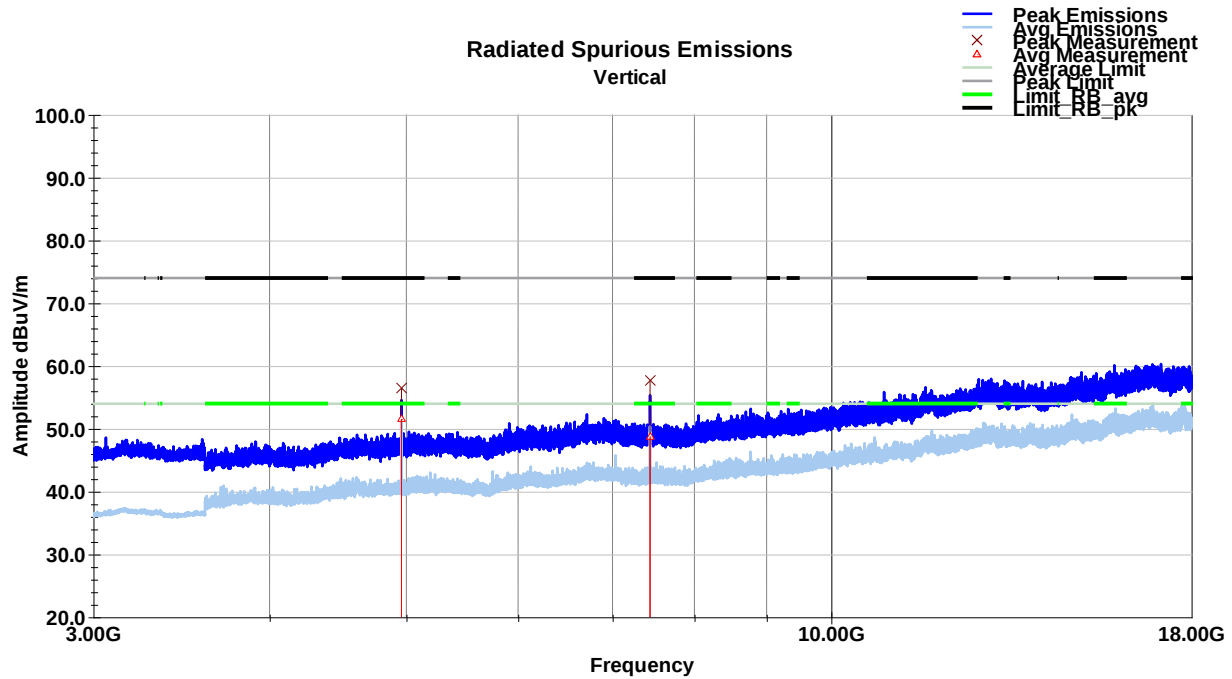
Peak Data

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
4879.68	49.771	H	107	245	34.5	4.7	34.6	54.384	74	-19.6
7321.36	50.252	H	247	205	35.7	5.7	35.1	56.629	74	-17.4
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)
4879.68	41.113	H	107	245	34.5	4.7	34.6	45.726	54	-8.3
7321.36	41.221	H	247	205	35.7	5.7	35.1	47.598	54	-6.4
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

3-18 GHz Vertical High Channel



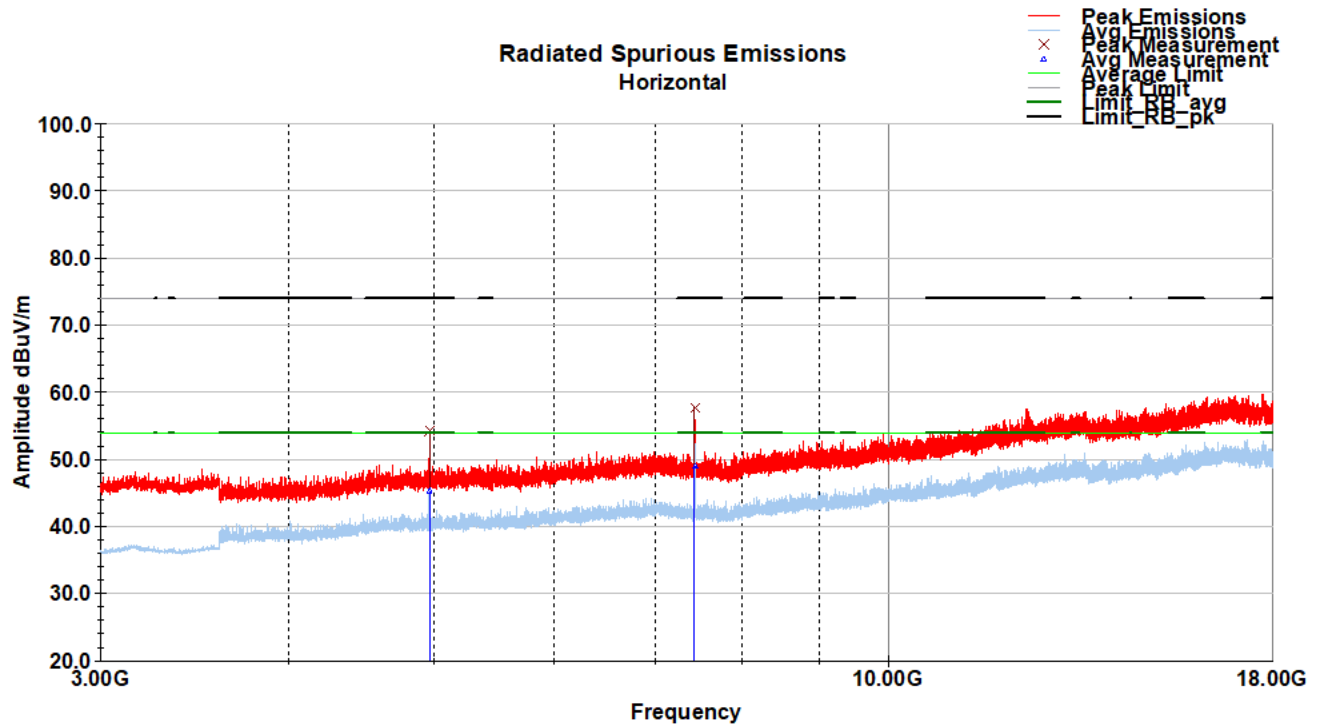
Peak Data

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	51.572	V	177	245	34.5	5	34.6	56.4	74	-17.6
7441.44	51.114	V	0	204	35.7	6.1	35.1	57.8	74	-16.2
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	46.711	V	177	245	34.5	5	34.6	51.544	54	-2.4
7441.44	42.091	V	0	204	35.7	6.1	35.1	48.756	54	-5.2
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

3-18GHz 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
4959.58	49.695	H	260	231	34.5	4.8	34.6	54.29	74	-19.7
7439.56	51.358	H	125	208	35.7	5.7	35.1	57.672	74	-16.3
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

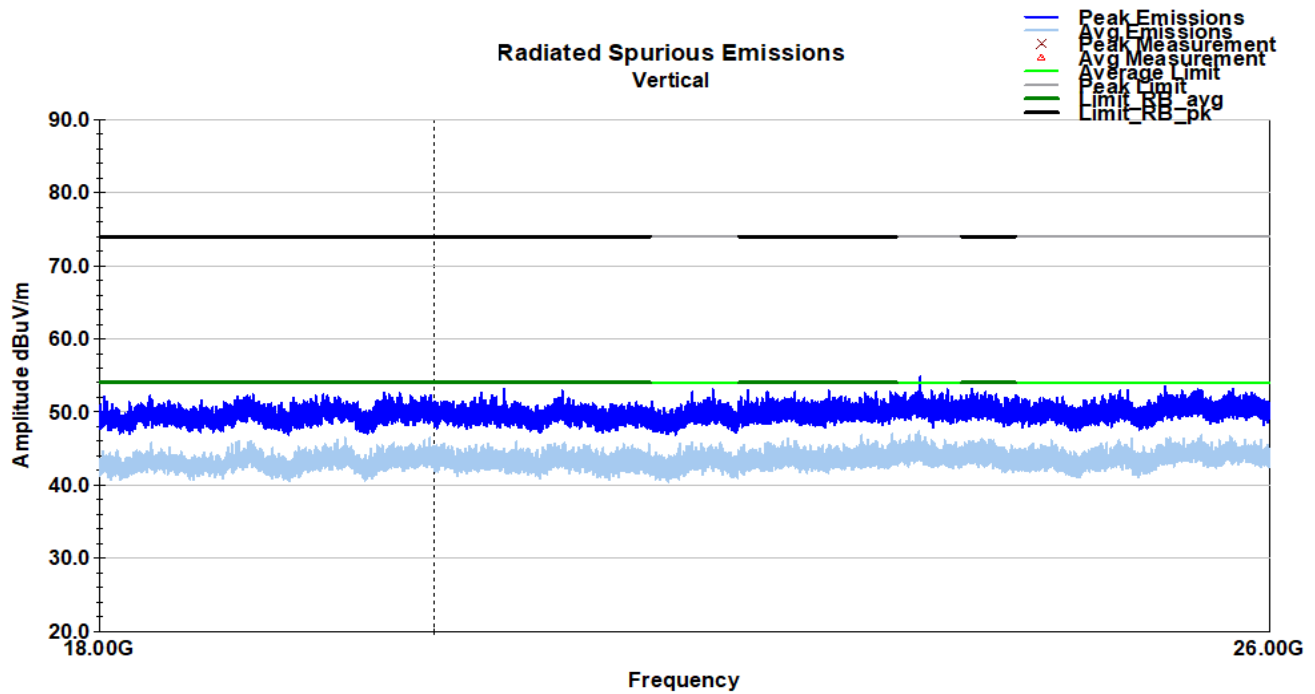
Average Data

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)
4959.58	40.652	H	260	231	34.5	4.8	34.6	45.246	54	-8.7
7439.56	42.582	H	125	208	35.7	5.7	35.1	48.895	54	-5.1
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

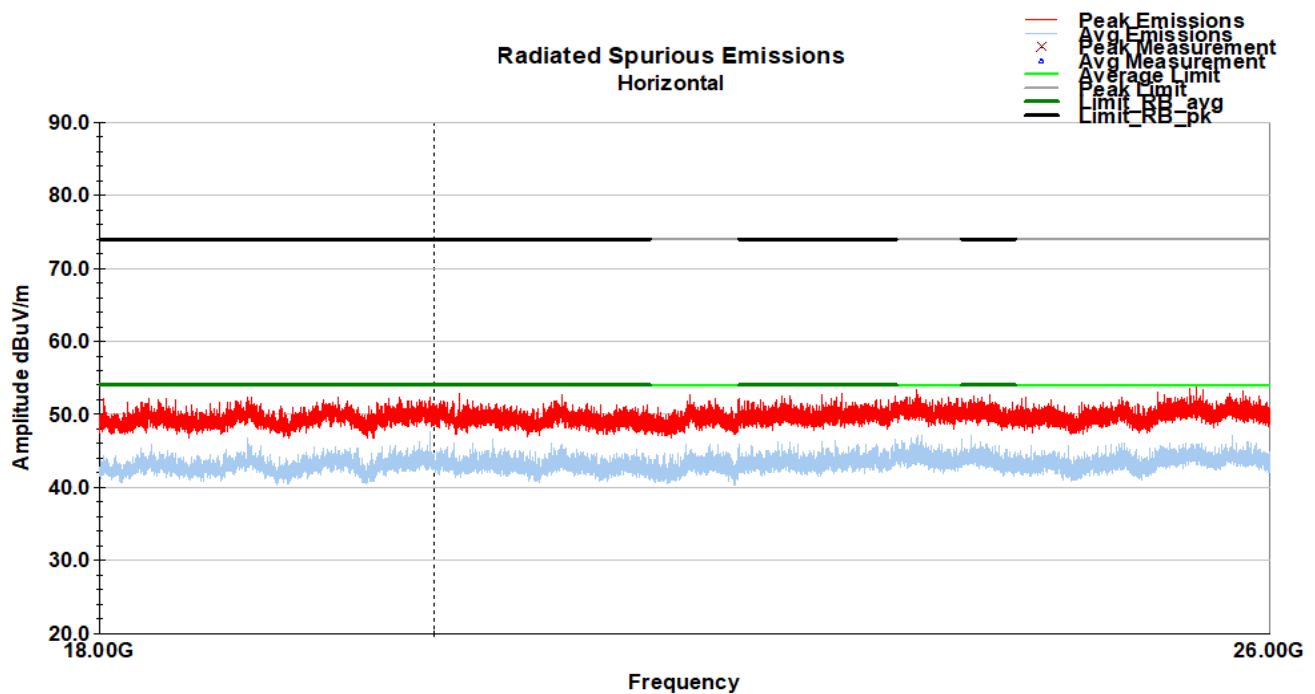
7.5.4 18-26 GHz

There was no deviation based on axis or channel in the 18-26 GHz spectrum.

18-26GHz Vertical



18-26GHz Horizontal



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.

The BLE 2Mbps data mode was used for these tests since it produced emissions closest to the band edges.

8.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 24.2 °C
Relative Humidity: 34.8 %
Atmospheric Pressure: 97.8 kPa

8.4 Test Equipment

Test End Date: 7-Apr-2021

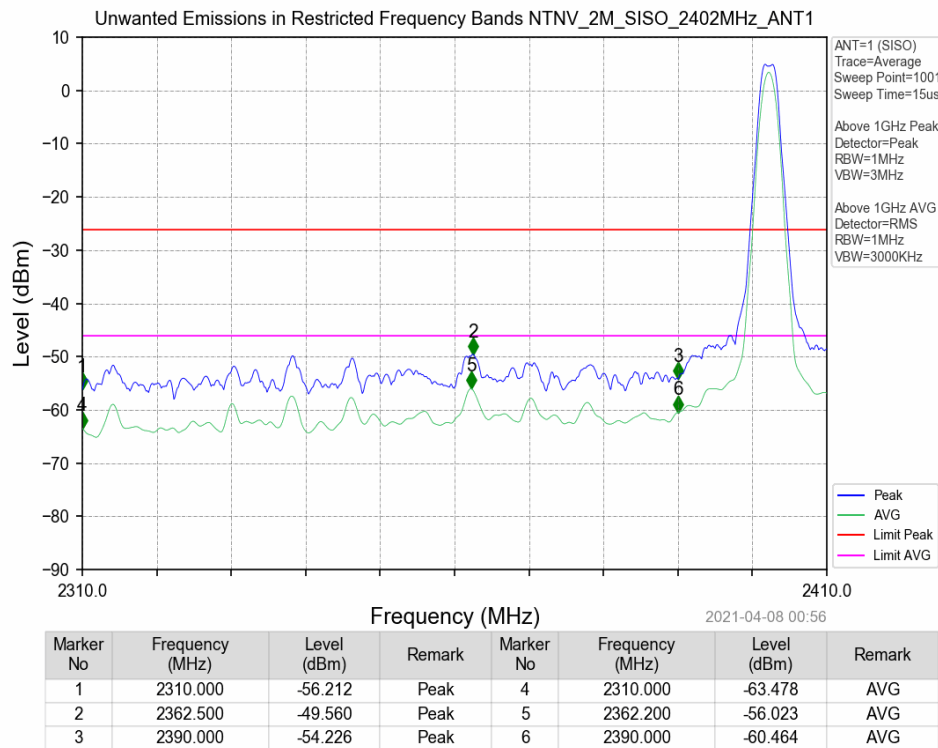
Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	27-Dec-2019	27-Dec-2021
ATTENUATOR, 10DB	BW-S10W2	Mini-Circuits	15032	28-Sep-2020	28-Sep-2021
RF Cable SMA to SMA, 0.01-40GHz	084-0505-059	TELEDYNE STORM MICROWAVE	20108	16-Mar-2021	16-Mar-2022

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

8.5 Test Data

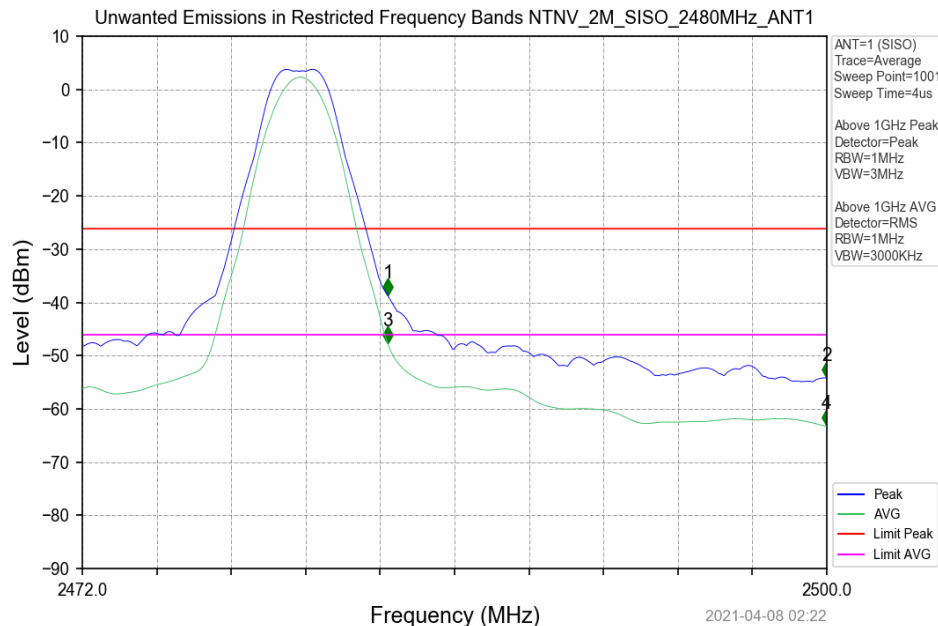
BLE – Low Channel – Plot



BLE – Low Channel – Data

Frequency (MHz)	Reading Level (dBm)	Antenna Gain (dBi)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
2310.000	-63.48	4.90	36.62	54	-17.38	AVG
	-56.21	4.90	43.89	74	-30.11	Peak
2362.200	-56.02	4.90	44.08	54	-9.92	AVG
2362.500	-49.56	4.90	50.54	74	-23.46	Peak
2390.000	-60.46	4.90	39.64	54	-14.36	AVG
	-54.23	4.90	45.87	74	-28.13	Peak

BLE – High Channel – Plot



Marker No	Frequency (MHz)	Level (dBm)	Remark	Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2483.500	-38.694	Peak	3	2483.500	-47.653	AVG
2	2500.000	-54.205	Peak	4	2500.000	-63.271	AVG

BLE – High Channel – Data

Frequency (MHz)	Reading Level (dBm)	Antenna Gain (dBi)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
2483.500	-47.65	4.90	52.45	54	-1.55	AVG
	-38.69	4.90	61.41	74	-12.59	Peak
2500.000	-63.27	4.90	36.83	54	-17.17	AVG
	-54.20	4.90	45.90	74	-28.11	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	$\pm 1 \times 10^{-5}$	$\pm 9.8 \times 10^{-8}$
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	$\pm 1^{\circ}\text{C}$	$\pm 0.5^{\circ}\text{C}$
humidity	± 5 %	$\pm 3.5\%$
DC and low frequency voltages	± 3 %	$\pm 0.4\%$
Conducted disturbance at mains port using AMN	± 3.4 dB	± 2.5 dB

10 Revision History

Revision Level	Description of changes	Revision Date
Draft	--	30 April 2021
0	Initial release	04 June 2021
1	- Added the SGS North America CAB ID in section 2.2 - Added details of the test mode firmware in section 2.4	28 June 2021