

RF Test Report

Project Number: 4681230**Proposal Number:** 11079**Report Number:** 4681230EMC01**Revision Level:** 1**Client:** ZEROKEY Inc.**Equipment Under Test:** 50V Ultrasonic Transducer**Model Name:** Mobile Node**Model Number:** AGISMB10 and ZKISMB10**FCC ID:** 2AX6LISMB10**IC:** 26679-ISMB10**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: 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:

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.

This document is issued by the Company under its General Conditions of Service accessible at <http://www.sgs.com/en/Terms-and-Conditions.aspx>. Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

Any holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful, and offenders may be prosecuted to the fullest extent of the law.

Table of Contents

1	SUMMARY OF TEST RESULTS	4
1.1	MODIFICATIONS REQUIRED FOR COMPLIANCE	4
2	GENERAL INFORMATION	5
2.1	CLIENT INFORMATION	5
2.2	TEST LABORATORY	5
2.3	GENERAL INFORMATION OF EUT	5
2.4	OPERATING MODES AND CONDITIONS	5
2.5	EUT CONNECTION BLOCK DIAGRAM – CONDUCTED MEASUREMENTS	6
2.6	EUT CONNECTION BLOCK DIAGRAM – RADIATED MEASUREMENTS	6
2.7	SYSTEM CONFIGURATIONS	6
2.8	CABLE LIST	6
3	BANDWIDTH	7
3.1	TEST RESULT	7
3.2	TEST METHODS	7
3.3	TEST SITE	7
3.4	TEST EQUIPMENT	7
3.5	TEST DATA – DTS BANDWIDTH (6dB)	8
3.6	TEST DATA – 99% OCCUPIED BANDWIDTH	9
4	OUTPUT POWER	10
4.1	TEST RESULT	10
4.2	TEST METHOD	10
4.3	TEST SITE	10
4.4	TEST EQUIPMENT	10
4.5	TEST DATA	11
5	POWER SPECTRAL DENSITY	12
5.1	TEST RESULT	12
5.2	TEST METHOD	12
5.3	TEST SITE	12
5.4	TEST EQUIPMENT	12
5.5	TEST DATA	13
6	CONDUCTED SPURIOUS EMISSIONS / BAND EDGE	14
6.1	TEST RESULT	14
6.2	TEST METHOD	14
6.3	TEST SITE	14
6.4	TEST EQUIPMENT	14
6.5	TEST DATA – DTS BAND EDGE	15
6.6	TEST DATA – DTS CONDUCTED SPURIOUS EMISSIONS	16
7	EMISSIONS IN RESTRICTED FREQUENCY BANDS	17
7.1	TEST RESULT	17
7.2	TEST METHOD	17
7.3	TEST SITE	17
7.4	TEST EQUIPMENT	18
7.5	TEST DATA	19
8	BAND EDGE EMISSIONS IN RESTRICTED FREQUENCY BANDS	35
8.1	TEST RESULT	35
8.2	TEST METHOD	35

8.3	TEST SITE	35
8.4	TEST EQUIPMENT	35
8.5	TEST DATA.....	36
9	AC POWERLINE CONDUCTED EMISSIONS.....	38
9.1	TEST RESULT.....	38
9.2	TEST METHOD.....	38
9.3	TEST SITE	38
9.4	TEST EQUIPMENT	38
9.5	TEST DATA.....	39
10	MEASUREMENT UNCERTAINTY.....	41
11	REVISION HISTORY	42

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	Compliant
Antenna Requirement	15.203	RSS-GEN S6.8	Compliant ⁽¹⁾

(1) The device uses an internal stamped metal 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: Mobile Node
Model Numbers: AGISMB10 and ZKISMB10
Sample ID: 5922
FCC ID: 2AX6LISMB10
IC ID: 26679-ISMB10

Frequency Range: 2402 – 2480 MHz
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: 3.7 Vdc Rechargeable Lithium Polymer Battery
Test Voltage: 3.7 Vdc Rechargeable Lithium Polymer Battery

Sample Received Date: 21 December 2020
Dates of testing: 22 December 2020 to 07 January 2021

2.4 Operating Modes and Conditions

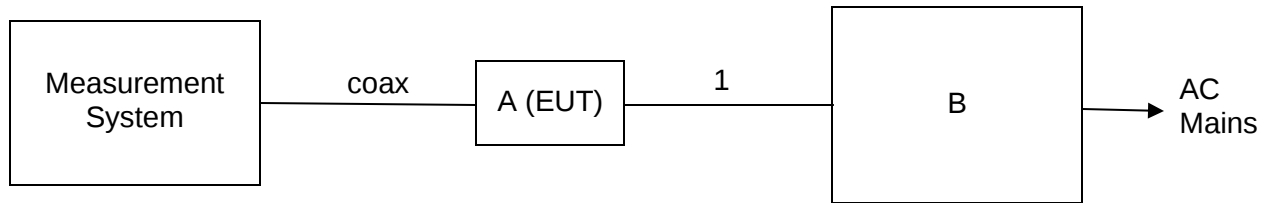
The EUT was running test mode firmware FCC Certification Version 1.0 that allowed control of the Bluetooth LE radio from Nordic Semiconductor. This firmware was based on Nordic SDK v15.2.0. This software allowed the following:

- 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.]

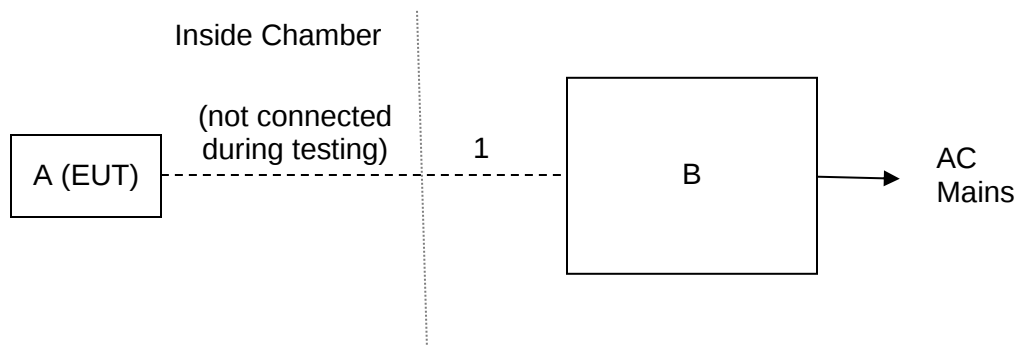
The following 3 data modes were tested and the worst-case results for each test were reported.

- 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)	AGISMB10 ZKISMB10	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-C	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: 23.7 °C

Relative Humidity: 28.3 %

Atmospheric Pressure: 98.2 kPa

3.4 Test Equipment

Test Date: 22-Dec-2020

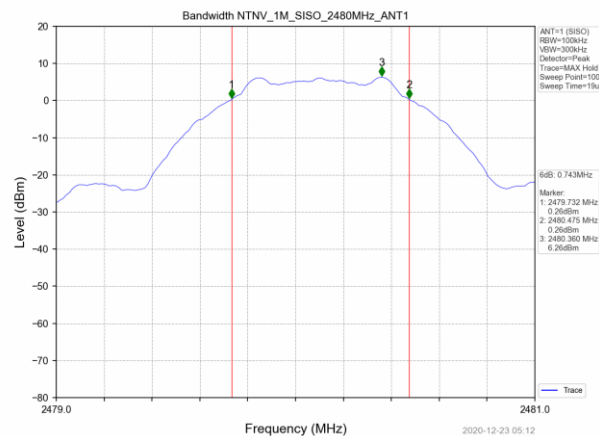
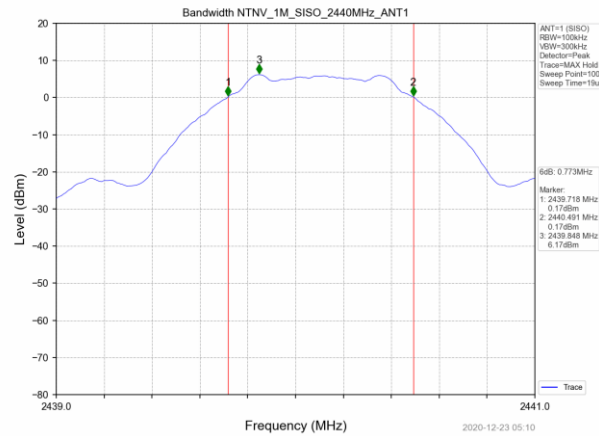
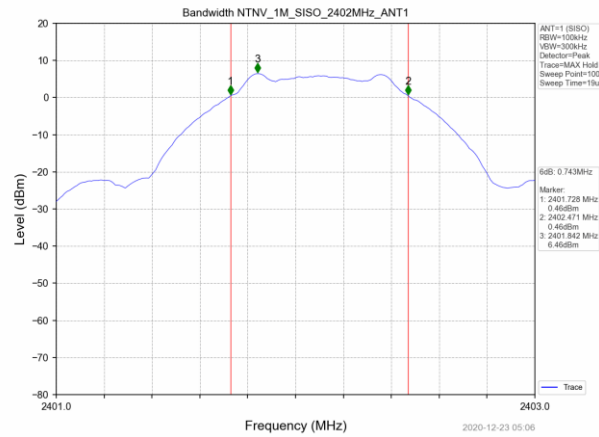
Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
RF CABLE SMA	HULL150A-29P-29P-36	HASCO COMPONENTS	19102	30-Mar-2020	30-Mar-2021
ATTENUATOR, 10DB	BW-S10W2	Mini-Circuits	15031	28-Sep-2020	28-Sep-2021
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.

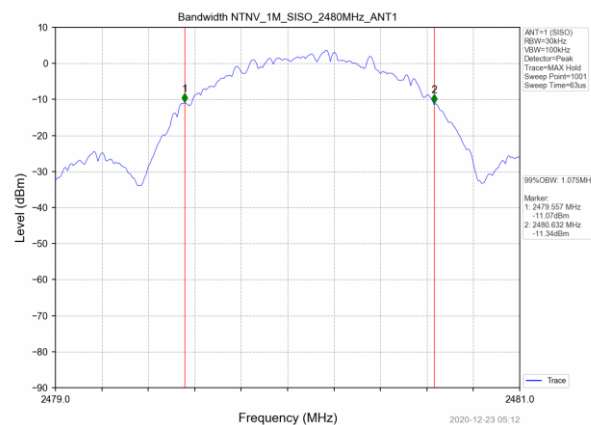
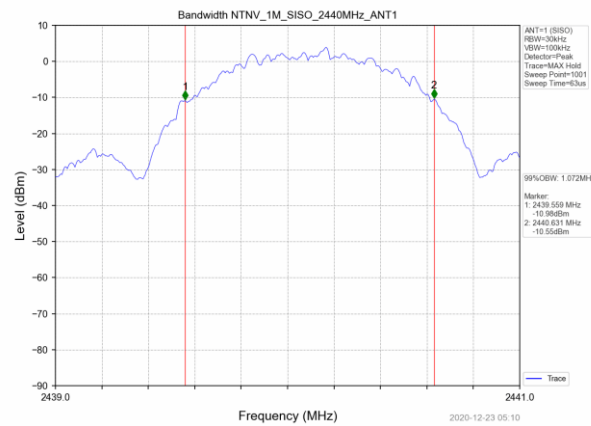
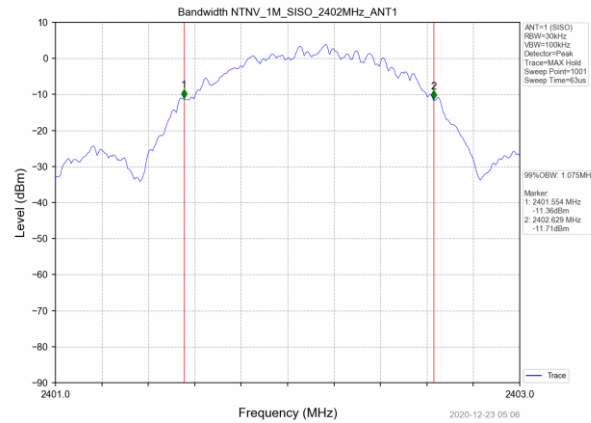
3.5 Test Data – DTS Bandwidth (6dB)

Test Mode	Channel	Frequency (MHz)	6dB Bandwidth		Verdict
			Test Result (MHz)	Limits (MHz)	
BLE 1Mbps	0	2402	0.743	≥0.5	Pass
	19	2440	0.773	≥0.5	Pass
	39	2480	0.743	≥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	1.075	Reported
	19	2440	1.072	Reported
	39	2480	1.075	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 BLE 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: 23.7 °C
Relative Humidity: 28.3 %
Atmospheric Pressure: 98.2 kPa

4.4 Test Equipment

Test Date: 22-Dec-2020

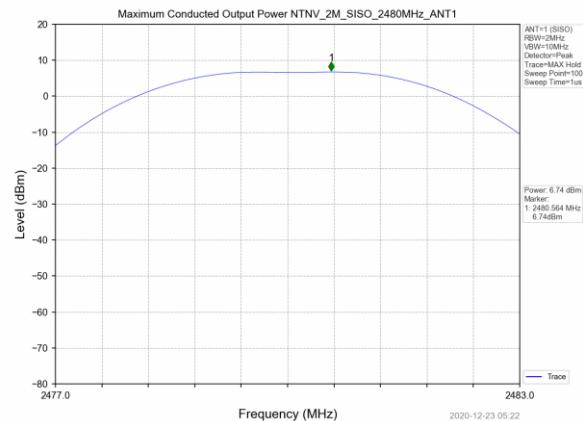
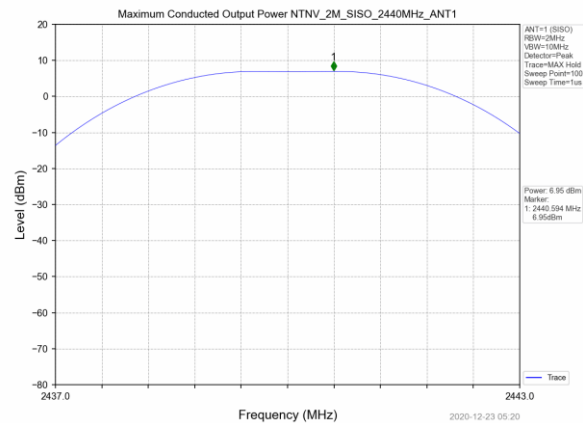
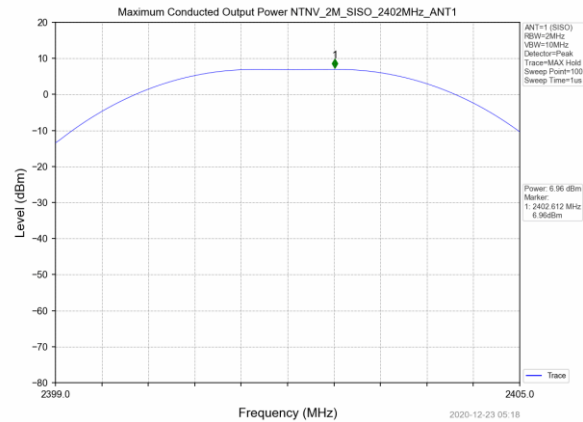
Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
RF CABLE SMA	HULL150A-29P-29P-36	HASCO COMPONENTS	19102	30-Mar-2020	30-Mar-2021
ATTENUATOR, 10DB	BW-S10W2	Mini-Circuits	15031	28-Sep-2020	28-Sep-2021
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.

4.5 Test Data

Channel	Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Peak EIRP (dBm)	Limit Max (dBm)	Verdict
0	2402	6.96	30	11.86	36	Pass
19	2440	6.95	30	11.85	36	Pass
39	2480	6.74	30	11.64	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 ShockBurst 2Mbps 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: 23.8 °C

Relative Humidity: 26.0 %

Atmospheric Pressure: 98.1 kPa

5.4 Test Equipment

Test Date: 23-Dec-2020

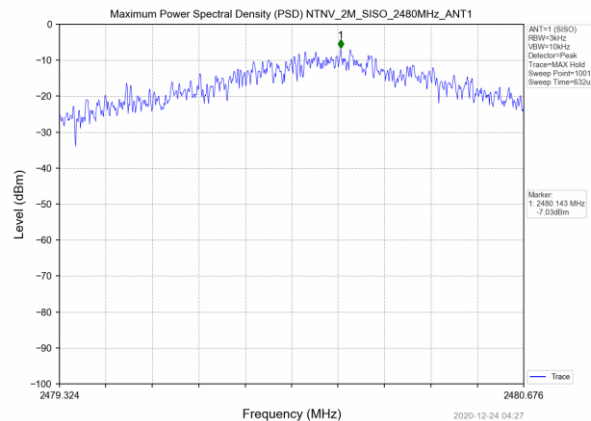
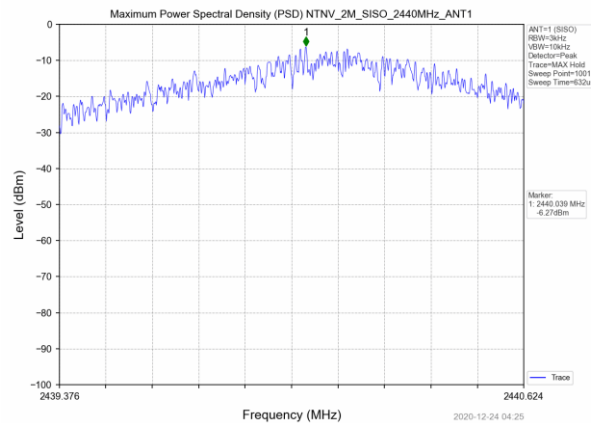
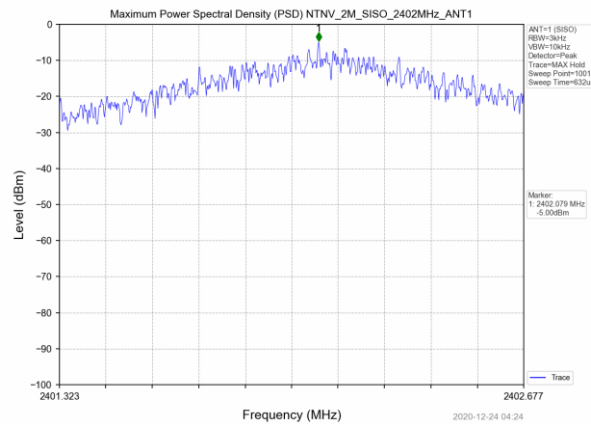
Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
RF CABLE SMA	HULL150A-29P-29P-36	HASCO COMPONENTS	19102	30-Mar-2020	30-Mar-2021
ATTENUATOR, 10DB	BW-S10W2	Mini-Circuits	15031	28-Sep-2020	28-Sep-2021
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.

5.5 Test Data

Channel	Frequency (MHz)	Peak PSD (dBm/3kHz)	Limit Max (dBm/3kHz)	Verdict
0	2402	-5.00	8	Pass
19	2440	-6.27	8	Pass
39	2480	-7.03	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: 23.8 °C
Relative Humidity: 26.0 %
Atmospheric Pressure: 98.1 kPa

6.4 Test Equipment

Test Date: 23-Dec-2020

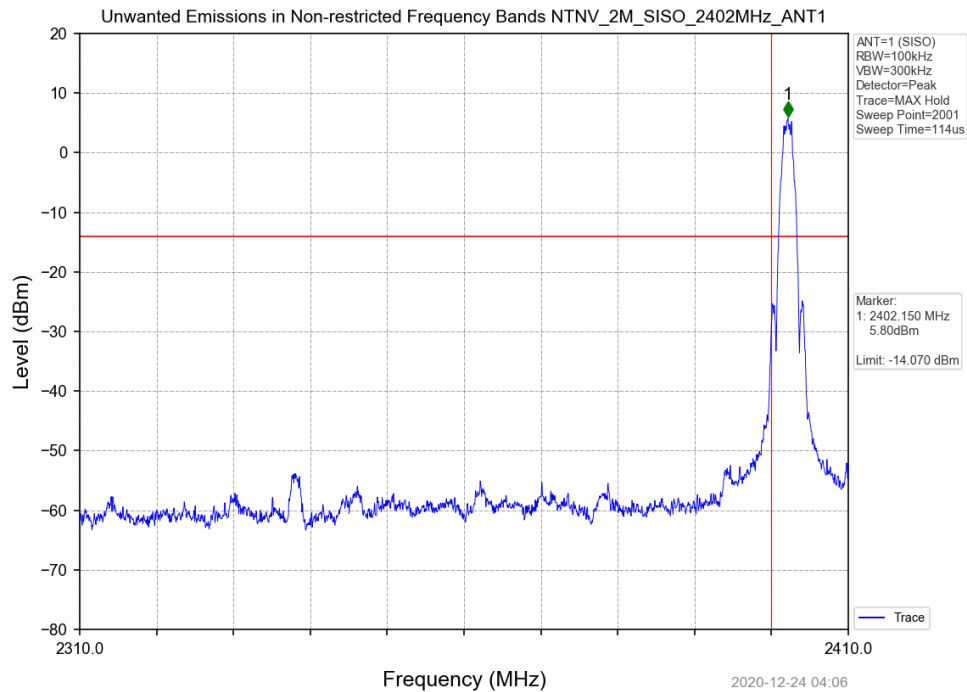
Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
RF CABLE SMA	HULL150A-29P-29P-36	HASCO COMPONENTS	19102	30-Mar-2020	30-Mar-2021
ATTENUATOR, 10DB	BW-S10W2	Mini-Circuits	15031	28-Sep-2020	28-Sep-2021
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	27-Dec-2019	27-Dec-2021

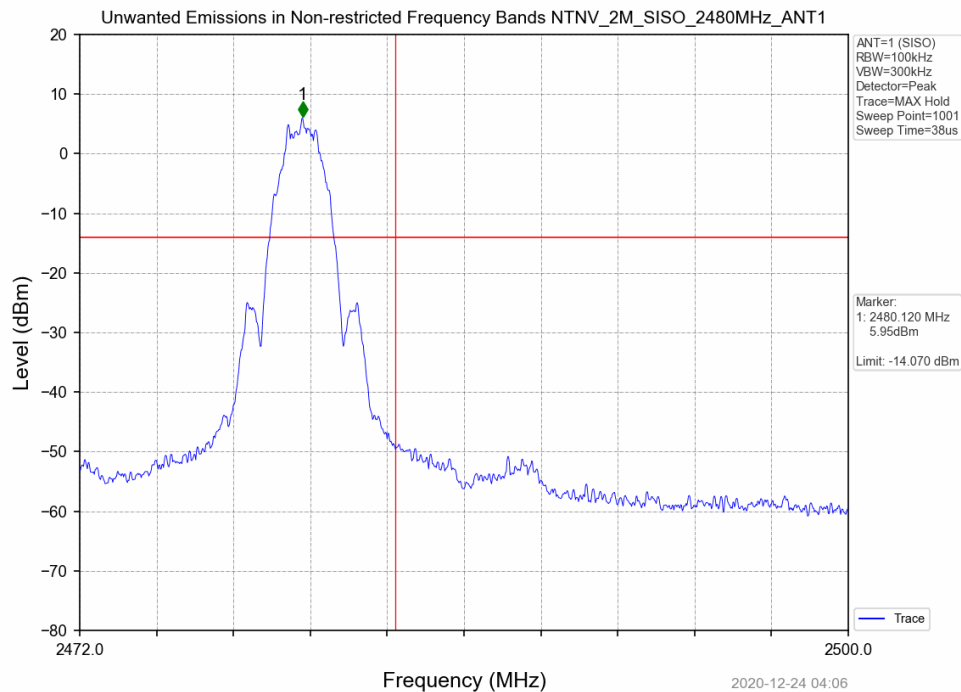
Note: The equipment calibration period is 1 year except for the FSV which is on a 2-year cycle.

6.5 Test Data – DTS Band Edge

BLE - Lower band edge

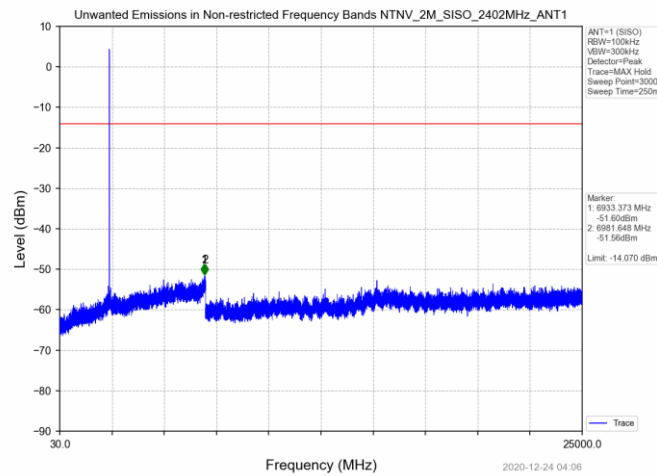


BLE - Upper band edge

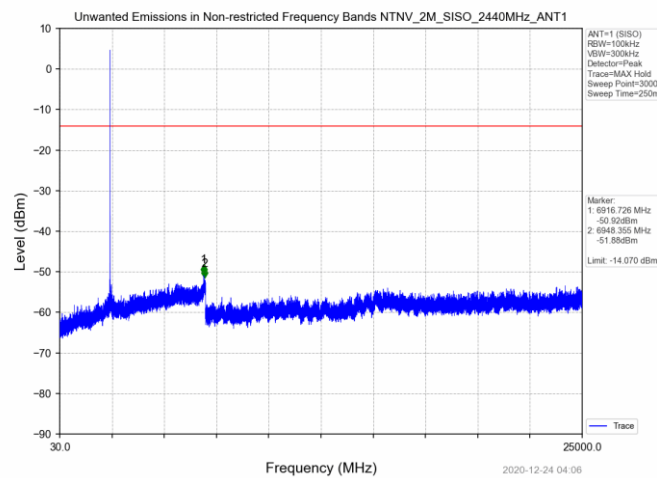


6.6 Test Data – DTS Conducted Spurious Emissions

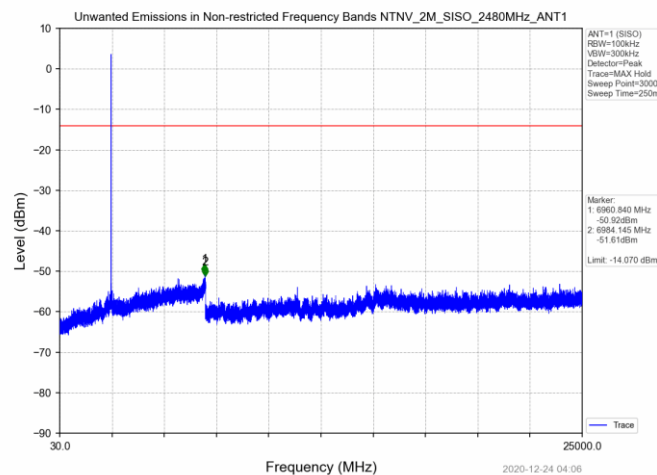
Conducted Spurs – BLE Channel 0



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

10m Absorber Lined Shielded Enclosure (ALSE), Suwanee, GA

Environmental Conditions

Temperature: 23.6°C

Relative Humidity: 24.6 %

Atmospheric Pressure: 98.5 kPa

7.4 Test Equipment

30-1000MHz

Test End Date: 22-Dec-2020

Tester: ASF

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
ANTENNA, BILOG	JB6	SUNOL	B079689	5-Nov-2022
6dB Attenuator NM to NF	BW-N6W5+	Mini-Circuits	19009	6-Apr-2021
RF Cable Nm to Nm, 0.01-18GHz	90-195-079	TELEDYNE STORM MICROWAVE	20124	2-Mar-2021
RF Cable Nm to Nm, 0.01-18GHz	90-195-157	TELEDYNE STORM MICROWAVE	20122	2-Mar-2021
RF CABLE	SF106	HUBER & SUHNER	B079713	3-Sep-2021
RF Cable Nm to Nm, 0.01-18GHz	90-195-118	TELEDYNE STORM MICROWAVE	20126	2-Mar-2021
LOW NOISE AMPLIFIER	ZKL-2+	Mini-Circuits	B079800	25-Sep-2021
RF CABLE	SUCOFLEX 100	Huber & Suhner	B108523	3-Sep-2021
EMI TEST RECEIVER	ESU8	ROHDE & SCHWARZ	B085759	7-May-2021

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

1-18GHz

Test Date: 23-Dec-2020

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	104PE	HUBER & SUHNER	B079793	3-Sep-2020	3-Sep-2021
LOW NOISE AMPLIFIER	TS-PR18	ROHDE & SCHWARZ	B094463	24-Nov-2020	24-Nov-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.

18-26GHz

Test Date: 28-Dec-2020

Tester: LM

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
RF CABLE	SF102	Huber & Suhner	B079823	24-Aug-2020	24-Aug-2021
RF Cable SMA to SMA, 0.01-40GHz	084-0505-138	TELEDYNE STORM MICROWAVE	20111	6-Mar-2020	6-Mar-2021
LOW NOISE AMPLIFIER	NSP1840-HG	MITEQ	B087572	3-Nov-2020	3-Nov-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.

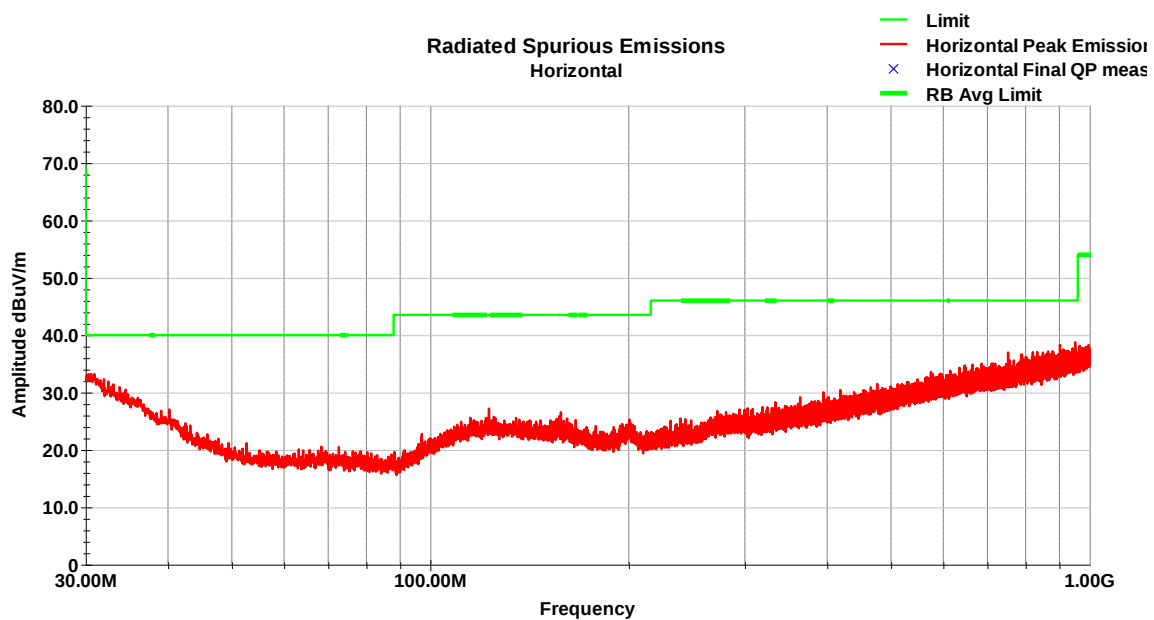
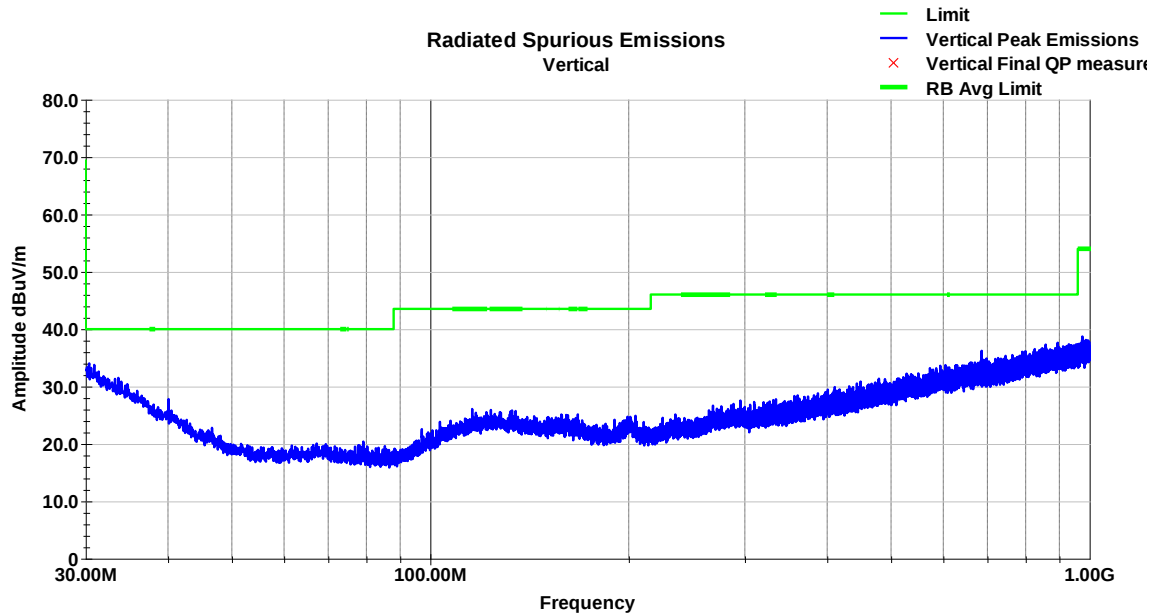
Software: "RSE 30-1000 MHz T7 201007" TILE 7! profile dated Oct 2020
"RSE 1-18 GHz T7 201007" TILE 7! profile dated Oct 2020
"RSE 18-40 GHz T7 190722" TILE 7! profile dated Jul 2019

7.5 Test Data

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

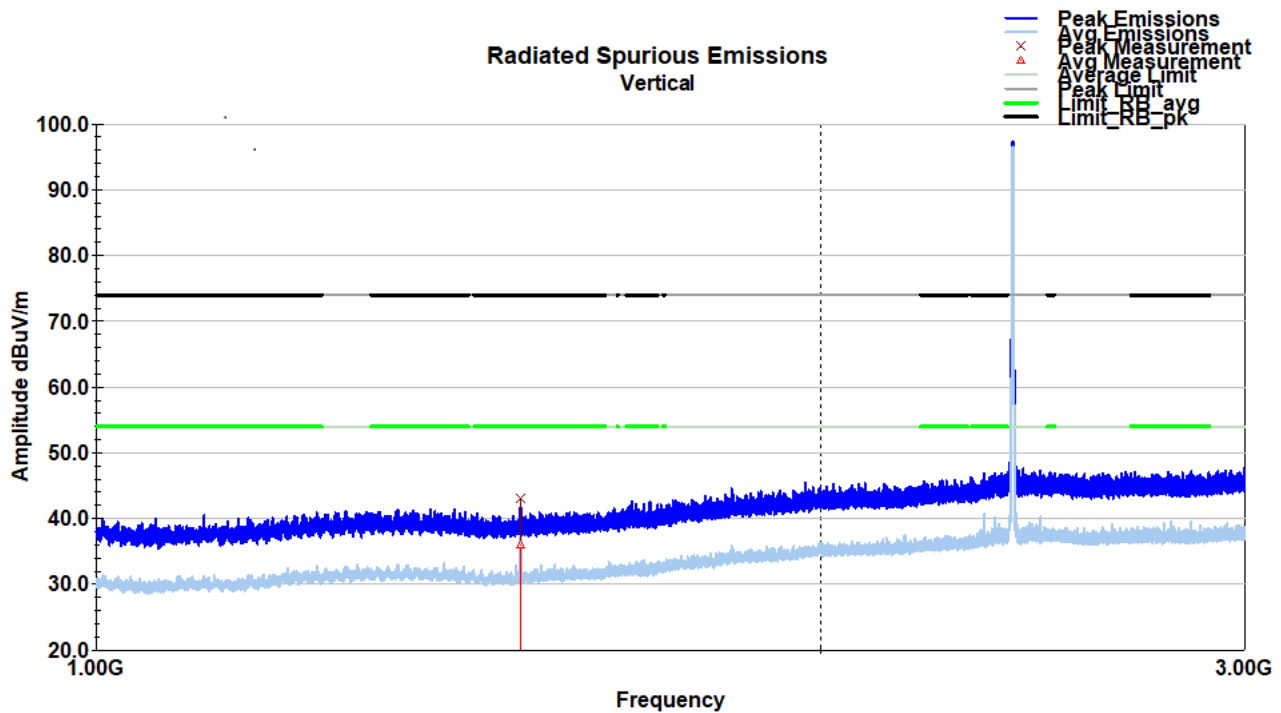
7.5.1 30-1000 MHz

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



7.5.2 1-3 GHz

1-3GHz Vertical Low Channel



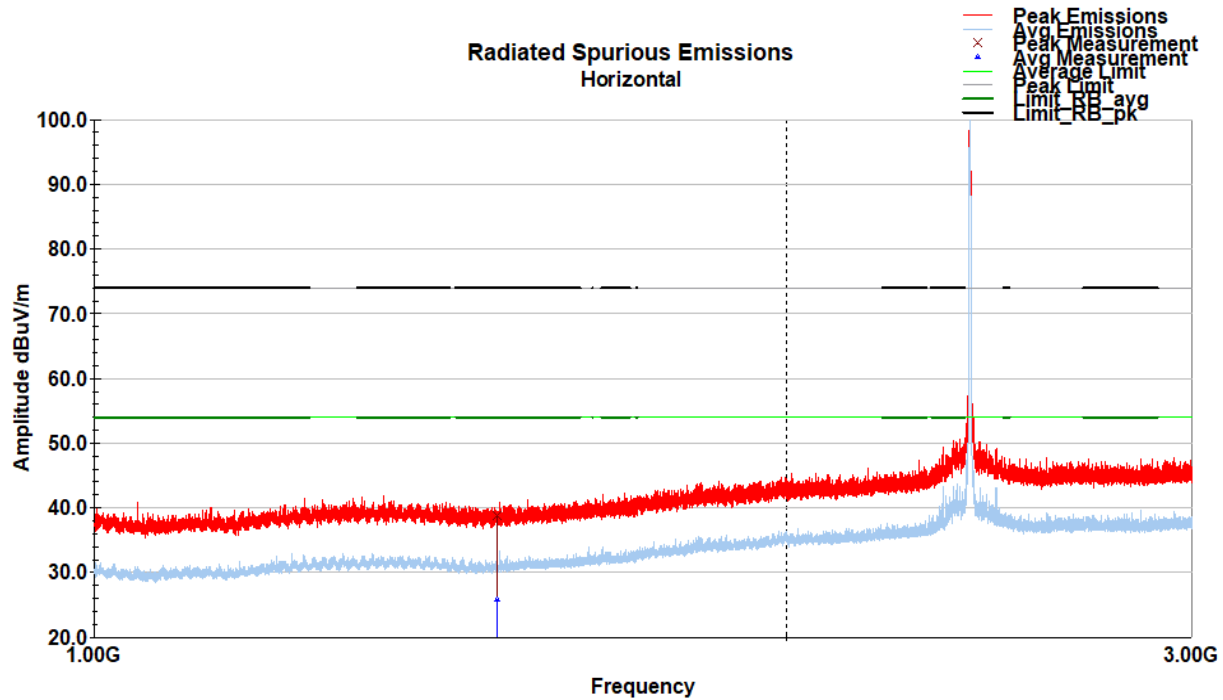
Peak Data

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
1499.92	47.5	V	177.0	241.0	27.7	2.5	34.7	43.0	74.0	-31.0
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

Average Data

Frequency MHz	Raw Avg dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Avg dBuV/m	Limit dBuV/m	Margin dB
1499.92	40.6	V	177.0	241.0	27.7	2.5	34.7	36.0	54.0	-17.9
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

1-3 GHz Horizontal Low Channel



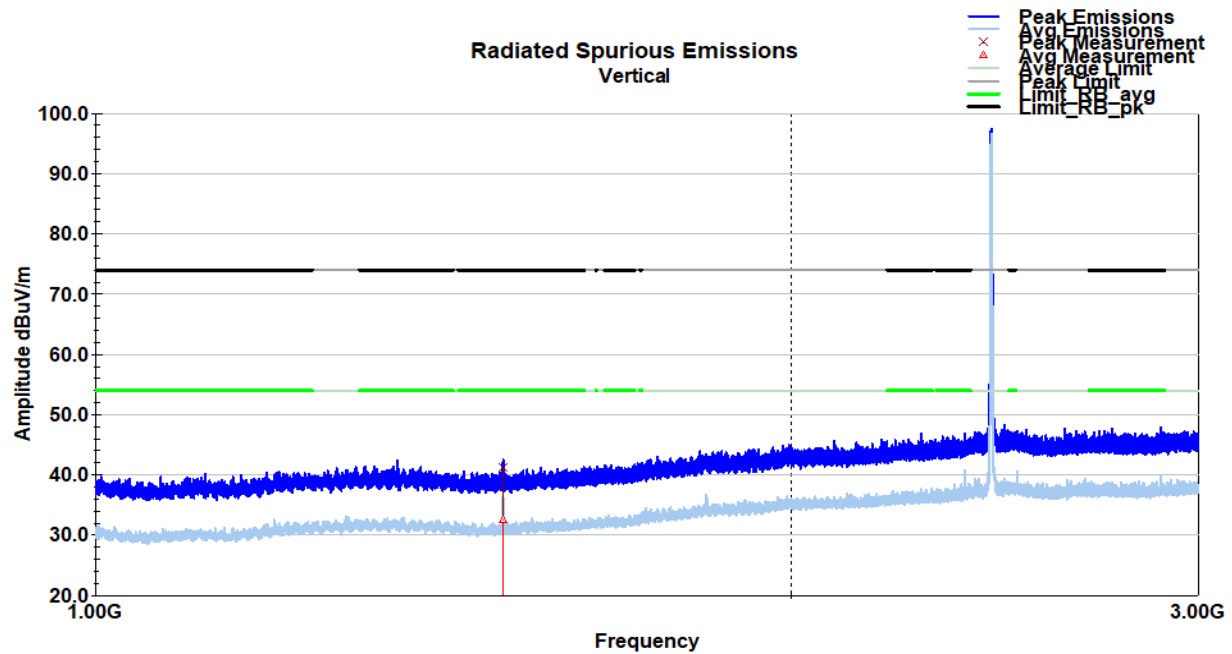
Peak Data

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
1496.20	43.3	H	248.0	141.0	27.7	2.5	34.7	38.7	74.0	-35.3
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

Average Data

Frequency MHz	Raw Avg dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Avg Value dBuV/m	Limit dBuV/m	Margin dB
1496.20	30.4	H	248.0	141.0	27.7	2.5	34.7	25.9	54.0	-28.1
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

1-3 GHz Vertical Mid Channel



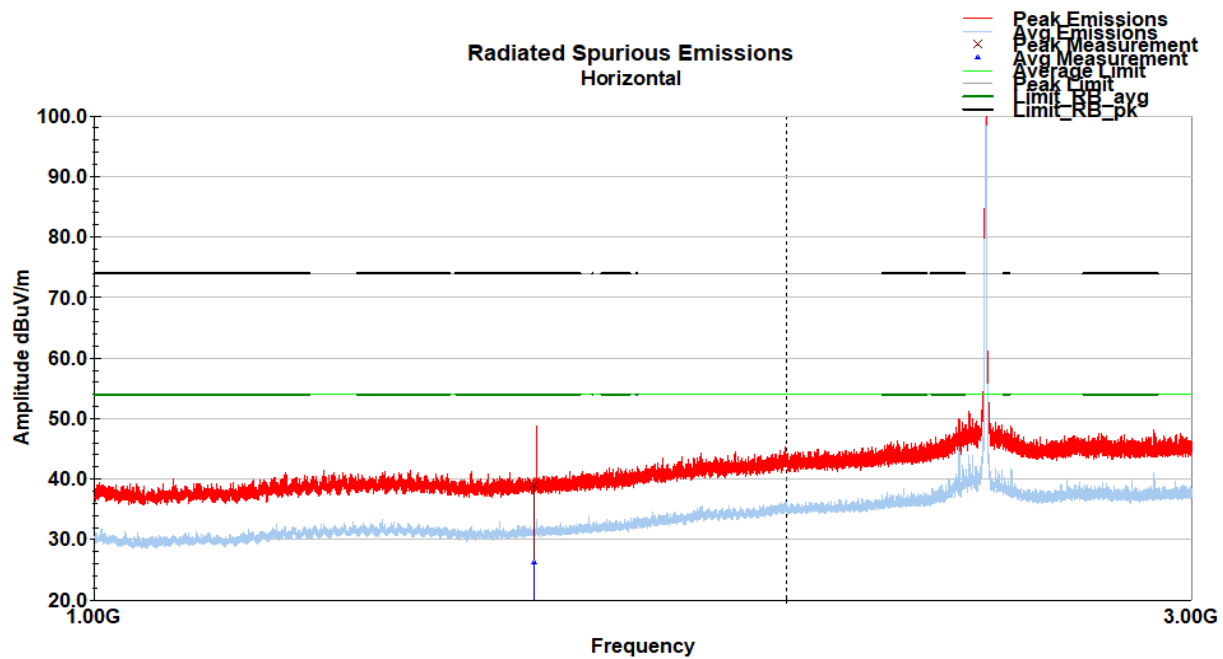
Peak Data

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
1500.04	45.7	V	277.0	187.0	27.7	2.5	34.7	41.2	74.0	-32.8
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

Average Data

Frequency MHz	Raw Avg dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Avg dBuV/m	Limit dBuV/m	Margin dB
1500.04	37.1	V	277.0	187.0	27.7	2.5	34.7	32.6	54.0	-21.4
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

1-3 GHz Horizontal Mid Channel



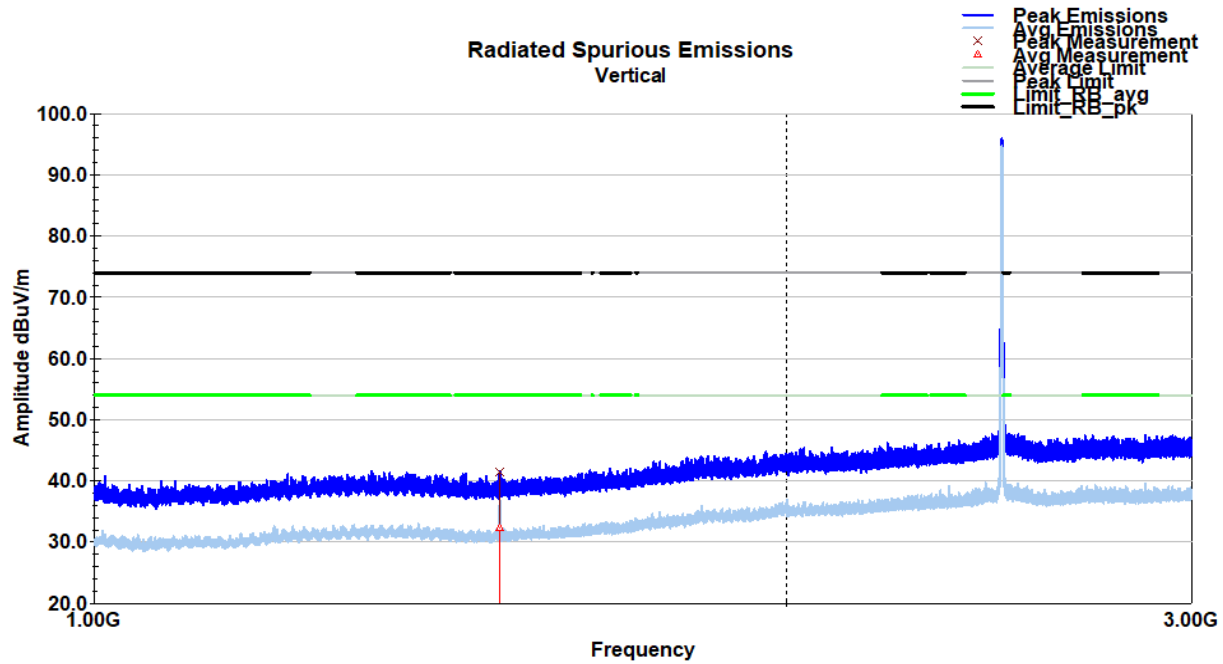
Peak Data

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
1553.40	43.0	H	240.0	229.0	28.1	2.5	34.7	39.1	74.0	-34.9
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

Average Data

Frequency MHz	Raw Avg dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Avg Value dBuV/m	Limit dBuV/m	Margin dB
1553.40	30.3	H	240.0	229.0	28.1	2.5	34.7	26.3	54.0	-27.7
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

1-3 GHz Vertical High Channel



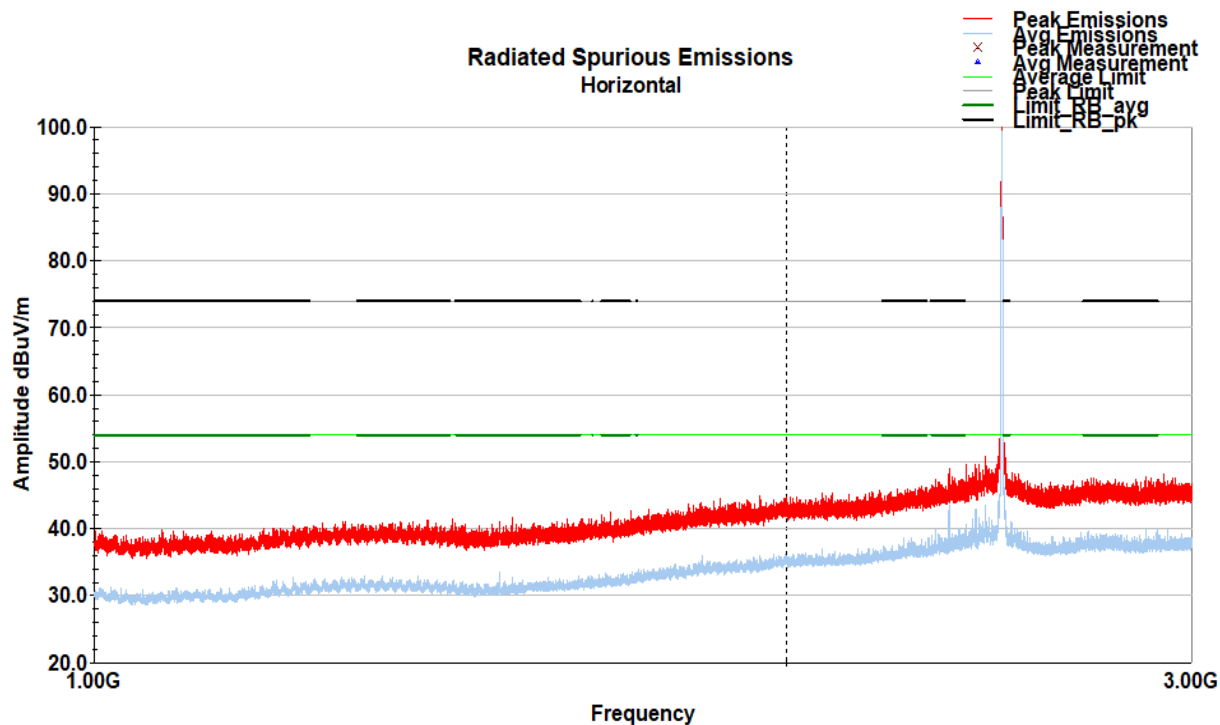
Peak Data

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
1500.04	45.9	V	72.0	187.0	27.7	2.5	34.7	41.4	74.0	-32.6
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

Average Data

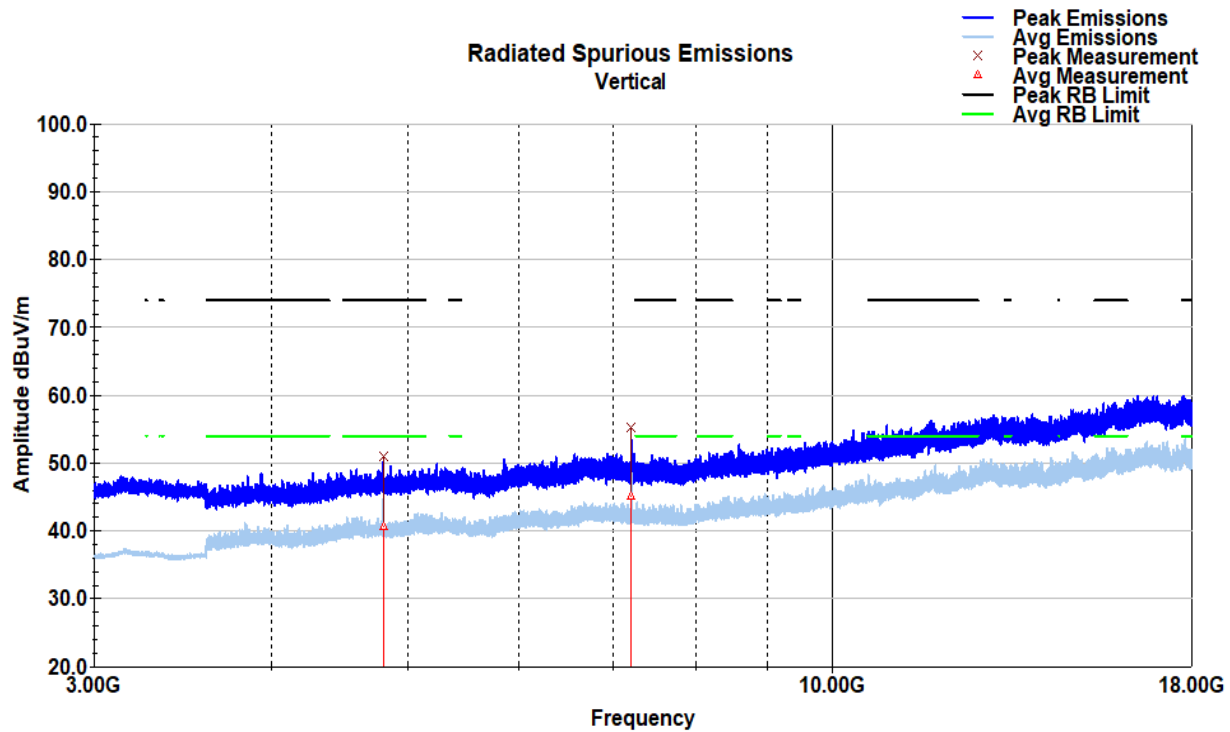
Frequency MHz	Raw Avg dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Avg dBuV/m	Limit dBuV/m	Margin dB
1500.04	36.9	V	72.0	187.0	27.7	2.5	34.7	32.4	54.0	-21.6
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

1-3 GHz Horizontal High Channel



7.5.3 3-18 GHz

3-18 GHz Vertical Low Channel



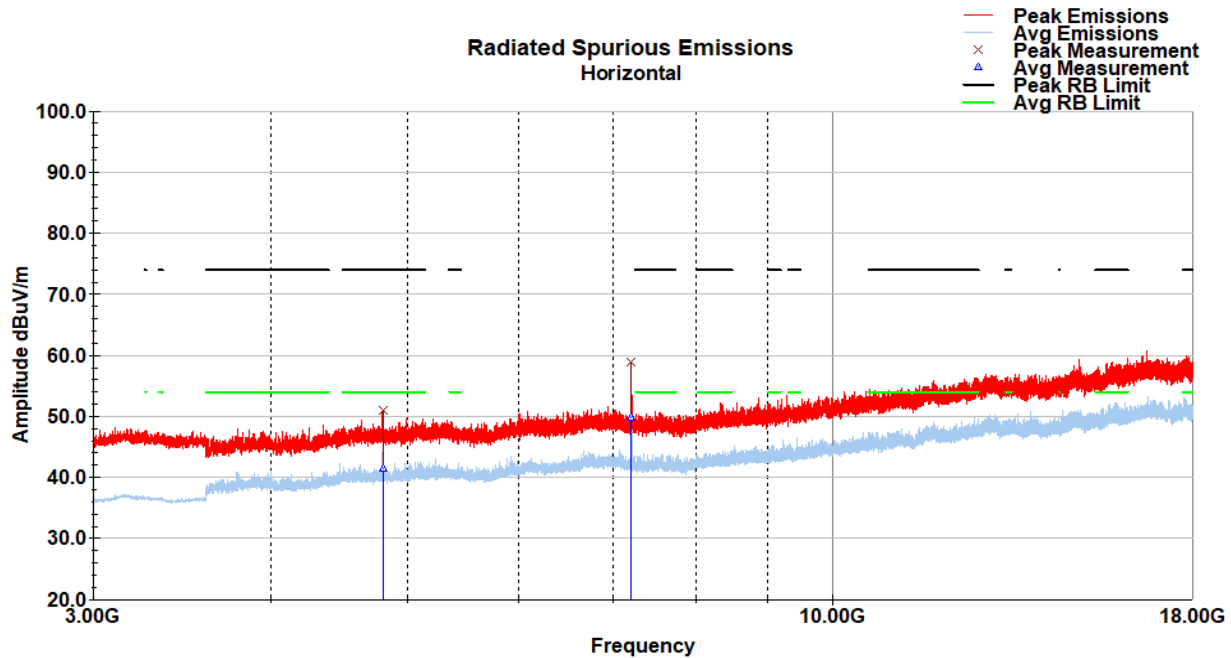
Peak Data

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
4804.86	46.3	V	75.0	198.0	34.6	4.7	34.6	51.0	74.0	-23.0
7204.92	48.8	V	266.0	244.0	35.7	5.7	35.0	55.2	74.0	-18.8
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

Average Data

Frequency MHz	Raw Avg dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Avg dBuV/m	Limit dBuV/m	Margin (dB)
4804.86	36.0	V	75.0	198.0	34.6	4.7	34.6	40.7	54.0	-13.3
7204.92	38.8	V	266.0	244.0	35.7	5.7	35.0	45.1	54.0	-8.8
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

3-18 GHz Horizontal Low Channel



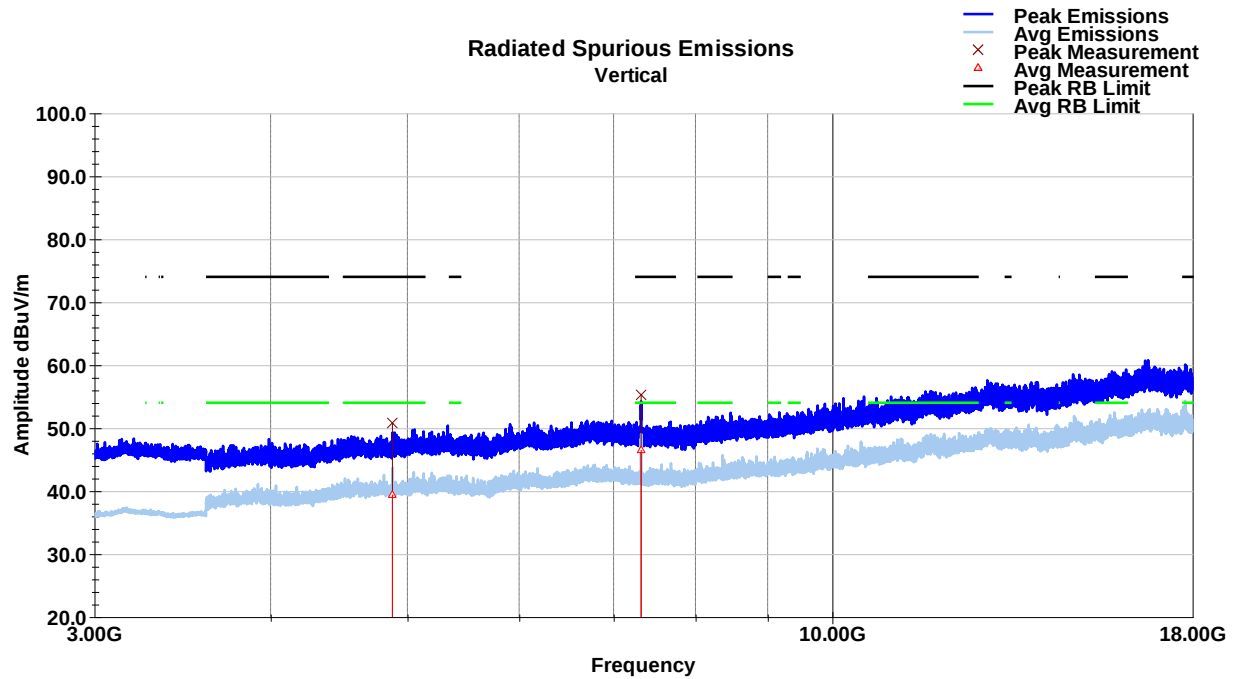
Peak Data

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
4804.38	46.4	H	107.0	204.0	34.6	4.7	34.6	51.0	74.0	-23.0
7204.92	52.5	H	59.0	135.0	35.7	5.7	35.0	58.9	74.0	-15.1
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

Average Data

Frequency MHz	Raw Avg dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Avg Value dBuV/m	Limit dBuV/m	Margin dB
4804.38	36.7	H	107.0	204.0	34.6	4.7	34.6	41.4	54.0	-12.6
7204.92	43.3	H	59.0	135.0	35.7	5.7	35.0	49.7	54.0	-4.3
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

3-18GHz Vertical Mid Channel



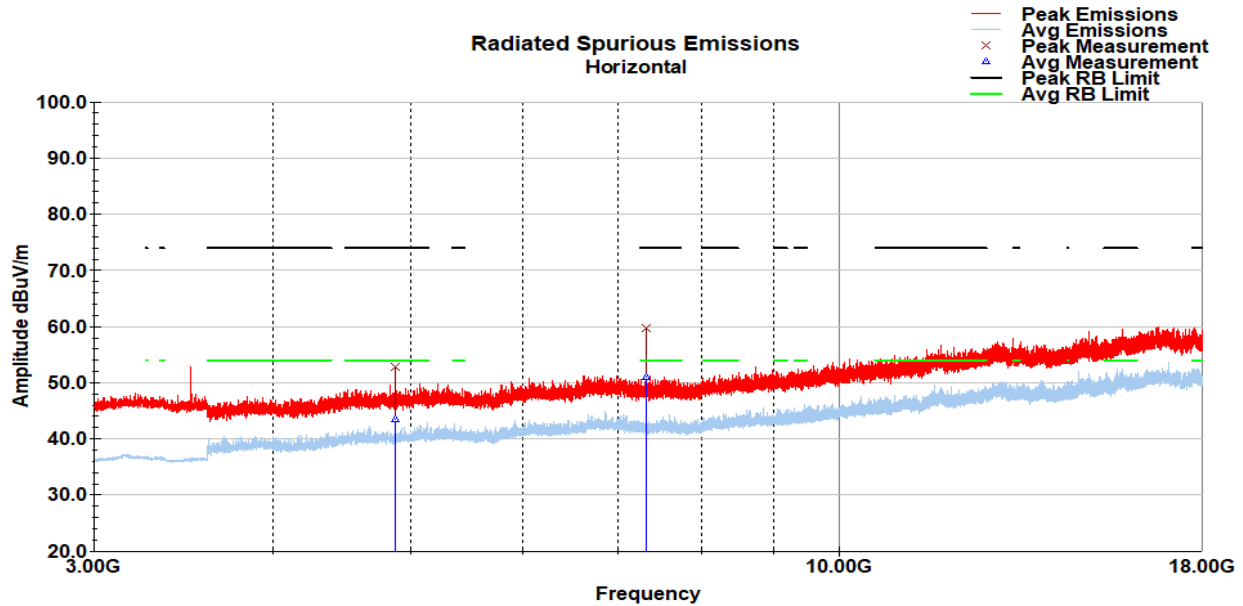
Peak Data

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
4879.08	46.2	V	146.0	140.0	34.6	4.7	34.6	50.8	74.0	-23.2
7321.08	48.9	V	150.0	241.0	35.7	5.7	35.1	55.3	74.0	-18.7
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

Average Data

Frequency MHz	Raw Avg dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Avg dBuV/m	Limit dBuV/m	Margin dB
4879.08	34.8	V	146.0	140.0	34.6	4.7	34.6	39.4	54.0	-14.6
7321.08	40.1	V	150.0	241.0	35.7	5.7	35.1	46.5	54.0	-7.5
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

3-18 GHz Horizontal Mid Channel



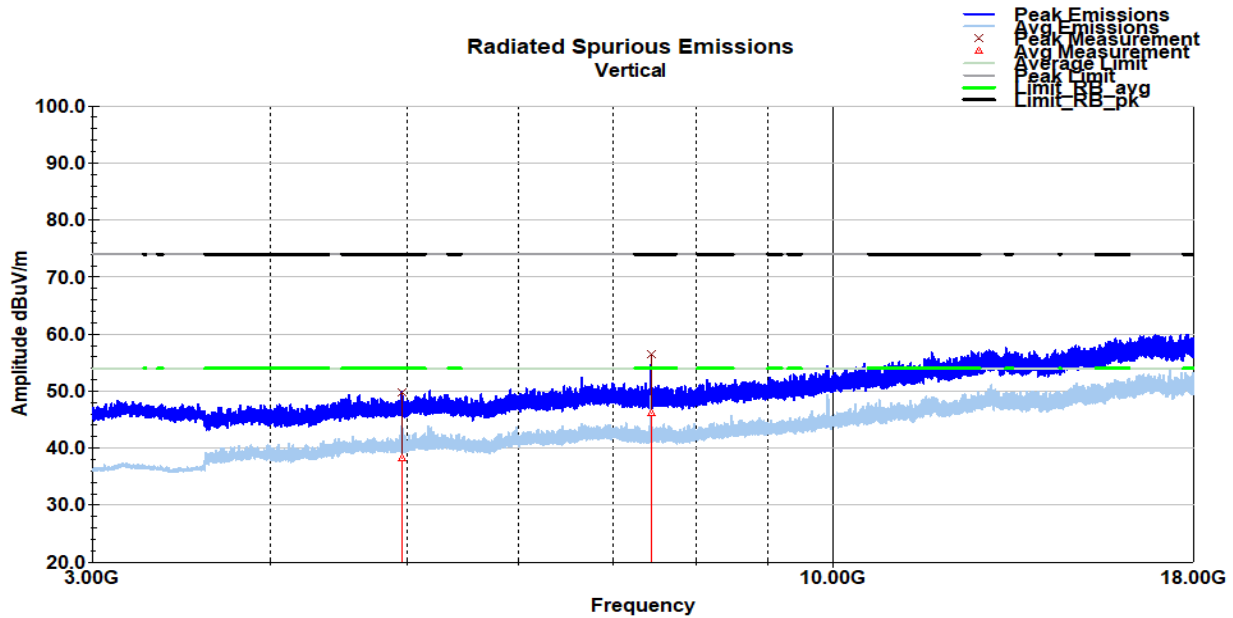
Peak Data

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
4880.88	48.2	H	285.0	215.0	34.5	4.7	34.6	52.9	74.0	-21.1
7321.68	53.4	H	226.0	130.0	35.7	5.7	35.1	59.8	74.0	-14.2
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

Average Data

Frequency MHz	Raw Avg dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Avg Value dBuV/m	Limit dBuV/m	Margin dB
4880.88	38.8	H	285.0	215.0	34.5	4.7	34.6	43.4	54.0	-10.6
7321.68	44.6	H	226.0	130.0	35.7	5.7	35.1	51.0	54.0	-3.0
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

3-18 GHz Vertical High Channel



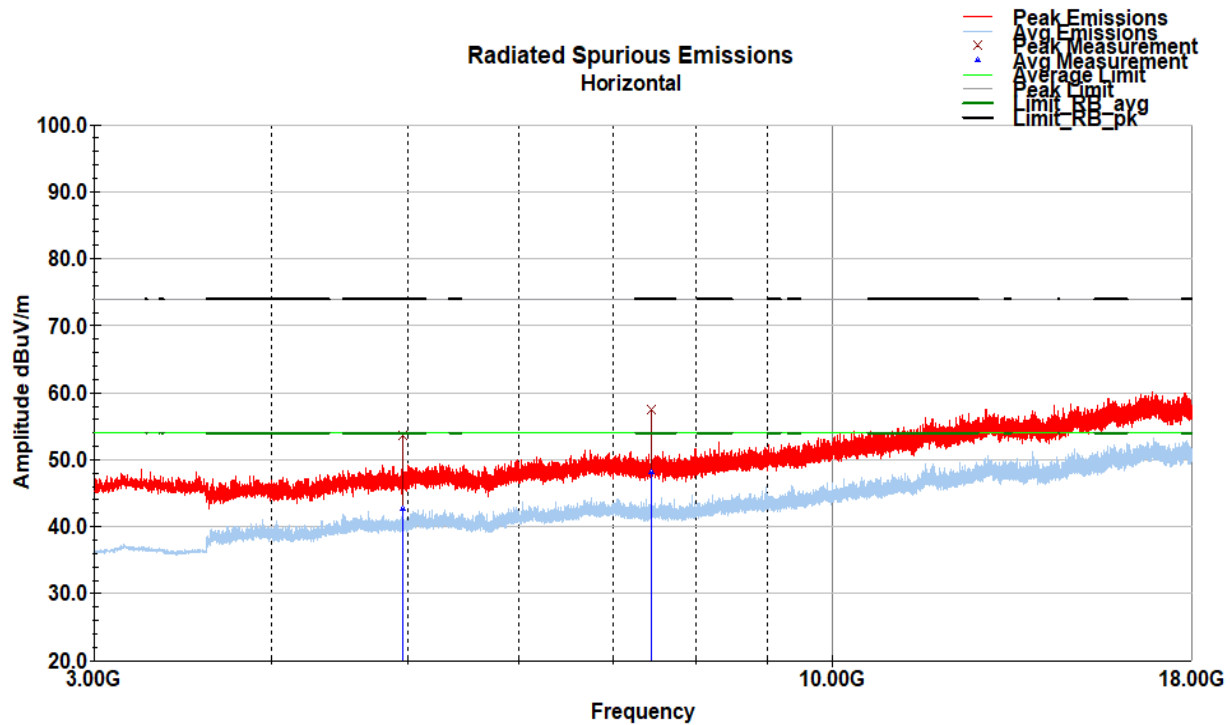
Peak Data

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
4961.44	45.2	V	354.0	111.0	34.5	4.8	34.6	49.8	74.0	-24.2
7439.04	50.2	V	145.0	207.0	35.7	5.7	35.1	56.5	74.0	-17.5
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

Average Data

Frequency MHz	Raw Avg dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Avg dBuV/m	Limit (dBuV/m)	Margin (dB)
4961.44	33.6	V	354.0	111.0	34.5	4.8	34.6	38.2	54.0	-15.8
7439.04	39.8	V	145.0	207.0	35.7	5.7	35.1	46.1	54.0	-7.9
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

3-18GHz Horizontal High Channel



Peak Data

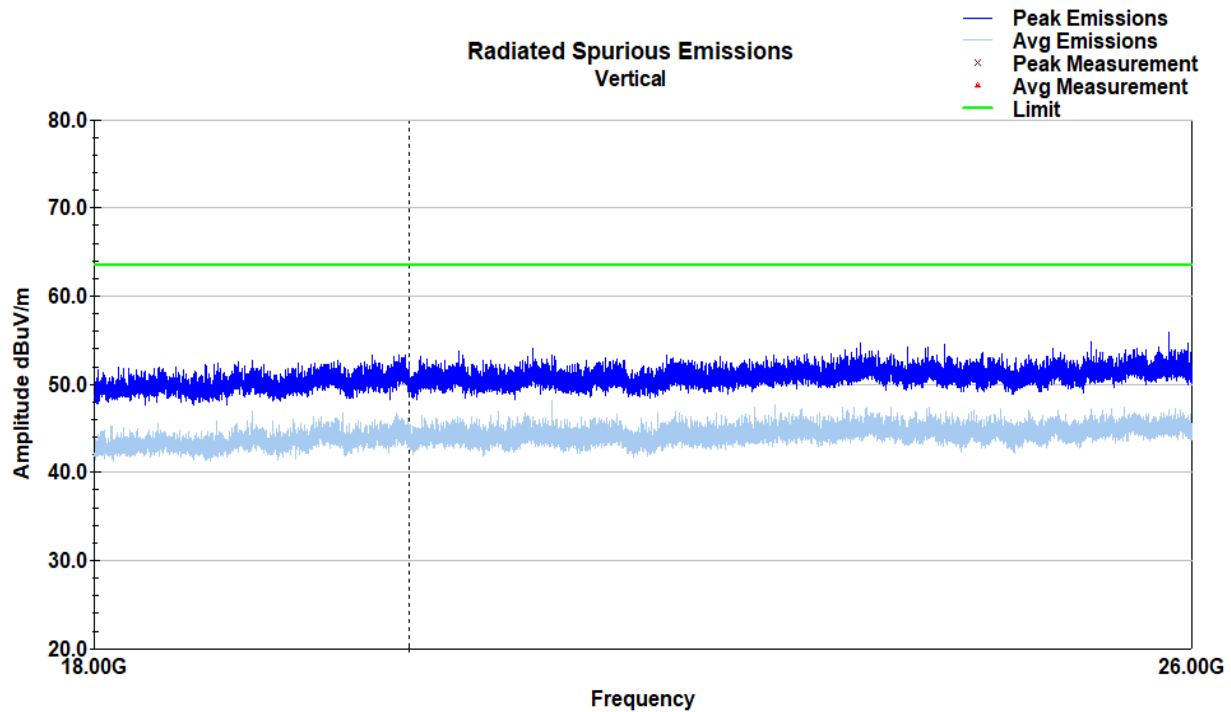
Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
4959.40	48.9	H	102.0	249.0	34.5	4.8	34.6	53.5	74.0	-20.5
7441.80	51.1	H	62.0	192.0	35.7	5.7	35.1	57.4	74.0	-16.6
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

Average Data

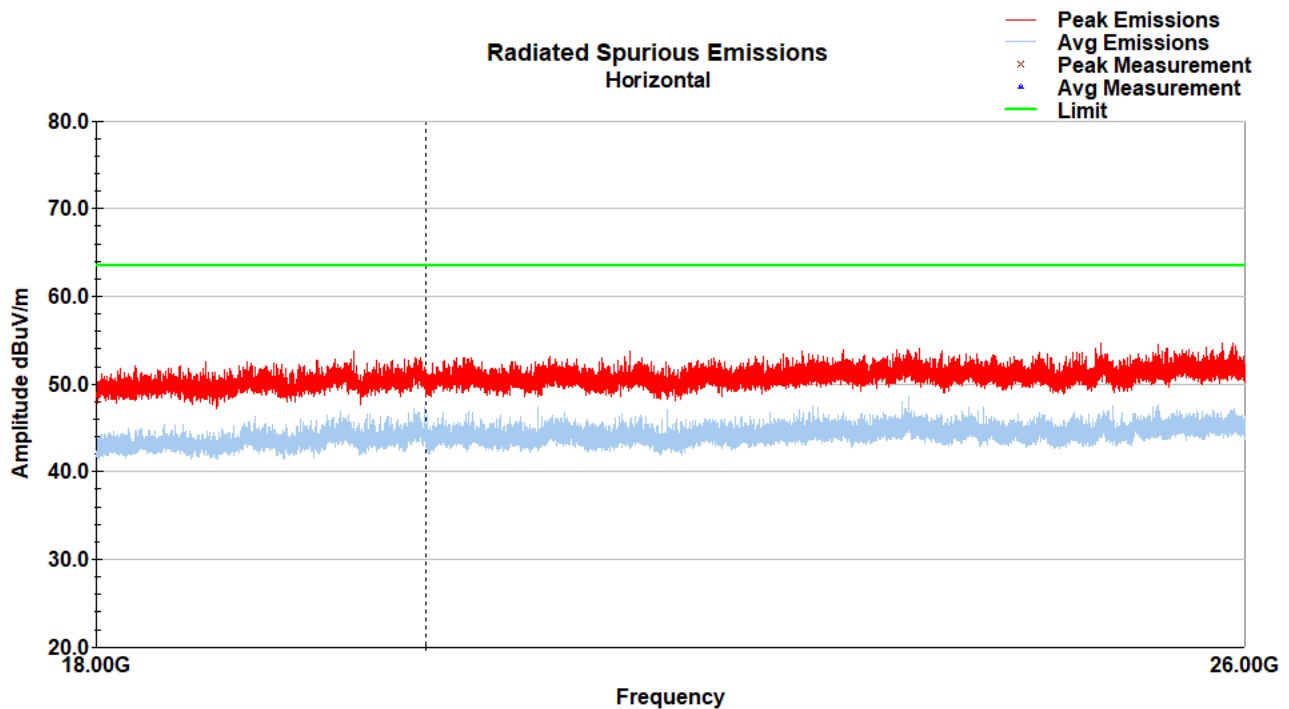
Frequency MHz	Raw Avg dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Avg Value dBuV/m	Limit (dBuV/m)	Margin (dB)
4959.40	38.1	H	102.0	249.0	34.5	4.8	34.6	42.7	54.0	-11.3
7441.80	41.8	H	62.0	192.0	35.7	5.7	35.1	48.1	54.0	-5.9
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

7.5.4 18-26 GHz

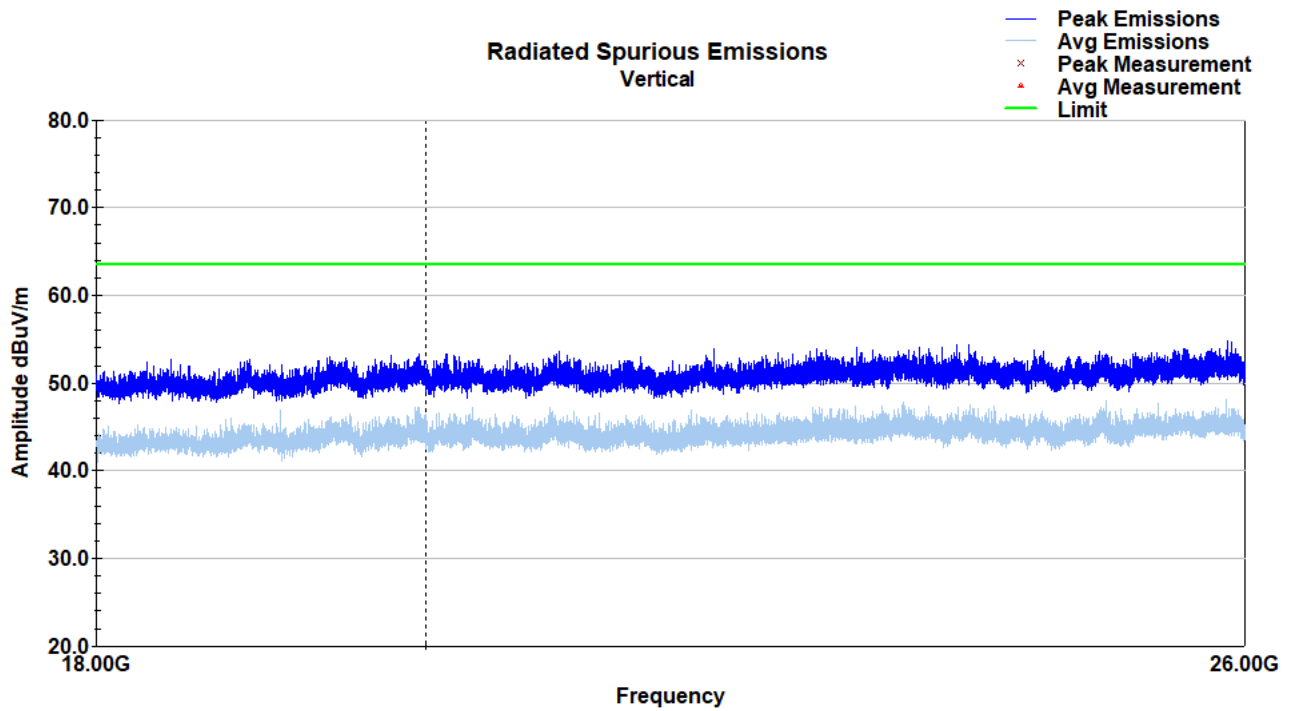
18-26GHz Vertical Low Channel



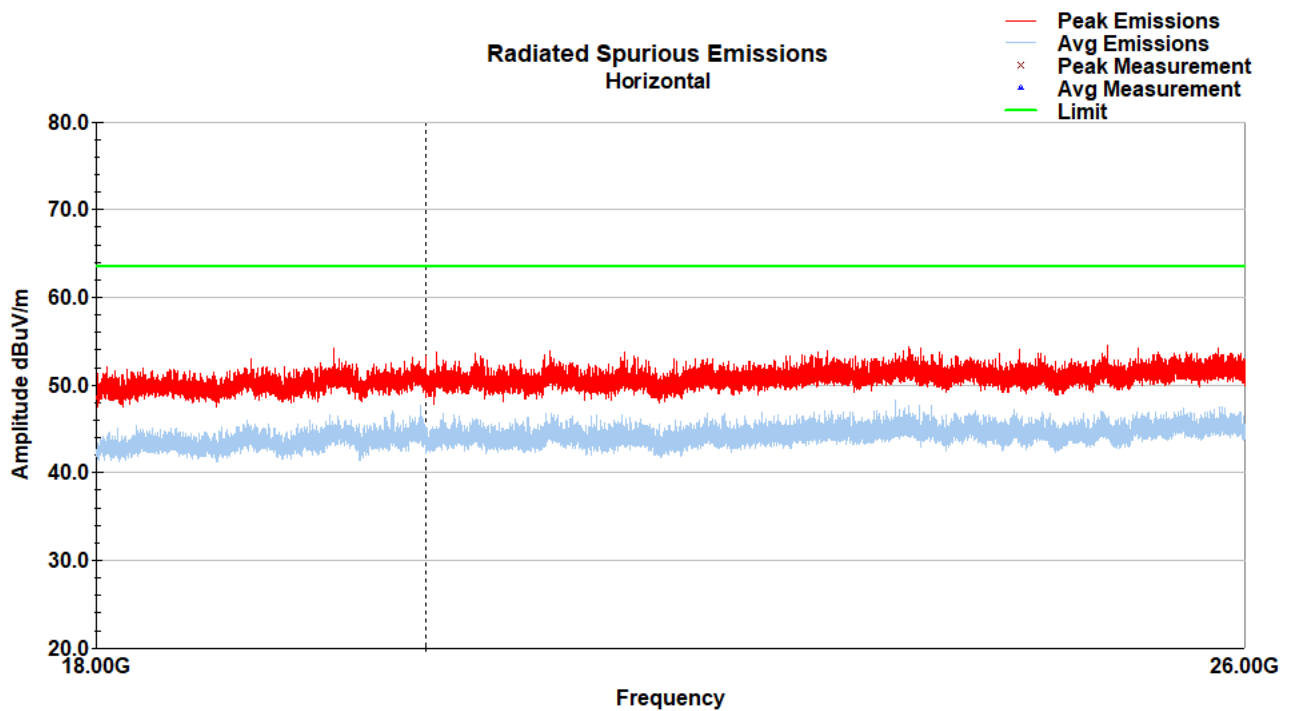
18-26GHz Horizontal Low Channel



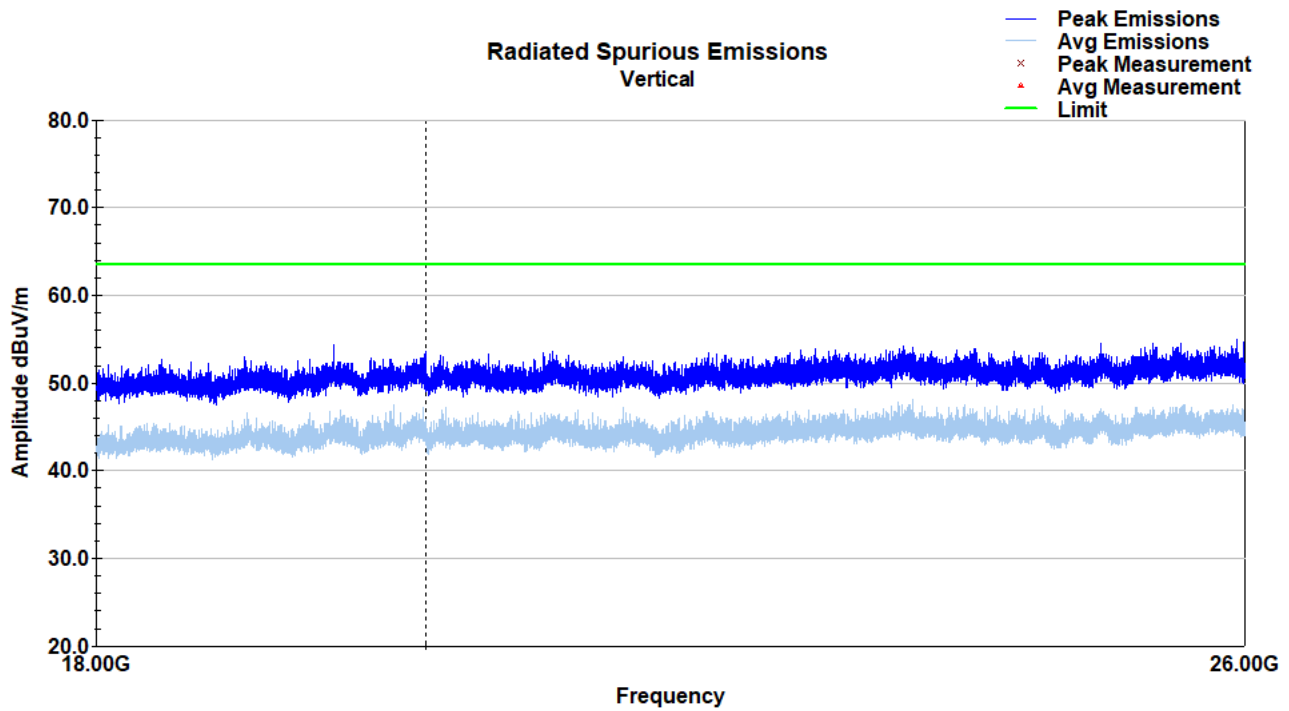
18-26GHz Vertical Mid Channel



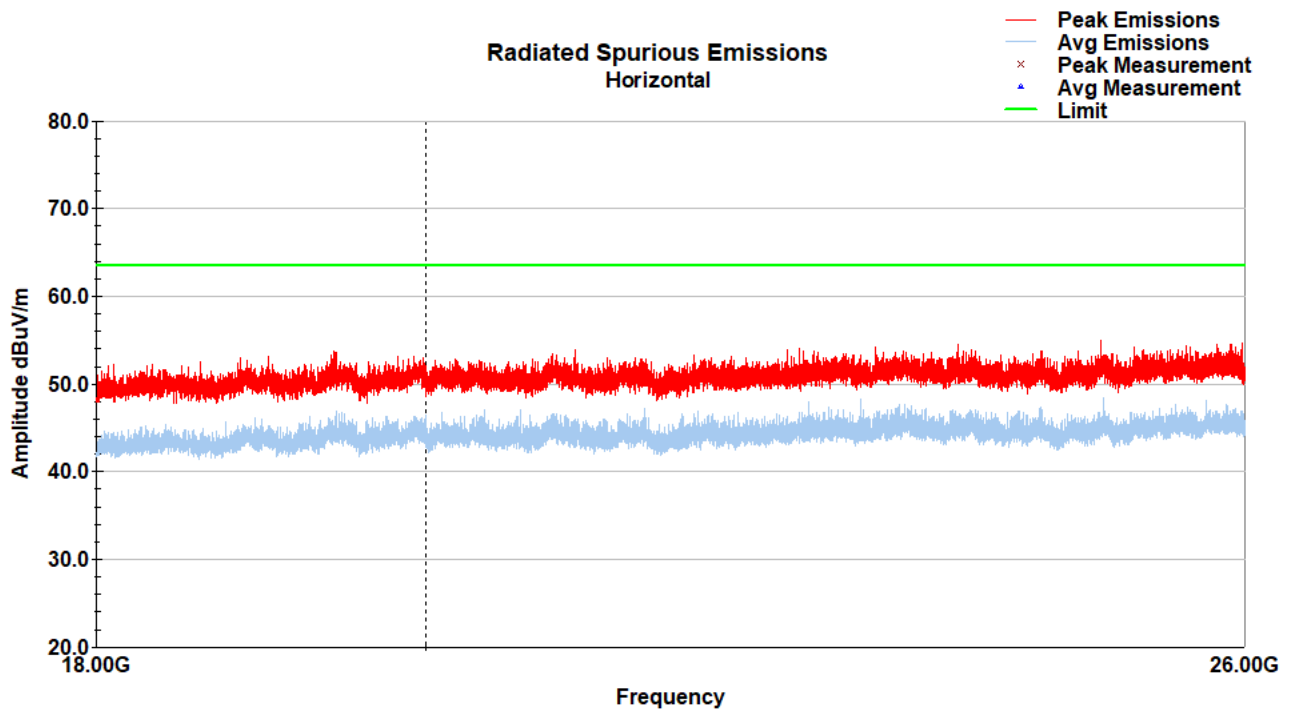
18-26GHz Horizontal Mid Channel



18-26GHz Vertical High Channel



18-26GHz Horizontal High Channel



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: 23.7 °C
Relative Humidity: 28.3 %
Atmospheric Pressure: 98.2 kPa

8.4 Test Equipment

Test Date: 22-Dec-2020

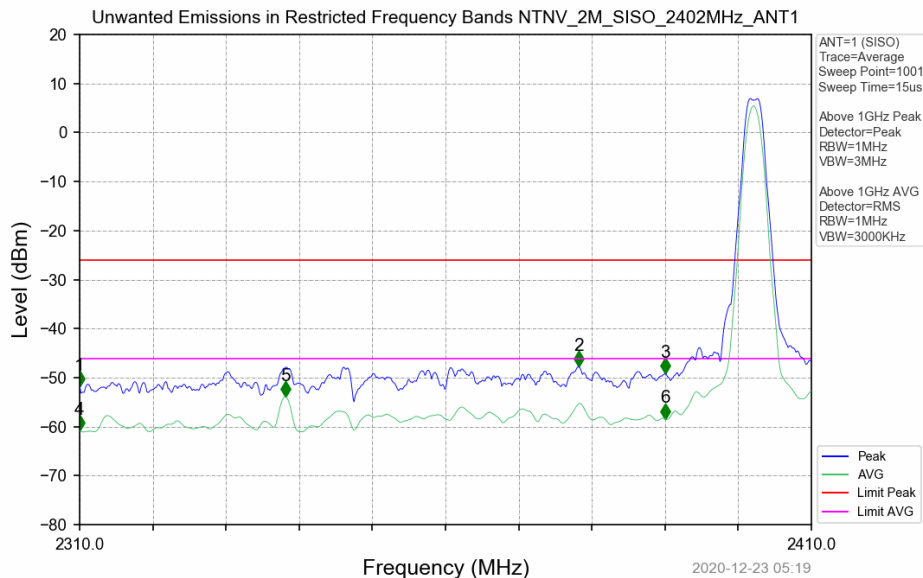
Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
RF CABLE SMA	HULL150A-29P-29P-36	HASCO COMPONENTS	19102	30-Mar-2020	30-Mar-2021
ATTENUATOR, 10DB	BW-S10W2	Mini-Circuits	15031	28-Sep-2020	28-Sep-2021
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.

8.5 Test Data

BLE – Low Channel – Plot

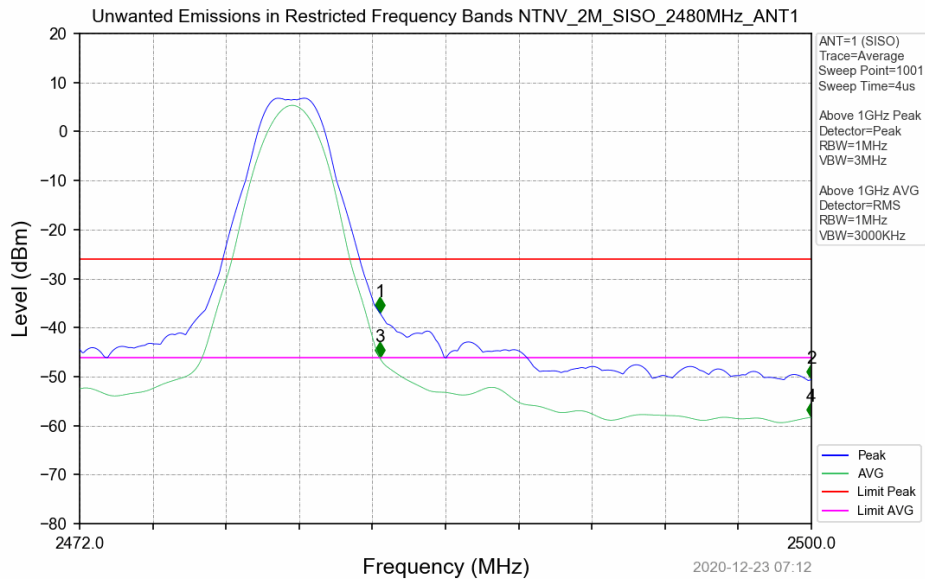


Marker No	Frequency (MHz)	Level (dBm)	Remark	Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2310.000	-51.783	Peak	4	2310.000	-60.828	AVG
2	2378.200	-47.803	Peak	5	2338.100	-53.893	AVG
3	2390.000	-49.205	Peak	6	2390.000	-58.409	AVG

BLE – Low Channel – Data

Frequency (MHz)	Reading Level (dBm)	Antenna Gain (dBi)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
2310.000	-60.83	4.90	39.27	54	-14.73	AVG
	-51.78	4.90	48.32	74	-25.68	Peak
2338.100	-53.89	4.90	46.21	54	-7.79	AVG
2378.200	-47.80	4.90	52.30	74	-21.70	Peak
2390.000	-58.41	4.90	41.69	54	-12.31	AVG
	-49.20	4.90	50.90	74	-23.11	Peak

BLE – High Channel – Plot



Marker No	Frequency (MHz)	Level (dBm)	Remark	Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2483.500	-36.957	Peak	3	2483.500	-46.132	AVG
2	2500.000	-50.610	Peak	4	2500.000	-58.347	AVG

BLE – High Channel – Data

Frequency (MHz)	Reading Level (dBm)	Antenna Gain (dBi)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
2483.500	-46.13	4.90	53.97	54	-0.03	AVG
	-36.96	4.90	63.14	74	-10.86	Peak
2500.000	-58.35	4.90	41.75	54	-12.25	AVG
	-50.61	4.90	49.49	74	-24.51	Peak

9 AC Powerline Conducted Emissions

9.1 Test Result

Test Description	Test Specification		Test Result
AC Powerline Conducted Emissions	15.207	RSS-GEN S8.8	Compliant

9.2 Test Method

With the receiver's resolution bandwidth was set to 9 kHz, exploratory scans were performed over the measuring frequency range (0.15 MHz to 30 MHz) using a max hold mode incorporating a Peak detector and Average detector and using the TILE! software. The final test data was measured using a Quasi-Peak detector and Average detector and compared against the limits indicated in the table below.

Frequency Range	Limits (dBuV)
0.15 to 0.5 MHz	Avg 56 to 46 QP 66 to 56
0.5 to 5 MHz	Avg 46 Pk 56
5 to 30 MHz	Avg 50 Pk 60

9.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions:

Temperature: 21.2°C
Relative Humidity: 27.3%
Atmospheric Pressure 97.8kpa

9.4 Test Equipment

Test EndDate: 7-Jan-2021

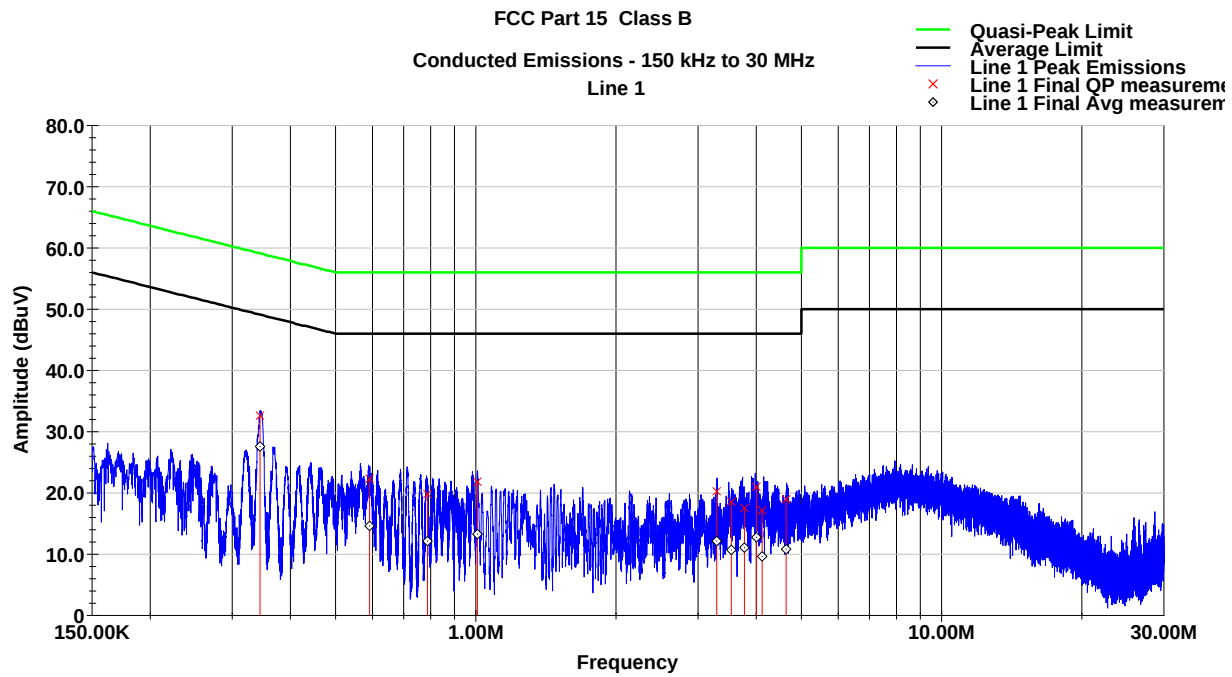
Tester: PL

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
LINE IMPEDANCE STABILIZATION NETWORK	NNB 51	TESEQ	B085882	9-Apr-2020	9-Apr-2021
EMI TEST RECEIVER	ESU8	ROHDE & SCHWARZ	B085759	7-May-2020	7-May-2021

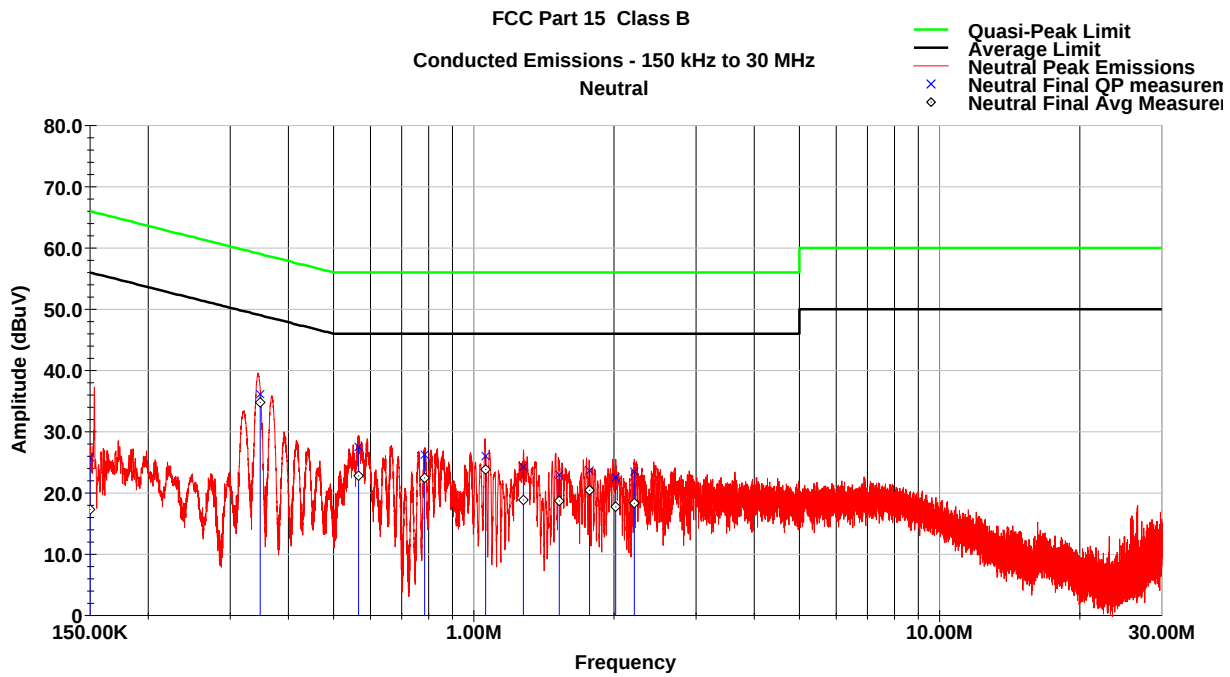
Notes: The equipment calibration period is 1 year.

Software: Conducted Emissions Tile7 200618.til

9.5 Test Data



Frequency	QP Value	QP Limit	QP Margin	Avg Value	Avg Limit	Avg Margin
MHz	dBuV	dBuV	dB	dBuV	dBuV	dB
0.344	32.6	59.1	-26.5	27.6	49.1	-21.5
0.592	22.3	56	-33.7	14.6	46	-31.4
0.788	19.8	56	-36.2	12.1	46	-33.9
1.008	21.8	56	-34.2	13.3	46	-32.7
3.29	20.3	56	-35.7	12.1	46	-33.9
3.536	18.5	56	-37.5	10.7	46	-35.3
3.774	17.5	56	-38.5	11.1	46	-34.9
4.003	21	56	-35	12.8	46	-33.2
4.118	17.1	56	-38.9	9.6	46	-36.4
4.638	18.9	56	-37.1	10.8	46	-35.2



Frequency	QP Value	QP Limit	QP Margin	Avg Value	Avg Limit	Avg Margin
MHz	dBuV	dBuV	dB	dBuV	dBuV	dB
0.15	25.8	66	-40.2	17.3	56	-38.7
0.348	36.1	59	-22.9	34.8	49	-14.3
0.566	27.5	56	-28.5	22.8	46	-23.2
0.784	26.2	56	-29.8	22.5	46	-23.5
1.06	26	56	-30	23.8	46	-22.2
1.278	24.3	56	-31.7	18.9	46	-27.1
1.526	23	56	-33	18.7	46	-27.3
1.772	23.6	56	-32.4	20.4	46	-25.6
2.017	22.5	56	-33.5	17.8	46	-28.2
2.211	23.5	56	-32.5	18.3	46	-27.7

10 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

11 Revision History

Revision Level	Description of changes	Revision Date
Draft	--	10 February 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