RF Test Report

Project Number:	**5028090**	**Offer Number:**	**SUW-202302004095**
Report Number:	**5028090EMC05**	**Revision Level:**	**1**
Client:	**UTEC, Inc.**		

Equipment Under Test:	**Refrigerated Shipping Container Controller**
Product Name:	**Micro-Link 5 Controller**
Model:	**MICROLINK5B**
FCC ID:	**2AK6N-MICROLINK5B**
IC:	**703A-MICROLINK5B**

Applicable Standards:	**FCC Part 15 Subpart C, § 15.247**
	RSS-247, Issue 3, August 2023
	RSS-GEN, Issue 5, February 2021, Amendment 2
	ANSI C63.10:2013

Report issued on:	**17 November 2023**
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.

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Reviewed by: Martin Taylor

Martin Taylor, EMC/RF Project Engineer

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

(1) The device uses a PCB trace PIFA antenna which cannot be replaced by the end user.

1.1 *Modifications Required for Compliance*

None.

2 General Information

2.1 *Client Information*

Company Name:	UTEC, Inc.
Address:	111 E. Wayne St., Suite 800
City, State, Zip, Country:	Fort Wayne, Indiana 46802, 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*

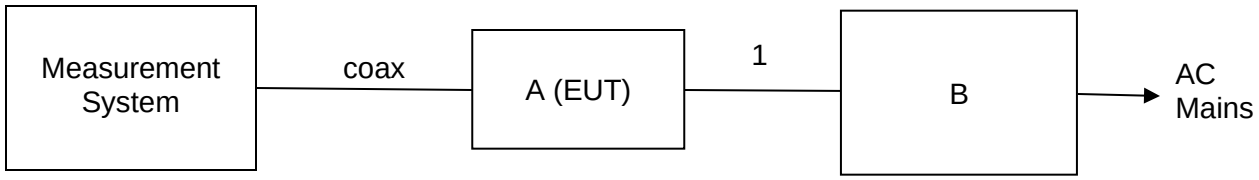
Equipment Under Test:	Refrigerated Shipping Container Controller
Product Name:	Micro-Link 5 Controller
Model:	MICROLINK5B
Serial Numbers:	4120W008381 (Conducted Sample) 3821W039479 (Radiated Sample)
FCC ID:	2AK6N-MICROLINK5B
IC:	703A-MICROLINK5B
Frequency Range:	2402 – 2480 MHz
Data Modes:	Bluetooth Low Energy (BLE) – GFSK
Antenna:	PCB Trace PIFA (4.54dBi gain)
Rated Voltage:	$5V_{DC}$ to Micro Board USB port or Dual phase $18V_{AC}$ to IO Board
Test Voltage:	$5V_{DC}$ to Micro Board USB port (for Conducted Measurements) Dual phase $18V_{AC}$ to IO Board (for Radiated Measurements)
Sample Received Date:	03 February 2023
Dates of testing:	15 March to 13 April 2023

2.4 *Operating Modes and Conditions*

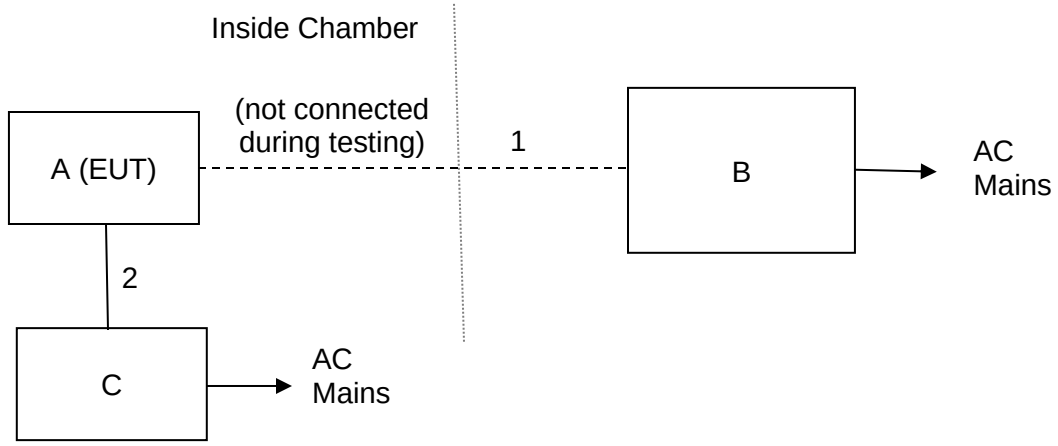
The EUT was running test mode firmware with TI tools which allowed the following:

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 power setting of 7 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	UTEC, Inc.	Micro-Link 5 Controller (EUT)	MICROLINK5B	4120W008381 3821W039479
B	Lenovo	Laptop Computer	T420	R8-X9XFV
C	UTEC, Inc.	Transformer Box	(none)	(none)

2.8 *Cable List*

Cable reference	Port Name	Start	End	Cable Length (m)	Ferrite installed?	Shielded?
1	USB	EUT	Laptop Computer	1.0	N	N
2	AC Power (5-wire harness)	EUT	Transformer Box	0.7	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.

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

3.3 *Test Site*

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature:	19.2 °C
Relative Humidity:	51.2 %
Atmospheric Pressure:	98.2 kPa

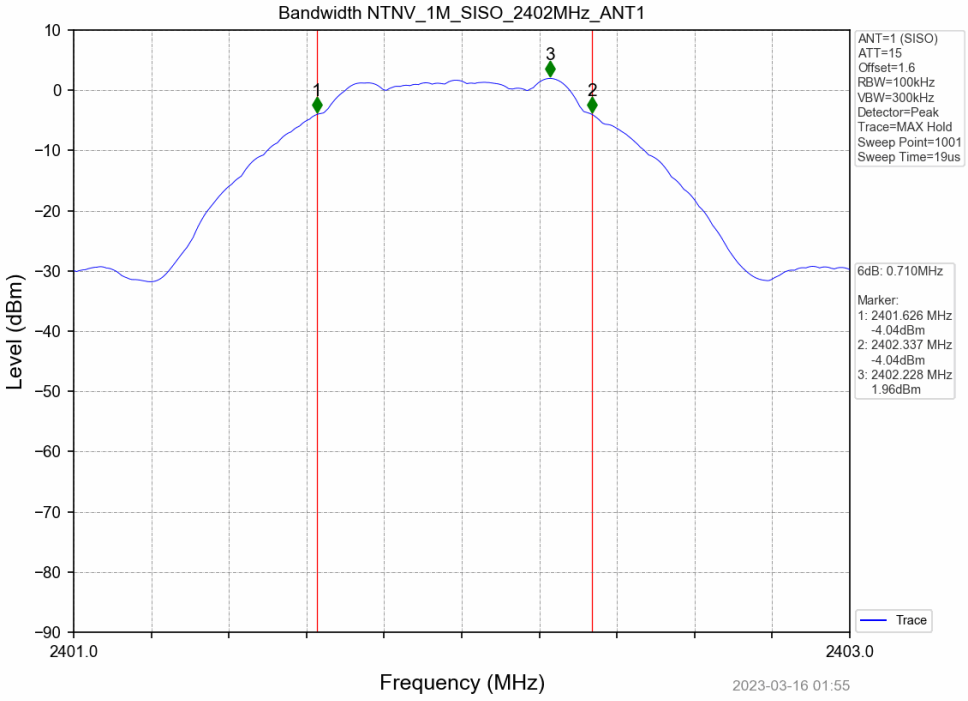
3.4 *Test Equipment*

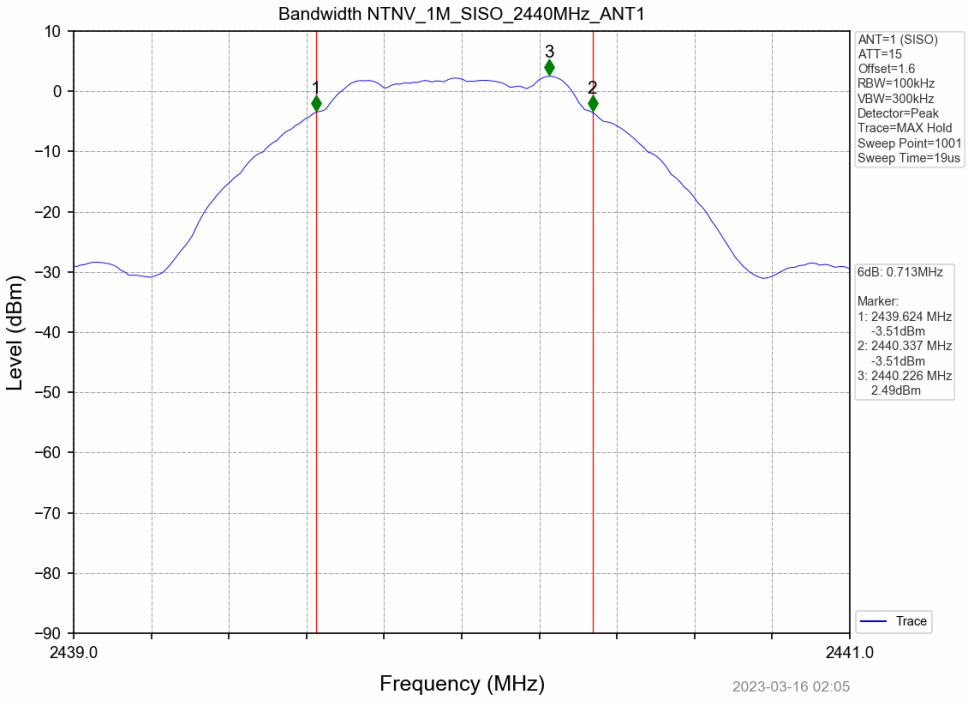
Test End Date: 15-Mar-2023 Tester: DA

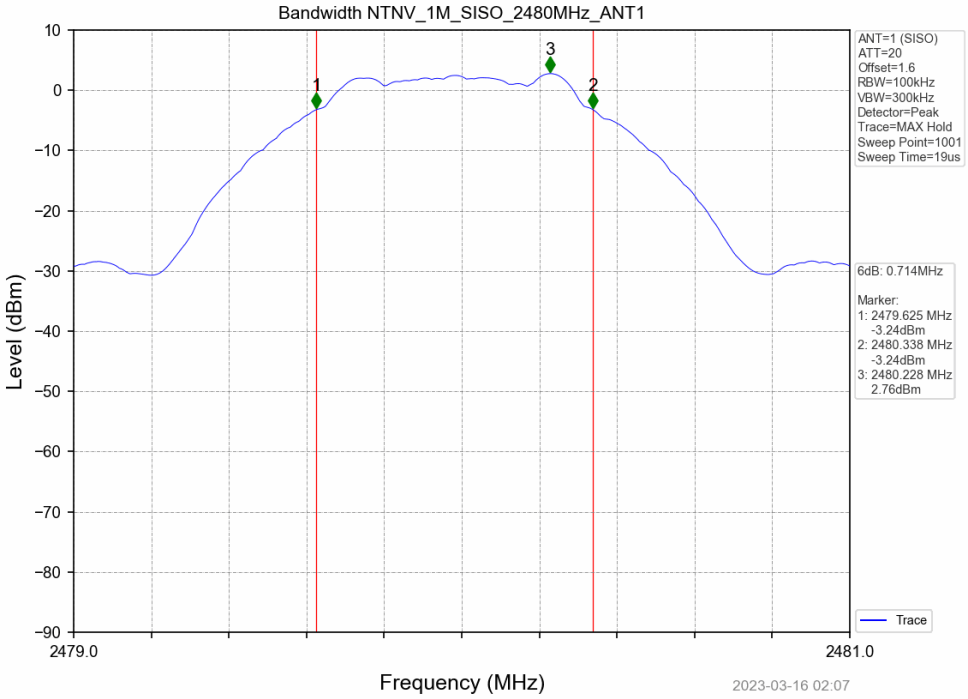
Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	7-Dec-2022	7-Dec-2023
RF CABLE (TS8997)	141	HUBER & SUHNER	B095588	5-Jul-2022	5-Jul-2023
TSTPASS SWITCHBOX	SB1	TSTPASS	20168	CNR	CNR
USB WIDEBAND POWER SENSOR	U2021XA	TSTPASS (KEYSIGHT TECHNOLOGIES)	20168C	24-Aug-2022	24-Aug-2023

3.5 *Test Data – DTS Bandwidth (6dB)*

Test Mode	Frequency (MHz)	TX Type	ANT No.	6dB Bandwidth Test Result (MHz)	Verdict
1M	2402	SISO	1	0.710	PASS
	2440	SISO	1	0.713	PASS
	2480	SISO	1	0.714	PASS

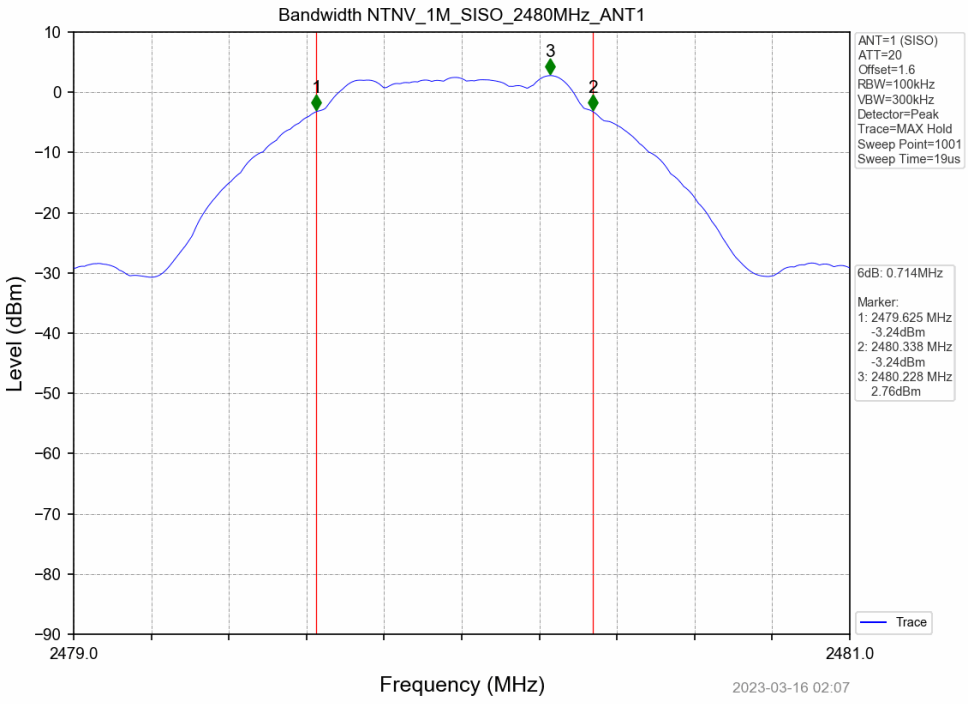

Bandwidth NTNV_1M_SISO_2402MHz_ANT1
ANT=1 (SISO)
ATT=15
Offset=1.6
RBW=100kHz
VBW=300kHz
Detector=Peak
Trace=MAX Hold
Sweep Point=1001
Sweep Time=19us
6dB: 0.710MHz
Marker:
1: 2401.626 MHz
-4.04dBm
2: 2402.337 MHz
-4.04dBm
3: 2402.228 MHz
1.96dBm
Trace
Level (dBm)
Frequency (MHz)
2401.0
2403.0
2023-03-16 01:55

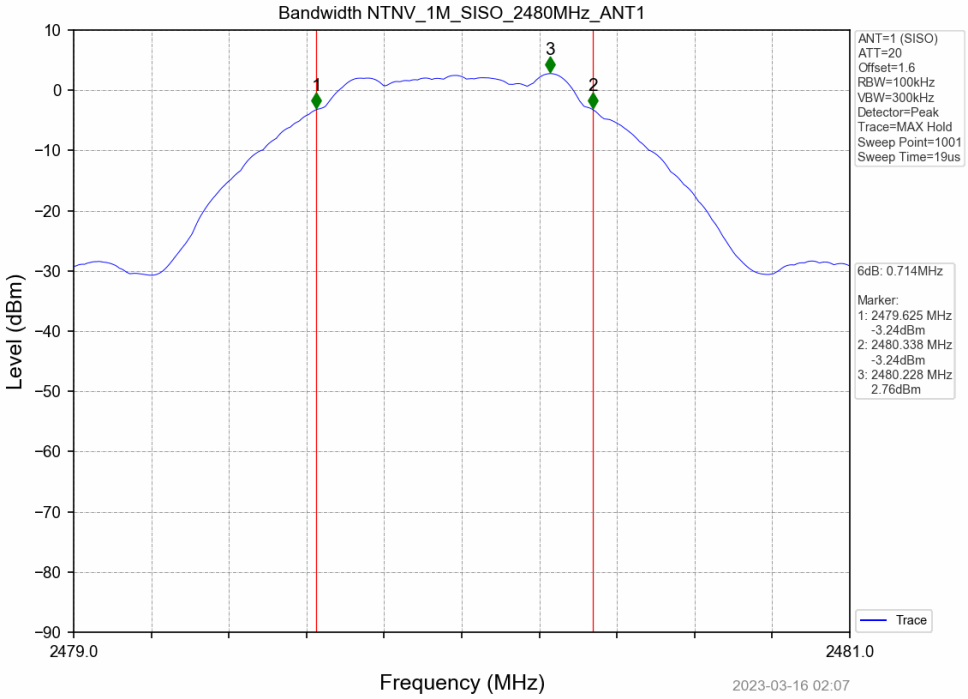

Bandwidth NTNV_1M_SISO_2440MHz_ANT1
ANT=1 (SISO)
ATT=15
Offset=1.6
RBW=100kHz
VBW=300kHz
Detector=Peak
Trace=MAX Hold
Sweep Point=1001
Sweep Time=19us
6dB: 0.713MHz
Marker:
1: 2439.624 MHz
-3.51dBm
2: 2440.337 MHz
-3.51dBm
3: 2440.226 MHz
2.49dBm
Trace
Level (dBm)
Frequency (MHz)
2439.0
2441.0
2023-03-16 02:05

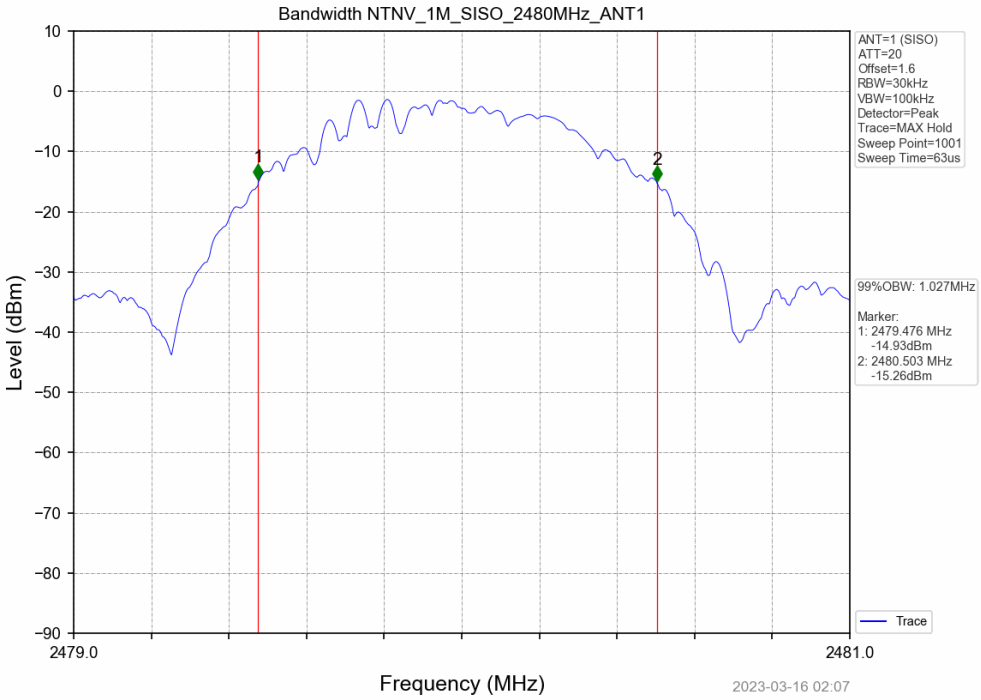

Bandwidth NTNV_1M_SISO_2480MHz_ANT1
ANT=1 (SISO)
ATT=20
Offset=1.6
RBW=100kHz
VBW=300kHz
Detector=Peak
Trace=MAX Hold
Sweep Point=1001
Sweep Time=19us
6dB: 0.714MHz
Marker:
1: 2479.625 MHz
-3.24dBm
2: 2480.338 MHz
-3.24dBm
3: 2480.228 MHz
2.76dBm
Trace
Level (dBm)
Frequency (MHz)
2479.0
2481.0
2023-03-16 02:07

3.6 *Test Data – 99% Occupied Bandwidth*

Test Mode	Frequency (MHz)	TX Type	ANT No.	99% Occupied Bandwidth	
				Test Result (MHz)	
1M	2402	SISO	1	1.027	Only for Report Use
	2440	SISO	1	1.029	Only for Report Use
	2480	SISO	1	1.027	Only for Report Use




Bandwidth NTNV_1M_SISO_2480MHz_ANT1
ANT=1 (SISO)
ATT=20
Offset=1.6
RBW=100kHz
VBW=300kHz
Detector=Peak
Trace=MAX Hold
Sweep Point=1001
Sweep Time=19us
6dB: 0.714MHz
Marker:
1: 2479.625 MHz
-3.24dBm
2: 2480.338 MHz
-3.24dBm
3: 2480.228 MHz
2.76dBm
Trace
Level (dBm)
Frequency (MHz)
2479.0
2481.0
2023-03-16 02:07


Bandwidth NTNV_1M_SISO_2480MHz_ANT1
ANT=1 (SISO)
ATT=20
Offset=1.6
RBW=30kHz
VBW=100kHz
Detector=Peak
Trace=MAX Hold
Sweep Point=1001
Sweep Time=63us
99%OBW: 1.027MHz
Marker:
1: 2479.476 MHz
-14.93dBm
2: 2480.503 MHz
-15.26dBm
Trace
Level (dBm)
Frequency (MHz)
2479.0
2481.0
2023-03-16 02:07

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 1Mbps data mode was used for this test.

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:	19.2 °C
Relative Humidity:	51.2 %
Atmospheric Pressure:	98.2 kPa

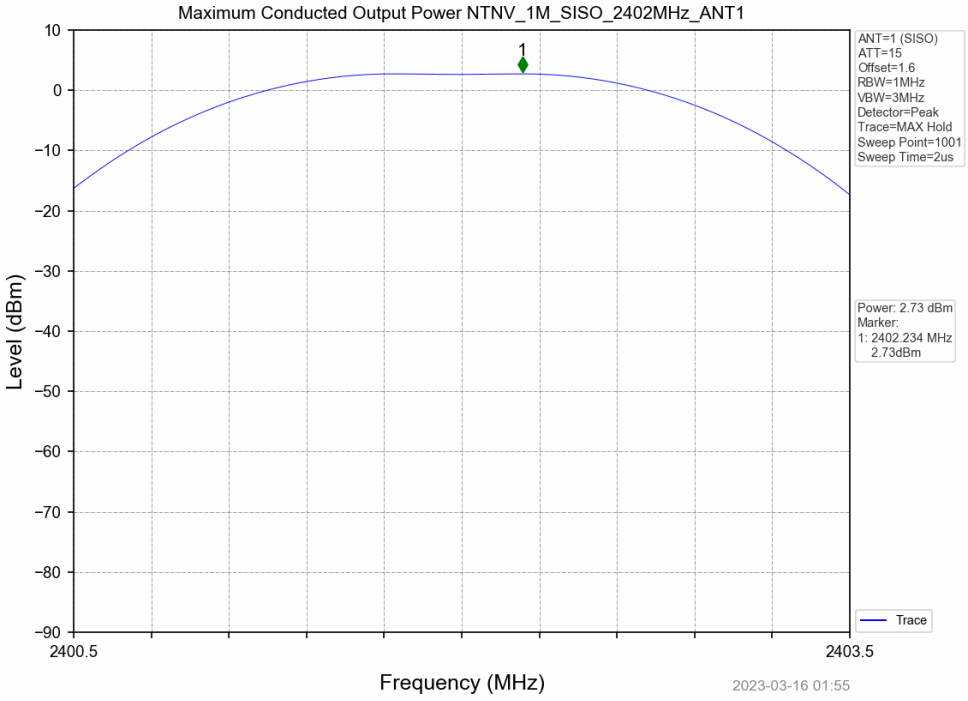
4.4 *Test Equipment*

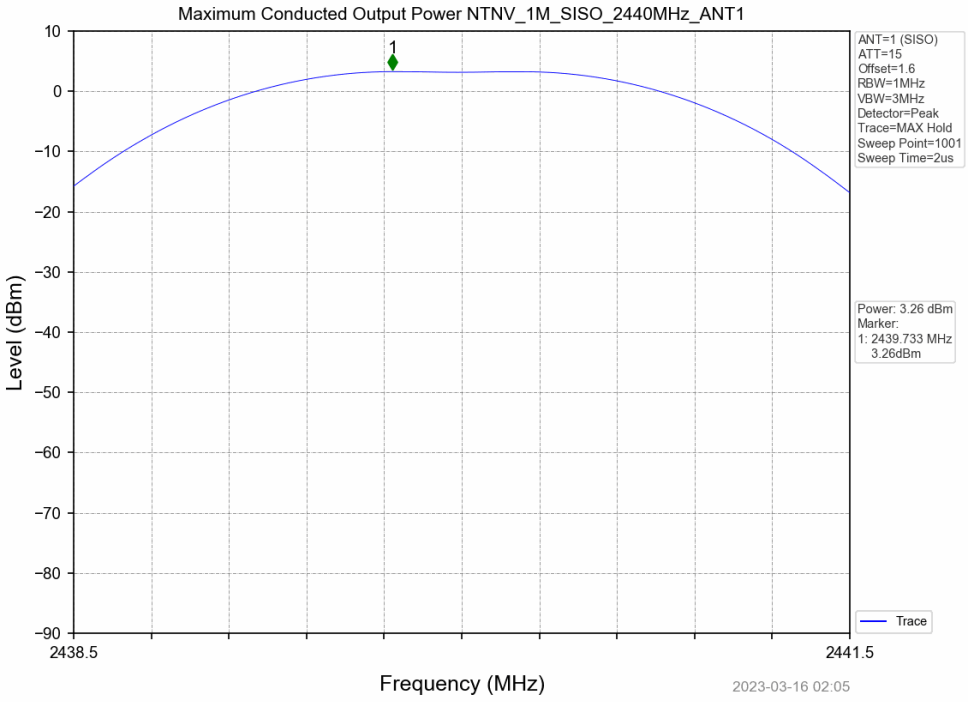
Test End Date: 15-Mar-2023 Tester: DA

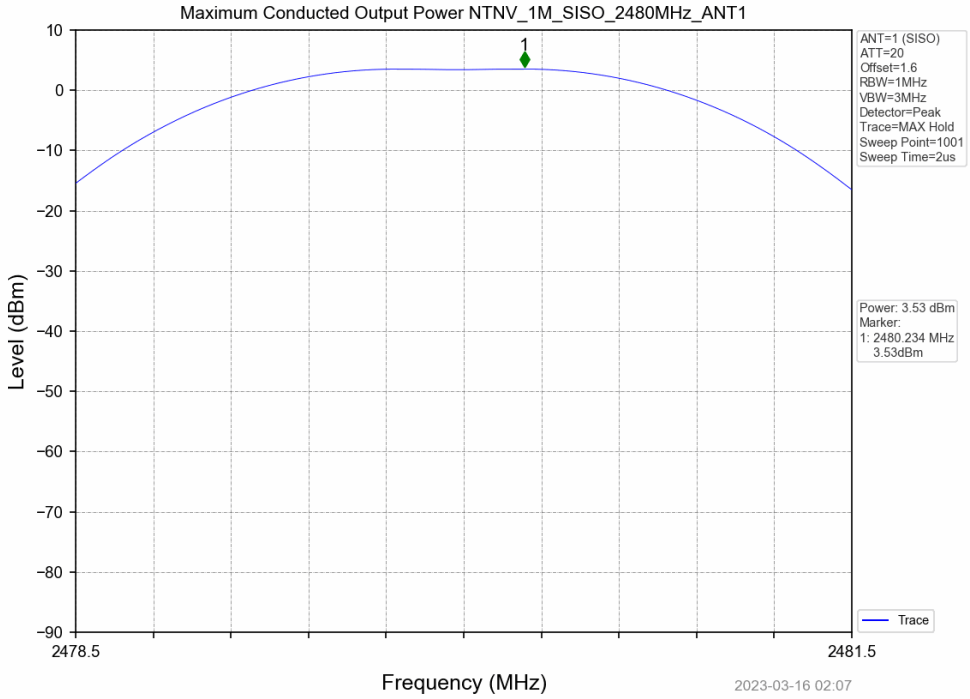
Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	7-Dec-2022	7-Dec-2023
RF CABLE (TS8997)	141	HUBER & SUHNER	B095588	5-Jul-2022	5-Jul-2023
TSTPASS SWITCHBOX	SB1	TSTPASS	20168	CNR	CNR
USB WIDEBAND POWER SENSOR	U2021XA	TSTPASS (KEYSIGHT TECHNOLOGIES)	20168C	24-Aug-2022	24-Aug-2023

4.5 *Test Data*

Test Mode	Frequency (MHz)	Tx Type	Measured Peak Output Power (dBm) Ant 1	Limits (dBm)	Verdict
1M	2402	SISO	2.73	30	PASS
	2440	SISO	3.26	30	PASS
	2480	SISO	3.53	30	PASS


Maximum Conducted Output Power NTNV_1M_SISO_2402MHz_ANT1
ANT=1 (SISO)
ATT=15
Offset=1.6
RBW=1MHz
VBW=3MHz
Detector=Peak
Trace=MAX Hold
Sweep Point=1001
Sweep Time=2us
Power: 2.73 dBm
Marker:
1: 2402.234 MHz
2.73dBm
Trace
Level (dBm)
Frequency (MHz)
2400.5
2403.5
2023-03-16 01:55


Maximum Conducted Output Power NTNV_1M_SISO_2440MHz_ANT1
ANT=1 (SISO)
ATT=15
Offset=1.6
RBW=1MHz
VBW=3MHz
Detector=Peak
Trace=MAX Hold
Sweep Point=1001
Sweep Time=2us
Power: 3.26 dBm
Marker:
1: 2439.733 MHz
3.26dBm
Trace
Level (dBm)
Frequency (MHz)
2438.5
2441.5
2023-03-16 02:05


Maximum Conducted Output Power NTNV_1M_SISO_2480MHz_ANT1
10
0
−10
−20
−30
−40
−50
−60
−70
−80
−90
Level (dBm)
1
ANT=1 (SISO)
ATT=20
Offset=1.6
RBW=1MHz
VBW=3MHz
Detector=Peak
Trace=MAX Hold
Sweep Point=1001
Sweep Time=2us
Power: 3.53 dBm
Marker:
1: 2480.234 MHz
3.53dBm
Trace
2478.5
2481.5
Frequency (MHz)
2023-03-16 02:07

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.

Limit
The maximum limit is 8 dBm / 3 kHz.

5.3 *Test Site*

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature:	19.2 °C
Relative Humidity:	51.2 %
Atmospheric Pressure:	98.2 kPa

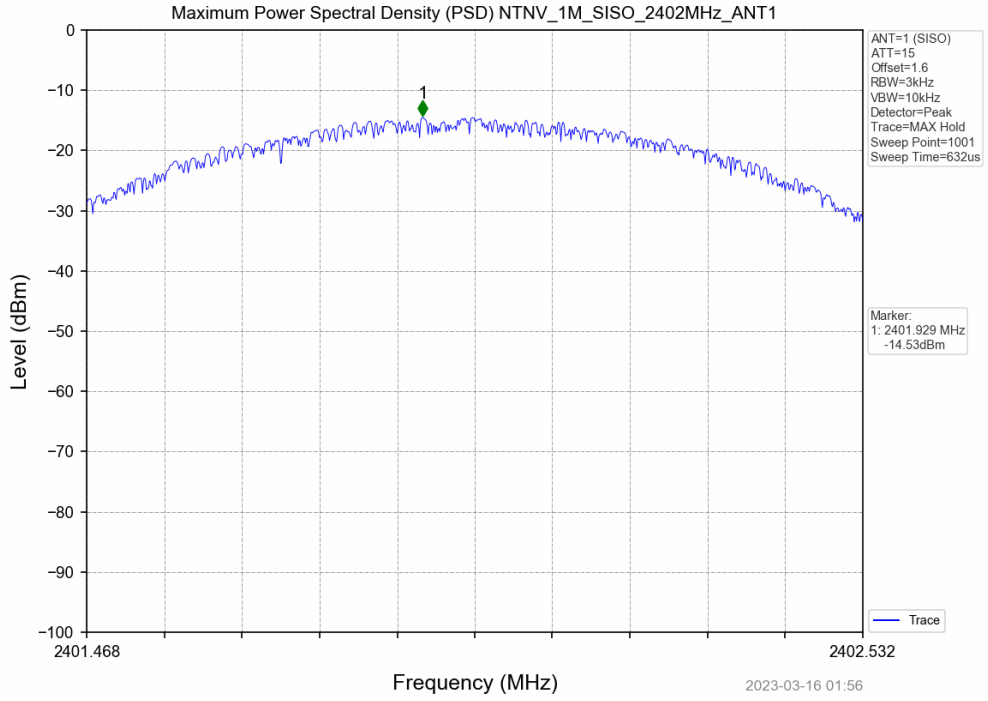
5.4 *Test Equipment*

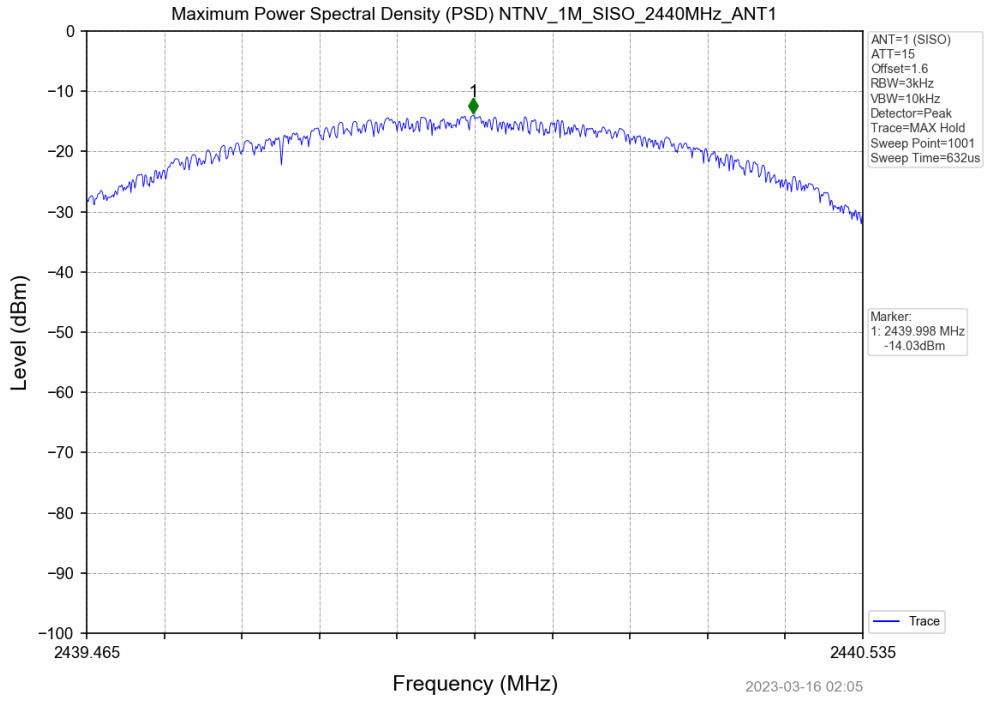
Test End Date: 15-Mar-2023 Tester: DA

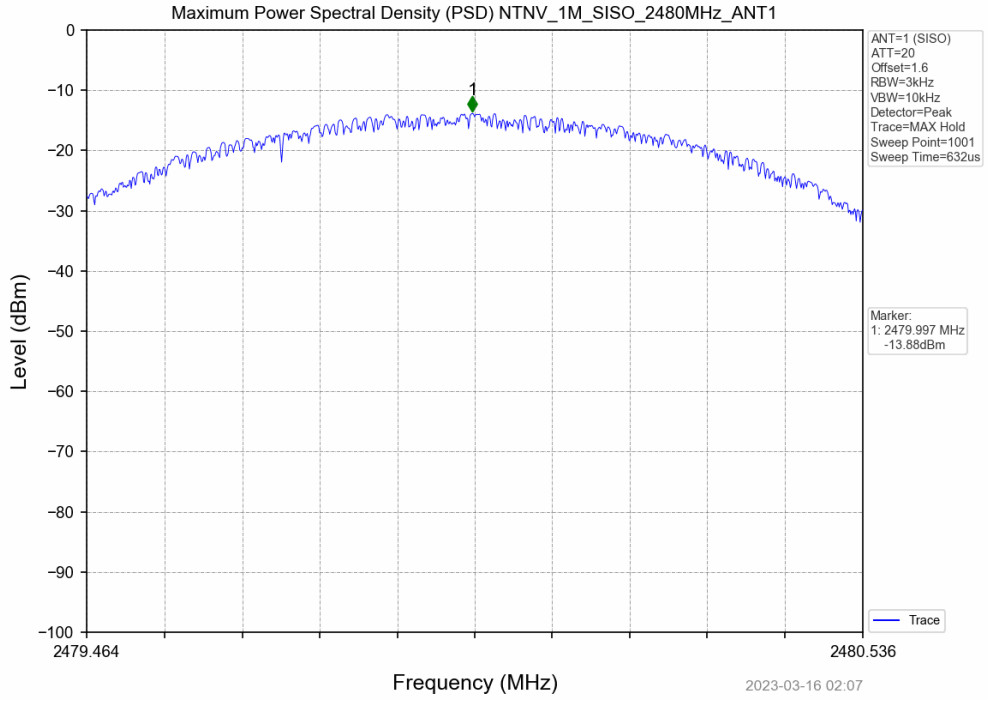
Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	7-Dec-2022	7-Dec-2023
RF CABLE (TS8997)	141	HUBER & SUHNER	B095588	5-Jul-2022	5-Jul-2023
TSTPASS SWITCHBOX	SB1	TSTPASS	20168	CNR	CNR
USB WIDEBAND POWER SENSOR	U2021XA	TSTPASS (KEYSIGHT TECHNOLOGIES)	20168C	24-Aug-2022	24-Aug-2023

5.5 *Test Data*

Test Mode	Frequency (MHz)	Tx Type	Maximum Power Spectral Density (dBm/3KHz)	Limits (dBm/3kHz)	Verdict
			Ant 1		
1M	2402	SISO	-14.53	≤8	PASS
	2440	SISO	-14.03	≤8	PASS
	2480	SISO	-13.88	≤8	PASS


Maximum Power Spectral Density (PSD) NTNV_1M_SISO_2402MHz_ANT1
ANT=1 (SISO)
ATT=15
Offset=1.6
RBW=3kHz
VBW=10kHz
Detector=Peak
Trace=MAX Hold
Sweep Point=1001
Sweep Time=632us
Marker:
1: 2401.929 MHz
-14.53dBm
Trace
Level (dBm)
Frequency (MHz)
2401.468
2402.532
2023-03-16 01:56


Maximum Power Spectral Density (PSD) NTNV_1M_SISO_2440MHz_ANT1
ANT=1 (SISO)
ATT=15
Offset=1.6
RBW=3kHz
VBW=10kHz
Detector=Peak
Trace=MAX Hold
Sweep Point=1001
Sweep Time=632us
Marker:
1: 2439.998 MHz
-14.03dBm
Trace
Level (dBm)
Frequency (MHz)
2439.465
2440.535
2023-03-16 02:05


Maximum Power Spectral Density (PSD) NTNV_1M_SISO_2480MHz_ANT1
ANT=1 (SISO)
ATT=20
Offset=1.6
RBW=3kHz
VBW=10kHz
Detector=Peak
Trace=MAX Hold
Sweep Point=1001
Sweep Time=632us
Marker:
1: 2479.997 MHz
-13.88dBm
Trace
Level (dBm)
Frequency (MHz)
2479.464
2480.536
2023-03-16 02:07

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 device does not utilize BLE 2Mbps data mode, so only BLE 1Mbps mode was tested.

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:	19.2 °C
Relative Humidity:	51.2 %
Atmospheric Pressure:	98.2 kPa

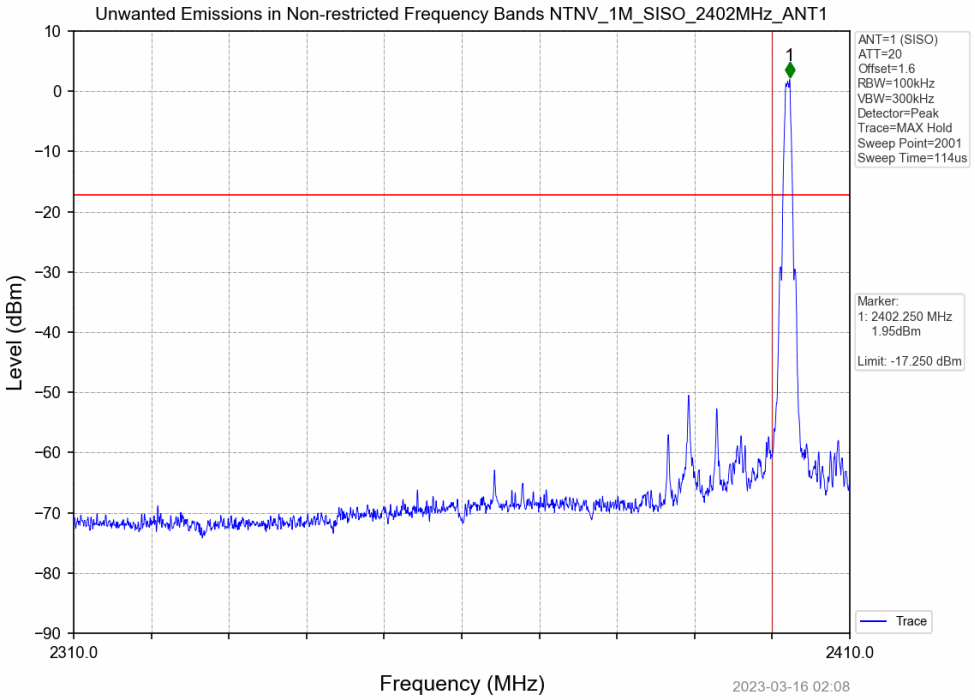
6.4 *Test Equipment*

Test End Date: 15-Mar-2023 Tester: DA

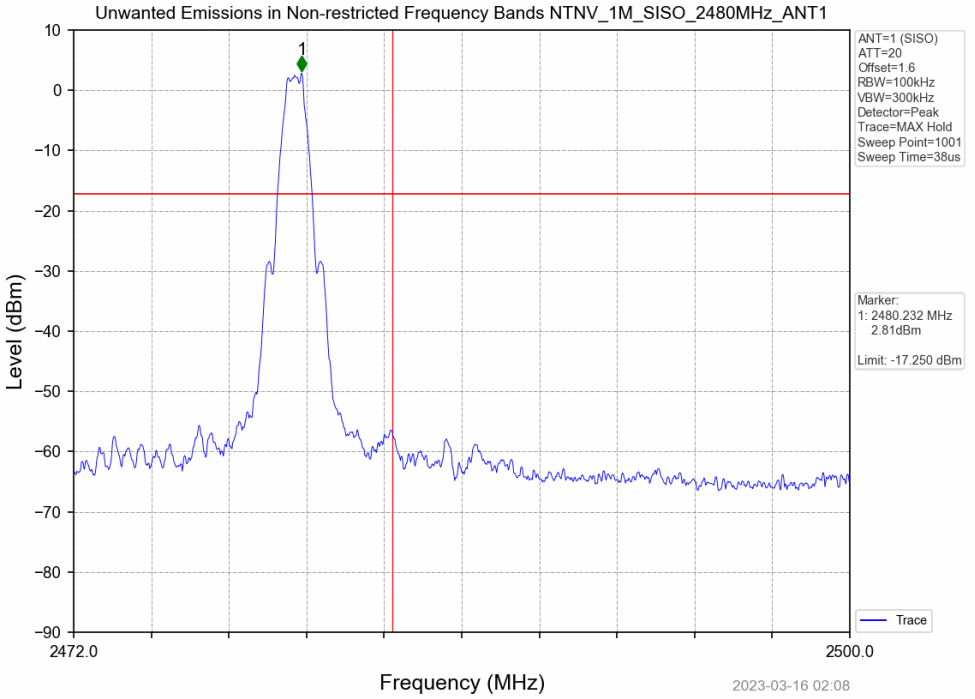
Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	7-Dec-2022	7-Dec-2023
RF CABLE (TS8997)	141	HUBER & SUHNER	B095588	5-Jul-2022	5-Jul-2023
TSTPASS SWITCHBOX	SB1	TSTPASS	20168	CNR	CNR
USB WIDEBAND POWER SENSOR	U2021XA	TSTPASS (KEYSIGHT TECHNOLOGIES)	20168C	24-Aug-2022	24-Aug-2023

6.5 *Test Data – DTS Band Edge*

BLE - Lower band edge

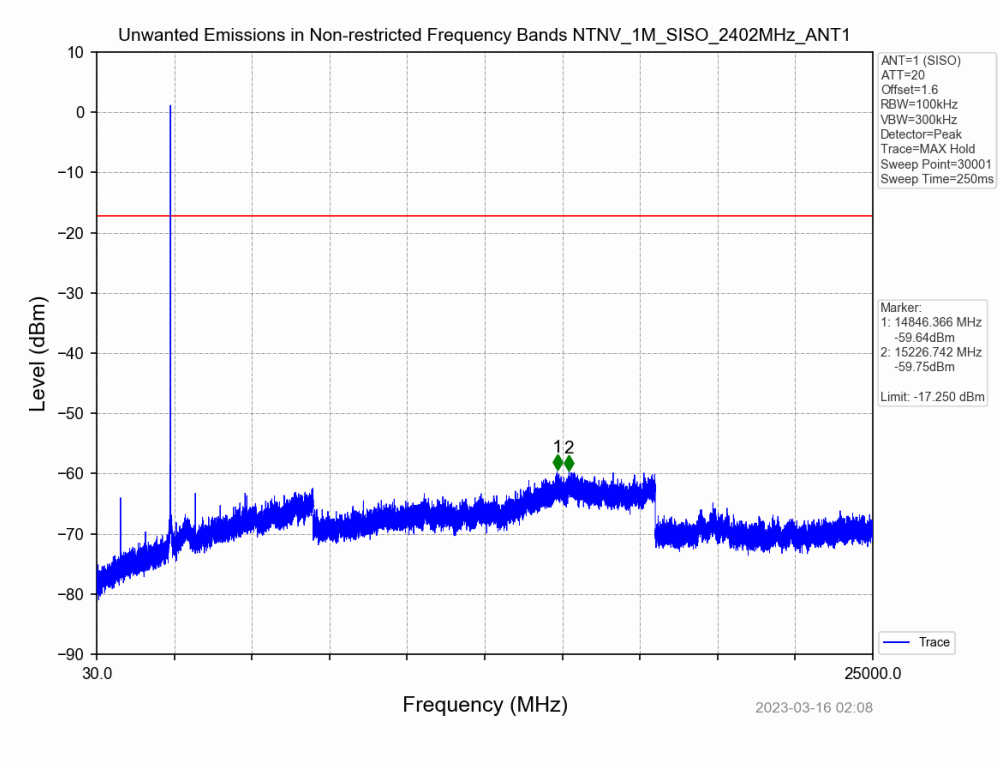


BLE - Upper band edge

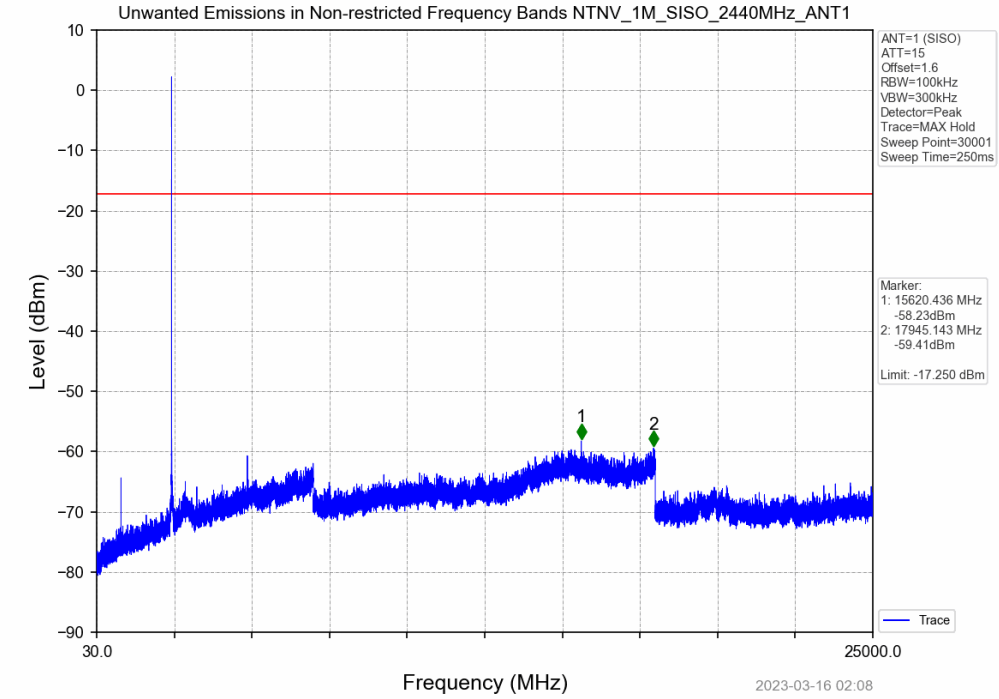


6.6 *Test Data – DTS Conducted Spurious Emissions*

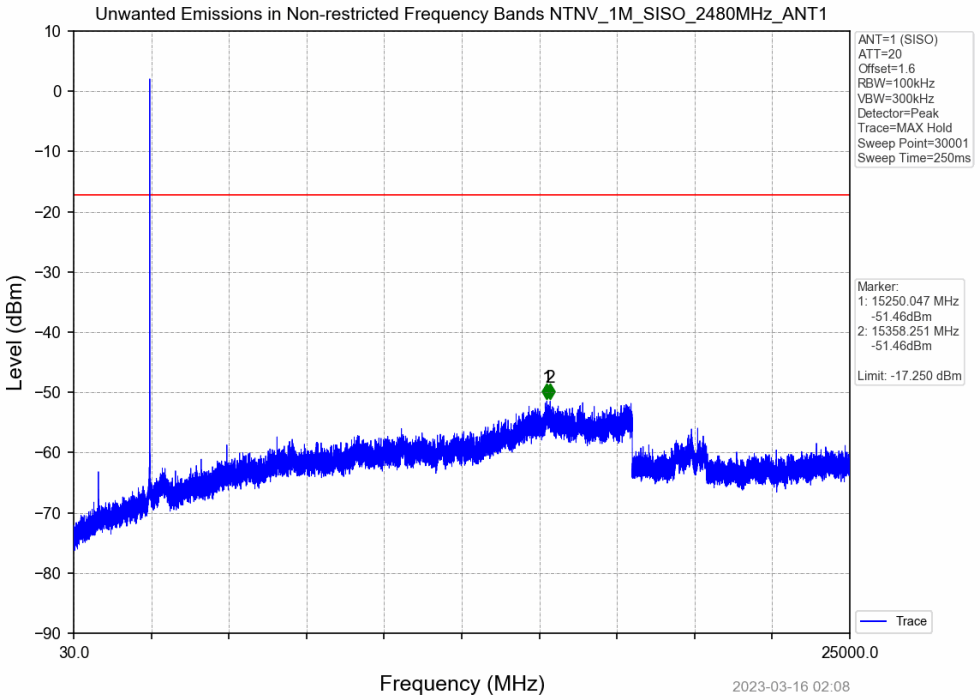
Conducted Spurs – BLE Channel 0



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

Environmental Conditions	30-1000MHz	1-18GHz
Temperature:	21.3 °C	25.7 °C
Relative Humidity:	49.3 %	44.3 %
Atmospheric Pressure:	97.9 kPa	98.3 kPa

7.4 *Test Equipment*

30-1000MHz

Test End Date: 4-Apr-2023 Tester: ZH

Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
ANTENNA, BILOG	JB6	SUNOL	B079689	26-May-2022	26-May-2024
N to N RF Cable	TR-48-25P	Echelon	23007	31-Mar-2023	31-Mar-2024
RF CABLE NM TO NM, 0.01-12GHZ	90-078-079	TELEDYNE STORM MICROWAVE	20115	15-Mar-2023	15-Mar-2024
RF CABLE NM TO NM, 0.01-18GHZ	90-195-079	TELEDYNE STORM MICROWAVE	20123	9-Feb-2023	9-Feb-2024
RF CABLE RIGHT ANGLE NM TO NM, 0.01-18GHZ	90-076-020	TELEDYNE STORM MICROWAVE	20131	13-Mar-2023	13-Mar-2024
LOW NOISE AMPLIFIER	ZKL-2+	MINI-CIRCUITS	B079817	25-Aug-2022	25-Aug-2023
EMI TEST RECEIVER	ESW44	ROHDE & SCHWARZ	22027	13-Sep-2022	13-Sep-2023

1-18GHz

Test End Date: 5-Apr-2023 Tester: ZH
6-Apr-2023

Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
ANTENNA, DRG HORN (MEDIUM)	3117	ETS LINDGREN	B079691	15-Aug-2022	15-Aug-2024
RF CABLE NM TO NF, 0.01-18GHZ	TR-48-25P	TELEDYNE STORM MICROWAVE	20118	13-Mar-2023	13-Mar-2024
RF CABLE, NM TO NM.	90-195-157	TELEDYNE STORM MICROWAVE	21019	14-Mar-2023	14-Mar-2024
RF CABLE RIGHT ANGLE NM TO NM, 0.01-	90-076-020	TELEDYNE STORM MICROWAVE	20132	13-Mar-2023	13-Mar-2024
LOW NOISE AMPLIFIER	TS-PR18	ROHDE & SCHWARZ	B094463	13-Jul-2022	13-Jul-2023
EMI TEST RECEIVER	ESW44	ROHDE & SCHWARZ	22032	24-Nov-2022	24-Nov-2023
FILTER, HIGH PASS, >2800MHZ	HPM50111	MICRO-TRONICS	22017	16-Jun-2022	16-Jun-2023

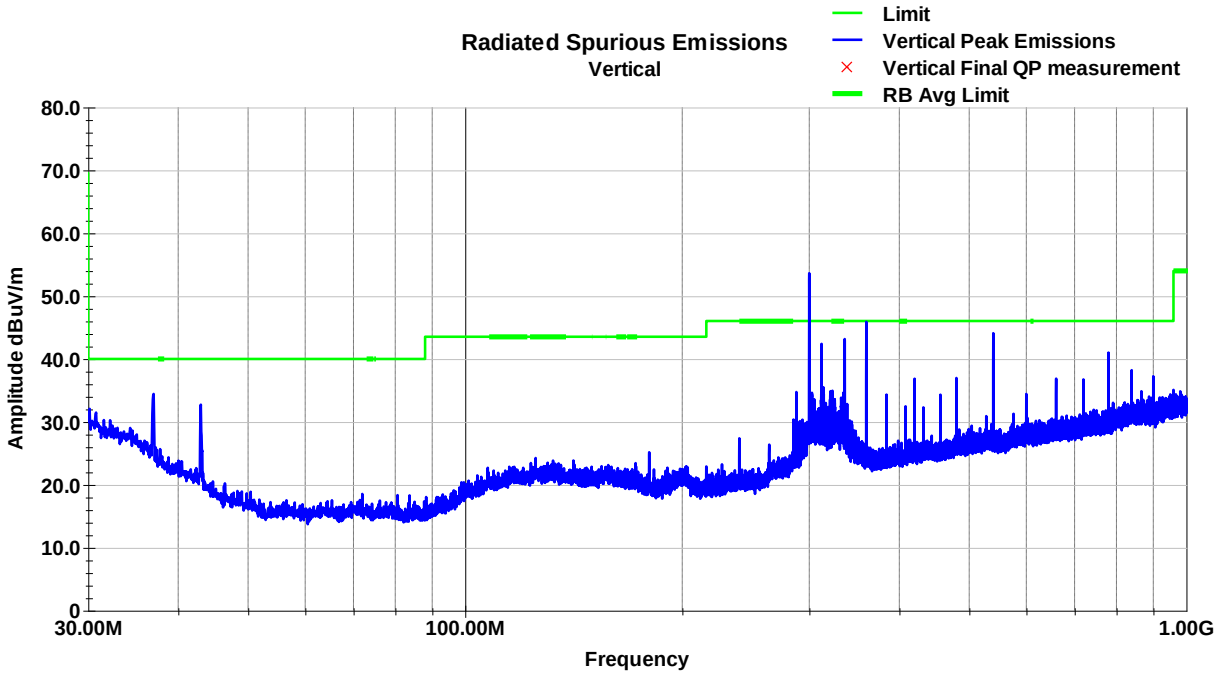
Software: “RSE 30-1000 MHz T7 220318” TILE 7! profile dated Mar 2022
“RSE 1-18 GHz T7 210212” TILE 7! profile dated Feb 2021

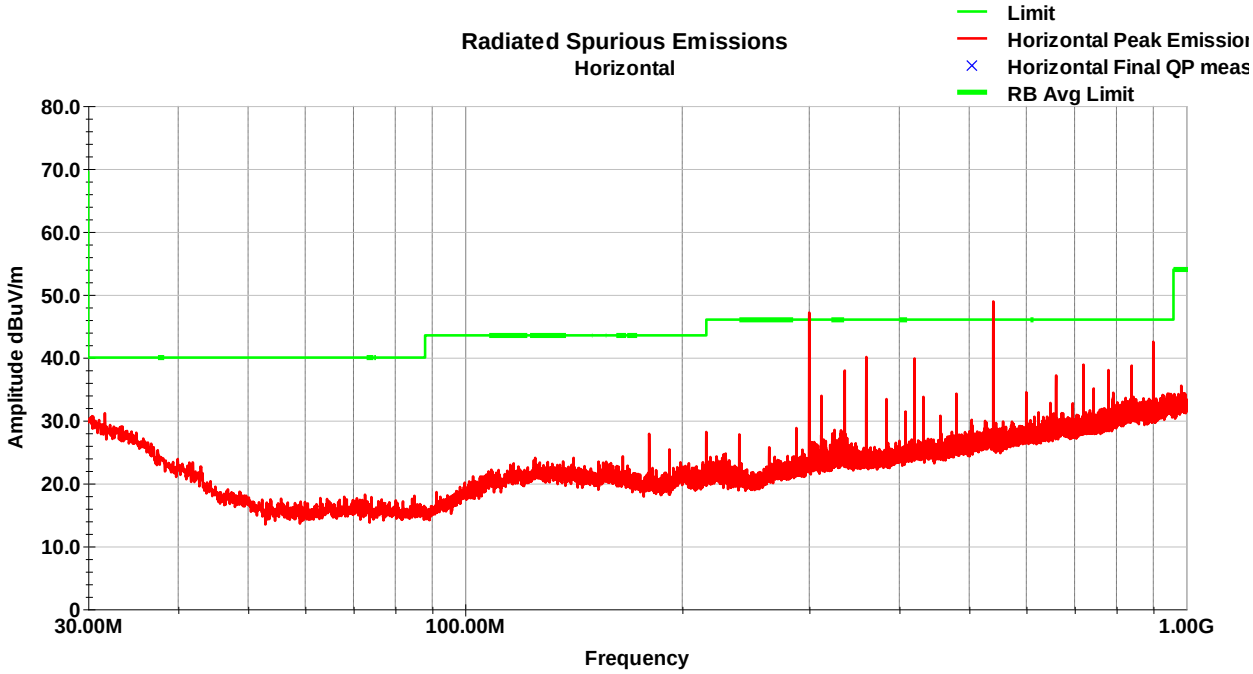
7.5 *Test Data*

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

7.5.1 30-1000 MHz

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

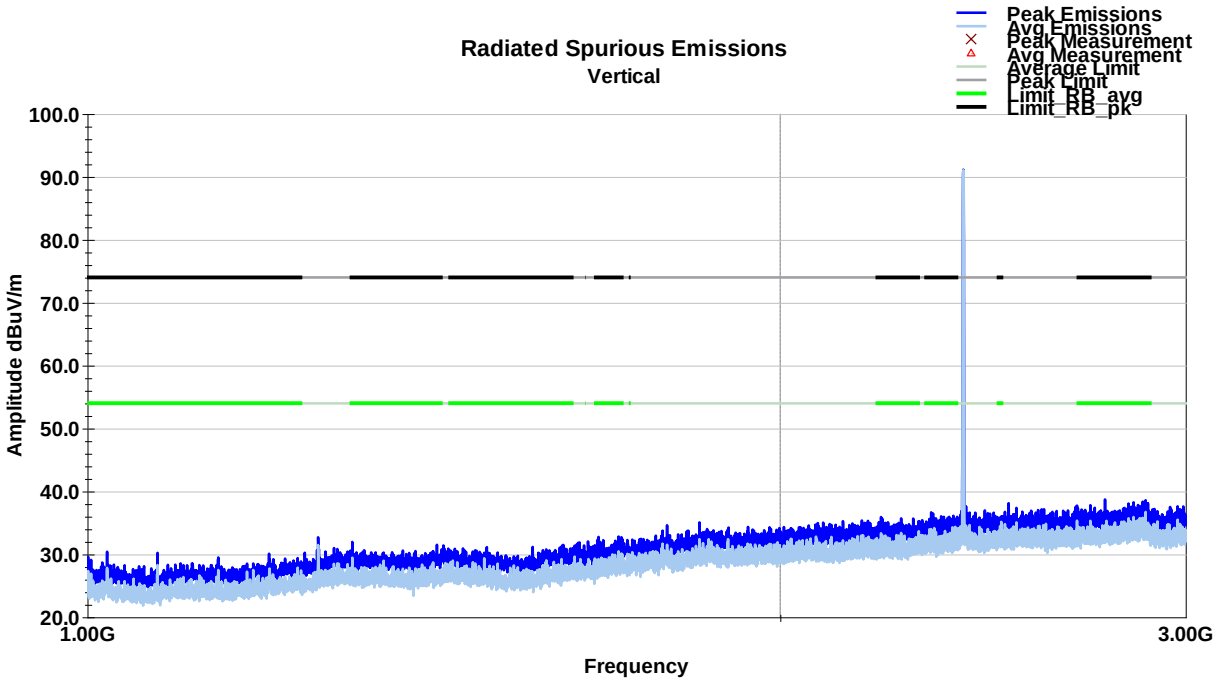




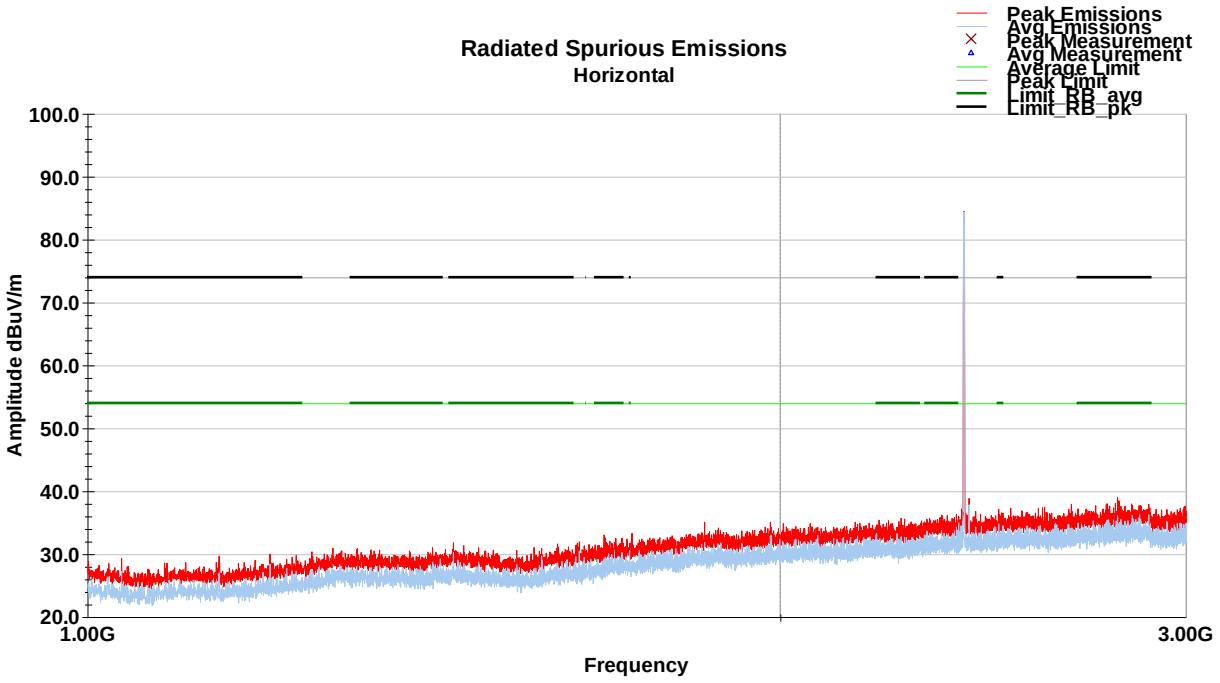
Emissions in above plots do not fall in restricted bands and so do not need to meet FCC 15.209 limits.

7.5.2 1-3 GHz

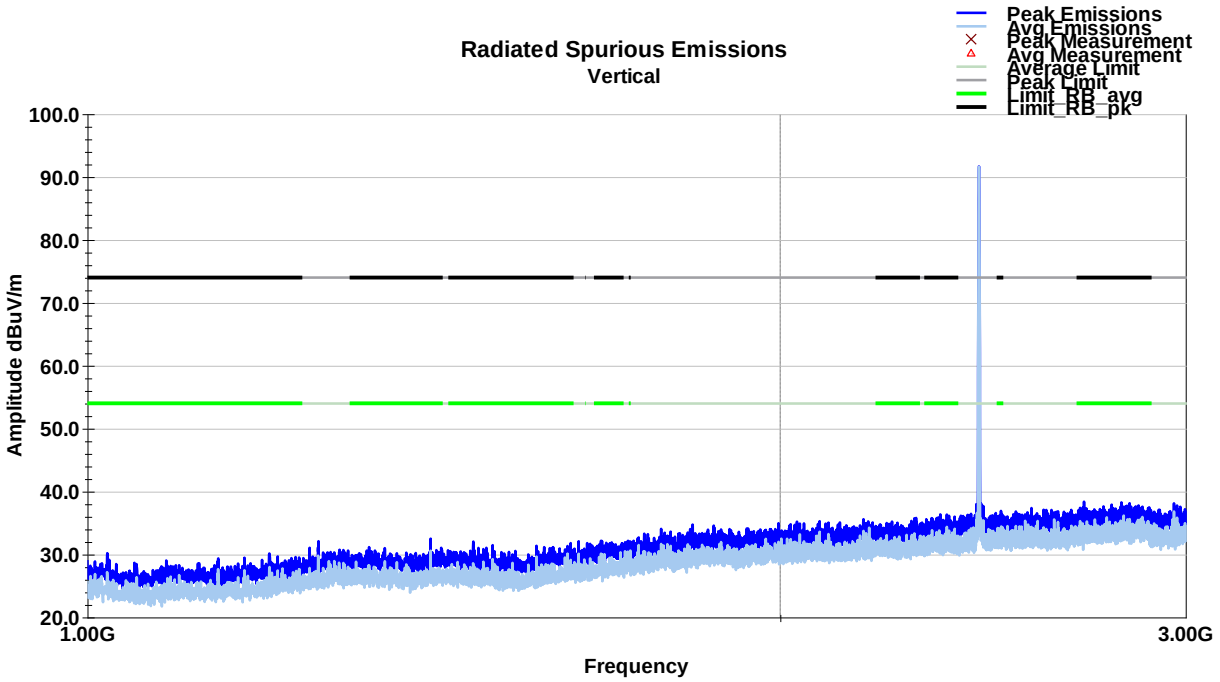
1-3GHz Vertical Low Channel



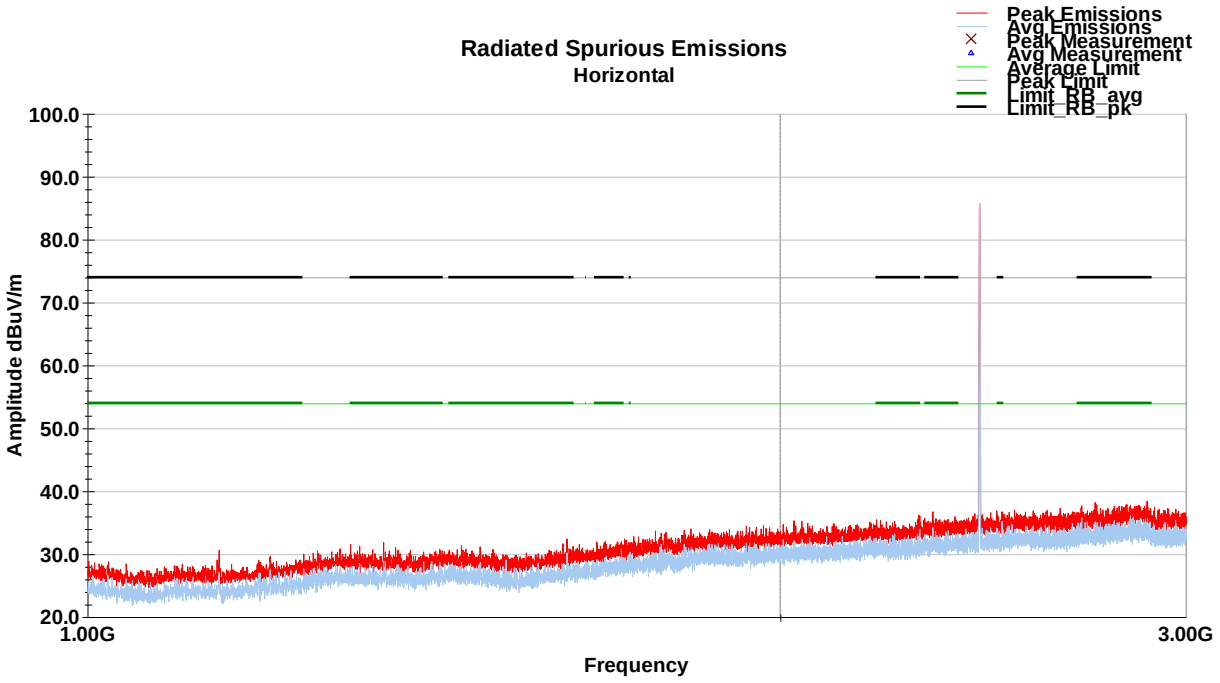
1-3 GHz Horizontal Low Channel



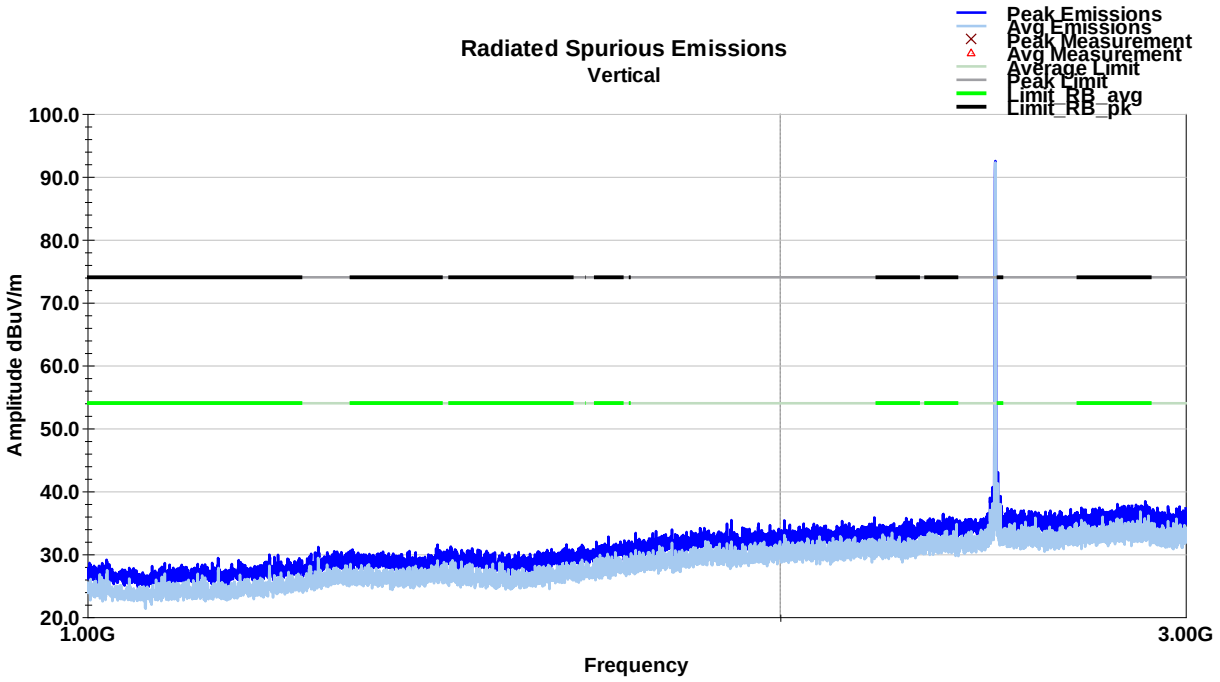
1-3 GHz Vertical Mid Channel



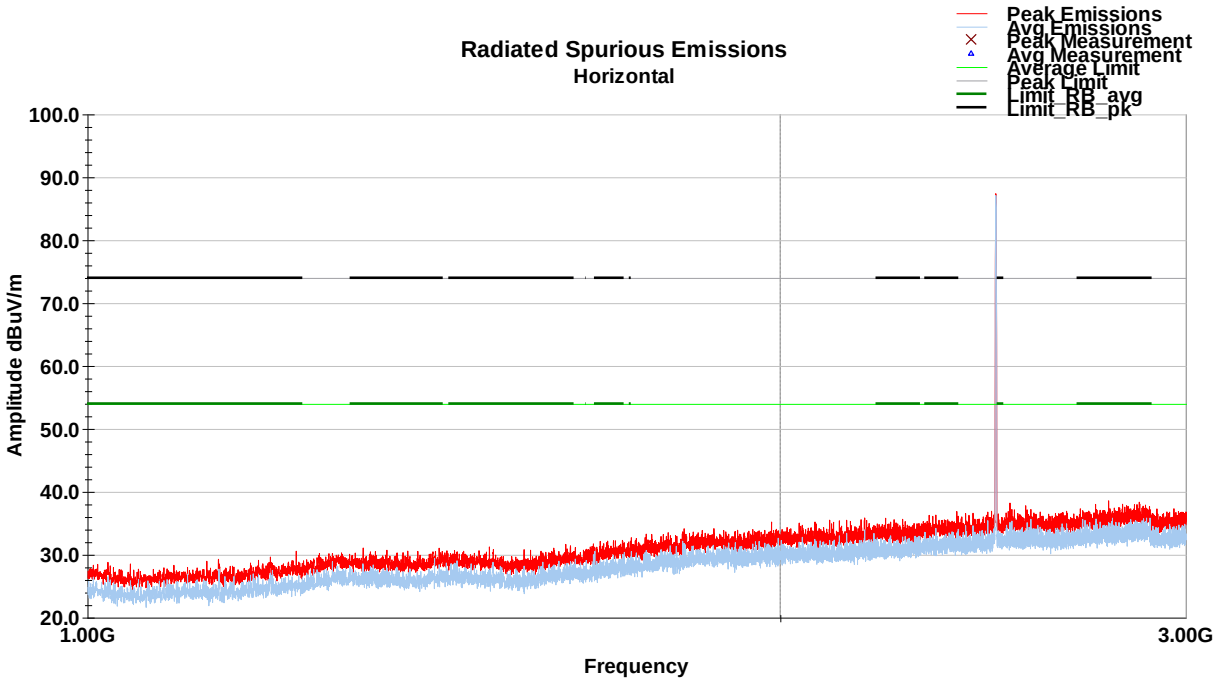
1-3 GHz Horizontal Mid Channel



1-3 GHz Vertical High Channel

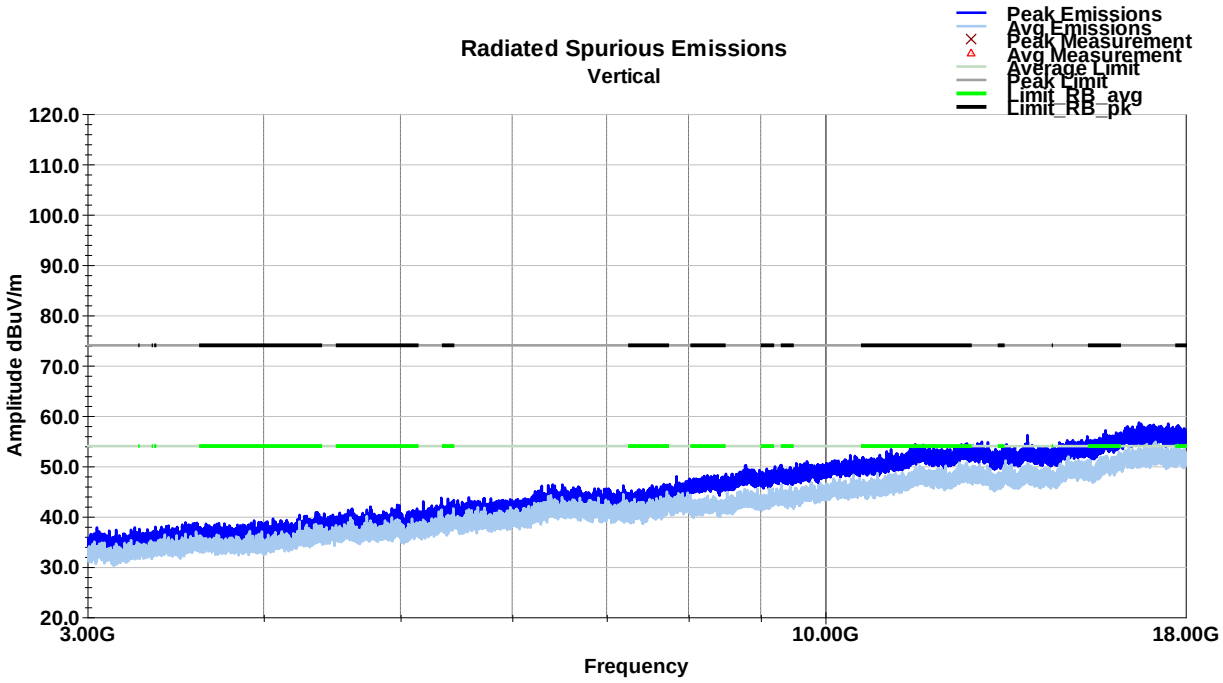


1-3 GHz Horizontal High Channel

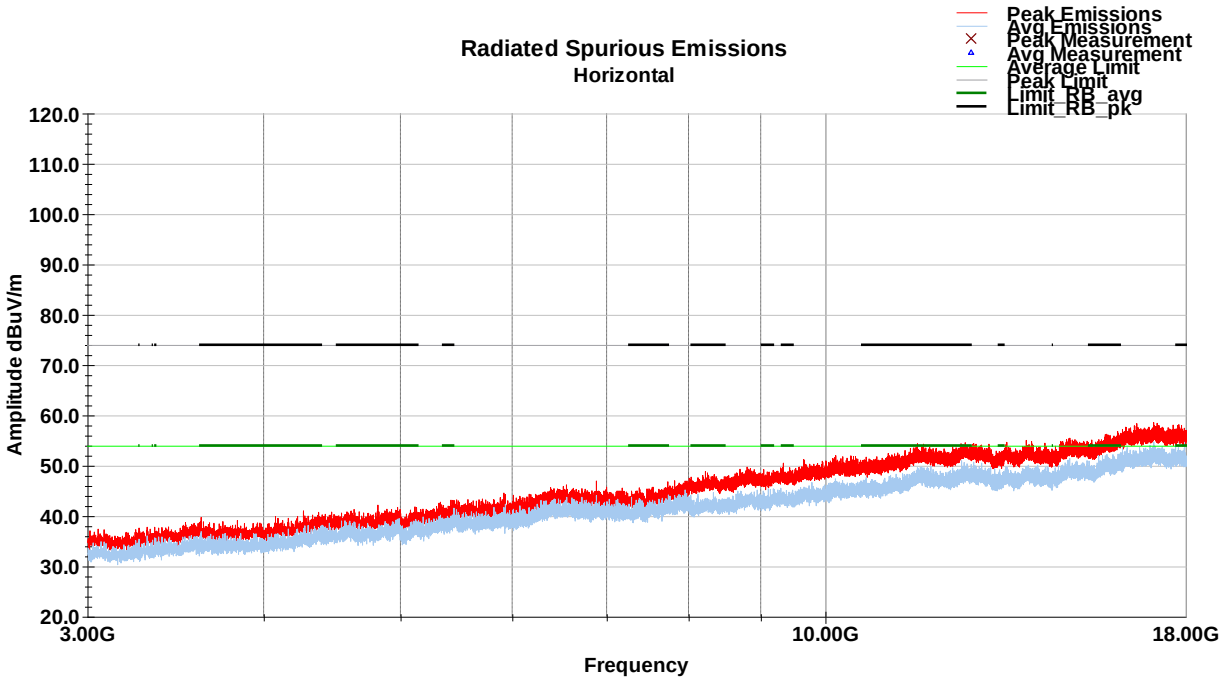


7.5.3 3-18 GHz

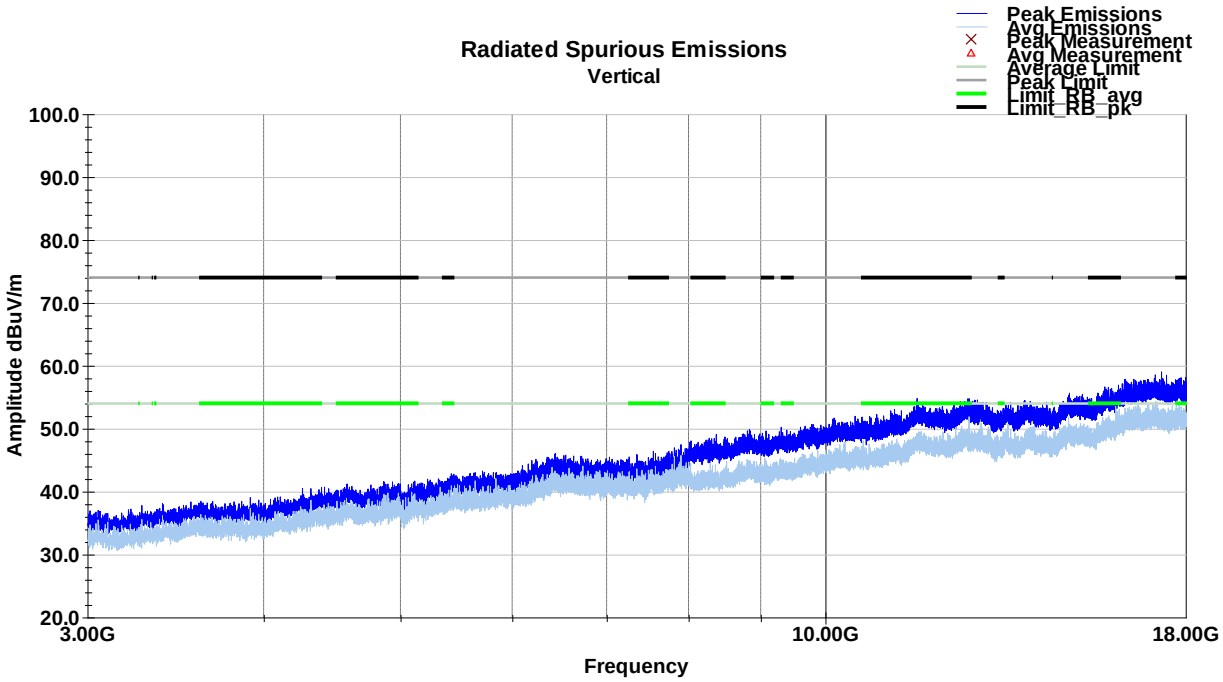
3-18 GHz Vertical Low Channel



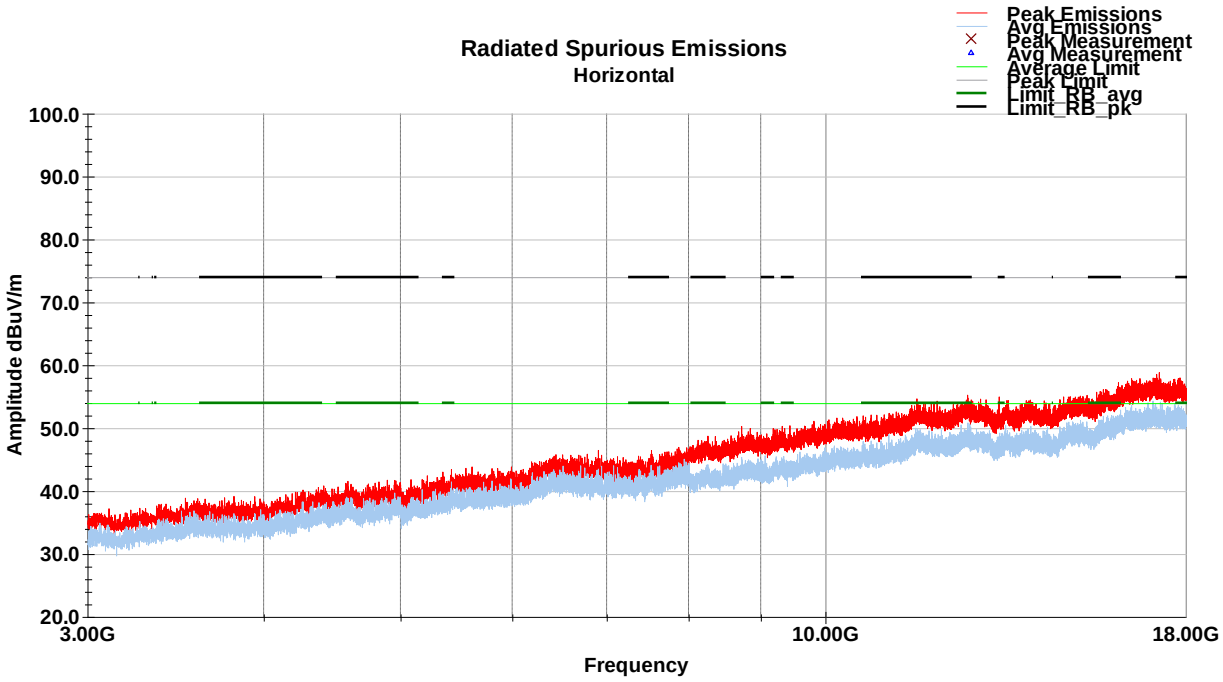
3-18 GHz Horizontal Low Channel



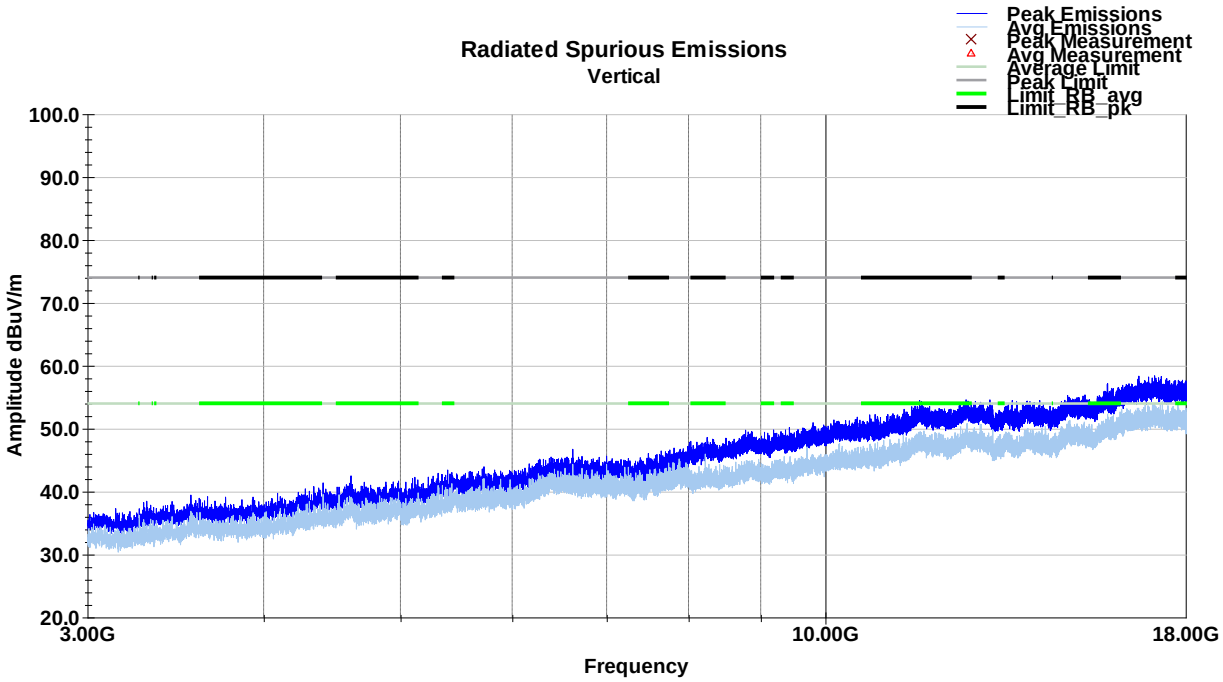
3-18GHz Vertical Mid Channel



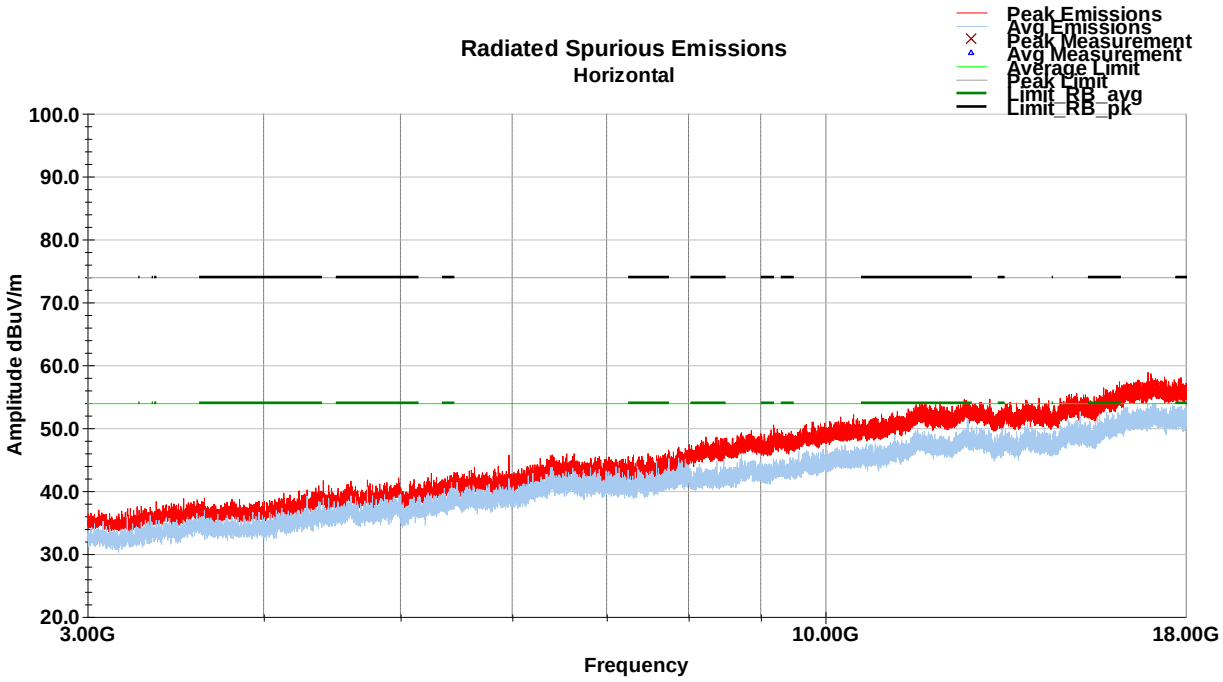
3-18 GHz Horizontal Mid Channel



3-18 GHz Vertical High Channel



3-18GHz Horizontal High Channel



There were no emissions in the 18-26GHz frequency range.

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 device does not utilize BLE 2Mbps data mode, so only BLE 1Mbps mode was tested.

8.3 *Test Site*

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature:	24.6 °C
Relative Humidity:	45.4 %
Atmospheric Pressure:	97.9 kPa

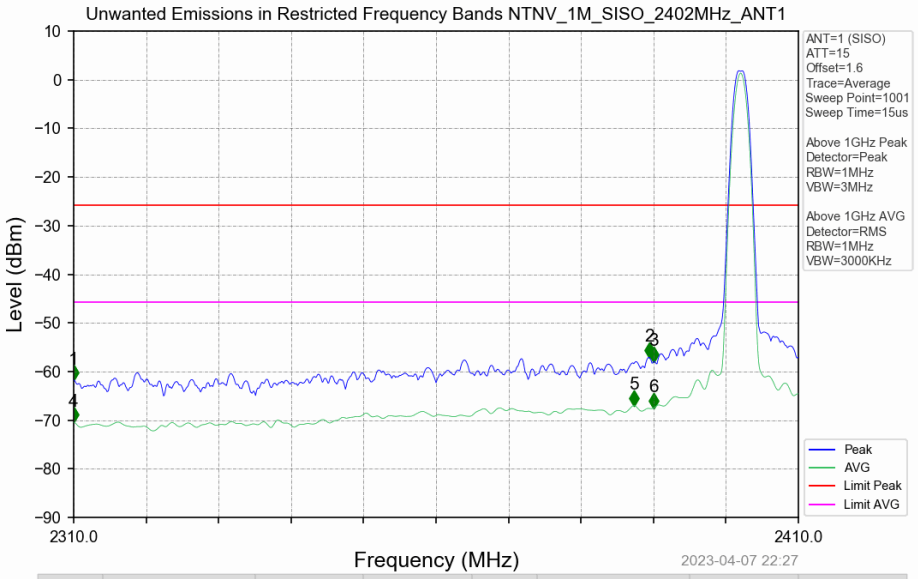
8.4 *Test Equipment*

Test End Date: 7-Apr-2023 Tester: DA

Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	7-Dec-2022	7-Dec-2023
RF CABLE (TS8997)	141	HUBER & SUHNER	B095588	5-Jul-2022	5-Jul-2023
TSTPASS SWITCHBOX	SB1	TSTPASS	20168	CNR	CNR
USB WIDEBAND POWER SENSOR	U2021XA	TSTPASS (KEYSIGHT TECHNOLOGIES)	20168C	24-Aug-2022	24-Aug-2023

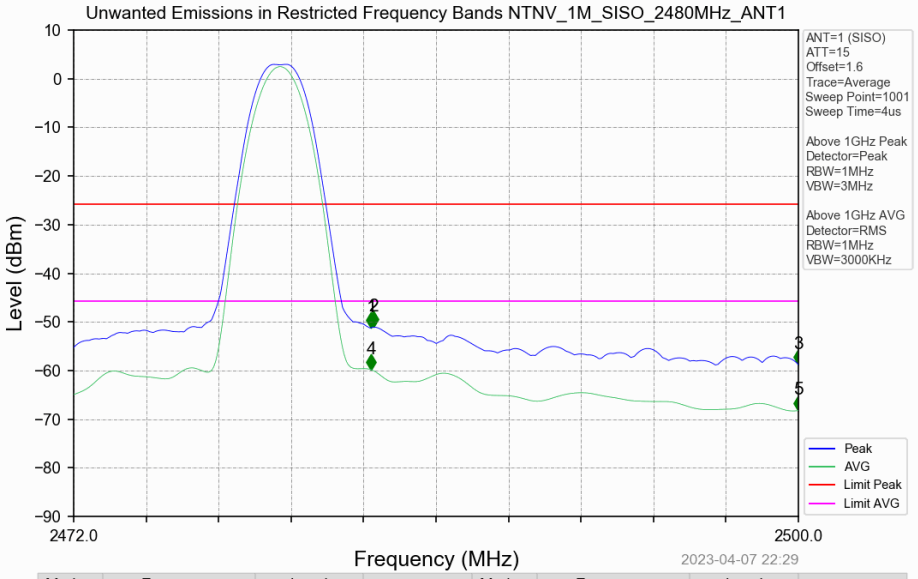
8.5 *Test Data*

BLE – Low Channel – Plot



Marker No	Frequency (MHz)	Level (dBm)	Remark	Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2310.000	-61.751	Peak	4	2310.000	-70.424	AVG
2	2389.400	-57.107	Peak	5	2387.300	-66.994	AVG
3	2390.000	-58.016	Peak	6	2390.000	-67.513	AVG

BLE – High Channel – Plot



Marker No	Frequency (MHz)	Level (dBm)	Remark	Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2483.500	-51.207	Peak	4	2483.500	-59.815	AVG
2	2483.592	-51.080	Peak	5	2500.000	-68.227	AVG
3	2500.000	-58.804	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:	22.7 °C
Relative Humidity:	38.8 %
Atmospheric Pressure	97.8 kPa

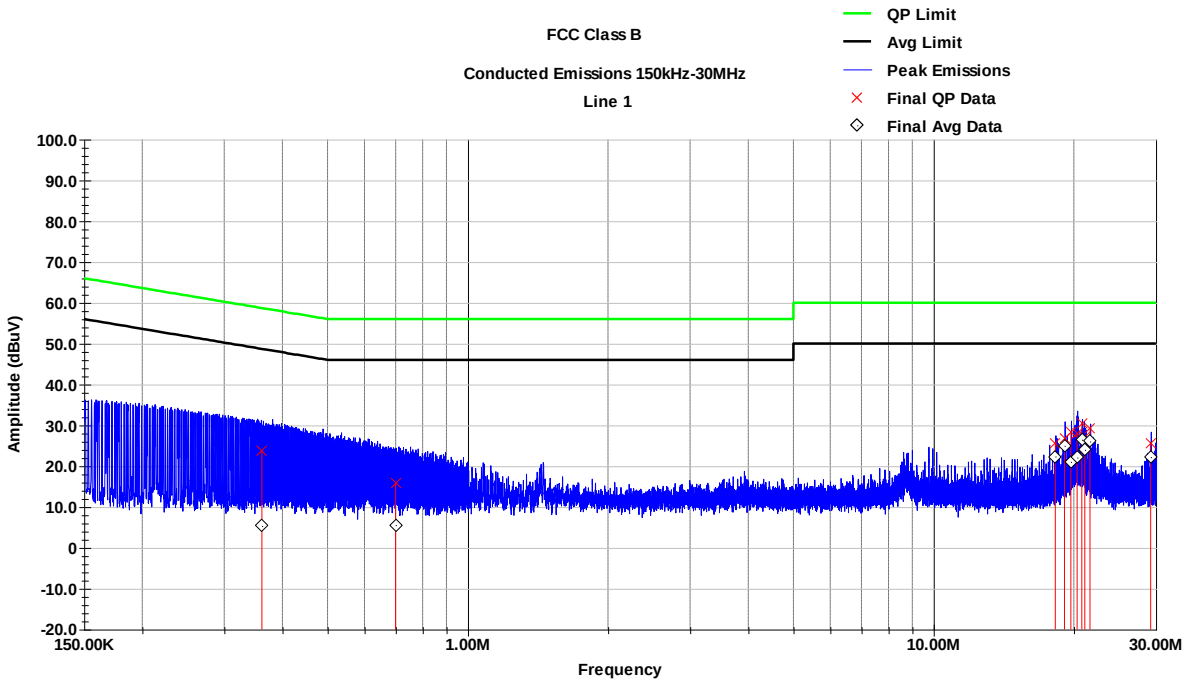
9.4 *Test Equipment*

Test End Date: 13-Apr-2023 Tester: EW

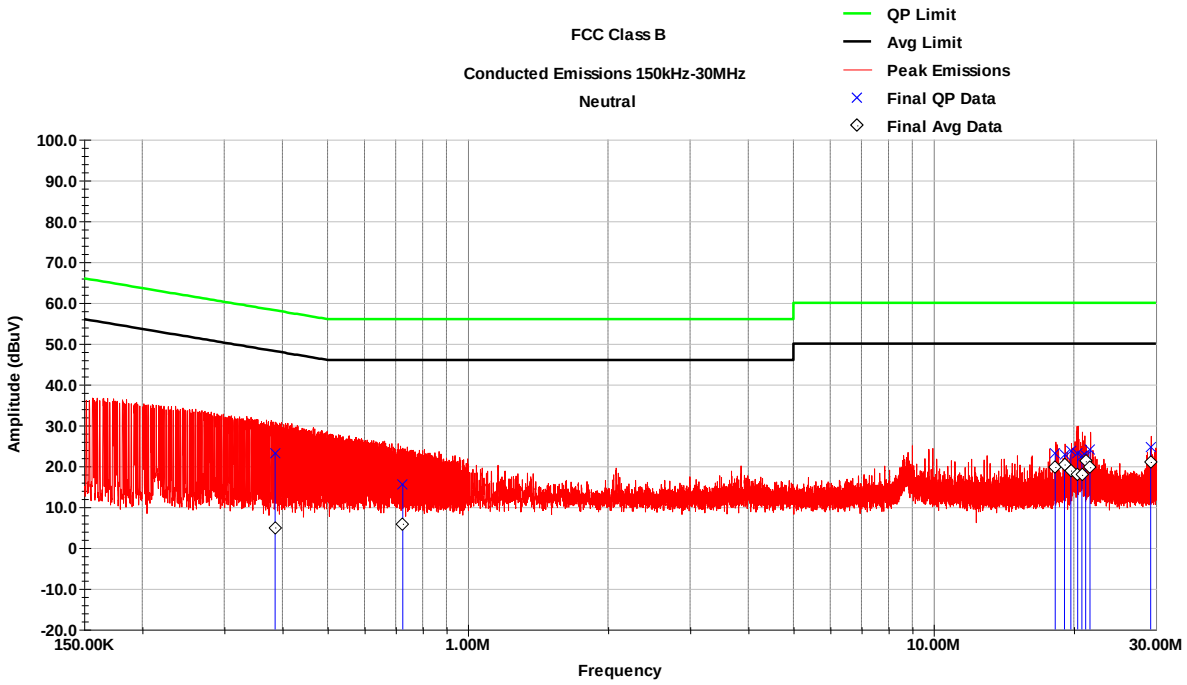
Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
LINE IMPEDANCE STABILIZATION NETWORK	NNB 51	TESEQ	B085882	15-Apr-2022	15-Apr-2023
RF CABLE	UC-N-MM-78	MAURY MICROWAVE	17017	25-Aug-2022	25-Aug-2023
EMI TEST RECEIVER	ESW44	ROHDE & SCHWARZ	22032	24-Nov-2022	24-Nov-2023

Software: Conducted Emissions 230206.til

9.5 *Test Data*



Frequency MHz	QP Value dBuV	QP Limit dBuV	QP Margin dB	Avg Value dBuV	Avg Limit dBuV	Avg Margin dB
0.361	23.7	58.7	-34.9	5.3	48.7	-43.3
0.700	15.9	56.0	-40.1	5.6	46.0	-40.4
18.244	25.7	60.0	-34.3	22.4	50.0	-27.6
19.098	26.8	60.0	-33.2	25.0	50.0	-25.0
19.708	28.2	60.0	-31.8	21.0	50.0	-29.0
20.323	27.9	60.0	-32.1	22.1	50.0	-27.9
20.808	30.5	60.0	-29.5	26.5	50.0	-23.5
21.113	27.2	60.0	-32.8	24.0	50.0	-26.0
21.663	29.4	60.0	-30.6	26.0	50.0	-24.0
29.235	25.6	60.0	-34.4	22.2	50.0	-27.8



Frequency MHz	QP Value dBuV	QP Limit dBuV	QP Margin dB	Avg Value dBuV	Avg Limit dBuV	Avg Margin dB
0.386	23.2	58.2	-34.9	5.0	48.2	-43.2
0.725	15.5	56.0	-40.5	5.9	46.0	-40.1
18.243	23.1	60.0	-36.9	19.8	50.0	-30.2
19.097	22.7	60.0	-37.3	20.4	50.0	-29.6
19.707	23.7	60.0	-36.3	18.9	50.0	-31.1
20.384	23.3	60.0	-36.7	18.1	50.0	-31.9
20.812	22.5	60.0	-37.5	17.9	50.0	-32.1
21.199	22.5	60.0	-37.5	21.2	50.0	-28.8
21.662	24.2	60.0	-35.8	19.8	50.0	-30.2
29.236	24.8	60.0	-35.2	21.0	50.0	-29.0

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	±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

11 Revision History

Revision Level	Description of changes	Revision Date
0	Initial release	31 May 2023
1	- Updated RSS-247 reference to latest issue on title page - Clarified antenna type in sections 1 & 2.3	17 November 2023