

RF Test Report

Project Number: 4975321

Proposal: SUW-202108001433

Report Number: 4975321EMC11

Revision Level: 3

Client: Deere & Company

Equipment Under Test: JLink™ M Modem - 4G

Model Number: MA4M

FCC ID: OV5-MA4M

IC ID: 11137A-MA4M

Applicable Standards: ANSI C63.10: 2013 (FCC Part 15 Subpart C, § 15.247)

RSS-247, Issue 2

RSS-GEN Issue 5

Report issued on: 28 February 2023


Test Result: Compliant



FOR THE SCOPE OF ACCREDITATION UNDER CERTIFICATE NUMBER: 3212.01

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:



Andrew Bluhm, Jr RF/EMC Project Engineer

Reviewed by:



Brandon Osborn, RF/EMC Project Engineer

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1 Summary of Test Results

Test Description	Test Specification		Test Result
Bandwidth	15.247(a)(2)	RSS-247 5.2(a) RSS-GEN 6.7	Compliant
Peak Output Power	15.247(b)(3)	RSS-247 5.4 (d)	Compliant
Power Spectral Density	15.247(e)	RSS-247 5.2 (b)	Compliant
Conducted Spurious Emissions / Band Edge	15.247(d)	RSS-247 5.5	Compliant
Field Strength of Spurious Radiation	15.247(d)	RSS-247 5.5	Compliant
Emissions in Restricted Frequency Bands	15.205, 15.209	RSS-GEN 8.9, 8.10	Compliant
Antenna Requirement	15.203	RSS-GEN 6.8	Compliant ²
AC Powerline Conducted Emissions	15.107, 15.207	RSS-GEN 8.8	NA ¹

1) The device has no facility for connection to the AC mains.

2) All antennas are internal.

1.1 Modifications Required for Compliance

None

2 General Information

2.1 Client Information

Name: Deere & Company dba John Deere Intelligent Solutions
Address: 9505 Northpark Drive
City, State, Zip, Country: Urbandale, IA 50131 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
Designation Number: US1126
CAB Identifier: US0186

2.3 General Information of EUT

Product Description: JDLINK™ M Modem - 4G
Model Number: MA4M
Serial Numbers: PCMA4MA101508 (Conducted) / PCMA4MA101503 (Radiated)

Frequency Range: 2402 – 2480 MHz
Data Modes: Basic Rate / EDR-2 / EDR-3
Antenna*: Internal – (4 dBi)

Rated Voltage: 9 – 32Vdc
Test Voltage: 12Vdc

Sample Received Date: 22 October 2022, 07 December 2022

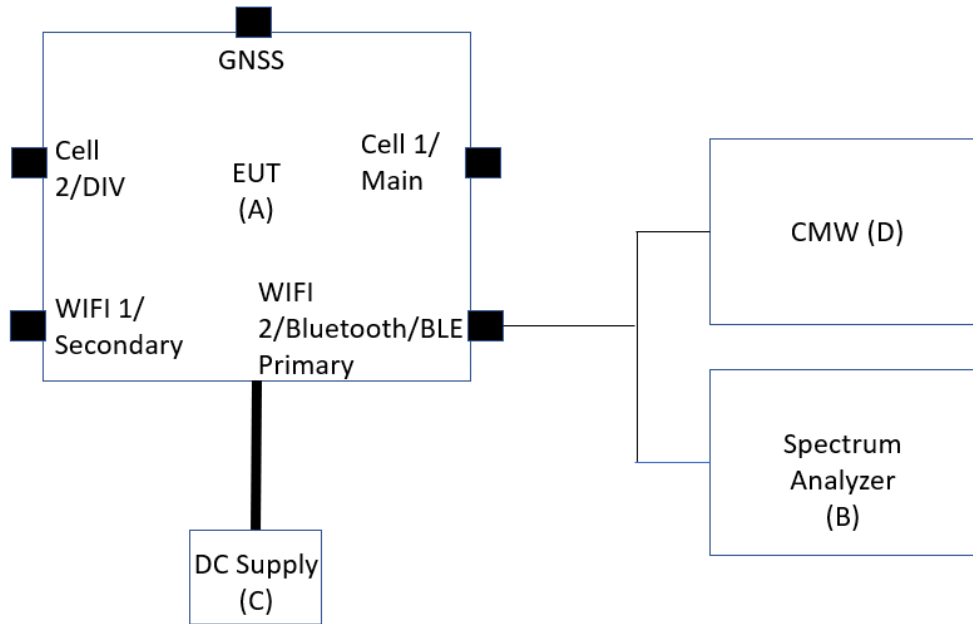
Dates of testing: 01 November – 09 December 2022

* Data was not measured by SGS laboratory and therefore not responsible for accuracy. Data obtained via customer, specification sheet, previous filing or other.

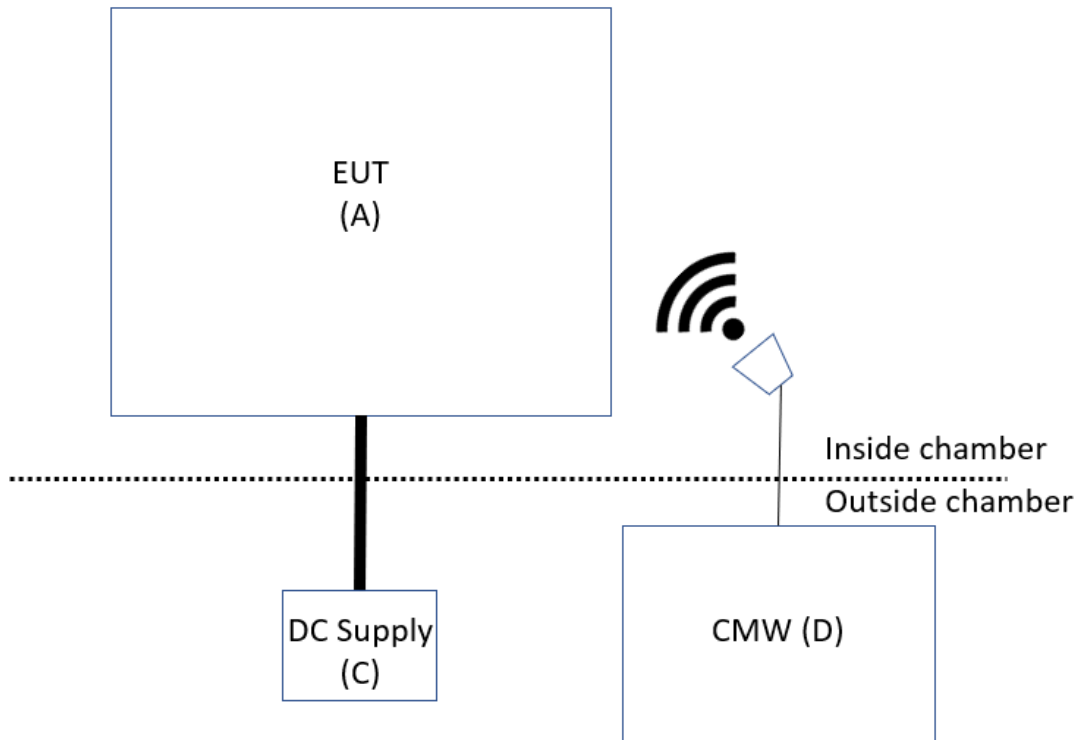
2.4 Operating Modes and Conditions

Using test commands through the Linux backbone, the EUT was configured in Bluetooth Test Mode. Using a CMW-500 to control the device, the modulation, packet-type, channel, and hopping mode could all be configured. During testing, the device was configured to transmit at 1 setting below max power which correlates to an internal software setting of 6.

2.5 EUT Connection Block Diagram – Conducted Measurements



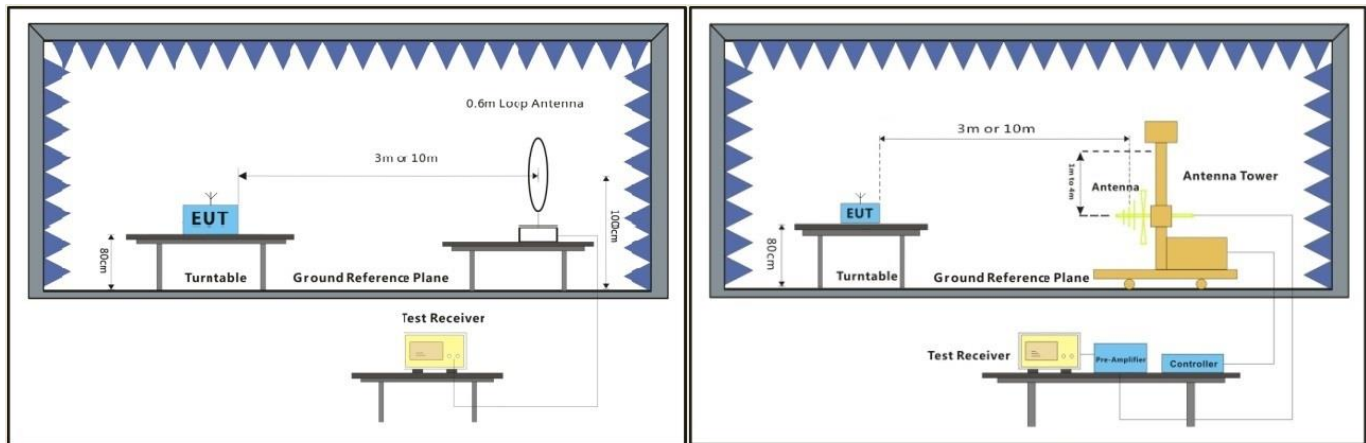
2.6 EUT Connection Block Diagram – Radiated Measurements



2.7 System Configurations

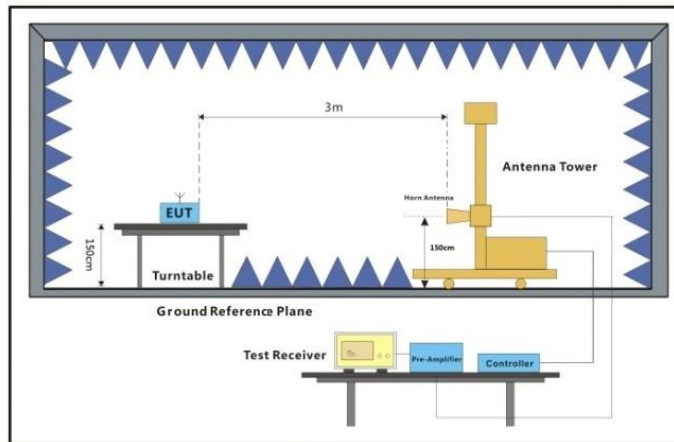
Device reference	Manufacturer	Description	Model Number	Serial Number
A	Deere & Company	JDLink™ M Modem - 4G	MA4M	PCMA4MA101508 (Conducted); PCMA4MA101503 (Radiated)
B	KEYSIGHT	EXA Signal Analyzer	N9010B	MY57110193
C	Rigol	DC Power Supply	DP711	DP7A202200419
D	Rohde & Schwarz	Communications Analyzer	CMW-500	127722 / 111428

2.8 Configuration Diagrams (Radiated)



Below 30MHz

30MHz-1GHz



Above 1GHz

3 Occupied Bandwidth

3.1 Test Result

Test Description	Test Specification		Test Result
Occupied Bandwidth 20dB Bandwidth	15.247(a)(1)	RSS-247 5.1(a) RSS-GEN 6.7	Compliant

3.2 Test Method

The procedures from ANSI C63.10: 2013 Clause 6.9.2 were used to measure the 99% Occupied Bandwidth and 20dB Bandwidth.

3.3 Test Site

EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.9 °C

Relative Humidity: 48.6 %

Atmospheric Pressure: 98.8 kPa

3.4 Test Equipment

Test End Date: 9-Dec-2022

Tester: AB

Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
WIDEBAND RADIO COMMUNICATION TESTER	CMW500	ROHDE & SCHWARZ	B079788	12-Sep-2022	12-Sep-2024
POWER SPLITTER	ZFRSC-123-S+	MINI-CIRCUITS	B101740	13-Jul-2022	13-Jul-2023
RF CABLE SMA TO SMA, 0.01-40GHZ	084-0505-059	TELEDYNE STORM MICROWAVE	20108	16-Mar-2022	16-Mar-2023
RF CABLE (TS8997)	141	HUBER & SUHNER	B095585	5-Jul-2022	5-Jul-2023
ATTENUATOR, 10DB (TS8997)	10DB	ROHDE & SCHWARZ	B095593	12-May-2022	12-May-2023
EXA SIGNAL ANALYZER	N9010B	KEYSIGT	1245605	17-Nov-2022	17-Nov-2023
TSTPASS SWITCHBOX	SB1	TSTPASS	20168	CNR	CNR
DC POWER SUPPLY, PROGRAMMABLE	DP711	RIGOL	18027	CNR	CNR

Software Profile:

TSTPASS Version: 1.1.0, build 2020.11.15.01

3.5 Test Data

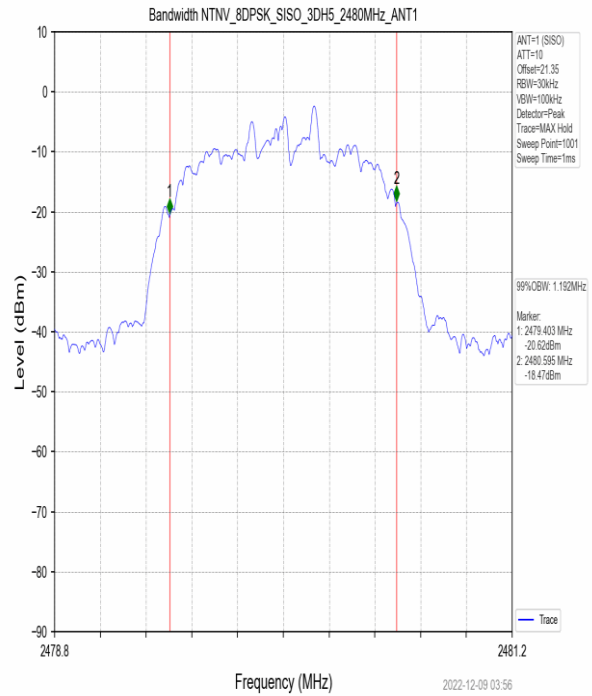
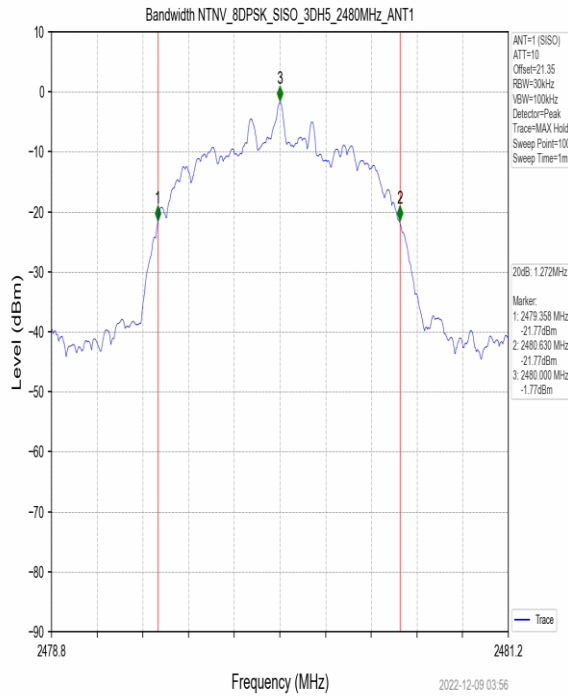
Test Mode	Frequency (MHz)	TX Type	ANT No.	20dB BW (MHz)	99% OBW (MHz)	Verdict
GFSK	2402	SISO	2	1.035	0.986	PASS
	2441	SISO	2	1.035	0.974	PASS
	2480	SISO	2	1.035	0.975	PASS
Pi/4DQPSK	2402	SISO	2	1.324	1.179	PASS
	2441	SISO	2	1.276	1.179	PASS
	2480	SISO	2	1.314	1.188	PASS
8DPSK	2402	SISO	2	1.289	1.180	PASS
	2441	SISO	2	1.295	1.188	PASS
	2480	SISO	2	1.272	1.192	PASS

Representative Plots taken from data measured

High Channel 8DPSK (2480MHz)

20dB Bandwidth

99% Occupied Bandwidth



4 Peak Output Power

4.1 Test Result

Test Description	Test Specification		Test Result
Peak Output Power	15.247(a)(1)	RSS-247 5.4(b)	Compliant

4.2 Test Method

Output power measurements were taken using the methods defined in ANSI C63.10, Clause 7.8.5 using a spectrum analyzer.

Limit

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels: 1 watt.

4.3 Test Site

EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.9 °C

Relative Humidity: 48.6 %

Atmospheric Pressure: 98.8 kPa

4.4 Test Equipment

Test End Date: 9-Dec-2022

Tester: AB

Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
WIDEBAND RADIO COMMUNICATION TESTER	CMW500	ROHDE & SCHWARZ	B079788	12-Sep-2022	12-Sep-2024
POWER SPLITTER	ZFRSC-123-S+	MINI-CIRCUITS	B101740	13-Jul-2022	13-Jul-2023
RF CABLE SMA TO SMA, 0.01-40GHZ	084-0505-059	TELEDYNE STORM MICROWAVE	20108	16-Mar-2022	16-Mar-2023
RF CABLE (TS8997)	141	HUBER & SUHNER	B095585	5-Jul-2022	5-Jul-2023
ATTENUATOR, 10DB (TS8997)	10DB	ROHDE & SCHWARZ	B095593	12-May-2022	12-May-2023
EXA SIGNAL ANALYZER	N9010B	KEYSIGT	1245605	17-Nov-2022	17-Nov-2023
TSTPASS SWITCHBOX	SB1	TSTPASS	20168	CNR	CNR
DC POWER SUPPLY, PROGRAMMABLE	DP711	RIGOL	18027	CNR	CNR

Software Profile:

TSTPASS Version: 1.1.0, build 2020.11.15.01

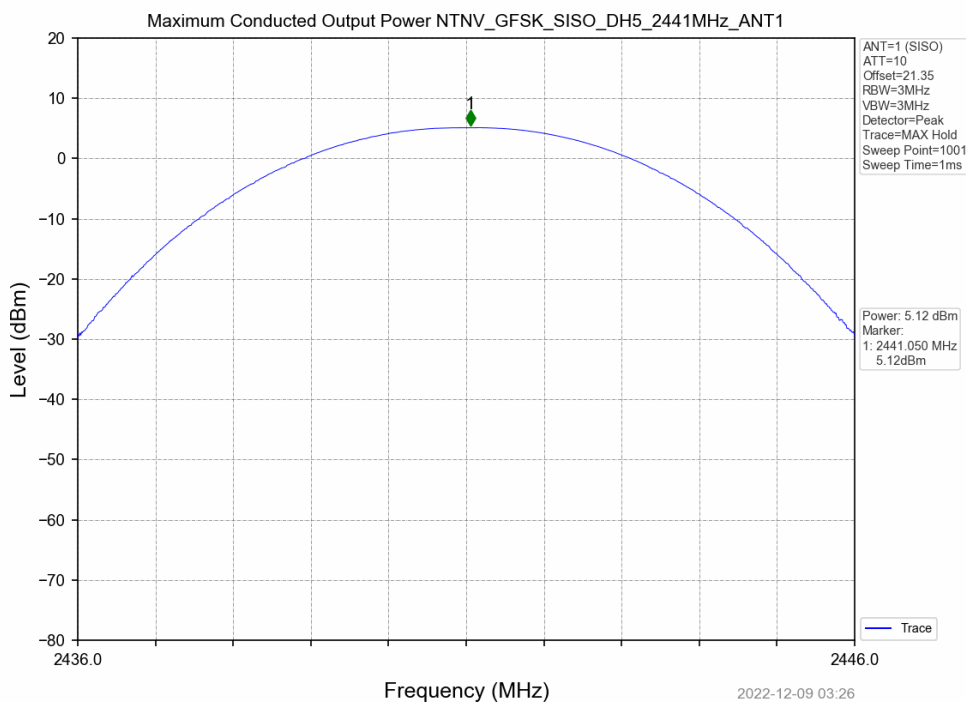
4.5 Test Data

Modulation	Frequency (MHz)	Peak Power (dBm)	Peak Power (mW)	Limit (dBm)	Verdict
GFSK	2402	3.98	2.85	20.97 ¹	PASS
	2441	5.12	3.25	20.97 ¹	PASS
	2480	4.02	2.52	20.97 ¹	PASS
Pi/4DQPSK	2402	0.71	1.18	20.97 ¹	PASS
	2441	1.97	1.57	20.97 ¹	PASS
	2480	1.17	1.31	20.97 ¹	PASS
8DPSK	2402	1.33	1.36	20.97 ¹	PASS
	2441	2.62	1.83	20.97 ¹	PASS
	2480	1.75	1.50	20.97 ¹	PASS

1) The 20dB Bandwidth exceeds the channel spacing; therefore, the limit is reduced to 125mW

Representative Plot from data taken

GFSK Middle Channel (2441MHz)



5 Carrier Frequency Separation

5.1 Test Result

Test Description	Test Specification		Test Result
Carrier Frequency Separation	15.247(a)(1)	RSS-247 5.1(b)	Compliant

5.2 Test Method

Measurements were taken using the methods defined in ANSI C63.10, Clause 7.8.2 using a spectrum analyzer.

Limit

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the -20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W.

5.3 Test Site

EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.9 °C

Relative Humidity: 48.6 %

Atmospheric Pressure: 98.8 kPa

5.4 Test Equipment

Test End Date: 9-Dec-2022

Tester: AB

Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
WIDEBAND RADIO COMMUNICATION TESTER	CMW500	ROHDE & SCHWARZ	B079788	12-Sep-2022	12-Sep-2024
POWER SPLITTER	ZFRSC-123-S+	MINI-CIRCUITS	B101740	13-Jul-2022	13-Jul-2023
RF CABLE SMA TO SMA, 0.01-40GHZ	084-0505-059	TELEDYNE STORM MICROWAVE	20108	16-Mar-2022	16-Mar-2023
RF CABLE (TS8997)	141	HUBER & SUHNER	B095585	5-Jul-2022	5-Jul-2023
ATTENUATOR, 10DB (TS8997)	10DB	ROHDE & SCHWARZ	B095593	12-May-2022	12-May-2023
EXA SIGNAL ANALYZER	N9010B	KEYSIGT	1245605	17-Nov-2022	17-Nov-2023
TSTPASS SWITCHBOX	SB1	TSTPASS	20168	CNR	CNR
DC POWER SUPPLY, PROGRAMMABLE	DP711	RIGOL	18027	CNR	CNR

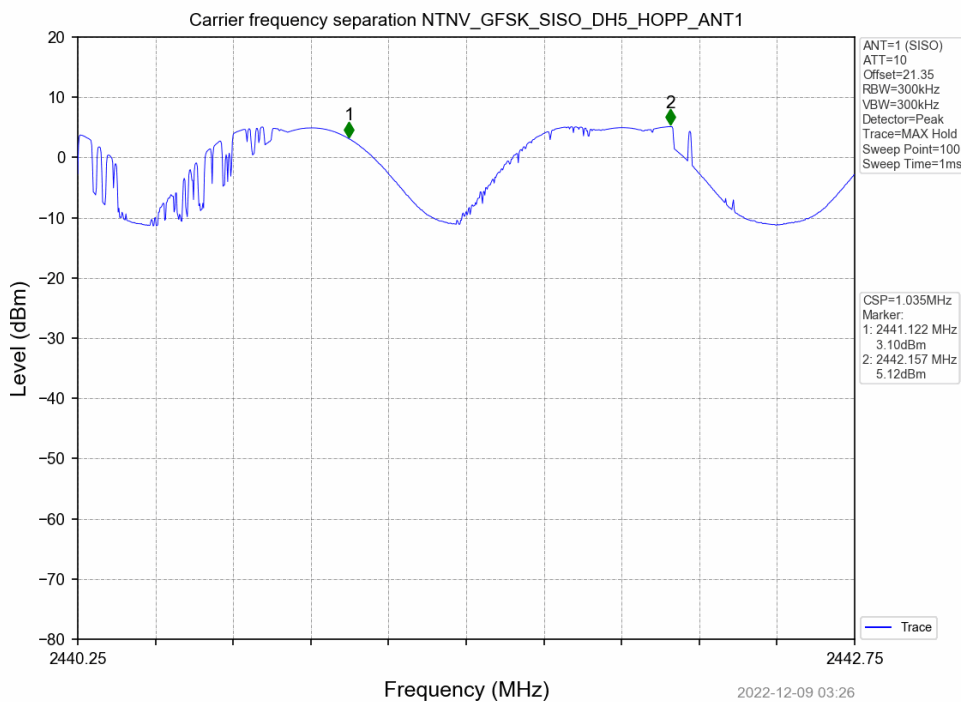
Software Profile:

TSTPASS Version: 1.1.0, build 2020.11.15.01

5.5 Test Data

Test Mode	TX Type	Channel Separation (MHz)	20dB Bandwidth (MHz)	Limits (MHz)	Verdict
GFSK	SISO	1.035	1.035	≥1.035	PASS
Pi/4DQPSK	SISO	1.000	1.324	≥0.883	PASS
8DPSK	SISO	1.000	1.295	≥0.863	PASS

Representative Plot taken from data measured
GFSK



6 Number of Hopping Channels

6.1 Test Result

Test Description	Test Specification		Test Result
Number of Hopping Channels	15.247(a)(1)(iii)	RSS-247 5.1(d)	Compliant

6.2 Test Method

Measurements were taken using the methods defined in ANSI C63.10, Clause 7.8.3 using a spectrum analyzer.

Limit

Frequency hopping systems operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels.

6.3 Test Site

EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.9 °C

Relative Humidity: 48.6 %

Atmospheric Pressure: 98.8 kPa

6.4 Test Equipment

Test End Date: 9-Dec-2022

Tester: AB

Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
WIDEBAND RADIO COMMUNICATION TESTER	CMW500	ROHDE & SCHWARZ	B079788	12-Sep-2022	12-Sep-2024
POWER SPLITTER	ZFRSC-123-S+	MINI-CIRCUITS	B101740	13-Jul-2022	13-Jul-2023
RF CABLE SMA TO SMA, 0.01-40GHZ	084-0505-059	TELEDYNE STORM MICROWAVE	20108	16-Mar-2022	16-Mar-2023
RF CABLE (TS8997)	141	HUBER & SUHNER	B095585	5-Jul-2022	5-Jul-2023
ATTENUATOR, 10DB (TS8997)	10DB	ROHDE & SCHWARZ	B095593	12-May-2022	12-May-2023
EXA SIGNAL ANALYZER	N9010B	KEYSIGT	1245605	17-Nov-2022	17-Nov-2023
TSTPASS SWITCHBOX	SB1	TSTPASS	20168	CNR	CNR
DC POWER SUPPLY, PROGRAMMABLE	DP711	RIGOL	18027	CNR	CNR

Software Profile:

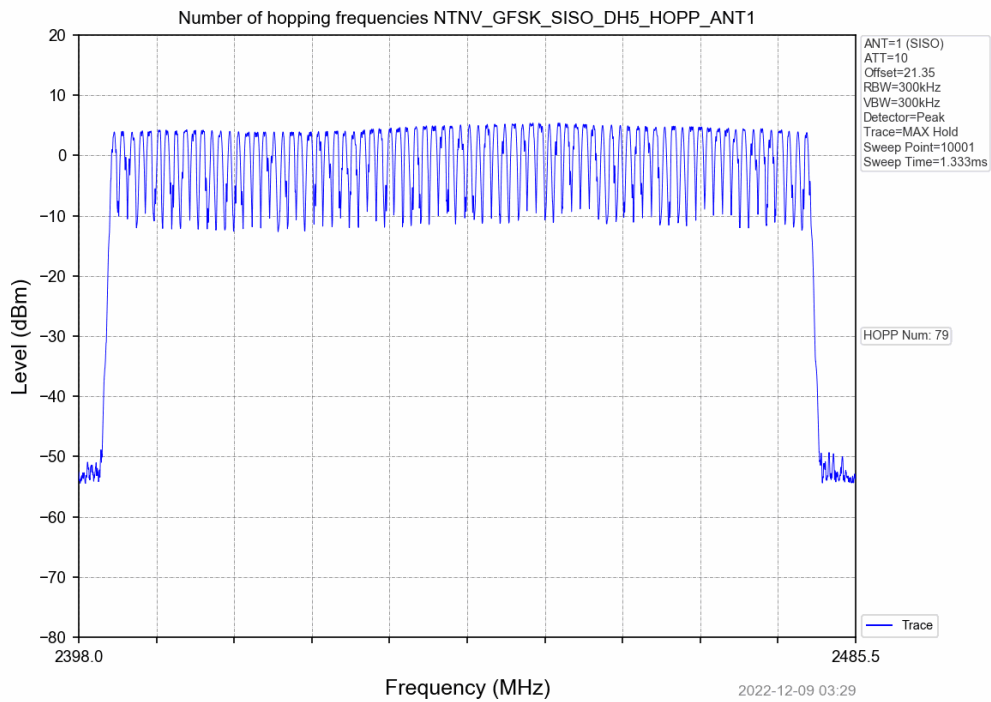
TSTPASS Version: 1.1.0, build 2020.11.15.01

6.5 Test Data

Test Mode	TX Type	Number of Hopping Channels	Limits (MHz)	Verdict
GFSK	SISO	79	≥15	PASS
Pi/4DQPSK	SISO	79	≥15	PASS
8DPSK	SISO	79	≥15	PASS

Representative Plot taken from data measured

GFSK



7 Dwell Time

7.1 Test Result

Test Description	Test Specification		Test Result
Dwell Time	15.247(a)(1)(iii)	RSS-247 5.1(d)	Compliant

7.2 Test Method

Measurements were taken using the methods defined in ANSI C63.10, Clause 7.8.4 using a spectrum analyzer and automated test system.

Limit

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed ($0.4 \times 79 = 31.6s$).

7.3 Test Site

EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.9 °C

Relative Humidity: 48.6 %

Atmospheric Pressure: 98.8 kPa

7.4 Test Equipment

Test End Date: 9-Dec-2022

Tester: AB

Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
WIDEBAND RADIO COMMUNICATION TESTER	CMW500	ROHDE & SCHWARZ	B079788	12-Sep-2022	12-Sep-2024
POWER SPLITTER	ZFRSC-123-S+	MINI-CIRCUITS	B101740	13-Jul-2022	13-Jul-2023
RF CABLE SMA TO SMA, 0.01-40GHZ	084-0505-059	TELEDYNE STORM MICROWAVE	20108	16-Mar-2022	16-Mar-2023
RF CABLE (TS8997)	141	HUBER & SUHNER	B095585	5-Jul-2022	5-Jul-2023
ATTENUATOR, 10DB (TS8997)	10DB	ROHDE & SCHWARZ	B095593	12-May-2022	12-May-2023
EXA SIGNAL ANALYZER	N9010B	KEYSIGT	1245605	17-Nov-2022	17-Nov-2023
TSTPASS SWITCHBOX	SB1	TSTPASS	20168	CNR	CNR
DC POWER SUPPLY, PROGRAMMABLE	DP711	RIGOL	18027	CNR	CNR

Software Profile:

TSTPASS Version: 1.1.0, build 2020.11.15.01

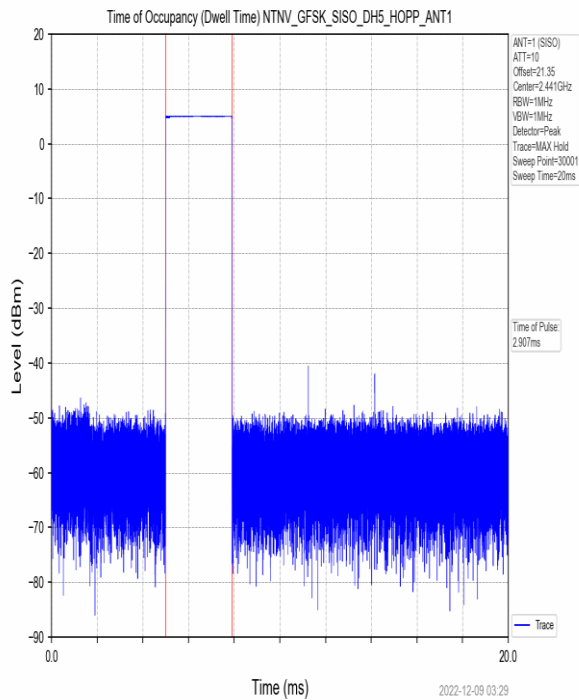
7.5 Test Data

Test Mode	Packet Type	Pulse Width ms	Pulses per 31.6 sec	Dwell Time (ms)	Limit (ms)	Result
GFSK	DH1	0.403	320	128.960	≤400	PASS
	DH3	1.659	106	175.854	≤400	PASS
	DH5	2.907	73	212.211	≤400	PASS
Pi/4DQPSK	DH1	0.408	320	130.560	≤400	PASS
	DH3	1.661	104	172.744	≤400	PASS
	DH5	2.909	69	200.721	≤400	PASS
8DPSK	DH1	0.411	320	131.520	≤400	PASS
	DH3	1.663	108	179.604	≤400	PASS
	DH5	2.912	62	180.544	≤400	PASS

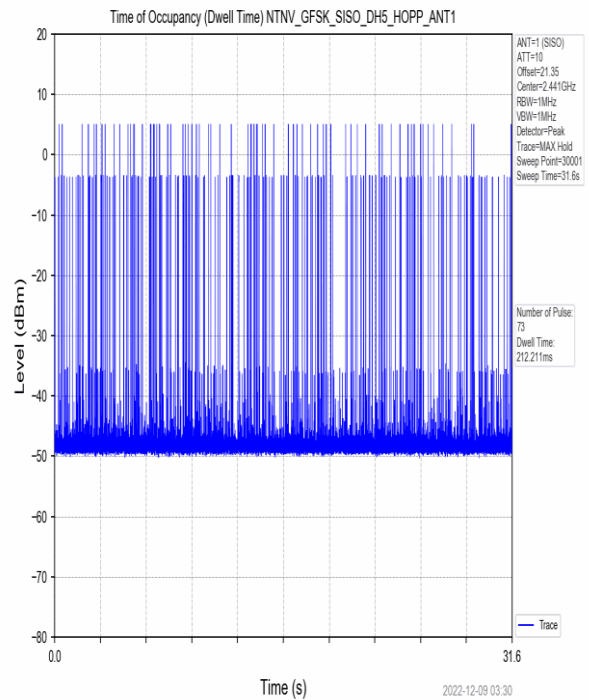
Representative Plots taken from data measured

GFSK – DH5

Single Pulse Width



Entire Measurement Window



8 Pseudo-Random Hop Sequence

8.1 Test Result

Test Description	Test Specification		Test Result
Pseudo-Random Hop Sequence	15.247(a)(1)	RSS-247 5.1(a)	Compliant

8.2 Test Method

Compliance is demonstrated by Manufacturer's declaration or is stated in the Theory of Operation.

Requirement

The hopset shall be such that the near-term distribution of frequencies appears random, with sequential hops randomly distributed in both direction and magnitude of change in the hopset, while the long-term distribution appears evenly distributed.

9 Conducted Spurious Emissions / Band Edge

9.1 Test Result

Test Description	Test Specification		Test Result
Conducted Spurious Emissions	15.247(d)	RSS-247 5.5	Compliant

9.2 Test Method

Conducted spurious emissions measurements were taken using the methods defined in ANSI C63.10, Clauses 5.5 and 5.6. Authorized band edge measurements were recorded using the methods in clause 6.10.4. DH-5 was the worst-case packet type for all modes.

Lowest, middle, and highest channels as well as hopping mode were investigated.

Limit:

The limit in any 100 kHz band outside of the authorized band is 20 dB below the maximum in-band peak level.

9.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.9 °C
 Relative Humidity: 48.6 %
 Atmospheric Pressure: 98.8 kPa

9.4 Test Equipment

Test End Date: 9-Dec-2022

Tester: AB

Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
WIDEBAND RADIO COMMUNICATION TESTER	CMW500	ROHDE & SCHWARZ	B079788	12-Sep-2022	12-Sep-2024
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RF CABLE SMA TO SMA, 0.01-40GHZ	084-0505-059	TELEDYNE STORM MICROWAVE	20108	16-Mar-2022	16-Mar-2023
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Software Profile:

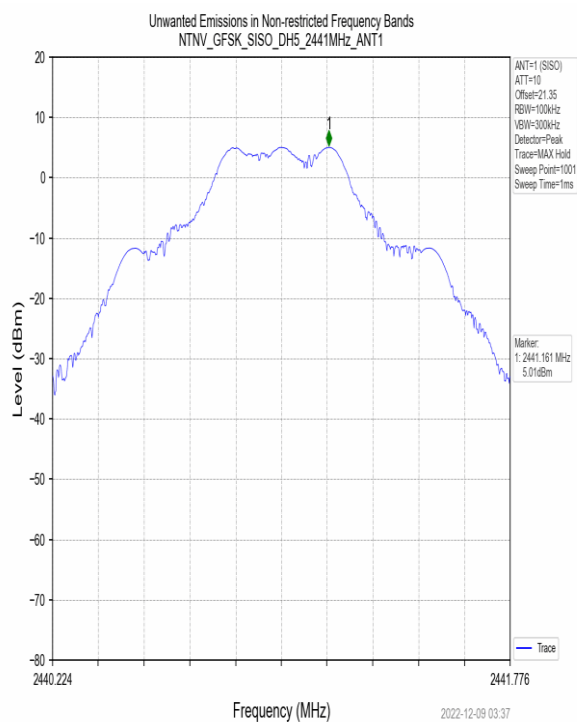
TSTPASS Version: 1.1.0, build 2020.11.15.01

9.5 Test Data

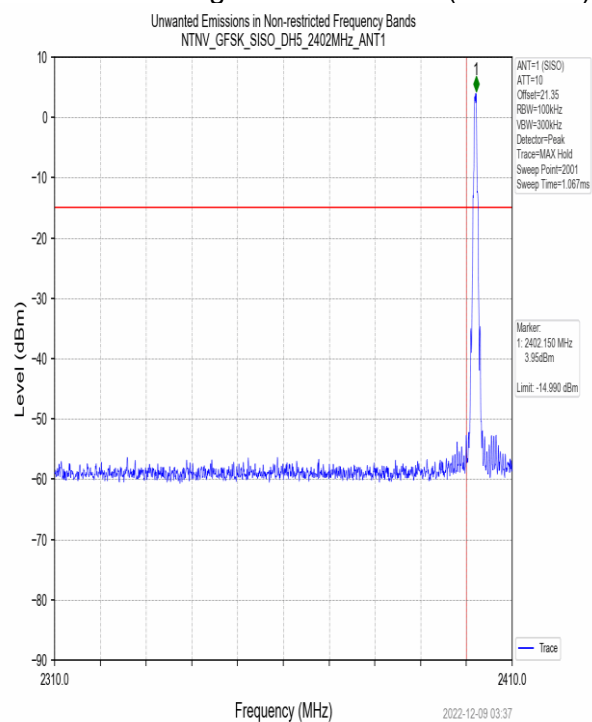
Test Mode	Frequency (MHz)	TX Type	Spurious Conducted Emission (dBm)	Limit (dBm)	Verdict
GFSK	2402	SISO	Refer to test graph	-14.99	PASS
	2441	SISO	Refer to test graph	-14.99	PASS
	2480	SISO	Refer to test graph	-14.99	PASS
	Hopping	SISO	Refer to test graph	-14.99	PASS
Pi/4DQPSK	2402	SISO	Refer to test graph	-20.77	PASS
	2441	SISO	Refer to test graph	-20.77	PASS
	2480	SISO	Refer to test graph	-20.77	PASS
	Hopping	SISO	Refer to test graph	-20.77	PASS
8DPSK	2402	SISO	Refer to test graph	-20.43	PASS
	2441	SISO	Refer to test graph	-20.43	PASS
	2480	SISO	Refer to test graph	-20.43	PASS
	Hopping	SISO	Refer to test graph	-20.43	PASS

GFSK

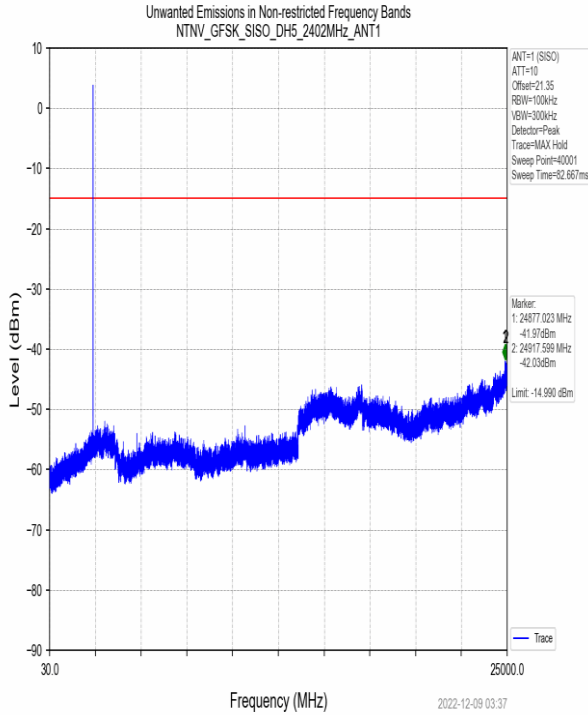
In-Band Reference



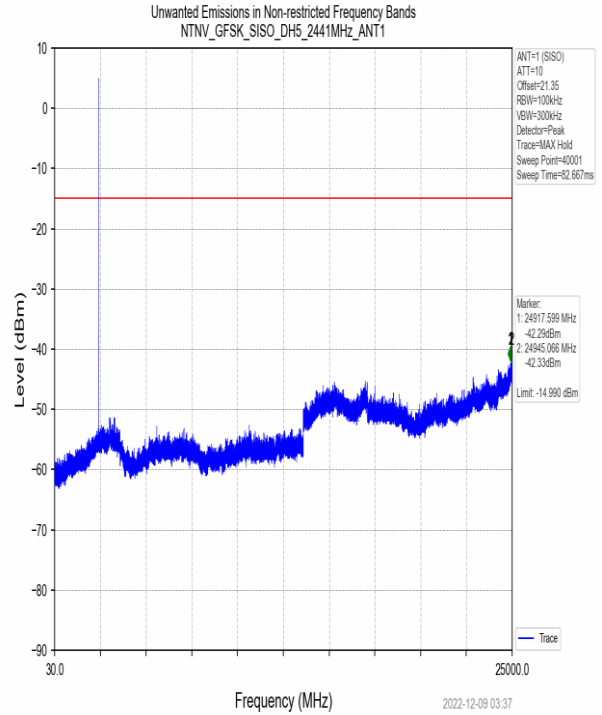
Lower Band Edge - Low Channel (2402MHz)



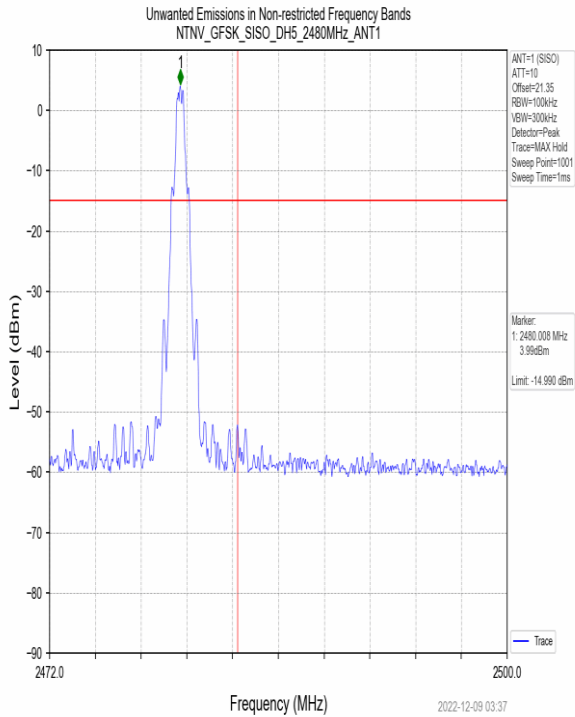
Full Spectrum - Low Channel (2402MHz)



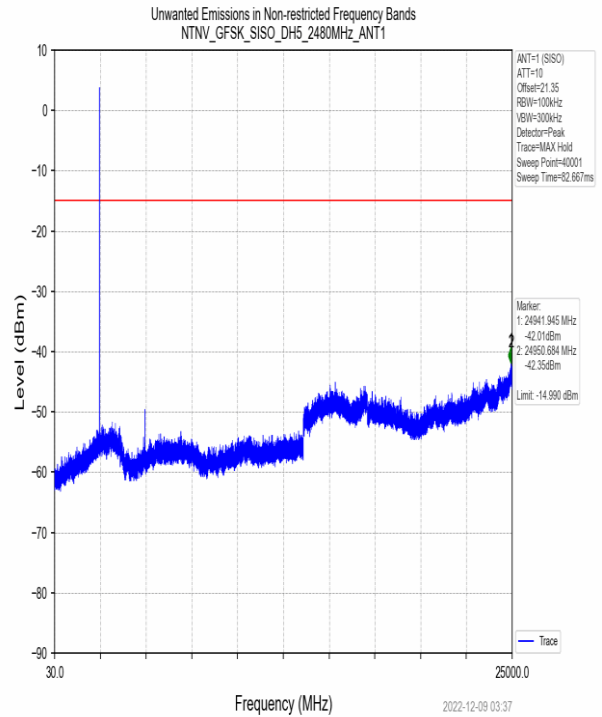
Full Spectrum - Mid Channel (2441MHz)



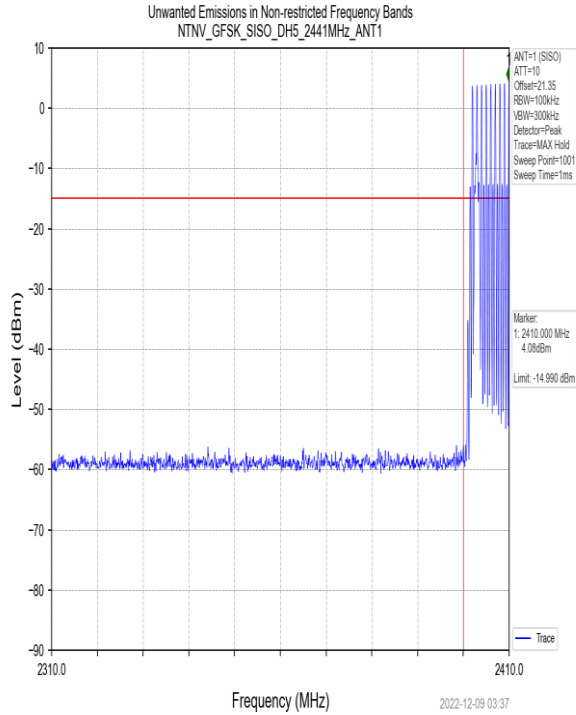
Upper Band Edge – High Channel (2480MHz)



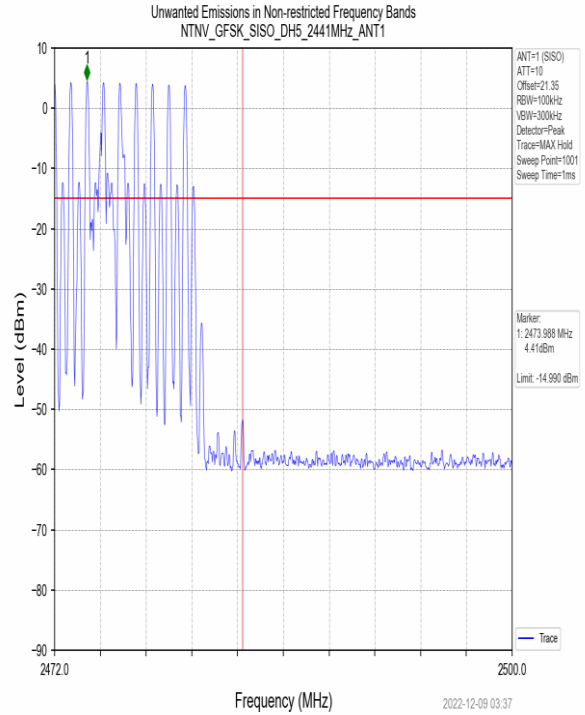
Full Spectrum - High Channel (2480MHz)



Lower Band Edge - Hopping

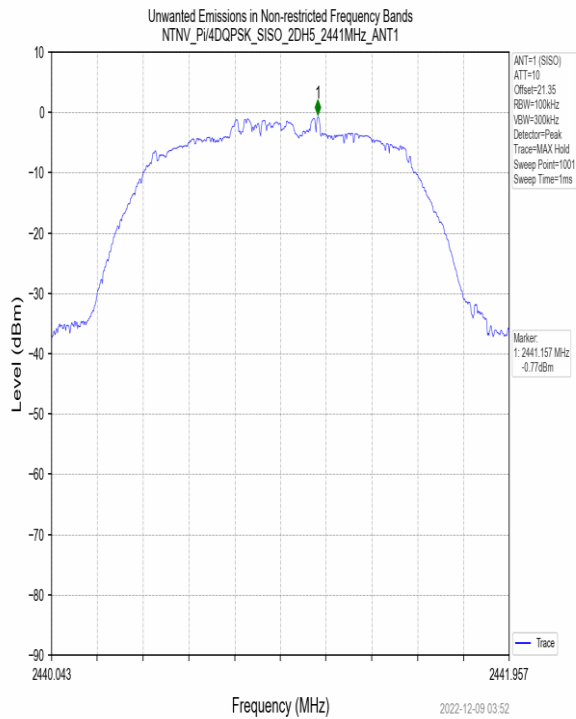


Upper Band Edge - Hopping

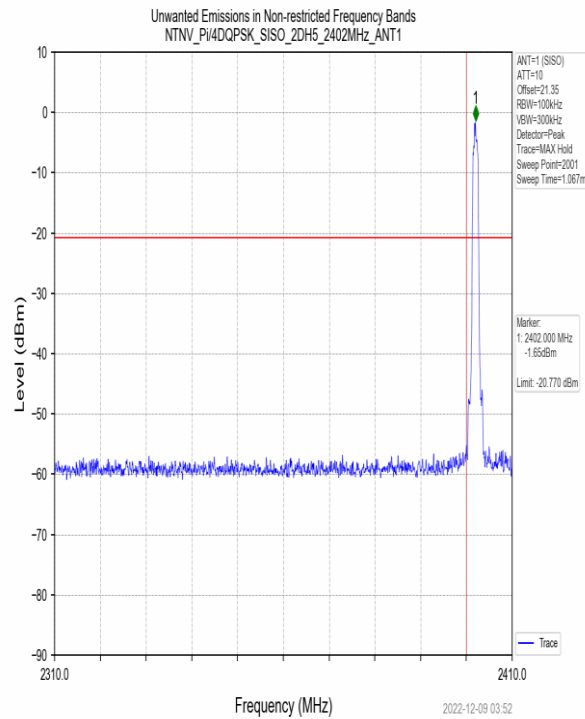


Pi/4DQPSK

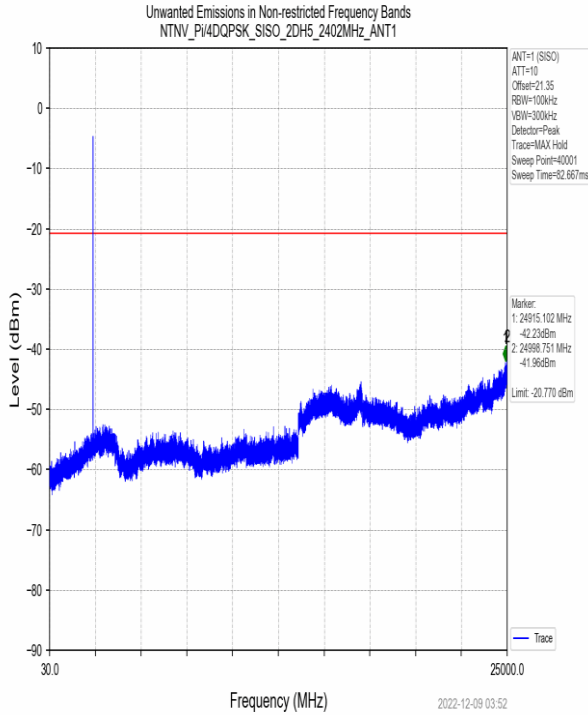
In-Band Reference



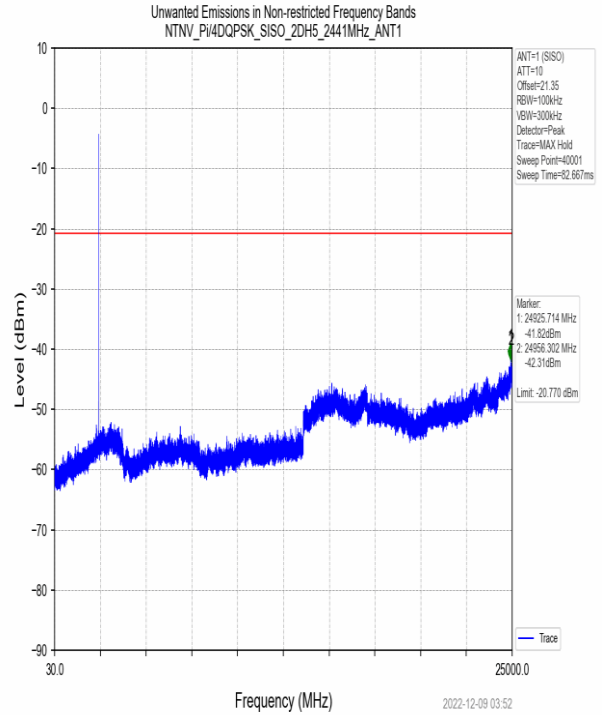
Lower Band Edge - Low Channel (2402MHz)



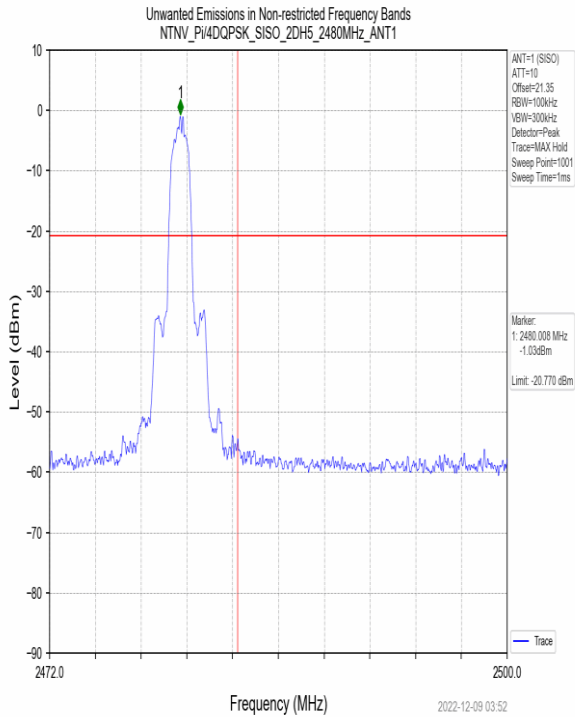
Full Spectrum - Low Channel (2402MHz)



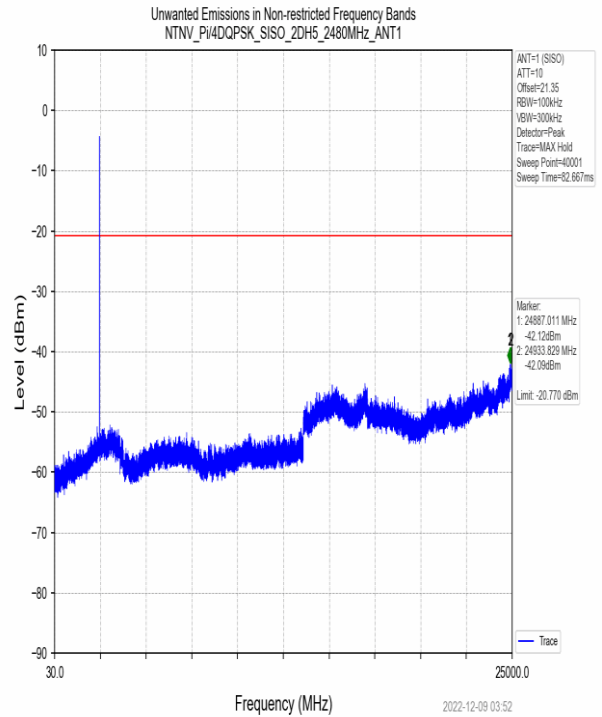
Full Spectrum - Mid Channel (2441MHz)



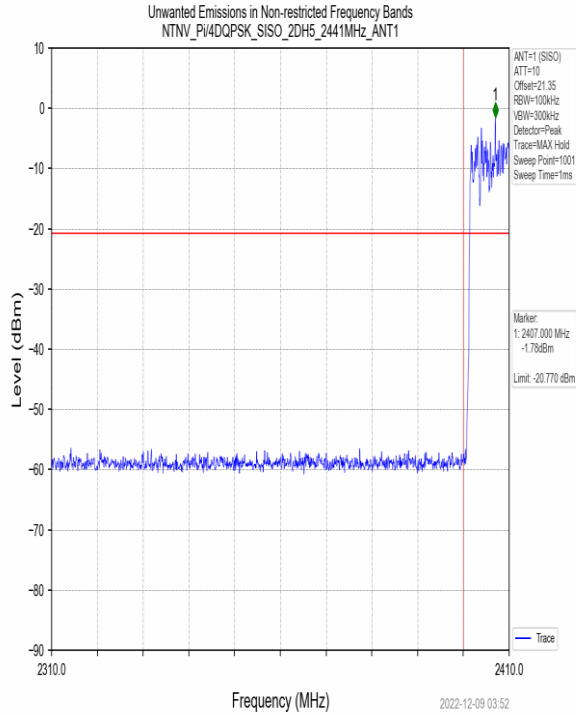
Upper Band Edge – High Channel (2480MHz)



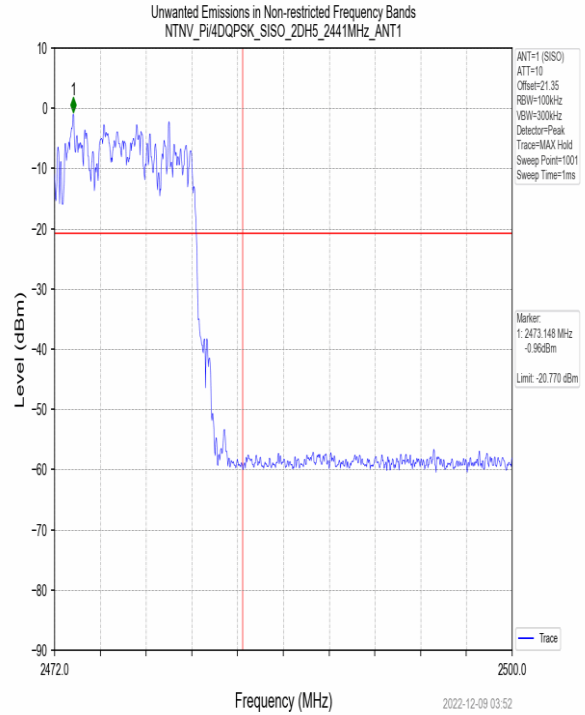
Full Spectrum - High Channel (2480MHz)



Lower Band Edge - Hopping

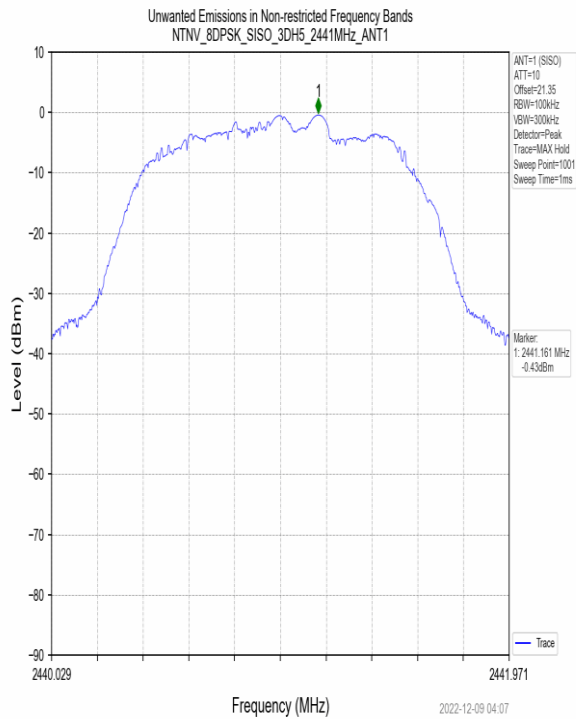


Upper Band Edge - Hopping

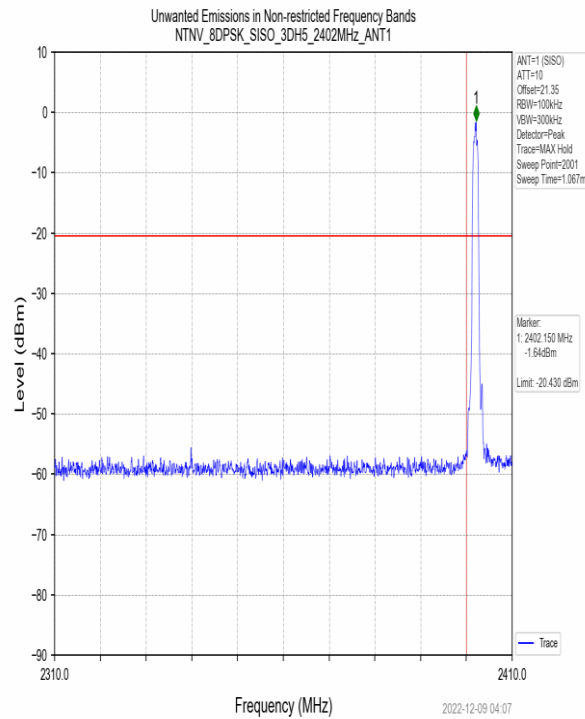


8DPSK

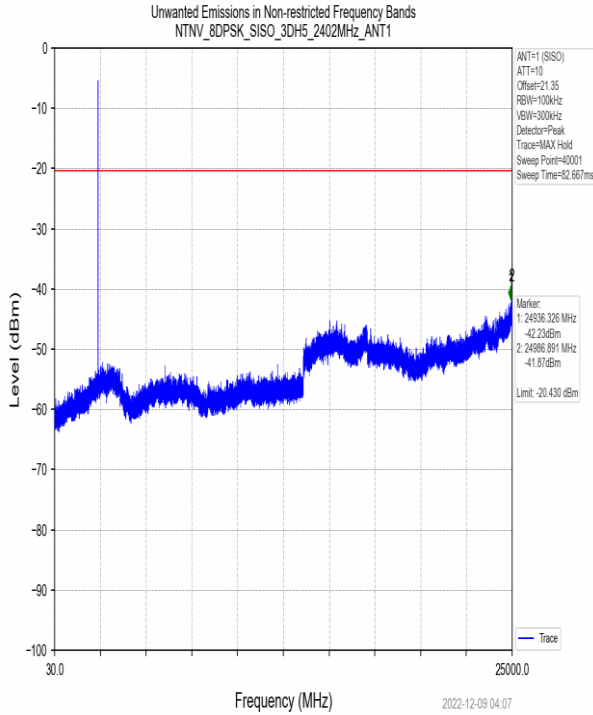
In-Band Reference



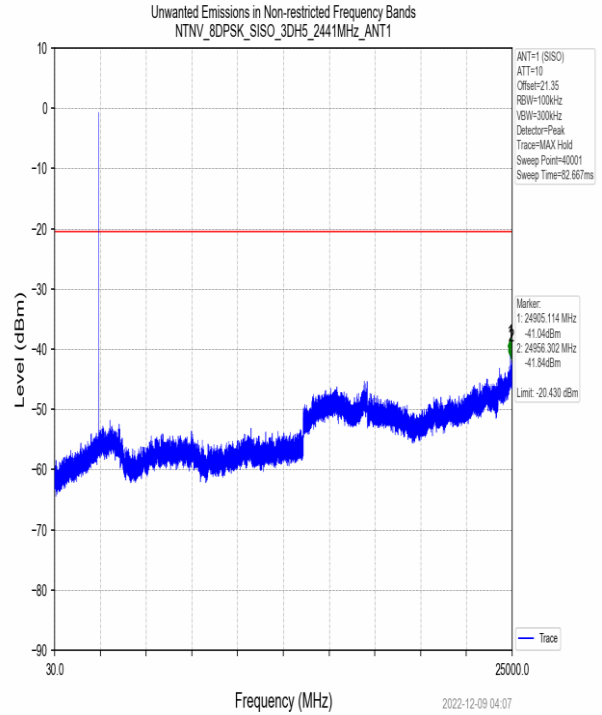
Lower Band Edge - Low Channel (2402MHz)



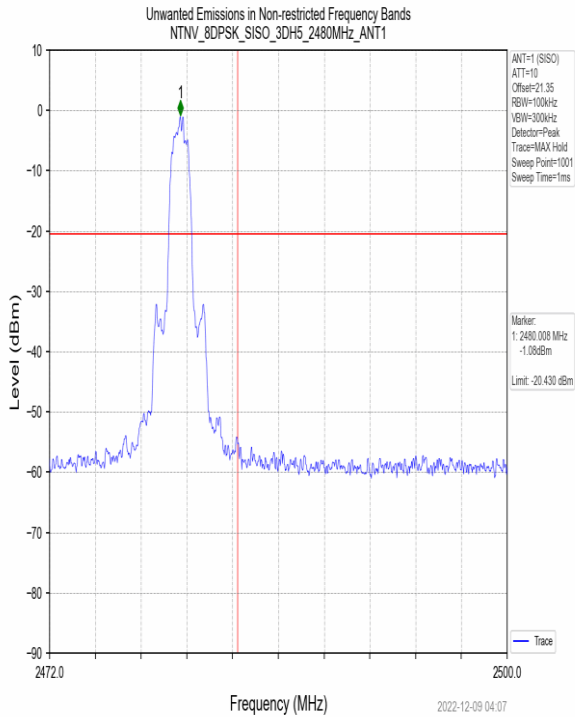
Full Spectrum - Low Channel (2402MHz)



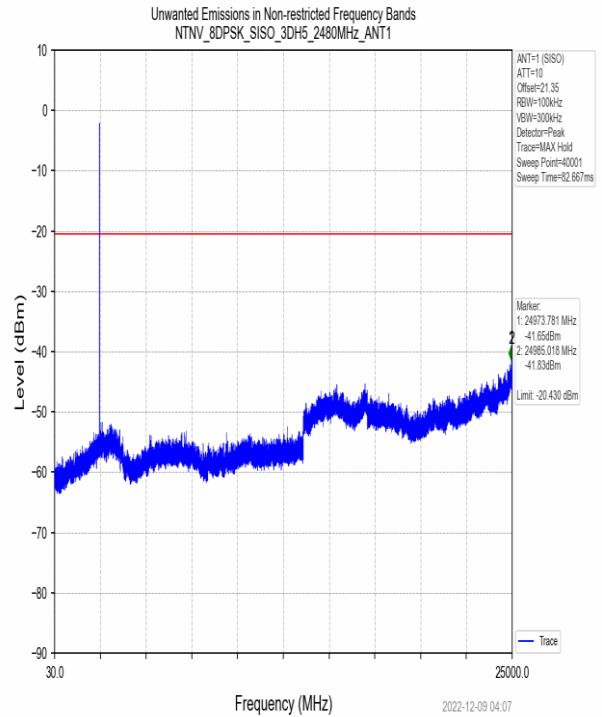
Full Spectrum - Mid Channel (2441MHz)



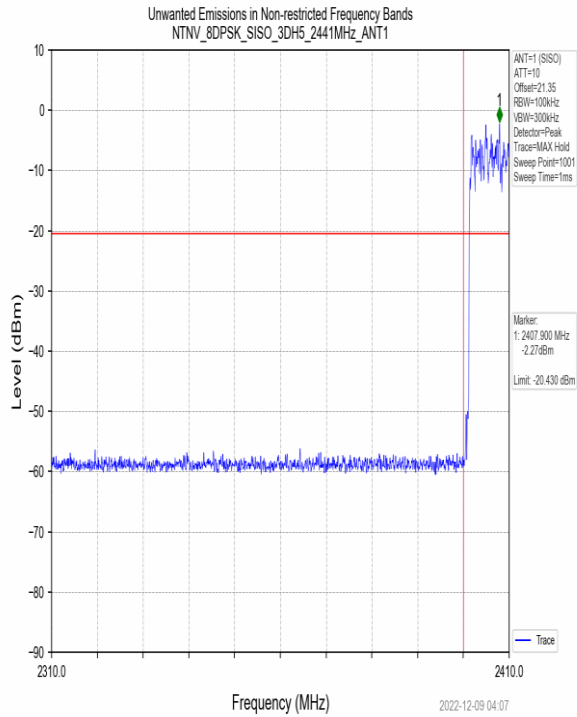
Upper Band Edge – High Channel (2480MHz)



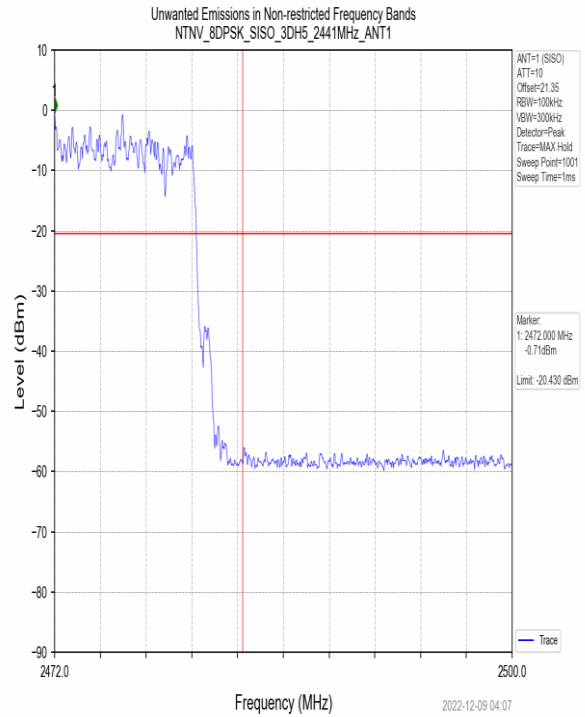
Full Spectrum - High Channel (2480MHz)



Lower Band Edge - Hopping



Upper Band Edge - Hopping



10 Field Strength of Spurious Radiation (Restricted Bands)

10.1 Test Result

Test Description	Test Specification		Test Result
Radiated Spurious Emissions	15.247(d) and 15.209	RSS-247 S5.5	Compliant

10.2 Test Method

The measurement methods defined in ANSI C63.10: 2013 were used.

Lowest, middle, and highest channels were investigated – the device was commanded to continuously transmit on low, middle, and high channels. Worst-case mode for spurious emissions was GFSK with a DH5 packet type.

Test distance:

- 9k to 30 MHz – The EUT to measurement antenna distance was 3 meters
- 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

10.3 Test Site

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

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

Environmental Conditions	9kHz-30MHz	30-1000MHz	1-18GHz
Temperature:	21.39°C	24.7 °C	21.22°C
Relative Humidity:	38.8%	36.9 %	40.5%
Atmospheric Pressure:	97.9 kPa	98.0 kPa	98.6kPa

10.4 Test Equipment

9kHz-30MHz

Test End Date: 28-Nov-2022

Tester: PL

Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
ANTENNA, LOOP, ACTIVE	6502	ETS LINDGREN	B085752	11-Aug-2022	11-Aug-2024
N to N RF Cable	NC12-N1N1-276	MEGAPHASE	22001	9-Jan-2023	9-Jan-2024
RF CABLE NM TO NF, 0.01-18GHZ	90-213-118	TELEDYNE STORM MICROWAVE	20117	13-Feb-2023	13-Feb-2024
RF CABLE NM TO NM, 0.01-18GHZ	90-195-079	TELEDYNE STORM MICROWAVE	20123	9-Feb-2023	9-Feb-2024
EMI TEST RECEIVER	ESW44	ROHDE & SCHWARZ	22027	13-Sep-2022	13-Sep-2023
SOFTWARE	TILE 7	ETS LINDGREN	N/A	CNR	CNR

30MHz-1000MHz

Test End Date: 18-Nov-2022

Tester: ZH

Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
ANTENNA, BILOG	JB6	SUNOL	B079690	19-Apr-2022	19-Apr-2024
N to N RF Cable	NC12-N1N1-276	MEGAPHASE	22001	9-Jan-2023	9-Jan-2024
RF CABLE NM TO NF, 0.01-18GHZ	90-213-118	TELEDYNE STORM MICROWAVE	20117	13-Feb-2023	13-Feb-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	20132	16-Mar-2022	16-Mar-2023
LOW NOISE AMPLIFIER	ZKL-2+	MINI-CIRCUITS	B079800	14-Sep-2022	14-Sep-2023
EMI TEST RECEIVER	ESU8	ROHDE & SCHWARZ	B085759	8-Sep-2022	8-Sep-2023
SOFTWARE	TILE 7	ETS LINDGREN	N/A	CNR	CNR

Above 1GHz

Test End Date: 10-Nov-2022

Tester: PL

Equipment	Model	Manufacturer	Asset Number	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	90-213-118	TELEDYNE STORM MICROWAVE	20118	16-Mar-2022	16-Mar-2023
RF CABLE NM TO NM, 0.01-18GHZ	90-195-118	TELEDYNE STORM MICROWAVE	20126	14-Feb-2022	14-Feb-2023
RF CABLE RIGHT ANGLE NM TO NM, 0.01-18GHZ	90-076-020	TELEDYNE STORM MICROWAVE	20131	16-Mar-2022	16-Mar-2023
LOW NOISE AMPLIFIER	TS-PR18	ROHDE & SCHWARZ	B094463	13-Jul-2022	13-Jul-2023
EMI TEST RECEIVER	ESW44	ROHDE & SCHWARZ	22027	13-Sep-2022	13-Sep-2023
FILTER, HIGH PASS, >2800MHZ	HPM50111	MICRO-TRONICS	22017	16-Jun-2022	16-Jun-2023
ANTENNA, HORN (SMALL)	LB-180400-20-C-KF	A-INFO	15007	18-Apr-2022	18-Apr-2024
RF CABLE SMA TO SMA, 0.01-40GHZ	084-0505-138	TELEDYNE STORM MICROWAVE	20111	16-Mar-2022	16-Mar-2023
RF CABLE SMA TO SMA, 0.01-40GHZ	084-0505-059	TELEDYNE STORM MICROWAVE	20108	16-Mar-2022	16-Mar-2023
LOW NOISE AMPLIFIER	NSP1840-HG	MITEQ	B087572	13-Oct-2022	13-Oct-2023
SOFTWARE	TILE 7	ETS LINDGREN	N/A	CNR	CNR

Software Profile:

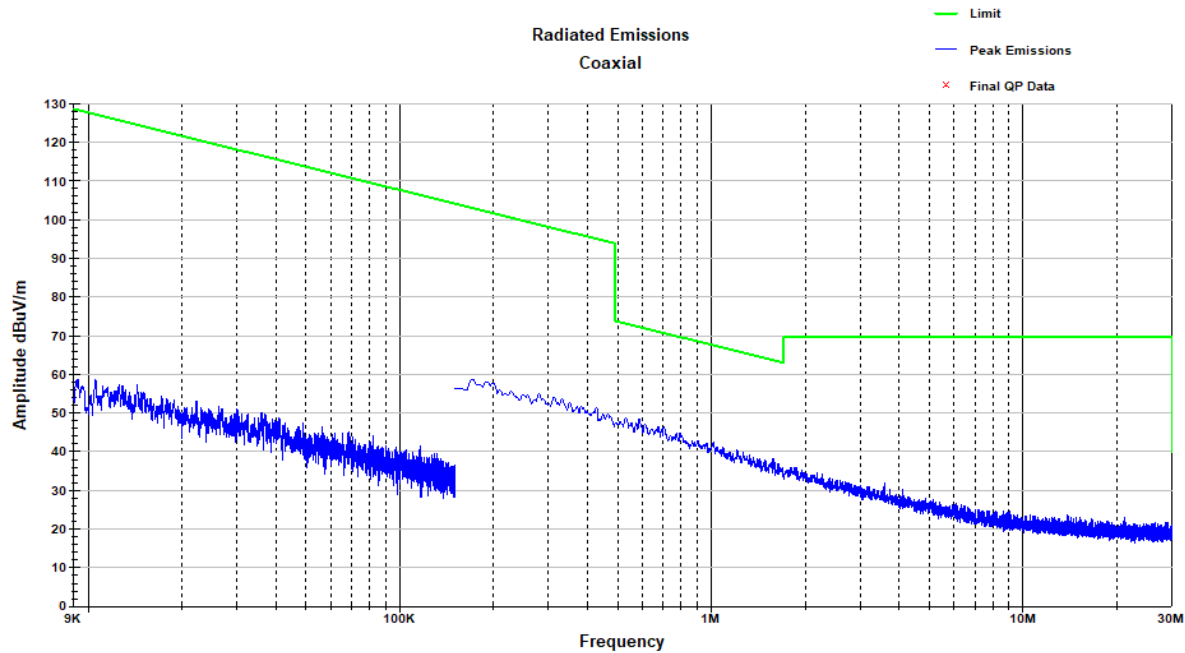
"RSE 9k - 30M 220804" ETS-Lindgren TILE! v7.6.0.14 profile dated 04 August 2022

"RSE 30-1000 MHz T7 220318" ETS-Lindgren TILE! v7.6.0.14 profile dated 18 March 2022

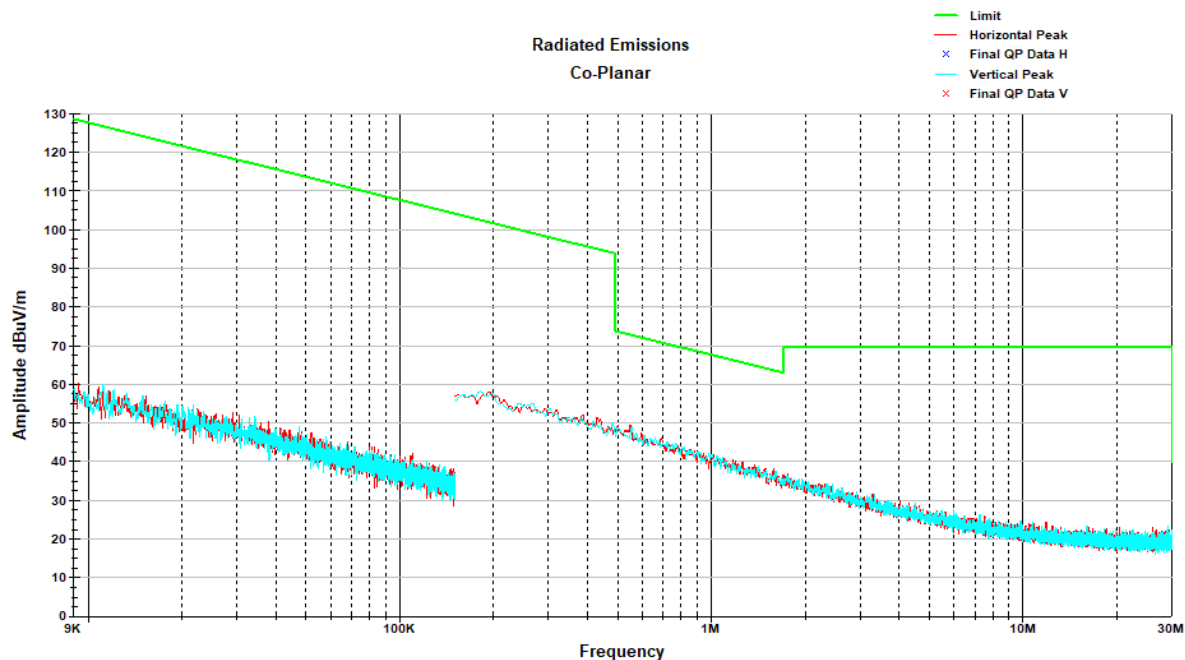
"RSE 1-18 GHz T7 210212" ETS-Lindgren TILE! v7.6.0.14 profile dated 12 February 2021

10.5 Test Data – Peak Plots

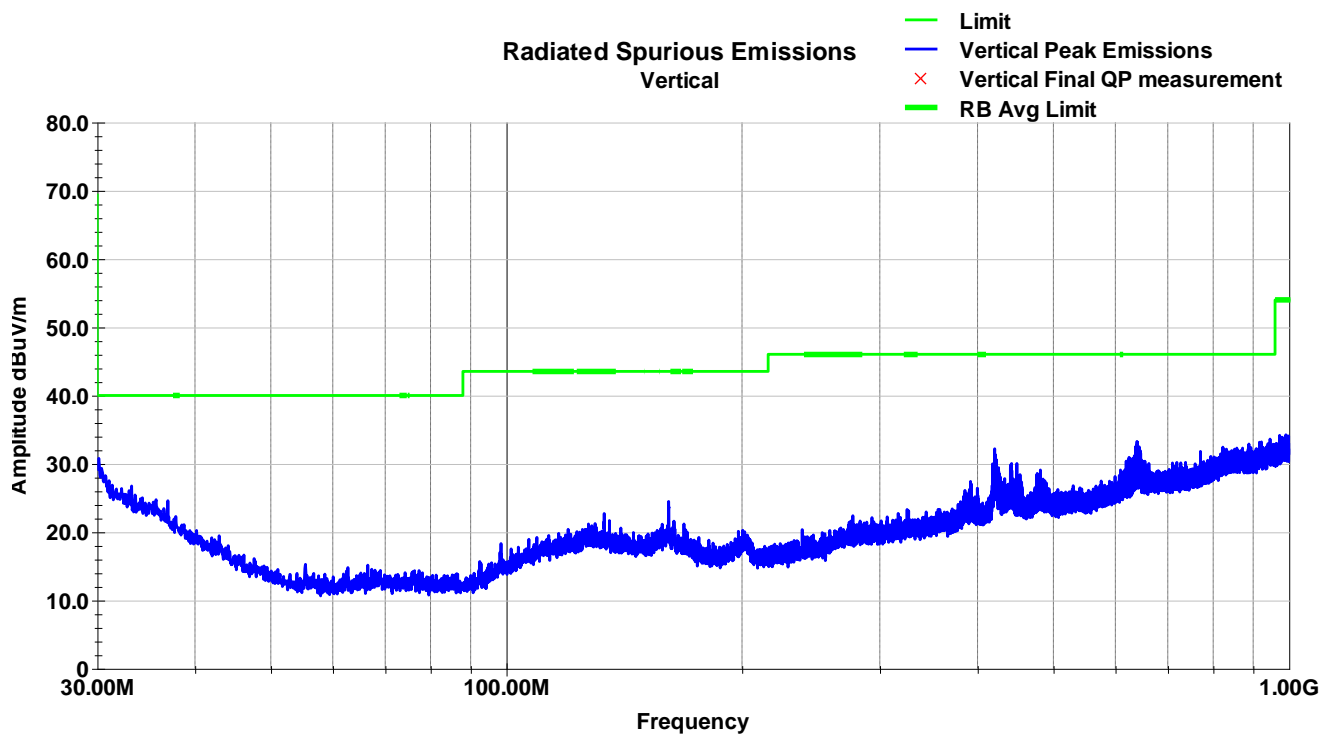
Between 9kHz and 1000MHz, there was no significant deviation with respect to axis or channel
 Co-Axial Radiated Spurious Emissions – 9kHz-30MHz (LCH)



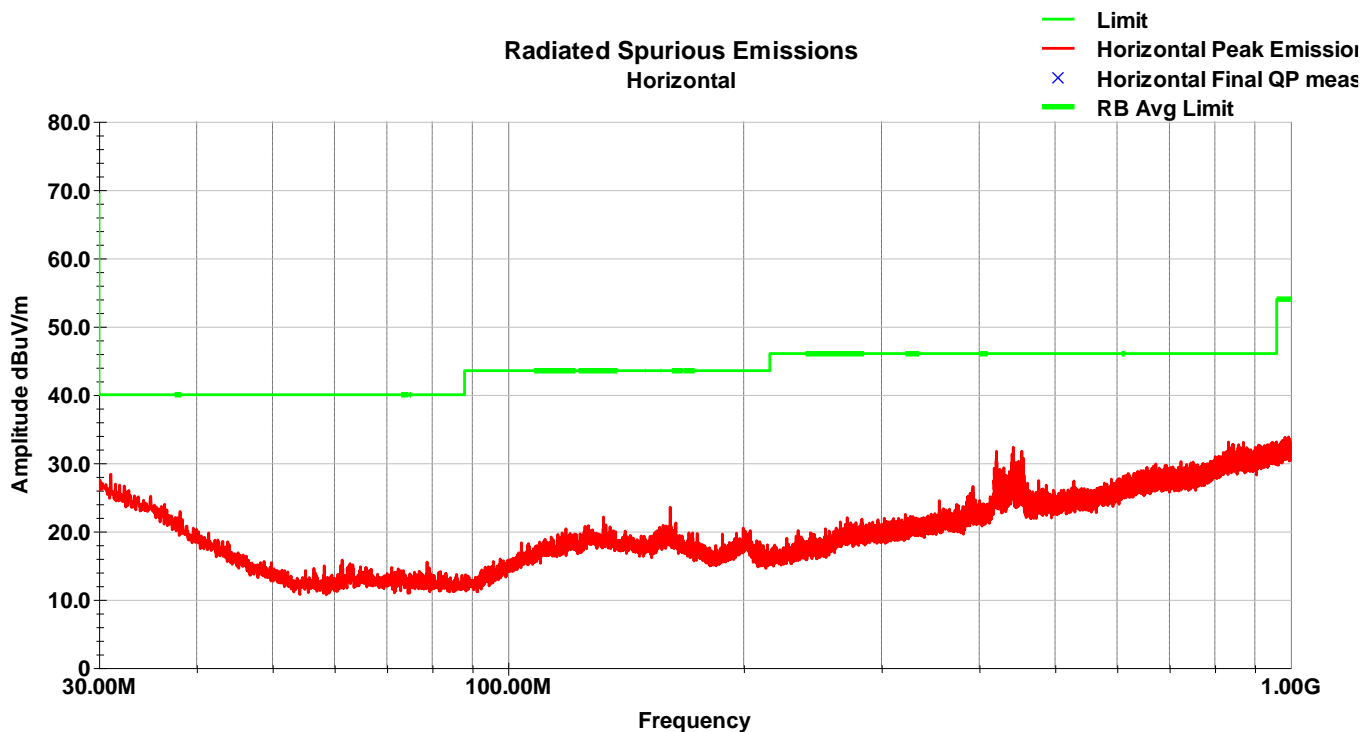
Co-Planar Radiated Spurious Emissions – 9kHz-30MHz (LCH)



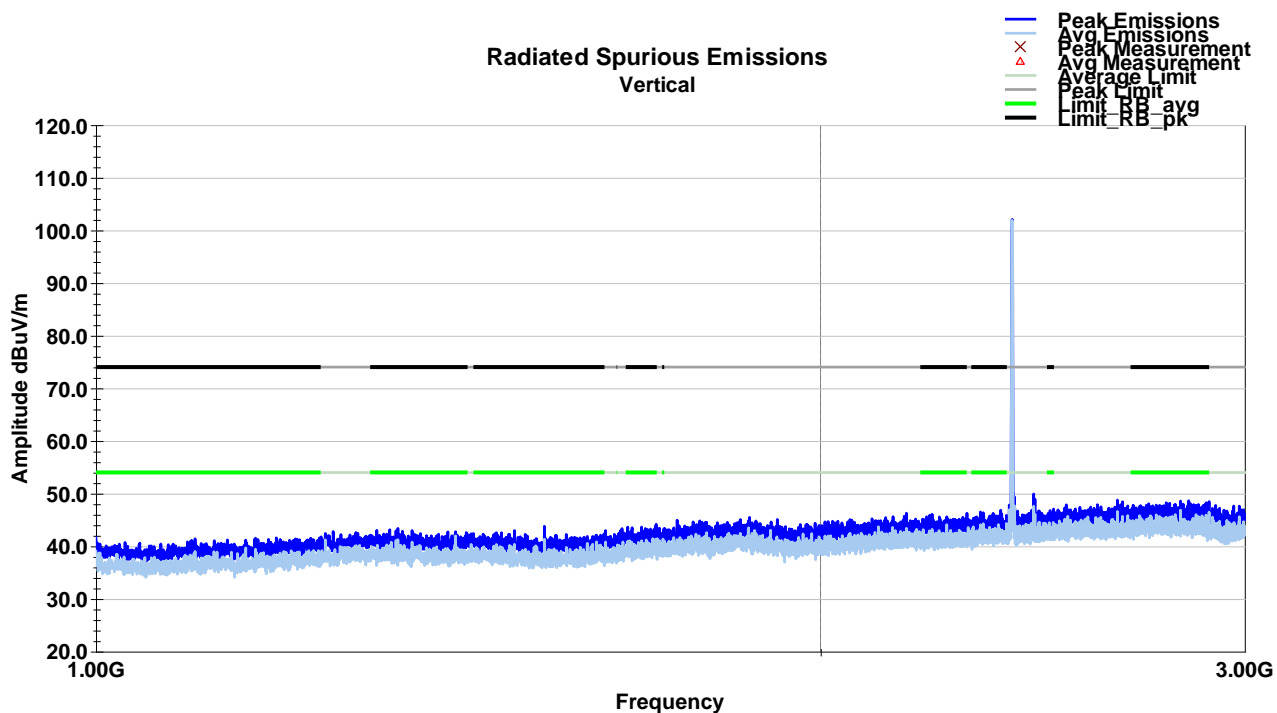
Vertical Radiated Spurious Emissions – 30-1000MHz (LCH)



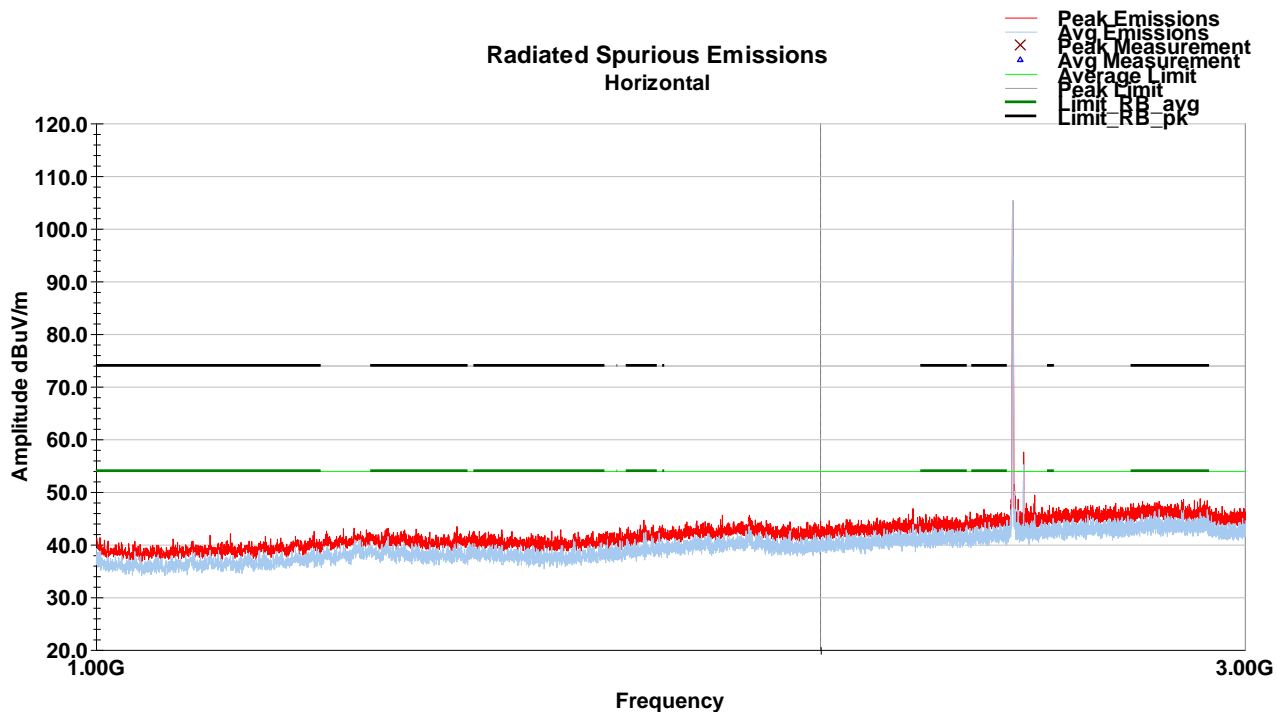
Horizontal Radiated Spurious Emissions – 30-1000MHz (LCH)



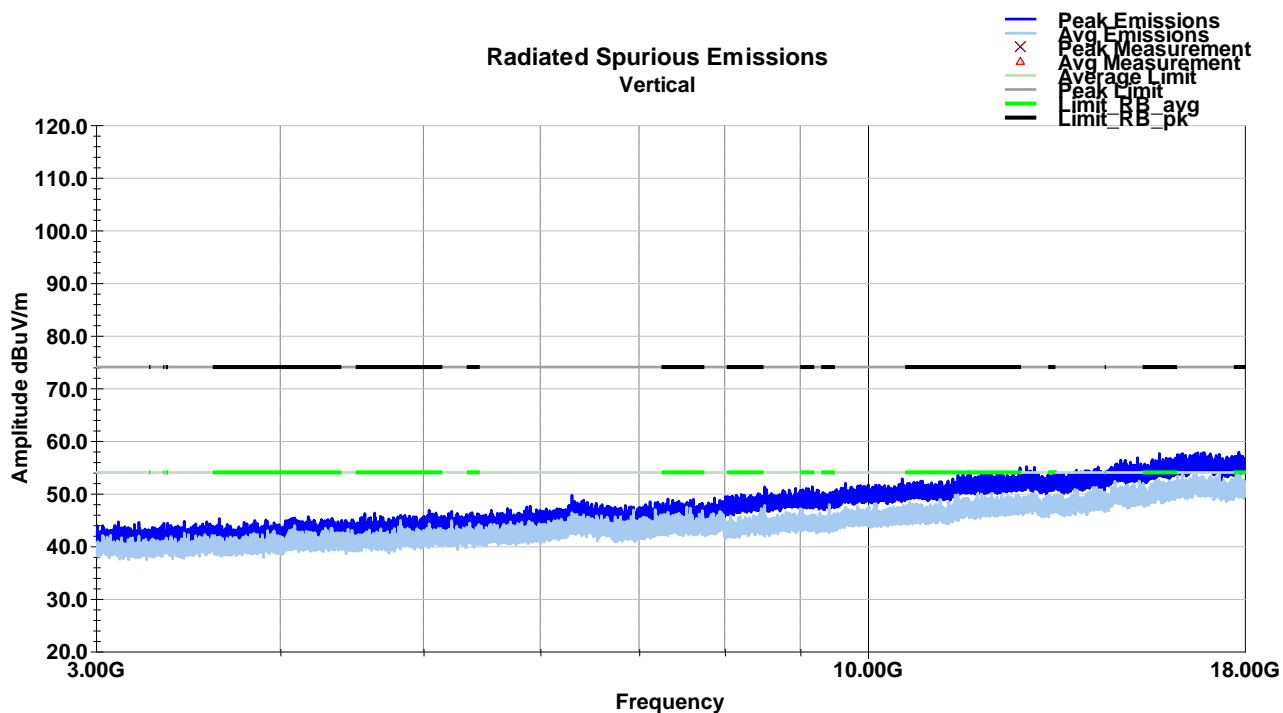
Vertical Radiated Spurious Emissions – 1-3GHz (LCH)



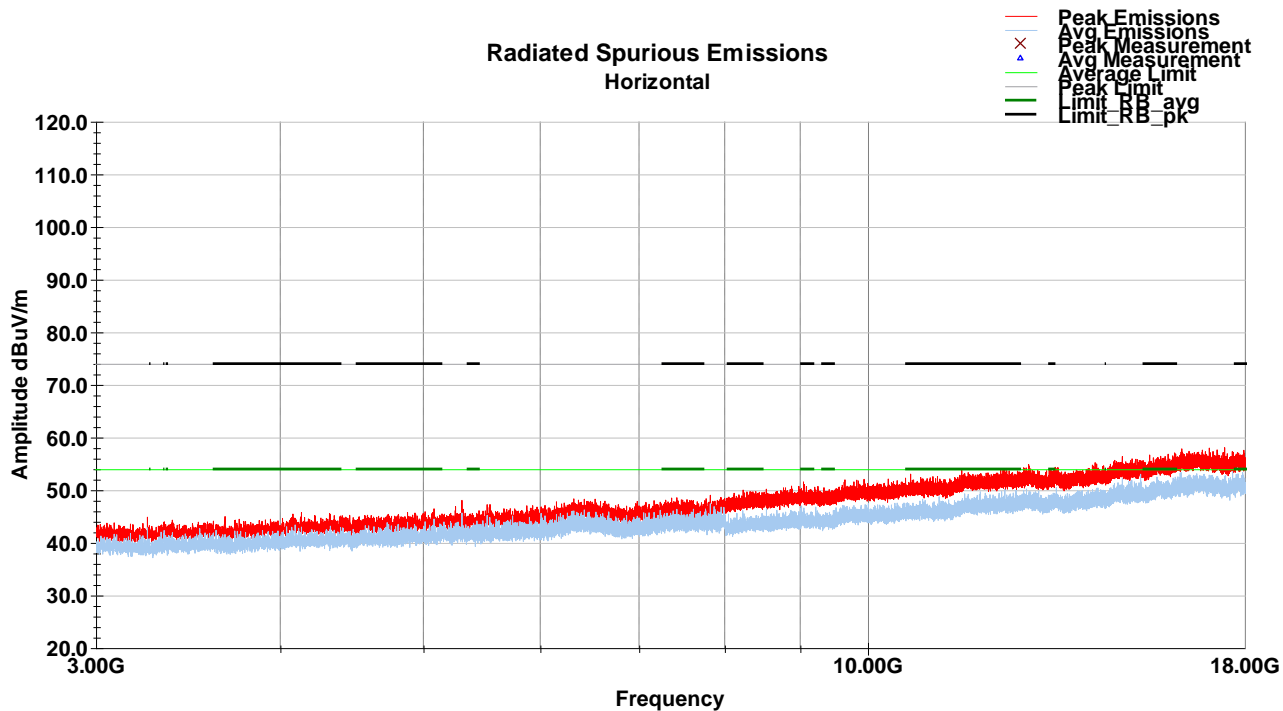
Horizontal Radiated Spurious Emissions – 1-3GHz (LCH)



Vertical Radiated Spurious Emissions – 3-18GHz (LCH)

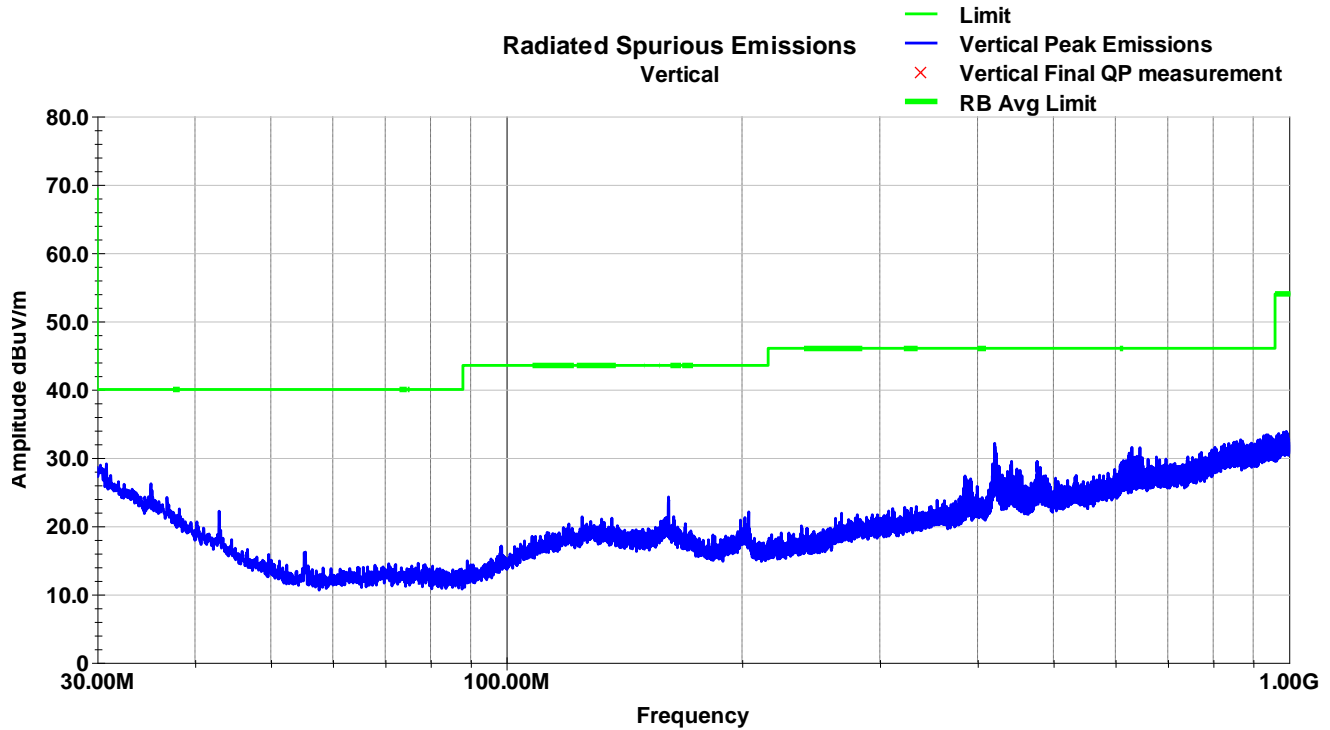


Horizontal Radiated Spurious Emissions – 3-18GHz (LCH)

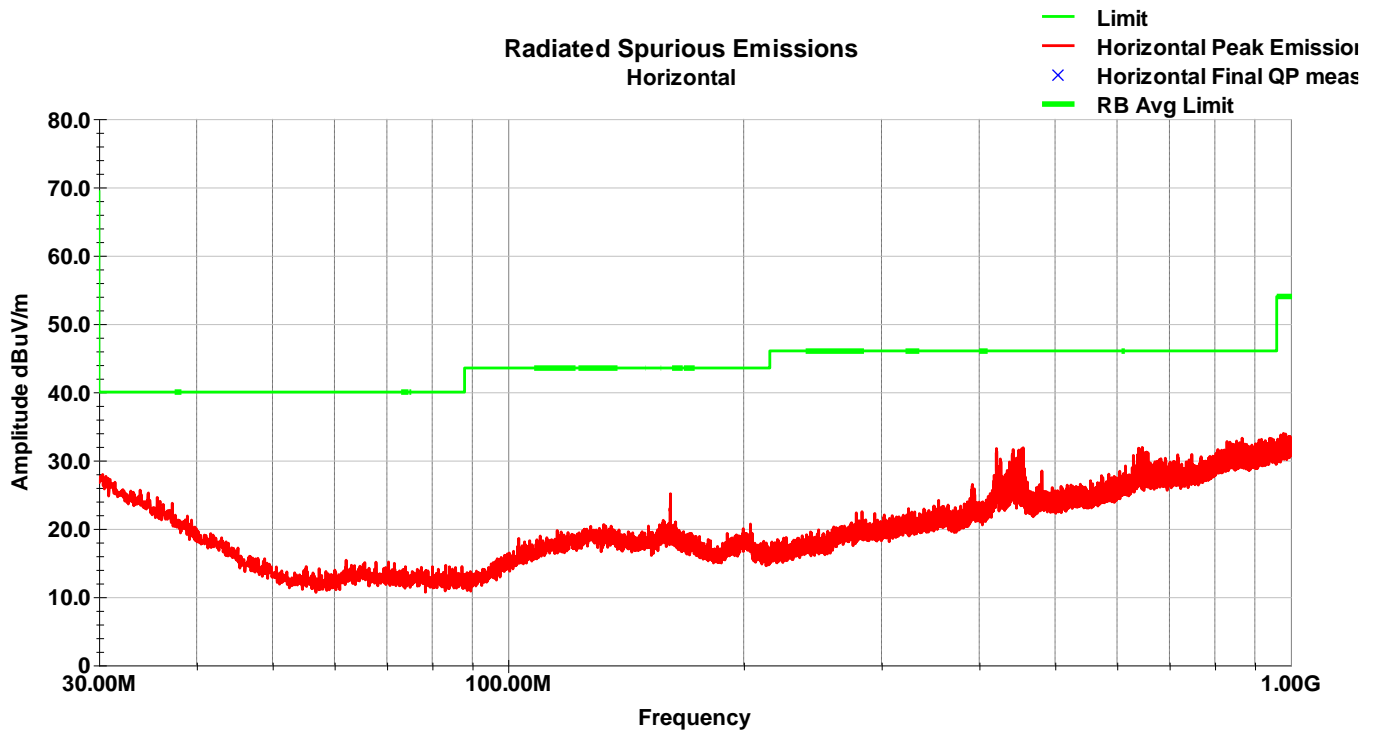


No discernible emissions detected from 18GHz – 26GHz.

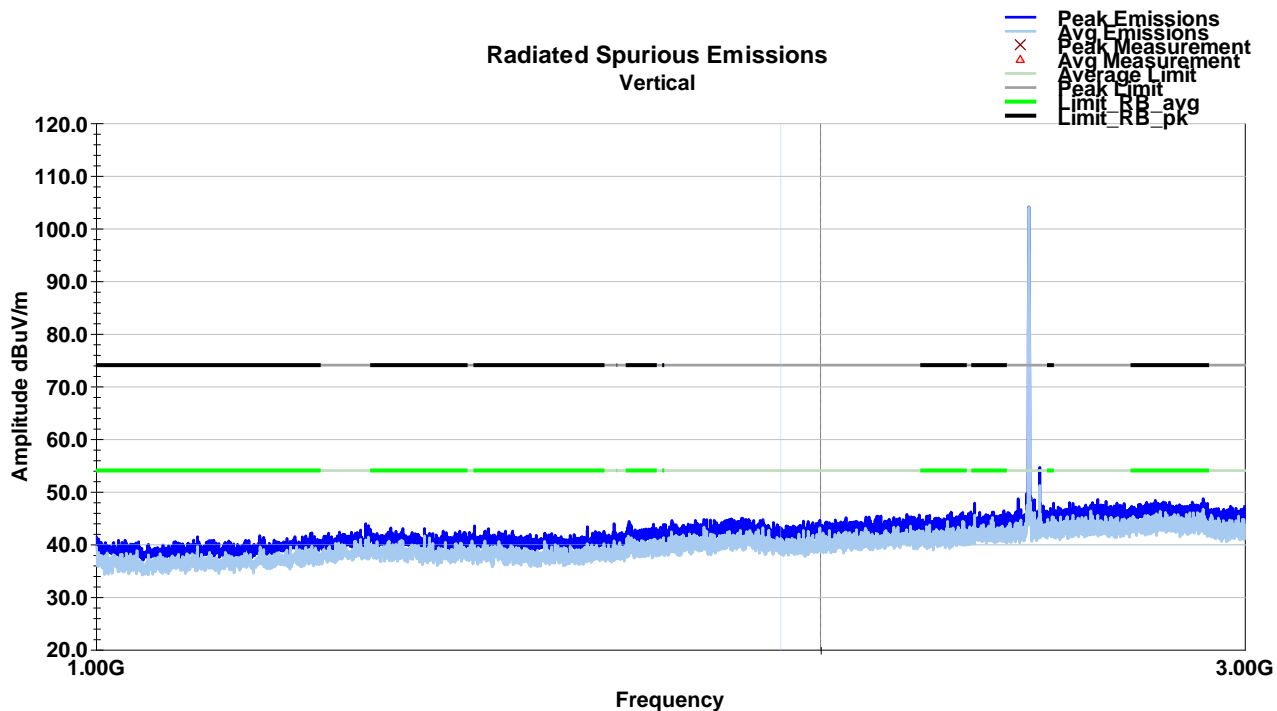
Vertical Radiated Spurious Emissions – 30-1000MHz (MCH)



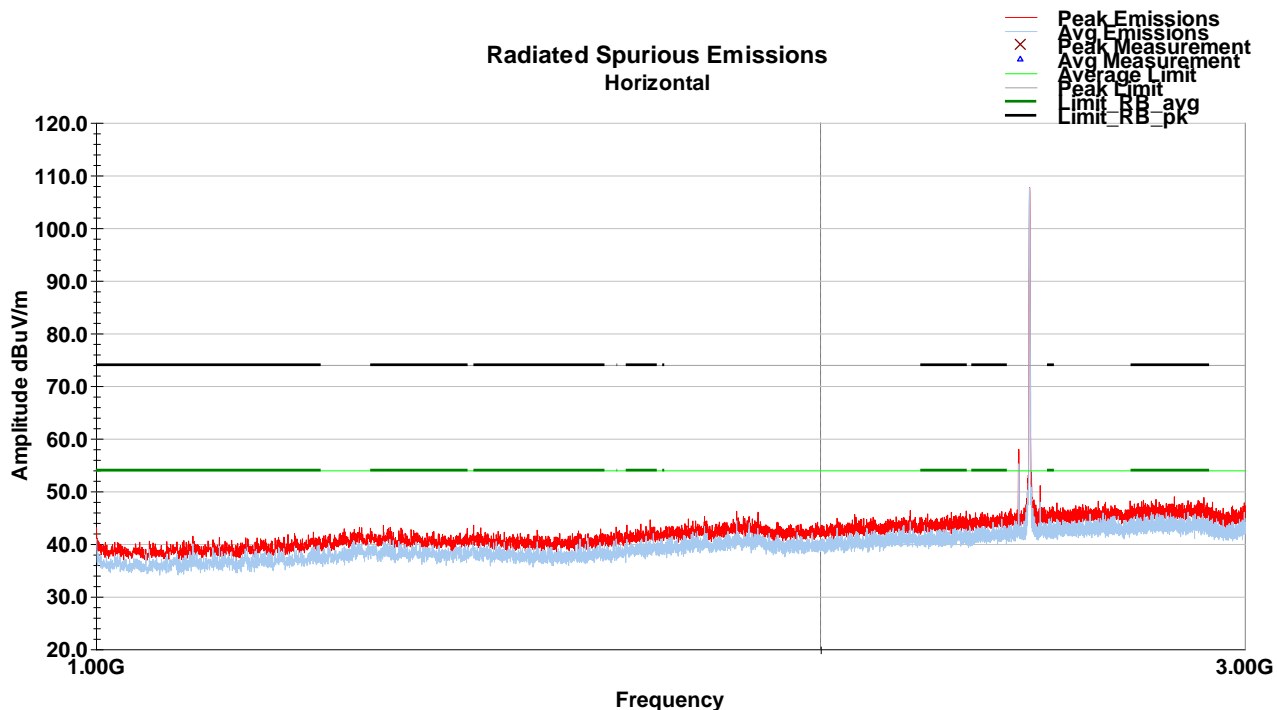
Horizontal Radiated Spurious Emissions – 30-1000MHz (MCH)



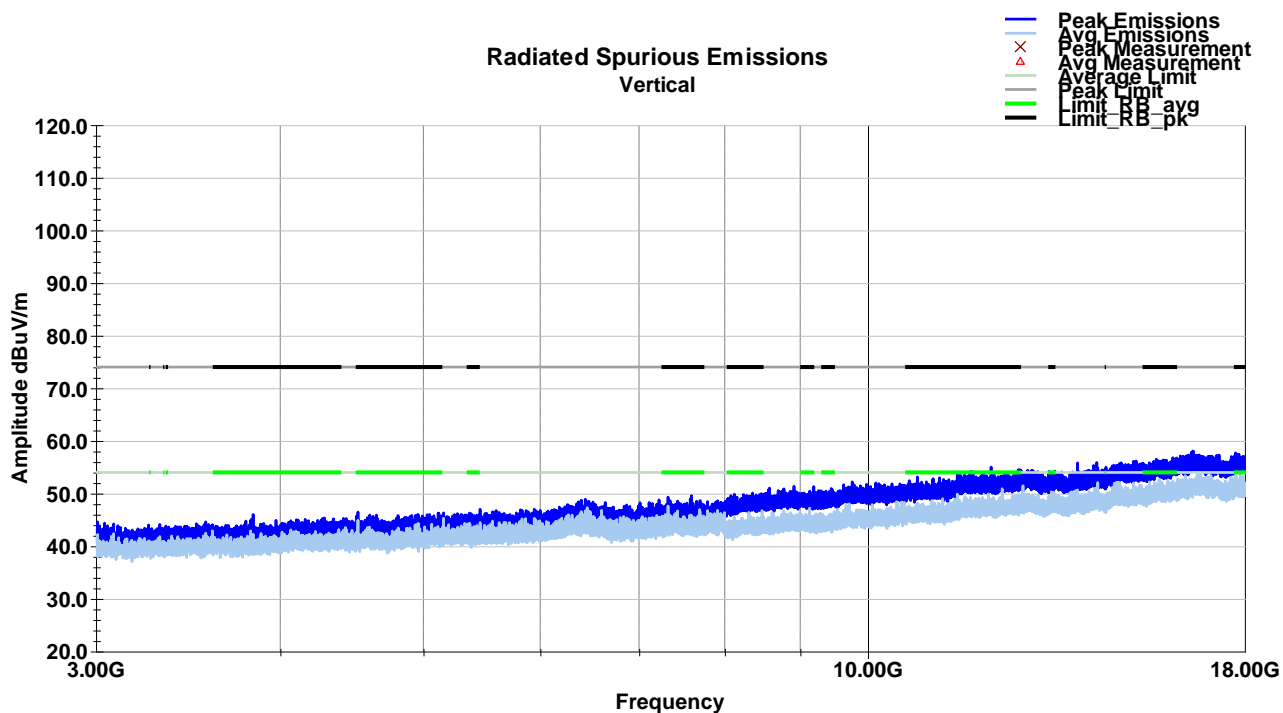
Vertical Radiated Spurious Emissions – 1-3GHz (MCH)



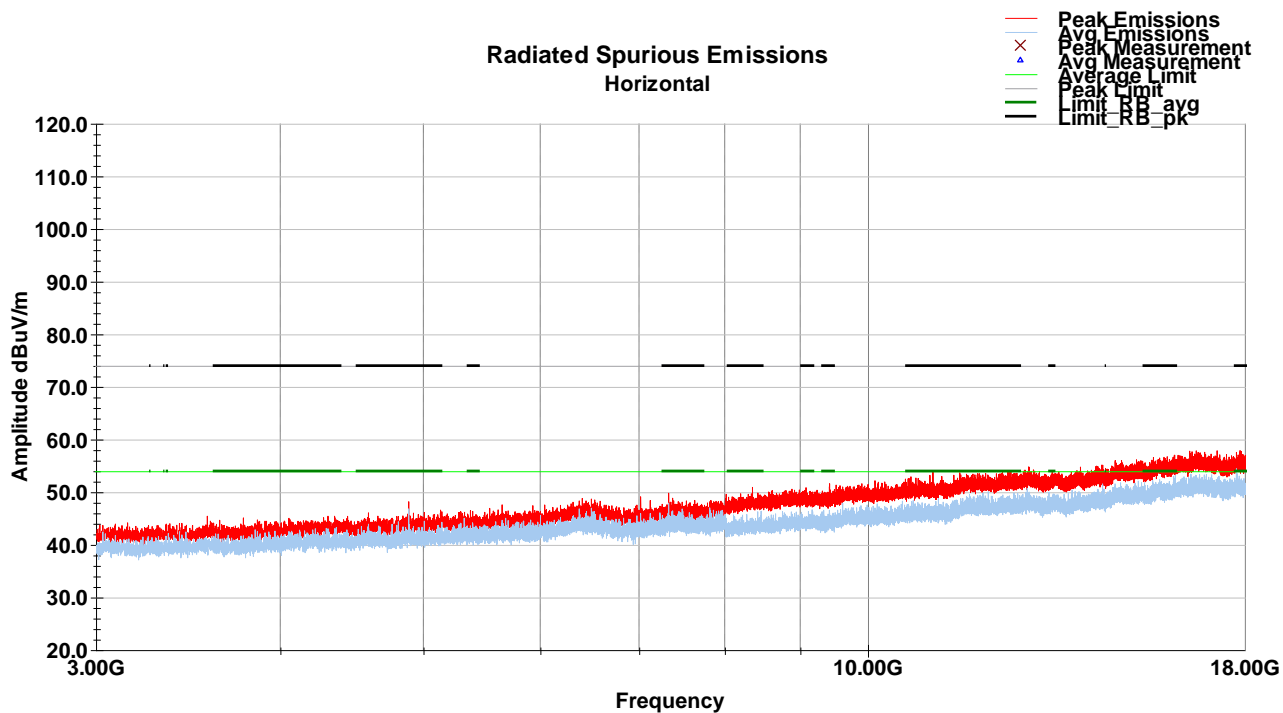
Horizontal Radiated Spurious Emissions – 1-3GHz (MCH)



Vertical Radiated Spurious Emissions – 3-18GHz (MCH)

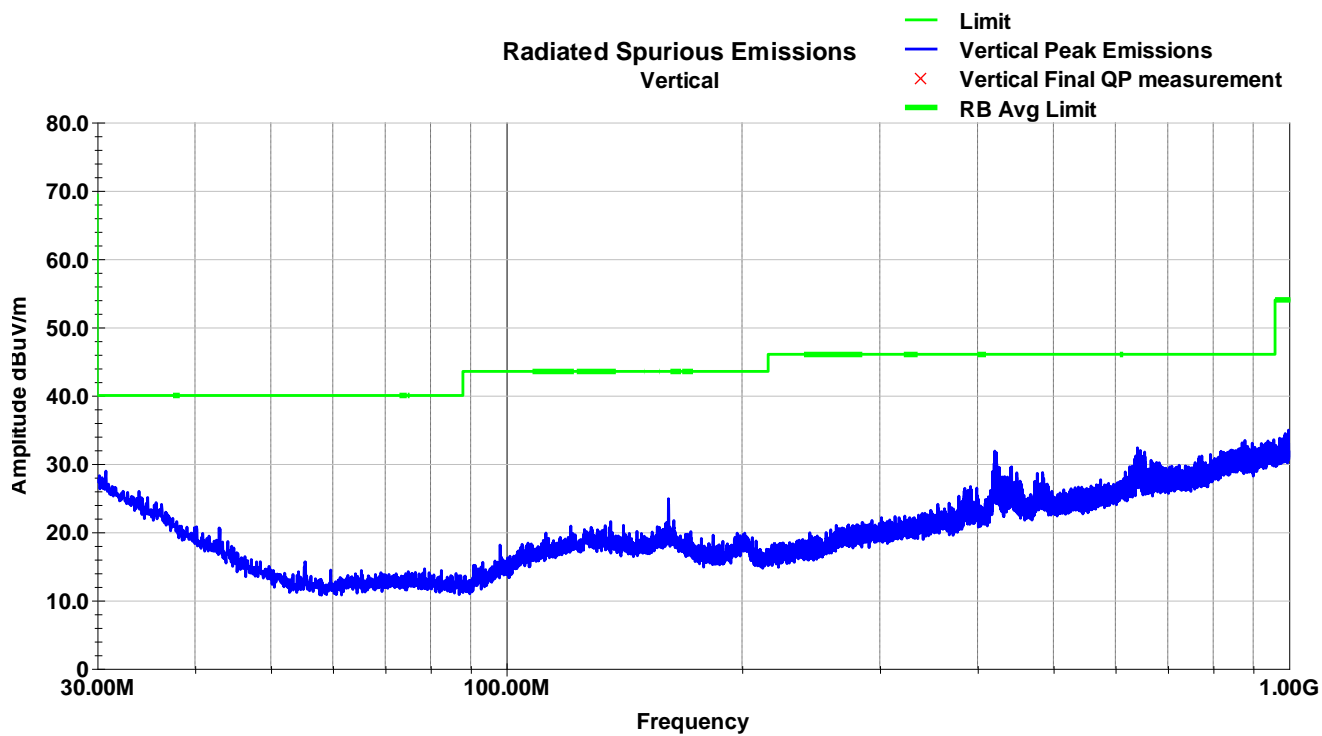


Horizontal Radiated Spurious Emissions – 3-18GHz (MCH)

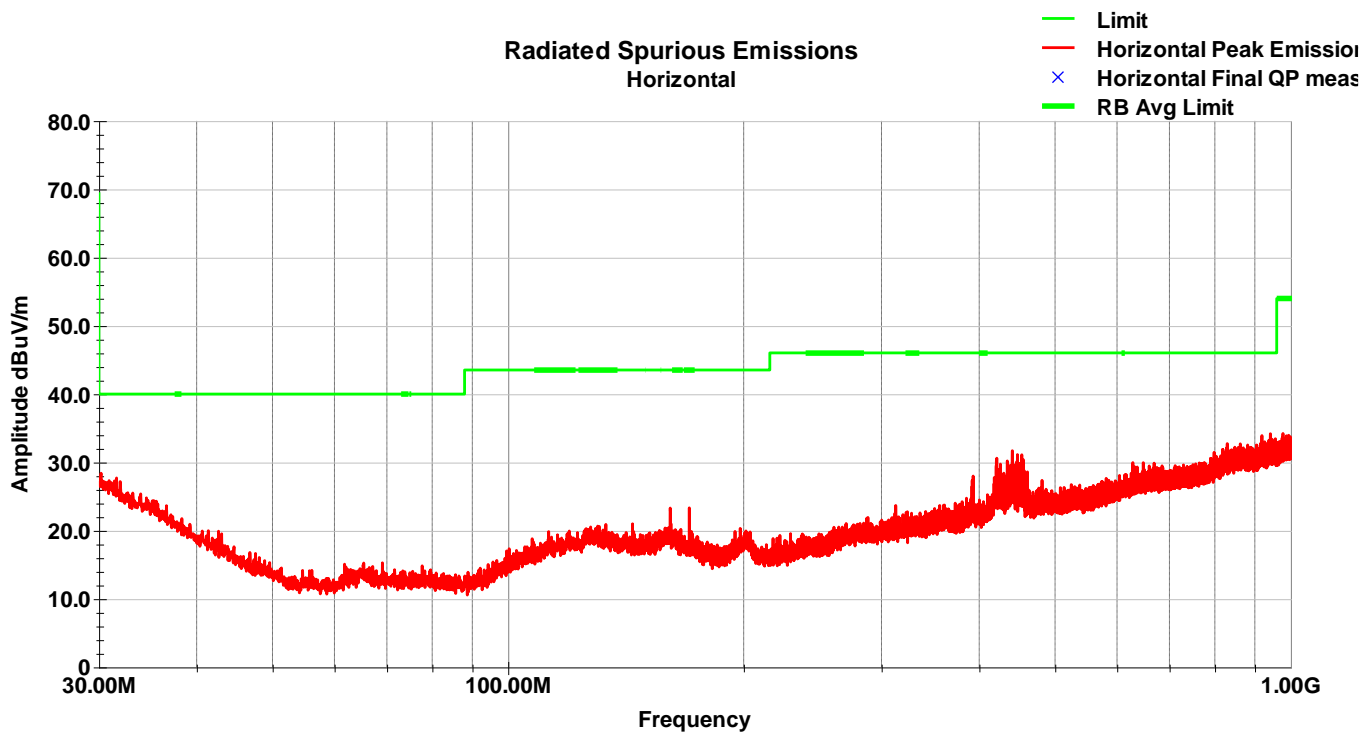


No discernible emissions detected from 18GHz – 26GHz.

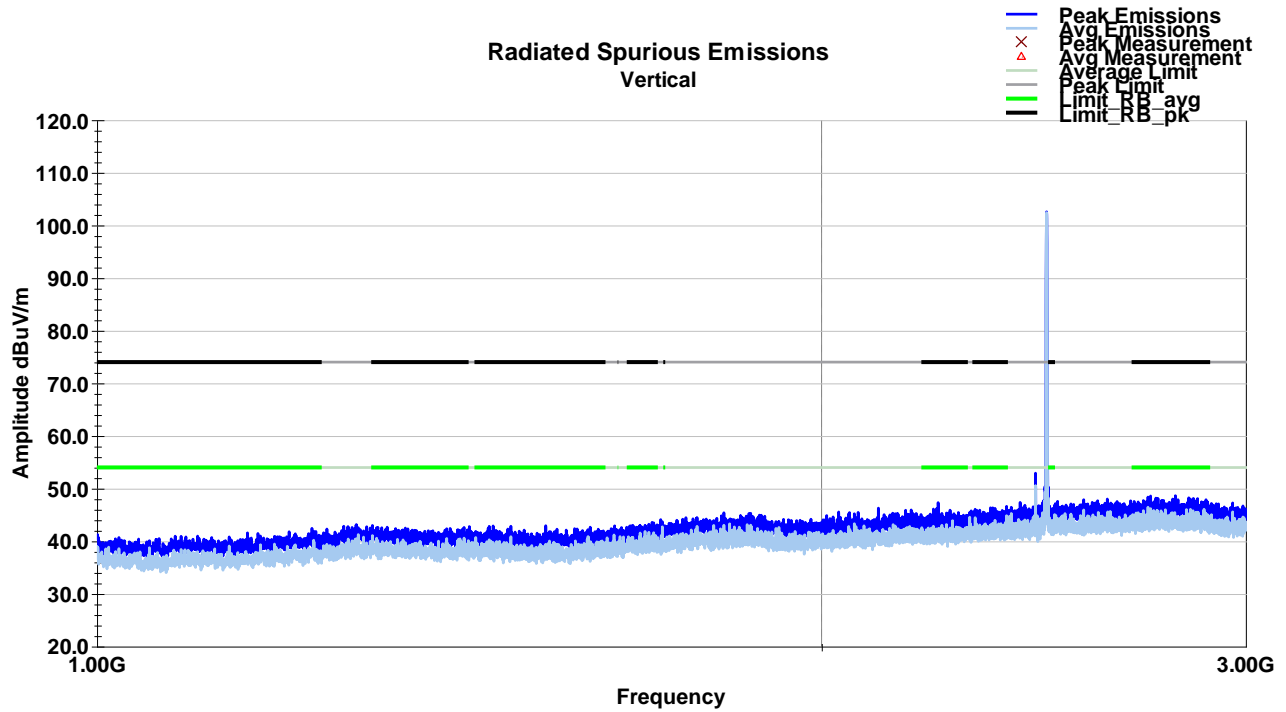
Vertical Radiated Spurious Emissions – 30-1000MHz (HCH)



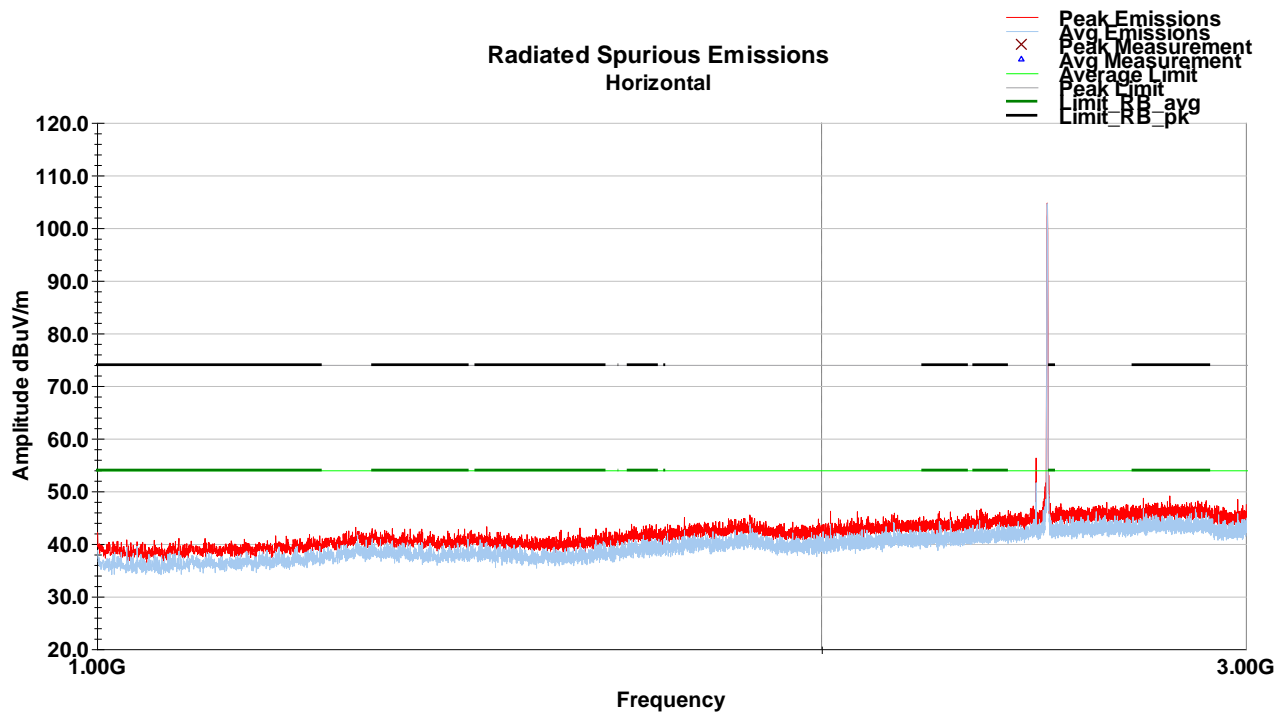
Horizontal Radiated Spurious Emissions – 30-1000MHz (HCH)



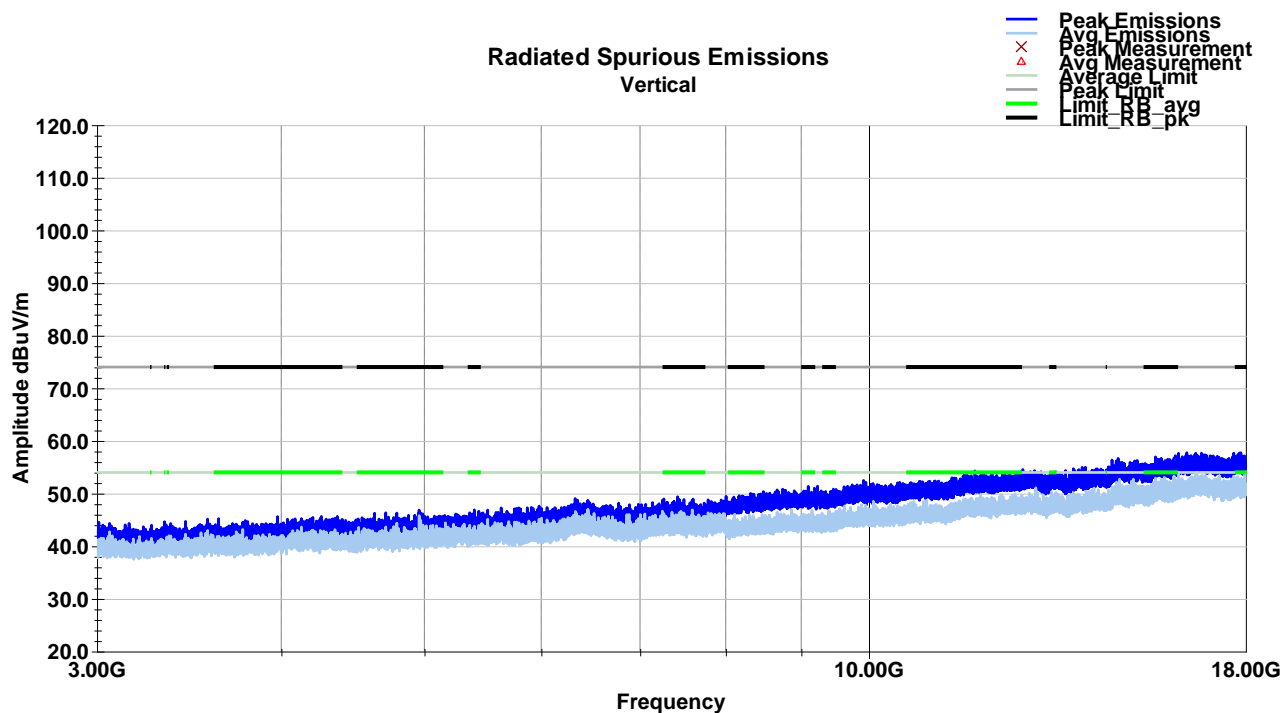
Vertical Radiated Spurious Emissions – 1-3GHz (HCH)



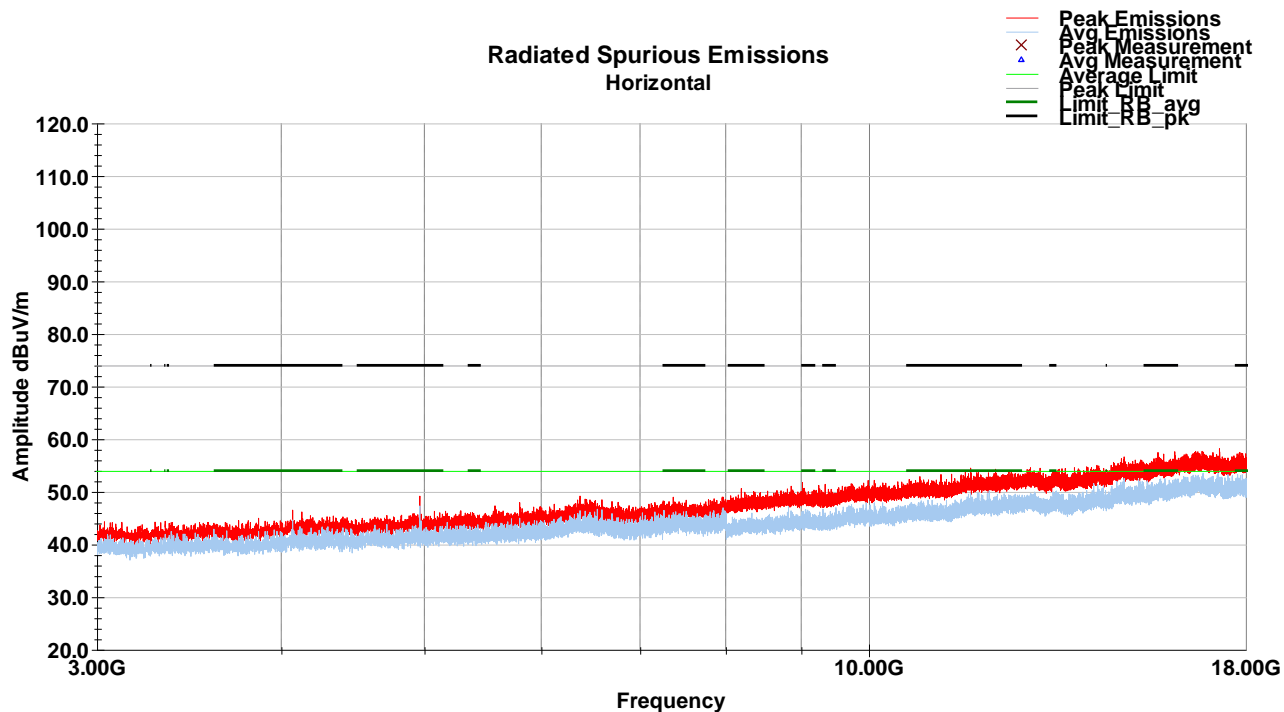
Horizontal Radiated Spurious Emissions – 1-3GHz (HCH)



Vertical Radiated Spurious Emissions – 3-18GHz (HCH)



Horizontal Radiated Spurious Emissions – 3-18GHz (HCH)



No discernible emissions detected from 18GHz – 26GHz.

11 Emissions in Restricted Frequency Bands (Band Edge)

11.1 Test Result

Test Description	Test Specification		Test Result
Restricted Band Emissions	15.205 / 15.209	RSS-GEN S8.9 / 8.10	Compliant

11.2 Test Method

Field strength measurements were performed at the restricted band edges of 2390MHz and 2483.5MHz for each modulation. Measurements were made using the conducted methods defined in ANSI C63.10, Section 11.12.2.

11.3 Test Site

EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.9 °C

Relative Humidity: 48.6 %

Atmospheric Pressure: 98.8 kPa

11.4 Test Equipment

Test End Date: 9-Dec-2022

Tester: AB

Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
WIDEBAND RADIO COMMUNICATION TESTER	CMW500	ROHDE & SCHWARZ	B079788	12-Sep-2022	12-Sep-2024
POWER SPLITTER	ZFRSC-123-S+	MINI-CIRCUITS	B101740	13-Jul-2022	13-Jul-2023
RF CABLE SMA TO SMA, 0.01-40GHZ	084-0505-059	TELEDYNE STORM MICROWAVE	20108	16-Mar-2022	16-Mar-2023
RF CABLE (TS8997)	141	HUBER & SUHNER	B095585	5-Jul-2022	5-Jul-2023
ATTENUATOR, 10DB (TS8997)	10DB	ROHDE & SCHWARZ	B095593	12-May-2022	12-May-2023
EXA SIGNAL ANALYZER	N9010B	KEYSIGT	1245605	17-Nov-2022	17-Nov-2023
TSTPASS SWITCHBOX	SB1	TSTPASS	20168	CNR	CNR
DC POWER SUPPLY, PROGRAMMABLE	DP711	RIGOL	18027	CNR	CNR

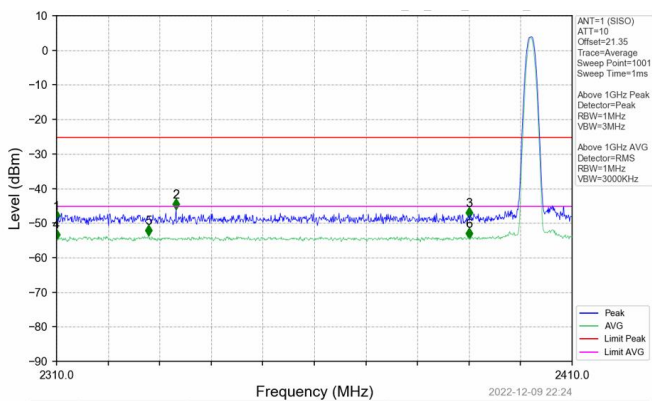
Software Profile:

TSTPASS Version: 1.1.0, build 2020.11.15.01

11.5 Test Data – Restricted Band Edges

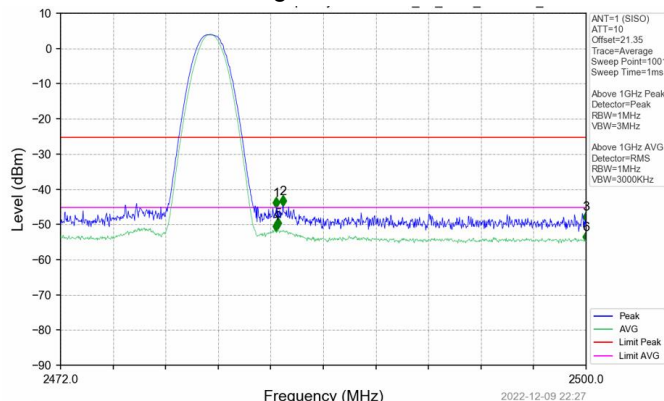
GFSK – DH5

Low Channel



Marker No	Frequency (MHz)	Level (dBm)	Remark	Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2310.000	-49.489	Peak	4	2310.000	-54.816	AVG
2	2333.200	-46.145	Peak	5	2327.800	-53.744	AVG
3	2390.000	-48.605	Peak	6	2390.000	-54.576	AVG

High Channel

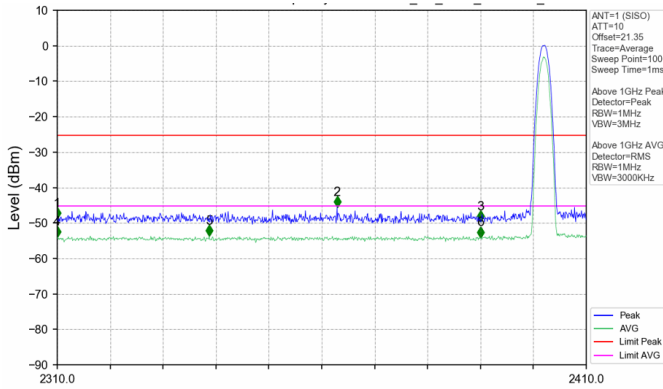


Marker No	Frequency (MHz)	Level (dBm)	Remark	Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2483.500	-45.433	Peak	4	2483.500	-52.016	AVG
2	2483.844	-44.897	Peak	5	2483.592	-51.280	AVG
3	2500.000	-49.369	Peak	6	2500.000	-55.100	AVG

Frequency (MHz)	Reading Level (dBm)	Antenna Gain (dBi)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
2310.000	-54.82	4.00	44.38	54	-9.62	AVG
	-49.49	4.00	49.71	74	-24.29	Peak
2327.800	-53.74	4.00	45.46	54	-8.54	AVG
2333.200	-46.15	4.00	53.05	74	-20.95	Peak
2390.000	-54.58	4.00	44.62	54	-9.38	AVG
	-48.60	4.00	50.59	74	-23.41	Peak
2483.500	-52.02	4.00	47.18	54	-6.82	AVG
	-45.43	4.00	53.77	74	-20.23	Peak
2483.592	-51.28	4.00	47.92	54	-6.08	AVG
2483.844	-44.90	4.00	54.30	74	-19.70	Peak
2500.000	-55.10	4.00	44.10	54	-9.90	AVG
	-49.37	4.00	49.83	74	-24.17	Peak

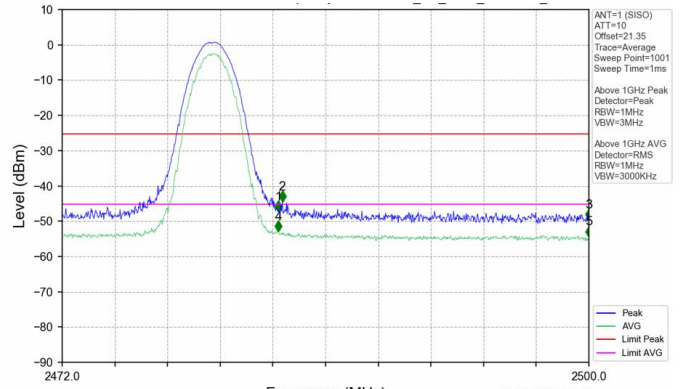
Pi/4DQPSK – DH5

Low Channel



Marker No	Frequency (MHz)	Level (dBm)	Remark	Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2310.000	-48.698	Peak	4	2310.000	-53.934	AVG
2	2362.900	-45.508	Peak	5	2338.700	-53.664	AVG
3	2390.000	-49.559	Peak	6	2390.000	-54.106	AVG

High Channel

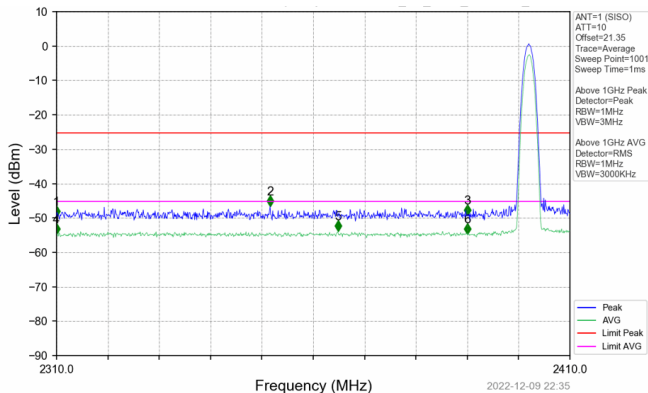


Marker No	Frequency (MHz)	Level (dBm)	Remark	Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2483.500	-47.273	Peak	4	2483.500	-53.003	AVG
2	2483.704	-44.548	Peak	5	2500.000	-54.478	AVG
3	2500.000	-49.594	Peak				

Frequency (MHz)	Reading Level (dBm)	Antenna Gain (dBi)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
2310.000	-53.93	4.00	45.27	54	-8.73	AVG
	-48.70	4.00	50.50	74	-23.50	Peak
2338.700	-53.66	4.00	45.54	54	-8.46	AVG
2362.900	-45.51	4.00	53.69	74	-20.31	Peak
2390.000	-54.11	4.00	45.09	54	-8.91	AVG
	-49.56	4.00	49.64	74	-24.36	Peak
2483.500	-53.00	4.00	46.20	54	-7.80	AVG
	-47.27	4.00	51.93	74	-22.07	Peak
2483.704	-44.55	4.00	54.65	74	-19.35	Peak
2500.000	-54.48	4.00	44.72	54	-9.28	AVG
	-49.59	4.00	49.61	74	-24.39	Peak

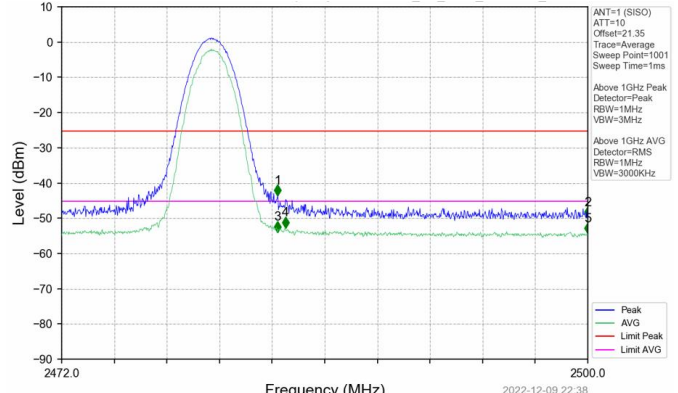
8DPSK – DH5

Low Channel



Marker No	Frequency (MHz)	Level (dBm)	Remark	Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2310.000	-49.570	Peak	4	2310.000	-54.714	AVG
2	2351.600	-46.608	Peak	5	2364.800	-53.848	AVG
3	2390.000	-49.331	Peak	6	2390.000	-54.746	AVG

High Channel



Marker No	Frequency (MHz)	Level (dBm)	Remark	Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2483.500	-43.660	Peak	4	2483.900	-52.715	AVG
2	2500.000	-49.777	Peak	5	2500.000	-54.385	AVG
3	2483.500	-53.939	AVG				

Frequency (MHz)	Reading Level (dBm)	Antenna Gain (dBi)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
2310.000	-54.71	4.00	44.49	54	-9.51	AVG
	-49.57	4.00	49.63	74	-24.37	Peak
2351.600	-46.61	4.00	52.59	74	-21.41	Peak
2364.800	-53.85	4.00	45.35	54	-8.65	AVG
2390.000	-54.75	4.00	44.45	54	-9.55	AVG
	-49.33	4.00	49.87	74	-24.13	Peak
2483.500	-53.94	4.00	45.26	54	-8.74	AVG
	-43.66	4.00	55.54	74	-18.46	Peak
2483.900	-52.72	4.00	46.48	54	-7.51	AVG
2500.000	-54.38	4.00	44.81	54	-9.19	AVG
	-49.78	4.00	49.42	74	-24.58	Peak

12 Measurement Uncertainty

The measurement uncertainty figures are be calculated in accordance with TR 100 028-1 [2] and correspond to an expansion factor (coverage factor) $k = 2$ (which provide 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 %	$\pm 0.4\%$

13 Revision History

Revision Level	Description of changes	Revision Date
0	Initial release	30 November 2022
1	Updated antenna port number to better match the EUT	18 January 2023
2	Added note: No discernible emissions detected from 18GHz – 26GHz. Added TSTPASS Switchbox to equipment list Added Tile 7 software to equipment list Updated Section 2.1 company name and address Test dates were corrected to be consistent with test duration on page 5 Updated Section 1 Table: All antennas are internal Added field strength tabular data in section 12.5.	24 February 2023
3	Updated section 10.4 Equipment List to include 18GHz – 26GHz information.	28 February 2023