Windrock, Inc.
TEST REPORT

SCOPE OF WORK
Emissions Testing –Gateway, Model(s): A4000-00-00

REPORT NUMBER
104473889BOX-001

ISSUE DATE
February 23, 2021

[REVISED DATE]
July 23, 2021

DOCUMENT CONTROL NUMBER
Non-Specific Radio Report Shell Rev. December 2017

EMISSIONS TEST REPORT

(FULL COMPLIANCE)

Report Number: 104473889BOX-001
Project Number: G104473889

Report Issue Date: 02/23/2021
Report Revision Date: 07/23/2021

Model(s) Tested: A4000-00-00
Model(s) Partially Tested: None
Model(s) Not Tested but declared equivalent by the client: A4000-CC1-00 and A4000-CC2-00

Standards: CFR47 FCC Part 15.247 Subpart C: 02/2021,
CFR47 FCC Part 15 Subpart B: 02/2021,
RSS-247 Issue 2 February 2017,
ICES-003 Issue 7 October 2020
RSS-Gen Issue 5 April 2018 +Amendment 1 March 2019,
RSS-102 Issue 5 March 2015

Tested by:
Intertek Testing Services NA, Inc.
70 Codman Hill Road
Boxborough, MA 01719
USA

Client:
Windrock Inc
1832 Midpark Rd Ste 102
Knoxville, TN 37921-5941
USA

Report prepared by

Vathana Ven / EMC Engineering Supervisor

Report reviewed by

Kouma Sinn / EMC Engineering Supervisor

Table of Contents

1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 4.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

2 Test Summary

Section	Test full name	Result
3	Client Information	--
4	Description of Equipment Under Test and Variant Models	--
5	System Setup and Method	--
6	Maximum Peak Output Power and Human RF exposure CFR47 FCC Part 15 Subpart C:02/2021, Section 15.247 (b)(3) RSS-247 Issue 2 February 2017, RSS-102 Issue 5 March 2015	Pass
7	6 dB Bandwidth and Occupied Bandwidth CFR47 FCC Part 15 Subpart C: 02/2021, Section 15.247 (a)(2) RSS-247 Issue 2 February 2017	Pass
8	Maximum Power Spectral Density CFR47 FCC Part 15 Subpart C: 02/2021, Section 15.247 (e) RSS-247 Issue 2 February 2017	Pass
9	Band Edge Compliance CFR47 FCC Part 15 Subpart C: 02/2021, Section 15.247 (d) RSS-247 Issue 2: 02/2017)	Pass
10	Transmitter spurious emissions CFR47 FCC Part 15 Subpart C: 02/2021, Section 15.247 (d) RSS-247 Issue 2 February 2017	Pass
11	Digital Device and Receiver Radiated Spurious Emissions (CFR47 FCC Part 15 Subpart B 15.109: 02/2021, ICES-003 Issue 7 October 2020	Pass
12	AC Mains Conducted Emissions FCC 47CFR Part 15.107: 02/2021 ICES-003 Issue 7 October 2020	Pass
13	Revision History	--

3 Client Information

This EUT was tested at the request of:

Client: Windrock Inc
1832 Midpark Rd Ste 102
Knoxville, TN 37921-5941
USA

Contact: Abdul Razzaq
Telephone: 908-238-7131
Email: abdul.razzaq@apergy.com

4 Description of Equipment Under Test and Variant Models

Manufacturer: Windrock Inc
1832 Midpark Rd Ste 102
Knoxville, TN 37921-5941
USA

Equipment Under Test			
Description	Manufacturer	Model Number	Serial Number
Gateway	Windrock Inc	A4000-00-00	BOX2101191351-001 (Intertek assigned)

Receive Date:	01/12/2021
Received Condition:	Good
Type:	Production

Description of Equipment Under Test (provided by client)
The Gateway isa24Vdc powered device that collects data either wirelessly or wired (using IEEE 802.3 standard) from field devices.Some of thewireless protocols are on separate M.2 cards thatneed to be connected to the gateway in order to be used. Once data is collected, the gateway organizes and processes the data.It then transmits the information to a cloud computing service.The gateway may transmit in two ways, the first way is throughcommercial cellular networks.The second way is using wired IEEE 802.3.

Equipment Under Test Power Configuration			
Rated Voltage	Rated Current	Rated Frequency	Number of Phases
10-30VDC	Max 55W	N/A	N/A

Operating modes of the EUT:

No.	Descriptions of EUT Exercising
1	The EUT was set to transmit at Low, Mid, and High channels continuously with modulation at 100 % duty cycle.
2	The EUT was set to receive mode.

Software used by the EUT:

No.	Descriptions of EUT Exercising
1	Software Version 0.104

Radio/Receiver Characteristics BLE	
Frequency Band(s)	2402-2480 MHz
Modulation Type(s)	GFSK
Maximum Output Power	6.06 dBm (conducted)
Test Channels	Low Channel (2402 MHz) Mid Channel (2442 MHz) High Channel (2480 MHz)
Occupied Bandwidth	Low Channel (2402 MHz): 1.06 MHz Mid Channel (2442 MHz): 1.06 MHz High Channel (2480 MHz): 1.06 MHz
6 dB Bandwidth	Low Channel (2402 MHz): 823.20 kHz Mid Channel (2442 MHz): 777.60 kHz High Channel (2480 MHz): 814.80 kHz
Frequency Hopper: Number of Hopping Channels	N/A
Frequency Hopper: Channel Dwell Time	N/A
Frequency Hopper: Max interval between two instances of use of the same channel	N/A
MIMO Information (# of Transmit and Receive antenna ports)	1
Equipment Type	Standalone
Antenna Type and Gain	Integrated, 2 dBi

Radio/Receiver Characteristics 802.15.4 Zigbee	
Frequency Band(s)	2405-2480 MHz
Modulation Type(s)	QPSK
Maximum Output Power	4.76 dBm (conducted)
Test Channels	Low Channel (2405 MHz) Mid Channel (2440 MHz) High Channel (2480 MHz)
Occupied Bandwidth	Low Channel (2405 MHz): 2.38 MHz Mid Channel (2440 MHz): 2.37 MHz High Channel (2480 MHz): 2.37 MHz
6 dB Bandwidth	Low Channel (2405 MHz): 1.66 MHz Mid Channel (2440 MHz): 1.65 MHz High Channel (2480 MHz): 1.58 MHz
Frequency Hopper: Number of Hopping Channels	N/A
Frequency Hopper: Channel Dwell Time	N/A
Frequency Hopper: Max interval between two instances of use of the same channel	N/A
MIMO Information (# of Transmit and Receive antenna ports)	1
Equipment Type	Standalone
Antenna Type and Gain	Integrated, 2 dBi

Variant Models:

The following variant models were not tested as part of this evaluation, but have been identified by the manufacturer as being electrically identical models, depopulated models, or with reasonable similarity to the model(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

A4000-CC1-00 and A4000-CC2-00

5 System Setup and Method

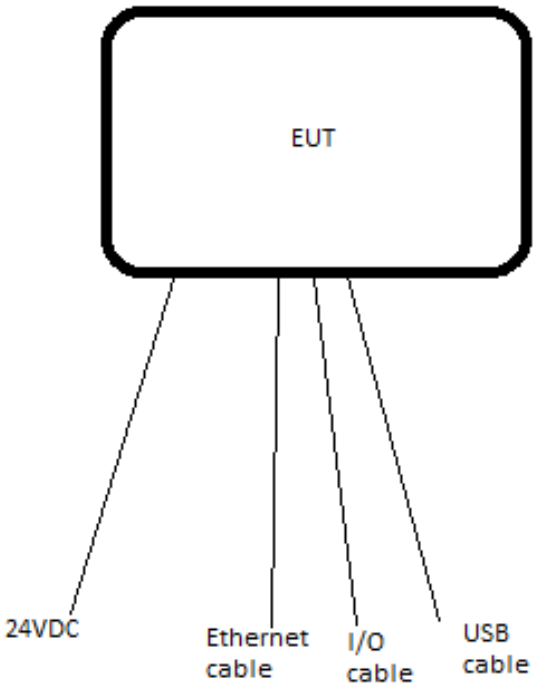
Cables					
ID	Description	Length (m)	Shielding	Ferrites	Termination
1	DC power cable	5	None	None	DC power supply
2	Ethernet cable	5	None	None	Unterminated
3	USB cable	1	None	None	Unterminated
4	I/O cable	3	None	None	Unterminated

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
Laptop	Lenovo	Yoga 7-14ITL5	Not Labelled
AC adapter	Lenovo	ADLX65YDC3D	Not Labelled
DC power supply	Electro Industries	DIGI 35A	Not Labelled

5.1 Method:

Configuration as required by Configuration as required by FCC Part 15 Subpart C 15.247: 02/2021, FCC Part 15 Subpart B: 01/2021, RSS 247 Issue 2: 02/2017, ICES-003 Issue 7 October 2020, RSS-Gen Issue 5 April 2018 +Amendment 1 March 2019, RSS-102 Issue 5 March 2015, ANSI C 63.10: 2013, ANSI C 63.4: 2014, and 558074 D0115.247Meas Guidancev05r02.

5.2 EUT Block Diagram:



6 Maximum Peak Output Power and Human RF exposure

6.1 Method

Tests are performed in accordance with CFR47 FCC Part 15.247, RSS-247, RSS-102, ANSI C63.10, and KDB 558074 D0115.247Meas Guidancev05r02.

TEST SITE: EMC Lab

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

6.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007'	Weather Station Vantage Vue	Davis	6250	MS191212003	03/12/2020	03/12/2021
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	10/27/2020	10/27/2021
CEN001'	DC-40GHz attenuator 20dB	Centric RF	C411-20	CEN001	01/22/2021	01/22/2022
CBLHF2012 -2M-2	2m 9kHz-40GHz Coaxial Cable - SET2	Huber & Suhner	SF102	252675002	02/10/2021	02/10/2022

Software Utilized:

Name	Manufacturer	Version
None	---	---

6.3 Results:

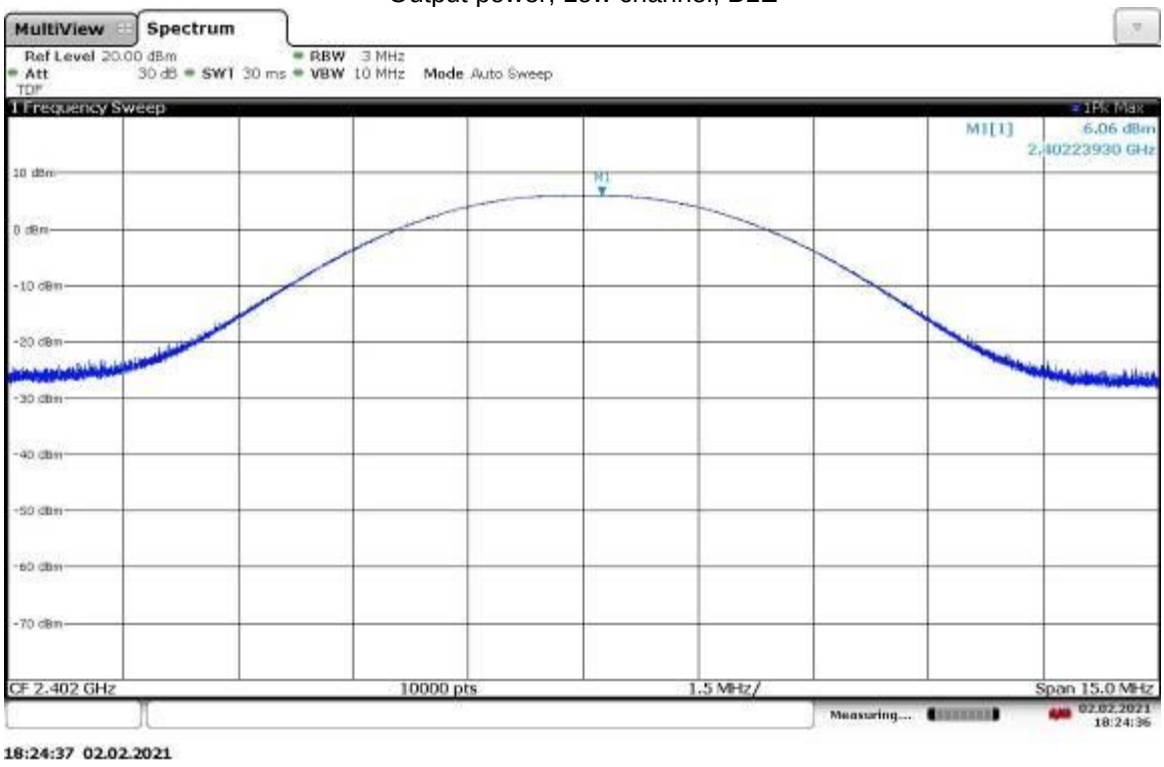
The sample tested was found to Comply.

§15.247 (b) (3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt or 30 dBm or 36 dBm EIRP.

6.4 Setup Photograph:

6.5 Test Data:

Output power, Low channel, BLE



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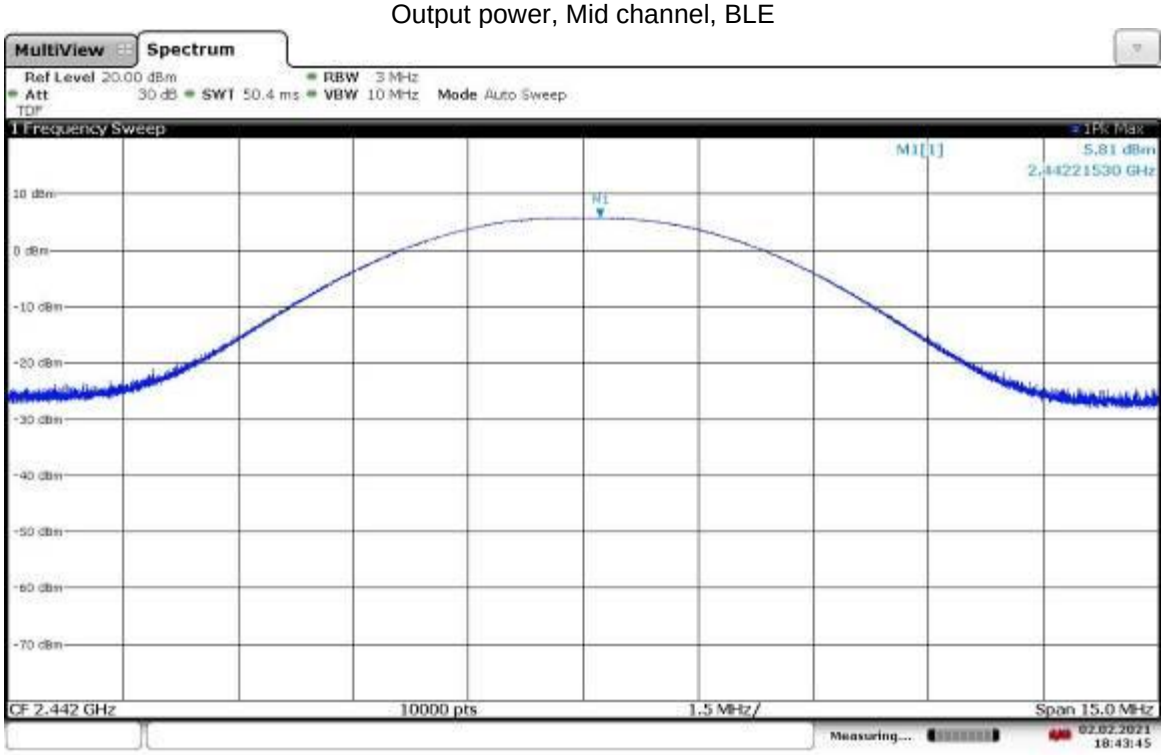
Output power, Mid channel, BLE



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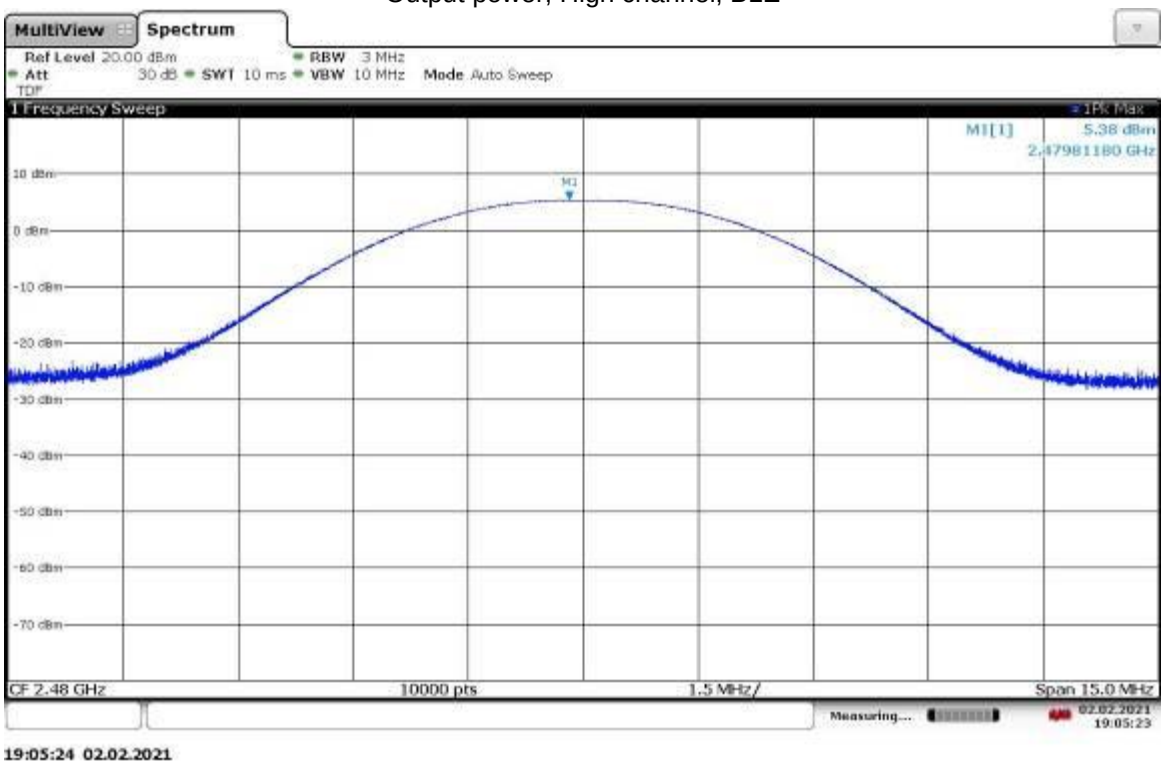
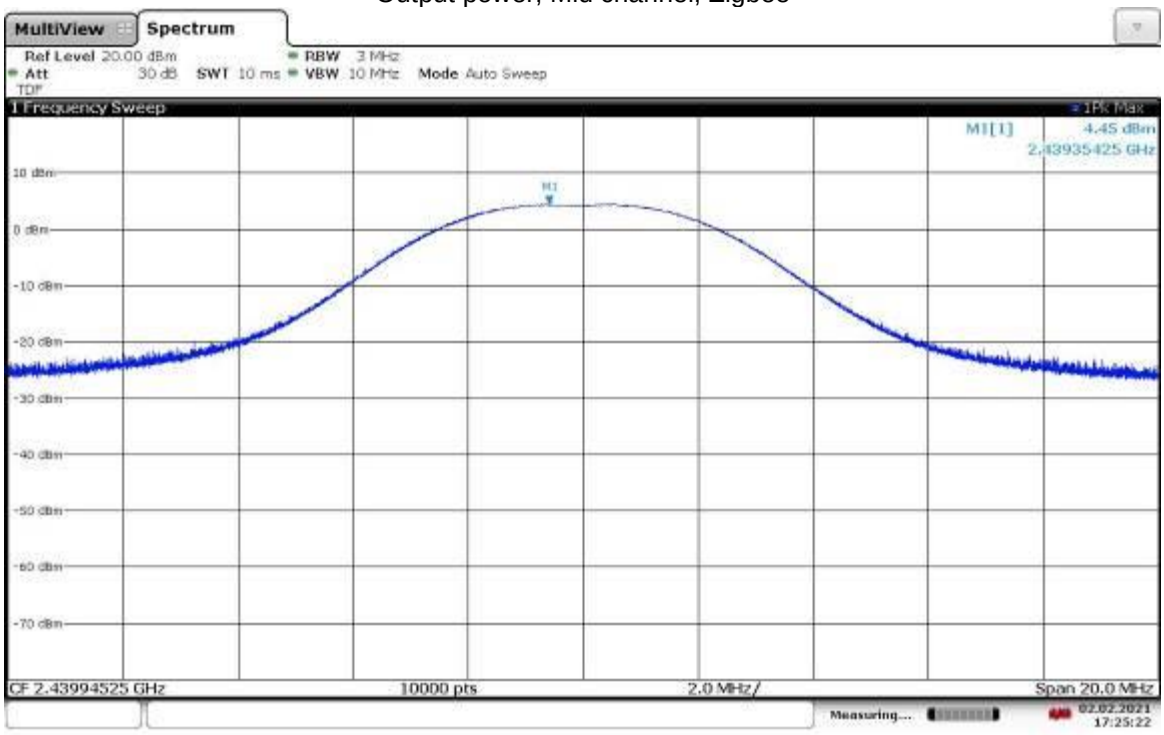
Output power, High channel, BLE



Output power, Low channel, Zigbee

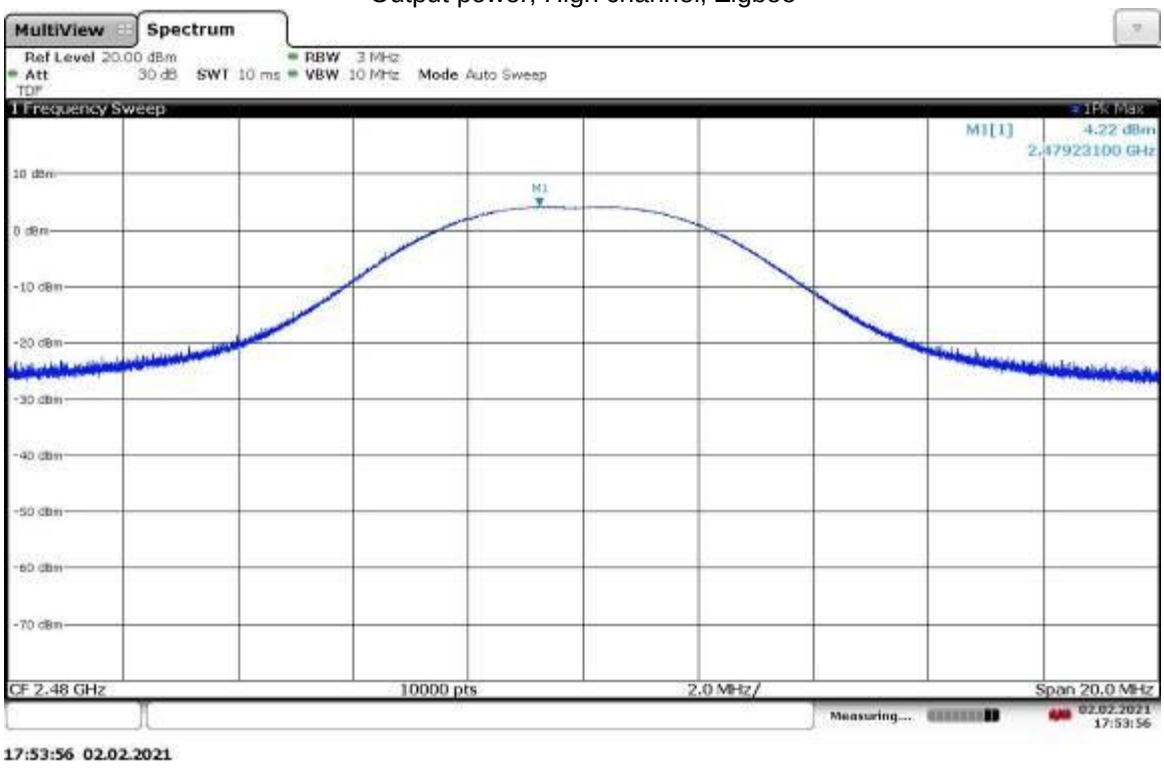
16:29:17 02.02.2021

Output power, Mid channel, Zigbee



17:25:22 02.02.2021

Output power, High channel, Zigbee



Output power BLE	
Channel, Frequency (MHz)	(dBm)
Low, 2402	6.06
Mid, 2442	5.81
High, 2480	5.38
Output power Zigbee	
Channel, Frequency (MHz)	(dBm)
Low, 2405	4.76
Mid, 2440	4.45
High, 2480	4.22

MPE Calculation

§ 1.1310: The criteria listed in table 1 shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

Part 1.1310 Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f^2)	6
30–300	61.4	0.163	1.0	6
300–1500			f/300	6
1500–100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f^2)	30
30–300	27.5	0.073	0.2	30
300–1500			f/1500	30
1500–100,000			1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

RSS-102 Issue 5 Exposure Limits:

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[21]	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142f^{0.3417}$	$0.008335f^{0.3417}$	$0.02619f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158f^{0.5}$	$4.21 \times 10^{-4}f^{0.5}$	$6.67 \times 10^{-5}f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

1.1 Test Procedure

An MPE evaluation for was performed in order to show that the device was compliant with §2.1091. The maximum power density was calculated for each transmitter at a separation distance of 20cm.

For each transmitter the maximum RF exposure at a 20 cm distance using the formula:

$$ConductedPower_{mW} = 10^{ConductedPower(dBm)/10}$$

$$PowerDensity = \frac{ConductedPower_{mW} \times Ant.Gain}{4\pi \times (20_{cm})^2}$$

1.2 Results:

The output power was derived from field strength readings at 3 meters using the formula in ANSI C63.10 Section 12.7.2. and Power (conducted)= EIRP (dBm) – Antenna Factor (dBi).

Worst-case output power of BLE:

Maximum Conducted Output Power = 6.06 dBm

EIRP = Power (conducted) + Antenna Factor = 6.06 dBm + 2 dBi = 8.06 dBm or 6.397 mW

Power Density = 6.397/5025.6

Power Density = 0.001273 mW/cm^2

Limit at 2.402 GHz = $1mW/cm^2$

RSS-102 Issue 5 Exposure Limit at 2.402GHz = 5.35 W/m^2

Power Density = 0.01273 W/m^2

The calculated maximum power density at 20cm distance is less than the limit for general population.

Worst-case output power of 802.15.4 Zigbee:

Maximum Conducted Output Power = 4.76 dBm

EIRP = Power (conducted) + Antenna Factor = 4.76 dBm + 2.0 dBi = 6.76 dBm or 4.742420 mW
Power Density = 4.742420/5025.6

Power Density = 0.000944 mW/cm^2

Limit at 2.405 GHz = 1mW/cm^2

RSS-102 Issue 5 Exposure Limit at 2.405GHz = 5.355 W/m^2

Power Density = 0.00944 W/m^2

The calculated maximum power density at 20cm distance is less than the limit for general population.

Test Personnel:	Vathana Ven VJV	Test Date:	02/02/2021
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 15.247 RSS-247, RSS-102	Limit Applied:	See report section 6.3
Input Voltage:	24VDC		
Pretest Verification w/ Ambient Signals or BB Source:	**N/A**	Ambient Temperature:	24ºC
		Relative Humidity:	24%
		Atmospheric Pressure:	1009mbars

Deviations, Additions, or Exclusions: None

7 6 dB Bandwidth and Occupied Bandwidth

7.1 Method

Tests are performed in accordance with CFR47 FCC Part 15.247, RSS-247, and ANSI C63.10 and KDB 558074 D0115.247Meas Guidancev05r02.

TEST SITE: EMC Lab

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

7.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007'	Weather Station Vantage Vue	Davis	6250	MS191212003	03/12/2020	03/12/2021
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	10/27/2020	10/27/2021
CEN001'	DC-40GHz attenuator 20dB	Centric RF	C411-20	CEN001	01/22/2021	01/22/2022
CBLHF2012 -2M-2	2m 9kHz-40GHz Coaxial Cable - SET2	Huber & Suhner	SF102	252675002	02/10/2021	02/10/2022

Software Utilized:

Name	Manufacturer	Version
None	---	---

7.3 Results:

The sample tested was found to Comply.

§15.247 (a) (2) Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

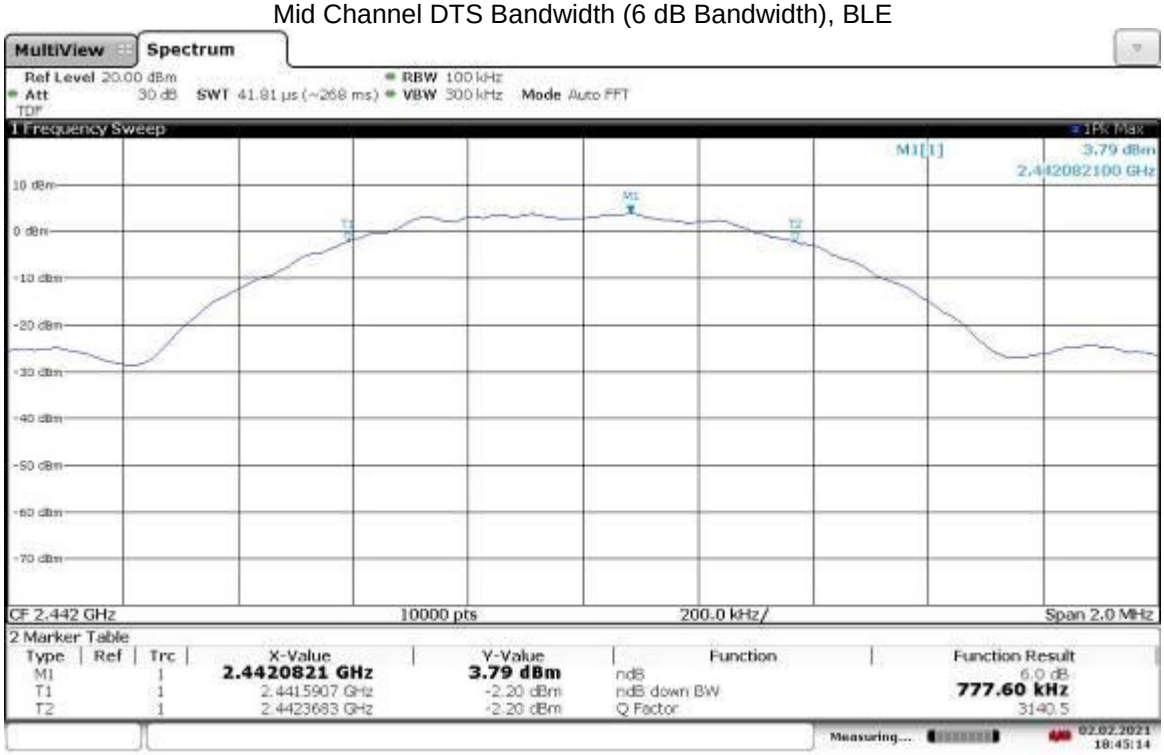
7.4 Setup Photograph:

7.5 Plots/Data:

Low Channel DTS Bandwidth (6 dB Bandwidth), BLE

18:18:36 02.02.2021

Mid Channel DTS Bandwidth (6 dB Bandwidth), BLE



18:45:14 02.02.2021

High Channel DTS Bandwidth (6 dB Bandwidth), BLE

Low Channel DTS Bandwidth (6 dB Bandwidth), 802.15.4 Zigbee

16:47:25 02.02.2021

Mid Channel DTS Bandwidth (6 dB Bandwidth), 802.15.4 Zigbee

17:18:55 02.02.2021

High Channel DTS Bandwidth (6 dB Bandwidth), 802.15.4 Zigbee

17:50:00 02.02.2021

Low Channel Occupied Bandwidth, BLE

18:21:00 02.02.2021

Mid Channel Occupied Bandwidth, BLE

18:46:12 02.02.2021

High Channel Occupied Bandwidth, BLE

Low Channel Occupied Bandwidth, 802.15.4 Zigbee

16:48:59 02.02.2021

Mid Channel Occupied Bandwidth, 802.15.4 Zigbee

17:20:50 02.02.2021

High Channel Occupied Bandwidth, 802.15.4 Zigbee

17:51:21 02.02.2021

DTS Bandwidth (6 dB Bandwidth) and Occupied Bandwidth, BLE

Frequency	DTS Bandwidth (6 dB Bandwidth)	Occupied Bandwidth
(MHz)	(kHz)	(MHz)
2402	823.20	1.06
2442	777.60	1.06
2480	814.80	1.06

DTS Bandwidth (6 dB Bandwidth) and Occupied Bandwidth, 802.15.4 Zigbee

Frequency	DTS Bandwidth (6 dB Bandwidth)	Occupied Bandwidth
(MHz)	(MHz)	(MHz)
2405	1.66	2.38
2440	1.65	2.37
2480	1.58	2.37

Test Personnel:	Vathana Ven VSV	Test Date:	02/02/2021
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 15.247 RSS-247	Limit Applied:	See report section 7.3
Input Voltage:	24VDC	Ambient Temperature:	24 ºC
Pretest Verification w/ Ambient Signals or BB Source:	**N/A**	Relative Humidity:	24 %
		Atmospheric Pressure:	1009 mbars

Deviations, Additions, or Exclusions: None

8 Maximum Power Spectral Density

8.1 Method

Tests are performed in accordance with CFR47 FCC Part 15.247, RSS-247, and ANSI C63.10, and KDB 558074 D0115.247Meas Guidancev05r02.

TEST SITE: EMC Lab

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

8.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
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ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	10/27/2020	10/27/2021
CEN001'	DC-40GHz attenuator 20dB	Centric RF	C411-20	CEN001	01/22/2021	01/22/2022
CBLHF2012-2M-2	2m 9kHz-40GHz Coaxial Cable - SET2	Huber & Suhner	SF102	252675002	02/10/2021	02/10/2022

Software Utilized:

Name	Manufacturer	Version
None	--	--

8.3 Results:

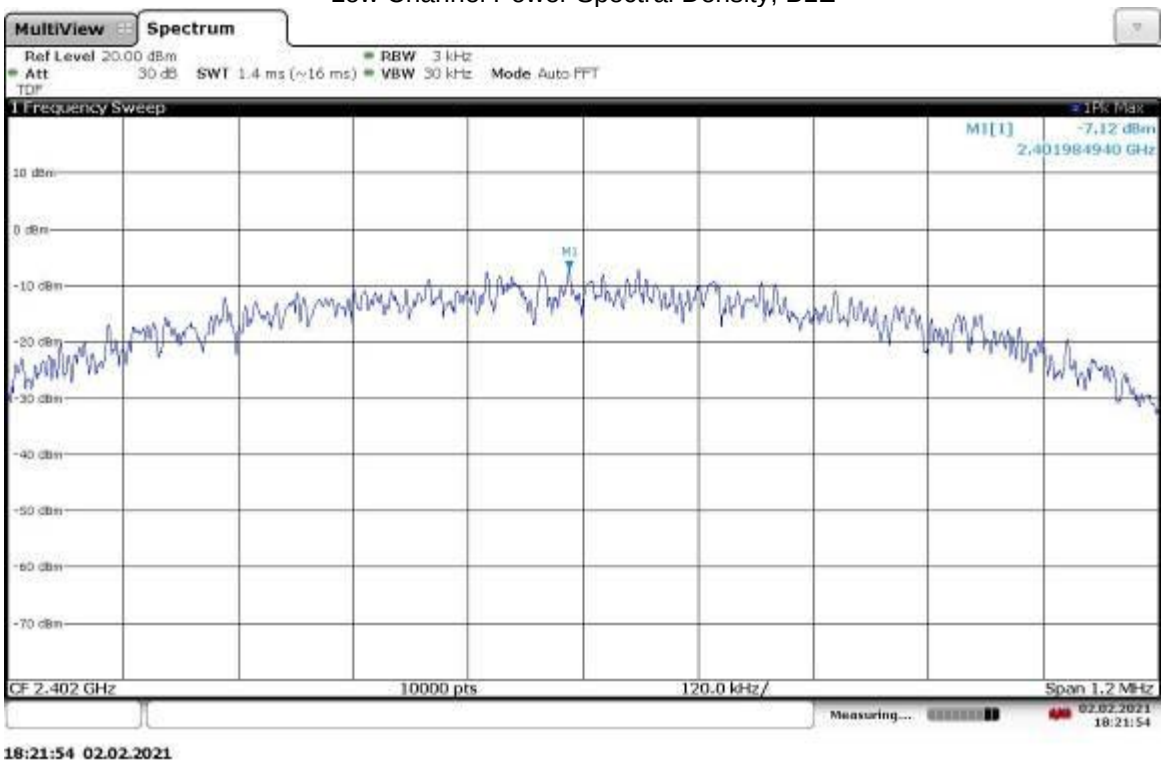
The sample tested was found to Comply.

§15.247 (e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

8.4 Setup Photograph:

8.5 Test Data:

Low Channel Power Spectral Density, BLE



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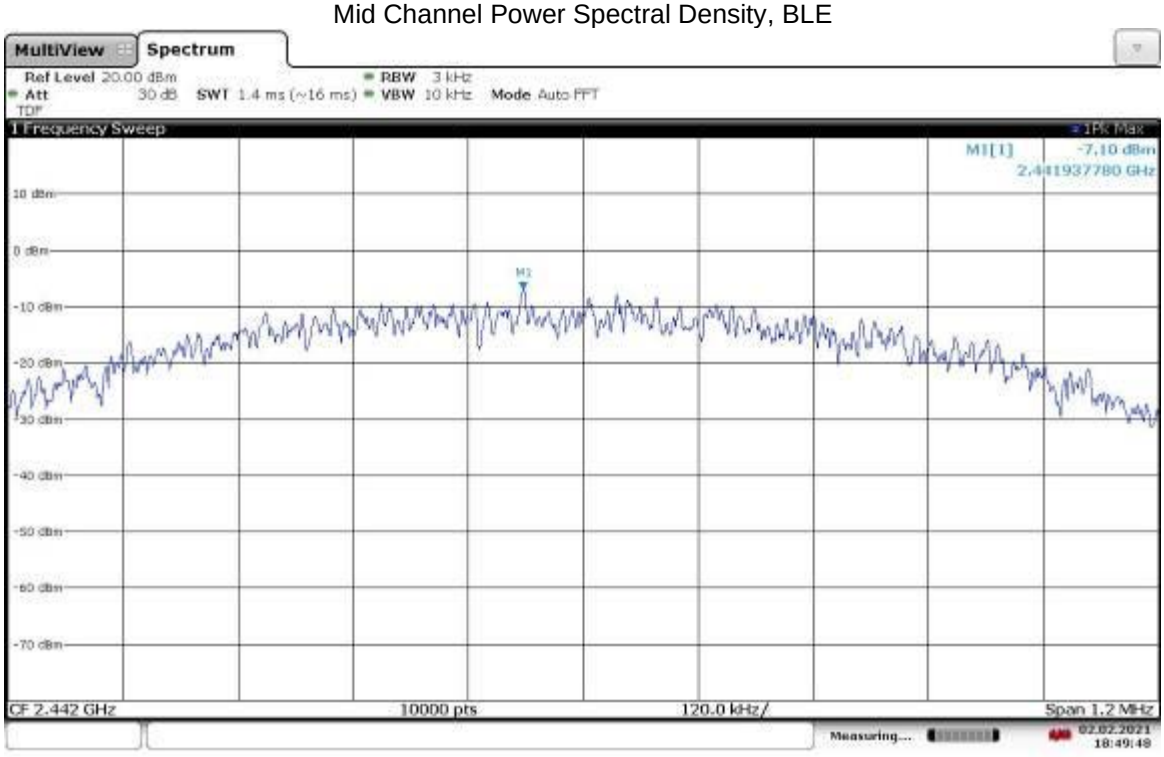
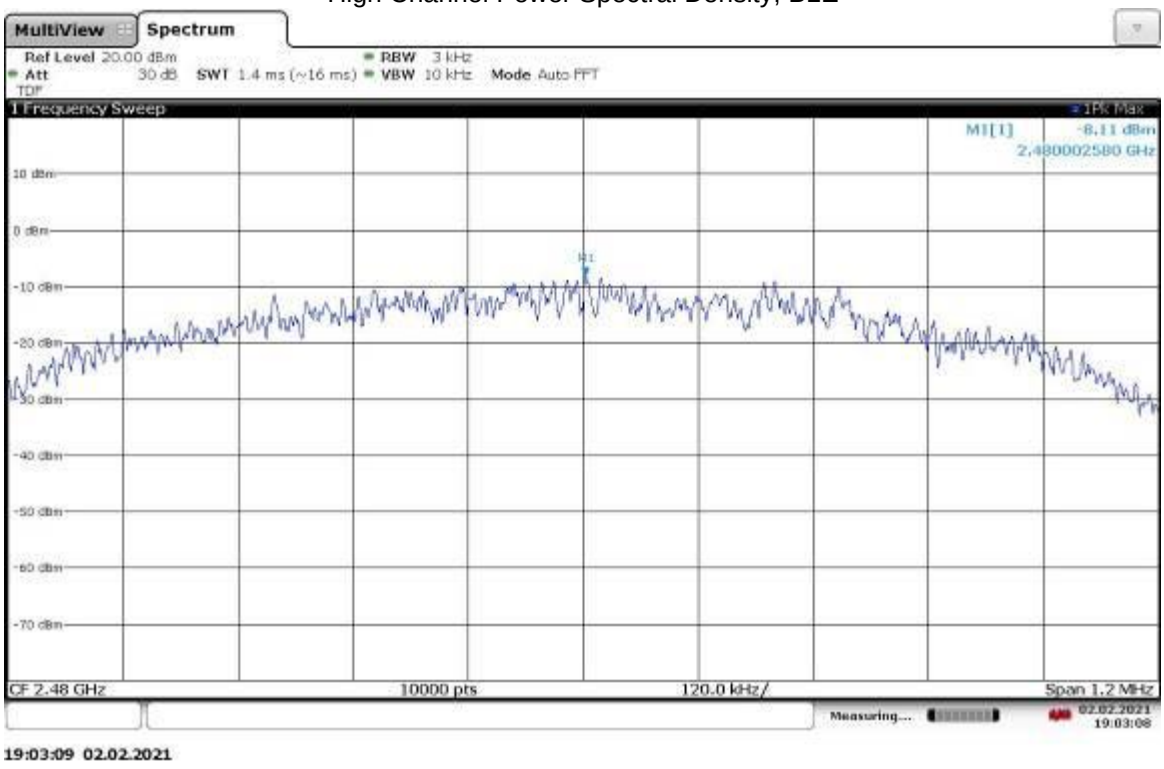
Mid Channel Power Spectral Density, BLE

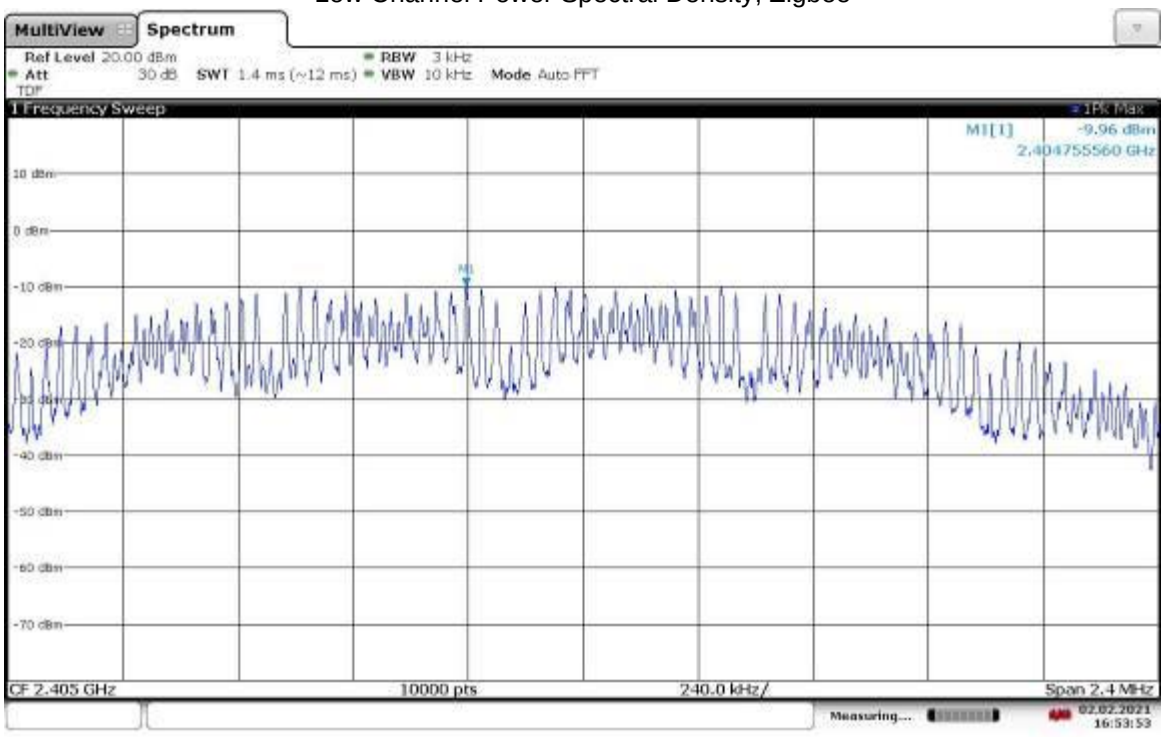


18:49:48 02.02.2021

High Channel Power Spectral Density, BLE



Low Channel Power Spectral Density, Zigbee



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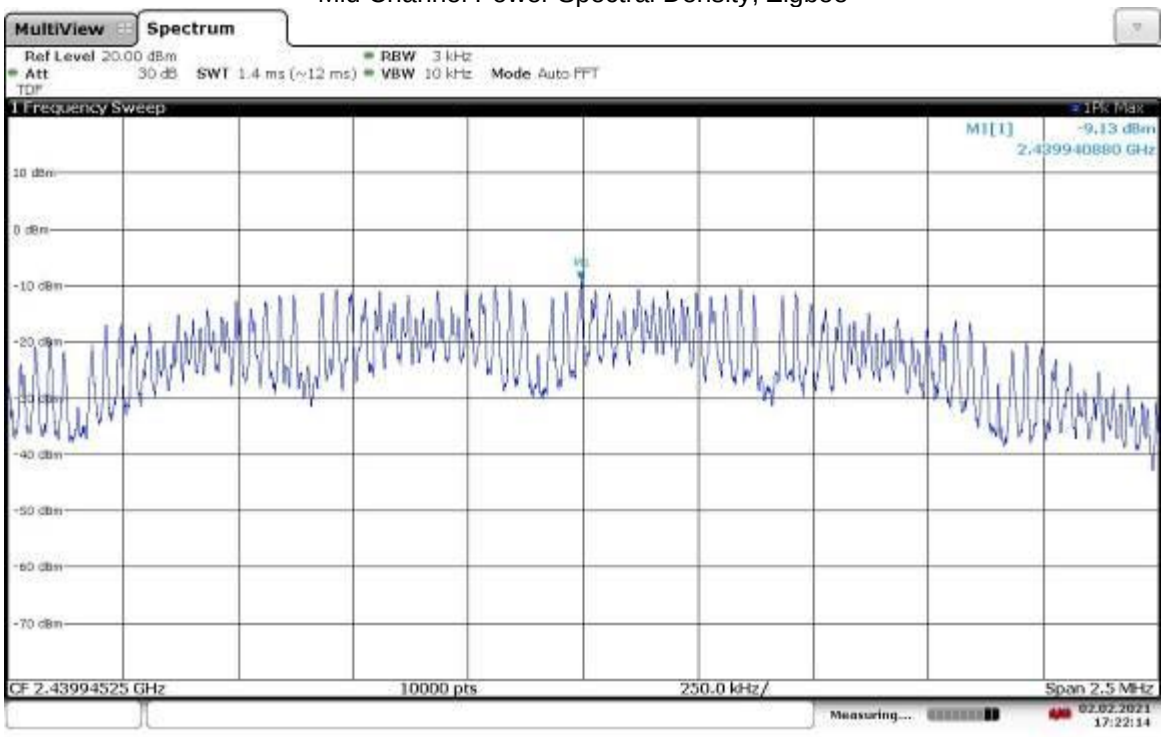
Mid Channel Power Spectral Density, Zigbee



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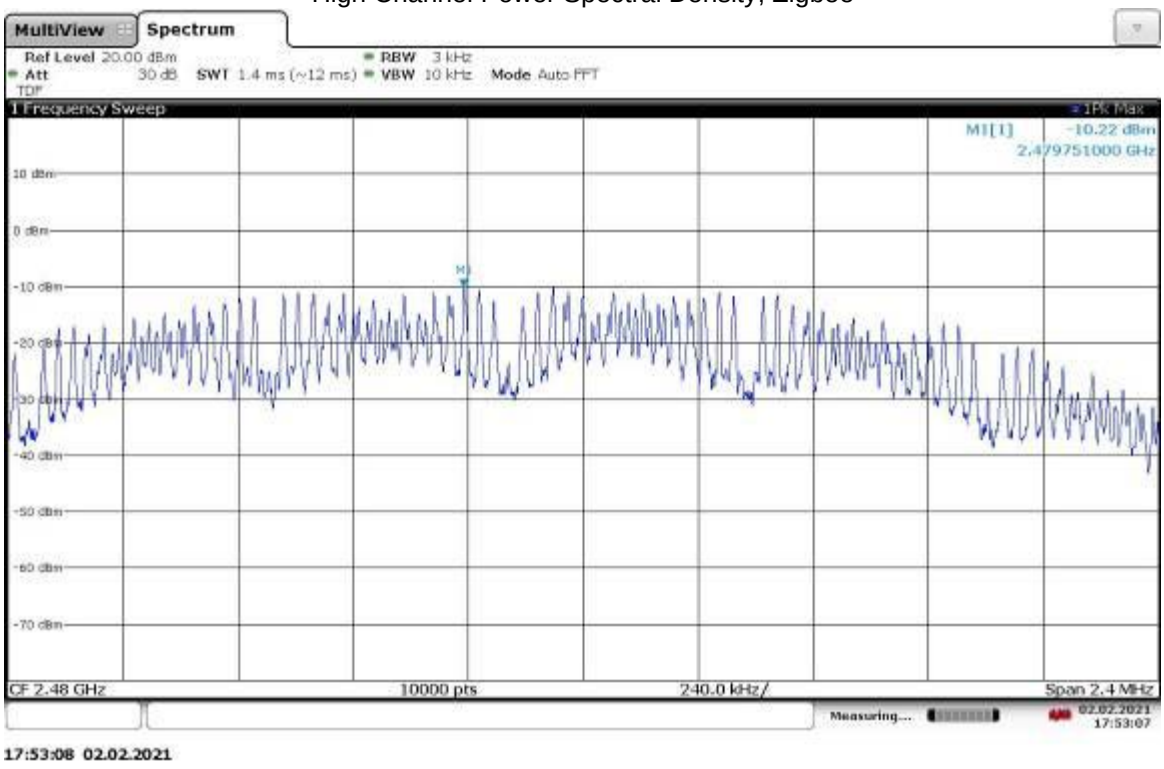
High Channel Power Spectral Density, Zigbee



Power Spectral Density, BLE

Frequency	PSD
(MHz)	(dBm)
2402	-7.12
2442	-7.10
2480	-8.11

Power Spectral Density, 802.15.4 Zigbee

Frequency	PSD
(MHz)	(dBm)
2405	-9.96
2440	-9.13
2480	-10.22

Test Personnel:	Vathana Ven VSV	Test Date:	02/02/2021
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 15.247 RSS-247	Limit Applied:	See report section 8.3
Input Voltage:	24VDC	Ambient Temperature:	24ºC
Pretest Verification w/ Ambient Signals or BB Source:	**N/A**	Relative Humidity:	24%
		Atmospheric Pressure:	1009mbars

Deviations, Additions, or Exclusions: None

9 Band Edge Compliance

9.1 Method

Tests are performed in accordance with FCC Part 15 Subpart C 15.247 RSS 247, ANSI C 63.10.

TEST SITE: EMC Lab

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

9.2 Test Equipment Used:

Equipment used for conducted measurements

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007'	Weather Station Vantage Vue	Davis	6250	MS191212003	03/12/2020	03/12/2021
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	10/27/2020	10/27/2021
CEN001'	DC-40GHz attenuator 20dB	Centric RF	C411-20	CEN001	01/22/2021	01/22/2022
CBLHF2012-2M-2	2m 9kHz-40GHz Coaxial Cable - SET2	Huber & Suhner	SF102	252675002	02/10/2021	02/10/2022

Equipment used for radiated measurements

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007'	Weather Station Vantage Vue	Davis	6250	MS191212003	03/12/2020	03/12/2021
ETS002'	1-18GHz DRG Horn Antenna	ETS Lindgren	3117	00143260	08/03/2020	08/03/2021
145108'	Receiver	Rhode & Schwarz	ESIB40	100209	06/08/2020	06/08/2021
HS002'	DC-18GHz cable 1.5M long	Huber & Suhner	SucoFlex 106A	HS002	11/19/2020	11/19/2021
145-423'	Pre-amp to under floor	Huber and Suhner	SF106A/11N/11N/1.5m	145-423	03/27/2020	03/27/2021
145-424'	9kHz to 40GHz Cable	Huber and Suhner	Sucoflex	145-424	03/27/2020	03/27/2021
145-414'	3m Track A cables	Huber + Suhner	3m Track A cables	multiple	06/25/2020	06/25/2021

Software Utilized:

Name	Manufacturer	Version
None	--	--

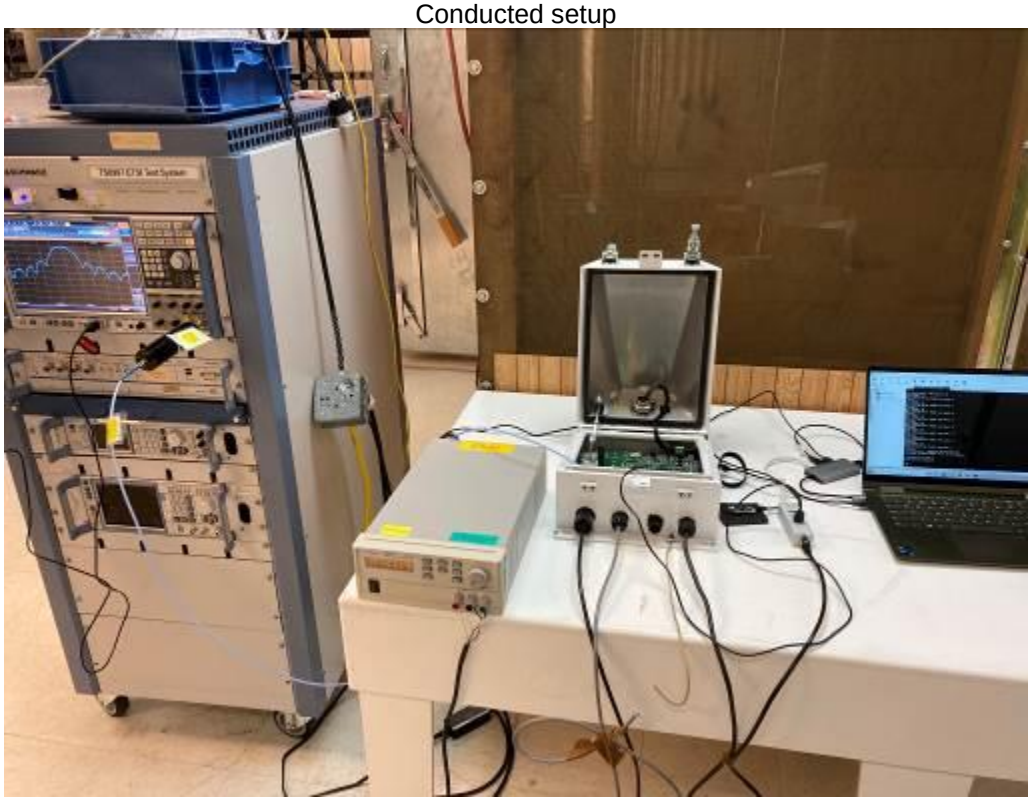
9.3 Results:

The sample tested was found to Comply.

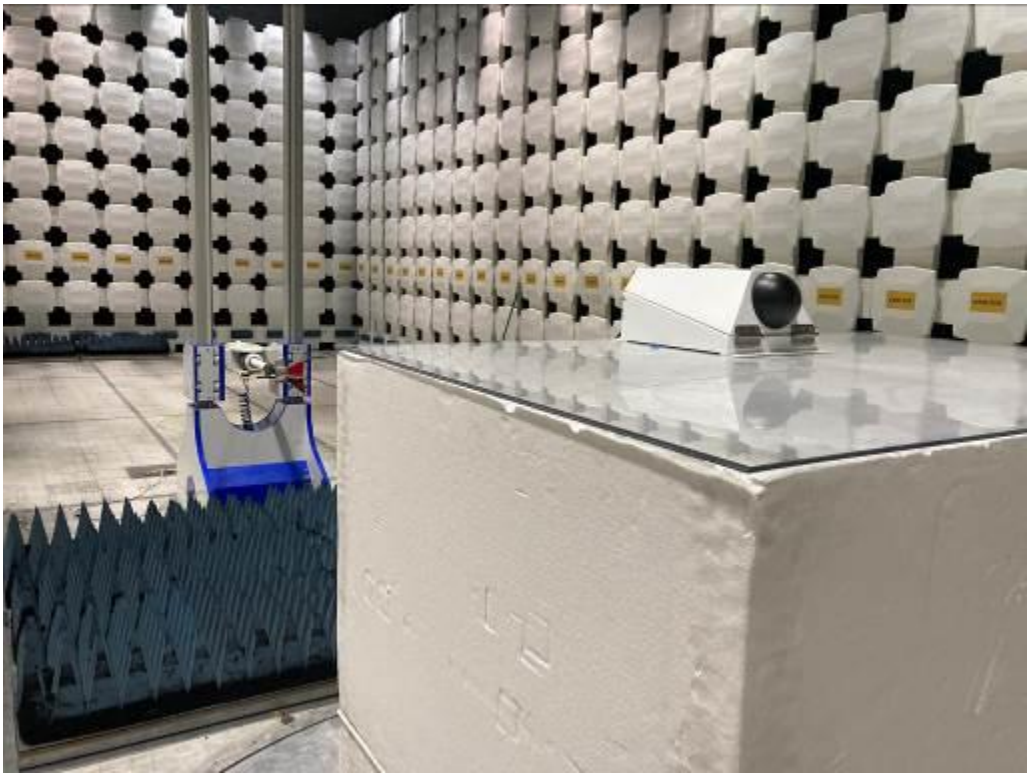
15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c))

9.4 Setup Photographs:

Conducted setup

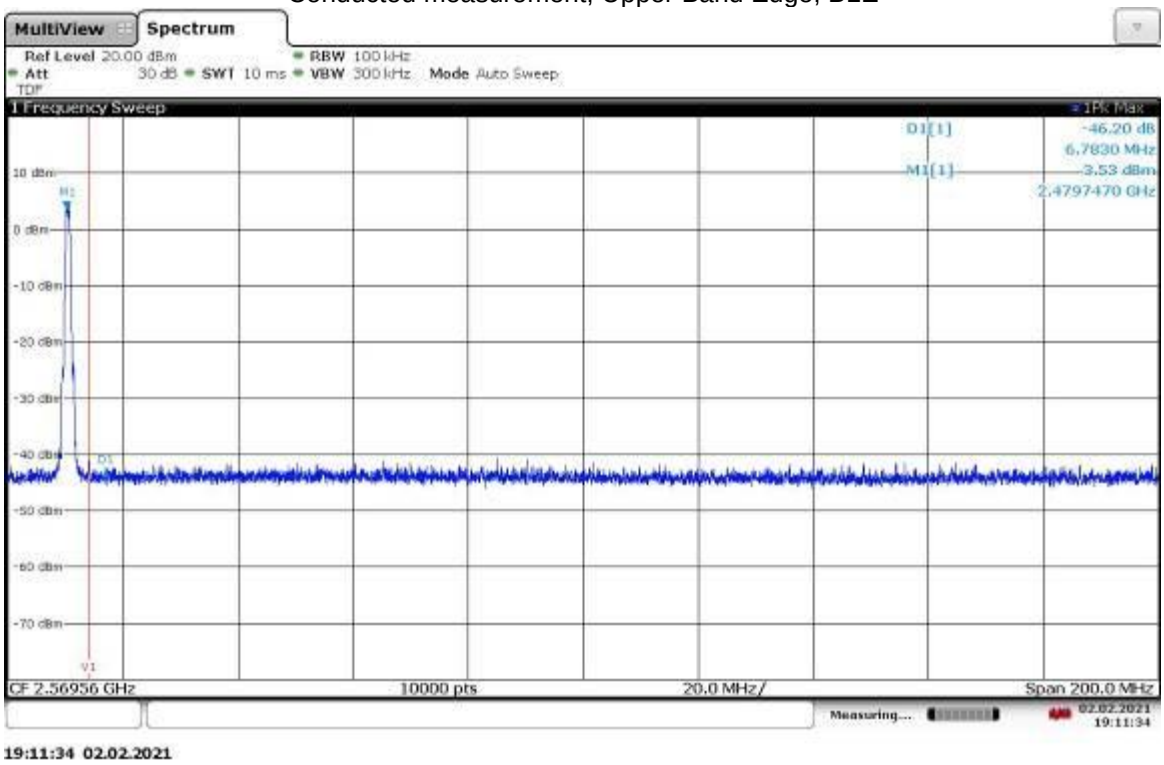


Radiated setup



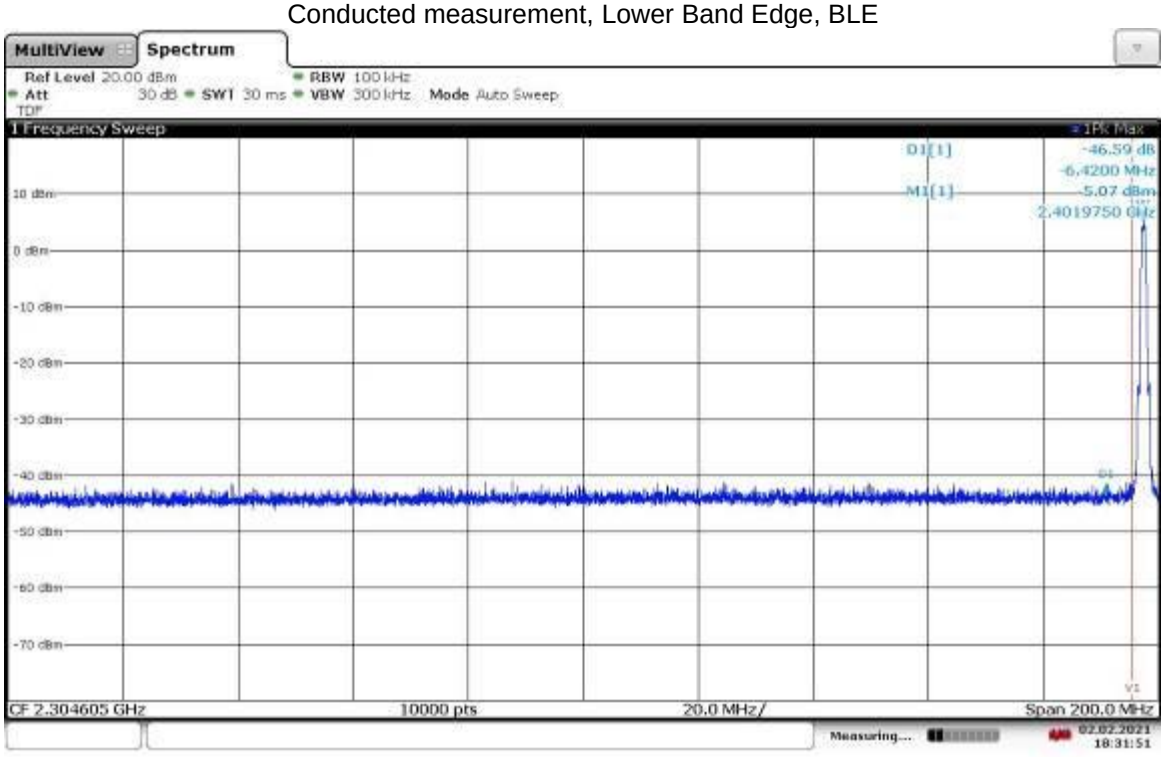
9.5 Test Data:

Conducted measurement, Upper Band Edge, BLE



19:11:34 02.02.2021

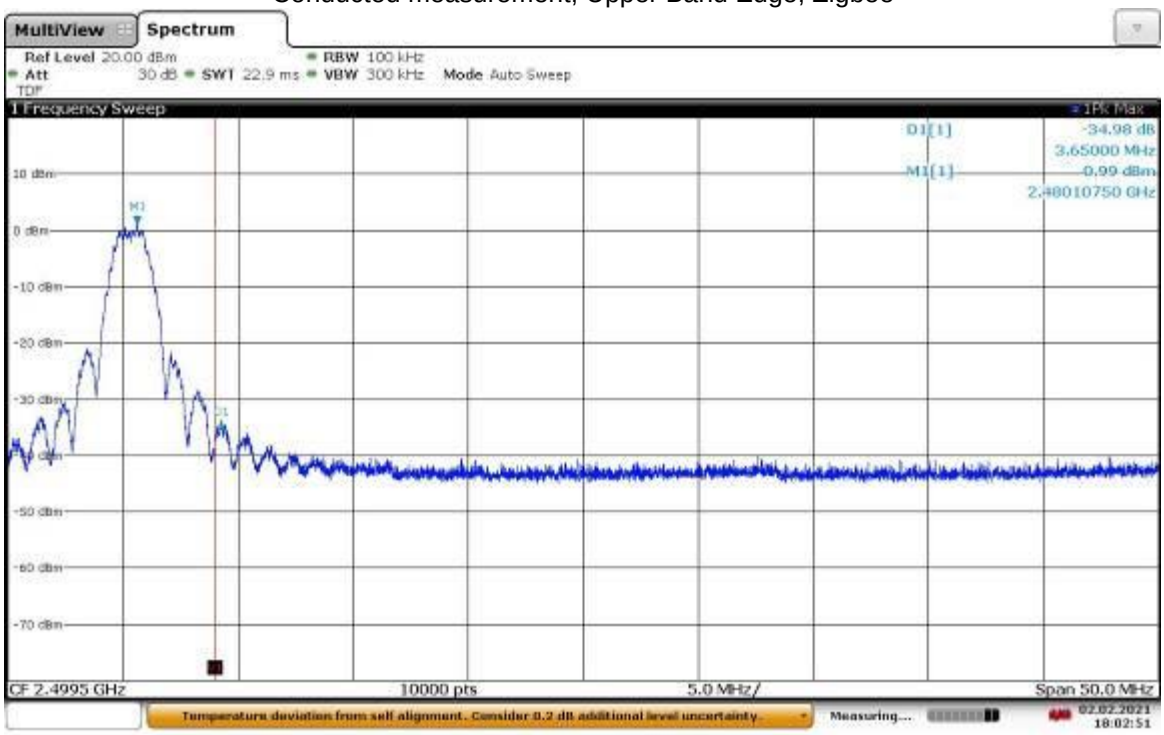
Conducted measurement, Lower Band Edge, BLE



18:31:52 02.02.2021

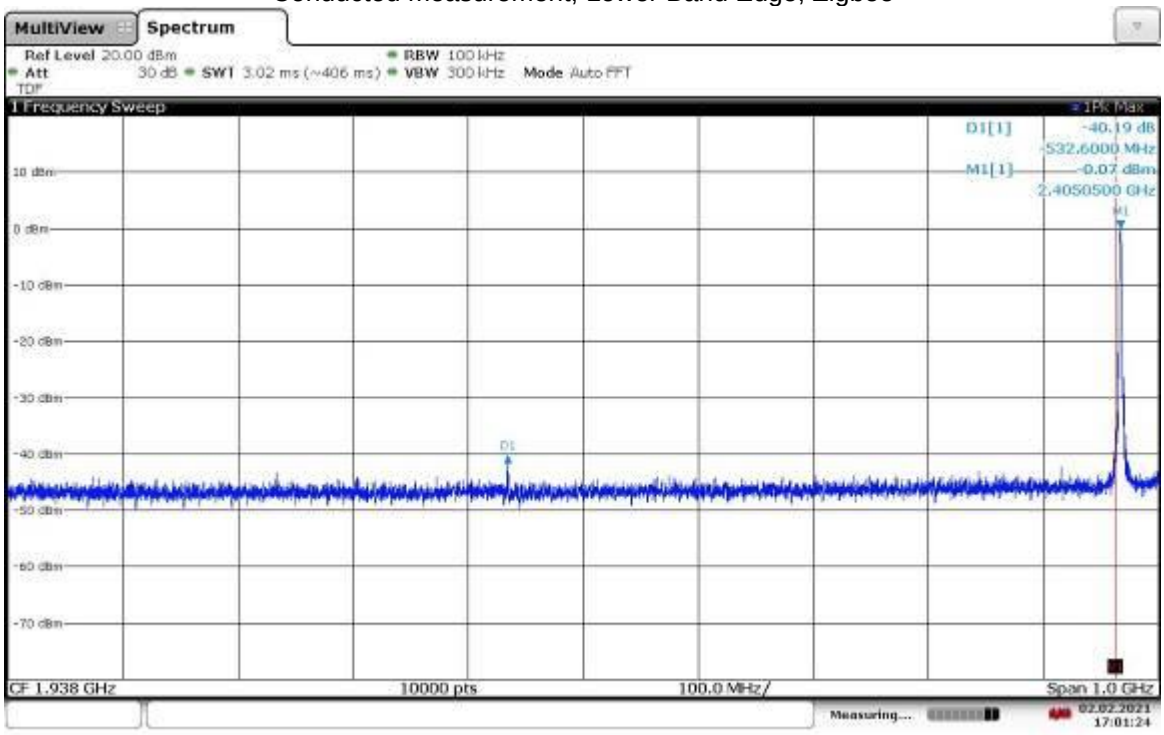
Notes: Cable loss and attenuator factors were internally compensated as transducer factor (TDF).

Conducted measurement, Upper Band Edge, Zigbee



18:02:51 02.02.2021

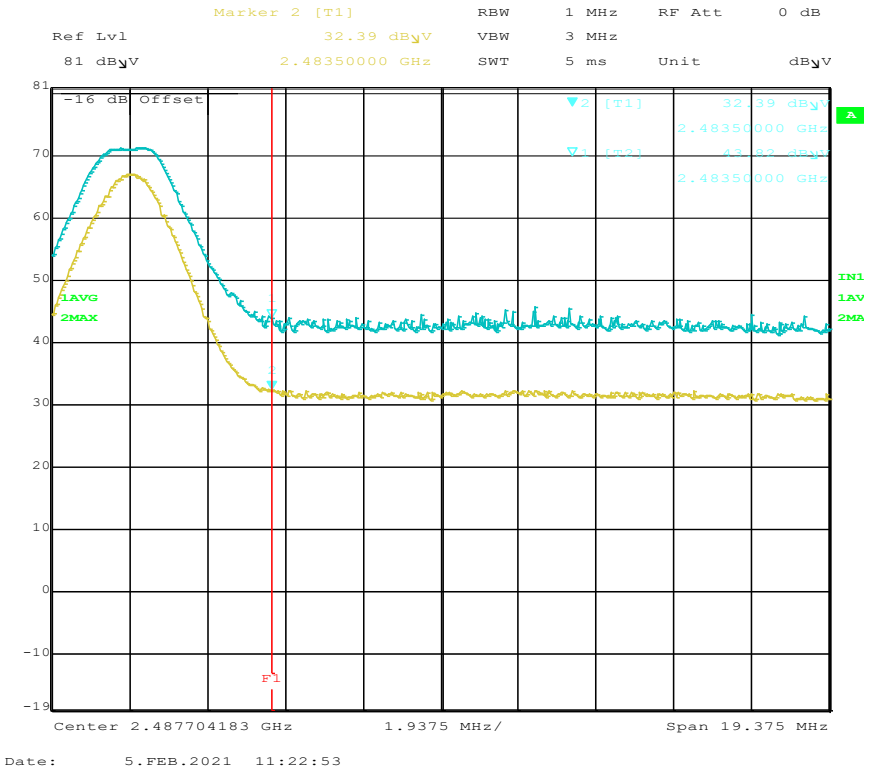
Conducted measurement, Lower Band Edge, Zigbee



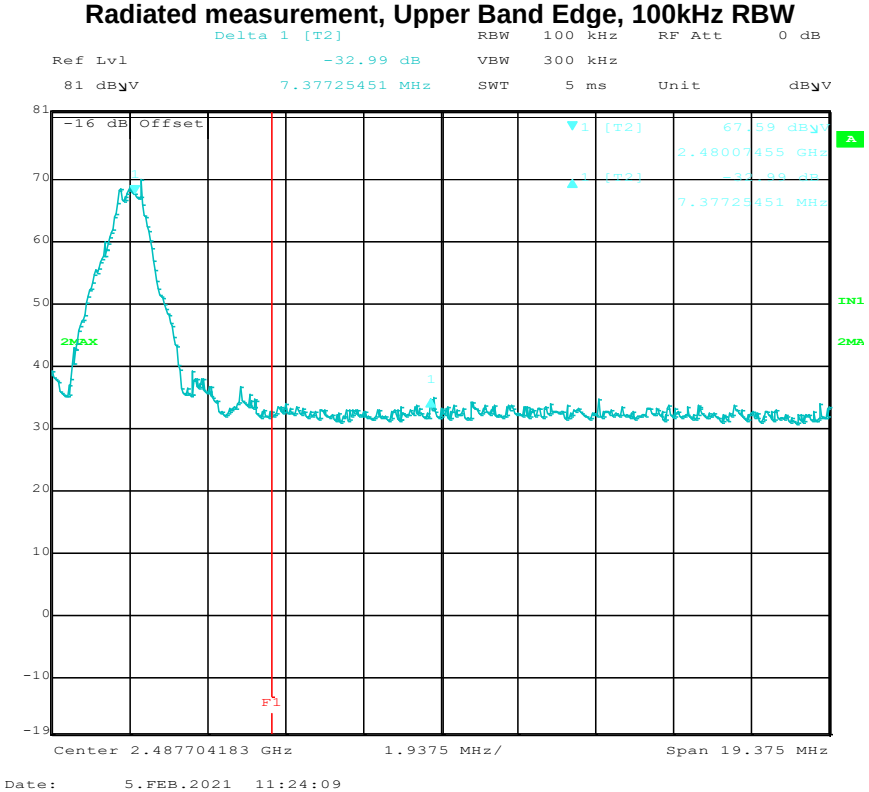
17:01:25 02.02.2021

Notes: Cable loss and attenuator factors were internally compensated as transducer factor (TDF).

Radiated measurement, Upper Band Edge, 1MHz RBW

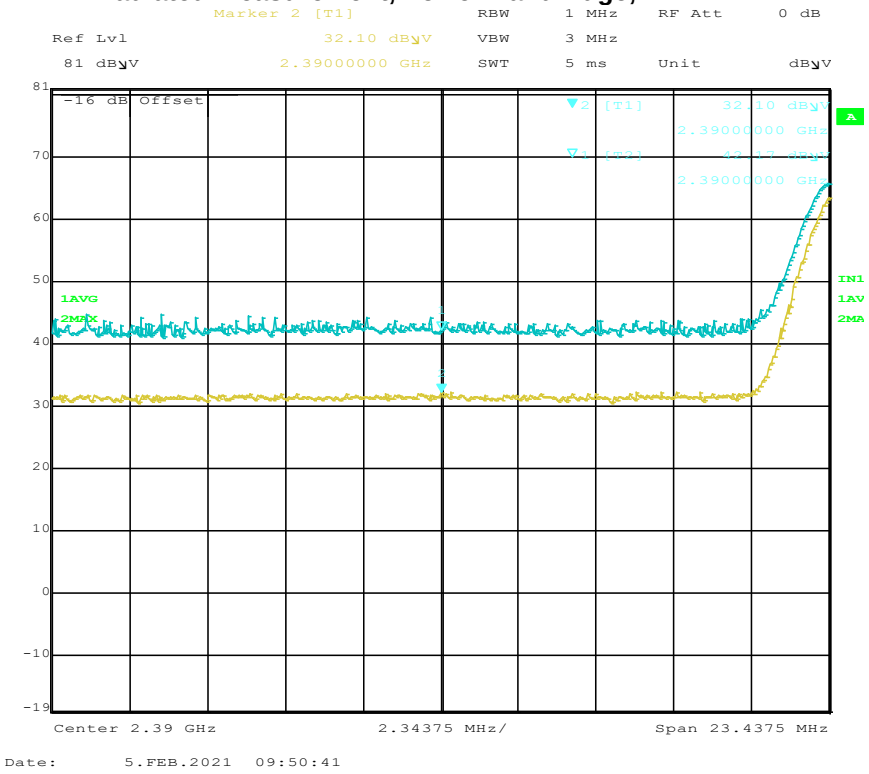


Radiated measurement, Upper Band Edge, 100kHz RBW

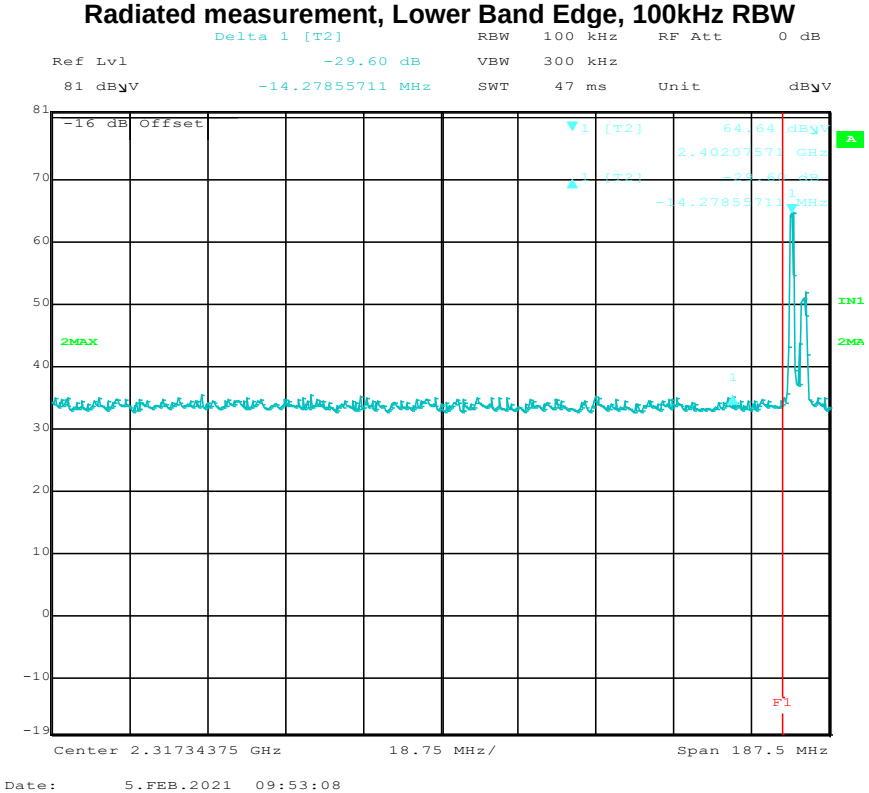


Notes: Cable loss, antenna, and pre-amp factors were internally compensated.

Radiated measurement, Lower Band Edge, 1MHz RBW



Radiated measurement, Lower Band Edge, 100kHz RBW



Notes: Cable loss, antenna, and pre-amp factors were internally compensated.

Test Personnel:	Vathana Ven	Test Date:	02/02/2021, 02/05/2021
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 15.247 RSS-247	Limit Applied:	See report section 9.3
Input Voltage:	24VDC	Ambient Temperature:	24, 24 ºC
Pretest Verification w/ Ambient Signals or BB Source:	**N/A**	Relative Humidity:	24, 21 %
		Atmospheric Pressure:	1009, 994 mbars

Deviations, Additions, or Exclusions: None

10 Transmitter spurious emissions

10.1 Method

Tests are performed in accordance with FCC Part 15 Subpart C 15.247, FCC Part 15 Subpart B, RSS 247 ICES 003, ANSI C 63.10, and ANSI C 63.4.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	4.6dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	5.3 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.5 dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	5.2 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	5.0 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	5.0 dB	5.5 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG
Where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

Alternately, when BAT-EMC Emission Software is used, the “Level” includes all losses and gains and is compared directly in the “Margin” column to the “Limit”. The “Correction” includes Antenna Factor, Preamp, and Cable Loss. These are already accounted for in the “Level” column.

TEST SITE: EMC Lab

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

10.2 Test Equipment Used:

Equipment for conducted measurements

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007'	Weather Station Vantage Vue	Davis	6250	MS191212003	03/12/2020	03/12/2021
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	10/27/2020	10/27/2021
CEN001'	DC-40GHz attenuator 20dB	Centric RF	C411-20	CEN001	01/22/2021	01/22/2022
CBLHF2012-2M-2	2m 9kHz-40GHz Coaxial Cable - SET2	Huber & Suhner	SF102	252675002	02/10/2021	02/10/2022

Equipment for Radiated measurements

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007'	Weather Station Vantage Vue	Davis	6250	MS191212003	03/12/2020	03/12/2021
145108'	EMI Test Receiver (20Hz - 40GHz)	Rohde & Schwarz	ESIB40	100209	06/08/2020	06/08/2021
PRE11'	50dB gain pre-amp	Pasternack	PRE11	PRE11	09/11/2020	09/11/2021
145145'	Broadband Hybrid Antenna 30 MHz - 3 GHz	Sunol Sciences Corp.	JB3	A122313	05/08/2020	05/08/2021
IW001'	2 meter cable	Insulated Wire	2801-NPS	001	10/08/2020	10/08/2021
145-406'	10m Track A In-floor Cable #1	Huber + Suhner	sucoflex 160-19220mm	001	09/21/2020	09/21/2021
HS001'	DC-18GHz cable 1.5m long	Huber & Suhner	SucoFlex 106A	HS001	10/07/2020	10/07/2021
IW003'	8.4 meter cable	Insulated Wire	2800-NPS	003	06/10/2020	06/10/2021
145-422'	10Amp Pre-amp to under floor	Utiflex	UFB311A-0-2756-70070	145-422	02/17/2020	02/17/2021
HS003'	10m under floor cable	Huber-Schuner	10m-1	HS003	04/29/2020	04/29/2021
ETS002'	1-18GHz DRG Horn Antenna	ETS Lindgren	3117	00143260	08/03/2020	08/03/2021
MEG002'	Cable,SMA-SMA,9KHz-40GHz, (Cable Kit 6)	Megaphase	TM40-K1K1-197	59006401001	09/22/2020	09/22/2021
REA004'	3GHz High Pass Filter	Reactel, Inc	7HSX-3G/18G-S11	06-1	02/25/2020	02/25/2021
REA006'	18GHz High Pass Filter	Reactel, Inc	7HS-18G/40G K11	(06)1	04/20/2020	04/20/2021
EMC02'	ANTENNA, RIDGED GUIDE, 1-18 GHZ	EMC84	3115	2784	09/28/2020	09/28/2021
ROS005-1'	Signal and Spectrum Analyzer	Rohde and Shwartz	FSW43	100646	10/27/2020	10/27/2021
CBLSHF201'	Cable, SMA - SMA, < 18GHz	Sucoflex (Huber Suhn	104PE	CBLSHF201	10/30/2020	10/30/2021
PRE8'	PREAMPLFIER 1- 40 GHz	MITEQ	NSP4000-NF	507145	11/25/2020	11/25/2021
BONN001'	1-18GHz low noise pre-amp	Bonn	BLMA 0118-M	1811749	07/11/2020	07/11/2021
ETS003'	9kHz-30MHz Active Loop Antenna	ETS Lindgren	6502	00143396	07/28/2020	07/28/2021

Software Utilized:

Name	Manufacturer	Version
EMI Boxborough.xls	Intertek	08/27/2010
BAT-EMC	Nexio	3.18.0.16

10.3 Results:

The sample tested was found to Comply when modified as described below.

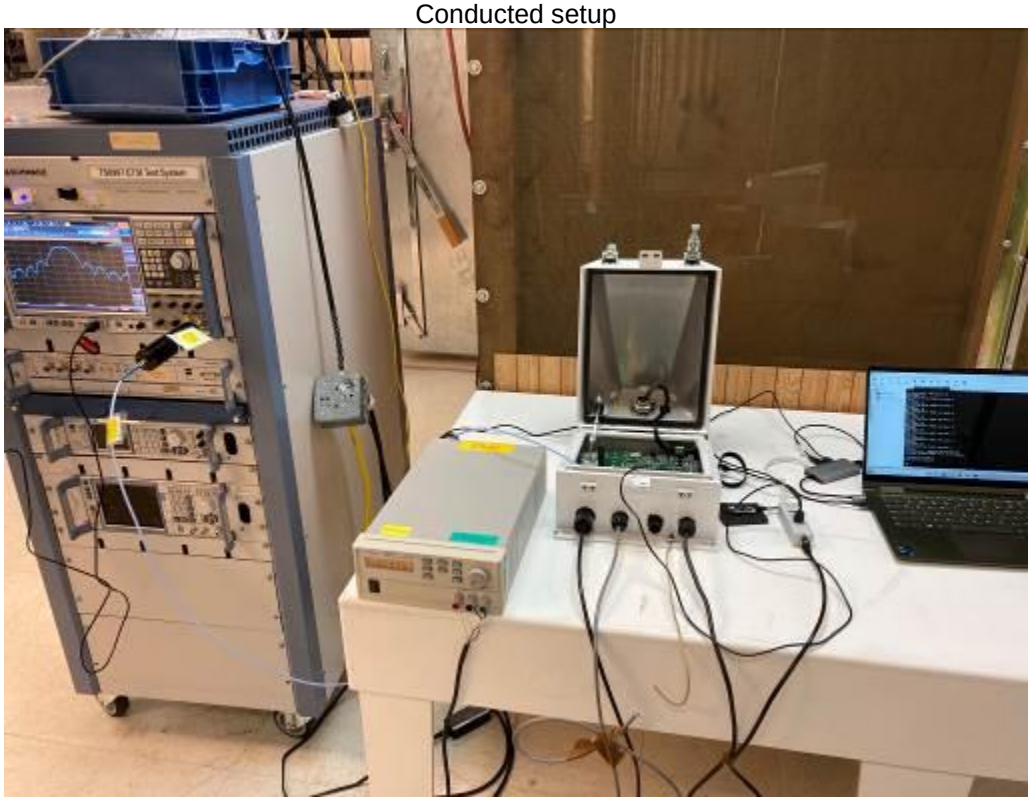
15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c))

Modifications:

(1) Ferrite sleeve (Fair-Rite, p/n: 0444164181) was externally installed around the power cable with one loop configuration as close to the EUT as possible.
(2) Ferrite sleeve (Fair-Rite, p/n: 0444164181) was externally installed around Ethernet cable with a straight through configuration as close to the EUT as possible.

10.4 Setup Photographs:

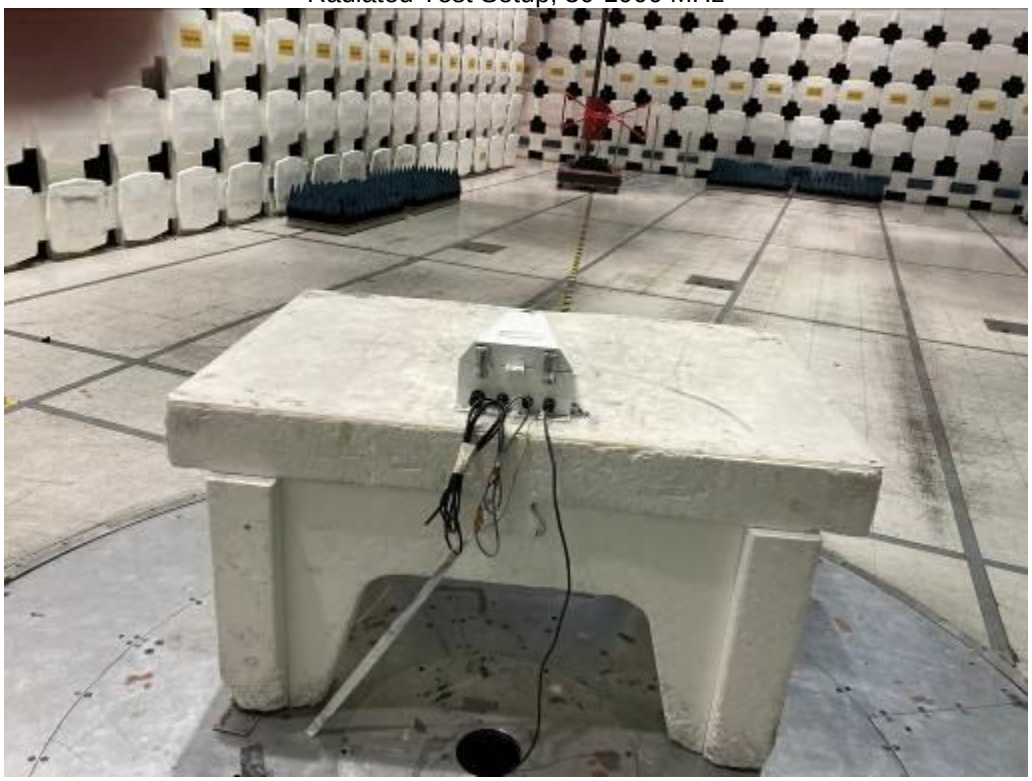
Conducted setup

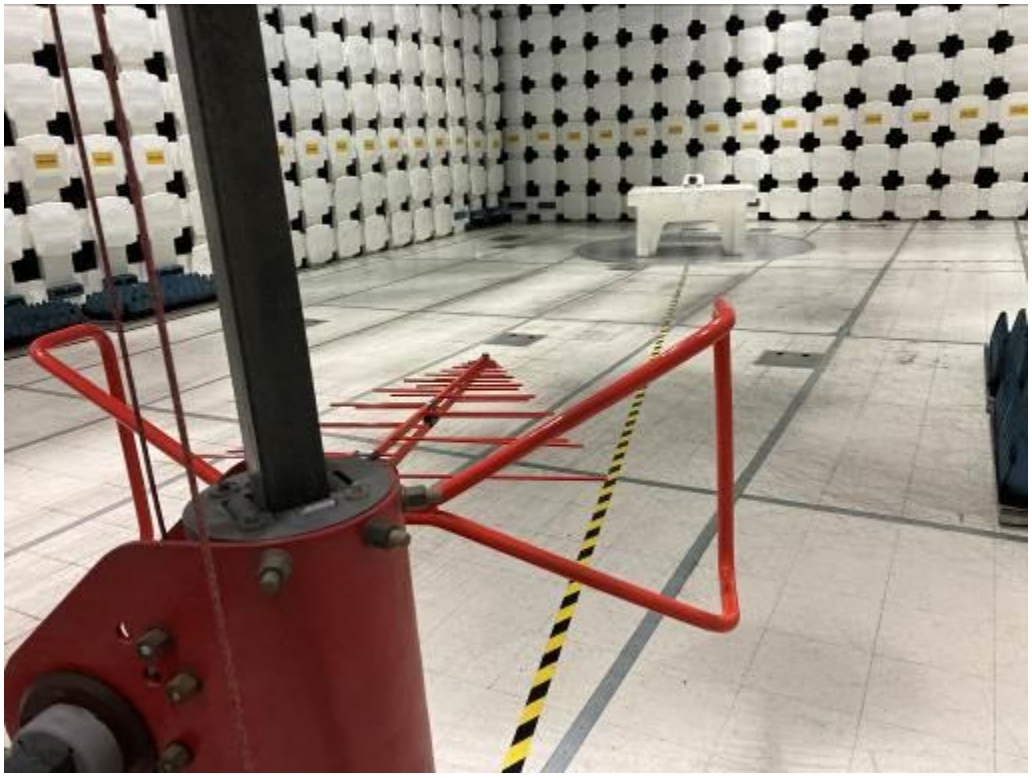


Radiated Test Setup, 9kHz-30MHz

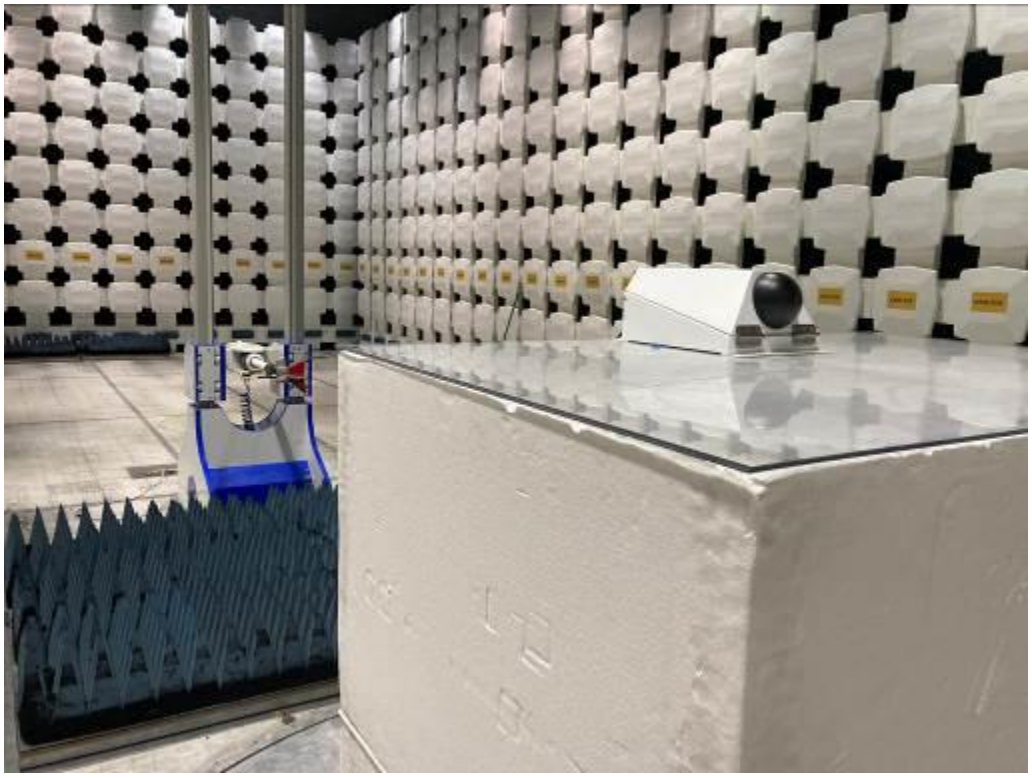
Photos not available

Radiated Test Setup, 30-1000 MHz

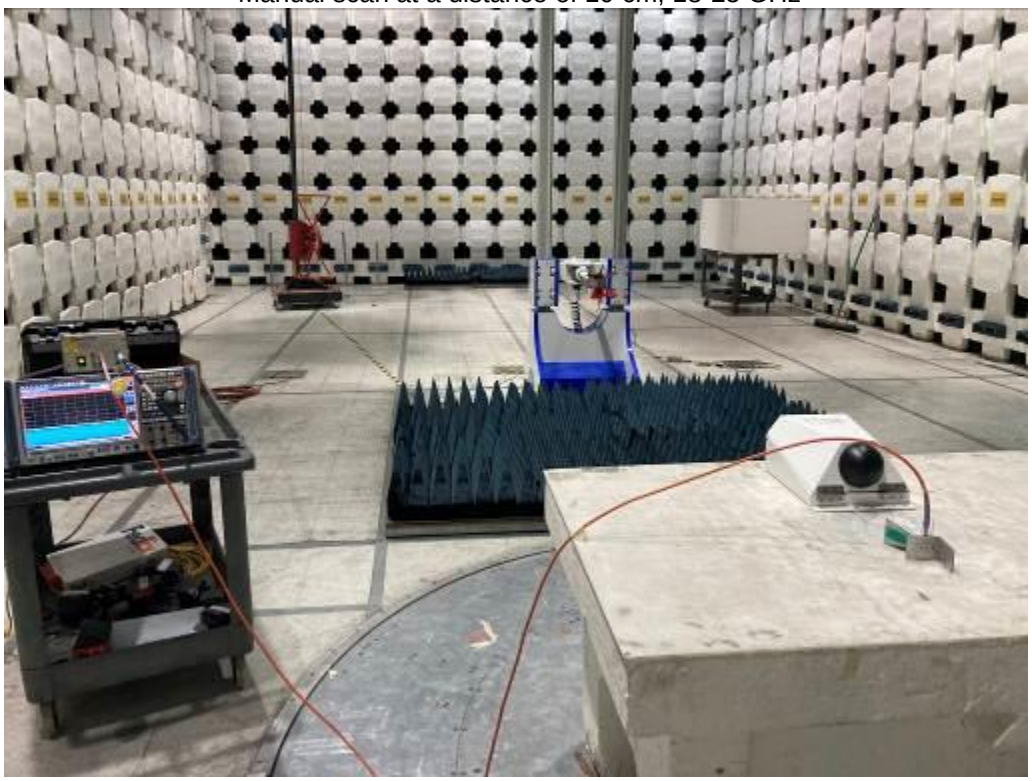


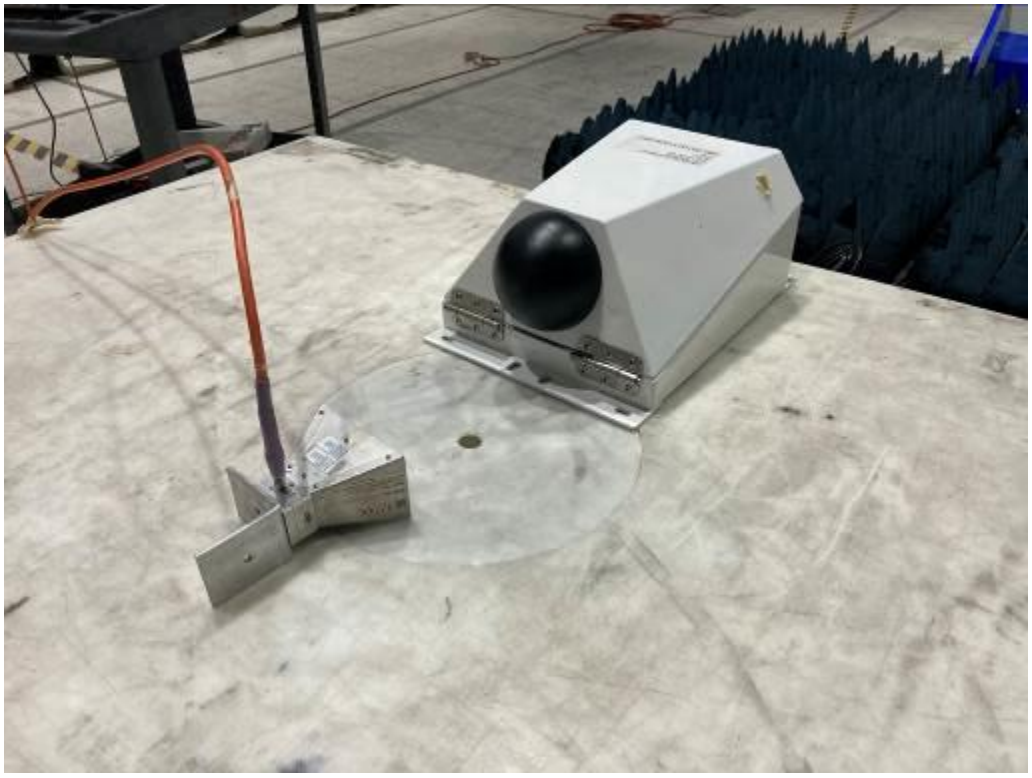


Test Setup, 1-18 GHz



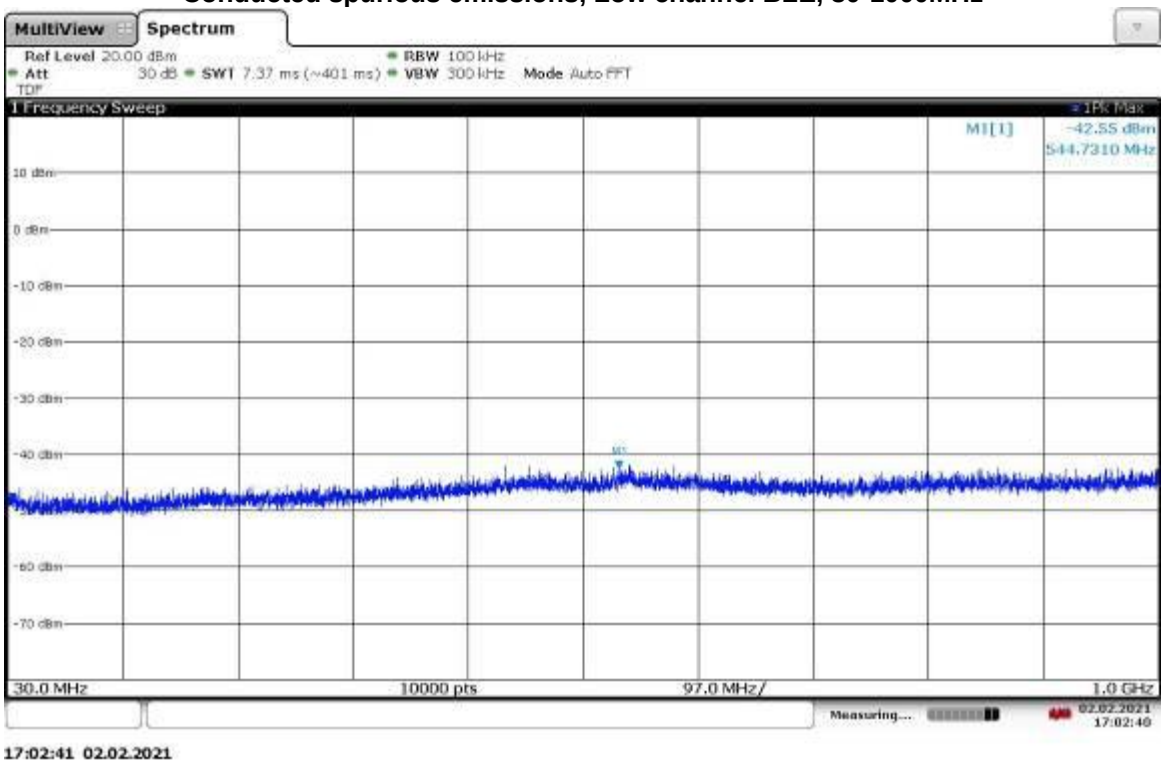
Manual scan at a distance of 10 cm, 18-25 GHz





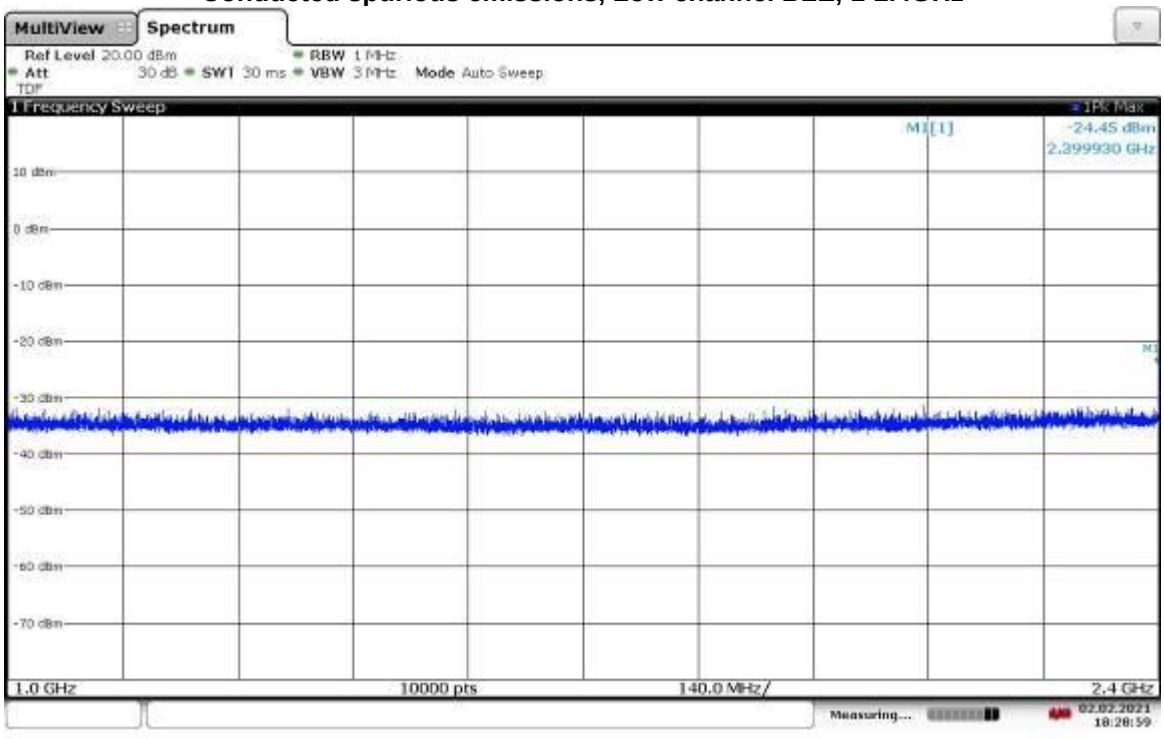
10.5 Plots/Data:

Conducted spurious emissions, Low channel BLE, 30-1000MHz



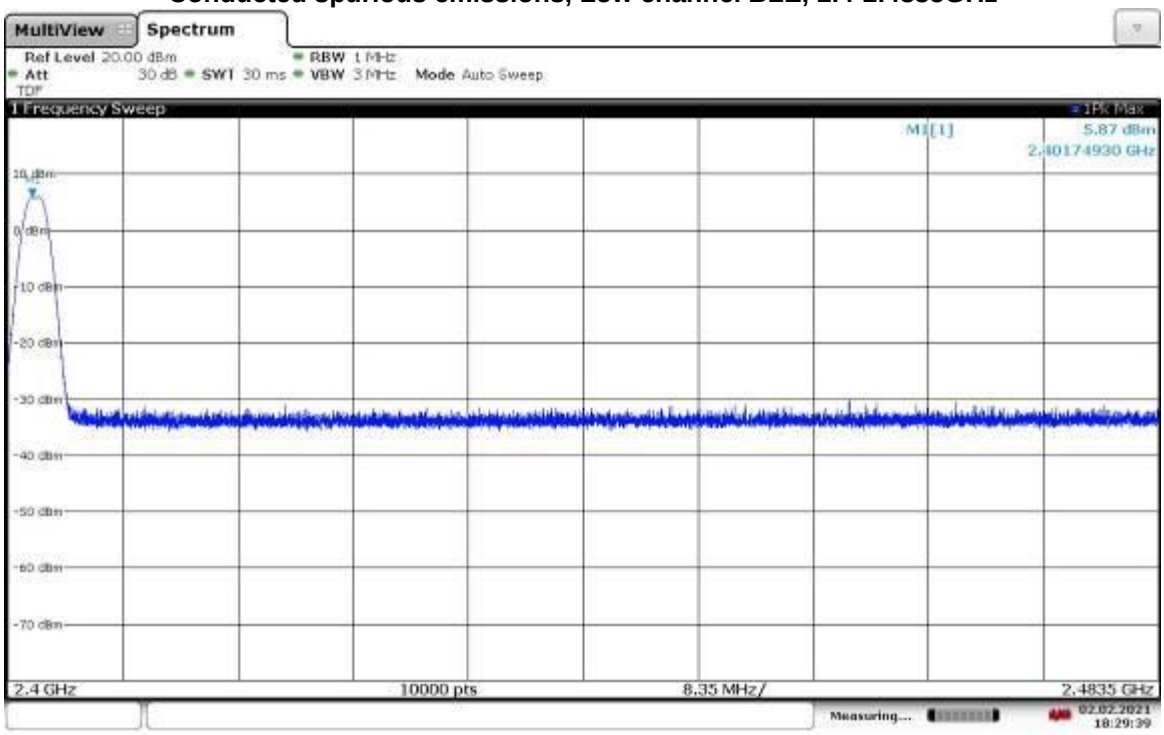
17:02:41 02.02.2021

Conducted spurious emissions, Low channel BLE, 1-2.4GHz



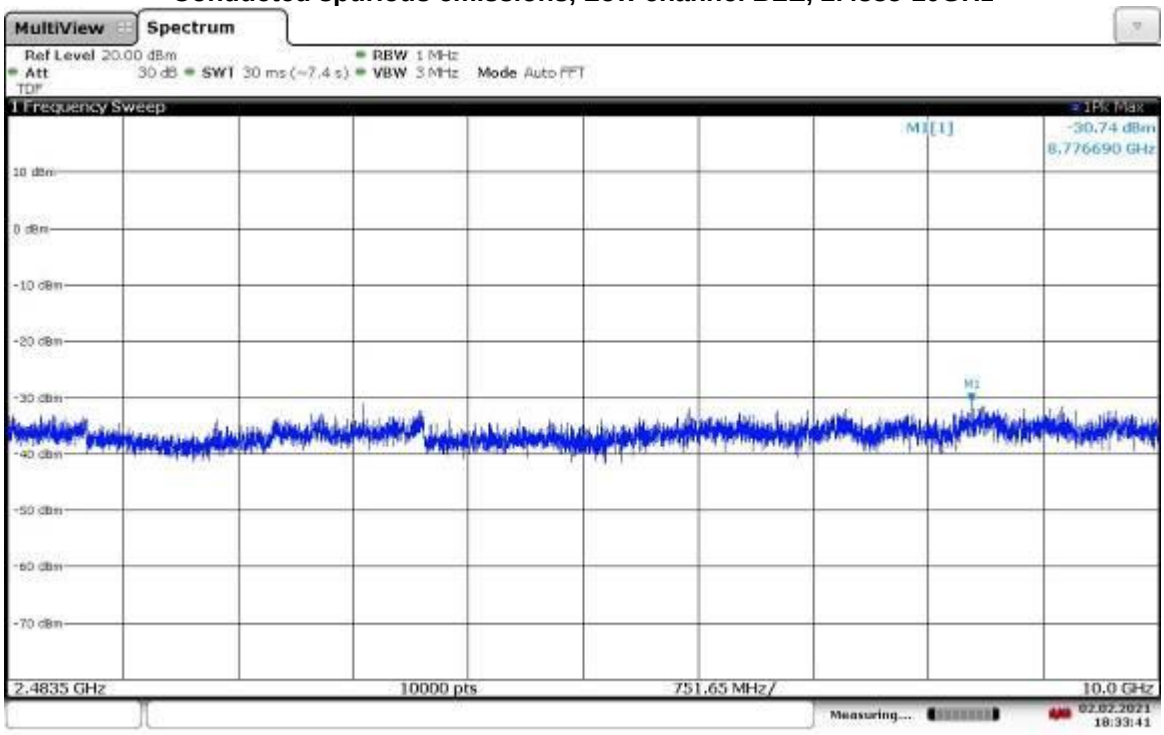
18:29:00 02.02.2021

Conducted spurious emissions, Low channel BLE, 2.4-2.4835GHz



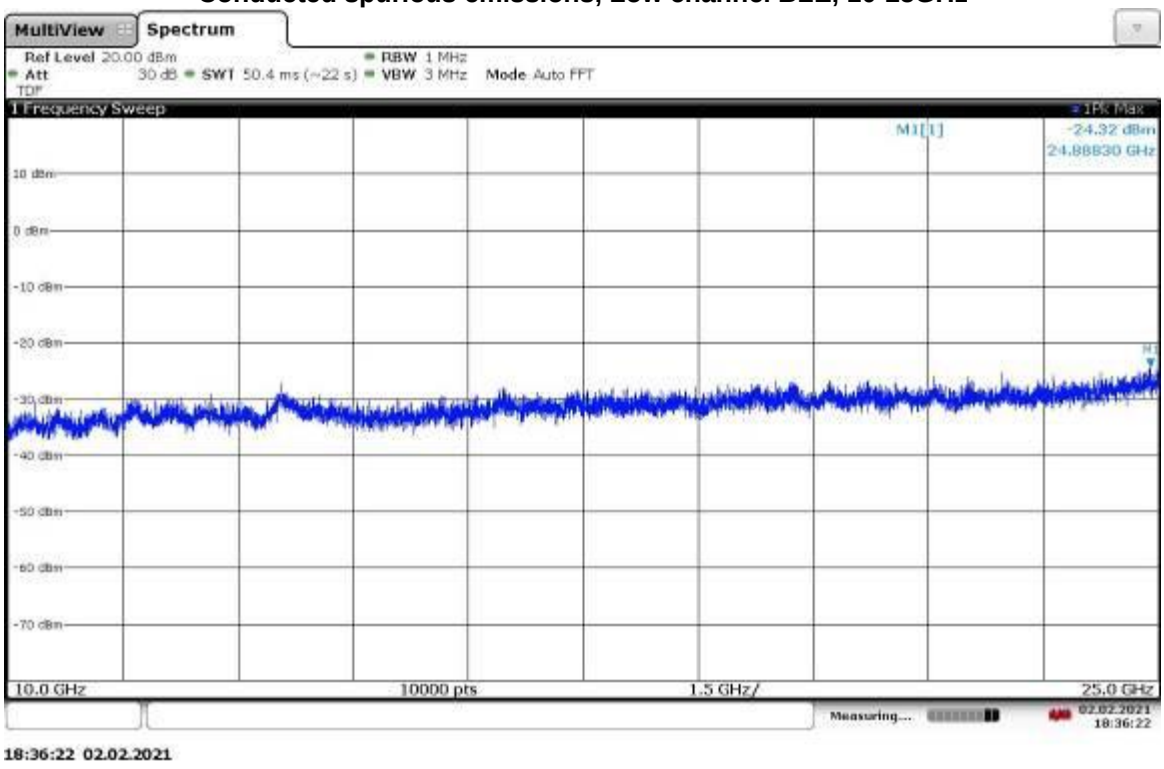
18:29:39 02.02.2021

Conducted spurious emissions, Low channel BLE, 2.4835-10GHz



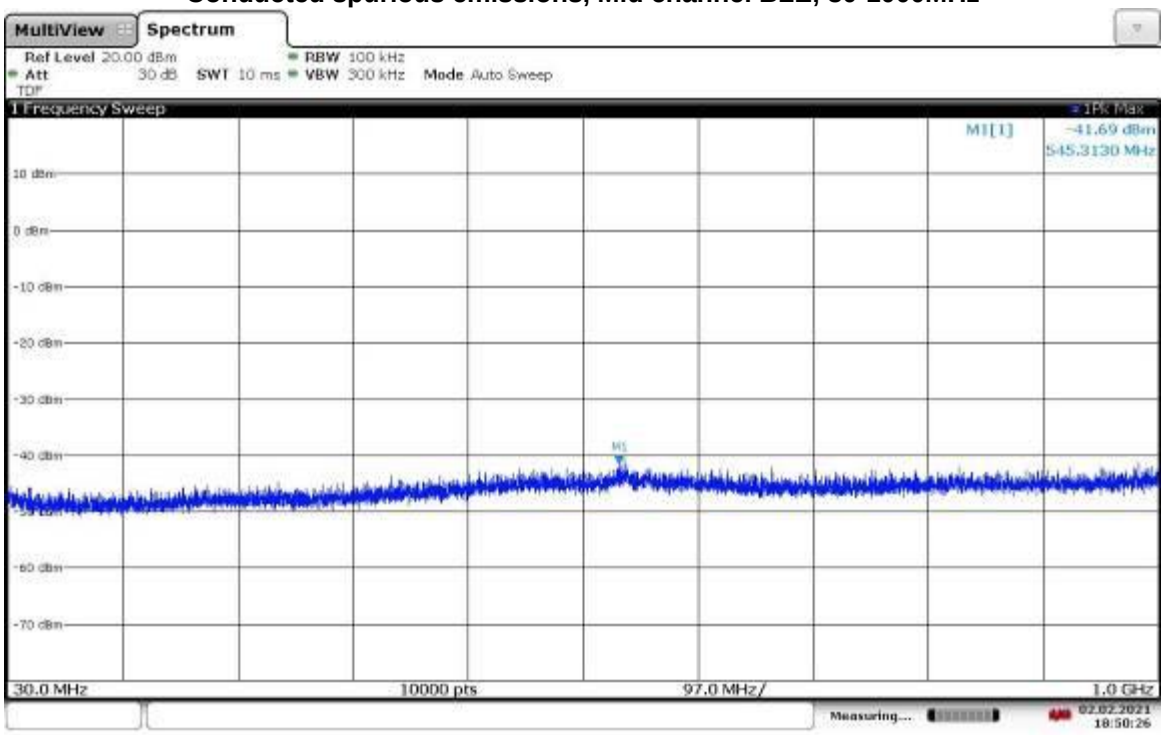
18:33:41 02.02.2021

Conducted spurious emissions, Low channel BLE, 10-25GHz



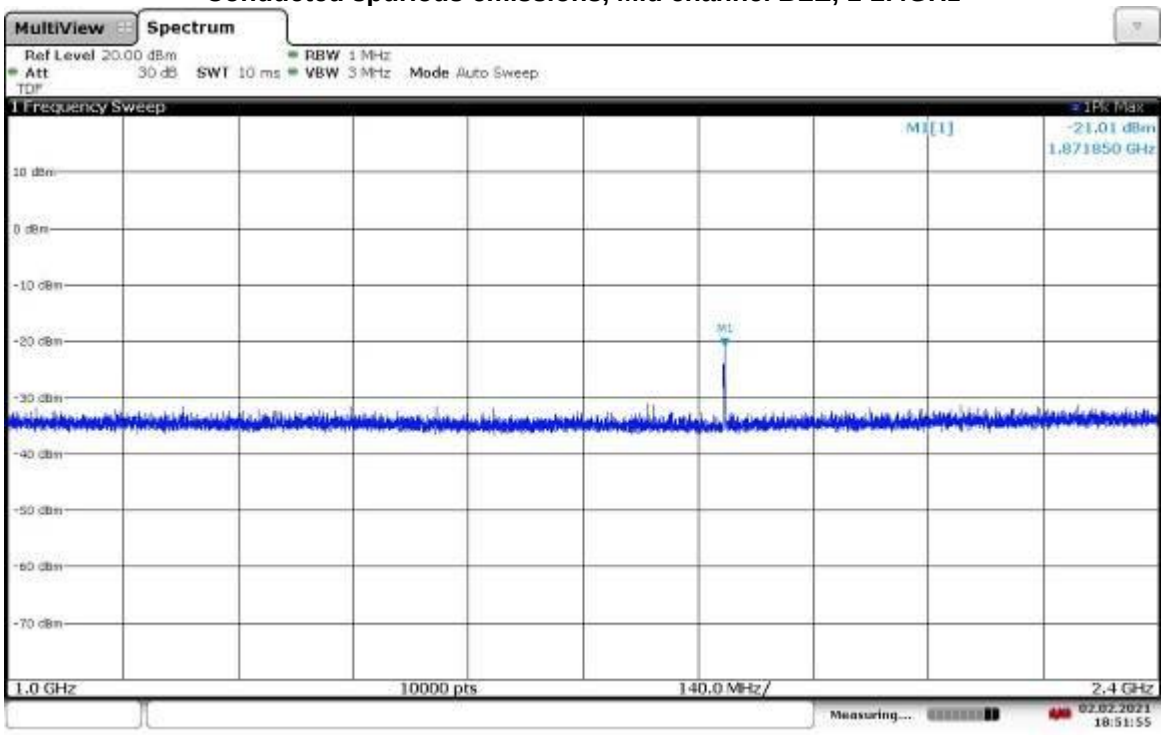
18:36:22 02.02.2021

Conducted spurious emissions, Mid channel BLE, 30-1000MHz



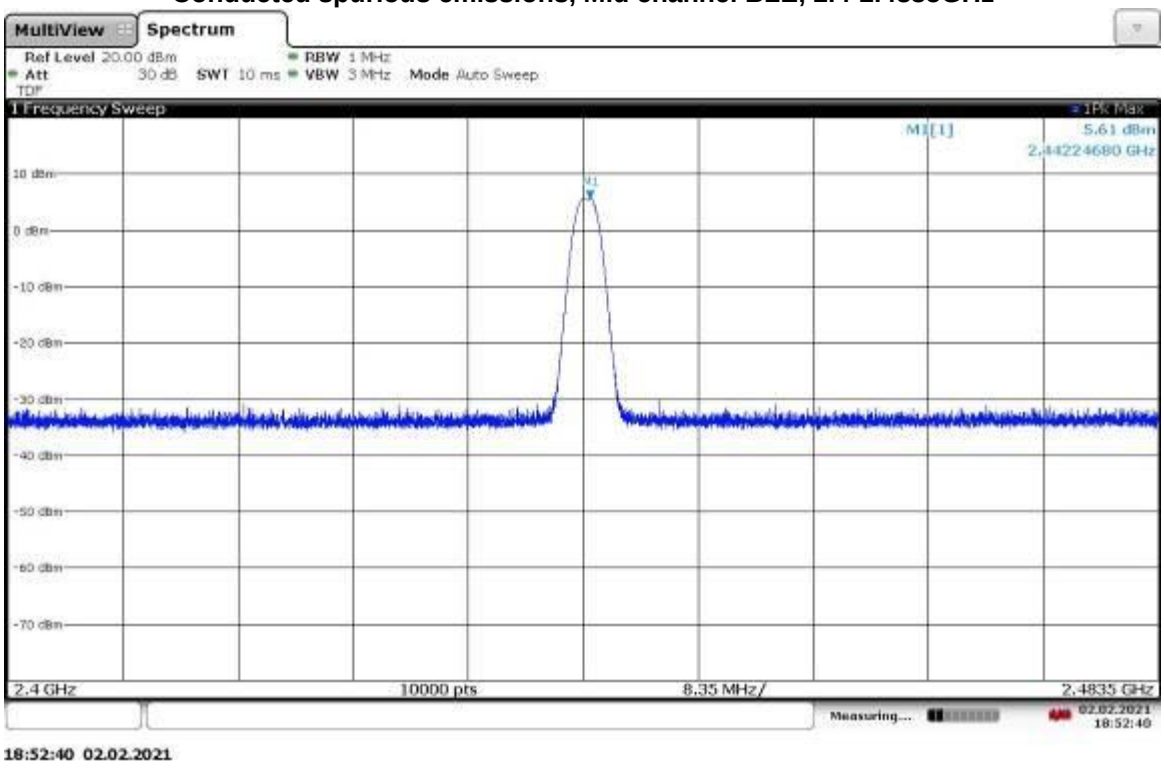
18:50:26 02.02.2021

Conducted spurious emissions, Mid channel BLE, 1-2.4GHz

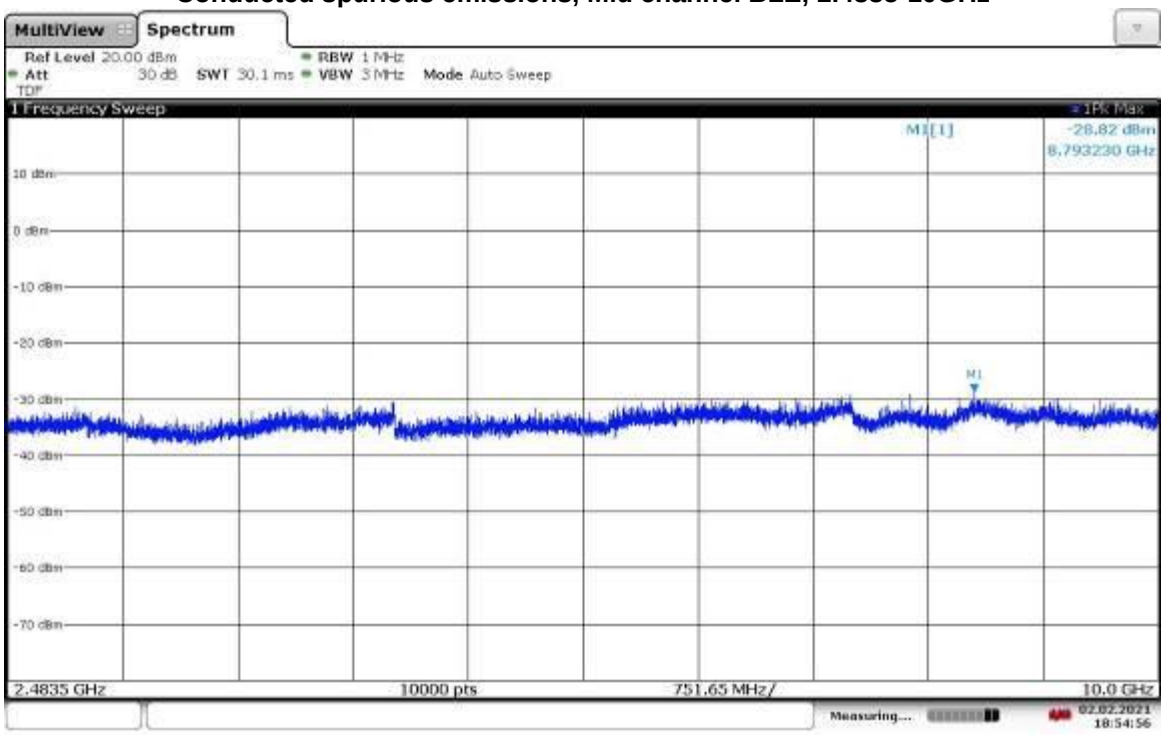


18:51:55 02.02.2021

Conducted spurious emissions, Mid channel BLE, 2.4-2.4835GHz

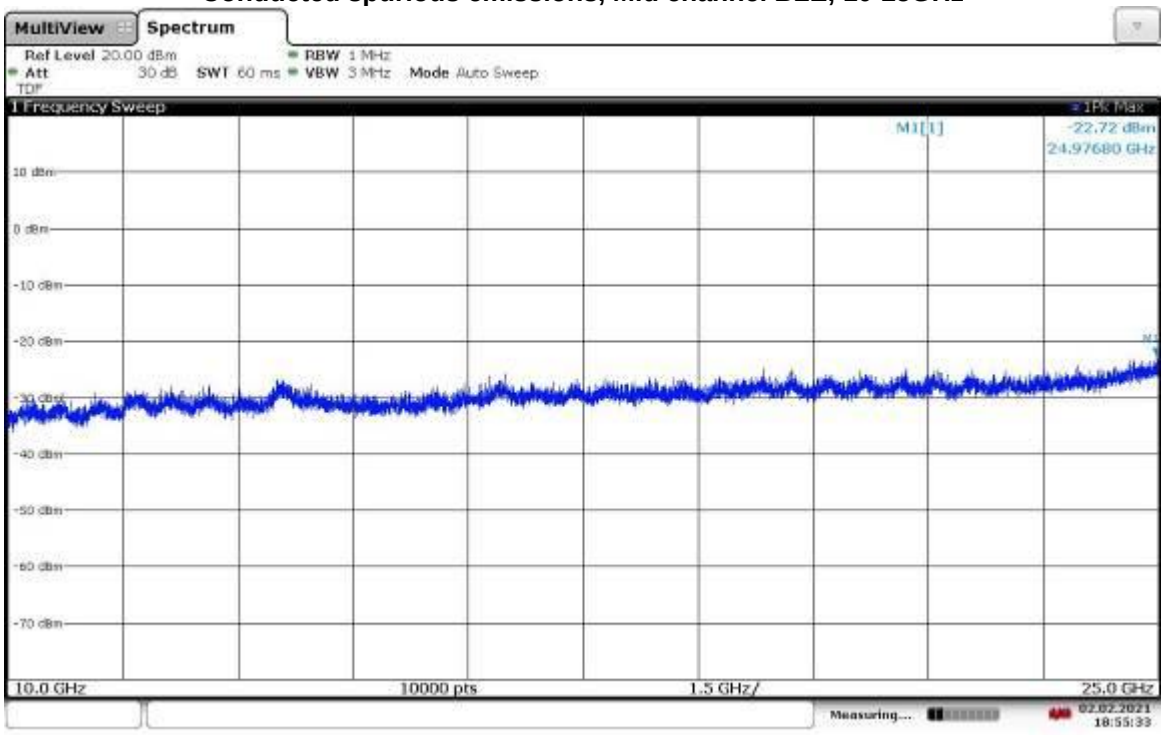


Conducted spurious emissions, Mid channel BLE, 2.4835-10GHz



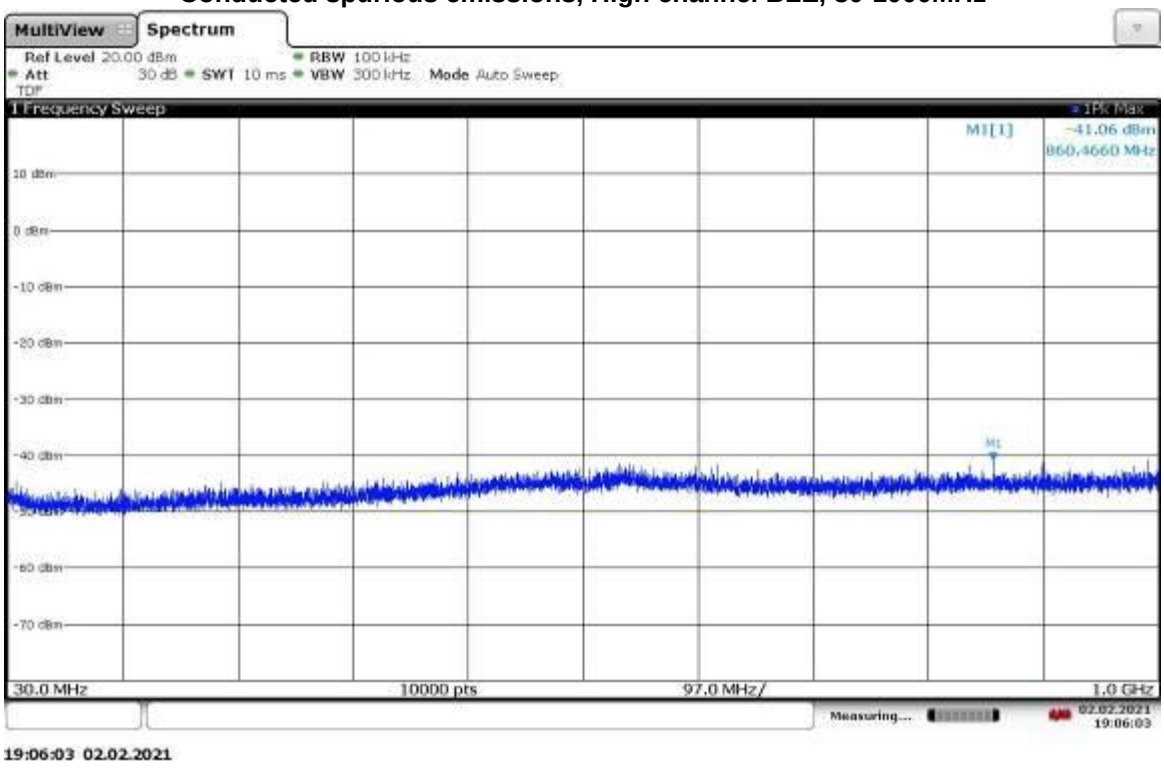
18:54:56 02.02.2021

Conducted spurious emissions, Mid channel BLE, 10-25GHz

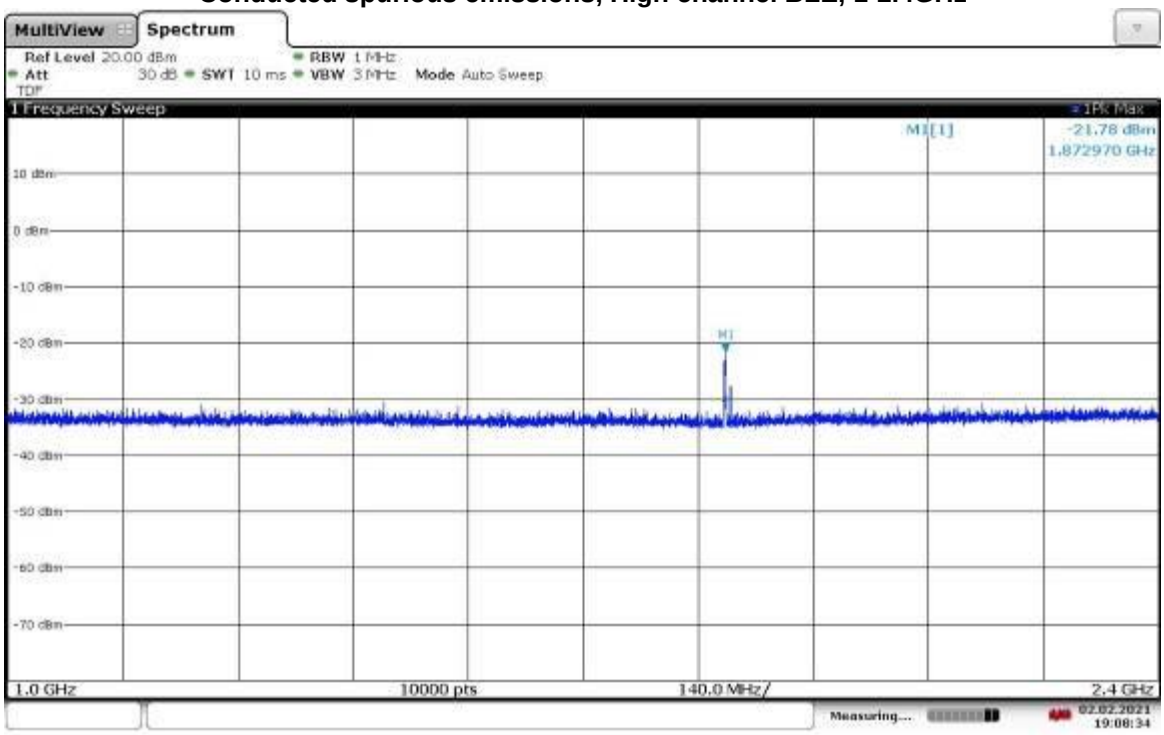


18:55:34 02.02.2021

Conducted spurious emissions, High channel BLE, 30-1000MHz

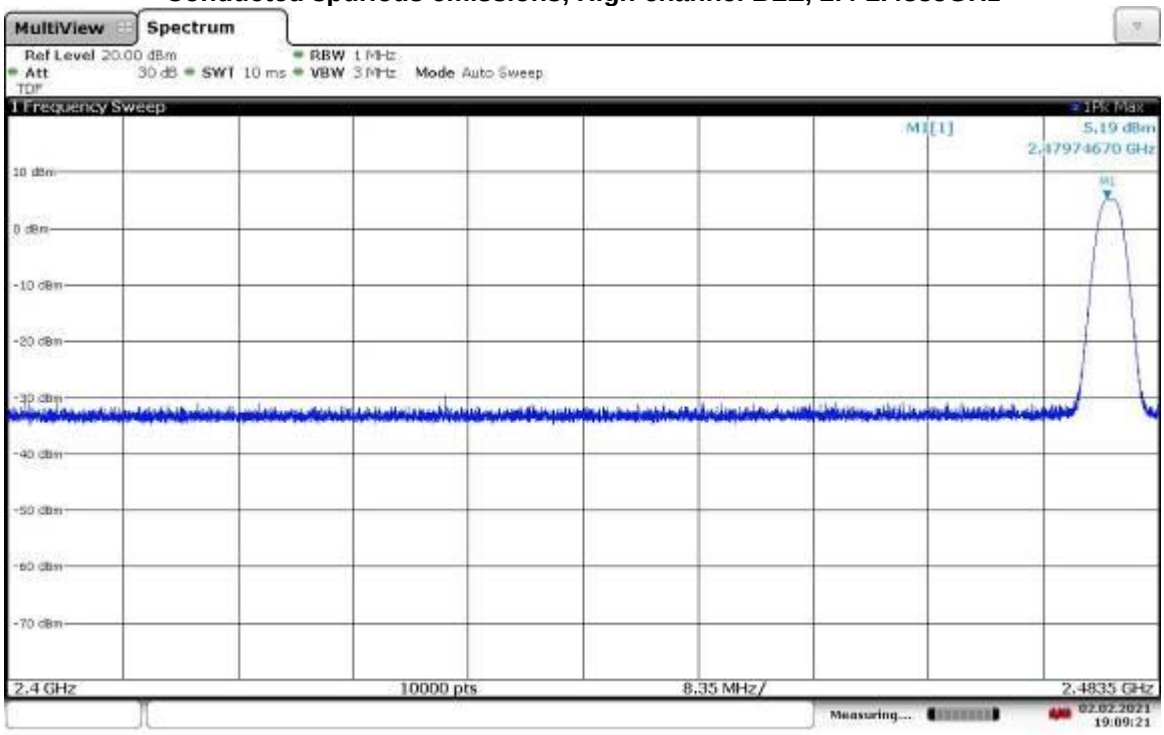


Conducted spurious emissions, High channel BLE, 1-2.4GHz



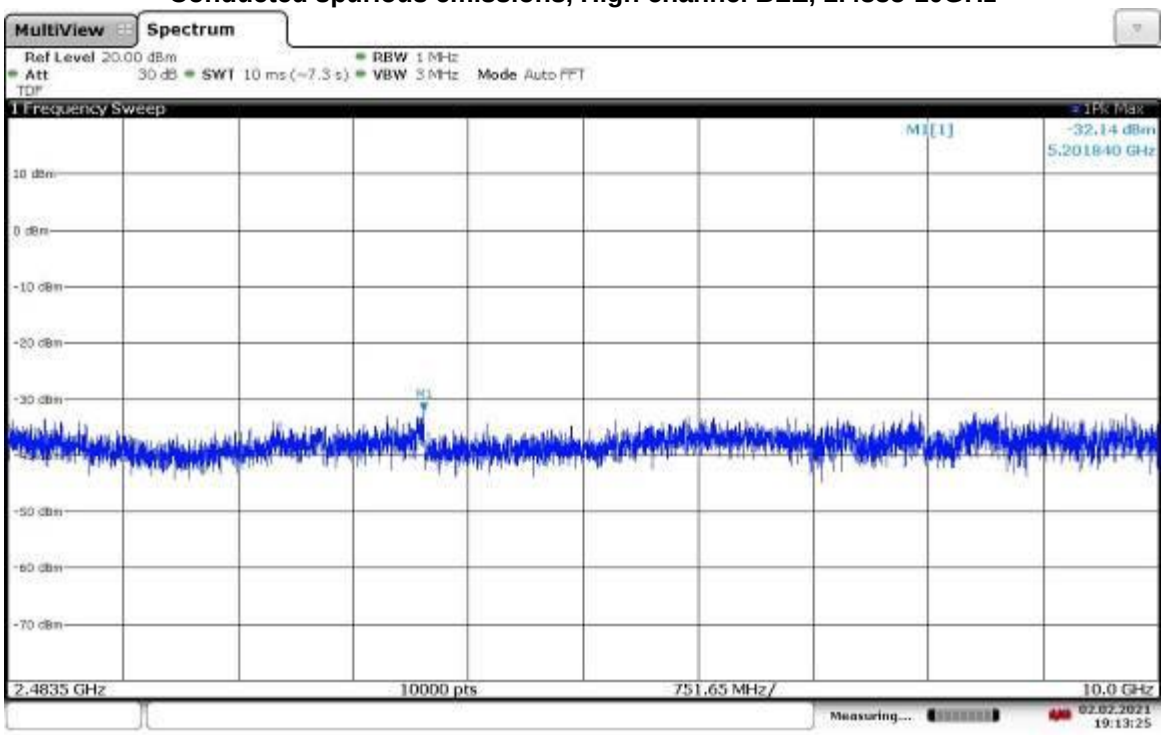
19:08:34 02.02.2021

Conducted spurious emissions, High channel BLE, 2.4-2.4835GHz



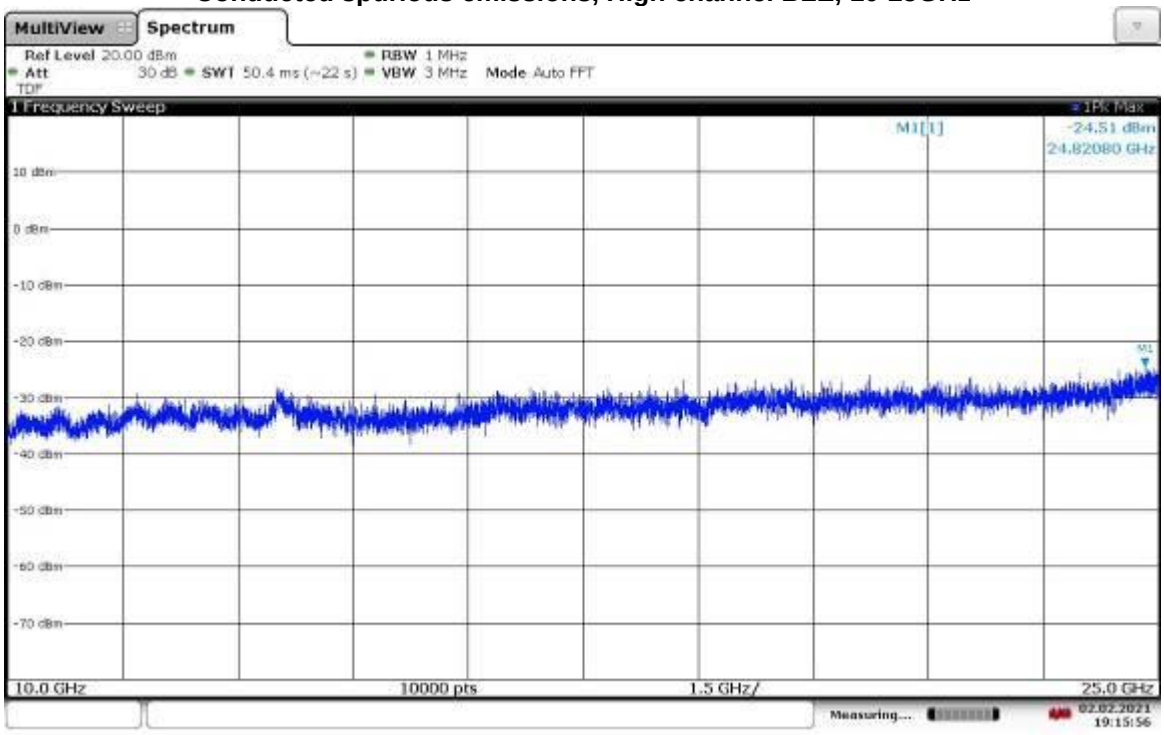
19:09:21 02.02.2021

Conducted spurious emissions, High channel BLE, 2.4835-10GHz



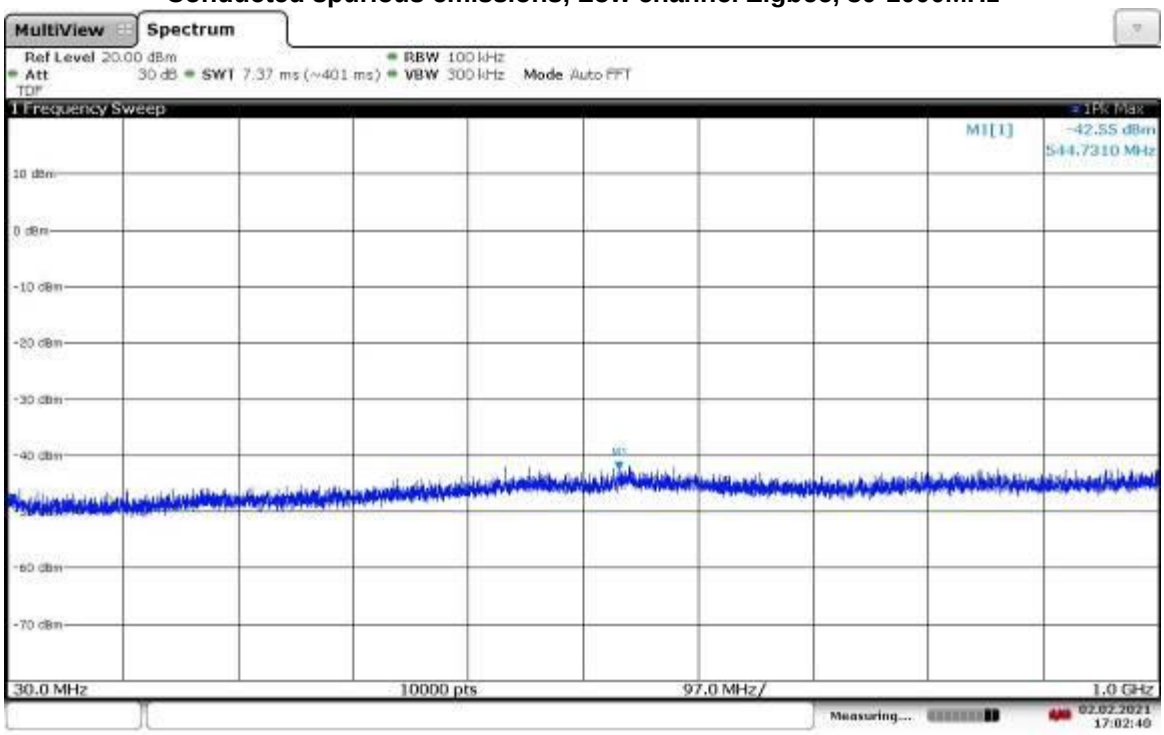
19:13:25 02.02.2021

Conducted spurious emissions, High channel BLE, 10-25GHz



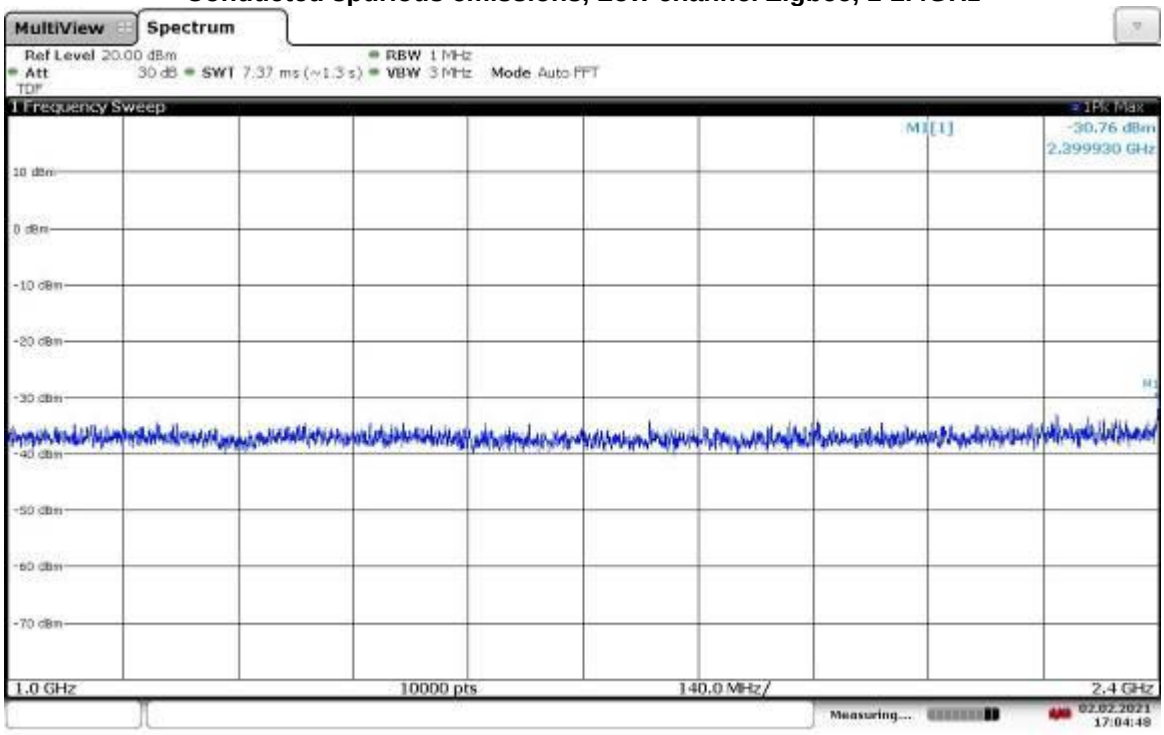
19:15:56 02.02.2021

Conducted spurious emissions, Low channel Zigbee, 30-1000MHz



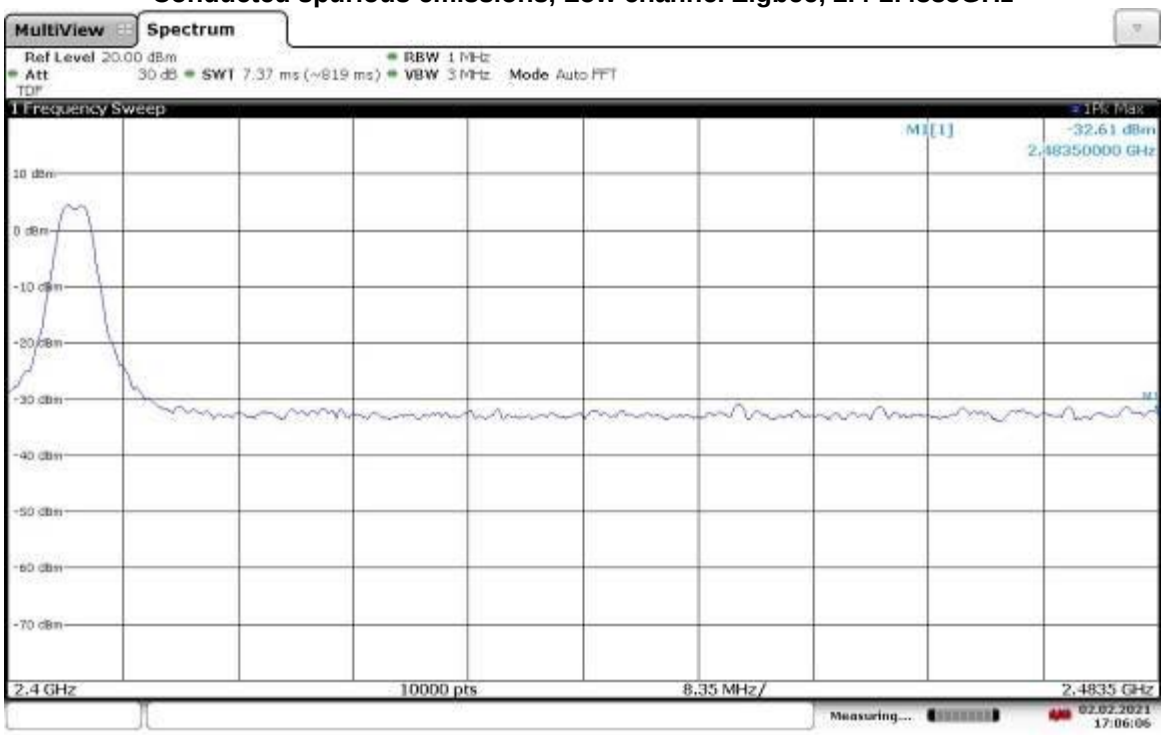
17:02:41 02.02.2021

Conducted spurious emissions, Low channel Zigbee, 1-2.4GHz



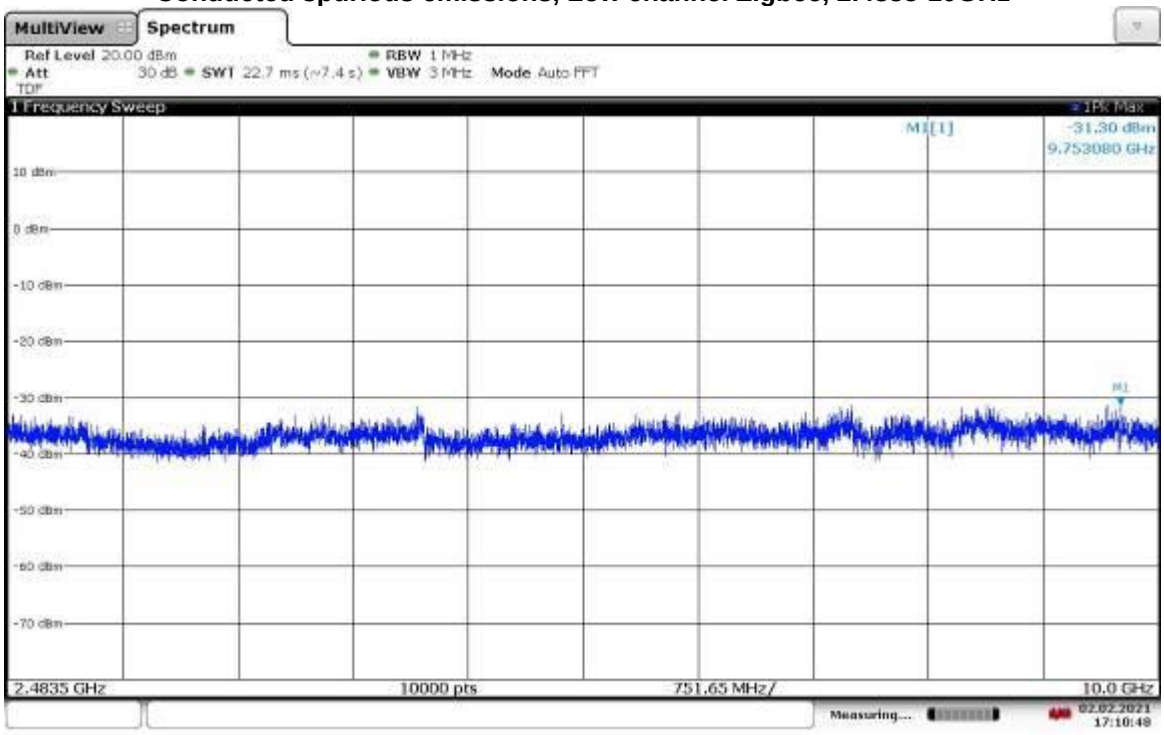
17:04:49 02.02.2021

Conducted spurious emissions, Low channel Zigbee, 2.4-2.4835GHz



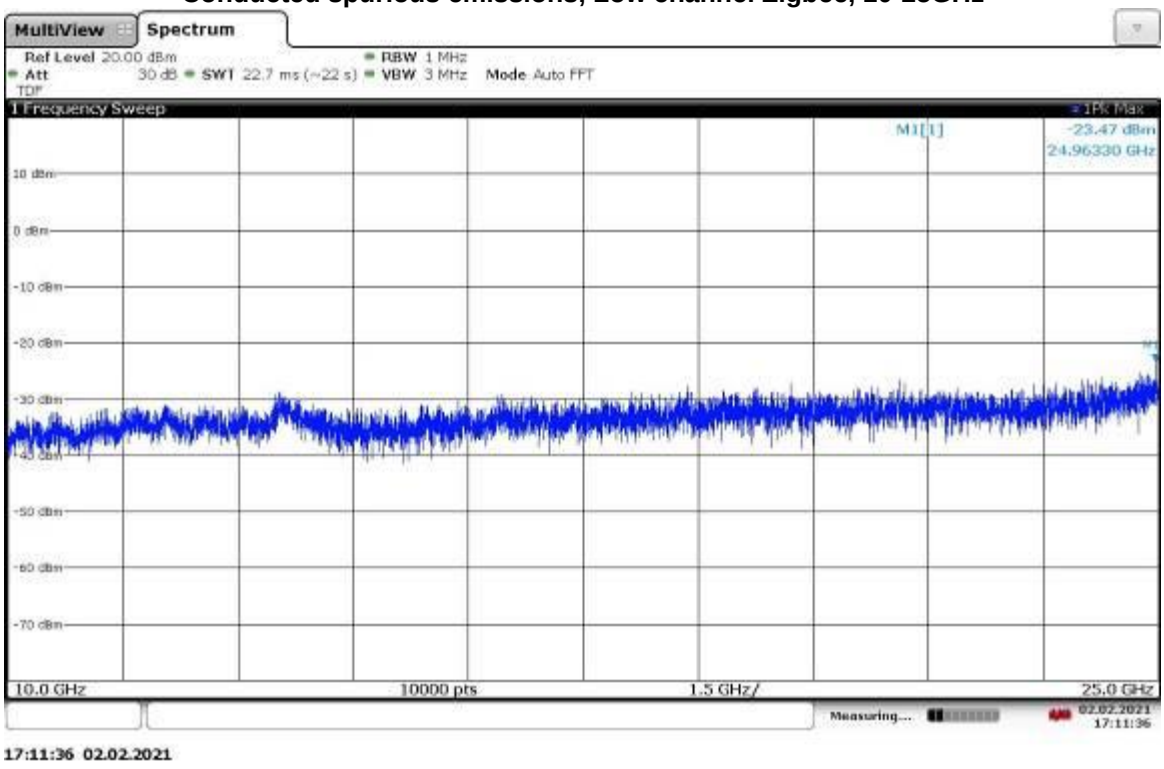
17:06:06 02.02.2021

Conducted spurious emissions, Low channel Zigbee, 2.4835-10GHz

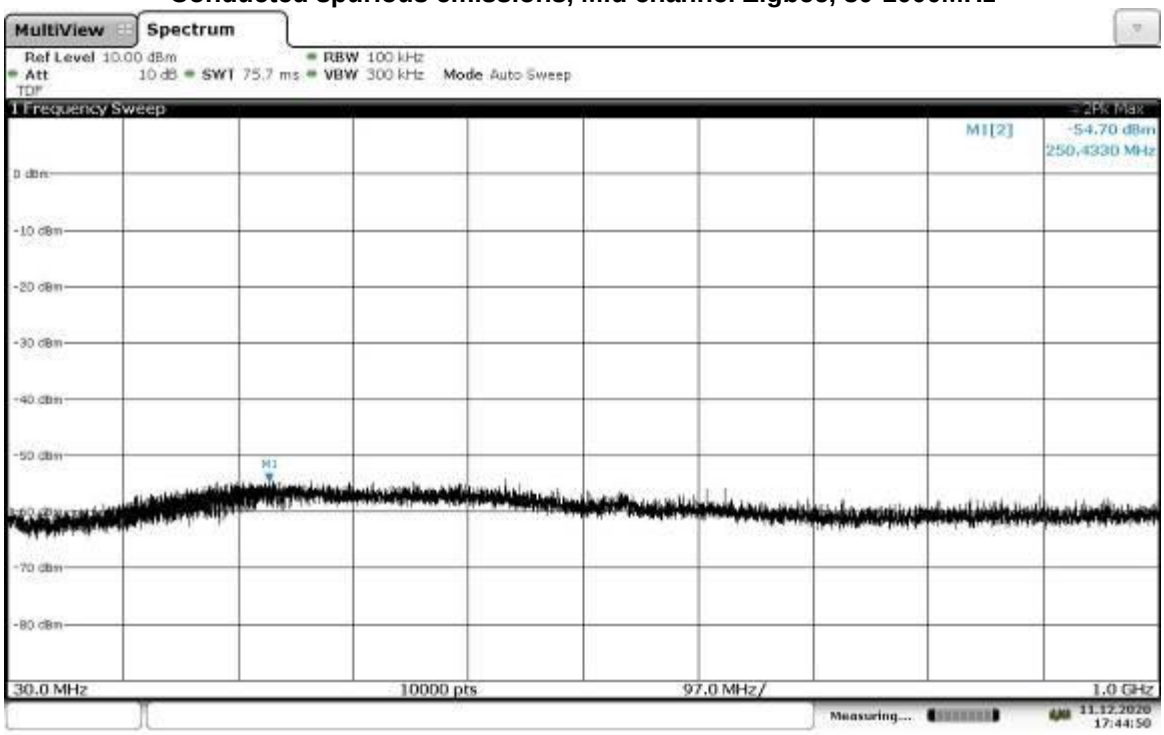


17:10:48 02.02.2021

Conducted spurious emissions, Low channel Zigbee, 10-25GHz

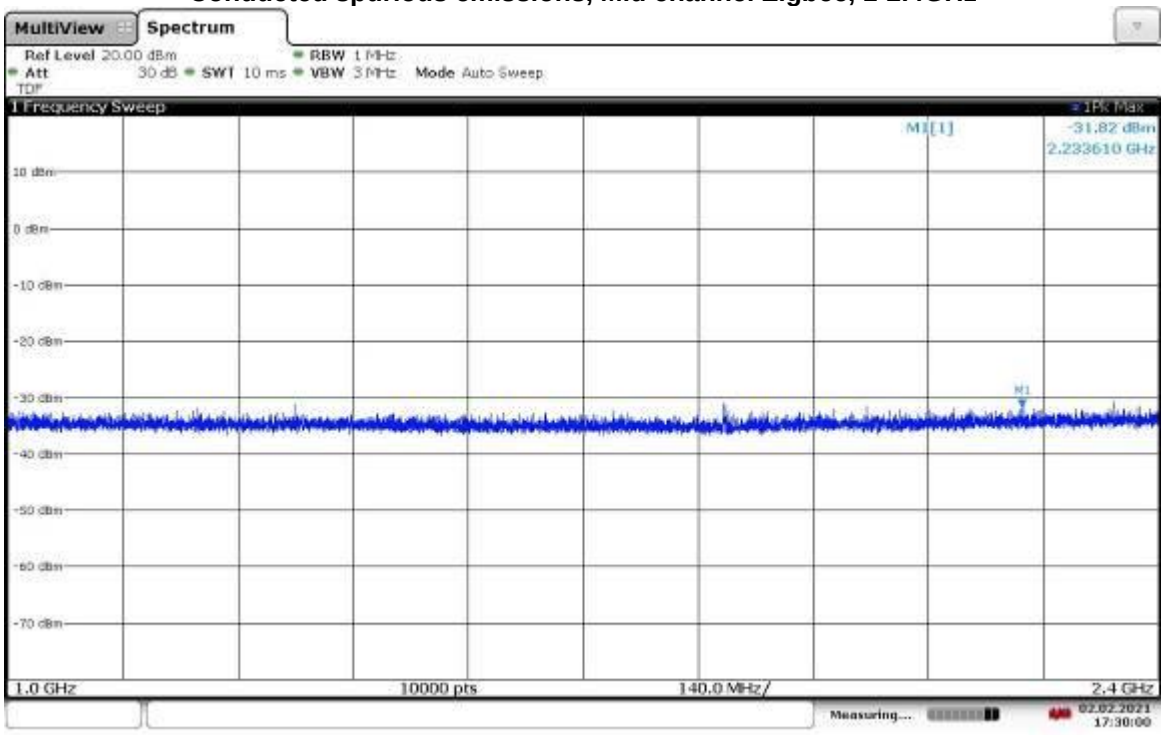


Conducted spurious emissions, Mid channel Zigbee, 30-1000MHz



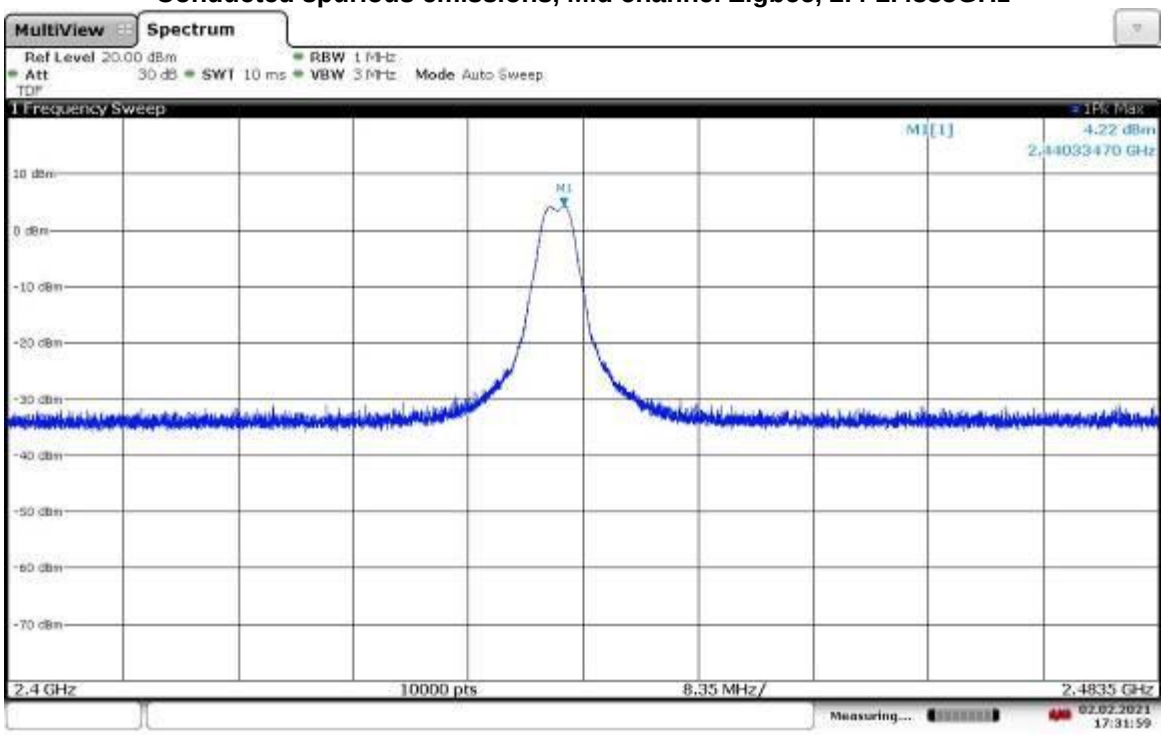
17:44:51 11.12.2020

Conducted spurious emissions, Mid channel Zigbee, 1-2.4GHz



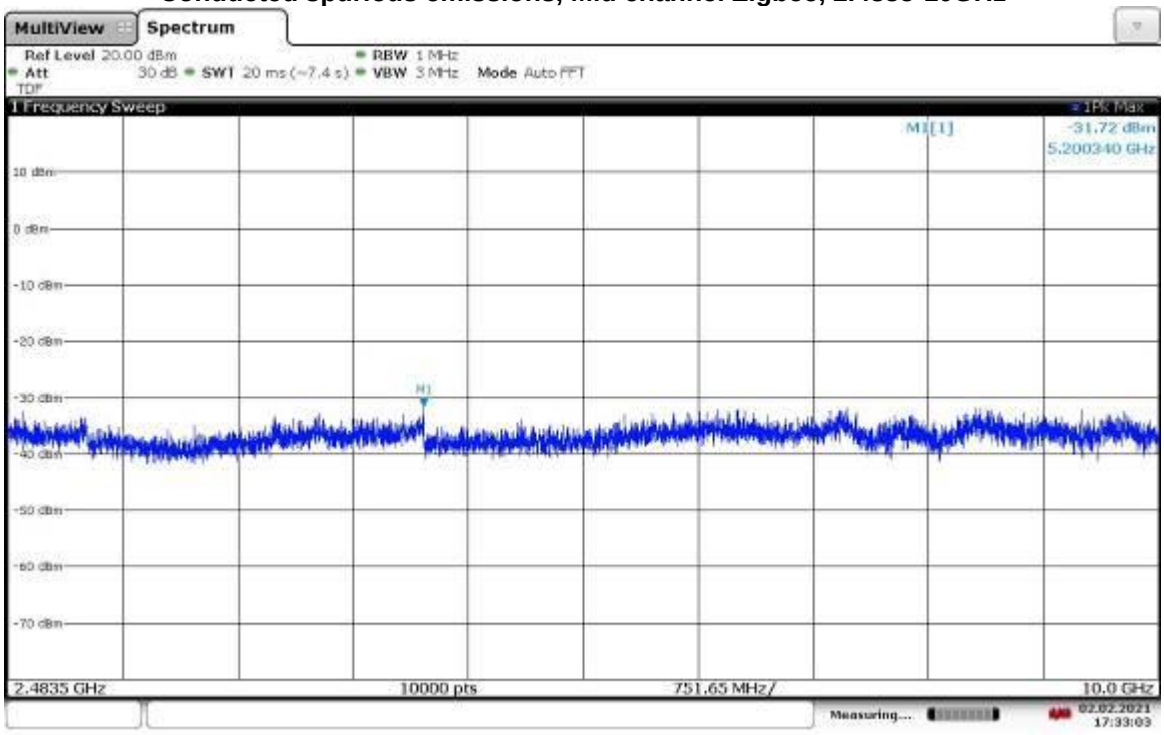
17:30:01 02.02.2021

Conducted spurious emissions, Mid channel Zigbee, 2.4-2.4835GHz



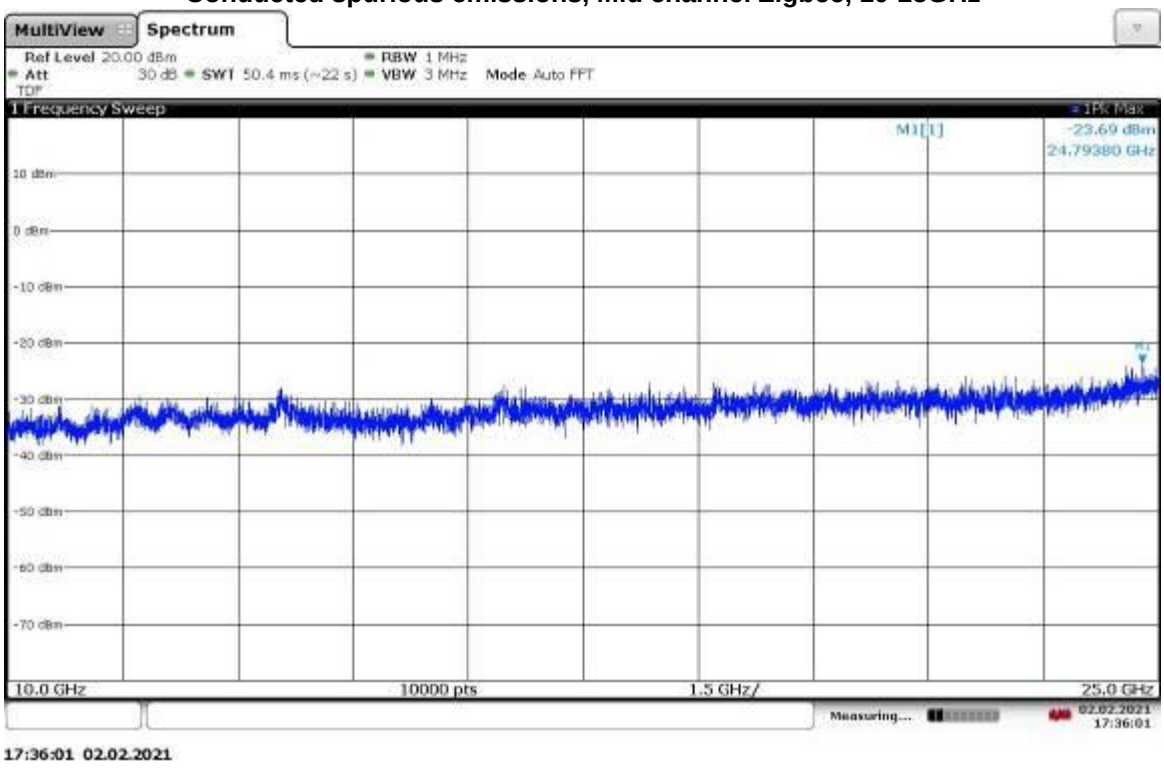
17:31:59 02.02.2021

Conducted spurious emissions, Mid channel Zigbee, 2.4835-10GHz

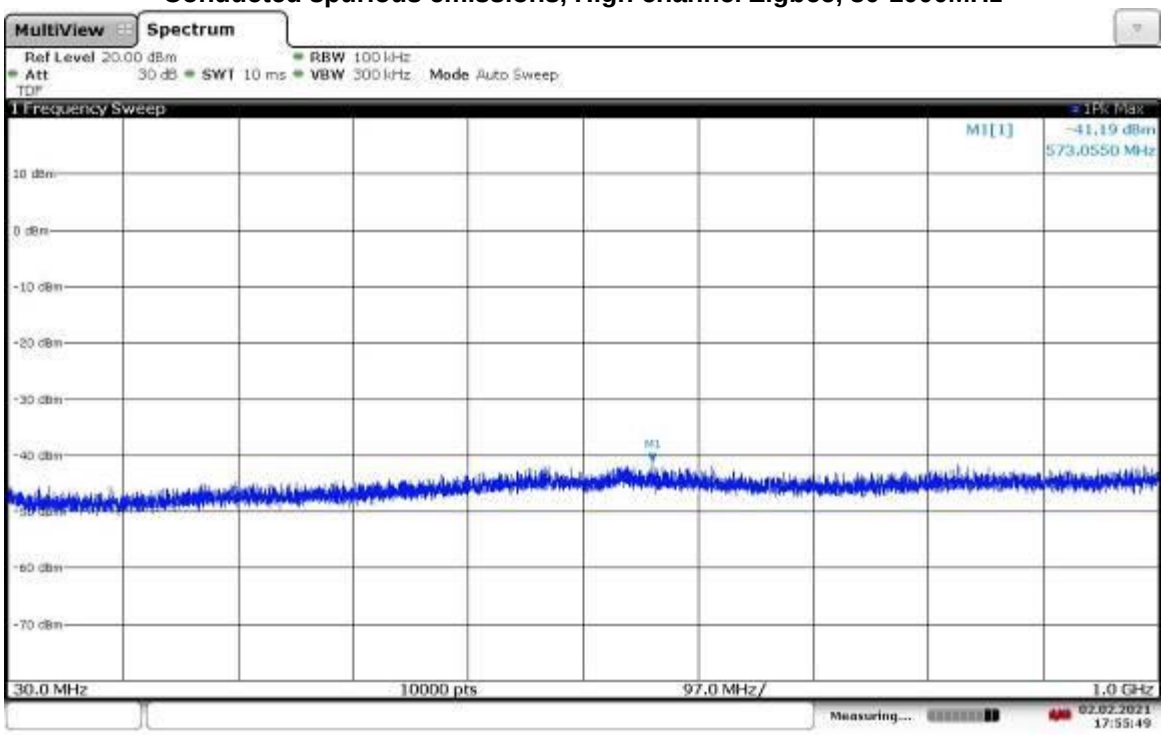


17:33:03 02.02.2021

Conducted spurious emissions, Mid channel Zigbee, 10-25GHz

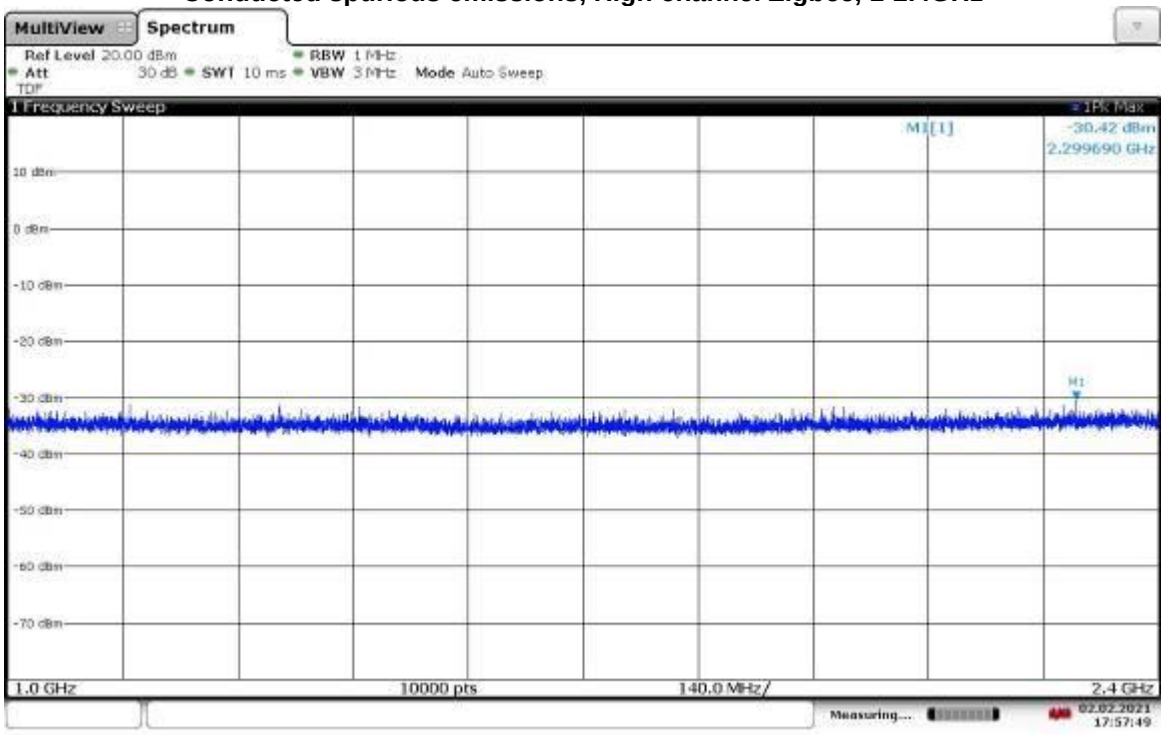


Conducted spurious emissions, High channel Zigbee, 30-1000MHz



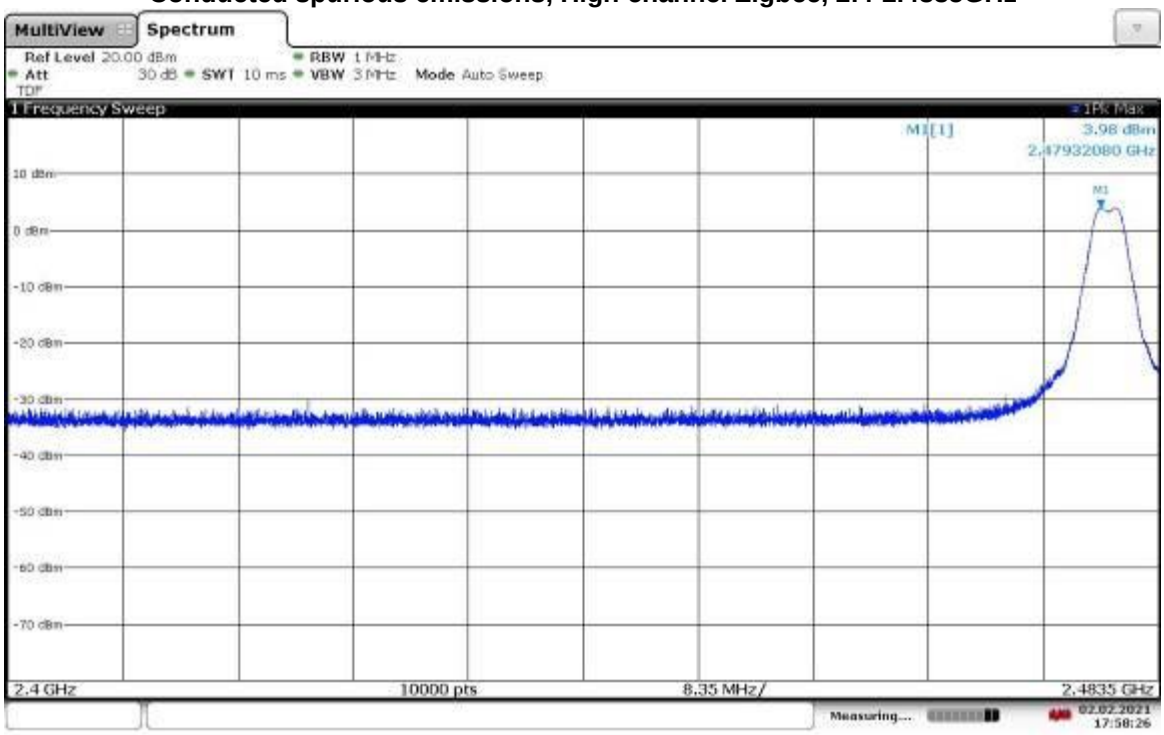
17:55:49 02.02.2021

Conducted spurious emissions, High channel Zigbee, 1-2.4GHz



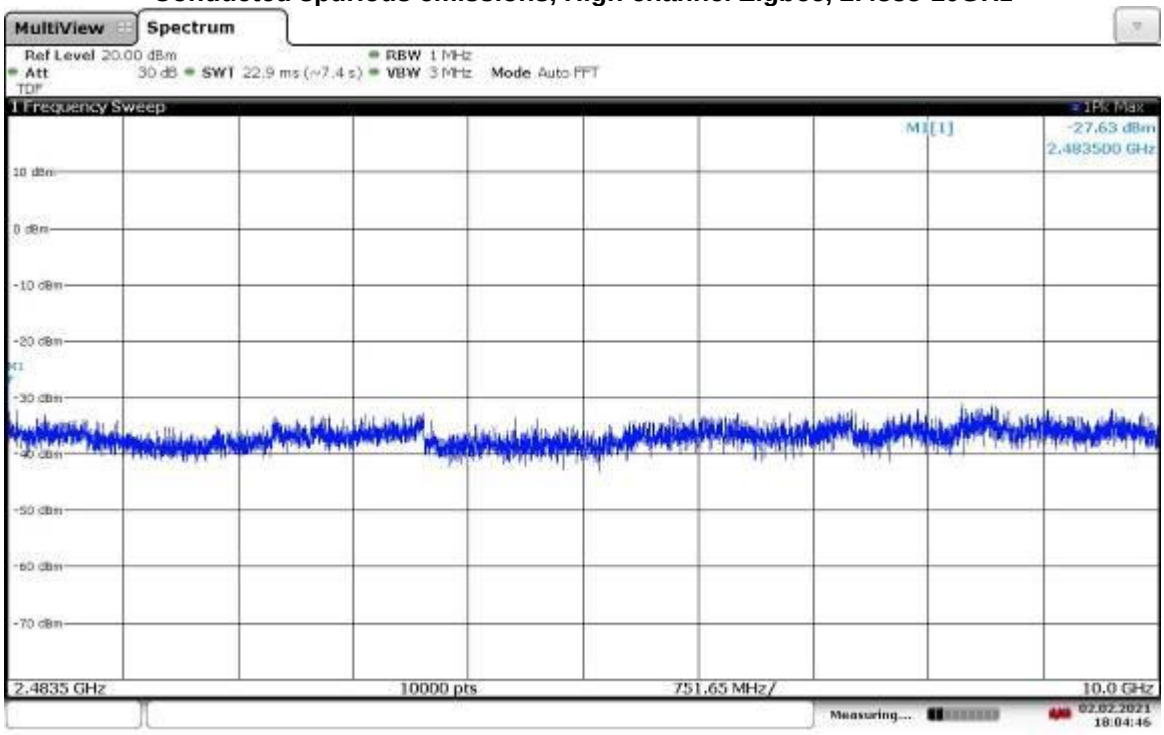
17:57:49 02.02.2021

Conducted spurious emissions, High channel Zigbee, 2.4-2.4835GHz



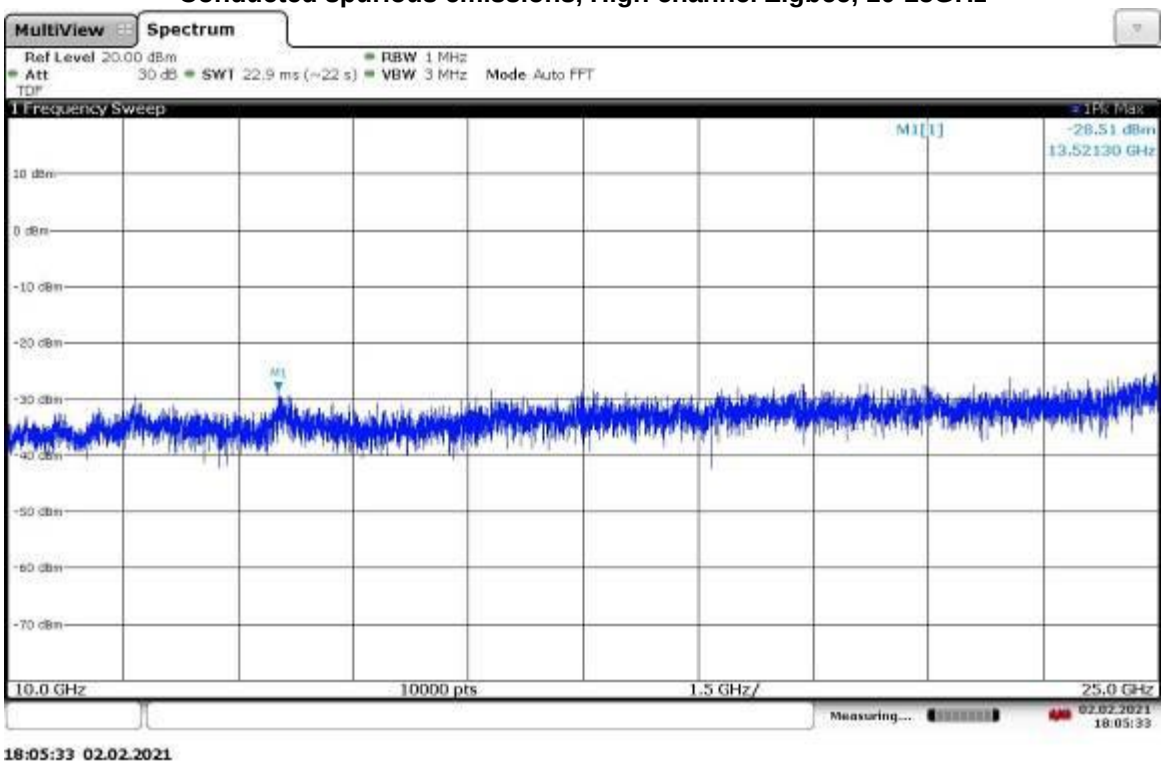
17:58:27 02.02.2021

Conducted spurious emissions, High channel Zigbee, 2.4835-10GHz

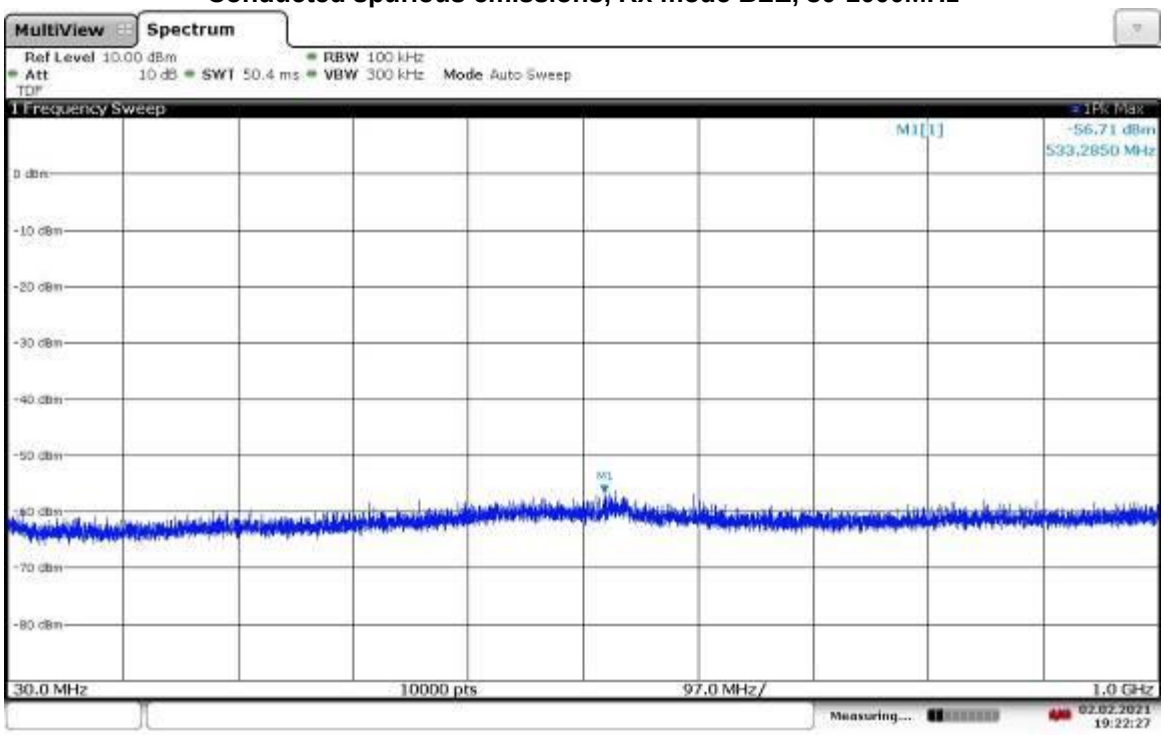


18:04:46 02.02.2021

Conducted spurious emissions, High channel Zigbee, 10-25GHz

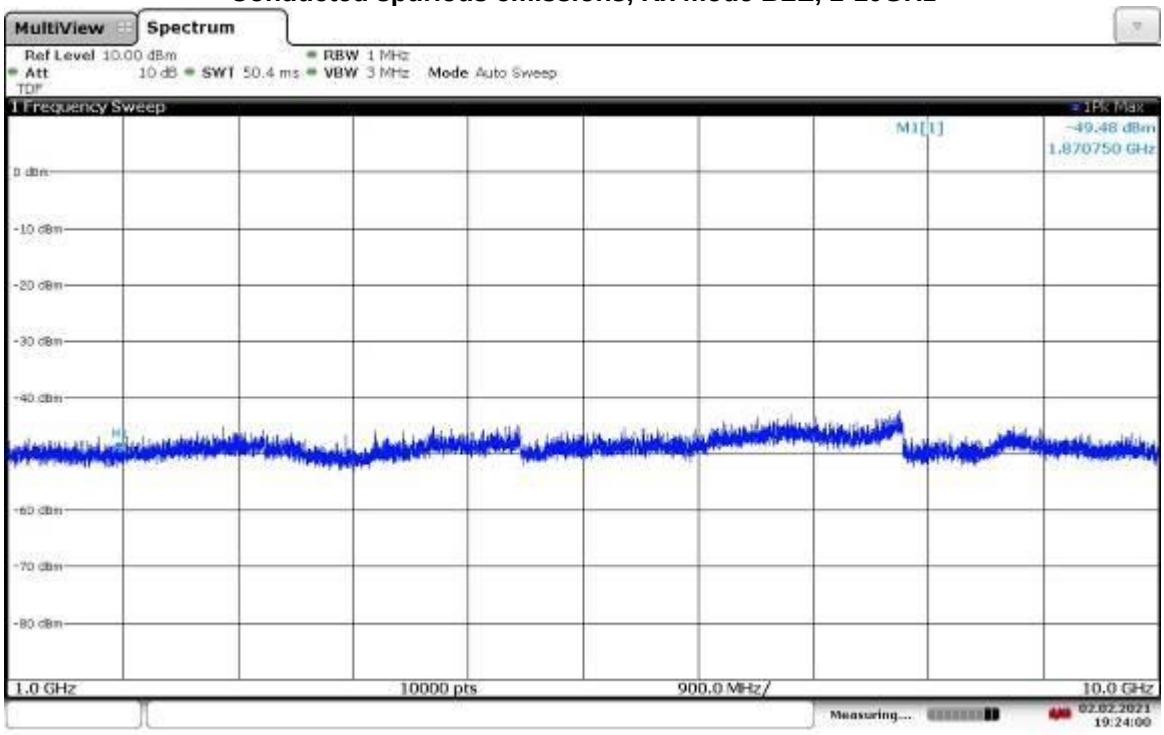


Conducted spurious emissions, Rx mode BLE, 30-1000MHz



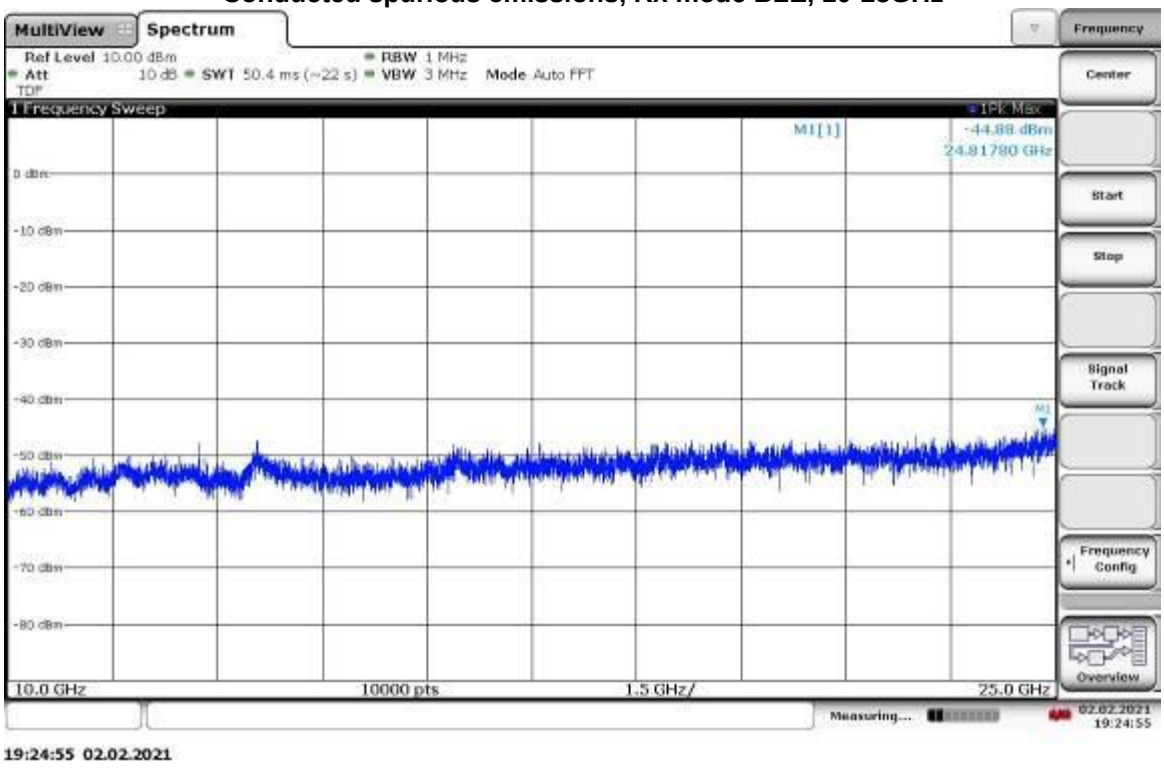
19:22:27 02.02.2021

Conducted spurious emissions, Rx mode BLE, 1-10GHz

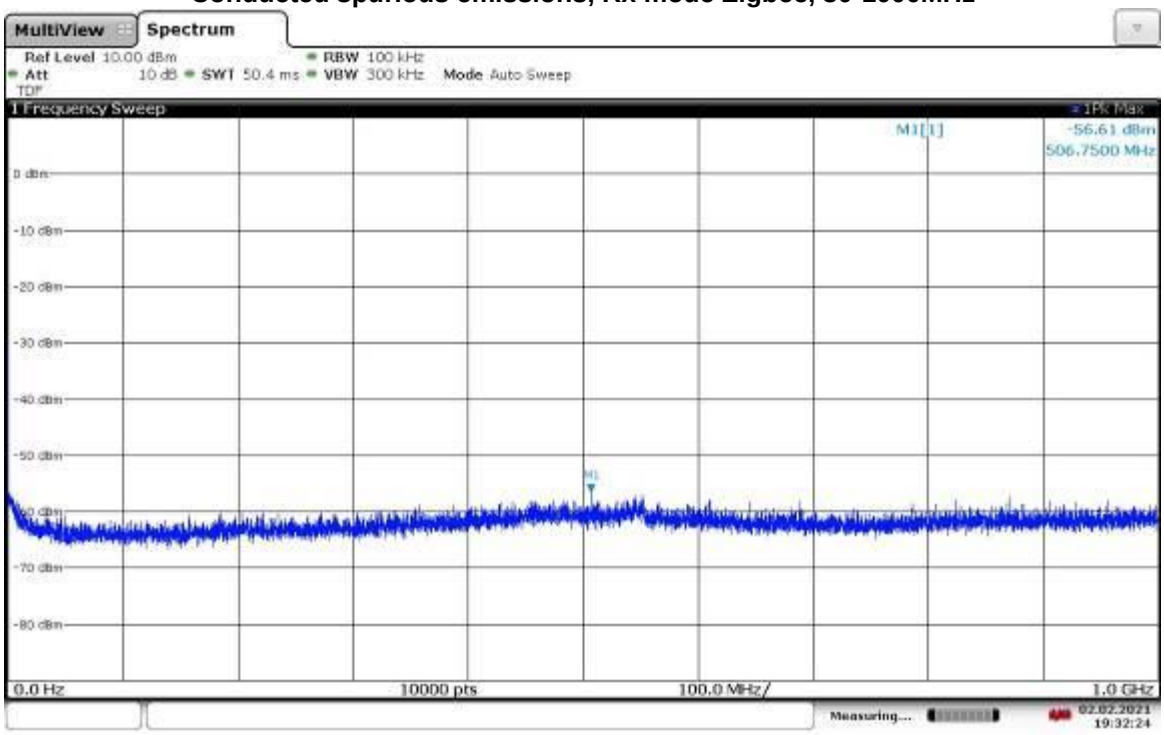


19:24:01 02.02.2021

Conducted spurious emissions, Rx mode BLE, 10-25GHz

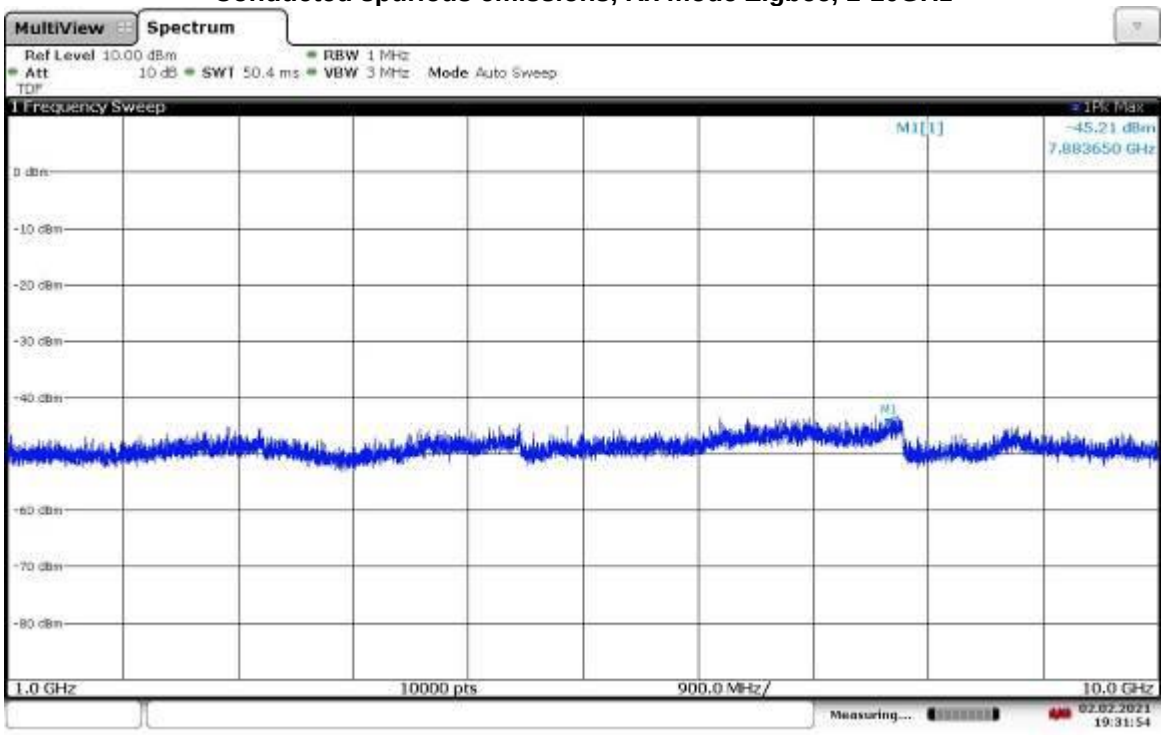


Conducted spurious emissions, Rx mode Zigbee, 30-1000MHz



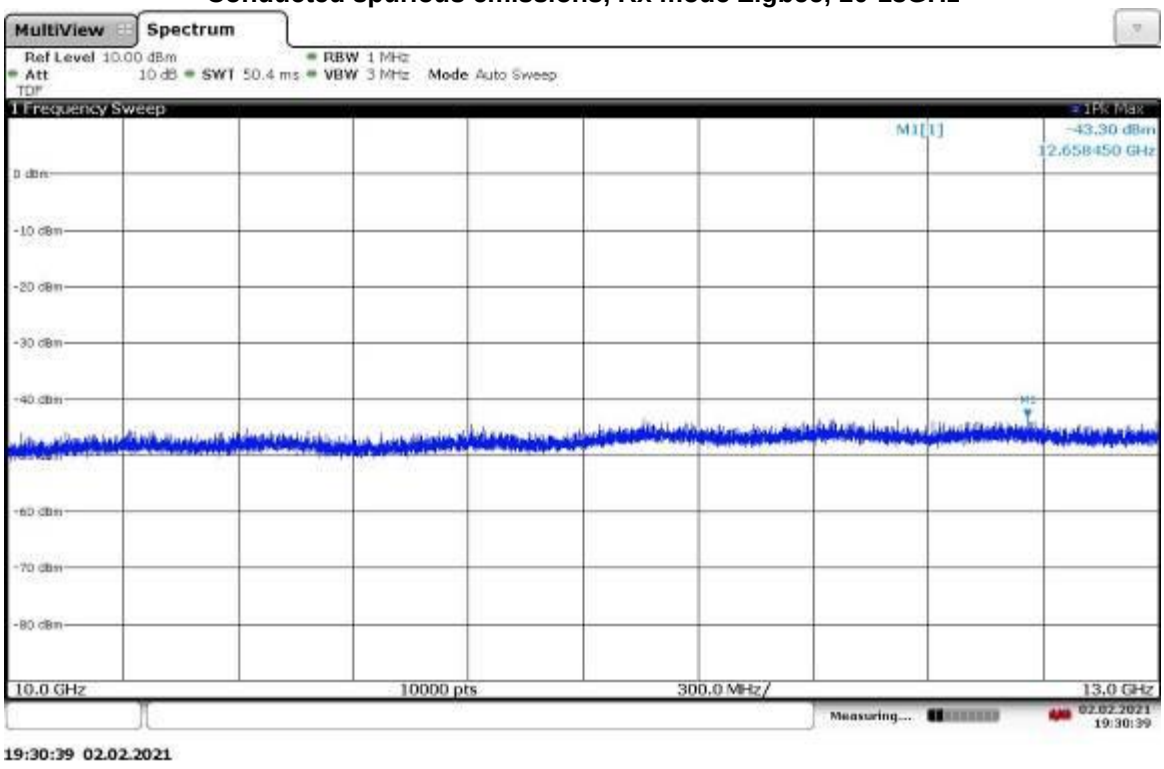
19:32:24 02.02.2021

Conducted spurious emissions, Rx mode Zigbee, 1-10GHz



19:31:54 02.02.2021

Conducted spurious emissions, Rx mode Zigbee, 10-13GHz

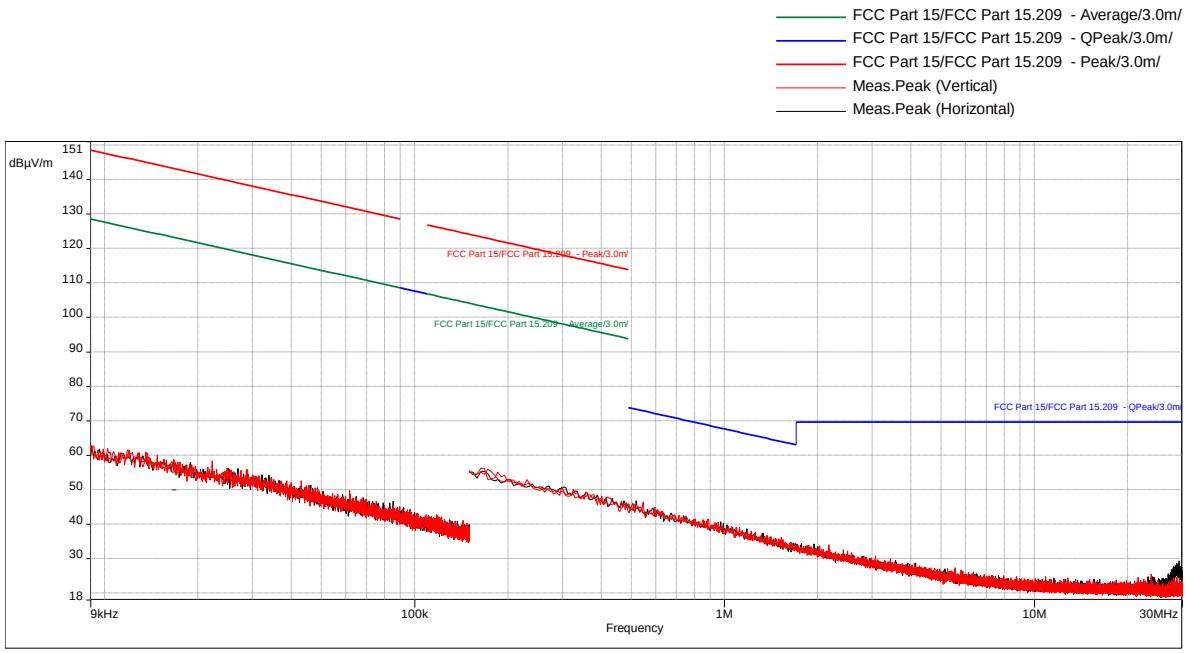


Radiated spurious emissions, radios transmitted simultaneously
Transmit at Low Channel, 9kHz-30 MHz

Test Information:

Date and Time	02/05/2021 4:50:07 PM
Client and Project Number	Windrock_G104473889
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	21%
Atmospheric Pressure	994 mB
Comments	9kH-30MHz_24VDC_Tx mode_Both radios set to Low CH

Graph:



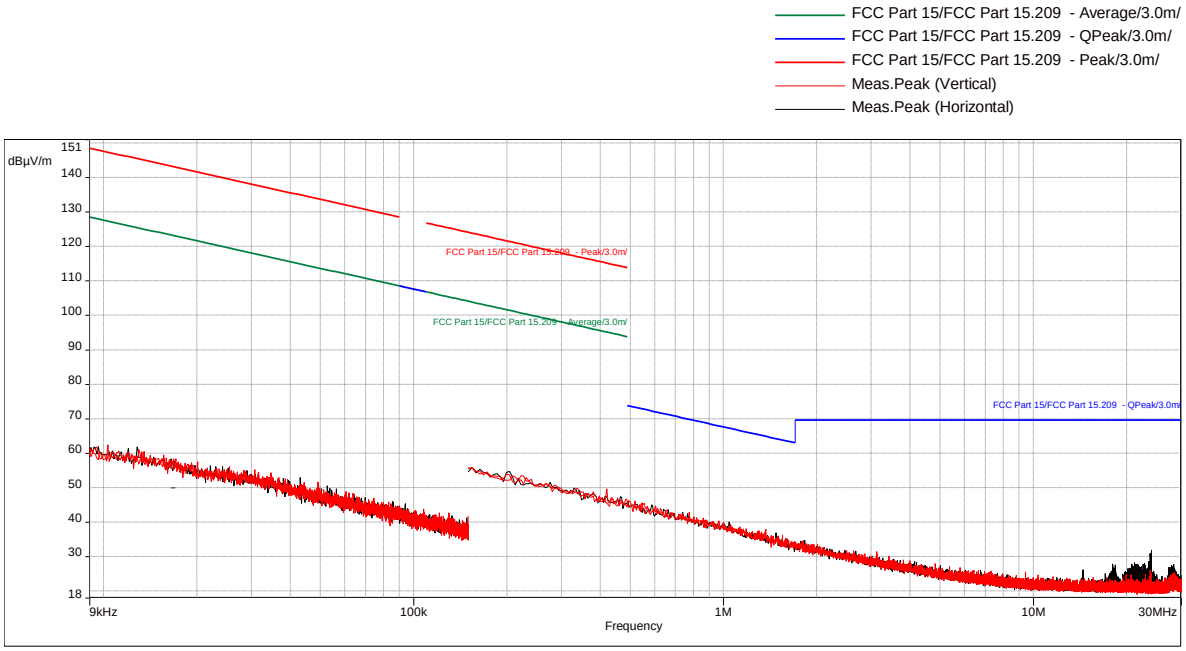
Results: No emissions were detected.

Radiated spurious emissions, radios transmitted simultaneously
Transmit at Mid Channel, 9kHz-30 MHz

Test Information:

Date and Time	02/05/2021 6:22:12 PM
Client and Project Number	Windrock_G104473889
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	21%
Atmospheric Pressure	994 mB
Comments	9kH-30MHz_24VDC_Tx mode_Both radios set to Mid CH

Graph:



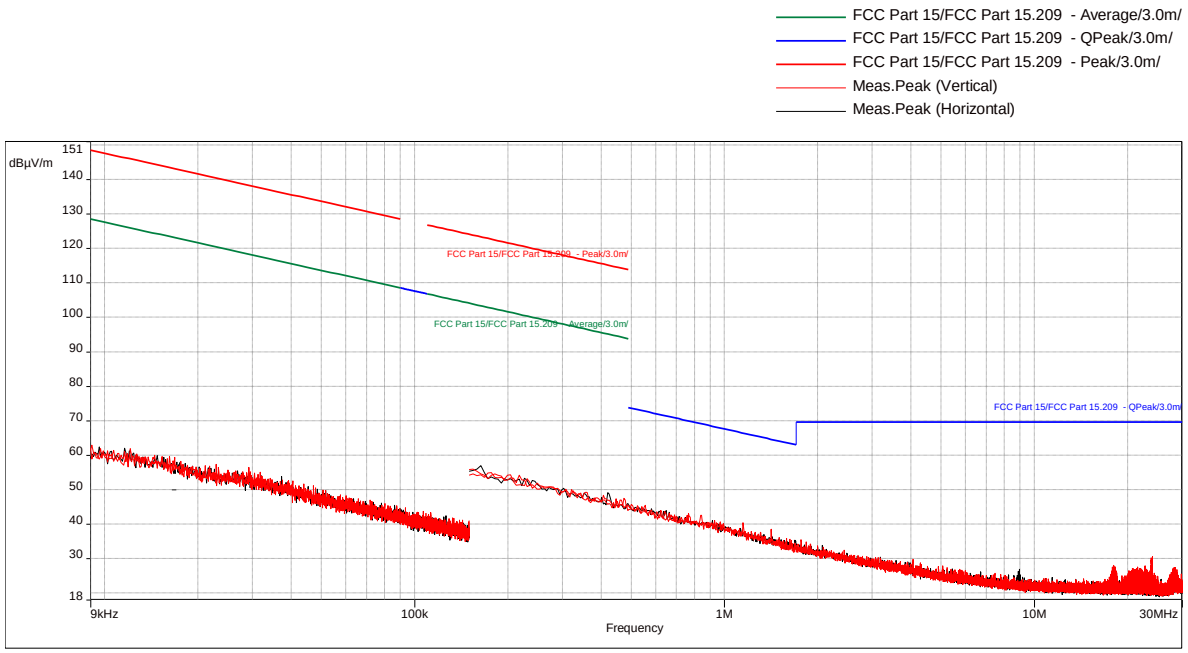
Results: No emissions were detected.

Radiated spurious emissions, radios transmitted simultaneously
Transmit at Mid Channel, 9kHz-30 MHz

Test Information:

Date and Time	02/05/2021 7:50:01 PM
Client and Project Number	Windrock_G104473889
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	21%
Atmospheric Pressure	994 mB
Comments	9kH-30MHz_24VDC_Tx mode_Both radios set to High CH

Graph:



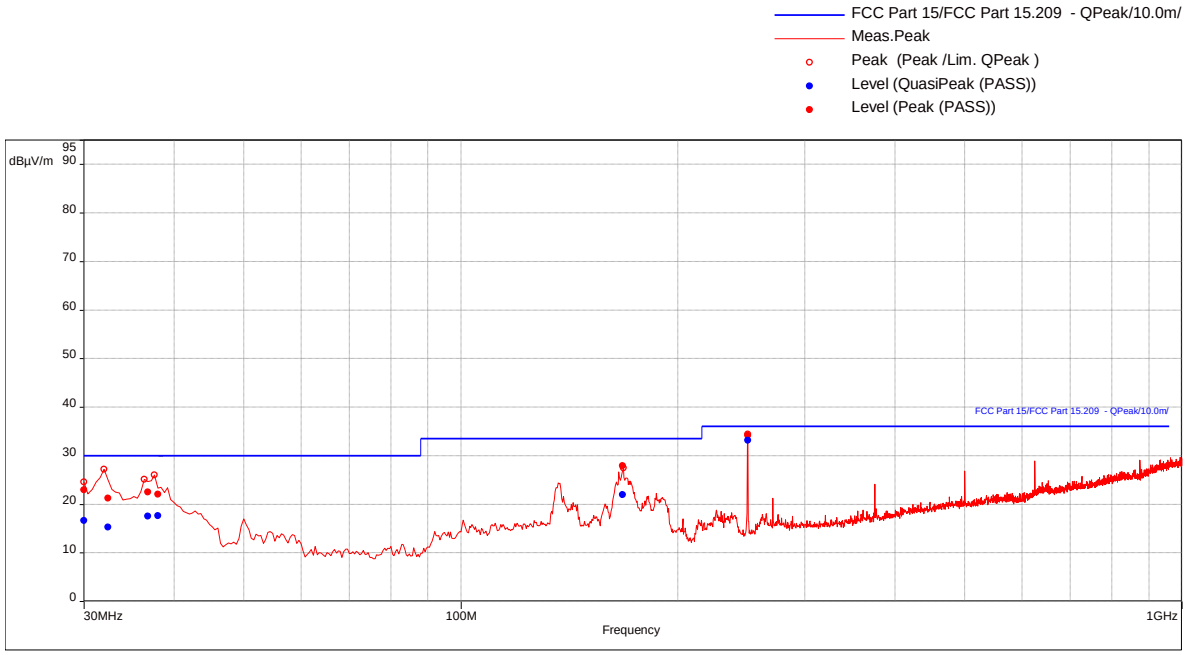
Results: No emissions were detected.

Radiated spurious emissions, radios transmitted simultaneously
Transmit at Low Channel, 30-1000 MHz

Test Information:

Date and Time	1/15/2021 7:06:49 PM
Client and Project Number	Windrock_G104473889
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	22%
Atmospheric Pressure	1008 mB
Comments	Scan#4_RE 30-1000MHz_24VDC_Tx mode_Low CH_New board w/shielding_Ferrite on power cable

Graph:



Results:

QuasiPeak (PASS) (6)

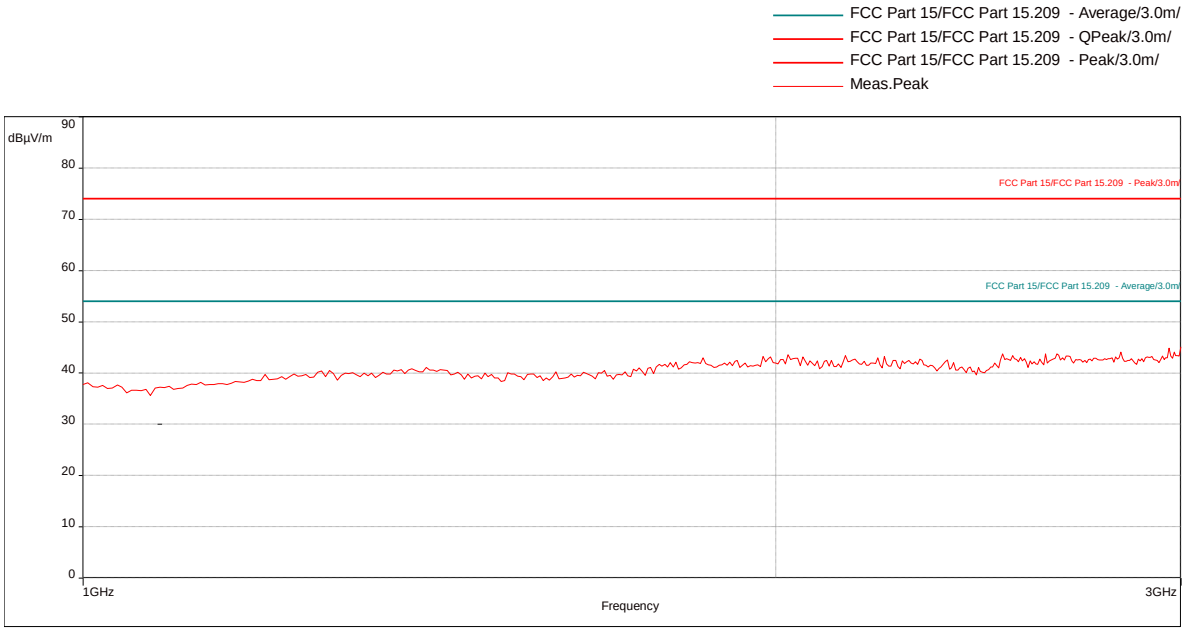
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
30.03157895	16.60	30.00	-13.40	166.00	3.94	Vertical	120000.00	-12.08
32.22105263	15.27	30.00	-14.73	166.00	3.84	Vertical	120000.00	-13.52
36.65263158	17.49	30.00	-12.51	306.00	3.87	Vertical	120000.00	-16.77
38.13684211	17.65	30.00	-12.35	314.00	1.00	Vertical	120000.00	-17.93
167.7789474	21.99	33.50	-11.51	321.00	1.67	Vertical	120000.00	-19.94
250	33.13	36.00	-2.87	223.00	1.00	Vertical	120000.00	-19.92

Radiated spurious emissions, radios transmitted simultaneously
Transmit at Low Channel, 1-3 GHz

Test Information:

Date and Time	2/5/2021 8:26:00 PM
Client and Project Number	Windrock_G104473889
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	21%
Atmospheric Pressure	994 mB
Comments	RE 1 to 3 GHz_24VDC_Tx mode_Both radios set to Low CH

Graph:



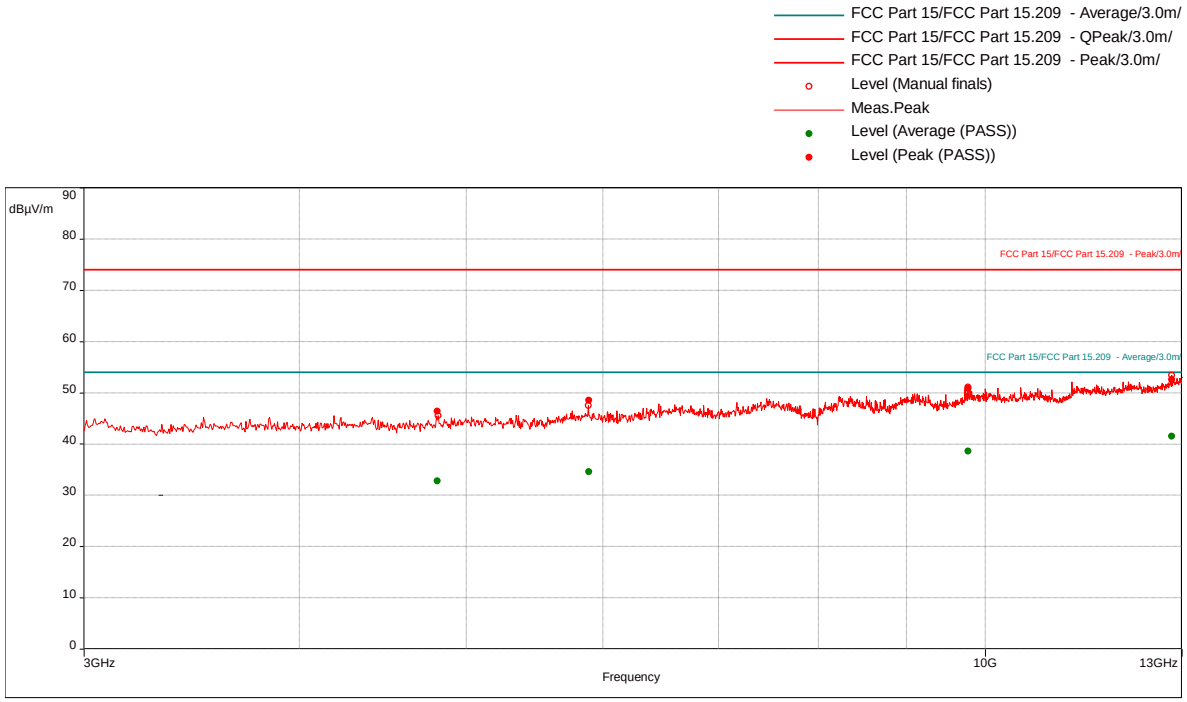
Results: No emissions were detected above the measuring equipment noise floor.

Radiated spurious emissions, radios transmitted simultaneously
Transmit at Low Channel, 3-25 GHz

Test Information:

Date and Time	2/5/2021 8:33:09 PM
Client and Project Number	Windrock_G104473889
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	21%
Atmospheric Pressure	994 mB
Comments	RE 3 to 13 GHz_24VDC_Tx mode_Both radios set to Low CH

Graph:



Results:

Peak (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
4811.842105	46.34	74.00	-27.66	343.00	1.35	Vertical	1000000.00	-9.96
5888.157895	48.47	74.00	-25.53	218.00	1.40	Vertical	1000000.00	-7.83
9774.210526	50.86	74.00	-23.14	69.00	3.54	Vertical	1000000.00	-2.74
12829.47368	52.50	74.00	-21.50	83.00	1.85	Vertical	1000000.00	2.28

Average (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
4811.842105	32.78	54.00	-21.22	343.00	1.35	Vertical	1000000.00	-9.96
5888.157895	34.61	54.00	-19.39	218.00	1.40	Vertical	1000000.00	-7.83
9774.210526	38.58	54.00	-15.42	69.00	3.54	Vertical	1000000.00	-2.74
12829.47368	41.49	54.00	-12.51	83.00	1.85	Vertical	1000000.00	2.28

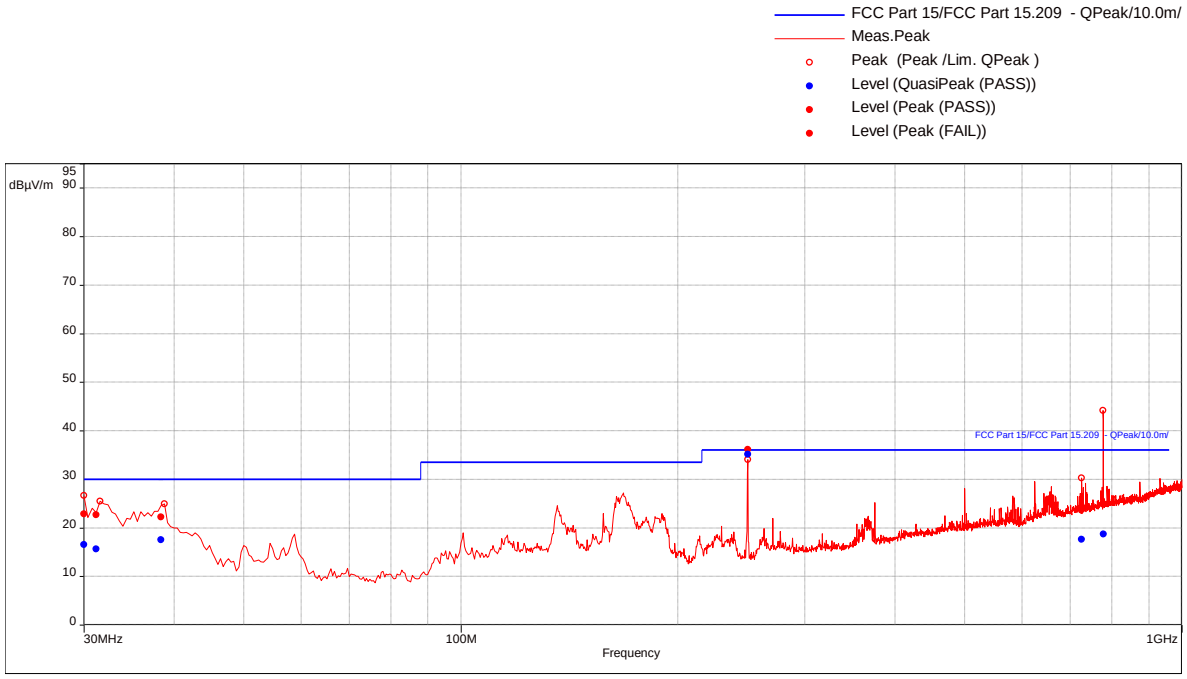
Note: Manual scan was performed from 13-25GHz, no emissions were detected above the measuring equipment noise floor.

Radiated spurious emissions, radios transmitted simultaneously
Transmit at Mid Channel, 30-1000 MHz

Test Information:

Date and Time	1/15/2021 8:37:45 PM
Client and Project Number	Windrock_G104473889
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	22%
Atmospheric Pressure	1008 mB
Comments	Scan#5_RE 30-1000MHz_24VDC_Tx mode_Mid CH_New board w/shielding_Ferrite on power cable

Graph:



Results:

QuasiPeak (PASS) (6)

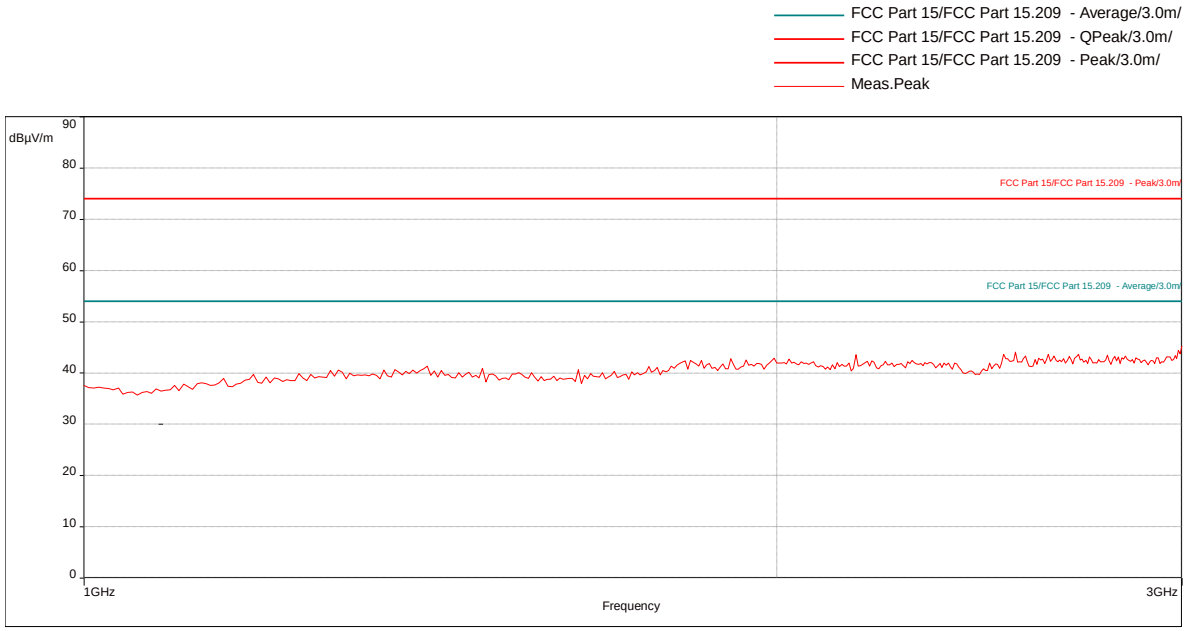
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
30.12631579	16.51	30.00	-13.49	216.00	2.86	Vertical	120000.00	-12.17
31.09473684	15.66	30.00	-14.34	143.00	3.63	Vertical	120000.00	-13.07
38.29473684	17.52	30.00	-12.48	269.00	2.26	Vertical	120000.00	-18.04
249.9684211	35.18	36.00	-0.82	62.00	1.00	Vertical	120000.00	-19.92
726.3052632	17.65	36.00	-18.35	99.00	1.38	Vertical	120000.00	-8.44
778.1263158	18.72	36.00	-17.28	335.00	3.35	Vertical	120000.00	-7.58

Radiated spurious emissions, radios transmitted simultaneously
Transmit at Mid Channel, 1-3 GHz

Test Information:

Date and Time	2/5/2021 10:43:22 PM
Client and Project Number	Windrock_G104473889
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	21%
Atmospheric Pressure	994 mB
Comments	RE 1 to 3 GHz_24VDC_Tx mode_Both radios set to Mid CH

Graph:



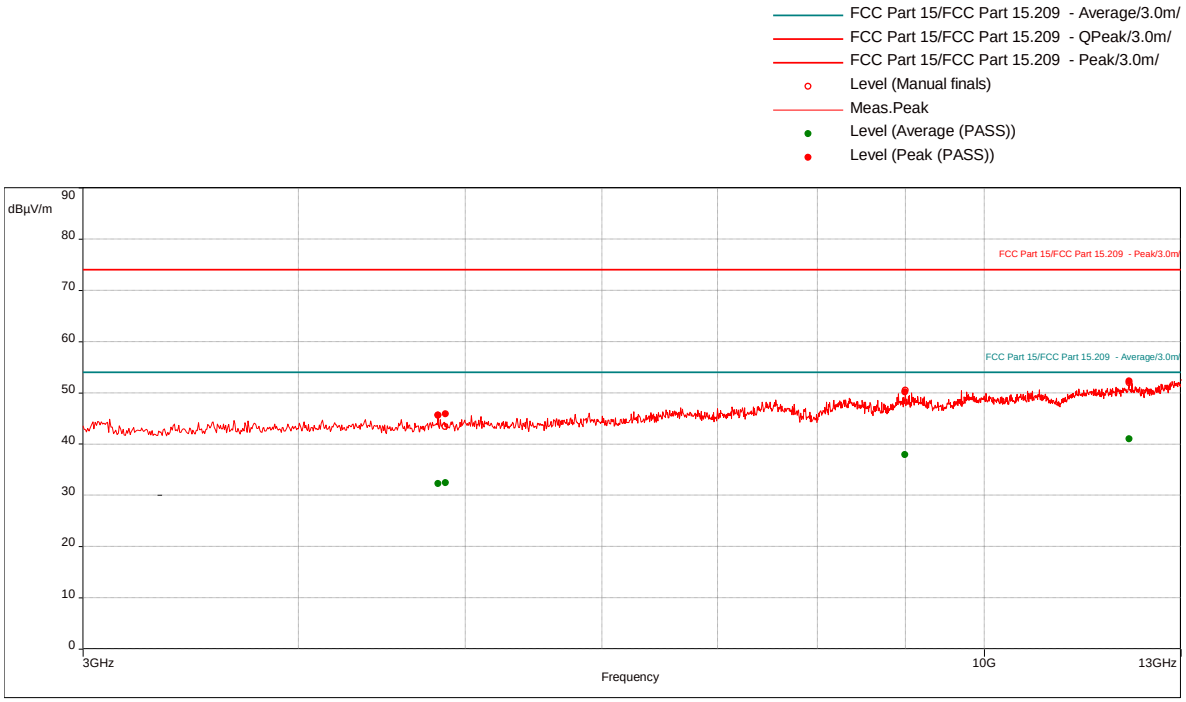
Results: No emissions were detected above the measuring equipment noise floor.

Radiated spurious emissions, radios transmitted simultaneously
Transmit at Mid Channel, 3-25 GHz

Test Information:

Date and Time	2/5/2021 10:37:06 PM
Client and Project Number	Windrock_G104473889
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	21%
Atmospheric Pressure	994 mB
Comments	RE 3 to 13 GHz_24VDC_Tx mode_Both radios set to Mid CH

Graph:



Results:

Peak (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
4819.210526	45.64	74.00	-28.36	151.00	3.64	Vertical	1000000.00	-9.98
4868.157895	45.86	74.00	-28.14	298.00	3.54	Horizontal	1000000.00	-10.04
8996.842105	50.15	74.00	-23.85	40.00	1.65	Horizontal	1000000.00	-4.04
12127.89474	52.29	74.00	-21.71	209.00	2.90	Vertical	1000000.00	1.20

Average (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
4819.210526	32.30	54.00	-21.70	151.00	3.64	Vertical	1000000.00	-9.98
4868.157895	32.44	54.00	-21.56	298.00	3.54	Horizontal	1000000.00	-10.04
8996.842105	37.89	54.00	-16.11	40.00	1.65	Horizontal	1000000.00	-4.04
12127.89474	41.01	54.00	-12.99	209.00	2.90	Vertical	1000000.00	1.20

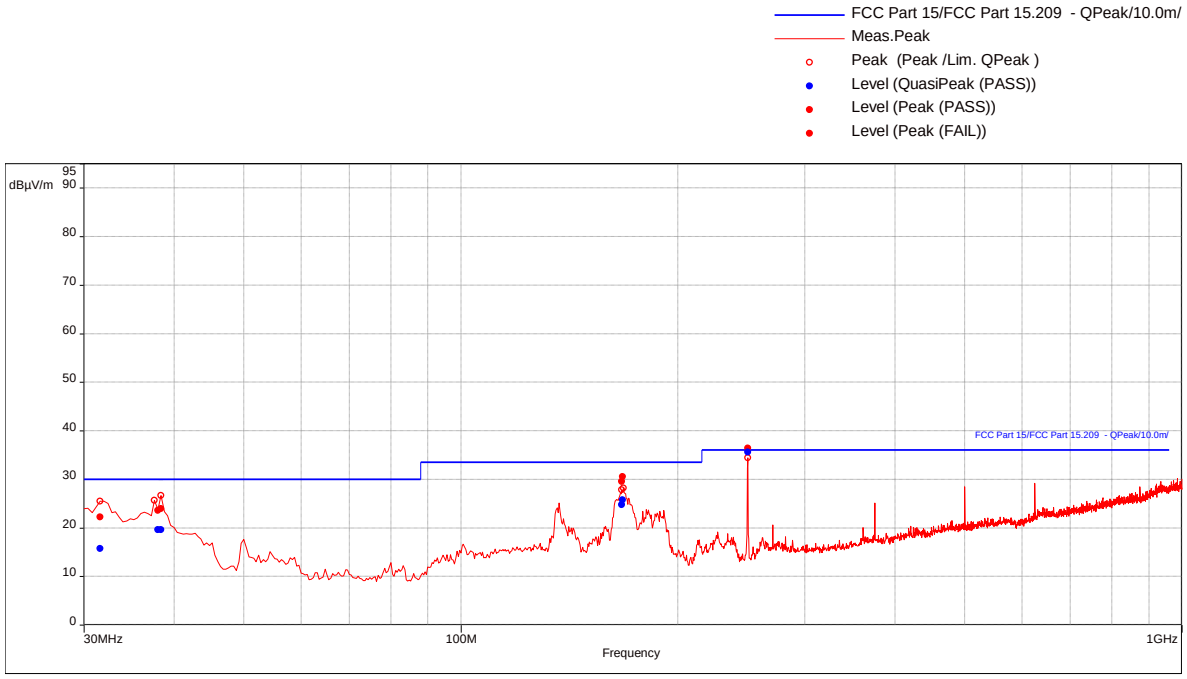
Note: Manual scan was performed from 13-25GHz, no emissions were detected above the measuring equipment noise floor.

Radiated spurious emissions, radios transmitted simultaneously
Transmit at High Channel, 30-1000 MHz

Test Information:

Date and Time	1/15/2021 8:48:01 PM
Client and Project Number	Windrock_G104473889
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	22%
Atmospheric Pressure	1008 mB
Comments	Scan#6_RE 30-1000MHz_24VDC_Tx mode_High CH_New board w/shielding_Ferrite on power cable

Graph:



Results:

QuasiPeak (PASS) (6)

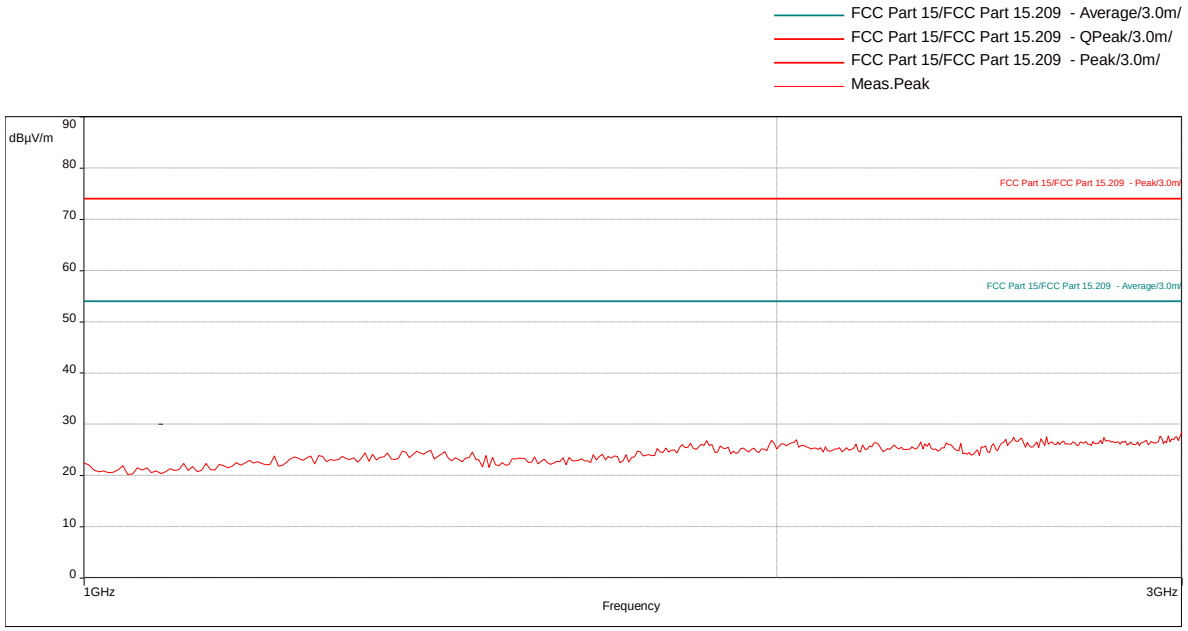
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
31.66315789	15.71	30.00	-14.29	143.00	1.37	Vertical	120000.00	-13.23
37.97894737	19.56	30.00	-10.44	268.00	1.43	Vertical	120000.00	-17.82
38.36842105	19.62	30.00	-10.38	269.00	2.83	Vertical	120000.00	-18.09
167.2	24.74	33.50	-8.76	10.00	1.44	Vertical	120000.00	-19.95
167.6526316	25.76	33.50	-7.74	313.00	1.60	Vertical	120000.00	-19.94
249.9684211	35.60	36.00	-0.40	61.00	1.00	Vertical	120000.00	-19.92

Radiated spurious emissions, radios transmitted simultaneously
Transmit at High Channel, 1-3 GHz

Test Information:

Date and Time	2/5/2021 11:22:35 PM
Client and Project Number	Windrock_G104473889
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	21%
Atmospheric Pressure	994 mB
Comments	RE 1 to 3 GHz_24VDC_Tx mode_Both radios set to High CH

Graph:



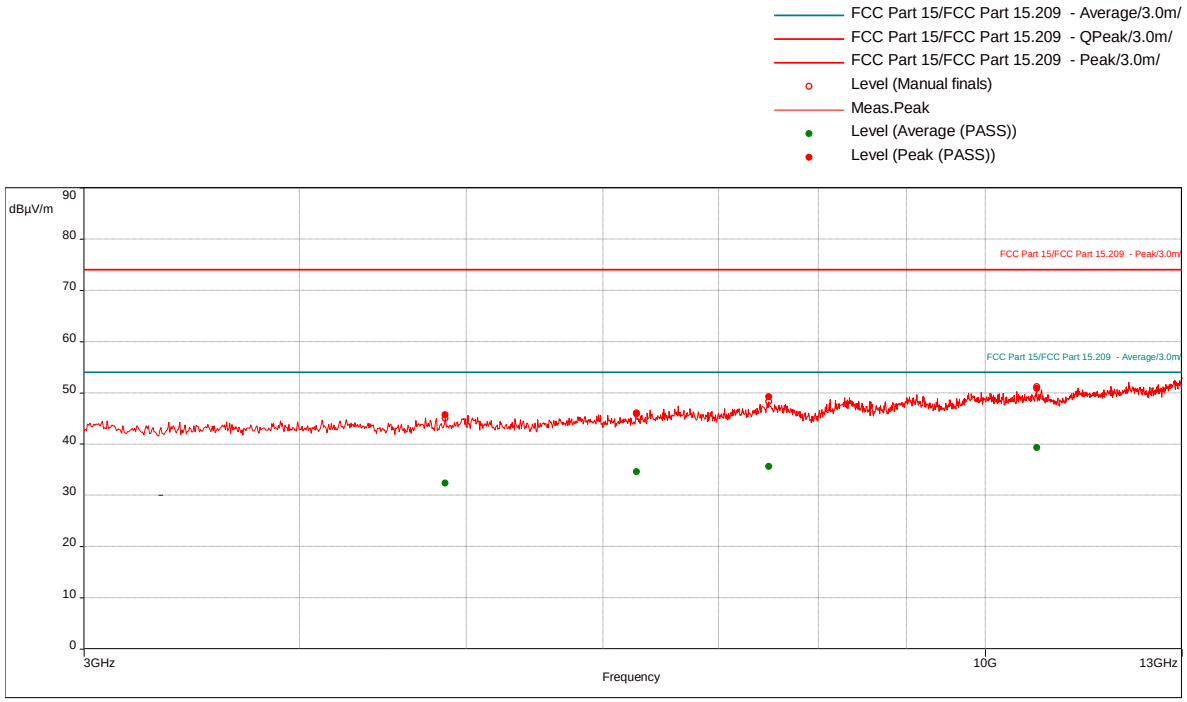
Results: No emissions were detected above the measuring equipment noise floor.

Radiated spurious emissions, radios transmitted simultaneously
Transmit at High Channel, 3-25 GHz

Test Information:

Date and Time	2/5/2021 11:27:30 PM
Client and Project Number	Windrock_G104473889
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	21%
Atmospheric Pressure	994 mB
Comments	RE 3 to 13 GHz_24VDC_Tx mode_Both radios set to High CH

Graph:



Results:

Peak (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
4860	45.72	74.00	-28.28	277.00	3.98	Vertical	1000000.00	-10.03
6273.947368	45.85	74.00	-28.15	121.00	2.95	Vertical	1000000.00	-7.03
7492.105263	49.18	74.00	-24.82	240.00	2.00	Horizontal	1000000.00	-5.87
10712.10526	50.82	74.00	-23.18	262.00	1.50	Horizontal	1000000.00	-1.49

Average (PASS) (4)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
4860	32.36	54.00	-21.64	277.00	3.98	Vertical	1000000.00	-10.03
6273.947368	34.61	54.00	-19.39	121.00	2.95	Vertical	1000000.00	-7.03
7492.105263	35.64	54.00	-18.36	240.00	2.00	Horizontal	1000000.00	-5.87
10712.10526	39.28	54.00	-14.72	262.00	1.50	Horizontal	1000000.00	-1.49

Note: Manual scan was performed from 13-25GHz, no emissions were detected above the measuring equipment noise floor.

Test Personnel:	Vathana Ven VJV	Test Date:	01/15/2021, 02/05/2021
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 15.247 RSS-247	Limit Applied:	See report section 10.3
Input Voltage:	24VDC	Ambient Temperature:	24, 24 ºC
Pretest Verification w/ Ambient Signals or BB Source:	**N/A**	Relative Humidity:	22, 21 %
		Atmospheric Pressure:	1008, 994 mbars

Deviations, Additions, or Exclusions: None

11 Digital Device and Receiver Radiated Spurious Emissions

11.1 Method

Tests are performed in accordance with FCC Part 15 Subpart B, ISED ICES-003, and ANSI C 63.4.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	4.6dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	5.3 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.5 dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	5.2 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	5.0 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	5.0 dB	5.5 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG
Where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

Alternately, when BAT-EMC Emission Software is used, the “Level” includes all losses and gains and is compared directly in the “Margin” column to the “Limit”. The “Correction” includes Antenna Factor, Preamp, and Cable Loss. These are already accounted for in the “Level” column.

11.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV007'	Weather Station Vantage Vue	Davis	6250	MS191212003	03/12/2020	03/12/2021
145108'	EMI Test Receiver (20Hz - 40GHz)	Rohde & Schwarz	ESIB40	100209	06/08/2020	06/08/2021
PRE11'	50dB gain pre-amp	Pasternack	PRE11	PRE11	09/11/2020	09/11/2021
145145'	Broadband Hybrid Antenna 30 MHz - 3 GHz	Sunol Sciences Corp.	JB3	A122313	05/08/2020	05/08/2021
IW001'	2 meter cable	Insulated Wire	2801-NPS	001	10/08/2020	10/08/2021
145-406'	10m Track A In-floor Cable #1	Huber + Suhner	sucoflex 160-19220mm	001	09/21/2020	09/21/2021
HS001'	DC-18GHz cable 1.5m long	Huber & Suhner	SucoFlex 106A	HS001	10/07/2020	10/07/2021
IW003'	8.4 meter cable	Insulated Wire	2800-NPS	003	06/10/2020	06/10/2021
145-422'	10Amp Pre-amp to under floor	Utiflex	UFB311A-0-2756-70070	145-422	02/17/2020	02/17/2021
HS003'	10m under floor cable	Huber-Schuner	10m-1	HS003	04/29/2020	04/29/2021
ETS002'	1-18GHz DRG Horn Antenna	ETS Lindgren	3117	00143260	08/03/2020	08/03/2021
BONN001'	1-18GHz low noise pre-amp	Bonn	BLMA 0118-M	1811749	07/11/2020	07/11/2021

Software Utilized:

Name	Manufacturer	Version
BAT-EMC	Nexio	3.18.0.16

11.3 Results:

The sample tested was found to Comply when modified as described below.

§15.109 Radiated emission limits.

The field strength of radiated emissions form unintentional radiators at a distance of 3 meters shall not exceed the following values.

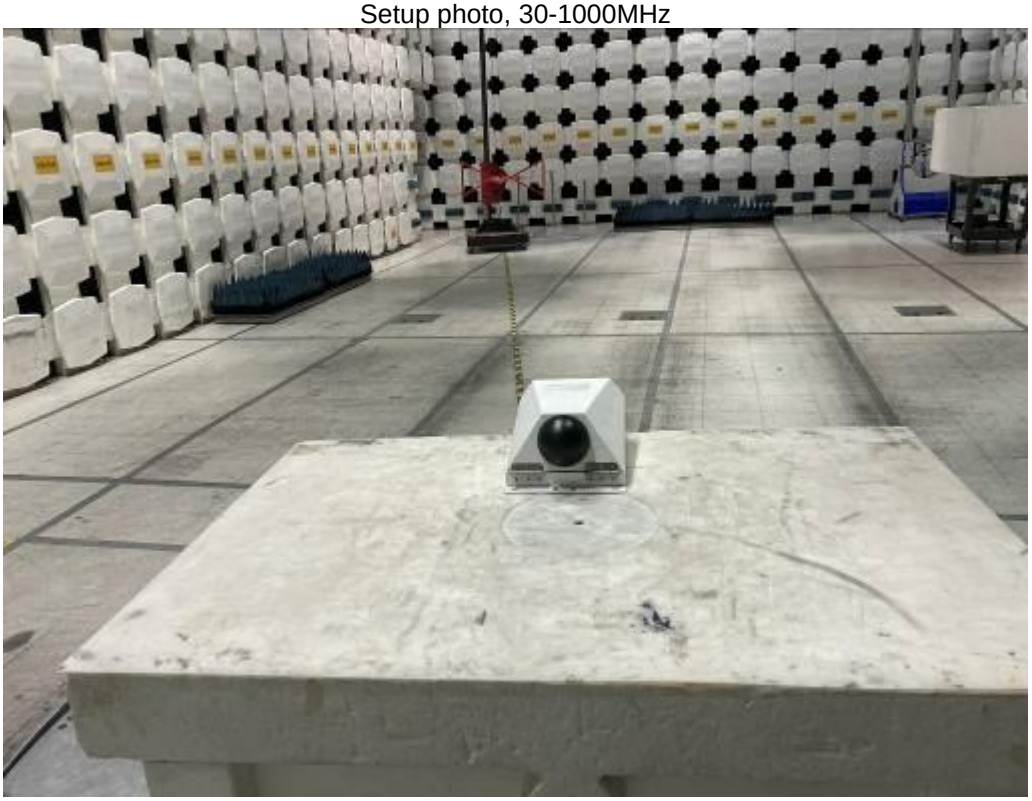
Frequency of emission (MHz)	Field strength (microvolts/meter)	Field strength (dBµV/m)
30-88	100	40.00
88-216	150	43.52
216-960	200	46.02
Above 960	500	54.00

Modifications:

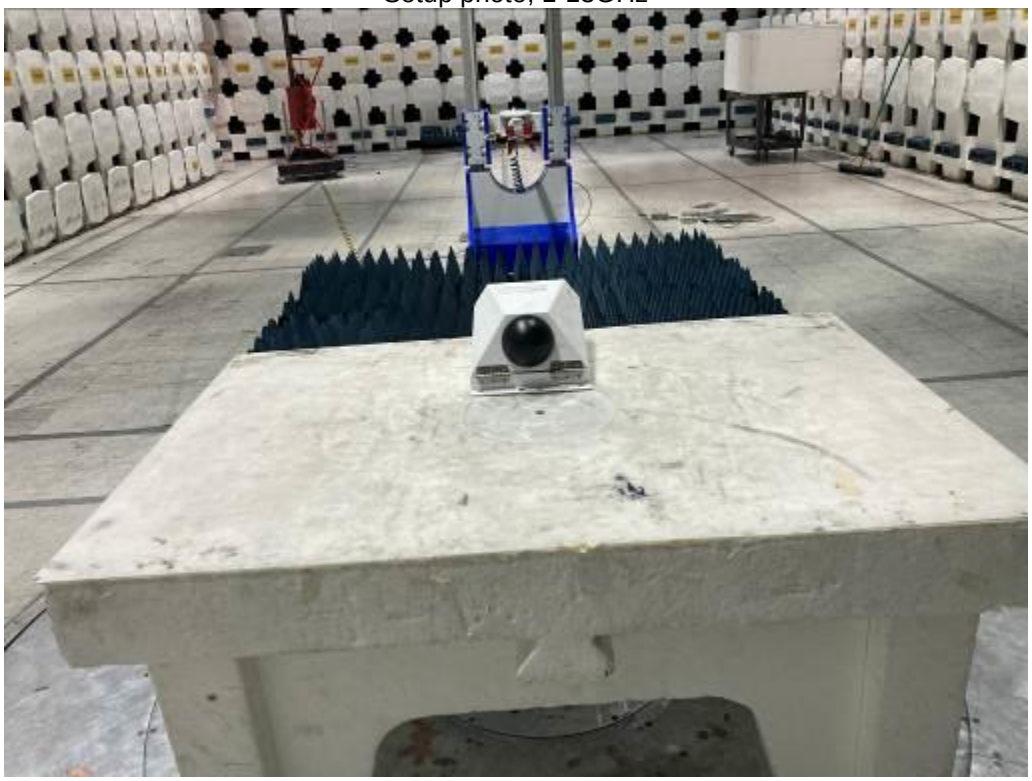
(3) Ferrite sleeve (Fair-Rite, p/n: 0444164181) was externally installed around the power cable with one loop configuration as close to the EUT as possible.
(4) Ferrite sleeve (Fair-Rite, p/n: 0444164181) was externally installed around Ethernet cable with a straight through configuration as close to the EUT as possible.

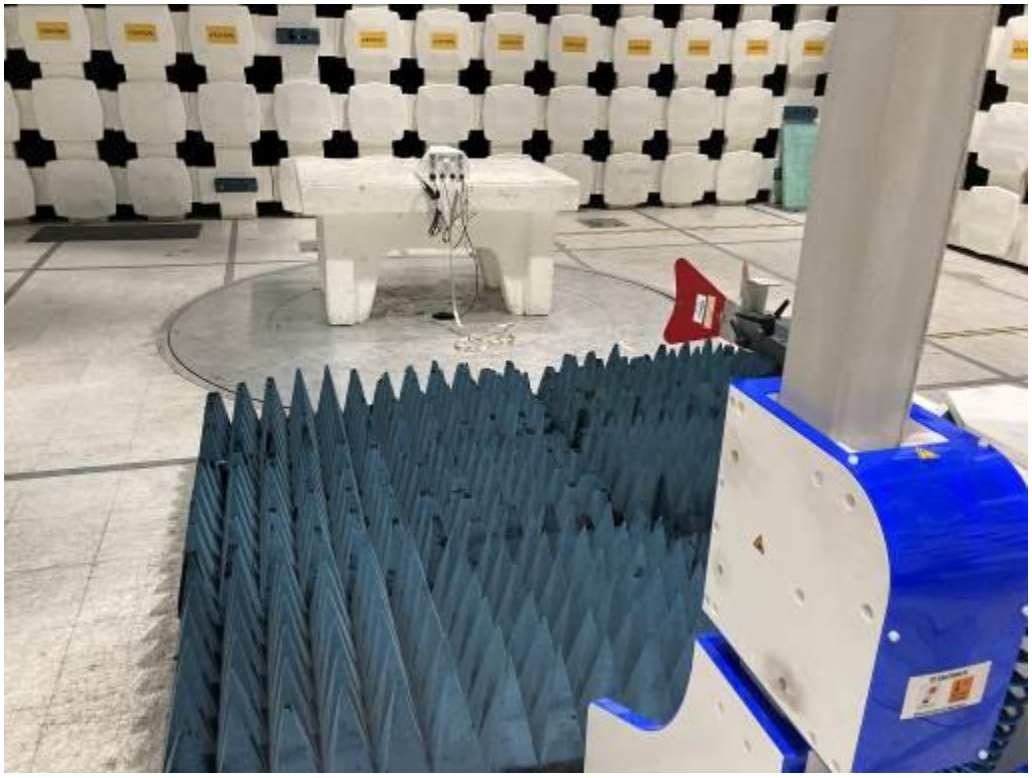
11.4 Setup Photographs:

Setup photo, 30-1000MHz



Setup photo, 1-13GHz





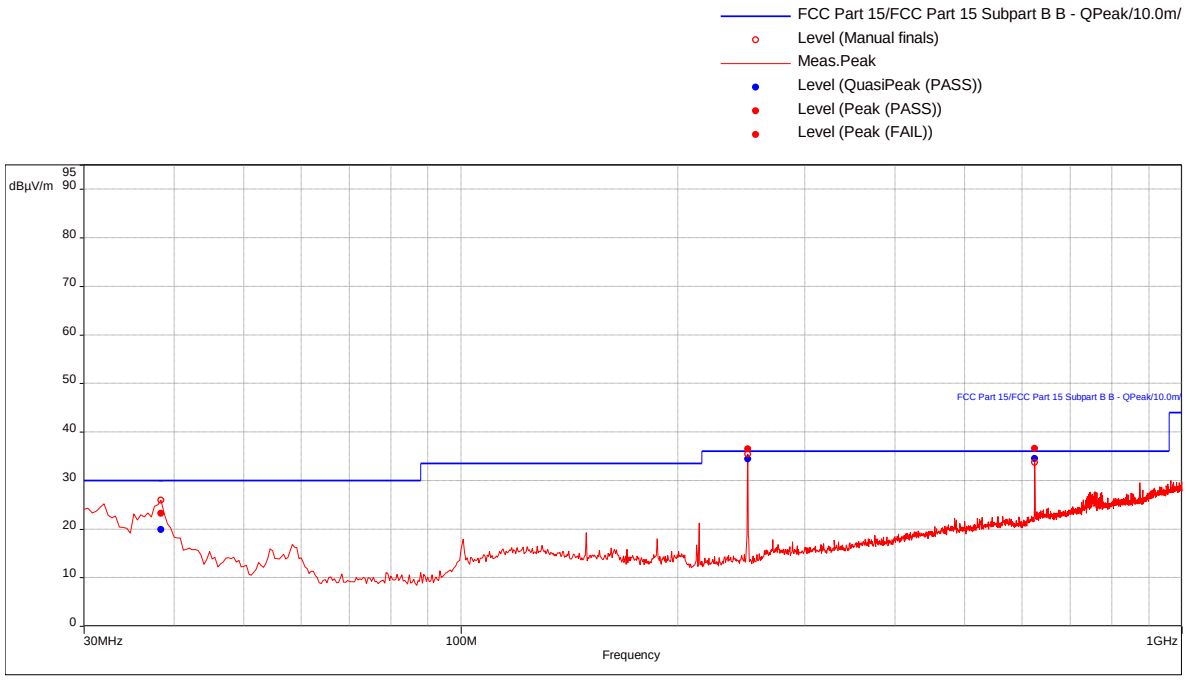
11.5 Plots/Data:

30-1000 MHz

Test Information:

Date and Time	1/15/2021 11:27:23 PM
Client and Project Number	Windrock_G104473889
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	22%
Atmospheric Pressure	1008 mB
Comments	Scan#10_Rx mode_New board w/shielding_Ferrite on power cable_Decreased ground Z_copper tape_changed grounding

Graph:



Results:

QuasiPeak (PASS) (3)

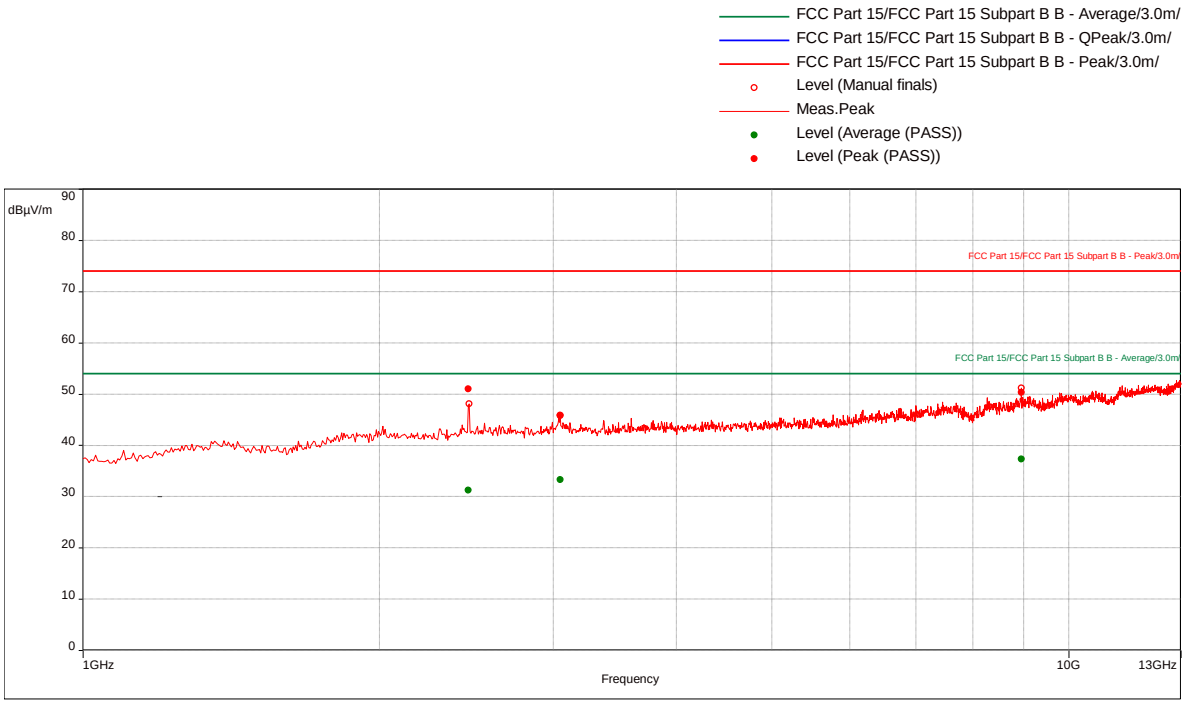
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
38.55789474	19.88	30.00	-10.12	25.00	2.18	Vertical	120000.00	-18.22
249.9684211	34.45	36.00	-1.55	321.00	1.00	Vertical	120000.00	-19.92
624.9789474	34.47	36.00	-1.53	62.00	1.96	Horizontal	120000.00	-10.29

1-13 GHz

Test Information:

Date and Time	2/6/2021 12:06:57 AM
Client and Project Number	Windrock_G104473889
Engineer	Vathana Ven
Temperature	24 deg C
Humidity	21%
Atmospheric Pressure	994 mB
Comments	RE 1 to 13 GHz_24VDC_Tx mode_Both radios set to Rx mode

Graph:



Results:

Peak (PASS) (3)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
2460.263158	51.02	74.00	-22.98	324.00	1.70	Vertical	1000000.00	-14.76
3050.789474	45.77	74.00	-28.23	90.00	1.10	Horizontal	1000000.00	-11.98
8954.210526	50.34	74.00	-23.66	261.00	2.30	Vertical	1000000.00	-4.13

Average (PASS) (3)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°)	Height (m)	Pol.	RBW (Hz)	Correction (dB)
2460.263158	31.25	54.00	-22.75	324.00	1.70	Vertical	1000000.00	-14.76
3050.789474	33.29	54.00	-20.71	90.00	1.10	Horizontal	1000000.00	-11.98
8954.210526	37.30	54.00	-16.70	261.00	2.30	Vertical	1000000.00	-4.13

Test Personnel:	Vathana Ven VSV	Test Date:	01/15/2021, 02/05/2021
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 15.247 RSS-247	Limit Applied:	See report section 11.3
Input Voltage:	24VDC	Ambient Temperature:	24, 24 ºC
Pretest Verification w/ Ambient Signals or BB Source:	**N/A**	Relative Humidity:	22, 21 %
		Atmospheric Pressure:	1008, 994 mbars

Deviations, Additions, or Exclusions: None

12 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	02/23/2021	104473889BOX-001	VFV	MFM	Original Issue
1	07/23/2021	104473889BOX-001	VFV	KPS	Added notes to Band Edge Compliance section and data for 9kHz-30MHz in Transmitter Spurious Emission section