

EMC Test Report

Project Number: 4659830**Proposal Number:** 10977 Rev1**Report Number:** 4659830EMC03**Revision Level:** 1**Client:** ST Engineering Aethon Inc.**Equipment Under Test:** IO Nuc Assembly**Model Number:** 293504**FCC ID:** 2AA6CSOMRPL20**IC:** 11082A-SOMRPL20**Applicable Standards:** FCC § 15.231

RSS-210, Issue 10 (Annex A)

ANSI C63.10-2013

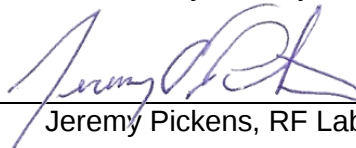
Report issued on: 02 November 2021**Test Result:** Compliant

Prepared by:



Martin Taylor, Project Engineer

Reviewed by:



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Remarks: This report details the results of the testing carried out on one sample; the results contained in this test report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.

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1 Summary of Test Results

Test Description	FCC Rule Part	ISED Specification	Test Procedure	Test Result
Dwell Time	15.231(a)(2)	RSS-210 (A.1.1)(b)	ANSI C63.10 (7.4)	Compliant
Periodic Transmissions	15.231(a)(3)	RSS-210 (A.1.1)(c)	ANSI C63.10 (7.4)	N/A ¹
Field Strength of Fundamental	15.231(b)	RSS-210 (A.1.2)	ANSI C63.10 (6.5)	Compliant
Field Strength of Spurious Radiation	15.231(b)	RSS-210 (A.1.2)	ANSI C63.10 (6.5)	Compliant
20 dB Bandwidth	15.231(c)	RSS-210 (A.1.3)	ANSI C63.10 (6.9)	Compliant
Antenna Requirement	15.203	RSS-GEN (6.8)	--	Compliant ²

Note 1: This rule part does not apply since the EUT does not use periodic transmissions at regular predetermined intervals (it only transmits when a hospital door needs to be opened) and it does not use polling or supervision transmissions in a security or safety application. See the Theory of Operation document for operational details of the transmitter.

Note 2: The antenna is connected to the outside of the EUT but is not replaceable by the end user since the EUT is installed by the manufacturer inside a final product.

1.1 Modifications Required for Compliance

None

2 General Information

2.1 Client Information

Name: ST Engineering Aethon Inc.
Address: 200 Business Center Dr.
City, State, Zip, Country: Pittsburgh, PA 15205, 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
Certification Number: 3212.01

2.3 General Information of EUT

Product Marketing Name (PMN): IO Nuc Assembly
Model Number (HVIN): 293504
Sample ID: 5580

FCC ID: 2AA6CSOMRPL20
IC: 11082A-SOMRPL20

Frequency Range: 418 MHz
Data Mode: modulated carrier pulse
Antenna: Omni-directional with SMA(M) connector (0 dBi)

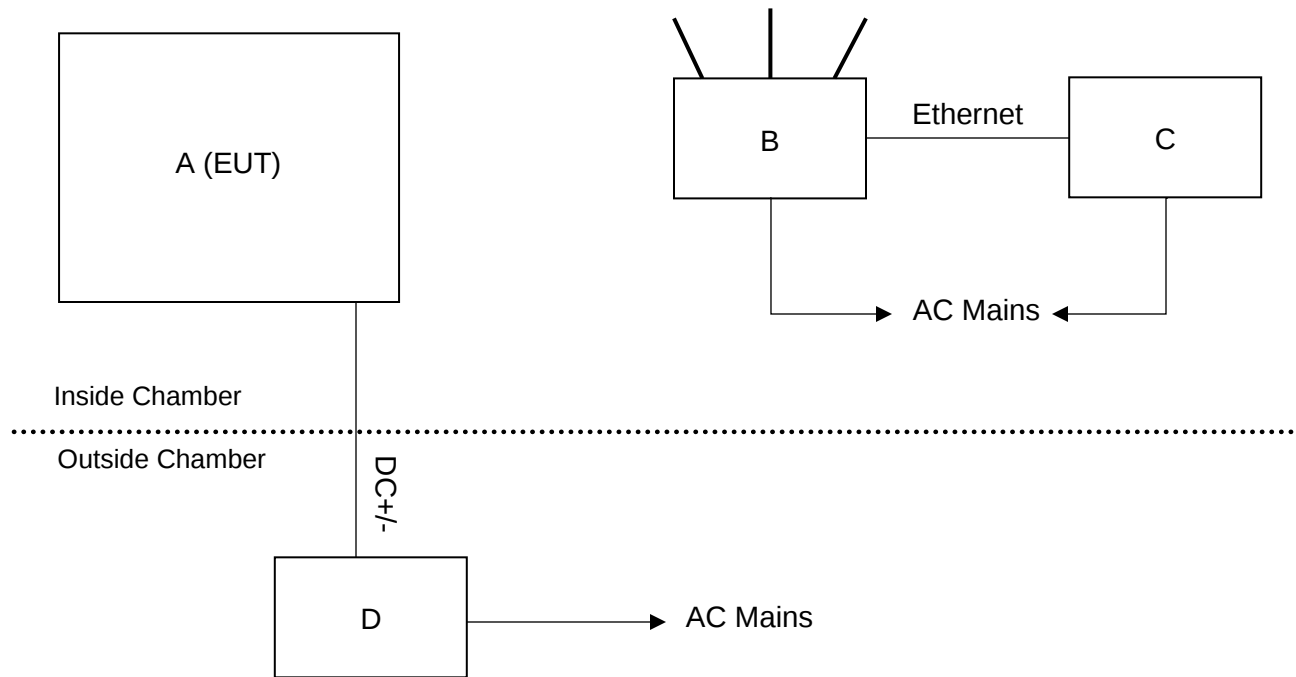
Rated Voltage: +48Vdc
Test Voltage: +48Vdc

Sample Received Date: 03 August 2020
Dates of testing: 30 October to 09 December 2020

2.4 Operating Modes and Conditions

The EUT was powered by a 48Vdc lab power supply capable of supplying 2A. Normal operating firmware was running on the EUT except that the ability was added to put the Sub-GHz radio (for the remote door opener) into test modes. The transmitter could either be turned on continuously or transmit 1500ms pulses. A WLAN router was used to form a Wi-Fi connection with the EUT, which in turn enabled commands to be sent to control the Sub-GHz radio.

2.5 EUT Connection Block Diagram



2.6 System Configurations

Device Reference	Manufacturer	Description	Model Number	Serial Number
A	Aethon, Inc.	IO Nuc Assembly (EUT)	293504	Not labeled
B	Netgear	Smart WiFi Router	R7000	3LG23C7F03390
C	HP	Laptop Computer	15-f233wm	5CD6415H9V
D	TDK-Lambda	DC Power Supply	GEN 50-30	12C3699Z

3 Dwell Time

3.1 Test Result

Test Description	Test Specification	Test Result
Dwell Time	ANSI C63.10-2013 Section 7.4	Compliant

3.2 Test Method

ANSI C63.10-2013 Section 7.4 was used for the test method, and the test was performed using a conducted connection. FCC 15.231(a)(2) requires that the transmitter not operate beyond 5 seconds.

"A transmitter activated automatically shall cease transmission within 5 seconds after activation."

3.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.6 °C

Relative Humidity: 25.8 %

Atmospheric Pressure: 98.0 kPa

3.4 Test Equipment

Test End Date: 9-Dec-2020

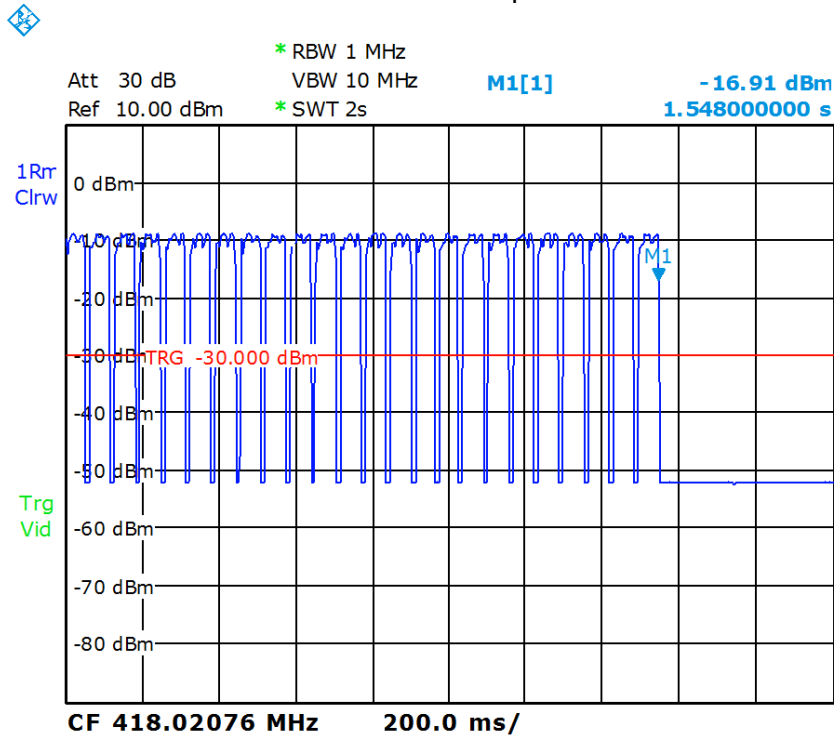
Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
RF CABLE (TS8997)	141	Huber & Suhner	B095586	3-Sep-2020	3-Sep-2021
NETWORK / SPECTRUM ANALYZER	ZVL6	ROHDE & SCHWARZ	B079799	15-Apr-2020	15-Apr-2021

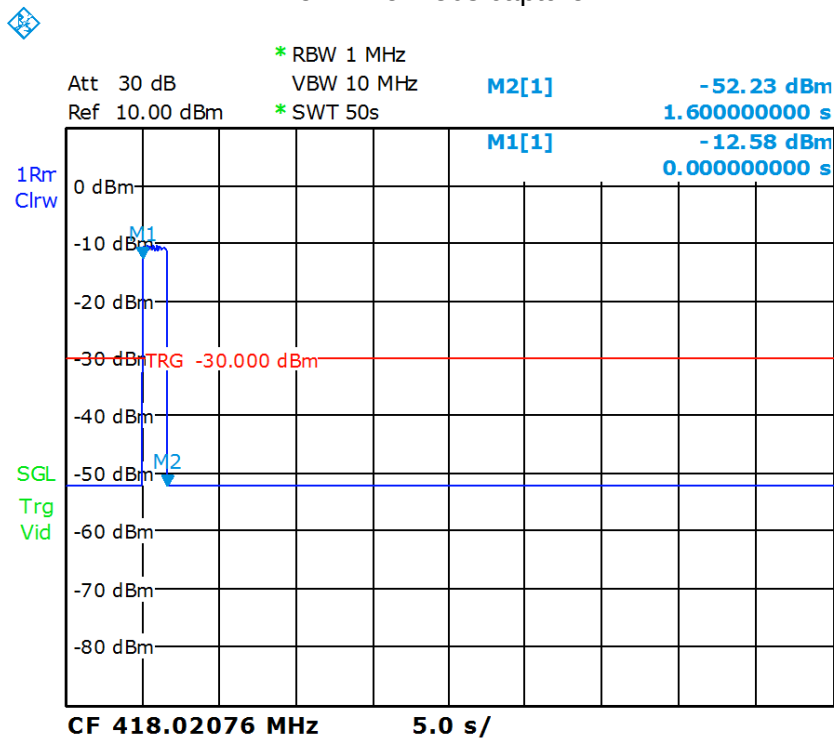
Note: The equipment calibration period is 1 year.

3.5 Test Data

Dwell Time – 2s capture



Dwell Time – 50s capture



Maximum transmitter on time = 1.6s < 5s (compliant)

4 Field Strength of Fundamental

4.1 Test Result

Test Description	Test Specification	Test Result
Field Strength of Fundamental	ANSI C63.10-2013 Section 6.5	Compliant

4.2 Test Method

The receiver's resolution bandwidth was set to 120 kHz for measurements taken in the 30MHz to 1GHz frequency range and 1MHz for measurements for 1GHz and higher. Measurements were made with the antenna positioned at a 3m distance from the EUT in both the horizontal and vertical planes of polarization. The antenna height was varied from 1 m to 4 m and the EUT was rotated 360° to find the maximum emitting point for each frequency. The radiated measurements were recorded and compared to the limits indicated in the table below.

The EUT was tested in the vertical orientation as that is how it will be mounted in the hospital robots.

Below are the field strength limits from FCC 15.231(b) for a measurement distance of 3 meters:

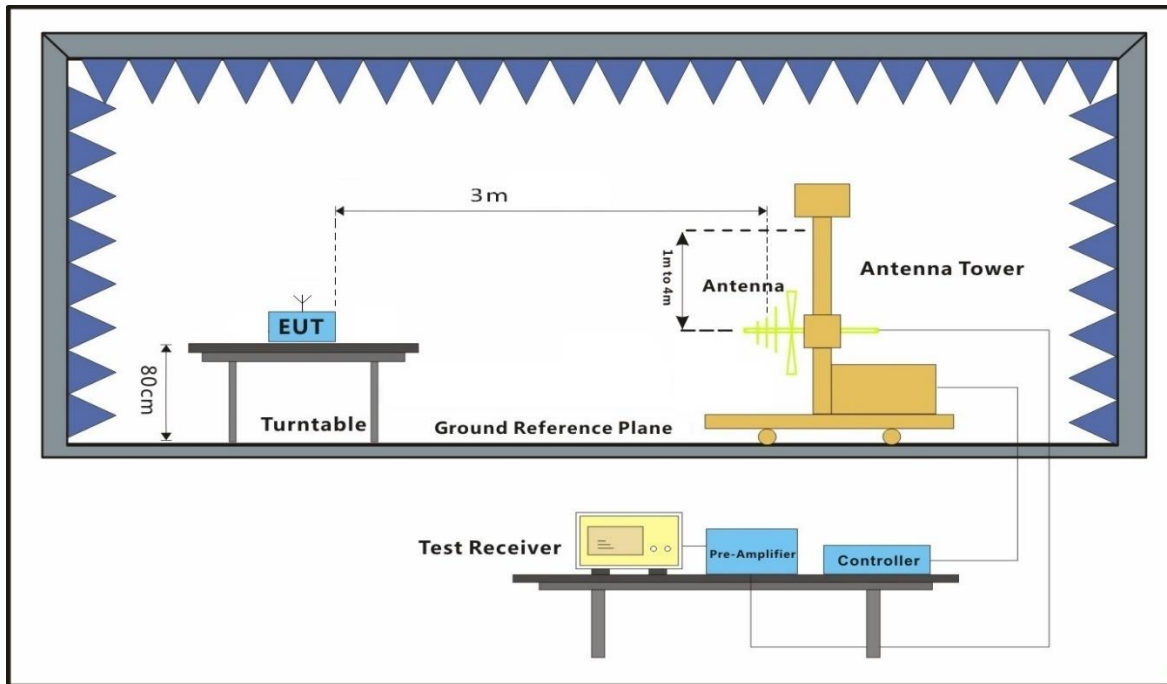
Fundamental frequency (MHz)	Field strength of fundamental (microvolts/meter)	Field strength of spurious emissions (microvolts/meter)
40.66-40.70	2250	225
70-130	1250	125
130-174	1250 to 3750 ¹	125 to 375 ¹
174-260	3750	375
260-470	3750 to 12500 ¹	375 to 1250 ¹
Above 470	12500	1250

¹ Linear interpolation

From the above table, the fundamental limit for a 418MHz fundamental frequency is determined by interpolation to be 80.2 dBuV/m.

Intentional radiators operating under the provisions of this section shall demonstrate compliance with the limits on the field strength of emissions, as shown in the above table, based on the average value of the measured emissions. As an alternative, compliance with the limits in the above table may be based on the use of measurement instrumentation with a CISPR quasi-peak detector.

4.3 Test Setup Diagram



4.4 Test Site

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

Environmental Conditions

Temperature: 23 °C

Relative Humidity: 25 %

Atmospheric Pressure: 98 kPa

4.5 Test Equipment

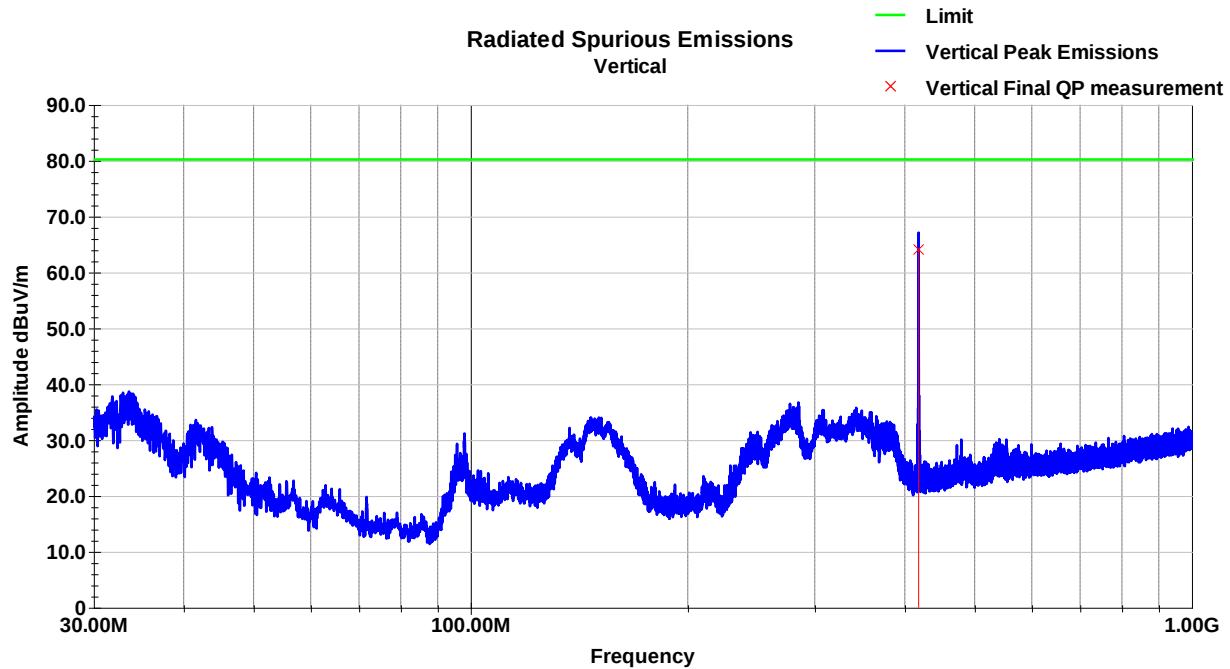
Test End Date: 30-Oct-2020

Tester: PV

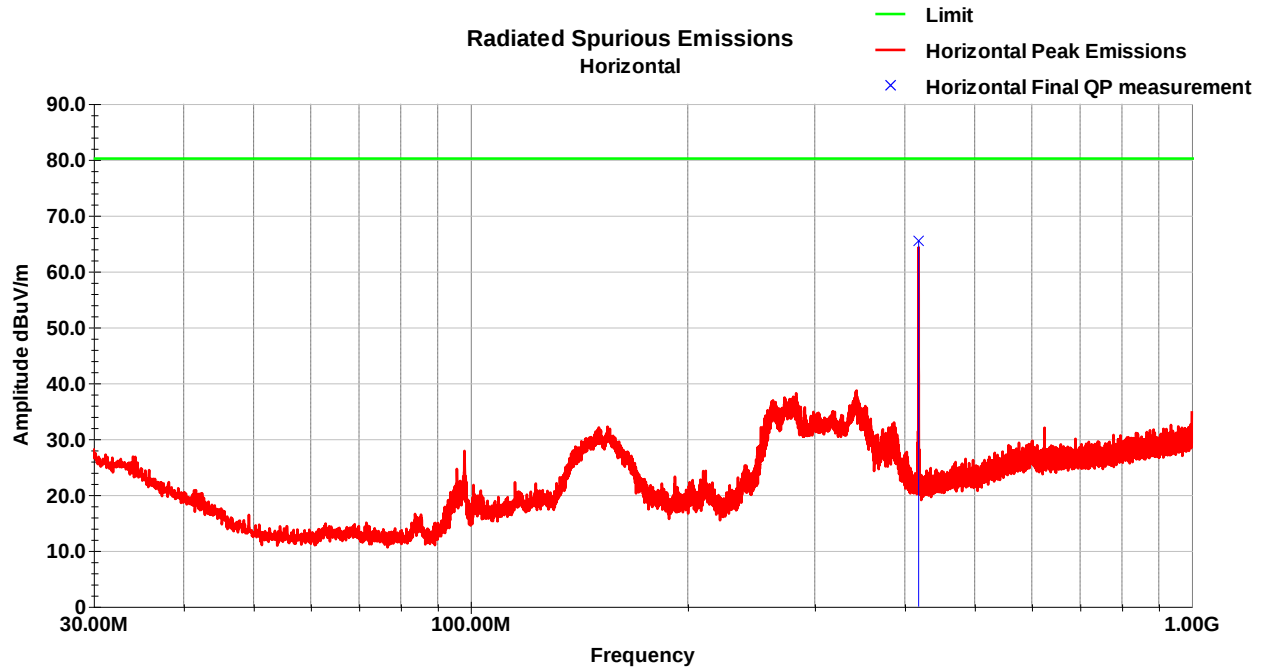
Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
ANTENNA, BILOG	JB6	SUNOL	B079690	11-Dec-2018	11-Dec-2020
RF Cable Nm to Nm, 0.01-18GHz	90-195-276	TELEDYNE STORM MICROWAVE	20114	2-Mar-2020	2-Mar-2021
RF CABLE	SF106	HUBER & SUHNER	B079713	3-Sep-2020	3-Sep-2021
RF Cable Nm to Nm, 0.01-18GHz	90-195-118	TELEDYNE STORM MICROWAVE	20126	2-Mar-2020	2-Mar-2021
LOW NOISE AMPLIFIER	ZKL-2+	Mini-Circuits	B079800	25-Sep-2020	25-Sep-2021
RF CABLE	104PE	HUBER & SUHNER	B079793	3-Sep-2020	3-Sep-2021
EMI TEST RECEIVER	ESU8	ROHDE & SCHWARZ	B085759	7-May-2020	7-May-2021

Note: The equipment calibration period is 1 year unless noted above.

4.6 Test Data



Frequency MHz	Raw QP (dBuV)	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	QP Value (dBuV/m)	Limit (dBuV/m)	Margin (dB)
418.03	75.9	V	93.0	202.0	16.6	2.3	30.7	64.0	80.2	-16.2
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										



Frequency MHz	Raw QP (dBuV)	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	QP Value (dBuV/m)	Limit (dBuV/m)	Margin (dB)
418.06	77.4	H	35.0	187.0	16.6	2.3	30.7	65.5	80.2	-14.7
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

5 Field Strength of Spurious Radiation

5.1 Test Result

Test Description	Test Specification	Test Result
Field Strength of Spurious Radiation	ANSI C63.10-2013 Section 6.5	Compliant

5.2 Test Method

The receiver's resolution bandwidth was set to 120 kHz for measurements taken in the 30MHz to 1GHz frequency range and 1MHz for measurements for 1GHz and higher. Measurements were made with the antenna positioned at a 3m distance from the EUT in both the horizontal and vertical planes of polarization. The antenna height was varied from 1 m to 4 m and the EUT was rotated 360° to find the maximum emitting point for each frequency. The radiated measurements were recorded and compared to the limits indicated in the table below.

The EUT was tested in the vertical orientation as that is how it will be mounted in the hospital robots.

Below are the field strength limits from FCC 15.231(b) for a measurement distance of 3 meters:

Fundamental frequency (MHz)	Field strength of fundamental (microvolts/meter)	Field strength of spurious emissions (microvolts/meter)
40.66-40.70	2250	225
70-130	1250	125
130-174	1250 to 3750 ¹	125 to 375 ¹
174-260	3750	375
260-470	3750 to 12500 ¹	375 to 1250 ¹
Above 470	12500	1250

¹ Linear interpolations

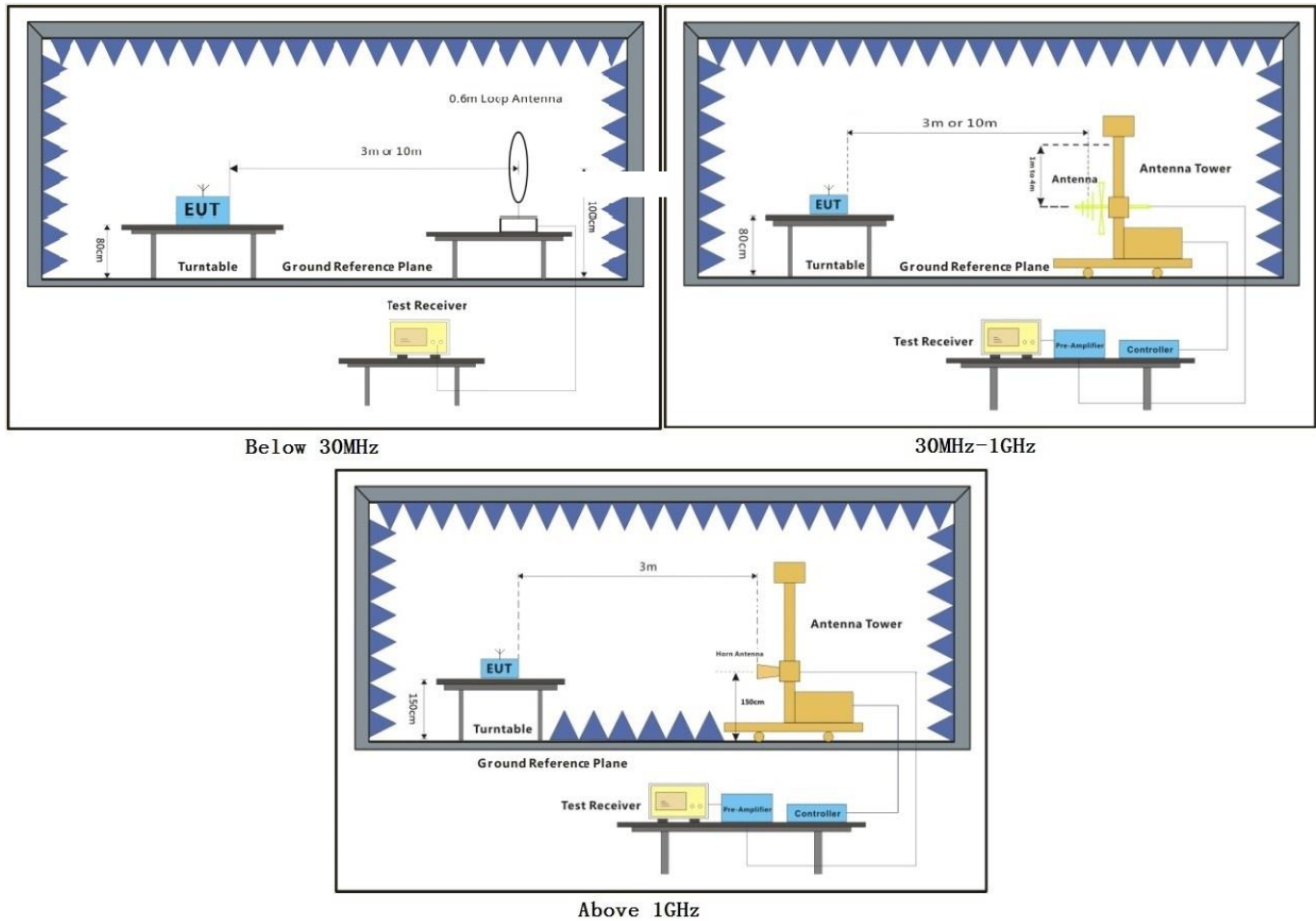
The limits on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator.

From the above table, the spurious emissions limit for a 418MHz fundamental frequency is determined by interpolation to be 60.2 dBuV/m.

Intentional radiators operating under the provisions of this section shall demonstrate compliance with the limits on the field strength of emissions, as shown in the above table, based on the average value of the measured emissions. As an alternative, compliance with the limits in the above table may be based on the use of measurement instrumentation with a CISPR quasi-peak detector.

Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in §15.209, whichever limit permits a higher field strength.

5.3 Test Setup Diagrams



5.4 Test Site

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

Environmental Conditions	9KHz-30MHz	30-1000MHz	1-5GHz
Temperature:	23.5 °C	23 °C	23.9 °C
Relative Humidity:	24.7 %	25 %	24.7 %
Atmospheric Pressure:	99.02 kPa	98 kPa	97.54 kPa

5.5 Test Equipment

9KHz-30MHz

Test End Date: 17-Nov-2020

Tester: ZH

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
ANTENNA, LOOP, ACTIVE	6502	ETS Lindgren	B085752	20-Aug-2022
RF Cable Nm to Nm, 0.01-18GHz	90-195-276	TELEDYNE STORM MICROWAVE	20114	2-Mar-2021
RF CABLE	SF106	HUBER & SUHNER	B079713	3-Sep-2021
RF Cable Nm to Nm, 0.01-18GHz	90-195-118	TELEDYNE STORM MICROWAVE	20126	2-Mar-2021
EMI TEST RECEIVER	ESU8	ROHDE & SCHWARZ	B085759	7-May-2021

30-1000MHz

Test End Date: 30-Oct-2020

Tester: PV

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
ANTENNA, BILOG	JB6	SUNOL	B079690	11-Dec-2018	11-Dec-2020
RF Cable Nm to Nm, 0.01-18GHz	90-195-276	TELEDYNE STORM MICROWAVE	20114	2-Mar-2020	2-Mar-2021
RF CABLE	SF106	HUBER & SUHNER	B079713	3-Sep-2020	3-Sep-2021
RF Cable Nm to Nm, 0.01-18GHz	90-195-118	TELEDYNE STORM MICROWAVE	20126	2-Mar-2020	2-Mar-2021
LOW NOISE AMPLIFIER	ZKL-2+	Mini-Circuits	B079800	25-Sep-2020	25-Sep-2021
RF CABLE	104PE	HUBER & SUHNER	B079793	3-Sep-2020	3-Sep-2021
EMI TEST RECEIVER	ESU8	ROHDE & SCHWARZ	B085759	7-May-2020	7-May-2021

1-5GHz

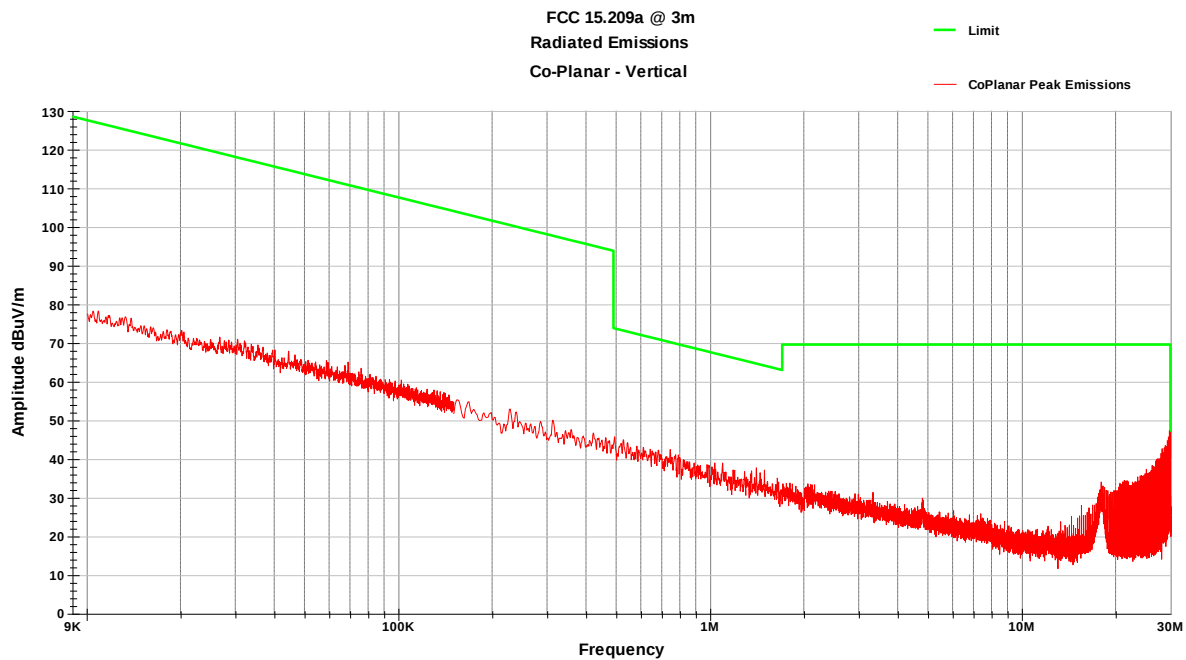
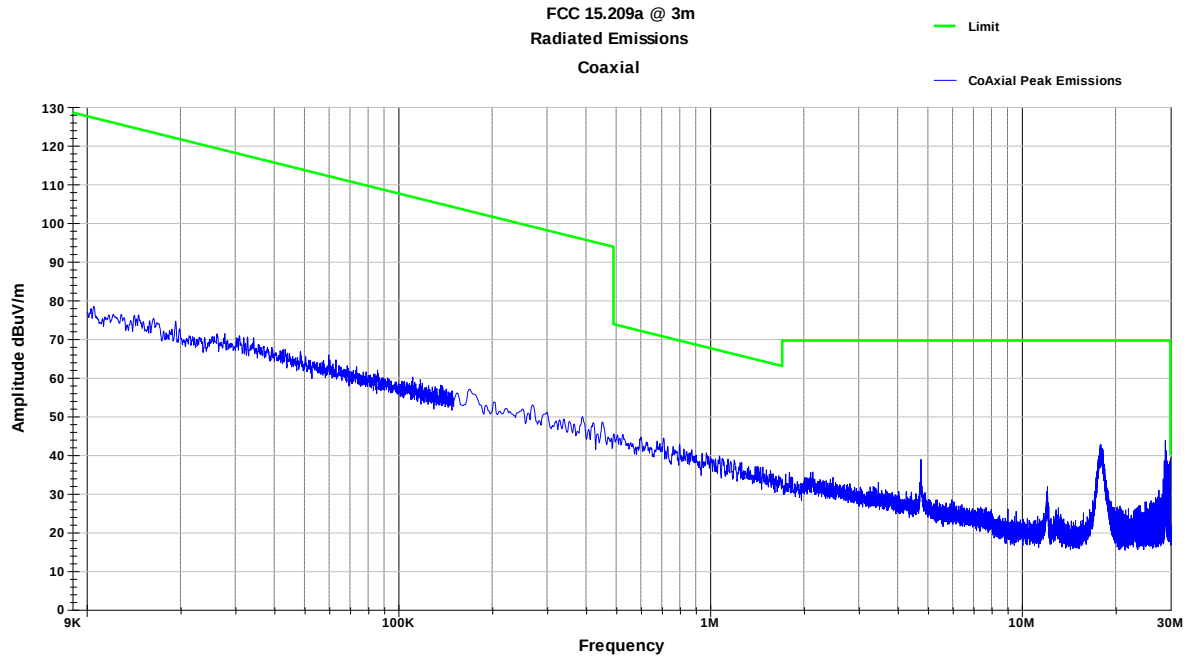
Test End Date: 18-Nov-2020

Tester: ZH

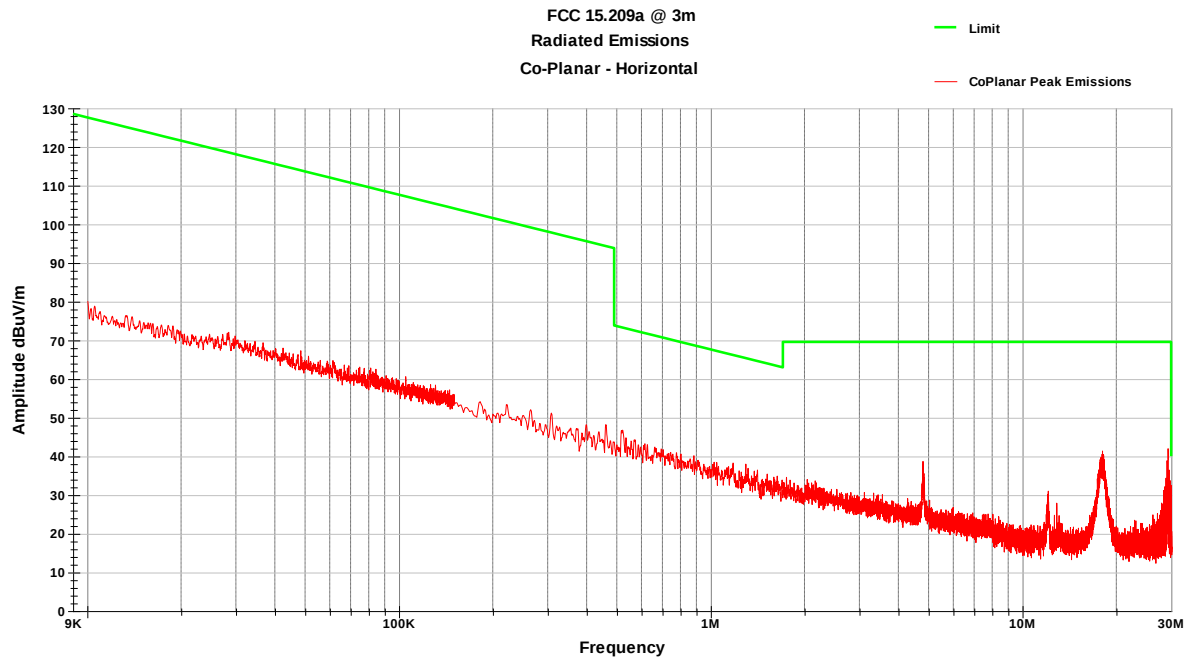
Equipment	Model	Manufacturer	Asset Number	Cal Due Date
EMI TEST RECEIVER	ESU40	ROHDE & SCHWARZ	B079629	6-Apr-2021
ANTENNA, DRG HORN (MEDIUM)	3117	ETS Lindgren	B079691	10-Aug-2022
RF Cable Nm to Nm, 0.01-18GHz	90-195-276	TELEDYNE STORM MICROWAVE	20114	2-Mar-2021
RF CABLE	SUCOFLEX 100	Huber & Suhner	B108523	3-Sep-2021
LOW NOISE AMPLIFIER	TS-PR18	ROHDE & SCHWARZ	15003	28-Oct-2021

Note: The equipment calibration period is 1 year unless otherwise noted.

5.6 Test Data – 9 kHz to 30 MHz



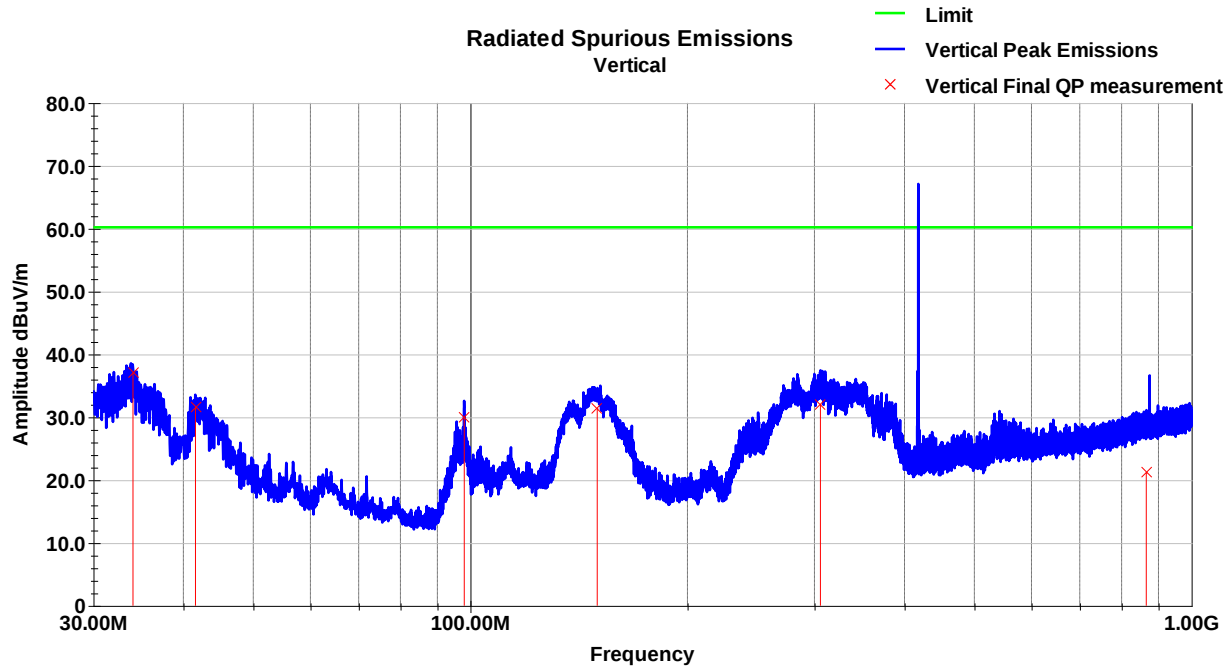
No emissions observed within 20dB of limit



No emissions observed within 20dB of limit

5.7 Test Data – 30 MHz to 1 GHz

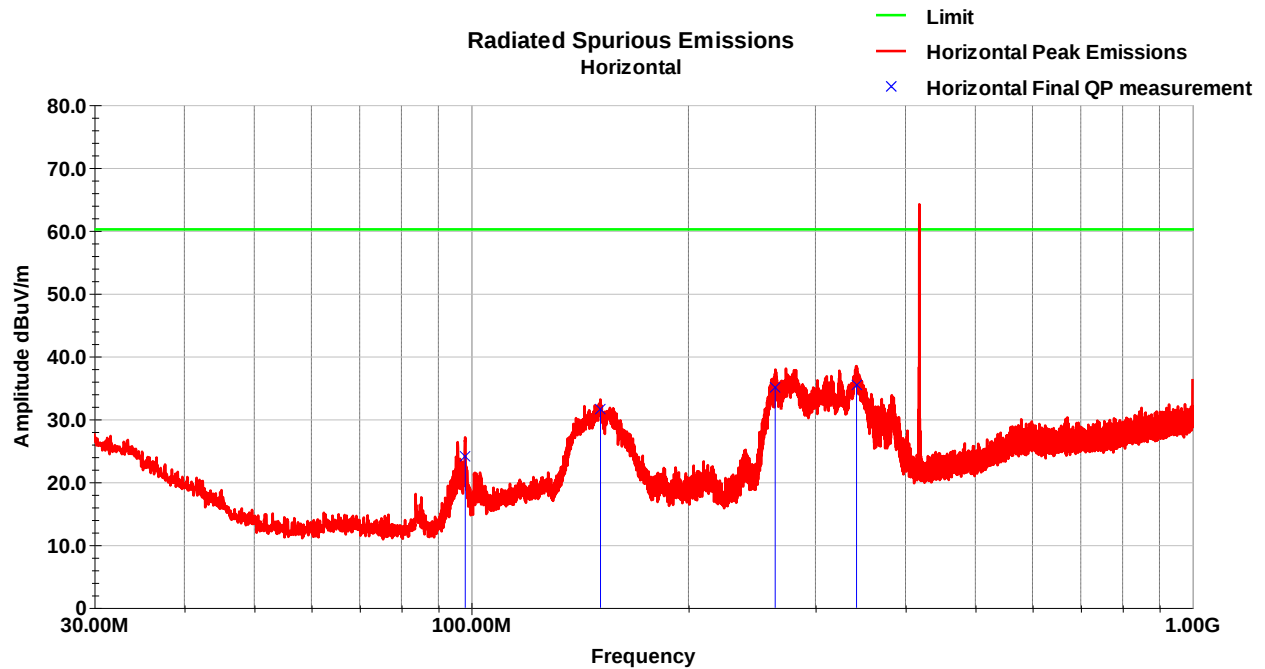
Vertical Emissions Plot 30-1000MHz



Vertical Emissions Data 30-1000MHz

Frequency MHz	Raw QP (dBuV)	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	QP Value (dBuV/m)	Limit (dBuV/m)	Margin (dB)
34.06	48.9	V	355.0	101.0	19.0	0.6	31.3	37.1	60.2	-23.1
41.57	48.9	V	359.0	101.0	13.3	0.7	31.3	31.5	60.2	-28.7
98.08	50.3	V	112.0	121.0	9.8	1.1	31.2	30.0	60.2	-30.2
149.97	48.3	V	269.0	117.0	12.8	1.3	31.1	31.4	60.2	-28.8
305.80	46.7	V	355.0	183.0	14.3	1.9	30.9	32.0	60.2	-28.2
865.64	25.5	V	161.0	340.0	22.6	3.2	30.1	21.2	60.2	-39.0
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

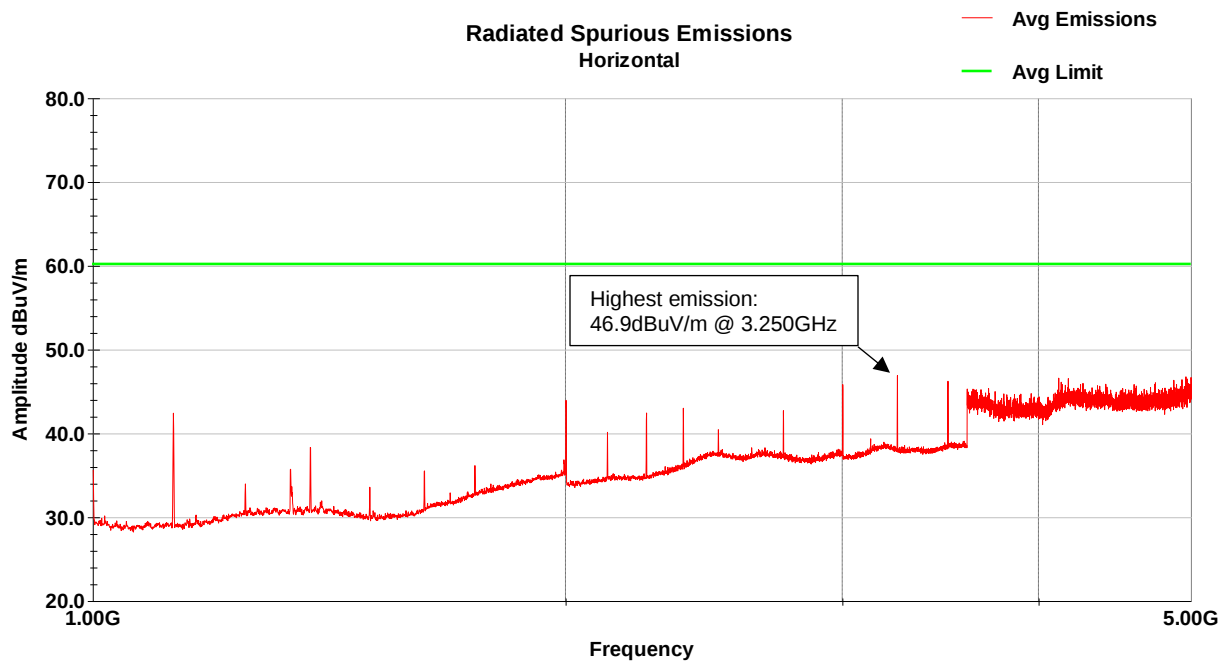
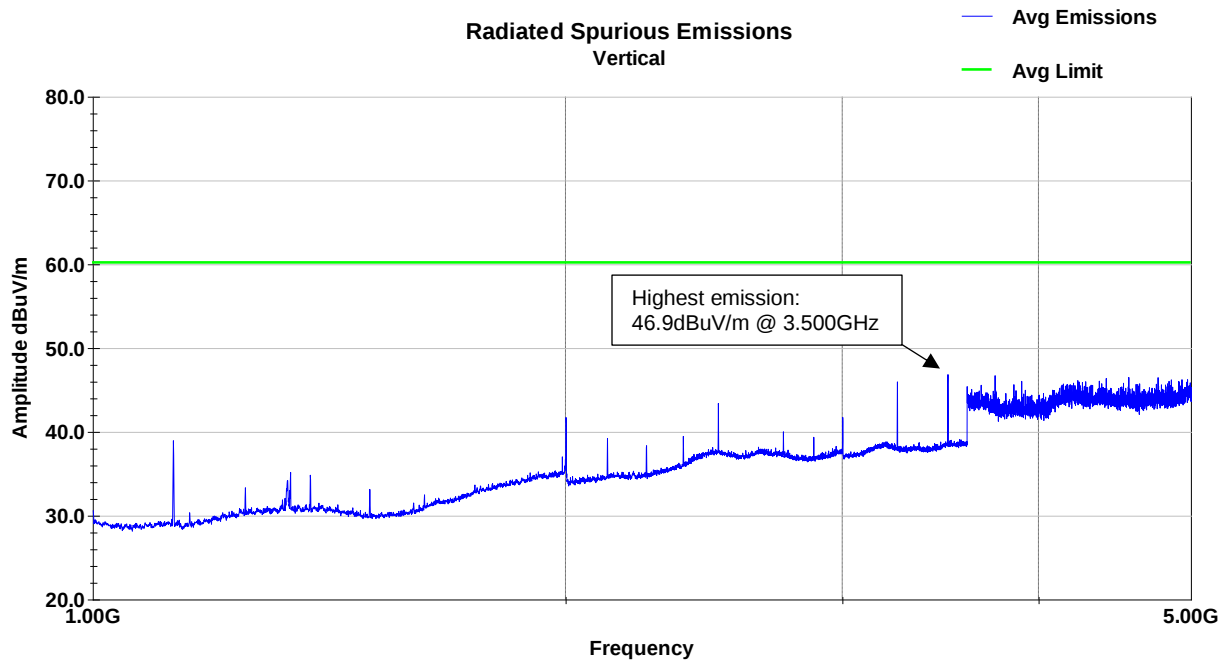
Horizontal Emissions Plot 30-1000MHz



Horizontal Emissions Data 30-1000MHz

Frequency MHz	Raw QP (dBuV)	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	QP Value (dBuV/m)	Limit (dBuV/m)	Margin (dB)
98.09	44.3	H	168.0	318.0	9.8	1.1	31.2	24.0	60.2	-36.2
151.05	48.5	H	7.0	218.0	12.8	1.4	31.1	31.6	60.2	-28.6
263.91	50.7	H	346.0	108.0	13.5	1.8	30.9	35.1	60.2	-25.1
342.14	49.1	H	243.0	106.0	15.1	2.0	30.8	35.4	60.2	-24.8
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

5.8 Test Data –1 to 5 GHz



6 20 dB Bandwidth

6.1 Test Result

Test Description	Basic Standards	Test Result
20 dB Bandwidth	ANSI C63.10-2013 Section 6.9	Compliant

6.2 Test Method

The procedures from ANSI C63.10-2013 Section 6.9 were used to determine the 20 dB bandwidth. The test was performed using the conducted method.

6.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.0 °C
Relative Humidity: 32.8 %
Atmospheric Pressure: 97.4 kPa

6.4 Test Equipment

Test End Date: 30-Nov-2020

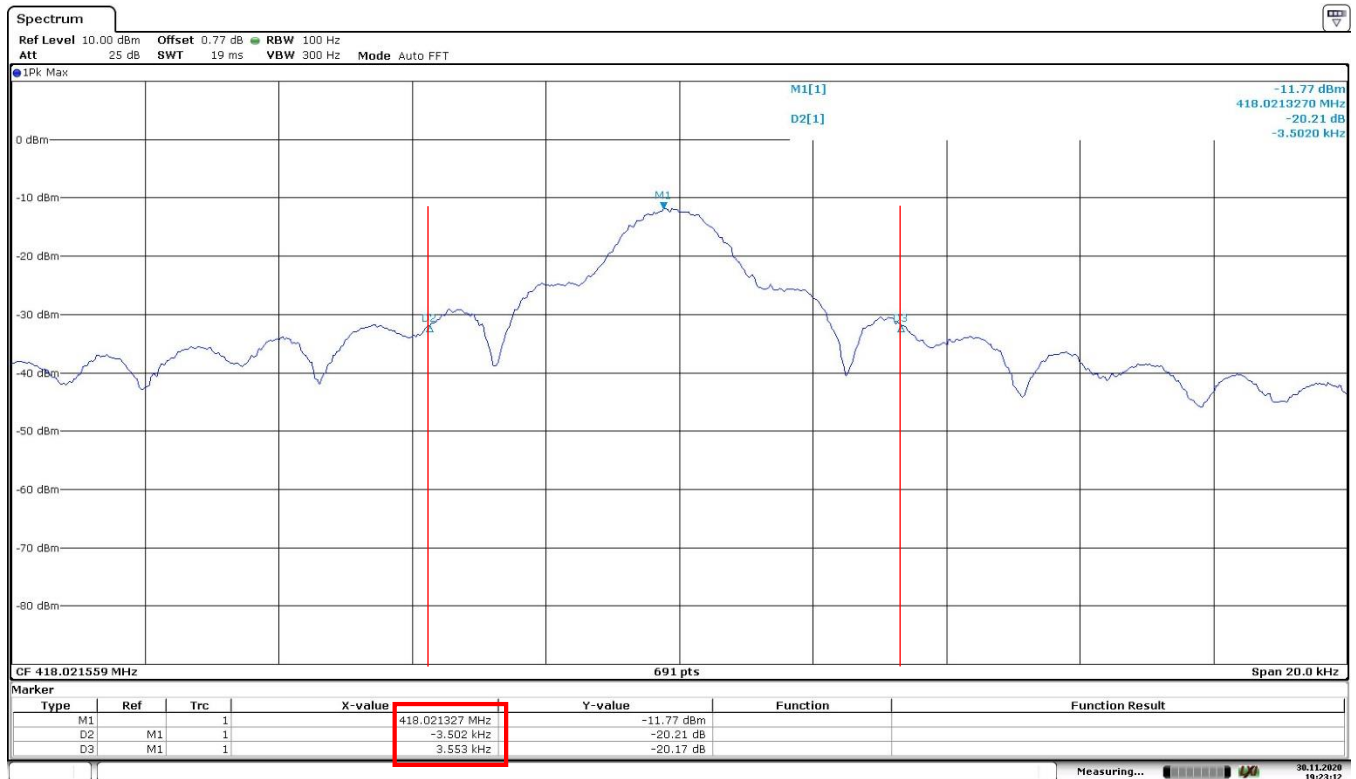
Tester: MT

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	27-Dec-2019	27-Dec-2021
RF Cable SMA to SMA, 0.01-40GHz	084-0505-059	TELEDYNE STORM MICROWAVE	20108	6-Mar-2020	6-Mar-2021

Note: The equipment calibration period is 1 year except for the FSV30 which is on a 2-year period.

6.5 Test Data

20 dB Bandwidth Plot



From FCC §15.231(c): The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. Bandwidth is determined at the points 20 dB down from the modulated carrier.

This allows for a 20 dB BW up to 1045 kHz for this modulated carrier.

The measured 20 dB BW from the above plot is 7.05 kHz, which is < 1045 kHz.

The BW is compliant for this transmit frequency.

7 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 %	$\pm 0.4\%$

8 Revision History

Revision Level	Description of changes	Revision Date
Draft	--	21 December 2020
0	Initial release	03 February 2021
1	- Section 1: Added row in table for periodic transmissions and a note explaining why this rule part does not apply to the EUT - Section 5.8: Added notes in plots indicating details of highest emissions	02 November 2021