EMC Test Report

Project Number: 4674140 **Proposal Number:** SUW-202107001251

Report Number: 4674140EMC02 **Revision Level:** 1

Client: Refrigerated Transport Electronics, Inc.

Equipment Under Test: Remote for Wireless Door Sensor

Model Name: Wireless Door Sensor

Model Number: 1H446800

FCC ID: 2A2YD1H4468

Applicable Standards: §15.231 Periodic Operation in the band 40.66-40.77MHz and above 70MHz

ANSI C63.10: 2009

Report issued on: 1 December 2021

Test Result: Compliant

Prepared by: Brandon Osborn, Project Engineer

Reviewed by: Shawn McGuinness, EMC Engineering Leader

Table of Contents

1 Summary of Test Results

Test Description	Test Specification	Test Result
Antenna Requirement	47 CFR Part 15, Subpart C 15.203	Compliant
Field strength of fundamental	15.231(b) ANSI C63.10:2013, Section 6.5	Compliant
Field strength of spurious radiation	ANSI C63.10:2013, Section 6.5	Compliant
Bandwidth	15.231(c) ANSI C63.10:2013, Section 6.9	Compliant
Deactivation Time (manual)	15.231(a)(1) ANSI C63.10:2013, Section 7.4	N/A [1]
Deactivation Time (automatic)	15.231(a)(2) ANSI C63.10:2013, Section 7.4	Compliant
Non-periodic; TX time per hour	15.231(a)(3)	N/A [2]
Transmission time for setup	15.231(a)(5) ANSI C63.10:2013, Section 7.4	N/A [3]
Frequency Stability	15.231(d) ANSI C63.10:2013, Section 6.8	N/A [4]
Low power operation	15.231(e) ANSI C63.10:2013, Section 7.4	N/A [5]

Notes:

1) Not applicable. There is no manual deactivation for this device.
2) Not applicable. There are no periodic transmissions for this device. It only transmits when requested to do so by the operator using a gateway device.
3) Not applicable. This function is not used for this device.
4) Not applicable. This device does not transmit in the 40.66-40.70 MHz frequency range.
5) Not applicable. This device does not operate under the provisions of this rule part.

1.1 *Modifications Required for Compliance*

None

2 General Information

2.1 *Client Information*

Name:	Refrigerated Transport Electronics, Inc.
Address:	1 West Center Street
City, State, Zip, Country:	McGraw, NY 13101, 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 Name:	Wireless Door Sensor
Model Number:	1H446800
Serial Number:	Sample ID – SUW-PK-20210800754
Hardware Version:	Not provided
Software Version:	Not provided
FCC ID:	2A2YD1H4468
Transmitter Frequency:	433.06MHz
Receiver Frequencies:	433.06MHz, 13.56MHz (NFC Tag)
Rated Voltage:	3.0 VDC (AA batteries)
Test Voltage:	3.0 VDC
Sample Received Date:	13 August 2021
Dates of testing:	13-20 August 2021

2.4 *Ratings and declarations*

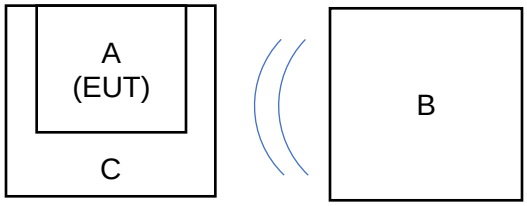
Operation Frequency Range (OFR) TX Mode:	433.06 MHz
Operation Frequency Range (OFR) RX Mode:	433.06MHz, 13.56MHz (NFC Tag)
Channel Bandwidth:	130.92 kHz
Effective radiated power:	-26.45dBm (68.75dBuV/m at 3.0 m)
Communication technique:	Digital
Modulation:	ASK
Antenna type and gain:	Embedded Module, -8dBi (peak)

2.5 *Operating Modes and Conditions*

Inserted 2 new alkaline AA batteries into Door Sensor (EUT). The EUT was placed in the test fixture to determine proper operation. When the fixture simulates an open door, then the sensor sends a signal to the gateway when the gateway operator checks status. The gateway acknowledges with a Green LED for okay or Red LED for door ajar.

Other than the fundamental transmission frequency, the highest clock frequency was 32.768kHz.

2.6 *EUT Connection Block Diagram*



2.7 *System Configurations*

Device reference	Manufacturer	Description	Model Number	Serial Number
A	Refrigerated Transport Electronics, Inc.	Wireless Door Sensor	1H446800	SUW-PK-20210800753

Note: Sample ID used for serial number.

2.8 *Support Equipment*

Device reference	Manufacturer	Description	Model Number	Serial Number
B	Refrigerated Transport Electronics, Inc.	Gateway	-	SUW-PK-20210800753
C	Refrigerated Transport Electronics, Inc.	Door Test Fixture	N/A	SUW-PK-20210800753

Note: Device C represents a door of a Refrigerated shipping container.

3 Intentional Radiator Antenna Requirement

3.1 *Result*

Test Description	Test Specification	Test Result
Antenna Requirement	47 CFR Part 15, Subpart C 15.203	Compliant

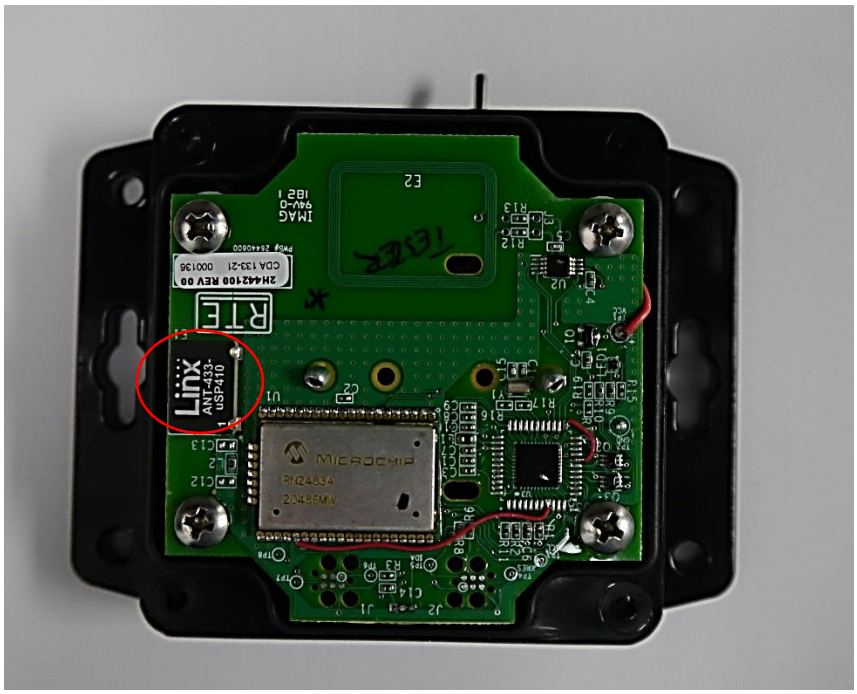
3.2 *Requirement*

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit permanently attached antenna or of so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

3.3 *Conclusion*

The Antenna on this device is an embedded module soldered to the main PCB and therefore cannot be easily replaced.

3.4 *Antenna Photograph*



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

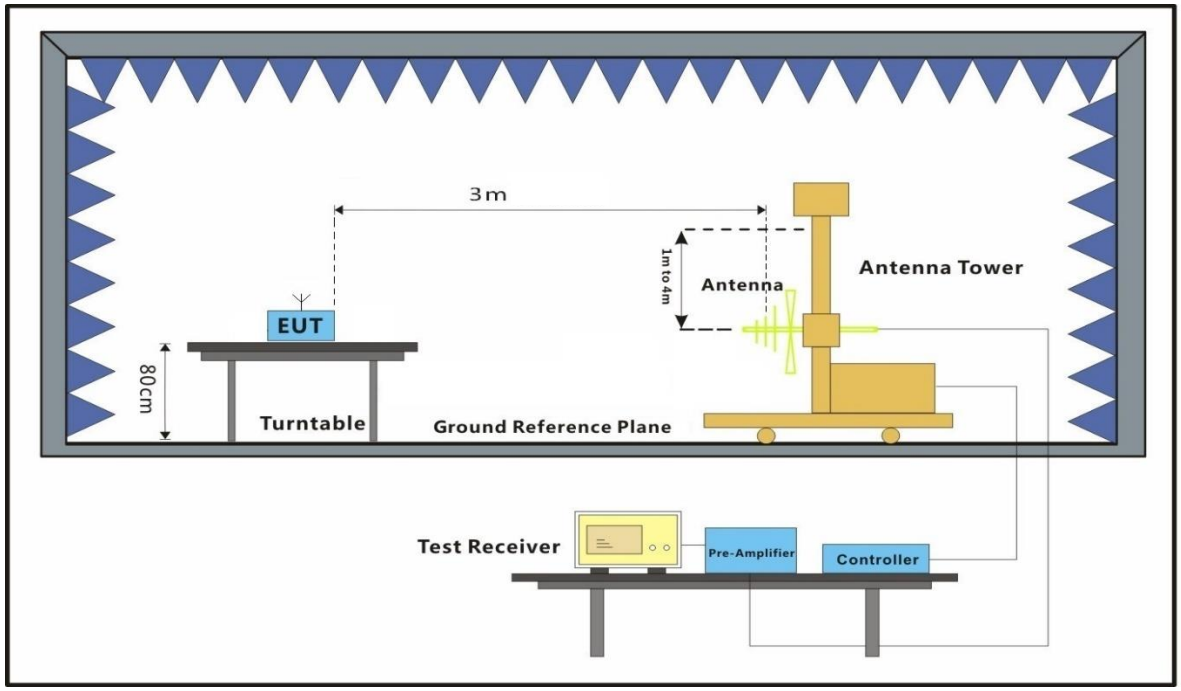
4.2 *Test Method*

The test data was measured using a Peak detector. Average data were calculated by correcting the peak value with the duty cycle correction factor. 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 radiation measurements are performed in X, Y, Z axis positioning. And found the Y axis positioning which it is worse case, only the test worst case mode is recorded in the report.
Remark: Level= Read Level+ Cable Loss+ Antenna Factor- Preamp Factor

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	125 to 375
174-260	3750	375
260-470	3750 to 12500	375 to 1250
Above 470	12500	1250
Remark: 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. If average emission measurements are employed, the provisions in §15.35 for averaging pulsed emissions and for limiting peak emissions apply.		

4.3 *Test Setup Diagram*



4.4 *Test Site*

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

Environmental Conditions	August 17
Temperature:	22.7 °C
Relative Humidity:	56.2 %
Atmospheric Pressure:	99.4 kPa

4.5 *Test Equipment*

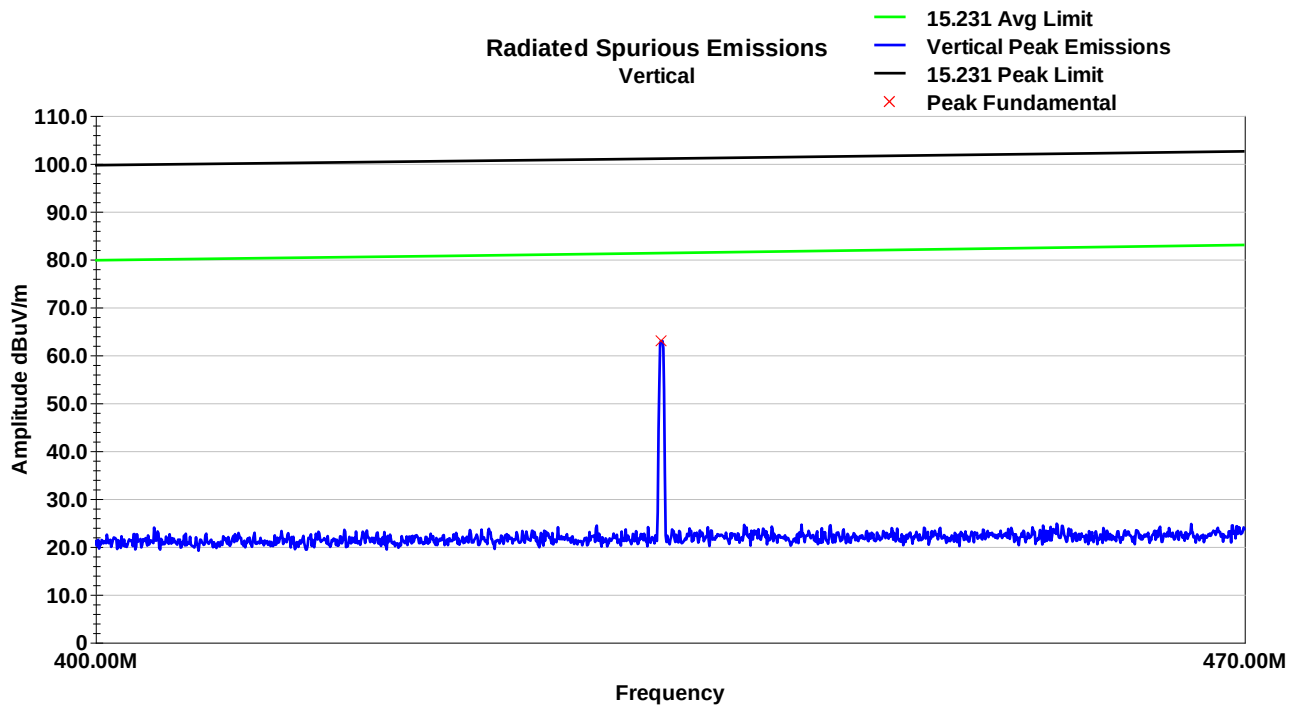
Field Strength

Test End Date: 19-Aug-2021 Tester: BEO

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
ANTENNA, BILOG	JB6	SUNOL	B079689	5-Nov-2020	5-Nov-2022
RF Cable Nm to Nm, 0.01-18GHz	90-195-354	TELEDYNE STORM MICROWAVE	20120	17-Feb-2021	17-Feb-2022
RF Cable Nm to Nf, 0.01-18GHz	90-213-118	TELEDYNE STORM MICROWAVE	20117	17-Feb-2021	17-Feb-2022
RF CABLE	SUCOFLEX 100	Huber & Suhner	B108523	3-Sep-2020	3-Sep-2021
LOW NOISE AMPLIFIER	ZKL-2+	Mini-Circuits	B079800	7-Jul-2021	7-Jul-2022
EMI TEST RECEIVER	ESU8	ROHDE & SCHWARZ	B085759	9-Jul-2021	9-Jul-2022
RF Cable Nm to Nm, 0.01-18GHz	90-195-157	TELEDYNE STORM MICROWAVE	20121	17-Feb-2021	17-Feb-2022

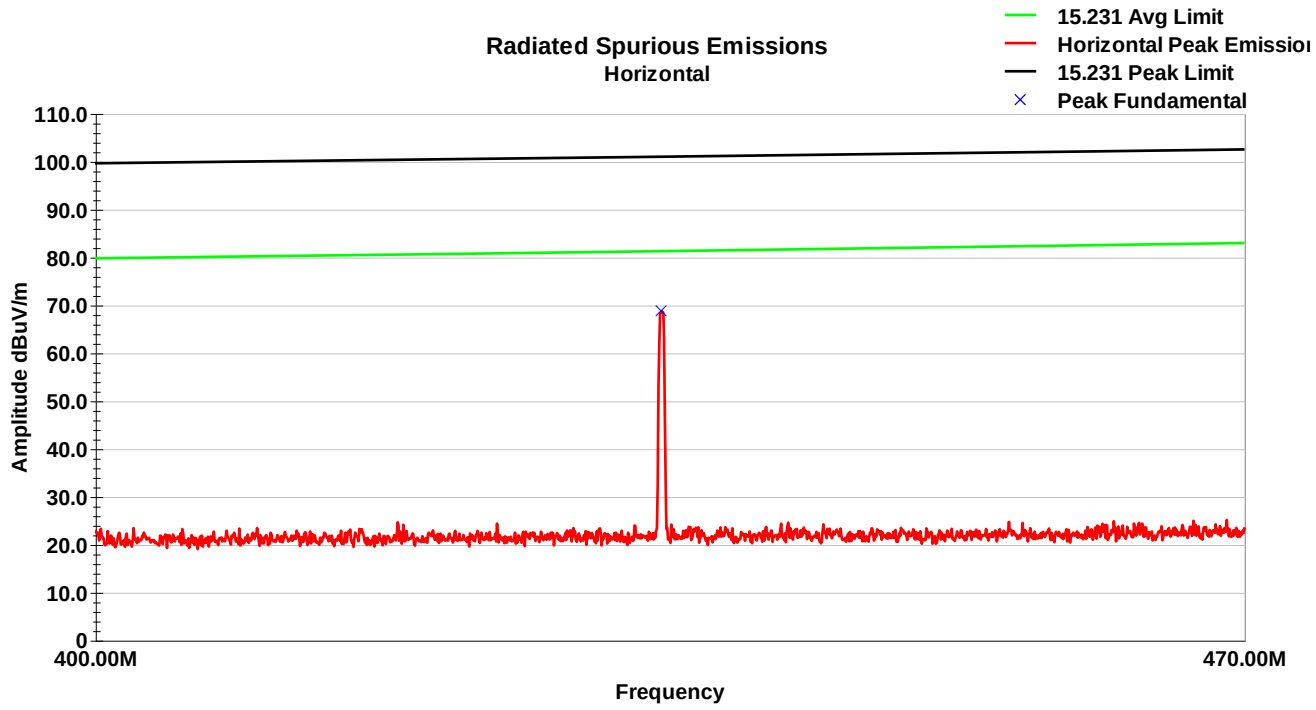
Note: Refer to table for calibration intervals.

4.6 *Test Data – Y-axis highest Fundamental*



Vertical Fundamental Peak Power = 62.95dBuV

Peak is less than Average Limit, therefore Average was not calculated.



Horizontal Fundamental Peak Power = 68.75dBuV

Peak is less than Average Limit, therefore Average was not calculated.

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*

Exploratory scans were performed over the frequency range as indicated in the tables below using the max hold function and incorporating a Peak detector and using TILE! software. The final test data was measured using a Quasi-Peak detector below 1GHz and a Peak detector above 1GHz. For harmonics of the fundamental, Average measurements were made by correcting the peak value with the duty cycle correction factor. For emissions other than harmonics of the fundamental, the Average measurements were made using the Average detector. 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 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 radiation measurements are performed in X, Y, Z axis positioning. Results for all 3 axes were ranked from highest to lowest measurement.

Remark: Level= Read Level+ Cable Loss+ Antenna Factor- Preamp Factor

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	125 to 375
174-260	3750	375
260-470	3750 to 12500	375 to 1250
Above 470	12500	1250
Remark: 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. If average emission measurements are employed, the provisions in §15.35 for averaging pulsed emissions and for limiting peak emissions apply. 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 Site*

10m Absorber Lined Shielded Enclosure (ALSE), Suwanee, GA
3m Absorber Lined Shielded Enclosure (ALSE), Suwanee, GA (>1GHz)

Environmental Conditions	Aug 13 2021
Temperature:	22.3 °C
Relative Humidity:	50.8 %
Atmospheric Pressure:	97.8 kPa

5.4 *Test Equipment*

30-1000MHz

Test End Date: 13-Aug-21 Tester: LM

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
ANTENNA, BILOG	JB6	SUNOL	B079689	5-Nov-20	5-Nov-22
RF Cable Nm to Nm, 0.01-18GHz	90-195-354	LEDYNE STORM MICROWA	20120	17-Feb-21	17-Feb-22
RF CABLE	104PE	HUBER & SUHNER	B079793	3-Sep-20	3-Sep-21
RF Cable Nm to Nf, 0.01-18GHz	90-213-118	LEDYNE STORM MICROWA	20117	17-Feb-21	17-Feb-22
RF Cable Nm to Nm, 0.01-18GHz	90-195-157	LEDYNE STORM MICROWA	20121	17-Feb-2021	17-Feb-2022
LOW NOISE AMPLIFIER	ZKL-2+	Mini-Circuits	B079800	7-Jul-2021	7-Jul-2022
EMI TEST RECEIVER	ESU40	ROHDE & SCHWARZ	B079629	21-Jun-2021	21-Jun-2022
FILTER, HIGH PASS, >1000MHz	HPM50108	MICRO-TRONICS	B079802	6-Jul-2021	6-Jul-2022

Above 1GHz

Test End Date: 13-Aug-21 Tester: LM

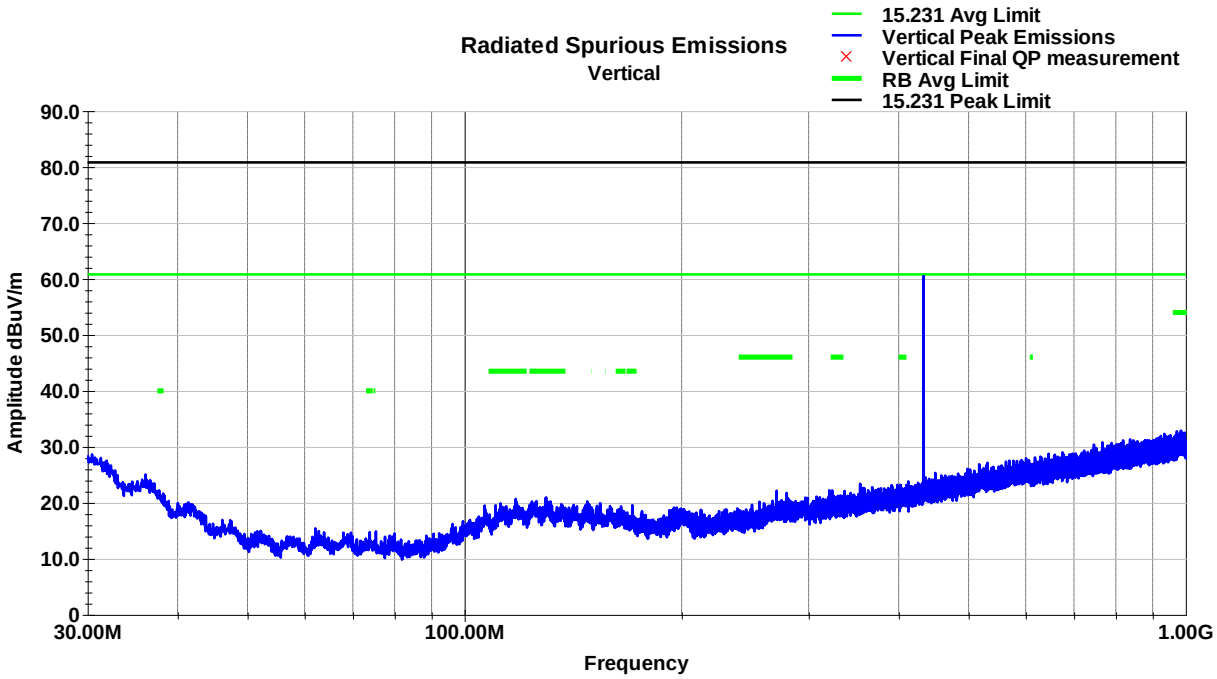
Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
ANTENNA, DRG HORN (MEDIUM)	3117	ETS Lindgren	B079699	15-Jul-20	15-Jul-22
RF Cable Nm to Nm, 0.01-18GHz	90-195-354	LEDYNE STORM MICROWA	20120	17-Feb-21	17-Feb-22
RF CABLE	104PE	HUBER & SUHNER	B079793	3-Sep-20	3-Sep-21
EMI TEST RECEIVER	ESU40	ROHDE & SCHWARZ	B079629	21-Jun-21	21-Jun-22
LOW NOISE AMPLIFIER	TS-PR18	ROHDE & SCHWARZ	B094463	7-Jul-2021	7-Jul-2022

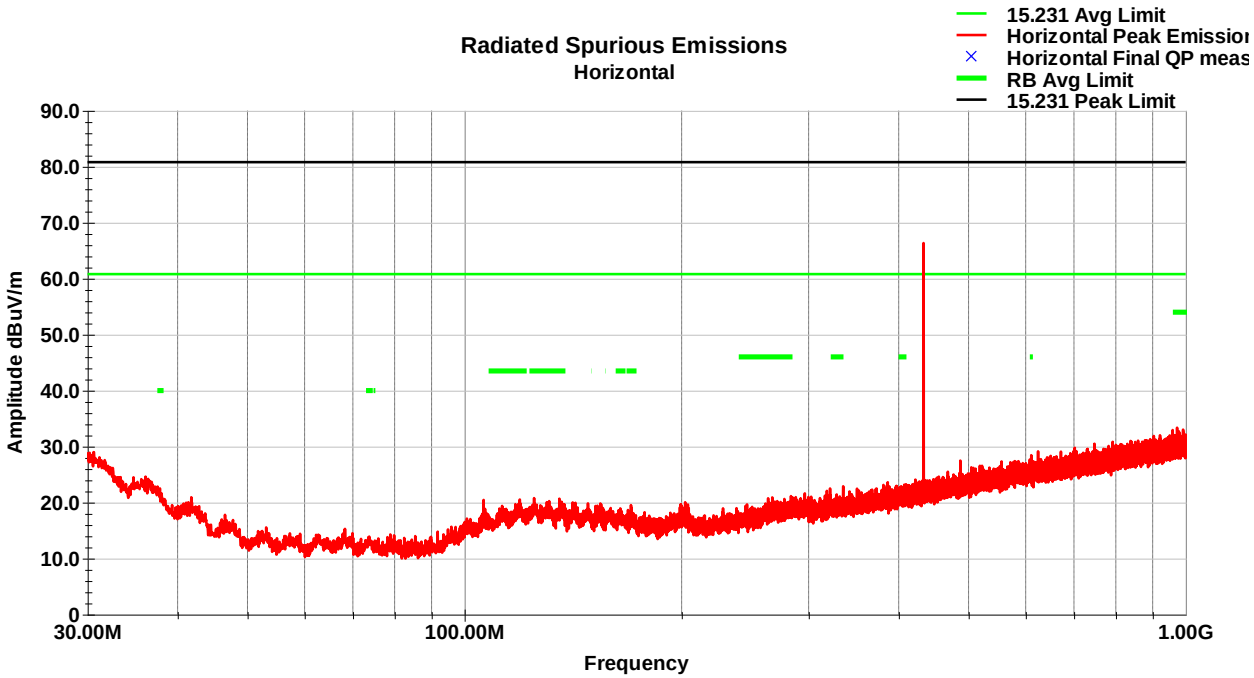
Note: Refer to table for calibration intervals.

5.5 *Test Data*

5.5.1 30 MHz to 1000 MHz

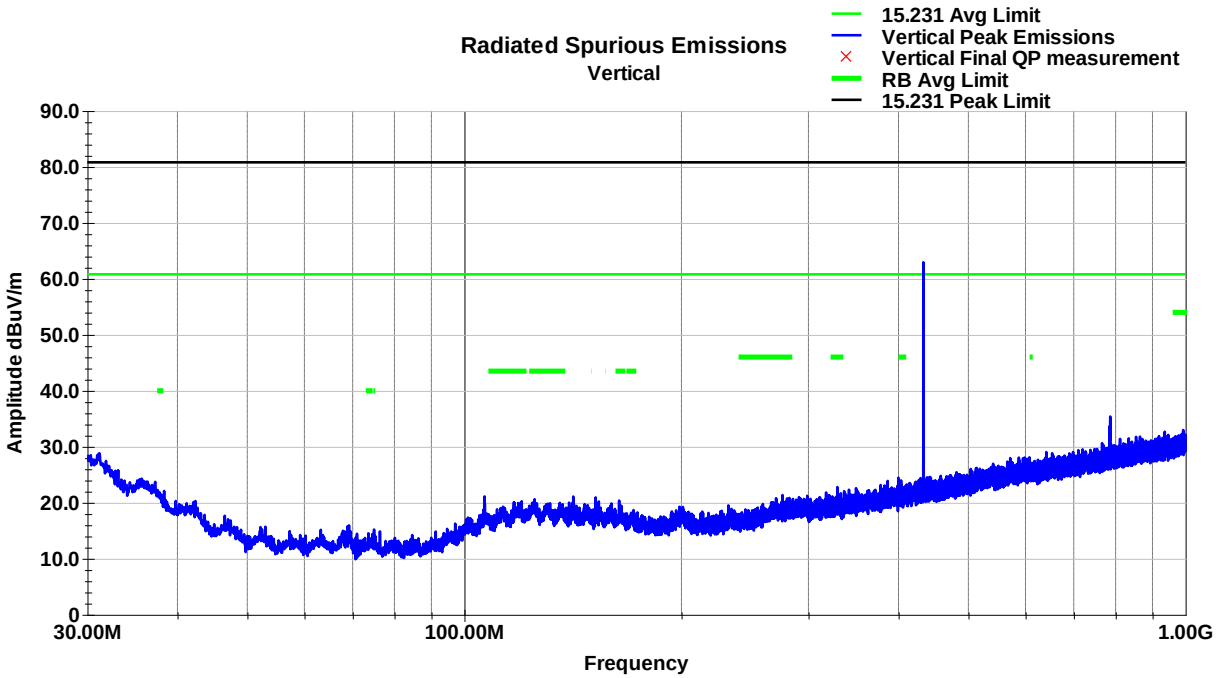
X-Axis

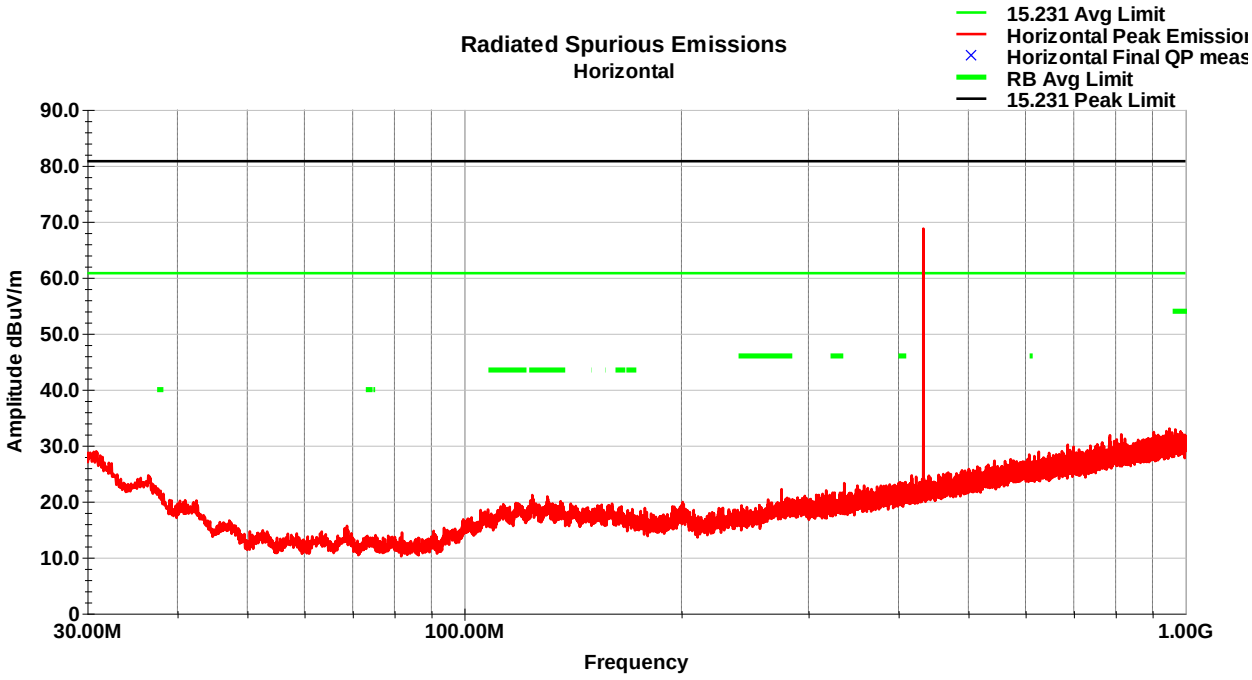




Note: Other than fundamental signal, no emissions within 20dB of limit.

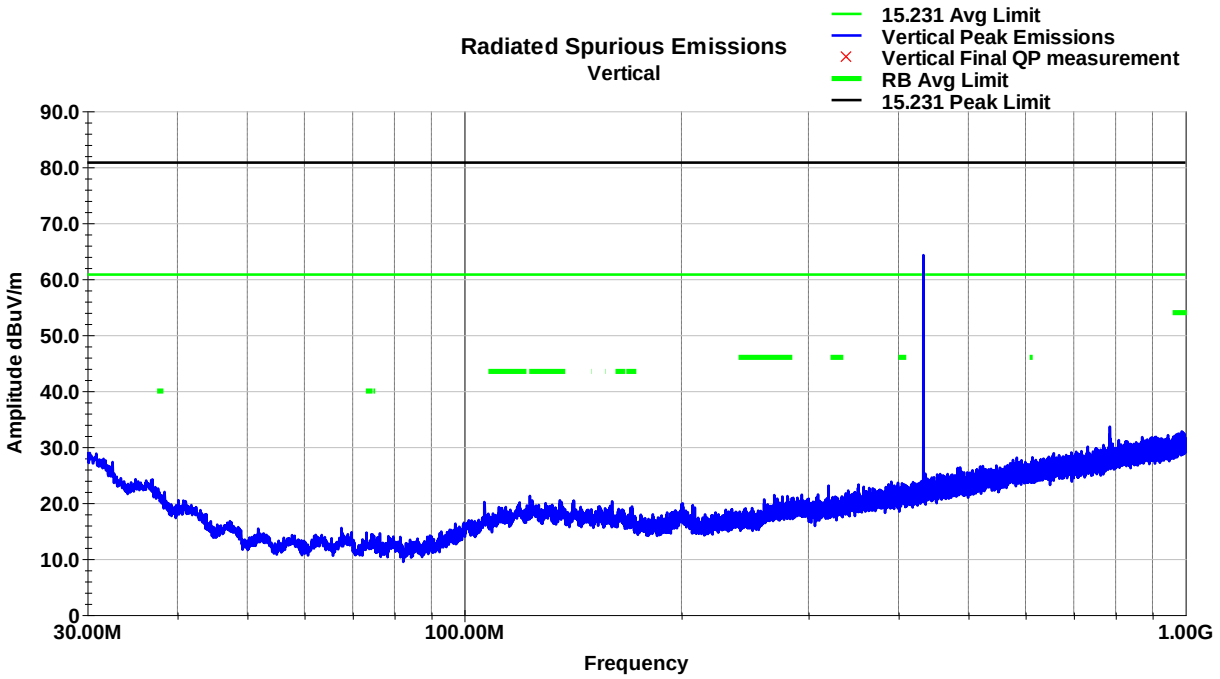
Y-Axis

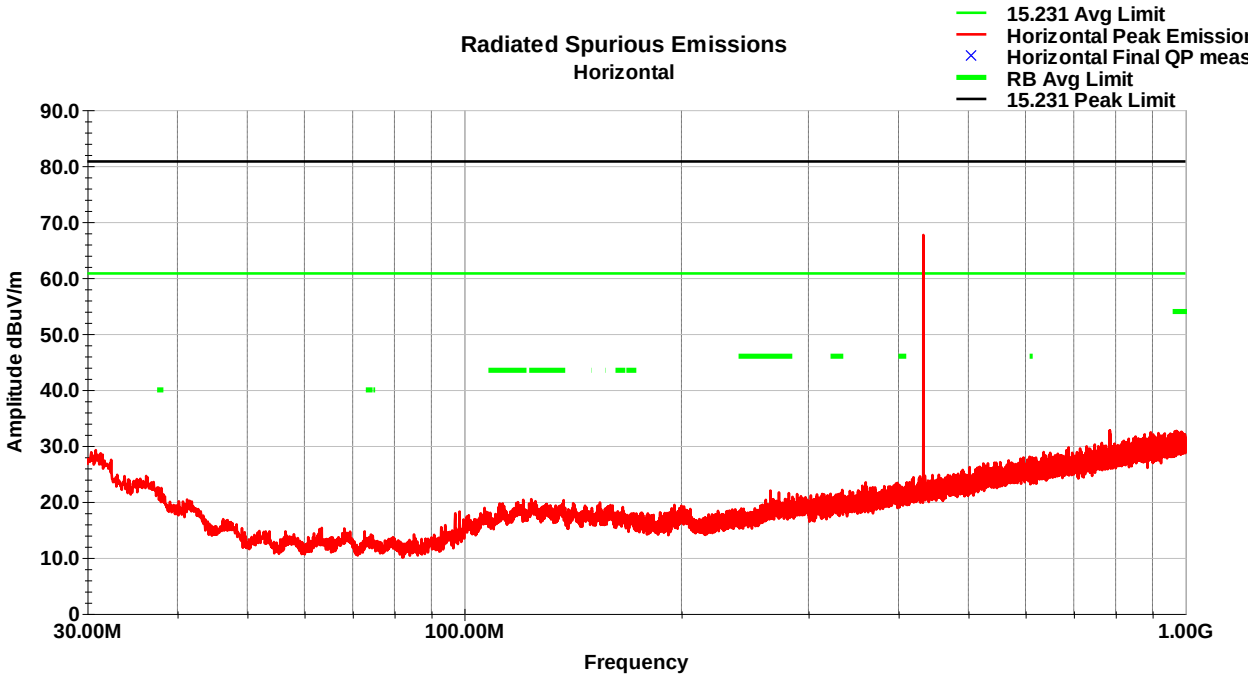




Note: Other than fundamental signal, no emissions within 20dB of limit.

Z-Axis





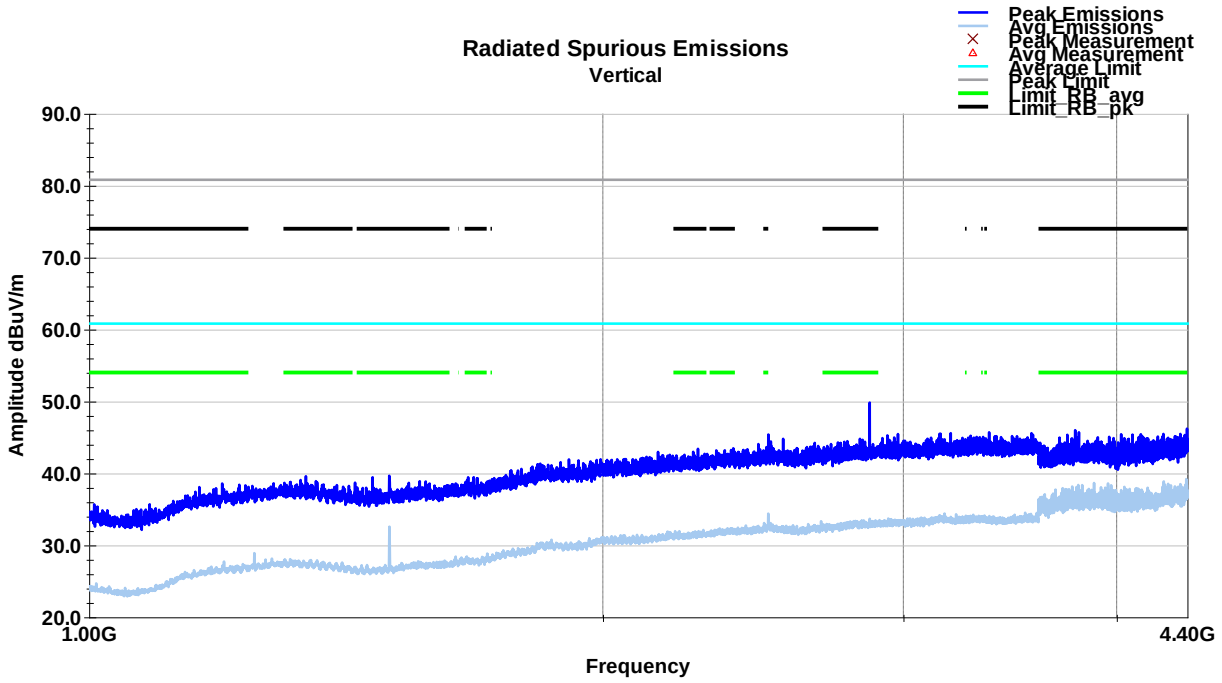
Note: Other that intentional, no emissions within 20dB of limit.

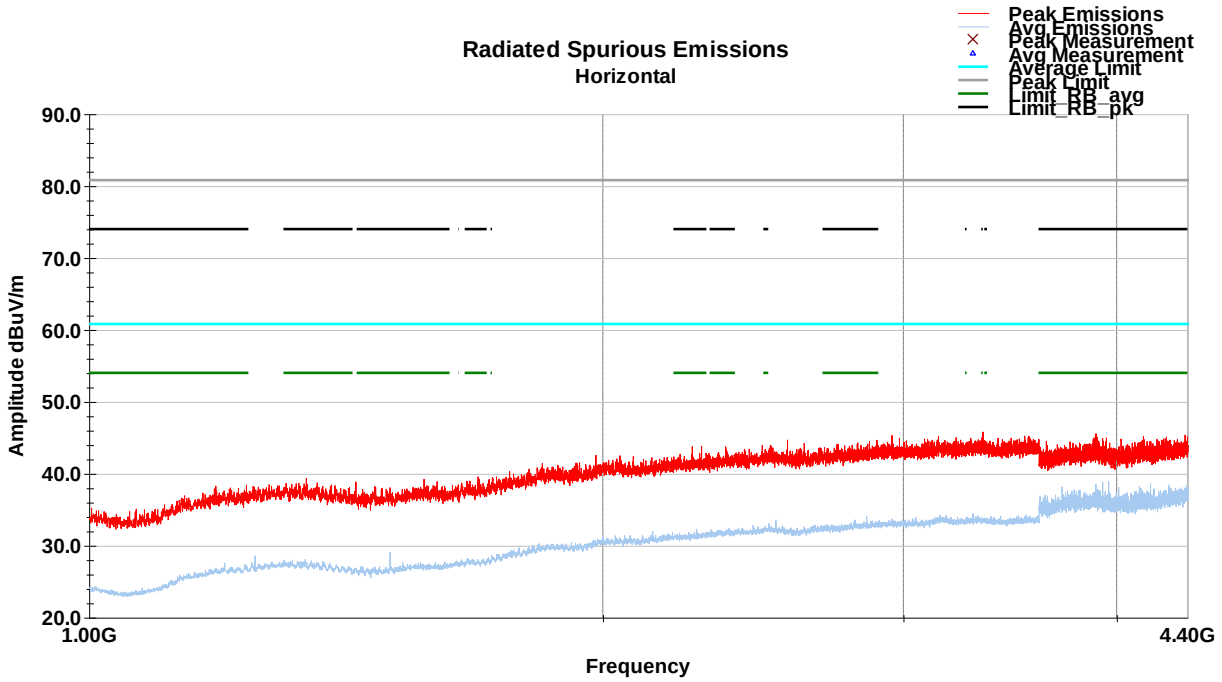
Table of measured radiated spurious emissions: 30-1000 MHz

No emissions within 20dB of limit.

5.5.2 1 GHz to 4.4 GHz

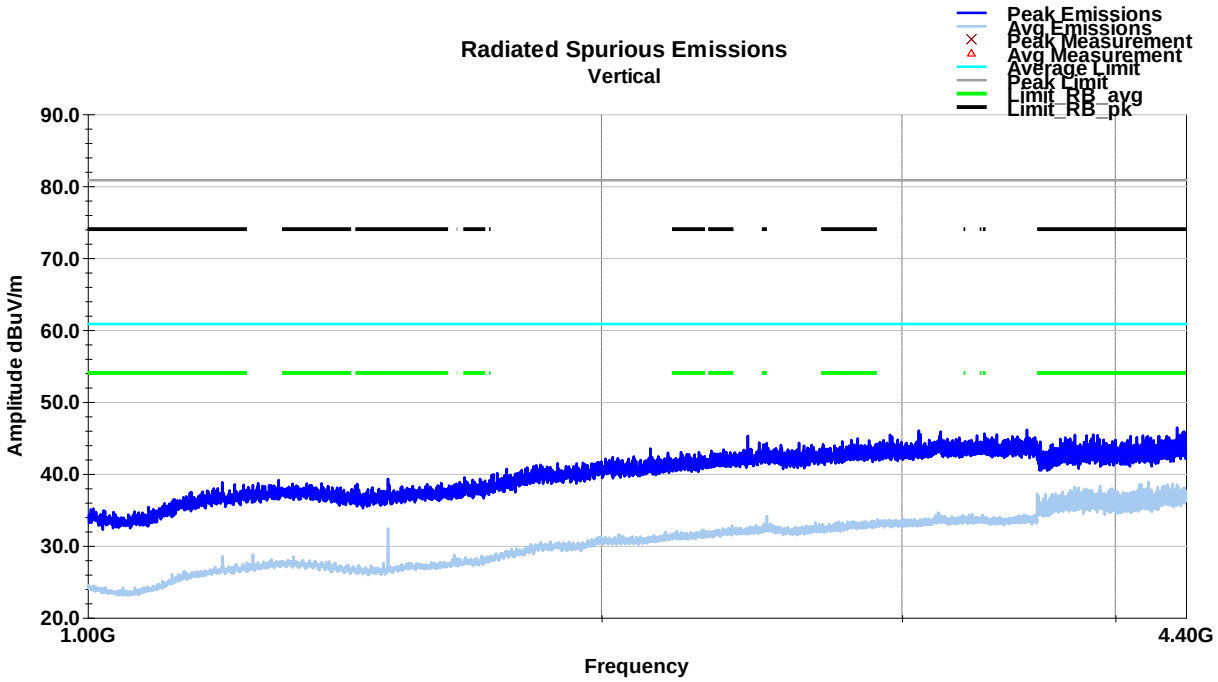
X-Axis

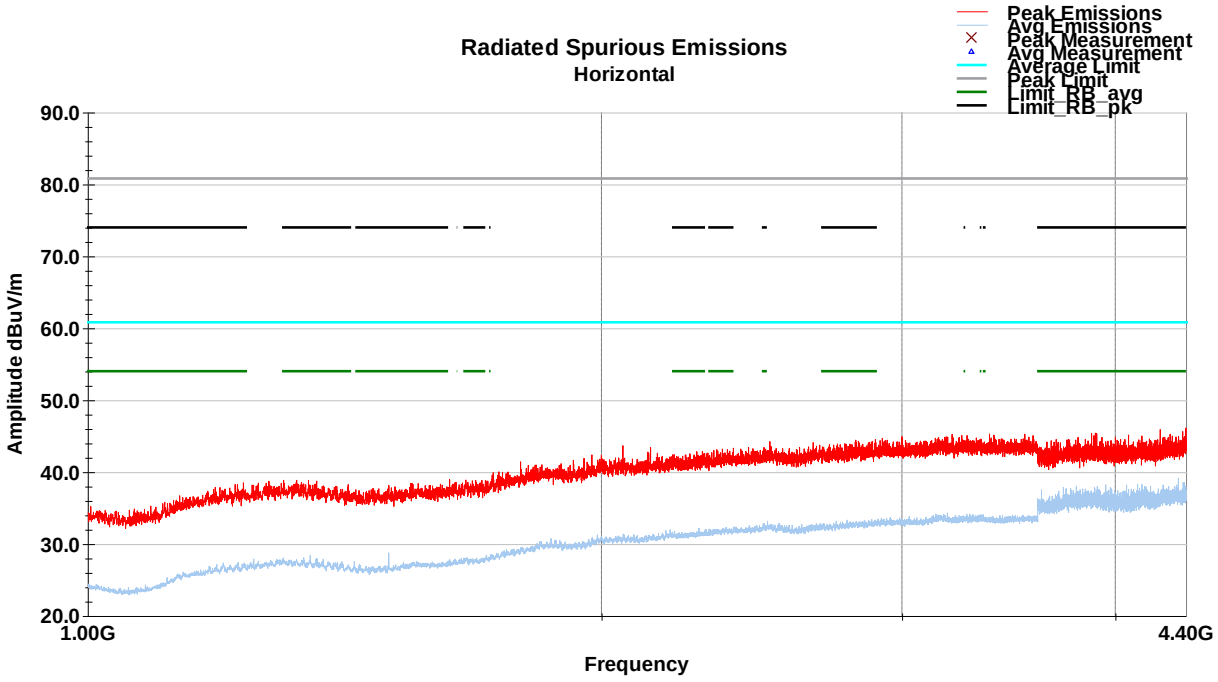




Note: No emissions within 20dB of limit.

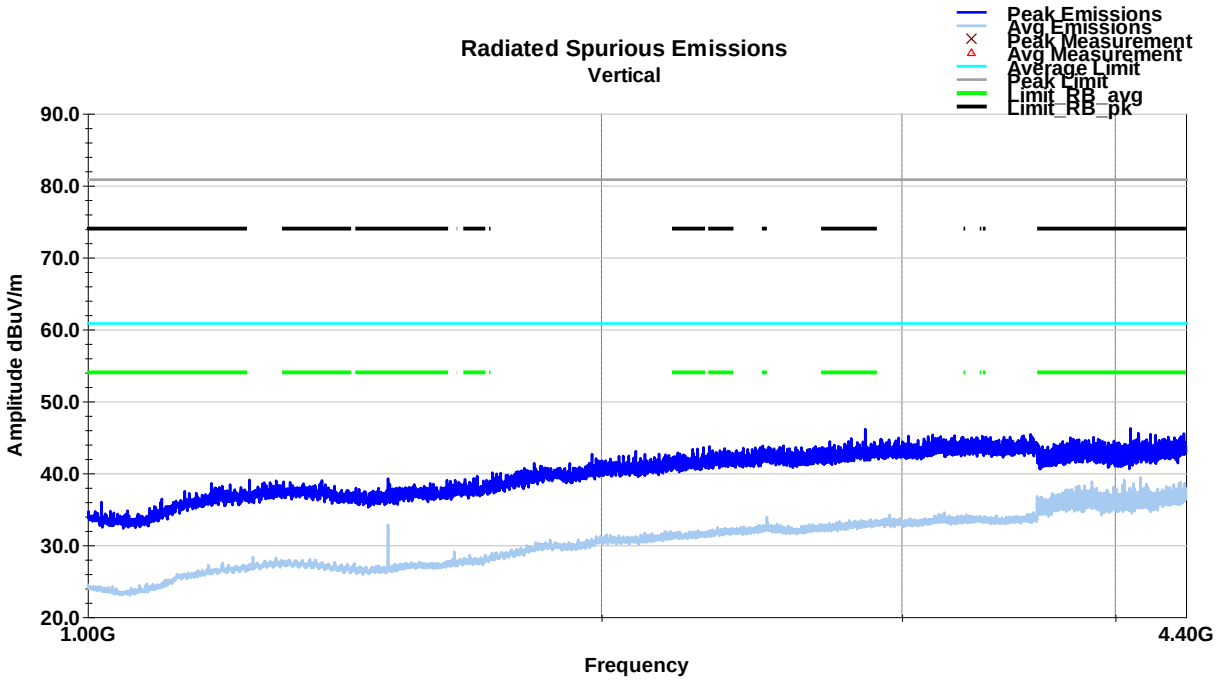
Y-Axis

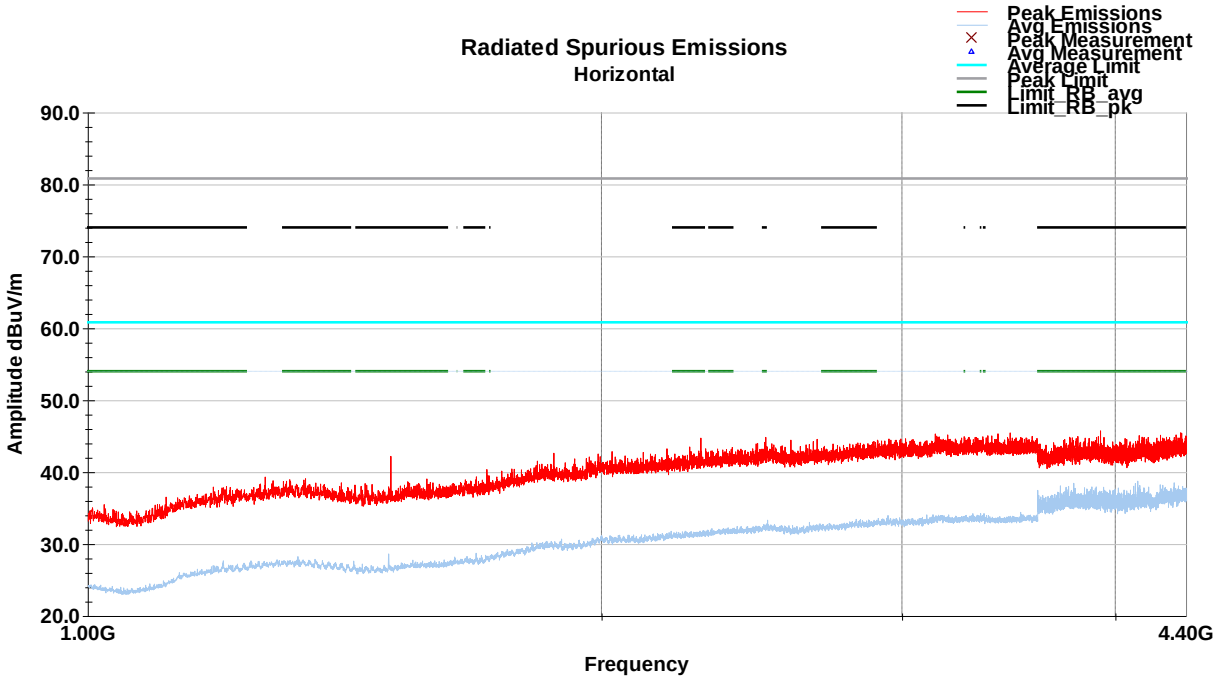




Note: No emissions within 20dB of limit.

Z-Axis





Note: No emissions within 20dB of limit.

Table of measured radiated spurious emissions: 1 to 4.4 GHz

No emissions were within 20dB of limit.

6 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 (2009) clause 6.9 were used to determine the 20dB bandwidth.

6.3 *Test Site*

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature:	22.7 °C
Relative Humidity:	56.2 %
Atmospheric Pressure:	99.4 kPa

6.4 *Test Equipment*

Test End Date: 17-Aug-2021 Tester: BEO

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	27-Dec-2019	27-Dec-2021
Medium-Loop H-Field Probe	100A	Beehive Electronics	15002A	CNR	CNR
RF Cable SMA to SMA, 0.01-40GHz	084-0505-059	TELEDYNE STORM MICROWAVE	20107	16-Mar-2021	16-Mar-2022

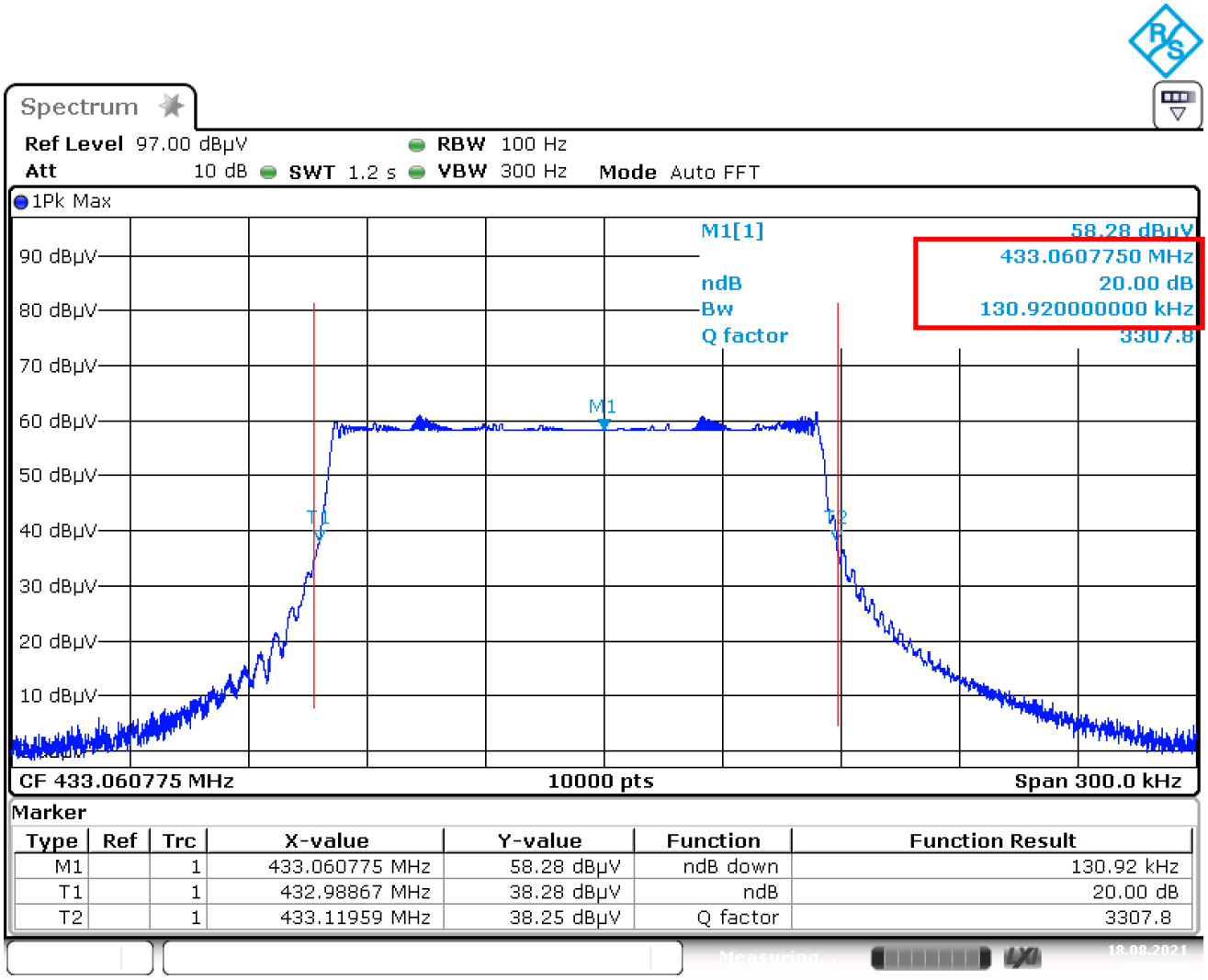
Note: Refer to table for calibration intervals.

6.5 *Test Setup Photographs*

Test setup photographs are located in a separate exhibit.

6.6 *Test Data*

20 dB Bandwidth Plot



Date: 18.AUG.2021 15:57:15

The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating from 70MHz to 900MHz. Bandwidth is determined at the points 20 dB down from the modulated carrier.

20dB Down BW ≤ 0.25% of Modulated Carrier

FCC Part 15.321 allows up to 1.084.8 MHz for this modulated carrier.

130.92kHz BW is compliant for this transmit frequency

7 Deactivation Time

7.1 *Test Result*

Test Description	Basic Standards	Test Result
Deactivation Time	ANSI C63.10:2013, Section 7.4	Compliant

7.2 *Test Method*

ANSI C63.10:2013, Section 7.4 was used for test method.

15.231 – Periodic operation in the band 40.66-40.7 MHz and above 70 MHz.

FCC Part 15.231(a)(2)
"A transmitter activated automatically shall cease transmission within 5 seconds after activation."

7.3 *Test Site*

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions
Temperature: 22.7 °C
Relative Humidity: 56.2 %
Atmospheric Pressure: 99.4 kPa

7.4 *Test Equipment*

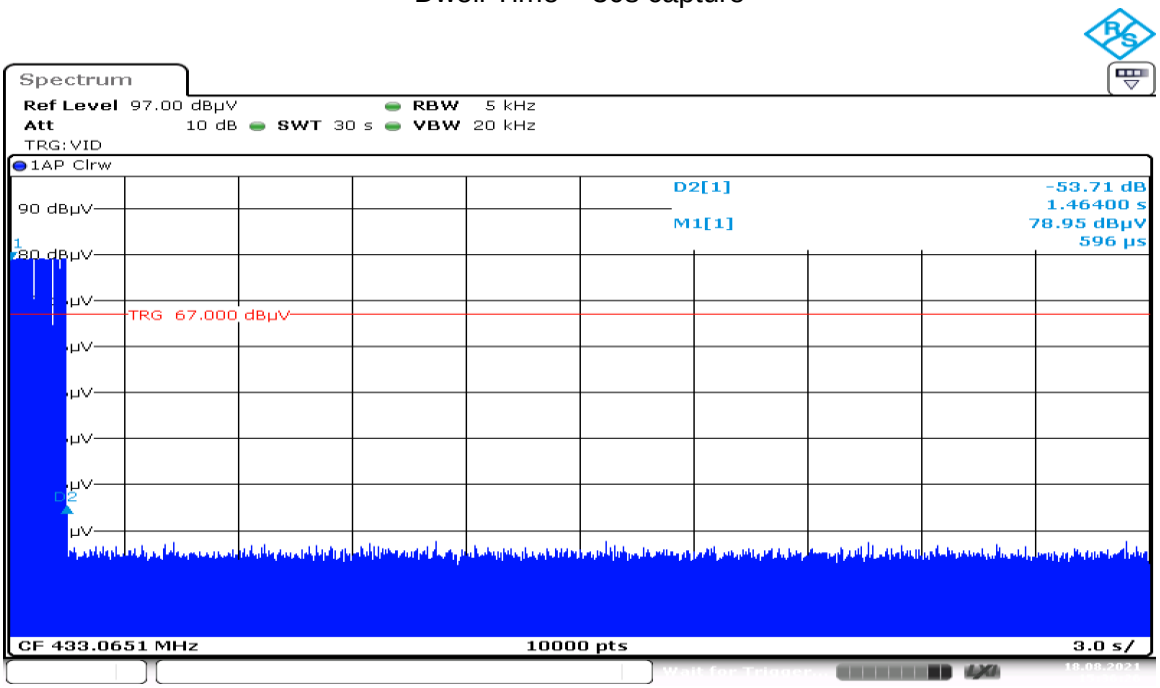
Test End Date: 17-Aug-2021 Tester: BEO

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	27-Dec-2019	27-Dec-2021
Medium-Loop H-Field Probe	100A	Beehive Electronics	15002A	CNR	CNR
RF Cable SMA to SMA, 0.01-40GHz	084-0505-059	TELEDYNE STORM MICROWAVE	20107	16-Mar-2021	16-Mar-2022

Note: Refer to table for calibration intervals.

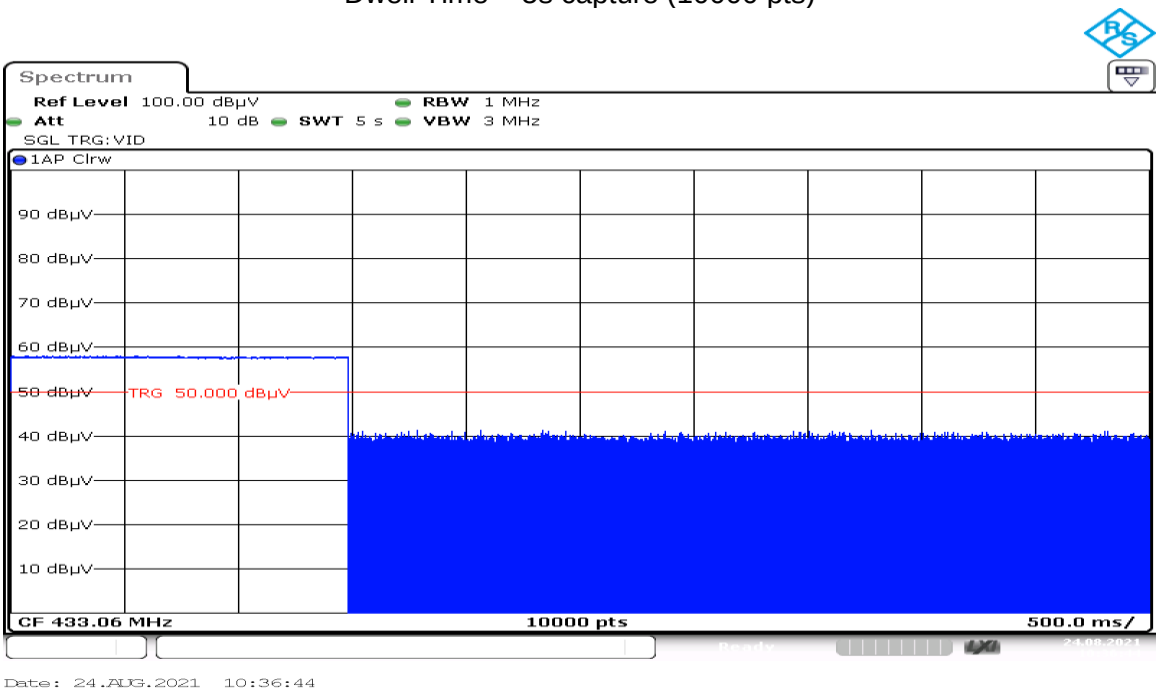
7.5 *Test Data*

Dwell Time – 30s capture



Transmitter does not retransmit

Dwell Time – 5s capture (10000 pts)



Transmitter maximum time = 1464ms. Compliant.

8 Revision History

Revision Level	Description of changes	Revision Date
0	Initial release	20 August 2021
1	Updated Sections 1 & 4, per TCB's comments	1 December 2021