

EMC Test Report

Project Number: 4278564

Report Number: 4278564EMC02

Revision Level: 2

Client: Air Innovations

Equipment Under Test: Wine Cellar Climate System Control Radio

Model Name: Main Board Radio

Tested Model Number: 39H0043/FG013580

FCC ID: 2AQX3-WG

IC ID: 24453-2AQX3WG

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

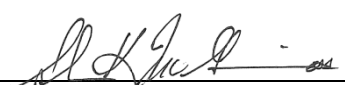
RSS-247, Issue 2

RSS-GEN Issue 4

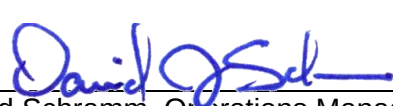
Report issued on: 24 December 2018

Test Result: Compliant

Tested by:


Shawn McGuinness, EMC Engineering Leader

Reviewed by:


David Schramm, Operations Manager

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	Test Specification		Test Result
DTS / Occupied Bandwidth	15.247(a)(2)	RSS-247 S5.2a RSS-GEN S6.6	Compliant
Fundamental Output Power	15.247(b)(3)	RSS-247 S5.4	Compliant
Power Spectral Density	15.247(e)	RSS-247 S5.2b	Compliant
Conducted Spurious Emissions / Band Edge	15.247(d)	RSS-247 S5.5	Compliant
Field Strength of Spurious Radiation	15.247(d), 15.209	RSS-247 S5.5	Compliant
Emissions in Restricted Frequency Bands	15.205, 15.209	RSS-GEN S8.9, S8.10	Compliant
Antenna Requirement	15.203	RSS-GEN S8.3	Compliant ¹
AC Powerline Conducted Emissions	15.107, 15.207	RSS-GEN S8.8	N/A ²

1) Internal PCB trace antenna

2) DUT is battery powered.

1.1 Modifications Required for Compliance

None

2 General Information

2.1 Client Information

Name: Air Innovations
Address: 7000 Performance Drive
City, State, Zip, Country: North Syracuse, NY 13212 USA

2.2 Test Laboratory

Name: SGS North America, Inc.
Address: 620 Old Peachtree Road NW, Suite 100
City, State, Zip, Country: Suwanee, GA 30024, USA

Accrediting Body: A2LA
Type of lab: Testing Laboratory
Certificate Number: 3212.01

2.3 General Information of EUT

Type of Product: Wine Cellar Climate System Control Radio
Model Name: Main Board Radio
Tested Model Number: 39H0043/FG013580
Serial Number: WH#2
Equivalent Modules: RUI 39H0044/FG13578
LUI 39H0045/FG014220
Remote T/RH Sensor 39H0046/FG13579
RUI 39H0044/FG13578

Frequency Range: 2402-2480MHz
Data Modes: Bluetooth Low Energy
Antenna: Internal PCB Trace

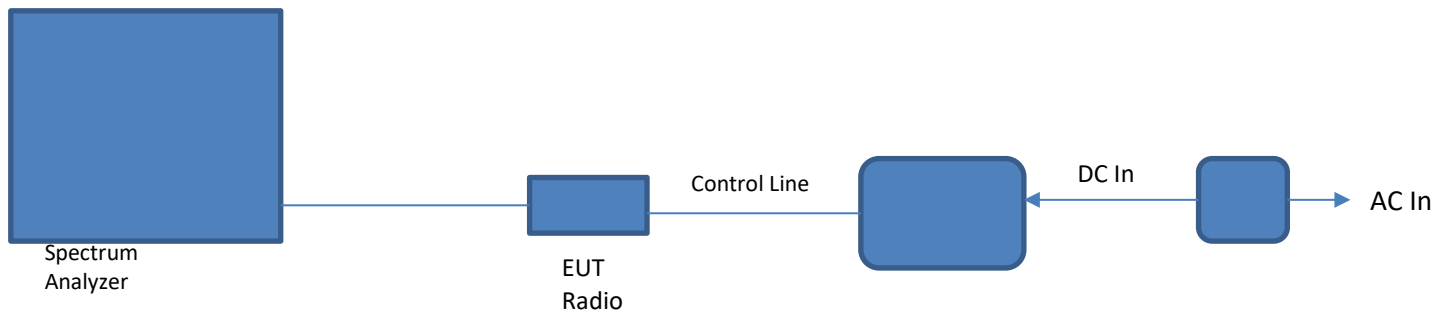
Rated Voltage: 3.6VDC
Test Voltage: 3.6VDC

Sample Received Date: 24 January 2018
Dates of testing: 11 June 2018 to 18 October 2018

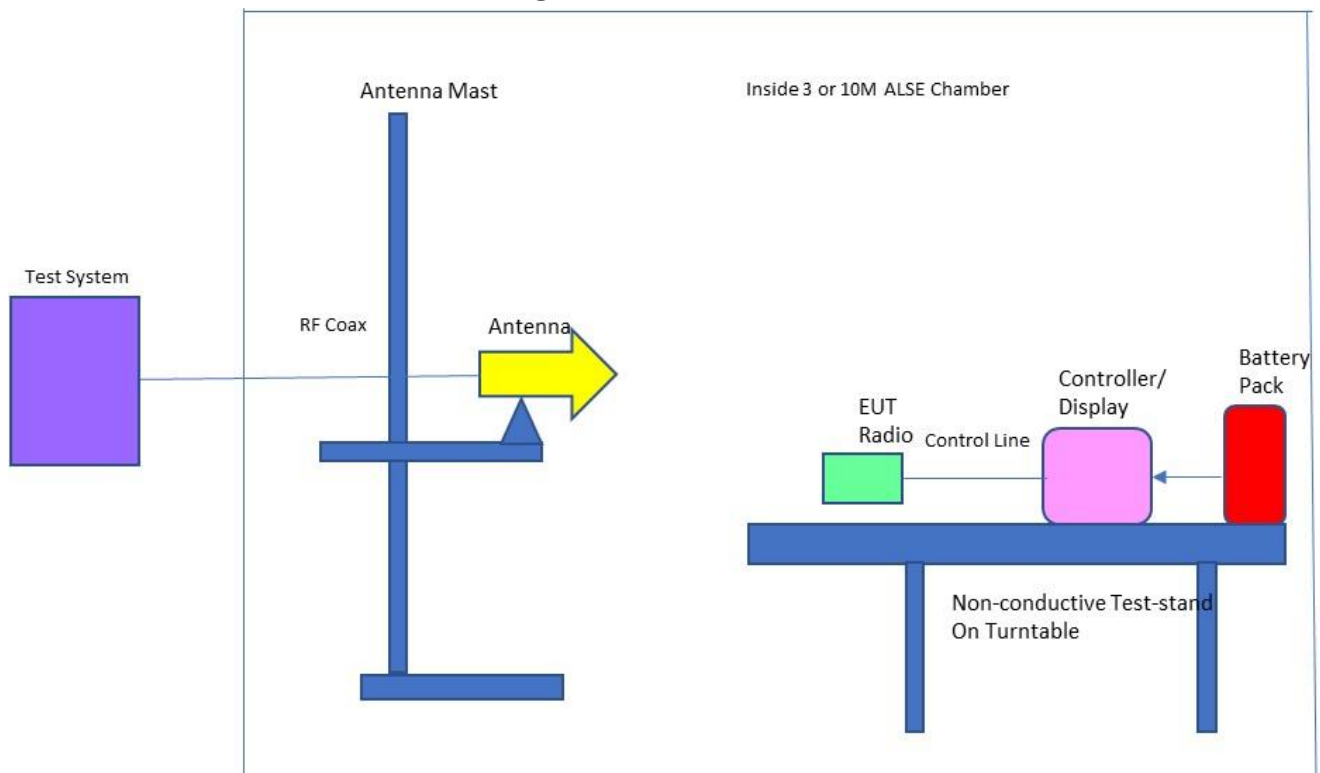
2.4 Operating Modes and Conditions

The EUT was operated at low middle and high channels in its normal modulated mode. The radio utilized the "FTDI VCP Chip Driver Software" Supported by "MegaLoad V3.b6" via Hyper-terminal with the Hex File loads power level set to TX Powerset default maximum power level. Radio frequency channels could be set, but there was no ability to change radio power levels.

2.5 EUT Connection Block Diagram – Conducted Measurements



2.6 EUT Connection Block Diagram – Radiated Measurements



2.7 System Configurations

Device reference	Manufacturer	Description	Model Number	Serial Number
Radio	Wilson-Hurd	Transceiver	Main Board Radio 39H0043/FG013580	WH#2
RUI	Wilson-Hurd	Remote User Interface	RUI	4217

3 DTS Bandwidth and Occupied Bandwidth

3.1 Test Result

Test Description	Test Specification		Test Result
DTS Bandwidth	15.247(a) (2) RSS-247 5.2	ANSI C63.10 Clause 11.8.2 Option 1 Clause 6.9.2	Compliant
20 dB Bandwidth	RSS-GEN 6.7	ANSI C63.10 Clause 6.9.2	Reported

3.2 Test Method

For measuring the DTS 6dB bandwidth:

- RBW = 100 kHz
- VBW $\geq [3 \times \text{RBW}]$
- Detector = peak
- Trace mode = max hold
- Sweep = auto couple
- Allow the trace to stabilize
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

For measuring the 20dB bandwidth:

- The transmitter was operated at its maximum carrier power
- RBW = 1% to 5% of the 20dB bandwidth
- VBW = $\geq [3 \times \text{RBW}]$
- The span of the spectrum analyzer was set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- Detector = Peak
- Trace mode = max hold
- The 20 dB down function of the spectrum analyzer was used

3.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 22.9 °C

Relative Humidity: 52.8 %

Atmospheric Pressure: 98.1 kPa

3.4 Test Equipment

Test End Date: 4-Oct-2018

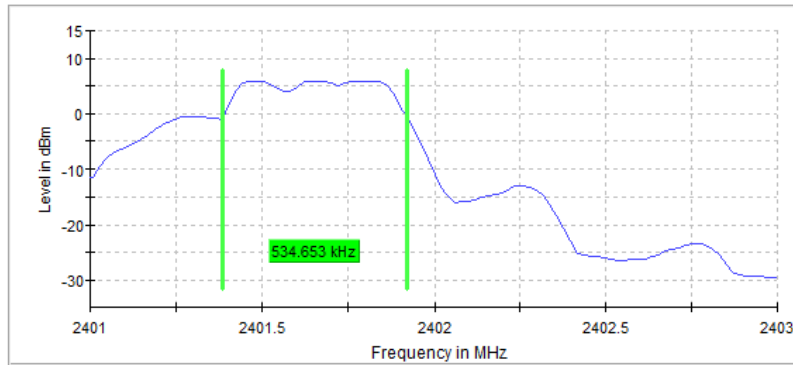
Tester: SKM

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
RF CABLE (TS8997)	141	HUBER & SUHNER	B095585	25-Jul-2019
ATTENUATOR, 10DB (TS8997)	10DB	ROHDE & SCHWARZ	B095591	25-Jul-2019
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	1-Nov-2019
ENVIRONMENTAL TEST CHAMBER	T2RC	TENNEY ENVIRONMENTAL	B094877	CNR

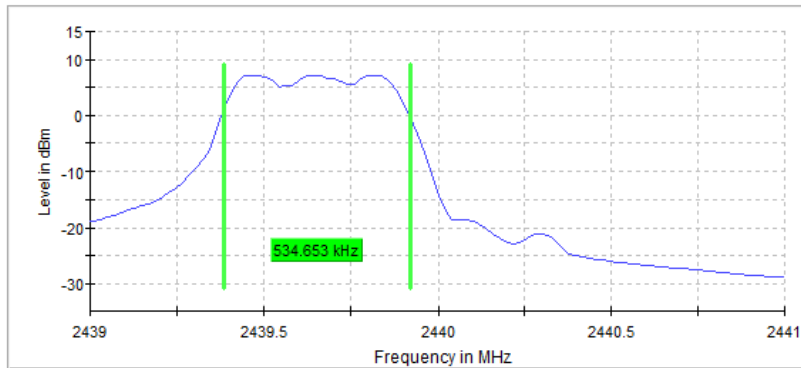
Note: The equipment calibration period is 1 year.

3.5 Test Data

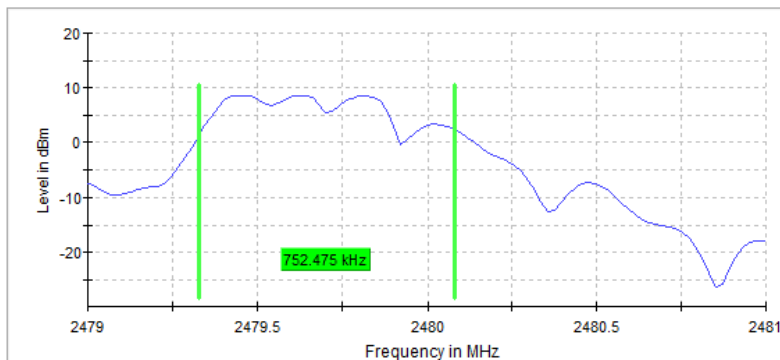
DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)	Max Level (dBm)	Result
2402.000000	0.534653	0.500000	2401.386139	2401.920792	5.9	PASS
2440.000000	0.534653	0.500000	2439.386139	2439.920792	7.2	PASS
2480.000000	0.752475	0.500000	2479.000000	2480.594059	8.5	PASS



Setting	Instrument Value	Target Value
Start Frequency	2.40100 GHz	2.40100 GHz
Stop Frequency	2.40300 GHz	2.40300 GHz
Span	2.000 MHz	2.000 MHz
RBW	100.000 kHz	~ 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	101	~ 40
SweepTime	18.938 μ s	AUTO
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	10.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
SweepType	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	10 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.00 dB	0.50 dB



Setting	Instrument Value	Target Value
Start Frequency	2.43900 GHz	2.43900 GHz
Stop Frequency	2.44100 GHz	2.44100 GHz
Span	2.000 MHz	2.000 MHz
RBW	100.000 kHz	~ 100.000 kHz
VBW	300.000 kHz	~ 300.000 kHz
SweepPoints	101	~ 20
SweepTime	18.938 μ s	AUTO
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	10.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
SweepType	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	9 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.13 dB	0.50 dB



Setting	Instrument Value	Target Value
Start Frequency	2.47900 GHz	2.47900 GHz
Stop Frequency	2.48100 GHz	2.48100 GHz
Span	2.000 MHz	2.000 MHz
RBW	100.000 kHz	~ 100.000 kHz
VBW	300.000 kHz	~ 300.000 kHz
SweepPoints	101	~ 20
SweepTime	18.938 μ s	AUTO
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	10.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
SweepType	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	9 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.49 dB	0.50 dB

4 Fundamental Output Power

4.1 Test Result

Test Description	Test Specification		Test Result
Peak Output Power	15.247(b)(3)	RSS-247 S5.4 (4)	Compliant

4.2 Test Method

Fundamental peak power measurements were recorded using the procedures from ANSI C63.10: 2013 clause 11.9 and KDB 558074 D01 Measurement Guidance v05r02.

Limit

(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. For using antennas with greater than 6dBi of gain, the limit is reduced in dB by the amount the gain exceeds 6dBi (e.g. for a 7.4dBi antenna, the limit is reduced from 30dBm to 28.6dBm)

4.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 22.9 °C

Relative Humidity: 52.8 %

Atmospheric Pressure: 98.1 kPa

4.4 Test Equipment

Test End Date: 4-Oct-2018

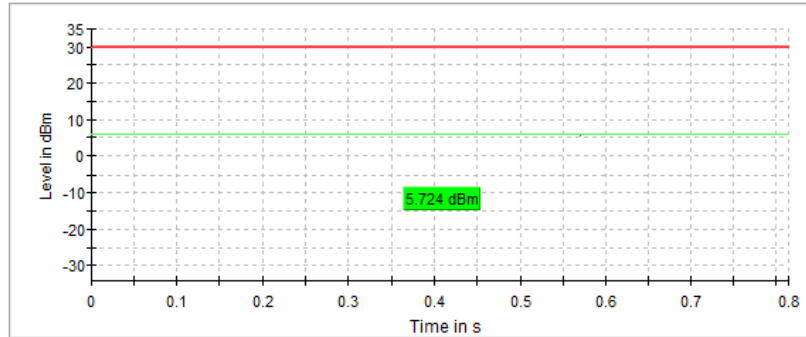
Tester: SKM

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
RF CABLE (TS8997)	141	HUBER & SUHNER	B095585	25-Jul-2019
ATTENUATOR, 10DB (TS8997)	10DB	ROHDE & SCHWARZ	B095591	25-Jul-2019
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	1-Nov-2019
ENVIRONMENTAL TEST CHAMBER	T2RC	TENNEY ENVIRONMENTAL	B094877	CNR

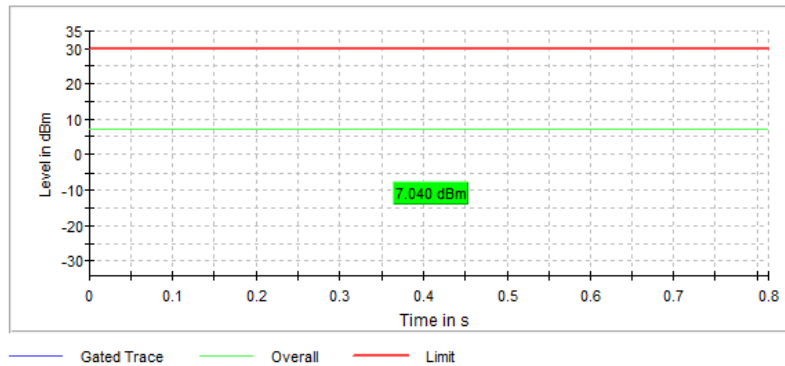
Note: The equipment calibration period is 1 year.

4.5 Test Data

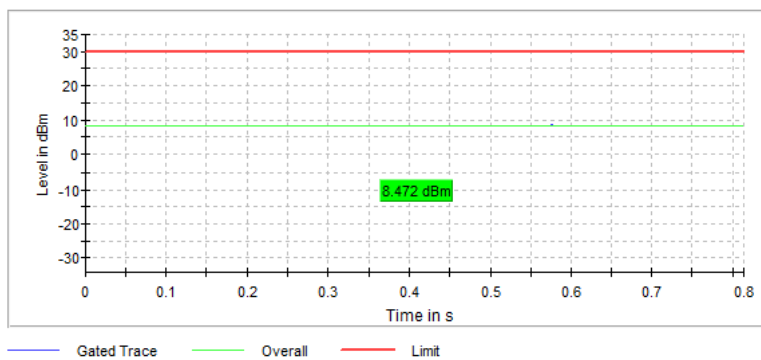
DUT Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Result
2402.000000	5.7	30.0	PASS
2440.000000	7.0	30.0	PASS
2480.000000	8.5	30.0	PASS



DUT Frequency (MHz)	Gated RMS (dBm)	Limit Max (dBm)	Gated EIRP (dBm)	DutyCycle (%)	Result
2402.000000	5.7	30.0	5.7	81.481	PASS



DUT Frequency (MHz)	Gated RMS (dBm)	Limit Max (dBm)	Gated EIRP (dBm)	DutyCycle (%)	Result
2440.000000	7.0	30.0	7.0	81.476	PASS



DUT Frequency (MHz)	Gated RMS (dBm)	Limit Max (dBm)	Gated EIRP (dBm)	DutyCycle (%)	Result
2480.000000	8.5	30.0	8.5	81.470	PASS

5 Power Spectral Density

5.1 Test Result

Test Description	Test Specification		Test Result
Power Spectral Density	15.247(e)	RSS-247 S5.2 (2)	Compliant

5.2 Test Method

Power spectral density measurements were recorded using the procedures from ANSI C63.10: 2013 clause 11.10 and KDB 558074 D01 Measurement Guidance v05r02.

Limit

The limit is 8 dBm.

5.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 22.9 °C

Relative Humidity: 52.8 %

Atmospheric Pressure: 98.1 kPa

5.4 Test Equipment

Test End Date: 4-Oct-2018

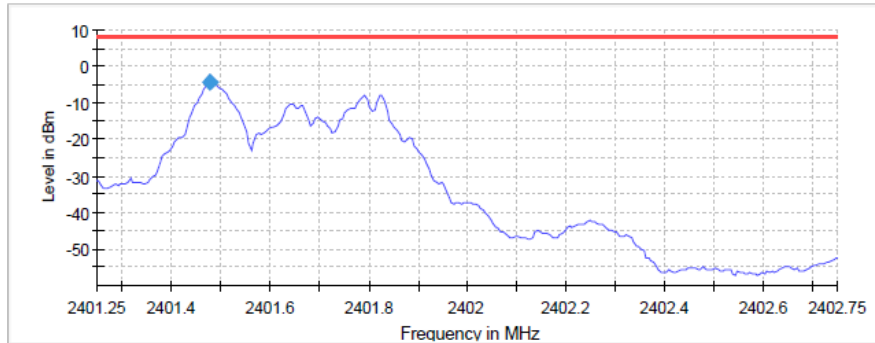
Tester: SKM

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
RF CABLE (TS8997)	141	HUBER & SUHNER	B095585	25-Jul-2019
ATTENUATOR, 10DB (TS8997)	10DB	ROHDE & SCHWARZ	B095591	25-Jul-2019
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	1-Nov-2019
ENVIRONMENTAL TEST CHAMBER	T2RC	TENNEY ENVIRONMENTAL	B094877	CNR

Note: The equipment calibration period is 1 year.

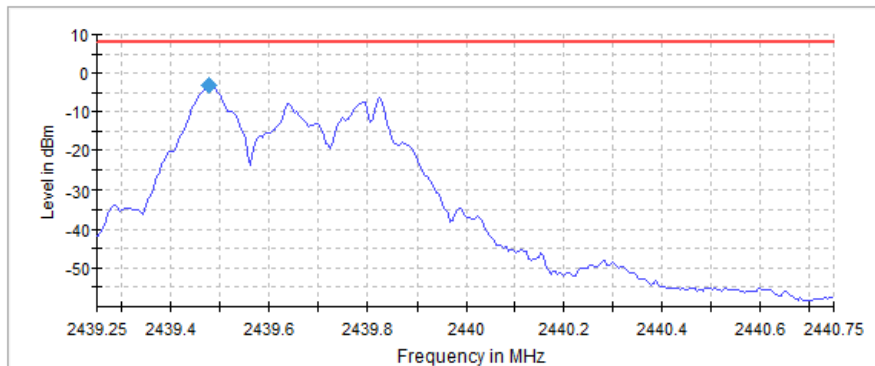
5.5 Test Data

DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2402.000000	2401.477500	-4.417	8.0	PASS
2440.000000	2439.477500	-3.291	8.0	PASS
2480.000000	2479.472500	-1.676	8.0	PASS



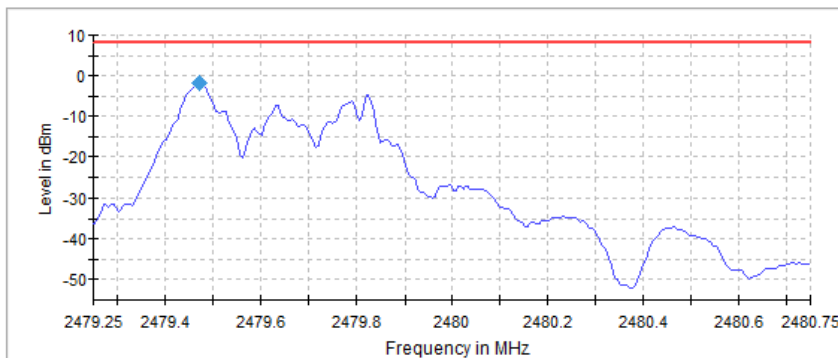
— Limit — Sum Level ◆ PSD

Setting	Instrument Value	Target Value
Start Frequency	2.40125 GHz	2.40125 GHz
Stop Frequency	2.40275 GHz	2.40275 GHz
Span	1.500 MHz	1.500 MHz
RBW	10.000 kHz	<= 10.000 kHz
VBW	30.000 kHz	>= 30.000 kHz
SweepPoints	300	~ 300
SweepTime	1.500 s	1.500 s
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	10.000 dB	AUTO
Detector	RMS	RMS
SweepCount	1	1
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
SweepType	Sweep	Sweep
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	11 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.30 dB	0.50 dB



— Limit — Sum Level ◆ PSD

Setting	Instrument Value	Target Value
Start Frequency	2.43925 GHz	2.43925 GHz
Stop Frequency	2.44075 GHz	2.44075 GHz
Span	1.500 MHz	1.500 MHz
RBW	10.000 kHz	<= 10.000 kHz
VBW	30.000 kHz	>= 30.000 kHz
SweepPoints	300	~ 300
SweepTime	1.500 s	1.500 s
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	10.000 dB	AUTO
Detector	RMS	RMS
SweepCount	1	1
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
SweepType	Sweep	Sweep
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	8 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.36 dB	0.50 dB



— Limit — Sum Level ◆ PSD

Setting	Instrument Value	Target Value
Start Frequency	2.47925 GHz	2.47925 GHz
Stop Frequency	2.48075 GHz	2.48075 GHz
Span	1.500 MHz	1.500 MHz
RBW	10.000 kHz	<= 10.000 kHz
VBW	30.000 kHz	>= 30.000 kHz
SweepPoints	300	~ 300
SweepTime	1.500 s	1.500 s
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	10.000 dB	AUTO
Detector	RMS	RMS
SweepCount	1	1
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
SweepType	Sweep	Sweep
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	10 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.44 dB	0.50 dB

6 Emissions in non-restricted frequency bands

6.1 Test Result

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

6.2 Test Method

The antenna port of the EUT was connected to a spectrum analyzer with

- Peak detector, max hold
- Resolution bandwidth of at least 100 kHz
 - o A larger RBW may be used to reduce test duration
- Video bandwidth at least 3x RBW
- Frequency range: 30 MHz to 25 GHz

Since the power is measured based on the use of the RMS averaging, the limit is 30 dB below that measured in the 100 kHz bandwidth within the band that contains the highest level of the desired power. All modes and data rates were investigated. Only the worst-case for each modulation was reported.

6.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 22.9 °C

Relative Humidity: 52.8 %

Atmospheric Pressure: 98.1 kPa

6.4 Test Equipment

Test End Date: 4-Oct-2018

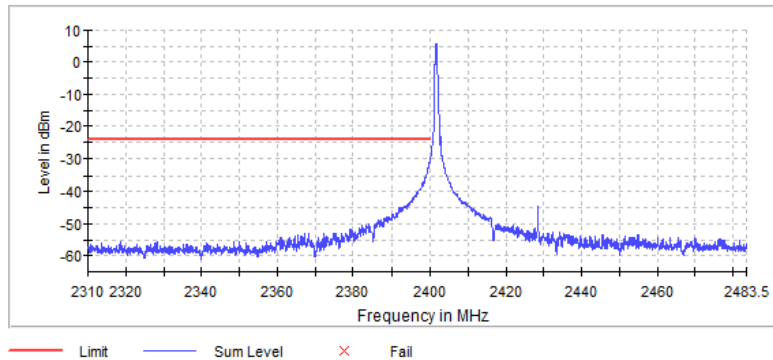
Tester: SKM

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
RF CABLE (TS8997)	141	HUBER & SUHNER	B095585	25-Jul-2019
ATTENUATOR, 10DB (TS8997)	10DB	ROHDE & SCHWARZ	B095591	25-Jul-2019
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	1-Nov-2019
ENVIRONMENTAL TEST CHAMBER	T2RC	TENNEY ENVIRONMENTAL	B094877	CNR

Note: The equipment calibration period is 1 year.

6.5 Test Data –Band Edge

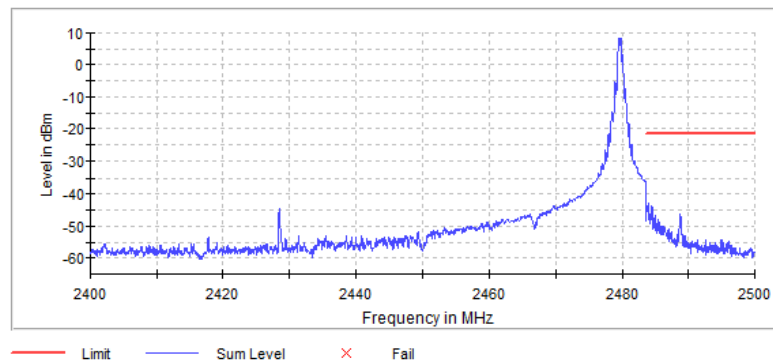
Lower Band Edge



Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.975000	-30.4	6.3	-24.1	PASS
2399.925000	-30.6	6.5	-24.1	PASS
2399.875000	-30.9	6.8	-24.1	PASS
2399.825000	-31.1	7.0	-24.1	PASS
2399.775000	-31.2	7.1	-24.1	PASS
2399.725000	-31.4	7.3	-24.1	PASS
2399.675000	-31.7	7.6	-24.1	PASS
2399.625000	-32.1	8.0	-24.1	PASS
2399.575000	-32.3	8.2	-24.1	PASS
2399.525000	-32.6	8.5	-24.1	PASS
2399.475000	-32.8	8.7	-24.1	PASS
2399.425000	-33.0	8.9	-24.1	PASS
2399.375000	-33.2	9.1	-24.1	PASS
2399.325000	-33.4	9.3	-24.1	PASS
2399.275000	-33.6	9.5	-24.1	PASS

Setting	Instrument Value	Target Value
Start Frequency	2.40000 GHz	2.40000 GHz
Stop Frequency	2.48350 GHz	2.48350 GHz
Span	83.500 MHz	83.500 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	1670	~ 1670
SweepTime	94.727 μ s	AUTO
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	10.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
SweepType	FFT	AUTO
Preamp	off	off
StableMode	Trace	Trace
StableValue	0.50 dB	0.50 dB
Run	13 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.02 dB	0.50 dB

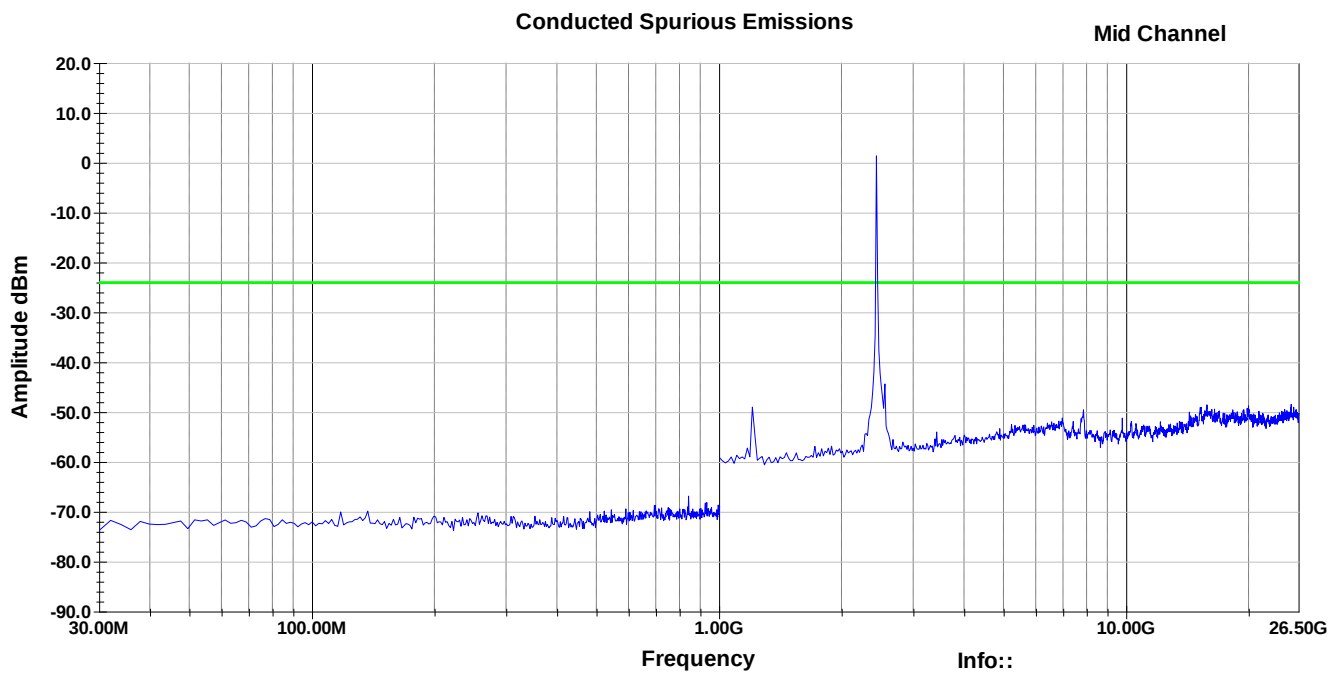
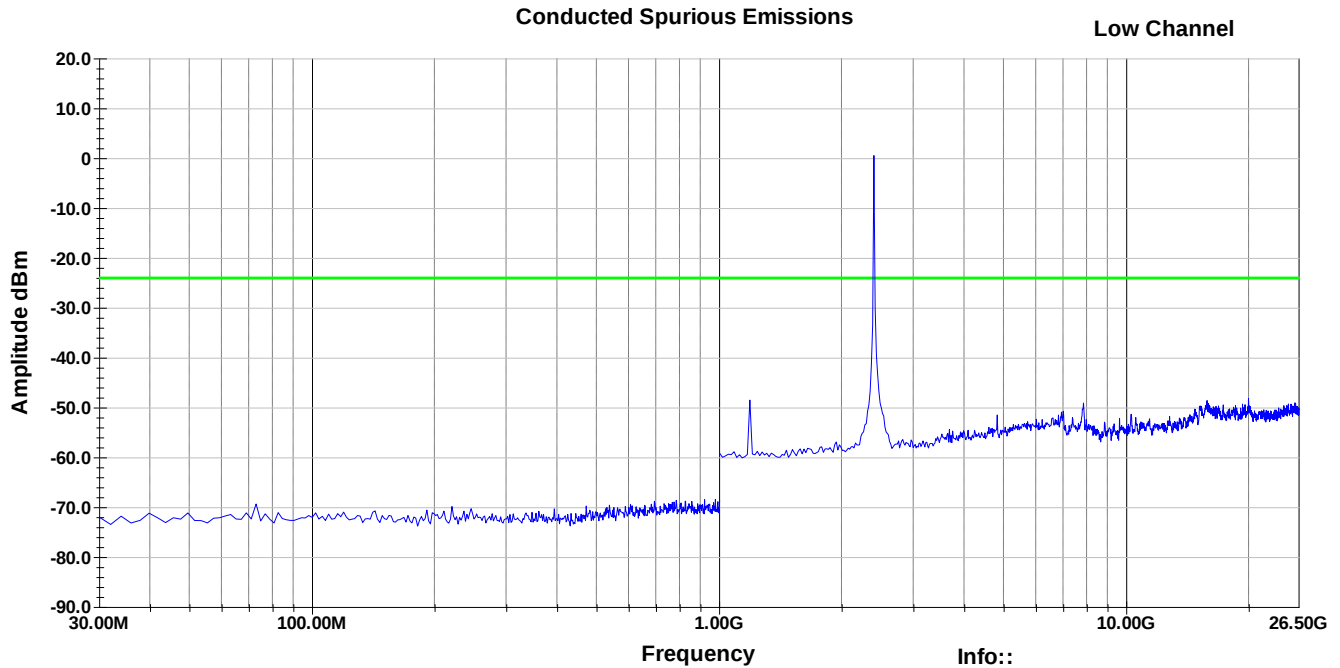
Upper Band Edge

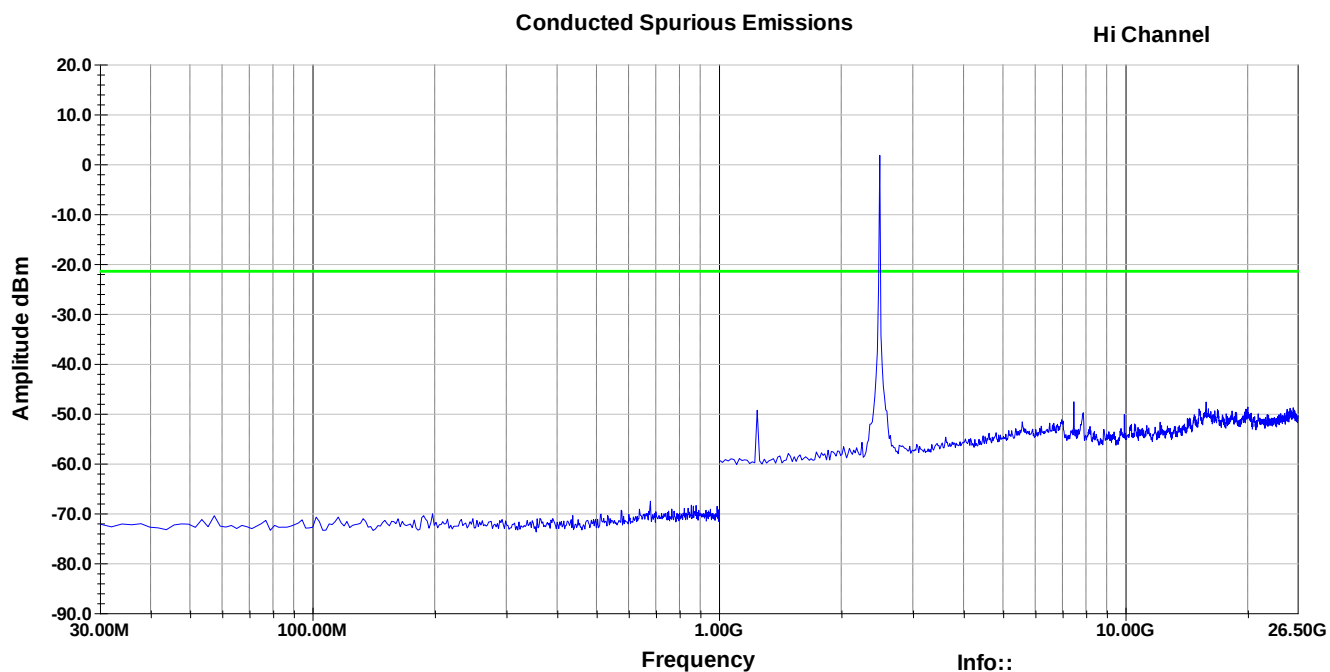


Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2483.525000	-41.4	19.9	-21.5	PASS
2483.975000	-42.9	21.4	-21.5	PASS
2484.025000	-43.2	21.7	-21.5	PASS
2484.425000	-43.5	22.0	-21.5	PASS
2483.725000	-43.7	22.2	-21.5	PASS
2483.925000	-43.8	22.4	-21.5	PASS
2484.475000	-43.9	22.4	-21.5	PASS
2483.675000	-44.1	22.6	-21.5	PASS
2484.525000	-44.2	22.7	-21.5	PASS
2483.875000	-44.5	23.0	-21.5	PASS
2484.375000	-44.7	23.2	-21.5	PASS
2483.775000	-45.0	23.5	-21.5	PASS
2483.825000	-45.5	24.0	-21.5	PASS
2483.575000	-45.9	24.4	-21.5	PASS
2488.775000	-46.2	24.7	-21.5	PASS

Setting	Instrument Value	Target Value
Start Frequency	2.48350 GHz	2.48350 GHz
Stop Frequency	2.50000 GHz	2.50000 GHz
Span	16.500 MHz	16.500 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	330	~ 330
SweepTime	18.945 μ s	AUTO
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	10.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
SweepType	FFT	AUTO
Preamp	off	off
StableMode	Trace	Trace
StableValue	0.50 dB	0.50 dB
Run	4 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

6.6 Test Data – 30 MHz to 26.5 GHz





7 Emissions in restricted frequency bands

7.1 Test Result

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

7.2 Test Method

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

Lowest, middle, and highest channels were investigated – the device was commanded to continuously transmit on channels 0, 19, and 39.

Test distance:

- 9k to 30 MHz – Near field prescan to determine if there were any emissions.
- 30 to 1000 MHz - The EUT to measurement antenna distance was 10 meters
- 1 to 18 GHz - The EUT to measurement antenna distance was 3 meters
- 18 to 26 GHz - The EUT to measurement antenna distance was 1 meters

Limits within restricted bands of operation:

Frequency	Limits ⁽¹⁾		Peak Limits dBuV/m
	Microvolts/m	dBuV/m	
30 - 88 MHz	100	40 ⁽²⁾	--
88 - 216 MHz	150	43.5 ⁽²⁾	--
216 - 960 MHz	200	46 ⁽²⁾	--
960 - 1000 MHz	500	54 ⁽²⁾	--
1 - 40 GHz	500	54 ⁽³⁾	74

(1) These limits are applicable to emissions outside of the intentional transmit frequency band.

(2) Quasi-peak limit

(3) Average limit

7.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 24.2 °C

Relative Humidity: 41.5 %

Atmospheric Pressure: 97.5 kPa

7.4 Test Equipment

Test End Date: 12-Jun-2018

Tester: SKM

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
ANTENNA, DRG HORN (MEDIUM)	3117	ETS LINDGREN	B079691	27-Jul-2018
RF CABLE	SF106	HUBER & SUHNER	B079716	24-Jul-2018
LOW NOISE AMPLIFIER	TS-PR18	ROHDE & SCHWARZ	B094463	6-Mar-2019
RF CABLE	104PE	HUBER & SUHNER	B079793	24-Jul-2018
EMI RECEIVER	ESU 40	ROHDE & SCHWARZ	Rental	2-Oct-2018
FILTER, HIGH PASS (>2800MHZ)	HPM50111	MICRO-TRONICS	B085747	27-Jul-2018
ANTENNA, BILOG	JB6	SUNOL	B079690	29-Nov-2018
RF CABLE	SF106	HUBER & SUHNER	B079661	25-Jul-2018
RF CABLE	SF106	HUBER & SUHNER	B079713	24-Jul-2018
RF CABLE	UC-N-MM-78	MAURY MICROWAVE	17017	25-Jul-2018
HORN(SMALL)	LB-180400-20-C-KF	A-INFO	15007	30-Mar-2019
RF CABLE	141	HUBER & SUHNER	B095590	26-Jul-2018
LOW NOISE AMPLIFIER	NSP1840-HG	MITEQ	B087572	28-Jul-2018
RF CABLE	SF102	HUBER & SUHNER	B079824	26-Jul-2018

Note: The equipment calibration period is 1 year.

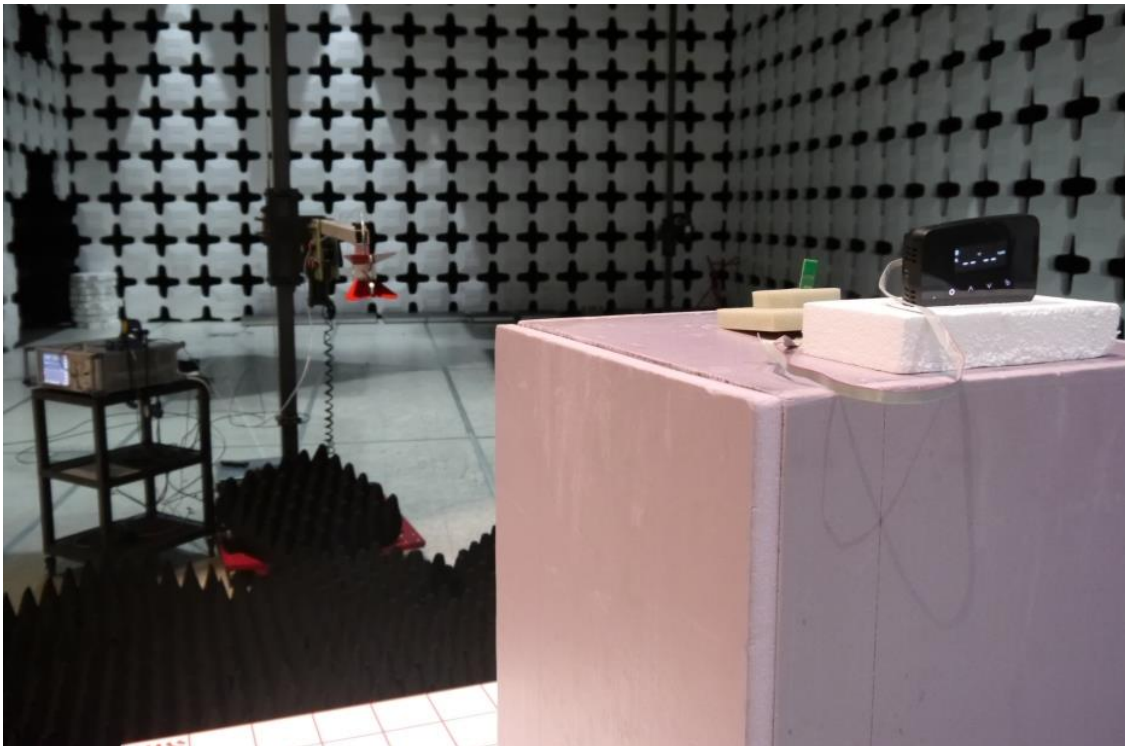
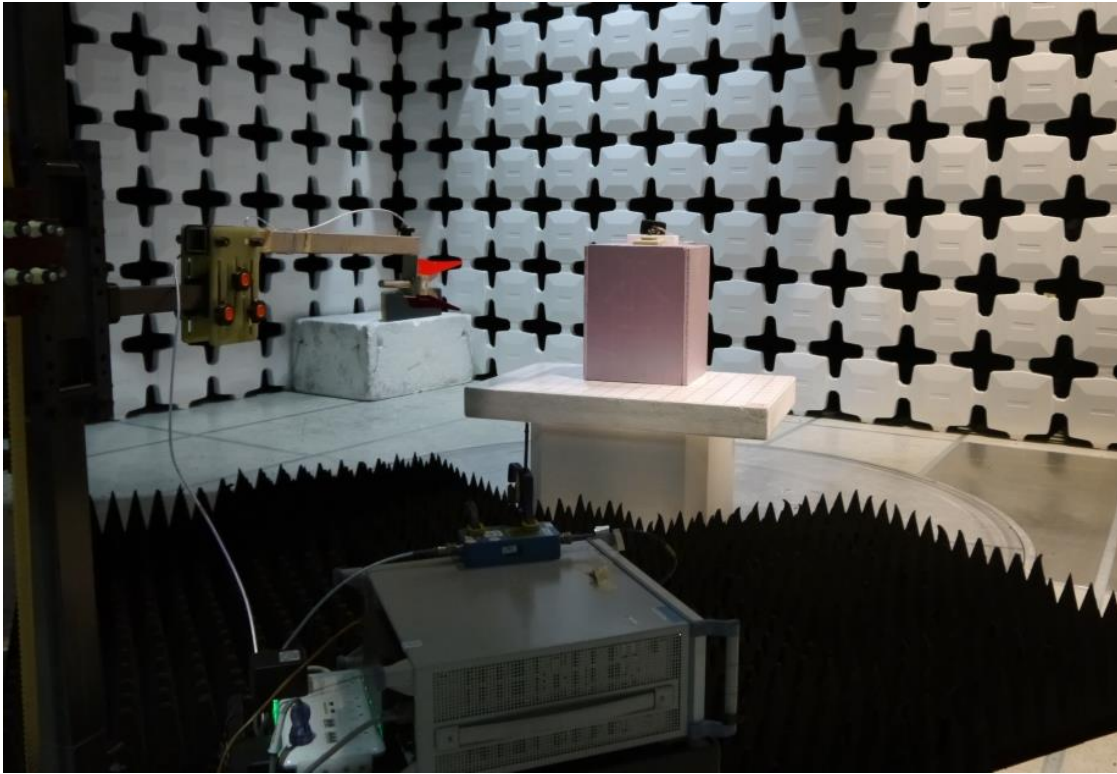
Test End Date: 8-Oct-2018

Tester: SKM

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
ANTENNA, DRG HORN (MEDIUM)	3117	ETS LINDGREN	B079691	10-Aug-2019
LOW NOISE AMPLIFIER	TS-PR18	ROHDE & SCHWARZ	B094463	6-Mar-2019
RF CABLE	104PE	HUBER & SUHNER	B079793	24-Jul-2019
RF CABLE	SF102	HUBER & SUHNER	B079823	25-Jul-2019
EMI TEST RECEIVER	ESU40	ROHDE & SCHWARZ	B079629	2-Jul-2019

Note: The equipment calibration period is 1 year.

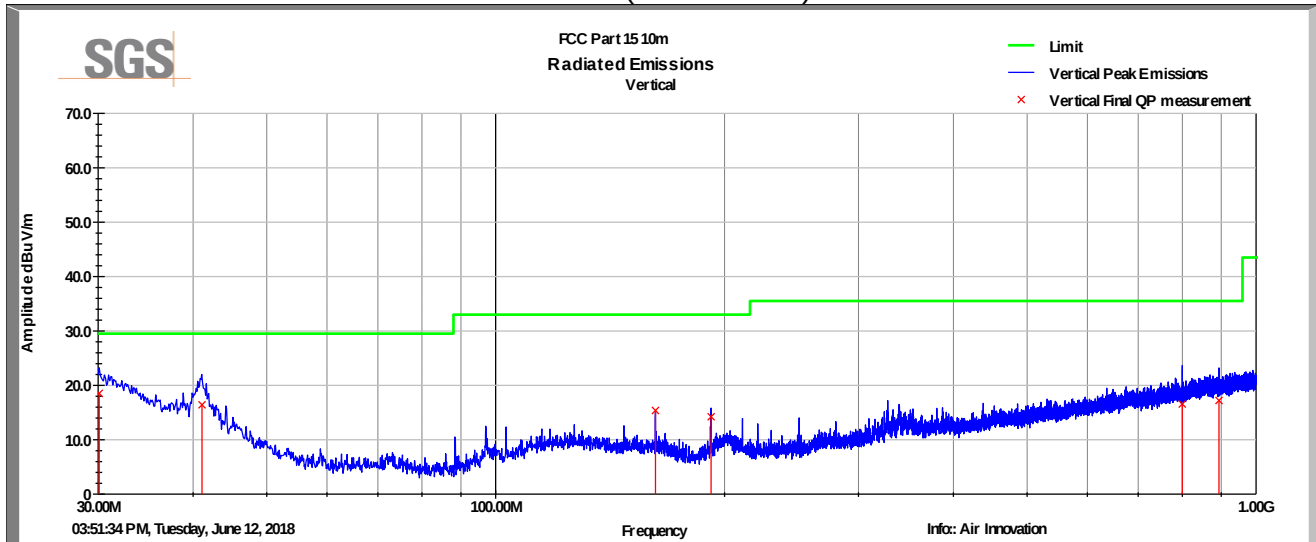
7.5 Test Setup Photographs



7.6 Test Data – Peak Plots

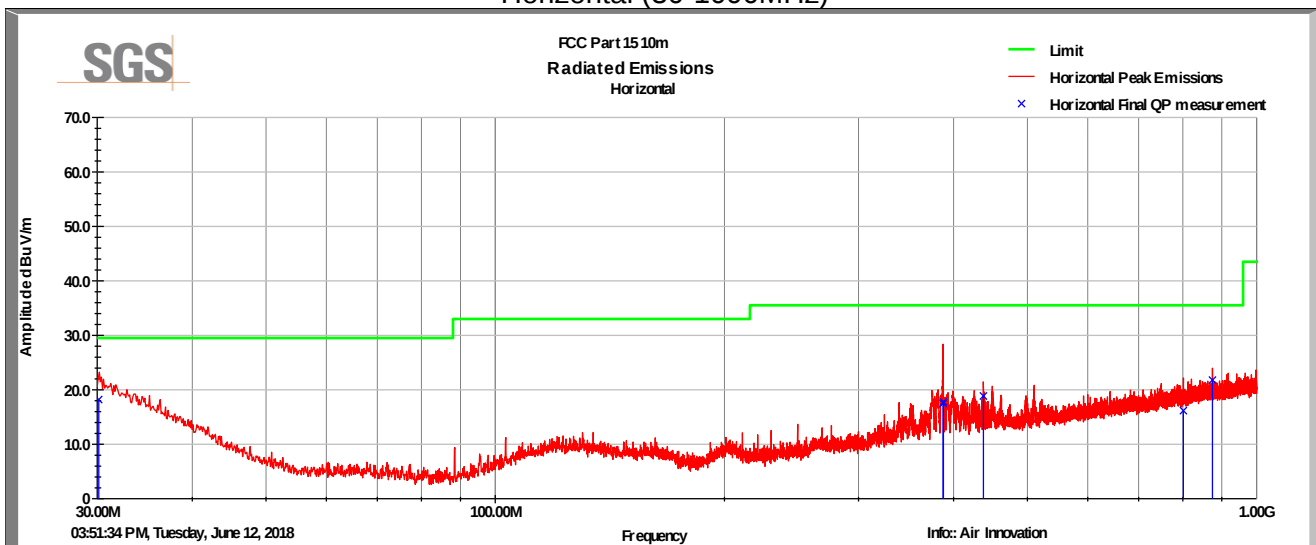
No emissions were detected in the range 30MHz to 1000MHz.

BLE Low Channel
Vertical (30-1000MHz)



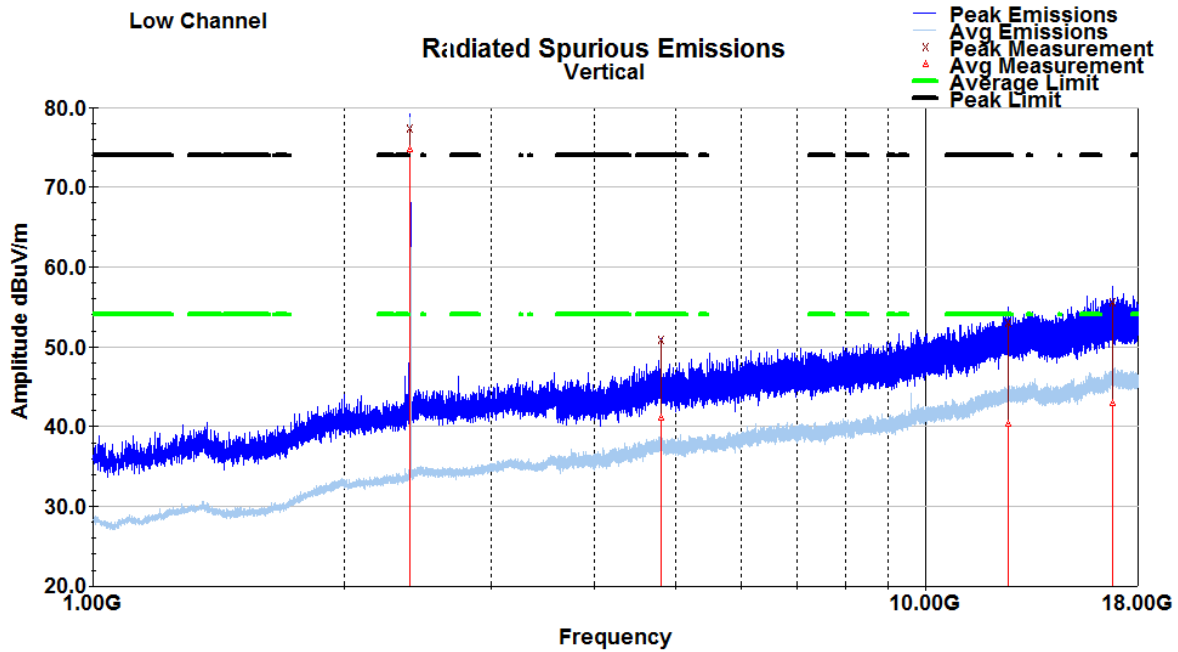
Below 1GHz, there was no discernible difference among the different transmit channels.

BLE Low Channel
Horizontal (30-1000MHz)

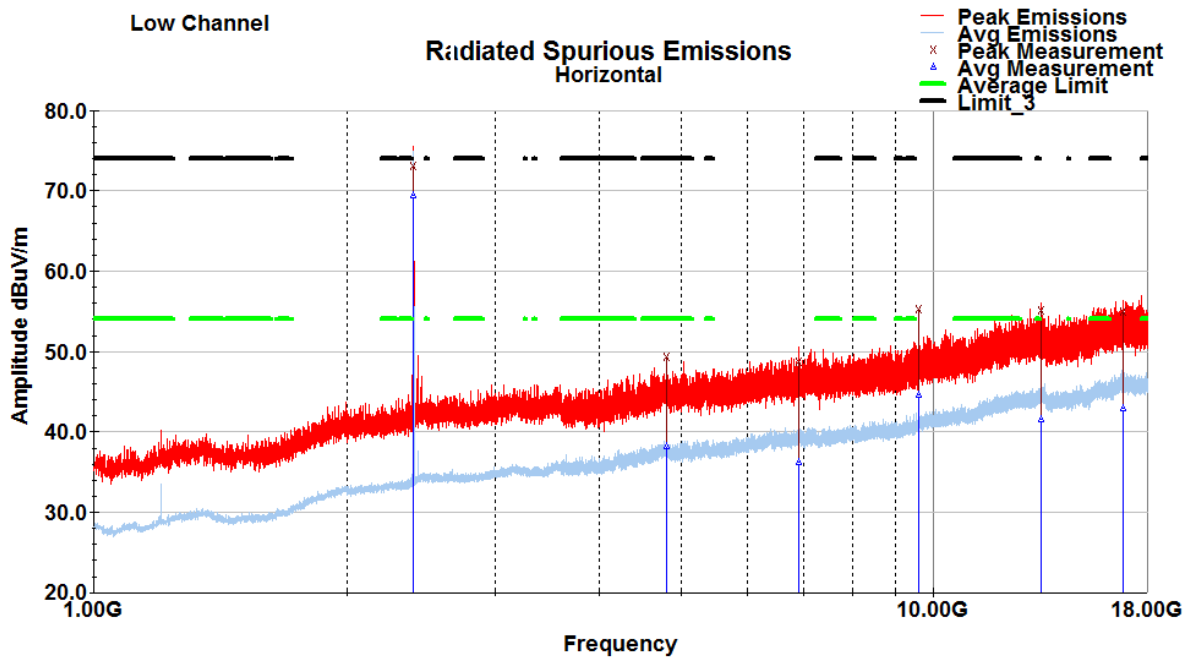


Below 1GHz, there was no discernible difference among the different transmit channels.

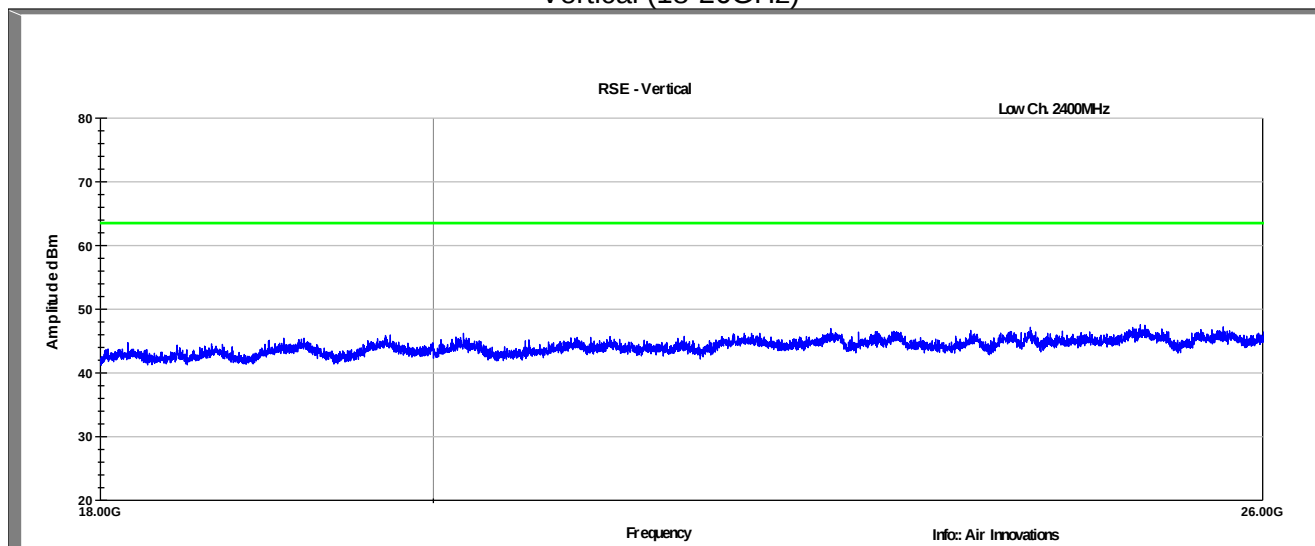
BLE Low Channel Vertical (1-18GHz)



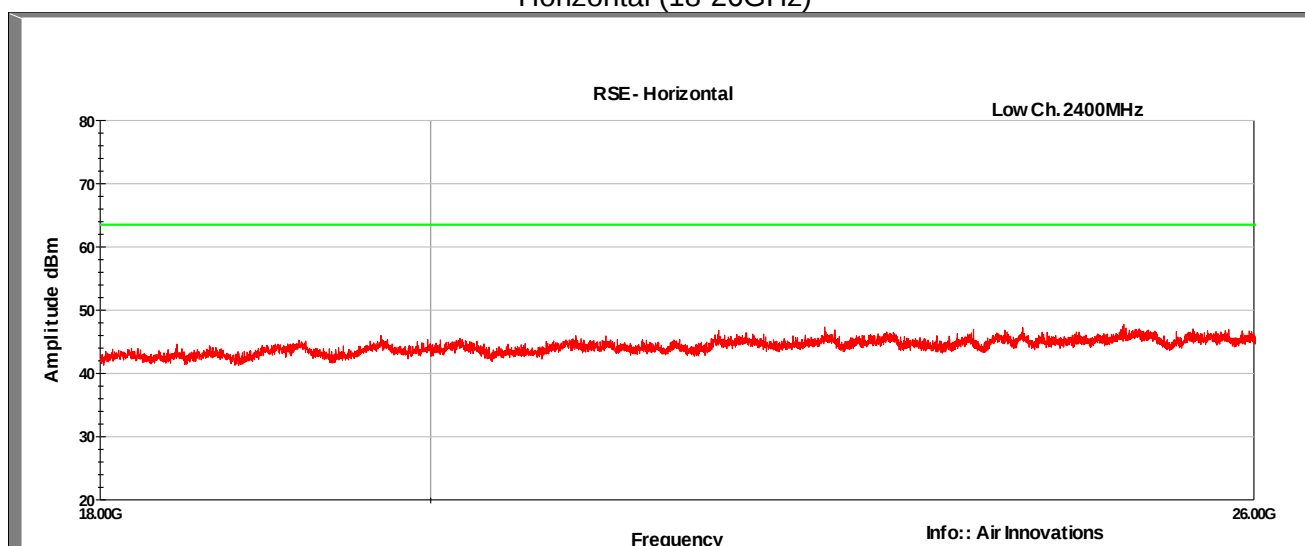
BLE Low Channel Horizontal (1-18GHz)



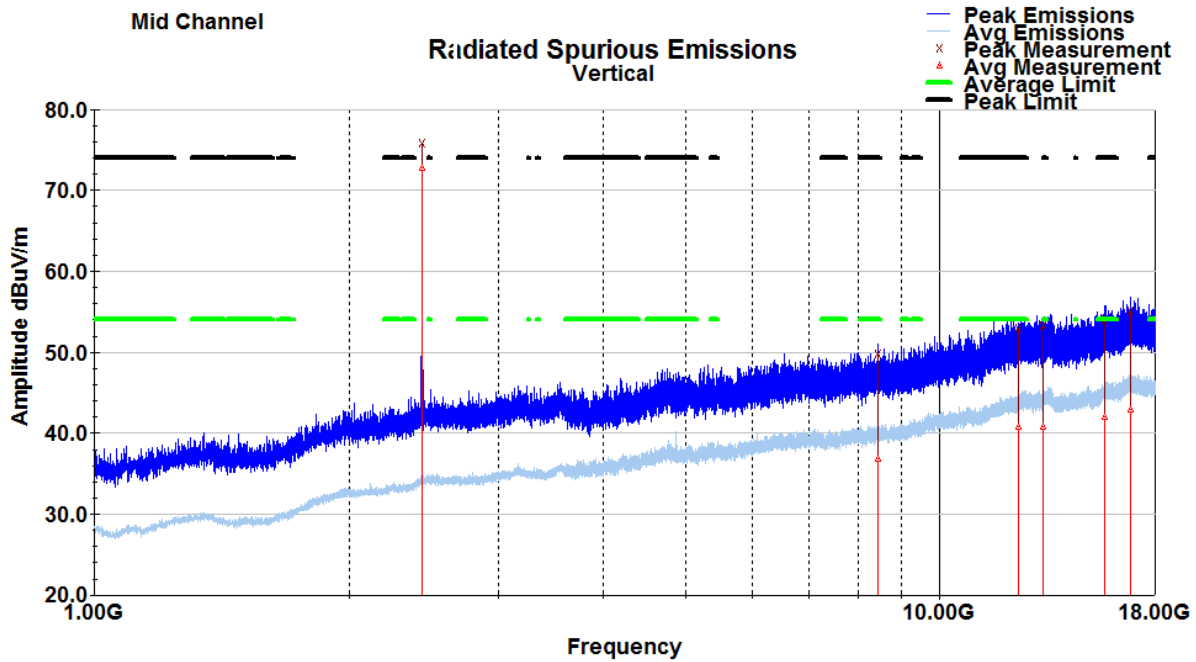
BLE Low Channel Vertical (18-26GHz)



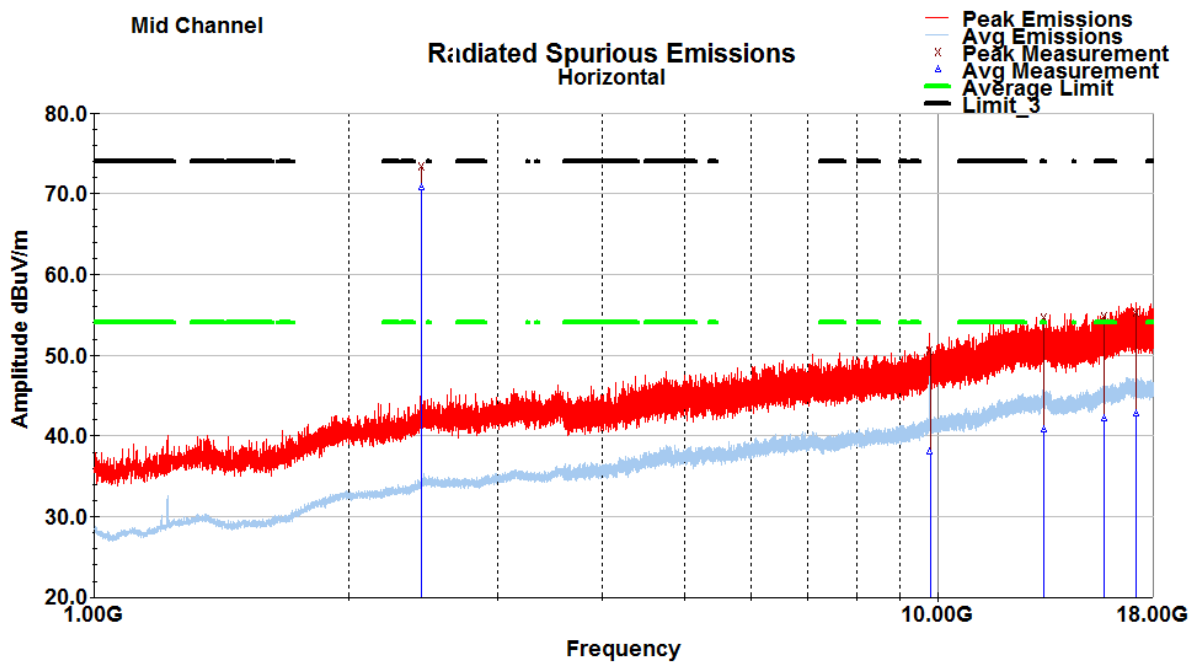
BLE Low Channel Horizontal (18-26GHz)



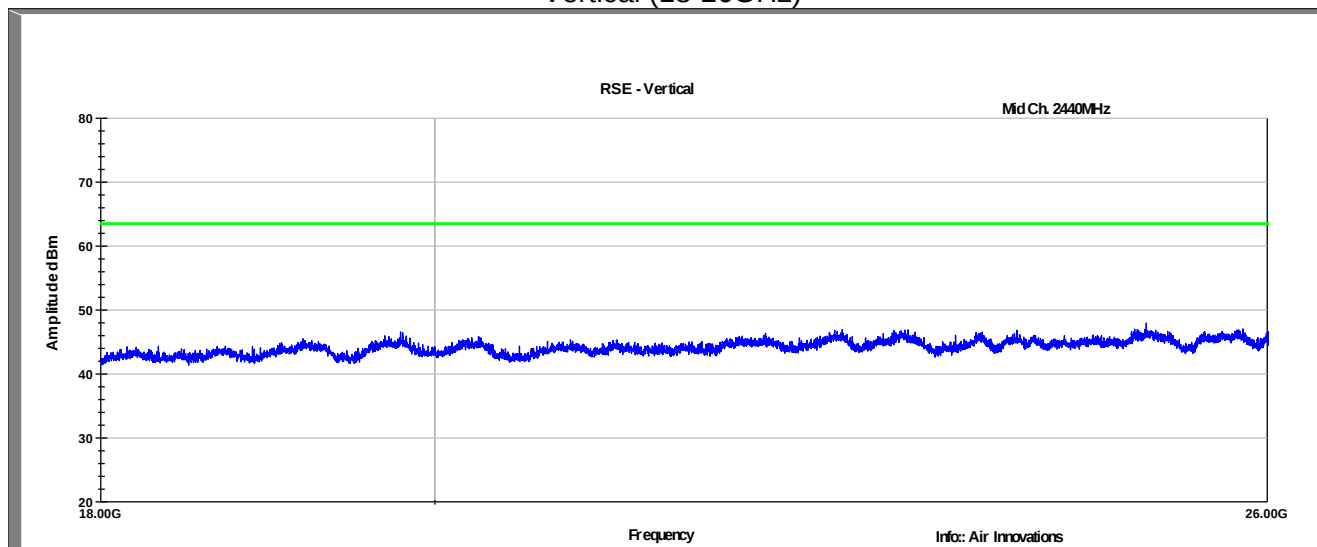
BLE Mid Channel Vertical (1-18GHz)



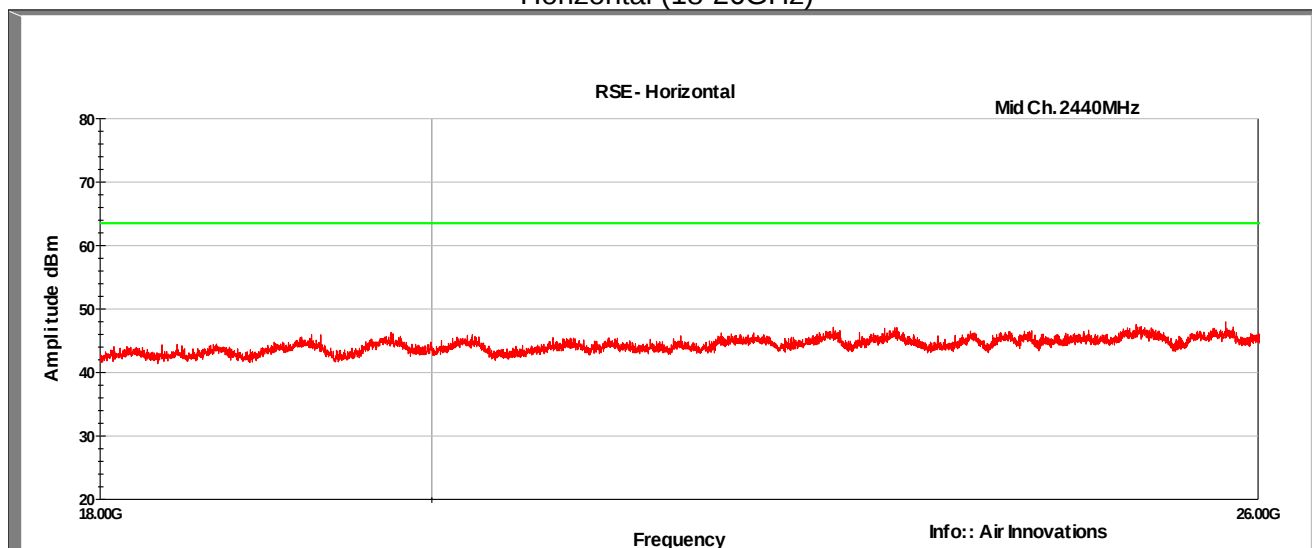
BLE Mid Channel Horizontal (1-18GHz)



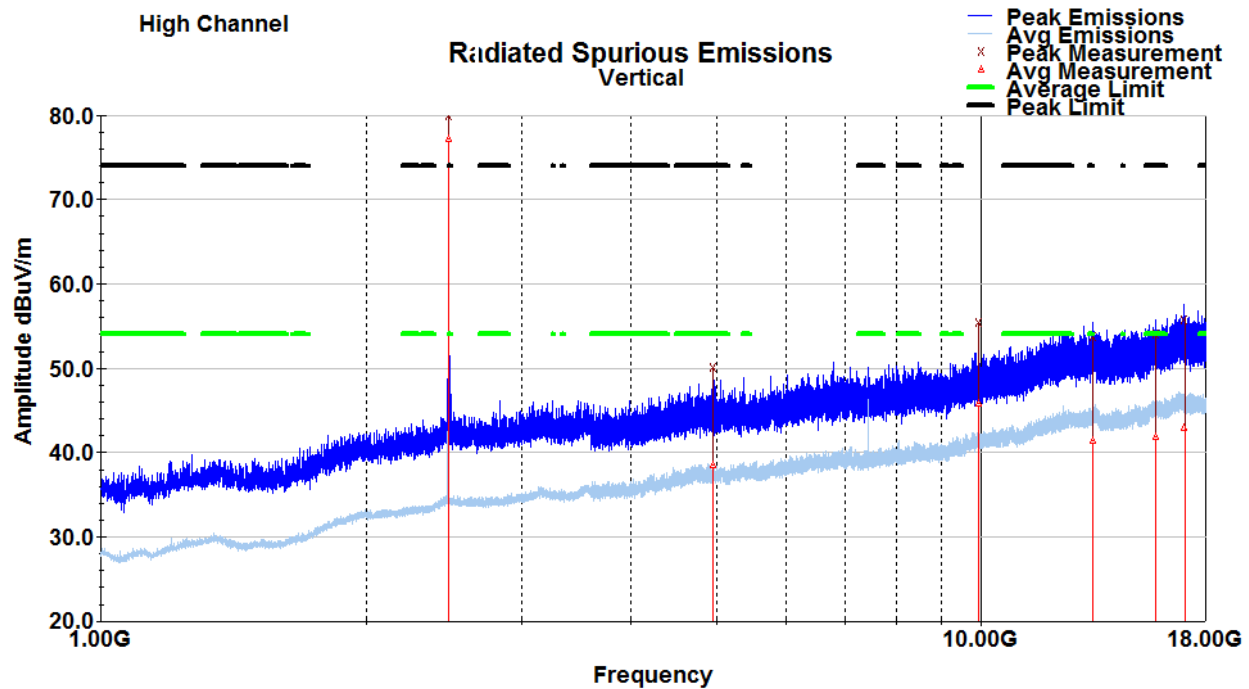
BLE Mid Channel Vertical (18-26GHz)



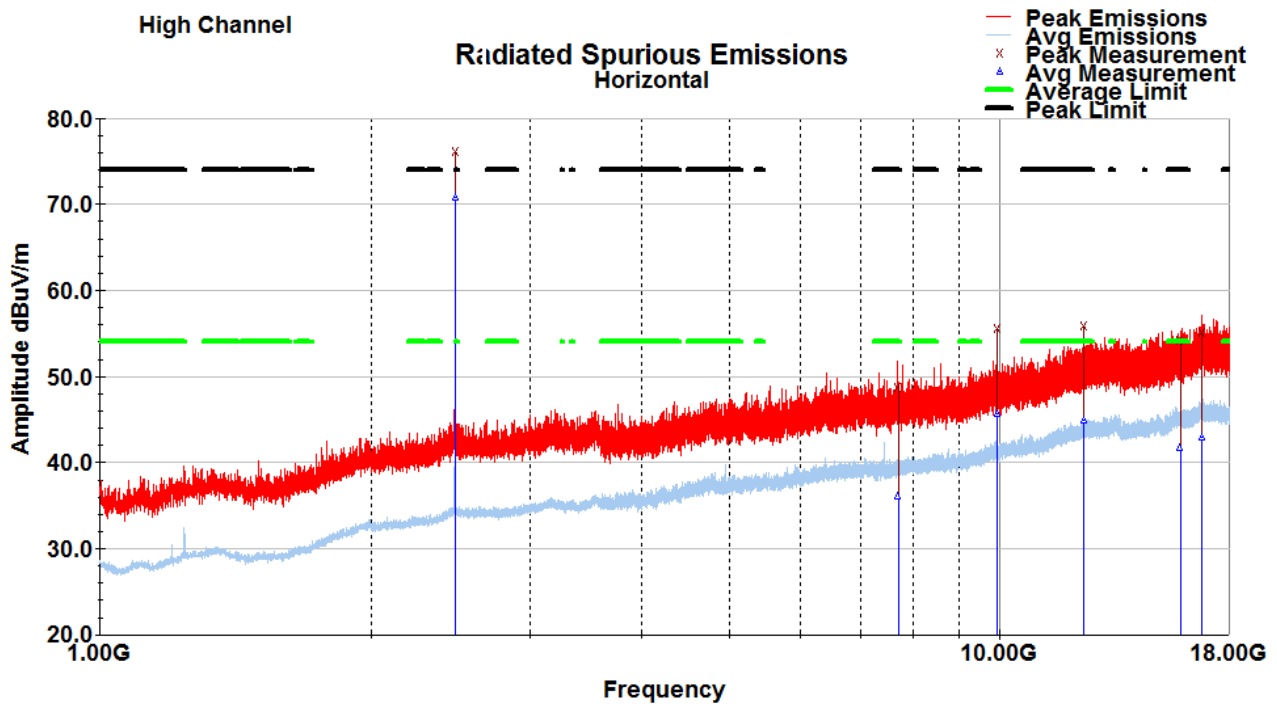
BLE Mid Channel Horizontal (18-26GHz)



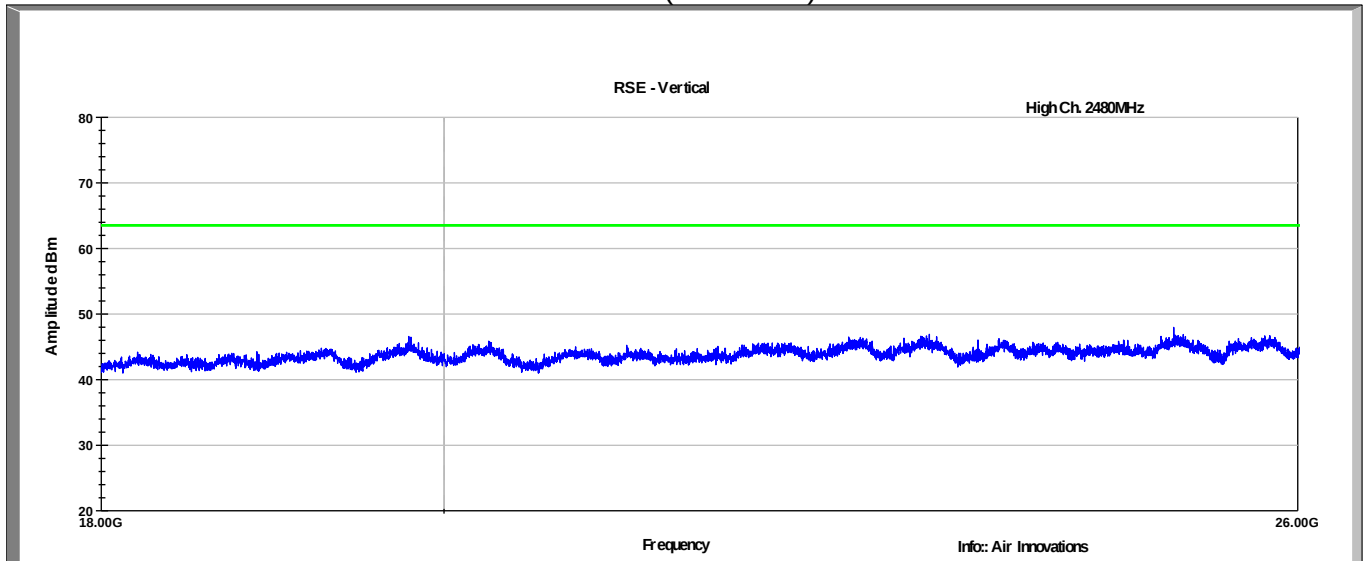
BLE High Channel Vertical (1-18GHz)



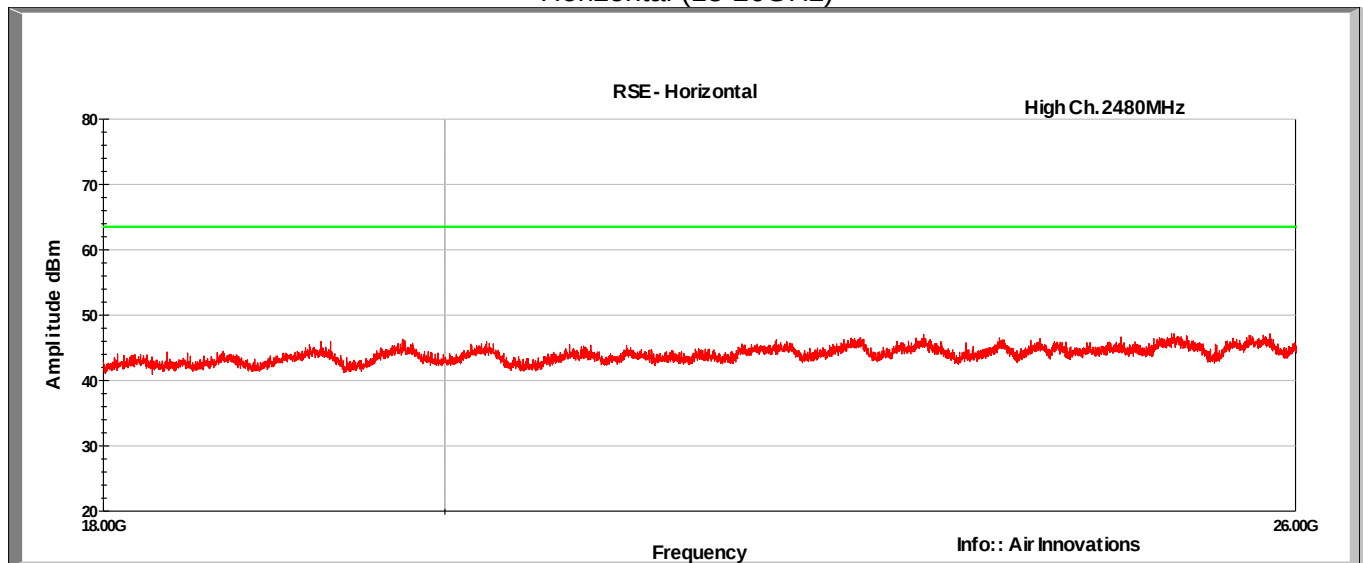
BLE High Channel Horizontal (1-18GHz)



BLE High Channel Vertical (18-26GHz)



BLE High Channel Horizontal (18-26GHz)



7.7 Test Data – Tabular Data

7.7.1 30-1000 MHz

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)
30.10	26.9	V	70.0	194.0	22.2	0.5	31.1	18.5	29.5	-11.0
41.10	33.8	V	293.0	200.0	13.9	0.6	31.9	16.4	29.5	-13.1
162.22	35.0	V	70.0	150.0	12.8	1.3	33.7	15.4	33.0	-17.6
192.00	35.0	V	135.0	163.0	11.6	1.4	33.7	14.2	33.0	-18.8
799.97	25.2	V	99.0	165.0	22.0	2.9	33.4	16.6	35.5	-18.9
893.99	24.7	V	90.0	184.0	22.9	3.0	33.5	17.2	35.5	-18.3
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)
30.14	26.6	H	45.0	163.0	22.2	0.5	31.1	18.2	29.5	-11.3
387.41	33.1	H	178.0	182.0	16.0	2.0	33.5	17.5	35.5	-18.0
387.75	33.3	H	189.0	163.0	16.0	2.0	33.5	17.8	35.5	-17.7
437.68	33.2	H	189.0	173.0	17.1	2.1	33.5	18.9	35.5	-16.6
801.45	24.7	H	179.0	194.0	22.0	2.9	33.4	16.2	35.5	-19.3
875.09	29.4	H	86.0	173.0	22.8	3.0	33.5	21.8	35.5	-13.7
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

7.7.2 Above 1 GHz

Above 18 GHz the test distance was reduced to 1 m, and the limit increased by 10 dB

7.7.2.1 Channel Low

Lo V

Frequency MHz	Raw Avg dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Avg dBuV/m	Limit (dBuV/m)	Margin (dB)
4803.16	36.8	V	0.0	250.0	34.7	3.1	33.5	41.0	54.0	-13.0
12548.40	29.7	V	0.0	250.0	39.3	4.5	33.2	40.3	54.0	-13.7
16757.36	30.1	V	0.0	250.0	41.6	5.0	33.8	42.9	54.0	-11.1
= Level + AF + CL - Amp										
Margin = QP Value - Limit										

Lo H

Frequency MHz	Raw Avg dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Avg Value dBuV/m	Limit (dBuV/m)	Margin (dB)
4802.64	33.9	H	0.0	100.0	34.7	3.1	33.5	38.1	54.0	-15.9
6901.44	30.2	H	0.0	156.0	35.8	3.6	33.5	36.2	54.0	-17.8
9606.92	36.6	H	0.0	168.0	36.7	4.3	33.0	44.6	54.0	-9.4
13435.96	30.0	H	0.0	105.0	39.9	4.9	33.2	41.6	54.0	-12.4
16831.56	30.1	H	0.0	113.0	41.6	5.0	33.8	43.0	54.0	-11.0
QP Value = Level + AF + CL - Amp										

7.7.2.2 Channel Mid

Mid V

Frequency	Raw Avg	Polarity	Azimuth	Height	AF	Loss	Amp	Final Avg	Limit	Margin
MHz	dBuV	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	dBuV/m	(dBuV/m)	(dB)
8439.56	30.0	V	0.0	175.0	36.1	4.0	33.2	36.8	54.0	-17.2
12404.24	30.2	V	0.0	175.0	39.1	4.5	33.1	40.8	54.0	-13.2
13273.52	29.6	V	0.0	175.0	39.8	4.6	33.2	40.8	54.0	-13.2
15690.24	29.8	V	0.0	175.0	40.4	5.3	33.5	42.0	54.0	-12.0
16804.24	30.0	V	0.0	175.0	41.6	5.3	33.8	43.0	54.0	-11.0

$$QPValue = Level + AF + CL - Amp$$

$$Margin = QPValue - Limit$$

Mid H

Frequency	Raw Avg	Polarity	Azimuth	Height	AF	Loss	Amp	Avg Value	Limit	Margin
MHz	dBuV	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	dBuV/m	(dBuV/m)	(dB)
9783.12	29.7	H	0.0	122.0	36.8	4.3	32.8	38.1	54.0	-15.9
13340.96	29.5	H	9.0	161.0	40.0	4.6	33.3	40.8	54.0	-13.2
15719.60	30.0	H	0.0	101.0	40.5	5.2	33.5	42.2	54.0	-11.8
17178.84	30.1	H	0.0	168.0	41.3	5.0	33.6	42.8	54.0	-11.2

$$= Level + AF + CL - Amp$$

$$Margin = QPValue - Limit$$

7.7.2.3 Channel High

High V

Frequency	Raw Avg	Polarity	Azimuth	Height	AF	Loss	Amp	Final Avg	Limit	Margin
MHz	dBuV	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	dBuV/m	(dBuV/m)	(dB)
4959.76	34.5	V	0.0	175.0	34.4	3.1	33.4	38.6	54.0	-15.4
9917.84	37.2	V	0.0	175.0	37.0	4.3	32.7	45.9	54.0	-8.1
13408.60	30.0	V	0.0	175.0	40.0	4.7	33.2	41.4	54.0	-12.6
15802.00	29.6	V	0.0	175.0	40.6	5.2	33.5	41.8	54.0	-12.2
17025.84	30.3	V	0.0	175.0	41.4	4.9	33.7	42.9	54.0	-11.1

$$QPValue = Level + AF + CL - Amp$$

$$Margin = QPValue - Limit$$

High H

Frequency	Raw Avg	Polarity	Azimuth	Height	AF	Loss	Amp	Avg Value	Limit	Margin
MHz	dBuV	(V/H)	(degrees)	(cm)	(dB/m)	(dB)	(dB)	dBuV/m	(dBuV/m)	(dB)
7705.88	29.8	H	0.0	121.0	35.8	3.8	33.3	36.1	54.0	-17.9
9917.76	37.0	H	0.0	175.0	37.0	4.3	32.7	45.7	54.0	-8.3
12397.44	34.4	H	0.0	157.0	39.1	4.5	33.1	45.0	54.0	-9.0
15883.96	29.7	H	0.0	154.0	40.6	5.0	33.6	41.7	54.0	-12.3
16785.72	29.9	H	0.0	100.0	41.6	5.2	33.8	42.9	54.0	-11.1

$$= Level + AF + CL - Amp$$

$$Margin = QPValue - Limit$$

8 Emissions in Restricted Frequency Bands at Band Edge

8.1 Test Result

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

8.2 Test Method

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

Offset Calculations:

Offset calculations so that conducted measurements on the spectrum analyzer in dBμV represent field strength measurements in dBμV/m.

$$\text{Offset} = -20\log(D) + 104.8 - 107 + \text{CL} + \text{DC} + \text{AG}$$

$$\text{Offset}_{3m} = -11.7 + \text{CL} + \text{DC} + \text{AG}$$

D = 3m	Distance
CL = 0.6 dB	Cable Loss
DC = 1.0 dB	Duty Cycle Correction Factor
AG = 2.0 dB	Antenna Gain

$$\text{Offset} = -8.1 \text{ dB}$$

8.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature:	22.9 °C
Relative Humidity:	52.8 %
Atmospheric Pressure:	98.1 kPa

8.4 Test Equipment

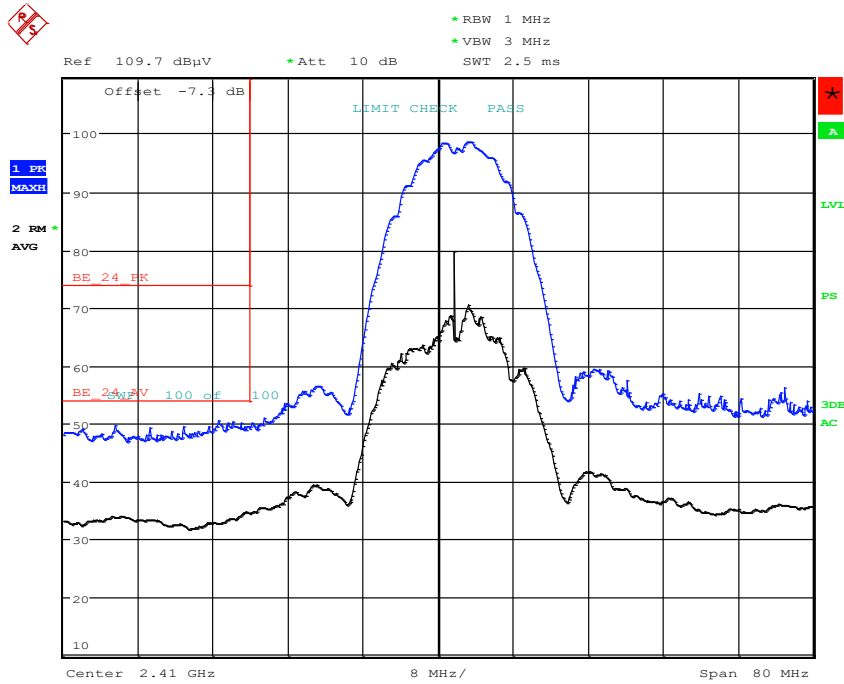
Test End Date: 12-Jun-2018

Tester: ASF

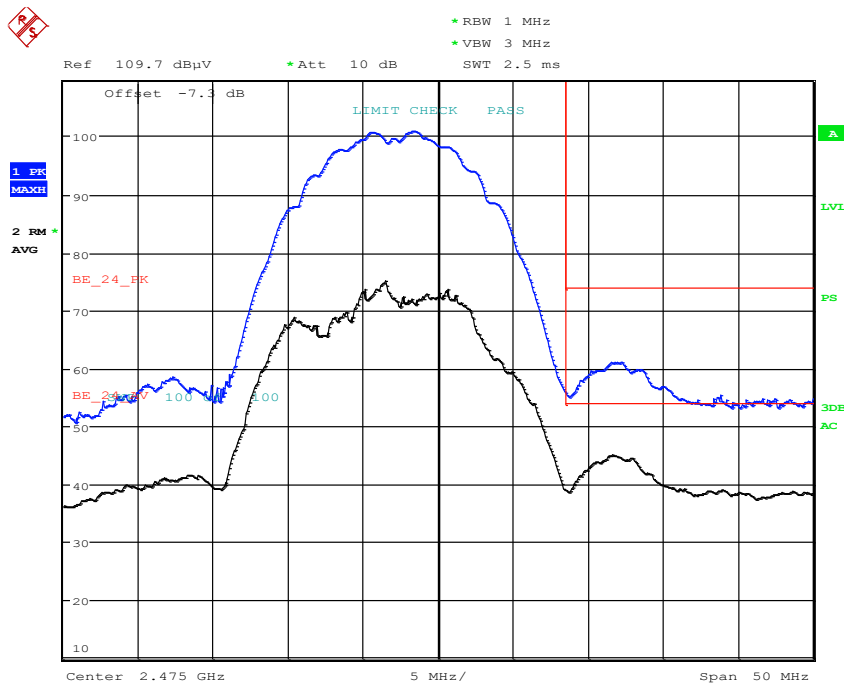
Equipment	Model	Manufacturer	Asset Number	Cal Due Date
RF CABLE	141	HUBER & SUHNER	B095585	26-Jul-2018
EMI TEST RECEIVER	ESU8	ROHDE & SCHWARZ	B085759	25-Jul-2018

Note: The equipment calibration period is 1 year.

8.5 Test Data – Restricted Band Edge



Date: 12.JUN.2018 22:16:31



Date: 12.JUN.2018 22:18:04

9 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 %	$\pm 0.4\%$

10 Revision History

Revision Level	Description of changes	Revision Date
0	Initial release	24 DEC 2018
1	Updated KDB References and WH software details	11 AUG 2020
2	Updated Section 2.4 with expanded software explanation	18 SEPT 2020
3	Improved Block Diagrams	10 NOV 2020