

EMC Test Report

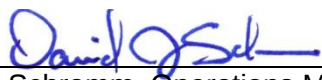
Project Number: 4226163**Report Number: 4226163EMC01****Revision Level: 0****Client: Crestron Electronics****Equipment Under Test: Zigbee Remote****Model: HR-310****FCC ID: EROHR310****IC ID: 5683C-HR310****Applicable Standards: FCC Part 15 Subpart C, § 15.247****RSS-247, Issue 2, May 2015****ANSI C63.10: 2013****RSS-GEN, Issue 4, November 2014****Report issued on: 30 November 2017****Test Result: Compliant**

Tested by:



Jeremy Pickens, Senior EMC Engineer

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
Bandwidth	15.247(d)	RSS-247 S5.2 (1) RSS-GEN S6.6	Compliant
Transmitter Output Power	15.247(b)(3)	RSS-247 S5.4 (4)	Compliant
Power Spectral Density	15.247(e)	RSS-247 S5.2 (2)	Compliant
Conducted Spurious Emissions / Band edge	15.247(d)	RSS-247 S5.5	Compliant
Radiated Spurious Emissions / Restricted Bands	15.35(b),15.209	RSS-GEN S6.13 RSS-GEN S8.10	Compliant
Antenna Requirement	15.203	RSS-GEN S8.3	Compliant (1)
AC Powerline Conducted Emission	15.107, 15.207	RSS-GEN S8.8	N/A(2)

- 1) The device uses an internal chip antenna. It is not replaceable by the end user.
- 2) Not Applicable – The device is powered via internal batteries with no facility to connect to the AC mains.

1.1 Modifications Required for Compliance

None

2 General Information

2.1 Client Information

Name: Crestron Electronics, Inc.
Address: 15 Volvo Drive
City, State, Zip, Country: Rockleigh, NJ 07647, 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: Zigbee Remote
Model Number: HR-310
Serial Number: Not labeled

Frequency Range: 2405-2480MHz
Modulation: 802.15.4 (Zigbee)
Antenna: 2.0dBi Chip Antenna

Rated Voltage: 4.5Vdc
Test Voltage: 4.5Vdc

Sample Received Date: 30 October 2017
Dates of testing: 08 - 17 November 2017

2.4 Operating Modes and Conditions

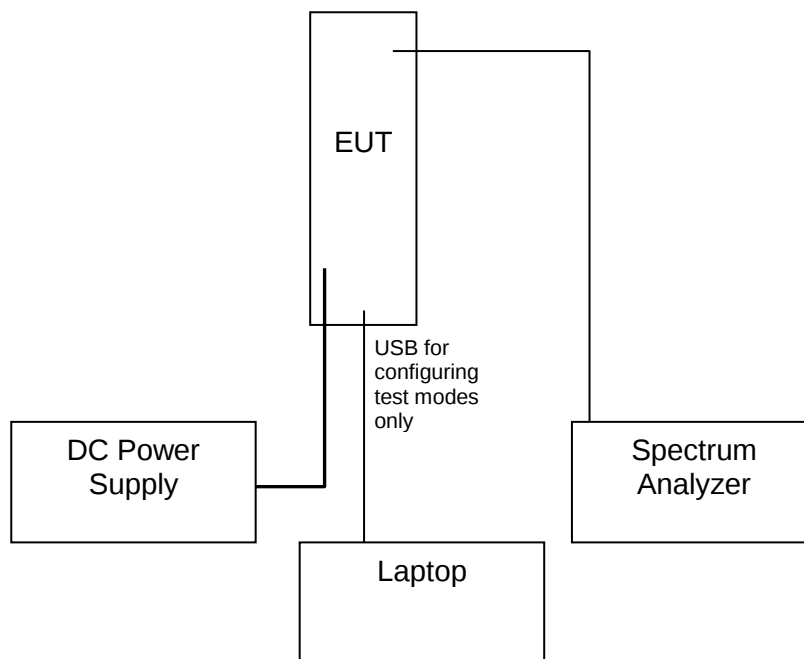
Continuous traffic was generated using test commands. The device was programmed to transmit at 100% duty cycle at low, middle, and high channels.

Channel 11, 2405MHz

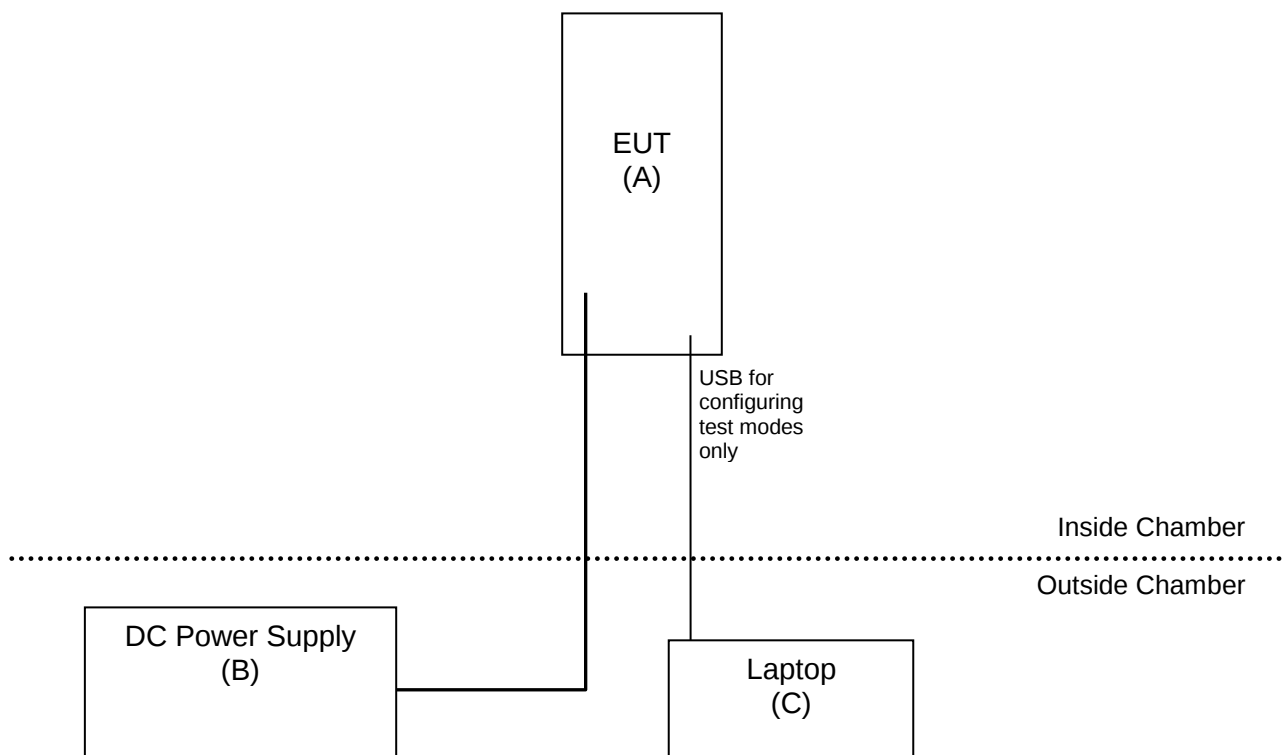
Channel 18, 2440MHz

Channel 26, 2480MHz

2.5 EUT Connection Block Diagram – Conducted Measurements



2.6 EUT Connection Block Diagram – Radiated Measurements



2.7 System Configurations

Device reference	Manufacturer	Description	Model Number	Serial Number
A	Crestron Electronics	Zigbee Remote	HR-310	Not Labeled
B	Rigol	DC Power Supply	DP711	DP7A182700833
C	Lenovo	Thinkpad Laptop	T420	4236B85

3 Bandwidth

3.1 Test Result

Test Description	Test Specification		Test Result
6 dB bandwidth / 99% OBW	15.247(d)	RSS-247 S5.2 (1) RSS-GEN S6.6	Compliant

3.2 Test Method

The procedures from ANSI C63.10: 2013 clause 11.8 and 558074 D01 DTS Meas Guidance v04 were used to determine the 6 dB bandwidth and 99% OBW.

3.3 Test Site

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

Environmental Conditions

Temperature: 23.2 °C

Relative Humidity: 34.5 %

3.4 Test Equipment

Test End Date: 15-Nov-2017

Tester: JOP

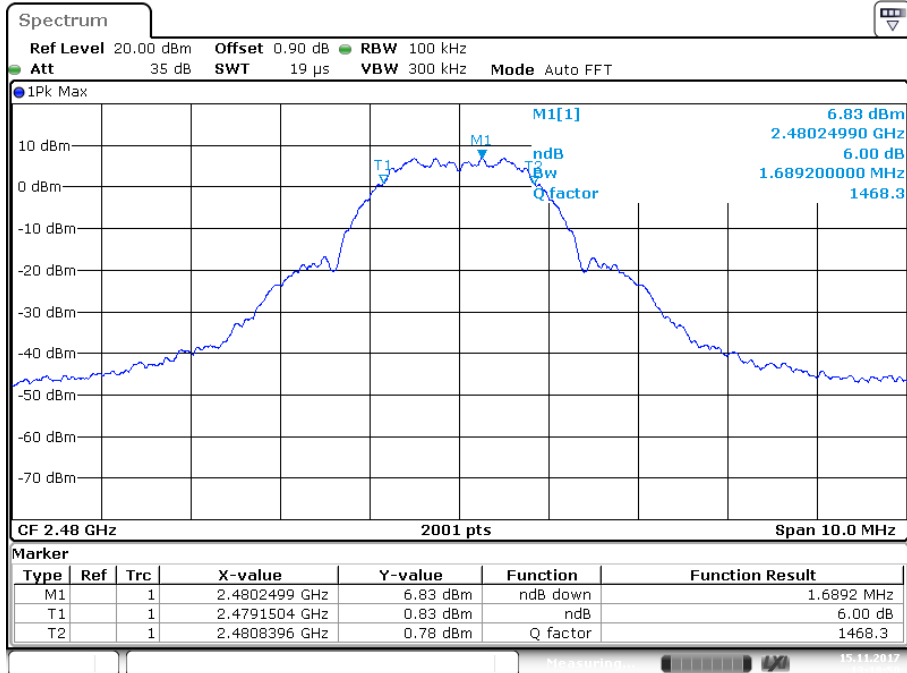
Equipment	Model	Manufacturer	Asset Number	Cal Due Date
SIGNAL ANALYZER	FSV30	ROHDE & SCHWARZ	B085749	1-Nov-2019
RF CABLE	SF102	HUBER & SUHNER	B079823	26-Jul-2018

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

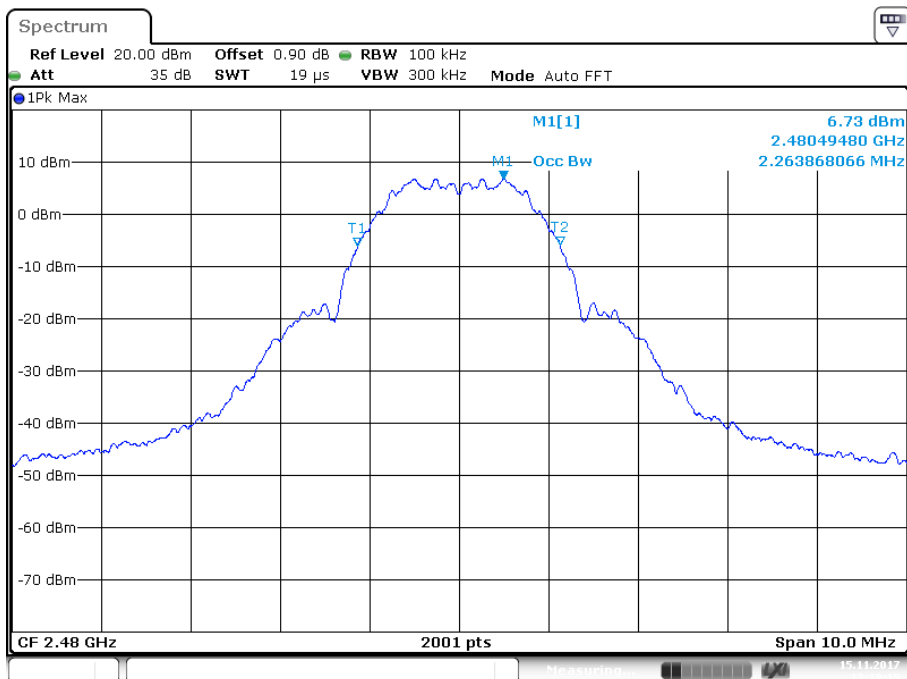
3.5 Test Data

Channel	6dB Bandwidth (MHz)	Occupied Bandwidth (99%) (MHz)
11	1.689	2.259
18	1.684	2.259
26	1.689	2.264

Sample Plots



Date: 15.NOV.2017 13:18:50



Date: 15.NOV.2017 13:19:15

4 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 power measurements were recorded using the peak power procedures from ANSI C63.10: 2013 clause 11.9 and KDB 558074 D01 Measurement Guidance v04.

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

4.3 Test Site

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

Environmental Conditions

Temperature: 23.2 °C
Relative Humidity: 34.5 %

4.4 Test Equipment

Test End Date: 15-Nov-2017

Tester: JOP

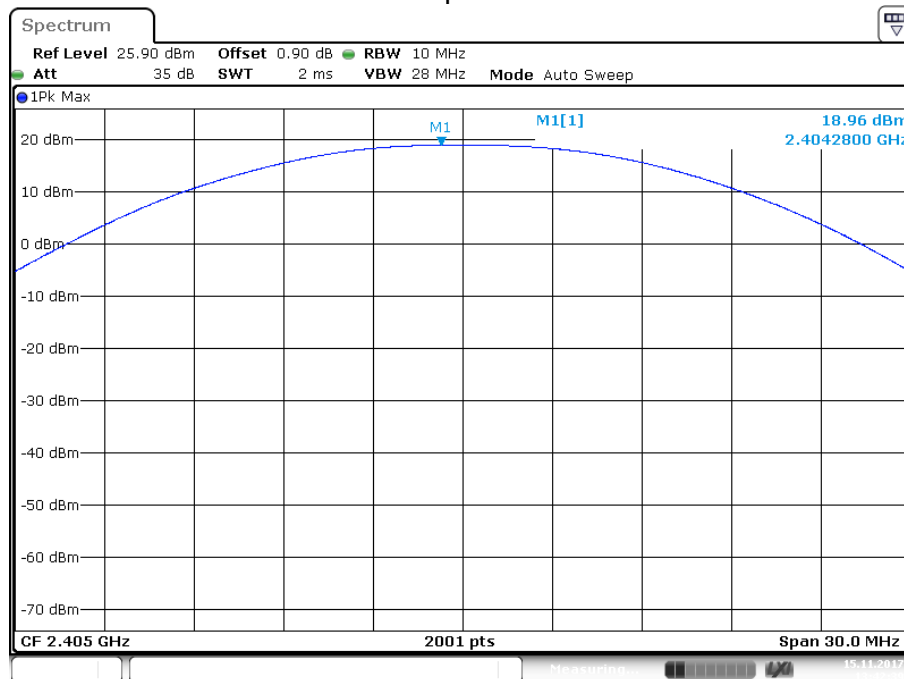
Equipment	Model	Manufacturer	Asset Number	Cal Due Date
SIGNAL ANALYZER	FSV30	ROHDE & SCHWARZ	B085749	1-Nov-2019
RF CABLE	SF102	HUBER & SUHNER	B079823	26-Jul-2018

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

4.5 Test Data

Channel	Frequency (MHz)	Peak Power (dBm)	Limit (30dBm)	Margin (dB)
11	2405	18.96	30	-11.04
18	2440	18.04	30	-11.96
25	2475	18.71	30	-11.29
26	2480	10.76	30	-19.24

Sample Plot



Date: 15.NOV.2017 13:42:40

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 peak PSD procedures from ANSI C63.10: 2013 clause 11.10 and KDB 558074 D01 Measurement Guidance v04.

Limit

The limit is 8 dBm.

5.3 Test Site

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

Environmental Conditions

Temperature: 23.2 °C

Relative Humidity: 34.5 %

5.4 Test Equipment

Test End Date: 15-Nov-2017

Tester: JOP

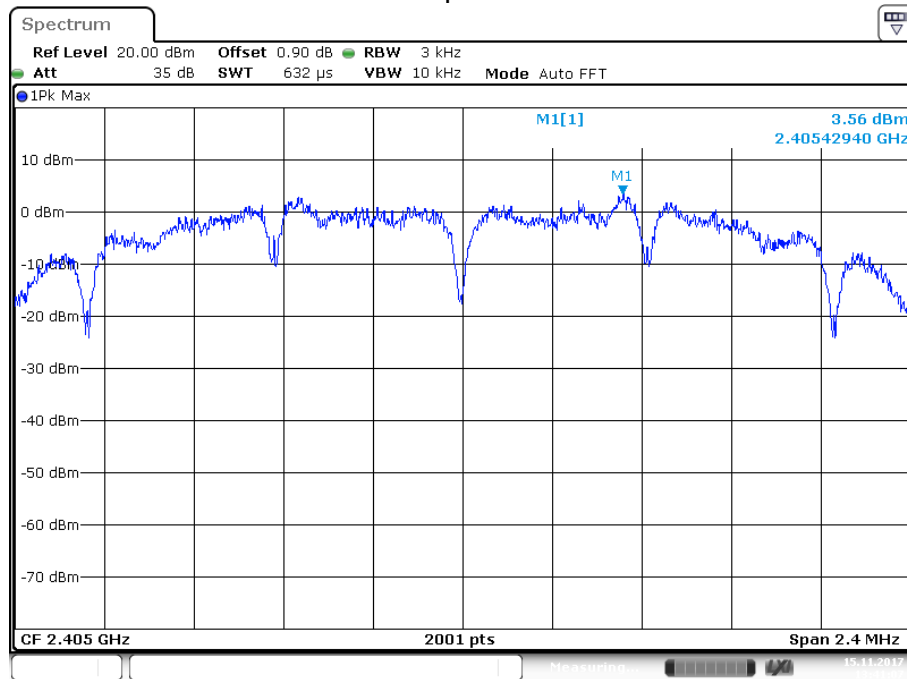
Equipment	Model	Manufacturer	Asset Number	Cal Due Date
SIGNAL ANALYZER	FSV30	ROHDE & SCHWARZ	B085749	1-Nov-2019
RF CABLE	SF102	HUBER & SUHNER	B079823	26-Jul-2018

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

5.5 Test Data

Channel	Frequency (MHz)	Peak PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
11	2405	3.56	8	-4.44
18	2440	2.5	8	-5.5
25	2475	3.14	8	-4.86
26	2480	-4.65	8	-12.65

Sample Plot



Date: 15.NOV.2017 13:41:07

6 Conducted Spurious Emissions

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

Spurious emissions in non-restricted frequency bands were recorded using the methods defined in ANSI C63.10: 2013 clause 11.11 and KDB 558074 D01 Measurement Guidance v04.

Lowest, middle, and highest channels were investigated. Only the worst-case (lowest data rate) for each modulation was reported. Antenna Port 2 yielded the higher output power levels and was used for conducted spurious measurements. The maximum target power was used (20dBm).

Because the maximum conducted peak output power was used to determine compliance with the output power limits, the limit is 20 dB below the maximum in-band peak PSD level in 100 kHz.

6.3 Test Site

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

Environmental Conditions

Temperature: 23.2 °C

Relative Humidity: 34.5 %

6.4 Test Equipment

Test End Date: 15-Nov-2017

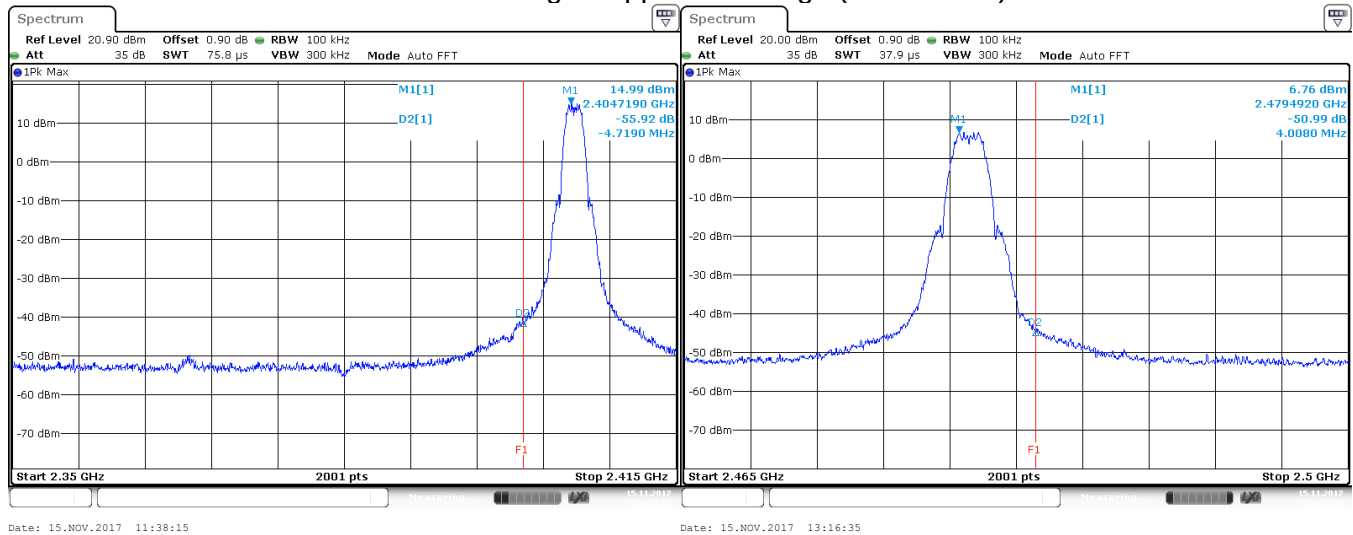
Tester: JOP

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
SIGNAL ANALYZER	FSV30	ROHDE & SCHWARZ	B085749	1-Nov-2019
RF CABLE	SF102	HUBER & SUHNER	B079823	26-Jul-2018

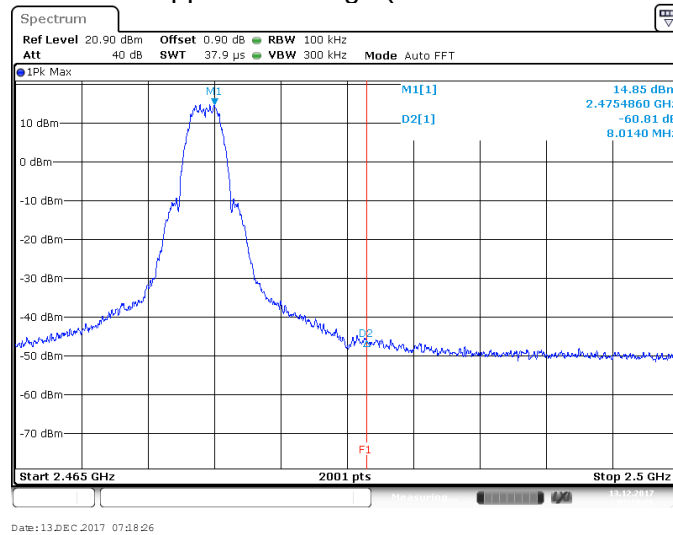
Note: The equipment calibration period is 1 year except for the FSV which is on a 2-year calibration cycle.

6.5 Test Data – DTS Bandedge

Lower band edge / Upper band edge (Channel 26)

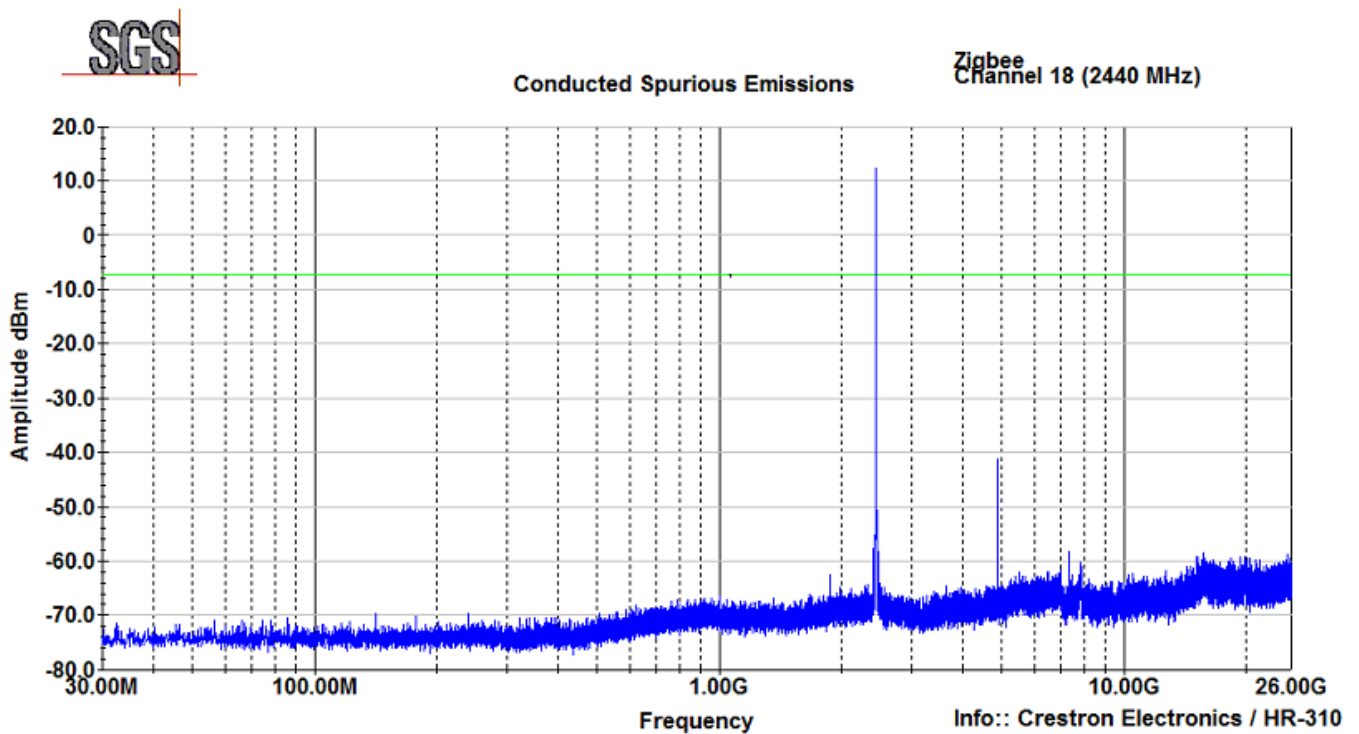
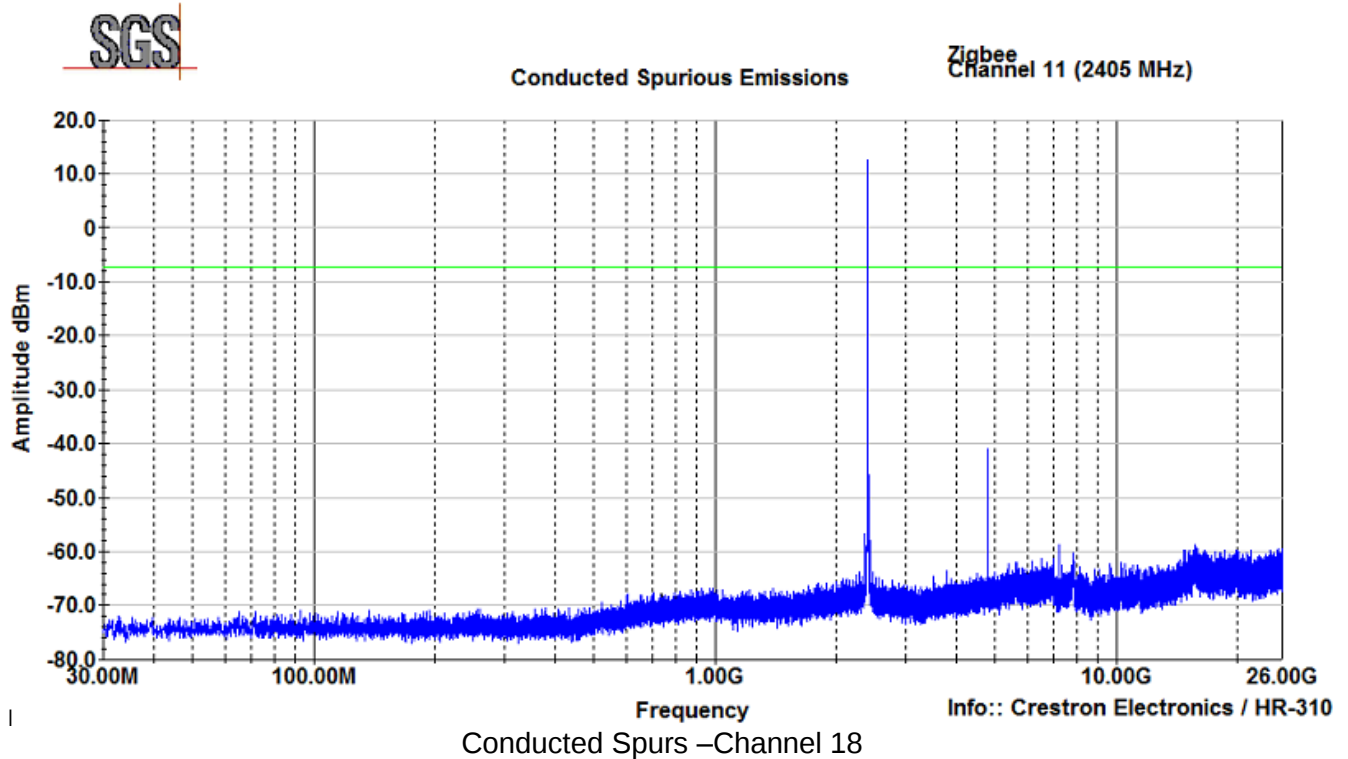


Upper band edge (Channel 25)

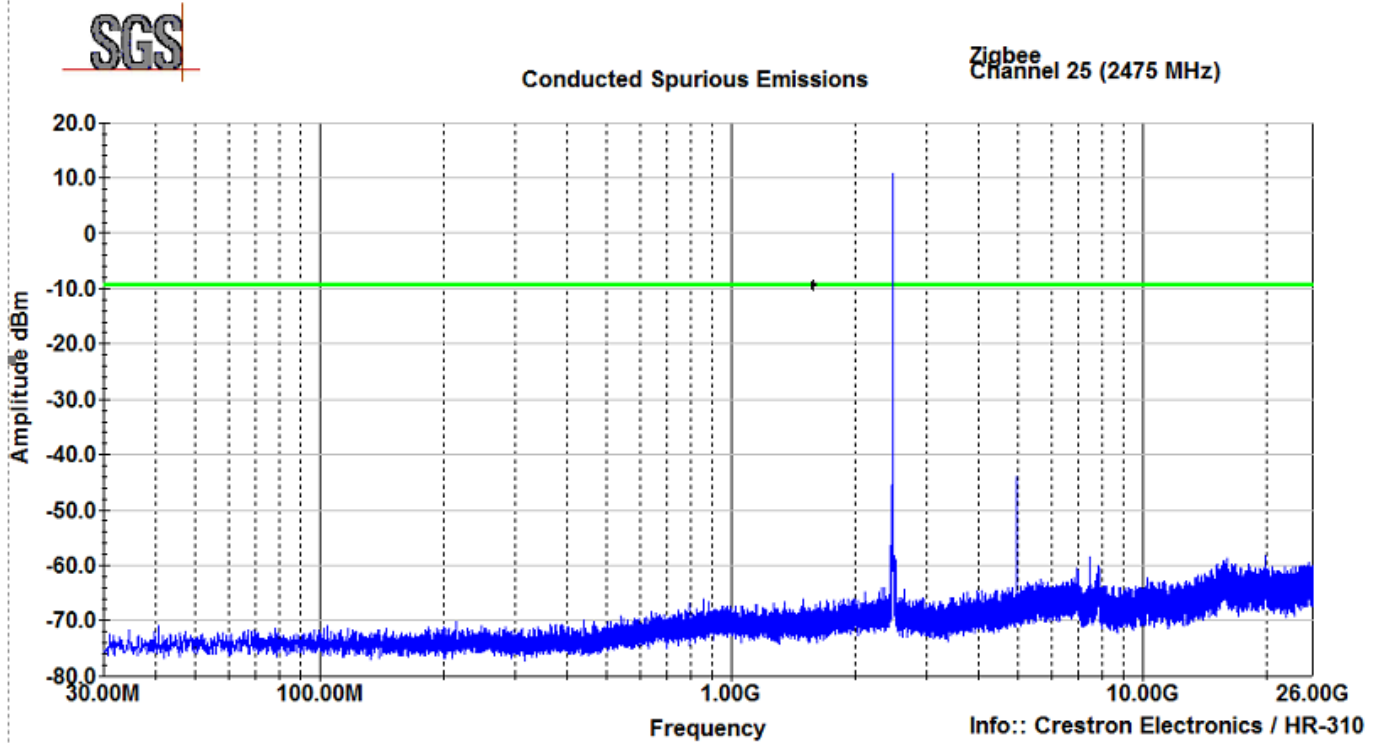


6.6 Test Data – Conducted Spurious Emissions

Conducted Spurs –Channel 11



Conducted Spurs –Channel 25



7 Field Strength of Spurious Radiation

7.1 Test Result

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

7.2 Test Method

Radiated emission measurements were performed with the chip antennas installed as intended. The measurement methods defined in ANSI C63.4: 2014 were used.

Lowest, middle, and highest channels were investigated. Because the power level at channel 26 was significantly reduced compared to other channels, channel 25 was used for the upper channel spurious emissions.

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 3 meters
- 1 to 18 GHz - The EUT to measurement antenna distance was 3 meters
- 18 to 26 GHz - The EUT to measurement antenna distance was 1 meter

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: 24.4 °C

Relative Humidity: 49.5 %

7.4 Test Equipment

Test End Date: 30-Nov-2017

Tester: JOP

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
EMI TEST RECEIVER	ESU40	ROHDE & SCHWARZ	B079629	25-Apr-2018
EMI TEST RECEIVER	ESU8	ROHDE & SCHWARZ	B085759	25-Jul-2018
ANTENNA, BILOG	JB6	SUNOL	B079689	16-Oct-2018
RF CABLE	SF106	HUBER & SUHNER	B079712	24-Jul-2018
RF CABLE	NFS-290-78.7-NFS	FLORIDA RF LABS	B095019	24-Jul-2018
RF CABLE	UC-N-MM-78	MAURY MICROWAVE	17017	25-Jul-2018
RF CABLE	SUCOFLEX 100	HUBER & SUHNER	B108523	24-Jul-2018
LOW NOISE AMPLIFIER	TS-PR18	ROHDE & SCHWARZ	B094463	22-Feb-2018
ANTENNA, DRG HORN (MEDIUM)	3117	ETS LINDGREN	B079691	27-Jul-2018
RF CABLE	104PE	HUBER & SUHNER	B079793	24-Jul-2018
LOW NOISE AMPLIFIER	TS-PR18	ROHDE & SCHWARZ	15003	28-Jul-2018
FILTER, HIGH PASS (>2800MHZ)	HPM50111	MICRO-TRONICS	B085747	27-Jul-2018
HORN(SMALL)	LB-180400-20-C-KF	A-INFO	15007	21-Mar-2018
RF CABLE	SF102	HUBER & SUHNER	B079822	27-Jul-2018
RF CABLE	SF102	HUBER & SUHNER	B079824	26-Jul-2018
LOW NOISE AMPLIFIER	NSP1840-HG	MITEQ	B087572	28-Jul-2018

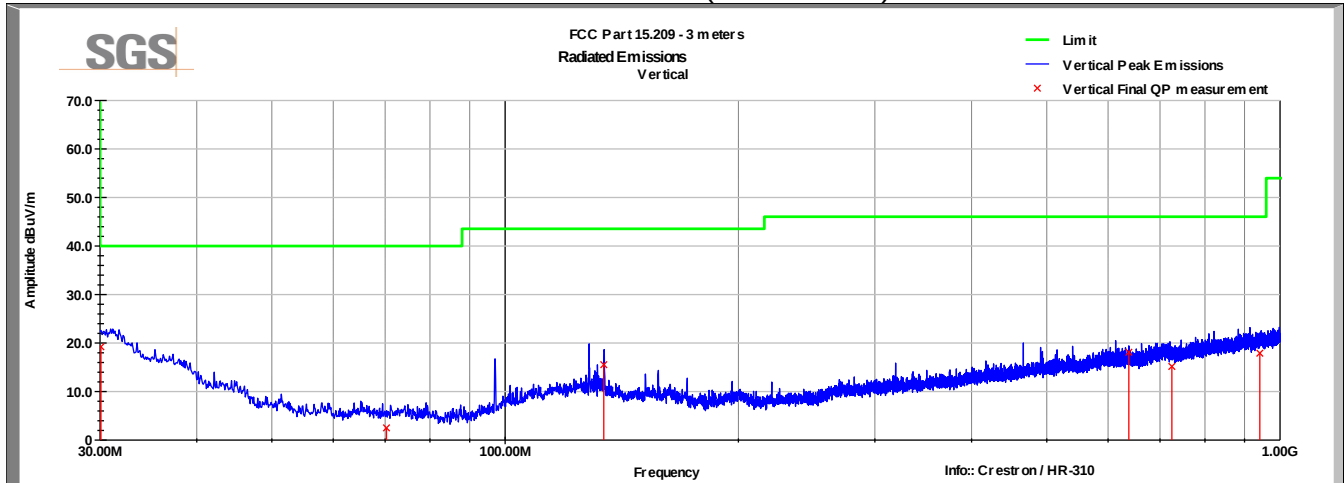
Note: The equipment calibration period is 1 year.

7.5 Test Data – Peak Plots

No emissions detected below 30MHz

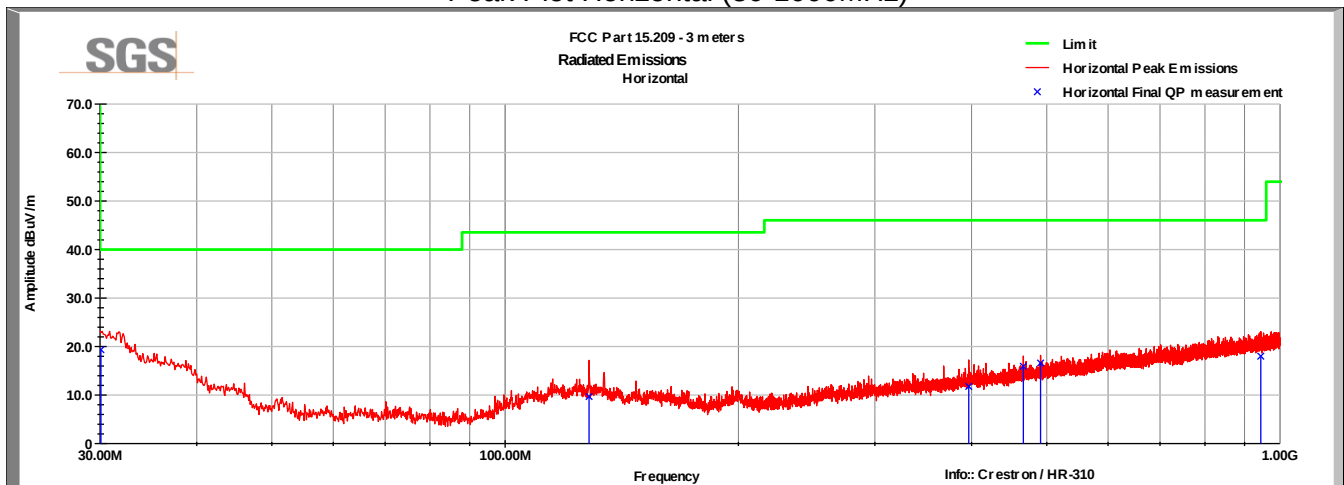
Low Channel (Channel 11, 2405MHz)

Peak Plot Vertical (30-1000MHz)

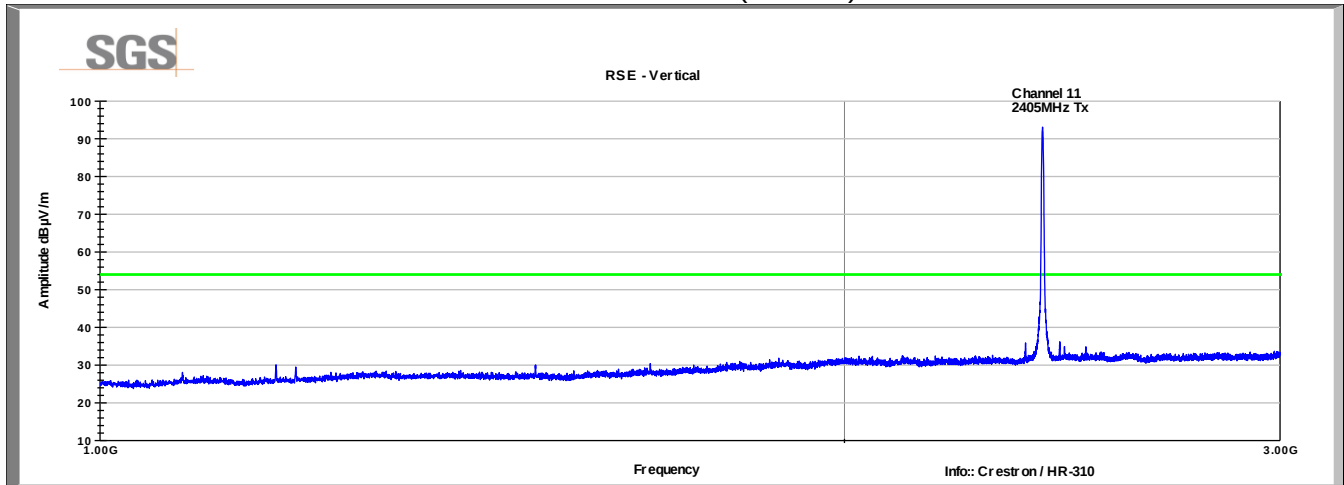


Low Channel (Channel 11, 2405MHz)

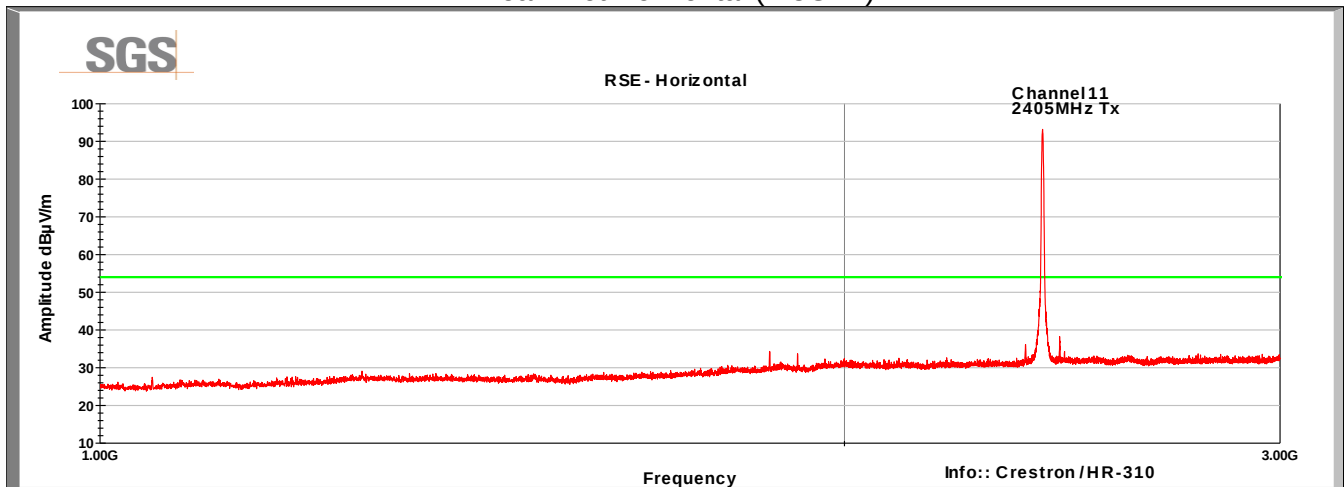
Peak Plot Horizontal (30-1000MHz)



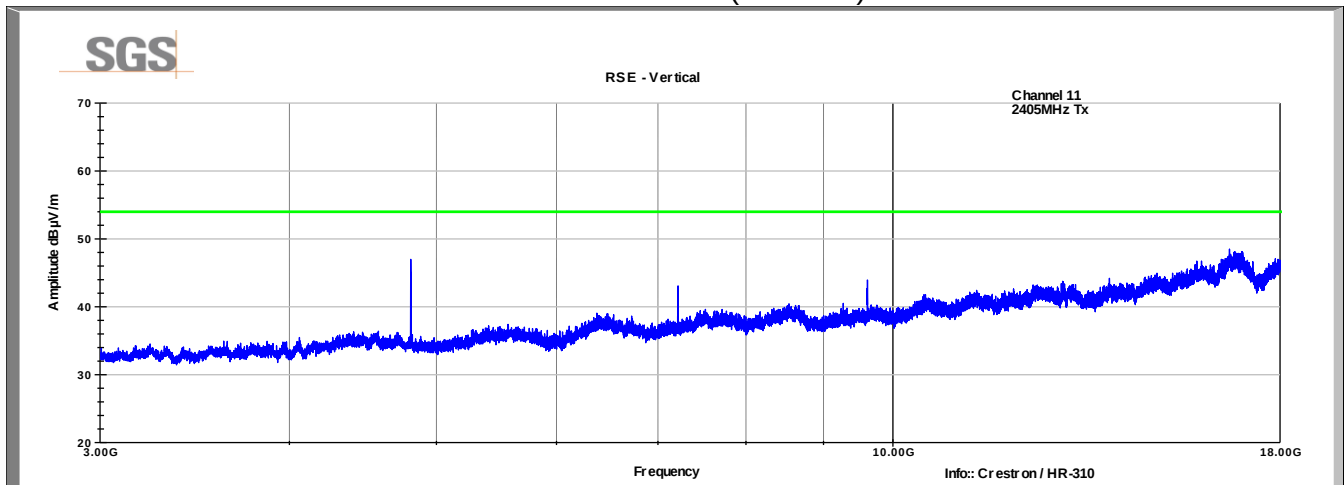
Low Channel (Channel 11, 2405MHz) Peak Plot Vertical (1-3GHz)



Low Channel (Channel 11, 2405MHz) Peak Plot Horizontal (1-3GHz)

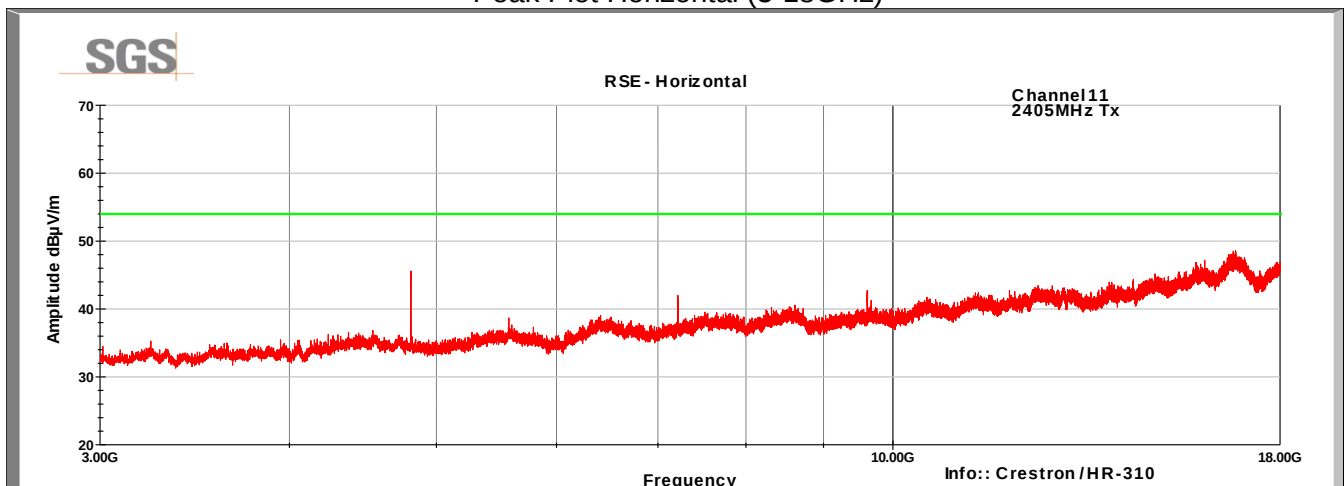


Low Channel (Channel 11, 2405MHz)
Peak Plot Vertical (3-18GHz)



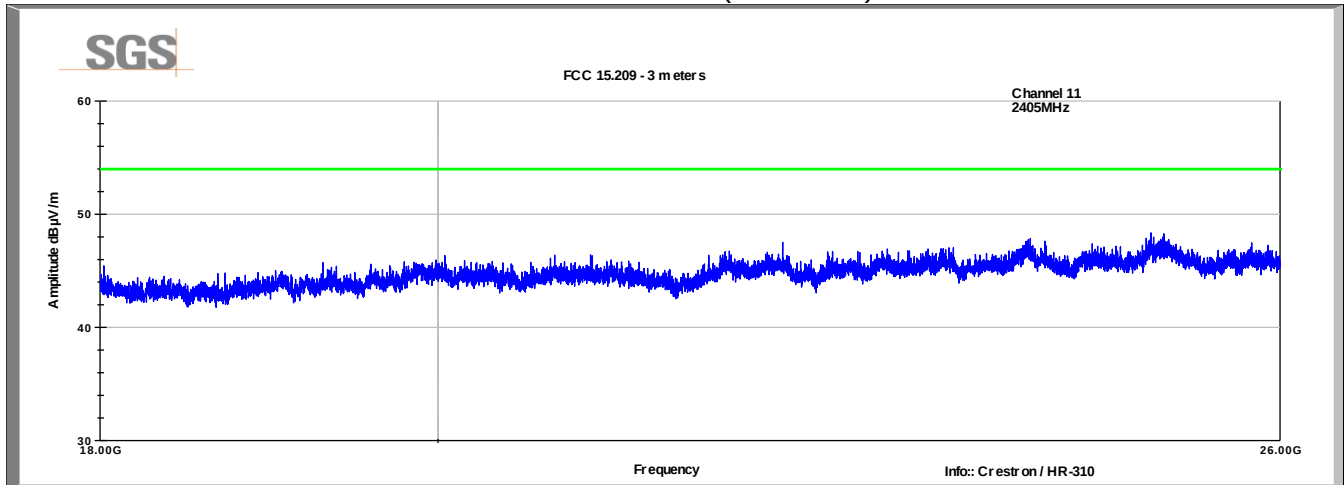
Worst-case spur: 46.8dBµV/m (Peak) @ 4210MHz (7.2dB Margin)

Low Channel (Channel 11, 2405MHz)
Peak Plot Horizontal (3-18GHz)

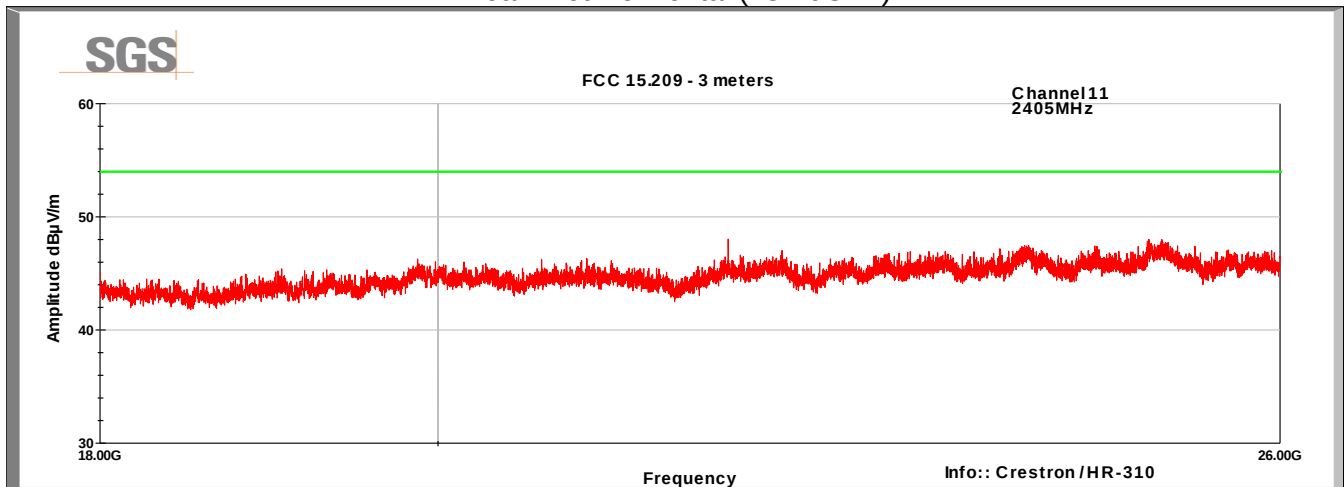


Worst-case spur: 45.5dBµV/m (Peak) @ 4210MHz (8.5dB Margin)

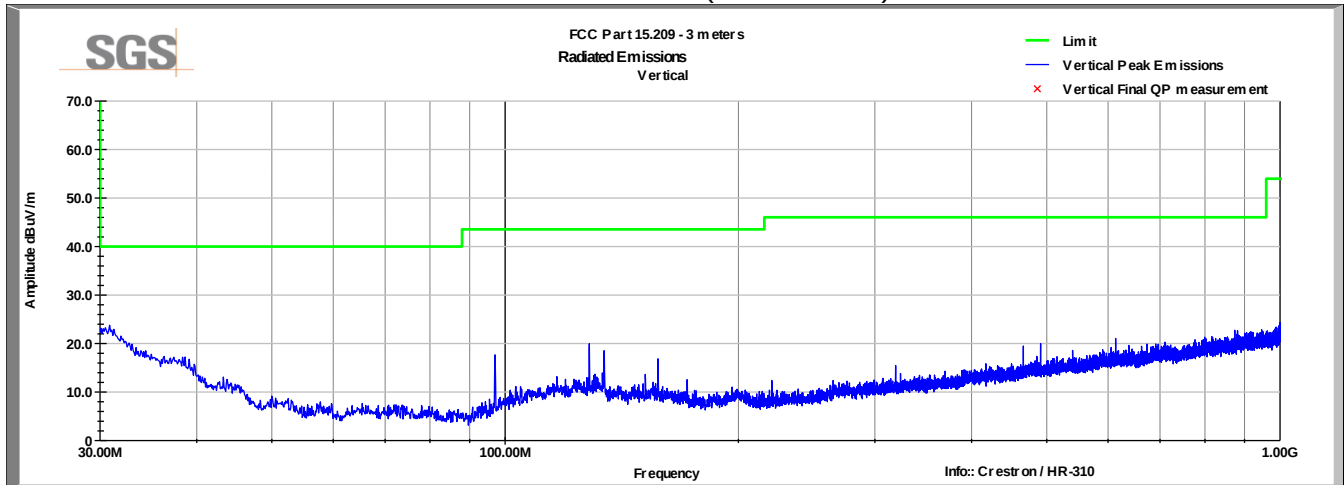
Low Channel (Channel 11, 2405MHz)
Peak Plot Vertical (18-26GHz)



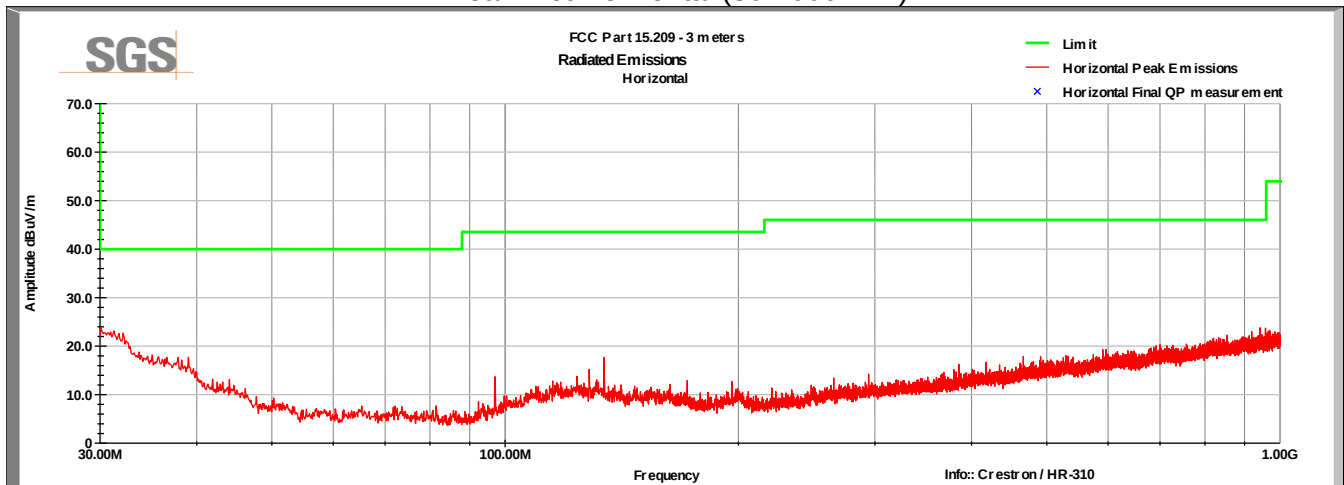
Low Channel (Channel 11, 2405MHz)
Peak Plot Horizontal (18-26GHz)



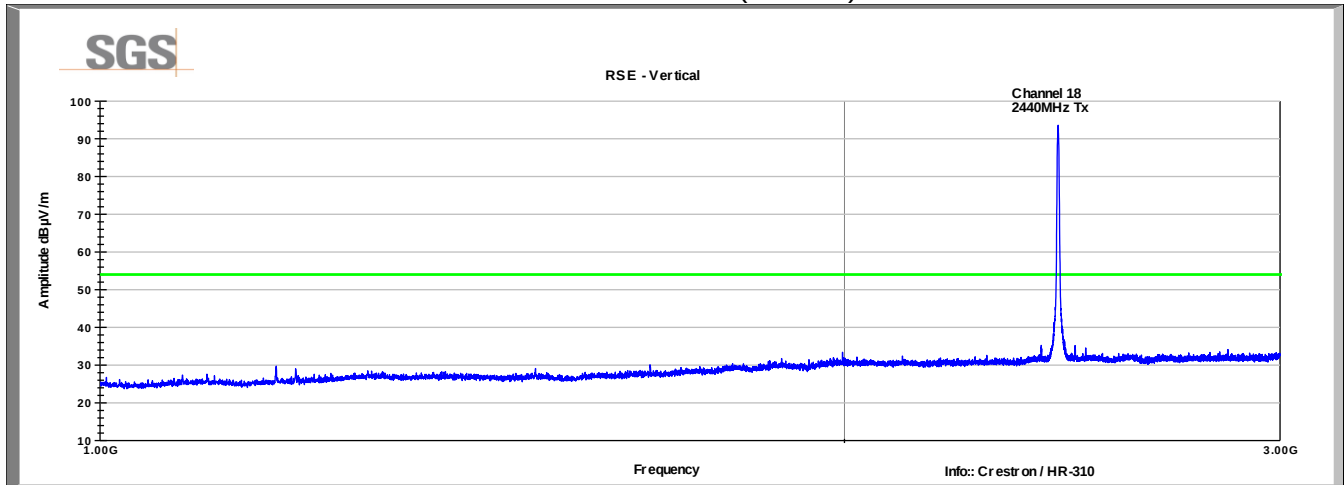
Mid Channel (Channel 18, 2440MHz) Peak Plot Vertical (30-1000MHz)



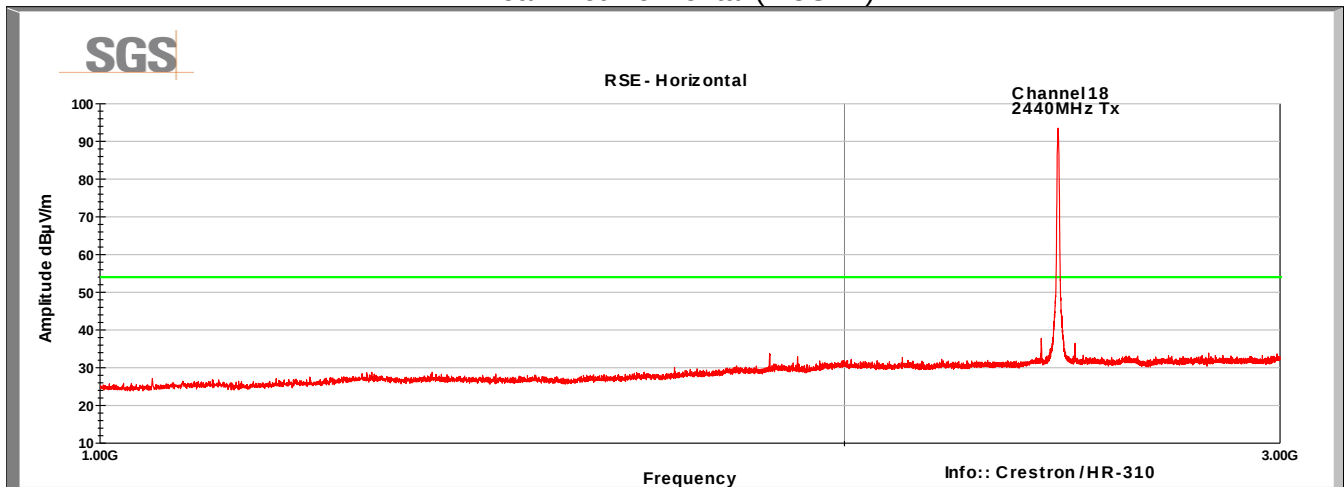
Mid Channel (Channel 18, 2440MHz) Peak Plot Horizontal (30-1000MHz)



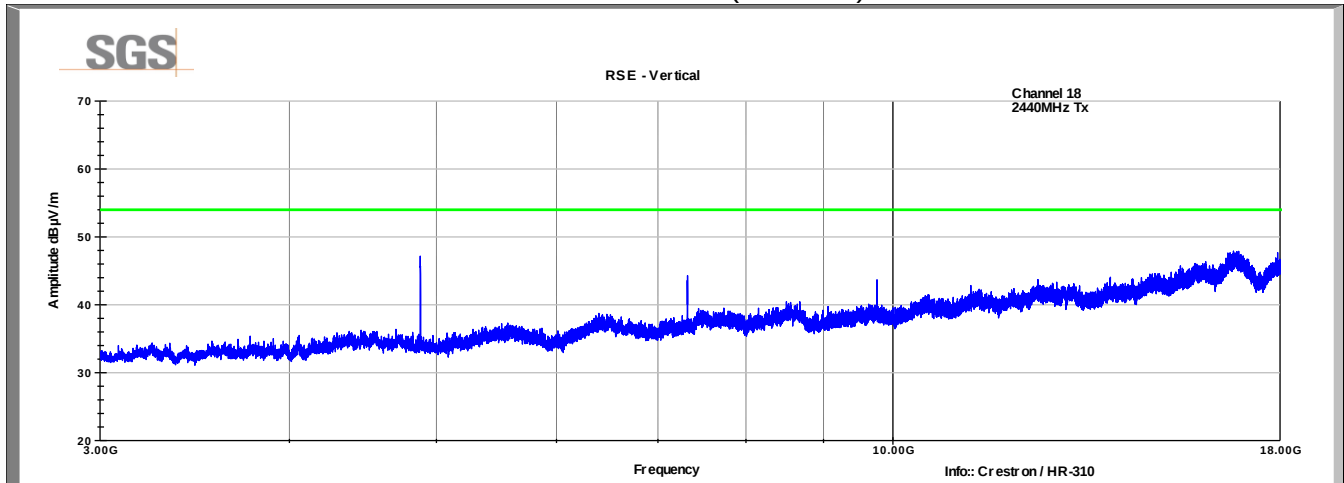
Mid Channel (Channel 18, 2440MHz)
Peak Plot Vertical (1-3GHz)



Mid Channel (Channel 18, 2440MHz)
Peak Plot Horizontal (1-3GHz)

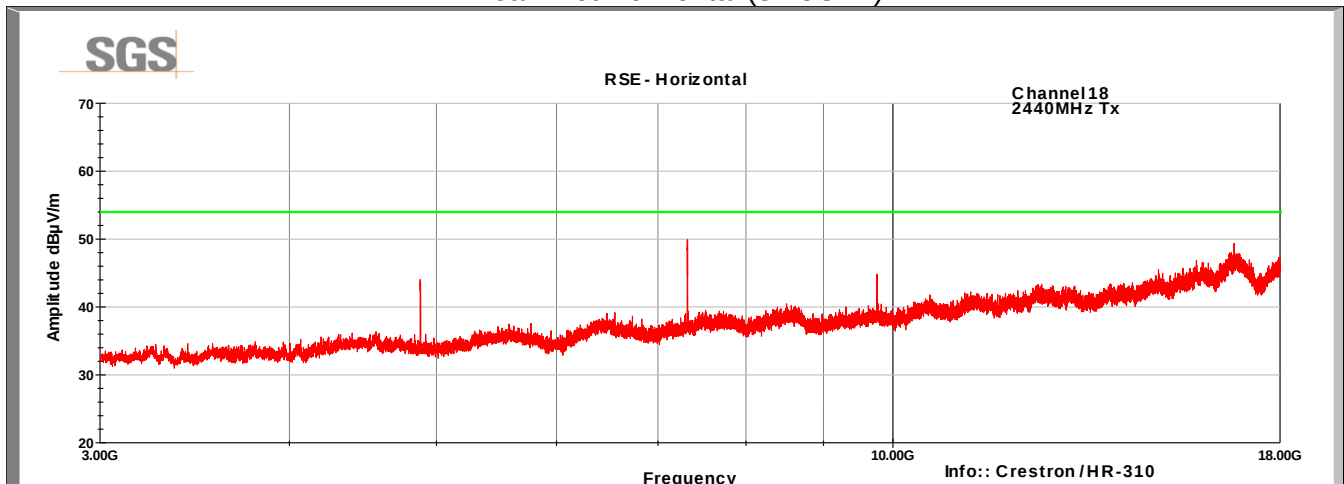


Mid Channel (Channel 18, 2440MHz)
Peak Plot Vertical (3-18GHz)



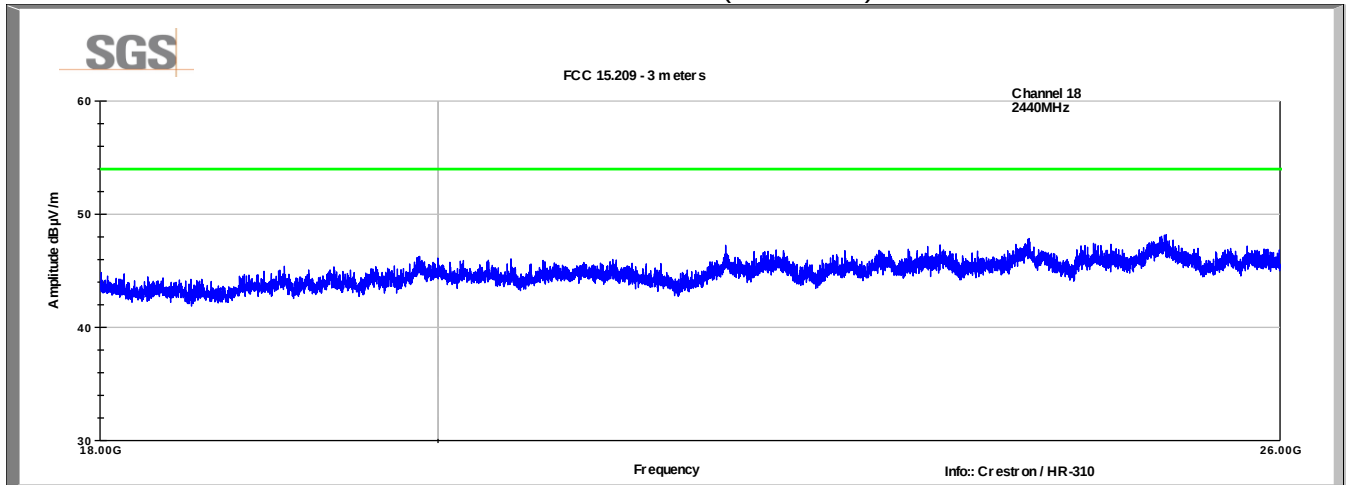
Worst-case spur: 47.2dBµV/m (Peak) @ 4280MHz (6.8dB Margin)

Mid Channel (Channel 18, 2440MHz)
Peak Plot Horizontal (3-18GHz)

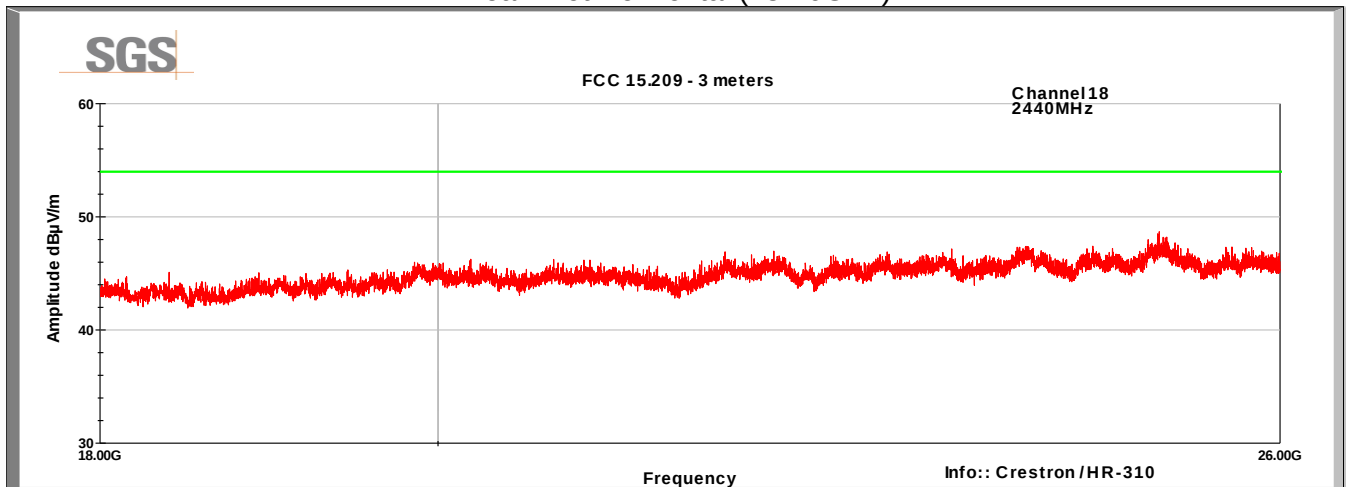


Worst-case spur: 49.9dBµV/m (Peak) @ 7320MHz (4.1dB Margin)

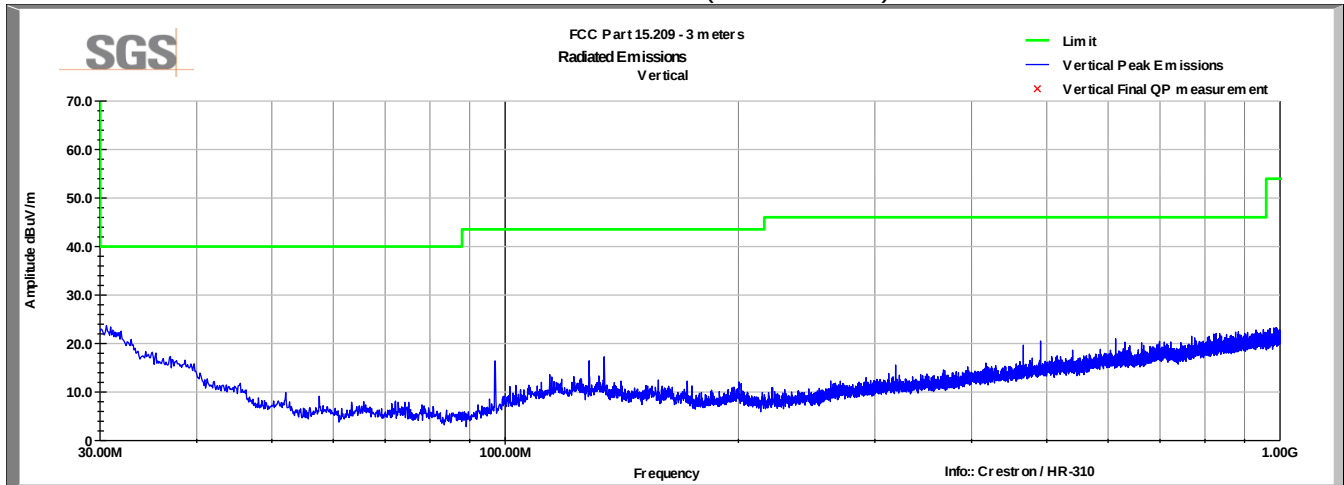
Mid Channel (Channel 18, 2440MHz) Peak Plot Vertical (18-26GHz)



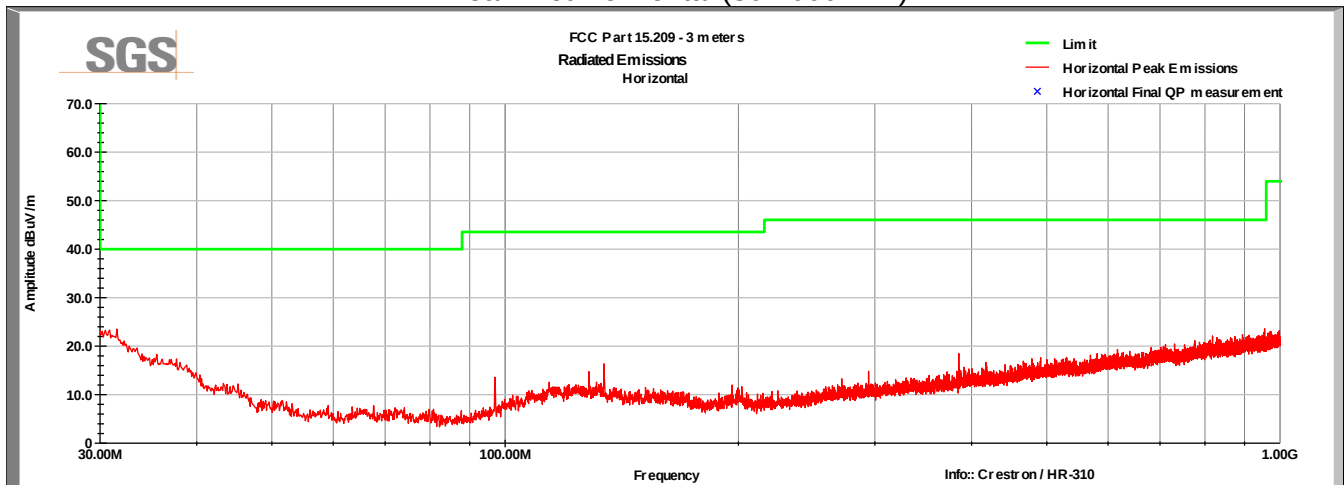
Mid Channel (Channel 18, 2440MHz) Peak Plot Horizontal (18-26GHz)



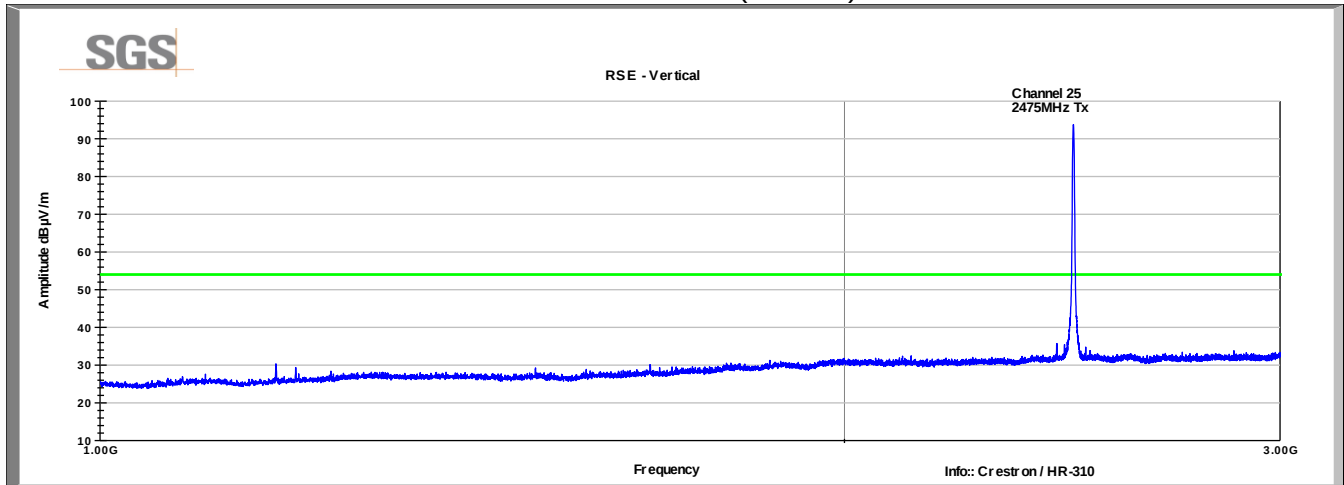
High Channel (Channel 25, 2475MHz) Peak Plot Vertical (30-1000MHz)



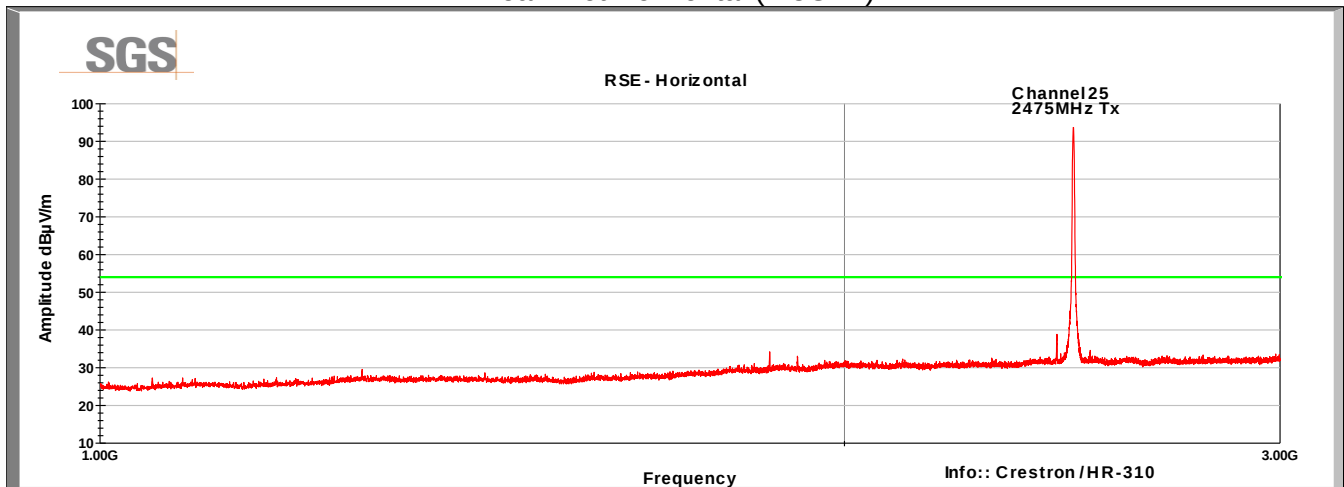
High Channel (Channel 25, 2475MHz) Peak Plot Horizontal (30-1000MHz)



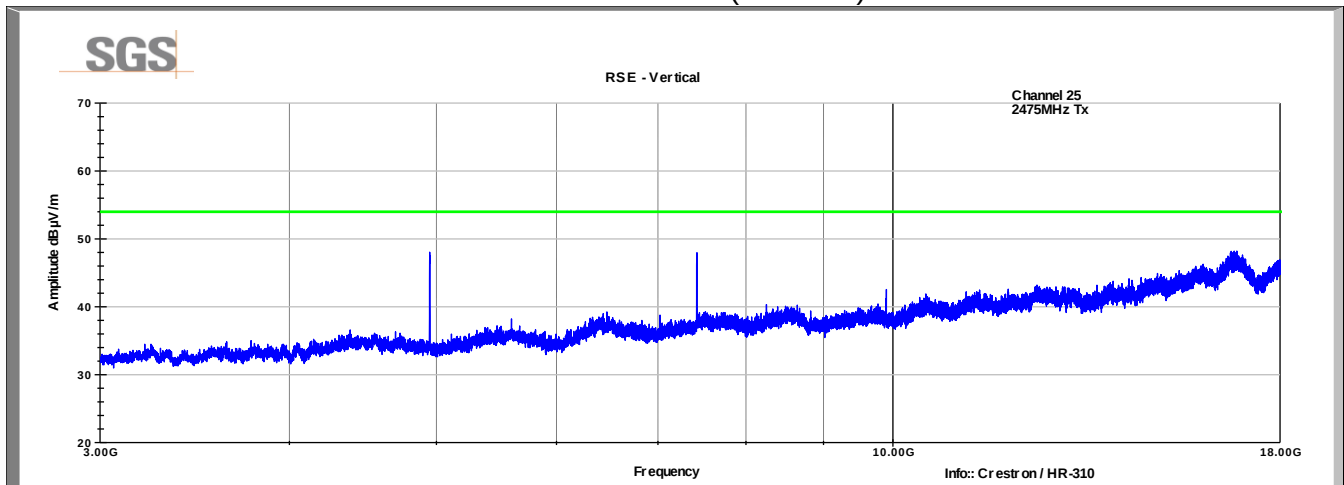
High Channel (Channel 25, 2475MHz)
Peak Plot Vertical (1-3GHz)



High Channel (Channel 25, 2475MHz)
Peak Plot Horizontal (1-3GHz)

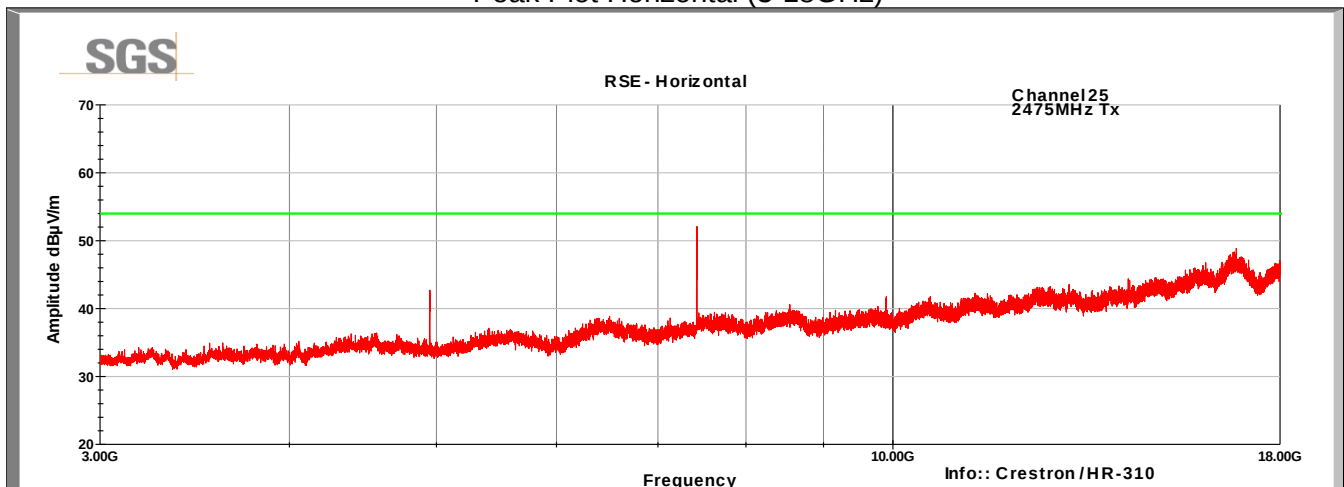


High Channel (Channel 25, 2475MHz) Peak Plot Vertical (3-18GHz)



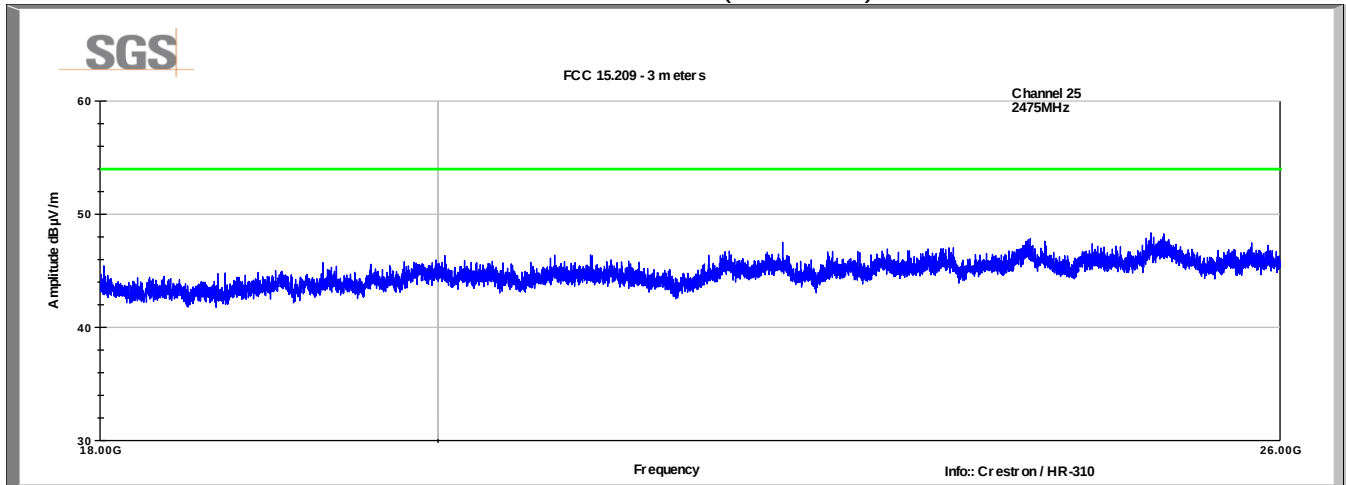
Worst-case spurs: 48.0dBµV/m (Peak) @ 4950MHz (6.0dB Margin)
48.0dBµV/m (Peak) @ 7425MHz (6.0dB Margin)

High Channel (Channel 25, 2475MHz) Peak Plot Horizontal (3-18GHz)

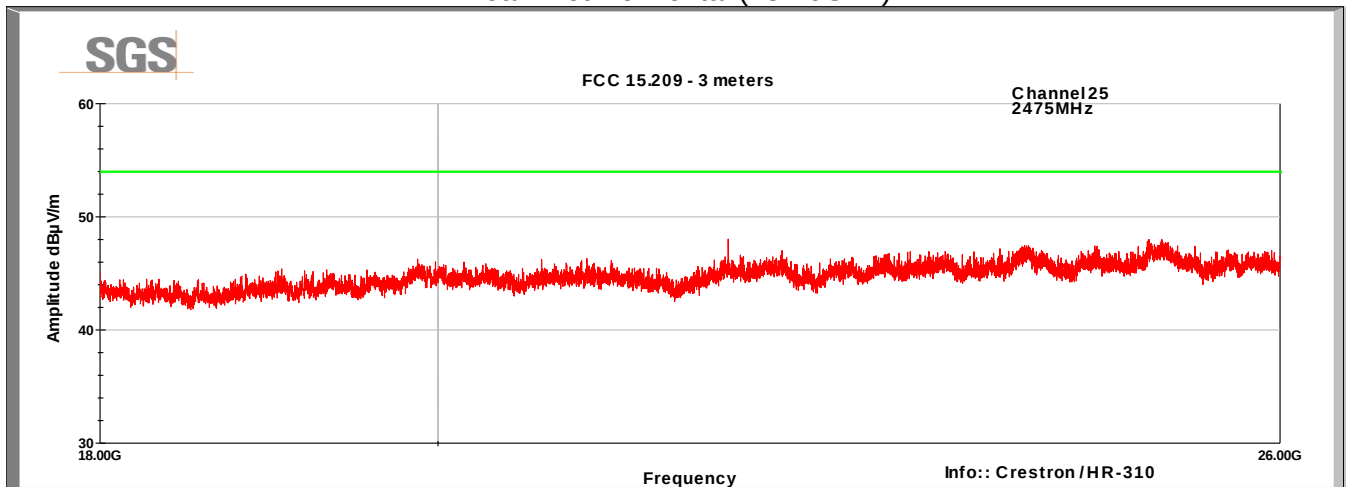


Worst-case spur: 52.0dBµV/m (Peak) @ 7425MHz (2.0dB Margin)

High Channel (Channel 25, 2475MHz) Peak Plot Vertical (18-26GHz)



High Channel (Channel 25, 2475MHz) Peak Plot Horizontal (18-26GHz)



7.6 Test Data – Tabular Data (<1GHz)

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)
30.09	28.8	V	26.0	0.0	21.7	0.4	31.7	19.2	40.0	-20.8
70.28	26.9	V	227.0	325.0	8.1	0.6	33.1	2.5	40.0	-37.5
134.06	34.8	V	347.0	175.0	13.5	0.8	33.7	15.5	43.5	-28.0
638.18	29.1	V	254.0	325.0	20.3	1.9	33.2	18.1	46.0	-27.9
725.11	25.2	V	88.0	175.0	21.2	2.0	33.2	15.2	46.0	-30.8
941.75	25.2	V	188.0	175.0	23.6	2.3	33.2	17.9	46.0	-28.1
30.09	28.9	H	91.0	0.0	21.7	0.4	31.7	19.4	40.0	-20.6
128.34	28.7	H	145.0	175.0	13.8	0.8	33.7	9.7	43.5	-33.8
396.62	27.4	H	283.0	325.0	16.3	1.5	33.4	11.8	46.0	-34.3
466.36	29.9	H	279.0	325.0	17.7	1.6	33.3	15.9	46.0	-30.1
490.91	30.2	H	37.0	175.0	18.1	1.6	33.3	16.6	46.0	-29.4
944.57	25.3	H	267.0	325.0	23.6	2.3	33.1	18.0	46.0	-28.0
QP Value = Level + AF + CL - Amp										
Margin = QP Value - Limit										

8 Radiated Emissions at Band Edge / Restricted Band

8.1 Test Result

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

8.2 Test Method

Peak and average field strength measurements were performed at the restricted band edges of 2390MHz and 2483.5MHz. Measurements were made using the conducted methods defined in FCC KDB publication 558074 D01 DTS Meas Guidance v04.

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 = 0.9 dB	Cable Loss
DC = 0 dB (100%)	Duty Cycle Correction Factor
AG = 2.0 dB	Antenna Gain

$$\text{Offset} = -8.8 \text{ dB}$$

8.3 Test Site

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

Environmental Conditions

Temperature:	23.2 °C
Relative Humidity:	34.5 %

8.4 Test Equipment

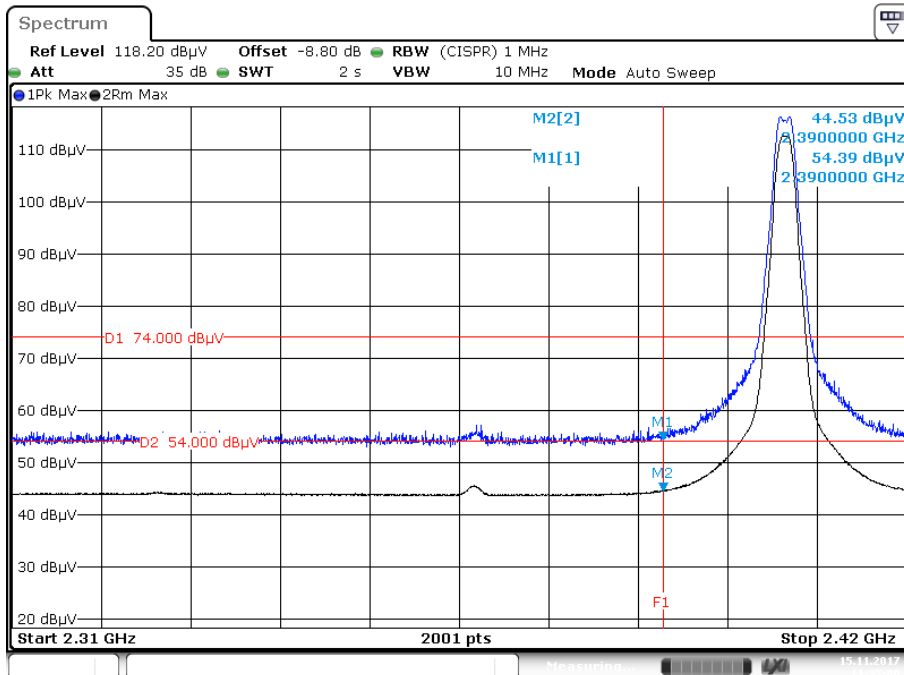
Test End Date: 15-Nov-2017

Tester: JOP

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
SIGNAL ANALYZER	FSV30	ROHDE & SCHWARZ	B085749	1-Nov-2019
RF CABLE	SF102	HUBER & SUHNER	B079823	26-Jul-2018

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

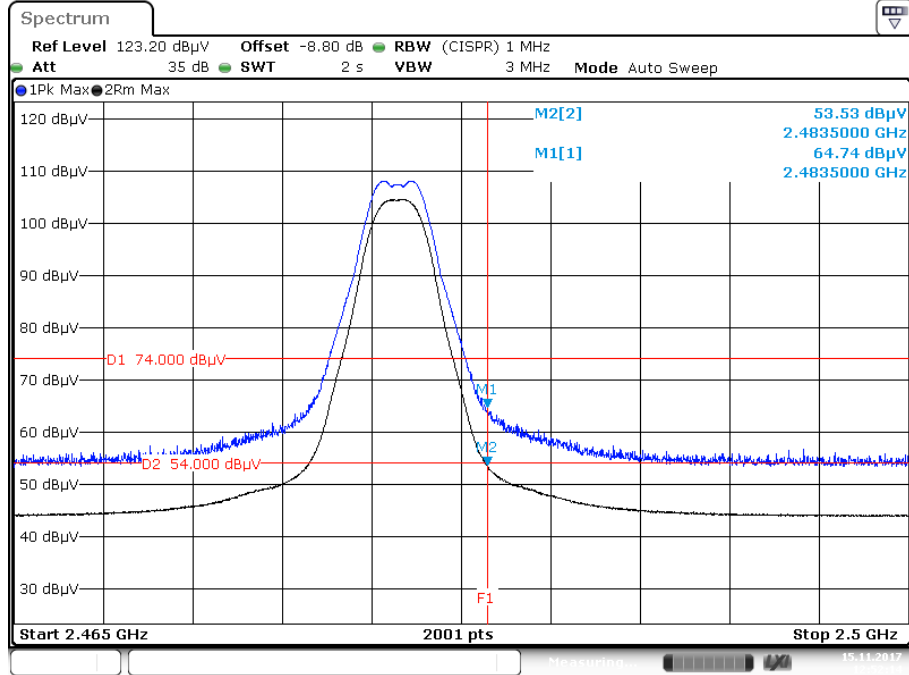
Test Data Channel 11



Date: 15.NOV.2017 11:35:01

Channel	Frequency (MHz)	Reading (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Measuremnt Detector
11	2390	54.39	74	-19.61	Peak
11	2390	44.53	54	-9.47	RMS

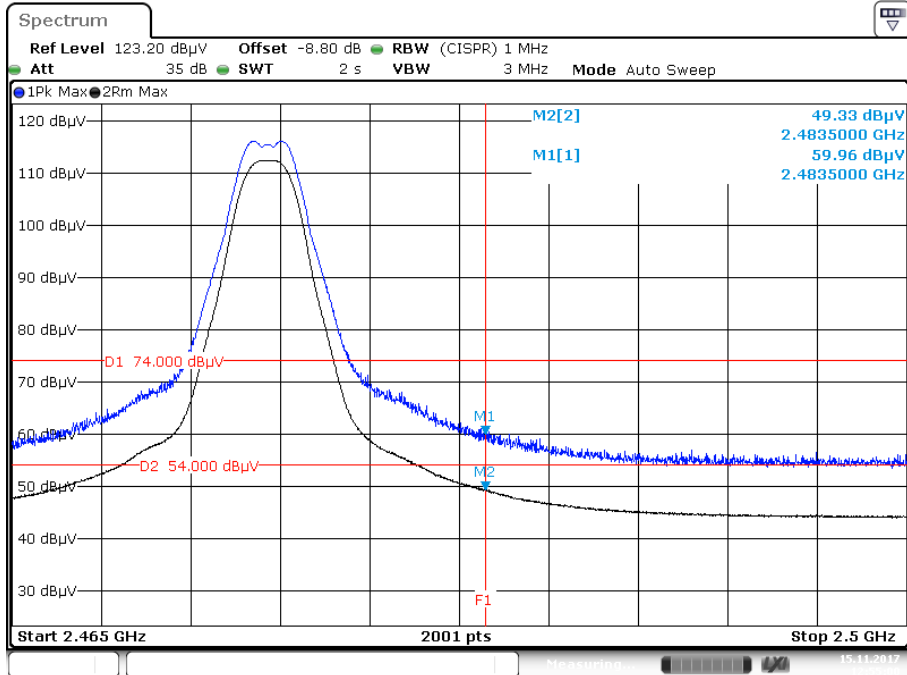
Channel 26



Date: 15.NOV.2017 12:52:15

Channel	Frequency (MHz)	Reading (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Measuremnt Detector
26	2483.5	64.74	74	-9.26	Peak
26	2483.5	53.53	54	-0.47	RMS

Channel 25



Date: 15.NOV.2017 12:55:00

Channel	Frequency (MHz)	Reading (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Measuremnt Detector
25	2483.5	59.96	74	-14.04	Peak
25	2483.5	49.33	54	-4.67	RMS

9 Revision History

Revision Level	Description of changes	Revision Date
0	Initial release	30 November 2017