

7 Field Strength of Spurious Radiation (Restricted 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 low, middle, and high channels.

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 3 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

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

Environmental Conditions	30-1000MHz	1-12.75GHz
Temperature:	22.2 °C	23.5 °C
Relative Humidity:	34.1 %	30.5 %
Atmospheric Pressure:	98.9 kPa	97.9 kPa

7.4 Test Equipment

30-1000MHz

Test End Date: 10-Apr-2023

Tester: EW

Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
ANTENNA, BILOG	JB6	SUNOL	B079690	19-Apr-2022	19-Apr-2024
N to N RF Cable	TR-48-25P	Echelon	22034	23-Jan-2022	23-Jan-2024
RF CABLE	SF106	HUBER & SUHNER	B079713	25-Aug-2022	25-Aug-2023
RF CABLE NM TO NM, 0.01-18GHZ	90-195-157	TELEDYNE STORM MICROWAVE	20121	9-Feb-2023	9-Feb-2024
RF CABLE RIGHT ANGLE NM TO NM, 0.01-18GHZ	90-076-020	TELEDYNE STORM MICROWAVE	20132	13-Mar-2023	13-Mar-2024
LOW NOISE AMPLIFIER	ZKL-2+	MINI-CIRCUITS	B079800	14-Sep-2022	14-Sep-2023
EMI TEST RECEIVER	ESW44	ROHDE & SCHWARZ	22032	24-Nov-2022	24-Nov-2023

Above 1GHz

Test End Date: 4-Apr-2023
13-Apr-2023

Tester: ZH, EW

Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
ANTENNA, DRG HORN (MEDIUM)	3117	ETS LINDGREN	B079699	29-Jul-2022	29-Jul-2024
RF CABLE NM TO NF, 0.01-18GHZ	TR-48-25P	TELEDYNE STORM MICROWAVE	20118	13-Mar-2023	13-Mar-2024
RF CABLE, NM TO NM.	90-195-157	TELEDYNE STORM MICROWAVE	21019	14-Mar-2023	14-Mar-2024
RF CABLE RIGHT ANGLE NM TO NM, 0.01-18GHZ	90-076-020	TELEDYNE STORM MICROWAVE	20132	13-Mar-2023	13-Mar-2024
LOW NOISE AMPLIFIER	TS-PR18	ROHDE & SCHWARZ	B094463	13-Jul-2022	13-Jul-2023
EMI TEST RECEIVER	ESW44	ROHDE & SCHWARZ	22032	24-Nov-2022	24-Nov-2023
FILTER, HIGH PASS, >2800MHZ	HPM50111	MICRO-TRONICS	22017	16-Jun-2022	16-Jun-2023

Software Profile:

"RSE 30-1000 MHz T7 220318" TILE! profile dated 18 March 2022

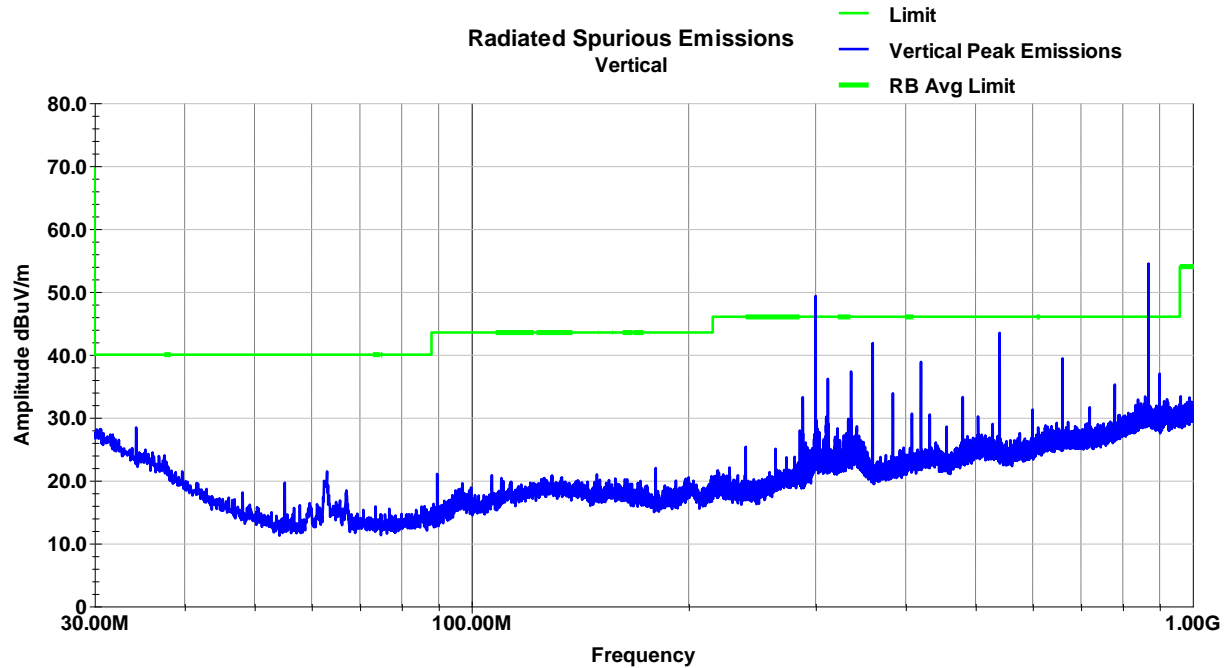
"RSE 1-18 GHz T7 210212" TILE! profile dated 12 February 2021

7.5 Test Data – Peak Plots

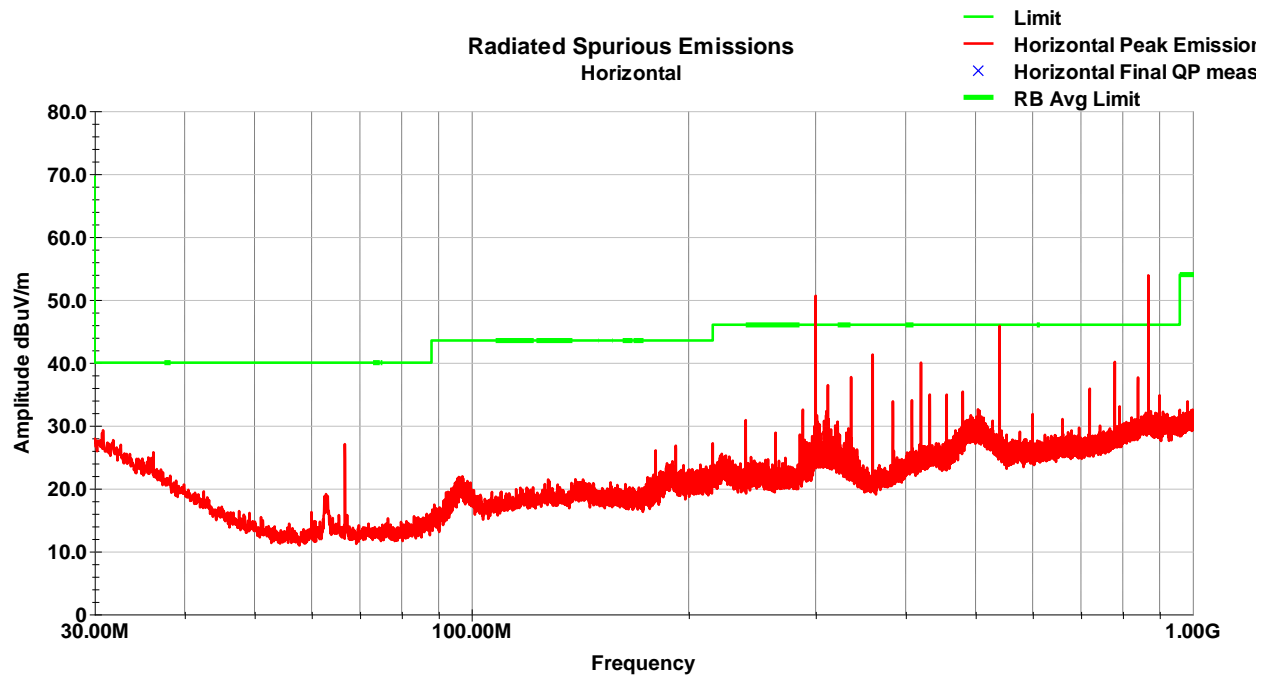
No emissions were detected in the 9kHz to 30MHz frequency range.

In the 30-1000MHz range there was little deviation with respect to axis, modulation or channel (worst case shown).

Vertical Radiated Spurious Emissions Plot – 30-1000MHz (802.11g MCH)

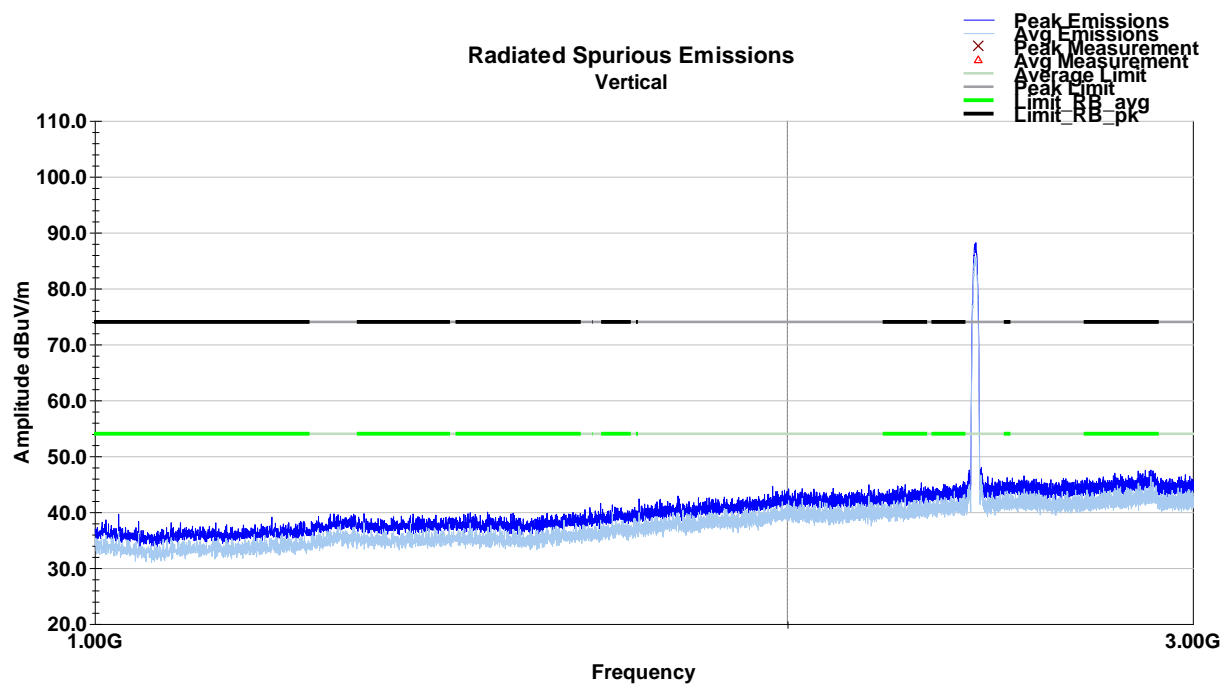


Horizontal Radiated Spurious Emissions Plot – 30-1000MHz (802.11g MCH)

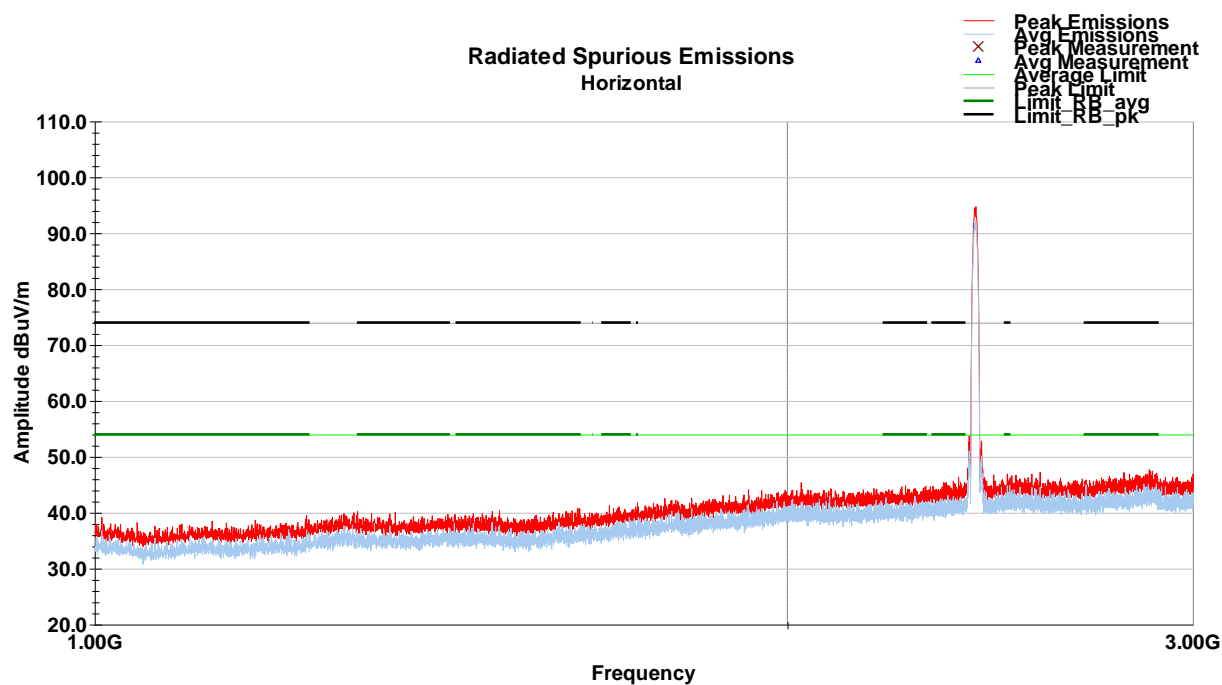


All emissions above were either not in restricted bands or were verified to be non-radio emissions.

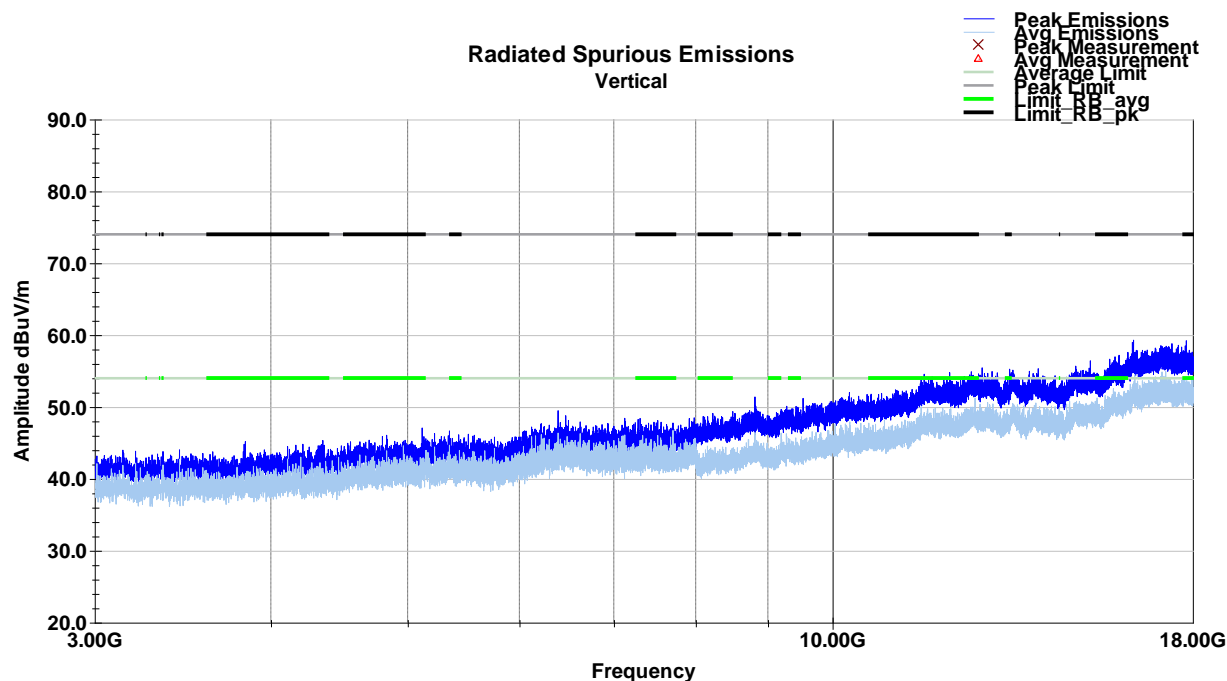
Vertical Radiated Spurious Emissions Plot – 1-3GHz (802.11b LCH)



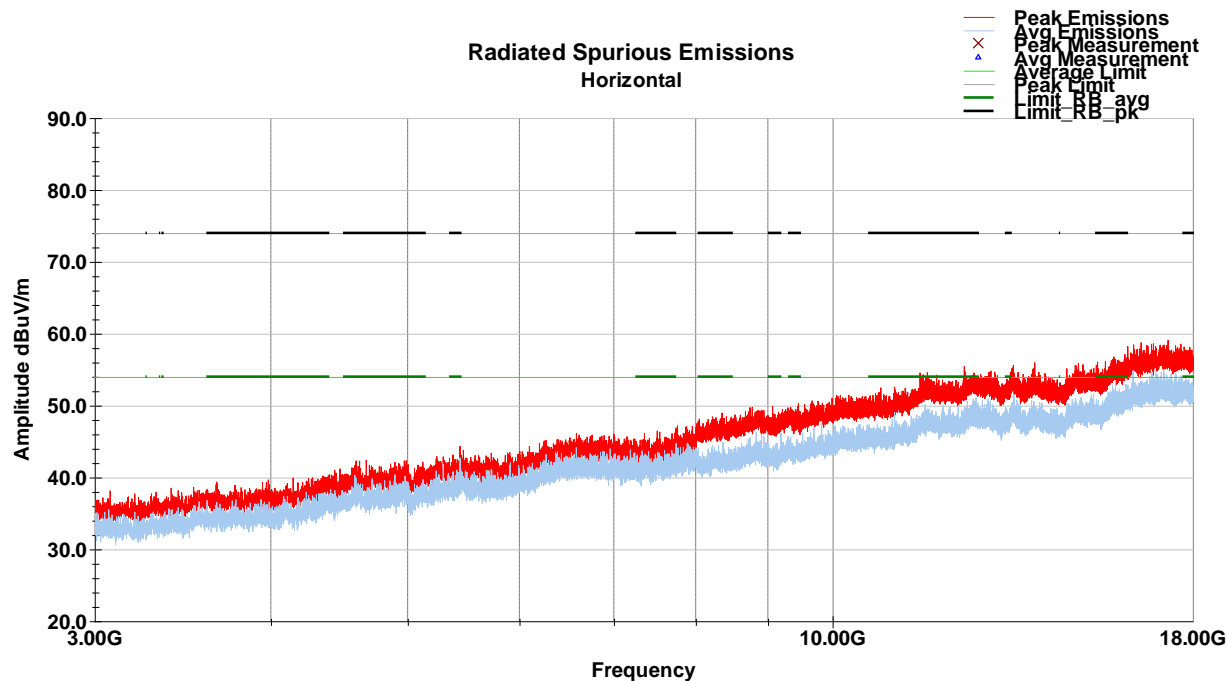
Horizontal Radiated Spurious Emissions Plot – 1-3GHz (802.11b LCH)



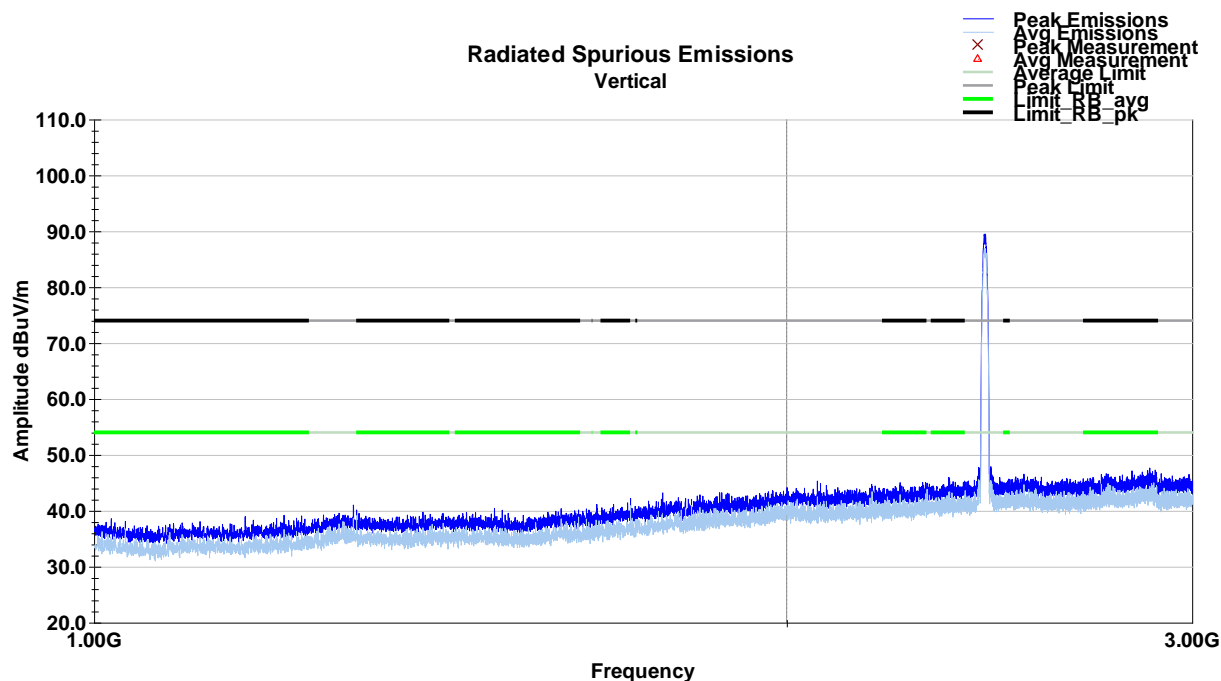
Vertical Radiated Spurious Emissions Plot – 3-18GHz (802.11b LCH)



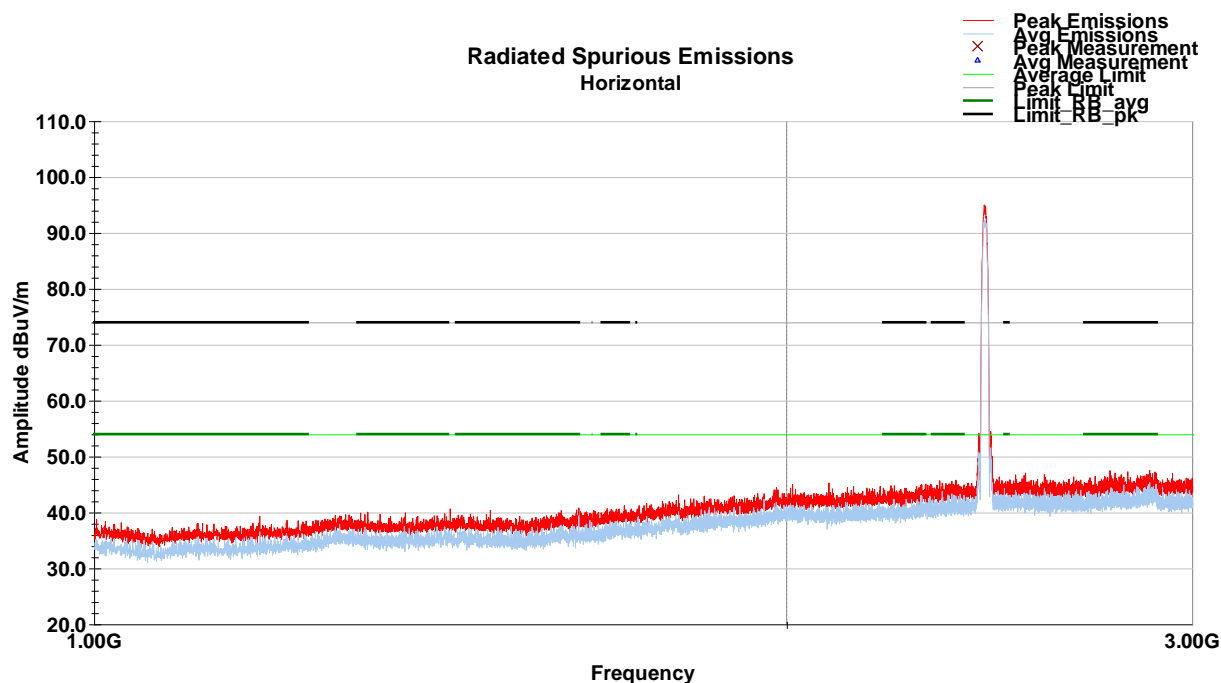
Horizontal Radiated Spurious Emissions Plot – 3-18GHz (802.11b LCH)



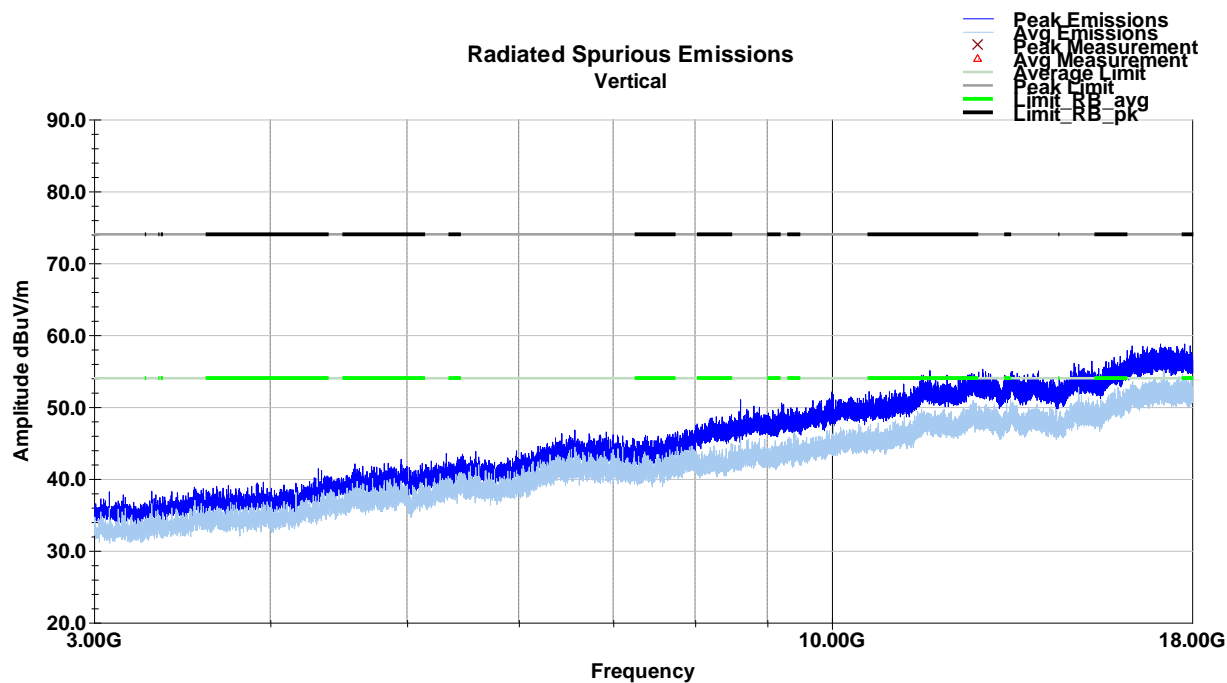
Vertical Radiated Spurious Emissions Plot – 1-3GHz (802.11b MCH)



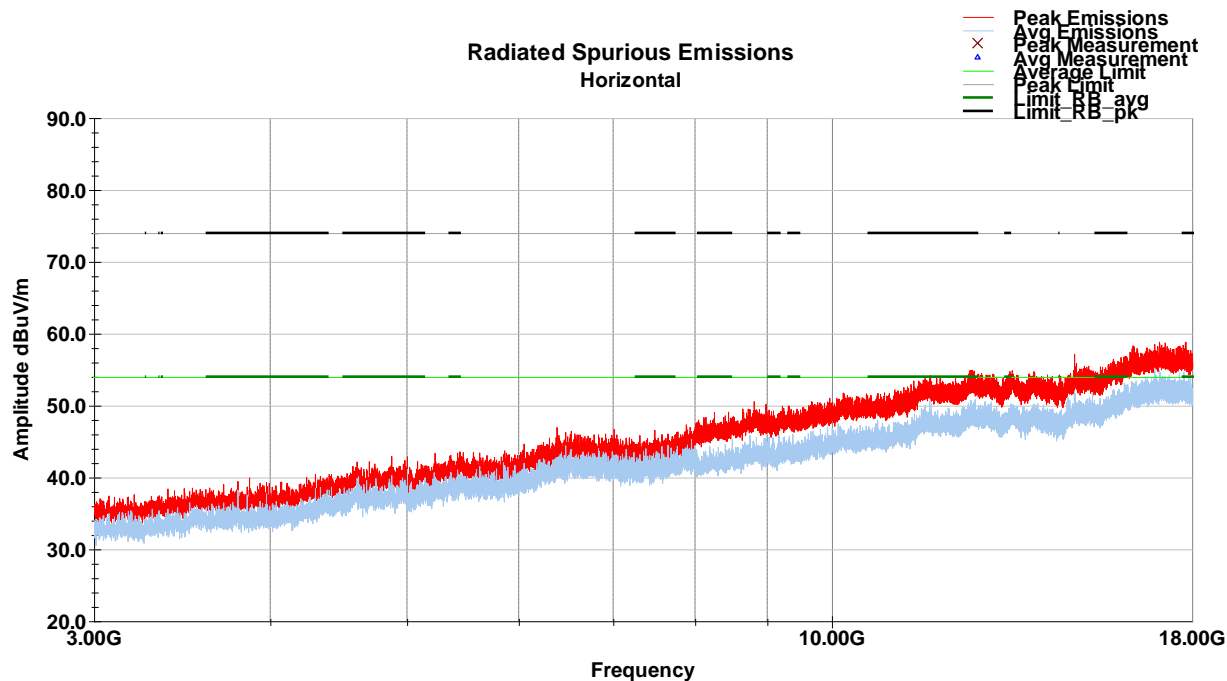
Horizontal Radiated Spurious Emissions Plot – 1-3GHz (802.11b MCH)



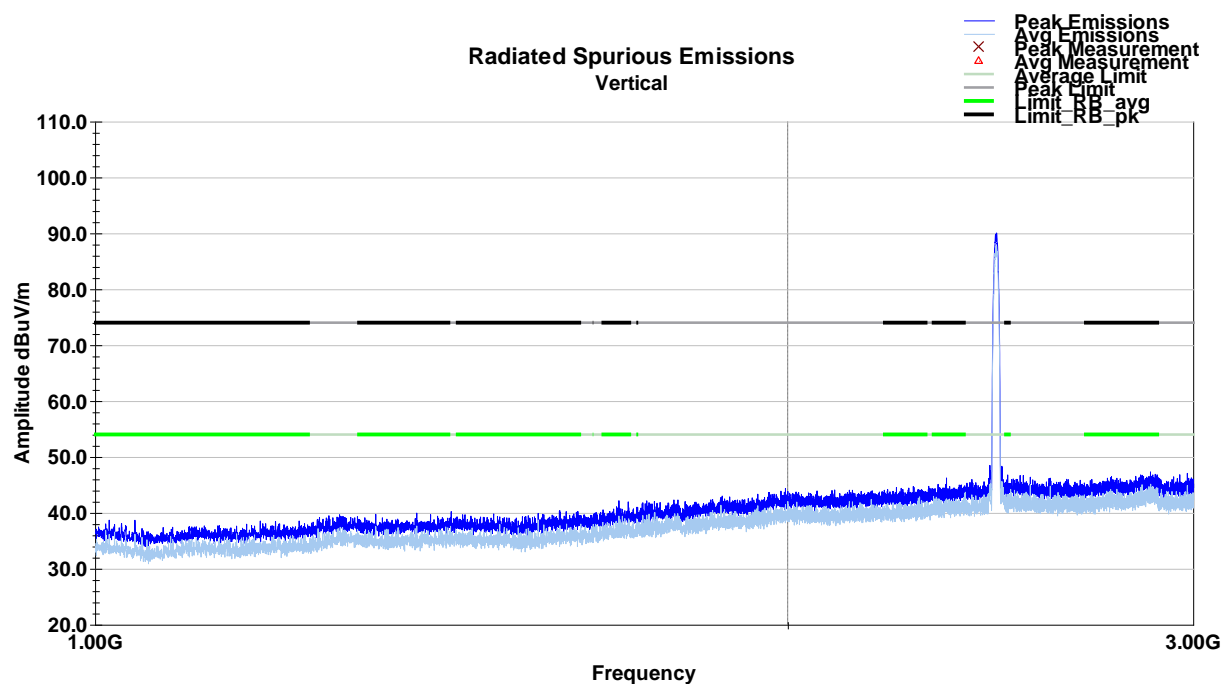
Vertical Radiated Spurious Emissions Plot – 3-18GHz (802.11b MCH)



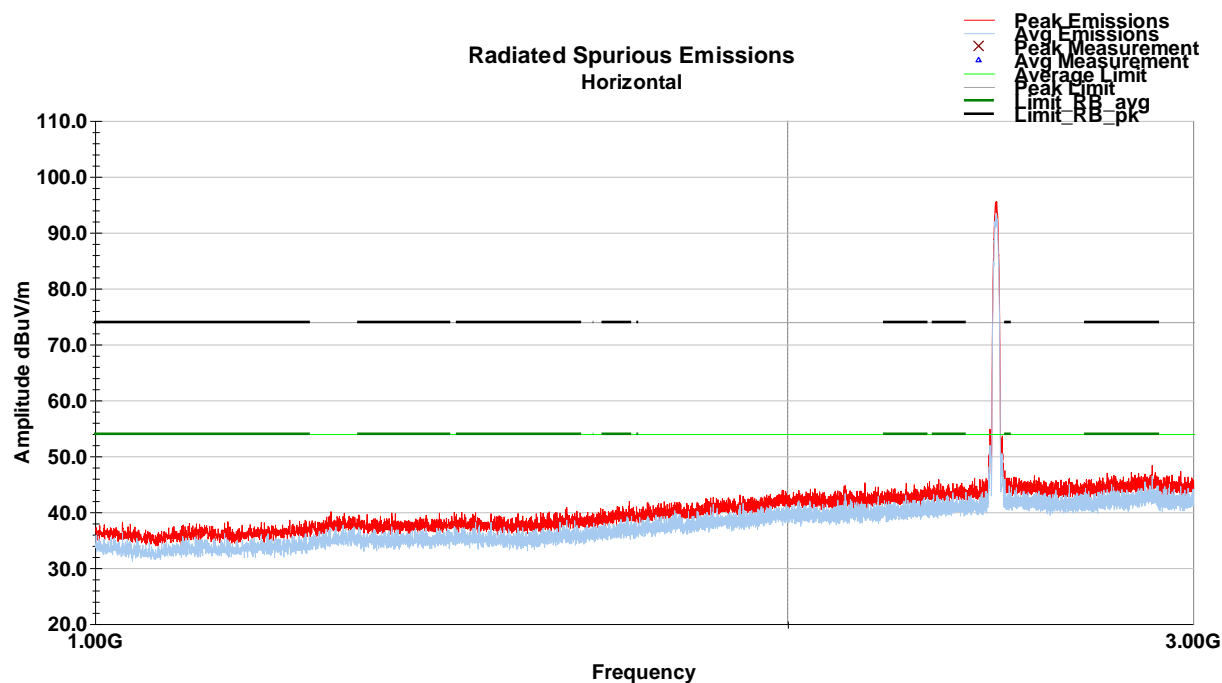
Horizontal Radiated Spurious Emissions Plot – 3-18GHz (802.11b MCH)



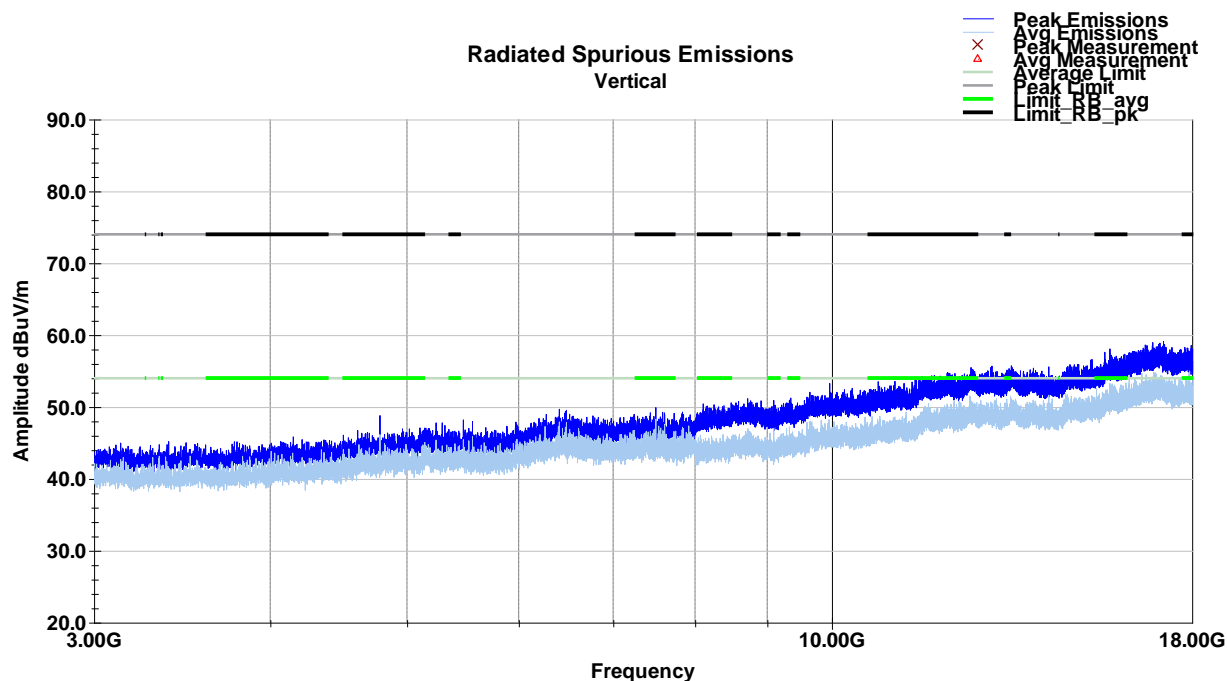
Vertical Radiated Spurious Emissions Plot – 1-3GHz (802.11b HCH)



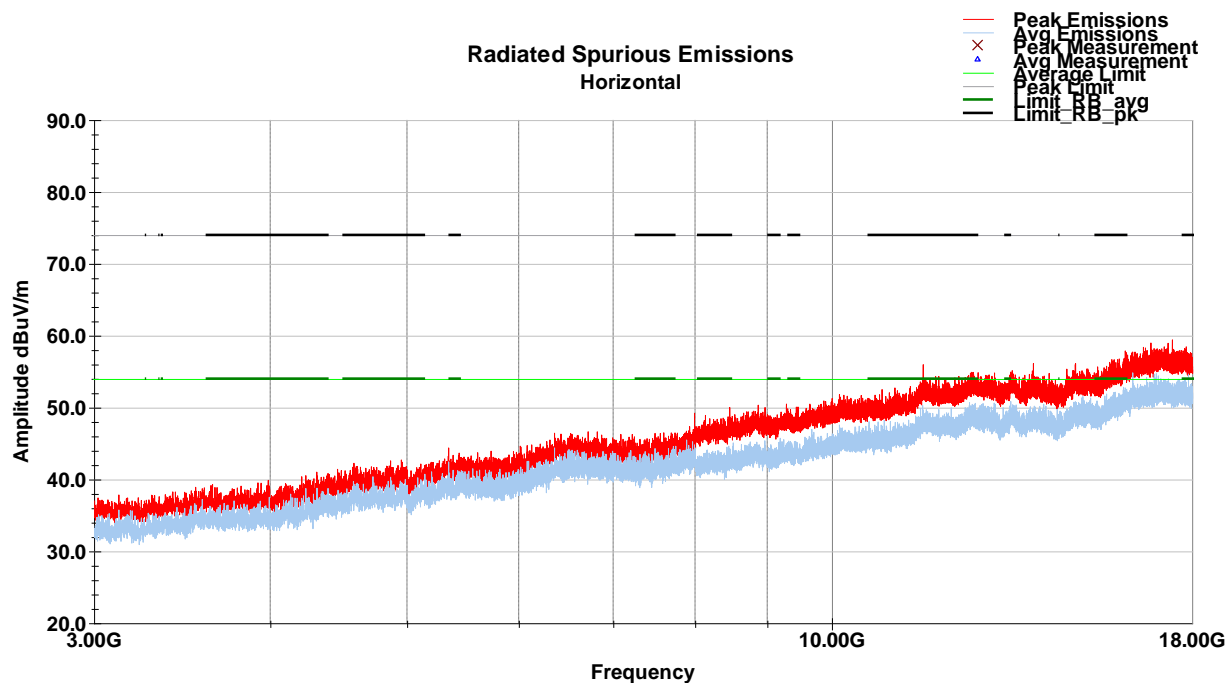
Horizontal Radiated Spurious Emissions Plot – 1-3GHz (802.11b HCH)



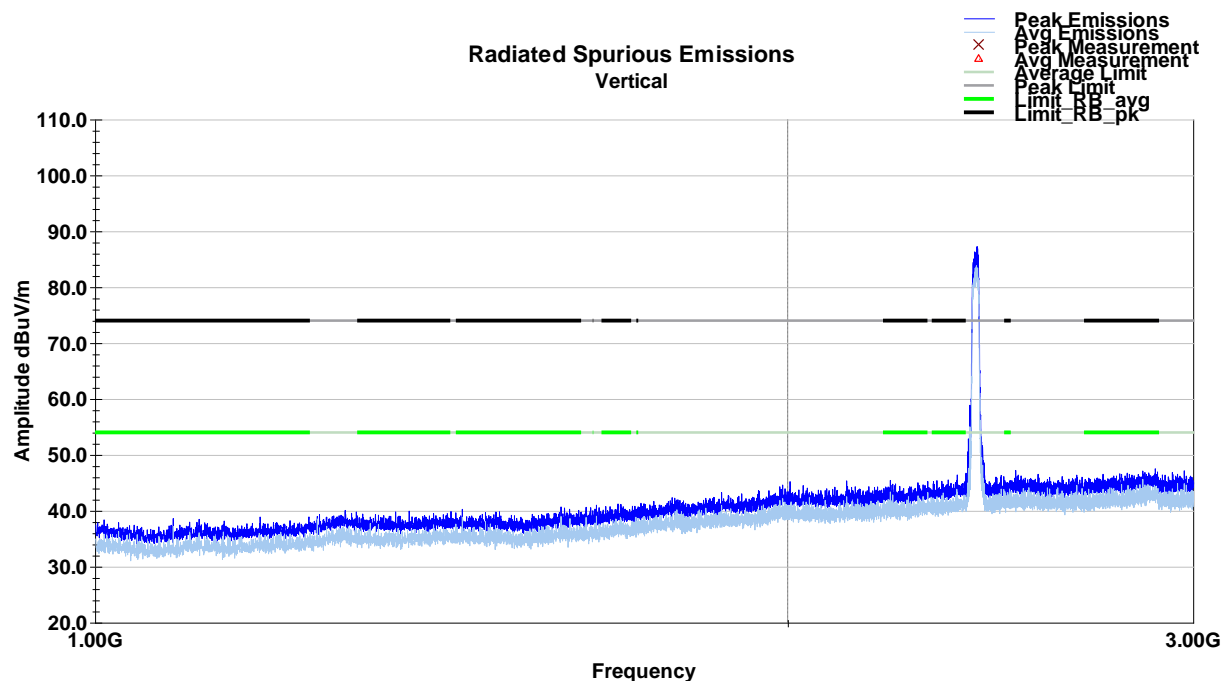
Vertical Radiated Spurious Emissions Plot – 3-18GHz (802.11b HCH)



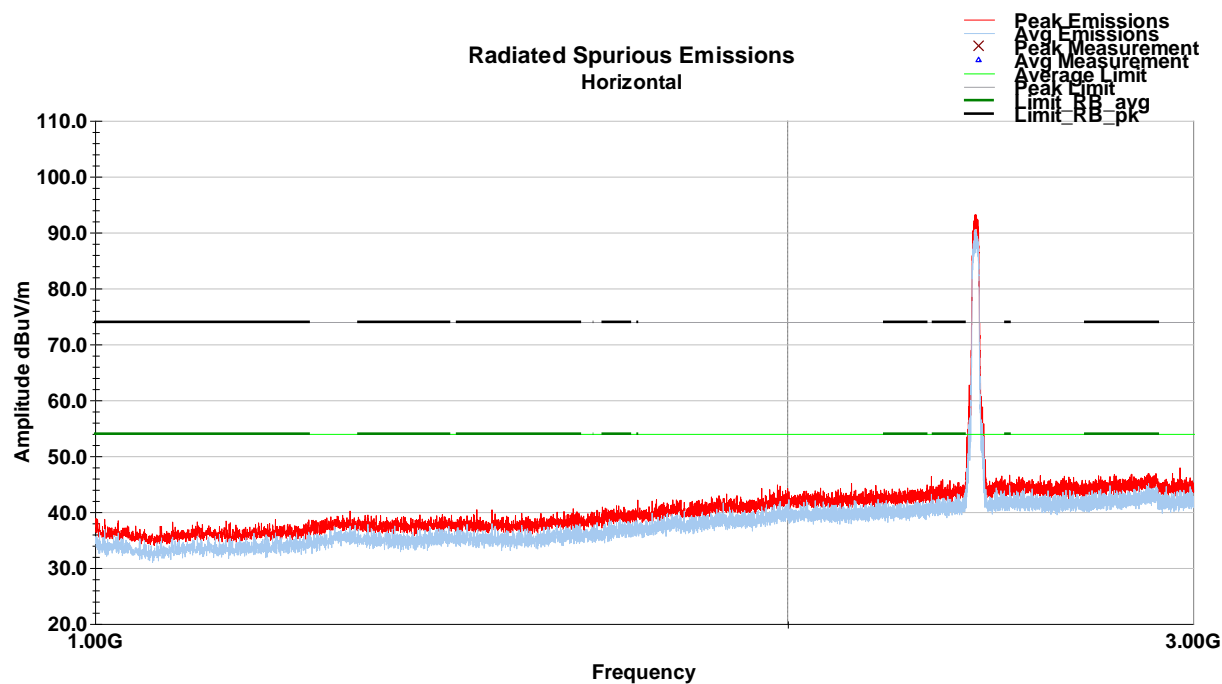
Horizontal Radiated Spurious Emissions Plot – 3-18GHz (802.11b HCH)



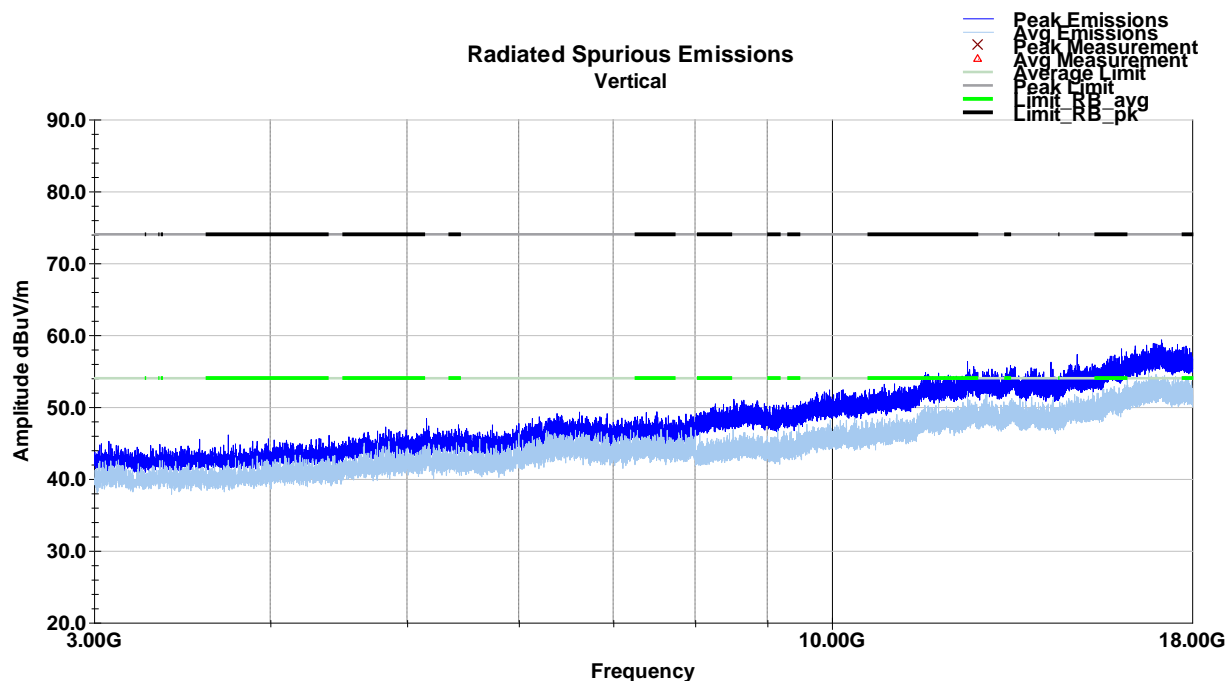
Vertical Radiated Spurious Emissions Plot – 1-3GHz (802.11g LCH)



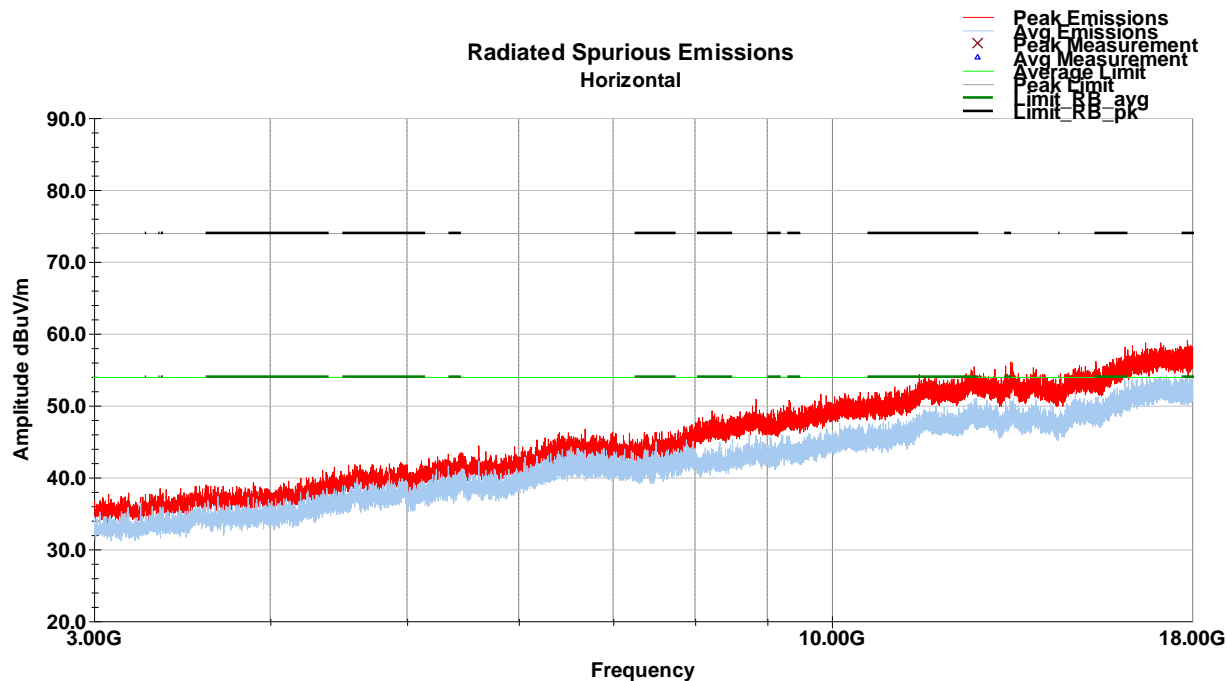
Horizontal Radiated Spurious Emissions Plot – 1-3GHz (802.11g LCH)



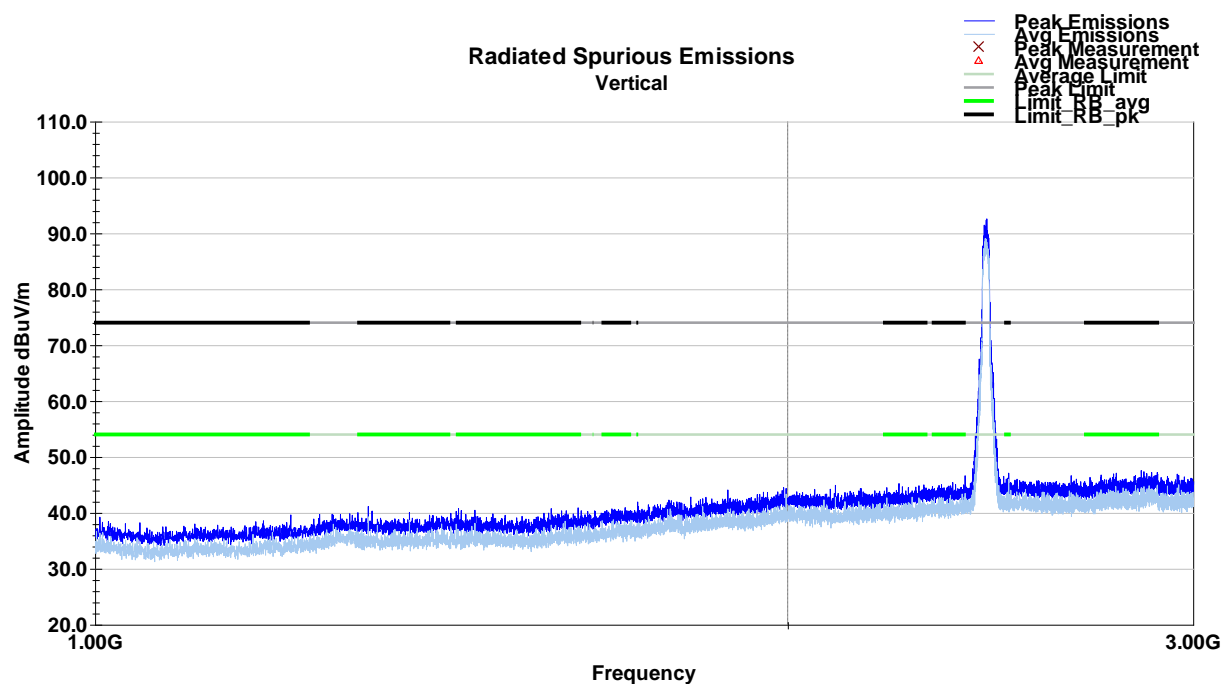
Vertical Radiated Spurious Emissions Plot – 3-18GHz (802.11g LCH)



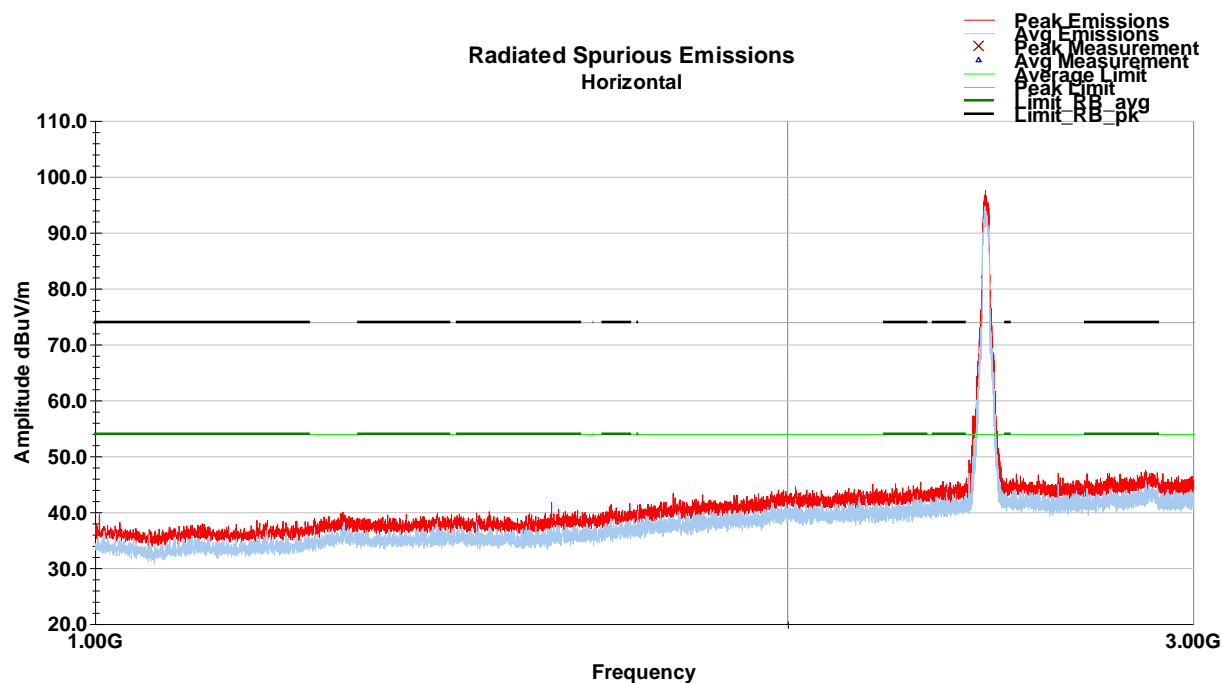
Horizontal Radiated Spurious Emissions Plot – 3-18GHz (802.11g LCH)



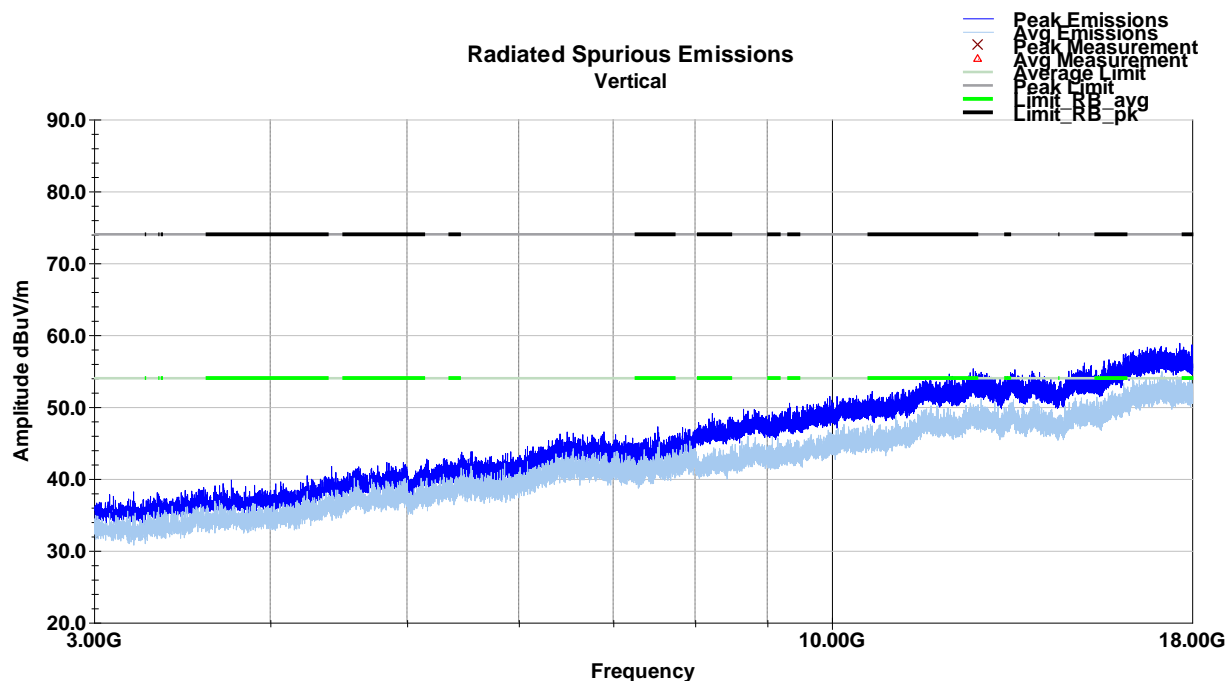
Vertical Radiated Spurious Emissions Plot – 1-3GHz (802.11g MCH)



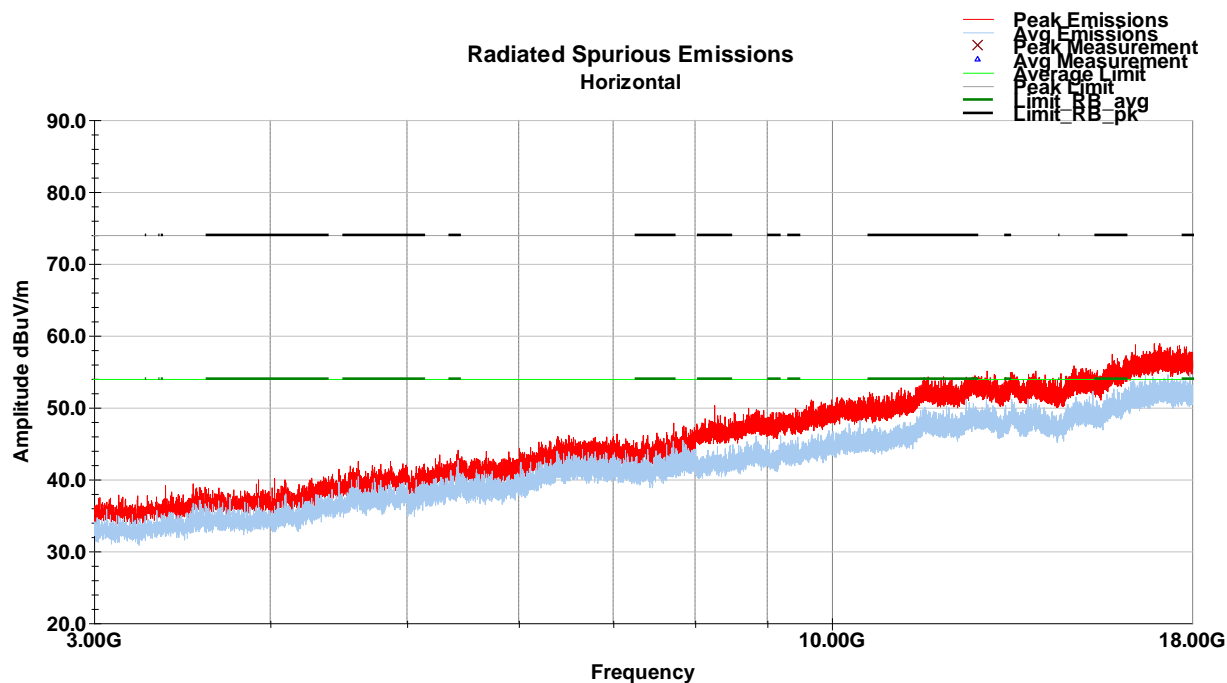
Horizontal Radiated Spurious Emissions Plot – 1-3GHz (802.11g MCH)



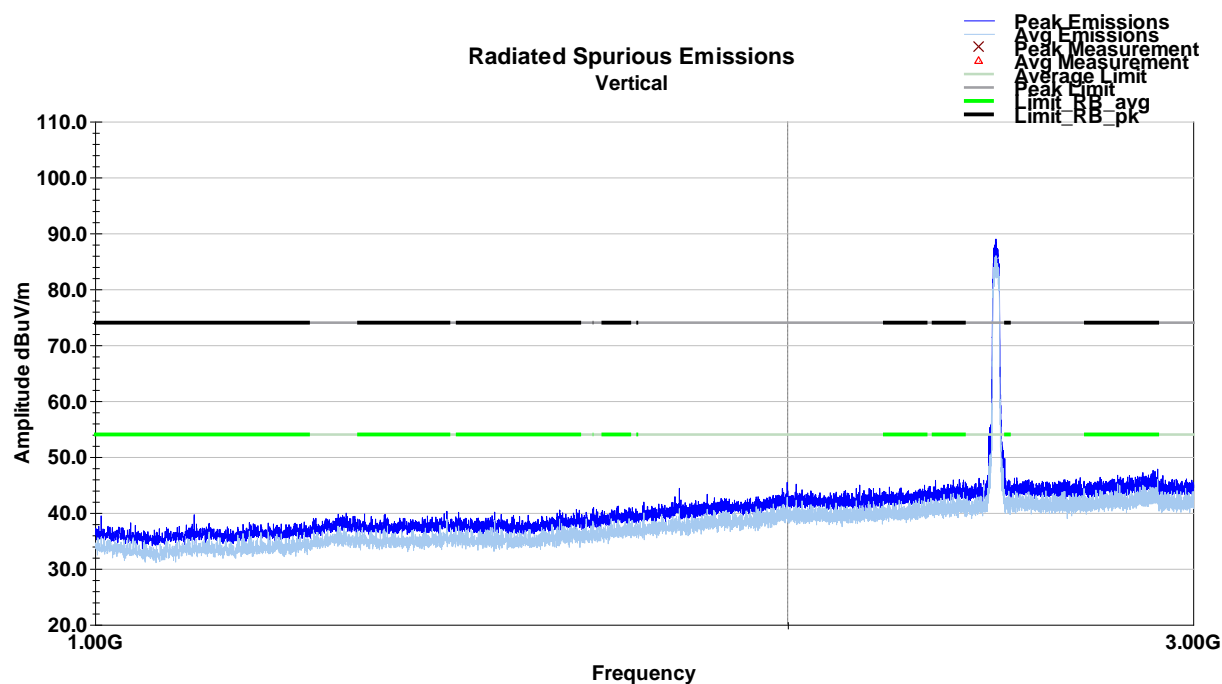
Vertical Radiated Spurious Emissions Plot – 3-18GHz (802.11g MCH)



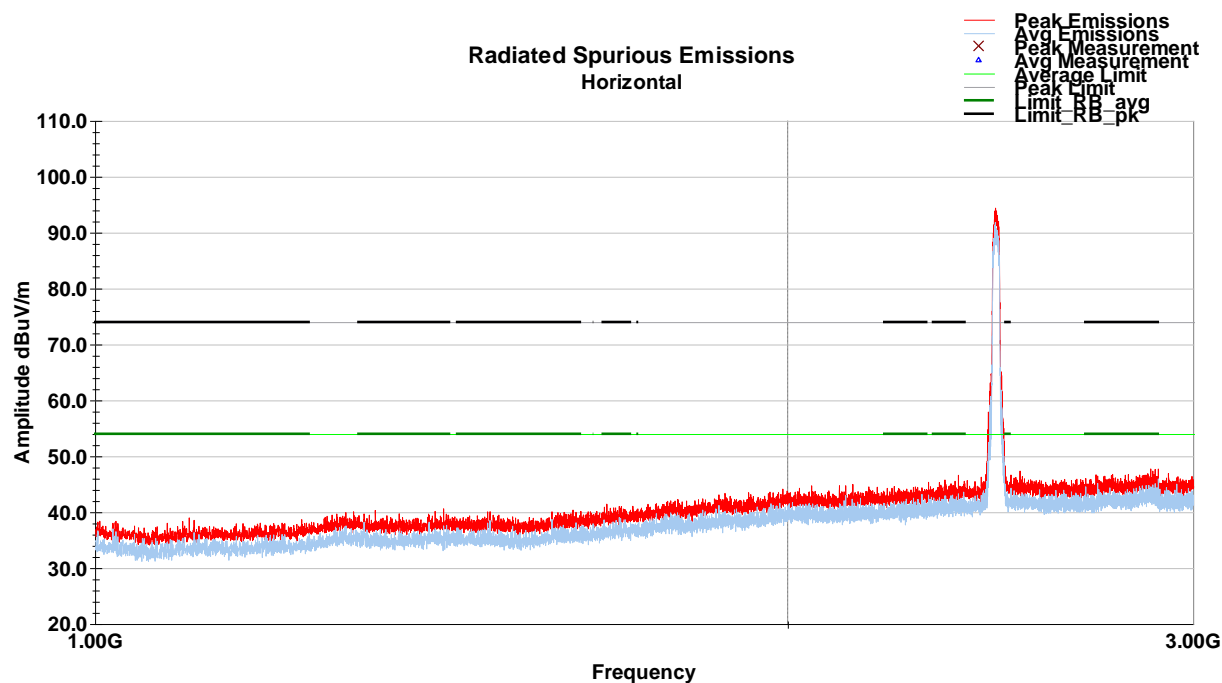
Horizontal Radiated Spurious Emissions Plot – 3-18GHz (802.11g MCH)



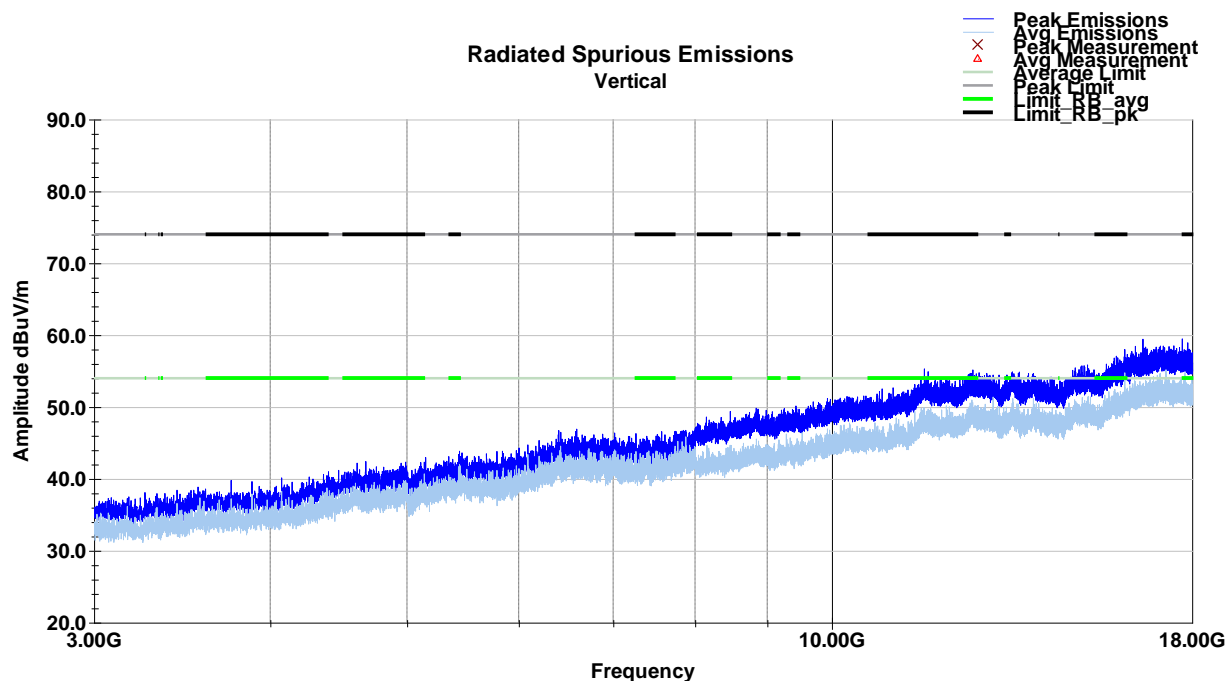
Vertical Radiated Spurious Emissions Plot – 1-3GHz (802.11g HCH)



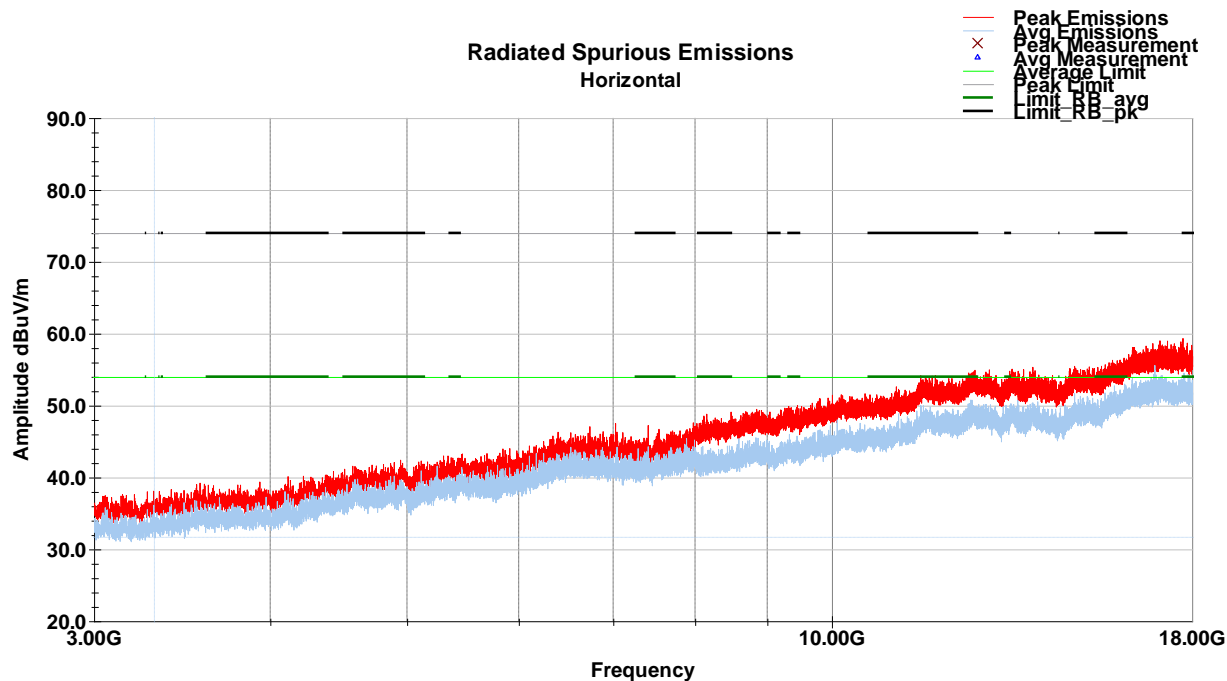
Horizontal Radiated Spurious Emissions Plot – 1-3GHz (802.11g HCH)



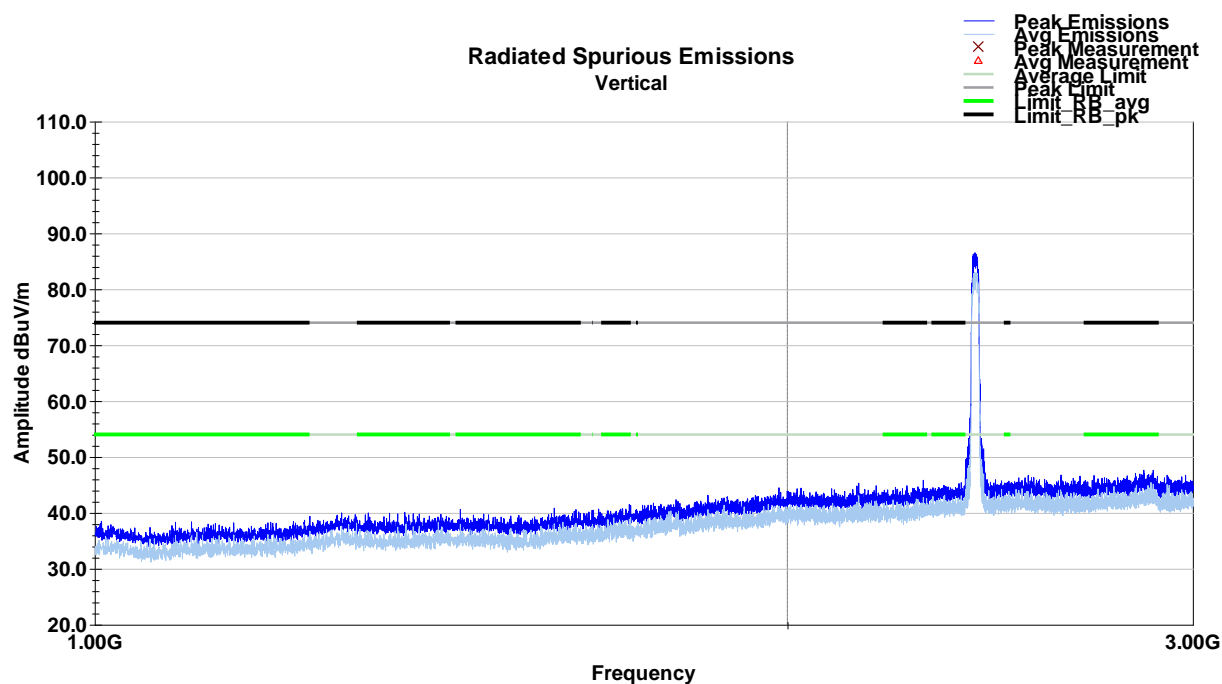
Vertical Radiated Spurious Emissions Plot – 3-18GHz (802.11g HCH)



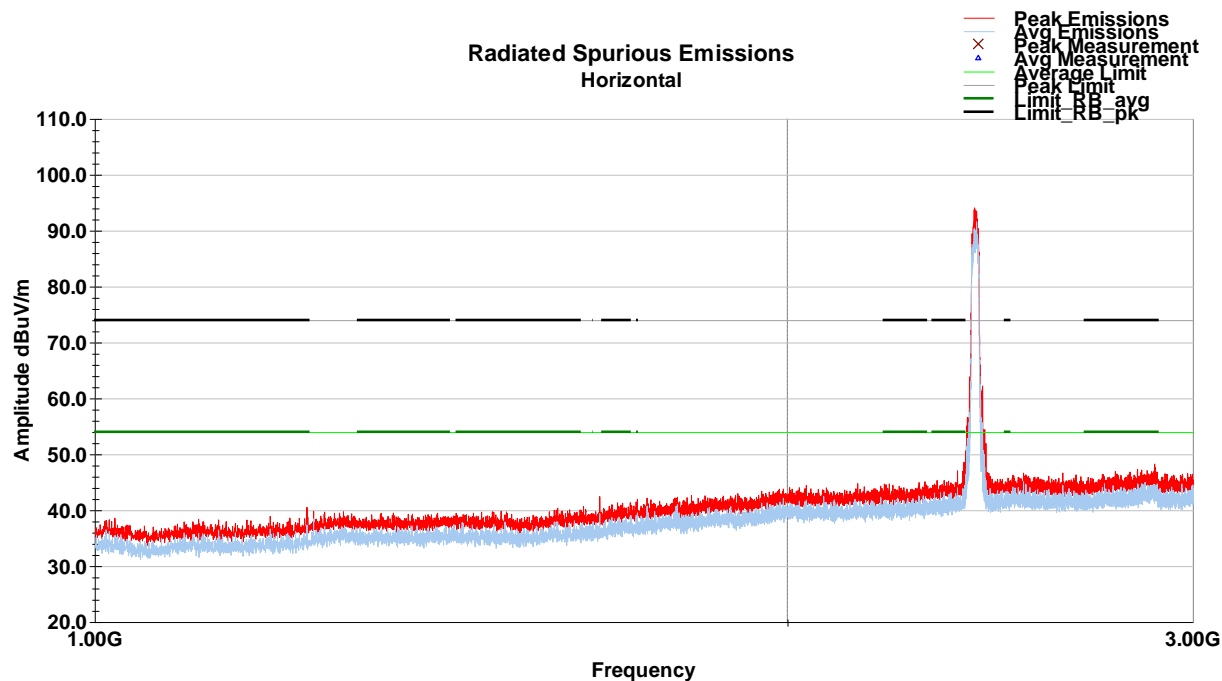
Horizontal Radiated Spurious Emissions Plot – 3-18GHz (802.11g HCH)



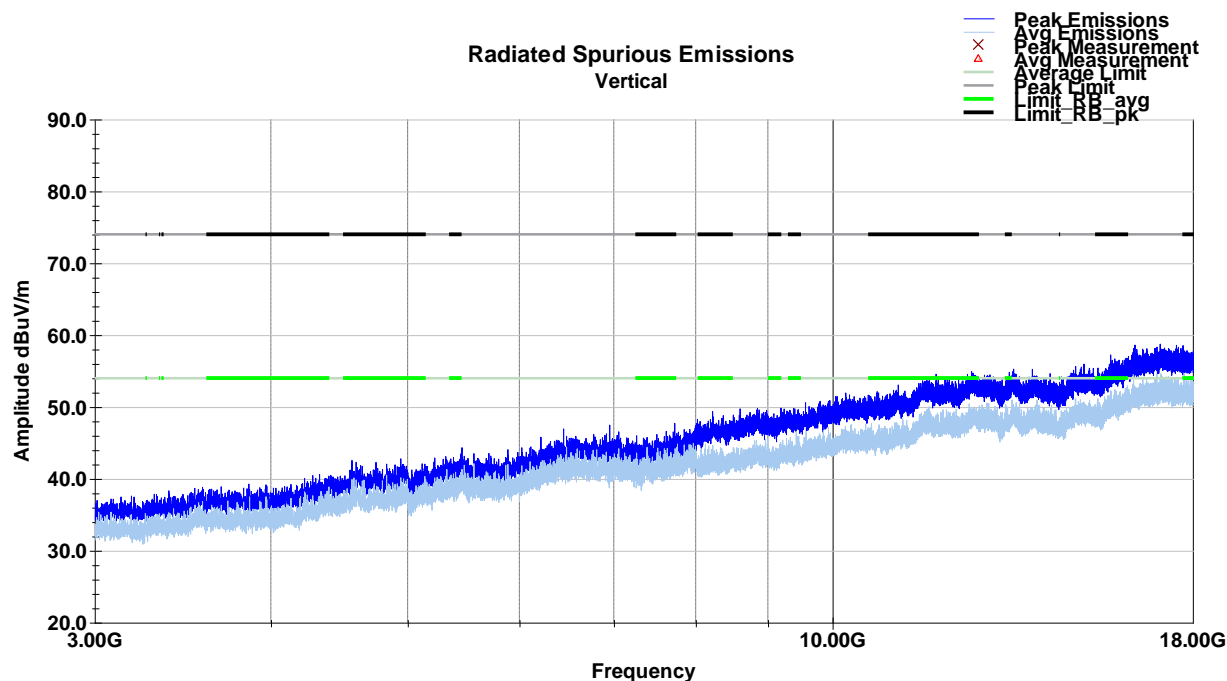
Vertical Radiated Spurious Emissions Plot – 1-3GHz (802.11n LCH)



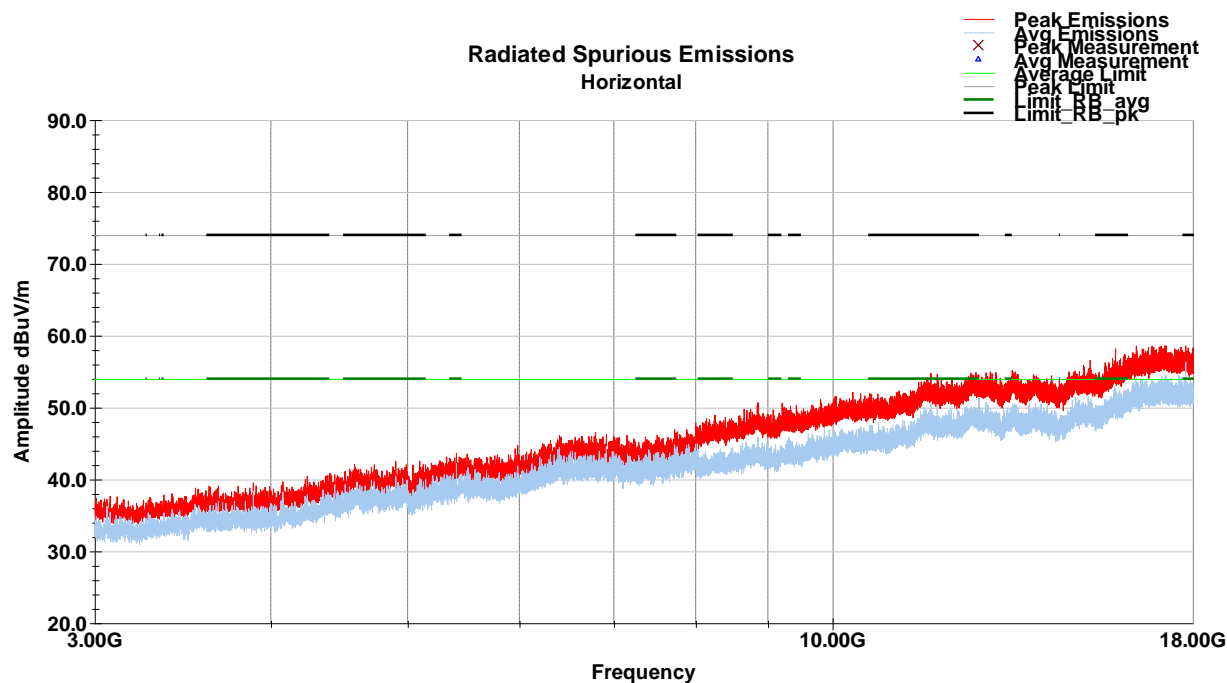
Horizontal Radiated Spurious Emissions Plot – 1-3GHz (802.11n LCH)



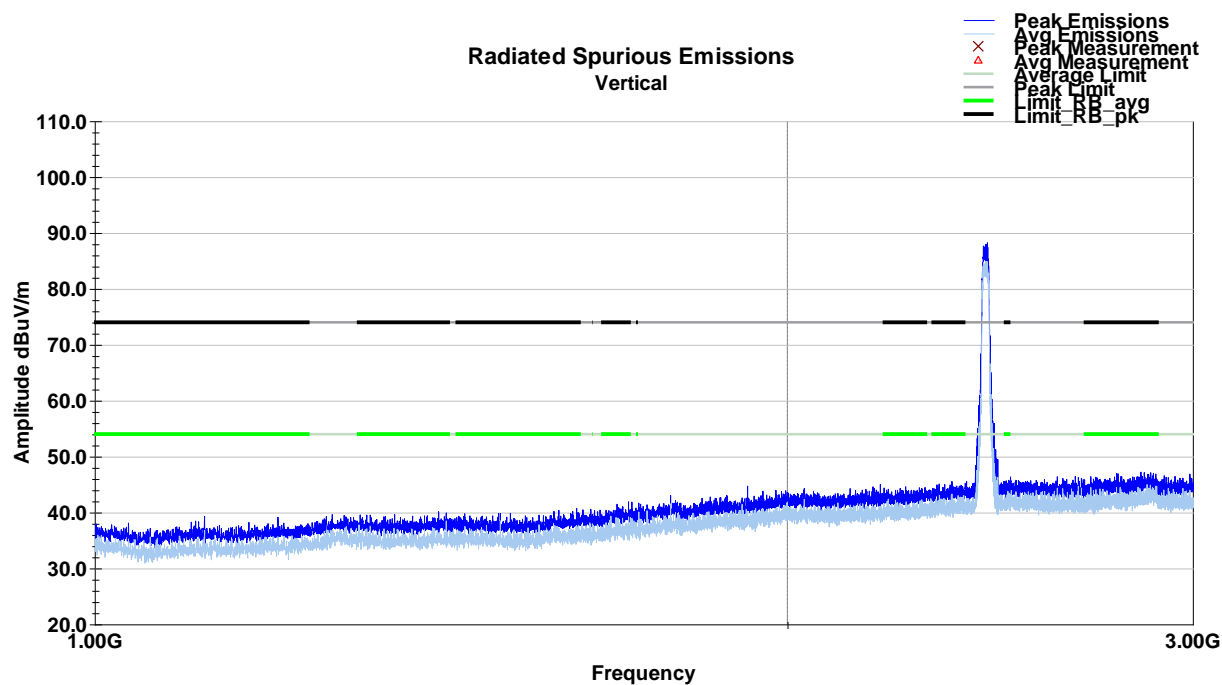
Vertical Radiated Spurious Emissions Plot – 3-18GHz (802.11n LCH)



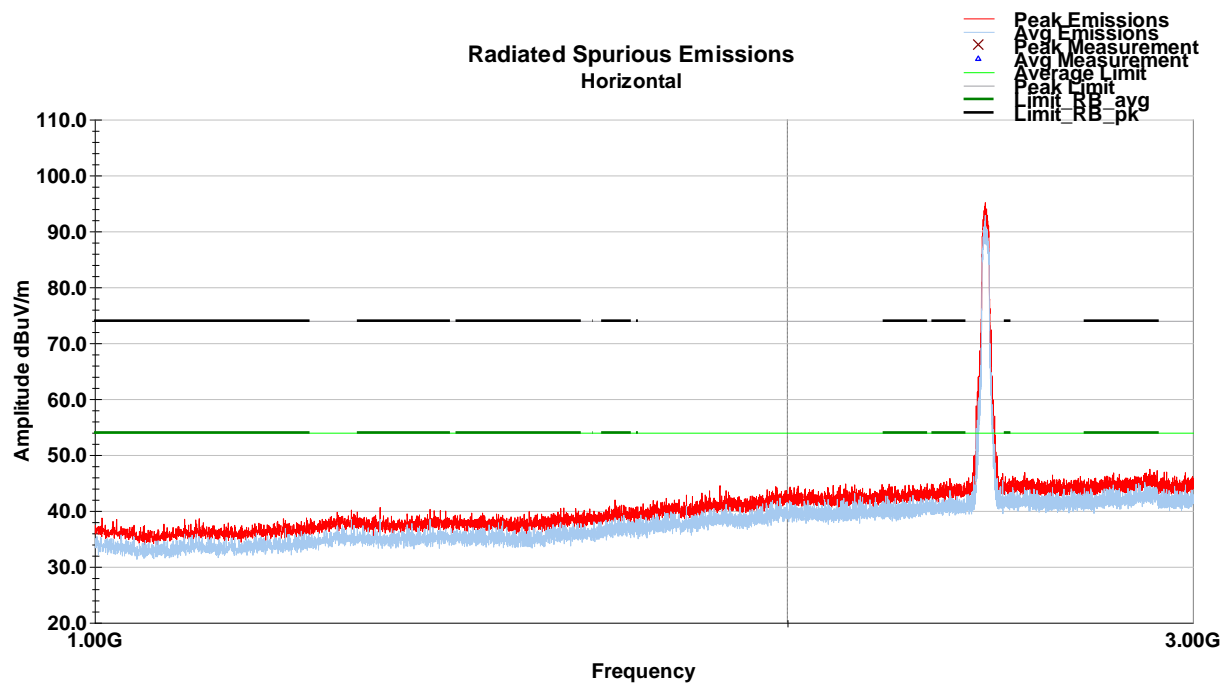
Horizontal Radiated Spurious Emissions Plot – 3-18GHz (802.11n LCH)



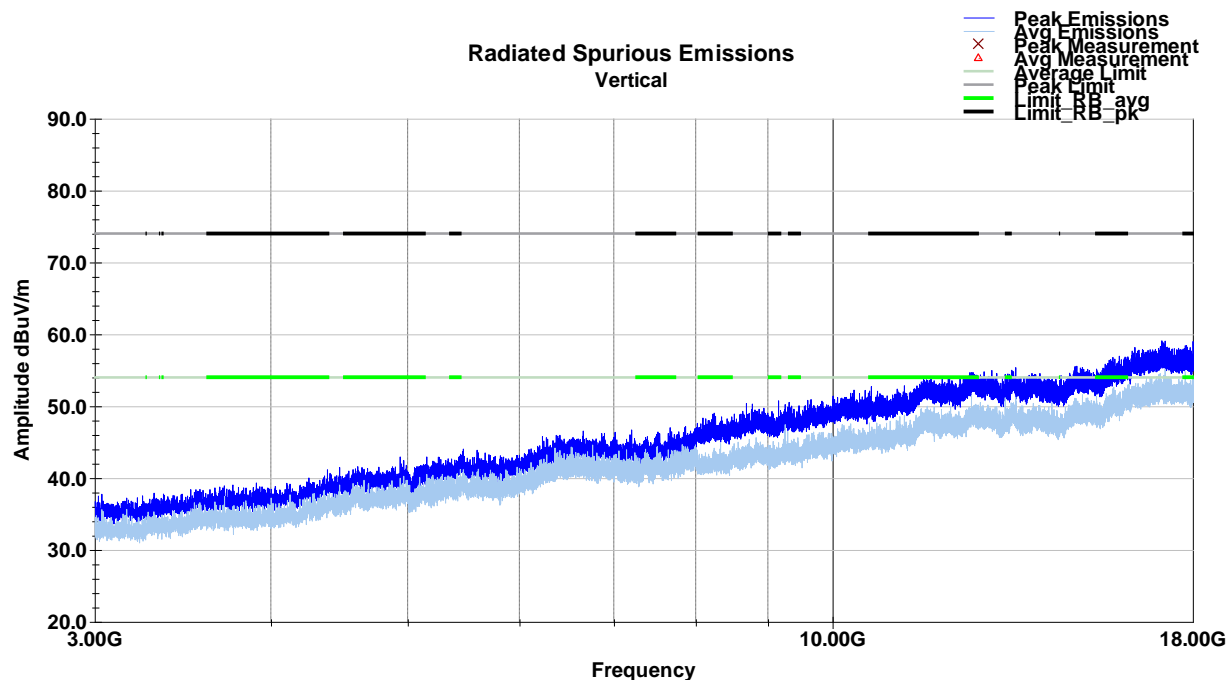
Vertical Radiated Spurious Emissions Plot – 1-3GHz (802.11n MCH)



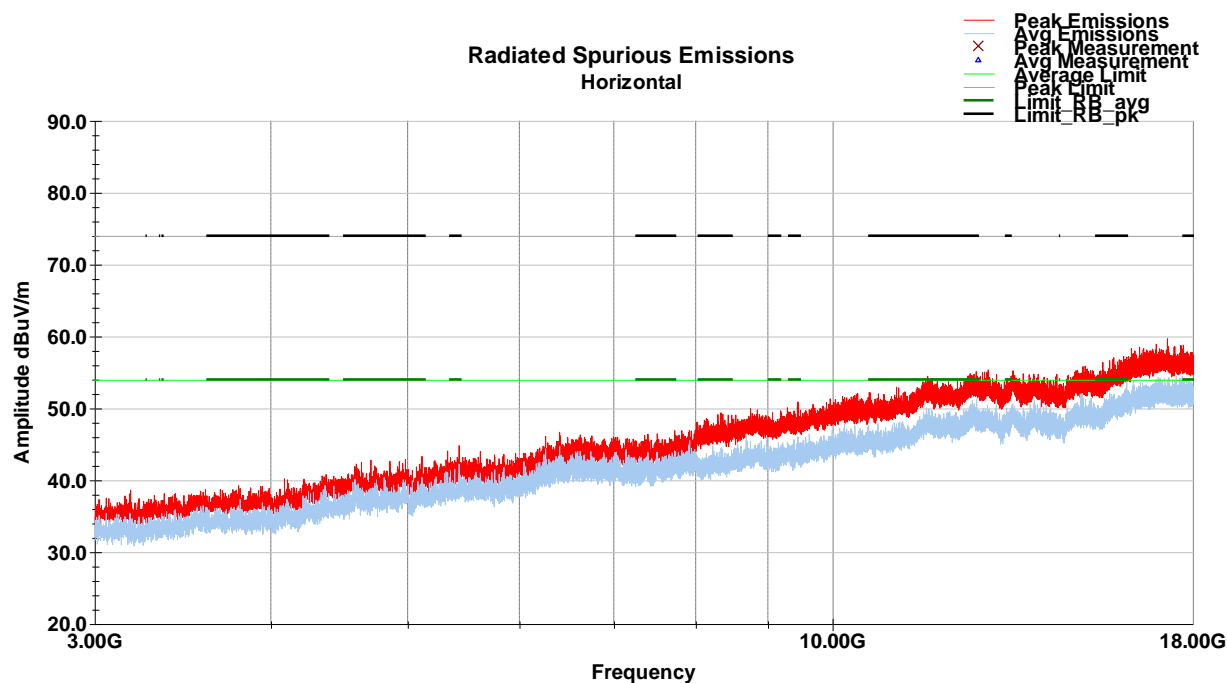
Horizontal Radiated Spurious Emissions Plot – 1-3GHz (802.11n MCH)



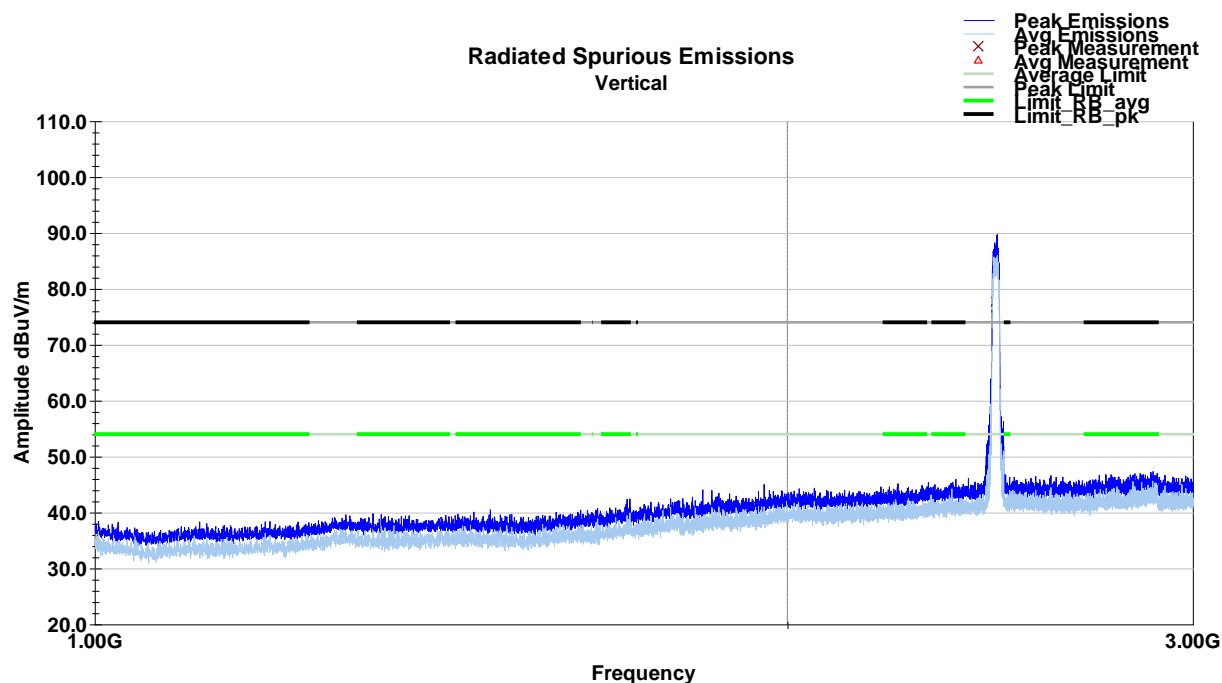
Vertical Radiated Spurious Emissions Plot – 3-18GHz (802.11n MCH)



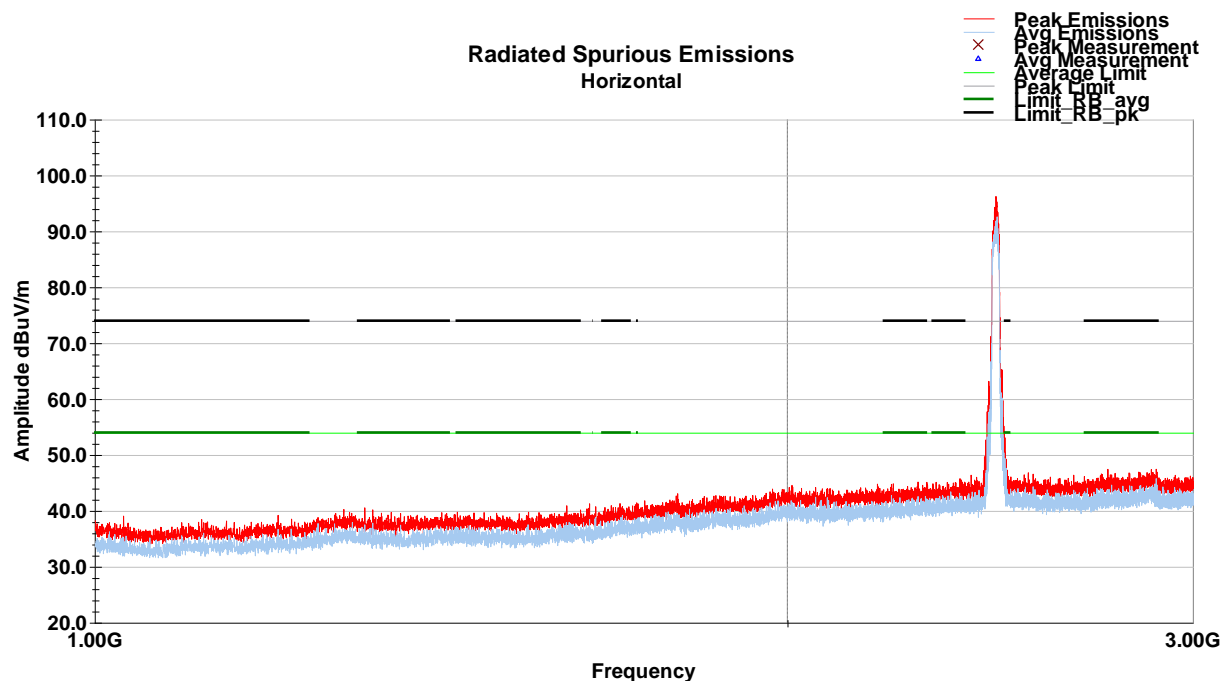
Horizontal Radiated Spurious Emissions Plot – 3-18GHz (802.11n MCH)



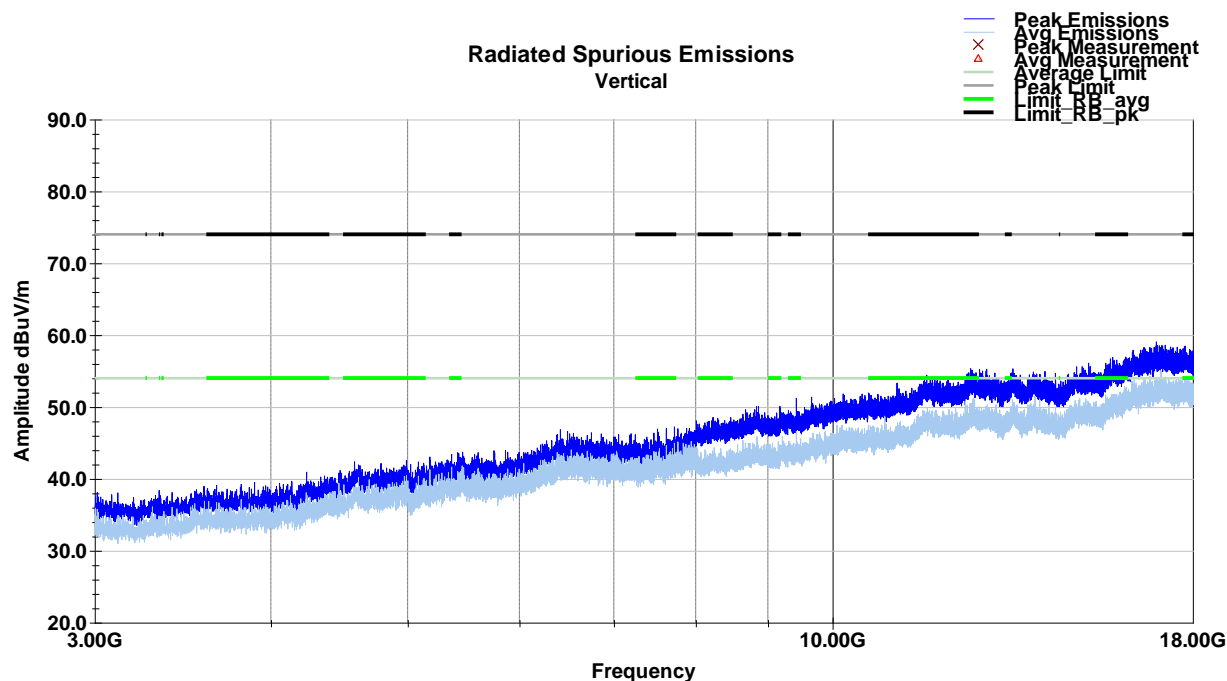
Vertical Radiated Spurious Emissions Plot – 1-3GHz (802.11n HCH)



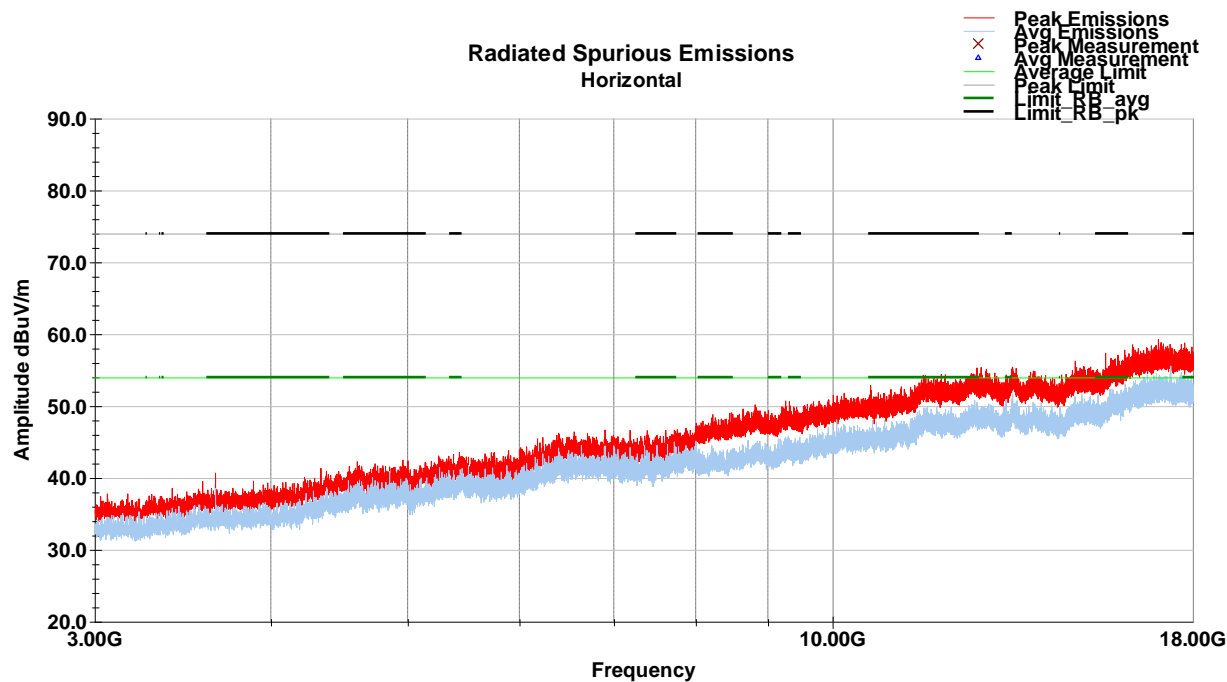
Horizontal Radiated Spurious Emissions Plot – 1-3GHz (802.11n HCH)



Vertical Radiated Spurious Emissions Plot – 3-18GHz (802.11n HCH)



Horizontal Radiated Spurious Emissions Plot – 3-18GHz (802.11n HCH)



There were no discernible emissions from 18 to 26 GHz.

8 Band Edge Emissions in Restricted Frequency Bands

8.1 Test Result

Test Description	Test Specification		Test Result
Band Edge Emissions in Restricted Frequency Bands	15.205 / 15.209	RSS-GEN S8.9 / S8.10	Compliant

8.2 Test Method

Measurements were made using the conducted methods defined in ANSI C63.10, Section 11.12.2.

The test system reported the following duty-cycles used for correcting the average measurements:

Ant1							
Mode	TX Type	Frequency (MHz)	T_on (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	Max. DC Variation (%)
802.11b	SISO	2412	32.950	33.138	99.43	0.02	0.00
		2437	32.950	33.150	99.40	0.03	0.04
		2462	32.950	33.150	99.40	0.03	0.04
802.11g	SISO	2412	5.487	5.531	99.20	0.03	0.27
		2437	5.481	5.701	96.14	0.17	0.14
		2462	5.481	5.702	96.12	0.17	0.14
802.11n (HT20)	SISO	2412	0.496	0.717	69.18	1.60	0.12
		2437	0.496	0.717	69.18	1.60	0.12
		2462	0.496	0.716	69.27	1.59	0.12
802.11n (HT40)	SISO	2422	0.258	0.478	53.97	2.68	0.07
		2437	0.258	0.478	53.97	2.68	0.13
		2452	0.258	0.478	53.97	2.68	0.13
802.11n (HT20)	MIMO	2412	0.359	0.579	62.00	2.08	0.13
		2437	0.358	0.579	61.83	2.09	0.13
		2462	0.359	0.579	62.00	2.08	0.13

8.3 Test Site

Environmental Conditions

Temperature: 20.3 °C

Relative Humidity: 33.6 %

Atmospheric Pressure: 98.2 kPa

8.4 Test Equipment

Test End Date: 11-Apr-2023

Tester: DA

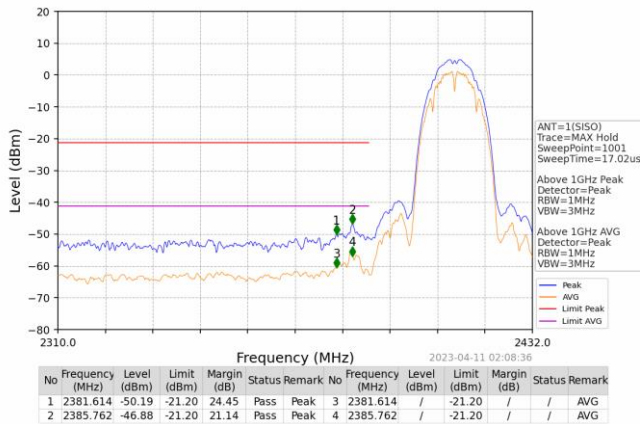
Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	7-Dec-2022	7-Dec-2023
RF CABLE SMA TO SMA, 0.01-40GHZ	084-0505-059	TELEDYNE STORM MICROWAVE	20108	13-Mar-2023	13-Mar-2024
RF CABLE SMA TO SMA, 0.01-40GHZ	084-0505-059	TELEDYNE STORM MICROWAVE	20109	13-Mar-2023	13-Mar-2024
TSTPASS SWITCHBOX	SB2	TSTPASS	23009	CNR	CNR

Software Profile:

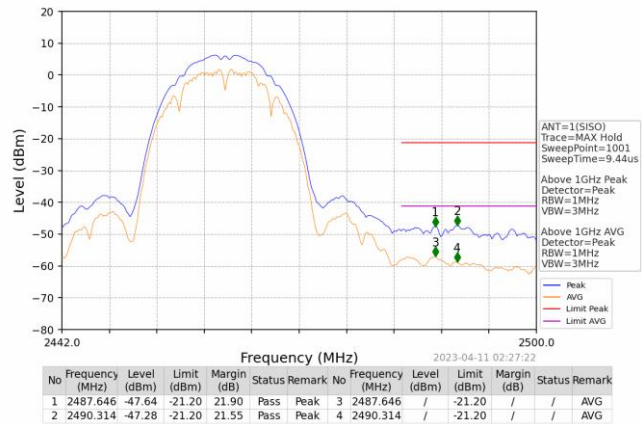
TSTPASS Version: 2.0

8.5 Test Data – Restricted Band Edges - SISO

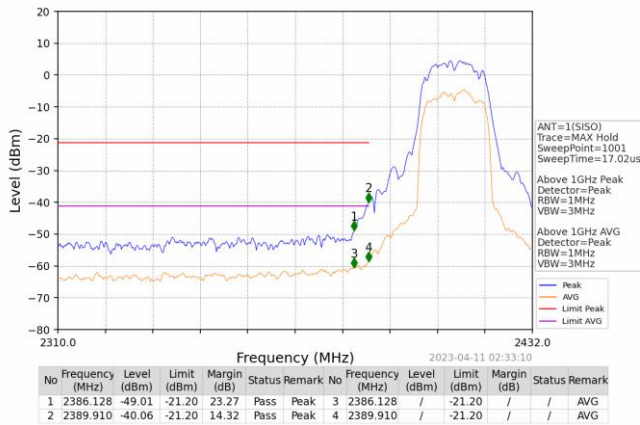
Low Channel(2412MHz) – 802.11b



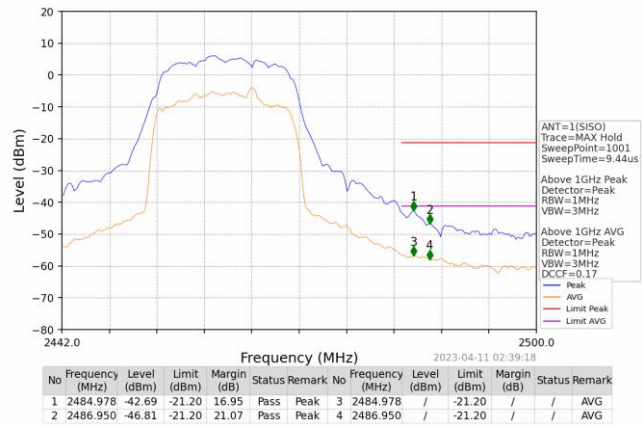
High Channel(2462MHz) – 802.11b



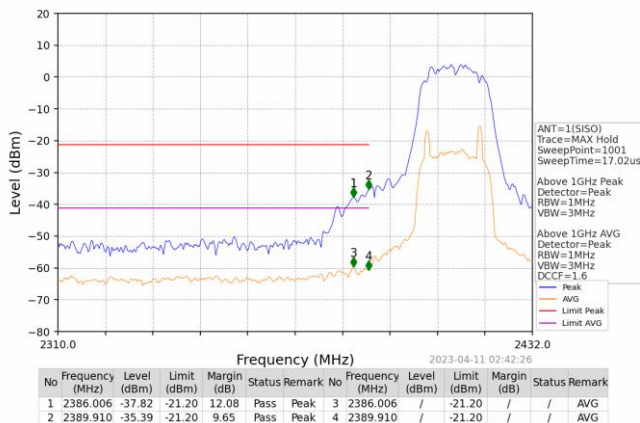
Low Channel(2412MHz) – 802.11g



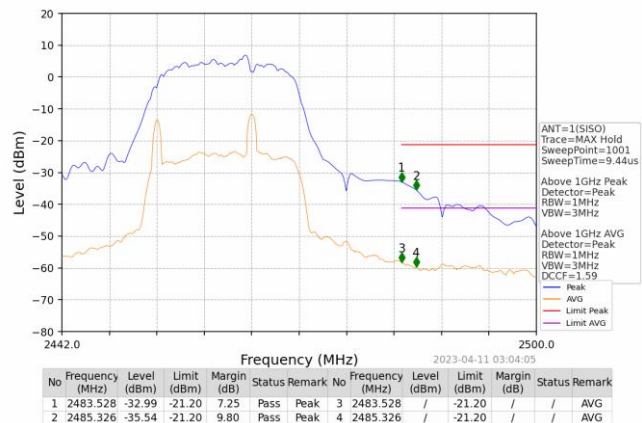
High Channel(2462MHz) – 802.11g



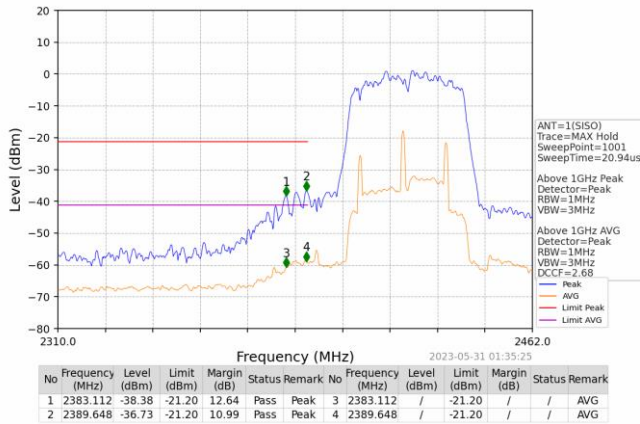
Low Channel(2412MHz) – 802.11n(HT20)



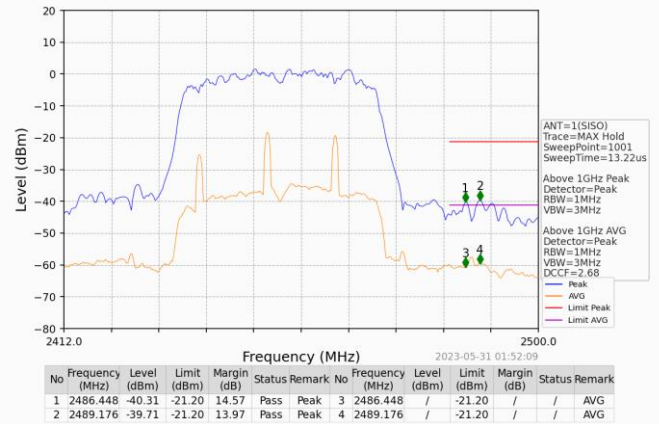
High Channel(2462MHz) – 802.11n(HT20)



Low Channel(2422MHz) – 802.11n(HT40)

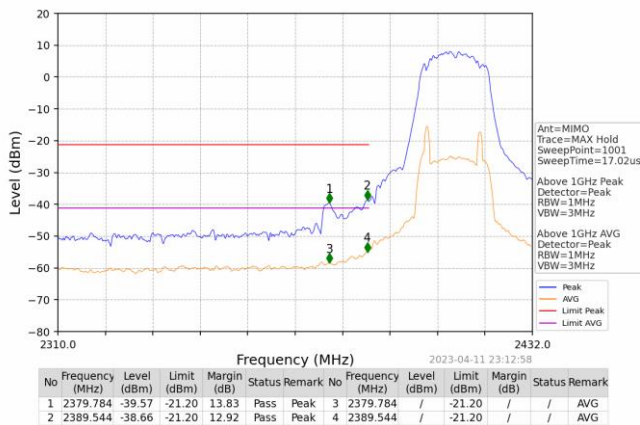


High Channel(2452MHz) – 802.11n(HT40)

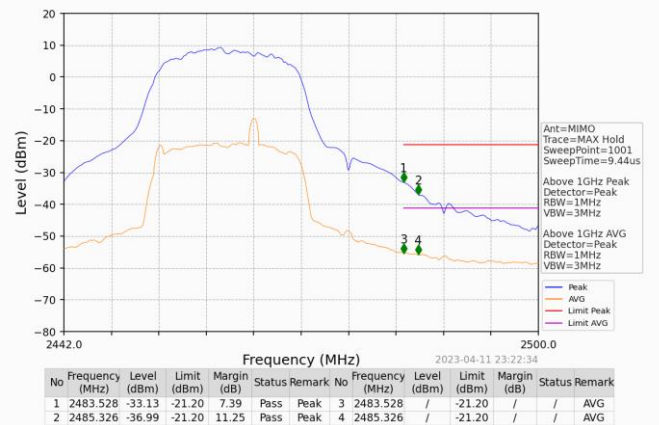


8.6 Test Data – Restricted Band Edges - MIMO

Low Channel(2412MHz) – 802.11n(HT20)



High Channel(2462MHz) – 802.11n(HT20)



9 AC Powerline Conducted Emissions

9.1 Test Result

Test Description	Test Specification		Test Result
AC Powerline Conducted Emissions	15.207	RSS-GEN S8.8	Compliant

9.2 Test Method

With the receiver's resolution bandwidth was set to 9 kHz, exploratory scans were performed over the measuring frequency range (0.15 MHz to 30 MHz) using a max hold mode incorporating a Peak detector and Average detector and using the TILE! software. The final test data was measured using a Quasi-Peak detector and Average detector and compared against the limits indicated in the table below.

Frequency Range	Limits (dBuV)
0.15 to 0.5 MHz	Avg 56 to 46 QP 66 to 56
0.5 to 5 MHz	Avg 46 Pk 56
5 to 30 MHz	Avg 50 Pk 60

9.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions:

Temperature: 22.7 °C
Relative Humidity: 38.8 %
Atmospheric Pressure 97.8 kPa

9.4 Test Equipment

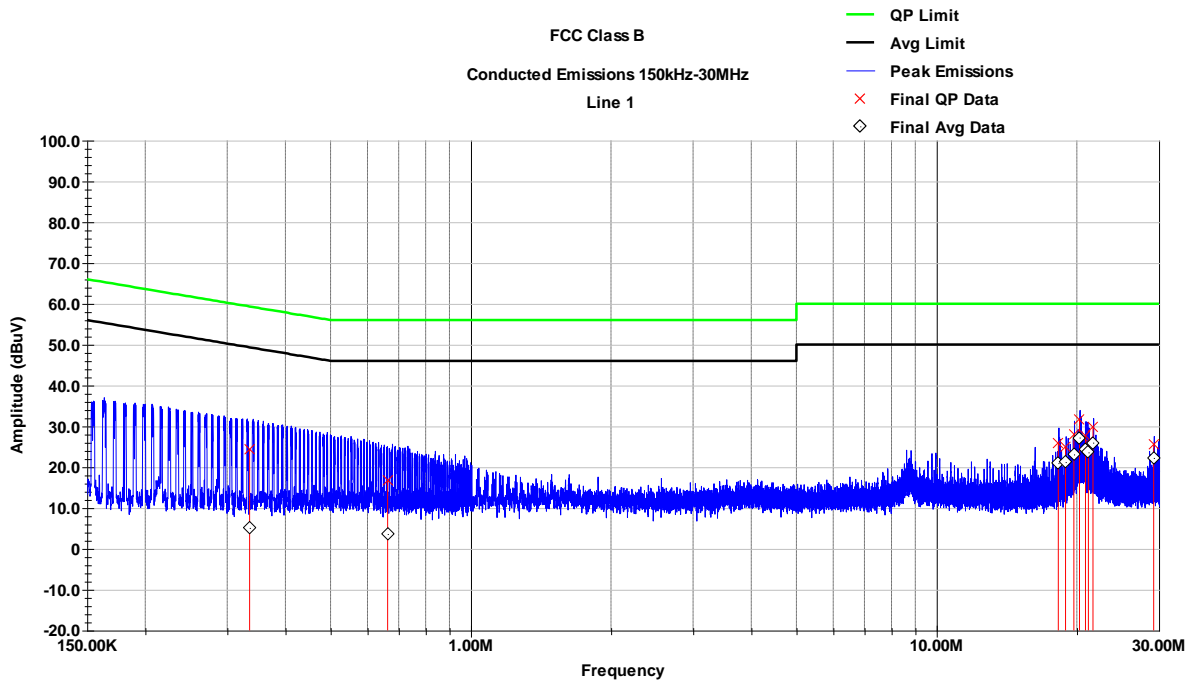
Test End Date: 13-Apr-2023

Tester: EW

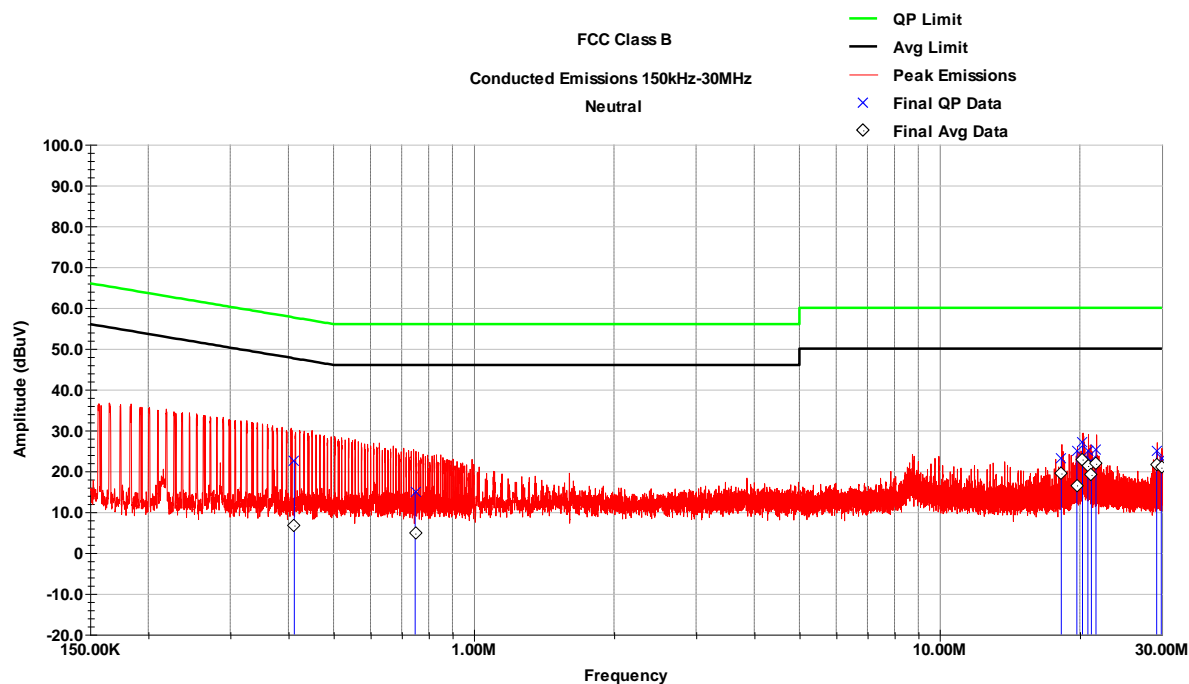
Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
LINE IMPEDANCE STABILIZATION NETWORK	NNB 51	TESEQ	B085882	15-Apr-2022	15-Apr-2023
RF CABLE	UC-N-MM-78	MAURY MICROWAVE	17017	25-Aug-2022	25-Aug-2023
EMI TEST RECEIVER	ESW44	ROHDE & SCHWARZ	22032	24-Nov-2022	24-Nov-2023

Software: Conducted Emissions 230206.til

9.5 Test Data



Frequency MHz	QP Value dBuV	QP Limit dBuV	QP Margin dB	Avg Value dBuV	Avg Limit dBuV	Avg Margin dB
0.335	24.3	59.3	-35.0	5.1	49.3	-44.2
0.663	16.7	56.0	-39.3	3.6	46.0	-42.4
18.244	25.8	60.0	-34.2	21.0	50.0	-29.0
18.913	24.9	60.0	-35.1	21.2	50.0	-28.8
19.708	28.1	60.0	-31.9	23.1	50.0	-26.9
20.257	31.5	60.0	-28.5	27.2	50.0	-22.8
20.868	27.8	60.0	-32.2	24.3	50.0	-25.7
21.174	26.3	60.0	-33.7	23.6	50.0	-26.4
21.663	29.7	60.0	-30.3	26.0	50.0	-24.0
29.235	25.5	60.0	-34.5	22.3	50.0	-27.7



Frequency MHz	QP Value dBuV	QP Limit dBuV	QP Margin dB	Avg Value dBuV	Avg Limit dBuV	Avg Margin dB
0.412	22.5	57.6	-35.1	6.7	47.6	-40.9
0.749	15.1	56.0	-40.9	4.7	46.0	-41.3
18.244	23.1	60.0	-36.9	19.4	50.0	-30.6
19.709	24.9	60.0	-35.1	16.5	50.0	-33.5
20.261	27.2	60.0	-32.8	22.9	50.0	-27.1
20.811	25.1	60.0	-34.9	21.3	50.0	-28.7
21.174	22.6	60.0	-37.4	19.1	50.0	-30.9
21.662	25.3	60.0	-34.7	21.8	50.0	-28.2
29.235	24.9	60.0	-35.1	21.7	50.0	-28.3
29.907	23.1	60.0	-36.9	20.8	50.0	-29.2

10 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 %	$\pm 0.4\%$

11 Revision History

Revision Level	Description of changes	Revision Date
0	Initial release	31 May 2023
1	<ul style="list-style-type: none"> - Updated RSS-247 reference to latest issue on title page - Clarified antenna type in section 1 - Added note about HT40 MIMO not being supported in section 4.6 - Added notes on prescan testing <30MHz in sections 7.2 & 7.5 	17 November 2023