

7 Field Strength of Spurious Radiation

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.

X, Y, and Z axes 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

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

Environmental Conditions	30-1000MHz	Above 1GHz
Temperature:	23.4 °C	22.5 °C
Relative Humidity:	40.6 %	47.3 %
Atmospheric Pressure:	98.4 kPa	99.1 kPa

7.4 Test Equipment

30-1000MHz:

Test End Date: 10-Oct-2022

Tester: ZH

Equipment	Model	Manufacturer	Asset Number	Cal Date	Cal Due Date
N to N RF Cable	NC12-N1N1-276	MEGAPHASE	22001	10-Jan-2022	10-Jan-2023
RF CABLE NM TO NF, 0.01-18GHZ	90-213-118	TELEDYNE STORM MICROWAVE	20117	17-Feb-2022	17-Feb-2023
RF CABLE NM TO NM, 0.01-18GHZ	90-195-079	TELEDYNE STORM MICROWAVE	20123	14-Feb-2022	14-Feb-2023
RF CABLE RIGHT ANGLE NM TO NM, 0.01-18GHZ	90-076-020	TELEDYNE STORM MICROWAVE	20131	16-Mar-2022	16-Mar-2023
EMI TEST RECEIVER	ESW44	ROHDE & SCHWARZ	22027	13-Sep-2022	13-Sep-2023
ANTENNA, BILOG	JB6	SUNOL	B079689	26-May-2022	26-May-2024
LOW NOISE AMPLIFIER	ZKL-2+	MINI-CIRCUITS	B079817	25-Aug-2022	25-Aug-2023

Above 1GHz:

Test End Date: 4-Oct-2022

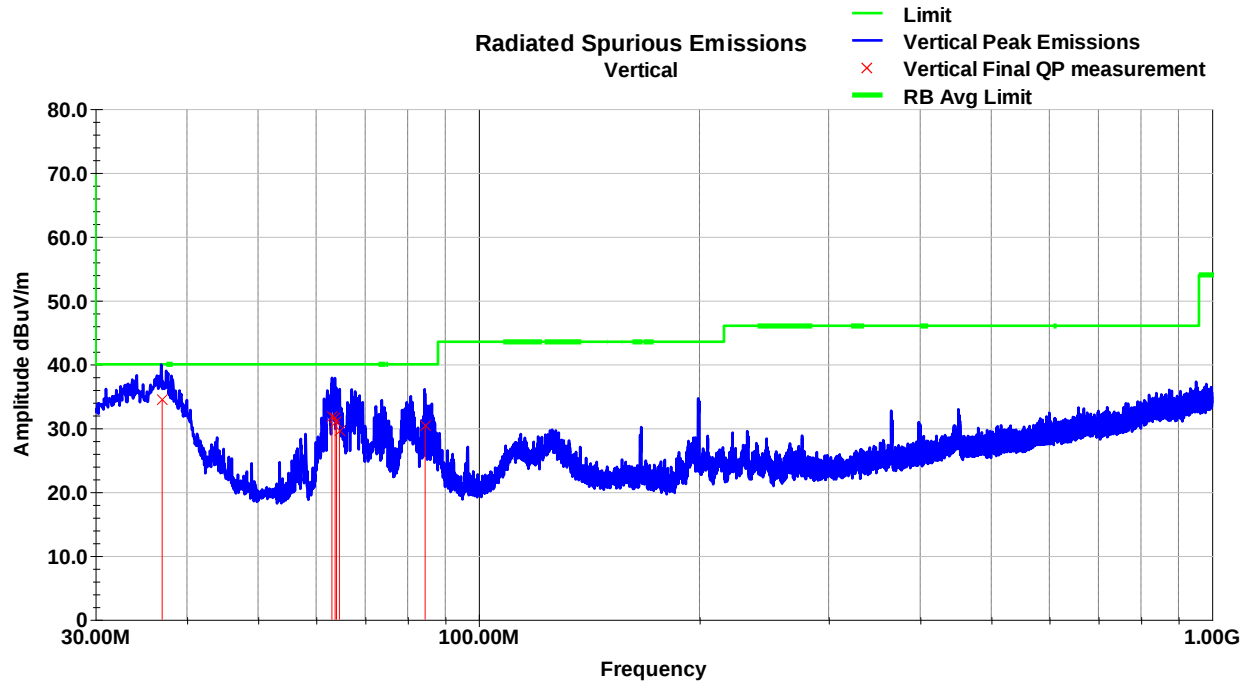
Tester: SF/AB

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 NM.	90-195-276	TELEDYNE STORM MICROWAVE	21020	16-Mar-2022	16-Mar-2023
LOW NOISE AMPLIFIER	TS-PR18	ROHDE & SCHWARZ	15003	3-Oct-2022	3-Oct-2023
RF CABLE RIGHT ANGLE NM TO NM, 0.01-18GHZ	90-076-020	TELEDYNE STORM MICROWAVE	20131	16-Mar-2022	16-Mar-2023
EMI TEST RECEIVER	ESW44	ROHDE & SCHWARZ	22027	13-Sep-2022	13-Sep-2023
FILTER, HIGH PASS, >2800MHZ	HPM50111	MICRO-TRONICS	22017	16-Jun-2022	16-Jun-2023

7.5 Test Data

7.5.1 30-1000 MHz – Y-Axis was found to be the worst case

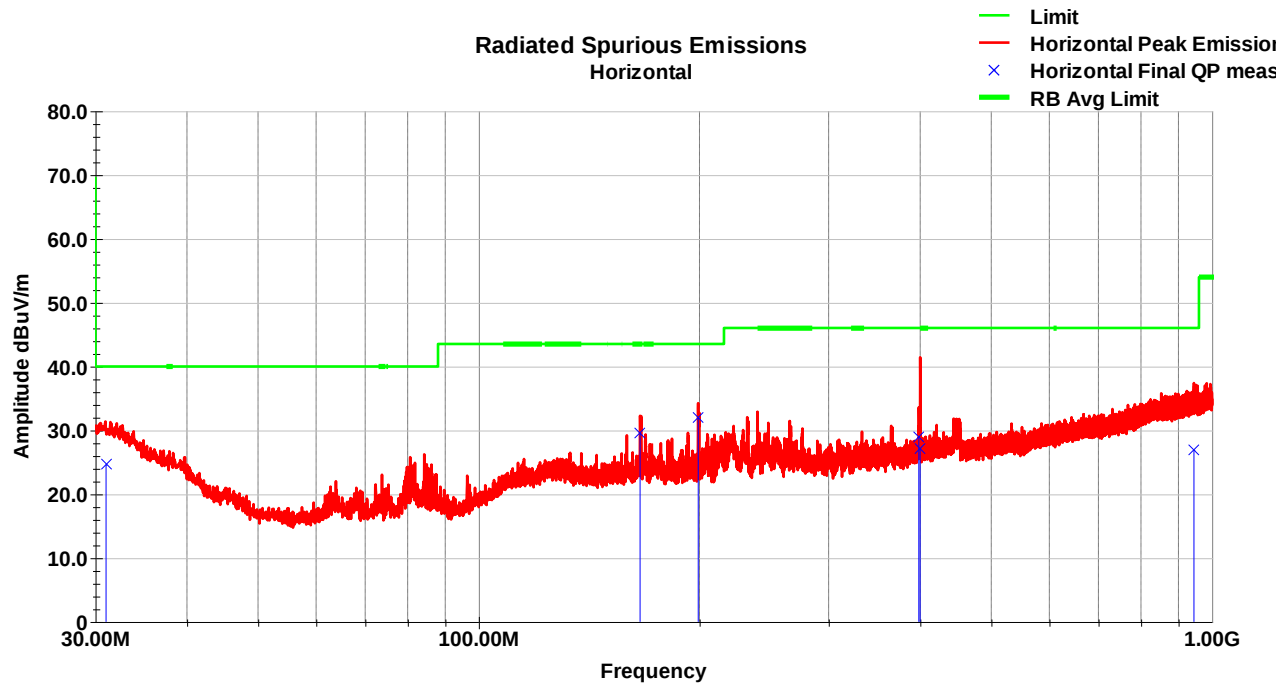
Vertical Plot – 30-1000MHz – LCH



Vertical Tabular Data – 30-1000MHz – LCH

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)
37.01	44.1	V	169.0	100.0	20.6	0.7	31.0	34.4	40.0	-5.6
63.06	50.1	V	69.0	100.0	11.6	1.0	31.0	31.7	40.0	-8.3
63.69	49.9	V	128.0	100.0	11.7	1.0	31.0	31.6	40.0	-8.4
63.98	49.3	V	45.0	100.0	11.7	1.0	31.0	31.0	40.0	-9.0
64.56	47.8	V	91.0	100.0	11.8	1.0	31.0	29.7	40.0	-10.3
84.49	48.6	V	158.0	100.0	11.6	1.2	30.9	30.4	40.0	-9.6
QP Value = Raw QP + AF + Loss - Amp										
Margin = QP Value - Limit										

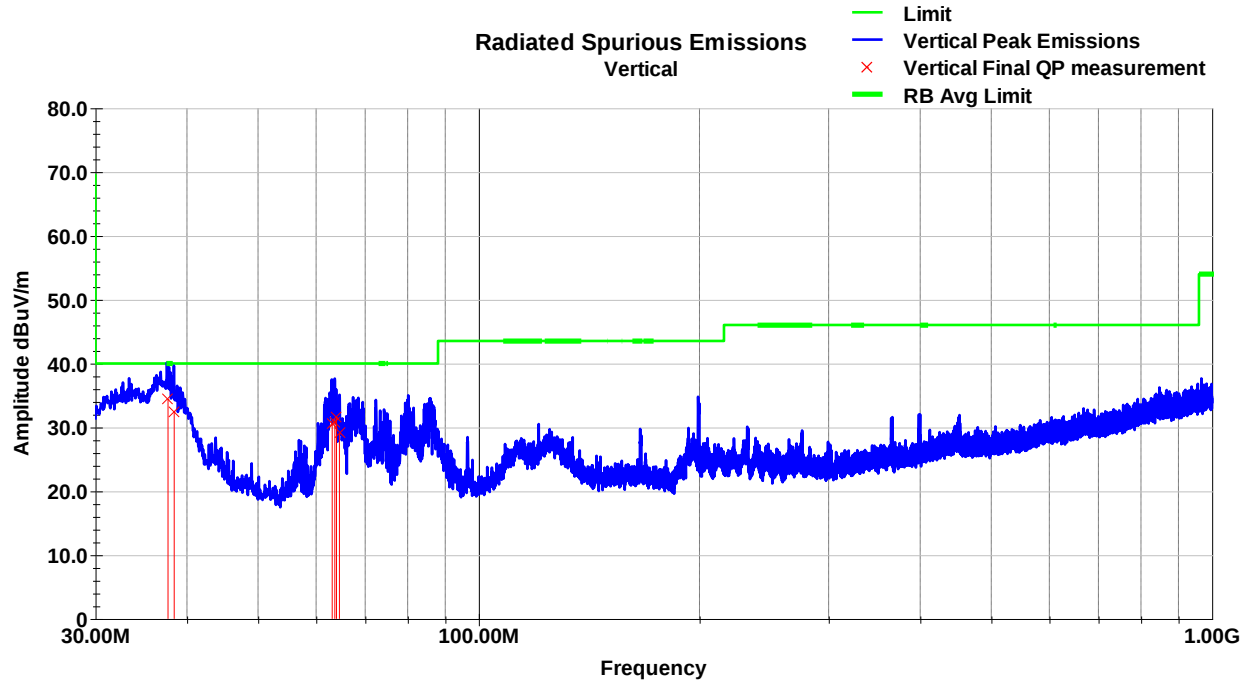
Horizontal Plot – 30-1000MHz – LCH



Horizontal Tabular Data – 30-1000MHz – LCH

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)
31.02	29.8	H	258.0	159.0	25.2	0.6	31.0	24.6	40.0	-15.4
165.98	42.1	H	54.0	175.0	16.5	1.6	30.7	29.5	43.5	-14.0
199.20	44.1	H	95.0	175.0	16.6	1.8	30.6	32.0	43.5	-11.6
398.33	36.6	H	279.0	120.0	20.2	2.6	30.4	29.1	46.0	-17.0
399.92	34.7	H	292.0	120.0	20.2	2.6	30.4	27.2	46.0	-18.8
944.98	24.9	H	21.0	399.0	27.3	3.9	29.3	27.0	46.0	-19.1
QP Value = Raw QP + AF + Loss - Amp										
Margin = QP Value - Limit										

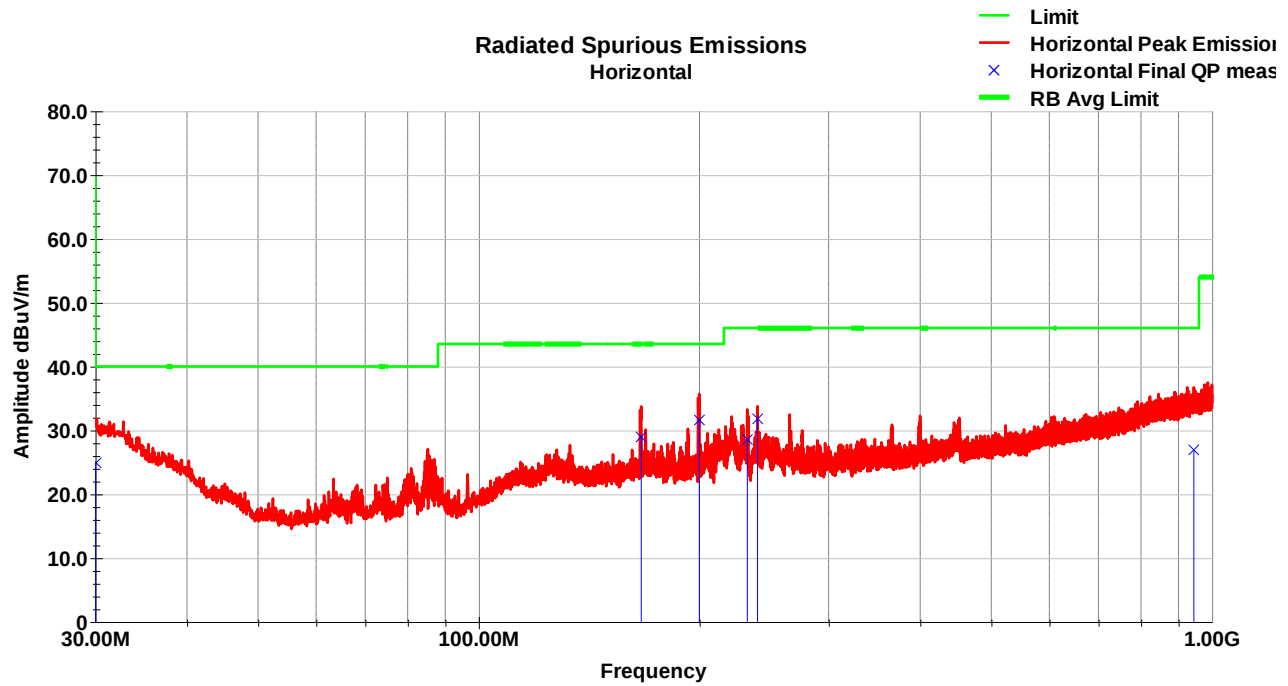
Vertical Plot – 30-1000MHz – MCH



Vertical Tabular Data – 30-1000MHz – MCH

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)
37.69	44.6	V	161.0	100.0	20.1	0.7	31.0	34.5	40.0	-5.5
38.42	43.2	V	122.0	100.0	19.6	0.7	31.0	32.5	40.0	-7.5
63.11	48.9	V	195.0	100.0	11.6	1.0	31.0	30.6	40.0	-9.4
63.64	49.1	V	59.0	100.0	11.7	1.0	31.0	30.9	40.0	-9.1
63.98	49.9	V	139.0	100.0	11.7	1.0	31.0	31.6	40.0	-8.4
64.56	47.2	V	59.0	100.0	11.8	1.0	31.0	29.1	40.0	-10.9
QP Value = Raw QP + AF + Loss - Amp										
Margin = QP Value - Limit										

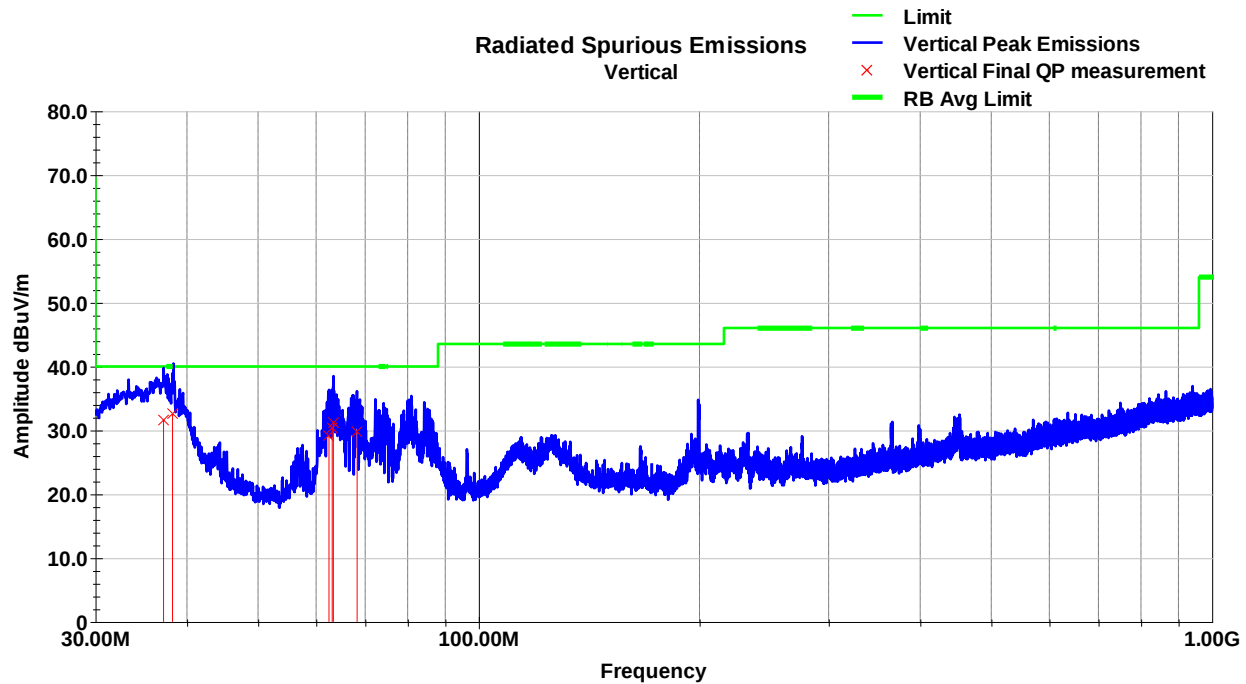
Horizontal Plot – 30-1000MHz – MCH



Horizontal Tabular Data – 30-1000MHz – MCH

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)
30.01	29.2	H	98.0	225.0	26.1	0.6	31.0	24.9	40.0	-15.1
166.59	41.5	H	221.0	146.0	16.4	1.6	30.7	28.9	43.5	-14.6
199.90	43.7	H	54.0	163.0	16.7	1.8	30.6	31.6	43.5	-11.9
232.41	41.4	H	42.0	146.0	15.8	2.0	30.6	28.6	46.0	-17.5
239.99	44.2	H	270.0	146.0	16.1	2.0	30.6	31.8	46.0	-14.2
944.70	24.9	H	55.0	399.0	27.3	3.9	29.3	27.0	46.0	-19.1
QP Value = Raw QP + AF + Loss - Amp										
Margin = QP Value - Limit										

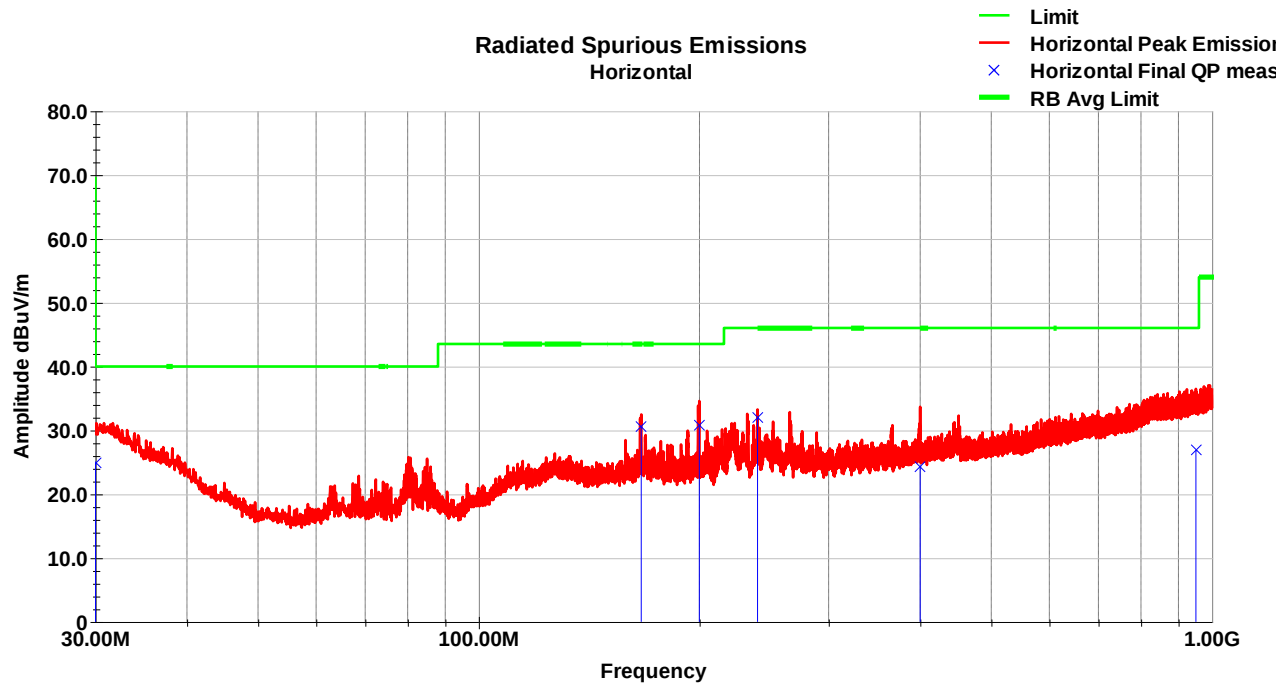
Vertical Plot – 30-1000MHz – HCH



Vertical Tabular Data – 30-1000MHz – HCH

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)
37.16	41.4	V	36.0	157.0	20.5	0.7	31.0	31.7	40.0	-8.3
38.22	43.1	V	105.0	100.0	19.7	0.7	31.0	32.5	40.0	-7.5
62.48	47.5	V	304.0	119.0	11.6	1.0	31.0	29.2	40.0	-10.8
63.11	48.7	V	345.0	100.0	11.6	1.0	31.0	30.4	40.0	-9.6
63.35	49.5	V	126.0	100.0	11.6	1.0	31.0	31.2	40.0	-8.8
68.25	47.7	V	132.0	100.0	11.9	1.0	30.9	29.7	40.0	-10.3
QP Value = Raw QP + AF + Loss - Amp										
Margin = QP Value - Limit										

Horizontal Plot – 30-1000MHz – HCH

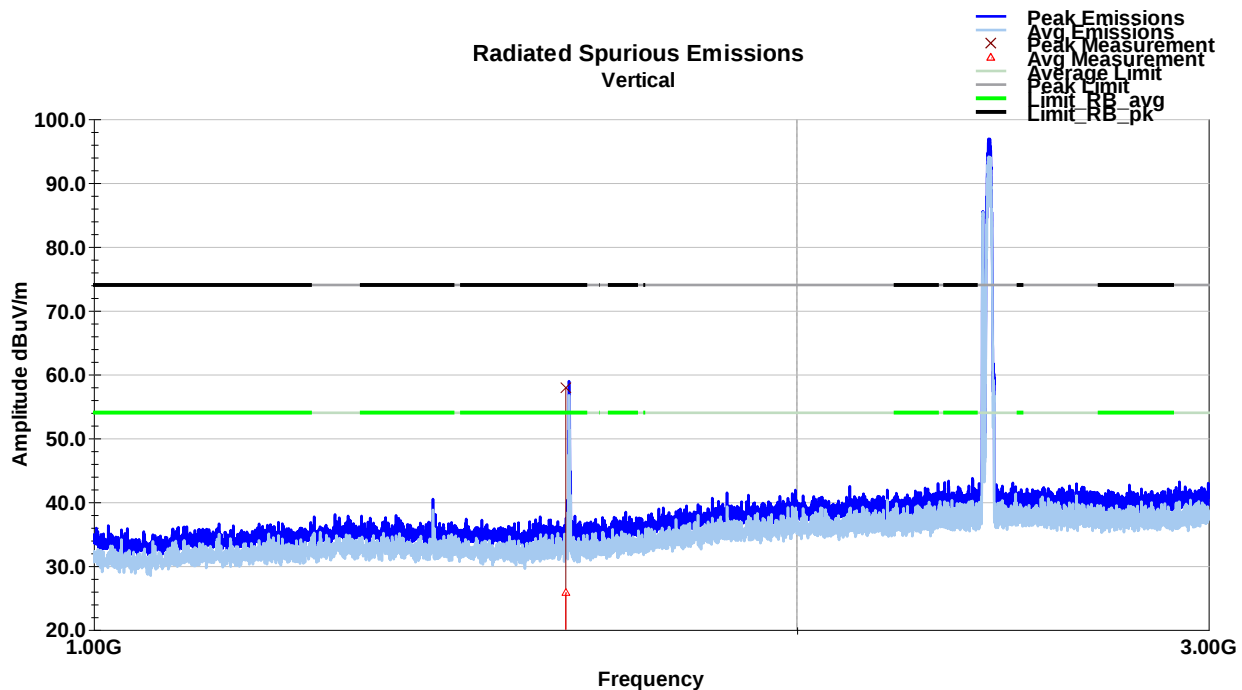


Horizontal Tabular Data – 30-1000MHz – HCH

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)
30.01	29.2	H	21.0	325.0	26.1	0.6	31.0	24.9	40.0	-15.1
166.55	43.2	H	86.0	175.0	16.4	1.6	30.7	30.6	43.5	-12.9
199.88	42.8	H	49.0	148.0	16.7	1.8	30.6	30.7	43.5	-12.8
240.00	44.5	H	53.0	131.0	16.1	2.0	30.6	32.0	46.0	-14.0
399.99	31.9	H	291.0	131.0	20.2	2.6	30.4	24.4	46.0	-21.7
950.86	24.8	H	121.0	399.0	27.3	3.9	29.3	26.9	46.0	-19.1
QP Value = Raw QP + AF + Loss - Amp										
Margin = QP Value - Limit										

7.5.2 1-18 GHz – Y-Axis was found to be the worst case

Vertical Plot – 1-3GHz – LCH

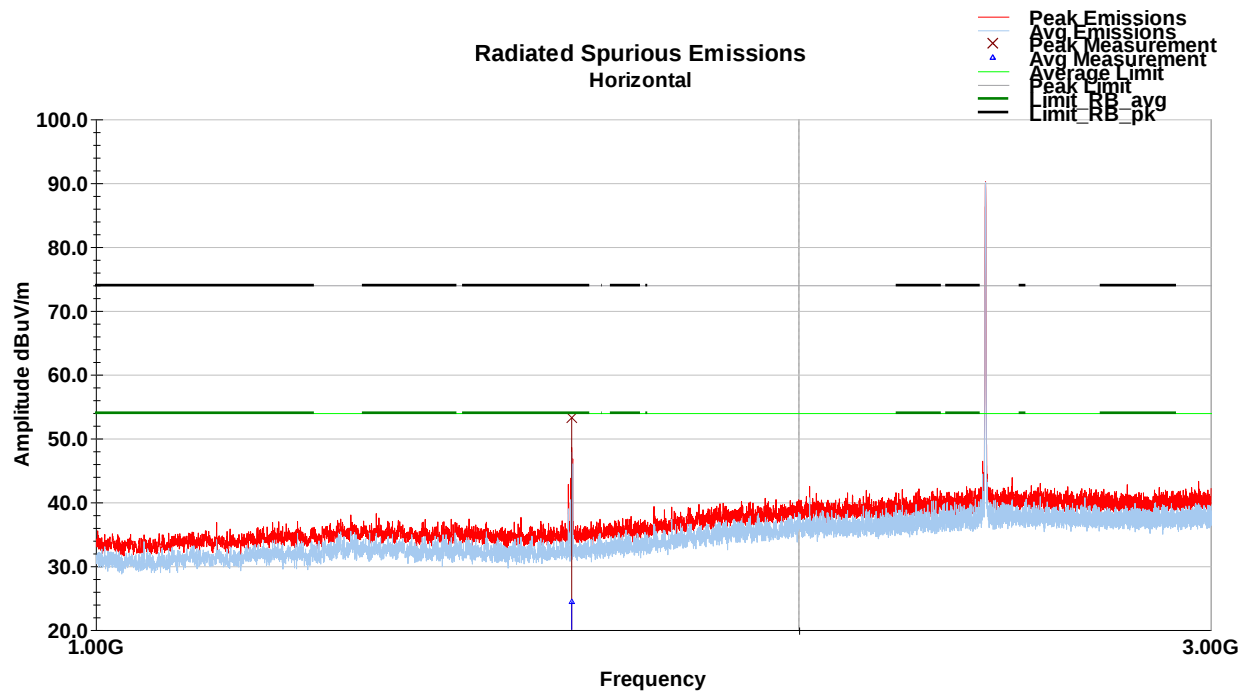


Vertical Tabular Data – 1-3GHz – LCH

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
1592.6	70.307	V	175	147	28.2	2	42.6	57.9	74	-16.1
Final Pk = Raw Pk + AF + Loss - Amp										
Margin = Final Pk - Limit										

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)
1592.6	38.204	V	175	147	28.2	2	42.6	25.844	54	-28.1
Final Avg = Raw Avg + AF + Loss - Amp										
Margin = Final Avg - Limit										

Horizontal Plot – 1-3GHz – LCH

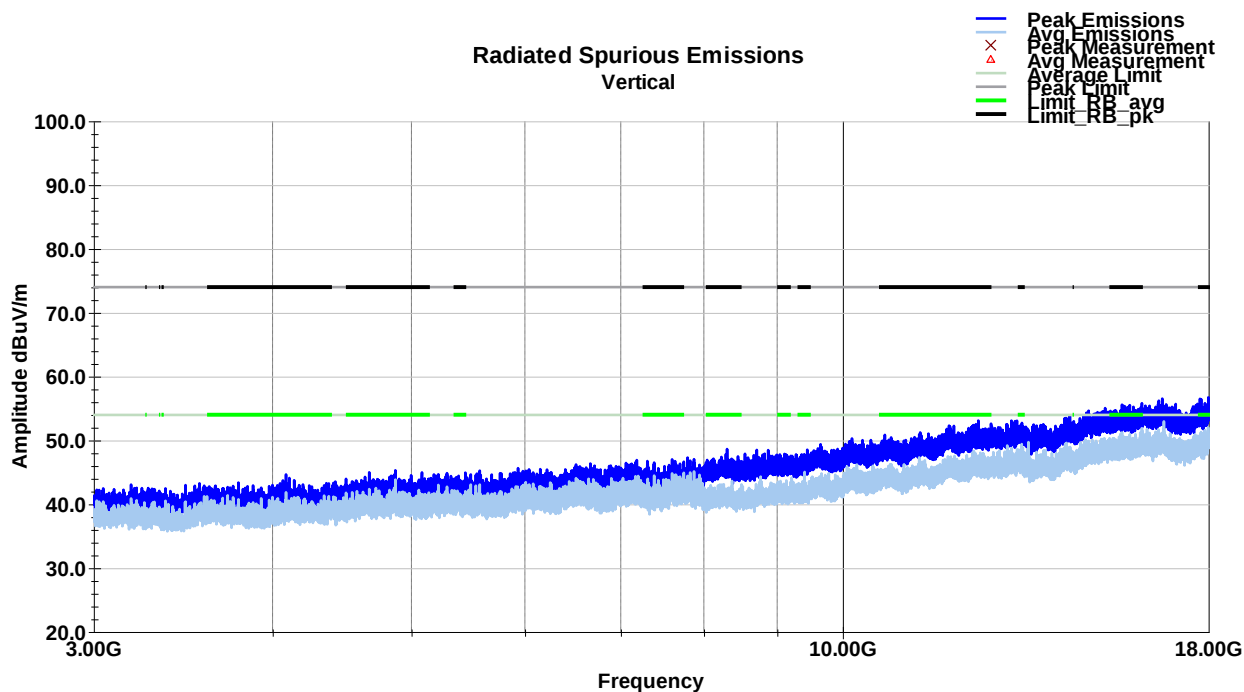


Horizontal Tabular Data – 1-3GHz – LCH

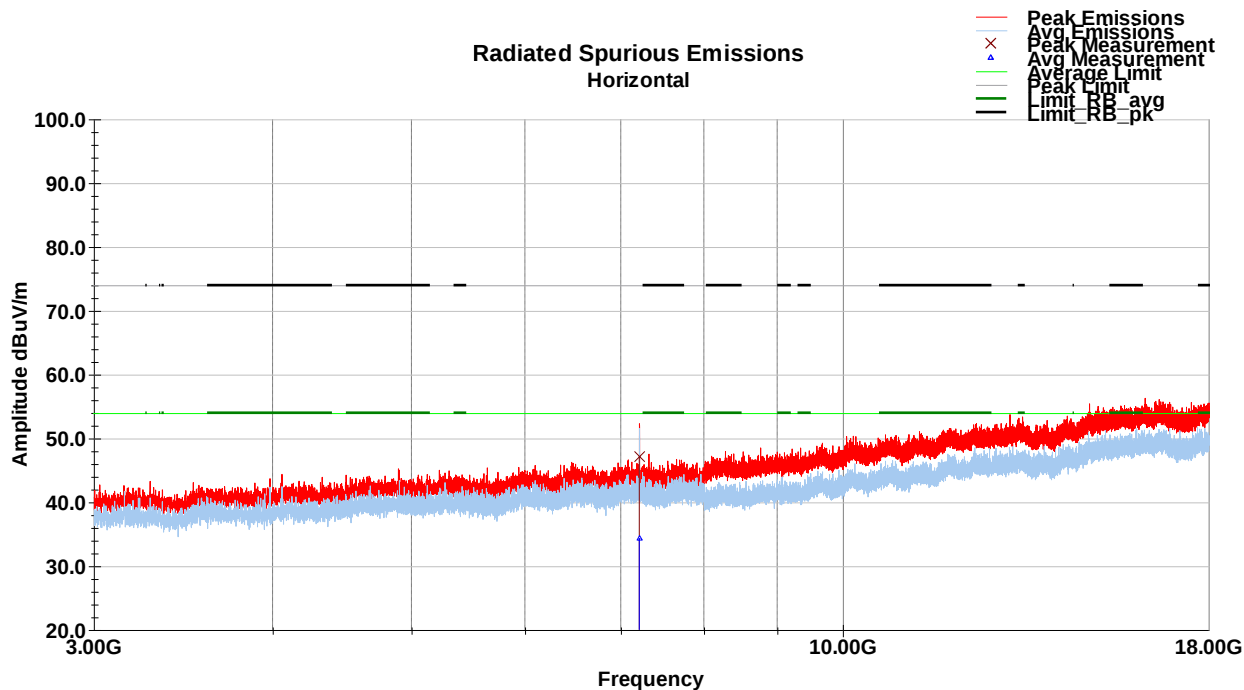
Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
1598.60	65.7	H	112.0	250.0	28.1	2.0	42.6	53.2	74.0	-20.8
Final Pk = Raw Pk + AF + Loss - Amp										
Margin = Final Pk - Limit										

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)
1598.60	36.9	H	112.0	250.0	28.1	2.0	42.6	24.4	54.0	-29.5
Final Avg = Raw Avg + AF + Loss - Amp										
Margin = Final Avg - Limit										

Vertical Plot – 3-18GHz – LCH



Horizontal Plot – 3-18GHz – LCH

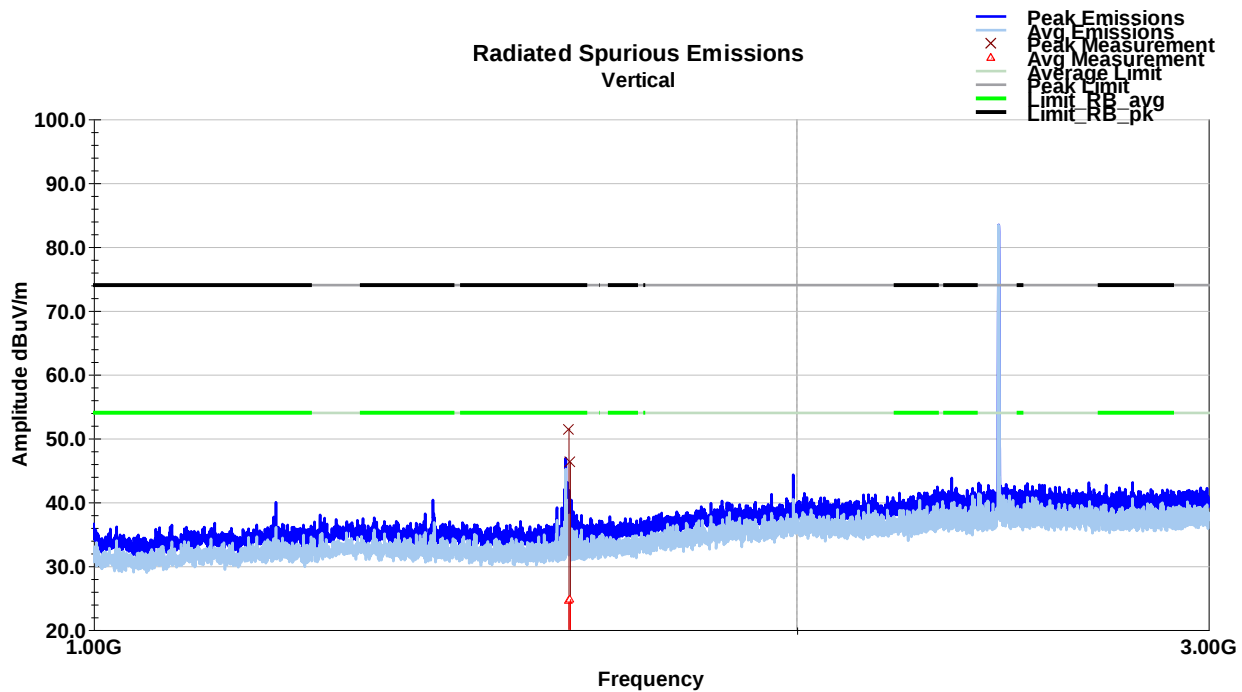


Horizontal Tabular Data – 3-18GHz – LCH

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
7210.96	49.1	H	49.0	250.0	35.9	4.3	42.0	47.2	74.0	-26.8
Final Pk = Raw Pk + AF + Loss - Amp										
Margin = Final Pk - Limit										

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)
7210.96	36.3	H	49.0	250.0	35.9	4.3	42.0	34.4	54.0	-19.6
Final Avg = Raw Avg + AF + Loss - Amp										
Margin = Final Avg - Limit										

Vertical Plot – 1-3GHz – MCH

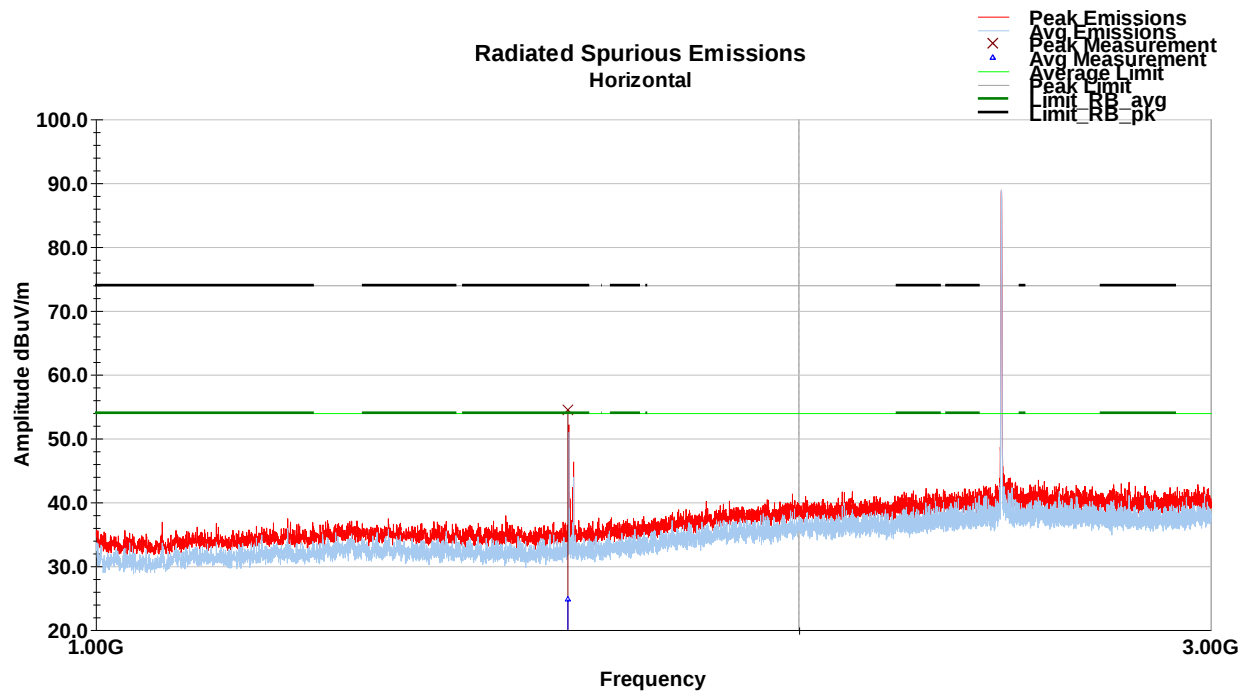


Vertical Tabular Data – 1-3GHz – MCH

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
1597.56	63.938	V	286	100	28.1	2	42.6	51.5	74	-22.5
Final Pk = Raw Pk + AF + Loss - Amp										
Margin = Final Pk - Limit										

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)
1597.56	37.056	V	286	100	28.1	2	42.6	24.62	54	-29.4
Final Avg = Raw Avg + AF + Loss - Amp										
Margin = Final Avg - Limit										

Horizontal Plot – 1-3GHz – MCH

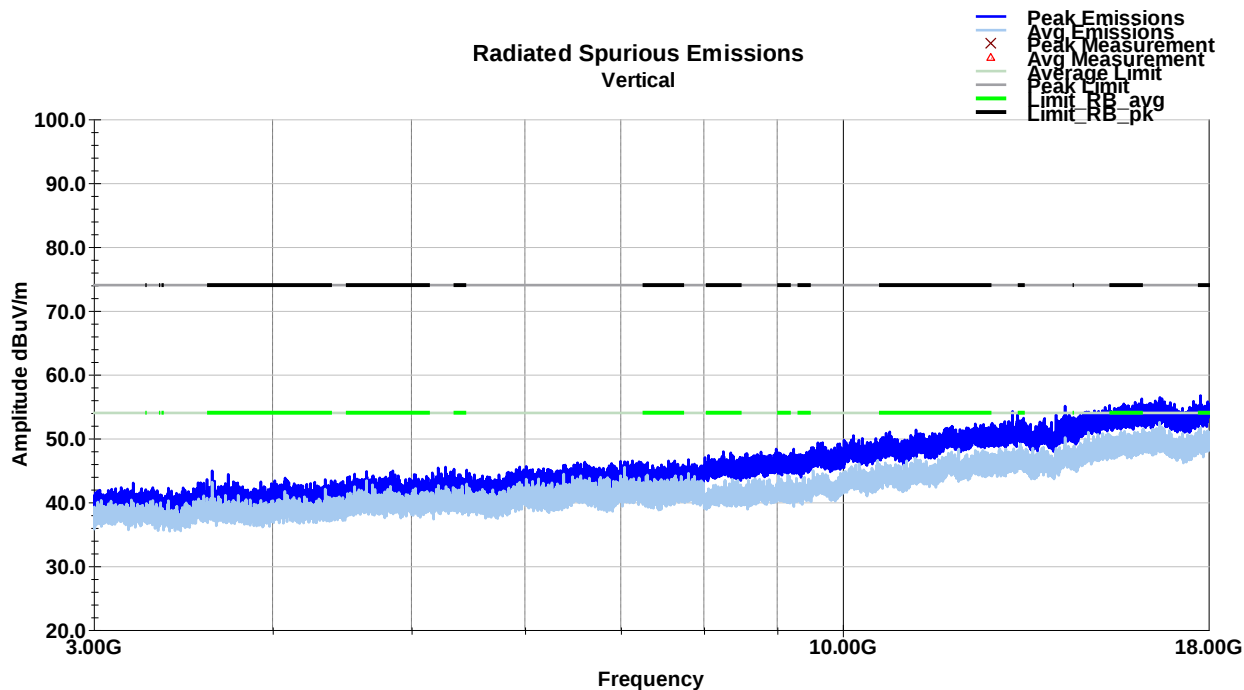


Horizontal Tabular Data – 1-3GHz – MCH

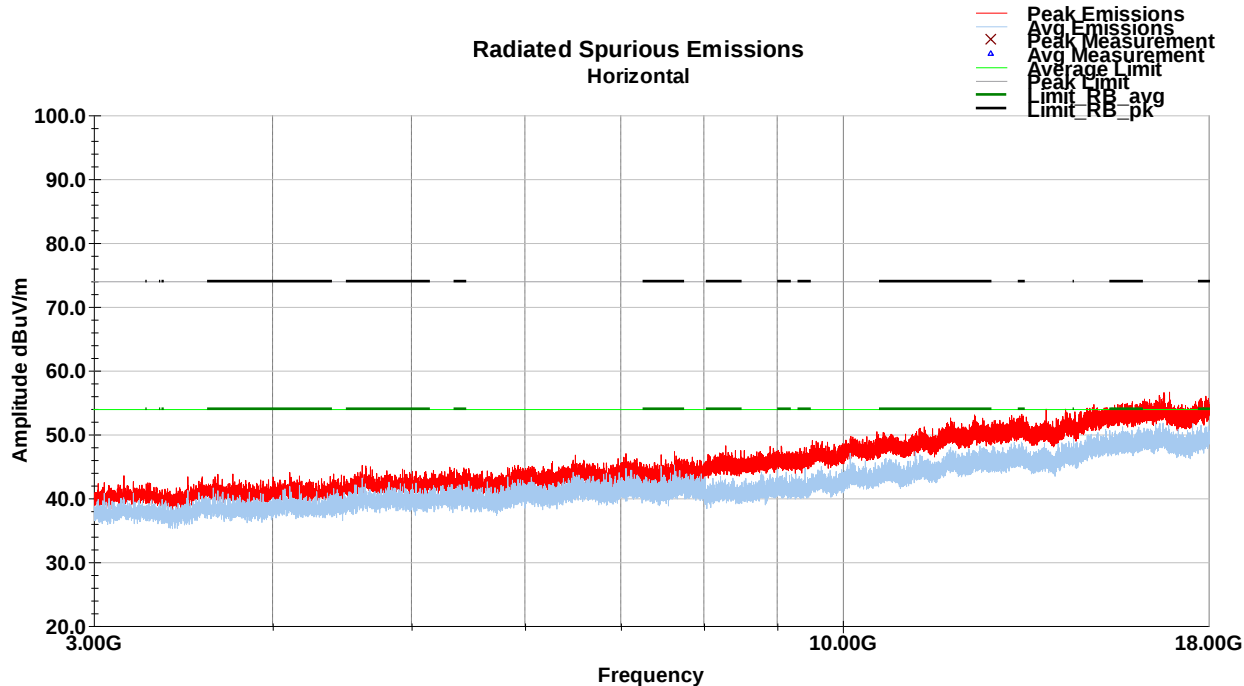
Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
1592.76	66.8	H	124.0	179.0	28.2	2.0	42.6	54.4	74.0	-19.6
Final Pk = Raw Pk + AF + Loss - Amp										
Margin = Final Pk - Limit										

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)
1592.76	37.1	H	124.0	179.0	28.2	2.0	42.6	24.7	54.0	-29.2
Final Avg = Raw Avg + AF + Loss - Amp										
Margin = Final Avg - Limit										

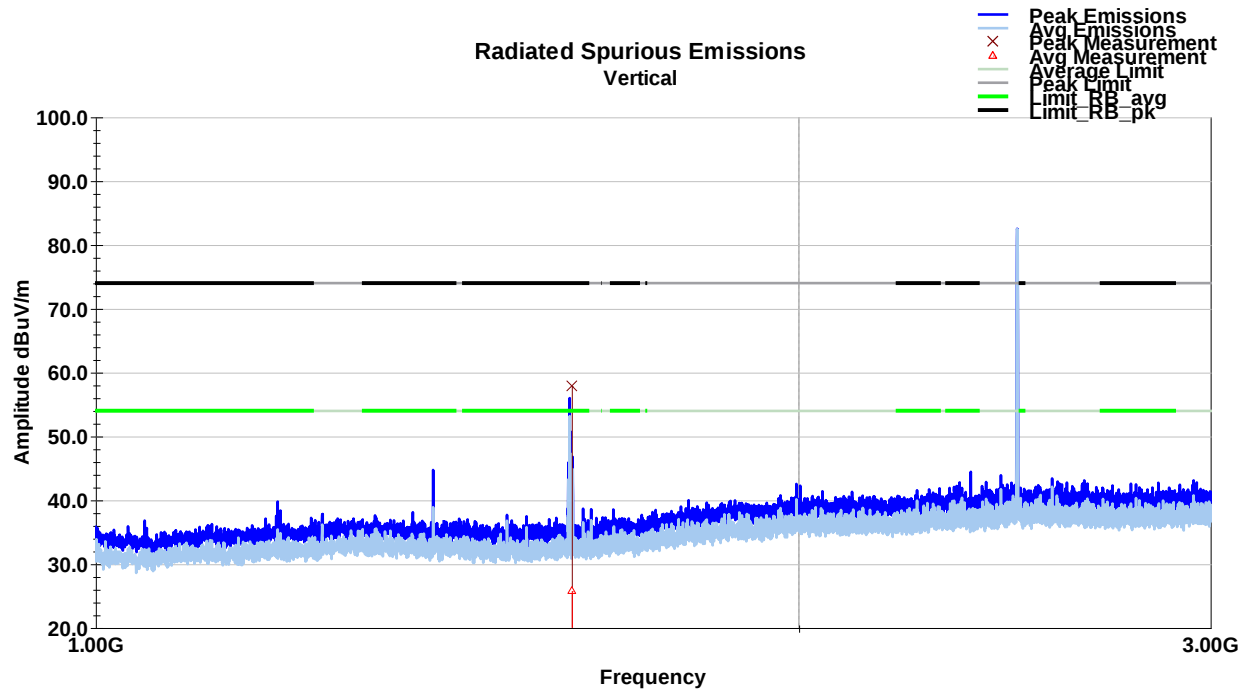
Vertical Plot – 3-18GHz – MCH



Horizontal Plot – 3-18GHz – MCH



Vertical Plot – 1-3GHz – HCH

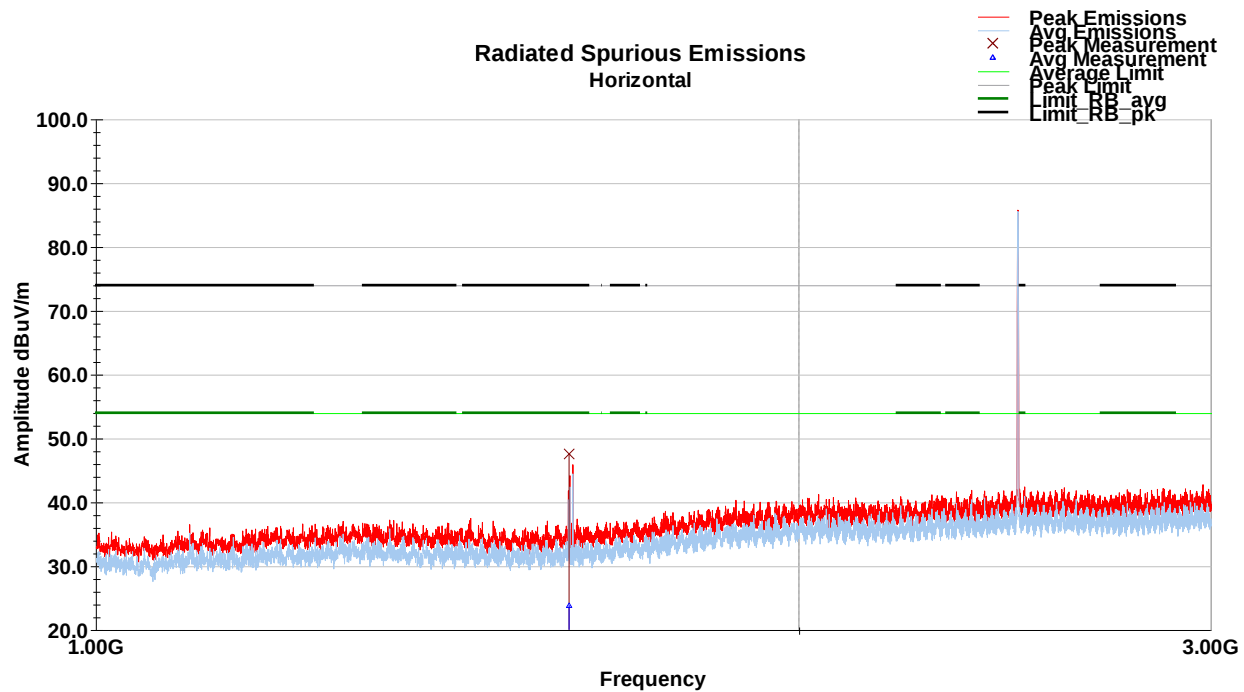


Vertical Tabular Data – 1-3GHz – HCH

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
1599.6	70.325	V	170	127	28.1	2	42.6	57.9	74	-16.1
Final Pk = Raw Pk + AF + Loss - Amp										
Margin = Final Pk - Limit										

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)
1599.6	38.234	V	170	127	28.1	2	42.6	25.767	54	-28.2
Final Avg = Raw Avg + AF + Loss - Amp										
Margin = Final Avg - Limit										

Horizontal Plot – 1-3GHz – HCH

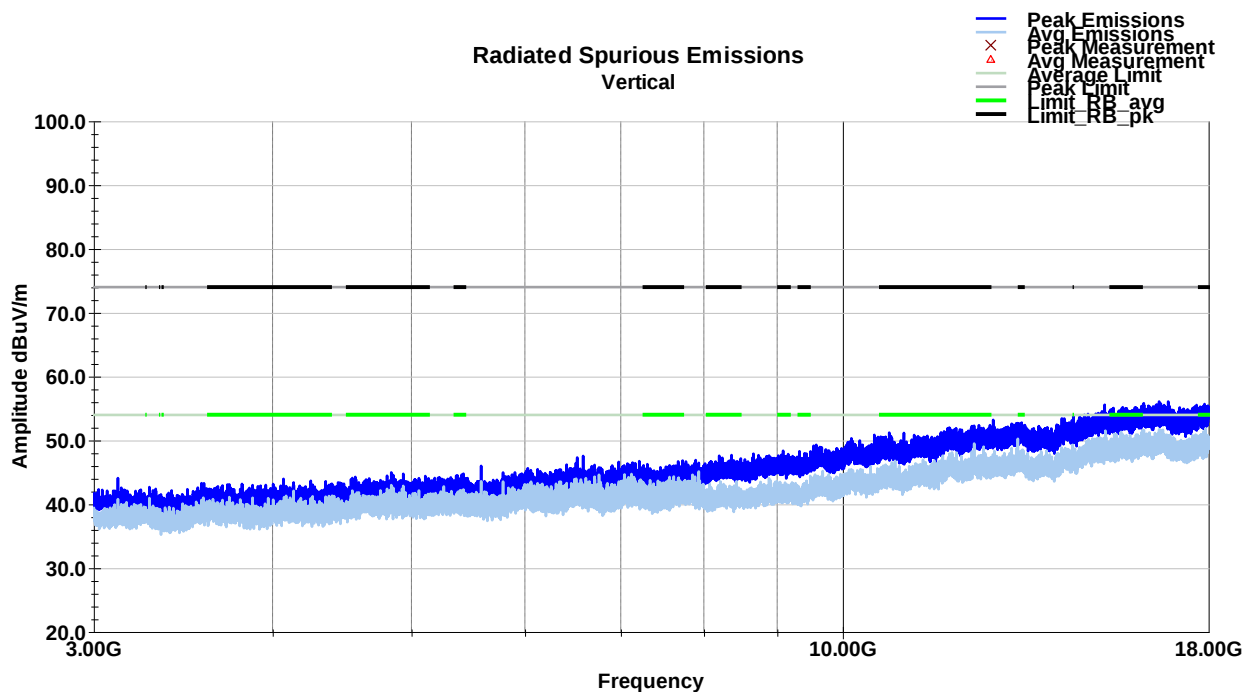


Horizontal Tabular Data – 1-3GHz – HCH

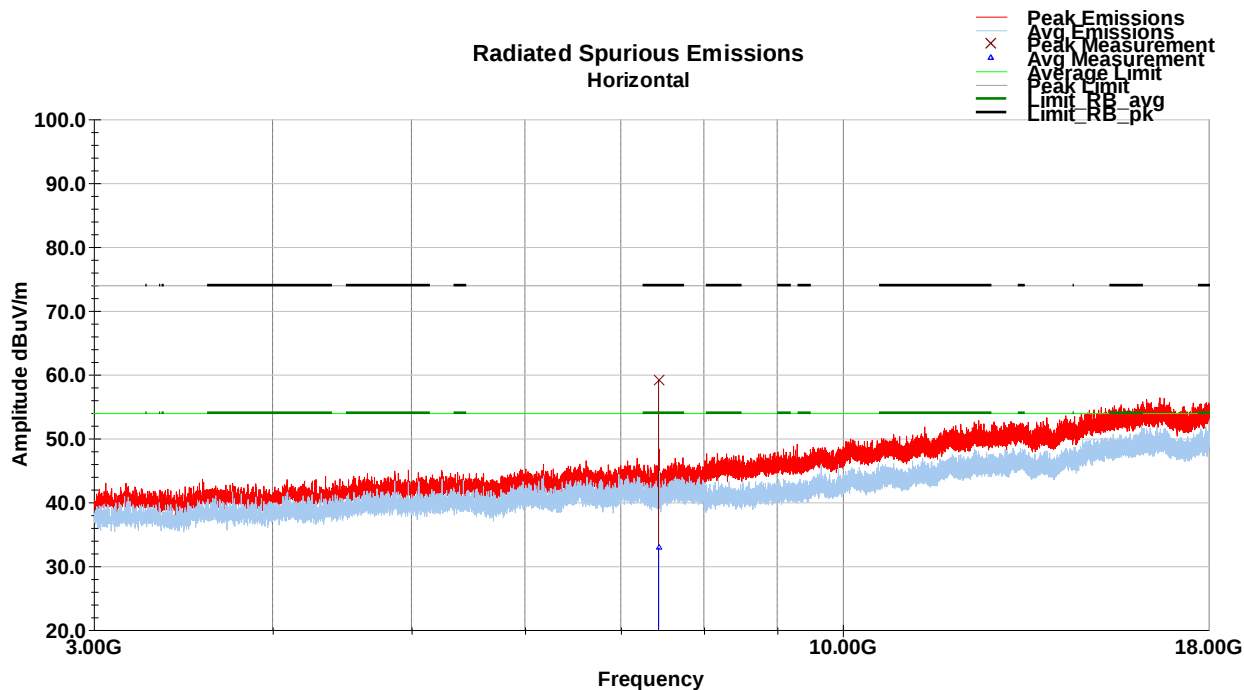
Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
1594.52	60.0	H	129.0	166.0	28.2	2.0	42.6	47.6	74.0	-26.4
Final Pk = Raw Pk + AF + Loss - Amp										
Margin = Final Pk - Limit										

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)
1594.52	36.2	H	129.0	166.0	28.2	2.0	42.6	23.8	54.0	-30.1
Final Avg = Raw Avg + AF + Loss - Amp										
Margin = Final Avg - Limit										

Vertical Plot – 3-18GHz – HCH



Horizontal Plot – 3-18GHz – HCH



Horizontal Tabular Data – 3-18GHz – HCH

Frequency MHz	Raw Pk dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	Loss (dB)	Amp (dB)	Final Pk dBuV/m	Limit dBuV/m	Margin dB
7438.78	61.1	H	344.0	175.0	35.8	4.4	42.1	59.1	74.0	-14.9
Final Pk = Raw Pk + AF + Loss - Amp										
Margin = Final Pk - Limit										

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)
7438.78	34.8	H	344.0	175.0	35.8	4.4	42.1	32.9	54.0	-21.1
Final Avg = Raw Avg + AF + Loss - Amp										
Margin = Final Avg - Limit										

8 Emissions in Restricted Frequency Bands

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.

8.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 21.2 °C

Relative Humidity: 52.4 %

Atmospheric Pressure: 98.5 kPa

8.4 Test Equipment

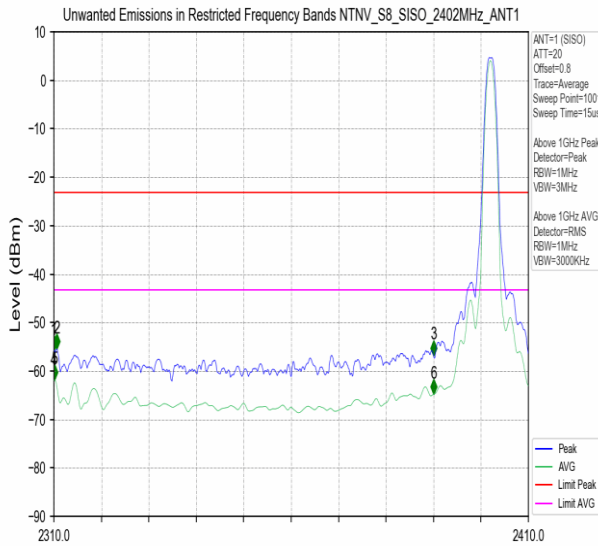
Test End Date: 4-Oct-2022

Tester: AB

Equipment	Model	Manufacturer	Asset	Cal Date	Cal Due Date
RF CABLE (TS8997)	141	HUBER & SUHNER	B095588	5-Jul-2022	5-Jul-2023
SIGNAL ANALYZER (TS8997)	FSV30	ROHDE & SCHWARZ	B085749	4-Jan-2022	4-Jan-2024

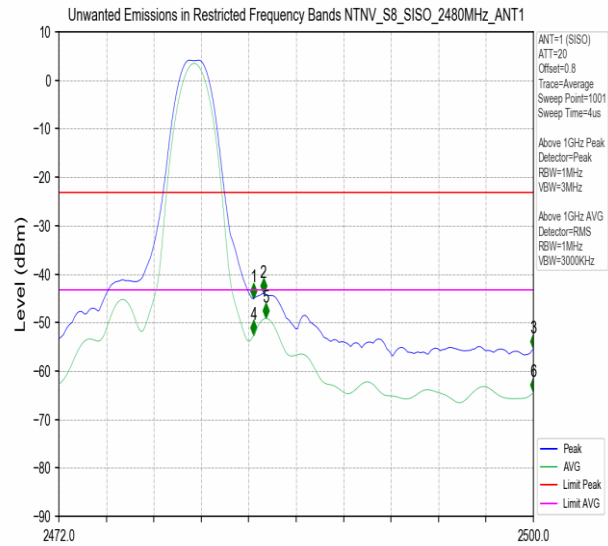
8.5 Test Data – Restricted Band Edge

S8 - Low Channel



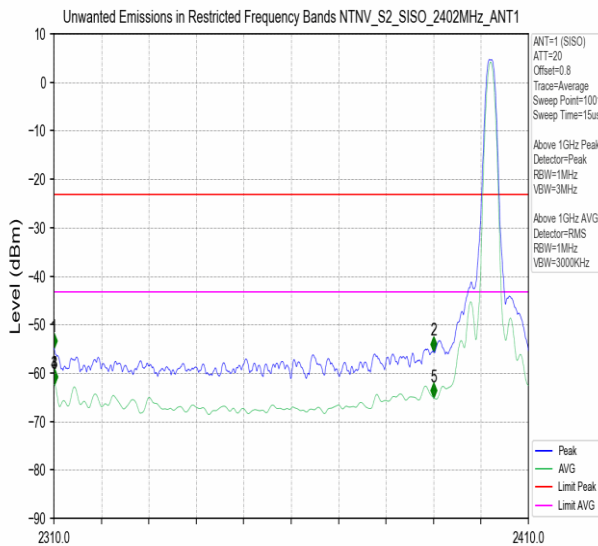
Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2310.000	-55.739	Peak
2	2310.600	-55.495	Peak
3	2390.000	-56.768	Peak

S8 - High Channel



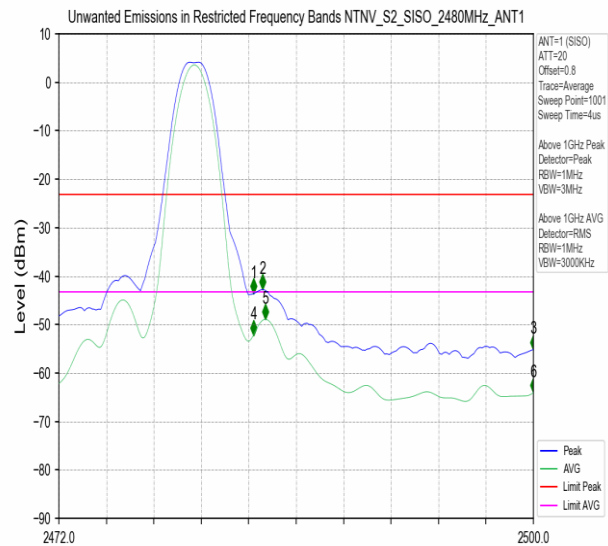
Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2483.500	-44.961	Peak
2	2484.068	-44.047	Peak
3	2500.000	-55.467	Peak

S2 – Low Channel



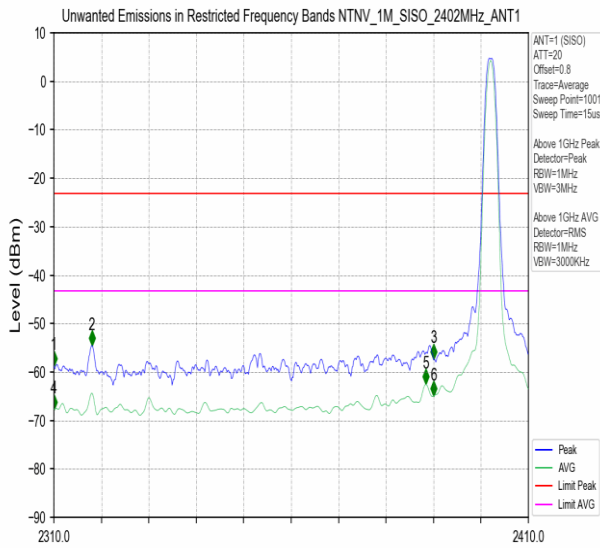
Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2310.000	-54.825	Peak
2	2390.000	-55.522	Peak
3	2310.000	-62.405	AVG

S2 – High Channel



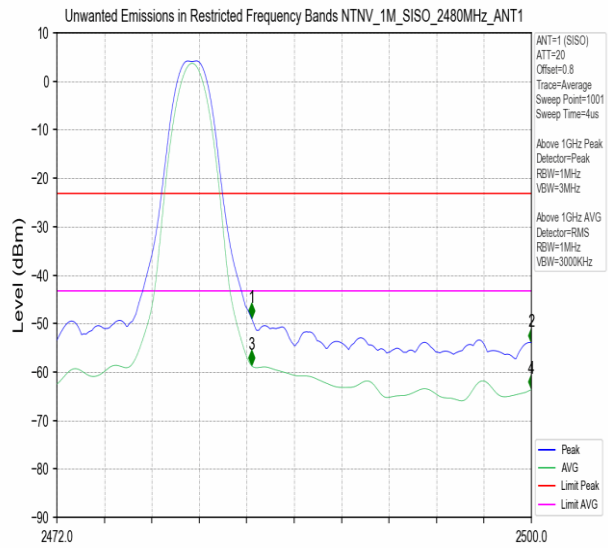
Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2483.500	-43.632	Peak
2	2484.012	-42.805	Peak
3	2500.000	-55.171	Peak

1M – Low Channel



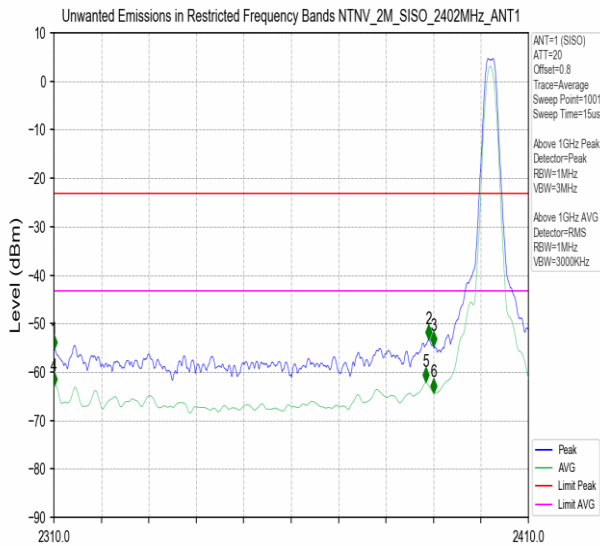
Marker No	Frequency (MHz)	Level (dBm)	Remark	Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2310.000	-58.721	Peak	4	2310.000	-67.708	AVG
2	2318.000	-54.534	Peak	5	2388.400	-62.552	AVG
3	2390.000	-57.309	Peak	6	2390.000	-64.979	AVG

1M – High Channel



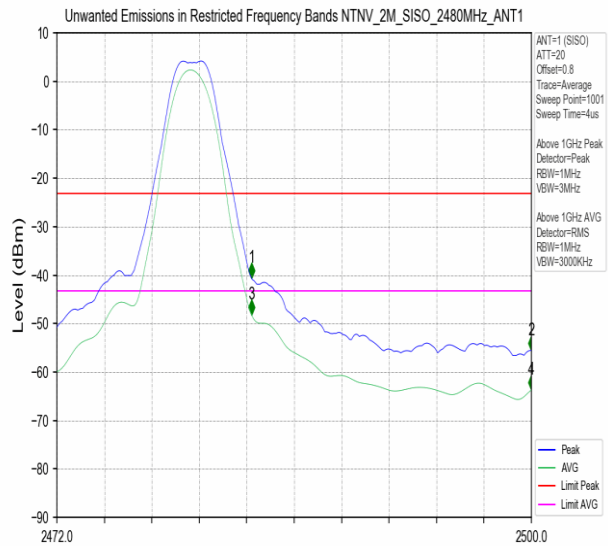
Marker No	Frequency (MHz)	Level (dBm)	Remark	Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2483.500	-48.875	Peak	3	2483.500	-58.681	AVG
2	2500.000	-53.946	Peak	4	2500.000	-63.612	AVG

2M – Low Channel



Marker No	Frequency (MHz)	Level (dBm)	Remark	Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2310.000	-55.480	Peak	4	2310.000	-63.043	AVG
2	2389.000	-53.346	Peak	5	2388.400	-62.152	AVG
3	2390.000	-54.746	Peak	6	2390.000	-64.347	AVG

2M – High Channel



Marker No	Frequency (MHz)	Level (dBm)	Remark	Marker No	Frequency (MHz)	Level (dBm)	Remark
1	2483.500	-40.673	Peak	3	2483.500	-48.163	AVG
2	2500.000	-55.574	Peak	4	2500.000	-63.711	AVG

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	17 February 2023