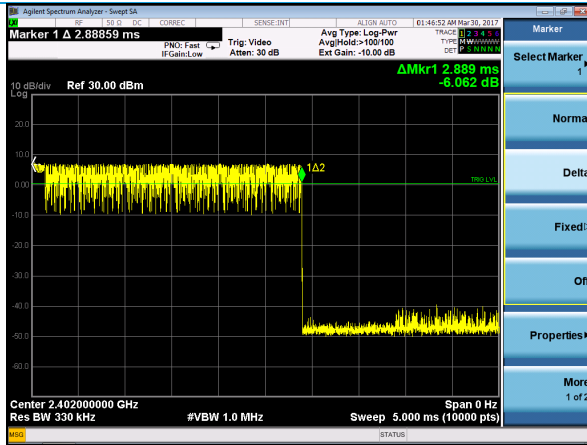


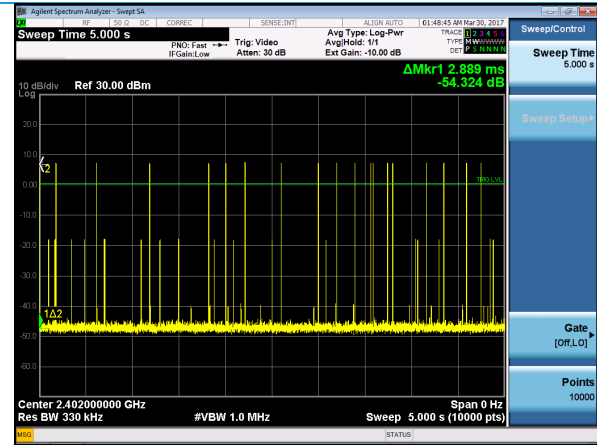
Plots – EDR2 Time of Occupancy

Single Hop Dwell Time

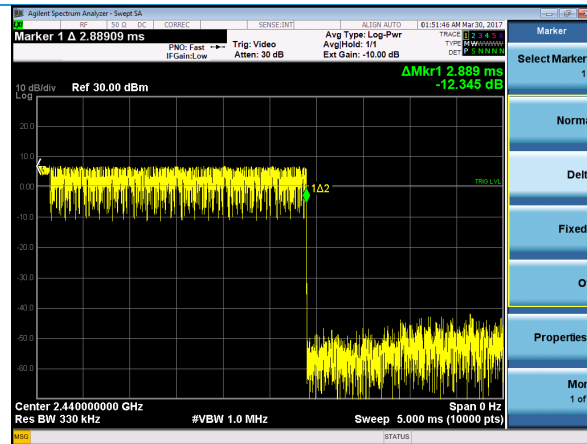


Low Channel

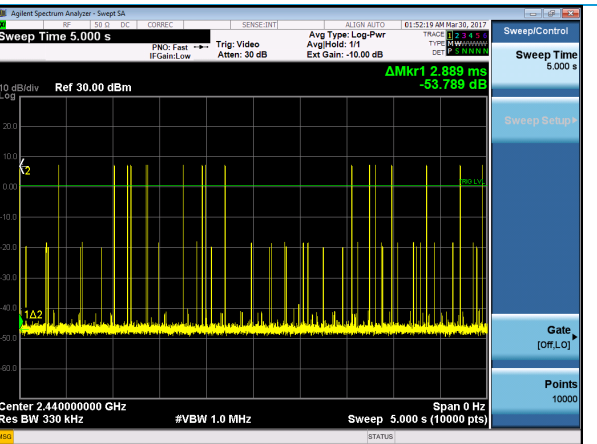
Occurrences in 5 sec Window



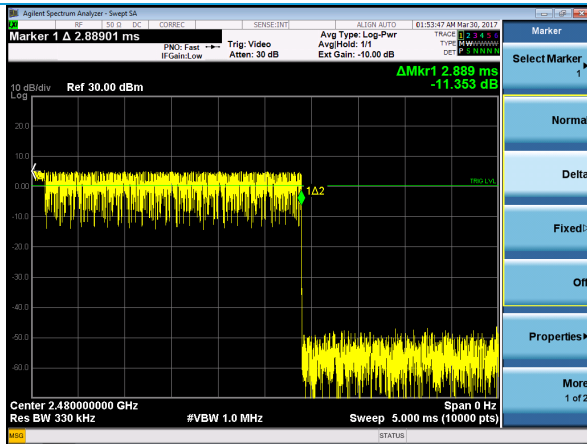
Low Channel



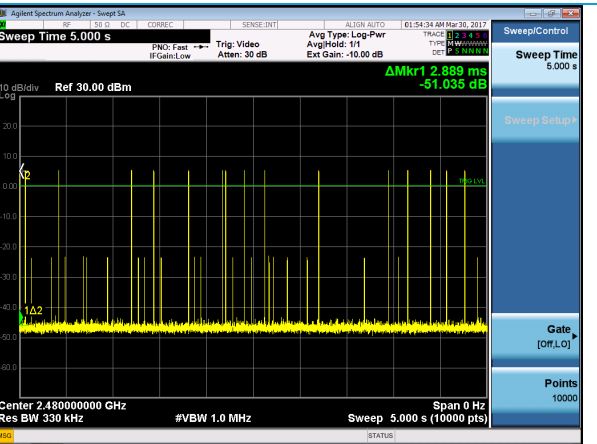
Mid Channel



Mid Channel



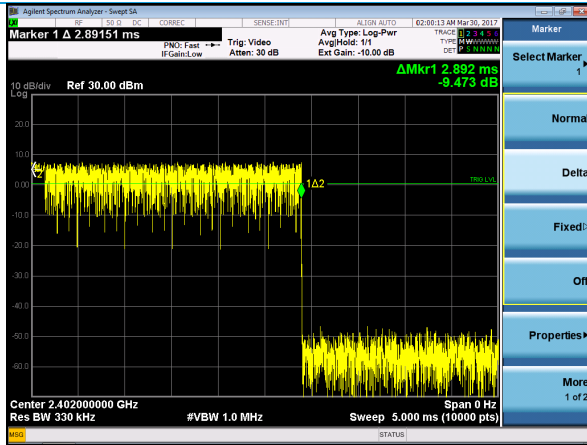
High Channel



High Channel

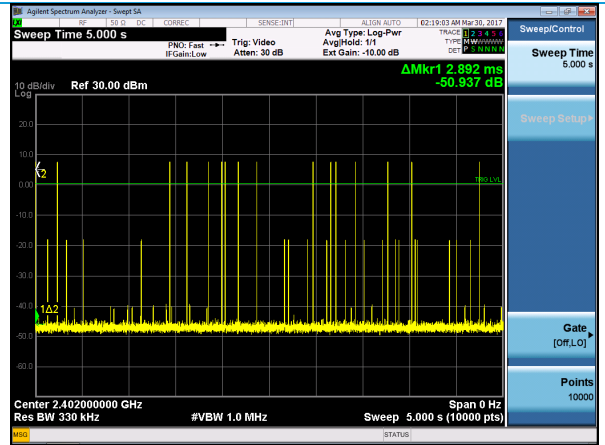
Plots – EDR3 Time of Occupancy

Single Hop Dwell Time

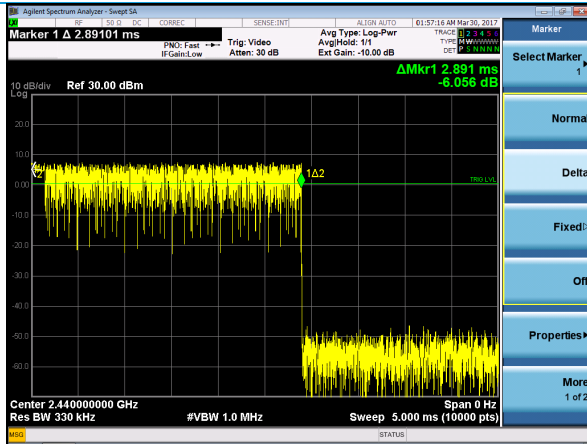


Low Channel

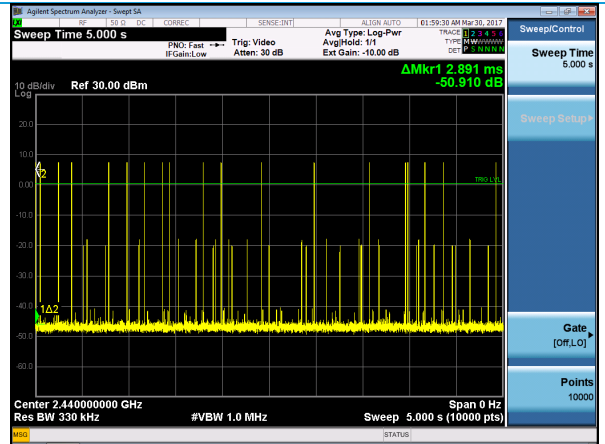
Occurrences in 5 sec Window



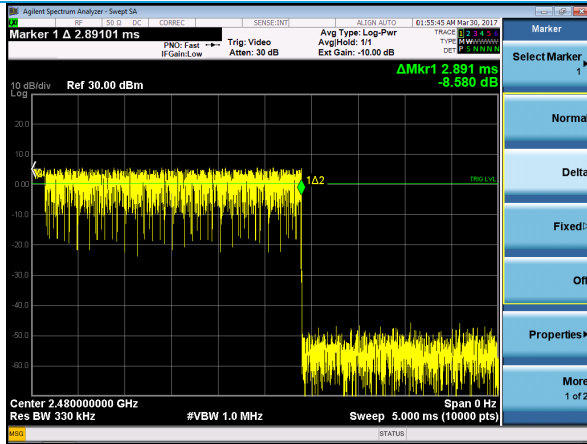
Low Channel



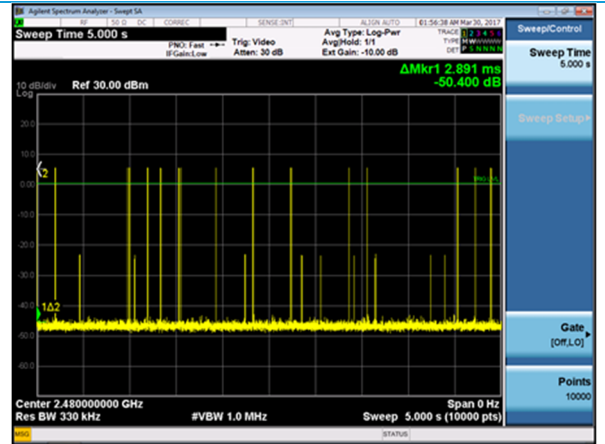
Mid Channel



Mid Channel



High Channel



High Channel

Company: Laird Technologies, Inc.	Page 37 of 50	Name: Sterling-LWB5
Report: TR 315356 B (FHSS)		Model: Sterling-LWB5
Job: C-2602		Serial: 00009, 00015, 00019, 00032

5.2 Radiated Emissions

<p>Description of Measurement</p>	<p>The frequency spectrum is investigated for intentional and / or unintentional signals emanating from the EUT by use of a standardized test site and measurement antenna.</p> <p>The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are performed allowing the data to be gathered and reported as corrected values.</p> <p>The maximum emissions from the EUT are determined by turn-table azimuth rotation (360°) and scanning of the measurement antenna. Maximized levels are noted at degree values of azimuth, measurement antenna height, and measurement antenna polarity.</p>
<p>Example Calculations</p>	<p>Measurement (dBμV) + Cable factor (dB) + Other (dB) + Antenna Factor (dB/m) = Corrected Reading (dBμV/m)</p> <p>Margin (dB) = Limit (dBμV/m) - Corrected Reading (dBμV/m)</p> <p>Example at 4000 MHz: Reading = 40 dBμV + 3.4 dB + 0.9 dB + 6.5 dB/m = 50.8 dBμV/m Average Limit = 20 log (500) = 54 dBμV/m Margin = 54 dBμV/m - 50.8 dBμV/m = 3.2 dB</p>

Block Diagram



5.2.1 Radiated – Restricted Band Edges

Operator	Kimberly Bay
QA	Shane Dock
Test Date	March 22, 2017 / May 7, 2017
Location	3-meter Semi-Anechoic Chamber
Temp. / R.H.	20°C/31%RH
Requirement	FCC 15.247 (d) / RSS-247 Section 5.5
Method	ANSI C63.10 2013 Section 6.10.5

FCC 15.209 Limits:

Frequency	Average Limit	Peak Limit
Above 960 MHz	54 dB μ V/m	74 dB μ V/m

Test Parameters

Frequency	2310-2390 MHz 2483.5-2500 MHz
Distance	3 meters
Test Chamber	Absorbers on floor, tilt-gear used with antenna to maintain cone of radiation
EUT	Maximum power setting, GFSK, single channel mode & hopping mode, random data pattern
Notes	FlexPIFA - Highest Gain Antenna Tested in three orientations with maximum results reported.

Instrumentation



Date : 6-Feb-2017

Type Test : Radiated Emissions

Job # : C-2602

Prepared By: Kim

Customer : LSR

Quote #: 316356

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960085	EMI Receiver	Agilent	N9038A	MY51210148	5/12/2016	5/12/2017	Active Calibration
2	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	7/22/2016	7/22/2017	Active Calibration

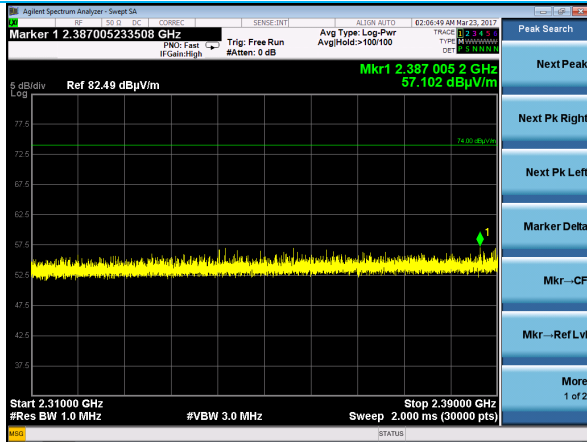
Table – Band Edges – Single Channel Mode

Band Edge	Data Rate	Peak Frequency (MHz)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Average Frequency (MHz)	Avg. Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)
Lower	GFSK	2387	57.1	74	16.9	2385	43.6	54	10.4
Upper	GFSK	2497	58.3	74	15.7	2484	44.6	54	9.4

Table – Band Edges – Hopping Mode

Band Edge	Data Rate	Peak Frequency (MHz)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Average Frequency (MHz)	Avg. Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)
Lower	GFSK	2368	51.6	74	22.4	2390	39.6	54	14.4
Upper	GFSK	2497	52.1	74	21.9	2497	39.7	54	14.3

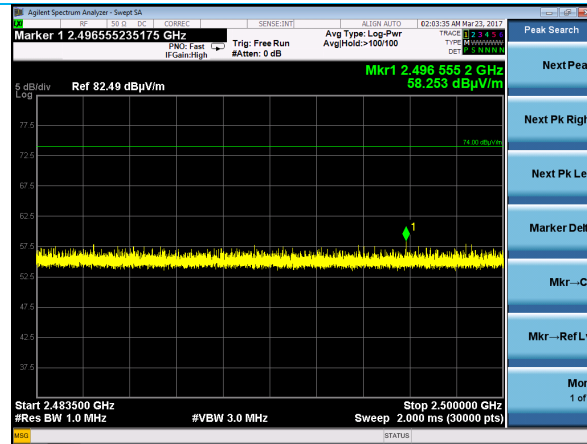
Plots – Radiated Band Edge – Single Channel Mode



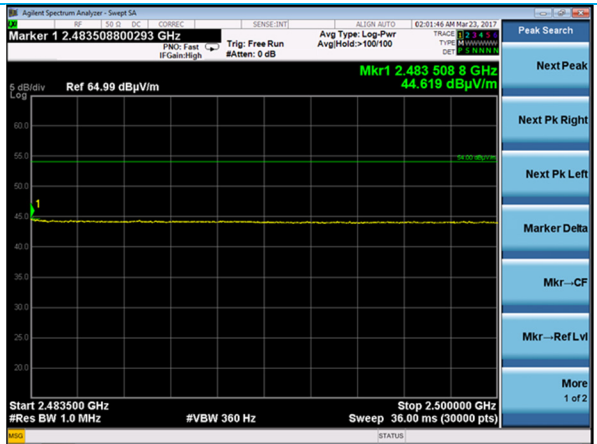
Low Channel - Peak



Low Channel - Average



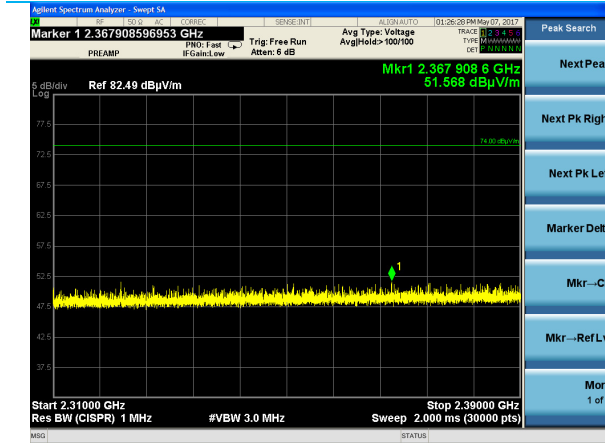
High Channel - Peak



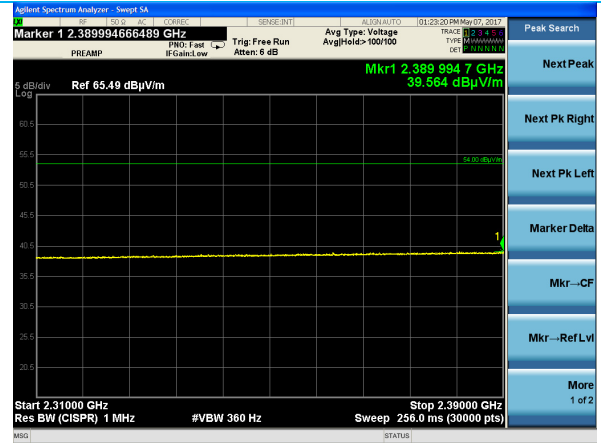
High Channel - Average



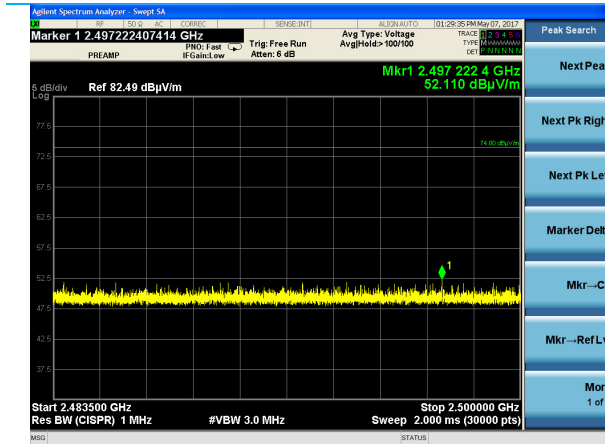
Plots – Radiated Band Edge – Hopping Mode



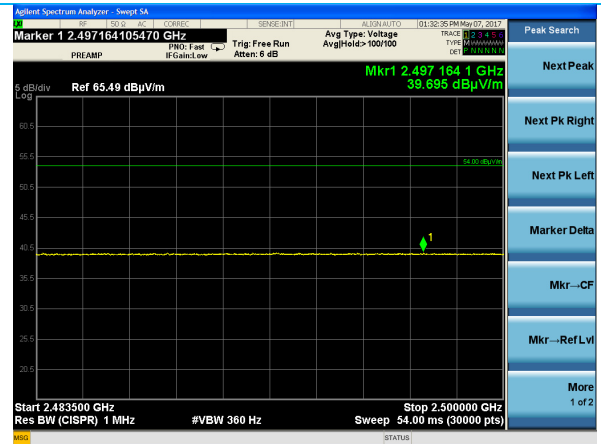
LBE Hopping Mode - Peak



LBE Hopping Mode - Average



UBE Hopping Mode - Peak



UBE Hopping Mode - Average

Company: Laird Technologies, Inc.	Page 42 of 50	Name: Sterling-LWB5
Report: TR 315356 B (FHSS)		Model: Sterling-LWB5
Job: C-2602		Serial: 00009, 00015, 00019, 00032

5.2.2 Radiated – Spurious Emissions

Operator	Shane Dock / Kimberly Bay
QA	Kimberly Bay / Shane Dock
Test Date	March 2, 2017 / March 23, 2017
Location	3-meter Semi-Anechoic Chamber
Temp. / R.H.	21°C / 30% R.H. / 21°C / 28%RH
Requirement	FCC 15.247 (d) / RSS-247 Section 5.5
Method	ANSI C63.10 2013 Sections 6.5 and 6.6

FCC 15.209 Limits:

Frequency (MHz)	Quasi-Peak Limit (dB μ V/m)	Average Limit (dB μ V/m)	Peak Limit (dB μ V/m)
30-88	40	N/A	N/A
88-216	43.5	N/A	N/A
216-960	46	N/A	N/A
Above 960	N/A	54	74

Test Parameters

Frequency	30 MHz – 25 GHz
Distance	3 meters
Settings	<u>Measurements below 1 GHz</u> EMI Receiver with QP detector, RBW = 120 kHz, VBW = 1.2 MHz <u>Measurements above 1 GHz</u> Spectrum Analyzer with Average and Peak detectors, RBW = 1 MHz, VBW = 3 MHz (unless otherwise noted)
Test Chamber	Above 1 GHz: absorbers on floor and tilt-gear used with antenna to maintain cone of radiation
EUT	Maximum power setting, GFSK, single channel mode (H, M, L channels), random data pattern
Notes	FlexPIFA - Highest Gain Antenna Tested in three orientation with maximum results reported.

Instrumentation



Date: 6-Feb-2017

Type Test: Radiated Emissions

Job #: C-2602

Prepared By: Kim

Customer: LSR

Quote #: 316356

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960085	EMI Receiver	Agilent	N9038A	MY51210148	5/12/2016	5/12/2017	Active Calibration
2	AA 960158	Double Ridge Horn Antenna	ETS Lindgren	3117	109300	10/13/2016	10/13/2017	Active Calibration
3	EE 960159	Low Noise Amplifier	Mini-Circuits	ZVA-213X-S+	40201429	10/13/2016	10/13/2017	Active Calibration
4	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	7/22/2016	7/22/2017	Active Calibration
5	AA 960153	High Pass Filter 2.4 GHz	KVM	HPF-L-14186	7272-04	4/23/2016	4/23/2017	Active Calibration
6	AA 960154	High Pass Filter 2.4 GHz	KVM	HPF-L-14186	7272-02	7/25/2016	7/25/2017	Active Calibration
7	EE 960160	Low Noise Amplifier	Mini-Circuits	ZVA-213X-S+	977711030	7/22/2016	7/22/2017	Active Calibration
8	AA 960174	Small Horn Antenna	ETS Lindgren	3116C-PA	00206880	4/23/2016	4/23/2017	Active Calibration

Table - Bluetooth Spurious Emission Data 30-1000 MHz

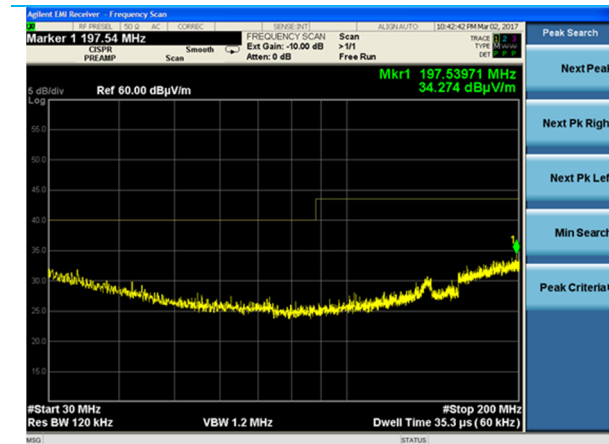
Frequency (MHz)	Height (m)	Azimuth (degree)	QP Reading (dBμV/m)	QP Limit (dBμV/m)	Margin (dB)	Antenna Polarity	EUT Orientation	Channel	Notes
949.18	1.00	0.0	28.5	43.5	15.0	Horizontal	Vertical	Low	1
947.08	1.00	0.0	28.4	43.5	15.1	Vertical	Vertical	Low	1
196.64	1.00	0.0	28.0	43.5	15.5	Vertical	Vertical	Low	1
198.74	1.00	0.0	28.0	43.5	15.5	Horizontal	Vertical	Low	1

1) Noise floor measurement

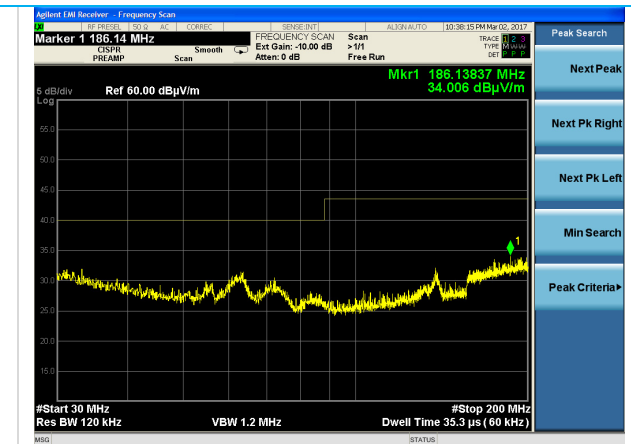
Table - Bluetooth Spurious Emission Data 1-25 GHz

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBμV/m)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Antenna Polarity	EUT Orientation	Channel
4804	1.67	235	44.5	37.8	54	16.2	Horizontal	Side	Low
4880	1.00	45	45.3	39.8	54	14.2	Horizontal	Side	Mid
7320	1.85	50	51.8	46.4	54	7.6	Horizontal	Side	Mid
4960	1.00	48.5	45.3	39.3	54	14.7	Horizontal	Side	High
7440	1.76	62	51.9	46.4	54	7.6	Horizontal	Side	High

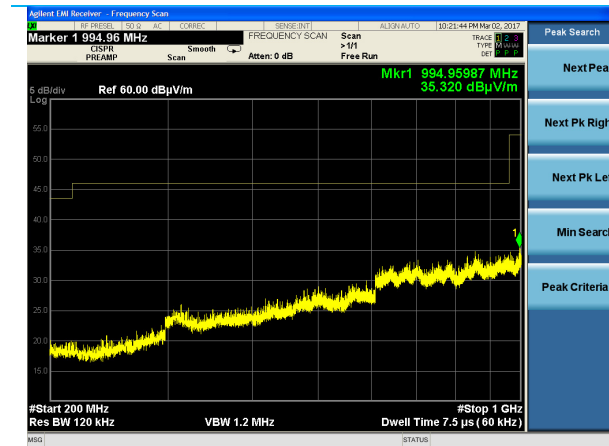
Plots – Radiated TX Spurious Emissions



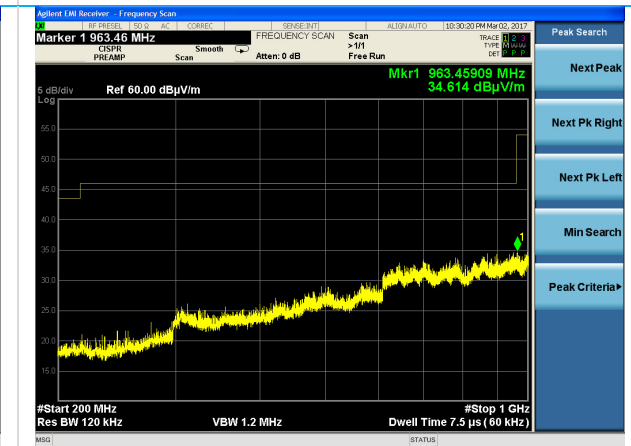
30-200 MHz – Horizontal Antenna



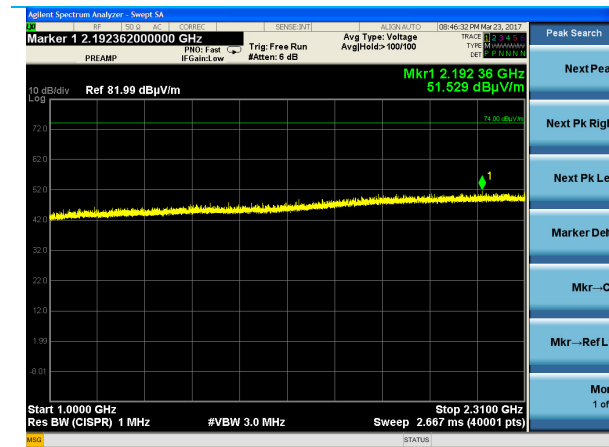
30-200 MHz – Vertical Antenna



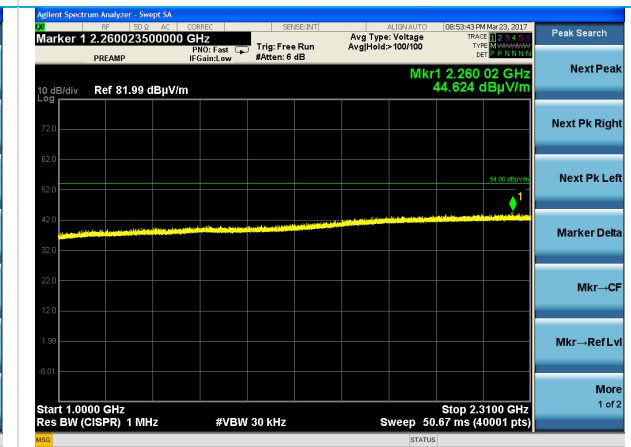
200-1000 MHz – Horizontal Antenna



200-1000 MHz – Vertical Antenna

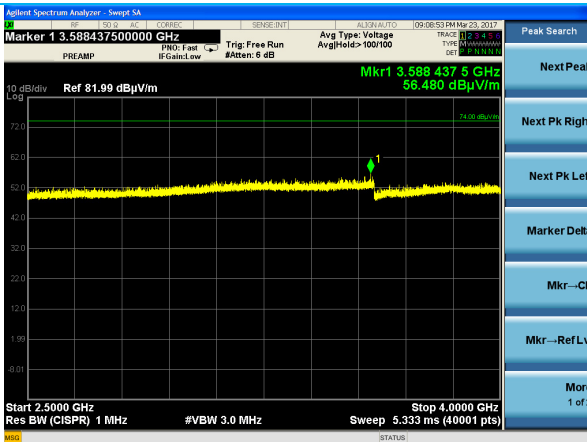


1-2.31 GHz – H+V Antenna

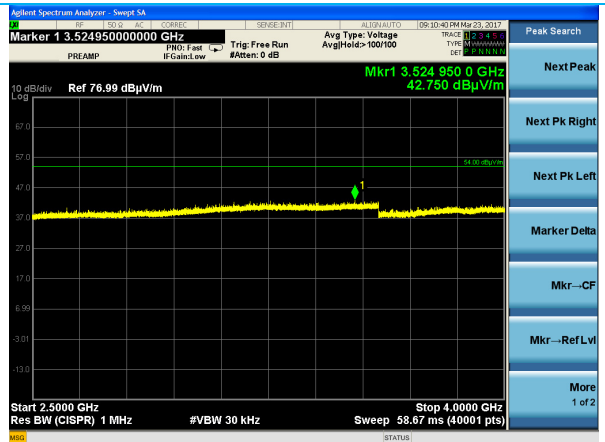


1-2.31 GHz – H+V Antenna – Reduced VBW

Plots – Radiated TX Spurious Emissions, continued



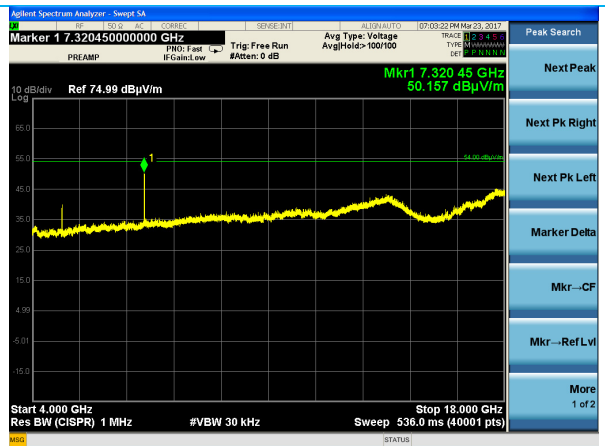
2.5-4 GHz – H+V Antenna



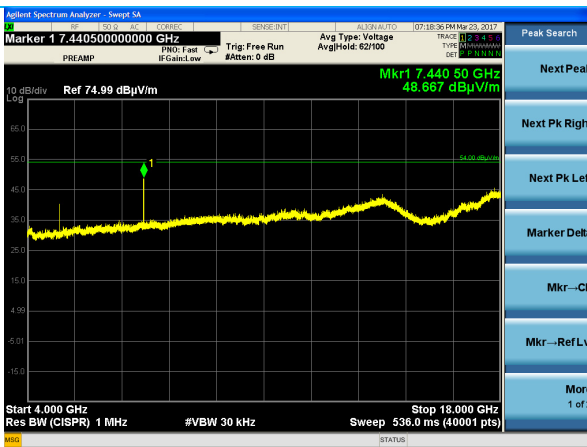
2.5-4 GHz – H+V Antenna – Reduced VBW



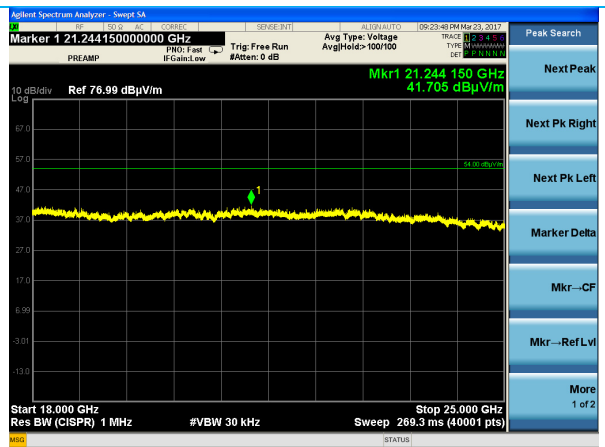
Low Channel – 4-18 GHz – Reduced VBW



Mid Channel – 4-18 GHz – Reduced VBW



High Channel – 4-18 GHz – Reduced VBW



18-25 GHz – Reduced VBW

5.3 AC Mains Conducted Emissions

A line impedance stabilization network (LISN) or artificial mains network (AMN) allows the emissions of the power supply conductors to be measured while isolating the EUT from the supply mains.

Description of Measurement

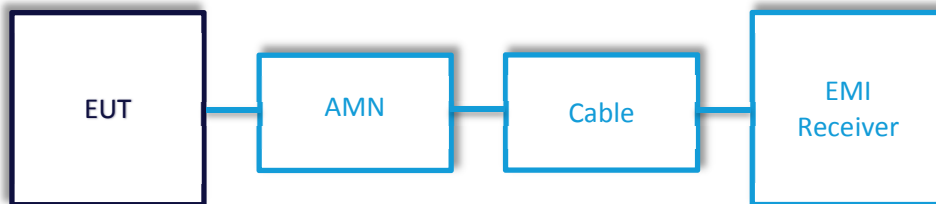
The AMN, cable, and other necessary measurement system correction factors are loaded onto the EMI receiver when the measurements are performed. The data is gathered and reported as the corrected values.

Maximum emissions are determined with a peak max hold trace then measurements at a selection of the highest points are made with quasi-peak and average detectors. Results are recorded and compared to limit for each line. (e.g. line and neutral)

Example Calculations

Measurement (dBμV) + Cable factor (dB) + Other (dB) = Corrected Reading (dBμV)
 Margin (dB) = Limit (dBμV) - Corrected Reading (dBμV)

Block Diagram



5.3.1 AC Mains Conducted Emissions

Operator	Kimberly Bay
QA	Shane Dock
Test Date	April 4, 2017
Location	H+V Ground Plane
Temp. / R.H.	21°C / 43% R.H.
Requirement	FCC 15.207 / RSS-Gen Section 8.8
Method	ANSI C63.10 2013 Section 6.2

FCC 15.207 Limits:

Frequency of Emission (MHz)	Conducted Limit (dBμV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency.

Test Parameters

Frequency	150 kHz to 30 MHz
Settings	RBW = 9 kHz, VBW = 90 kHz
EUT	Maximum power, GFSK, single channel mode, random data pattern
Notes	Tested with an off-the-shelf AC-DC adapter at 3.3VDC No change in emissions between channels and modulation types.

Instrumentation



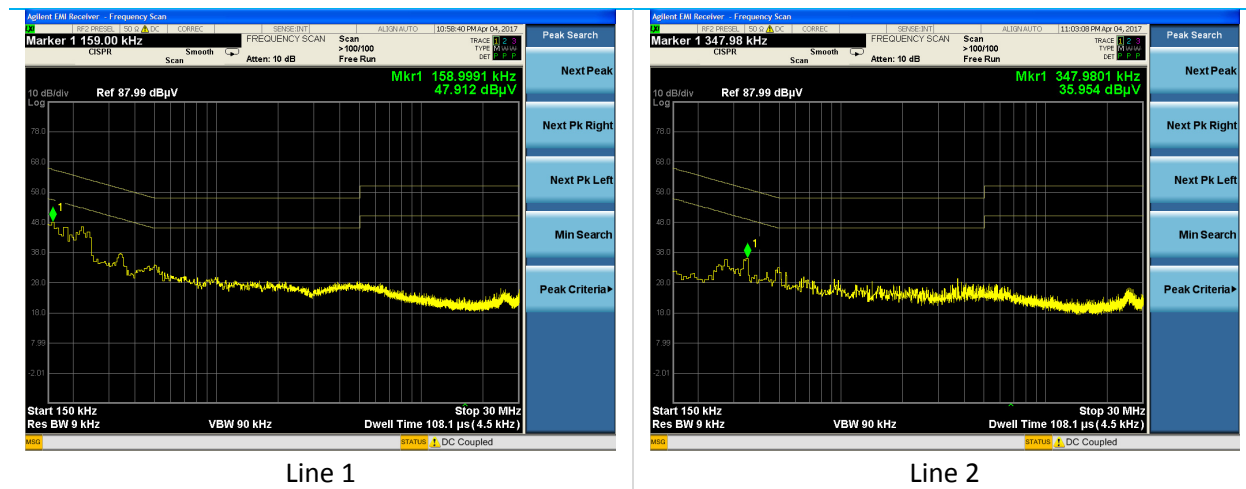
Date: 4-Apr-2017 Type Test: Bluetooth Cond AC Emissions Job #: C-2602
Prepared By: Kim Customer: LSR Quote #: 316356

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960089	LISN	CDM-POWER	LI-215A	191943	3/13/2017	3/13/2018	Active Calibration
2	EE 960088	MXE Spectrum Analyzer	Agilent	N9038A	MY51210138	3/2/2017	3/2/2018	Active Calibration

Table – Bluetooth Conducted AC Emissions Data

Frequency (MHz)	Line	Quasi-Peak			Average		
		Q-Peak Reading (dBμV)	Q-Peak Limit (dBμV)	Quasi-Peak Margin (dB)	Average Reading (dBμV)	Average Limit (dBμV)	Average Margin (dB)
0.159	1	42.5	65.5	23.0	32.6	55.5	23.0
0.186	1	40.8	64.2	23.4	31.2	54.2	23.1
0.222	1	39.6	62.7	23.1	29.9	52.7	22.8
0.348	2	30.0	59.0	29.0	21.9	49.0	27.1
0.276	2	30.1	60.9	30.9	22.9	50.9	28.1
0.483	2	26.5	56.3	29.8	18.6	46.3	27.6

Plots – Bluetooth Conducted AC Emissions



6 REVISION HISTORY

Version	Date	Notes	Person
V0	5/1/17	Initial Draft Release	KB
V1	5/9/17	Final	KB

END OF REPORT