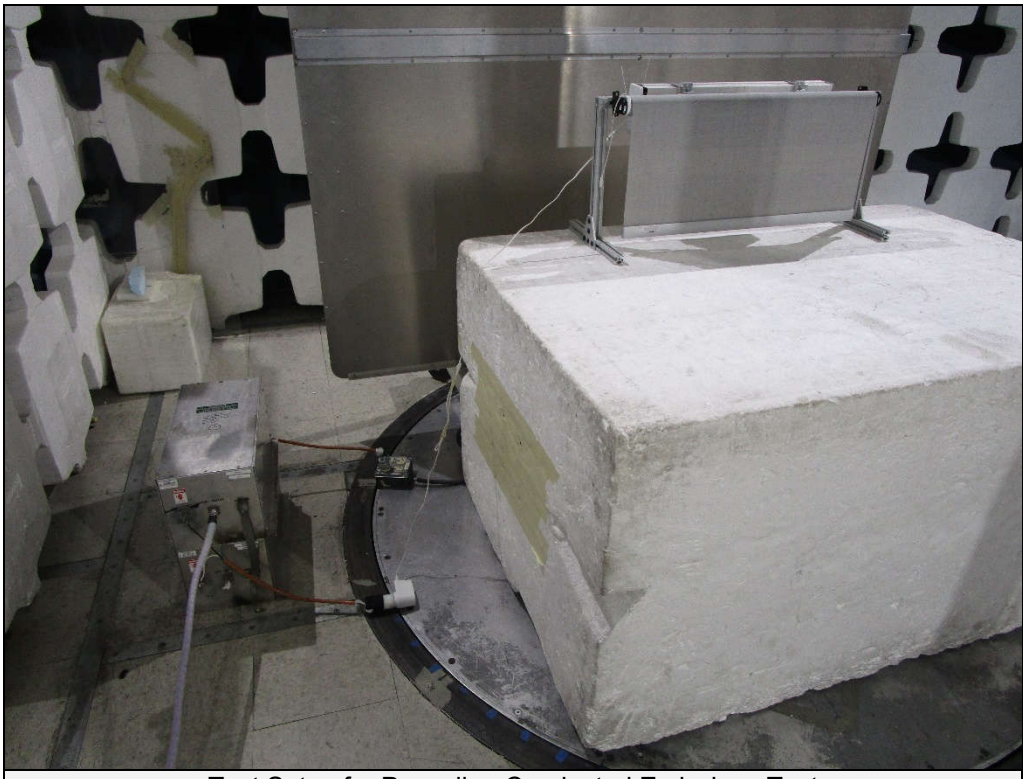
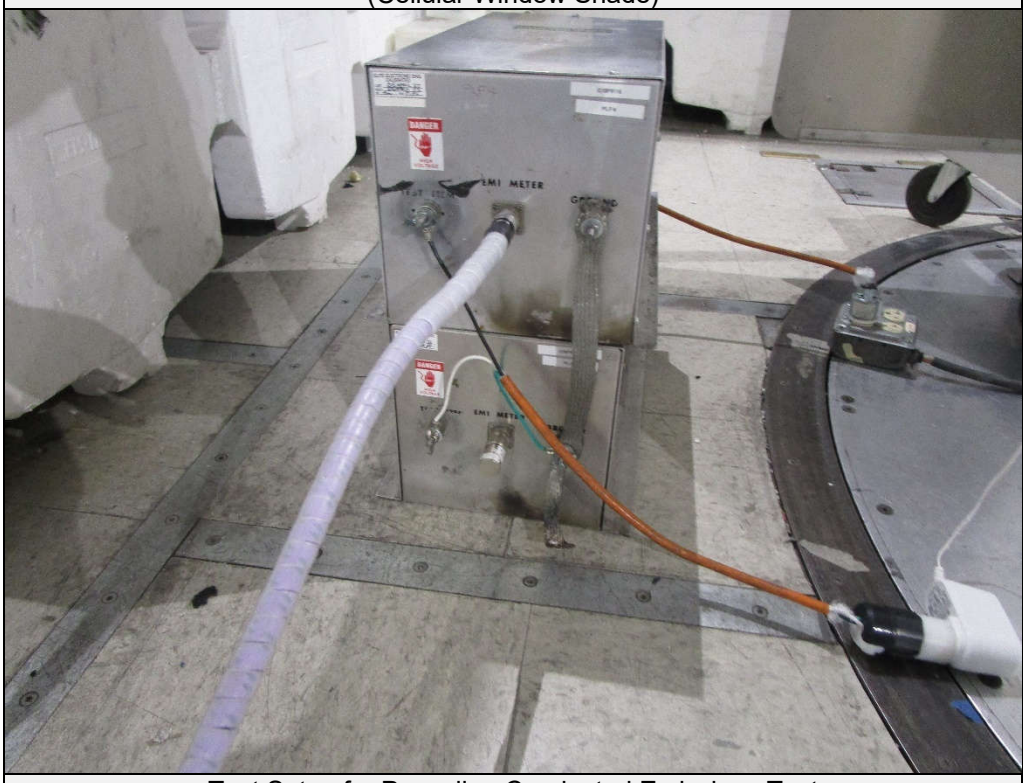
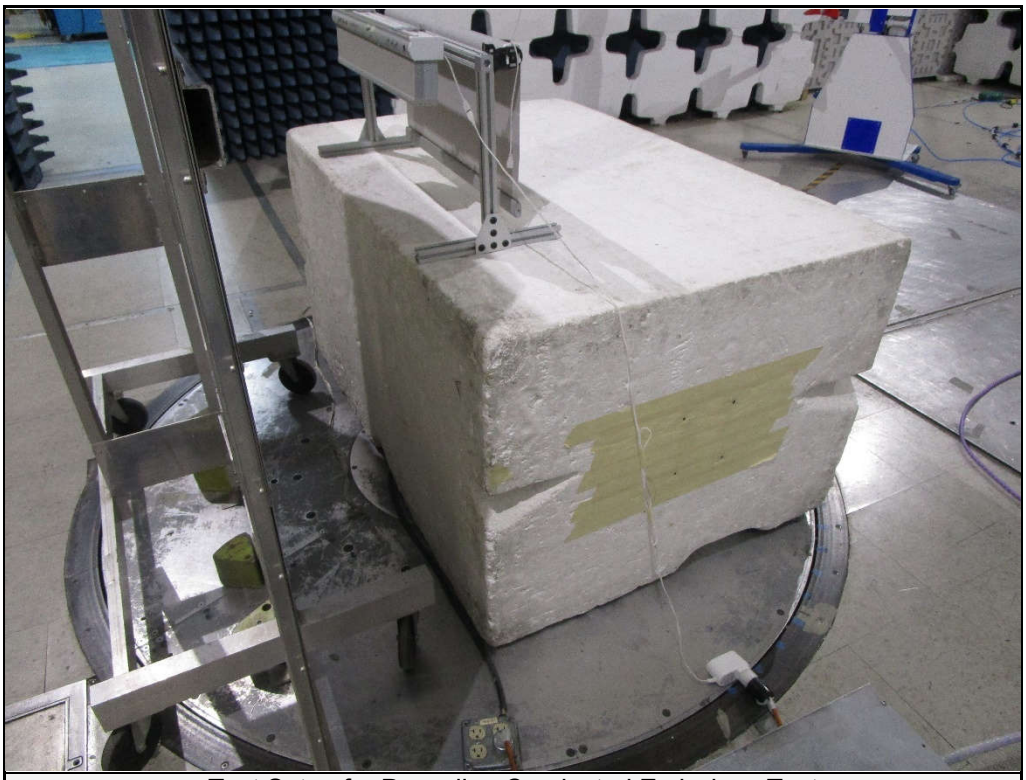


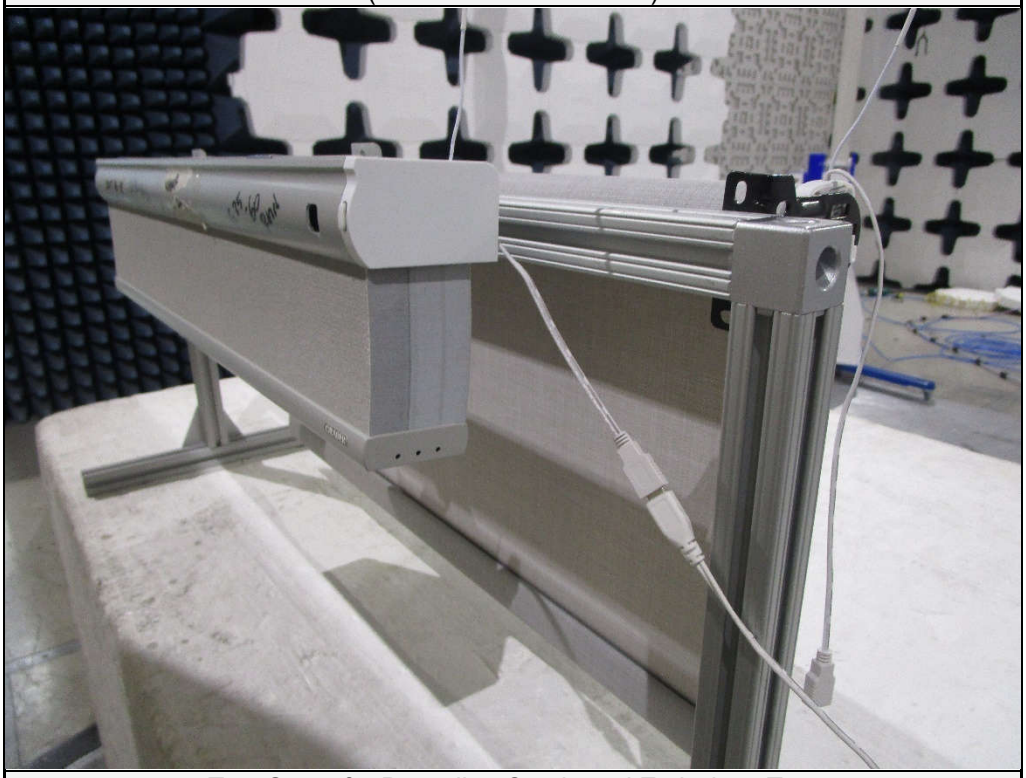
Test Setup for Powerline Conducted Emissions Test
(Cellular Window Shade)



Test Setup for Powerline Conducted Emissions Test
(Cellular Window Shade)

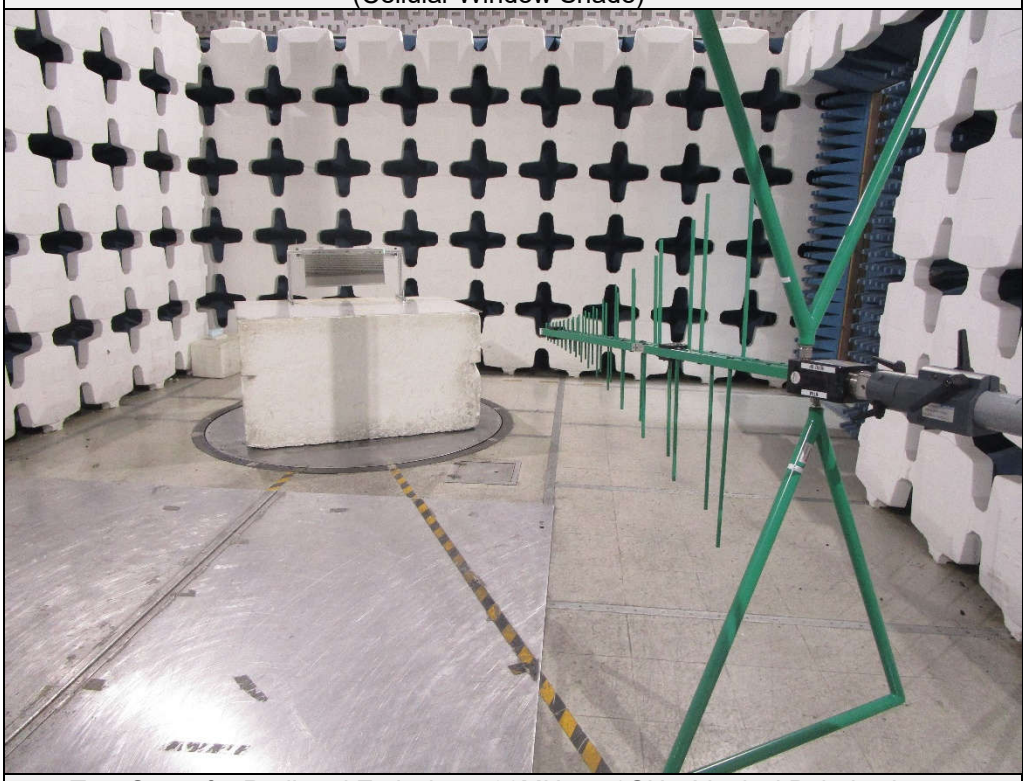


Test Setup for Powerline Conducted Emissions Test
(Cellular Window Shade)

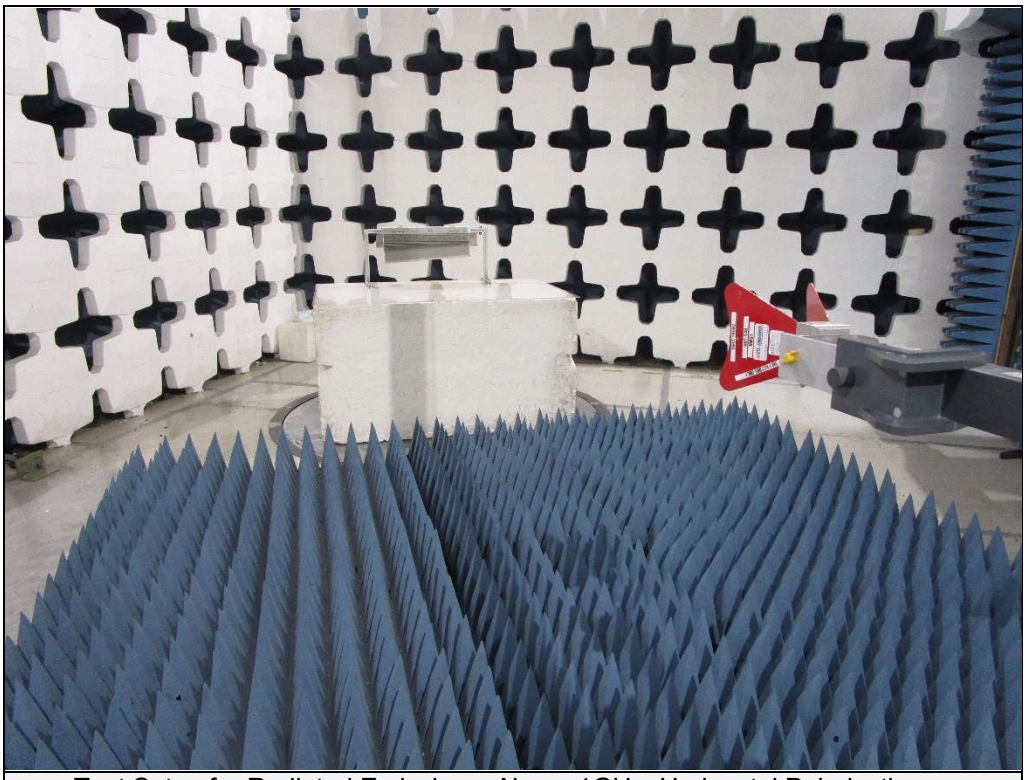


Test Setup for Powerline Conducted Emissions Test
(Cellular Window Shade)

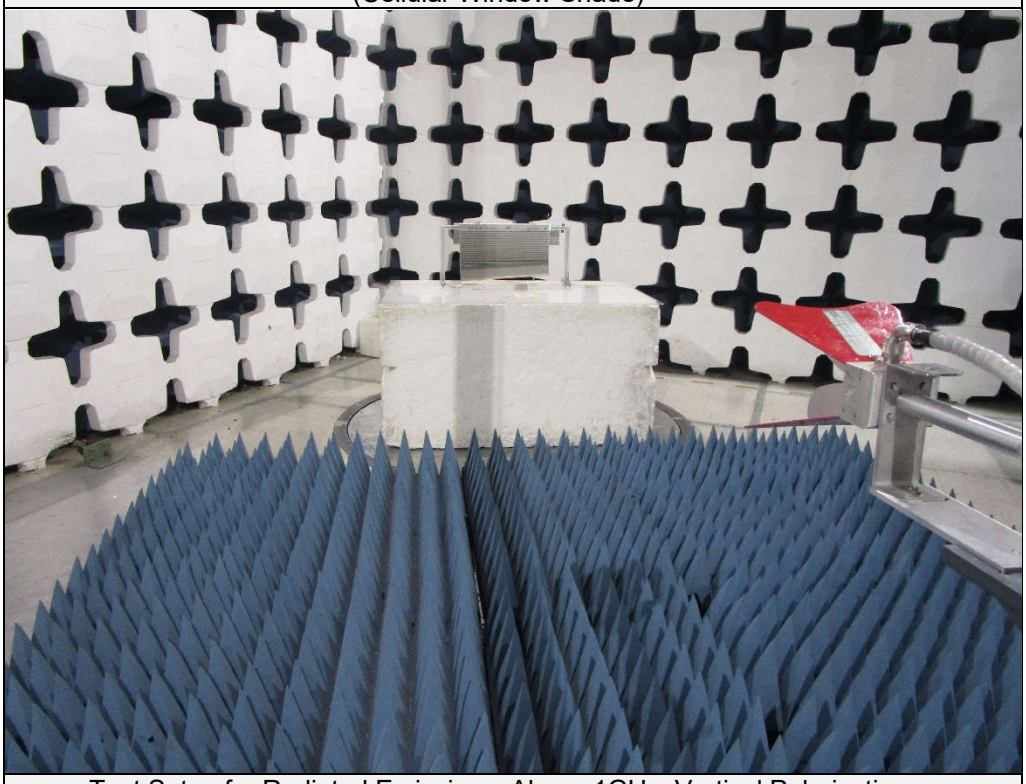
Test Setup for Radiated Emissions: 30MHz to 1GHz, Horizontal Polarization
(Cellular Window Shade)



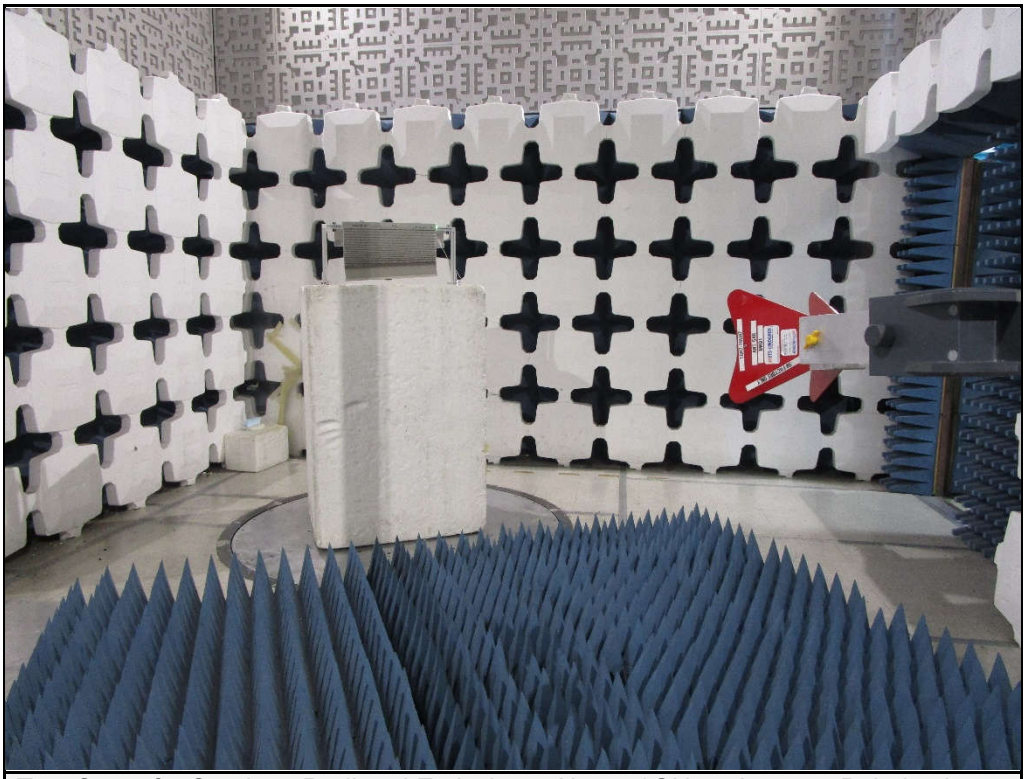
Test Setup for Radiated Emissions: 30MHz to 1GHz, Vertical Polarization
(Cellular Window Shade)



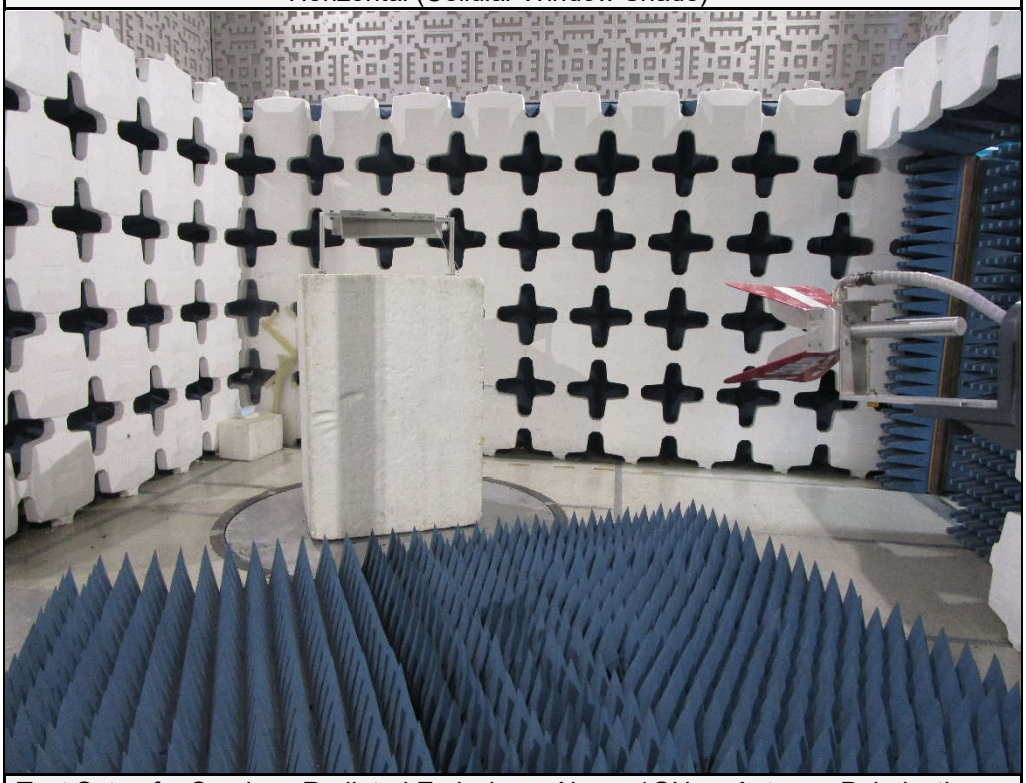
Test Setup for Radiated Emissions: Above 1GHz, Horizontal Polarization
(Cellular Window Shade)



Test Setup for Radiated Emissions: Above 1GHz, Vertical Polarization
(Cellular Window Shade)



Test Setup for Spurious Radiated Emissions, Above 1GHz – Antenna Polarization Horizontal (Cellular Window Shade)



Test Setup for Spurious Radiated Emissions, Above 1GHz – Antenna Polarization Vertical (Cellular Window Shade)

Test Details	
Manufacturer	Spring Window Fashions LLC
Model	CRZB
S/N	Unit 1
Mode	ZWave Tx @ 908.4MHz
Carrier Frequency	908.4MHz
Parameters	Peak Measurements
Notes	None

Frequency (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Peak Total (dBµV/m) at 3m	Peak Total (µV/m) at 3 m	Peak Limit (µV/m) at 3 m	Margin (dB)
908.400	H	55.8		2.0	26.4	0.0	84.2	16271.8	50000.0	-9.8
908.400	V	57.7		2.0	26.4	0.0	86.2	20437.8	50000.0	-7.8
1816.800	H	51.9	*	2.9	30.9	-40.9	44.9	175.5	5000.0	-29.1
1816.800	V	51.4	*	2.9	30.9	-40.9	44.4	166.7	5000.0	-29.5
2725.200	H	53.2		3.7	32.6	-40.4	49.1	283.7	5000.0	-24.9
2725.200	V	53.4		3.7	32.6	-40.4	49.2	290.0	5000.0	-24.7
3633.600	H	49.6	*	4.3	33.2	-40.3	46.8	219.5	5000.0	-27.2
3633.600	V	49.0	*	4.3	33.2	-40.3	46.2	204.6	5000.0	-27.8
4542.000	H	50.2	*	4.7	34.2	-40.1	49.1	284.7	5000.0	-24.9
4542.000	V	50.3	*	4.7	34.2	-40.1	49.1	285.1	5000.0	-24.9
5450.400	H	50.0	*	5.2	35.0	-40.2	49.9	313.4	5000.0	-24.1
5450.400	V	49.2	*	5.2	35.0	-40.2	49.1	284.5	5000.0	-24.9
6358.800	H	49.5	*	5.6	35.5	-40.1	50.5	334.7	5000.0	-23.5
6358.800	V	49.7	*	5.6	35.5	-40.1	50.7	341.7	5000.0	-23.3
7267.200	H	49.4	*	6.1	35.7	-40.1	51.2	362.4	5000.0	-22.8
7267.200	V	49.4	*	6.1	35.7	-40.1	51.2	361.9	5000.0	-22.8
8175.600	H	49.7	*	6.5	35.8	-40.0	52.1	402.9	5000.0	-21.9
8175.600	V	51.4		6.5	35.8	-40.0	53.7	486.1	5000.0	-20.2
9084.000	H	49.4	*	6.5	36.3	-39.7	52.5	423.0	5000.0	-21.5
9084.000	V	49.9	*	6.5	36.3	-39.7	53.0	448.6	5000.0	-20.9

Test Details	
Manufacturer	Spring Window Fashions LLC
Model	CRZB
S/N	Unit 1
Mode	ZWave Tx @ 908.4MHz
Carrier Frequency	908.4MHz
Parameters	Average Measurements
Notes	None

Freq. (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Duty Cycle (dB)	Average Total (dBuV/m) at 3m	Average Total (uV/m) at 3 m	Average Limit (uV/m) at 3 m	Margin (dB)
1816.80	H	35.5	*	2.9	30.9	-40.9	0.0	28.5	26.6	500.0	-25.5
1816.80	V	35.5	*	2.9	30.9	-40.9	0.0	28.5	26.6	500.0	-25.5
2725.20	H	44.8		3.7	32.6	-40.4	0.0	40.7	108.0	500.0	-13.3
2725.20	V	44		3.7	32.6	-40.4	0.0	39.9	98.5	500.0	-14.1
3633.60	H	34.3	*	4.3	33.2	-40.3	0.0	31.5	37.5	500.0	-22.5
3633.60	V	34.5	*	4.3	33.2	-40.3	0.0	31.7	38.4	500.0	-22.3
4542.00	H	36	*	4.7	34.2	-40.1	0.0	34.8	55.3	500.0	-19.1
4542.00	V	36	*	4.7	34.2	-40.1	0.0	34.8	55.3	500.0	-19.1
5450.40	H	34.3	*	5.2	35.0	-40.2	0.0	34.2	51.4	500.0	-19.8
5450.40	V	34.3	*	5.2	35.0	-40.2	0.0	34.2	51.4	500.0	-19.8
6358.80	H	34.6	*	5.6	35.5	-40.1	0.0	35.6	60.3	500.0	-18.4
6358.80	V	35.1	*	5.6	35.5	-40.1	0.0	36.1	63.9	500.0	-17.9
7267.20	H	34	*	6.1	35.7	-40.1	0.0	35.8	61.5	500.0	-18.2
7267.20	V	34	*	6.1	35.7	-40.1	0.0	35.8	61.5	500.0	-18.2
8175.60	H	35.3	*	6.5	35.8	-40.0	0.0	37.7	76.6	500.0	-16.3
8175.60	V	39.6		6.5	35.8	-40.0	0.0	42.0	125.7	500.0	-12.0
9084.00	H	34.3	*	6.5	36.3	-39.7	0.0	37.4	74.4	500.0	-16.5
9084.00	V	34.4	*	6.5	36.3	-39.7	0.0	37.5	75.3	500.0	-16.4

Test Details	
Manufacturer	Spring Window Fashions LLC
Model	CRZB
S/N	Unit 1
Mode	ZWave Tx @ 916MHz
Carrier Frequency	916MHz
Parameters	Peak Measurements
Notes	None

Frequency (MHz)	Ant Pol	Meter Reading (dBµV)	Ambient	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Peak Total (dBµV/m) at 3m	Peak Total (µV/m) at 3 m	Peak Limit (µV/m) at 3 m	Margin (dB)
916.000	H	57.7		2.1	26.4	0.0	86.2	20366.3	50000.0	-7.8
916.000	V	60.0		2.1	26.4	0.0	88.4	26418.7	50000.0	-5.5
1832.000	H	51.9	*	2.9	30.9	-40.8	44.9	176.2	5000.0	-29.1
1832.000	V	51.3	*	2.9	30.9	-40.8	44.3	164.0	5000.0	-29.7
2748.000	H	54.0		3.7	32.6	-40.4	49.9	313.4	5000.0	-24.1
2748.000	V	54.0		3.7	32.6	-40.4	49.9	313.4	5000.0	-24.1
3664.000	H	49.0	*	4.3	33.2	-40.3	46.3	205.4	5000.0	-27.7
3664.000	V	49.0	*	4.3	33.2	-40.3	46.2	203.5	5000.0	-27.8
4580.000	H	50.3	*	4.7	34.3	-40.1	49.3	291.3	5000.0	-24.7
4580.000	V	50.8		4.7	34.3	-40.1	49.7	307.1	5000.0	-24.2
5496.000	H	49.4	*	5.2	35.0	-40.2	49.4	294.1	5000.0	-24.6
5496.000	V	49.6	*	5.2	35.0	-40.2	49.5	299.5	5000.0	-24.5
6412.000	H	50.3	*	5.7	35.5	-40.1	51.4	370.0	5000.0	-22.6
6412.000	V	49.8	*	5.7	35.5	-40.1	50.9	351.0	5000.0	-23.1
7328.000	H	49.8	*	6.2	35.7	-40.1	51.6	378.3	5000.0	-22.4
7328.000	V	49.8	*	6.2	35.7	-40.1	51.6	378.3	5000.0	-22.4
8244.000	H	50.4	*	6.5	35.9	-39.9	52.9	440.7	5000.0	-21.1
8244.000	V	52.1		6.5	35.9	-39.9	54.5	531.0	5000.0	-19.5
9160.000	H	49.3	*	6.6	36.3	-39.7	52.5	421.7	5000.0	-21.5
9160.000	V	49.9	*	6.6	36.3	-39.7	53.1	454.5	5000.0	-20.8

Test Details	
Manufacturer	Spring Window Fashions LLC
Model	CRZB
S/N	Unit 1
Mode	ZWave Tx @ 916MHz
Carrier Frequency	916MHz
Parameters	Average Measurements
Notes	None

Freq. (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB/m)	Pre Amp (dB)	Duty Cycle (dB)	Average Total (dBuV/m) at 3m	Average Total (uV/m) at 3 m	Average Limit (uV/m) at 3 m	Margin (dB)
1832.00	H	35.8	*	2.9	30.9	-40.8	0.0	28.8	27.7	500.0	-25.1
1832.00	V	35.8	*	2.9	30.9	-40.8	0.0	28.8	27.7	500.0	-25.1
2748.00	H	45.3		3.7	32.6	-40.4	0.0	41.2	115.0	500.0	-12.8
2748.00	V	47.1		3.7	32.6	-40.4	0.0	43.0	141.4	500.0	-11.0
3664.00	H	34.3	*	4.3	33.2	-40.3	0.0	31.5	37.7	500.0	-22.5
3664.00	V	34.2	*	4.3	33.2	-40.3	0.0	31.4	37.2	500.0	-22.6
4580.00	H	35	*	4.7	34.3	-40.1	0.0	33.9	49.8	500.0	-20.0
4580.00	V	37.2		4.7	34.3	-40.1	0.0	36.1	64.2	500.0	-17.8
5496.00	H	34.1	*	5.2	35.0	-40.2	0.0	34.0	50.3	500.0	-19.9
5496.00	V	34.1	*	5.2	35.0	-40.2	0.0	34.0	50.3	500.0	-19.9
6412.00	H	34.8	*	5.7	35.5	-40.1	0.0	35.9	62.2	500.0	-18.1
6412.00	V	34.8	*	5.7	35.5	-40.1	0.0	35.9	62.2	500.0	-18.1
7328.00	H	34	*	6.2	35.7	-40.1	0.0	35.8	61.7	500.0	-18.2
7328.00	V	34	*	6.2	35.7	-40.1	0.0	35.8	61.7	500.0	-18.2
8244.00	H	35.6	*	6.5	35.9	-39.9	0.0	38.1	79.9	500.0	-15.9
8244.00	V	43.3		6.5	35.9	-39.9	0.0	45.8	193.9	500.0	-8.2
9160.00	H	34.6	*	6.6	36.3	-39.7	0.0	37.8	77.7	500.0	-16.2
9160.00	V	34.6	*	6.6	36.3	-39.7	0.0	37.8	77.7	500.0	-16.2

25. Band-Edge Compliance

Test Information	
Manufacturer	Spring Window Fashions LLC
Product	Cellular Window Shade
Model	CRZB
Serial No	Unit 1
Modes	ZWave Tx @ 908.4MHz ZWave Tx @ 916MHz

Test Setup Details	
Setup Format	Tabletop
Height of Support	N/a
Measurement Method	Radiated
Type of Test Site	Semi-Anechoic Chamber
Test site used	Room 21
Notes	None

Requirements
Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209 and RSS-GEN, whichever is the lesser attenuation.

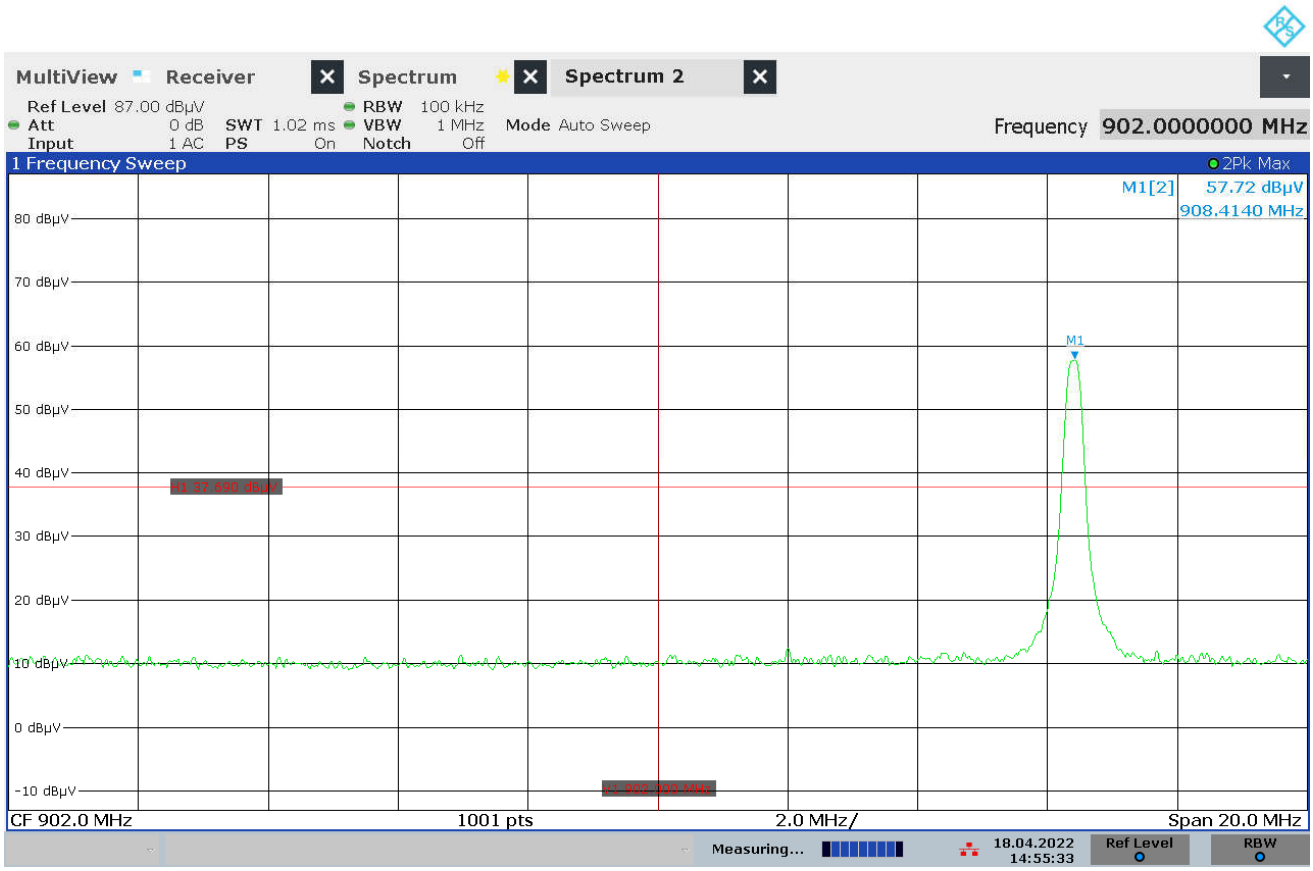
Procedures
Low Band Edge 1) The EUT was setup inside the test chamber on a non-conductive stand. 2) A broadband measuring antenna was placed at a test distance of 3 meters from the EUT. 3) The EUT was set to transmit continuously at the channel closest to the low band-edge. 4) The EUT was maximized for worst case emissions at the measuring antenna. The maximum meter reading was recorded. 5) To determine the band edge compliance, the following spectrum analyzer settings were used: a. Center frequency = low band-edge frequency. b. Span = Wide enough to capture the peak level of the emission operating on the channel closest to the band-edge, as well as any modulation products which fall outside of the authorized band of operation. c. Resolution bandwidth (RBW) ≥ 1% of the span. d. The 'Max-Hold' function was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined. e. The marker was set on the peak of the in-band emissions. A display line was placed 20dB down from the peak of the in-band emissions. All emissions which fall outside of the authorized band of operation must be below the 20dB down display line. (All emissions to the left of the center frequency (band-edge) must be below the display line.) f. The analyzer's display was plotted using a 'screen dump' utility. High Band Edge 1) The EUT was setup inside the test chamber on a non-conductive stand. 2) A broadband measuring antenna was placed at a test distance of 3 meters from the EUT. 3) The EUT was set to transmit continuously at the channel closest to the high band-edge.

4) The EUT was maximized for worst case emissions at the measuring antenna.
5) To determine the band edge compliance, the following spectrum analyzer settings were used:

a. Center frequency = high band-edge frequency.
b. Span = Wide enough to capture the peak level of the emission operating on the channel closest to the band-edge, as well as any modulation products which fall outside of the authorized band of operation.
c. Resolution bandwidth (RBW) ≥ 1% of the span.
d. The 'Max-Hold' function was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined.
e. The marker was set on the peak of the in-band emissions. A display line was placed 20dB down from the peak of the in-band emissions. All emissions which fall outside of the authorized band of operation must be below the 20dB down display line. (All emissions to the right of the center frequency (band-edge) must be below the display line.)
f. The analyzer's display was plotted using a 'screen dump' utility.

Measurement Uncertainty	
Measurement Type	Expanded Measurement Uncertainty
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (1 GHz – 6 GHz)	3.1
Radiated disturbance (electric field strength on an open area test site or alternative test site) (6 GHz – 18 GHz)	3.2
Radiated disturbance (electric field strength on an open area test site or alternative test site) (18 GHz – 26.5 GHz)	3.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (26.5 GHz – 40 GHz)	3.4

Test Details	
Manufacturer	Spring Window Fashions LLC
Model	CRZB
S/N	Unit 1
Mode	ZWave Tx @ 908.4MHz
Carrier Frequency	908.4MHz
Parameters	Low Band-Edge
Notes	None



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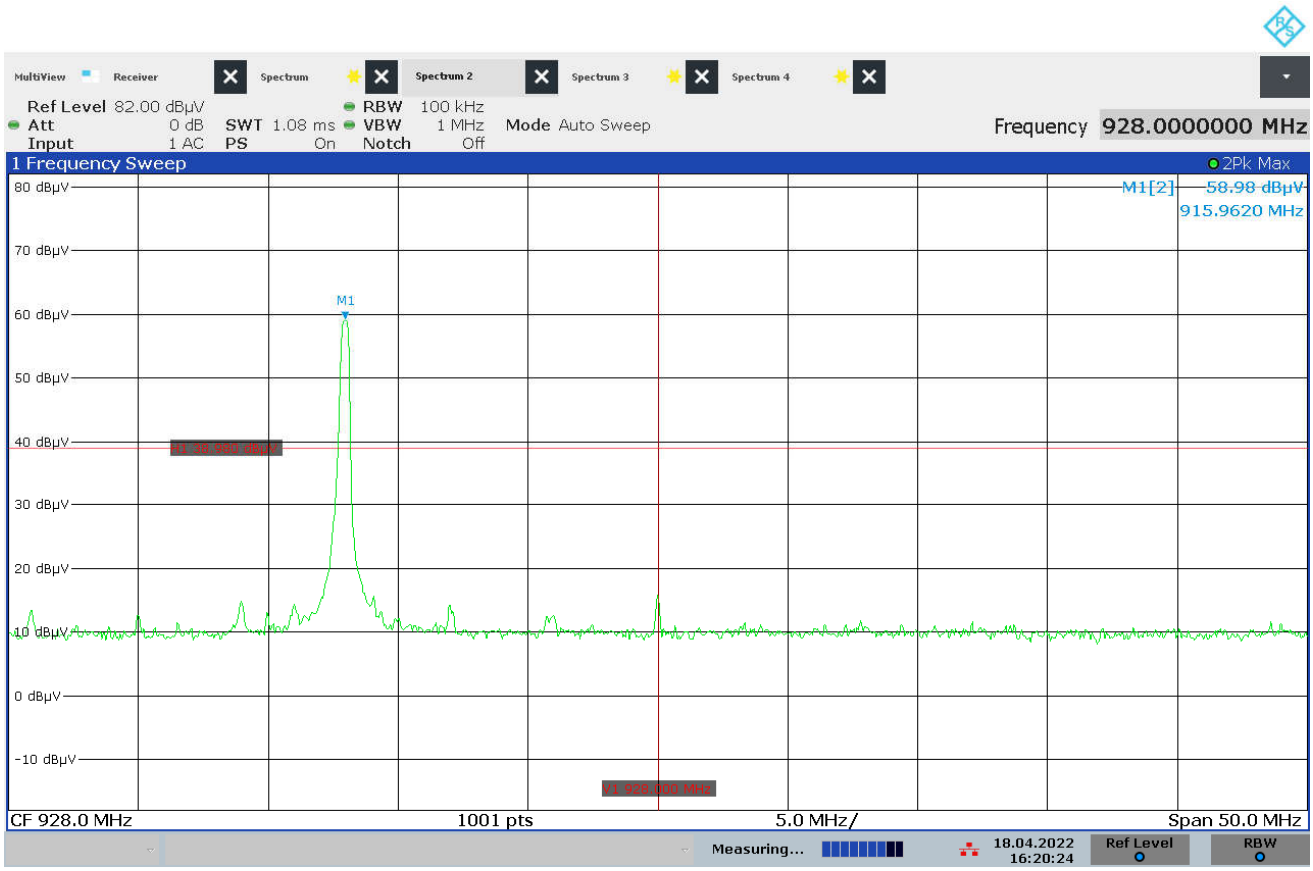
Test Details	
Manufacturer	Spring Window Fashions LLC
Model	CRZB
S/N	Unit 1
Mode	ZWave Tx @ 916MHz
Carrier Frequency	916MHz
Parameters	High Band-Edge
Notes	None



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26. Module Integration – Emissions Test

EUT Information	
Manufacturer	Spring Window Fashions LLC
Product	Cellular Window Shade
Model No.	CRZB
Serial No.	Unit 1
Modes	BLE Tx Ch0 @ 2402MHz BLE Tx Ch19 @ 2440MHz BLE Tx Ch39 @ 2480MHz MultiTx

Test Site Information	
Setup Format	Tabletop
Height of Support	N/a
Type of Test Site	Semi-Anechoic Chamber
Test Site Used	Room 21
Type of Antennas Used	Below 1GHz: Bilog (or equivalent) Above 1GHz: Double-ridged waveguide (or equivalent)
Notes	The cables were manually maximized during the preliminary emissions sweeps. The cable arrangement which resulted in the worst-case emissions was utilized.

Measurement Uncertainty	
Measurement Type	Expanded Measurement Uncertainty
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (1 GHz – 6 GHz)	3.1
Radiated disturbance (electric field strength on an open area test site or alternative test site) (6 GHz – 18 GHz)	3.2
Radiated disturbance (electric field strength on an open area test site or alternative test site) (18 GHz – 26.5 GHz)	3.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (26.5 GHz – 40 GHz)	3.4

Requirements
Per 996369 D04 Module Integration Guide v01: Testing of the host product with all the transmitters installed is recommended, to verify that the host product meets all the applicable FCC rules. The radio spectrum is to be investigated with all the transmitters in the final host product functioning to determine that no emissions exceed the highest limit permitted for any one individual transmitter as required by Section 2.947(f). The testing shall also check for emissions that may occur due to the intermixing of emissions with the other transmitters, digital circuitry, or due to physical properties of the host product (enclosure). This investigation is especially important when integrating multiple modular transmitters where the certification is based on testing each of them in a stand-alone configuration. No emissions exceed the highest limit permitted for any one individual transmitter as required by Section 2.947(f). FCC 15.247: In any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30dB instead of 20dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Procedures
Radiated measurements were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. The walls and ceiling of the shielded chamber are lined with ferrite tiles and anechoic absorber material is installed over the ferrite tiles. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4-2014 for site attenuation. The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads. Preliminary radiated emissions tests were performed to determine the emission characteristics of the EUT. For the preliminary test, a broadband measuring antenna was positioned at a 3-meter distance from the EUT. The entire frequency range from 30MHz to 18.0GHz was investigated using a peak detector function. The final open field emission tests were then manually performed over the frequency range of 30MHz to 18.0GHz. 1) For all harmonics not in the restricted bands, the following procedure was used: a) The field strength of the fundamental was measured using a double ridged waveguide antenna. The waveguide antenna was positioned at a 3-meter distance from the EUT. The EUT was placed on a 1.5-meter-high non-conductive stand. A peak detector with a resolution bandwidth of 100 kHz was used on the spectrum analyzer. b) The field strengths of all of the harmonics not in the restricted band were then measured using a double-ridged waveguide antenna. The waveguide antenna was positioned at a 3-meter distance from the EUT. The EUT was placed on a non-conductive stand. A peak detector with a resolution bandwidth of 100 kHz was used on the spectrum analyzer. c) To ensure that maximum or worst-case emission levels at the fundamental and harmonics were measured, the following steps were taken when measuring the fundamental emissions and the spurious emissions: i. The EUT was rotated so that all of its sides were exposed to the receiving antenna. ii. Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured. iii. The measuring antenna was raised and lowered for each antenna polarization to maximize the readings. iv. In instances where it was necessary to use a shortened cable between the measuring antenna and the spectrum analyzer, the measuring antenna was not raised or lowered to ensure maximized readings. Instead, the EUT was rotated through all axis to ensure the maximum readings were recorded for the EUT. d) All harmonics not in the restricted bands must be at least 20dB below levels measured at the fundamental. However, attenuation below the general limits specified in §15.209(a) is not required. 2) For all emissions in the restricted bands, the following procedure was used: a) The field strengths of all emissions below 1GHz were measured using a bi-log antenna. The bilog antenna was positioned at a 3-meter distance from the EUT. The EUT was placed on an 80cm high non-conductive stand. A peak detector with a resolution bandwidth of 100kHz was used on the spectrum analyzer. b) The field strengths of all emissions above 1GHz were measured using a double-ridged waveguide antenna. The waveguide antenna was positioned at a 3-meter distance from the EUT. The EUT was placed on a 1.5-meter-high non-conductive stand. A peak detector with a resolution bandwidth of 1MHz was used on the spectrum analyzer.

c) To ensure that maximum (or worst case) emission levels were measured, the following steps were taken when taking all measurements:

i. The EUT was rotated so that all of its sides were exposed to the receiving antenna.

ii. Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.

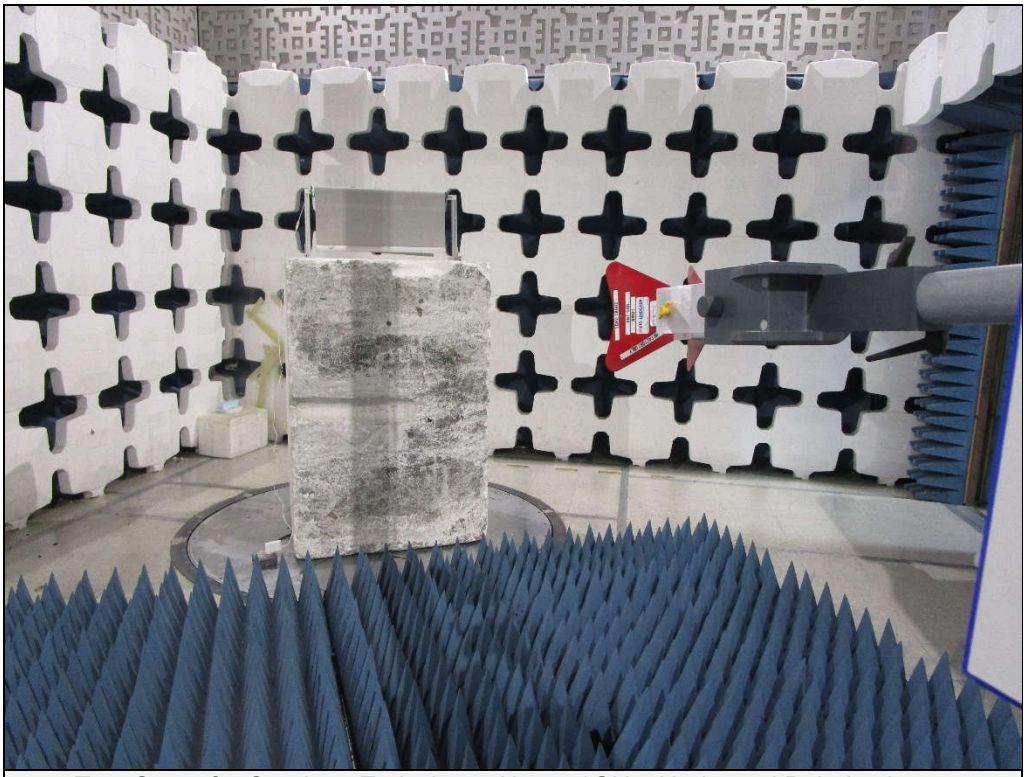
iii. The measuring antenna was raised and lowered for each antenna polarization to maximize the readings.

iv. In instances where it was necessary to use a shortened cable between the measuring antenna and the spectrum analyzer, the measuring antenna was not raised or lowered to ensure maximized readings. Instead, the EUT was rotated through all axis to ensure the maximum readings were recorded.

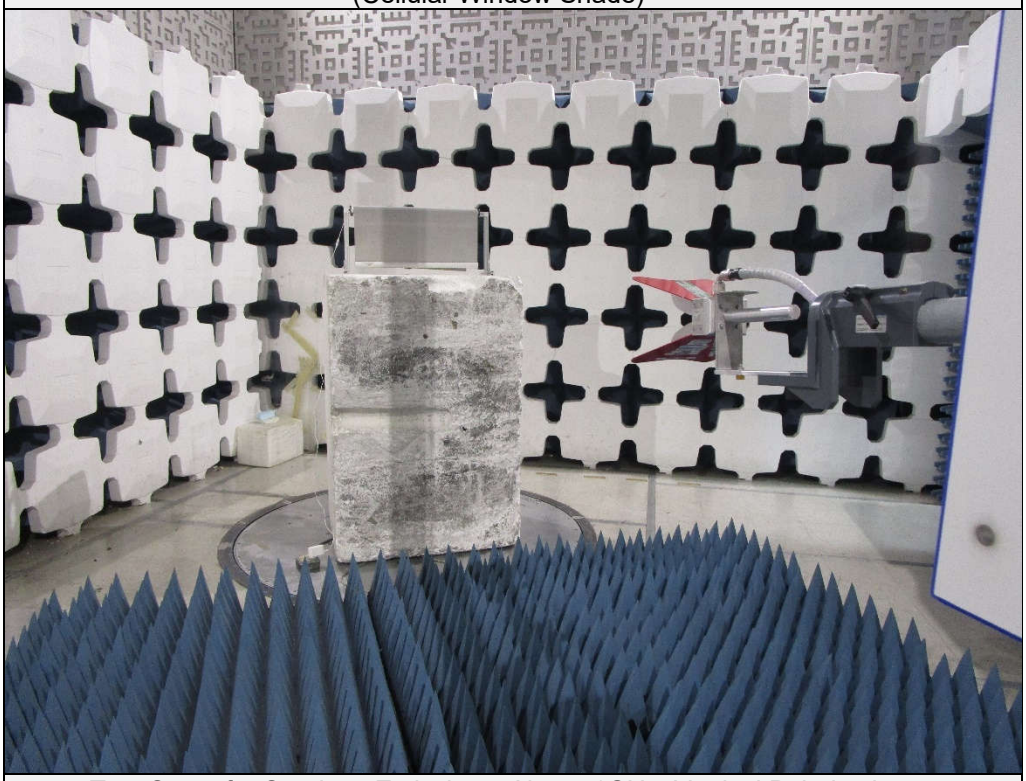
d) For all radiated emissions measurements below 1GHz, if the peak reading is below the limits listed in §15.209(a), no further measurements are required. If, however, the peak readings exceed the limits listed in 15.209(a), then the emissions are remeasured using a quasi-peak detector.

e) For all radiated emissions measurements above 1GHz, the peak readings must comply with the §15.35(b) limits. §15.35(b) states that when average radiated emissions measurements are specified, there also is a limit on the peak level of the radiated emissions. The limit on the peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. Therefore, all peak readings above 1GHz must be no greater than 20dB above the limits specified in §15.209(a).

f) Next, for all radiated emissions measurements above 1GHz, the resolution bandwidth was set to 1MHz. The analyzer was set to linear mode with a 10Hz video bandwidth in order to simulate an average detector and an average reading was taken.



Test Setup for Spurious Emissions: Above 1GHz, Horizontal Polarization
(Cellular Window Shade)



Test Setup for Spurious Emissions: Above 1GHz, Vertical Polarization
(Cellular Window Shade)