EMC Test Report

Project Number: 4035896

Report Number: 4035896EMC01 **Revision Level:** 0

Client: Sensorfield LLC

Equipment Under Test: Wireless Monitoring Units (Sensor, Hub, Gateway)

Models: S1-B / H1

FCC ID: 2AJRESFNJR1

Applicable Standards: FCC Part 15 Subpart C, § 15.247

ANSI C63.10: 2013

Report issued on: 04 October 2016

Test Result: Compliant

Tested by: _____
Fabian Nica, Senior Engineering Technician

Reviewed by: _____
Jeremy Pickens, Senior EMC Engineer

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.

Table of Contents

1 Summary of Test Results

Test Description	Test Specification	Test Result
Occupied Bandwidth	15.247(a) (1)	Compliant
Peak Power Output	15.247(a) (1)	Compliant
Power Spectral Density	15.247(f)	Compliant
Conducted Spurious Emissions	15.247(d)	Compliant
Radiated Spurious Emissions	15.247(d), 15.35(b),15.205, 15.209	Compliant
Dwell time	15.247(f)	Compliant
Number of Hopping Frequencies	15.247(a) (1)(iii)	Compliant
Channel separation	15.247(a)(1)	Compliant
AC Power Line Conducted Emission	15.107, 15.207	N/A(1)

(1) Not Applicable – The device is powered via solar panel or internal LiPo battery.

1.1 *Modifications Required for Compliance*

None

2 General Information

2.1 *Client Information*

Name:	Sensorfield LLC
Address:	2503 Robinhood, Suite 165
City, State, Zip, Country:	Houston, TX 77005, 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

2.3 *General Information of EUT*

EUT:	Wireless Monitoring Units (Sensor, Hub, Gateway)
Model Number:	S1-B / H1
Serial Number:	Not labeled
Frequency Range:	903.074 to 926.826 MHz
Number of channels:	15.247 Hybrid device employing 10 channels
Modulation type:	LoRa
Channel spacing:	1 and 2.2 MHz
Antenna:	9” Wire
Rated Voltage:	3.7 VDC Solar Power / Internal Battery
Sample Received Date:	07 September 2016
Dates of testing:	22 – 28 September 2016

Operating Modes and Conditions

The EUT was configured in software to allow the user to the control the EUT to run continuously exercising all modes of operation.

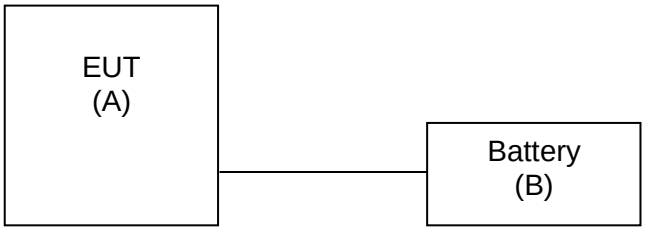
During testing, the hopping sequence was stopped in accordance with Section 5.1 of ANSI C63.10-2013 so that the low, mid and high channels could be tested independently.

As specified in Section 5.10.5 of ANSI C63.10:2013:

- Software was designed to allow the EUT to operate
  - at 98 % duty cycle
  - at the worst-case duty cycle to allow measurements in instances where an average correction factor needs to be determined to calculate the average field strength from the measured peak field strength
- The software allowed configuration and operation on all available unlicensed wireless device channels.
- The software allowed configuration and operation using all available modulations and data rates
- The software allowed configuration and operation on all available power out levels

- Since this is a hybrid frequency hopping system, the software allowed the hopping sequence to be turned off

2.4 *EUT Connection Block Diagram*



2.5 *System Configurations*

Device reference	Manufacturer	Description	Model Number	Serial Number
A	Sensorfield LLC	Wireless Monitoring Units (Sensor, Hub, Gateway)	S1-B H1	None
B	Unknown	3.7Vdc Li-Po Battery*	805080	Not Labeled

* The external battery was used to facilitate testing by supplying a longer life than the battery that will be supplied with the devices.

2.6 *Cable List*

Cable reference	Port Name	Start	End	Cable Length (m)	Ferrite installed?	Shielded?
1	DC Power	Battery	EUT	0.2	N	N

3 Occupied Bandwidth

3.1 *Test Result*

Test Description	Basic Standards	Test Result
Bandwidth	15.247(a) (1)	Pass

3.2 *Test Method*

The procedures from ANSI C63.10 Clause 6.9.2 were used to determine the 6dB and 20 dB bandwidths.

3.3 *Test Site*

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions
Temperature: 23.9 °C
Relative Humidity: 44.2 %

3.4 *Test Equipment*

Test Date: 22-Sep-2016 Tester: JOP

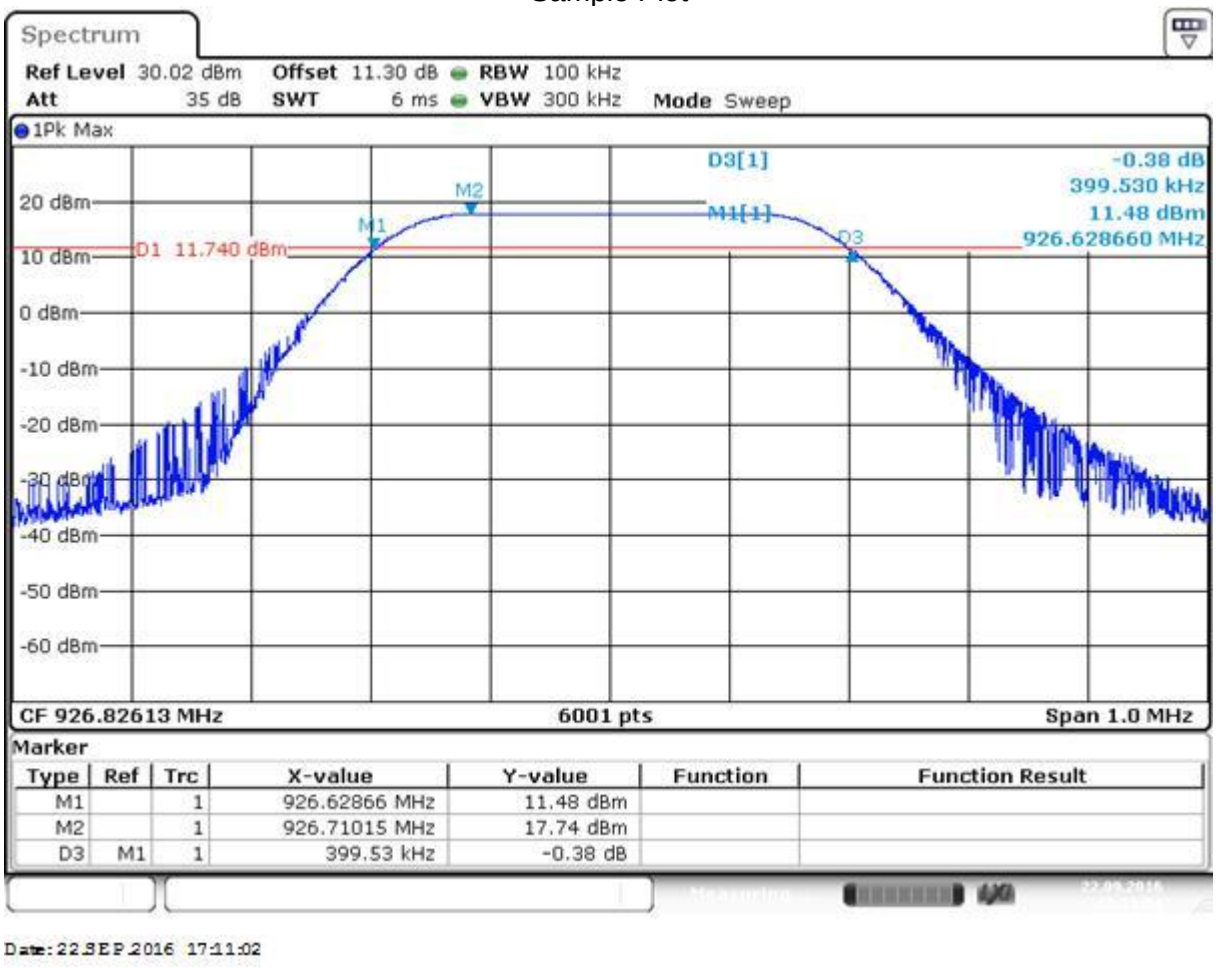
Equipment	Model	Manufacturer	Asset Number	Cal Due Date
SIGNAL ANALYZER	FSV40	ROHDE & SCHWARZ	S/N: 101401	19-Aug-2017
ATTENUATOR, 10DB	10DB	ROHDE & SCHWARZ	B095593	27-Jul-2017
RF CABLE	1134	GORE	B094785	26-Jul-2017

Note: The equipment calibration period is 1 year.

3.5 *Test Data*

Frequency (MHz)	6 dB bandwidth **(MHz)**	20 dB bandwidth **(MHz)**
903.074	0.398	0.521
915	0.404	0.527
926.826	0.400	0.515

Sample Plot


Spectrum
Ref Level 30.02 dBm Offset 11.30 dB RBW 100 kHz
Att 35 dB SWT 6 ms VBW 300 kHz Mode Sweep
1Pk Max
D3[1] -0.38 dB
399.530 kHz
M1[1] 11.48 dBm
926.628660 MHz
D1 11.740 dBm
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
CF 926.82613 MHz
6001 pts
Span 1.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 926.62866 MHz 11.48 dBm
M2 1 926.71015 MHz 17.74 dBm
D3 M1 1 399.53 kHz -0.38 dB
Date: 22.SEP.2016 17:11:02

4 Peak Output Power

4.1 *Test Result*

Test Description	Test Specification	Test Result
Peak Output Power	15.247(a)(1)	Compliant

4.2 *Test Method*

Measurements were recorded using the test methods defined in ANS C63.10, Clause 7.8.5.

Limit

For hybrid DTS / frequency hopping systems operating in the 902-928 MHz band: 1 watt.

4.3 *Test Site*

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.9 °C
Relative Humidity: 44.2 %

4.4 *Test Equipment*

Test Date: 22-Sep-2016 Tester: JOP

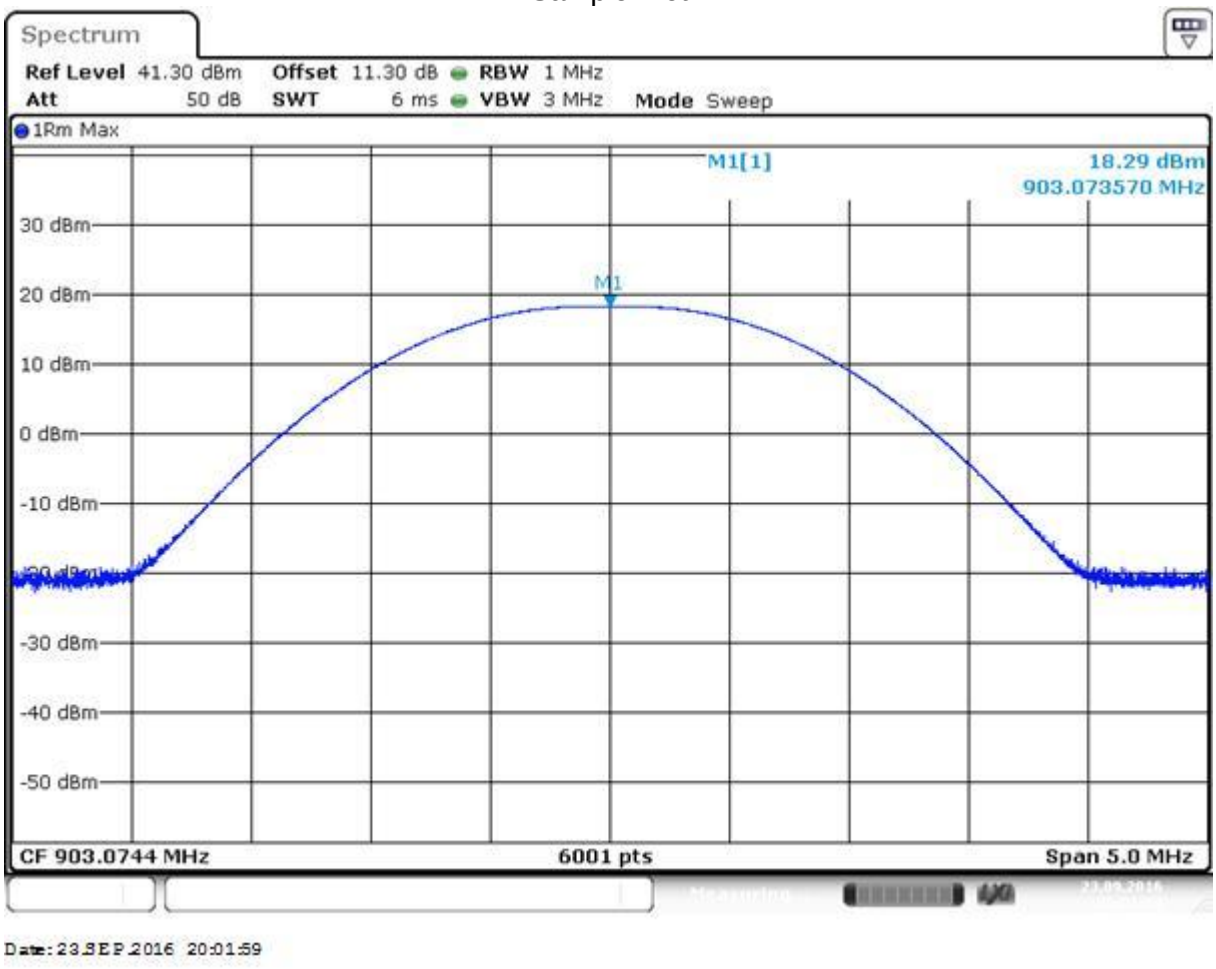
Equipment	Model	Manufacturer	Asset Number	Cal Due Date
SIGNAL ANALYZER	FSV40	ROHDE & SCHWARZ	S/N: 101401	19-Aug-2017
ATTENUATOR, 10DB	10DB	ROHDE & SCHWARZ	B095593	27-Jul-2017
RF CABLE	1134	GORE	B094785	26-Jul-2017

Note: The equipment calibration period is 1 year.

4.5 *Test Data*

Frequency	Peak Output Power (dBm)	Peak Output Power (W)
903.074	18.29	0.067
915	18.32	0.068
926.826	18.36	0.069

Sample Plot



5 Power Spectral Density

5.1 *Test Result*

Test Description	Test Specification	Test Result
Power Spectral Density	15.247(f)	Compliant

5.2 *Test Method*

Power spectral density measurements were recorded using the procedures from ANSI C63.10: 2013 clause 11.10 and KDB 558074 D01 Measurement Guidance v03r05.

Limit
The limit is 8 dBm.

5.3 *Test Site*

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.9 °C
Relative Humidity: 44.2 %

5.4 *Test Equipment*

Test Date: 22-Sep-2016 Tester: JOP

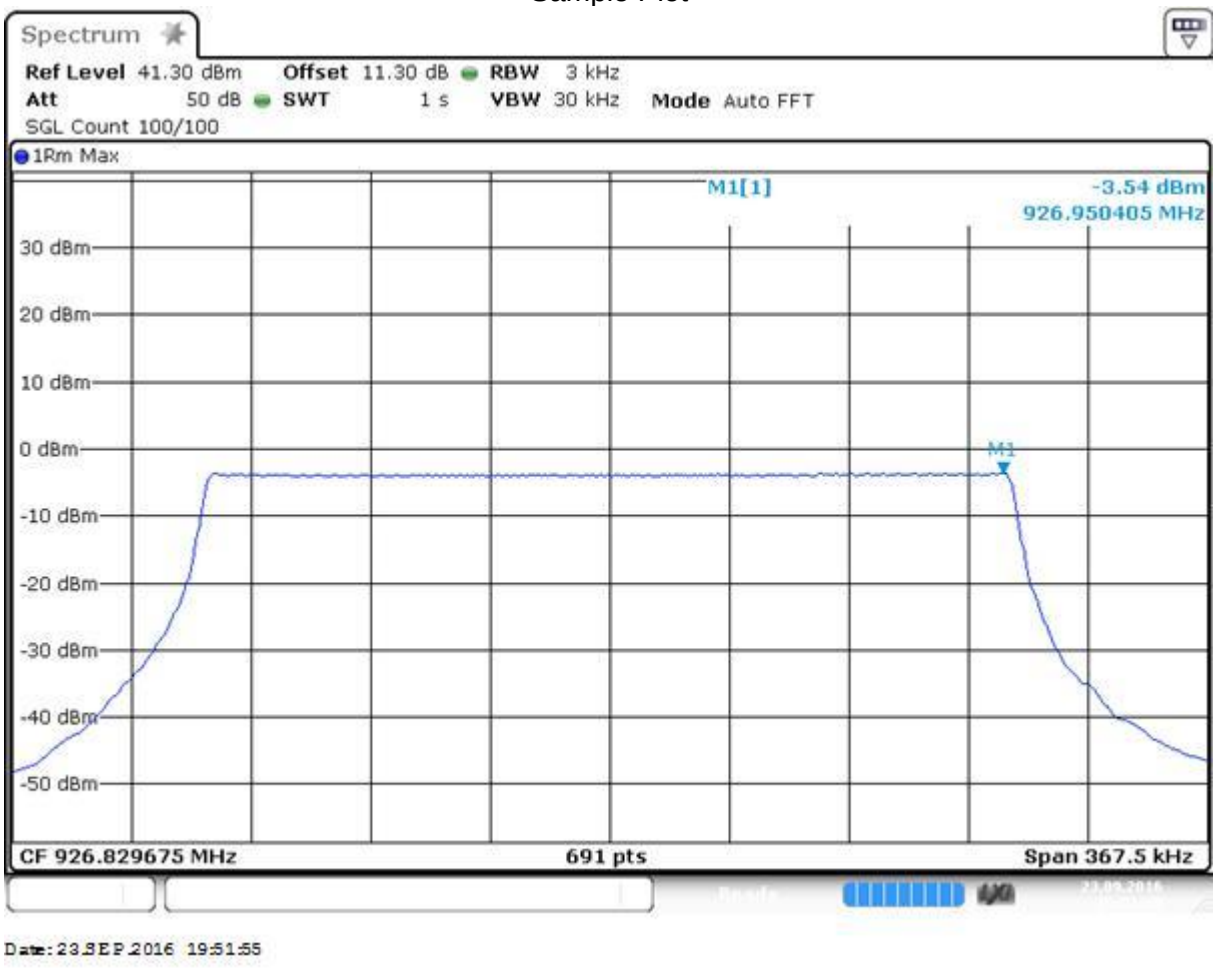
Equipment	Model	Manufacturer	Asset Number	Cal Due Date
SIGNAL ANALYZER	FSV40	ROHDE & SCHWARZ	S/N: 101401	19-Aug-2017
ATTENUATOR, 10DB	10DB	ROHDE & SCHWARZ	B095593	27-Jul-2017
RF CABLE	1134	GORE	B094785	26-Jul-2017

Note: The equipment calibration period is 1 year.

5.5 *Test Data*

Protocol	Channel	Peak PSD (dBm)	Limit (dBm)	Margin (dB)
LoRa	903.07	-3.41	8	-11.4
LoRa	915	-3.54	8	-11.5
LoRa	926.826	-3.54	8	-11.5

Sample Plot


Spectrum
Ref Level 41.30 dBm
Offset 11.30 dB
RBW 3 kHz
Att 50 dB
SWT 1 s
VBW 30 kHz
Mode Auto FFT
SGL Count 100/100
1Rm Max
M1[1]
-3.54 dBm
926.950405 MHz
30 dBm
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
M1
CF 926.829675 MHz
691 pts
Span 367.5 kHz
Date: 23.SEP.2016 19:51:55

6 Conducted Spurious Emissions

6.1 *Test Result*

Test Description	Test Specification	Test Result
Conducted Spurious Emissions	15.247(d)	Compliant

6.2 *Test Method*

Measurements were recorded using the test methods defined in ANS C63.10, Clause 7.8.8.

The limit is 20 dB below the measured peak power.

6.3 *Test Site*

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions
Temperature: 23.9 °C
Relative Humidity: 44.2 %

6.4 *Test Equipment*

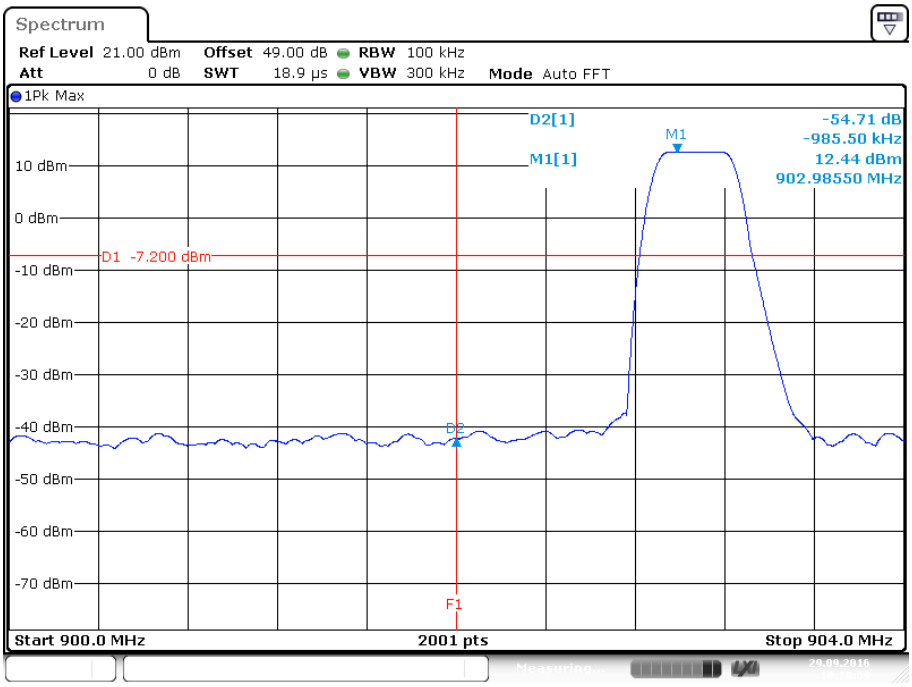
Test Date: 22-Sep-2016 Tester: JOP

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
SIGNAL ANALYZER	FSV40	ROHDE & SCHWARZ	S/N: 101401	19-Aug-2017
ATTENUATOR, 10DB	10DB	ROHDE & SCHWARZ	B095593	27-Jul-2017
RF CABLE	1134	GORE	B094785	26-Jul-2017

Note: The equipment calibration period is 1 year.

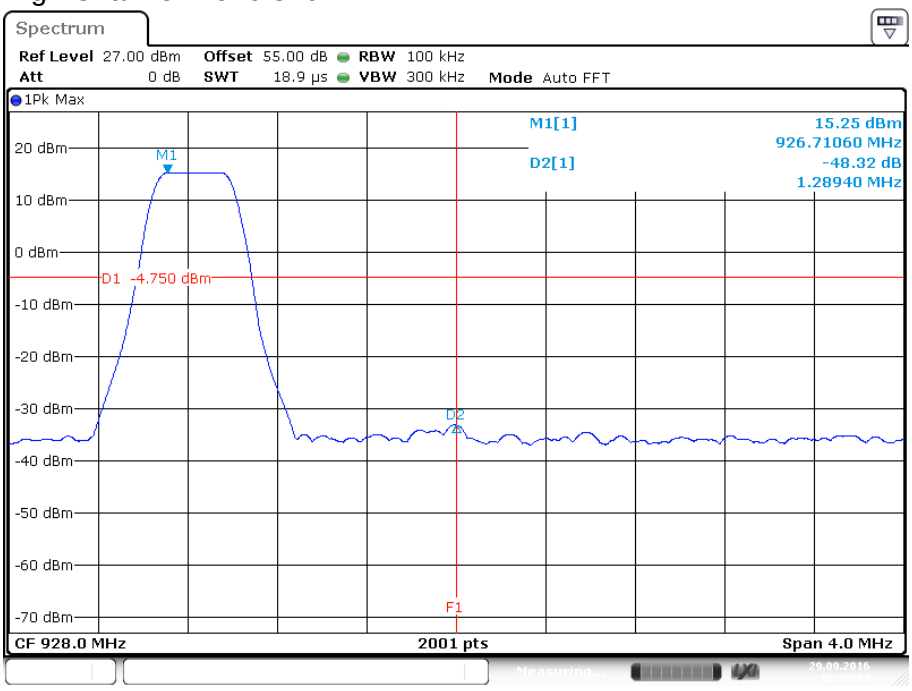
6.5 *Test Data (Band-Edge)*

Low Channel – 903.07



Date: 29.SEP.2016 10:18:09

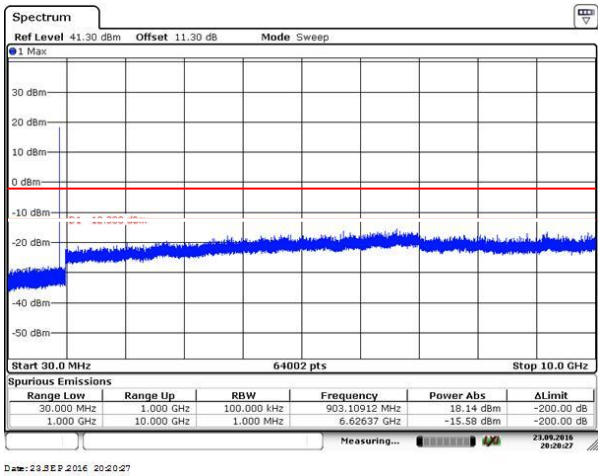
High Channel – 926.826



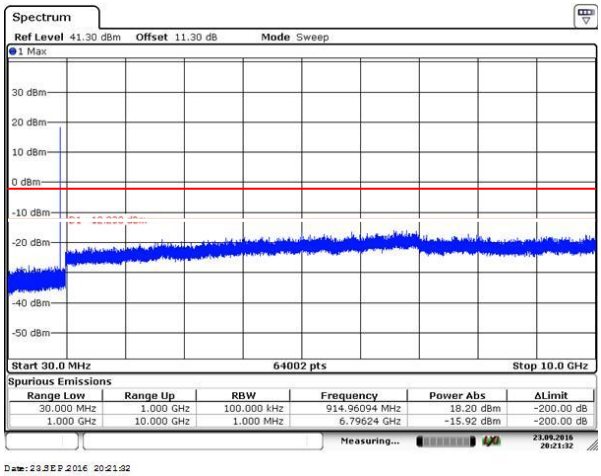
Date: 29.SEP.2016 10:20:02

6.6 *Test Data (Spurious Emissions)*

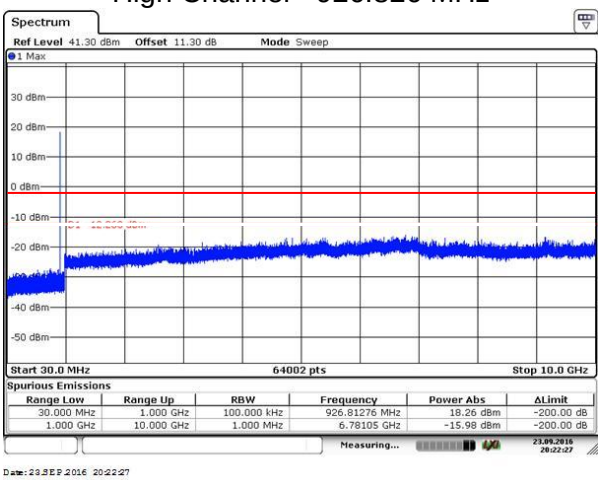
Low Channel - 903.07 MHz



Mid Channel - 915 MHz



High Channel - 926.826 MHz



7 Field Strength of Spurious Radiation

7.1 *Test Result*

Test Description	Test Specification	Test Result
Field strength of spurious radiation	15.247(d), 15.35(b),15.205, 15.209	Compliant

7.2 *Test Method*

Radiated spurious emissions measurements were recorded with the device configured to transmit at the lowest, middle, and highest channels. The frequency range investigated was up through the 10th harmonic of the fundamental transmit frequency. The methods defined in ANSI C63.10: 2013 were used.

For measurements below 1GHz, the device was manipulated through three orthogonal axes. Above 1GHz, the alternative method in Clause 6.6.5 was used.

Test distance:

30 MHz to 1 GHz - The EUT to measurement antenna distance is 3 meters
1 to 18 GHz - The EUT to measurement antenna distance is 3 meters
18 to 40 GHz - The EUT to measurement antenna distance is 1 meter

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 within the restricted bands of operation defined in FCC §15.205.
(2) Quasi-peak limit
(3) Average limit

7.3 *Test Site*

10m Absorber Lined Shielded Enclosure (ALSE), Suwanee, GA (Measurements < 1GHz)

Environmental Conditions

Temperature: 24.4 °C
Relative Humidity: 49.5 %

7.4 *Test Equipment*

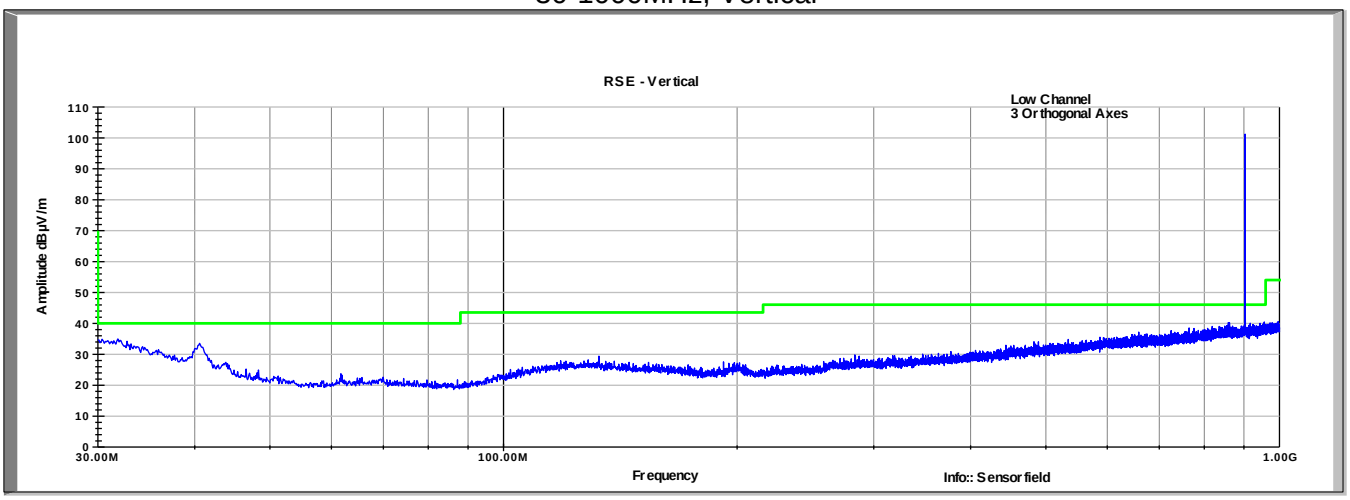
Test End Date: 28-Sep-2016 Tester: JOP

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
EMI TEST RECEIVER	ESU40	ROHDE & SCHWARZ	B079629	20-Jun-2017
ANTENNA, BILOG	CBL 6143A	TESEQ	B085931	1-Dec-2016
RF CABLE	SF106	HUBER & SUHNER	B079712	27-Jul-2017
RF CABLE	SF106	HUBER & SUHNER	B079713	27-Jul-2017
RF CABLE	SF106	HUBER & SUHNER	B079716	27-Jul-2017
RF CABLE	SF102	HUBER & SUHNER	B079822	27-Jul-2017
RF CABLE	SF102	HUBER & SUHNER	B079824	27-Jul-2017
RF CABLE	SF106	HUBER & SUHNER	B085892	27-Jul-2017
RF CABLE	SUCOFLEX 100	HUBER & SUHNER	B108523	4-Aug-2017
LOW NOISE AMPLIFIER	TS-PR18	ROHDE & SCHWARZ	B094463	16-Feb-2017
DRG HORN (MEDIUM)	3117	ETS LINDGREN	B079691	27-Jul-2017

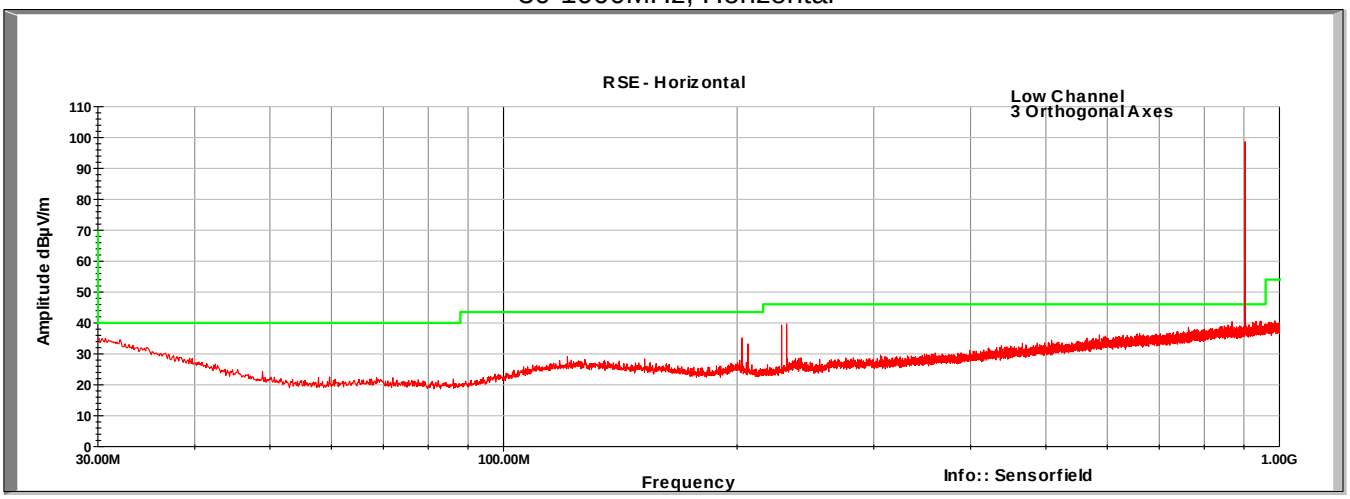
Note: The equipment calibration period is 1 year.

7.5 *Test Data – Peak Data*

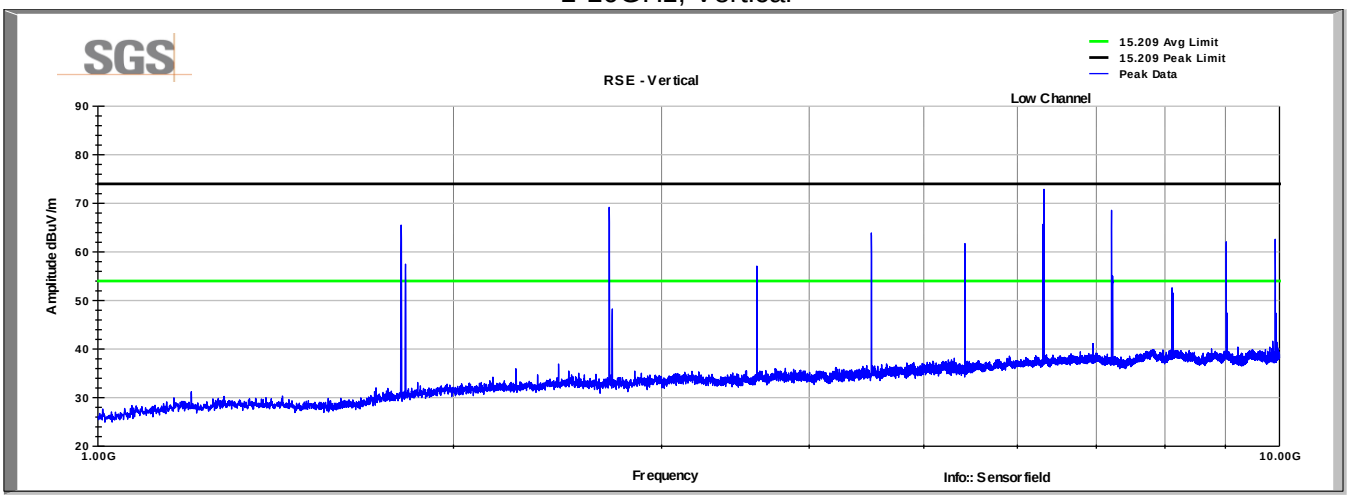
S1-B Low Channel, 903.07 MHz
30-1000MHz, Vertical



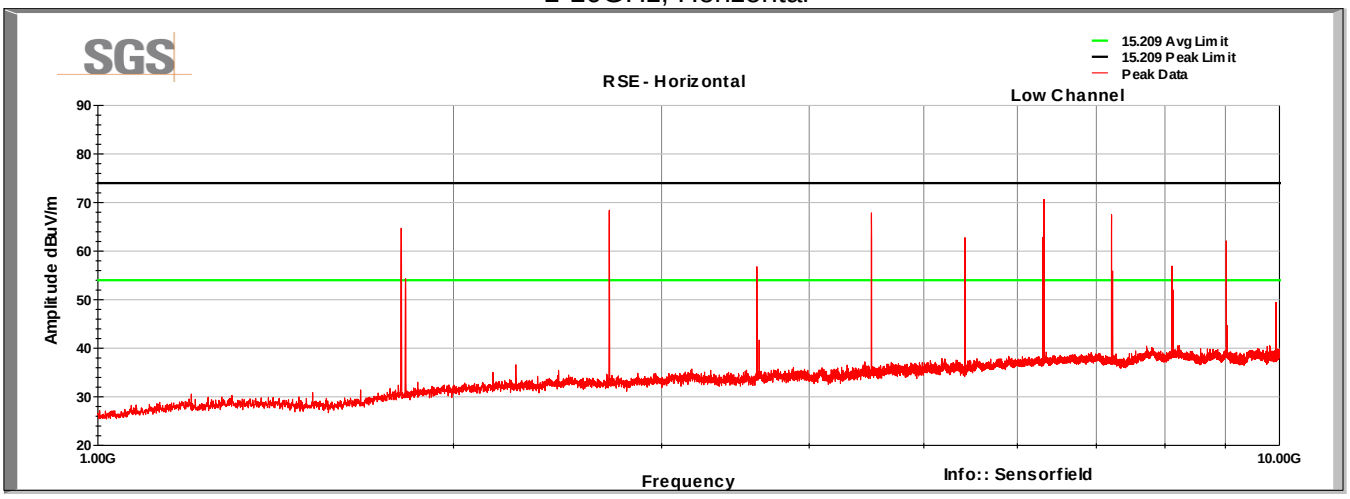
S1-B Low Channel, 903.07 MHz
30-1000MHz, Horizontal



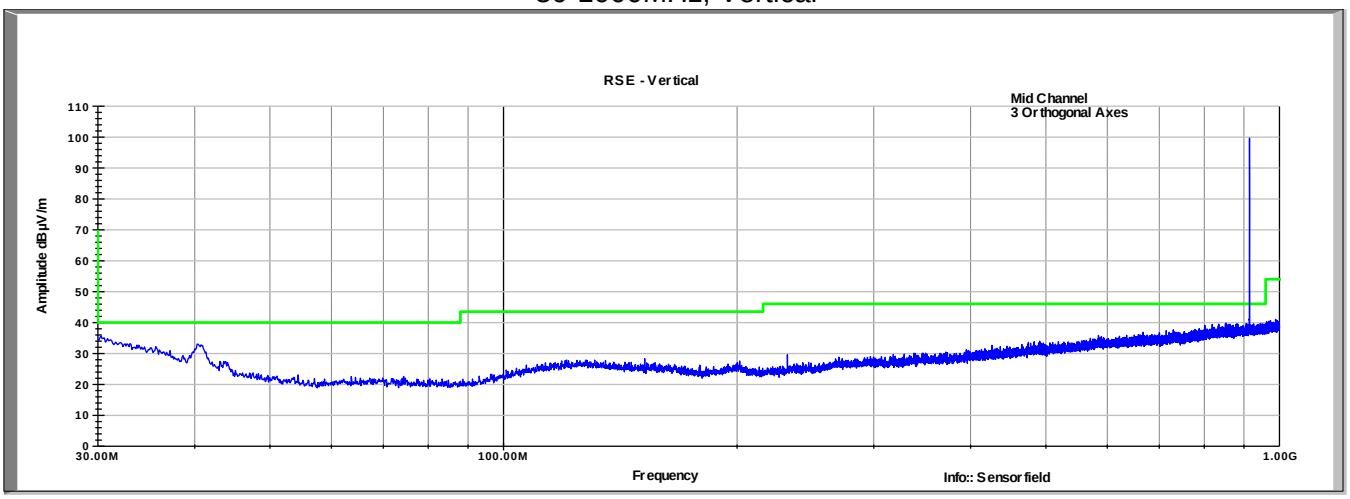
S1-B Low Channel, 903.07 MHz
1-10GHz, Vertical



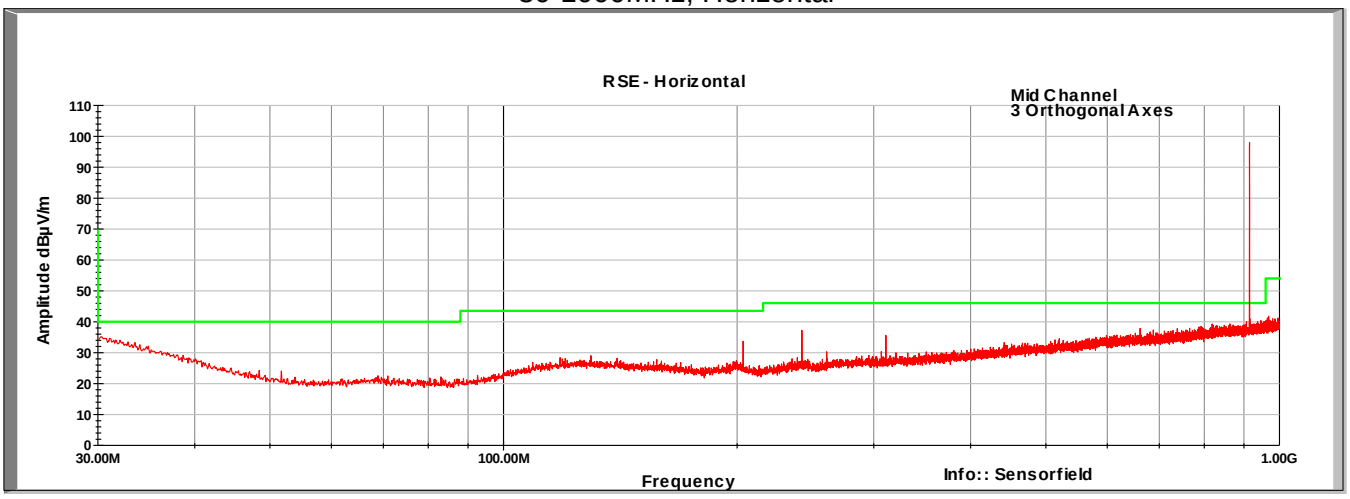
S1-B Low Channel, 903.07 MHz
1-10GHz, Horizontal



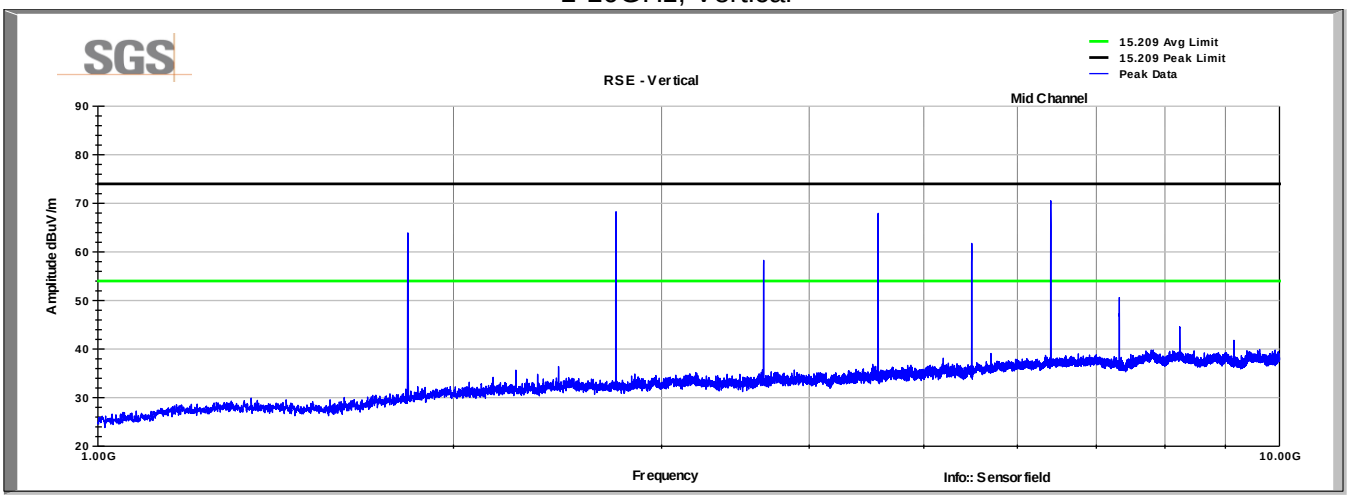
S1-B Mid Channel, 915 MHz
30-1000MHz, Vertical



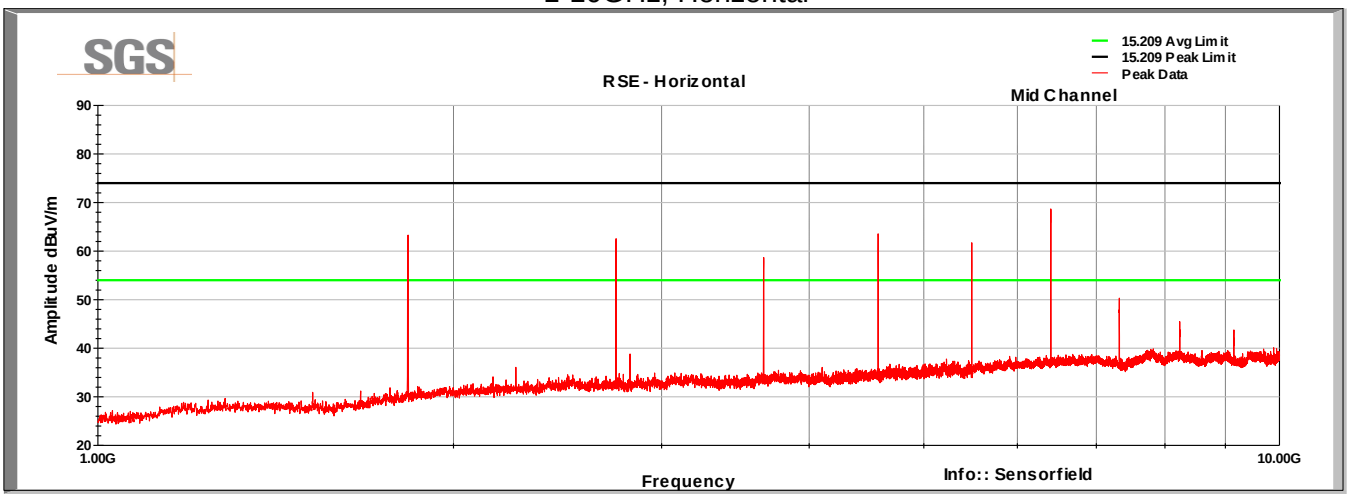
S1-B Mid Channel, 915 MHz
30-1000MHz, Horizontal



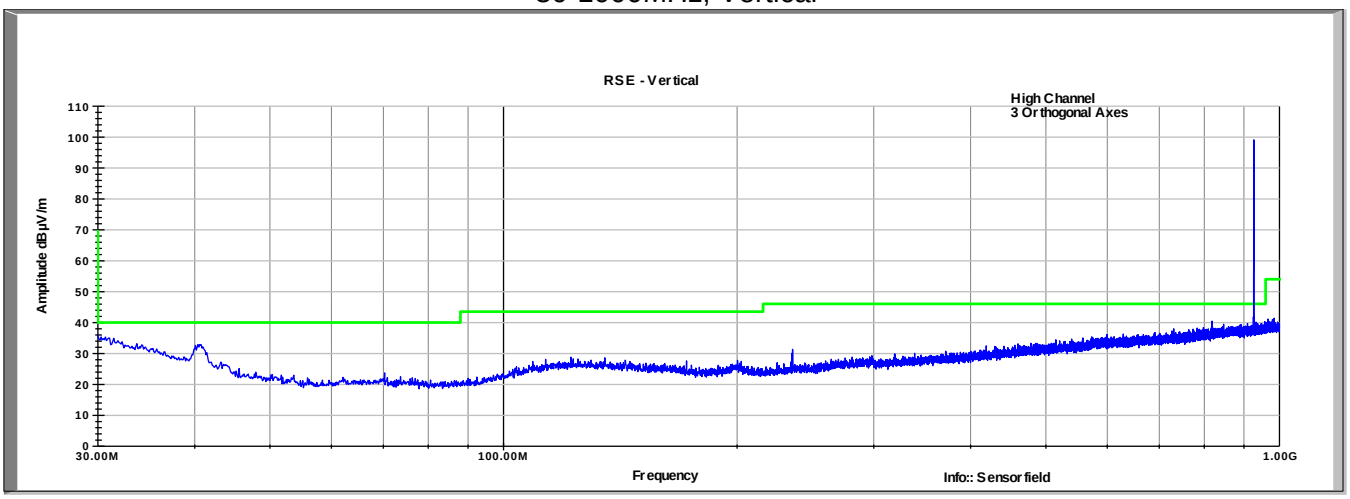
S1-B Mid Channel, 915 MHz
1-10GHz, Vertical



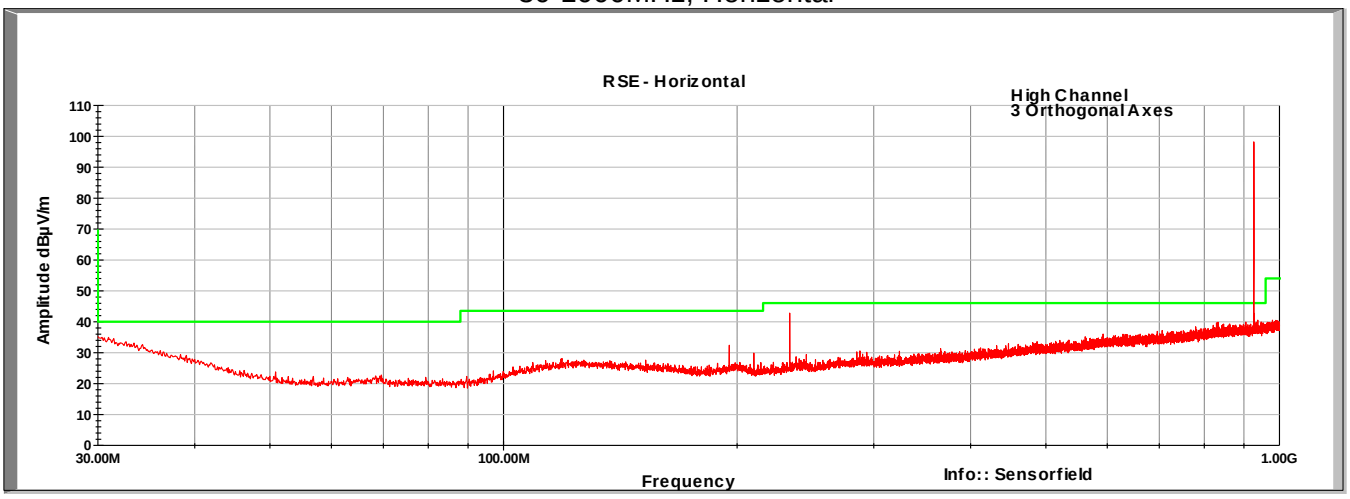
S1-B Mid Channel, 915 MHz
1-10GHz, Horizontal



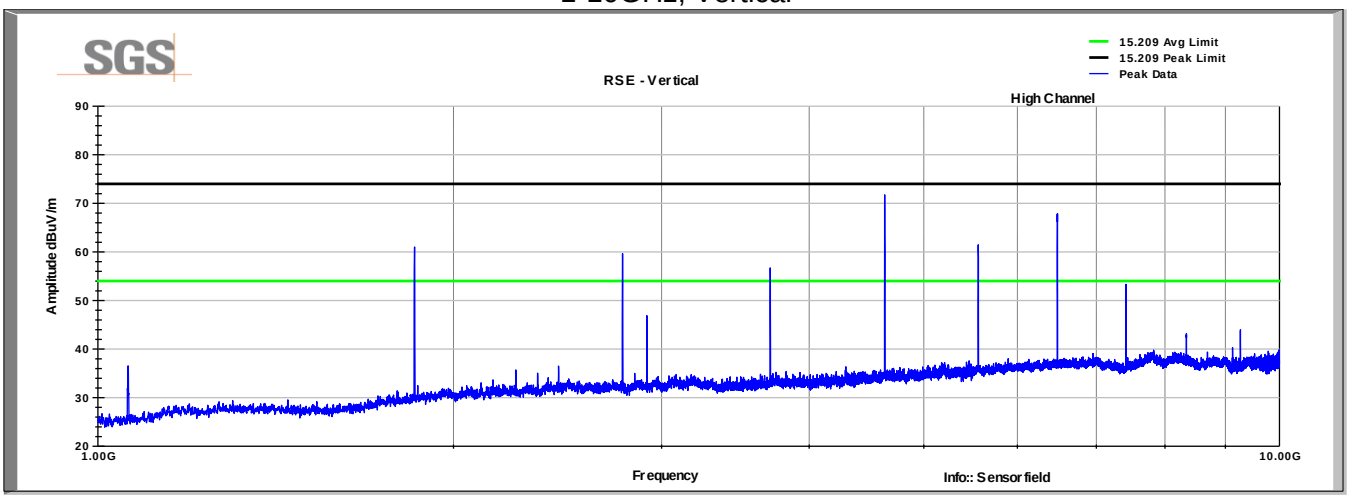
S1-B High Channel, 926.826 MHz
30-1000MHz, Vertical



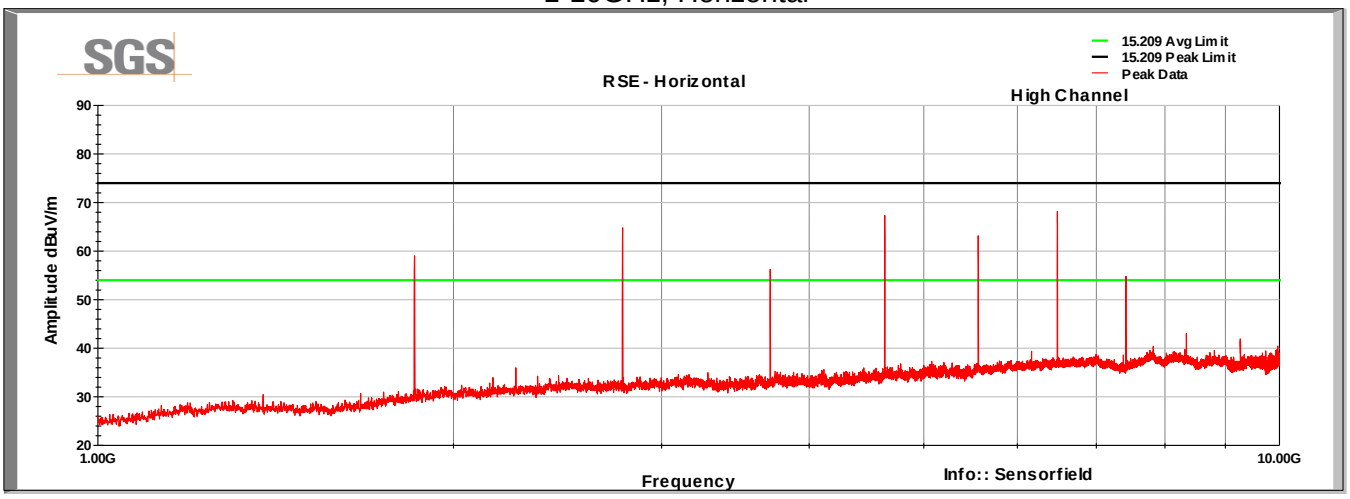
S1-B High Channel, 926.826 MHz
30-1000MHz, Horizontal



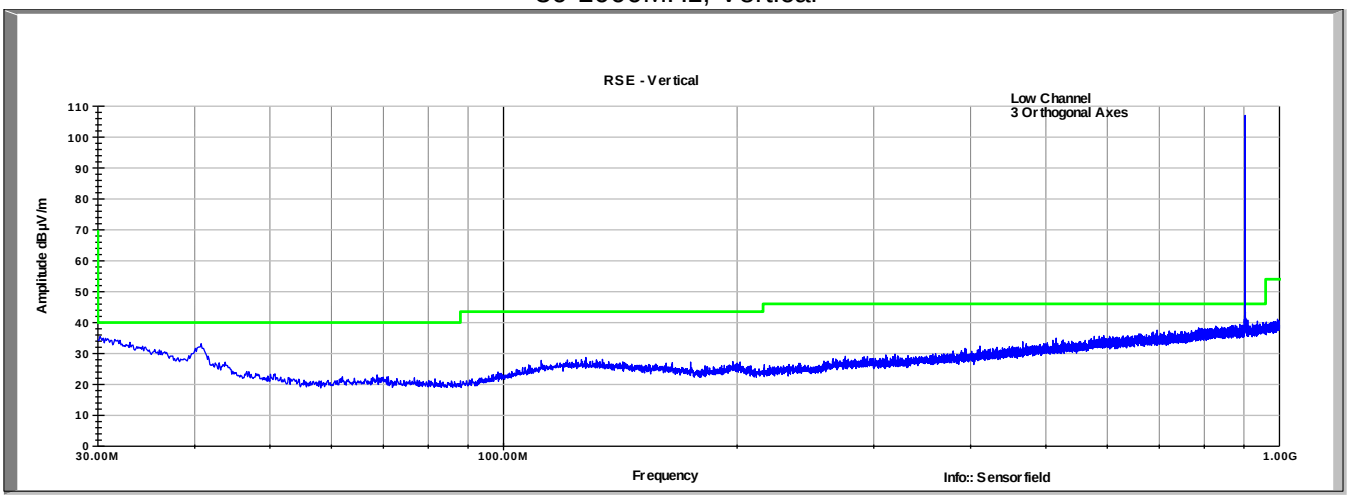
S1-B High Channel, 926.826 MHz
1-10GHz, Vertical



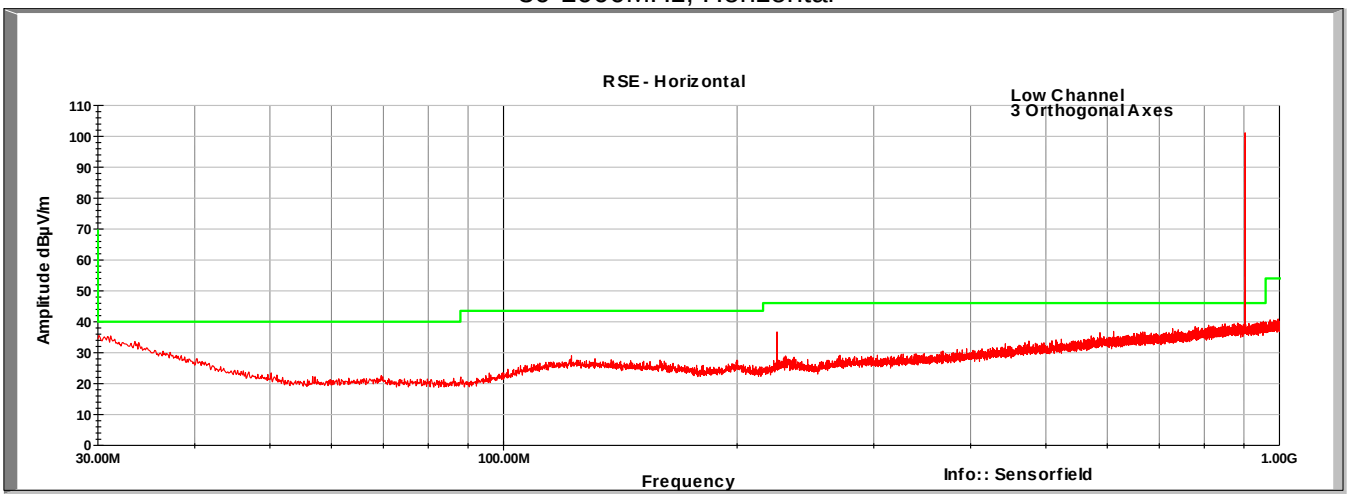
S1-B High Channel, 926.826 MHz
1-10GHz, Horizontal



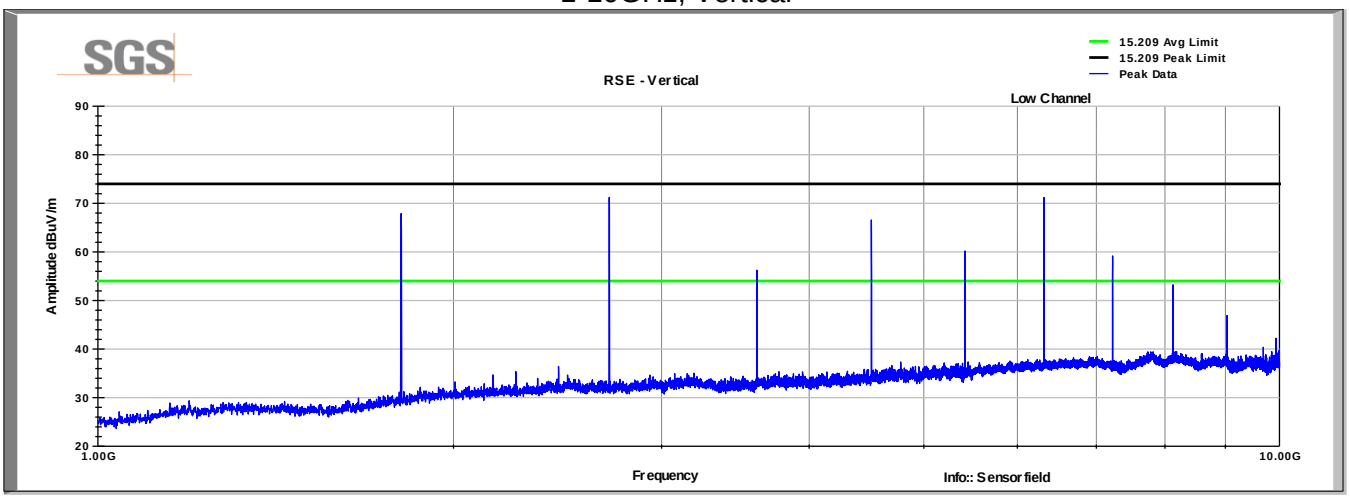
H1 Low Channel, 903.07 MHz
30-1000MHz, Vertical



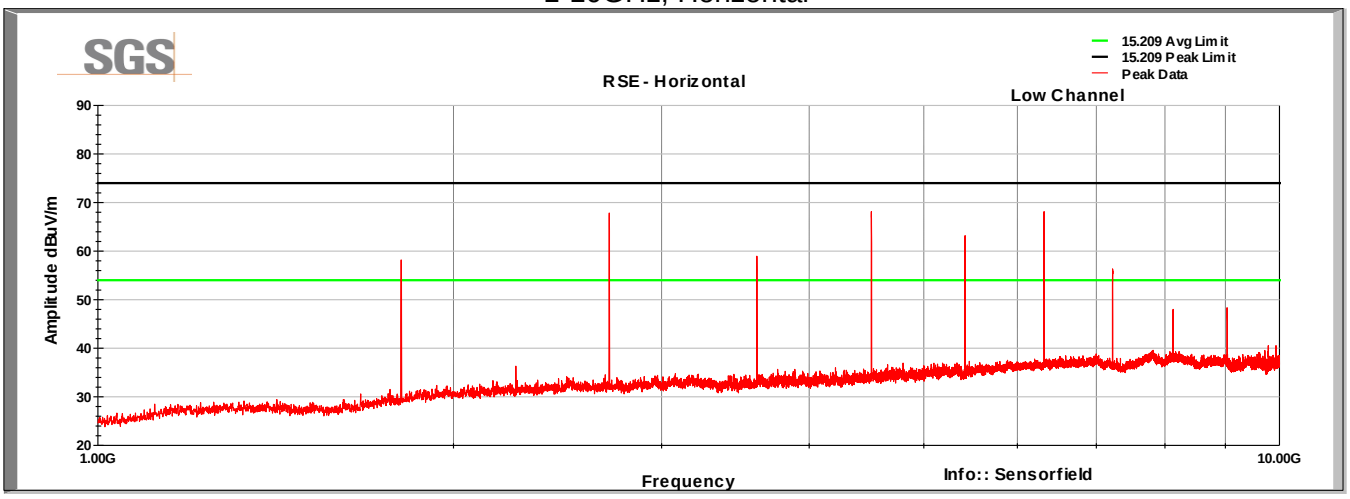
H1 Low Channel, 903.07 MHz
30-1000MHz, Horizontal



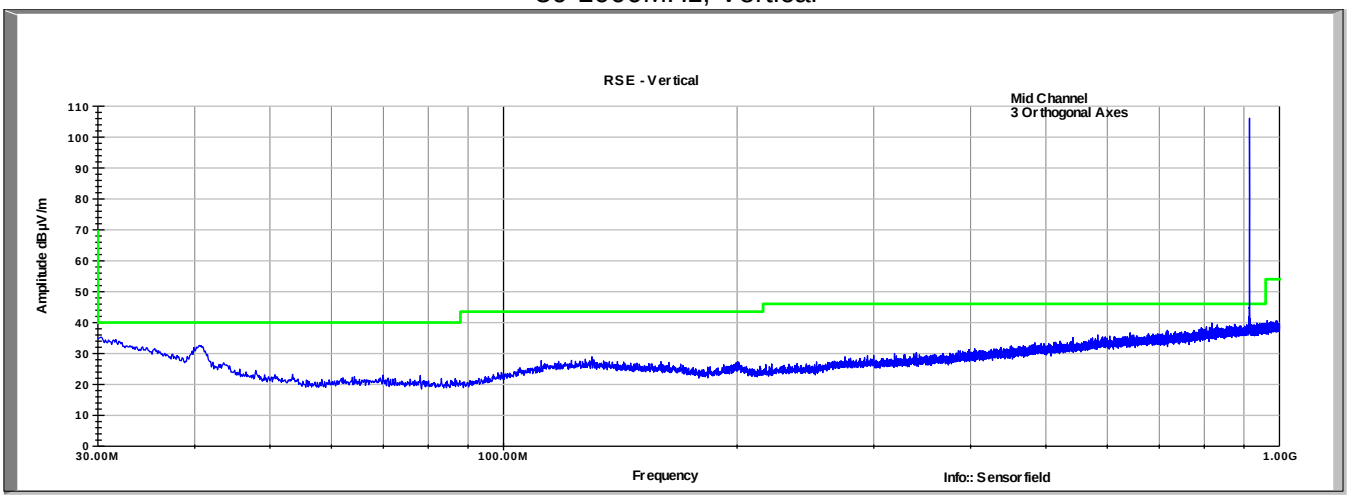
H1 Low Channel, 903.07 MHz
1-10GHz, Vertical



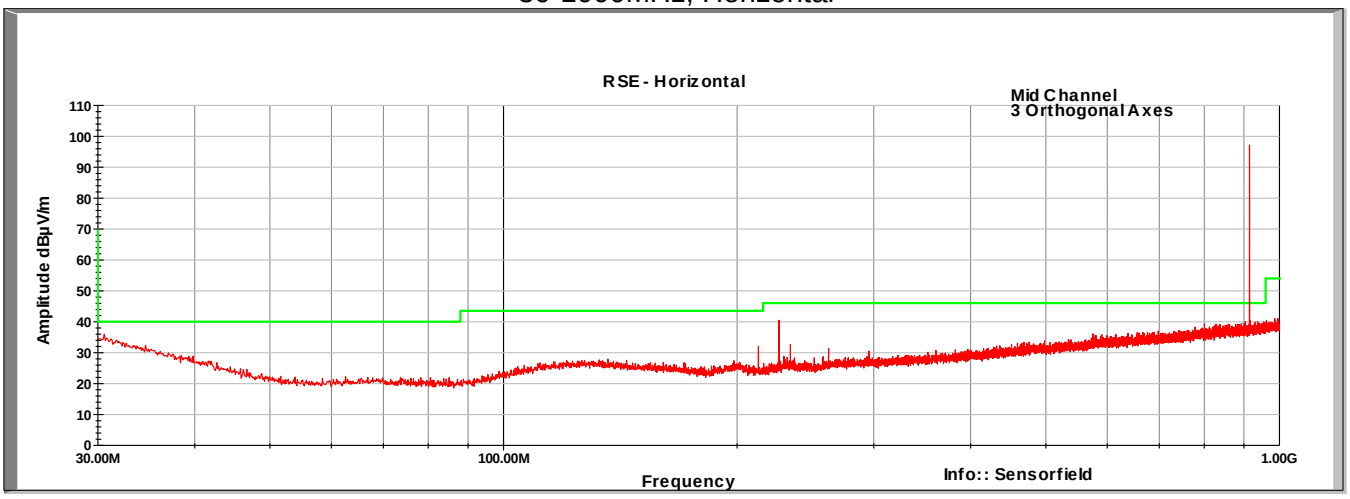
H1 Low Channel, 903.07 MHz
1-10GHz, Horizontal



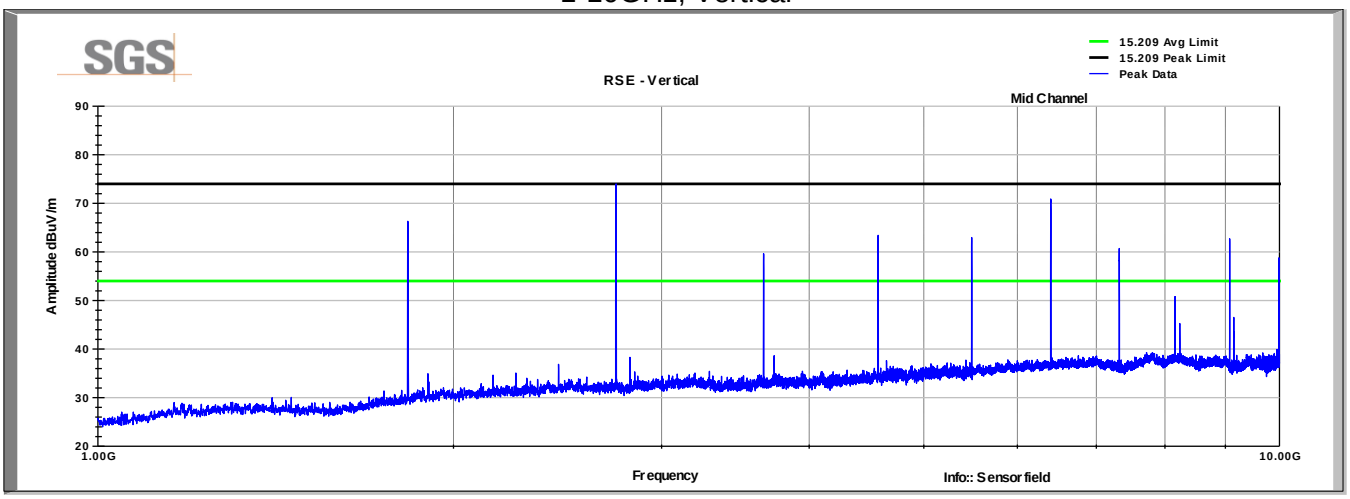
H1 Mid Channel, 915 MHz
30-1000MHz, Vertical



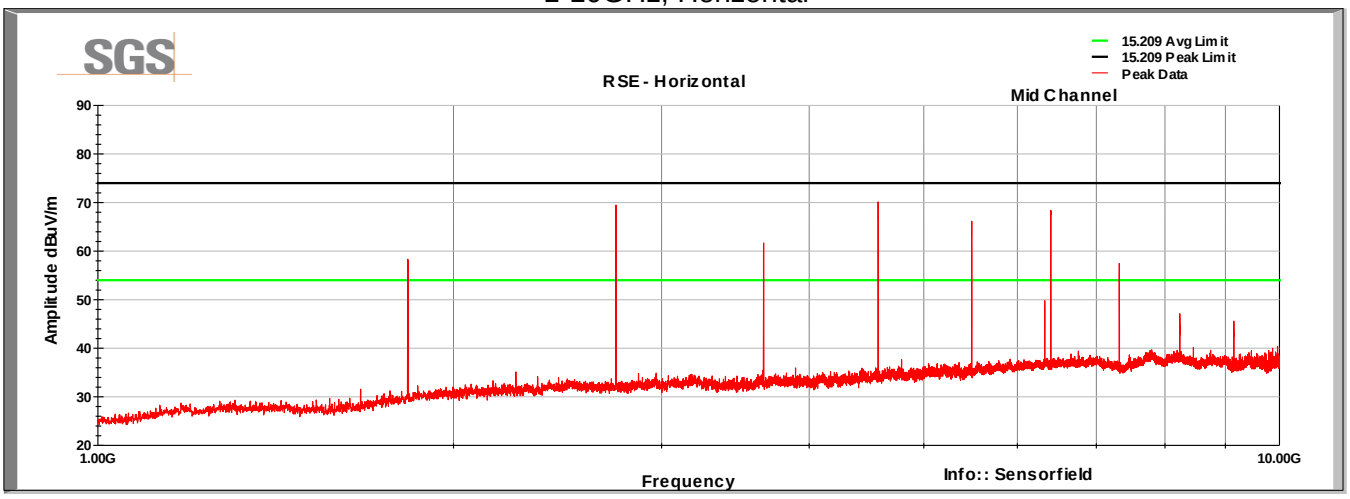
H1 Mid Channel, 915 MHz
30-1000MHz, Horizontal



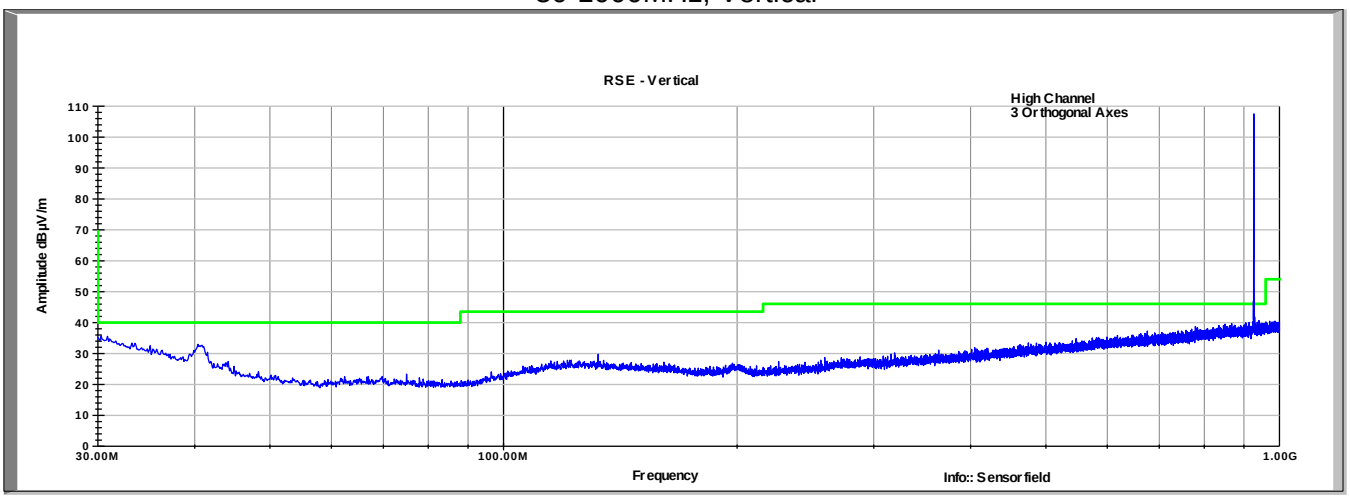
H1 Mid Channel, 915 MHz
1-10GHz, Vertical



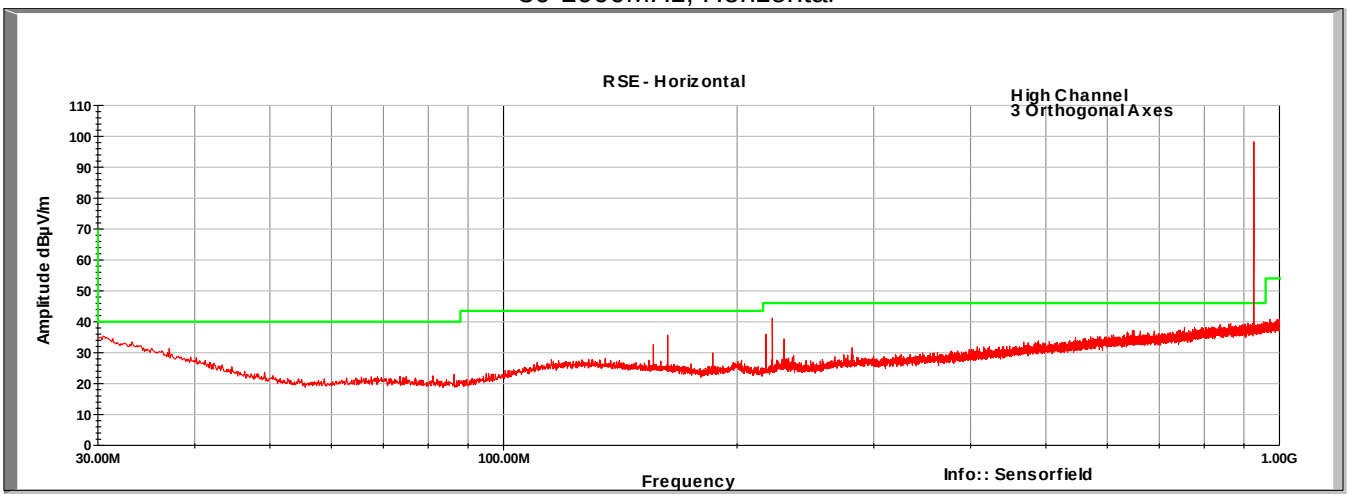
H1 Mid Channel, 915 MHz
1-10GHz, Horizontal



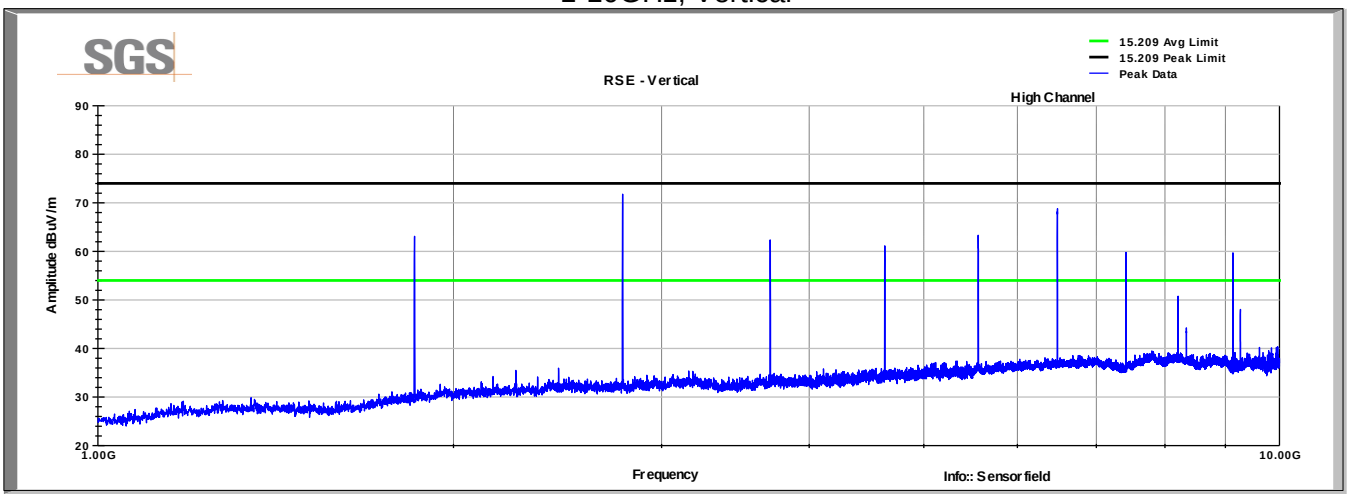
H1 High Channel, 926.826 MHz
30-1000MHz, Vertical



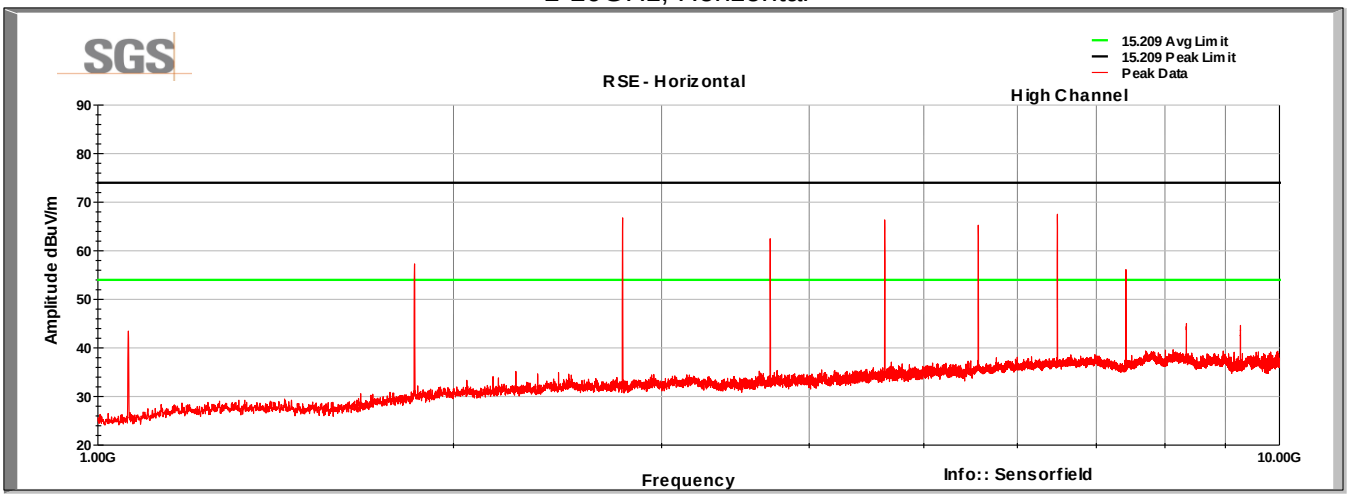
H1 High Channel, 926.826 MHz
30-1000MHz, Horizontal



H1 High Channel, 926.826 MHz
1-10GHz, Vertical



H1 High Channel, 926.826 MHz
1-10GHz, Horizontal



7.6 *Test Data – Tabular Data – S1-B*

Frequency MHz	Raw Meas (dBuV)	Polarity (V/H)	Correction (dB/m)	Corr Value dBuV/m	Limit (dBuV/m)	Margin (dB)	Detector	
Low Channel (903.07 MHz)								
1806.14	67.0	V	-1.5	65.5	NA	NA	Peak	*
2709.21	68.1	V	1.1	69.2	74.0	-4.8	Peak	
2709.21	43.1	V	1.1	44.2	54.0	-9.8	Average	
2709.21	67.2	H	1.1	68.3	74.0	-5.7	Peak	
2709.21	42.2	H	1.1	43.3	54.0	-10.7	Average	
3612.28	54.9	V	2.0	56.9	74.0	-17.1	Peak	
3612.28	29.9	V	2.0	31.9	54.0	-22.1	Average	
3612.28	54.8	H	2.0	56.8	74.0	-17.2	Peak	
3612.28	29.8	H	2.0	31.8	54.0	-22.2	Average	
4515.35	60.5	V	3.4	63.9	74.0	-10.1	Peak	
4515.35	35.5	V	3.4	38.9	54.0	-15.1	Average	
4515.35	64.5	H	3.4	67.9	74.0	-6.1	Peak	
4515.35	39.5	H	3.4	42.9	54.0	-11.1	Average	
5418.42	57.3	V	4.4	61.7	74.0	-12.3	Peak	
5418.42	32.3	V	4.4	36.7	54.0	-17.3	Average	
5418.42	58.3	H	4.4	62.7	74.0	-11.3	Peak	
5418.42	33.3	H	4.4	37.7	54.0	-16.3	Average	
6321.49	67.5	H	5.2	72.7	NA	NA	Peak	*
7224.56	62.4	V	6.0	68.4	NA	NA	Peak	*
8127.63	45.4	V	7.2	52.6	74.0	-21.4	Peak	
8127.63	20.4	V	7.2	27.6	54.0	-26.4	Average	
8127.63	49.7	H	7.2	56.9	74.0	-17.1	Peak	
8127.63	24.7	H	7.2	31.9	54.0	-22.1	Average	
9030.70	54.9	V	7.2	62.1	74.0	-11.9	Peak	
9030.70	29.9	V	7.2	37.1	54.0	-16.9	Average	
9030.70	54.9	H	7.2	62.1	74.0	-11.9	Peak	
9030.70	29.9	H	7.2	37.1	54.0	-16.9	Average	

* These frequencies do not land in a restricted band of operation.

Frequency MHz	Raw Meas (dBuV)	Polarity (V/H)	Correction (dB/m)	Corr Value dBuV/m	Limit (dBuV/m)	Margin (dB)	Detector	
Mid Channel (915 MHz)								
1830.00	65.0	V	-1.1	63.9	NA	NA	Peak	*
2745.00	67.2	V	1.1	68.3	74.0	-5.7	Peak	
2745.00	42.2	V	1.1	43.3	54.0	-10.7	Average	
2745.00	61.5	H	1.1	62.6	74.0	-11.4	Peak	
2745.00	36.5	H	1.1	37.6	54.0	-16.4	Average	
3660.00	56.3	V	2.0	58.3	74.0	-15.7	Peak	
3660.00	31.3	V	2.0	33.3	54.0	-20.7	Average	
3660.00	56.7	H	2.0	58.7	74.0	-15.3	Peak	
3660.00	31.7	H	2.0	33.7	54.0	-20.3	Average	
4575.00	64.5	V	3.4	67.9	74.0	-6.1	Peak	
4575.00	39.5	V	3.4	42.9	54.0	-11.1	Average	
4575.00	60.1	H	3.4	63.5	74.0	-10.5	Peak	
4575.00	35.1	H	3.4	38.5	54.0	-15.5	Average	
5490.00	57.2	H	4.5	61.7	NA	NA	Peak	*
6405.00	58.1	V	5.4	63.5	NA	NA	Peak	*
7320.00	44.5	V	6.1	50.6	74.0	-23.4	Peak	
7320.00	19.5	V	6.1	25.6	54.0	-28.4	Average	
7320.00	44.2	H	6.1	50.3	74.0	-23.7	Peak	
7320.00	19.2	H	6.1	25.3	54.0	-28.7	Average	

* These frequencies do not land in a restricted band of operation.

Frequency MHz	Raw Meas (dBuV)	Polarity (V/H)	Correction (dB/m)	Corr Value dBuV/m	Limit (dBuV/m)	Margin (dB)	Detector	
High Channel (926.826 MHz)								
1853.65	62.1	V	-1.1	61.0	NA	NA	Peak	*
2780.48	58.5	V	1.1	59.6	74.0	-14.4	Peak	
2780.48	33.5	V	1.1	34.6	54.0	-19.4	Average	
2780.48	63.7	H	1.1	64.8	74.0	-9.2	Peak	
2780.48	38.7	H	1.1	39.8	54.0	-14.2	Average	
3707.30	54.7	V	2.0	56.7	74.0	-17.3	Peak	
3707.30	29.7	V	2.0	31.7	54.0	-22.3	Average	
3707.30	54.2	H	2.0	56.2	74.0	-17.8	Peak	
3707.30	29.2	H	2.0	31.2	54.0	-22.8	Average	
4634.13	68.3	V	3.4	71.7	74.0	-2.3	Peak	
4634.13	43.3	V	3.4	46.7	54.0	-7.3	Average	
4634.13	63.9	H	3.4	67.3	74.0	-6.7	Peak	
4634.13	38.9	H	3.4	42.3	54.0	-11.7	Average	
5560.96	58.7	H	4.5	63.2	NA	NA	Peak	*
6487.78	62.3	V	5.4	67.7	NA	NA	Peak	*
7414.61	47.2	V	6.1	53.3	74.0	-20.7	Peak	
7414.61	22.2	V	6.1	28.3	54.0	-25.7	Average	
7414.61	48.6	H	6.1	54.7	74.0	-19.3	Peak	
7414.61	23.6	H	6.1	29.7	54.0	-24.3	Average	

* These frequencies do not land in a restricted band of operation.

7.7 *Test Data – Tabular Data – H1*

Frequency MHz	Raw Meas (dBuV)	Polarity (V/H)	Correction (dB/m)	Corr Value dBuV/m	Limit (dBuV/m)	Margin (dB)	Detector	
Low Channel (903.07 MHz)								
1806.14	69.0	V	-1.5	67.5	NA	NA	Peak	*
2709.21	70.1	V	1.1	71.2	74.0	-2.8	Peak	
2709.21	45.1	V	1.1	46.2	54.0	-7.8	Average	
2709.21	66.7	H	1.1	67.8	74.0	-6.2	Peak	
2709.21	41.7	H	1.1	42.8	54.0	-11.2	Average	
3612.28	54.1	V	2.0	56.1	74.0	-17.9	Peak	
3612.28	29.1	V	2.0	31.1	54.0	-22.9	Average	
3612.28	56.9	H	2.0	58.9	74.0	-15.1	Peak	
3612.28	31.9	H	2.0	33.9	54.0	-20.1	Average	
4515.35	63.2	V	3.4	66.6	74.0	-7.4	Peak	
4515.35	38.2	V	3.4	41.6	54.0	-12.4	Average	
4515.35	64.7	H	3.4	68.1	74.0	-5.9	Peak	
4515.35	39.7	H	3.4	43.1	54.0	-10.9	Average	
5418.42	55.6	V	4.4	60.0	74.0	-14.0	Peak	
5418.42	30.6	V	4.4	35.0	54.0	-19.0	Average	
5418.42	58.8	H	4.4	63.2	74.0	-10.8	Peak	
5418.42	33.8	H	4.4	38.2	54.0	-15.8	Average	
6321.49	66.0	V	5.2	71.2	NA	NA	Peak	*
7224.56	53.1	V	6.0	59.1	NA	NA	Peak	*
8127.63	45.8	V	7.2	53.0	74.0	-21.0	Peak	
8127.63	20.8	V	7.2	28.0	54.0	-26.0	Average	
8127.63	40.6	H	7.2	47.8	74.0	-26.2	Peak	
8127.63	15.6	H	7.2	22.8	54.0	-31.2	Average	

* These frequencies do not land in a restricted band of operation.

Frequency MHz	Raw Meas (dBuV)	Polarity (V/H)	Correction (dB/m)	Corr Value dBuV/m	Limit (dBuV/m)	Margin (dB)	Detector	
Mid Channel (915 MHz)								
1830.00	67.4	V	-1.1	66.3	NA	NA	Peak	*
2745.00	70.9	V	1.1	72.0	74.0	-2.0	Peak	
2745.00	45.9	V	1.1	47.0	54.0	-7.0	Average	
2745.00	68.4	H	1.1	69.5	74.0	-4.5	Peak	
2745.00	43.4	H	1.1	44.5	54.0	-9.5	Average	
3660.00	57.6	V	2.0	59.6	74.0	-14.4	Peak	
3660.00	32.6	V	2.0	34.6	54.0	-19.4	Average	
3660.00	59.7	H	2.0	61.7	74.0	-12.3	Peak	
3660.00	34.7	H	2.0	36.7	54.0	-17.3	Average	
4575.00	60.0	V	3.4	63.4	74.0	-10.6	Peak	
4575.00	35.0	V	3.4	38.4	54.0	-15.6	Average	
4575.00	66.7	H	3.4	70.1	74.0	-3.9	Peak	
4575.00	41.7	H	3.4	45.1	54.0	-8.9	Average	
5490.00	61.6	H	4.5	66.1	NA	NA	Peak	*
6405.00	65.5	V	5.4	70.9	NA	NA	Peak	*
7320.00	54.6	V	6.1	60.7	74.0	-13.3	Peak	
7320.00	29.6	V	6.1	35.7	54.0	-18.3	Average	
7320.00	51.3	H	6.1	57.4	74.0	-16.6	Peak	
7320.00	26.3	H	6.1	32.4	54.0	-21.6	Average	
9150.00	55.6	V	7.1	62.7	74.0	-11.3	Peak	
9150.00	30.6	V	7.1	37.7	54.0	-16.3	Average	

* These frequencies do not land in a restricted band of operation.

Frequency MHz	Raw Meas (dBuV)	Polarity (V/H)	Correction (dB/m)	Corr Value dBuV/m	Limit (dBuV/m)	Margin (dB)	Detector	
High Channel (926.826 MHz)								
1853.65	64.2	V	-1.1	63.1	NA	NA	Peak	*
2780.48	70.7	V	1.1	71.8	74.0	-2.2	Peak	
2780.48	45.7	V	1.1	46.8	54.0	-7.2	Average	
2780.48	65.7	H	1.1	66.8	74.0	-7.2	Peak	
2780.48	40.7	H	1.1	41.8	54.0	-12.2	Average	
3707.30	64.8	V	2.0	66.8	74.0	-7.2	Peak	
3707.30	39.8	V	2.0	41.8	54.0	-12.2	Average	
3707.30	60.5	H	2.0	62.5	74.0	-11.5	Peak	
3707.30	35.5	H	2.0	37.5	54.0	-16.5	Average	
4634.13	57.7	V	3.4	61.1	74.0	-12.9	Peak	
4634.13	32.7	V	3.4	36.1	54.0	-17.9	Average	
4634.13	62.8	H	3.4	66.2	74.0	-7.8	Peak	
4634.13	37.8	H	3.4	41.2	54.0	-12.8	Average	
5560.96	60.8	H	4.5	65.3	NA	NA	Peak	*
6487.78	63.4	V	5.4	68.8	NA	NA	Peak	*
7414.61	53.7	V	6.1	59.8	74.0	-14.2	Peak	
7414.61	28.7	V	6.1	34.8	54.0	-19.2	Average	
7414.61	50.0	H	6.1	56.1	74.0	-17.9	Peak	
7414.61	25.0	H	6.1	31.1	54.0	-22.9	Average	

* These frequencies do not land in a restricted band of operation.

8 Pseudo-Random Hop Sequence

8.1 *Test Result*

Test Description	Test Specification	Test Result
Pseudo-Random Hop Sequence	15.247(d)	Compliant(1)

Note (1): The theory of operation states that the device is LoRa and operates using a pseudo-random hopping technique.

8.2 *Test Method*

Compliance is demonstrated by Manufacturer's declaration or is stated in the Theory of Operation.

Requirement

The hopset shall be such that the near-term distribution of frequencies appears random, with sequential hops randomly distributed in both direction and magnitude of change in the hopset, while the long-term distribution appears evenly distributed.

9 Channel Separation

9.1 *Test Result*

Test Description	Test Specification	Test Result
Channel Separation	15.247(a)(1)	Compliant

9.2 *Test Method*

Measurements were recorded using the test methods defined in ANSI C63.10, Clause 7.8.2.

Requirement

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the -20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W.

9.3 *Test Site*

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.4 °C
Relative Humidity: 48.8 %

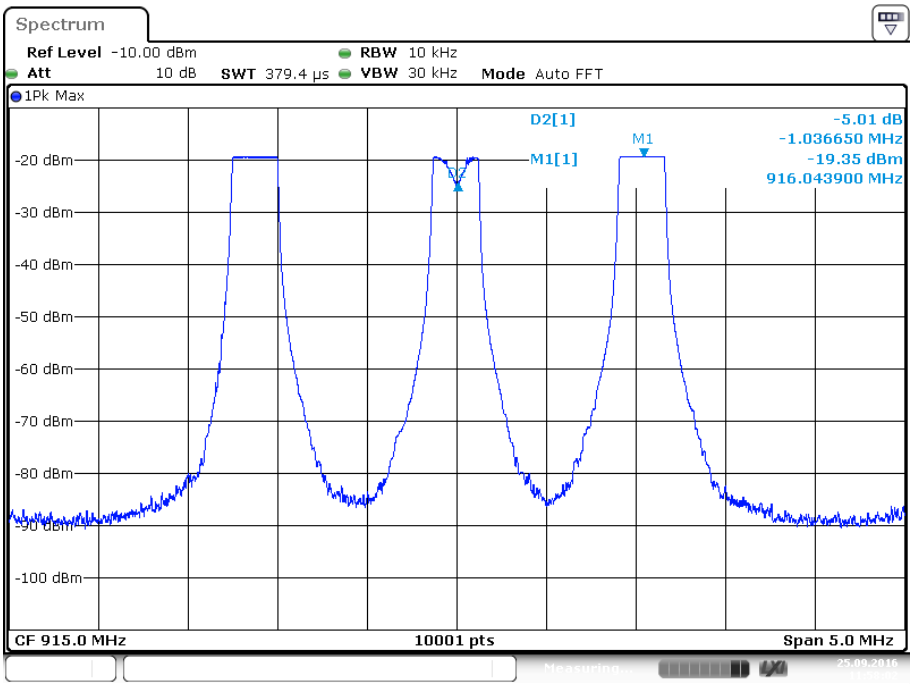
9.4 *Test Equipment*

Test Date: 25-Sep-2016 Tester: JOP

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
SIGNAL ANALYZER	FSV30	ROHDE & SCHWARZ	B085749	8-Oct-2017
RF CABLE	1134	GORE	B094785	26-Jul-2017
ATTENUATOR, 10DB	10DB	ROHDE & SCHWARZ	B095593	27-Jul-2017

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

9.5 *Test Data*



Date: 25.SEP.2016 11:58:02

The minimum channel separation was 1.037 MHz which is greater than the worst-case 20dB bandwidth of 0.527MHz.

10 Number of Hopping Channels

10.1 *Test Result*

Test Description	Test Specification	Test Result
Number of Hopping Channels	15.247(a)(1)(i)	Reported

10.2 *Test Method*

Measurements were recorded using the methods defined in ANSI C63.10, Clause 7.8.3.

Requirement
For hybrid DTS / frequency hopping systems operating in the 902-928 MHz band there is no minimum channel requirement.

10.3 *Test Site*

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions
Temperature: 23.1 °C
Relative Humidity: 53.5 %

10.4 *Test Equipment*

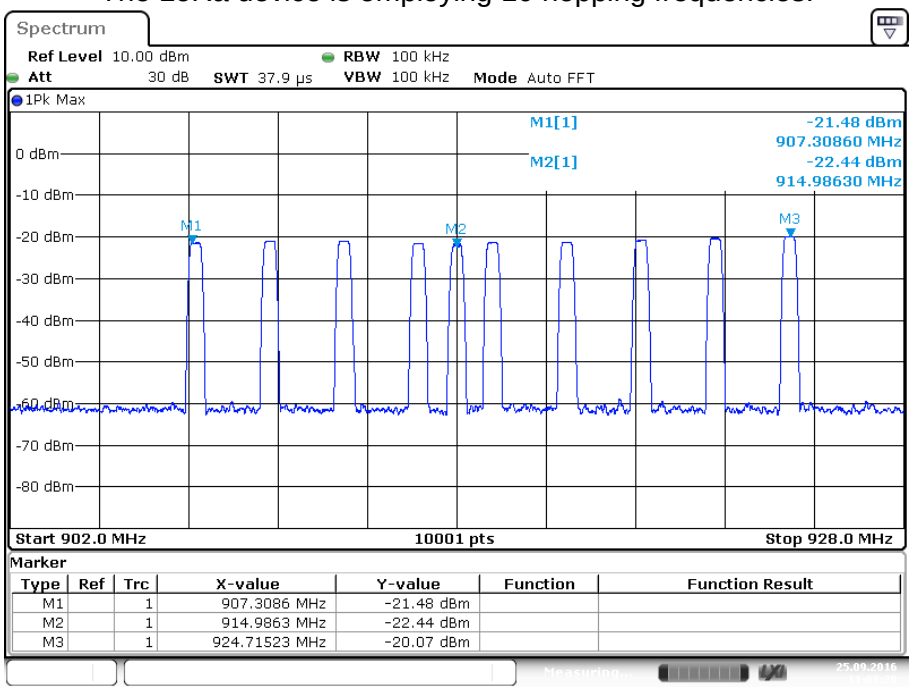
Test Date: 25-Sep-2016 Tester: JOP

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
SIGNAL ANALYZER	FSV30	ROHDE & SCHWARZ	B085749	8-Oct-2017
RF CABLE	1134	GORE	B094785	26-Jul-2017
ATTENUATOR, 10DB	10DB	ROHDE & SCHWARZ	B095593	27-Jul-2017

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

10.5 *Test Data*

The LoRa device is employing 10 hopping frequencies.



Date: 25.SEP.2016 11:03:20

11 Dwell Time

11.1 *Test Result*

Test Description	Test Specification	Test Result
Dwell Time	15.247(f)	Compliant

11.2 *Test Method*

Measurements were recorded using the methods defined in ANSI C63.10, Clause 7.8.4.

Requirement

The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned-off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4. For this device employing 10 hopping channels, the occupancy period is 10 * 0.4 = 4 seconds

11.3 *Test Site*

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.1 °C
Relative Humidity: 53.5 %

11.4 *Test Equipment*

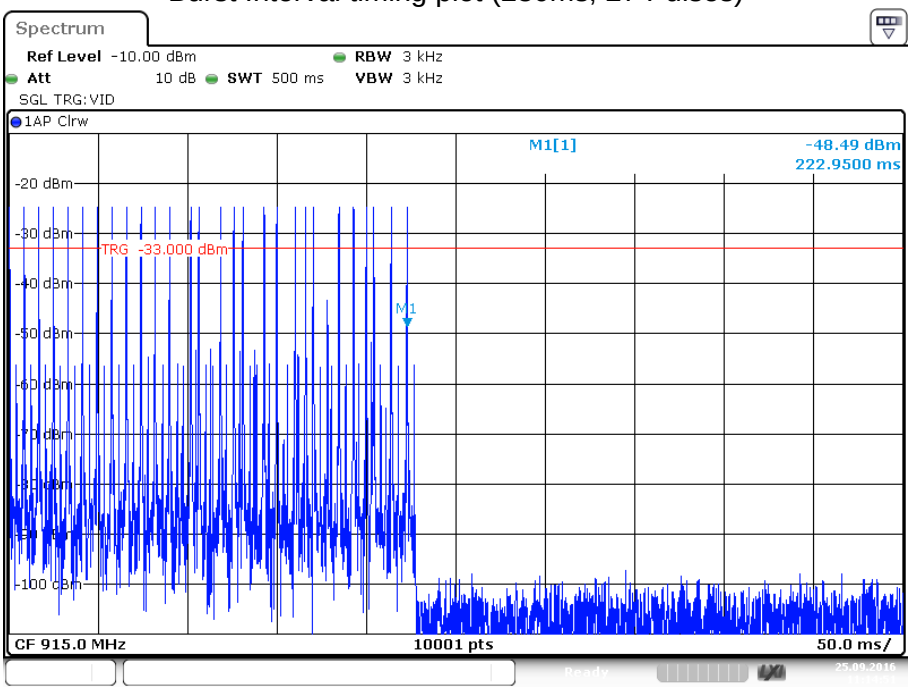
Test Date: 25-Sep-2016 Tester: JOP

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
SIGNAL ANALYZER	FSV30	ROHDE & SCHWARZ	B085749	8-Oct-2017
RF CABLE	1134	GORE	B094785	26-Jul-2017
ATTENUATOR, 10DB	10DB	ROHDE & SCHWARZ	B095593	27-Jul-2017

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

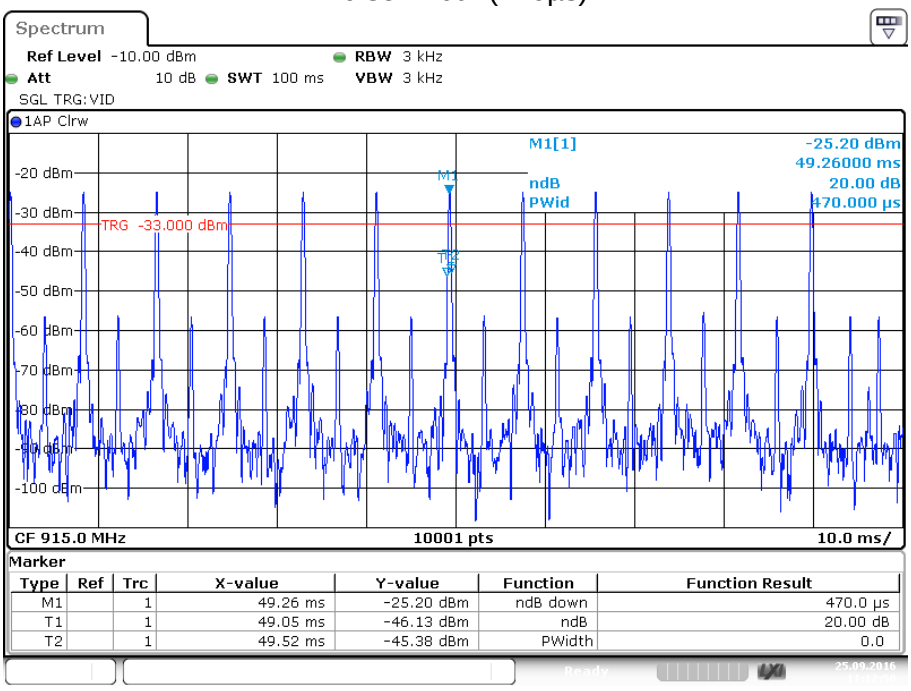
11.5 *Test Data*

Burst Interval timing plot (230ms, 27 Pulses)



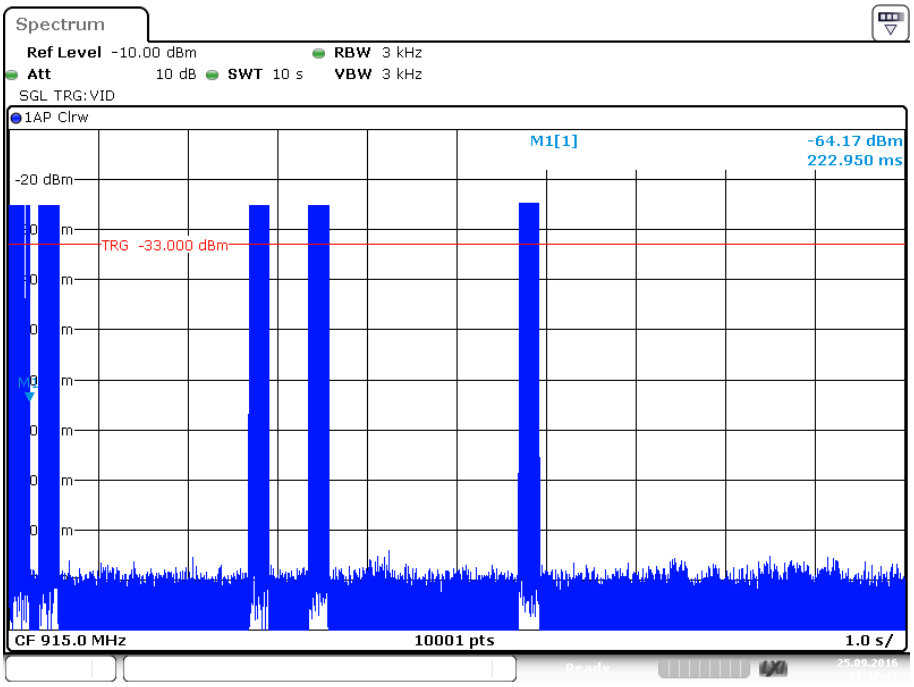
Date: 25.SEP.2016 11:14:51

Pulse Width (470µs)



Date: 25.SEP.2016 11:12:50

Bursts in 10s



Max Bursts in any 4 seconds = 4
0.47ms (pulse width) *27 (pulses/burst) *4 bursts = 50.8ms = 0.05s

12 Revision History

Revision Level	Description of changes	Revision Date
0	Initial release	04 October 2016