

EMC Test Report

Project Number: 3071804**Report Number: 3071804EMC04****Revision Level: 0****Client: Airo Wireless, Inc.****Equipment Under Test: Intrinsically Safe Cellular Phone****Model: I-SAFE™28****Applicable Standards: FCC Part 15 Subpart C, § 15.247****RSS-210, Issue 8, December 2010****ANSI C63.10: 2009****Report issued on: 11 September 2013****Test Result: Compliant**

Tested by:



Jeremy O. Pickens, Senior EMC Engineer

Reviewed by:



David Schramm, EMC Manager**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.

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1 Summary of Test Results

Test Description	Test Specification		Test Result
Occupied Bandwidth	15.247(a) (1)	RSS-210 A8.1(a)	Compliant
Peak Power Output	15.247(a) (1)	RSS-210 A8.4(4)	Compliant
Conducted Spurious Emissions	15.247(d)	RSS-210 A8.5	Compliant
Band Edge	15.247(d)	RSS-210 A8.5	Compliant
Radiated Spurious Emissions	15.247(d), 15.35(b), 15.209	RSS-210 A8.5	Compliant
Dwell Time	15.247(a) (1)(iii)	RSS-210 A8.1(d)	Compliant
Channel separation	15.247(a) (1)(iii)	RSS-210 A8.1(b)	Compliant
Spectral Density	15.247(f), 15.247(e)	RSS-210 A8.2(b)	Compliant
Number of hopping frequencies	15.247(a) (1)(iii)	RSS-210 A8.1(d)	Compliant
AC Powerline Conducted Emission	15.107, 15.207	RSS-GEN 7.2.4	Compliant

1.1 Modifications Required for Compliance

None

2 General Information

2.1 Client Information

Name: Airo Wireless, Inc.

Address: 12 Piedmont Center, Suite 205

City, State, Zip, Country: Atlanta, GA 30305

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

Type of Product: Intrinsically Safe Cellular Phone

Model: I-SAFE™ 28

Serial Number: Not Labeled

FCC ID: QDL-ISAFE28

Frequency Range: 2402 to 2480 MHz

Number of channels: 79

Modulation type: GFSK, EDR 2, EDR 3

Channel spacing: 1 MHz

Antenna: Integral

Rated Voltage: 3.7 VDC Internal Battery

Sample Received Date: 03 July 2013

Dates of testing: 23 July – 05 September 2013



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Airo Wireless / I-SAFE™28

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Operating Modes and Conditions

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

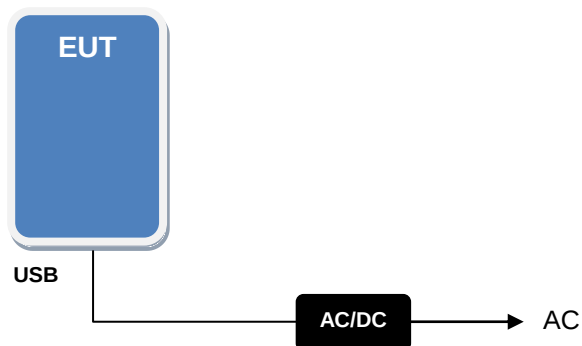
During testing, the hopping sequence was stopped in accordance with Section 5.1 of ANSI C63.10-2009 so that the low, mid and high channels could be tested independently.

Modulations used: For fundamental and spurious measurements, the EUT was configured to operate continuously with Bluetooth modulation enabled.

As specified in Section 5.10.5 of ANSI C63.10:2009:

- Software was designed to allow the EUT to operate
 - at 100 % 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 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	Airo Wireless	EUT	28	Not Labeled
B	Phihong	AC Adapter	PSB05R-050Q	P22709221A3

3 Occupied Bandwidth

3.1 Test Result

Test Description	Basic Standards	Test Result
99% bandwidth	15.247(a) (1)	Pass

3.2 Test Method

Measurements were taken using the 99% OBW function of the measurement receiver..

3.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 21.7 °C

Relative Humidity: 46.9 %

3.4 Test Equipment

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
SPECTRUM ANALYZER	FSL	R&S	1257361J	8-Jan-2014

Note: The calibration period equipment is 1 year.

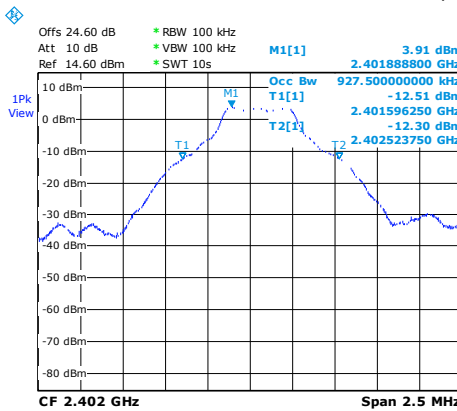
3.5 Test Setup Photographs

Test setup photographs are located in a separate exhibit.

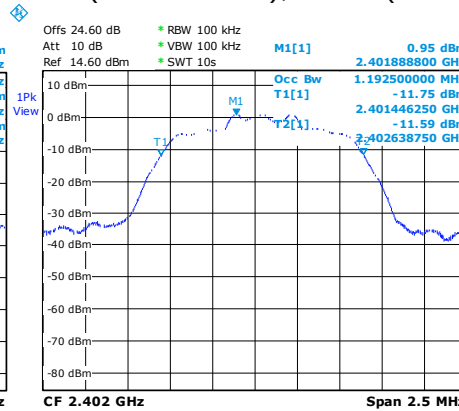
3.6 Test Data

Frequency	Channel No	Modulation	20 dB bandwidth kHz
2402	0	GFSK	927.5
		EDR-2	1192.5
		EDR-3	1202.5
2441	39	GFSK	915.0
		EDR-2	1192.5
		EDR-3	1205.0
2480	78	GFSK	915.0
		EDR-2	1200.0
		EDR-3	1210.0

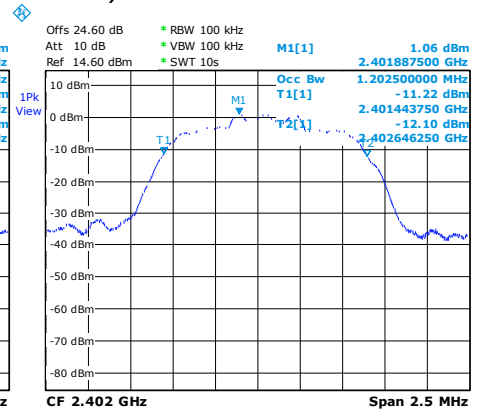
Occupied Bandwidth Plot, Low Channel
GFSK, EDR-2(2-DH3 GFSK), EDR-3(3-DH3 GFSK)



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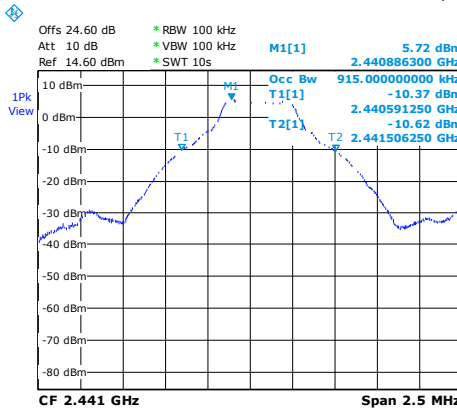


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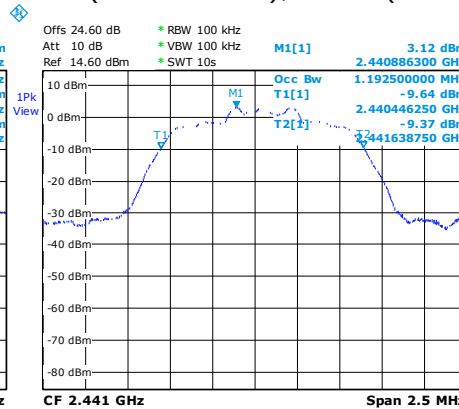


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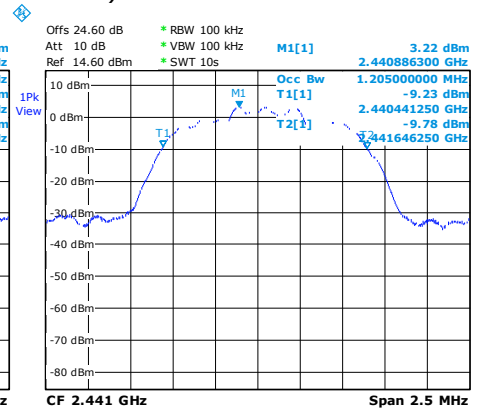
Occupied Bandwidth Plot, Mid Channel
GFSK, EDR-2(2-DH3 GFSK), EDR-3(3-DH3 GFSK)



Date: 22.JUL.2013 10:25:30

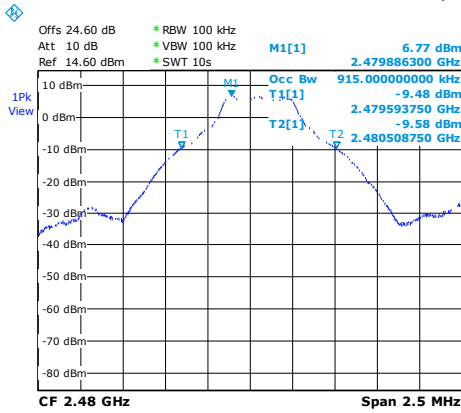


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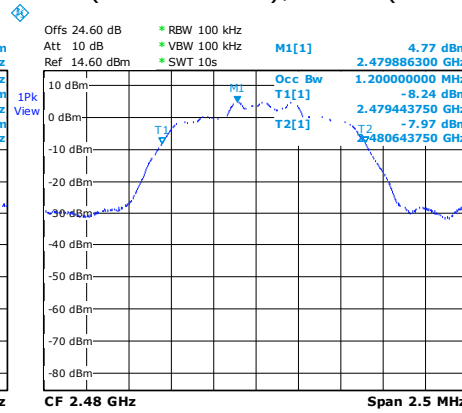


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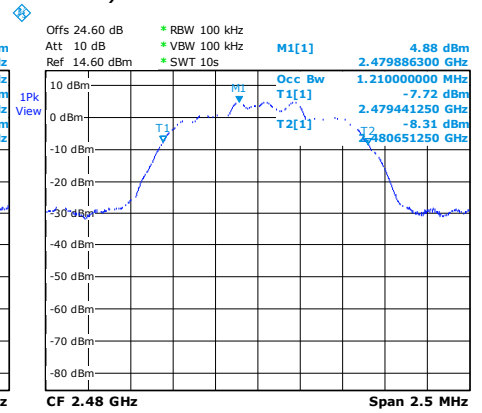
Occupied Bandwidth Plot, High Channel GFSK, EDR-2(2-DH3 GFSK), EDR-3(3-DH3 GFSK)



Date: 22.JUL.2013 10:26:20



Date: 22.JUL.2013 10:19:34



Date: 22.JUL.2013 10:16:47

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

The test data was measured using a spectrum analyzer with Peak detector and a resolution bandwidth of 3 MHz.

Limit

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels: 1 watt.

4.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 21.9 °C
Relative Humidity: 46.8 %

4.4 Test Equipment

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
SPECTRUM ANALYZER	FSL	R&S	1257361J	8-Jan-2014

Note: The calibration period equipment is 1 year.

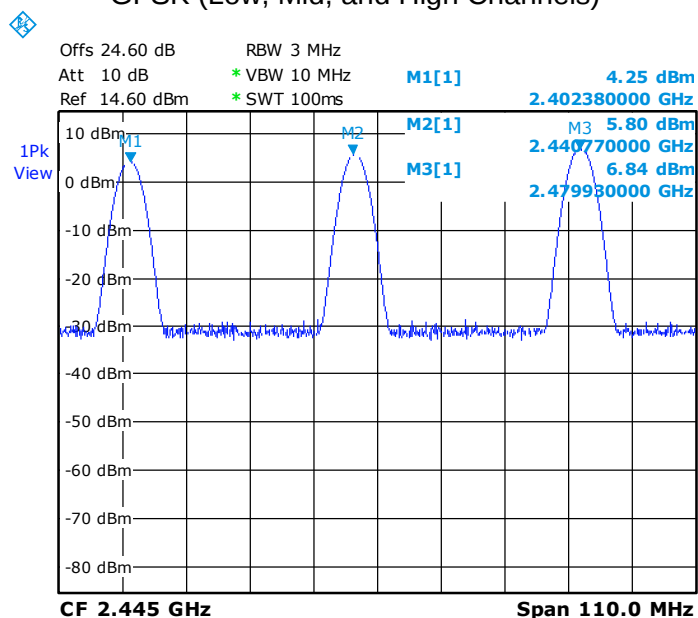
4.5 Test Setup Photographs

Test setup photographs are located in a separate exhibit.

4.6 Test Data

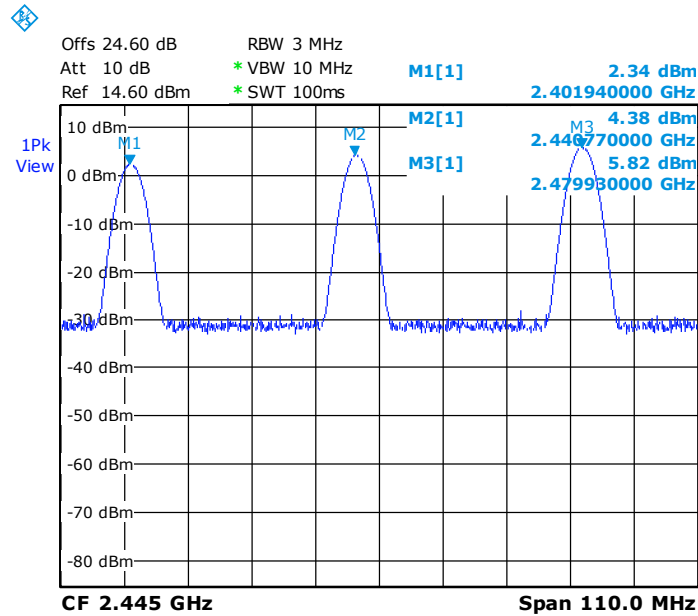
Frequency	Channel No	Modulation	Peak Output Power (dBm)
2402	0	GFSK	4.25
		EDR-2	2.34
		EDR-3	2.65
2441	39	GFSK	5.80
		EDR-2	4.38
		EDR-3	4.68
2480	78	GFSK	6.84
		EDR-2	5.82
		EDR-3	6.09

GFSK (Low, Mid, and High Channels)



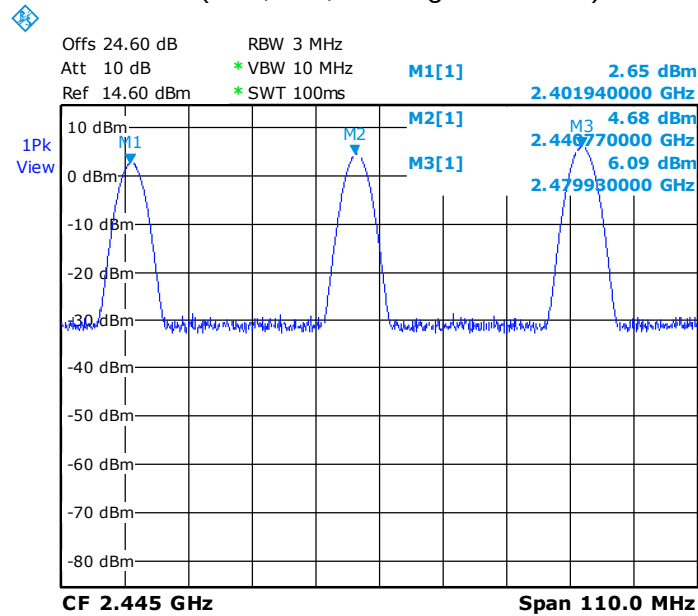
Date: 22.JUL.2013 08:25:01

EDR2 (Low, Mid, and High Channels)



Date: 22.JUL.2013 08:29:03

EDR3 (Low, Mid, and High Channels)



Date: 22.JUL.2013 08:31:12

5 Conducted Spurious Emissions

5.1 Test Result

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

5.2 Test Method

The test data was measured using a spectrum analyzer with

- Peak detector, max hold
- Resolution bandwidth of at least 100 kHz
- Video bandwidth at least 3x RBW
- Frequency range: 30 MHz to 25 GHz

The limit is 20 dB below the measured peak power.

5.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 21.7 °C
Relative Humidity: 46.9 %

5.4 Test Equipment

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
EMI TEST RECEIVER	ESU40	ROHDE & SCHWARZ	B079629	24-Sep-2013

Note: The calibration period equipment is 1 year.

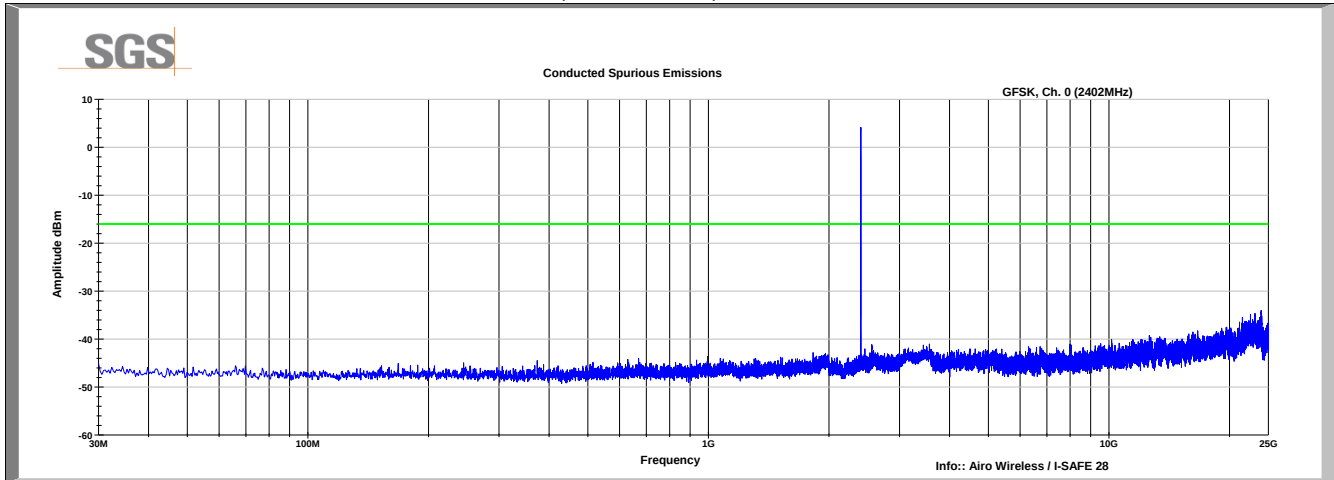
5.5 Test Setup Photographs

Test setup photographs are located in a separate exhibit.

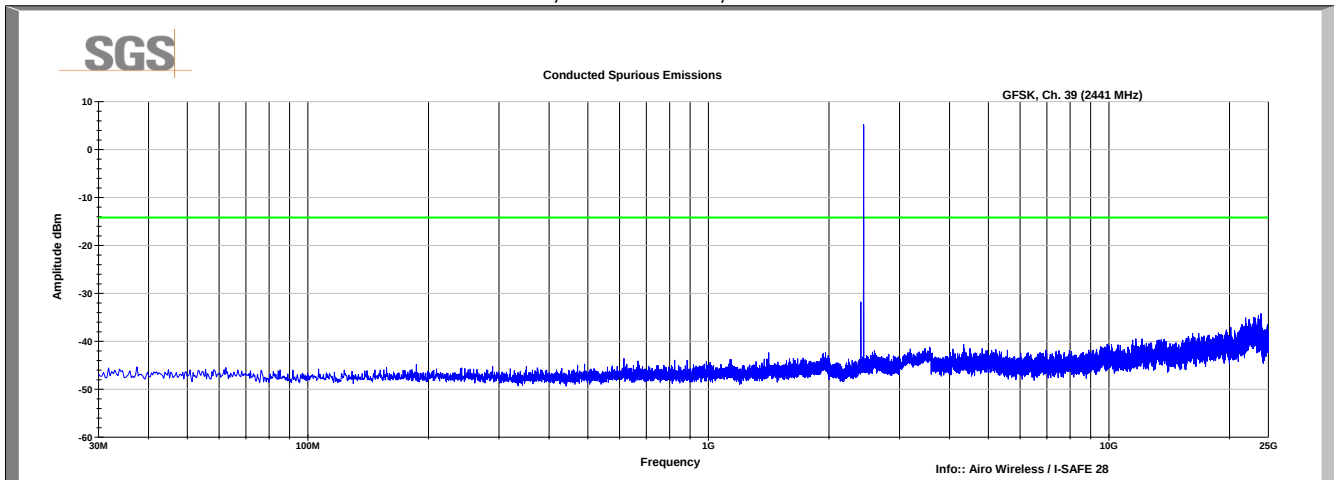
5.6 Test Data

No spurious emissions detected within 20dB of the limit.

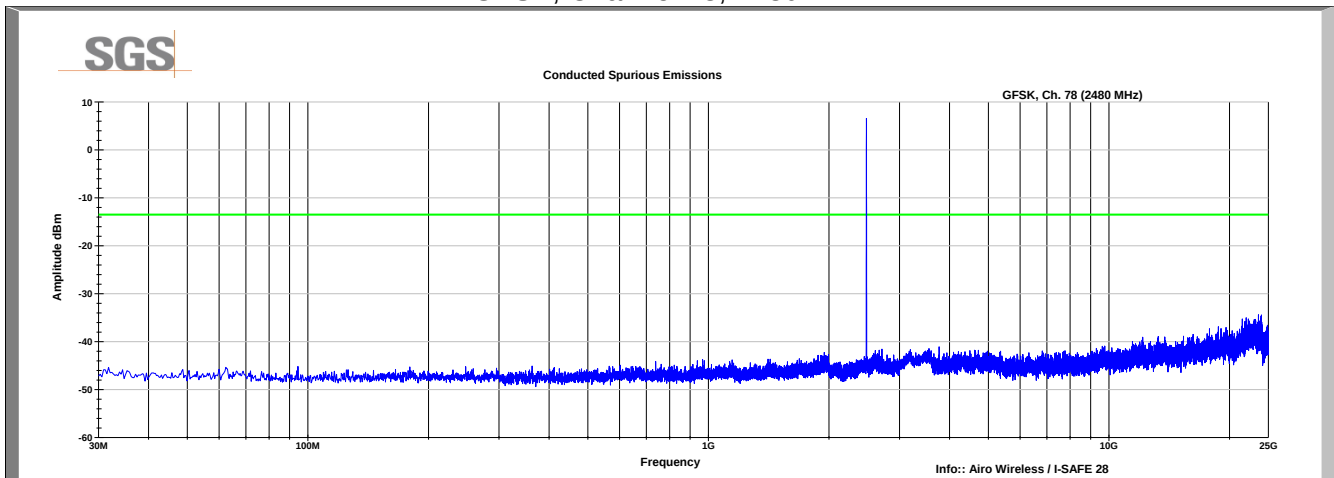
GFSK, Channel 0, 2402 MHz



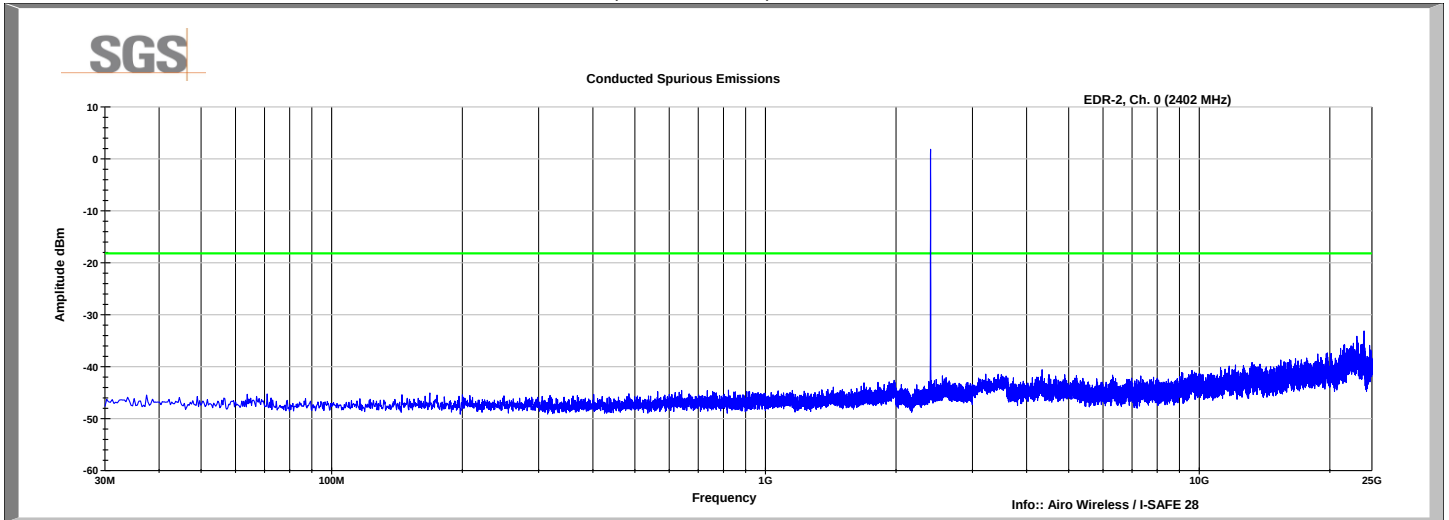
GFSK, Channel 39, 2441 MHz



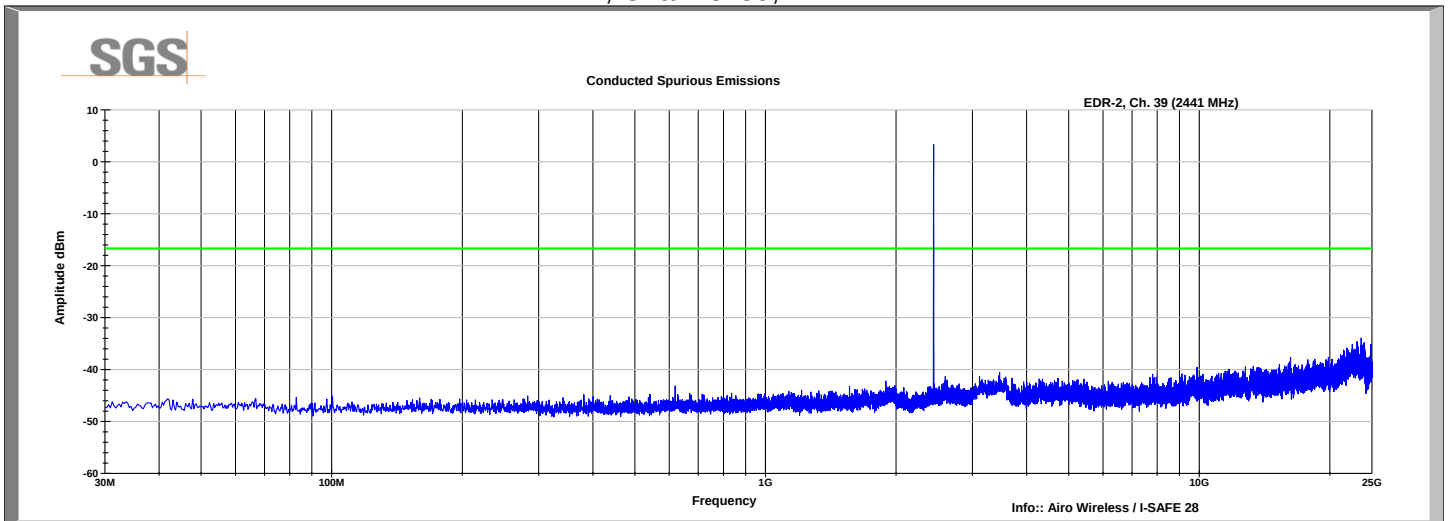
GFSK, Channel 78, 2480 MHz



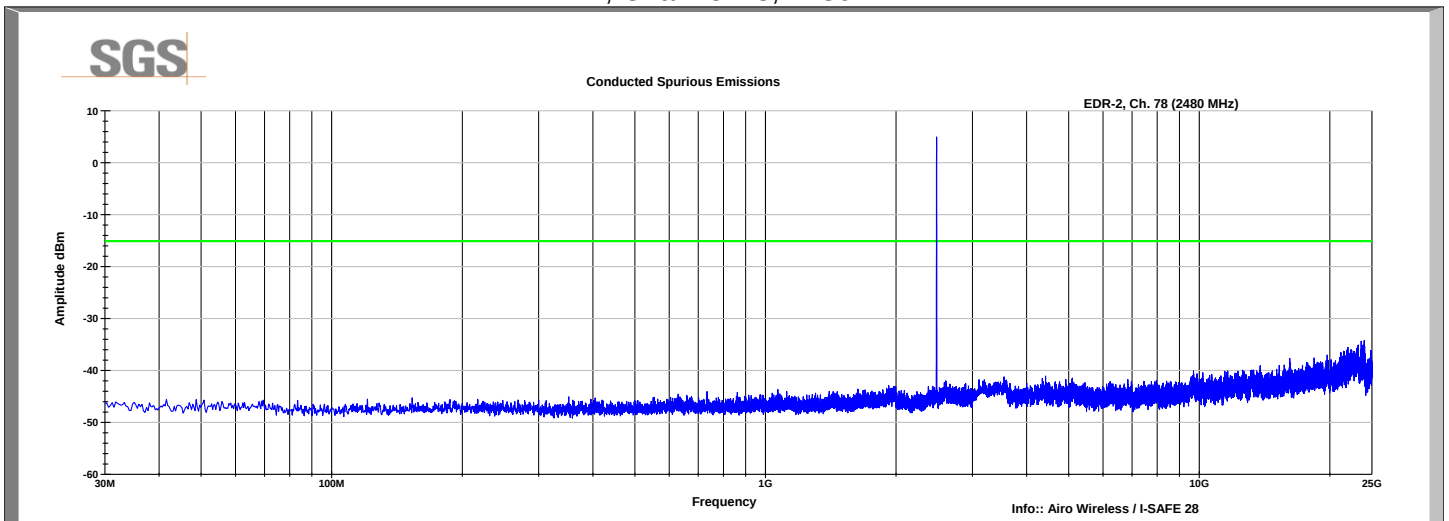
EDR2, Channel 0, 2402 MHz



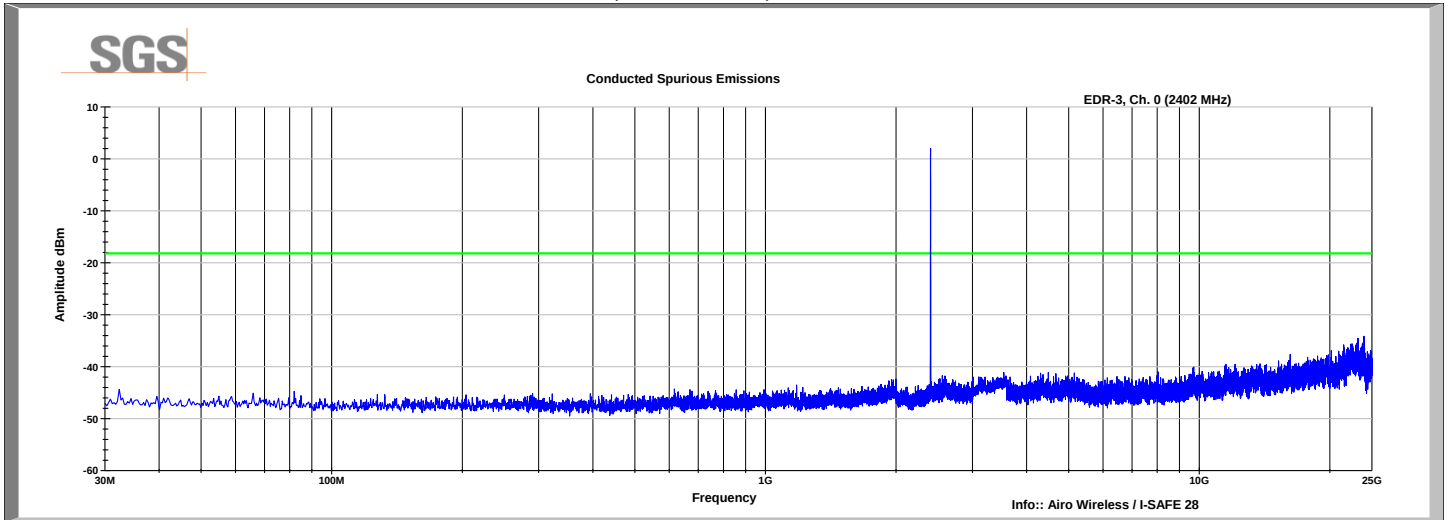
EDR2, Channel 39, 2441 MHz



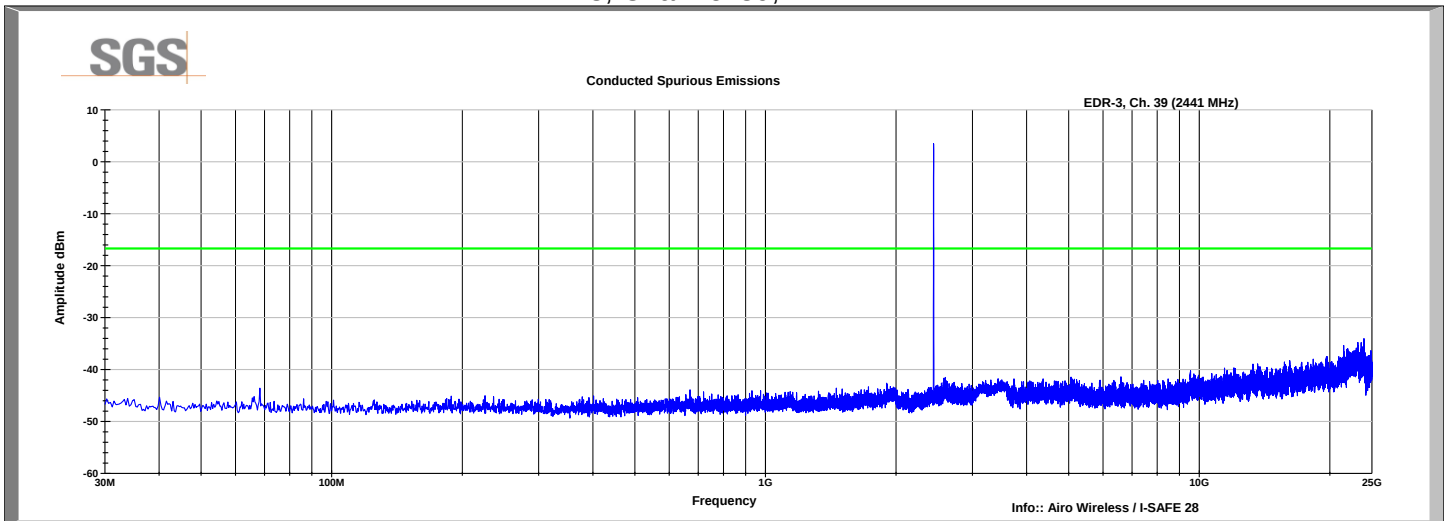
EDR2, Channel 78, 2480 MHz



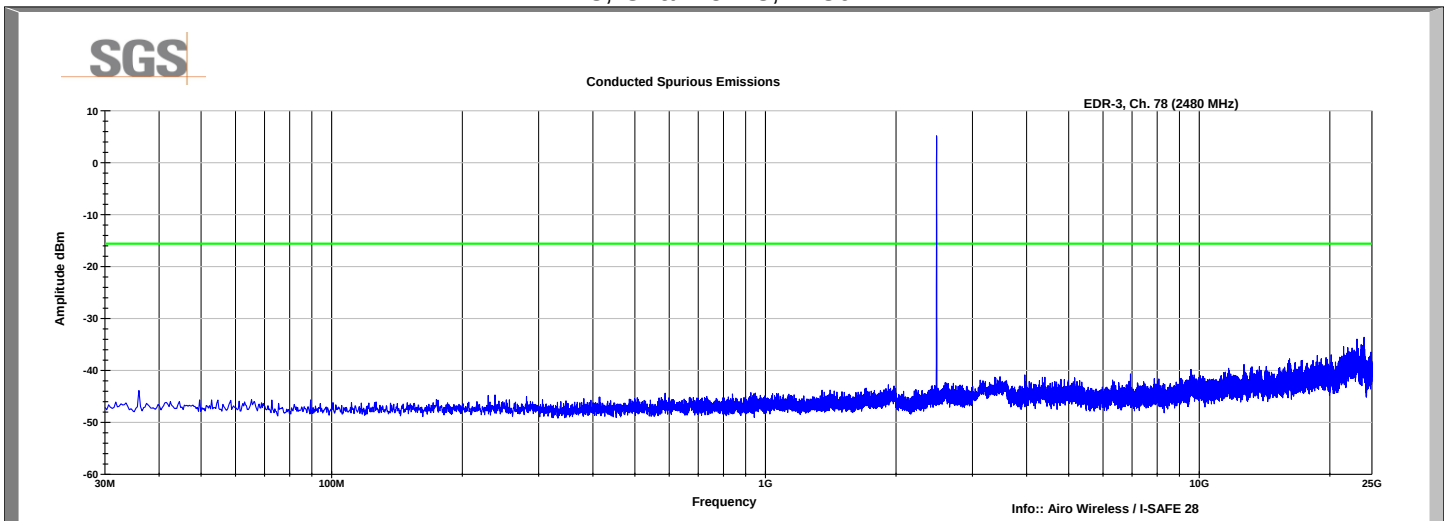
EDR3, Channel 0, 2402 MHz



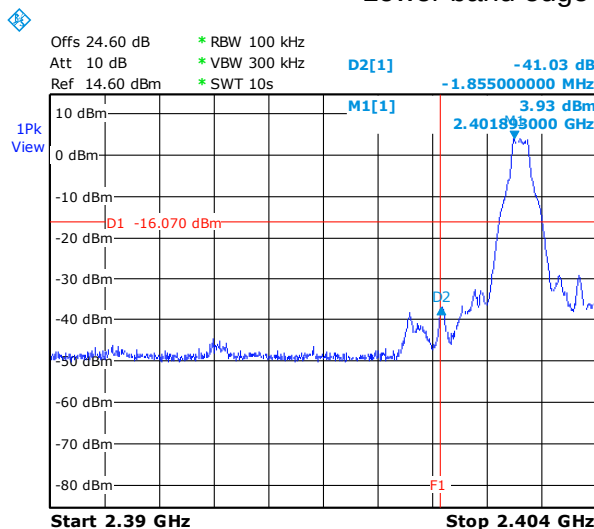
EDR3, Channel 39, 2441 MHz



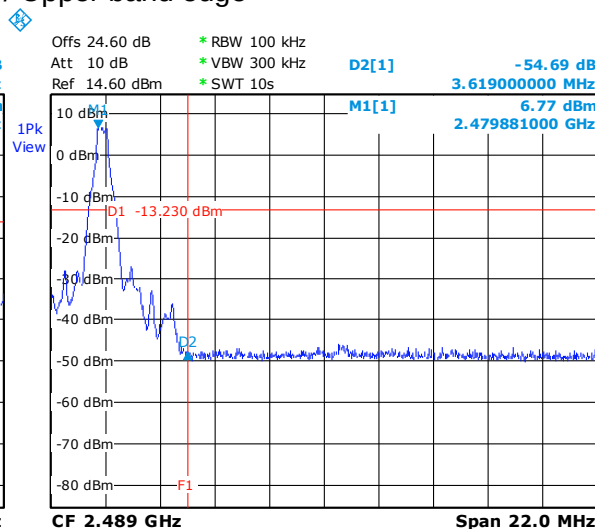
EDR3, Channel 78, 2480 MHz



GFSK Lower band edge / Upper band edge

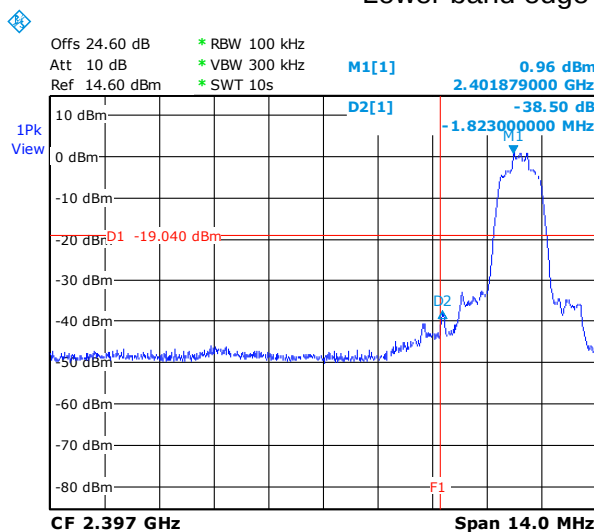


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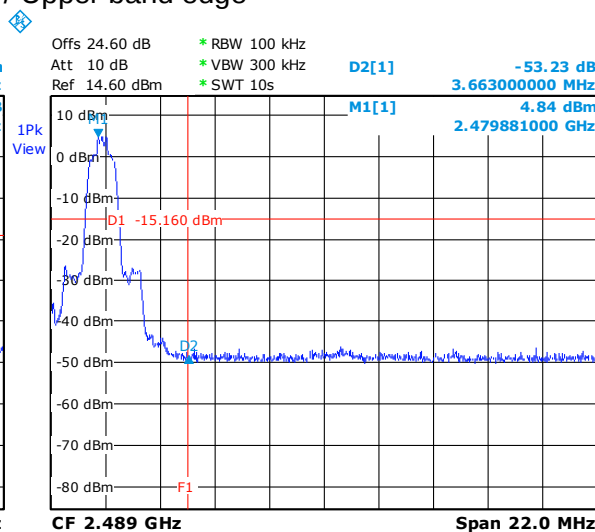


Date: 22.JUL.2013 10:54:50

EDR 2 Lower band edge / Upper band edge

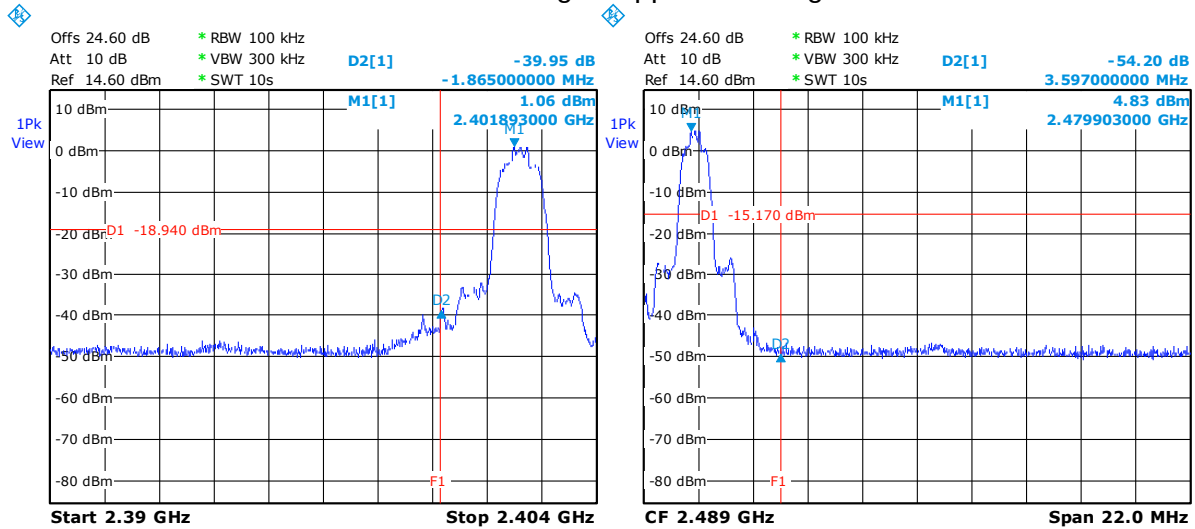


Date: 22.JUL.2013 10:52:23



Date: 22.JUL.2013 10:56:31

EDR 3 Lower band edge / Upper band edge



Date: 22.JUL.2013 10:50:48

Date: 22.JUL.2013 10:57:56

6 Field Strength of Spurious Radiation

6.1 Test Result

Test Description	Test Specification	Test Result
Field strength of spurious radiation	15.249 (a) and 15.209 RSS 210 2.6, A2.9 (1)(2)	Compliant

6.2 Test Method

The initial preliminary exploratory scans were performed over the frequency range as indicated in the tables below using the max hold function and incorporating a Peak detector and using TILE! software. The final test data was measured using a Quasi-Peak detector below 1GHz and a Peak detector above 1GHz. For harmonics of the fundamental, Average measurements were made by correcting the peak value with the duty cycle correction factor. For emissions other than harmonics of the fundamental, the Average measurements were made using the Average detector. The receivers resolution bandwidth was set to 120 kHz for measurements taken in the 30MHz to 1GHz frequency range and 1MHz for measurements for 1GHz and higher. Measurements were made with the antenna positioned in both the horizontal and vertical planes of polarization. The antenna height was varied from 1 m to 4 m and the EUT was rotated 360° to find the maximum emitting point for each frequency. The radiated measurements were recorded and compared to the limits indicated in the table below.

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 outside of the intentional transmit frequency band.

(2) Quasi-peak limit

(3) Average limit

6.3 Test Site

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

Environmental Conditions

Temperature: 23.8 °C

Relative Humidity: 46.6 %

6.4 Test Equipment

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
ANTENNA, BILOG	JB6	SUNOL	B079690	12-Sep-2013
DRG HORN (MEDIUM)	3117	ETS-LINDGREN	B079699	25-Mar-2014
EMI TEST RECEIVER	ESU40	ROHDE & SCHWARZ	B079629	24-Sep-2013
RF CABLE - 7000MM (10KHZ - 18GHZ)	SF106	HUBER&SUHNER	B079712	20-Sep-2013
RF CABLE - 7500MM (10KHZ - 18GHZ)	SF106	HUBER&SUHNER	B079711	20-Sep-2013
RF CABLE	SF106	HUBER&SUHNER	B085888	22-Oct-2013
RF CABLE - 7000MM (10KHZ - 18GHZ)	SF106	HUBER&SUHNER	B079716	20-Sep-2013
COAXIAL CABLE	1134	GORE	B094785	16-May-2014
RF CABLE	SF106	HUBER&SUHNER	B085892	23-Oct-2013
DESKTOP AMPLIFIER 1-18 GHZ	NSP1800-25-HG	MITEQ	B085930	30-Oct-2013
FIXED GAIN AMPLIFIER	NSP1840-HG	MITEQ	B087572	22-Oct-2013
BAND REJECT FILTER	BRM50702	MICRO-TRONICS	NA	105

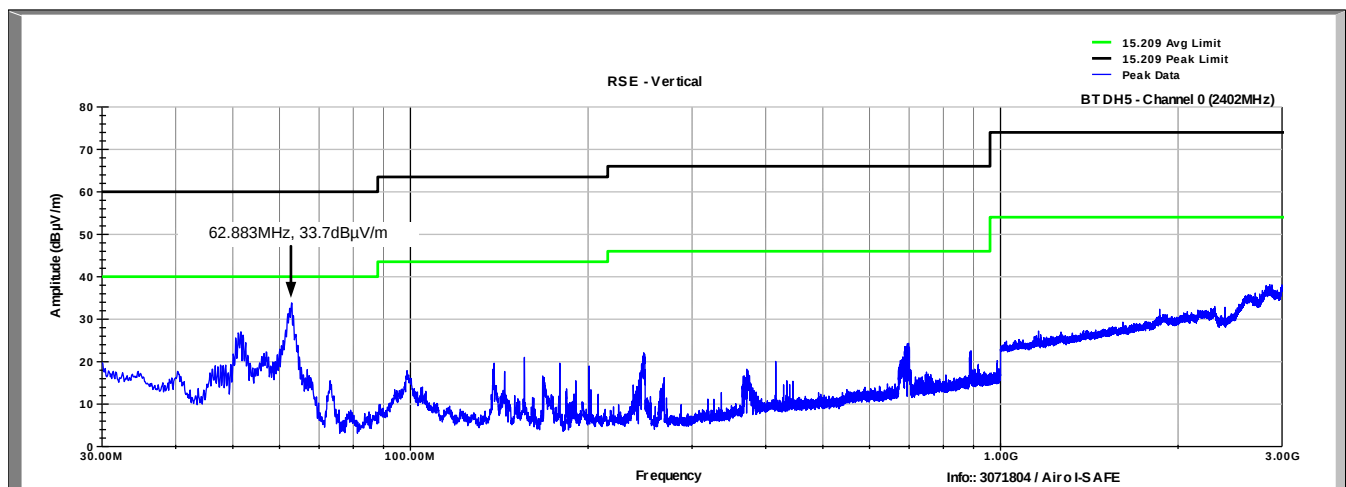
Note: The calibration period equipment is 1 year.

6.5 Test Setup Photographs

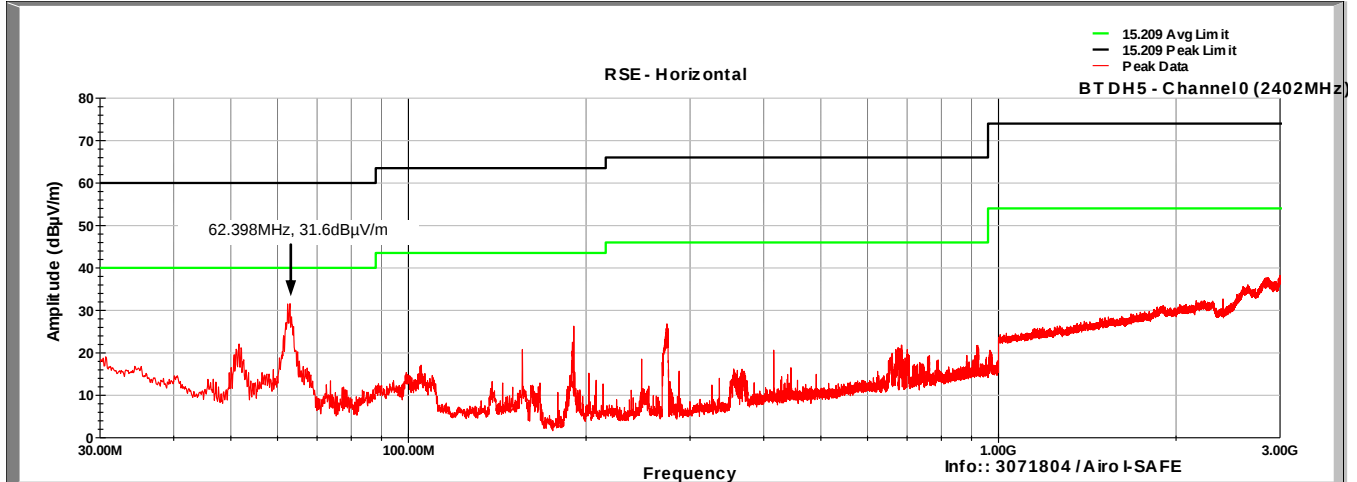
Test setup photographs are located in a separate exhibit.

6.6 Test Data

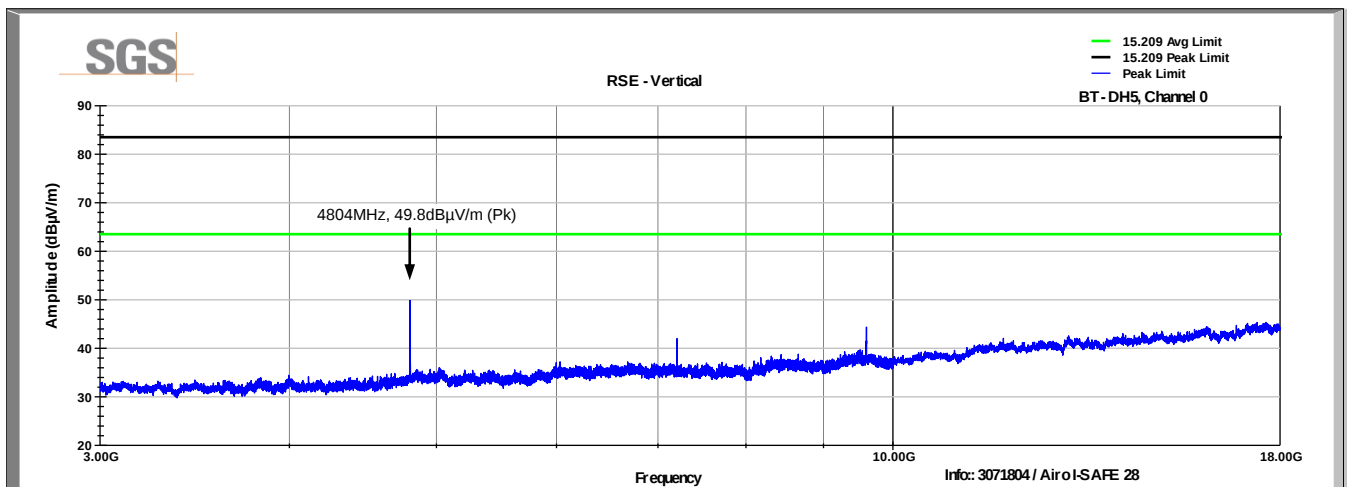
Bluetooth, Channel 0
30-3000MHz
Vertical
(3 meter test distance)



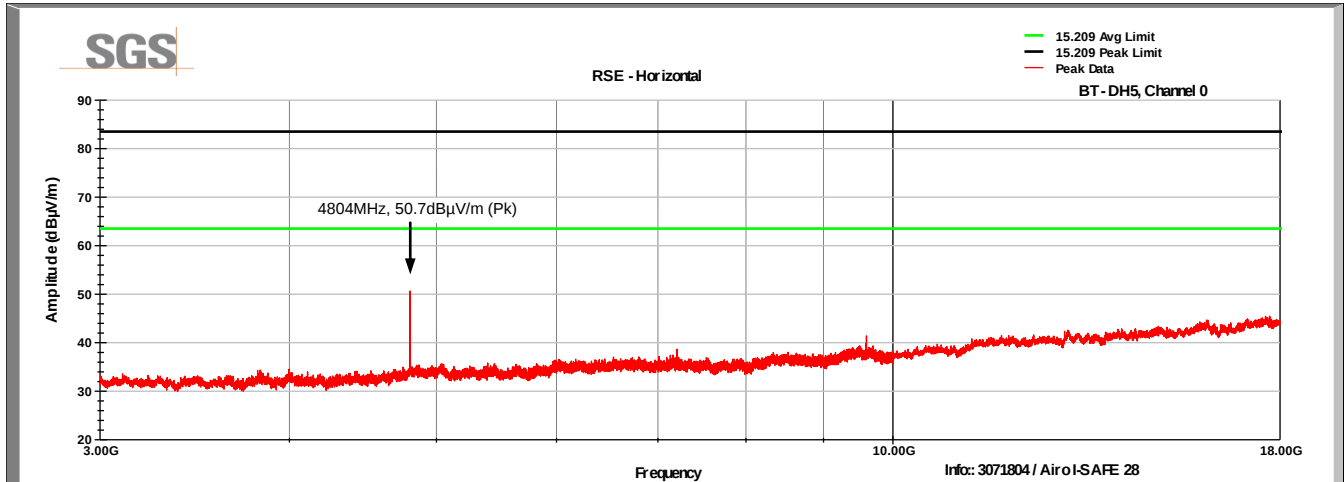
Bluetooth, Channel 0
30-3000MHz
Horizontal
(3 meter test distance)



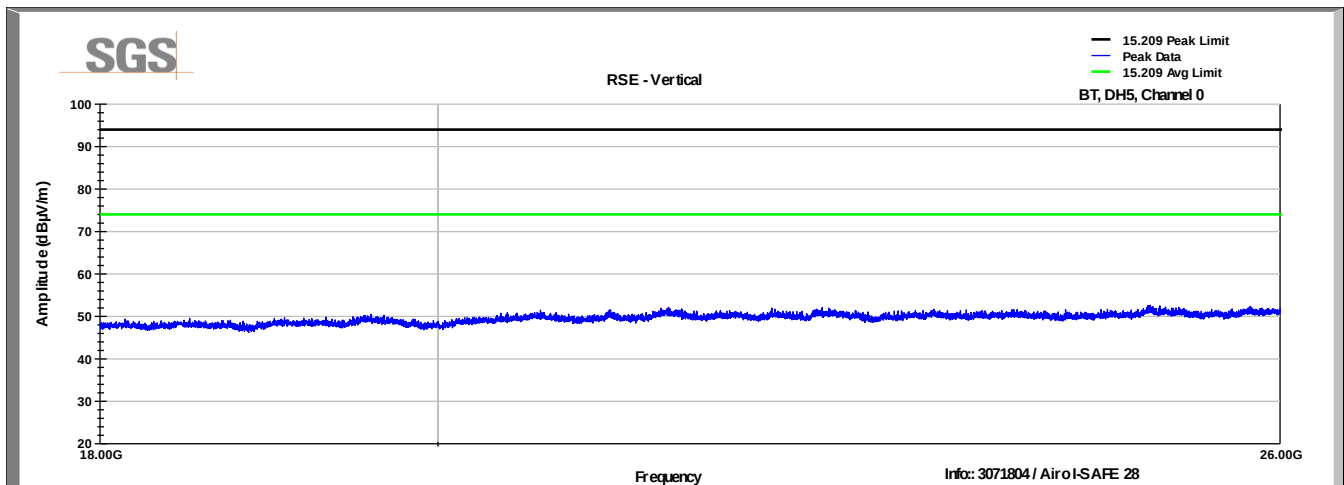
Bluetooth, Channel 0
3-18GHz
Vertical
(1m test distance)



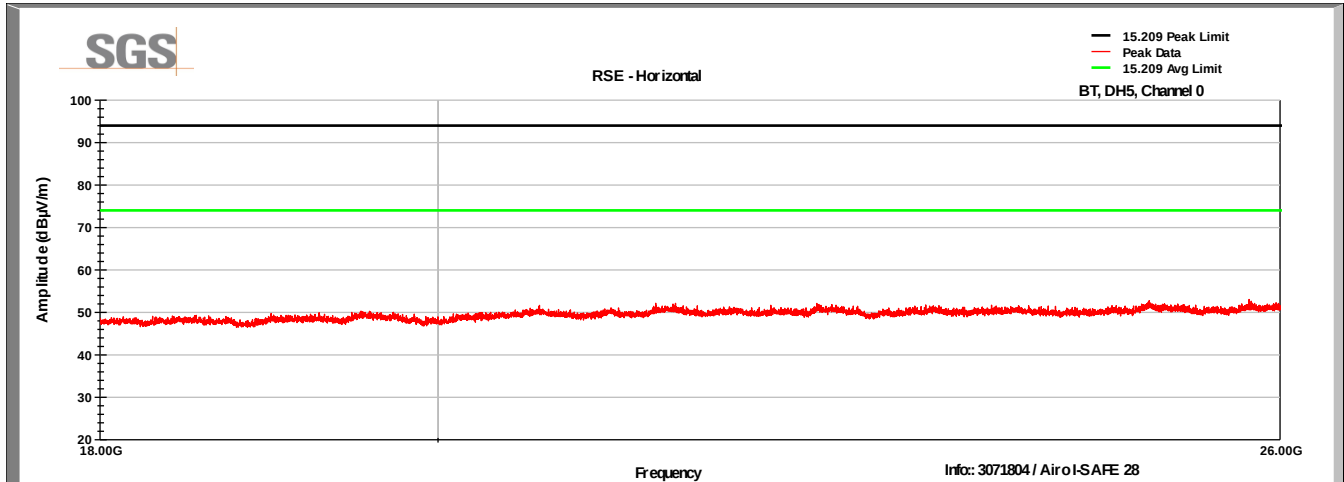
Bluetooth, Channel 0
3-18GHz
Horizontal
(1m test distance)



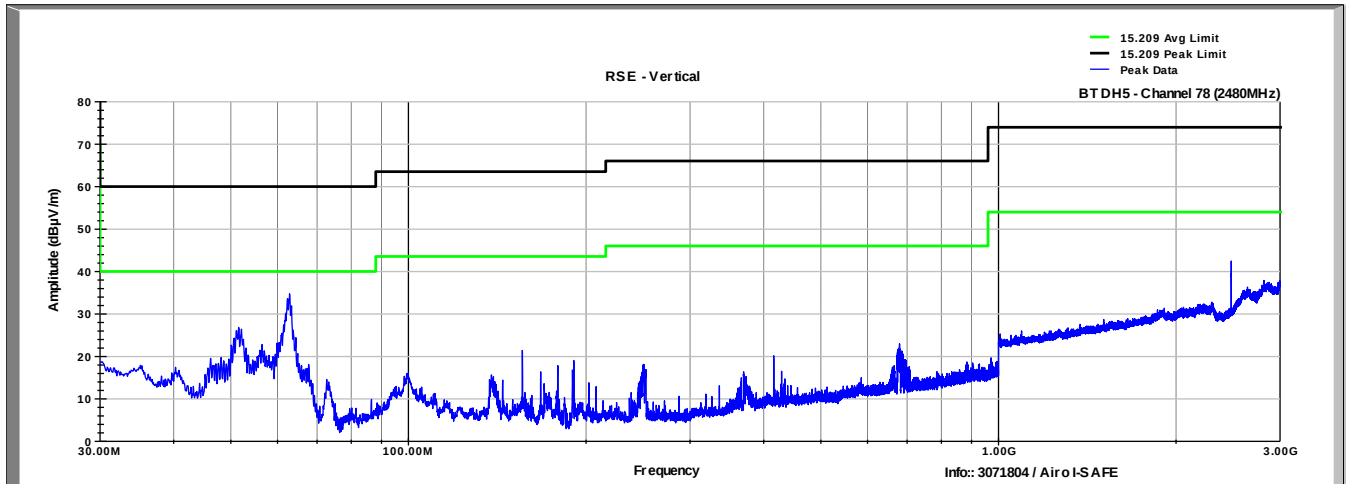
Bluetooth, Channel 0
18-26GHz
Vertical
(0.3 meter test distance)



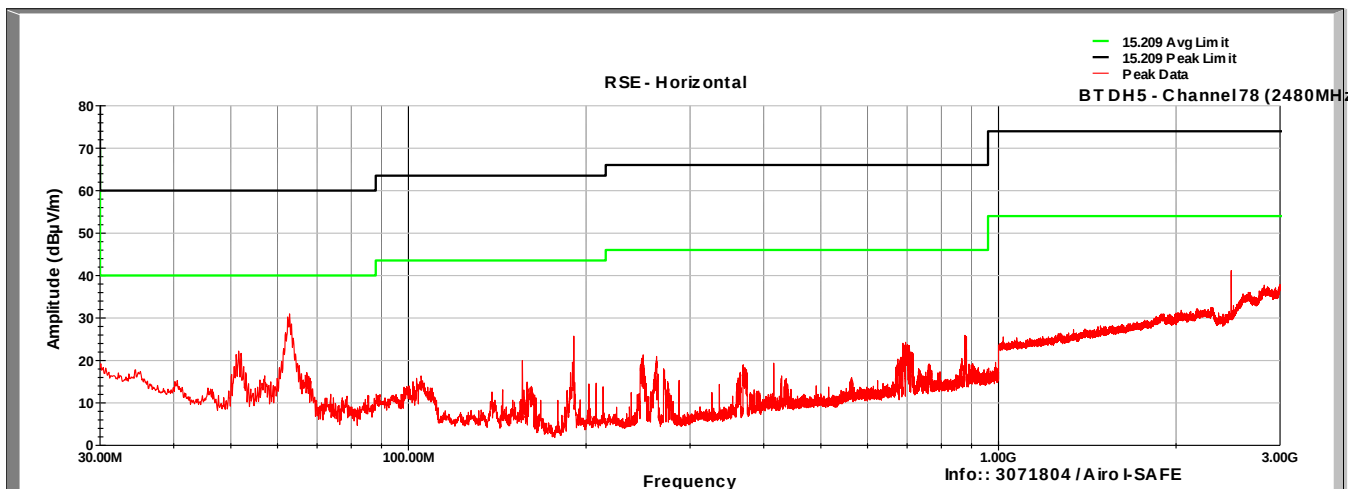
Bluetooth, Channel 0
18-26GHz
Horizontal
(0.3 meter test distance)



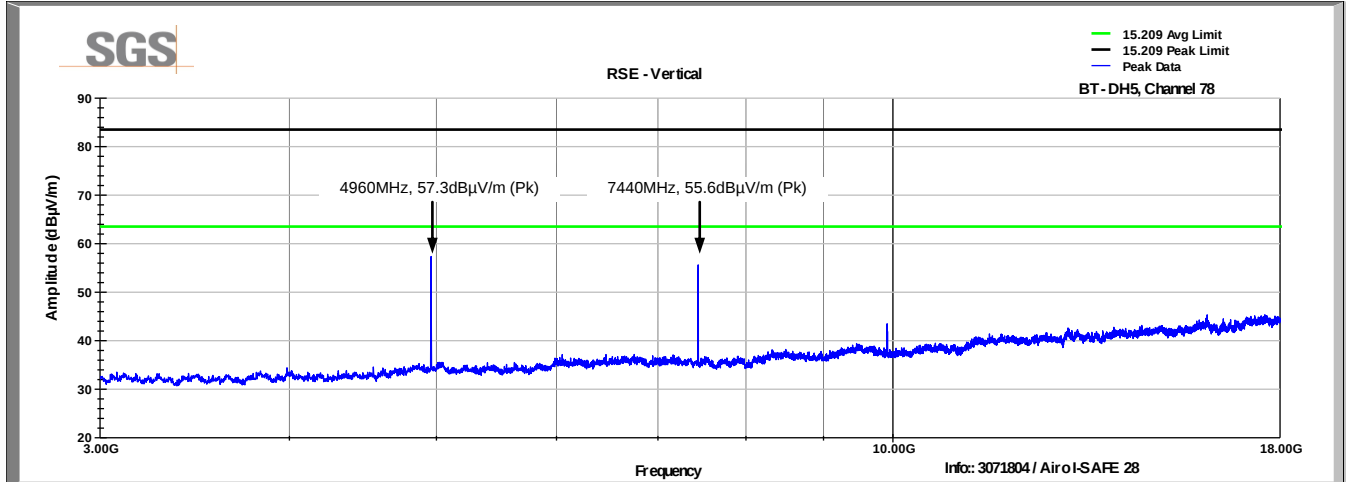
Bluetooth, Channel 78
30-3000MHz
Vertical
(3 meter test distance)



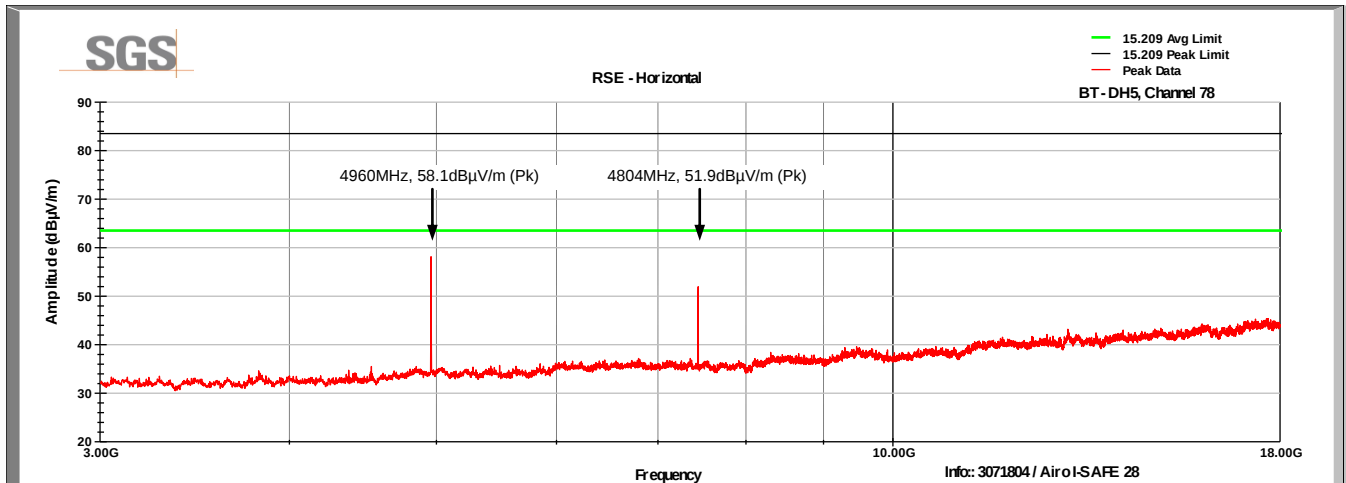
Bluetooth, Channel 78
30-3000MHz
Horizontal
(3 meter test distance)



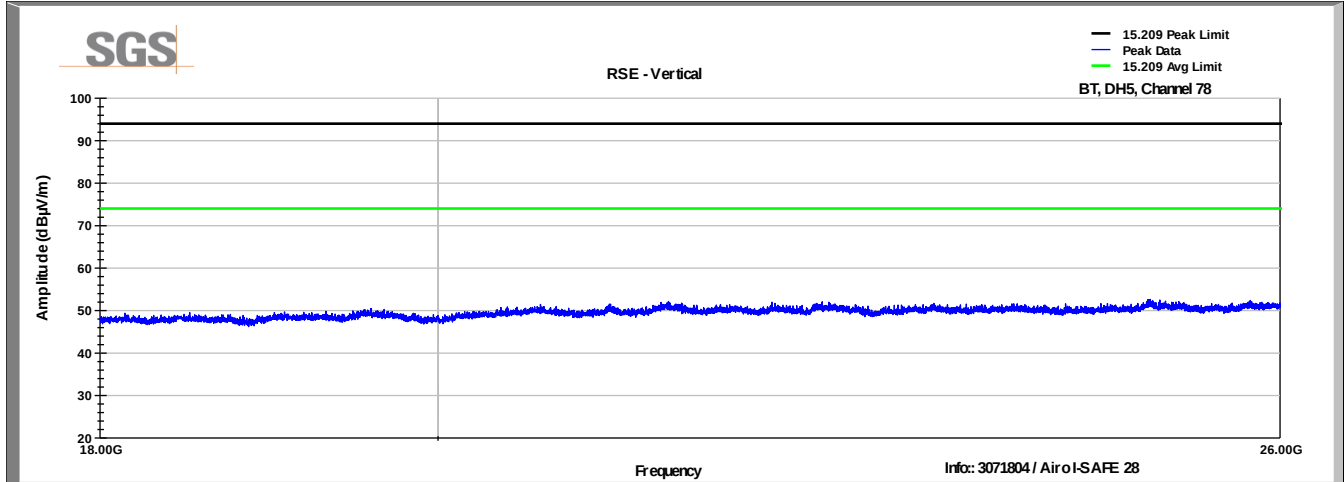
Bluetooth, Channel 78
3-18GHz
Vertical
(1m test distance)



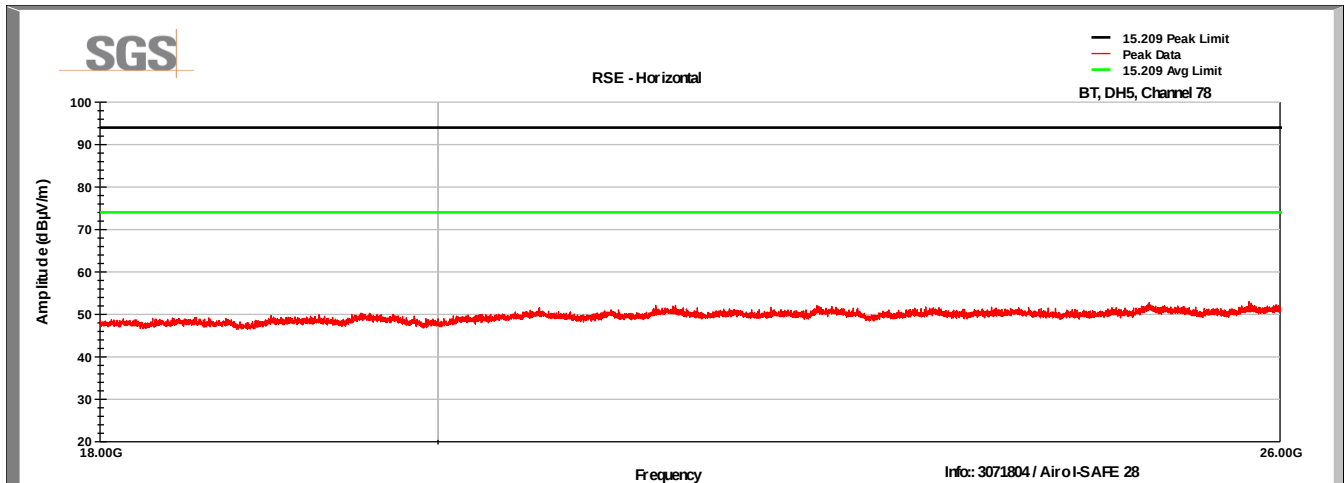
Bluetooth, Channel 78
3-18GHz
Horizontal
(1m test distance)



Bluetooth, Channel 78
18-26GHz
Vertical
(0.3 meter test distance)



Bluetooth, Channel 78
18-26GHz
Horizontal
(0.3 meter test distance)



7 Radiated Emissions at Band Edge / Restricted Band

7.1 Test Result

Test Description	Test Specification	Test Result
Field strength of spurious radiation	15.247 (d) and 15.209	Compliant

7.2 Test Method

Peak and average field strength measurements were performed at the restricted band edges of 2390MHz and 2483.5MHz. Measurements were made using the conducted methods defined in Section 12 of FCC publication D01 DTS Meas Guidance v03r01. The measurements were recorded and using the equation $E = \text{EIRP} - 20\log D + 104.8$, the readings were converted to a radiated field strength equivalent. The resultant data were compared to the average limit of 54 dBμV/m and peak limit of 74 dBμV/m.

Measurements were made in the following modes of operation: 802.11g and n at low and high channels. The worst-case data rates of 6Mbit/s and MCS0 were used.

7.3 Test Site

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

Environmental Conditions

Temperature: 24.8 °C
Relative Humidity: 30.7 %

7.4 Test Equipment

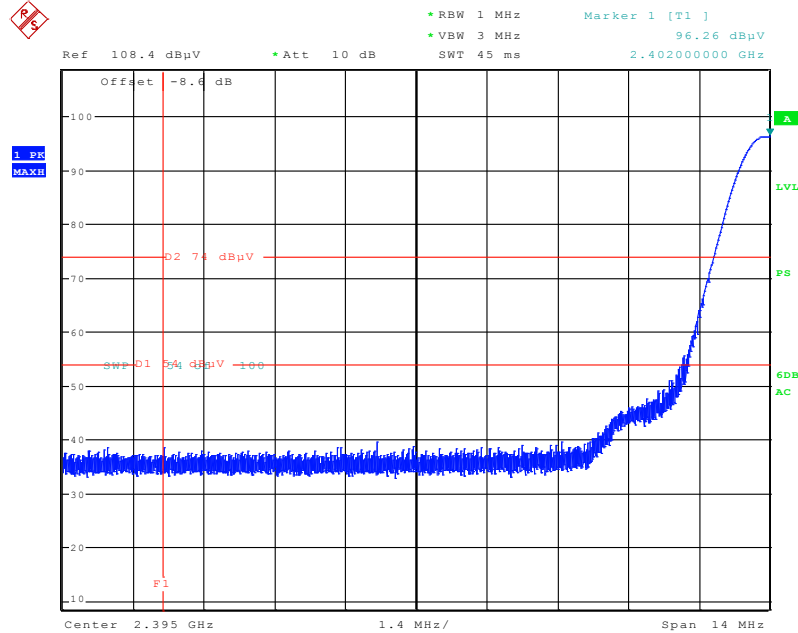
Equipment	Model	Manufacturer	Asset Number	Cal Due Date
EMI TEST RECEIVER	ESU40	ROHDE & SCHWARZ	B079629	24-Sep-2013

Note:

The calibration period equipment is 1 year.

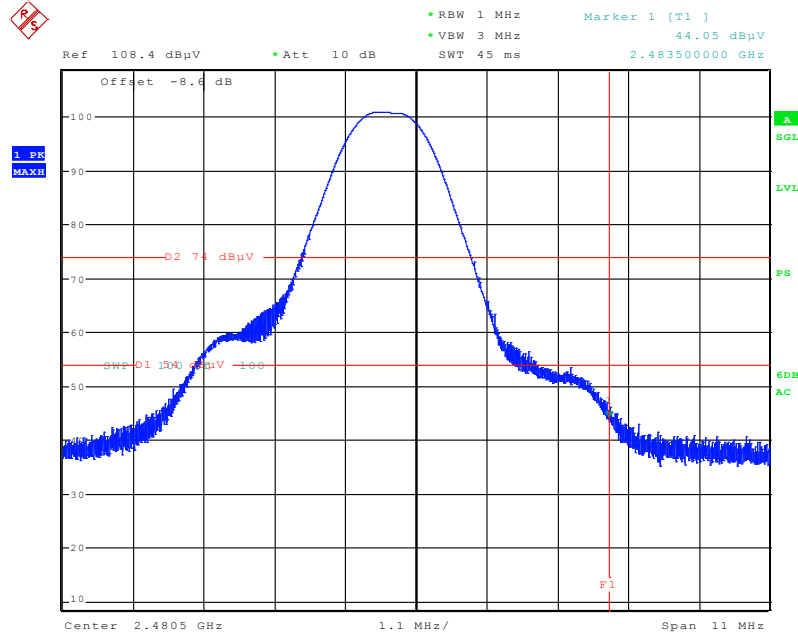
7.5 Test Data

DH1, Ch0 (Peak meets the average limit)



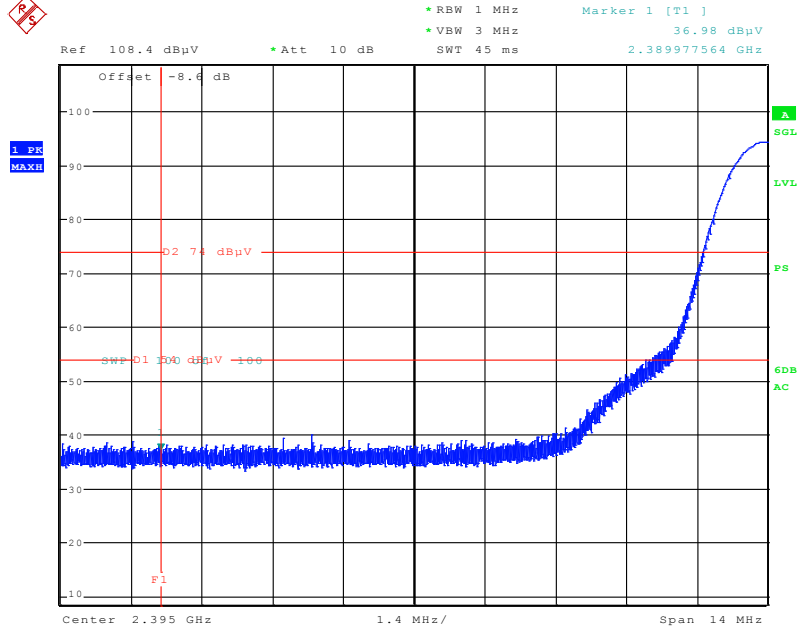
Date: 4.SEP.2013 14:20:42

DH1, Ch78 (Peak meets the average limit)



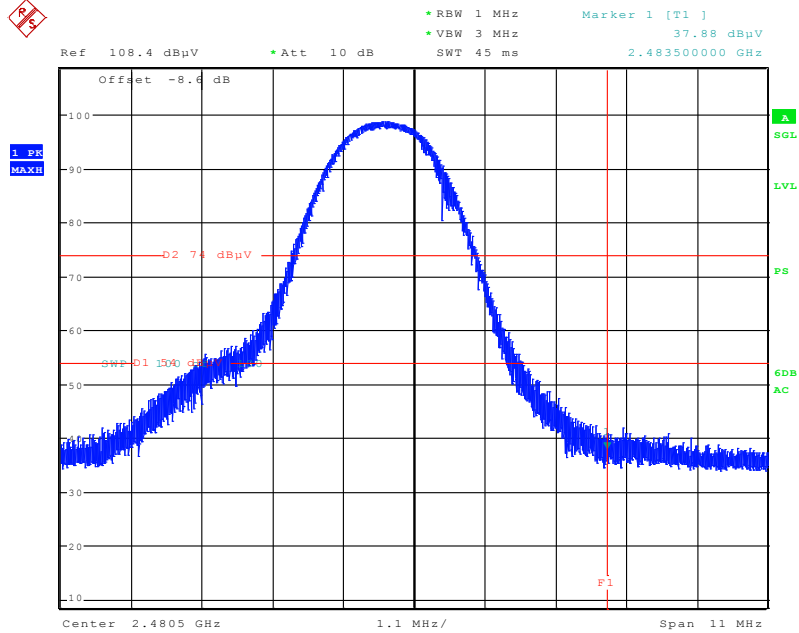
Date: 4.SEP.2013 14:24:55

EDR 3-DH5, Ch0 (Peak meets the average limit)



Date: 4.SEP.2013 14:22:20

EDR 3-DH5, Ch78 (Peak meets the average limit)



Date: 4.SEP.2013 14:25:52

8 Power Spectral Density

8.1 Test Result

Test Description	Basic Standards	Test Result
Power Spectral Density	15.247(f), 15.247(e) ANSI C63.4:2009	Compliant

8.2 Test Method

The EUT was set at each channel and data rate to transmit continuously, the peak emission was located and set as the center frequency. It was connected via customer supplied cable to the spectrum analyzer. The span was reduced to 300 kHz, swept 100 times with a 3 kHz RBW, peak detector and trace averaged. The peak signal was then measured and reported. The limit is 8 dBm in any 3 kHz band during any time interval of continuous transmission.

8.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 21.7 °C

Relative Humidity: 46.9 %

8.4 Test Equipment

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
EMI TEST RECEIVER	ESU8	ROHDE & SCHWARZ	B085759	21-Jun-2014
COAXIAL CABLE	SUCOFLEX 102	HUBER&SUHNER	B079822	12-Dec-2013

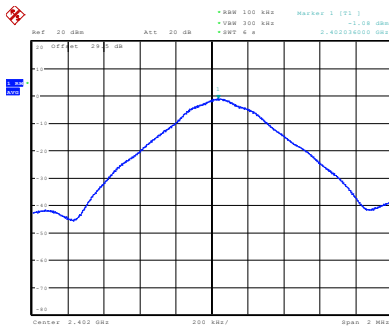
Note: The calibration period equipment is 1 year.

Prior to test, the measurement system was characterized over the test frequency range using the Receiver and Signal Generator.

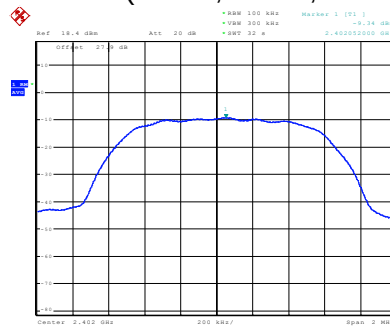
8.5 Test Data

Frequency	Channel No	Modulation	Spectral Density Value, dBm
2402	0	GFSK	-1.16
		EDR-2	-9.34
		EDR-3	-9.47
2441	39	GFSK	0.59
		EDR-2	-7.13
		EDR-3	-7.23
2480	78	GFSK	1.73
		EDR-2	-5.43
		EDR-3	-5.56

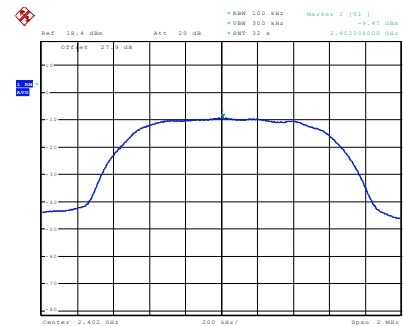
CH0(GFSK, EDR2, EDR3)



Date: 22_JUL_2013 22:38:08

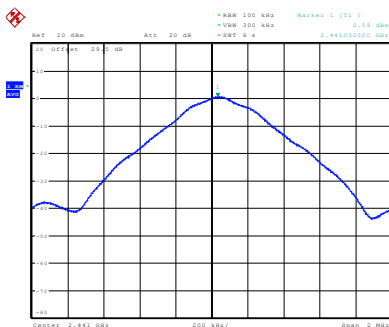


Date: 22_JUL_2013 22:43:18

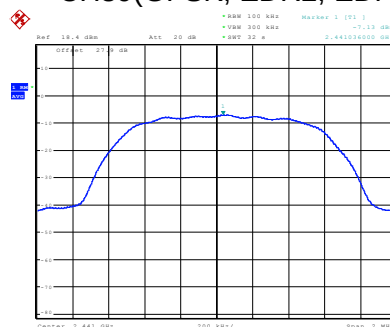


Date: 22_JUL_2013 22:48:24

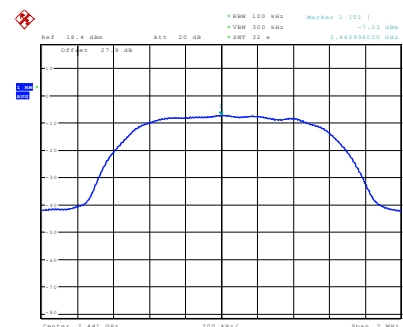
CH39(GFSK, EDR2, EDR3)



Date: 22_JUL_2013 22:37:14

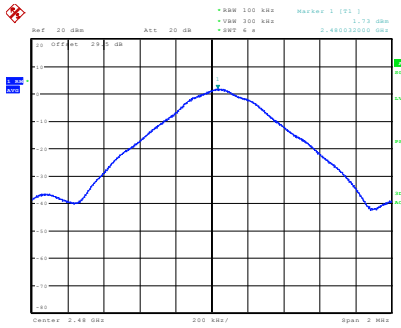


Date: 22_JUL_2013 22:46:13

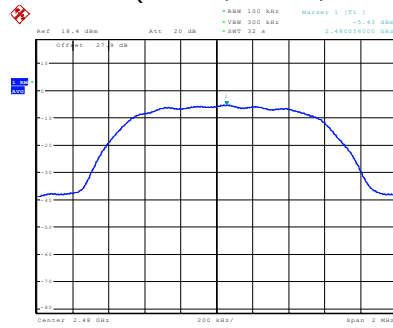


Date: 22_JUL_2013 22:47:30

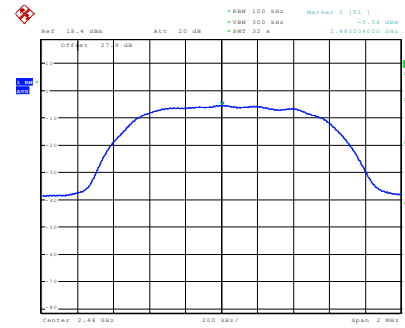
CH78(GFSK, EDR2, EDR3)



Date: 22.JUL.2013 22:36:46



Date: 22.JUL.2013 22:45:16



Date: 22.JUL.2013 22:46:35

9 Conducted Emissions

9.1 Test Result

Test Description	Basic Standards	Test Result
Conducted Emissions	15.107, Class B ANSI C63.4:2009	Compliant

9.2 Test Method

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

Frequency Range	Class A Limits (dBuV)		Class B Limits (dBuV)	
	FCC	CISPR	FCC	CISPR
0.15 to 0.5 MHz		Avg 66 QP 79		Avg 56 to 46 QP 66 to 56
0.5 to 5 MHz		Avg 60 QP 73		Avg 46 Pk 56
5 to 30 MHz		Avg 60 QP 73		Avg 50 Pk 60

9.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 24.4 °C
Relative Humidity: 47.8 %

9.4 Test Equipment

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
EMI TEST RECEIVER	ESU8	ROHDE & SCHWARZ	B085759	21-Jun-2014
TWO-LINE V-NETWORK	NNB 51	TESEQ	B085882	9-Oct-2013
17 FT N TYPE COAX CABLE	HS 84133232	HUBER&SUHNER	B079661	13-Aug-2013

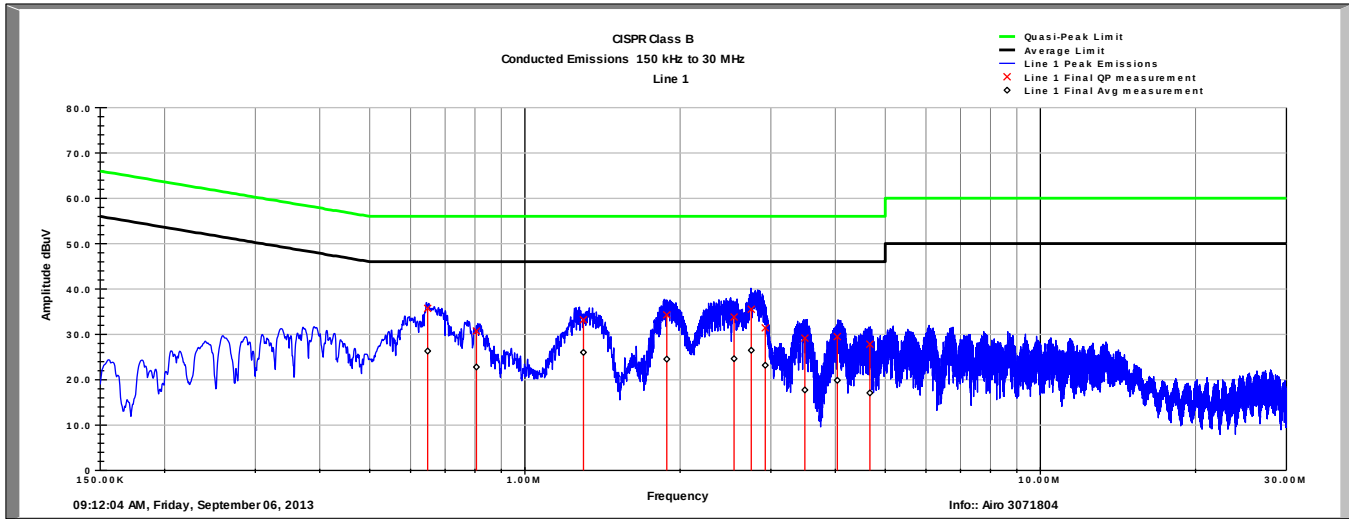
Note: The calibration period equipment is 1 year.

Software:

“Conducted Emissions” TILE! profile dated 10 Nov 2011

9.5 Test Data

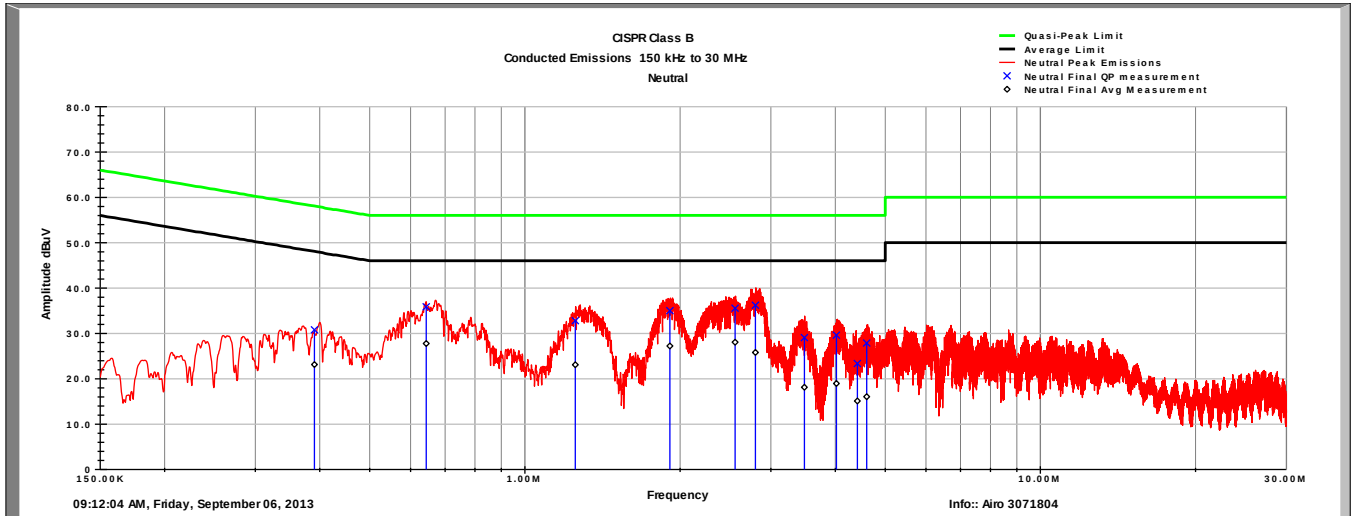
Line 1 Conducted Emissions Plot



Line 1 Conducted Emissions Data

Frequency MHz	QP Value dBuV	QP Limit dBuV	Margin dB	Avg Value dBuV	Avg Limit dBuV	Avg Margin dB
0.648	35.7	56.0	-20.3	26.3	46.0	-19.7
0.805	30.7	56.0	-25.3	22.8	46.0	-23.2
1.298	33.2	56.0	-22.8	26.0	46.0	-20.0
1.885	34.3	56.0	-21.7	24.5	46.0	-21.5
2.546	33.8	56.0	-22.2	24.6	46.0	-21.4
2.749	35.5	56.0	-20.5	26.5	46.0	-19.5
2.927	31.4	56.0	-24.6	23.2	46.0	-22.8
3.493	29.2	56.0	-26.8	17.7	46.0	-28.3
4.037	29.5	56.0	-26.5	19.9	46.0	-26.1
4.669	27.8	56.0	-28.2	17.1	46.0	-28.9

Neutral Conducted Emissions Plot



Neutral Conducted Emissions Data

Frequency MHz	QP Value dBuV	QP Limit dBuV	QP Margin dB	Avg Value dBuV	Avg Limit dBuV	Avg Margin dB
0.391	30.8	58.1	-27.3	23.1	48.1	-25.0
0.644	35.9	56.0	-20.1	27.8	46.0	-18.2
1.253	32.8	56.0	-23.2	23.1	46.0	-22.9
1.911	35.0	56.0	-21.0	27.2	46.0	-18.8
2.557	35.5	56.0	-20.5	28.1	46.0	-17.9
2.800	36.2	56.0	-19.8	25.8	46.0	-20.2
3.485	29.1	56.0	-26.9	18.1	46.0	-27.9
4.020	29.6	56.0	-26.4	19.0	46.0	-27.0
4.416	23.4	56.0	-32.6	15.1	46.0	-30.9
4.604	27.9	56.0	-28.1	16.0	46.0	-30.0



10 Revision History

Revision Level	Description of changes	Revision Date
0	Initial release	11 Sept 2013