

EMC Test Report

Project Number: 2721158

Report Number: 2721158EMC01 **Revision Level:** 2

Client: PLUS Location Systems

Equipment Under Test: UWB transmitter

Model Name: Region 1 Vertical Tag

Model Number: 1104

Applicable Standards: FCC Part 15.250

Report issued on: 31 May 2012

Test Result: Compliant

Tested by:



Brian Forster, 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

Reference	Description	Test Result
15.250(a)	10dB bandwidth contained within 5925 to 7250 MHz with frequency stability	Compliant
15.250(b)	10dB bandwidth greater than 50 MHz	Compliant
15.250(d)(1)	Radiated emissions above 960 MHz	Compliant
15.250(d)(2)	Radiated emissions in GPS receive band	Compliant
15.250(d)(3)	Peak emission in a 50 MHz bandwidth	Compliant
15.250(d)(4)	Radiated emissions below 960 MHz per 15.209	Compliant

1.1 ***Modifications Required to Compliance***

None

2 General Information

2.1 Client Information

Name: Keven Trach
Address: 4955 Corporate Drive Suite 101
City, State, Zip, Country: Huntsville AL 35805

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

Product Name: UWB Transmitter Tag
Model Name: Plus Region 1 Vertical Tag
Model Number: 1104
Serial Number: 002
Hardware Version: 300-0192 REV A
Voltage: 3Vdc cell / CR2354

Sample Received Date: April 18, 2012
Dates of testing: April 18 to May 12, 2012

2.4 Operating Modes and Conditions

The EUT was programmed by the manufacturer to run continuously exercising all modes of operation.

3 UWB Bandwidth requirements

3.1 Test Result

Test Description	Reference	Test Result
10dB bandwidth contained within 5925 to 7250 MHz	15.250(a)	Compliant
Frequency stability vs Temperature Frequency stability vs Voltage	15.250(a) and 2.1055	Compliant
10dB bandwidth greater than 50 MHz	15.250(b)	Compliant

3.2 Test Method

- 1) The -10 dB bandwidth of a device operating under the provisions of this section must be contained within the 5925–7250 MHz band under all conditions of operation including the effects from stepped frequency, frequency hopping or other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. The -10 dB points are measured over the temperature range and input voltage specified for this product.
- 2) The -10 dB bandwidth of the fundamental emission shall be at least 50 MHz. For transmitters that employ frequency hopping, stepped frequency or similar modulation types, measurement of the -10 dB minimum bandwidth specified in this paragraph shall be made with the frequency hop or step function disabled and with the transmitter operating continuously at a fundamental frequency following the provisions of §15.31(m).
- 3) The -10 dB bandwidth is based on measurement using a peak detector, a 1 MHz resolution bandwidth, and a video bandwidth greater than or equal to the resolution bandwidth.

3.3 Test Site

SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.4 to 24.7 °C

Relative Humidity: 37 to 47 %

3.4 Test Equipment

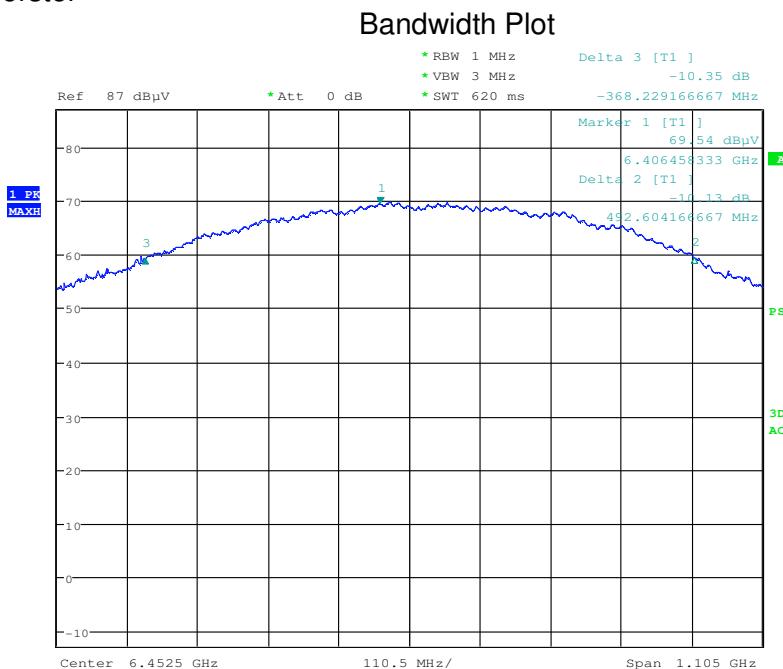
Equipment	Model	Manufacturer	Asset Number	Cal Due Date
Spectrum Analyzer	ESU8	Rohde & Schwarz	B085759	19 May 2012
DRWG Antenna	3117	ETS-Lindgren	B079691	31 May 2012
RF Preamplifier	NSP1800-25-HG	Miteq	B085930	10/14/2012
RF Cable	Sucoflex 106	Huber+Suhner	B079711	24 Aug 2012
RF Cable	Sucoflex 106	Huber+Suhner	B079713	24 Aug 2012
Temperature Chamber	SM-16-8200	Thermotron	B079728	1 Sep 2012
DC Power Supply	UP20-10	TDK-Lamda	B079774	14 Nov 2012

Note: The calibration period for this equipment is 1 year.

3.5 Test Data

Test Date: 20 April 2012

Operator: Brian Forster



Date: 20.APR.2012 10:32:01

Test Date: 20 April 2012

Operator: Brian Forster

Bandwidth Results					
Antenna Polarity	Frequency 10dB below peak MHz	Frequency 10dB above peak MHz	10 dB bandwidth MHz	Bandwidth requirement >50 MHz	Detectors / RBW / VBW
V	6,038.221	6899.05	860.829	Compliant	RMS 1MHz / 3MHz

Environmental Conditions

Temperature: 25.5 °C
 Relative Humidity: 40.9 %

Test Date: 31 May 2012

Operator: Brian Forster / David Schramm

Note	Voltage, DC	Stability vs input voltage 10 dB down points						Bandwidth, MHz	
		Low Frequency			High Frequency				
		Actual MHz	Limit MHz	Compliant?	Actual MHz	Limit MHz	Compliant?		
1,3	2.0	6166.3	5925	Yes	6845.6	7250	Yes	679.3	
3	2.2	6159.2	5925	Yes	6860.0	7250	Yes	700.8	
3	2.4	6115.6	5925	Yes	6856.0	7250	Yes	740.4	
3	2.6	6110.2	5925	Yes	6846.3	7250	Yes	736.1	
3	2.8	6128.9	5925	Yes	6832.0	7250	Yes	703.1	
2,3	3.0	6144.2	5925	Yes	6836.8	7250	Yes	692.6	

Note 1: Battery end point

Note 2: Maximum battery voltage

Note 3: The addition of leads to externally power the device alters the shape of the UWB signal. These measurements should be referenced only to show the 10dB down points remain within the allowed transmission band.

Note	Temperature C	Stability vs temperature						Bandwidth, MHz	
		Low Frequency			High Frequency				
		Actual MHz	Limit MHz	Compliant?	Actual MHz	Limit MHz	Compliant?		
1,3	-20	6051.0	5925	Yes	6944.3	7250	Yes	893.3	
3	-10	6045.3	5925	Yes	6944.3	7250	Yes	899.0	
3	+0	6045.3	5925	Yes	6944.3	7250	Yes	899.0	
3	+10	6042.6	5925	Yes	6939.5	7250	Yes	896.9	
3	+20	6045.3	5925	Yes	6944.3	7250	Yes	899.0	
3	+30	6046.2	5925	Yes	6944.3	7250	Yes	898.1	
3	+40	6059.4	5925	Yes	6881.8	7250	Yes	822.4	
3	+50	6055.5	5925	Yes	6877.0	7250	Yes	821.5	
2,3	+55	6055.0	5925	Yes	6877.1	7250	Yes	822.1	

Note 1: Lowest temperature specification by product description

Note 2: Highest temperature specification by product description

Note 3: The shape of the signal was slightly distorted due to the highly reflective lining of the environmental chamber.

4 Radiated emissions above 960 MHz

4.1 Test Result

Test Description	Reference	Test Result
Radiated emissions above 960 MHz	15.250(d)(1)	Compliant

4.2 Test Method

Emissions from a transmitter operating under this section shall not exceed the following equivalent isotropically radiated power (EIRP) density levels:

- 1) The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following RMS average limits based on measurements using a 1 MHz resolution bandwidth:

Frequency (MHz)	EIRP in dBm	EIRP (dB μ V/m) at 3m	EIRP (dB μ V/m) at 1m
960–1610	-75.3	19.9	29.4
1610–1990	-63.3	31.9	41.4
1990–3100	-61.3	33.9	43.4
3100–5925	-51.3	43.9	53.4
5925–7250	-41.3	53.9	63.4
7250–10600	-51.3	43.9	53.4
Above 10600	-61.3	33.9	43.4

Because the limits are so low, some bands may have been scanned at a distance closer than 1 meter. If any emissions were detected in these bands, final measurements were made at distance of 1 meter or greater. The actual distance for final measurement was indicated in the measurement data.

4.3 Test Site

10m Absorber Lined Shielded Enclosure, SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.4 to 24.7 °C

Relative Humidity: 37 to 47 %

4.4 Test Equipment

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
Bilog Antenna	JB6	Sunol	B079689	26 Aug 2012
Receiver	ESU8	R & S	B085759	19 May 2012
Receiver	ESU40	R & S	B079629	25 Aug 2012
DRWG Antenna	3117	ETS-Lindgren	B079691	31 May 2012
DRWG Antenna	3116B	ETS-Lindgren	B079697	27 Feb 2013
RF Preamplifier	NSP1800-25-HG	Miteq	B085930	14 Oct 2012
RF Preamplifier	NSP1840-HG	Miteq	B087572	28 Oct 2012
Coaxial Cable	Sucoflex 106	Huber+Suhner	B079711	24 Aug 2012
Coaxial Cable	Sucoflex 106	Huber+Suhner	B079713	24 Aug 2012
Coaxial Cable	Sucoflex 106	Huber+Suhner	B079715	24 Aug 2012
Coaxial Cable	Sucoflex 106	Huber+Suhner	B079660	12 Aug 2012
Coaxial Cable	Sucoflex 102	Huber+Suhner	B079824	23 Nov 2012
Coaxial Cable	Sucoflex 102	Huber+Suhner	B079822	23 Nov 2012

Note: The calibration period equipment is 1 year.

Software:

“Direct_Final_Radiated Emissions 1-18GHz.TIL” TILE! profile dated 03 MAY 2012

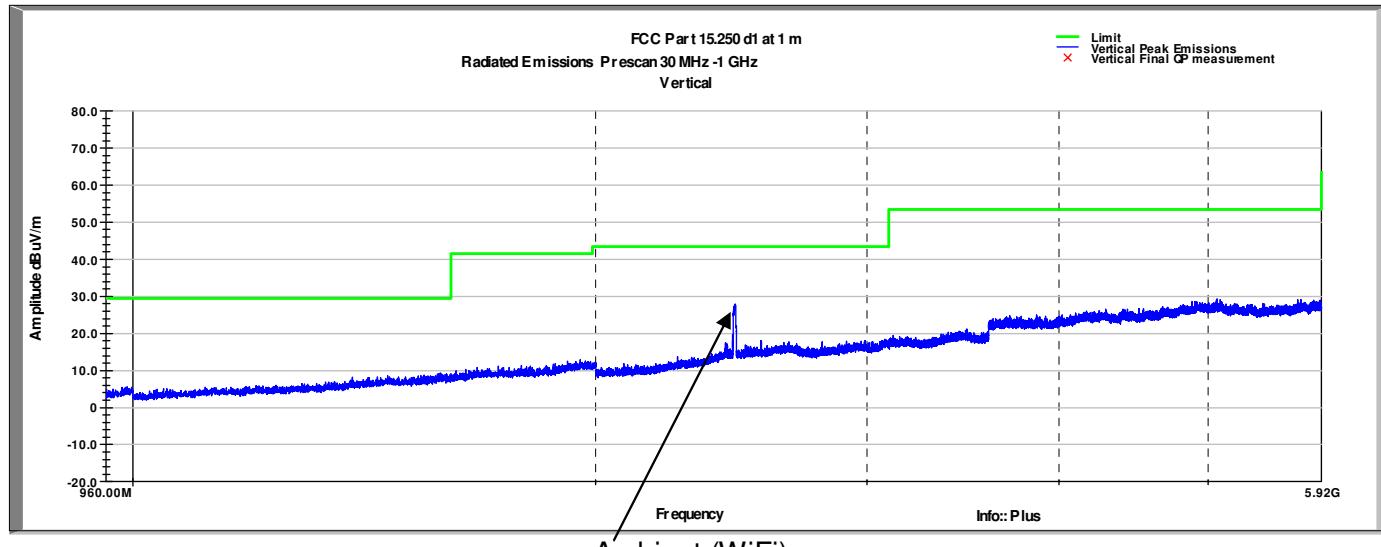
“Direct_Final_Radiated Emissions 18-40GHz.TIL” TILE! profile dated 03 MAY 2012

4.5 Test Data

Test Date: 20 APR 2012 / 12 MAY 2012

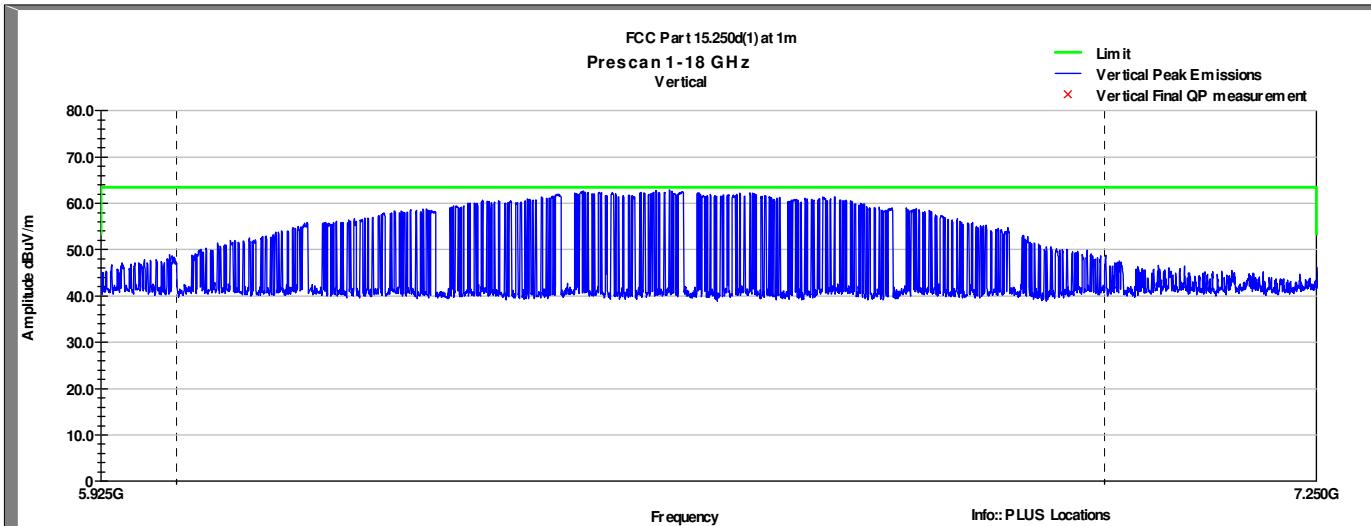
Operator: Brian Forster / David Schramm

Plot: Vertical Emissions Pre-scan from 960 MHz to 5925 MHz at 1m



Please note this ambient emission is ~40 dB below the Class B limit at 1 meter.

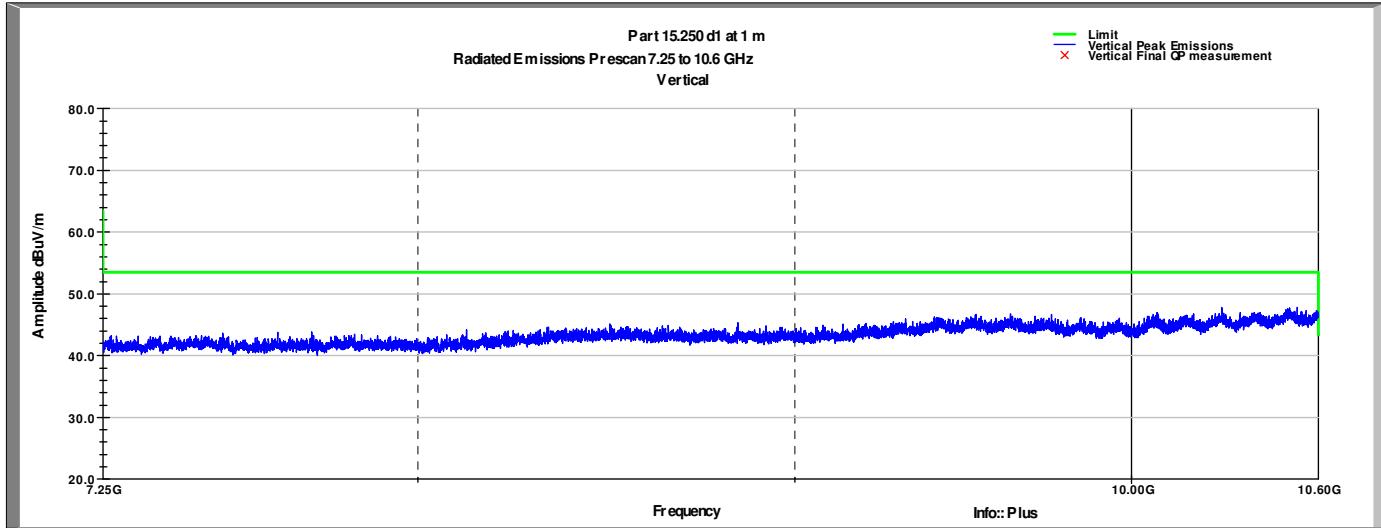
Plot: Vertical Emissions Pre-scan from 5.925 to 7.25 GHz at 1m



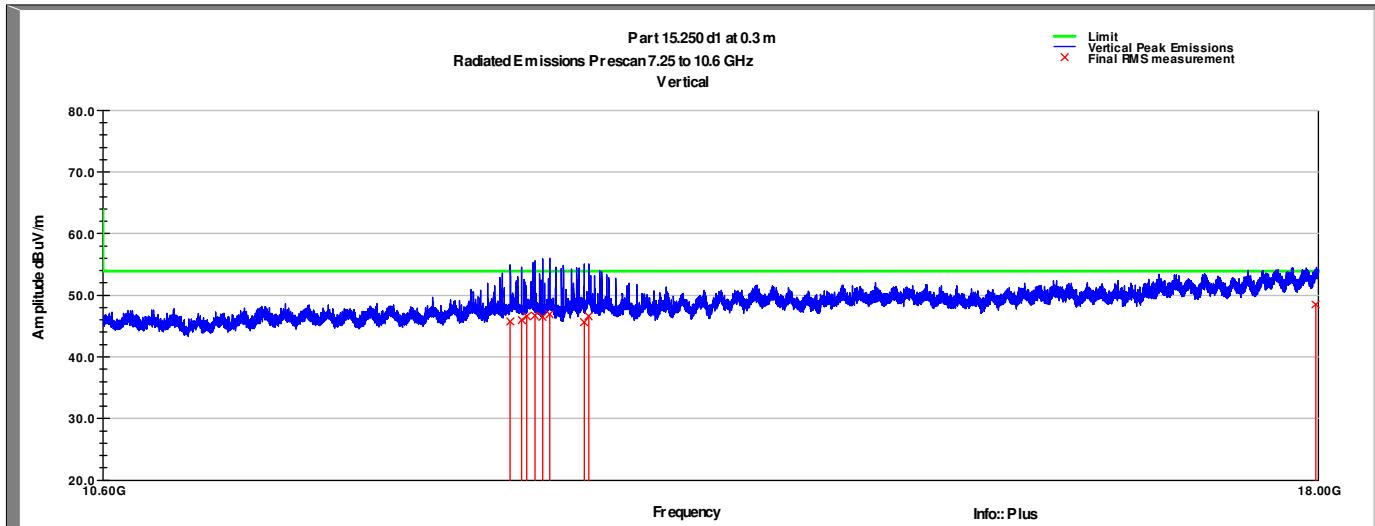
Radiated Power Density Results					
Antenna Polarity	Frequency MHz	Measurement at 1m dB(μ V/m)	Limit at 1m dB(μ V/m)	Margin dB	Detectors / RBW / VBW
V	6046.45	52.75	63.4	-10.65	RMS / 1 MHz / 3 MHz
This frequency denotes the highest result in the 5.925 to 7.25 GHz band					

Radiated Power Density Results					
Antenna Polarity	Frequency MHz	Measurement dBm	Limit dBm	Margin dB	Detectors / RBW / VBW
V	6046.45	-51.95	-41.3	-10.65	RMS / 1 MHz / 3 MHz
This frequency denotes the highest result in the 5.925 to 7.25 GHz band					

Plot: Vertical Emissions Pre-scan from 7.25 to 10.6 GHz at 1m



Plot: Vertical Emissions Pre-scan from 10.6 to 18 GHz at 0.3m



Frequency MHz	RMS (dBuV)	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	CL (dB)	Amp (dB)	QP Value (dBuV/m)	Limit (dBuV/m)	Margin (dB)
12659.79	39.4	V	270.0	125.0	39.6	9.2	42.5	45.7	53.9	-8.2
12722.32	39.7	V	270.0	125.0	39.6	9.2	42.5	46.0	53.9	-7.9
12751.92	40.2	V	270.0	125.0	39.5	9.2	42.3	46.6	53.9	-7.3
12796.69	40.4	V	270.0	125.0	39.5	9.2	42.4	46.7	53.9	-7.2
12838.50	40.2	V	270.0	125.0	39.5	9.2	42.4	46.5	53.9	-7.4
12877.70	40.5	V	270.0	125.0	39.5	9.2	42.3	46.9	53.9	-7.0
13074.20	39.3	V	270.0	125.0	39.5	9.3	42.5	45.6	53.9	-8.3
13099.70	40.2	V	270.0	125.0	39.5	9.4	42.5	46.6	53.9	-7.3
13150.00	37.8	H	0.0	125.0	39.5	9.4	42.5	44.2	53.9	-9.7
17980.24	35.4	V*	0.0	125.0	42.9	10.9	40.7	48.5	53.9	-5.4
17980.24	35.4	H*	0.0	125.0	42.9	10.9	40.7	48.5	53.9	-5.4

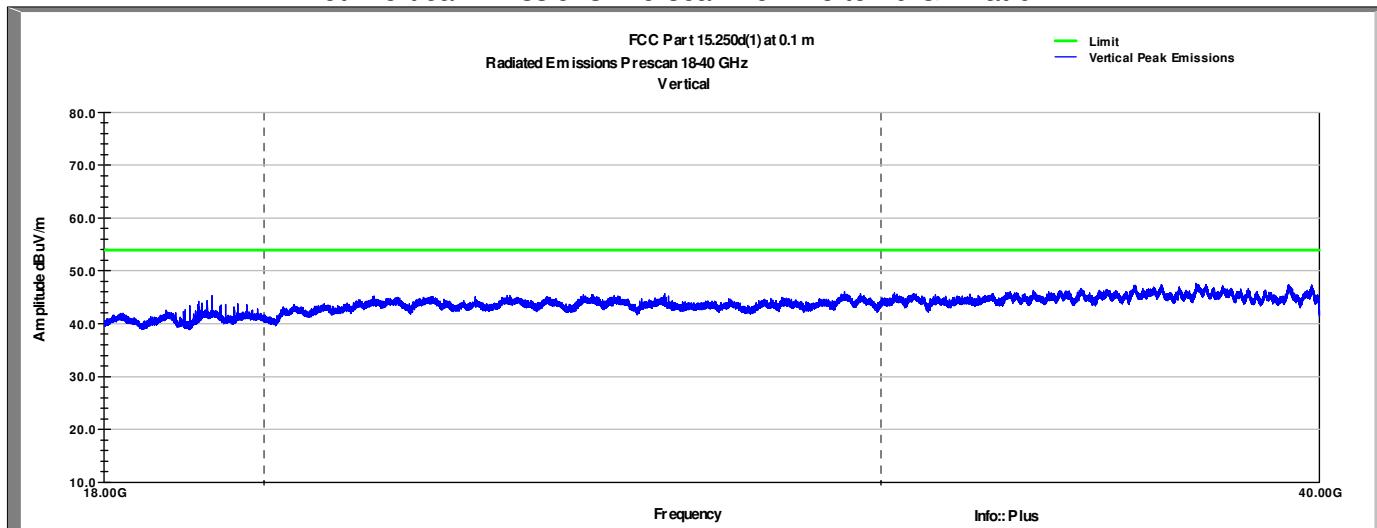
QP Value = Level + AF + CL - Amp

Margin = QP Value - Limit

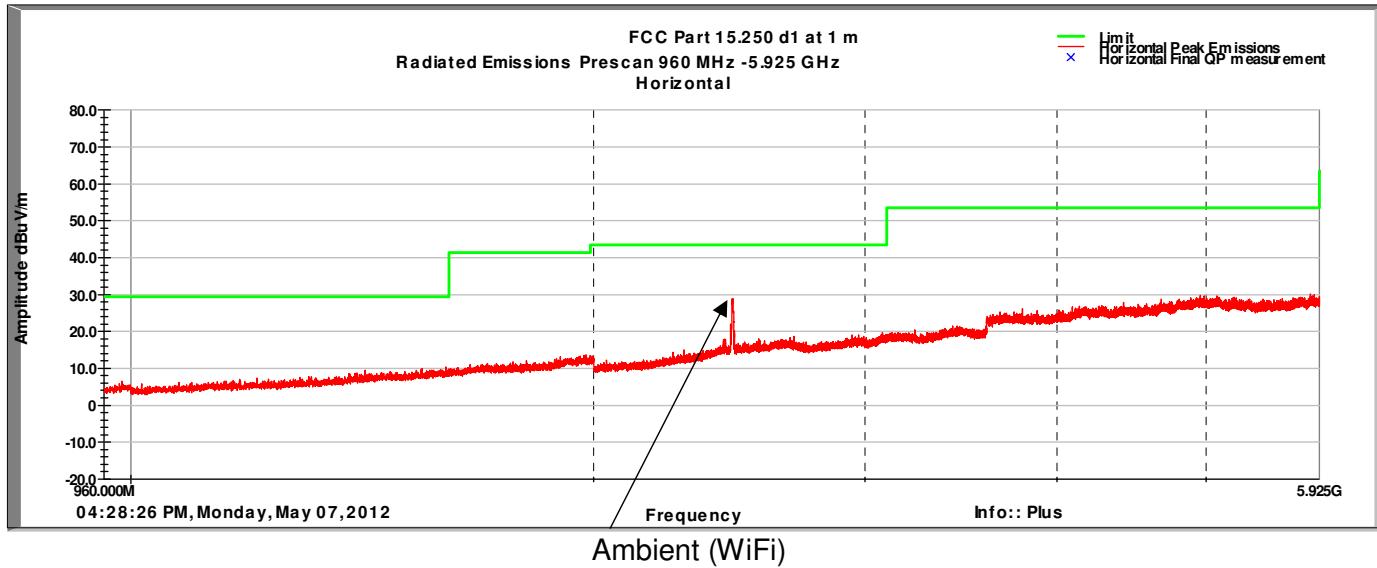
* denotes noise floor measurement

Frequency MHz	RMS Value (dBm)	Limit (dBm)	Margin (dB)
12659.79	-69.5	-61.3	-8.2
12722.32	-69.2	-61.3	-7.9
12751.92	-68.6	-61.3	-7.3
12796.69	-68.5	-61.3	-7.2
12838.50	-68.7	-61.3	-7.4
12877.70	-68.3	-61.3	-7.0
13074.20	-69.6	-61.3	-8.3
13099.70	-68.6	-61.3	-7.3
13150.00	-71.0	-61.3	-9.7
17980.24	-66.7	-61.3	-5.4
17980.24	-66.7	-61.3	-5.4

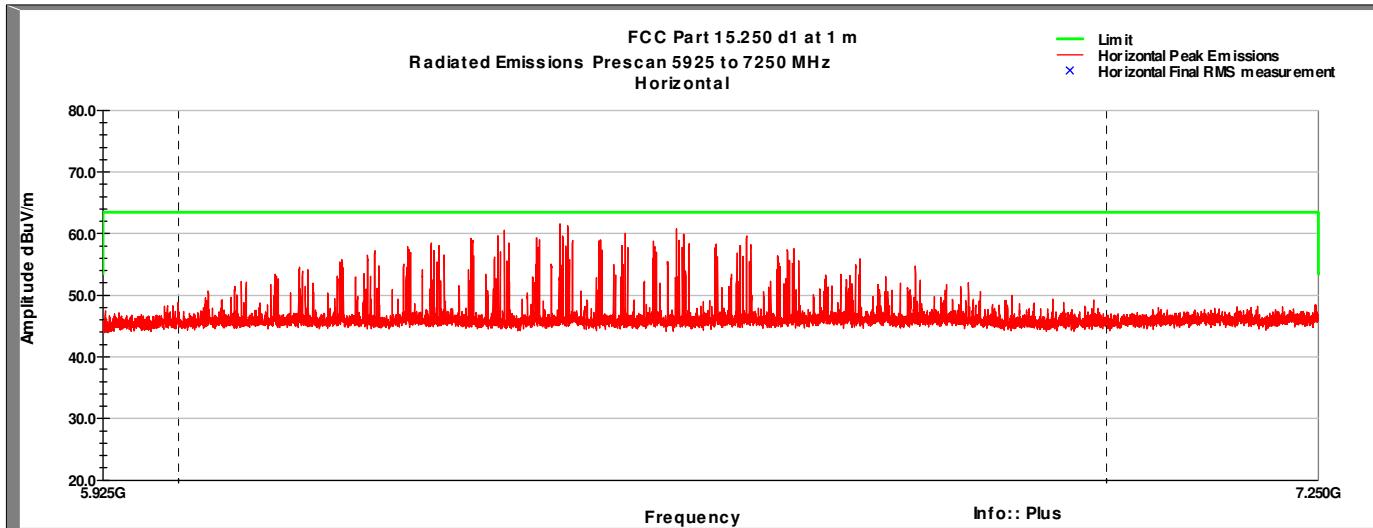
Plot: Vertical Emissions Pre-scan from 18 to 40 GHz at 0.1m



Plot: Horizontal Emissions Pre-scan from 960 to 5925 MHz at 1m



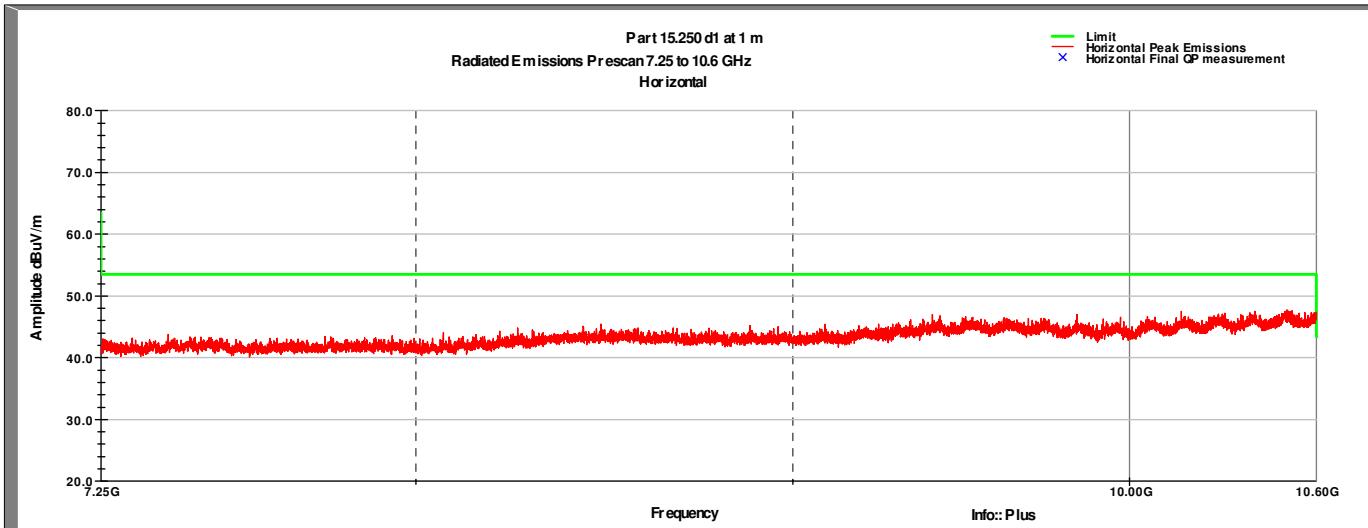
Plot: Horizontal Emissions Pre-scan from 5.925 to 7.25 GHz at 1m



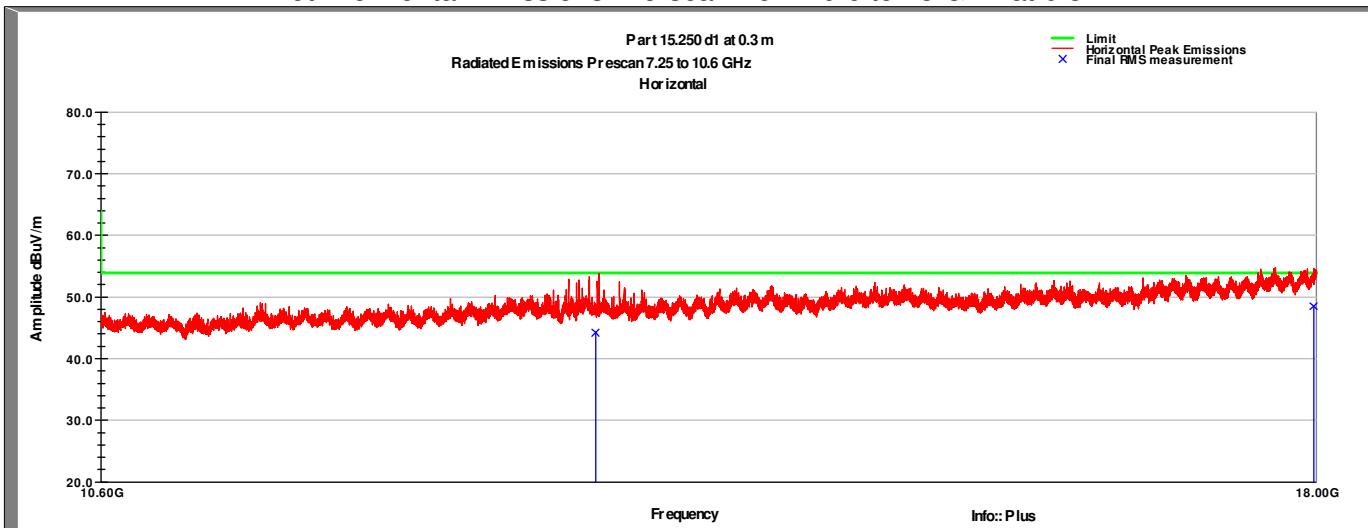
Radiated Power Density Results					
Antenna Polarity	Frequency MHz	Measurement at 1m dB(μV/m)	Limit at 1m dB(μV/m)	Margin dB	Detectors / RBW / VBW
H	6404.65	52.1	63.4	-11.3	RMS / 1 MHz / 3 MHz
This frequency denotes the highest result in the 5.925 to 7.25 GHz band					

Antenna Polarity	Frequency MHz	Measurement dBm	Limit dBm	Margin dB	Detectors / RBW / VBW
H	6404.65	-52.6	-41.3	-11.3	RMS / 1 MHz / 3 MHz
This frequency denotes the highest result in the 5.925 to 7.25 GHz band					

Plot: Horizontal Emissions Pre-scan from 7.25 to 10.6 GHz at 1m



Plot: Horizontal Emissions Pre-scan from 10.6 to 18 GHz at 0.3m



Frequency MHz	RMS (dBuV)	Polarity (V/I)	Azimuth (degrees)	Height (cm)	AF (dB/m)	CL (dB)	Amp (dB)	QP Value (dBuV/m)	Limit (dBuV/m)	Margin (dB)
13150.00	37.8	H	0.0	125.0	39.5	9.4	42.5	44.2	53.9	-9.7
17980.24	35.4	H*	0.0	125.0	42.9	10.9	40.7	48.5	53.9	-5.4

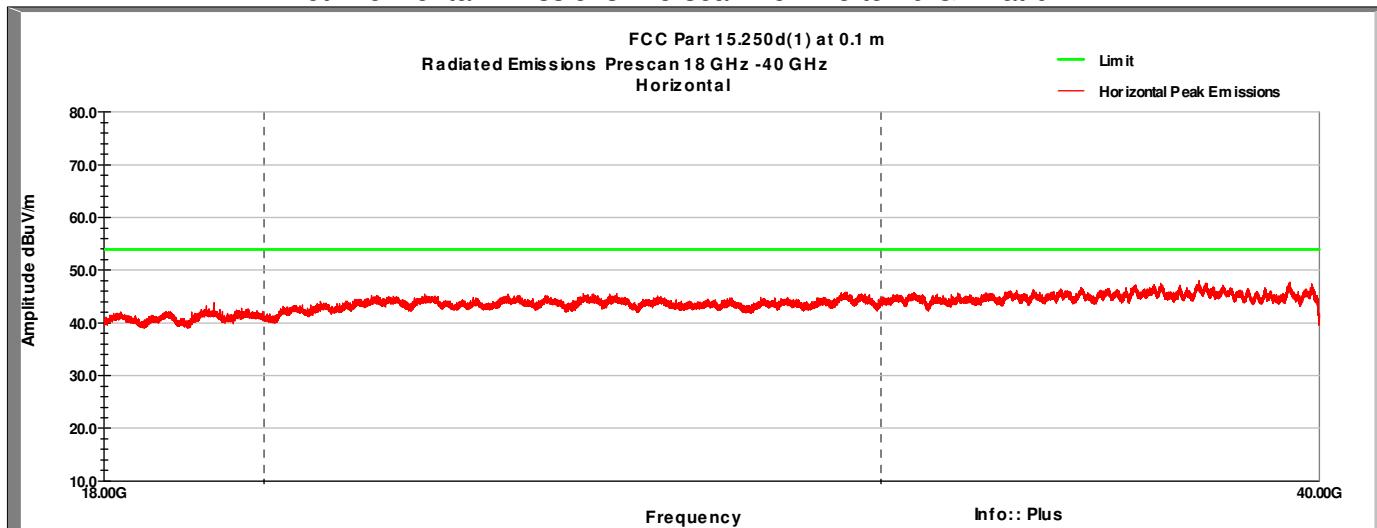
QP Value = Level + AF + CL - Amp

Margin = QP Value - Limit

* denotes noise floor measurement

Frequency MHz	RMS Value (dBm)	Limit (dBm)	Margin (dB)
13150.00	-71.0	-61.3	-9.7
17980.24	-66.7	-61.3	-5.4

Plot: Horizontal Emissions Pre-scan from 18 to 40 GHz at 0.1m



5 Radiated emissions in GPS receive band

5.1 Test Result

Test Description	Reference	Test Result
Radiated emissions in GPS receive band	15.250(d)(2)	Compliant

5.2 Test Method

In addition to the radiated emission limits specified in the table in paragraph (d)(1) of this section, transmitters operating under the provisions of this section shall not exceed the following RMS average limits when measured using a resolution bandwidth of no less than 1 kHz:

Frequency (MHz)	EIRP dBm	EIRP (dB μ V/m) at 3m	EIRP (dB μ V/m) at .1m
1164–1240	-85.3	9.9	19.4
1559–1610	-85.3	9.9	19.4

5.3 Test Site

10m Absorber Lined Shielded Enclosure, SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.4 to 24.7 °C

Relative Humidity: 37 to 47 %

5.4 Test Equipment

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
Spectrum Analyzer	ESU8	Rohde & Schwarz	B085759	19 May 2012
DRWG Antenna	3117	ETS-Lindgren	B079691	31 May 2012
RF Preamplifier	NSP1800-25-HG	Miteq	B085930	14 Oct 2012
RF Cable	Sucoflex 106	Huber+Suhner	B079711	24 Aug 2012
RF Cable	Sucoflex 106	Huber+Suhner	B079713	24 Aug 2012

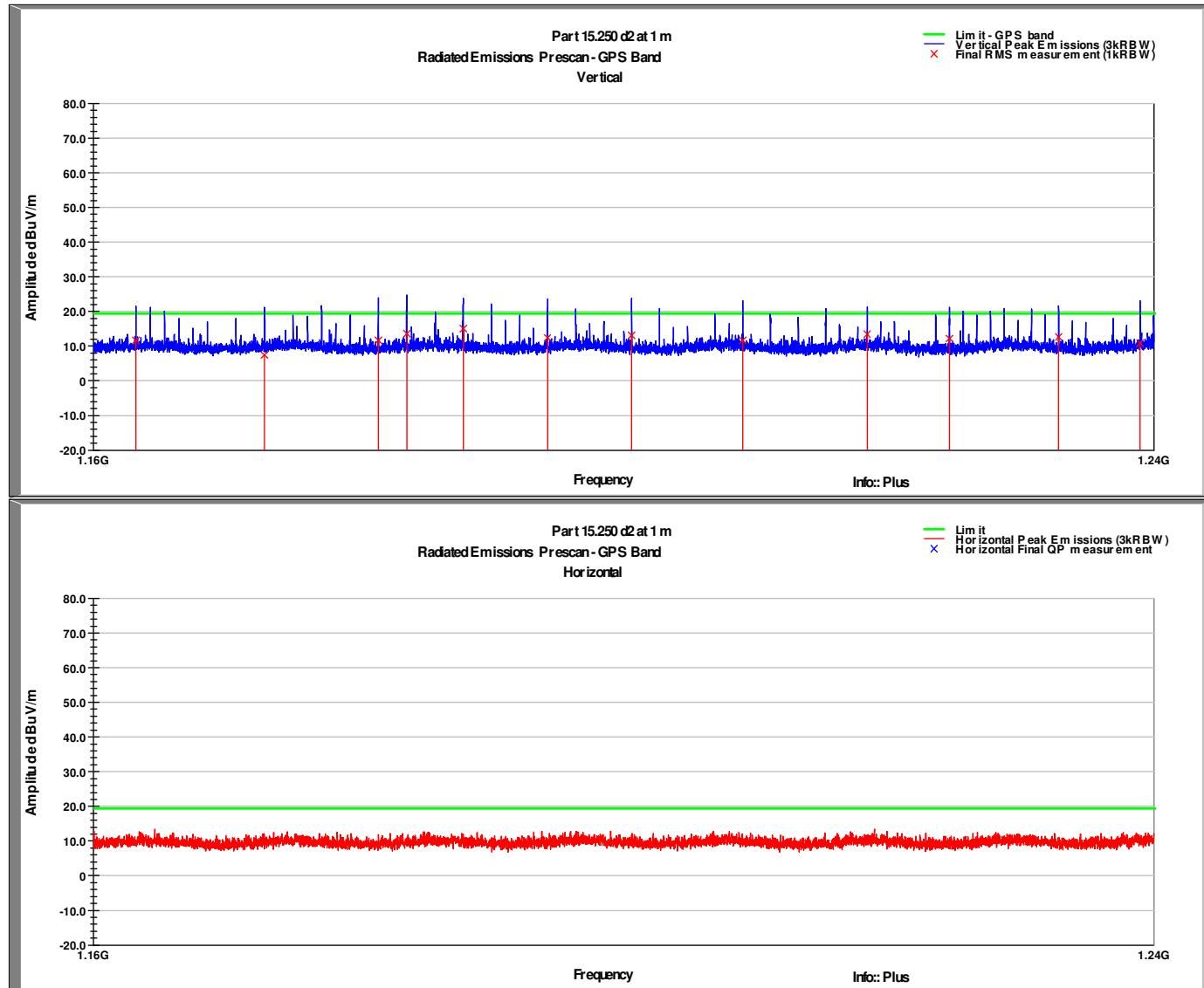
Note: The calibration period equipment is 1 year.

5.5 Test Data

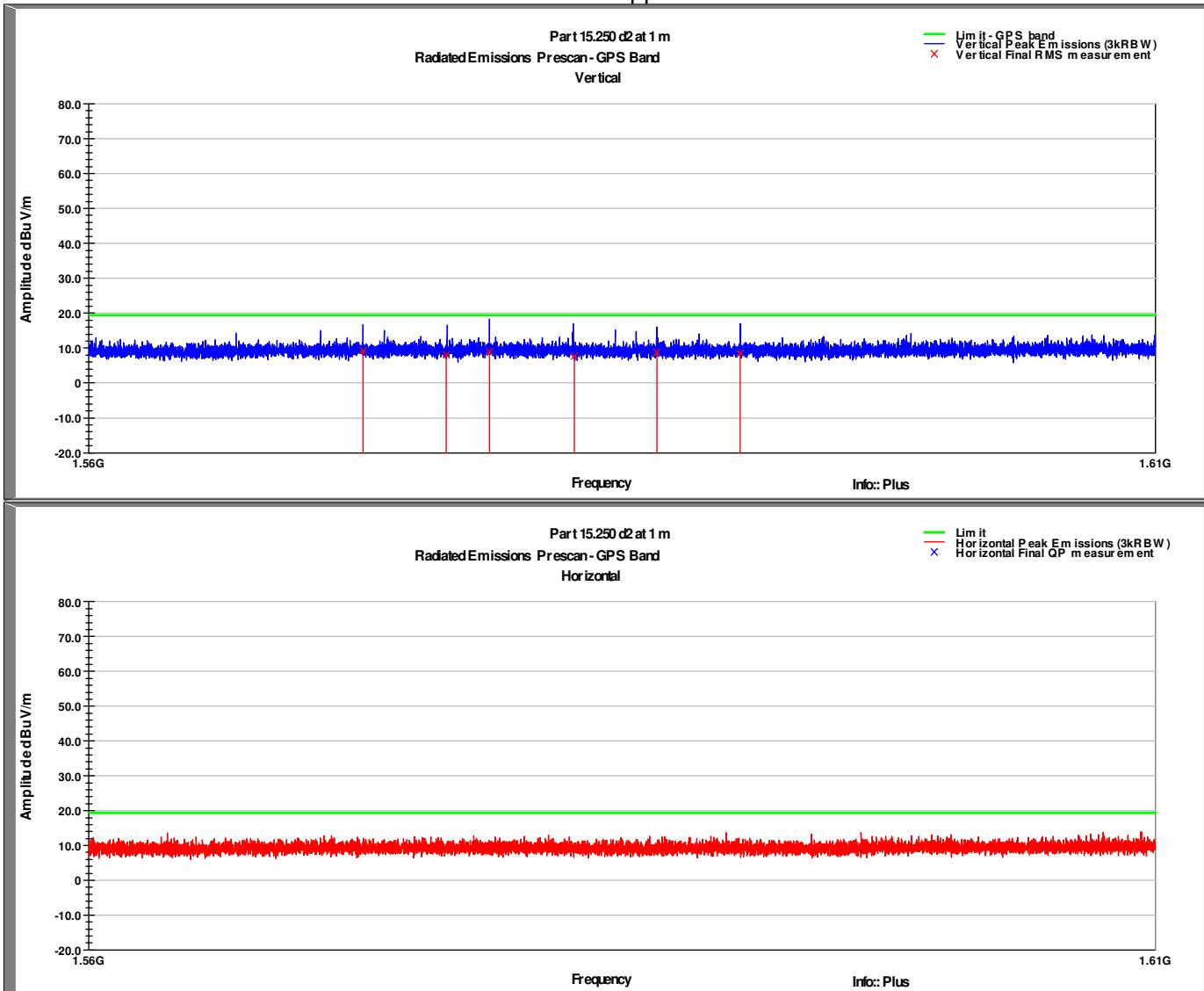
Test Date: 20 APR 2012 / 12 MAY 2012

Operator: Brian Forster / David Schramm

Plot: Radiated Emissions in lower GPS Receive Band



Plot: Radiated Emissions in upper GPS Receive Band



Data: Radiated Emissions in GPS Receive Bands

Frequency MHz	QP Value dBm	Limit dBm	Margin dB
1183.97	-93.0	-85.3	-7.7
1166.97	-93.0	-85.3	-7.7
1175.96	-97.3	-85.3	-12.0
1218.98	-91.3	-85.3	-6.0
1224.98	-92.5	-85.3	-7.2
1232.98	-92.1	-85.3	-6.8
1238.98	-93.8	-85.3	-8.5
1185.97	-91.1	-85.3	-5.8
1189.98	-89.7	-85.3	-4.4
1195.97	-92.4	-85.3	-7.1
1201.98	-91.6	-85.3	-6.3
1209.97	-93.0	-85.3	-7.7
1571.96	-95.4	-85.3	-10.1
1575.93	-96.7	-85.3	-11.4
1577.98	-95.8	-85.3	-10.5
1582.02	-97.0	-85.3	-11.7
1585.96	-96.0	-85.3	-10.7
1589.95	-96.2	-85.3	-10.9

6 Peak Power within a 50 MHz bandwidth

6.1 Test Result

Test Description	Basic Standards	Test Result
Peak Power in a 50 MHz Bandwidth	15.250	Compliant

6.2 Test Method

- 1) There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs and this 50 MHz bandwidth must be contained within the 5925–7250 MHz band.
- 2) The peak EIRP limit is $20 \log (RBW/50)$ dBm where RBW is the resolution bandwidth in megahertz that is employed by the measurement instrument. RBW shall not be lower than 1 MHz or greater than 50 MHz. The video bandwidth of the measurement instrument shall not be less than RBW.
- 3) If RBW is greater than 3 MHz, the application for certification filed with the Commission shall contain a detailed description of the test procedure, calibration of the test setup, and the instrumentation employed in the testing.

Limits

Frequency (MHz)	EIRP in 50 MHz BW dBm	EIRP in 50 MHz BW (dB μ V/m) at 3m	EIRP in 50 MHz BW (dB μ V/m) at .1m
5925 – 7250	0	95.2	104.7

Limits converted to 1 MHz RBW

Frequency (MHz)	EIRP in 1 MHz BW dBm	EIRP in 1 MHz BW (dB μ V/m) at 3m	EIRP in 50 MHz BW (dB μ V/m) at 1m
5925 - 7250	-34	61.2	70.7

6.3 Test Site

10m Absorber Lined Shielded Enclosure, SGS EMC Laboratory, Suwanee, GA

Environmental Conditions

Temperature: 23.4 to 24.7°C
Relative Humidity: 37 to 47 %

6.4 Test Equipment

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
Spectrum Analyzer	ESU8	Rohde & Schwarz	B085759	19 May 2012
DRWG Antenna	3117	ETS-Lindgren	B079691	31 May 2012
RF Preamplifier	NSP1800-25-HG	Miteq	B085930	14 Oct 2012
RF Cable	Sucoflex 106	Huber+Suhner	B079711	24 Aug 2012
RF Cable	Sucoflex 106	Huber+Suhner	B079713	24 Aug 2012

Note: The calibration period for this equipment is 1 year.

6.5 Test Data

Test Date: 20 APR 2012

Operator: Brian Forster

Peak Power Results						
Antenna Polarity	Frequency MHz	Field Strength at 1m dB μ V/m	EIRP RBW: 1 MHz dBm	EIRP 1 MHz Limit dBm	Margin	Detectors / RBW / VBW
V	6046.45	62.44	-42.3	-34.0	-8.3	Peak 1MHz / 3MHz

EIRP = Field Strength (at 1m) – 104.74

Margin = EIRP - Limit

7 Radiated emissions below 960 MHz

7.1 Test Result

Test Description	Basic Standards	Test Result
Radiated Emissions	FCC Part 15.250(d)(4) and 15.209	Compliant

7.2 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 and Average detector above 1GHz. 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.

Radiated emissions limit below 1 GHz		
Frequency Range(MHz)	Limit(QP dB μ V/m)	Distance
30 – 88	40	3m
88 – 216	43.5	3m
216 – 960	46	3m

7.3 Test Site

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

Environmental Conditions

Temperature: 23.4 to 24.7°C

Relative Humidity: 37 to 47 %

7.4 Test Equipment

Equipment	Model	Manufacturer	Asset Number	Cal Due Date
Bilog Antenna	JB6	Sunol	B079689	24 Aug 2012
Receiver	ESU8	Rohde & Schwarz	B085759	19 May 2012
Pre-Amplifier	NSP1800-25-HG	Mini-Circuits	B079817	14 Oct 2012
Coaxial Cable	Sucoflex 106	Huber+Suhner	B079712	12 Aug 2012
Coaxial Cable	Sucoflex 106	Huber+Suhner	B079711	12 Aug 2012
Coaxial Cable	Sucoflex 106	Huber+Suhner	B085888	26 Sep 2012

Note: The calibration period equipment is 1 year.

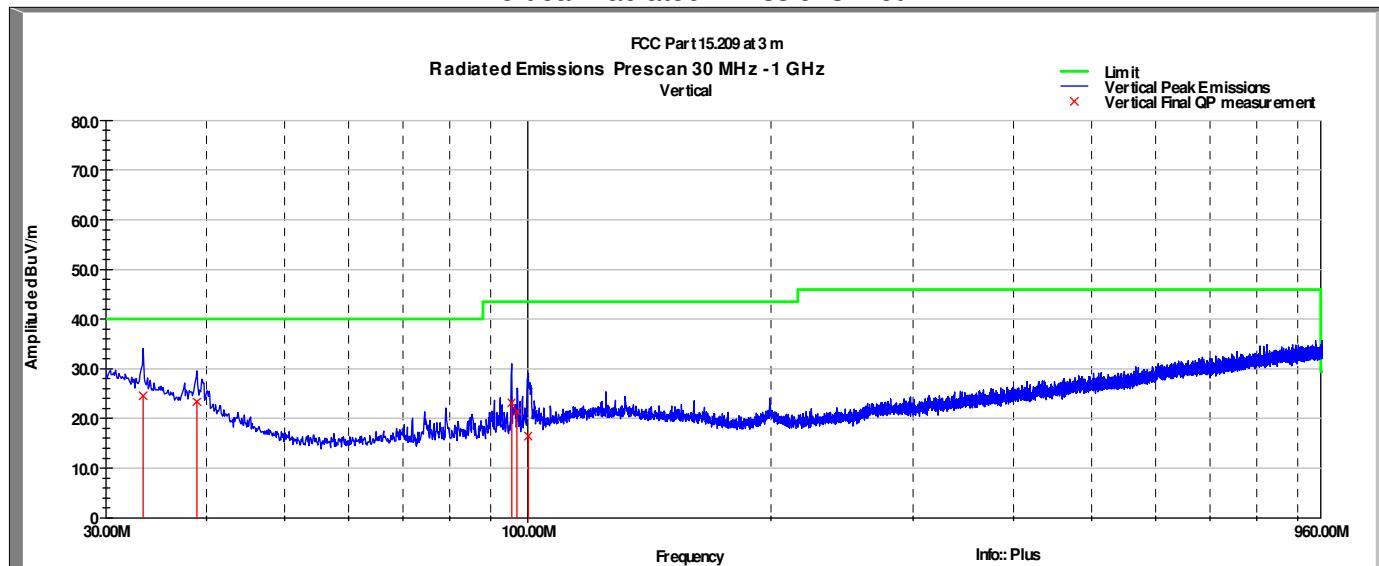
Software: "Radiated Emissions" TILE! profile dated 15 Oct 2011

7.5 Test Data

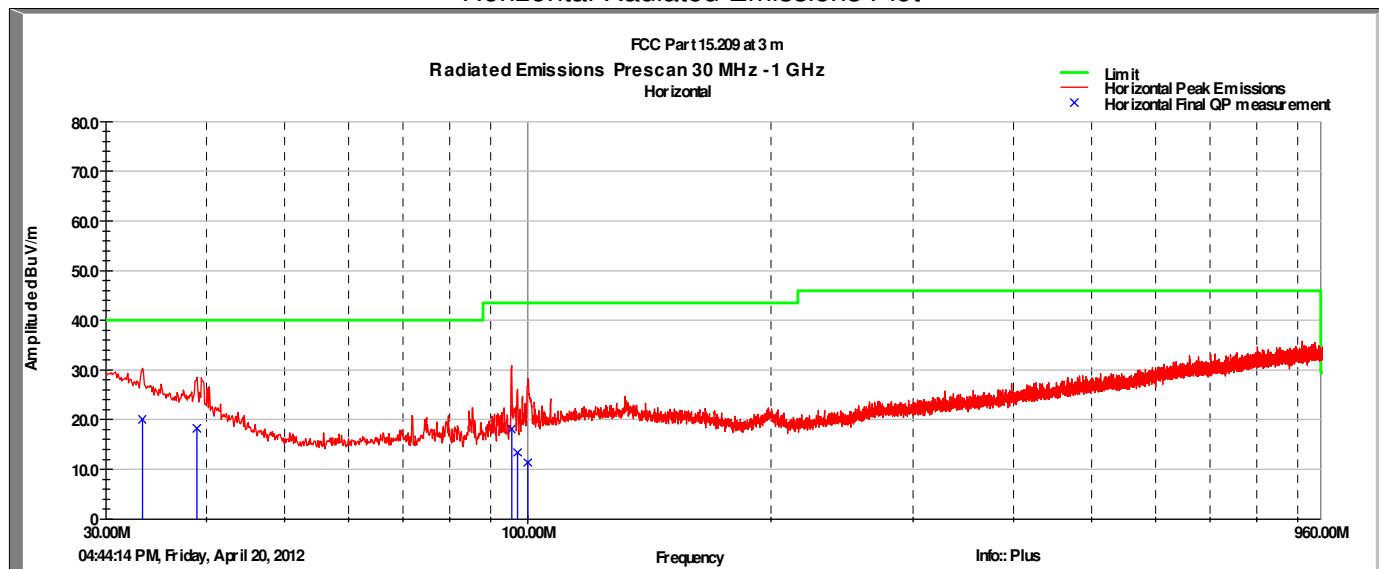
Test Date: 20 APR 2012

Operator: Brian Forster

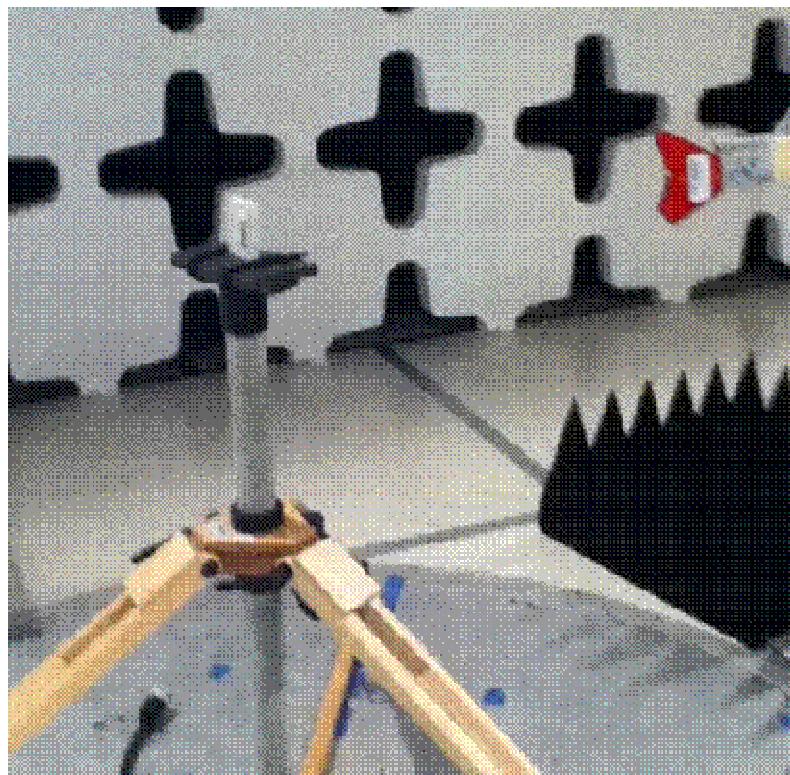
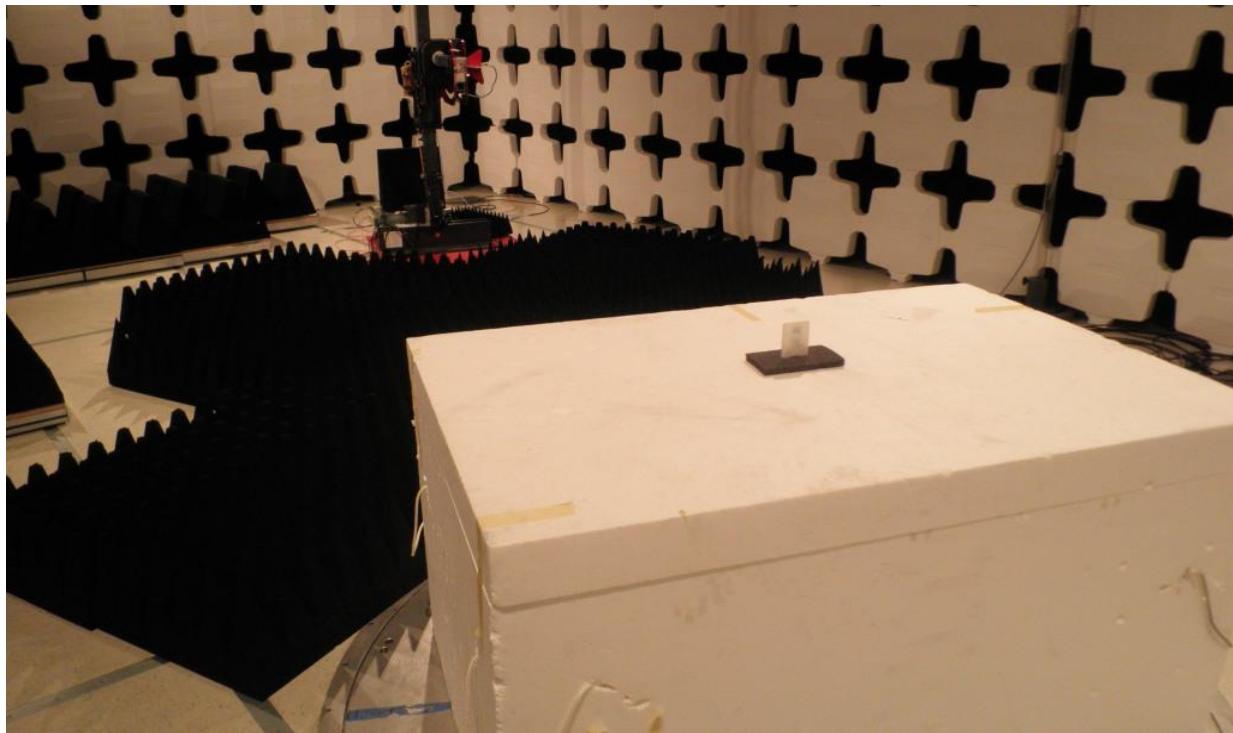
Vertical Radiated Emissions Plot



Horizontal Radiated Emissions Plot



8 Test Setup Photographs



9 Revision History

Revision Level	Description of changes	Revision Date
0	Initial release	12 May 2012
1	Corrected model number from CR80 to 1104	21 May 2012
2	Added frequency stability data versus temperature and input voltage to Section 3. Added RMS values in power for Sections 4 and 5.	31 May 2012