

EMISSIONS TEST REPORT

Report Number: 3122967DAL-001

Project Number: 3122967

Testing performed on the

Spot RFLS Location System – Mini Tag

Model: 40009A001

FCC ID: RO540009A001

To

FCC Part 15 Subpart C 15.247

Industry Canada's RSS-210 Issue 6 September 2005, Annex 8

FCC Part 15 Subpart B and ICES-003 Issue 4 February 2004

For

InnerWireless, Inc.

Test Performed by:
Intertek – ETL SEMKO
420 N Dorothy Drive,
Richardson, TX 75081 USA

Test Authorized by:
Wavetrix, Inc.
1601 N. Glenville Dr., Suite 100
Richardson, TX 75081 USA

Prepared by: Skamble
Sudesh Kamble, Team Leader

Date: July 26, 2007

Reviewed by: Quilich

Date: July 27, 2007



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Intertek Testing Services NA, Inc.

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1 Job Description

1.1 Client Information

This EUT has been tested at the request of:

Company: InnerWireless, Inc.
1155 Kas Drive,
Richardson, TX 75081 USA
Contact: Mr. James McCoy
Telephone: (972) 201-2522
Fax: (972) 479-9625

1.2 Equipment Under Test

Equipment Type: Mini Tag
Model Number(s): 40009A001 (see section 1.4.3 for individual items)
Serial number(s): ABCDEF0000000B01
Manufacturer: Creation Technologies, Inc.
1001 Klein Rd, Suite 100
Plano, TX 75074 USA
Mr. Carl Gordon
Phone : (972) 265-4179

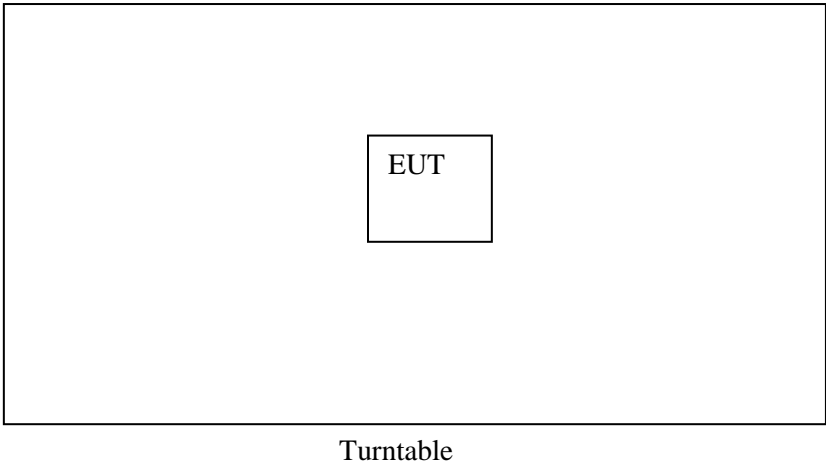
EUT receive date: 05/07/07
EUT received condition: Prototypes in Good Condition
Test start date: 05/07/07
Test end date: 07/28/07

1.3 Test Plan Reference

Tested according to the standards listed, ANSI C63.4:2003, and RSS-Gen Issue 1 September 2005.

1.4 Test Configuration

1.4.1 Block Diagram



1.4.2 Cables:

	Cable	Shielding	Connector	Length (m)
Qty.	None			

1.4.3 Support Equipment & Equipment Under Test:

Support Equipment:
Name: None
Model No.:
Serial No.:

1.5 Mode(s) of Operation:

The Mini Tag was activated from a fresh 3.0V lithium battery. Only one battery is required for system operation. The EUT was continuously transmitting on low, mid, and high channels and was manipulated in three orthogonal axes. The EUT does not have an antenna port.

1.6 Floor Standing Equipment:

Applicable: ☐ Not Applicable: ☒

1.7 Modifications Required for Compliance:

No modifications required.

2 Test Summary

TEST STANDARD		RESULTS
FCC Part 15 Subpart C 15.247, Industry Canada's RSS-210 Issue 6 September 2005 Annex 8, FCC Part 15 Subpart B, and Industry Canada's ICES-003 Issue 4 February 2004		
SUB-TEST	TEST PARAMETER	COMMENT
Maximum Peak Conducted Output Power and Human RF Exposure FCC 15.247(b)(3-5), RSS-210 A8.4, RSS-102 4.3	The output power of the Radio Module must not exceed 1 Watt (30 dBm) and 36 dBm EIRP. The human RF Exposure limit is 1 mW/cm ² .	Pass
Occupied Bandwidth FCC 15.247(a)(2), RSS-210 A8.2	The 6 dB bandwidth of the Radio Module must be at least 500 kHz.	Pass
Antenna Port Conducted Spurious Emissions FCC 15.209, 15.247(d), RSS-210 A8.5	The spurious emissions of the Radio Module must be attenuated below the level of the fundamental by at least 20 dBc.	Not Applicable Integral Antenna
Radiated Spurious Emissions FCC 15.205, 15.209, 15.247(d), 15.109, RSS-210 2.2, 2.7, A8.5, ICES-003	The spurious emissions of the Radio Module must be attenuated below the level of the fundamental by at least 20 dBc. Emissions which fall in the restricted bands must meet the general limits of 15.209 and RSS-210 2.7 Table 2. The spurious emissions of the BEP must not exceed the limits of 15.109 Class A and ICES-003 Class A.	Pass
Peak Power Spectral Density FCC 15.247(e), RSS-210 A8.2	The peak power spectral density of the Radio Module must not exceed 8 dBm / 3 kHz.	Pass
Band Edge Compliance FCC 15.215, RSS-210 2.1, A8.5	The fundamental frequency of the Radio Module must stay within the assigned frequency band.	Pass
AC Line-Conducted Emissions FCC 15.207, 15.107, RSS-Gen 7.2.2, ICES- 003	The AC line-conducted emissions of the Radio Module must not exceed the limits of 15.207 and RSS-Gen 7.2.2 Table 2. The AC line-conducted emissions of the BEP must not exceed the limits of 15.107 Class A and ICES-003 Class A.	Not Applicable Battery powered Device

Notes: The Mini Tag was tested as a Class A digital device to FCC Part 15 Subpart B and ICES-003, Intentional transmission was tested as a transmitter to the requirements of FCC Part 15 Subpart C 15.247 and RSS-210 Annex 8. Channels selected for test were:

Channel 11: 2405 MHz,

Channel 17: 2435 MHz,

Channel 26: 2480 MHz

3 REVISION SUMMARY

The following changes have been made to this Report:

Date	Project No.	Project Handler	Page(s)	Item	Description of change
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4 Sample Calculations

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where

- FS = Field Strength in dB μ V/m
- RA = Receiver Amplitude (including preamplifier) in dB μ V
- CF = Cable Attenuation Factor in dB
- AF = Antenna Factor in dB
- AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dB μ V is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dB μ V/m. This value in dB μ V/m was converted to its corresponding level in μ V/m.

RA = 52.0 dB μ V
 AF = 7.4 dB/m
 CF = 1.6 dB
 AG = 29.0 dB
 FS = 32 dB μ V/m

$$\text{Level in } \mu\text{V/m} = [10(32 \text{ dB}\mu\text{V/m})/20] = 39.8 \mu\text{V/m}$$

The following is how net line-conducted readings were determined:

$$NF = RF + LF + CF + AF$$

Where

- NF = Net Reading in dB μ V
- RF = Reading from receiver in dB μ V
- LF = LISN Correction Factor in dB
- CF = Cable Correction Factor in dB
- AF = Attenuator Loss Factor in dB

To convert from dB μ V to μ V or mV the following was used:

$$UF = 10^{(NF/20)} \text{ where UF = Net Reading in } \mu\text{V}$$

Example:

$$NF = RF + LF + CF + AF = 28.5 + 0.2 + 0.4 + 20.0 = 49.1 \text{ dB}\mu\text{V}$$

$$UF = 10^{(49.1 \text{ dB}\mu\text{V} / 20)} = 254 \mu\text{V/m}$$

4.1 Measurement Uncertainty

Compliance of the product is based on the measured value. However, the measurement uncertainty is included for informational purposes.

The expanded uncertainty ($k = 2$)¹ for radiated emissions from 30 to 1000 MHz has been determined to be:

$$\pm 3.1 \text{ dB at 3m}$$

The expanded uncertainty ($k = 2$) for mains conducted emissions from 150 kHz to 30 MHz has been determined to be:

$$\pm 1.74 \text{ dB}$$

¹ $k=2$ represents 95% Confidence Level.

5 Site Description

Test Site(s): 1

The test facility is located at 420 N Dorothy Drive, Richardson, TX - 75081

The FCC site registration number for this site is 10157.

The Industry Canada file no. is IC 6018.

Measurements are conducted with a quasi-peak detector instrument in the frequency range of 30 MHz to 1000 MHz. The measuring receiver meets the requirements of Section One of CISPR 16/ ANSI 63.4 and the measuring antenna correlates to a balanced dipole.

Measurements of the radiated field are made with the antenna located at a distance of 10 meters from the EUT. If the field-strength measurements at 10m cannot be made because of high ambient noise level or for other reasons, measurements of Class B equipment may be made at a closer distance, for example 3m. An inverse proportionality factor of 20 dB per decade should be used to normalize the measured data to the specified distance for determining compliance.

The antenna is adjusted between 1m and 4m in height above the ground plane for maximum meter reading at each test frequency.

The antenna-to-EUT azimuth is varied during the measurement to find the maximum field-strength readings.

The antenna-to-EUT polarization (horizontal and vertical) is varied during the measurements to find the maximum field-strength readings.

The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane.

The table is constructed of non-conductive materials. Its dimensions are 1m by 1.5m, but may be extended for larger EUT.

Equipment setup for radiated disturbance tests followed the guidelines of CISPR 16 and ANSI 63.4.

6 Test Results

6.1 Test: Transmitter Output Power and EIRP, and Human RF Exposure

Test Standard: FCC 15.247(b)(3-5), RSS-210 A8.4, RSS-102 4.3

Test Results: Pass

Test Environment:

Environmental Conditions During Testing:	Humidity (%):	N/A	Pressure (hPa):	N/A	Ambient (°C):	N/A
Pretest Verification Performed	N/A		Equipment under Test:	Mini Tag		

Maximum Test Parameters: The output power of the Radio Module must not exceed 1 Watt (30 dBm) and 36 dBm EIRP. The human RF Exposure limit is 1 mW/cm².

Test Equipment Used:

Equip. ID	Description	Manufacturer	Model	Serial Number	Cal Date	Cal Due
77	EMI Receiver	R & S	ES17	100044	12/29/06	12/29/07
192	Handheld Manometer	Omega	HHP-102F	19.99/29.0 PSIA	03/03/07	03/03/08
260	Humidity Temperature	Extech	445580	17-260	12/01/06	12/01/07
30	DMM	Fluke	8060A	6191012	02/08/07	02/08/08
82	Bi-ConiLog Antenna	Schaffner	CBL6112B	2726	06/24/07	06/24/08
128	RF Cable	Custom made	#1	none	07/26/07	07/26/08
131	RF Cable	Custom made	#4	none	07/26/07	07/26/08
271	Horn Antenna	A H Systems	SAS-571	787	02/24/07	02/24/08
101	EMI Receiver	Agilent	E7405A	US40240235	12/20/06	12/20/07

Test Results:

Notes: The cable loss and antenna factor were compensated for in the spectrum analyzer. The field strength obtained at 3 meters distance was converted to EIRP using the equations of DA-00-705A1. A 100 kHz bandwidth and RMS detector were used with a 50 MHz span in order to have 500 discrete non-overlapping values for integration. Since the antenna is integral, conducted output power compliance cannot be demonstrated.

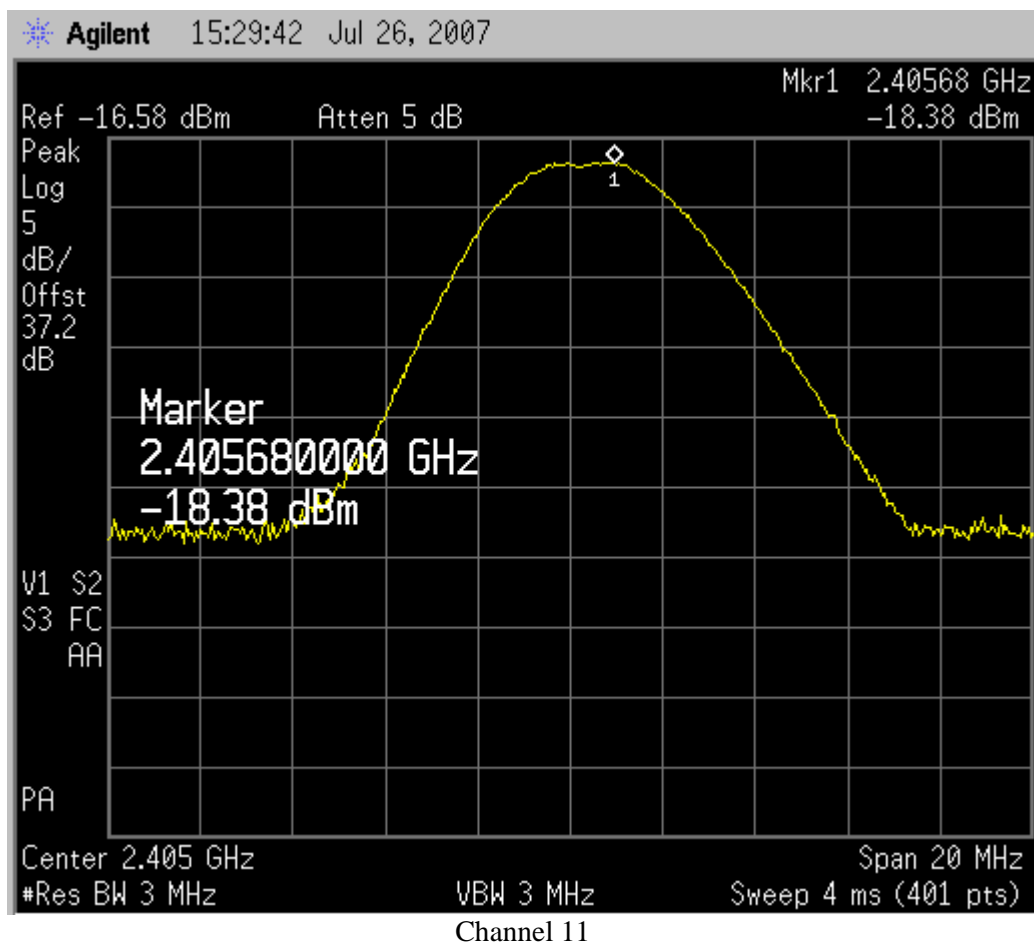
As referenced in RSS-102 2.5, the EUT is exempt from SAR evaluation because the output power is less than 20 mW and RF evaluation because the operating frequency is above 1.5 GHz and the EIRP does not exceed 5 watts. The FCC human RF exposure limit is 1 mW/cm². The power density S generated by some value of EIRP at a given distance d is related by the equation:

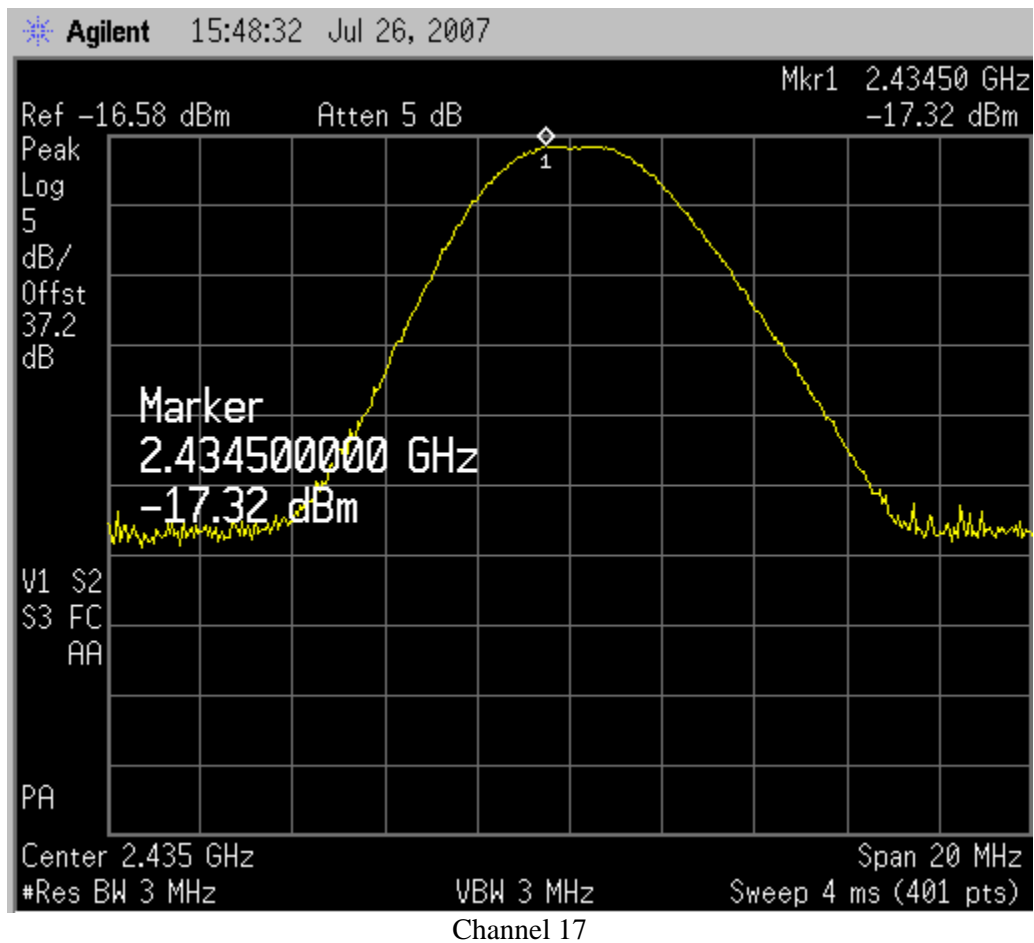
$$S = \text{EIRP} / (4\pi d^2)$$

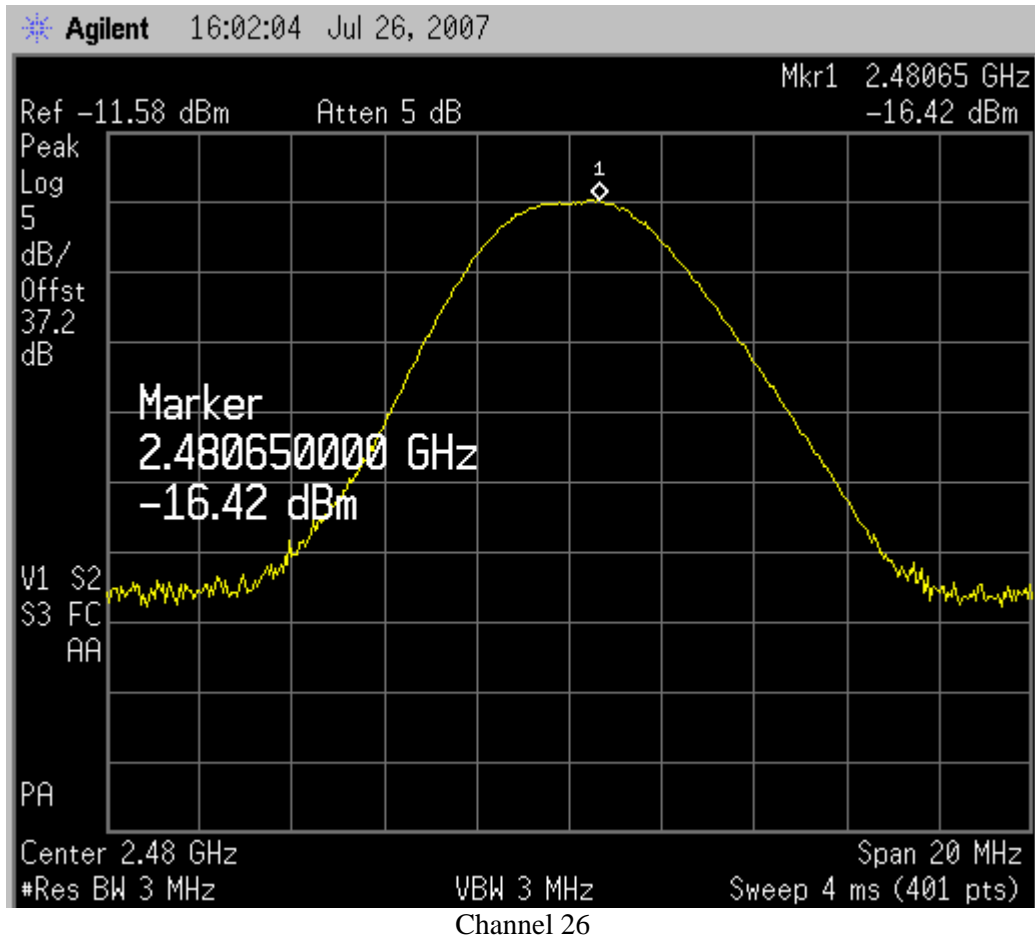
The distance, given a maximum EIRP of -14.27 dBm (0.0374 mW) at which the radiated power density of the EUT is equal to the human RF exposure limit is 0.0545 cm from the antenna. Note that the EUT is exempt from FCC SAR evaluation because the output power is less than 25 mW.

Antenna	Type	Model	Connector	Gain
Integral Antenna	N/A	N/A	N/A	N/A

Pol	Channel	Frequency (MHz)	Power (dBm)	Limit (dBm)	EIRP (dBm)	EIRP Limit (dBm)
V	11	2405	-18.38	30.0	-16.23	36.0
V	17	2435	-17.32	30.0	-15.17	36.0
V	26	2480	-18.01	30.0	-17.86	36.0
H	11	2405	-18.94	30.0	-16.79	36.0
H	17	2435	-17.50	30.0	-15.45	36.0
H	26	2480	-16.42	30.0	-14.27	36.0







6.2 Test: Occupied Bandwidth

Test Standard: FCC 15.247(a)(2), RSS-210 A8.2

Test Results: Pass

Test Environment:

Environmental Conditions During Testing:	Humidity (%):	N/A	Pressure (hPa):	N/A	Ambient (°C):	N/A
Pretest Verification Performed	N/A		Equipment under Test:	Mini Tag		

Maximum Test Parameters: The 6 dB bandwidth of the Radio Module must be at least 500 kHz.

Test Equipment Used:

Equip. ID	Description	Manufacturer	Model	Serial Number	Cal Date	Cal Due
77	EMI Receiver	R & S	ES17	100044	12/29/06	12/29/07
192	Handheld Manometer	Omega	HHP-102F	19.99/29.0 PSIA	03/03/07	03/03/08
260	Humidity Temperature	Extech	445580	17-260	12/01/06	12/01/07
30	DMM	Fluke	8060A	6191012	02/08/07	02/08/08
82	Bi-ConiLog Antenna	Schaffner	CBL6112B	2726	06/24/07	06/24/08
128	RF Cable	Custom made	#1	none	07/26/07	07/26/08
131	RF Cable	Custom made	#4	none	07/26/07	07/26/08
271	Horn Antenna	A H Systems	SAS-571	787	02/24/07	02/24/08
101	EMI Receiver	Agilent	E7405A	US40240235	12/20/06	12/20/07

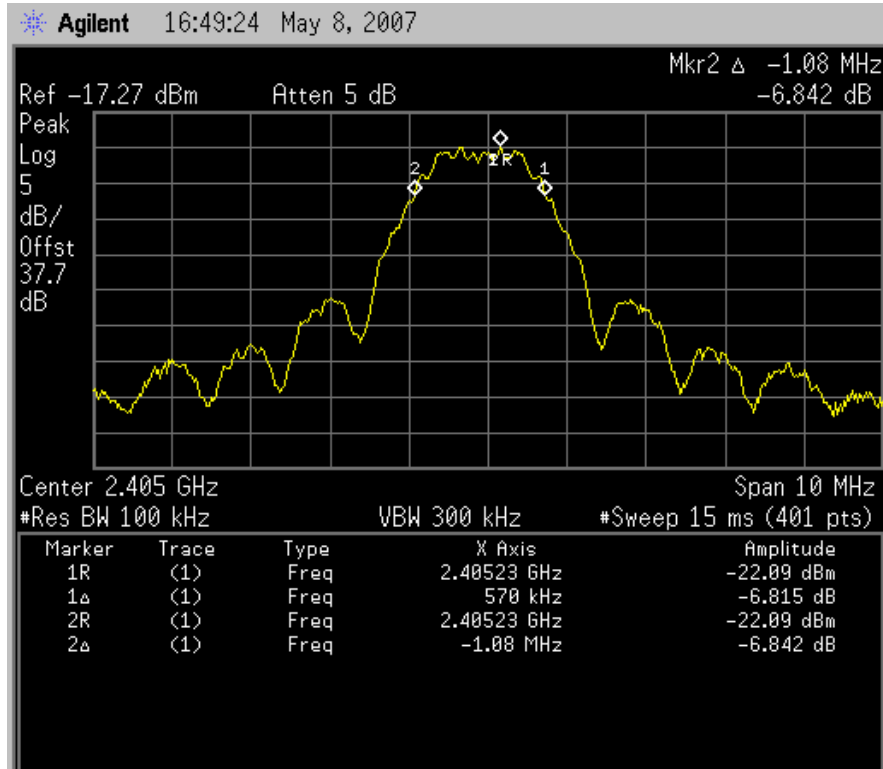
Test Results:

Notes: There is no limit on the 20 dB bandwidth; it is simply included for informational purposes. The 20 dB bandwidth is referenced to the actual RF output power.

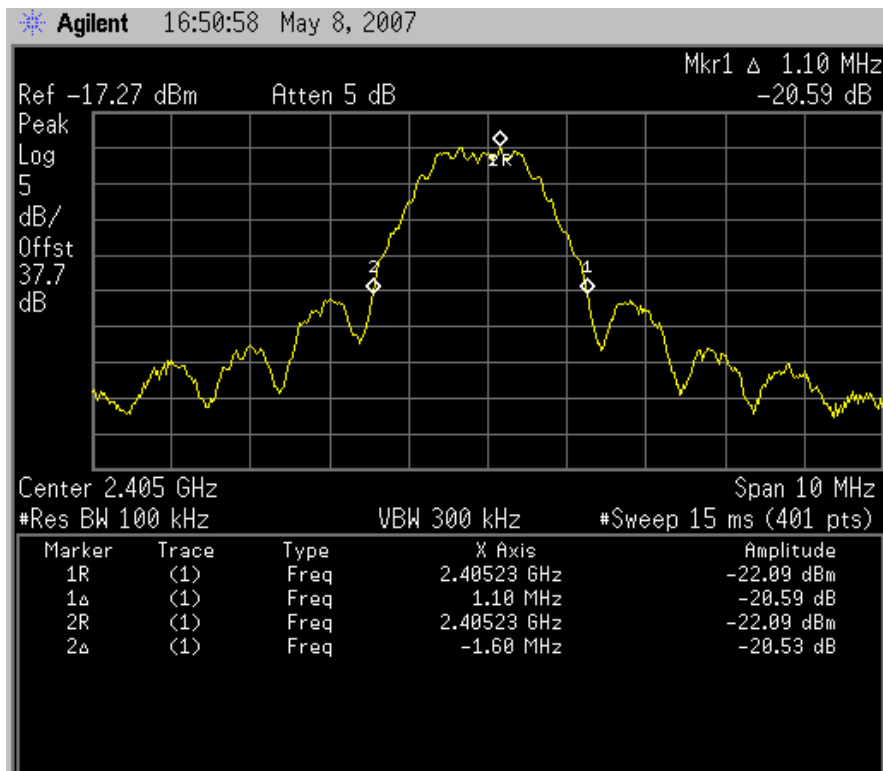
Channel	Frequency	6 dB Bandwidth
11	2405 MHz	1.65 MHz
17	2435 MHz	1.65 MHz
26	2480 MHz	1.65 MHz

Channel	Frequency	20 dB Bandwidth
11	2405 MHz	2.70 MHz
17	2435 MHz	2.70 MHz
26	2480 MHz	2.73 MHz

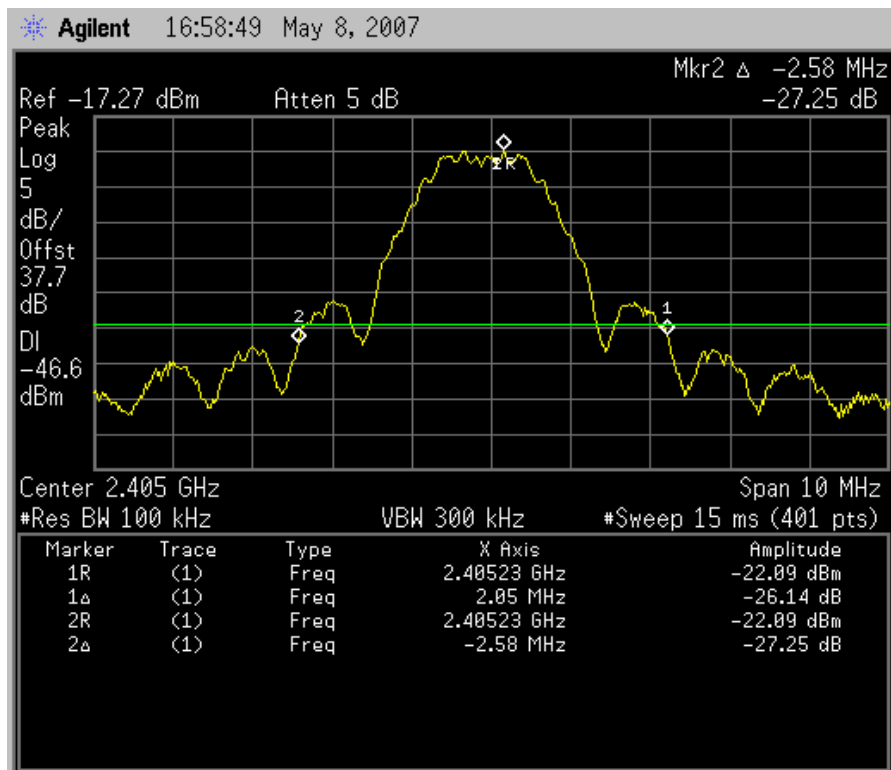
Channel	Frequency	26 dB Bandwidth
11	2405 MHz	5.63 MHz
17	2435 MHz	4.62 MHz
26	2480 MHz	6.63 MHz



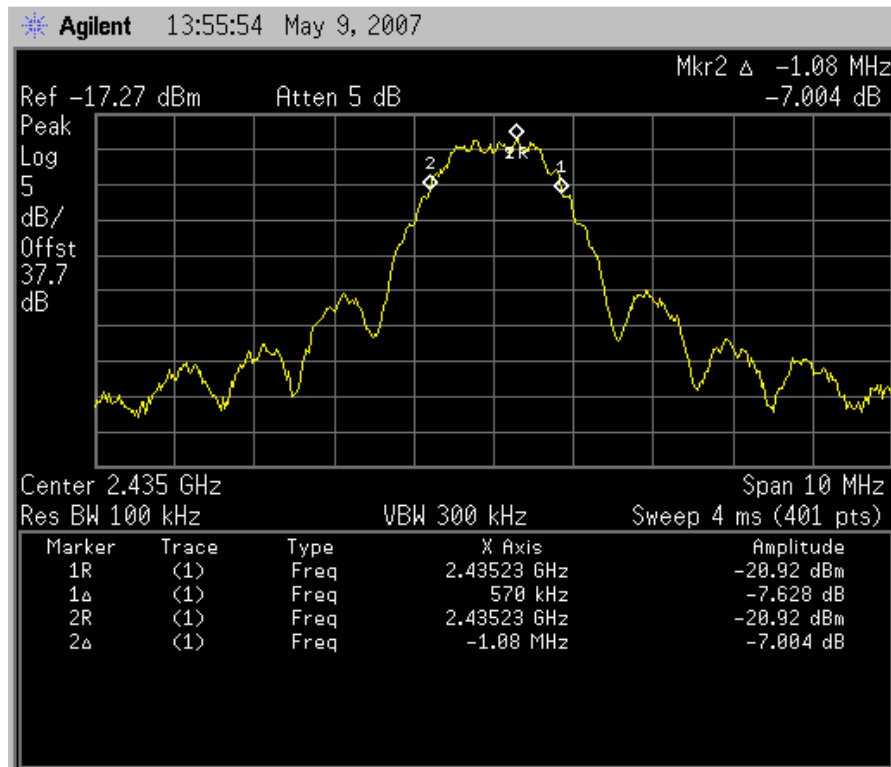
Channel 11: 6dB Bandwidth



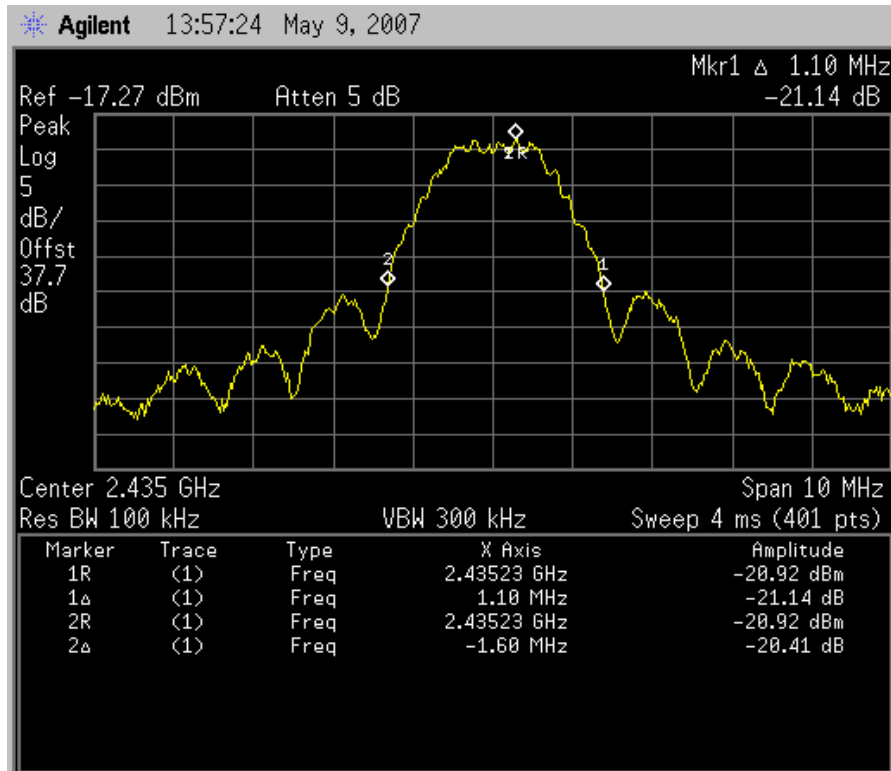
Channel 11: 20 dB Bandwidth



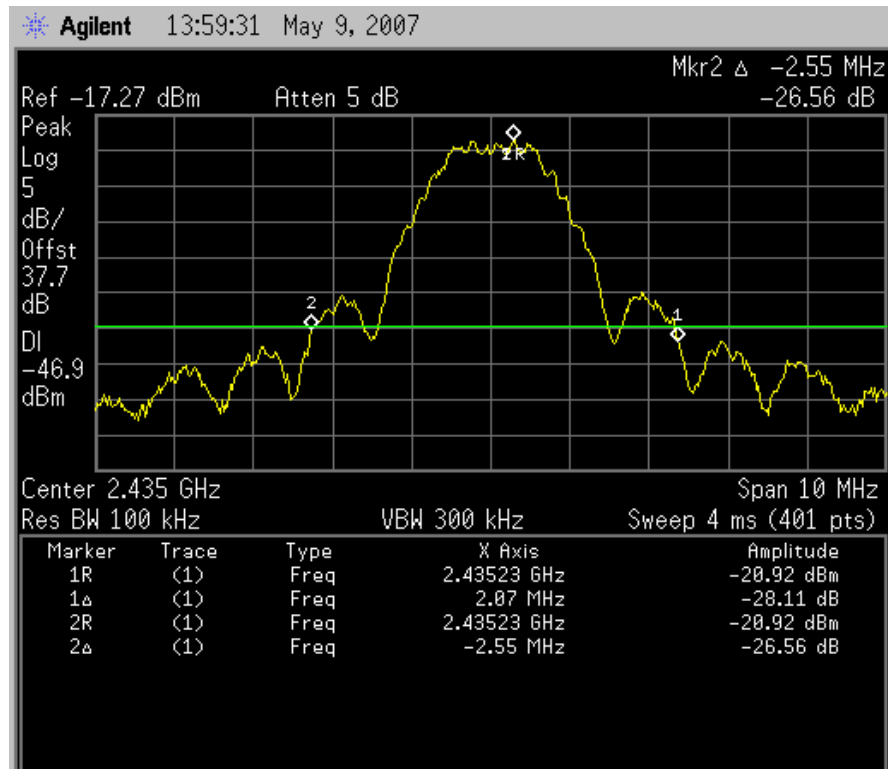
Channel 11: 26 dB Bandwidth



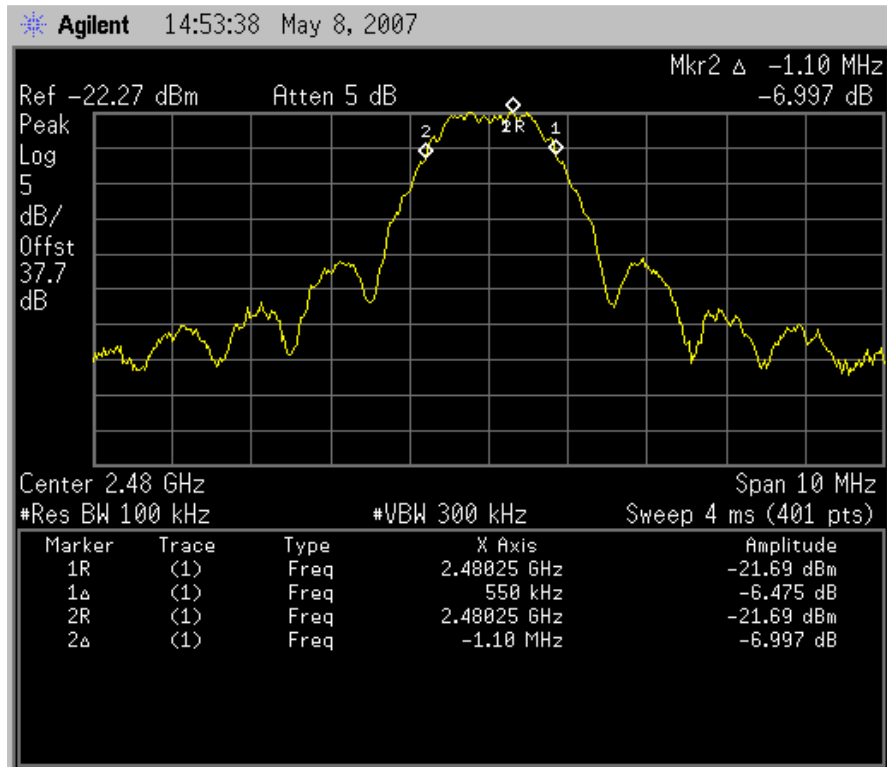
Channel 17: 6 dB Bandwidth



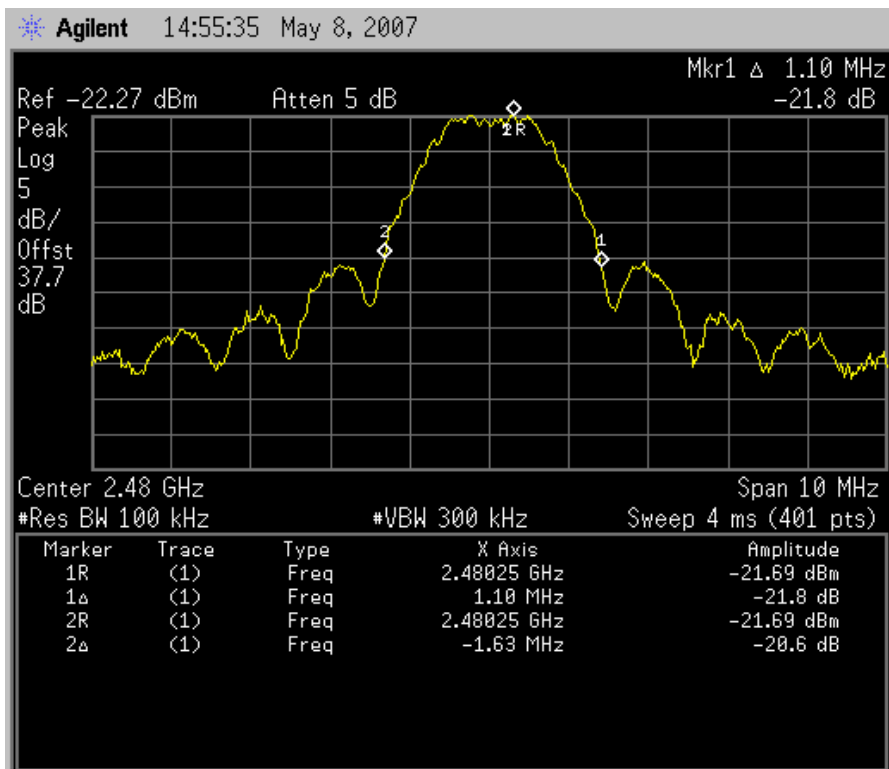
Channel 17: 20 dB Bandwidth



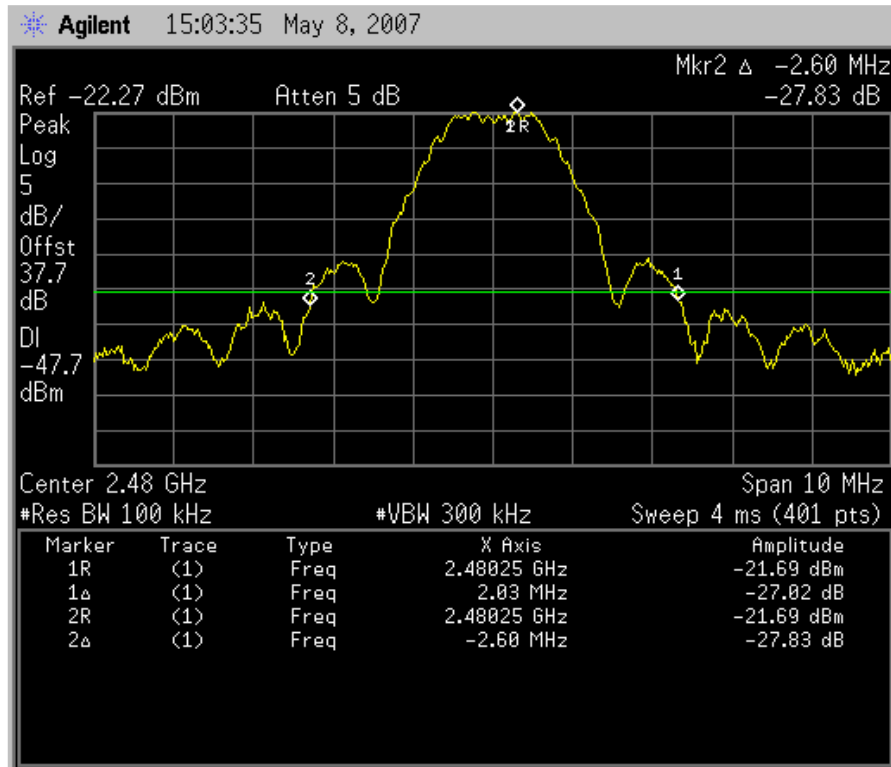
Channel 17: 26 dB Bandwidth



Channel 26: 6 dB Bandwidth



Channel 26: 20 dB Bandwidth



Channel 26: 26 dB Bandwidth

6.3 Test: Radiated Spurious Emissions

Test Standard: FCC 15.205, 15.209, 15.247(d), 15.109, RSS-210 2.2, 2.7, A8.5, ICES-003

Test Results: Pass

Test Environment:

Environmental Conditions During Testing:	Humidity (%):	See Tables	Pressure (hPa):	See Tables	Ambient (°C):	See Tables
Pretest Verification Performed	N/A		Equipment under Test:	Mini Tag		

Maximum Test Parameters: The spurious emissions of the Radio Module must be attenuated below the level of the fundamental by at least 20 dBc. Emissions which fall in the restricted bands must meet the general limits of 15.209 and RSS-210 2.7 Table 2. The spurious emissions of the EUT must not exceed the limits of 15.109 Class A and ICES-003 Class A.

Test Equipment Used:

Equip. ID	Description	Manufacturer	Model	Serial Number	Cal Date	Cal Due
77	EMI Receiver	R & S	ES17	100044	12/29/06	12/29/07
192	Handheld Manometer	Omega	HHP-102F	19.99/29.0 PSIA	03/03/07	03/03/08
260	Humidity Temperature	Extech	445580	17-260	12/01/06	12/01/07
30	DMM	Fluke	8060A	6191012	02/08/07	02/08/08
82	Bi-ConiLog Antenna	Schaffner	CBL6112B	2726	06/24/07	06/24/08
128	RF Cable	Custom made	#1	none	07/26/07	07/26/08
131	RF Cable	Custom made	#4	none	07/26/07	07/26/08
271	Horn Antenna	A H Systems	SAS-571	787	02/24/07	02/24/08
101	EMI Receiver	Agilent	E7405A	US40240235	12/20/06	12/20/07
222	Pre-Amp	Miteq	AMF-4D-001180-24-10P	1020106	08/01/06	08/01/07
129	RF Cable	Custom made	#2	None	08/01/06	08/01/07

Test Results:

Notes: Above 1 GHz, the emissions shown compare the peak values with the average limits in order to demonstrate overall compliance. The range up to 26 GHz was investigated using the SHF equipment listed in the tables, but only the emissions shown were observed. In cases where no emissions were observed, the noise floor was verified to be under the limit.

Notes: The Mini Tag was tested as a Class A digital device to FCC Part 15 Subpart B and ICES-003, Intentional transmission was tested as a transmitter to the requirements of FCC Part 15 Subpart C 15.247 and RSS-210 Annex 8. Channels selected for test were:

Channel 11: 2405 MHz,

Channel 17: 2435 MHz,

Channel 26: 2480 MHz

Standard: FCC 15.109
 Test: Radiated Emissions
 Frequency Range: 30 MHz to 1000 MHz
 Limits: Class A
 Measurement Distance: 3 meters

Measurement Uncertainty: 3.6 dB
 Temperature: 24.9 °C
 Relative Humidity: 47 %Rh
 Atmospheric Pressure: 996 mbar

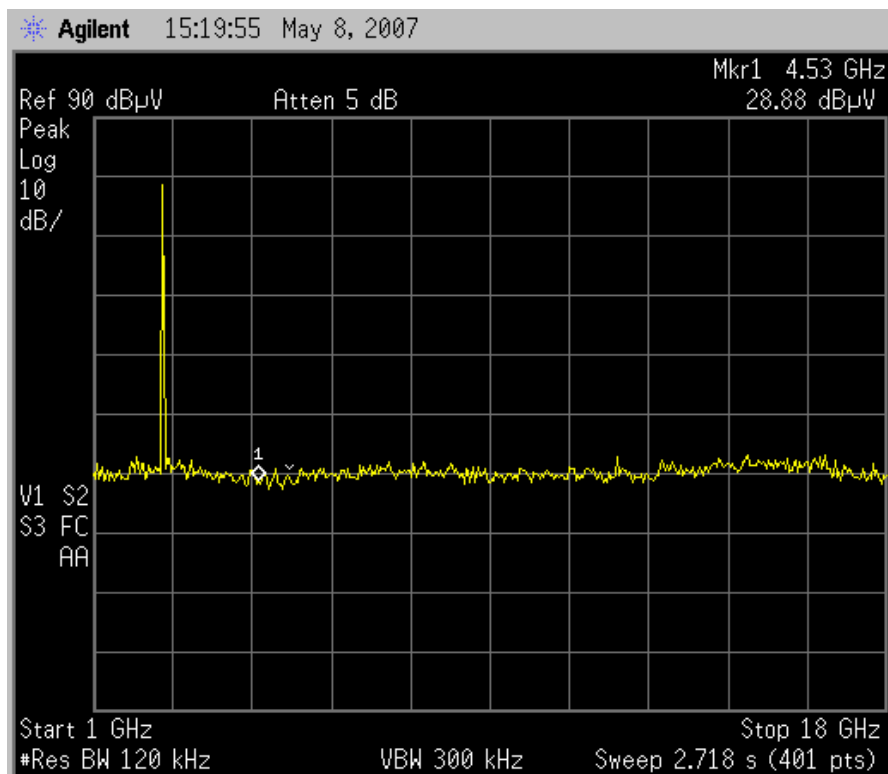
EUT Configuration: Mini Tag (Measured as complete System with Master Radio (AC Adapter) and Beacon)

Radiated Disturbance

Polarity	Frequency	Ant	Azimuth	QP	LIMIT	Margin
H	960.145	311.00	9.00	35.37	57.46	-22.09
H	936.227	363.00	21.00	35.04	57.46	-22.42
H	99.505	290.00	242.00	34.67	50.46	-15.79
H	97.147	209.00	292.00	26.99	50.46	-23.47
H	97.099	357.00	256.00	29.10	50.46	-21.36
H	69.05	308.00	108.00	20.57	50.46	-29.89
H	30.997	305.00	154.00	25.85	50.46	-24.61
V	31.356	123.00	183.00	31.45	50.46	-19.01
V	32.198	117.00	345.00	36.17	50.46	-14.29
V	32.775	133.00	339.00	35.56	50.46	-14.90
V	33.336	124.00	340.00	37.57	50.46	-12.89
V	33.349	117.00	340.00	37.79	50.46	-12.67
V	39.408	261.00	294.00	39.05	50.46	-11.41
V	39.435	314.00	320.00	41.15	50.46	-9.31
V	40.297	349.00	217.00	39.05	50.46	-11.41
V	40.300	346.00	289.00	34.53	50.46	-15.93
V	954.927	197.00	27.00	36.39	57.46	-21.07

Polarity	Frequency GHz	Ant Height cm	Azimuth deg.	Peak dBuV/m	LIMIT dBuV/m	Margin dB
V	2.40545	100	0	88.74	---	---
V	2.43448	100	0	89.94	---	---
V	2.48050	100	0	89.12	---	---
H	2.40545	100	0	87.97	---	---
H	2.43448	100	0	89.53	---	---
H	2.48050	100	0	88.91	---	---

Polarity	Frequency GHz	Ant Height cm	Azimuth deg.	AVG dBuV/m	LIMIT dBuV/m	Margin dB
V	4.81090	100	0	40.23	54.00	-13.77
V	4.86896	100	0	41.56	54.00	-12.44
V	4.96100	100	0	42.91	54.00	-11.09
V	7.21635	100	0	39.95	54.00	-14.05
V	7.30344	100	0	41.67	54.00	-12.33
V	7.44150	100	0	43.01	54.00	-10.99



Pre-Scan

6.3.1 Setup Photos





Test Results: Pass

6.4 Test: Peak Power Spectral Density

Test Standard: FCC 15.247(e)(2), RSS-210 A8.2

Test Environment:

Environmental Conditions During Testing:	Humidity (%):	N/A	Pressure (hPa):	N/A	Ambient (°C):	N/A
Pretest Verification Performed	N/A		Equipment under Test:	Mini Tag		

Maximum Test Parameters: The peak power spectral density of the Radio Module must not exceed 8 dBm / 3 kHz.

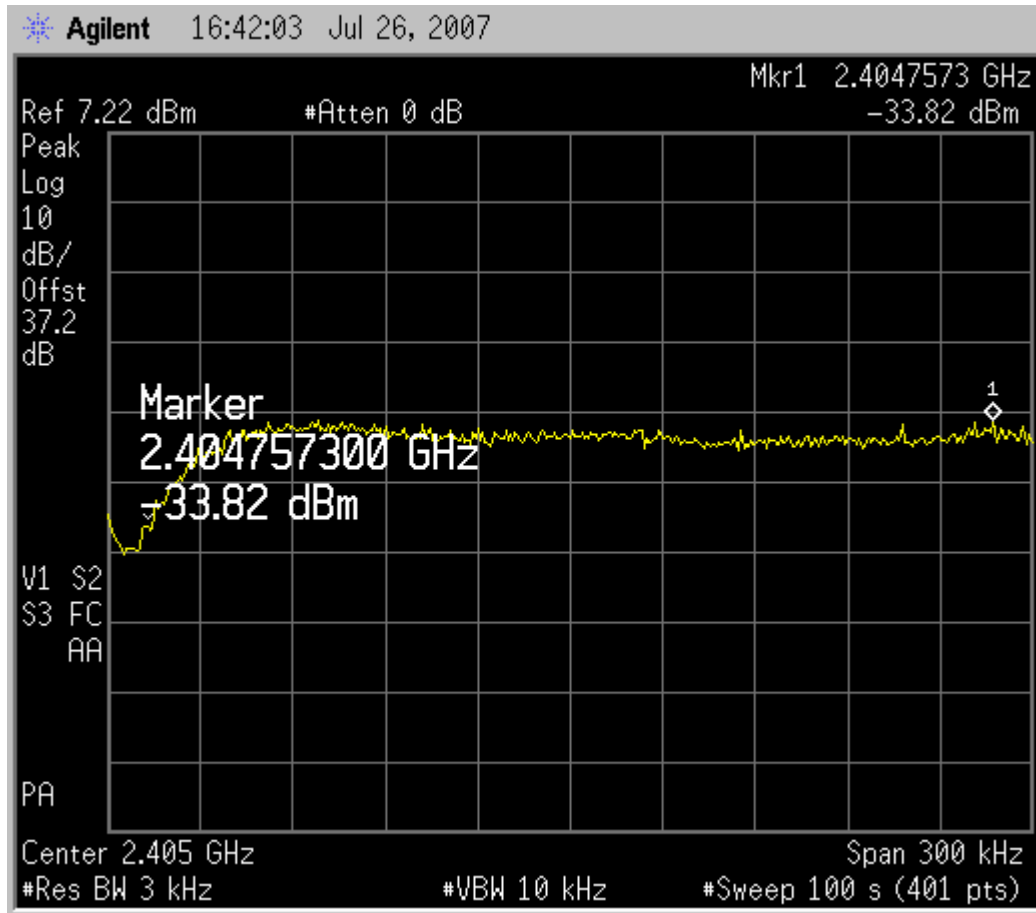
Test Equipment Used:

Equip. ID	Description	Manufacturer	Model	Serial Number	Cal Date	Cal Due
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260	Humidity Temperature	Extech	445580	17-260	12/01/06	12/01/07
30	DMM	Fluke	8060A	6191012	02/08/07	02/08/08
82	Bi-ConiLog Antenna	Schaffner	CBL6112B	2726	06/24/07	06/24/08
128	RF Cable	Custom made	#1	none	07/26/07	07/26/08
131	RF Cable	Custom made	#4	none	07/26/07	07/26/08
271	Horn Antenna	A H Systems	SAS-571	787	02/24/07	02/24/08
101	EMI Receiver	Agilent	E7405A	US40240235	12/20/06	12/20/07
222	Pre-Amp	Miteq	AMF-4D-001180-24-10P	1020106	08/01/06	08/01/07

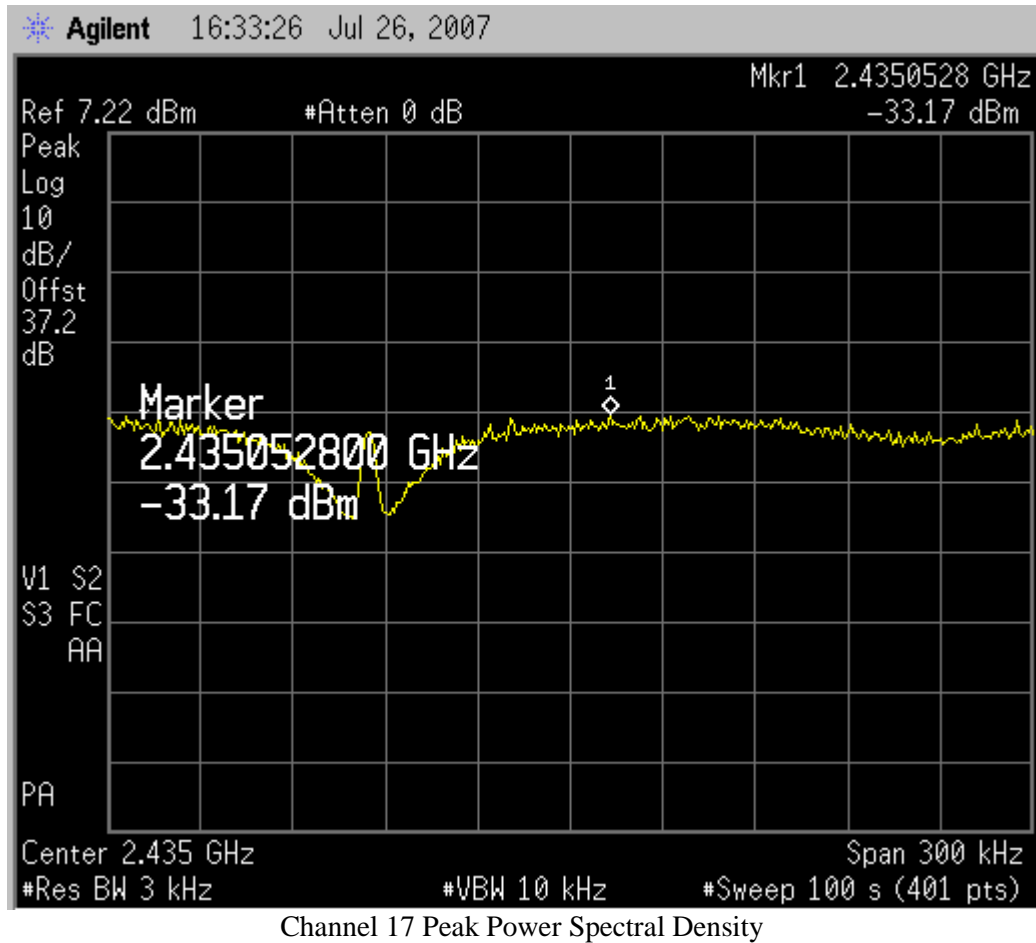
Test Results: Pass

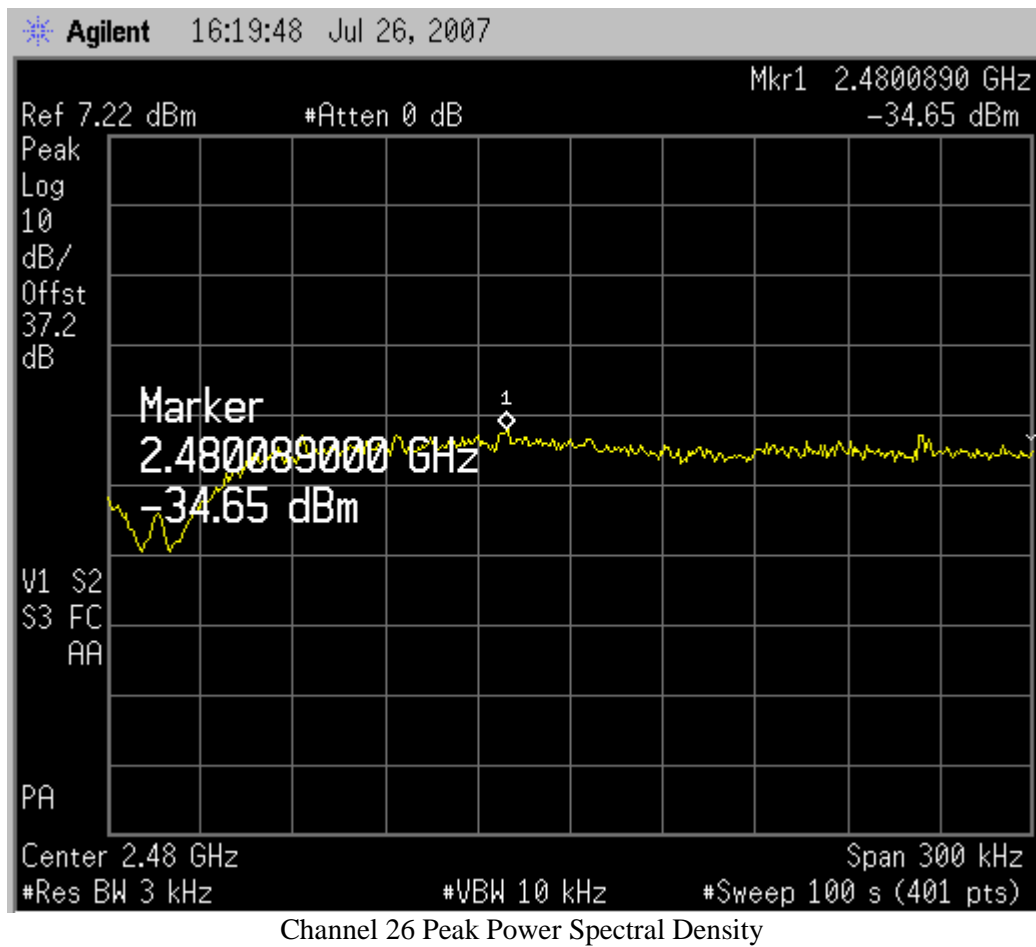
Notes: The cable loss was compensated for in the spectrum analyzer.

Channel	Frequency	Peak Power Spectral Density
11	2405 MHz	-33.82 dBm
17	2435 MHz	-33.17 dBm
26	2480 MHz	-34.65 dBm



Channel 11 Peak Power Spectral Density





Test Results: Pass

6.5 Test: Band Edge Compliance

Test Standard: FCC 15.215, RSS-210 2.1, A8.5

Test Environment:

Environmental Conditions During Testing:	Humidity (%):	N/A	Pressure (hPa):	N/A	Ambient (°C):	N/A
Pretest Verification Performed	N/A		Equipment under Test:	Mini Tag		

Maximum Test Parameters: The fundamental frequency of the Radio Module must stay within the assigned frequency band. The emissions beyond band edges must be at least 20 dB below the fundamental and shall meet the requirements of FCC 15.209 limits for out of band emissions.

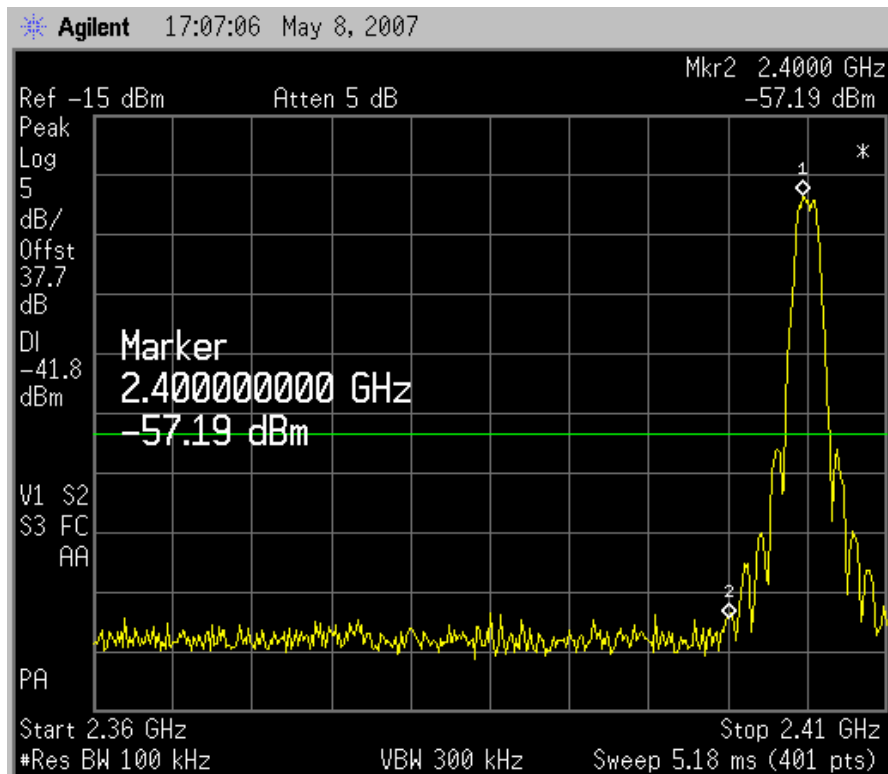
Test Equipment Used:

Equip. ID	Description	Manufacturer	Model	Serial Number	Cal Date	Cal Due
77	EMI Receiver	R & S	ES17	100044	12/29/06	12/29/07
192	Handheld Manometer	Omega	HHP-102F	19.99/29.0 PSIA	03/03/07	03/03/08
260	Humidity Temperature	Extech	445580	17-260	12/01/06	12/01/07
30	DMM	Fluke	8060A	6191012	02/08/07	02/08/08
82	Bi-ConiLog Antenna	Schaffner	CBL6112B	2726	06/24/07	06/24/08
128	RF Cable	Custom made	#1	none	07/26/07	07/26/08
131	RF Cable	Custom made	#4	none	07/26/07	07/26/08
271	Horn Antenna	A H Systems	SAS-571	787	02/24/07	02/24/08
101	EMI Receiver	Agilent	E7405A	US40240235	12/20/06	12/20/07
222	Pre-Amp	Miteq	AMF-4D-001180-24-10P	1020106	08/01/06	08/01/07

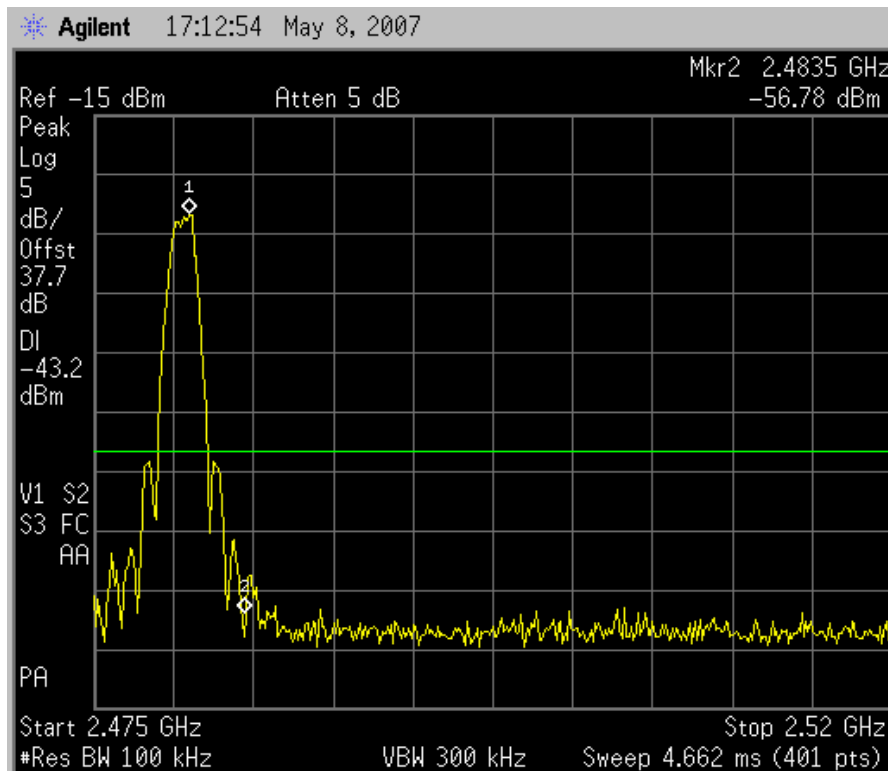
Test Results:

Notes: The cable/Antenna loss was compensated for in the spectrum analyzer. A 100 kHz bandwidth and peak detector was used, and a marker was placed at the peak fundamental level. A marker was placed at the band edge at the highest signal outside the band edge.

The display line shows the level 20 dB below the fundamental in the following graphs.



Channel 11: Low Band Edge Compliance



Channel 26: High Band Edge Compliance