731 Enterprise Drive
Lexington, KY 40510

Telephone: 859-226-1000
Facsimile: 859-226-1040
www.intertek-etlsemko.com

TEST REPORT

Report Number: 100596650LEX-001
Project Number: G100596650

Report Issue Date: 2/21/2012

Product Name: Appliance Communication Module (ACM)
Model Number: DRM1E3000T0
FCCID: ZKJ-DSM03R01
FCC Standards: Title 47 CFR Part 15 Subpart B and C

Tested by:
Intertek Testing Services NA, Inc.
731 Enterprise Drive
Lexington, KY 40510

Client:
GE Appliance & Lighting
AP35-1403-02
Louisville, KY 40225

Report prepared by
Bryan Taylor, Team Leader

Report reviewed by
James Sudduth, Assistant Chief Engineer

TABLE OF CONTENTS

1 Introduction and Conclusion

The tests indicated in section 2 were performed on the product constructed as described in Section 3. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test method, a list of the actual test equipment used, documentation photos, results and raw data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested complied with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested.

All testing was performed at the Intertek office located at 731 Enterprise Drive, Lexington Kentucky, 40510. The radiated emission test site is a 10-meter semi-anechoic chamber. The chamber meets the characteristics of CISPR 16-1 and ANSI C63.4. For measurements, a remotely controlled flush-mount metal-top turntable is used to rotate the EUT a full 360 degrees. A remote controlled non-conductive antenna mast is used to scan the antenna height from one to four meters. The test site is listed with the FCC under Registration Number 485103. The test site is listed with Industry Canada under Site Number IC 2042M-1.

2 Test Summary

Page	Test full name	FCC Reference	IC Reference	Result
6	Peak Conducted Power	§ 15.247(b)(3)(4)	RSS210 A8.4 (4)	Pass
7	Occupied Bandwidth	§ 15.247(a)(2)	RSS210 A8.2(A)	Pass
13	Conducted Spurious Emissions	§ 15.247(d)	RSS210 (A8.5)	Pass
18	Power Spectral Density	§ 15.247(e)	RSS210 A8.2(B)	Pass
22	Radiated Spurious Emissions (Transmitter)	§ 15.247(d), § 15.209, and § 15.205	RSS-210 (2.2)	Pass
31	Radiated Spurious Emissions (Receiver)	§ 15.109	RSS-Gen (7.2.3)	Pass
34	AC Powerline Conducted Emissions	§ 15.207	RSS-Gen (7.2.2)	Pass
37	Antenna Requirement per FCC Part 15.203	§ 15.203	RSS-Gen (7.1.4)	Pass

3 Description of Equipment Under Test

Equipment Under Test	
Manufacturer	GE Appliance & Lighting
Model Number	DRM1E3000T0
Serial Number	VV100918W
FCC Identifier	ZKJ-DSM03R01
Receive Date	12/7/2011
Test Start Date	12/7/2011
Test End Date	12/12/2011
Device Received Condition	Good
Test Sample Type	Production
Frequency Band	2405MHz – 2480MHz
Mode(s) of Operation	Zigbee
Modulation Type	QPSK
Transmission Control	Test Commands via Ember InSight Adapter
Maximum Output Power	21.2dBm (conducted output)
Test Channels	11, 19, 25, and 26 (reduced power band edge)
Antenna Type (15.203)	Internal PCB Antenna (0.5dBi Peak Gain)
Operating Voltage	115VAC/60Hz
Power Supply	AC Bel, Model: WAA019, Sn: V123400271

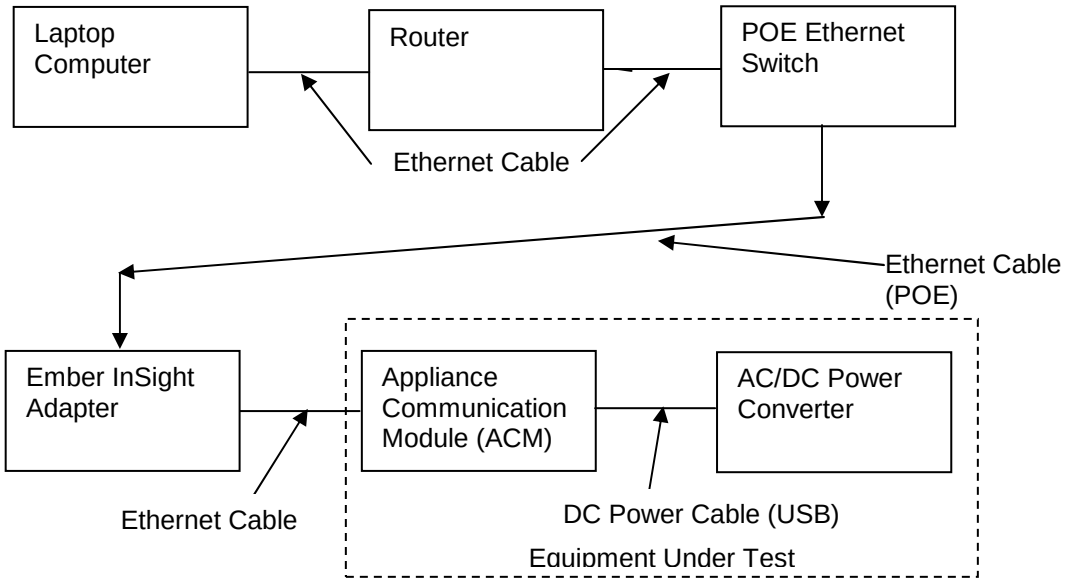
Description of Equipment Under Test
The DRM1E3000T0 a communication module which attaches externally to various appliances allowing the user to control certain features wirelessly.

Operating modes of the EUT:

No.	**Descriptions of EUT Exercising**
1	Transmitting on channels 11, 19, 25, and 26 (reduced power at band edge). For all other tests other than the band edge measurements, channel 25 was used as the highest channel as it had a higher output power.
2	Receive / idle mode

3.1 System setup including cable interconnection details, support equipment and simplified block diagram

3.2 EUT Block Diagram:



3.3 Cables Connected to Test Sample:

Cables					
Description	Length	Shielding	Ferrites	Connection	
				From	To
DC Power Cable (USB)	6ft	Yes	None	AC/DC Power Converter	DC Input to Test Sample
Ethernet Cable	50ft	None	None	Ethernet Port on Test Sample	Support Equipment

3.4 Support Equipment:

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
Programming Adapter	Ember	InSight	Not Labeled
Laptop Computer	Gateway	LT2802u	11906695725
Ethernet Switch	Netgear	FS108P	1DL2013D00C6F
Router	Cisco	E1000	CVN01K670165

4 Peak Conducted Power

4.1 Test Limits

§ 15.247(b)(3): For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.

§ 15.247(b)(4): The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

4.2 Test Procedure

ANSI C63.10: 2009 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

4.3 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
Spectrum Analyzer	3099	Rohde & Schwarz	FSP7	9/23/2011	9/23/2012

4.4 Results:

Channel Number	Frequency (MHz)	Peak Conducted Power (dBm)	Peak Conducted Power Limit (dBm)	Margin (dB)	Result
11	2405	21.1dBm	30	-8.9dBm	Pass
19	2445	21.2dBm	30	-8.8dBm	Pass
25	2475	18.7dBm	30	-11.3	Pass

5 Occupied Bandwidth

5.1 Test Limits

§ 15.247(a)(2): For digital modulation systems, the minimum 6dB bandwidth shall be at least 500kHz.

5.2 Test Procedure

ANSI C63.10: 2009 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

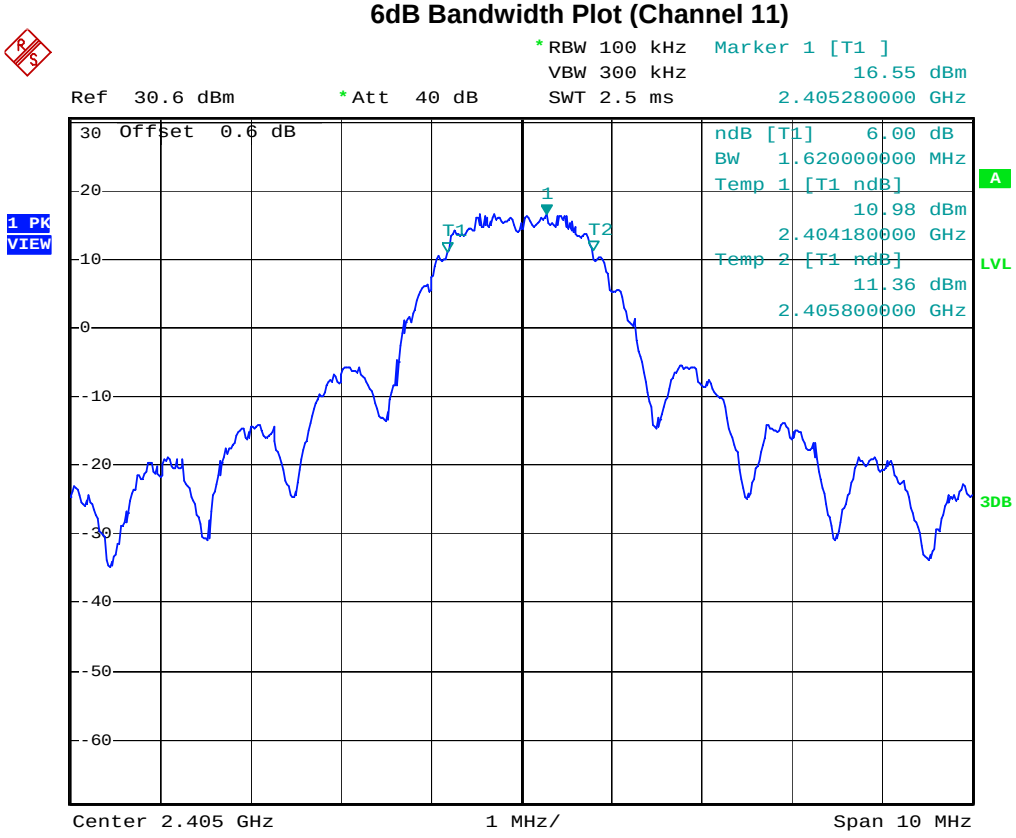
5.3 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
Spectrum Analyzer	3099	Rohde & Schwarz	FSP7	9/23/2011	9/23/2012

5.4 Results:

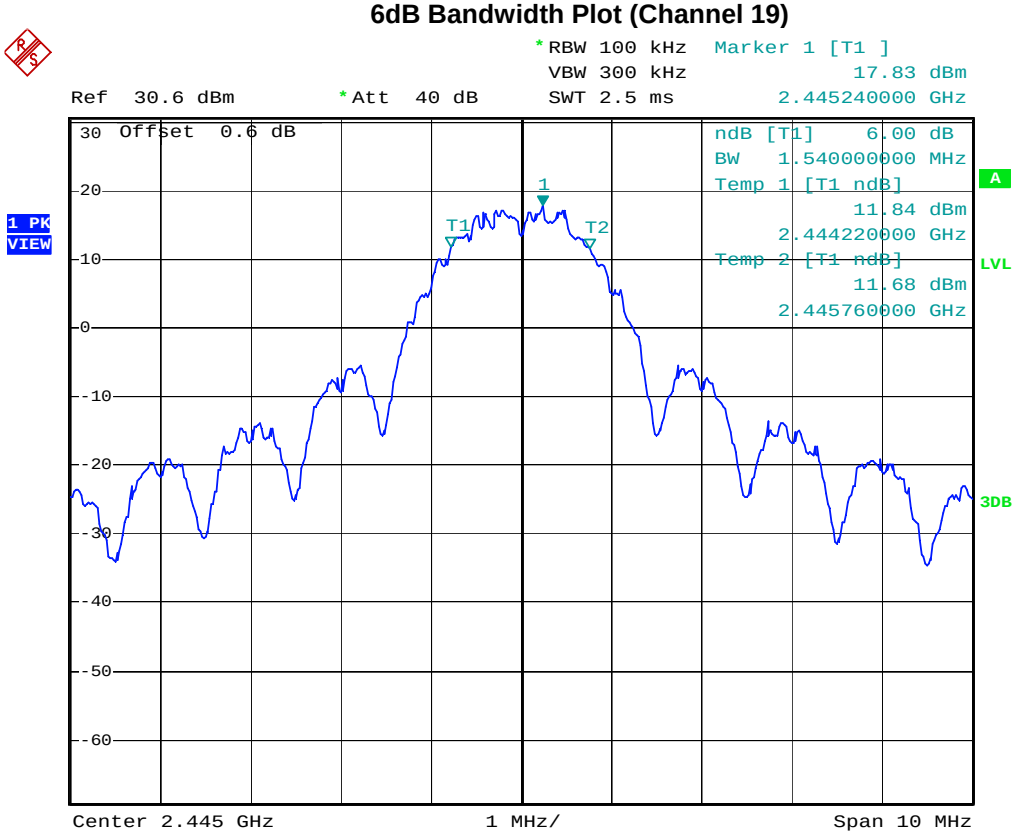
Channel Number	Frequency (MHz)	6dB Bandwidth	99% Power Bandwidth	Result
11	2405	1.62MHz	---	Pass
19	2445	1.54MHz	2.42	Pass
25	2475	1.62MHz	---	Pass

6dB Bandwidth Plot (Channel 11)



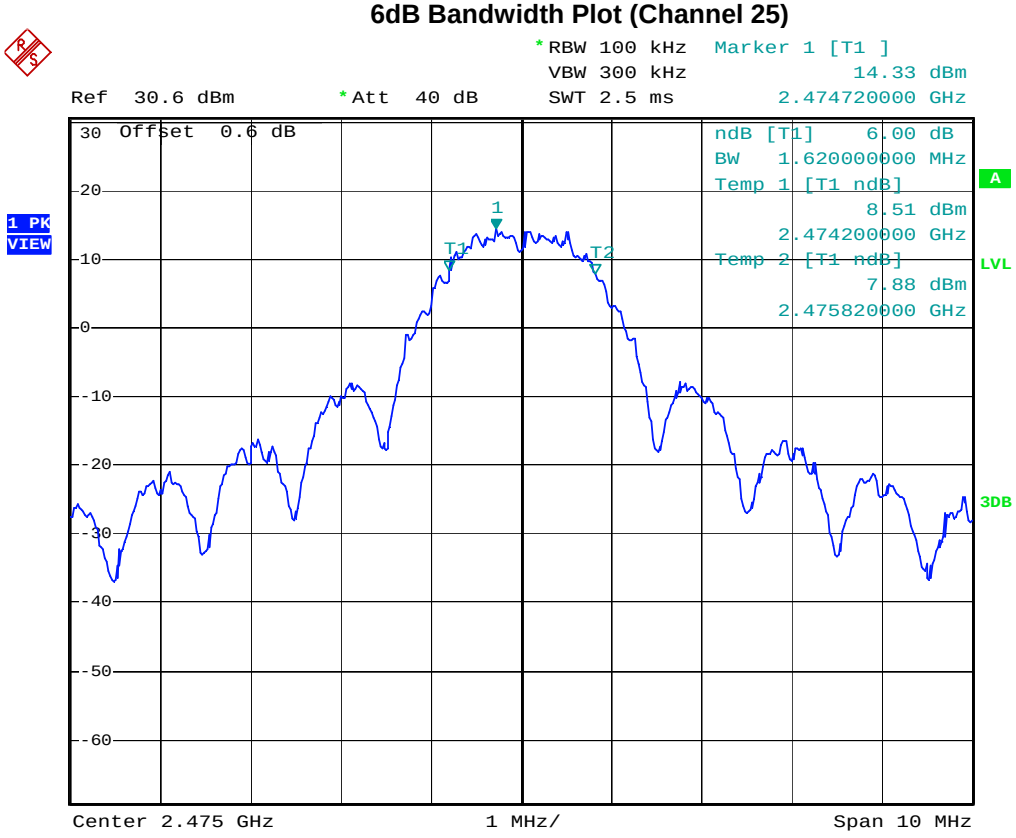
Date: 12.DEC.2011 15:30:09

6dB Bandwidth Plot (Channel 19)



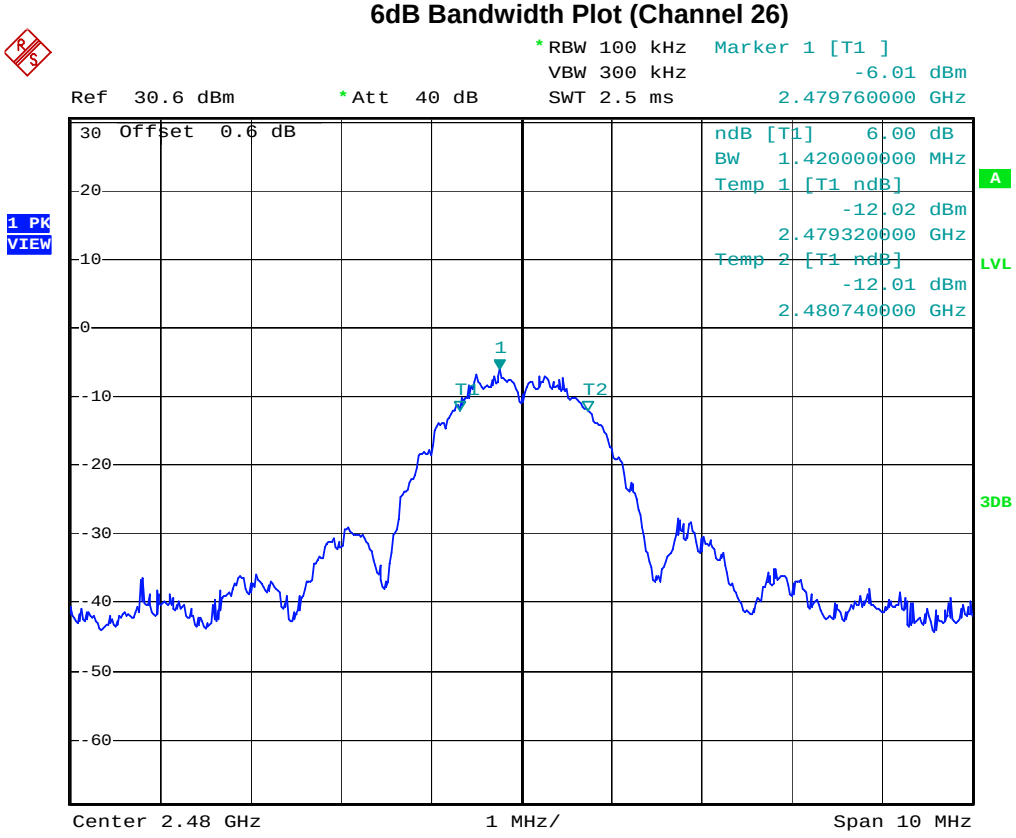
Date: 12.DEC.2011 15:31:47

6dB Bandwidth Plot (Channel 25)



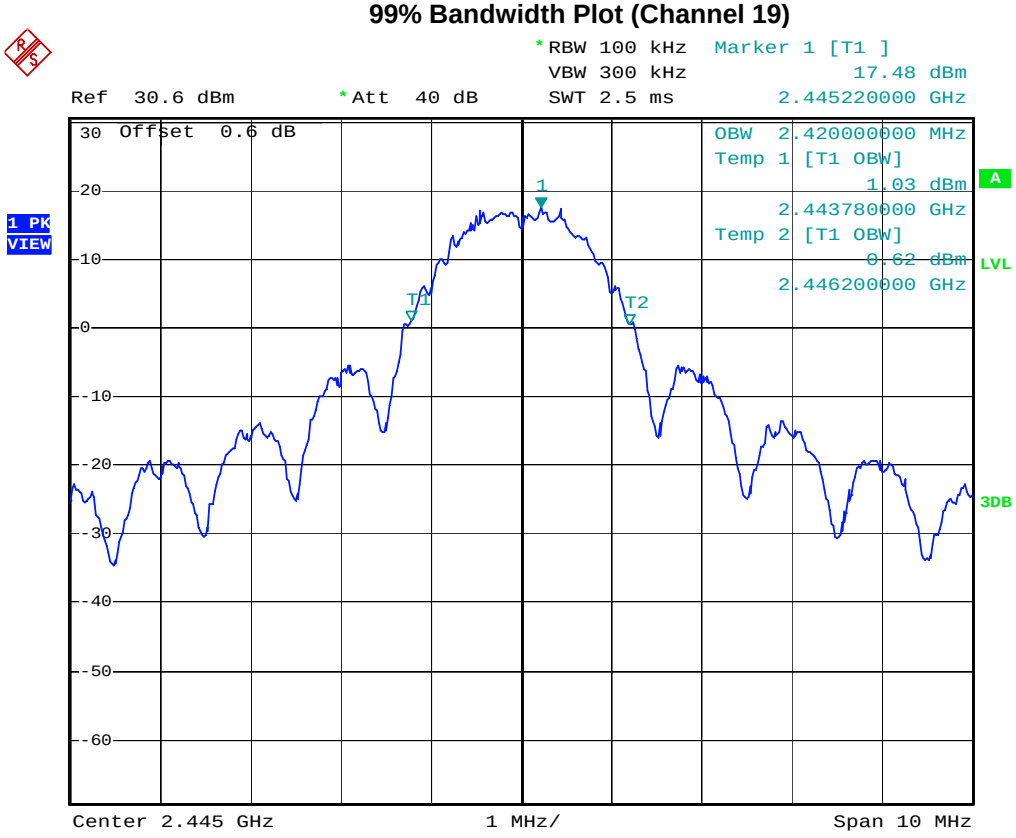
Date: 12.DEC.2011 15:33:26

6dB Bandwidth Plot (Channel 26)



Date: 12.DEC.2011 15:39:13

99% Bandwidth Plot (Channel 19)



Date: 12.DEC.2011 15:48:57

6 Conducted Spurious Emissions

6.1 Test Limits

§ 15.247(d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

6.2 Test Procedure

ANSI C63.10: 2009 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

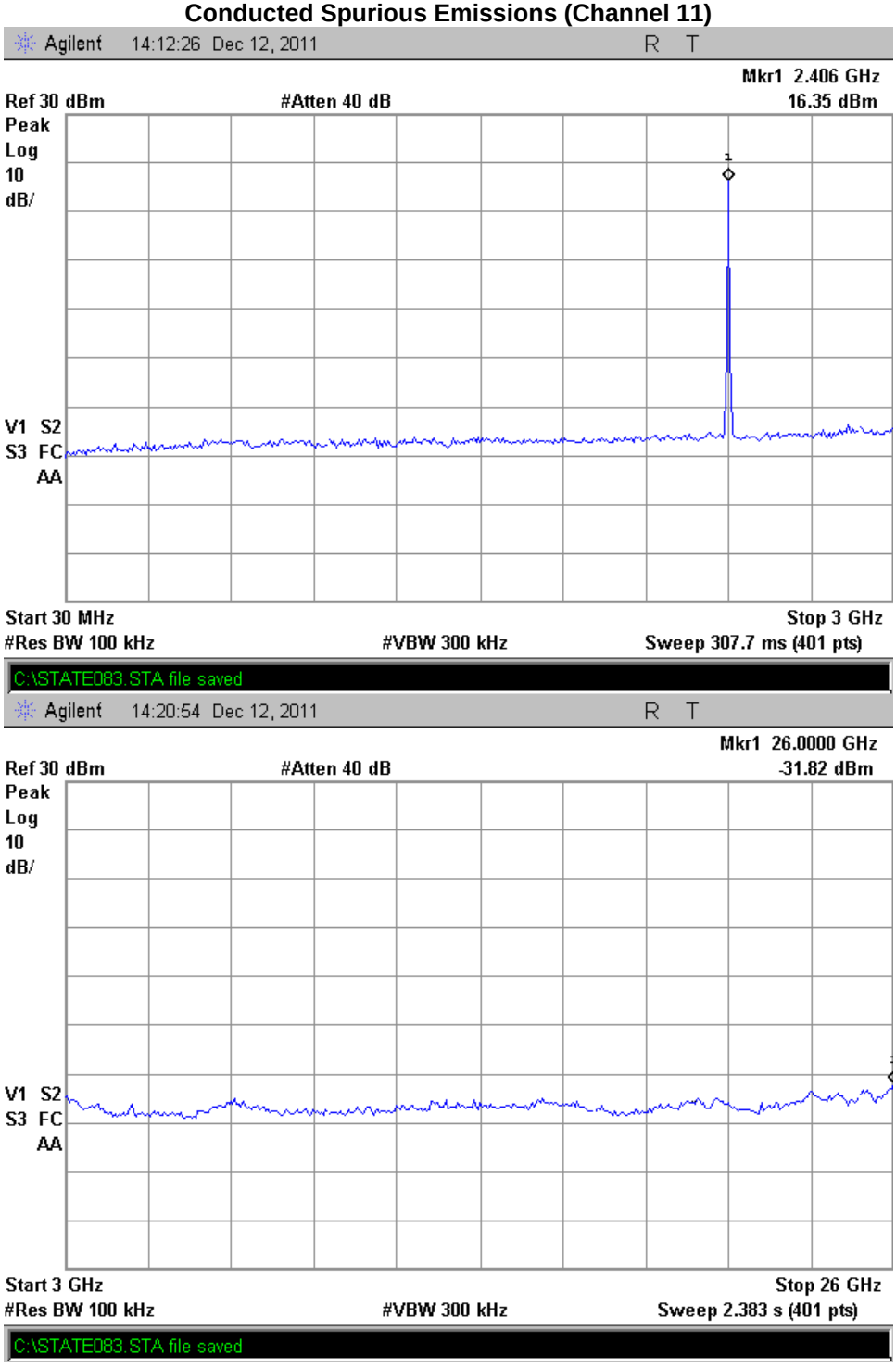
6.3 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMC Analyzer	2142	HP	E7405	9/23/2011	9/23/2012

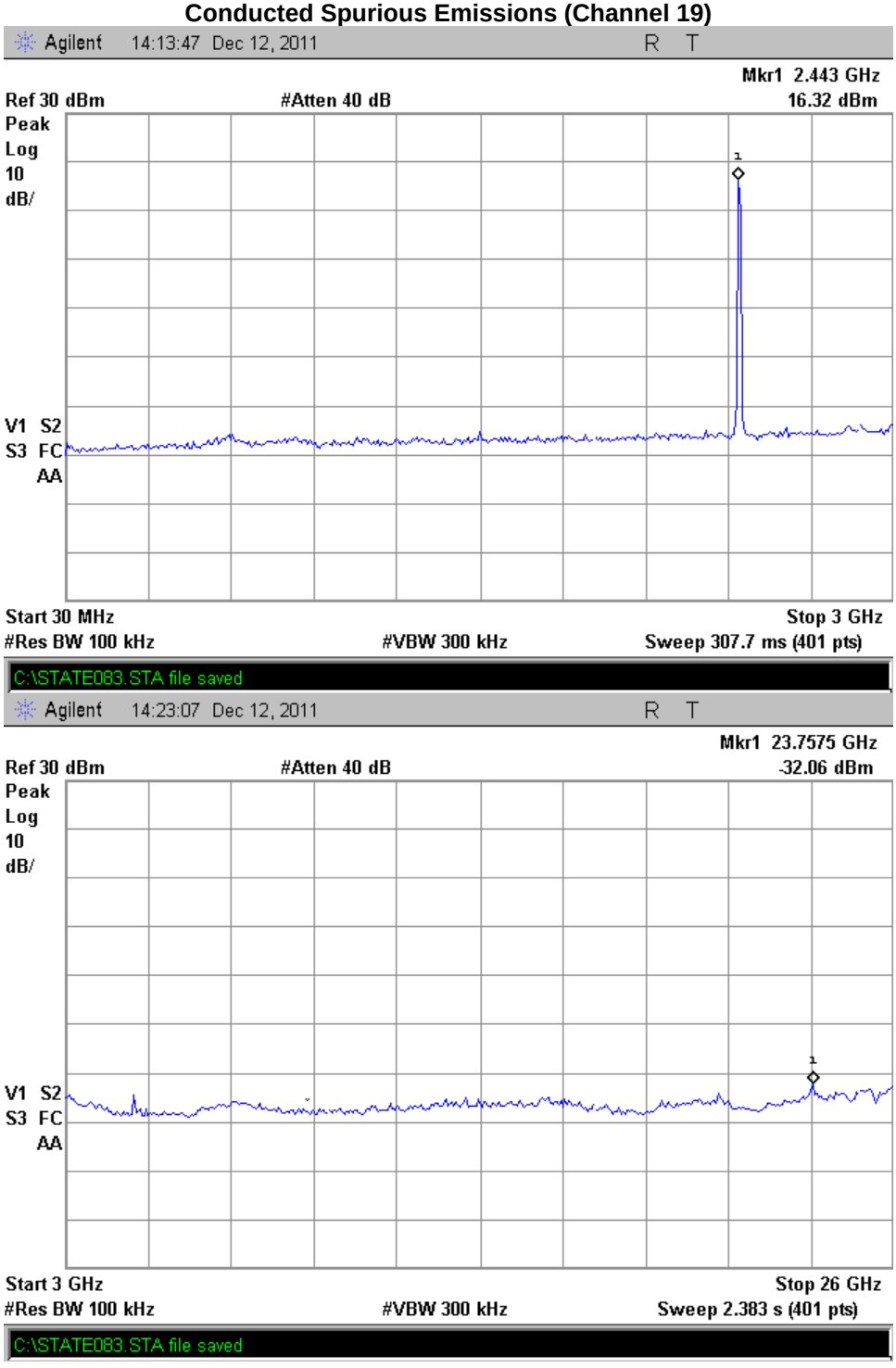
6.4 Results:

The following plots show that there are no conducted spurious emissions exceeding the 20dB down criteria.

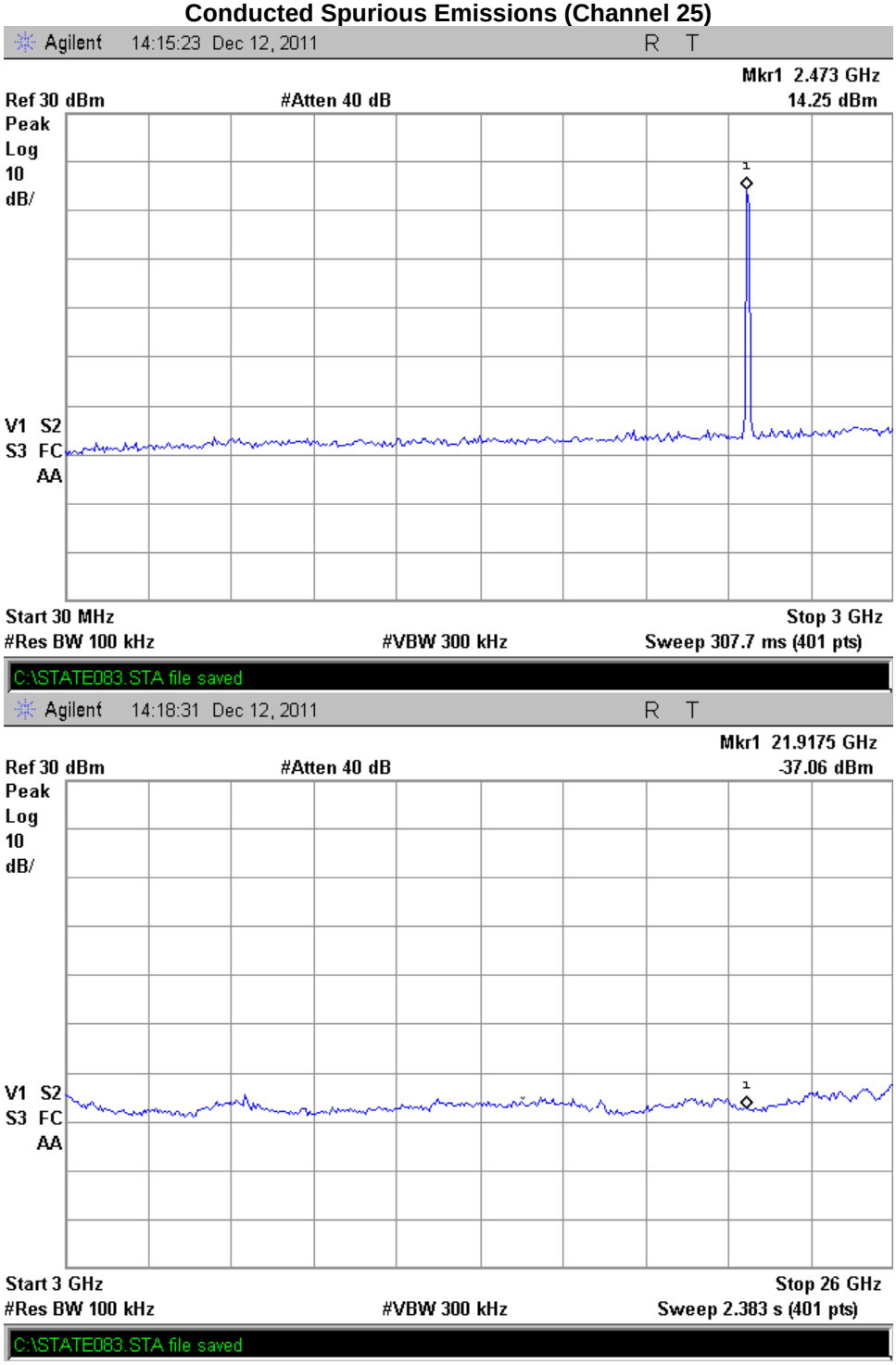
Conducted Spurious Emissions (Channel 11)



Conducted Spurious Emissions (Channel 19)



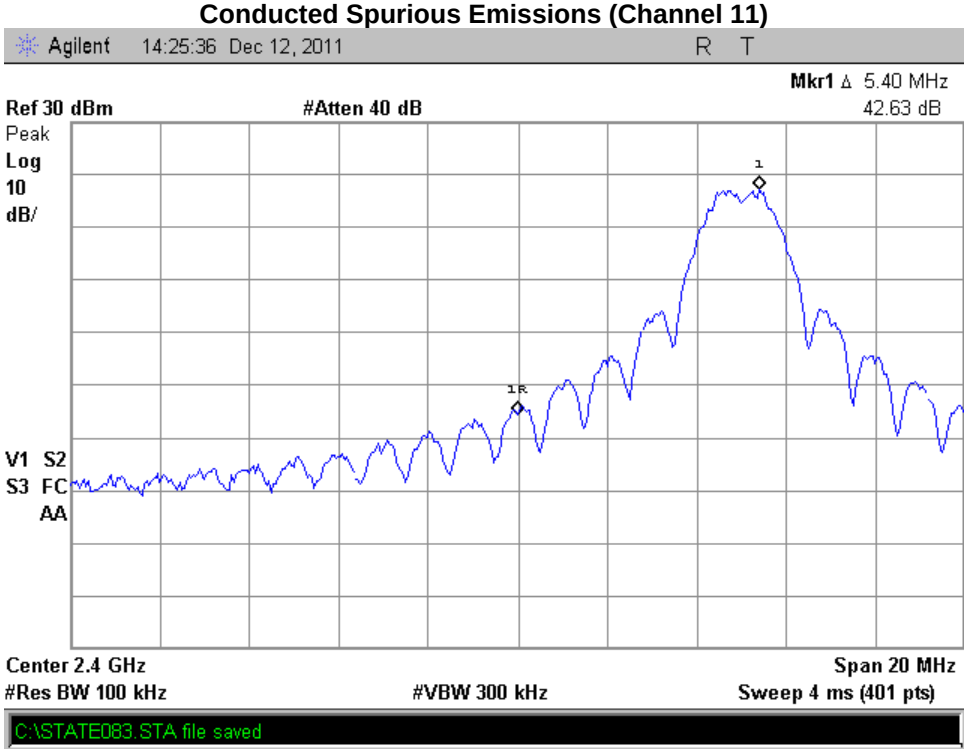
Conducted Spurious Emissions (Channel 25)



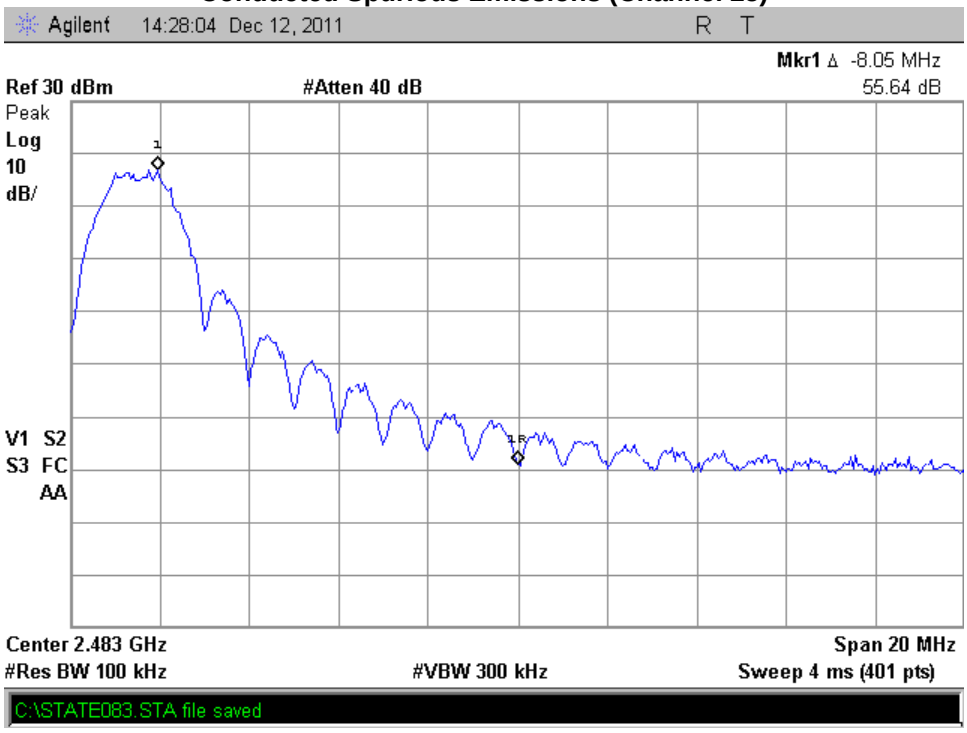
Conducted Spurious Emissions Close to Fundamental:

The following plots show that the conducted spurious emissions close to the fundamental signal are at least 20dB down.

Conducted Spurious Emissions (Channel 11)



Conducted Spurious Emissions (Channel 25)



7 Power Spectral Density

7.1 Test Limits

§ 15.247(e): For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

7.2 Test Procedure

ANSI C63.10: 2009 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247) PSD Option 1 Method

7.3 Test Equipment Used:

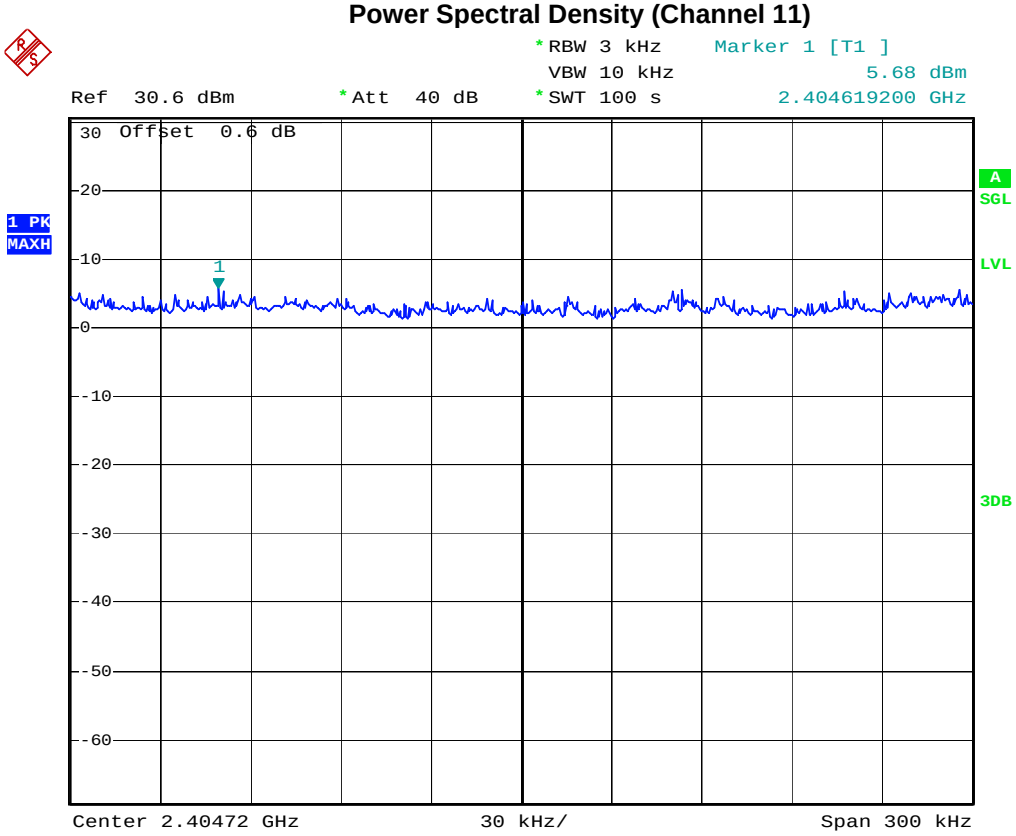
Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
Spectrum Analyzer	3099	Rohde & Schwarz	FSP7	9/23/2011	9/23/2012

7.4 Results:

***PSD Option 1 Method**

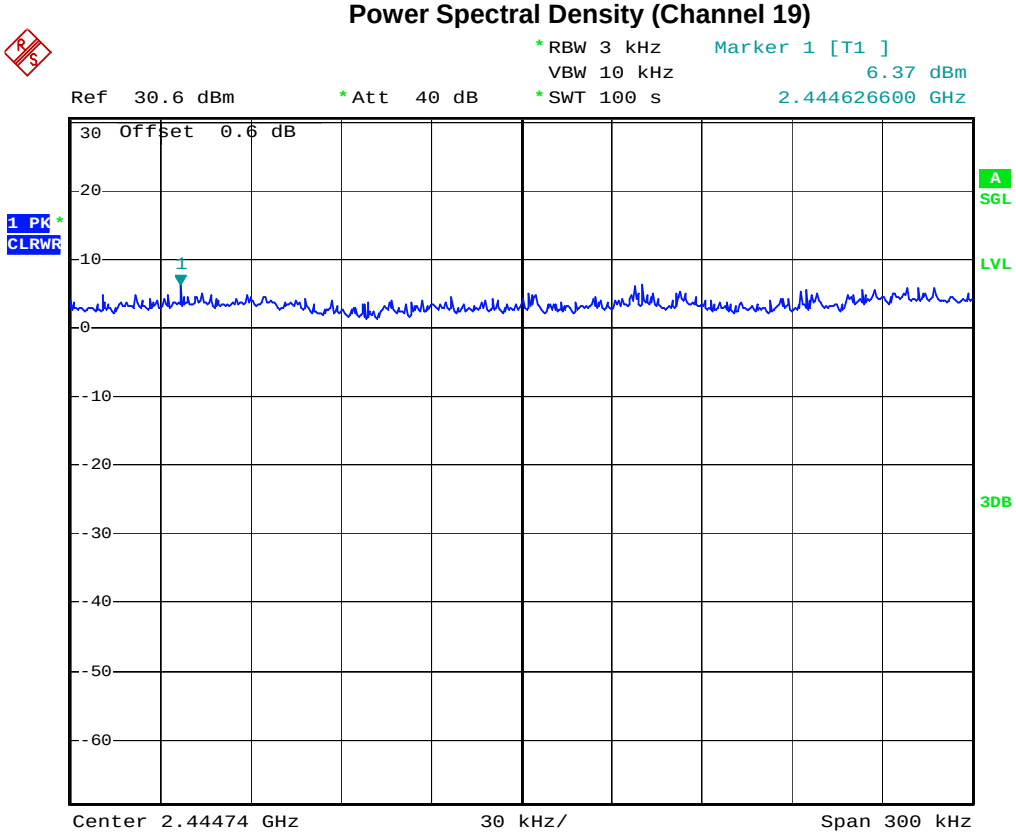
Channel Number	PSD in 3kHz BW (dBm)	Limit (dBm)	Margin (dB)	Result
11	5.68dBm	8	-2.32dB	Pass
19	6.37dBm	8	-1.63 dB	Pass
25	3.37dBm	8	-4.63 dB	Pass

Power Spectral Density (Channel 11)



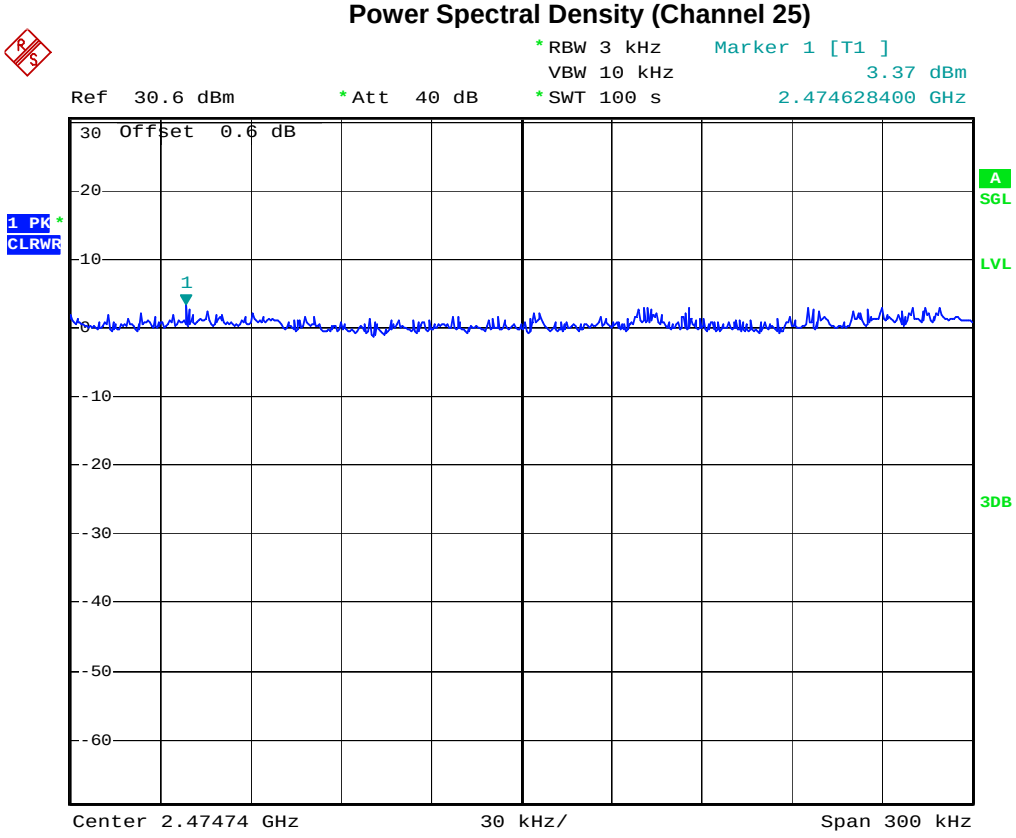
Date: 12.DEC.2011 15:55:23

Power Spectral Density (Channel 19)



Date: 12.DEC.2011 15:59:17

Power Spectral Density (Channel 25)



Date: 12.DEC.2011 16:05:26

8 Radiated Spurious Emissions (Transmitter)

8.1 Test Limits

§ 15.247(d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Part 15.205(a): Restricted Bands of Operations

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
[1] 0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	[2]
13.36–13.41.			

[1] Until February 1, 1999, this restricted band shall be 0.490–0.510 MHz.
[2] Above 38.6

Part 15.209(a): Field Strength Limits for Restricted Bands of Operation

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2,400 / F (kHz)	300
0.490 - 1.705	24,000 / F (kHz)	30
1.705 - 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

8.2 Test Procedure

ANSI C63.10: 2009 and KDB Publication No. 558074: Guidance on Measurements for Digital Transmission Systems (47 CFR 15.247)

8.3 Example of Field Strength Calculation Method:

The measured field strength was calculated by summing the readings taken from the spectrum analyzer with the appropriate correction factors associated with the antenna losses and cable losses. The calculation formula and sample calculations are listed below:

Formula:
FS = RA + AF + CF

FS = Field Strength in dBμV/m
RA = Receiver Amplitude in dBμV
AF = Antenna Factor in dB
CF = Cable Attenuation Factor in dB (Including preamplifier and filter attenuation)

Example Calculation:

RA = 19.48 dBμV
AF = 18.52 dB
CF = 0.78 dB

FS = 19.48 + 18.52 + 0.78 = 38.78 dBμV/m
Level in μV/m = Common Antilogarithm [(38.78 dBμV/m)/20] = 86.89 μV/m

8.4 Test Equipment Used:

Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	6/29/2011	6/29/2012
Preamplifier	987410	Miteq	AFS44-00102000-30-10P-44	2/4/2011	2/4/2012
Preamplifier	SF456200904	Mini-Circuits	ZX60-3018G-S+	2/4/2011	2/4/2012
Biconnilog Antenna	00051864	ETS	3142C	12/20/2010	12/20/2011
Horn Antenna	6556	ETS	3115	8/24/2011	8/24/2012
Horn Antenna	1096	Antenna Research	DRG-118/A	7/20/2011	7/20/2012
System Controller	121701-1	Sunol Sciences	SC99V	Time of Use	Time of Use
High Pass Filter	3986-01 DC0408	Microwave Circuits, Inc.	H3G020G2	Time of Use	Time of Use

8.5 Results:

All spurious emissions were attenuated by at least 20dB below the level of the fundamental as required by Part 15.247(d). Additionally, all emissions falling within restricted bands of operation and at the band edges were found to be below the limit specified in Part 15.209(a). The spurious emissions listed in the following tables are the worst case emissions.

Worst Case Spurious Measurements (Channel 11)

TX Channel	Spurious Frequency	Polarity	Corr. Peak Reading. (dBuV/m)	Avg Reading. (dBuV/m)	Duty Cycle Factor (dB)	Corr. Avg Reading. (dBuV/m)	Peak Limit (dBuV/m)	Avg. Limit (dBuV/m)	Results
11	4.8089 GHz	V	46.054	37.209	0	37.209	74	54	Compliant
11	7.2165 GHz	V	50.584	41.874	0	41.874	74	54	Compliant
11	9.6179 GHz	V	55.387	46.007	0	46.007	74	54	Compliant
11	12.022 GHz	V	57.083	48.283	0	48.283	74	54	Compliant
11	14.427 GHz	V	59.958	51.668	0	51.668	74	54	Compliant
11	16.835 GHz	V	49.875	39.325	0	39.325	74	54	Compliant
11	4.8092 GHz	H	47.201	39.691	0	39.691	74	54	Compliant
11	7.2135 GHz	H	49.936	39.046	0	39.046	74	54	Compliant
11	9.6179 GHz	H	49.847	38.957	0	38.957	74	54	Compliant
11	12.022 GHz	H	57.583	47.083	0	47.083	74	54	Compliant
11	14.433 GHz	H	55.762	45.201	0	45.201	74	54	Compliant
11	16.835 GHz	H	48.805	39.285	0	39.285	74	54	Compliant

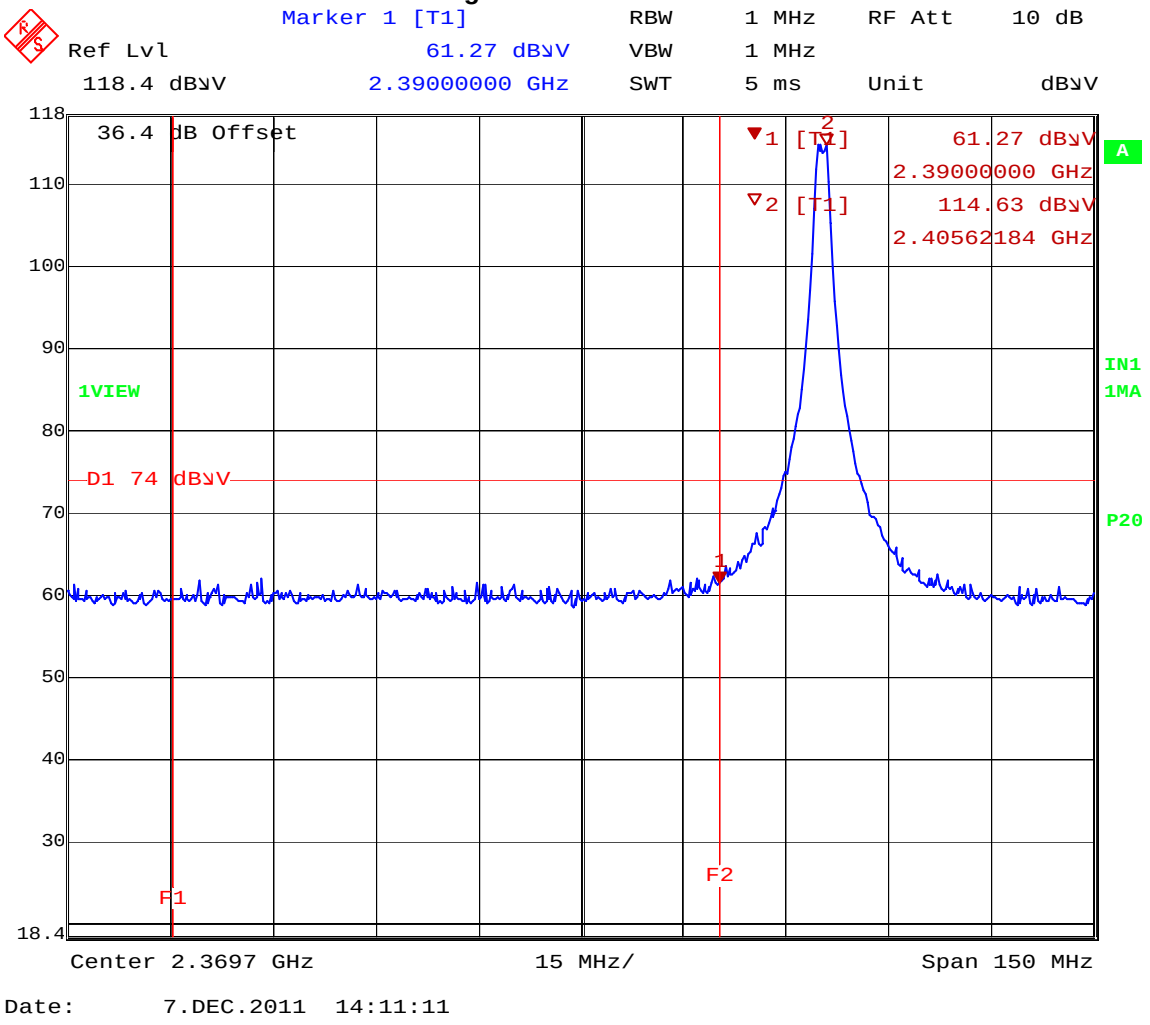
Worst Case Spurious Measurements (Channel 19)

TX Channel	Spurious Frequency	Polarity	Corr. Peak Reading. (dBuV/m)	Avg Reading. (dBuV/m)	Duty Cycle Factor (dB)	Corr. Avg Reading. (dBuV/m)	Peak Limit (dBuV/m)	Avg. Limit (dBuV/m)	Results
19	4.8889 GHz	V	45.895	37.449	0	37.449	74	54	Compliant
19	7.3334 GHz	V	49.794	40.614	0	40.614	74	54	Compliant
19	9.7821 GHz	V	51.42	41.21	0	41.21	74	54	Compliant
19	12.223 GHz	V	58.271	48.751	0	48.751	74	54	Compliant
19	14.667 GHz	V	59.102	50.662	0	50.662	74	54	Compliant
19	17.115 GHz	V	50.983	41.593	0	41.593	74	54	Compliant
19	4.889 GHz	H	47.54	38.97	0	38.97	74	54	Compliant
19	7.3334 GHz	H	48.184	38.064	0	38.064	74	54	Compliant
19	9.7821 GHz	H	48.776	38.59	0	38.59	74	54	Compliant
19	12.228 GHz	H	57.09	47.598	0	47.598	74	54	Compliant
19	14.673 GHz	H	56.652	47.142	0	47.142	74	54	Compliant
19	17.112 GHz	H	55.611	42.851	0	42.851	74	54	Compliant

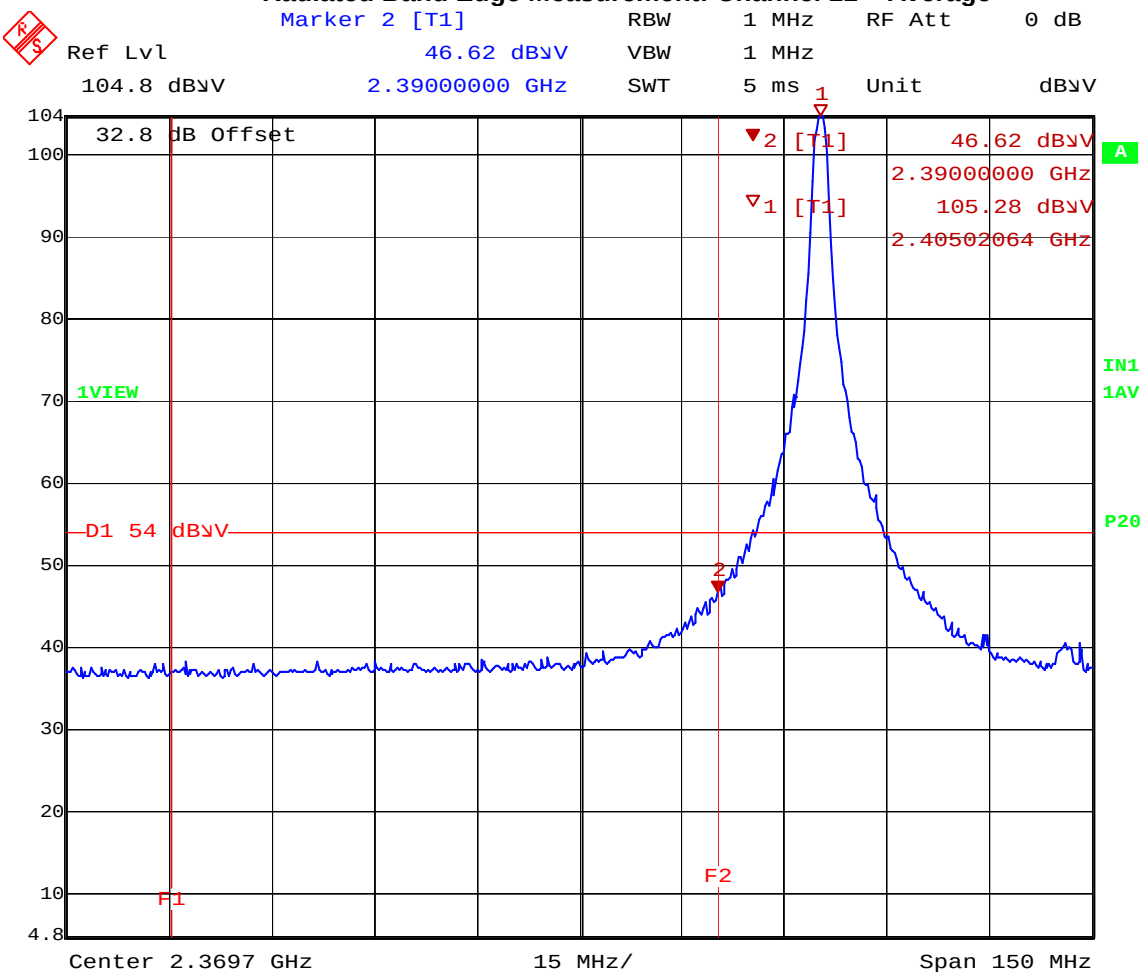
Worst Case Spurious Measurements (Channel 25)

TX Channel	Spurious Frequency	Polarity	Corr. Peak Reading. (dBuV/m)	Avg Reading. (dBuV/m)	Duty Cycle Factor (dB)	Corr. Avg Reading. (dBuV/m)	Peak Limit (dBuV/m)	Avg. Limit (dBuV/m)	Results
25	4.951 GHz	V	47.369	39.689	0	39.689	74	54	Compliant
25	7.4233 GHz	V	45.842	33.622	0	33.622	74	54	Compliant
25	9.9021 GHz	V	49.717	38.287	0	38.287	74	54	Compliant
25	12.378 GHz	V	54.168	44.338	0	44.338	74	54	Compliant
25	14.853 GHz	V	53.128	41.828	0	41.828	74	54	Compliant
25	4.9491 GHz	H	46.478	37.728	0	37.728	74	54	Compliant
25	7.4232 GHz	H	44.782	32.257	0	32.257	74	54	Compliant
25	9.8977 GHz	H	47.955	35.375	0	35.375	74	54	Compliant
25	12.377 GHz	H	52.516	41.206	0	41.206	74	54	Compliant
25	14.847 GHz	H	52.166	39.076	0	39.076	74	54	Compliant

Radiated Band Edge Measurement: Channel 11 – Peak



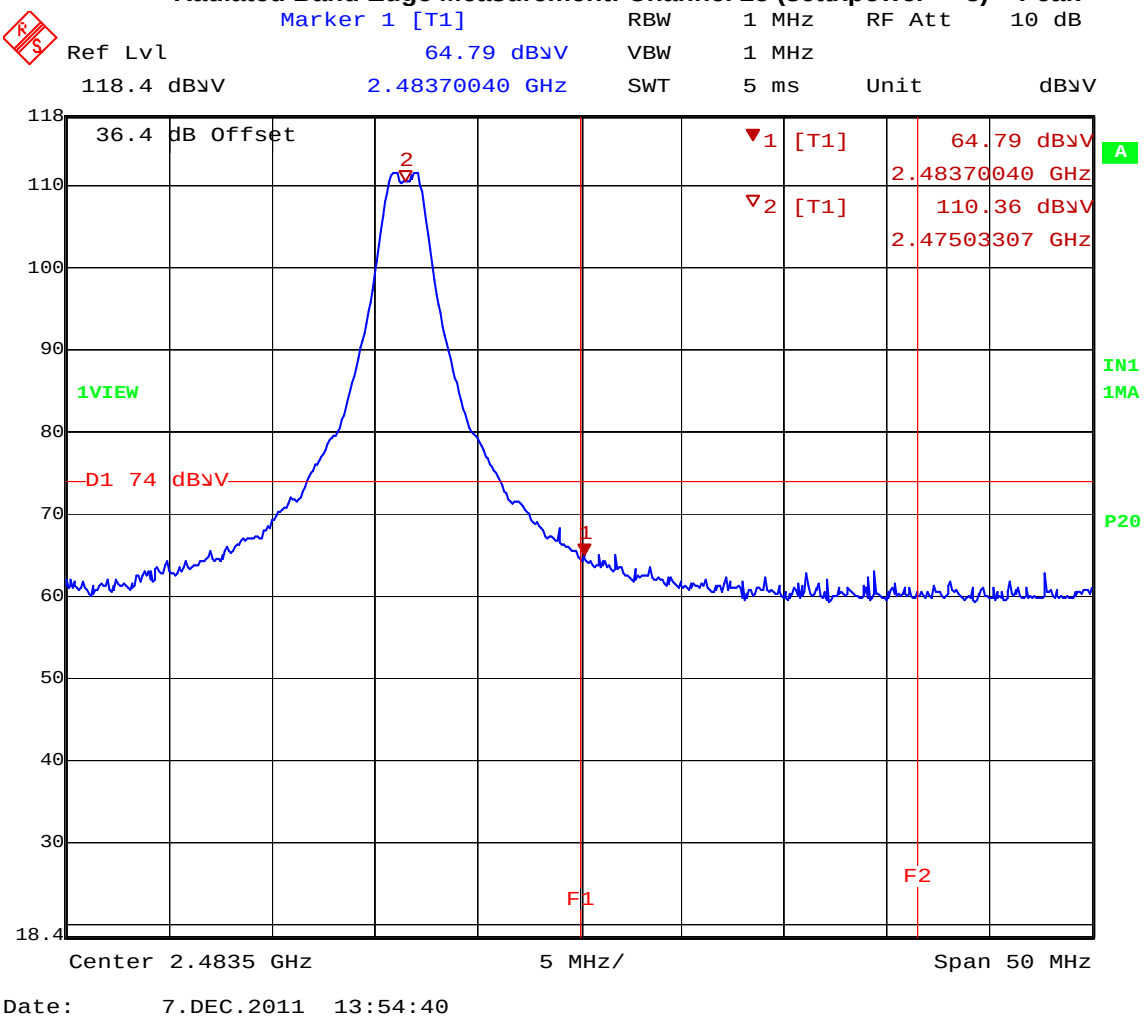
Radiated Band Edge Measurement: Channel 11 – Average



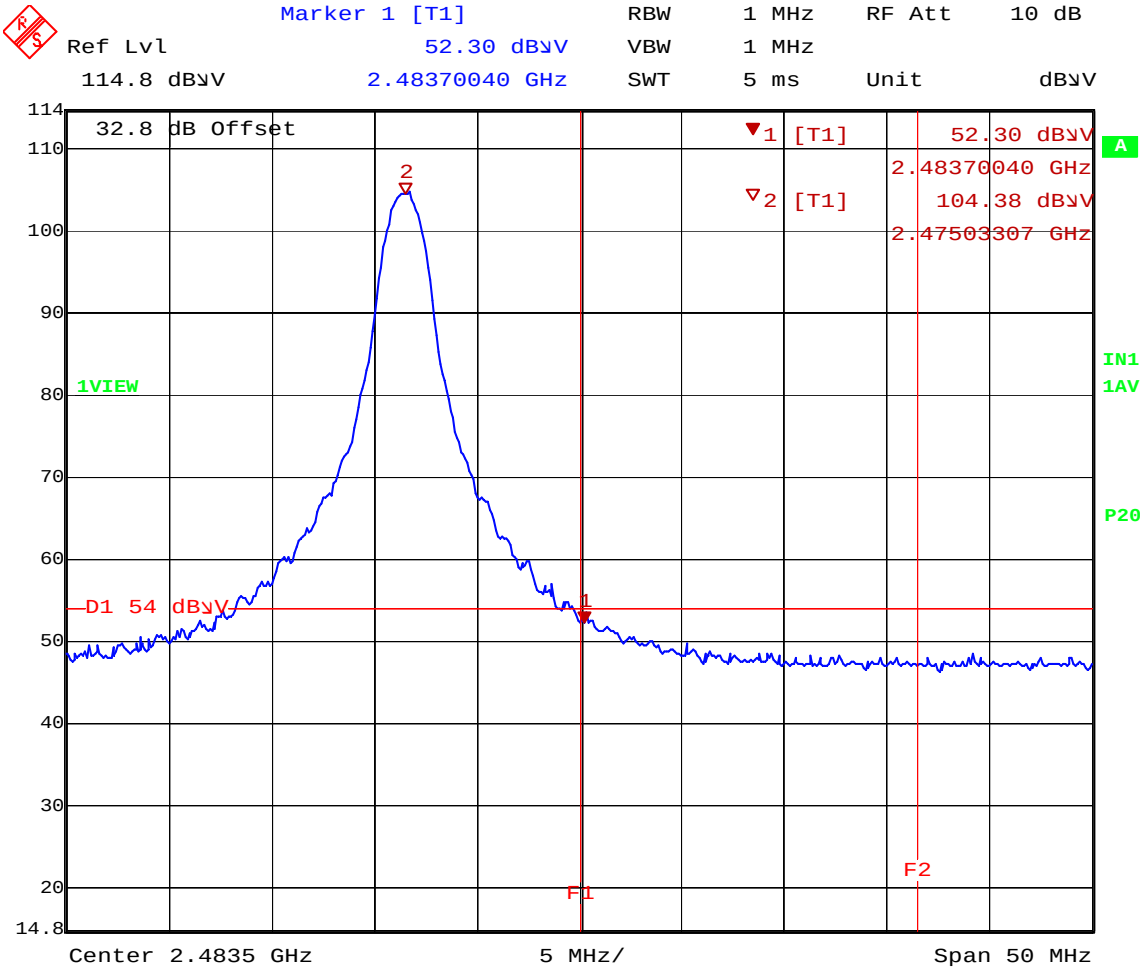
Date: 7.DEC.2011 14:13:04

Note: A 3.6dB duty cycle correction factor was also applied to this measurement. See section 12 of this report for calculation of the duty cycle correction factor.

Radiated Band Edge Measurement: Channel 25 (settxpower = -3) – Peak



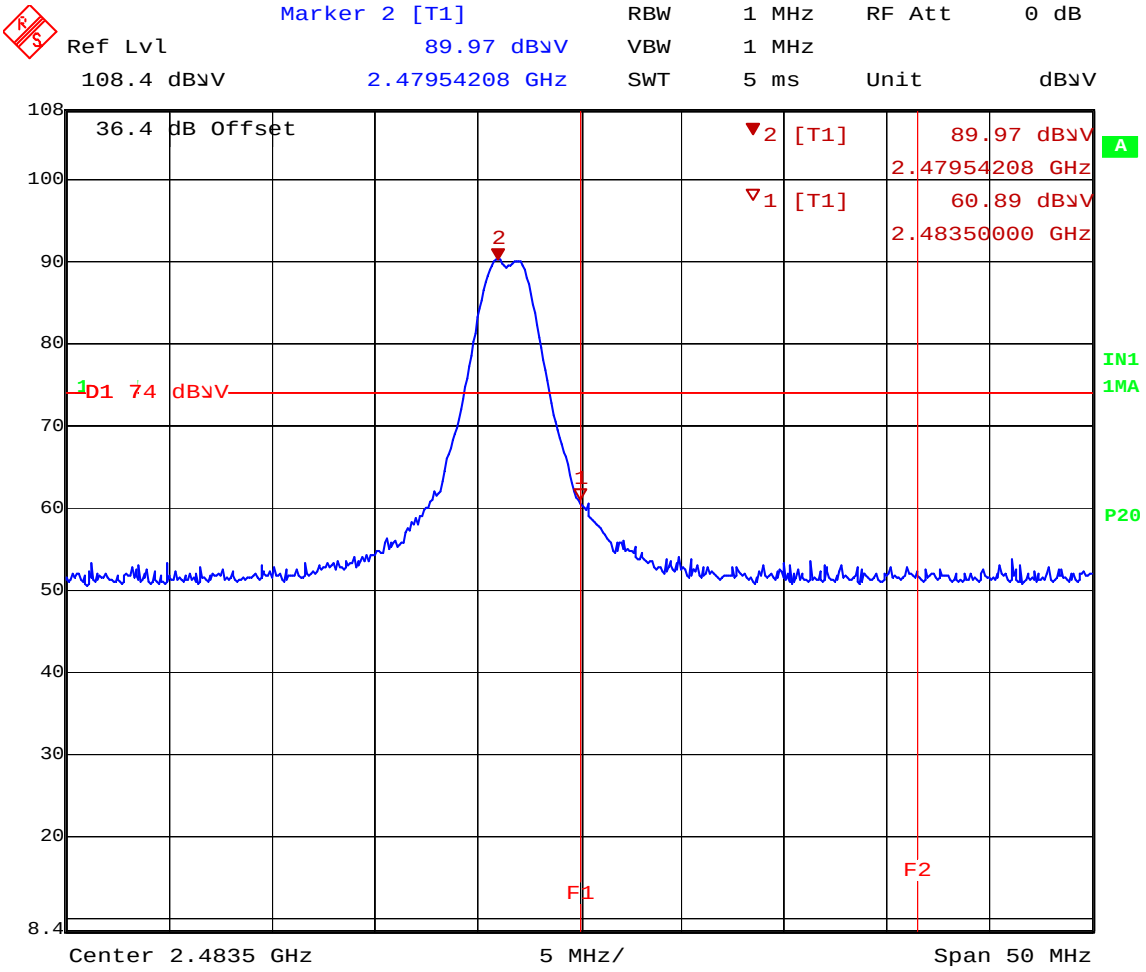
Radiated Band Edge Measurement: Channel 25 (settxpower = -3) – Average



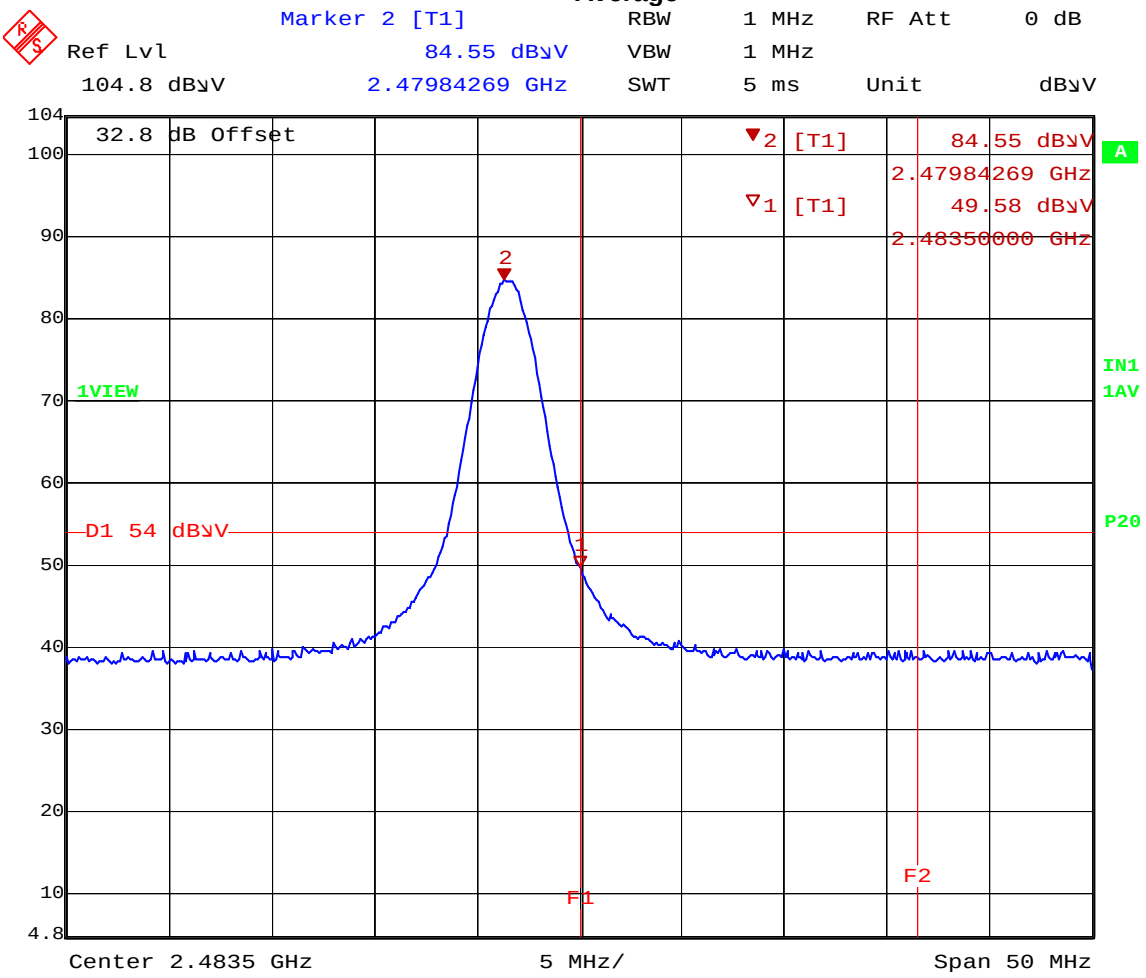
Date: 7.DEC.2011 13:53:27

Note: A 3.6dB duty cycle correction factor was also applied to this measurement. See section 12 of this report for calculation of the duty cycle correction factor.

Radiated Band Edge Measurement: Channel 26 (Reduced Power Level, settxpower = -15) – Peak



Radiated Band Edge Measurement: Channel 26 (Reduced Power Level, settxpower = -15) – Average



Note: A 3.6dB duty cycle correction factor was also applied to this measurement. See section 12 of this report for calculation of the duty cycle correction factor.

9 Radiated Spurious Emissions (Receiver)

9.1 Test Limits

§ 15.109: Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency of emission (MHz)	Field strength (microvolts/meter)	Field strength (dBuV/m)
30–88	100	40
88–216	150	43.5
216–960	200	46
Above 960	500	54

9.2 Test Procedure

ANSI C63.4: 2009

9.3 Example of Field Strength Calculation Method:

The measured field strength was calculated by summing the readings taken from the spectrum analyzer with the appropriate correction factors associated with the antenna losses and cable losses. The calculation formula and sample calculations are listed below:

Formula:
FS = RA + AF + CF

FS = Field Strength in dBμV/m
RA = Receiver Amplitude in dBμV
AF = Antenna Factor in dB
CF = Cable Attenuation Factor in dB (Including preamplifier and filter attenuation)

Example Calculation:

RA = 19.48 dBμV
AF = 18.52 dB
CF = 0.78 dB

FS = 19.48 + 18.52 + 0.78 = 38.78 dBμV/m
Level in μV/m = Common Antilogarithm [(38.78 dBμV/m)/20] = 86.89 μV/m

9.4 Test Equipment Used:

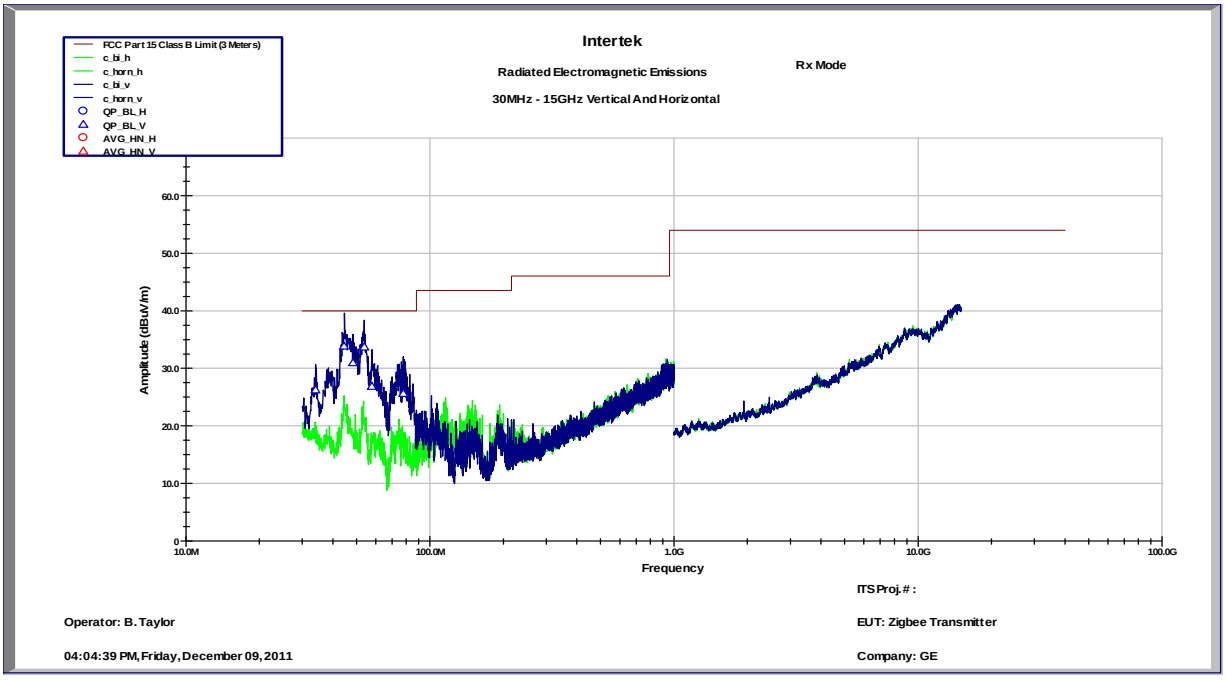
Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	6/29/2011	6/29/2012
Preamplifier	987410	Miteq	AFS44-00102000-30-10P-44	2/4/2011	2/4/2012
Preamplifier	SF456200904	Mini-Circuits	ZX60-3018G-S+	2/4/2011	2/4/2012
Biconnilog Antenna	00051864	ETS	3142C	12/20/2010	12/20/2011
Horn Antenna	6556	ETS	3115	8/24/2011	8/24/2012
Horn Antenna	1096	Antenna Research	DRG-118/A	7/20/2011	7/20/2012
System Controller	121701-1	Sunol Sciences	SC99V	Time of Use	Time of Use

9.5 Results:

All spurious emissions with the test sample in receive mode were below the limits specified in Part 15.109 for a class B digital device.

Radiated Emissions										
Test Engineer:	B. Taylor	**Start Date:**	12/9/2011	**End Date:**	12/9/2011					
Temperature:	25.1C	**Humidity:**	17.20%	**Pressure:**	998.98mbar					
Specification:	FCC Part 15B	**Test Limit:**	Class B							
Notes:	RX Mode									
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Frequency	**Polarity (H/V)**	**Raw Reading (dBuV)**	**Cab. (dB)**	**Ant. (dB)**	**Corr. Reading. (dBuV/m)**	**Limit (dBuV/m)**	**Delta (dB)**	**RBW / Detector**	**Test Distance**	**Results**
33.998 MHz	V	26.49	-16.05	15.8	26.24	40	-13.76	120kHz / QP	3m	**Compliant**
44.437 MHz	V	38.93	-15.96	10.87	33.84	40	-6.16	120kHz / QP	3m	**Compliant**
48.4 MHz	V	37.15	-15.94	9.74	30.95	40	-9.05	120kHz / QP	3m	**Compliant**
53.8 MHz	V	40.95	-15.89	8.62	33.68	40	-6.32	120kHz / QP	3m	**Compliant**
57.801 MHz	V	34.73	-15.87	8	26.86	40	-13.14	120kHz / QP	3m	**Compliant**
77.802 MHz	V	33.69	-15.62	7.54	25.61	40	-14.39	120kHz / QP	3m	**Compliant**
Calculations:					F = C + D + E		H = F - G			

Maximized Quasi Peak Emissions



Peak Scan (Receive Mode)

10 AC Powerline Conducted Emissions

10.1 Test Limits

§ 15.107(e): Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases with the logarithm of the frequency.

10.2 Test Procedure

ANSI C63.4: 2009

10.3 Test Equipment Used:

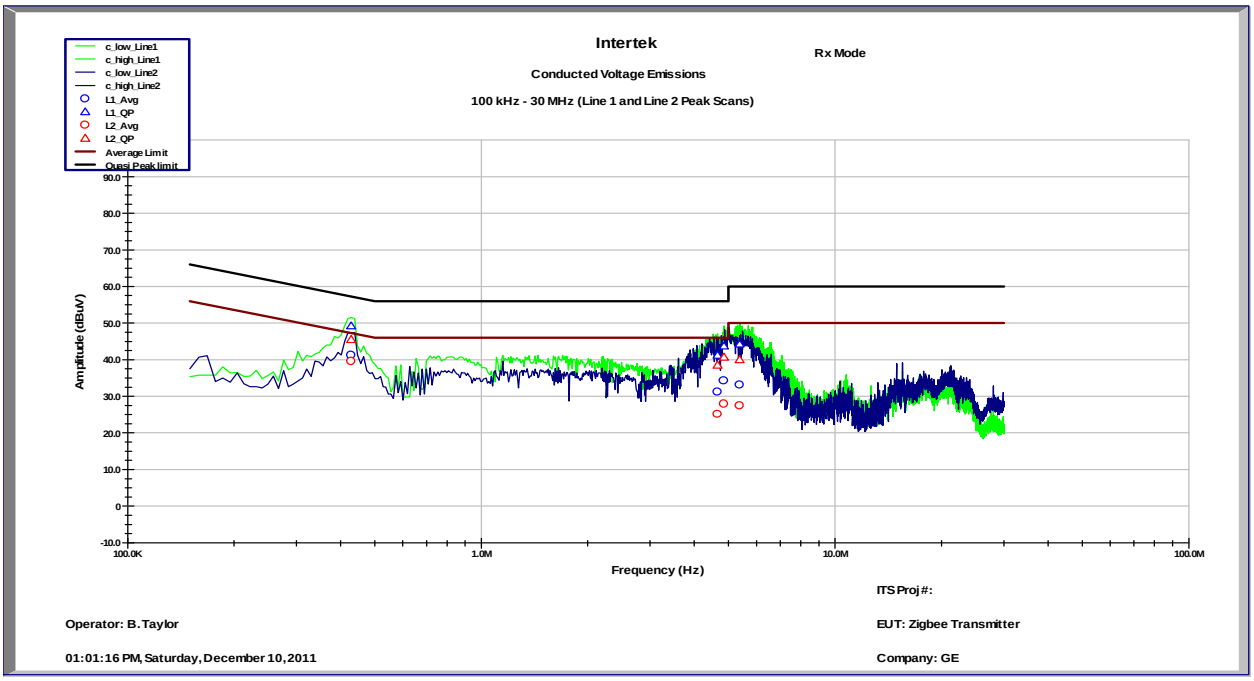
Description	Serial Number	Manufacturer	Model	Cal. Date	Cal. Due
EMI Test Receiver	10887490.26	Rohde & Schwarz	ESI26	6/29/2011	6/29/2012
LISN	3333	Teseq	NNB52	3/3/2011	3/3/2012

10.4 Results:

Conducted Voltage Emissions on Power Lines								
Test Engineer:	B. Taylor	**Start Date:**	12/10/2011	**End Date:**	12/10/2011			
Temperature:	25.1C	**Humidity:**	17.20%	**Pressure:**	998.98mbar			
Specification:	FCC Part 15	**Test Limit:**	Class B	**RBW:**	9kHz			
Notes:	Receive Mode							

Line	Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Delta (dB)	Average (dBuV)	Average Limit (dBuV)	Average Delta (dB)	Results
Line 1	428.3 KHz	49.2	57.29	-8.08	41.19	47.29	-6.09	**Compliant**
Line 1	4.6494 MHz	41.21	56	-14.79	31.18	46	-14.82	**Compliant**
Line 1	4.848 MHz	43.7	56	-12.3	34.26	46	-11.74	**Compliant**
Line 1	5.3761 MHz	44.24	60	-15.76	33.12	50	-16.88	**Compliant**
Line 2	428.4 KHz	45.49	57.28	-11.79	39.54	47.28	-7.74	**Compliant**
Line 2	4.6521 MHz	38.47	56	-17.53	25.11	46	-20.89	**Compliant**
Line 2	4.8506 MHz	40.66	56	-15.34	27.91	46	-18.09	**Compliant**
Line 2	5.3762 MHz	39.99	60	-20.01	27.41	50	-22.59	**Compliant**

RX Mode
Quasi-Peak and Average Measurements

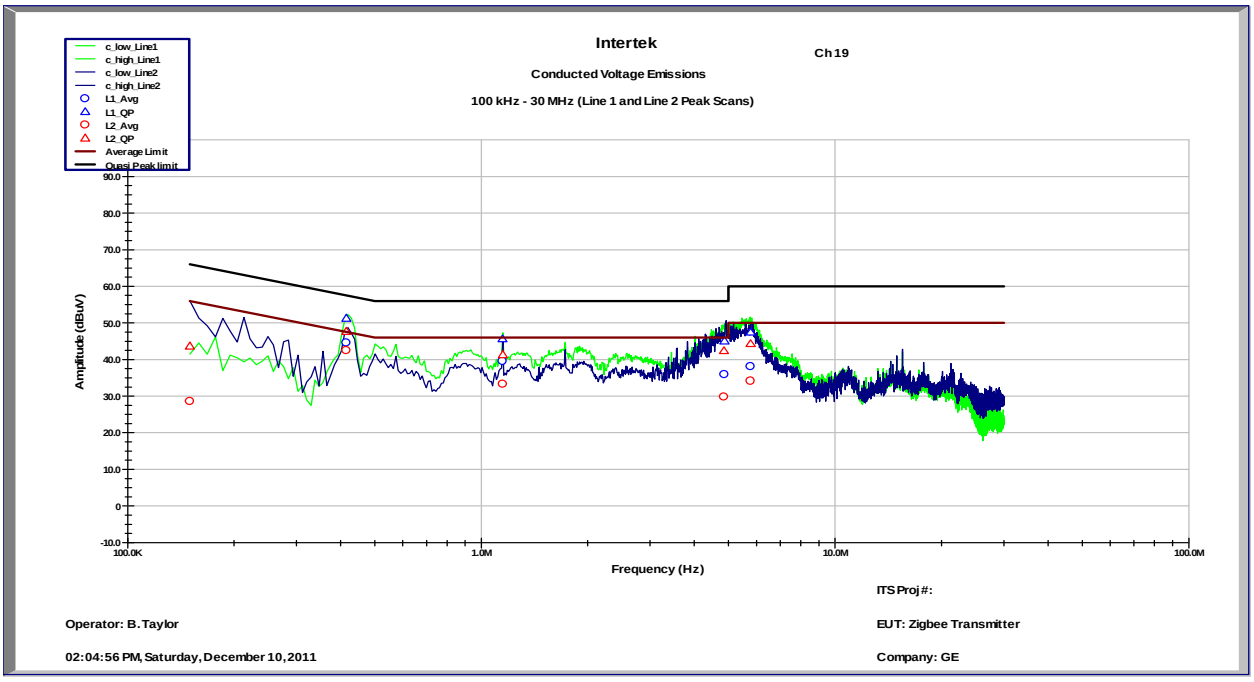


RX Mode
Peak Scan (Line 1 and 2)

Conducted Voltage Emissions on Power Lines							
Test Engineer:	B. Taylor	**Start Date:**	12/10/2011	**End Date:**	12/10/2011		
Temperature:	25.1C	**Humidity:**	17.20%	**Pressure:**	998.98mbar		
Specification:	FCC Part 15	**Test Limit:**	Class B	**RBW:**	9kHz		
Notes:	Transmitting on Middle Channel						

Line	Frequency (MHz)	Quasi-Peak (dBuV)	Quasi-Peak Limit (dBuV)	Quasi-Peak Delta (dB)	Average (dBuV)	Average Limit (dBuV)	Average Delta (dB)	Results
Line 1	415.3 KHz	51.25	57.54	-6.29	44.53	47.54	-3.01	**Compliant**
Line 1	1.1481 MHz	45.61	56	-10.39	39.56	46	-6.44	**Compliant**
Line 1	4.866 MHz	45.06	56	-10.94	35.9	46	-10.1	**Compliant**
Line 1	5.7716 MHz	47.46	60	-12.54	38.1	50	-11.9	**Compliant**
Line 2	150.0 KHz	43.66	66	-22.34	28.58	56	-27.42	**Compliant**
Line 2	415.3 KHz	47.66	57.54	-9.88	42.45	47.54	-5.09	**Compliant**
Line 2	1.15 MHz	41.28	56	-14.72	33.29	46	-12.71	**Compliant**
Line 2	4.8517 MHz	42.36	56	-13.64	29.81	46	-16.19	**Compliant**
Line 2	5.7716 MHz	44.31	60	-15.69	34.09	50	-15.91	**Compliant**

Transmitting on Middle Channel
Quasi-Peak and Average Measurements



Transmitting on Middle Channel
Peak Scan (Line 1 and 2)

11 Antenna Requirement per FCC Part 15.203

11.1 Test Limits

§ 15.203: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

11.2 Results:

The sample tested met the antenna requirement. The antenna utilized a PCB antenna that was not detachable.

12 Duty Cycle Correction Factor Determination

The worst case duty cycle over a 100ms windows was calculated by the manufacture to determine the duty cycle factor.

Goal: Calculate the worse case time a ZigBee Node will be in TX Mode in any 100ms Time Window.
Correction Factor is: 20*Log10(Duty Cycle)

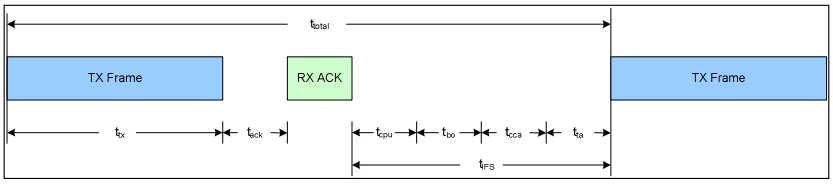
Procedure: In order to calculate the worse case TX on time, Ember started by reviewing the IEEE 802.15.4 MAC and PHY constants. In addition, Ember used the slotted ACK LIFS and SIFS scenarios. Each scenario is described below.

Worst Case Scenario: The worst case scenario utilizes LIFS, and a TX, RX ACK, TX, RX ACK… from a single node. It has been proven through calculation, this scenario keeps the node in TX Mode for the longest

Summary: ***If you are using EmberZNet Stack SW, the TX duty cycle: 66%***

IEEE 802.15.4-2003 2.4 GHz PHY Constants

Data Rate	250000	bits / sec	
	31250	bytes / sec	
Symbols/byte	2	sym / bytes	
Symbol Timing	62500	sym / sec	
	0.000016	sec / sym	
Byte Timing	0.000032	sec / byte	
PHY PSDU	6	bytes	4 Pramble, SPD, Length
Max Length	127	bytes	
Total Packet Length	133	bytes	
Maximum Time TX PKT	0.004256	sec	



Long Frame Scenario:
1) TX Frame — Assume Frame is Data Frame
2) Wait for ACK
3) RX ACK
4) CPU Processing of ACK
5) Wait for Backoff
6) Repeat 1)

MAC-Level Calculation (LIFS)

Long InterFrame Spacing (Slotted w/ ACK)			
Long Frame	127	bytes	
Data Frame Payload	102	bytes	
ACK Frame	5	bytes	
tack	12	sym	
LIFS	40	sym	
Backoff Period	20	sym	
Maximum Backoff	7		Random between 0 and 7
Backoff Required	2		
Backoff Time	70	sym	Average at 3.5

Transmit Time	
TX Time (Packet)	0.004256
Total TX Time (sec)	0.004256

NOT Transmit time (RX or Idle)		
Wait for ACK (tack)	0.000192	
RX Time (ACK)	0.000352	
Backoff Time (tbo)	0.00112	(Backoff Time * Backoff Period)
CPU Processing (tcpu)	0.0002	(0.2ms average on EM2xx running EmberZNet)
CCA Assessment (tcca)	0.000128	(averaged over 8 symbols in RX Mode)
Turn Around Time (RX to TX)	0.000192	(After CCA, Radio turns over to TX in 12 symbols)
Total Off Time (sec)	0.002184	

Total Time (ttotal)	0.00644
Number of RX / TX cycles in 100ms	15.5279503

Worse Case (100ms window)

TX Frame 10 times	0.04256
RX or IDLE 10 Times	0.02184
Sum	0.0644

MAC TX Duty Cycle (On /total)	66.09%		Represents theoretical ZigBee / MAC performance
	3.59768496	dB	

13 Measurement Uncertainty

The measured value related to the corresponding limit will be used to decide whether the equipment meets the requirements.

The measurement uncertainty figures were calculated and correspond to a coverage factor of k = 2, providing a confidence level of respectively 95.45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian).

Measurement uncertainty Table

Parameter	Uncertainty	Notes
Radiated emissions, 30 to 1000 MHz	±3.9dB	
Radiated emissions, 1 to 18 GHz	±4.2dB	
Radiated emissions, 18 to 40 GHz	±4.3dB	
Power Port Conducted emissions, 150kHz to 30 MHz	±2.8dB	

14 Revision History

Revision Level	Date	Report Number	Notes
0	2/21/2012	100596650LEX-001	Original Issue