REGULATORY COMPLIANCE REPORT

TITLE: FCC & IC Test Report for 15.247 & RSS-210 IEEE 802.15.4™; Zigbee® Digital Transmission Device (DTS), 2.405 – 2.475 GHz

(product model: 2.4GZ Remote, Itron part numbers: OWG-5001/2-501, 502, 503, 504)

AUTHOR: Douglas Knoll

REV	CCO	DESCRIPTION OF CHANGE	DATE	APPROVALS	
001		INITIAL RELEASE		Engineering	Douglas Knoll
				Regulatory	

REVISION HISTORY

D		ready for upload		Engineering	Douglas Knoll
				Regulatory	Jay R. Holcomb
				Engineering	
				Regulatory	
				Engineering	
				Regulatory	

Test Data Summary

FCC 15.247 / IC RSS-210
2.4GZ OpenWay Gas Remote, Zigbee®, Digital Transmission System (DTS), 2405 – 2475 MHz
FCC ID: EO924GZR
IC: 864D-24GZR
IC Device Models (for IC): 24GZR7
Itron Part Numbers: OWG-5001/2-501, 502, 503, 504
Serial Numbers – see below
OATS Registration Number: FCC 90716, IC 864D-1

Rule	Description	Spec Limit	Reading	Pass/Fail
Part 15.31(e)	Variation of Input Voltage – Conducted		N/A (battery device)	N/A
Part 15.207 / RSS-Gen 7.2.2	AC Power line Conducted Emissions		N/A (battery device)	N/A
Part 15.247(a)(2) / RSS 210 8.2 (a)	6dB Bandwidth – Conducted	>500kHz	1.600MHz@2440MHz	Pass
Part 15.247(b) (3) / RSS-210 A8.4(4)	Peak Power Output – Conducted	<1W	.034W@2440MHz	Pass
RSS-210 A1.1.3	Bandwidth of Momentary Signals (99% BW)	<0.5% of Fc	2.8MHz@2440MHz	Pass
Part 15.247(e) / RSS-210 A8.2(b)	Peak Power Spectral Density – Conducted	<8dBm per 3kHz	-0.05dBm@2440MHz	Pass
Part 15.247 (d)	Band-edge compliance of RF Conducted Emissions	<-20dBc	-43.33dBc@2400MHz	Pass
Part 15.247(d)/ RSS-210 A8.5	Spurious Emmisions – Conducted	<-20dBc (100kHz)	-51.68dBc@9620MHz	Pass
Part 15.247(d) / RSS-210 A8.5	Spurious Emissions – Radiated	<-20dBc (100kHz)	-39.69dBc@9760MHz	Pass
Parts 15.205 & 15.209 / RSS-210 2.2, 2.6 Tables 1 & 2	Restricted Bands / Spurious Emissions – Radiated	54dBuV/m avg@3m 74dBuV/m pk@3m	29.46dBuV/m@2326.8MHz avg Horizontal	Pass
15.247 (d)	Band-edge compliance of RF Radiated emissions	54dBuV/m avg@3m 74dBuV/m pk@3m	26.35dBuV/m@2390MHz avg Horizontal 57.48dBuV/m@2390MHz pk Horizontal	Pass
RSS-Gen 7.2.3	Receiver Spurious Emissions - Radiated	54dBuV/m avg@3m 74dBuV/m pk@3m	43.55dBuV/m@4806MHz avg vertical	Pass
Parts 1.1310 & 2.1091(mobile) or 2.1093 (portable) / RSS-102 Sec 4.2	Limits for Maximum Permissible Exposure (MPE)	<1mW/cm^2 <10W/m^2	0.00676mW/cm^2 0.0676W/m^2 @ 0.2M	Pass

Rule versions: FCC Part 1 (01-2006), FCC Part 2 (01-2006), FCC Part 15 (02-01-2006), RSS-102 Issue 2 (11-2005), RSS-210 Issue 7 (June 2007), RSS-Gen Issue 1 (09-2005).
Reference docs: ANSI C63.4-2003, DA 00-705 (03-30-2000), OET65 (08-1997), OET65C (06-2001), IEEE C95.3-2002.

Cognizant Personnel	
Name	Title
Douglas Knoll	Test Engineer
Name	Title
Jay Holcomb	Regulatory Manager
Name	Title
Dan Bomsta	Project Lead

CONDITIONS DURING TESTING

No Modifications to the EUT were necessary during the testing.

FCC 15.31(m) – IC _n/a_; Number of Channels
This device was tested on three channels; 2405MHz, 2440MHz, and 2475MHz

ANSI C63.4 - Temperature and Humidity During Testing
The temperature during testing was within +10º C and +40º C.(50°F and 104°F)
The Relative humidity was between 10% and 90%.
RSS-Gen 4.3: Tests shall be performed at ambient temperature

EQUIPMENT UNDER TEST (EUT) DESCRIPTION
Itron declares that the EUT tested was representative of a production unit.

EQUIPMENT UNDER TEST

EUT Module
Manuf: Itron, Inc.
Model: OWG-5001-502
Serial Number(s) 16080017, 19080001, 19080002
FCC ID: EO924GZR
Power source: Fresh Battery

15.31(e)

Variation of Supply Voltage

Vary the supply voltage from 85% to 115% of the nominal voltage. If the power level of the fundamental signal varies with supply voltage, record the voltage level at which the fundamental signal is at its highest and use that voltage level for all further testing.

DEVICE IS BATTERY OPERATED NOT CONNECTED TO THE POWER LINE. BATTERY IS NOT RECHARGEABLE. THERFORE THIS TEST IS N/A.

15.207 / RSS-210 Sec. 6.6(a)

Power line Conducted Emissions

Measure the AC power line conducted emissions from 150kHz to 30 MHz using a 50□H/50□ line impedance stabilization network (LISN) according to the procedure specified in ANSI C63.4. Verify that no emissions exceed the following limits:

Frequency (MHz)	Quasi-Peak (dB□V)	Average (dB□V)
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of frequency

DEVICE IS BATTERY OPERATED NOT CONNECTED TO THE POWER LINE. BATTERY IS NOT RECHARGEABLE. THERFORE THIS TEST IS N/A.

15.247(a) (2) / RSS-210 A8.2 (a)

6 dB Bandwidth, conducted

Systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Use the following spectrum analyzer settings:

Span = 5MHz
RBW = 100kHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

The EUT should be transmitting at its maximum data rate. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 6 dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 6 dB bandwidth of the emission. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation.

Equipment Used	Serial Number	Cal Date	Due
HP8560E	3825A03709	6/09/09	6/09/11
Date	Tested by		
8/26/09	Douglas Knoll		

Unit tested: 16080017

Frequency, (MHz)	6dB Bandwidth (MHz)
2405	1.608
2440	1.600
2475	1.625

Table 1: Summary of 6dB Bandwidth Measurements

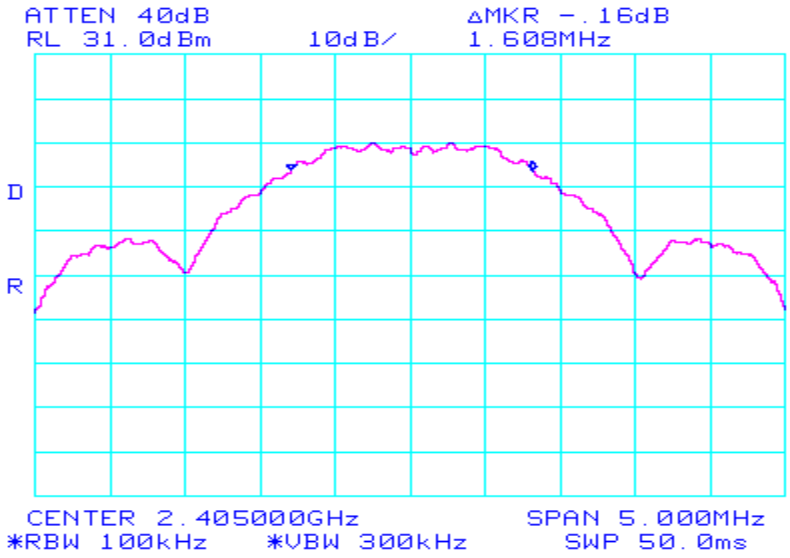


Figure 1: 6dB Bandwidth Measurement: f=2405MHz

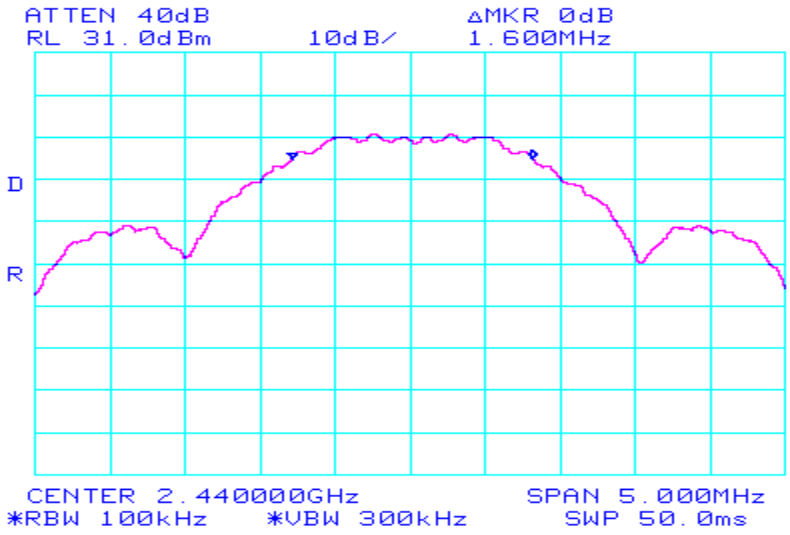


Figure 2: 6dB Bandwidth Measurement: f=2440MHz

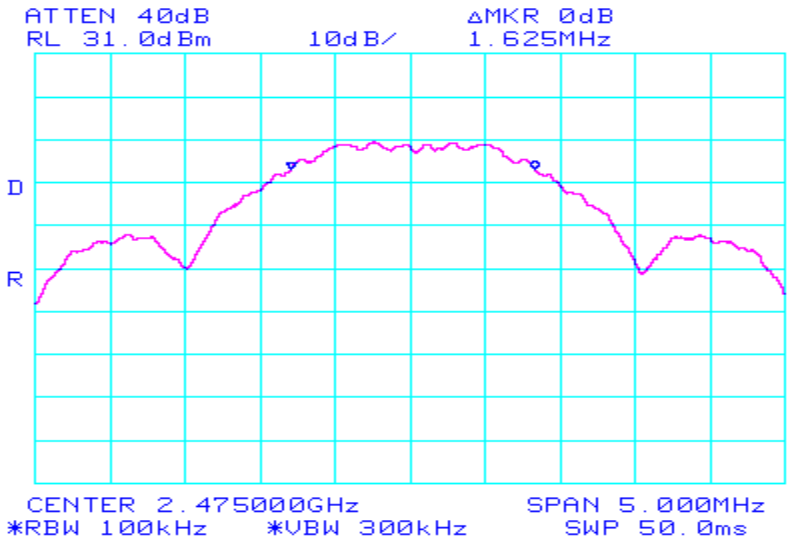


Figure 3: 6dB Bandwidth Measurement: f=2475MHz

15.247(b) (3) / RSS-210 A8.4 (4)

Power Output – Conducted

The maximum peak conducted output power of the intentional radiator shall not exceed the following: For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

Use the following spectrum analyzer settings:

Span = > 6dB bandwidth of the emission
RBW > the6 dB bandwidth of the emission being measured.
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
Set RF level offset=cable loss

Cable loss of 0.95 dB was added to the spectrum analyzer as a correction. The marker value in the plots is the true corrected value. The cable loss was measured by a calibrated Network Analyzer (Agilent 8753D)

Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power.

Equipment Used	Serial Number	Cal Date	Due
HP8560E	3825A03709	6/09/09	6/09/11
Agilent 8753D	3410A04770	3/27/09	3/27/11
ESM Cable Corp TB086 AMAM-36	n/a	8/26/09	see above
Date	Tested by		
8/26/09	Douglas Knoll		

Unit tested: 16080017

Frequency, MHz	Power out, dBm	Power out, Watts
2405	14.91	.031
2440	15.31	.034
2475	13.98	.025

Table 2: Summary Table of Output Power Measurements

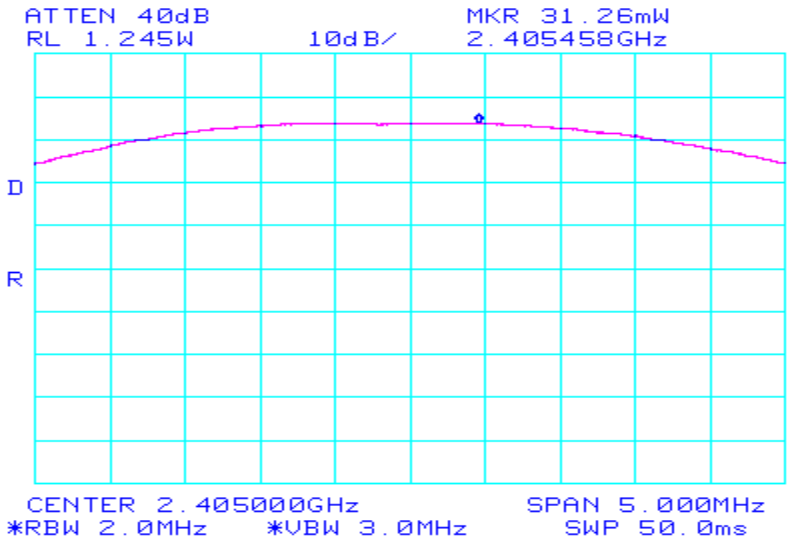


Figure 4: Conducted Power Measurement: f=2405MHz

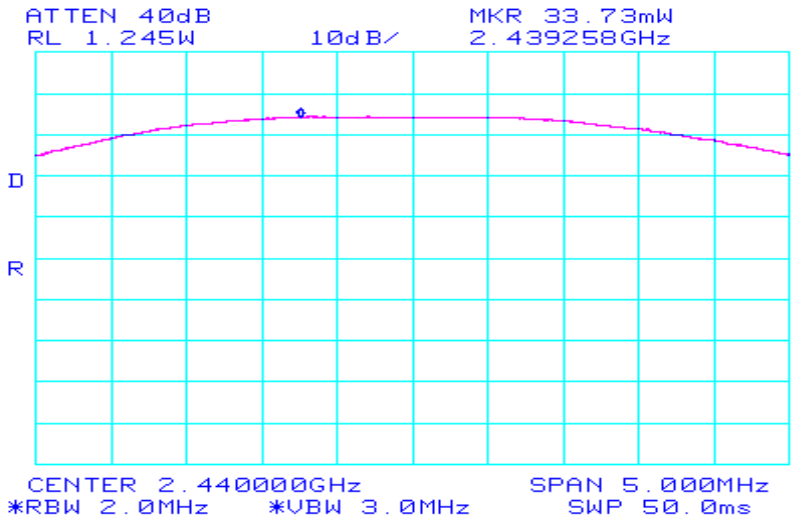


Figure 5: Conducted Power Measurement: f=2440MHz

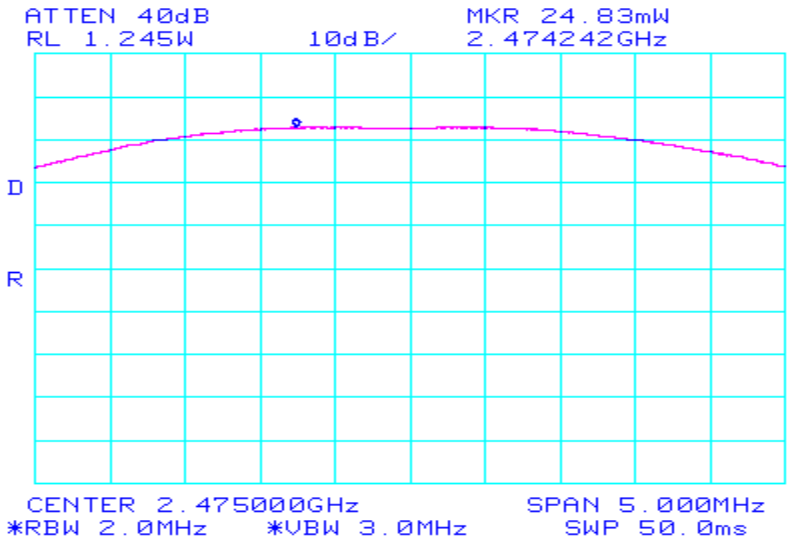


Figure 6: Conducted Power Measurement: f=2475MHz

RSS-210 A1.1.3: Bandwidth of Momentary Signals (99% BW)

For the purpose of Section A1.1, the 99% bandwidth shall be no wider than 0.25% of the center frequency for devices operating between 70-900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency.

Equipment Used	Model Number	Serial Number	Cal Date	Due
Spectrum Analyzer	HP 8560E	3825A03709	6/09/09	6/09/11
Date		Tested by		
8/26/09		Douglas Knoll		

Unit tested: 16080017

Frequency (MHz)	Limit 0.5% of center frequency (MHz)	99% Bandwidth (MHz)
2405	12	2.750
2440	12.2	2.800
2475	12.4	2.750

Table 3: Summary table of 99% Bandwidth Measurements

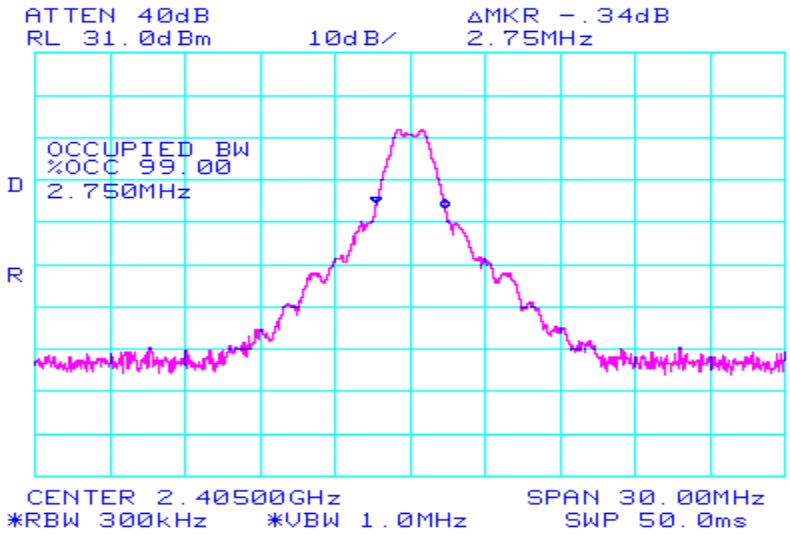


Figure 7: 99%Bandwidth Measurement: f=2405MHz

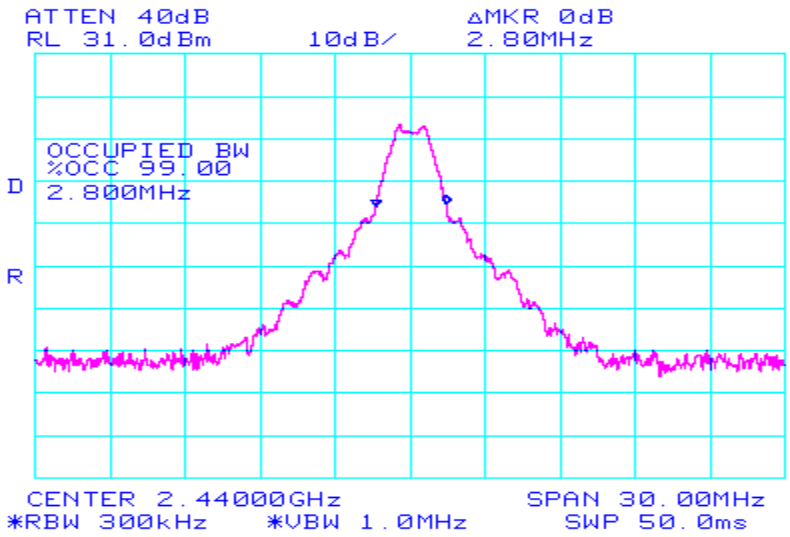


Figure 8: 99%Bandwidth Measurement: f=2440MHz

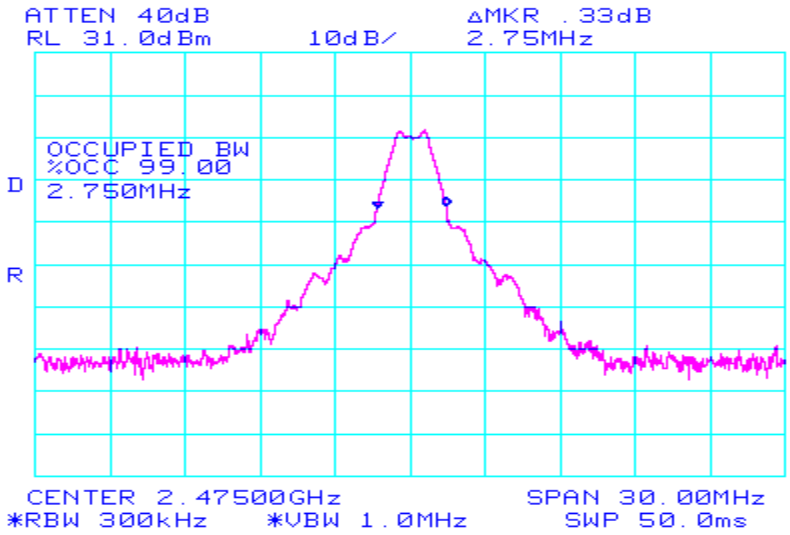


Figure 9: 99%Bandwidth Measurement: f=2475MHz

Part 15.247(e) / RSS-210 A8.2 (b)
Power Spectral Density, conducted

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.

Use the following spectrum analyzer settings:

RBW = 3 kHz
VBW ≥ RBW
Span = > 3 dB bandwidth
Sweep = SPAN/3 kHz
Detector function = peak
Trace = max hold

Tested in Accordance with PSD Option 1

Equipment Used	Model Number	Serial Number	Cal Date	Due
Spectrum Analyzer	HP 8560E	3825A03709	6/09/09	6/09/11
Network Analyzer	Agilent 8753D	3410A04770	3/27/09	3/27/11
Coaxial cable	ESM Cable Corp TB086 AMAM-36		8/26/09	
Date				Tested by
8/26/09				Douglas Knoll

The Agilent 8753D Network Analyzer was used to measure the loss of the coaxial cable.
Unit tested: 16080017

Frequency (MHz)	Corrected Power Spectral Density (dBm)
2405	-1.05
2440	-0.05
2475	-0.38

Table 4: Summary table of Power Spectral Density Measurements

Cable loss of 0.95 dB was added to the spectrum analyzer as a correction. The marker value in the plots is the true corrected value. The cable loss was measured by a calibrated Network Analyzer

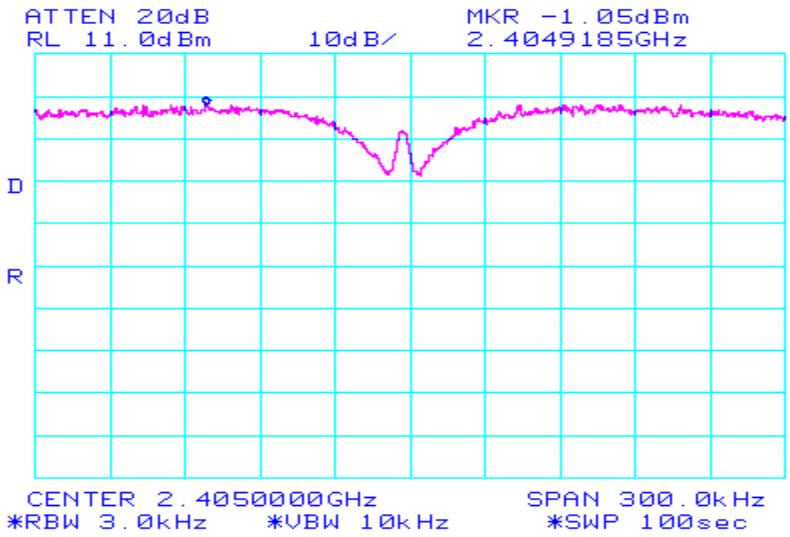


Figure 10: Power Spectral Density Measurement: f=2405MHz

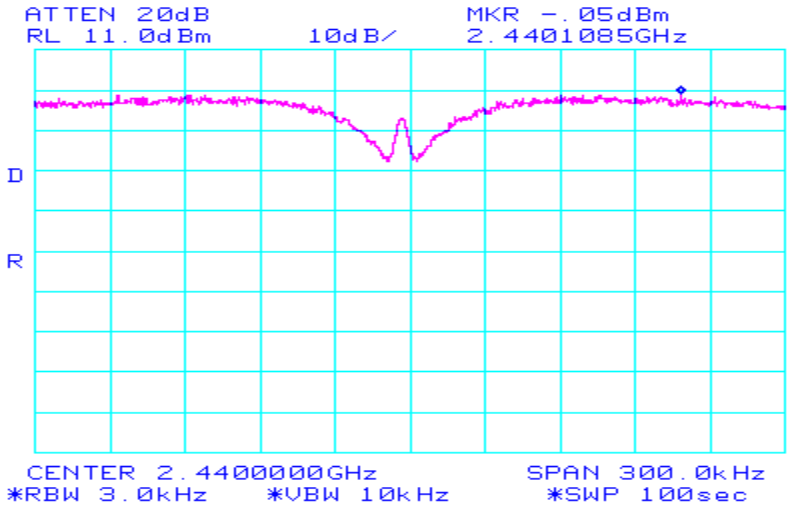


Figure 11: Power Spectral Density Measurement: f=2440MHz

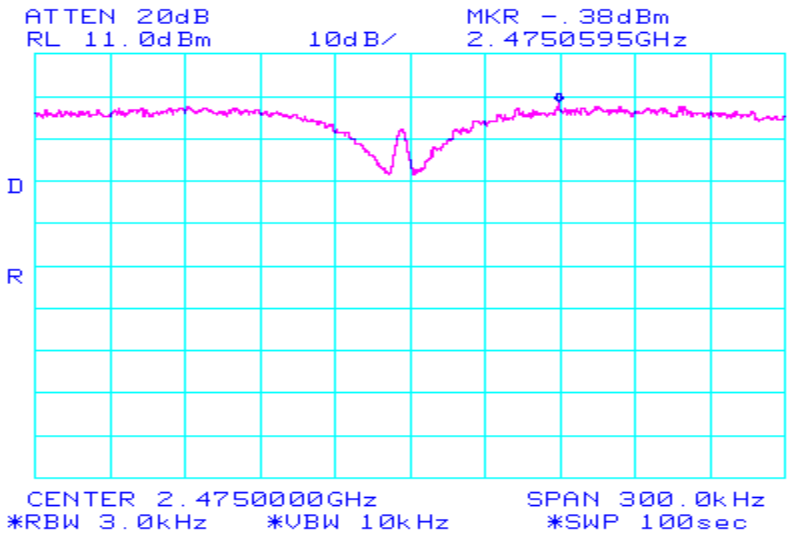


Figure 12: Power Spectral Density Measurement: f=2475MHz

15.247 (d)

Band-edge compliance of RF Conducted Emissions

see spurious emissions section above for rules.

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation
RBW ≥ 1% of the span
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Allow the trace to stabilize. Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission. The marker-delta value now displayed must comply with the limit specified in this Section. Submit this plot.

Equipment Used	Serial Number	Cal Date	Due
HP8560E	3825A03709	6/09/09	6/09/11
Date	Tested by		
8/26/09	Douglas Knoll		

Unit tested: 16080017

Band Edge	dB below channel power in 100kHz RBW
Low (2400MHz/2405MHz)	43.33
High (2483.5MHz/2475MHz)	61.00

Table 5: Summary Table of Conducted Band Edge Measurements

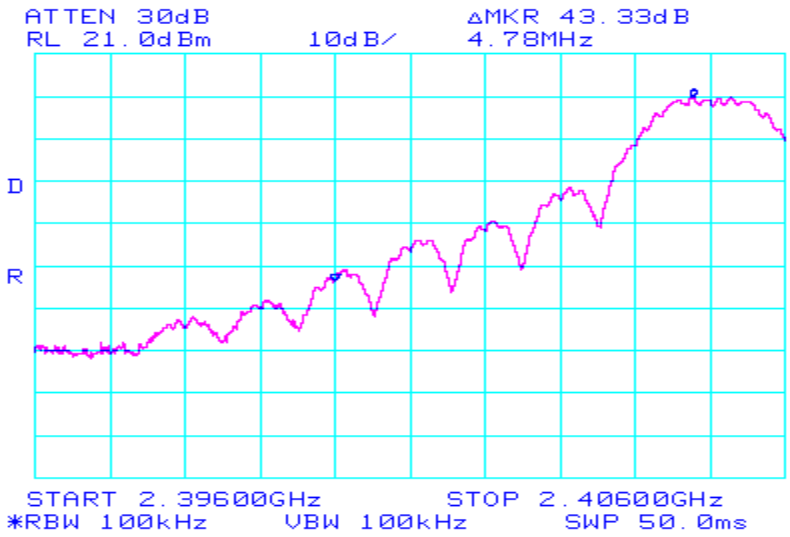


Figure 13: Conducted Band Edge Measurement: f=2400MHz

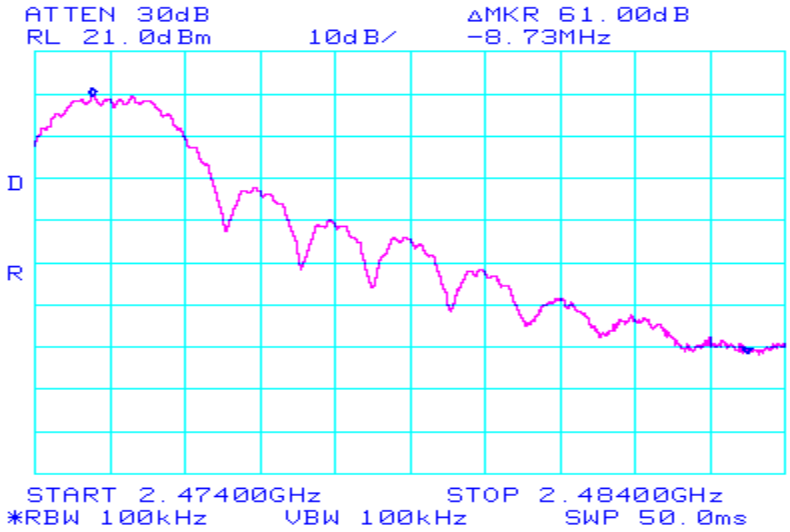


Figure 14: Conducted Band Edge Measurement: f=2483.5MHz

15.247 (d) / RSS-210 A8.5: Spurious RF Conducted Emissions

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,

Unit Tested: 16080017. Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the tenth harmonic.
RBW = 100 kHz
VBW > RBW
Sweep = auto
Detector function = peak
Trace = max hold

Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded. The level displayed must comply with the limit specified.

Equipment Used	Model Number	Serial Number	Cal Date	Due
Spectrum Analyzer	Agilent E7405A	MY45113415	7/31/09	7/31/10
Network Analyzer	Agilent 8753D	3410A04770	3/27/09	3/27/11
Coaxial cable	ESM Cable Corp TB086 AMAM-36		8/26/09	
Date				**Tested by**
8/26/2009				Douglas Knoll

Frequency range investigated was 9 kHz to 26.5 GHz.

Fundamental Frequency (MHz)	Fundamental Power dBm	Spurious RF Frequency (MHz)	Spurious RF Conducted (dBc)
2405	9.396	9620	-51.68
2440	10.39	9760	-53.33
2475	10.1	9900	-54.18

Table 6: Summary table Spurious RF Conducted Emissions

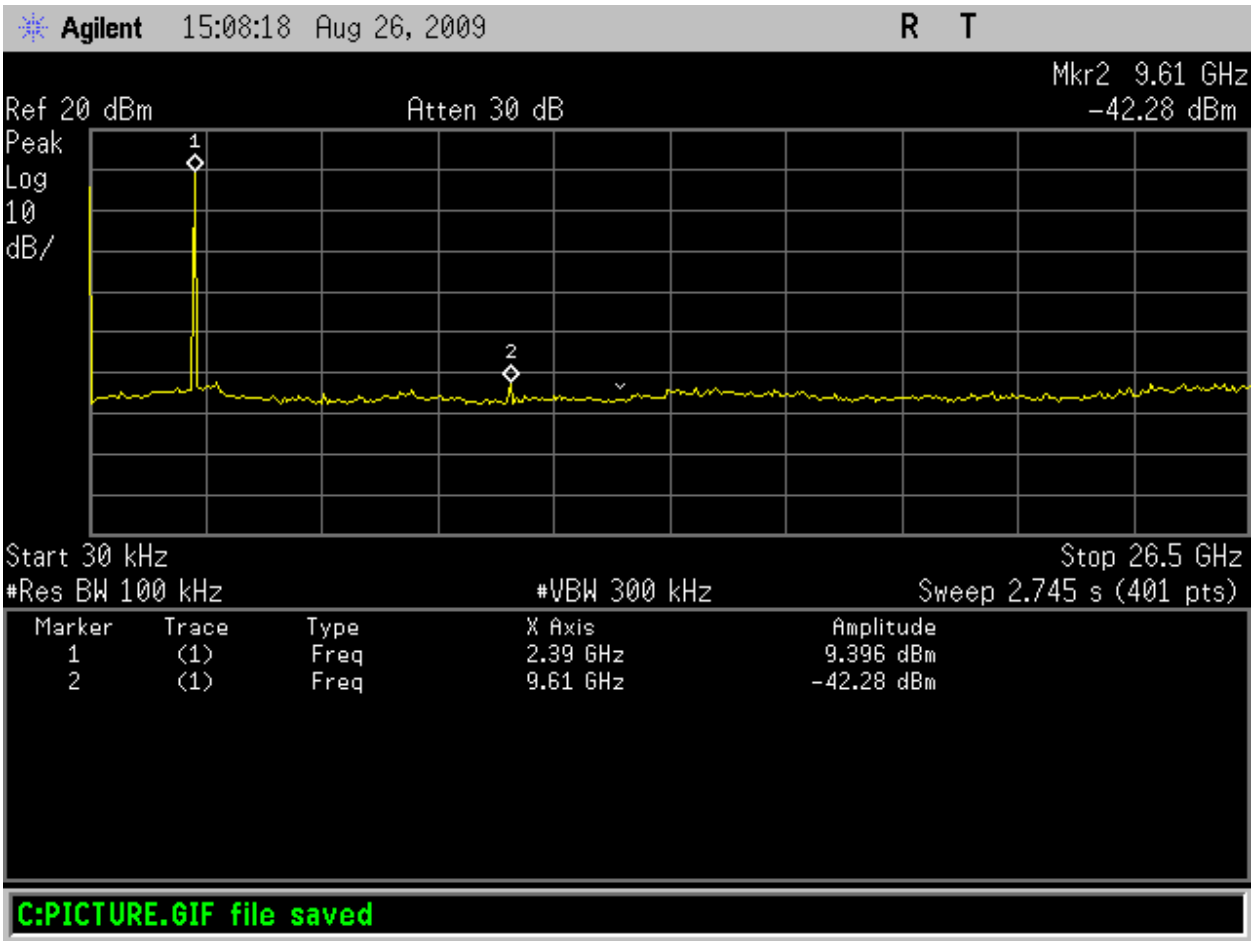


Figure 15: Conducted Spurious Measurement: f=2405MHz

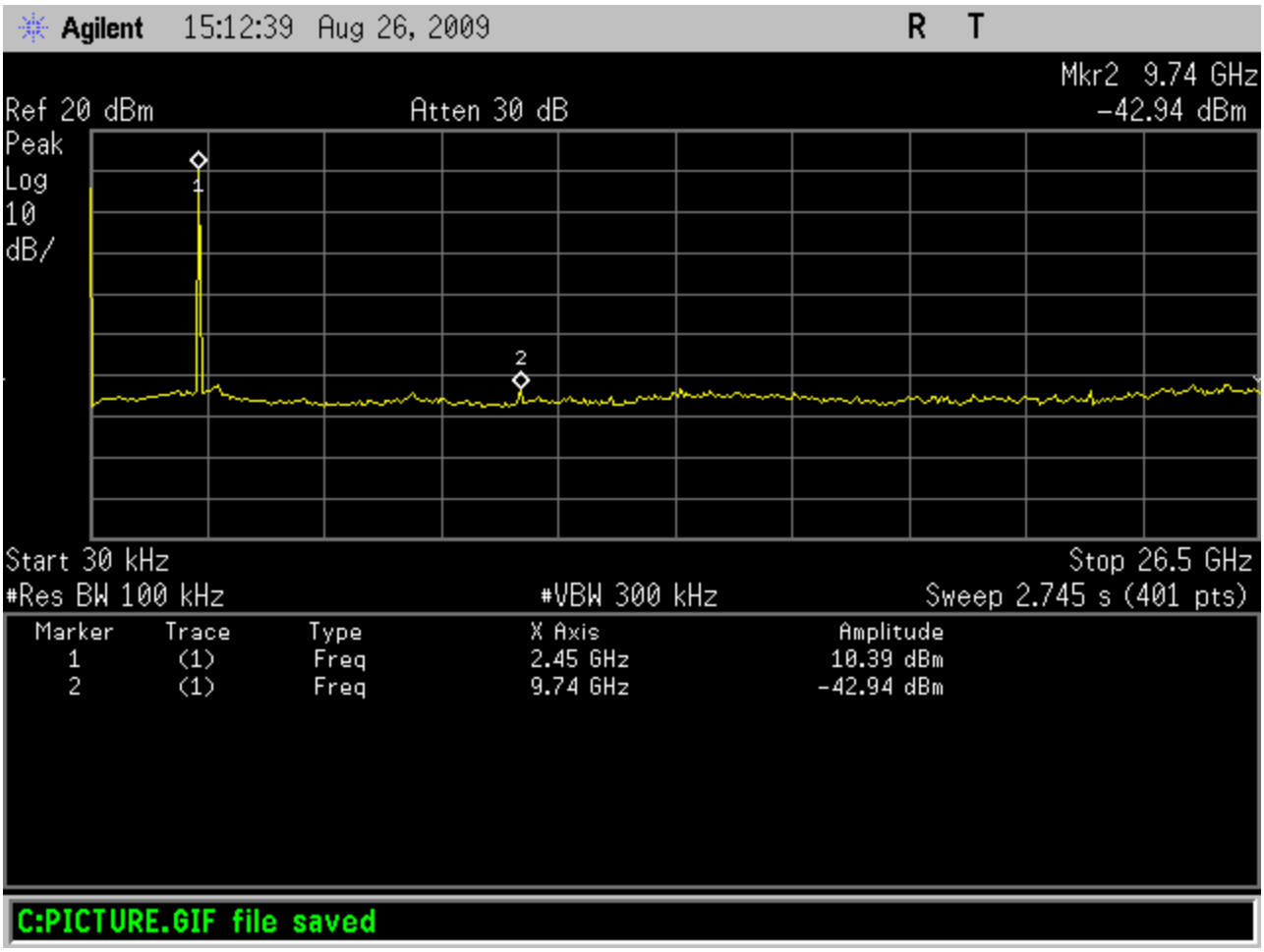


Figure 16: Conducted Spurious Measurement: f=2440MHz

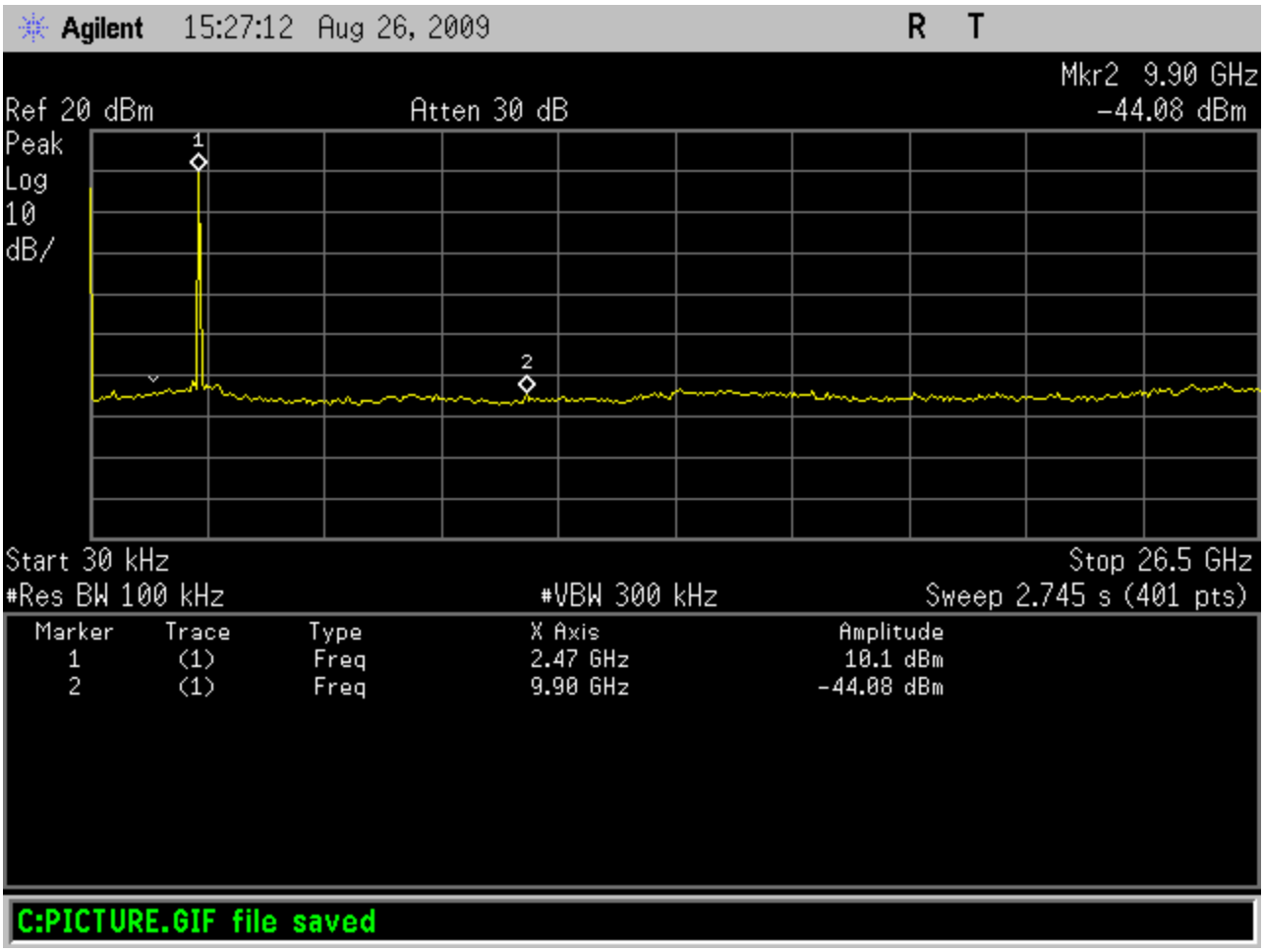


Figure 17: Conducted Spurious Measurement: f=2475MHz

15.247(d) / RSS-210 A8.5

Spurious Emissions - Radiated

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)). (note: 15.247 (b)(3) is for digital modulation.

Follow the procedure outlined in Annex A, and B of this document.

Equipment Used	Serial Number	Cal Date	Due
AH systems preamplifier model PAM 0126	146	3/13/09	3/13/10
Mini-Circuits ZHL 1042J	D021000-23	8/18/09	9/18/10
Agilent 8753D	3410A04770	3/27/09	3/27/11
H/S Sucoflex 40ft cable	220297001	12/03/07	12/03/09
Agilent E7405A Spectrum Analyzer	MY45113415	7/31/09	7/31/10
Emco 6502 Loop (9kHz to 30Mhz)	9509-2970	10/08	10/10
Emco 3110B Biconical (30MHz-to 300MHz)	9807-3129	10/04/07	10/04/09
Emco 3148 Log Periodic (200Mhz to 2GHz)	9901-1044	10/14/08	10/14/10
Emco 3115 wave guide (1GHz-18GHz)	9205-3878	3/17/08	3/17/10
AH systems Horn ant. SAS-572 (18GHz to 26.5GHz)	231	1/27/09	1/27/11
Date	Tested by		
8/12/09	Douglas Knoll		

The fundamental radiated power (listed in the first six rows of the following table) were measured without an amplifier and without a high pass filter. The spurious close to the fundamental was measured with the Mini-Circuits ZHL 1042J amplifier without a high pass filter. The ZHL-1042J has less gain and a higher input compression point. The Agilent 8753D network analyzer was used to calibrate the gain of the ZHL 1042J amplifier. Spurious well away from the fundamental was measured with the PAM 0126 amplifier. Spurious above 3GHz was measured with the PAM 0126 amplifier and the Microwave Circuits H3G020G4 High Pass Filter. The PAM 0126 amplifier has more gain but a lower input compression point. That is why it is used with a HPF to measure spurious above the cut off of the HPF. The amplifier gains in the chart are appropriate for the amp used at that particular frequency.

Unit tested: 19080001

Frequency range investigated was 9 kHz to 26GHz. (part 15.33 (a))

Fundamental frequencies; 2405MHz, 2440MHz, 2475MHz

1	2	3	4	5	6	7	8	9	10	11
Freq. MHz	Ant. Pos. Vert. or Horz.	Antenna Height cm/ Table Azimuth deg	Level dBm	Cable Loss dB	HPF Loss dB	Ant. Cor Factor dB/m	Amplifier Gain dB	peak corrected Level dBuV/m	emissions dBc	Margin dB
2405	V	109.6/188.2	-32.26	4.28		28.27		107.29		
2405	H	106.1/259.8	-27.53	4.28		28.37		112.12		
2440	V	100/6.2	-33.93	4.32		28.36		105.75		
2440	H	103/274.5	-26.97	4.32		28.46		112.81		
2475	V	100/49.8	-34.39	4.35		28.44		105.4		
2475	H	103/274.3	-27.3	4.35		28.54		112.59		
2113.5	V	101.4/174.3	-58.77	4.02		27.57	30.04	49.78	-57.51	37.51
2113.5	H	120.4/85.6	-58.36	4.02		27.67	30.04	50.29	-61.83	41.83
2549	V	100/78.6	-58.26	4.63		28.66	30.25	51.78	-55.51	35.51
2549	H	100/251.6	-51.86	4.63		28.76	30.25	58.28	-53.84	33.84

2056.5	V	106.2/146.3	-62.79	4.11		27.43	30.14	45.61	-60.14	40.14
2056.5	H	100/74.6	-62.43	4.11		27.53	30.14	46.07	-66.74	46.74
2136	V	100/177.5	-62.65	4.19		27.63	30.01	46.16	-59.59	39.59
2136	H	150/93.1	-61.43	4.19		27.73	30.01	47.48	-65.33	45.33
2027	V	100/47.3	-62.64	4.08		27.36	30.19	45.61	-59.79	39.79
2027	H	100/76.3	-59.89	4.08		27.46	30.19	48.46	-64.13	44.13
2099	V	104.6/160.4	-61.98	4.15		27.54	30.08	46.63	-58.77	38.77
2099	H	100/92.9	-61.16	4.15		27.64	30.08	47.55	-65.04	45.04
2175	V	100/179.4	-58.59	4.24		27.72	30.03	50.34	-55.06	30.34
2175	H	117.5/82.8	-56.5	4.24		27.82	30.03	52.53	-60.06	40.06
2625	V	104.3/184.3	-57.49	4.71		28.90	30.48	52.64	-52.76	32.76
2625	H	100/242.3	-55.52	4.71		29.03	30.48	54.74	-57.85	37.85
9620	V	115.1/202.7	-56.96	9.52	0.50	37.87	32.91	65.01	-42.28	22.28
9620	H	121.8/213.3	-60.06	9.52	0.50	37.87	32.91	61.91	-50.21	30.21
9760	V	101.4/287.8	-56.25	9.59	0.45	37.96	32.69	66.06	-39.69	19.69
9760	H	101.1/215.4	-60.64	9.59	0.45	37.96	32.69	61.67	-51.14	31.14
9900	V	111.4/287.5	-60.09	9.66	0.42	38.04	32.48	62.55	-42.85	22.85
9900	H	100.1/218	-63.18	9.66	0.42	38.04	32.48	59.46	-53.13	33.13

[9] = [4] + [5] + [6] +[7] - [8] +107; [10] = [9] – Fundemental radiated level; [11] = -20 – [10]

Table 7: Summary Table of Radiated Spurious Emissions

15.205, 15.209(Radiated) / RSS-210 2.2, 2.6

Restricted Bands Spurious Emissions

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:
(b) Except as provided in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

Equipment Used	Serial Number	Cal Date	Due
Mini-Circuits ZHL 1042J	D021000-23	8/18/09	8/18/10
Agilent 8753D	3410A04770	3/27/09	3/27/11
AH systems preamplifier model PAM 0126	146	3/13/09	3/13/10
H/S Sucoflex 40ft cable	220297001	12/03/07	12/03/09
Agilent E7405A Spectrum Analyzer	MY45113415	7/31/09	7/31/10
Emco 6502 Loop (9kHz to 30Mhz)	9509-2970	10/08	10/10
Emco 3110B Biconical (30MHz-to 300MHz)	9807-3129	10/04/07	10/04/09
Emco 3148 Log Periodic (200Mhz to 2GHz)	9901-1044	10/14/08	10/14/10
Emco 3115 wave guide (1GHz to 18GHz)	9205-3878	3/17/08	3/17/10
AH systems Horn ant. SAS-572 (18GHz to 26.5GHz)	231	1/27/09	1/27/11
Date	Tested by		
8/07/09	Douglas Knoll		

Measure the field strength of all transmitter spurious emissions in the restricted bands listed below. Follow the procedure outlined in Annex A and B of this document.

MHz	MHz	MHz	GHz
0.090-0.110	13.36-13.41	399.9-410	5.35-5.46
0.495-0.505 (FCC)	16.42-16.423	608-614	7.25-7.75
2.1735-2.1905	16.69475-16.69525	960- 1427*	8.025-8.5
4.125-4.128	16.80425-16.80475	1435-1626.5	9.0-9.2
4.17725-4.17775	25.5-25.67	1645.5-1646.5	9.3-9.5
4.20725-4.20775	37.5-38.25	1660-1710	10.6-12.7
5.677-5.683 (IC)	73-74.6	1718.8-1722.2	13.25-13.4
6.215-6.218	74.8-75.2	2200-2300	14.47-14.5
6.26775-6.26825	108-121.94	2310-2390	15.35-16.2
6.31175-6.31225	123-138	2483.5-2500	17.7-21.4
8.291-8.294	149.9-150.05	2655-2900**	22.01-23.12
8.362-8.366	156.52475-156.52525	3260-3267	23.6-24.0
8.37625-8.38675	156.7-156.9	3332-3339	31.2-31.8
8.41425-8.41475	162.0125-167.17	3345.8-3358	36.43-36.5
12.29-12.293	167.72-173.2	3600-4400	Above 38.6
12.51975-12.52025	240-285	4.5-5.15	
12.57675-12.57725	322-335.4		

- for reference the FCC has relaxed some of the restricted bands and IC has not. In the FCC rules today: *960-1240 and *1300-1427MHz; **2690-2900MHz;

Unit tested: 19080001

Average power levels are to be measured on spurious signals above 1GHz. This may be implemented by changing the video bandwidth filter to 10Hz (RBW=1MHz). However the E7405A analyzer does not have a 10Hz video bandwidth filter. For the average power data in this report, a 30Hz video bandwidth filter was used. Since the testing was done on a continuous signal with 100% duty cycle, the 30Hz video filter will give an absolute reading that will be higher than if a 10Hz filter were used. The true margin under the average power limit in a restricted band will be better than recorded here

Per KDB-558074 DTS Measurement, . a *Duty Cycle Correction Factor* (20log(TX time/100mS)) can be applied to show compliance to the 15.209 limit.

.The Maximum TX on time during any 100mS window for this device is 10mS.
20 log (10ms / 100mS) = -20dB

Spurious Emission Limits

Frequency (MHz)	Field Strength (microvolts/meter)	in dBuV/m	Measurement Distance (meters)	maximum Peak +20 over Avg limit dBuV/m
0.009-0.490 2400F	2440F (kHz)		300	
0.490-1.705 24000F	2400F (kHz)		30	
1.705-30.0	30	29.5	30	49.5
30-88	100	40	3	60
88-216	150	43.5	3	43.5
216-960	200	46	3	66
Above 960	500	54	3	74

FS (dBuV/) = 20 * log (FS(uV/m)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
								VBW RBW	1MHz 1MHz			30Hz 1MHz		
Freq. MHz	Ant. Position cm/pol	Table Azimuth Degrees	Peak Level dBm	Avg Level dBm	High Pass Filter dB	Cable Loss dB	Ant. Factor dB/m	Amplifier Gain dB	Peak Corrected Level dBuV/m	Peak Limit dBuV/m	Peak Margin dB	Average Corrected Level dBuV/m	Average Limit dBuV/m	Average Margin dB
1237.5	136.4/V	245.9	-64.96	-74.76		3.24	24.69	29.54	40.43	74	33.57	10.63	54	43.37
1385.3	127.6/V	235.3	-63.52	-72.73		3.40	24.81	29.31	42.38	74	31.62	13.17	54	40.83
1500.3	100.3V	199.3	-64.15	-73.63		3.52	24.9	29.8	41.47	74	32.53	11.99	54	42.01
2213.5	100V	198.6	-63.72	-74.71		4.28	27.81	30.24	45.13	74	28.87	14.14	54	39.86
2213.5	111.1H	269.7	-64.12	-73.22		4.28	27.91	30.24	44.83	74	29.17	15.73	54	38.27
2257.5	181.6V	224.4	-59.1	-65.02		4.32	27.92	30.58	49.56	74	24.44	23.64	54	30.36
2257.5	143.3H	267.7	-56.17	-61.32		4.32	28.02	30.58	52.59	74	21.41	27.44	54	26.56
1526	107.9V	214.3	-63.01	-70.66		3.55	25.02	29.83	42.73	74	31.27	15.08	54	38.92
2311.8	209.1V	206.3	-61.74	-71.91		4.38	28.05	30.74	46.95	74	27.05	16.78	54	37.22
2311.8	135.9H	264.1	-59.49	-69.31		4.38	28.15	30.74	49.30	74	24.70	19.48	54	34.52
2326.8	208.6V	208.7	-57.82	-63.19		4.40	28.08	30.70	50.96	74	23.04	25.59	54	28.41
2326.8	135H	257.3	-54.42	-59.42		4.40	28.18	30.70	54.46	74	19.54	29.46	54	24.54
4810	113.9V	160.3	-60.73	-70.48	0.21	6.55	32.80	34.79	51.04	74	22.96	21.29	54	32.71
4810	111.1H	297.3	-56.95	-66.25	0.21	6.55	32.76	34.79	54.78	74	19.22	25.48	54	28.52
4880	102.8V	167.3	-58.54	-68.22	0.18	6.60	32.91	34.84	53.31	74	20.69	23.63	54	30.37
4880	122H	288.2	-56.7	-66.02	0.18	6.60	32.88	34.84	55.12	74	18.88	25.80	54	28.20
4950	100V	167.9	-58.74	-68.75	0.19	6.65	33.02	34.89	53.24	74	20.76	23.23	54	30.77
4950	126.4H	113	-58.36	-68.18	0.19	6.65	33.01	34.89	53.61	74	20.39	23.79	54	30.21
7215	100V	290.8	-56.89	-67.36	0.16	8.12	35.70	34.63	59.46	74	14.54	28.99	54	25.01
7215	105.5H	197.3	-60.97	-71.33	0.16	8.12	35.82	34.63	55.50	74	18.50	25.14	54	28.86
7320	133.3V	297.1	-56.36	-67.67	0.16	8.18	36.00	34.62	60.36	74	13.64	29.05	54	24.95

7320	131.2H	202.6	-58.87	-69.35	0.16	8.18	36.07	34.62	57.92	74	16.08	27.44	54	26.56
7425	100.2V	228.9	-60.73	-71.51	0.13	8.24	36.29	34.60	56.34	74	17.66	25.56	54	28.44
7425	103.1H	216.8	-61.02	-71.05	0.13	8.24	36.32	34.60	56.08	74	17.92	26.05	54	27.95

Table 8: Summary Table of Restricted Band Radiated Spurious Emissions

[10] = [4]+[6]+[7]+[8]-[9]+107; [12] = [11]-[10]; [11] from table above
[13] = [5]+[6]+[7]+[8]-[9] +107- Duty Cycle Factor; [15] = [14]-[13]; [14] from table above

15.247 (d)

Band-edge compliance of RF Radiated Emissions

see spurious emissions section above for rules.

Also, Refer to Restricted Bands Spurious Emissions Radiated section above as the adjacent bands here are Restricted Bands and particular attention was paid to meeting those levels.

Equipment Used	Serial Number	Cal Date	Due
Mini-Circuits ZHL 1042J	D021000-23	8/18/09	8/18/10
Agilent 8753D	3410A04770	3/27/09	3/27/11
H/S Sucoflex 40ft cable	220297001	12/03/07	12/03/09
Agilent E7405A Spectrum Analyzer	MY45113415	7/31/09	7/31/10
Emco 3115 wave guide (1GHz to 18GHz)	9205-3878	3/17/08	3/17/10
Mini-Circuits ZHL 1042J		8/18/09	
Agilent 8753D	3410A04770	3/27/09	3/27/11
Date	Tested by		
8/07/09	Douglas Knoll		

The Agilent 8753D Network Analyzer was used to calibrate the gain of the ZHL 1042J amplifier.

Unit tested: 19080001

Frequency (MHz)	Polarity	Angle of DUT (degrees)	Height of Antenna (cm)	Reading (Peak or Average)	Corrected Maximum Reading (dBuV/m @ 3m)	Avg. reading w/ 10%duty cycle (dBuV/m@3cm)	Radiated Limit dBuV/m	Margin dB
2390	Vertical	30.1	104.8	Peak	50.47		74	23.53
2390	Vertical	30.1	104.8	Average	39.74	19.74	54	34.26
2483.5	Vertical	45.5	100	Peak	48.99		74	25.01
2483.5	Vertical	45.5	100	Average	38.09	18.09	54	35.91
2390	Horizontal	280.5	105	Peak	57.48		74	16.52
2390	Horizontal	280.5	105	Average	46.35	26.35	54	27.65
2483.5	Horizontal	281	101.8	Peak	56.03		74	17.97
2483.5	Horizontal	281	101.8	Average	46.3	26.3	54	27.7

Table 9: Summary Table of Radiated Restricted Band Edge Measurements

Band-Edge Measurement Plots @ 3 meters

2310 - 2390 MHz & 2483.5 - 2500 MHz

***Note: All calibration factors for test equipment are entered into the spectrum analyzer (E7405A). The reported data and plots reflect the corrected reading except a duty cycle correction factor has not been been applied. Since maximum duty cycle is 10%, the average readings will actually be at least 20dB lower than shown here. These plots show that all the band edges comply with limits even if duty cycle is not taken into account.*

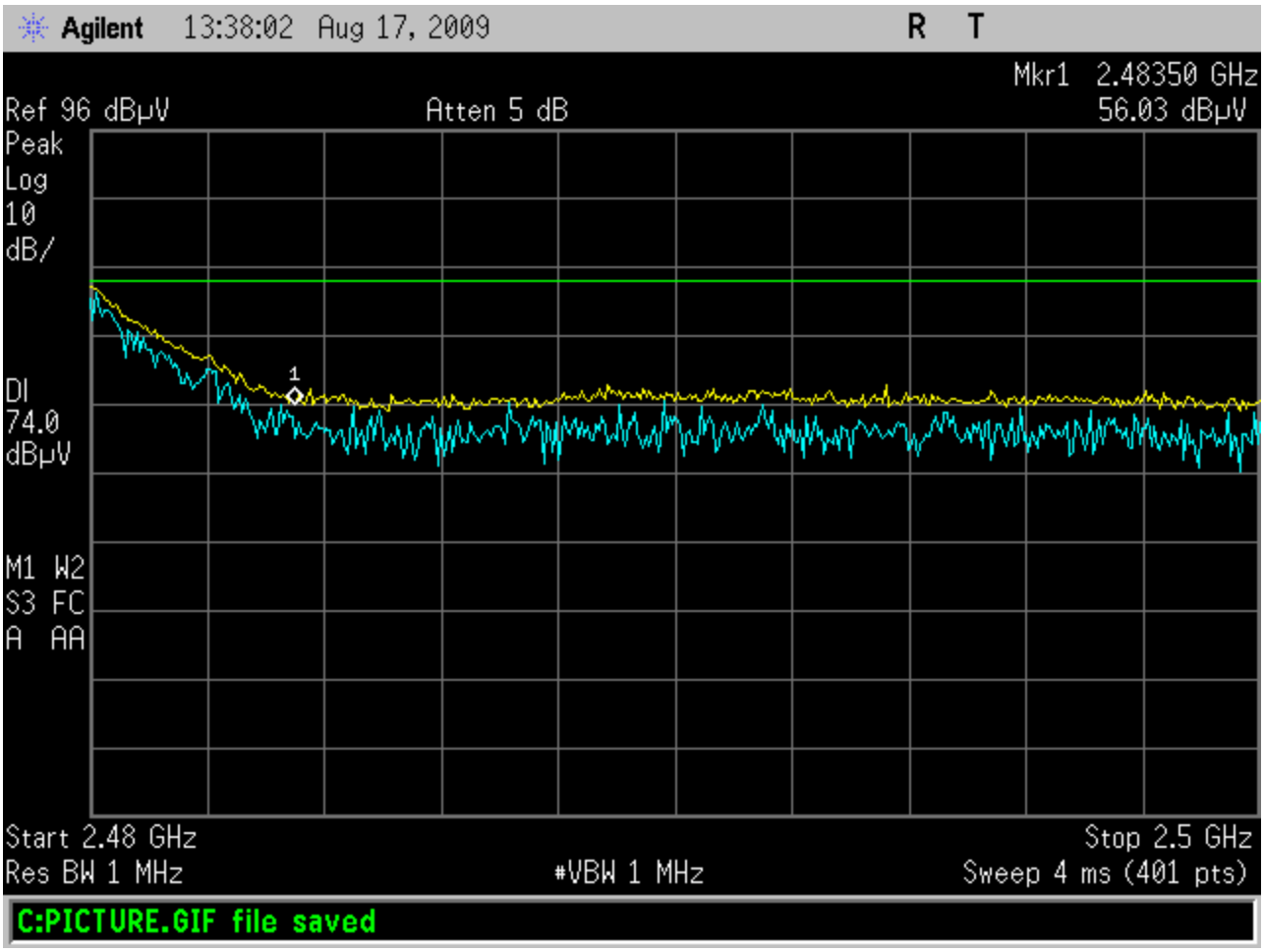


Figure 18: Peak Horizontal Radiated Band Edge (2475MHz Fundemental)

Figure 19: Average Horizontal Radiated Band Edge (2475MHz Fundemental)

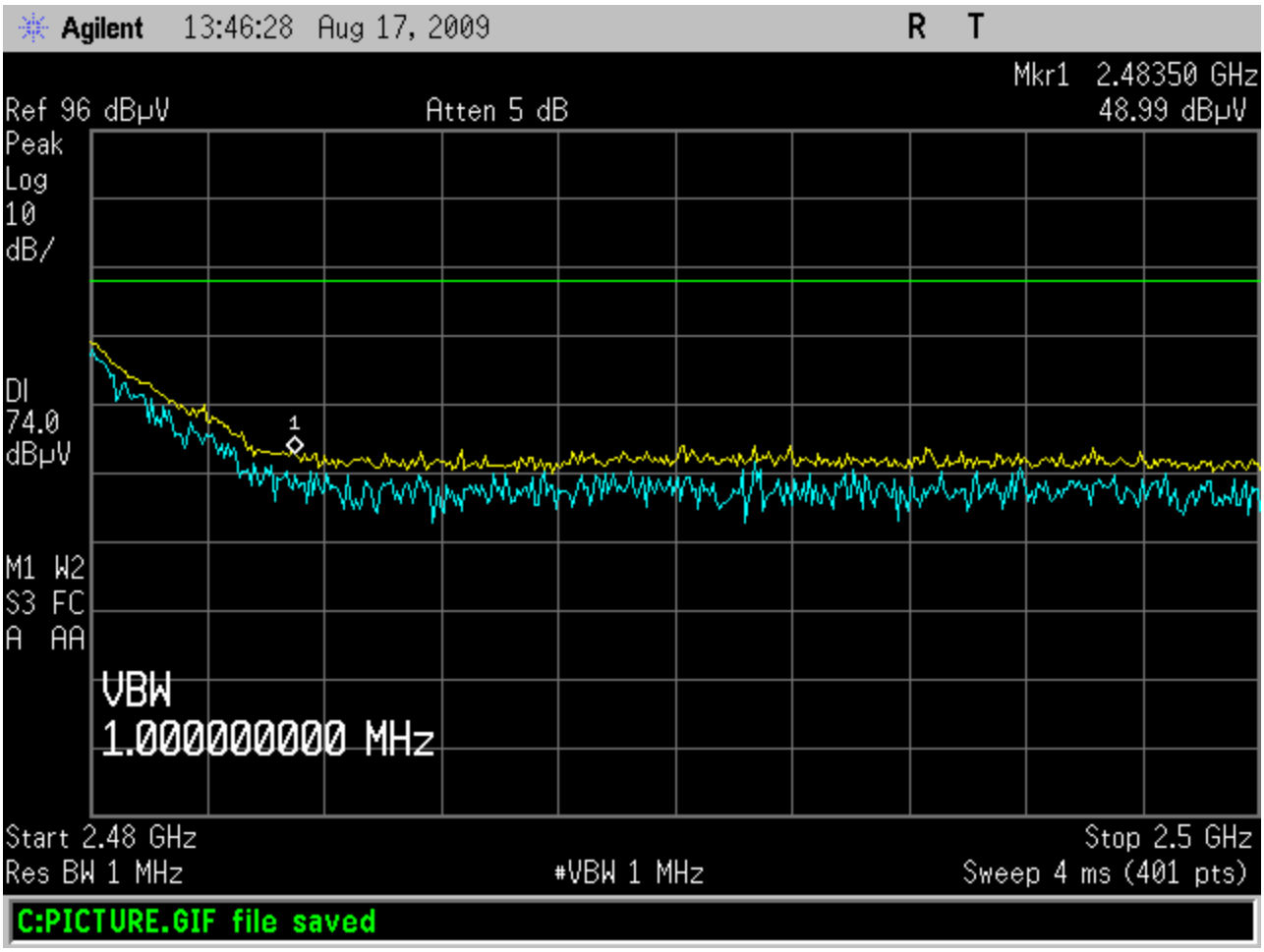


Figure 20: Peak Vertical Radiated Band Edge (2475MHz Fundemental)

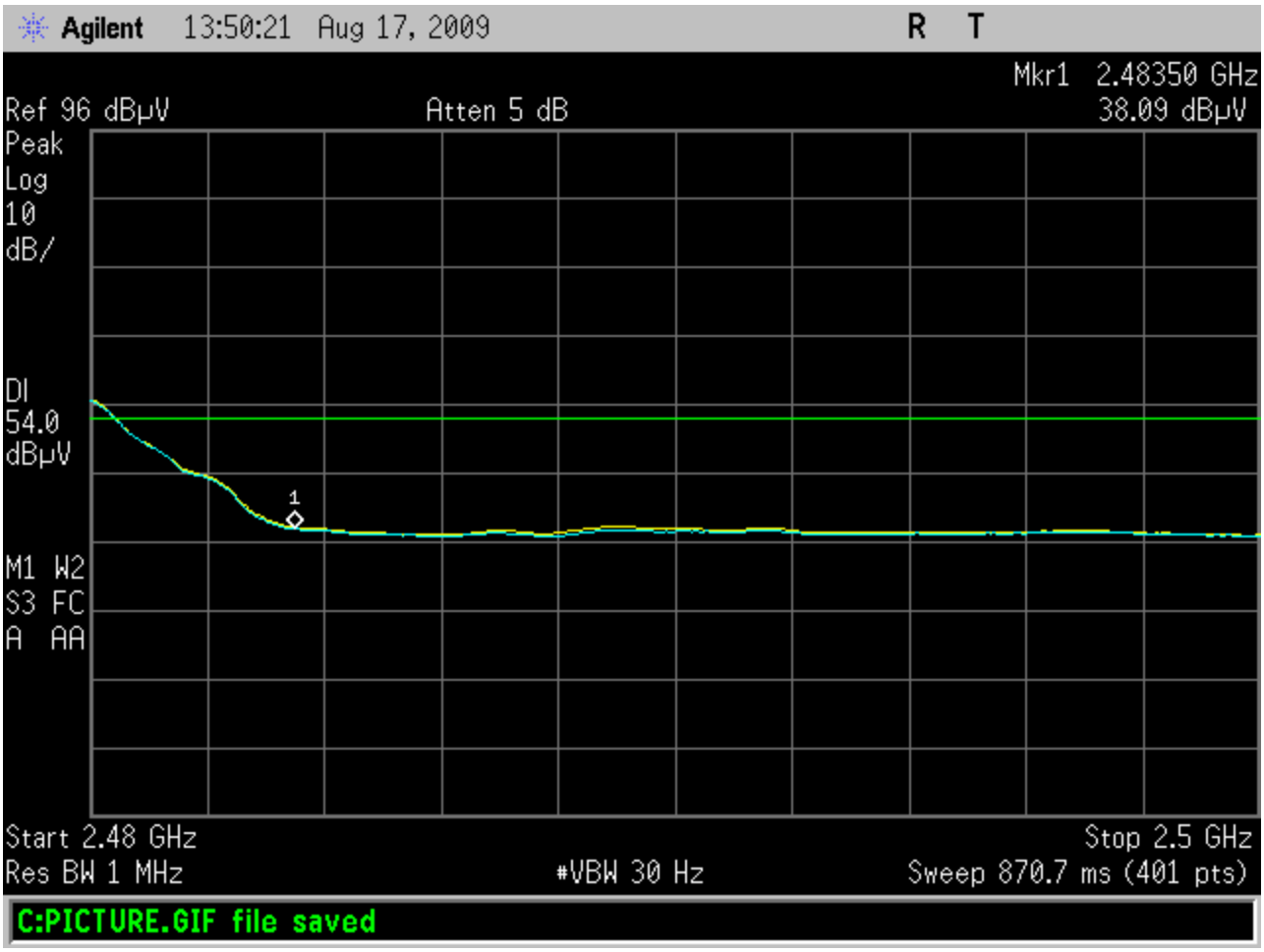


Figure 21: Average Vertical Radiated Band Edge (2475MHz Fundemental)

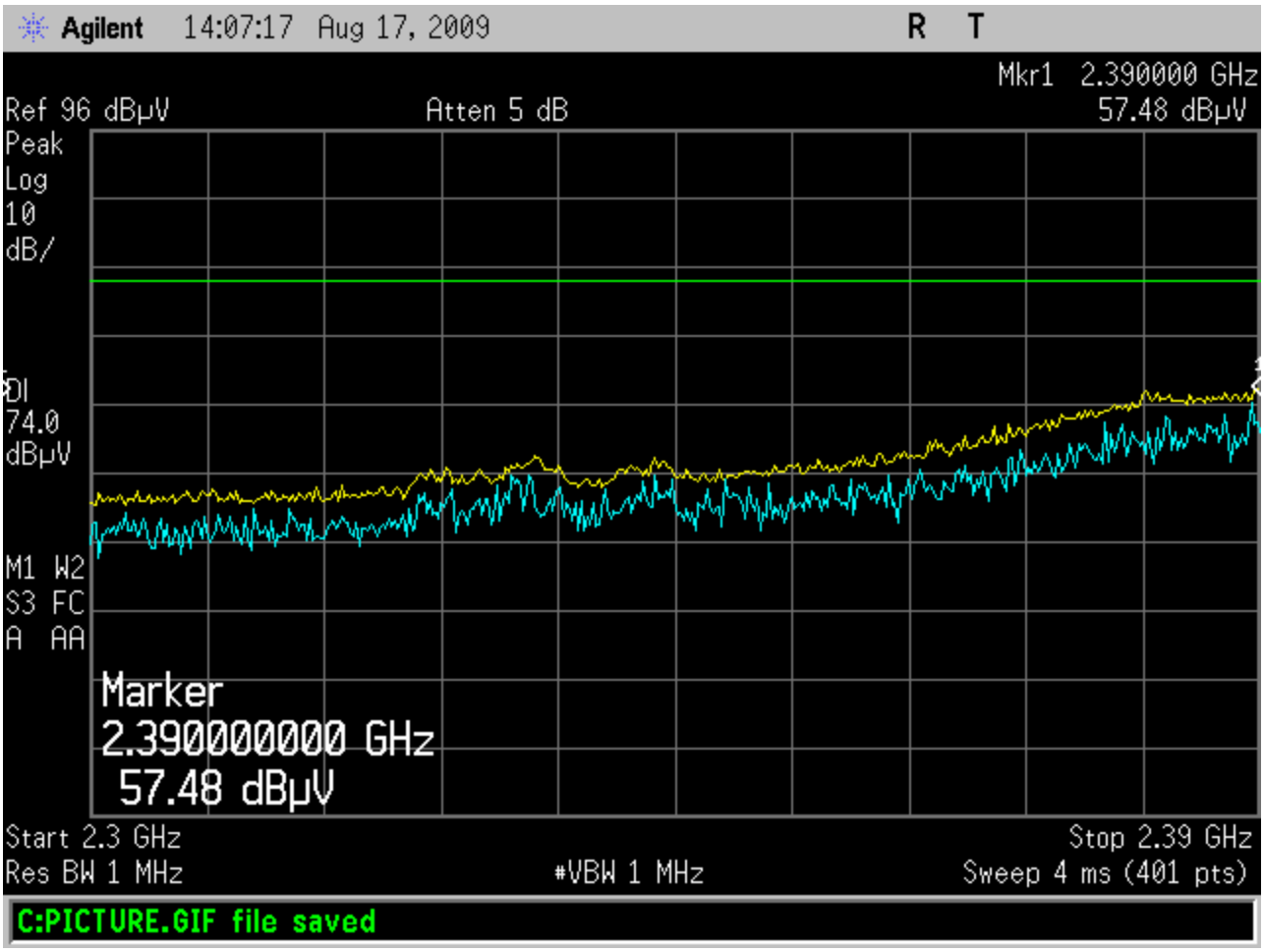


Figure 22: Peak Horizontal Radiated Band Edge (2405MHz Fundemental)

Figure 23: Average Horizontal Radiated Band Edge (2405MHz Fundemental)

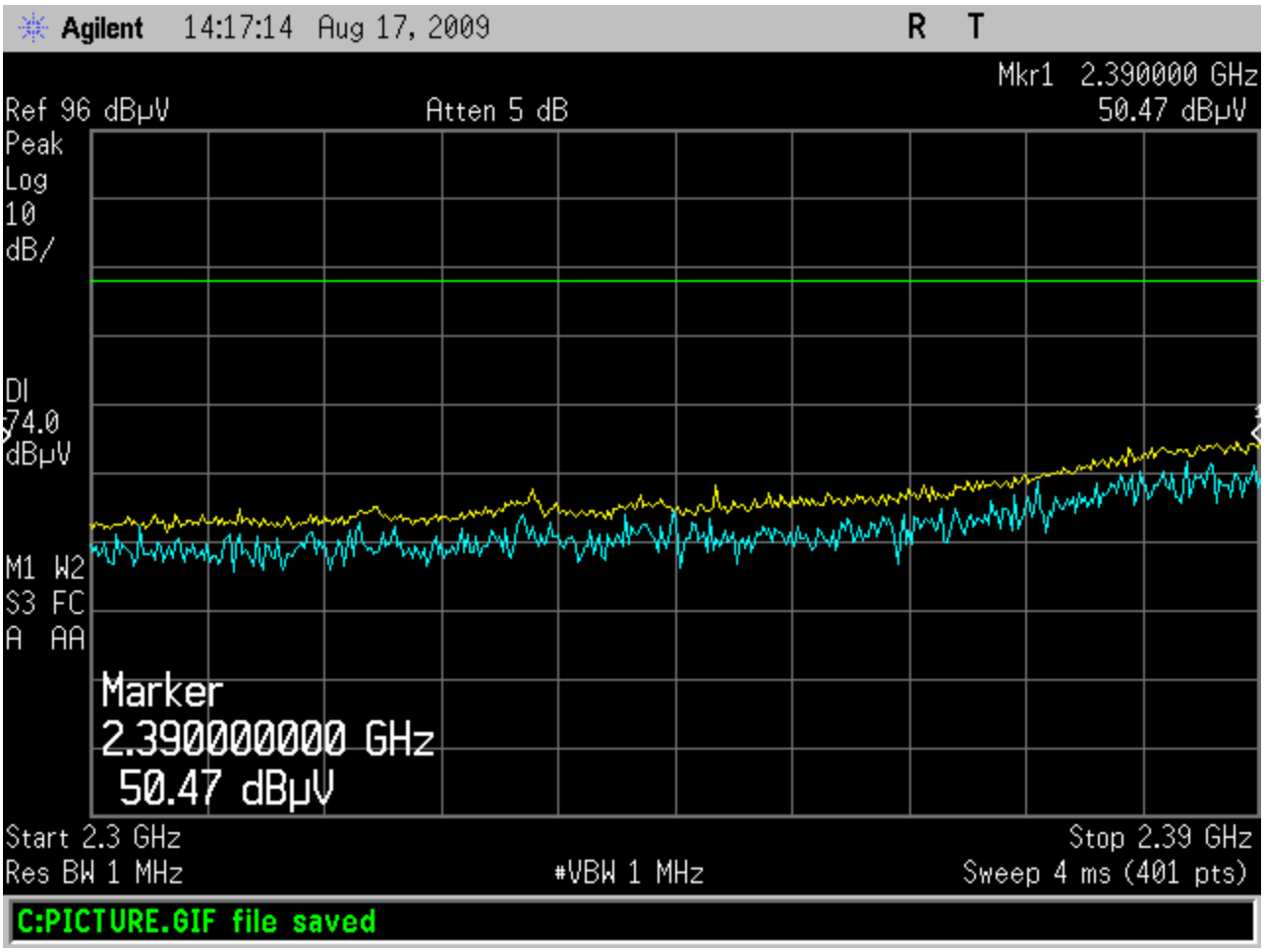


Figure 24: Peak Vertical Radiated Band Edge (2405MHz Fundemental)

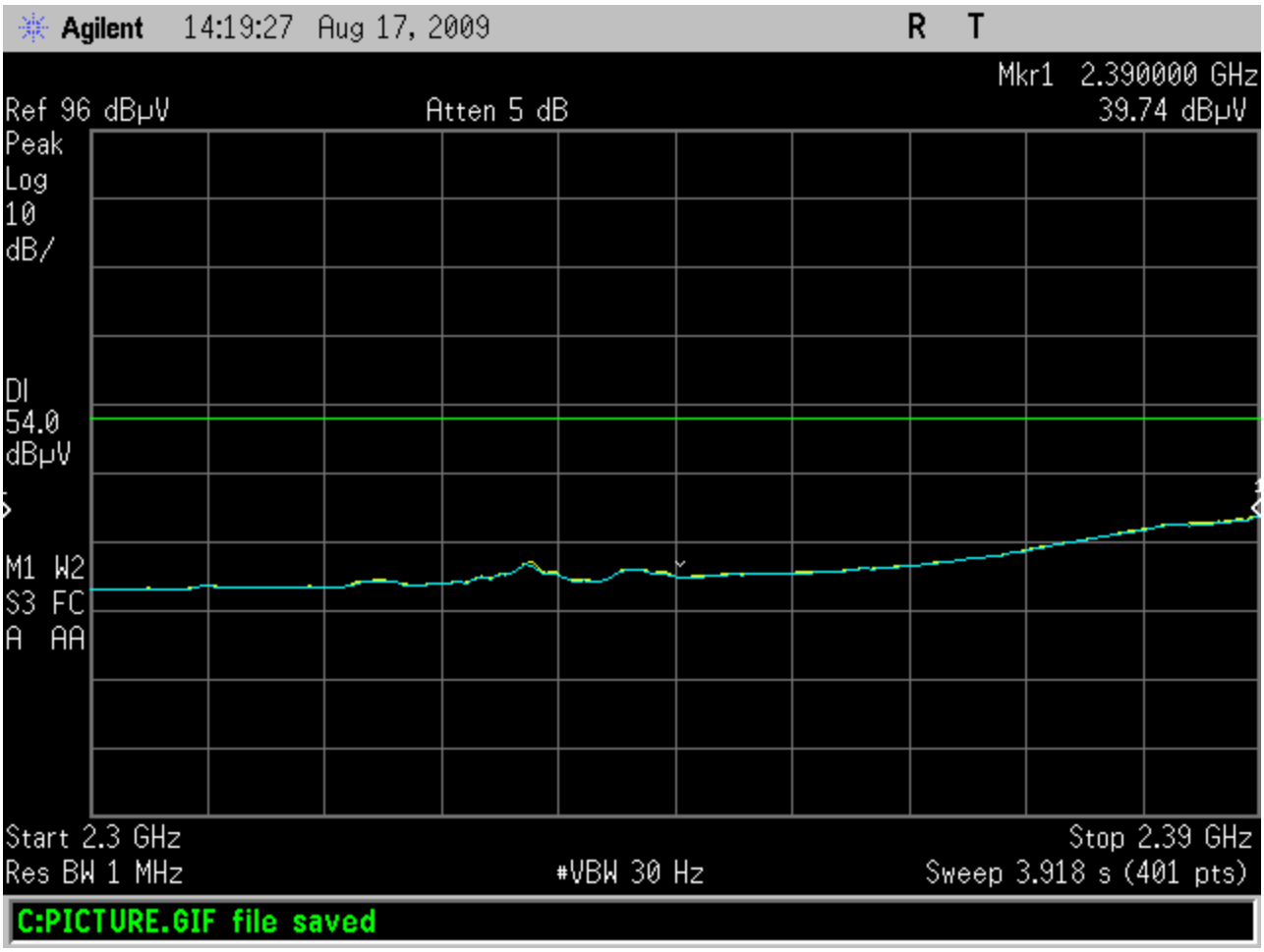


Figure 25: Average Vertical Radiated Band Edge (2405MHz Fundemental)

RSS-Gen 7.2.3 Receiver Spurious Emission Limits

7.2.3.2 Radiated Measurement

All spurious emissions shall comply with the limits of Table 1.

Receiver Spurious Emissions

The receiver shall be operated in the normal receive mode near the mid-point of the band over which the receiver is designed to operate. Unless otherwise specified in the applicable RSS, the radiated emission measurement is the standard measurement method (with the device's antenna in place) to measure receiver spurious emissions. Radiated emission measurements are to be performed using a calibrated open-area test site. As an alternative, the conducted measurement method may be used when the antenna is detachable. In such a case, the receiver spurious signal may be measured at the antenna port. …..the search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is the higher, to at least 3 times the highest tunable or local oscillator frequency, whichever is the higher, without exceeding 40 GHz.

Receiver Spurious Emission Standard

The following receiver spurious emission limits shall be complied with:

(a) If a radiated measurement is made, all spurious emissions shall comply with the limits of Table 1. The resolution bandwidth of the spectrum analyzer shall be 100 kHz for spurious emission measurements below 1.0 GHz, and 1.0 MHz for measurements above 1.0 GHz.

Equipment Used	Serial Number	Cal Date	Due
Agilent E7405A Spectrum Analyzer	MY45113415	7/31/09	7/31/10
Huber&Suhner 40 foot cable	220297 001	12/03/07	12/03/09
AH systems preamplifer model number PAM 0126	146	3/13/09	3/13/10
Emco 3110B Biconical (30MHz-to 300MHz)	9807-3129	10/04/07	10/04/09
Emco 3148 Log Periodic (200Mhz to 2GHz)	9901-1044	10/14/08	10/14/10
Emco 3115 waveguide (1Ghz - 18GHz)	9205-3878	3/17/08	3/17/10
Date	Tested by		
8/12/09	Douglas Knoll		

Unit tested: 19080002

Spurious Frequency (MHz)	Field Strength (microvolt/m at 3 meters)	in dBuV/m
30-88	100	40
88-216	150	43.5
216-960	200	46
Above 960	500	54

FS(uV/m) = 10 raised to the power of {(dBuV/m)/20}

Table 10- Spurious Emission Limits for Receivers

Frequency range investigated was 30MHz to 15 GHz.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
								VBW RBW	1MHz 1MHz			30Hz 1MHz		
Freq. MHz	Ant. Position cm/pol	Table Azimuth Degrees	Peak Level dBm	Avg Level dBm	High Pass Filter dB	Cable Loss dB	Ant. Factor dB/m	Amplifier Gain dB	Peak Corrected Level dBuV/m	Peak Limit dBuV/m	Peak Margin dB	Average Corrected Level dBuV/m	Average Limit dBuV/m	Average Margin dB
4806	103.2V	280.2	-63.03	-68.18	0.21	6.55	32.76	34.79	48.70	74	25.30	43.55	54	10.45
4806	109.1H	301.2	-64.06	-70.7	0.21	6.55	32.76	34.79	47.67	74	26.33	41.03	54	12.97
4876	101.2V	286.5	-62.9	-69.17	0.18	6.60	32.88	34.84	48.92	74	25.08	42.65	54	11.35
4876	107.4H	300.6	-64.04	-70.61	0.18	6.60	32.88	34.84	47.78	74	26.22	41.21	54	12.79
4946	100V	280.8	-62.93	-68.71	0.19	6.65	33.01	34.88	49.05	74	24.95	43.27	54	10.73
4946	131.4H	321.8	-64.17	-71.03	0.19	6.65	33.01	34.88	47.81	74	26.19	40.95	54	13.05

Table 11: Summary Table of Receiver Spurious Measurements

[10] = [4]+[6]+[7]+[8]-[9]+107; [12] = [11]-[10]; [11] from table above
[13] = [5]+[6]+[7]+[8]-[9] +107; [15] = [14]-[13]; [14] from table above

1.1310 & 2.1091 / RSS-102

Maximum Permissible Exposure (MPE)

Determine the maximum power density for the general / uncontrolled population minimum separation distance of 20 cm.

FCC Limit: f > 1500 MHz = 1mW/cm^2; IC Limit: f=1500 to 15000 MHz = 10W/m^2

The power density is calculated as:

$$P_d = \frac{P_t \times G}{4 \times \pi \times r^2}$$

P_d = power density in watts
P_t = transmit power in milliwatts
G = numeric antenna gain
r = distance between body and transmitter in centimeters.

Other Technical Information:
Antenna Type: Omni
Antenna Gain: 0 dBi
Transmitter Power (Conducted): 34mW
Frequency: 2440 MHz

---

results: P_D = (34x 1) / (4 x pi x 20cm^2) =0.00676mW/cm$^{2=}$ 0.0676W/m^2 @ 20 cm

ANNEX A

direct from FCC KDB-558074 DTS Measurement

Section 15.247(c) – Spurious emissions.
The following tests are required:
1. **RF antenna conducted test:** Set RBW = 100 kHz, Video bandwidth (VBW) > RBW, scan up through 10th harmonic. All harmonics/spurs must be at least 20 dB down from the highest emission level within the authorized band *as measured with a 100 kHz RBW. Note: If the device complies with the use of power option 2 the attenuation under this paragraph shall be 30 dB instead of 20 dB.*
2. **Radiated emission test:** Applies to harmonics/spurs that fall in the restricted bands listed in Section 15.205. The maximum permitted average field strength is listed in Section 15.209. A pre-amp (and possibly a high-pass filter) is necessary for this measurement. For measurements above 1 GHz, set RBW = 1MHz, VBW = 10 Hz, Sweep: Auto. If the emission is pulsed, modify the unit for continuous operation; use the settings shown above, then correct the reading by subtracting the peak-average correction factor, derived from the appropriate duty cycle calculation. See Section 15.35(b) and (c).
Section 15.247(d) – Power spectral density (PSD).
The same method of determining the conducted output power shall be used to determine the power spectral density. If a peak output power is measured, then a peak power spectral density measurement is required. If an average output power is measured, then an average power spectral density measurement should be used. Use PSD Option 1 if Power output Option 1 was used. Use PSD Option 2 if power output Option 2 was used.

PSD Option 1
Locate and zoom in on emission peak(s) within the passband. Set RBW = 3 kHz, VBW > RBW, sweep= (SPAN/3 kHz) e.g., for a span of 1.5 MHz, the sweep should be $1.5 \times 10^6 \div 3 \times 10^3 = 500$ seconds. The peak level measured must be no greater than + 8 dBm. If external attenuation is used, don't forget to add this value to the reading. Use the following guidelines for modifying the power spectral density measurement procedure when necessary.

• For devices with spectrum line spacing greater than 3 kHz no change is required.
• For devices with spectrum line spacing equal to or less than 3 kHz, the resolution bandwidth must be reduced below 3 kHz until the individual lines in the spectrum are resolved. The measurement data must then be normalized to 3 kHz by summing the power of all the individual spectral lines within a 3kHz band (in linear power units) to determine compliance.
• If the spectrum line spacing cannot be resolved on the available spectrum analyzer, the noise density function on most modern conventional spectrum analyzers will directly measure the noise power density normalized to a 1 Hz noise power bandwidth. Add 35 dB for correction to 3 kHz.
• Should all the above fail or any controversy develop regarding accuracy of measurement, the FCC Laboratory will use the HP 89440A Vector Signal Analyzer for final measurement unless a clear showing can be made for a further alternate.

PSD Option 2
Locate and zoom in on emission peak(s) within the passband.

• Set RBW = 3 kHz.
• Set VBW > 9 kHz.
• Set Sweep time to Automatic
• Use a peak detector. A sample detector mode can be used only if the following can be achieved with automatic sweep time and adjusting the bin width. 1. Bin width (i.e., span/number of points in spectrum display) < 0.5 RBW. 2. The transmission pulse or sequence of pulses remains at maximum transmit power throughout each of the 100 sweeps of averaging and that the interval between pulses is not included in any of the sweeps (e.g., 100 sweeps should occur during one transmission, or each sweep gated to occur during a transmission).
Note: If condition 2 cannot be achieved, then PSD Option 1 (peak detector on max hold) must be used and trace averaging cannot be used.
• Use a video trigger with the trigger level set to enable triggering only on full power pulses. Transmitter must operate at full control power for entire sweep of every sweep. If the device transmits continuously, with no off intervals or reduced power intervals, the trigger may be set to "free run".
- 6 -
• Trace average 100 traces in power averaging mode. Do not use video averaging mode.
Note: Some analyzers will automatically select sample mode when trace averaging is selected. If a peak detector is used, then peak detector must be manually selected when trace averaging is enabled.

ALTERNATIVE TEST PROCEDURES
If antenna conducted tests cannot be performed on this device, radiated tests to show compliance with the various conducted requirements of Section 15.247 are acceptable. As stated previously, a pre-amp must be used in making the following measurements.

1. Calculate the transmitter's peak power using the following equation:
Where: E = the measured maximum field strength in V/m.
Set the RBW > 6dB bandwidth of the emission or use a peak power meter.
P = (E x d) squared / (30 x G)
G = the numeric gain of the transmitting antenna over an isotropic radiator.
d = the distance in meters from which the field strength was measured.
P = the power in watts for which you are solving:

2. Measure the power spectral density as follows:

A. Tune the analyzer to the highest point of the maximized fundamental emission.
Reset the analyzer to a RBW = 3 kHz, VBW > RBW, span = 300 kHz, sweep =
100 sec.

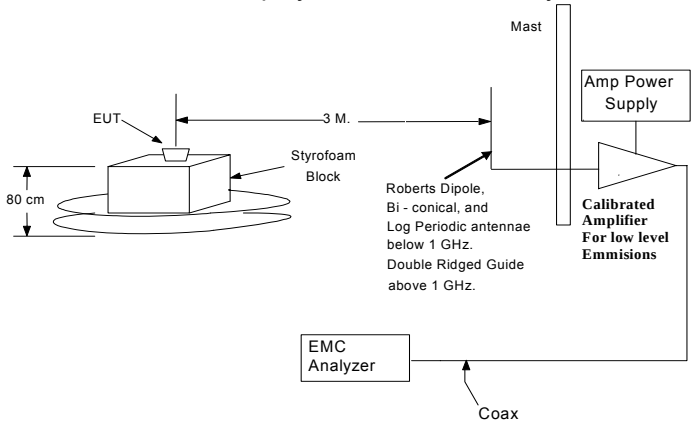
B. From the peak level obtained in (A), derive the field strength, E, by applying the appropriate antenna factor, cable loss, pre-amp gain, etc. Using the equation listed in (1), calculate a power level for comparison to the + 8 dBm limit. Note: The above settings are used for peak measurements. The optional procedures for output power and power spectral density measurements can be used when applicable.

ANNEX B

Field Strength Measurement Procedure

This test measures the field strength of radiated emissions using a spectrum analyzer and a receiving antenna in accordance with ANSI C63.4-2003. During the test, the EUT is to be placed on a non-conducting support at 80 cm above the horizontal ground plane of the OATS. The horizontal distance between the antenna and the EUT is to be 3 meters. The bandwidths used shall be; 200 Hz from 9 kHz to 150 kHz, 9 kHz from 150 kHz to 30 MHz, 120 kHz from 30 MHz to 1000 MHz, and 1 MHz from 1 GHz to 40 GHz, with the detector set to peak hold.

1) The antenna correction factor, preamplifier gain (if the preamplifier is installed), and cable loss may be stored in tables in the EMC analyzer and the level at the analyzer is then the corrected level in dbuV/m. Otherwise it is calculated externally.
2) Monitor the frequency range of interest at a fixed antenna height and EUT azimuth.
3) If appropriate, manipulate the system cables to produce the highest amplitude signal relative to the limit. Note the amplitude and frequency of the suspect signal.
4) Rotate the EUT 360° to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, go back to the azimuth and repeat step 3). Otherwise, orient the EUT azimuth to repeat the highest amplitude observation and proceed.
5) Move the antenna over its fully allowed range of travel to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, return to step 3) with the antenna fixed at this height. Otherwise, move the antenna to the height that repeats the highest amplitude observation and proceed.
6) Change the polarity of the antenna and repeat step 3), step 4), and step 5). Compare the resulting suspected highest amplitude signal with that found for the other polarity. Select and note the higher of the two signals.
7) The final maximized level displayed on the EMC analyzer is the field strength.



ANNEX C

Several of the FCC / IC rules that are referenced.

Section 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.

1997 FCC Decisions, Amendment of Parts 2 and 15. 7 CR 534, 12 FCC Rcd 7488, 62 FR 26239, 1997 FCC LEXIS 1927. FCC 917-114 Report and Order, Released: April 10, 1997:
Section 15.247(c): Spurious emissions. The following tests are required:

(1) RF antenna conducted test: Set RBW = 100 kHz, Video bandwidth (VBW) > RBW, scan up through 10th harmonic. All harmonics/spurs must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100 kHz RBW.
(2) Radiated emission test: Applies to harmonics/spurs that fall in the restricted bands listed in Section 15.205. The maximum permitted average field strength is listed in Section 15.209. A pre-amp (and possibly a high-pass filter) is necessary for this measurement. For measurements above 1 GHz, set RBW = 1 MHz, VBW = 10 Hz, Sweep: Auto. If the emission is pulsed, modify the unit for continuous operation, use the settings shown above, then correct the reading by subtracting the peak-average correction factor, derived from the appropriate duty cycle calculation. See Section 15.35(b) and (c).

§15.33 Frequency range of radiated measurements.
(a) For an intentional radiator, the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to at least the frequency shown in this paragraph:
(1) If the intentional radiator operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Section 15.35 Measurement detector functions and bandwidths. - The conducted and radiated emission limits shown in this part are based on the following, unless otherwise specified elsewhere in this part:

(a) …((a) does not apply to this report)

(b) Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz. When average radiated emission measurements are specified in this part, including average emission measurements below 1000 MHz, there also is a limit on the peak level of the radio frequency emissions. Unless otherwise specified, e.g., see §§15.250, 15.252, 15.255, and 15.509-15.519, the limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device, e.g., the total peak power level. Note that the use of a pulse desensitization correction factor may be needed to determine the total peak emission level. The instruction manual or application note for the measurement instrument should be consulted for determining pulse desensitization factors, as necessary.

(c) Unless otherwise specified, e.g. §15.255(b), when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to Declaration of Conformity or verification.

RSS-GEN 4.9 Transmitter Unwanted Emissions:
The search for unwanted emissions shall be from the lowest frequency internally generated or used in the device (local oscillator, intermediate or carrier frequency), or from 30 MHz, whichever is the lower, to the 5^{th} harmonic of the highest frequency generated without exceeding 40 GHz.