REGULATORY COMPLIANCE REPORT

TITLE:FCC&IC Test Report for 15.247&RSS-210 Frequency Hopping Device, 100GDLD
AUTHOR: Mark Kvamme

REV	CCO	DESCRIPTION OF CHANGE	DATE	APPROVALS	
001		INITIAL RELEASE	05may09	Engineering	
				Regulatory	

REVISION HISTORY

001a		answer non-conforms of 12may		Engineering	
				Regulatory	
				Engineering	
				Regulatory	
				Engineering	
				Regulatory	

Test Data Summary

FCC 15.247 / IC RSS-210
Frequency Hopping Transmitter 100GDLC, 908 – 924 MHz
FCC ID: EO9100GDLD
IC ID: 864D-100GDLD
Device Models (for IC): Model 3 and Model 4
Item Numbers: ERG-5002-005 to -006
Serial Numbers: FCC 247, 9001 Std
OATS Registration Number: FCC 90716, IC 864D

Rule	Description	Max. Reading	Pass/Fail
Part 15.247 (a)(1)	System Receivers	Match this device	Pass
Part 15.31(e)	Variation of Input Voltage – Conducted	N/A	N/A
Part 15.207 / RSS-Gen 7.2.2	AC Power line Conducted Emissions	N/A	N/A
Part 15.247(a)(1) / RSS-210 A8.1(b)	Carrier Frequency Separation – Conducted	200 kHz @ 915Mhz	Pass
Part 15.247(a)(1)(i) / RSS-210 A8.1(c)	Number of Hopping Channels – Conducted	50	Pass
Part 15.247(a)(1)(i) / RSS 210 8.1 (a)	20dB Bandwidth – Conducted	106 Khz @ 913 Mhz	Pass
Part 15.247(b) (2) / RSS-210 A8.4(1)	Power Output – Conducted	0.188 Watts @ 908 Mhz	Pass
Part 15.247(d) / RSS-210 A8.5	Spurious Emissions – Radiated	-24.06 dbc @ 1816 Mhz	Pass
Parts 15.205 & 15.209 / RSS-210 2.2, 2.6 Tables 1 & 2	Restricted Bands / Spurious Emissions – Radiated	Average 48.14 dbuV/m @ 4620 Mhz Peak 68.25 dbuV/m @ 4575 Mhz	Pass
Part 15.247(a)(1)(i);(g); (h) / RSS-210 A8.1(c)	Time of Occupancy, Short Burst, Intelligence	282.75 ms in 20 sec.	Pass
RSS-Gen 7.2.3	Receiver Spurious Emissions	27 dbuV/m	Pass
Parts 1.1310 / RSS-102	Limits for Maximum Permissible Exposure (MPE)	FCC 0.045 mW / cm^2 @ 20 cm IC 0.445 W / M^2 @ 0.2M	Pass
15.247 (d)	Band-edge compliance of RF Conducted Emissions	-44.94 dbc	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
Mark Kvamme	Test Technician
Name	Title
Jay Holcomb	R&D Regulatory Manager
Name	Title
Jon Mueller	R&D Manager

15.247(a)(1)

System receivers

… … …The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

THIS DEVICE IS OPERATED IN SYSTEMS THAT THE READING DEVICES, HAVE INPUT BANDWIDTHS THAT MATCH THIS DEVICE AND THAT STAY IN SYNCRONIZATION.

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. BATTER IS NOT RECHARGABLE. 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 50μH/50Ω 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 (dBμV)	Average (dBμV)
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. BATTER IS NOT RECHARGABLE.   THERFORE THIS TEST IS N/A.

15.247(a) (1) / RSS-210 A8.1 (b)

Carrier Frequency Separation

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Verify that the channel separation is > the 20dB bandwidth of a single transmission.
The EUT must have its hopping function enabled. Use the following analyzer settings:

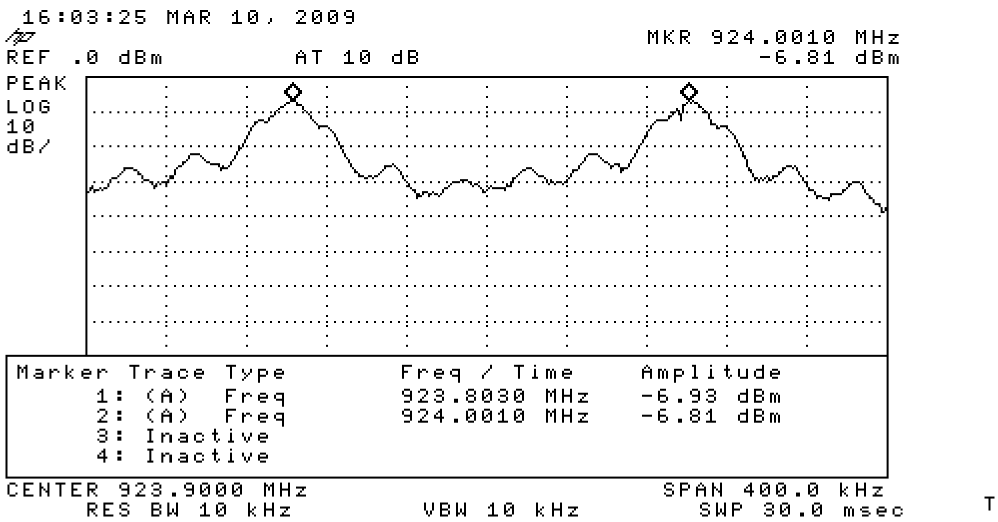
RBW ≥ 1% of the span
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

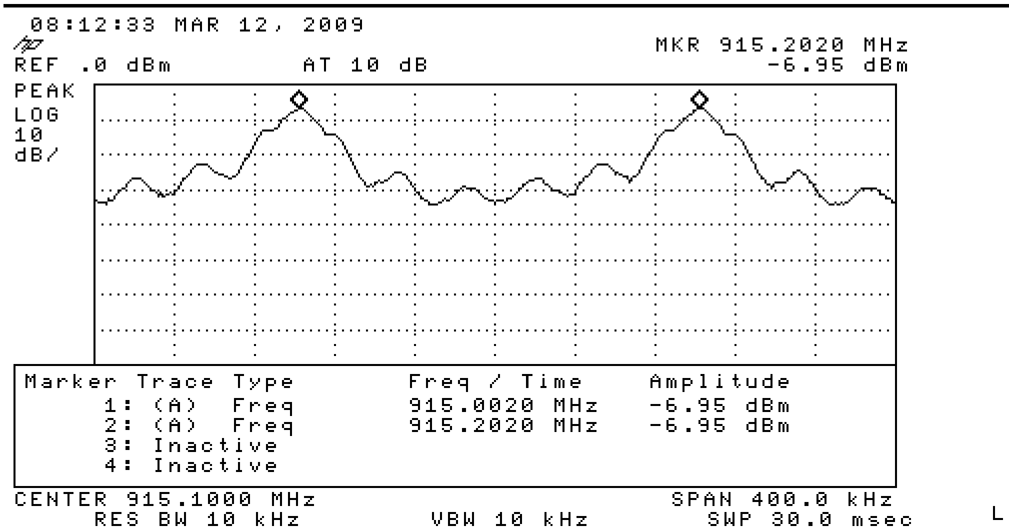
Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

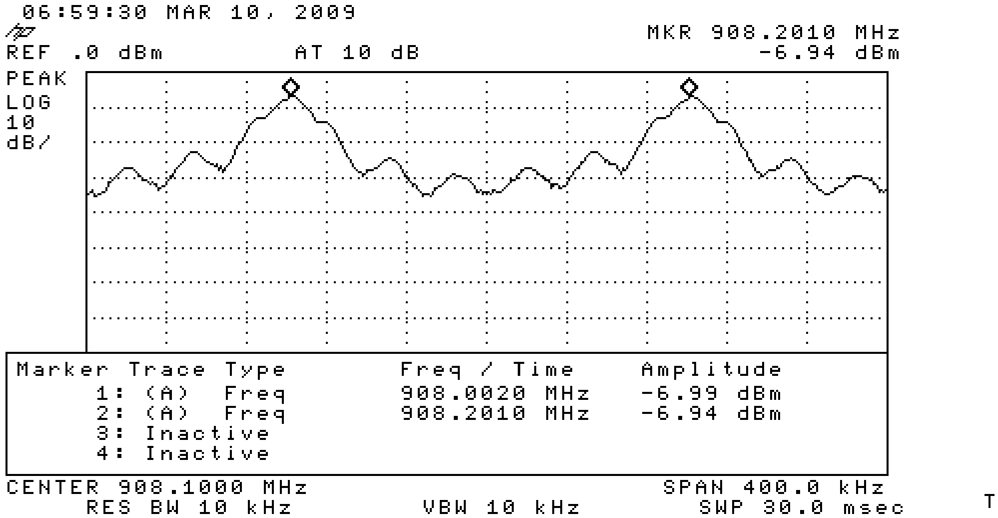
Equipment Used	Serial Number	Cal Date	Due
Hewlett Packard 8593E Spectrum Analyzer	3543A02032	09-dec-08	09-dec-09
Date	Tested by		
3/10/2009	Mark Kvamme		

Unit tested: ID 9001 Standard Code 1.14. A new battery was installed for testing.

channels	Channel separation
Low (908Mhz)	199KHz
Middle (915.2Mhz)	200KHz
High (924Mhz)	198KHz


16:03:25 MAR 10, 2009
MKR 924.0010 MHz
REF .0 dBm AT 10 dB -6.81 dBm
PEAK
LOG
10
dB/
Marker Trace Type Freq / Time Amplitude
1: (A) Freq 923.8030 MHz -6.93 dBm
2: (A) Freq 924.0010 MHz -6.81 dBm
3: Inactive
4: Inactive
CENTER 923.9000 MHz SPAN 400.0 kHz
RES BW 10 kHz VBW 10 kHz SWP 30.0 msec
T


08:12:33 MAR 12, 2009
MKR 915.2020 MHz
REF .0 dBm AT 10 dB -6.95 dBm
PEAK
LOG
10
dB/
Marker Trace Type Freq / Time Amplitude
1: (A) Freq 915.0020 MHz -6.95 dBm
2: (A) Freq 915.2020 MHz -6.95 dBm
3: Inactive
4: Inactive
CENTER 915.1000 MHz SPAN 400.0 kHz
RES BW 10 kHz VBW 10 kHz SWP 30.0 msec
L


06:59:30 MAR 10, 2009
MKR 908.2010 MHz
REF .0 dBm
AT 10 dB
-6.94 dBm
PEAK
LOG
10
dB/
Marker Trace Type
Freq / Time
Amplitude
1: (A) Freq
908.0020 MHz
-6.99 dBm
2: (A) Freq
908.2010 MHz
-6.94 dBm
3: Inactive
4: Inactive
CENTER 908.1000 MHz
SPAN 400.0 kHz
RES BW 10 kHz
VBW 10 kHz
SWP 30.0 msec
T

15.247(a) (1) (i) / RSS-210 A8.1 (c)

Number of Hopping Channels

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies.

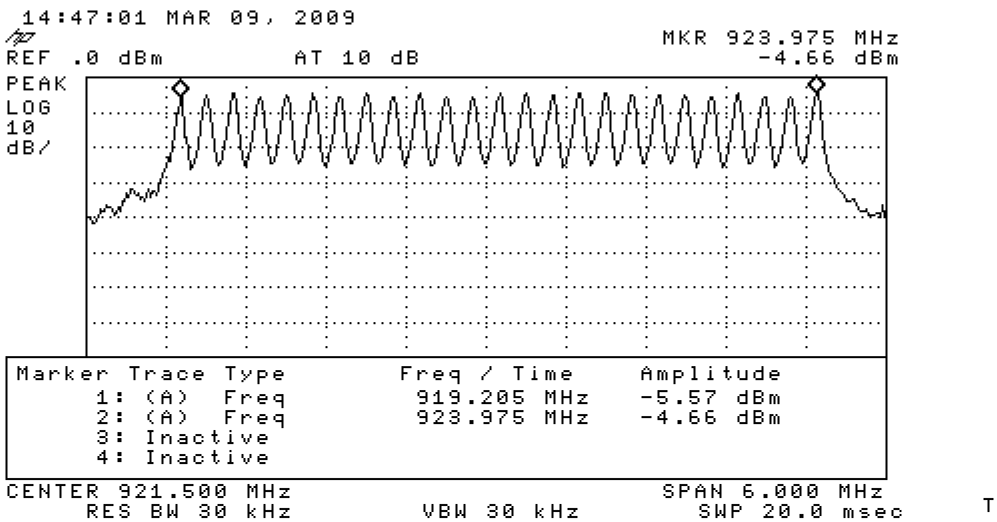
The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

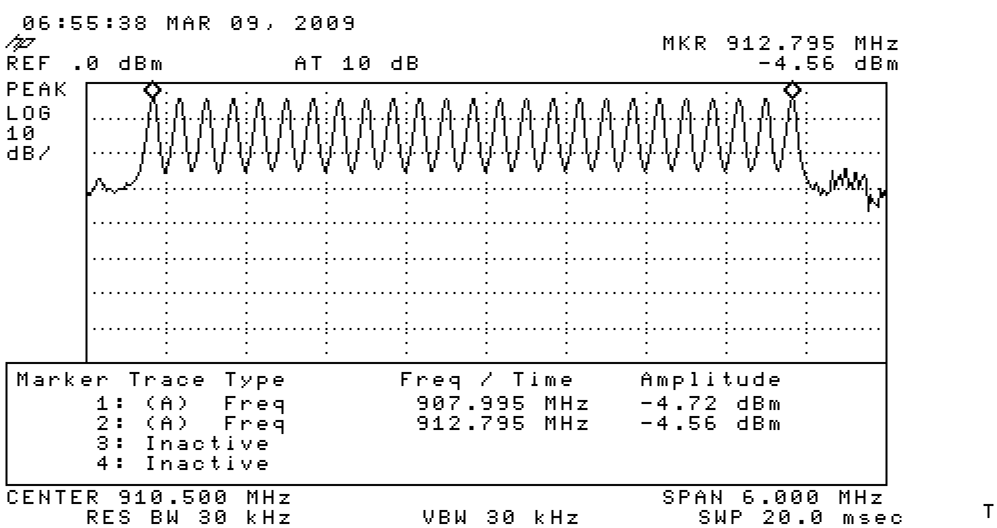
Span = the frequency band of operation
RBW = 30Khz
VBW ≥ RBW
Sweep = auto
Detector function = Peak
Trace = max hold

Allow the trace to stabilize. It may prove necessary to break the span up into sections, in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

Equipment Used	Serial Number	Cal Date	Due
Hewlett Packard 8593E Spectrum Analyzer	3543A02032	09-dec-08	09-dec-09
Date	Tested by		
3/9/2009	Mark Kvamme		

Unit tested: ID 9001 Standard Code 1.14. A new battery was installed for testing. There are 50 channels.


14:47:01 MAR 09, 2009
MKR 923.975 MHz
REF .0 dBm
AT 10 dB
-4.66 dBm
PEAK
LOG
10
dB/
Marker Trace Type
Freq / Time
Amplitude
1: (A) Freq 919.205 MHz -5.57 dBm
2: (A) Freq 923.975 MHz -4.66 dBm
3: Inactive
4: Inactive
CENTER 921.500 MHz
SPAN 6.000 MHz
RES BW 30 kHz
VBW 30 kHz
SWP 20.0 msec
T


06:55:38 MAR 09, 2009
MKR 912.795 MHz
REF .0 dBm
AT 10 dB
-4.56 dBm
PEAK
LOG
10
dB/
Marker Trace Type
Freq / Time
Amplitude
1: (A) Freq 907.995 MHz -4.72 dBm
2: (A) Freq 912.795 MHz -4.56 dBm
3: Inactive
4: Inactive
CENTER 910.500 MHz
SPAN 6.000 MHz
RES BW 30 kHz
VBW 30 kHz
SWP 20.0 msec
T

15.247(a) (1) (i) / RSS-210 A8.1 (a)

20 dB Bandwidth

Verify that the 20 dB bandwidth of the hopping channel is less than 250 kHz.

Use the following spectrum analyzer settings:

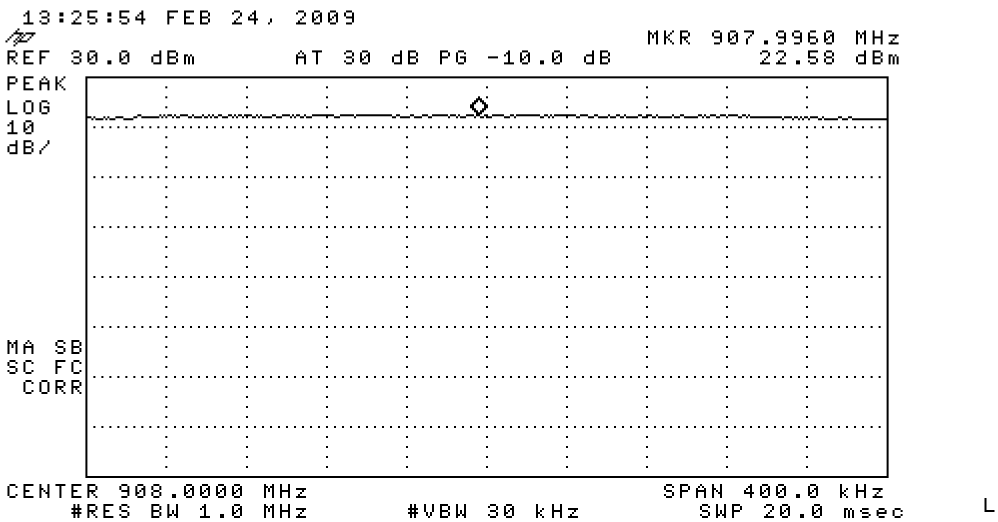
Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel.
RBW ≥ 1% of the 20 dB bandwidth
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

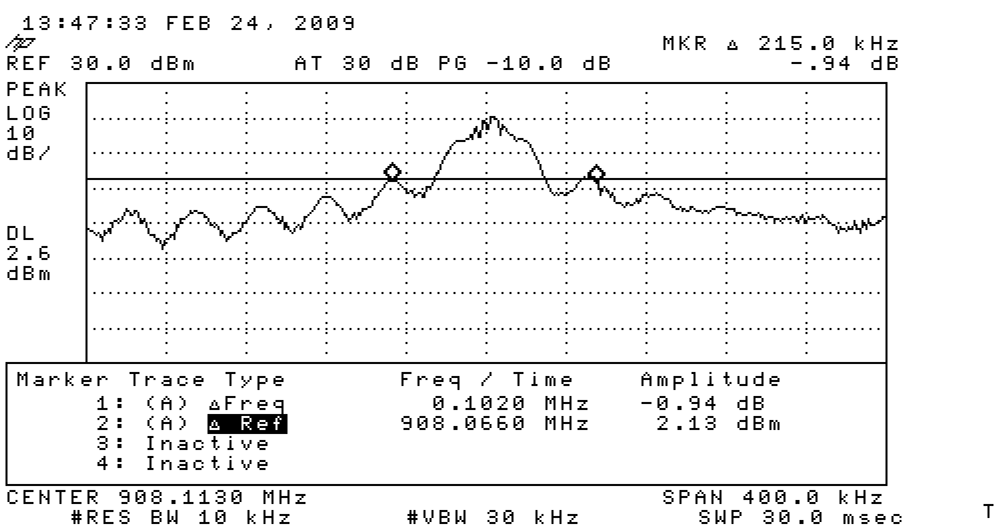
The EUT should be transmitting at its maximum data rate. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the mission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 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. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

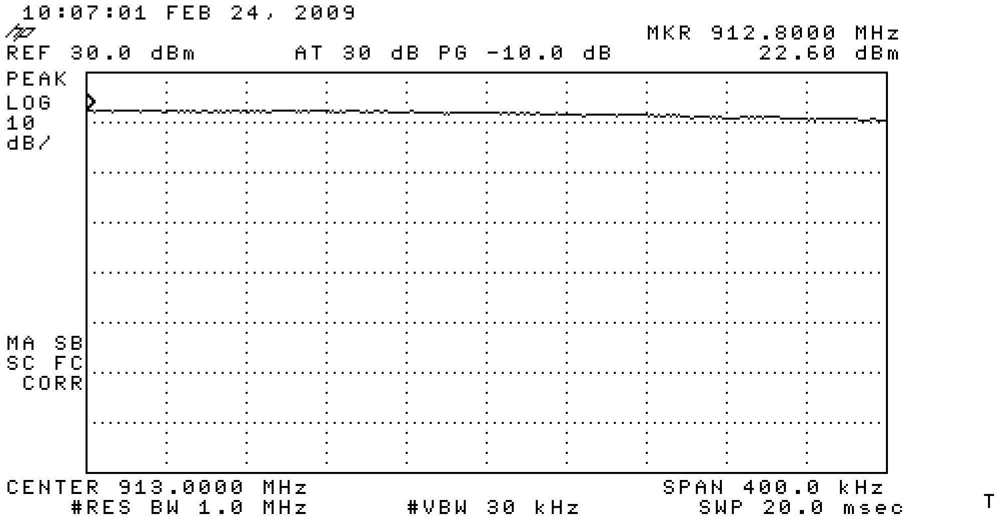
Equipment Used	Serial Number	Cal Date	Due
Hewlett Packard 8593E Spectrum Analyzer	3543A02032	09-dec-08	09-dec-09
Date	Tested by		
3/10/2009	Mark Kvamme		

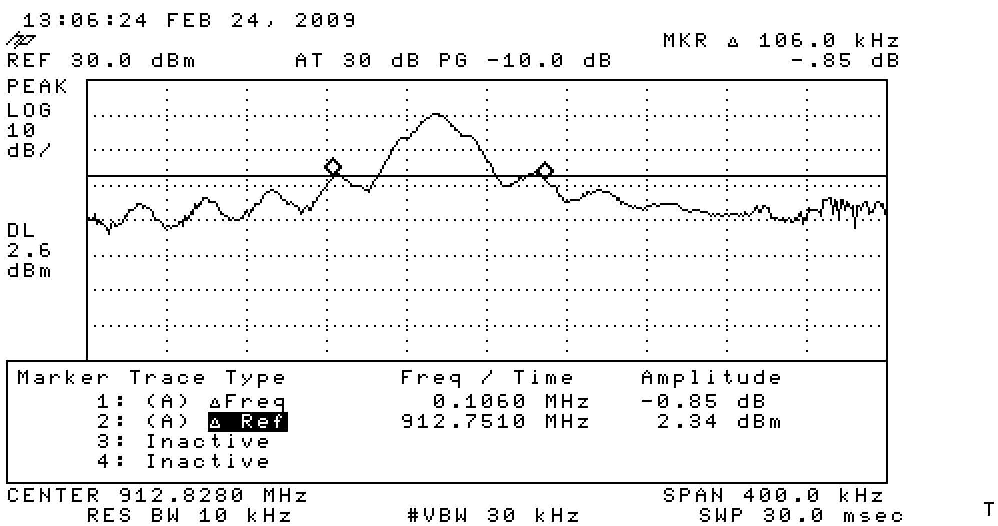
Unit tested: Unit 9001 special software with Low Middle and High channel hopping. A new battery was installed for testing.

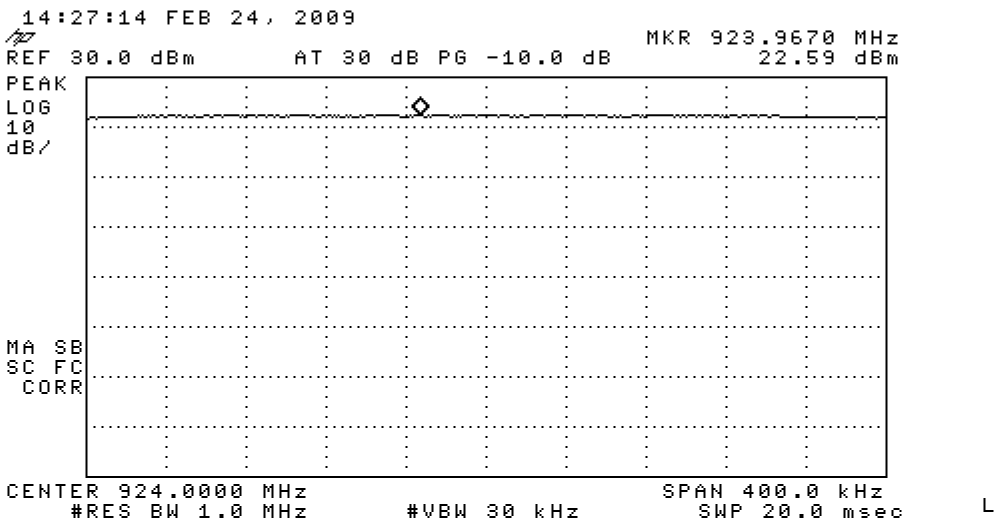
Frequency, MHz	total BW, kHz
908	*102*
913	*106*
924	*103*

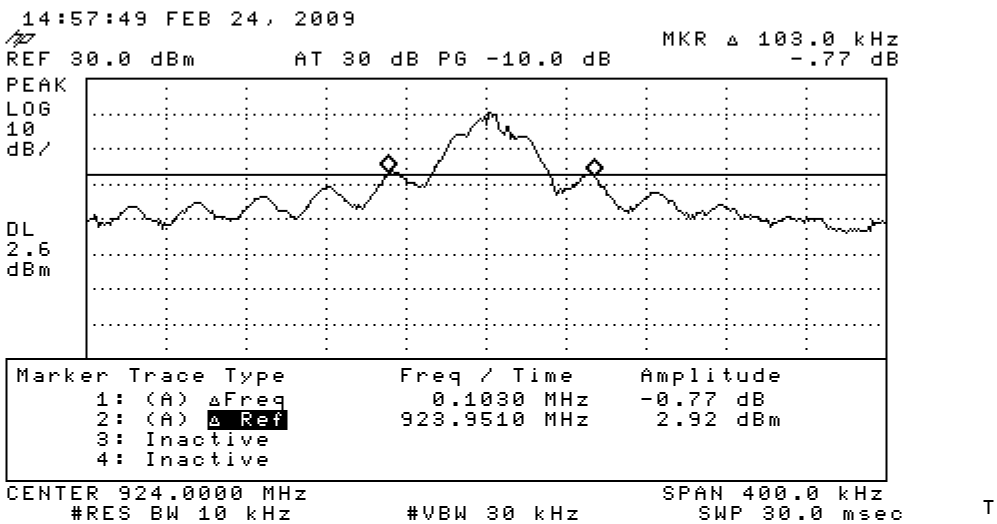

13:25:54 FEB 24, 2009
MKR 907.9960 MHz
REF 30.0 dBm
AT 30 dB PG -10.0 dB
22.58 dBm
PEAK
LOG
10
dB/
MA SB
SC FC
CORR
CENTER 908.0000 MHz
SPAN 400.0 kHz
#RES BW 1.0 MHz
#VBW 30 kHz
SWP 20.0 msec
L


13:47:33 FEB 24, 2009
MKR Δ 215.0 kHz
REF 30.0 dBm
AT 30 dB PG -10.0 dB
-.94 dB
PEAK
LOG
10
dB/
DL
2.6
dBm
Marker Trace Type
Freq / Time
Amplitude
1: (A) ΔFreq 0.1020 MHz -0.94 dB
2: (A) Δ Ref 908.0660 MHz 2.13 dBm
3: Inactive
4: Inactive
CENTER 908.1130 MHz
SPAN 400.0 kHz
#RES BW 10 kHz
#VBW 30 kHz
SWP 30.0 msec
T


10:07:01 FEB 24, 2009
MKR 912.8000 MHz
REF 30.0 dBm AT 30 dB PG -10.0 dB 22.60 dBm
PEAK
LOG
10
dB/
MA SB
SC FC
CORR
CENTER 913.0000 MHz SPAN 400.0 kHz
#RES BW 1.0 MHz #VBW 30 kHz SWP 20.0 msec
T


13:06:24 FEB 24, 2009
MKR △ 106.0 kHz
REF 30.0 dBm AT 30 dB PG -10.0 dB -.85 dB
PEAK
LOG
10
dB/
DL
2.6
dBm
Marker Trace Type Freq / Time Amplitude
1: (A) △Freq 0.1060 MHz -0.85 dB
2: (A) △ Ref 912.7510 MHz 2.34 dBm
3: Inactive
4: Inactive
CENTER 912.8280 MHz SPAN 400.0 kHz
RES BW 10 kHz #VBW 30 kHz SWP 30.0 msec
T


14:27:14 FEB 24, 2009
MKR 923.9670 MHz
REF 30.0 dBm
AT 30 dB PG -10.0 dB
22.59 dBm
PEAK
LOG
10
dB/
MA SB
SC FC
CORR
CENTER 924.0000 MHz
SPAN 400.0 kHz
#RES BW 1.0 MHz
#VBW 30 kHz
SWP 20.0 msec
L


14:57:49 FEB 24, 2009
MKR Δ 103.0 kHz
REF 30.0 dBm
AT 30 dB PG -10.0 dB
-.77 dB
PEAK
LOG
10
dB/
DL
2.6
dBm
Marker Trace Type
Freq / Time
Amplitude
1: (A) ΔFreq
0.1030 MHz
-0.77 dB
2: (A) Δ Ref
923.9510 MHz
2.92 dBm
3: Inactive
4: Inactive
CENTER 924.0000 MHz
SPAN 400.0 kHz
#RES BW 10 kHz
#VBW 30 kHz
SWP 30.0 msec
T

15.247(a) (1) (i); (g); (h) / RSS-210 A8.1 (c)

Time of Occupancy

Verify that the transmitted signal does not occupy a single frequency for more than 400 mS in a 20 second period.

Short Bursts

… a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

Intelligence

The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = zero span, centered on a hopping channel
RBW = 1 MHz
VBW ≥ RBW
Sweep = as necessary to capture the entire dwell time per hopping channel
Detector function = peak
Trace = max hold

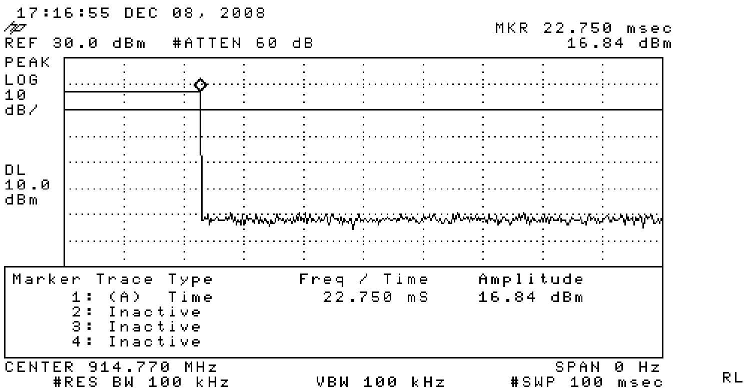
If possible, use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation. Submit this plot(s).

There is the possibility of up to six pulses on a single channel within a 20second period. The first is an initial pulse and the second is responses with the requested data. Each of these series of transmissions takes place on one of 50 different channels in a pseudo-random sequence. All 50 channels are used equally on the average. The algorithm that determines the pseudo-random hop sequence does not allow the device to transmit on the same channel more than once in a 20 second period. The maximum possible occupancy time on any one frequency is 282.75mS within a 20 second period.

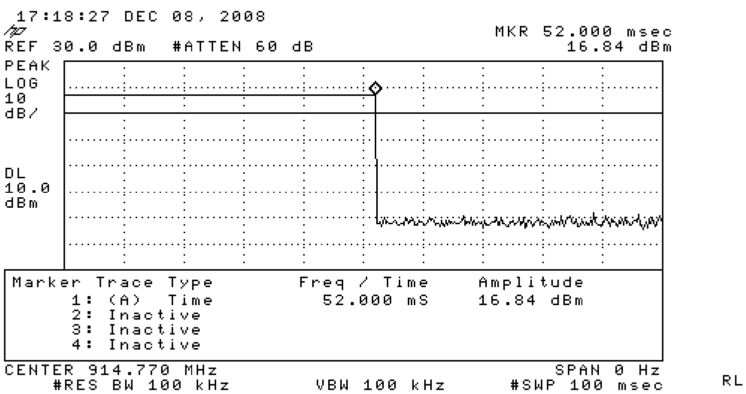
The system this product is used in does not incorporate any type of intelligence to avoid the simultaneous occupancy of individual hopping frequencies.

Equipment Used	Serial Number	Cal Date	Due
HP8596E	3528U00340	4 April 08	4 April 10
Cable	220057002	1 Dec 07	1 Dec 09
Date	Tested by		
12/08/08	Mark Kvamme		

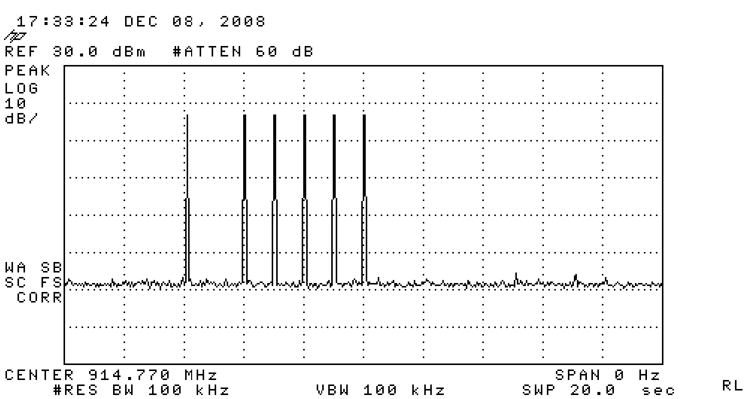
Unit tested: Unit 7002 with a new battery and standard f/w w/low-mid-high hop table, was installed for testing. This is a generic compliance test unit that has the same firmware module and timing hardware as the device being certified. Being it is the same, as the device being certified it demonstrates compliance to Time of Occupancy.



This is the longest initial packet at 22.75mS.



This is the longest possible response packet and can occur 5 times, for a total of 260mS.



This the longest possible duration on a single channel in a 20 second period:
22.75mS + 5 * 52mS == 282.75mS.

15.247(b) (2) / RSS-210 A8.4 (1)

Power Output

The maximum peak conducted output power of the intentional radiator shall not exceed the following: For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels.

Use the following spectrum analyzer settings:

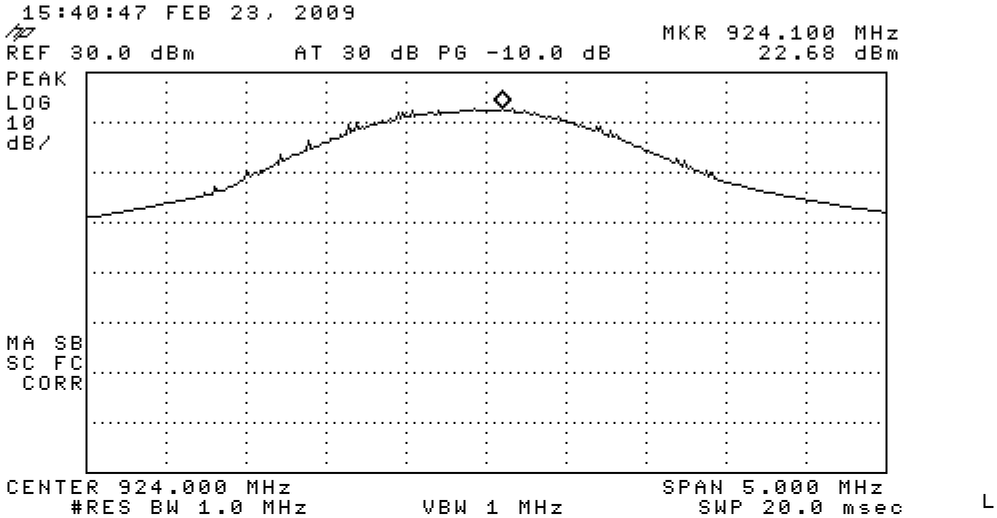
Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel.
RBW > the 20 dB bandwidth of the emission being measured.
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
Set RF level offset=cable loss

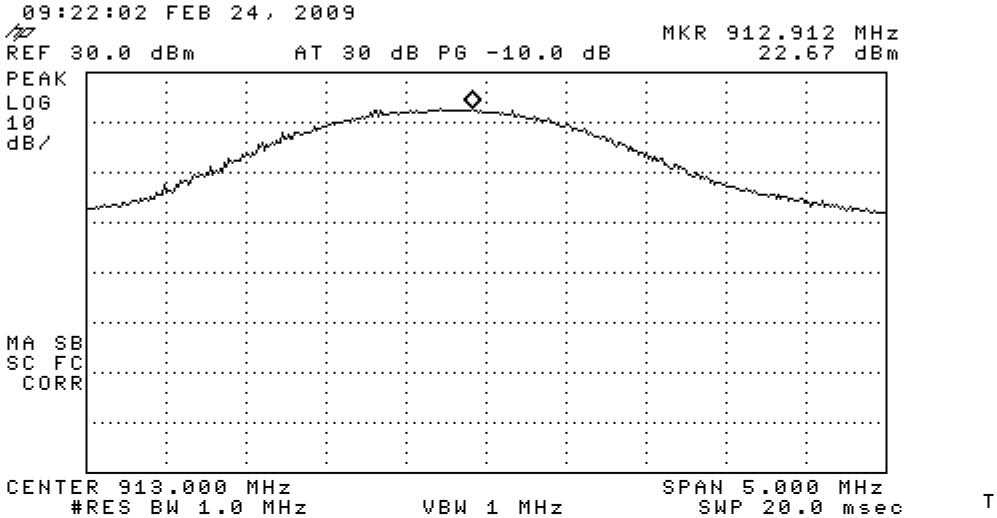
Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power. The limit is specified in one of the subparagraphs of this Section. Submit this plot. A peak responding power meter may be used instead of a spectrum analyzer.

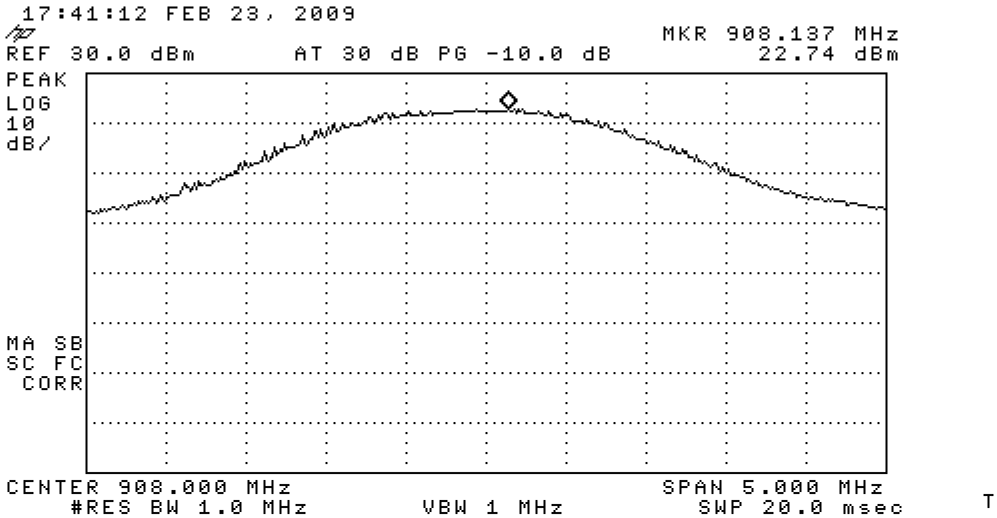
Equipment Used	Serial Number	Cal Date	Due
Hewlett Packard 8593E Spectrum Analyzer	3543A02032	09-dec-08	09-dec-09
Date	Tested by		
2/23/2009	Mark Kvamme		

Unit tested: Unit 9001 special software with Low Middle and High channel hopping. A new battery was installed for testing.

Frequency, MHz	Power out, dBm	Power out, Watts
924	*22.68*	*0.185*
913	*22.67*	*0.185*
908	*22.74*	*0.188*


15:40:47 FEB 23, 2009
MKR 924.100 MHz
REF 30.0 dBm
AT 30 dB PG -10.0 dB
22.68 dBm
PEAK
LOG
10
dB/
MA SB
SC FC
CORR
CENTER 924.000 MHz
SPAN 5.000 MHz
#RES BW 1.0 MHz
VBW 1 MHz
SWP 20.0 msec
L


09:22:02 FEB 24, 2009
MKR 912.912 MHz
REF 30.0 dBm AT 30 dB PG -10.0 dB 22.67 dBm
PEAK
LOG
10
dB/
MA SB
SC FC
CORR
CENTER 913.000 MHz SPAN 5.000 MHz
#RES BW 1.0 MHz VBW 1 MHz SWP 20.0 msec
T


17:41:12 FEB 23, 2009
MKR 908.137 MHz
REF 30.0 dBm AT 30 dB PG -10.0 dB 22.74 dBm
PEAK
LOG
10
dB/
MA SB
SC FC
CORR
CENTER 908.000 MHz SPAN 5.000 MHz
#RES BW 1.0 MHz VBW 1 MHz SWP 20.0 msec
T

15.247(d) / RSS-210 A8.5

Spurious 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, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak 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
H/S Sucoflex 40ft cable	220297001	12/3/07	12/3/09
Huber&Suhner 18 inch. Sma to Sma	220060 002	3-Dec-07	3-Dec-09
Agilent E7405A Spectrum Analyzer	MY45113415	8/7/07	8/7/09
Preamplifier JCA010-415 (0.1 to 10Ghz)	103	1/30/09	1/30/10
Emco 6502 Loop (9kHz to 30Mhz)	9509-2970	01oct08	01oct09
Emco 3110B Biconical (30MHz-to 300MHz)	9807-3129	04oct07	04oct09
Emco 3146 Log Periodic (200Mhz to 1GHz)	9203-3358	03oct07	03oct09
Emco 3115 wave guide (1GHz-18GHz)	9205-3878	3/17/08	3/17/10
Lindgren DB-4 Dipole (400Mhz-1GHz)	78573	9/18/2008	9/18/2010
Date	Tested by	Temperature/humidity	
2/10/2009	Mark Kvamme	55F/50%	

Unit tested: Unit FCC 247 special software with Low Middle and High channel hopping. A new battery was installed for testing. Frequency range investigated was 9 kHz to 9.24GHz.

Freq. MHz	Ant. Pos.	Level dBm	Level dBuV	Gain dB	Factor dB	Loss dB	Level dBuV/m	emissions dBc
908	Vertical	-17.36	89.64	0	27.93	2.61	120.18	
915	Vertical	-17.85	89.15	0	28.04	2.63	119.82	
924	Vertical	-20.16	86.84	0	28.18	2.64	117.66	
1816	Vertical	-41.84	65.16	0	26.52	4.44	96.12	-24.06
1848	Vertical	-42.75	64.25	0	26.67	4.46	95.38	-24.8
1830	Vertical	-42.71	64.29	0	26.58	4.45	95.32	-24.86
1848	Horizontal	-48.45	58.55	0	26.67	4.46	89.68	-30.5
1830	Horizontal	-48.77	58.23	0	26.58	4.45	89.26	-30.92
1816	Horizontal	-48.95	58.05	0	26.52	4.44	89.01	-31.17
6356	Horizontal	-32.88	74.12	43.51	34.47	8.13	73.21	-46.97
6405	Horizontal	-35.01	71.99	43.52	34.48	8.15	71.1	-49.08
6356	Vertical	-37.9	69.1	43.51	34.47	8.13	68.19	-51.99

15.205, 15.209 / 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.

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	16.42-16.423	399.9-410	4.5-5.15
0.495-0.505 1	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	Above 38.6
13.36-13.41			

Equipment Used	Serial Number	Cal Date	Due
Huber&Suhner 18 inch. Sma to Sma	220060 002	3-Dec-07	3-Dec-09
H/S Sucoflex 40ft cable	220297001	12/3/07	12/3/09
Agilent E7405A Spectrum Analyzer	MY45113415	8/7/07	8/7/09
Hewlett Packard 8593E Spectrum Analyzer	3543A02032	09-dec-08	09-dec-09
Preamplifier JCA010-415 (0.1 to 10Ghz)	103	1/30/09	1/30/10
Emco 3110B Biconical (30MHz-to 300MHz)	9807-3129	04oct07	04oct09
Emco 3146 Log Periodic (200Mhz to 1GHz)	9203-3358	03oct07	03oct09
Emco 3115 wave guide (1GHz to 18GHz)	9205-3878	3/17/08	3/17/10
Emco 6502 Loop (9kHz to 30Mhz)	9509-2970	01oct08	01oct09
Date	**Tested by**	**Temperature/humidity**	
2/10/2008	Mark Kvamme	53F/50%	

Unit tested: Unit FCC 247 with special software with Low Middle and High channel hopping. A new battery was installed for testing.

Per FCC DA 00-705. a Duty Cycle Correction Factor (20log(dwell time/100mS)) can be applied to show compliance to the 15.209 limit. The maximum allowed correction factor is 20 dB.

20 log (52.8 ms / 100mS) = -5.5 dB

dwell time is defined here as: 52.8 ms.

Spurious Emission Limits

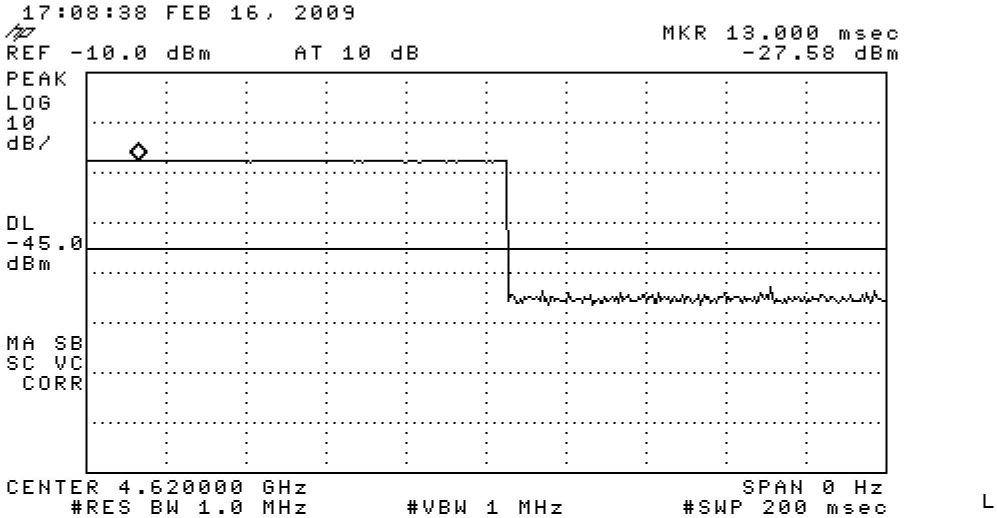
Frequency range investigated was 9 kHz to 9.24GHz.

Frequency (MHz)	Field Strength (microvolts/meter)	in dBuV/m	Measurement Distance (meters)
0.009-0.490 2400F	2440F (kHz)		300
0.490-1.705 24000F	2400F (kHz)		30
1.705-30.0	30	29.5	30
30-88	100	40	3
88-216	200	43.5	3
216-960	200	46	3
Above 960	500	54	3

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

Freq. MHz	Polarity	peak Level dBm	Average Level dBm	Amplifier Gain dB	Ant. Factor dB/m	Cable Loss dB	peak *5.5 db Corr. Level dBuV/m	Peak Power Margin (db) Limit (74 dbuV/m)	Average *5.5 db Corr. Level dBuV/m	Avg Power Margin (db) Limit (54 dbuV/m)
4620	Vertical	-27.58	-47.35	45.27	32.42	6.84	67.91	6.09	48.14	5.86
4575	Vertical	-27.09	-47.33	45.3	32.33	6.81	68.25	5.75	48.01	5.99
4575	Horizontal	-27.49	-47.42	45.3	32.33	6.81	67.85	6.15	47.92	6.08
4540	Horizontal	-27.77	-47.53	45.27	32.27	6.79	67.52	6.48	47.76	6.24
4620	Horizontal	-28.88	-48.17	45.27	32.42	6.84	66.61	7.39	47.32	6.68
4540	Vertical	-27.54	-48.11	45.27	32.27	6.79	67.75	6.25	47.18	6.82
5448	Vertical	-35.49	-52.4	44.31	34.09	7.42	63.21	10.79	46.3	7.7
2772	Horizontal	-26.88	-46.91	44.43	29.52	5.58	65.29	8.71	45.26	8.74
2745	Horizontal	-26.95	-46.85	44.44	29.43	5.56	65.1	8.9	45.2	8.8

* duty cycle correction factor with the dwell time from above.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-27.58 dBm
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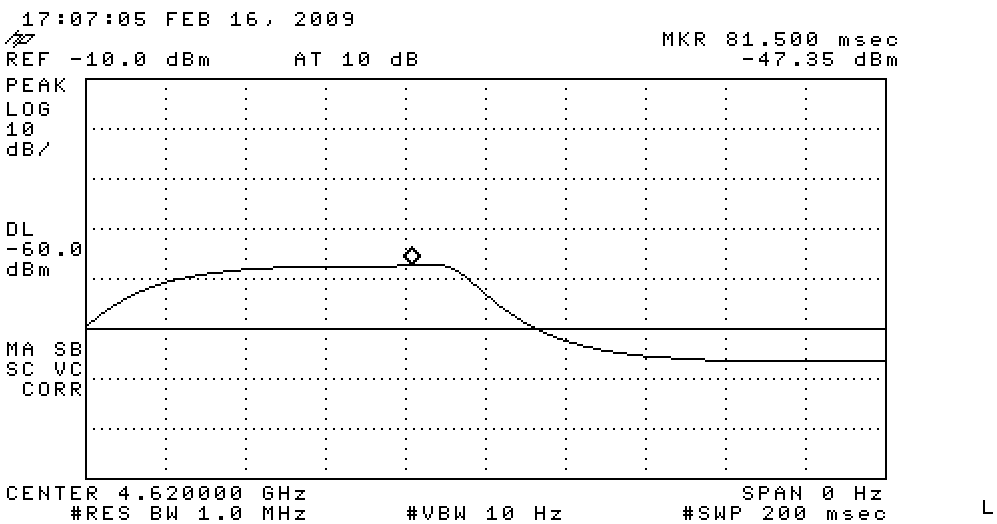
AT 10 dB
PEAK
LOG
10
dB/
DL
-45.0
dBm
MA SB
SC VC
CORR
CENTER 4.620000 GHz
SPAN 0 Hz
#RES BW 1.0 MHz
#VBW 1 MHz
#SWP 200 msec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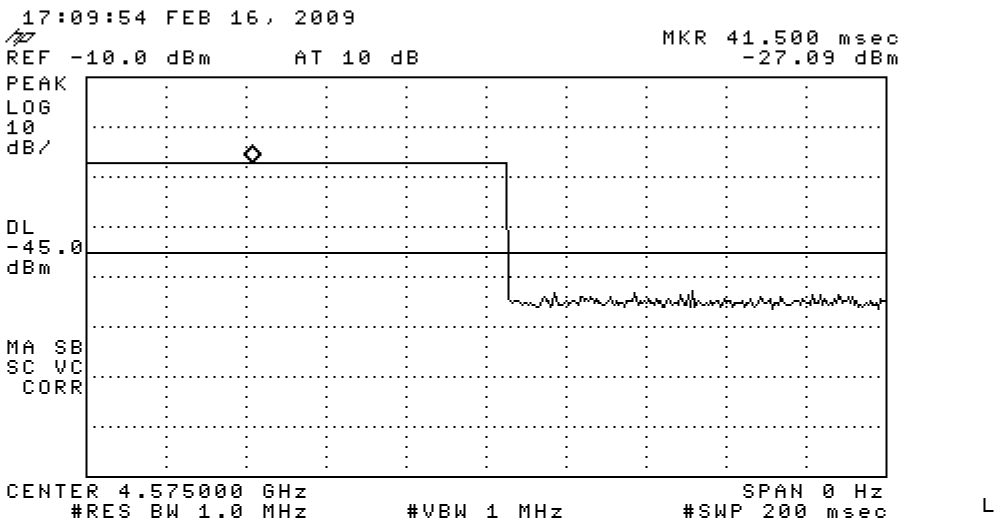
MKR 81.500 msec
-47.35 dBm
REF -10.0 dBm
AT 10 dB
PEAK
LOG
10
dB/
DL
-60.0
dBm
MA SB
SC VC
CORR
CENTER 4.620000 GHz
SPAN 0 Hz
#RES BW 1.0 MHz
#VBW 10 Hz
#SWP 200 msec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MKR 41.500 msec
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REF -10.0 dBm AT 10 dB
PEAK
LOG
10
dB/
DL
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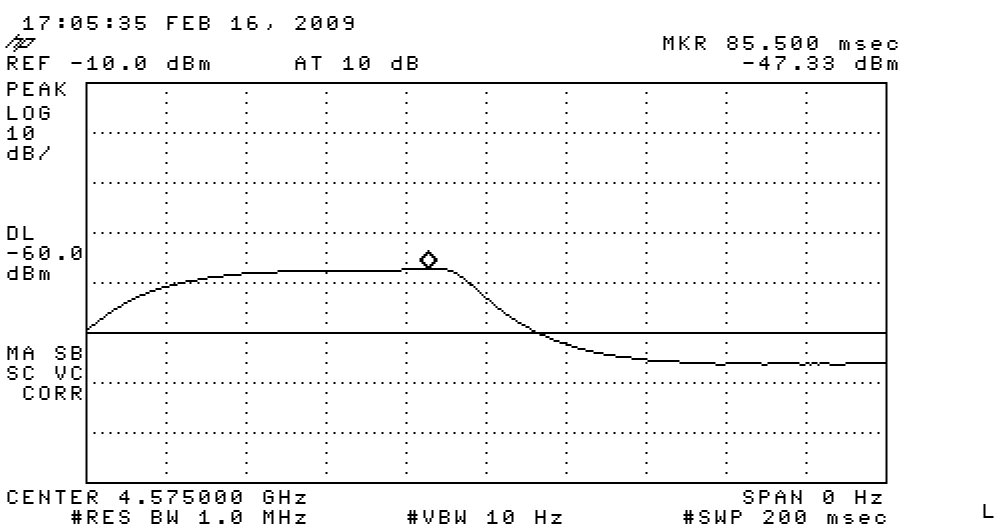
dBm
MA SB
SC VC
CORR
CENTER 4.575000 GHz
SPAN 0 Hz
#RES BW 1.0 MHz #VBW 1 MHz #SWP 200 msec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PEAK
LOG
10
dB/
DL
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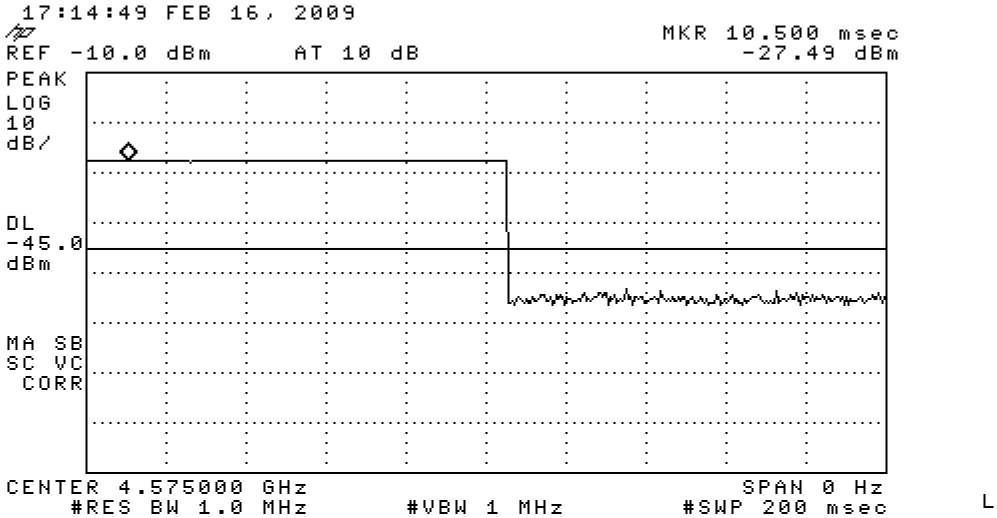
dBm
MA SB
SC VC
CORR
CENTER 4.575000 GHz
SPAN 0 Hz
#RES BW 1.0 MHz #VBW 10 Hz #SWP 200 msec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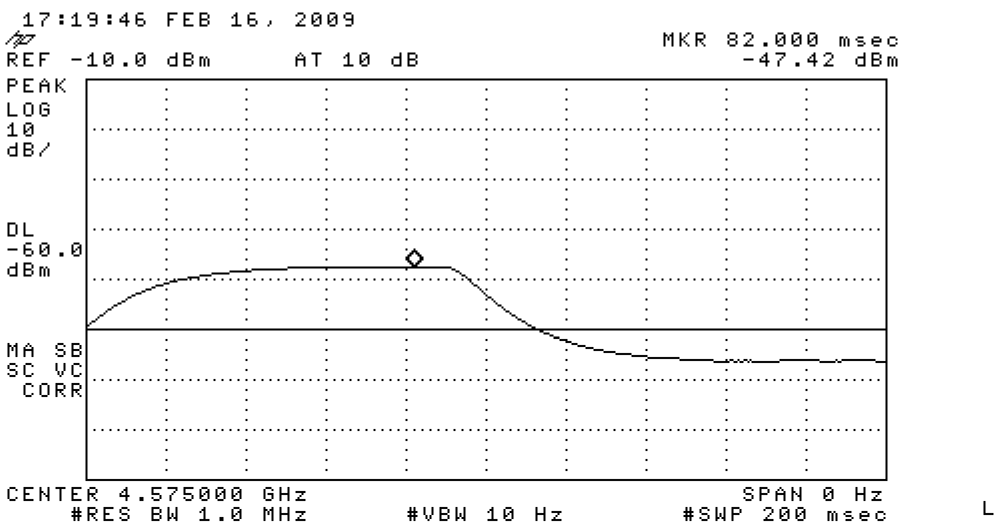
REF -10.0 dBm
AT 10 dB
PEAK
LOG
10
dB/
DL
-45.0
dBm
MA SB
SC VC
CORR
CENTER 4.575000 GHz
SPAN 0 Hz
#RES BW 1.0 MHz
#VBW 1 MHz
#SWP 200 msec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REF -10.0 dBm
AT 10 dB
PEAK
LOG
10
dB/
DL
-60.0
dBm
MA SB
SC VC
CORR
CENTER 4.575000 GHz
SPAN 0 Hz
#RES BW 1.0 MHz
#VBW 10 Hz
#SWP 200 msec

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. If the receiver is super-regenerative, stabilize it by coupling to it an un-modulated carrier on the receiver frequency (antenna conducted measurement) or by transmitting an un-modulated carrier on the receiver frequency from an antenna in the proximity of the receiver (radiated measurement). Taking care not to overload the receiver, vary the amplitude and frequency of the stabilizing signal to obtain the highest level of the spurious emissions from the receiver. For either method, 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-Aug-07	7-Aug-09
Huber&Suhner 40 foot cable	220297 001	3-Dec-07	3-Dec-09
Preamplifier JCA010-415 (0.1 to 10Ghz)	103	1/30/09	1/30/10
Emco 3110B Biconical (30MHz-to 300MHz)	9807-3129	04oct07	04oct09
Emco 3146 Log Periodic (200Mhz to 1GHz)	9203-3358	03oct07	03oct09
Emco 3115 waveguide (1Ghz - 18GHz)	9205-3878	17mar08	17mar10
Date	Tested by	Temp/Humidity, ºF / %	
2/4/2009	Mark Kvamme	55F/35%	

Unit tested: *32011710 in factory mode.* A new battery was installed for testing.

Table 1- Spurious Emission Limits for Receivers

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}

Frequency range investigated was 30MHz to 9.24 GHz. Emissions from the Receiver were below the noise floor.

freq	Level (dbm)	Level (dbuV)	antenna correction factor (db/m)	coax loss (db)	pre amplifier Gain (db)	peak level (noise floor) (dbuV/m)	Margin dB
908	-69.97	37.03	23.2	2.61	35.84	27	19

1.1310 / RSS-102 Sec 4.2-Canada Safety Code 6; Table 5 Maximum Permissible Exposure (MPE)

Radiofrequency radiation exposure limits. - The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

1.1307 (b) In addition to the actions listed in paragraph (a) of this section, Commission actions granting construction permits, licenses to transmit or renewals thereof, equipment authorizations or modifications in existing facilities, require the preparation of an Environmental Assessment (EA) if the particular facility, operation or transmitter would cause human exposure to levels of radiofrequency radiation in excess of the limits in §§1.1310 and 2.1093 of this chapter.

Determine the maximum power density for the general / uncontrolled population minimum separation distance of 20 cm. (FCC limit = $f_{MHz\ /}$ 1500 mW/cm^2) (IC limit = $f_{MHz\ /}$ 150W/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 milliwatts/cm^2 (FCC) or watts/m^2(IC)
P_t = transmit power in milliwatts(FCC) or watts(IC)
G = numeric antenna gain
r = distance between body and transmitter in centimeters(FCC) or meters(IC).

FCC Limits

908 MHz / 1500 = 0.605 mW / cm^2 @ 20cm

IC Limits:

908 MHz / 150 = 6.05 W / M^2 @ 0.2M

Max antenna gain = 0.74 dBi = 1.19 numeric

Max TX power = 22.74 dBm = 188 mW =0.188 Watts

results: FCC P_D = (1.19 x 188) / (4 x pi x 20cm^2) = 0.045 mW / cm^2 @ 20 cm
results: IC P_D = (1.19 x 0.188) / (4 x pi x 0.20M^2) = 0.445 W / M^2 @ 0.2M

These results are not in excess of the limits set forth in the rules, therefore an EA is not required.

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 bandedge, 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

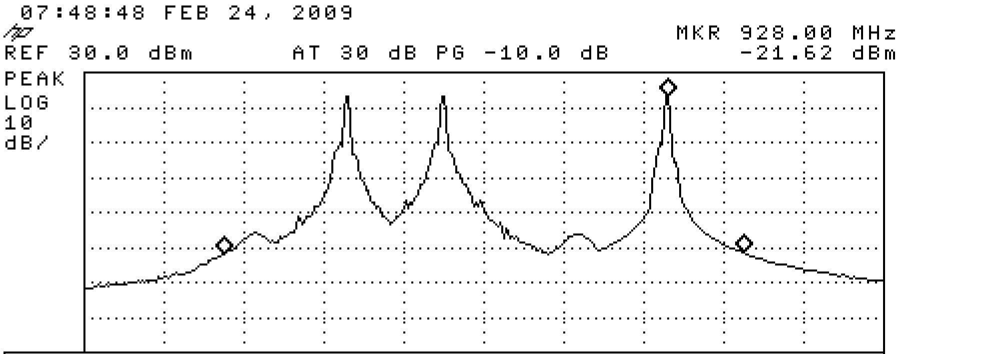
Allow the trace to stabilize. Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the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

Now, using the same instrument settings, enable the hopping function of the EUT. Allow the trace to stabilize. Follow the same procedure listed above to determine if any spurious emissions caused by the hopping function also comply with the specified limit. Submit this plot.

Equipment Used	Serial Number	Cal Date	Due
Hewlett Packard 8593E Spectrum Analyzer	3543A02032	09-dec-08	09-dec-09
Date	Tested by		
2/23/2009	Mark Kvamme		

Unit tested: Unit FCC 247 special software with Low Middle and High channel hopping. A new battery was installed for testing.

Band edge @ 928 MHz is down -44.94 dbc



Marker	Trace	Type	Freq / Time	Amplitude
1:	(A)	Freq	924.20 MHz	23.32 dBm
2:	(A)	Freq	902.00 MHz	-21.80 dBm
3:	(A)	Freq	928.00 MHz	-21.62 dBm
4:	Inactive			

ANNEX A
direct from FCC DA-00-705, March 30, 2000

Spurious RF Conducted Emissions

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 10^{th} harmonic. Typically, several plots are required to cover this entire span.

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 in this Section. Submit these plots.

Spurious Radiated Emissions

This test is required for any spurious emission or modulation product that falls in a Restricted Band, as defined in Section 15.205. It must be performed with the highest gain of each type of antenna proposed for use with the EUT. Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Follow the guidelines in ANSI C63.4-1992 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization, etc. A pre-amp and a high pass filter are required for this test, in order to provide the measuring system with sufficient sensitivity. Allow the trace to stabilize. The peak reading of the emission, after being corrected by the antenna factor, cable loss, pre-amp gain, etc., is the peak field strength, which must comply with the limit specified in Section 15.35(b). Submit this data.

Now set the VBW to 10 Hz, while maintaining all of the other instrument settings. This peak level, once corrected, must comply with the limit specified in Section 15.209. If the dwell time per channel of the hopping signal is less than 100 ms, then the reading obtained with the 10 Hz VBW may be further adjusted by a "duty cycle correction factor", derived from 20log(dwell time/100 ms), in an effort to demonstrate compliance with the 15.209 limit. Submit this data.

If the emission on which a radiated measurement must be made is located at the edge of the authorized band of operation, then the alternative "marker-delta" method, listed at the end of this document, may be employed.

Alternative Test Procedures

If antenna conducted tests cannot be performed on this device, radiated tests to show compliance with the peak output power limit specified in Section 15.247(b) (2) and the spurious RF conducted emission limit specified in Section 15.247(d) are acceptable. A pre-amp, and, in the latter case, a high pass filter, are required for the following measurements.

1) Calculate the transmitter's peak power using the following equation:

$$E = \frac{\sqrt{30PG}}{d}$$

Where: E is the measured maximum fundamental field strength in V/m, utilizing a RBW ≥ the 20 dB bandwidth of the emission, VBW > RBW, peak detector function. Follow the procedures in C63.4-2003 with respect to maximizing the emission.

G is the numeric gain of the transmitting antenna with reference to an isotropic radiator.

d is the distance in meters from which the field strength was measured.

P is the power in watts for which you are solving:

$$P = \frac{(E \times d)^2}{30G}$$

2) To demonstrate compliance with the spurious RF conducted emission requirement of Section 15.247(d), use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

RBW = 100 kHz

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Measure the field strength of both the fundamental emission and all spurious emissions with these settings. Follow the procedures in C63.4-2003 with respect to maximizing the emissions. The measured field strength of all spurious emissions must be below the measured field strength of the fundamental emission by the amount specified in Section 15.247(d). Note that if the emission falls in a Restricted Band, as defined in Section 15.205, the procedure for measuring spurious radiated emissions, listed above, must be followed.

Marker-Delta Method

In making radiated band-edge measurements, there can be a problem obtaining meaningful data since a measurement instrument that is tuned to a band-edge frequency may also capture some in-band signals when using the resolution bandwidth (RBW) required by measurement procedure ANSI C63.4-1992 (hereafter C63.4). In an effort to compensate for this problem, we have developed the following technique for determining band-edge compliance.

STEP 1) Perform an in-band field strength measurement of the fundamental emission using the RBW and detector function required by C63.4 and our Rules for the frequency being measured. For example, for a device operating in the 902-928 MHz band under Section 15.249, use a 120 kHz RBW with a CISPR QP detector (a peak detector with 100 kHz RBW may alternatively be used). For transmitters operating above 1 GHz, use a 1 MHz RBW, a 1 MHz VBW, and a peak detector (as required by Section 15.35). Repeat the measurement with an average detector (i.e., 1 MHz RBW with 10 Hz VBW). Note: For pulsed emissions, other factors must be included. Please contact the FCC Lab for details if the emission under investigation is pulsed. Also, please note that radiated measurements of the fundamental emission of a transmitter operating under 15.247 are not normally required, but they are necessary in connection with this procedure.

STEP 2) Choose a spectrum analyzer span that encompasses both the peak of the fundamental emission and the band-edge emission under investigation. Set the analyzer RBW to 1% of the total span (but never less than 30 kHz) with a video bandwidth equal to or greater than the RBW. Record the peak levels of the fundamental emission and the relevant band-edge emission (i.e., run several sweeps in peak hold mode). Observe the stored trace and measure the amplitude delta between the peak of the fundamental and the peak of the band-edge emission. This is not a field strength measurement; it is only a relative measurement to determine the amount by which the emission drops at the band-edge relative to the highest fundamental emission level.

STEP 3) Subtract the delta measured in step (2) from the field strengths measured in step (1). The resultant field strengths (CISPR QP, average, or peak, as appropriate) are then used to determine band-edge compliance as required by Section 15.205.

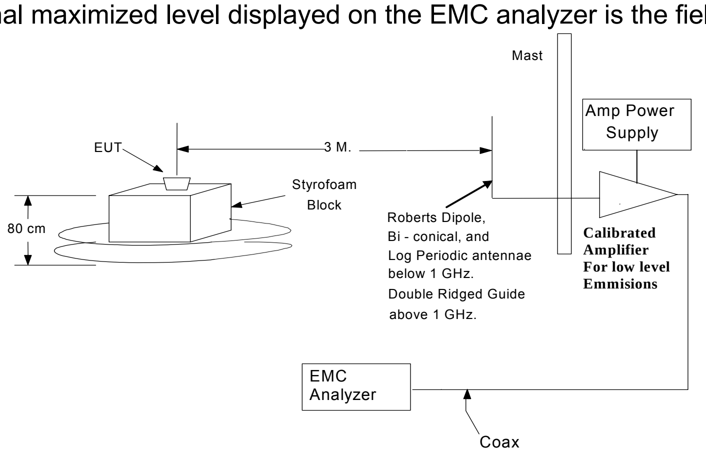
STEP 4) The above "delta" measurement technique may be used for measuring emissions that are up to two "standard" bandwidths away from the band-edge, where a "standard" bandwidth is the bandwidth specified by C63.4 for the frequency being measured. For example, for band-edge measurements in the restricted band that begins at 2483.5 MHz, C63.4 specifies a measurement bandwidth of at least 1 MHz. Therefore you may use the "delta" technique for measuring emissions up to 2 MHz removed from the band-edge. Radiated emissions that are removed by more than two “standard” bandwidths must be measured in the conventional manner.

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 exactly 3 meters. The bandwidths used shall be per ANSI C63.4-2003; 200 Hz from 9 kHz to 150 kHz, 9 kHz from 150 kHz to 30 MHz, 100 kHz from 30 MHz to 1000 MHz, and 1 MHz from 1 GHz to 40 GHz, with the detector set to peak hold for peak measurements. Alternatively average measurements may be used for frequencies above 1GHz and Quasi peak measurements may be used for frequencies below 1 GHz.

1) The antenna correction factor, preamplifier gain (if the preamplifier is installed), and cable loss are stored in tables in the EMC analyzer and the level at the analyzer is the corrected level in dbuV/m.
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 parts 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).

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) …

(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.