EMISSIONS TEST REPORT FOR A LOW POWER TRANSMITTER

I. GENERAL INFORMATION

Requirement: FCC
Test Requirements: FCC Part 15

Applicant: Silver Spring Networks
575 Broadway Street
Redwood City, CA 94063

FCC ID: OWS-NIC711
IC: 5975A-NIC711
Model No.: NIC411

II. DESCRIPTION OF EQUIPMENT UNDER TEST (EUT)

The Silver Spring Networks (SSN) model NIC411 is a radio module for electric power meter communications use. The board incorporates a 900 MHz frequency hopping mesh network radio.

III. TEST DATES AND TEST LOCATION

Testing was performed on various dates between 18 April 2011 and 11 June 2012.

Radiated emissions and AC Line Conducted Emissions:
Compliance Certification Services
47173 Benicia Street
Fremont, CA 94538

Radiated emissions and antenna port conducted emissions:
BACL Laboratories
1274 Anvilwood Ave.
Sunnyvale, CA 94089

Antenna port conducted emissions tests were performed at Silver Spring Networks.

T.N. Cokenias 11 June 2012
EMC Consultant/Agent for Silver Spring Networks

15.203 Antenna connector requirement

The EUT uses a custom permanently attached integral antenna, a special sheet metal antenna manufactured by Silver Spring Networks for electric meters. There is also an optional external antenna that can be used with this radio.

Antenna description	Mfr.	Model No.	Gain
Built-in sheet metal electric meter	SSN	n/a	4 dBi at 915 MHz 1 dBi at 2.4 GHz
External monopole antenna (omni)	SSN		3 dBi at 915 MHz 3.6 dBi at 2.4 GHz

TEST PROCEDURES

All tests were performed in accordance with the applicable procedures called out in the following documents, unless otherwise noted:

FCC 47CFR15

DA 00-705: Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems

RSS-Gen Issue 3: General Requirements and Information for the Certification of Radio Apparatus

RSS-210 Issue 8: Low power license exempt radio frequency devices (December 2010)
RSS-212: Test Facilities and Test Methods for Radio Equipment

ANSI C63.4 – 2003, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

Laboratory Accreditation Information

UL CCS
2.948 FCC: Registration Number: 152170
Industry Canada Test Site: 2324B
Accrediting Body: NVLAP

BACL
2.948 FCC Registration Number: 90464
Industry Canada Test Site Registration Number: 3062A
Accrediting Body:: A2LA

Test Equipment

Compliance Certification Services:

TEST EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Asset**	**Cal Due**
Antenna, Bilog, 2 GHz	Sunol Sciences	JB1	C01011	07/16/12
PSA Series Spectrum Analyzer	Agilent / HP	E4440A	C01179	04/28/12
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C01052	07/12/12
Horn Antenna	EMCO	3115	C00945	06/30/12
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00885	11/11/12
LISN, 30 MHz	FCC	LISN-50/250-25-2	N02625	11/11/12
LISN, 30 MHz	Solar	8012-50-R-24-BNC	N02481	11/20/12

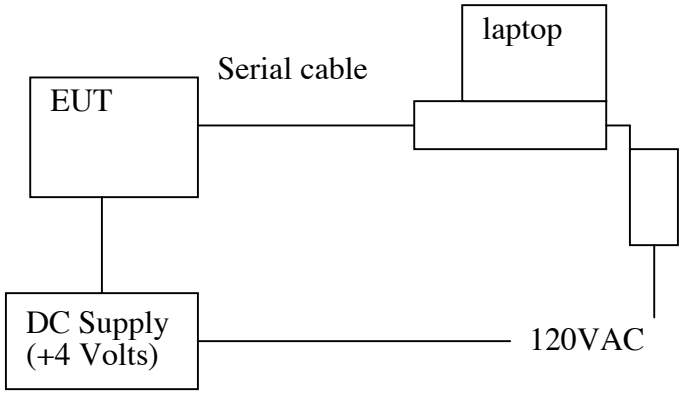
Silver Spring Networks:

Equipment	Mfr	Model	Serial No.	Cal Due
Spectrum analyzer	Agilent	E4405B	MY45113391	01/23/13
Spectrum analyzer	Agilent	N9030A	MY48030147	01/23/13
Spectrum Analyzer	HP	8652B	2712A00113	9/28/12

BACL

Manufacturer	Description	Model No.	Serial No.	Calibration Date
Rohde & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100337	2012-03-22
Agilent	Spectrum Analyzer	E4440A	MY44303352	2012-05-10
Sunol Science Corp	System Controller	SC99V	122303-1	N/R
Sunol Science Corp	Combination Antenna	JB3	A0020106-3	2011-06-29
EMCO	Horn antenna	3115	9511-4627	2011-10-03
Hewlett Packard	Pre amplifier	8447D	2944A06639	2012-06-09
Mini-Circuits	Pre Amplifier	ZVA-183-S	570400946	2012-05-09

Test Set-up Diagram



Support Equipment

Equipment	Mfr	Model	Asset No.
DC Power Supply	Agilent	E3610A	2844
Laptop PC	Dell	PP01L	TW-0791UH1280-OC9-6558
AC/DC adapter	CUI Inc.	DSA-60W-20	2607HB

900 MHz FREQUENCY HOPPING SPREAD SPECTRUM RADIO EMISSIONS

The 900 MHz FHSS will employ the following channel separations and modulations:

Channel Separation	Modulation
400 kHz	GFSK
300 kHz	FSK, GFSK
200 kHz	FSK, GFSK

The following data is presented for all channel separation modes:

Occupied Bandwidth
Hopping Channel Separation
Number of hopping channels
Channel occupancy in 20 seconds

Worst-case data for radiated emissions, antenna port conducted spurious, and output power was obtained for 300 kHz channel separation.

TEST RESULTS

Radiated Test Set-up, 30 MHz-9.3 GHz

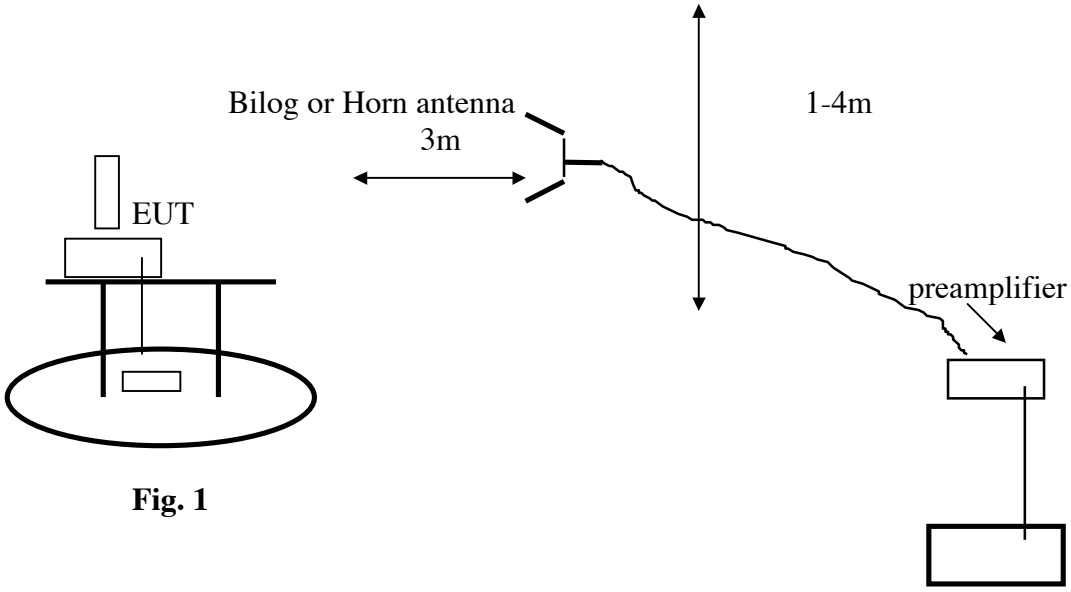


Fig. 1

Test Procedures

Radiated emissions generated by the transmitter portion of the EUT were measured.

1. The EUT was placed on a wooden table resting on a turntable on the test site. The search antenna was placed 3m from the EUT. The EUT antenna was mounted in the with the EUT TX antenna pointed directly to the search antenna.

2. The turntable was slowly rotated to locate the direction of maximum emission at each emission falling in the restricted bands of 15.205.

3. Emissions were investigated to the 10^{th} harmonic of the fundamental.

4. Once maximum direction was determined, the search antenna was raised and lowered in both vertical and horizontal polarizations. The maximum readings so obtained are recorded in the data listed below.

Test Results: Worst-case results are presented. Refer to data sheets below. Restricted band emissions meet 54 dBuV/m. Other undesired emissions from the transmitter meet the -20 dBc requirement in 15.247(d).

15.205 Restricted Frequency Bands

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 -	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.52525	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	156.7 - 156.9	3260 - 3267	23.6 - 24.0
12.29 - 12.293	162.0125 - 167.17	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	167.72 - 173.2	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	240 - 285	3600 - 4400	
13.36 - 13.41	322 - 335.4		

15.209 General Field Strength Limits

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F (kHz)	300
0.490 - 1.705	24000/F (kHz)	30
1.705 - 30.0	30	30
30 - 88	100 **	3
88 - 216	150 **	3
216 - 960	200 **	3
Above 960	500	3

Radiated Emissions Above 1 GHz

Internal antenna

Company: Silver Spring Network
Project number: T1201261
Frequency: 900 MHz
measurement: Radiated Spurious Emission above 1GHz
Date: 01-26-2012
Tester: Quinn Jiang
EUT info: S/N: 174029000 Rev 02, MAC 001350040000002E

internal antenna

Low Channel

Frequency (MHz)	S.A. Reading (dBµV)	Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments	
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)		
Low channel 902.3 MHz measured at 3 meters												
2706	50.71	82	100	V	28.6	4.1	27.60	55.81	74	-18.19	peak	ats=60
2706	48.42	197	100	H	28.6	4.1	27.60	53.52	74	-20.48	peak	ats=60
2706	48.17	82	100	V	28.6	4.1	27.60	53.27	54	-0.73	Ave	ats=60
2706	45.34	197	100	H	28.6	4.1	27.60	50.44	54	-3.56	Ave	ats=60
4511	43.52	329	100	V	32.0	5.10	27.4	53.22	74	-20.78	peak	ats=60
4511	42.86	121	152	H	32.0	5.10	27.4	52.56	74	-21.44	peak	ats=60
4511	38.17	329	100	V	32.0	5.10	27.4	47.87	54	-6.13	Ave	ats=60
4511	36.56	121	152	H	32.0	5.10	27.4	46.26	54	-7.74	Ave	ats=60

Middle Channel

Frequency (MHz)	S.A. Reading (dBµV)	Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments	
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)		
Middle channel 915.2 MHz measured at 3 meters												
2745	44.54	286	100	V	28.6	4.1	27.60	49.64	74	-24.36	peak	ats=60
2745	44.17	198	100	H	28.6	4.1	27.60	49.27	74	-24.73	peak	ats=60
2745	38.01	286	100	V	28.6	4.1	27.60	43.11	54	-10.89	Ave	ats=60
2745	37.85	198	100	H	28.6	4.1	27.60	42.95	54	-11.05	Ave	ats=60
4576	41.9	331	100	V	32.0	5.10	27.4	51.60	74	-22.40	peak	ats=60
4576	39.22	76	150	H	32.0	5.10	27.4	48.92	74	-25.08	peak	ats=60
4576	35.08	331	100	V	32.0	5.10	27.4	44.78	54	-9.22	Ave	ats=60
4576	29.25	76	150	H	32.0	5.10	27.4	38.95	54	-15.05	Ave	ats=60

High Channel

Frequency (MHz)	S.A. Reading (dBµV)	Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments	
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)		
High channel 927.8 MHz measured at 3 meters												
3711	44.31	139	100	V	31.5	4.8	27.20	53.41	74	-20.59	peak	ats=60
3711	43.01	180	100	H	31.5	4.8	27.20	52.11	74	-21.89	peak	ats=60
3711	39.09	139	100	V	31.5	4.8	27.20	48.19	54	-5.81	Ave	ats=60
3711	37	180	100	H	31.5	4.8	27.20	46.10	54	-7.90	Ave	ats=60

note: no 3nd and 5th harmonics

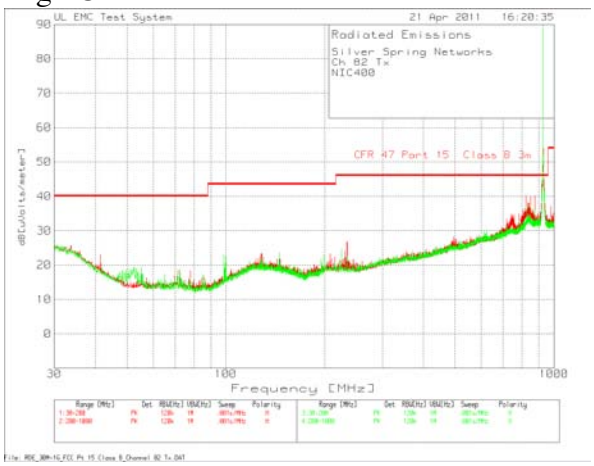
Radiated Emissions Below 1 GHZ

Internal antenna

Low Channel

Mid Channel

High Channel



Note: All TX emissions more than 20 dB below limits

Radiated Emissions Above 1 GHz

External antenna

Company: Silver Spring Network
Project number: T1201261
Frequency: 900 MHz
measurement: Radiated Spurious Emission above 1GHz
Date: 01-31-2012
Tester: Quinn Jiang
EUT info: S/N: 174029000 Rev 02, MAC 001350040000002E

External antenna

Low Channel

Frequency (MHz)	S.A. Reading (dBµV)	Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments	
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)		
Low channel 902.3 MHz measured at 3 meters												
2706	49.92	268	100	V	28.6	4.1	27.60	55.02	74	-18.98	Peak	ats=40
2706	49.22	148	100	H	28.6	4.1	27.60	54.32	74	-19.68	Peak	ats=40
2706	48.73	268	100	V	28.6	4.1	27.60	53.83	54	-0.17	Ave	ats=40
2706	47.7	148	100	H	28.6	4.1	27.60	52.80	54	-1.20	Ave	ats=40

Middle Channel

Frequency (MHz)	S.A. Reading (dBµV)	Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments	
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)		
Middle channel 915.2 MHz measured at 3 meters												
2745	45.09	73	118	V	28.6	4.1	27.60	50.19	74	-23.81	peak	ats=40
2745	43.78	147	100	H	28.6	4.1	27.60	48.88	74	-25.12	peak	ats=40
2745	42.31	73	118	V	28.6	4.1	27.60	47.41	54	-6.59	Ave	ats=40
2745	40.08	147	100	H	28.6	4.1	27.60	45.18	54	-8.82	Ave	ats=40

High Channel

Frequency (MHz)	S.A. Reading (dBµV)	Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC		Comments	
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)		
High channel 927.8 MHz measured at 3 meters												
3711	38.15	180	122	V	31.5	4.8	27.20	47.25	74	-26.75	peak	ats=40
3711	39.88	272	100	H	31.5	4.8	27.20	48.98	74	-25.02	peak	ats=40
3711	30.88	180	122	V	31.5	4.8	27.20	39.98	54	-14.02	Ave	ats=40
3711	34.39	272	100	H	31.5	4.8	27.20	43.49	54	-10.51	Ave	ats=40

Radiated Emissions Below 1 GHZ

External antenna
All emissions from transmitter more than 20 dB limits.

20 dB Bandwidth

LIMIT

15.247(a) i: 500 kHz maximum bandwidth allowed.

TEST PROCEDURE

The TX output is connected to a spectrum analyzer. The OCC BW function is activated.
RBW > 1% of 20 dB BW
VBW>RBW
Detector: PEAK

RESULTS

No non-compliance noted:

NOTE: Only GFSK modulation is available for 400 kHz channel separation. Both GFSK and FSK modulations are available for 300 kHz and 200 kHz channel separations. Worst case (largest occupied bandwidths) are reported below.

400 kHz Channel Separation (worst case)

Channel	Frequency (MHz)	20 dB Bandwidth (kHz)
Low	902.3	355.72
Middle	915.2	356.96
High	926.9	352.58

300 kHz Channel Separation (FSK worst case)

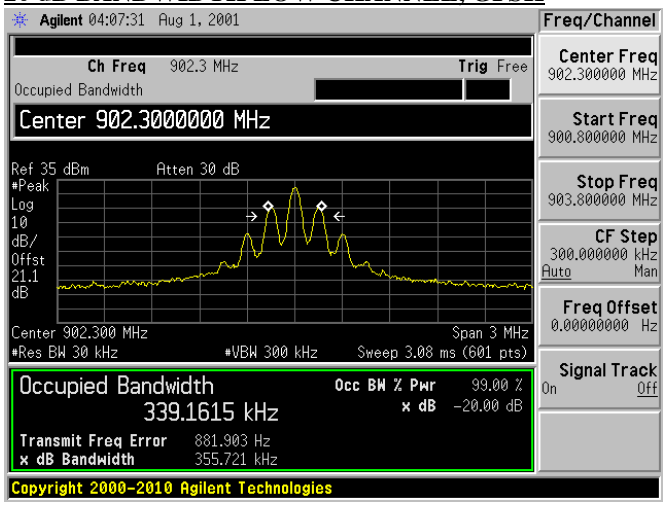
Channel	Frequency (MHz)	20 dB Bandwidth (kHz)
Low	902.3	232.67
Middle	915.2	232.6
High	926.9	232.29

200 kHz Channel Separation (FSK worst case)

Channel	Frequency (MHz)	20 dB Bandwidth (kHz)
Low	902.4	187.37
Middle	915	189.45
High	926.9	187.27

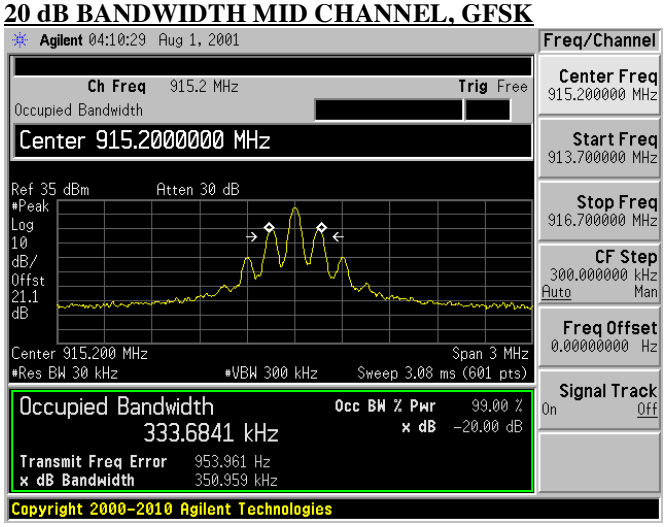
400 kHz Channel Separation

20 dB BANDWIDTH LOW CHANNEL, GFSK



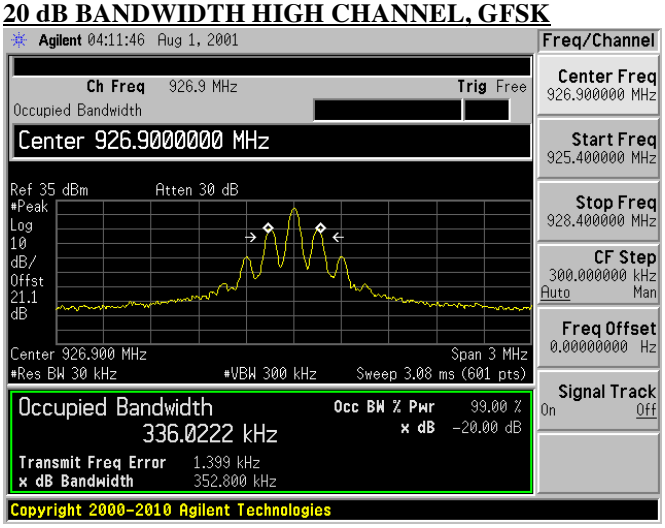
400 kHz Channel Separation

20 dB BANDWIDTH MID CHANNEL, GFSK



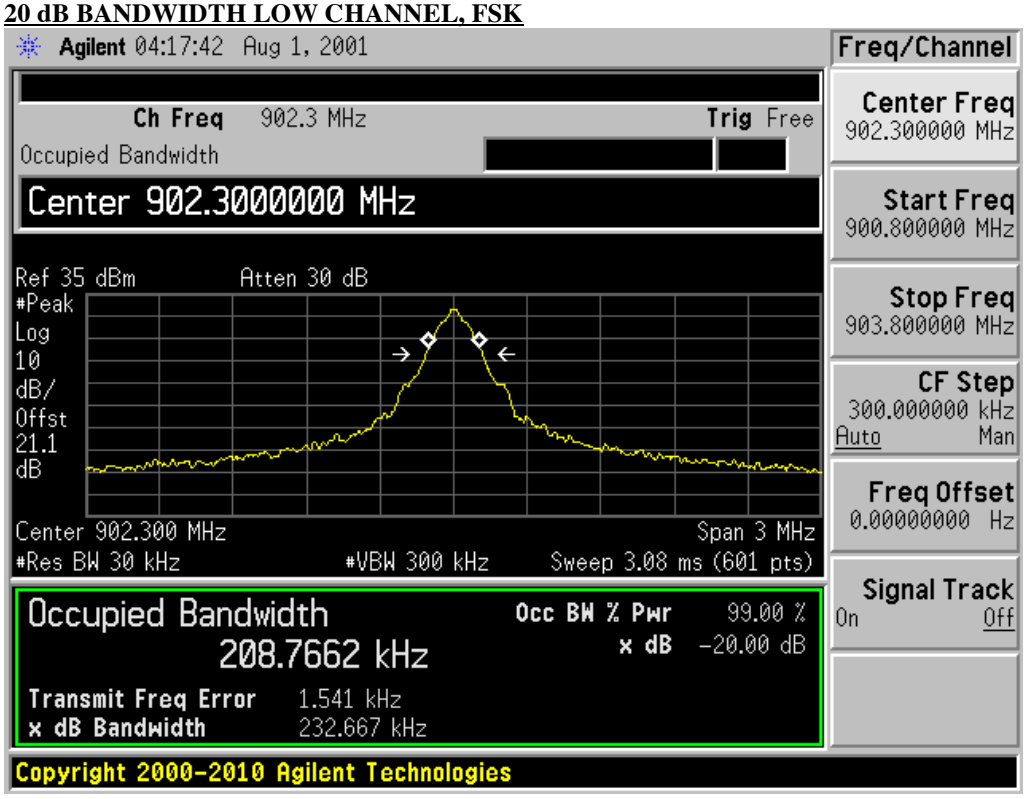
400 kHz Channel Separation

20 dB BANDWIDTH HIGH CHANNEL, GFSK

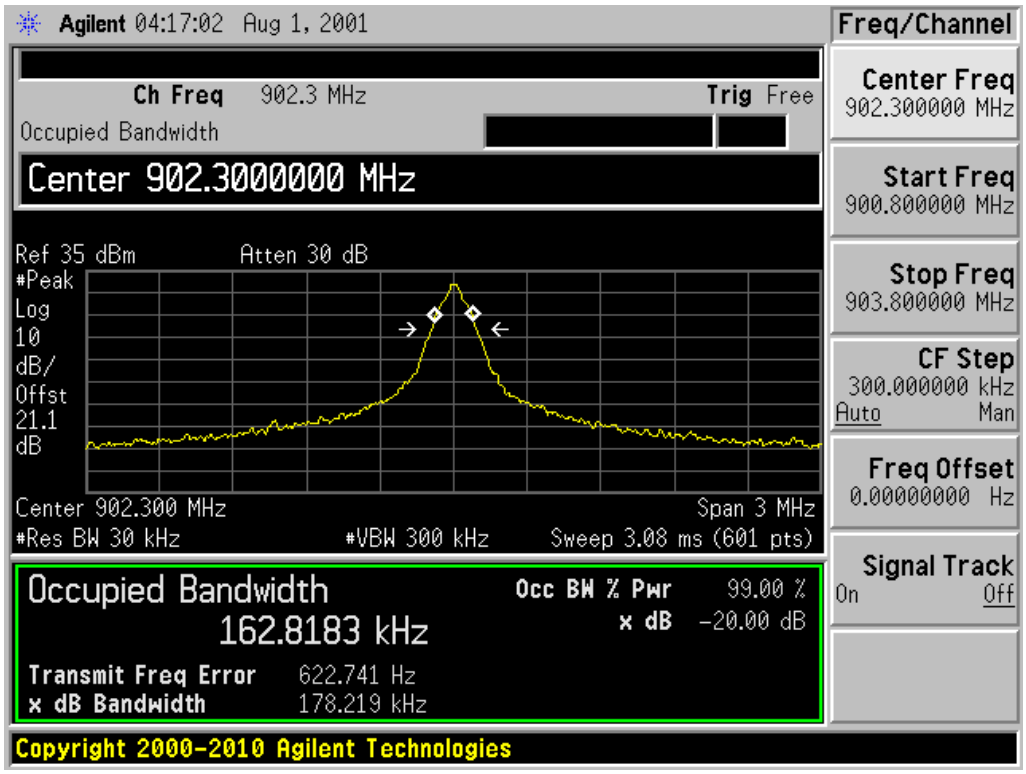


300 kHz Channel Separation

20 dB BANDWIDTH LOW CHANNEL, FSK

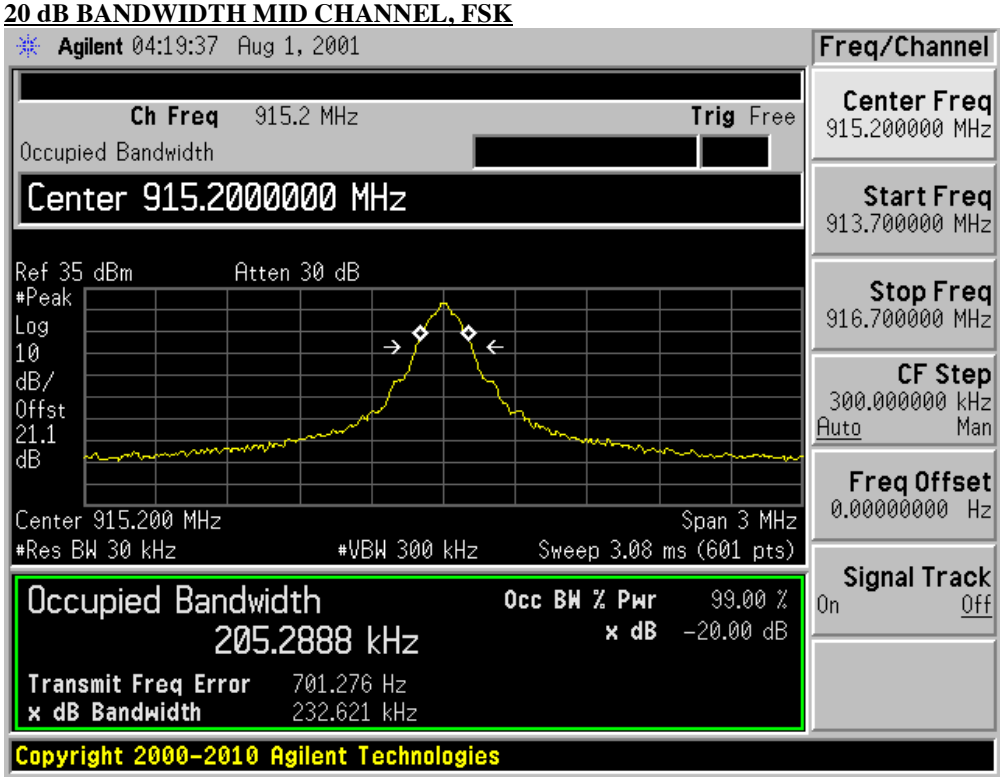


20 dB BANDWIDTH LOW CHANNEL, GFSK

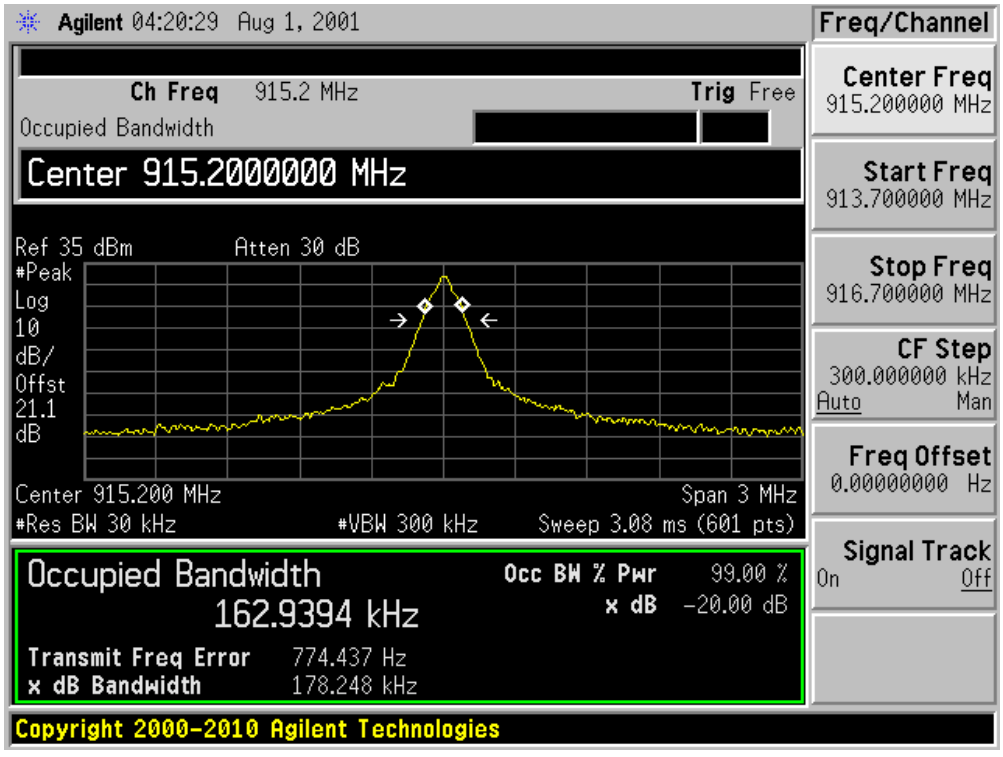


300 kHz Channel Separation

20 dB BANDWIDTH MID CHANNEL, FSK

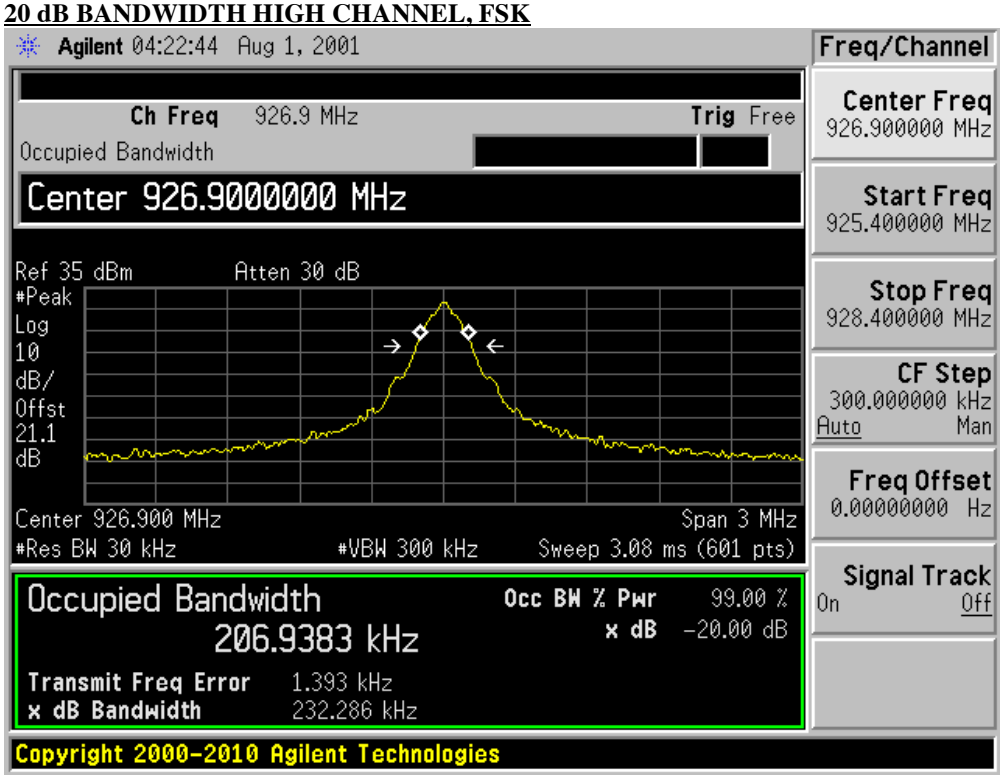


20 dB BANDWIDTH MID CHANNEL, GFSK



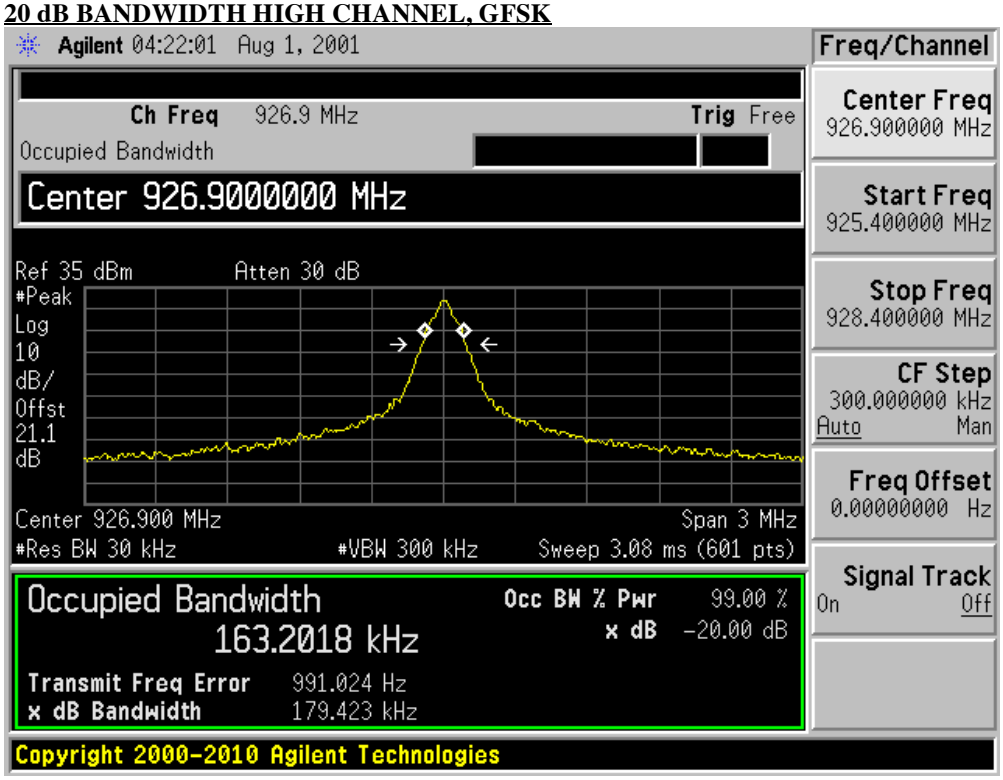
300 kHz Channel Separation

20 dB BANDWIDTH HIGH CHANNEL, FSK



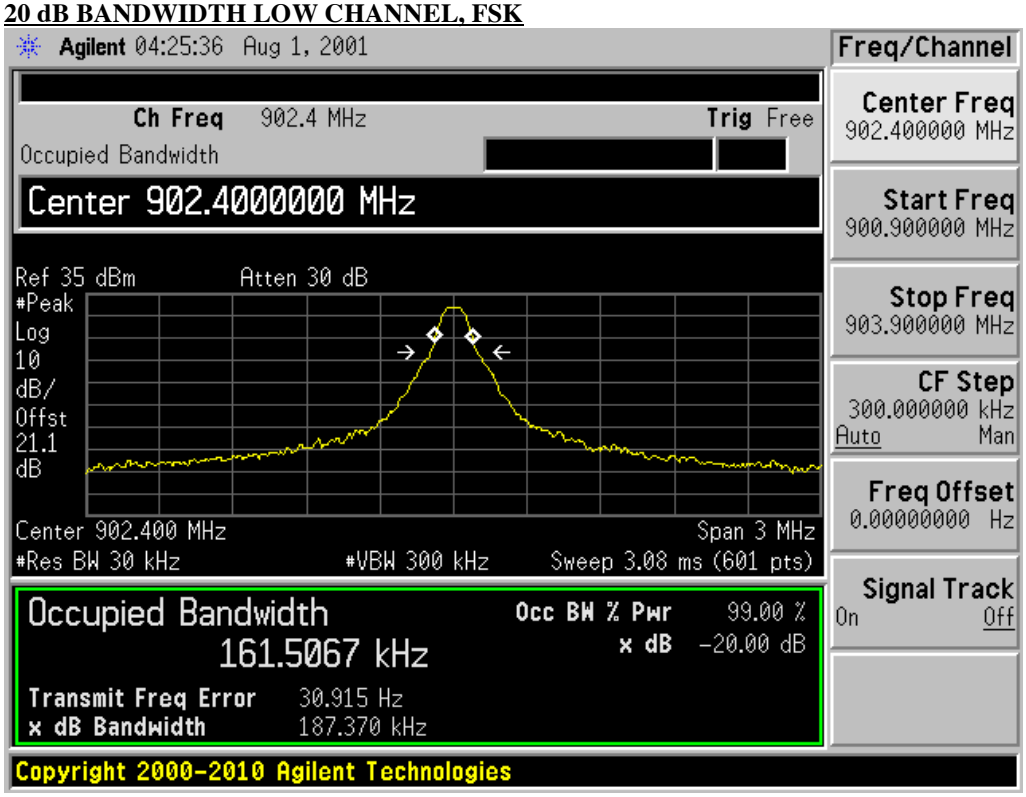
300 kHz Channel Separation

20 dB BANDWIDTH HIGH CHANNEL, GFSK

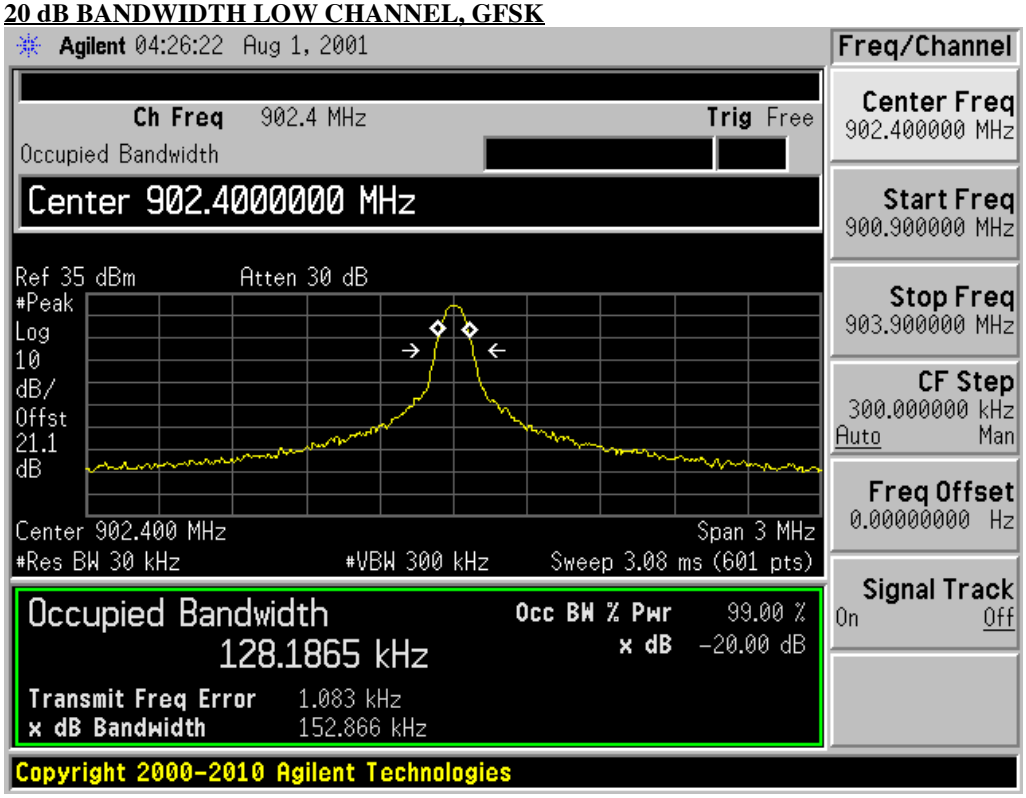


200 kHz Channel Separation

20 dB BANDWIDTH LOW CHANNEL, FSK

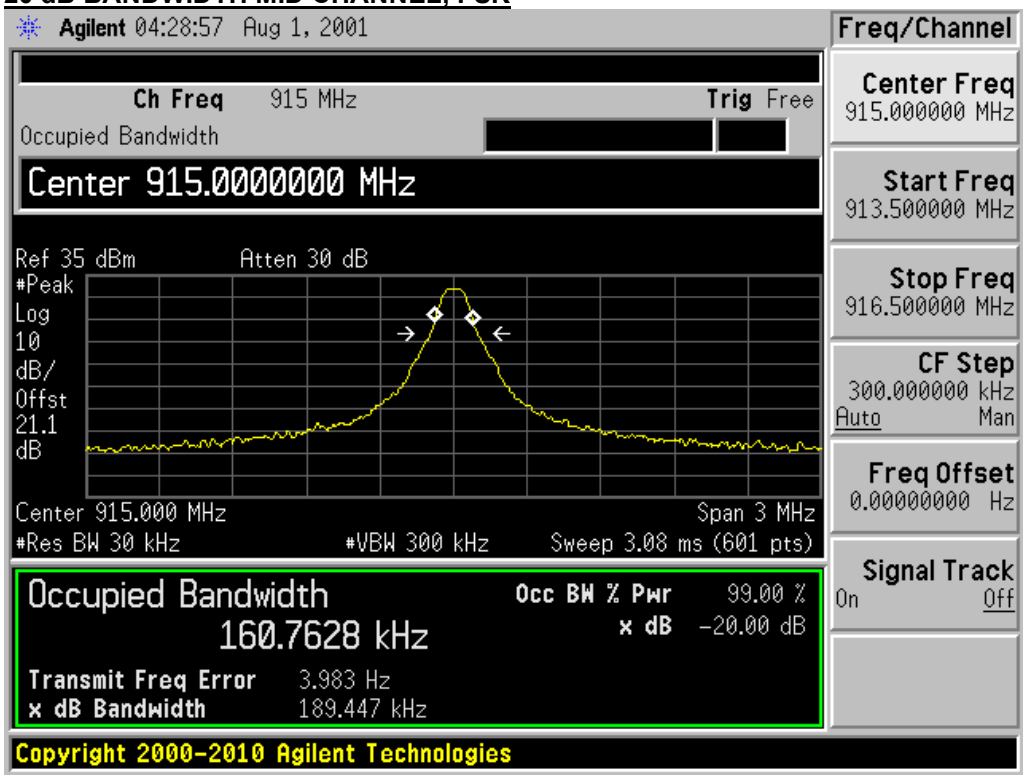


20 dB BANDWIDTH LOW CHANNEL, GFSK

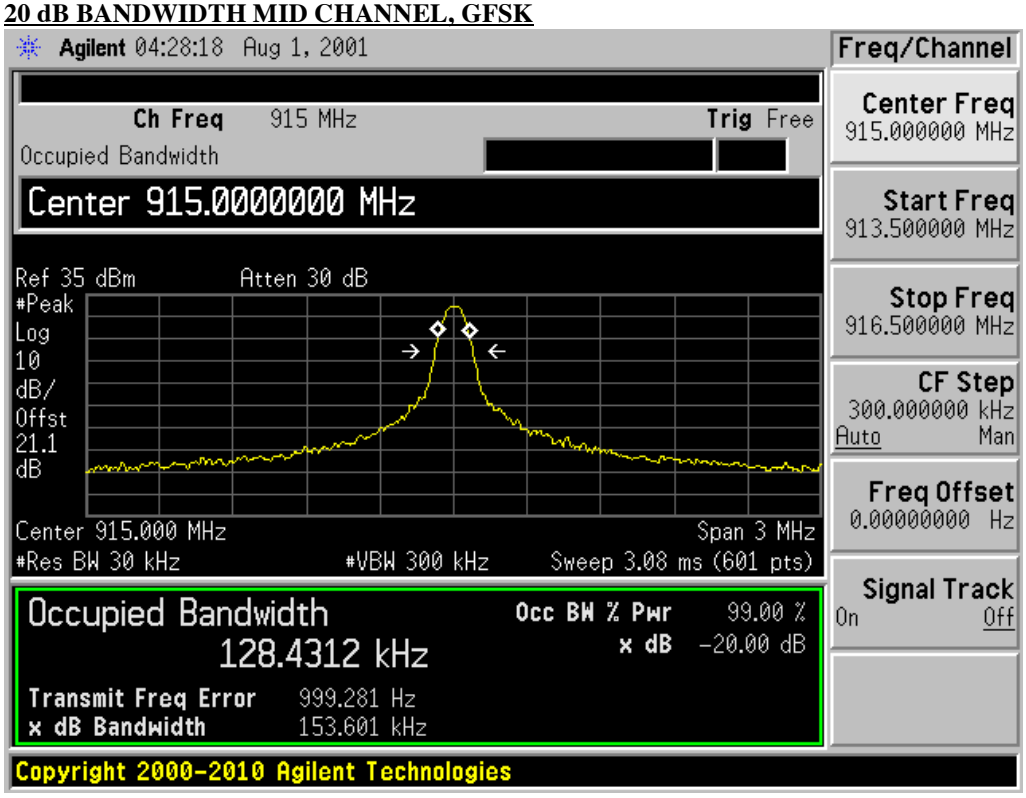


200 kHz Channel Separation

20 dB BANDWIDTH MID CHANNEL, FSK

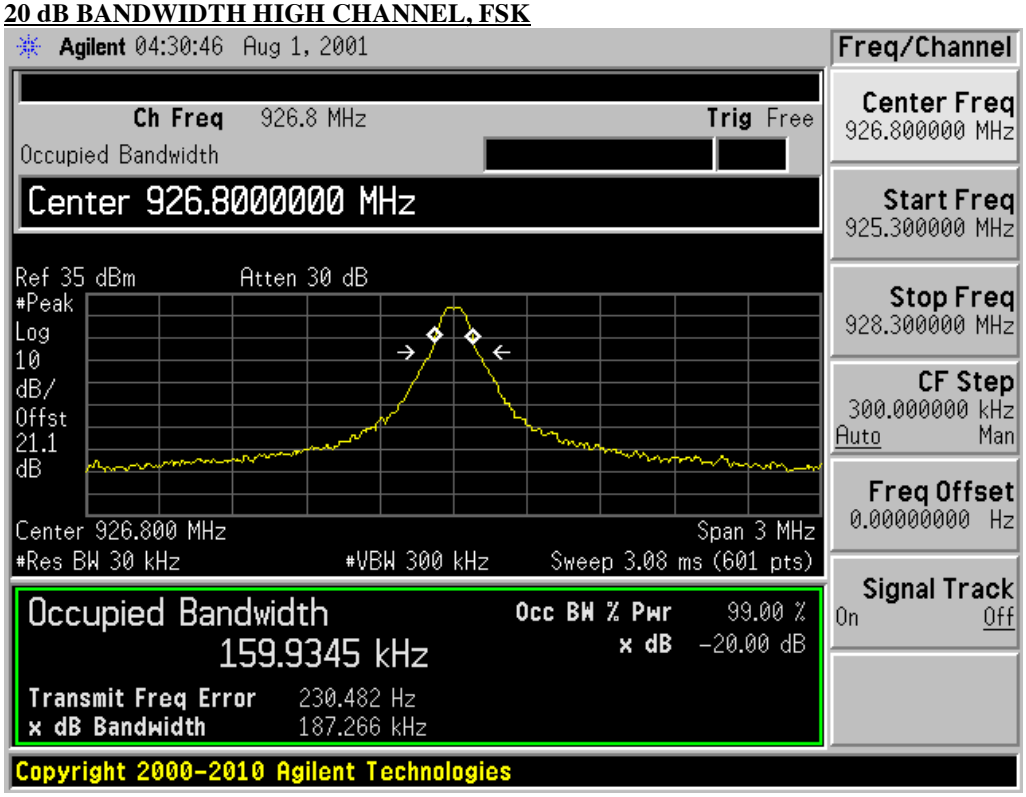


20 dB BANDWIDTH MID CHANNEL, GFSK

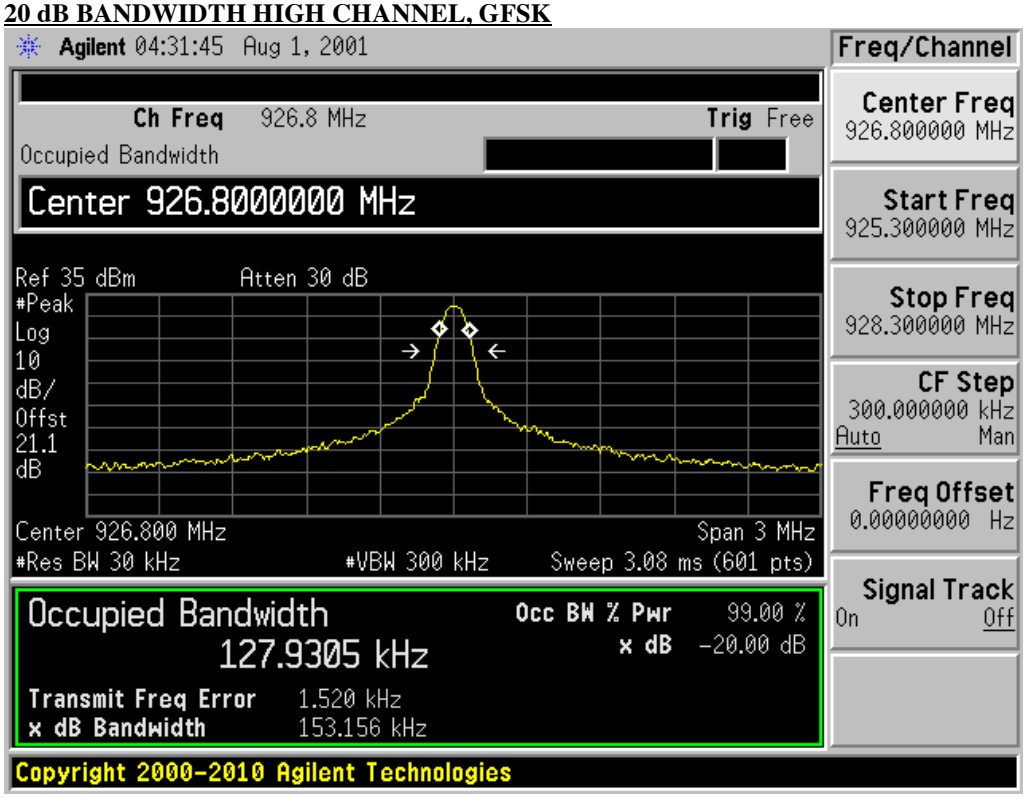


200 kHz Channel Separation

20 dB BANDWIDTH HIGH CHANNEL, FSK



20 dB BANDWIDTH HIGH CHANNEL, GFSK



99% Occupied Bandwidth

LIMIT

None, for information purposes only.
The TX output is connected to a spectrum analyzer. The OCC BW function is activated.
RBW > 1% of SPAN
VBW> 3xRBW
Detector: SAMPLE

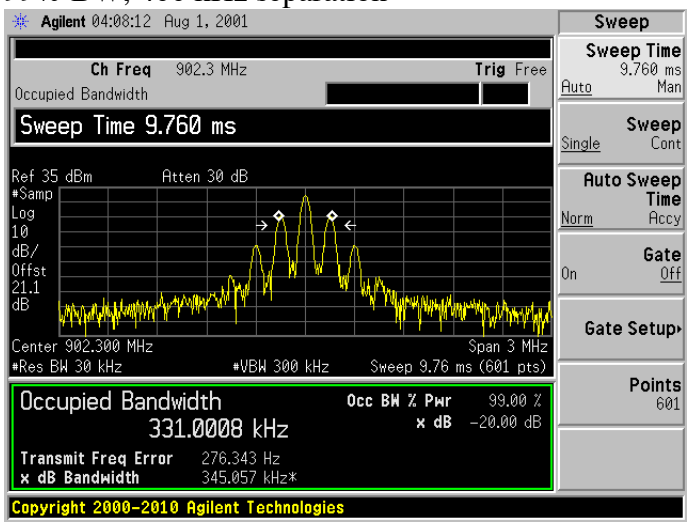
RESULTS

No non-compliance noted.

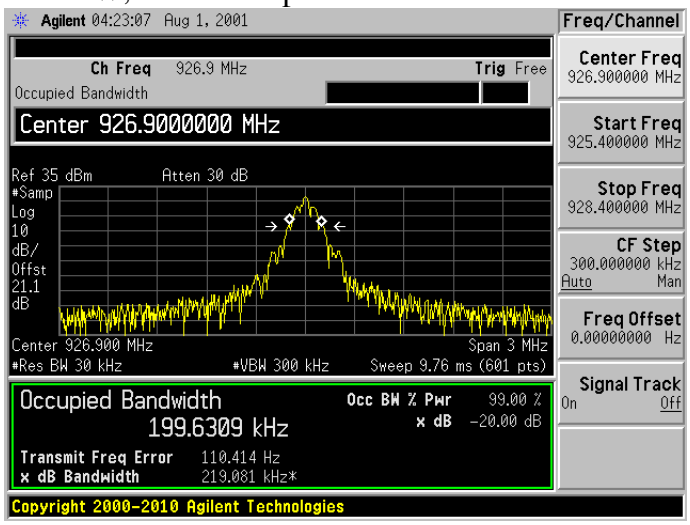
Plots below show worst-case occupied bandwidth for each channel separation.

Channel Separation	Worst-case Occupied BW
400 kHz	331 kHz (Low channel)
300 kHz	199.63 kHz (High channel)
200 kHz	151.86 kHz (High channel)

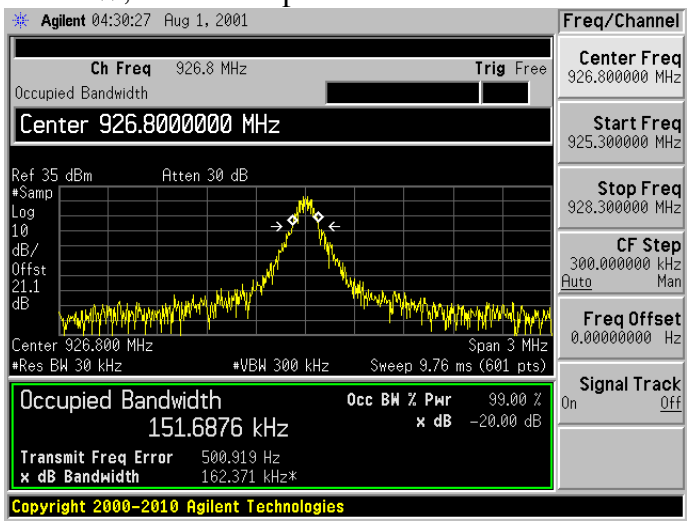
99% BW, 400 kHz separation



99% BW, 300 kHz separation



99% BW, 200 kHz separation



HOPPING FREQUENCY SEPARATION

LIMIT

§15.247 (a) (1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hoping channel, whichever is greater.

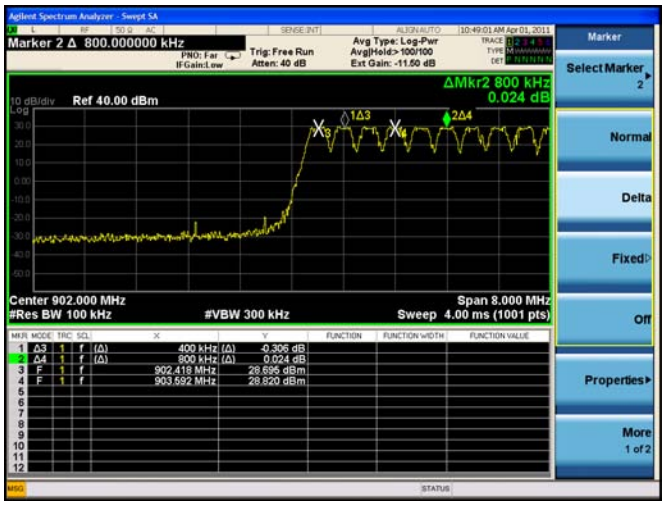
TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The RBW is set to 10 kHz and the VBW is set to 30 kHz. The sweep time is coupled.

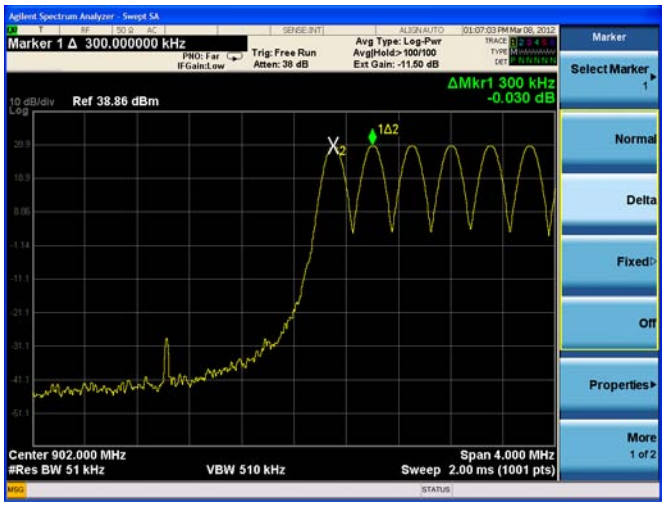
RESULTS

No non-compliance noted:

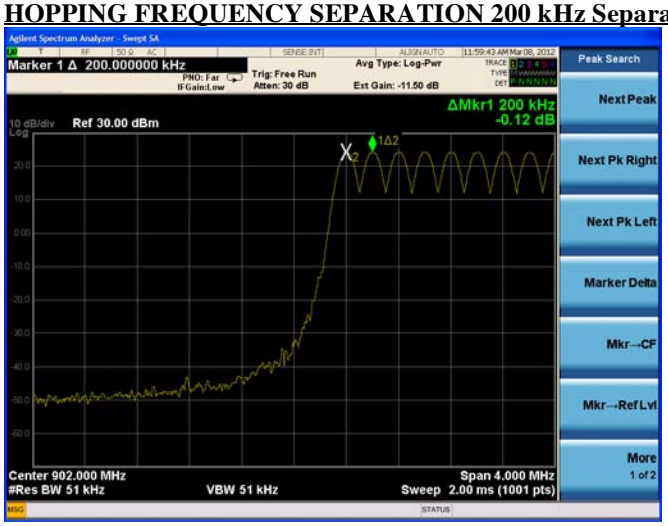
HOPPING FREQUENCY SEPARATION 400 kHz Separation



HOPPING FREQUENCY SEPARATION 300 kHz Separation



HOPPING FREQUENCY SEPARATION 200 kHz Separation



NUMBER OF HOPPING CHANNELS

LIMIT

§15.247 (a) (1) (i) 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 and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to 3 % of the span. The analyzer is set to Max Hold.

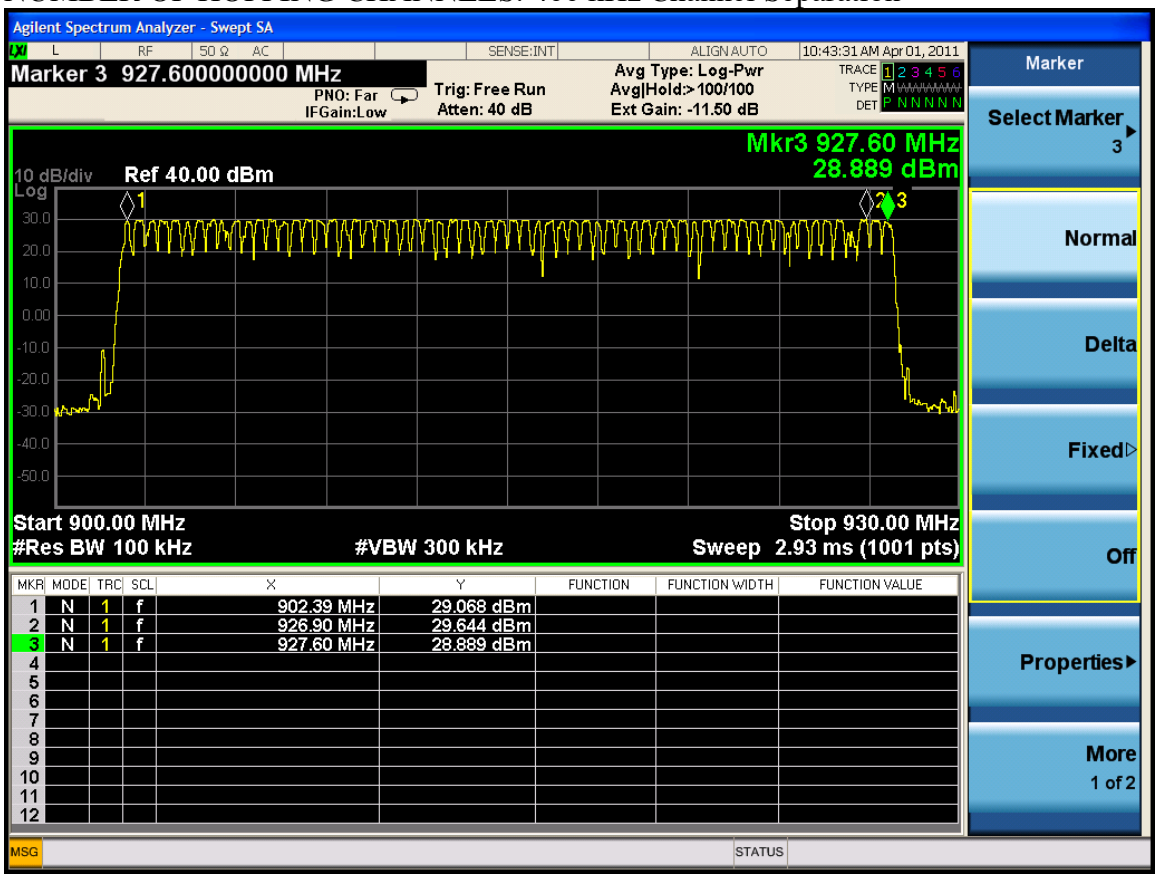
RESULTS

No non-compliance noted:

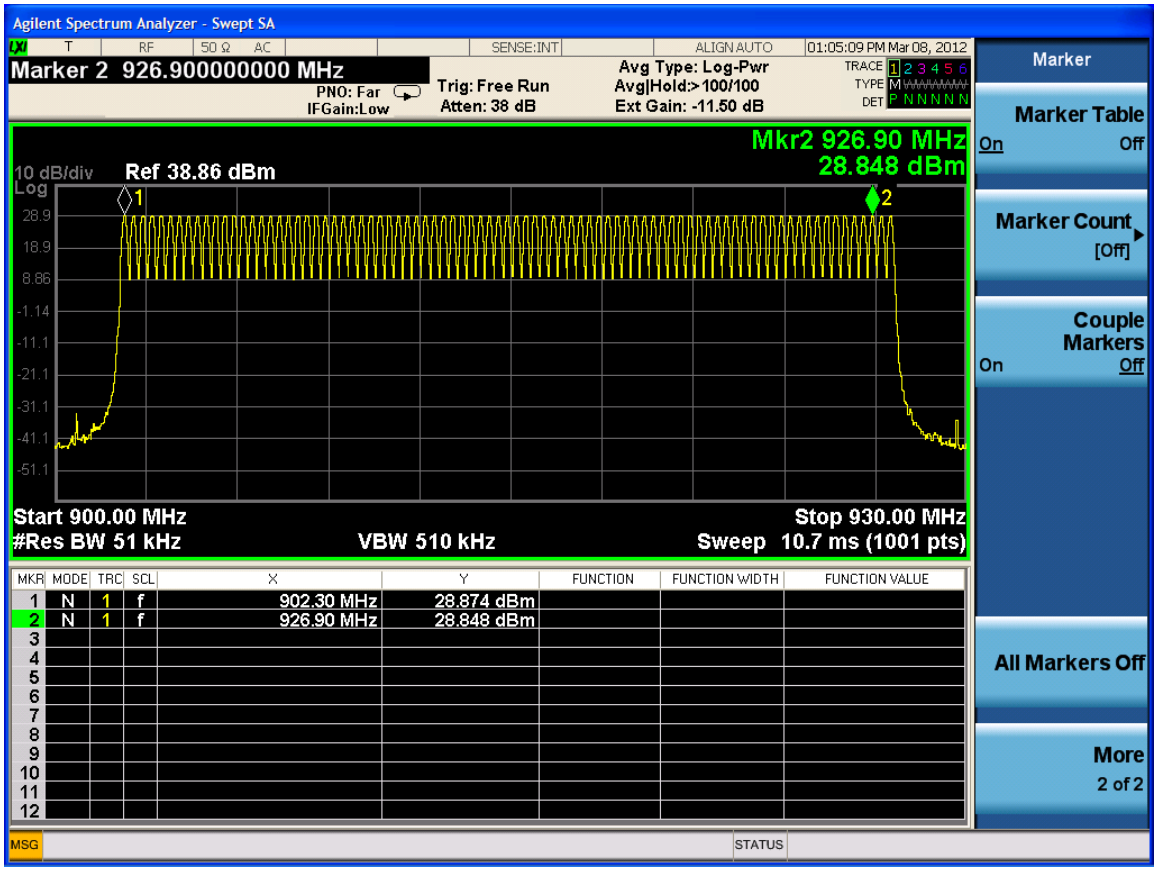
400 kHz channel separation: 62 channels
300 kHz channel separation: 83 channels
200 kHz channel separation: 123 channels

NOTE: The hopping channel plots below show higher numbers of channels than listed above. The test software is limited to showing all available channels, and some of the channels are used in other regulatory domains (ex.: Australia) but are not used in the United States or Canada.

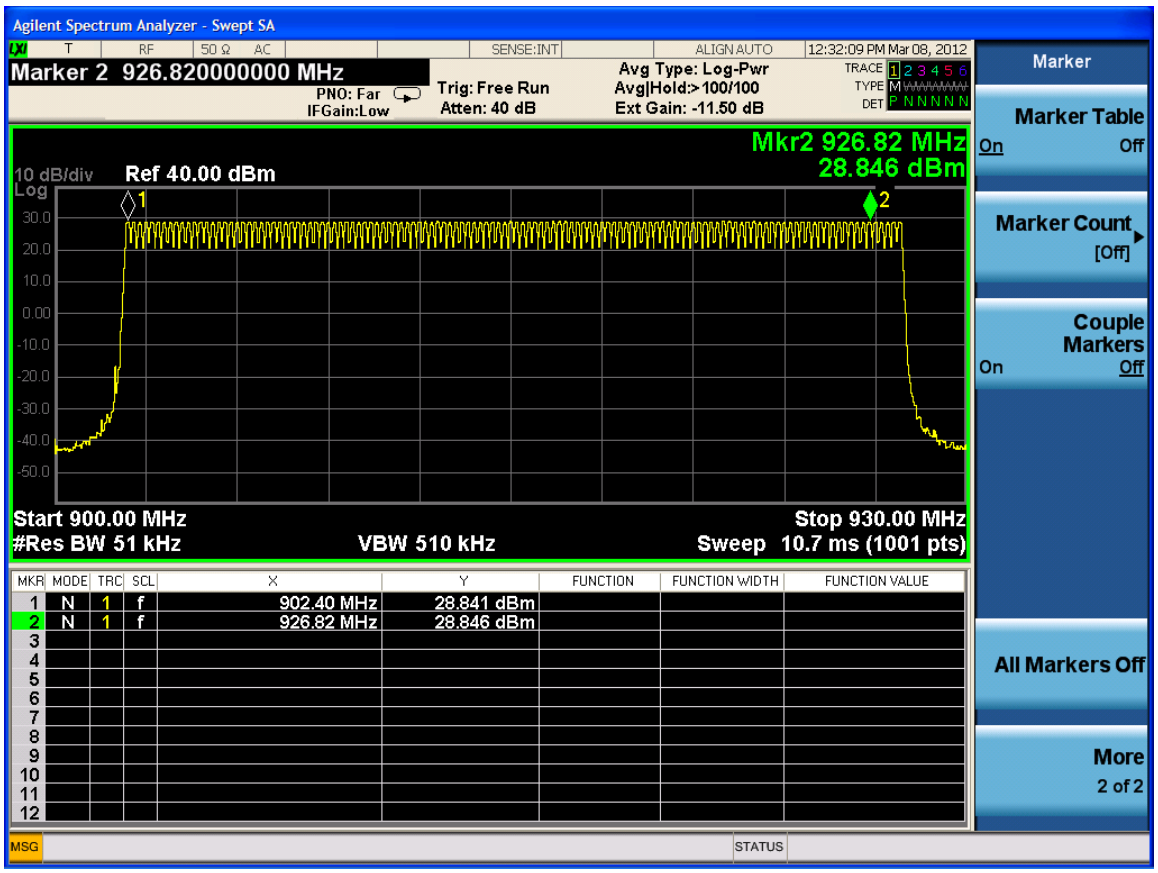
NUMBER OF HOPPING CHANNELS: 400 kHz Channel Separation



NUMBER OF HOPPING CHANNELS: 300 kHz Channel Separation



NUMBER OF HOPPING CHANNELS: 200 kHz Channel Separation



AVERAGE TIME OF OCCUPANCY

LIMIT

§15.247 (a) (1) (i) 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 and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

TEST PROCEDURE

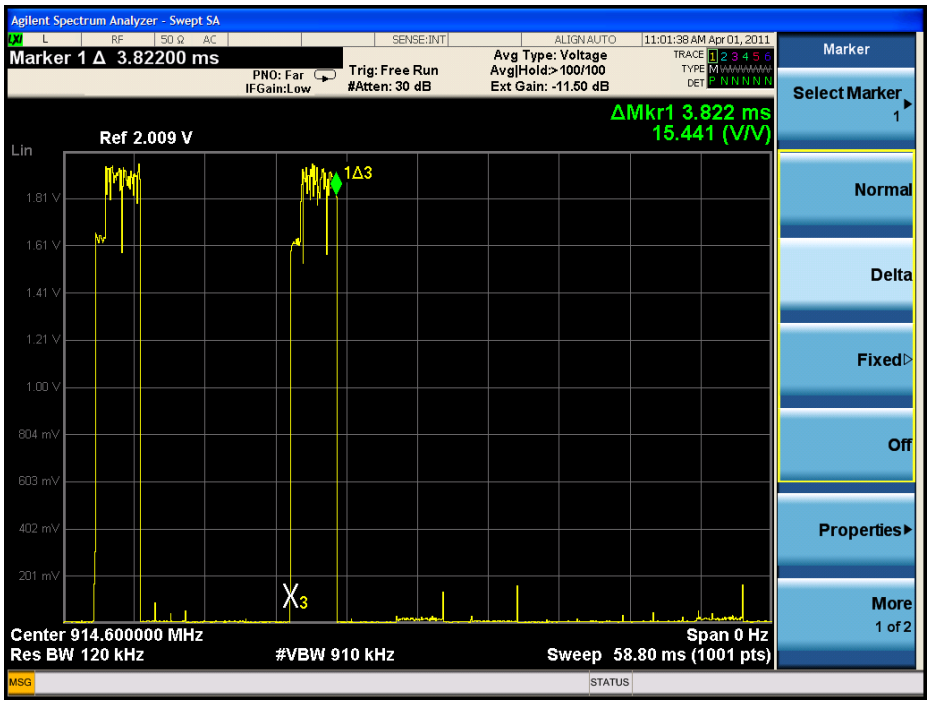
The transmitter output is connected to a spectrum analyzer. The span is set to 0 Hz, centered on a single, selected hopping channel. The width of a single pulse is measured in a fast scan. The number of pulses is measured in a 20 second scan, to enable resolution of each occurrence.

RESULTS

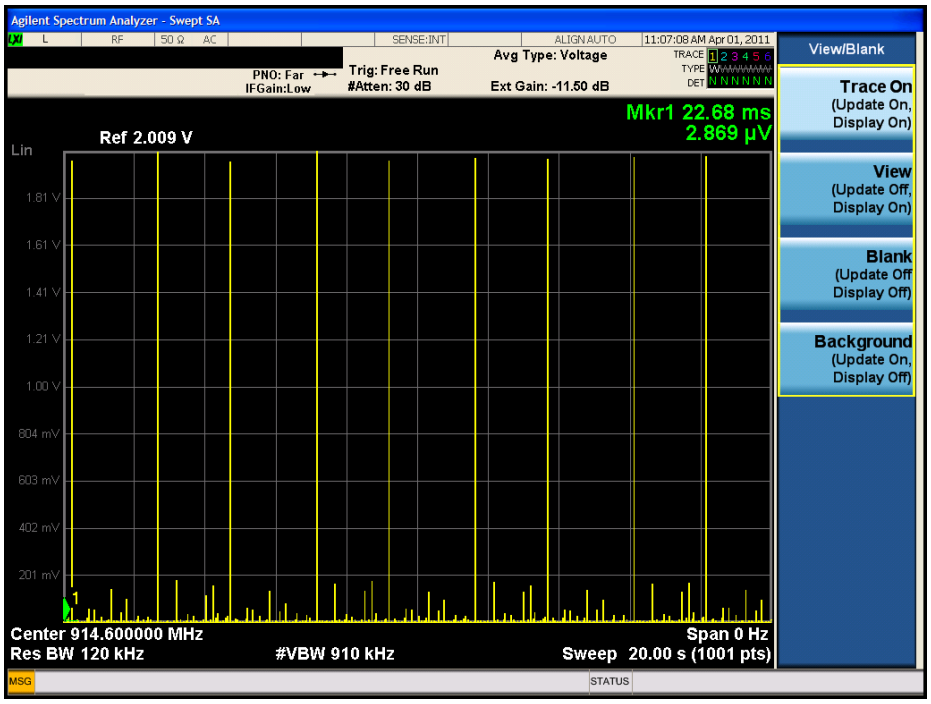
No non-compliance noted:

Channel Separation	Hop duration msec	Total hops/20 sec	Average time of occupancy msec	Limit in 20 sec msec
400 kHz	3.8	9	34.2	400
300 kHz	1.95	12	13.95	400
200 kHz	2.0	8	16	400

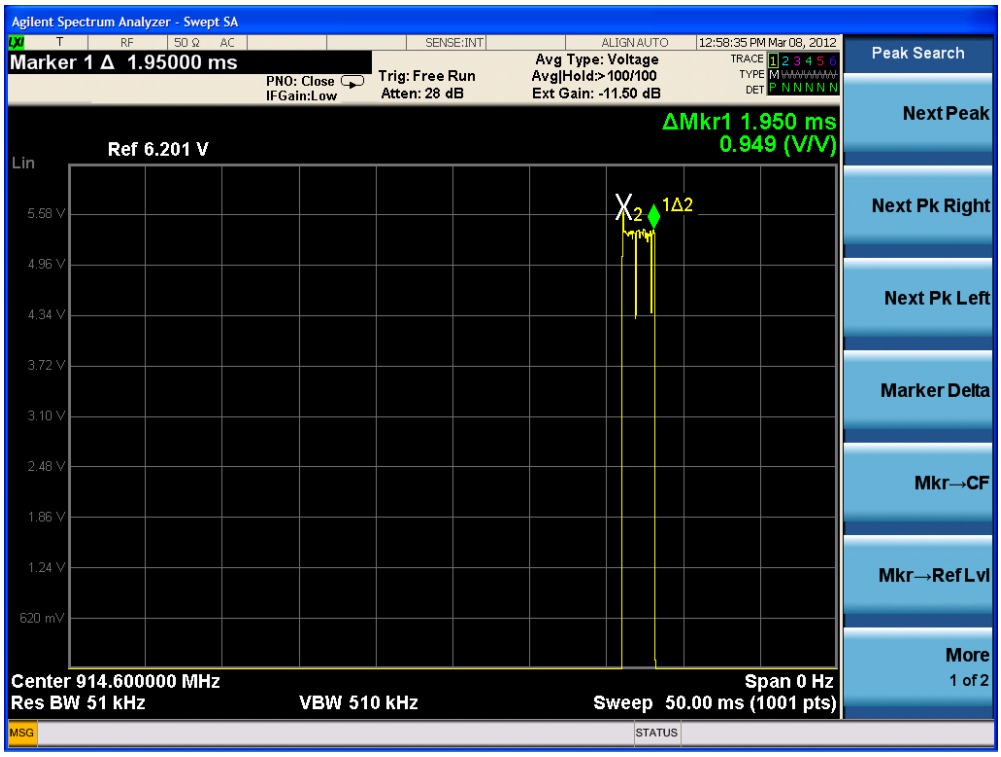
Hop duration 400kHz Channel Separation



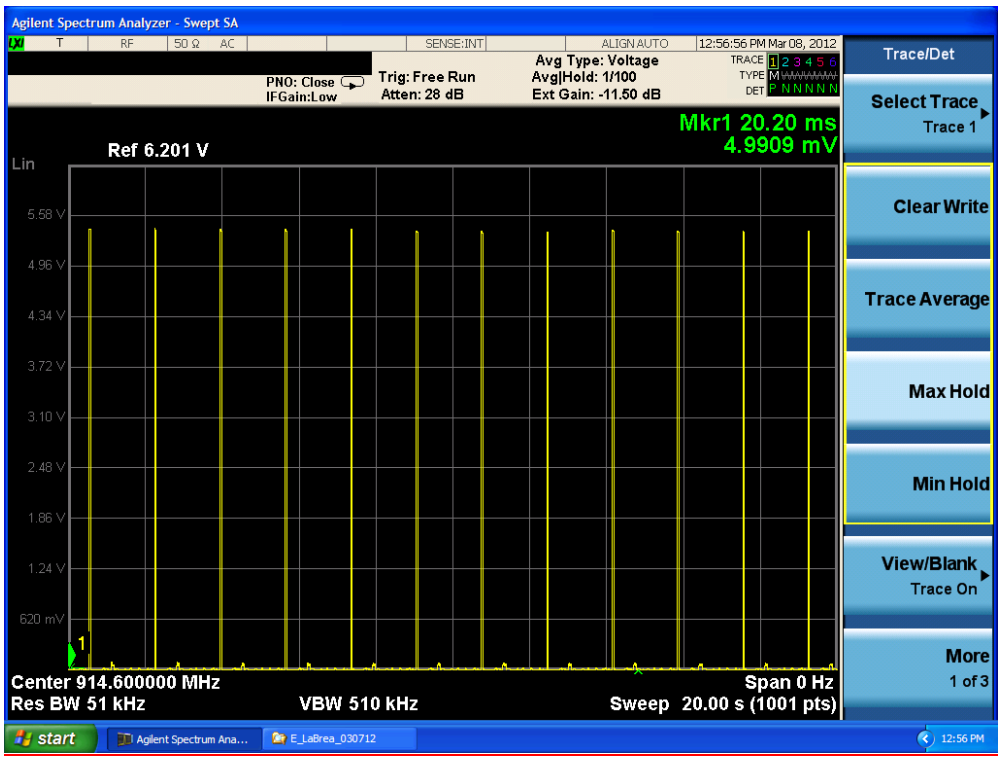
NUMBER OF PULSES IN 20 SECOND OBSERVATION PERIOD 400kHz Channel Separation



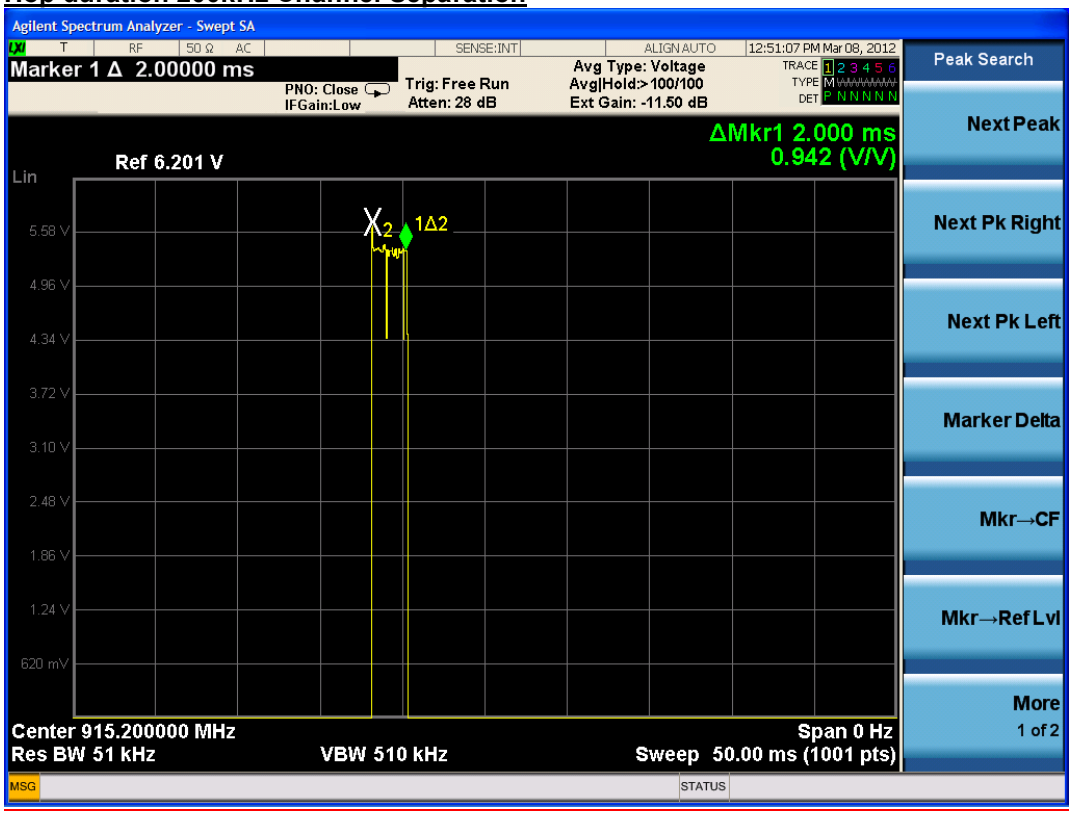
Hop duration 300kHz Channel Separation



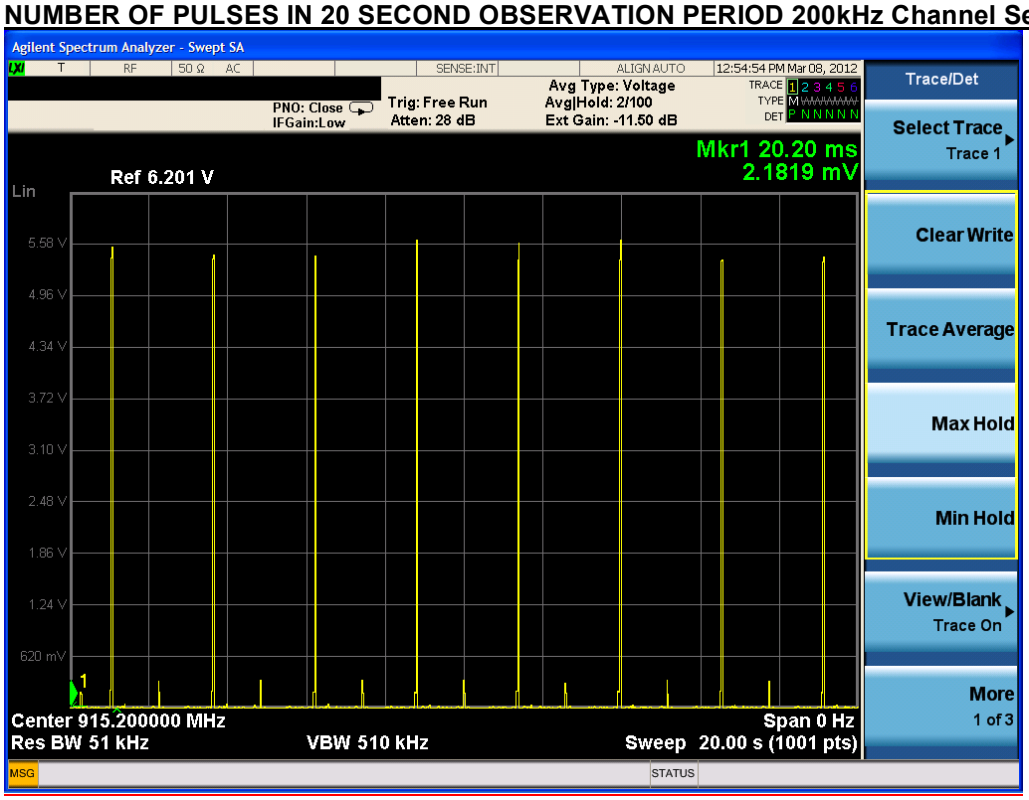
NUMBER OF PULSES IN 20 SECOND OBSERVATION PERIOD 300kHz Channel Separation



Hop duration 200kHz Channel Separation



NUMBER OF PULSES IN 20 SECOND OBSERVATION PERIOD 200kHz Channel Separation



PEAK OUTPUT POWER

PEAK POWER LIMIT

§15.247 (b) The maximum peak output power of the intentional radiator shall not exceed the following:

§15.247 (b) (2) For frequency hopping systems operating in the 902-928 MHz band, employing at least 50 hopping channels: 1 watt; and employing less than 50 hopping channels, but at least 25 hopping channels: 0.25 watt.

§15.247 (b) (4) Except as shown in paragraphs (b)(3) (i), (ii) and (iii) of this section, if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1) or (b)(2) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

The maximum antenna gain is 4 dBi, therefore the power limit is 30 dBm.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer through appropriate attenuation. Analyzer settings:

RBW > EBW
VBW = 3xRBW
Detector: PEAK

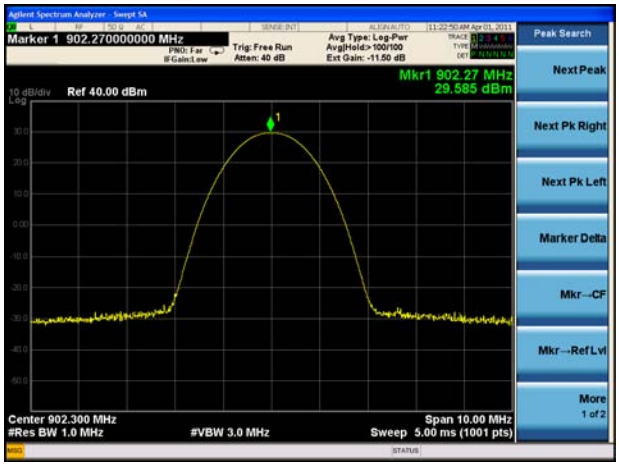
RESULTS

No non-compliance noted:

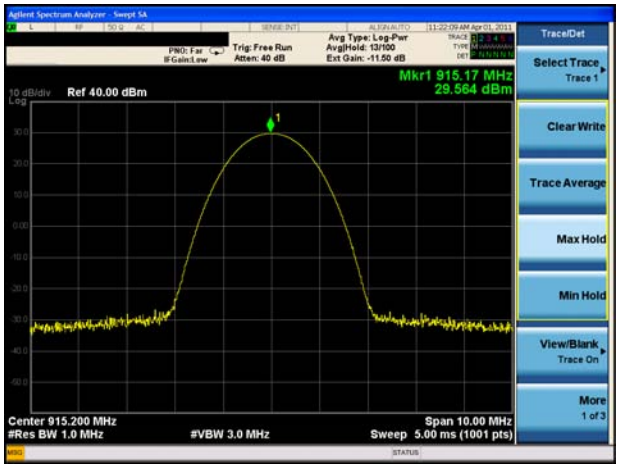
Channel	Frequency	P out
Low	902.3	29.56
Mid	914.9	29.56
High	926.9	29.54

Note: Power output essentially equal for all hopping channel separation modes. Data presented for 300 kHz channel separation mode as most typical worst case.

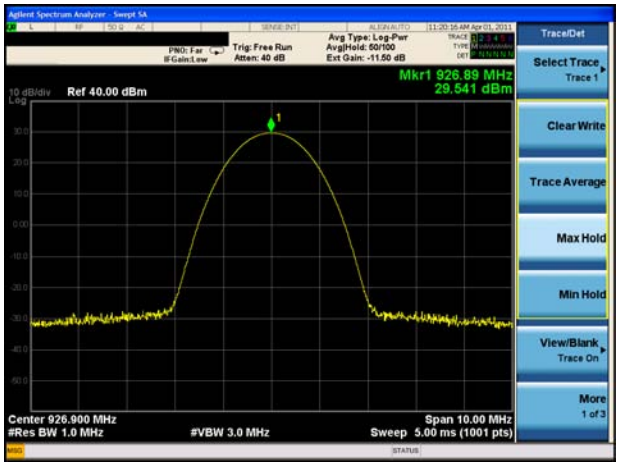
OUTPUT POWER LOW CHANNEL



OUTPUT POWER MID CHANNEL



OUTPUT POWER HIGH CHANNEL



MAXIMUM PERMISSIBLE EXPOSURE

LIMITS

§1.1310 The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio-frequency (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.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*($900/f^2$)	6
30–300	61.4	0.163	1.0	6
300–1500	.....	.....	f/300	6
1500–100,000	.....	.....	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*($180/f^2$)	30

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)—Continued

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
30–300	27.5	0.073	0.2	30
300–1500	.....	.....	f/1500	30
1500–100,000	.....	.....	1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

CALCULATIONS

Given

$E = \sqrt{(30 * P * G)} / d$

and

$S = E ^ 2 / 3770$

where

E = Field Strength in Volts/meter
P = Power in Watts
G = Numeric antenna gain
d = Distance in meters
S = Power Density in milliwatts/square centimeter

Combining equations and rearranging the terms to express the distance as a function of the remaining variables yields:

$d = \sqrt{((30 * P * G) / (3770 * S))}$

Changing to units of Power to mW and Distance to cm, using:

P (mW) = P (W) / 1000 and
d (cm) =100 * d (m)

yields

$d = 100 * \sqrt{((30 * (P / 1000) * G) / (3770 * S))}$
$d = 0.282 * \sqrt{(P * G / S)}$

where

d = distance in cm
P = Power in mW
G = Numeric antenna gain
S = Power Density in mW/cm^2

Substituting the logarithmic form of power and gain using:

P (mW) = 10 ^ (P (dBm) / 10) and
G (numeric) = 10 ^ (G (dBi) / 10)

yields

$d = 0.282 * 10 ^ ((P + G) / 20) / \sqrt{S}$ Equation (1)

where

d = MPE distance in cm
P = Power in dBm
G = Antenna Gain in dBi
S = Power Density Limit in mW/cm^2

Equation (1) and the measured peak power is used to calculate the MPE distance.

LIMITS

From §1.1310 Table 1 (B), S = 0.6 mW/cm^2

RESULTS

No non-compliance noted:

Worst-case RF exposure condition is for internal antenna operation as the gain is higher

Power Density Limit (mW/cm^2)	Output Power (dBm)	Antenna Gain (dBi)	S, mW/cm2 at 20cm
0.6	29.56	4.00	0.45

MPE Distance: 17.4 cm (for 900 MHz operation alone). MPE calculation for dual 900/2.4 GHz operation is presented in a separate document.

NOTE: For mobile or fixed location transmitters, the minimum separation distance is 20 cm, even if calculations indicate that the MPE distance would be less.

CONDUCTED SPURIOUS EMISSIONS

LIMITS

§15.247 (c) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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. 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)).

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 100 kHz.

The spectrum from 30 MHz to 10 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

Testing was performed for worst-case operation:

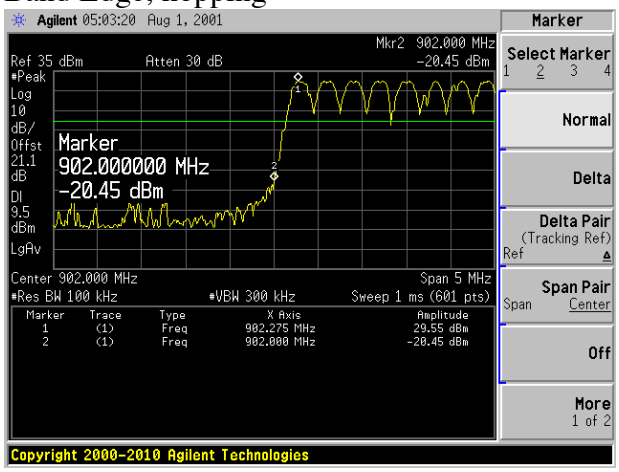
300 kHz channel separation FSK modulation

RESULTS

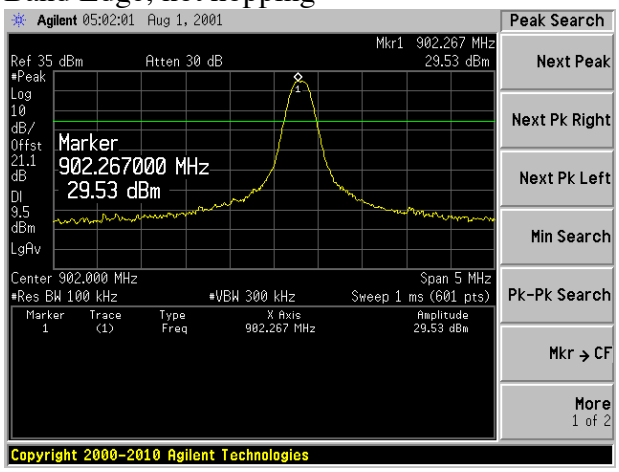
No non-compliance noted:

SPURIOUS EMISSIONS, LOW CHANNEL

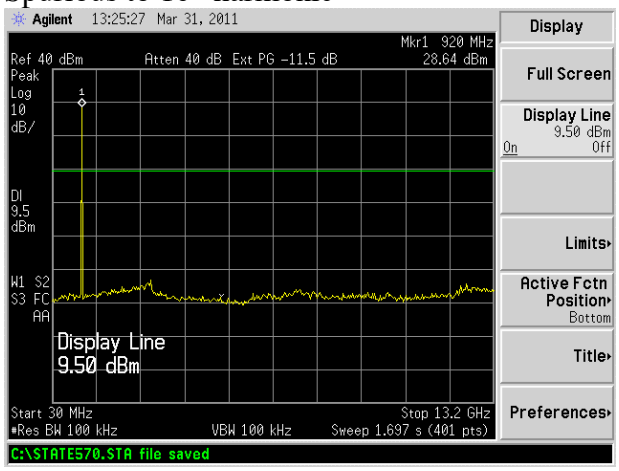
Band Edge, hopping



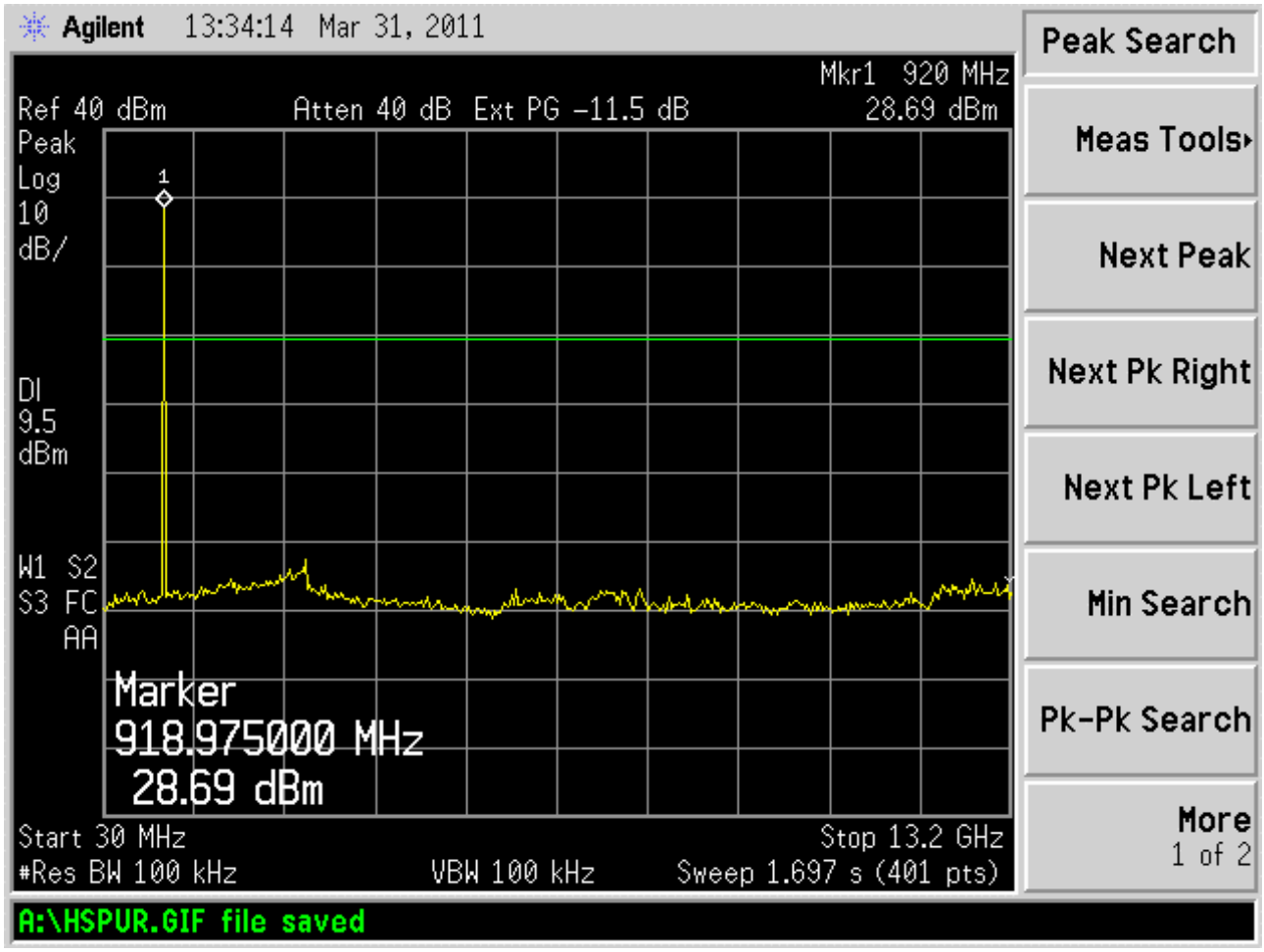
Band Edge, not hopping



Spurious to 10th harmonic

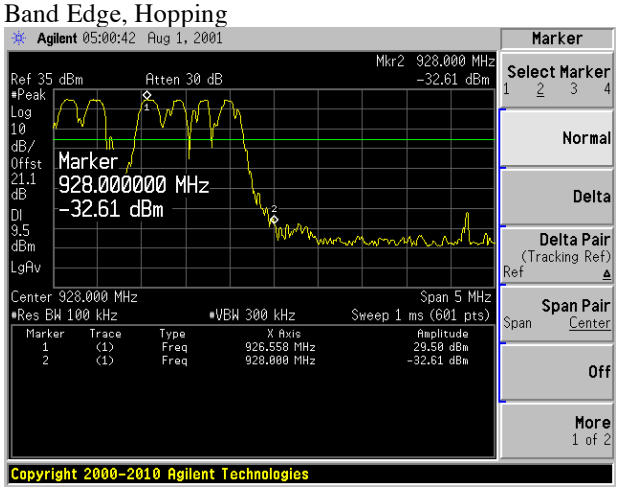


SPURIOUS EMISSIONS, MID CHANNEL

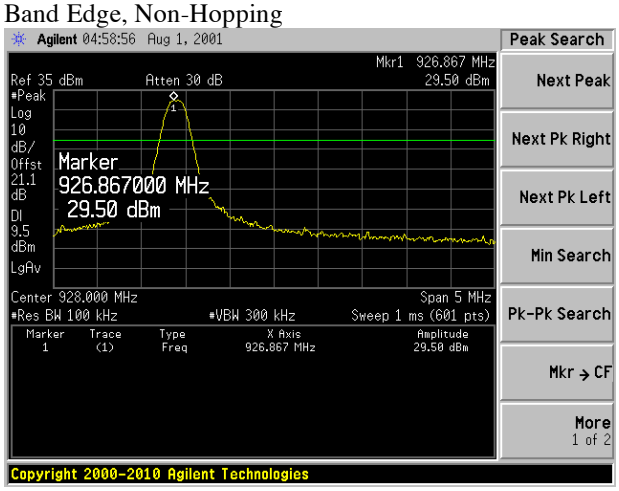


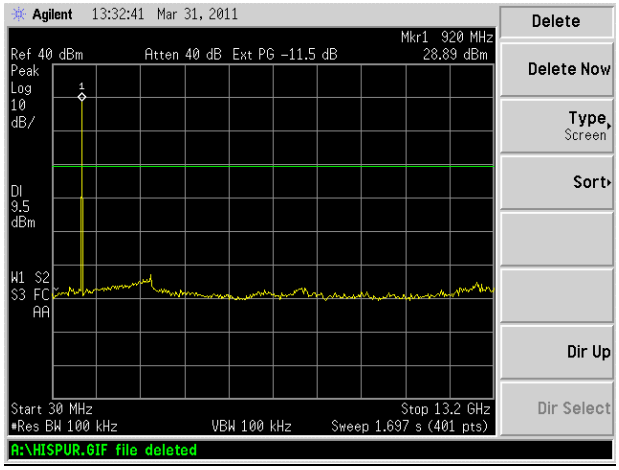
SPURIOUS EMISSIONS, HIGH CHANNEL

Band Edge, Hopping



Band Edge, Non-Hopping





4.4 POWERLINE CONDUCTED EMISSIONS

LIMIT

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

The lower limit applies at the boundary between the frequency ranges.

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency.

TEST PROCEDURE

The EUT is placed on a non-conducting table 40 cm from the vertical ground plane and 80 cm above the horizontal ground plane. The EUT is configured in accordance with ANSI C63.4.

The resolution bandwidth is set to 9 kHz for both peak detection and quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

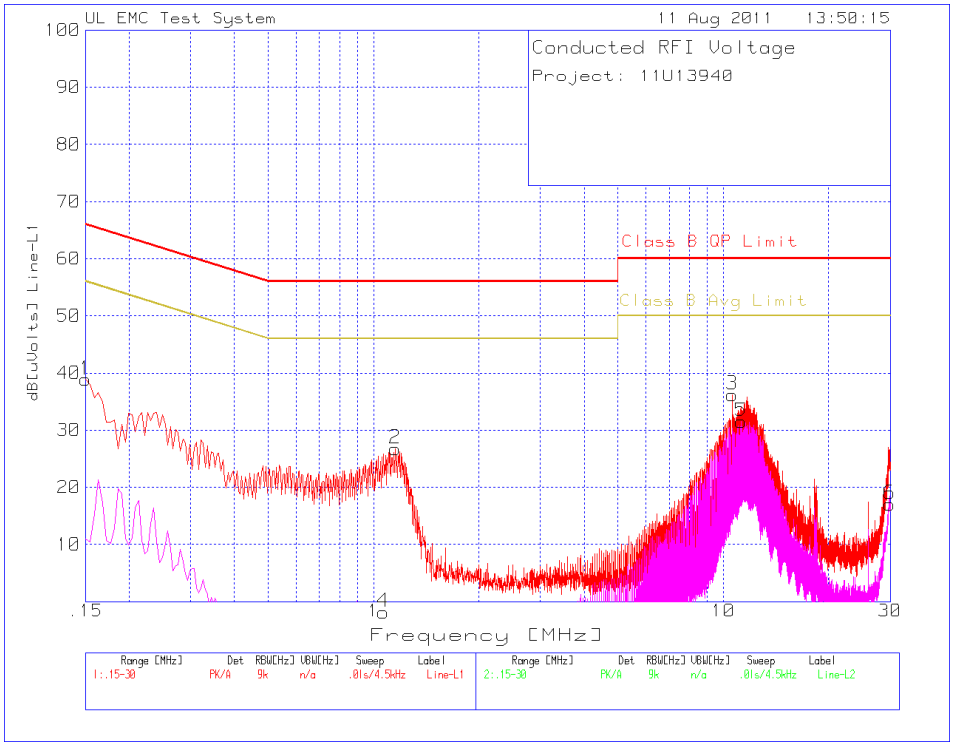
The transmitter was configured to simultaneously transmit FHSS mode in the 902 MHz and 2.4 GHz bands simultaneously, since this is the worst case operation (maximum output power) for simultaneous operation.

Line conducted data is recorded for both NEUTRAL and HOT lines.

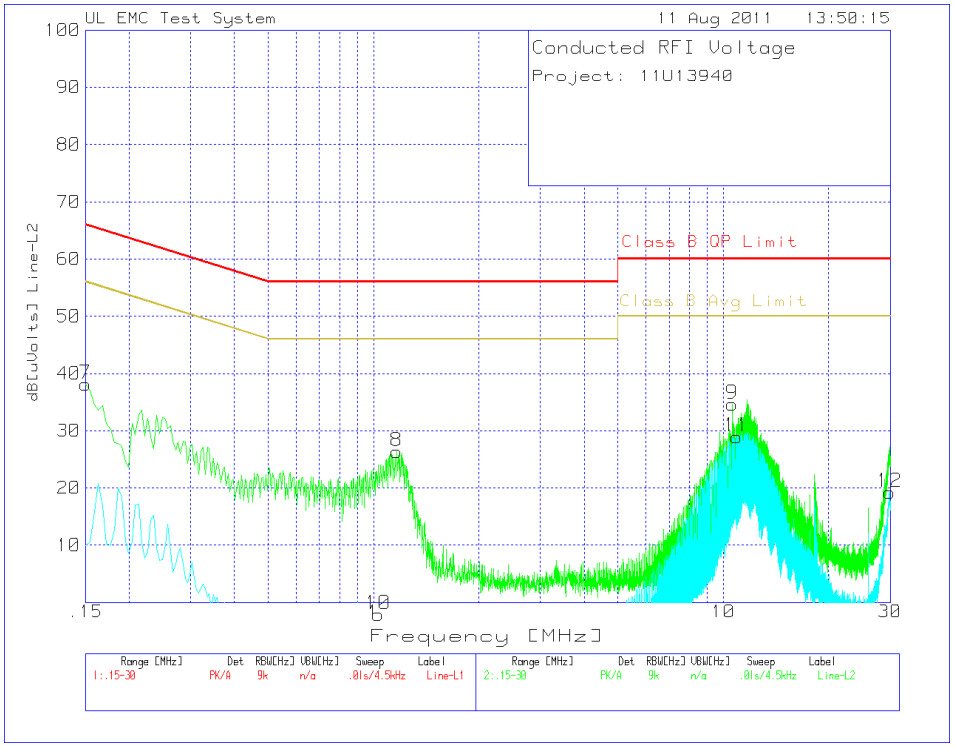
RESULTS

No non-compliance noted:

LINE 1 RESULTS



LINE 2 RESULTS



END OF REPORT

Report Revision History

Revision No.	Revision Description	Pages Revised	Revised by	Date
-	Original issue		T. Cokenias	12 March 2012
1	Insert correct spectrum analyzer charts for 400 kHz channel separation mode	10-12	T. Cokenias	15 March 2012
2	Per 5/25/12 reviewer email: Correct table heading Add DA-00-705 reference Correct table entries Add Occ BW plots with PEAK detector Add Close-in Band edge emissions plots	 8 2 11 12-18 35, 37	T. Cokenias	11 June 2011