FCC CFR47 PART 15 SUBPART C

Test Report

902-928 MHZ RFID READER

Model Numbers: SR2200, SR2204

FCC ID: NTTWJSR22XX

Report Number: 05WJ22XXFCC

Issue Date: August 29, 2005

Prepared for

WJ Communications Inc.
401 River Oaks Parkway
San Jose 95134

Prepared by

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El Granada CA 94018

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1. TEST AND TEST LOCATION INFORMATION

COMPANY NAME: WJ COMMUNICATIONS
401 RIVER OAKS PARKWAY
SAN JOSE, CA 95134

EUT DESCRIPTION: RFID READER CARD

MODEL: SR2200

DATA ALSO APPLIES TO : SR2201

DATE TESTED: JUNE 23 – AUGUST 5 2005

All tests were performed by

Compliance Certification Services
561F Monterey Road
Morgan Hill CA 95037

29 August 2005

T.N. Cokenias
Agent for WJ Communications Inc.

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.4-2003, FCC CFR 47 Part 2 and FCC CFR 47 Part 15.

3. EQUIPMENT UNDER TEST

3.1. DESCRIPTION OF EUT

The EUT is a 1 watt RFID Reader card with a 6dBi circularly polarized antenna.

The EUT is capable of producing two types of modulation that are standards in the RFID tag industry, Class 0 and Class 1. Passive RF ID tags are manufactured to respond to either Class 0 or Class 1 reader interrogation. A third mode of operation, called Mode 1800, is also available on the EUT.

All three modes were tested.

3.2. MAXIMUM OUTPUT POWER

CLASS 0

Channel	Frequency (MHz)	Power (dBm)	Power (mW)
Low	902.75	29.51	893.3
Middle	915.25	29.54	899.5
High	927.25	29.31	853.1

CLASS 1

Channel	Frequency (MHz)	Power (dBm)	Power (mW)
Low	902.75	29.58	907.8
Middle	915.25	29.59	909.9
High	927.25	29.36	863.0

MODE 1800

	(MHz)	(dBm)	(mW)
Low	902.75	29.58	907.8
Middle	915.25	29.71	935.4
High	927.25	29.32	855.1

3.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a circularly polarized antenna, with a maximum effective gain of 6 dBi. The effective gain is the sum of published antenna gain plus minimum antenna cable loss. Minimum antenna cable loss is 1 dB.

Published maximum gain: 6.97 dBi
Minimum cable loss: 1.00 dB

Effective antenna gain at EUT antenna port: 5.97 dBi

3.4. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was MPR version 2.0

3.5. WORST-CASE CONFIGURATION AND MODE

For antenna conducted emissions, Class 0 , Class 1 and Mode 1800 modulations were investigated. During radiated emissions tests, there was an RFID tag on the table with the reader. The tag was appropriate for the type modulation being investigated.

Worst case emissions are reported.

3.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

PERIPHERAL SUPPORT EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
LAPTOP	IBM	390E	AF - 1B8BD	N/A
AC/DC ADAPTER	IBM	N/A	02K6555	N/A
AC/DC POWER SUPPLY				

I/O CABLES

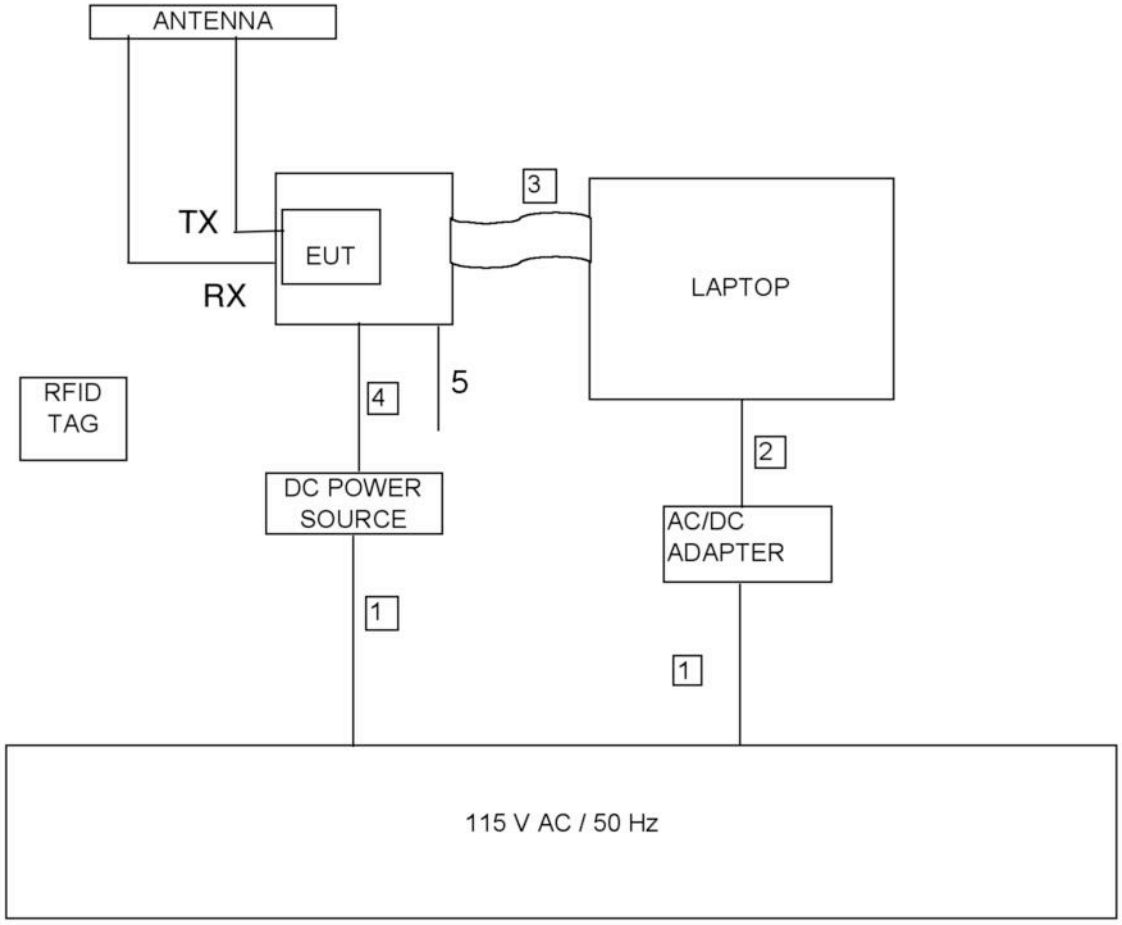
I/O CABLE LIST						
Cable No.	**Port**	**# of Identical Ports**	**Connector Type**	**Cable Type**	**Cable Length**	**Remarks**
1	AC	2	AC	Un-shielded	0.5 m	N/A
2	DC	1	DC	Un-shielded	1m	N/A
3	SERIAL	1	RS-232	Un-shielded	1m	N/A
4	DC	1	DC	Un-shielded	0.5m	N/A
5	I/O	1	multi pin	Shielded	1m	N/A

TEST SETUP

The EUT is a stationary RFID reader, which is connected to the Laptop (support equipment) via an a serial cable.

The software on the Laptop exercises the EUT in different channels and also into hopping mode when needed.

SETUP DIAGRAM FOR TESTS



3.7 Modifications to EUT

The multi-pin I/O port was grounded to the I/O cable shield by a short length of braid. The I/O cable manufactured for this product was not available, instead, an engineering prototype was used. Actual cables will have shield grounds that will contact shield ground of the I/O connector.

TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

TEST EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Serial Number**	**Cal Due**
LISN, 10 kHz ~ 30 MHz	FCC	50/250-25-2	7/15/05	8/30/05
LISN, 10 kHz ~ 30 MHz	Solar	8012-50-R-24-BNC	8379443	10/21/05
EMI Test Receiver	R & S	ESHS 20	827129/006	6/3/06
EMI Receiver, 9 kHz ~ 2.9 GHz	HP	8542E	3942A00286	3/29/06
RF Filter Section	HP	85420E	3705A00256	3/29/06
30MHz---- 2Ghz	Sunol Sciences	JB1 Antenna	A121003	3/3/06
Antenna, Horn 1 ~ 18 GHz	EMCO	3115	2238	4/22/06
Amplifier 1-26GHz	MITEQ	NSP2600-SP	924342	8/17/05
Spectrum Analyzer 20 Hz ~ 44 GHz	Agilent	E4446A	US42070220	1/1/06
1.5 GHz High Pass Filter	Micro-Tronics	HPM13193	2	NCR

4. LIMITS AND RESULTS

4.1. ANTENNA PORT CHANNEL TESTS FOR CLASS 0 MODULATION

4.1.1. 20 dB BANDWIDTH

LIMIT

None; for reporting purposes only.

TEST PROCEDURE

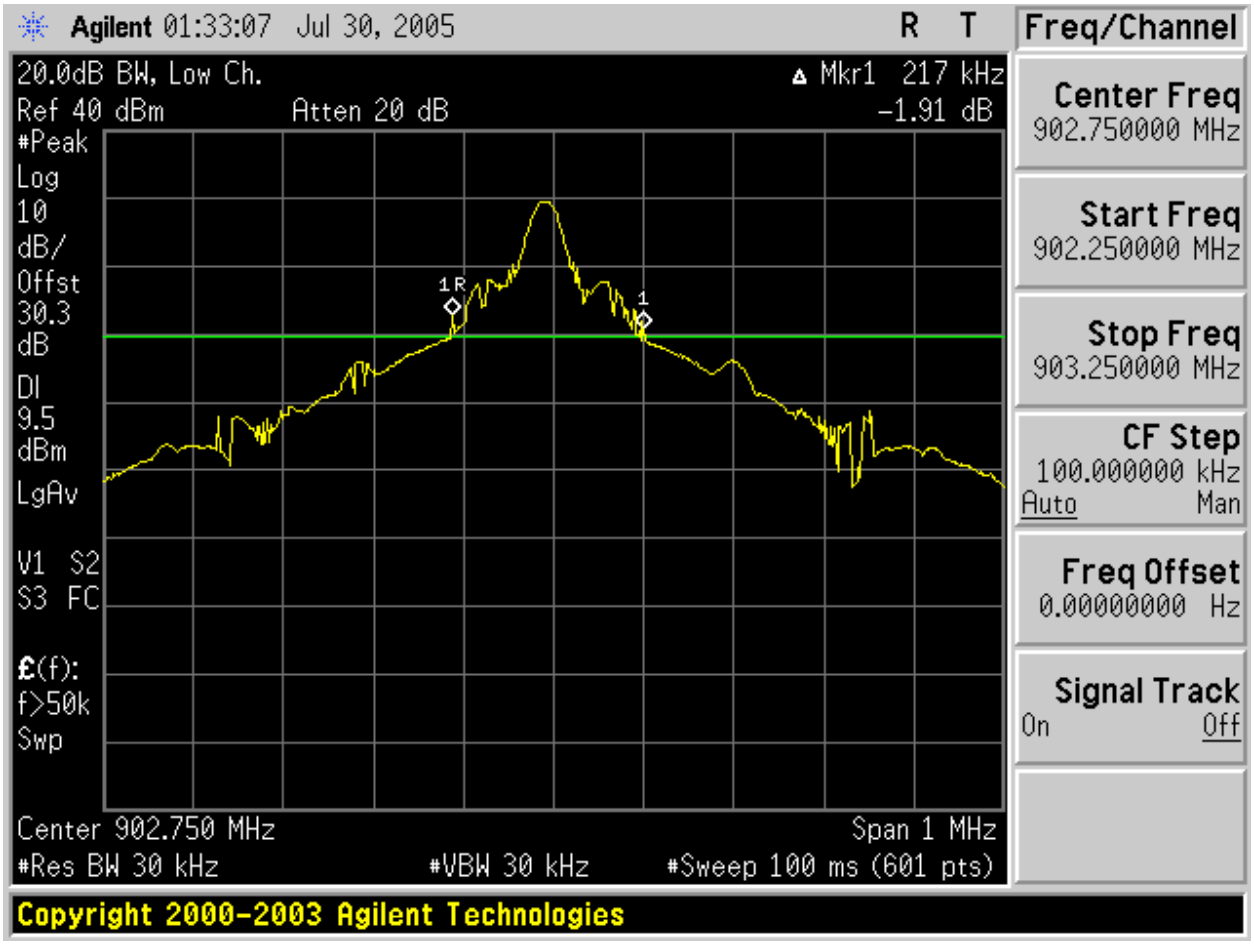
The transmitter output is connected to a spectrum analyzer. The RBW is set to 1% to 3% of the 20 dB bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled.

RESULTS

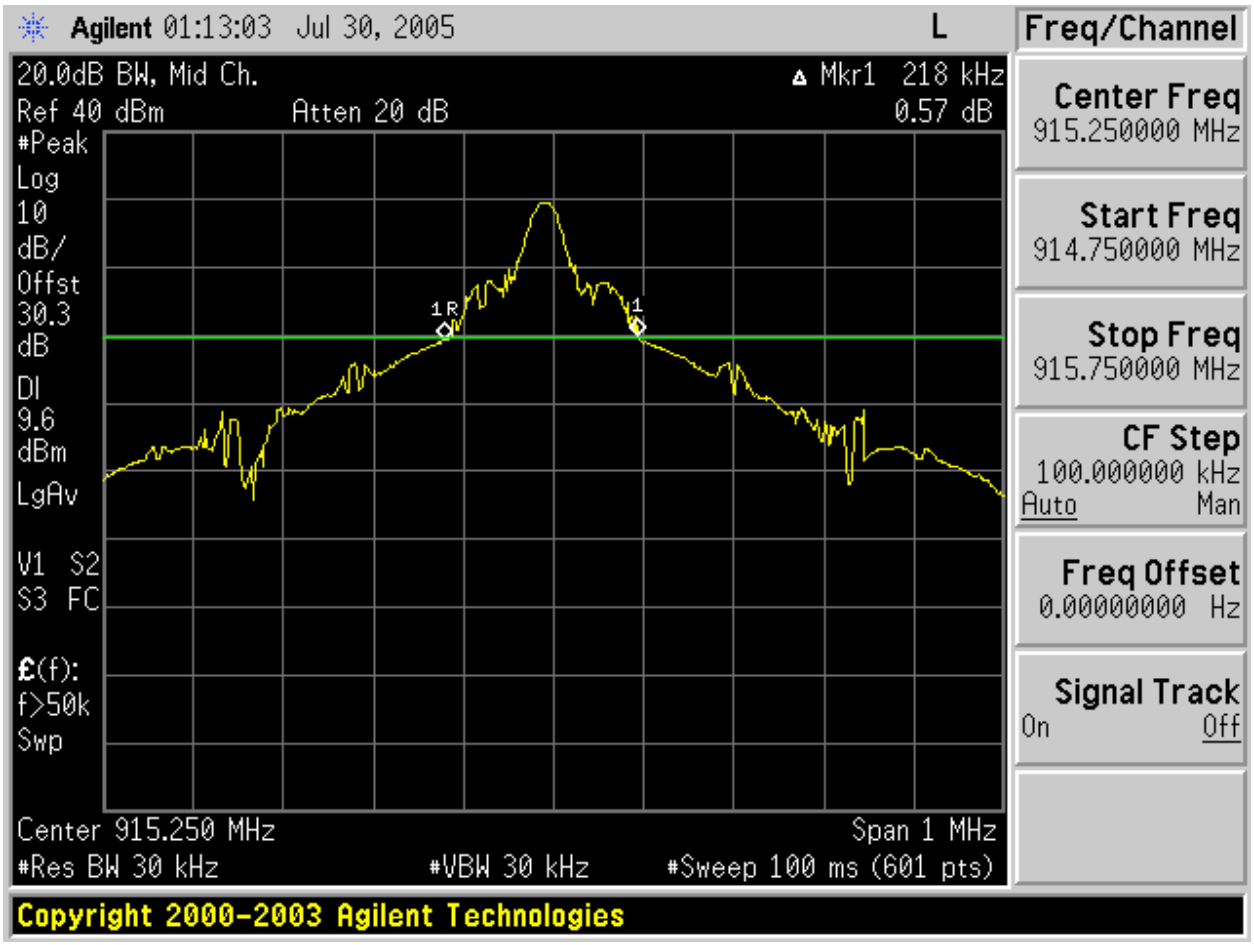
No non-compliance noted:

Channel	Frequency (MHz)	20 dB Bandwidth (kHz)
Low	902.75	217
Middle	915.25	218
High	927.25	212

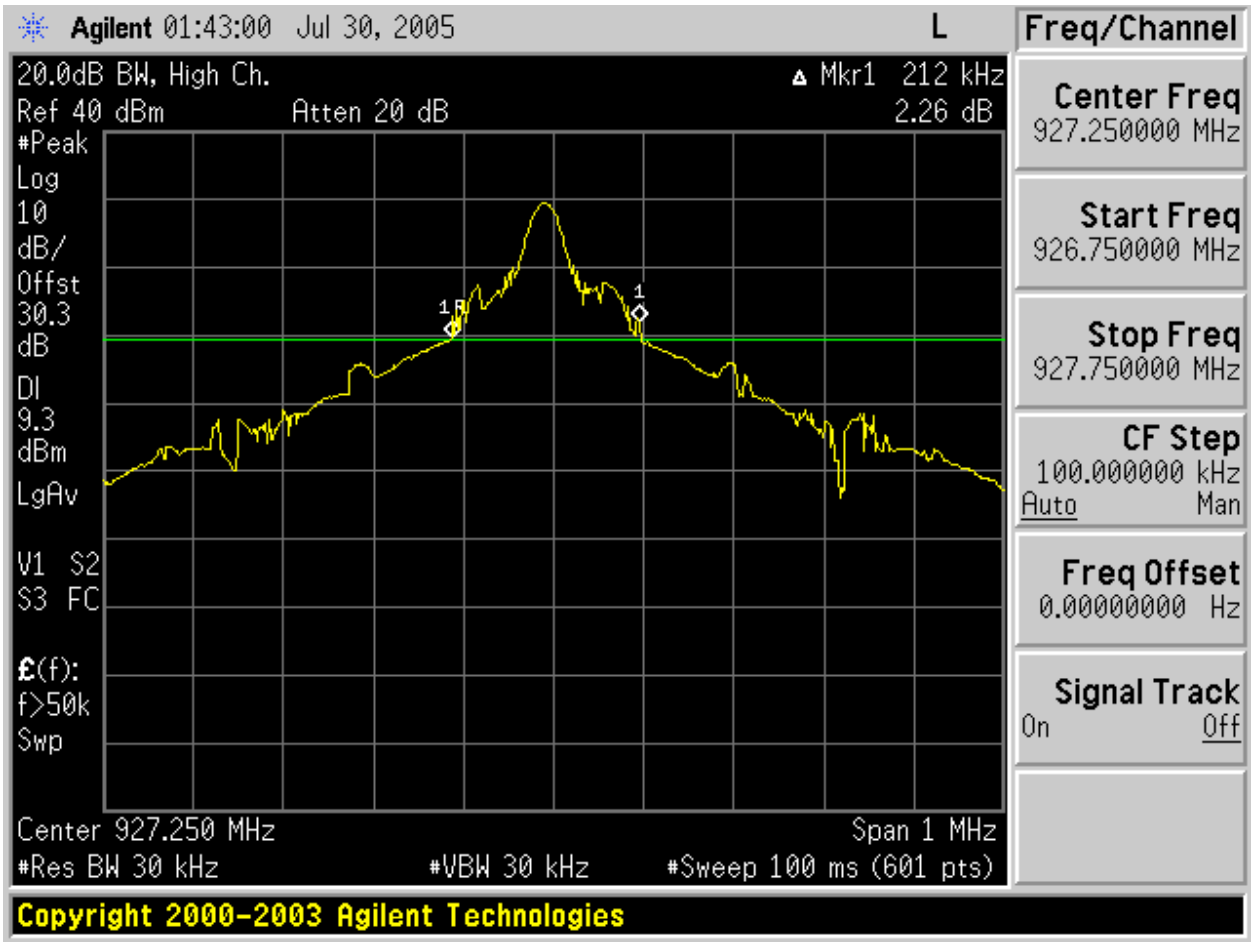
20 dB BANDWIDTH LOW CHANNEL CLASS 0



20 dB BANDWIDTH MID CHANNEL CLASS 0



20 dB BANDWIDTH HIGH CHANNEL CLASS 0



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

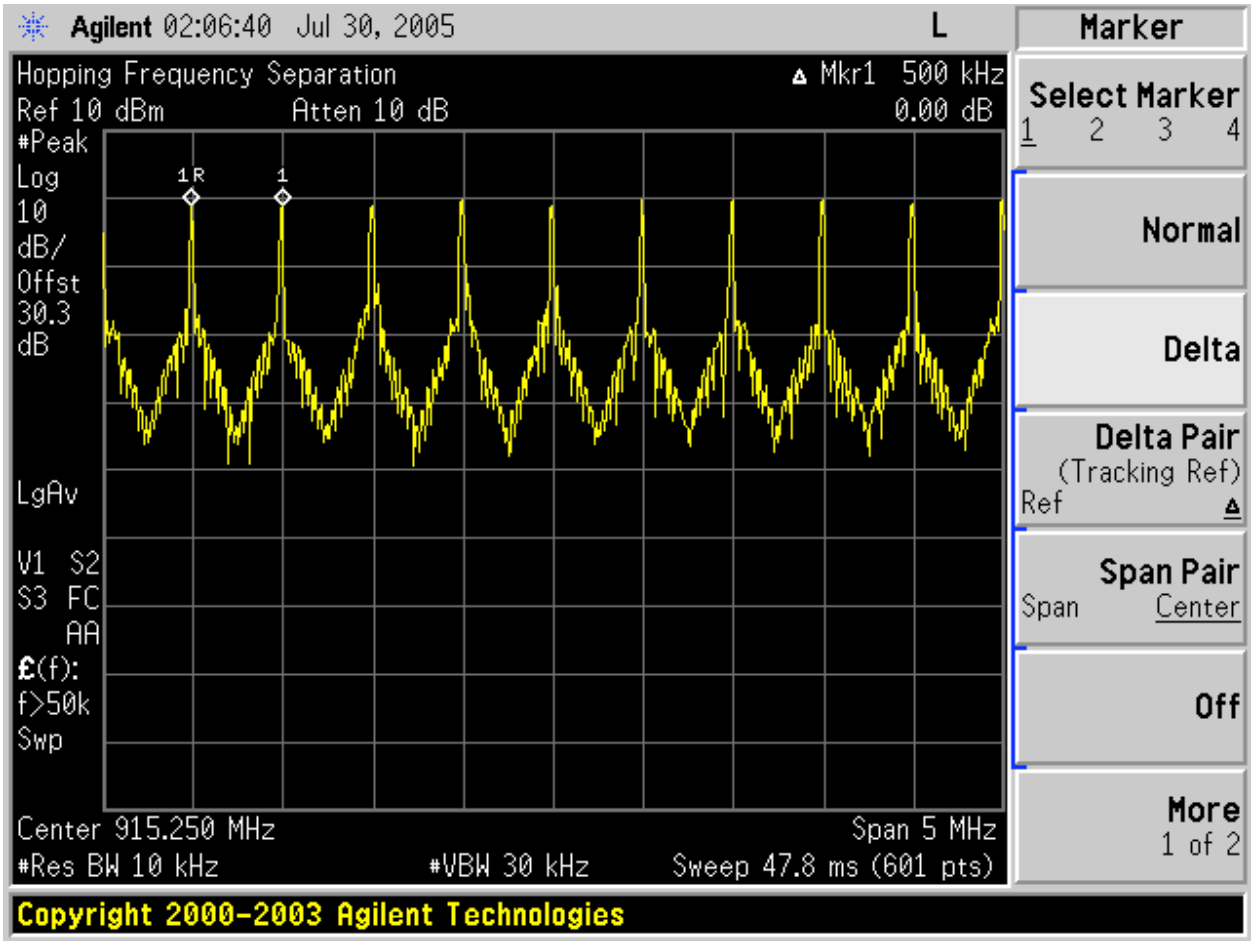
The transmitter output is connected to a spectrum analyzer. The RBW is set to 10 kHz and the VBW is set to 30 kHz. The sweep time is coupled.

RESULTS

No non-compliance noted:

The separation is 500KHz.

HOPPING FREQUENCY SEPARATION CLASS 0



4.1.2. 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

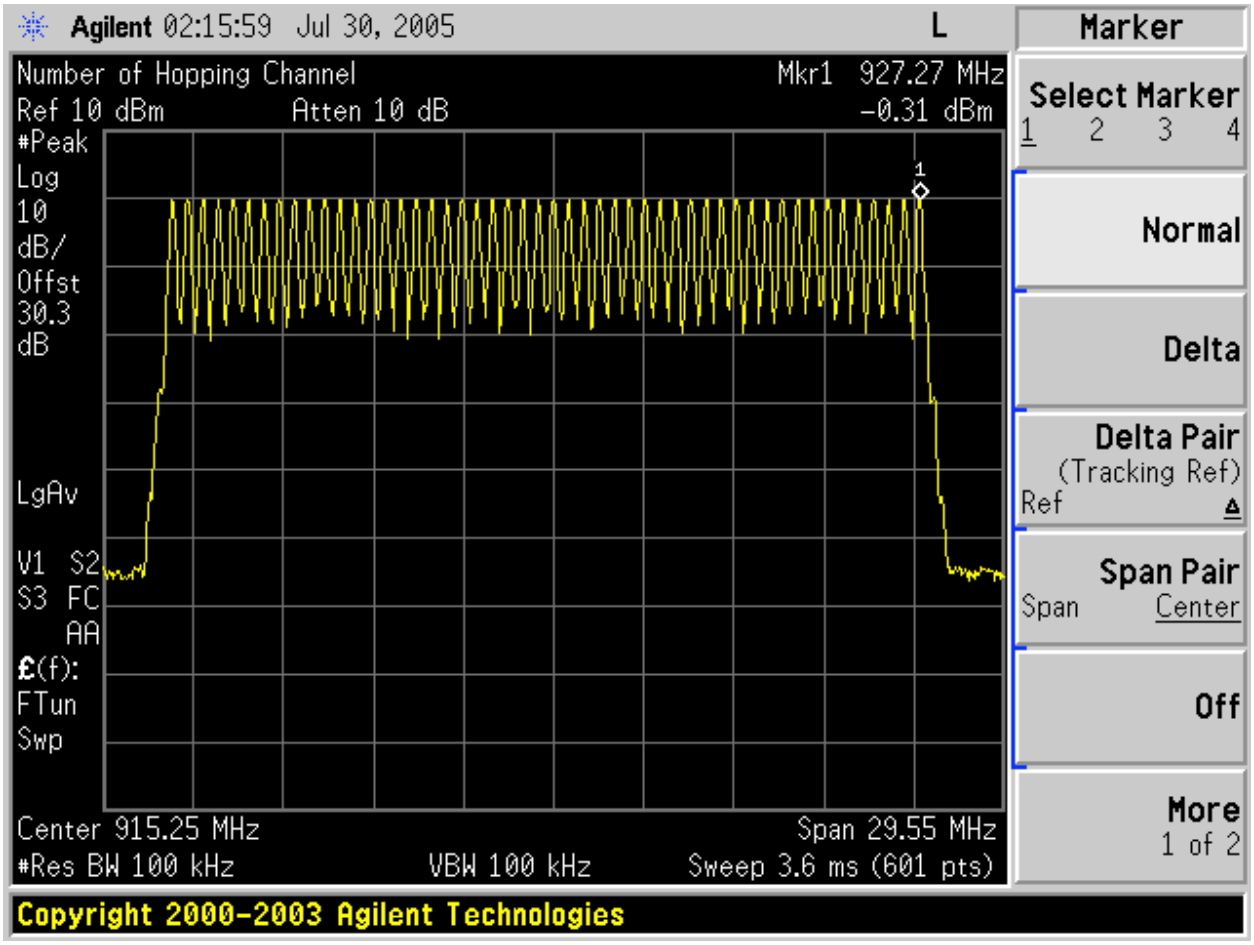
The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to 3 % of the span. The analyzer is set to Max Hold.

RESULTS

No non-compliance noted:

50 Channels observed.

NUMBER OF HOPPING CHANNELS CLASS 0



4.1.3. 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

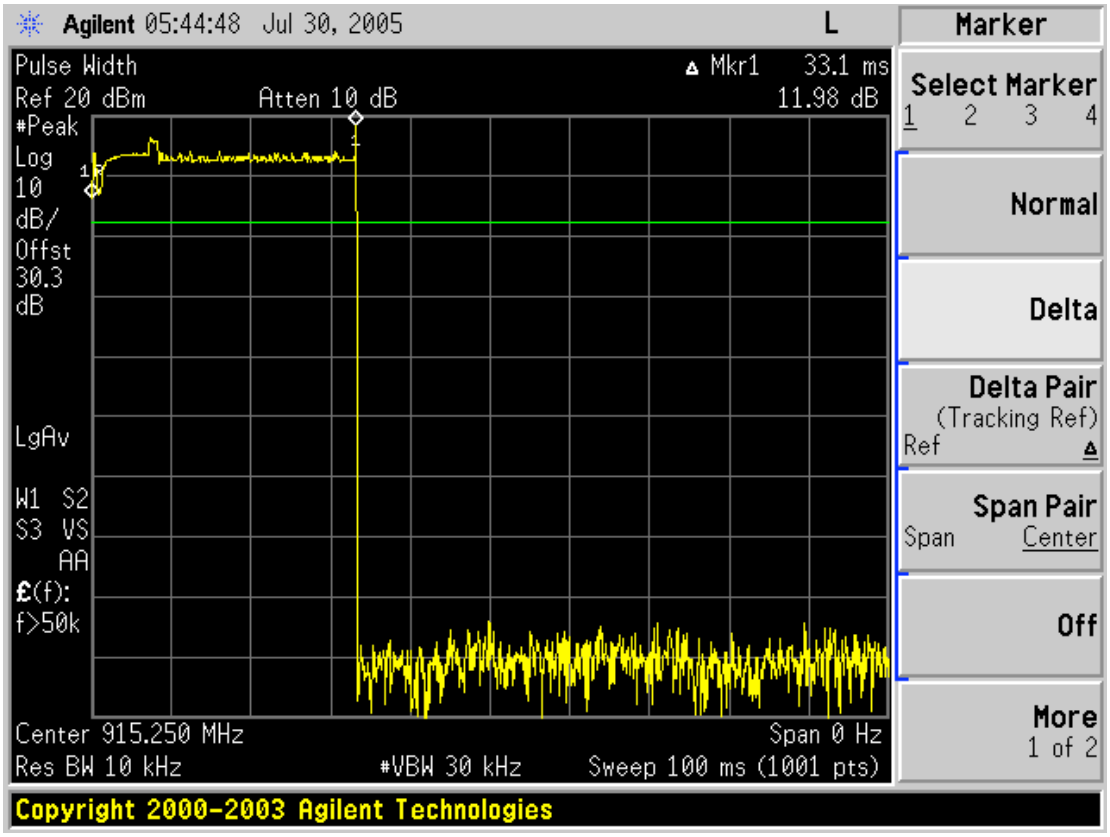
No non-compliance noted:

The system has 50 hopping frequencies. There are 9 pulses within the 20-second period. The on time for each pulse is 33.1 ms.

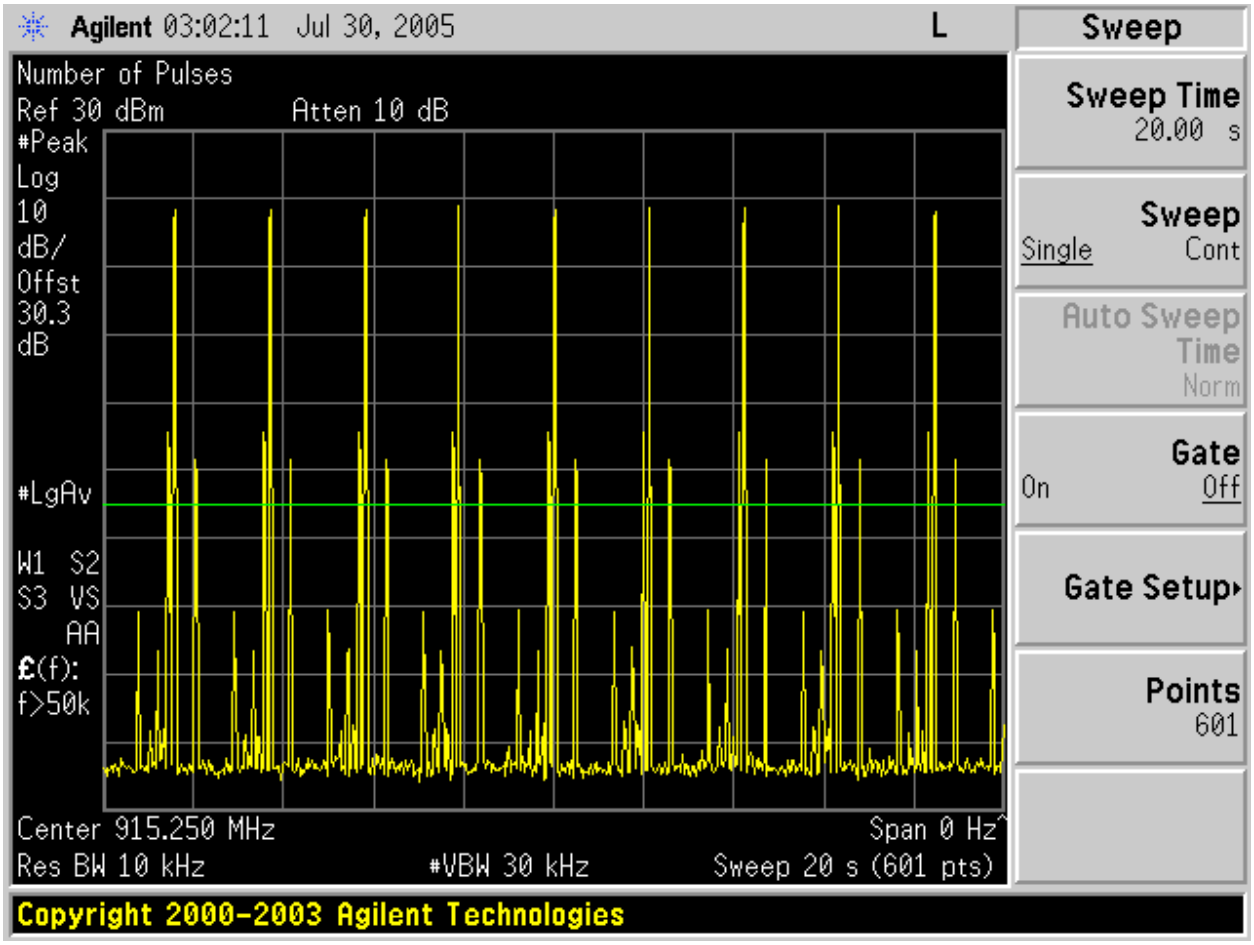
Therefore, the average time of occupancy in the specified 20-second period is:

9 x 33.1 ms = 297.9 ms = 0.298 s

PULSE WIDTH CLASS 0



NUMBER OF PULSES IN 20 SECOND OBSERVATION PERIOD CLASS 0



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 6 dBi, therefore the limit is 30 dBm.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer and the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

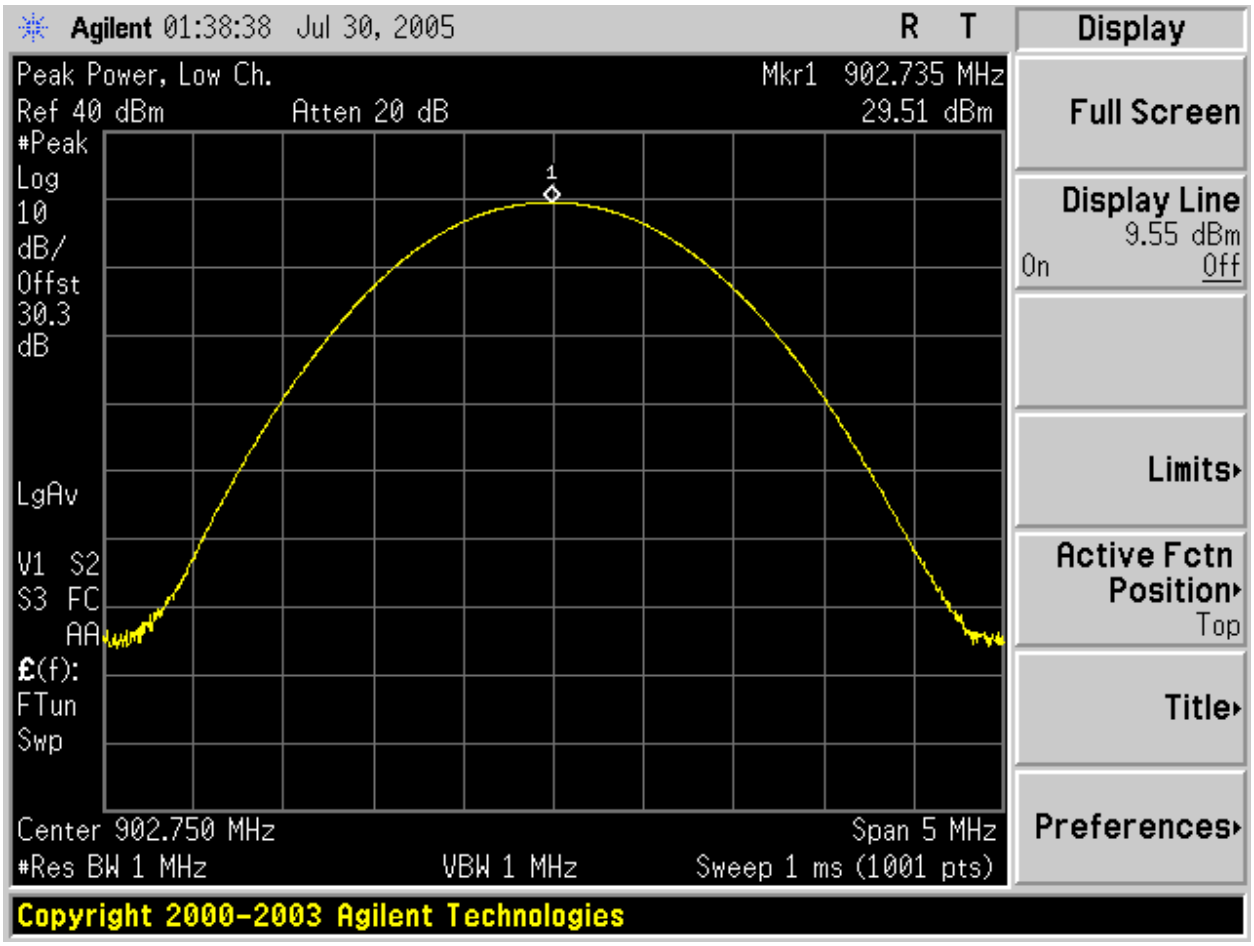
RESULTS

No non-compliance noted:

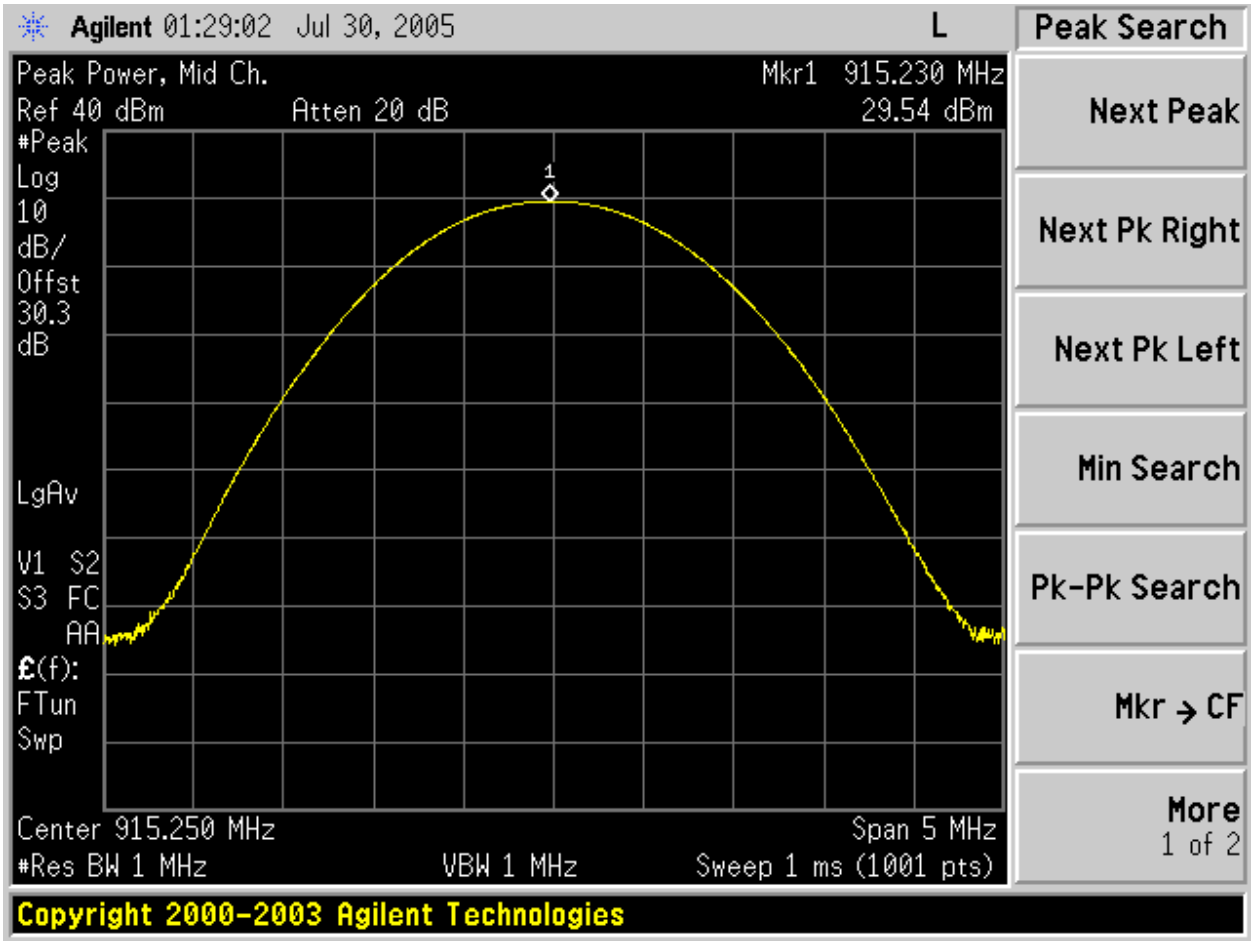
CLASS 0

Channel	Frequency (MHz)	Power (dBm)	Power (mW)
Low	902.75	29.51	893.3
Middle	915.25	29.54	899.5
High	927.25	29.31	853.1

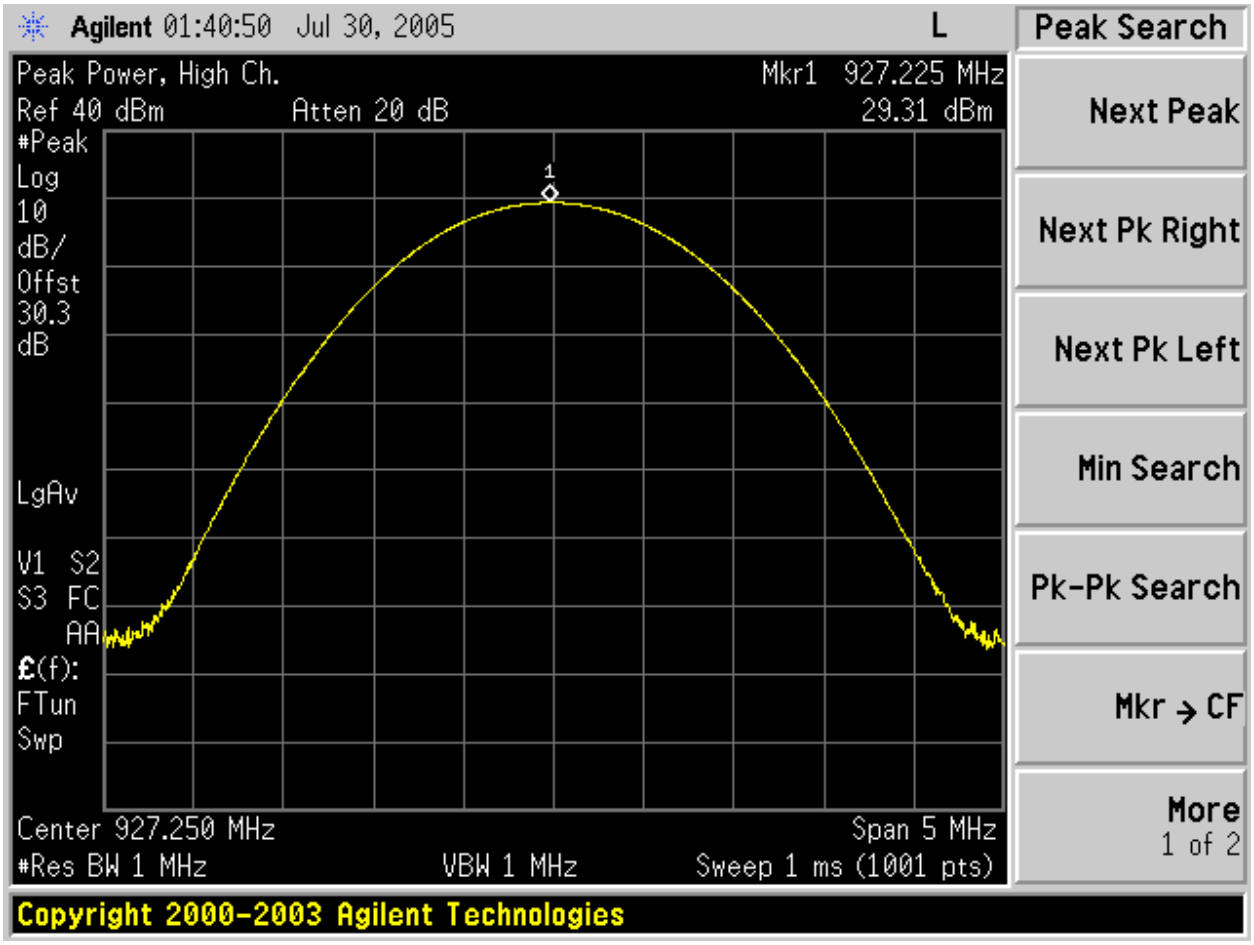
OUTPUT POWER LOW CHANNEL CLASS 0



OUTPUT POWER MID CHANNEL CLASS 0



OUTPUT POWER HIGH CHANNEL CLASS 0



4.1.4. 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:

Power Density Limit (mW/cm^2)	Output Power (dBm)	Antenna Gain (dBi)	MPE Distance (cm)
0.6	29.54	6.00	21.79

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.

4.1.5. 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

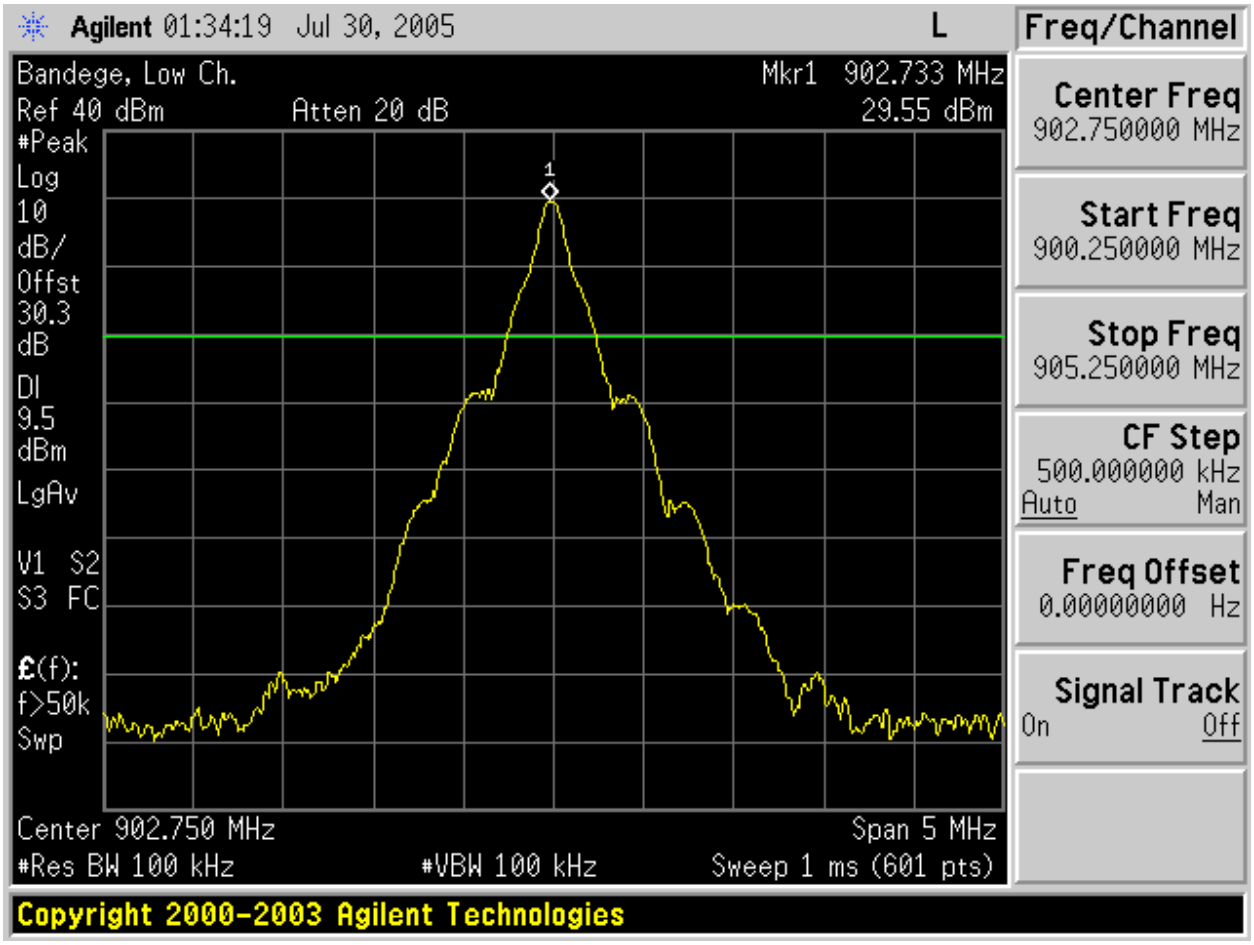
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 100 kHz.

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

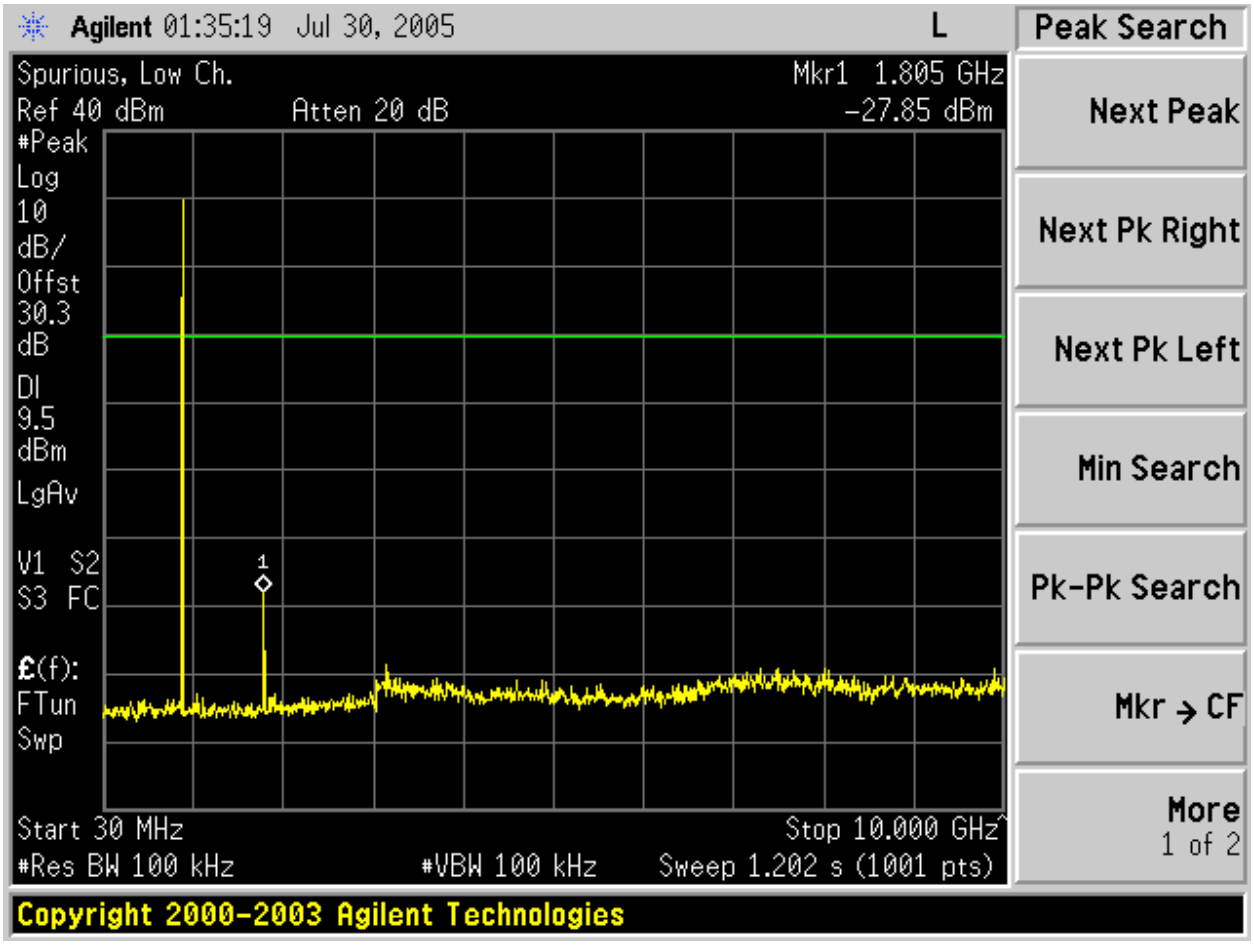
RESULTS

No non-compliance noted:

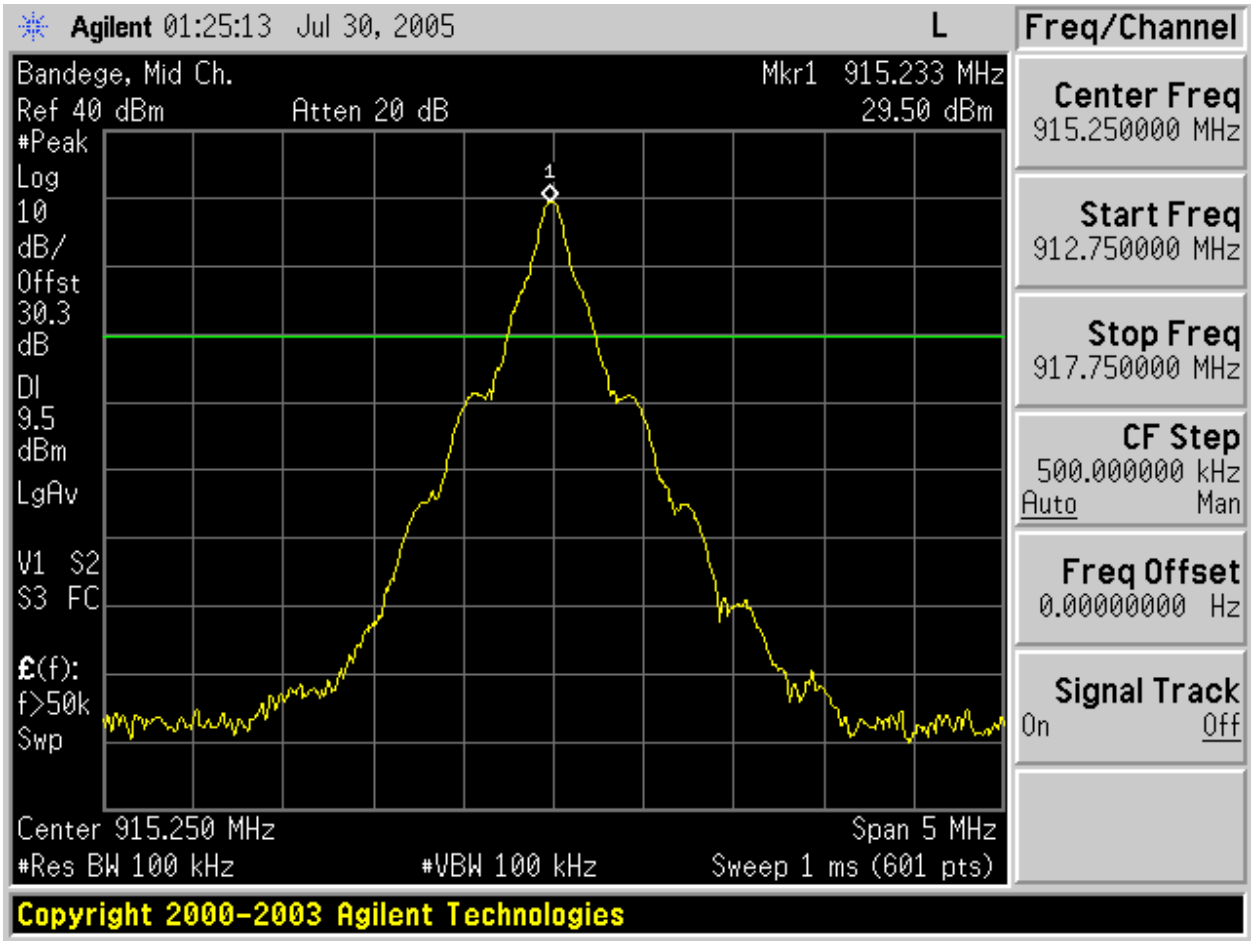
SPURIOUS EMISSIONS, LOW CHANNEL CLASS 0



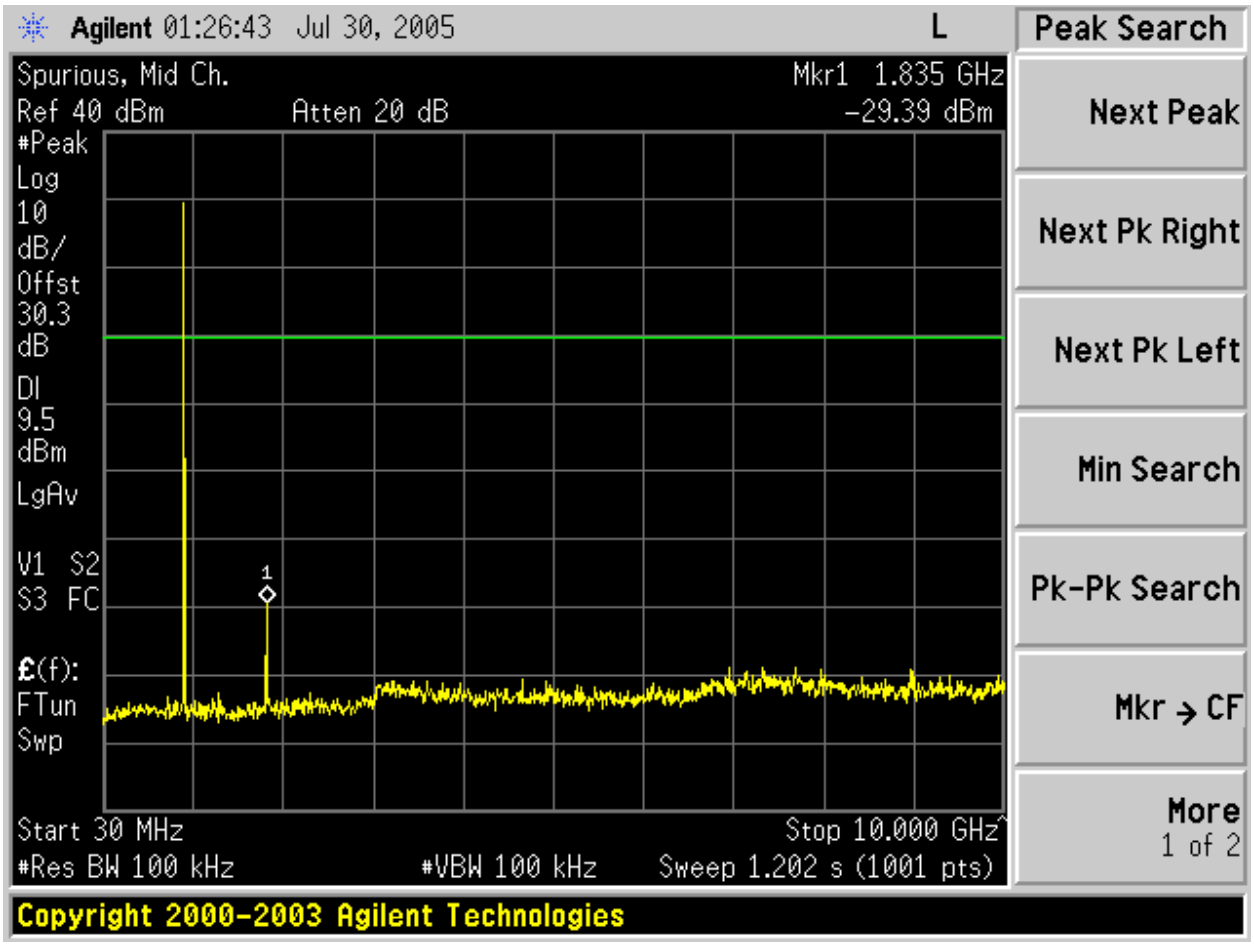
SPURIOUS EMISSIONS, LOW CHANNEL CLASS 0



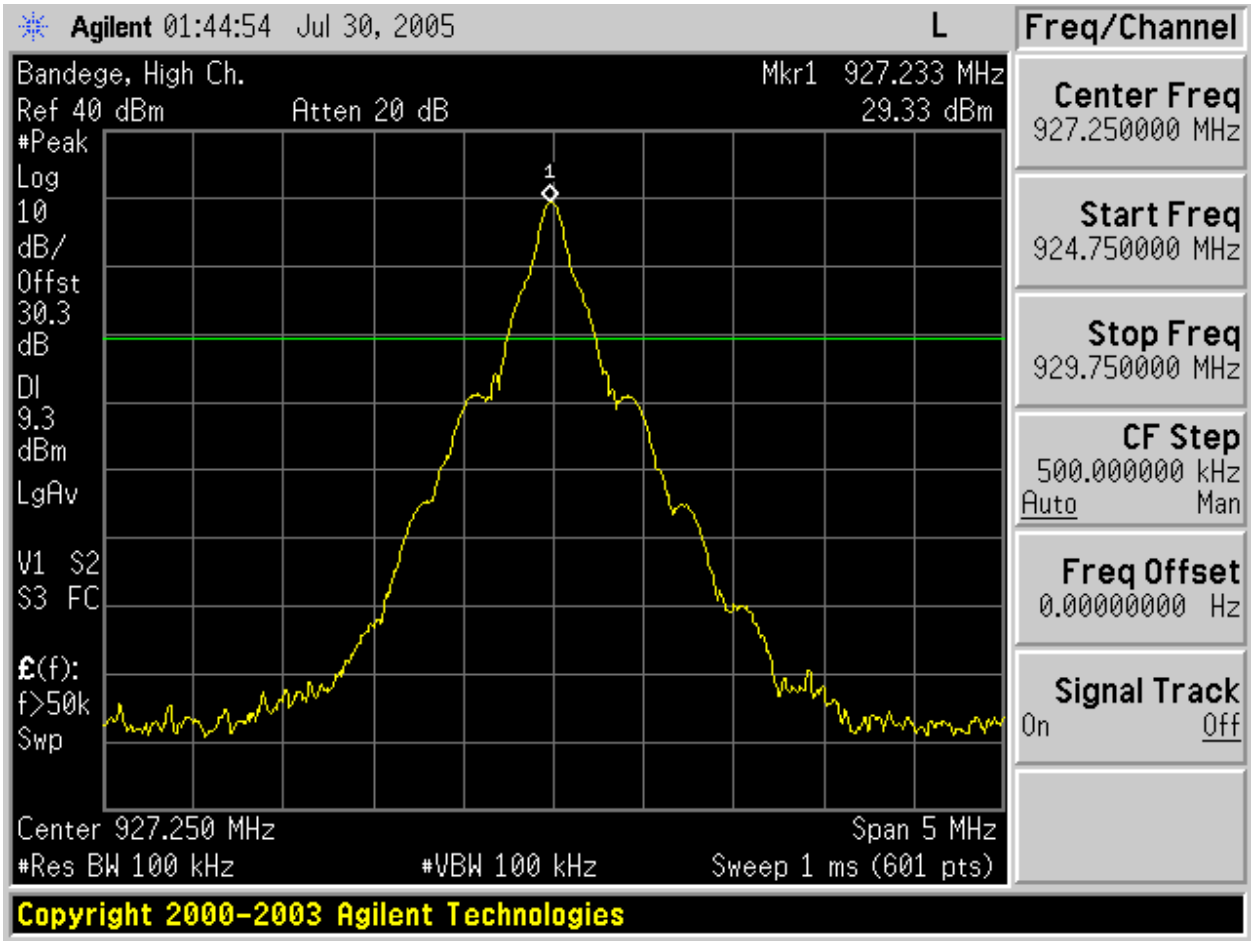
SPURIOUS EMISSIONS, MID CHANNEL CLASS 0



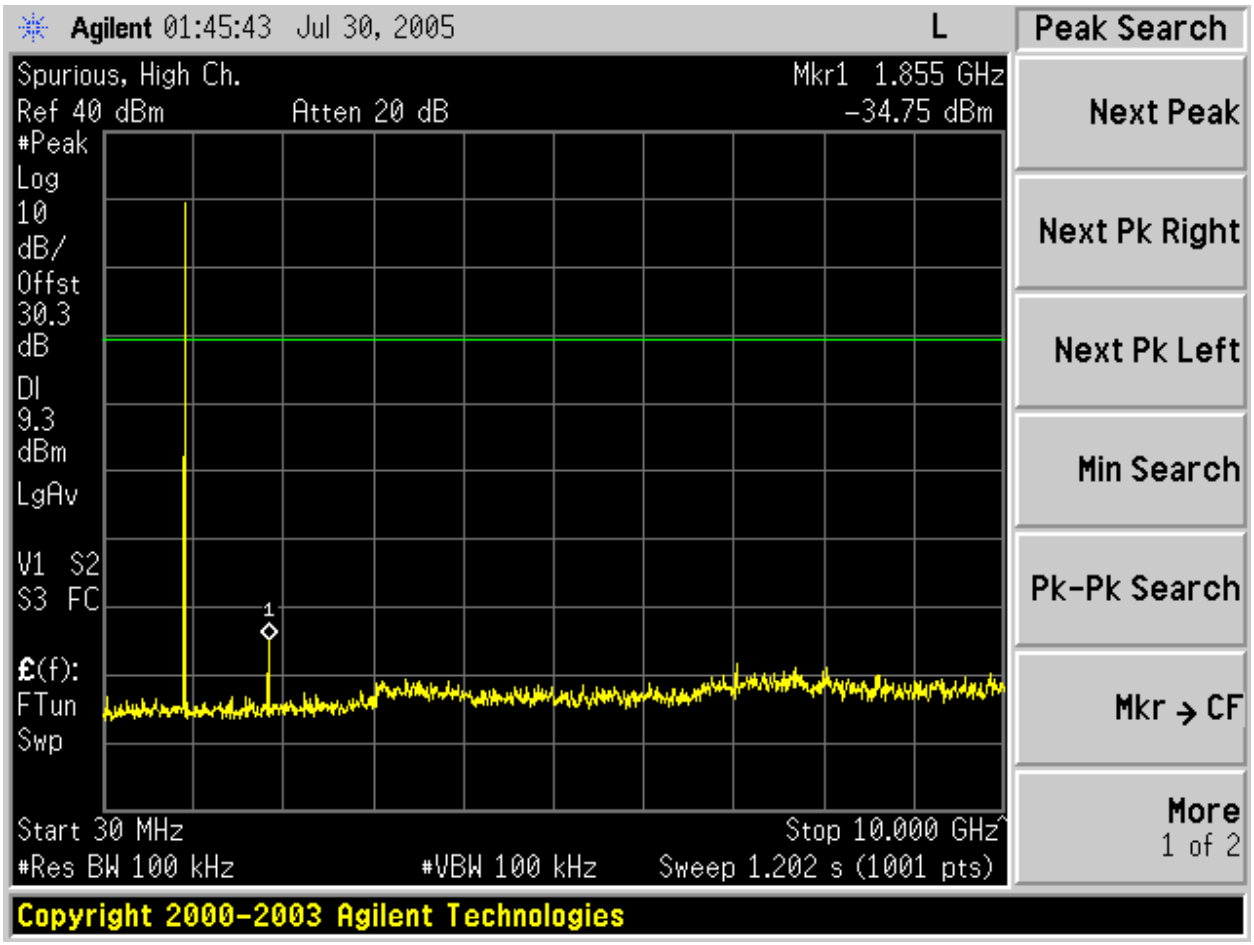
SPURIOUS EMISSIONS, MID CHANNEL CLASS 0



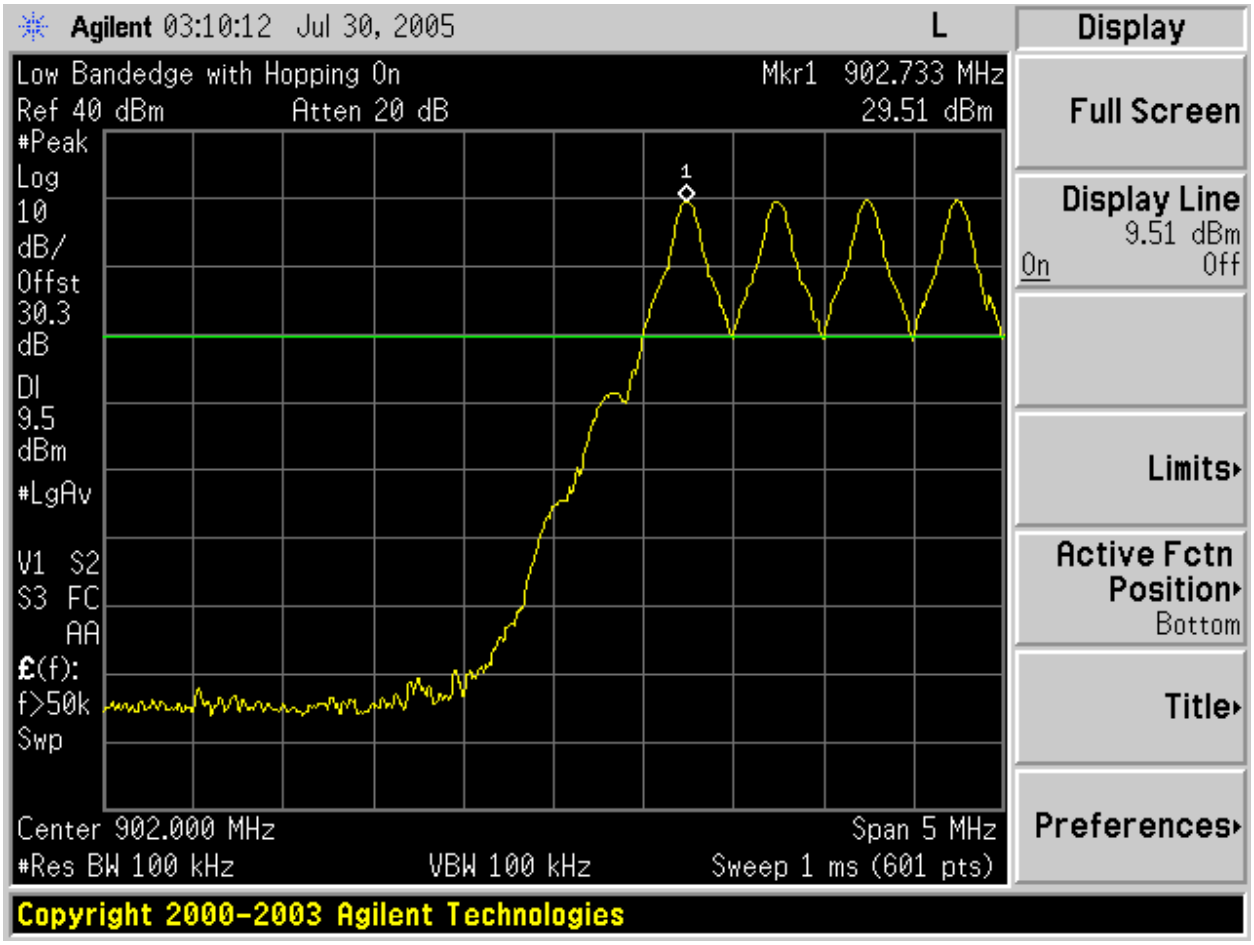
SPURIOUS EMISSIONS, HIGH CHANNEL CLASS 0



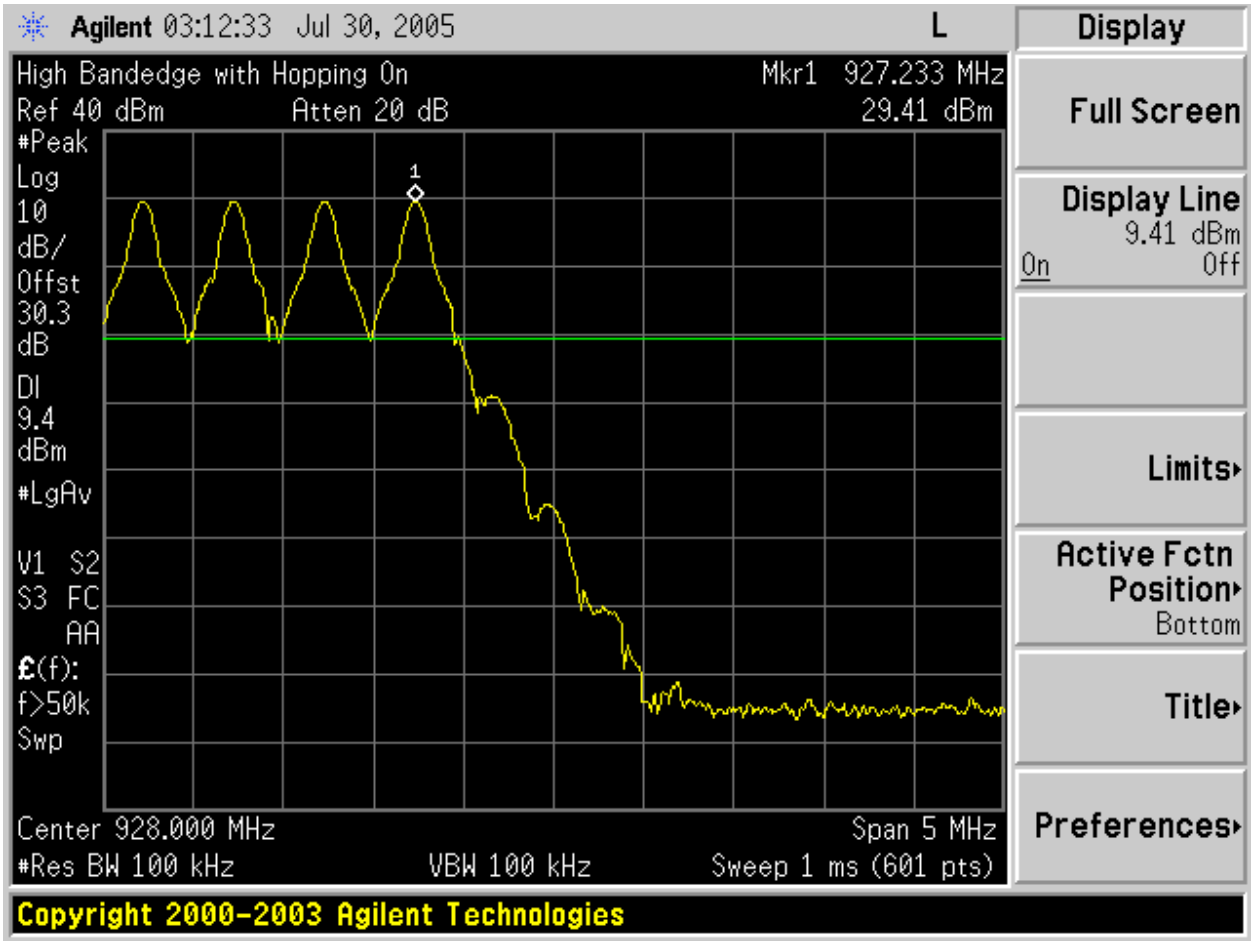
SPURIOUS EMISSIONS, HIGH CHANNEL CLASS 0



HOPPING FUNCTION ON, CLASS 0 LOW CHANNEL



HOPPING FUNCTION ON, CLASS 0 HIGH CHANNEL



4.2. ANTENNA PORT CHANNEL TESTS FOR CLASS 1 MODULATION

4.2.1. 20 dB BANDWIDTH

LIMIT

None: for reporting purposes only.

TEST PROCEDURE

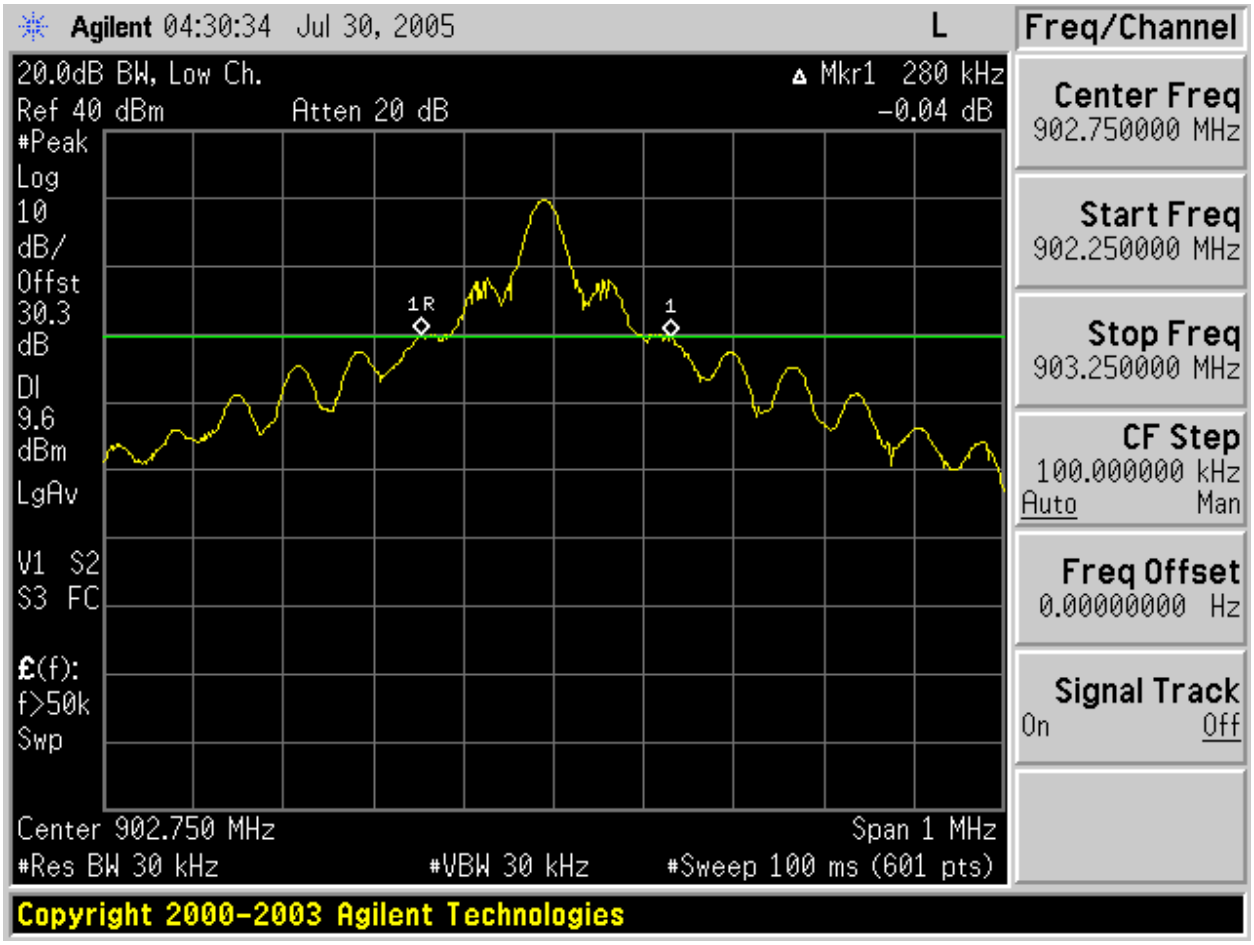
The transmitter output is connected to a spectrum analyzer. The RBW is set to 1% to 3% of the 20 dB bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled.

RESULTS

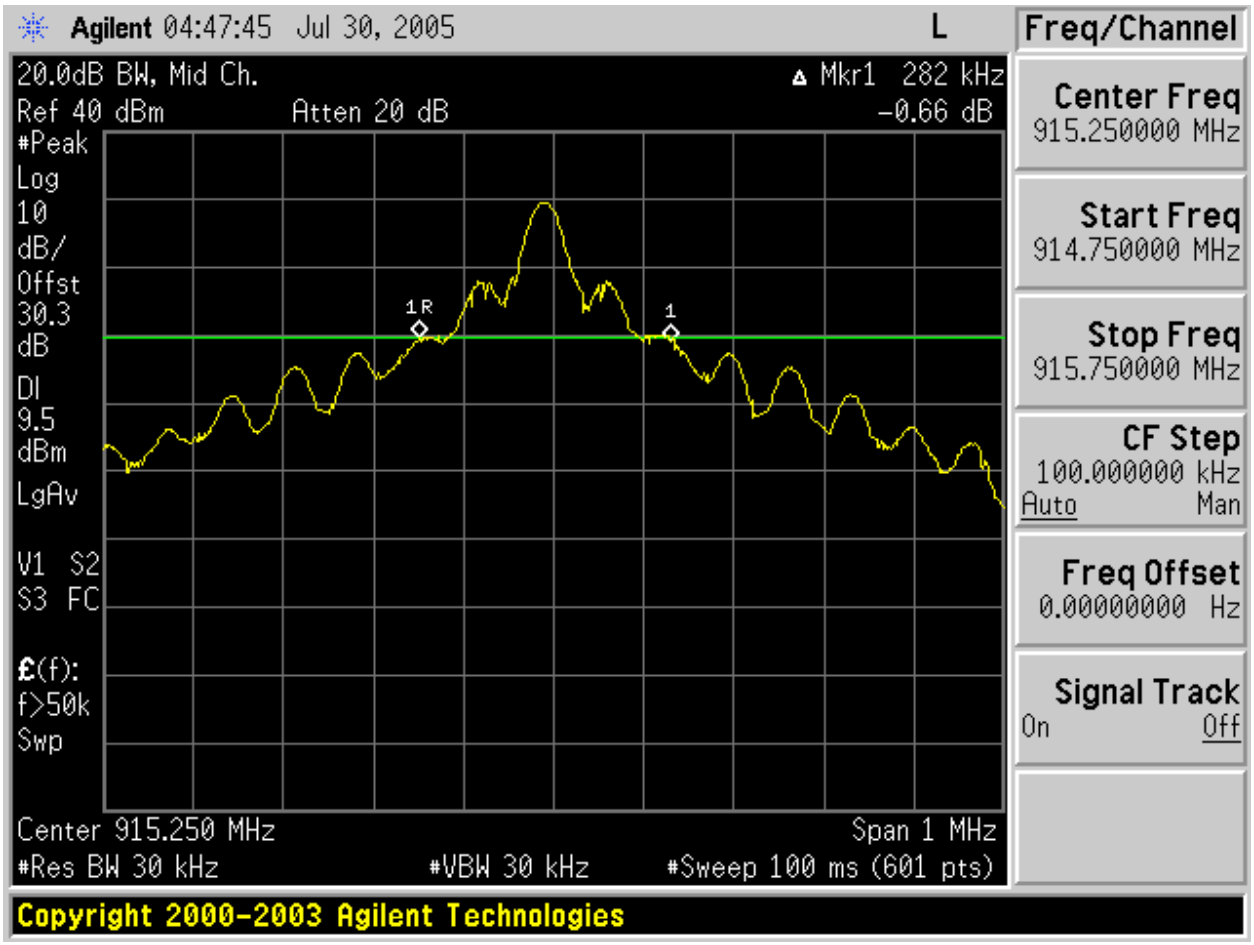
No non-compliance noted:

Channel	Frequency (MHz)	20 dB Bandwidth (kHz)
Low	902.75	280
Middle	915.25	282
High	927.25	273

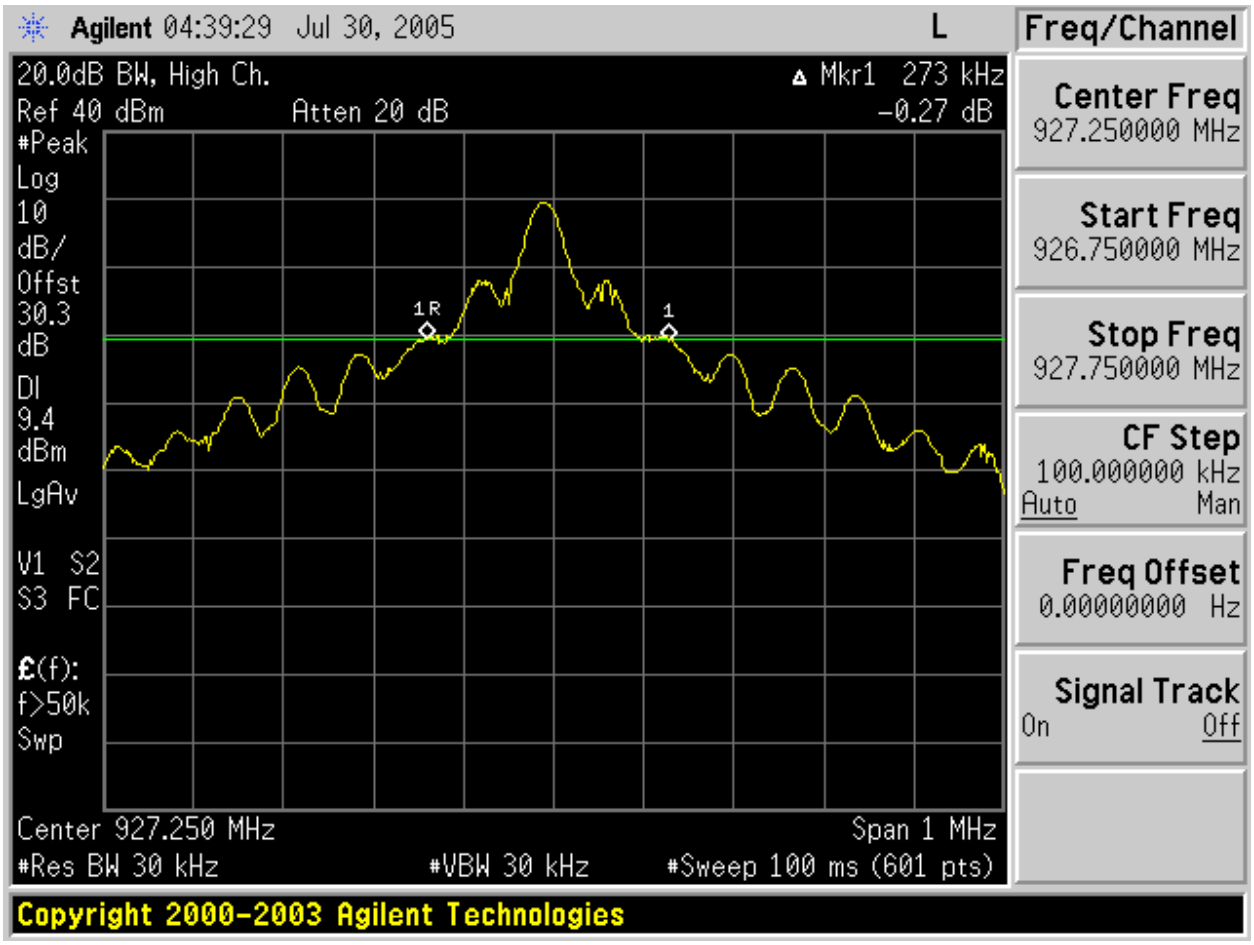
20 dB BANDWIDTH LOW CHANNEL CLASS 1



20 dB BANDWIDTH MID CHANNEL CLASS 1



20 dB BANDWIDTH HIGH CHANNEL CLASS 1



4.2.2. 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

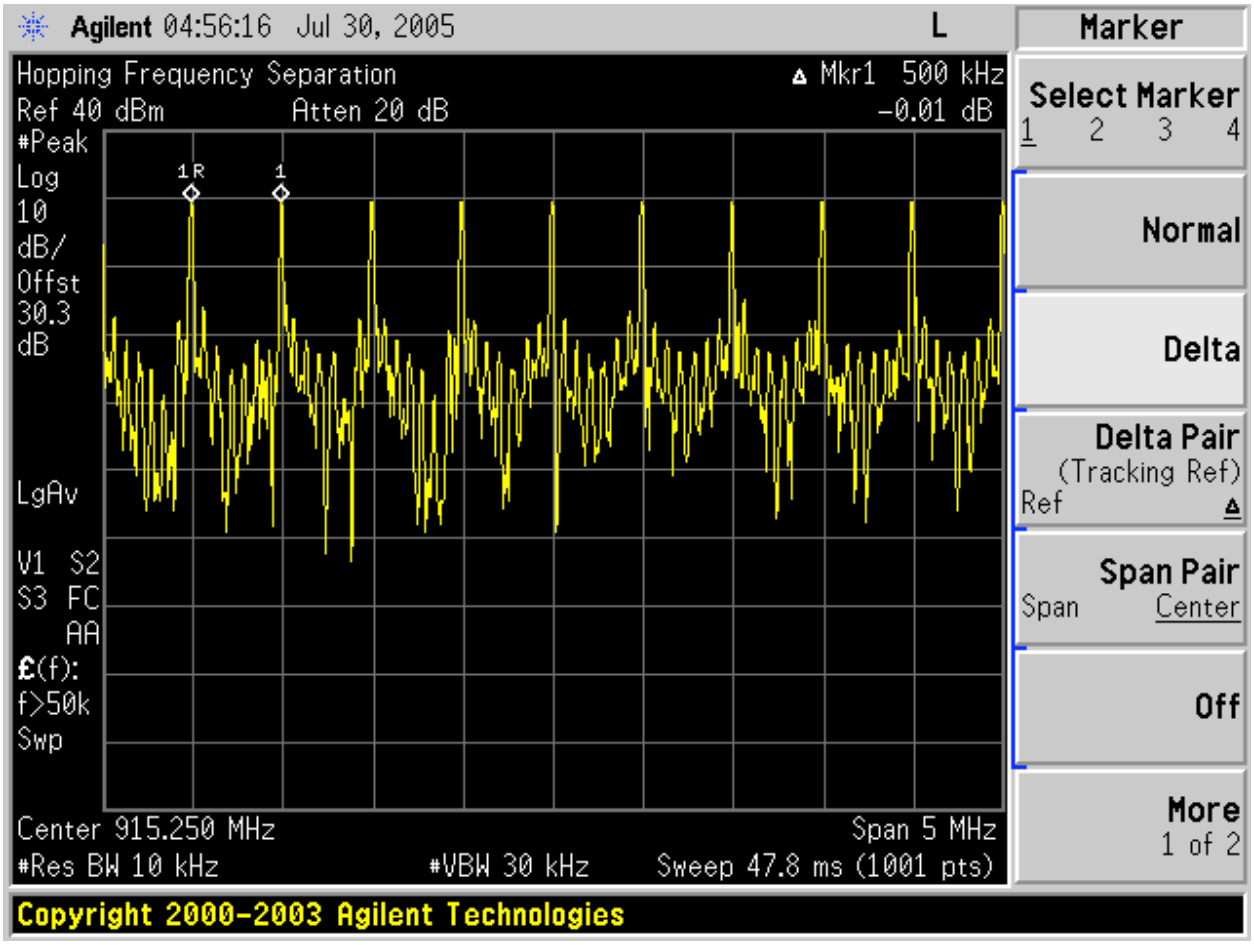
The transmitter output is connected to a spectrum analyzer. The RBW is set to 10 kHz and the VBW is set to 30 kHz. The sweep time is coupled.

RESULTS

No non-compliance noted:

The channel separation is 500KHz.

HOPPING FREQUENCY SEPARATION CLASS 1



4.2.3. 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

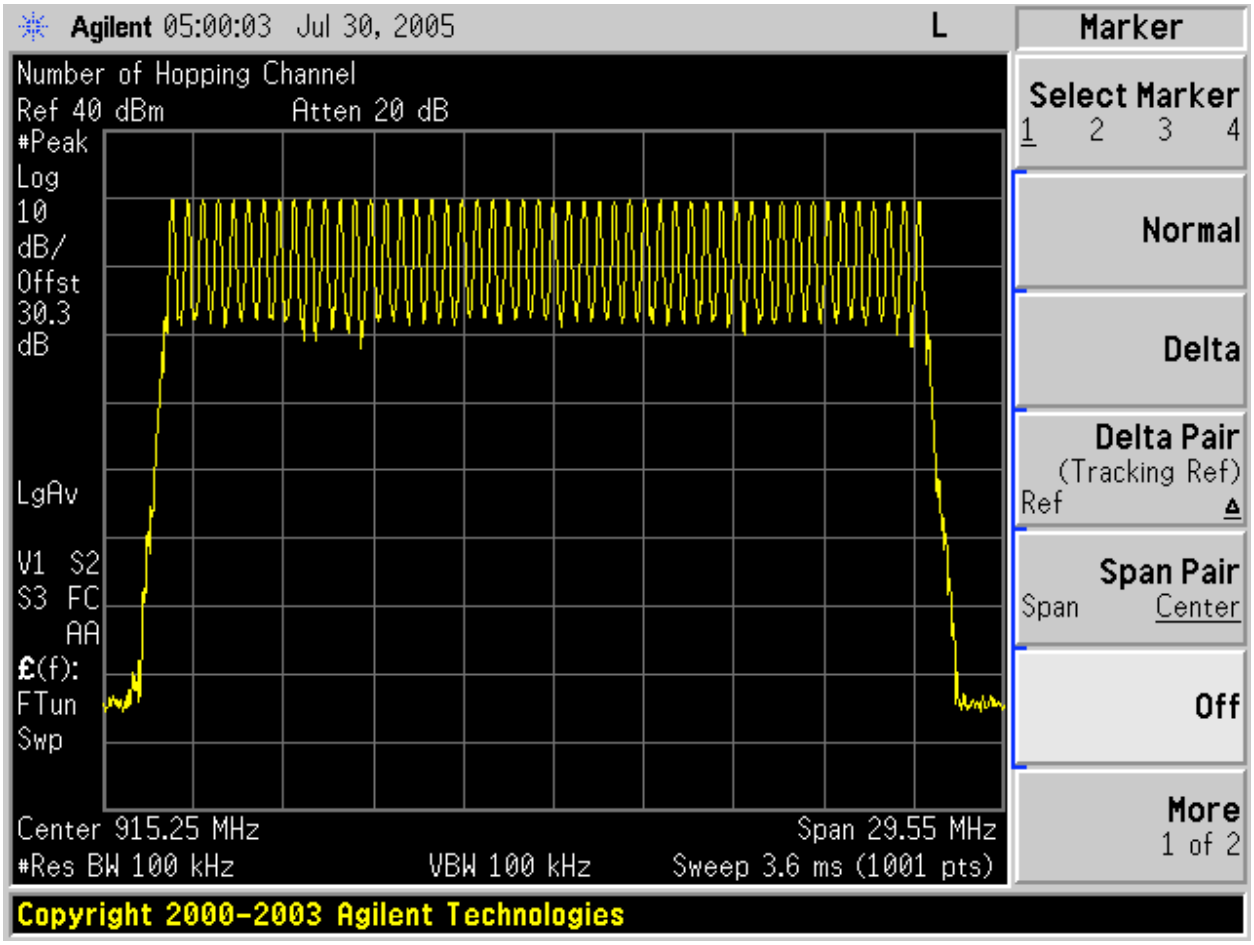
The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to 1 % of the span. The analyzer is set to Max Hold.

RESULTS

No non-compliance noted:

50 Channels observed.

NUMBER OF HOPPING CHANNELS CLASS 1



4.2.4. 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

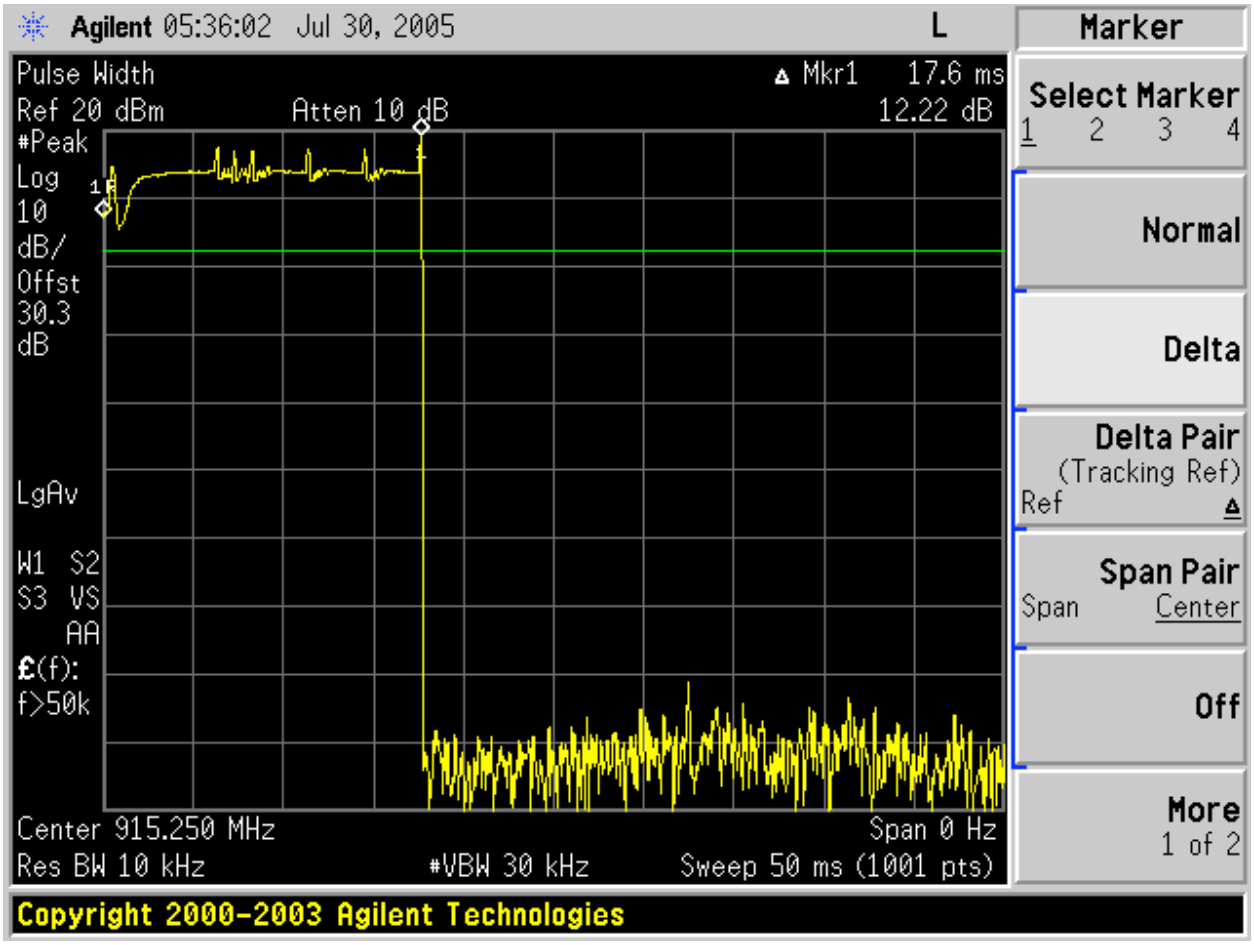
No non-compliance noted:

The system has 50 hopping frequencies. There are 15 pulses within the 20-second period. The on time for each pulse is 17.6 ms.

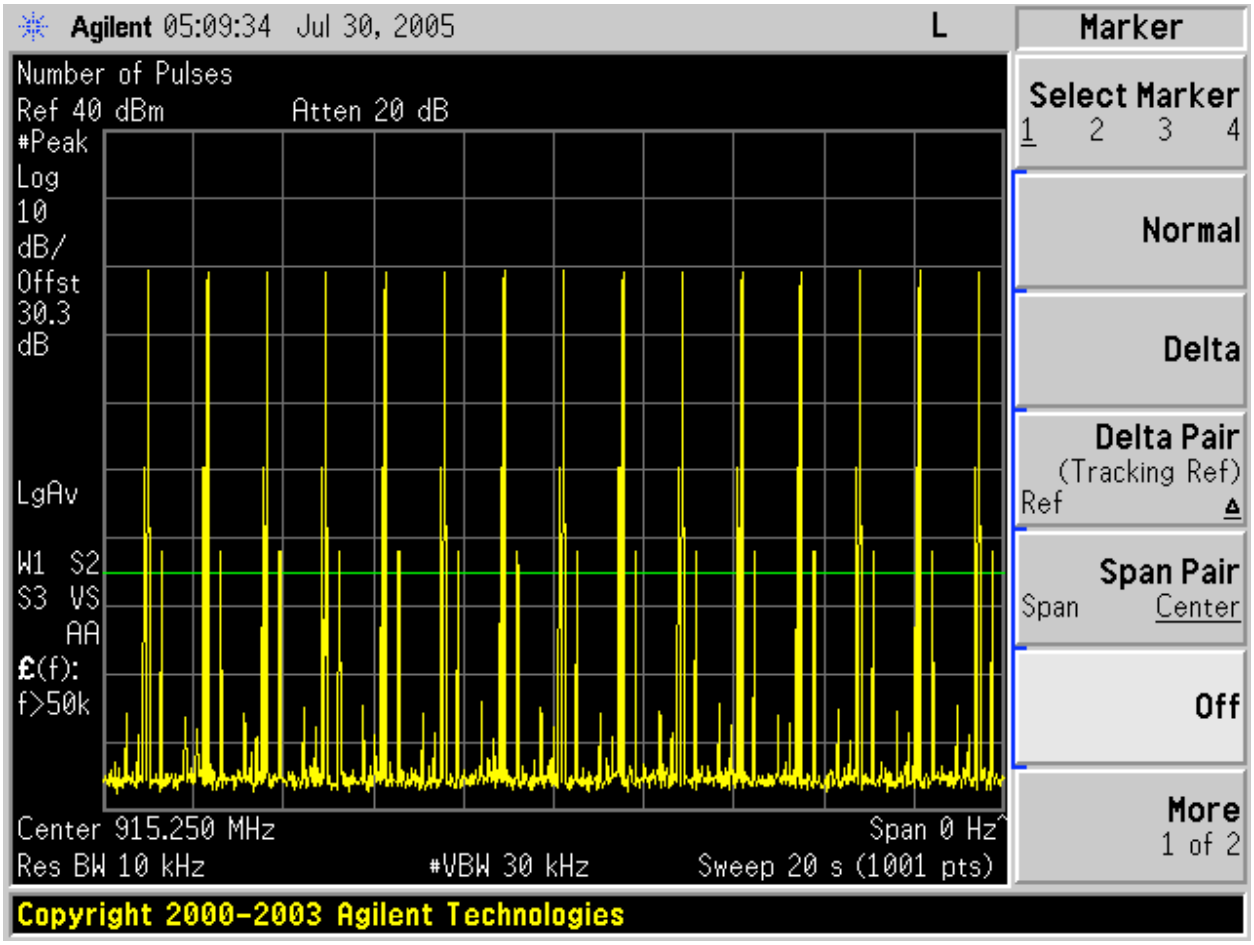
Therefore, the average time of occupancy in the specified 20-second period is:

17.6 x 15 = 264 ms = 0.264s in 20 seconds = 0.132 sec occupancy in 10 seconds.

PULSE WIDTH CLASS 1



NUMBER OF PULSES IN 20 SECOND OBSERVATION PERIOD CLASS 1



4.2.5. 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 6 dBi, therefore the limit is 30 dBm.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer and the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

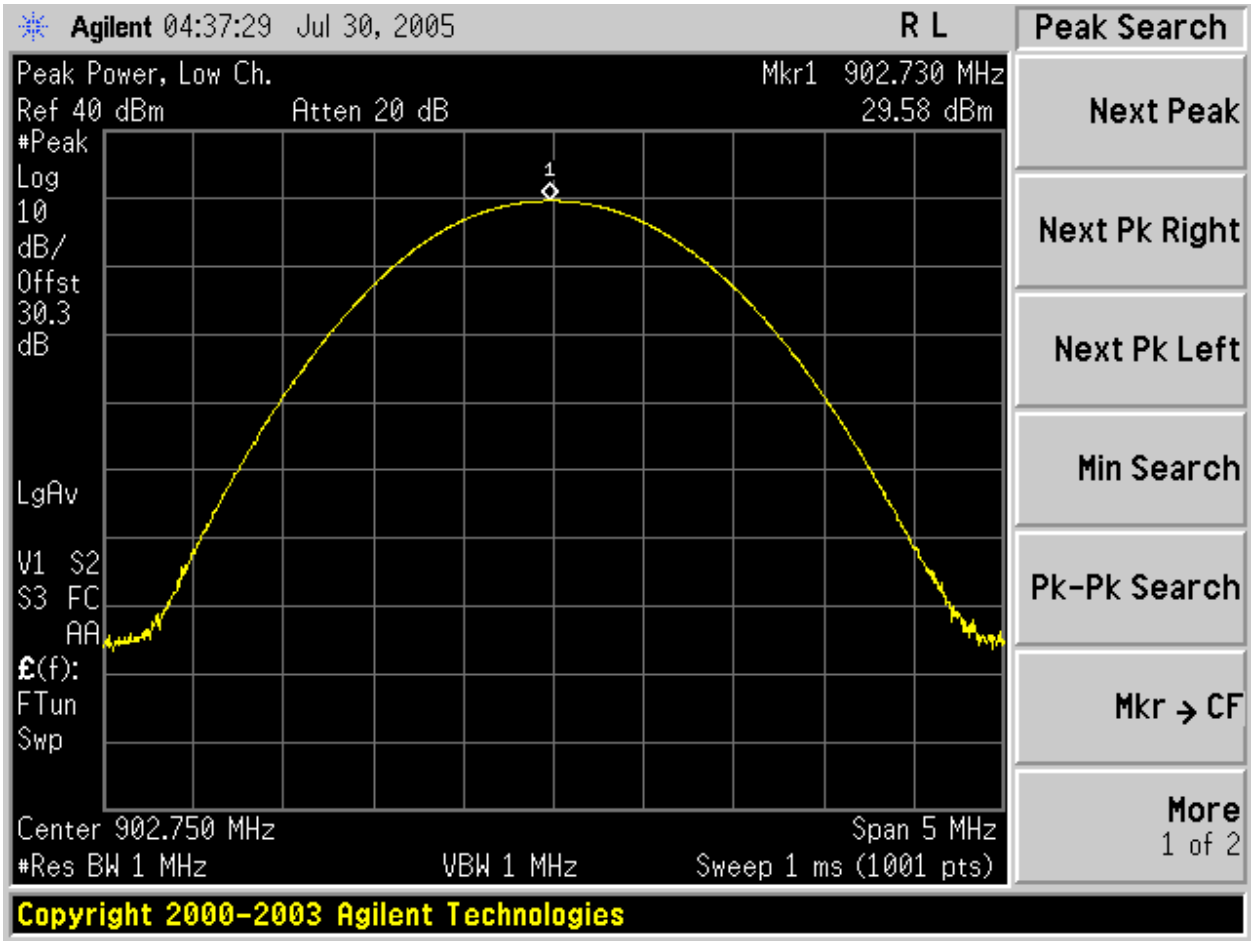
RESULTS

No non-compliance noted:

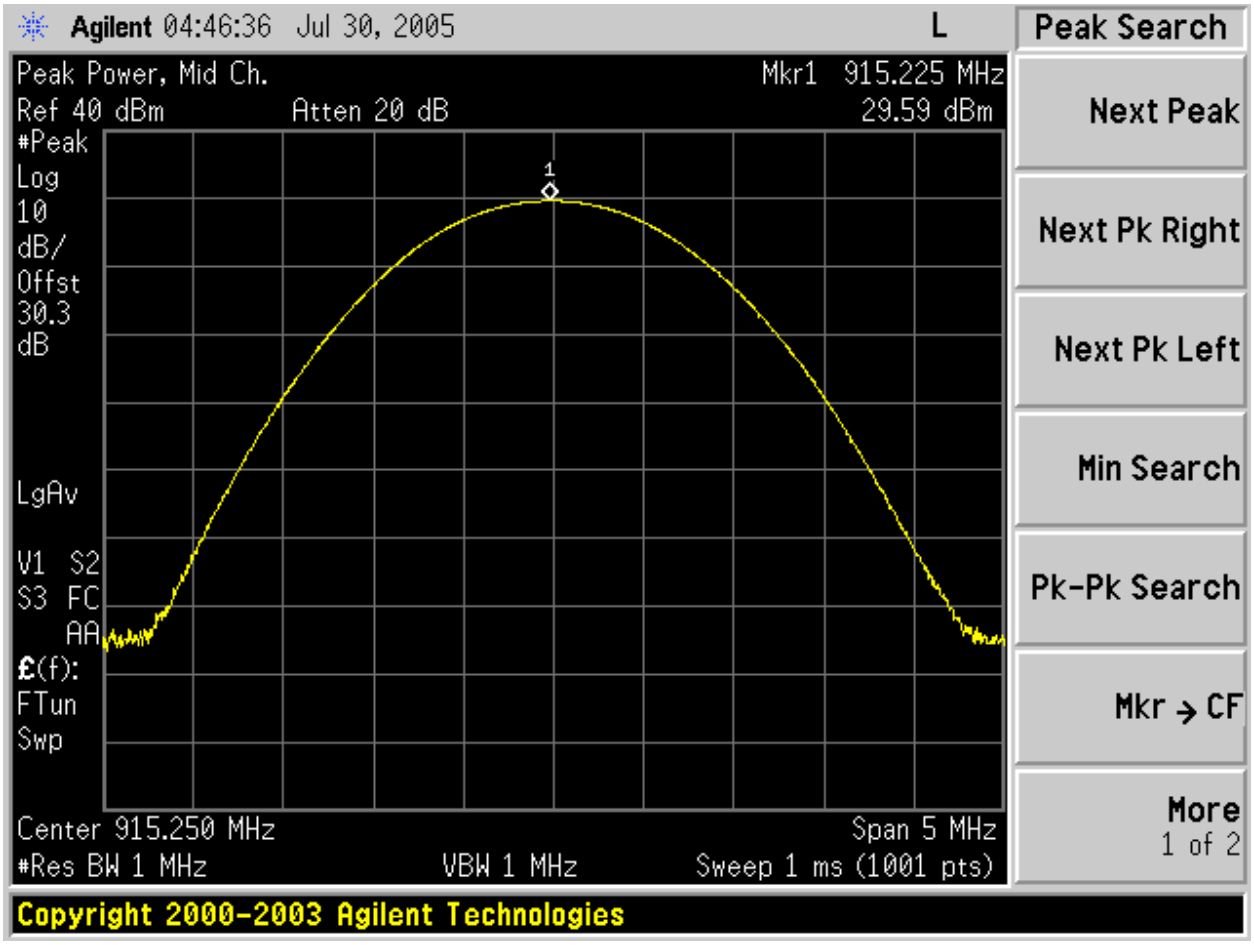
CLASS 1

Channel	Frequency (MHz)	Power (dBm)	Power (mW)
Low	902.75	29.58	907.8
Middle	915.25	29.59	909.9
High	927.25	29.36	863.0

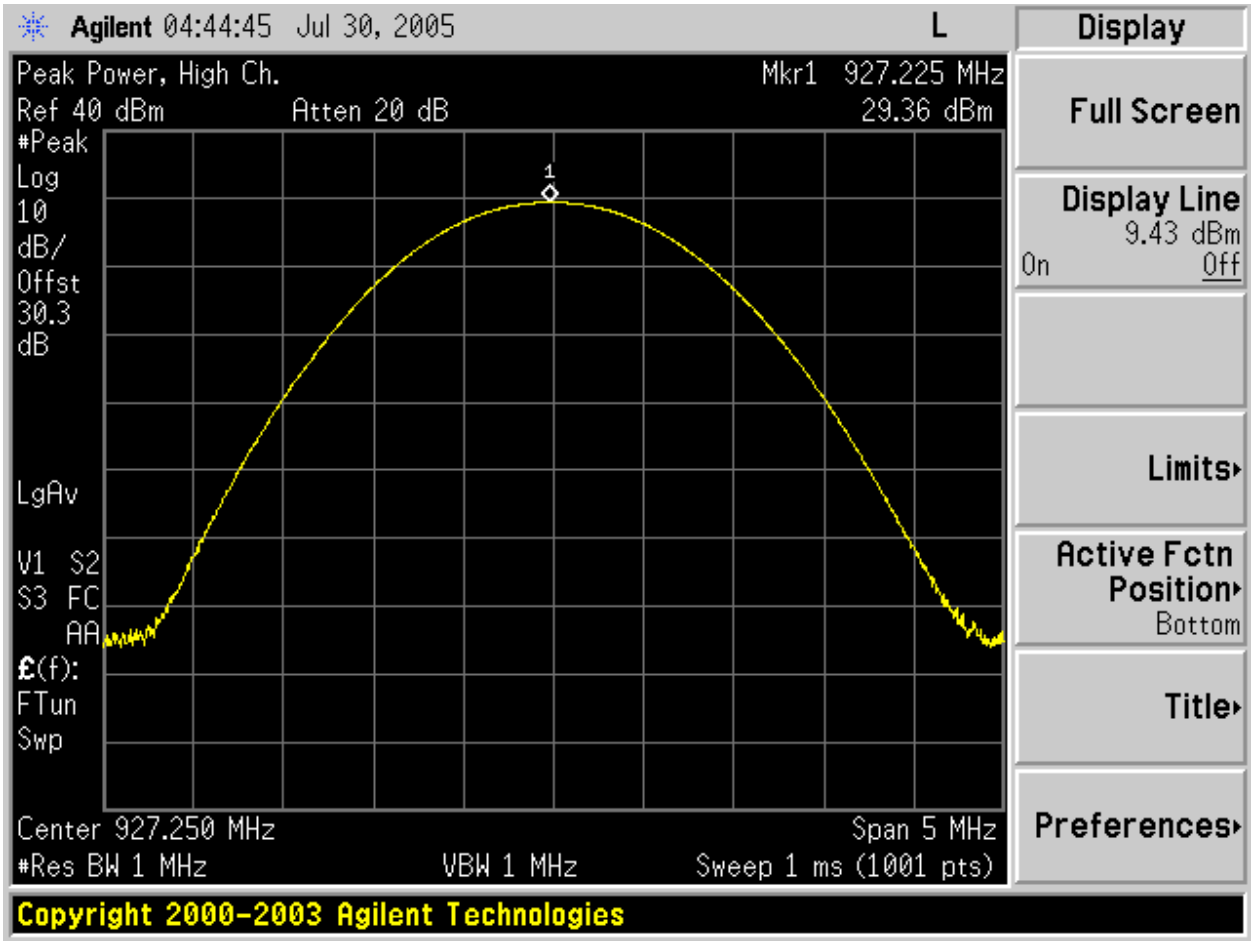
OUTPUT POWER LOW CHANNEL CLASS 1



OUTPUT POWER MID CHANNEL CLASS 1



OUTPUT POWER HIGH CHANNEL CLASS 1



4.2.6. 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:

Power Density Limit (mW/cm^2)	Output Power (dBm)	Antenna Gain (dBi)	MPE Distance (cm)
0.6	29.59	6.00	21.91

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.

4.2.7. 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

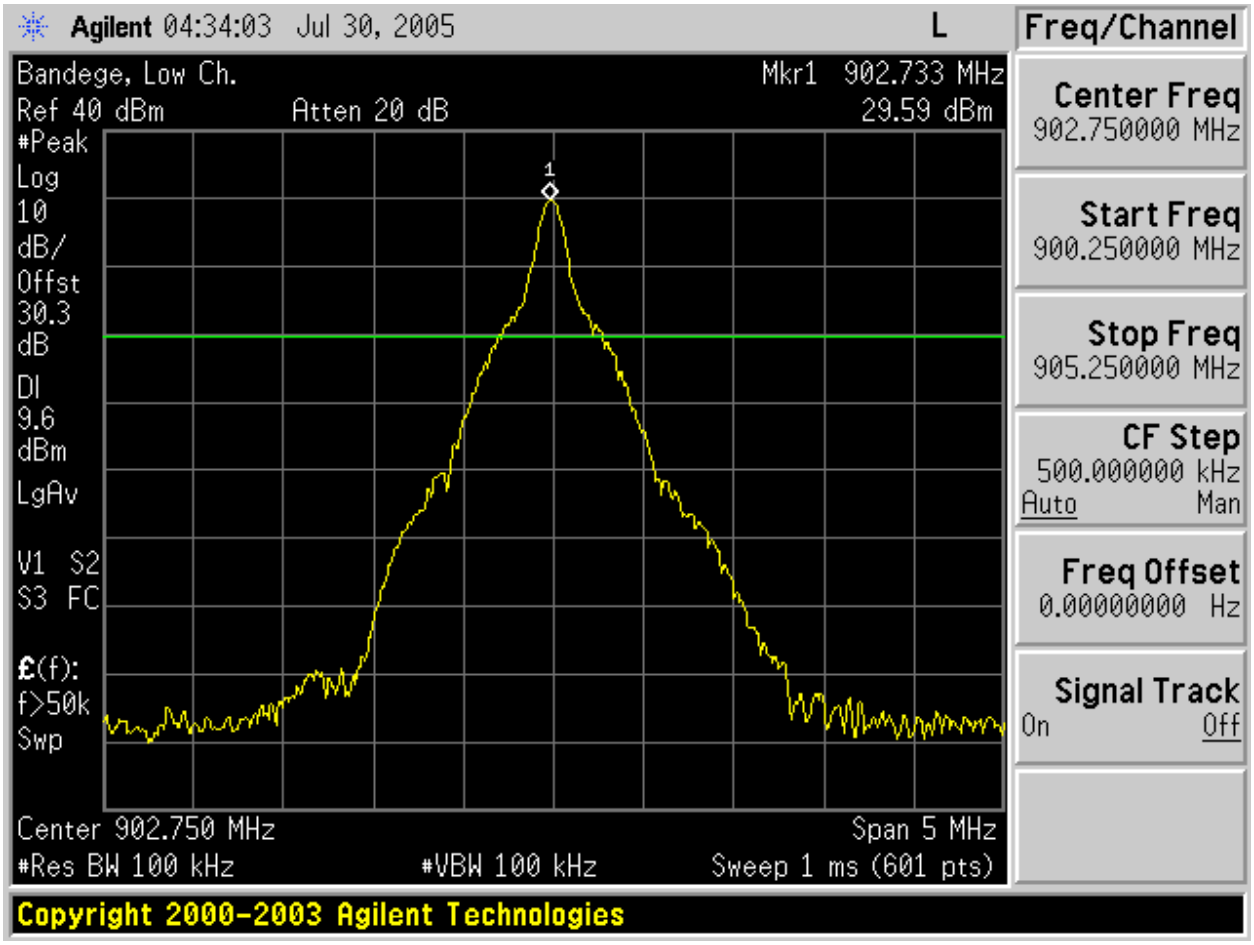
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 100 kHz.

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

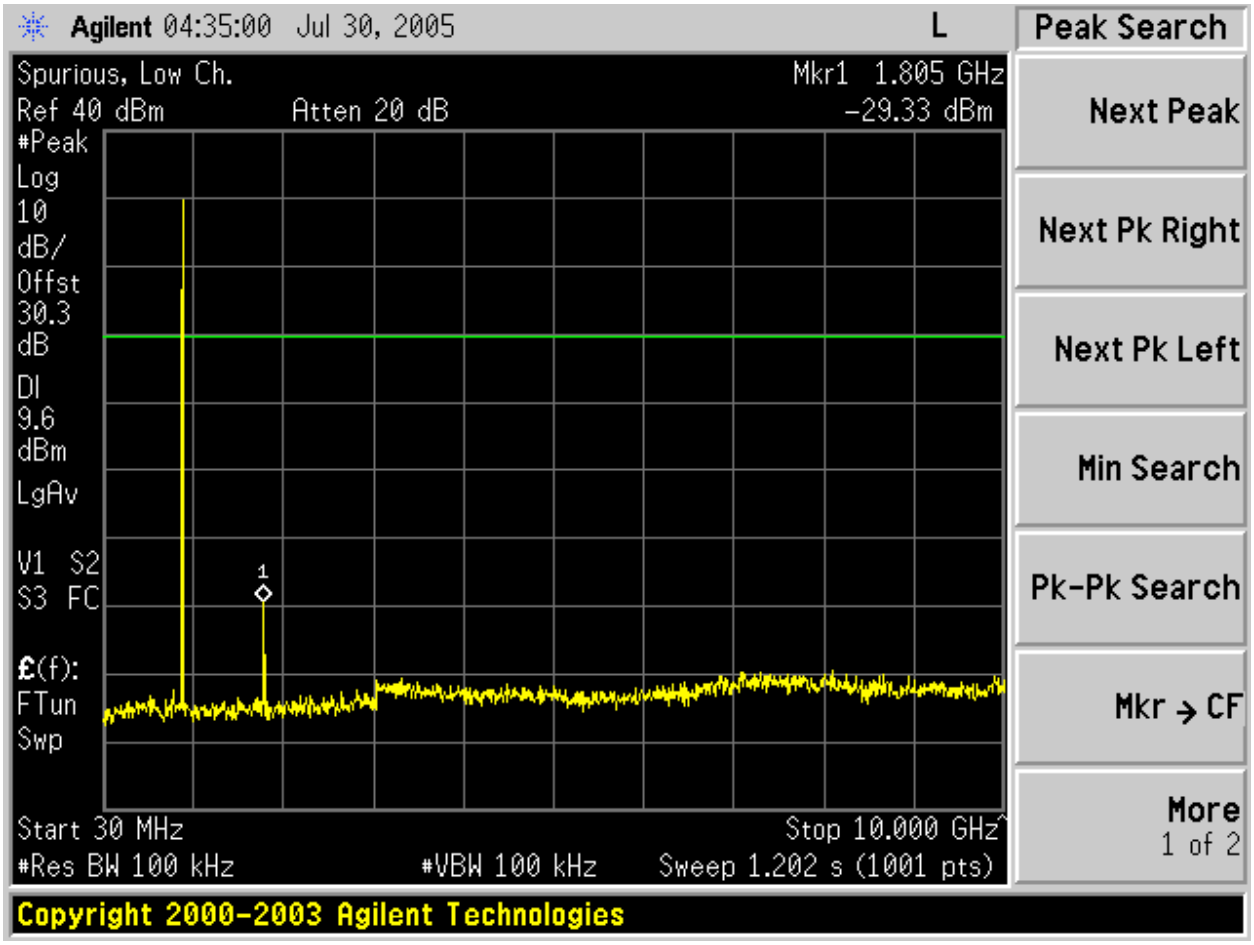
RESULTS

No non-compliance noted:

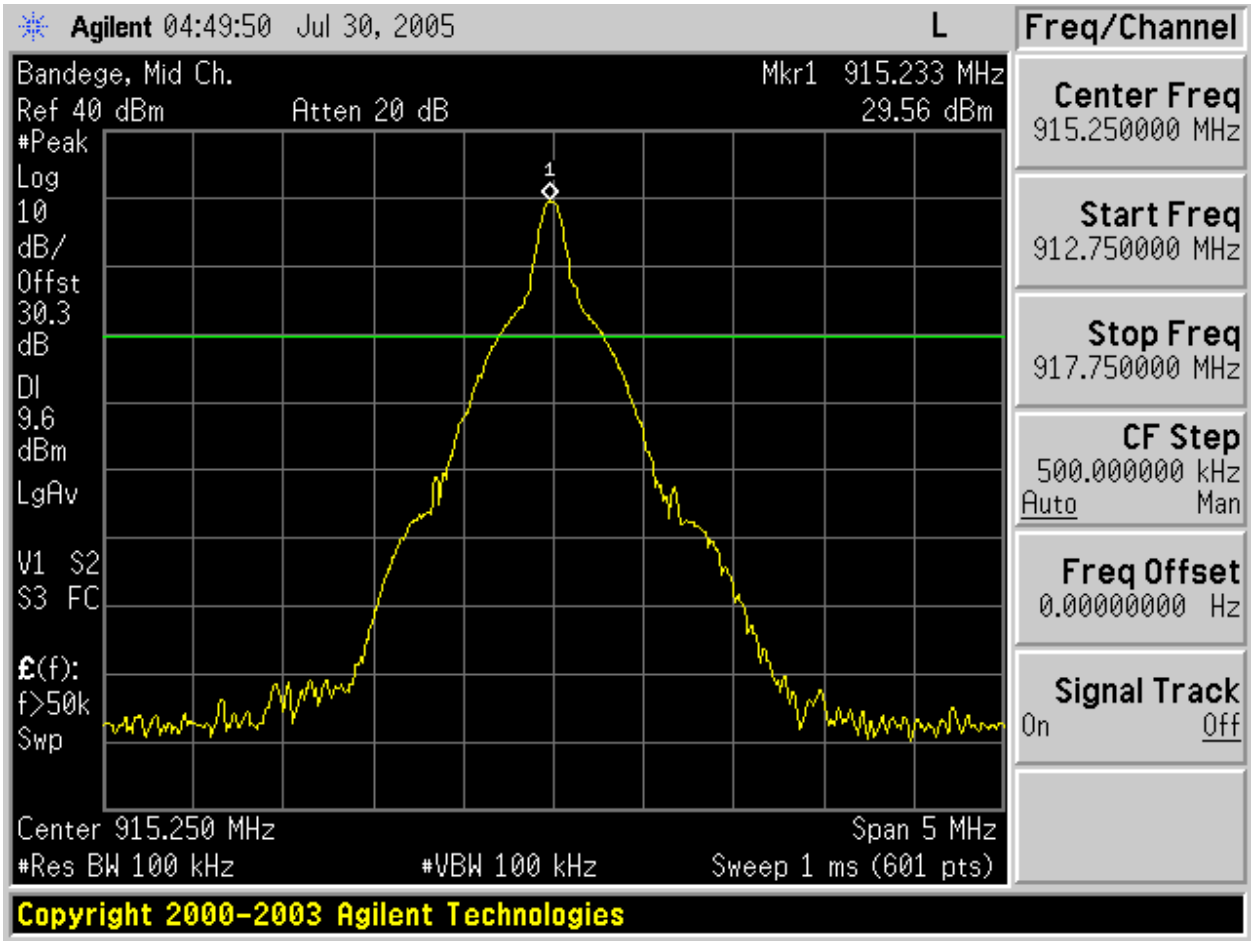
SPURIOUS EMISSIONS, LOW CHANNEL CLASS 1



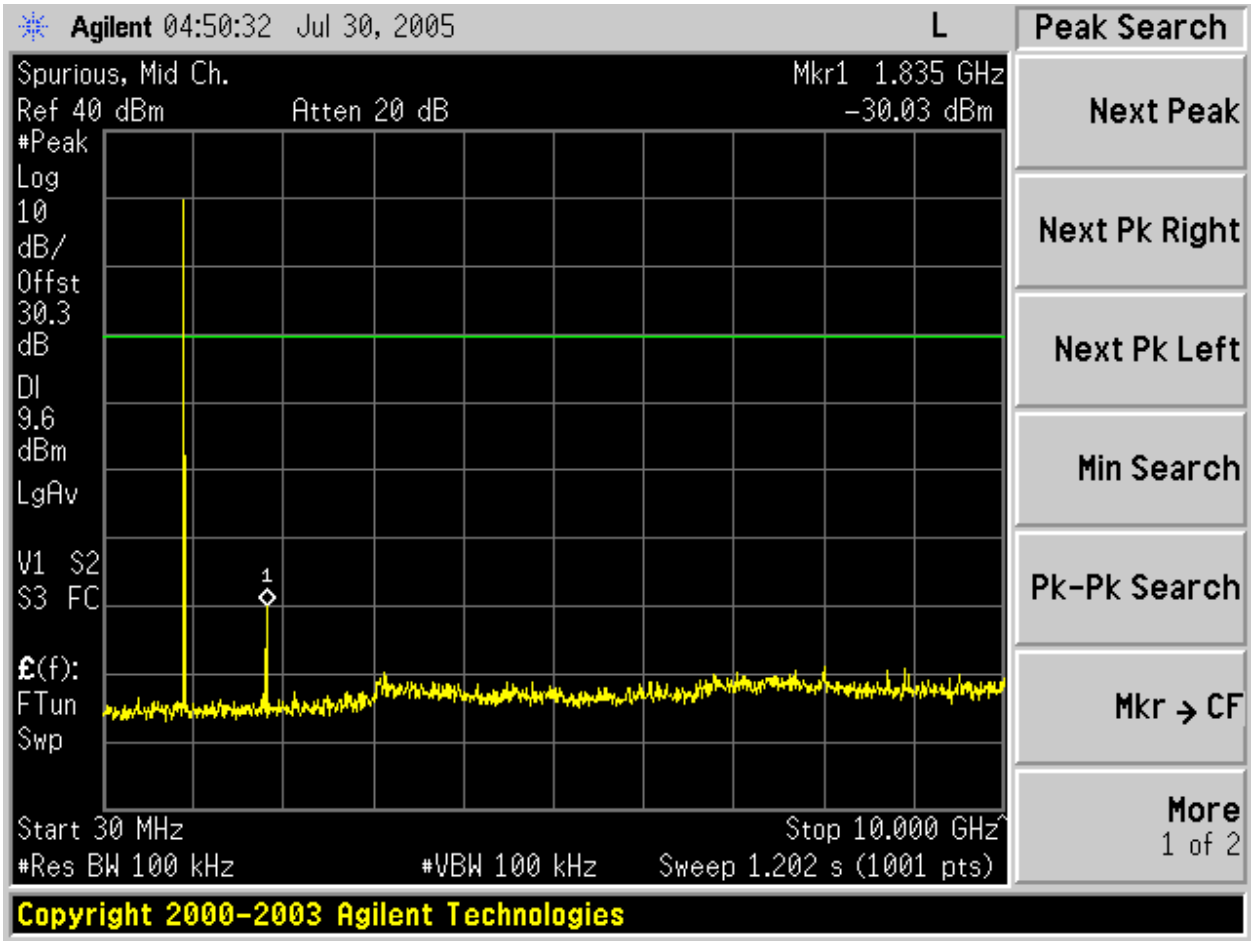
SPURIOUS EMISSIONS, LOW CHANNEL CLASS 1



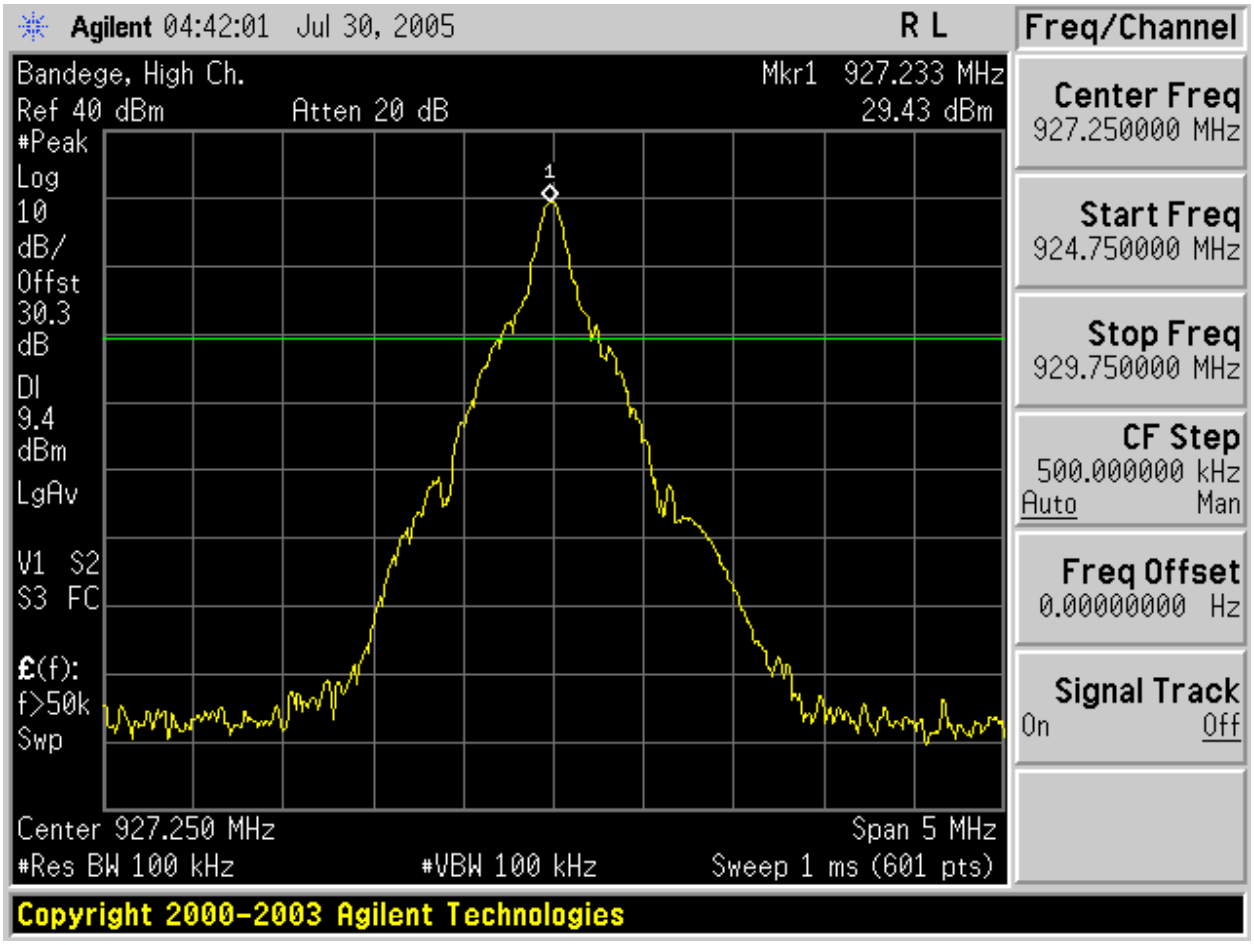
SPURIOUS EMISSIONS, MID CHANNEL CLASS 1



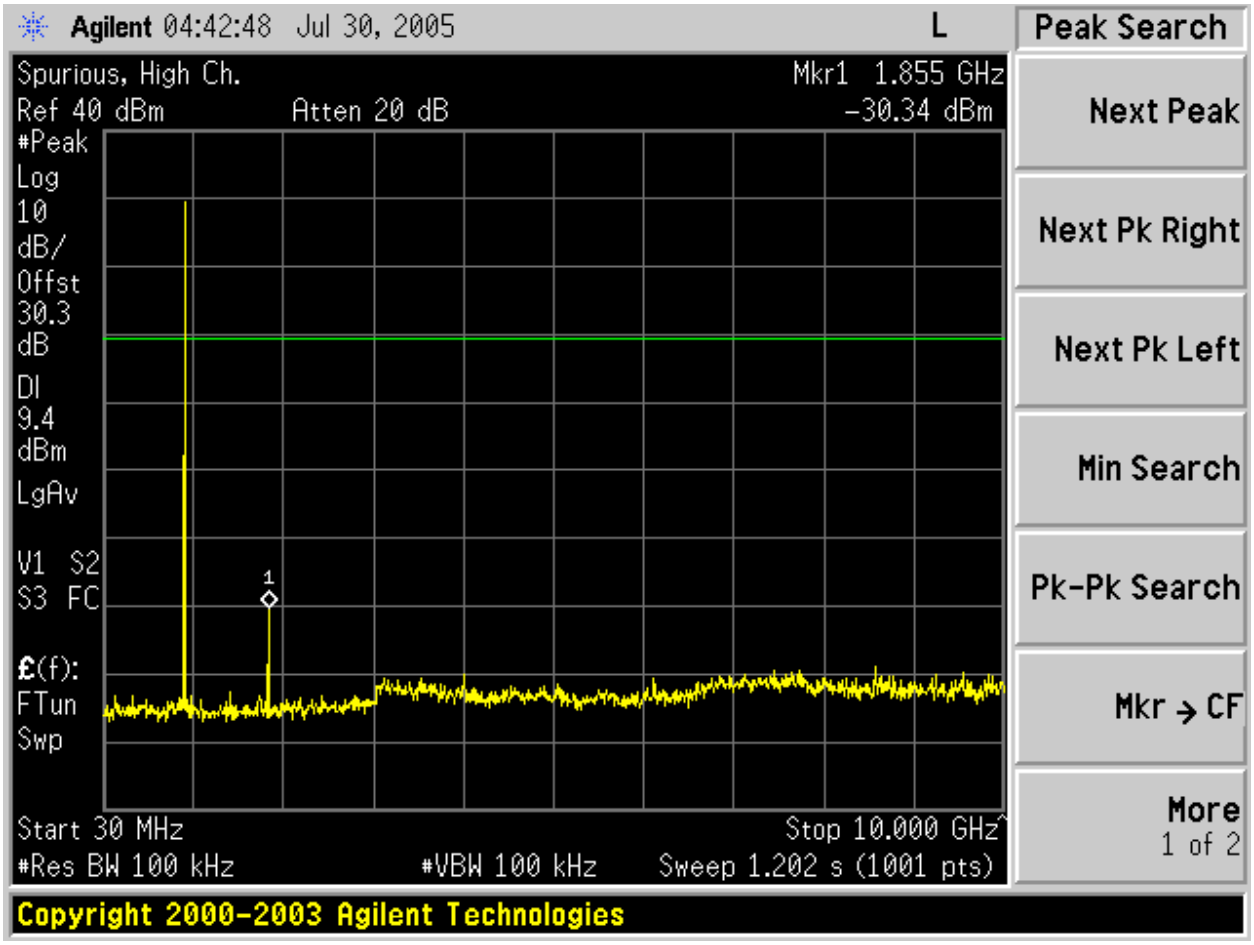
SPURIOUS EMISSIONS, MID CHANNEL CLASS 1



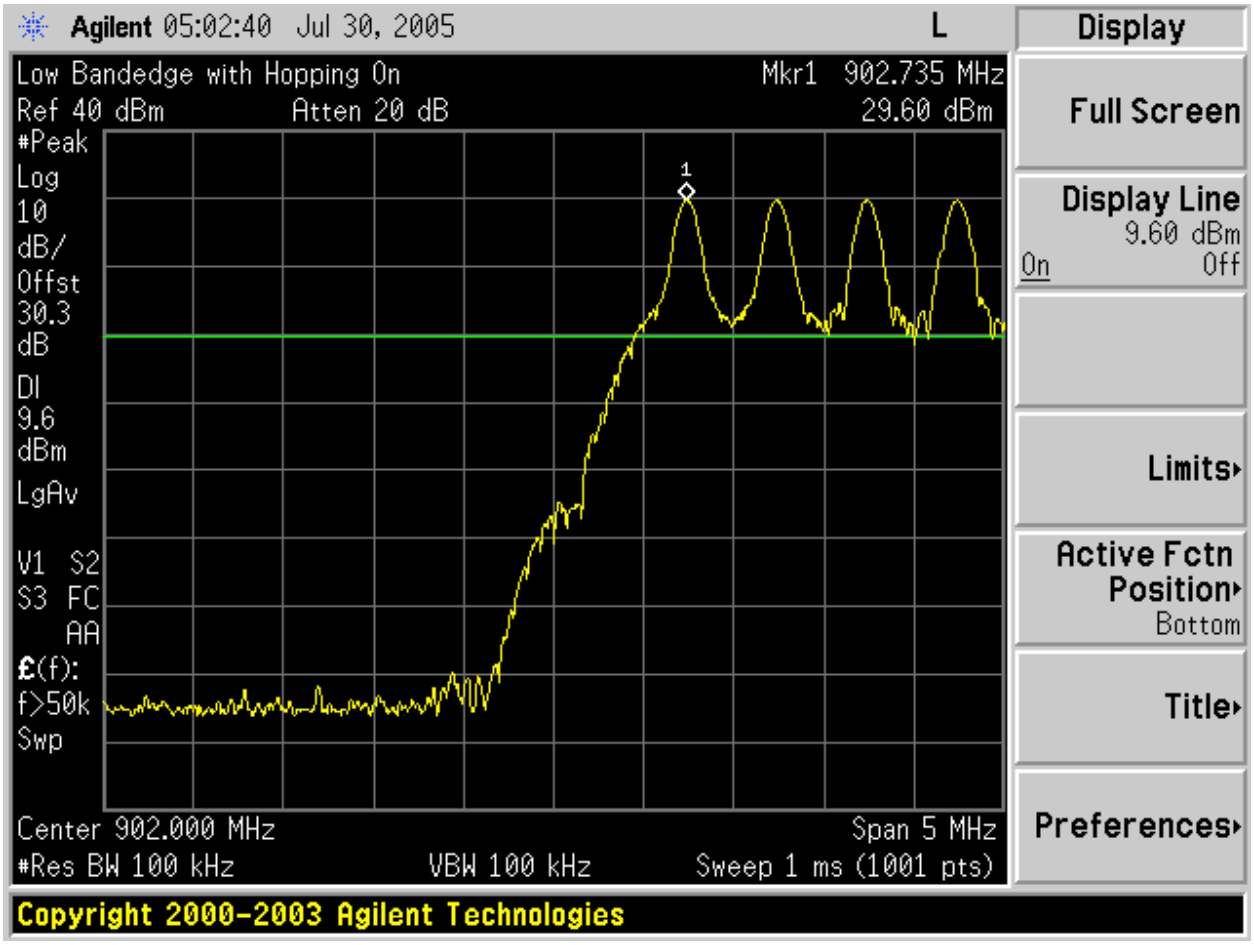
SPURIOUS EMISSIONS, HIGH CHANNEL CLASS 1



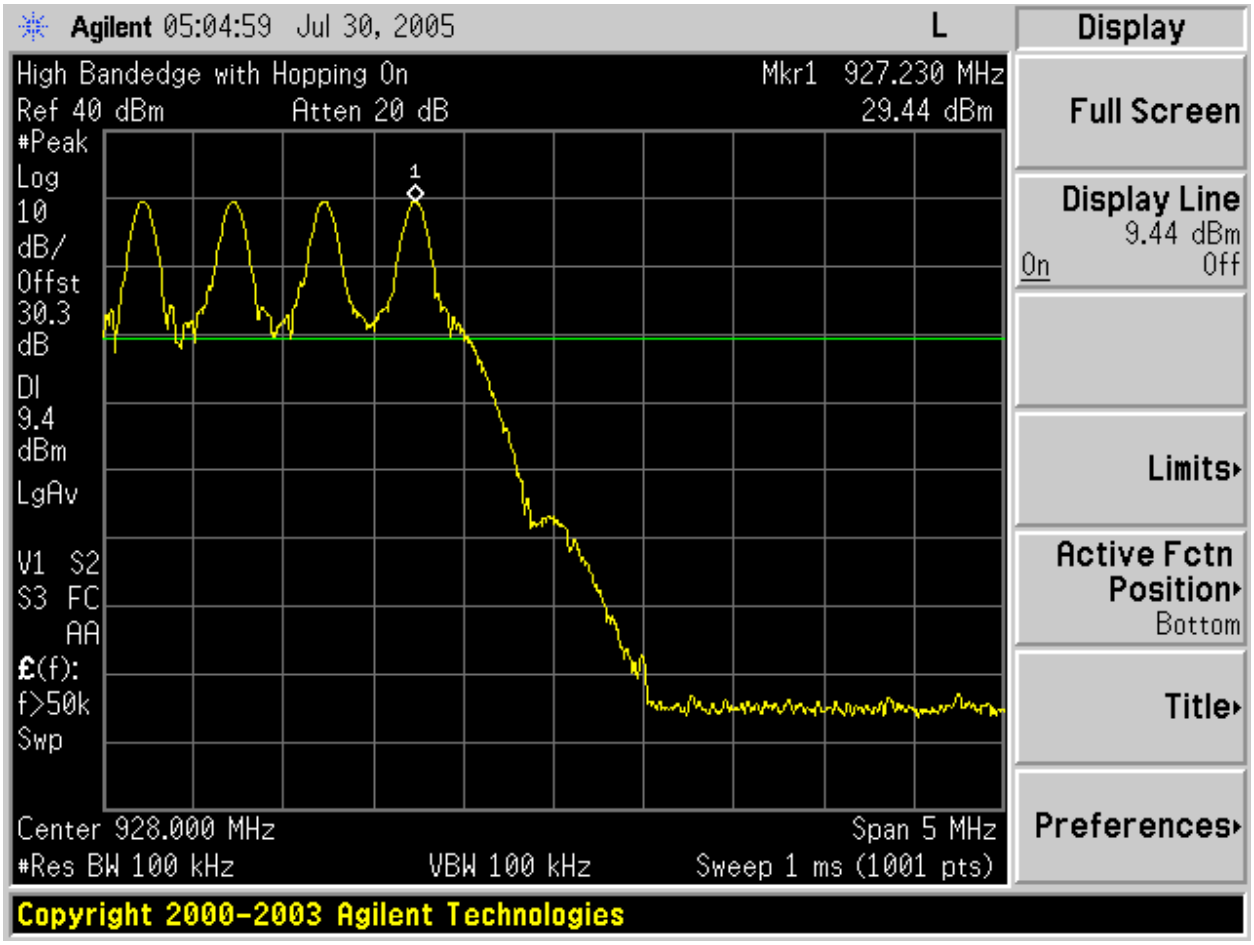
SPURIOUS EMISSIONS, HIGH CHANNEL CLASS 1



HOPPING FUNCTION ON, CLASS 1 LOW CHANNEL



HOPPING FUNCTION ON, CLASS 1 HIGH CHANNEL



4.3. ANTENNA PORT CHANNEL TESTS FOR MODE 1800 MODULATION

4.3.1. 20 dB BANDWIDTH

LIMIT

None: for reporting purposes only.

TEST PROCEDURE

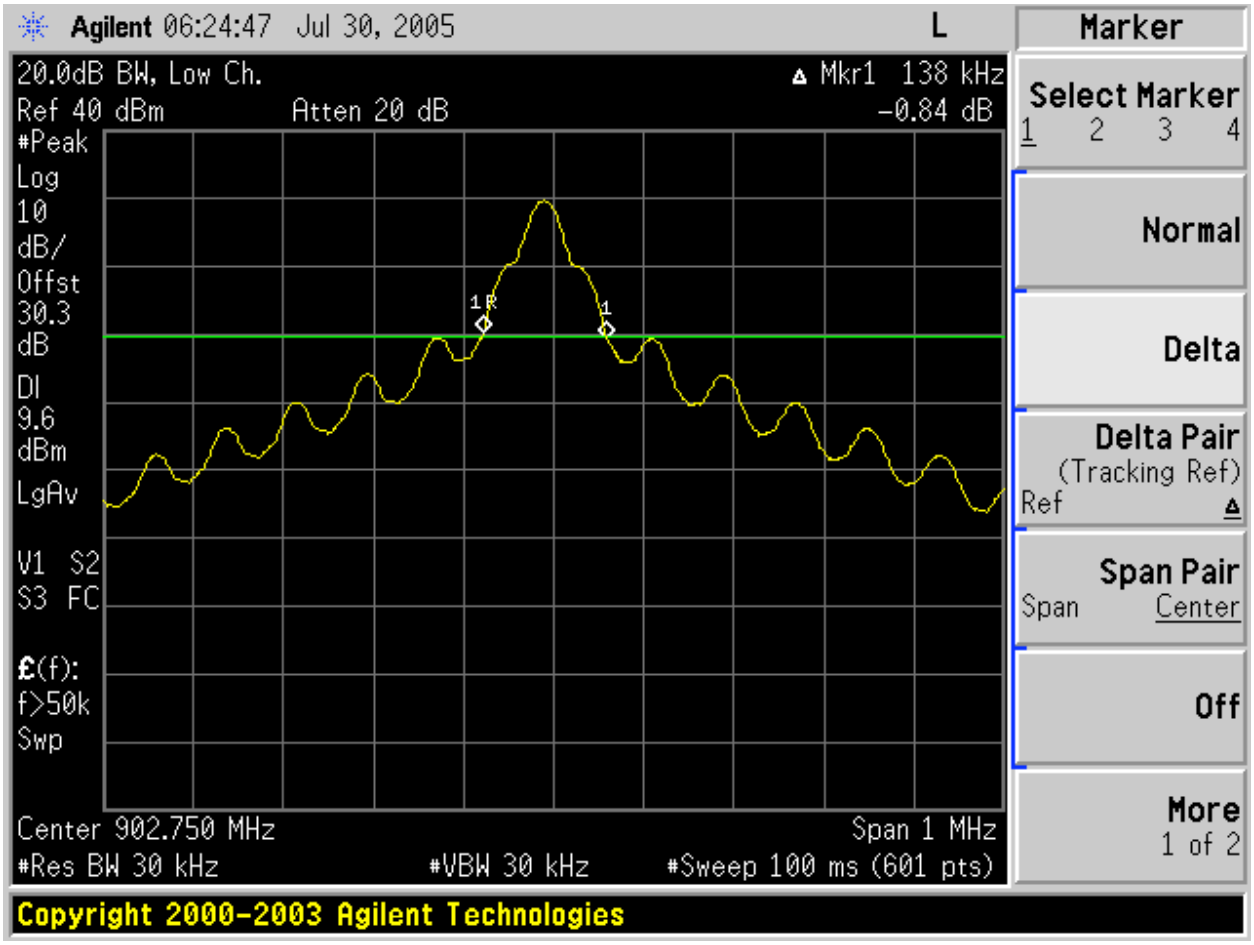
The transmitter output is connected to a spectrum analyzer. The RBW is set to 1% to 3% of the 20 dB bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled.

RESULTS

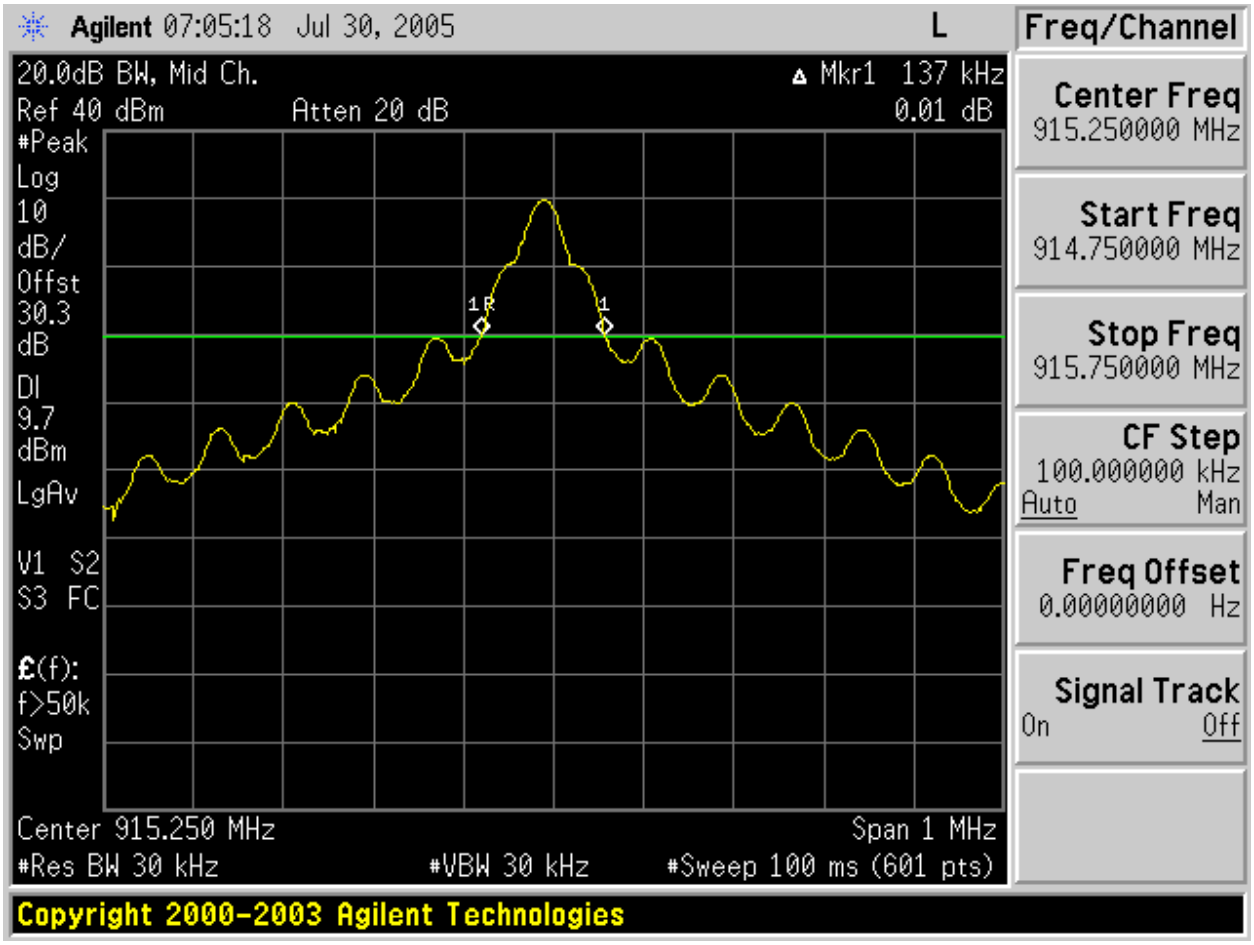
No non-compliance noted:

Channel	Frequency (MHz)	20 dB Bandwidth (kHz)
Low	902.75	138
Middle	915.25	137
High	927.25	140

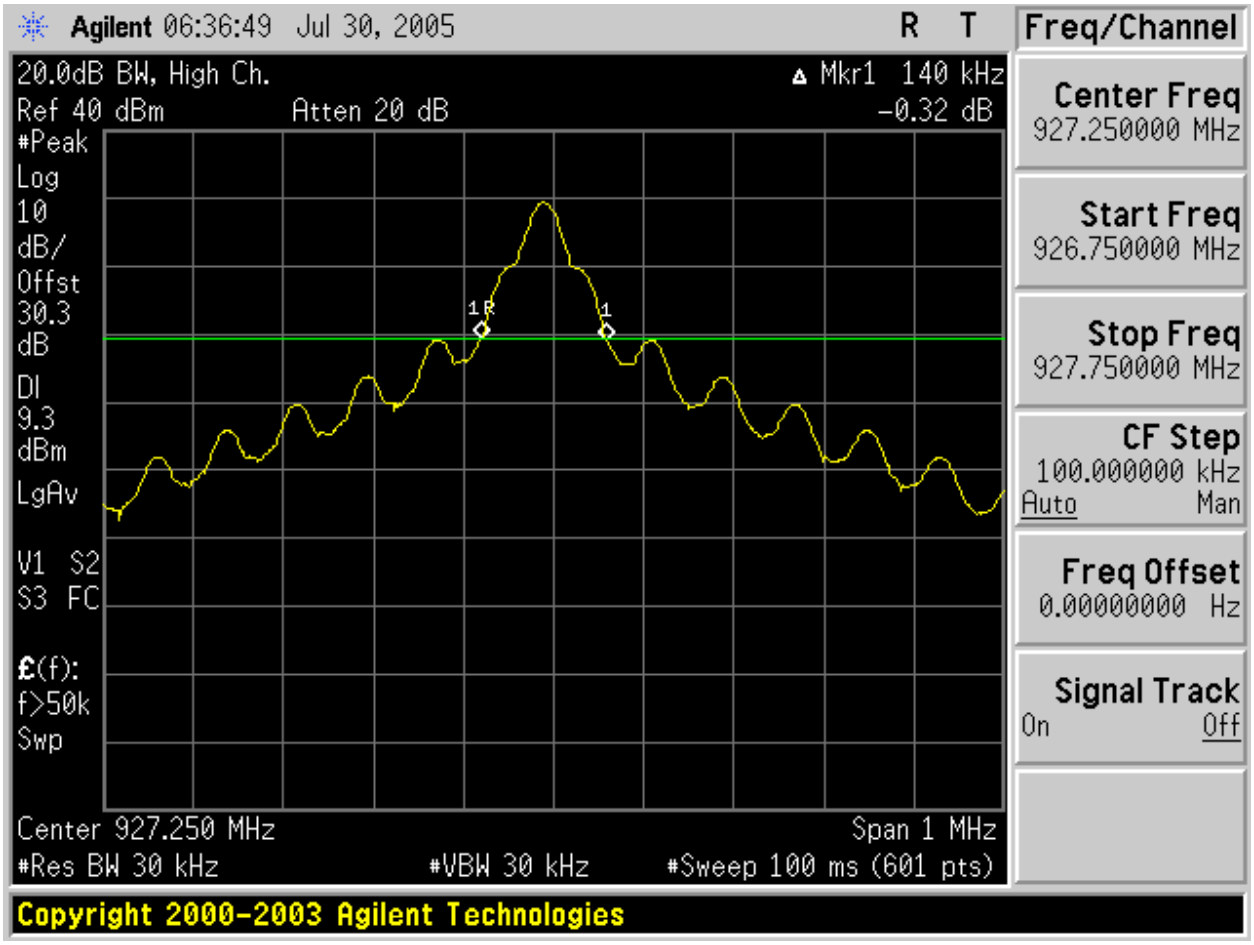
20 dB BANDWIDTH LOW CHANNEL MODE 1800



20 dB BANDWIDTH MID CHANNEL MODE 1800



20 dB BANDWIDTH HIGH CHANNEL MODE 1800



4.3.2. 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

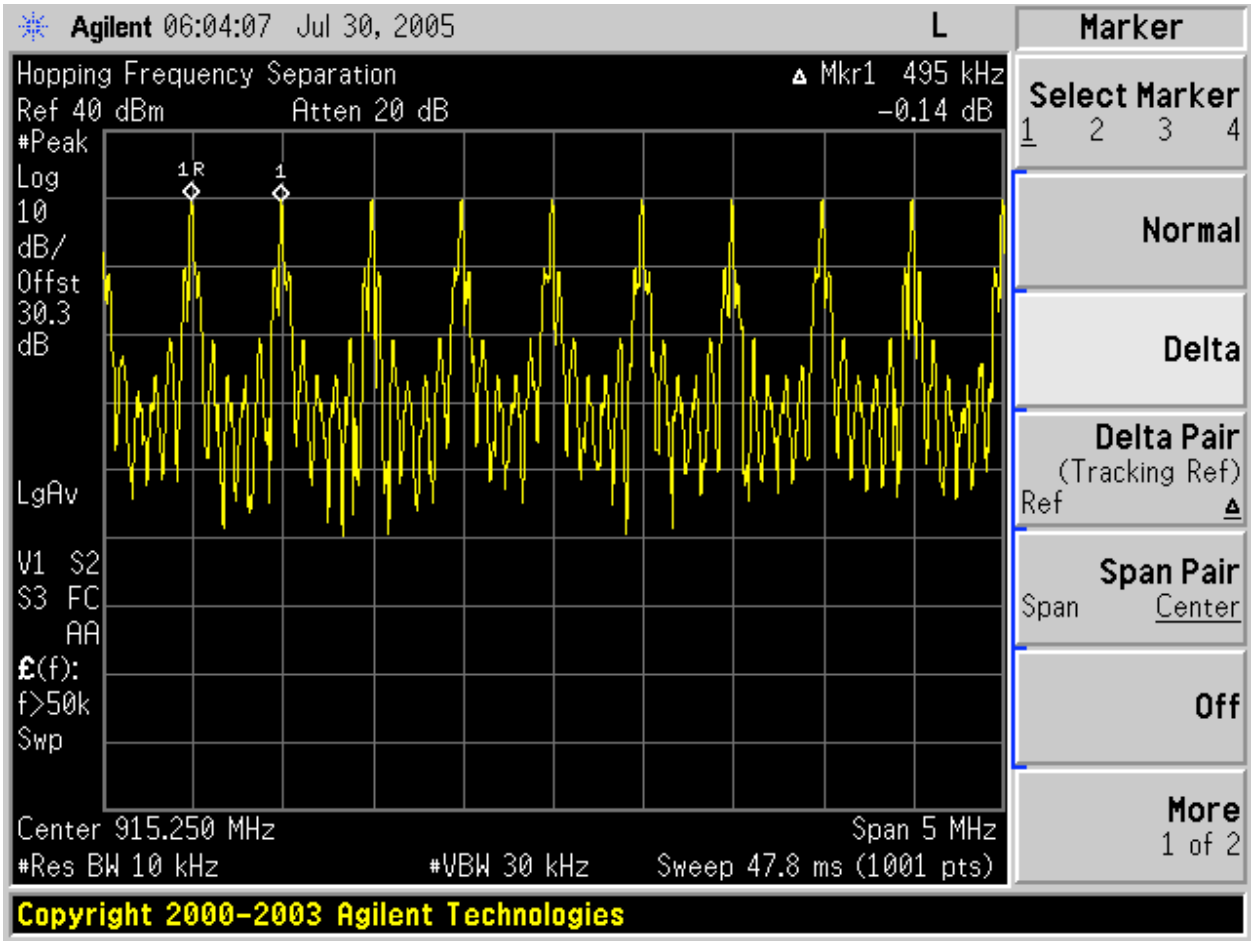
The transmitter output is connected to a spectrum analyzer. The RBW is set to 10 kHz and the VBW is set to 30 kHz. The sweep time is coupled.

RESULTS

No non-compliance noted:

The channel separation is 495 KHz.

HOPPING FREQUENCY SEPARATION MODE 1800



4.3.3. 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

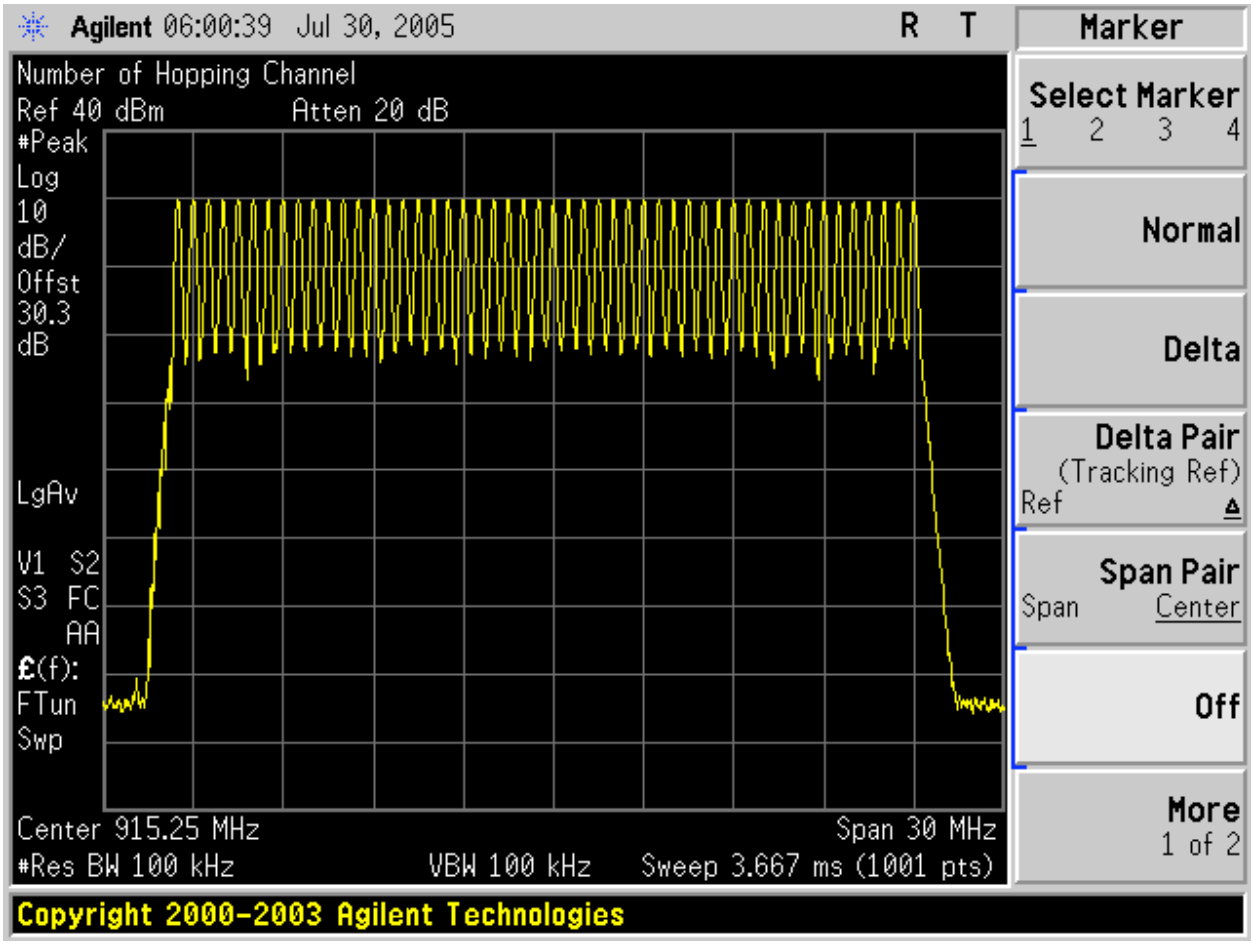
The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to 1 % of the span. The analyzer is set to Max Hold.

RESULTS

No non-compliance noted:

50 Channels observed.

NUMBER OF HOPPING CHANNELS MODE 1800



4.3.4. 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

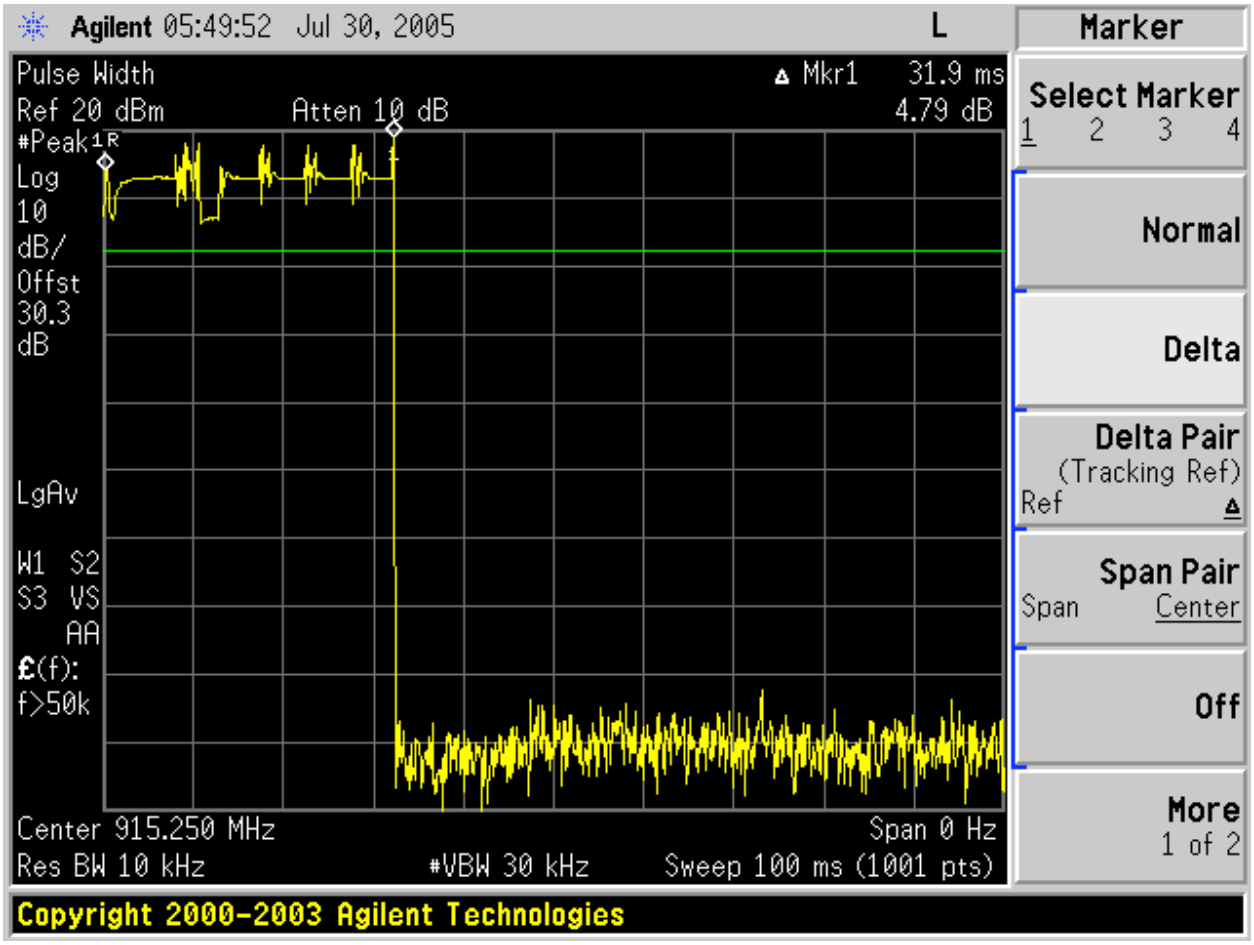
No non-compliance noted:

The system has 50 hopping frequencies. There are 10 pulses within the 20-second period. The on time for each pulse is 31.9 ms.

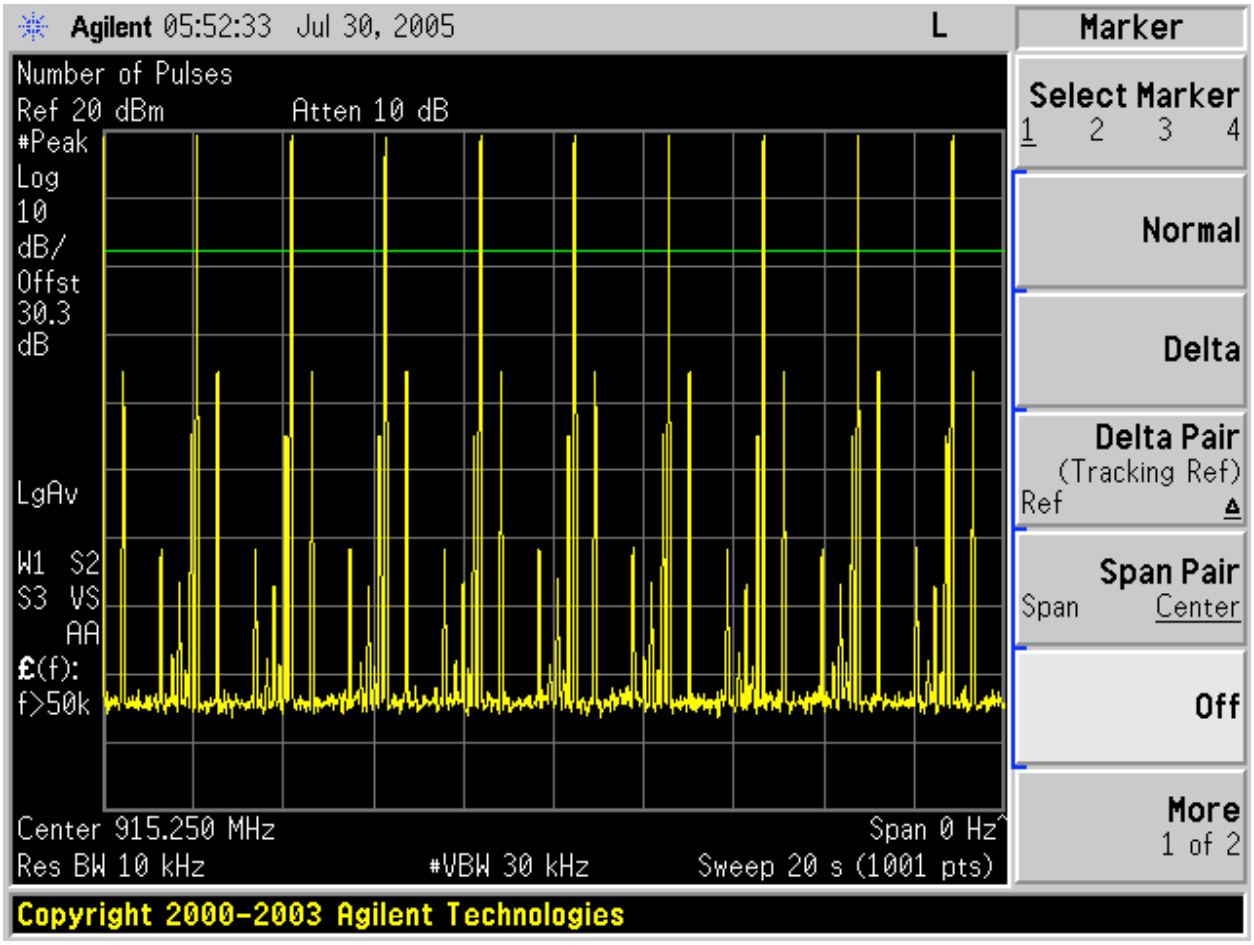
Therefore, the average time of occupancy in the specified 20-second period is:

31.9 x 10 = 319ms = 0.319s

PULSE WIDTH MODE 1800



NUMBER OF PULSES IN 20 SECOND OBSERVATION PERIOD MODE 1800



4.3.5. 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 6 dBi, therefore the limit is 30 dBm.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer and the analyzer bandwidth is set to a value greater than the 20 dB bandwidth of the EUT.

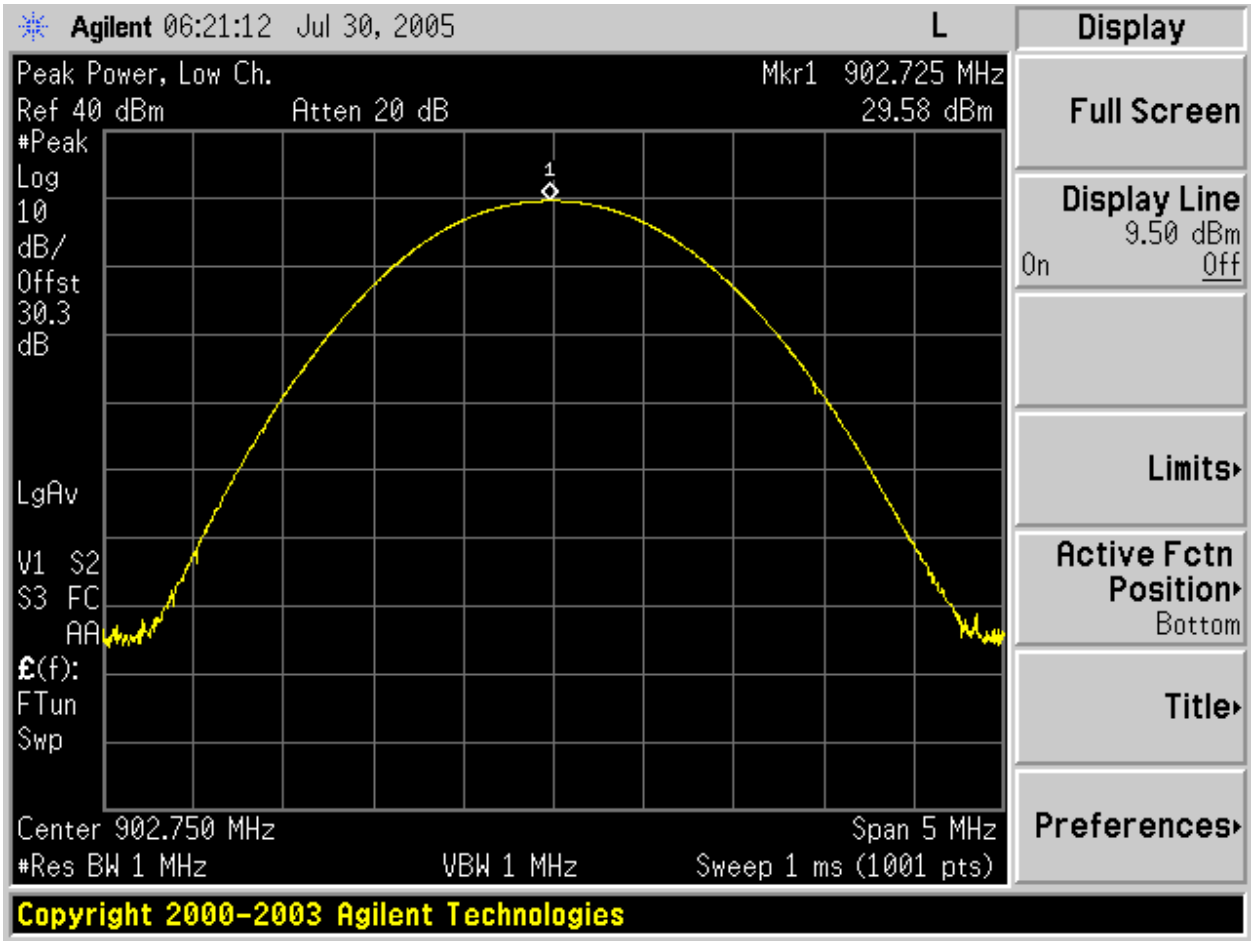
RESULTS

No non-compliance noted:

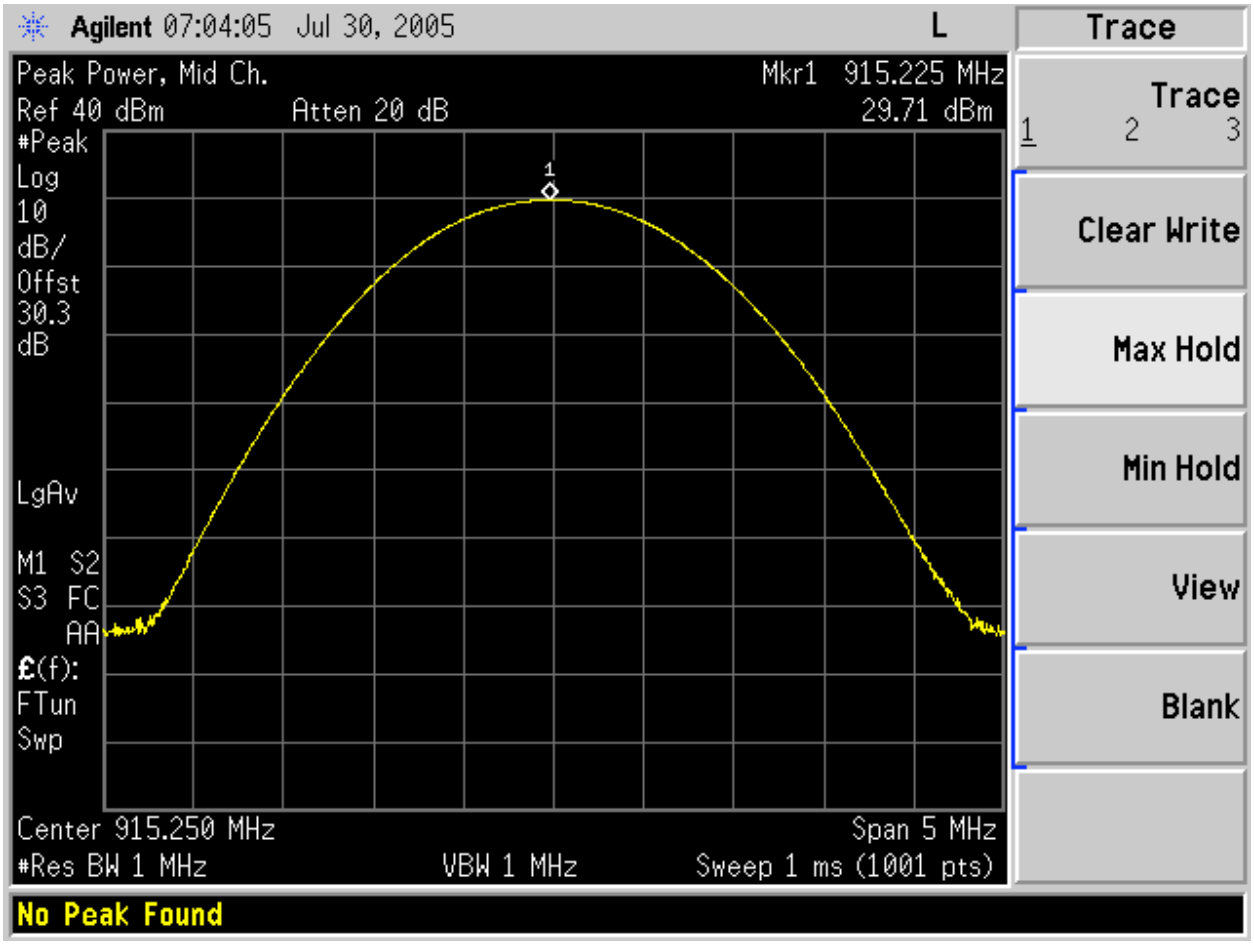
MODE 1800

	(MHz)	(dBm)	(mW)
Low	902.75	29.58	907.8
Middle	915.25	29.71	935.4
High	927.25	29.32	855.1

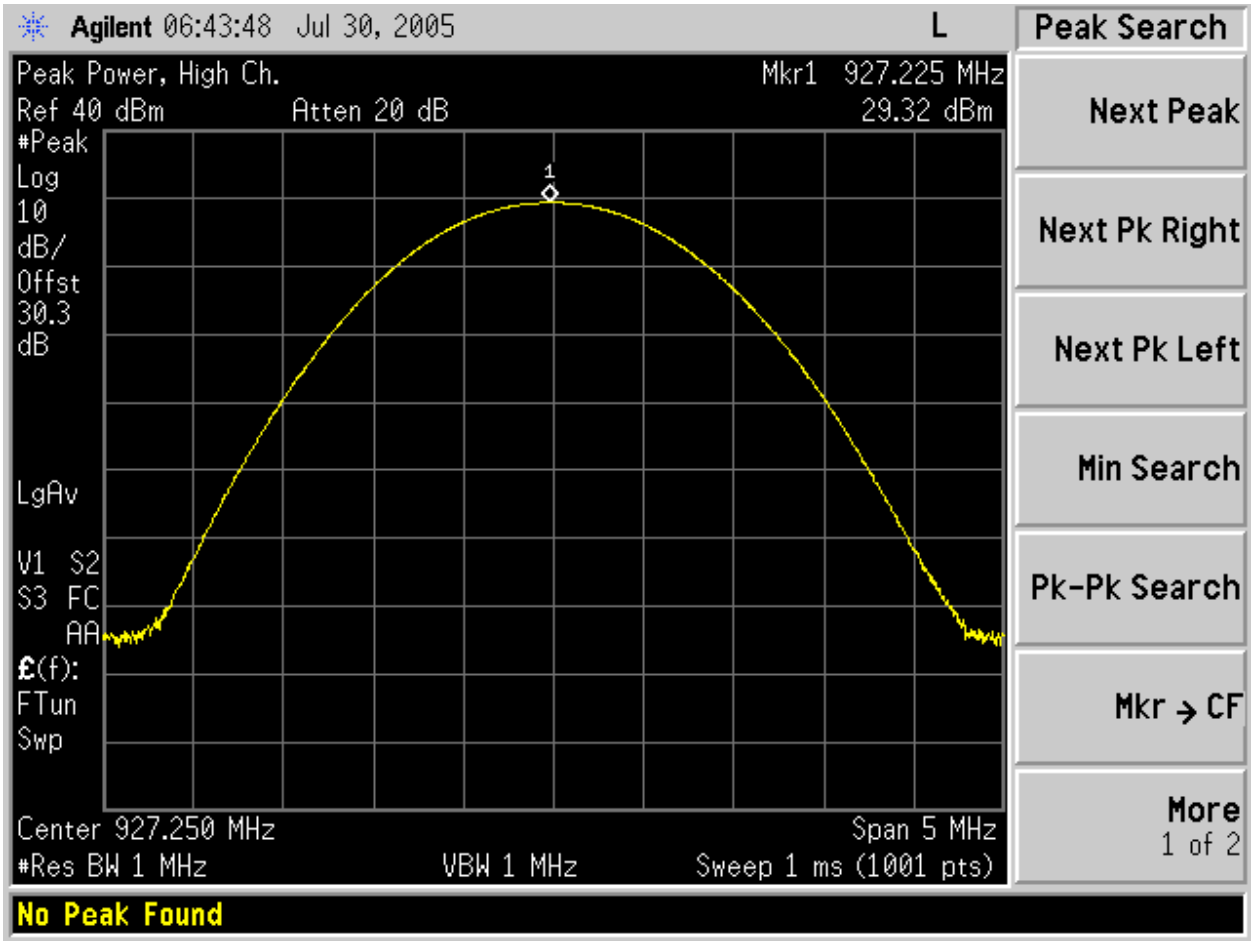
OUTPUT POWER LOW CHANNEL MODE 1800



OUTPUT POWER MID CHANNEL MODE 1800



OUTPUT POWER HIGH CHANNEL MODE 1800



4.3.6. 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:

Power Density Limit (mW/cm^2)	Output Power (dBm)	Antenna Gain (dBi)	MPE Distance (cm)
0.6	29.71	6.00	22.22

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.

4.3.7. 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

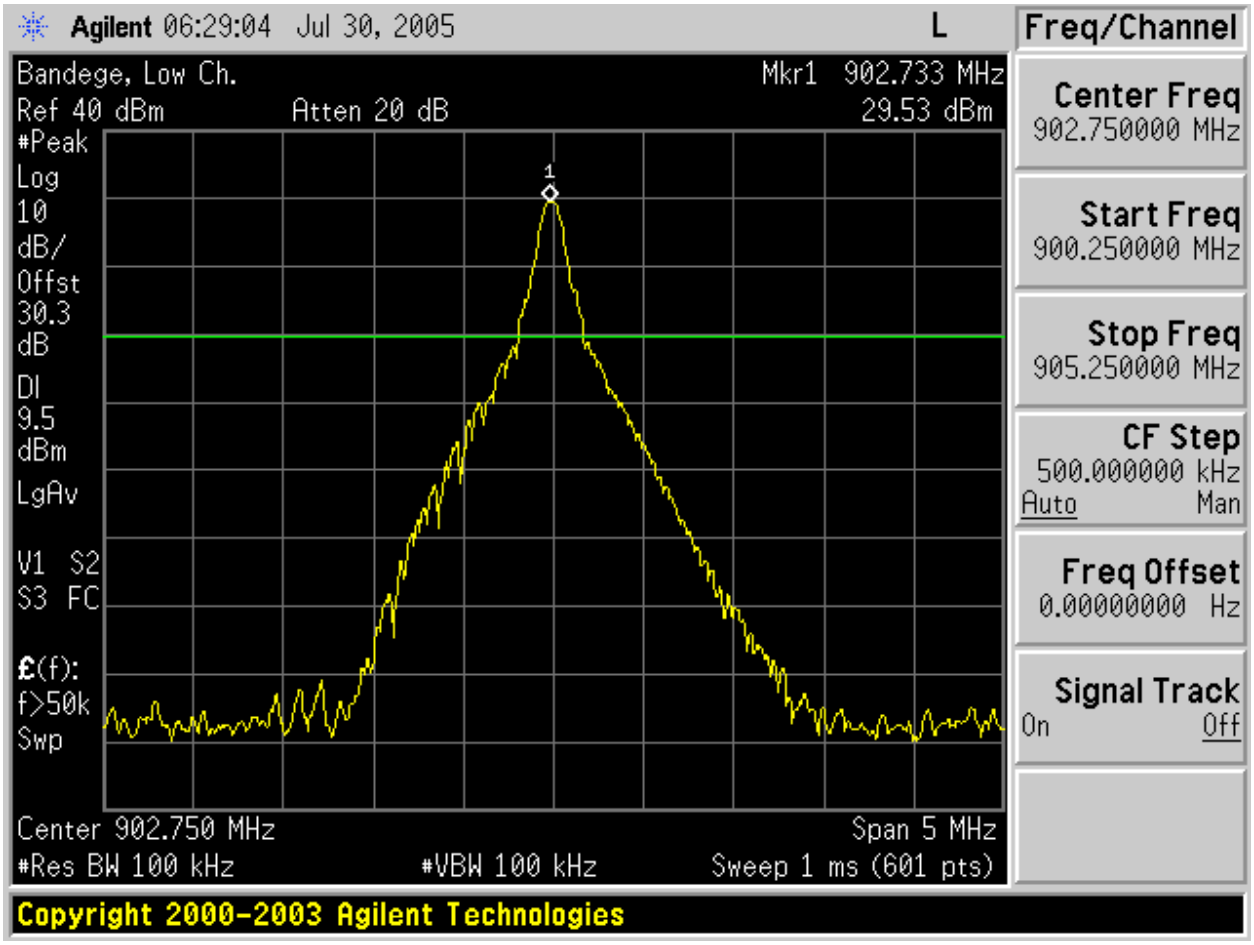
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 100 kHz.

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

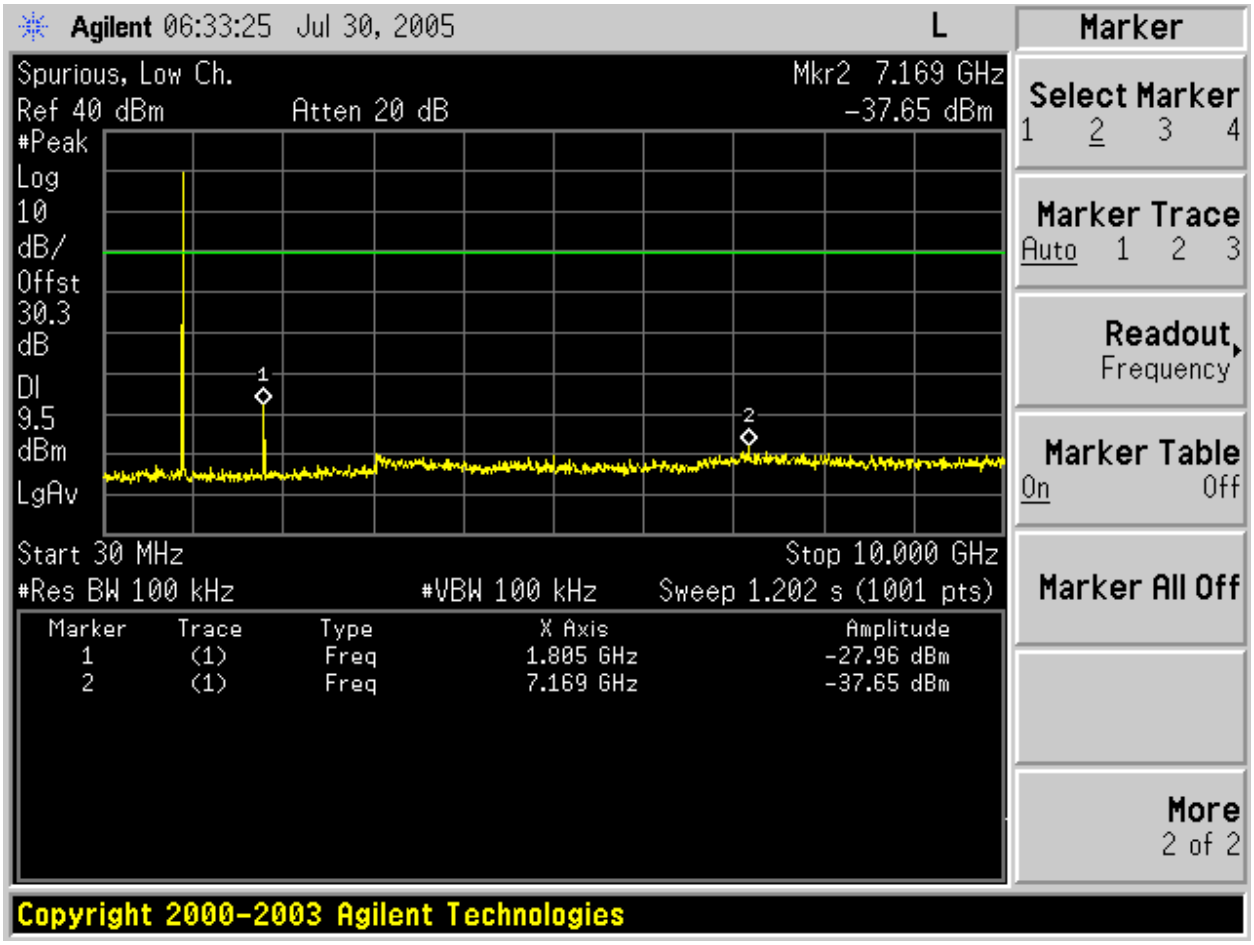
RESULTS

No non-compliance noted:

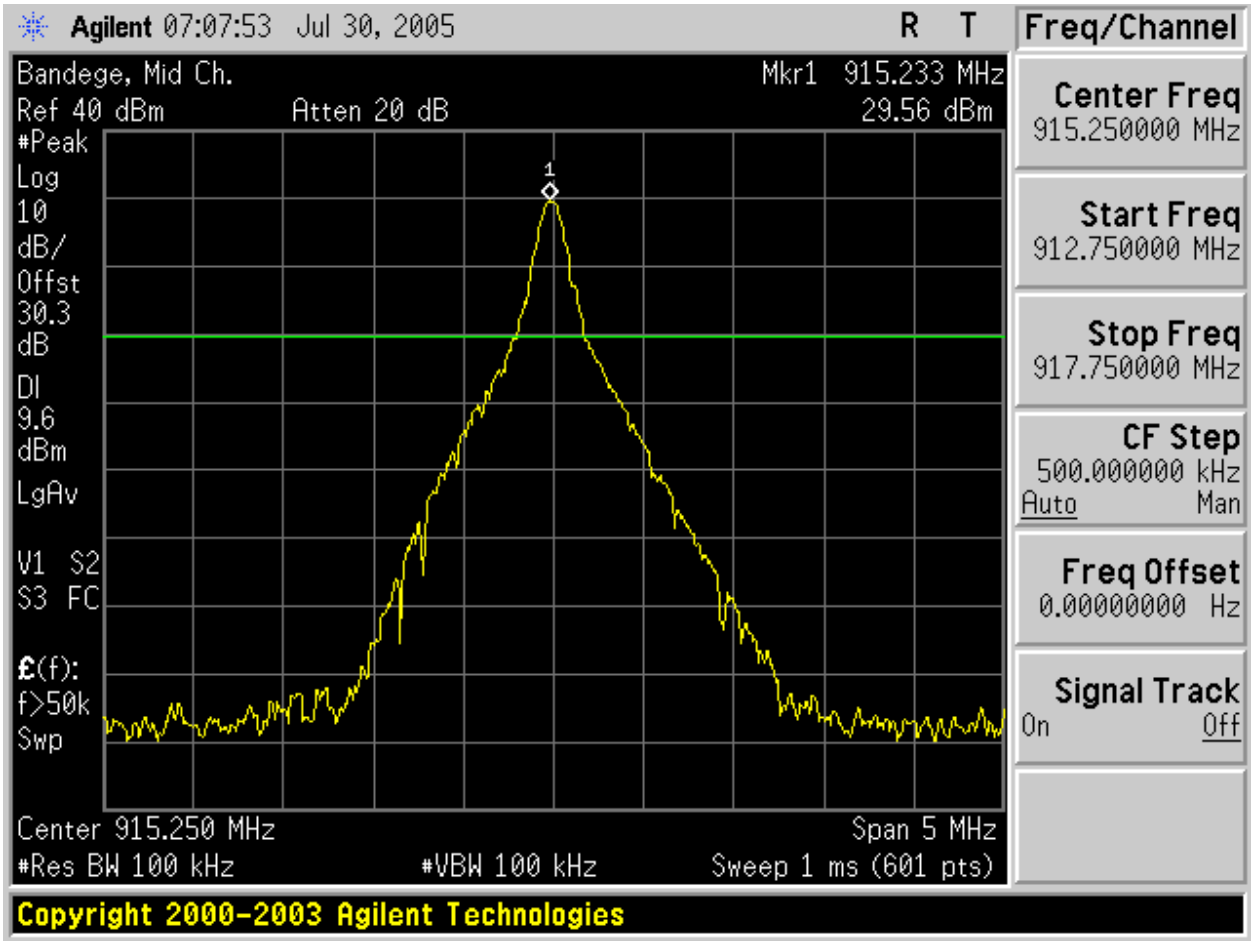
SPURIOUS EMISSIONS, LOW CHANNEL MODE 1800



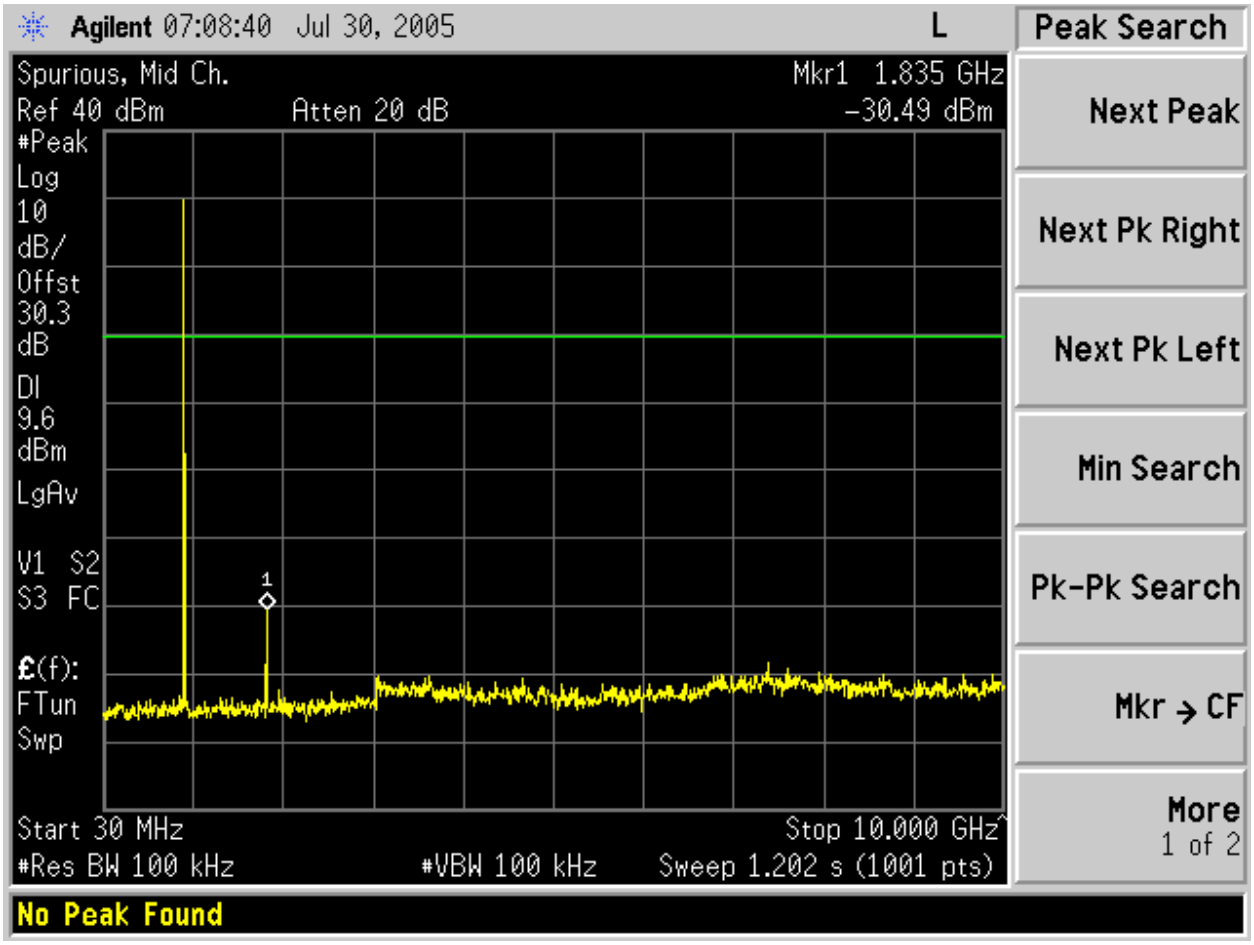
SPURIOUS EMISSIONS, LOW CHANNEL MODE 1800



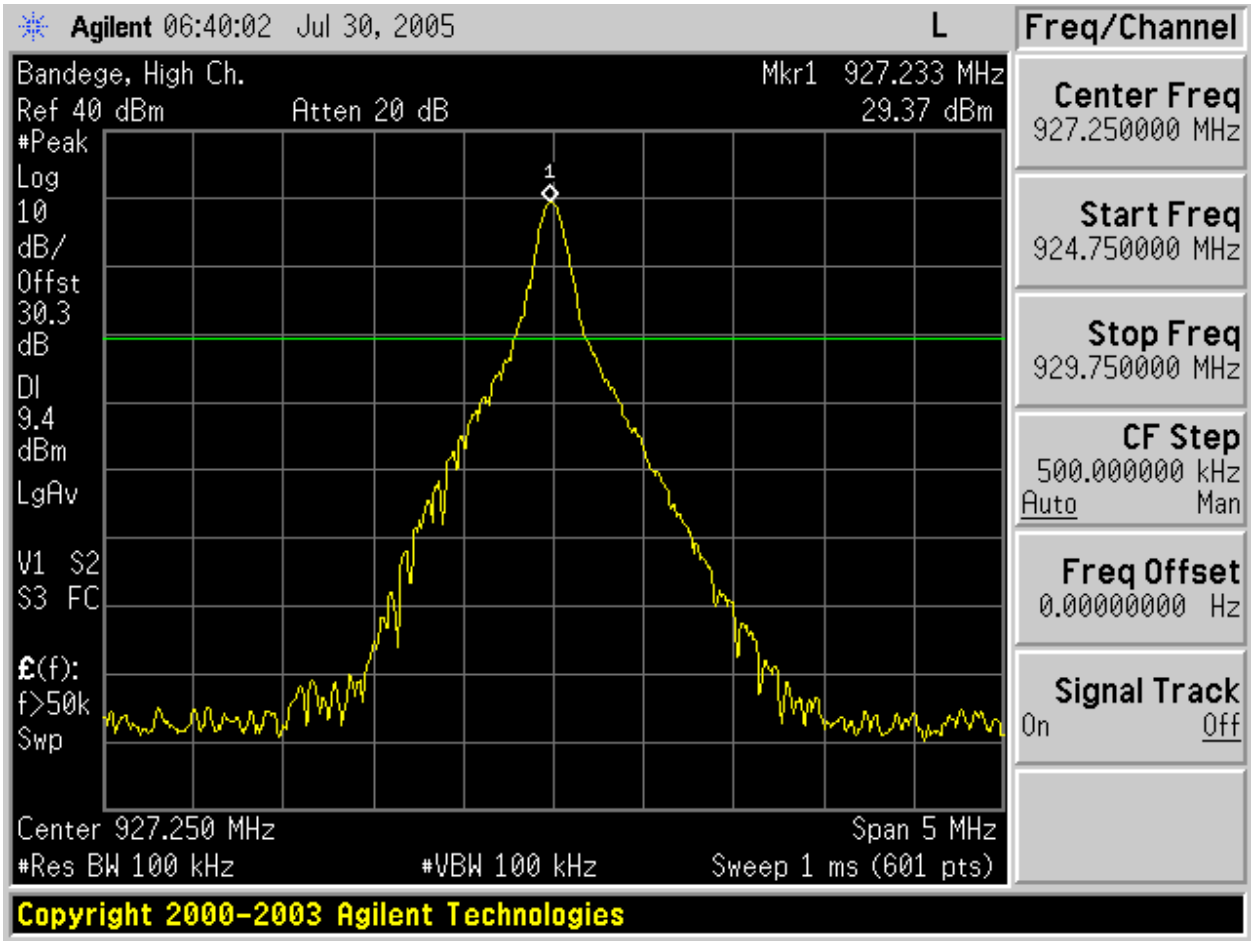
SPURIOUS EMISSIONS, MID CHANNEL MODE 1800



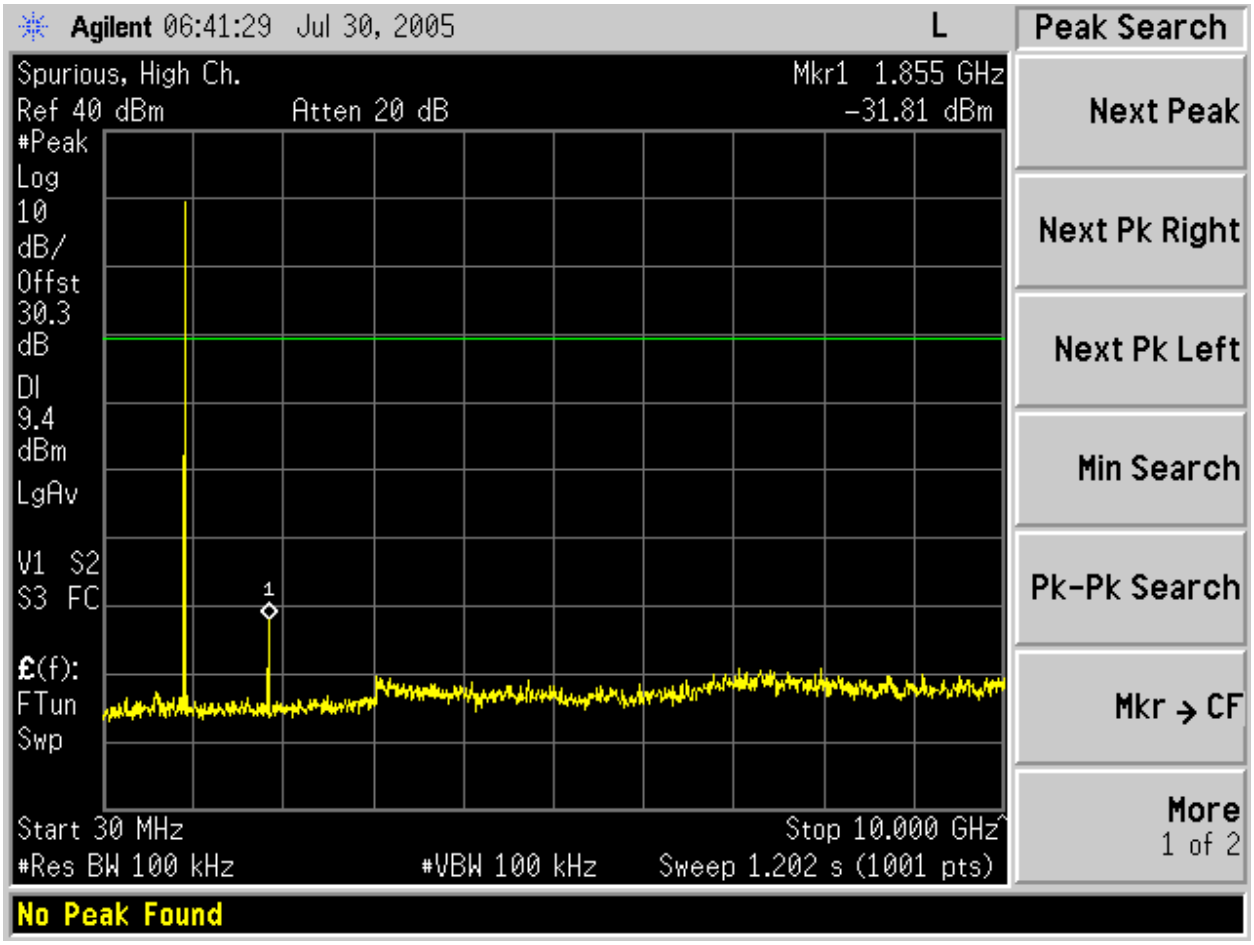
SPURIOUS EMISSIONS, MID CHANNEL MODE 1800



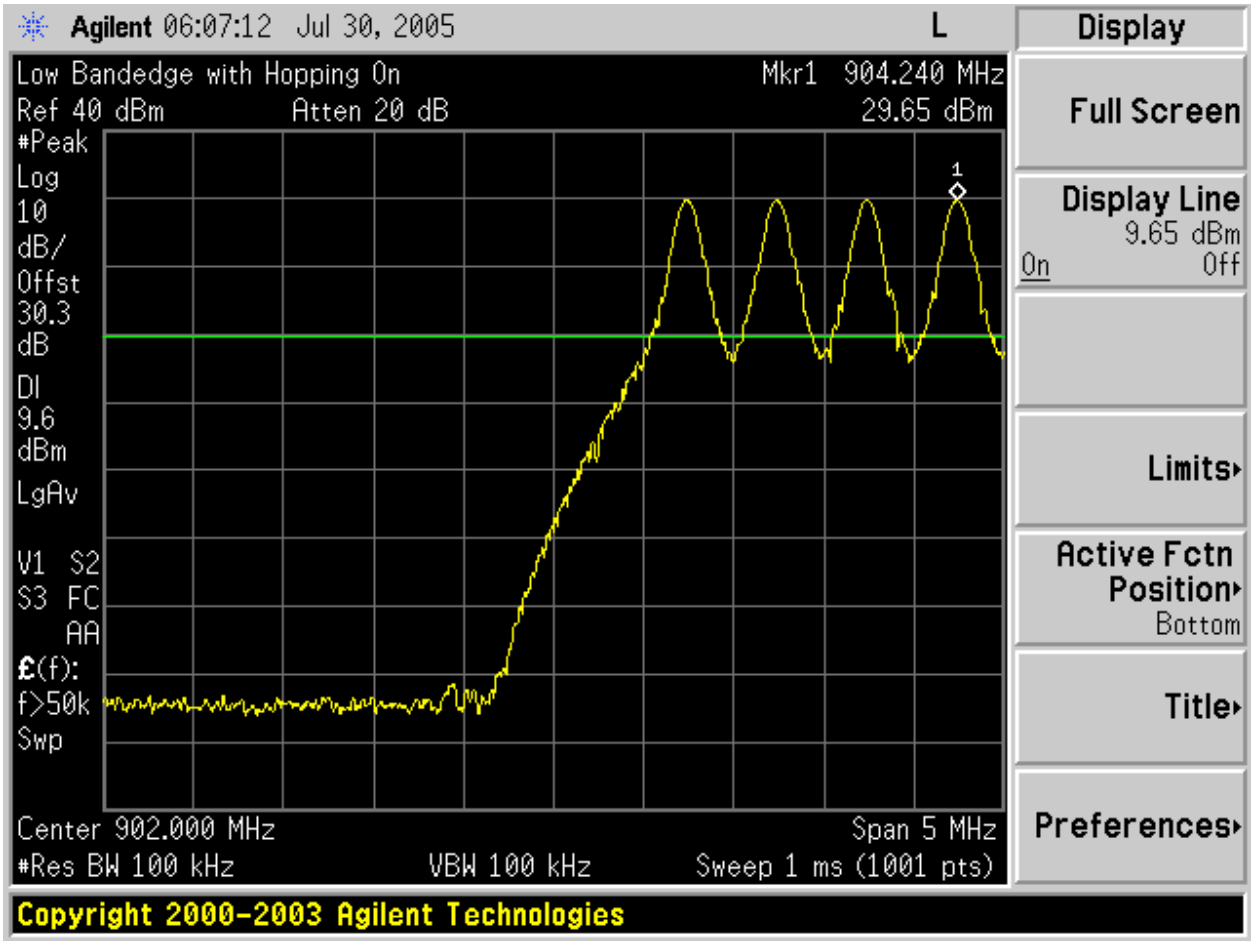
SPURIOUS EMISSIONS, HIGH CHANNEL MODE 1800



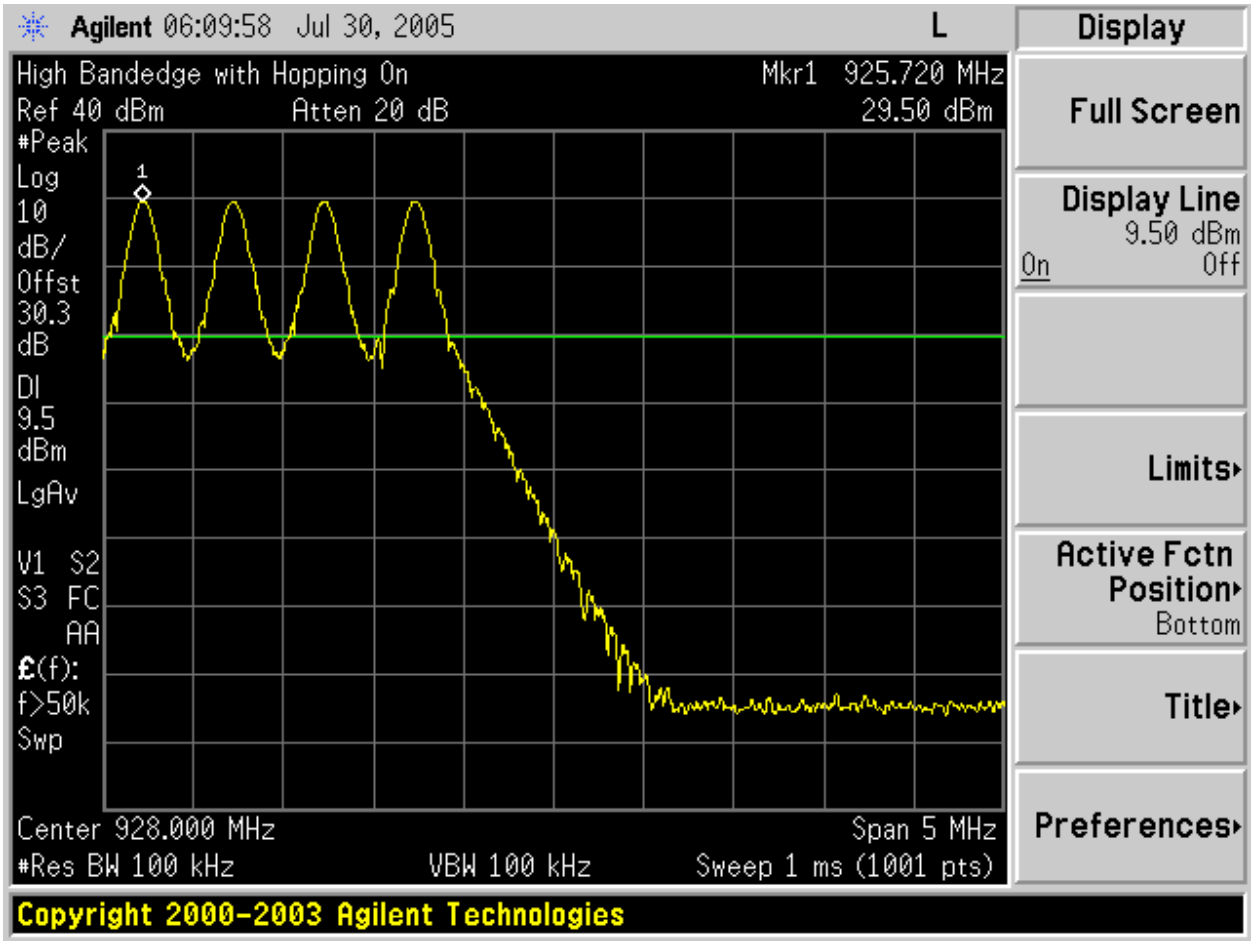
SPURIOUS EMISSIONS, HIGH CHANNEL MODE 1800



HOPPING FUNCTION ON, MODE 1800 LOW CHANNEL



HOPPING FUNCTION ON, MODE 1800 HIGH CHANNEL



4.4. RADIATED EMISSIONS

4.4.1. TRANSMITTER RADIATED SPURIOUS EMISSIONS

LIMITS

§15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

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

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

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

§15.209 (a) Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
30 - 88	100 **	3
88 - 216	150 **	3
216 - 960	200 **	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

§15.209 (b) In the emission table above, the tighter limit applies at the band edges.

TEST PROCEDURE

The EUT is placed on a non-conducting table 80 cm above the ground plane. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.4. The EUT is set to transmit in a continuous mode.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in the 2.4 GHz band.

The spectrum from 30 MHz to 40 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each 5 GHz band.

The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

For each frequency investigated, the EUT was cycled through Class 0, Class 1, and Mode 1800 modulations. Worst case emission for each case was for Mode 1800, data reported below.

4.4.2. TRANSMITTER RADIATED EMISSIONS ABOVE 1 GHZ HARMONICS AND SPURIOUS EMISSIONS

08/05/05 **High Frequency Measurement**
Compliance Certification Services, Morgan Hill Open Field Site

Test Engr:William Zhuang
Project #:05U3437
Company:WJ Communications
EUT Descrip.:902MHz-928MHz RFID Reader
EUT M/N:SR2200, FCC Regular Unit
Test Target:FCC 15.247
Mode Oper:Tx on with Panel Antenna

f	Measurement Frequency	Amp	Preamp Gain	Avg Lim	Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters	Pk Lim	Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m	Avg Mar	Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field Strength	Pk Mar	Margin vs. Peak Limit
CL	Cable Loss	HPF	High Pass Filter		

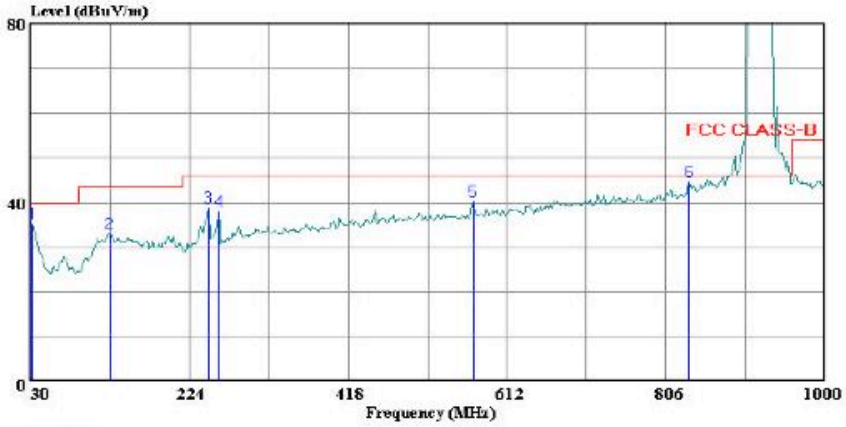
f GHz	Dist (m)	Read Pk dBuV	Read Avg. dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes (V/H)
High Ch. 927.25MHz, 30dBm															
2.782	3.0	56.1	50.8	29.5	2.4	-38.8	0.0	0.6	49.8	44.4	74.0	54.0	-24.2	-9.6	V
3.709	3.0	54.7	50.3	32.0	2.8	-38.3	0.0	0.6	51.7	47.3	74.0	54.0	-22.3	-6.7	V
4.636	3.0	56.0	52.9	33.5	3.1	-38.0	0.0	0.6	55.2	52.1	74.0	54.0	-18.8	-1.9	V
5.564	3.0	47.6	40.9	34.4	3.6	-38.0	0.0	0.5	48.0	41.3	74.0	54.0	-26.0	-12.7	V
6.491	3.0	49.3	45.0	34.6	3.8	-37.7	0.0	0.5	50.5	46.2	74.0	54.0	-23.5	-7.8	V
7.418	3.0	44.2	34.3	35.6	4.0	-36.8	0.0	0.6	47.6	37.7	74.0	54.0	-26.4	-16.3	V
2.782	3.0	60.1	54.9	29.5	2.4	-38.8	0.0	0.6	53.7	48.5	74.0	54.0	-20.3	-5.5	H
3.709	3.0	51.6	47.1	32.0	2.8	-38.3	0.0	0.6	48.6	44.2	74.0	54.0	-25.4	-9.8	H
4.636	3.0	56.5	54.6	33.5	3.1	-38.0	0.0	0.6	55.7	53.8	74.0	54.0	-18.3	-0.2	H
5.564	3.0	45.4	35.8	34.4	3.6	-38.0	0.0	0.5	45.8	36.2	74.0	54.0	-28.2	-17.8	H
6.491	3.0	47.5	40.1	34.6	3.8	-37.7	0.0	0.5	48.7	41.3	74.0	54.0	-25.3	-12.7	H
7.418	3.0	43.6	31.3	35.6	4.0	-36.8	0.0	0.6	47.0	34.8	74.0	54.0	-27.0	-19.2	H
Low ch. 902.75 MHz															
2.708	3.0	56.6	47.9	29.3	2.3	-38.8	0.0	0.6	49.9	41.2	74.0	54.0	-24.1	-12.8	V
3.611	3.0	54.2	51.4	31.8	2.7	-38.4	0.0	0.6	51.0	48.1	74.0	54.0	-23.0	-5.9	V
4.514	3.0	58.3	53.9	33.4	3.1	-38.0	0.0	0.6	57.3	52.9	74.0	54.0	-16.7	-1.1	V
5.417	3.0	46.4	37.9	34.3	3.5	-38.0	0.0	0.5	46.7	38.2	74.0	54.0	-27.3	-15.8	V
6.319	3.0	50.1	45.2	34.5	3.8	-37.9	0.0	0.5	50.9	46.1	74.0	54.0	-23.1	-7.9	V
7.222	3.0	46.4	39.0	35.4	3.9	-37.0	0.0	0.6	49.3	41.9	74.0	54.0	-24.7	-12.1	V
2.708	3.0	51.7	45.6	29.3	2.3	-38.8	0.0	0.6	45.1	39.0	74.0	54.0	-28.9	-15.0	H
3.611	3.0	50.0	45.8	31.8	2.7	-38.4	0.0	0.6	46.7	42.5	74.0	54.0	-27.3	-11.5	H
4.514	3.0	56.7	54.8	33.4	3.1	-38.0	0.0	0.6	55.7	53.8	74.0	54.0	-18.3	-0.2	H
5.417	3.0	45.7	36.1	34.3	3.5	-38.0	0.0	0.5	46.0	36.4	74.0	54.0	-28.0	-17.6	H
6.319	3.0	50.5	45.7	34.5	3.8	-37.9	0.0	0.5	51.3	46.6	74.0	54.0	-22.7	-7.4	H
7.222	3.0	44.2	33.6	35.4	3.9	-37.0	0.0	0.6	47.1	36.5	74.0	54.0	-26.9	-17.5	H
Mid ch 9114.25 MHZ															
2.743	3.0	51.9	47.7	29.4	2.3	-38.8	0.0	0.6	45.4	41.2	74	54	-28.6	-12.8	H
3.661	3.0	51.0	46.2	31.9	2.7	-38.3	0.0	0.6	47.9	43.1	74.0	54.0	-26.1	-10.9	H
4.576	3.0	53.9	48.8	33.4	3.1	-38.0	0.0	0.6	53.1	48.0	74.0	54.0	-20.9	-6.0	H
5.492	3.0	44.5	36.1	34.4	3.5	-38.0	0.0	0.5	44.9	36.5	74.0	54.0	-29.1	-17.5	H
6.407	3.0	50.3	47.3	34.6	3.8	-37.8	0.0	0.5	51.4	48.4	74.0	54.0	-22.6	-5.6	H
2.743	3.0	54.3	47.5	29.4	2.3	-38.8	0.0	0.6	47.7	40.9	74	54	-26.3	-13.1	V
3.661	3.0	51.8	48.3	31.9	2.7	-38.3	0.0	0.6	48.7	45.2	74.0	54.0	-25.3	-8.8	V
4.576	3.0	54.7	52.6	33.4	3.1	-38.0	0.0	0.6	53.8	51.7	74.0	54.0	-20.2	-2.3	V
5.492	3.0	46.1	36.8	34.4	3.5	-38.0	0.0	0.5	46.5	37.3	74.0	54.0	-27.5	-16.7	V
6.407	3.0	48.6	42.1	34.6	3.8	-37.8	0.0	0.5	49.6	43.1	74.0	54.0	-24.4	-10.9	V
7.322	3.0	45.6	38.8	35.5	3.9	-36.9	0.0	0.6	48.8	42.0	74.0	54.0	-25.2	-12.0	V

1. WORST-CASE RADIATED EMISSIONS BELOW 1 GHz

SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION, HORIZONTAL)

561F Monterey Road
Morgan Hill, CA 95037
Tel: (408) 463-0888
Fax: (408) 463-0885

Data#: 13 File#: EMI.EMI Date: 07-27-2005 Time: 16:46:09



(Audix ATC)

Trace: 12 Ref Trace:

Condition: FCC CLASS-B HORIZONTAL
Test Operator: : William Zhuang
Project #: : 05U3437
Company: : TomCokenias/WJ Communications
EUT: : 902MHz-928MHz RFID Reader
Model No. : SR2200 FCC backup
Configuration : EUT, w/Panel Antenna
Target of Test : FCC Class B
Mode ofOperation: Tx on, Hopping

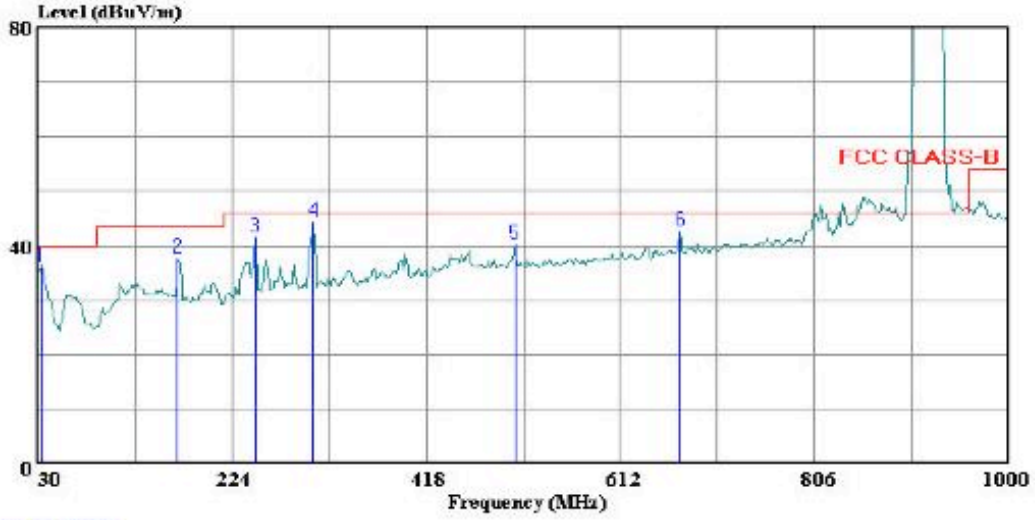
Page: 1

	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1	31.940	15.14	19.94	35.08	40.00	-4.92	Peak
2	127.000	17.61	15.22	32.84	43.50	-10.66	Peak
3	247.280	24.92	13.75	38.66	46.00	-7.34	Peak
4	259.890	23.57	14.25	37.82	46.00	-8.18	Peak
5	570.290	19.07	21.14	40.21	46.00	-5.79	Peak
6	834.130	19.54	24.99	44.53	46.00	-1.47	Peak

SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION, VERTICAL)

561F Monterey Road
Morgan Hill, CA 95037
Tel: (408) 463-0888
Fax: (408) 463-0885

Data#: 11 File#: EMI.EMI Date: 07-27-2005 Time: 16:40:33



(Audix ATC)

Trace: 10 Ref Trace:

Condition: FCC CLASS-B VERTICAL
Test Operator: : William Zhuang
Project #: : 05U3437
Company: : TomCokenias/WJ Communications
EUT: : 902MHz-928MHz RFID Reader
Model No. : SR2200 FCC backup
Configuration : EUT, w/Panel Antenna
Target of Test : FCC Class B
Mode ofOperation: Tx on, Hopping

Page: 1

	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1	32.910	16.03	19.94	35.96	40.00	-4.04	Peak
2	169.680	24.30	13.40	37.70	43.50	-5.80	Peak
3	247.280	27.88	13.75	41.62	46.00	-4.38	Peak
4	305.480	28.48	15.80	44.28	46.00	-1.72	Peak
5	507.240	19.80	20.31	40.11	46.00	-5.89	Peak
6	672.140	20.00	22.68	42.68	46.00	-3.32	Peak

4.5. 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.

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

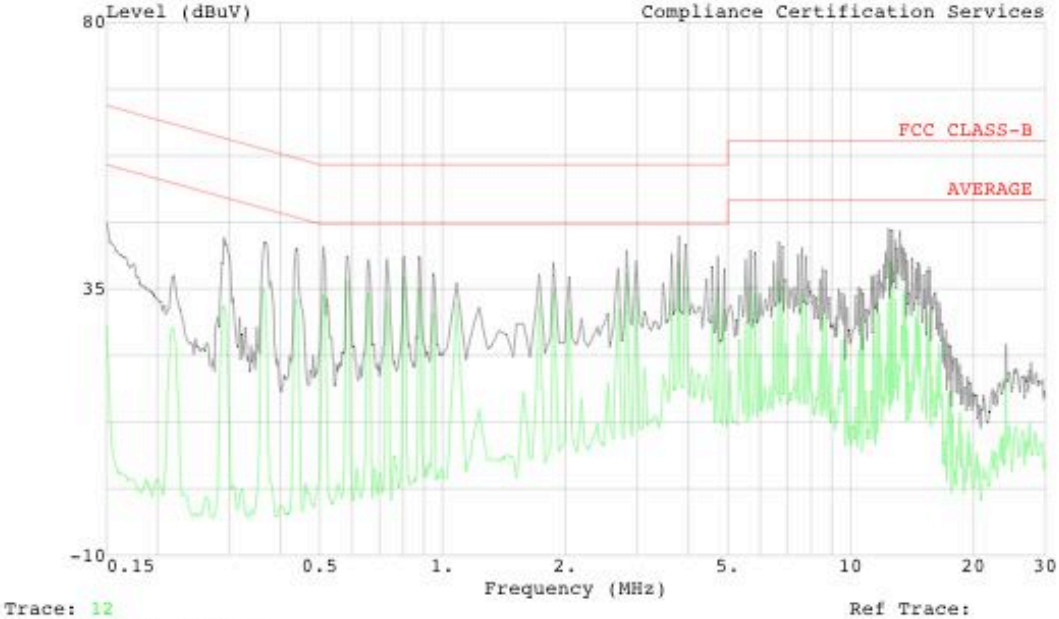
RESULTS

No non-compliance noted:

LINE 1 RESULTS

COMPLIANCE Engineering Services, Inc.

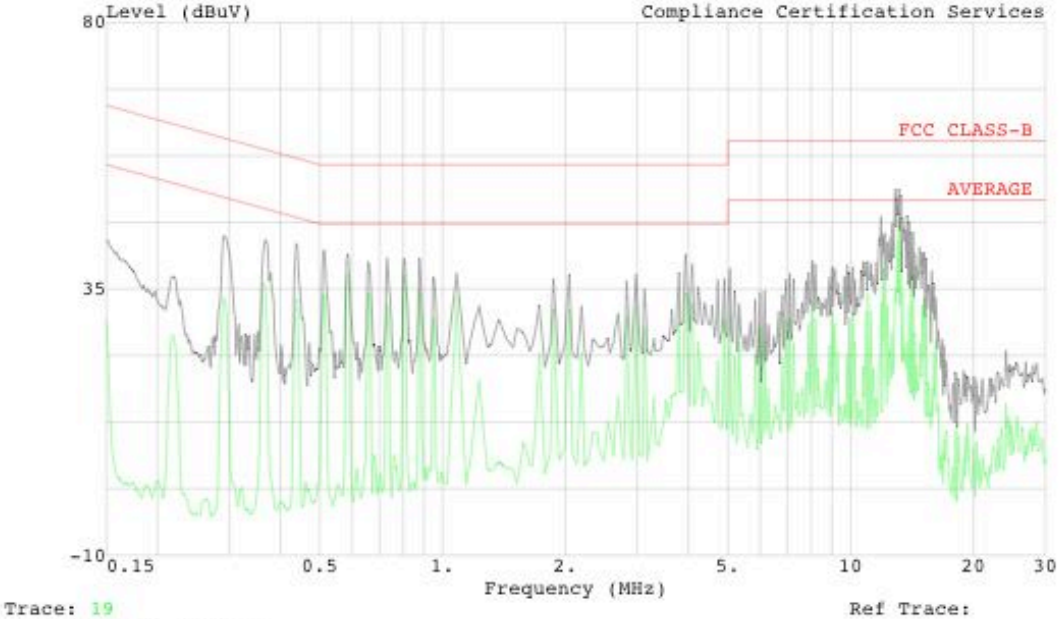
561F Monterey Road
Morgan Hill, CA 95037 USA
Tel: (408) 463-0885
Fax: (408) 463-0888



Trace: 12 Ref Trace:
Project No. : 05U3555
Test Engr : David Garcia
Company : WJ Communications Inc.
EUT : ISM Band, RFID Reader
Model No. : SX2201
Test Config.: EUT, Antenna, laptop
Mode of Op. : Tx low channel (910.6 MHz)
Type of Test: FCC CLASS B
Power Mains : 115 VAC, 60 Hz
: L1: Peak (Black) ; Avg (Green)

LINE 2 RESULTS

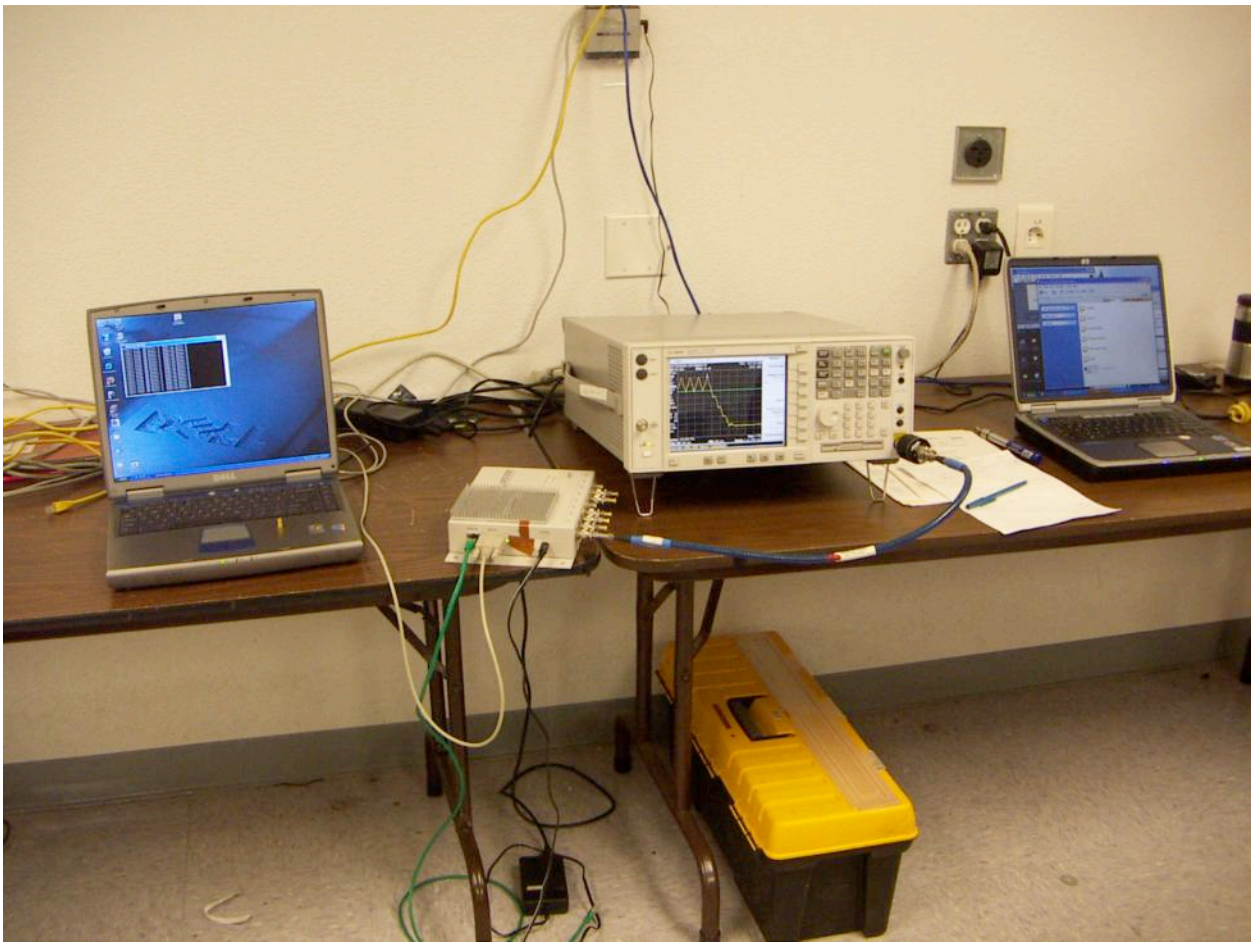
561F Monterey Road
Morgan Hill, CA 95037 USA
Tel: (408) 463-0885
Fax: (408) 463-0888



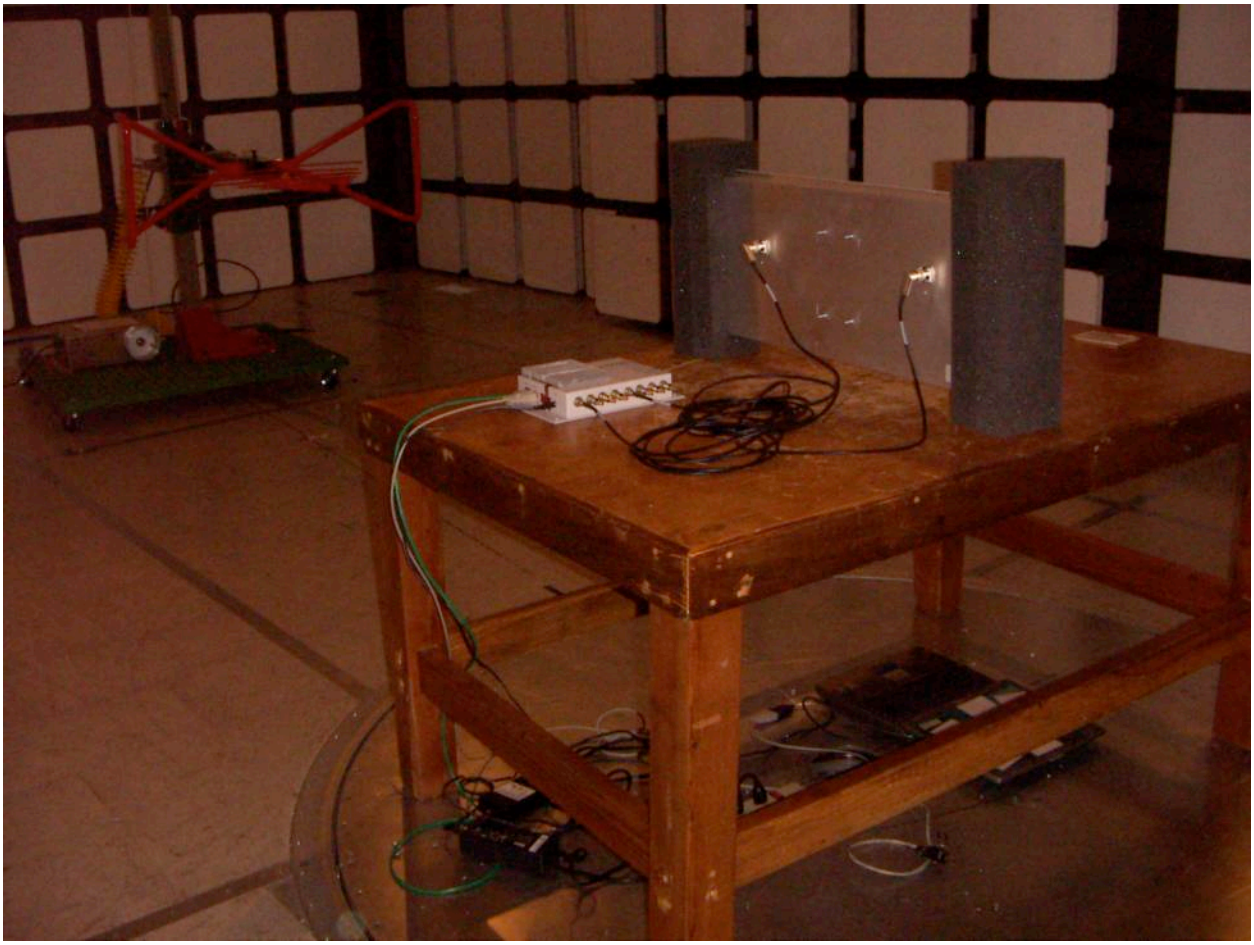
Trace: 19 Ref Trace:
Project No. : 05U3555
Test Engr : David Garcia
Company : WJ Communications Inc.
EUT : ISM Band, RFID Reader
Model No. : SX2201
Test Config.: EUT, Antenna, laptop
Mode of Op. : Tx low channel (910.6 MHz)
Type of Test: FCC CLASS B
Power Mains : 115 VAC, 60 Hz
: L2: Peak (Black) ; Avg (Green)

5. SETUP PHOTOS

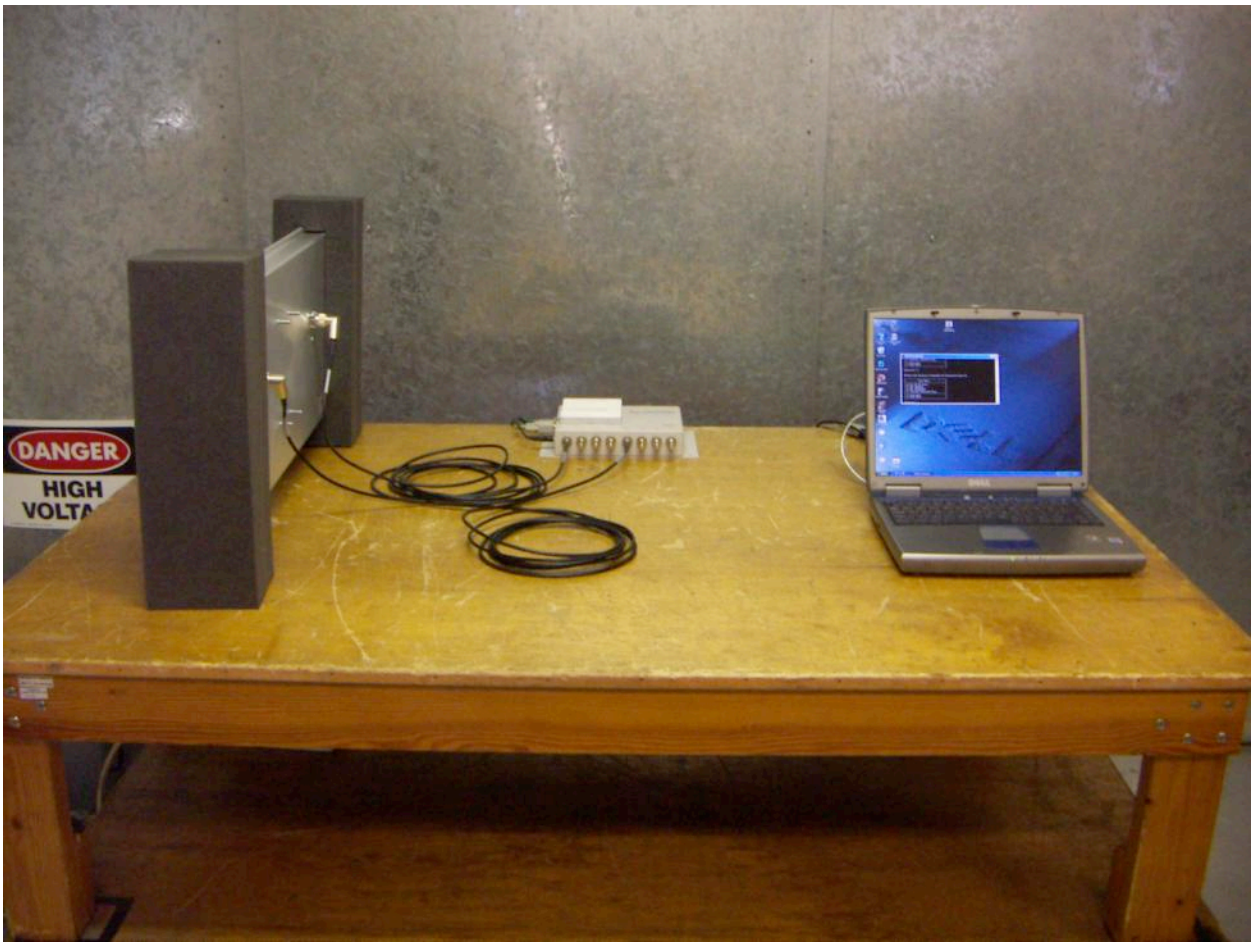
ANTENNA PORT CONDUCTED RF MEASUREMENT SETUP



RADIATED RF MEASUREMENT SETUP



POWERLINE CONDUCTED EMISSIONS MEASUREMENT SETUP



END OF REPORT