

**FCC CFR47 PART 15 SUBPART C**

**Test Report**

**902-928 MHZ RFID READER**

**Model Numbers: SR320**

**FCC ID: NTTSR320**

**Report Number: 06PR039FCC Rev 1.1**

**Issue Date: 19 June 2006**

Prepared for

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Prepared by

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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:** SR320  
**FCC ID:** NTTSR320

**DATA ALSO APPLIES TO :** N/A

**DATE TESTED:** 1 June – 2, 19 June 2006

Testing performed by

Compliance Certification Services  
561F Monterey Road  
Morgan Hill CA 95037

Plots with number of channels, channel separation, and bandedge with hopping function on provided by WJ.



19 June 2006

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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 1 GEN 2 and Class 3. Passive RF ID tags are manufactured to respond to either CLASS 1 GEN 2 or Class 3 reader interrogation.

Both modes were tested.

### 3.2. MAXIMUM OUTPUT POWER

#### CLASS 1 GEN 2

Channel	Frequency (MHz)	Power (dBm)	Power (mW)
Low	902.75	28.51	709.6
Middle	915.25	28.39	690.2
High	927.25	28.50	707.9

#### CLASS 3

Channel	Frequency (MHz)	Power (dBm)	Power (mW)
Low	902.75	28.51	709.6
Middle	915.25	28.55	716.1
High	927.25	28.58	721.1

### **3.3. DESCRIPTION OF AVAILABLE ANTENNAS**

The radio utilizes a circularly polarized antenna, with a maximum published gain of 6.75 dBi. The antenna cable is supplied by WJ and has a minimum loss of 1.65 dB in the 902-928 MHz band.

All antenna port conducted tests were performed with the WJ supplied antenna cable between the EUT antenna port and the spectrum analyzer.

### **3.4. SOFTWARE AND FIRMWARE**

The firmware used was ' sr320\_1\_7 ', and the software for the testing was the ' rftest ' program.

### **3.5. WORST-CASE CONFIGURATION AND MODE**

For antenna conducted emissions, CLASS 1 GEN 2 and CLASS 3 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	Sony Vaio	PCG-Z505HE	N/A	N/A
AC/DC ADAPTER	Sony	PCGA-AC19V1	N/A	N/A
AC/DC POWER SUPPLY	CUI	3A-501DN24	DTS240210UTC-P5PSZ	N/A

#### I/O CABLES

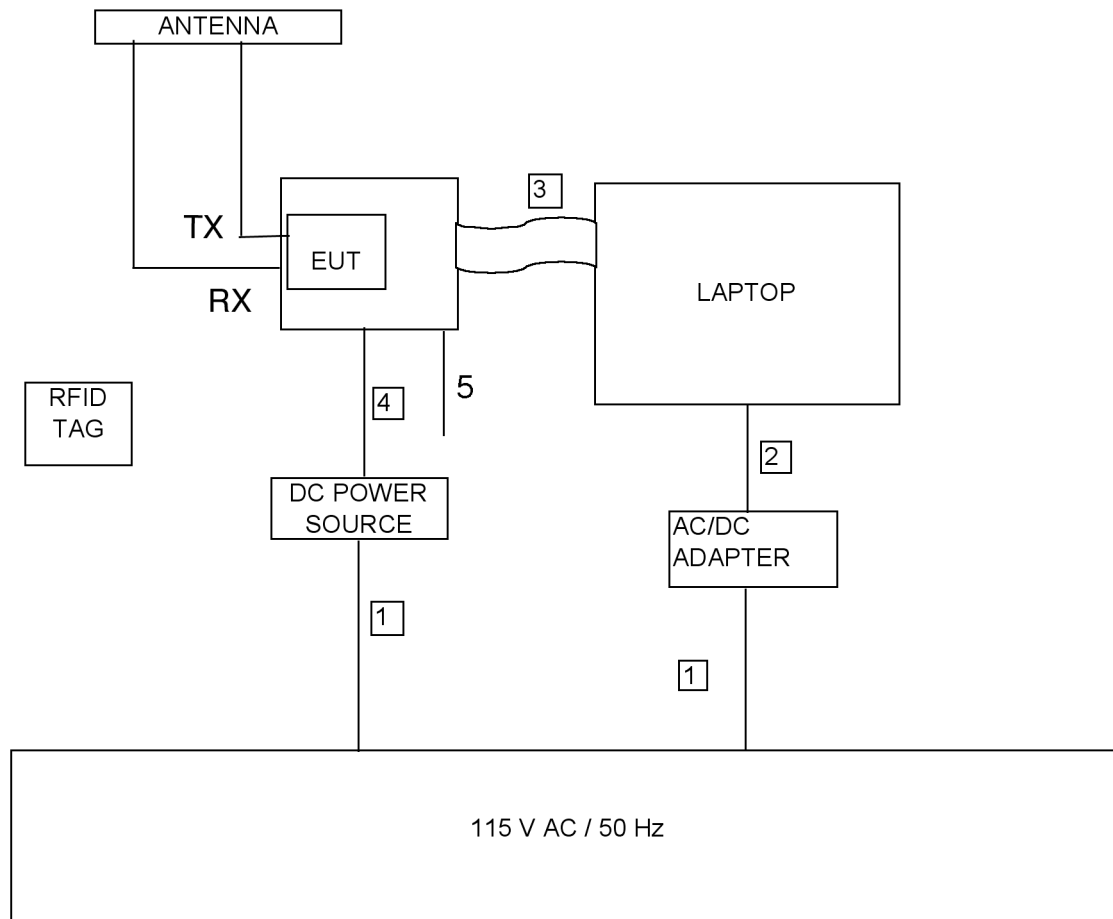
I/O CABLE LIST						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length	Remarks
1	AC	2	AC	Un-shielded	0.5 m	N/A
2	DC	1	DC	Un-shielded	1m	N/A
3	SERIAL	1	RS-232	Un-shielded	1m	N/A
4	DC	1	DC	Un-shielded	0.5m	N/A
5	I/O	1	multi pin	Shielded	1m	N/A

#### TEST SETUP

The EUT is a stationary RFID reader, which is connected to the Laptop (support equipment) via 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**

None.



## TEST AND MEASUREMENT EQUIPMENT

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

TEST EQUIPMENT LIST				
Name of Equipment	Manufacturer	Model No.	Serial No.	Due Date
EMI Receiver, 9 kHz ~ 2.9 GHz	Agilent / HP	8542E	3942A00286	2/4/07
RF Filter Section	Agilent / HP	85420E	3705A00256	2/4/07
Antenna, Bilog 30 MHz ~ 2 GHz	Sunol Sciences	JB1	A121003	9/3/06
Antenna, Horn 1 ~ 18 GHz	ETS	3117	29310	4/22/07
Preamplifier, 1 ~ 26 GHz	Miteq	NSP2600-SP	924342	9/2/06
Spectrum Analyzer, 26.5 GHz	Agilent / HP	8593EM	3710A00205	7/26/06
LISN, 10 kHz ~ 30 MHz	FCC	LISN-50/250-25-2	2023	8/30/06
LISN, 10 kHz ~ 30 MHz	Solar	8012-50-R-24-BNC	8379443	8/30/06
EMI Test Receiver	R & S	ESHS 20	827129/006	6/3/06
Spectrum Analyzer 3 Hz ~ 44 GHz	Agilent / HP	E4446A	US42510266	10/19/06
Peak / Average Power Sensor	Agilent	E9327A	US40440755	12/2/07
Peak Power Meter	Agilent / HP	E4416A	GB41291160	12/2/07
Spectrum Analyzer, 26.5 GHz	Agilent	E4407B	ITEM33478-86	2/13/07

## 4. LIMITS AND RESULTS

### 4.1. ANTENNA PORT CHANNEL TESTS FOR CLASS 1 GEN 2 MODULATION

#### 4.1.1. 20 dB BANDWIDTH

##### LIMIT

None; for reporting purposes only.

##### TEST PROCEDURE

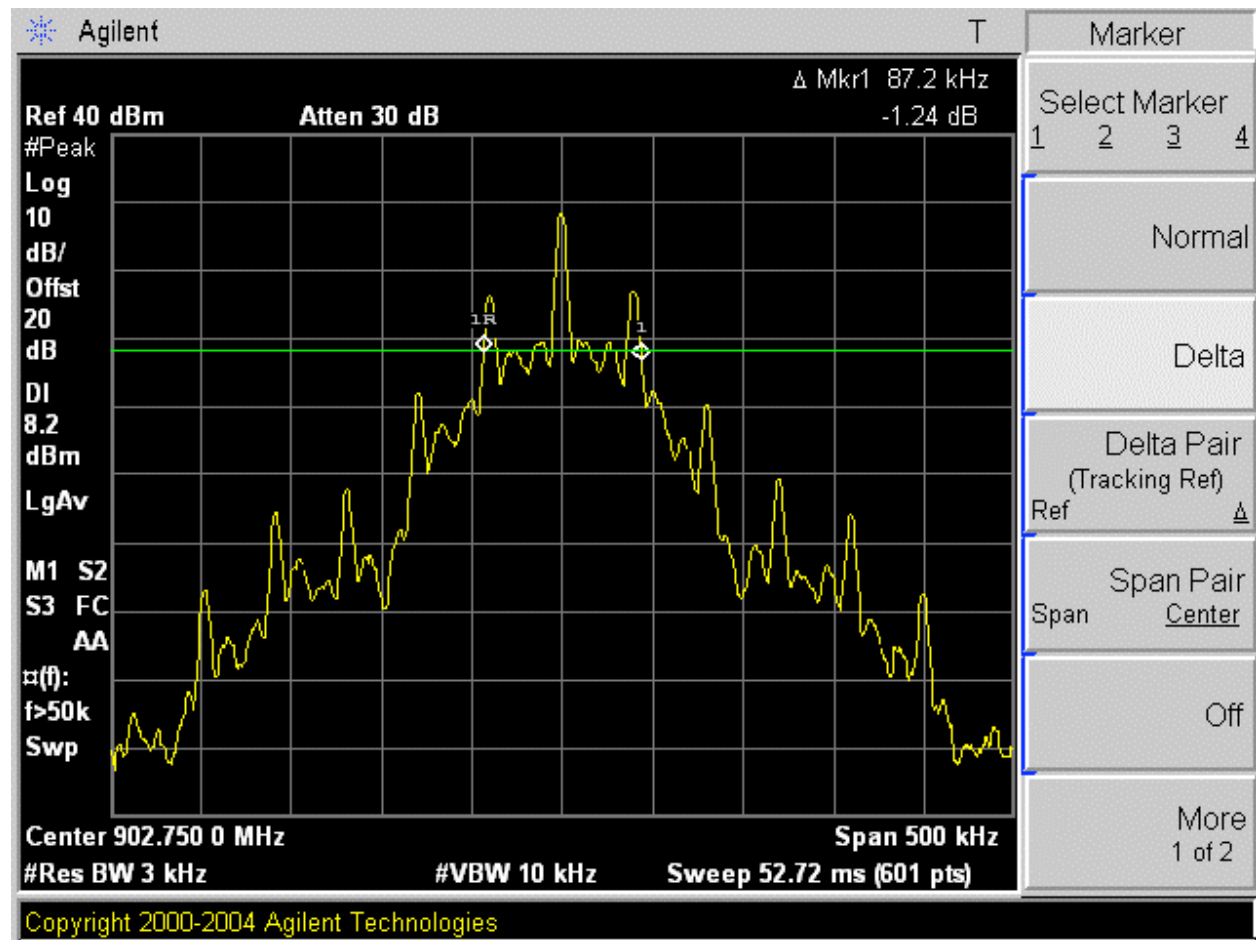
The transmitter output is connected to a spectrum analyzer. The RBW is set to approximately 3% of the 20 dB bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled.

##### RESULTS

No non-compliance noted:

Channel	Frequency (MHz)	20 dB Bandwidth (kHz)
Low	902.75	87.2
Middle	915.25	87.3
High	927.25	87.2

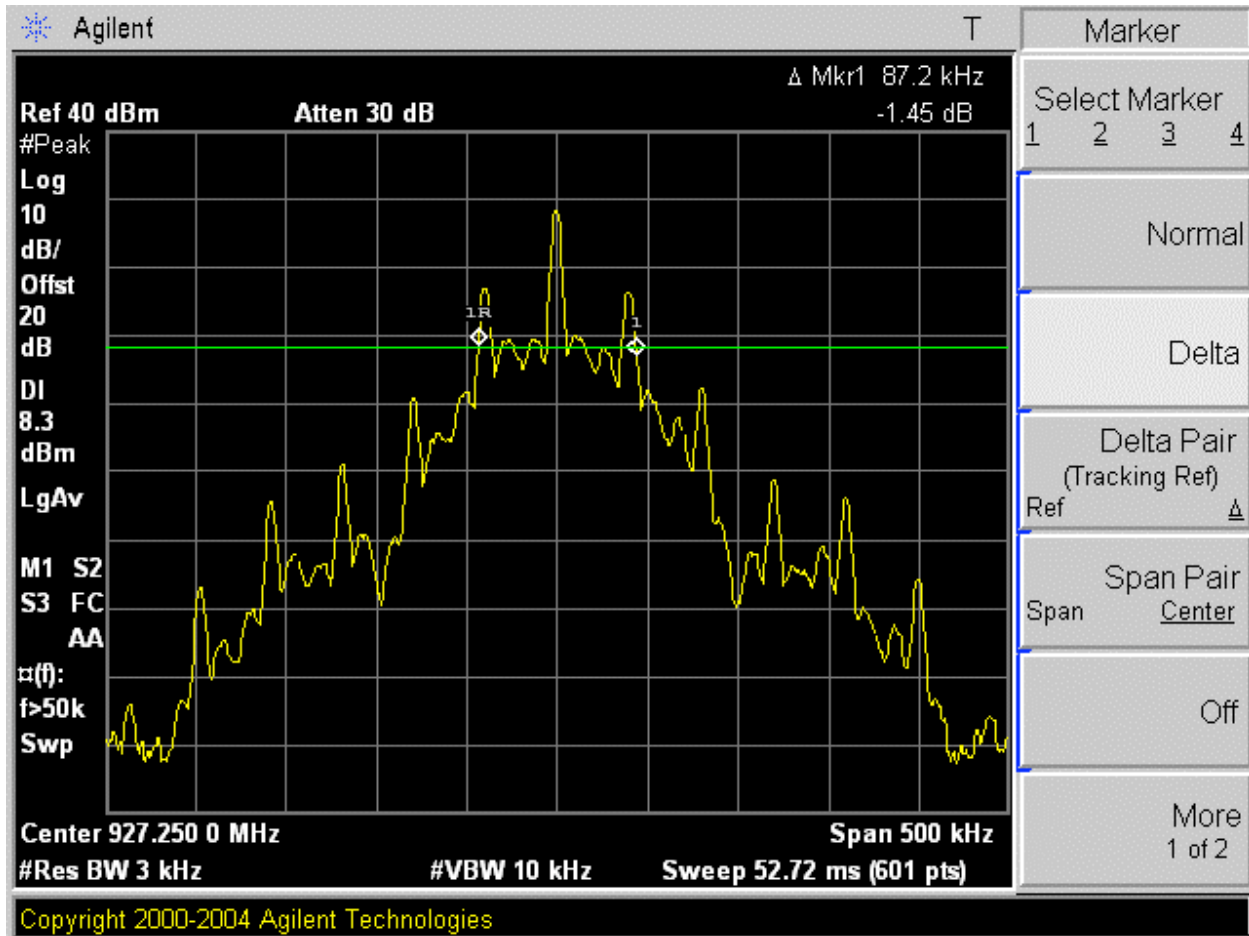
**20 dB BANDWIDTH LOW CHANNEL CLASS 1 GEN 2**



**20 dB BANDWIDTH MID CHANNEL CLASS 1 GEN 2**



**20 dB BANDWIDTH HIGH CHANNEL CLASS 1 GEN 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 hopping 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.

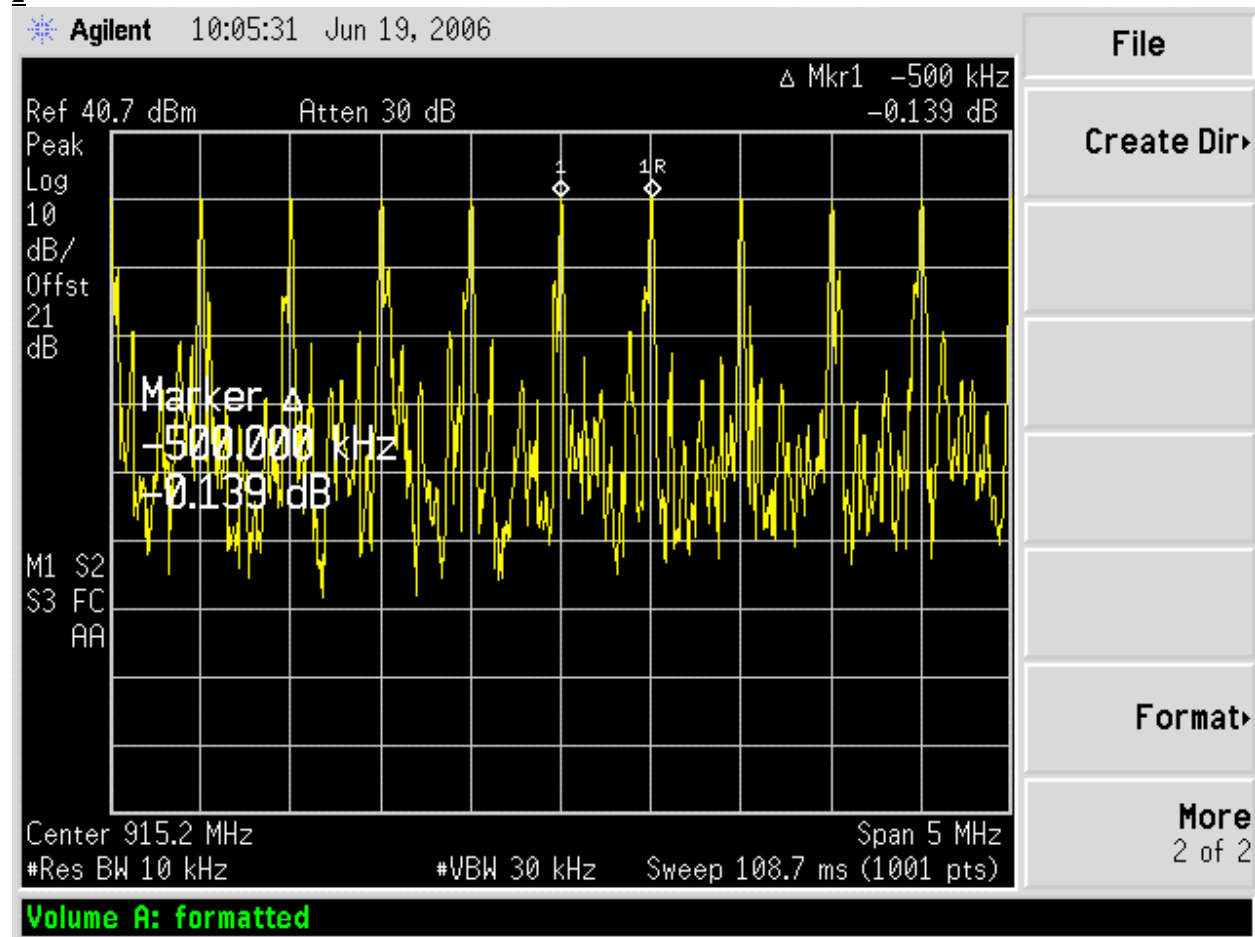
### **RESULTS**

No non-compliance noted:

The separation is 500KHz.

**HOPPING FREQUENCY SEPARATION CLASS 1 GEN**

2



#### **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.

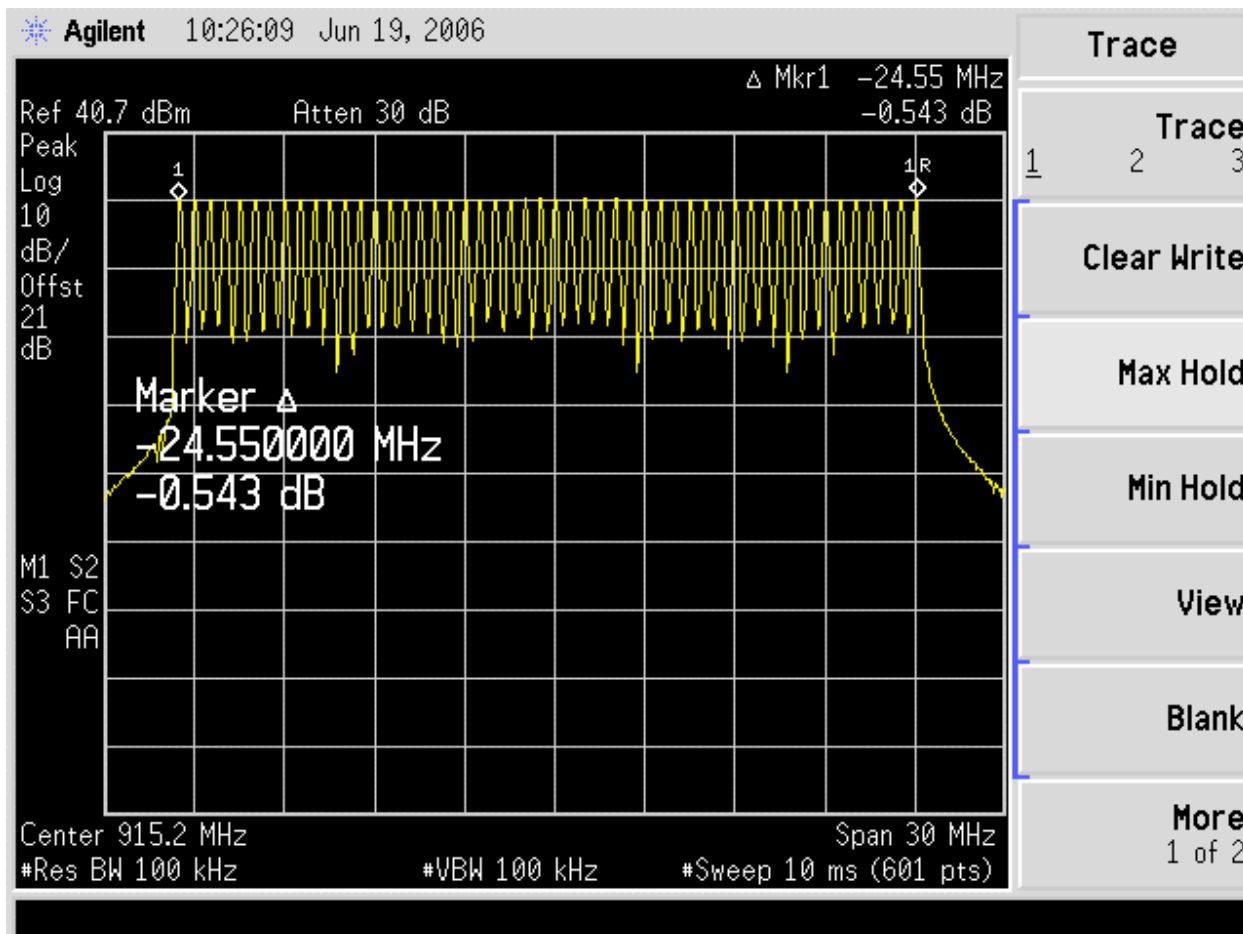
##### **RESULTS**

No non-compliance noted:

50 Channels observed.



**NUMBER OF HOPPING CHANNELS CLASS 1 GEN 2**



### **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.

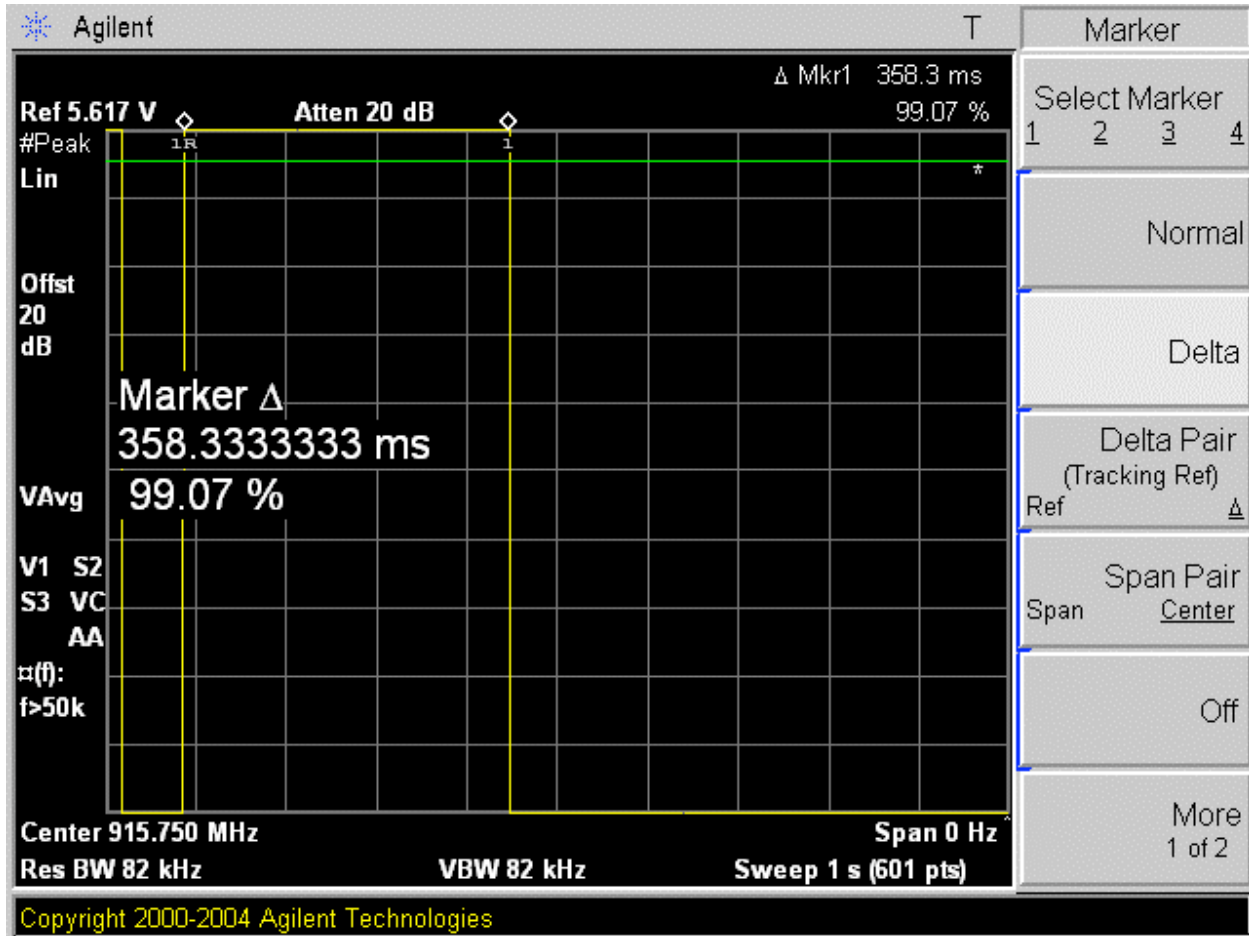
#### **RESULTS**

No non-compliance noted:

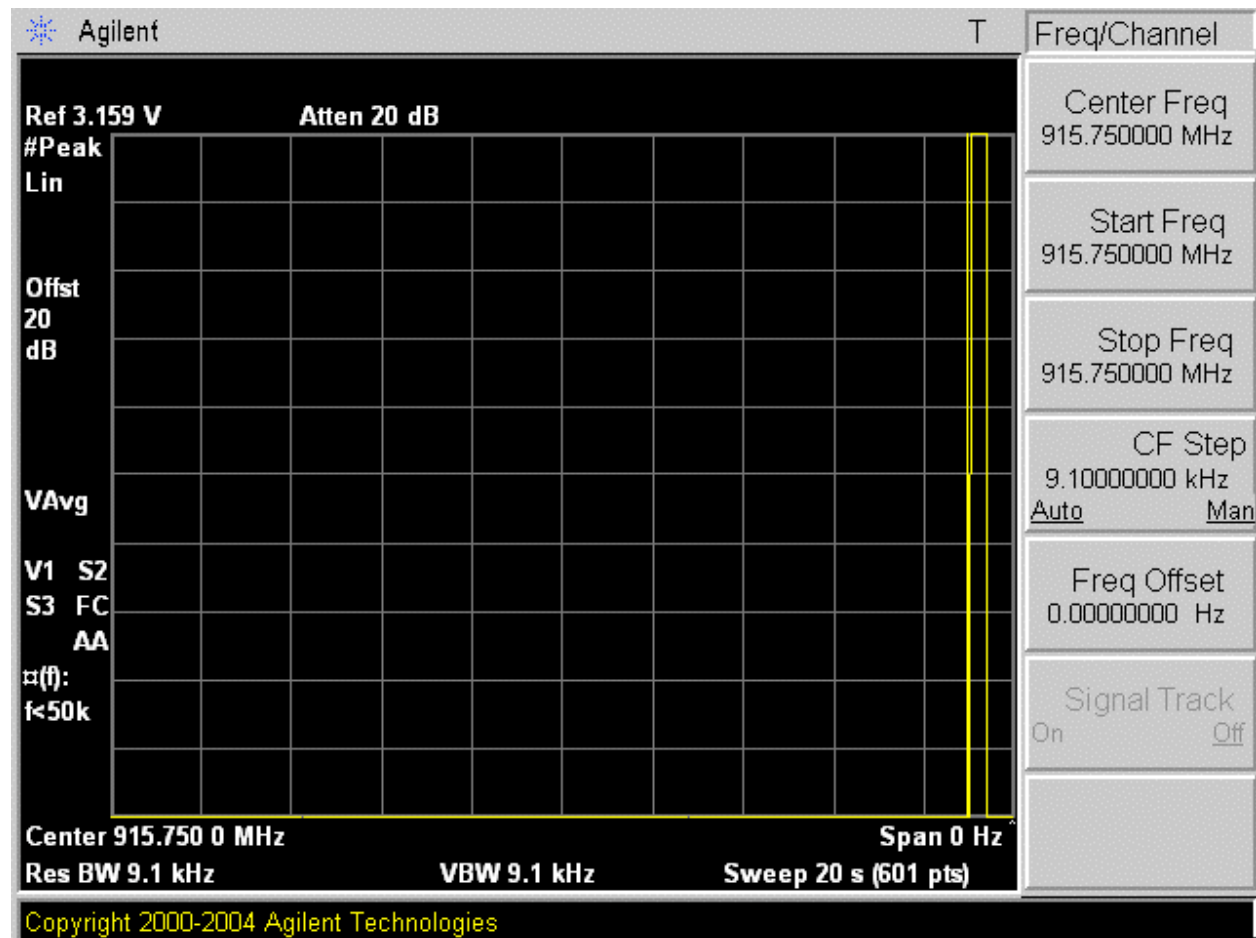
The system has 50 hopping frequencies. There is 1 pulse within the 20-second period. The on time for each pulse is 358.3ms.

Therefore, the average time of occupancy in the specified 20-second period is 358.3 sec.

**PULSE WIDTH CLASS 1 GEN 2**



NUMBER OF PULSES IN 20 SECOND OBSERVATION PERIOD CLASS 1 GEN 2



### **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 6.75 dBi, therefore the power limit is 29.25 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.

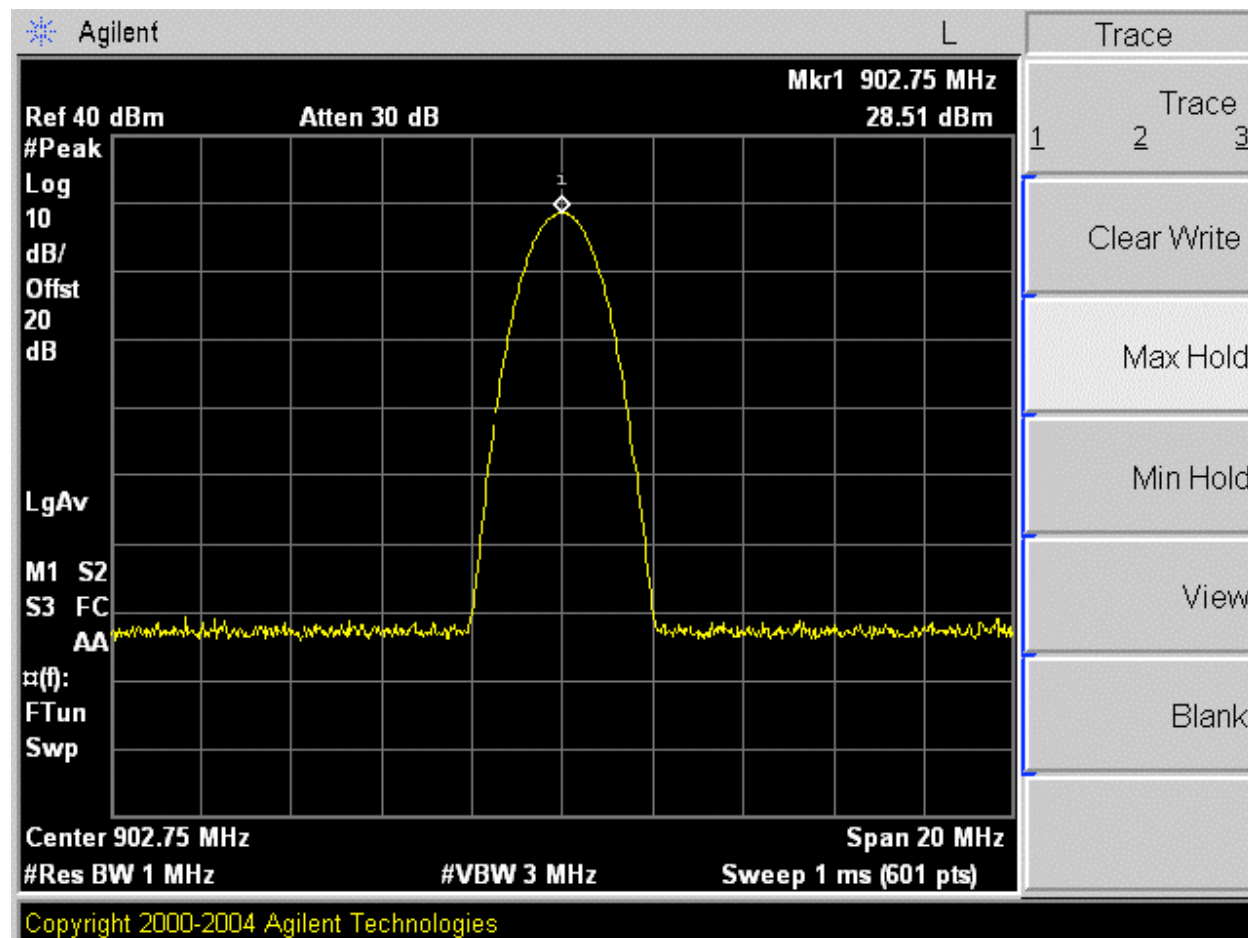
### **RESULTS**

No non-compliance noted:

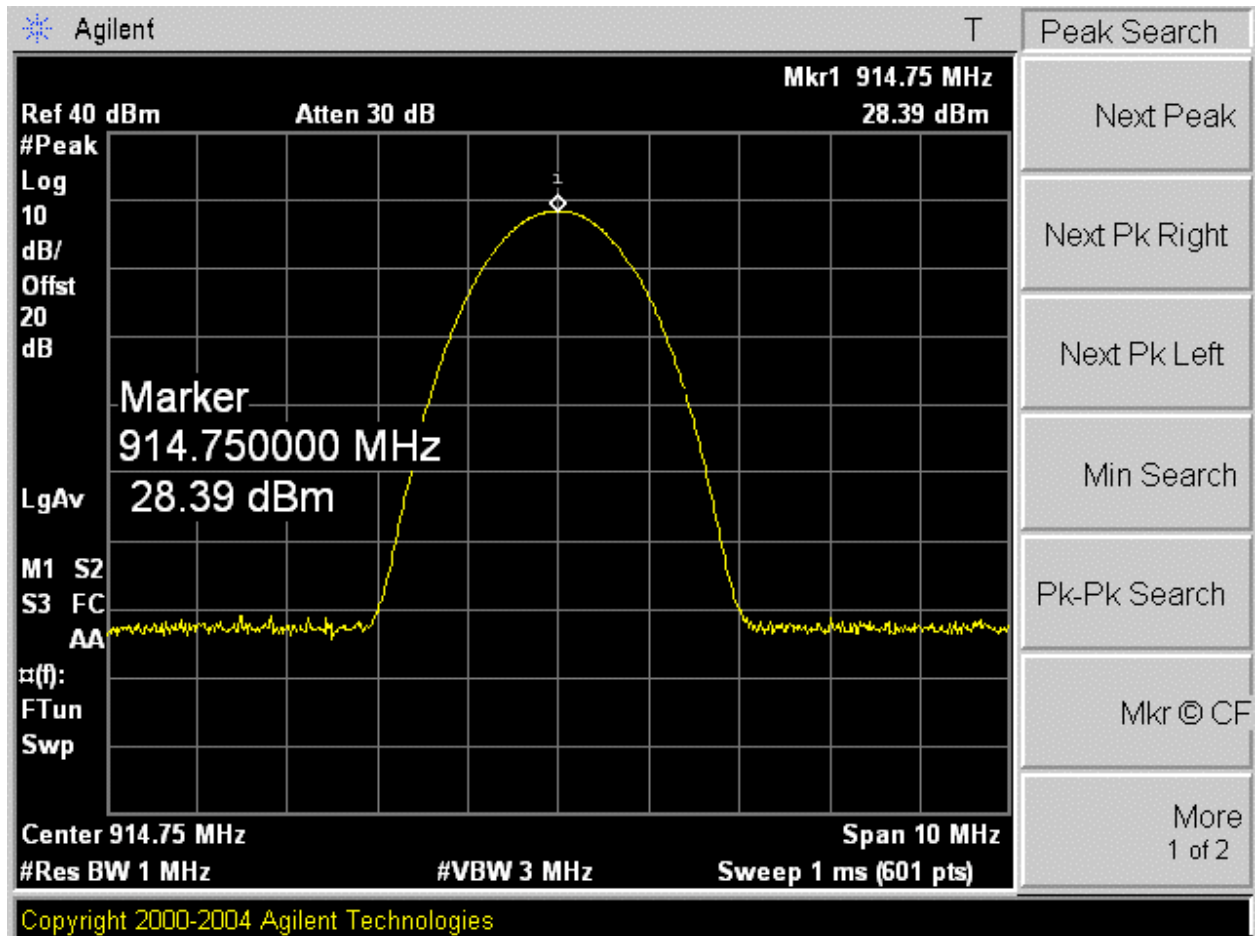
#### **CLASS 1 GEN 2**

<b>Channel</b>	<b>Frequency (MHz)</b>	<b>Power (dBm)</b>	<b>Power (mW)</b>
Low	902.75	28.51	709.6
Middle	915.25	28.39	690.2
High	927.25	28.50	707.9

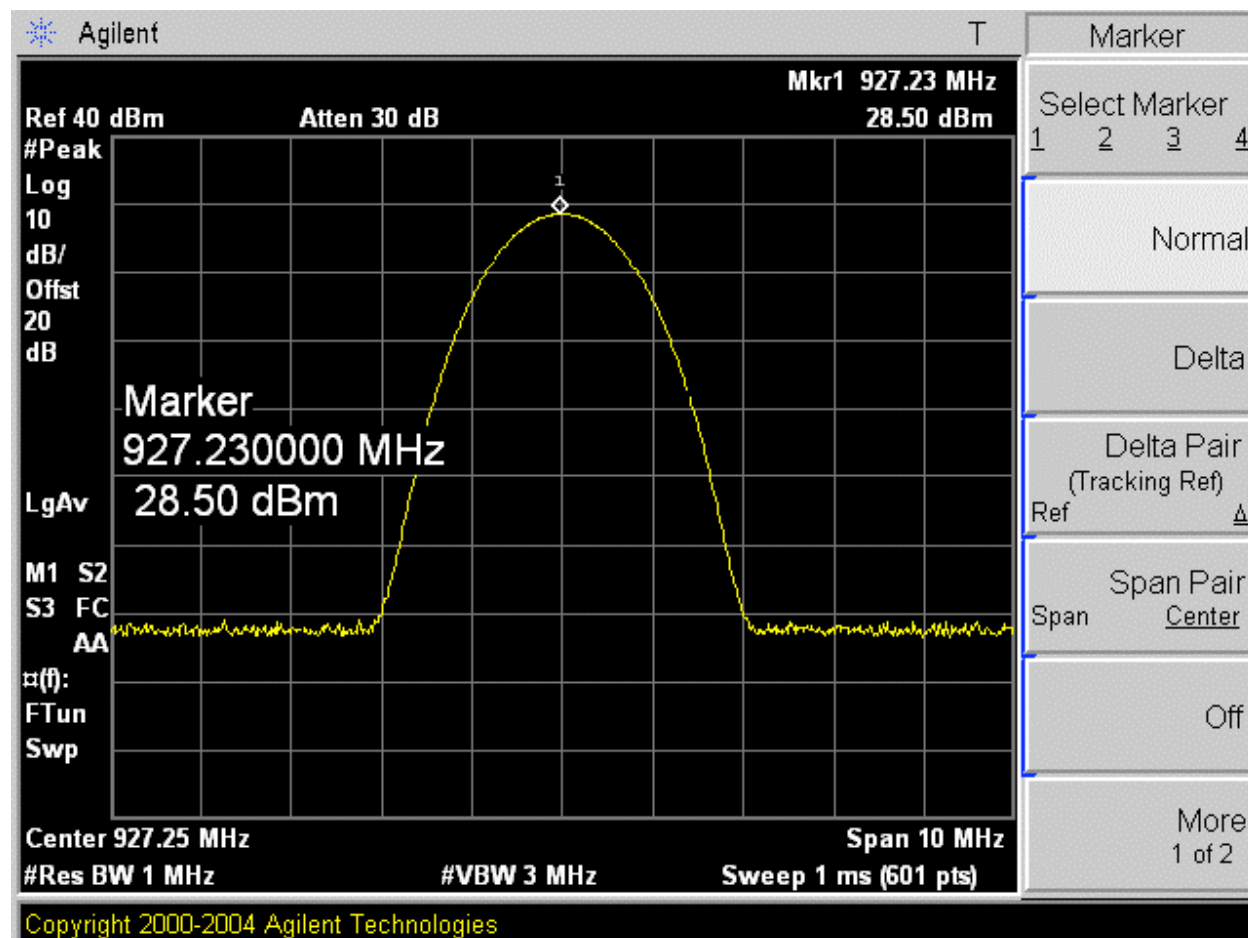
**OUTPUT POWER LOW CHANNEL CLASS 1 GEN 2**



OUTPUT POWER MID CHANNEL CLASS 1 GEN 2



**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 <sup>2</sup> )	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 <sup>2</sup> )	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 <sup>2</sup> )	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 <sup>2</sup> )	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:

$$P \text{ (mW)} = P \text{ (W)} / 1000 \text{ and}$$

$$d \text{ (cm)} = 100 * d \text{ (m)}$$

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<sup>2</sup>

Substituting the logarithmic form of power and gain using:

$$P \text{ (mW)} = 10^{(P \text{ (dBm)} / 10)} \text{ and}$$

$$G \text{ (numeric)} = 10^{(G \text{ (dBi)} / 10)}$$

yields

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

where

d = MPE distance in cm

P = Power in dBm

G = Antenna Gain in dBi

S = Power Density Limit in mW/cm<sup>2</sup>

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

### **LIMITS**

From §1.1310 Table 1 (B),  $S = 0.6 \text{ mW/cm}^2$

### **RESULTS**

No non-compliance noted:

<b>Power Density Limit (mW/cm<sup>2</sup>)</b>	<b>Output Power (dBm)</b>	<b>Antenna Gain (dBi)</b>	<b>MPE Distance (cm)</b>
0.6	28.51	6.75	21.09

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**

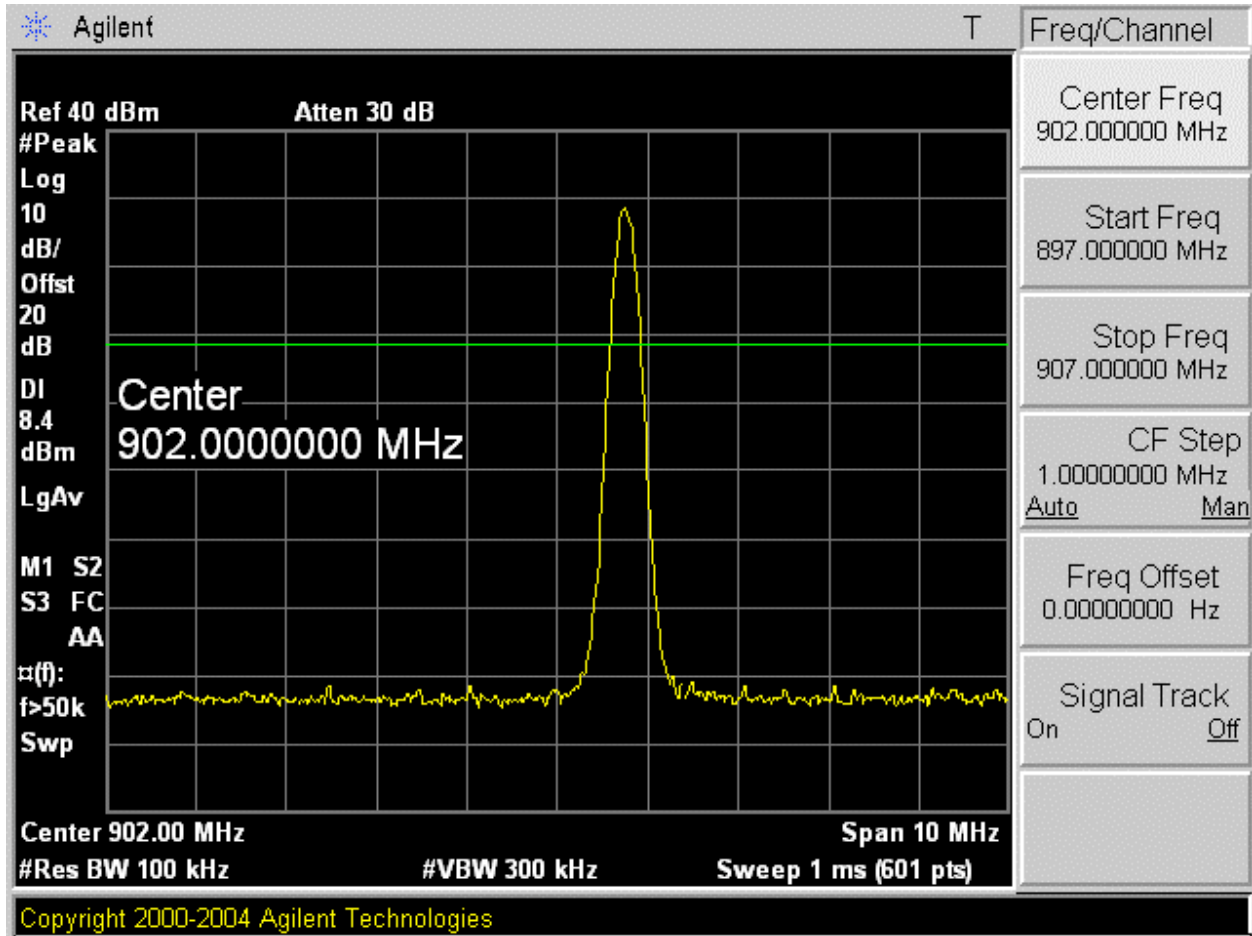
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 100 kHz.

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

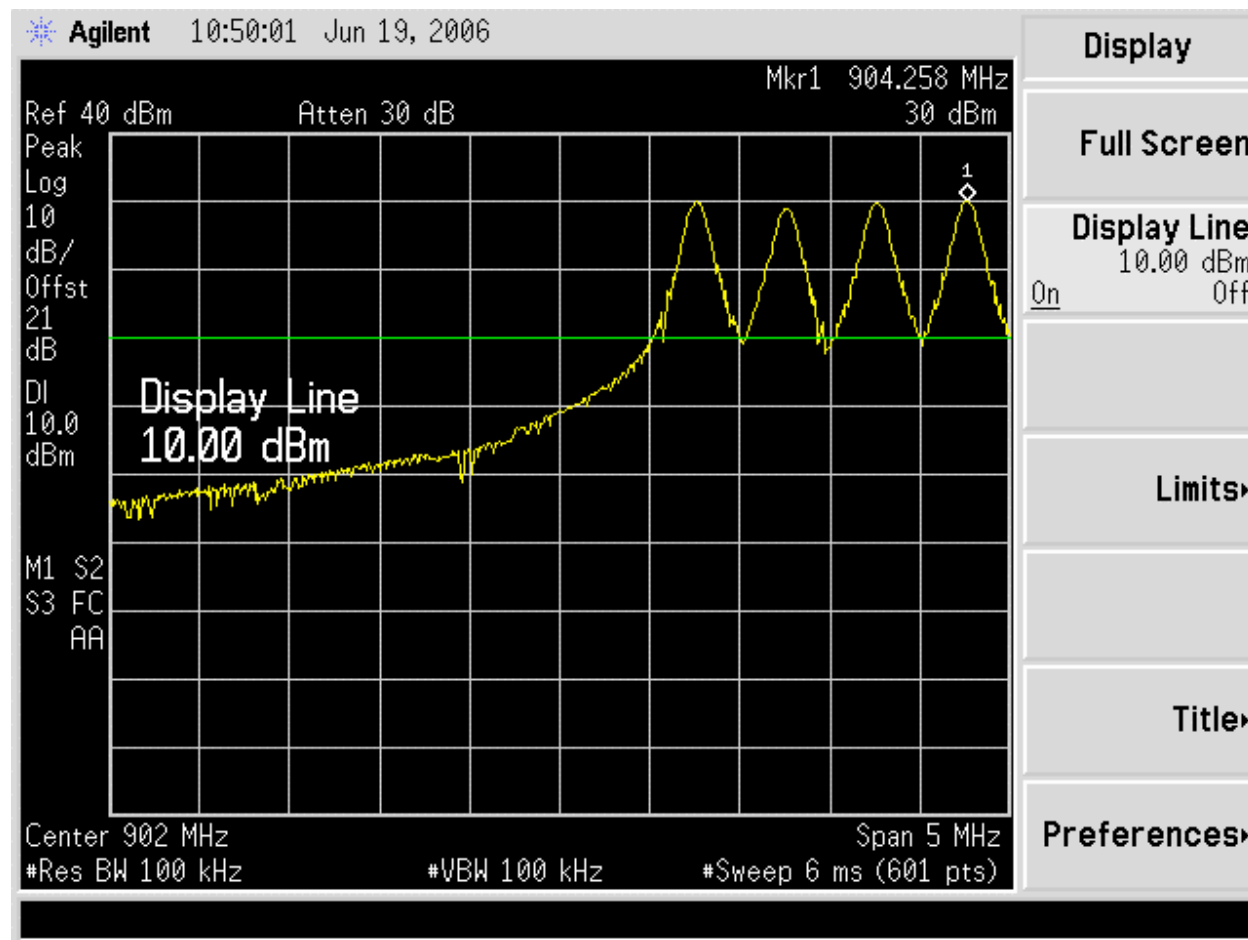
##### **RESULTS**

No non-compliance noted:

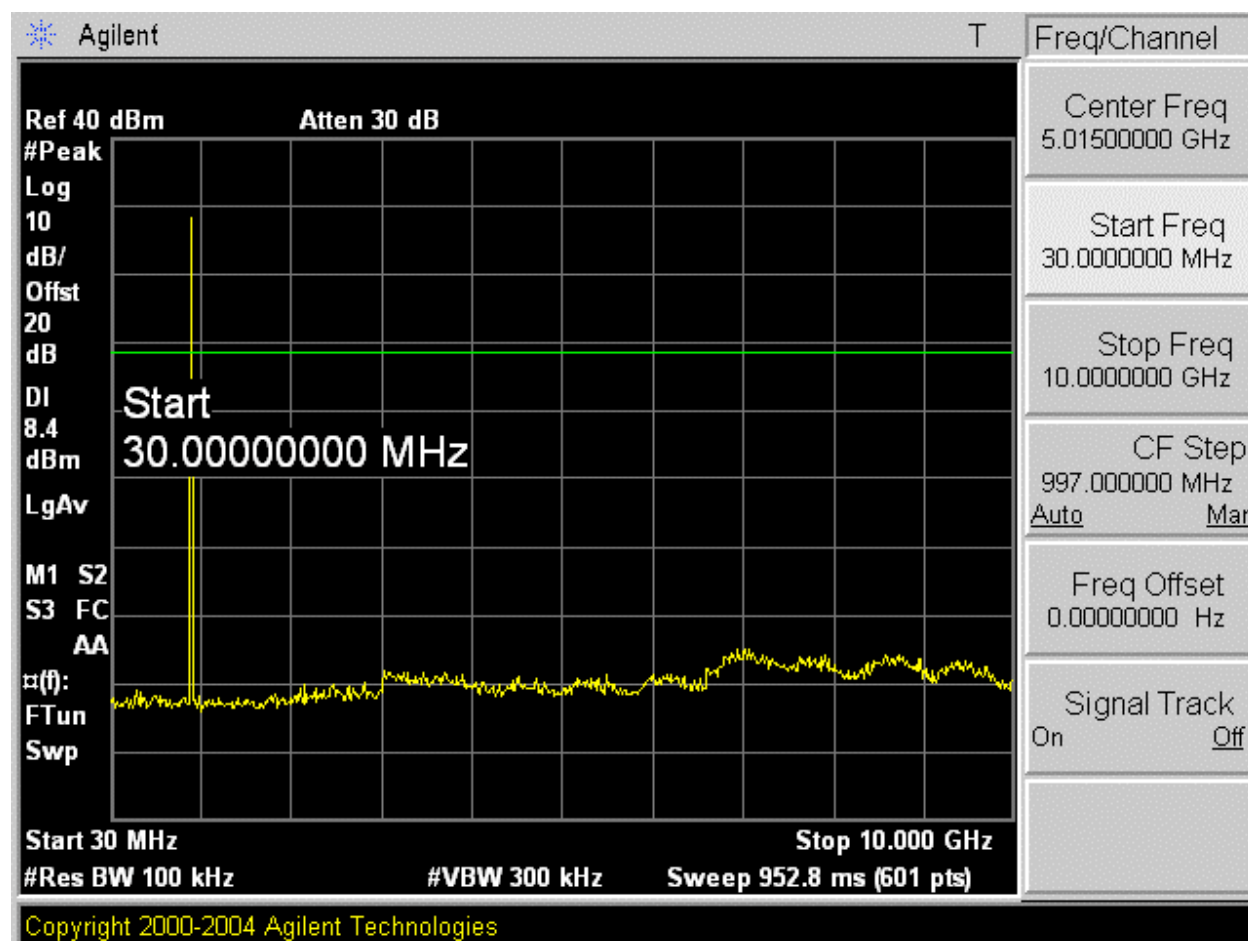
**SPURIOUS EMISSIONS, LOW CHANNEL CLASS 1 GEN 2**



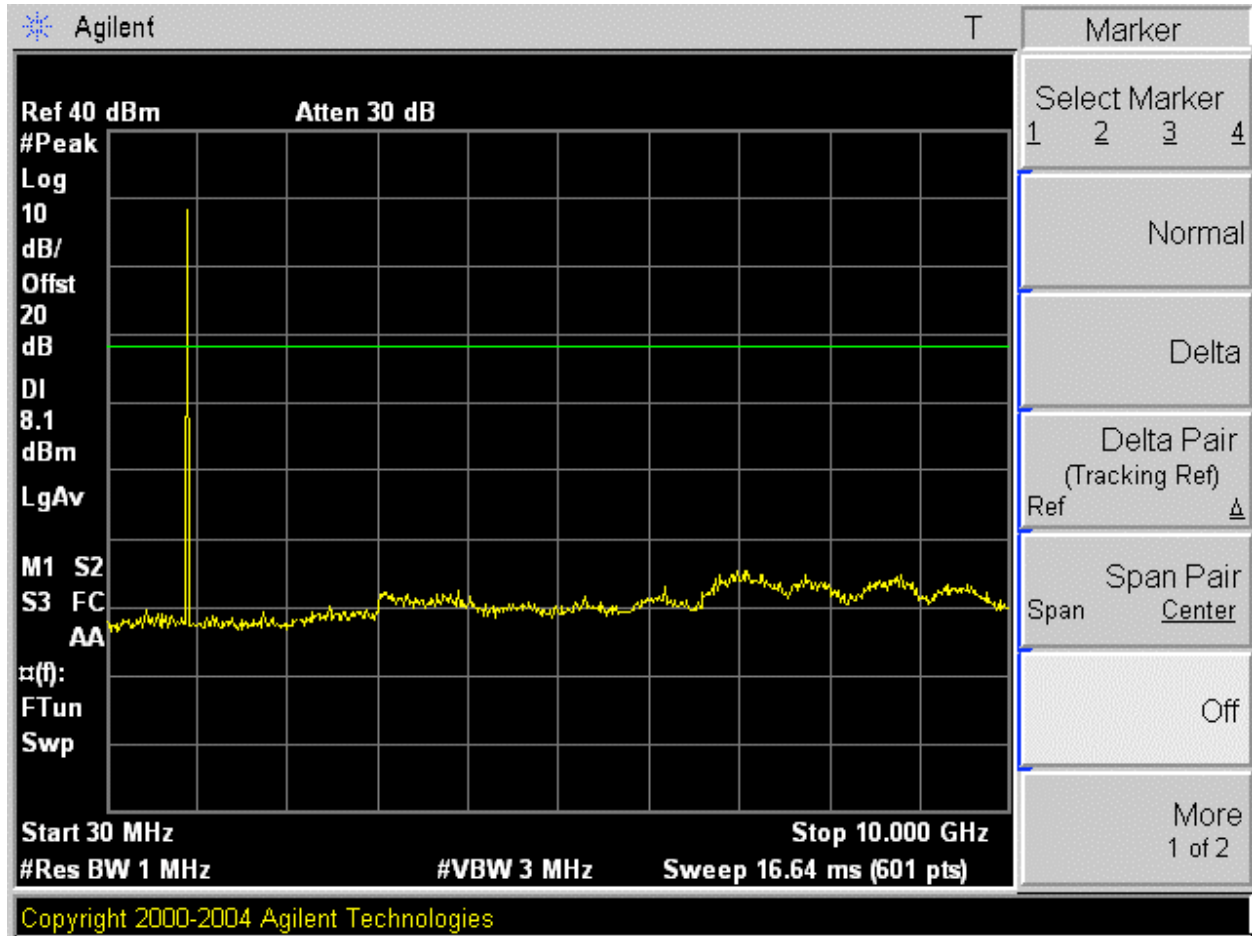
**HOPPING FUNCTION ON, LOW CHANNEL CLASS 1 GEN 2**



**SPURIOUS EMISSIONS, LOW CHANNEL CLASS 1 GEN 2**

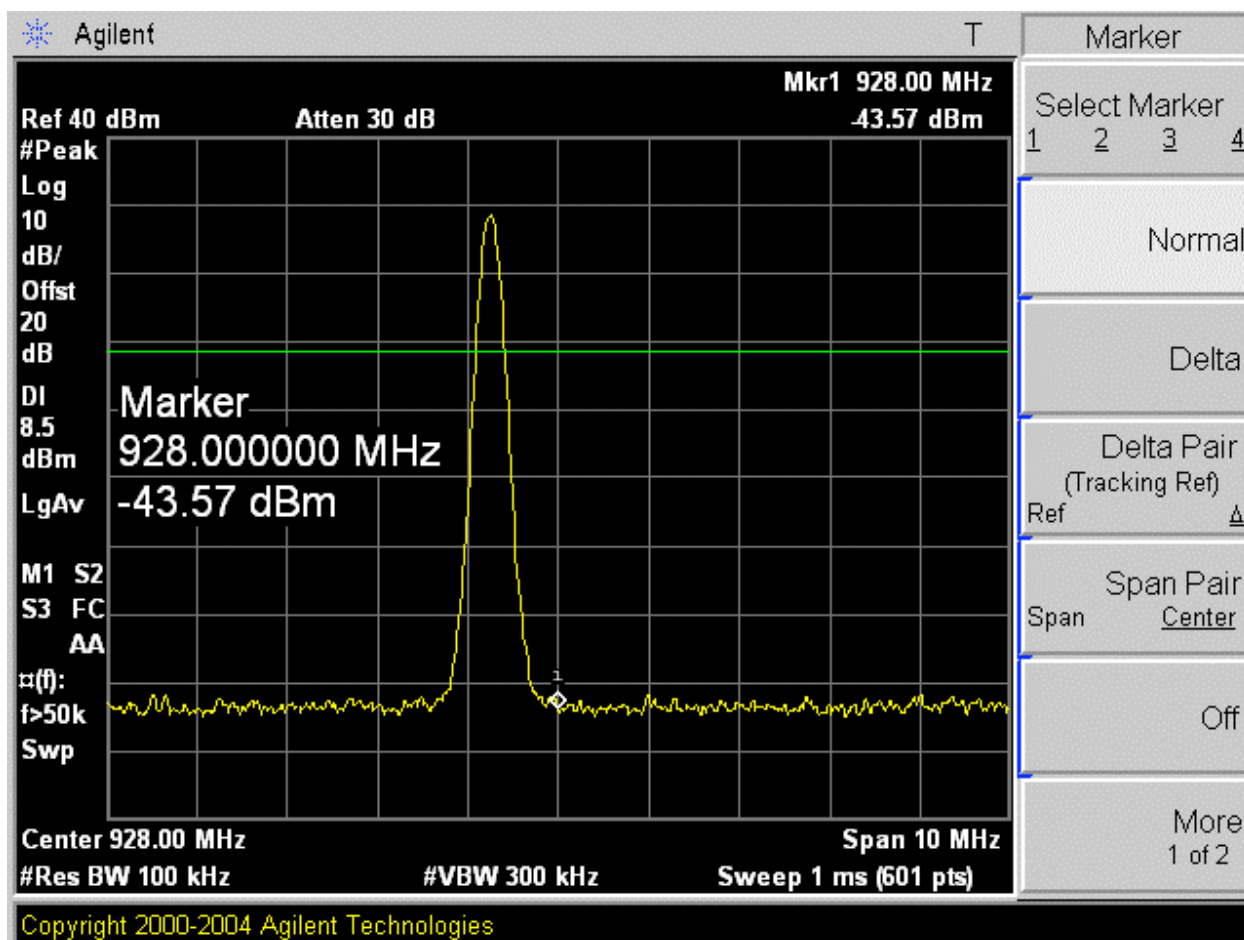


**SPURIOUS EMISSIONS, MID CHANNEL CLASS 1 GEN 2**

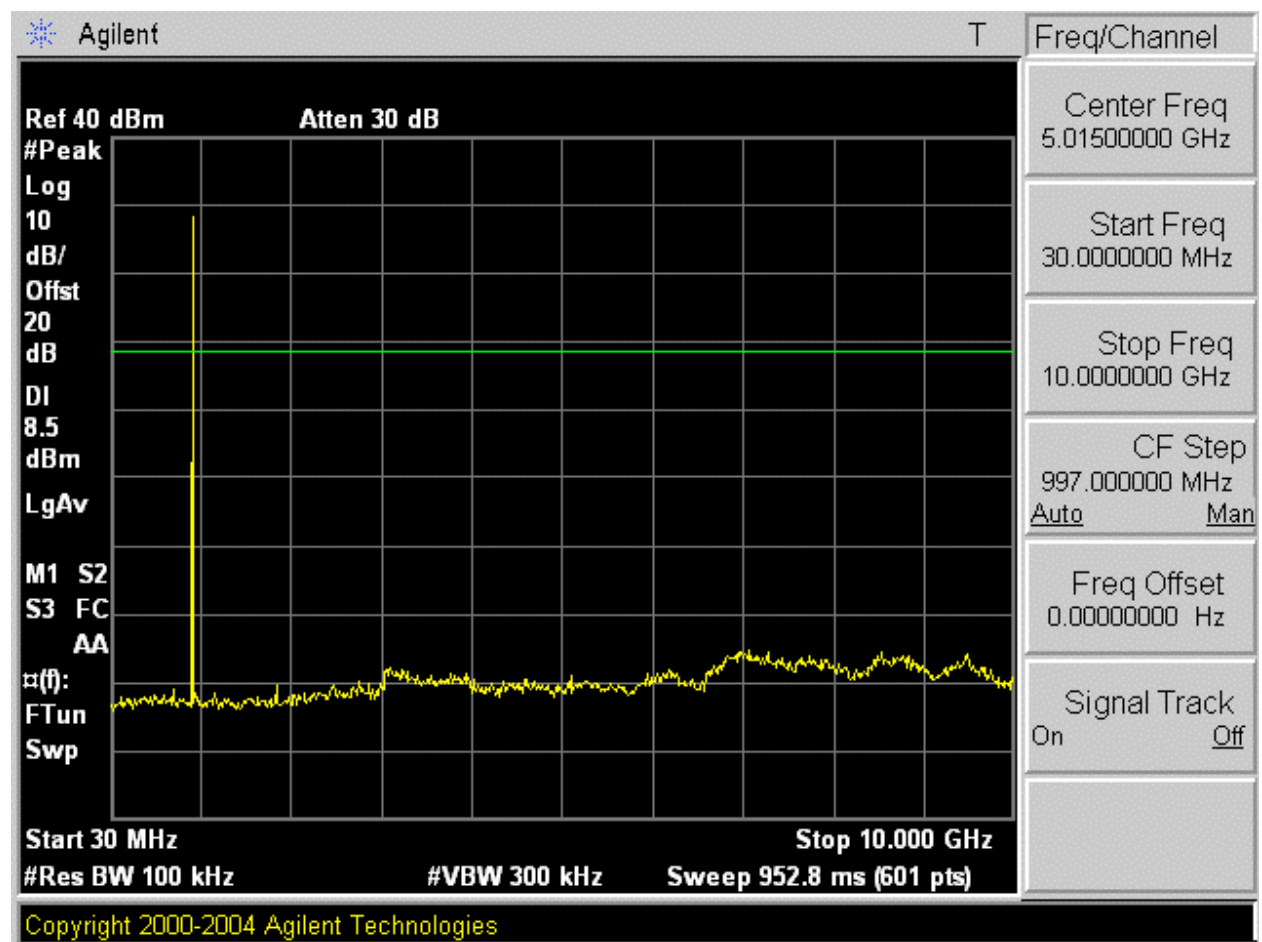




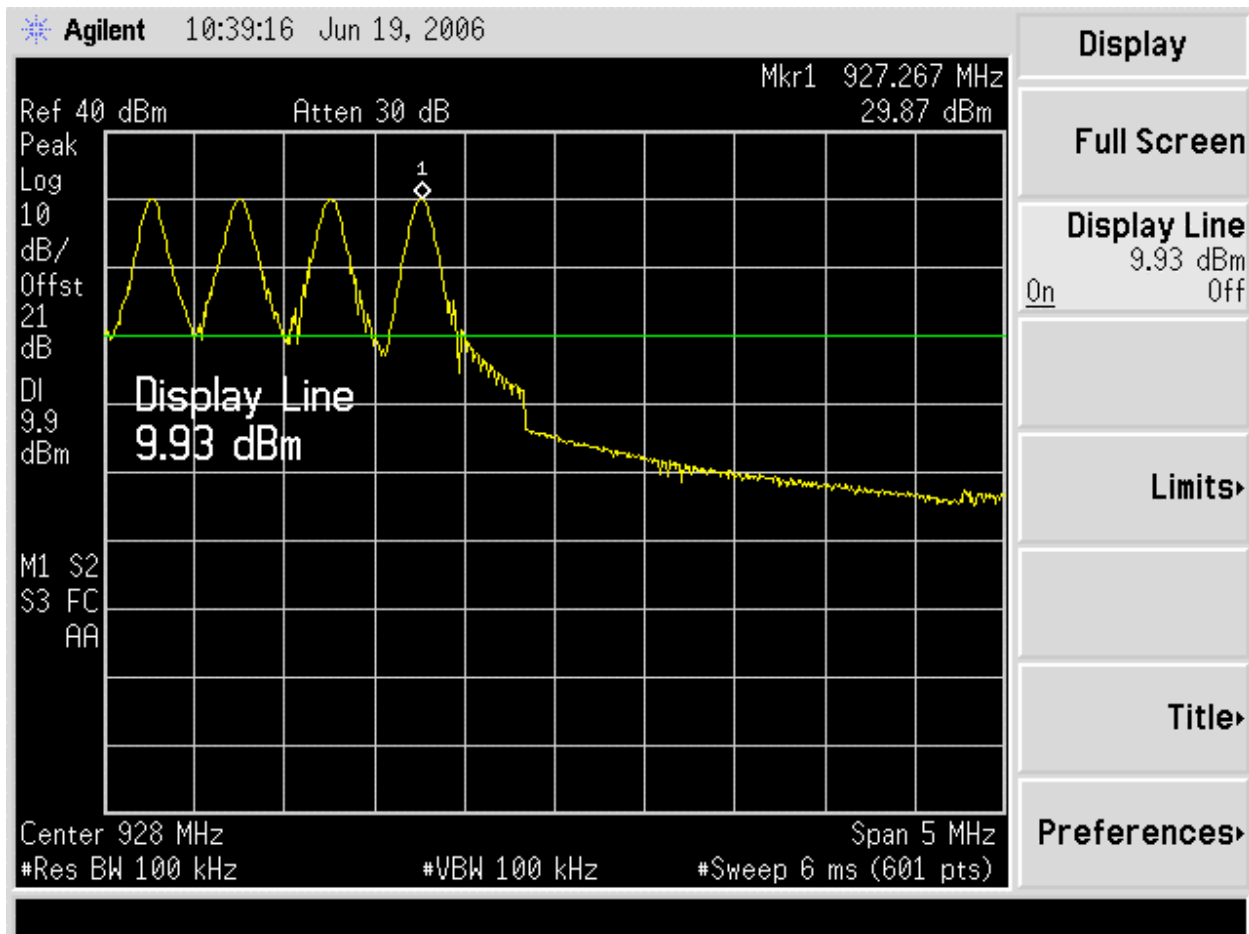
SPURIOUS EMISSIONS, HIGH CHANNEL CLASS 1 GEN 2



SPURIOUS EMISSIONS, HIGH CHANNEL CLASS 1 GEN 2



HOPPING FUNCTION ON, HIGH CHANNEL CLASS 1 GEN 2



## **4.2. ANTENNA PORT CHANNEL TESTS FOR CLASS 3 MODULATION**

### **4.2.1. 20 dB BANDWIDTH**

#### **LIMIT**

None: for reporting purposes only.

#### **TEST PROCEDURE**

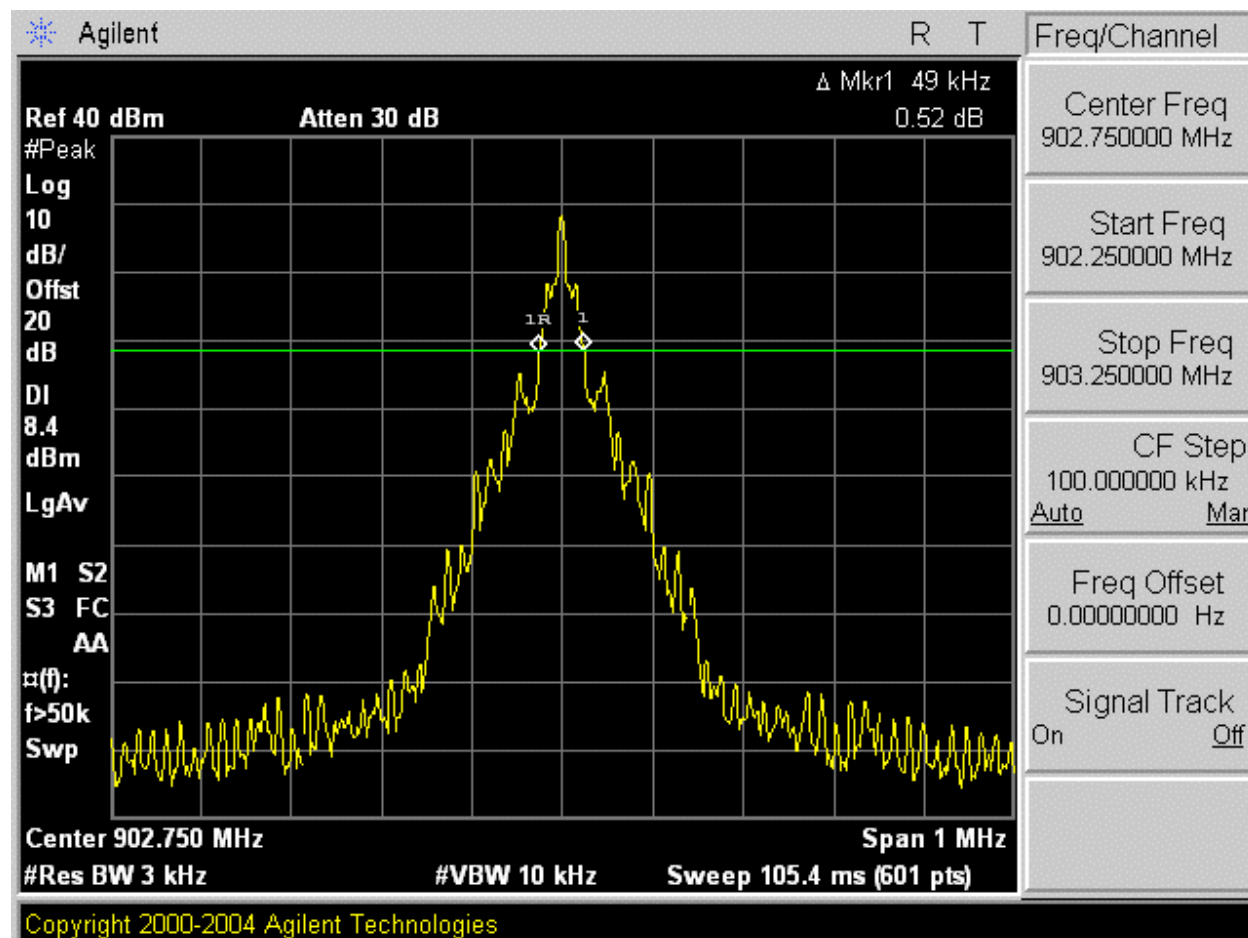
The transmitter output is connected to a spectrum analyzer. The RBW is set to 1% to 3% of the 20 dB bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled.

#### **RESULTS**

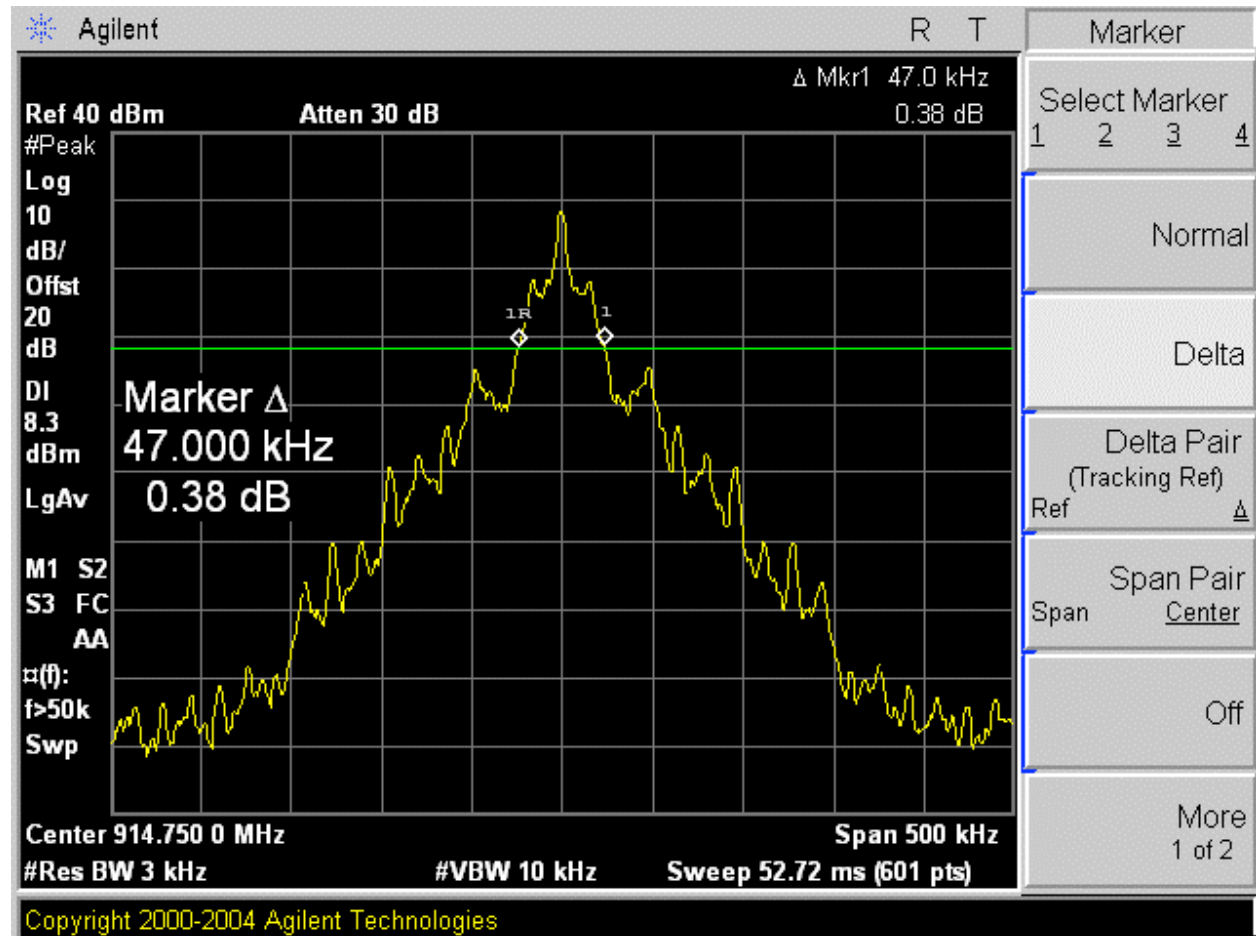
No non-compliance noted:

<b>Channel</b>	<b>Frequency (MHz)</b>	<b>20 dB Bandwidth (kHz)</b>
Low	902.75	49
Middle	915.25	47
High	927.25	47

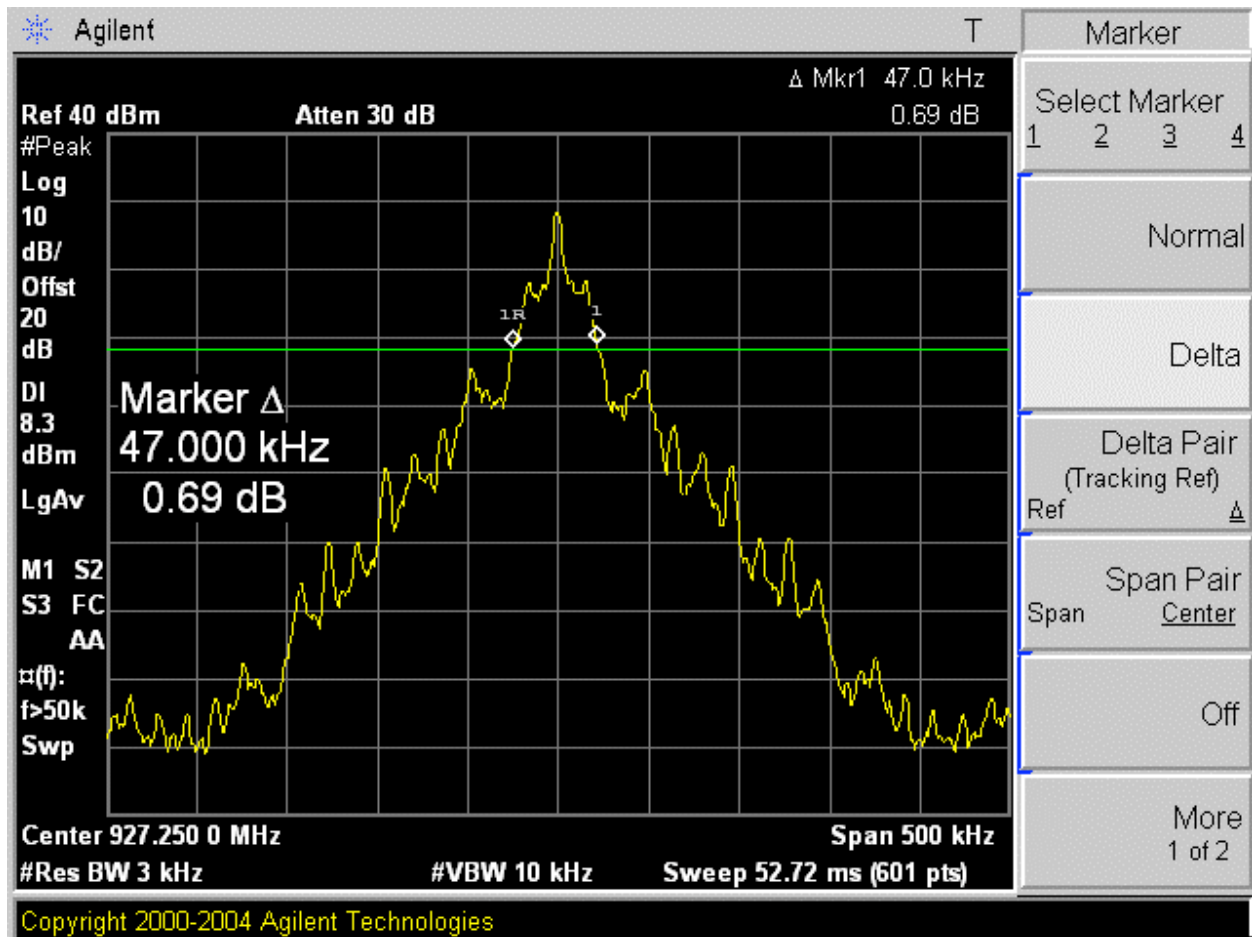
**20 dB BANDWIDTH LOW CHANNEL CLASS 3**



**20 dB BANDWIDTH MID CHANNEL CLASS 3**



**20 dB BANDWIDTH HIGH CHANNEL CLASS 3**



#### **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 hopping 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.

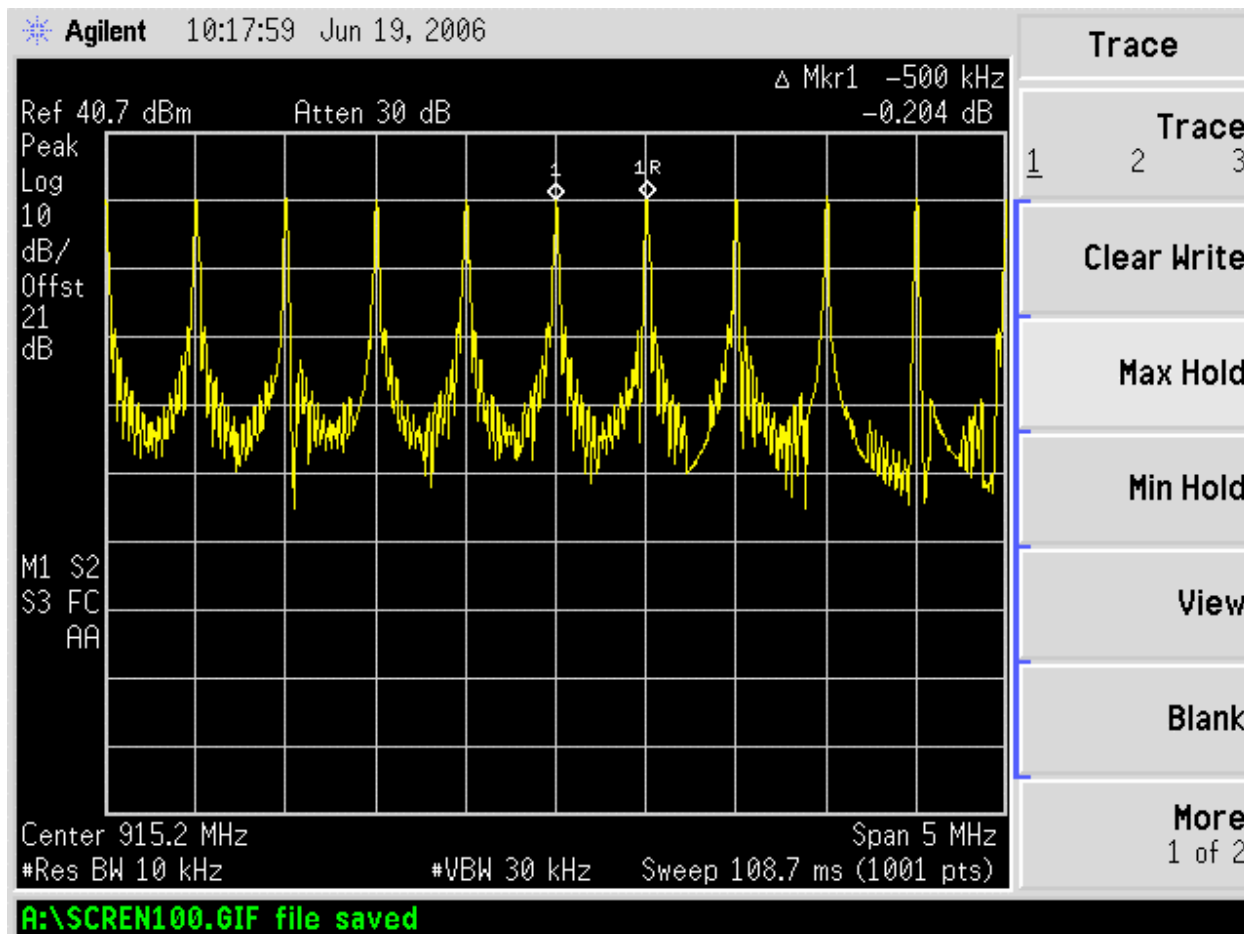
##### **RESULTS**

No non-compliance noted:

The channel separation is 500 KHz.



**HOPPING FREQUENCY SEPARATION CLASS 3**



### **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**

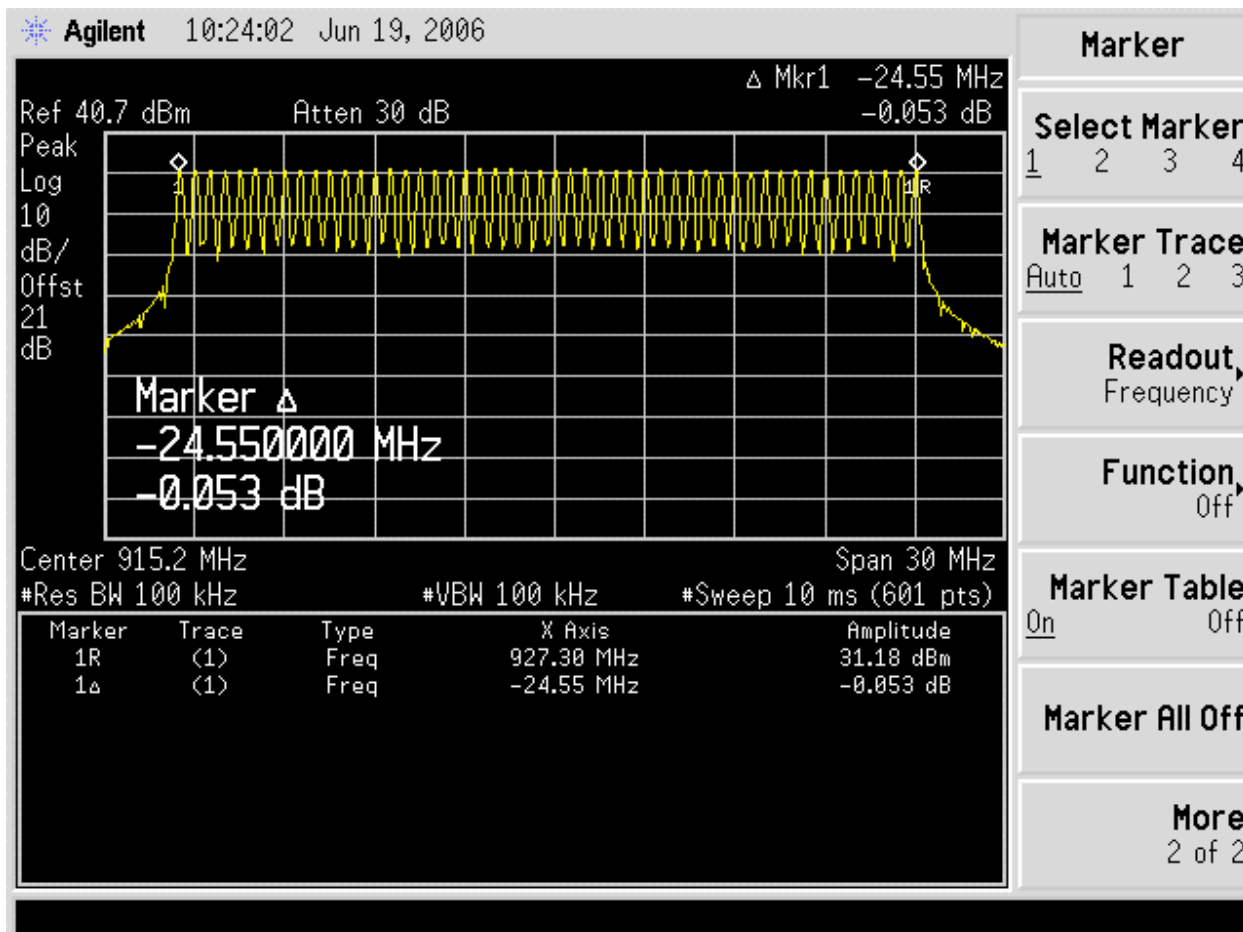
The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to 1 % of the span. The analyzer is set to Max Hold.

#### **RESULTS**

No non-compliance noted:

50 Channels observed.

**NUMBER OF HOPPING CHANNELS CLASS 3**



#### **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**

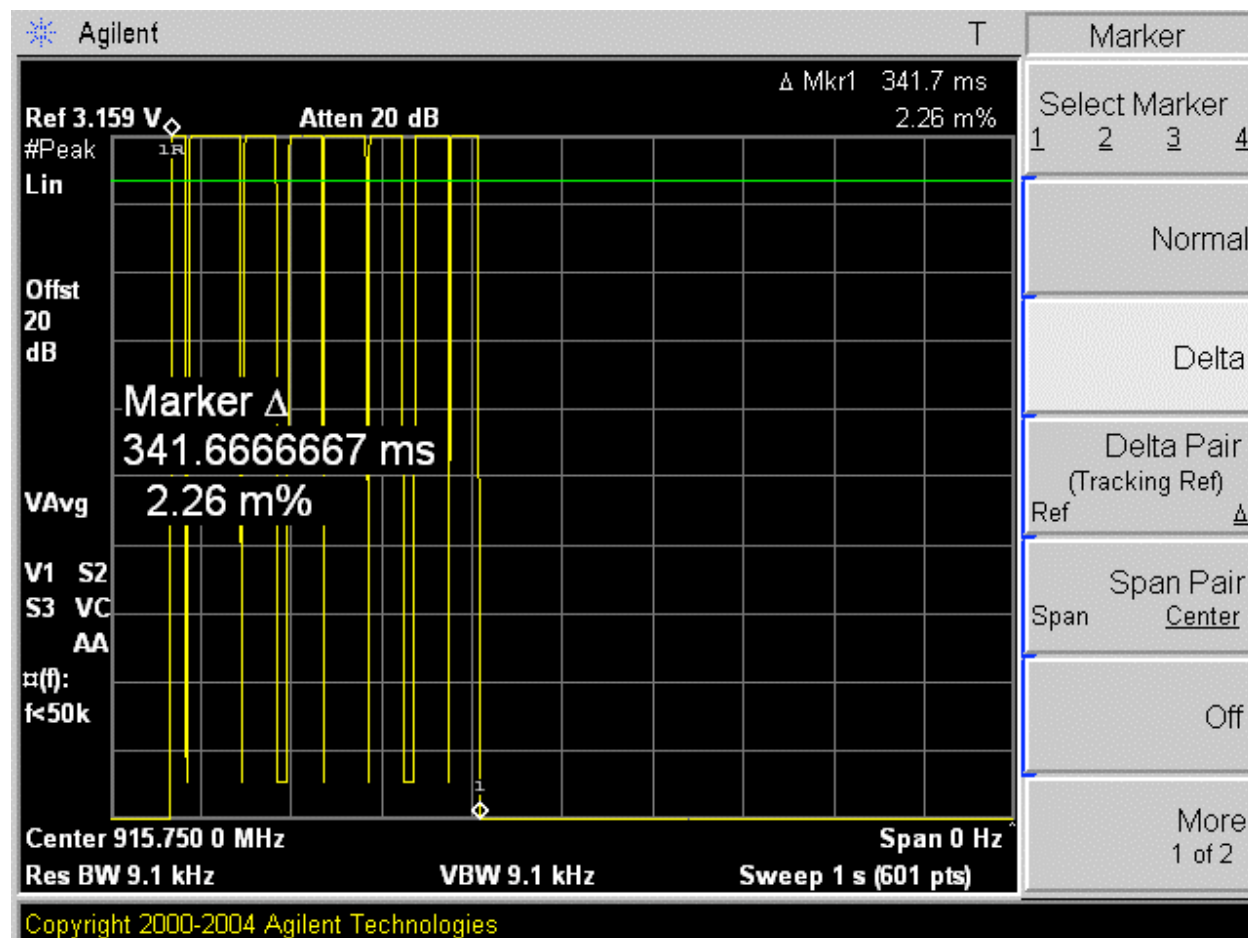
No non-compliance noted:

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

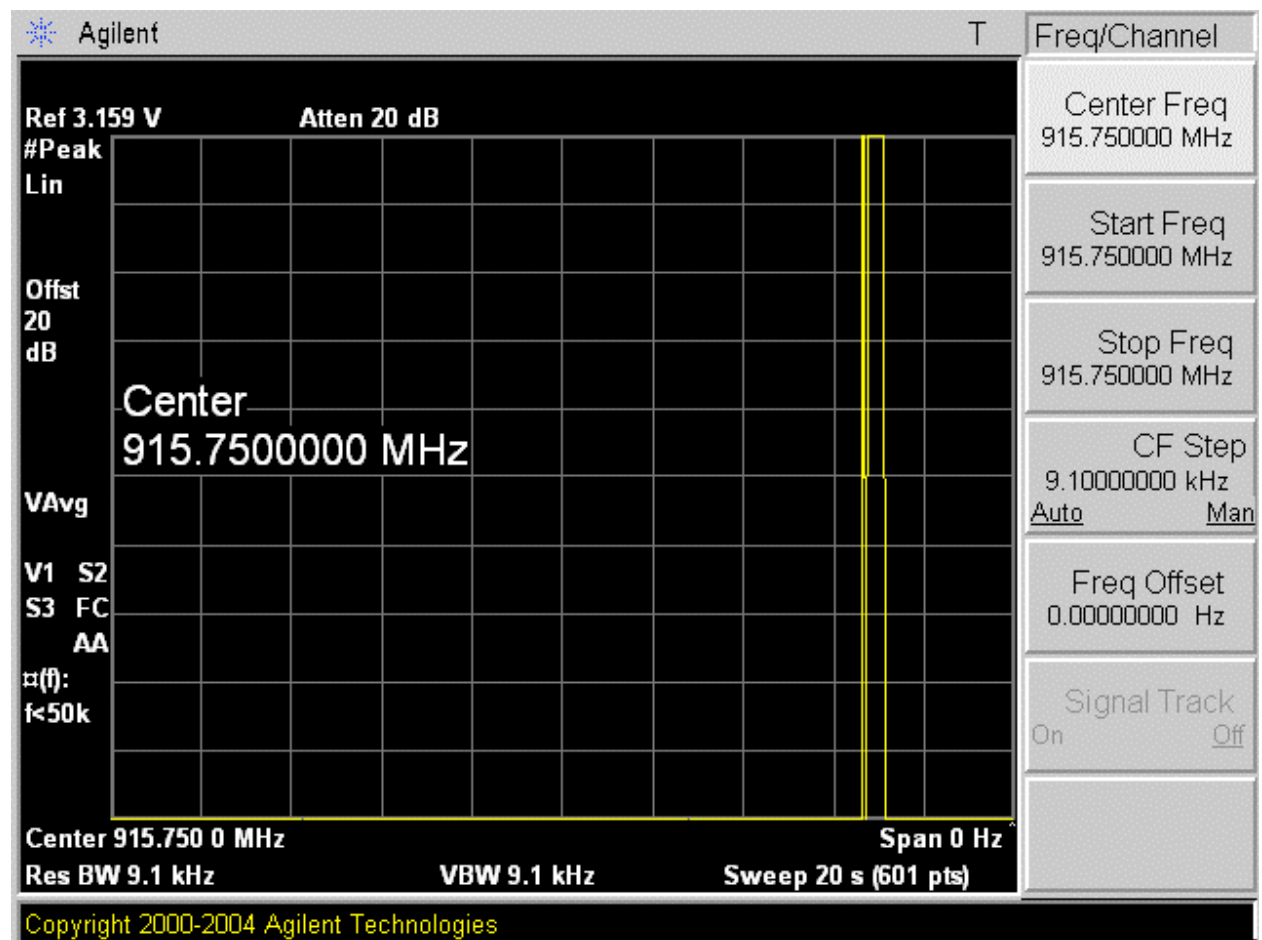
Therefore, the average time of occupancy in the specified 20-second period is:

$$31.9 \times 10 = 319\text{ms} = 0.319\text{s}$$

**PULSE WIDTH CLASS 3**



**NUMBER OF PULSES IN 20 SECOND OBSERVATION PERIOD CLASS 3**



#### **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 6.75 dBi, therefore the limit is 29.25 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.

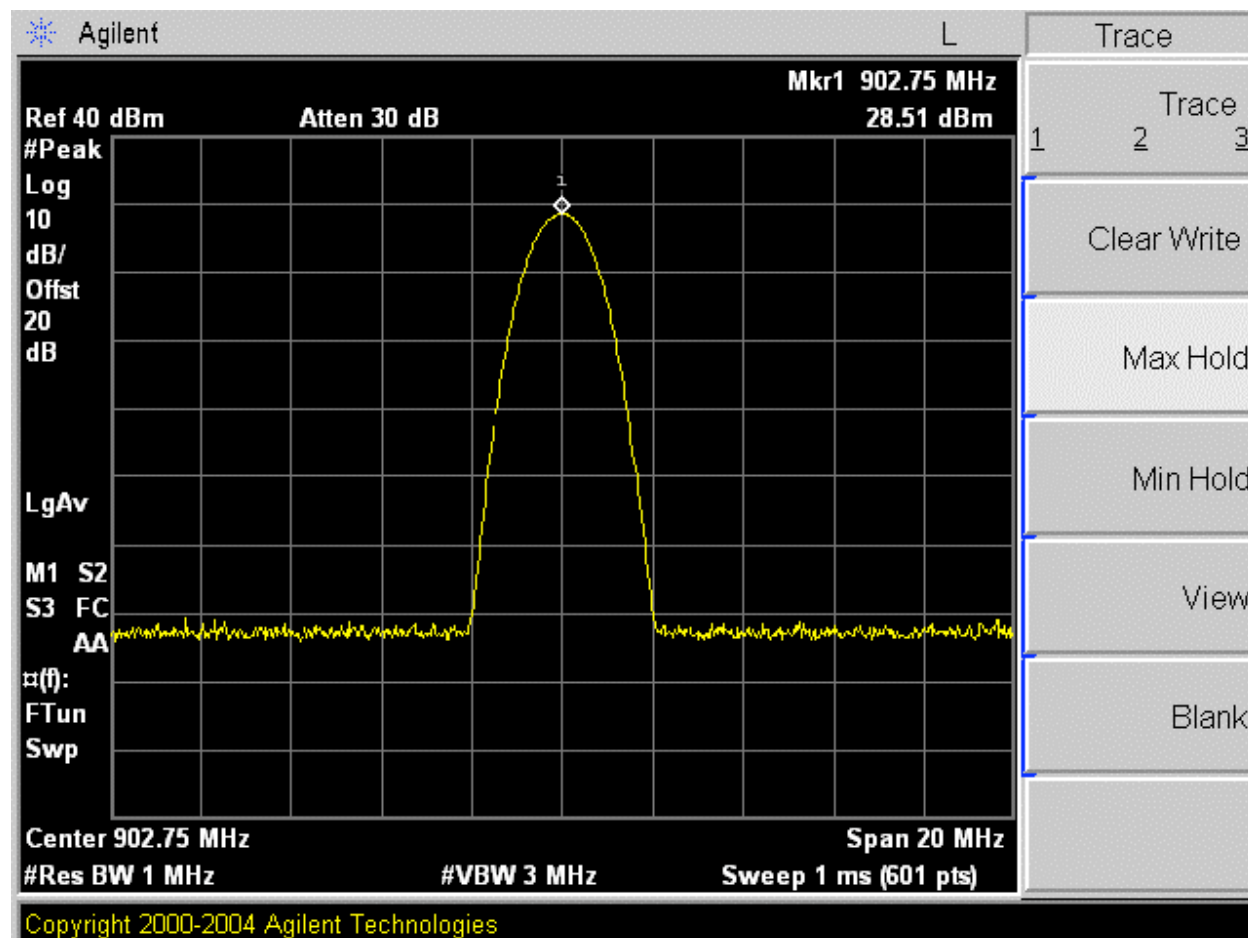
##### **RESULTS**

No non-compliance noted:

##### **CLASS 3**

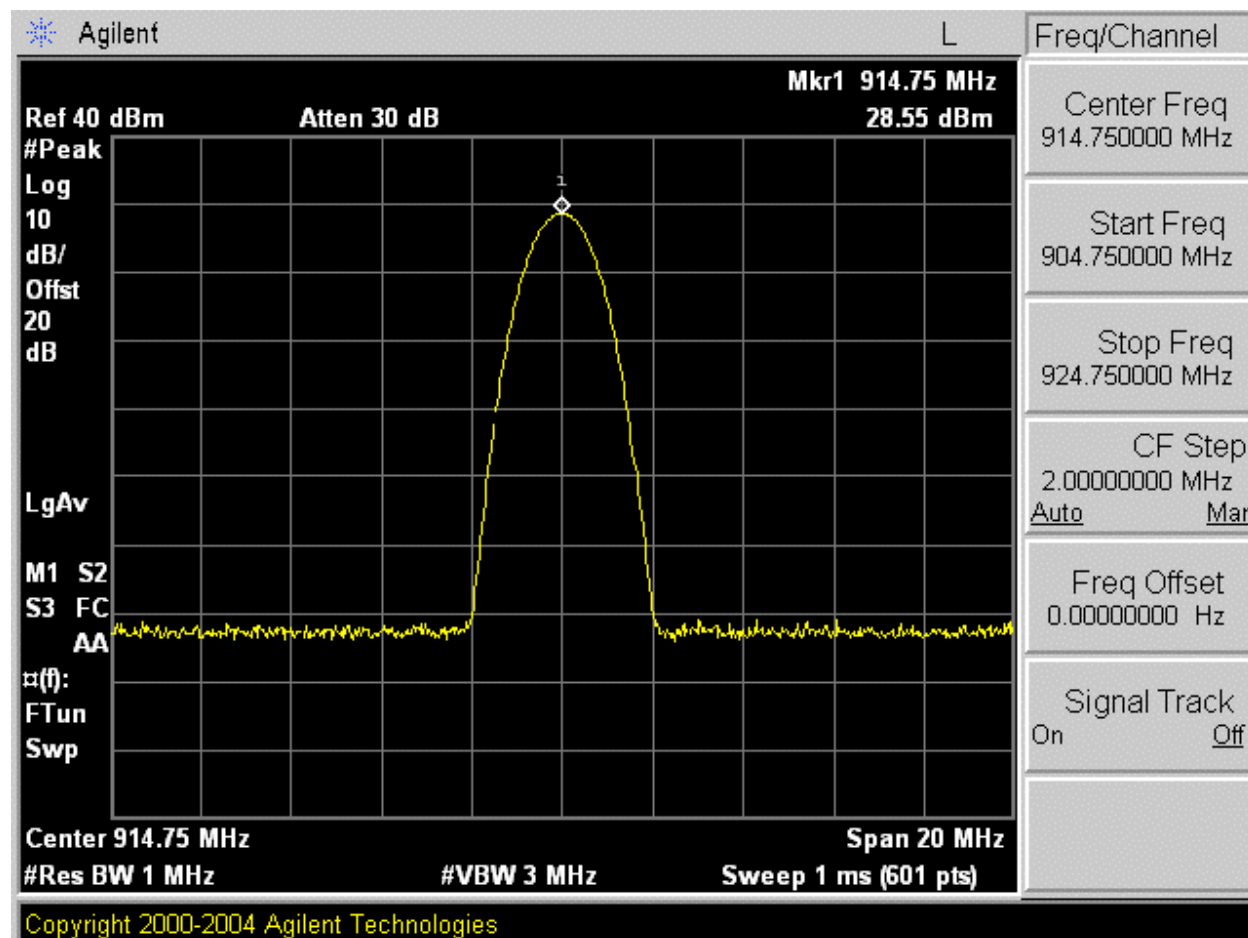
	<b>(MHz)</b>	<b>(dBm)</b>	<b>(mW)</b>
Low	902.75	28.51	709.6
Middle	915.25	28.55	716.1
High	927.25	28.58	721.1

**OUTPUT POWER LOW CHANNEL CLASS 3**

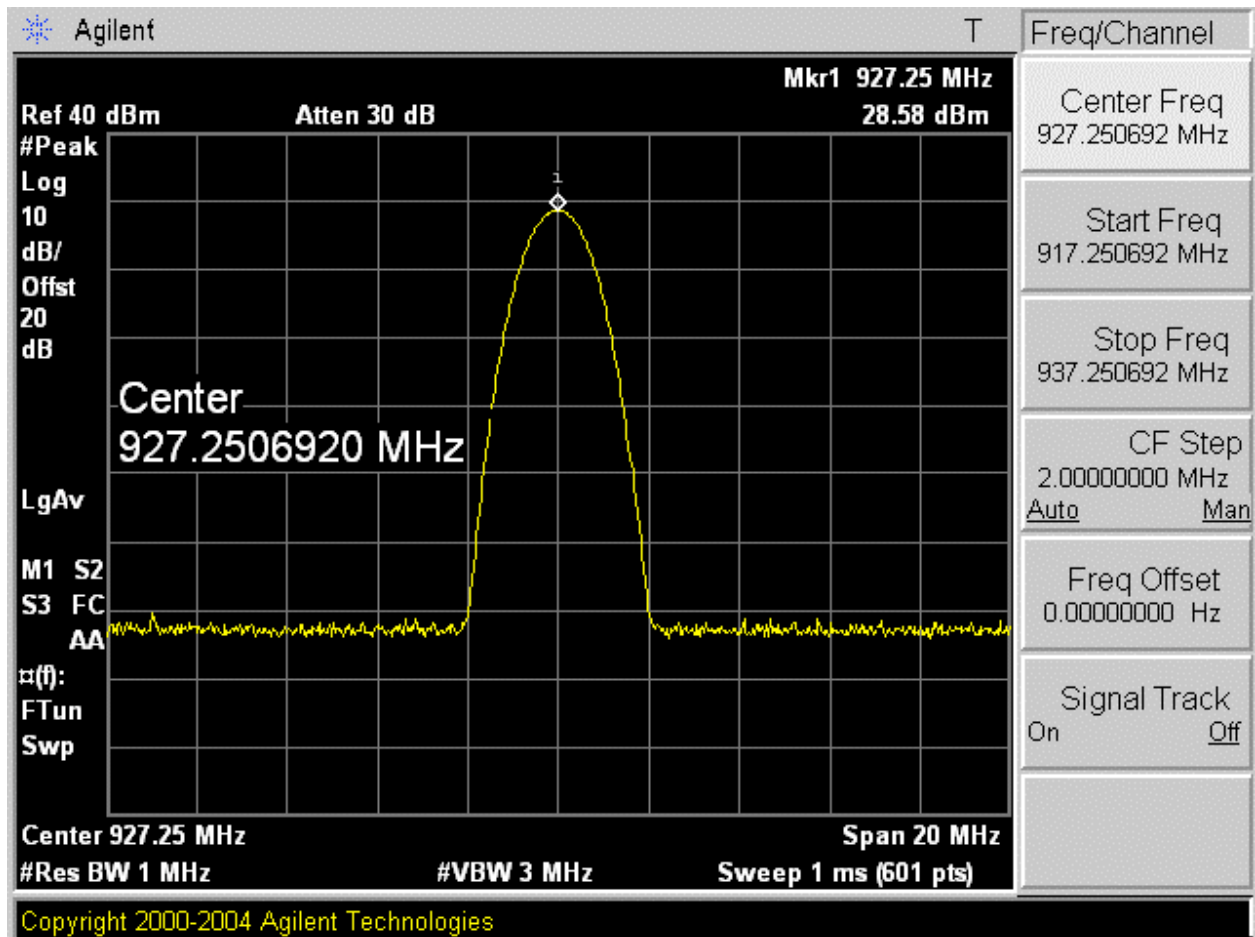




**OUTPUT POWER MID CHANNEL CLASS 3**



**OUTPUT POWER HIGH CHANNEL CLASS 3**



## 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 <sup>2</sup> )	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 <sup>2</sup> )	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 <sup>2</sup> )	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 <sup>2</sup> )	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:

$$P \text{ (mW)} = P \text{ (W)} / 1000 \text{ and}$$

$$d \text{ (cm)} = 100 * d \text{ (m)}$$

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<sup>2</sup>

Substituting the logarithmic form of power and gain using:

$$P \text{ (mW)} = 10^{(P \text{ (dBm)} / 10)} \text{ and}$$

$$G \text{ (numeric)} = 10^{(G \text{ (dBi)} / 10)}$$

yields

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

where

d = MPE distance in cm

P = Power in dBm

G = Antenna Gain in dBi

S = Power Density Limit in mW/cm<sup>2</sup>

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

### **LIMITS**

From §1.1310 Table 1 (B),  $S = 0.6 \text{ mW/cm}^2$

### **RESULTS**

No non-compliance noted:

<b>Power Density Limit (mW/cm<sup>2</sup>)</b>	<b>Output Power (dBm)</b>	<b>Antenna Gain (dBi)</b>	<b>MPE Distance (cm)</b>
0.6	28.58	6.75	21.27

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**

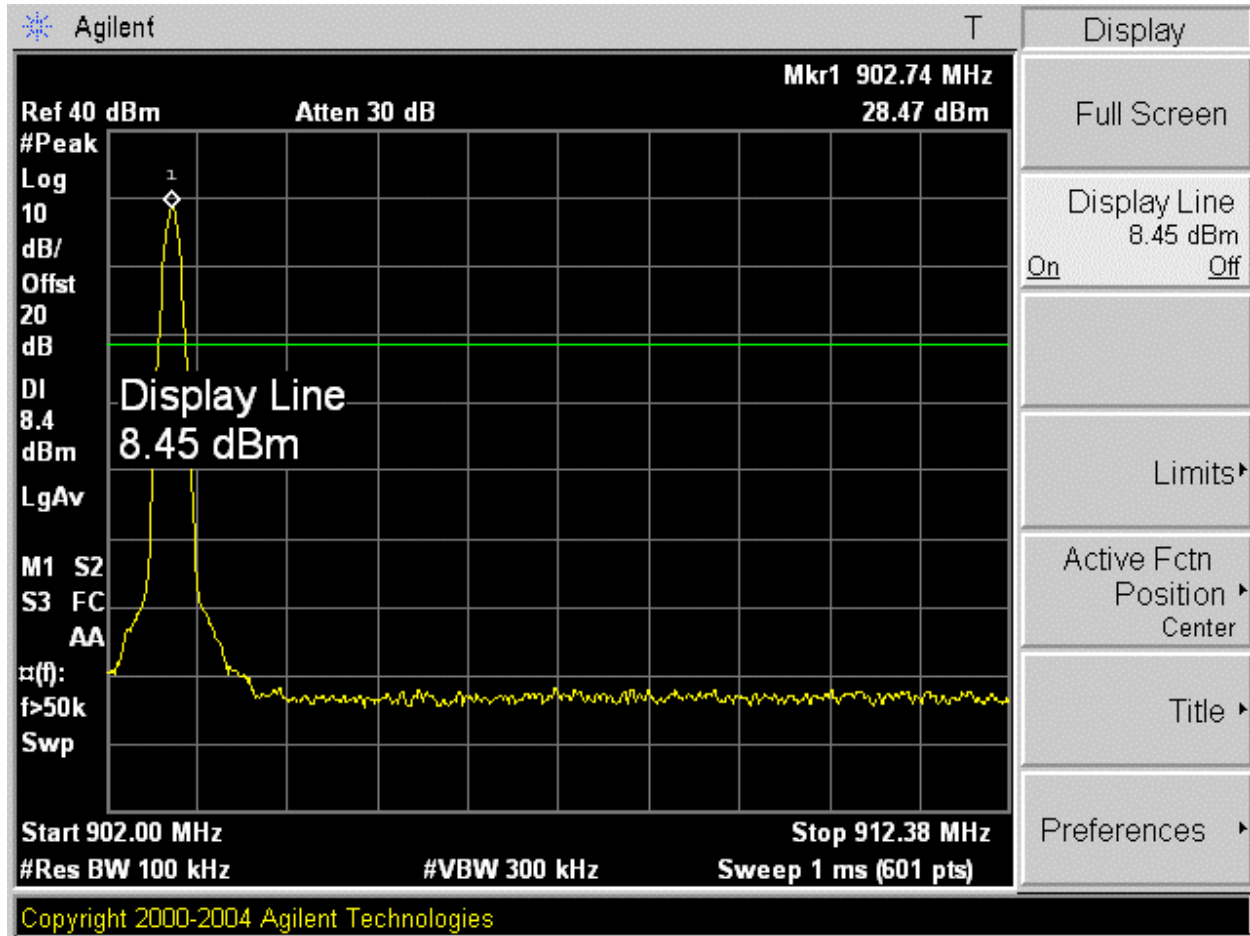
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 100 kHz.

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

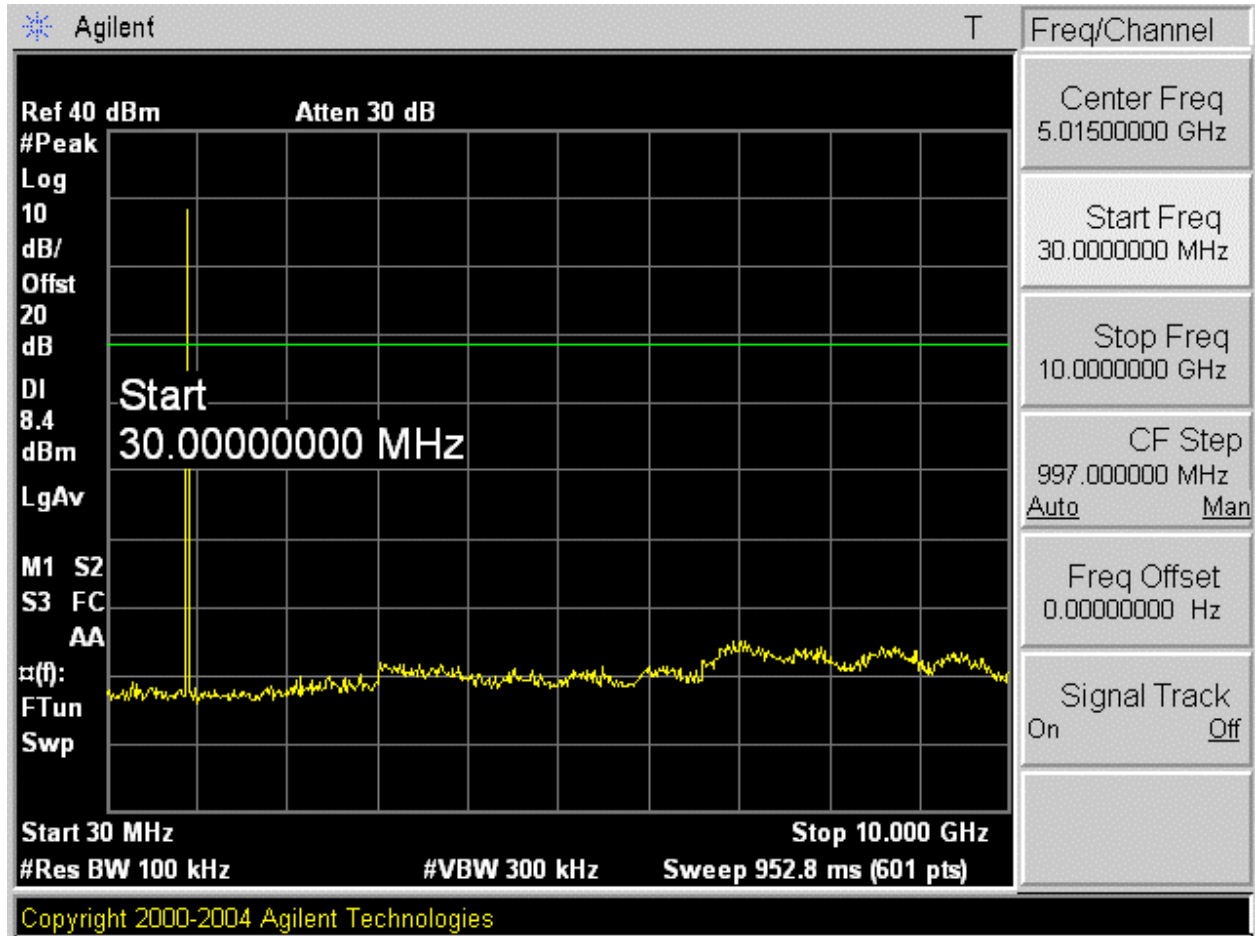
##### **RESULTS**

No non-compliance noted:

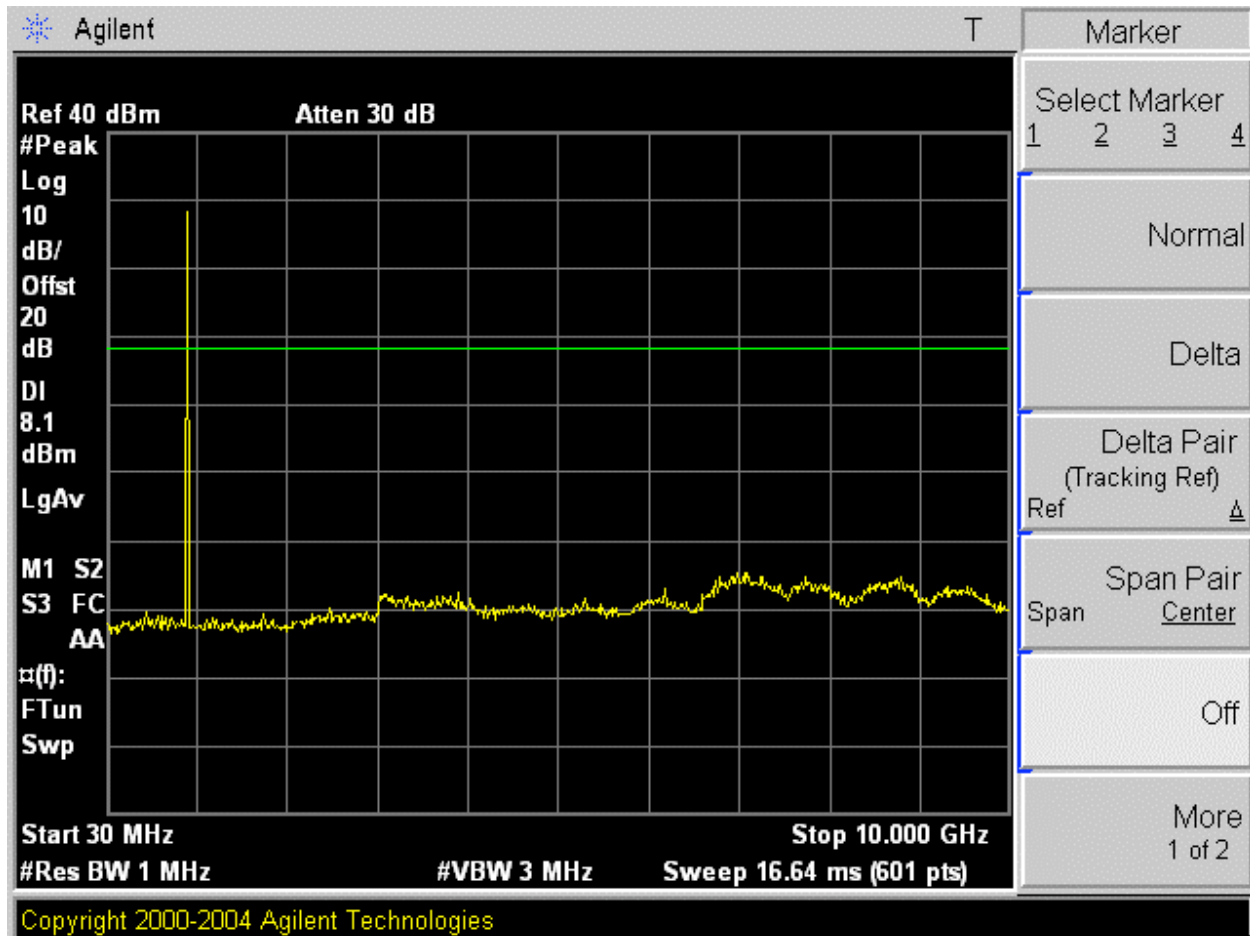
SPURIOUS EMISSIONS, LOW CHANNEL CLASS 3



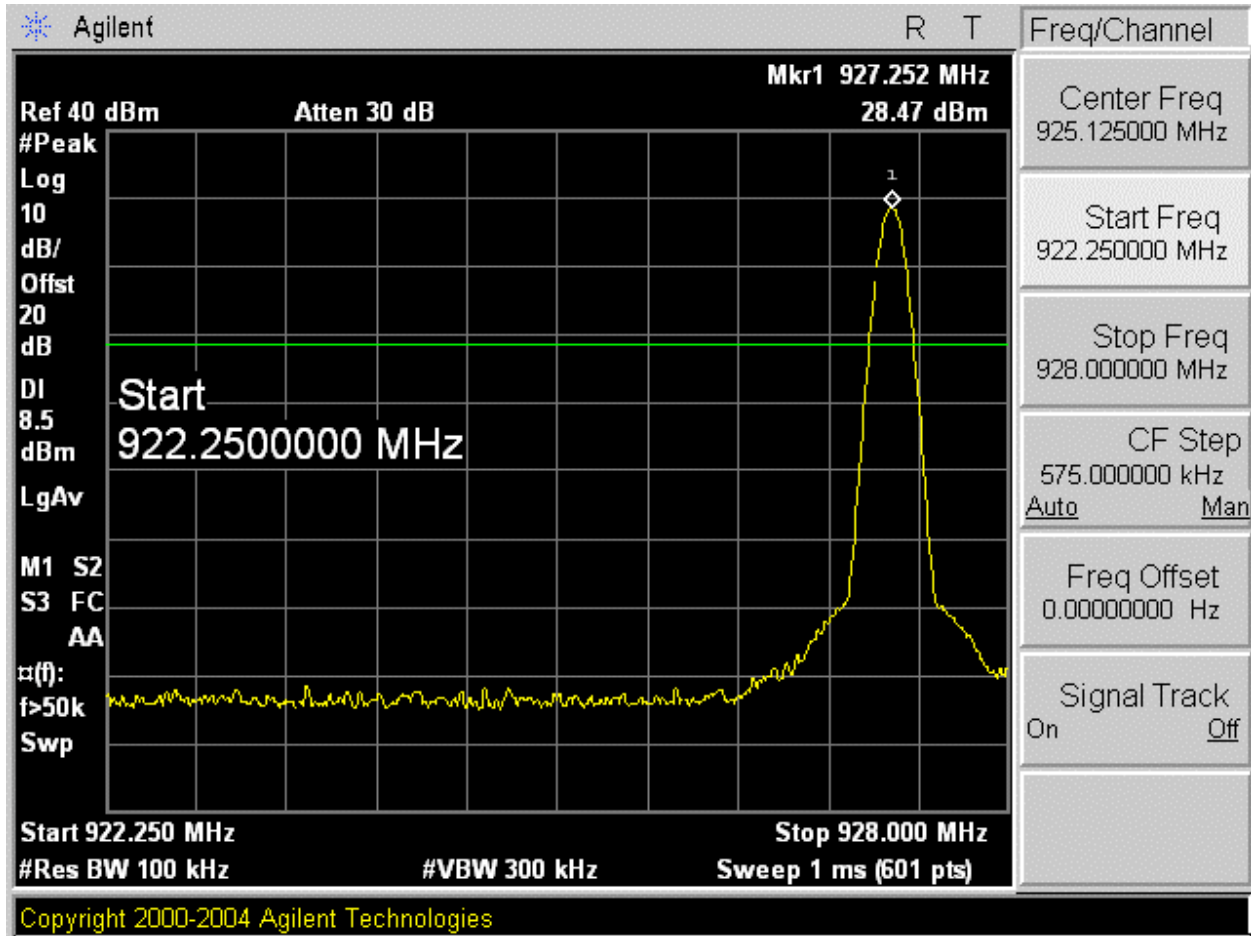
**SPURIOUS EMISSIONS, LOW CHANNEL CLASS 3**



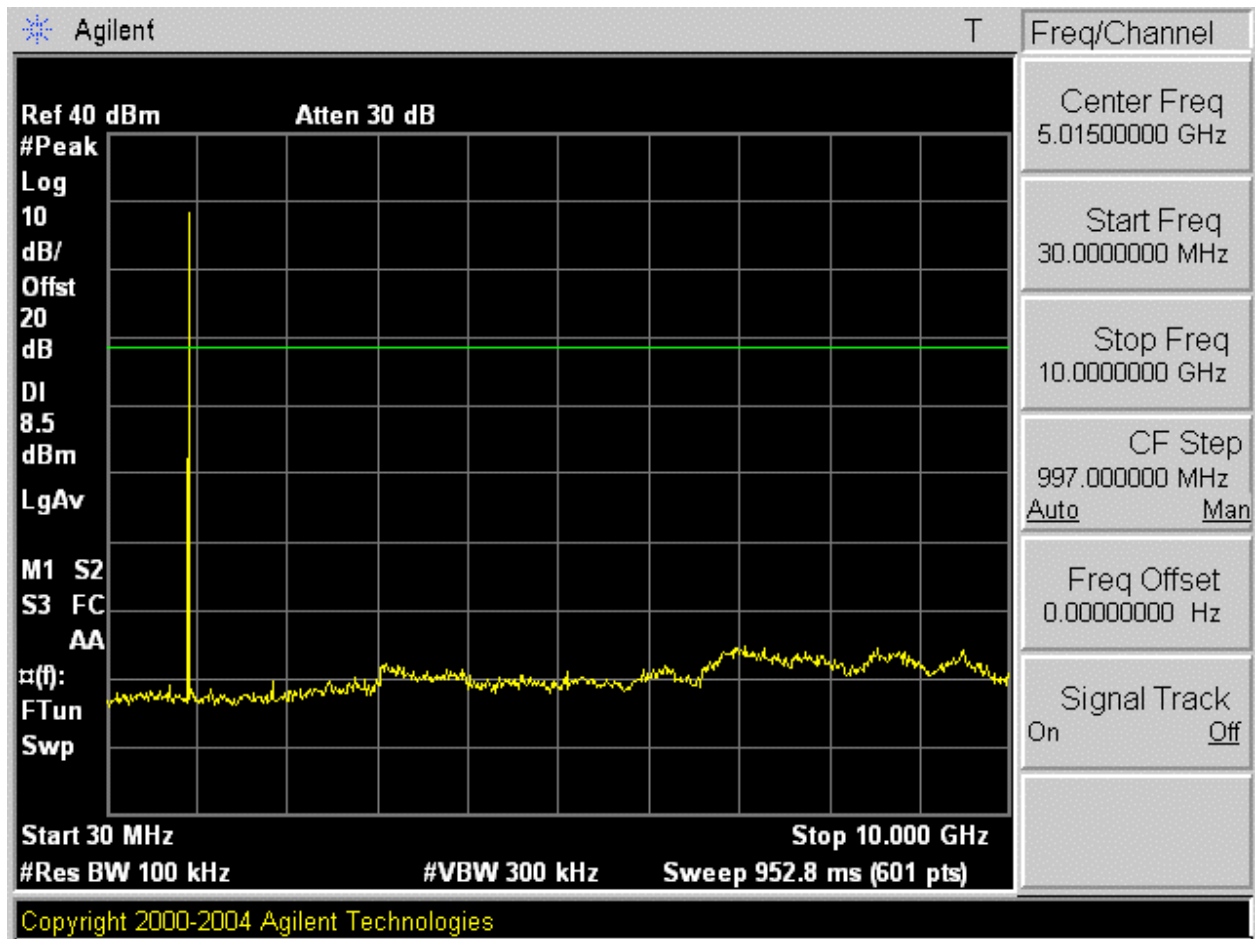




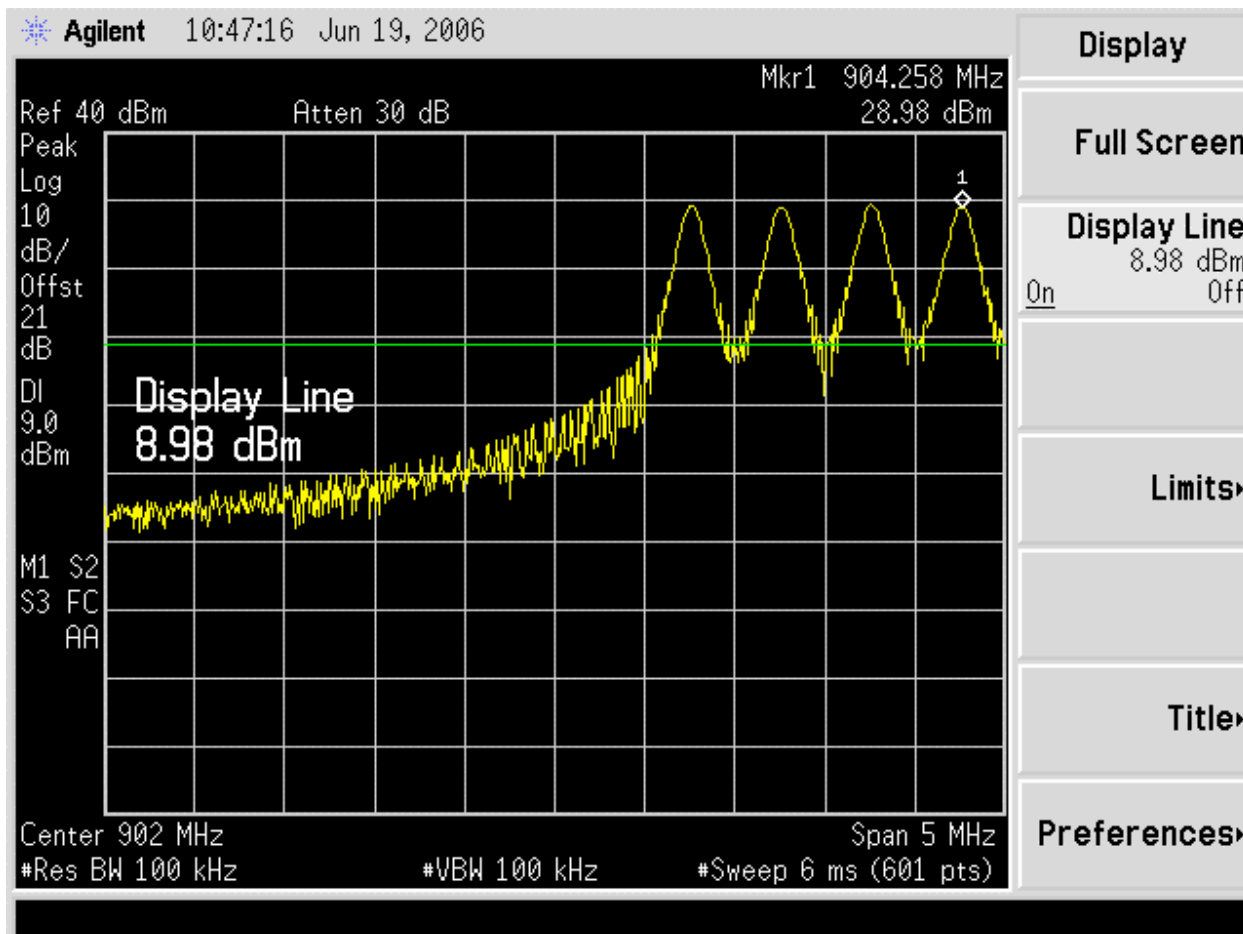
**SPURIOUS EMISSIONS, HIGH CHANNEL CLASS 3**



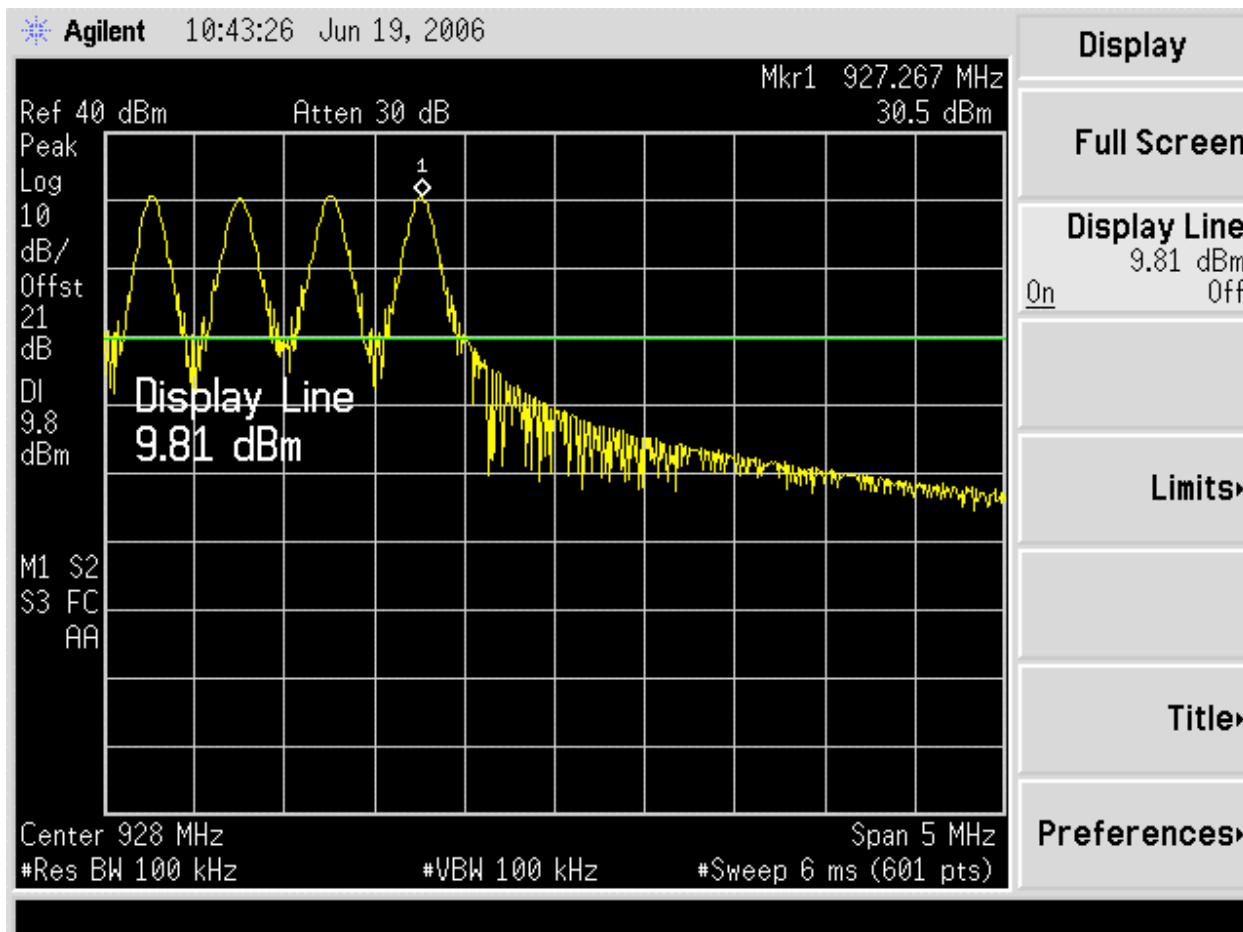
**SPURIOUS EMISSIONS, HIGH CHANNEL CLASS 3**



**HOPPING FUNCTION ON, CLASS 3 LOW CHANNEL**



**HOPPING FUNCTION ON, CLASS 3 HIGH CHANNEL**



### 4.3. RADIATED EMISSIONS

#### 4.3.1. 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
<sup>1</sup> 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	( <sup>2</sup> )
13.36 - 13.41			

<sup>1</sup> Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

<sup>2</sup> 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 10 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in the 902-928 MHz 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 1 GEN 2 and CLASS 3 modulations. Data for emissions above 1 GHz is presented for both modulations. Data for emissions below 1 GHz was essentially identical for both modulations, CLASS 1 GEN2 data is presented.



[illegible]

[illegible]

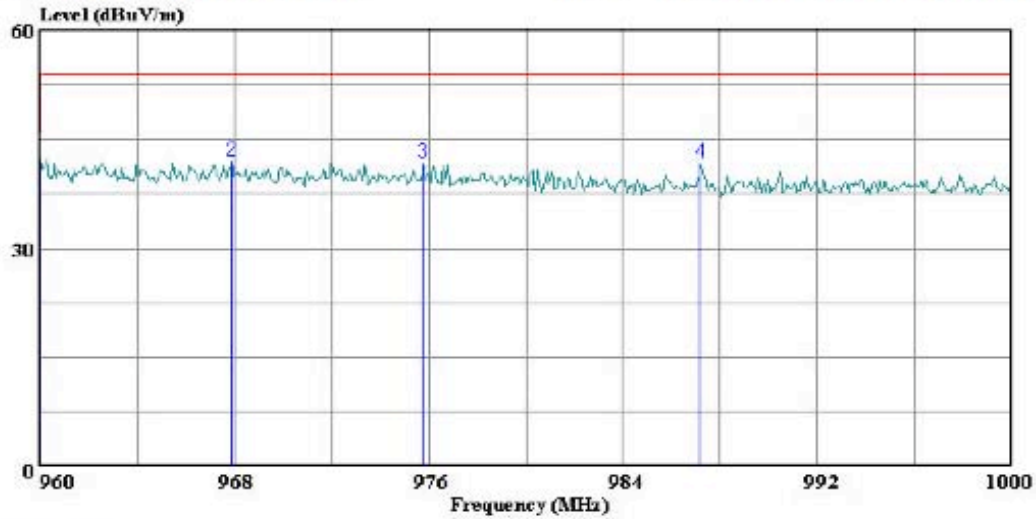
# 1. WORST-CASE RADIATED EMISSIONS BELOW 1 GHz

## 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#: 42 File#: 315.EMI Date: 06-01-2006 Time: 12:38:08



(Auxin ATC)

Trace: 41

Ref Trace:

Condition: FCC CLASS-B HORIZONTAL  
Test Operator: : Thanh Nguyen  
Company: : WJ Communication  
Project #: : 06U10315  
S/N: : RFID Reader, M/N SR320  
Configuration: : EUT and support equipment  
Mode of Operation: Transmit High Channel, Reading class 1  
: Gen 2, RFID tag .With LAB DC supply

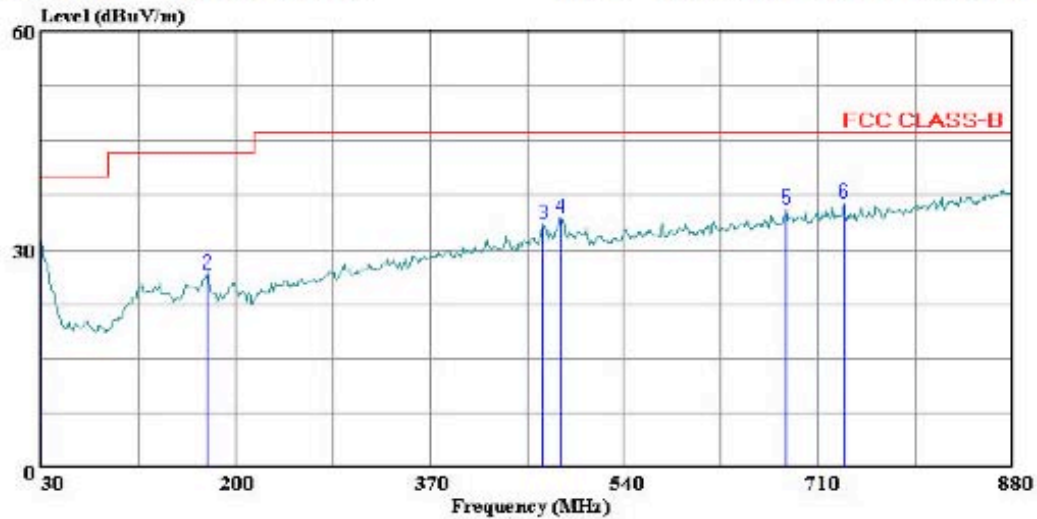
Page: 1

	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1	960.000	15.58	26.54	42.12	54.00	-11.88	Peak
2	967.880	15.33	26.65	41.98	54.00	-12.02	Peak
3	975.760	15.05	26.71	41.76	54.00	-12.24	Peak
4	987.160	14.97	26.80	41.77	54.00	-12.23	Peak



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

Data#: 44 File#: 315.emi Date: 06-02-2006 Time: 13:19:17



(Auxiliary ATC)

Trace: 43

Ref Trace:

Condition: FCC CLASS-B HORIZONTAL  
Test Operator: : Thanh Nguyen  
Company: : WJ Communication  
Project #: : 06U10315  
S/N: : RFID Reader, M/N SR320  
Configuration: : EUT and support equipment  
Mode of Operation: Transmit Mid Channel, Reading class 1  
: Gen 2, RFID tag .  
: With CUI AC/DC Adapter M/N 3A-501DN24

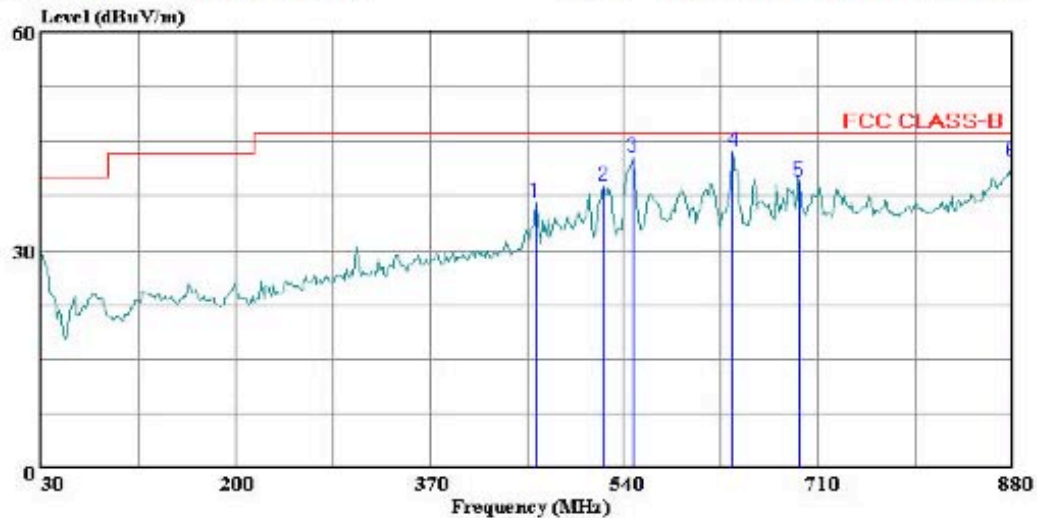
Page: 1

		Read		Limit	Over	
	Freq	Level	Factor	Level	Line	Limit Remark
	MHz	dBuV	dB	dBuV/m	dBuV/m	dB
1	30.000	10.80	20.45	31.25	40.00	-8.75 Peak
2	175.350	13.50	13.16	26.66	43.50	-16.84 Peak
3	469.450	13.90	19.63	33.53	46.00	-12.47 Peak
4	484.750	14.28	19.91	34.19	46.00	-11.81 Peak
5	681.950	12.63	22.86	35.49	46.00	-10.51 Peak
6	732.950	12.73	23.64	36.37	46.00	-9.63 Peak



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Morgan Hill, CA 95037  
Tel: (408) 463-0888  
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Data#: 53 File#: 315.emi Date: 06-02-2006 Time: 13:55:07



(Auxiliary ATC)

Trace: 52

Ref Trace:

Condition: FCC CLASS-B HORIZONTAL  
Test Operator: : Thanh Nguyen  
Company: : WJ Communication  
Project #: : 06U10315  
S/N: : RFID Reader, M/N SR320  
Configuration: : EUT and support equipment  
Mode of Operation: Transmit High Channel, Reading class 1  
: Gen 2, RFID tag .With LAB DC supply  
: With CUI AC/DC Adapter M/N 3A-501DN24

Page: 1

	Freq	Read Level	Factor	Level	Limit	Over Limit	Remark
	MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1	462.650	17.12	19.49	36.61	46.00	-9.39	Peak
2	522.150	18.30	20.56	38.86	46.00	-7.14	Peak
3	547.650	21.99	20.86	42.85	46.00	-3.15	Peak
4	635.200	21.54	22.08	43.62	46.00	-2.38	Peak
5	693.000	16.37	22.99	39.36	46.00	-6.64	Peak
6	879.150	16.55	25.68	42.23	46.00	-3.77	Peak

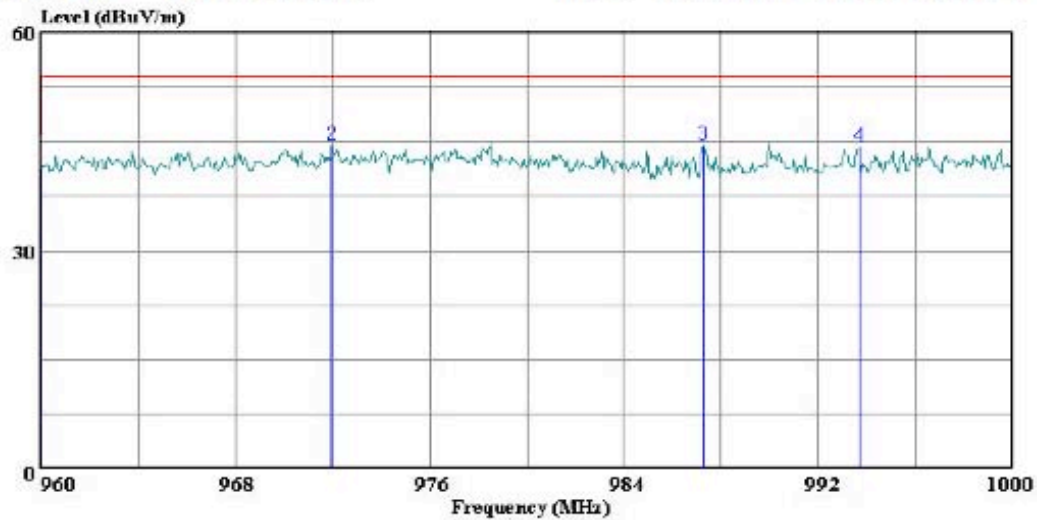


**SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION, VERTICAL)**



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

Data#: 40 File#: 315.EMI Date: 06-01-2006 Time: 12:35:19



(Audix ATC)

Trace: 39

Ref Trace:

Condition: FCC CLASS-B VERTICAL  
Test Operator: : Thanh Nguyen  
Company: : WJ Communication  
Project #: : 06U10315  
S/N: : RFID Reader, M/N SR320  
Configuration: : EUT and support equipment  
Mode of Operation: Transmit High Channel, Reading class 1  
: Gen 2, RFID tag .With LAB DC supply

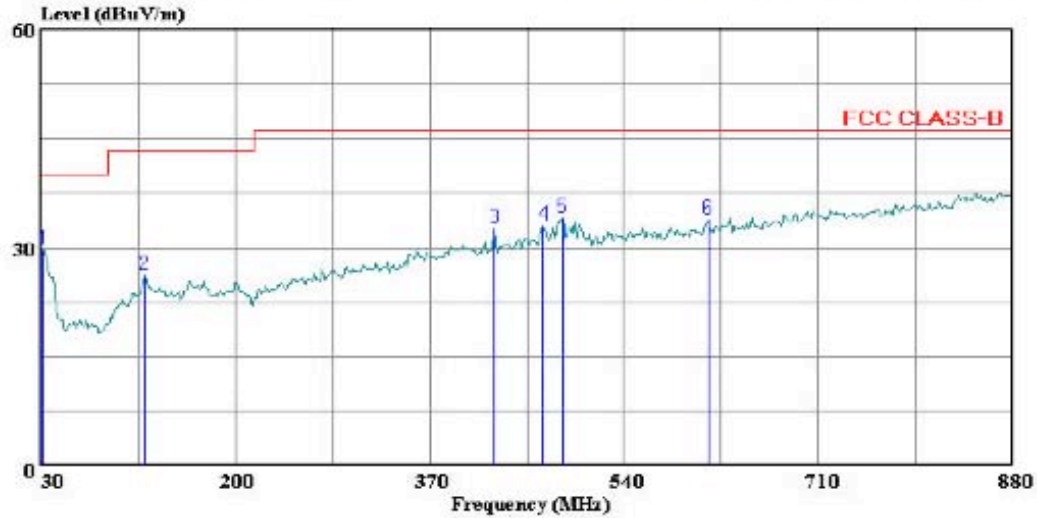
Page: 1

	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1	960.000	14.84	26.54	41.38	54.00	-12.62	Peak
2	971.960	17.70	26.68	44.38	54.00	-9.62	Peak
3	987.280	17.68	26.81	44.49	54.00	-9.51	Peak
4	993.680	17.29	26.94	44.23	54.00	-9.77	Peak



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Morgan Hill, CA 95037  
Tel: (408) 463-0888  
Fax: (408) 463-0885

Data#: 46 File#: 315.emi Date: 06-02-2006 Time: 13:25:15



(Auxil ATC)

Trace: 45

Ref Trace:

Condition: FCC CLASS-B VERTICAL  
Test Operator: : Thanh Nguyen  
Company: : WJ Communication  
Project #: : 06U10315  
S/N: : RFID Reader, M/N SR320  
Configuration: : EUT and support equipment  
Mode of Operation: Transmit High Channel, Reading class 1  
: Gen 2, RFID tag .With LAB DC supply  
: With CUI AC/DC Adapter M/N 3A-501DN24

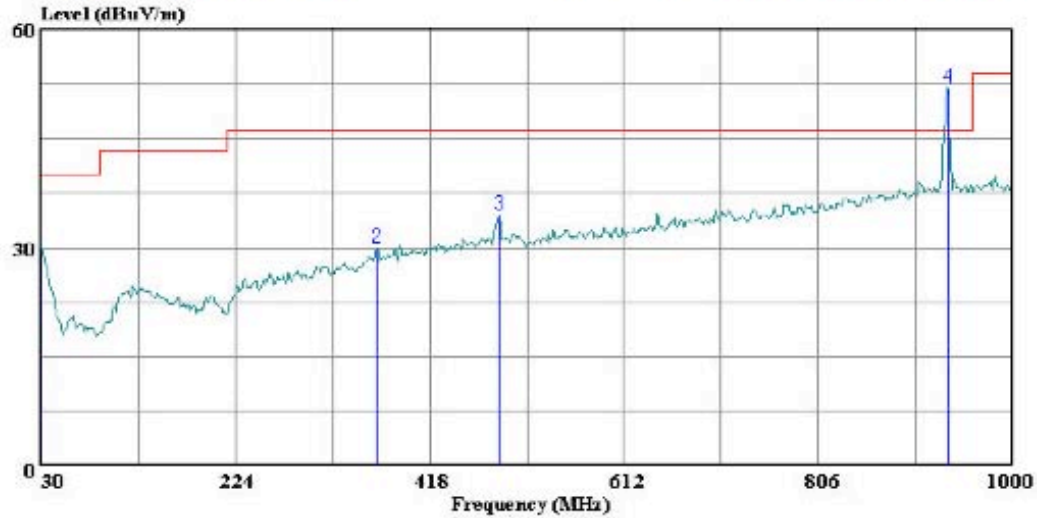
Page: 1

	Read		Limit	Over		
Freq	Level	Factor	Level	Line	Limit	Remark
MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1	31.700	9.80	19.99	29.79	40.00	-10.21 Peak
2	120.950	11.11	15.16	26.27	43.50	-17.23 Peak
3	426.950	13.94	18.67	32.61	46.00	-13.39 Peak
4	469.450	13.35	19.63	32.98	46.00	-13.02 Peak
5	486.450	14.05	19.96	34.01	46.00	-11.99 Peak
6	613.950	12.24	21.70	33.94	46.00	-12.06 Peak



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

Data#: 28 File#: 315.EMI Date: 06-01-2006 Time: 12:04:01



(Auxiliary ATC)

Trace: 27

Ref Trace:

Condition: FCC CLASS-B VERTICAL  
Test Operator: : Thanh Nguyen  
Company: : WJ Communication  
Project #: : 06U10315  
S/N: : RFID Reader, M/N SR320  
Configuration: : EUT and support equipment  
Mode of Operation: No transmit  
: With LAB DC supply

Page: 1

	Freq	Read Level	Factor	Level	Limit	Over	Remark
	MHz	dBuV	dB	dBuV/m	dBuV/m	dB	
1	30.000	9.21	20.45	29.66	40.00	-10.34	Peak
2	365.620	12.55	17.28	29.83	46.00	-16.17	Peak
3	487.840	14.56	20.00	34.56	46.00	-11.44	Peak
4 *	935.980	25.63	26.33	51.96	46.00	5.96	Peak

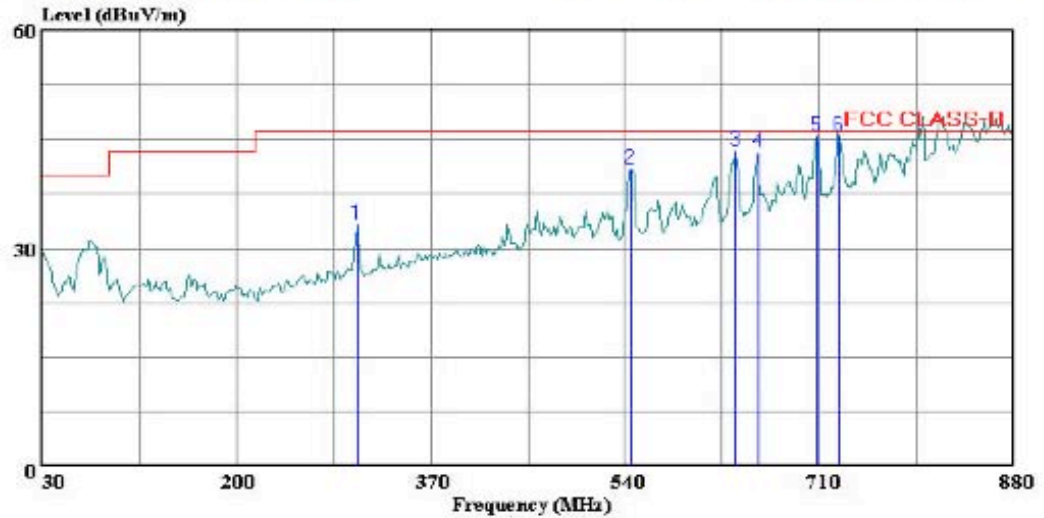
\* Emission generated by TX LO/VCO circuitry. -20 dBc limit applies





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Morgan Hill, CA 95037  
Tel: (408) 463-0888  
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Data#: 54 File#: 315.emi Date: 06-02-2006 Time: 13:58:56



(Auxiliary ATC)

Trace: 47

Ref Trace:

Condition: FCC CLASS-B VERTICAL  
Test Operator: : Thanh Nguyen  
Company: : WJ Communication  
Project #: : 06U10315  
S/N: : RFID Reader, M/N SR320  
Configuration: : EUT and support equipment  
Mode of Operation: Transmit High Channel, Reading class 1  
: Gen 2, RFID tag .With LAB DC supply  
: With CUI AC/DC Adapter M/N 3A-501DN24

Page: 1

	Freq	Read		Limit	Over	
	MHz	Level	Factor	Level	Line	Limit Remark
	MHz	dBuV	dB	dBuV/m	dBuV/m	dB
1	305.400	17.42	15.80	33.22	46.00	-12.78 Peak
2	545.100	20.03	20.81	40.83	46.00	-5.17 Peak
3	636.900	21.20	22.13	43.33	46.00	-2.67 Peak
4	656.450	20.73	22.45	43.18	46.00	-2.82 Peak
5	707.450	22.36	23.21	45.57	46.00	-0.43 Peak
6	727.000	21.87	23.53	45.40	46.00	-0.60 Peak

## 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  $\mu$ H/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

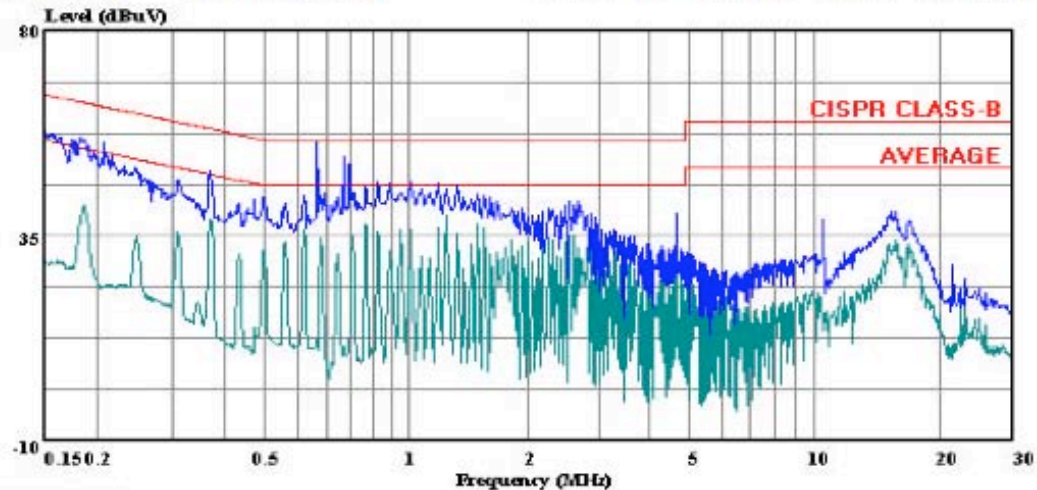
No non-compliance noted:

## LINE 1 RESULTS



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

Data#: 22 File#: 315.emi Date: 06-02-2006 Time: 12:10:15



(Auxiliary ATC)

Trace: 20

Ref Trace:

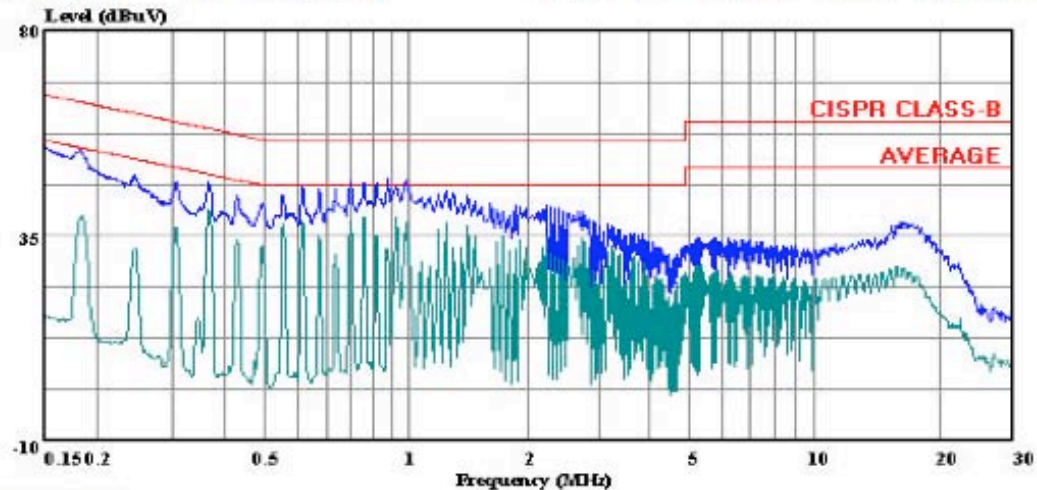
Condition: CISPR CLASS-B  
Test Operator : Thanh Nguyen  
Project # : 06U10315  
Company : WJ Communication  
EUT configuration: EUT w/ CUI AC/DC Adapter  
EUT mode : TX Class 3 RFID Tag (Worst case)  
Power Source : 115 VAC, 60 Hz  
: Line 1, Peak:(Blue), Average:(Green)

## LINE 2 RESULTS



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

Data#: 29 File#: 315.emi Date: 06-02-2006 Time: 12:28:54



(Auxiliary ATC)

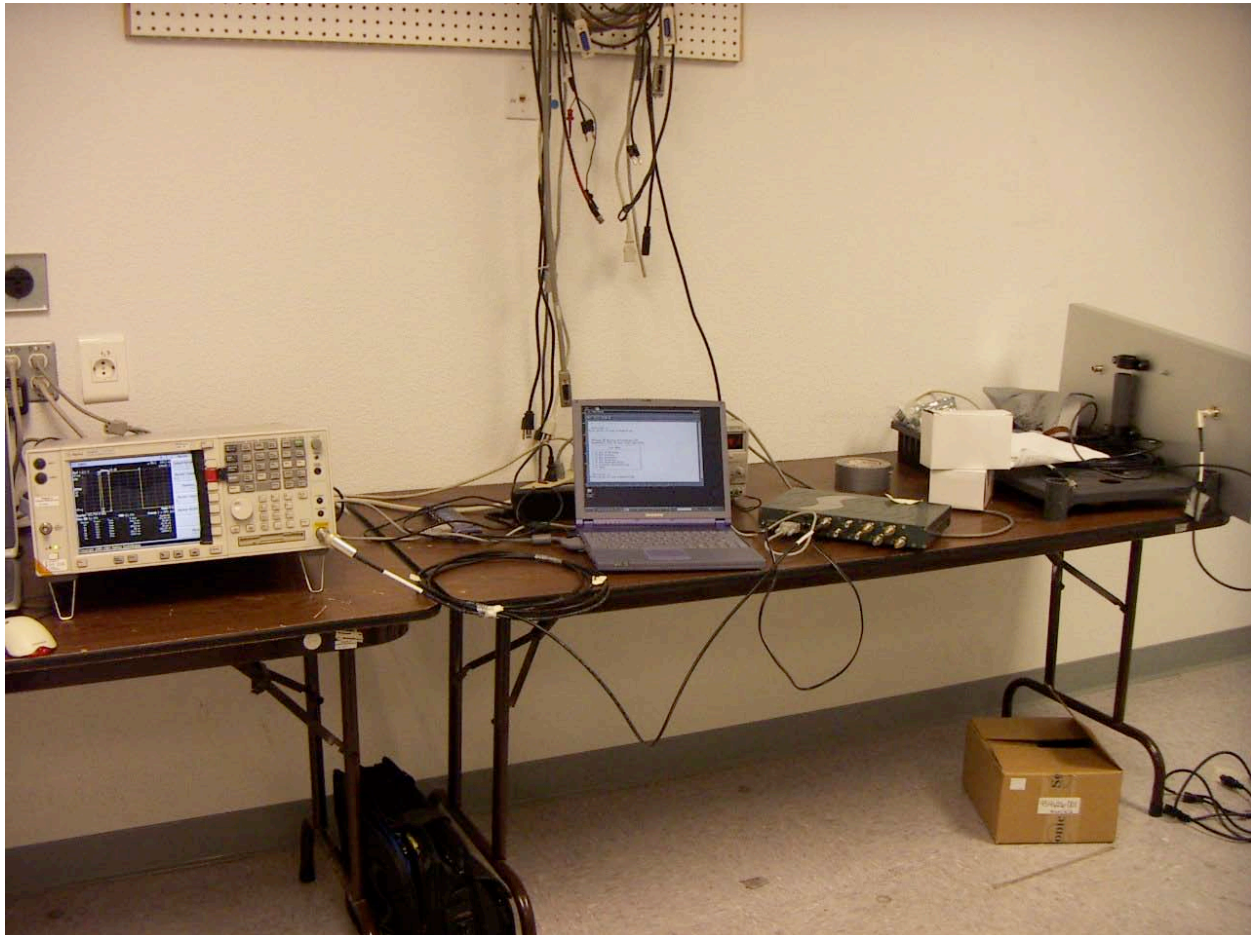
Trace: 27

Ref Trace:

Condition: CISPR CLASS-B  
Test Operator : Thanh Nguyen  
Project # : 06U10315  
Company : WJ Communication  
EUT configuration: EUT w/ CUI AC/DC Adapter  
EUT mode : TX Class 3 RFID Tag (Worst case)  
Power Source : 115 VAC, 60 Hz  
: Line 2, Peak:(Blue), Average:(Green)

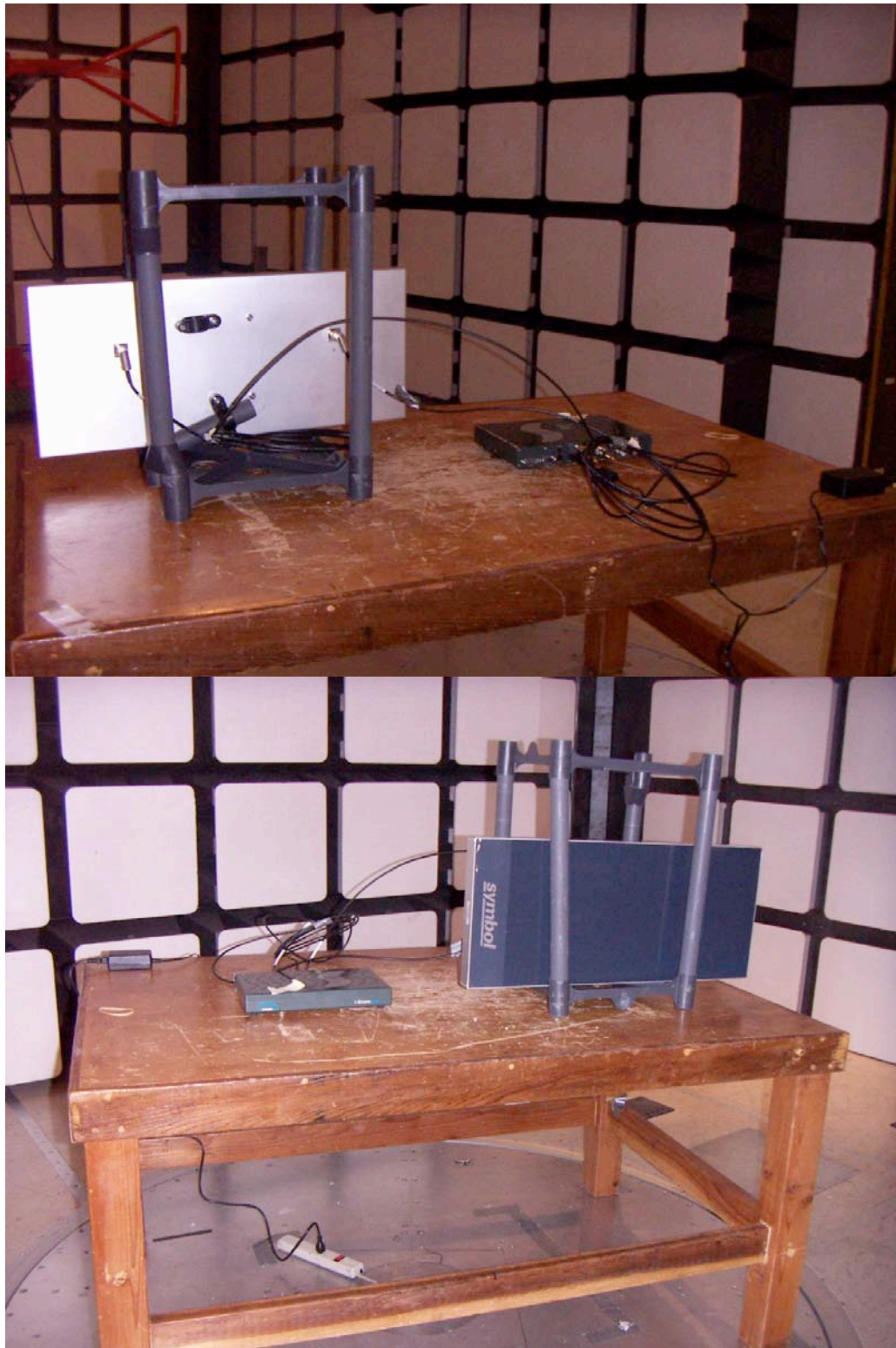
## 5. SETUP PHOTOS

### ANTENNA PORT CONDUCTED RF MEASUREMENT SETUP





**RADIATED RF MEASUREMENT SETUP**



**POWERLINE CONDUCTED EMISSIONS MEASUREMENT SETUP**



**END OF REPORT**

## 6. Report Revision History

Revision No.	Revision Description	Pages Revised	Revised by	Date
-	Original Issue		T. Cokenias	6/18/06
1.1	Update support equipment info and software/firmware info Insert correct data plots  Insert correct test setup photos	6,7,9  17,30,35,41,43,60, 68-73, 75  77-79	T. Cokenias	6/19/06