FCC Certification Test Report

FCC Certification Test Report for Matrics, Inc. FCC ID: PYFAR400US

June 18, 2004

Prepared for:

Matrics, Inc.
8850 Stanford Boulevard Ste 3000
Columbia, MD 21045

Prepared By:

Washington Laboratories, Ltd.
7560 Lindbergh Drive
Gaithersburg, Maryland 20879

FCC Certification Test Program

FCC Certification Test Report
for the
Matrics, Inc.
AR-400-US RFID Reader
FCC ID: PYFAR400US

June 18, 2004

WLL JOB# 8096

Prepared by: Brian J. Dettling
Documentation Specialist

Reviewed by: Gregory M. Snyder
Chief EMC Engineer

Abstract

This report has been prepared on behalf of Matrics, Inc. to support the attached Application for Equipment Authorization. The test report and application are submitted for a Frequency Hopping Spread Spectrum Transmitter under Part 15.247 of the FCC Rules and Regulations. This Federal Communication Commission (FCC) Certification Test Report documents the test configuration and test results for a Matrics, Inc. AR-400-US RFID Reader.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

The Matrics, Inc. AR-400-US RFID Reader complies with the limits for a Frequency Hopping Spread Spectrum Transmitter device under Part 15.247 of the FCC Rules and Regulations.

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1 Introduction

1.1 Compliance Statement

The Matrics, Inc. AR-400-US RFID Reader complies with the limits for a Frequency Hopping Spread Spectrum Transmitter device under Part 15.247 of the FCC Rules and Regulations.

1.2 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed. All measurements were performed in accordance with FCC Public Notice DA 00-705 and the 2001 version of ANSI C63.4. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	Matrics, Inc. 8850 Stanford Boulevard Ste 3000 Columbia, MD 21045
Purchase Order Number:	SOL693
Quotation Number:	61556

1.4 Test Dates

Testing was performed from April 14 to April 28, 2004.

1.5 Test and Support Personnel

Washington Laboratories, LTD	Greg Snyder, James Ritter, Ken Gemmell
Client Representative	Matt Truong

1.6 Abbreviations

A	Ampere
Ac	alternating current
AM	Amplitude Modulation
Amps	Amperes
b/s	bits per second
BW	Bandwidth
CE	Conducted Emission
cm	centimeter
CW	Continuous Wave
dB	decibel
dc	direct current
EMI	Electromagnetic Interference
EUT	Equipment Under Test
FM	Frequency Modulation
G	giga - prefix for 10^9 multiplier
Hz	Hertz
IF	Intermediate Frequency
k	kilo - prefix for 10^3 multiplier
M	Mega - prefix for 10^6 multiplier
m	Meter
μ	micro - prefix for 10^{-6} multiplier
NB	Narrowband
LISN	Line Impedance Stabilization Network
RE	Radiated Emissions
RF	Radio Frequency
rms	root-mean-square
SN	Serial Number
S/A	Spectrum Analyzer
V	Volt

2 Equipment Under Test

2.1 EUT Identification & Description

The Matrics, Inc. AR-400-US RFID Reader is a multi-protocol reader providing real-time tag processing for all EPC-compliant tags: Class 0 (Read), Class 0+ (Read/Write), and Class 1 (Read/Write). The system power output is selectable from 14.5dbm to 30dBm and operates in the 902 MHz to 928 MHz frequency band.

Power to the device is provided via an AC/DC converter.

Table 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	Matrics, Inc.
FCC ID Number	PYFAR400US
EUT Name:	RFID Reader
Model:	AR-400-US
FCC Rule Parts:	§15.247
Frequency Range:	902.729- 927.220 MHz
Maximum Output Power:	1W
Occupied Bandwidth:	347 kHz
Keying:	Automatic
Type of Information:	Data
Number of Channels:	50
Power Output Level	Variable from 14.5dBm to 30dBm.
Antenna Connector	8 ports (4-Tx, 4-Rx)
Antenna Type	6 dBi Flat Panel
Interface Cables:	Tx 1 & Rx 1 from EUT to CPU
Power Source & Voltage:	24Vdc from 100-240Vac

2.2 Test Configuration

The AR-400-US was connected via TX1 and RX1 ports to a 6dBi plate antenna. Only one of the ports was utilized as the unit switches to one port at a time. The unit was provided power via a 100-240VAC, +24VDC out AC/DC converter. Information was provided to the EUT via a RS-422 port and a DB9 comport line from support laptop PC. A ping was set up from laptop to the EUT to utilize the available LAN connection.

2.3 Testing Algorithm

The AR-400-US used a Hyperterminal (ART) to enter parameters for all non-hopping tests on low, middle, and high channels. Frequency hopping tests were conducted utilizing the Matrics Tag Tracker 4.0.2 program.

Tests were performed for both the high and low power settings. Worst case emission levels are provided in the test results data.

2.4 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

2.5 Measurements

2.5.1 References

FCC Public Notice DA 00-705, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems

ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation

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

2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. For the purposes of the measurements performed by Washington Laboratories, the measurement uncertainty is ±2.3 dB. This has been calculated for a *worst-case situation* (radiated emissions measurements performed on an open area test site).

The following measurement uncertainty calculation is provided:

$$\text{Total Uncertainty} = (A^2 + B^2 + C^2)^{1/2}/(n-1)$$

where:

A = Antenna calibration uncertainty, in dB = 2 dB

B = Spectrum Analyzer uncertainty, in dB = 1 dB

C = Site uncertainty, in dB = 4 dB

n = number of factors in uncertainty calculation = 3

Thus, Total Uncertainty = $0.5\ (2^2 + 1^2 + 4^2)^{1/2} = \pm 2.3$ dB.

3 Test Equipment

Table 2 shows a list of the test equipment used for measurements along with the calibration information.

Table 2: Test Equipment List

Site 2 List:

Manufacturer	Model/Type	Function	Identification	Cal. Due
HP	8568B	Spectrum Analyzer	2634A02888	7/07/04
HP	85650A	Quasi-Peak Adapter	3303A01786	7/08/04
HP	HP 8593A	Spectrum Analyzer	3009A00739	6/25/04
HP	8449B	Microwave Preamp	3008A00385	9/29/05
Solar	8012-50-R-24BNC	LISN	8379493	6/30/04
ARA	LPB-2520	BiconiLog Antenna	1044	6/20/04
ARA	DRG118/A	Microwave Horn Antenna	1236	4/17/05
HP	85685A	RF Preselector	3221A01395	7/07/04
EMCO	3110B	Biconical Antenna	9808-1078	6/20/04
EMCO	3146A	Log Periodic Antenna	8912-1129	6/20/04

4 Test Results

4.1 Duty Cycle Correction

In accordance with the FCC Public Notice the spurious radiated emissions measurements June be adjusted if using a duty cycle correction factor if the dwell time per channel of the hopping signal is less than 100 ms.

The duty cycle correction factor is calculated by:

20 x LOG (dwell time/100 ms)

The following figure shows the plot of the dwell time for the transmitter. Based on this plot, the dwell time per hop is 7 ms. Since there are 50 channels, and all channels are to be used equally, it will be approximately 350ms before the hop could return to this channel. Therefore the total dwell time per 100ms is 7ms. This corresponds to a duty cycle correction of 23dB, however, the maximum allowed duty cycle correction is 20dB. Also, in accordance with 15.247(a)(1)(i) the average time of occupancy on any channel shall be no greater than 0.4 seconds within a 10 second period for this type of device. Based on the dwell time information the average time of occupancy on any channel will be 200ms.

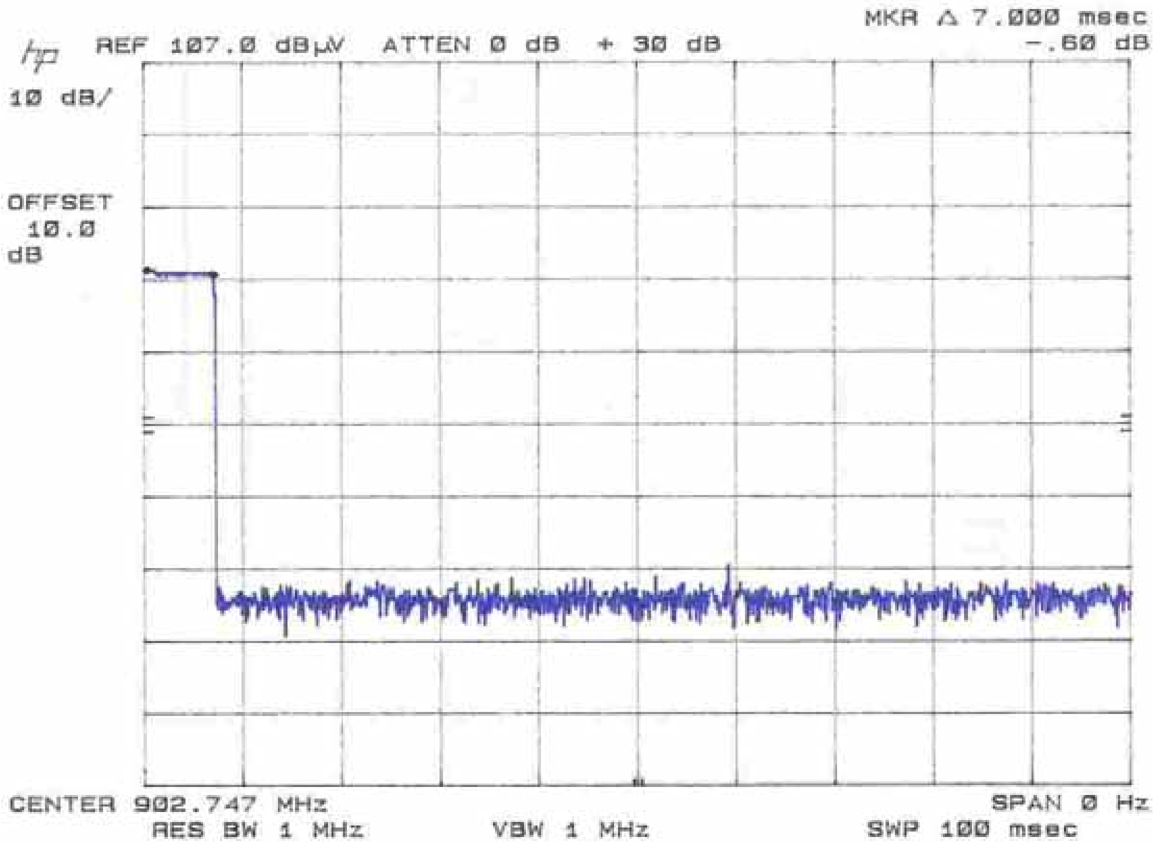

Figure 4-1. Duty Cycle Plot

4.2 RF Power Output: (FCC Part §2.1046)

To measure the output power the hopping sequence was stopped while the frequency dwelled on a low, high and middle channel. This was conducted at both the low power setting and the high power setting. The output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum Analyzer. The analyzer offset was adjusted to compensate for the attenuator and other losses in the system.

Table 3. RF Power Output

Frequency	Power Setting	Level	Limit	Pass/Fail
Low Channel 902.7MHz	Low High	14.33 dBm 30.00 dBm	30 dBm 30 dBm	Pass
Mid Channel 915MHz	Low High	14.5 dBm 30.00 dBm	30 dBm 30 dBm	Pass
High Channel 928MHz	Low High	14.5 dBm 30.00 dBm	30 dBm 30 dBm	Pass

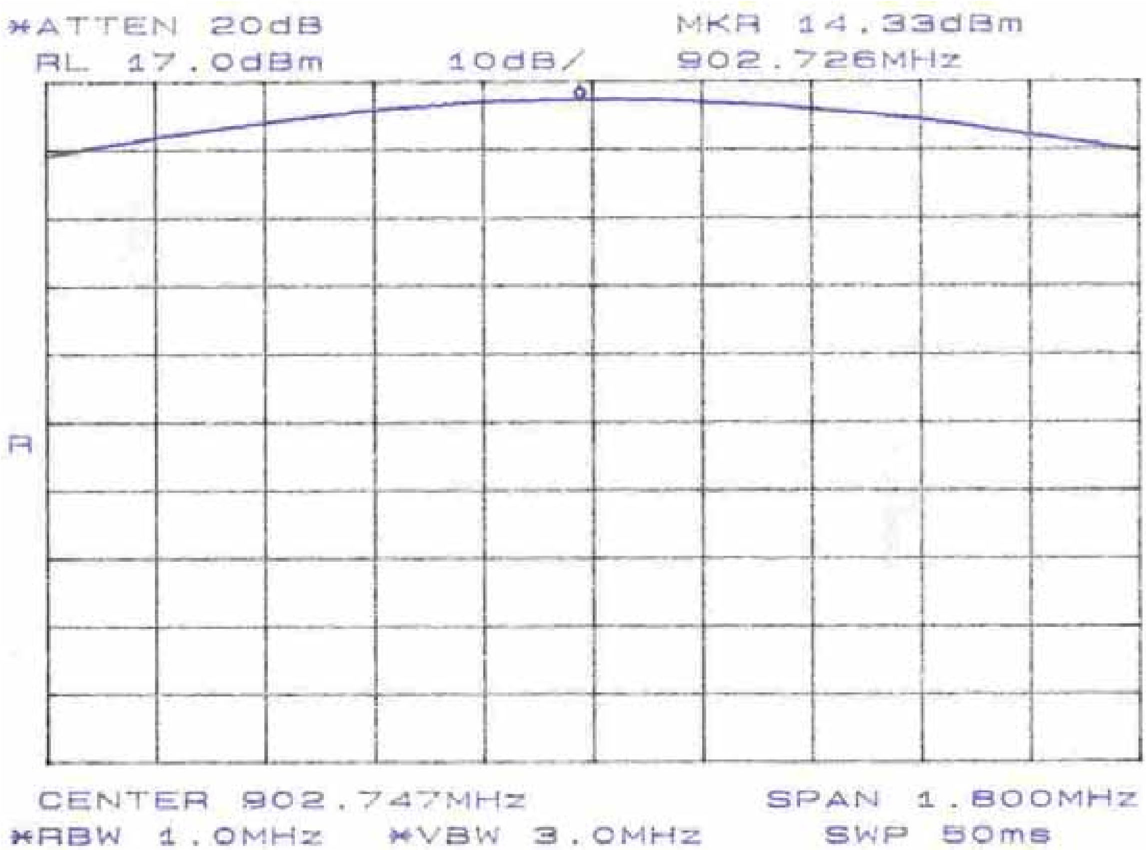

Figure 4-2. Low Level RF Peak Power, Low Channel

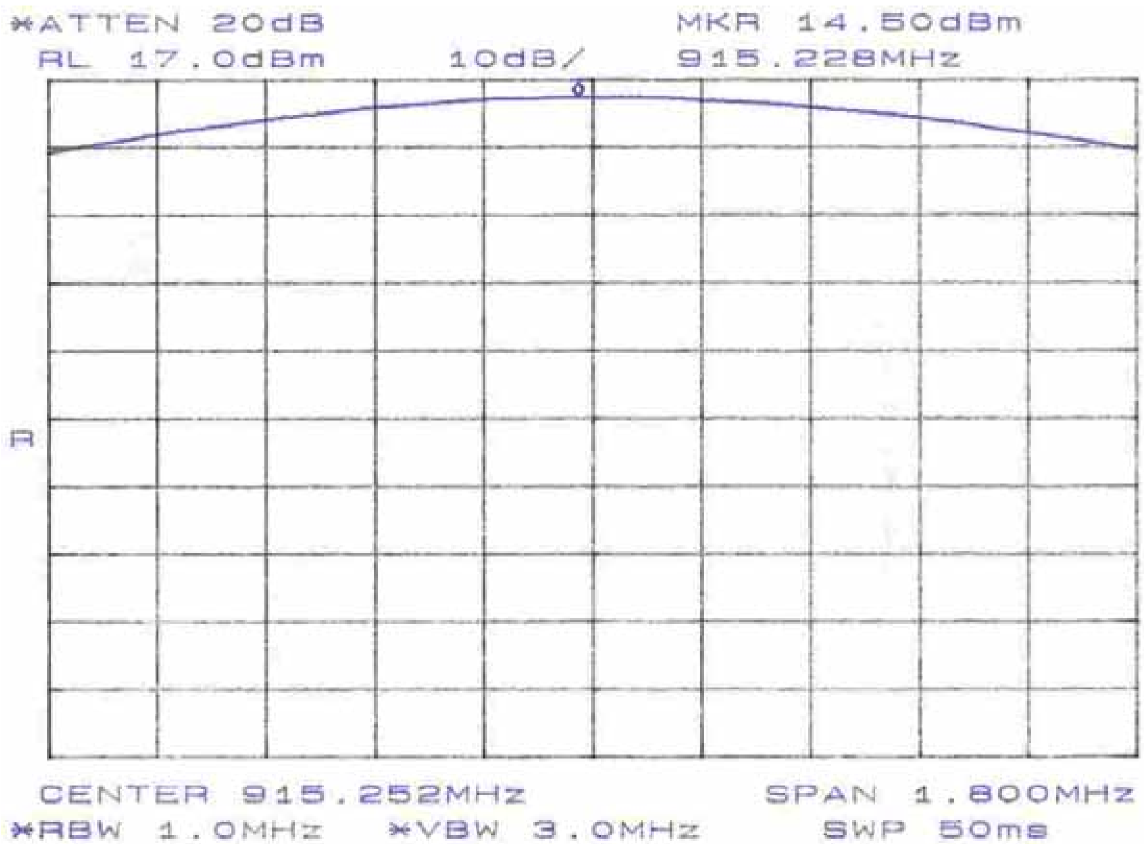

Figure 4-3. Low Level RF Peak Power, Mid Channel

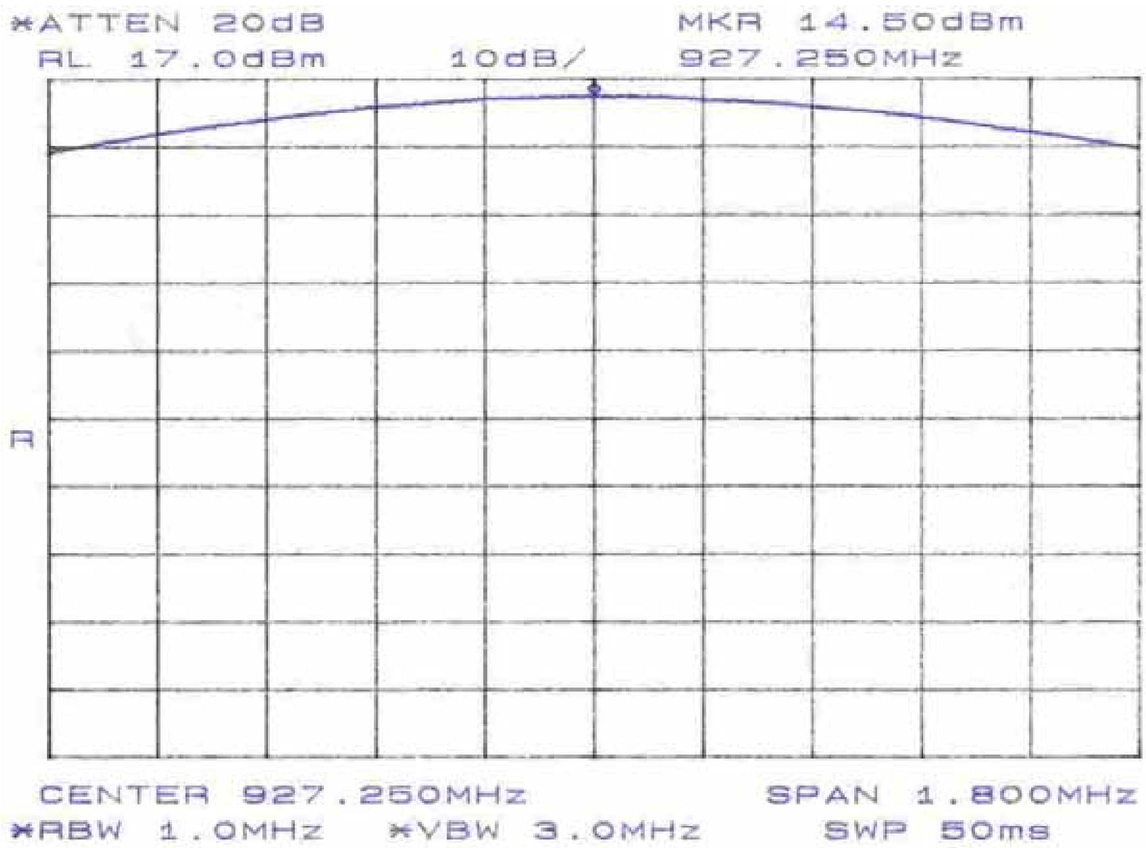

Figure 4-4. Low Level RF Peak Power, High Channel

Figure 4-5. High Level RF Peak Power, Low Channel

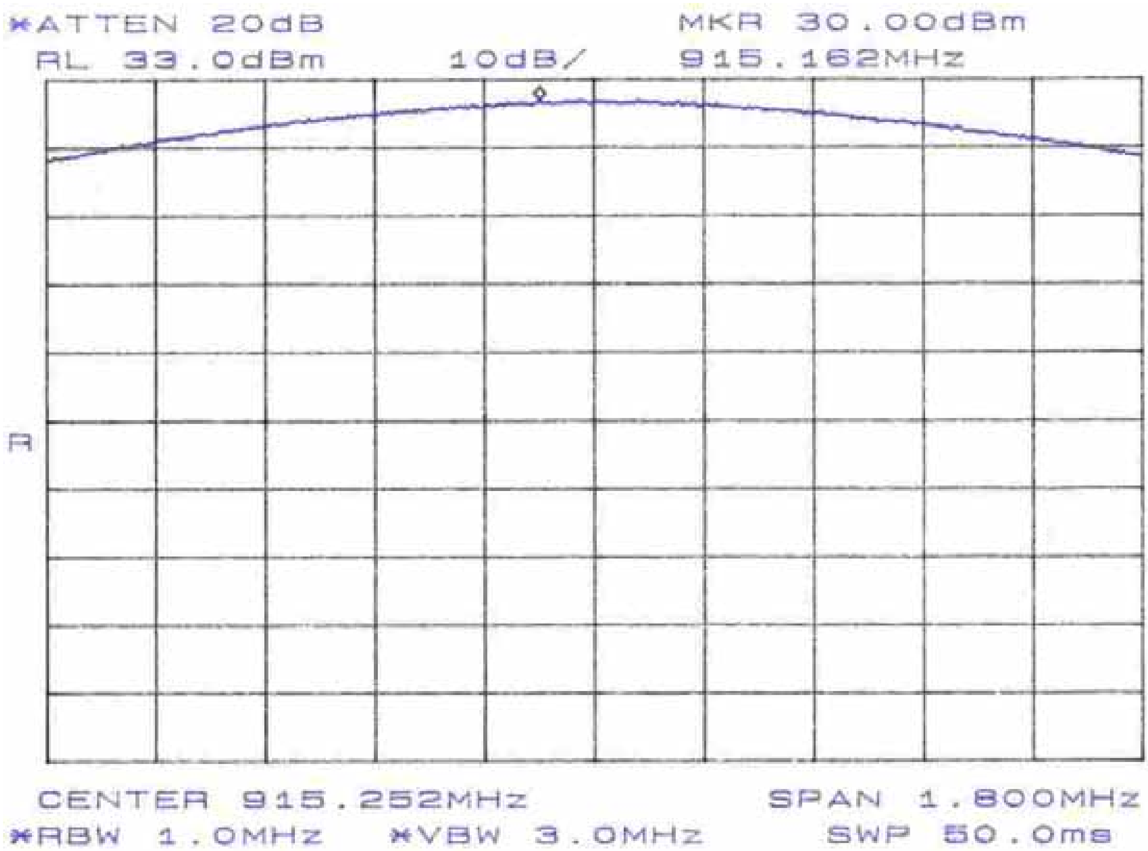

Figure 4-6. High Level RF Peak Power, Mid Channel

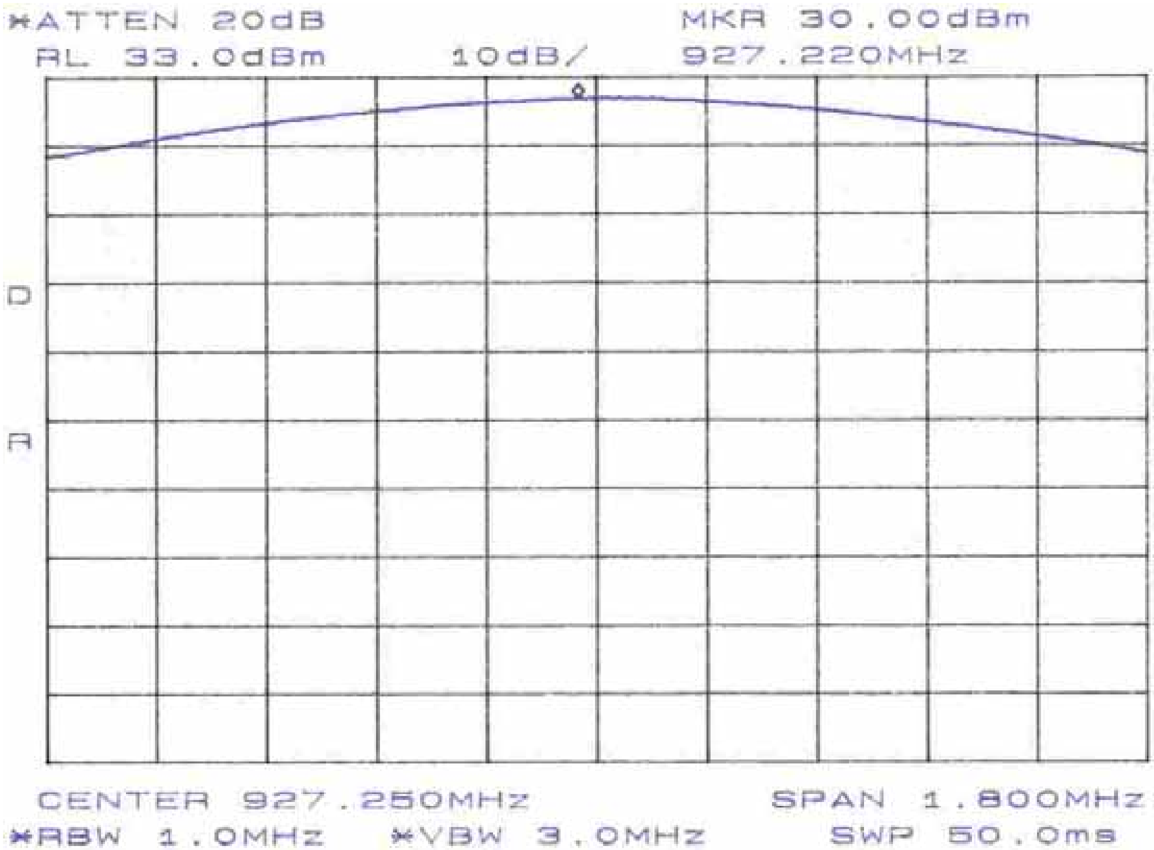

Figure 4-7. High Level RF Peak Power, High Channel

4.3 Occupied Bandwidth: (FCC Part §2.1049)

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer. This was accomplished at the low power setting and the high power setting.

For Frequency Hopping Spread Spectrum Systems, FCC Part 15.247 requires the maximum 20 dB bandwidth not exceed 1MHz.

At full modulation, the occupied bandwidth was measured as shown:

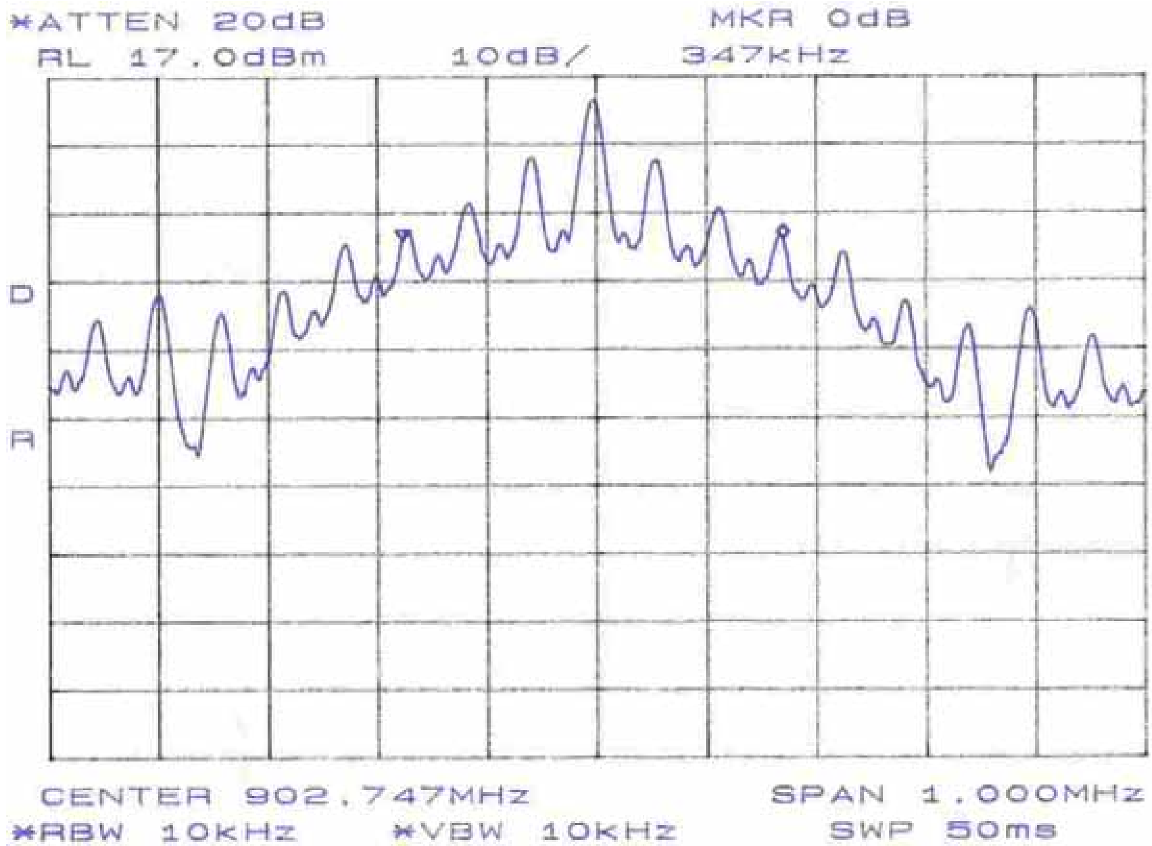

Figure 4-8. Low Power Occupied Bandwidth, Low Channel

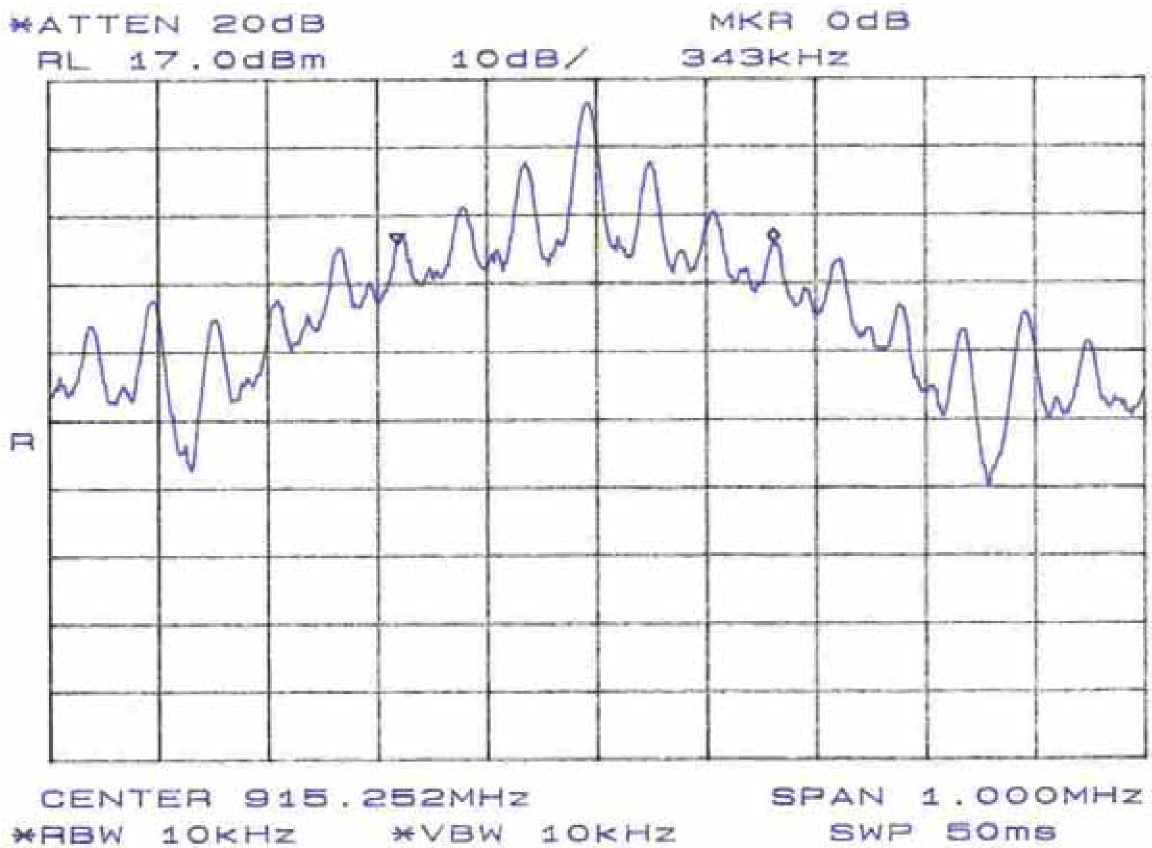

Figure 4-9. Low Power Occupied Bandwidth, Mid Channel

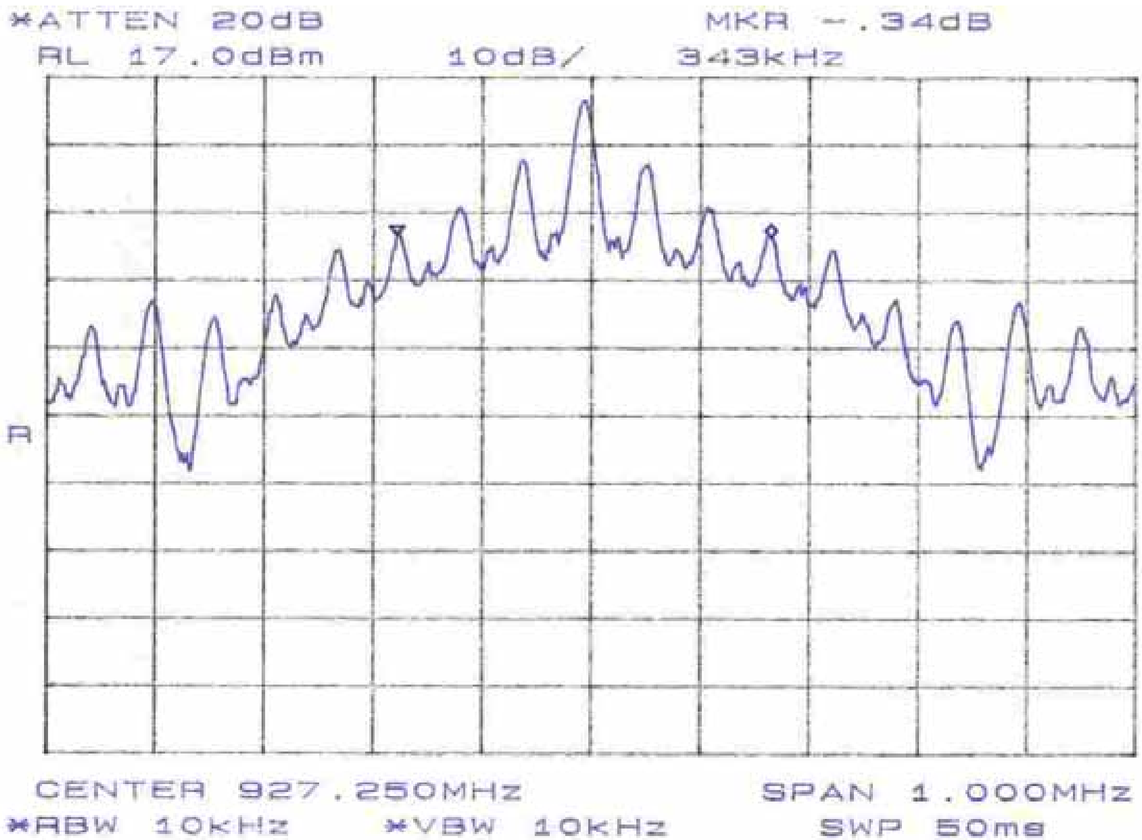

Figure 4-10. Low Power Occupied Bandwidth, High Channel

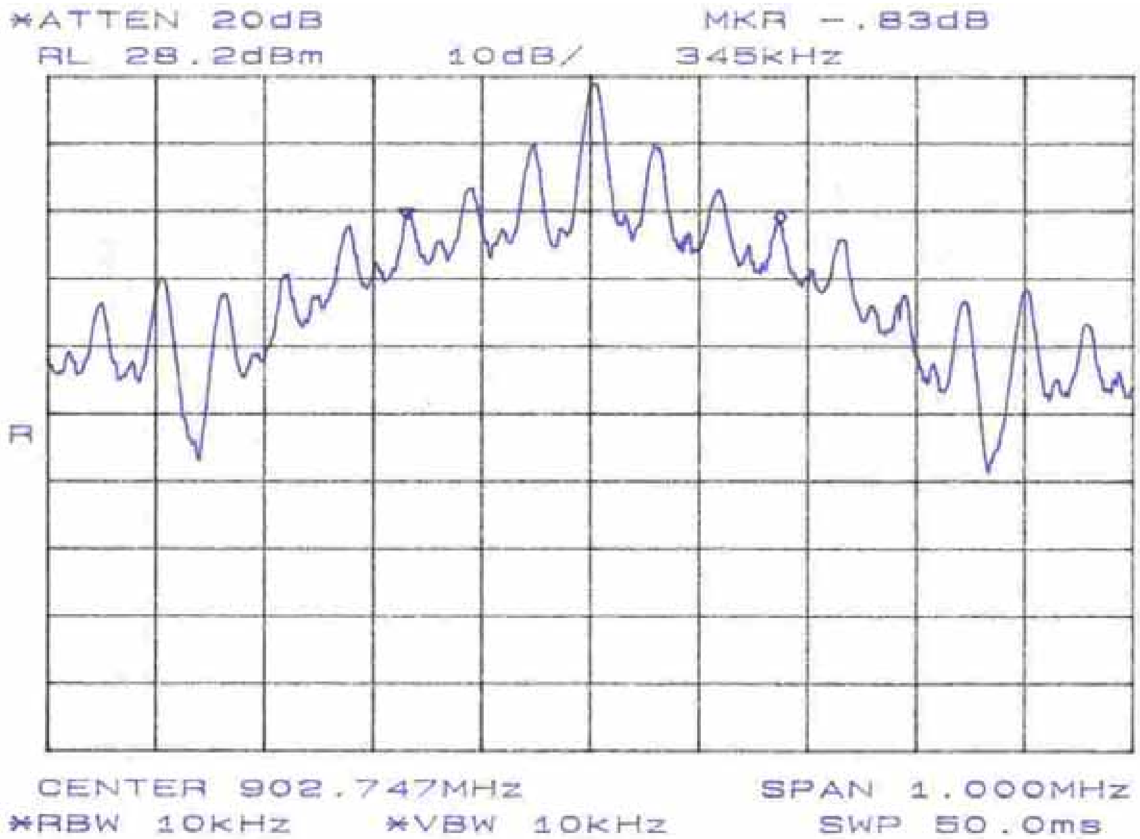

Figure 4-11. High Power Occupied Bandwidth, Low Channel

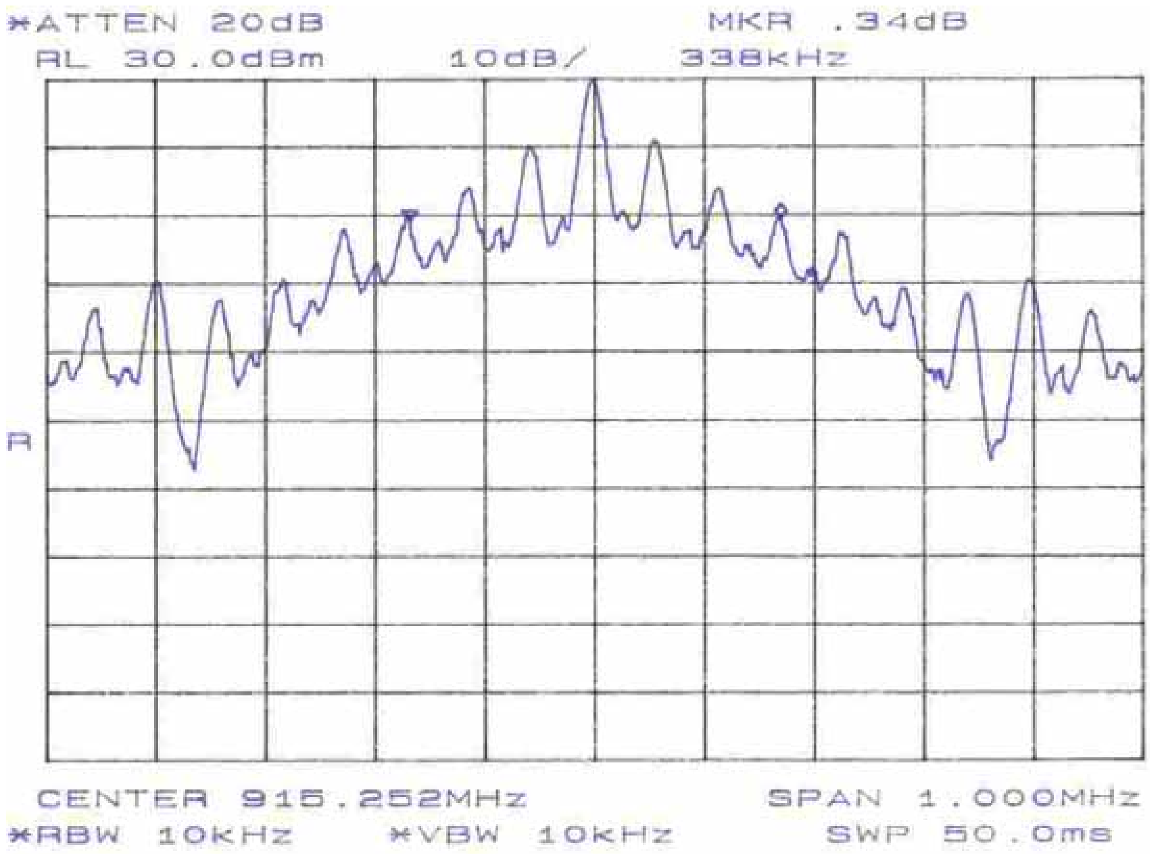

Figure 4-12. High Power Occupied Bandwidth, Mid Channel

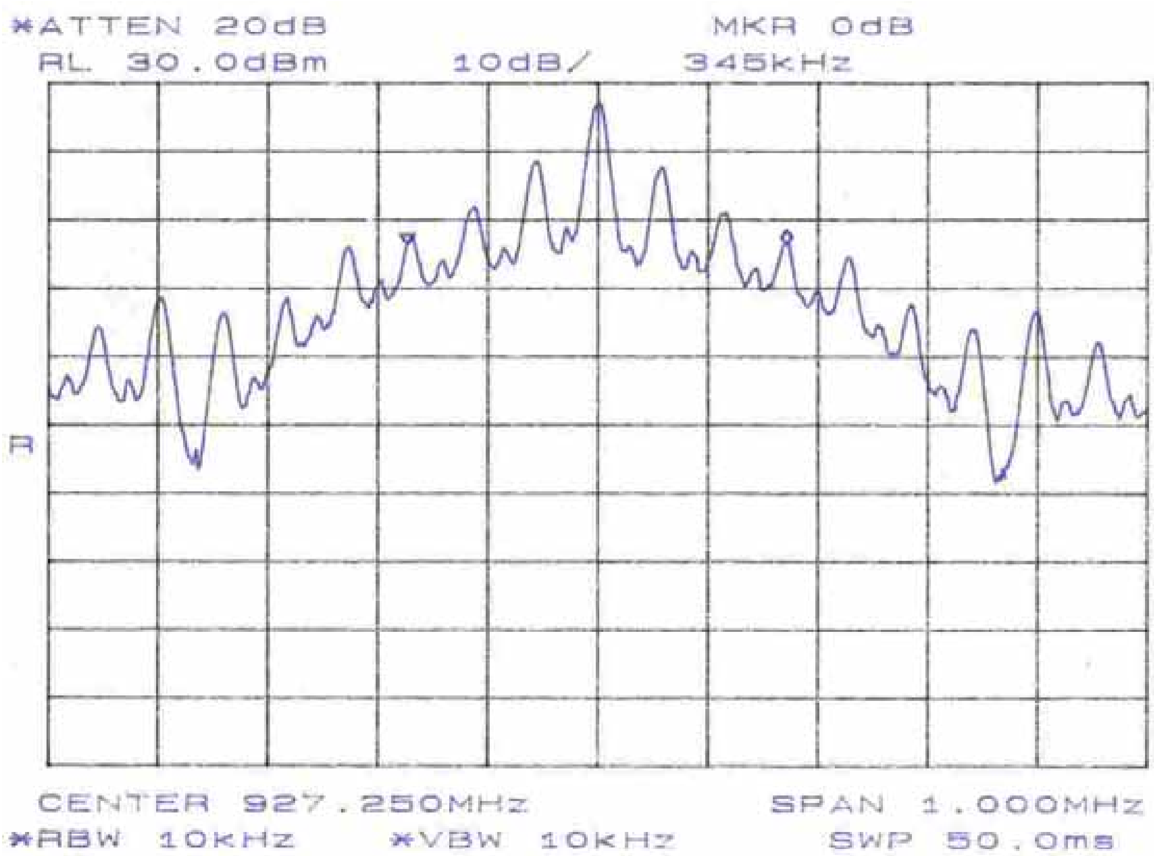

Figure 4-13. Hi Power Occupied Bandwidth, High Channel

Table 4 provides a summary of the Occupied Bandwidth Results.

Table 4. Occupied Bandwidth Results

Frequency	Power Setting	Bandwidth	Limit	Pass/Fail
Low Channel 902.7MHz	Low High	347kHz 345kHz	500 kHz 500 kHz	Pass
Mid Channel 915MHz	Low High	343kHz 338kHz	500 kHz 500 kHz	Pass
High Channel 928MHz	Low High	343kHz 345kHz	500 kHz 500 kHz	Pass

4.4 Channel Spacing and Number of Hop Channels (FCC Part §15.247(a)(1)

Per the FCC requirements, frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20dB bandwidth, whichever is greater. The maximum 20dB bandwidth measured is 347 kHz so the channel spacing must be more than 347 kHz. Additionally, a device operating from 902 MHz to 928 MHz with a bandwidth greater than 250 kHz must have a minimum of 25 hop channels.

The EUT antenna was removed and the cable was connected directly into a spectrum analyzer through a 10 dB attenuator. An offset was programmed into the spectrum analyzer to compensate for the loss of the external attenuator. The spectrum analyzer resolution bandwidth was set to 30 kHz and the video bandwidth was set to 100 kHz. The channel spacing of 2 adjacent channels was measured using a spectrum analyzer span setting of 1 MHz. Also, the number of hopping channels was measured from 902 MHz to 928 MHz.

The following are plots of the channel spacing and number of hopping channels data. The channel spacing was measured to be 502 kHz and the number of channels used is 50.

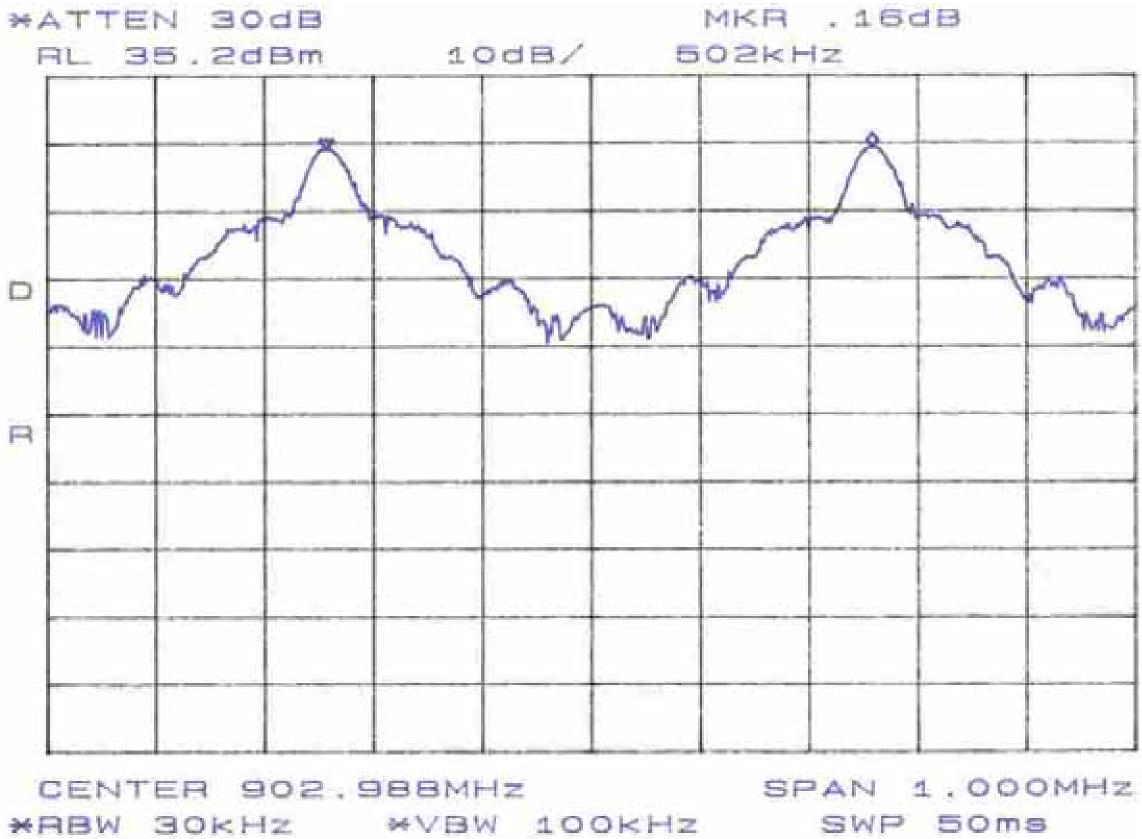

Figure 4-14, Channel Spacing, 502kHz

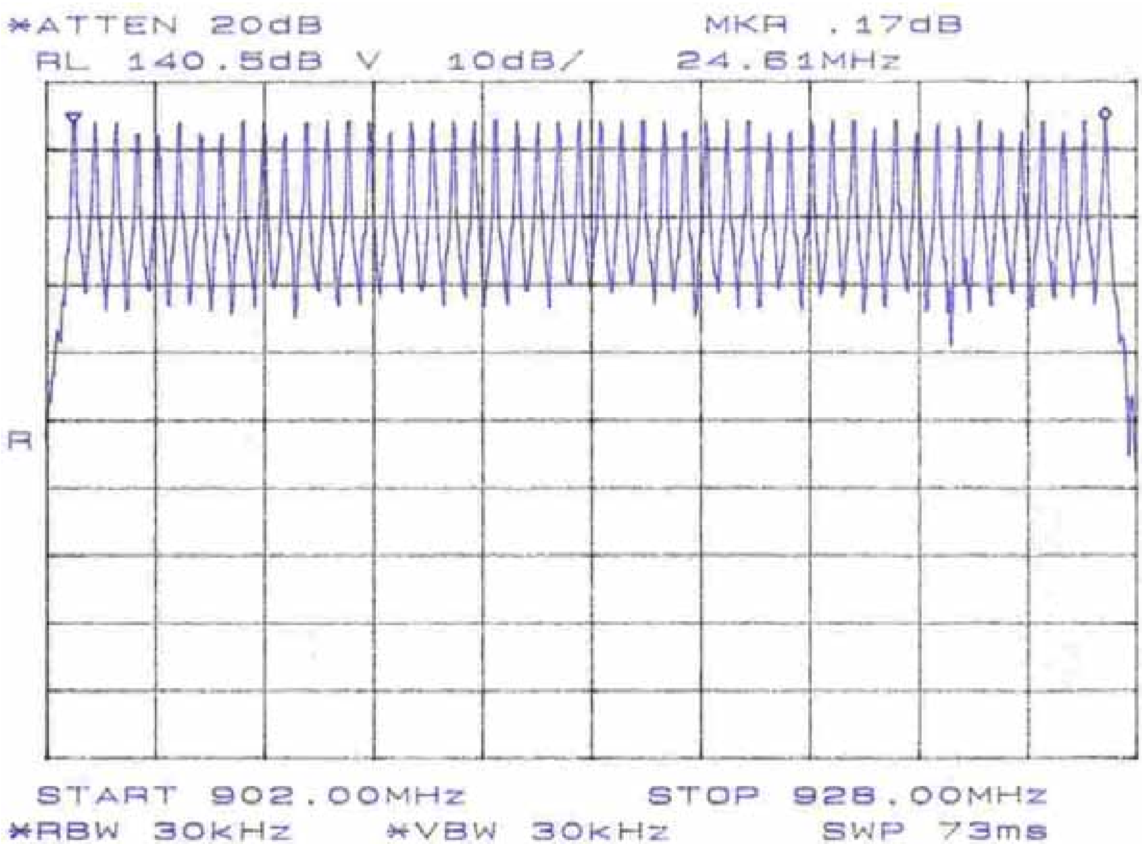

Figure 4-15, Number of Channels

4.5 Conducted Spurious Emissions at Antenna Terminals (FCC Part §2.1051)

The EUT must comply with requirements for spurious emissions at antenna terminals. Per §15.247(c) all spurious emissions in any 100 kHz bandwidth outside the frequency band in which the spread spectrum device is operating shall be attenuated 20 dB below the highest power level in a 100 kHz bandwidth within the band containing the highest level of the desired power.

The EUT antenna was removed and the cable was connected directly into a spectrum analyzer through a 10 dB attenuator. An offset was programmed into the spectrum analyzer to compensate for the loss of the external attenuator. The spectrum analyzer resolution bandwidth was set to 100 kHz and the video bandwidth was set to 1 MHz. The amplitude of the EUT carrier frequency was measured to determine the emissions limit (20 dB below the carrier frequency amplitude). The emissions outside of the allocated frequency band were then scanned from 30 MHz up to the tenth harmonic of the carrier. Spurious emissions were measured at both the low power and high power settings.

The following are plots of the conducted spurious emissions data.

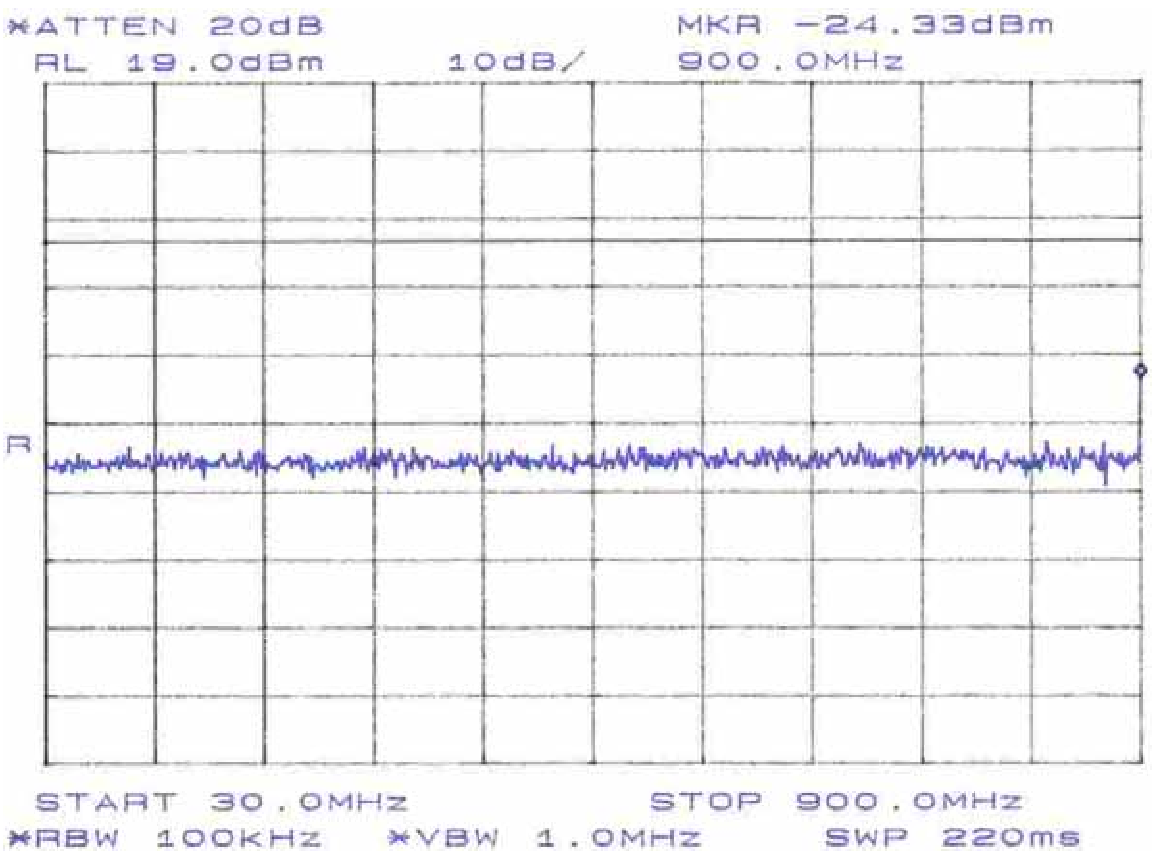

Figure 4-16. Low Power Conducted Spurious Emissions, Low Channel 30 - 900MHz

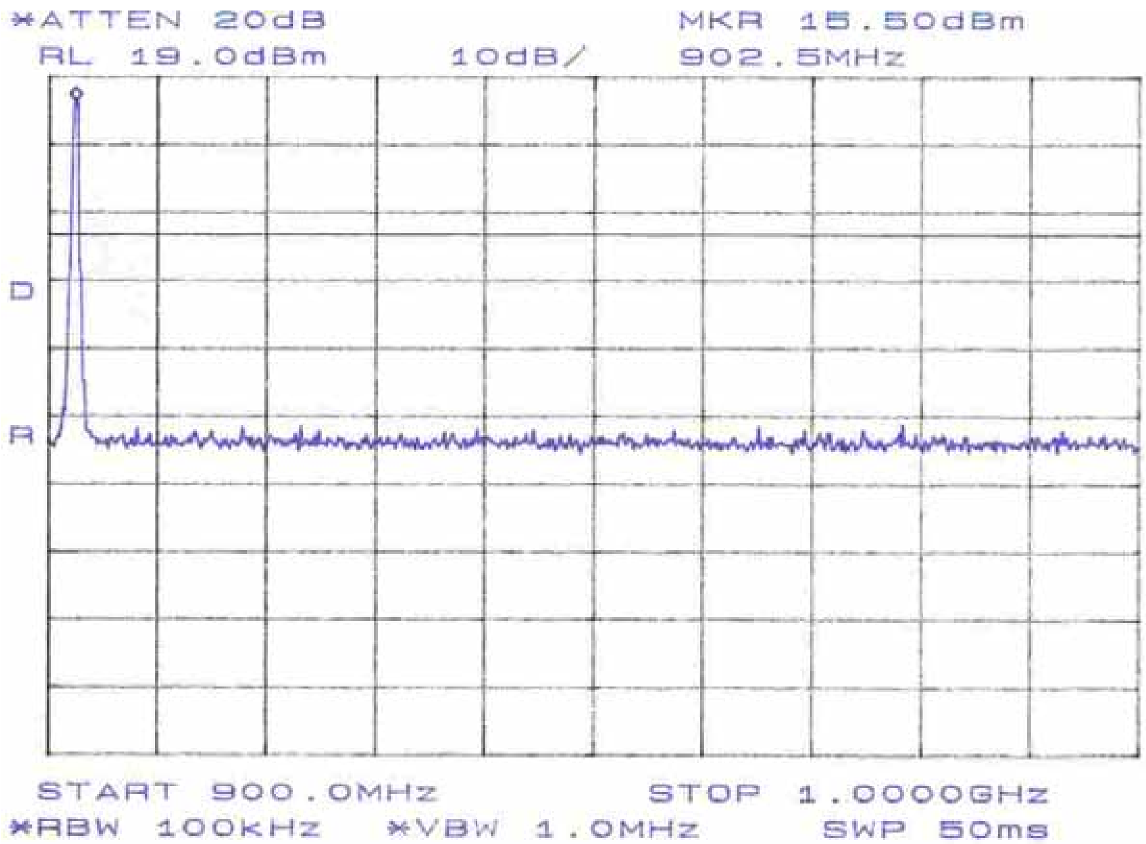

Figure 4-17. Low Power Conducted Spurious Emissions, Low Channel 900MHz - 1GHz

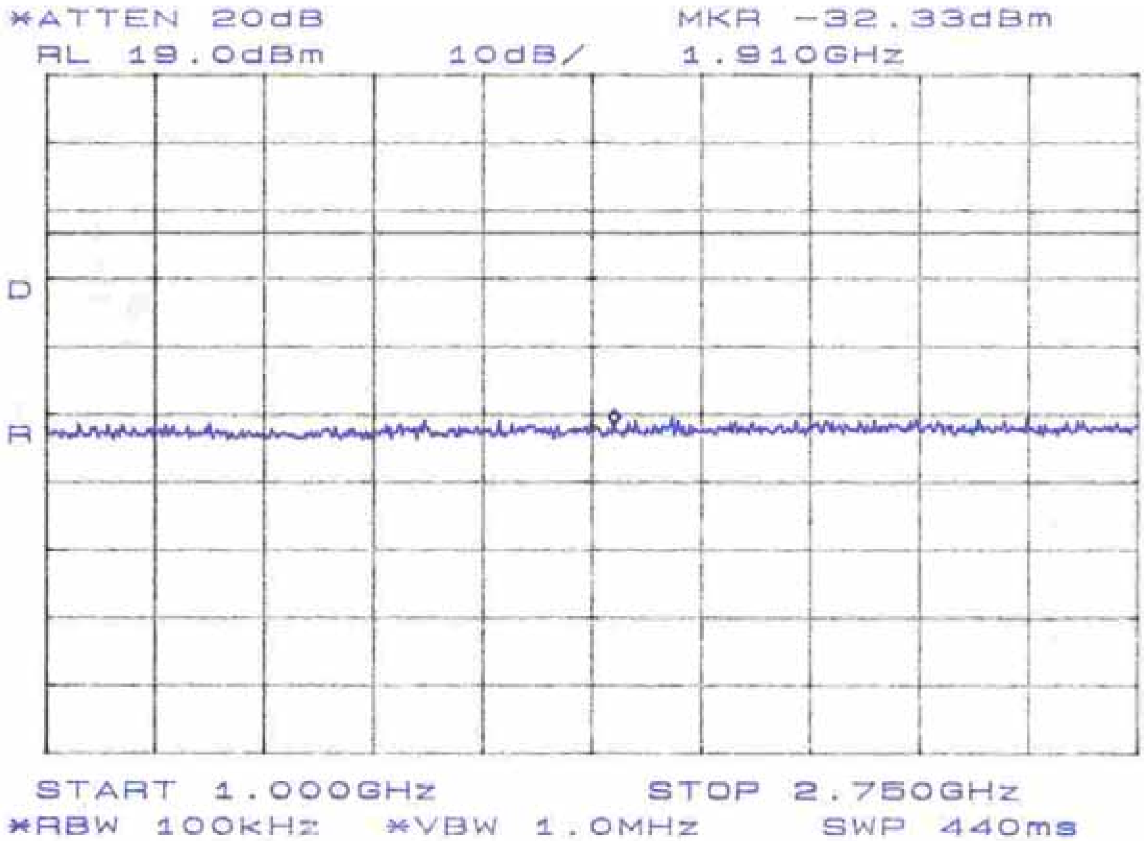

Figure 4-18. Low Power Conducted Spurious Emissions, Low Channel 1 – 2.75GHz

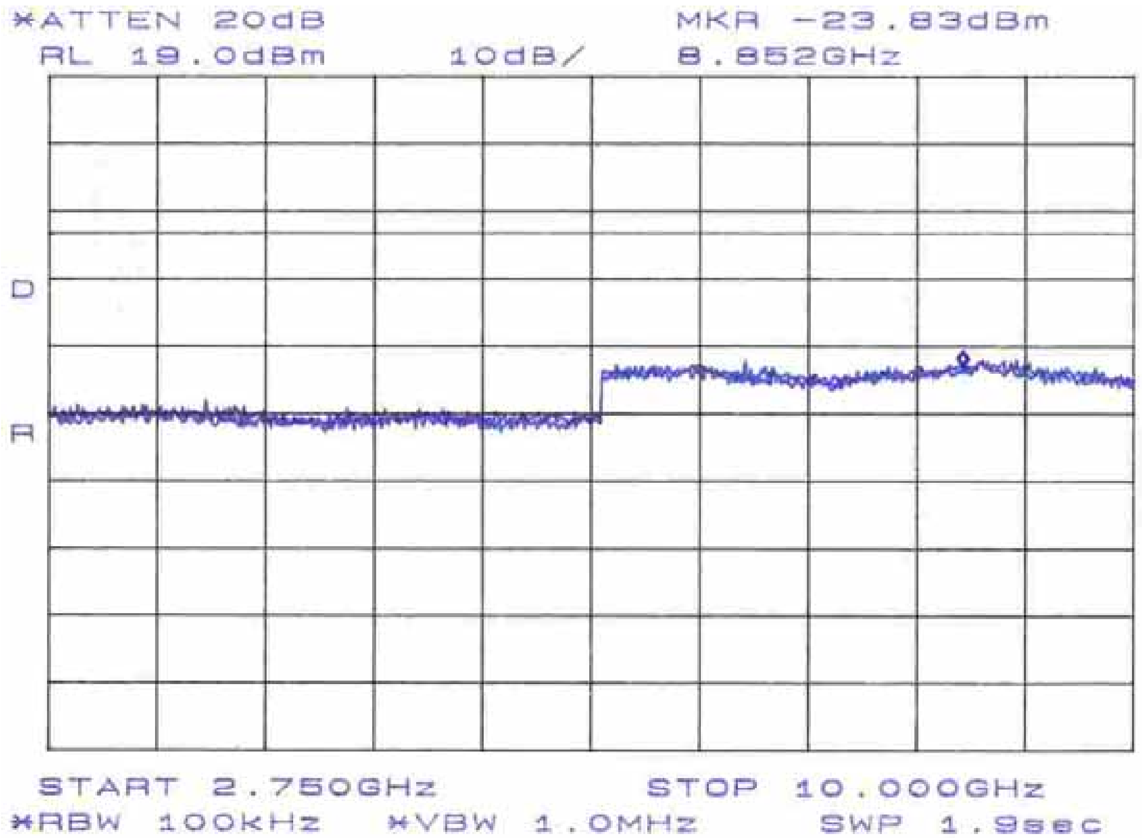

Figure 4-19. Low Power Conducted Spurious Emissions, Low Channel 2.75 – 10GHz

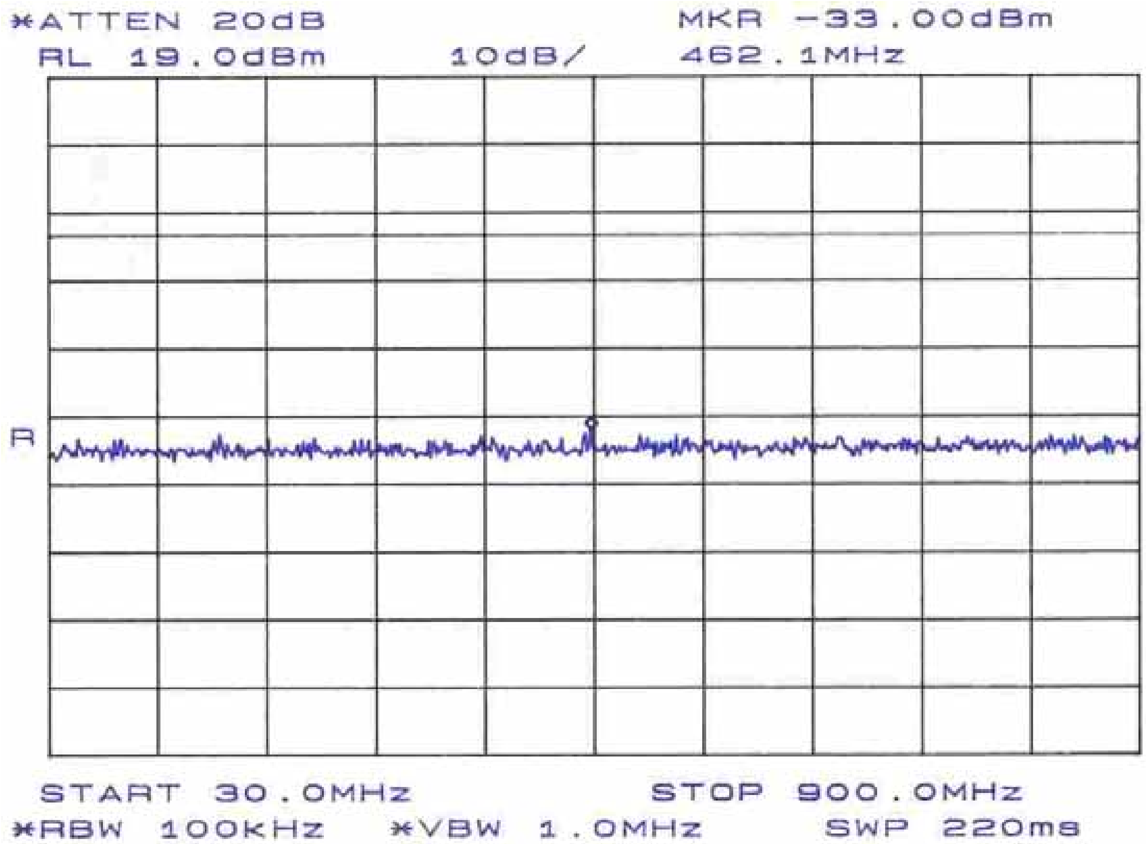

Figure 4-20. Low Power Conducted Spurious Emissions, Mid Channel 30 - 900MHz

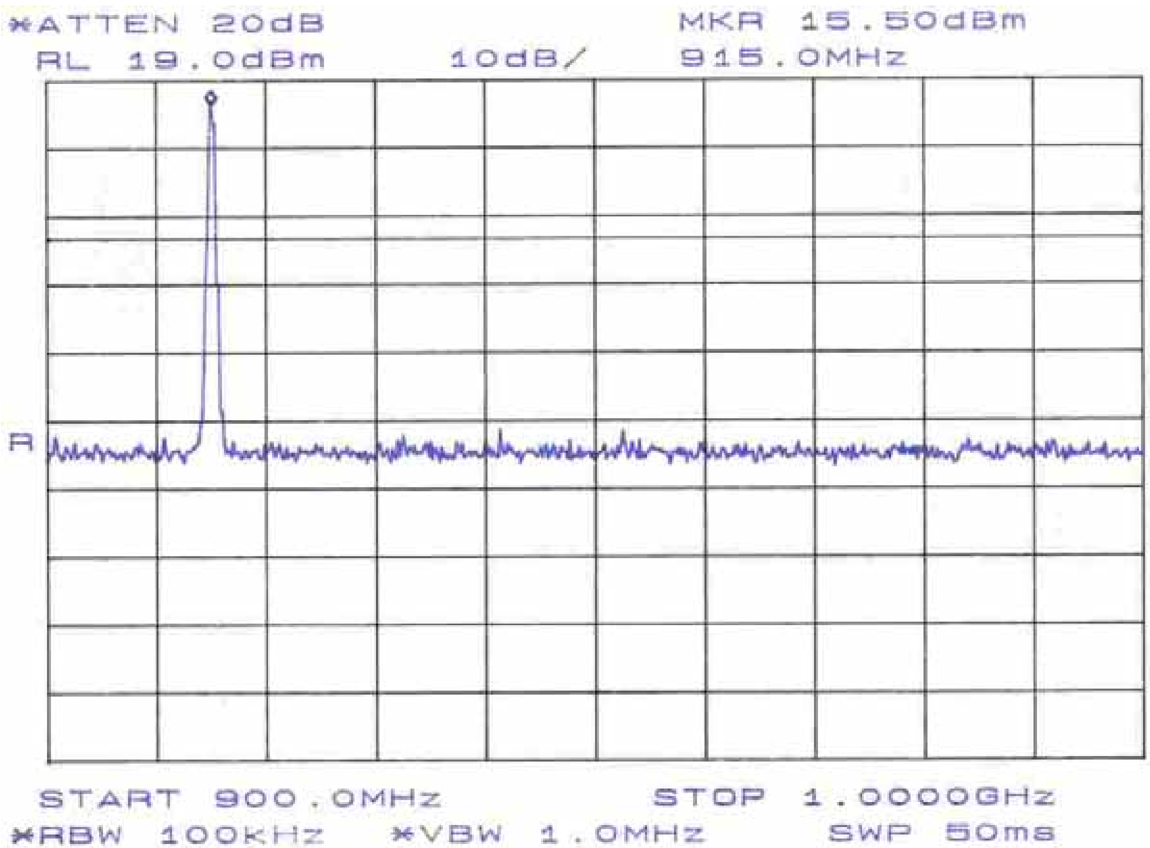

Figure 4-21. Low Power Conducted Spurious Emissions, Mid Channel 900MHz - 1GHz

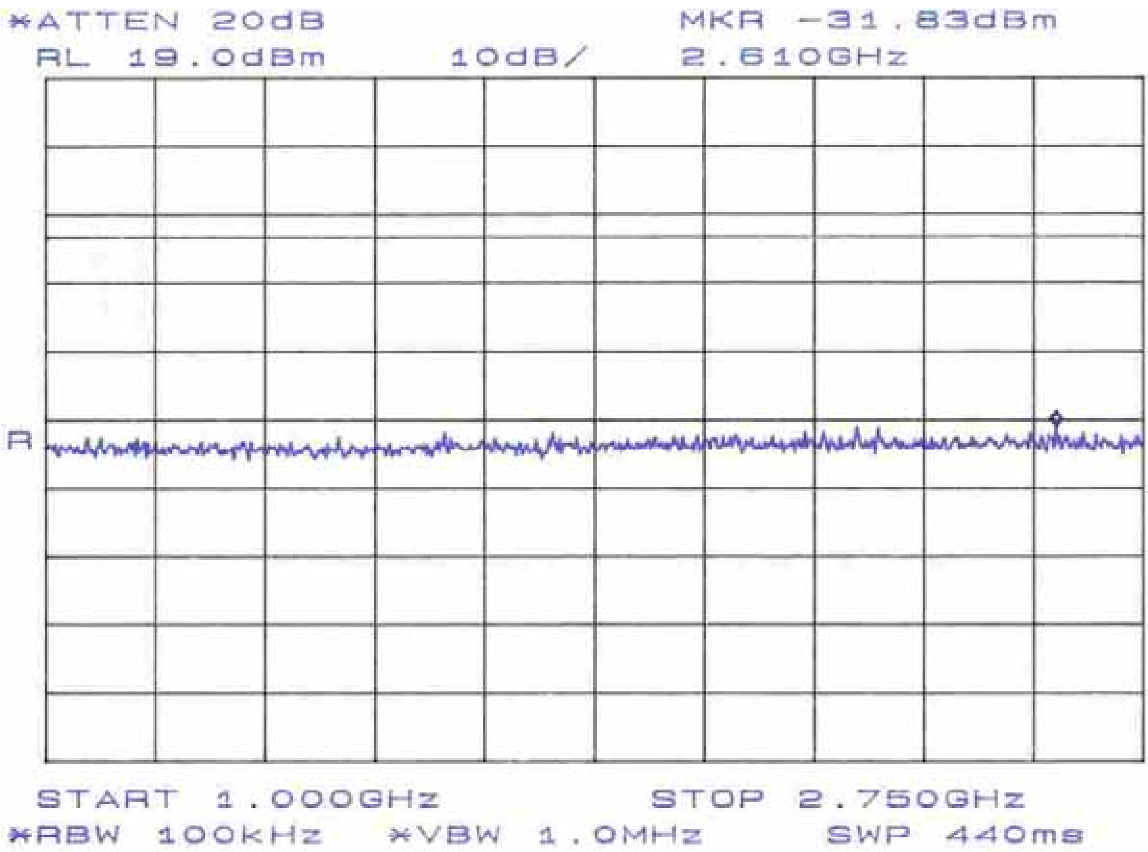

Figure 4-22. Low Power Conducted Spurious Emissions, Mid Channel 1 – 2.75GHz

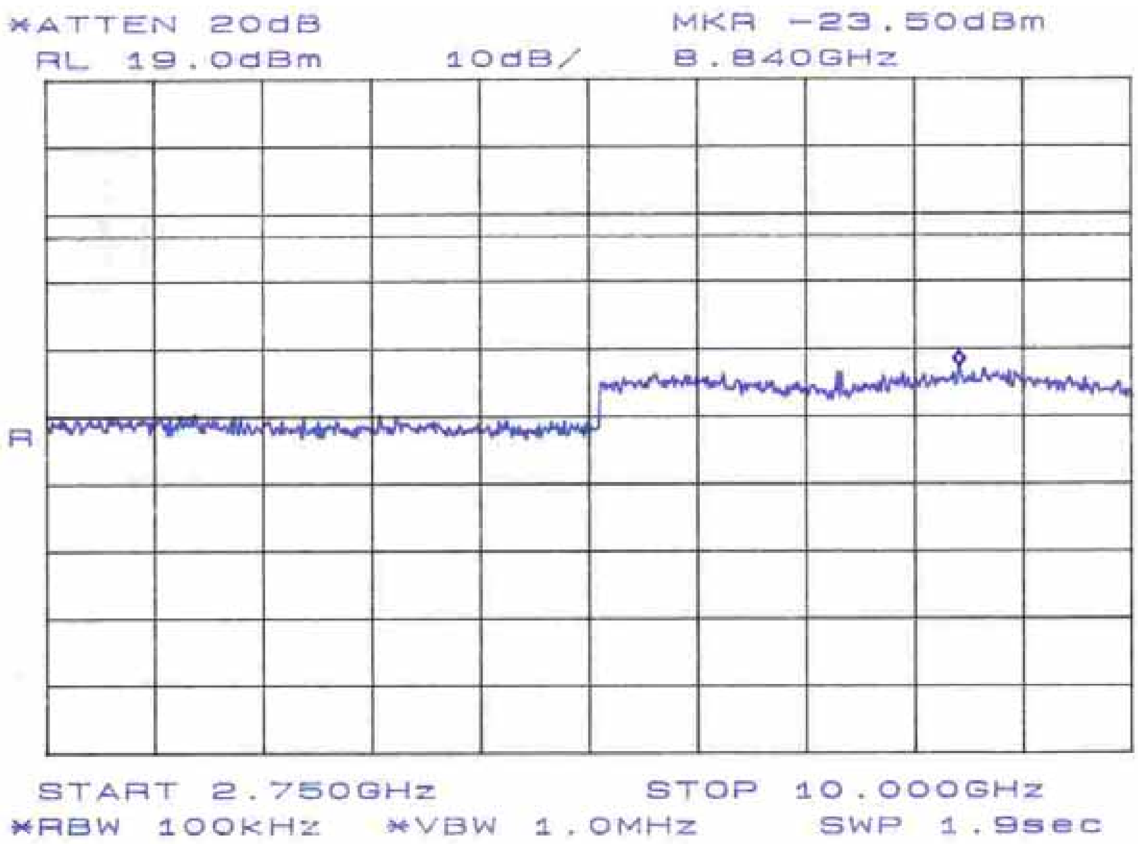

Figure 4-23. Low Power Conducted Spurious Emissions, Mid Channel 2.75 -10GHz

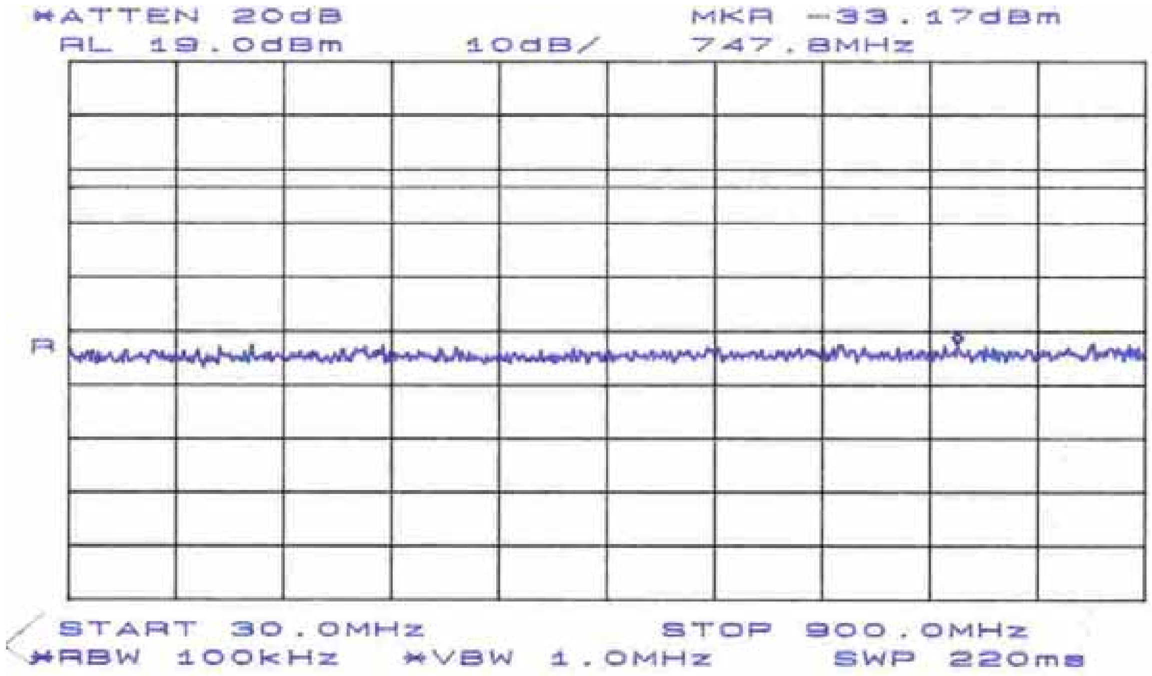

Figure 4-24. Low Power Conducted Spurious Emissions, High Channel 30 - 900MHz

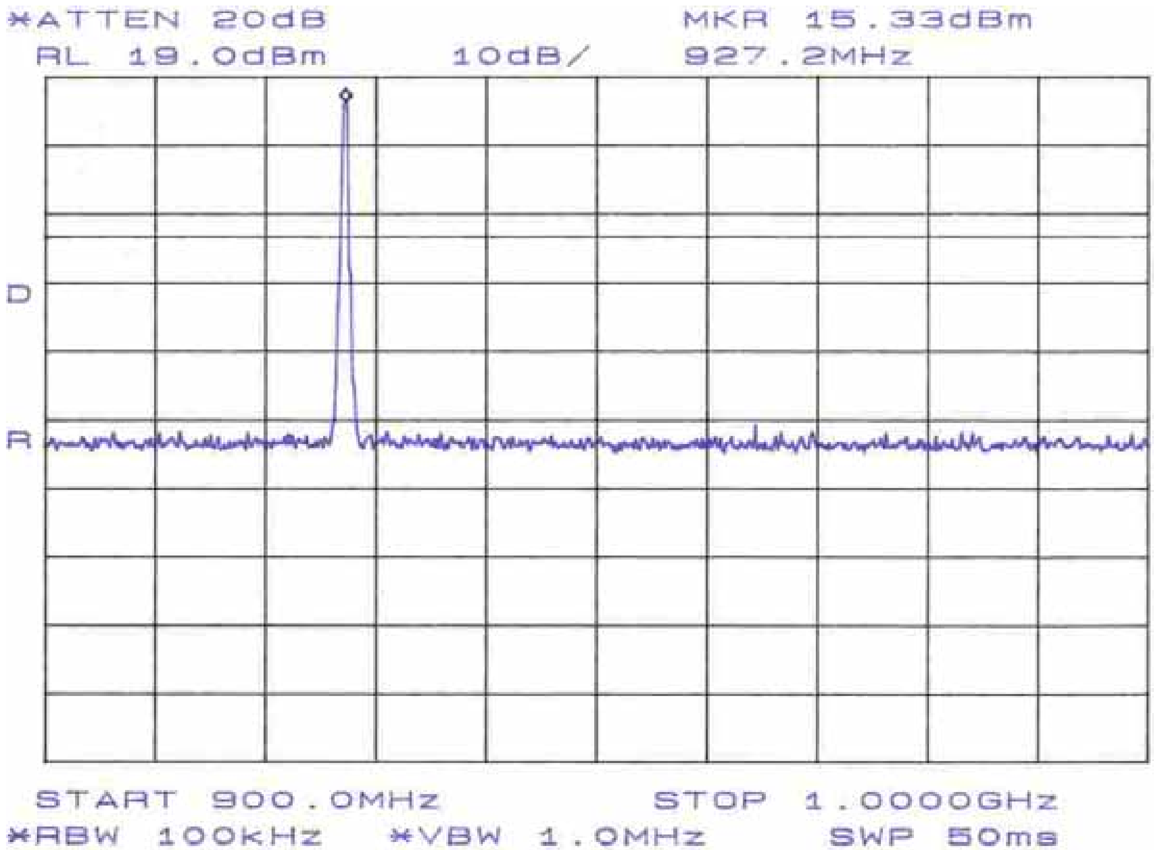

Figure 4-25. Low Power Conducted Spurious Emissions, High Channel 900MHz - 1GHz

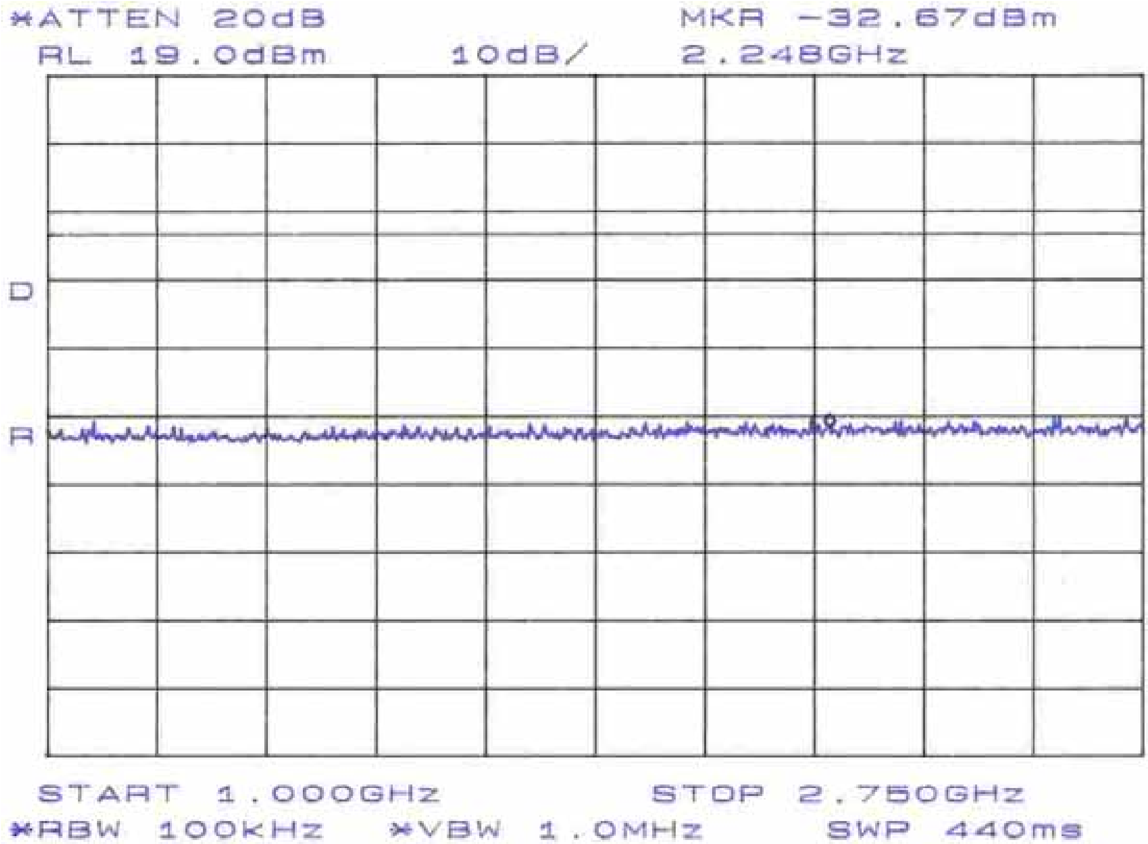

Figure 4-26. Low Power Conducted Spurious Emissions, High Channel 1 – 2.75GHz

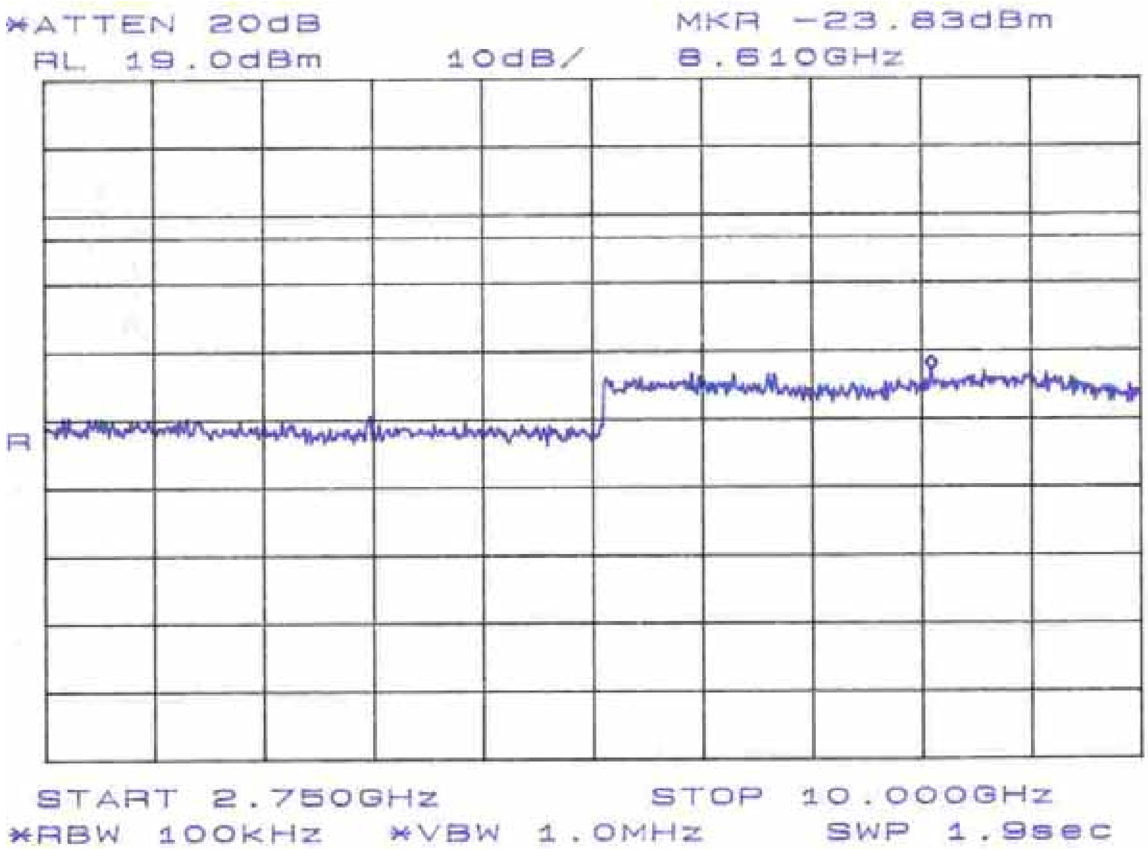

Figure 4-27. Low Power Conducted Spurious Emissions, High Channel 2.75 – 10GHz

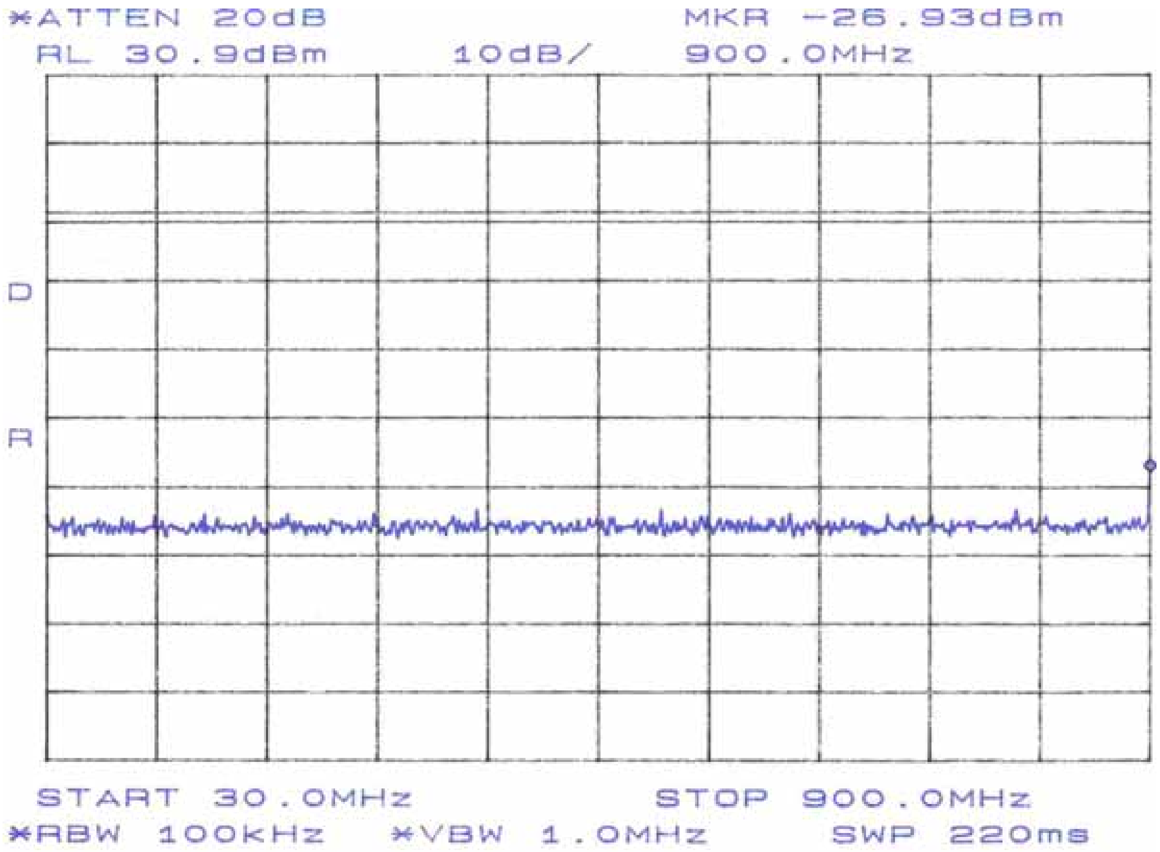

Figure 4-28. High Power Conducted Spurious Emissions, Low Channel 30 - 900MHz

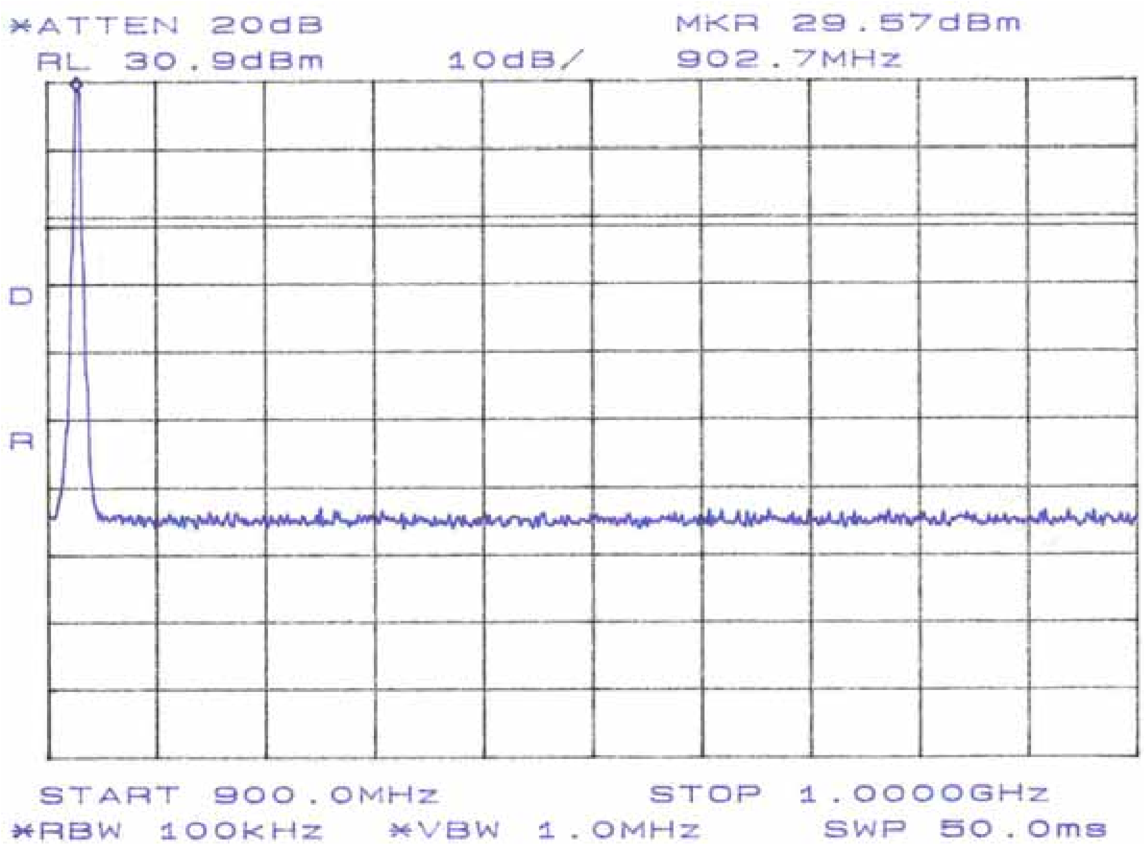

Figure 4-29. High Power Conducted Spurious Emissions, Low Channel 900MHz - 1GHz

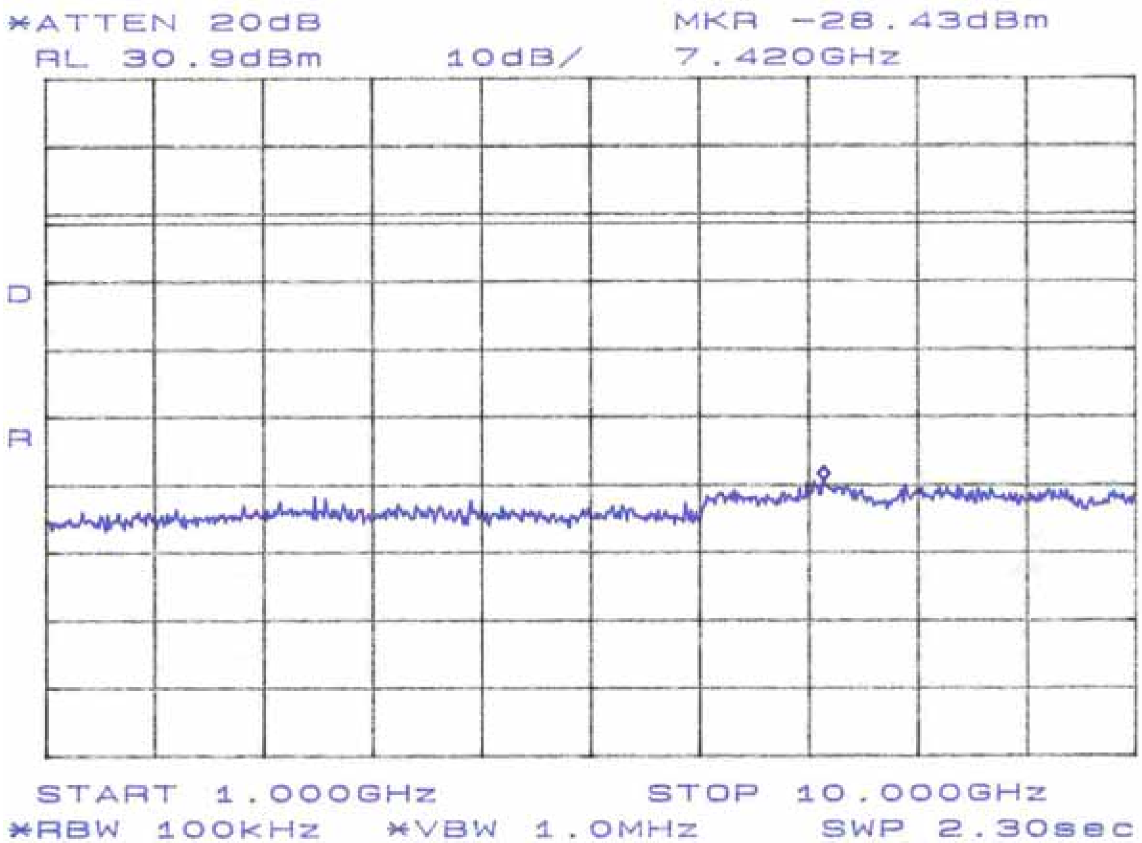

Figure 4-30. High Power Conducted Spurious Emissions, Low Channel 1 – 10GHz

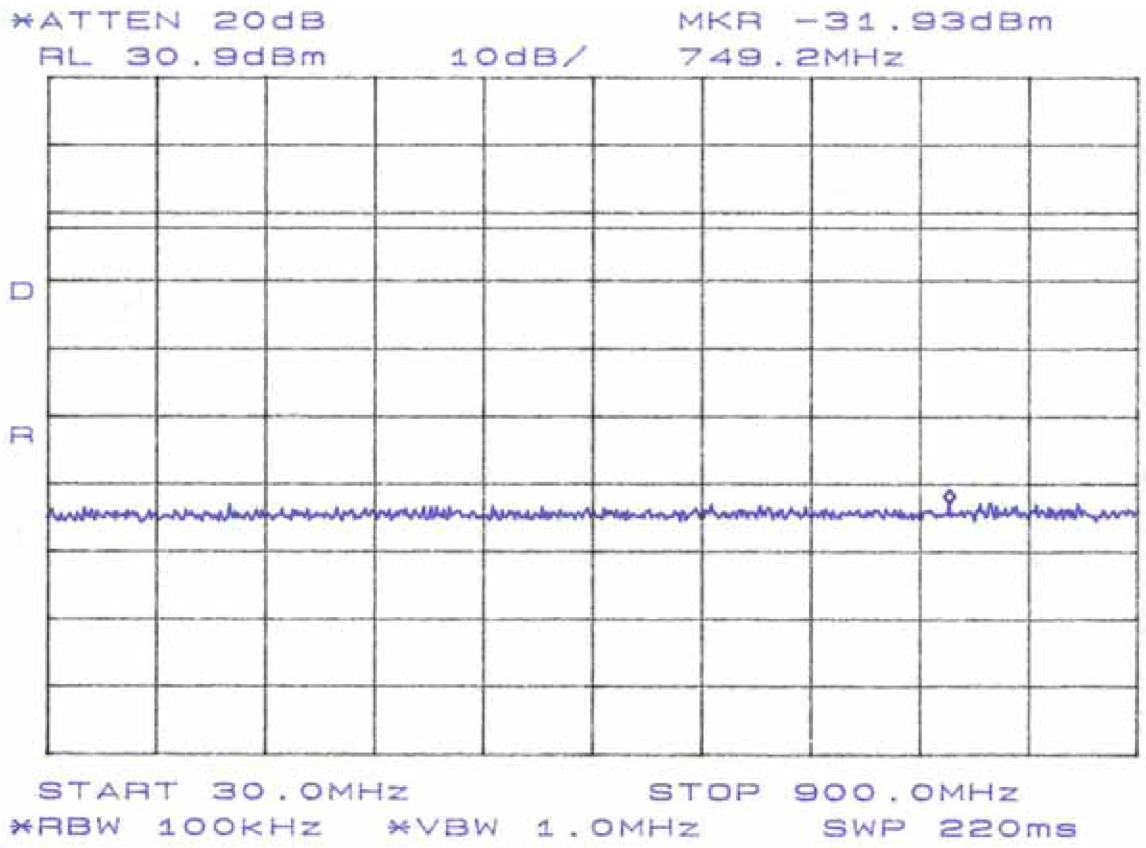

Figure 4-31. High Power Conducted Spurious Emissions, Mid Channel 30 - 900MHz

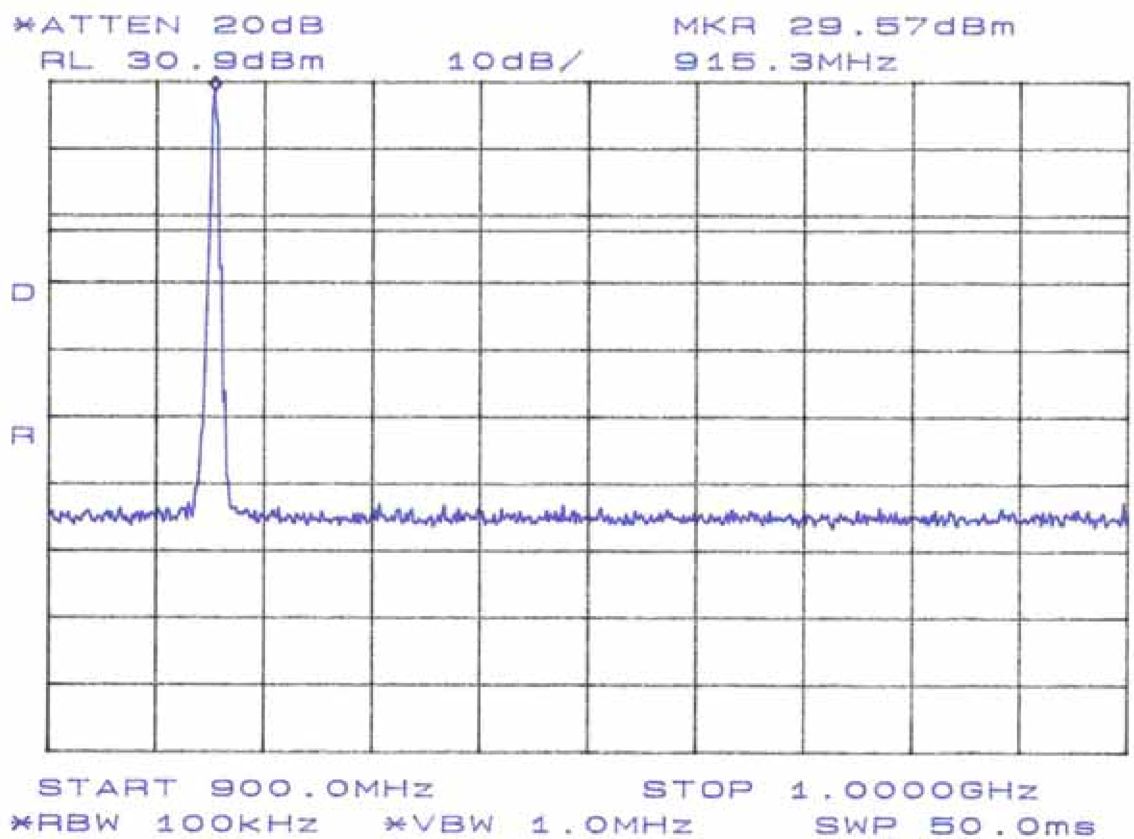

Figure 4-32. High Power Conducted Spurious Emissions, Mid Channel 900MHz - 1GHz

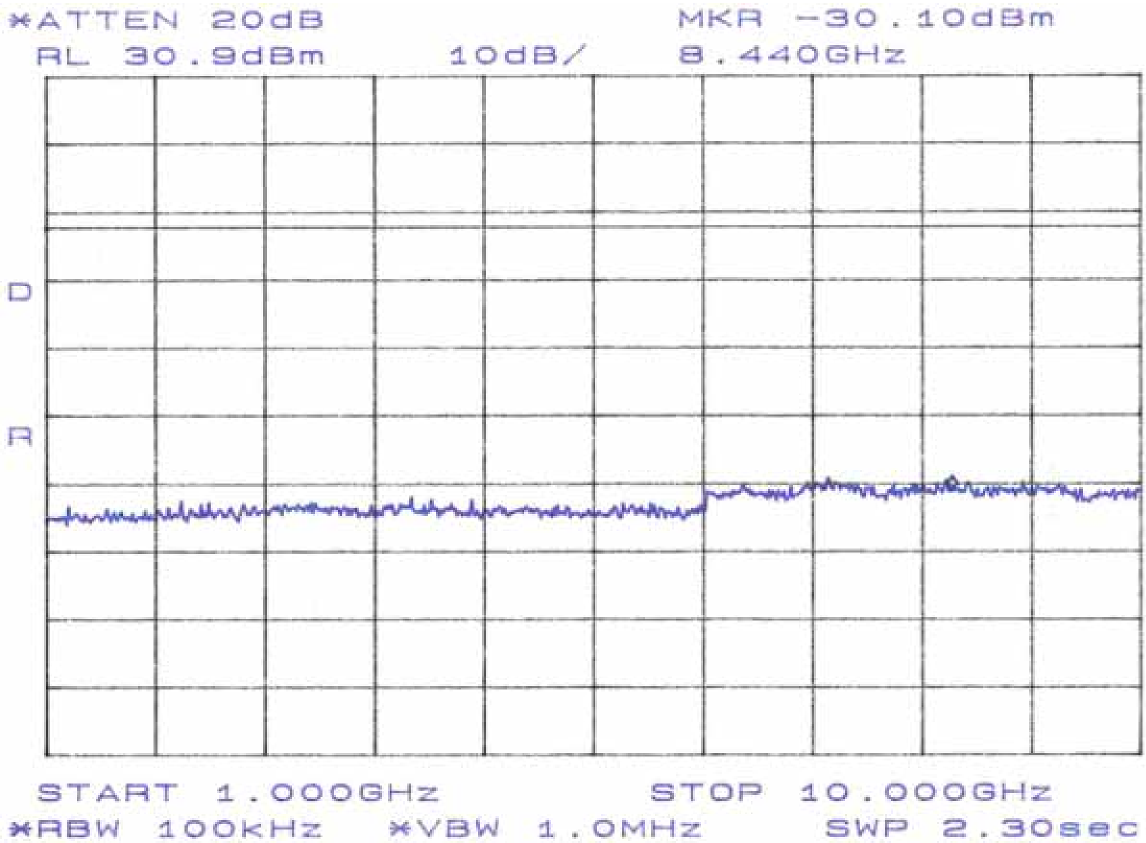

Figure 4-33. High Power Conducted Spurious Emissions, Mid Channel 1 – 10GHz

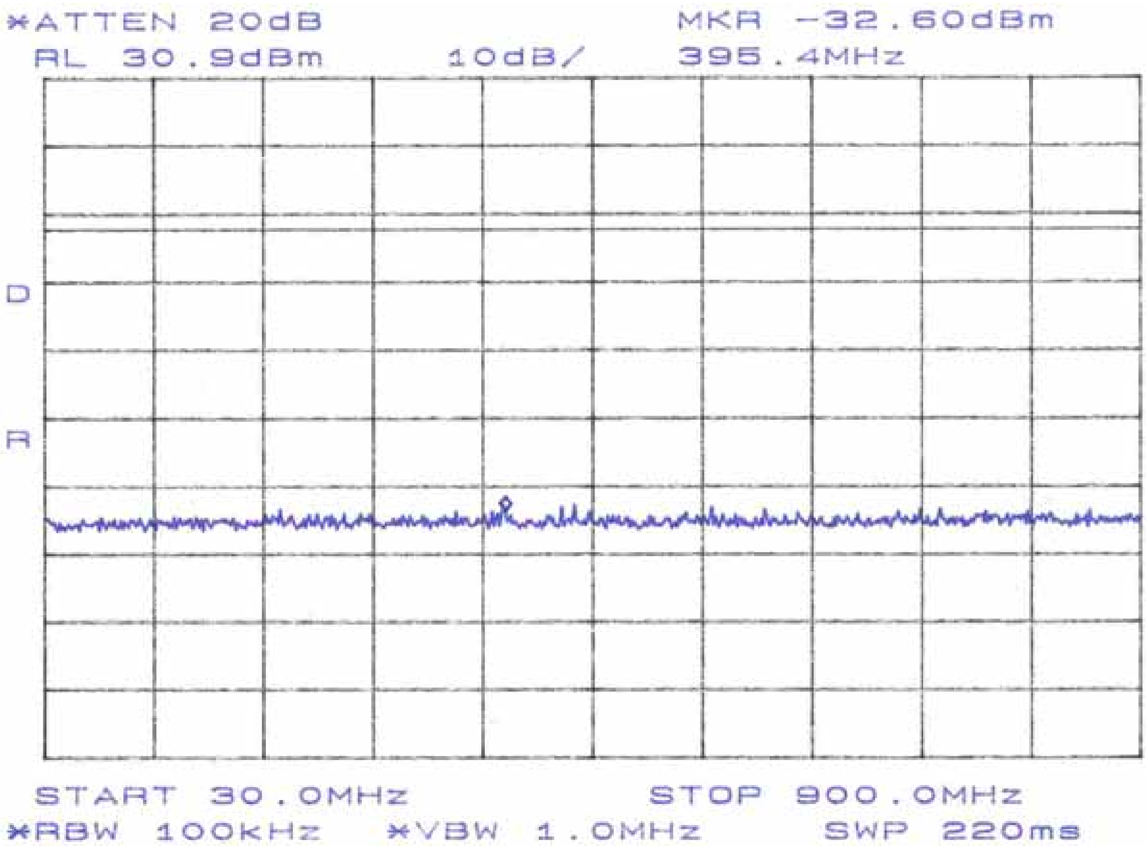

Figure 4-34. High Power Conducted Spurious Emissions, High Channel 30 - 900MHz

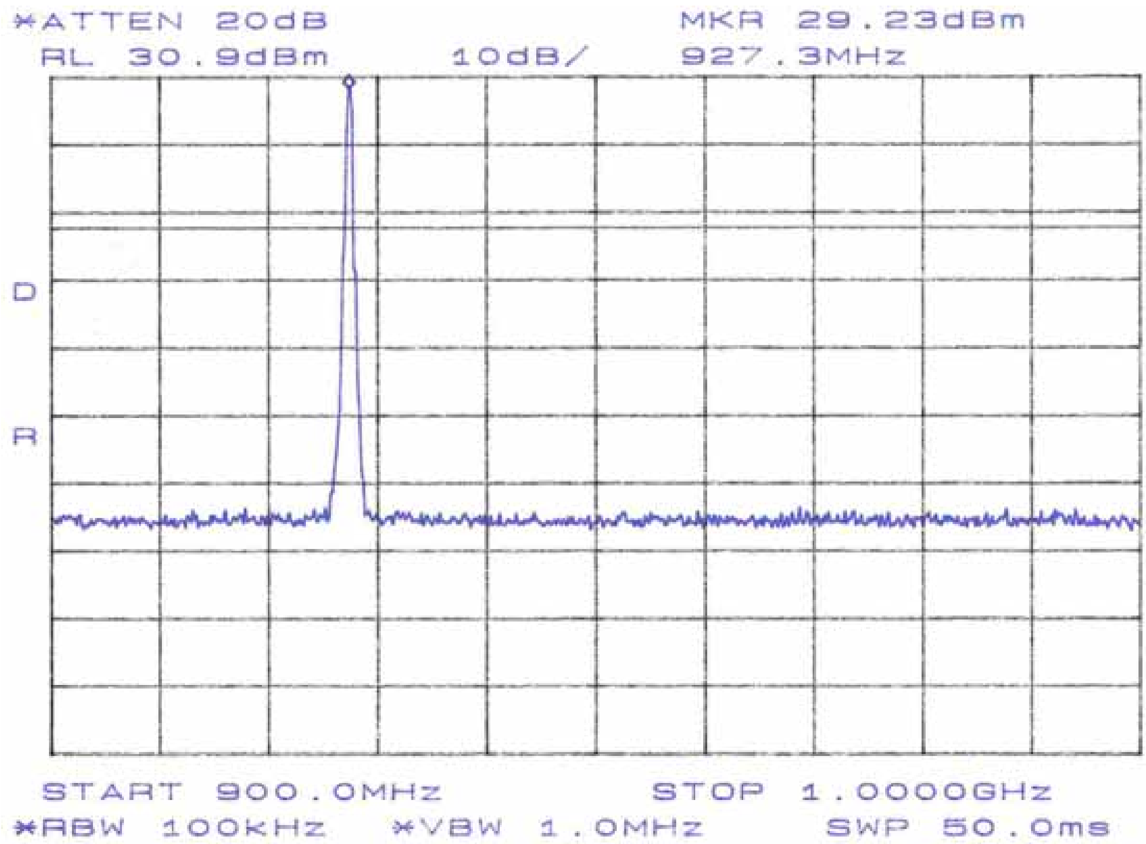

Figure 4-35. High Power Conducted Spurious Emissions, High Channel 900MHz - 1GHz

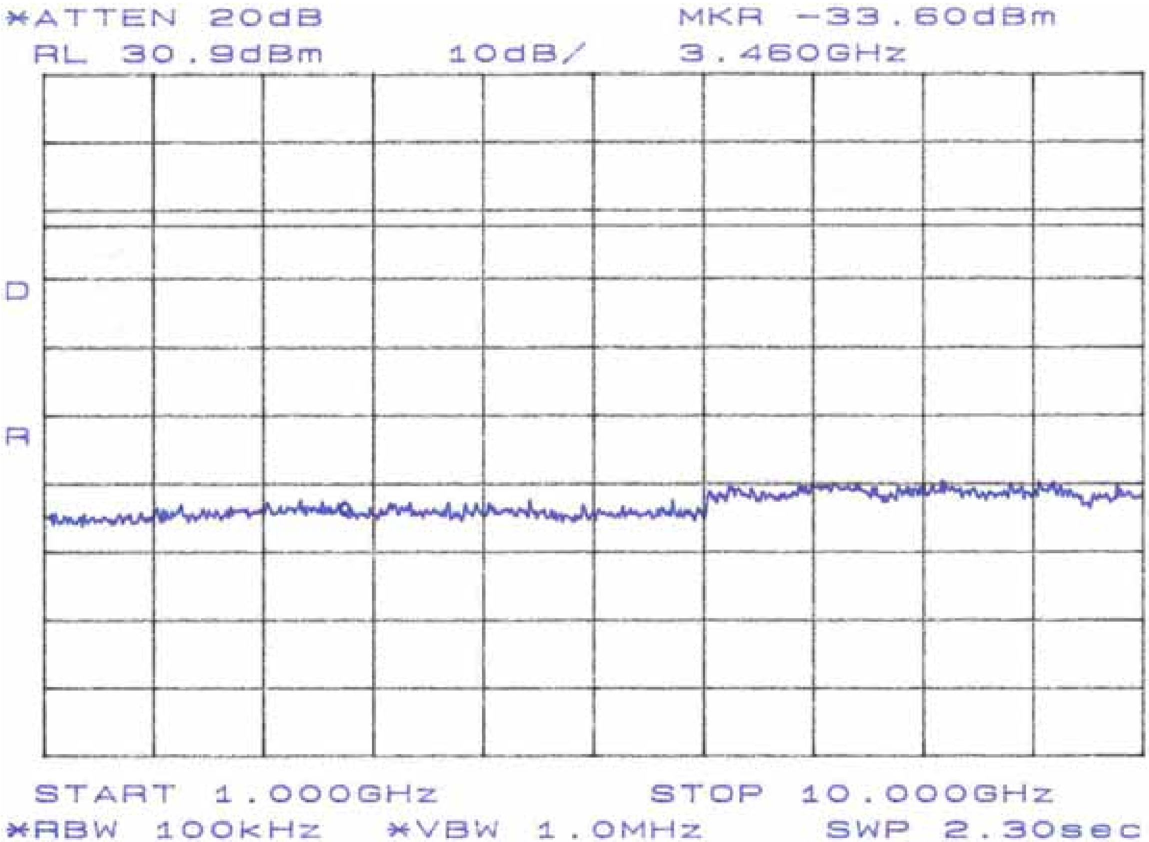

Figure 4-36. High Power Conducted Spurious Emissions, High Channel 1 – 10GHz

4.6 Conducted Emissions at the Band:

The following plots are band edge measurements at both the low and high channels and at the low and high power settings. The band edge is located at the center frequency of each of the following plots.

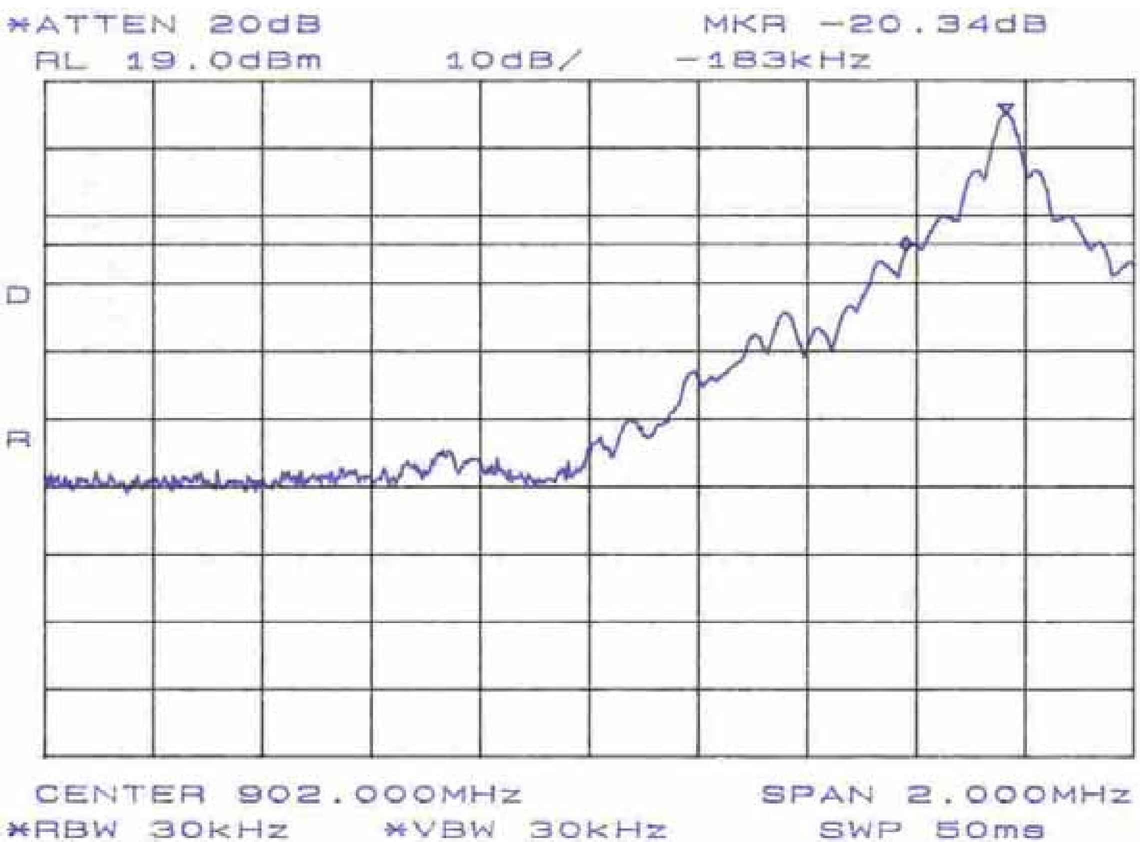

Figure 4-37. Low Power Band Edge, Channel 0

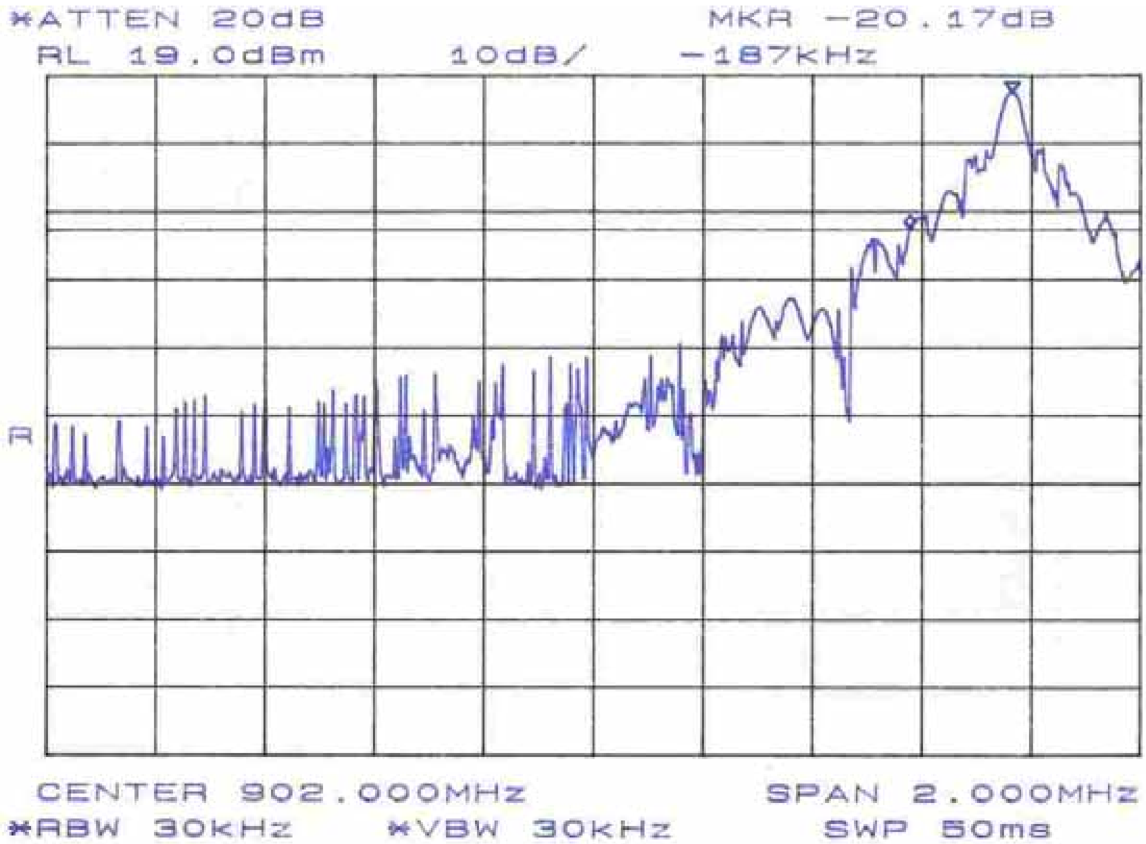

Figure 4-38. Low Power Band Edge, Channel 0, Hopping

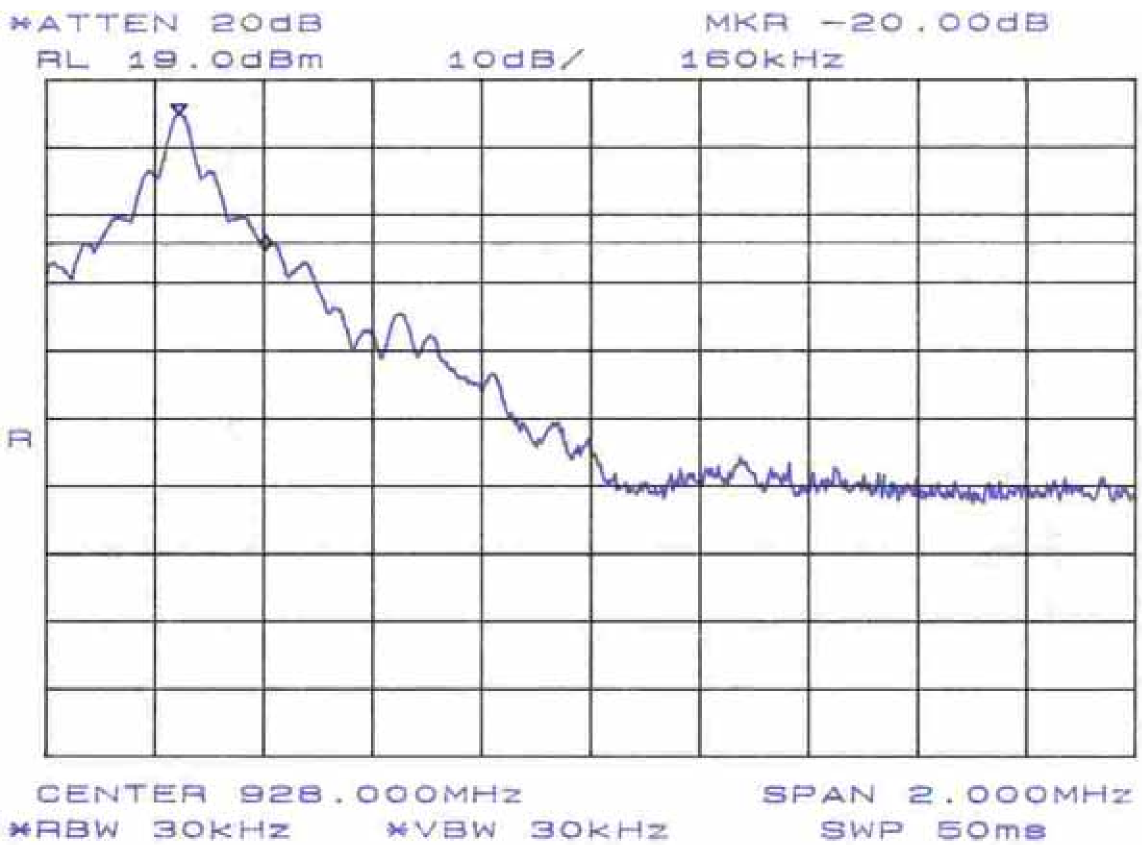

Figure 4-39. Low Power Band Edge, Channel 49

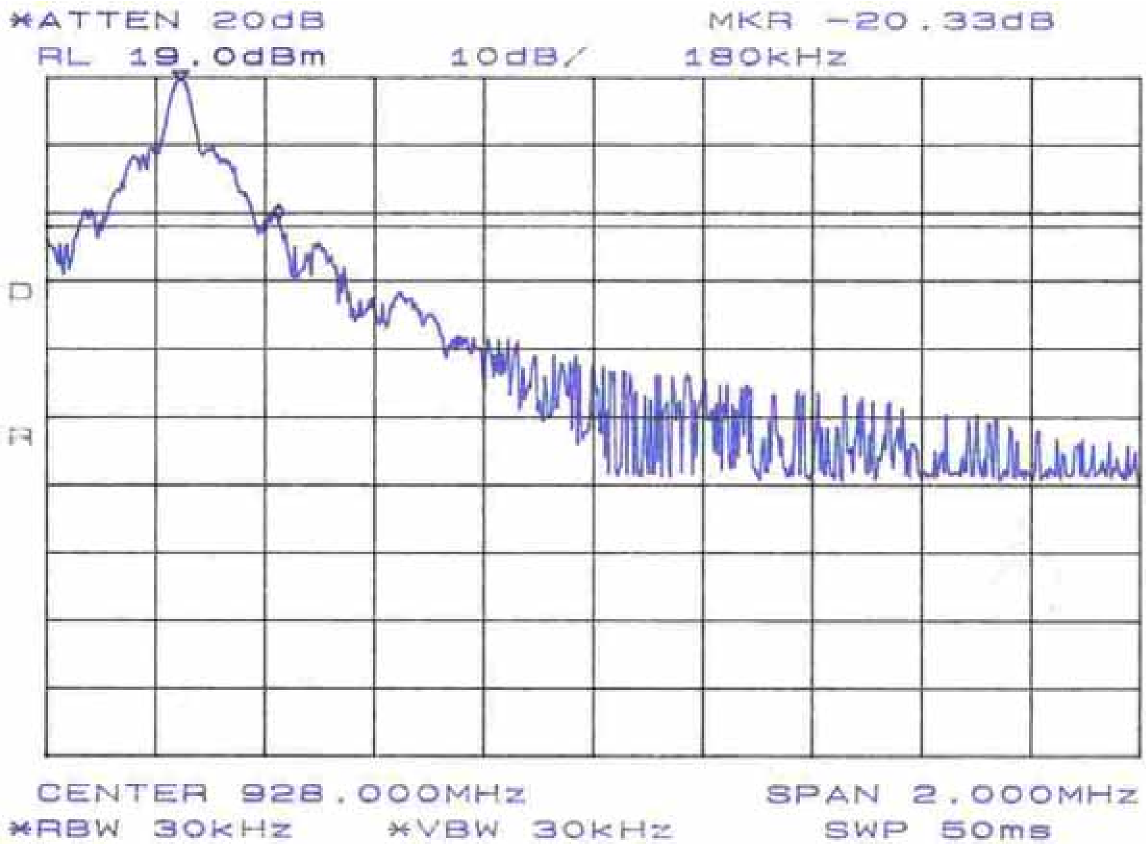

Figure 4-40. Low Power Band Edge, Channel 49, Hopping

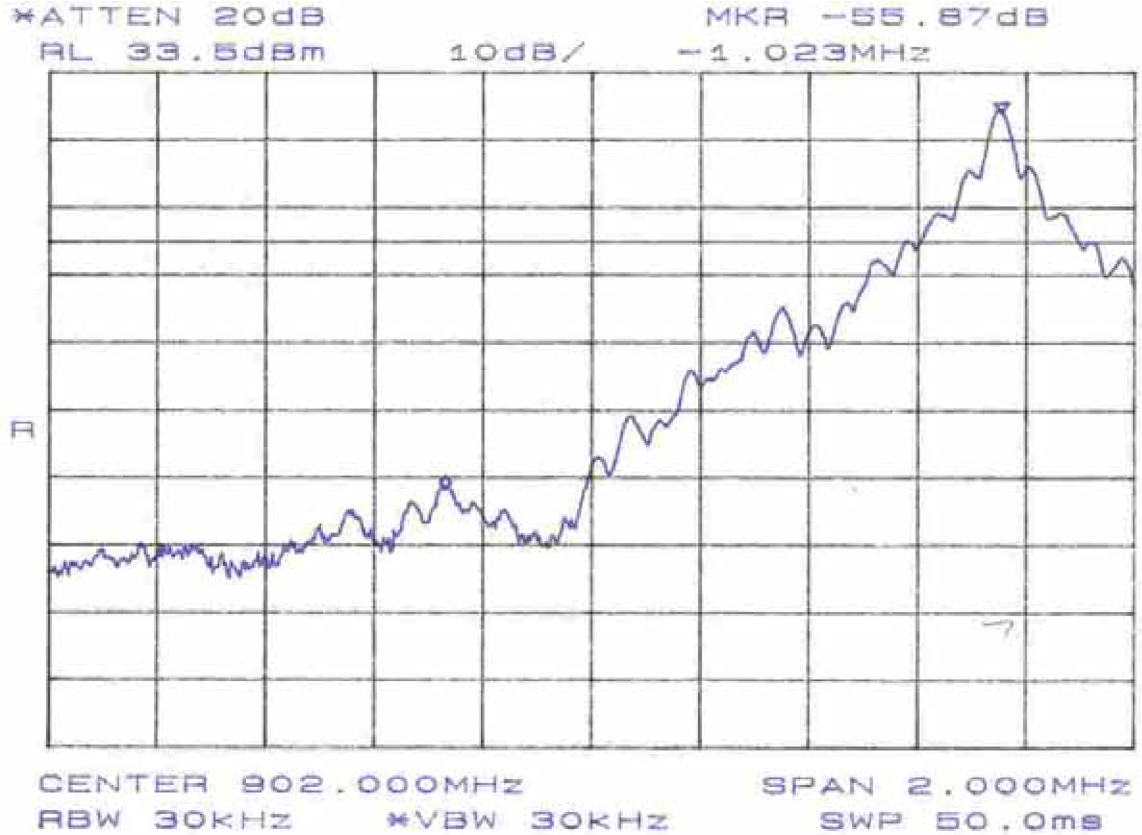

Figure 4-41. High Power Band Edge, Channel 0

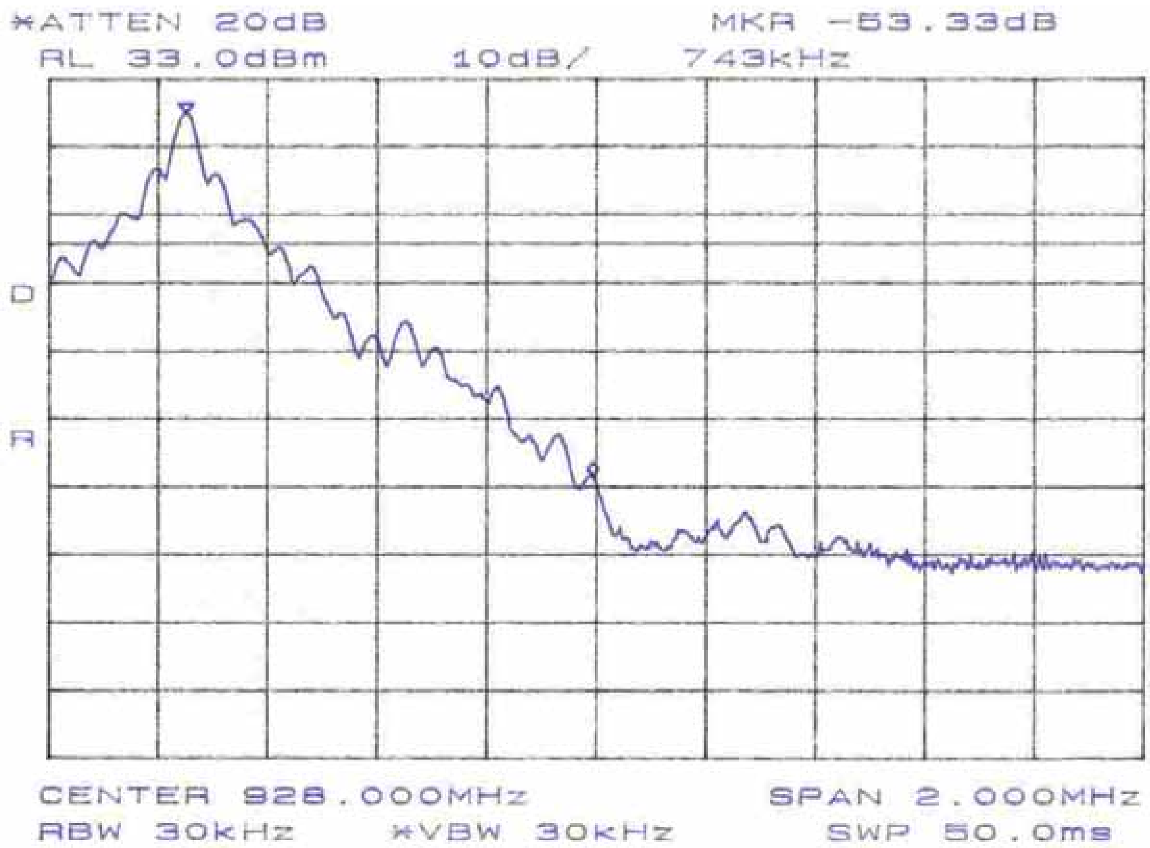

Figure 4-42. High Power Band Edge, Channel 49

4.7 Radiated Spurious Emissions: (FCC Part §2.1053)

The EUT must comply with the requirements for radiated spurious emissions that fall within the restricted bands. These emissions must meet the limits specified in §15.209 and §15.35(b) for peak measurements.

4.7.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The peripherals were placed on the table in accordance with ANSI C63.4-2001. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

The emissions were measured using the following resolution bandwidths:

Frequency Range	Resolution Bandwidth	Video Bandwidth
30MHz-1000 MHz	120kHz	>100 kHz
>1000 MHz	1 MHz	<30 Hz (Avg.) 1MHz (Peak)

The following is a sample calculation used in the data tables for calculating the final field strength of spurious emissions and comparing these levels to the specified limits.

<u>Sample Calculation:</u>

Spectrum Analyzer Voltage (SA Level):	V dBμV
Antenna Factor (Ant Corr):	AFdB/m
Cable Loss Correction (Cable Corr):	CCdB
Amplifier Gain:	GdB
Electric Field (Corr Level):	EdBμV/m = VdBμV + AFdB/m + CCdB - GdB
To convert to linear units:	EμV/m = antilog (EdBμV/m/20)

Data are supplied in the following tables. Testing was performed to the tenth harmonic. Both peak and average measurements are listed.

Table 5: Radiated Emissions Test Data, Channel 0

CLIENT:	Matrics	DATE:	4/26/2004
TESTER:	James Ritter	JOB #:	8096

EUT Information:		**Test Requirements:**	
EUT:	AR400 RFID Reader	TEST STANDARD:	FCC Part 15
CONFIGURATION:	with 6 dBi ant	DISTANCE:	3m
CLOCKS:	Channel 0 - 902.747 MHz	CLASS:	B
Test Equipment/Limit:			
ANTENNA:	A_00425	LIMIT:	LFCC_3m_Class_B
CABLE:	CSITE2_HF	AMPLIFIER (dB)	A_00312

Peak Data

Freq (MHz)	Pol H/V	Azimuth Degree	Ant. Height (m)	SA Level (Peak) dBμV	Ant. Corr. dB/m	Cable Corr. dB	Amp Gain dB	Corr. Level dBμV/m	Corr. Level μV/m	Limit μV/m	Margin dB	Comments
Chan 0												
2708.24	V	0.0	1.0	46.2	30.3	2.9	34.4	45.0	178.3	5000.0	-29.0	
2708.24	H	0.0	1.0	47.8	30.3	2.9	34.4	46.6	214.4	5000.0	-27.4	
3610.99	V	270.0	1.0	57.2	31.0	2.8	34.6	56.4	657.8	5000.0	-17.6	
3610.99	H	270.0	1.0	60.8	31.0	2.8	34.6	60.0	1004.9	5000.0	-13.9	
4513.74	V	180.0	1.0	44.5	32.6	3.7	34.5	46.2	204.4	5000.0	-27.8	
4513.74	H	0.0	1.0	42.1	32.6	3.7	34.5	43.8	155.0	5000.0	-30.2	
5416.48	V	0.0	1.0	42.0	34.4	4.3	34.5	46.2	203.7	5000.0	-27.8	Amb
5416.48	H	0.0	1.0	41.0	34.4	4.3	34.5	45.2	181.5	5000.0	-28.8	Amb
8124.72	V	0.0	1.0	43.7	38.4	4.9	34.3	52.6	425.9	5000.0	-21.4	Amb
8124.72	H	0.0	1.0	43.5	38.4	4.9	34.3	52.4	417.6	5000.0	-21.6	Amb
9027.47	V	0.0	1.0	40.2	39.0	4.9	33.0	51.1	358.2	5000.0	-22.9	Amb
9027.47	H	0.0	1.0	42.1	39.0	4.9	33.0	53.0	447.3	5000.0	-21.0	Amb

Average Data

Freq (MHz)	Pol H/V	Azimuth Degree	Ant. Height (m)	SA Level Avg. dBμV	Ant. Corr. dB/m	Cable Corr. dB	Amp Gain dB	Duty Cycle dB	Corr. Level dBμV/m	Corr. Level μV/m	Limit μV/m	Margin dB	Comments
2708.24	V	0.0	1.0	42.7	30.3	2.9	34.4	-20.0	21.5	11.9	500.0	-32.5	res
2708.24	H	0.0	1.0	43.7	30.3	2.9	34.4	-20.0	22.5	13.3	500.0	-31.5	res
3610.99	V	270.0	1.0	51.5	31.0	2.8	34.6	-20.0	30.7	34.3	500.0	-23.3	res
3610.99	H	270.0	1.0	53.5	31.0	2.8	34.6	-20.0	32.7	43.2	500.0	-21.3	res
4513.74	V	180.0	1.0	33.5	32.6	3.7	34.5	-20.0	15.2	5.8	500.0	-38.8	res
4513.74	H	0.0	1.0	31.0	32.6	3.7	34.5	-20.0	12.7	4.3	500.0	-41.3	res
5416.48	V	0.0	1.0	31.1	34.4	4.3	34.5	-20.0	15.3	5.8	500.0	-38.7	res-amb
5416.48	H	0.0	1.0	29.7	34.4	4.3	34.5	-20.0	13.8	4.9	500.0	-40.1	res-amb
8124.72	V	0.0	1.0	32.2	38.4	4.9	34.3	-20.0	21.1	11.3	500.0	-32.9	res-amb
8124.72	H	0.0	1.0	32.2	38.4	4.9	34.3	-20.0	21.1	11.3	500.0	-32.9	res-amb
9027.47	V	0.0	1.0	30.5	39.0	4.9	33.0	-20.0	21.4	11.8	500.0	-32.6	res-amb
9027.47	H	0.0	1.0	30.7	39.0	4.9	33.0	-20.0	21.6	12.0	500.0	-32.4	res-amb

Table 6: Radiated Emissions Test Data, Channel 25

CLIENT:	Matrics	DATE:	4/26/2004
TESTER:	James Ritter	JOB #:	8096
EUT Information:		**Test Requirements:**	
EUT:	AR400 RFID Reader	TEST STANDARD:	FCC Part 15
CONFIGURATION:	with 6 dBi ant	DISTANCE:	3m
CLOCKS:	Channel 25 - 915.218MHz	CLASS:	B
Test Equipment/Limit:			
ANTENNA:	A_00425	LIMIT:	LFCC_3m_Class_B
CABLE:	CSITE2_HF	AMPLIFIER (dB)	A_00312

Peak Data

Freq (MHz)	Pol H/V	Azimuth Degree	Ant. Height (m)	SA Level (Peak) (dBµV)	Ant. Corr. (dB/m)	Cable Corr. (dB)	Amp Gain (dB)	Corr. Level (dBµV/m)	Corr. Level (µV/m)	Limit (µV/m)	Margin dB	Comments
Chan 25												
2745.63	V	0.0	1.0	52.3	30.4	2.9	34.4	51.1	360.3	5000.0	-22.8	res
2745.63	H	0.0	1.0	55.3	30.4	2.9	34.4	54.1	508.9	5000.0	-19.8	res
3660.84	V	100.0	1.0	53.7	31.0	2.8	34.6	52.9	441.9	5000.0	-21.1	res
3660.84	H	90.0	1.0	50.3	31.0	2.8	34.6	49.5	299.8	5000.0	-24.4	res
4576.05	V	180.0	1.0	46.0	32.7	3.8	34.5	48.0	250.3	5000.0	-26.0	res
4576.05	H	90.0	1.0	44.8	32.7	3.8	34.5	46.8	218.8	5000.0	-27.2	res
7321.68	V	0.0	1.0	41.1	37.7	4.6	34.8	48.6	268.9	5000.0	-25.4	res-amb
7321.68	H	0.0	1.0	42.6	37.7	4.6	34.8	50.1	319.6	5000.0	-23.9	res-amb
8236.89	V	0.0	1.0	40.0	38.5	4.9	34.2	49.2	287.7	5000.0	-24.8	res-amb
8236.89	H	0.0	1.0	42.1	38.5	4.9	34.2	51.3	366.3	5000.0	-22.7	res-amb
9152.10	V	0.0	1.0	42.3	39.2	5.0	33.0	53.4	467.7	5000.0	-20.6	res-amb
9152.10	H	0.0	1.0	41.1	39.2	5.0	33.0	52.2	407.3	5000.0	-21.8	res-amb

Average Data

Freq. (MHz)	Pol. H/V	Azimuth Degree	Ant. Height (m)	SA Level (Avg.) (dBµV)	Ant. Corr. (dB/m)	Cable Corr. (dB)	Amp Gain (dB)	Duty Cycle (dB)	Corr. Level (dBµV/m)	Corr. Level (µV/m)	Limit (µV/m)	Margin dB	Comments
2745.63	V	0.0	1.0	42.7	30.4	2.9	34.4	-20.0	21.5	11.9	500.0	-32.5	res-
2745.63	H	0.0	1.0	43.3	30.4	2.9	34.4	-20.0	22.1	12.8	500.0	-31.8	res-
3660.84	V	100.0	1.0	45.8	31.0	2.8	34.6	-20.0	25.1	17.9	500.0	-28.9	res
3660.84	H	90.0	1.0	44.2	31.0	2.8	34.6	-20.0	23.4	14.8	500.0	-30.6	res
4576.05	V	180.0	1.0	36.2	32.7	3.8	34.5	-20.0	18.1	8.1	500.0	-35.8	res
4576.05	H	90.0	1.0	33.9	32.7	3.8	34.5	-20.0	15.9	6.2	500.0	-38.1	res
7321.68	V	0.0	1.0	32.2	37.7	4.6	34.8	-20.0	19.7	9.6	500.0	-34.3	res-amb
7321.68	H	0.0	1.0	32.7	37.7	4.6	34.8	-20.0	20.2	10.2	500.0	-33.8	res-amb
8236.89	V	0.0	1.0	32.2	38.5	4.9	34.2	-20.0	21.4	11.7	500.0	-32.6	res-amb
8236.89	H	0.0	1.0	32.5	38.5	4.9	34.2	-20.0	21.7	12.1	500.0	-32.3	res-amb
9152.10	V	0.0	1.0	31.9	39.2	5.0	33.0	-20.0	23.0	14.1	500.0	-31.0	res-amb
9152.10	H	0.0	1.0	33.0	39.2	5.0	33.0	-20.0	24.1	16.0	500.0	-29.9	res-amb

Table 7: Radiated Emissions Test Data, Channel 49

CLIENT:	Matrics	DATE:	4/26/2004
TESTER:	James Ritter	JOB #:	8096
EUT Information:		**Test Requirements:**	
EUT:	AR400 RFID Reader	TEST STANDARD:	FCC Part 15
CONFIGURATION:	with 6 dBi ant	DISTANCE:	3m
CLOCKS:	Channel 49 - 927.248MHz	CLASS:	B
Test Equipment/Limit:			
ANTENNA:	A_00425	LIMIT:	LFCC_3m_Class_B
CABLE:	CSITE2_HF	AMPLIFIER (dB)	A_00312

Peak Data

Freq. (MHz)	Pol. H/V	Azimuth Degree	Ant. Height (m)	SA Level (Peak) (dBμV)	Ant. Corr. (dB/m)	Cable Corr. (dB)	Amplifier Gain (dB)	Corr. Level (dBμV/m)	Corr. Level (μV/m)	Limit (μV/m)	Margin dB	Comments
Chan 49												
2781.74	V	245.0	1.0	57.0	30.4	2.9	34.5	55.8	619.6	5000.0	-18.1	res
2781.74	H	0.0	1.0	53.7	30.4	2.9	34.5	52.5	422.3	5000.0	-21.5	res
3708.99	V	270.0	1.0	51.5	31.1	2.8	34.6	50.8	345.1	5000.0	-23.2	res
3708.99	H	90.0	1.0	52.2	31.1	2.8	34.6	51.4	372.8	5000.0	-22.6	res
4636.24	V	190.0	1.0	45.2	32.9	3.9	34.5	47.4	233.6	5000.0	-26.6	res
4636.24	H	180.0	1.0	42.8	32.9	3.9	34.5	45.1	178.9	5000.0	-28.9	res
7417.98	V	0.0	1.0	41.3	37.8	4.6	34.7	49.0	280.5	5000.0	-25.0	res-amb
7417.98	H	0.0	1.0	42.3	37.8	4.6	34.7	50.0	314.7	5000.0	-24.0	res-amb
8345.23	V	0.0	1.0	40.1	38.6	4.9	34.0	49.5	299.5	5000.0	-24.5	res-amb
8345.23	H	0.0	1.0	42.8	38.6	4.9	34.0	52.2	408.7	5000.0	-21.8	res-amb

Average Data

Freq. (MHz)	Pol. H/V	Azimuth Degree	Ant. Height (m)	SA Level (Avg) (dBμV)	Ant. Corr. (dB/m)	Cable Corr. (dB)	Amp Gain (dB)	Duty Cycle (dB)	Corr. Level (dBμV/m)	Corr. Level (μV/m)	Limit (μV/m)	Margin dB	Comments
2781.74	V	245.0	1.0	45.8	30.4	2.9	34.5	-20.0	24.7	17.1	500.0	-29.3	res
2781.74	H	0.0	1.0	44.5	30.4	2.9	34.5	-20.0	23.3	14.7	500.0	-30.6	res-
3708.99	V	270.0	1.0	46.2	31.1	2.8	34.6	-20.0	25.4	18.7	500.0	-28.6	res
3708.99	H	90.0	1.0	48.3	31.1	2.8	34.6	-20.0	27.6	23.9	500.0	-26.4	res
4636.24	V	190.0	1.0	33.5	32.9	3.9	34.5	-20.0	15.7	6.1	500.0	-38.3	res
4636.24	H	180.0	1.0	32.4	32.9	3.9	34.5	-20.0	14.7	5.4	500.0	-39.3	res
7417.98	V	0.0	1.0	30.0	37.8	4.6	34.7	-20.0	17.7	7.6	500.0	-36.3	res-amb
7417.98	H	0.0	1.0	32.1	37.8	4.6	34.7	-20.0	19.8	9.7	500.0	-34.2	res-amb
8345.23	V	0.0	1.0	32.4	38.6	4.9	34.0	-20.0	21.8	12.3	500.0	-32.2	res-amb
8345.23	H	0.0	1.0	32.7	38.6	4.9	34.0	-20.0	22.1	12.7	500.0	-31.9	res-amb

Table 8: Radiated Emissions Test Data (Restricted Bands <1GHz)

CLIENT:	Matrics	DATE:	4/26/2004
TESTER:	James Ritter	JOB #:	8096
EUT Information:		**Test Requirements:**	
EUT:	AR400 RFID Reader	TEST STANDARD:	FCC Part 15
CONFIGURATION:	with 6 dBi ant	DISTANCE:	3m
Test Equipment/Limit:			
Above 1 GHz		Below 1GHz	
ANTENNA:	A_00425	ANTENNA:	A_00007
LIMIT:	LFCC_3m_Class_B	AMPLIFIER (dB)	A_00312
CABLE:	CSITE2_HF	CABLE:	CSITE1_3m

Frequency (MHz)	Polarity H/V	Azimuth Degree	Ant. Hght (m)	SA Level (QP) (dBμV)	Ant. Corr. (dB/m)	Cable Corr. (dB)	Amp Gain (dB)	Corr. Level (dBμV/m)	Corr. Level (μV/m)	Limit (μV/m)	Margin dB	Comments
Channel 0, 25,49 on all channels												
111.59	V	90.0	1.2	13.7	10.2	1.6	0.0	25.5	18.8	150.0	-18.0	
113.08	V	90.0	1.0	10.1	10.4	1.5	0.0	22.1	12.7	150.0	-21.5	
149.99	V	0.0	1.0	14.6	8.7	1.6	0.0	24.9	17.7	150.0	-18.6	
162.54	V	90.0	1.3	19.6	9.6	1.7	0.0	30.9	35.1	150.0	-12.6	
965.40	V	0.0	2.5	8.3	22.6	4.0	0.0	34.9	55.6	500.0	-19.1	
111.59	H	0.0	4.0	7.2	10.2	1.6	0.0	19.0	8.9	150.0	-24.5	
113.08	H	0.0	3.5	6.1	10.4	1.5	0.0	18.1	8.0	150.0	-25.5	
149.99	H	90.0	2.3	10.7	8.7	1.6	0.0	21.0	11.3	150.0	-22.5	
162.54	H	90.0	4.0	22.2	9.6	1.7	0.0	33.5	47.4	150.0	-10.0	

4.8 AC Powerline Conducted Emissions: (FCC Part §15.207)

The EUT was placed on an 80 cm high 1 x 1.5 m non-conductive table above a ground plane. Power to the EUT was provided through a Solar Corporation 50 Ω/50 μH Line Impedance Stabilization Network bonded to a 3 x 2 meter ground plane. The LISN has its AC input supplied from a filtered AC power source. Power and data cables were moved about to obtain maximum emissions.

The 50 Ω output of the LISN was connected to the input of the spectrum analyzer and the emissions in the frequency range of 150 kHz to 30 MHz were measured. The detector function was set to quasi-peak or peak, as appropriate, and the resolution bandwidth during testing was at least 9 kHz, with all post-detector filtering no less than 10 times the resolution bandwidth.

Data is recorded in Table 9.

Table 9. AC Mains Conducted Emissions

CLIENT:	Matrics	DATE:	4/21/2004
MODEL:	AR400 RFID READER	JOB #:	8096
TESTER:	James Ritter	TEST SITE:	CSITE2_CE
TEST STANDARD:	FCC Part 15	CLASS:	FCC_B
TEST VOLTAGE:	120 VAC		

LINE 1 - NEUTRAL

Frequency MHz	Level QP dBuV	Cable Loss dB	Limit QP dBuV	Margin QP dB	Level AVG dBuV	Cable Loss dB	Limit AVG dBuV	Margin AVG dB
0.194	44.7	10.7	63.9	-8.5	37.6	10.7	53.9	-5.6
0.397	36.0	10.7	57.9	-11.2	20.5	10.7	47.9	-16.7
1.671	36.5	11.1	56.0	-8.4	24.5	11.1	46.0	-10.4
2.465	31.6	11.2	56.0	-13.2	26.2	11.2	46.0	-8.6
2.56	32.3	11.3	56.0	-12.4	28.1	11.3	46.0	-6.6
3.047	32.8	11.3	56.0	-11.9	26.7	11.3	46.0	-8.0
3.150	33.1	11.3	56.0	-11.6	26.9	11.3	46.0	-7.8
15.41	24.6	12.3	60.0	-23.1	24.6	12.3	50.0	-13.1

LINE 2 - PHASE

Frequency MHz	Level QP dBuV	Cable Loss dB	Limit QP dBuV	Margin QP dB	Level AVG dBuV	Cable Loss dB	Limit AVG dBuV	Margin AVG dB
0.194	42.7	10.7	63.9	-10.5	37.5	10.7	53.9	-5.7
0.397	33.2	10.7	57.9	-14.0	26.3	10.7	47.9	-10.9
1.671	31.8	11.1	56.0	-13.1	25.7	11.1	46.0	-9.2
2.465	37.0	11.2	56.0	-7.8	27.4	11.2	46.0	-7.4
2.56	34.8	11.3	56.0	-9.9	28.8	11.3	46.0	-5.9
3.047	36.4	11.3	56.0	-8.3	26.8	11.3	46.0	-7.9
3.150	34.6	11.3	56.0	-10.1	28.2	11.3	46.0	-6.5
15.41	23.4	12.3	60.0	-24.3	23.4	12.3	50.0	-14.3