



**FCC Class II Permissive Change Test Report
(FCC Part 15.247)**

**For the
MUELLER SYSTEMS
RFDC RADIO MODULE
FCC ID: SM6-RFDC**

**WLL Report# 12233-01 Rev. 0
October 04, 2011**

Prepared for:

**Mueller Systems
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Middleboro, MA 02346**

Prepared By:

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7560 Lindbergh Drive
Gaithersburg, Maryland 20879**



Testing Certificate AT-1448

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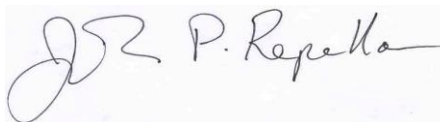
October 4, 2011

WLL Report# 12233-01 Rev. 0



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Reviewed by:



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Abstract

This report has been prepared on behalf of Mueller Systems to support Application for a Class II Permissive Change to existing certified equipment. The test report and application are submitted for a Digital Transmission System under Part 15.247 (10/2009) of the FCC Rules & Regulations. This Permissive Change Test Report documents the test configuration and test results for a Mueller Systems RFDC Radio Module.

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 ACLASS under Certificate AT-1448 as an independent FCC test laboratory.

The Mueller Systems RFDC Radio Module remains in compliance with the limits for a Digital Transmission System under Part 15.247 (10/2009).

Revision History	Reason	Date
Rev 0	Initial Release	October 4, 2011

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1 Introduction

1.1 Reason for Class II Permissive Change

The permissive change incorporates the addition of two antennas, an Inverted F PCB trace antenna and an external Omni directional dipole antenna. The antennas have the following characteristics:

Inverted F PCB trace antenna:

Frequency Range = 902 – 928MHz

Gain = 4.8dBi

Omni directional dipole antenna:

Frequency Range = 900 – 928MHz

Gain = 6.0dBi

1.2 Compliance Statement

The Mueller Systems RFDC Radio Module remains in compliance with the limits for a Digital Transmission System under Part 15.247 (10/2009).

1.3 Test Scope

Tests for radiated emissions and conducted Peak Power (at antenna terminal) were performed. All measurements were performed in accordance with FCC Public Notice DA 00-705 and the 2009 version of ANSI C63.4. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation unless a different measurement technique is specified by the FCC.

1.4 Contract Information

Customer:	Mueller Systems 48 Leona Drive Middleboro, MA 02346
Purchase Order Number:	774094
Quotation Number:	66474

1.5 Test Dates

Testing was performed on the following date(s): 9/19/2011 to 9/21/2011

1.6 Test and Support Personnel

Washington Laboratories, LTD	John Reidell
Client Representative	David Splitz

1.7 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 10⁹ multiplier
Hz	Hertz
IF	Intermediate Frequency
k	kilo - prefix for 10³ multiplier
LISN	Line Impedance Stabilization Network
M	Mega - prefix for 10⁶ multiplier
m	meter
μ	micro - prefix for 10⁻⁶ multiplier
NB	Narrowband
QP	Quasi-Peak
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 Mueller Systems device is an RFDC Radio Module.

Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	Mueller Systems
FCC ID:	SM6-RFDC
Model:	RFDC RADIO MODULE
FCC Rule Parts:	§15.247
Frequency Range:	902.5MHz – 927.35MHz
Maximum Output Power:	29.8dBm
Antenna Connector	RPSMA (for external whip)
Antenna Type	Inverted F PCB trace and Omni directional Dipole antenna
Antenna Gain	4.8dBi and 6.0dBi
Power Source & Voltage:	120VAC

2.2 Test Configuration

The RFDC Radio Module was operated from 120VAC 60Hz power. Commands were sent to the RFDC Radio Module using an RS232 port connected to a support laptop using Windows HyperTerminal program. Radiated Emissions test were performed with both of the replacement antennas in place in the worst case orthogonal of the EUT.

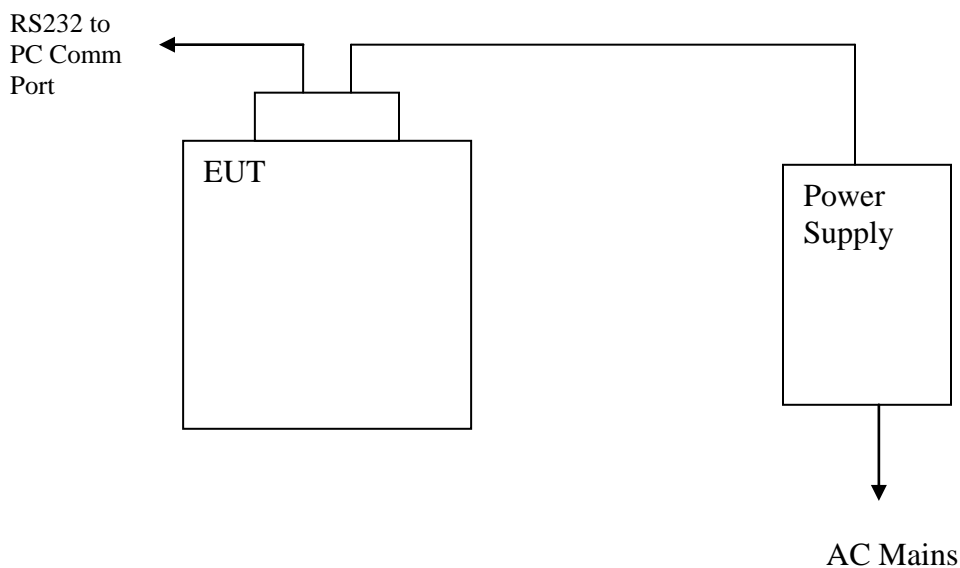


Figure 1: Test Configuration

2.3 Testing Algorithm

The RFDC Radio Module was programmed for operation via a serial cable connected to a laptop running HyperTerminal. Channel selection and modulation was accomplished using the laptop to set the EUT into a continuous transmit pseudo-random data stream at the Low, Center and High channels. Once the channel was set, the laptop was removed from the setup.

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 ACLASS under Certificate AT-1448 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

2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in Equation 1 to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

Equation 1: Standard Uncertainty

$$u_c = \pm \sqrt{\frac{a^2}{div_a^2} + \frac{b^2}{div_b^2} + \frac{c^2}{div_c^2} + \dots}$$

Where u_c = standard uncertainty
 a, b, c, \dots = individual uncertainty elements
 $Div_{a, b, c}$ = the individual uncertainty element divisor based on the probability distribution
 Divisor = 1.732 for rectangular distribution
 Divisor = 2 for normal distribution
 Divisor = 1.414 for trapezoid distribution

Equation 2: Expanded Uncertainty

$$U = k u_c$$

Where U = expanded uncertainty
 k = coverage factor
 $k \leq 2$ for 95% coverage (ANSI/NCSL Z540-2 Annex G)
 u_c = standard uncertainty

Measurement uncertainty is not used to adjust the measurements to determine compliance. The expanded uncertainty values for the various scopes in the WLL accreditation are provided in Table 2 below.

Table 2: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Radiated Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	± 4.55 dB

3 Test Equipment

Table 3 lists the test equipment used for measurements along with the calibration information.

Table 3: Test Equipment List

Test Name: Conducted Emissions at Antenna Terminal		Test Date: 09/19/2011	
Asset #	Manufacturer/Model	Description	Cal. Due
728	HP – 8564E	ANALYZER SPECTRUM	4/28/2012
Test Name: Radiated Emissions		Test Date: 09/19/2011	
Asset #	Manufacturer/Model	Description	Cal. Due
71	HP - 85685A	PRESELECTOR RF	6/26/2012
73	HP - 8568B	ANALYZER SPECTRUM	6/26/2012
69	HP - 85650A	ADAPTER QP	6/28/2012
644	SUNOL SCIENCES CORPORATION - JB1 925-833-9936	BICONALOG ANTENNA	12/20/2011
4	ARA - DRG-118/A	ANTENNA DRG 1-18GHZ	2/15/2013
767	MEGAPHASE - EM18-NK5NK-600	LOW LOSS ARMORED CABLE DC-18GHZ N-N FACTORY FORMED RA	6/1/2012
627	AGILENT - 8449B	AMPLIFIER 1-26GHZ	5/4/2012
337	WLL - 1.2-5GHZ	FILTER BAND PASS	3/24/2012
281	ITC - 21A-3A1	WAVEGUIDE 4.51-10.0GHZ	3/24/2012
283	ITC - 21KU-3A1	WAVEGUIDE 9.8-20.5GHZ	3/24/2012
618	HP - 8563A	ANALYZER SPECTRUM	7/15/2012

4 Test Results

4.1 FCC Part 15.247 (b) RF Power Output: (FCC Part §2.1046)

To measure the output power the output from the transmitter was connected to the input of a spectrum analyzer. The original grant RF power levels and the original report filing levels are reported in the tables below along with the measured RF power levels.

This is applicable for the 902 – 928MHz band of this device.

Table 4: Part 15.247 RF Power Output Results

Grant listed as 0.955 Watts for 902 - 928MHz

Channel and/or Frequency	Peak Measured Level (dBm)	Peak Measured Level (Watts)	Original Grant Report Level (dBm)	Original Grant Report Level (Watts)	Limit (dBm)
Low Channel (902.5MHz)	29.50	0.891	29.76	0.946	30
Mid Channel (915.35MHz)	29.50	0.891	29.00	0.794	30
High Channel (927.35MHz)	28.84	0.766	29.32	0.855	30

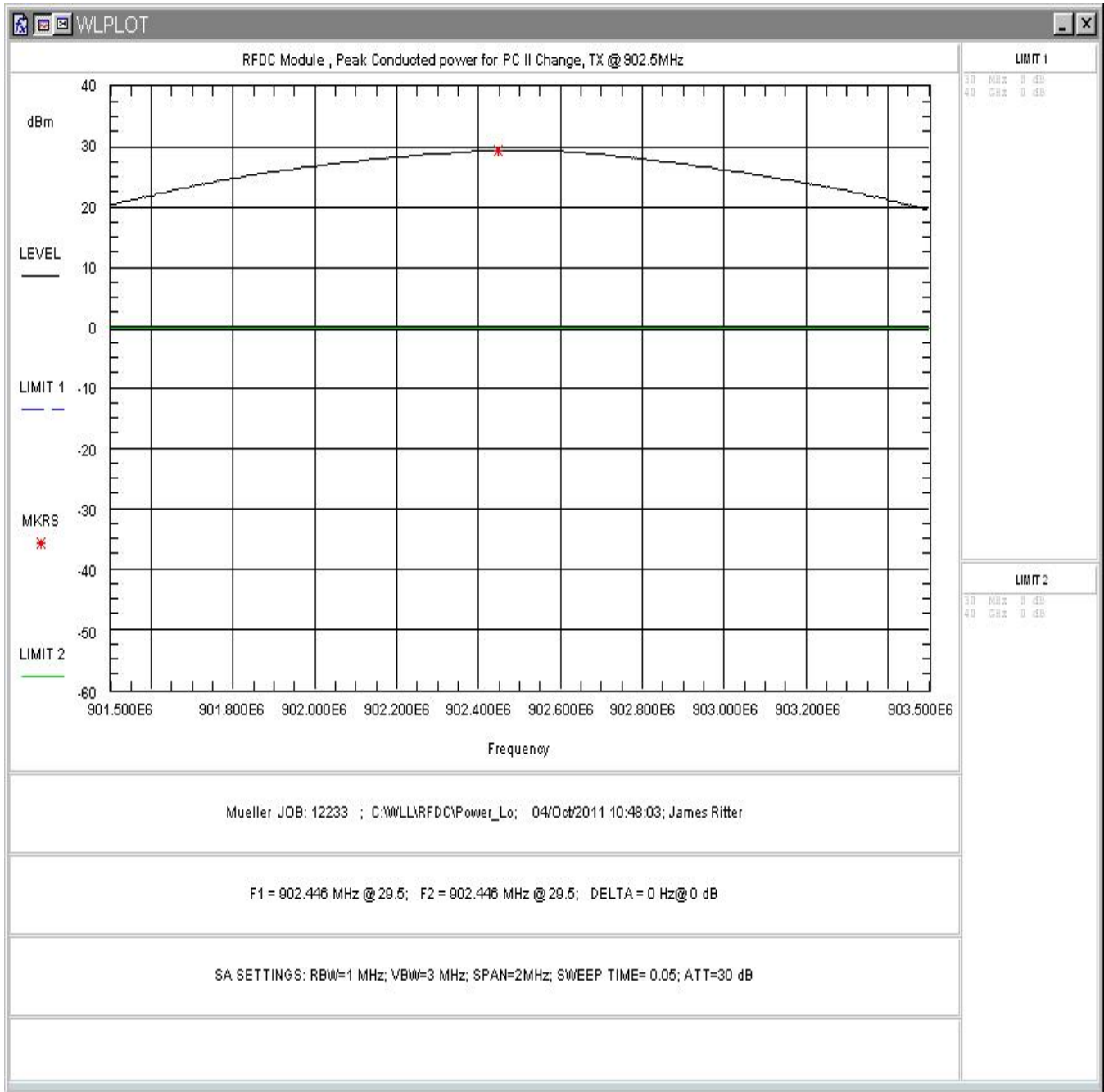


Figure 2: Conducted Peak Power, 902.5MHz

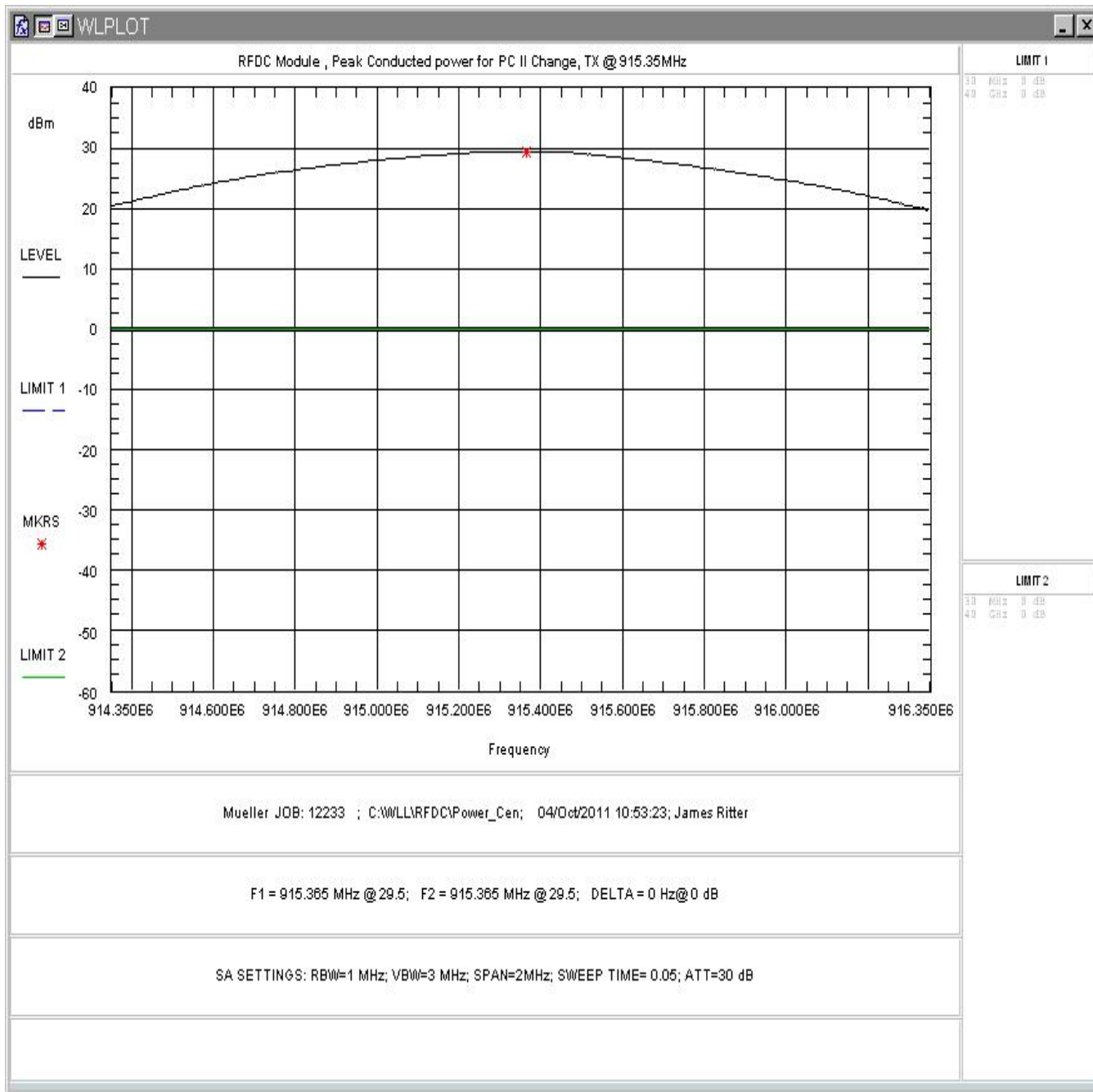


Figure 3: Conducted Peak Power, 915.35MHz

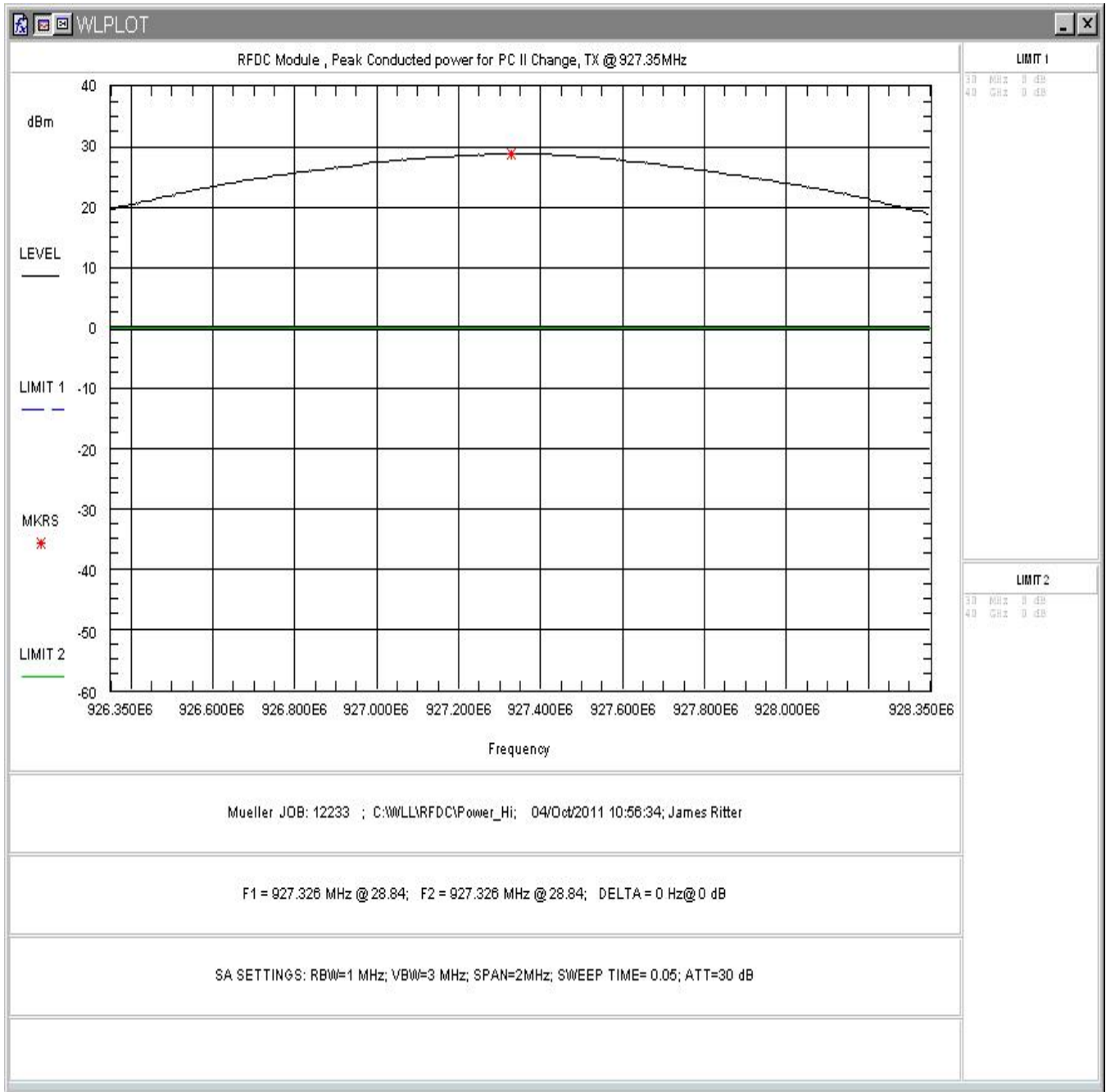


Figure 4: Conducted Peak Power, 927.35MHz

4.2 Radiated Spurious Emissions: (FCC Part §15.247)

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.

4.2.1 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 C63.4-2003. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

3 Orthogonals of the EUT were scanned in the restricted bands up to the 10th harmonic with the worst case readings shown.

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	10 Hz (Avg.) 1MHz (Peak)

Table 5: Radiated Emission Test Data, PCB Antenna, TX@ 902.5MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)
114.40	V	180.00	1.00	3.80	14.9	8.6	150.0	-24.8
123.94	V	90.00	1.00	6.80	15.6	13.2	150.0	-21.1
963.69	V	90.00	1.00	4.50	29.7	51.1	500.0	-19.8
964.00	V	90.00	1.00	6.50	29.7	64.4	500.0	-17.8
964.26	V	90.00	1.00	5.70	29.7	58.8	500.0	-18.6
114.40	H	0.00	4.00	4.10	14.9	8.9	150.0	-24.5
123.94	H	135.00	4.00	8.20	15.6	15.5	150.0	-19.7
963.69	H	55.00	1.00	6.00	29.7	60.7	500.0	-18.3
964.00	H	55.00	1.00	8.90	29.7	84.9	500.0	-15.4
964.26	H	55.00	1.00	6.40	29.7	63.7	500.0	-17.9
Peak								
2707.50	V	180.00	3.04	48.33	-2.6	193.3	5000.0	-28.3
3610.00	V	325.00	2.32	47.17	-2.6	193.3	5000.0	-28.3
4512.50	V	345.00	2.96	48.17	-0.5	215.7	5000.0	-27.3
Average								
2707.50	V	180.00	3.04	38.67	-2.6	63.6	500.0	-17.9
3610.00	V	325.00	2.32	39.83	-0.5	92.7	500.0	-14.6
4512.50	V	345.00	2.96	39.17	0.7	98.6	500.0	-14.1
Peak								
2707.50	H	90.00	2.73	46.17	-2.6	150.8	5000.0	-30.4
3610.00	H	190.00	3.10	47.00	-0.5	211.5	5000.0	-27.5
4512.50	H	180.00	2.50	49.80	0.7	335.2	5000.0	-23.5
Average								
2707.50	H	90.00	2.73	35.33	-2.6	43.3	500.0	-21.3
3610.00	H	190.00	3.10	38.90	-0.5	83.3	500.0	-15.6
4512.50	H	180.00	2.50	39.20	0.7	98.9	500.0	-14.1

Table 6: Radiated Emission Test Data, PCB Antenna, TX@ 915.35MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)
114.42	V	270.00	1.00	5.20	14.9	10.1	150.0	-23.4
123.95	V	0.00	1.00	8.90	15.6	16.8	150.0	-19.0
240.00	V	90.00	1.00	4.00	14.9	8.8	200.0	-27.1
263.98	V	15.00	1.00	7.60	16.6	16.3	200.0	-21.8
114.42	H	315.00	4.00	2.60	14.9	7.5	150.0	-26.0
123.95	H	90.00	4.00	7.40	15.6	14.1	150.0	-20.5
240.00	H	180.00	4.00	3.60	14.9	8.5	200.0	-27.5
263.98	H	0.00	4.00	1.80	16.6	8.3	200.0	-27.6
Peak								
2746.05	V	90.00	2.99	50.00	-2.6	235.5	5000.0	-26.5
4576.75	V	235.00	3.06	47.00	0.8	244.6	5000.0	-26.2
Average								
2746.05	V	90.00	2.99	42.67	-2.6	101.3	500.0	-13.9
4576.75	V	235.00	3.06	36.50	0.8	73.0	500.0	-16.7
Peak								
2746.05	H	90.00	2.07	48.00	-2.6	187.0	5000.0	-28.5
4576.75	H	260.00	3.77	45.00	0.8	194.3	5000.0	-28.2
Average								
2746.05	H	90.00	2.07	38.67	-2.6	63.9	500.0	-17.9
4576.75	H	260.00	3.77	35.67	0.8	66.4	500.0	-17.5

Table 7: Radiated Emission Test Data, PCB Antenna, TX@ 927.35MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)
114.41	V	315.00	1.00	5.90	14.9	11.0	150.0	-22.7
123.93	V	45.00	1.00	8.20	15.6	15.5	150.0	-19.7
240.00	V	225.00	1.00	4.60	14.9	9.5	200.0	-26.5
114.41	H	0.00	4.00	2.00	14.9	7.0	150.0	-26.6
123.93	H	90.00	4.00	2.10	15.6	7.7	150.0	-25.8
240.00	H	90.00	4.00	3.60	14.9	8.5	200.0	-27.5
Peak								
2782.05	V	355.00	2.07	47.50	-2.5	177.4	5000.0	-29.0
3709.40	V	0.00	2.16	47.00	-0.4	212.6	5000.0	-27.4
4636.77	V	325.00	2.81	47.67	0.8	265.7	5000.0	-25.5
Average								
2782.05	V	355.00	2.07	37.83	-2.5	58.3	500.0	-18.7
3709.40	V	0.00	2.16	35.17	-0.4	54.5	500.0	-19.3
4636.77	V	325.00	2.81	38.33	0.8	90.7	500.0	-14.8
Peak								
2782.05	H	90.00	3.60	47.83	-2.5	184.2	5000.0	-28.7
3709.40	H	325.00	2.84	46.67	-0.4	204.7	5000.0	-27.8
4636.77	H	340.00	3.48	46.00	0.8	219.2	5000.0	-27.2
Average								
2782.05	H	90.00	3.60	37.50	-2.5	56.1	500.0	-19.0
3709.40	H	3.25	2.84	35.00	-0.4	53.4	500.0	-19.4
4636.77	H	340.00	3.48	36.00	0.8	69.3	500.0	-17.2

Table 8: Radiated Emission Test Data, OD9-6-ANT Antenna TX@ 902.5MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)
114.40	V	180.00	1.00	3.80	14.9	8.6	150.0	-24.8
123.94	V	90.00	1.00	6.80	15.6	13.2	150.0	-21.1
963.69	V	90.00	1.00	4.50	29.7	51.1	500.0	-19.8
964.00	V	90.00	1.00	6.50	29.7	64.4	500.0	-17.8
964.26	V	90.00	1.00	5.70	29.7	58.8	500.0	-18.6
114.40	H	0.00	4.00	4.10	14.9	8.9	150.0	-24.5
123.94	H	135.00	4.00	8.20	15.6	15.5	150.0	-19.7
963.69	H	55.00	1.00	6.00	29.7	60.7	500.0	-18.3
964.00	H	55.00	1.00	8.90	29.7	84.9	500.0	-15.4
964.26	H	55.00	1.00	6.40	29.7	63.7	500.0	-17.9
Peak								
2707.50	V	180.00	2.22	50.00	-2.6	234.3	5000.0	-26.6
3610.00	V	0.00	3.06	47.00	-2.6	234.3	5000.0	-26.6
4512.50	V	0.00	3.06	49.17	-0.5	211.5	5000.0	-27.5
Average								
2707.50	V	180.00	2.22	43.33	-2.6	108.7	500.0	-13.3
3610.00	V	0.00	3.06	37.00	-0.5	66.9	500.0	-17.5
4512.50	V	0.00	3.06	40.83	0.7	119.4	500.0	-12.4
Peak								
2707.50	H	235.00	3.37	46.50	-2.6	156.6	5000.0	-30.1
3610.00	H	235.00	3.30	45.33	-0.5	174.5	5000.0	-29.1
4512.50	H	135.00	2.33	47.17	0.7	247.7	5000.0	-26.1
Average								
2707.50	H	235.00	3.37	36.33	-2.6	48.6	500.0	-20.3
3610.00	H	235.00	3.30	35.33	-0.5	55.2	500.0	-19.1
4512.50	H	135.00	2.33	36.67	0.7	73.9	500.0	-16.6

Table 9: Radiated Emission Test Data, OD9-6-ANT Antenna, TX@ 915.35MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)
114.42	V	270.00	1.00	5.20	14.9	10.1	150.0	-23.4
123.95	V	0.00	1.00	8.90	15.6	16.8	150.0	-19.0
240.00	V	90.00	1.00	4.00	14.9	8.8	200.0	-27.1
263.98	V	15.00	1.00	7.60	16.6	16.3	200.0	-21.8
114.42	H	315.00	4.00	2.60	14.9	7.5	150.0	-26.0
123.95	H	90.00	4.00	7.40	15.6	14.1	150.0	-20.5
240.00	H	180.00	4.00	3.60	14.9	8.5	200.0	-27.5
263.98	H	0.00	4.00	1.80	16.6	8.3	200.0	-27.6
Peak								
2746.05	V	180.00	2.85	50.00	-2.6	235.5	5000.0	-26.5
3661.40	V	0.00	2.87	46.50	-2.6	235.5	5000.0	-26.5
4576.75	V	0.00	2.96	49.00	-0.5	200.1	5000.0	-28.0
7322.80	V	180.00	2.47	45.17	7.5	431.0	5000.0	-21.3
Average								
2746.05	V	180.00	2.85	44.33	-2.6	122.6	500.0	-12.2
3661.40	V	0.00	2.87	36.17	-0.5	60.9	500.0	-18.3
4576.75	V	0.00	2.96	42.67	0.8	148.6	500.0	-10.5
7322.80	V	180.00	2.47	34.67	7.5	128.7	500.0	-11.8
Peak								
2746.05	H	235.00	2.76	47.00	-2.6	166.7	5000.0	-29.5
4576.75	H	0.00	3.51	46.17	0.8	222.3	5000.0	-27.0
7322.80	H	270.00	3.85	44.00	7.5	376.7	5000.0	-22.5
Average								
2746.05	H	235.00	2.76	36.83	-2.6	51.7	500.0	-19.7
4576.75	H	0.00	3.51	35.33	0.8	63.8	500.0	-17.9
7322.80	H	270.00	3.85	36.50	7.5	158.9	500.0	-10.0

Table 10: Radiated Emission Test Data, OD9-6-ANT Antenna, TX@ 927.35MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)
114.41	V	315.00	1.00	5.90	14.9	11.0	150.0	-22.7
123.93	V	45.00	1.00	8.20	15.6	15.5	150.0	-19.7
240.00	V	225.00	1.00	4.60	14.9	9.5	200.0	-26.5
114.41	H	0.00	4.00	2.00	14.9	7.0	150.0	-26.6
123.93	H	90.00	4.00	2.10	15.6	7.7	150.0	-25.8
240.00	H	90.00	4.00	3.60	14.9	8.5	200.0	-27.5
Peak								
2782.05	V	200.00	2.83	46.67	-2.5	161.2	5000.0	-29.8
3709.40	V	0.00	2.87	48.17	-2.5	161.2	5000.0	-29.8
4636.77	V	15.00	3.44	47.17	-0.4	243.3	5000.0	-26.3
Average								
2782.05	V	200.00	2.83	36.67	-2.5	51.0	500.0	-19.8
3709.40	V	0.00	2.87	37.17	-0.4	68.6	500.0	-17.3
4636.77	V	15.00	3.44	40.00	0.8	109.9	500.0	-13.2
Peak								
2782.05	H	245.00	2.00	0.00	-2.5	0.7	5000.0	-76.5
3709.40	H	0.00	2.48	46.67	-0.4	204.7	5000.0	-27.8
4636.77	H	235.00	2.59	46.50	0.8	232.2	5000.0	-26.7
Average								
2782.05	H	245.00	2.48	35.50	-2.5	44.6	500.0	-21.0
3709.40	H	0.00	0.00	0.00	-0.4	0.9	500.0	-54.4
4636.77	H	235.00	2.59	36.00	0.8	69.3	500.0	-17.2