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

For the

MUELLER SYSTEMS

DCOM III RADIO MODULE

FCC ID: SM6-MINODE-WATER3

WLL Report# **12822-01 Rev. 0**
April 13, 2013

Prepared for:

Mueller Systems
48 Leona Drive
Middleboro, MA 02346

Prepared By:

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ACLASS ACCREDITED TESTING

Testing Certificate AT-1448

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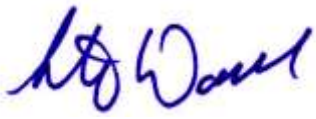

Steven Dovell
EMC Compliance Engineer

Reviewed by:

Steven D. Koster
Vice President

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 (10/2010) of the FCC Rules & Regulations. This Permissive Change Test Report documents the test configuration and test results for a Mueller Systems DCOM III.

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 DCOM III remains in compliance with the limits for a Digital Transmission System under Part 15.247 (10/2010).

Revision History	Reason	Date
Rev 0	Initial Release	April 13, 2013

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1 Introduction

1.1 Reason for Class II Permissive Change

The reason for the change is to incorporate the following modifications:

The new shield size has been reduced to be approximately one half the height of the original shield and to remove the need for the RF absorber on the bottom side of the module and removal of one of the digital ports.

1.2 Compliance Statement

The Mueller Systems DCOM III remains in compliance with the limits for a Digital Transmission System under Part 15.247 (10/2010).

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:	855335
Quotation Number:	67234

1.5 Test Dates

Testing was performed on the following date(s):	4/8/2013

1.6 Test and Support Personnel

Washington Laboratories, LTD	John P. Repella, Steven Dovell
Customer Representative	David Splitz

1.7 Abbreviations

A	**A**mpere
ac	**a**lternating **c**urrent
AM	Amplitude Modulation
Amps	**Amp**ere**s**
b/s	**b**its per **s**econd
BW	**B**and**W**idth
CE	**C**onducted **E**mission
cm	**C**enti**m**eter
CW	**C**ontinuous **W**ave
dB	**decibel**
dc	**d**irect **c**urrent
EMI	**E**lectro**m**agnetic **I**nterference
EUT	**E**quipment **U**nder **T**est
FM	**F**requency **M**odulation
G	**g**iga - prefix for 10^9 multiplier
Hz	**H**ertz
IF	**I**ntermediate **F**requency
k	**k**ilo - prefix for 10^3 multiplier
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
M	**M**ega - prefix for 10^6 multiplier
m	**M**eter
µ	**m**icro - prefix for 10^{-6} multiplier
NB	**N**arrow**b**and
QP	**Q**uasi-**P**eak
RE	**R**adiated **E**missions
RF	**R**adio **F**requency
rms	**r**oot-**m**ean-**s**quare
SN	**S**erial **N**uMber
S/A	**S**pectrum **A**nalyzer
V	**V**olt

2 Equipment Under Test

2.1 EUT Identification & Description

The Mueller Systems device is a Repeater Radio Module.

Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	Mueller Systems
FCC ID: IC ID:	SM6-MINODE-WATER3
Model:	DCOM III
FCC Rule Parts:	§15.247
Frequency Range:	902.5MHz – 927.35MHz
Maximum Output Power:	29.49 dBm (0.8892W)
Antenna Connector	PCB Mounted Whip
Antenna Type	Dipole
Antenna Gain	< 1 dBi
Power Source & Voltage:	3.7VDC

2.2 Test Configuration

The DCOM III was operated from 120VAC 60Hz power. Commands were sent to the DCOM III 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.

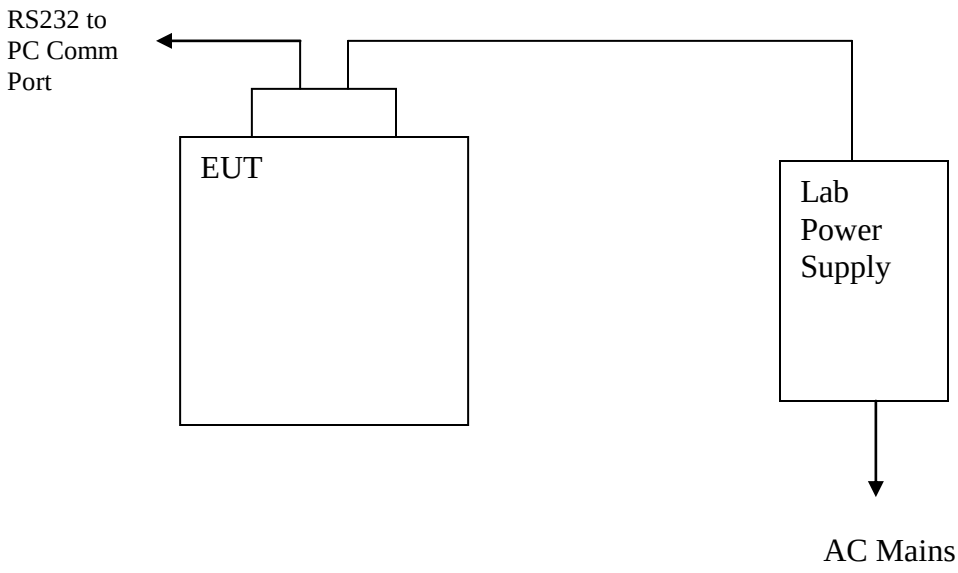

Figure 1: Test Configuration

2.3 Testing Algorithm

The DCOM III 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

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

Where u_c = standard uncertainty

a, b, c,.. = 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

$$U = ku_c$$

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:	**01/10/2013**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
74	HP – 8593A	ANALYZER SPECTRUM	10/4/2013

Test Name:	**Radiated Emissions**	Test Date:	4/8/2013
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
74	HP - 8593A	ANALYZER SPECTRUM	10/4/2013
69	HP - 85650A	ADAPTER QP	6/27/2013
71	HP - 85685A	PRESELECTOR RF	6/27/2013
73	HP - 8568B	ANALYZER SPECTRUM	6/27/2013
382	SUNOL SCIENCES CORPORATION - JB1	ANTENNA BICONLOG	6/26/2014
731	MEGAPHASE - TM40-K1K5-36	RF CABLE 1M 2-9M TO 2-9M RA ONE END	5/25/2013
337	WLL - 1.2-5GHZ	FILTER BAND PASS	4/19/2014
280	ITC - 21C-3A1	WAVEGUIDE 3.45-11.0GHZ	5/29/2014
281	ITC - 21A-3A1	WAVEGUIDE 4.51-10.0GHZ	5/29/2014

4 Test Results

4.1 FCC Part15.247 (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 0.946 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)	29.37dBm	0.865	29.51dBm	0.893	30
Mid Channel (915.0MHz)	29.49dBm	0.889	29.76dBm	0.946	30
High Channel (927.35MHz)	28.60dBm	0.724	28.83dBm	0.764	30

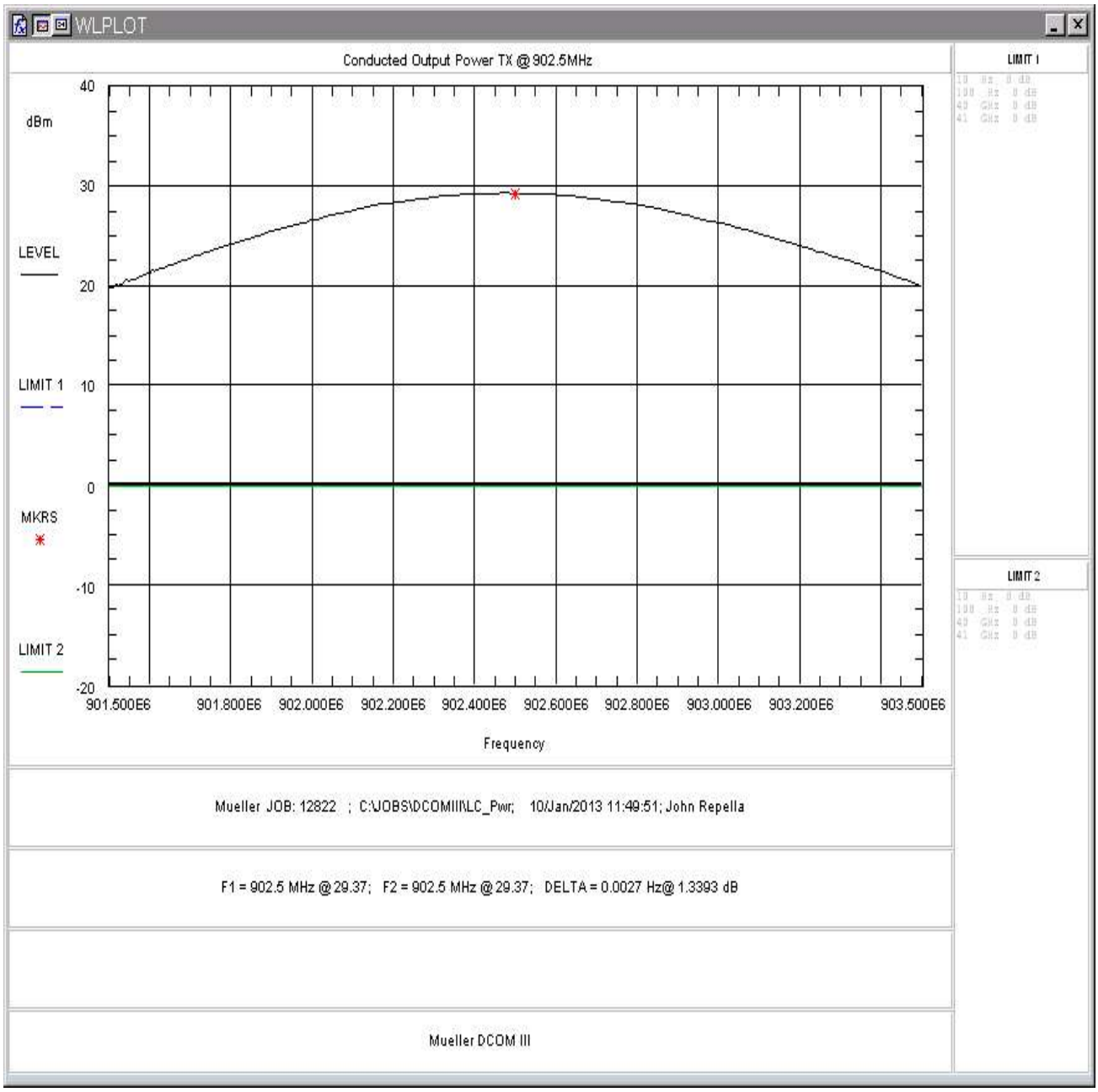

Figure 2: Conducted Peak Power, 902.5MHz

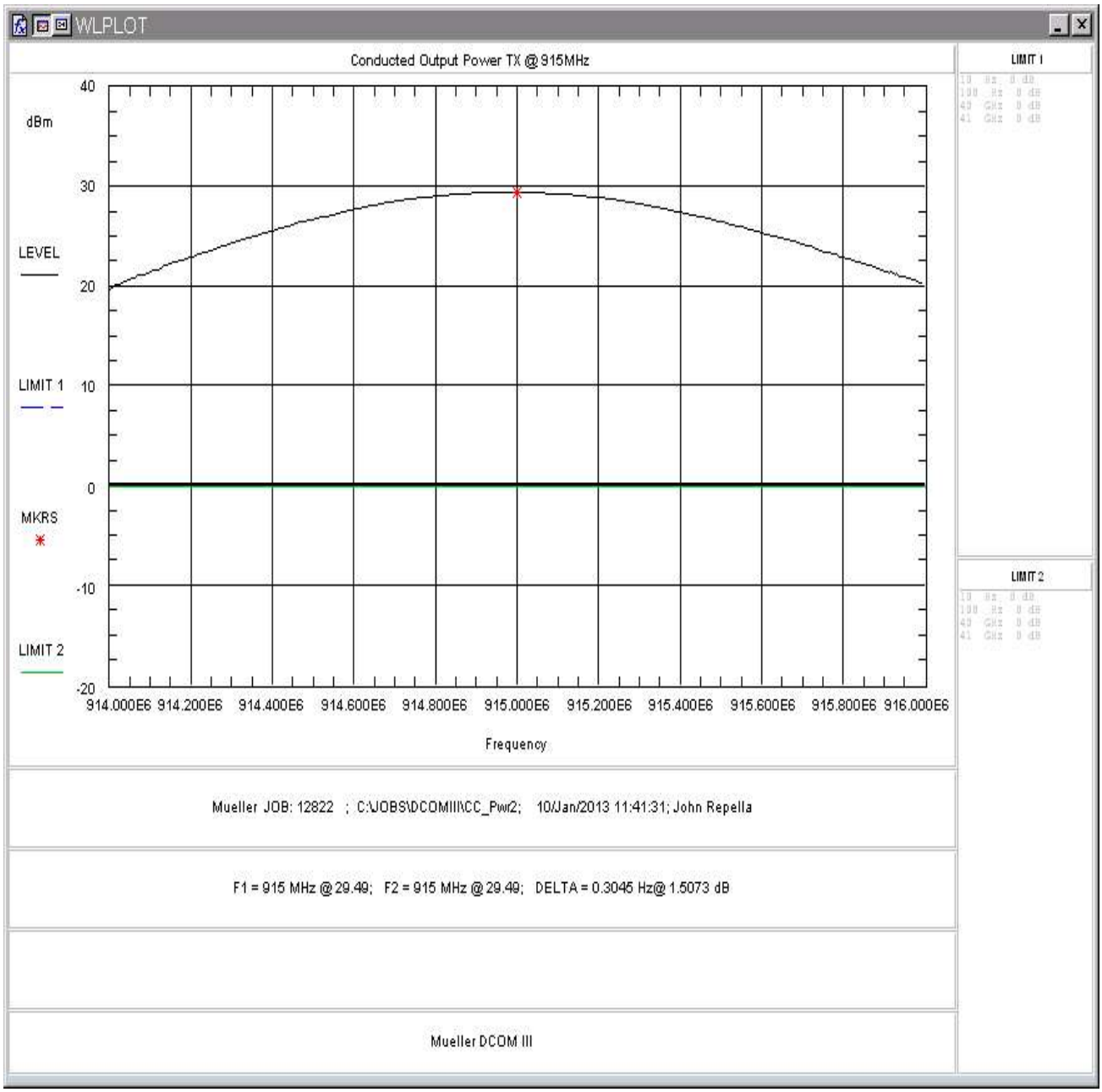

Figure 3: Conducted Peak Power, 915MHz

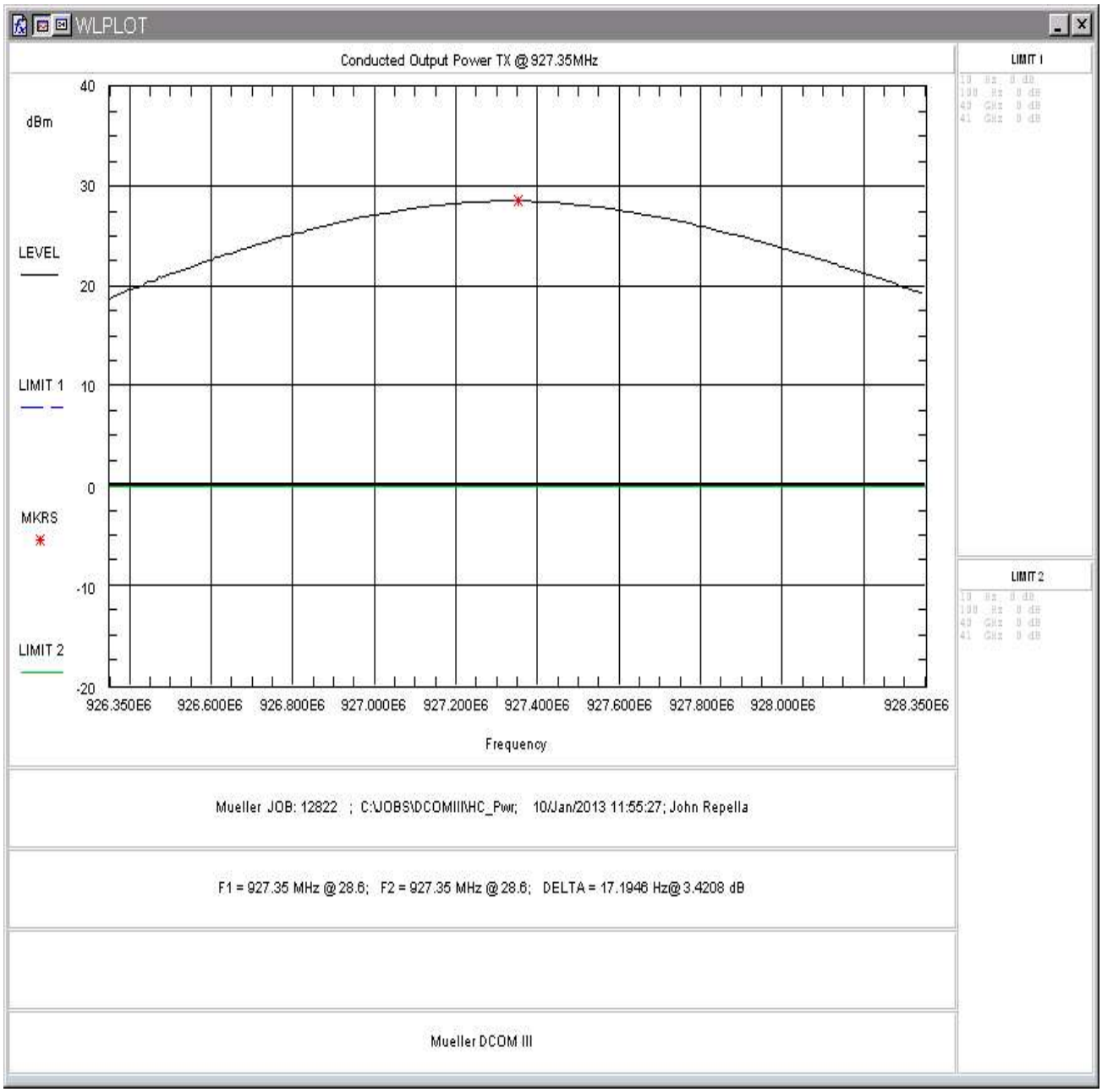

Figure 4: Conducted Peak Power, 927.35MHz

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 10^{th} 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 below 1GHz

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)
36.00	V	145.00	1.00	15.00	16.8	38.8	100.0	-8.2
43.00	V	0.00	1.00	20.30	12.8	45.0	100.0	-6.9
49.83	V	180.00	1.00	13.60	9.7	14.6	100.0	-16.7
80.00	V	90.00	1.00	14.00	9.0	14.1	100.0	-17.0
110.89	V	355.00	1.00	17.60	15.3	44.1	150.0	-10.6
127.35	V	120.00	1.00	14.00	15.5	30.0	150.0	-14.0
209.79	V	0.00	2.50	22.10	13.9	63.1	150.0	-7.5
217.57	V	180.00	2.50	15.60	13.8	29.5	200.0	-16.6
36.86	H	180.00	4.00	14.20	16.4	34.0	100.0	-9.4
43.16	H	180.00	4.00	11.00	12.7	15.2	100.0	-16.3
60.00	H	270.00	4.00	13.10	9.4	13.3	100.0	-17.5
80.00	H	180.00	4.00	13.00	9.0	12.5	100.0	-18.0
110.98	H	200.00	4.00	16.20	15.3	37.7	150.0	-12.0
124.47	H	45.00	4.00	16.40	15.5	39.4	150.0	-11.6
168.84	H	185.00	3.20	9.20	14.1	14.7	150.0	-20.2
219.33	H	150.00	3.00	16.80	13.9	34.4	200.0	-15.3
450.05	H	150.00	1.00	6.80	21.7	26.6	200.0	-17.5

Table 6: Radiated Emission Test Data, < 1dBi dipole 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)	Comments
2707.98	V	355.00	2.04	51.70	-1.4	326.2	5000.0	-23.7	Peak
2707.98	V	355.00	2.04	49.60	-1.4	256.2	500.0	-5.8	Average
3610.60	V	355.00	2.01	46.60	-0.3	206.5	5000.0	-27.7	Peak
3610.60	V	355.00	2.01	40.00	-0.3	96.6	500.0	-14.3	Average
4513.25	V	0.00	2.05	42.10	1.6	153.8	5000.0	-30.2	Peak
4513.25	V	0.00	2.05	36.00	1.6	76.2	500.0	-16.3	Average
2707.98	H	185.00	1.54	52.43	-1.4	354.8	5000.0	-23.0	Peak
2707.98	H	185.00	1.54	49.40	-1.4	250.3	500.0	-6.0	Average
3610.60	H	90.00	1.55	46.37	-0.3	201.1	5000.0	-27.9	Peak
3610.60	H	90.00	1.55	39.00	-0.3	86.1	500.0	-15.3	Average
4513.25	H	270.00	1.53	43.90	1.6	189.2	5000.0	-28.4	Peak
4513.25	H	270.00	1.53	34.70	1.6	65.6	500.0	-17.6	Average

Table 7: Radiated Emission Test Data, < 1dBi dipole Antenna, TX@ 915MHz

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)	Comments
2746.05	V	0.00	1.96	52.58	-1.5	359.4	5000.0	-22.9	Peak
2746.05	V	0.00	1.96	49.34	-1.5	247.5	500.0	-6.1	Average
3661.40	V	300.00	1.93	49.40	0.0	294.0	5000.0	-24.6	Peak
3661.40	V	300.00	1.93	42.30	0.0	129.8	500.0	-11.7	Average
4576.75	V	0.00	1.87	41.40	1.7	143.7	5000.0	-30.8	Peak
4576.75	V	0.00	1.87	34.30	1.7	63.4	500.0	-17.9	Average
2746.05	H	190.00	1.45	49.55	-1.5	253.6	5000.0	-25.9	Peak
2746.05	H	190.00	1.45	46.10	-1.5	170.4	500.0	-9.3	Average
3661.40	H	270.00	1.38	48.16	0.0	255.0	5000.0	-25.8	Peak
3661.40	H	270.00	1.38	38.00	0.0	79.1	500.0	-16.0	Average
4576.75	H	15.00	1.40	42.10	1.7	155.7	5000.0	-30.1	Peak
4576.75	H	15.00	1.40	34.70	1.7	66.4	500.0	-17.5	Average

Table 8: Radiated Emission Test Data, < 1dBi dipole 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)	Comments
2782.05	V	325.00	1.94	52.65	-1.5	360.8	5000.0	-22.8	Peak
2782.05	V	325.00	1.94	49.40	-1.5	248.2	500.0	-6.1	Average
3709.40	V	355.00	1.88	48.50	0.2	272.7	5000.0	-25.3	Peak
3709.40	V	355.00	1.88	44.50	0.2	172.0	500.0	-9.3	Average
4636.75	V	355.00	1.96	44.00	2.1	202.0	5000.0	-27.9	Peak
4636.75	V	355.00	1.96	34.90	2.1	70.9	500.0	-17.0	Average
2782.05	H	200.00	1.97	55.20	-1.5	483.9	5000.0	-20.3	Peak
2782.05	H	200.00	1.97	52.30	-1.5	346.6	500.0	-3.2	Average
3709.40	H	185.00	2.05	47.50	0.2	243.0	5000.0	-26.3	Peak
3709.40	H	185.00	2.05	42.70	0.2	139.8	500.0	-11.1	Average
4636.75	H	180.00	1.97	44.30	2.1	209.1	5000.0	-27.6	Peak
4636.75	H	180.00	1.97	33.60	2.1	61.0	500.0	-18.3	Average