Washington Laboratories, Ltd.
www.wll.com
7560 Lindbergh Drive . Gaithersburg, MD 20879
301.216.1500 . info@wll.com

FCC Permissive Class 2 Test Report

For the

TRX Systems

2.4GHz CSS Transceiver Module

FCC ID: BXONNT5375-1000
IC: 1023A-NNT53751000

WLL JOB# **12506-01 Rev 0**
June 27, 2012

Prepared for:

TRX Systems
7500 Greenway Ctr Drive - Ste 420,
Greenbelt, MD, 20770

Prepared By:

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

ACCREDITED TESTING

Testing Certificate AT-1448

FCC Permissive Class 2 Test Report

For the

TRX Systems

2.4GHz CSS Transceiver Module

FCC ID: BXONNT5375-1000
IC: 1023A-NNT53751000

June 27, 2012

WLL JOB# 12506-01 Rev 0

Prepared by:

James Ritter
EMC Compliance Engineer

Reviewed by:

Steven D. Koster
Vice President

Abstract

This report has been prepared on behalf of TRX Systems to support the attached Class 2 permissive change. The Permissive Class 2 Test Report for a modular Digital Transmission System (DTS) Spectrum Transmitter operating under Part 15.247 (10/2010) of the FCC Rules and RSS210 issue 8. This Certification Permissive Class 2 Test Report documents the test configuration and test results for a TRX Systems 2.4GHz CSS Transceiver 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. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ACLASS under Certificate AT-1448 as an independent FCC test laboratory.

The TRX Systems 2.4GHz CSS Transceiver Module remains in compliance with the limits for a Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247 and RSS-210 issue 8.

Revision History	Description of Change	Date
Rev 0	Initial Release	June 27,2012

Table of Contents

List of Tables

List of Figures

1 Introduction

1.1 Reason for Class 2 Permissive Change

This class 2 permissive change is being generated in order to allow this module to be used in the TRX NEON-TU-1000 host configuration. In this configuration the module will provide the RF output to a trace on the host that leads to an RF switch which will enable one of two possible chip antennas located on the host board. Only one antenna can be active at a time and they are identical 2dBi antennas (JTI P/N 2450AT43A100), the original antenna was a 2.15 dBi fixed monopole antenna.

FCC OET 996369 D01 "Module Certification Guide v01r03" dated 7/12/2011 allows this, per question 11, provided the combination of the host layout and antenna are treated as a separate antenna type.

1.2 Compliance Statement

The TRX Systems 2.4GHz CSS Transceiver Module remains in compliance with the limits for a modular DTS device under FCC Part 15.247 (10/2010).

1.3 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed in the host device. All measurements were performed in accordance with FCC OET 558074 D01 "DTS Meas Guidance v01". The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.4 Contract Information

Customer:	TRX Systems 7500 Greenway Ctr Drive - Ste 420 Greenbelt, MD, 20770
Quotation Number:	66703

1.5 Test Dates

Testing was performed on the following date(s):	4/19/2012 to 4/20/2012

1.6 Test and Support Personnel

Washington Laboratories, LTD	James Ritter
Client Representative	Benjamin Funk

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	**d**eci**B**el
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 TRX Systems 2.4GHz CSS Transceiver Module is a single channel wideband chirp transceiver centered on 2441MHz used for Communication and Real Time Location Systems in 2.4 GHz ISM Band. This module was previously certified under FCC ID: BXONNT5375-1000 and IC:1023A-NNT53751000. The unit was tested on the NEON-TU-1000 host radio board (FCC ID:BXONEON-TU-1000, IC:10230A-NEONTU1000) which contained the radios chip antennas and RF switch.

2.2 Test Configuration

The 2.4GHz CSS Transceiver Module was placed on the NEON-TU-1000 host radio board and operated from hosts 3.7Vdc LiPo battery. Commands were sent to the 2.4GHz CSS Transceiver Module using a terminal program on a support laptop to activate the radio transmits. This connection was disconnected after the test mode was set (radiated tests).

2.3 Testing Algorithm

The 2.4GHz CSS Transceiver Module was programmed via the host boards miniUSB programming port on the EUT to a USB port on the support laptop. The support laptop used a terminal program to command the EUT to transmit at 2441MHz (only channel).

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. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. 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 OET 996369 D01 Module Certification Guide v01r03 Dated 7/12/2011

FCC OET 558074 D01 DTS Meas Guidance v01 Dated 1/18/2012

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 ≤ 2 for 95% coverage (ANSI/NCSL Z540-2 Annex G)

u_c = standard uncertainty

The measurement uncertainty complies with the maximum allowed uncertainty from CISPR 16-4-2. 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 1 below.

Table 1: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	2.63 dB
Radiated Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	4.55 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

Test Name: **Conducted Emissions Voltage**		Test Date: **4/19/2012**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
605	AGILENT HP - N1911A	POWER METER	4/29/2012
606	AGILENT HP - N1921A	POWER SENSOR	4/24/2012
74	HP - 8593A	ANALYZER SPECTRUM	7/29/2012
Test Name: **Radiated Emissions**		Test Date: **4/20/2012**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
280	ITC - 21C-3A1	WAVEGUIDE 3.45-11.0GHZ	4/24/2012
282	ITC - 21X-3A1	WAVEGUIDE 6.8-15GHZ	4/24/2012
66	HP - 8449B	PRE-AMPLIFIER RF. 1-26.5GHZ	04/30/2012
4	ARA - DRG-118/A	ANTENNA DRG 1-18GHZ	2/15/2013
644	SUNOL SCIENCES CORPORATION - JB1 925-833-9936	BICONALOG ANTENNA	1/12/2013
74	HP - 8593A	ANALYZER SPECTRUM	7/29/2012
276	ELECTROMETRICS - BPA-1000	PRE-AMPLIFIER RF 50KHZ-1GHZ	9/8/2012

4 Test Summary

The Table Below shows the results of testing for compliance with a DTS in accordance with FCC Part 15.247 andRSS210 issue 8. Full results are shown in section 5.

Table 3. Test Summary Table

FCC Rule Part	Industry Canada Rule Part	Description	Result
15.247 (a)(2)	A8.2 (a)	6dB Bandwidth	Pass
15.247 (b)(3)	A8.4 (4)	Transmit Output Power	Pass
15.205 15.209	RSS-GEN issue 3, 7.2.2	General Field Strength Limits (Restricted Bands Limits)	Pass

5 Test Results

5.1 Occupied Bandwidth: (FCC Part §2.1049)

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer. The method used is in accordance with FCC OET 558074 D01 DTS Meas Guidance v01 section 5.1.1.

For DTS Systems, FCC Part 15.247 requires the maximum 6 dB bandwidth be greater or equal to 500kHz. As this system only has 1 wideband channel only 1 channel was tested.

This test as performed in order to determine the proper Power Measurement Technique.

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

Table 4 provides a summary of the Occupied Bandwidth Results.

Table 4: Occupied Bandwidth Results

Frequency	Bandwidth	Limit	Pass/Fail
2441MHz	56.256MHz	≥500kHz	Pass

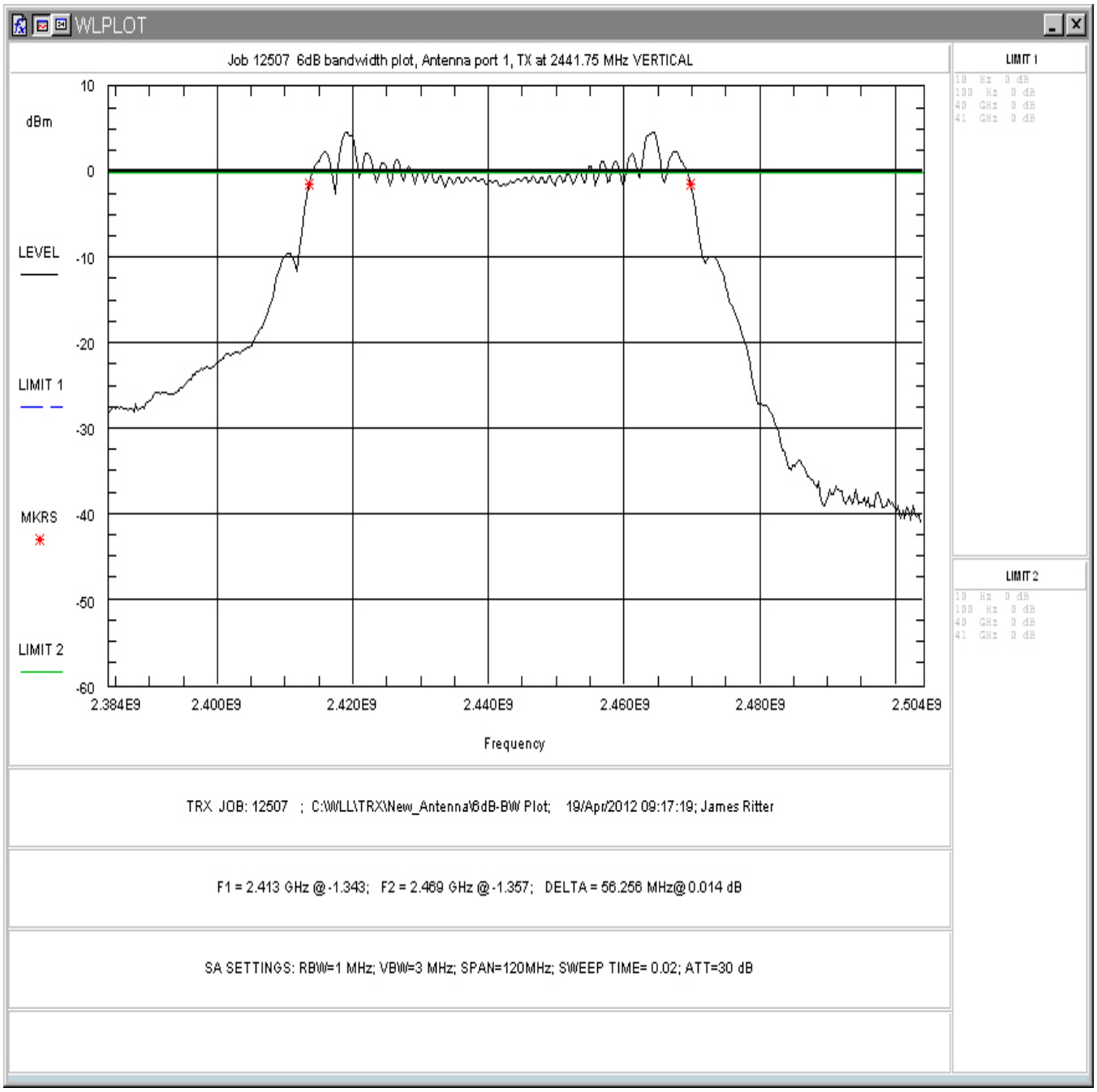

Figure 1: Occupied Bandwidth

5.2 RF Power Output: (FCC Part §2.1046)

To measure the output power the radio was transmitting on 2441MHz. The manufacturer provided a unit with the chip antennas removed and replaced by a short (<10cm) temporary antenna connector port. The output from the transmitter was connected to an attenuator and then to the input of a wideband power meter. Both antenna ports were tested by switching the software command to select either antenna 1 or antenna 2. The power meter offset was adjusted to compensate for the attenuator in the system. This is performed in accordance with FCC procedures (Note the FCC has allowed the use of power meters for this measurement with corrected draft OET procedure 558074 DTS Meas Guidance DR01 and Test Methods of C63.10:2009).

The final result was compared to the previous grant listing for this device to ensure that the output was within +/-1dB (without exceeding the rule part limit of +30dBm).

The unit was within the acceptable tolerance for this permissive change.

Table 5: Data Channel RF Power Output

Channel and/or Frequency	Peak Measured Level (dBm)	Peak Measured Level (Watts)	Present Grant Level (dBm)	Present Grant Level (Watts)
2441.75MHz (ant Port 1)	19.48	0.0887	19.89	0.0975
2441.75MHz (ant Port 2)	19.56	0.0904	19.89	0.0975

5.3 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.

5.3.1 Test Procedure

The EUT was placed on a 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 EUT was tested in 3 orthogonals with the worst case readings provided. 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	10 Hz (Avg.) 1MHz (Peak)

The techniques were performed using the techniques specified in FCC OET 558074 D01 DTS Meas Guidance v01 section 5.4.2.

As this device covers >56MHz bandwidth with a slow chirp frequency it acts as a pulsed signal that over reacts to averaging. In order not to over-average the signal was tested using the duty cycle method –subtracting the worst case on time per 100mS from the peak reading using the formula:

20Log((On time per 100mS)/(100mS)).

5.3.2 Duty Cycle Measurements

5.3.2.1 Procedure

As per FCC part 15.35 and FCC OET 558074 D01 DTS Meas Guidance v01 section 5.4.2.2.3 a duty cycle correction to the peak signal is allowed in place of an averaged reading based on 100mS for pulse trains larger than 100mS. As this signal chirps across 56MHz a diode detector connected to an oscilloscope was used to capture the on/ off timing of this signal. The below plots show this timing (on time is shown as the negative pulses).

5.3.2.2 Duty Cycle Results

The duty cycle was stated to be 6% per the manufacturer. The verified Duty cycle was at 6.598%. A single pulse is 768uS with 9 pulses per 100mS (one pulse is not shown at trigger point. As a result the Duty Cycle correction =20Log(768uS*9/100mS)= 23.2dB. This correction is on applied to the fundamental and harmonics of the transmit above 1GHz that are normally averaged. The unit was tested in 3 orthogonals.

5.3.3 Test Results

The unit complies with FCC and Industry Canada requirements for spurious emissions from intentional radiators

Figure 2: Duty Cycle- Percent of Duty Cycle

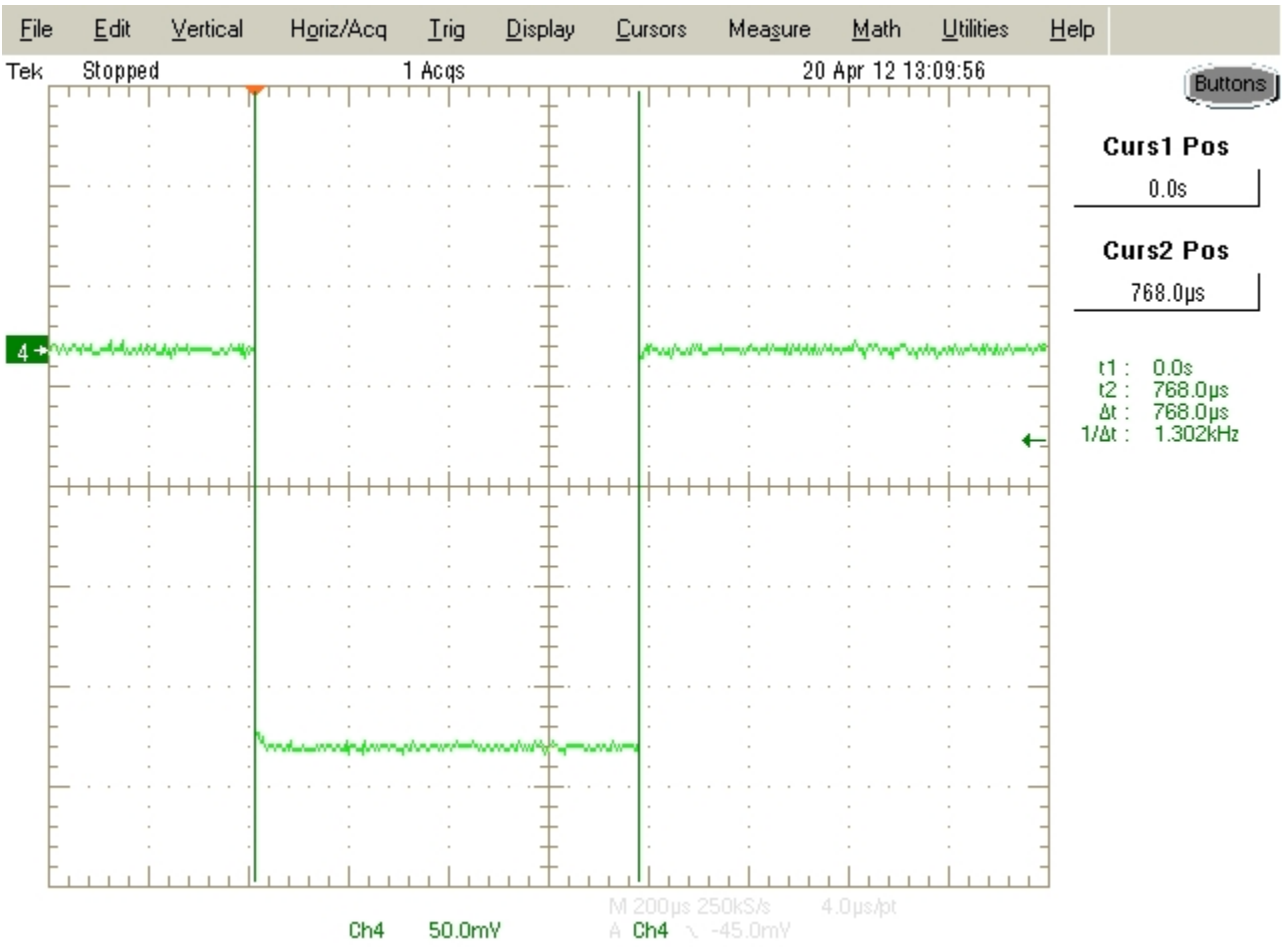

Figure 3: Duty Cycle-Single Pulse On Time

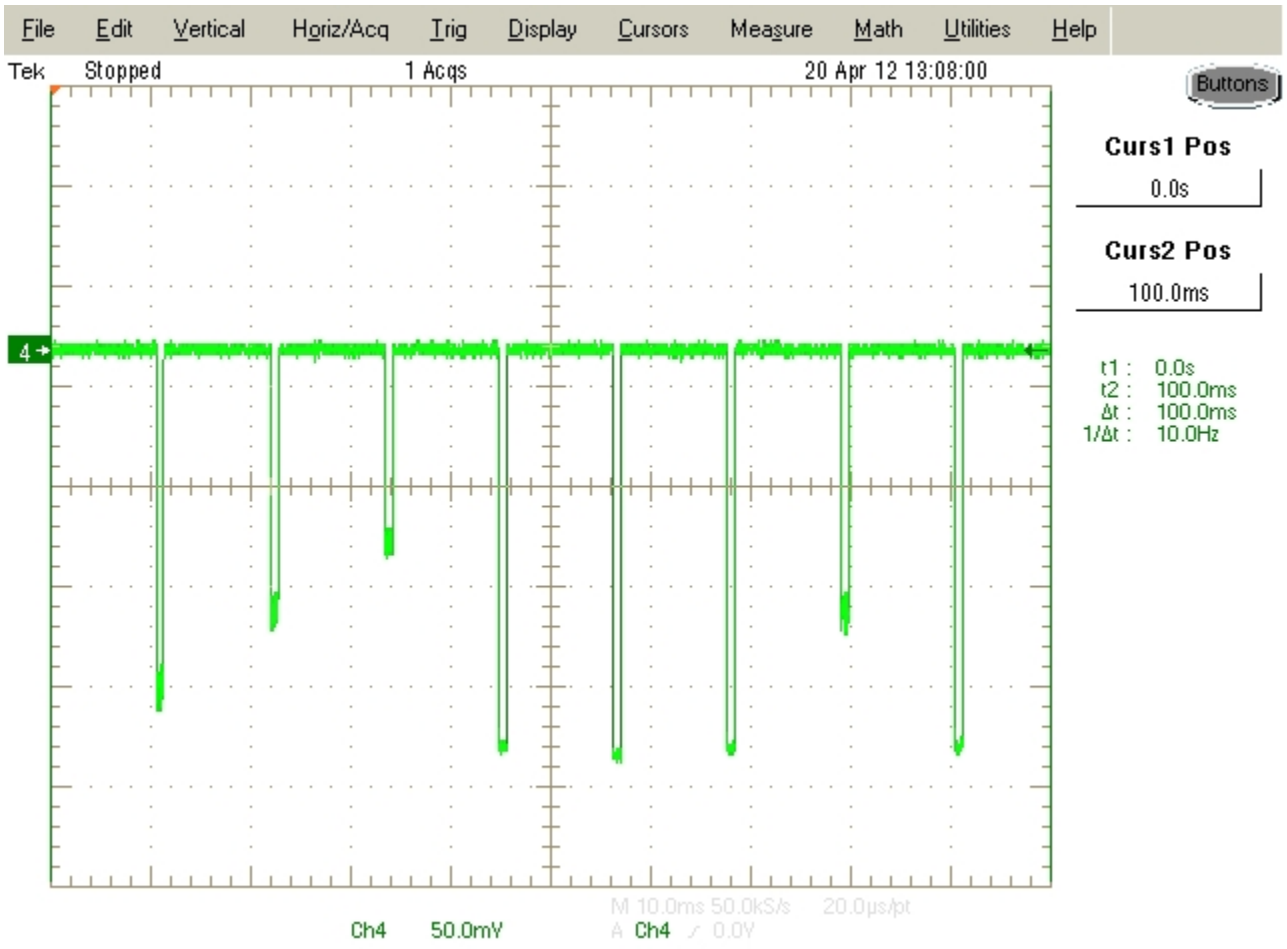

Figure 4: Duty Cycle-Pulses per 100mS

Table 6: Radiated Emission Test Data

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Duty Cycle Correction (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)
75.100	H	90.00	3.60	35.80	-17.3	0.0	8.4	100.0	-21.5
114.300	H	90.00	3.50	32.00	-10.4	0.0	12.1	150.0	-21.9
400.000	H	190.00	2.20	31.70	-7.1	0.0	16.9	200.0	-21.5
Peak									
4883.50	H	90.00	2.50	56.08	0.6	0.0	685.6	5000.0	-17.3
7325.25	H	180.00	3.28	62.41	7.3	0.0	3054.4	5000.0	-4.3
12208.75	H	10.00	2.87	47.21	12.3	0.0	943.9	5000.0	-14.5
2390.00	H	190.00	2.65	55.28	-4.1	0.0	361.9	5000.0	-22.8
2483.50	H	180.00	2.54	64.84	-3.6	0.0	1154.9	5000.0	-12.7
Average									
4883.50	H	90.00	2.50	56.08	0.6	-23.2	47.4	500.0	-20.5
7325.25	H	180.00	3.28	62.41	7.3	-23.2	211.3	500.0	-7.5
12208.75	H	10.00	2.87	47.21	12.3	-23.2	65.3	500.0	-17.7
2390.00	H	190.00	2.65	55.28	-4.1	-23.2	25.0	500.0	-26.0
2483.50	H	180.00	2.54	64.84	-3.6	-23.2	79.9	500.0	-15.9
75.100	V	190.00	1.10	36.10	-17.3	0.0	8.7	100.0	-21.2
400.000	V	90.00	3.10	31.30	-7.1	0.0	16.1	200.0	-21.9
Peak									
4883.50	V	145.00	2.88	55.89	0.6	0.0	670.7	5000.0	-17.4
7325.25	V	0.00	0.00	61.56	7.3	0.0	2769.6	5000.0	-5.1
12208.75	V	0.00	0.00	0.00	12.3	0.0	4.1	5000.0	-61.7
2390.00	V	90.00	2.99	48.10	-4.1	0.0	158.4	5000.0	-30.0
2483.50	V	100.00	1.73	65.92	-3.6	0.0	1307.9	5000.0	-11.7
Average									
4883.50	V	145.00	2.88	55.89	0.6	-23.2	46.4	500.0	-20.6
7325.25	V	0.00	0.00	61.56	7.3	-23.2	191.6	500.0	-8.3
12208.75	V	0.00	0.00	0.00	12.3	-23.2	0.3	500.0	-64.9
2390.00	V	90.00	2.99	48.10	-4.1	-23.2	11.0	500.0	-33.2
2483.50	V	100.00	1.73	65.92	-3.6	-23.2	90.5	500.0	-14.8