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FCC Certification Test Report

For the

TRX Systems

NEON-TU-1000

FCC ID: BXONEON-TU-1000
IC: 10230A-NEONTU1000

June 18, 2012

WLL JOB# 12503-01 Rev2
Re-issued April 23, 2013

Prepared for:

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

Prepared By:

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

ACLASS ACCREDITED TESTING

Testing Certificate AT-1448

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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 Application for Equipment Authorization. The test report and application are submitted for a Transceiver under Part 15.209 (10/2010) of the FCC Rules and Regulations RSS-210 issue 8 of Industry Canada. This Certification Test Report documents the test configuration and test results for the TRX Systems NEON-TU-1000.

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 NEON-TU-1000 complies with the limits for a Transceiver device under FCC Part 15.209 and Industry Canada RSS-210 issue 8.

Revision History	Description of Change	Date
Rev 0	Initial Release	June 18, 2012
Rev 1	Corrected Bluetooth module FCC ID and Industry Canada Number on Page 3.	October 15, 2012 JR
Rev 2	Edited Bluetooth module FCC ID and Industry Canada Number on Page 3.	April 23, 2013

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1 Introduction

1.1 Compliance Statement

The TRX Systems NEON-TU-1000 complies with the limits for an Intentional Radiator device under Part 15.209 of the FCC Rules and Regulations and RSS-210 for Industry Canada.

1.2 Test Scope

Tests for radiated emissions were performed. All measurements were performed according to the 2003 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:	TRX Systems 7500 Greenway Ctr Drive - Ste 420, Greenbelt, MD, 20770
Quotation Number:	66703

1.4 Test Dates

Testing was performed on the following date(s):	4/10/2012 to 4/12/2012

1.5 Test and Support Personnel

Washington Laboratories, LTD	James Ritter
Client Representative	Benjamin Funk

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
m	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 Neon-TU-1000 is a personnel tracking device intended to be worn on the user's belt. Location is tracked using inertial sensors, GPS, and RF ranging. Location data is transmitted via Bluetooth to a 3rd party radio and then forwarded to a command station.

This report covers the low power 125kHz transceiver portion of this device covered under FCC part 15.209 and Industry Canada RSS210 issue 8. The Neon-TU-1000 also houses two previously approved radio modules in the form of a Bluetooth module (FCC ID: BXOWT12-1000, IC: 1023A-WT121000) and a 2441MHz Chirp Spread Spectrum Module (FCC ID: BXONNT5375-1000, IC: 1023A-NNT53751000).

Table 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	TRX Systems
FCC ID:	BXONEON-TU-1000
Industry Canada:	1023A-NEONTU1000
EUT Name:	NEON-TU-1000
FCC Rule Parts:	15.209
Industry Canada Rule Parts:	RSS210 issue 8 (section 2.5.1)
Frequency Range:	125kHz (single frequency)
20dB Occupied Bandwidth:	3.98kHz
Keying:	Automatic
Type of Information:	Data – OOK modulation
Number of Channels:	1
Power Output Level	Fixed
Antenna Type	Integral Magnetic Induction
Interface Cables:	Power
Power Source & Voltage:	3.7 Vdc LiPo Battery (USB for charging battery)

2.2 Test Configuration

The TRX Systems NEON-TU-1000, Equipment Under Test (EUT), was operated from the 3.7Vdc LiPo battery. Commands were sent to the transceiver using a terminal program on a support laptop to activate the radio transmit. This connection was disconnected after the test mode was set (radiated tests). The unit was tests as a standalone unit.

2.3 Equipment Configuration

The EUT was set up as outlined in Figure 1. The EUT was comprised of the following equipment. (All Modules, PCBs, etc. listed were considered as part of the EUT, as tested.)

Table 2: Equipment Configuration

Name / Description	Model Number	Part Number	Serial Number	Revision
Tracking Unit	NEON-TU-1000	NA	60	C

2.4 Support Equipment

The following support equipment was used during testing:

Table 3: Support Equipment

Item	Model/Part Number	Serial Number
Laptop PC	HP Latitude	E6520
AC to USB adaptor	Barnes & Noble model BNRP5-850	--

2.5 Interface Cables

Table 4: Interface Cables

Port Identification	Connector Type	Cable Length	Shielded (Y/N)	Termination Point
Maintenance/Charge	Mini-USB	1.5M	N	Laptop USB

2.6 Testing Algorithm

The EUT was operated continuously by being placed into a continuous 125kHz transmit mode. The maintenance programming cable was removed after programming as this is thye normal operational state.

An AC Mains tests was also run with the programming/ charging cables connected to an AC to USB adaptor and all the transmitters in transmit mode. Although this is not a normal operational condition (as the unit is belt worn), it provided a worst case condition for reference only.

Worst case emission levels are provided in the test results data.

2.7 Test Location

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

2.8 Measurements

2.8.1 References

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

RSS-GEN issue 3 General Requirements and Information for the Certification of Radio Apparatus- Industry Canada

2.9 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

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 5 below.

Table 5: 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 6 shows a list of the test equipment used for measurements along with the calibration information.

Table 6: Test Equipment List

Test Name: **Radiated Emissions**		Test Date: **4/10/2012**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
31	EMCO - 6502	ANTENNA ACTIVE LOOP	2/23/2014
382	SUNOL SCIENCES CORPORATION - JB1	ANTENNA BICONLOG	12/27/2012
68	HP - 85650A	ADAPTER QP	6/22/2012
70	HP - 85685A	PRESELECTOR RF W/OPT 8ZE	6/22/2012
72	HP - 8568B	ANALYZER SPECTRUM	6/22/2012

Test Name: **Conducted Emissions Voltage**		Test Date: **04/11/2012**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
124	SOLAR - 8012-50-R-24-BNC	LISN	7/8/2012
68	HP - 85650A	ADAPTER QP	6/22/2012
70	HP - 85685A	PRESELECTOR RF W/OPT 8ZE	6/22/2012
72	HP - 8568B	ANALYZER SPECTRUM	6/22/2012
53	HP - 11947A	LIMITER TRANSIENT	3/28/2013

4 Test Results

4.1 Occupied Bandwidth: (FCC Part §2.1049, RSS-GEN Sect. 4.6)

Occupied bandwidth was performed by setting the EUT near the loop antenna to allow for sufficient pickup of the signal.

The resolution bandwidth (RBW) of the spectrum analyzer was set to ≥1% of the estimated occupied bandwidth with the video bandwidth (VBW) set to at least 3 times greater than the RBW. The higher and lower points 20dB down from the main peak of the signal were located and their delta to each other measured and recorded as the occupied bandwidth

The transmit signal is a single channel 125 kHz OOK modulated signal with a measured bandwidth of 3.98kHz. There is no limit set for the occupied bandwidth for this type of device.

A plot of the bandwidth is shown in Figure 1.

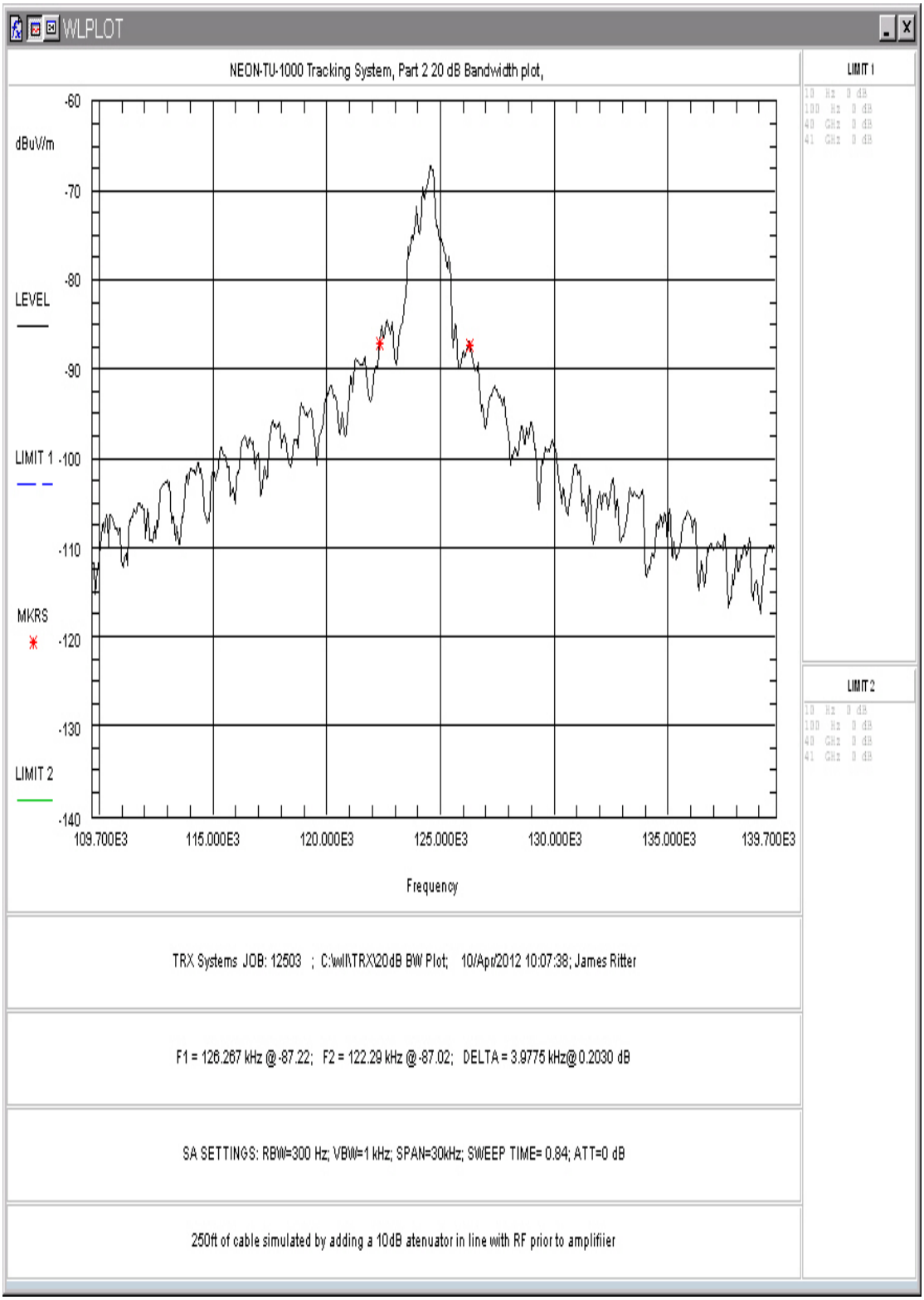

Figure 1: 20dB bandwidth Plot

4.2 Radiated Spurious Emissions: (FCC Part §15.209, RSS-210 section 2.5.1)

Transmitters operating under §15.209 must comply with the radiated emissions listed in the following table:

Table 7. Radiated Emissions Limits

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

*Industry Canada RSS-210 section 2.5.1 states that devices with wanted and unwanted emissions below the general field strength emissions of RSS-Gen may operate in any band (except restricted bands). The limits of RSS-Gen tables 5 & 6 are the same as the above FCC 15.209 table.

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.

- As note signals were noted at 10meters the antenna was moved to 3 meters and the limits extrapolated.

For frequencies between 10 kHz and 30 MHz, a loop antenna was mounted of a tripod at a height of 1m. The Loop antenna was rotated about its vertical and horizontal axis to determine the highest emissions.

For frequencies above 30MHz the 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. Both the horizontal and vertical field components were measured. Measurements of frequencies above 30MHz were made at a distance of 3m.

The EUT was scanned from 10k to 1GHz. The limit has been interpolated to 3m.

The correction factor for extrapolating the limits was based using the square of an inverse linear distance extrapolation factor (40 dB/decade) as stated in FCC part 15.31(f)(2). This correction factor was added to the limit stated in FCC part 15.209(a).

The EUT was examined in three orthogonals and the orthogonal the demonstrated the highest emission was reported.

In accordance with FCC Part 15.209(d) emissions in the bands 9-90kHz and 110-490kHz are performed using an average detector. All other readings below 1000MHz were taken with a quasi-peak detector.

Resolution bandwidths used:

For frequencies measured between 9kHz – 150kHz RBW = 200Hz

For frequencies measured between 150kHz – 30MHz, RBW = 9kHz

For frequencies measured between 30MHz – 1GHz, RBW = 120kHz

Table 8. Radiated Emissions Test Data < 30MHz @ 3m

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)
0.125	X	0.00	1.00	40.90	10.9	386.9	192000.0	-53.9
0.250	X	0.00	1.00	34.60	10.7	185.1	96000.0	-54.3
0.375	X	0.00	1.00	24.00	10.8	55.1	64000.0	-61.3
0.500	X	10.00	1.00	21.60	11.1	43.1	4800.0	-40.9
0.625	X	0.00	1.00	16.10	11.1	23.0	3840.0	-44.5
0.750	X	0.00	1.00	21.80	11.1	44.4	3200.0	-37.2
0.875	X	10.00	1.00	13.80	11.2	17.9	2742.9	-43.7
1.000	X	10.00	1.00	17.80	11.7	29.8	2400.0	-38.1
1.125	X	0.00	1.00	13.10	11.7	17.3	2133.3	-41.8
1.250	X	10.00	1.00	21.00	11.7	43.0	1920.0	-33.0

Limits adjusted to 3m using a 40dB/decade correction factor.

Table 9. Radiated Emissions Test Data > 30MHz @ 3m

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)
38.155	V	90.00	1.00	5.70	15.1	11.0	100.0	-19.2
42.300	V	10.00	1.10	14.80	12.2	22.4	100.0	-13.0
54.705	V	0.00	1.20	13.40	9.0	13.1	100.0	-17.6
58.425	V	45.00	1.00	17.80	10.1	24.9	100.0	-12.1
72.339	V	90.00	1.10	10.30	11.4	12.1	100.0	-18.3
138.080	V	100.00	1.31	2.70	15.0	7.7	150.0	-25.8
263.240	V	90.00	1.90	2.50	15.3	7.8	200.0	-28.2
300.010	V	0.00	2.40	5.80	16.4	12.9	200.0	-23.8
400.000	V	45.00	2.90	6.00	19.2	18.2	200.0	-20.8
38.155	H	0.00	4.00	3.20	15.1	8.2	100.0	-21.7
42.300	H	0.00	3.80	7.40	12.2	9.5	100.0	-20.4
58.453	H	10.00	3.67	6.50	10.1	6.8	100.0	-23.4
72.479	H	190.00	3.30	8.70	11.4	10.1	100.0	-19.9
114.309	H	270.00	3.80	3.50	16.5	10.0	150.0	-23.6
300.010	H	45.00	1.98	4.70	16.4	11.4	200.0	-24.9
400.000	H	10.00	1.80	9.30	19.2	26.6	200.0	-17.5

4.3 Conducted Emissions

4.3.1 Requirements

Test Arrangement: Table Top

Compliance Standard: FCC Part 15 (10/2010), Class B

FCC Compliance Limits		
Frequency	**Quasi-peak**	**Average**
0.15-0.5MHz	66 to 56dBµV	56 to 46dBµV
0.5 to 5MHz	56dBµV	46dBµV
0.5-30MHz	60dBµV	50dBµV

4.3.2 Test Procedure

The requirements of FCC Part 15 (10/2010) call for the EUT to be 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 USB cable connected to a USB wall Power adapter which was connected `through a Solar Corporation 50 W/50 mH 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. The peripherals were placed on the table in accordance with ANSI C63.4-2003. Power and data cables were moved about to obtain maximum emissions.

The 50 W 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, peak, or average 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. For average measurements the post-detector filter was set to 10 Hz.

At frequencies where quasi-peak or peak measurements comply with the average limit, no average measurements need be performed.

Unit tested via charging AC to USB adaptor (supplied by test lab) (Barnes & Noble model BNRP5-850)

4.3.3 Conducted Data Reduction and Reporting

At frequencies where quasi-peak or peak measurements comply with the average limit, no average measurements need be performed. The Conducted emissions level to be compared to the FCC limit is calculated as shown in the following example.

Example:

Spectrum Analyzer Voltage: VdBµV

LISN Correction Factor: LISN dB

Cable Correction Factor: CF dB

Electric Field: EdBµV = V dBµV + LISN dB + CF dB

4.3.4 Test Data

The EUT complied with the Class B Conducted Emissions requirements. Table 10 provides the test results for phase and neutral line power line conducted emissions.

Test Engineer(s): James Ritter

Test Date(s): 4/11/12

Table 10: Conducted Emission Test Data

EUT charging- Neutral

Frequency (MHz)	Level QP (dBµV)	Level AVG (dBµV)	Cable Loss (dB)	LISN Corr (dB)	Level QP Corr (dBµV)	Level Corr Avg (dBµV)	Limit QP (dBµV)	Limit AVG (dBµV)	Margin QP (dB)	Margin AVG (dB)
0.150	32.7	11.9	10.2	0.3	43.2	22.4	66.0	56.0	-22.8	-33.6
0.222	27.4	10.4	10.2	0.1	37.7	20.7	62.7	52.7	-25.1	-32.1
0.289	26.4	9.6	10.2	0.1	36.7	19.9	60.6	50.6	-23.9	-30.7
0.465	28.3	9.1	10.2	0.1	38.6	19.4	56.6	46.6	-18.0	-27.2
0.776	22.0	7.8	10.3	0.1	32.4	18.2	56.0	46.0	-23.6	-27.8
10.414	21.1	7.7	11.1	0.6	32.8	19.4	60.0	50.0	-27.2	-30.6

EUT charging - Phase

Frequency (MHz)	Level QP (dBµV)	Level AVG (dBµV)	Cable Loss (dB)	LISN Corr (dB)	Level QP Corr (dBµV)	Level Corr Avg (dBµV)	Limit QP (dBµV)	Limit AVG (dBµV)	Margin QP (dB)	Margin AVG (dB)
0.153	31.1	10.8	10.2	0.1	41.4	21.1	65.8	55.8	-24.4	-34.7
0.348	26.5	5.8	10.2	0.6	37.3	16.6	59.0	49.0	-21.7	-32.4
0.479	26.0	9.8	10.2	0.7	36.9	20.7	56.4	46.4	-19.5	-25.7
0.592	24.8	8.6	10.2	0.7	35.7	19.5	56.0	46.0	-20.3	-26.5
0.685	22.4	7.6	10.3	0.7	33.3	18.5	56.0	46.0	-22.7	-27.5
0.888	21.7	6.8	10.3	0.7	32.7	17.8	56.0	46.0	-23.3	-28.2

5 Attestation for co-located antennas

5.1 Attestation Statement

This device complied with the EMC requirements for following co-located transmitters:

1) TRX NEON Tracking Device with LF (124.7KHz) transmitter
FCC ID: BXONEON-TU-1000
IC: 10230A-NEONTU1000

2) Bluetooth Transceiver Module
FCC ID: BXOWT12-1000
IC: 1023A-WT121000

3) 2.4GHz CSS Transceiver Module

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

Plots of this data are held at Washington laboratories. This attestation only applies to the EMC requirements for co-located devices. Additional tests may be required to evaluate human exposure requirements

5.2 Test Scenario

The TRX LF transmitter was located on the host radio board that contained the TRX 2.4GHz Chirp Spread Spectrum transmitter and the TRX BlueTooth Transceiver. All antennas are located within 20cm of the other transmitters. Testing was performed to measure any potential spurious interactions between these 3 devices. This testing was performed in a radiated fashion with all transceivers continuously transmitting on a stationary frequency. The module was then scanned up to 25GHz verifying that all spurious products that fall within the restricted bands remain under FCC class B limits.

