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FCC & Industry Canada Certification Test Report
For the
NBB Controls and Components AG
NANO-L SMJ91

FCC ID: SJ7NLSMJ915
IC ID: 2634B-NLSMJ915

WLL JOB# 14072 REV. 1
February 15, 2016
Revised March 14, 2016

Prepared for:

NBB Controls and Components AG
Otto-Hahn-Strasse 3-5
Oelbronn-Duerrn, N-A 75248

Prepared By:

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

ANAB ACCREDITED ISO/IEC 17025 TESTING LABORATORY

Testing Certificate AT-1448

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Prepared by:

James Ritter
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Reviewed by:

Steven D. Koster
President

Abstract

This report has been prepared on behalf of NBB Controls and Components AG to support the attached Application for Equipment Authorization. The test report and application are submitted for an Intentional Radiator under Part 15.249(10/2014) of the FCC Rules and Regulations and Spectrum Management and Telecommunications Policy RSS-210 issue 8, 12/2010 of Industry Canada. This Certification Test Report documents the test configuration and test results for the NBB Controls and Components AG NANO-L SMJ91.

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 NBB Controls and Components AG NANO-L SMJ91 complies with the limits for an Intentional Radiator device under FCC Part 15.249 and RSS-210 of Industry Canada.

Revision History	Description of Change	Date
Rev 0	Initial Release	February 15, 2016
Rev. 1	Changed model name from NANO-L SMJ to NANO-L SMJ91	March 14, 2016

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1 Introduction

1.1 Compliance Statement

The NBB Controls and Components AG NANO-L SMJ91 complies with the limits for an Intentional Radiator device under FCC Part 15.249 (10/2014) and Industry Canada RSS-210 issue 8 December 2010.

1.2 Test Scope

Tests for radiated and conducted emissions were performed. All measurements were performed in accordance 2013 version of ANSI C63.10. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	NBB Controls and Components AG Otto-Hahn-Strasse 3-5 Oelbronn-Duerrn, N-A 75248
Quotation Number:	68821

1.4 Test Dates

Testing was performed on the following date(s):	12/15/2015 and 2/6/2016

1.5 Test and Support Personnel

Washington Laboratories, LTD	James Ritter, Misael Flores
Client Representative	Thomas Burchard

1.6 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 NBB Controls and Components AG NANO-L SMJ91 is a Low Power Transmitter for industrial radio control purposes.

Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	NBB Controls and Components AG
FCC ID:	SJ7NLSMJ915
IC:	2634B-NLSMJ915
Model:	NANO-L SMJ91
FCC Rule Parts:	§15.249
Industry Canada:	RSS210
Frequency Range:	915.00 to 916.65MHz
Maximum Output Power:	26249.7 uV/m at 3m
Modulation:	GFSK
Occupied Bandwidth:	19.26kHz (20dB), 16.375kHz (99%)
Keying:	Manual
Type of Information:	Control Data
Number of Channels:	67 Channels
Power Output Level	Fixed
Antenna Connector	None
Antenna Type	Integral
Interface Cables:	None
Power Source & Voltage:	1 x rechargeable Batteries NBB 7.2 Volt NiMH
Emission Designator	16K4F1D
Highest TX spurious Emission	702.83MHz: 153.8uV/m @ 3m
Highest RX Spurious Emission	459.55MHz: 90.5uV/m @ 3m

Test Configuration

The NANO-L SMJ91 was is a standalone unit that is battery powered only

The NANO-L SMJ91 was programmed to transmit on any of 67 channels via toggle buttons on the device that sequentially selected the frequency. The EUT was set to transmit continuously (modulated) on the desired test channel.

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

2.2 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.

2.3 Measurements

2.3.1 References

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

ANSI C63.10:2013 American National Standard for Methods of Procedures for Compliance Testing of Unlicensed Wireless Devices.

2.4 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 2 below.

Table 2: 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 3 shows a list of the test equipment used for measurements along with the calibration information.

Table 3: Test Equipment List

Test Name: **Radiated Emissions**			Test Date: **02/06/2016**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
528	AGILENT - E4446A	3HZ - 44GHZ ANALYZER SPECTRUM	7/15/2016
65	HP - 8447D	PRE-AMPLIFIER RF 50KHZ-1GHZ	6/6/2016
644	SUNOL SCIENCES CORPORATION - JB1 925-833-9936	BICONALOG ANTENNA	8/14/2017
823	AGILENT - N9010A	EXA SPECTRUM ANALYZER	8/5/2016
627	AGILENT - 8449B	AMPLIFIER 1-26GHZ	6/6/2016
626	ARA - DRG-118/A	ANTENNA HORN	2/29/2016

4 Test Results

4.1 Occupied Bandwidth (FCC Part §2.1049 and RSS-Gen [6.6]):

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer.

No Limits are provided for this measurement. Since the operating range of this device is 1.65MHz the low and high channels was investigated.

Table 4: Occupied Bandwidth Spectrum Analyzer Settings

Resolution Bandwidth	Video Bandwidth
300Hz	3kHz

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

Table 5 provides a summary of the Occupied Bandwidth Results.

Table 5: Occupied Bandwidth Results

Frequency	20dB Bandwidth	99% bandwidth	Limit	Pass/Fail
Low Channel: 915.00MHz	15.17kHz	16.127kHz	NA	Pass
High Channel: 916.65MHz	19.267kHz	16.375kHz	NA	Pass

Figure 1: 20dB Occupied Bandwidth, Low Channel

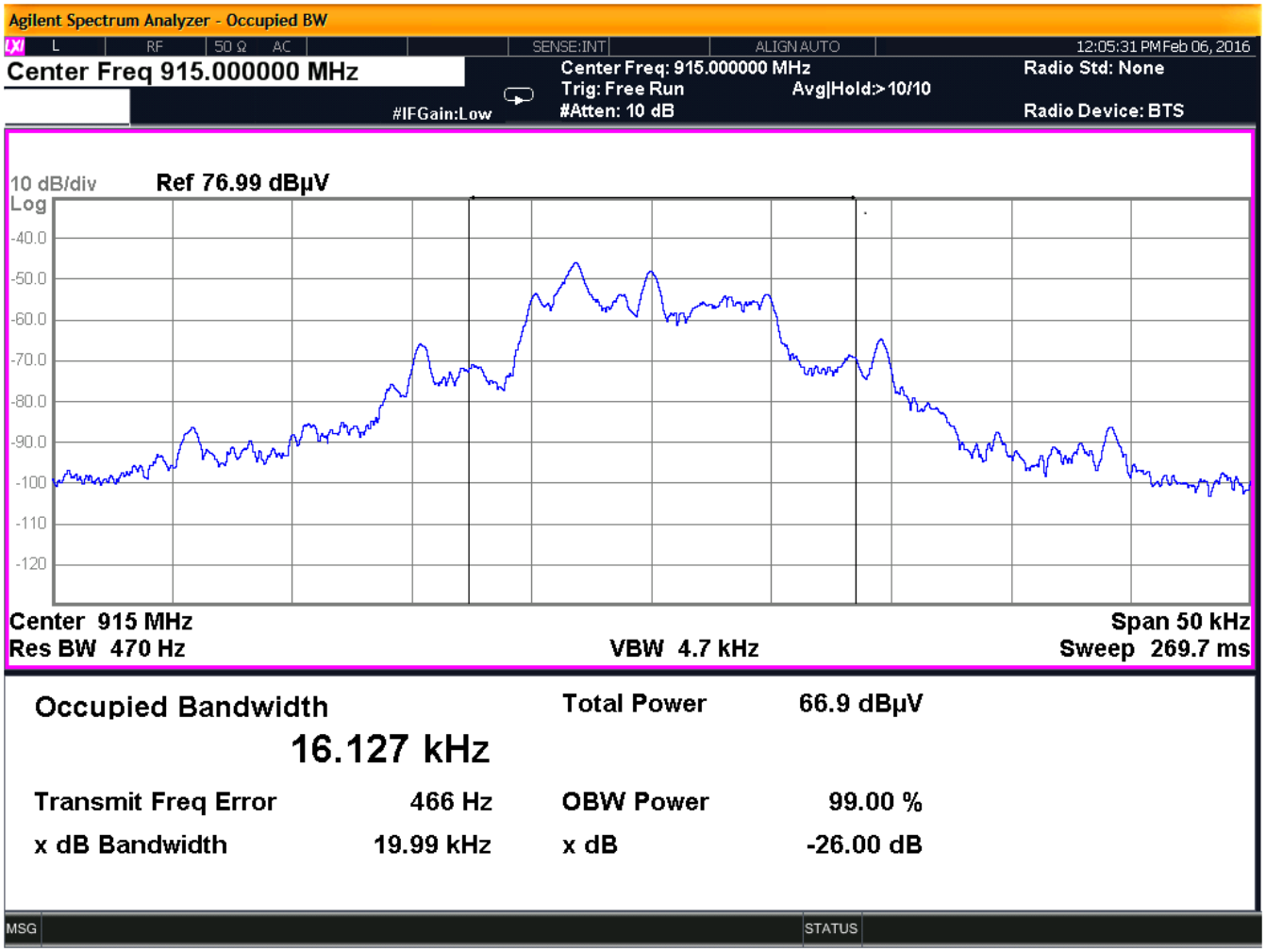

Figure 2: 99% Occupied Bandwidth, Low Channel

Figure 3: 20dB Occupied Bandwidth, High Channel

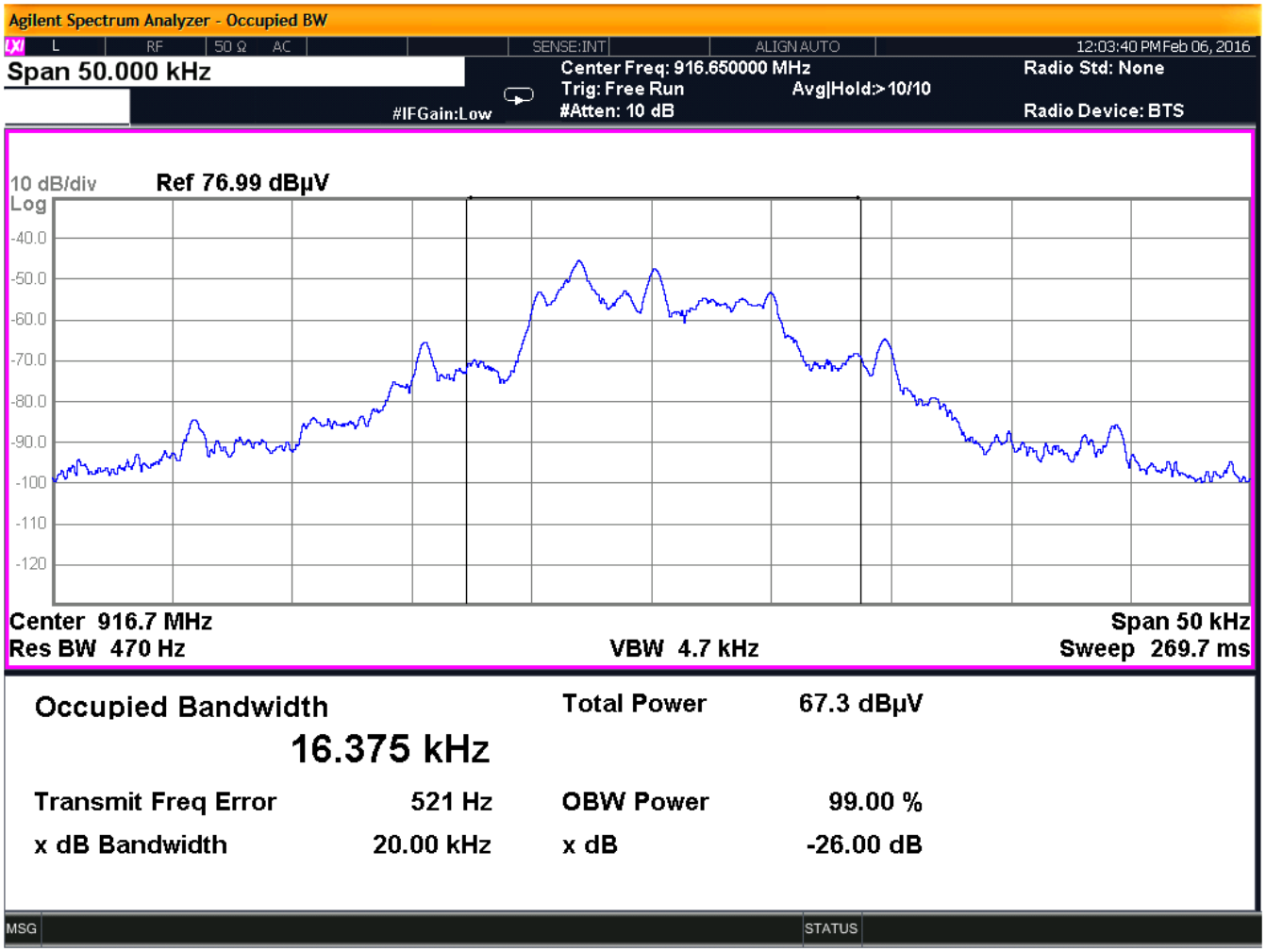

Figure 4: 99% Occupied Bandwidth, High Channel

4.2 Radiated Spurious Emissions: (FCC Part §15.249(a), RSS210 A2.9)

4.2.1 Limits

The EUT must comply with the radiated emission limits of 15.249(a) & RSS210 A2.9. The limits are as shown in the following table.

Table 6: Radiated Emissions Limits

Fundamental Frequency	Field Strength of Fundamental (µV/m)	Field Strength of Harmonics (µV/m)
902 – 928 MHz	50,000	500

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.

4.2.2 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. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

In accordance with ANSI C63.10 measurements above 1GHz were conducted with RF absorber between the EUT and Receive antenna with the EUT placed 1.5meters above the ground.

Since the operating range of this device is less than 10 MHz only the Low and High channels were investigated.

The emissions were measured using the following resolution bandwidths:

Table 7: Spectrum Analyzer Settings

Frequency Range	Resolution Bandwidth	Video Bandwidth
30MHz-1000 MHz	120kHz	>100 kHz
>1000 MHz	1 MHz	10 Hz (Avg.), 1MHz (Peak)

Average measurements made with the Spectrum analyzer set to the linear mode with a Video bandwidth of 10Hz, and the resultant reading converted to dBuV. Correction factors were then applied and the resulting value was compared to the limit.

Table 8: Radiated Emission Test Data, Low Channel

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
915.00	V	190.00	2.00	83.50	1.5	17708.1	50000.0	-9.0	Pk
1830.00	V	180.00	3.60	51.63	-5.4	203.9	5000.0	-27.8	pk
1830.00	V	180.00	3.60	47.50	-5.4	126.8	500.0	-11.9	avg
2745.00	V	0.00	3.60	48.45	-0.7	242.7	5000.0	-26.3	pk
2745.00	V	0.00	3.60	41.60	-0.7	110.3	500.0	-13.1	avg
3660.00	V	0.00	4.00	48.50	1.4	312.6	5000.0	-24.1	pk
3660.00	V	0.00	4.00	42.10	1.4	149.6	500.0	-10.5	avg
4575.00	V	10.00	3.80	48.00	3.5	376.9	5000.0	-22.5	pk
4575.00	V	10.00	3.80	42.10	3.5	191.1	500.0	-8.4	avg
Non Harmonics									
457.91	V	270.00	1.00	37.56	-6.0	37.7	200.0	-14.5	
457.91	V	270.00	1.00	36.78	-6.0	34.5	200.0	-15.3	QP
693.81	V	200.00	1.00	38.29	-3.7	53.8	200.0	-11.4	
701.16	V	135.00	1.00	41.05	-3.3	77.2	200.0	-8.3	
708.55	V	135.00	1.00	41.72	-2.8	88.4	200.0	-7.1	
716.18	V	170.00	1.00	36.74	-2.5	51.4	200.0	-11.8	
813.90	V	180.00	1.00	39.20	0.4	95.6	200.0	-6.4	
915.00	H	190.00	1.20	85.90	1.5	23343.9	50000.0	-6.6	Pk
1830.00	H	90.00	3.80	51.90	-5.4	210.3	5000.0	-27.5	pk
1830.00	H	90.00	3.80	48.07	-5.4	135.4	500.0	-11.3	avg
2745.00	H	45.00	3.00	53.06	-0.7	412.6	5000.0	-21.7	pk
2745.00	H	45.00	3.00	40.40	-0.7	96.1	500.0	-14.3	avg
3660.00	H	90.00	3.40	48.06	1.4	297.2	5000.0	-24.5	pk
3660.00	H	90.00	3.40	42.33	1.4	153.6	500.0	-10.2	avg
4575.00	H	0.00	4.00	47.35	3.5	349.8	5000.0	-23.1	pk
4575.00	H	0.00	4.00	41.56	3.5	179.6	500.0	-8.9	avg
Non Harmonics									
457.91	V	270.00	1.00	37.56	-6.0	37.7	200.0	-14.5	
457.91	V	270.00	1.00	36.78	-6.0	34.5	200.0	-15.3	QP

693.81	V	200.00	1.00	38.29	-3.7	53.8	200.0	-11.4	
701.16	V	135.00	1.00	41.05	-3.3	77.2	200.0	-8.3	
708.55	V	135.00	1.00	41.72	-2.8	88.4	200.0	-7.1	
716.18	V	170.00	1.00	36.74	-2.5	51.4	200.0	-11.8	
813.90	V	180.00	1.00	39.20	0.4	95.6	200.0	-6.4	

Table 9: Radiated Emission Test Data, High Channel

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
916.65	V	180.00	1.00	81.71	1.4	14316.1	50000.0	-10.9	pk Power
1833.33	V	180.00	3.90	50.85	-5.4	186.9	5000.0	-28.5	pk
1833.33	V	180.00	3.90	44.47	-5.4	89.7	500.0	-14.9	Avg
2749.95	V	0.00	3.20	49.55	-0.8	275.3	5000.0	-25.2	pk
2749.95	V	0.00	3.20	44.80	-0.8	159.3	500.0	-9.9	Avg
3666.60	V	0.00	3.80	47.59	1.4	281.6	5000.0	-25.0	pk
3666.60	V	0.00	3.80	42.39	1.4	154.6	500.0	-10.2	Avg
4583.25	V	90.00	3.20	43.85	3.6	234.7	5000.0	-26.6	pk
4583.25	V	90.00	3.20	32.60	3.6	64.3	500.0	-17.8	Avg
Non Harmonics									
452.15	V	270.00	3.00	39.18	-6.5	43.2	200.0	-13.3	
457.00	V	270.00	3.00	39.79	-6.5	46.1	200.0	-12.7	
459.55	V	270.00	2.50	41.94	-6.6	58.5	200.0	-10.7	
673.35	V	205.00	1.00	35.06	-2.4	42.9	200.0	-13.4	
680.72	V	180.00	3.00	41.49	-2.2	92.2	200.0	-6.7	
695.47	V	270.00	3.00	42.34	-2.3	100.2	200.0	-6.0	
702.84	V	270.00	3.00	43.27	-1.9	117.5	200.0	-4.6	QP
710.21	V	270.00	3.00	42.16	-1.3	109.8	200.0	-5.2	QP
717.57	V	180.00	2.50	39.81	-1.3	84.6	200.0	-7.5	
724.96	V	180.00	1.00	37.95	-1.2	69.1	200.0	-9.2	
1144.94	V	45.00	3.00	48.59	-8.7	98.6	500.0	-14.1	
916.65	H	270.00	1.00	86.98	1.4	26249.7	50000.0	-5.6	pk
1833.33	H	45.00	3.80	52.88	-5.4	236.2	5000.0	-26.5	pk
1833.33	H	45.00	3.80	47.33	-5.4	124.7	500.0	-12.1	Avg
2749.95	H	90.00	4.00	50.07	-0.8	292.3	5000.0	-24.7	pk
2749.95	H	90.00	4.00	43.04	-0.8	130.1	500.0	-11.7	Avg

3666.60	H	90.00	2.80	50.30	1.4	384.3	5000.0	-22.3	pk
3666.60	H	90.00	2.80	46.20	1.4	239.8	500.0	-6.4	Avg
4583.25	H	90.00	3.00	47.50	3.6	357.3	5000.0	-22.9	pk
4583.25	H	90.00	3.00	41.40	3.6	177.0	500.0	-9.0	Avg
Non Harmonics									
228.55	H	180.00	1.00	43.68	-13.7	31.5	200.0	-16.0	
452.15	H	0.00	1.00	38.88	-6.5	41.8	200.0	-13.6	
459.55	H	0.00	3.50	45.73	-6.6	90.5	200.0	-6.9	
673.34	H	190.00	1.00	36.59	-2.4	51.1	200.0	-11.9	
680.72	H	0.00	1.50	45.23	-2.2	141.8	200.0	-3.0	QP
695.49	H	205.00	1.50	44.18	-2.3	123.9	200.0	-4.2	QP
702.83	H	205.00	1.50	45.61	-1.9	153.8	200.0	-2.3	QP
710.21	H	205.00	1.50	44.93	-1.3	151.1	200.0	-2.4	QP
717.59	H	0.00	1.00	42.88	-1.3	120.5	200.0	-4.4	QP
724.96	H	0.00	1.00	39.35	-1.2	81.1	200.0	-7.8	

4.3 Receiver Radiated Spurious Emissions

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.

4.3.1 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.. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

Measurements above 1GHz were performed with RF absorber material placed on the site between the receive antenna and the EUT unit.

The emissions were measured using the following resolution bandwidths:

Table 10: Spectrum Analyzer Settings

Frequency Range	Resolution Bandwidth	Video Bandwidth
30MHz-1000 MHz	120kHz	>100 kHz
>1000 MHz	1 MHz	10 Hz (Avg.), 1MHz (Peak)

Average measurements above 1GHz were made with the Spectrum analyzer set to the linear mode with a Video bandwidth of 10Hz, and the resultant reading mathematically converted to dBuV. Correction factors were then applied and the resulting value was compared to the limit.

Table 11: Radiated Emission Test Data, Receiver

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
452.15	V	270.00	3.00	39.18	-6.5	43.2	200.0	-13.3	
457.00	V	270.00	3.00	39.79	-6.5	46.1	200.0	-12.7	
459.55	V	270.00	2.50	41.94	-6.6	58.5	200.0	-10.7	
1144.94	V	45.00	3.00	48.59	-8.7	98.6	500.0	-14.1	
228.55	H	180.00	1.00	43.68	-13.7	31.5	200.0	-16.0	
452.15	H	0.00	1.00	38.88	-6.5	41.8	200.0	-13.6	
459.55	H	0.00	3.50	45.73	-6.6	90.5	200.0	-6.9	