


**Advanced
Compliance Laboratory**

210 Cougar Court
Hillsborough, NJ 08844
Tel: (908) 927 9288
Fax: (908) 927 0728

Electromagnetic Emission Compliance Test Report



Equipment Under Test (EUT)	NX15	
Model	NX15	
Applicant	Geophysical Survey Systems, Inc.	
In Accordance With	FCC Part 15, Subpart F Industry Canada RSS-220 (Issue 1/2009)	
Tested by	Advanced Compliance Laboratory, Inc. 210 Cougar Court Hillsborough, New Jersey 08844	
Authorized by	Wei Li Lab Manager	Signature 
Date	February 2, 2024	
AC Lab Report Number	0048-240115-01-FCC-IC	



Lab Code:200101-0

The test result in this report is supported and covered by the NVLAP accreditation.

Table of Contents

Section 1. Summary of Test Results	3
Section 2. General Equipment & Test Configuration	6
Section 3. Test Methodology & Facilities	8
Section 4. Measurement Data	9
Section 5. ID Labeling	49
Section 6. Setup Photos.....	50
Section 7. EUT Photos	53

Section 1. Summary of Test Results

Manufacturer: Geophysical Survey Systems, Inc.
Product Name: NX15

Model/Parts No. : NX15
S/N: 1002

General: **All measurements are traceable to national standards**

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with FCC Part 15, Sub Part F and Industry Canada RSS-220 (Issue 1/2009).

- New Submission Production Unit
 Class I Permissive Change Pre-Production Unit

THIS TEST REPORT RELATES ONLY TO THE ITEM(S) TESTED.

THE FOLLOWING DEVIATIONS FROM, ADDITIONS TO, OR EXCLUSIONS FROM THE TEST SPECIFICATIONS HAVE BEEN MADE.

“See Summary of Test Data”



NVLAP LAB CODE: 200101-0

Advanced Compliance Laboratory, Inc. authorizes the above named company to reproduce this report provided it is reproduced in its entirety and for use by the company’s employees only.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Advanced Compliance Laboratory, Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. This report applies only to the items tested.

Summary of Test Data

Compliance Requirement	FCC & IC Rule Part	Test No. in Section 4	Result
Cross Reference	15.505 &RSS-GEN	1	Complies
Marketing of UWB Equipment	15.507 &RSS-GEN	2	Complies
Pulse Repetition Frequency(PRF)	15.509 &RSS-220 6.2	3	Complies
UWB Bandwidth	15.509(a) &RSS-220 6.2.1(a)	4	Complies
General Operational Requirements for LF Imaging System	15.509(b) &RSS-220 6	5	Complies
Spurious Radiated Emissions≤960MHz	15.509(d) 15.209 &RSS-220 3.4, 6.2(c), 6.2(d)	6	Complies
Spurious Radiated Emissions>960MHz	15.509(d) 15.209 &RSS-220 3.4, 6.2(c), 6.2(d)	7	Complies
Radiated Emissions in GPS Bands	15.509(e) 15.209 &RSS-220 6.2(e)	8	Complies
Highest Radiated Emission at f_M	15.509(f) 15.209 &RSS-220 6.2(g)	9	Complies
Technical Requirements Applicable to All UWB Devices	15.521	10	Complies
Coordination Requirement	15.525	11	N/A
Antenna Requirement	15.203& 15.204 &RSS-GEN 7.1.4	12	Complies
Radio Frequency Exposure	FCC OET Bulletin 65 &RSS-GEN	13	N/A
Conducted Emissions	15.507 &RSS-GEN	14	*
Transmission Duration	15.509(c) &15.519(a)(1)	15	Complies
Wavier DA 23-065A1 Conditions	DA 23-1041, Sec. 11	16	Complies

* NOT APPLICABLE to the EUT as it is a battery-powered device;

The estimated uncertainty of the test result is given as following. The method of uncertainty calculation is provided in Advanced Compliance Lab. Doc. No. 0048-01-01.

	Prob. Dist.	Uncertainty(dB) 30-1000MHz	Uncertainty(dB) 1-6.5GHz	Uncertainty(dB) Conducted
Combined Std. Uncertainty u_c	norm.	± 2.36	± 2.99	± 1.83



Wei Li
Lab Manager
Advanced Compliance Lab

Date: Feb 2, 2024

Section 2. General Equipment & Test Configuration

2.1. EUT Specification

EUT	NX15 , Model No.: NX15 manufactured by Geophysical Survey Systems, Inc., is a Ground Penetrating Radar (GPR) equipment. This GPR is a SFCW radar system intended to be used in non-destructive testing and geophysical surveying.
Supply Voltage	7.2V Smart Li-on Battery
Operating Frequency	Specific Frequency Range: 320MHz to 3500 MHz
-10dB UWB Bandwidth	Normal Operation Mode: 2060 MHz (from $f_L=1635$ MHz to $f_H=3045$ MHz)
Modulation Type	SFCW: 20MHz Stepped CW, Dwell Time 2us, Cycle time 9.6ms
Peak Emissions in a 50 MHz Bandwidth	Max. peak emissions: <u>68.6dBuV/m (RBW=3MHz) @1720MHz</u> as d=3m i.e 93.0dBuV/m (RBW=50MHz), equivalent to -2.2dBm under 0dBm limit
Antenna	Single Dipole Antenna Pairs
Hardware Version	A
Software Version	5.6.0 -devel-20230808154216+build.0

2.2. Description of Operation

The system performs time domain reflectometry by radiating a radio frequency CW with a cycle frequency of up to 200Hz from a transmitting dipole (TX dipole). Transitions between materials exhibiting different wave impedance through which the electromagnetic wave travels cause the wave to be reflected. These reflections are

received by the receiving dipole (RX dipole) and sampled by the instrument. In the field, the system is powered from a removable rechargeable battery.

2.3. System Diagram

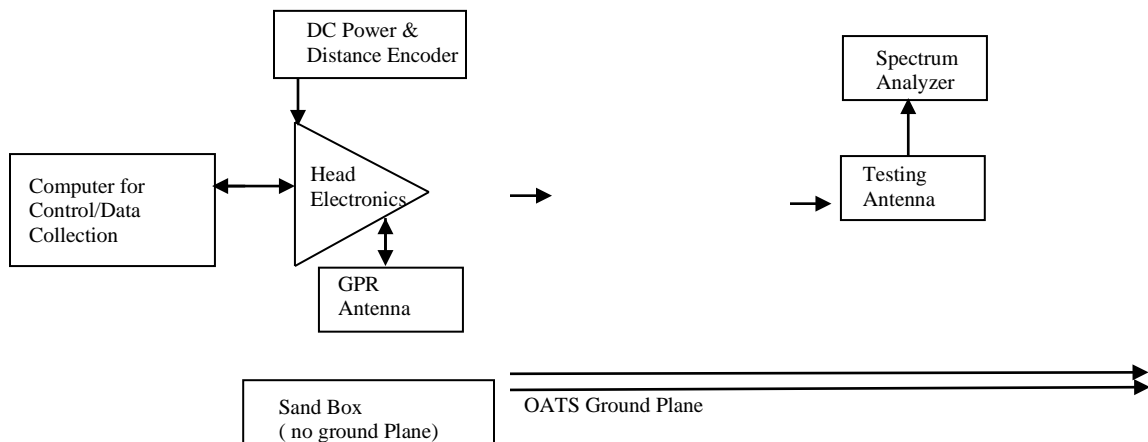
See Attachment provided by Applicant.

2.4. General EUT Setup

The EUT is operated in continuous transmission mode with the antennas permanently mounted in an all in one plastic housing with the controlling electronics and battery.

All measurements shall be made at room temperature and at nominal DC input voltage (provided by a battery). The EUT is placed directly on the dry sand with no ground plane under it.

Per Waiver DA-23-650A1 requirement, for certification testing, the measurement of emissions from the GSSI GPR device shall be conducted with the stepping function active for all possible frequency step sizes.



2.5. Operational Frequency channel(s) for testing:

- CPU Clock : 1.6GHz, 400MHz
- Other Clocks: 40MHz ADI, 27.12MHz NFC, 100MHz for PCIE
- RF antenna center frequencies for TX/RX modulations : 320-3,500MHz

Section 3. Test Methodology & Facilities

3.1 Measurement Procedure

The tests documented in this report were performed in accordance with ANSI C63.4 /C63.10, FCC CFR 47 Part 2 & 15, Industry Canada RSS-220 (Issue 1/2009) & FCC Order, ET Docket No. 980153(FCC02-08). Test procedure described in FCC “KDB 393764, UWB Compliance Measurements” is used in this report. The test methods used to generate the data in this test report is in accordance with ANSI C63.10:2013, American National Standard for Testing Unlicensed Wireless Devices.

In accordance with ANSI C63.10:2013, Section 10.2.2, the device under test was placed on a bed of dry sand and rotated through 16 azimuth angles (Clause 5.4) to determine which produced the highest emission relative to the limit. The azimuth that produced the highest emission relative to the limit was used for all radiated emission measurements.

3.2. Facilities and Accreditation

The test sites and measurement facilities used to collect data are located at Hillsborough, New Jersey, USA. The sites are constructed in conformance with the requirements of ANSI C63.4, ANSI C63.7 and CISPR Publication 32. All receiving equipment conforms to CISPR Publication 16-1, “Radio Interference Measuring Apparatus and Measurement Methods”.

This site is accepted by FCC to perform measurements under Part 15 or 18 (Registration # 90601, MRA designation No. US5347) and also designated by IC as “ site IC 3130A”. ACL is accredited by NVLAP, Laboratory Code 200101-0. No part of this report may be used to claim or imply product endorsement by NVLAP or any agency of the US Government.

3.3. Test and Measurement Equipment

The following test and measurement equipment was utilized for the tests documented in this report:

Manufacture	Model	Serial No.	Description	Cal Due dd/mm/yy
Hewlett-Packard	HP8546A	3448A00290	EMI Receiver	25/09/24
Agilent	E4440A	US40420700	3Hz-26.5GHz Spectrum Analyzer	17/06/24
EMCO	3104C	9307-4396	20-300MHz Biconical Antenna	15/01/25
EMCO	3146	9008-2860	200-1000MHz Log-Periodic Antenna	15/01/25
EMCO	3115	4945	Double Ridge Guide Horn Antenna	22/01/25

All Test Equipment Used is Calibrated, Traceable to NIST Standards. 2 Year Interval.

Section 4. Measurement Data

Test No.1

Name of Test:	<i>Cross Reference</i>	Test Standard:	<i>15.505 &RSS-GEN</i>
Tested By:	WEI LI	Test Date:	01/15/2024-02/02/2024

Minimum Standard: 15.505(a)
Equipment under test complies with all the relevant and applicable requirements of Subpart A, Subpart B and Section 15.201 through 15.204 and Section 15.207 of Subpart C. 15.505(b)
The Digital circuitry portion of the EUT has been tested and verified to comply with 47 CFR Part 15, subpart B.

Method of Measurement: a) Except where specifically stated otherwise within this subpart, the provisions of Subparts A and B and of Sections 15.201 through 15.204 and Section 15.207 of Subpart C of this part apply to unlicensed UWB intentional radiators. The provisions of Sections 15.35(c) and 15.205 do not apply to devices operated under this subpart. The provisions of Footnote US 246 to the Table of Frequency Allocations contained in Section 2.106 of this chapter do not apply to devices operated under this subpart.

b) The requirements of Subpart F apply only to the radio transmitter, i.e., the intentional radiator, contained in the UWB device. Other aspects of the operation of a UWB device may be subject to requirements contained elsewhere in this chapter. In particular, a UWB device that contains digital circuitry not directly associated with the operation of the transmitter also is subject to the requirements for unintentional radiators in Subpart B of this chapter. Similarly, an associated receiver that operates (tunes) within the frequency range 30 MHz to 960 MHz is subject to the requirements in Subpart B of this chapter.

Test Result: **Complies**

Test Data: **Data and Plots**

Project Number:	0048-240115-01-FCC-IC
EUT:	NX15
S/N:	1002
Tested By:	David Tu
Temperature:	65°F
Humidity:	30%

Spurious Radiated Emissions from Digital Circuitry (RF off) complies with FCC Part 15.109 (Class A), measured per ANSI C63.4 with standard setup.

Freq.* (MHz)	H,V	SA QP Reading (dBuV/m)	Height (m)	Angle (degree)	Refer to Part 15.209 10m Limit (dBuV/m)	Margin (dB)	Result
42.8	H	29.1	1.5	180	40.0	-10.9	Pass
104.1	H	30.7	1.5	180	40.0	-9.3	Pass
220.0	H	31.2	1.1	180	46.0	-14.8	Pass
260.0	H	28.8	1.1	135	46.0	-17.2	Pass
400.0	H	36.4	1.1	135	46.0	-9.6	Pass
1050.0	H	40.8	1.1	180	49.5	-8.7	Pass
1150.0	H	37.2	1.1	180	49.5	-12.3	Pass
1500.0	H	36.7	1.1	135	49.5	-12.8	Pass
30.4	V	32.2	1.1	000	40.0	-7.8	Pass
112.0	V	27.5	1.1	000	40.0	-12.5	Pass
158.8	V	32.0	1.1	000	40.0	-8	Pass
184.2	V	32.8	1.1	000	40.0	-7.2	Pass
350.0	V	28.9	1.1	000	46.0	-17.1	Pass
500.0	V	38.8	1.1	000	46.0	-7.2	Pass
1050.0	V	39.0	1.1	315	49.5	-10.5	Pass
1150.0	V	35.8	1.1	315	49.5	-13.7	Pass
1500.0	V	32.4	1.1	315	49.5	-17.1	Pass

Note: Quasi-peak readings will be marked with *. The missions with peak values close to (or over) the specification limit (if any) will be also measured in the quasi-peak or average mode to determine the compliance. Distance factor (Radiated field Strength at 10m distance = Radiated field Strength at 3m distance - 10.5 dBuV/m) can be used for low level signals with high level ambient, if test distance is changed from 10m to 3m.

Test No.2

Name of Test:	<i>Marketing of UWB Equipment</i>	Test Standard:	<i>15.507 &RSS-GEN</i>
Tested By:	WEI LI	Test Date:	01/15/2024-02/02/2024

Minimum 15.507/ 2.909

Standard: The responsible party is properly informed about the responsible for ensuring that the equipment is marketed only to eligible parties, and provide correct information on the customers and users.
(See Important note for the US customers of the Installation Guide and User Manual)

Method of Measurement: In some cases, the operation of UWB devices is limited to specific parties, e.g., law enforcement, fire and rescue organizations operating under the auspices of a state or local government. The marketing of UWB devices must be directed solely to parties eligible to operate the equipment. The responsible party, as defined in Section 2.909 of this chapter, is responsible for ensuring that the equipment is marketed only to eligible parties. Marketing of the equipment in any other manner may be considered grounds for revocation of the grant of certification issued for the equipment.

Test Result:

Complies

Test Data:

NA

Test No.3

Name of Test:	<i>Pulse Repetition Frequency (PRF)</i>	Test Standard:	<i>15.509(d) & RSS-220 6.2</i>
Tested By:	WEI LI	Test Date:	01/15/2024-02/02/2024

Minimum Standard: Definition:
Pulse Repetition Frequency (PRF) is the trigger repetition frequency.

Cycle Frequency=104Hz SFCW

Method of Measurement: Tested at 3-meter OATS per ANSI C63.4
Spectrum Analyzer Settings:
RBW: 30KHz
VBW: \geq RBW
Detector: Peak
Span: As required
Sweep: Auto

Test Result: **Complies**

Test Data: **Cycle Frequency=104Hz SFCW**

Test No.4

Name of Test:	<i>UWB Bandwidth</i>	Test Standard:	<i>15.509(a) 15.503(a) & RSS-220 6.2.1(a)</i>
Tested By:	WEI LI	Test Date:	01/15/2024-02/02/2024

Minimum Standard:

Definition:

The bandwidth of a UWB emission is defined by the points on the emission spectrum where the amplitude is 10 dB below the maximum emission amplitude (i.e., the -10 dB points), as based on the complete transmission system including the antenna. The upper boundary is designated f_H and the lower boundary is designated f_L . The frequency at which the highest radiated emission occurs is designated f_M . The center frequency f_C , equals $(f_H + f_L) / 2$. The fractional bandwidth equals $2 * (f_H - f_L) / (f_H + f_L)$.

In cases where the measured emission spectrum contains multiple (more than two) -10 dB points, the outermost points define the bandwidth (i.e., the widest bandwidth is assumed).

Limits:

The UWB bandwidth of an imaging system operating under the provisions of this section must be below 10.6 GHz.

Method of Measurement:

Tested at 3-meter OATS per ANSI C63.4

Spectrum Analyzer Settings:

RBW: 1MHz

VBW: 3MHz

Detector: Peak

Span: As required (to display a full spectrum of the RF emission)

Sweep: Auto

Test Procedure:

- 1) The receiving antenna which varied from 1 to 4 m to find the highest emission is positioned 3 m away from the EUT.
- 2) Measure the Highest radiated emission at f_M as described in the test No. 9.
- 3) Recorded the upper and lower frequency that are at the side of the band bounded by the points at 10 dB below the highest radiated UWB emission level. Measuring the bandwidth of a UWB device using a radiated test set-up, it is imperative that appropriate adjustments be made to the measured amplitude levels to account for the frequency-dependent components of the measurement system (e.g., antenna gain

or factor, pre-amplifier gain, cable loss, etc). Since UWB emissions can have bandwidths several GHz wide, these frequency-dependent characteristics can vary dramatically over the fundamental emission. According to the nature of the broadband emission characteristics, significant care must be taken to capture the true spectrum of emission, extremely narrow sweep widths is recommended.

4) The UWB bandwidth is the different of the upper and lower frequency recorded.

Test Result: Complies

Test Data: Data and Plots

Measurement Data (Values in MHz):

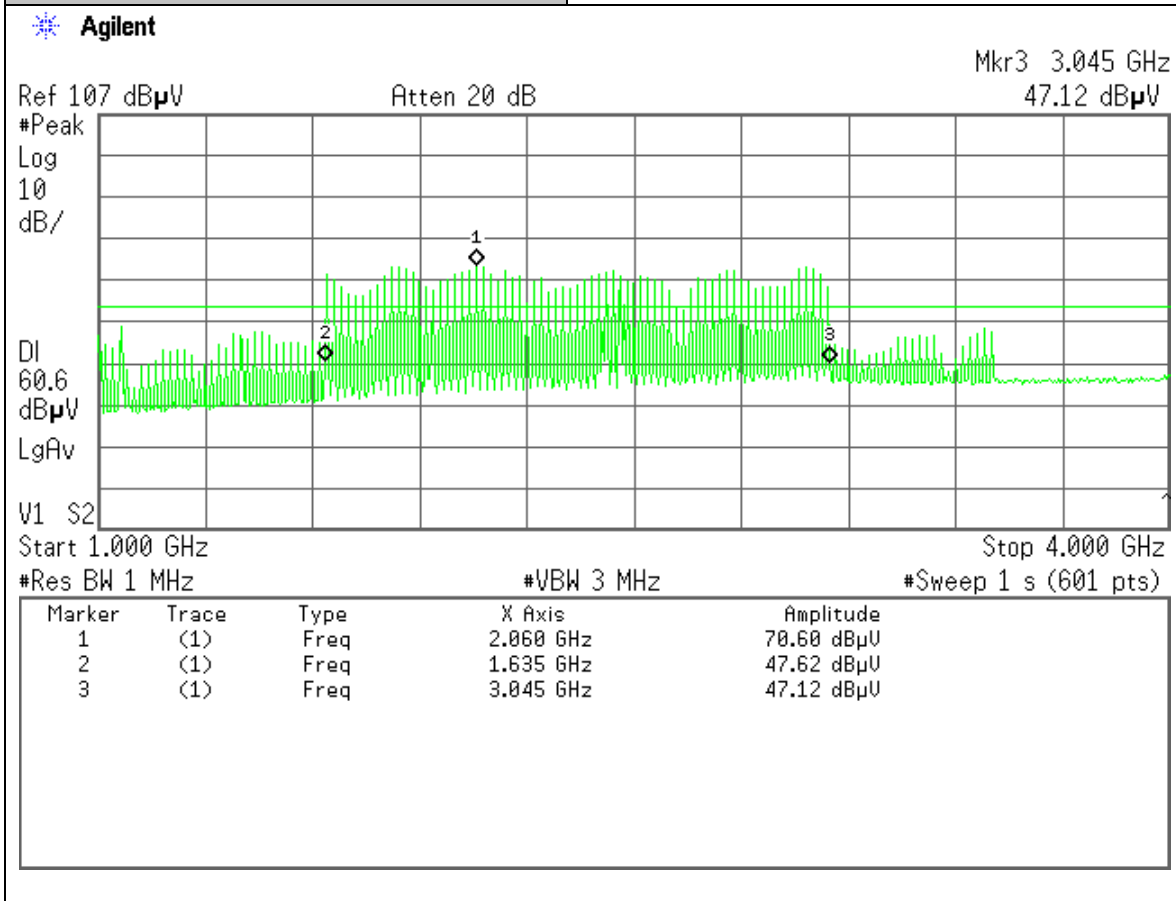
f_M	The highest emission peak	2060
f_L	10 dB below the highest peak	1635
f_H	10 dB above the highest peak	3045
f_C	Calculated: $(f_H + f_L)/2$	2340
Bandwidth	Calculated: $(f_H - f_L)$	1410
Fractional BW	Calculated: $2*(f_H - f_L)/(f_H + f_L)$	0.6

Note: The Fraction Bandwidth is greater than 0.2.

Measurement Plots:

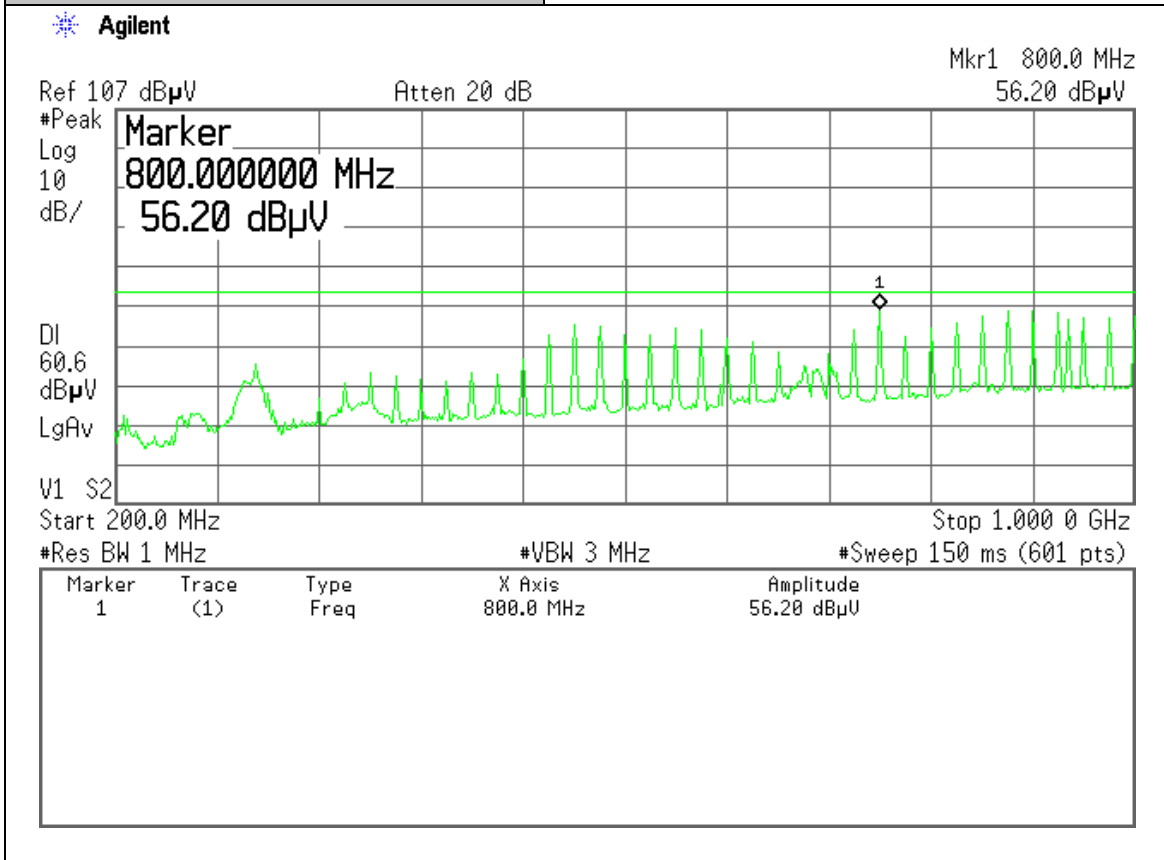
Project Number:	0048-240115-01-FCC-IC
EUT:	NX15
S/N:	1002
Tested By:	Wei Li
Temperature:	65°F
Humidity:	30%

Section:	UWB Bandwidth
Plot Name:	-10dB UWB Bandwidth in Anechoic Chamber (above 1GHz) Max Peak, low edge & upper edge
Configuration:	Stand alone, Continue operation



Project Number:	0048-240115-01-FCC-IC
EUT:	NX15
S/N:	1002
Tested By:	Wei Li
Temperature:	65°F
Humidity:	30%

Section:	UWB Bandwidth
Plot Name:	-10dB UWB Bandwidth in Anechoic Chamber (under 1GHz) Max Peak, low edge & upper edge
Configuration:	Stand alone, Continue operation



Test No.5

Name of Test:	<i>General Operational Requirements for LFIS</i>	Test Standard:	<i>15.509(b) &RSS-220 6</i>
Tested By:	WEI LI	Test Date:	01/15/2024-02/02/2024

Minimum 15.509(b) &RSS-220 6

Standard: Operation under the provisions of this section is limited to NX15s and wall imaging systems operated for the purposes with law enforcement, fire fighting, emergency rescue, scientific research, commercial mining, or construction.

Method of Measurement: The manufacturer Shall state that the device under test complies with the requirements outlined in section FCC Part 15.509 (b).

Test Result:

Complies

Test Data:

NA

Test No.6

Name of Test:	<i>Spurious Radiated Emissions ≤960MHz</i>	Test Standard:	<i>15.509(d) 15.209 & RSS-220 3.4, 6.2(c), 6.2(d)</i>
Tested By:	David Tu	Test Date:	01/15/2024-02/02/2024

Minimum Standard: Definition:
 The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in Section 15.209.

Limits:

Frequency (MHz)	Field Strengths Limits (dBµV/m)	Measuring RBW kHz	Distance (meters)
0.009-0.490	67,6-20*Logf(kHz)	1	300
0.490-1.705	87,6-20*Logf(kHz)	9	30
1.705-30	29.5	9	30
30-88	40.0	120	3
88-216	43.5	120	3
216-960	46.0	120	3

Method of Measurement: Tested at 3-meter OATS per ANSI C63.4
Spectrum Analyzer Settings:
RBW: 120KHz
VBW: $\geq 3x$ RBW
Detector: Quasi-Peak
Span: As required
Sweep: Auto

Test Procedure:

- 1) The EUT was placed on sandpit area filled with dry sand initially placed in front of the ground plane (0° degree position)
- 2) The receiving antenna which varied from 1 to 4 m to find the highest emission is positioned 3 m away from the EUT.
- 3) The receiving antenna was positioned in horizontal polarization.
- 4) The measurements were made with the detector set to peak with a bandwidth of 120 kHz during monitoring the frequency range below 960 MHz.
- 5) Upon detection of a suspect emission signal, its amplitude and frequency were noted.
- 6) It is recommended to demodulate the received signals for suitable discrimination of the ambient emission from the EUT emission.
- 7) At the worst case combination of the EUT operating mode and antenna height, the field strength measure was recorded. At each of the frequencies were a field strength was recorded the final measurement was performed with a Quasi-Peak detector.
- 8) The receiving antenna was positioned in vertical polarization and the steps 2 to 6 was repeated.
- 9) The EUT was rotating from 0° to 360° degrees with 45° step increment and the steps 4 to 7 was repeated.
- 10) All the worst case combination field strength emissions founded of each EUT position and antenna polarization was recorded in the following table and compared with the applicable limits.

Test Result:

Complies

Test Data:

Data

Project Number:	0048-240115-01-FCC-IC
EUT:	NX15
S/N:	1002
Tested By:	David Tu
Temperature:	65°F
Humidity:	30%

Worst Case Scenario: the worst case combination field strength emissions founded of each EUT position and antenna polarization was recorded in the following table and compared with the applicable limits.

- EUT Position (angle) : 45 ° interval.
- Antenna Polarization : Horizontal & Vertical; Antenna Height : 1-4m

Freq.* (MHz)	H,V	SA QP Reading (dBuV/m)	Height (m)	Angle (degree)	Refer to Part 15.209 3m Limit (dBuV/m)	Margin (dB)	Result
360	H	39.1	1.1	000	46.0	-6.9	Pass
420	H	38.2	1.1	000	46.0	-7.8	Pass
500	H	40.7	1.1	000	46.0	-5.3	Pass
520	H	42.1	1.1	090	46.0	-3.9	Pass
660	H	44.0	1.1	090	46.0	-2	Pass
680	H	44.3	1.1	090	46.0	-1.7	Pass
700	H	44.6	1.1	090	46.0	-1.4	Pass
780	H	40.2	1.1	180	46.0	-5.8	Pass
380	V	39.7	1.0	090	46.0	-6.3	Pass
420	V	37.8	1.0	090	46.0	-8.2	Pass
520	V	41.0	1.0	000	46.0	-5	Pass
660	V	38.3	1.1	135	46.0	-7.7	Pass
680	V	40.7	1.0	135	46.0	-5.3	Pass
700	V	42.0	1.0	135	46.0	-4	Pass
820	V	39.8	1.1	000	46.0	-6.2	Pass
900	V	37.8	1.1	000	46.0	-8.2	Pass

*Emissions from Digital circuitry (identified in Test No.1 for FCC Part 15 B) shall be excluded.

Test No.7

Name of Test:	<i>Spurious Radiated Emissions >960MHz</i>	Test Standard:	<i>15.509(d) 15.209 &RSS-220 3.4, 6.2(c), 6.2(d)</i>
Tested By:	David Tu	Test Date:	01/15/2024-02/02/2024

Minimum Definition:

Standard: The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz.

Limits:

Frequency (MHz)	EIRP @ 3 meters (1 MHz BW) (dBm)	Field strength @ 3 meters (1 MHz BW) (dBµV/m)	Field strength @ 1 meters (1 MHz BW) (dBµV/m)
960-1610	-	29,9	39,4
1610-1990	-	41,9	51,4
1990-3100	-	43,9	53,4
3100-10600	-	53,9	63,4
Above 10600	-	43,9	53,9

Remark: The limits were converted from EIRP to field strength at 3 and 1 meter according to FCC 15.503(k).

Method of Measurement: Tested at 3-meter OATS per ANSI C63.4
Spectrum Analyzer Settings:
RBW: 1MHz
VBW: $\geq 3 \times$ RBW
Detector: RMS Average Detector
Span: As required
Sweep: Auto

Test Procedure:

- 1) The EUT was placed on sandpit area filled with dry sand initially placed in front of the ground plane (0° degree position)
- 2) The receiving antenna is placed at 1 meter away from the EUT and it is pointed in the direction of the radiating head with an inclination of -10° to find the highest emission.
- 3) The receiving antenna was positioned in horizontal polarization.
- 4) The measurements were made with the detector set to RMS with a bandwidth of 1 MHz during monitoring the frequency range above 960 MHz.
- 5) Upon detection of a suspect emission signal, its amplitude and frequency were noted.
- 6) It is recommended to demodulate the received signals for suitable discrimination of the ambient emission from the EUT emission.
- 7) At the worst case combination of the EUT operating mode and antenna height, the field strength measure was recorded.
- 8) The receiving antenna was positioned in vertical polarization and the steps 2 to 6 were repeated.
- 9) The EUT was rotating from 0° to 360° degrees with 45° step increment and the steps 4 to 7 was repeated.
- 10) All the worst case combination field strength emissions founded of each EUT position and antenna polarization was recorded in the following table and compared with the applicable limits.

Test Result:

Complies

Test Data:

Data

Project Number:	0048-240115-01-FCC-IC
EUT:	NX15
S/N:	1002
Tested By:	David Tu
Temperature:	65°F
Humidity:	30%

Worst Case Scenario: the worst case combination field strength emissions founded of each EUT position and antenna polarization was recorded in the following table and compared with the applicable limits.

- EUT Position (angle) : 45 ° interval.
- Antenna Polarization : Horizontal & Vertical; Antenna Height: 1m-4m.

Freq.* (MHz)	H,V	SA Average Reading @1m (dBuV/m)	Height (m)	Angle (degree)	Refer to 15.509(d) 15.209 & RSS-220 3.4, 6.2(c), 6.2(d) Limit (dBuV/m)	Margin (dB)	Result
1020	H	35.3	1.0	000	39.4	-4.1	Pass
1080	H	34.8	1.0	000	39.4	-4.6	Pass
1100	H	33.5	1.0	000	39.4	-5.9	Pass
1180	H	37.0	1.0	000	39.4	-2.4	Pass
1220	H	36.0	1.0	315	39.4	-3.4	Pass
1300	H	38.2	1.0	315	39.4	-1.2	Pass
1400	H	38.1	1.0	315	39.4	-1.3	Pass
1460	H	37.9	1.0	315	39.4	-1.5	Pass
1520	H	36.6	1.0	000	39.4	-2.8	Pass
1540	H	37.2	1.0	000	39.4	-2.2	Pass
1600	H	35.8	1.0	000	39.4	-3.6	Pass
1640	H	45.3	1.0	000	51.4	-6.1	Pass
1680	H	44.2	1.0	000	51.4	-7.2	Pass
1760	H	46.8	1.0	000	51.4	-4.6	Pass
1820	H	46.0	1.0	000	51.4	-5.4	Pass
1980	H	43.7	1.0	000	51.4	-7.7	Pass
2060	H	47.6	1.0	315	53.4	-5.8	Pass
2140	H	48.4	1.0	315	53.4	-5	Pass
2280	H	48.7	1.0	315	53.4	-4.7	Pass

2380	H	46.3	1.0	315	53.4	-7.1	Pass
2540	H	47.5	1.0	315	53.4	-5.9	Pass
2640	H	45.9	1.0	315	53.4	-7.5	Pass
2720	H	44.7	1.0	315	53.4	-8.7	Pass
2840	H	46.1	1.0	315	53.4	-7.3	Pass
3020	H	45.0	1.0	315	53.4	-8.4	Pass
3180	H	46.3	1.0	315	63.4	-17.1	Pass
3240	H	44.1	1.0	315	63.4	-19.3	Pass
3360	H	46.4	1.0	315	63.4	-17	Pass
3480	H	45.0	1.0	315	63.4	-18.4	Pass
1020	V	34.6	1.0	000	39.4	-4.8	Pass
1060	V	35.0	1.0	000	39.4	-4.4	Pass
1120	V	37.1	1.0	000	39.4	-2.3	Pass
1180	V	35.8	1.0	000	39.4	-3.6	Pass
1240	V	38.3	1.0	000	39.4	-1.1	Pass
1280	V	37.2	1.0	000	39.4	-2.2	Pass
1400	V	36.8	1.0	000	39.4	-2.6	Pass
1440	V	33.2	1.0	000	39.4	-6.2	Pass
1560	V	35.9	1.0	000	39.4	-3.5	Pass
1600	V	35.6	1.0	000	39.4	-3.8	Pass
1660	V	43.8	1.0	000	51.4	-7.6	Pass
1700	V	45.2	1.0	000	51.4	-6.2	Pass
1820	V	46.6	1.0	000	51.4	-4.8	Pass
1900	V	44.4	1.0	000	51.4	-7	Pass
2040	V	46.0	1.0	000	53.4	-7.4	Pass
2180	V	47.4	1.0	000	53.4	-6	Pass
2220	V	46.7	1.0	000	53.4	-6.7	Pass
2240	V	47.2	1.0	000	53.4	-6.2	Pass
2320	V	46.3	1.0	045	53.4	-7.1	Pass
2380	V	48.0	1.0	045	53.4	-5.4	Pass
2500	V	46.9	1.0	045	53.4	-6.5	Pass
2560	V	47.7	1.0	000	53.4	-5.7	Pass
2640	V	48.0	1.0	000	53.4	-5.4	Pass
2720	V	47.3	1.0	000	53.4	-6.1	Pass
2780	V	48.2	1.0	000	53.4	-5.2	Pass
2880	V	45.9	1.0	000	53.4	-7.5	Pass
2960	V	46.6	1.0	000	53.4	-6.8	Pass
3120	V	46.8	1.0	000	63.4	-16.6	Pass
3260	V	47.2	1.0	000	63.4	-16.2	Pass
3440	V	45.4	1.0	000	63.4	-18	Pass

*Emissions from Digital circuitry (identified in Test No.1 for FCC Part 15 B) shall be excluded.

** Emissions above 3100MHz has larger margin comparing to the higher limit.

Test No.8

Name of Test:	<i>Radiated Emissions in GPS Bands</i>	Test Standard:	<i>15.509(e) 15.209 & RSS-220 6.2(e)</i>
Tested By:	David Tu	Test Date:	01/15/2024-02/02/2024

Minimum Standard:

Definition:

In addition to the radiated emission limits specified for frequency above 960 MHz, UWB transmitters operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz in the GPS frequency bands.

Limits:

Frequency (MHz)	EIRP @ 3 meters (1 MHz BW) (dBm)	Field strength @ 3 meters (1 MHz BW) (dBµV/m)	Field strength @ 1 meters (1 MHz BW) (dBµV/m)
1164-1240	-75.3	19.9	29.4
1559-1610	-75.3	19.9	29.4

Remark: The limits were converted from EIRP to field strength at 3 and 1 meter according to FCC 15.503(k).

Method of Measurement: Tested at 3-meter OATS per ANSI C63.4
Spectrum Analyzer Settings:
RBW: 1KHz
VBW: >3xRBW
Detector: RMS Average Detector
Span: As required
Sweep: Auto

Test Procedure:

- 1) The EUT was placed on sandpit area filled with dry sand initially placed in front of the ground plane (0° degree position)
- 2) The receiving antenna is placed at 1 meter away from the EUT and it is pointed in the direction of the radiating head with an inclination of -10° to find the highest emission.
- 3) The receiving antenna was positioned in horizontal polarization.
- 4) The measurements were made with the detector set to RMS during monitoring the frequency range above 960 MHz.
- 5) Upon detection of a suspect emission signal, its amplitude and frequency were noted.
- 6) It is recommended to demodulate the received signals for suitable discrimination of the ambient emission from the EUT emission.
- 7) At the worst case combination of the EUT operating mode and antenna height, the field strength measure was recorded.
- 8) The receiving antenna was positioned in vertical polarization and the steps 2 to 6 were repeated.
- 9) The EUT was rotating from 0° to 360° degrees with 45° step increment and the steps 4 to 7 was repeated.
- 10) All the worst case combination field strength emissions founded of each EUT position and antenna polarization was recorded in the following table and compared with the applicable limits.

Test Result:

Complies

Test Data:

Data and Plot

Project Number:	0048-240115-01-FCC-IC
EUT:	NX15
S/N:	1002
Tested By:	David Tu
Temperature:	65°F
Humidity:	30%

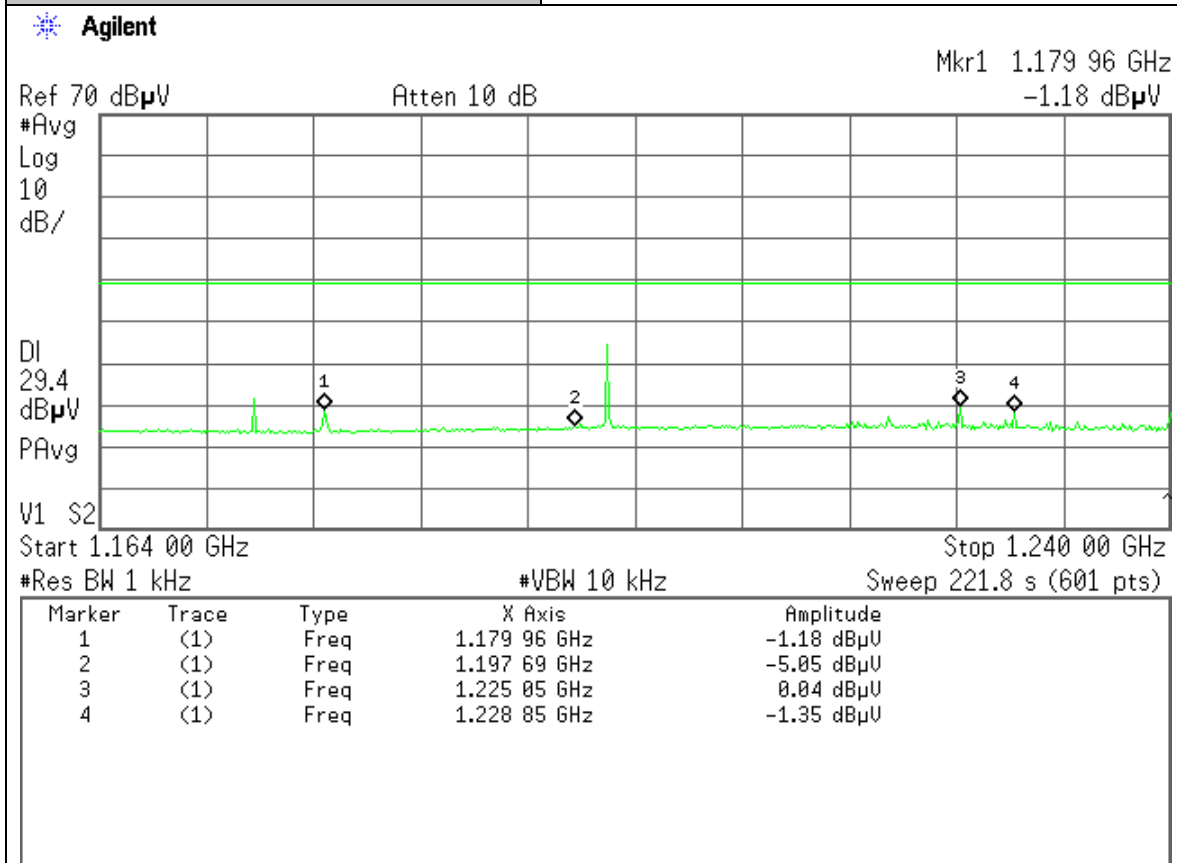
Worst Case Scenario: All maximum Field strength emissions were found at the following test set-up conditions:

Freq. (MHz)	H,V	SA Reading (dBuV/m)	Height (m)	Angle (degree)	1m Limit (dBuV/m)	Margin (dB)	Result
1179.96	H	-1.18	1.1	135	29.4	-30.58	Pass
1197.69	H	-5.05	1.1	135	29.4	-34.45	Pass
1225.05	H	0.04	1.1	180	29.4	-29.36	Pass
1228.85	H	-1.35	1.1	180	29.4	-30.75	Pass
1560.20	H	-0.88	1.1	180	29.4	-30.28	Pass
1570.56	H	-2.77	1.1	135	29.4	-32.17	Pass
1584.76	H	-3.39	1.1	135	29.4	-32.79	Pass
1603.63	H	-3.27	1.1	135	29.4	-32.67	Pass
1175.02	V	-0.09	1.1	090	29.4	-29.49	Pass
1179.96	V	-1.94	1.1	090	29.4	-31.34	Pass
1222.77	V	-2.67	1.1	315	29.4	-32.07	Pass
1225.05	V	-0.58	1.1	315	29.4	-29.98	Pass
1560.20	V	-0.88	1.1	315	29.4	-30.28	Pass
1570.56	V	-2.77	1.1	315	29.4	-32.17	Pass
1584.76	V	-3.39	1.1	090	29.4	-32.79	Pass
1603.63	V	-3.27	1.1	090	29.4	-32.67	Pass

* Digital Circuitry emissions do not fall under the requirements of this section.

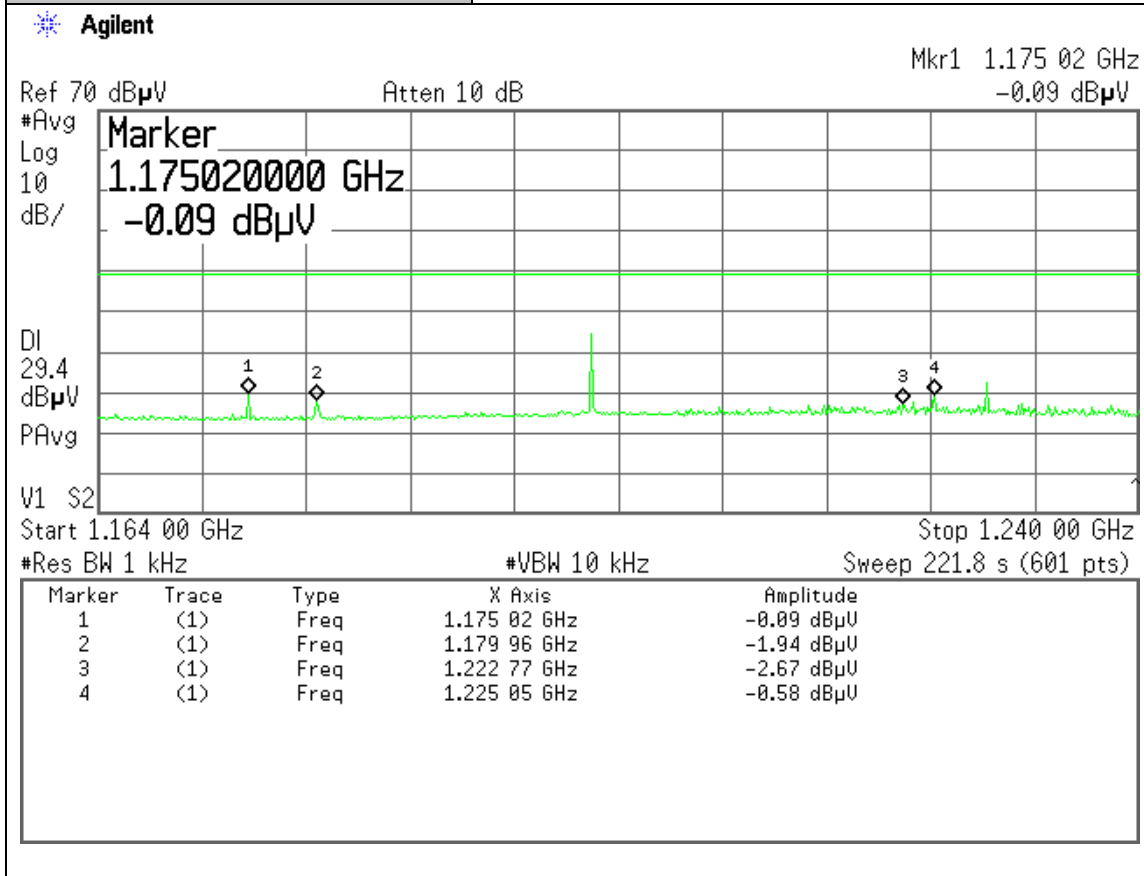
Project Number:	0048-240115-01-FCC-IC
EUT:	NX15
S/N:	1002
Tested By:	Wei Li
Temperature:	65°F
Humidity:	30%

Section:	<i>Radiated Emissions in GPS Bands</i>
Plot Name:	Radiated Emissions in 1164-1240MHz Band H Polarity
Configuration:	Stand alone, Continue operation



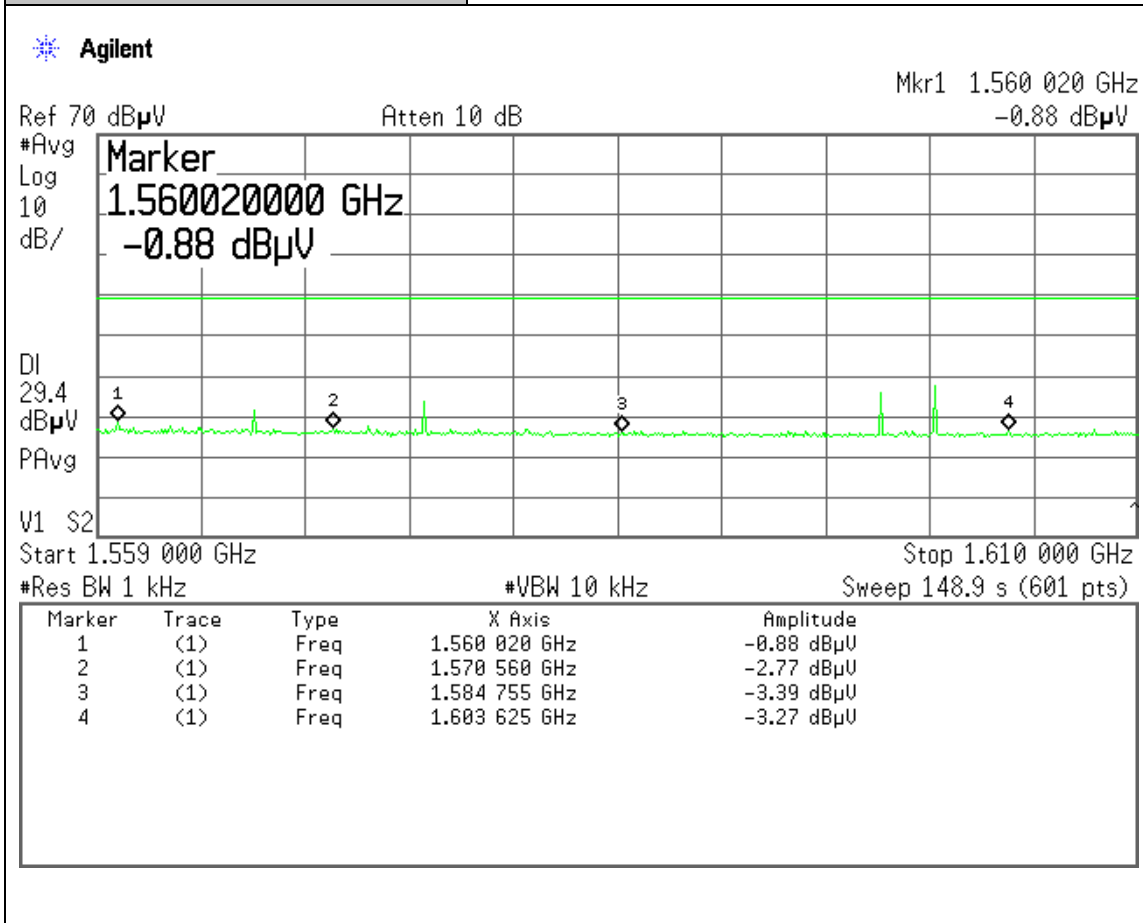
Project Number:	0048-240115-01-FCC-IC
EUT:	NX15
S/N:	1002
Tested By:	Wei Li
Temperature:	65°F
Humidity:	30%

Section:	<i>Radiated Emissions in GPS Bands</i>
Plot Name:	Radiated Emissions in 1164-1240MHz Band V Polarity
Configuration:	Stand alone, Continue operation



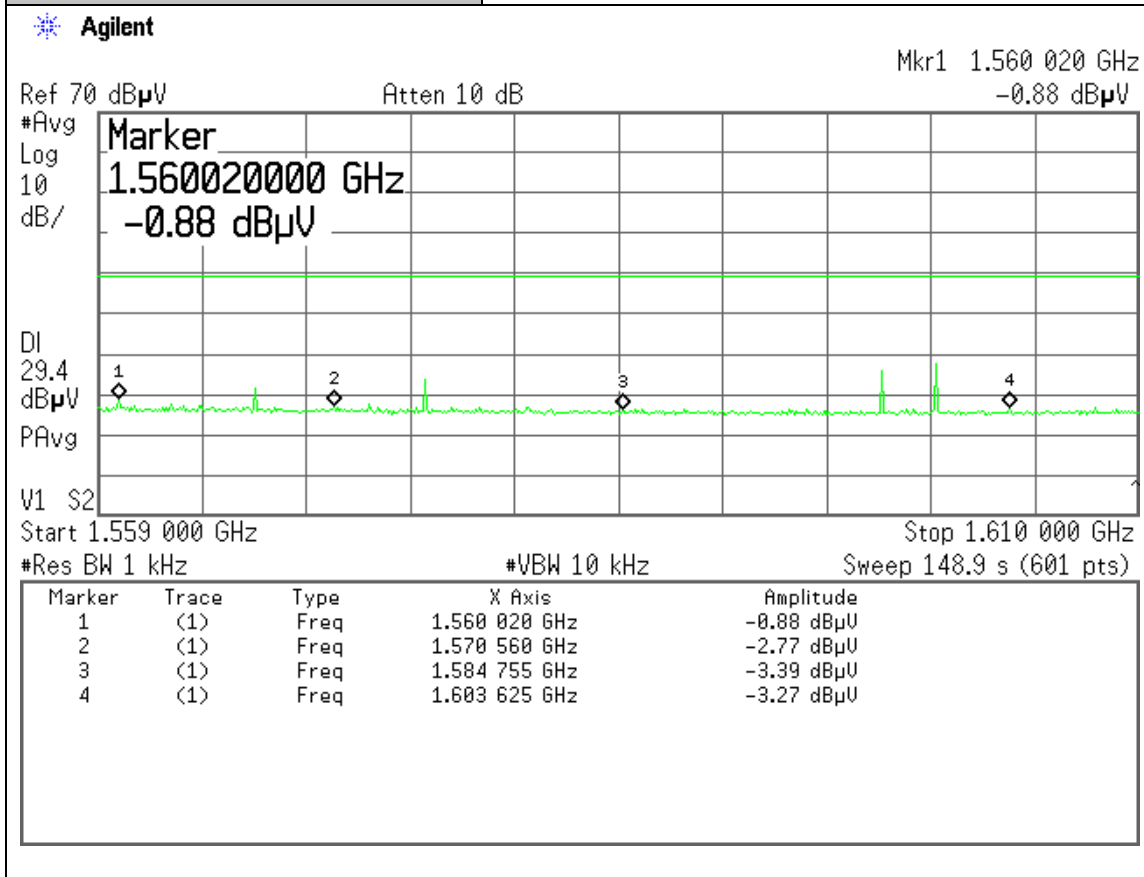
Project Number:	0048-240115-01-FCC-IC
EUT:	NX15
S/N:	1002
Tested By:	Wei Li
Temperature:	65°F
Humidity:	30%

Section:	<i>Radiated Emissions in GPS Bands</i>
Plot Name:	Radiated Emissions in 1559-1610MHz Band H Polarity
Configuration:	Stand alone, Continue operation



Project Number:	0048-240115-01-FCC-IC
EUT:	NX15
S/N:	1002
Tested By:	Wei Li
Temperature:	65°F
Humidity:	30%

Section:	<i>Radiated Emissions in GPS Bands</i>
Plot Name:	Radiated Emissions in 1559-1610MHz Band V Polarity
Configuration:	Stand alone, Continue operation



Test No.9

Name of Test:	<i>Highest Radiated Emission at f</i>	Test Standard:	<i>15.509(f) 15.209 &RSS-220 6.2(g)</i>
Tested By:	David Tu	Test Date:	01/15/2024-02/02/2024

Minimum Definition:

Standard: For UWB devices where the frequency at which the highest radiated emission occurs, f_M , is above 960 MHz, there is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on f_M .

Limits:

The peak emission level contained within a 50 MHz bandwidth centered on f_M must be limited to a maximum of 0 dBm EIRP.

EIRP limit (dBm)	Field strength limit @ 3 meters for 50MHz RBW (dBuV/m) (dBμV/m)	Field strength limit @ 3 meters (measured with 3 MHz RBW) (dBμV/m)
0	95.2	70.8

The limits were converted from EIRP to field strength at 3 meter according to FCC 15.503(k).

As the measurement was employed with a 3 MHz resolution bandwidth the applicable limit is adjusted with a $20\log(1/50)$ dB factor.

$20\log(3/50) = -24.4$ dB. Therefore the 0dBm limit will be converted to -24.4 dBm with 3MHz RBW, i.e 70.8 dBuV/m field strength.

Method of Measurement: Tested at 3-meter OATS per ANSI C63.4
Spectrum Analyzer Settings:
RBW: 3MHz
VBW: ≥ 3 x RBW
Detector: Peak
Span: As required
Sweep: Auto

Test Procedure:

- 1) The EUT was placed on sandpit area filled with dry sand initially placed in front of the ground plane (0° degree position).
- 2) The receiving antenna which varied from 1 to 4 m to find the highest emission is positioned 3 m away from the EUT.
- 3) The receiving antenna was positioned in horizontal polarization.
- 4) The measurements were made with the detector set to peak with a bandwidth of 3 MHz during monitoring the frequency range inside the UWB of the EUT.
- 5) At the worst case combination of the EUT operating mode and antenna height, the field strength measure was recorded.
- 6) The receiving antenna was positioned in vertical polarization and the steps 4 to 6 were repeated.
- 7) The EUT was rotating from 0° to 360° degrees with 45° step increment and the steps 4 to 7 was repeated.
- 8) Record the peak emission from the EUT.

Test Result:

Complies

Test Data:

Project Number:	0048-240115-01-FCC-IC
EUT:	NX15
S/N:	1002
Tested By:	David Tu
Temperature:	65°F
Humidity:	30%

Worst Case Scenario: The maximum peak level of emission is found at the following test set-up conditions:

Applicable to Normal Mode:

Freq. (MHz)	H,V	SA Peak Reading At 3 meter (dBuV/m)	RBW	Reading correction		Limit (dBuV/m)	Margin (dB)	Result
1720*	V	68.6	3MHz	0		70.8	-2.2	Pass

Test No.10

Name of Test:	<i>Technical Requirements Applicable to ALL UWB Devices</i>	Test Standard:	<i>15.521</i>
Tested By:	WEI LI	Test Date:	01/15/2024-02/02/2024

Requirement **Description**

15.521(a)	The EUT is not employed for the operation of toys, operation onboard an aircraft, ship and satellite.
15.521(b)	Permanent attached antenna, no External radio frequency power amplifiers and antenna modifications are permitted.
15.521(c)	The Digital circuitry portion of the EUT has been tested and verified to comply with 47 CFR Part 15, subpart B.
15.521(d)	Considered
15.521(e)	The f_M , frequency at which the highest radiated emission occurs is contained within the measured UWB bandwidth.
15.521(f)	The EUT is not intended to detection of tags or the transfer or data or voice information.
15.521(g)	Considered
15.521(h)	Considered
15.521(i)	Prohibition in Sections 2.201(f) and 15.5(d) of this chapter against Class B (damped wave) emissions is not applied.
15.521(j)	Battery operating device not connected to AC power lines.
15.521(a)	The EUT is not employed for the operation of toys, operation onboard an aircraft, ship and satellite.

Test Result:

Complies

Test Data:

NA

Test No.11

Name of Test:	<i>Coordination Requirement</i>	Test Standard:	<i>15.525</i>
Tested By:	Wei Li	Test Date:	01/15/2024-02/02/2024

Minimum Standard: The responsible party is properly informed about the required coordination requirement and provide correct information to the customers and users about their specific care and legislative obligations.

(See Important note for the US customers of the Installation Guide and User Manual)

Method of Measurement: (a) UWB imaging systems require coordination through the FCC before the equipment may be used. The operator shall comply with any constraints on equipment usage resulting from this coordination.

(b) The users of UWB imaging devices shall supply operational areas to the FCC Office of Engineering and Technology, which shall coordinate this information with the Federal Government through the National Telecommunications and Information Administration.

(c) The manufacturers, or their authorized sales agents, must inform purchasers and users of their systems of the requirement to undertake detailed coordination of operational areas with the FCC prior to the equipment being operated.

(d) Users of authorized, coordinated UWB systems may transfer them to other qualified users and to different locations upon coordination of change of ownership or location to the FCC and coordination with existing authorized operations.

(e) The FCC/NTIA coordination report shall identify those geographical areas within which the operation of an imaging system requires additional coordination or within which the operation of an imaging system is prohibited.

(f) The coordination of routine UWB operations shall not take longer than 15 business days from the receipt of the coordination request by NTIA.

Test Result:

Test Data: NA

Test No. 12

Name of Test:	<i>Antenna Requirement</i>	Test Standard:	<i>15.203&15.204 &RSS-GEN 7.1.4</i>
Tested By:	WEI LI	Test Date:	

Minimum Standard: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply.

Method of Measurement: The antenna utilized by the device under test is an internal, non user replaceable unit.

Antenna Characteristics are not necessary as all compliance measurements were made in radiated mode.

Test Result: Complied with using an internal, non user replaceable Antenna

Test Data: NA

Test No.13

Name of Test:	Radio Frequency Exposure	Test Standard:	FCC OET Bulletin 65 &RSS-GEN
Tested By:	WEI LI	Test Date:	01/15/2024-02/02/2024

LIMITS for FCC RF Exposure Evaluation

§1.1310 The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f ²)	6
30–300	61.4	0.163	1.0	6
300–1500			f/300	6
1500–100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f ²)	30

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)—Continued

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
30–300	27.5	0.073	0.2	30
300–1500			f/1500	30
1500–100,000			1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

LIMITS for FCC SAR Evaluation

KDB 447498 D04 Interim General RF Exposure Guidance v01, section 2.1.3 SAR-Based Exemption:

“A more comprehensive exemption, considering a variable power threshold that depends on both the *separation distance* and power, is provided in § 1.1307(b)(3)(i)(B). This exemption is applicable to the frequency range between 300 MHz and 6 GHz, with *test separation distances* between 0.5 cm and 40 cm, and for all RF sources in fixed, mobile, and portable device exposure conditions.”

For 100 MHz to 6 GHz and test separation distances ≤ 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following:

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0 \text{ for 1-g SAR, and } \leq 7.5 \text{ for 10-g extremity SAR,}$$

where f (GHz) is the RF channel transmit frequency in GHz

FCC KDB 447498 D01 General RF Exposure Guidance v06, section 4.3.1 & Appendix A provides the SAR Test Exclusion Thresholds (ERP/Conducted) to verify that the device is exempt from 1-g extremity SAR at different separation distances. As example, for 900MHz Tx: 16mW (12dBm); For 2450MHz Tx: 10mW (10dBm) at ≤ 5 mm.

Details in calculation formula for reference, given in § 1.1307(b)(3)(i)(B) to calculate the exemption:

$$P_{th} \text{ (mW)} = \begin{cases} ERP_{20 \text{ cm}} (d/20 \text{ cm})^x & d \leq 20 \text{ cm} \\ ERP_{20 \text{ cm}} & 20 \text{ cm} < d \leq 40 \text{ cm} \end{cases}$$

Where

$$x = -\log_{10} \left(\frac{60}{ERP_{20 \text{ cm}} \sqrt{f}} \right) \text{ and } f \text{ is in GHz;}$$

and

$$ERP_{20 \text{ cm}} \text{ (mW)} = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases}$$

d = the separation distance (cm);

LIMITS per ISED RSS-102, Section 2.5 & Table 1

Per 2.5.1 Exemption Limits for Routine Evaluation — SAR Evaluation

Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance^{4,5}

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤ 5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤ 300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥ 50 mm
≤ 300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 2.5.

Example: Exclusion Thresholds to verify that the 2450MHz Tx is exempt from 1-g SAR at separation distance of ≤ 5 mm: 4mW (6dBm) & 10-g SAR at separation distance of ≤ 5 mm: 10mW (10dBm).

Per 2.5.2 Exemption Limits for Routine Evaluation – RF Exposure Evaluation

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- **at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;**
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

Summary

For FCC and IC, that max. declared power level can be modified by any duty cycle over the time averaging period. Time-averaging period is a time period not to exceed 30 minutes for fixed RF sources or a time period inherent from device transmission characteristics not to exceed 30 minutes for mobile and portable RF sources.

For rf exposure, the averaging period is 6 minutes for ISED Canada and for FCC it varies by frequency but 1~60 second for RF exposure or the period specified by product design spec. for RF exposure can be used.

So the power value for RF exposure= Declared power x Duty Cycle factor

CALCULATIONS for MPE distance and Power Density

Given

$$E = \sqrt{(30 * P * G) / d}$$

and

$$S = E^2 / 3770$$

where

E = Field Strength in Volts/meter

P = Power in Watts

G = Numeric

antenna gain

d = Distance in

meters

S = Power Density in milliwatts/square centimeter

Combining equations and rearranging the terms to express the distance as a function of the remaining variables yields:

$$d = \sqrt{((30 * P * G) / (3770 * S))}$$

Changing to units of Power to mW and Distance to

cm, using: $P(\text{mW}) = P(\text{W}) / 1000$ and

$$d(\text{cm}) = 100 * d(\text{m})$$

yields

$$d = 100 * \sqrt{((30 * (P / 1000) * G) / (3770 * S))}$$

$$d = 0.282 * \sqrt{(P * G / S)}$$

where

d = distance in cm
P = Power in mW
G = Numeric antenna gain
S = Power Density in mW/cm²

Substituting the logarithmic form of power and gain using: $P \text{ (mW)} = 10^{(P \text{ (dBm)} / 10)}$ and $G \text{ (numeric)} = 10^{(G \text{ (dBi)} / 10)}$

yields

$$d = 0.282 * 10^{((P + G) / 20)} / \sqrt{S} \quad \text{Equation (1)}$$

$$S = 0.0795 * 10^{((P + G)/10)} / d^2 \quad \text{Equation (2)}$$

where

d = MPE distance in cm
P = Power in dBm
G = Antenna Gain in dBi
S = Power Density Limit in mW/cm²

Equation (1) and the measured Output power is used to calculate the MPE distance.
Equation (2) and the measured Output power is used to calculate the Power density.

APPLICABLE LIMITS

RF Exposure for separation $\geq 20\text{cm}$

FCC: From §1.1310 Table 1 (B), for Public $S = 1.0 \text{ mW/cm}^2$; for Professional, $S = 5.0 \text{ mW/cm}^2$

IC: With formula of $1.31 \times 10^{-2} f^{0.6834} \text{ W}$, more restricted EIRP limit value are 1.37W at 902MHz, 2.67W at 2400MHz.

SAR Exclusion Thresholds for separation $\leq 5\sim 40\text{cm}$:

FCC : Use Formular in FCC § 1.1307(b)(3)(i)(B) & KDB 447498 D04

IC: Use RSS-102 Table1

Apply duty cycle factor & 2.5 factor for extremity or limb-worn devices

RESULTS

No non-compliance noted.

For GPR UWB Transmitter:

1-mW Test Exemption:

Per § 1.1307(b)(3)(i)(A), a single RF source is exempt RF device (from the requirement to show data demonstrating compliance to RF exposure limits, as previously mentioned) if the available maximum time-averaged power is no more than 1 mW, regardless of separation distance.

This exemption applies to all operating configurations and exposure conditions, for the frequency range 100 kHz to 100 GHz, regardless of fixed, mobile, or portable device exposure conditions.

For this EUT, max emission level is under the 0dBm limit set in Part 15F: -2.2dBm (0.603mW). No RF hazard need to be concerned.

For WiFi Transmitter:

with Hand-held /limb-worn usage: **SAR Exemption Evaluation** (2.5 factor with 10-g extremity SAR)

WiFi Module Information:

Chip Module: Marvell / NXP/ W8997-M1216/FCC ID: UAY-W8997-M1216

Modular: AzureWave /AW-CM276NF with preset max. RF power:15dBm at 5GHz band only

Antenna: Molex /2042810100. 2.8dBi gain for 5GHz band.

Max. duty cycle factor is close to 100%.

Minimum separation distance: 29mm .

There are two Wifi antennas (Molex 2042810100) are inside EUT (shown as the following diagram. The distance between the WIFI antenna and the possible human body location (hand) is no less than 29mm. See separate documents for description in details.



Worst Case Scenario: GPR and WiFi Transmitting Simultaneously

	GPR	WiFi 5GHz	Combined GPR+WiFi 5G (mW)
Frequency (MHz)	320-3500	5GHz Band	
Antenna Gain (dBi)		2.8	
Conducted Power (dBm/mW)		15.0 /31.623	31.623mW
EIRP (dBm/mW)	-2.2/ 0.603	17.8 /60.256	60.859mW

---For FCC:

Using the formula in 1.1307(b)(3)(i)(B), $ERP_{20cm}=3060mW$, $d=2.9cm$,
 $\min. x=-\log_{10}(60/(3060\sqrt{5.18}))=2.06$ corresponding to the lowest frequency of 5GHz band.
 Then the most restricted conducted $P_{th}= 3060 (2.9/20)^{2.06}=57.3mW$, which is more than
 31.623mW. So the SAR test exclusion condition is met.

--- For IC:

With the max. combined power calculated above, considering a factor of 2.5 for 10-g extremity SAR, the EIRP value used to compare Table 1 threshold is
 $60.619/2.5=24.25mW$ for 5GHz Band, which is under the limit of 41mW at mini. separation distance of 25mm.

Conclusion: This module is used limited portable application (Handheld/limb-worn) with minimum 29mm separation distance from antenna to user's hand/wrist, which meets the requirement for SAR test exclusion.

Test No.14

Name of Test:	<i>Conducted Emissions</i>	Test Standard:	<i>15.507 &RSS-GEN</i>
Tested By:	-	Test Date:	-

Minimum Standard: 15.507 &RSS-GEN
 Limit

Frequency Range (MHz)	Limits (dBµV)	
	Quasi-Peak	Average
0.15 to 0.50	66 to 56*	56 to 46*
0.50 to 5.0	56	46
5.0 to 30.0	60	50

* Decreases with the logarithm of the frequency.

Method of Measurement: Test measurements were made in accordance with ANSI C63.4-2003, Standard Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronics Equipment in the Range of 9 kHz to 40 GHz.

Spectrum Analyzer Setting:
 Frequency Range: 150KHz to 30MHz
 RBW: 9KHz
 VBW: 30KHz
 Detector: Peak/QP/Average

Test Result: NA
 (The EUT is only powered via a lithium-ion battery which is remotely recharged)

Test Data: NA

Test No.15

Name of Test:	<i>Transmission Duration</i>	Test Standard:	<i>15.509(c)& 15.519(a)(1)</i>
Tested By:	-	Test Date:	-

Minimum Standard: 15.509 (c)
 A GPR that is designed to be operated while being hand held and a wall imaging system shall contain a manually operated switch that causes the transmitter to cease operation within 10 seconds of being released by the operator. In lieu of a switch located on the imaging system, it is permissible to operate an imaging system by remote control provided the imaging system ceases transmission within 10 seconds of the remote switch being released by the operator.

15.519(a)(1)---for hand held UWB Systems
 A UWB device operating under the provisions of this section shall transmit only when it is sending information to an associated receiver. The UWB intentional radiator shall cease transmission within 10 seconds unless it receives an acknowledgement from the associated receiver that its transmission is being received. An acknowledgment of reception must continue to be received by the UWB intentional radiator at least every 10 seconds or the UWB device must cease transmitting.

Method of Measurement: Functional Check

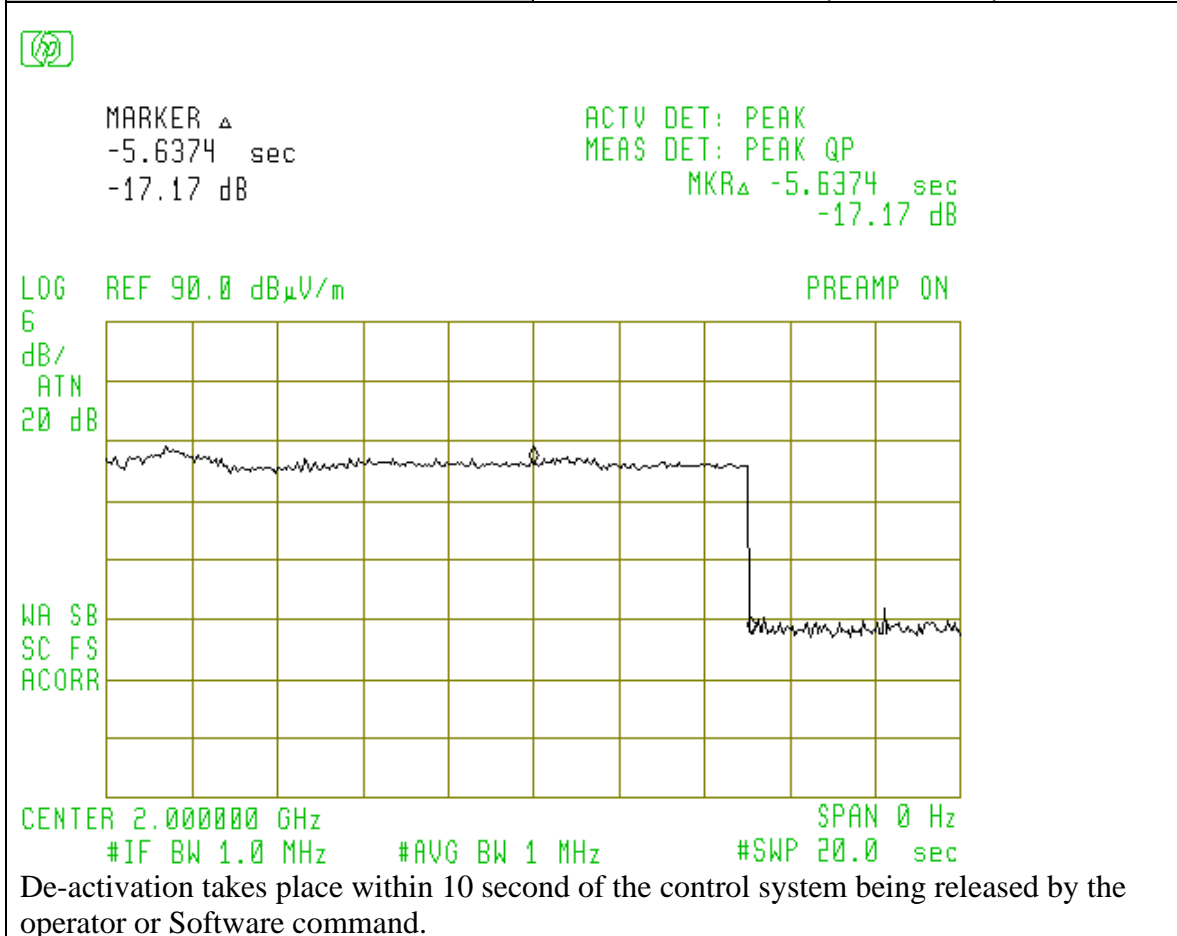
Test Result: **Complies**

De-activation takes place within 10 seconds of the control system being switched off/not active or released by the operator or an acknowledgment of reception was received by the UWB intentional radiator within 10 seconds. Procedure is documented in operational description manual.

Test Data:
 The system does not transmit until someone goes to the data collection screen on the controller and presses the Start Button. Once pressed, the NX15 unit continues to transmit until the scan is stopped via the Stop Button or an inactivity timer expires after 10 seconds of inactivity.

Project Number:	0048-230201-01
EUT:	NX15
S/N:	1002
Tested By:	Wei Li
Temperature:	65°F
Humidity:	30%

Section:	<i>Transmission Duration</i>
Plot Name:	Transmission Duration with Switch Control (worst case)
Configuration:	Stand alone, Software Control or Power Switch (worst case)



Test No.16

Name of Test:	<i>Wavier DA 23-065A1 Conditions</i>	Standards:	<i>DA 23-065A1, Sec. 11</i>
Tested By:	WEI LI	Test Date:	01/15/2024-02/02/2024

Minimum Standard: Wavier DA 23-065A1, Section 11: This waiver is subject to the following conditions:

- 1) The GSSI GPR device shall be certified by an authorized Telecommunications Certification Body. A copy of this Order must be submitted with the application for certification.
- 2) The GSSI GPR device shall operate with stepped frequency CW modulation in 1-40 megahertz steps between 30-6000 MHz.
- 3) The GSSI GPR device dwell time on any one frequency shall not exceed 2 microseconds.
- 4) The dwell time during any step of the GSSI GPR shall not exceed 0.04 percent of the devices minimum scan/cycle rate.
- 5) For certification testing, the measurement of emissions from the GSSI GPR device shall be conducted with the stepping function active for all possible frequency step sizes.
- 6) The GSSI GPR device will comply with all other technical and operational requirements applicable to UWB GPR devices under Part 15, Subpart F of the Commission's rules.
- 7) The entities permitted to operate the GSSI GPR device are limited to those specified in Section 15.509(b) of the Commission's rules.
- 8) Sales of the GSSI GPR device authorized under this waiver are subject to an annual limit of 5,000 devices for each of the first two years and 10,000 devices each year thereafter.

Method of

Measurement: Same method as defined in Test No.6.

Test Result: **Complies**

Requirement No. 1 & 5 & 6: Complied with this report filing;

Requirement No. 7 & 8: See GSSI Compliance Attestation;

Requirement No. 2 & 3 & 4: The SFCW Sensor module generates wide-band continuous-wave signals from 320MHz to 3.5GHz at 20MHz steps (160 frequency points). The dwelling time at each frequency does not exceed 2us and 0.04 percent of the devices minimum scan/cycle rate (9.6ms), i.e. 3.84us. See plots in details in Operational Description.