



MEASUREMENT REPORT

FCC PART 15.247 WLAN 802.11b/g/n

Report No.: S20241022815702

Issue Date: 11-29-2024

Applicant: Bolt Technology OÜ
Address: Vana – Lõuna 15, 10134 Tallinn, Estonia
FCC ID: 2BHTW-BOLT-IOTD-2
Product: IoT module
Model No.: IOTD-2
FCC Classification: Digital Transmission System (DTS)
FCC Rule Part(s): Part 15 Subpart C (15.247)
Test Procedure(s): ANSI C63.10-2013, KDB 558074 D01v05r02
Result: Pass
Item Receipt Date: Oct 22, 2024
Test Date: Oct 23 ~ Nov 28, 2024

Compiled By Stone Zhang.
 (Stone Zhang)
 Senior Test Engineer

Approved By Line Chen
 (Line Chen)
 Engineer Manager



The test results relate only to the samples tested.
 This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.4-2014. Test results reported herein relate only to the item(s) tested. The test report shall not be reproduced except in full without the written approval of Fangguang Inspection & Testing Co., Ltd. Wuxi Branch
 The test report must not be used by the client to claim product certifications, approval, or endorsement by NVLAP, NIST or any agency of U.S. Government.

Revision History

Report No.	Version	Description	Issue Date
S20241022815702	Rev. 01	/	11-29-2024

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§2.1033 General Information

Applicant:	Bolt Technology OÜ
Applicant Address:	Vana – Lõuna 15, 10134 Tallinn, Estonia
Manufacturer:	Bolt Operations OÜ
Manufacturer Address:	Vana – Lõuna 15, 10134 Tallinn, Estonia
Test Site:	Fanguang Inspection & Testing Co., Ltd.
LAB ID:	CN5037
Test Site Address:	No.8 Ningyun Rd., Xinwu District Wuxi, Jiangsu 214000 China
FCC Rule Part(s):	Part 15 Subpart C (15.247)
FCC ID:	2BHTW-BOLT-IOTD-2
Test Device Serial No.:	S/N.:/ <input type="checkbox"/> Production <input checked="" type="checkbox"/> Pre-Production <input type="checkbox"/> Engineering
FCC Classification:	Digital Transmission System (DTS)

1. INTRODUCTION

1.1. Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Innovation, Science and Economic Development Canada.

1.2. Fangguang Test Location

These measurement tests were performed at the Fangguang Inspection and testing Co.,LTD located at No.8 Ningyun Rd., Xinwu District Wuxi, Jiangsu 214000 China. The detailed description of the measurement facility was found to be in compliance with the requirements of ANSI C63.4-2014.

2. PRODUCT INFORMATION

2.1. Equipment Description

Product Name:	IoT module
Model Name:	IOTD-2
Trade Mark:	Bolt
Input Voltage Range:	DC24V 0.5A

Note:

This information is provided by the Customer and its authenticity is the responsibility of the Customer.

2.2. Product Specification Subjective to this Report

Frequency Range:	802.11b/g/n-HT20: 2412 ~ 2462MHz 802.11n-HT40: 2422 ~ 2452MHz
Channel Number:	802.11b/g/n-HT20: 11 802.11n-HT40: 7
Type of Modulation:	802.11b: DSSS 802.11g/n-HT20/n-HT40: OFDM
Data Rate:	802.11b: 1/2/5.5/11Mbps 802.11g: 6/9/12/18/24/36/48/54Mbps 802.11n-HT20/n-HT40: MCS0~MCS7
Antenna Type:	PCB Antenna
Antenna Gain:	0.04

Note:

The maximum Antenna Gain was declared by the manufacturer.

2.3. Operation Frequency / Channel List

802.11b/g/n-HT20

Channel	Frequency	Channel	Frequency	Channel	Frequency
01	2412 MHz	02	2417 MHz	03	2422 MHz
04	2427 MHz	05	2432 MHz	06	2437 MHz
07	2442 MHz	08	2447 MHz	09	2452 MHz
10	2457 MHz	11	2462 MHz	--	--

EUT was tested with Channel 01, 06 and 11.

802.11n-HT40

Channel	Frequency	Channel	Frequency	Channel	Frequency
--	--	--	--	03	2422 MHz

04	2427 MHz	05	2432 MHz	06	2437 MHz
07	2442 MHz	08	2447 MHz	09	2452 MHz

EUT was tested with Channel 03, 06 and 09.

2.4. Device Capabilities

This device contains the following capabilities: 2.4GHz WLAN (DTS)

Note: 2.4GHz WLAN (DTS) operation is possible in 20MHz channel bandwidths. The maximum achievable duty cycle was determined based on measurements performed on a spectrum analyzer in zero-span mode with RBW = 8MHz, VBW = 8MHz. The RBW and VBW were both greater than $50/T$, where T is the minimum transmission duration, and the number of sweep points across T was greater than 100. The duty cycles:

Test Mode	Channel	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]
802.11b	2412	19.00	19.00	100.00
	2437	17.00	17.00	100.00
	2462	19.00	19.00	100.00
802.11g	2412	5.49	5.51	99.64
	2437	5.48	5.51	99.46
	2462	5.49	5.51	99.64
802.11n-HT20	2412	5.08	5.11	99.41
	2437	5.08	5.11	99.41
	2462	5.08	5.11	99.41
802.11n-HT40	2422	2.47	2.50	98.80
	2437	2.47	2.50	98.80
	2452	2.47	2.49	99.20

Test Graphs:

11B_Ant1_2412



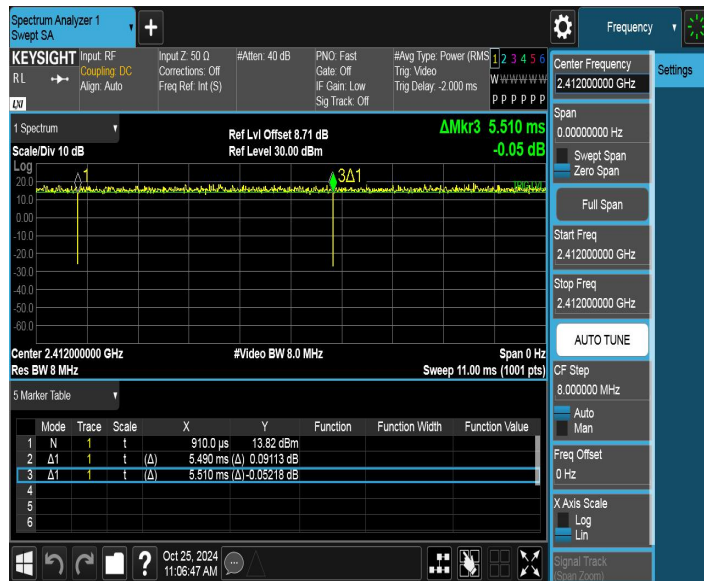
11B_Ant1_2437



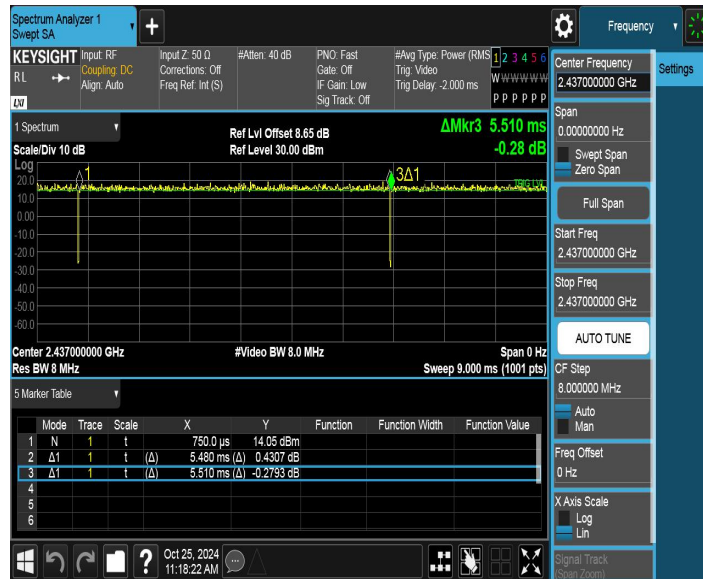
11B_Ant1_2462



11G_Ant1_2412



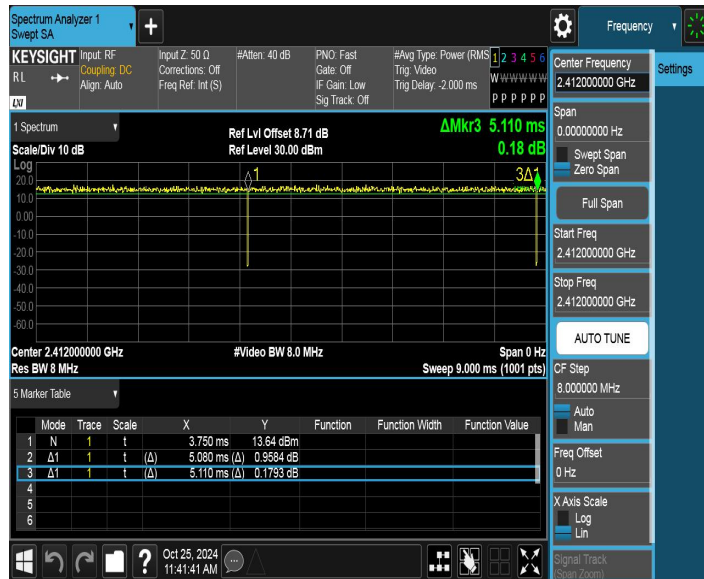
11G_Ant1_2437



11G_Ant1_2462



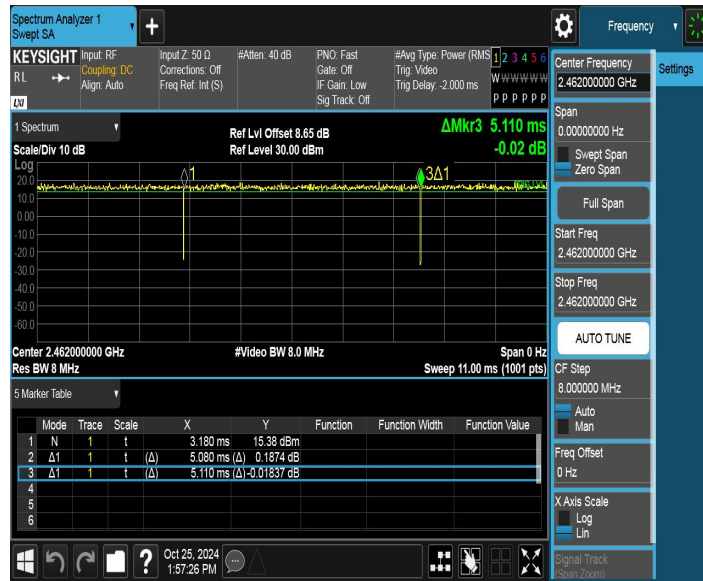
11N20SISO_Ant1_2412



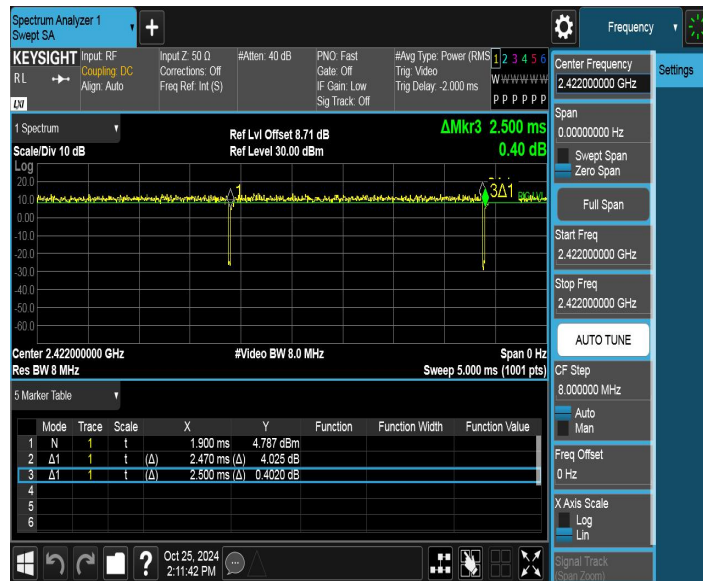
11N20SISO_Ant1_2437



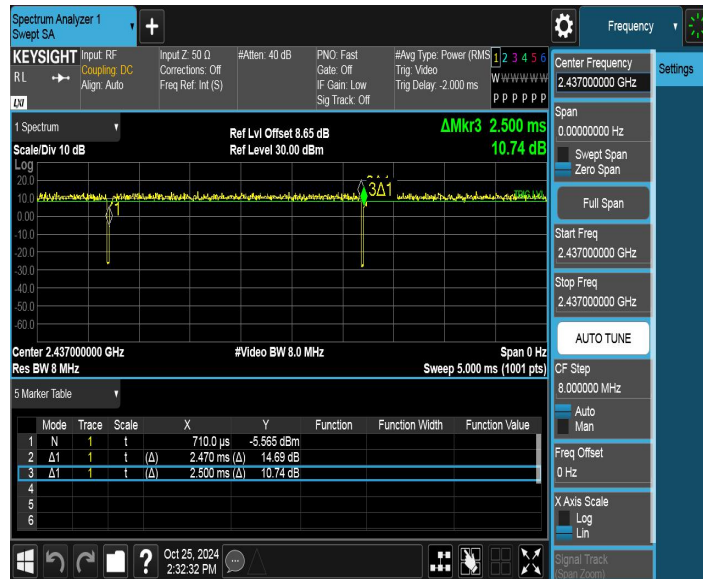
11N20SISO_Ant1_2462



11N40SISO_Ant1_2422



11N40SISO_Ant1_2437



11N40SISO_Ant1_2452



2.5. Description of Test Software

The test utility software used during testing was “EspRFTTestTool_v3.6_Manual.exe”, pre-scan with all the data rates, and the worst case was performed as below:

Test Mode	Data Rate	Channel	*Power Level Setting
802.11b	1 Mbps	Low	24
		Middle	26
		High	30
802.11g	6 Mbps	Low	20
		Middle	20
		High	20
802.11n-HT20	MCS0	Low	14
		Middle	14
		High	14
802.11n-HT40	MCS0	Low	20
		Middle	20
		High	20

2.6. Test Mode

Test Mode	Mode 1: Transmit by 802.11b
	Mode 2: Transmit by 802.11g
	Mode 3: Transmit by 802.11n-HT20
	Mode 4: Transmit by 802.11n-HT40

2.7. Test Configuration

The EUT was tested per the guidance of KDB 558074 D01 v05r02. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing.

2.8. EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and/or no modifications were made during testing.

2.9. EUT Photo

The EUT external photo, internal photo and test setup photo, please refer to the plots in the S202410228157-A1/A2/A3.

2.10. Labeling Requirements

Per 2.1074 & 15.19; Docket 95-19

The label shall be permanently affixed at a conspicuous location on the device; instruction manual or pamphlet supplied to the user and be readily visible to the purchaser at the time of purchase.

However, when the device is so small wherein placement of the label with specified statement is not practical, only the FCC ID must be displayed on the device per Section 15.19(a)(5). Please see attachment for FCC ID label and label location.

2.11. Calculation with all conversion and correction factors used

For AC Line Conducted Emissions Test:

Measure Level (dB μ V) = Reading Level (dB μ V) + Factor (dB)

Factor (dB) = Cable Loss (dB) + LISN Factor (dB)

For Radiated Emissions Below 1GHz Test:

Measure Level (dB μ V/m) = Reading Level (dB μ V) + Factor (dB)

Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m).

For Radiated Emissions Above 1GHz Test:

Measure Level (dB μ V/m) = Reading Level (dB μ V) + Factor (dB)

Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m) - Pre_Amplifier Gain (dB).

3. DESCRIPTION OF TEST

3.1. Evaluation Procedure

The measurement procedures described in the American National Standard for Testing Unlicensed Wireless Devices (ANSI C63.10-2013), and the guidance provided in KDB 558074 D01 v05r02 were used in the measurement of the EUT.

Deviation from measurement procedure.....None

3.2. AC Line Conducted Emissions

The line-conducted facility is located inside an 8'x4'x4' shielded enclosure. A 1m x 2m wooden table 80cm high is placed 40cm away from the vertical wall and 80cm away from the sidewall of the shielded room. Two 10kHz-30MHz, 50Ω/50uH Line-Impedance Stabilization Networks (LISNs) are bonded to the shielded room floor. Power to the LISNs is filtered by external high-current high-insertion loss power line filters. These filters attenuate ambient signal noise from entering the measurement lines. These filters are also bonded to the shielded enclosure.

The EUT is powered from one LISN and the support equipment is powered from the second LISN. All interconnecting cables more than 1 meter were shortened to a 1 meter length by non-inductive bundling (serpentine fashion) and draped over the back edge of the test table. All cables were at least 40cm above the horizontal reference ground-plane. Power cables for support equipment were routed down to the second LISN while ensuring that that cables were not draped over the second LISN.

Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the receiver and exploratory measurements were made to determine the frequencies producing the maximum emission from the EUT. The receiver was scanned from 150kHz to 30MHz. The detector function was set to peak mode for exploratory measurements while the bandwidth of the analyzer was set to 9kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Each emission was also maximized by varying: power lines, the mode of operation or data exchange speed, or support equipment whichever determined the worst-case emission. Once the worst case emissions have been identified, the one EUT cable configuration/arrangement and mode of operation that produced these emissions are used for final measurements on the same test site. The analyzer is set to CISPR quasi-peak and average detectors with a 9kHz resolution bandwidth for final measurements.

An extension cord was used to connect to a single LISN which powered by EUT. The extension cord was calibrated with LISN, the impedance and insertion loss are compliance with the requirements as stated in ANSI C63.10-2013.

3.3. Radiated Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. For measurements above 1GHz absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections. For measurements below 1GHz, the absorbers are removed. The turntable is used for radiated measurement. It is a continuously rotatable, remote controlled, metallic turntable and 2 meters (6.56 ft.) in diameter. The turn table is flush with the raised floor of the chamber in order to maintain its function as a ground plane. An 80cm high PVC support structure is placed on top of the turntable.

For all measurements, the spectrum was scanned through all EUT azimuths and from 1 to 4 meter receive antenna height using a broadband antenna from 30MHz up to the upper frequency shown in 15.33(b)(1) depending on the highest frequency generated or used in the device or on which the device operates or tunes. For frequencies above 1GHz, linearly polarized double ridge horn antennas were used. For frequencies below 30MHz, a calibrated loop antenna was used. When exploratory measurements were necessary, they were performed at 1 meter test distance inside the semi-anechoic chamber using broadband antennas, broadband amplifiers, and spectrum analyzers to determine the frequencies and modes producing the maximum emissions. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The test set-up for frequencies below 1GHz was placed on top of the 0.8 meter high, 1 x 1.5 meter table; and test set-up for frequencies 1-25GHz was placed on top of the 1.5 meter high, 1 x 1.5 meter table. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Appropriate precaution was taken to ensure that all emissions from the EUT were maximized and investigated. The system configuration, clock speed, mode of operation or video resolution, if applicable, turntable azimuth, and receive antenna height was noted for each frequency found.

Final measurements were made in the semi-anechoic chamber using calibrated, linearly polarized broadband and horn antennas. The test setup was configured to the setup that produced the worst case emissions. The spectrum analyzer was set to investigate all frequencies required for testing to compare the highest radiated disturbances with respect to the specified limits. The turntable containing the EUT was rotated through 360 degrees and the height of the receive antenna was varied 1 to 4 meters and stopped at the azimuth and height producing the maximum emission. Each emission was maximized by changing the orientation of the EUT through three orthogonal planes and changing the polarity of the receive antenna, whichever produced the worst-case emissions. According to 3dB Beam-Width of horn antenna, the horn antenna should be always directed to the EUT when rising height.

4. ANTENNA REQUIREMENTS

Excerpt from §15.203 of the FCC Rules/Regulations:

“An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can 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 with the provisions of this section.”

- Use a unique coupling to the intentional radiator.

5. TEST EQUIPMENT CALIBRATION DATE

Conducted Emissions

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
EMI Test Receiver	R&S	ESR3	FWXGJC-2016-181	1 year	2025/03/07
Two-Line V-Network	R&S	ENV 216	FWXGJC-2016-182	1 year	2025/04/28
Thermohygrometer	Yuhuaze	HTC-1	FWXDA-2016-385	1 year	2025/02/25

Radiated Emission

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
Loop Antenna	Schwarzbeck	FMZB 1519B	FWXGJC-2018-015	1 year	2025/03/16
Bi-Log Antenna	R&S	HL562E	FWXGJC-2016-267-06	1 year	2025/07/26
Broadband Horn Antenna	R&S	HF907	FWXGJC-2016-267-07	1 year	2025/03/01
Broadband Horn Antenna	Schwarzbeck	BBHA9170	FWXGJC-2018-016	1 year	2025/07/26
EMI Receiver	R&S	ESR26	FWXGJC-2016-267-01	1 year	2025/07/26
Pre-Amplifier	R&S	SCU-18D	FWXGJC-2016-267-05	1 year	2025/07/23
Pre-Amplifier	R&S	EMC184055 SE	FWXGJC-2018-018	1 year	2025/04/13
Thermohygrometer	Yuhuaze	HTC-1	FWXDA-2016-387	1 year	2025/02/25
Anechoic Chamber	Aimuke	EMCCT-3	FWXGJC-2016-270	3 year	2026/04/05

Conducted Test Equipment

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
EXA Signal Analyzer	Keysight	N9010B	FWXGJC-2018-010	1 year	2025/03/02
RF Control Unit	Toncend	JS0806-2	FWXGJC-2018-013	1 year	2025/05/19
Thermohygrometer	Yuhuaze	HTC-1	FWXDA-2016-385	1 year	2025/02/25

Test Software	Manufacturer	Version	Asset No.	Function
EMI Test Software	tonscend	V3.3.10	/	/
JS32	tonscend	V2.5.2.4	/	/

Auxiliary Equipment

Instrument	Manufacturer	Type No.	Asset No.	Function
Filter	Toncend	ZBSF6	07247867	/
Filter	Toncend	ZHPF6	07233297	/
Attenuator	Toncend	10dB	/	/



RF Cable	Tonscend	T-1	/	/
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