

RF Exposure Lab

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CERTIFICATE OF COMPLIANCE MPE EVALUATION


Intel Corporation
100 Center Point Circle, Suite 200
Columbia, SC 29210

Dates of Test: July 29, 2021
Test Report Number: MPE.20210701

FCC ID:	PD9AX211D2L
IC Certificate:	100M-AX211D2L
Model/HVIN:	AX211D2WL
PMN:	AX211D2WL
Test Sample:	Engineering Unit Same as Production
Equipment Type:	Wireless Module
Classification:	Mobile Transmitter
TX Frequency Range:	2412 – 2462 MHz; 5180 – 5320 MHz; 5500 – 5700 MHz; 5745 – 5825 MHz
Frequency Tolerance:	± 2.5 ppm
Maximum RF Output:	2450 MHz (BT) – 10.50 dB, 2450 MHz (DTS) – 21.00 dB, 5150 MHz (UNII-1) – 21.00 dB, 5250 MHz (UNII-2A) – 21.00 dB, 5600 MHz (UNII-2C) – 21.00 dB, 5800 MHz (UNII-3) – 21.00 dB Conducted
Signal Modulation:	DSSS, OFDM, GFSK
Antenna Type:	Wieson Model ARY121-0009-002-H0; Dipole
Application Type:	Certification
KDB Test Methodology:	KDB 447498 D01 v06
FCC Rule Parts:	47 CFR 1.1310 & 47 CFR 2.1091
Industry Canada:	RSS-102 Issue 5, Safety Code 6
Maximum Power Density Value:	0.0824 mW/cm ² (FCC); 0.824 W/m ² (IC)
Maximum E-Field Value:	N/A V/m (FCC); 17.63 V/m (IC)
Maximum H-Field Value:	N/A A/m (FCC); 0.05 A/m (IC)
Maximum Simultaneous PD Ratio:	0.165 (FCC); 0.169 (IC)
Maximum Simultaneous E-Field Ratio:	N/A V/m (FCC); 0.582 (IC)
Maximum Simultaneous H-Field Ratio:	N/A A/m (FCC); 0.626 (IC)
Separation Distance:	20 cm

This wireless mobile and/or portable device has been shown to be compliant for RF exposure requirements for uncontrolled environment/general exposure limits specified in 47 CFR 1.1310, 47 CFR 2.1091 and RSS-102 Issue 5 (See test report).

I attest to the accuracy of the data. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.



Jay M. Moulton
Vice President



Certificate # 2387.01

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Comment/Revision	Date
Original Release	July 20, 2021

Note: The latest version supersedes all previous versions listed in the above table. The latest version shall be used.

1. Introduction

This measurement report shows compliance of the Intel Corporation Model AX211D2WL Wireless Module with Wison Dipole Model ARY121-0009-002-H0.

2. Characteristics of the Evaluation

2.1 Requirements and Methods

RF exposure assessment of the Intel Corporation Model AX211D2WL Wireless Module with Wison Dipole Model ARY121-0009-002-H0.

Requirements	Frequency Bands
47 CFR 1.1310 Radio Frequency (RF) Radiation Exposure Limits & 47 CFR 2.1091 Radio Frequency Radiation Exposure Evaluation: Mobile Device.	2400 – 2480 MHz (BT) 2412 – 2462 MHz (DTS) 5150 – 5250 MHz (UNII-1) 5250 – 5350 MHz (UNII-2A) 5470 – 5725 MHz (UNII-2C) 5725 – 5825 MHz (UNII-3)
RSS-102 Issue 5 Radio Frequency (RF) Exposure Compliance of Radio communication Apparatus (All Frequency Bands)	2400 – 2480 MHz (BT) 2412 – 2462 MHz (DTS) 5150 – 5250 MHz (UNII-1) 5250 – 5350 MHz (UNII-2A) 5470 – 5725 MHz (UNII-2C) 5725 – 5825 MHz (UNII-3)

3. Data Supplied by the Applicant

3.1 Applicant

Name/Company: Steven C. Hackett, Intel Corporation
Address: 100 Center Point Circle, Suite 200
City/State/Zip Code: Columbia, SC 29210
Country: USA
Email: steven.c.hackett@intel.com

3.2 Canadian Representative

Name/Company: Elaine Mah, Intel Canada Ltd.
Company No.: 1000T
Address: 150 Bloor Street W, Suite 400
City/State/Zip Code: Toronto, Ontario M5S 2X9
Country: Canada
Email: elaine.mah@intel.com

3.3 Identification of Item Evaluated

Product: Wireless Module with Wison Dipole Model ARY121-0009-002-H0
Model: AX211D2WL
Manufacturer: Intel Corporation

4. Evaluation Results

Abbreviations used in the RESULTS column of the following tables are:

C	Compliant with requirements
NC	Not Compliant with requirements
NA	Not Applicable
NE	Not Evaluated

Document/Standard	Results
47 CFR 1.1310 Radio Frequency (RF) Radiation Exposure Limits & 47 CFR 2.1091 Radio Frequency Radiation Exposure Evaluation: Mobile Device.	C
RSS-102 Radio Frequency (RF) Exposure Compliance of Radio communication Apparatus (All Frequency Bands)	C

5. Summary

Considering the results of the performed analysis and evaluation, stated in Appendix A and B, the item under evaluation is **IN COMPLIANCE** with the specifications listed in Section 2.1 "Requirements and Methods".

Appendix A

Host Analysis

A.1. Device

The device is in a mobile exposure condition (antenna-to-user distance ≥ 20 cm).

Main/Primary Transmitter:

WLAN Transmitter:

Type of Equipment: : Wireless Module
Model: : AX211D2WL
Antennas Evaluated: : Wieson Dipole Model ARY121-0009-002-H0
Cable Use for Evaluation: : AR9851-0009-005-H0
Minimum Cable Loss: : 50 ohm Coaxial 1.1 mm diameter 12 cm in length. The loss is included in the gain values below.
Maximum gain (Ant – Cable) : 2450 MHz – 3.10 dBi
5150-5250 MHz – 4.11 dBi
5250-5350 MHz – 4.11 dBi
5470-5725 MHz – 5.17 dBi
5725-5825 MHz – 5.17 dBi
Output power : 2450 MHz (BT) – 10.50 dBm
2450 MHz (DTS) – 21.00 dBm
5150-5250 MHz – 21.00 dBm
5250-5350 MHz – 21.00 dBm
5470-5725 MHz – 21.00 dBm
5725-5825 MHz – 21.00 dBm

Frequency Band	Mode	Frequency Range (MHz)	Maximum Conducted output power (dBm)	Maximum Conducted output power (mW)	Duty Cycle	Equivalent conducted output power (mW)	Maximum antenna gain (dBi)	Maximum antenna gain (numerical)	EIRP (mW)
2450 MHz	BT	2400-2480	10.50	11.2	100%	11.2	3.10	2.04	22.85
2450 MHz	DTS	2412-2462	21.00	125.9	100%	125.9	3.10	2.04	256.84
5150 MHz	UNII-1	5150-5250	21.00	125.9	100%	125.9	4.11	2.58	324.82
5250 MHz	UNII-2A	5250-5350	21.00	125.9	100%	125.9	4.11	2.58	324.82
5600 MHz	UNII-2C	5470-5725	21.00	125.9	100%	125.9	5.17	3.29	414.21
5800 MHz	UNII-3	5725-5825	21.00	125.9	100%	125.9	5.17	3.29	414.21

Worst Case Considerations:

- Minimum Antenna-to-user distance: 20 cm
 - Any antenna-to-user distance > 20 cm would be covered by the analysis included in this report as far as it would provide better exposure conditions.
- Maximum Antenna gains:
 - 2450 MHz – 3.10 dBi
 - 5150-5250 MHz – 4.11 dBi
 - 5250-5350 MHz – 4.11 dBi
 - 5470-5725 MHz – 5.17 dBi
 - 5725-5825 MHz – 5.17 dBi
 - Any antenna gains below the specified would be covered by the analysis included in this report as far as it would provide better exposure conditions.

Appendix B

RF Exposure Assessment

B.1 Maximum Permissible Exposure (MPE) Limits

B.1.1 FCC MPE Limits

Normative document:

- 47 CFR 1.1310 Radio Frequency (RF) Radiation Exposure Limits & 47 CFR 2.1091 Radio Frequency Radiation Exposure Evaluation: Mobile Device.

Reference levels:

The table below is excerpted from Table 1 of 47 CFR 1.1310 Radio Frequency (RF) Radiation Exposure Limits:

Frequency Range (MHz)	E-field strength (V/m)	H-field strength (A/m)	Power Density (S) (mW/cm ²)	Averaging Time (minutes)
0.3-1.34	614	1.63	100	<30
1.34-30	842/f	2.19/f	180/f ²	<30
30-300	27.5	0.073	0.2	<30
300-1,500	--	--	f/1500	<30
1,00-100,000	--	--	1.0	<30

Note: f is frequency in MHz.

MPE limits:

Frequency Band	Mode	Frequency Range (MHz)	Reference frequency (MHz)	MPE limit S _{eq} (mW/cm ²)	E-Field Strength (V/m)	H-Field Strength (A/m)
2450 MHz	BT	2400-2480	2480	1.0	--	--
2450 MHz	DTS	2412-2462	2462	1.0	--	--
5150 MHz	UNII-1	5150-5250	5250	1.0	--	--
5250 MHz	UNII-2A	5250-5350	5350	1.0	--	--
5600 MHz	UNII-2C	5470-5725	5725	1.0	--	--
5800 MHz	UNII-3	5725-5825	5825	1.0	--	--

B.2 Maximum Permissible Exposure (MPE) Limits

B.2.1 IC MPE Limits

Normative document:

- RSS-102 Radio Frequency (RF) Exposure Compliance of Radio communication Apparatus (All Frequency Bands)

Reference levels:

The table below is excerpted from Table 6 of RSS-102 Issue 5 Radio Frequency (RF) Exposure Compliance of Radio communication Apparatus (All Frequency Bands):

Frequency Range (MHz)	E-field strength (V/m)	H-field strength (A/m)	Power Density (S) (W/m ²)	Averaging Time (minutes)
0.003-10 ²³	83	90	--	Instantaneous
0.1-10	--	0.73/f	--	6
1.29-10	87/f ^{0.5}	--	--	6
10-20	27.46	0.0728	2	6
20-48	58.07/f ^{0.25}	0.1540/f ^{0.25}	8.944/f ^{0.5}	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142f ^{0.3417}	0.008335f ^{0.3417}	0.02619f ^{0.6834}	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/f ^{1.2}
150000-300000	0.158f ^{0.5}	4.21x10 ⁻⁴ f ^{0.5}	6.67x10 ⁻⁵ f	616000/f ^{1.2}

Note: f is frequency in MHz.

MPE limits:

Frequency Band	Mode	Frequency Range (MHz)	Reference frequency (MHz)	MPE limit S _{eq} (mW/cm ²)	E-Field Strength (V/m)	H-Field Strength (A/m)
2450 MHz	BT	2400-2480	2480	5.47	45.40	0.12
2450 MHz	DTS	2412-2462	2462	5.44	45.29	0.12
5150 MHz	UNII-1	5150-5250	5250	9.13	58.67	0.16
5250 MHz	UNII-2A	5250-5350	5350	9.25	59.05	0.16
5600 MHz	UNII-2C	5470-5725	5725	9.69	60.43	0.16
5800 MHz	UNII-3	5725-5825	5825	9.80	60.79	0.16

B.3 RF Exposure Assessment – Individual Transmitters

B.3.1 Introduction

Calculations to predict power density levels in the far-field of the antenna are made by use of the following equation:

$$S = \frac{P \bullet G}{4\pi R^2} = \frac{EIRP}{4\pi R^2}$$

where: S = power density (in appropriate units, e.g. mW/cm²)

P = power input to the antenna (in appropriate units, e.g. mW)

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna (in appropriate units, e.g. cm)

B.3.2 RF Exposure Assessment for AX211D2WL Wireless Module

FCC Requirements

Frequency Band	Mode	Frequency Range (MHz)	EIRP (mW)	Evaluation distance (R) (cm)	Power Density (S _{eq}) $S = \frac{P \bullet G}{4\pi R^2} = \frac{EIRP}{4\pi R^2}$ (mW/cm ²)	MPE limit (S _{lim}) (mW/cm ²)	Compliance (S _{eq} < S _{lim}) (mW/cm ²)
2450 MHz	BT	2400-2480	22.85	20	0.005	1.0	COMPLIANT
2450 MHz	DTS	2412-2462	256.84	20	0.051	1.0	COMPLIANT
5150 MHz	UNII-1	5150-5250	324.82	20	0.0646	1.0	COMPLIANT
5250 MHz	UNII-2A	5250-5350	324.82	20	0.0646	1.0	COMPLIANT
5600 MHz	UNII-2C	5470-5725	414.21	20	0.0824	1.0	COMPLIANT
5800 MHz	UNII-3	5725-5825	414.21	20	0.0824	1.0	COMPLIANT

B.4 RF Exposure Assessment – Individual Transmitters

B.4.1 Introduction

Calculations to predict power density levels in the far-field of the antenna are made by use of the following equation:

$$S = \frac{P \cdot G}{4\pi R^2} = \frac{EIRP}{4\pi R^2}$$

where: S = power density (in appropriate units, e.g. W/m²)

P = power input to the antenna (in appropriate units, e.g. mW)

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna (in appropriate units, e.g. cm)

B.4.2 RF Exposure Assessment for AX211D2WL Wireless Module

IC Requirements

Frequency Band	Mode	Frequency Range (MHz)	EIRP (mW)	Evaluation distance (R) (cm)	Power Density (S _{eq}) $S = \frac{P \cdot G}{4\pi R^2} = \frac{EIRP}{4\pi R^2}$ (W/m ²)	MPE limit (S _{lim}) (W/m ²)	Compliance (S _{eq} < S _{lim}) (mW/cm ²)
2450 MHz	BT	2400-2480	22.85	20	0.045	5.47	COMPLIANT
2450 MHz	DTS	2412-2462	256.84	20	0.512	5.44	COMPLIANT
5150 MHz	UNII-1	5150-5250	324.82	20	0.646	9.13	COMPLIANT
5250 MHz	UNII-2A	5250-5350	324.82	20	0.646	9.25	COMPLIANT
5600 MHz	UNII-2C	5470-5725	414.21	20	0.824	9.69	COMPLIANT
5800 MHz	UNII-3	5725-5825	414.21	20	0.824	9.80	COMPLIANT

Frequency Band	Mode	Frequency Range (MHz)	EIRP (mW)	Evaluation distance (R) (cm)	E-Field Strength (V/m)	MPE limit	Compliance
2450 MHz	BT	2400-2480	22.85	20	4.12	45.40	COMPLIANT
2450 MHz	DTS	2412-2462	256.84	20	13.89	45.29	COMPLIANT
5150 MHz	UNII-1	5150-5250	324.82	20	15.61	58.67	COMPLIANT
5250 MHz	UNII-2A	5250-5350	324.82	20	15.61	59.05	COMPLIANT
5600 MHz	UNII-2C	5470-5725	414.21	20	17.63	60.43	COMPLIANT
5800 MHz	UNII-3	5725-5825	414.21	20	17.63	60.79	COMPLIANT

Frequency Band	Mode	Frequency Range (MHz)	EIRP (mW)	Evaluation distance (R) (cm)	H-Field Strength (A/m)	MPE limit	Compliance
2450 MHz	BT	2400-2480	22.85	20	0.01	0.12	COMPLIANT
2450 MHz	DTS	2412-2462	256.84	20	0.04	0.12	COMPLIANT
5150 MHz	UNII-1	5150-5250	324.82	20	0.04	0.16	COMPLIANT
5250 MHz	UNII-2A	5250-5350	324.82	20	0.04	0.16	COMPLIANT
5600 MHz	UNII-2C	5470-5725	414.21	20	0.05	0.16	COMPLIANT
5800 MHz	UNII-3	5725-5825	414.21	20	0.05	0.16	COMPLIANT

B.5 RF Exposure Assessment – Simultaneous Evaluation

B.5.1 Introduction

Calculations to predict power density levels in the far-field of the antenna are made by use of the following equation:

$$S = \frac{P \bullet G}{4\pi R^2} = \frac{EIRP}{4\pi R^2}$$

where: S = power density (in appropriate units, e.g. mW/cm²)

P = power input to the antenna (in appropriate units, e.g. mW)

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna (in appropriate units, e.g. cm)

B.5.2 RF Exposure Assessment for AX211D2WL Wireless Module

FCC Requirements

The module supports MIMO. The two antennas can transmit simultaneously. To assess the worst case simultaneous transmission, the sum of the two highest bands were added together. If the sum of the two bands are less than the limit, the simultaneous evaluation is compliant.

Each band was evaluated to the limit and the ratio to the limit was used to calculate the simultaneous value. The sum of the 2 antennas ratio must be less than 1 to pass.

The table below shows the 2 highest ratios for the AX211D2WL Wireless Module with Wieson Dipole Model ARY121-0009-002-H0 antenna.

Frequency Band	Mode	Frequency Range (MHz)	Power Density (S _{eq}) $S = \frac{P \bullet G}{4\pi R^2} = \frac{EIRP}{4\pi R^2}$ (W/m ²)	MPE limit (S _{lim}) (W/m ²)	Ratio	Sum of all the Ratios	Compliance
5600 MHz	UNII-2C	5470-5725	0.0824	1.0	0.0824	0.165	COMPLIANT
5800 MHz	UNII-3	5725-5825	0.0824	1.0	0.0824		

B.6 RF Exposure Assessment – Simultaneous Evaluation

B.6.1 Introduction

Calculations to predict power density levels in the far-field of the antenna are made by use of the following equation:

$$S = \frac{P \cdot G}{4\pi R^2} = \frac{EIRP}{4\pi R^2}$$

where: S = power density (in appropriate units, e.g. mW/cm²)

P = power input to the antenna (in appropriate units, e.g. mW)

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna (in appropriate units, e.g. cm)

B.6.2 RF Exposure Assessment for AX211D2WL Wireless Module

IC Requirements

The module supports MIMO. The two antennas can transmit simultaneously. To assess the worst case simultaneous transmission, the sum of the two highest bands was added together. If the sum of the two bands are less than the limit, the simultaneous evaluation is compliant.

Each band was evaluated to the limit and the ratio to the limit was used to calculate the simultaneous value. The sum of the 2 antennas ratio must be less than 1 to pass.

Frequency Band	Mode	Frequency Range (MHz)	Power Density (S _{eq}) $S = \frac{P \cdot G}{4\pi R^2} = \frac{EIRP}{4\pi R^2}$ (W/m ²)	MPE limit (S _{lim}) (W/m ²)	Ratio	Sum of all the Ratios	Compliance
5600 MHz	UNII-2C	5470-5725	0.824	9.69	0.085	0.169	COMPLIANT
5800 MHz	UNII-3	5725-5825	0.824	9.80	0.084		

For the E-Field and H-Field simultaneous evaluation, each band was evaluated to the limit and the ratio to the limit was used to calculate the simultaneous value. The sum of the 2 antennas ratio must be less than 1 to pass.

Frequency Band	Mode	Frequency Range (MHz)	E-Field Strength (V/m)	MPE limit	Ratio	Sum of all the Ratios	Compliance
5600 MHz	UNII-2C	5470-5725	17.63	60.43	0.292	0.582	COMPLIANT
5800 MHz	UNII-3	5725-5825	17.63	60.79	0.290		

Frequency Band	Mode	Frequency Range (MHz)	H-Field Strength (V/m)	MPE limit	Ratio	Sum of all the Ratios	Compliance
5600 MHz	UNII-2C	5470-5725	0.05	0.16	0.313	0.626	COMPLIANT
5800 MHz	UNII-3	5725-5825	0.05	0.16	0.313		

Appendix C

Antenna Photo

