# **Exposure Calculation Report**

Apple Inc. Model: A2615

# In accordance with FCC CFR 47 Part 1.1310 and Canada Safety Code 6

Prepared for: Apple Inc

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# **COMMERCIAL-IN-CONFIDENCE**

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## SIGNATURE

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#### **EXECUTIVE SUMMARY**

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The calculation of exposure for this product was found to be compliant at a minimum distance of 20 cm with FCC CFR 47 Part 1.1310 and Canada safety Code 6 assuming continuous exposure of 6 minutes or more. If alternative antennas are used with greater gains, the distance must be recalculated.

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# Contents

| 1       | Report Summary                            | 2          |
|---------|---|------------|
| 1.1     | Report Modification Record                | 2          |
| 1.2     | Introduction                              | 2          |
| 1.3     | Brief Summary of Results                  | 3          |
| 1.4     | Product Information                       | 4          |
| 2       | Assessment Details                        | 5          |
| 2.1     | Assessment Method                         | 5          |
| 2.2     | Individual Antenna Port Exposure Results  |            |
| 2.3     | Combined Antenna Port RF Exposure Results |            |
| 2.4     | Far Field Region Boundary Results         |            |
| 2.5     | Uncertainty                               |            |
| Annex A | Regional Requirements                     | <b>A.2</b> |



#### **Report Summary** 1

#### 1.1 **Report Modification Record**

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

| Issue | Description of Change | Date of Issue    |
|-------|-----------------------|------------------|
| 1     | First Issue           | 04 February 2022 |

#### Table 1

#### 1.2 Introduction

Applicant Apple Inc Manufacturer Apple Inc A2615 Model Number(s) Hardware Version(s) **Rev 1.0** Software Version(s) 21C23

 FCC 47 CFR Part 1.1310: 2021 Specification/Issue/Date

• ISED Canada: Health Canada Safety Code 6:2015

Order Number 0540220896 Date 20.05.21

Related Document(s) • FCC 47 CFR Part 1.1307: 2021

> OET65:97 Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic **Fields**

• IEEE C95.3:2002 IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields with Respect to Human Exposure to Such Fields, 100 kHz-300 GHz



#### 1.3 Brief Summary of Results

The wireless device described within this report was compliant with the restrictions related to human exposure to electromagnetic fields for both general public and worker/occupational exposures at the minimum compliance distances calculated.

The calculations shown in this report were made in accordance with the procedures specified in the applied test specification(s).

#### 1.3.1 Compliance Boundary

| Regional<br>Reguirement | Configuration                          | Calculated minimum compliance boundary (m) (rounded up to nearest 0.1 m) |                |  |
|-------------------------|--|--|----------------|--|
| Requirement             |  | Worker/Occupational  | General Public |  |
| FCC                     | 5.0 GHz WLAN + 2.4GHz WLAN             | 0.2  | 0.2            |  |
| FCC                     | 5.0 GHz WLAN + Bluetooth               | 0.2  | 0.2            |  |
| FCC                     | 5.0 GHz WLAN + 2.4GHz WLAN + Bluetooth | 0.2  | 0.2            |  |
| CANADA                  | 5.0 GHz WLAN + 2.4GHz WLAN             | 0.2  | 0.2            |  |
| CANADA                  | 5.0 GHz WLAN + Bluetooth               | 0.2  | 0.2            |  |
| CANADA                  | 5.0 GHz WLAN + 2.4GHz WLAN + Bluetooth | 0.2  | 0.2            |  |

Table 2 - Compliance Boundary Calculation Results

Note: The calculated minimum compliance distances were less than that stated in Table 2, however the assessment method of RF exposure calculation described in Section 2 is applicable only to separation distances of 0.2 m or more, therefore a minimum separation distance of 0.2 m is required.



#### 1.4 Product Information

#### 1.4.1 Technical Description

The Equipment Under Test (EUT) was a desktop computer with Bluetooth, Bluetooth Low Energy and 802.11 a/b/g/n/ac/ax WLAN capabilities in the 2.4 GHz and 5 GHz bands.

#### 1.4.2 Transmitter Description

The following radio access technologies and frequency bands are supported by the equipment under test.

| Radio Access<br>Technology | Antenna Port | Frequency Band<br>(MHz) | Minimum Frequency<br>(MHz) | Output Power (dBm) | Duty Cycle (%) |
|----------------------------|--------------|-------------------------|----------------------------|--------------------|----------------|
| Bluetooth                  | 1            | 2402-2480               | 2402.0                     | 16.00              | 100.0          |
| 2.4GHz WLAN                | 1            | 2412-2472               | 2412.0                     | 22.50              | 100.0          |
| 5.0GHz WLAN                | 1            | 5180-5825               | 5180.0                     | 21.00              | 100.0          |

**Table 3 – Transmitter Description** 

Note: Transmitter power includes upper bounds of uncertainty therefore maximum values are used in accordance with Section 2.5.

### 1.4.3 Antenna Description

The following antennas are supported by the equipment under test.

| Antenna No | Radio Access Technology | Antenna Model | Gain (dBi) | Antenna length (cm) |
|------------|-------------------------|---------------|------------|---------------------|
| 1          | Bluetooth/2.4GHz WLAN   | WF1           | 2.2        | 6.82                |
| 1          | 5.0GHz WLAN             | WF1           | 3.3        | 6.82                |
| 2          | Bluetooth/2.4GHz WLAN   | WF2           | 1.4        | 6.82                |
| 2          | 5.0GHz WLAN             | WF2           | 0.14       | 6.82                |
| 3          | Bluetooth               | WF3           | 1.7        | 6.82                |

Table 4 - Antenna description

In the case of more than one type of antenna being supported by the equipment, the calculation is based on the maximum of the antenna gains. If other antennas can be used that have greater gains, the minimum separation distances will need to be recalculated.

Note: Antenna gain includes upper bounds of uncertainty therefore maximum values are used in accordance with Section 2.5.

## 1.4.4 Equipment Configuration

Scenario 1 - 5.0 GHz WLAN + 2.4GHz WLAN

Scenario 2 - 5.0 GHz WLAN + Bluetooth

Scenario 3 - 5.0 GHz WLAN + 2.4GHz WLAN + Bluetooth



#### 2 Assessment Details

#### 2.1 Assessment Method

The assessment method is by calculation of the power density S, electric field strength E, magnetic field strength H or magnetic flux density B.

The calculation uses the spherical model applicable under far field conditions.

$$S = E \times H = \frac{E^2}{\eta} = H^2 \times \eta = \frac{P \times G_i}{4 \times \pi \times r^2}$$

Where:

η - Impedance of free space (377 ohm in far field)

P - Average transmitter power W (Pav = Pmax x Duty Cycle)

Gi – Antenna gain ratio relative to isotropic

r - Separation distance m

The magnetic flux density is related to the magnetic field strength by a constant:

$$B = \mu_o \times H$$

Where:

 $\mu_0$  – Permeability of free space 4 x  $\pi$  E-7 H/m

This assessment assumes that exposure is continuous for 6 minutes or more in accordance with the averaging time required by the exposure standards at the stated minimum compliance boundary separation distance. Exposures of less than 6 minutes at other separation distances are not addressed by this report.

This assessment method of RF exposure is applicable to separation distances of 20 cm or more. Separation distances of less than 20 cm require a Specific Absorption Rate (SAR) assessment.

The far field region boundary depends on the frequency and wavelength and also on the antenna dimension. The boundary of the far field region is calculated below to demonstrate the validity of using the spherical model.

The result is compared to the limits in Annex A to determine compliance or to calculate the required compliance distance. The calculation is based on the lowest frequency in each band as the most onerous requirement as the limits increase with frequency for frequencies above 10-50 MHz (dependent on region).



#### 2.2 Individual Antenna Port Exposure Results

#### 2.2.1 Calculation of Compliance Distance

The frequencies shown in the tables below have been chosen based on the lowest possible frequency that the EUT can transmit. A full list of the regional requirements is shown in Annex A.

| Degional                | Antenna |                | Fraguenav          | Minimum Calo       | num Calculated Compliance Boundary (m) at Limit for: |         |         |  |
|-------------------------|---------|----------------|--------------------|--------------------|--|---------|---------|--|
| Regional<br>Requirement | Port    | RAT            | Frequency<br>(MHz) | S Power<br>Density | E Field  | H Field | B Field |  |
| FCC                     | 1       | Bluetooth      | 2402.0             | 0.0103             | N/A  | N/A     | N/A     |  |
| FCC                     | 1       | 2.4GHz<br>WLAN | 2412.0             | 0.0217             | N/A  | N/A     | N/A     |  |
| FCC                     | 1       | 5.0GHz<br>WLAN | 5180.0             | 0.0207             | N/A  | N/A     | N/A     |  |
| CANADA                  | 1       | Bluetooth      | 2402.0             | 0.0129             | 0.0129   | 0.0129  | N/A     |  |
| CANADA                  | 1       | 2.4GHz<br>WLAN | 2412.0             | 0.0272             | 0.0272   | 0.0272  | N/A     |  |
| CANADA                  | 1       | 5.0GHz<br>WLAN | 5180.0             | 0.0215             | 0.0215   | 0.0215  | N/A     |  |

Table 5 – Calculation of Compliance Distance Worker/Occupational

The calculations show that the EUT complies with the worker/occupational exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.0272 m. However the assessment method of RF exposure calculation described in Section 2 is applicable only to separation distances of 0.2 m or more, therefore a minimum separation distance of 0.2 m is required.

| Danianal                | Antonno         |                | F                   | Minimum Calc | ulated Compliar | nce Boundary (r | n) at Limit for: |
|-------------------------|-----------------|----------------|---------------------|--------------|-----------------|-----------------|------------------|
| Regional<br>Requirement | Antenna<br>Port | RAT            | RAT Frequency (MHz) |              | E Field         | H Field         | B Field          |
| FCC                     | 1               | Bluetooth      | 2402.0              | 0.0229       | N/A             | N/A             | N/A              |
| FCC                     | 1               | 2.4GHz<br>WLAN | 2412.0              | 0.0485       | N/A             | N/A             | N/A              |
| FCC                     | 1               | 5.0GHz<br>WLAN | 5180.0              | 0.0463       | N/A             | N/A             | N/A              |
| CANADA                  | 1               | Bluetooth      | 2402.0              | 0.0313       | 0.0313          | 0.0313          | N/A              |
| CANADA                  | 1               | 2.4GHz<br>WLAN | 2412.0              | 0.0662       | 0.0662          | 0.0662          | N/A              |
| CANADA                  | 1               | 5.0GHz<br>WLAN | 5180.0              | 0.0487       | 0.0487          | 0.0487          | N/A              |

Table 6 – Calculation of Compliance Distance General Public

The calculations show that the EUT complies with the general public exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.0662 m. However the assessment method of RF exposure calculation described in Section 2 is applicable only to separation distances of 0.2 m or more, therefore a minimum separation distance of 0.2 m is required.



The following table shows the regional requirements for the frequencies used in the RF exposure calculation. A full list of the requirements is shown in Annex A.

|                         |                    | Worker/Occupational Limit    |                  |                  |                 | General Public Limit         |                  |                  |                 |
|-------------------------|--------------------|------------------------------|------------------|------------------|-----------------|------------------------------|------------------|------------------|-----------------|
| Regional<br>Requirement | Frequency<br>(MHz) | S Power<br>Density<br>(W/m²) | E Field<br>(V/m) | H Field<br>(A/m) | B Field<br>(μT) | S Power<br>Density<br>(W/m²) | E Field<br>(V/m) | H Field<br>(A/m) | B Field<br>(μT) |
| FCC                     | 2402               | 50.00                        | N/A              | N/A              | N/A             | 10.00                        | N/A              | N/A              | N/A             |
| FCC                     | 2412               | 50.00                        | N/A              | N/A              | N/A             | 10.00                        | N/A              | N/A              | N/A             |
| FCC                     | 5180               | 50.00                        | N/A              | N/A              | N/A             | 10.00                        | N/A              | N/A              | N/A             |
| CANADA                  | 2402               | 31.64                        | 109.21           | 0.2897           | N/A             | 5.35                         | 44.91            | 0.1191           | N/A             |
| CANADA                  | 2412               | 31.70                        | 109.32           | 0.2900           | N/A             | 5.37                         | 44.97            | 0.1193           | N/A             |
| CANADA                  | 5180               | 46.46                        | 132.34           | 0.3511           | N/A             | 9.05                         | 58.40            | 0.1549           | N/A             |

Table 7 - Limits

#### 2.3 Combined Antenna Port RF Exposure Results

As the frequency of operation for each transmitter is not the same, in order to evaluate compliance with the limit which is dependent on frequency, the fractional exposure value is calculated: The calculated S power density is divided by the limit to get a fractional exposure value. The calculated E and H fields are divided by the limit and squared to get a fractional exposure value. The summation of the fractional RF exposure results for each transmitter provides the combined result. Any values less than one are compliant with the limit. The compliance boundary distance has been calculated to ensure the summation is ≤1.

Calculations are made on an Excel spreadsheet and numbers may not add up exactly due to rounding.



#### 2.3.1 Configuration 1 – 5.0 GHz WLAN + 2.4GHz WLAN

FCC OET 65 specifies the method of summation in clause; Multiple-Transmitter Sites and Complex Environments; with results as follows:

|  | Antenna<br>Port RAT Frequ |                 | Calculated RF exposure level at minimum compliance boundary 0.0300 m as a fraction of the limit |            |         |         |
|--|---------------------------|-----------------|---|------------|---------|---------|
|  |                           | Frequency (MHz) | S Power<br>Density  | E Field    | H Field | B Field |
|  |                           |                 | Summa   | e to be <1 |         |         |
| 1  | 2.4GHz WLAN               | 2412.0          | 0.5219  | N/A        | N/A     | N/A     |
| 1  | 5.0GHz WLAN               | 5180.0          | 0.4760  | N/A        | N/A     | N/A     |
| Summation         0.9979         N/A         N/A         N/A |                           |                 |   |            | N/A     |         |

Table 8 - FCC Worker/Occupational Combined Exposure

The calculations show that the EUT complies with the worker/occupational exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.0300 m. However the assessment method of RF exposure calculation described in Section 2Error! Reference source not found. is applicable only to separation distances of 0.2 m or more, therefore a minimum separation distance of 0.2 m is required.

|                 |             |                 |   | exposure level at 0.0670 m as a f | minimum complia<br>raction of the limit |         |
|-----------------|-------------|-----------------|---|-----------------------------------|---|---------|
| Antenna<br>Port | RAT         | Frequency (MHz) | S Power<br>Density                                  | E Field                           | H Field                                 | B Field |
|                 |             |                 | Summation for simultaneous exposure; value to be <1 |                                   |   |         |
| 1               | 2.4GHz WLAN | 2412.0          | 0.5229  | N/A                               | N/A                                     | N/A     |
| 1               | 5.0GHz WLAN | 5180.0          | 0.4768  | N/A                               | N/A                                     | N/A     |
|                 |             | Summation       | 0.9997  | N/A                               | N/A                                     | N/A     |

Table 9 - FCC General Public Combined Exposure

The calculations show that the EUT complies with the general public exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.0670 m. However the assessment method of RF exposure calculation described in Section 2Error!

Reference source not found. is applicable only to separation distances of 0.2 m or more, therefore a minimum separation distance of 0.2 m is required.



CANADA Health Canada Safety Code 6 specifies the method of summation in clause 2.2.1 Note 6 with results as follows:

|                 |                                    |        | Calculated RF exposure level at minimum compliance boundary of 0.0347 m as a fraction of the limit |         |         |         |  |
|-----------------|------------------------------------|--------|--|---------|---------|---------|--|
| Antenna<br>Port | I RAI   Frequency (MHz)            |        | S Power<br>Density   | E Field | H Field | B Field |  |
|                 |                                    |        | Summation for simultaneous exposure; value to be <1  |         |         |         |  |
| 1               | 2.4GHz WLAN                        | 2412.0 | 0.6152   | 0.6152  | 0.6152  | N/A     |  |
| 1               | 5.0GHz WLAN                        | 5180.0 | 0.3829   | 0.3829  | 0.3829  | N/A     |  |
|                 | Summation 0.9981 0.9981 0.9981 N/A |        |  |         |         |         |  |

Table 10 – CANADA Worker/Occupational Combined Exposure

The calculations show that the EUT complies with the worker/occupational exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.0347 m. However the assessment method of RF exposure calculation described in Section 2 is applicable only to separation distances of 0.2 m or more, therefore a minimum separation distance of 0.2 m is required.

|                                    |             |                 |   | Calculated RF exposure level at minimum compliance boundary of 0.0821 m as a fraction of the limit |         |         |  |
|------------------------------------|-------------|-----------------|---|--|---------|---------|--|
| Antenna<br>Port                    | RAT         | Frequency (MHz) | S Power<br>Density                                  | E Field  | H Field | B Field |  |
|                                    |             |                 | Summation for simultaneous exposure; value to be <1 |  |         |         |  |
| 1                                  | 2.4GHz WLAN | 2412.0          | 0.6487  | 0.6488   | 0.6487  | N/A     |  |
| 1                                  | 5.0GHz WLAN | 5180.0          | 0.3509  | 0.3509   | 0.3509  | N/A     |  |
| Summation 0.9996 0.9997 0.9996 N/A |             |                 |   |  |         | N/A     |  |

Table 11 – CANADA General Public Combined Exposure

The calculations show that the EUT complies with the general public exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.0821 m. However the assessment method of RF exposure calculation described in Section 2 is applicable only to separation distances of 0.2 m or more, therefore a minimum separation distance of 0.2 m is required.



#### 2.3.2 Configuration 2 – 5.0 GHz WLAN + Bluetooth

FCC OET 65 specifies the method of summation in clause; Multiple-Transmitter Sites and Complex Environments; with results as follows:

|                 |             |                 | Calculated RF exposure level at minimum compliance boundary of 0.0231 m as a fraction of the limit |         |         |         |  |
|-----------------|-------------|-----------------|--|---------|---------|---------|--|
| Antenna<br>Port | RAT         | Frequency (MHz) | S Power<br>Density   | E Field | H Field | B Field |  |
|                 |             |                 | Summation for simultaneous exposure; value to be <1  |         |         |         |  |
| 1               | Bluetooth   | 2402.0          | 0.1971   | N/A     | N/A     | N/A     |  |
| 1               | 5.0GHz WLAN | 5180.0          | 0.8028   | N/A     | N/A     | N/A     |  |
| Summation       |             | 0.9998          | N/A  | N/A     | N/A     |         |  |

**Table 12 - FCC Worker/Occupational Combined Exposure** 

The calculations show that the EUT complies with the worker/occupational exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.0231 m. However the assessment method of RF exposure calculation described in Section 2 is applicable only to separation distances of 0.2 m or more, therefore a minimum separation distance of 0.2 m is required.

|                 |             |                 | Calculated RF exposure level at minimum compliance boundary of 0.0517 m as a fraction of the limit |         |         |         |  |
|-----------------|-------------|-----------------|--|---------|---------|---------|--|
| Antenna<br>Port | RAT         | Frequency (MHz) | S Power<br>Density   | E Field | H Field | B Field |  |
|                 |             |                 | Summation for simultaneous exposure; value to be <1  |         |         |         |  |
| 1               | Bluetooth   | 2402.0          | 0.1971   | N/A     | N/A     | N/A     |  |
| 1               | 5.0GHz WLAN | 5180.0          | 0.8029   | N/A     | N/A     | N/A     |  |
|                 |             | Summation       | 1.0000   | N/A     | N/A     | N/A     |  |

Table 13 - FCC General Public Combined Exposure

The calculations show that the EUT complies with the general public exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.0517 m. However the assessment method of RF exposure calculation described in Section 2 is applicable only to separation distances of 0.2 m or more, therefore a minimum separation distance of 0.2 m is required.



CANADA Health Canada Safety Code 6 specifies the method of summation in clause 2.2.1 Note 6 with results as follows:

|                 |             |                 | Calculated RF exposure level at minimum compliance boundary of 0.0251 m as a fraction of the limit |         |         |         |  |
|-----------------|-------------|-----------------|--|---------|---------|---------|--|
| Antenna<br>Port | RAT         | Frequency (MHz) | S Power<br>Density   | E Field | H Field | B Field |  |
|                 |             |                 | Summation for simultaneous exposure; value to be <1  |         |         |         |  |
| 1               | Bluetooth   | 2402.0          | 0.2648   | 0.2648  | 0.2648  | N/A     |  |
| 1               | 5.0GHz WLAN | 5180.0          | 0.7347   | 0.7347  | 0.7347  | N/A     |  |
|                 |             | Summation       | 0.9996   | 0.9995  | 0.9995  | N/A     |  |

Table 14 – CANADA Worker/Occupational Combined Exposure

The calculations show that the EUT complies with the worker/occupational exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.0251 m. However the assessment method of RF exposure calculation described in Section 2 is applicable only to separation distances of 0.2 m or more, therefore a minimum separation distance of 0.2 m is required.

|                 |             | Calculated RF exposure level at minimum compliance boundary of 0.0579 m as a fraction of the limit |   |         |         |         |  |
|-----------------|-------------|--|---|---------|---------|---------|--|
| Antenna<br>Port | RAT         | Frequency (MHz)  | S Power<br>Density                                  | E Field | H Field | B Field |  |
|                 |             |  | Summation for simultaneous exposure; value to be <1 |         |         |         |  |
| 1               | Bluetooth   | 2402.0   | 0.2931  | 0.2931  | 0.2931  | N/A     |  |
| 1               | 5.0GHz WLAN | 5180.0   | 0.7062  | 0.7063  | 0.7062  | N/A     |  |
| Summation       |             | 0.9993   | 0.9994  | 0.9993  | N/A     |         |  |

Table 15 – CANADA General Public Combined Exposure

The calculations show that the EUT complies with the general public exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.0579 m. However the assessment method of RF exposure calculation described in Section 2 is applicable only to separation distances of 0.2 m or more, therefore a minimum separation distance of 0.2 m is required.



#### 2.3.3 Configuration 3 – 5.0 GHz WLAN + 2.4GHz WLAN + Bluetooth

FCC OET 65 specifies the method of summation in clause; Multiple-Transmitter Sites and Complex Environments; with results as follows:

|                 |             |                 | Calculated RF exposure level at minimum compliance boundary of 0.0317 m as a fraction of the limit |         |         |         |  |
|-----------------|-------------|-----------------|--|---------|---------|---------|--|
| Antenna<br>Port | RAT         | Frequency (MHz) | S Power<br>Density   | E Field | H Field | B Field |  |
|                 |             |                 | Summation for simultaneous exposure, value to be <1  |         |         |         |  |
| 1               | Bluetooth   | 2402.0          | 0.1046   | N/A     | N/A     | N/A     |  |
| 1               | 2.4GHz WLAN | 2412.0          | 0.4674   | N/A     | N/A     | N/A     |  |
| 1               | 5.0GHz WLAN | 5180.0          | 0.4263   | N/A     | N/A     | N/A     |  |
| Summation       |             | 0.9983          | N/A  | N/A     | N/A     |         |  |

**Table 16 - FCC Worker/Occupational Combined Exposure** 

The calculations show that the EUT complies with the worker/occupational exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.0317 m. However the assessment method of RF exposure calculation described in Section 2 is applicable only to separation distances of 0.2 m or more, therefore a minimum separation distance of 0.2 m is required.

|                 |             |                 | Calculated RF exposure level at minimum compliance boundary of 0.0708 m as a fraction of the limit |         |         |         |  |
|-----------------|-------------|-----------------|--|---------|---------|---------|--|
| Antenna<br>Port | RAT         | Frequency (MHz) | S Power<br>Density   | E Field | H Field | B Field |  |
|                 |             |                 | Summation for simultaneous exposure; value to be <1  |         |         |         |  |
| 1               | Bluetooth   | 2402.0          | 0.1048   | N/A     | N/A     | N/A     |  |
| 1               | 2.4GHz WLAN | 2412.0          | 0.4680   | N/A     | N/A     | N/A     |  |
| 1               | 5.0GHz WLAN | 5180.0          | 0.4268   | N/A     | N/A     | N/A     |  |
| Summation       |             | 0.9996          | N/A  | N/A     | N/A     |         |  |

Table 17 – FCC General Public Combined Exposure

The calculations show that the EUT complies with the general public exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.0708 m. However the assessment method of RF exposure calculation described in Section 2 is applicable only to separation distances of 0.2 m or more, therefore a minimum separation distance of 0.2 m is required.



CANADA Health Canada Safety Code 6 specifies the method of summation in clause 2.2.1 Note 6 with results as follows:

|                 |             |                 | Calculated RF exposure level at minimum compliance boundary of 0.0370 m as a fraction of the limit |         |         |         |  |
|-----------------|-------------|-----------------|--|---------|---------|---------|--|
| Antenna<br>Port | RAT         | Frequency (MHz) | S Power<br>Density   | E Field | H Field | B Field |  |
|                 |             |                 | Summation for simultaneous exposure; value to be <1  |         |         |         |  |
| 1               | Bluetooth   | 2402.0          | 0.1214   | 0.1214  | 0.1214  | N/A     |  |
| 1               | 2.4GHz WLAN | 2412.0          | 0.5411   | 0.5411  | 0.5411  | N/A     |  |
| 1               | 5.0GHz WLAN | 5180.0          | 0.3368   | 0.3367  | 0.3368  | N/A     |  |
| Summation       |             | 0.9993          | 0.9992   | 0.9993  | N/A     |         |  |

Table 18 - CANADA Worker/Occupational Combined Exposure

The calculations show that the EUT complies with the worker/occupational exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.0370 m. However the assessment method of RF exposure calculation described in Section 2 is applicable only to separation distances of 0.2 m or more, therefore a minimum separation distance of 0.2 m is required.

|                 |             |                 | Calculated RF exposure level at minimum compliance boundary of 0.0879 m as a fraction of the limit |         |         |         |  |
|-----------------|-------------|-----------------|--|---------|---------|---------|--|
| Antenna<br>Port | RAT         | Frequency (MHz) | S Power<br>Density   | E Field | H Field | B Field |  |
|                 |             |                 | Summation for simultaneous exposure; value to be <1  |         |         |         |  |
| 1               | Bluetooth   | 2402.0          | 0.1271   | 0.1271  | 0.1271  | N/A     |  |
| 1               | 2.4GHz WLAN | 2412.0          | 0.5662   | 0.5663  | 0.5662  | N/A     |  |
| 1               | 5.0GHz WLAN | 5180.0          | 0.3063   | 0.3063  | 0.3063  | N/A     |  |
|                 |             | Summation       | 0.9996   | 0.9997  | 0.9996  | N/A     |  |

Table 19 – CANADA General Public Combined Exposure

The calculations show that the EUT complies with the general public exposure levels described in in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.0879 m. However the assessment method of RF exposure calculation described in Section 2 is applicable only to separation distances of 0.2 m or more, therefore a minimum separation distance of 0.2 m is required.



### 2.4 Far Field Region Boundary Results

The far field region boundary calculation result is shown in Table 20:

| (Ref: FCC 1.13 | Near Field / Far Field Boundary (Ref: FCC 1.1307(b)(3)(i)(C), Technical Guide for Interpretation and Compliance Assessment of Health Canada's Radiofrequency Exposure Guidelines 7.1) |   |                                       |  |  |  |  |  |
|----------------|---|---|---------------------------------------|--|--|--|--|--|
| RAT Name       | Frequency MHz   | Reactive Near Field Boundary (Wave Impedance Dependent) | Far Field Boundary (Antennas on axis) |  |  |  |  |  |
|                | . ,   | λ/2π (m)  | 2D²/λ (m)                             |  |  |  |  |  |
| Bluetooth      | 2402.0  | 0.0199  | 0.0745                                |  |  |  |  |  |
| 2.4GHz WLAN    | 2412.0  | 0.0198  | 0.0748                                |  |  |  |  |  |
| 5.0GHz WLAN    | 5180.0  | 0.0092  | 0.1606                                |  |  |  |  |  |

Table 20 - Far Field Boundary (FCC, CANADA)

The table below shows the maximum calculated near field / far field region boundaries.

The compliance boundary of 0.2 m is in the far field region and therefore, the approach described in section 2.1 is valid.

| Field Region                    | Reactive Near Field Region  | Radiating Near Field Region                        | Far Field Region      |
|---------------------------------|---|--|-----------------------|
| Maximum Boundary                | <0.0199 m   | 0.0199 m – 0.1606 m                                | > 0.1606 m            |
| Validity of Regions             | Spherical model potential under-estimate: SAR assessment required | Spherical model over-<br>estimate and conservative | Spherical model valid |
| Compliance Boundary<br>Location | N/A   | N/A  | 0.2 m                 |

Table 21 - Assessment Method Validity

#### 2.5 Uncertainty

The basic computation formulas presented in section 2.1 are conservative formulas for the estimation of RF field strength or power density.

No uncertainty estimations are required when using these formulas but there is clear guidance on where and when these formulas are applicable. For the estimate of S, E or H to be conservative, the transmitter power P and antenna gain  $G_i$  values shall be the upper bounds of uncertainty therefore maximum values are used.

The spherical formula is valid under far field conditions which are established in section 2.4.



### **ANNEX A**

## **REGIONAL REQUIREMENTS**



| Frequency Range (MHz) | Power Density (mW/cm²)<br>Note 1 | Electric Field Strength (V/m) | Magnetic Field Strength (A/m) |
|-----------------------|----------------------------------|-------------------------------|-------------------------------|
| 0 - 0.3               | -                                | -                             | -                             |
| 0.3 - 3               | 100                              | 614                           | 1.63                          |
| 3 - 30                | 900/f^2                          | 1842/f                        | 4.89/f                        |
| 30 - 300              | 1                                | 61.4                          | 0.163                         |
| 300 - 1500            | f/300                            | -                             | -                             |
| 1500 - 100000         | 5                                | -                             | -                             |

Table A.1 – FCC CFR 47 Pt.1.1310 Worker/Occupational Limits

| Frequency Range (MHz) | Power Density (mW/cm²)<br>Note 1 | Electric Field Strength (V/m) | Magnetic Field Strength (A/m) |
|-----------------------|----------------------------------|-------------------------------|-------------------------------|
| 0 - 0.3               | -                                | -                             | -                             |
| 0.3 - 3               | 100                              | 614                           | 1.63                          |
| 3 - 30                | 180/f^2                          | 824/f                         | 2.19/f                        |
| 30 - 300              | 0.2                              | 27.5                          | 0.073                         |
| 300 - 1500            | f/1500                           | -                             | -                             |
| 1500 - 100000         | 1                                | -                             | -                             |

Table A.2 - FCC CFR 47 Pt.1.1310 General Public Limits

Note 1: The calculations and limits presented in this report for power density are in units of  $W/m^2$ . The conversion factor is; 1  $mW/cm^2 = 10 W/m^2$ .

| Frequency Range (MHz) | Power Density (W/m²) | Electric Field Strength (V/m) | Magnetic Field Strength (A/m) |
|-----------------------|----------------------|-------------------------------|-------------------------------|
| 10 - 20               | 10                   | 61.4                          | 0.163                         |
| 20 - 48               | 44.72/f^0.5          | 129.8/f^0.25                  | 0.3444/f^0.25                 |
| 48 - 100              | 6.455                | 49.33                         | 0.1309                        |
| 100 - 6000            | 0.6455*f^0.5         | 15.60*f^0.25                  | 0.04138*f^0.25                |
| 6000 - 150000         | 50                   | 137                           | 0.364                         |

Table A.3 – Health Canada Safety Code 6 Worker/Occupational Limits

| Frequency Range (MHz) | Power Density (W/m²) | Electric Field Strength (V/m) | Magnetic Field Strength (A/m) |
|-----------------------|----------------------|-------------------------------|-------------------------------|
| 10 - 20               | 2                    | 27.46                         | 0.0728                        |
| 20 - 48               | 8.944/f^0.5          | 58.07/f^0.25                  | 0.1540/f^0.25                 |
| 48 - 300              | 1.291                | 22.06                         | 0.05852                       |
| 300 - 6000            | 0.02619*f^0.6834     | 3.142*f^0.3417                | 0.008335*f^0.3417             |
| 6000 - 15000          | 10                   | 61.4                          | 0.163                         |

Table A.4 – Health Canada Safety Code 6 General Public Limits