

# Exposure Calculation Report

SECO S.p.A.

Wireless Network Device, Model: SYS-C60-LMC1

In accordance with EN 62311, FCC CFR 47 Pt  
1.1310, Health Canada Safety Code 6



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## COMMERCIAL-IN-CONFIDENCE

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### SIGNATURE

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### EXECUTIVE SUMMARY

The calculation of exposure for this product was found to be compliant at 20 cm with EN 62311, FCC CFR 47 Pt.1.1310 and Health 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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# 1 Report Summary

## 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	20 July 2021

**Table 1**

## 1.2 Introduction

Applicant	La Marzocco
Manufacturer	SECO S.p.A.
Model Number(s)	SYS-C60-LMC1
Hardware Version(s)	SYS-C60-LMC1
Software Version(s)	HEDGEHOG 1.0
Specification/Issue/Date	<ul style="list-style-type: none"> <li>• EN 50665:2017 Generic standard for assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz)</li> <li>• FCC 47 CFR Part 1.1310: 2018</li> <li>• ISED Canada: Health Canada Safety Code 6:2015</li> </ul>
Order Number	42000627551
Date	08-July-2021
Related Document(s)	<ul style="list-style-type: none"> <li>• EN 62311:2008 Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz to 300 GHz)</li> <li>• Directive 2013/35/EU on minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields).</li> <li>• European Council Recommendation 1999/519/EC of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz), Official Journal, L199, of 1999-7-30, p.59-70.</li> <li>• OET65:97 Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields</li> <li>• 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</li> <li>• RSS-102 Issue 5 Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)</li> </ul>



### 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.

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

#### 1.3.1 Configuration 1 - Single transmitters

Regional Requirement	Radio Access Technology	Calculated RF exposure level at minimum compliance boundary of 0.2 m							
		S Power Density (W/m <sup>2</sup> )		E Field (V/m)		H Field (A/m)		B Field (μT)	
		Result	Limit	Result	Limit	Result	Limit	Result	Limit
EN	WI-FI 2.4 GHz	0.20	N/A	8.66	140.00	0.0230	N/A	0.0289	0.4500
EN	WI-FI 5 GHz	0.18	N/A	8.27	140.00	0.0219	N/A	0.0276	0.4500
EN	GSM 900	1.50	N/A	23.77	88.99	0.0630	N/A	0.0792	0.2966
EN	DCS 1800	0.57	N/A	14.65	124.06	0.0389	N/A	0.0488	0.4135
EN	WCDMA FDD 8	1.20	N/A	21.26	88.99	0.0564	N/A	0.0709	0.2966
EN	WCDMA FDD 1	1.01	N/A	19.48	131.45	0.0517	N/A	0.0649	0.4382
EN	LTE FDD 1	1.01	N/A	19.48	131.45	0.0517	N/A	0.0649	0.4382
EN	LTE FDD 3	0.67	N/A	15.94	124.06	0.0423	N/A	0.0531	0.4135
EN	LTE FDD 8	1.20	N/A	21.26	88.99	0.0564	N/A	0.0709	0.2966
EN	LTE FDD 20	1.01	N/A	19.50	86.53	0.0517	N/A	0.0650	0.2884
EN	LTE FDD 28	0.85	N/A	17.89	79.54	0.0474	N/A	0.0596	0.2651
EN	LTE TDD 38	0.67	N/A	15.94	140.00	0.0423	N/A	0.0531	0.4500
EN	Bluetooth	0.20	N/A	8.66	140.00	0.0230	N/A	0.0289	0.4500
FCC	WI-FI 2.4 GHz	0.20	50.00	8.66	N/A	0.0230	N/A	0.0289	N/A
FCC	WI-FI 5 GHz	0.18	50.00	8.27	N/A	0.0219	N/A	0.0276	N/A
FCC	GSM 850	1.26	27.47	21.80	N/A	0.0578	N/A	0.0727	N/A
FCC	GSM 1900	0.77	50.00	17.02	N/A	0.0451	N/A	0.0567	N/A
FCC	WCDMA FDD 5	1.01	27.53	19.50	N/A	0.0517	N/A	0.0650	N/A
FCC	LTE FDD 4	0.67	50.00	15.94	N/A	0.0423	N/A	0.0531	N/A
FCC	LTE FDD 12	0.85	23.30	17.89	N/A	0.0474	N/A	0.0596	N/A
FCC	Bluetooth	0.20	50.00	8.66	N/A	0.0230	N/A	0.0289	N/A
Canada	WI-FI 2.4 GHz	0.20	31.70	8.66	109.32	0.0230	0.2900	0.0289	N/A
Canada	WI-FI 5 GHz	0.18	46.46	8.27	132.34	0.0219	0.3511	0.0276	N/A
Canada	GSM 850	1.26	18.53	21.80	83.58	0.0578	0.2217	0.0727	N/A
Canada	GSM 1900	0.77	27.76	17.02	102.31	0.0451	0.2714	0.0567	N/A
Canada	WCDMA FDD 5	1.01	18.55	19.50	83.63	0.0517	0.2218	0.0650	N/A
Canada	LTE FDD 4	0.67	32.28	15.94	110.31	0.0423	0.2926	0.0531	N/A
Canada	LTE FDD 7	0.85	17.07	17.89	80.21	0.0474	0.2128	0.0596	N/A



Canada	LTE FDD 12	0.67	32.72	15.94	111.07	0.0423	0.2946	0.0531	N/A
Canada	LTE TDD 38	0.20	31.64	8.66	109.21	0.0230	0.2897	0.0289	N/A
Canada	Bluetooth	0.20	31.70	8.66	109.32	0.0230	0.2900	0.0289	N/A

**Table 2 – Worker/Occupational Exposure Results**

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 of 0.2 m.

Regional Requirement	Radio Access Technology	Calculated RF exposure level at minimum compliance boundary of 0.2 m							
		S Power Density (W/m <sup>2</sup> )		E Field (V/m)		H Field (A/m)		B Field (µT)	
		Result	Limit	Result	Limit	Result	Limit	Result	Limit
EN	WI-FI 2.4 GHz	0.20	N/A	8.66	140.00	0.0230	N/A	0.0289	0.4500
EN	WI-FI 5 GHz	0.18	N/A	8.27	140.00	0.0219	N/A	0.0276	0.4500
EN	GSM 900	1.50	N/A	23.77	88.99	0.0630	N/A	0.0792	0.2966
EN	DCS 1800	0.57	N/A	14.65	124.06	0.0389	N/A	0.0488	0.4135
EN	WCDMA FDD 8	1.20	N/A	21.26	88.99	0.0564	N/A	0.0709	0.2966
EN	WCDMA FDD 1	1.01	N/A	19.48	131.45	0.0517	N/A	0.0649	0.4382
EN	LTE FDD 1	1.01	N/A	19.48	131.45	0.0517	N/A	0.0649	0.4382
EN	LTE FDD 3	0.67	N/A	15.94	124.06	0.0423	N/A	0.0531	0.4135
EN	LTE FDD 8	1.20	N/A	21.26	88.99	0.0564	N/A	0.0709	0.2966
EN	LTE FDD 20	1.01	N/A	19.50	86.53	0.0517	N/A	0.0650	0.2884
EN	LTE FDD 28	0.85	N/A	17.89	79.54	0.0474	N/A	0.0596	0.2651
EN	LTE TDD 38	0.67	10.00	15.94	61.00	0.0423	0.1600	0.0531	0.2000
EN	Bluetooth	0.20	N/A	8.66	140.00	0.0230	N/A	0.0289	0.4500
FCC	WI-FI 2.4 GHz	0.20	50.00	8.66	N/A	0.0230	N/A	0.0289	N/A
FCC	WI-FI 5 GHz	0.18	50.00	8.27	N/A	0.0219	N/A	0.0276	N/A
FCC	GSM 850	1.26	5.49	21.80	N/A	0.0578	N/A	0.0727	N/A
FCC	GSM 1900	0.77	50.00	17.02	N/A	0.0451	N/A	0.0567	N/A
FCC	WCDMA FDD 5	1.01	5.51	19.50	N/A	0.0517	N/A	0.0650	N/A
FCC	LTE FDD 4	0.67	50.00	15.94	N/A	0.0423	N/A	0.0531	N/A
FCC	LTE FDD 12	0.85	23.30	17.89	N/A	0.0474	N/A	0.0596	N/A
FCC	Bluetooth	0.20	50.00	8.66	N/A	0.0230	N/A	0.0289	N/A
Canada	WI-FI 2.4 GHz	0.20	5.37	8.66	44.97	0.0230	0.1193	0.0289	N/A
Canada	WI-FI 5 GHz	0.18	9.05	8.27	58.40	0.0219	0.1549	0.0276	N/A
Canada	GSM 850	1.26	2.58	21.80	31.16	0.0578	0.0827	0.0727	N/A
Canada	GSM 1900	0.77	4.48	17.02	41.08	0.0451	0.1090	0.0567	N/A
Canada	WCDMA FDD 5	1.01	2.58	19.50	31.18	0.0517	0.0827	0.0650	N/A
Canada	LTE FDD 4	0.67	5.50	15.94	45.53	0.0423	0.1208	0.0531	N/A
Canada	LTE FDD 7	0.85	2.30	17.89	29.46	0.0474	0.0781	0.0596	N/A
Canada	LTE FDD 12	0.67	5.60	15.94	45.96	0.0423	0.1219	0.0531	N/A



Canada	LTE TDD 38	0.20	5.35	8.66	44.91	0.0230	0.1191	0.0289	N/A
Canada	Bluetooth	0.20	5.37	8.66	44.97	0.0230	0.1193	0.0289	N/A

**Table 3 – General Public Exposure Results**

The calculations show that the EUT complies with the general public exposure levels described in the listed specifications in Annex A at the point of investigation, a minimum of 0.2 m.

**1.3.1 Configuration 2 - Multiple transmitters**

Regional Requirement	Radio Access Technology	Calculated RF exposure level at minimum compliance boundary of 0.2 m as a fraction of the limit			
		S Power Density	E Field	H Field	B Field
		Summation for simultaneous exposure; value to be <1			
EN	WI-FI 2.4 GHz	N/A	0.0038	N/A	0.0041
EN	WI-FI 5 GHz	N/A	0.0035	N/A	0.0038
EN	GSM 900	N/A	0.0713	N/A	0.0713
EN	DCS 1800	N/A	0.0140	N/A	0.0140
EN	WCDMA FDD 8	N/A	0.0571	N/A	0.0571
EN	WCDMA FDD 1	N/A	0.0220	N/A	0.0220
EN	LTE FDD 1	N/A	0.0220	N/A	0.0220
EN	LTE FDD 3	N/A	0.0165	N/A	0.0165
EN	LTE FDD 8	N/A	0.0571	N/A	0.0571
EN	LTE FDD 20	N/A	0.0508	N/A	0.0508
EN	LTE FDD 28	N/A	0.0506	N/A	0.0506
EN	LTE TDD 38	N/A	0.0130	N/A	0.0139
EN	Bluetooth	N/A	0.0038	N/A	0.0041
FCC	WI-FI 2.4 GHz	0.0040	N/A	N/A	N/A
FCC	WI-FI 5 GHz	0.0036	N/A	N/A	N/A
FCC	GSM 850	0.0459	N/A	N/A	N/A
FCC	GSM 1900	0.0154	N/A	N/A	N/A
FCC	WCDMA FDD 5	0.0366	N/A	N/A	N/A
FCC	LTE FDD 4	0.0135	N/A	N/A	N/A
FCC	LTE FDD 12	0.0364	N/A	N/A	N/A
FCC	Bluetooth	0.0040	N/A	N/A	N/A
Canada	WI-FI 2.4 GHz	0.0063	0.0063	0.0063	N/A
Canada	WI-FI 5 GHz	0.0039	0.0039	0.0039	N/A
Canada	GSM 850	0.0680	0.0680	0.0680	N/A
Canada	GSM 1900	0.0277	0.0277	0.0277	N/A
Canada	WCDMA FDD 5	0.0544	0.0544	0.0544	N/A
Canada	LTE FDD 4	0.0253	0.0253	0.0253	N/A
Canada	LTE FDD 7	0.0209	0.0209	0.0209	N/A



Canada	LTE FDD 12	0.0497	0.0497	0.0497	N/A
Canada	LTE TDD 38	0.0206	0.0206	0.0206	N/A
Canada	Bluetooth	0.0063	0.0063	0.0063	N/A

**Table 4 – Worker/Occupational Exposure Results**

The calculations show that the EUT complies with the worker/occupational exposure levels described in the listed specifications in Annex A at the point of investigation, a minimum of 0.2 m.

Regional Requirement	Radio Access Technology	Calculated RF exposure level at minimum compliance boundary of 0.2 m as a fraction of the limit			
		S Power Density	E Field	H Field	B Field
		Summation for simultaneous exposure; value to be <1			
EN	WI-FI 2.4 GHz	0.0199	0.0202	0.0206	0.0208
EN	WI-FI 5 GHz	0.0181	0.0184	0.0188	0.0190
EN	GSM 900	0.3406	0.3395	0.3299	0.3371
EN	DCS 1800	0.0666	0.0664	0.0646	0.0659
EN	WCDMA FDD 1	0.1048	0.1045	0.1016	0.1037
EN	WCDMA FDD 8	0.2724	0.2716	0.2639	0.2696
EN	LTE FDD 1	0.1048	0.1045	0.1016	0.1037
EN	LTE FDD 3	0.0788	0.0786	0.0764	0.0780
EN	LTE FDD 8	0.2724	0.2716	0.2639	0.2696
EN	LTE FDD 20	0.2425	0.2417	0.2349	0.2400
EN	LTE FDD 28	0.2414	0.2407	0.2339	0.2390
EN	LTE TDD 38	0.0674	0.0683	0.0698	0.0706
EN	Bluetooth	0.0199	0.0202	0.0206	0.0208
FCC	WI-FI 2.4 GHz	0.0199	N/A	N/A	N/A
FCC	WI-FI 5 GHz	0.0181	N/A	N/A	N/A
FCC	GSM 850	0.2295	N/A	N/A	N/A
FCC	GSM 1900	0.0768	N/A	N/A	N/A
FCC	WCDMA FDD 5	0.1832	N/A	N/A	N/A
FCC	LTE FDD 4	0.0674	N/A	N/A	N/A
FCC	LTE FDD 12	0.1821	N/A	N/A	N/A
FCC	Bluetooth	0.0199	N/A	N/A	N/A
Canada	WI-FI 2.4 GHz	0.0371	0.0371	0.0371	N/A
Canada	WI-FI 5 GHz	0.0201	0.0201	0.0201	N/A
Canada	GSM 850	0.4895	0.4896	0.4895	N/A
Canada	GSM 1900	0.1717	0.1717	0.1717	N/A
Canada	WCDMA FDD 5	0.3910	0.3910	0.3910	N/A
Canada	LTE FDD 4	0.1589	0.1589	0.1589	N/A
Canada	LTE FDD 7	0.1226	0.1226	0.1226	N/A



Canada	LTE FDD 12	0.3687	0.3688	0.3687	N/A
Canada	LTE TDD 28	0.1203	0.1203	0.1203	N/A
Canada	Bluetooth	0.0372	0.0372	0.0372	N/A

**Table 5 – General Public Exposure Results**

The calculations show that the EUT complies with the general public exposure levels described in the listed specifications in Annex A at the point of investigation, a minimum of 0.2 m.





**1.4 Product Information**

**1.4.1 Technical Description**

Wireless Network device equipped with one Dual-Band Module–Wi-Fi, Bluetooth, and Bluetooth Low Energy (LE) and one LTE, WCDMA, GSM module.

**1.4.2 Transmitter Description**

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

Radio Access Technology	Antenna Port	Frequency Band (MHz)	Minimum Frequency (MHz)	Output Power (dBm)	Duty Cycle (%)
2.4 GHz WI-FI	1 & 2	2412 - 2484	2412	17.3	100.0
5 GHz WI-FI	1 & 2	5150 - 5825	5180	18.0	100.0
GSM 850	3	824 -849	824	35.0	12.5
GSM 900	3	880 - 915	880	35.0	12.5
DCS 1800	3	1710-1788	1710	32.0	12.5
GSM 1900	3	1850 - 1910	1850	32.0	12.5
WCDMA FDD 1	3	1920 - 1980	1920	25.0	100.0
WCDMA FDD 5	3	826 -847	826	25.0	100.0
WCDMA FDD 8	3	880 - 915	880	25.0	100.0
LTE FDD 1	3	1920 - 1980	1920	25.0	100.0
LTE FDD 3	3	1710 - 1785	1710	25.0	100.0
LTE FDD 4	3	1710 - 1755	1710	25.0	100.0
LTE FDD 7	3	2500 - 2570	2500	25.0	100.0
LTE FDD 8	3	880 - 915	880	25.0	100.0
LTE FDD 12	3	699 - 716	699	25.0	100.0
LTE FDD 20	3	832 - 862	832	25.0	100.0
LTE FDD 28	3	703 – 748	703	25.0	100.0
LTE TDD 38	3	2570 - 2620	2570	25.0	100.0
Bluetooth	1	2402 - 2480	2402	17.3	100.0

**Table 6 – 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 Port	Radio Access Technology	Antenna Model	Gain (dBi)	Antenna length (cm)
1 & 2	2.4 GHz WI-FI	Dynaflex 814_1000RG316_SMMRP	2.7	100.0
1 & 2	5 GHz WI-FI	Dynaflex 814_1000RG316_SMMRP	1.6	100.0
3	GSM-835	Dynaflex 814_1000RG316_SMMRP	2.05	100.0
3	GSM 900	Dynaflex 814_1000RG316_SMMRP	2.8	100.0
3	DCS 1800	Dynaflex 814_1000RG316_SMMRP	1.6	100.0
3	GSM 1900	Dynaflex 814_1000RG316_SMMRP	2.9	100.0
3	WCDMA FDD 1	Dynaflex 814_1000RG316_SMMRP	2.04	100.0
3	WCDMA FDD 5	Dynaflex 814_1000RG316_SMMRP	2.05	100.0
3	WCDMA FDD 8	Dynaflex 814_1000RG316_SMMRP	2.8	100.0
3	LTE FDD 1	Dynaflex 814_1000RG316_SMMRP	2.04	100.0
3	LTE FDD 3	Dynaflex 814_1000RG316_SMMRP	0.3	100.0
3	LTE FDD 4	Dynaflex 814_1000RG316_SMMRP	0.3	100.0
3	LTE FDD 7	Dynaflex 814_1000RG316_SMMRP	0.3	100.0
3	LTE FDD 8	Dynaflex 814_1000RG316_SMMRP	2.8	100.0
3	LTE FDD 12	Dynaflex 814_1000RG316_SMMRP	1.3	100.0
3	LTE FDD 20	Dynaflex 814_1000RG316_SMMRP	2.05	100.0
3	LTE FDD 28	Dynaflex 814_1000RG316_SMMRP	1.3	100.0
3	LTE TDD 38	Dynaflex 814_1000RG316_SMMRP	0.3	100.0
1	Bluetooth	Dynaflex 814_1000RG316_SMMRP	2.7	100.0

**Table 7 – 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

Simultaneous transmission of Cellular Technologies and Wi-Fi or 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:

$\eta$  - Impedance of free space (377 ohm in far field)

$P$  – Average transmitter power W ( $P_{av} = P_{max} \times \text{Duty Cycle}$ )

$G_i$  – 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:

$\mu_o$  – Permeability of free space  $4 \times \pi \text{ E-7 H/m}$

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 Exposure at Specified Separation 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.

Regional Requirement	Antenna Port	RAT	Frequency (MHz)	RF Exposure Level at minimum compliance boundary of 0.2 m							
				S Power Density (W/m <sup>2</sup> )		E Field (V/m)		H Field (A/m)		B Field (µT)	
				Result	Limit	Result	Limit	Result	Limit	Result	Limit
EN	1 & 2	WI-FI 2.4 GHz	2412.0	0.20	N/A	8.66	140.00	0.0230	N/A	0.0289	0.4500
EN	1 & 2	WI-FI 5 GHz	5180.0	0.18	N/A	8.27	140.00	0.0219	N/A	0.0276	0.4500
EN	3	GSM 900	880.0	1.50	N/A	23.77	88.99	0.0630	N/A	0.0792	0.2966
EN	3	DCS 1800	1710.0	0.57	N/A	14.65	124.06	0.0389	N/A	0.0488	0.4135
EN	3	WCDMA FDD 8	880.0	1.20	N/A	21.26	88.99	0.0564	N/A	0.0709	0.2966
EN	3	WCDMA FDD 1	1920.0	1.01	N/A	19.48	131.45	0.0517	N/A	0.0649	0.4382
EN	3	LTE FDD 1	1920.0	1.01	N/A	19.48	131.45	0.0517	N/A	0.0649	0.4382
EN	3	LTE FDD 3	1710.0	0.67	N/A	15.94	124.06	0.0423	N/A	0.0531	0.4135
EN	3	LTE FDD 8	880.0	1.20	N/A	21.26	88.99	0.0564	N/A	0.0709	0.2966
EN	3	LTE FDD 20	832.0	1.01	N/A	19.50	86.53	0.0517	N/A	0.0650	0.2884
EN	3	LTE FDD 28	703.0	0.85	N/A	17.89	79.54	0.0474	N/A	0.0596	0.2651
EN	3	LTE TDD 38	2570.0	0.67	N/A	15.94	140.00	0.0423	N/A	0.0531	0.4500
EN	1	Bluetooth	2402.0	0.20	N/A	8.66	140.00	0.0230	N/A	0.0289	0.4500
FCC	1 & 2	WI-FI 2.4 GHz	2412.0	0.20	50.00	8.66	N/A	0.0230	N/A	0.0289	N/A
FCC	1 & 2	WI-FI 5 GHz	5180.0	0.18	50.00	8.27	N/A	0.0219	N/A	0.0276	N/A
FCC	3	GSM 850	824.0	1.26	27.47	21.80	N/A	0.0578	N/A	0.0727	N/A
FCC	3	GSM 1900	1850.0	0.77	50.00	17.02	N/A	0.0451	N/A	0.0567	N/A
FCC	3	WCDMA FDD 8	826.0	1.01	27.53	19.50	N/A	0.0517	N/A	0.0650	N/A
FCC	3	LTE FDD 4	1710.0	0.67	50.00	15.94	N/A	0.0423	N/A	0.0531	N/A
FCC	3	LTE FDD 12	699.0	0.85	23.30	17.89	N/A	0.0474	N/A	0.0596	N/A
FCC	1	Bluetooth	2402.0	0.20	50.00	8.66	N/A	0.0230	N/A	0.0289	N/A
Canada	1 & 2	WI-FI 2.4 GHz	2412.0	0.20	31.70	8.66	109.32	0.0230	0.2900	0.0289	N/A
Canada	1 & 2	WI-FI 5 GHz	5180.0	0.18	46.46	8.27	132.34	0.0219	0.3511	0.0276	N/A
Canada	3	GSM 850	824.0	1.26	18.53	21.80	83.58	0.0578	0.2217	0.0727	N/A
Canada	3	GSM 1900	1850.0	0.77	27.76	17.02	102.31	0.0451	0.2714	0.0567	N/A
Canada	3	WCDMA FDD 5	826.0	1.01	18.55	19.50	83.63	0.0517	0.2218	0.0650	N/A
Canada	3	LTE FDD 4	1710.0	0.67	32.28	15.94	110.31	0.0423	0.2926	0.0531	N/A
Canada	3	LTE FDD 7	2500.0	0.85	17.07	17.89	80.21	0.0474	0.2128	0.0596	N/A
Canada	3	LTE FDD 12	699.0	0.67	32.72	15.94	111.07	0.0423	0.2946	0.0531	N/A
Canada	3	LTE TDD 38	2570.0	0.20	31.64	8.66	109.21	0.0230	0.2897	0.0289	N/A



Canada	1	Bluetooth	2402.0	0.20	31.70	8.66	109.32	0.0230	0.2900	0.0289	N/A
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**Table 8 – Worker/Occupational Individual Transmitter Result**

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 0.2 m.

Regional Requirement	Antenna Port	RAT	Frequency (MHz)	RF Exposure Level at minimum compliance boundary of 0.2 m							
				S Power Density (W/m <sup>2</sup> )		E Field (V/m)		H Field (A/m)		B Field (μT)	
				Result	Limit	Result	Limit	Result	Limit	Result	Limit
EN	1 & 2	WI-FI 2.4 GHz	2412.0	0.20	N/A	8.66	140.00	0.0230	N/A	0.0289	0.4500
EN	1 & 2	WI-FI 5 GHz	5180.0	0.18	N/A	8.27	140.00	0.0219	N/A	0.0276	0.4500
EN	3	GSM 900	880.0	1.50	N/A	23.77	88.99	0.0630	N/A	0.0792	0.2966
EN	3	DCS 1800	1710.0	0.57	N/A	14.65	124.06	0.0389	N/A	0.0488	0.4135
EN	3	WCDMA FDD 8	880.0	1.20	N/A	21.26	88.99	0.0564	N/A	0.0709	0.2966
EN	3	WCDMA FDD 1	1920.0	1.01	N/A	19.48	131.45	0.0517	N/A	0.0649	0.4382
EN	3	LTE FDD 1	1920.0	1.01	N/A	19.48	131.45	0.0517	N/A	0.0649	0.4382
EN	3	LTE FDD 3	1710.0	0.67	N/A	15.94	124.06	0.0423	N/A	0.0531	0.4135
EN	3	LTE FDD 8	880.0	1.20	N/A	21.26	88.99	0.0564	N/A	0.0709	0.2966
EN	3	LTE FDD 20	832.0	1.01	N/A	19.50	86.53	0.0517	N/A	0.0650	0.2884
EN	3	LTE FDD 28	703.0	0.85	N/A	17.89	79.54	0.0474	N/A	0.0596	0.2651
EN	3	LTE TDD 38	2570.0	0.67	10.00	15.94	61.00	0.0423	0.1600	0.0531	0.2000
EN	1	Bluetooth	2402.0	0.20	N/A	8.66	140.00	0.0230	N/A	0.0289	0.4500
FCC	1 & 2	WI-FI 2.4 GHz	2412.0	0.20	50.00	8.66	N/A	0.0230	N/A	0.0289	N/A
FCC	1 & 2	WI-FI 5 GHz	5180.0	0.18	50.00	8.27	N/A	0.0219	N/A	0.0276	N/A
FCC	3	GSM 850	824.0	1.26	5.49	21.80	N/A	0.0578	N/A	0.0727	N/A
FCC	3	GSM 1900	1850.0	0.77	50.00	17.02	N/A	0.0451	N/A	0.0567	N/A
FCC	3	WCDMA FDD 5	826.0	1.01	5.51	19.50	N/A	0.0517	N/A	0.0650	N/A
FCC	3	LTE FDD 4	1710.0	0.67	50.00	15.94	N/A	0.0423	N/A	0.0531	N/A
FCC	3	LTE FDD 12	699.0	0.85	23.30	17.89	N/A	0.0474	N/A	0.0596	N/A
FCC	1	Bluetooth	2402.0	0.20	50.00	8.66	N/A	0.0230	N/A	0.0289	N/A
Canada	1 & 2	WI-FI 2.4 GHz	2412.0	0.20	5.37	8.66	44.97	0.0230	0.1193	0.0289	N/A



Canada	1 & 2	WI-FI 5 GHz	5180.0	0.18	9.05	8.27	58.40	0.0219	0.1549	0.0276	N/A
Canada	3	GSM 850	824.0	1.26	2.58	21.80	31.16	0.0578	0.0827	0.0727	N/A
Canada	3	GSM 1900	1850.0	0.77	4.48	17.02	41.08	0.0451	0.1090	0.0567	N/A
Canada	3	WCDMA FDD 5	826.0	1.01	2.58	19.50	31.18	0.0517	0.0827	0.0650	N/A
Canada	3	LTE FDD 4	1710.0	0.67	5.50	15.94	45.53	0.0423	0.1208	0.0531	N/A
Canada	3	LTE FDD 7	2500.0	0.85	2.30	17.89	29.46	0.0474	0.0781	0.0596	N/A
Canada	3	LTE FDD 12	699.0	0.67	5.60	15.94	45.96	0.0423	0.1219	0.0531	N/A
Canada	3	LTE TDD 38	2570.0	0.20	5.35	8.66	44.91	0.0230	0.1191	0.0289	N/A
Canada	1	Bluetooth	2402.0	0.20	5.37	8.66	44.97	0.0230	0.1193	0.0289	N/A

**Table 9 – General Public Individual Transmitter Result**

The calculations show that the EUT complies with the general public exposure levels described in the listed specifications in Annex A at the point of investigation, a minimum distance of 0.2 m.



### 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.

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

EN 62311 specifies the method of summation in clause 8.3 with results as follows:

Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at minimum compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
			Summation for simultaneous exposure; value to be <1			
3	GSM 900	880	N/A	0.0713	N/A	0.0713
1&2	2.4 GHz WI-FI	2412	N/A	0.0038	N/A	0.0041
Summation			N/A	0.0752	N/A	0.0754

**Table 2 – EN 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 0.2 m.

Note: The worst case Cellular and Wi-Fi or Bluetooth configuration from Table 4 used.

Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at minimum compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
			Summation for simultaneous exposure; value to be <1			
3	GSM 900	880	0.0199	0.0202	0.0206	0.0208
1&2	2.4 GHz WI-FI	2412	0.3406	0.3395	0.3299	0.3371
Summation			0.3604	0.3597	0.3505	0.3579

**Table 11 – EN 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 0.2 m.

Note: The worst case Cellular and Wi-Fi or Bluetooth configuration from Table 5 used.



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

Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at minimum compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
			Summation for simultaneous exposure; value to be <1			
3	GSM 850	824	0.0459	N/A	N/A	N/A
1&2	2.4 GHz WI-FI	2412	0.0040	N/A	N/A	N/A
Summation			0.0499	N/A	N/A	N/A

**Table 3 - 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 0.2 m.

Note: The worst case Cellular and Wi-Fi or Bluetooth configuration from Table 4 used.

Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at minimum compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
			Summation for simultaneous exposure; value to be <1			
3	GSM 850	842	0.2295	N/A	N/A	N/A
1&2	2.4 GHz WI-FI	2412	0.0199	N/A	N/A	N/A
Summation			0.2494	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 0.2 m.

Note: The worst case Cellular and Wi-Fi or Bluetooth configuration from Table 5 used.





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

Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at minimum compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
			Summation for simultaneous exposure; value to be <1			
3	GSM 850	842	0.0680	0.0673	0.0673	N/A
1&2	2.4 GHz WI-FI	2412	0.0063	0.0063	0.0063	N/A
Summation			0.0743	0.0736	0.0736	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 0.2 m.

Note: The worst case Cellular and Wi-Fi or Bluetooth configuration from Table 4 used.

Antenna Port	RAT	Frequency (MHz)	Calculated RF exposure level at minimum compliance boundary of 0.2 m as a fraction of the limit			
			S Power Density	E Field	H Field	B Field
			Summation for simultaneous exposure; value to be <1			
3	GSM 850	842	0.4895	0.4896	0.4895	N/A
1&2	2.4 GHz WI-FI	2412	0.0371	0.0371	0.0371	N/A
Summation			0.5266	0.5266	0.5266	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 0.2 m.

Note: The worst case Cellular and Wi-Fi or Bluetooth configuration from Table 5 used.



## 2.4 Far Field Region Boundary Results

The far field region boundary calculation result is shown in 16

Near Field / Far Field Boundary (Ref: IEEE C95.3 Annex B.2, EN 62311 Annex A, 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)
		$\lambda/4$ (m)	$2D^2/\lambda$ (m)
2.4 GHz WI-FI	2412	0.0311	16.0800
5 GHz WI-FI	5180	0.0145	34.5333
GSM 850	842	0.0910	5.4933
GSM 900	880	0.0405	12.3333
DCS 1800	1710	0.0439	11.4000
GSM 1900	1850	0.0405	12.3333
WCDMA FDD 1	1920	0.0391	12.8000
WCDMA FDD 5	846	0.0908	5.5067
WCDMA FDD 8	880	0.0852	5.8667
LTE FDD 1	1920	0.0391	12.8000
LTE FDD 3	1710	0.0439	11.4000
LTE FDD 4	1710	0.0439	11.4000
LTE FDD 7	2500	0.0300	16.6667
LTE FDD 8	880	0.0852	5.8667
LTE FDD 12	699	0.1073	4.6600
LTE FDD 20	832	0.0901	4.6867
LTE FDD 28	703	0.1067	4.6867
LTE TDD 38	2570	0.0292	17.1333
Bluetooth	2402	0.0312	16.0133

**Table 16 – Far Field Boundary**



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

RAT / Configuration	Field Region			Compliance Boundary Location (m) - Occupational	Compliance Boundary Location (m) - General Public
	Reactive Near Field Region (m)	Radiating Near Field Region (m)	Far Field Region(m)		
2.4 GHz WI-FI	< 0.0311	0.0311 - 16.0800	> 16.0800	0.2	0.2
5 GHz WI-FI	< 0.0145	0.0145 – 34.5333	> 34.5333	0.2	0.2
GSM 850	< 0.0910	0.0910 – 5.4933	> 5.4933	0.2	0.2
GSM 900	< 0.0405	0.0405 - 12.3333	> 12.3333	0.2	0.2
DCS 1800	< 0.0439	0.0439 - 11.4000	> 11.4000	0.2	0.2
GSM 1900	< 0.0405	0.0405 - 2.3333	> 12.3333	0.2	0.2
WCDMA FDD 1	< 0.0391	0.0391 - 12.8000	> 12.8000	0.2	0.2
WCDMA FDD 5	< 0.0908	0.0908 – 5.5067	> 5.5067	0.2	0.2
WCDMA FDD 8	< 0.0852	0.0852 - 5.8667	> 5.8667	0.2	0.2
LTE FDD 1	< 0.0391	0.0391 - 12.8000	> 12.8000	0.2	0.2
LTE FDD 3	< 0.0439	0.0439 - 11.4000	> 11.4000	0.2	0.2
LTE FDD 4	< 0.0439	0.0439 - 11.4000	> 11.4000	0.2	0.2
LTE FDD 7	< 0.0300	0.0300 - 16.6667	> 16.6667	0.2	0.2
LTE FDD 8	< 0.0852	0.0852 - 5.8667	> 5.8667	0.2	0.2
LTE FDD 12	< 0.1073	0.1073 - 4.6600	> 4.6600	0.2	0.2
LTE FDD 20	< 0.0901	0.0901 - 4.6867	> 4.6867	0.2	0.2
LTE FDD 28	< 0.1067	0.1067 - 4.6867	> 4.6867	0.2	0.2
LTE TDD 38	< 0.0292	0.0292 - 17.1333	> 17.1333	0.2	0.2
Bluetooth	< 0.0312	0.0312 - 16.0133	> 16.0133	0.2	0.2

**Table 17 – Assessment Method Validity**

The table shows that the compliance boundaries are not within the reactive near field region, where the spherical model could lead to a potential underestimate, therefore the approach described in section 2.1 is valid. The spherical model is valid in the far field region and overestimates in the radiating field region, therefore being a conservative assessment.

**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<sub>i</sub> 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 (W/m <sup>2</sup> )	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Magnetic Flux Density (μT)
0.1 - 1	-	610	N/A	2/f
1 - 10	-	610/f	N/A	2/f
10 - 400		61	N/A	0.2
400 - 2000		3*f <sup>0.5</sup>	N/A	1E-2*f <sup>0.5</sup>
2000 - 6000		140	N/A	0.45
6000 - 300000	50	140	N/A	0.45

**Table A.1 – EN: Action levels in Directive 2013/35/EU Annex III Table B1 Worker/Occupational Limits**

Frequency Range (MHz)	Power Density (W/m <sup>2</sup> )	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Magnetic Flux Density (μT)
0.003 - 0.15	-	87	5	6.25
0.15 - 1	-	87	0.73/f	0.92/f
1 - 10	-	87/f <sup>0.5</sup>	0.73/f	0.92/f
10 - 400	2	28	0.073	0.092
400 - 2000	f/200	1.375*f <sup>0.5</sup>	0.0037*f <sup>0.5</sup>	0.0046*f <sup>0.5</sup>
2000 - 300000	10	61	0.16	0.2

**Table A.2 – EN: Council Recommendation 1999/519/EC Annex II Table 1 General Public Limits**

Frequency Range (MHz)	Power Density (mW/cm <sup>2</sup> ) 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 <sup>2</sup>	1842/f	4.89/f
30 - 300	1	61.4	0.163
300 - 1500	f/300	-	-
1500 - 100000	5	-	-

**Table A.3 – FCC CFR 47 Pt.1.1310 Worker/Occupational Limits**

Frequency Range (MHz)	Power Density (mW/cm <sup>2</sup> ) 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 <sup>2</sup>	824/f	2.19/f
30 - 300	0.2	27.5	0.073
300 - 1500	f/1500	-	-
1500 - 100000	1	-	-

**Table A.4 – 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<sup>2</sup>.  
 The conversion factor is; 1 mW/cm<sup>2</sup> = 10 W/m<sup>2</sup>.

Frequency Range (MHz)	Power Density (W/m <sup>2</sup> )	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.5 – Health Canada Safety Code 6 Worker/Occupational Limits**

Frequency Range (MHz)	Power Density (W/m <sup>2</sup> )	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.6 – Health Canada Safety Code 6 General Public Limits**