

Exposure Calculation Report

Silicon Laboratories Finland Oy

Main Model: SiW917Y1GA

Series Model: SiW917Y1GN

In accordance with ETSI EN 50665 and EN 50663



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EXECUTIVE SUMMARY

The calculation of exposure for this product was found to be compliant at a minimum distance of 20 cm with ETSI EN 50665 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	29-August-2024

Table 1

1.2 Introduction

Applicant	Silicon Laboratories Finland Oy
Manufacturer	Silicon Laboratories Finland Oy
Model Number(s)	Main Model SiW917Y1GA Series Model: SiW917Y1GN
Hardware Version(s)	1.0
Software Version(s)	Stack's "Connectivity Firmware" version 2.10.1.2.0.4 (WLAN) Stack's "Connectivity Firmware" version 2.12.1.0.0.1 (BLE)
Specification/Issue/Date	• EN 50665:2017 Generic standard for assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz) • EN 50663:2017 Generic standard for assessment of low power electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (10 MHz - 300 GHz)
Order Number	PTP ~ 6000530772
Date	08-March-2024
Related Document(s)	• EN 62311:2008 Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz to 300 GHz) • EN 62479:2010 Assessment of the compliance of low power electronic and electrical equipment with the basic restrictions related to human exposure to electromagnetic fields (10 MHz to 300 GHz) • 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. • Directive 2013/35/EU on minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields).



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 WLAN radio within the device is compliant for separation distances greater than or equal to 20 cm as per the calculations made in accordance with EN 62311: 2008.

The BLE radio within this device is compliant at any separation distance as compliance is based on compliance with the Low Power Exclusion Level in EN 62479: 2010.

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

1.4 Product Information

1.4.1 Technical Description

Bluetooth Low Energy (LE), and Wi-Fi 802.11b/g/n/ax wireless radio module.

1.4.2 Transmitter Description

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

Radio Access Technology	Frequency Band (MHz)	Minimum Frequency (MHz)	Output Power (dBm)	Duty Cycle (%)
BLE	2402 – 2480	2402	8.8	100
WLAN	2412 – 2472	2412	19.7	100

Table 2 – Transmitter Description

Note: Transmitter power includes upper bounds of uncertainty therefore maximum values are used in accordance with Section 2.4.

1.4.3 Antenna Description

The following antennas are supported by the equipment under test.

Antenna Model	Gain (dBi)	Antenna length (cm)	Minimum Separation Distance (cm)
Integral Antenna	2.26	1.4	20
ANT-2.4-CW-CT-SMA-RPS by TE Connectivity	2.80	14.2	20

Table 3 – 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 2.4.

1.4.4 Equipment Configuration

Single Transmitter, simultaneous transmission of BLE and WLAN is not supported.

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 and also radiating near field conditions where applicable (see Section 2.3).

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

Where:

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

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

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:

$$B = \mu_0 \times H$$

Where:

μ_0 – Permeability of free space $4 \times \pi \times 10^{-7}$ 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 beyond the reactive near field boundary. Separation distances of less than 20 cm require a Specific Absorption Rate (SAR) assessment.

The reactive near field boundary and far field region boundary depend on the frequency and wavelength and also on the antenna dimension. The boundaries of the field regions are calculated in Section 2.3 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.

RAT	Frequency (MHz)	RF Exposure Level at minimum compliance boundary of 0.2 m							
		S Power Density (W/m ²)		E Field (V/m)		H Field (A/m)		B Field (μT)	
		Result	Limit	Result	Limit	Result	Limit	Result	Limit
BLE (ext. ant.)	2402	0.03	N/A	3.28	140.00	0.0087	N/A	0.0109	0.4500
WLAN (ext. ant.)	2412	0.35	N/A	11.55	140.00	0.0306	N/A	0.0385	0.4500
BLE (int. ant.)	2402	0.03	N/A	3.08	140.00	0.0082	N/A	0.0103	0.4500
WLAN (int. ant.)	2412	0.31	N/A	10.85	140.00	0.0288	N/A	0.0362	0.4500

Table 4 – Worker/Occupational Individual Transmitter Result

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 distance of 0.2 m.

RAT	Frequency (MHz)	RF Exposure Level at minimum compliance boundary of 0.2 m							
		S Power Density (W/m ²)		E Field (V/m)		H Field (A/m)		B Field (μT)	
		Result	Limit	Result	Limit	Result	Limit	Result	Limit
BLE (ext. ant.)	2402	0.03	10.00	3.28	61.00	0.0087	0.1600	0.0109	0.2000
WLAN (ext. ant.)	2412	0.35	10.00	11.55	61.00	0.0306	0.1600	0.0385	0.2000
BLE (int. ant.)	2402	0.03	10.00	3.08	61.00	0.0082	0.1600	0.0103	0.2000
WLAN (int. ant.)	2412	0.31	10.00	10.85	61.00	0.0288	0.1600	0.0362	0.2000

Table 5 – 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 Far Field Region Boundary Results

The far field region boundary calculation result is shown in Table 6:

Near Field / Far Field Boundary (Ref: EN 62311:2008)			
RAT Name	Frequency MHz	Reactive Near Field Boundary (Wave Impedance Dependent)	Radiating Near Field Boundary (Antennas on axis)
		$\lambda/4$ (m)	$2D^2/\lambda$ (m)
BLE (ext. ant.)	2402	0.0312	0.3229
WLAN (ext. ant.)	2412	0.0311	0.3242
BLE (int. ant.)	2402	0.0312	0.0031
WLAN (int. ant.)	2412	0.0311	0.0032

Table 6 – Far Field Boundary

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

The compliance boundary of 0.2 m is in the radiating near field region and therefore, the approach described in section 2.1 is an over estimate of the exposure and therefore a conservative assessment.

Field Region	Reactive Near Field Region	Radiating Near Field Region	Far Field Region $\lambda/4 < r \leq 2D^2/\lambda$ (m)
Maximum Boundary	< 0.0312 m	0.0312 – 0.3242 m	> 0.3242 m
Validity of Regions	Spherical model potential under-estimate: SAR / test assessment required	Spherical model over-estimate and conservative	Spherical model valid
Compliance Boundary Location	N/A	0.2 m	N/A

Table 7 – Assessment Method Validity

2.4 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 2.3.



ANNEX A

REGIONAL REQUIREMENTS



Frequency Range (MHz)	Power Density (W/m ²)	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 ^{0.5}	N/A	1E-2*f ^{0.5}
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 ²)	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 ^{0.5}	0.73/f	0.92/f
10 - 400	2	28	0.073	0.092
400 - 2000	f/200	1.375*f ^{0.5}	0.0037*f ^{0.5}	0.0046*f ^{0.5}
2000 - 300000	10	61	0.16	0.2

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



ANNEX B

BLE radio compliance as per EN 50663 referencing EN 62479



EN 62479 Section 4.1 Route B and 4.2 Low-power exclusion level P_{max}

EN 62479 Section 4.1 states: If the electrical power used by or radiated by the equipment is sufficiently low, the electromagnetic fields emitted will be incapable of producing exposures that exceed the basic restrictions.

Four routes A, B, C or D can be used to demonstrate compliance. The route selected is B.;

B The input power level to electrical or electronic components that are capable of radiating electromagnetic energy in the relevant frequency range is so low that the available antenna power and/or the average total radiated power cannot exceed the low-power exclusion level defined below.

The applicable low power exclusion level P_{max} from EN 62479 Table A.1 is 20 mW corresponding to;

- ICNIRP (guideline in accordance with Council Recommendation 1999/519/EC),

Route B Low Power Exclusion Result:

RAT	Frequency (MHz)	Maximum Conducted Power Output (mW)	Antenna Gain Ratio	Duty Cycle (%)	Source Based Power (mW)	Separation Distance (mm)	Exemption Limit (mW)*	SAR Test Exclusion (Yes/No)
BLE (int. ant.)	2402	7.59	1.68	100	12.75	0	20	Yes
BLE (ext. ant.)	2402	7.59	1.91	100	14.50	0	20	Yes

Table 8

The Low Power exclusion threshold has been evaluated using the method described above from information supplied by the manufacturer. Based on the evaluation above, the BLE radio is categorically excluded from SAR/RF exposure testing.