DEKRA Testing and Certification, S.A.U.
Parque Tecnológico de Andalucía,
c/ Severo Ochoa nº 2 · 29590 Campanillas · Málaga · España

Assessment report No:

NIE: 54913RAN.001

Assessment report
RF EXPOSURE REPORT ACCORDING TO FCC 47 CFR Part 2.1091 ISED RSS-102 Issue 5:2015

Identification of item tested.....:	Zigbee module 2.4GHz
Trademark .....:	Soltec
Model and /or type reference .....:	SolBee
Other identification of the product .....:	FCC ID: 2AOO8SOLBEE IC: 23674-SOLBEE
Final HW version .....:	1.2
Final SW version .....:	1.0
Features.....:	Operating voltage: 3.3vdc. Mount type: SMD. SPI control interface. Up to 20 dBm.
Manufacturer.....:	SOLTEC ENERGIAS RENOVABLES S.L. C/ Gabriel Campillo s/n, 30500 Molina de Segura Murcia, Spain.
Test method requested, standard.....:	FCC 47 CFR Part 2.1091 Radiofrequency radiation exposure evaluation: mobile devices. ISED RSS-102 Issue 5 (2015-03) – Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
Summary.....:	IN COMPLIANCE
Approved by (name / position & signature) .....:	Miguel Lacave Antennas Lab Manager  MIGUEL LACAVE GARCÍA 2018.03.22 15:46:46 +01'00'
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In order to assure the traceability to other national and international laboratories, DEKRA has a calibration and maintenance program for its measurement equipment.

DEKRA guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at DEKRA at the time of performance of the test.

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The results presented in this Test Report apply only to the particular item under test established in this document.

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Identification of the client

SOLTEC ENERGIAS RENOVABLES S.L.

C/ Gabriel Campillo s/n, 30500 Molina de Segura Murcia, Spain.

General description of the device under evaluation

The device under evaluation consists of a 2.4 GHz IEEE 802.15.4 radio transceiver module with integrated matching circuitry, LNA, PA, filter, U.FL 50 Ω connector for external antenna and SPI interface

The device will be installed be installed into host devices that will be used at a distance greater than 20 cm from the user. In order to perform the assessement a conservative separation distance of 20 cm has been used.

As stated in DEKRA Testing and Certification, S.A.U. test report num. 54913RRF.001, the maximum measured output output power values of the device are:

Band (MHz)	Technology	Frequency (MHz)	Maximum RF output power (dBm)	Maximum antenna gain (dBi)	Maximum radiated power (E.I.R.P.) (dBm)
2450	Zigbee	2405	6.00	+2.00	8.00
		2440	5.10	+2.00	7.10
		2475	4.11	+2.00	6.11

Table 1: Maximum E.I.R.P

Assessment summary

Radiofrequency radiation exposure limits			
FCC 47 CFR § 2.1091 & ISED RSS-102 Issue 5 (2015-03)			
Band (MHz)	**Technology**	**Band**	**VERDICT (Pass/Fail)**
2450	Zigbee	ISM	Pass

Table 2: Assessment summary

Appendix A – FCC RF Exposure

FCC RF Exposure evaluation for mobile devices

Devices operating in standalone mobile device exposure conditions may contain a single transmitter or multiple transmitters that do not transmit simultaneously. A minimum test separation distance ≥ 20 cm is required between the antenna and radiating structures of the device and nearby persons to apply mobile device exposure limits. The distance must be at least 20 cm and fully supported by the operating and installation configurations of the transmitter and its antenna(s), according to the source-based time-averaged maximum power requirements of § 2.1091(d)(2). In cases where cable losses or other attenuations are applied to determine compliance, the most conservative operating configurations and exposure conditions must be evaluated. The minimum test separation distance required for a device to comply with mobile device exposure conditions must be clearly identified in the installation and operating instructions, for all installation and exposure conditions, to enable users and installers to comply with RF exposure requirements. For mobile devices that have the potential to operate in portable device exposure conditions, similar to the configurations described in § 2.1091(d)(4), a KDB inquiry is required to determine the SAR test requirements for demonstrating compliance.

When a device qualifies for the categorical exclusion provision of § 2.1091(c), the minimum test separation distance may be estimated, when applicable, by simple calculations according to plane-wave equivalent conditions, to ensure the transmitter and its antenna(s) can operate in manners that meet or exceed the estimated distance. The source-based time-averaged maximum radiated power, according to the maximum antenna gain, must be applied to calculate the field strength and power density required to establish the minimum test separation distance. When the estimated test separation distance becomes overly conservative and does not support compliance, MPE measurement or computational modeling may be used to determine the required minimum separation distance.

According to §1.1310 Radiofrequency radiation exposure limits, paragraph (e), the limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields are:

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3–3.0	614	1.63	*100	6
3.0–30	1842/f	4.89/f	*900/f²	6
30–300	61.4	0.163	1.0	6
300–1,500			f/300	6
1,500–100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*100	30
1.34–30	824/f	2.19/f	*180/f²	30
30–300	27.5	0.073	0.2	30
300–1,500			f/1500	30
1,500–100,000			1.0	30

f = frequency in MHz * = Plane-wave equivalent power density

FCC MPE Evaluation Results

Each supported transmission technology will be evaluated to determine if it is in compliance with limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields.

In order to perform the assessment, the following equations have been used for the calculations; these equations are accurate in the far-field of an antenna and will over-predict power density in the near field, where they could be used for making a "worst case" or conservative prediction:

Power density: $S[mW/cm^2] = \frac{P_{max}[mW]}{4\Pi R[cm]^2}$

Minimum compliance distance: $R_{min}[cm] = \sqrt{\frac{P_{max}[mW]}{4\Pi S[mW/cm^2]}}$

Maximum gain to meet the MPE limit: $G_{max}[dBi] = (10 * \log[S[mW/cm^2] * 4\Pi R[cm]^2) - P_{max}[dBm]$

S = power density

P_{max} = power input to the antenna

R = distance to the center of radiation of the antenna (evaluation distance)

R_{min} = distance to the center of radiation of the antenna

G_{max} = power gain of the antenna in the direction of interest relative to an isotropic radiator

Assessment 1- Zigbee – 2450 MHz Band

Maximum output power (dBm):	6.0
Maximum antenna Gain (dBi):	2.0
Minimum use distance (cm):	20
Worst Case Frequency (MHz):	2405.0
Maximum EIRP (dBm):	8.0
Maximum EIRP (mW):	6.31
General population - Power density limit (mW/cm^2):	1.0

Power density at minimum use distance:

Power density (mW/cm^2):	0.001
General population - Power density limit (mW/cm^2):	1.0
Verdict for general population:	PASS

The power density level for this transmission mode is below general population exposure power density limit.

Minimum compliance distance for this technology:

Minimum compliance distance for general population (cm):	0.71
Minimum use distance (cm):	20.0
Verdict for general population:	PASS

The minimum use distance is greater than general population exposure minimum compliance distance.

Maximum gain to meet the §1.1310 Radiofrequency radiation exposure limits:

Maximum antenna gain to meet reference level (dBi):	31.0
Power density using max antenna gain (mW/cm^2):	0.997

The power density level using the maximum antenna gain for this transmission mode will be below power density reference level.

Appendix B – ISED RF Exposure

ISED RF Exposure evaluation for mobile devices

According to RSS-102 Issue 5, Paragraph "4. Exposure Limits", Industry of Canada has adopted the RF field strength limits stablished in Healths Canada's RF exposure guideline, Safety code 6:

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[21]	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	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	$0.158f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

ISED MPE Evaluation Results

Each supported transmission technology will be evaluated to determine if it is in compliance with RSS-102 Issue 5, RF Field Strength Limits for devices used by the General Public.

In order to perform the assessment, the following equations have been used for the calculations; these equations are accurate in the far-field of an antenna and will over-predict power density in the near field, where they could be used for making a "worst case" or conservative prediction:

Power density: $S[W/m^2] = \frac{P_{max}[W]}{4\Pi R[m]^2}$

Minimum compliance distance: $R_{min}[m] = \sqrt{\frac{P_{max}[W]}{4\Pi S[W/m^2]}}$

Maximum gain to meet the RSS -102 limit: $G_{max}[dBi] = (10 * \log[S[W/m^2] * 4\Pi R[m]^2) + 30 - P_{max}[dBm]$

S = power density

P_{max} = power input to the antenna

R = distance to the center of radiation of the antenna (evaluation distance)

R_{min} = distance to the center of radiation of the antenna

G_{max} = power gain of the antenna in the direction of interest relative to an isotropic radiator

Assessment 1- Zigbee – 2450 MHz Band

Maximum output power (dBm):	6.0
Maximum antenna gain (dBi):	2.0
Minimum use distance (m):	0.2
Worst Case Frequency (MHz):	2405.0
Maximum EIRP (dBm):	8.0
Maximum EIRP (W):	0.01
General public - Power density limit (W/m^2):	5.35

Power density at minimum use distance:

Power density (W/m^2):	0.013
General public - Power density limit (W/m^2):	5.35
Verdict for general public:	PASS

The power density level for this transmission mode is below general public power density limit.

Minimum compliance distance for this technology:

Minimum compliance distance for general public (m):	0.010
Minimum use distance (m):	0.20
Verdict for general public:	PASS

The minimum use distance is greater than general public minimum compliance distance.

Maximum gain to meet the RSS -102 limits:

Maximum antenna gain to meet reference level (dBi):	28.2
Power density using max antenna gain (W/m^2):	5.23

The power density level using the maximum antenna gain for this transmission mode will be below power density reference level.