

Client:	Ecobee Inc.
Product Name/Model:	EB-SOC60G
FCC ID:	WR925SC1AG0ARC
Reference	FCC KDB 447498 D04 v01

FCC RF Exposure

Where the Device Under Test (DUT) can be shown to meet the requirements for an exemption pursuant to FCC 47 CFR §1.1307(b)(3), an evaluation is not required with respect to the limits on human exposure to RF emissions provided in FCC 47 CFR §1.1310.

1. Determination of Exemption

As per 47 CFR §1.1307(b)(3), for single RF sources (i.e., any single fixed RF source, mobile device, or portable device), a single RF source is exempt if:

- A. **1-mW Test Exemption:** The available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those in paragraph (b)(3)(ii)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(ii)(A);
- B. **SAR-Based Exemption:** The available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold P_{th} (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive). P_{th} is given by:

$$P_{th} (mW) = \begin{cases} ERP(d/20 \text{ cm})^x & d \leq 20 \text{ cm} \\ ERP_{20cm} & 20 \text{ cm} < d \leq 40 \text{ cm} \end{cases}$$

Where

$$x = -\log_{10} \left(\frac{60}{ERP_{20cm} \sqrt{f}} \right) \text{ and } f \text{ is in GHz}$$

And

$$ERP_{20cm} (mW) = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases}$$

d = the minimum separation distance (cm) in any direction from any part of the device antenna(s) or radiating structure(s) to the body of the device user.

- C. **MPE-Based Exemption:** Using Table 1 and the minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, R must be at least $\lambda/2\pi$, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of $\lambda/4$ or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

Table 1 of § 1.1307(b)(3)(i)(C) - Single RF Sources Subject to Routine Environmental Evaluation

RF Source Frequency (MHz)	Threshold ERP (Watts)
0.3-1.34	$1,920 R^2$
1.34-30	$3,450 R^2/f^2$
30-300	$3.83 R^2$
300-1,500	$0.0128 R^2 f$
1,500-100,000	$19.2 R^2$

Where R is the separation distance in meters and f is in MHz

2. RF Exposure Evaluation

The DUT is a mobile device designed to be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the RF source's radiating structure and the body of the user or nearby persons.

The EUT contains 57.0 – 64.0 GHz transmitter. EIRP exemption threshold was calculated using the lowest operating frequency for each transmitter; the lower frequency resulted in a lower exemption limit.

ERP exemption threshold was calculated using the lowest operating frequency for each transmitter; the lower frequency resulted in a lower exemption limit.

2.1 DUT RF Output Power

Highest power (peak or average) for each operation band was used in the RF exposure evaluation.

Transmitter	Operation Band (MHz)	EIRP (dBm)	ERP (dBm)	Max ERP (W)	Minimum Separation Distance (cm)
Radar	57,000 – 64,000	7.6	5.45	0.004	20

Note:

- ERP (dBm) = EIRP – 2.15

2. $ERP (W) = 10^{((ERP(dBm) - 30)/10)}$
3. See Section 7.5 of test report for EIRP.

2.2 MPE-Based Exemption

The EUT contains 57.0 – 64.0 GHz transmitter. ERP exemption threshold was calculated using the lowest operating frequency for the transmitter; the lower frequency resulted in a lower exemption limit.

Evaluation Frequency (MHz)	Minimum Required Separation Distance ($\lambda/2\pi$) (cm)	Threshold ERP (W)	DUT Maximum ERP (W)
57,000	0.084	0.768	0.004

Note:

$\lambda/2\pi = (3 \times 10^8 \text{ m/s}) / (2 * 3.14 * f (\text{Hz}))$ in meters

Threshold ERP = $19.2 * 0.2^2 = 0.768$

The DUT separation distance is greater than the Minimum Required Separation Distance. And the transmitter operates below its applicable Threshold ERP Limit; thus, the RF Exposure Exemption requirement is met.

According to 47 CFR §1.1307(b)(3)(i)(B), this device complies with the RF exposure test exemption.

3. Host RF Exposure Evaluation

The host is a mobile device designed to be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the RF source's radiating structure and the body of the user or nearby persons.

ERP exemption threshold was calculated using the lowest operating frequency for each transmitter; the lower frequency resulted in a lower exemption limit.

3.1 Host Transmitter RF Output Power

The host contains 902 – 928 MHz FHSS/Hybrid transmitters, 2400 – 2483.5 MHz DTS/FHSS transmitters, 5.2 GHz and 5.8 GHz WLAN transmitters.

The table below shows the type of transmitter, operation band, max ERP, and minimum separation distance of the host transmitters:

Host Transmitters						
Transmitter	Operation Band (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Max ERP (dBm)	Max ERP (W)	Minimum Separation Distance (cm)
FHSS/Hybrid	920 – 927	17.99	-9.71	6.13	0.0041	20
BLE	2400 - 2480	11.36	-2.05	7.16	0.0052	20

WIFI	2412 - 2462	25.35	-2.05	21.15	0.1303	20
WLAN	5150 - 5250	19.54	-1.88	15.51	0.0356	20
WLAN	5725 - 5850	20.98	-1.88	16.95	0.0495	20

3.2 Host MPE-Based Exemption

Host Transmitter			
Evaluation Frequency (MHz)	Minimum Required Separation Distance ($\lambda/2\pi$) (cm)	Threshold ERP (W)	Host Maximum ERP (W)
920.00	5.19	0.471	0.0041
2402.00	1.99	0.768	0.0052
2412.00	1.99	0.768	0.1303
5180.00	0.92	0.768	0.0356
5745.00	0.83	0.768	0.0495

The host separation distance is greater than the Minimum Required Separation Distance. Each transmitter operates below its Threshold ERP Limit; thus, the RF Exposure Exemption requirement is met for each of the host's transmitter.

According to 47 CFR §1.1307(b)(3)(i)(B), each transmitter of the host complies with the RF exposure test exemption.

3.3 Host Simultaneous Transmission Evaluation

The transmitters on the host are located on two different SoCs (System on Chip). BLE, 2.4 GHz WIFI and WLANs are on SoC1; 900 MHz transmitter is on SoC2.

The 2.4 GHz BLE and 2.4 GHz WLAN use the same antenna; 5.2GHz and 5.8 GHz WLAN use the same antenna.

At any instance, SoC1 could only either transmit BLE, 2.4 GHz WLAN, 5.18 GHz WLAN, or 5.745 GHz WLAN. SoC1 can only transmit one protocol at a time.

There is no coordination between SoC1, SoC2, and the radar. Therefore, SoC1, SoC2, and the radar can transmit simultaneously.

Per 47 CFR Section 1307(b)(3)(ii)(B), the host qualify for simultaneous transmit exemption if the transmitters meet the following requirement:

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure\ Limit_k} \leq 1$$

The worst-case simultaneous RF exposure is a combination of the highest ERP from each SoC and radar. The highest ERP from SoC1 is 0.1303 W, from SoC2 is 0.004 W, and from the radar is 0.004 W.

$$\frac{0.130W}{0.768W} + \frac{0.004W}{0.471W} + \frac{0.004W}{0.768W} = 0.18 < 1$$

The host qualifies for simultaneous transmission exemption.