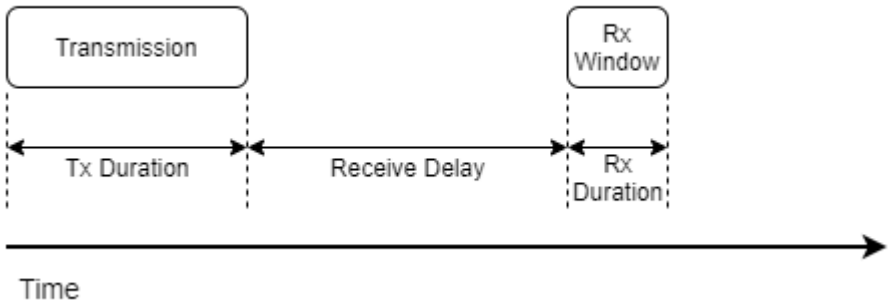

All device variants in the BLE Sensor Family Gen2 are LoRaWAN Class A devices that are fully compliant with the LoRaWAN Specification v1.0.2 and the LoRaWAN Regional Parameters v1.0.2. These documents specify the Tx and Rx scheme as shown in the figure. These specifications also place limits on the Tx and Rx behaviour as follows:

- The maximum allowable transmission duration is 399.6 ms.
- The device only opens Rx windows after the transmission of a packet. The first Rx window begins after a period of time called the *receive delay* following the end of every transmission. The shortest possible receive delay is 1000 ms.
- The shortest possible Rx duration is 5.2 ms. This occurs when the shortest possible packet is sent at the quickest data rate.
- All of these limits are the same regardless of whether the packets require acknowledgement.

Given these values and the fact that a device can send another transmission immediately following the end of the Rx window, the maximum possible duty cycle for a LoRaWAN device is calculated as follows.

$$Duty\ Cycle_{MAX} = \frac{399.6\ \text{ms}}{399.6\ \text{ms} + 1000\ \text{ms} + 5.2\ \text{ms}} \times 100\% = 28.45\%$$

According to 47 CFR, a device conforms to the SAR-based exemption if each of the maximum time-averaged available (matched conducted) power and effective radiated power (ERP) is no more than:

$$P_{th}(\text{mW}) = \begin{cases} ERP_{20\text{ cm}}\left(\dfrac{d}{20\text{ cm}}\right)^{x}, & d \le 20\text{ cm} \\ ERP_{20\text{ cm}}, & 20\text{ cm} < \text{d} \le 40\text{ cm} \end{cases}$$

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

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

The BLE Sensor Family Gen2 devices have a minimum antenna separation distance of **3.3 mm (< 5 mm)**, and operate in a band where the **maximum Tx frequency is 914.9 MHz**. Therefore, P_{th} is calculated as follows (**based on a 5-mm separation distance**):

$$ERP_{20\text{ cm}} = 2040(0.9149\text{ GHz}) = 1866.396$$

$$\rightarrow x = -\log_{10}\left(\frac{60}{1866.396\sqrt{0.9149\text{ GHz}}}\right) = 1.47354$$

$$\rightarrow P_{th} = 1866.396\left(\frac{0.5\text{ cm}}{20\text{ cm}}\right)^{1.47354} = 8.134\text{ mW}$$

Considering this limit as well as the maximum possible duty cycle of 28.45%, P_{th} calculated above converts to

$$P_{th,\text{duty cycled}} = \frac{P_{th}}{0.2845} = 28.5906\text{ mW} = 14.562\text{ dBm}$$

But this is a limit on the maximum of conducted power and ERP. In the case of the BLE sensors, an antenna with a **peak gain of 2.8 dBi** is used, and therefore,

$$\text{ERP} = P_{\text{conducted}} + 2.8 - 2.15 = P_{\text{conducted}} + 0.65$$

thus we have,

$$\max\{P_{\text{conducted}}, \text{ERP}\} = P_{\text{conducted}} + 0.65\text{ dB}$$

Consequently, we should have

$$P_{\text{conducted}} + 0.65 \le P_{th,\text{duty cycled}} = 14.562\text{ dBm}$$

or

$$P_{\text{conducted}} \leq 13.912 \text{ dBm}$$

Therefore, for portable device variants, the firmware (FW) limits the Tx power output of the SX1262 module to **13 dBm**. Note: there is no way for the end-user to modify the maximum Tx power output level set by the FW.