The eDoctor is a low-power, low cost commercial indoor and residential LoRa health monitoring portable sensor for IoT applications. eDoctor is evaluated for RF radiation exposure according to the provisions of FCC §2.1093, MPE guidelines identified in FCC §1.1310 , § 1.1307and FCC KDB 447498 D04 Interim General RF Exposure Guidance v01:2021.

§ 1.1307(b)(3)(i)(B) / FCC KDB 447498:2021 clauses 2.1.3 (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 Pth (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).

Pth is given by:

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

Where

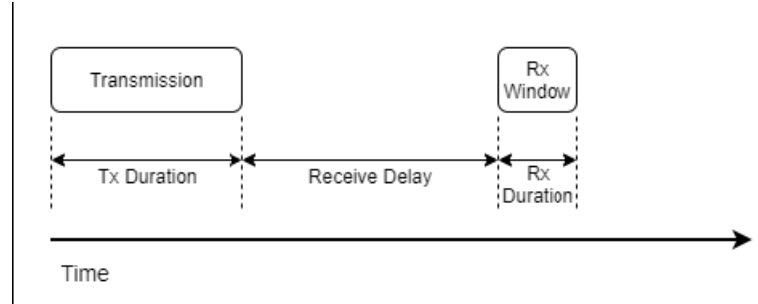$$x = -\log_{10}\left(\frac{60}{ERP_{20\ cm}\sqrt{f}}\right) \text{ and } f \text{ is in GHz;}$$

and

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

d = the separation distance (cm);

LoRa Duty Cycle:

The eDoctor is a LoRaWAN Class A device that is 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.

$$Duty\ Cycle_{MAX} = (\ 399.6\ ms\ /\ 399.6\ ms + 1000\ ms + 5.2\ ms) \times 100\% = 28.45\%$$

The eDoctor has a minimum antenna separation distance of 3.11 mm, and operates 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):

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

$$\rightarrow \qquad x = -\log_{10}(60\ /\ 1866.396\sqrt{0.9149\ GHz}) = 1.47354$$

$$\rightarrow \qquad P_{th\ (mW)} = 1866.396_{(mW)}\ (0.5\ cm\ /\ 20\ cm)^\wedge\ 1.47354 = 8.134\ mW$$

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

$$P_{th,\text{duty cycled}} = (8.134\ mW\ /\ 0.2845) = 28.5906\ mW = 14.563\ dBm$$

But this is a limit on the maximum of conducted power and ERP. In the case of the eDoctor, an antenna with a **peak gain of 2.2 dBi** is used, and therefore,

$$ERP = P_{conducted} + 2.2 - 2.15 = P_{conducted} + 0.05$$

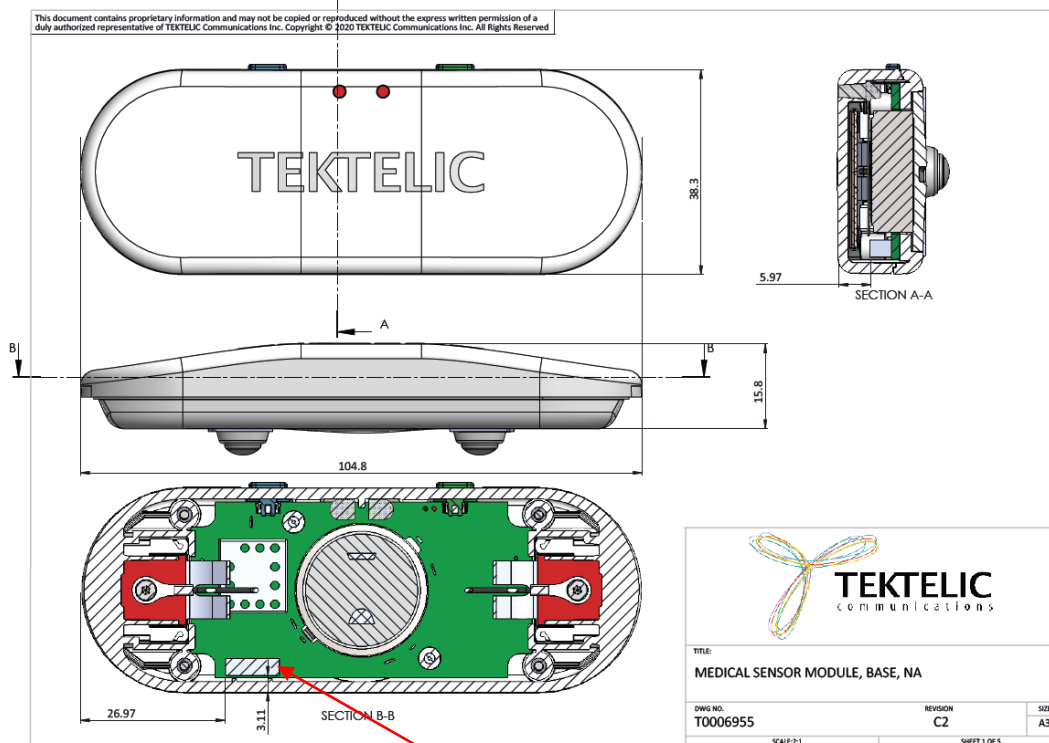Thus we have,

$$\max\{P_{conducted}, ERP\} = P_{conducted} + 0.05\ dB$$

Consequently, we should have

$$P_{conducted} + 0.05\ \leq\ P_{th,\text{duty cycled}}\ = 14.563\ dBm$$

LoRa RF conducted power measurement and antenna gain as per ETC test reports t29e23a260_DTS and t29e23a260_DSS section 2.3.5 are reported below.

The maximum duty cycle for radio is stated in the **Operation Description exhibit section 2.1 is 28.45%**. The worst-case value is in bold below

TX Mode	Frequency (MHz)	Conducted RF Output 100% Duty Cycle (dBm)	Max. antenna gain (dBi)	EIRP 100% duty Cycle		EIRP 28.45% duty Cycle		ERP 100% duty Cycle		ERP Limit
				(dBm)	(mW)	(dBm)	(mW)	(dBm)	(mW)	
LoRa 500 KHz	903.0	12.51	2.2	14.71	29.58	4.185	8.42	12.56	18.03	≤14.563 dBm ≤ 28.596 mW
	909.95	12.58	2.2	14.78	30.06	4.205	8.55	12.63	18.32	
	914.2	12.43	2.2	14.63	29.04	4.16	8.26	12.48	17.70	
LoRa 125 KHz	902.3	12.11	2.2	14.31	26.98	4.071	8.53	12.16	16.44	
	908.7	12.44	2.2	14.64	29.11	4.165	8.28	12.49	17.74	
	914.9	12.56	2.2	14.76	29.92	4.20	8.51	12.61	18.28	
Worse Case as per Tuning Procedure										
Tx Power		**14**	**2.2**	**16.2**	**41.69**	**4.61**	**11.86**	**14.05**	**25.41**	≤14.563 dBm ≤ 28.596 mW

LoRa Antenna

EUT meet SAR exception limit.