Memo

Medtronic

Date: July 26, 2023

To: Element

From: Medtronic Lafayette R&D Team

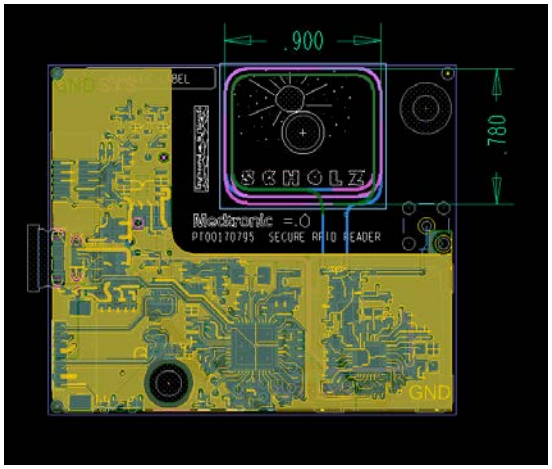
Subject: **Antenna Information**

RE: FCC ID: P7G-170793; IC: 23825-170793

1.0 RFID MODULE OVERVIEW

The Secure RFID Module is a RFID reader/writer manufactured by **Covidien llc, 15 Hampshire Street, Mansfield, MA 02048**. The RFID module incorporates a Texas Instruments TRF7970A chip operating at 13.56 MHz (HF) in the ISM frequency band. The antenna for the design was derived using the Texas Instruments application report SLOA241C. It is an integrated, loop coil antenna with no alternates or otherwise replaceable antennas; hence compliance with 15.203 is demonstrated.

- **Coil Dimensions:** The 5 turns antenna coil with a 20mil space/trace is embedded into the PCBA on layers 2 (1T), 3 (2T), and 4 (2T). It measures 0.900”x0.780” giving a square area of 0.702” as seen in the image below.

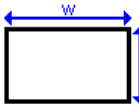


- **Coil Inductance:** The inductance of a rectangular loop can be calculated using the number of turns, the area of the rectangular loop, the radius of the wire and the relative permeability of the medium. The embedded coil of the Secure RFID Module is constructed on FR4, which has an approximate relative permeability of 1.

  Where,
  N = Number of turns

w = Average width of the rectangle
h = Average height of the rectangle
a = PCB trace width
μ0 = Permeability of the medium

Loop of wire with rectangular shape



N	5	**[ ]**	number of turns
w	0.02286	**[m]**	width of the rectangle
h	0.019812	**[m]**	height of the rectangle
a	0.000508	**[m]**	wire radius
μ_r	1	**[ ]**	relative permeability of the medium
L	0.00000126265560654947	**[H]**	Inductance

Calculate Clear

NOTE: numbers are in scientific notation (e.g.: 1.427e-9 H = 1.1427·10^{-9} H = 1.427 nH)

$$L_{rect} \approx N^2 \frac{\mu_0 \mu_r}{\pi}\left[-2(w+h)+2\sqrt{h^2+W^2}-h\ln\left(\frac{h+\sqrt{h^2+W^2}}{W}\right)-W\ln\left(\frac{W+\sqrt{h^2+W^2}}{h}\right)+h\ln\left(\frac{2h}{a}\right)+W\ln\left(\frac{2W}{a}\right)\right]$$

This theoretical equation is provided in the TI application report SLOA241C and calculated here: https://technick.net/tools/inductance-calculator/rectangular-loop/.

Note: This equation is for a single loop of wire which doesn't span multiple layers of a PCB and doesn't account for parasitic capacitance. If using the average width and height of the inner and outer portions of the coil, then the inductance can change as much as 11%. When taking the parasitic capacitance into account, the coil inductance is back calculated to be approximately 1.034uH.