Antenna Parameters

The following section gives some key antenna performance parameters.

- **Return loss**: The return loss of an antenna signifies how well the antenna is matched to the 50-Ω transmission line (TL), shown as a signal feed in Figure 7. The TL impedance is typically 50 Ω, although it could be a different value. The industry standard for commercial antennas and testing equipment is 50-Ω impedance, so it is most convenient to use this value.

  Return loss indicates how much of the incident power is reflected by the antenna due to mismatch (Equation 1). An ideal antenna when perfectly matched will radiate the entire energy without any reflection.

  If the return loss is infinite, the antenna is said to be perfectly matched to the TL, as shown in Figure 7. S_{11} is the negative of return loss expressed in decibels. As a rule of thumb, a return loss ≥ 10 dB (equivalently, $S_{11} \leq -10$ dB) is considered sufficient. Table 1 relates the return loss (dB) to the power reflected from the antenna (percent). A return loss of 10 dB signifies that the 90% of the incident power goes into the antenna for radiation.

Equation 1

$$Return\ Loss\ (dB) = 10 \log \left(\frac{P_{incident}}{P_{reflected}} \right)$$

Figure 7. Return Loss

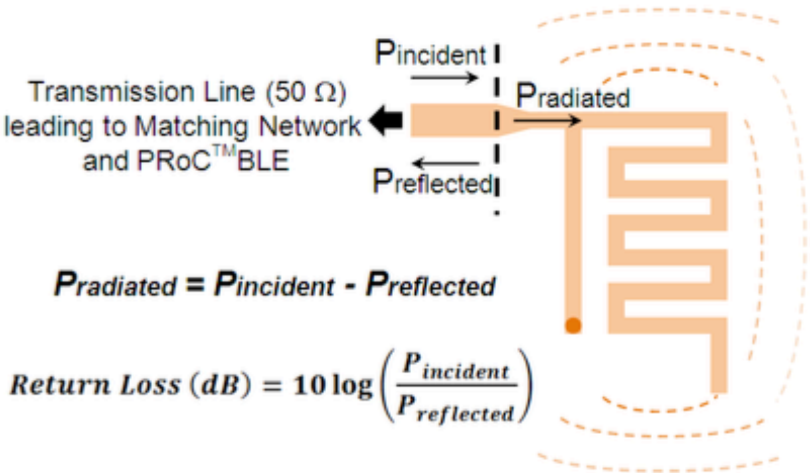


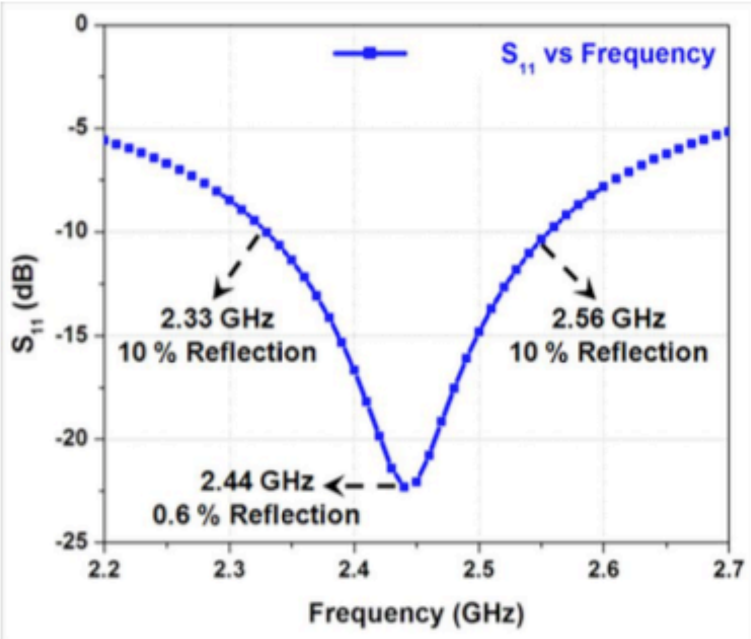
Table 1. Return Loss and Power Reflected from Antenna

S_{11} (dB)	Return Loss (dB)	$P_{reflected}$ / $P_{incident}$ (%)	$P_{radiated}$ / $P_{incident}$ (%)
–20	20	1	99
–10	10	10	90
–3	3	50	50
–1	1	79	21

Manufacture's Name：HALOG Inc.
8 The Green, Dover, DE 19901, USA

- **Bandwidth**: Bandwidth indicates the frequency response of an antenna. It signifies how well the antenna is matched to the 50-Ω transmission line over the entire band of interest, that is, between 2.40 GHz and 2.48 GHz for BLE applications.

Figure 8. Bandwidth

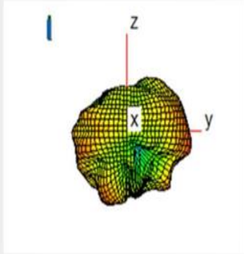


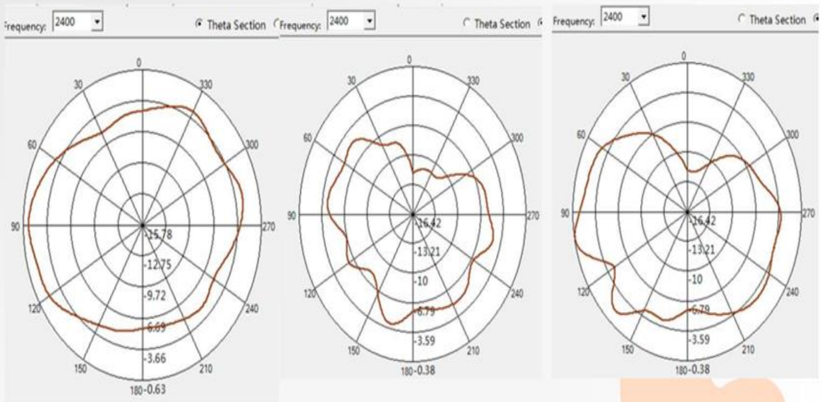
As Figure 8 shows, the return loss is greater than 10 dB from 2.33 GHz to 2.55 GHz. Therefore, the bandwidth of interest is around 200 MHz.

- **Radiation efficiency**: A portion of the non-reflected power (see Figure 7) gets dissipated as heat or as thermal loss in the antenna. Thermal loss is due to the dielectric loss in the FR4 substrate and the conductor loss in the copper trace. This information is characterized as radiation efficiency. A radiation efficiency of 100 percent indicates that all non-reflected power is radiated to free space. For a small-form-factor PCB, the heat loss is minimal.

- **Radiation pattern**: Radiation pattern indicates the directional property of radiation, that is, which directions have more radiation and which have less. This information helps to orient the antenna properly in an application.

Freq	Gain	Efficiency_Pcent
2400	-0.38	33.53
2410	-0.71	34.84
2420	-0.82	34.94
2430	-0.47	37.67
2440	-0.06	39.99
2450	0.17	40.95
2460	0.73	45.21
2470	0.98	47.50
2480	0.91	45.64
2490	1.06	45.29
2500	0.87	42.69



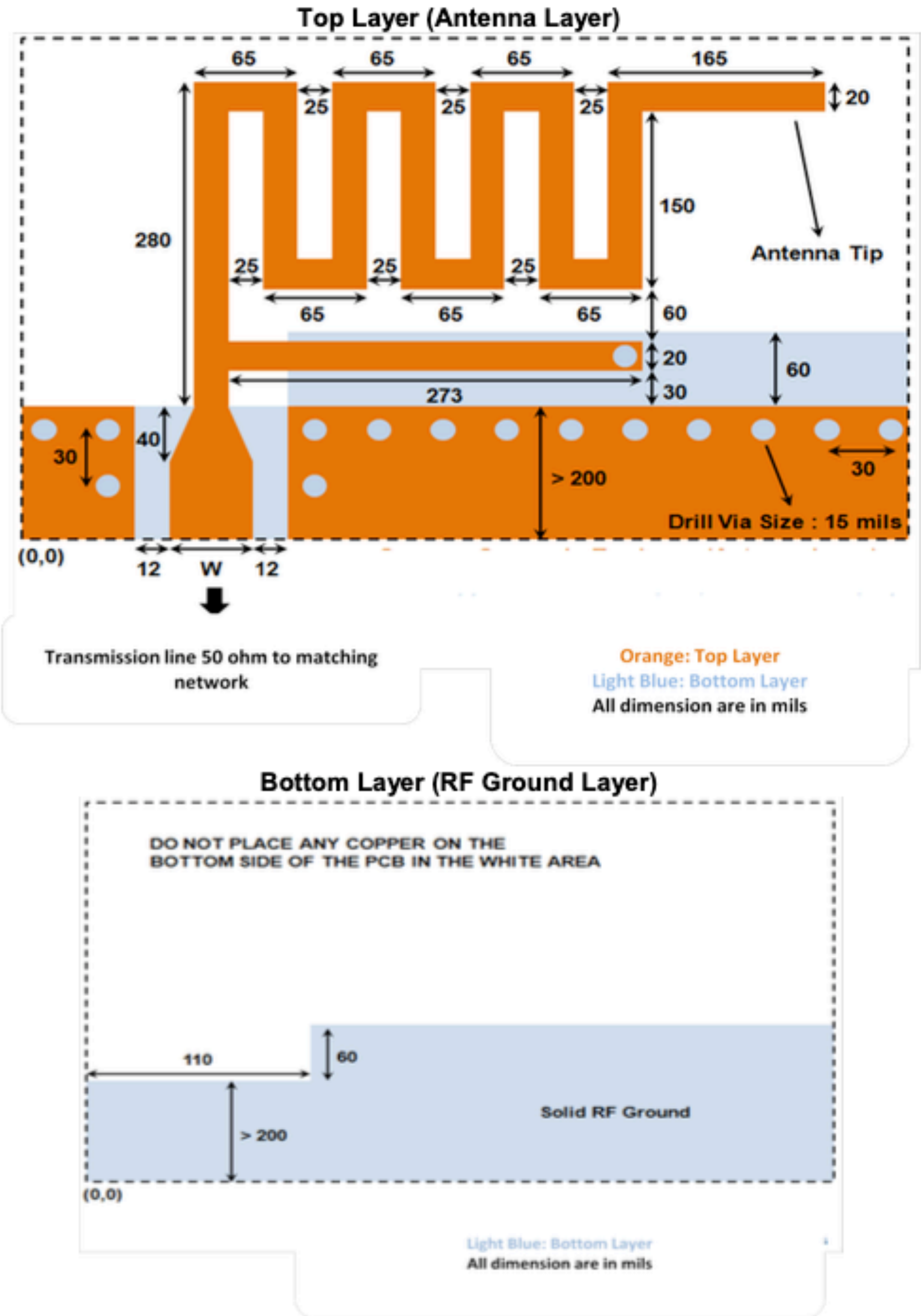


X-Y　　Y-Z　　X-Z

Meandered Inverted-F Antenna (MIFA)

The MIFA is a popular antenna widely used in human interface devices (HIDs) because it occupies a small PCB area. Cypress has designed a robust MIFA that offers an excellent performance with a small form factor. The antenna size is 7.2 mm × 11.1 mm (284 mils × 437 mils), making it suitable for HID applications such as a wireless mouse, keyboard, or presenter. Figure 10 shows the layout details of the recommended MIFA, both top layer and bottom layer in a two-layer PCB. The antenna trace-width is 20 mils throughout. The main parameter that would change, depending on the PCB stack spacing, is the value of "W," the RF trace (transmission line) width.

Figure 10. MIFA Layout



Antenna Feed Consideration

Table 2 provides the "W" value for different PCB thicknesses between the top and bottom layers for a two-layer FR4 substrate (relative dielectric constant = 4.3) for coplanar waveguide model. The top layer contains the antenna trace; the bottom layer is the immediate next layer containing the solid RF ground plane. The remaining PCB area of the bottom layer can be used as a signal ground plane (for the PRoC/ PSoC and other circuitry). Figure 11 relates the PCB thickness to "W" for a typical two-layer PCB.

Table 2. Value of "W" for FR4 PCB: Thickness Between Antenna Layer and Adjacent RF Ground Layer

Thickness (mils)	W (mils)
60	65
50	59
40	52
30	44
20	33

Figure 11. Clarification of PCB Thickness

For the small length of PCB trace that feeds the antenna, the width requirement can be relaxed. Ensure that the antenna trace width and the antenna feed connection have the same width. Figure 12 shows one such case where the trace width feeding the antenna is not as wide as recommended in Table 2.