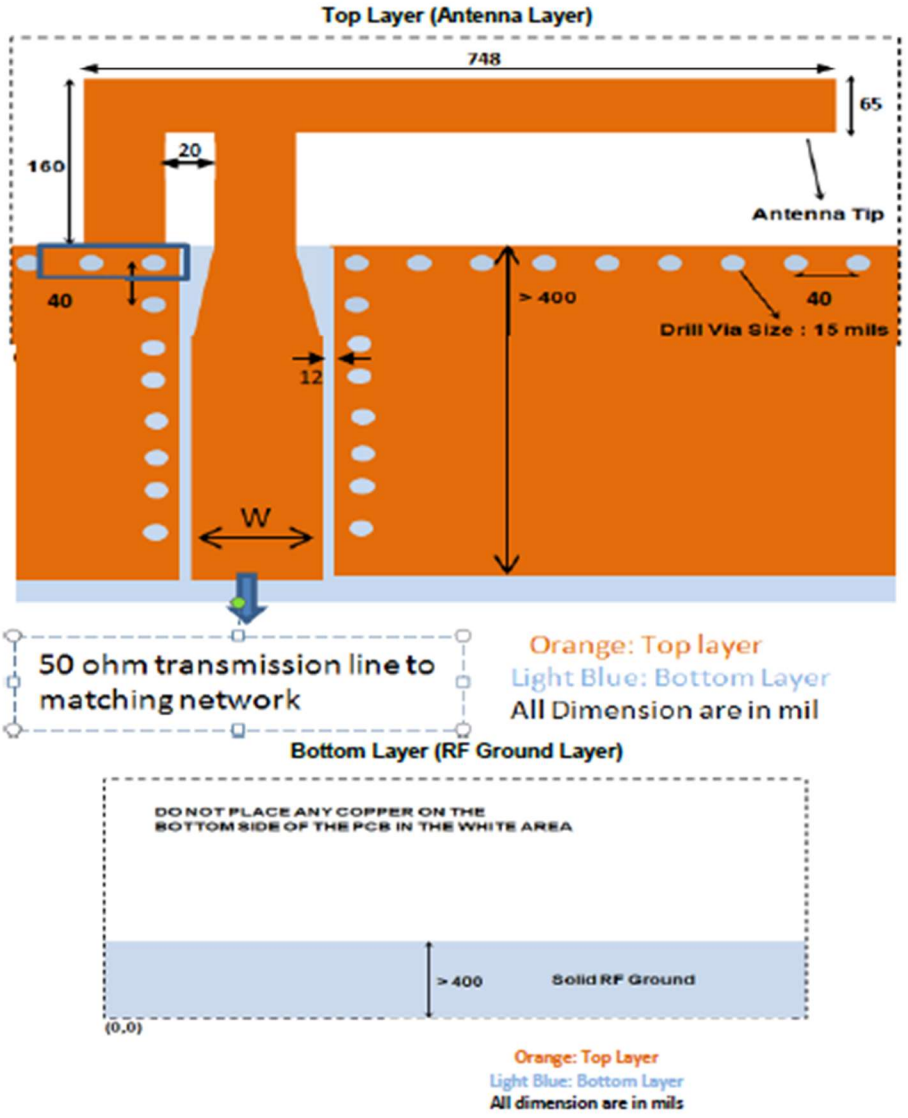
- Design follows Cypress application note: 'AN91445 – Antenna Design and RF Layout Guidelines'
  - Sections 7.4 - Inverted-F Antenna : Section 10 – Antenna Comparison Table 5-column IFA

7.4 Inverted-F Antenna (IFA)

IFA is a better antenna compared to MIFA for radiation. Given space availability IFA antenna is a better antenna than a MIFA antenna. It has better efficiency. However, it requires more area compared to MIFA.

The IFA is recommended for applications in which one of the antenna dimensions is constrained, such as in a heart rate monitor. Figure 16 shows the layout details of the recommended IFA, both top layer and bottom layer, in a two-layer PCB. The trace width is 24 mils. The IFA is designed with a size of 4 mm × 20.5 mm (157.5 mils × 807 mils) for an FR4 PCB with a 1.6-mm thickness. The IFA has a larger aspect ratio (width to height) than the MIFA.

Figure 16. IFA Layout



Note: The Gerber file (as well as the *.brd* file) for an FR4 PCB with 1.6-mm thickness is provided in the *AN91445.zip* file at www.cypress.com/go/AN91445.

As explained for the MIFA antenna, the feed trace width "W" is dependent on the PCB stack of the product. Table 4 provides the "W" value for different PCB thicknesses between the top layer (antenna layer) and bottom layer (adjacent RF ground layer) for an FR4 substrate (relative dielectric constant = 4.3) for coplanar waveguide model.

Table 4. Value of "W" for FR4 PCB: Thickness between Antenna Layer and Adjacent RF Ground Layer for 50-ohm Impedance

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

For short traces less than 3 mm, the width of the trace for antenna feed can be relaxed. The antenna feed can be of the same width as the antenna trace; see Figure 12. Please refer to coplanar wave guide calculator in Appendix B for the calculation of width for Coplanar transmission line.

The bandwidth ($S_{11} \leq -10$ dB) of the IFA is 220 MHz around 2.44 GHz, as shown in Figure 17.

Figure 17. S_{11} of the IFA (Return Loss = -S_{11})

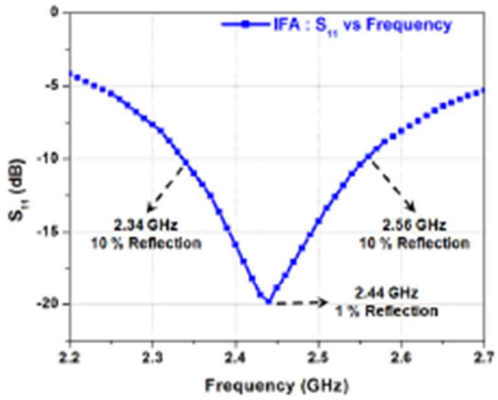
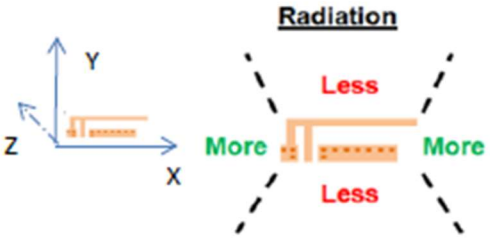


Figure 18 shows the qualitative radiation pattern of an IFA in the XY plane. This information is helpful in placing the IFA suitably for custom applications to maximize the radiation in the desired direction. For the sake of brevity, only a qualitative radiation direction is shown. For detailed radiation patterns in all XY, YZ, and ZX planes, contact Cypress Technical Support.

Figure 18. Qualitative 2D Radiation Gain Pattern for IFA



10 Antenna Comparison

Use Table 5 as a quick reference to select the appropriate antenna for your application.

Table 5. Comparison of MIFA, IFA, Chip, and Wire Antennas

Properties at 2.44 GHz	MIFA	IFA	Chip Antenna	Wire Antenna
Appearance				
Recommended Applications	Less Area (Mouse, Keyboard, Presenter)	Height Constrain (Heart Rate Monitor)	Small Area (Nano Dongle, BLE Module)	More Height (6 mm) (3D) (Sensor Hub)
Dimensions (mm)	7.2 x 11.1	4 x 20.5	3.2 x 1.6	6 x 30
Dimensions (mils)	284 x 437	157.5 x 807	126 x 63	250 x 1200
Gerber File	Web	Web	Refer to datasheet	
Cost (US$)	Minimal	Minimal	0.1–0.5	0.1
Bandwidth (MHz) ($S_{11} \leq -10$ dB)	230	220	200	200
Gain (dBi)	1.6	1.1	0.5	2