8 Design Guidelines

The DA14535 SmartBond TINY™ Module comes with an integrated PCB trace antenna. The antenna area is 12x4 mm. The antenna's Voltage Standing Wave Ratio (VSWR) and efficiency depend on the installation location.

The radiation performance of the PCB trace antenna depends on the host PCB layout. The maximum antenna gain is -0.5 dBi when installed on a 50x50 mm reference board, as shown in Figure 21. The radiation pattern is omnidirectional. The RF front end is optimized to achieve the maximum possible efficiency for various installation positions of the module on a host PCB. To obtain a similar performance, follow the guidelines described in the following sections.

8.1 Installation Location

For optimum performance, install the module at the edge of a host PCB with the antenna edge facing out. The module can be located on either of the outer corners or the middle of the host PCB with equivalent performance.

The antenna should have 4 mm free space in all directions. Copper or laminate in the proximity of the PCB trace antenna will affect the efficiency of the antenna. Laminate or copper under the antenna should be avoided as it severely affects the performance of the antenna. The antenna keep-out area can be seen in Figure 11.

Metals close to the antenna will degrade the antenna's performance. The amount of degradation depends on the host system's characteristics.

Table 10 summarizes the antenna efficiency at different installation locations on a host PCB as shown in Figure 10.

Table 10: Antenna Efficiency vs TINY™ Module Positions

	Position # 1 (Left)		Position # 2 (Middle)		Position # 3 (Right)	
Freq	Antenna efficiency		Antenna efficiency		Antenna efficiency	
[MHz]	[%]	[dB]	[%]	[dB]	[%]	[dB]
2405	52	-2,8	40	-4,0	40	-4,0
2440	46	-3,4	34	-4,7	41	-3,9
2480	50	-3,0	40	-4,0	52	-2,8

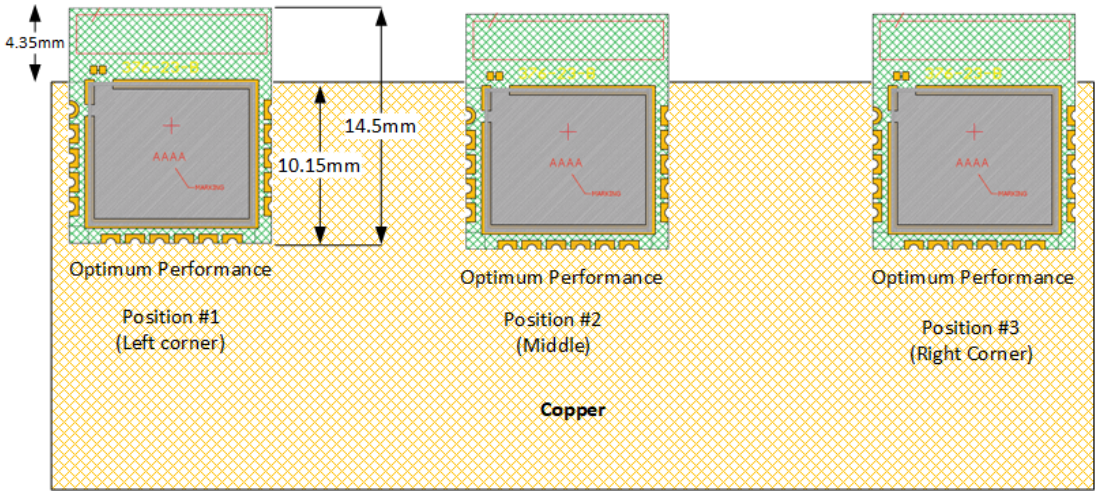

Figure 10: Installation Locations for Optimum Antenna Performance

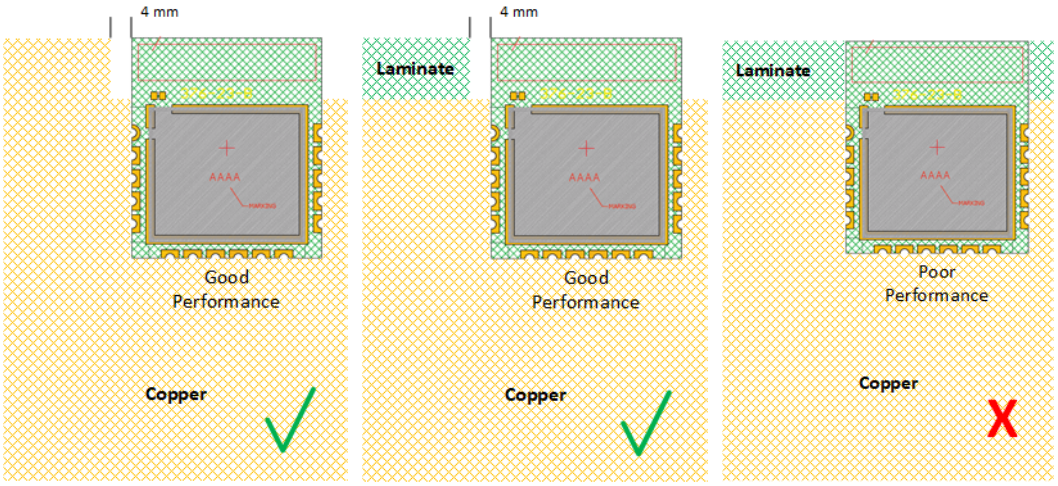

Figure 11: Antenna Performance in Proximity of Copper (Left), Laminate (Middle), and Laminate under Antenna (Right)

The actual TINY™ module evaluation board layout that has been used to conduct measurements is shown in Figure 12.

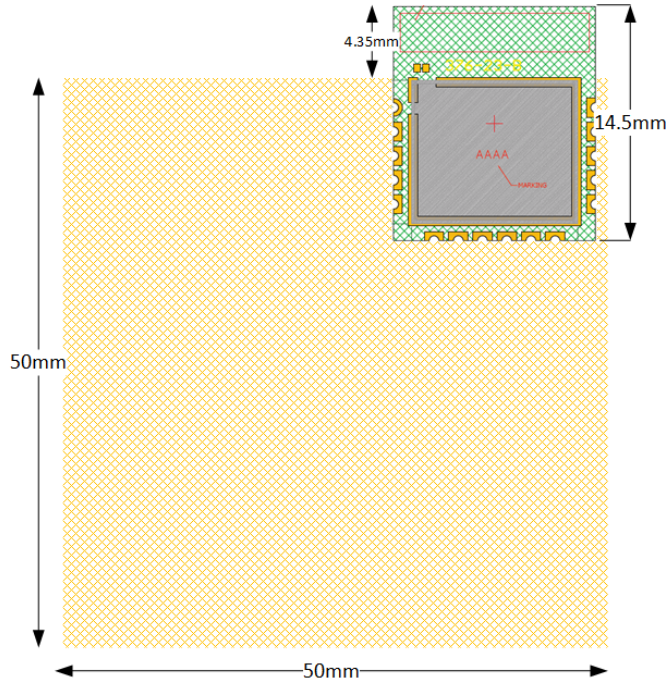

Figure 12: DA14535 TINY™ Module Evaluation Board

8.2 Antenna Graphs

The antenna VSWR measurements for the three installation positions are shown in the following figures.

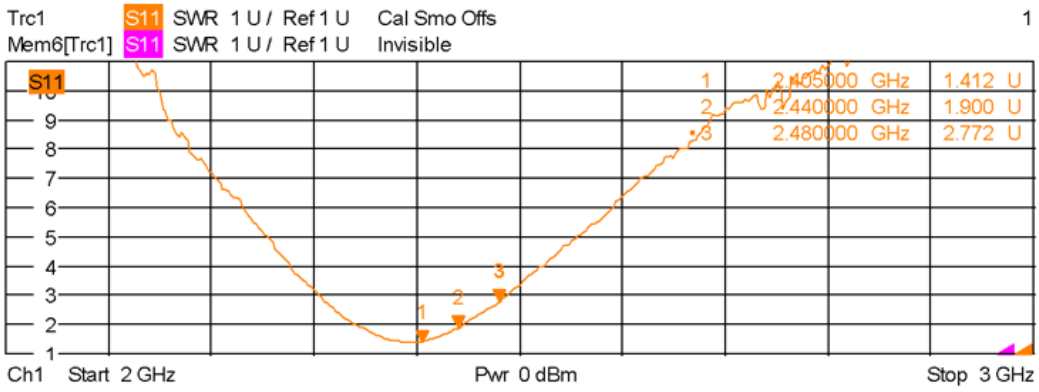

Figure 13: VSWR Installed in the Upper Left Corner (Position #1) of Evaluation Board

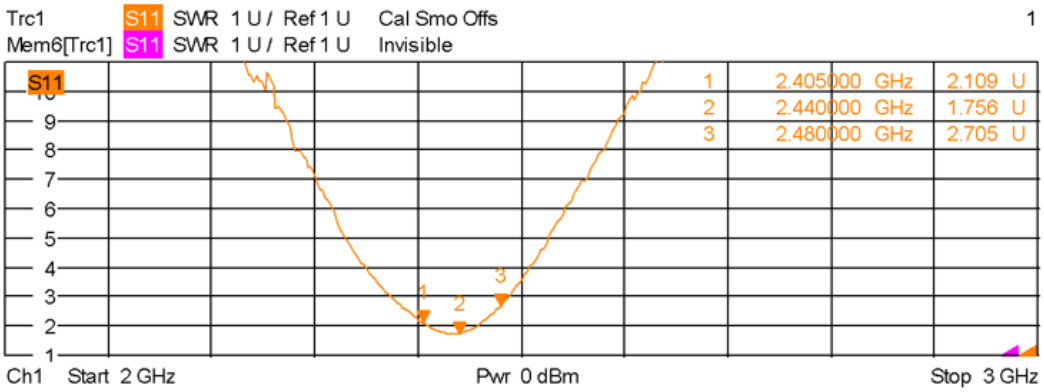

Figure 14: VSWR with Module Installed in Center (Position #2) of the Evaluation Board

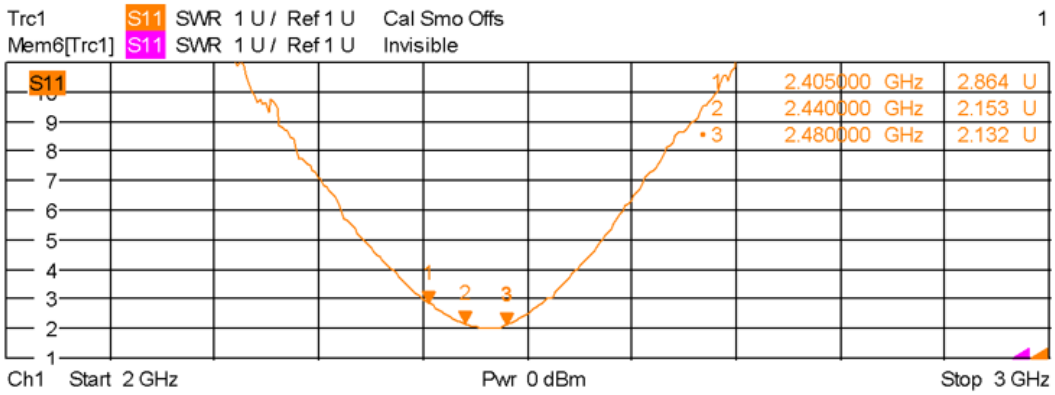

Figure 15: VSWR with Module Installed in the Upper Right Corner (Position #3) of the Evaluation Board

8.3 Radiation Pattern

The antenna radiation pattern measurements are carried out in an anechoic chamber. Radiation patterns are presented for three measurement planes: XY-, XZ-, and YZ- planes with horizontal and vertical polarization of the receiving antenna.

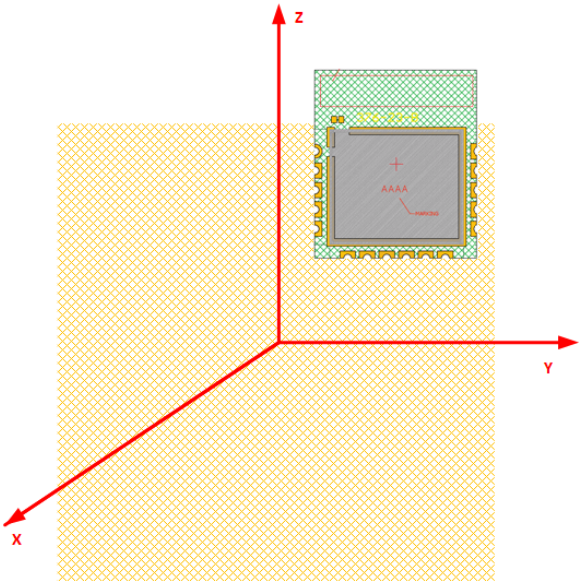

Figure 16: Measurement Plane Definition

Measurements are carried out for the module installed in the upper right corner on the reference board with no laminate below the antenna trace.

Radiation Pattern for Antenna Trace	
Horizontal polarization	**Vertical polarization**
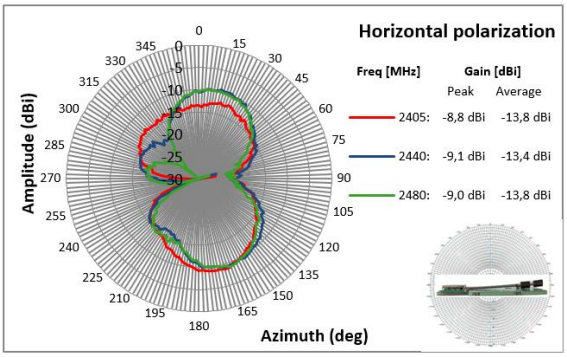	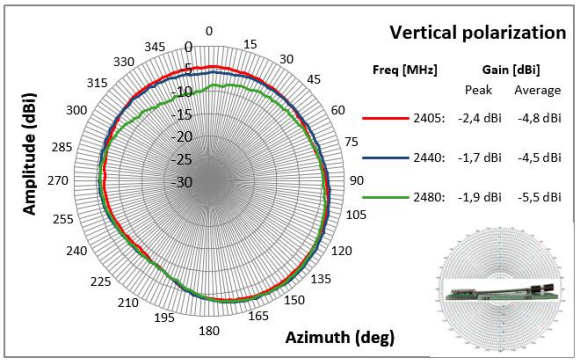
Figure 17: Radiation Pattern for XY-Plane, Horizontal Polarization	**Figure 18: Radiation Pattern for XY-Plane, Vertical Polarization**
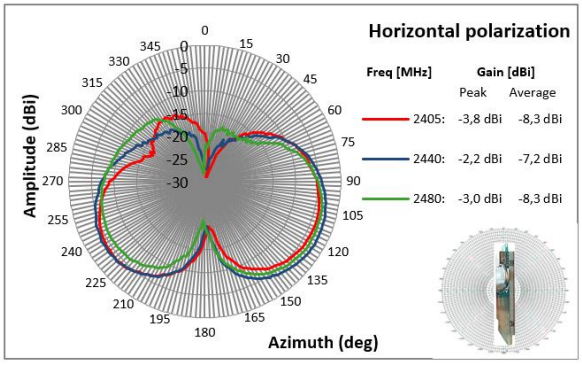	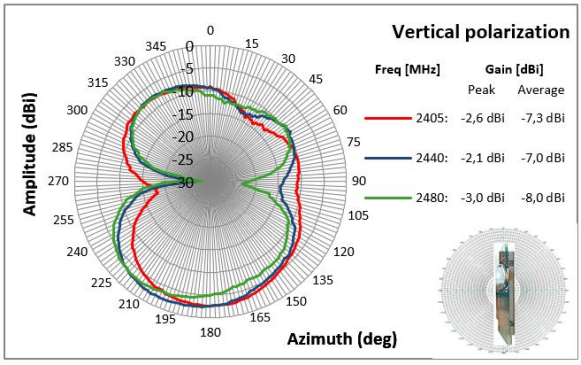
Figure 19: Radiation Pattern for XZ-Plane, Horizontal Polarization	**Figure 20: Radiation Pattern for XZ-Plane, Vertical Polarization**
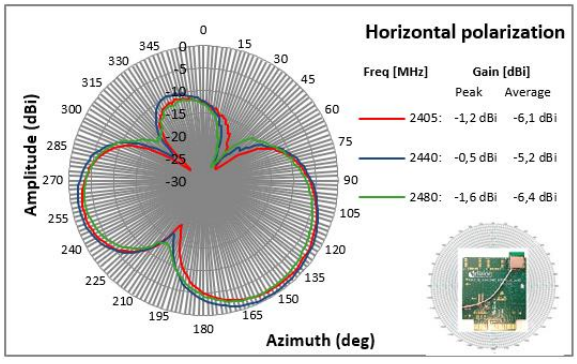	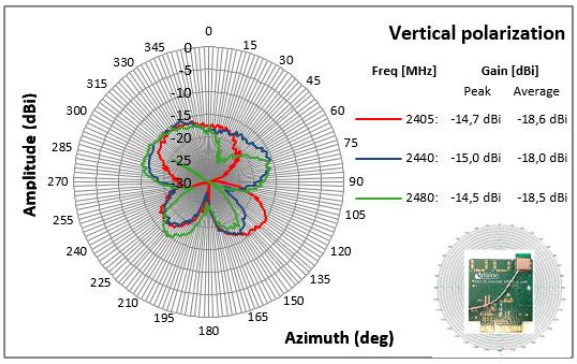
Figure 21: Radiation Pattern for YZ-Plane, Horizontal Polarization	**Figure 22: Radiation Pattern for YZ-Plane, Vertical Polarization**