



INSTALLATION AND INTEGRATION GUIDE

EMB-910004

Dual-Band Dipole Antenna
for 2.4/5 GHz Wi-Fi

Embedded Wi-Fi Antennas



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Referenced Documents

Document	Description
PCTEL® EMB-910004 Datasheet	Dual-Band Dipole Antenna for 2.4/5 GHz Wi-Fi

1. Overview

EMB-910004 is a dual-band dipole antenna assembly that covers the 2.4 and 5 GHz Wi-Fi bands. It is designed for use in products that require an embedded antenna that operates independent of a metallic surface or ground plane. The element is tuned to be mounted to a plastic carrier and is terminated in a micro-coaxial cable having a U.FL-style connector.

The purpose of this document is to help end users install and properly integrate the assembly to ensure quality RF performance. The forthcoming sections describe how to mechanically secure and properly integrate the antenna assembly.

Additional information can be found in the PCTEL EMB-910004 Datasheet.

2. Host Interface

EMB-910004 is terminated in a U.FL-style plug connector following a six-inch run of micro-coaxial cable. The host interface must be a surface mount U.FL-style receptacle in order to mate with the plug connector. PCTel recommends using surface mount receptacle U.FL-R-SMT-1 that is supplied by Hirose Electric Co., Ltd. It is a 50 Ω characteristic impedance part that can be used to transition from a coaxial transmission line to microstrip or to another planar transmission line.

3. Securing the Antenna

EMB-910004 is tuned to be mounted to a 2.5 [mm]-thick plastic carrier that is 46 [mm] long by 29 [mm] wide. The assembly is fastened to the carrier using heat-stakes or #4-40 mounting hardware. An exploded view of the mounting hardware is given in Figure 1 below. The plastic carrier could be a wall of the enclosure or an auxiliary construct.

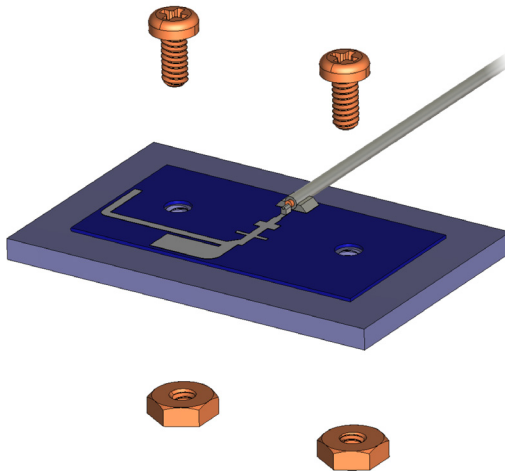


Figure 1: Exploded view of EMB-910004 and its associated mounting hardware.

4. Integration

4.1. Orientation

Care must be taken in the integration of embedded antennas and the first point to consider is the orientation of the antenna element within the wireless product. Proper orientation of an antenna element matches the radiation pattern of the antenna to the target coverage area of the application. The simulated three-dimensional radiation pattern of EMB-910004 at 5.5 GHz is given below in Figure 2.

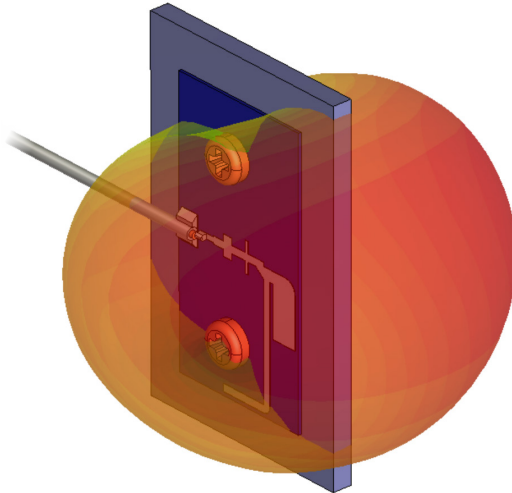


Figure 2: Three-dimensional radiation pattern of EMB-910004.

Observe that the antenna pattern is slightly directional, pointing in the direction away from the coaxial cable. The design consists of 2.4 GHz and 5 GHz dipoles and a 5 GHz reflector. The use of a reflector produces a slight directionality in the 5 GHz radiation patterns and desensitizes the antenna to reflective surfaces, or obstructions, that are located behind the antenna in the direction of the cable. This allows the antenna to be placed in front of an external reflector to direct the radiated energy at 2.4 GHz (if desirable) without severely impacting the 5 GHz return loss and radiation patterns. Additionally, the slight directionality in the 5 GHz radiation patterns can be exploited to improve pattern diversity and increase the overall system coverage area when utilized in MIMO and MU-MIMO systems. An application example employing a MIMO diversity system is given in Section 5.

4.2. The Impact of Radome Proximity on Return Loss

The simulated return loss of the antenna is given below in Figure 3 for a variety of radome separations from EMB-910004, with the antenna mounted to the plastic carrier as defined in Section 3. It is assumed that the radome is 2.5 [mm] thick and is a polycarbonate/ABS blend. The radome separation is defined as the distance in millimeters between the bottom of the radome and the edge of the PCB (this is illustrated in Figure 4). Since, by design, the antenna is tuned to be loaded by a plastic carrier, the addition of more plastic further from the antenna does not significantly impact the return loss in the 2.4 GHz or 5 GHz bands. Additionally, the extent of the carrier, in the plane of the printed circuit board, does not significantly impact the return loss, so long as it spans the extent of the EMB-910004's printed circuit board.

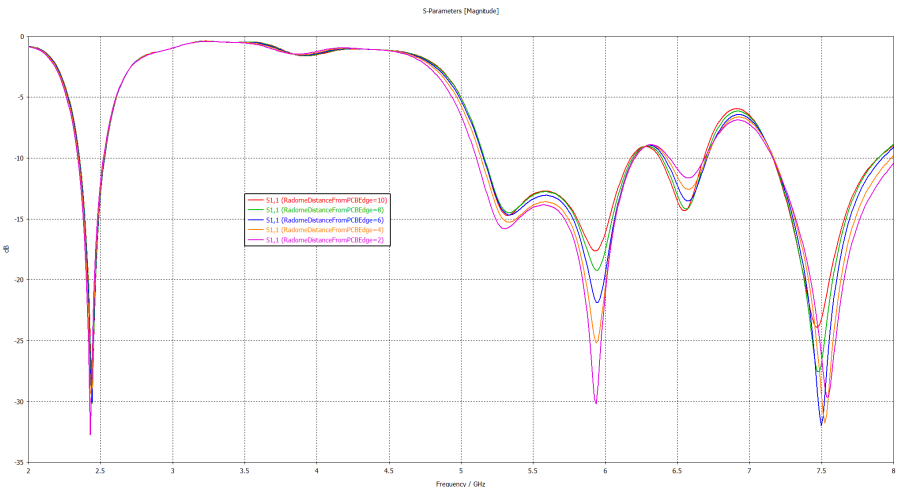


Figure 3: Return loss for various separations of the radome to the antenna PCB

4.3 Managing Obstructions

Metallic obstructions, if large enough, close enough, and oriented properly, will alter the radiation performance of any antenna. Still, EMB-910004 is resilient to the detuning effects of metallic obstructions, particularly over the 5 GHz band. In general, the total efficiency will not be affected by large metallic obstructions that are at least 1" from the edge of the antenna PCB even if the radiation patterns are changed. Ideally, the antenna should not be loaded from the dipole-edge by metal (where the radome is typically located, as shown in Figure 4).

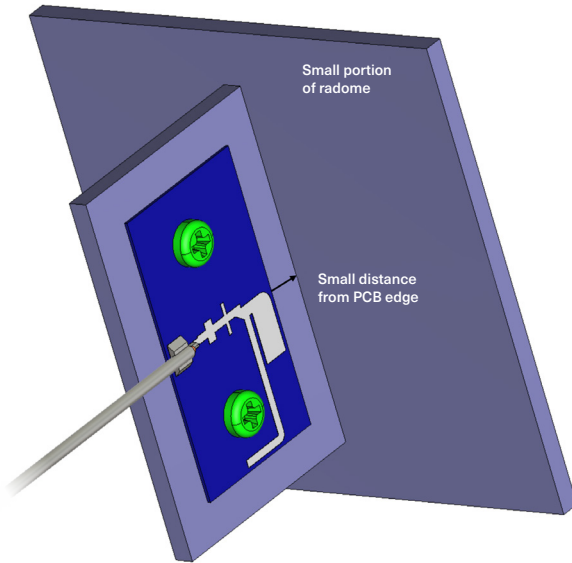


Figure 4: Simulation model used to explore the effect of radome proximity on return loss.

5. Application Example

Let's consider an application example of a compact Wi-Fi router that utilizes two EMB-910004 antennas. The simulation model consists of an enclosure, motherboard, heat sink, mount and two antennas that are heat-staked to the mount. The model is depicted below in Figure 5.

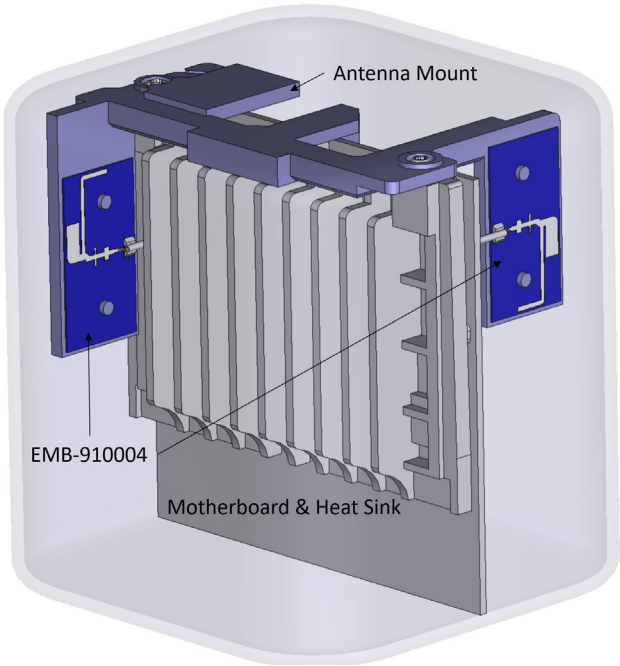


Figure 5: MIMO diversity system consisting of two EMB-910004 antennas.

Observe that the motherboard and heat sink are oriented vertically and present highly reflective surfaces that are situated close to the antennas. We deploy one EMB-910004 on each side of the motherboard to cover the space 360° around the router. The three-dimensional radiation pattern at 5.5 GHz of the EMB-910004 assembly deployed on the side of the heat sink is given in Figure 6. A top-view of the overlayed 5.5 GHz radiation patterns is provided in Figure 7. The results demonstrate excellent pattern diversity, shape, and complementarity. Furthermore, the motherboard acts to isolate (< -30 dB at 2.4 GHz) and decorrelate the antennas over both bands.

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We note that the placement of EMB-910004 near a large metallic surface will alter the tuning of the antenna, especially in the 2.4 GHz band. The extent of the detuning depends on the proximity to the surface – the closer the surface, the greater the change to the antenna's input impedance. PCTEL engineering can assist customers to properly integrate EMB-910004 to achieve good performance.

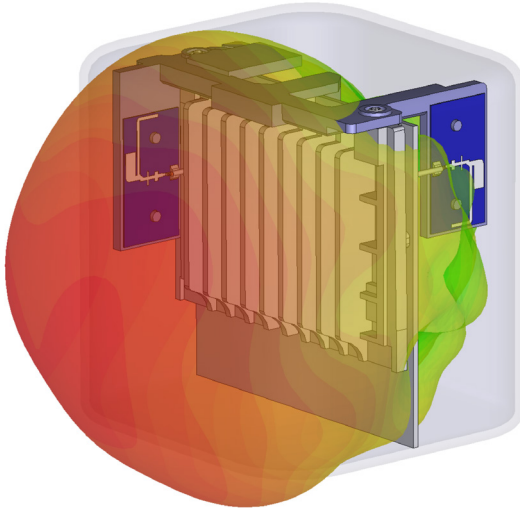


Figure 6: Three-dimensional radiation pattern of the EMB-910004 antenna deployed on the side of the heat sink.

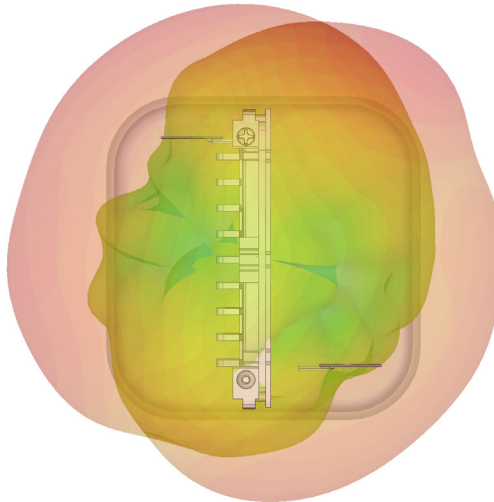


Figure 7: Overhead view of the overlaid three-dimensional radiation patterns.

6. Choosing the Right Embedded Antenna

The choice and proper integration of an embedded antenna is a custom exercise. Many wireless products possess significant mechanical and material differences that can complicate the integration of embedded antennas. Still, it is oftentimes possible to leverage aspects of the host product to achieve efficient operation and tailored radiation performance for the application. PCTEL is happy to assist with the selection, integration, and customization of embedded antennas. Please contact your local PCTEL sales representative for more information.

Product Usage

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