

Antenna Boosters versus Meander Antennas for Bluetooth Module Integration

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A comparative evaluation of an antenna booster and a meander antenna integrated into a 21×14 mm² Bluetooth module is presented. The performance of both antenna systems was assessed across four different positions on the main board (left corner, short-edge center, right corner, and long-edge center) and with three different PCB sizes (50×50 mm², 75×50 mm², and 100×50 mm²). A single matching network was applied for each antenna system across all positions to maintain a fixed bill of materials (BoM), ensuring compliance with certification requirements and reflecting real-world constraints where retuning after certification is not feasible. Additionally, both modules were evaluated in free space to establish a baseline comparison. Where the antenna booster achieved an average total efficiency of 48.4% in measurements, compared to 23.6% for the meander antenna.

When integrated into the main board, performance was further analyzed in all four positions for each of the three PCB sizes. The antenna booster consistently delivered higher simulated total efficiency across all configurations, achieving an average improvement of 2 dB in total efficiency compared to the meander antenna. For instance, at the left corner position, the antenna booster achieved 56.7% simulated total efficiency compared to 26.7% for the meander antenna. At the short-edge center position, where the meander antenna performed best, the antenna booster still outperformed it with 71.7% versus 59.6%. Similarly, at the right corner and long-edge center positions, the booster achieved 2.5 dB and 1.3 dB higher efficiency, respectively. The results highlight the resilience of the antenna booster to positional variations, as its performance remained more stable compared to the meander antenna, which exhibited significant frequency shifts depending on placement.

Experimental validation confirmed that antenna boosters outperform meander antennas across all module positions. Achieving an average total efficiency improvement of 3.2 dB when the meander is placed in the left corner, 0.8 dB when placed on the short-edge, 2.5 dB on the right corner, and 1.3 dB on the center of the long-edge. Achieving an average measured total efficiency improvement of 2 dB, when the modules are mounted on a 100×50 mm² PCB. Antenna Boosters increased bandwidth and improved current distribution provide a more robust solution for Bluetooth module designs.

These findings underscore the superior performance and robustness of antenna boosters for Bluetooth module integration in practical use cases, especially in scenarios where the module's final placement and PCB size are uncertain.

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