

A Tightly Coupled Monopole Array with Improved Bandwidth and Simplified Structure

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This paper presents a novel tightly coupled monopole array (TCMA) featuring enhanced bandwidth and simplified architecture. The proposed antenna array unit-cell achieves an operating bandwidth of 12.25:1, maintaining active VSWR < 2.7 and simulated radiation efficiency exceeding 90% across the entire frequency range. Analysis of low-frequency loop resonance reveals that TCMA demonstrate superior bandwidth potential compared to conventional tightly coupled dipole arrays. The unit-cell design comprises three essential components: a radiator, a tapered balun, and a superstrate, as illustrated in Fig. 1. The radiator incorporates a monopole with a tightly coupled plate to achieve optimal inter-element coupling. A standard linear tapered balun provides the feed network, while the superstrate, positioned above the radiator, enhances impedance matching characteristics.

Ultra-wideband antenna arrays find extensive applications in communication systems and advanced wideband radars. Tightly coupled arrays, characterized by strong capacitive coupling between adjacent elements, have emerged as promising candidates for these applications due to their wide bandwidth capabilities and low-profile architecture, making them suitable for integration into mobile platforms such as aircraft. Previous work has demonstrated a tightly coupled dipole array utilizing a resistive sheet, achieving a 13.9:1 bandwidth [W. F. Moulder, K. Sertel and J. L. Volakis, *IEEE Transactions on Antennas and Propagation*, vol. 61, no. 11, pp. 5802-5807, Nov. 2013]. However, this design suffers from reduced radiation efficiency due to the inherent losses in the resistive sheet. Another approach employing a lossless frequency selective surface achieved a 13.66:1 bandwidth [H. Tang et al., *IEEE Open Journal of Antennas and Propagation*, vol. 2, pp. 1087-1097, 2021], but exhibited high cross-polarization levels.

To overcome these limitations while maintaining broadband performance, we propose a novel TCMA design that eliminates the need for lossy materials or frequency selective surfaces between the radiators and ground plane. This approach achieves comparable bandwidth while demonstrating superior radiation efficiency compared to designs incorporating lossy materials. Furthermore, the proposed design exhibits enhanced polarization purity relative to implementations based on polarization converters. The proposed design concept has been validated experimentally.

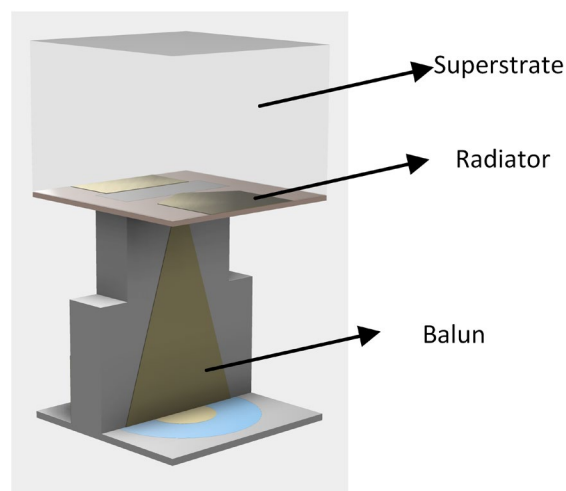


Figure 1. The general schematic of the proposed TCMA unit-cell.