

Antenna decoupling based on coupled transmission line

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With the continuous emergence of emerging application driven by the fifth-generation (5G) and even next-generation wireless communication technologies, such as smart wearables, smart homes and telemedicine, the multiple-input multiple-output (MIMO) technology has demonstrated great value in aspects like expanding channel capacity and improving signal transmission quality. Currently, MIMO technology has already become the cornerstone for building high-speed and highly stable 5G and future wireless communication systems. In recent years, wireless terminal devices adapted to the above applications have increasingly pursued miniaturization and portability, which has led to antennas having to be placed closer to each other and consequently facing more serious mutual coupling problems. These problems have set numerous obstacles to the performance improvement of MIMO communication systems, and also made it extremely urgent to build compact multi-antenna systems. In this context, exploring practical methods to reduce the mutual coupling between antennas has already become a challenging yet crucial task, which is of great significance for MIMO wireless systems to achieve wideband, low-interference and high-efficiency transmission.

To solve these problems, We propose a clear two-step method for antenna decoupling and matching based on odd-even mode theory to simplify MIMO antenna design. Finally, we constructed a broadband printed monopole antenna pair with high isolation. First, we adjust the element spacing to match the OM (odd-mode) input impedance. Then we add a coupled transmission line to match the EM (even-mode) input impedance. In the above two-step decoupling method, the OM and EM input impedances can be adjusted independently. The non-dispersive coupled transmission line enables broadband decoupling and allows for an extremely small feed-point spacing. As a result, the proposed antenna achieves over 20 dB isolation and over 87% total efficiency from 3.7 to 7.3 GHz (65.5%). The feed-point spacing is only 5.6 mm (0.069λ at 3.7 GHz). Furthermore, in order to make the design process of the decoupling network intuitive and efficient, we have also constructed an antenna decoupling network based on cascaded coupled transmission lines (CTLs). We map the OM and EM characteristic impedances of the CTL onto the Smith charts of the antenna's OM and EM input impedances, which enables the CTL parameters (OM and EM) required for antenna decoupling to be determined intuitively. After adding the CTLs, the isolation of the antenna increases from 5 dB to above 15 dB, covering the frequency band from 3.24 GHz to 3.88 GHz (with a bandwidth of 18.0%). The peak isolation exceeds 30 dB. Moreover, the antenna efficiency in this frequency band rises from around 60% to over 85%, peaking at 95%. This method greatly simplifies the complicated optimization and trial-and-error processes in traditional designs and has great potential in 5G and future communication systems.