

# Mutual Coupling Reduction in Aperture-Coupled Patch Antennas Fed by Orthogonal SIW Line by Metasurface

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Millimeter wave frequencies (30-300 GHz) are of increasing interest for various applications including imaging. For an imaging system, antennas (microstrip or slot antennas) with an orthogonal feed line is of significant interest due to the limited availability of space in a closely-packed 2D array. For a conventional waveguide feed line, the large size of the feeding waveguides results in large antenna spacing, which leads to grating lobes when utilized in an array configuration or under sampling (based on Nyquist sampling) problems for imaging systems. Hence, a substrate integrated waveguide (SIW) feed line can be utilized as an effective alternative to conventional waveguides in order to overcome these limitations and used to design a compact feeding network. Thus, in spite of the higher dielectric loss compared to a conventional waveguide feed line, smaller waveguide dimensions can be achieved to meet the requirement of imaging systems. However, since each antenna (in an imaging system) is excited through the coupling aperture from the orthogonal feed line, mutual coupling (resulting from the aperture coupling) between two adjacent antennas is inevitable. The main coupling mechanism can be explained as a result of the leakage of the electric field (used to excite the corresponding microstrip patch antenna) that couples to adjacent antennas. Since this coupling can deteriorate the obtained image (for both near-field and far-field imaging), an artificial impedance surface (i.e., metasurface) can be utilized to compensate or cancel its effect. A metasurface is an electromagnetic structure that acts as a reactive surface impedance. This structure can be designed to interact with the electromagnetic fields in order to achieve a desired response (here, acting as a bandgap structure for the coupled electric field and therefore reducing the mutual coupling between two adjacent antennas). As such, by integrating a metasurface with the aperture-coupled patch antenna fed by orthogonal SIW line, a closely-packed 2D array of antenna for millimeter wave imaging applications can be achieved. The proposed orthogonally-feed antenna is designed to operate at 30 GHz. The mutual coupling between two adjacent elements for both vertical and horizontal adjacent elements will be presented with and without the inclusion of a metasurface in the design.