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The Ground Plane Mirror

The integration of small antennas into modern devices presents engineers and designers with a variety of challenges. One of the most important yet often overlooked components is the ground plane of the printed circuit board. If we think of the antenna as a kind of mirror, the ground plane is a crucial part of the antenna that significantly influences its radiation behavior. A ground plane that is too small can severely affect antenna performance, much like a mirror that is too small to reflect the entire image.

This principle applies to all antenna technologies: whether resonant structures on a PCB, chip antennas, or resonator antennas, the ground plane is crucial. In resonant structures, it acts as the "second pole," influencing radiation just as much as the radiator. For chip and resonator antennas, the ground plane itself becomes a radiating element.

For small antennas in portable devices or compact solutions, the ground plane's size and properties are vital for performance. An undersized ground plane reduces efficiency and weakens antenna performance.

Optimizing Antenna Performance with Characteristic Mode Analysis (CMA)

The geometric dimensions of the PCB directly influence the modes that can be excited on the ground plane. Precise design and mode analysis are essential. At Quarterwave, we use Characteristic Mode Analysis (CMA) to identify the frequency ranges where the antenna achieves maximum efficiency. This helps us understand how PCB dimensions affect radiation behavior.

CMA is particularly useful when design goals are not fully met, allowing for performance compromises. It guides the selection of the best antenna for a specific application and optimizes antenna placement. In MIMO applications, CMA improves decoupling through orthogonal modes.

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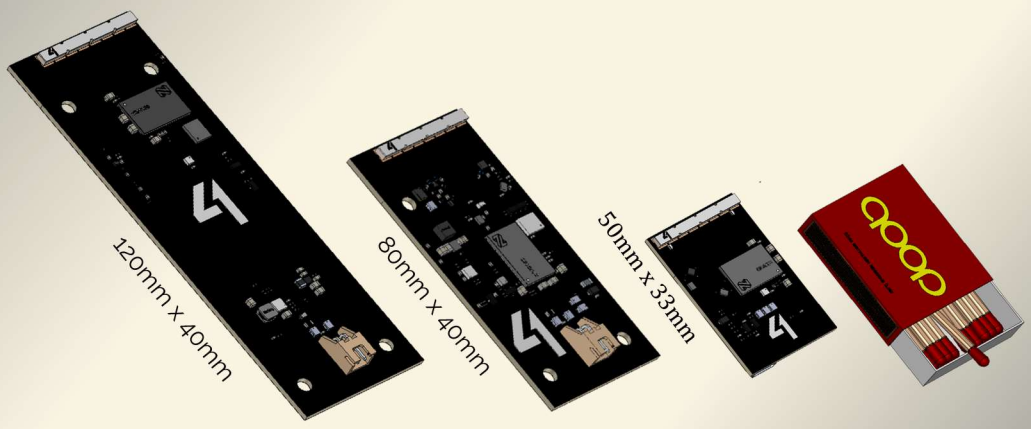
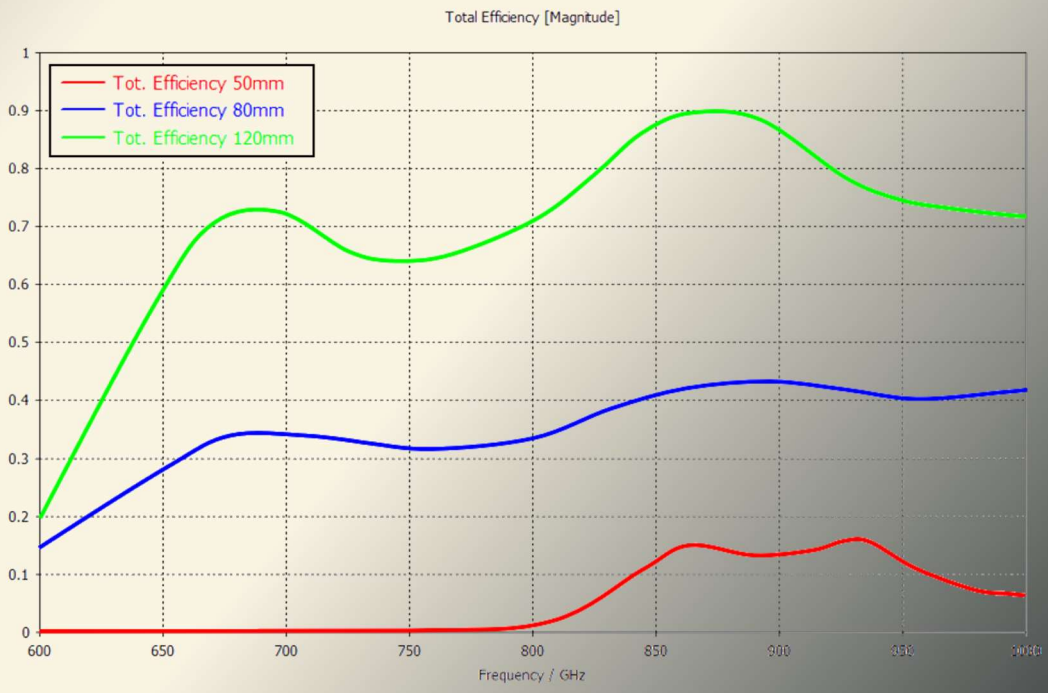
Invisible Power Visible Impact

A clear example of this challenge is reflected in the various PCB sizes we have specifically developed and optimized for our Quarterwave chip antennas, tailored for tracker applications. In these applications, GPS data is captured and transmitted to the cloud via NB-IoT, a cellular communication technology. These solutions require both a GPS antenna and a suitable LTE antenna, optimized for the widely used LTE bands B20 (800MHz) and B8 (900MHz). Our innovative solution integrates both functionalities, with a single chip antenna supporting both GPS and NB-IoT bands.

The challenge with these low frequencies is that smaller PCB sizes, and consequently smaller ground planes, impair antenna performance. This makes the design of small antennas for these frequencies particularly challenging, as the limited size of the ground plane does not provide enough support to ensure optimal antenna performance.





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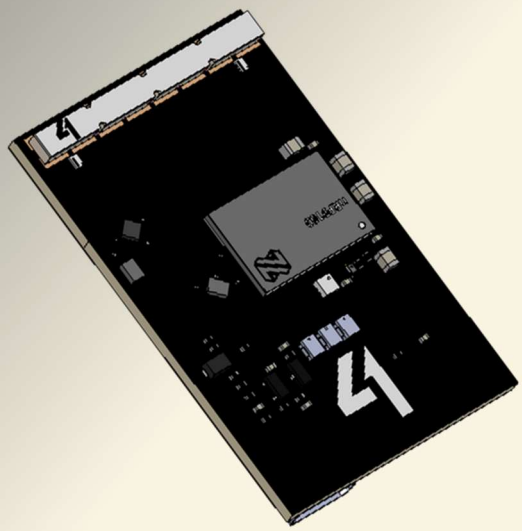
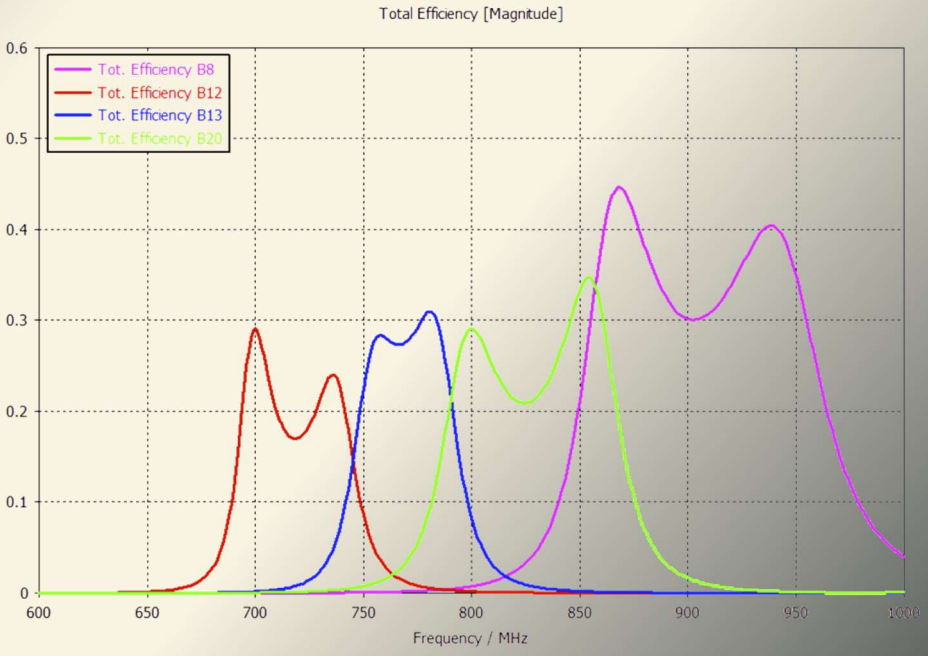
The Future of Efficient Antennas

To overcome the challenges of small ground planes, Quarterwave has developed a solution that significantly enhances antenna efficiency. Our Quarterwave chip antenna is designed for compact PCBs, roughly the size of a matchbox, where achieving sufficient efficiency is particularly challenging. Conventional chip antennas and similar technologies in this size range, especially for lower cellular bands, often have efficiencies of no more than 15%. Another issue is their narrowband nature.

Our solution surpasses conventional designs by incorporating an intelligent matching circuit, boosting efficiency by up to 30% across multiple bands. This allows optimization for the B20 and B8 bands within a highly compact form factor.

Through precise design, efficient ground plane utilization, and advanced matching circuitry, we achieve up to 30% efficiency for B20 and B8 frequencies in a PCB size no larger than a matchbox. This results in higher efficiency and more reliable performance compared to traditional chip antennas.





Conclusion: Ground Plane – Key to Antenna Efficiency

The ground plane and precise design are critical for small antenna performance. A sufficiently large and continuous ground plane is essential to maximize efficiency and achieve optimal radiation characteristics, particularly when integrating antennas into portable devices and low-frequency applications.

At Quarterwave, leveraging Characteristic Mode Analysis allows us to create custom antenna designs that exceed standard solutions. With innovations like our chip antenna and intelligent matching circuit, we deliver superior performance and efficiency, enabling the integration of small antennas into complex applications without compromising size.

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