

# DockOn<sup>®</sup> CPL Antennas Overview



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## DockOn<sup>®</sup> low-cost, high-efficiency CPL Antennas

QuantalRF is the innovator of the unique, patented Compound Planar Loop (CPL) antenna representing a breakthrough in two-dimensional, commercially viable antenna technology, offering simplicity in manufacturing through conventional PCB processes.

### Key Features of CPL Antenna Elements

CPL Antenna Elements can be seamlessly integrated into existing applications, either embedded directly on an existing substrate or mounted externally with or without a ground plane. This paper provides an overview of the capabilities of the CPL antenna and its advantages over traditional antenna designs.

### CPL Antenna Design

The CPL concept enables the combination of multiple electrically small radiating elements to excite both Transverse Electric (TE) and Transverse Magnetic (TM) modes, thereby achieving superior performance, such as higher radiation intensity and bandwidth, within smaller form factors. A basic CPL element consists of at least one electric radiator and one magnetic radiator operating orthogonally to minimize reactive power across a certain bandwidth. The configuration can be optimized depending on the application, frequency band, radiation specifications, and feeding structure. This synergistic approach can result in a higher radiation efficiency and/or higher gain in comparison with conventional single element antennas.

### Efficiency and Size Advantages

CPL antennas exhibit high efficiencies, often exceeding 80%, when designed to their optimal size. The optimal size of a CPL antenna can vary depending on the number and the location of radiating elements. For a basic CPL element with single electric/magnetic radiators, this optimal size is approximately a quarter wavelength. However, this size can be significantly reduced (e.g., to about one-eighth of a wavelength) using capacitive loading and the presence of a ground plane. This reduction makes CPL antennas remarkably smaller than conventional antennas, such as dipoles, patches and PIFAs.

### Integrated Balun

CPL elements can easily adapt to both balanced and unbalanced designs and simplifying placement within applications. This integration of a balun also minimizes the impact of surrounding components and proximity to the human body.

### Tuning and Integration

The built-in balun makes impedance tuning straightforward with both a balanced and an unbalanced 50-ohm trace line from the RF source. Any necessary tuning adjustments are made within the CPL element itself, without altering the board layout or adding external components.

## Advantages of CPL Antenna Elements

- **Greater Efficiency:** Optimal size with efficiencies often above 80%.
- **Higher Gain:** Smaller size with higher gain values.
- **Compact Size:** Physically small, making integration easier.
- **Integrated Tuning:** Simplified tuning within the antenna element.
- **Cost-Effective Manufacturing:** Can be designed and manufactured in standard PCB materials.
- **Omnidirectional Patterns:** Planar design offering versatile patterns.
- **Versatile Substrate Use:** Compatible with various substrates like FR4, PTFE, and Rogers.
- **Easy Integration:** Seamless integration into diverse applications.

## Comparison with Other Antenna Types

### CPL vs. Patch Antenna

- **Size:** CPL antennas are significantly smaller; while patch antennas are typically between  $1/2$  to  $1/4$  wavelength, a CPL antenna is typically between  $1/4$  to  $1/8$  wavelength.
- **Pattern:** CPL offers omnidirectional or directional patterns, while patch antennas are typically directional.
- **Gain and Efficiency:** Efficiency, bandwidth, and gain of a patch antenna are intrinsically linked to the substrate material, substrate height, and the presence of a ground plane. CPL antennas, on the other hand, do not rely on substrates and/or ground planes.

### CPL vs. Planar Inverted F Antenna (PIFA)

- **Size and Ground Plane:** A CPL does not require a ground plane and provides remarkable versatility, whereas PIFA needs a substantial ground plane with limited design flexibility.
- **Pattern:** Both CPL and PIFA provide omnidirectional radiation patterns.
- **Gain and Efficiency:** CPL antennas do not require a ground plane, whereas the gain and efficiency of PIFAs are fundamentally dependent on having one.

## Conclusion

The CPL antenna element's compact size, high efficiency, and ease of integration offer significant advantages over traditional antenna designs. Its ability to be manufactured using standard PCB processes and integrated directly into various applications makes it a superior choice for modern communication needs.

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