

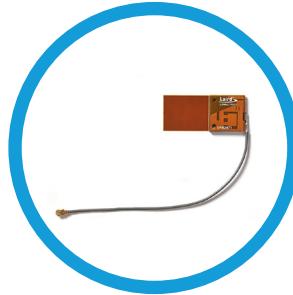
# Do You Know Your PIFAs?

An introduction to PIFA  
antenna technology and  
advantages Vs traditional  
omnidirectional antennas



Chris Boorman, Senior Product Manager,  
Laird Connectivity

# Do You Know Your PIFAs?



As technology continues to evolve, RF systems and wireless connectivity become more complicated. Industries expect higher data rates, lower latency, greater reliability, and performance. In the midst of this complication, antenna selection and integration – one of the most confusing aspects – is often simply an after-thought and added on towards the end of the design process. It's important to acknowledge that much of the success or failure of a RF system project depends on the performance of the associated antennas. RF design is certainly a challenge but following best practices and carefully considering the most effective antenna type for your design is critical.

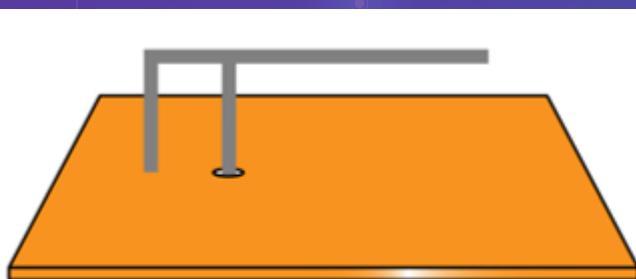
There is a plethora of available antennas to choose from depending on your industry, RF design, and wireless technology or application. Choosing the best type can be a daunting task. There is a wide selection of antennas of various sizes, shapes, performance, and cost – all factors that are important in your selection. With all these choices and the complexity of RF design, there is no one-size-fits-all antenna solution.

Understanding various types of antennas, how they function, and in what environment they best perform, may help you select the best antenna solution for your device or system. This white paper specifically focuses on one type of antenna – the planar inverted-F antenna known as a PIFA. In this paper, we discuss what it is, how it functions, the benefits of its design, and how it compares to some other common antenna types.

## WHAT IS A PIFA?

A PIFA antenna, as the name suggests, is a mirror image of a capital letter F that runs parallel to a ground plane when installed. This antenna type originated from the inverted-F antenna which is essentially a monopole antenna. The inverted-F antenna sits parallel to the PCB with the implementation of a short circuit arm (as shown in Figure 1).

The planar inverted-F, on the other hand, has a flat top plate instead of a single wire (as shown in Figure 2). A planar inverted-F antenna is made up of a radiating plate that sits above a ground plane via a feeding point and short circuit pin.



**Figure 1: Inverted-F antenna**



**Figure 2: Planar inverted-F antenna**

Traditionally, a PIFA is a ground-plane dependent antenna (unlike a dipole antenna which is ground-plane independent). Both its gain pattern and tuning rely on the ground plane. That being said, this type of antenna can often be used without a separate ground plane, making it even more versatile. Antenna expertise may be required to advise of the placement in non-ground plane locations.

# PIFA Advantages

PIFAs present a significant number of advantages as an effective antenna solution, especially when faced with challenging environments and placement. Recognizing these benefits can help you differentiate between this style of antenna compared to other options for your RF system design.

PIFAs tend to be more compact with a low profile. Because of their smaller size, PIFAs are commonly used in space-constrained devices and housings – as is the case with many of today's IoT wireless, handheld, and wearable devices. One significant benefit related to its size and structure is the fact that these antennas generally require a minimal amount of space on the PCB. Because a PIFA is positioned above and parallel to the PCB, the only space that is paramount is the area to which the mounting pins are attached.

This type of antenna is also relatively forgiving in terms of RF performance. It is also easy to tune and more importantly less likely to detune in the presence of other structures such as metal surfaces or in proximity to the human body.

In regard to actual performance, the bandwidth of PIFAs ranges from moderate to high depending on the type of environment or application for in which they are used. The PIFA design also brings with it an omnidirectional radiation pattern and mixed polarization. These performance factors can be significantly beneficial in environments that frequently shift or change such as mobile and wearable devices. PIFAs also perform exceptionally well in some more difficult RF environments. Consider a situation where an antenna is in close proximity to metal, for example. Where the metal acts as interference to some antennas, the PIFA can continue to function efficiently.

One last advantage that we'll discuss in this paper is a safety factor related to the PIFA design. This benefit is related to the Specific Absorption Rate (or SAR) of the applicable device. Because of its design, the PIFA transmits less radiation back towards the ground plane which, when used in a mobile or wearable device, ensures that less RF energy is directed back towards the device user.

# Omnidirectional Antenna Comparisons

Understanding how a PIFA antenna compares with other antenna types may help in the decision-making process when looking for the best antenna for your RF system. The following table gives a brief overview of some basic characteristics and practical applications for a variety of omnidirectional antennas.

Antenna Type	Characteristics	Practical Applications/Use Cases
PIFA	<ul style="list-style-type: none"><li>Small, compact profile</li><li>Simple design – Relatively easy to install and tune</li><li>Stable performance – Reliable even in fluctuating environments</li><li>Radiation efficiency near metal</li><li>Mixed polarization</li></ul>	<ul style="list-style-type: none"><li>Wearable technology</li><li>Metal and plastic enclosures</li><li>Changing environments such as with mobile devices</li></ul>
Chip	<ul style="list-style-type: none"><li>Small, compact profile</li><li>More complex tuning process – Not a 'plug-and-play' antenna solution</li><li>Some design restrictions may create a need for additional space within a device (such as co-existence issues and its need for a larger ground plane)</li><li>Performance lower than that of a PIFA or dipole</li><li>Less expensive than many other types</li></ul>	<ul style="list-style-type: none"><li>Smaller wireless devices</li><li>Devices that don't require the highest level of performance</li></ul>
Monopole	<ul style="list-style-type: none"><li>Works with a relatively large ground – sensitive to ground size and shape (ground plane material can affect performance)</li><li>Usually requires external mounting so is not practical for small IoT devices</li></ul>	<ul style="list-style-type: none"><li>Larger wireless devices or where the antenna can be mounted externally</li></ul>
Dipole	<ul style="list-style-type: none"><li>Less compact than a PIFA or chip antenna</li><li>A true ground-independent antenna</li><li>Usually requires external mounting so is not practical for small IoT devices</li><li>Can add gain but difficult to add directivity</li><li>Mounting limitations</li><li>More dependent on orientation</li><li>More expensive</li></ul>	<ul style="list-style-type: none"><li>Larger wireless devices or where the antenna can be mounted externally</li></ul>

# Laird Connectivity PIFA Antennas

Laird Connectivity has pioneered PIFA antenna technologies for many years including multiple first-to-market solutions for MIMO and SISO operations. Below are some examples of notable PIFA antennas from our portfolio.

- **FlexPIFA 6E:** A full Wi-Fi 6E capable flexible PIFA antenna covering all three Wi-Fi bands 2.4/5/6 GHz (802.11ax standard) in a single antenna.
- **FlexMIMO 6E:** A full Wi-Fi 6E PIFA antenna for MIMO applications covering all three Wi-Fi bands 2.4/5/6 GHz in a single antenna.
- **FlexPIFA:** The industry's first flexible PIFA antenna. The single band 2.4 GHz FlexPIFA is ideally suited for use with 2.4 GHz applications such as, Wi-Fi® 802.11 b/g/n and Bluetooth. The dual-band FlexPIFA antenna is ideal for Wi-Fi applications across both traditional 2.4/5 GHz bands, such as 802.11 'a'.
- **FlexMIMO:** The world's first embedded PIFA antenna for Wi-Fi MIMO applications. The Laird FlexMIMO is different in that it is a single unit with two integrated dual-band antennas specifically designed for 802.11 a/b/g/n as well as 802.11ac Wi-Fi modules that use MIMO or Wi-Fi diversity.
- **mFlexPIFA: Single or Dual-Band**  
Specifically tuned for direct mounting to metal surfaces (metal doesn't detune the antenna). Uses the metal as a ground plane. Consistent performance. Flat, concave, convex surfaces.
- **D-Puck:** A cost-effective, small-scale metal antenna designed for maximum durability.



## What Next?

The biggest companies in the world choose Laird Connectivity to solve their wireless challenges with expert support and reliable materials that ensure they're connected, no matter what. That begins with reliable hardware and extends to our unique customization and integration support capabilities.

Laird Connectivity offers our customers the certainty that their wireless applications drive their organizational objectives, perform at their peak, and last for years. We're THE antenna authority focused on your success with materials and support to match.

Contact us today to discuss your PIFA antenna requirements or any other antenna requirements you may have.

[www.lairdconnect.com/contact](http://www.lairdconnect.com/contact)



## About the Author:

Chris Boorman is a Senior Product Manager at Laird Connectivity, which provides a full range of wireless modules, antennas, and sensors that simplify the process of using wireless technology. In his role at Laird Connectivity, Chris oversees engineering and innovation for the companies antennas and IoT platforms. Chris has more than 20 years of engineering experience in the telecom and IoT field. Prior to joining Laird Connectivity, he held senior engineering positions at Fujitsu Services and Toshiba Business. He is based in the UK.

## About Laird Connectivity:

Laird Connectivity simplifies the enablement of wireless technologies with market-leading wireless modules and antennas, integrated sensor and gateway platforms, and customer-specific wireless solutions. Our best-in-class support and comprehensive engineering services help reduce risk and improve time-to-market. When you need unmatched wireless performance to connect electronics with security and confidence, Laird Connectivity delivers — no matter what.

Learn more at [www.lairdconnect.com](http://www.lairdconnect.com).

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