

Wireless design in compact wearables

Introduction

Designing wearables is challenging due to their small size and ergonomic requirements. Despite these constraints, there are numerous innovative wireless solutions available.

Balancing wireless performance and ergonomics is crucial, as decisions like using lightweight metal may impact RF signals but enhance mobility. This guide navigates through the design cycle, emphasizing the importance of early consideration of wireless solutions for innovative designs and addressing common issues in wearables design.

antenova

Wireless for the next generation

Antenova is a leading innovator in wireless technology solutions. With a passion for connectivity, we specialize in designing and manufacturing high-performance antennas and radio frequency (RF) modules for a wide range of applications. Our mission is to empower the Internet of Things (IoT), providing seamless and reliable connectivity for smart devices, wearables, and more. At Antenova, we combine cutting-edge engineering expertise with a commitment to customer success, delivering compact, efficient, and reliable wireless solutions that enable the next generation of connected devices.

Join us on the journey to make the world more connected, efficient, and smarter.

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Researching the most appropriate wireless solution

In the conceptual stages of your project, you should consider the range of appropriate wireless solutions available. For wearables, in particular, many of their control mechanisms and functions are dictated by other devices, therefore, high levels of wireless performance are essential.

“Each antenna type comes with its own design challenges and integration considerations, and you should consider these before you make a final decision”

Fortunately, antennas now come in a range of sizes and forms: big and small, flexible and fixed, ceramic and laminate. Each antenna type comes with its own design challenges and integration considerations, and you should consider these before you make a final decision. Here are four antenna types to consider:

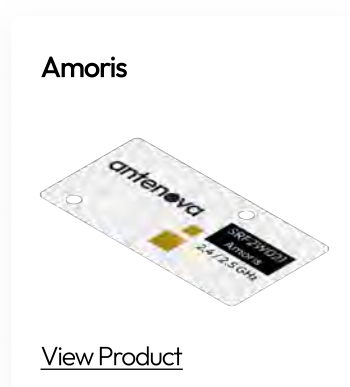
1. Low-profile SMD antennas

Surface mount devices (SMD) attach directly to the circuit board. New low-profile SMD antennas are exceptionally slim — **Antenova's Weii antenna** measures just 1 x 0.5 x 0.5 mm and works for 2.4GHz. For comparison, most leading wireless modules are over 2mm in height. This opens a new world for product designers working on wearables, where space is at a premium.

With a low-profile SMD antenna, wearables designers will have an antenna that can easily be integrated into the device without taking up too much real estate on your circuit board. So long as you review potential interference from other components on the circuit board, lowprofile SMD antennas are an excellent choice for wearables making use of a conventional circuit board. Furthermore, they also come in tape and reel form for high volume assembly

2. FPC antennas

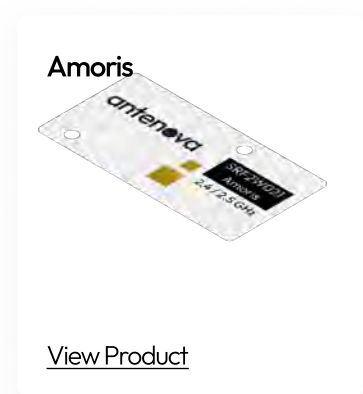
Flexible printed circuit boards (FPCs) blend circuit functionality with extreme thinness and malleability, using a flexible polymer film and patterned conductive material. Ideal for wearables, FPCs fold, twist, and move, integrating seamlessly with organic, user-centric functionality. FPC antennas, with a thickness of around 0.15mm, provide cost-effective integration into flexible circuit board designs, reducing manufacturing costs. They can be connected later with adhesive backing, offering flexibility for space-sensitive wearable devices and placement in areas like wrist straps or lanyards.



3. Multilayer antennas

Multilayer antennas solve one of the major potential issues for wearables: electromagnetic transmissions and noise generated by conductive materials. Metals, carbon fibre, and fibreglass housings incorporated into a wearable design can all negatively impact wireless performance. These surfaces create electromagnetic fields around antennas, which causes detuning and can interfere with transmissions.

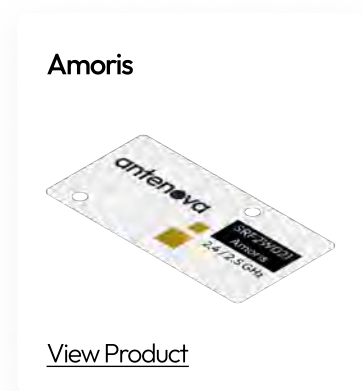
Multilayer antennas have a small footprint, meaning they can be easily hidden by designers if planned for in advance. For example, our REFLECTOR antennas are as thin as 1.6mm. They use ferritelike layers to isolate noise, meaning the antenna performs as if it was in free space, isolated from whatever radiation is taking



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4. Ceramic patch antennas

Another option are ceramic patch antennas. Typically in the past, ceramic antennas have been used for GNSS applications, but there have been three major issues: the patches are heavy, adding extra weight to the wearable device and increasing the likelihood of failing drop tests, they're typically larger than other antennas, and they have to be hand fitted during product assembly, adding cost and time delay. Antenova supplies Sinica antennas which perform just as well as an 18mm ceramic patch, but measure just 7 x 5.8 x 0.4mm, are exceptionally lighter, and come in tape and reel for high volume assembly



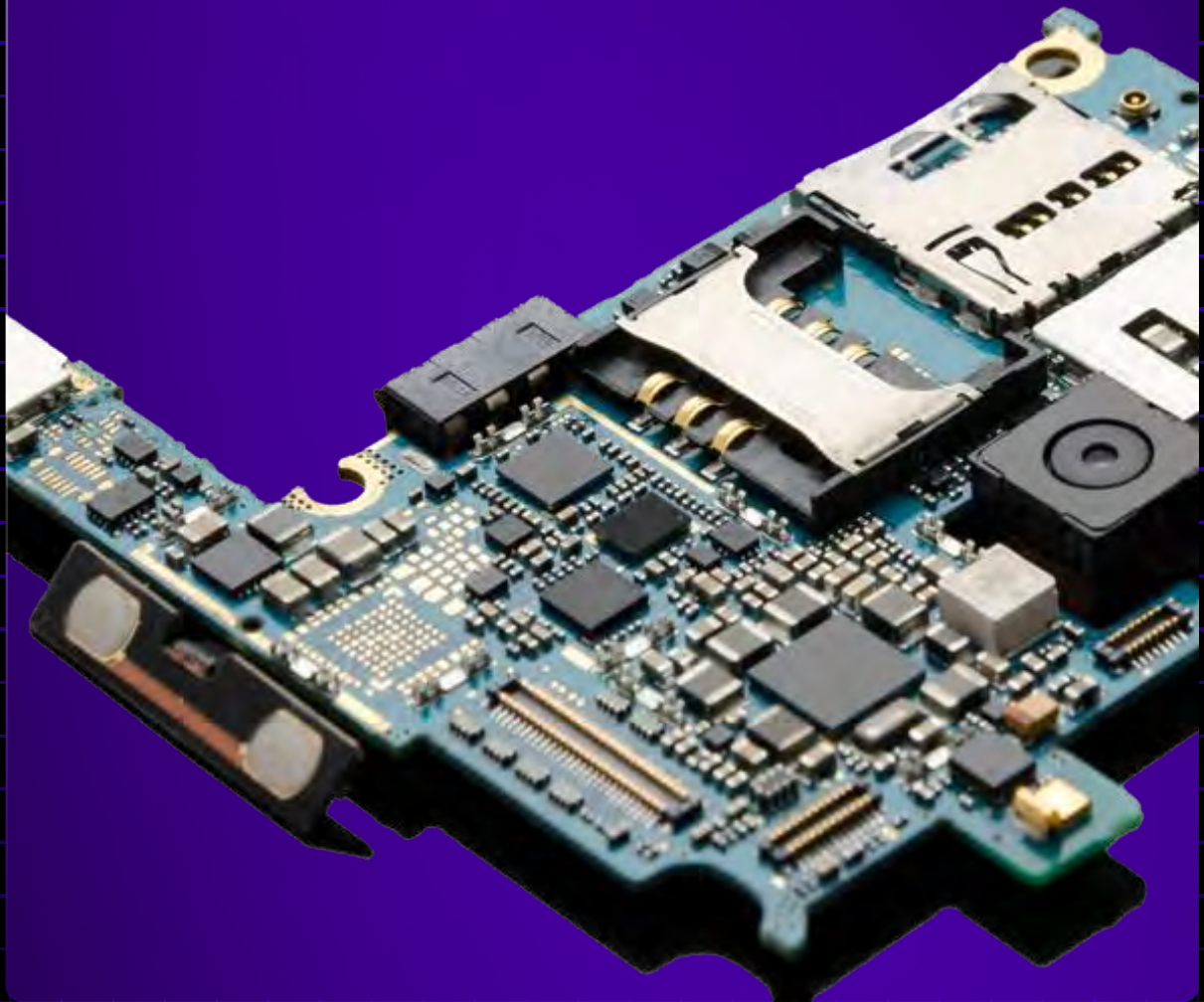
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Board design and architecture layout

Once you have decided upon a wireless solution, the placement of your wearables' internal components is the next crucial consideration. The specific demands of wearables can throw up all sorts of considerations to keep in mind when selecting and positioning your antenna. Here are three issues to consider, before you get to them:

1. Wearables don't tend to allow sufficient space for ground plane lengths

The importance of keeping wearables' size down often means that ground planes become an impossible luxury: there just isn't enough flat surface space for them. As a result, wearables designers sometimes realise too late that many antennas just aren't suitable for their context. Check datasheets of antennas first, and don't simply select an antenna based on performance parameters, always review the implementation guidelines.

If this is likely to be the case for your product, be aware of ground plane independent antennas. Alternatives like Antenova's flexiiANT family of antennas don't need a ground plane yet still offer high efficiency even for low transmission bands. Freeing yourself from the need for a ground plane can radically impact on other aspects of your product's design, enabling even more compact solutions.

2. Wearable housing is often in close vicinity to antennas

The beauty of wearables comes from how efficiently they use space, components are packed in to maximise efficiency. This can pose a problem for wireless design, as metallic housings can prevent effective wireless transmissions. At its worst, this can affect wireless performance to such an extent that the final product fails to function.

A common issue in these devices is the gap between housing and antenna. The smaller the gap, the more significant the impact of user operators will be. The human body acts as a dielectric material, which has an effect on the electric field portion of the antenna's near-field operation. These effects are difficult to quantify due to body movement, but you may be able to get a clear idea through the use of phantom body part testing in anechoic chambers.

Look into how your wearable's housing will interact with transmission signals. Often the compact size of wearables makes it impossible to create a large enough gap in the housing to allow wireless transmission. Antenova's REFLECTOR series of antennas is just one example of an antenna that can thrive in the presence of metal parts, making a virtue of a potential problem.

3. Compact board designs featuring metallic and magnetised components

The nature of wearables makes it almost impossible to avoid metallic and magnetised components within the circuitry of the device. Unfortunately, electromagnetic signals can detrimentally impact wireless transmissions, while the premium of space can make it hard to place an antenna onto a PCB (with a sufficiently sized ground plane) if things haven't been taken into consideration in advance.

Make sure you are prepared for how different antennas will respond to the other components on your circuit board. Flexible circuit boards or multilayer antennas may be a more suitable option, improving ergonomics while allowing for flexible sheltered antennas.

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Avoiding interference and error through matching and Gerber reviews

It's important to make use of all the resources you can when designing a wearable, as there are so many factors that could impact performance. Small changes in design, even at the later stages, have been known to render devices unable to work.

There is lots of support out there for product designers. At Antenova, we offer support for every stage of the design process:

- We can help you select an appropriate antenna with our Intelligent Antenna Selector, this recommends an appropriate antenna based on the number of antennas on your PCB and the dimensions of your PCB.
- During design, we provide a free transmission line calculator, which helps you optimise grounded coplanar waveguide dimensions to help minimise reflections and return loss.
- Once designed, Antenova help engineers by offering free Gerber File Reviews, whereby our team of RF engineers (the very same team that creates our innovative antennas) will review your design for any potential RF issues.

Failing to review performance across these can be critical. There have been projects where an antenna has simply been 'added in' at the final stages of a project, and, surprise, surprise, the device failed to work. This makes testing imperative.

Design test

It is imperative that you test wearable products before finalising your design. When in the hands of consumers, and being used next to human flesh, wireless performance can dramatically vary. The last thing any designer wants to hear is reports of device failure in the hands of consumers, therefore, we recommend taking the following steps to test your device before production begins:

- **Anechoic chamber testing** isolates your wearable from all external wireless interference, thus providing an accurate measure of antenna performance in free space. However, free space testing is not sufficient enough in the case of a wearable, where you will need to assess performance.
- This can be done with **phantom body parts**: modelled heads, hands and other limbs can provide an accurate view of how your wearable will really perform once in the hands of users, in a highly controlled environment for thorough testing.

Get off to the right start on your project

It's essential that you take a holistic approach to product design, one that considers wireless performance at every stage of design. You should not be in the dark over wireless performance when you are heading towards your design deadline. Ensure you make use of all the support available to you. To summarise:

- Use the Intelligent Antenna Selector tool to find appropriate antennas for your PCB dimensions.
- Review data sheets and design guidelines thoroughly, thinking about design challenges rather than performance specifications in free space.
- Consult Antenova's engineers when you've got your design files completed, they'll check for design discrepancies and potential issues.
- Thoroughly test your wearable using phantom body parts within the closed testing environment of an anechoic chamber.

"No designer wants to hear about device failures in the hands of consumers."

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Wireless connectivity
without compromise.