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WHITEPAPER

Wireless Antennas: The Comparison Guide

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THIRD EDITION

Contents

Introduction

Antenna selection is an important stage in the design of any wireless device. Regardless of its design, components or application, the antenna dictates how well it performs wirelessly. Simply put, the correct choice of antenna is the difference between a device that performs well and one that doesn't.

The wireless technology space is evolving, with new and exciting technologies launching. 5G is capturing the attention for its breaking-edge cellular capabilities in terms of speed, connectivity and bandwidth. Innovations in antenna technology are enabling the miniaturisation of high-performance devices. IoT devices are gradually introducing 'smart' capabilities thanks to the adoption of Wi-Fi 6 & 6E and Ultra-wideband technologies.

In light of the ever changing landscape of wireless technologies, choosing the right antenna for your device can seem like a complicated and daunting task. But by understanding the key features, technologies and form factors that define the specific choice of antenna, this process can become simple and intuitive.

Terminal/External Antennas

Terminal or external antennas are positioned outside of the component enclosure of a device. These antennas can be mounted externally on a device via a fixed, hinged or wired RF connection to the PCB.

Terminal antennas provide impressive performance whilst maintaining a fairly simple integration process. As technology moves in the direction of miniaturisation, embedded antennas have replaced external solutions as the cutting-edge of wireless technology. Nevertheless, Terminal antennas still provide impressive capabilities that outperform its embedded counterparts.

Browse our range of Terminal antennas.

Features

- **Make more space for on-board components -** Terminal antennas pose no impact on the design of internal components and PCB layout, creating freedom of internal space for device designers.
- **Superiority of performance and efficiency -** Terminal antennas outperform embedded solutions across all RF parameters and provide greater levels of efficiency (typically 10% greater).
- **Interference-free -** External antennas are free of the interference and noise created from internal components.

Integration challenges

- **Manufacturing complexity and assembly costs -** Additional manufacturing considerations are required for the specific RF connection and placement method (angled, fixed, wired) of external antennas on the device housing.
- **Protrusion and fragility -** The size and placing of terminal antennas brings considerable restrictions to form factor, removing the possibility of integrating them for compact and wearable devices.
- **Increased material cost -** A tradeoff for the superior performance and efficiency of terminal antennas is the increased cost compared to its embedded counterparts.

Applicable technologies and form factors

Cellular (5G)

Automotive, industrial, smart home

SMD Antennas

Surface-mounted device (SMD) antennas are a form of embedded antenna that ismounted directly onto the host PCB alongside other components.

SMD antennas are key enablers of device miniaturisation. They have made it possibles to remove large external antennas with compact and streamlined designs. That said, these antennas have ground plane and placement requirements to perform well.

Browse our range of SMD antennas, including our lamiiANT family.

Features

- **Compact -** Compact SMD antennas are integrated inside the component enclosure of a device, enabling the miniaturisation of designs whilst maintaining wireless capabilities.
- **Easy to integrate -** Low part cost and compact size makes SMD antennas a cost effective choice for devices.
- **Suited to high-volume manufacturing -** SMD antennas can be easily assembled for mass production using pick and place machinery.

Integration challenges

- **Ground plane requirements -** In order for SMD antennas to function efficiently without negatively impacting TRP (total radiated power), they must have a ground plane that is a quarter of the length of the lowest frequency, potentially causing PCB design complications.
- **Component noise/interference -** As an SMD antenna is placed alongside components on a PCB, they are susceptible to component noise and interference that can impact wireless performance.
- **Role of PCB design -** Device designers must integrate SMD antennas and their appropriate ground plane into their PCB design rather than alternative plug-and-play integration types.

Applicable technologies and form factors

Cellular (3G, 4G, 5G), Wi-Fi/BT, NB-IoT

Wearable, handheld, automotive, smart home, industrial

FPC Antennas

Flexible printed circuit (FPC) antennas are another form of embedded antenna that bring wireless connectivity to complex and compact device designs and form factors. FPC antennas are malleable, have their own ground plane and can be placed on the device housing using an adhesive strip.

FPC antennas provide a unique solution for designs that have particularly complex or compact form factors, or simply lack PCB space for an effective ground plane. They can adhere to curved device housings, providing full wireless capability whilst freeing up valuable PCB space for designers.

Browse our range of FPC antennas, including our flexiiANT family.

Features

- **Ease of integration -** FPC antennas can be placed vertically, horizontally and bent inside a device housing, making integration simple – they are essentially plug 'n' play.
- **Save PCB space -** As they do not require a PCB ground plane, FPC antennas save valuable PCB space for other device components.
- **Flexibility and performance -** FPC antennas can bend (to a degree) and still maintain performance comparable to SMD antennas.
- **Well-suited to new product introductions -** They offer a good solution for low-volume production runs and prototypes, as they can be assembled easily.

Integration challenges

- **Clearance requirements -** Even though FPC antennas can be placed away from the PCB, RF interference can still affect wireless performance and requires specific amounts of clearance.
- **Assembly complexity -** For high-volume manufacturing, they come with a certain level of assembly complexity, as they must be installed by hand, limiting their use in high-volume manufacturing runs.
- **Limitations with tuning and matching -** As off-the-shelf products, they offer limited customisation options to RF experts, barring cable length and connector type.

Applicable technologies and form factors

Cellular (3G, 4G), W-Fi/BT, NB-IoT

Wearable, handheld, automotive, industrial, smart-home

Case-mounted antennas

Case-mounted antennas are unique in that they can operate in free space, as an external antenna would. Antenova introduced REFLECTOR® in 2017, an antenna series designed with two layers where one is isolated from the other, allowing the antenna to radiate on a metal surface.

Antenova developed REFLECTOR® antennas to solve integration challenges for a range of IoT devices. They caught attention at Embedded World for the various features they can offer to smart cities devices, winning the annual Embedded Hardware award. REFLECTOR® antennas represent Antenova's increasing innovation in the wireless technology space to solve difficult integration challenges.

Browse our REFLECTOR antennas.

Features

- **Metal surface mounting options -** REFLECTOR® antennas allow placement on metallic surfaces that would otherwise prevent them from radiating.
- **Thin form factor -** REFLECTOR® antennas have an extremely thin size (down to 1.6mm) and are able to be hidden discreetly behind branding, logos or other design features.
- **No PCB ground plane required -** As they are placed on the inside of a product housing or elsewhere, REFLECTOR® antennas do not require PCB ground plane space to operate.

Integration challenges

- **Lack of flexibility -** Unlike its similar adhesive counterpart FPC, REFLECTOR® antennas are not malleable. This means that they can only be placed on flat surfaces and cannot be integrated in curved or complex form factors.
- **Placement -** Even though they have inbuilt RF protection, the placement of REFLECTOR® antennas can cause interference from other components and needs to be taken into account.

Applicable technologies and form factors

Cellular (3G, 4G), Wi-Fi, NB-IoT

Wearable, handheld, automotive, industrial, smart home

Antenna Modules

Antenna modules represent a pre-assembled collection of components into a single package. These components include SAW filters, LNA for low power signals and the antenna itself. As all these components are in one modular package, they save time on integration and testing when getting a product to market.

Modular solutions are mainly used for GPS/GNSS capabilities by including all the RF solutions required to efficiently receive satellite signals. As they are all in one package, they take up less space on the PCB and are perfect for navigation applications.

Browse our range of module antennas, including our RADIONOVA family.

Features

- **Simple integration -** Modular solutions house various RF components into one package, making integration simple and efficient.
- **Less PCB space -** As they house all required components in one package, modules can save valuable PCB space for various designs.
- **Specialist performance -** Modular solutions include specifically tuned RF components to provide specialist performance for GNSS/GPS.

Integration challenges

- **PCB placement -** Modules require a very specific placement on the host PCB, usually along the longest edge.
- **Ground plane space -** GNSS/GPS signals are weak and therefore require an optimised RF environment to perform well – this often requires ground plane space and adequate clearance.
- **Lack of flexibility -** As an all-in-one solution, the convenience and plug 'n' play nature of modules comes with the drawback of flexibility – for specific performance characteristics, rather than a well-rounded solution, an SMD solution may be more appropriate.

Applicable technologies and form factors

GNSS

Wearable, handheld, automotive, industrial, smart home

Antenna integration: Wireless technologies & antenna families

[table with all of the antennas, families and relevant wireless technologies]

	gigaNOVA	RADIONOVA	lamiiANT	ceriiANT	flexiiANT
5G	–		Allani, Lepida, Minima	–	Affini, Lutosa, Zhengi
4G/3G/LTE	Calvus	– –	Allani, Integra - L, Integra - R, Intersa - L, Inversa - R, Lepida, Minima, Pharaoh, Similis	–	Affini, Armata, Atta, Avia, Mitis, Moseni, Zhengi
GNSS	–	M20047-1, M20057-1, M10578-A2, M20048-1, M10578-A3, M20050-1, M20071	Agosti, Raptor, Sinica	–	Asper, Bentoni
Wi-Fi/BT	Comata, Fusca, Mica, Mixtus, Rufa,	–	Mutica, Serica	–	Amoris, Dromus
NB-IoT	–	–	Latona	–	–
ISM	–	–	Grandis, Latona, Velox	–	Fera, Inca, Lama, Montana

Integrating the right antenna for the best results

Choosing the right antenna for your device is vital in ensuring functionality and the highest performance possible. Understanding the factors that influence this choice, such as technology, form factor and noise, are vital in making the correct decision of antenna.

Comparing the various types, shapes and sizes of antenna is your first step in integrating the perfect antenna for your device. After you've got a grasp on these specific antenna variables, you should look at our various datasheets to ensure you have the most optimised antenna possible.

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