ABRACON

A Study on Niche Antenna vs. Chip Antenna

Roshni Prasad
Senior Product Engineer RF and Antennas
With contributions from Viktor Lundstrom and Evgenii Filatov
Abracon, LLC

12/2022

Table of Contents

5101 Hidden Creek Ln Spicewood TX 78669 | 512.371.6159 | www.abracon.com

Introduction

The industry's demand for higher efficiency with the decreased weight of wireless devices/machines pushes for the miniaturization of electronic devices coupled with reduced power consumption for wireless communication. Given the already limited real estate for the antenna design on the PCBs, engineers must design a good-performing antenna element considering several other constraints from the presence of battery, reflections from other metals, and absorption by human body tissue in the vicinity. Further, manufacturability and ease of integration also play a crucial role in determining the choice of the antenna for a product. The present study signifies the features of the Niche antenna in comparison to the commonly used chip antenna in the dual-band 2.4/5GHz WLAN spectrum.

General Overview of an RF System

A radio frequency (RF) system enables wireless communication between any two machines (M2M – machine-to-machine communication). Commonly, an RF module encases the chipset and other components, such as filters, amplifiers, diplexers, duplexers, and switches, along with the most critical element, the antenna. Here is an example of UBlox module MAYA-161 showcasing its module architecture with the Niche – internal PCB antenna for operation in 2.4 GHz and 5 GHz bands of WLAN/ Wi-Fi.

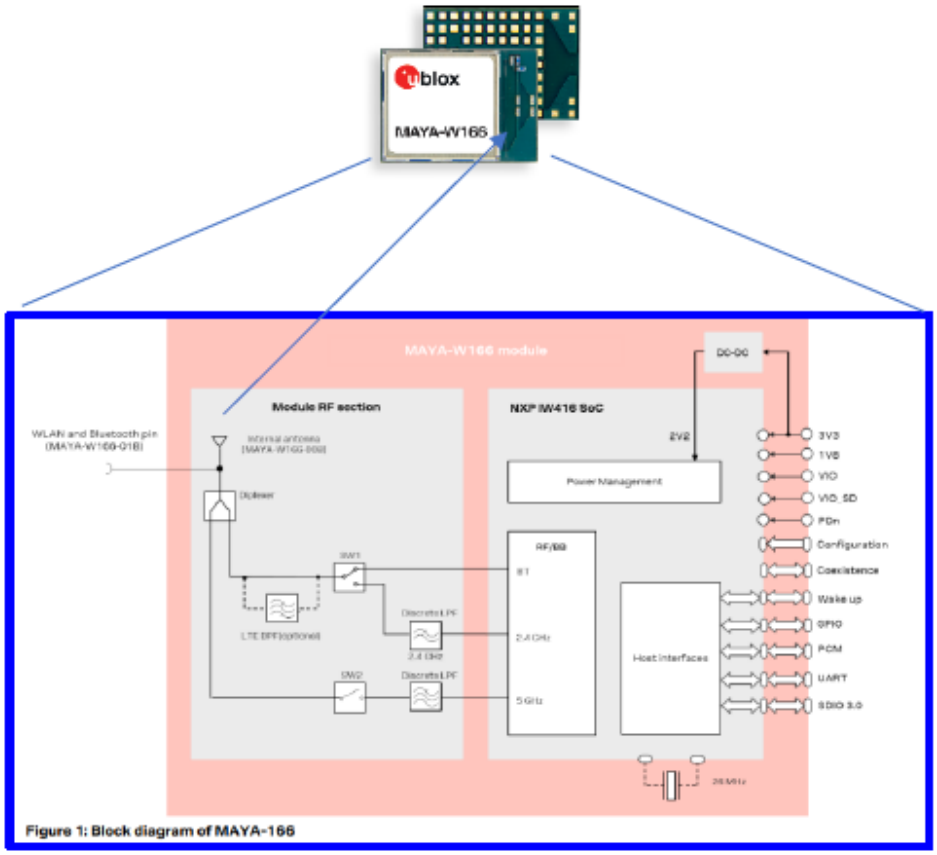


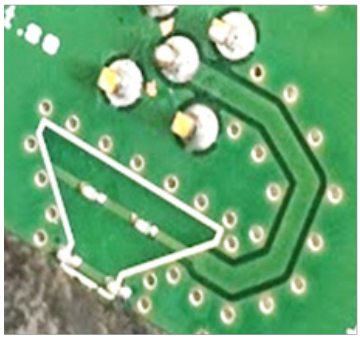
Figure 1: MAYA-W166 - 2.4/5GHz - Niche Antenna

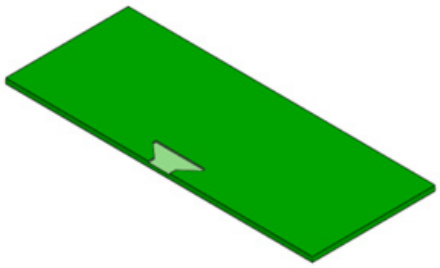
5101 Hidden Creek Ln Spicewood TX 78669 | 512.371.6159 | www.abracon.com

Overview of Niche and Chip Antennas

Niche Antenna

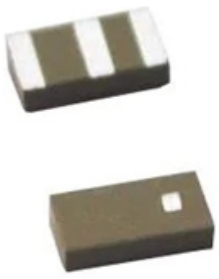
The Niche antenna is a license-based slot antenna offered by Abracon. While the common goal of any new antenna design is to improve the size, efficiency, and cost, the Niche antenna provides the perfect balance among these main parameters. As shown in figure (1), a niche antenna with two sides electrically connected to each other and the RF circuitry is required to realize the design on the PCB. Further, the RF signal is fed from one side to the other through a physical path. The size of the slot combined with the discrete capacitance, the position of the feed, and the ground plane size, enable desired frequency of resonance in the antenna. For this study, a dual-band Niche antenna operating at 2.4 GHz and 5 GHz is considered. The overall size of the Niche is 12 x 6 mm and requires a particular shape of metal clearance on the PCB. The ground plane under consideration is 50x20 mm.

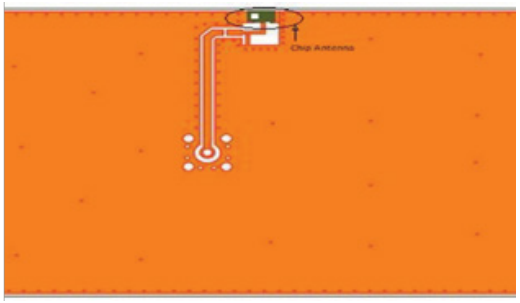




Chip Antenna

Commonly, chip antennas are the go-to in the industry. The compactness of the chip antenna makes it an attractive candidate for smaller PCBs. Chip antennas are physical components with a layout of their own and require a specific ground plane size to achieve the required performance metrics at the desired frequency range. For this comparative study, a dual-band multi-layer ceramic loop chip antenna in the market was selected. The size of the chip antenna is 3.2x1.6x1.2 mm which occupies an overall metal-clearance space of 6x5 mm on the PCB. The ground plane under consideration is 50x20 mm.





5101 Hidden Creek Ln Spicewood TX 78669 | 512.371.6159 | www.abracon.com

Why Niche is a more suitable candidate in the following scenarios?

Small PCB Size

The ground plane size of the PCB has a significant impact on the bandwidth and efficiency of the antenna. With a reduced ground plane, the bandwidth commonly reduces, the frequency resonance shifts to a higher range, and efficiency is impacted.
Most commonly, a chip antenna is chosen to be implemented in ultra-compact PCBs. It can be seen from the following return loss and efficiency plots that Niche is a better-suited candidate. The Niche antenna exhibits a wider bandwidth even for smaller ground planes compared to the chip antenna in comparison which proves it to be tolerable to slight changes in the PCB size without requiring the need for re-tuning.

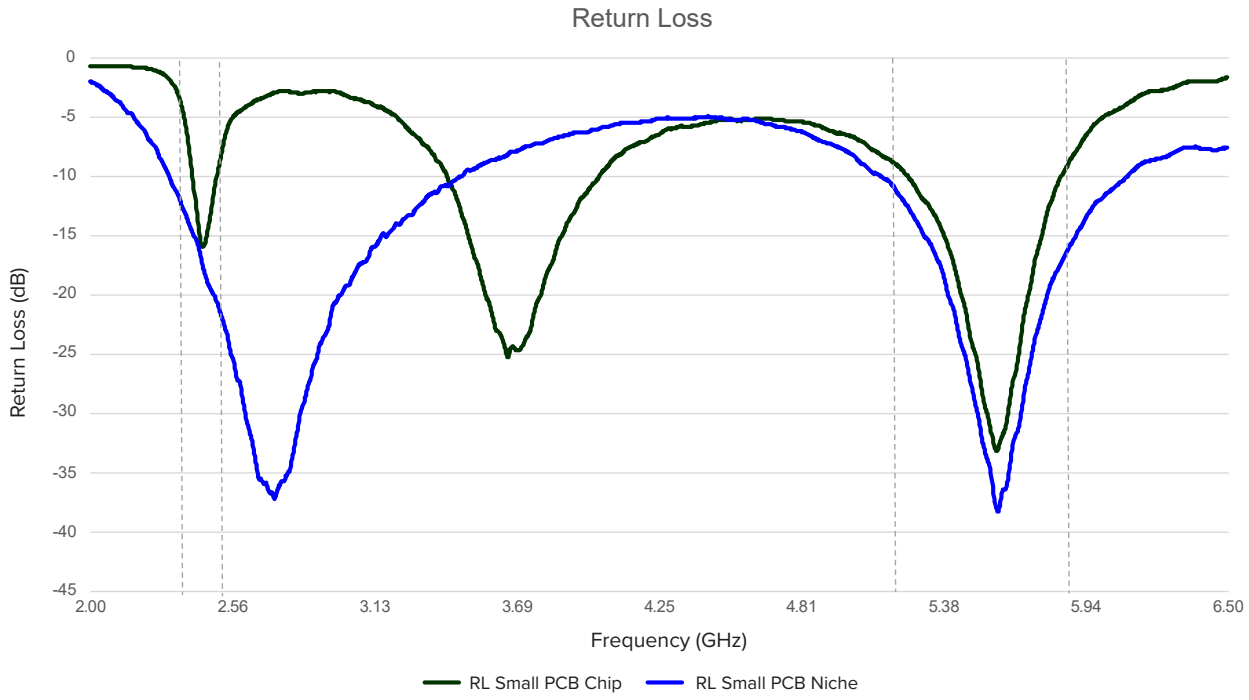


Figure 2: Return Loss - Chip vs. Niche Antenna

Similarly, as seen in figure (3) below, the efficiency of Niche is also preserved well under compact ground plane conditions compared to a chip antenna. While it may not be suitable to have higher antenna efficiencies in the out-of-band, it shall be brought down by using a filter with the antenna.

5101 Hidden Creek Ln Spicewood TX 78669 | 512.371.6159 | www.abracon.com

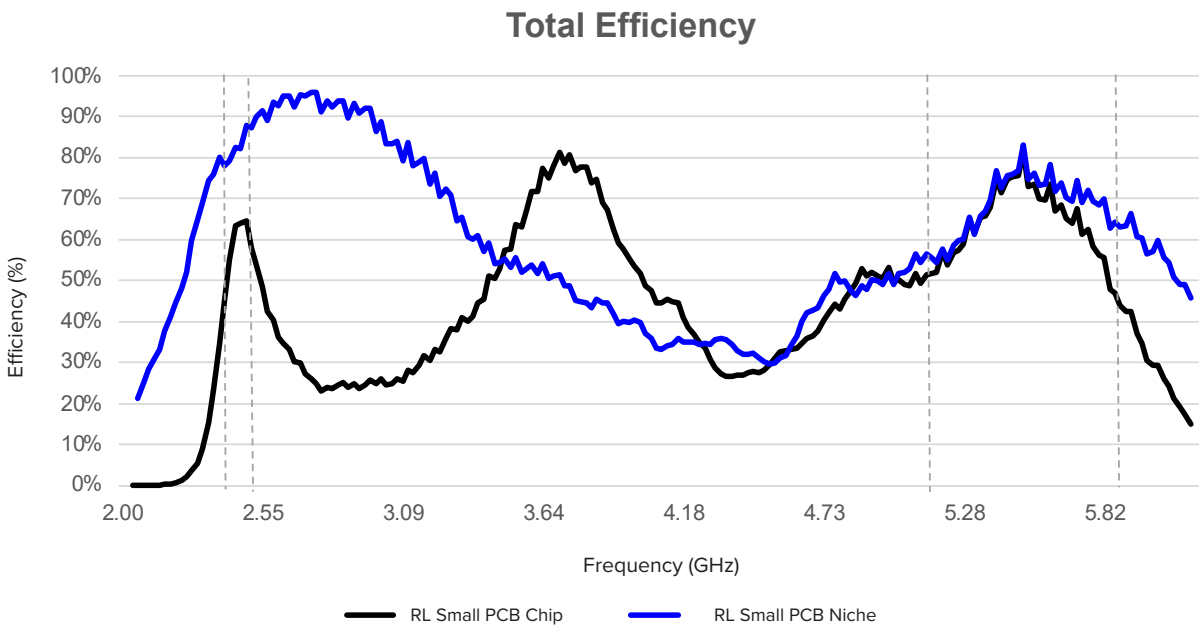


Figure 3: Total Efficiency - Chip vs. Niche Antenna

Environments Requiring Extreme Reliability Conditions

For instance, automotive applications require the components to have passed several reliability test conditions, including vibration test, shock test, stress test, extended temperature cycle tests, and operational life as per the MIL-STD to ensure the product can withstand extreme environments. While these tests are applicable for a chip antenna, a Niche antenna is exempt from these test criteria. This is because Niche is a license-based concept that does not require a physical component to be added to the application board in the place of an antenna. Instead, it only requires an exclusion of ground around a certain outline on the PCB.

Environments Requiring Potting Of PCB

Potting of the PCB is commonly required for physically demanding applications in the automotive and medical industries involving electronics. This is done to ensure safe usage against exposure to vibration, abrasion, heat, and chemicals in the environment. Since the design of chip antennas requires dielectric loading to allow compactness, the performance is highly impacted by the addition of epoxy coating. A Niche antenna, on the other hand, can ensure superior performance even under potting conditions.

Mechanical Mounting and Implementation

A chip antenna is a physical component that is easy to pick and place on a PCB using machine. There are instances where it becomes difficult to inspect the solder-component contacts for poor solderability.

Further, tombstoning is another issue when dealing with SMD components like the chip antenna while it goes through the re-flow soldering process. Since the Niche antenna is not a physical component and does not require a special procedure to be followed for physical implementation, it's relatively easy to specify the metal clearance area on the PCB while defining the polygon pour in PCB design. The manufacturing process issues can be eliminated using a Niche antenna.

Material And Resource Cost

Particularly for higher volumes of usage, a chip antenna always tends to be more expensive compared to a Niche antenna. The ability to avoid implementing a physical component as an addition to the PCB eliminates the material cost to design and manufacture Niche into various applications. Further, for applications demanding the antenna to go through an extensive reliability study extending for over three months of testing, the Niche antenna would be the best suitable candidate as it can be directly implemented as long as the customer PCB material and the choice of capacitors for impedance matching the antenna to desired frequency are in accordance with the requirements, thus reducing the time and cost for implementation.

Summary of Findings

Antennas are more prevalent in IoT devices than ever in today's automotive, medical, consumer, infrastructure, and military market segments. The superior performance, coupled with the ease of integration of the Niche antenna compared to a chip antenna, makes it a perfect candidate for any application. Particularly automotive and medical devices that require reliable performance in demanding environments. Ultimately, the license-based model enables Abracon to facilitate the implementation of Niche antenna in customer products at a low cost compared to other antenna designs in the industry.

5101 Hidden Creek Ln Spicewood TX 78669 | 512.371.6159 | www.abracon.com

References

[1] MAYA W1 Series

a. https://www.u-blox.com/en/product/maya-w1-series

[2] Niche Patent

a. https://patentimages.storage.googleapis.com/39/da/99/a6a16469f1c9ba/US10910715.pdf