ignion

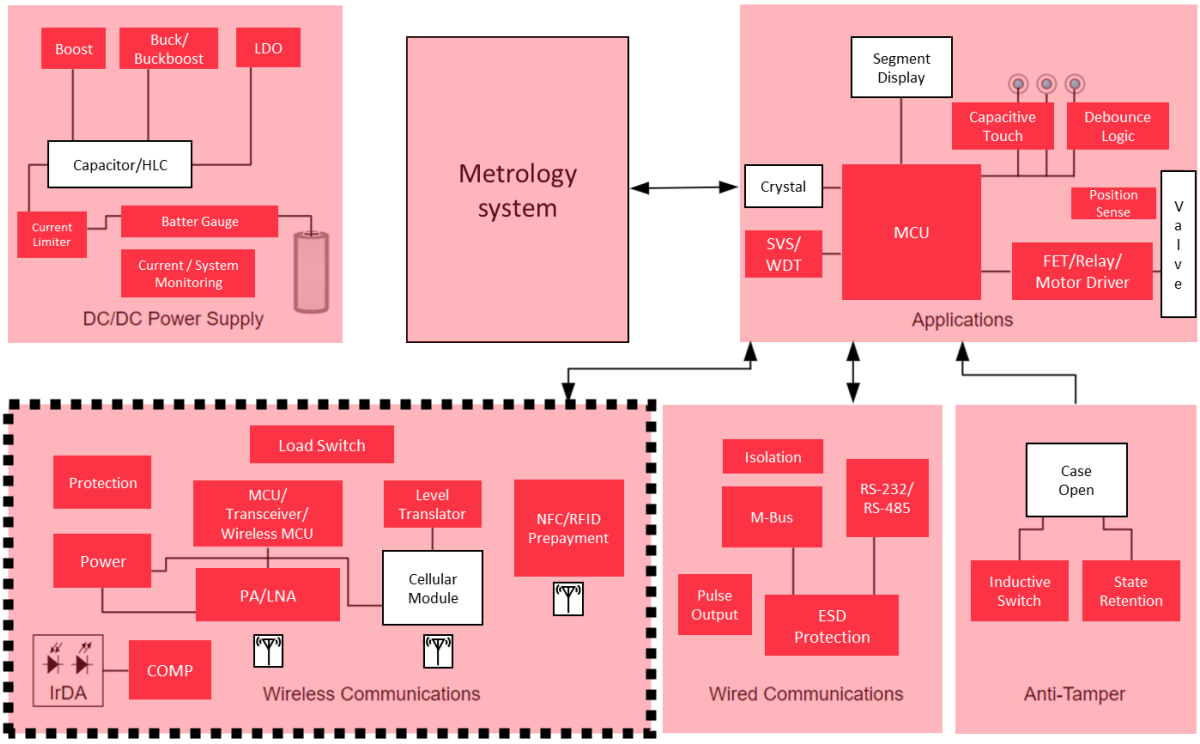
Your innovation.
Accelerated.

Wi-SUN smart meter antenna: 868/915 MHz + 2.4 GHz across three board sizes

APPLICATION NOTE
RUN mXTEND™ (NN02-224)

SMART METERING

Nowadays, the main challenges faced by smart meter manufacturers, when designing a new metering device, are price, size, global coverage, long range and considering surrounding environments that could affect the overall performance.
Any wireless smart metering device's data transmission has to be completely reliable, therefore, the antenna is a critical component in such device.
First, chip antenna technology is perfect for providing cost savings in your smart meter production. It is often a lower cost component than an external antenna or FPC, and, by being SMD pick and place, it provides savings on assembly costs.
The internally mounted chip antenna provides the benefit of increased protection against environmental factors and vandalism compared to an external antenna. Our patented technology, Virtual antenna® allows for the same antenna part to cover multiple frequency bands simultaneously and offers any device designer the flexibility of selecting and tuning the frequency bands simply through adjustment of the matching network. Virtual Antenna offers a predictable and optimized performance ensuring metering devices easily comply with cellular certifications.
Second, Virtual Antenna® components use the PCB to resonate, which enables high performance in space constrained device designs. Even with a small size Virtual Antenna® component, the metering device will perform with optimal efficiency and high gain in all the bands, helping with long-range communications.
Smart meters are subject to long product development cycles and massive deployment and installation. Altogether, this can span to several years. And it might happen that in the midst of the deployment, a new connectivity standard arises that improves the business model of the utility provider: e.g., using 5G instead of 4G or older 3G, 2G. A fast upgrade of the smart meter design becomes then very convenient and Virtual Antenna® ensures that the same component used for 3G will be capable of upgrading to 4G, 5G or any "G" with just a minimum change of the matching network. Even the same antenna can be used with non-cellular LPWAN standards such as LoRa and Sigfox.



Block Diagram of a Smart Meter

In the Block Diagram above, we see an example of a Smart Metering Application. Some of the main components within a device like this, are:

Microcontroller unit (MCU):
An MCU or MPU is an intelligent semiconductor and the main component in any device. It is what allows for the entire system to function, by translating the data programmed in it to commands that all the other components will understand an execute to deliver results. It is the brains of the module.
Choosing the best performing antenna will allow for a faster data transmission, which will lead the MPU to perform at its full capacity.

Metrology system:
Another especially important unit in a Smart Meter is the metrology system as the devices needs to constantly measure the gas flow rate within an installation in a fully accurate way in order to be able to collect data, to be sent afterwards. In the next bullet point you can read how important the antenna is for the data collected by the metrology system to be correctly sent.

Antenna (Wireless Communications):
For optimal communication efficiency, the antenna's placement is crucial, therefore, its implementation within the device's design has to be in an early stage. That early implementation has to be done also because, usually, an antenna needs a clearance area in the PCB.
At this point, Virtual Antenna® technology becomes the best solution for any metering device. It gives the customer the ability to design the antenna set-up, in-house, with no expertise required. Furthermore, the customer will also be able to fine tune the performance given its overall product's structure from the beginning.

In summary, when designing a Smart Meter Device, the customer should think about the antenna at the early stage of the design process, as the location, PCB dimension and overall mechanics of the product will all determine/impact the overall performance of the antenna. Ignion can help and guide/advise the customer, using our Antenna Services. By choosing Virtual Antenna® technology as your antenna solution, thanks to its high RF efficiency and adaptability, you will ensure best performance in your Smart Metering Device.

Moreover, Virtual Antenna® components, by being off-the-shelf, tunable, and versatile antennas, will allow for faster development times, predictability of design from minute one and a fast and flexible adaptation to different tracking forms.
In this application note, we will review the performance and different metrics, of the ALL mXTEND™ (NN02-224), our top performing multiband antenna in Wi-Sun applications for Smart Metering.

USING THE RUN mXTEND™ IN Wi-SUN COMPATIBLE IoT DEVICES

- **Antenna Component:** RUN mXTEND™ NN02-224
- **Dimensions :** 12.0 mm x 3.0 mm x 2.4 mm
- **Frequency regions:** 863-928MHz and 2400-2500MHz

RUN mXTEND™ is the perfect antenna component for any **IoT device** designed to operate at **Wi-SUN** network standard frequency bands

The RUN mXTEND™ is ideally suited for any Wi-SUN compatible device as it works at operating frequencies compatible with the Wi-SUN standards of 868 MHz (EU), 915 MHz (USA), and 2.4 GHz ISM bands (Worldwide). Moreover, its **small size** means more of your device space can be used for other components or you can **reduce the footprint** of your final design.

Devices built to the Wi-SUN standards boast a higher data rate and lower latency than those operating on other IoT standards such as LoRa and Sigfox. Additionally, Wi-SUN can be implemented with **very low levels of power consumption** when compared to WLAN. These Wi-SUN standard characteristics paired with the RUN mXTEND™ flexibility allows for high performing large-scale outdoor IoT networks applications.

This chip antenna component is also **easy to use** as it´s an off the shelf component meaning no assembly is required and it's ready to be placed into any of your designs as soon as it arrives. In this application note you will find information about the RUN mXTEND™´s technical characteristics and learn about its performance on three different PCB board sizes, so you can be sure of its functionality in a variety of IoT device sizes, from **smart meters** for utilities management, to **smart street lighting** solutions, to **smart parking sensors** for smart cities.

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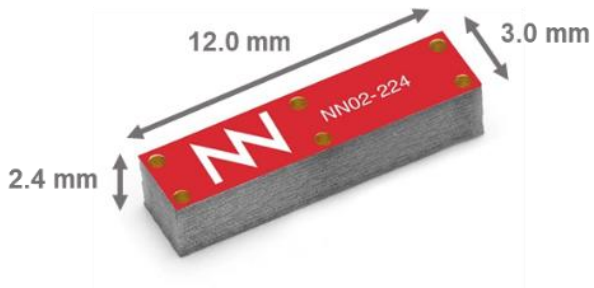
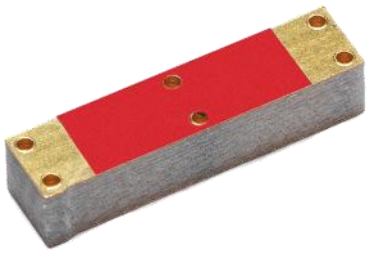
1. PRODUCT DESCRIPTION NN02-224

The RUN mXTEND™ antenna booster has been specifically designed for providing multiband performance in wireless devices, enabling worldwide coverage by allowing operation in the Wi-SUN standard, among others This application note shows how RUN mXTEND™ can be used to provide coverage in the Wi-SUN standards of 868 MHz (EU), 915 MHz (USA), and 2.4 GHz ISM bands. A single antenna is used for both frequency regions saving PCB size and cost.

TOP



BOTTOM



Material: The RUN mXTEND™ antenna booster is built on glass epoxy substrate.

APPLICATIONS

- IoT devices
- Modules
- Routers
- Handsets and smartphones
- Tablets
- Digital cameras
- Smartwatches and wearables

BENEFITS

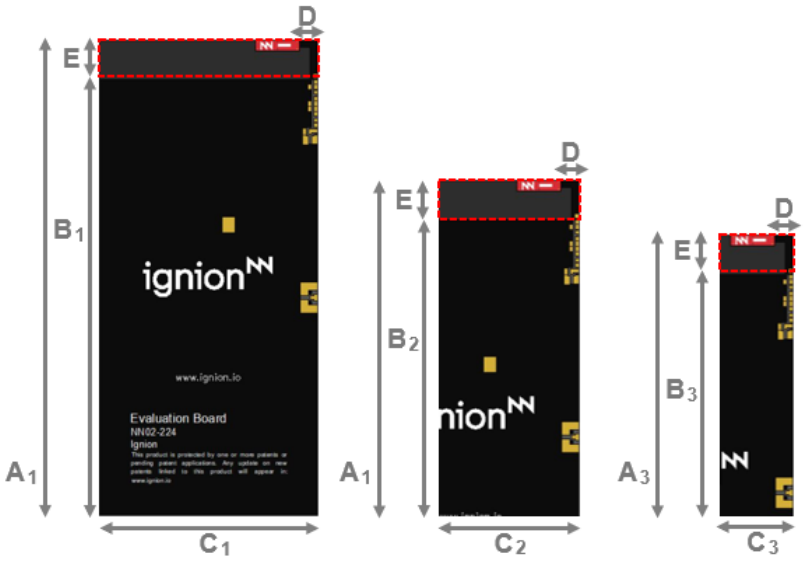
- High efficiency
- Small size
- Cost-effective
- Easy-to-use (pick and place)
- Off-the-Shelf standard product (no customization is required)
- No clearance beyond footprint.

The RUN mXTEND™ antenna booster belongs to a new generation of antenna solutions based on the Virtual Antenna® technology developed by Ignion. The technology is mainly focused on replacing conventional antenna solutions by miniature, general purpose, and off-the-shelf components.

2. Wi-SUN STANDARD SOLUTION WITH DIFFERENT PCB DIMENSIONS FOR SEVERAL DEVICES

2.1. DIFFERENT EVALUATION BOARDS FOR MULTIPLE SOLUTIONS

Considering using a single antenna for your new IoT device? The following solution explains how the RUN mXTEND™ antenna booster provides operation in the Wi-SUN standards of 868 MHz (EU), 915 MHz (USA), and 2.4 GHz ISM bands through a single input/output port. The design is shown in 3 different IoT boards sizes, all of them reusing exacting the same component but just a different matching network.



Measure	mm
$A_{1\text{-}2\text{-}3}$	131 - 93 - 76
$B_{1\text{-}2\text{-}3}$	120 - 82 - 65
$C_{1\text{-}2\text{-}3}$	60 - 38 - 20
D	5.0
E	11.0

Tolerance: ±0.2 mm

E: Distance between the edge of the PCB and the ground plane.

Clearance area: 11mm x $C_{1\text{-}2\text{-}3}$ mm (red dotted square)

Material: The evaluation board is built on FR4 substrate. Thickness is 1 mm.

Figure 1 – Evaluation Board with different size dimensions providing operation from 863 MHz to 928 MHz and from 2400 MHz to 2500 MHz.

2.2. VSWR AND EFFICIENCY

VSWR (Voltage Standing Wave Ratio) and Total Efficiency versus Frequency (GHz).

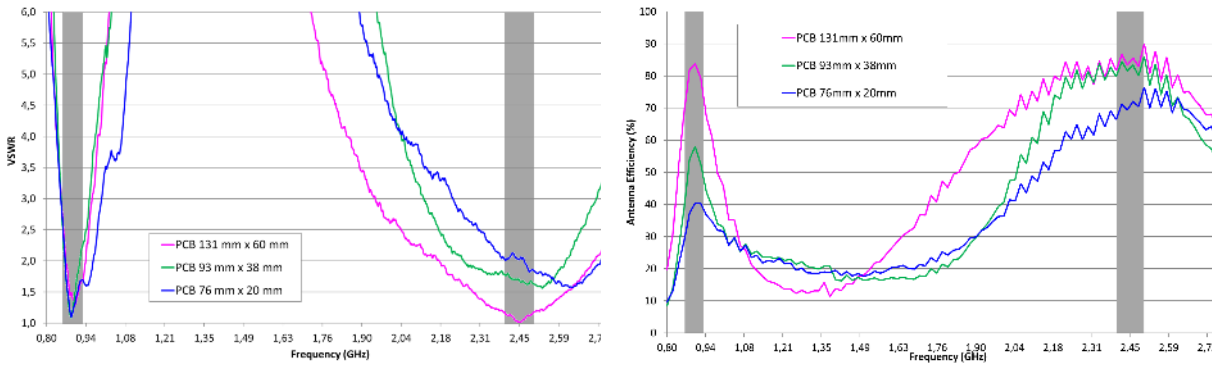


Figure 2 – VSWR and Total Efficiency for the 863 – 928 MHz and 2400 – 2500MHz from the evaluation board (Figure 1).

	LFR (863 – 928 MHz)					HFR (2400 – 2500 MHz)				
A	**$\eta_{a\ 863MHz}$**	**$\eta_{a\ 928MHz}$**	**Min**	**Max**	**Av. η_a**	**$\eta_{a\ 2400MHz}$**	**$\eta_{a\ 2500MHz}$**	**Min**	**Max**	**Av. η_a**
131mm x 60mm	70.5	74.5	70.5	83.7	79.9	81.8	89.8	81.8	89.8	84.9
93mm x 38mm	40.9	49.1	40.9	57.8	52.8	79.9	85.9	79.9	85.9	82.5
76mm x 20mm	29.9	38.8	29.9	36.8	40.4	66.6	76.3	66.6	76.3	70.9

Table 1 – Antenna efficiency (%) comparison considering the different PCB dimensions.

2.3. MATCHING NETWORK

The matching network and value components for these devices and PCB sizes are provided below. While the RUN mXTEND™ antenna booster remains the same in all the platforms the matching network topology and value of its components is adapted to every different PCB size for an optimum performance. The specs of a Ignion standard product are measured in a reference evaluation board, to isolate the antenna performance from other system elements. However, when incorporating into real designs, nearby components such as LCD's, batteries, covers and connectors may affect the antenna performance. For this reason, placing pads compatible with 0402 and 0603 SMD components for a matching network as close as possible to the feeding point is highly recommended. The matching network should be implemented in the ground plane area rather than the clearance area, this will provide a degree of freedom for tuning the RUN mXTEND™ antenna booster once the design is finished, taking into account all elements of the system (batteries, displays, covers, etc.). To ensure optimal results, the use of high Q and tight tolerance components is highly recommended (Murata components).

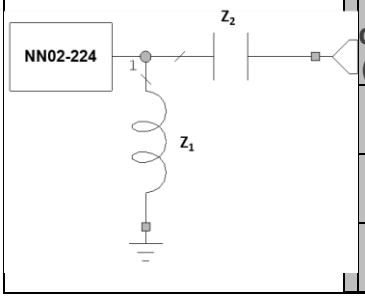
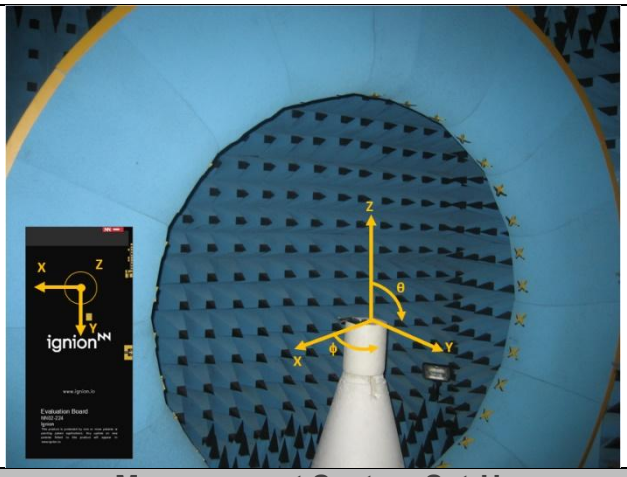
863 – 928 MHz and 2400 – 2500 MHz			
	**PCB dimensions (mm x mm)**	**Z_1** [Value (Part Number)]	**Z_2** [Value (Part Number)]
	131 x 60	19 nH (LQW18AN19NG80)	0.6 pF (GJM1555C1HR60WB01)
	93 x 38	19 nH (LQW18AN19NG80)	0.6 pF (GJM1555C1HR60WB01)
	76 x 20	18 nH (LQW18AN18NG80)	0.7 pF (GJM1555C1HR70WB01)

Figure 3 – Matching Network implemented in the evaluation board (**Figure** 1) and Values of the components for each PCB dimensions

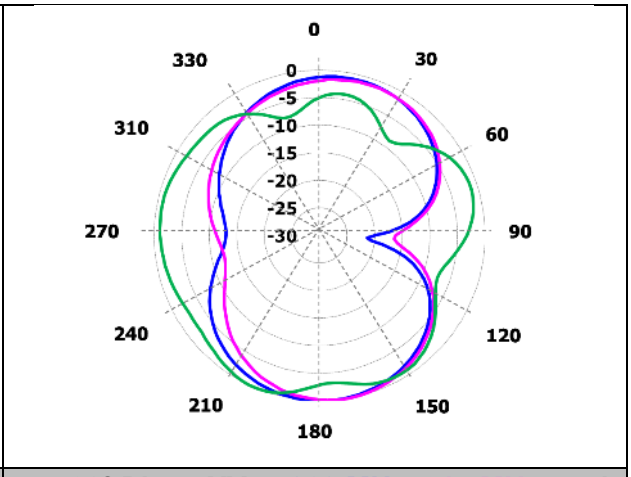
If you are designing a different device size or frequency band, run your configuration through Oxion™ at https://oxion.ai, Ignion's free-of-charge[1] AI-powered antenna integration platform, and get a complete design report with a custom matching network for your device in 24h. Ignion's engineering services: https://ignion.io/design-center/engineering-support/

1 See terms and conditions for the free-of-charge Oxion™ service at: https://oxion.ai

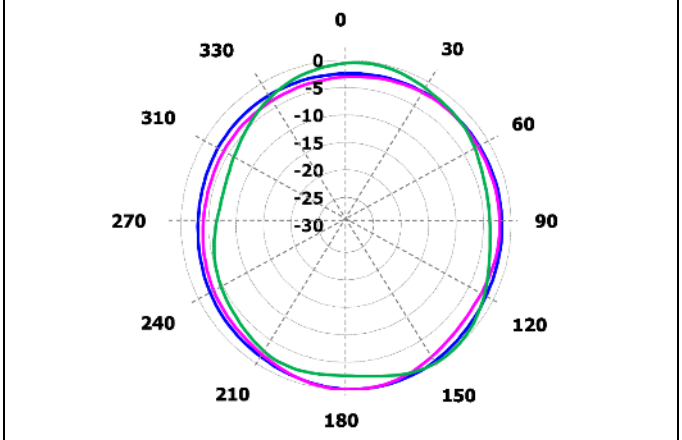
2.4. RADIATION PATTERNS 868/915 MHz AND 2.4 GHz ISM, GAIN AND EFFICIENCY FOR A 131mm X 60mm PCB SIZE



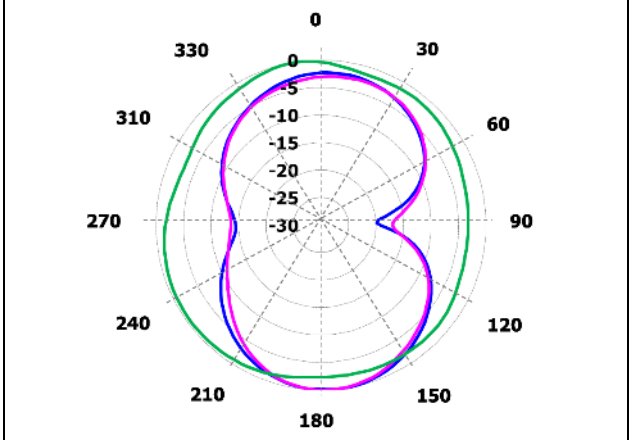
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 868 MHz, 915 MHz, and 2450 MHz



ϕ = 0º Plane XZ at 868 MHz, 915 MHz, and 2450 MHz

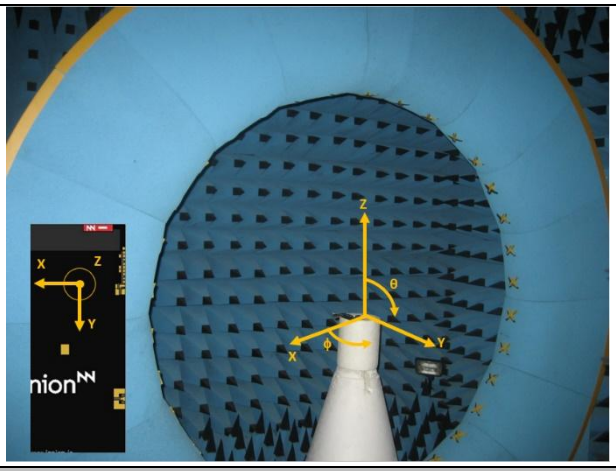


ϕ = 90º Plane YZ at 868 MHz, 915 MHz, and 2450 MHz

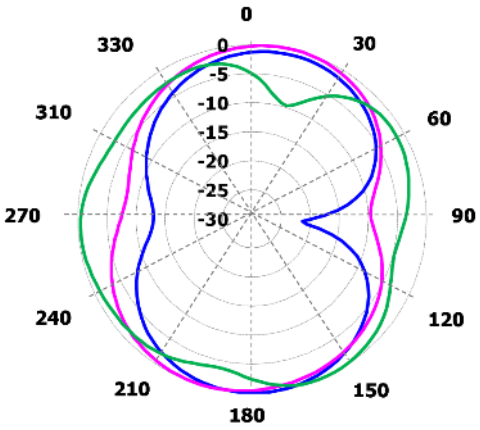
ISM868/915	Gain	Peak Gain	3.3 dBi
		Average Gain across the band	3.0 dBi
		Gain Range across the band (min, max)	2.2 <–> 3.3 dBi
	Efficiency	Peak Efficiency	83.7 %
		Average Efficiency across the band	79.9 %
		Efficiency Range across the band (min, max)	70.5 – 83.7 %
Bluetooth	Gain	Peak Gain	2.7 dBi
		Average Gain across the band	2.3 dBi
		Gain Range across the band (min, max)	2.0 <–> 2.7 dBi
	Efficiency	Peak Efficiency	89.8 %
		Average Efficiency across the band	84.9 %
		Efficiency Range across the band (min, max)	81.8 – 89.8 %

Table 2 – Antenna Gain and Total Efficiency from the evaluation board 131mm x 60mm PCB dimensions (Figure 1) within the 868 MHz, 915 MHz, and 2.4 GHz ISM bands. Measures made in the Satimo STARGATE 32 anechoic chamber.

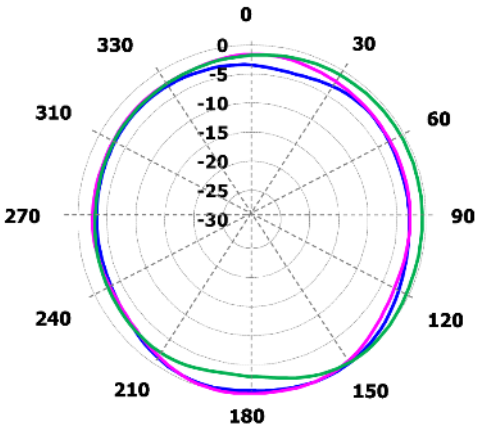
2.5. RADIATION PATTERNS 868/915 MHz AND 2.4 GHz ISM, GAIN AND EFFICIENCY FOR A 93mm X 38mm PCB SIZE



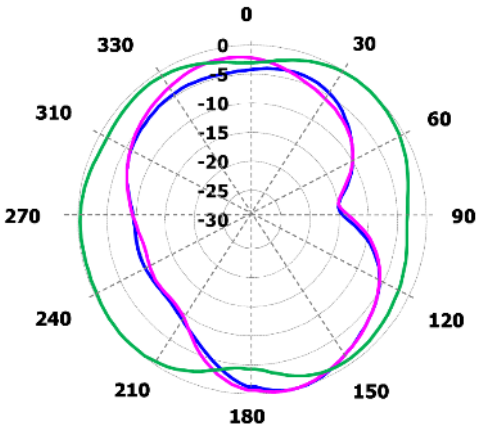
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 868 MHz, 915 MHz, and 2450 MHz



ϕ = 0º Plane XZ at 868 MHz, 915 MHz, and 2450 MHz

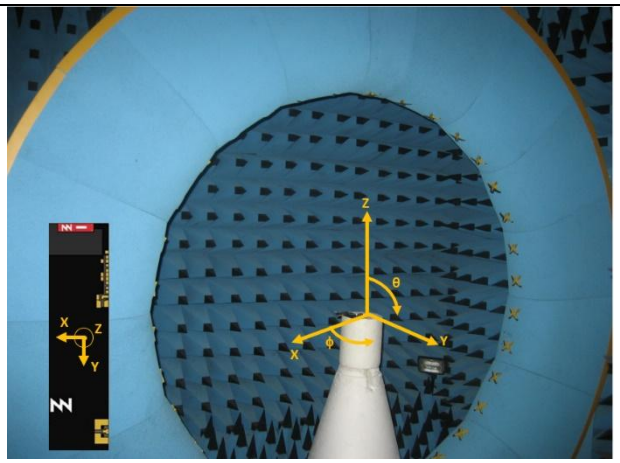


ϕ = 90º Plane YZ at 868 MHz, 915 MHz, and 2450 MHz

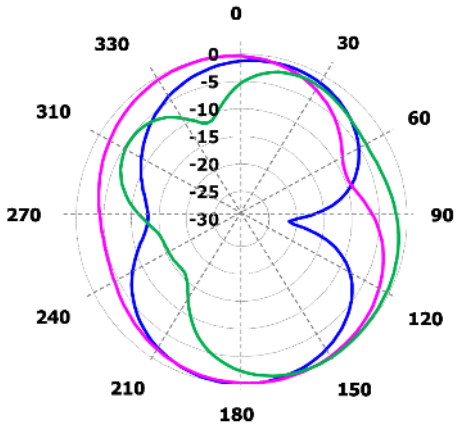
ISM868/915	Gain	Peak Gain	2.3 dBi
		Average Gain across the band	1.6 dBi
		Gain Range across the band (min, max)	0.2 <–> 2.3 dBi
	Efficiency	Peak Efficiency	57.8 %
		Average Efficiency across the band	52.8 %
		Efficiency Range across the band (min, max)	40.9 – 57.8 %
Bluetooth	Gain	Peak Gain	1.9 dBi
		Average Gain across the band	1.8 dBi
		Gain Range across the band (min, max)	1.7 <–> 1.9 dBi
	Efficiency	Peak Efficiency	85.9 %
		Average Efficiency across the band	82.5 %
		Efficiency Range across the band (min, max)	79.9 – 85.9 %

Table 3 – Antenna Gain and Total Efficiency from the evaluation board 93mm x 38mm PCB dimensions (Figure 1) within the 863 – 928 MHz and 2400 – 2500 MHz ISM bands. Measures made in the Satimo STARGATE 32 anechoic chamber.

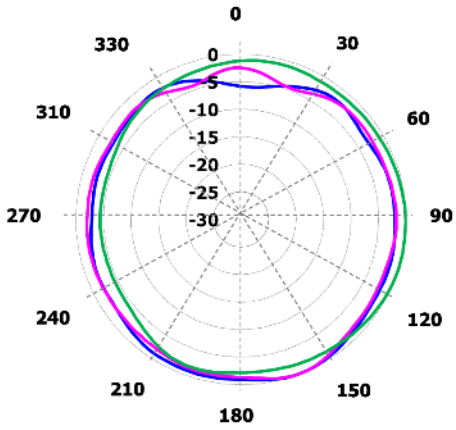
2.6. RADIATION PATTERNS 868/915 MHz AND 2.4 GHz ISM, GAIN AND EFFICIENCY FOR A 76mm X 20mm PCB SIZE



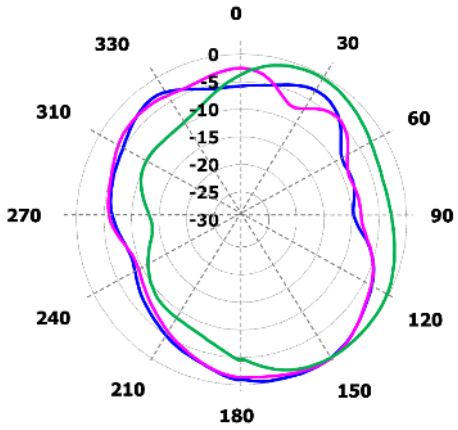
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 868 MHz, 915 MHz, and 2450 MHz



ϕ = 0º Plane XZ at 868 MHz, 915 MHz, and 2450 MHz



ϕ = 90º Plane YZ at 868 MHz, 915 MHz, and 2450 MHz

ISM868/915	Gain	Peak Gain	0.4 dBi
		Average Gain across the band	-0.2 dBi
		Gain Range across the band (min, max)	-1.4 <–> 0.4 dBi
	Efficiency	Peak Efficiency	40.4 %
		Average Efficiency across the band	38.0 %
		Efficiency Range across the band (min, max)	29.9 – 40.4 %
Bluetooth	Gain	Peak Gain	3.4 dBi
		Average Gain across the band	2.9 dBi
		Gain Range across the band (min, max)	2.6 <–> 3.4 dBi
	Efficiency	Peak Efficiency	76.3 %
		Average Efficiency across the band	70.9 %
		Efficiency Range across the band (min, max)	66.6 – 76.3 %

Table 4 – Antenna Gain and Total Efficiency from the evaluation board 76mm x 20mm PCB dimensions (Figure 1) within the 863 – 928 MHz and 2400 – 2500 MHz ISM bands. Measures made in the Satimo STARGATE 32 anechoic chamber.

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Ignion is an ISO 9001:2015 certified company. All our antennas are lead-free and RoHS compliant.

ISO 9001: 2015 Certified

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