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Wi-SUN antenna connectivity

APPLICATION NOTE
RUN mXTEND™ (NN02-224)

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.

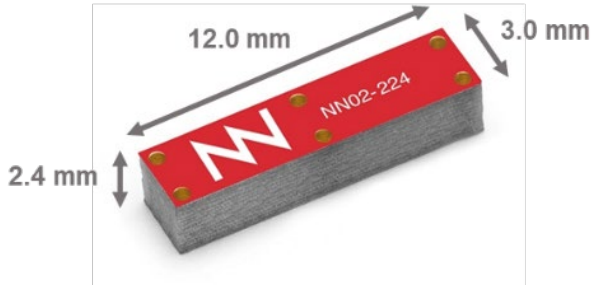
This chip antenna component is also **easy to use** as it´s an off the shelf component meaning no assembly is required and it's ready to be placed into any of your designs as soon as it arrives. In this application note you will find information about the RUN mXTEND™´s technical characteristics and learn 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.

TABLE OF CONTENTS

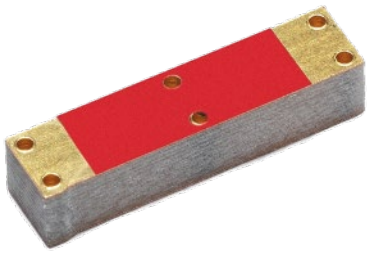
1. PRODUCT DESCRIPTION NN02-224

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

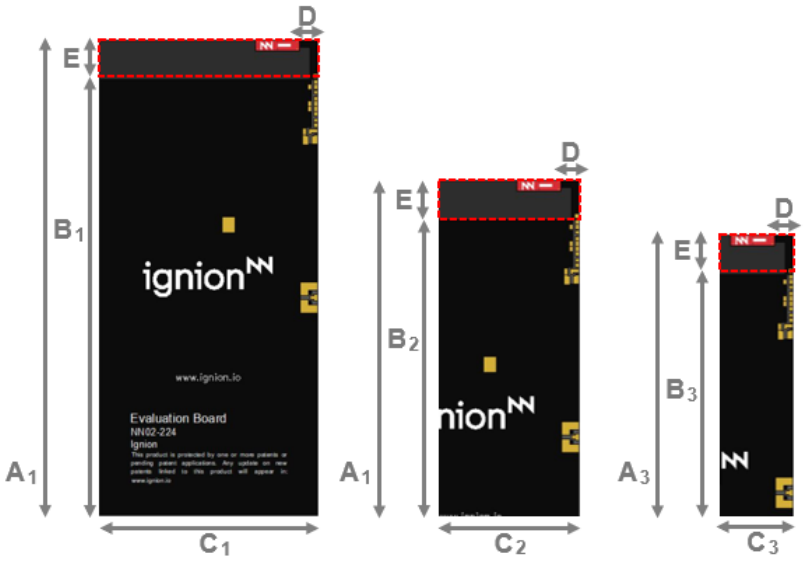
- High efficiency
- Small size
- Cost-effective
- Easy-to-use (pick and place)
- Off-the-Shelf standard product (no customization is required)
- No clearance beyond footprint.

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).

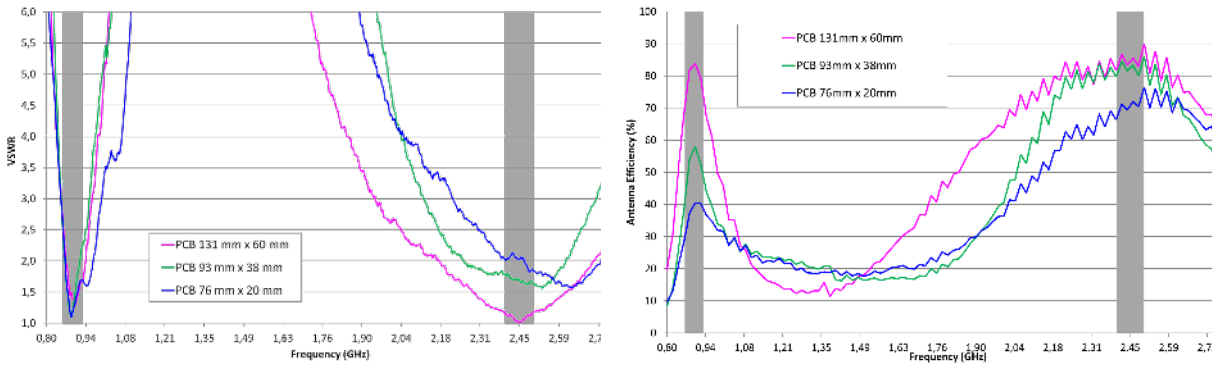


Figure 2 – VSWR and Total Efficiency for the 863 – 928 MHz and 2400 – 2500MHz from the evaluation board (Figure 1).

	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).

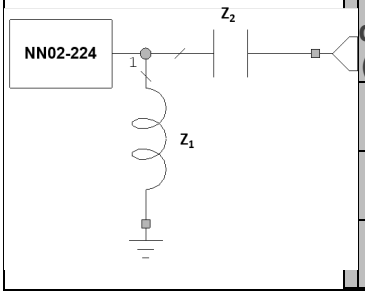
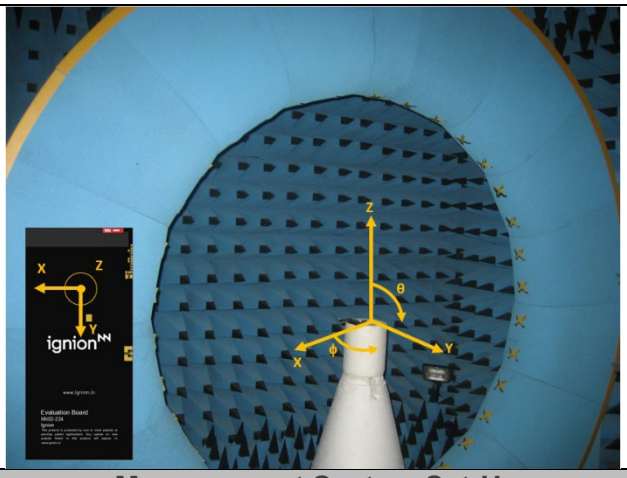
863 – 928 MHz and 2400 – 2500 MHz			
	**PCB dimensions (mm x mm)**	**Z_1** [Value (Part Number)]	**Z_2** [Value (Part Number)]
	131 x 60	19 nH (LQW18AN19NG80)	0.6 pF (GJM1555C1HR60WB01)
	93 x 38	19 nH (LQW18AN19NG80)	0.6 pF (GJM1555C1HR60WB01)
	76 x 20	18 nH (LQW18AN18NG80)	0.7 pF (GJM1555C1HR70WB01)

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

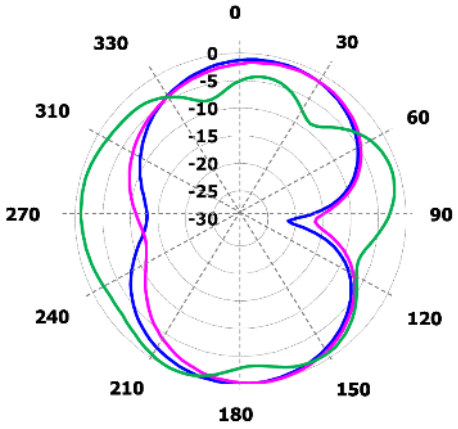
If you need assistance to design your matching network beyond this application note, please contact support@ignion.io, or if you are designing a **different device size** or a **different frequency band**, **we can assist you** in less than 24 hours. Please, try our free-of-charge[1] Antenna Intelligence Cloud, which will get you a complete design report including a custom matching network for your device in 24h[1]. Additional information related to NN's range of R&D services is available at: https://ignion.io/rdservices/

[1] See terms and conditions for a free Antenna Intelligence Cloud service in 24h at: https://www.ignion.io/antenna-intelligence/

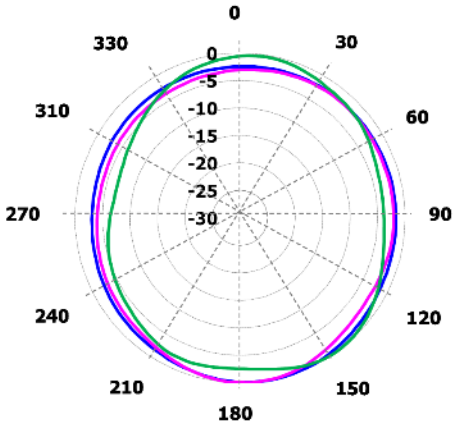
2.4. RADIATION PATTERNS 868/915 MHz AND 2.4 GHz ISM, GAIN AND EFFICIENCY FOR A 131mm X 60mm PCB SIZE



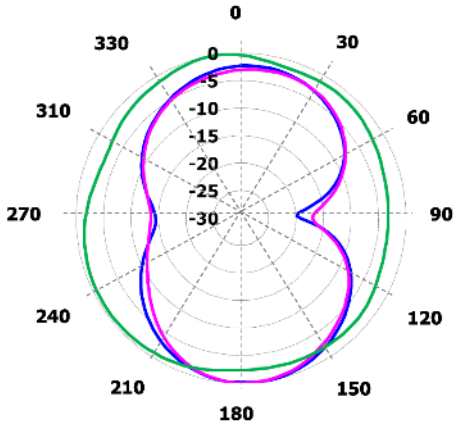
Measurement System Set-Up Evaluation Board in Plane XY



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



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

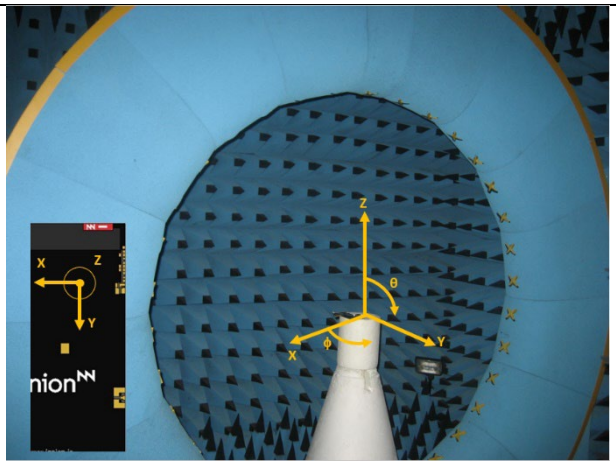


ϕ = 90º Plane YZ at 868 MHz, 915 MHz, and 2450 MHz

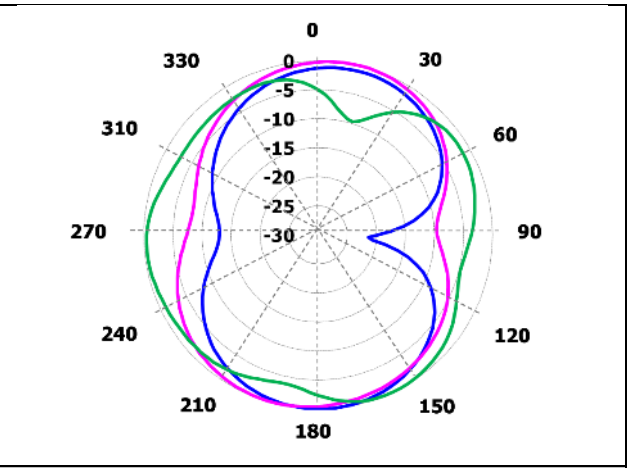
ISM868/915	Gain	Peak Gain	3.3 dBi
		Average Gain across the band	3.0 dBi
		Gain Range across the band (min, max)	2.2 <–> 3.3 dBi
	Efficiency	Peak Efficiency	83.7 %
		Average Efficiency across the band	79.9 %
		Efficiency Range across the band (min, max)	70.5 – 83.7 %
Bluetooth	Gain	Peak Gain	2.7 dBi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

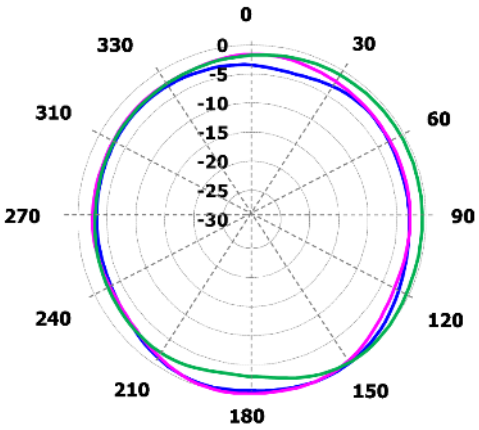
2.5. RADIATION PATTERNS 868/915 MHz AND 2.4 GHz ISM, GAIN AND EFFICIENCY FOR A 93mm X 38mm PCB SIZE



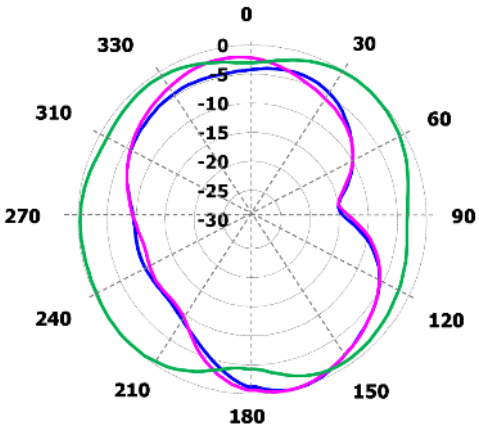
Measurement System Set-Up Evaluation Board in Plane XY



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



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

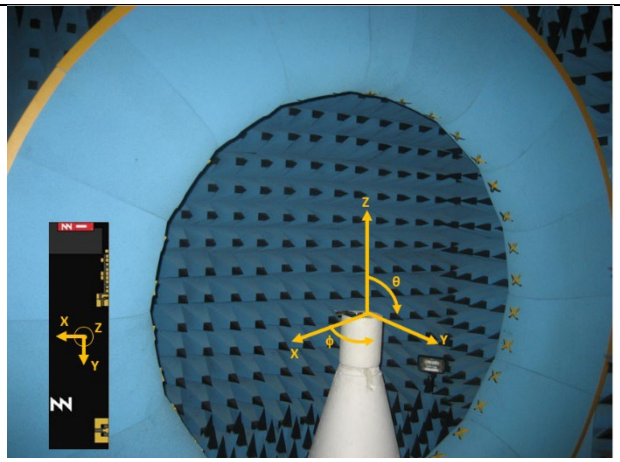


ϕ = 90º Plane YZ at 868 MHz, 915 MHz, and 2450 MHz

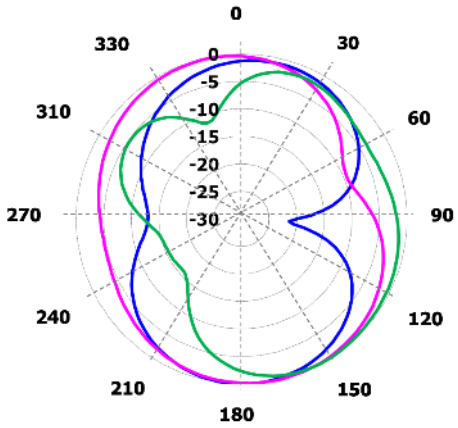
ISM868/915	Gain	Peak Gain	2.3 dBi
		Average Gain across the band	1.6 dBi
		Gain Range across the band (min, max)	0.2 <–> 2.3 dBi
	Efficiency	Peak Efficiency	57.8 %
		Average Efficiency across the band	52.8 %
		Efficiency Range across the band (min, max)	40.9 – 57.8 %
Bluetooth	Gain	Peak Gain	1.9 dBi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

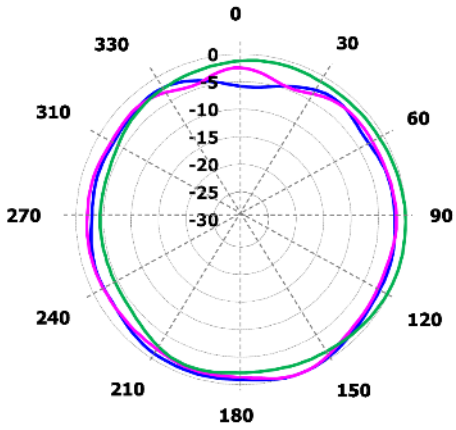
2.6. RADIATION PATTERNS 868/915 MHz AND 2.4 GHz ISM, GAIN AND EFFICIENCY FOR A 76mm X 20mm PCB SIZE



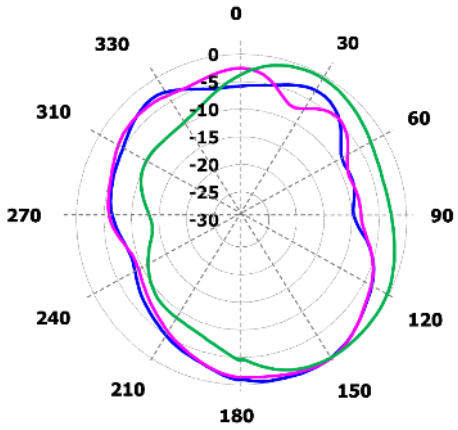
Measurement System Set-Up Evaluation Board in Plane XY



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.

Ignion products are protected by Ignion patents.

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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