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DUO mXTEND™ - Enabling GNSS and Wi-Fi/BLE connection.

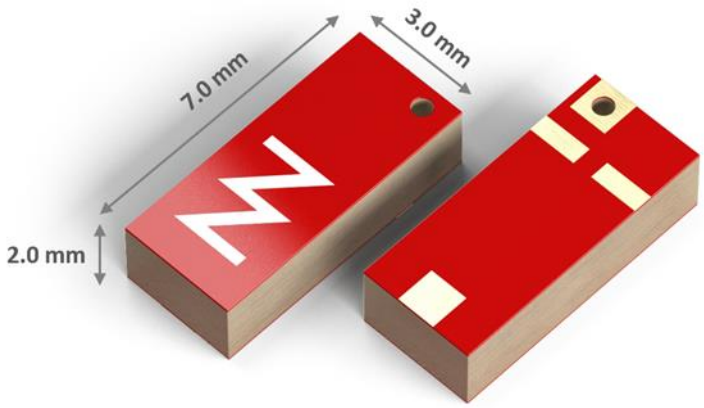
APPLICATION NOTE

TABLE OF CONTENTS

1. PRODUCT DESCRIPTION NN03-320

The **DUO mXTEND™** (NN03-320) current operating range extends from 1500 MHz up to 10600 MHz, making it a versatile component to cover any radio application within that range, including **Bluetooth**, **Wi-Fi**, and **UWB**, but also **5G** and **CBRS**. Its miniature and slim form factor, together with its **no-ground clearance** and **dual-mounting** features makes it the ideal wireless connectivity chip for small indoor/outdoor tracking devices and all kinds of miniature IoT sensors. Due to the minimum footprint and size of the **DUO mXTEND™**, embedded massive MIMO (e.g. 8 x 8) devices are a good application, where the density of installed antennas in a PCB is inherently high.

TOP **BOTTOM**



Material: The DUO mXTEND™ antenna component is built on glass epoxy substrate.

APPLICATIONS

- Industrial IoT
- Asset Tracking & Logistics
- Wearables
- Consumer Electronics

BENEFITS

- High efficiency
- Small size
- Cost-effective
- Easy-to-use (pick and place)
- Multiband
- Off-the-Shelf Standard Product

2. EVALUATION BOARD

The DUO mXTEND™ (NN03-320) antenna booster has been specifically designed for providing worldwide Global Navigation Satellite Systems (GNSS) and Bluetooth (BT) performance in wireless devices with small space requirements. Here we will compare BeiDou, GPS & Galileo and GLONASS performance operating in conjunction with Bluetooth. Using one of our Evaluation Boards, an example of a common DUO mXTEND™ placement is seen. Finally, two different matching networks are selected, using both ports, for both GNSS and BT, allowing us to test, obtain, and analyze the VSWR, total efficiency, gain and radiation patterns.

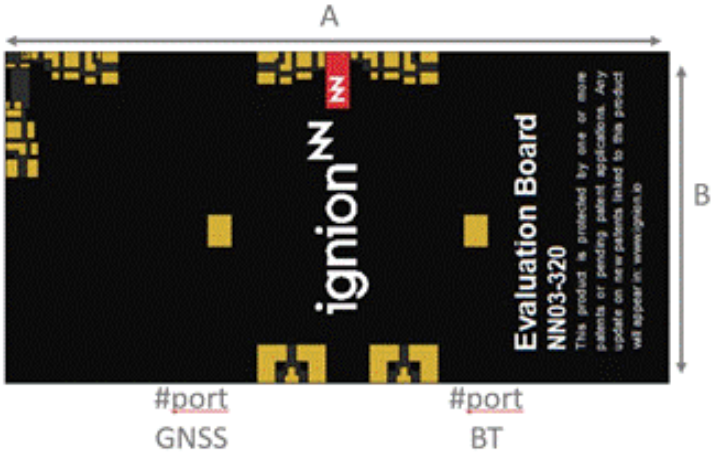
2.1. QUICK REFERENCE GUIDE

Technical features	BeiDou	GPS & GALILEO	GLONASS	Bluetooth
	1561MHz	1575MHz	1598 – 1606MHz	2400 – 2500MHz
Average Efficiency	> 40%	> 45%	> 50%	> 50%
Peak Gain	-1.1 dBi	-1.0 dBi	-1.0 dBi	-0.9 dBi
VSWR	< 3:1			
Radiation Pattern	Omnidirectional			
Polarization	Linear			
Weight (approx.)	0.11 g.			
Temperature	-40 to +125 ºC			
Impedance	50 Ω			
Dimensions (L x W x H)	7.0 mm x 3.0 mm x 2.0 mm			

Table 1 – Technical Features. Measures from the Evaluation Board. See Figure 1.

2.2. EVALUATION BOARD

This Evaluation Board (part number: EB_NN03-320-m-GNSS-BT) integrates one DUO mXTEND™ antenna booster to provide operation in four frequency regions, 1561MHz (BeiDou E1 band), 1575 MHz (GPS L1 band and GALILEO E1), from 1598 MHz to 1606 MHz (GLONASS L1 band) and from 2400 MHz to 2500MHz (Bluetooth). A couple of UFL cables connect this dual input/output port configuration to the SMA connectors for testing purposes.



Measure	mm
A	25.0
B	20.0

Tolerance: ±0.2 mm

Material: The Evaluation Board is built on a FR4 substrate.

Thickness is 1 mm.

Figure 1 – EB_NN03-320-m-GNSS-BT Evaluation Board providing operation at BeiDou E1 band (1561 MHz), GPS L1 band and GALILEO E1 band (1575 MHz), GLONASS L1 band (from 1598 MHz to 1606 MHz) and Bluetooth (from 2400MHz to 2480MHz). Notice that the clearance area is equal to the DUO mXTEND™ 's footprint.

This product and/or its use is protected by at least one or more patents and patent applications. Please check related patent information at: Ignion patents.

2.2.1. MATCHING NETWORK

The DUO mXTEND™ needs two matching networks to connect to your device, a first for the Bluetooth port, a second for the GNSS one (Figure 2). This section describes (in Figure 3) a suitable matching network for the DUO mXTEND™ and the resulting product specs when measured in the reference evaluation board (EB_NN03-320-m-GNSS-BT) described in the previous section. Please note that different tracking devices with different form factors, RF ground planes, and nearby components may need a different matching network. 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] Oxion™ platform, which will get you a complete design report including a custom matching network for your device in 24h[1]. Additional information related to Ignion's range of R&D services is available at: https://ignion.io/rdservices/

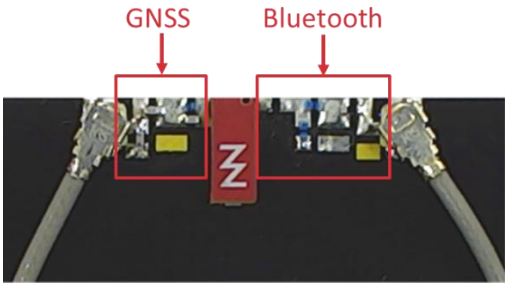


Figure 2 – Matching network distribution in the Evaluation Board (Figure 1).

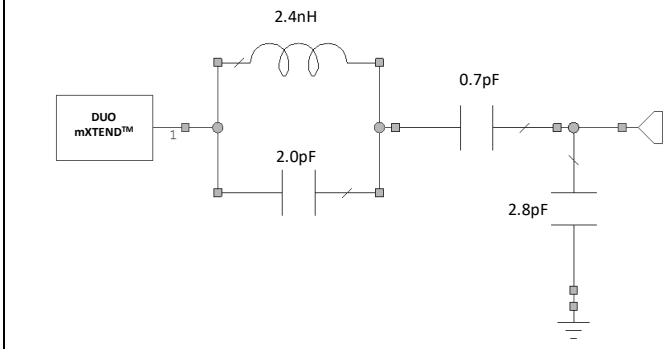
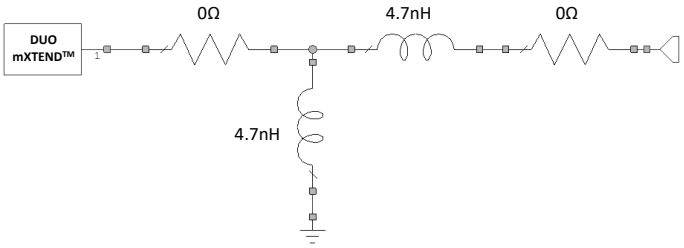
<table>
<tr><th colspan="3">1561 MHz – 1606 MHz and 2400 MHz – 2500 MHz</th></tr>
<tr><td>MN
GNSS</td><td> 
</td><td>
<table>
<tr><th>Value</th><th>Part Number</th></tr>
<tr><td>2.4 nH</td><td>LQW15AN2N4C00</td></tr>
<tr><td>2.0 pF</td><td>GJM1555C1H2R0WB01</td></tr>
<tr><td>0.7 pF</td><td>GJM1555C1HR70WB01</td></tr>
<tr><td>2.8 pF</td><td>GJM1555C1H2R8WB01</td></tr>
</table>
</td></tr>
<tr><td>MN
BT</td><td> 
</td><td>
<table>
<tr><th>Value</th><th>Part Number</th></tr>
<tr><td>0 Ω</td><td>-</td></tr>
<tr><td>4.7 nH</td><td>LQW15AN4N7G80</td></tr>
<tr><td>4.7 nH</td><td>LQW15AN4N7G80</td></tr>
<tr><td>0 Ω</td><td>-</td></tr>
</table>
</td></tr>
</table>

Figure 3 – Matching network implemented in the Evaluation Board 1 port (Figure 1).

To ensure optimal results, the use of high-quality factor (Q) and tight tolerance components is highly recommended (e.g., Murata components with part numbers as in Figure 3). The antenna performance is always conditioned by its operating environment so that different devices with different printed circuit board sizes, components nearby the antenna, LCDs, batteries, covers, connectors, etc. affect the antenna performance. Accordingly, it is highly recommended placing pads compatible with 0402 and 0603 SMD components for a matching network as close as possible to the feeding point of the antenna element. Do it in the ground plane area, not in the clearance area. By tuning the matching network in your final design with your final surrounding components (batteries, displays, covers, etc.) you will be able to optimize the antenna performance without changing the antenna part.

For additional information, please visit www.ignion.io or contact info@ignion.io.

If you are designing a device with a different size or operating frequency than shown above, you can assess the performance of this configuration using our free-of-charge Oxion™ platform. This platform provides a complete design report, including expected performance and tailored design guide, within 24 hours. For additional information about Ignion's range of R&D services, please visit: https://ignion.io/resources-support/technical-center/engineering-support/. If you require further assistance, please contact support@ignion.io.

Purchase this or other evaluation boards through our main distributors by visiting the following link: https://ignion.io/distributors/.

2.2.2. VSWR, TOTAL EFFICIENCY AND TRANSMISSION COEFFICIENT

- VSWR (Voltage Standing Wave Ratio) **is defined as the relation of transmitted and reflected standing waves of voltage in a radio frequency (RF) electrical transmission system.** In other words, VSWR or Return Loss is directly related to the coverage. If these values are not optimal, the communication will be dropped and there will be a poor signal.

- Total Efficiency is a term used to **measure the ratio between the power supplied to the antenna and the radiated power of the system.** Power is supplied to the antenna by the RF module and then, a part of that power is radiated to space and the other is transformed into losses (reflection due to decoupling between the transmission line and the antenna, loss during conduction, heat losses, etc.). Total Efficiency measures the quantity of power from the RF module that is effectively radiated to the space.

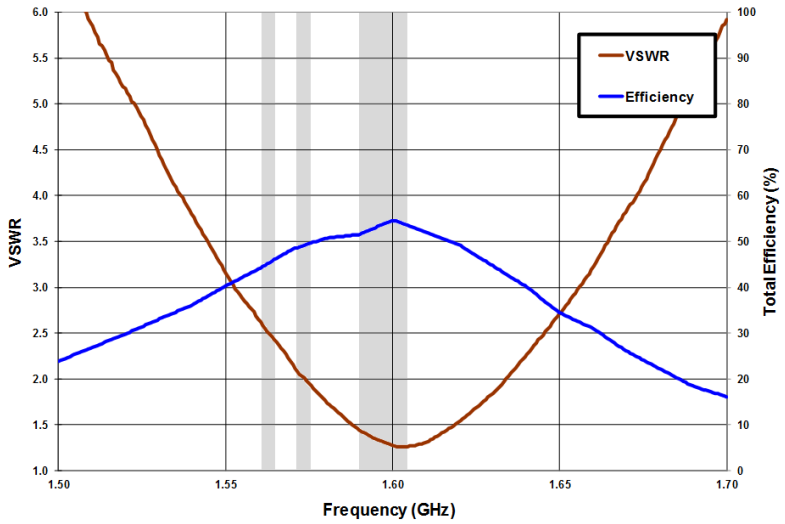


Figure 4 – VSWR and Total Efficiency at BeiDou E1 band (1561 MHz), GPS L1 band and GALILEO E1 band (1575 MHz), GLONASS L1 band (from 1598 to 1606 MHz) (from the Evaluation Board) (Figure 1).

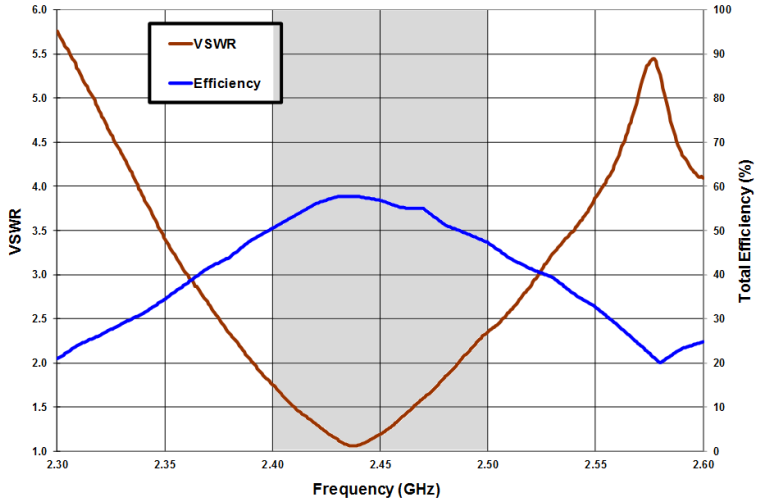


Figure 5 – VSWR and Total Efficiency for the 2400 – 2500 MHz (from the Evaluation Board Figure 1).

- The **transmission coefficient** is used in physics and engineering when considering media with discontinuities in **wave propagation**. The **transmission coefficient** describes the **amplitude** (or intensity) of a **transmitted wave** with respect to the **incident wave**. The transmission coefficient is closely related to the reflection coefficient.

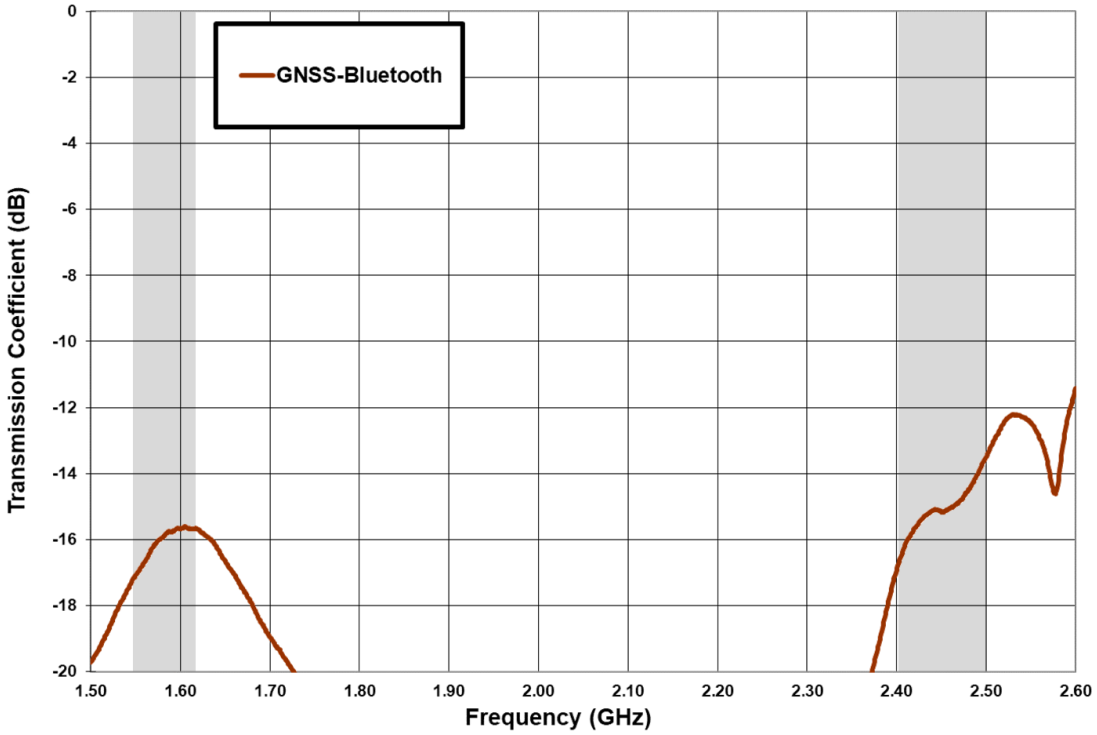
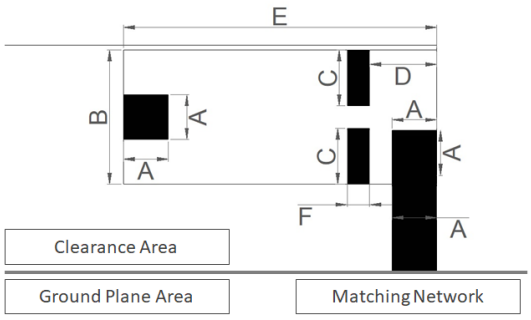


Figure 6 – Transmission coefficient between GNSS (1561 – 1606 MHz) and Bluetooth (2400 – 2500 MHz) from the Evaluation Board (Figure 1).

2.2.3. RECOMMENDED ANTENNA FOOTPRINT FOR NN03-320

The DUO mXTEND™ antenna component (NN03-320) can be placed close to a corner of the PCB or close to the center of the longitudinal PCB edge. See below the recommended footprint dimensions when it is placed close to a corner of the PCB with the feeding line aligned with the longest side of the board according to the Evaluation Board (Figure 1).



Measure	mm
A	1.0
B	3.0
C	1.25
D	1.5
E	7.0
F	0.5

Tolerance: ±0.05mm

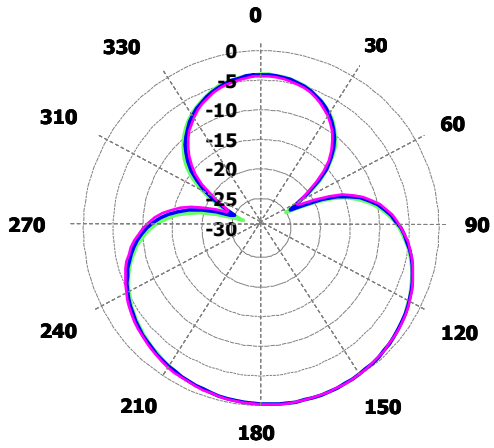
Figure 7 – Footprint dimensions for the NN03-320.

For additional support in the integration process, please contact support@ignion.io.

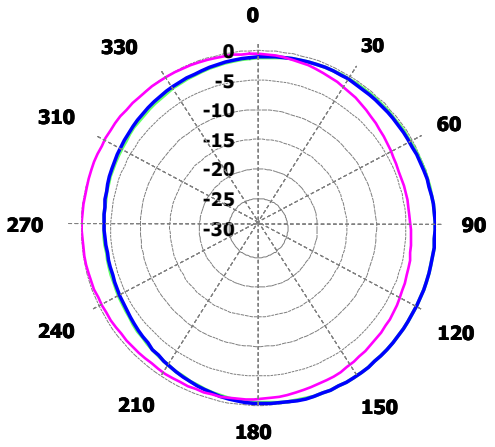
2.2.4. RADIATION PATTERNS (1561 MHz, 1575 MHz and 1598 – 1606 MHz), GAIN AND EFFICIENCY

The radiation pattern of the dual configuration (GNSS + BT/BLE) of the DUO mXTEND™ is shown below. The radiation pattern is **the graphical representation of the radiation characteristics of an antenna**, as a function of direction (azimuth and elevation coordinates). Among the characteristic parameters of a radiation pattern, the most important are gain and directivity. In this case, the radiation patterns are omnidirectional.

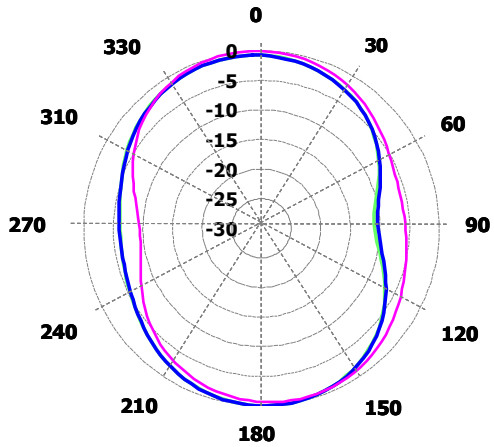
Measurement System Set-Up
Evaluation Board in Plane XY



θ = 90º Plane XY at 1561 MHz, 1575 MHz, and 1602 MHz



ϕ = 0º Plane XZ at 1561 MHz, 1575 MHz, and 1602 MHz



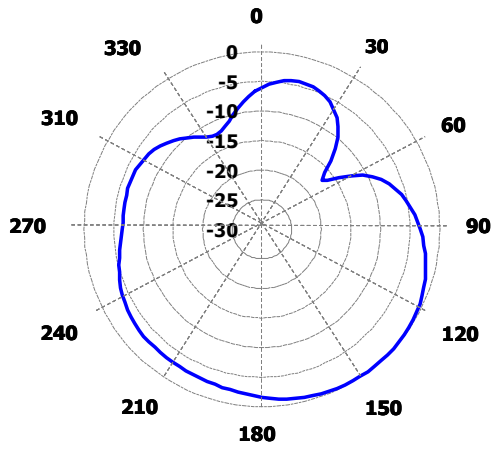
ϕ = 90º Plane YZ at 1561 MHz, 1575 MHz, and 1602 MHz

BeiDou	**Gain**		-1.1 dBi
	Efficiency		44.6 %
GPS	**Gain**		-1.0 dBi
	Efficiency		49.7 %
GLONASS	**Gain**	**Peak Gain**	-1.0 dBi
		Average Gain across the band	-1.0 dBi
		Gain Range across the band (min, max)	-1.0 **<–>** -1.0 dBi
	Efficiency	**Peak Efficiency**	54.6 %
		Average Efficiency across the band	53.9 %
		Efficiency Range across the band (min, max)	53.0 – 54.6 %

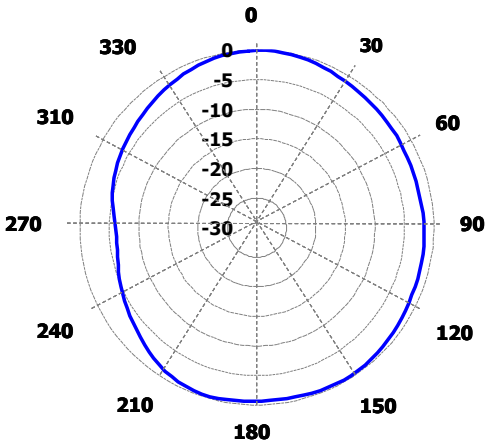
Table 2 – Antenna Gain and Total Efficiency from the Evaluation Board (Figure 1) for BeiDou E1 (1561 MHz), GPS L1 (1575 MHz) and GLONASS L1 (1598 MHz – 1606 MHz) bands. Measures made in the Satimo STARGATE 32 anechoic chamber.

2.2.5. RADIATION PATTERNS (2400 - 2500 MHz), GAIN AND EFFICIENCY

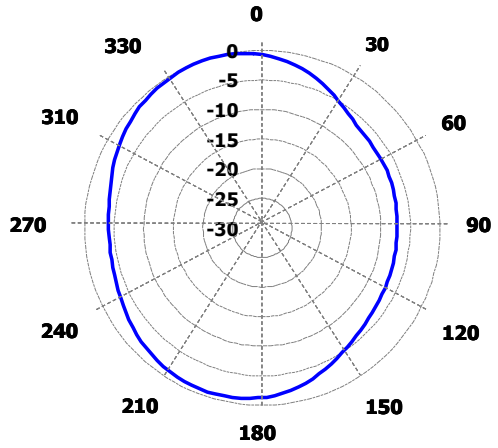
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 2450MHz



ϕ = 0º Plane XZ at 2450MHz



ϕ = 90º Plane YZ at 2450MHz

Gain	**Peak Gain**	-0.9 dBi
	Average Gain across the band	-0.9 dBi
	Gain Range across the band (min, max)	-1.0 dBi **<–>** -0.9 dBi
Efficiency	**Peak Efficiency**	57.7 %
	Average Efficiency across the band	54.1 %
	Efficiency Range across the band (min, max)	47.2 – 57.7 %

Table 3 – Antenna Gain and Total Efficiency for the Evaluation Board (Figure 1) for Bluetooth (2400 MHz - 2500 MHz). Measures made in the Satimo STARGATE 32 anechoic chamber.

This product and its use is protected by at least one or more of the following patents and patent applications **US 8,203,492**; **US 8,237,615**; **PCT/EP2013/064692**; **WO2014/012842**; **US 62/028,494**; **US 62/072,671**; and other domestic and international patents pending. Additional information about patents related to this product is available at https://ignion.io/virtual-antenna/

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

- This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement **Nº 674491**.

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