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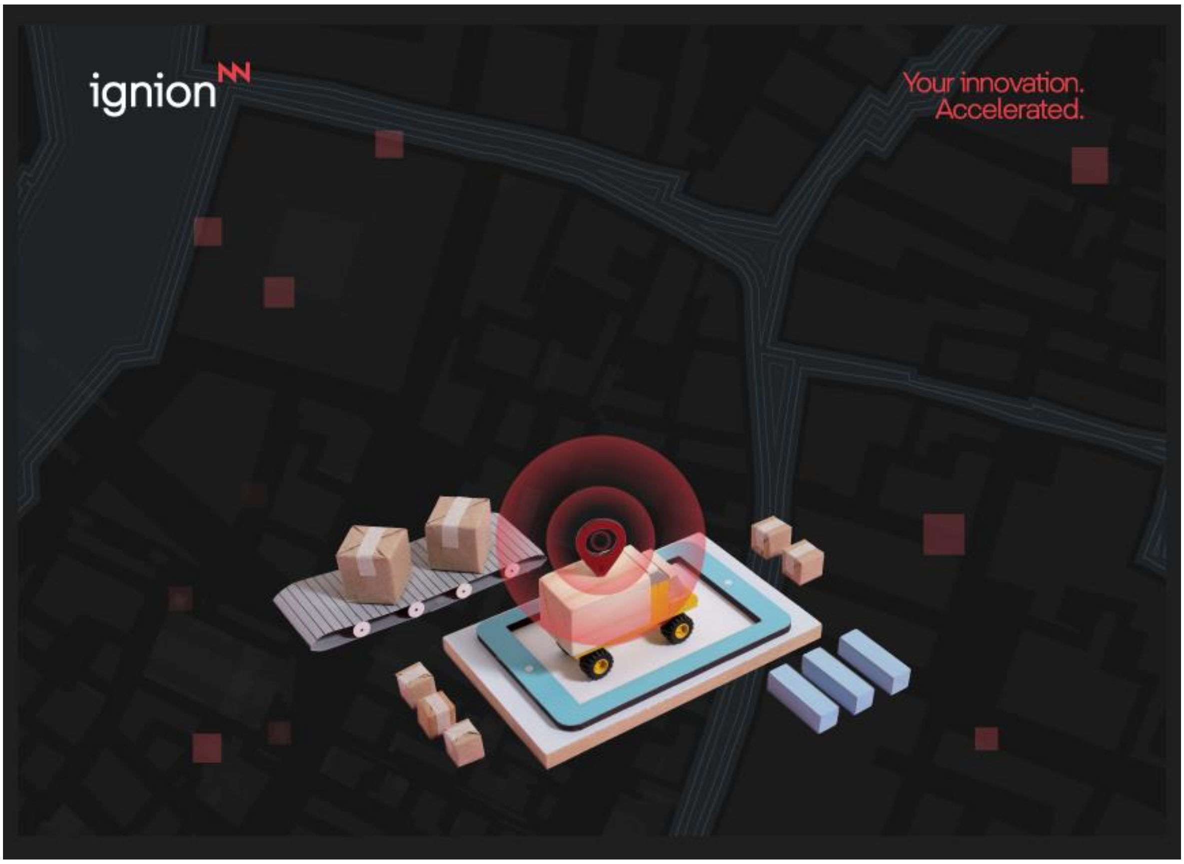
Cover any Ultra-Wideband frequency with DUO mXTEND™ or NANO mXTEND™

APPLICATION NOTE

Cover any Ultra-Wideband frequency with DUO mXTEND™ or NANO mXTEND™

Ultra-Wideband (UWB) technology is utilized in a growing variety of IoT applications, including smart locks, asset tracking systems, as well as precision agriculture and many more. At Ignion **we enable you to easily maximize the antenna performance in your next UWB product**.



Ultra-wideband offers a precise indoor and outdoor location with positioning accuracy under 10 centimeters. Unlike Bluetooth, which estimates location based on signal strength, **UWB calculates the time it takes for the signal to travel back and forth**, thus achieving a **higher level of accuracy**. In security applications like passive keyless entry and automotive, building automation, and smart homes, knowing the precise location or distance can be critical to the application.

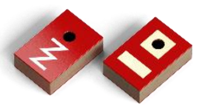
UWB is a spread spectrum technology **that radiates very narrow pulses in the order of nanoseconds, covering a wide bandwidth of frequency** (typically between **3.1 GHz and 10.6 GHz**). This reduces interference and enables high data rates, making it a reliable option for applications such as real-time collision avoidance.

With an optimized antenna, **UWB provides high accuracy, high energy efficiency, low radio interference, and high data rates. Ignion DUO mXTEND™** and **NANO mXTEND™** make it easy to cover the whole UWB frequency spectrum (3.1 GHz - 10.6 GHz).

This application note shows how the Virtual Antenna® components can be used to operate in the **UWB frequency bands** from **3.1 GHz up to 8.5 GHz.**

IGNION PRODUCTS RECOMMENDED FOR UWB

The versatility of the **Virtual Antenna®** technology makes it easy to cover the vast majority of the UWB frequency range (3.1-4.8 GHz and 6.0-8.5 GHz) in any device.

NANO mXTEND™ (NN02-101) 	**DUO mXTEND™ (NN03-320)** 
Dimensions: 3.0 mm x 2.0 mm x 0.8 mm The **NANO mXTEND™** antenna booster is **the smallest Virtual Antenna® component,** the perfect choice for small devices limited in terms of PCB real estate, where both the antenna component and clearance area needed are of minimal size. This off-the-shelf **chip antenna** is highly cost-optimized, enabling low-cost designs to benefit from the customizable performance of the Virtual Antenna technology. It Is available for both **corner and edge mounting on printed circuit boards**. Supports UWB frequency range (3.1-4.8 GHz and 6.0-8.5 GHz)	**Dimensions**: 7.0 mm x 3.0 mm x 2.0 mm **DUO mXTEND™** is a chip antenna component delivering **high performance** in UWB devices, ideal for devices where the extra percentages matter. DUO mXTEND™ is **dual-port** and supports most wireless technologies making it the ideal antenna part for indoor/outdoor tracking devices where UWB is combined with other technologies such as BLE, Wi-Fi, and others. It is designed for mounting either at the center edge or at the corner of your device. Supports UWB frequency range (3.1-4.8 GHz and 6.0-8.5 GHz)

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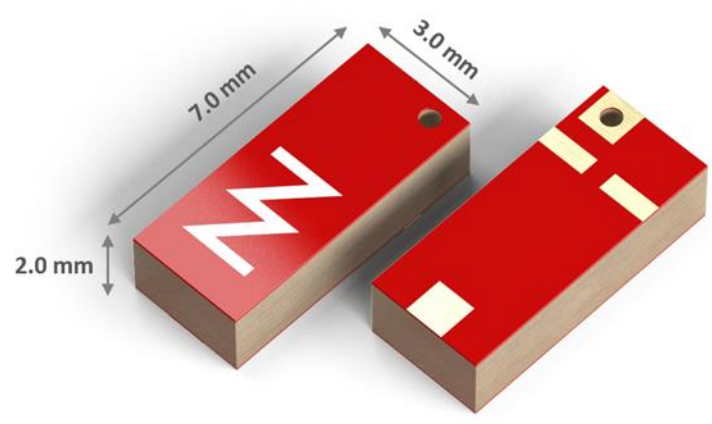
1. HIGH-PERFORMANCE UWB DESIGNS WITH DUO mXTEND™

1.1. PRODUCT DESCRIPTION NN03-320

The DUO mXTEND™ antenna component is a versatile product that can be used to operate communication standards such as, **5G, GNSS, BT, Wi-Fi, or UWB in a single port or multiport configuration.** Multiport allows you to have two antennas in one. You can allocate two different communication standards through the same single antenna piece, simplifying the design and reducing board space to leave room for other components and functionalities, while reducing costs. The DUO mXTEND™ can be used for any UWB frequency, and this section illustrates how it can be used to operate **UWB frequency bands 5 and 9** ranging from: **6.0 GHz up to 8.5GHz** in a **single port configuration**.

TOP **BOTTOM**



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

APPLICATIONS

- UWB PCB modules.
- Asset tracking devices & tags.
- Automotive positioning & data transfer solutions.
- Indoor & outdoor location tracking infrastructure.
- Access control, security & locks.
- Healthcare.

FEATURES & BENEFITS

- High efficiency for reliable wireless range and optimized device power consumption.
- Dual port: ability to support 2. independent radios with 1 antenna component.
- Small size: Easy to integrate into miniaturized IoT designs.
- Cost-effective one SKU can be used for multiple designs to cover different regional frequencies.
- Easy to mount (pick and place).
- Off-the-Shelf standard product (no customization is required).

1.2. EVALUATION BOARD FOR UWB FOR 6.0 – 8.5GHz

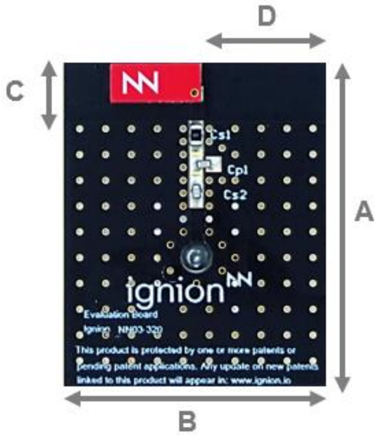
1.2.1. QUICK REFERENCE GUIDE

Technical features	UWB (HFR) 6.0 – 8.5 GHz
Average Efficiency	77%
Peak Gain	4.1 dBi
VSWR	< 2.5:1
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.

1.2.2. EVALUATION BOARD

The Evaluation Board EB_NN03-320-UWB-HFR integrates the DUO mXTEND™ antenna component to provide operation in the frequency region from 6.0 GHz to 8.5 GHz, through a single input/output port.



Measure	mm
A	25.0
B	20.0
C	5.0
D	10.0

Tolerance: ±0.2 mm

Material: The Evaluation Board is built on a very Low-Loss Laminate substrate (FR-4 process compatible). Thickness is 0.8 mm.

Clearance Area: 20.0 mm x 5.0 mm (B x C)

Figure 1 – EB_NN03-320-UWB-HFR. Evaluation Board providing operation at UWB (from 6.0 GHz to 8.5 GHz).

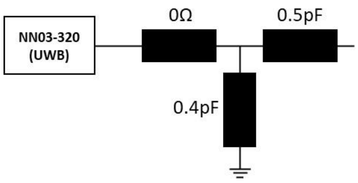
This product and/or its use is protected by at least one or more patents and patent applications. Please check related patent information at: Ignion patents.

1.2.3. MATCHING NETWORK

DUO mXTEND™ antenna component needs a matching network to connect to your UWB RF transceiver or module. This section presents the proposed matching network and specifications obtained in the corresponding Evaluation Board (Figure 1), which is an ideal case. Thanks to its versatility the DUO mXTEND™ antenna component **can be easily tuned to cover different regions of the Ultra-Wideband spectrum** by adjusting the matching network. The excellent tuning capabilities of the DUO mXTEND™ make it ideal to avoid unnecessary product redesigns each time your product specifications and operating frequencies change.

The matching networks presented here illustrate this flexibility in covering channels operating from 6-8.5 GHz.

6 GHz – 8.5 GHz



Value	Part Number
0Ω	-
0.4pF	GJM1555C1HR40WB01
0.5pF	GJM1555C1HR50WB01

Figure 2 – Matching network implemented in the Evaluation Board (Figure 1) for covering the frequency region from 6GHz to 8.5GHz.

The antenna performance is **always conditioned by its operating environment**. Different devices with different printed circuit board sizes, components nearby the antenna, LCD's, batteries, covers, connectors, etc. may require retuning the matching network for best RF performance. Accordingly, it is highly recommended to place pads compatible with 0402 and 0603 SMD components for a matching network as close as possible to the feeding point of the antenna element in the ground plane area, not in the clearance area. This provides a degree of freedom to tune the DUO mXTEND™ antenna component once the design is finished and considering all elements of the system (batteries, displays, covers, etc.). To ensure optimal results, the use of high-quality factor (Q) and tight tolerance components in the matching network is highly recommended (e.g., Murata components (Figure 2)).

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 Ignion's range of Engineering services is available at: https://ignion.io/design-center/engineering-support/.

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

1.2.4. VSWR AND TOTAL EFFICIENCY

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.

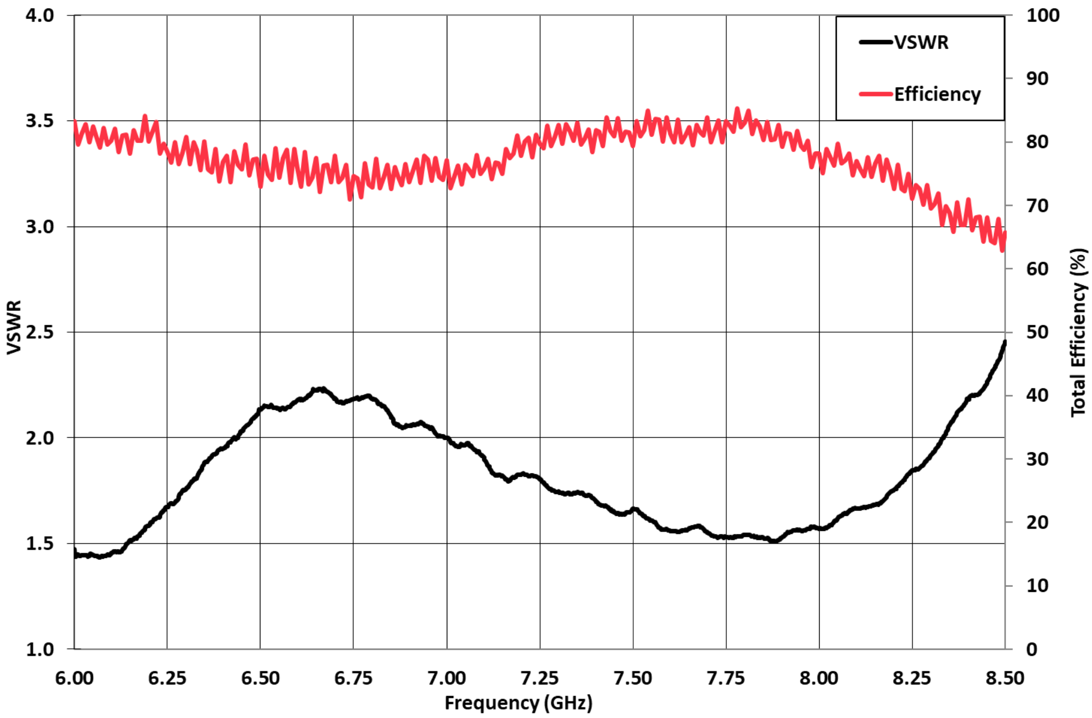


Figure 3 – VSWR and Total Efficiency for the UWB High Frequency Response (6.0 GHz – 8.5 GHz) from the Evaluation Board (Figure 1) with the matching networks in Figure 2.

1.2.5. GROUP DELAY, FIDELITY FACTOR, AND SYSTEM FIDELITY FACTOR

Group delay is a far-field parameter **that measures the distortion of the signal when it goes from the antenna transmitter to the antenna receiver**. This parameter evaluates the delay experimented by each frequency component of the bandwidth and **should not exceed the limit of 250ps** in an antenna system to ensure the correct reception of the signal. Five different angles of rotation of the antenna receiver are considered in the example below, where the antenna transmitter remains stationary (Figure 6).**The maximum variation between the highest and the lowest value of group delay does not exceed 200ps**, which is within the recommended targets for a UWB system (Figure 7).

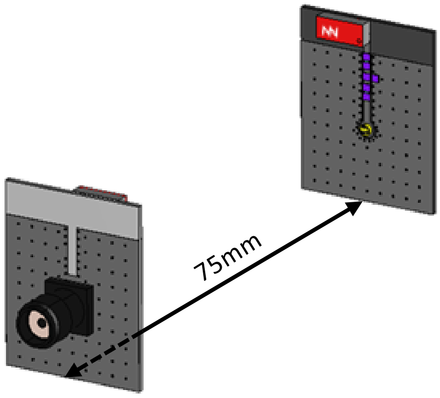


Figure 4: EB_NN03-320-UWB-HFR in 0 degrees

Two EB_NN03-320-UWB-HFR Full Layout Simulation representation for Group Delay and Fidelity Factor values. The 2 EB are fronted (0 degrees)

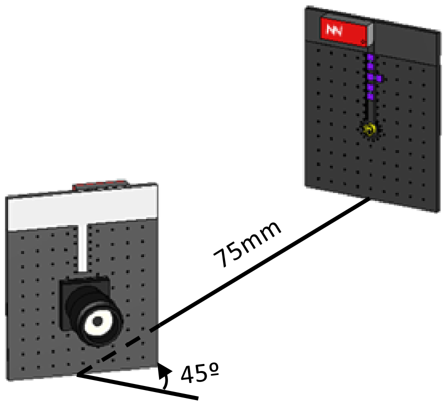


Figure 5: EB_NN03-320-UWB-HFR in 45 degrees

Two EB_NN03-320-UWB-HFR Full Layout Simulation representation for Group Delay and Fidelity Factor values. The 2 EB are fronted but the second is slightly rotated (45 degrees)

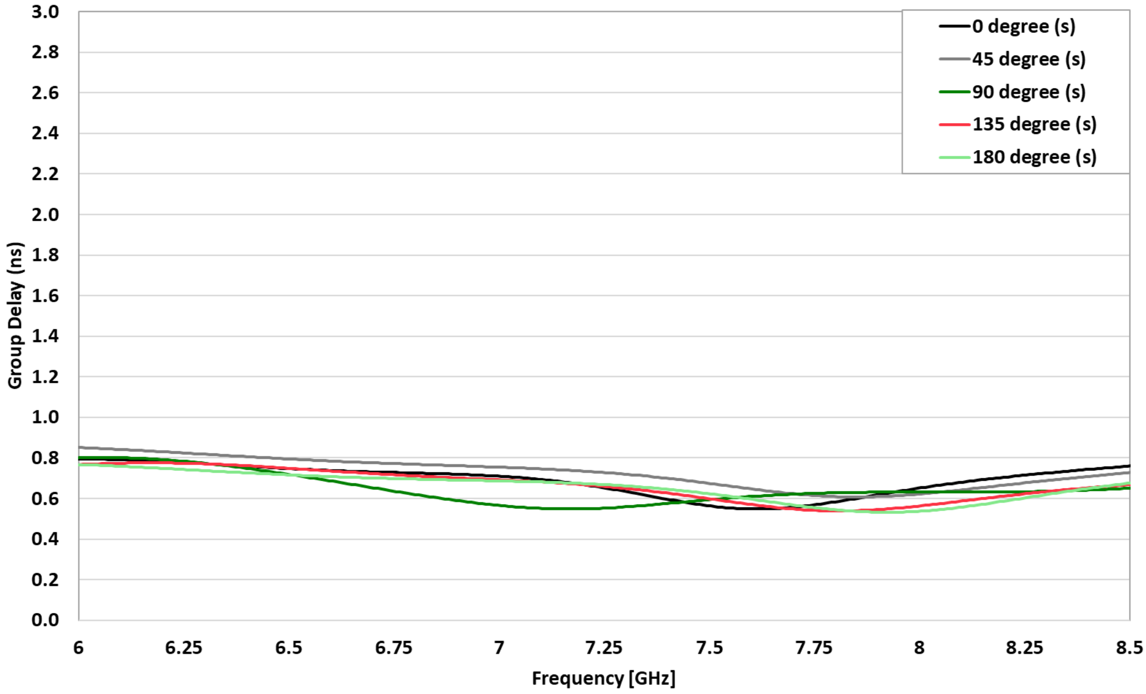


Figure 6 - Group Delay Simulation of two EB_NN03-320-UWB-HFR placed at a far-field distance of 75 mm. One antenna was kept stationary, while the other was rotated in 45º intervals.

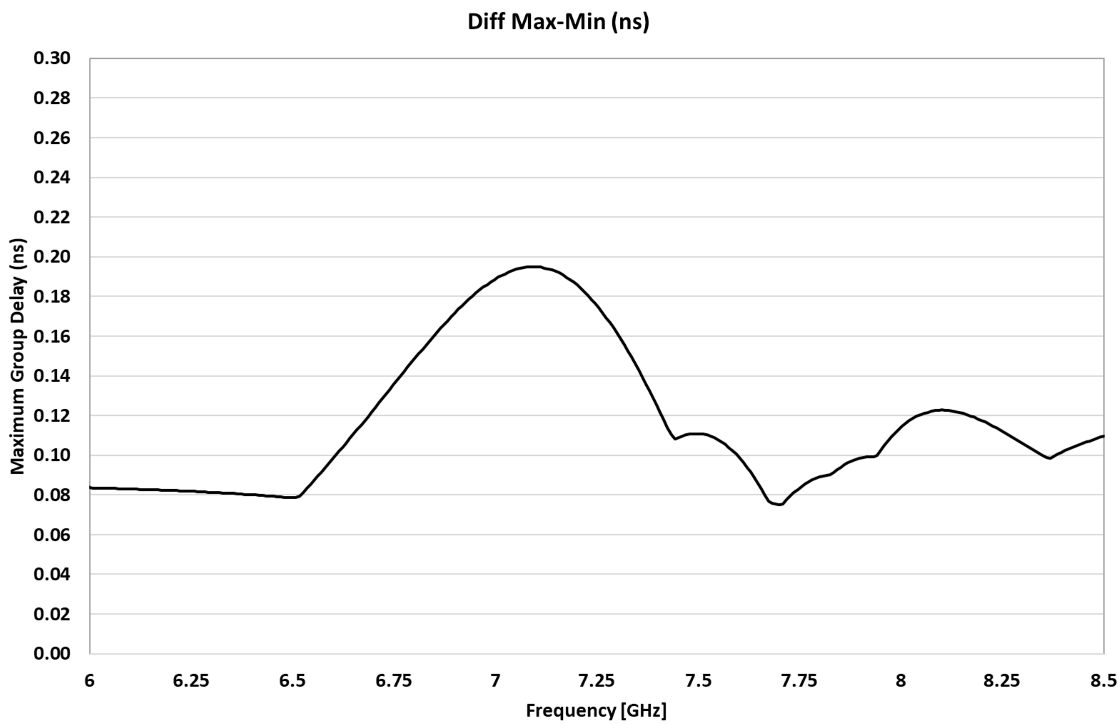


Figure 7 – Maximum difference between the highest and the lowest group delay value considering all angles of rotation of two EB_NN03-320-UWB-HFR.

Distortion is a critical parameter to control to guarantee a proper communication between two devices. It is measured through the **Fidelity Factor (FF)** and the **System Fidelity Factor (SFF)**.

The FF (Figure 8) is a measurement of the **correlation between the injected signal by the RF module to the antenna and the radiated signal**. This parameter must be over 0.9. On the other hand, the SFF (Figure 9) is the correlation between the signal radiated and the signal received. As in group delay, here five different angles of rotation of the antenna receiver are also considered, while the antenna transmitter remains fixed. This parameter must be over 0.5.

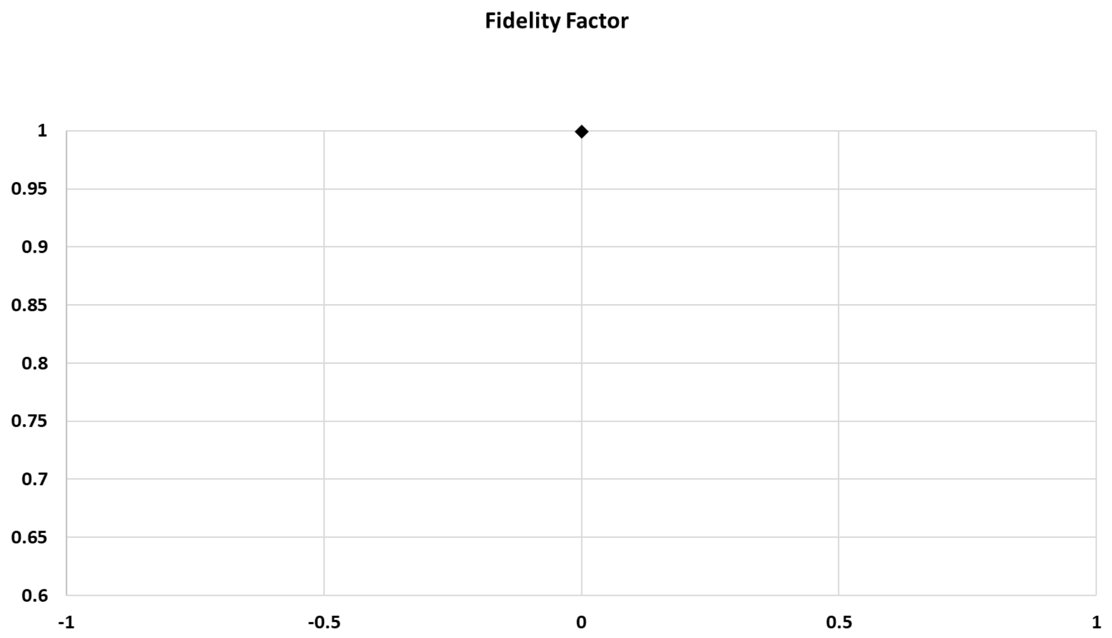


Figure 8 – Fidelity factor of the EB_NN03-320-UWB-HFR

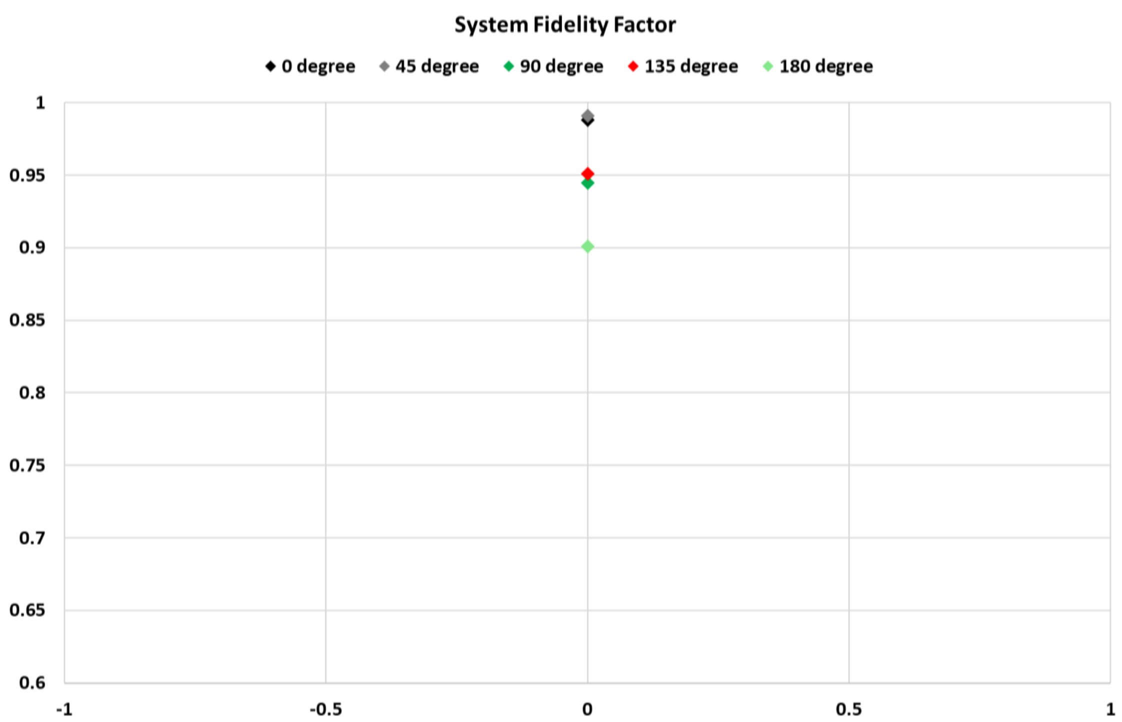
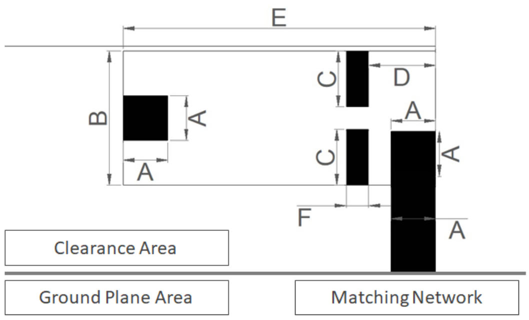


Figure 9 - System Fidelity Factor of a system composed by two EB_NN03-320-UWB-HFR placed at a far-field distance of 75mm. One antenna was kept stationary, while the other was rotated in 45º intervals.

It is important to notice that the fidelity factor (FF) is different from SFF. SFF considers only the effect of the transmit antenna, since the correlation is between the input pulse and the signals radiated by the other antenna of the system.

1.2.6. 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

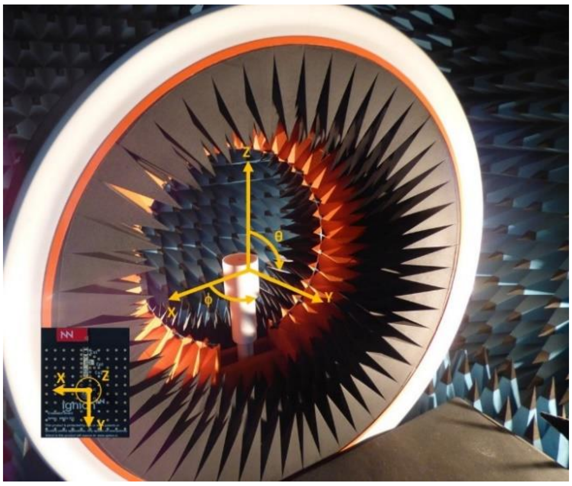
Tolerance: ±0.05mm

Figure 10 – Footprint dimensions for the NN03-320 in the corner for UWB.

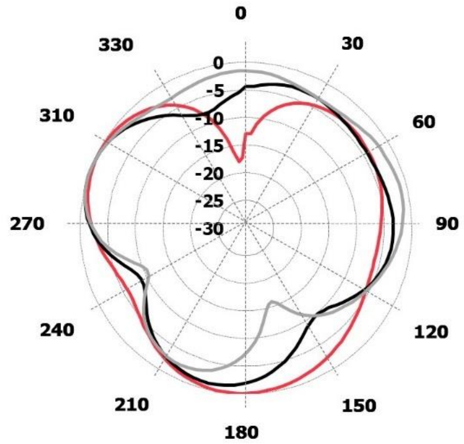
For additional support in the integration process, please contact support@ignion.io.

1.2.7. RADIATION PATTERNS UWB (6 to 8.5 GHz), GAIN, AND EFFICIENCY

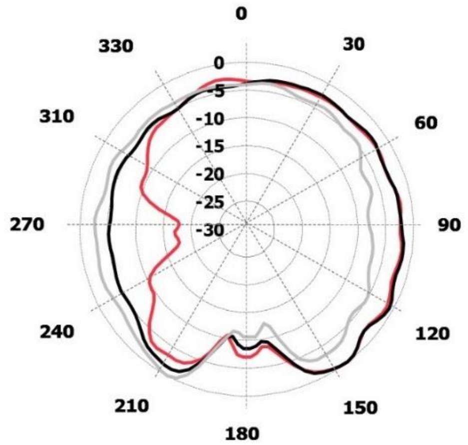
The radiation pattern of the UWB HFR solution of the DUO mXTEND™ is shown below. The radiation pattern is **the graphical representation of the radiation characteristics of an antenna**, as a function of direction (azimuth and elevation coordinates). Among the characteristic parameters of a radiation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



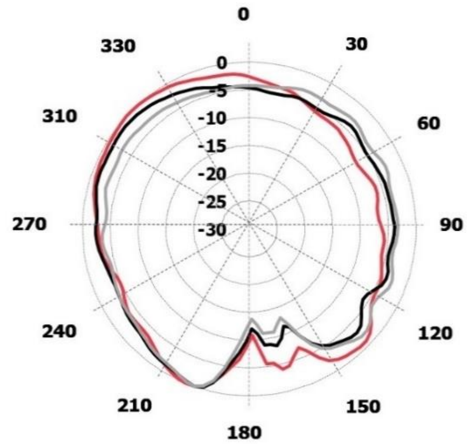
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 6.0 GHz, 7.3 GHz and 8.5 GHz



ϕ = 0º Plane XZ at 6.0 GHz, 7.3 GHz and 8.5 GHz



ϕ = 90º Plane YZ at 6.0 GHz, 7.3 GHz and 8.5 GHz

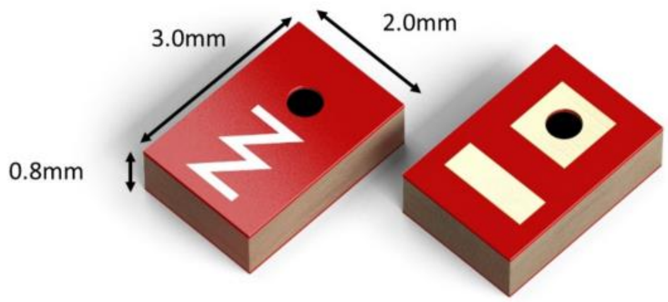
HFR UWB 6-8.5 GHz	**Gain**	**Peak Gain**	4.1 dBi
		Average Gain across the band	3.3 dBi
		Gain Range across the band (min, max)	1.4 <–> 4.1 dBi
	Efficiency	**Peak Efficiency**	85.3 %
		Average Efficiency across the band	77.4 %
		Efficiency Range across the band (min, max)	62.8 – 85.3%

Table 2 – Antenna gain and total efficiency from the Evaluation Board (Figure 1) for 6GHz – 8.5GHz with the matching network of Figure 2.

2. SMALL UWB DESIGNS WITH NANO mXTEND™

2.1. PRODUCT DESCRIPTION NN02-101

The NANO mXTEND™ is the smallest Virtual Antenna® component to date. Featuring a size of 3 mm x 2 mm x 0.8 mm, this off-the-shelf chip antenna has been designed to fit almost every IoT device from entry level to high-end products. Thanks to its versatility, the same antenna component can be used to operate one or multiple wireless protocols such as, Bluetooth, Wi-Fi, or UWB. This section is focused on illustrating how the **NANO mXTEND™** can be used to operate **UWB frequency bands** in a **single port configuration**, namely **bands 5 and 9** ranging from: **6.0 GHz up to 8.5GHz (Section 2.2)**, and bands 1 to 4 ranging from: **3.1 GHz up to 4.8GHz (Section 2.3).**



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

APPLICATIONS

- UWB PCB modules.
- Small asset tracking devices & tags.
- Automotive positioning & data transfer solutions.
- Indoor & outdoor location tracking infrastructure.
- Access control, security & locks.
- Healthcare.

FEATURE BENEFITS

- Smallest size: Easy to integrate into any miniaturized IoT designs.
- Cost-effective one SKU can be used for multiple designs to cover different regional frequencies.
- Optimized efficiency for reliable wireless range and optimized device power consumption.
- Easy to mount (pick and place).
- Off-the-Shelf standard product (no customization is required).

2.2. EVALUATION BOARD FOR UWB 6 – 8.5GHz

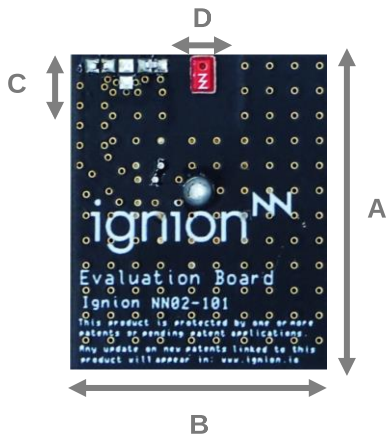
2.2.1. QUICK REFERENCE GUIDE

Technical features	UWB (HFR) 6.0 – 8.5 GHz
Average Efficiency	70.4%
Peak Gain	3.1 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)	3.0 mm x 2.0 mm x 0.8 mm

Table 3 – Technical Features. Measurements from the Evaluation Board. See Figure 11.

2.2.2. EVALUATION BOARD

The Evaluation Board EB_NN02-101-UWB-HFR integrates the NANO mXTEND™ antenna component to provide operation in the frequency region from 6.0 GHz to 8.5 GHz, through a single input/output port.



Measure	mm
A	25.0
B	20.0
C	6.0
D	6.0

Tolerance: ±0.2 mm

Material: The Evaluation Board is built on a very Low-Loss Laminate substrate (FR-4 process compatible). Thickness is 0.8 mm.

Clearance Area: 6.0 mm x 6.0 mm (C x D)

Figure 11 – EB_NN02-101-UWB-HFR. Evaluation Board providing operation at UWB (from 6.0 GHz to 8.5 GHz).

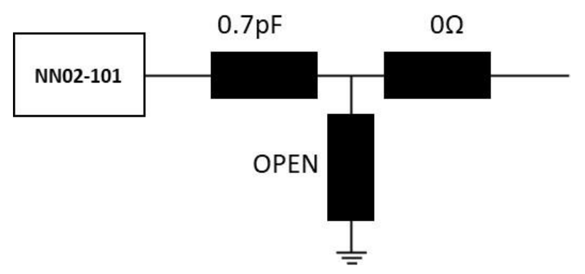
This product and/or its use is protected by at least one or more patents and patent applications. Please check related patent information at: Ignion patents.

2.2.3. MATCHING NETWORK

NANO mXTEND™ antenna component needs a matching network to connect to your UWB RF module. This section presents the proposed matching network and specifications obtained in the corresponding Evaluation Board (**Figure 11**). Thanks to its versatility the NANO mXTEND™ antenna component **can be easily tuned to cover different regions of the UWB spectrum** through just the proper adjustment of the matching network. The excellent tuning capabilities of the NANO mXTEND™ avoid unnecessary product redesigns each time your product specifications and operating frequencies vary. It allows you to **easily adapt your design to different applications, market segments, and devices** through just the proper tunning of the matching network while still maintaining the same antenna part.

Matching networks are presented here to illustrate how this flexibility can be used to cover channels operating from 6.0-8.5 GHz.

6.0 GHz – 8.5 GHz



Value	Part Number
0.7pF	GJM1555C1HR70WB01
OPEN	-
0Ω	-

Figure 12 – Matching network implemented in the Evaluation Board (Figure 11) for covering the high-frequency region from 6.0 GHz to 8.5 GHz.

The antenna performance is **always conditioned by its operating environment**. Different devices with different printed circuit board sizes, components near the antenna, LCD's, batteries, covers, connectors, etc. may require retuning the matching network for best RF 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 in the ground plane area, not in the clearance area. This provides a degree of freedom to tune the NANO mXTEND™ antenna component once the design is finished and considering all elements of the system (batteries, displays, covers, etc.). To ensure optimal results, the use of high-quality factor (Q) and tight tolerance components in the matching network is highly recommended (e.g. Murata components (Figure 12)).

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[2]. Additional information related to Ignion's range of Engineering services is available at: https://ignion.io/design-center/engineering-support/.

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

2.2.4. VSWR AND TOTAL EFFICIENCY

VSWR (Voltage Standing Wave Ratio) and total efficiency versus frequency (GHz).

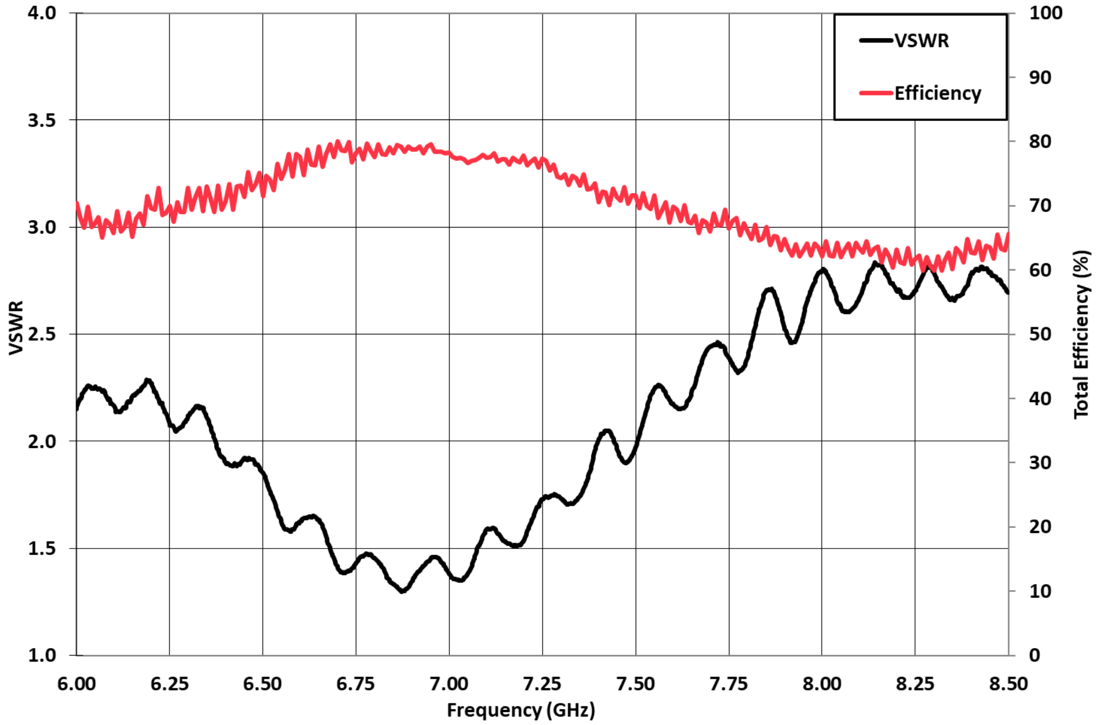


Figure 13 - VSWR and Total Efficiency for the UWB High Frequency Response (6.0GHz – 8.5GHz) from the Evaluation Board (Figure 11) with the matching networks in Figure 12.

2.2.5. GROUP DELAY, FIDELITY FACTOR, AND SYSTEM FIDELITY FACTOR

In this section the results of group delay of a system formed by two EB_NN02-101-UWB-HFR are presented. The maximum variation between the highest and the lowest value of group delay does not exceed 160ps, which is within the targets for a UWB system.

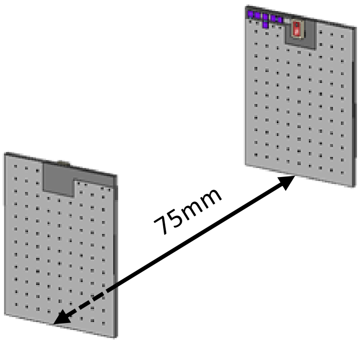


Figure 14: EB_NN02-101-UWB-HFR in 0 degrees

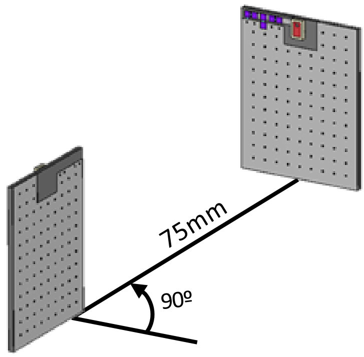


Figure 15: EB_ NN02-101-UWB-HFR in 90 degrees

Two EB_NN02-101-UWB-HFR Full Layout Simulation representation for Group Delay and Fidelity Factor values. The 2 EB are fronted (0 degrees).

Two EB_ NN02-101-UWB-HFR Full Layout Simulation representation for Group Delay and Fidelity Factor values. The 2 EB are fronted but the second is rotated 90 degrees.

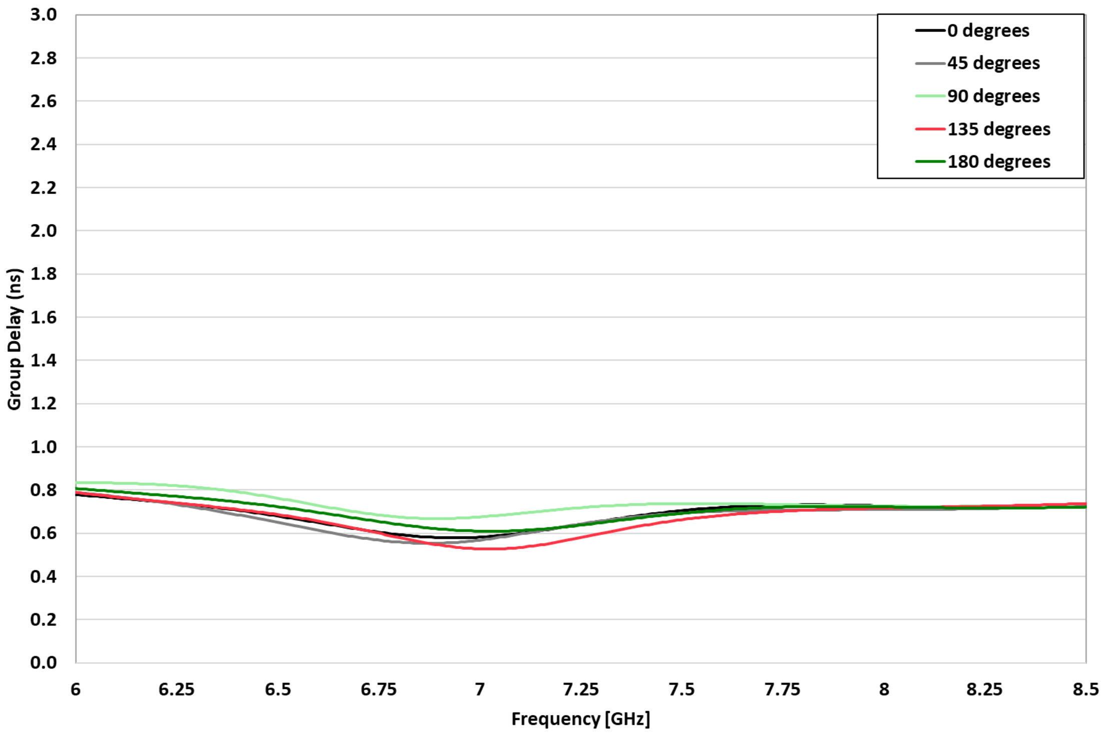


Figure 16 - Group Delay Simulation of two EB_NN02-101-UWB-HFR placed at a far-field distance of 75mm. One antenna was kept stationary, while the other was rotated in 45º intervals.

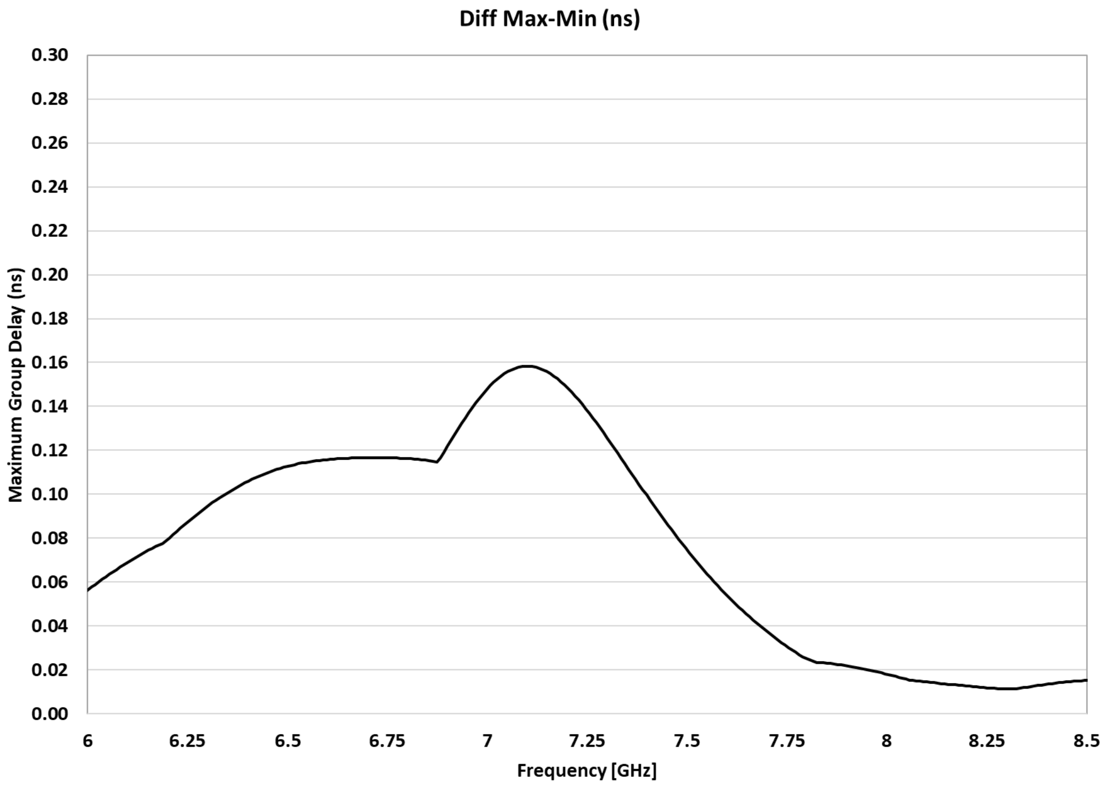


Figure 17 - Maximum difference between the highest and the lowest group delay value considering all angles of rotation.

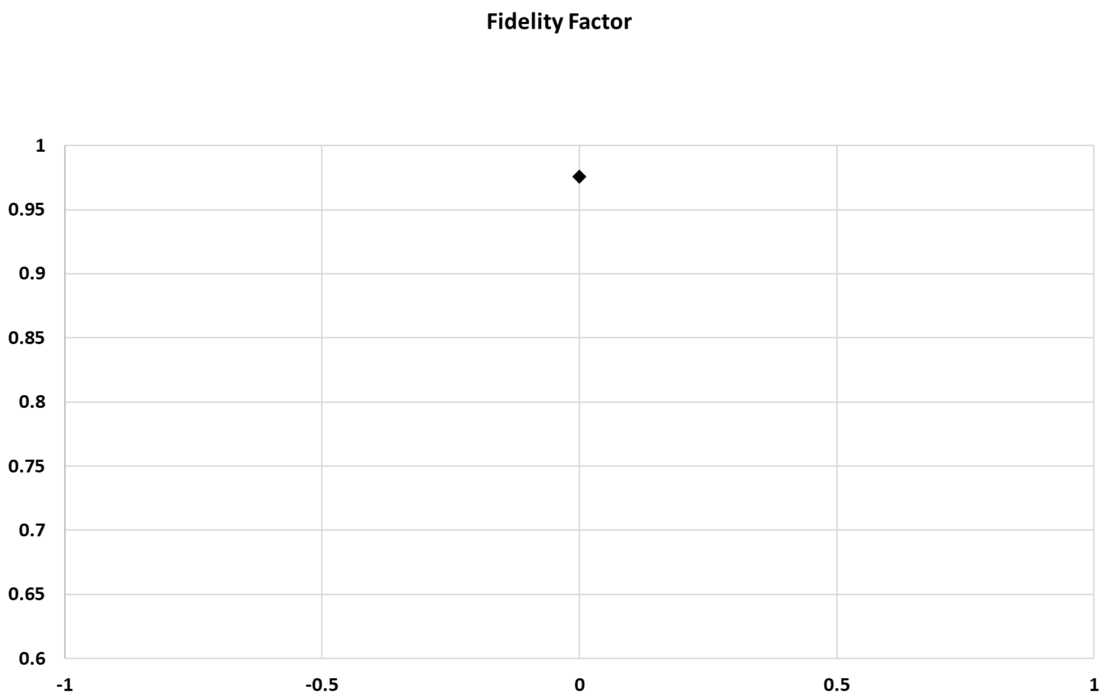


Figure 18 – Fidelity factor of the EB_NN02-101-UWB-HFR

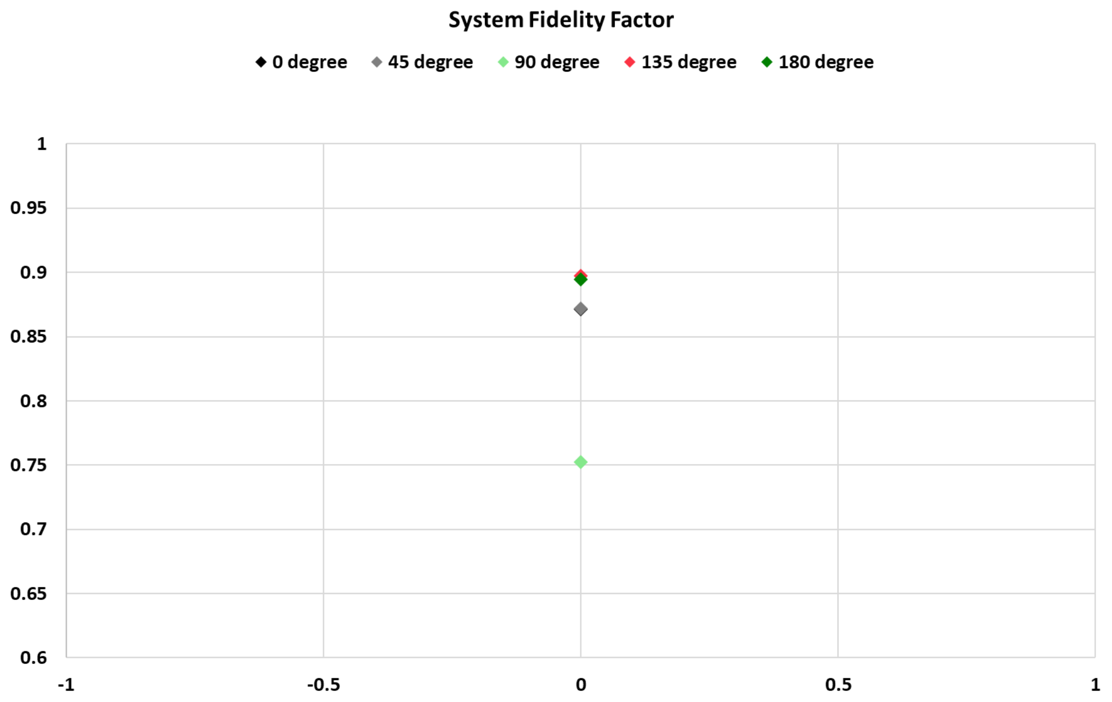
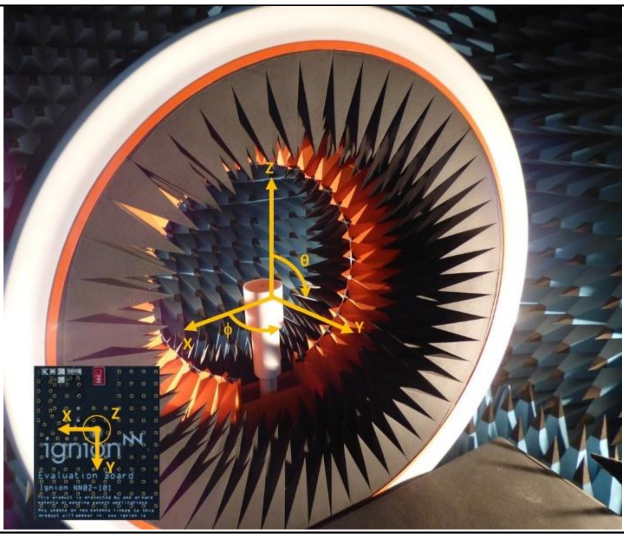


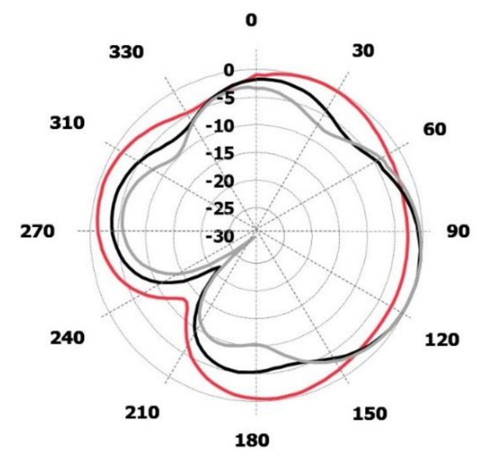
Figure 19 - System Fidelity Factor of a system composed of two EB_NN02-101-UWB-HFR placed at a far-field distance of 75mm. One antenna was kept stationary, while the other was rotated in 45º intervals.

2.2.6. RADIATION PATTERNS UWB (6.0 to 8.5 GHz), GAIN, AND EFFICIENCY

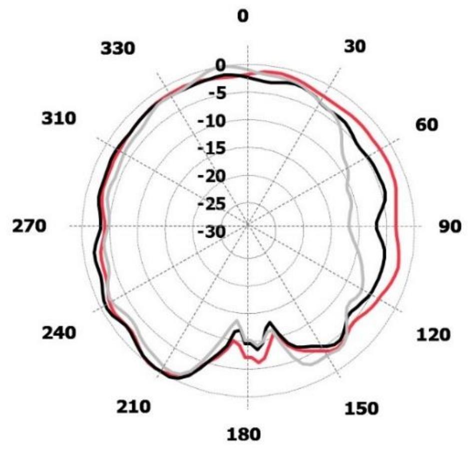
The radiation pattern of the Ultra-Wideband HFR solution of the NANO mXTEND™ is shown below. **The radiation pattern is the graphical representation of the radiation characteristics of an antenna**, as a function of direction (azimuth and elevation coordinates). Among the characteristic parameters of a radiation pattern, the most important are gain and directivity. In this case, the radiation patterns are **omnidirectional**.



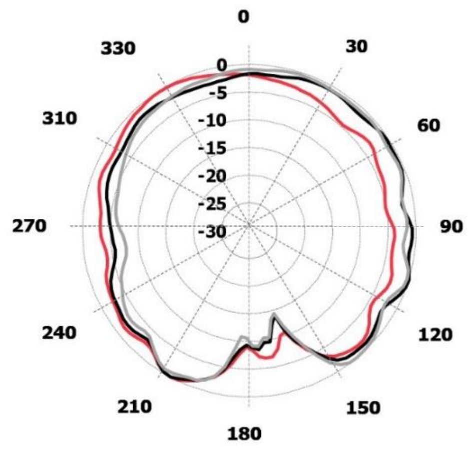
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 6.0 GHz and 8.5 GHz



ϕ = 0º Plane XZ at 6.0 GHz and 8.5 GHz



ϕ = 90º Plane YZ at 6.0 GHz and 8.5 GHz

HFR UWB 6.0-10.6GHz	**Gain**	**Peak Gain**	3.1 dBi
		Average Gain across the band	2.1 dBi
		Gain Range across the band (min, max)	0.0 <–> 3.1 dBi
	Efficiency	**Peak Efficiency**	80.1 %
		Average Efficiency across the band	70.4 %
		Efficiency Range across the band (min, max)	59.9 – 80.1 %

Table 4 – Antenna Gain and Total Efficiency from the Evaluation Board (Figure 11) for 6.0GHz – 8.5GHz band considering the matching network in Figure 12.

2.3. EVALUATION BOARD FOR UWB 3.1 – 4.8GHz

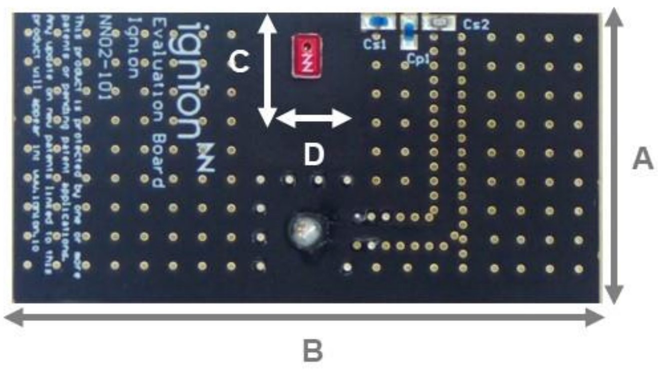
2.3.1. QUICK REFERENCE GUIDE

Technical features	UWB (LFR)
	3.1 – 4.8 GHz
Average Efficiency	77%
Peak Gain	3.6 dBi
VSWR	< 2.6:1
Radiation Pattern	Omnidirectional
Polarization	Linear
Weight (approx.)	0.11 g.
Temperature	-40 to + 125 ºC
Impedance	50 Ω
Dimensions (L x W x H)	3.0 mm x 2.0 mm x 0.8 mm

Table 5 - Technical Features. Measures from the Evaluation Board. See Figure 1.

2.3.2. EVALUATION BOARD

The Evaluation Board EB_NN02-101-UWB-LFR integrates the NANO mXTEND™ antenna component to provide operation in the frequency region from 3.1 GHz to 4.8 GHz, through a single input/output port.



Measure	mm
A	20.0
B	40.0
C	10.0
D	7.6

Tolerance: ±0.2 mm

Material: The Evaluation Board is built on a very Low-Loss Laminate substrate (FR-4 process compatible). Thickness is 0.8 mm.

Clearance Area: 10.0 mm x 7.6 mm (B x C)

Figure 20 – EB_NN02-101-UWB-LFR. Evaluation Board providing operation at UWB (from 3.1 GHz to 4.8 GHz).

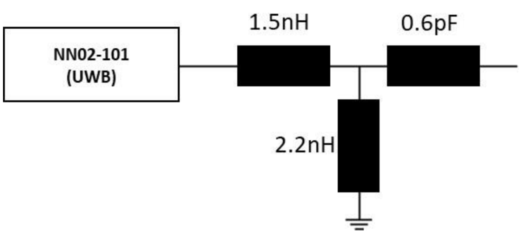
This product and/or its use is protected by at least one or more patents and patent applications. Please check related patent information at: Ignion patents.

2.3.3. MATCHING NETWORK

NANO mXTEND™ antenna component needs a matching network to connect to your UWB RF transceiver or module. This section presents the proposed matching network and specifications obtained in the corresponding Evaluation Board (Figure 20).

The matching networks presented here illustrate the flexibility in covering channels operating from 3.1-4.8 GHz.

3.1 GHz – 4.8 GHz



Value	Part Number
1.5nH	LQW15AN1N5C80
2.2nH	LQW15AN2N2G80
0.6pF	LQW15AN2N2G80

Figure 21 – Matching network implemented in the Evaluation Board (**Figure 20**) for covering the frequency region from 3.1GHz to 4.8GHz.

The antenna performance is **always conditioned by its operating environment**. Different devices with different printed circuit board sizes, components nearby the antenna, LCD's, batteries, covers, connectors, etc. may require retuning the matching network for best RF 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 in the ground plane area, not in the clearance area. This provides a degree of freedom to tune the NANO mXTEND™ antenna component once the design is finished and considering all elements of the system (batteries, displays, covers, etc.). To ensure optimal results, the use of high-quality factor (Q) and tight tolerance components in the matching network is highly recommended (e.g., Murata components (Figure 21)).

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[3]. Additional information related to Ignion's range of Engineering services is available at: https://ignion.io/design-center/engineering-support/.

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

2.3.4. VSWR AND TOTAL EFFICIENCY

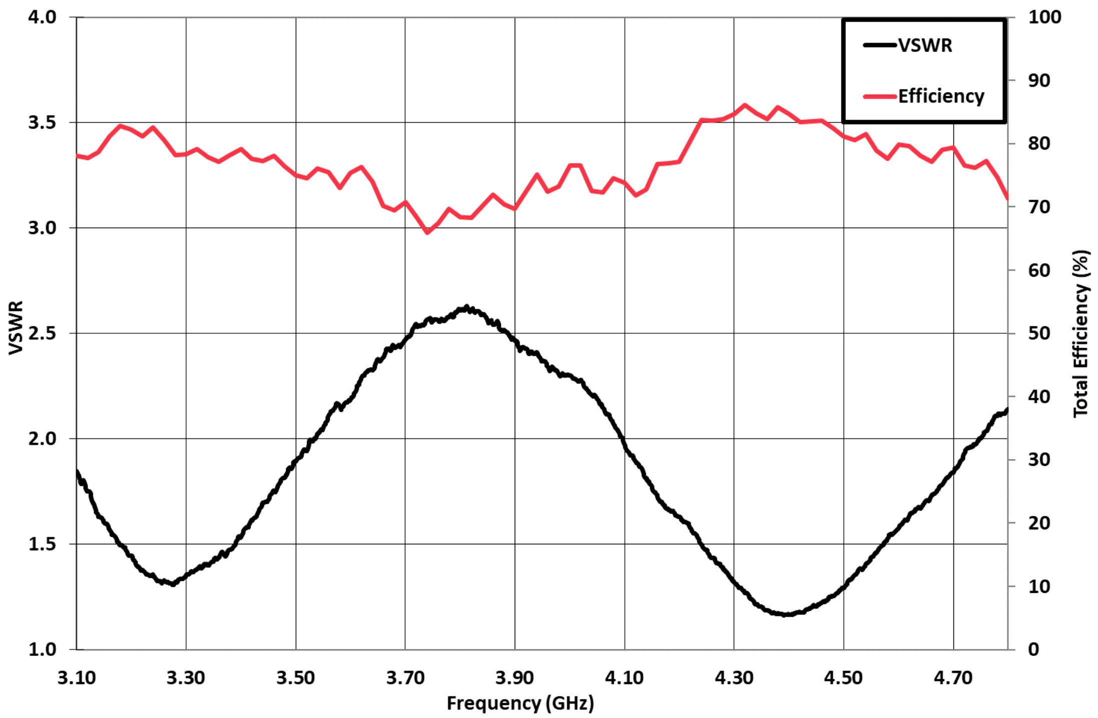


Figure 22 – VSWR and Total Efficiency for the UWB Low Frequency Response (3.1 GHz – 4.8 GHz) from the Evaluation Board (Figure 20) with the matching network in Figure 21.

2.3.5. GROUP DELAY, FIDELITY FACTOR, AND SYSTEM FIDELITY FACTOR

In this section the results of group delay of a system formed by two EB_NN02-101-UWB-LFR are presented. The maximum variation between the highest and the lowest value of group delay does not exceed 220ps, which is within the targets for a UWB system.

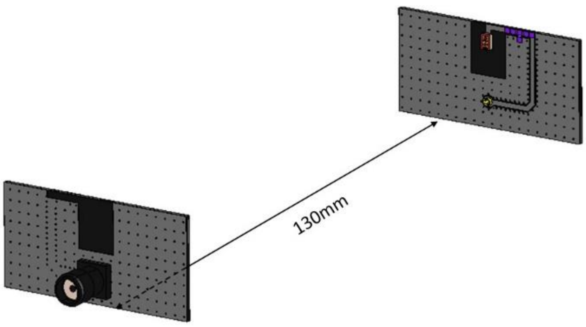


Figure 23: EB_NN02-101-UWB-LFR in 0 degrees

Two EB_NN02-101-UWB-LFR Full Layout Simulation representation for Group Delay and Fidelity Factor values. The 2 EB are fronted (0 degrees)

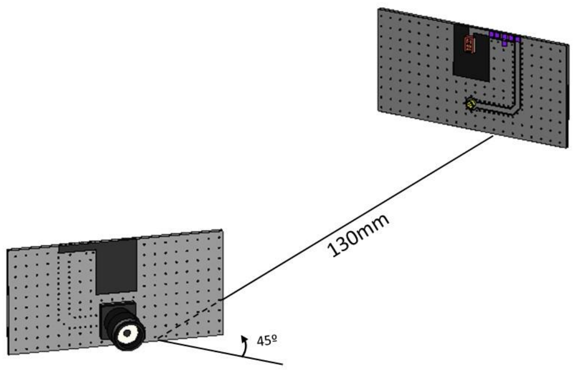


Figure 24: EB_NN03-320-UWB-LFR in 45 degrees

Two EB_NN02-101-UWB-LFR Full Layout Simulation representation for Group Delay and Fidelity Factor values. The 2 EB are fronted but the second is slightly rotated (45 degrees)

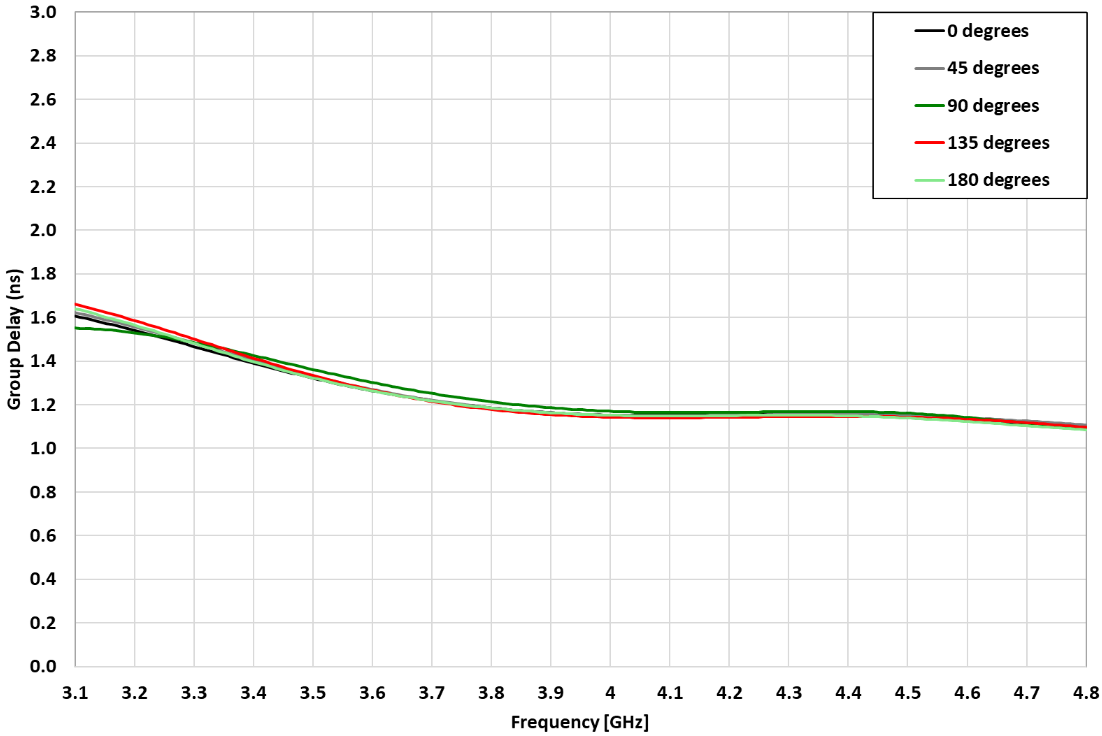


Figure 25 - Group Delay Simulation of two EB_NN02-101-UWB-LFR placed at a far-field distance of 130 mm. One antenna was kept stationary, while the other was rotated in 45° intervals.

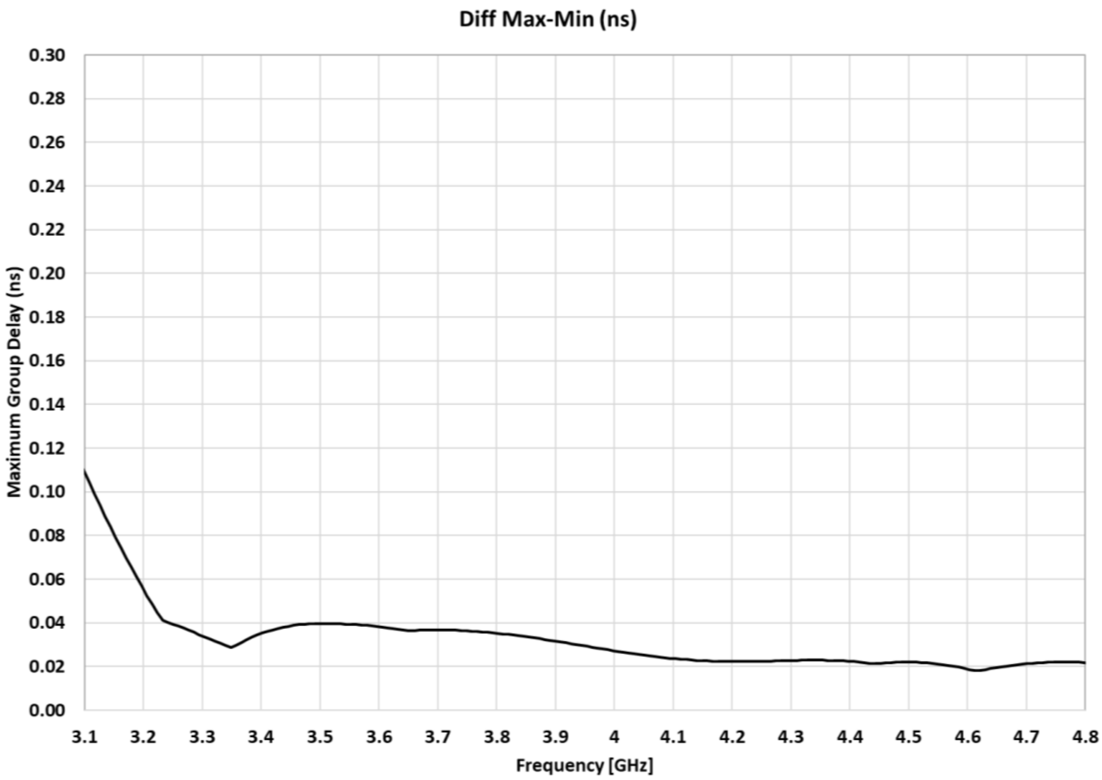


Figure 26 – Maximum difference between the highest and the lowest group delay value considering all angles of rotation of two EB_NN02-101-UWB-LFR.

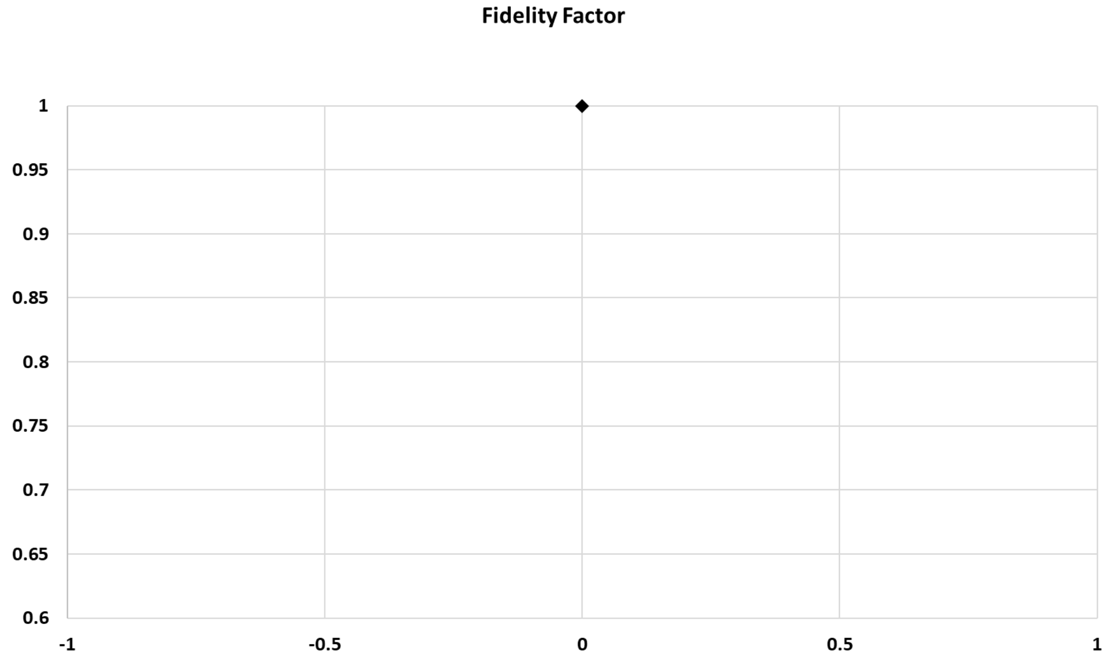


Figure 27 – Fidelity factor of the EB_NN02-101-UWB-LFR

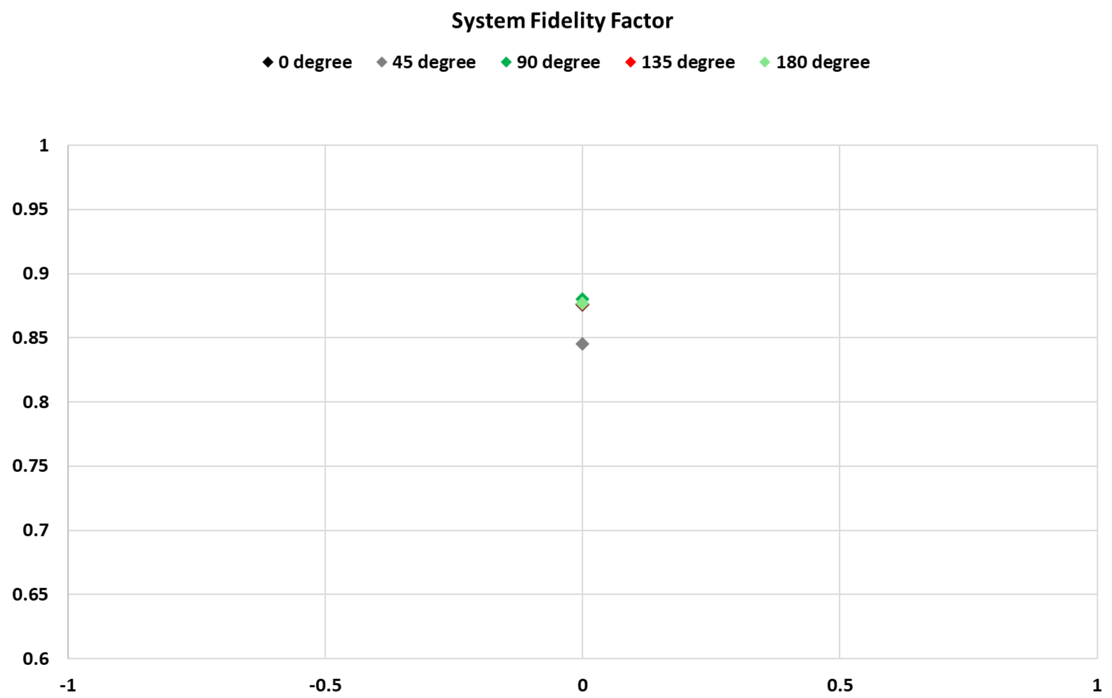
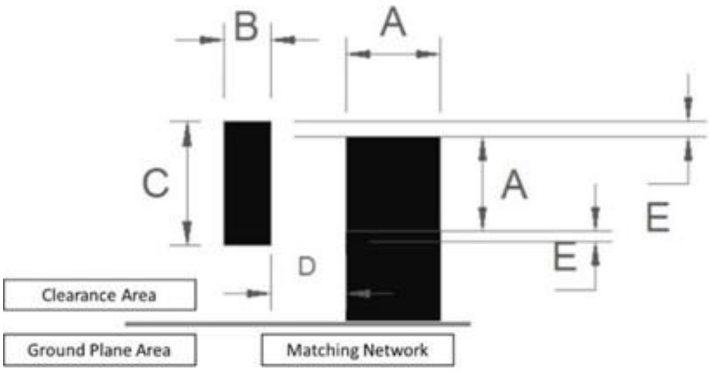


Figure 28 - System Fidelity Factor of a system composed by two EB_NN02-101-UWB-LFR placed at a far-field distance of 130mm. One antenna was kept stationary, while the other was rotated in 45º intervals.

2.3.6. RECOMMENDED ANTENNA FOOTPRINT FOR NN02-101

See below the recommended footprint dimensions for the NANO mXTEND™ antenna component NN02-101.



Measure	mm
A	1.0
B	0.5
C	1.3
D	0.8
E	0.15

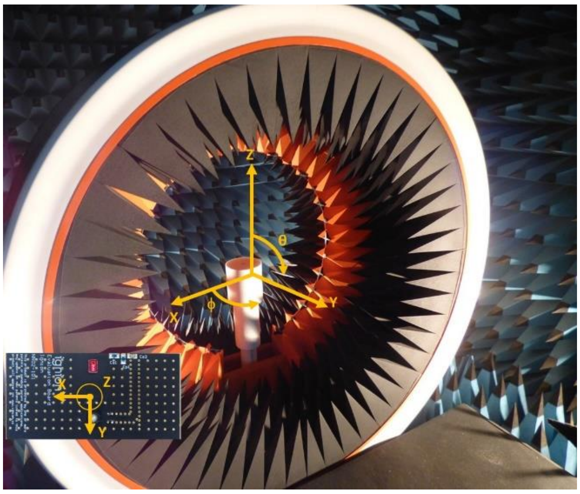
Tolerance: ±0.05mm

Figure 29 – Footprint dimensions with the NN02-101 for UWB.

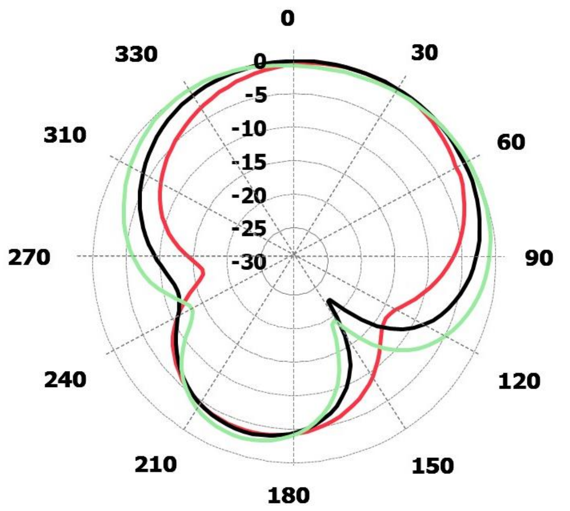
For additional support in the integration process, please contact support@ignion.io.

2.3.7. RADIATION PATTERNS UWB (3.1 to 4.8 GHz), GAIN, AND EFFICIENCY

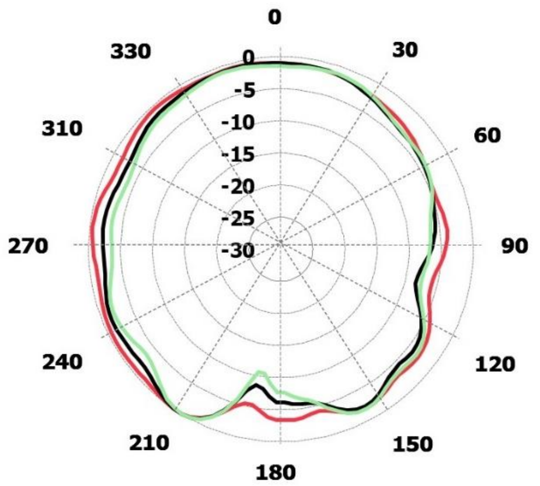
The radiation pattern of the UWB LFR solution of the NANO mXTEND™ is shown below.



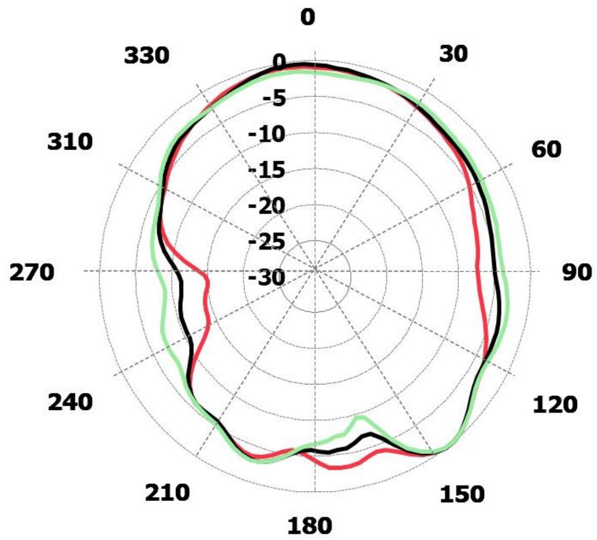
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 3.1 GHz, 4 GHz and 4.8 GHz



ϕ = 0º Plane XZ at 3.1 GHz, 4 GHz and 4.8 GHz



ϕ = 90º Plane YZ at 3.1 GHz, 4 GHz and 4.8 GHz

LFR UWB 3.1-4.8 GHz	**Gain**	**Peak Gain**	3.6 dBi
		Average Gain across the band	2.9 dBi
		Gain Range across the band (min, max)	2.1 <–> 3.6 dBi
	Efficiency	**Peak Efficiency**	86.1 %
		Average Efficiency across the band	77.0 %
		Efficiency Range across the band (min, max)	65.9 – 86.1%

Table 6 – Antenna gain and total efficiency from the Evaluation Board (Figure 1) for 3.1GHz – 4.8GHz with the matching network of Figure 21.

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.

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