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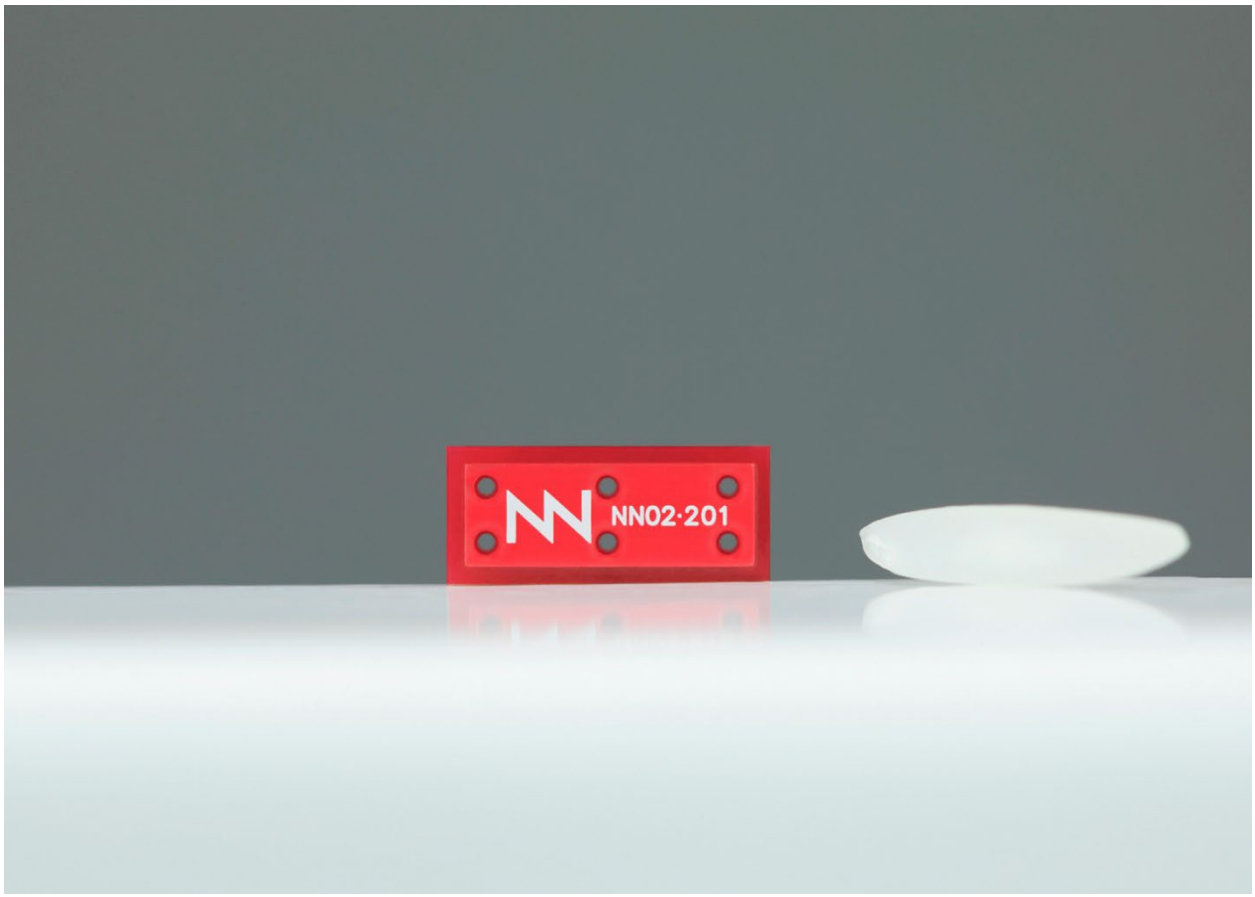
Mini-antenna for IoT cellular applications

APPLICATION NOTES
ONE mXTEND™ (NN02-201)

ONE mXTEND™: Cellular IoT in the smallest antenna ever

- **Antenna component:** ONE mXTEND™ NN02-201
- **Dimensions:** 7.0 mm x 3.0 mm x 1.0 mm
- **Frequency regions:** 880-960 MHz, 1710-2170 MHz and 824-894 MHz, 1850-2170 MHz



Cellular IoT coverage in a super slim chip antenna as big as a rice grain.

Engineers working in all the new bunch of IoT devices need the fastest, easiest and cheapest path to go wireless. The ONE mXTEND™ is the **IoT smallest antenna ever** and the ideal option if you are developing a new wireless IoT device with a reduced size and in a reduced period of time. This miniature antenna booster in only **7.0 x 3.0 x 1.0 mm** giving any wireless designer the **smallest volume antenna for cellular IoT**.

Its tiny volume, only **21mm^3**, allows this unique multiband antenna to fit in about all wireless designs, enabling **2G, 3G, 4G and 5G easy cellular IoT worldwide connectivity**. The ONE mXTEND™ ultra slim antenna booster is an off the shelf component ready to be assembled into any wireless device as any other chip is mounted.

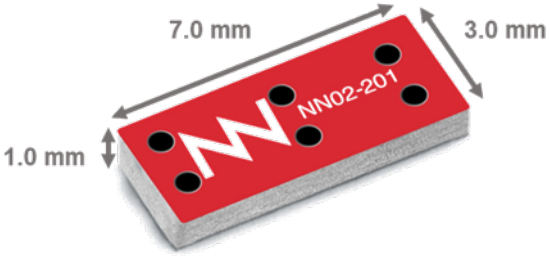
Cellular IoT made simple: ONE mXTEND™.

TABLE OF CONTENTS

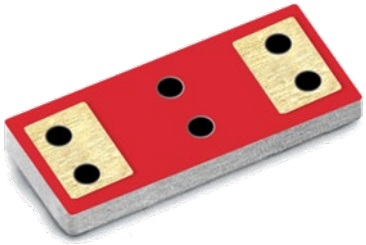
1. PRODUCT DESCRIPTION NN02-201

The ONE mXTEND™ antenna booster has been specifically designed for providing multiband performance in wireless devices with small space requirements. It is a miniature antenna capable of being adapted, with a high level of flexibility, to the antenna designer needs. Featured by an extremely reduced package, the ONE mXTEND™ is a versatile product capable of enabling 2G, 3G, 4G, and 5G coverage through the same single antenna package. The configuration presented herein illustrates how to tune the antenna component to provide operation in the 2G and 3G communication standards GSM850, GSM900, GSM1800/DCS, GSM1900/PCS and UMTS.

TOP



BOTTOM



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

APPLICATIONS

- Asset Tracking
- Fleet Management
- Modules
- IoT
- Routers
- Handsets and smartphones
- Tablets and PCs
- Digital cameras
- Sensors
- 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)

The ONE mXTEND™ antenna booster belongs to a new generation of antenna solutions based on Virtual Antenna™ technology owned by Ignion. This technology enables replacing conventional and custom antenna solutions by a new class of so-called antenna boosters, delivered in the form of a new range of miniature and off-the-shelf chip antenna components. These new chip antennas are by nature multiband and multipurpose, so they fit in a variety of wireless platforms to provide a wireless link at many different communication services. By using a Virtual Antenna™ component the design becomes more predictable compared to a custom solution, making the whole process ***faster, cheaper and easier.***

2. EVALUATION BOARD (2G/3G-Europe)

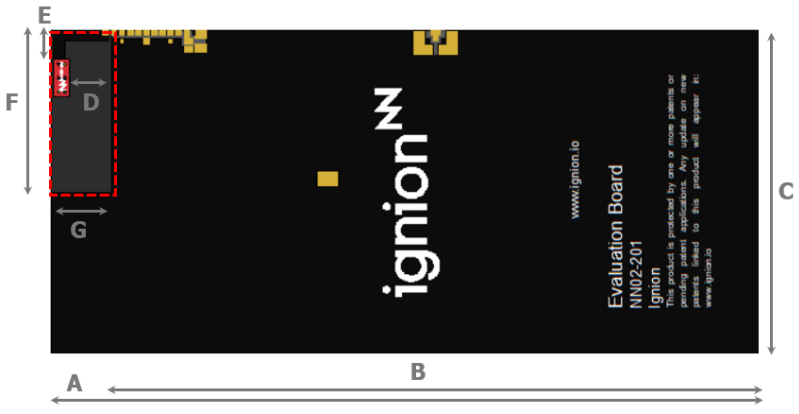
2.1. QUICK REFERENCE GUIDE

Technical features	880 – 960 MHz	1710 – 2170 MHz
Average Efficiency	> 55%	> 65%
Peak Gain	1.3 dBi	1.7 dBi
VSWR	< 3:1	
Radiation Pattern	Omnidirectional	
Polarization	Linear	
Weight (approx.)	0.02 g.	
Temperature	-40 to +125 ºC	
Impedance	50 Ω	
Dimensions (L x W x H)	7.0 mm x 3.0 mm x 1.0 mm	

Table 1 – Technical Features. Measures from the evaluation board (Figure 1)

2.2. EVALUATION BOARD

This evaluation board (part number: EB_NN02-201-2G/3G-Europe) integrates a UFL cable to connect the ONE mXTEND™ antenna booster with the SMA connector. The ONE mXTEND™ provides operation in two frequency regions, from 880 MHz to 960 MHz and from 1710 MHz to 2170 MHz, through a single input/output port.



Measure	mm
A	131
B	120
C	60
D	8.0
E	5.0
F	30
G	11

Tolerance: ±0.2 mm

D: Distance between the ONE mXTEND™ antenna booster and the ground plane.

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

Clearance Area: 30 mm x 8.0 mm (FxG)

Figure 1 – EB_NN02-201-2G_3G-Europe. Evaluation board providing operation at 2G/3G-Europe band (880 – 960 MHz and 1710 – 2170 MHz).

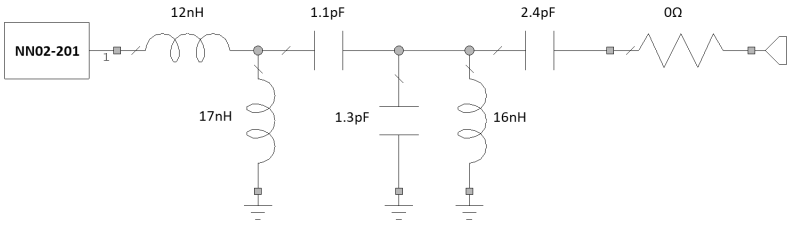
This product and its use are protected by at least one or more of the following patents and patent applications PAT. US 62/529032; and other domestic and international patents pending. Additional information about patents related to this product is available at www.ignion.io/virtual-antenna/.

2.3. MATCHING NETWORK

ONE mXTEND™ antenna booster needs a matching network to connect to your 2G and 3G receiver. This section describes a suitable matching network (Figure 2) for ONE mXTEND™ and the resulting product specs when measured in the reference evaluation board (EB_NN02-201-2G/3G-Europe) (**Figure 1**). 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 try our free-of-charge[1] Antenna Intelligence Cloud design service, which will get you a chip antenna design including a custom matching network for your device in 24h[1]. Other information related to Ingion's range of R&D services is available at: https://www.ignion.io/rdservices/

880 – 960 MHz and 1710 – 2170 MHz



Value	Part Number
12 nH	LQW15AN12NG00
17 nH	LQW15AN17NG80
1.1 pF	GJM1555C1H1R1WB 01
1.3 pF	GJM1555C1H1R3WB 01
16 nH	LQW15AN16NG80
2.4 pF	GJM1555C1H2R4WB 01

Figure 2 – Matching network implemented in the evaluation board (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 2). The antenna performance is always conditioned by its operating environment so that different devices with different printed circuit board sizes, components nearby the antenna, LCD's, 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.

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

2.4. VSWR AND TOTAL EFFICIENCY

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

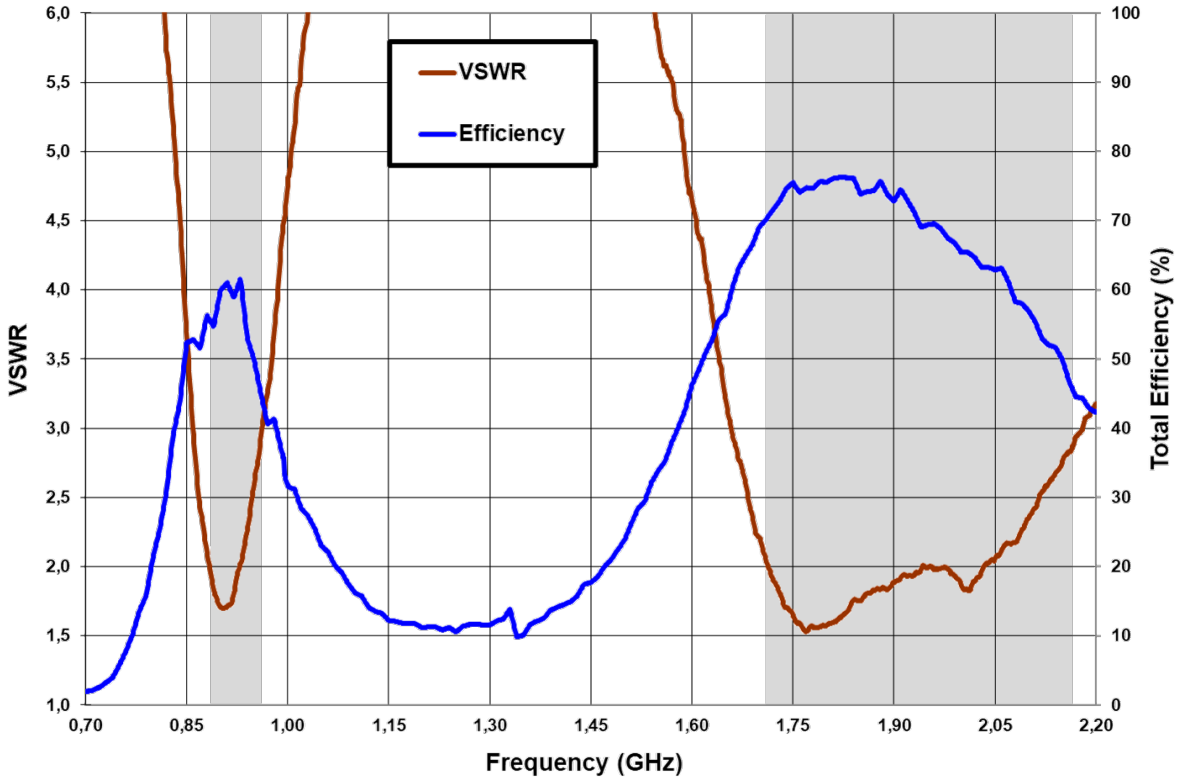
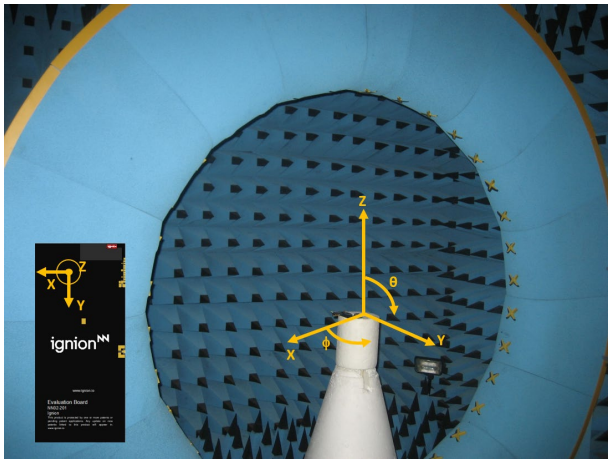
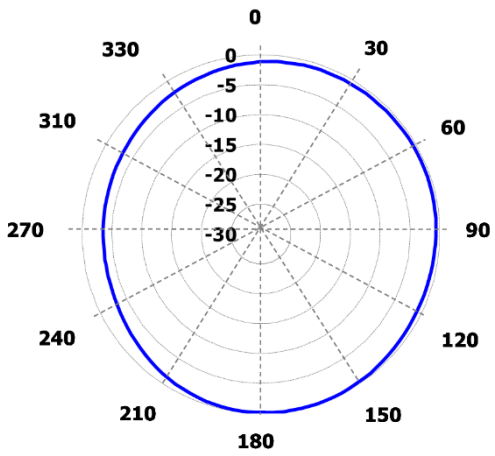


Figure 3 – VSWR and Total Efficiency at 2G/3G-Europe band (880 – 960 MHz and 1710 – 2170 MHz) (from the evaluation board (Figure 1)).

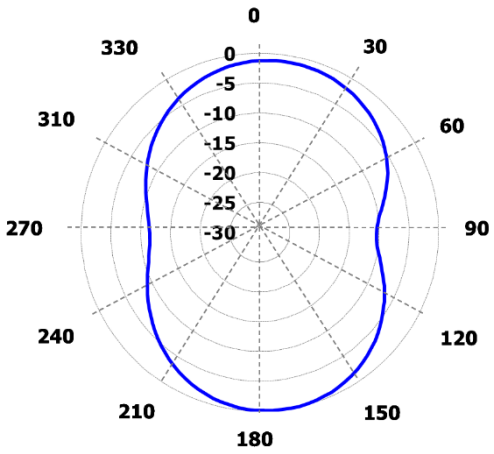
2.5. RADIATION PATTERNS (880 MHz – 960 MHz), GAIN, AND EFFICIENCY



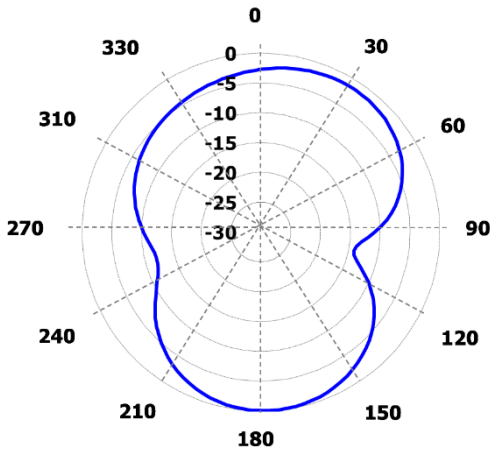
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 920MHz



ϕ = 0º Plane XZ at 920MHz

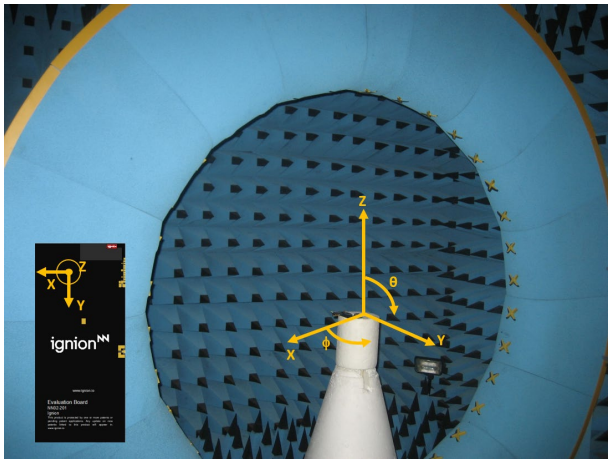


ϕ = 90º Plane YZ at 920MHz

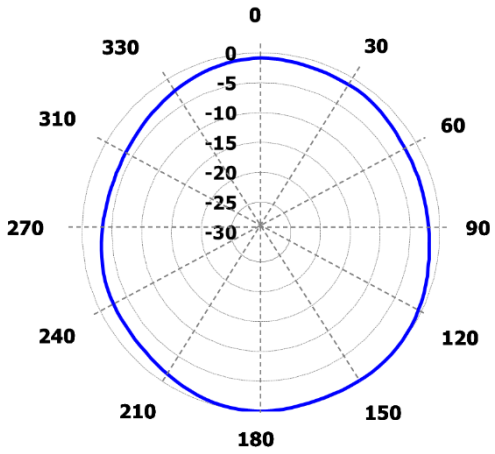
Gain	**Peak Gain**	1.3dBi
	Average Gain across the band	0.7dBi
	Gain Range across the band (min, max)	-0.2dBi <–> 1.3dBi
Efficiency	**Peak Efficiency**	61.5%
	Average Efficiency across the band	56.2%
	Efficiency Range across the band (min, max)	45.3% - 61.5%

Table 2 – Antenna Gain and Total Efficiency from the evaluation board (Figure 1) 2G/3G-Europe band (880 – 960 MHz). Measures made in the Satimo STARGATE 32 anechoic chamber.

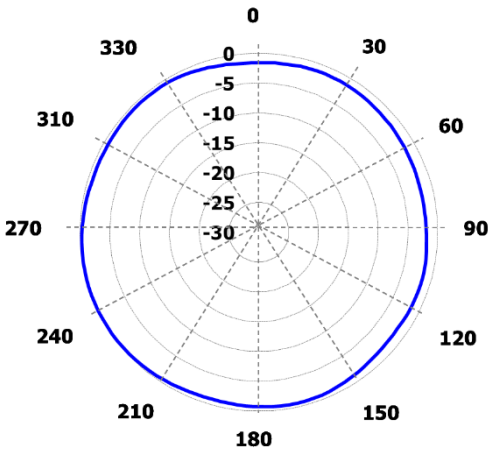
2.6. RADIATION PATTERNS (1710 MHz – 2170 MHz), GAIN, AND EFFICIENCY



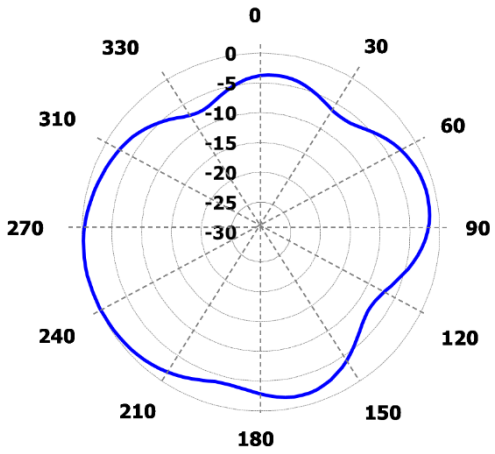
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 1940MHz



ϕ = 0º Plane XZ at 1940MHz



ϕ = 90º Plane YZ at 1940MHz

Gain	**Peak Gain**	1.7dBi
	Average Gain across the band	0.9dBi
	Gain Range across the band (min, max)	-0.9Bi <–> 1.7dBi
Efficiency	**Peak Efficiency**	76.2%
	Average Efficiency across the band	67.3%
	Efficiency Range across the band (min, max)	44.5% - 73.4%

Table 3 – Antenna Gain and Total Efficiency from the evaluation board (Figure 1) 2G/3G-Europe band (1710 – 1880 MHz). Measures made in the Satimo STARGATE 32 anechoic chamber.

3. EVALUATION BOARD (2G/3G-USA)

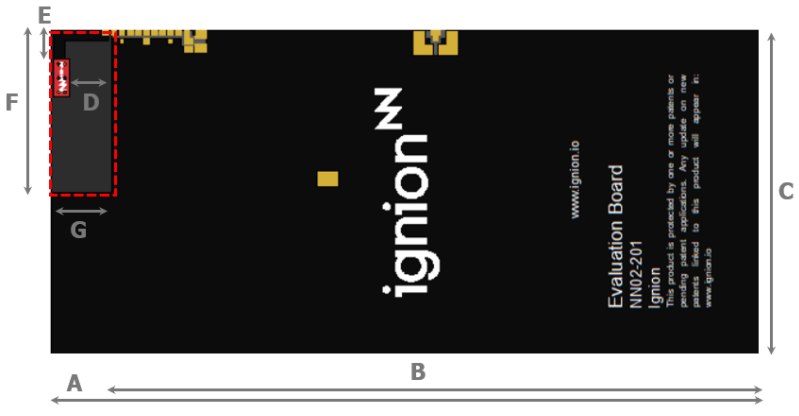
3.1. QUICK REFERENCE GUIDE

Technical features	824 – 894 MHz	1850 – 2170 MHz
Average Efficiency	> 65%	> 70%
Peak Gain	1.9	2.0
VSWR	< 3:1	
Radiation Pattern	Omnidirectional	
Polarization	Linear	
Weight (approx.)	0.02 g.	
Temperature	-40 to +125 ºC	
Impedance	50 Ω	
Dimensions (L x W x H)	7.0 mm x 3.0 mm x 1.0 mm	

Table 4 – Technical Features. Measures from the evaluation board (Figure 1).

3.2. EVALUATION BOARD

This evaluation board (part number: EB_NN02-201-2G/3G-USA) integrates a UFL cable to connect the ONE mXTEND™ antenna booster with the SMA connector. The ONE mXTEND™ provides operation in two frequency regions, from 880 MHz to 894 MHz and from 1850 MHz to 2170 MHz, through a single input/output port.



Measure	mm
A	131
B	120
C	60
D	8.0
E	5.0
F	30
G	11

Tolerance: ±0.2 mm

D: Distance between the ONE mXTEND™ antenna booster and the ground plane.

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

Clearance Area: 30 mm x 8.0 mm (FxG)

Figure 4 – EB_NN02-201-2G/3G-USA evaluation board providing operation at 2G/3G-USA band (824 – 894 MHz and 1850 – 2170 MHz).

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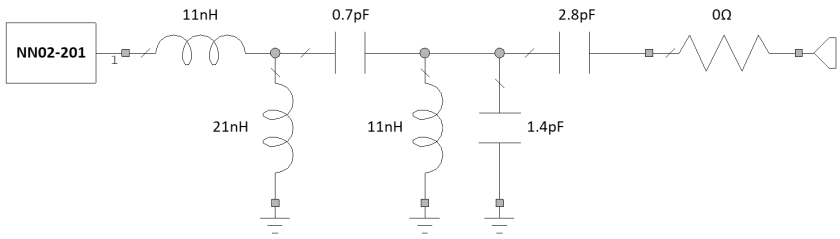
824 – 894 MHz and 1850 – 1990 MHz



Value	Part Number
11 nH	LQW18AN11NG80
21 nH	LQW15AN21NG80
0.7 pF	GJM1555C1HR70WB01
11 nH	LQW18AN11NG80
1.4 pF	GJM1555C1H1R4WB01
2.8 pF	GJM1555C1H2R8WB01

Figure 5 – Matching network implemented in the evaluation board (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 2). The antenna performance is always conditioned by its operating environment so that different devices with different printed circuit board sizes, components nearby the antenna, LCD's, 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.

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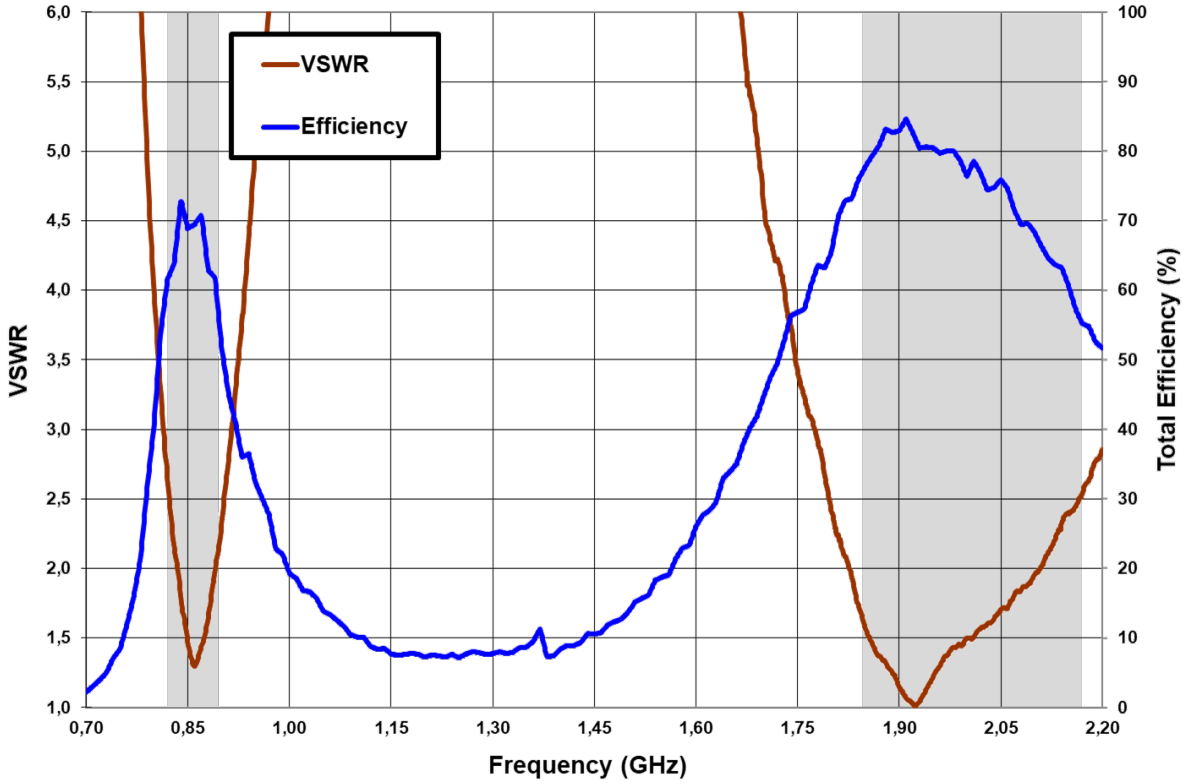
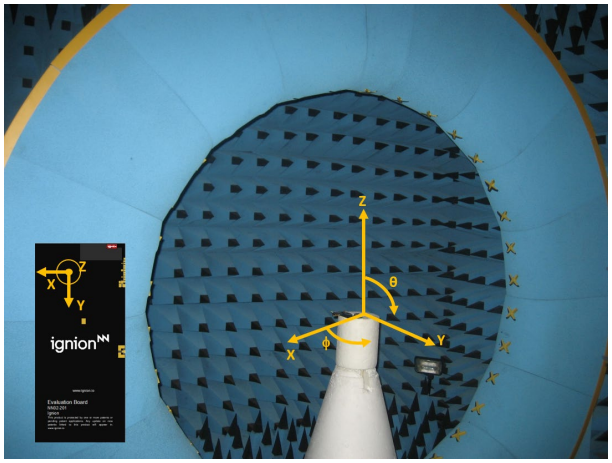
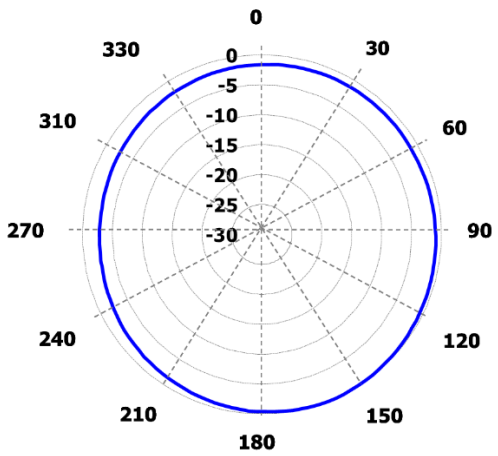


Figure 6 – VSWR and Total Efficiency at 2G/3G-USA band (824 – 894 MHz and 1850 – 2170 MHz) (from the evaluation board) (Figure 4).

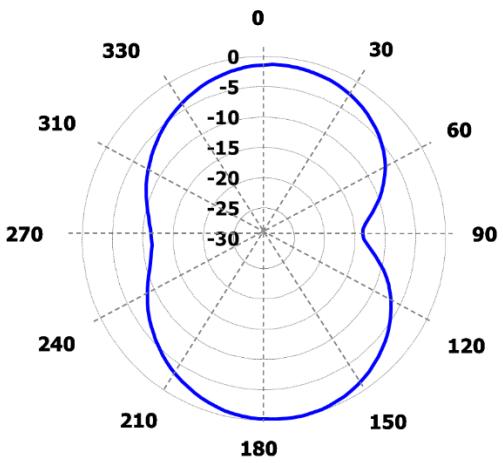
3.5. RADIATION PATTERNS (824 MHz – 894 MHz), GAIN, AND EFFICIENCY



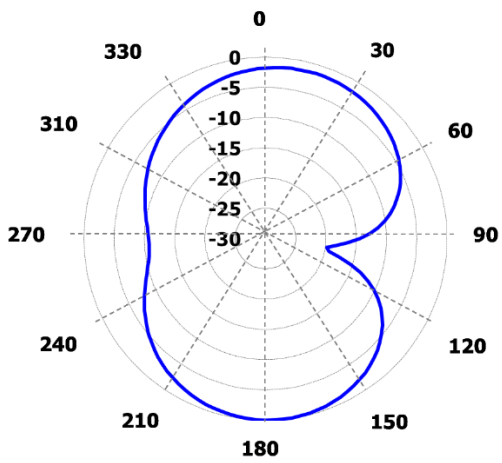
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 860MHz



ϕ = 0º Plane XZ at 860MHz

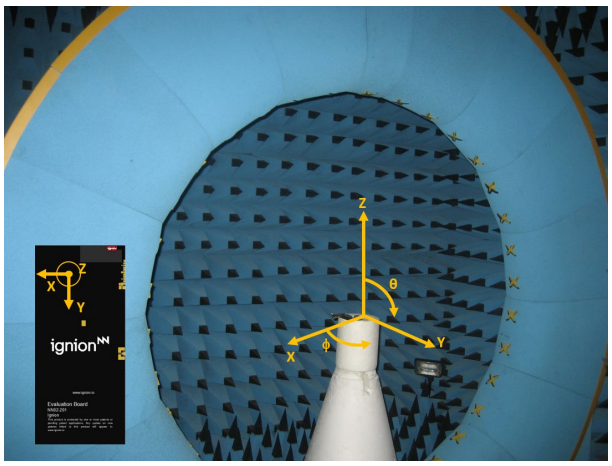


ϕ = 90º Plane YZ at 860MHz

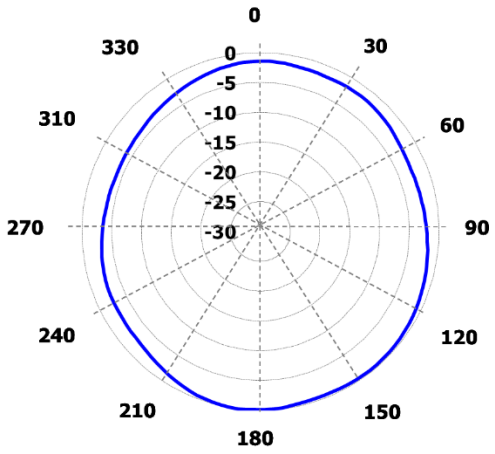
Gain	**Peak Gain**	1.9dBi
	Average Gain across the band	1.4dBi
	Gain Range across the band (min, max)	0.7dBi <–> 1.9dBi
Efficiency	**Peak Efficiency**	72.7%
	Average Efficiency across the band	67.0%
	Efficiency Range across the band (min, max)	57.7 – 72.7%

Table 5 – Antenna Gain and Total Efficiency from the evaluation board (**Figure** 4) 2G/3G-USA band (824 – 894 MHz). Measures made in the Satimo STARGATE 32 anechoic chamber

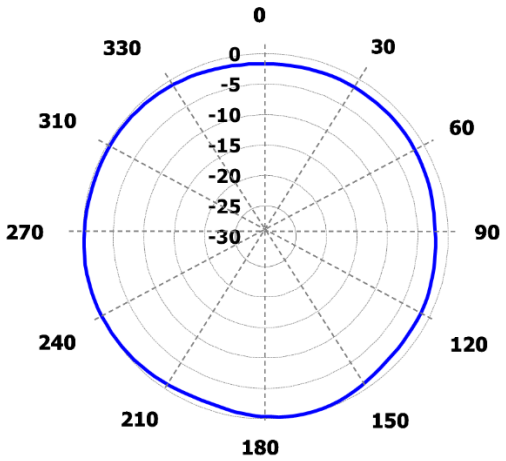
3.6. RADIATION PATTERNS (1850 MHz – 2170 MHz), GAIN, AND EFFICIENCY



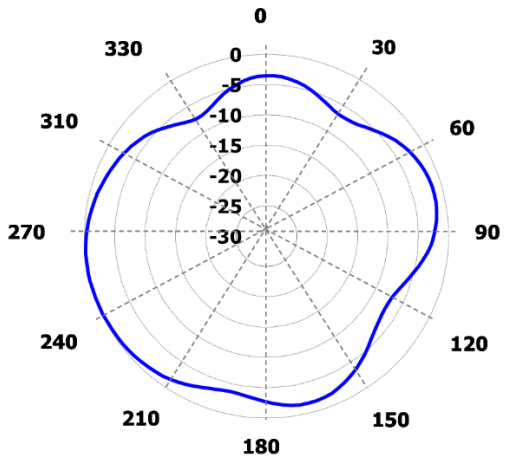
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 1920MHz



ϕ = 0º Plane XZ at 1920MHz



ϕ = 90º Plane YZ at 1920MHz

Gain	**Peak Gain**	2.0dBi
	Average Gain across the band	1.3dBi
	Gain Range across the band (min, max)	0dBi <–> 2.0dBi
Efficiency	**Peak Efficiency**	84.6%
	Average Efficiency across the band	74.6%
	Efficiency Range across the band (min, max)	55.2 – 84.6%

Table 6 – Antenna Gain and Total Efficiency from the evaluation board (**Figure** 4) 2G/3G-USA band (1850 – 2170 MHz). Measures made in the Satimo STARGATE 32 anechoic chamber.

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