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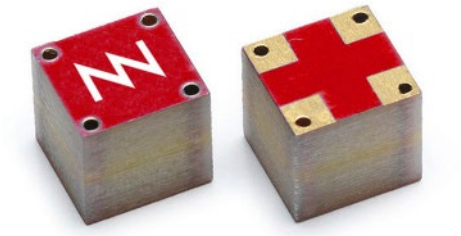
CUBE mXTEND™: A STANDARD ANTENNA SOLUTION FOR MOBILE FREQUENCIES

APPLICATION NOTE
CUBE mXTEND™ (NN02-250)

CUBE mXTEND™: A standard antenna solution for mobile frequency bands

Ignion specializes in enabling effective mobile communications. Using Ignion technology, we design and manufacture optimized antennas to make your wireless devices more competitive. Our mission is to help our clients develop innovative products and accelerate their time to market through our expertise in antenna design, testing and manufacturing.



CUBE mXTEND™ antenna booster

NN02-250

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

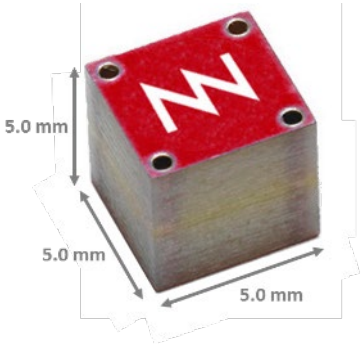
ISO 9001: 2015 Certified

TABLE OF CONTENTS

1. ANTENNA DESCRIPTION

The CUBE mXTEND™ antenna booster component has been specifically designed for providing multiband performance in wireless devices (in particular in mobile devices), enabling worldwide coverage by allowing operation in the communication standards GSM850, GSM900, GSM1800/DCS, GSM1900/PCS, UMTS, LTE700, LTE800, LTE850, LTE900, LTE1700, LTE1800, LTE1900, LTE2000, LTE2100, LTE2300, LTE2500, and LTE2600.

TOP



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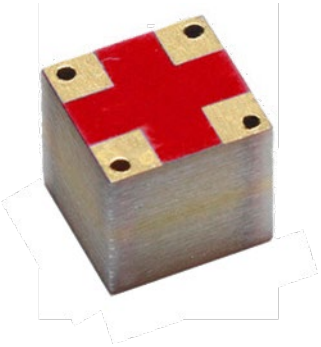


Material: The CUBE mXTEND™ antenna booster is built on glass epoxy substrate.

APPLICATIONS

- Handsets
- Smartphones
- Tablets
- Phablets
- Laptop PCs
- Netbooks
- Modules
- Routers
- eBooks

BENEFITS

- High efficiency
- Small size
- Cost-effective
- Easy-to-use (pick and place)
- Multiband behaviour (worldwide standards)
- Off-the-Shelf Standard Product (no customization is required)

The CUBE mXTEND™ antenna booster belongs to a new generation of antenna solutions based on the Virtual Antenna™ technology owned by Ignion. The technology is mainly focused on replacing conventional antenna solutions by miniature and standard components.

2. EVALUATION BOARDS 1 PORT (698-798 MHz)

2.1. QUICK REFERENCE GUIDE

Technical features	Evaluation Board with UFL cables	Evaluation Board with coplanar transmission lines
Frequency Range	698 – 798 MHz	
Average Efficiency	> 45 %	> 40 %
Peak Gain	0.2 dBi	0.1 dBi
VSWR	< 3:1	
Radiation Pattern	Omnidirectional	
Polarization	Linear	
Weight (approx.)	0.25 g	
Temperature	-40 to +125 ºC	
Impedance	50 Ω	
Dimensions (L x W x H)	5.0 mm x 5.0 mm x 5.0 mm	

Table 1 – Technical features. Measures from the Evaluation Board. See Figure 1. Note that for obtaining comparable results, a ground plane length larger than 100 mm is recommended.

2.2. EVALUATION BOARDS 1 PORT (698-798 MHz)

This section depicts two different Evaluation Boards. The first one is built with UFL cables to connect the two CUBE mXTEND™ antenna boosters with the SMA connector. The part number is EB_NN02-250-UFL1R-700 and it is shown in the left picture of Figure 1. The second Evaluation Board is made with coplanar grounded transmission lines (traces on a PCB) to connect the two CUBE mXTEND™ antenna boosters with the SMA connector. The part number is EB_NN02-250-CPW1R-700 and it is shown in the right picture of Figure 1.

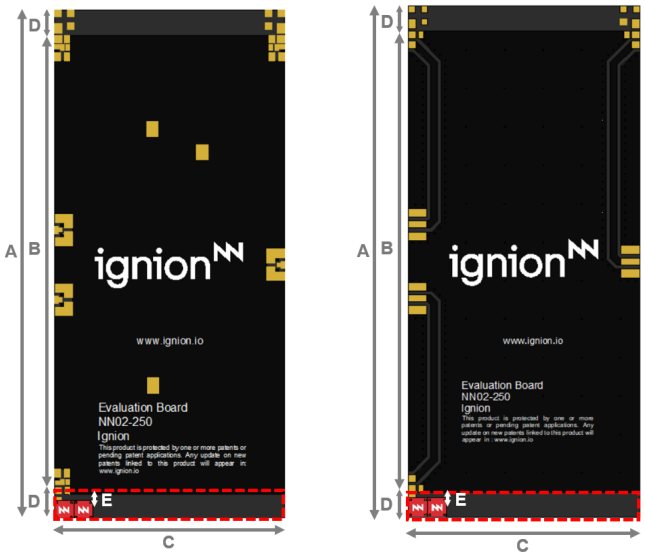


Figure 1 – Evaluation Boards providing operation at LTE700, 1 port configuration.

Measure	Mm
A	133.0
B	120.0
C	60.0
D	6.5
E	1.5

Tolerance: ±0.2 mm

Material: The Evaluation Boards are built on FR4 substrate. Thickness is 1 mm.

E: Distance between the CUBE mXTEND™ antenna booster and the ground plane

Clearance Area: 60 mm x 6.5 mm (CxD)

This product is protected by at least the following patent PAT. US 8,203,492 and other domestic and international patents pending. Any update on new patents linked to this product will appear in www.ignion.io/virtual-antenna/.

Comments:

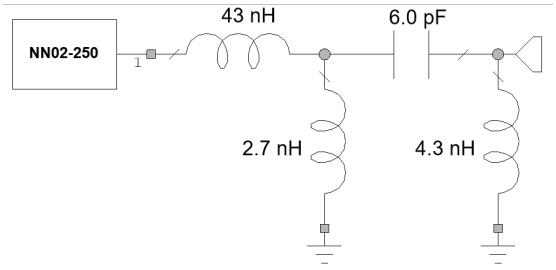
- Note that in the Evaluation Boards (Figure 1), 2 CUBE mXTEND™ antenna boosters are placed together to provide operation at LTE700 (698 – 798 MHz). Please see Figure 13 for the recommended footprint.
- The efficiency measures (Figure 3 and Figure 4) are shown from 700 MHz due to the minimum frequency specifications of the Satimo STARGATE 32 anechoic chamber.
- Please contact support@ignion.io for more information related to the antenna booster matching service.

2.3. MATCHING NETWORKS

The specs of a Ignion standard product are measured in their Evaluation Board, which is an ideal case. In a real design, components nearby the antenna, LCD's, batteries, covers, connectors, etc. affect the antenna performance. This is the reason why 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. Do it in the ground plane area, not in the clearance area. This provides a degree of freedom to tune the CUBE mXTEND™ antenna booster once the design is finished and considering all elements of the system.

Please notice that different devices with different ground planes and components nearby the CUBE mXTEND™ antenna booster may need a different matching network. To ensure optimal results, the use of high Q and tight tolerance components is highly recommended (Murata components). 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] **NN Wireless Fast-Track** design service, you will get your chip antenna design including a custom matching network for your device in 24h[1]. Other related to NN's range of R&D services is available at: https://www.ignion.io/rdservices/

[1] See terms and conditions for a free NN Wireless Fast-Track service in 24h at: https://www.ignion.io/fast-track-project/

<table>
<tr><th></th><th>Matching network for the Evaluation Board</th></tr>
<tr><td>with UFL cables</td><td>


<table>
<tr><th>Value</th><th>Part Number</th></tr>
<tr><td>43 nH</td><td>LQW18AN43NG00</td></tr>
<tr><td>2.7 nH</td><td>LQW15AN2N7B80</td></tr>
<tr><td>6.0 pF</td><td>GJM1555C1H6R0WB01</td></tr>
<tr><td>4.3 nH</td><td>LQW15AN4N3B80</td></tr>
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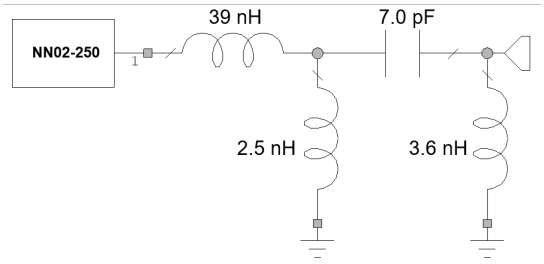
</td></tr>
<tr><td>with coplanar transmission lines</td><td>


<table>
<tr><th>Value</th><th>Part Number</th></tr>
<tr><td>39 nH</td><td>LQW18AN39NG80</td></tr>
<tr><td>2.5 nH</td><td>LQW15AN2N5B80</td></tr>
<tr><td>7.0 pF</td><td>GJM1555C1H7R0WB01</td></tr>
<tr><td>3.6 nH</td><td>LQW18AN3N6C00</td></tr>
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</td></tr>
</table>

Figure 2 – Matching networks for the LTE700, 1 port configuration.

2.4. VSWR AND TOTAL EFFICIENCY FOR 1 PORT (698-798 MHz)

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

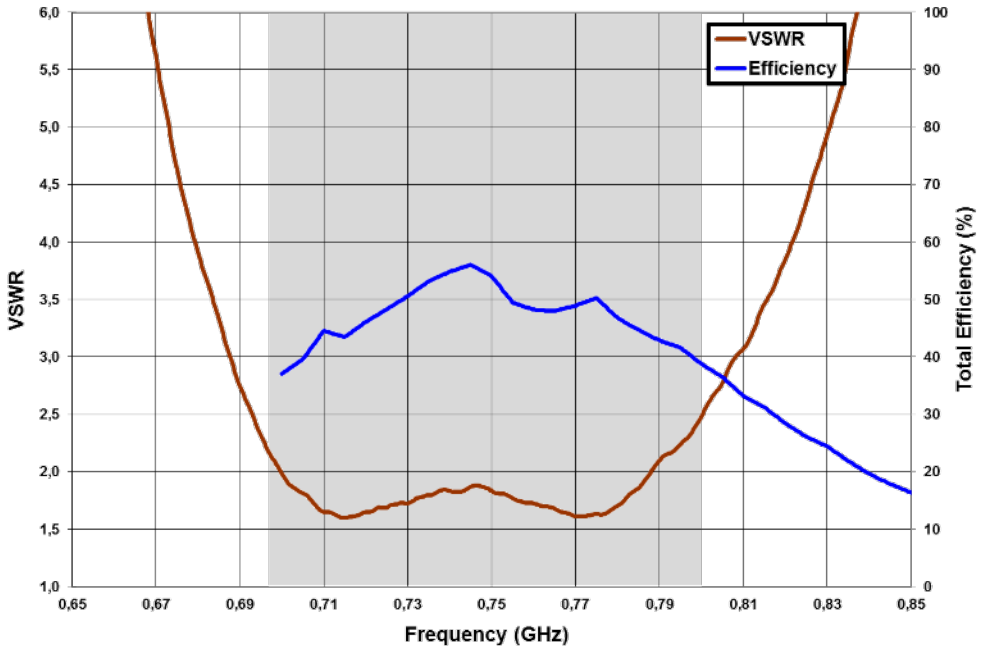


Figure 3 – VSWR and Total Efficiency for Evaluation Board with UFL cables.Part Number: EB_NN02-250-UFL1R-700.

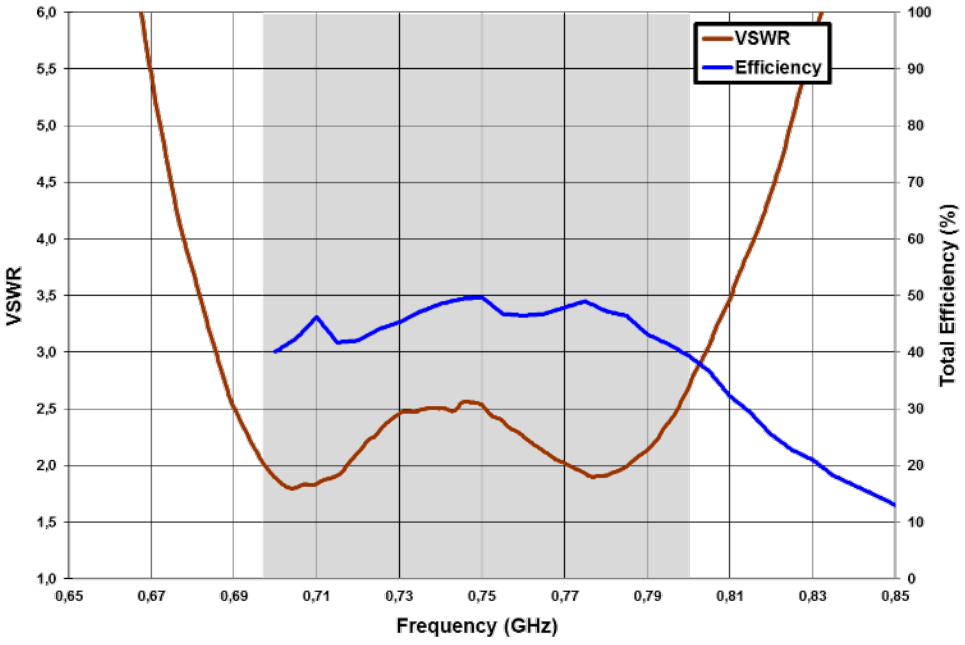
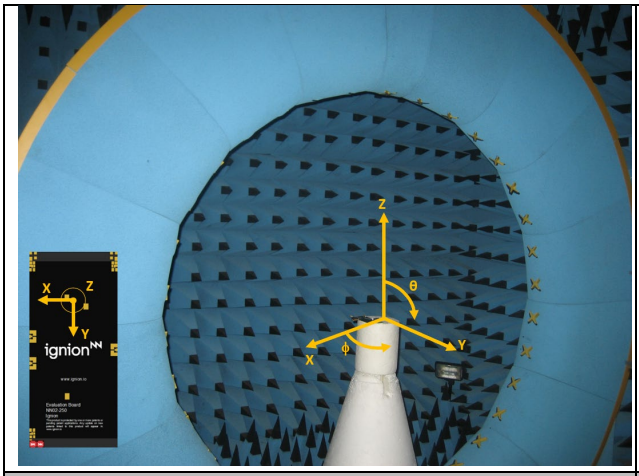


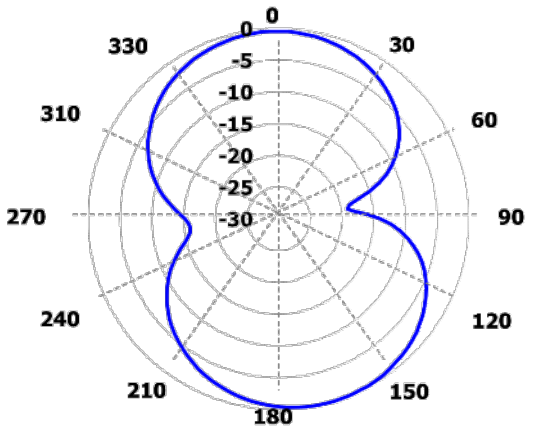
Figure 4 – VSWR and Total Efficiency for the Evaluation Board with coplanar transmission lines. Part Number: EB_NN02-250-CPW1R-700.

Note: The Satimo STARGATE 32 anechoic chamber measures from 700 MHz.

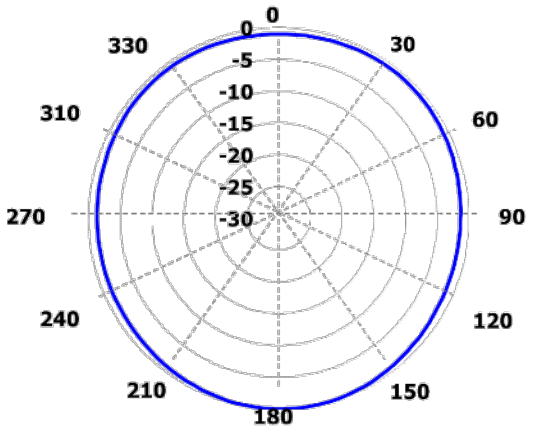
2.5. RADIATION PATTERNS (698-798 MHz), GAIN AND EFFICIENCY (UFL cables)



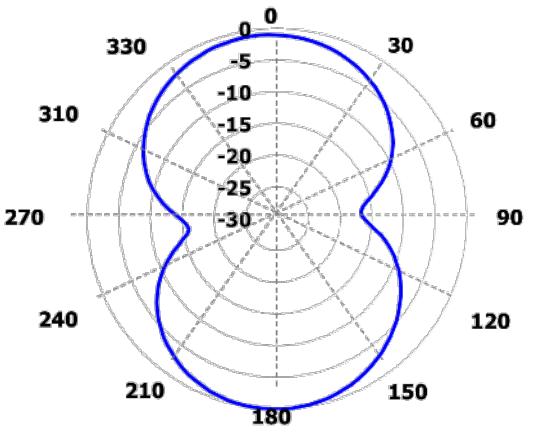
Measurement System Set-Up
Evaluation Board in Plane XY



θ = 90º Plane XY at **750 MHz**



ϕ = 0º Plane XZ at **750 MHz**

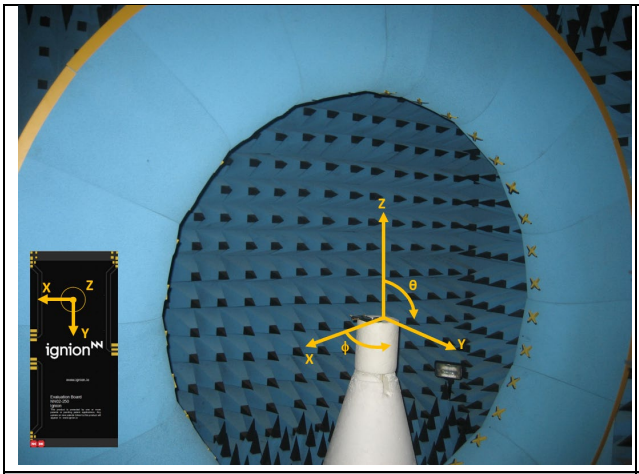


ϕ = 90º Plane YZ at **750 MHz**

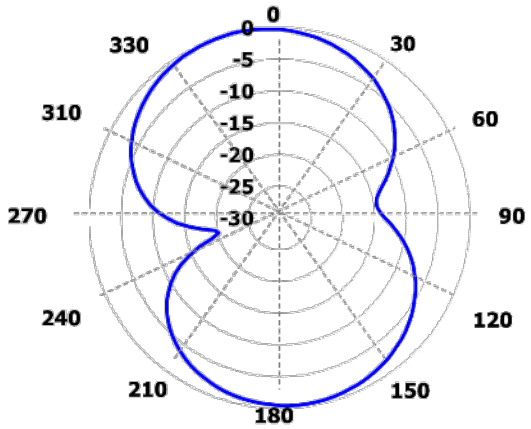
Gain	**Peak Gain**	0.2 dBi
	Average Gain across the band	-0.5 dBi
	Gain Range across the band (min, max)	-1.8 **<–>** 0.2 dBi
Efficiency	**Peak Efficiency**	56.0 %
	Average Efficiency across the band	47.6 %
	Efficiency Range across the band (min, max)	37.1 – 56.0 %

Table 2 – Antenna Gain and Total Efficiency for the Evaluation Board EB_NN02-250-UFL1R-700 within the 698 – 798 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.

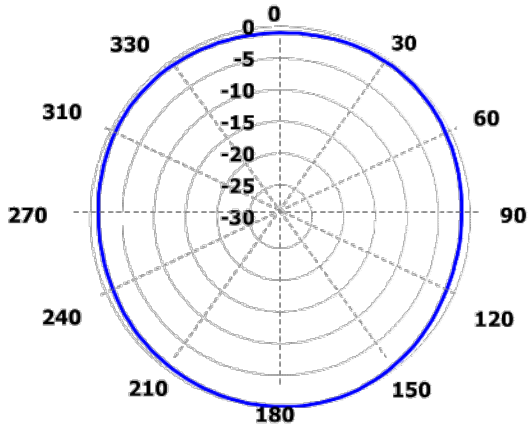
2.6. RADIATION PATTERNS (698-798 MHz), GAIN AND EFFICIENCY (CPW lines)



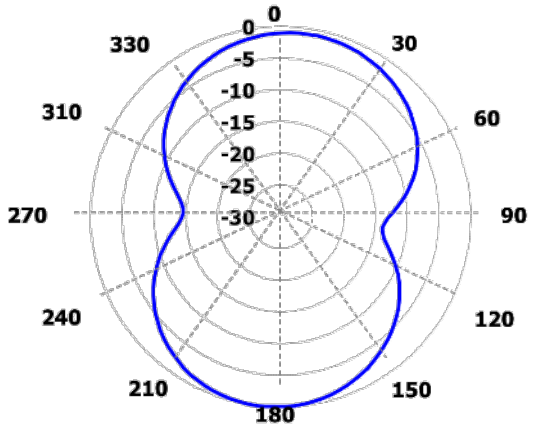
Measurement System Set-Up
Evaluation Board in Plane XY



θ = 90º Plane XY at 750 MHz



ϕ = 0º Plane XZ at 750 MHz



ϕ = 90º Plane YZ at 750 MHz

Gain	**Peak Gain**	0.1 dBi
	Average Gain across the band	-0.7 dBi
	Gain Range across the band (min, max)	-1.4 **<–>** 0.1 dBi
Efficiency	**Peak Efficiency**	49.7%
	Average Efficiency across the band	45.7 %
	Efficiency Range across the band (min, max)	40.1 – 49.7%

Table 3 – Antenna Gain and Total Efficiency for the Evaluation Board EB_NN02-250-CPW1R-700 within the 698 – 798 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.

3. EVALUATION BOARDS 1 PORT (824-960 MHz)

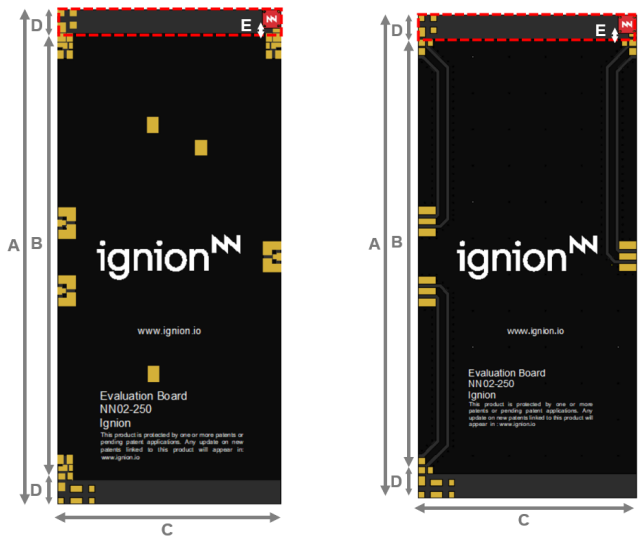
3.1. QUICK REFERENCE GUIDE

Technical features	Evaluation Board with UFL cables	Evaluation Board with coplanar transmission lines
Frequency Range	824 – 960 MHz	
Average Efficiency	> 50 %	> 50 %
Peak Gain	1.0 dBi	1.2 dBi
VSWR	< 3:1	
Radiation Pattern	Omnidirectional	
Polarization	Linear	
Weight (approx.)	0.25 g	
Temperature	-40 to +125 ºC	
Impedance	50 Ω	
Dimensions (L x W x H)	5.0 mm x 5.0 mm x 5.0 mm	

Table 4 – Technical features. Measures from the Evaluation Board. See Figure 5. Note that for obtaining comparable results, a ground plane length larger than 100 mm is recommended.

3.2. EVALUATION BOARDS 1 PORT (824-960 MHz)

This section depicts two different Evaluation Boards. The first one is built with UFL cables to connect the CUBE mXTEND™ antenna booster with the SMA connector. The part number is EB_NN02-250-UFL1R-850 and it is shown in the left picture of Figure 5. The second Evaluation Board is made with coplanar grounded transmission lines (traces on a PCB) to connect the CUBE mXTEND™ antenna booster with the SMA connector. The part number is EB_NN02-250-CPW1R-850 and it is shown in the right picture of Figure 5.



Measure	mm
A	133
B	120
C	60
D	6.5
E	1.5

Tolerance: ±0.2 mm

Material: The Evaluation Boards are built on FR4 substrate. Thickness is 1 mm.

E: Distance between the CUBE mXTEND™ antenna booster and the ground plane

Clearance Area: 60 mm x 6.5 mm (CxD)

Figure 5 – Evaluation Boards providing operation at GSM850-GSM900, 1 port configuration.

This product is protected by at least the following patent PAT. US 8,203,492 and other domestic and international patents pending. Any update on new patents linked to this product will appear in www.ignion.io/virtual-antenna/.

3.3. MATCHING NETWORKS

The specs of a Ignion standard product are measured in their Evaluation Board, which is an ideal case. In a real design, components nearby the antenna, LCD's, batteries, covers, connectors, etc. affect the antenna performance. This is the reason why 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. Do it in the ground plane area, not in the clearance area. This provides a degree of freedom to tune the CUBE mXTEND™ antenna booster once the design is finished and considering all elements of the system.

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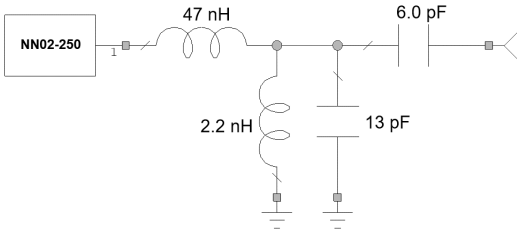
	Matching network for the Evaluation Board

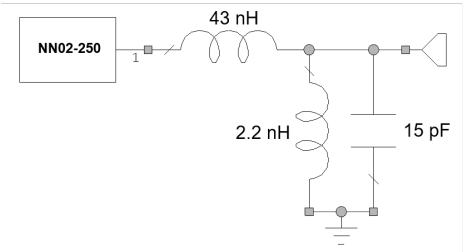
[2] See terms and conditions for a free NN Wireless Fast-Track service in 24h at: https://www.ignion.io/fast-track-project/

with UFL cables



Value	Part Number
47 nH	LQW18AN47NG80
2.2 nH	LQW15AN2N2B80
13 pF	GJM1555C1H130FB01
6.0 pF	GJM1555C1H6R0WB01

with coplanar transmission lines



Value	Part Number
43 nH	LQW18AN43NG00
2.2 nH	LQW15AN2N2B80
15 pF	GJM1555C1H150FB01

Figure 6 – Matching networks for the GSM850-GSM900, 1 port configuration.

3.4. VSWR and TOTAL Efficiency FOR 1 port (824-960 MHz)

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

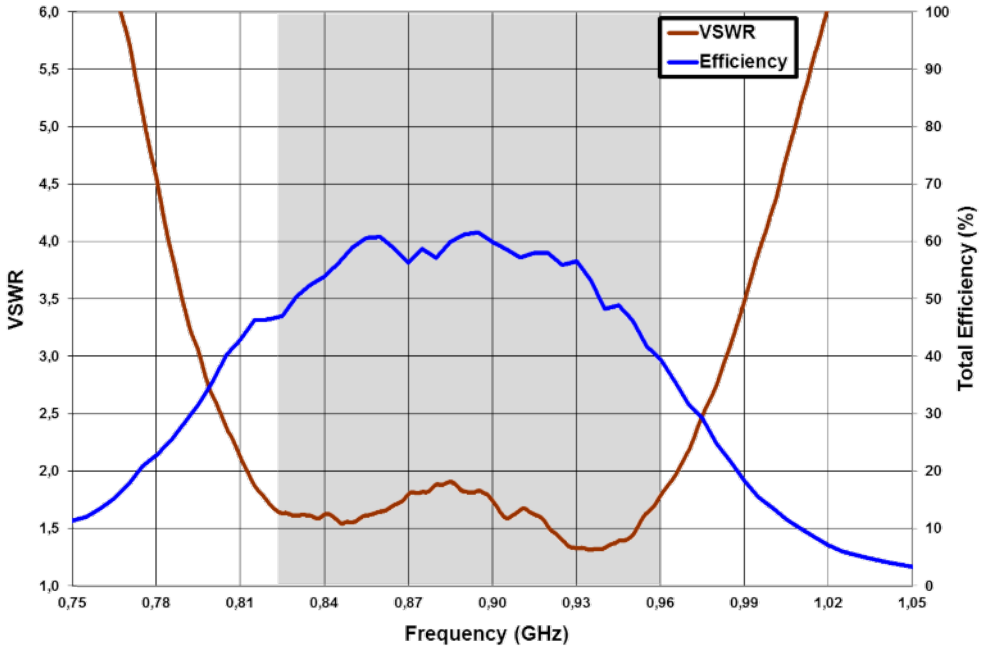


Figure 7 – VSWR and Total Efficiency for Evaluation Board with UFL cables.Part Number: EB_NN02-250-UFL1R-850.

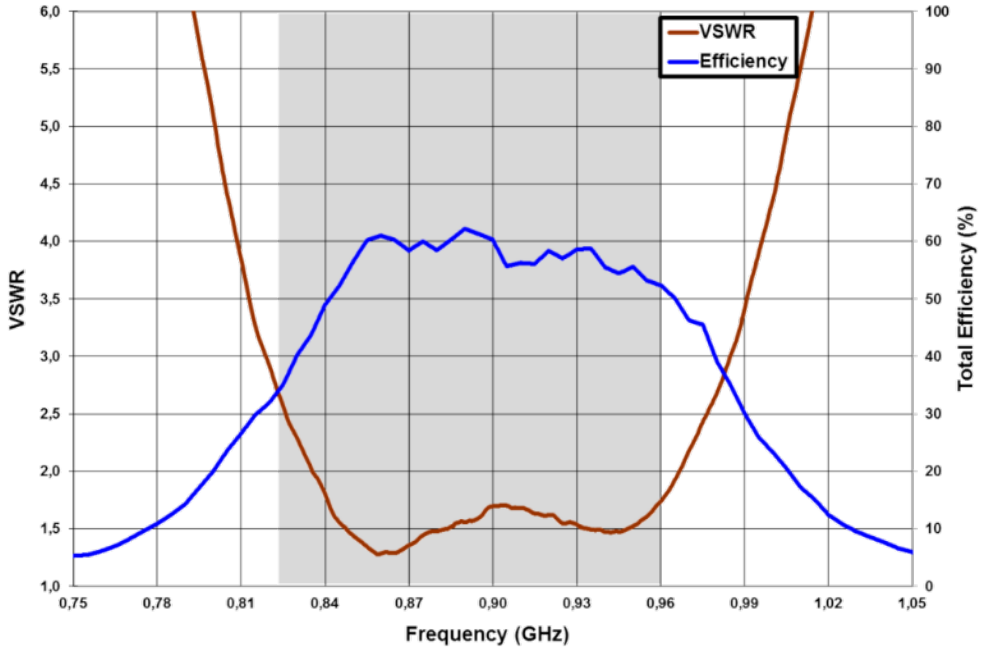
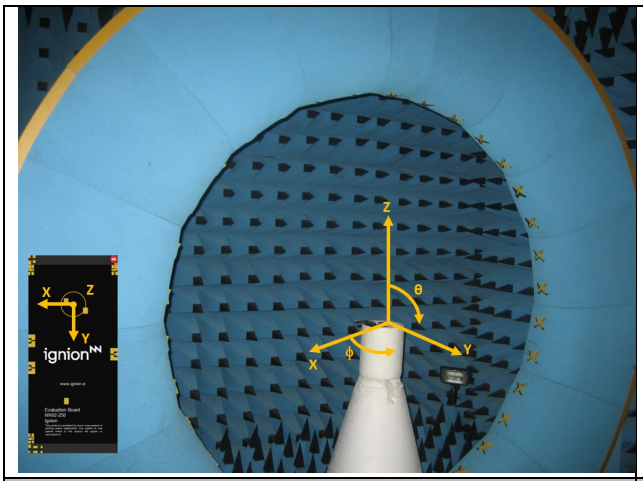
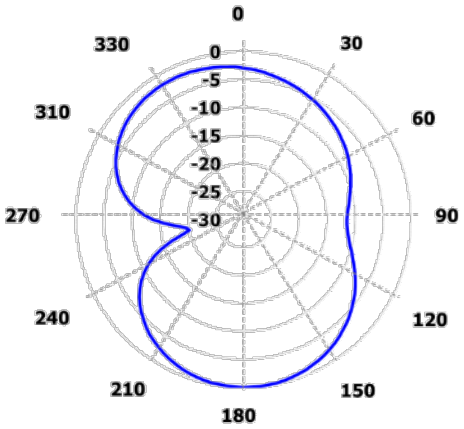


Figure 8 – VSWR and Total Efficiency for the Evaluation Board with coplanar transmission lines.Part Number: EB_NN02-250-CPW1R-850.

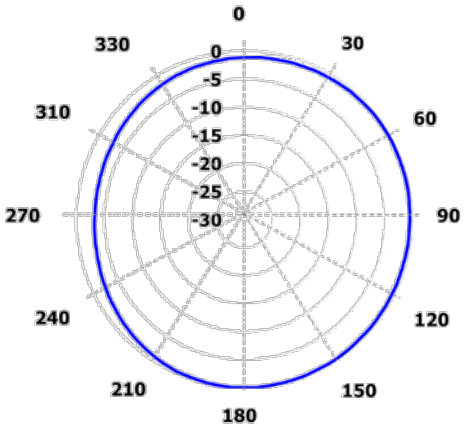
3.5. RADIATION PATTERNS (824-960 MHz), GAIN AND EFFICIENCY (UFL cables)



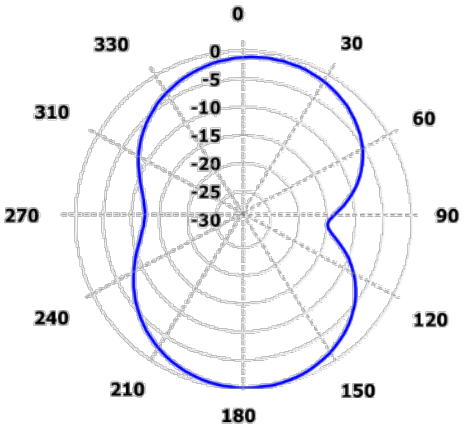
Measurement System Set-Up
Evaluation Board in Plane XY



θ = 90º Plane XY at **890 MHz**



ϕ = 0º Plane XZ at **890 MHz**

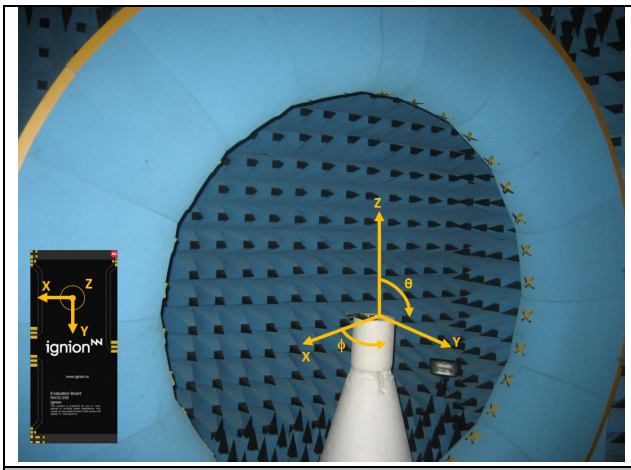


ϕ = 90º Plane YZ at **890 MHz**

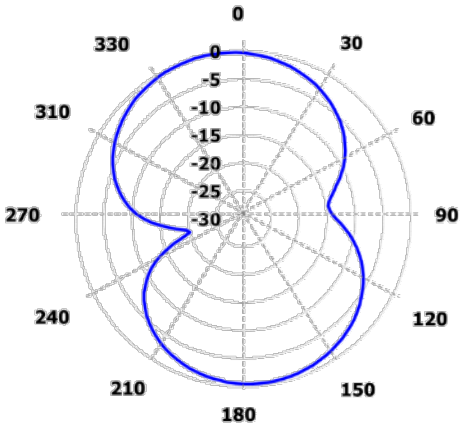
Gain	**Peak Gain**	1.0 dBi
	Average Gain across the band	0.3 dBi
	Gain Range across the band (min, max)	-1.2 **<–>** 1.0 dBi
Efficiency	**Peak Efficiency**	61.6 %
	Average Efficiency across the band	55.2 %
	Efficiency Range across the band (min, max)	39.5 – 61.6 %

Table 5 – Antenna Gain and Total Efficiency for the Evaluation Board EB_NN02-250-UFL1R-850 within the 824 – 960 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.

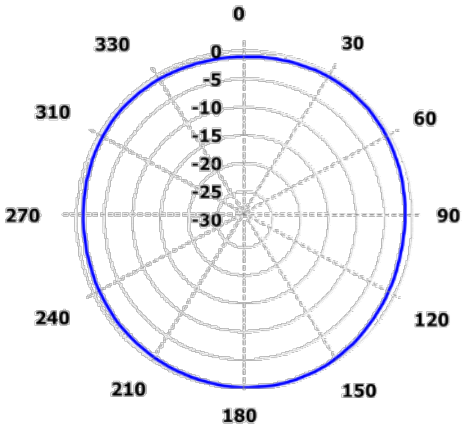
3.6. RADIATION PATTERNS (824-960 MHz), GAIN AND EFFICIENCY (CPW lines)



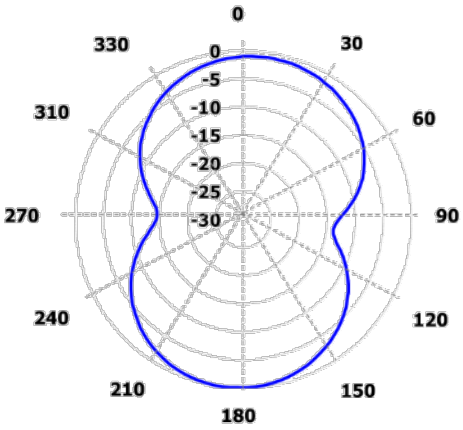
Measurement System Set-Up
Evaluation Board in Plane XY



θ = 90º Plane XY at 890 MHz



ϕ = 0º Plane XZ at 890 MHz



ϕ = 90º Plane YZ at 890 MHz

Gain	**Peak Gain**	1.2 dBi
	Average Gain across the band	0.5 dBi
	Gain Range across the band (min, max)	-1.3 **<–>** 1.2 dBi
Efficiency	**Peak Efficiency**	62.2 %
	Average Efficiency across the band	55.6 %
	Efficiency Range across the band (min, max)	34.4 – 62.2 %

Table 6 – Antenna Gain and Total Efficiency for the Evaluation Board EB_NN02-250-CPW1R-850 within the 824 – 960 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.

4. EVALUATION BOARDS 1 PORT (1710-2690 MHz)

4.1. QUICK REFERENCE GUIDE

Technical features	Evaluation Board with UFL cables	Evaluation Board with coplanar transmission lines
Frequency Range	1710 – 2690 MHz	
Average Efficiency	> 75 %	> 70 %
Peak Gain	3.3 dBi	2.8 dBi
VSWR	< 3:1	
Radiation Pattern	Omnidirectional	
Polarization	Linear	
Weight (approx.)	0.25 g	
Temperature	-40 to +125 ºC	
Impedance	50 Ω	
Dimensions (L x W x H)	5.0 mm x 5.0 mm x 5.0 mm	

Table 7 – Technical features. Measures from the Evaluation Board. See pictures in Figure 9. Note that for obtaining comparable results, a ground plane length larger than 100 mm is recommended.

4.2. EVALUATION BOARDS 1 PORT (1710-2690 MHz)

This section depicts two different Evaluation Boards. The first one is built with UFL cables to connect the CUBE mXTEND™ antenna booster with the SMA connector. The part number is EB_NN02-250-UFL1R-1700 and it is shown in the left picture of Figure 9. The second Evaluation Board is made with coplanar grounded transmission lines (traces on a PCB) to connect the CUBE mXTEND™ antenna booster with the SMA connector. The part number is EB_NN02-250-CPW1R-1700 and it is shown in the right picture of Figure 9.

Figure 9 – Evaluation Boards providing operation at LTE1700-LTE2600, 1 port configuration.

Measure	mm
A	133
B	120
C	60
D	6.5
E	1.5

Tolerance: ±0.2 mm

Material: The Evaluation Boards are built on FR4 substrate. Thickness is 1 mm.

E: Distance between the CUBE mXTEND™ antenna booster and the ground plane

Clearance Area: 60 mm x 6.5 mm (CxD)

This product is protected by at least the following patent PAT. US 8,203,492 and other domestic and international patents pending. Any update on new patents linked to this product will appear in www.ignion.io/virtual-antenna/.

4.3. MATCHING NETWORKS

The specs of a Ignion standard product are measured in their Evaluation Board, which is an ideal case. In a real design, components nearby the antenna, LCD's, batteries, covers, connectors, etc. affect the antenna performance. This is the reason why 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. Do it in the ground plane area, not in the clearance area. This provides a degree of freedom to tune the CUBE mXTEND™ antenna booster once the design is finished and considering all elements of the system.

Please notice that different devices with different ground planes and components nearby the CUBE mXTEND™ antenna booster may need a different matching network. To ensure optimal results, the use of high Q and tight tolerance components is highly recommended (Murata components). 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] **NN Wireless Fast-Track** design service, you will get your chip antenna design including a custom matching network for your device in 24h[3]. Other related to NN's range of R&D services is available at: https://www.ignion.io/rdservices/

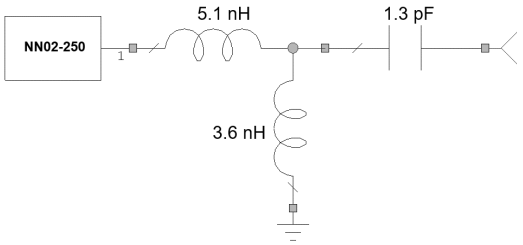
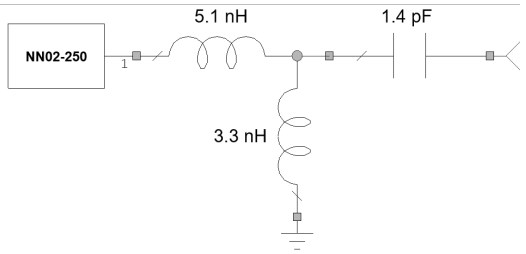
	Matching network for the Evaluation Board	
with UFL cables		**Value** / **Part Number** **5.1 nH** LQW15AN5N1B80 **3.6 nH** LQW15AN3N6B80 **1.3 pF** GJM1555C1H1R3WB01
with coplanar transmission lines		**Value** / **Part Number** **5.1 nH** LQW15AN5N1B80 **3.3 nH** LQW15AN3N3B80 **1.4 pF** GJM1555C1H1R4WB01

Figure 10 – Matching networks for the LTE1700-LTE2600, 1 port configuration.

[3] See terms and conditions for a free NN Wireless Fast-Track service in 24h at: https://www.ignion.io/fast-track-project/

4.4. VSWR and TOTAL Efficiency 1 port (1710-2690 MHz)

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

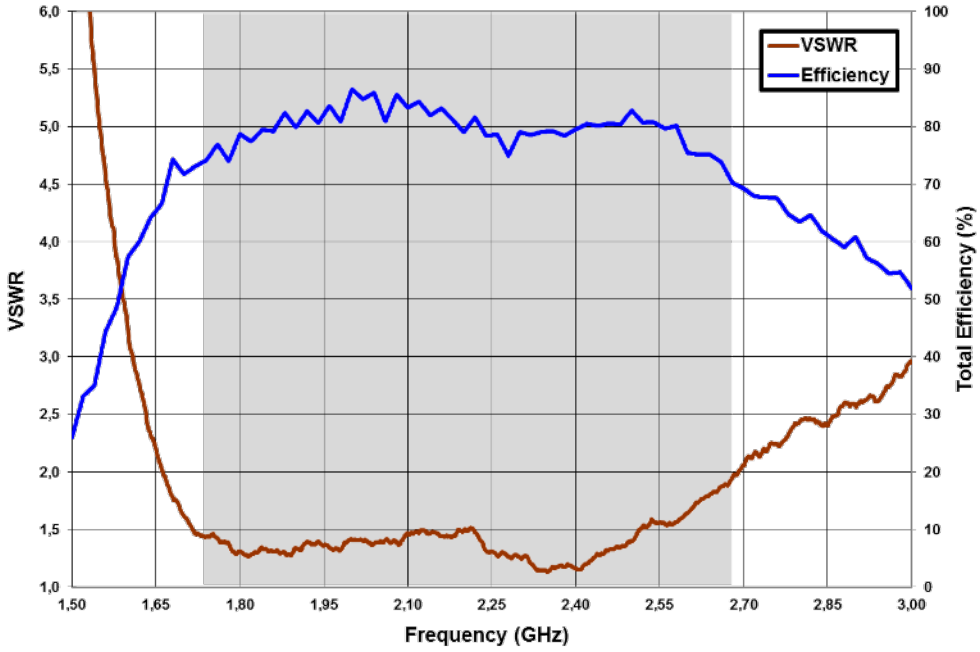


Figure 11 – VSWR and Total Efficiency for Evaluation Board with UFL cables. Part Number: EB_NN02-250-UFL1R-1700.

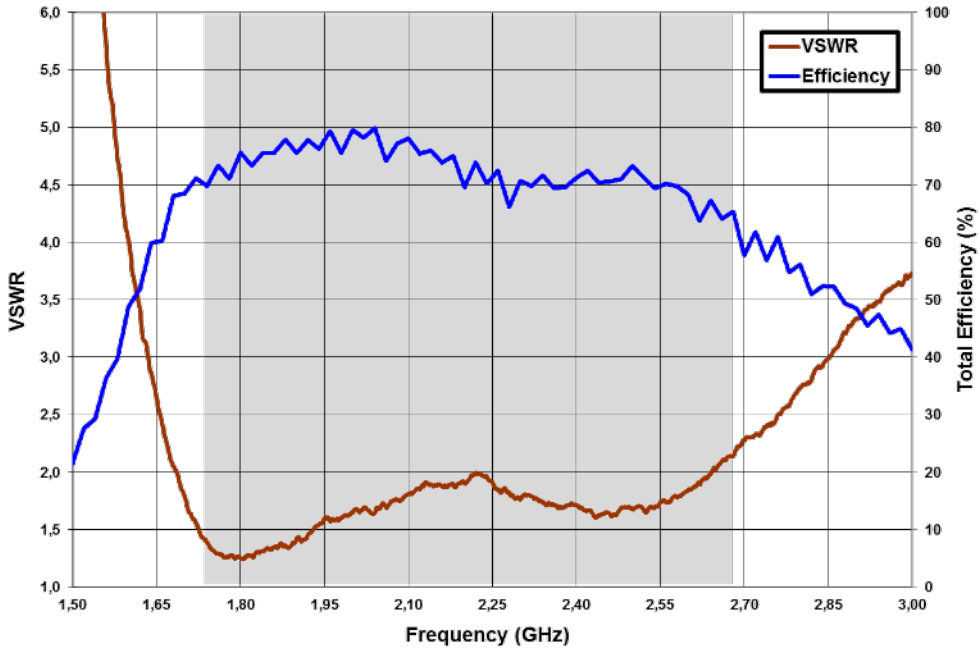
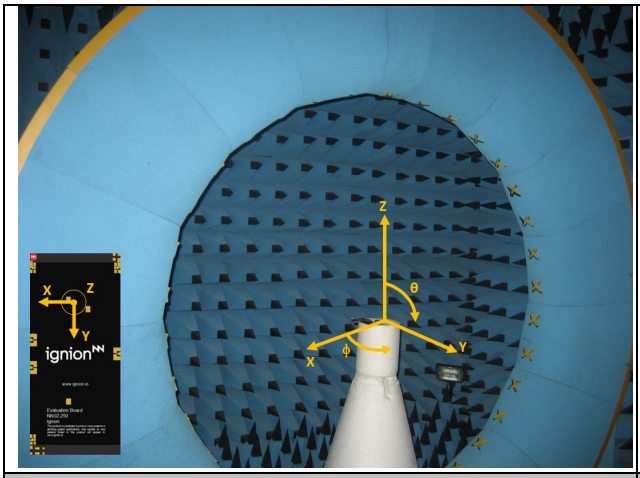
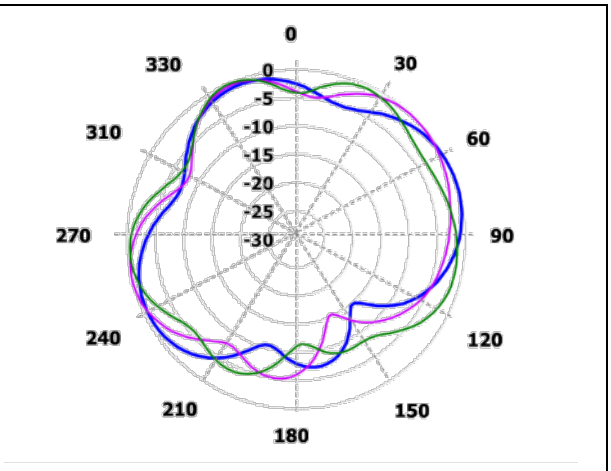


Figure 12 – VSWR and Total Efficiency for the Evaluation Board with coplanar transmission lines.Part Number: EB_NN02-250-CPW1R-1700.

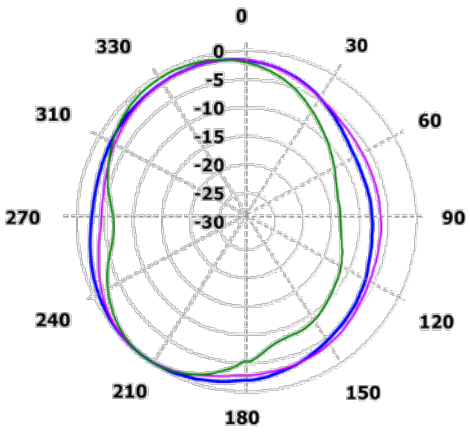
4.5. RADIATION PATTERNS (1710-2690 MHz), GAIN AND EFFICIENCY (UFL cables)



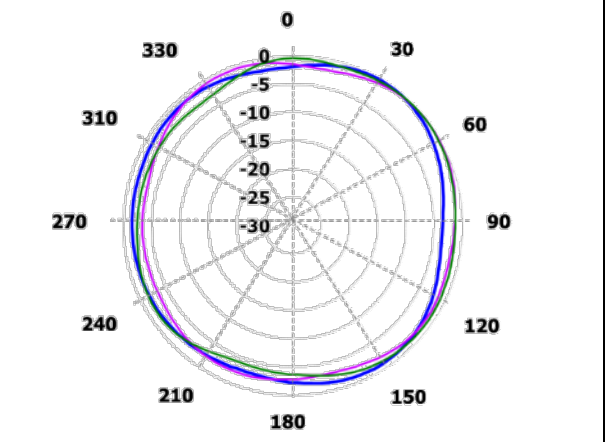
Measurement System Set-Up
Evaluation Board in Plane XY



θ = 90º Plane XY at 1.71 GHz, 2.2 GHz and 2.69 GHz



ϕ = 0º Plane XZ at 1.71 GHz, 2.2 GHz and 2.69 GHz

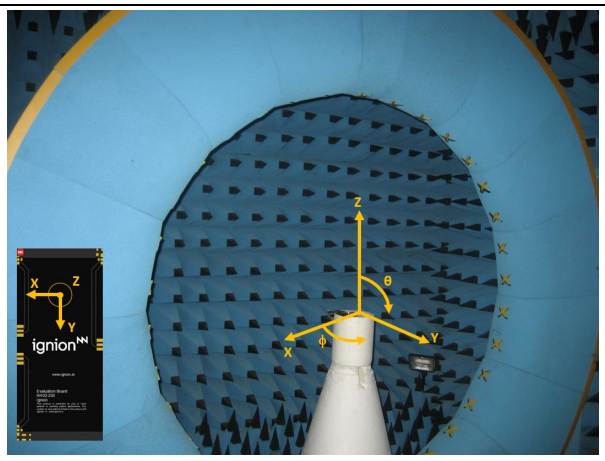


ϕ = 90º Plane YZ at 1.71 GHz, 2.2 GHz and 2.69 GHz

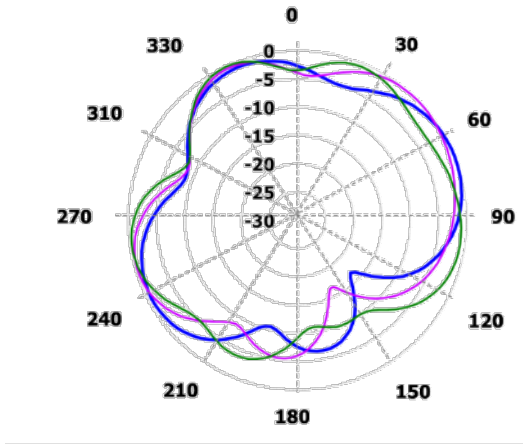
Gain	**Peak Gain**	3.3 dBi
	Average Gain across the band	2.6 dBi
	Gain Range across the band (min, max)	1.7 **<–>** 3.3 dBi
Efficiency	**Peak Efficiency**	86.4 %
	Average Efficiency across the band	79.6 %
	Efficiency Range across the band (min, max)	69.7 – 86.4 %

Table 8 – Antenna Gain and Total Efficiency for the Evaluation Board EB_NN02-250-UFL1R-1700 within the 1710 – 2690 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.

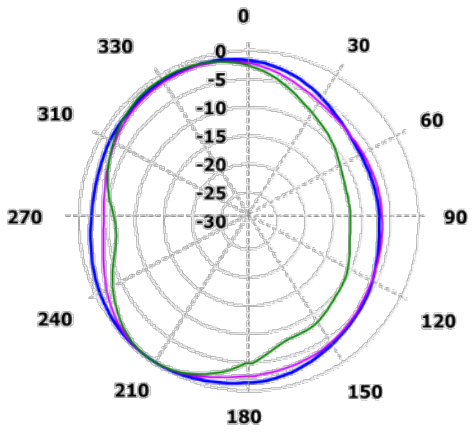
4.6. RADIATION PATTERNS (1710-2690 MHz), GAIN AND EFFICIENCY (CPW lines)



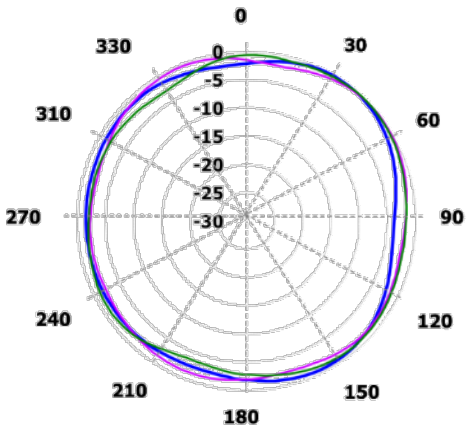
Measurement System Set-Up
Evaluation Board in Plane XY



θ = 90º Plane XY at 1.71 GHz, 2.2 GHz and 2.69 GHz



ϕ = 0º Plane XZ at 1.71 GHz, 2.2 GHz and 2.69 GHz



ϕ = 90º Plane YZ at 1.71 GHz, 2.2 GHz and 2.69 GHz

Gain	**Peak Gain**	2.8 dBi
	Average Gain across the band	2.2 dBi
	Gain Range across the band (min, max)	1.4 **<–>** 2.8 dBi
Efficiency	**Peak Efficiency**	79.9 %
	Average Efficiency across the band	72.6 %
	Efficiency Range across the band (min, max)	61.7 – 79.9 %

Table 9 – Antenna Gain and Total Efficiency for the Evaluation Board EB_NN02-250-CPW1R-1700 within the 1710 – 2690 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.

5. ANTENNA FOOTPRINT

Assuming that the CUBE mXTEND™ antenna booster NN02-250 is placed in the clearance area of the PCB, see below the recommended footprint dimensions.

Measure	mm
A	1.7
B	1.6
C	2.0

Tolerance: ±0.1 mm

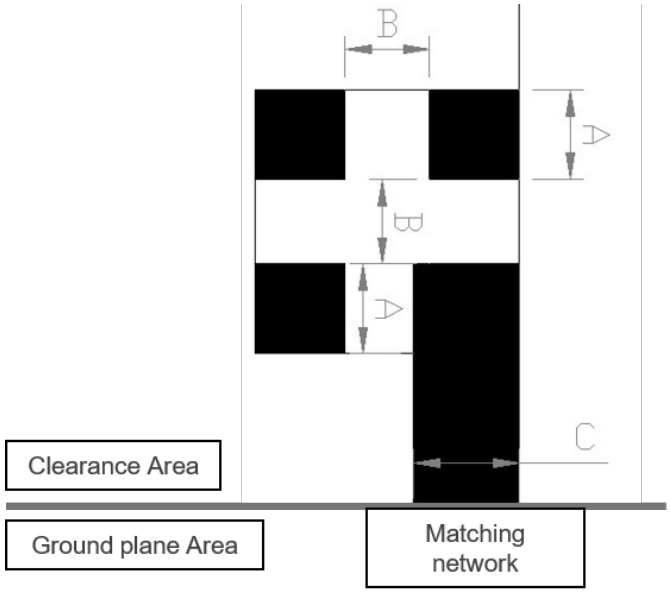


Figure 13 – Footprint dimensions for the single booster.

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