ignion

Your innovation.
Accelerated.

Smart meter antenna: 698–960 & 1710–2170 MHz cellular for utility metering

APPLICATION NOTE
ALL mXTEND™ (NN02-220)
RUN mXTEND™ (NN02-224)

SMART METERING

Nowadays, the main challenges faced by smart meter manufacturers, when designing a new metering device, are price, size, global coverage, long range and considering surrounding environments that could affect the overall performance.

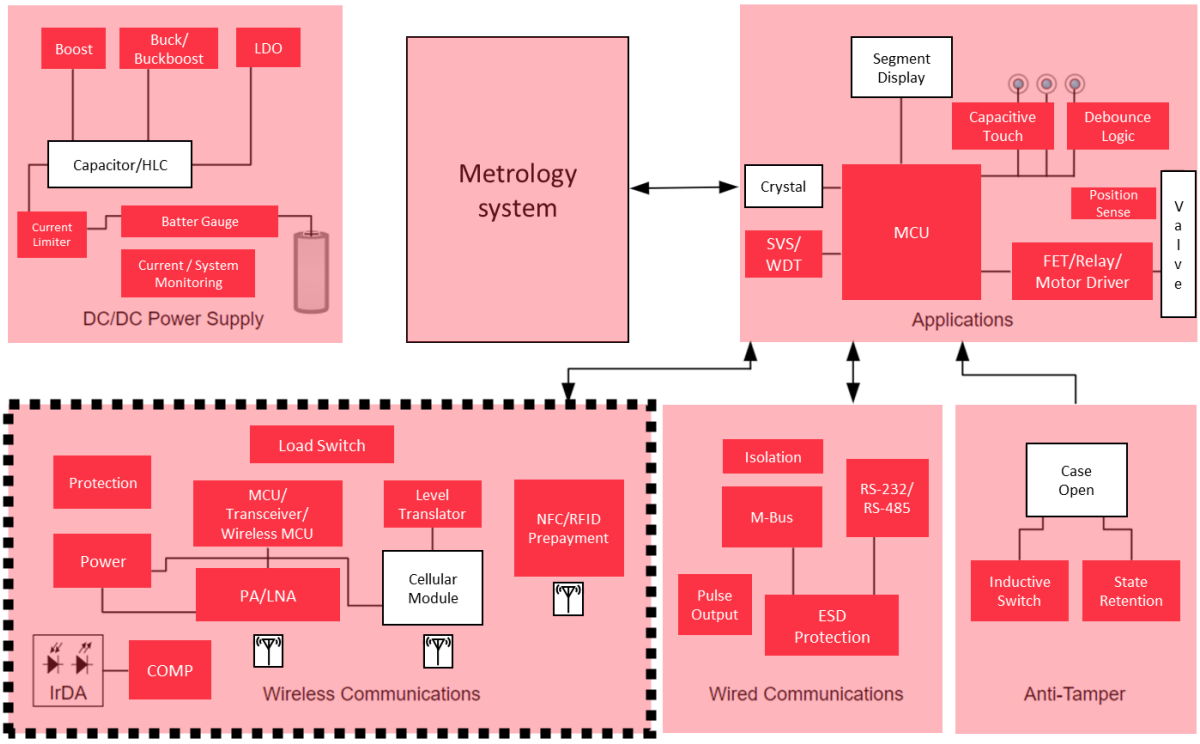
Any wireless smart metering device's data transmission has to be completely reliable, therefore, the antenna is a critical component in such device.

First, chip antenna technology is perfect for providing cost savings in your smart meter production. It is often a lower cost component than an external antenna or FPC, and, by being SMD pick and place, it provides savings on assembly costs.

The internally mounted chip antenna provides the benefit of increased protection against environmental factors and vandalism compared to an external antenna. Our patented technology, Virtual antenna® allows for the same antenna part to cover multiple frequency bands simultaneously and offers any device designer the flexibility of selecting and tuning the frequency bands simply through adjustment of the matching network. Virtual Antenna offers a predictable and optimized performance ensuring metering devices easily comply with cellular certifications.

Second, Virtual Antenna® components use the PCB to resonate, which enables high performance in space constrained device designs. Even with a small size Virtual Antenna® component, the metering device will perform with optimal efficiency and high gain in all the bands, helping with long-range communications.

Smart meters are subject to long product development cycles and massive deployment and installation. Altogether, this can span to several years. And it might happen that in the midst of the deployment, a new connectivity standard arises that improves the business model of the utility provider: e.g., using 5G instead of 4G or older 3G, 2G. A fast upgrade of the smart meter design becomes then very convenient and Virtual Antenna® ensures that the same component used for 3G will be capable of upgrading to 4G, 5G or any "G" with just a minimum change of the matching network. Even the same antenna can be used with non-cellular LPWAN standards such as LoRa and Sigfox.



Block Diagram of a Smart Meter

In the Block Diagram above, we see an example of a Smart Metering Application. Some of the main components within a device like this, are:

Microcontroller unit (MCU):
An MCU or MPU is an intelligent semiconductor and the main component in any device. It is what allows for the entire system to function, by translating the data programmed in it to commands that all the other components will understand an execute to deliver results. It is the brains of the module.
Choosing the best performing antenna will allow for a faster data transmission, which will lead the MPU to perform at its full capacity.

Metrology system:
Another especially important unit in a Smart Meter is the metrology system as the devices needs to constantly measure the gas flow rate within an installation in a fully accurate way in order to be able to collect data, to be sent afterwards. In the next bullet point you can read how important the antenna is for the data collected by the metrology system to be correctly sent.

Antenna (Wireless Communications):
For optimal communication efficiency, the antenna's placement is crucial, therefore, its implementation within the device's design has to be in an early stage. That early implementation has to be done also because, usually, an antenna needs a clearance area in the PCB.
At this point, Virtual Antenna® technology becomes the best solution for any metering device. It gives the customer the ability to design the antenna set-up, in-house, with no expertise required. Furthermore, the customer will also be able to fine tune the performance given its overall product's structure from the beginning.

In summary, when designing a Smart Meter Device, the customer should think about the antenna at the early stage of the design process, as the location, PCB dimension and overall mechanics of the product will all determine/impact the overall performance of the antenna. Ignion can help and guide/advise the customer, using our Antenna Services. By choosing Virtual Antenna® technology as your antenna solution, thanks to its high RF efficiency and adaptability, you will ensure best performance in your Smart Metering Device.

Moreover, Virtual Antenna® components, by being off-the-shelf, tunable, and versatile antennas, will allow for faster development times, predictability of design from minute one and a fast and flexible adaptation to different tracking forms.
In this application note, we will review the performance and different metrics, on various ground planes and clearance lengths, of the RUN mXTEND™ (NN02-224) and the ALL mXTEND (NN02-220), our top performing multiband antennas for Smart Metering application.

SIMPLE AND COST-EFFICIENT SMART METER ANTENNA INTEGRATION

ALL mXTEND™ (NN02-220) and RUN mXTEND™ (NN02-224) AN for Smart Meters 698 – 960 MHz and 1710 – 2170 MHz

Ignion specializes in enabling effective mobile communications by designing and manufacturing optimized antenna products that will make your wireless devices more competitive. Our mission is to transform our clients' product development processes with innovative components that accelerate time-to-market without compromising functionality.

ALL mXTEND™ chip antenna component

NN02-220

Ignion products are protected by Ignion patents.

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

RUN mXTEND™ antenna booster

NN02-224

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ISO 9001: 2015 Certified

TABLE OF CONTENTS

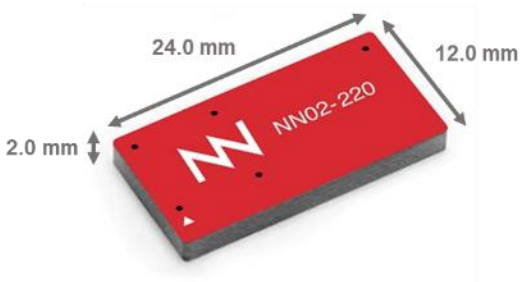
1. PRODUCT DESCRIPTION NN02-220 6
2. PRODUCT DESCRIPTION NN02-224 7
3. EVALUATION BOARD SMART METERING – ALL mXTEND™ 8
3.1. QUICK REFERENCE GUIDE 8
3.2. EVALUATION BOARD 8
3.3. MATCHING NETWORK 9
3.4. VSWR AND TOTAL EFFICIENCY 10
3.5. RADIATION PATTERNS (698 – 960 MHz), GAIN AND EFFICIENCY 11
3.6. RADIATION PATTERNS (1710 – 2170 MHz), GAIN AND EFFICIENCY 12
4. EVALUATION BOARD SMART METERING – RUN mXTEND™ 13
4.1. QUICK REFERENCE GUIDE 13
4.2. EVALUATION BOARD 13
4.3. MATCHING NETWORK 14
4.4. VSWR AND TOTAL EFFICIENCY 15
4.5. RADIATION PATTERNS (824 – 960 MHz), GAIN AND EFFICIENCY 16
4.6. RADIATION PATTERNS (1710 – 2170 MHz), GAIN AND EFFICIENCY 17

1. PRODUCT DESCRIPTION NN02-220

The rate of smart meter implementation is projected to continue to grow as governments implement programs to encourage their deployment, helping providers get more detailed information which in turn allows them to better match utility generation with customer consumption. In this application note we illustrate how to use the ALL mXTEND™ chip antenna component (NN02-220) for operating at the 698-960MHz and 1710-2170MHz frequency ranges used in smart meters. Additionally, we have performed our tests using an Evaluation Board the size of a typical smart meter to provide the most relevant results possible for those who design smart meters.

The ALL mXTEND™ is perfect for providing cost savings in your smart meter production. It is often a lower cost component than an external antenna and being SMD pick and place it provides savings on assembly labor costs. Additionally, as this antenna is mounted internally it provides the further benefit of increased protection against environmental factors versus an external antenna. The same antenna part can be used to cover different frequency ranges, since it offers the antenna designer the flexibility of selecting the frequency regions to operate through just the customization of the matching network.

TOP



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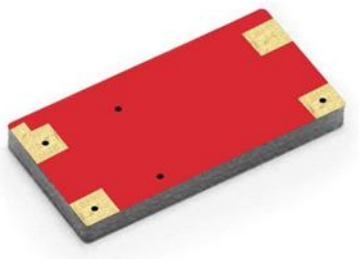


Material: The ALL mXTEND™ chip antenna component is built on glass epoxy substrate.

APPLICATIONS

- Smart meters
- Handsets
- Tablets
- Laptop PCs
- Tracking devices
- Etc.

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)

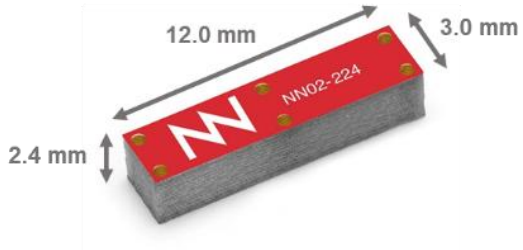
Based on Ignion proprietary Virtual Antenna ® technology, the ALL mXTEND™ belongs to a new generation of antenna products focused on replacing conventional antenna solutions with miniature, off-the-shelf components that drive fast, intelligent design. This breakthrough technology has been specifically designed to fit a diverse set of wireless applications – smart meters are just one of the many environments where this tiny antenna can be transformational.

2. PRODUCT DESCRIPTION NN02-224

The rate of smart meter implementation is projected to continue to grow as governments implement programs to encourage their deployment, helping providers get more detailed information which in turn allows them to better match utility generation with customer consumption. In this application note we illustrate how to use the RUN mXTEND™ antenna booster (NN02-224) for operating at the 824-960MHz and 1710-2170MHz frequency ranges used in smart meters. Additionally, we have performed our tests using an Evaluation Board the size of a typical smart meter to provide the most relevant results possible for those who design smart meters.

The RUN mXTEND™ is perfect for providing cost savings in your smart meter production. It is often a lower cost component than an external antenna and being SMD pick and place it provides savings on assembly labor costs. Additionally, as this antenna is mounted internally it provides the further benefit of increased protection against environmental factors versus an external antenna. The same antenna part can be used to cover different frequency ranges, since it offers the antenna designer the flexibility of selecting the frequency regions to operate through just the customization of the matching network.

TOP



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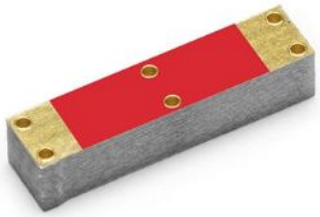


Material: The RUN mXTEND™ antenna booster is built on glass epoxy substrate.

APPLICATIONS

- Smart meters
- Smartwatches
- IoT Devices
- Modules
- Remote Sensors
- Etc.

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)

Based on Ignion proprietary Virtual Antenna® technology, the RUN mXTEND™ belongs to a new generation of antenna products focused on replacing conventional antenna solutions with miniature, off-the-shelf components that drive fast, intelligent design. This breakthrough technology has been specifically designed to fit a diverse set of wireless applications – smart meters are just one of the many environments where this tiny antenna can be transformational.

3. EVALUATION BOARD SMART METERING – ALL mXTEND™

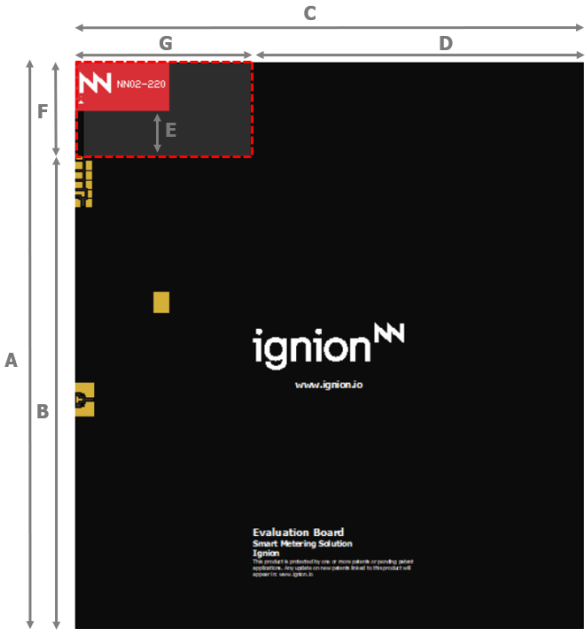
3.1. QUICK REFERENCE GUIDE

Technical features	698 – 960 MHz	1710 – 2170 MHz
Average Efficiency	> 65%	> 70%
Peak Gain	2.2 dBi	0.1 dBi
VSWR	< 3:1	
Radiation Pattern	Omnidirectional	
Polarization	Linear	
Weight (approx.)	1.23 g	
Temperature	-40 to +125 ºC	
Impedance	50 Ω	
Dimensions (L x W x H)	24.0 mm x 12.0 mm x 2.0 mm	

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

3.2. EVALUATION BOARD

This Evaluation Board EB_NN02-220-SM integrates a UFL cable to connect the ALL mXTEND™ chip antenna component with the SMA connector. The ALL mXTEND™ provides operation in the frequency region which covers from 698 to 960 MHz and from 1710 to 2170 MHz, through a single input/output port.



Measure	mm
A	145.0
B	121.0
C	130.0
D	85.0
E	12.0
F	24.0
G	45.0

Tolerance: ±0.2 mm

E: Distance between the ALL mXTEND™ chip antenna component and the ground plane.

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

Clearance Area: 24 mm x 45 mm (FxG)

Figure 1 – EB_NN02-220-SM. Evaluation Board providing operation from 698 to 960 MHz and from 1710 to 2170 MHz.

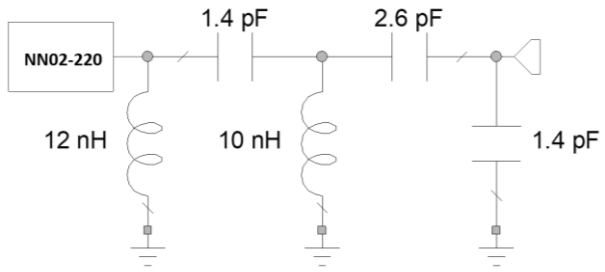
This product and/or its use are protected by Ignion patents. Other domestic and international patents pending. Additional information about patents related to this product is available at www.ignion.io/virtual-antenna/.

3.3. MATCHING NETWORK

The specs of a Ignion standard product are measured in an Evaluation Board, where an ideal case is created. However, when incorporating into real designs, nearby components such as LCD's, batteries, covers and connectors may affect the antenna performance. For this reason, placing pads compatible with 0402 and 0603 SMD components for a matching network as close as possible to the feeding point is highly recommended. Create this matching network in the ground plane area rather than the clearance area – this will provide a degree of freedom for tuning the ALL mXTEND™ chip antenna component once the design is finished, taking into account all elements of the system (batteries, displays, covers, etc.).

Please notice that different devices with different ground planes and different components nearby the ALL mXTEND™ chip antenna component 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 help designing your matching network beyond this application note, contact support@ignion.io or run your device through Oxion™ at https://oxion.ai, Ignion's free-of-charge[1] AI-powered antenna integration platform, for a custom matching network and a complete design report in 24h. Ignion's engineering services: https://ignion.io/design-center/engineering-support/

698 – 960 MHz and 1710 – 2170 MHz



Value	Part Number
12 nH	LQW18AN12NG10
1.4 pF	GJM1555C1H1R4W B01
10 nH	LQW18AN10NG10
2.6 pF	GJM1555C1H2R6W B01
1.4 pF	GJM1555C1H1R4W B01

Figure 2 – Matching Network implemented in the Evaluation Board (Figure 1).

1 See terms and conditions for the free-of-charge Oxion™ service at: https://oxion.ai

3.4. VSWR AND TOTAL EFFICIENCY

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

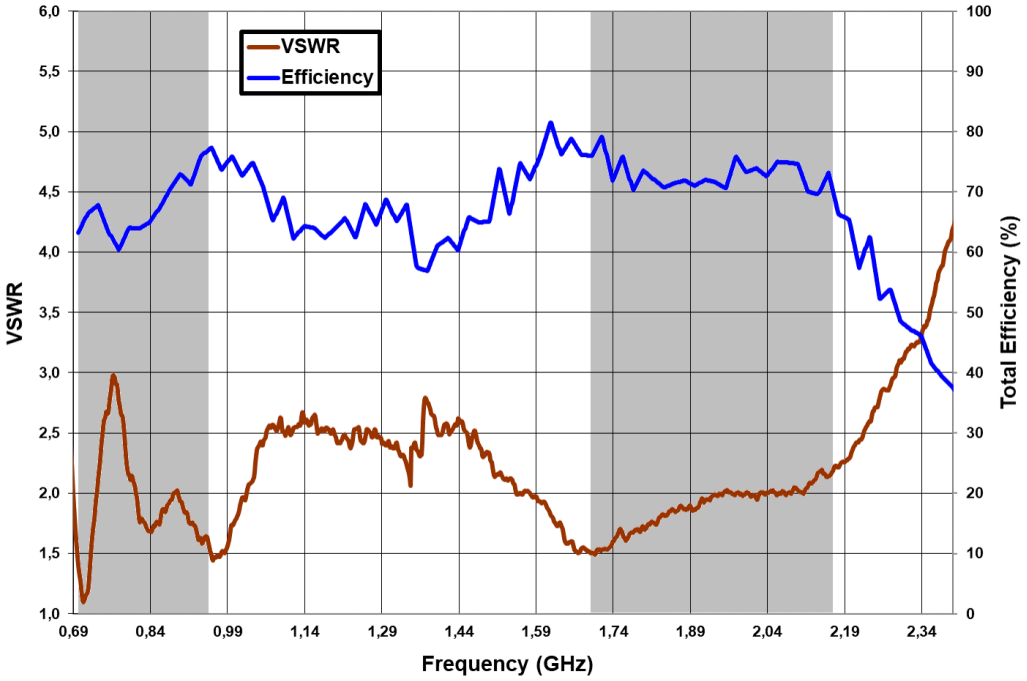
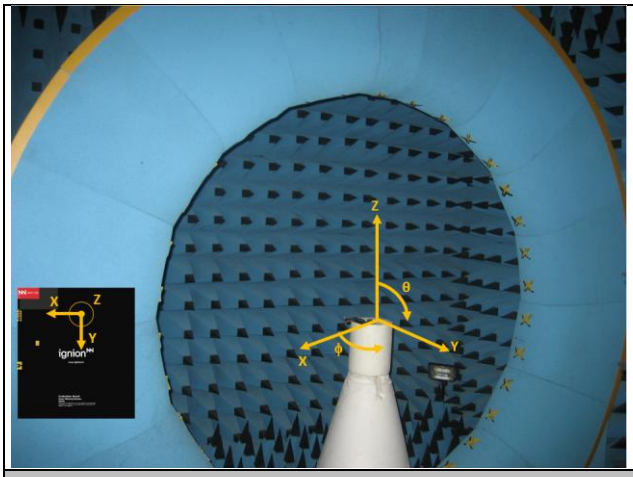
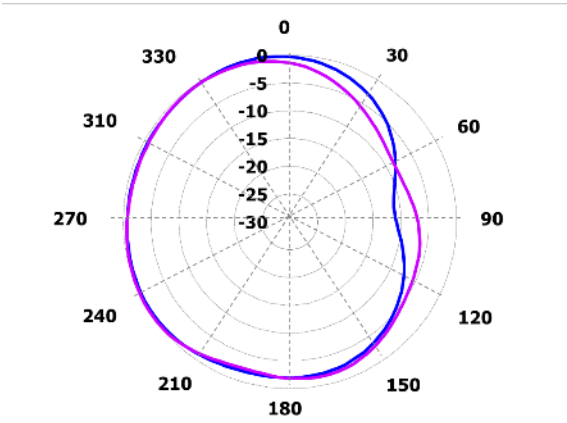


Figure 3 – VSWR and Total Efficiency for the 698 - 960 MHz and 1710 - 2170 MHz frequency range (from the Evaluation Board (Figure 1)).

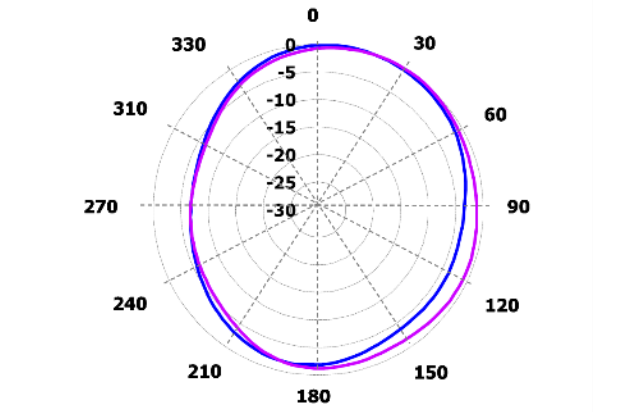
3.5. RADIATION PATTERNS (698 – 960 MHz), GAIN AND EFFICIENCY



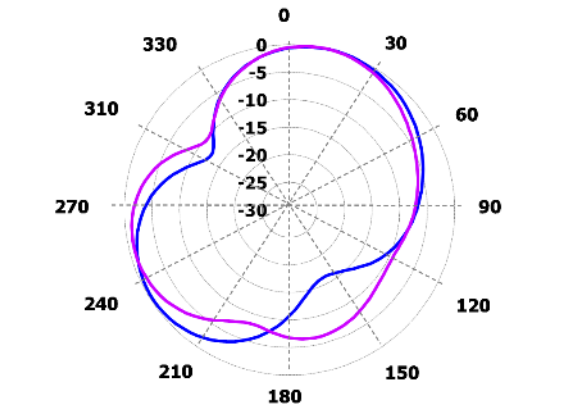
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 750 MHz and 890 MHz



ϕ = 0º Plane XY at 750 MHz and 890 MHz

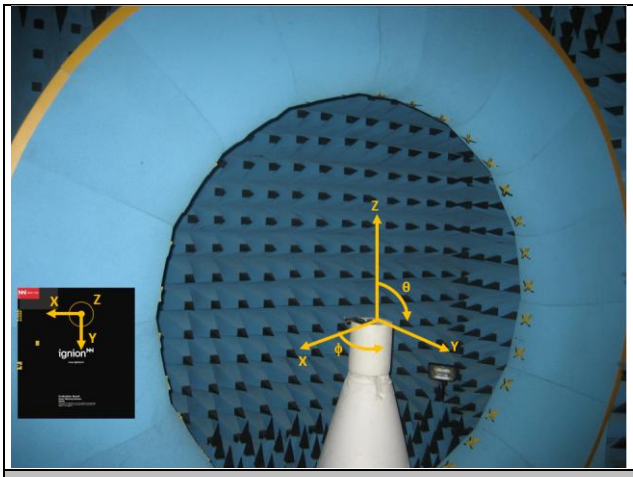


ϕ = 90º Plane YZ at 750 MHz and 890 MHz

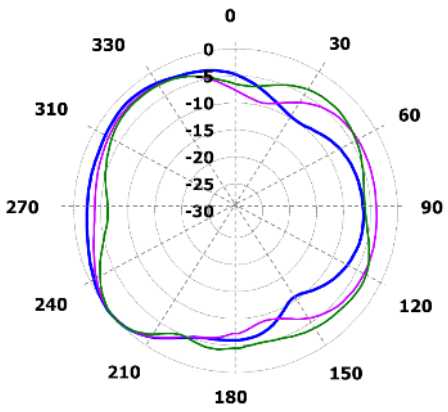
Gain	**Peak Gain**	2.7 dBi
	Average Gain across the band	2.15 dBi
	Gain Range across the band (min, max)	0.9 **<–>** 2.7 dBi
Efficiency	**Peak Efficiency**	77.4 %
	Average Efficiency across the band	67.7 %
	Efficiency Range across the band (min, max)	60.5 – 77.4 %

Table 2 – Antenna Gain and Total Efficiency from the Evaluation Board (Figure 1) within the 698 – 960 MHz frequency range. Measurements made in the Satimo STARGATE 32 anechoic chamber.

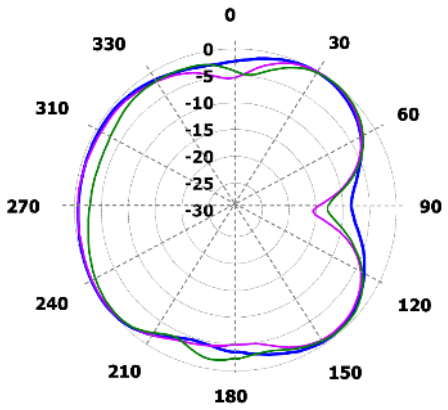
3.6. RADIATION PATTERNS (1710 – 2170 MHz), GAIN AND EFFICIENCY



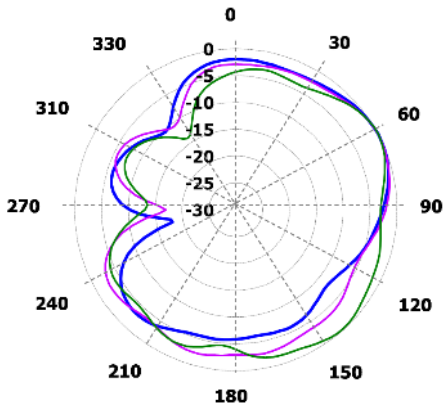
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 1710 MHz, 1940 MHz and 2170 MHz



ϕ = 0º Plane XZ at 1710 MHz, 1940 MHz and 2170 MHz



ϕ = 90º Plane YZ at 1710 MHz, 1940 MHz and 2170 MHz

Gain	**Peak Gain**	2.9 dBi
	Average Gain across the band	0.1 dBi
	Gain Range across the band (min, max)	-3.7 **<–>** 2.9 dBi
Efficiency	**Peak Efficiency**	79.2 %
	Average Efficiency across the band	72.8 %
	Efficiency Range across the band (min, max)	68.2 – 79.2 %

Table 3 – Antenna Gain and Total Efficiency from the Evaluation Board (Figure 1) within the 1710 – 2170 MHz frequency range. Measurements made in the Satimo STARGATE 32 anechoic chamber.

4. EVALUATION BOARD SMART METERING – RUN mXTEND™

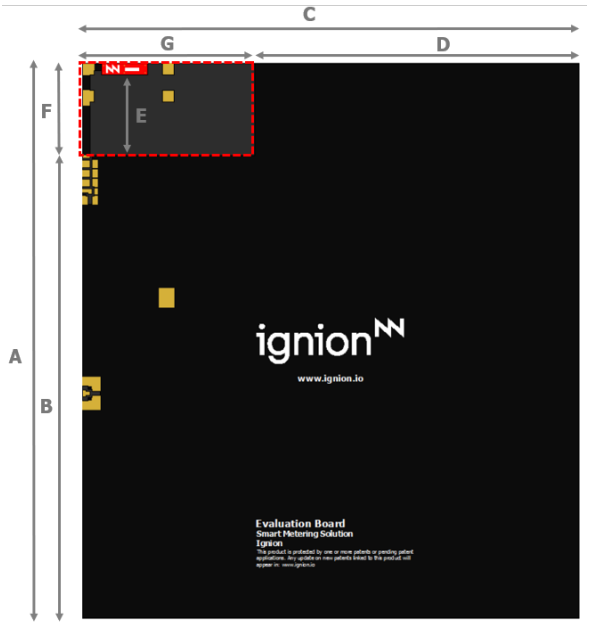
4.1. QUICK REFERENCE GUIDE

Technical features	824 – 960 MHz	1710 – 2170 MHz
Average Efficiency	> 70%	> 65%
Peak Gain	-5.7 dBi	-0.7 dBi
VSWR	< 3:1	
Radiation Pattern	Omnidirectional	
Polarization	Linear	
Weight (approx.)	0.19 g	
Temperature	-40 to +125 ºC	
Impedance	50 Ω	
Dimensions (L x W x H)	12.0 mm x 3.0 mm x 2.4 mm	

Table 4 – Technical Features. Measurements from the Evaluation Board. See Figure 4.

4.2. EVALUATION BOARD

This Evaluation Board EB_NN02-224-SM integrates a UFL cable to connect the RUN mXTEND™ antenna booster with the SMA connector. The RUN mXTEND™ provides operation in the frequency region which covers from 824 to 960 MHz and from 1710 to 2170 MHz, through a single input/output port.



Measure	mm
A	145.0
B	121.0
C	130.0
D	85.0
E	21.0
F	24.0
G	45.0

Tolerance: ±0.2 mm

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

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

Clearance Area: 24 mm x 45 mm (FxG)

Figure 4 – EB_NN02-224-SM. Evaluation Board providing operation from 824 to 960 MHz and from 1710 to 2170 MHz.

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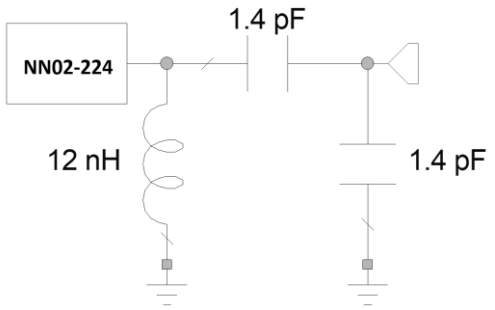
4.3. MATCHING NETWORK

The specs of a Ignion standard product are measured in an Evaluation Board, where an ideal case is created. However, when incorporating into real designs, nearby components such as LCD's, batteries, covers and connectors may affect the antenna performance. For this reason, placing pads compatible with 0402 and 0603 SMD components for a matching network as close as possible to the feeding point is highly recommended. Create this matching network in the ground plane area rather than the clearance area – this will provide a degree of freedom for tuning the RUN mXTEND™ antenna booster once the design is finished, taking into account all elements of the system (batteries, displays, covers, etc.).

Please notice that different devices with different ground planes and different components nearby the RUN 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 help designing your matching network beyond this application note, contact support@ignion.io or run your device through Oxion™ at https://oxion.ai, Ignion's free-of-charge[2] AI-powered antenna integration platform, for a custom matching network and a complete design report in 24h. Ignion's engineering services: https://ignion.io/design-center/engineering-support/

824 – 960 MHz and 1710 – 2170 MHz



Value	Part Number
12 nH	LQW18AN12NG10
1.4 pF	GJM1555C1H1R4WB01
1.4 pF	GJM1555C1H1R4WB01

Figure 5 – Matching Network implemented in the evaluation board (Figure 4).

2 See terms and conditions for the free-of-charge Oxion™ service at: https://oxion.ai

4.4. VSWR AND TOTAL EFFICIENCY

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

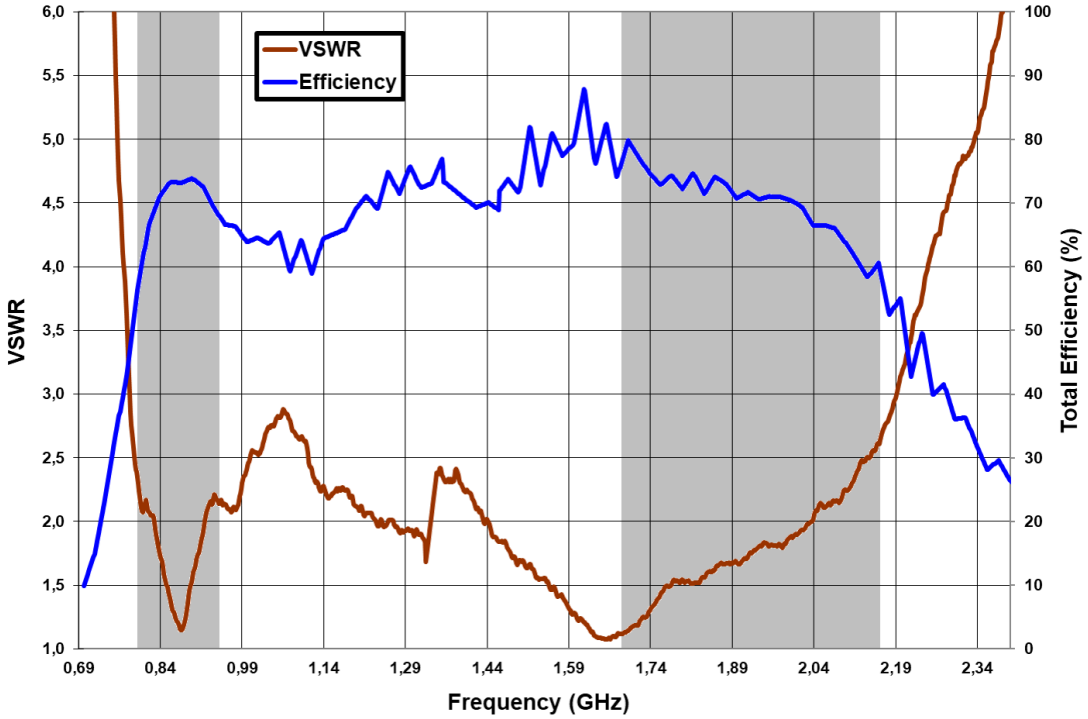
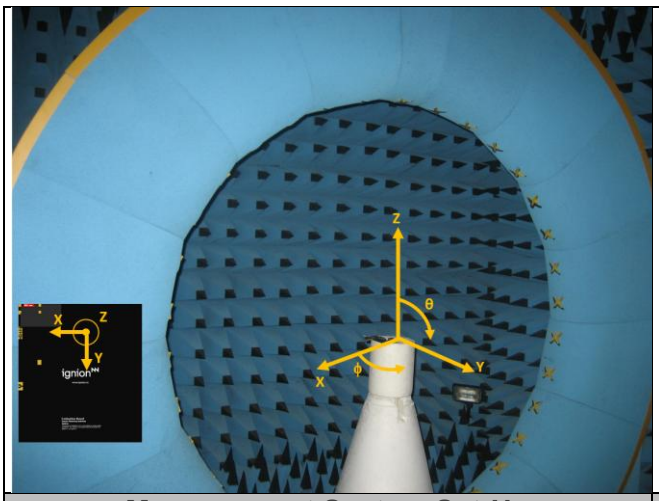
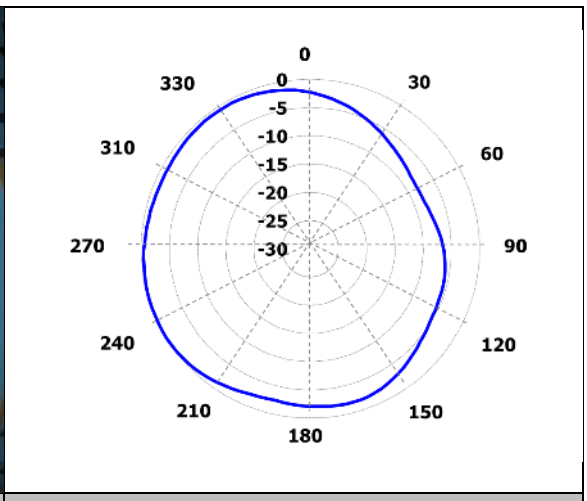


Figure 6 – VSWR and Total Efficiency for the 824 - 960 MHz and 1710 - 2170 MHz frequency range (from the Evaluation Board (Figure 4)).

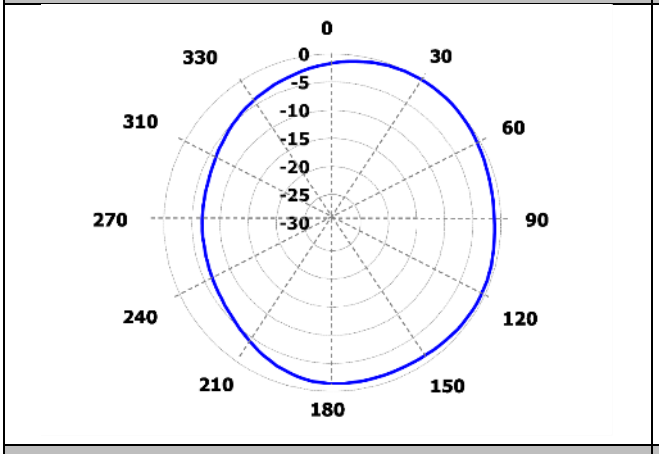
4.5. RADIATION PATTERNS (824 – 960 MHz), GAIN AND EFFICIENCY



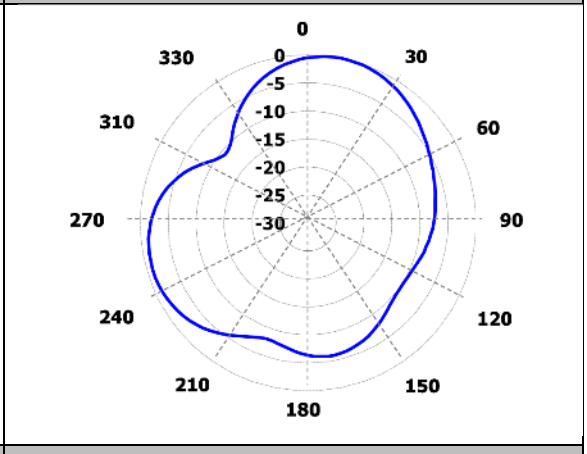
Measurement System Set-Up
Evaluation Board in Plane XY



θ = 90º Plane XY at **890 MHz**



ϕ = 0º Plane XY at **890 MHz**

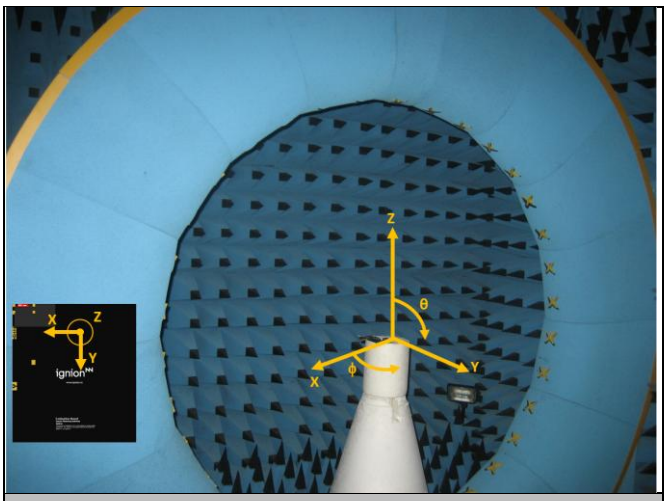


ϕ = 90º Plane YZ at **890 MHz**

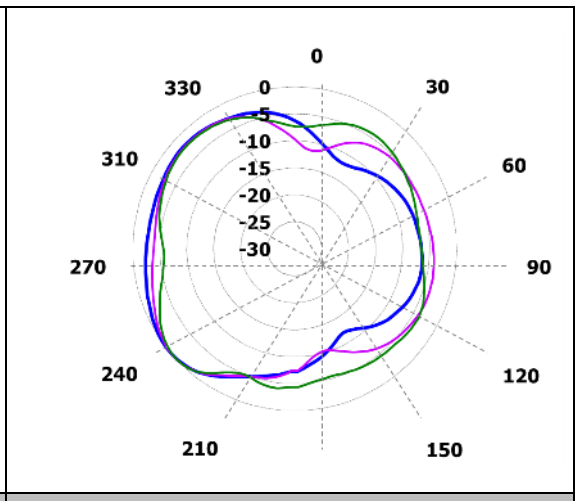
Gain	**Peak Gain**	2.8 dBi
	Average Gain across the band	-5.7 dBi
	Gain Range across the band (min, max)	-7.0 **<–>** 2.8 dBi
Efficiency	**Peak Efficiency**	73.8 %
	Average Efficiency across the band	71.5 %
	Efficiency Range across the band (min, max)	66.6 – 73.9 %

Table 5 – Antenna Gain and Total Efficiency from the Evaluation Board (Figure 1) within the 824 – 960 MHz frequency range. Measurements made in the Satimo STARGATE 32 anechoic chamber.

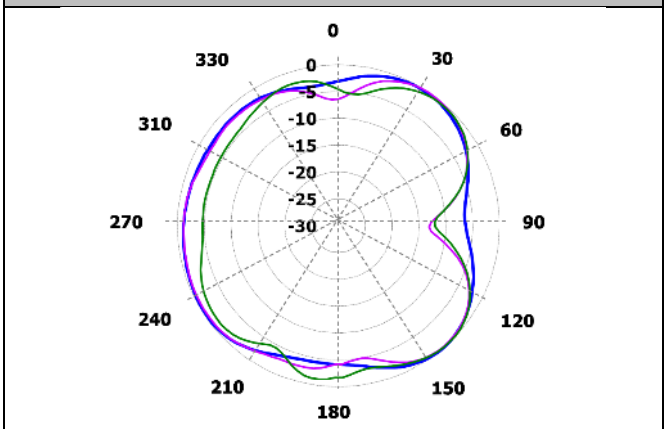
4.6. RADIATION PATTERNS (1710 – 2170 MHz), GAIN AND EFFICIENCY



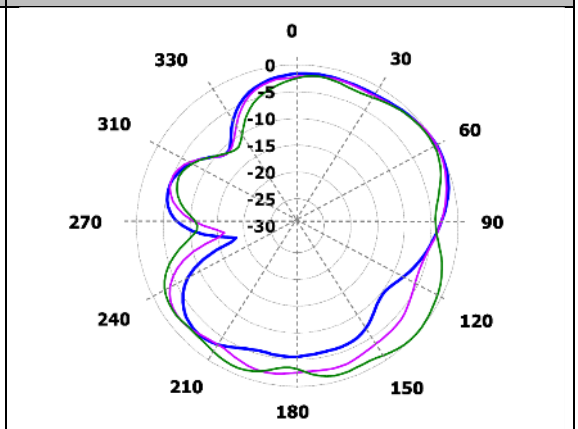
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 1710 MHz, 1940 MHz and 2170 MHz



ϕ = 0º Plane XZ at 1710 MHz, 1940 MHz and 2170 MHz



ϕ = 90º Plane YZ at 1710 MHz, 1940 MHz and 2170 MHz

Gain	**Peak Gain**	3.0 dBi
	Average Gain across the band	-0.7 dBi
	Gain Range across the band (min, max)	-4.5 **<–>** 3.0 dBi
Efficiency	**Peak Efficiency**	78.5 %
	Average Efficiency across the band	69.5 %
	Efficiency Range across the band (min, max)	54.7 – 78.5 %

Table 6 – Antenna Gain and Total Efficiency from the Evaluation Board (Figure 1) within the 1710 – 2170 MHz frequency range. Measurements made in the Satimo STARGATE 32 anechoic chamber.

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