ignion

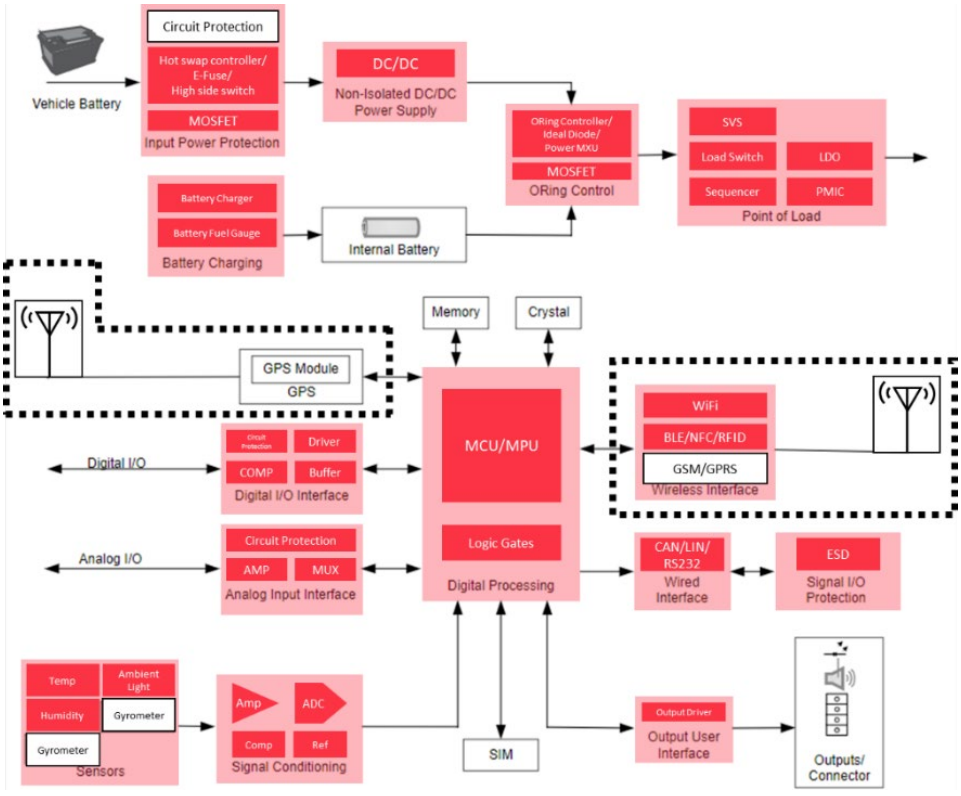
Your innovation.
Accelerated.

Cellular and GNSS for tracking in a single, small-scale antenna

APPLICATION NOTE
TRIO mXTEND™ (NN03-310)

ASSET TRACKING – Asset Tracker

Some of the most important challenges that manufacturers face when designing and prototyping an asset tracker, are performance, battery life, accuracy and so on.
Any asset tracking device's data transmission has to be completely reliable, therefore, the antenna is a critical component in such device.
First, chip antenna technology has been proven to deliver top GNSS (GPS, GLONASS, GALILEO, BeiDou…) performance in a variety of tracking devices and fleet management applications. Usually, a ceramic patch antenna is the option of choice for its traditional connection with satellite systems applications in terms of a good reception if the receiver is reasonably stable with respect to the GNSS satellite constellation and if the application has no relevant space and cost constrains. Nowadays, the range of different types of tracking devices is very large, and all of them have different sizes and requirements. These have to consider one important fact: they are located everywhere and not always stable and facing to the satellite reception. As modern smartphones proved that an omnidirectional, linearly polarized antenna can deliver an optimal GNSS performance for the vast majority of applications, such antenna to integrate into your tracking device will ensure the best GNSS signal regardless of the satellite location and/or the distance from the data receiver. At this point, with the endless diversity of new devices requiring versatile GNSS connection, Virtual Antenna™ components, being omnidirectional antennas, become the perfect choice where also, size, weight, portability, and cost are a priority.
Second, Virtual Antenna® technology allows for a single antenna to use multiple RF protocols with a single antenna component, letting your tracking device to broadcast a location via GPS while using Bluetooth or Cellular to receive or transmit data with an external device for configuration or managing purposes apart from location. This antenna versatility can be determining when deciding which is the best fit for your device, as you might have multiple solutions within only just one antenna component.
Furthermore, thanks to the use of the PCB for radiating, Virtual Antenna® technology allows for de-tuning to be easily solved by minor adjustments of the matching network, to adapt with the device's environment, such as close proximity to biological tissue, metal casings, concrete and so on. Also, the optimal use of the PCB to radiate the RF signal, ensures a top performance as the full size of the device is used as part of the antenna system. This will have an impact on how accurate and reliable a tracking device is.



Block Diagram: Asset Tracking – Asset Tracker

In the Block Diagram above, we see an example of an Asset Tracker 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 whole 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 essentially 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.

Battery system:
Whether if it's a rechargeable battery or a regular one, it's the main power unit for any Asset Tracker. All this system, engineered to manage the power transmission, is essential for the proper function of the device. For a sensor tag, the battery will be the factor that defines the life of the device (until recharging or changing the battery).
Chip antenna technology ensures a lower consumption than other types of antennas, such as an external one, bringing the overall device consumption to its lowest, which translates into longer battery life. Also, if the device doesn't have the right antenna, the transceiver will have to consume more power, reducing the battery life.

Antenna/s (wireless interface and GPS):
Any tracking device needs to have a reliable transmission of data to both satellites and gateways or other devices in other to do its function properly. That is why the antenna is one of the most important components within any tracking device. For an optimal antenna efficiency (and clearance area), the component's placement is crucial, therefore, its implementation within the device's design has to be in an early stage.
Furthermore, when tracking assets globally or through different types of networks and frequency bands, Virtual Antenna® technology will enable for a single antenna to be used, making the overall tracking device smaller, slimmer, and simpler.

In summary, when designing an Asset Tracking Device, you should consider, at an early stage, the best performance and size antenna needed for your device. This will ensure its optimal clearance area as well as placement within the PCB, along with the avoidance of any potential future connectivity, efficiency, de-tuning and/or interferences issues. By choosing Virtual Antenna® technology as your antenna solution, thanks to its high RF efficiency and adaptability, you will ensure best performance in your Asset Tracking 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 of the TRIO mXTEND™ (NN03-310), our top performing multiband, multiport antenna, working in cellular and GNSS.

TRIO mXTEND™: MOBILE AND GNSS IN THE SAME PACKAGE AT THE SAME TIME

- **Antenna Component:** TRIO mXTEND™ NN03-310
- **Dimensions :** 30.0 mm x 3.0 mm x 1.0 mm
- **Frequency regions:** 824-960 MHz, 1710-2170 MHz, 1561 MHz, 1575 MHz & 1598-1606 MHz

The trend these days is that any wireless project offers connectivity at multiple communication standards, therefore more than one antenna should be used. We care about the usual **lack of space** and the **double cost** of integrating two different antennas into one device. Accordingly, the result is the challenge of reducing two antennas into one: **TRIO mXTEND™**, the antenna component that **enables GNSS and Mobile connectivity simultaneously through a single antenna package.**

Forget about having too many antenna choices, just select TRIO mXTEND™. This chip antenna is an off-the-shelf piece, no customization is needed and even better, it works in multiple frequency regions at the same time thanks to its **modular**, **multiband** and **multi-port** configuration.

The double functionality of this chip antenna component will save time, cost and could accelerate time to market to all those applications requiring this dual relation, as for example fleet management, automotive or IoT, the new generation of “connected things”.

TRIO mXTEND™, the newest member of the Virtual Antenna® (antenna less) family, is presented in an **ultra slim, off the shelf component of only 1.0 mm height** and could be easily assembled into virtually any mobile or IoT device.

TABLE OF CONTENTS

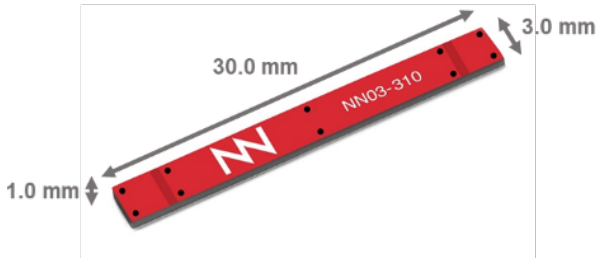
1. PRODUCT DESCRIPTION NN03-310

The TRIO mXTEND™ chip antenna component has been specifically designed for providing the major level of flexibility to operate at any required frequency band inside any wireless device and enables the antenna to work in different frequency bands at the same time.

TRIO mXTEND™ chip antenna component covers among many others, the frequency bands used for operating at the Global Navigation Satellite Systems, GPS, Galileo, GLONASS and BeiDou while it covers worldwide 2G, 3G and 4G.

It offers the flexibility to be tuned at the frequency regions of interest through the proper adjustment of the matching network. This feature provides an important benefit since removes the need of including different antenna parts inside the same wireless device for operating different communication standards, thus reducing considerably the integration complexity while saving costs. The results gathered herein presents how the matching network should be configured for operating the main mobile communication standards of 2G, 3G, 4G and GNSS bands.

TOP



BOTTOM

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

APPLICATIONS

- Handsets
- Smartphones
- Tablets
- Tracking systems
- Navigation Devices
- Smart Meters (Gas, Electricity, Water...)
- Digital Cameras
- Wearables
- Sensors (Parking, Speed control, Optics…)
- IoT Devices
- GPS/GLONASS/BeiDou Modules

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)

2. EVALUATION BOARD (824-960MHz, 1710-2170MHz and 1561MHz, 1575MHz, and 1598-1606MHz)

2.1. QUICK REFERENCE GUIDE

Technical features	824 – 960 MHz	1710 – 2170 MHz
Average Efficiency	> 55 %	> 60 %
Peak Gain	1.9 dBi	1.9 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)	30.0 mm x 3.0 mm x 1.0 mm	

Table 1 – Technical features for the 2G/3G/4G bands. Measures from the Evaluation Board port #1. See Figure 1. Note that for obtaining comparable results, a ground plane length larger than 100 mm is recommended.

Technical features	1561 MHz	1575 MHz	1598 – 1606 MHz
Average Efficiency	> 40 %	> 40 %	> 40 %
Peak Gain	0.5 dBi	0.8 dBi	1.5 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)	30.0 mm x 3.0 mm x 1.0 mm		

Table 2 – Technical Features for the GNSS bands (BeiDou, GPS, Galileo, and GLONASS). Measures from the Evaluation Board port #2. See **Figure** 1.

2.2. EVALUATION BOARD (824-960 MHz, 1710-2170 MHz and 1561 MHz, 1575 MHZ, and 1598-1606 MHz)

This Evaluation Board (part number: EB_NN03-310-M-GNSS) integrates one TRIO mXTEND™ chip antenna component to provide operation from 824 to 960 MHz, 1710 to 2170 MHz through port #1, and 1561 MHz, 1575 MHz, and 1598 to 1606 MHz through port #2. Two UFL cable connects each input/output port to SMA connectors.

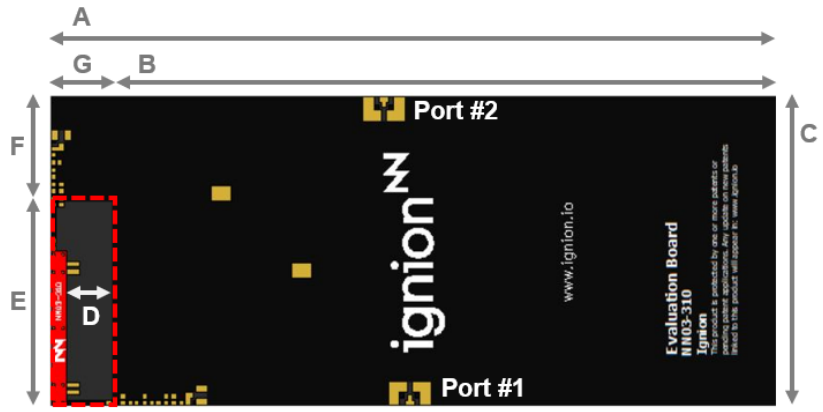


Figure 1 – EB_NN03-310-M-GNSS. Evaluation Board for providing operation at 824 – 960MHz, 1710 – 2170MHz (port #1), and 1561MHz, 1575MHz, and 1598 – 1606MHz (port #2).

Measure	mm
A	142
B	130
C	60
D	9
E	40
F	20
G	12

Tolerance: ±0.2 mm

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

D: Distance between the TRIO mXTEND™ chip antenna component and the ground plane.

Clearance Area: 40 mm x 12 mm (ExG)

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

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 TRIO mXTEND™ chip antenna component once the design is finished and considering all elements of the system (batteries, displays, covers, etc.).

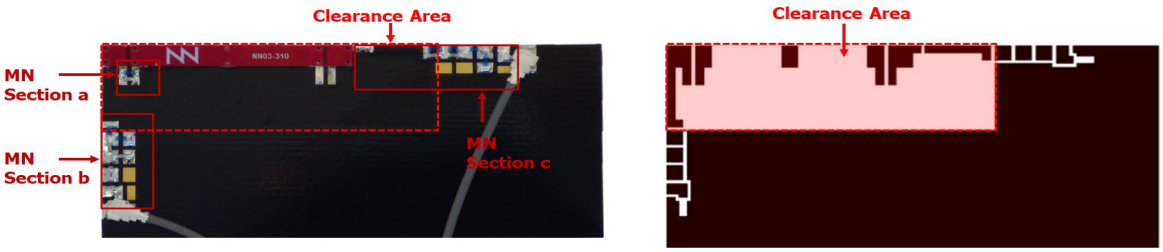


Figure 2 – Matching network distribution

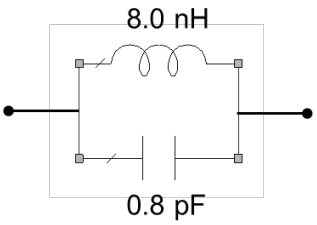
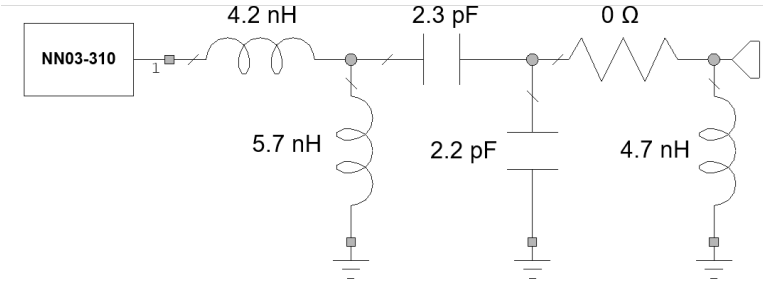
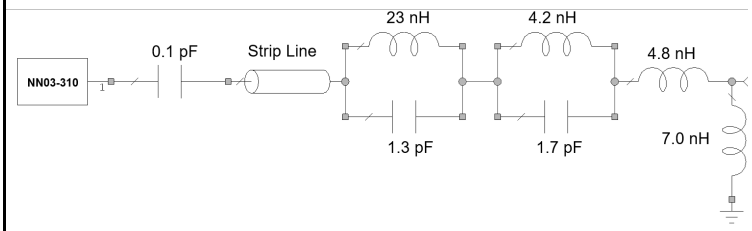
824 MHz – 960 MHz and 1710 MHz – 2170 MHz			
MN Section a		**Value**	**Part Number**
		8.0 nH	LQW15AN8N0G80
		0.8 pF	GJM1555C1HR80WB01
MN Section b		**Value**	**Part Number**
		4.2 nH	LQW15AN4N2G80
		5.7 nH	LQW15AN5N7B80
		2.3 pF	GJM1555C1H2R3WB01
		2.2 pF	GJM1555C1H2R2WB01
		0 Ω	
		4.7 nH	LQW15AN4N7G80

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

1561MHz, 1575 MHz and 1598MHz – 1606MHz

MN Section c



Value	Part Number
0.1 pF	GJM1555C1HR10WB01
23 nH	LQW18AN23NG80
1.3 pF	GJM1555C1H1R3WB01
4.2 nH	LQW15AN4N2G80
1.7 pF	GJM1555C1H1R7WB01
4.8 nH	LQW15AN4N8G80
7.0 nH	LQW15AN7N0G80

Figure 4 – Matching network implemented in the Evaluation Board port #2 (Figure 1).

Please notice that different devices with different ground planes and different components nearby the TRIO 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 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 NN's range of R&D services is available at: https://ignion.io/rdservices/

[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).

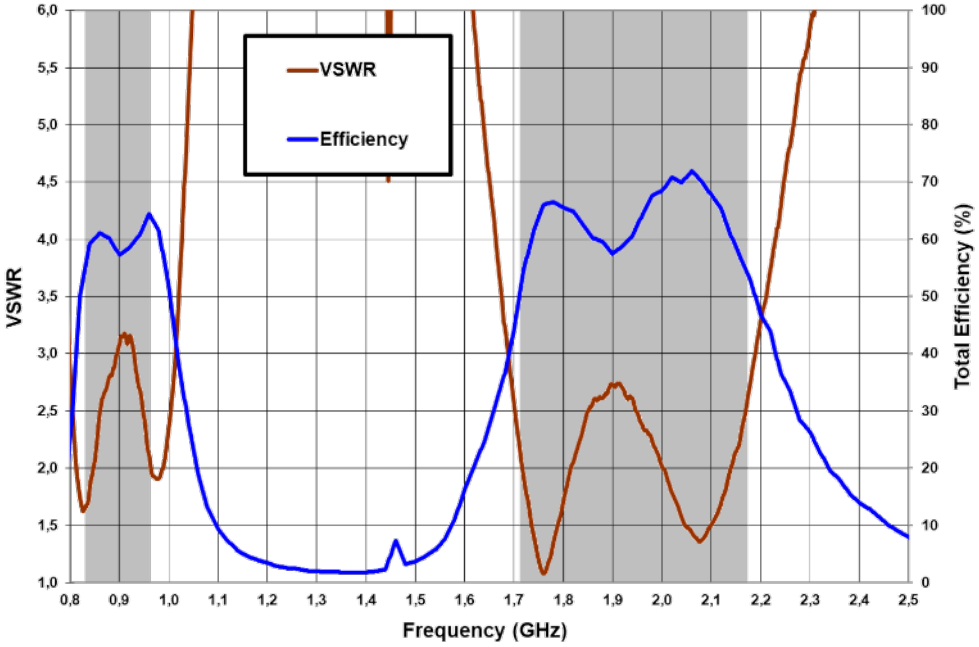


Figure 4 – VSWR and Total Efficiency for the 824 – 960 MHz frequency range and for the 1710 – 2170 MHz frequency range (from the Evaluation Board, port #1) (Figure 1).

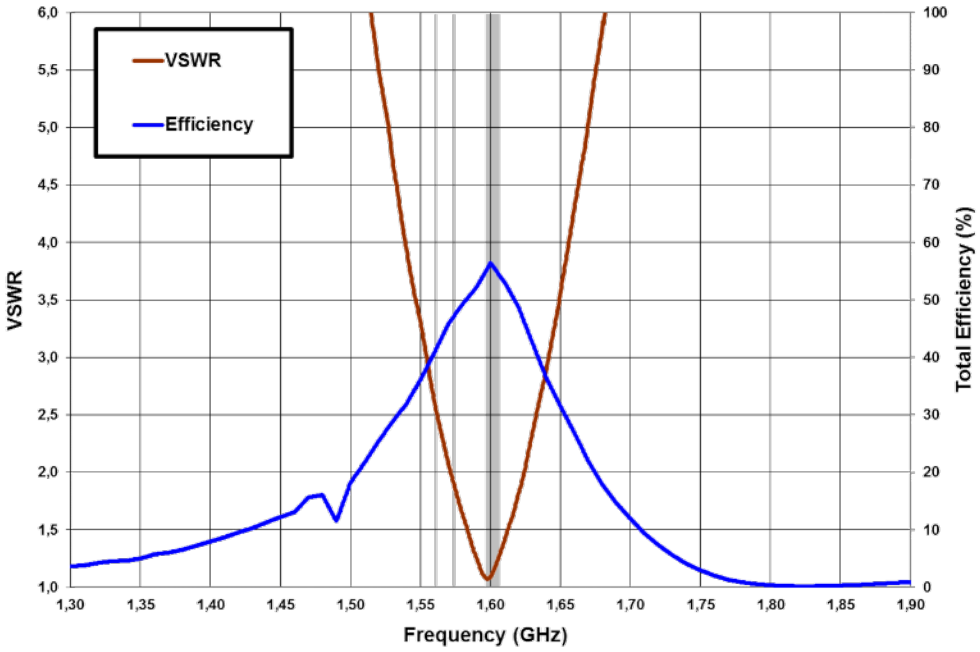


Figure 5 – VSWR and Total Efficiency for BeiDou E1 band (1561 MHz), GPS L1 band, Galileo E1 (1575 MHz), and GLONASS L1 band (1598 – 1606 MHz) (from the Evaluation Board, port #2) (Figure 1)

2.5. TRANSMISSION COEFFICENT

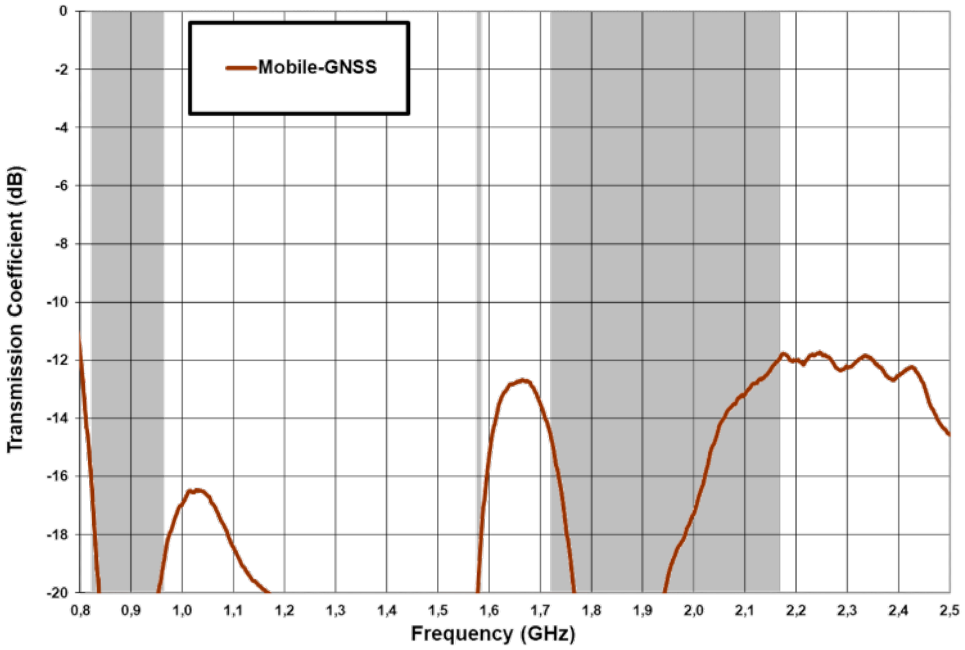
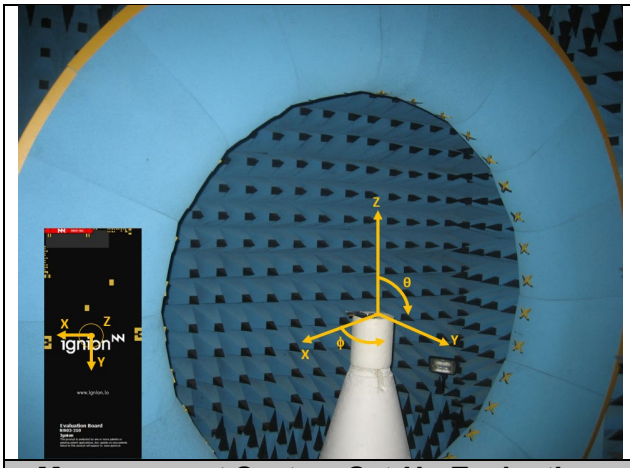
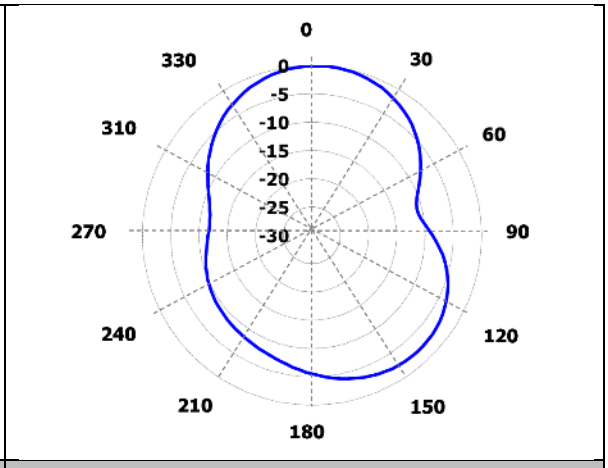


Figure 6 – Transmission coefficient between port #1 (824 – 960 MHz and 1710 – 2170 MHz) and port #2 (1561 – 1606 MHz) from the Evaluation Board (Figure 1)

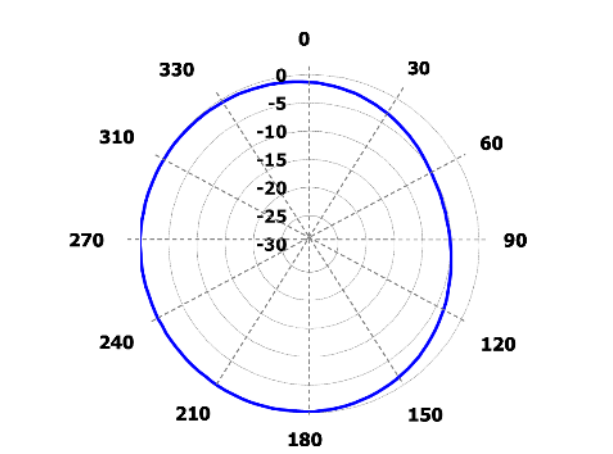
2.6. RADIATION PATTERNS (824 – 960 MHz), GAIN AND EFFICIENCY



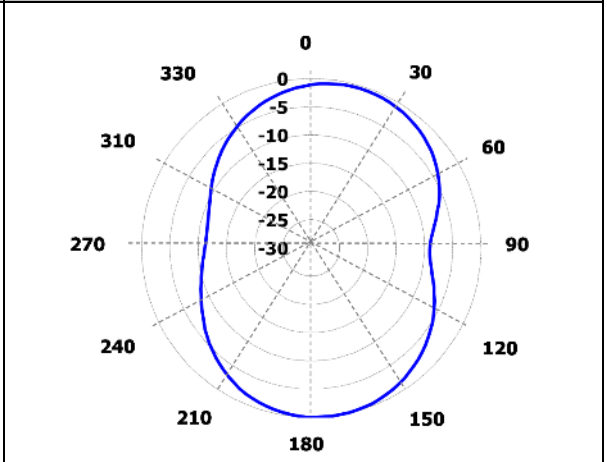
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 890 MHz



ϕ = 0º Plane XZ at 890 MHz

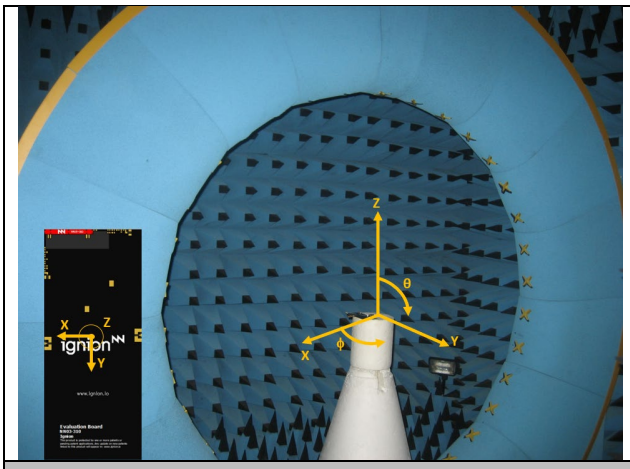


ϕ = 90º Plane YZ at 890 MHz

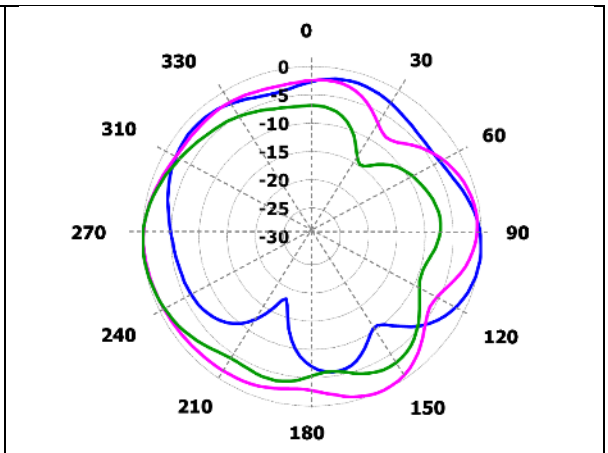
Gain	**Peak Gain**	1.9 dBi
	Average Gain across the band	1.1 dBi
	Gain Range across the band (min, max)	0.2 **<–>** 1.9 dBi
Efficiency	**Peak Efficiency**	64.5 %
	Average Efficiency across the band	59.4 %
	Efficiency Range across the band (min, max)	52.2 – 64.5 %

Table 3 - Antenna Gain and Total Efficiency from the Evaluation Board port #1 (Figure 1) within the 824 – 960 MHz frequency range. Measures made in the Satimo STARGATE 32 anechoic chamber.

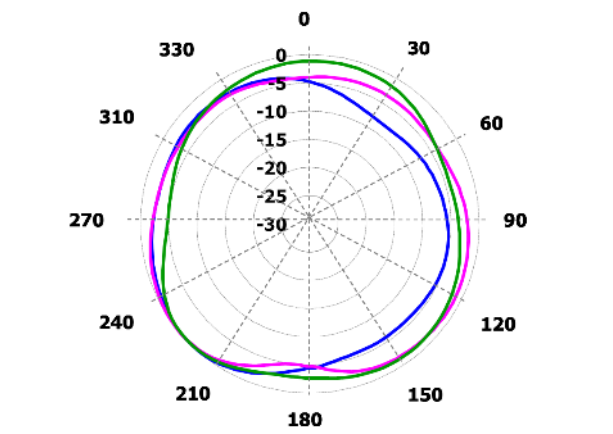
2.7. RADIATION PATTERNS (1710 – 2170 MHz), GAIN AND EFFICIENCY



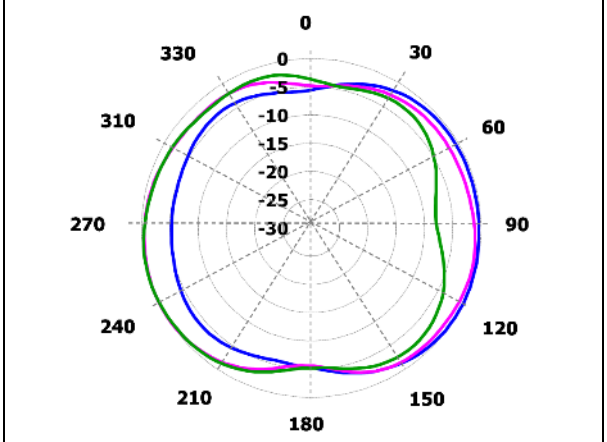
Measurement System Set-Up Evaluation Board in Plane XY



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



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

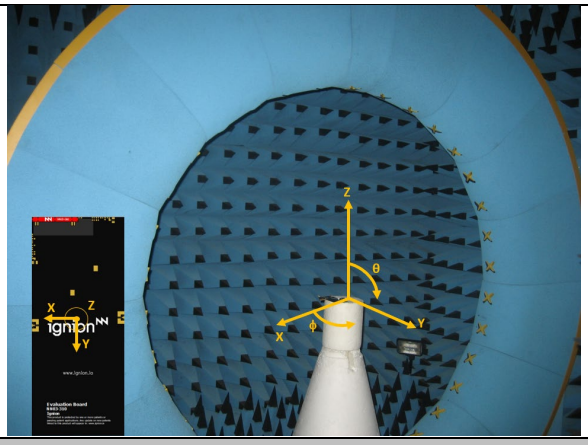


ϕ = 90º Plane YZ at 1710 MHz, 1940 MHz and 2170 MHz

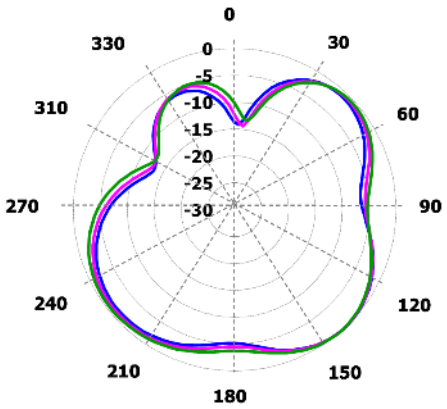
Gain	**Peak Gain**	1.9 dBi
	Average Gain across the band	0.9 dBi
	Gain Range across the band (min, max)	-0.2 **<–>** 1.9 dBi
Efficiency	**Peak Efficiency**	71.9 %
	Average Efficiency across the band	63.9 %
	Efficiency Range across the band (min, max)	49.7 – 71.9 %

Table 4 - Antenna Gain and Total Efficiency from the Evaluation Board port #1 (Figure 1) within the 1710 – 2170 MHz frequency range. Measures made in the Satimo STARGATE 32 anechoic chamber.

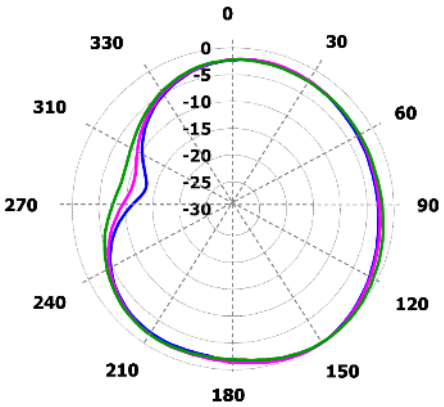
2.8. RADIATION PATTERNS (1561 MHz, 1575 MHz, 1598 - 1606 MHz), GAIN AND EFFICIENCY



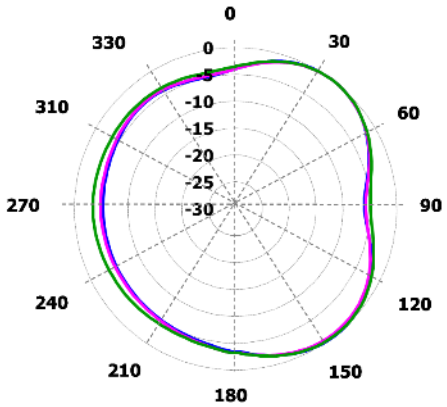
Measurement System Set-Up Evaluation Board in Plane XY



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



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



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

BeiDou	**Gain**	0.5 dBi	
	Efficiency	41.4%	
GPS Galileo	**Gain**	0.8 dBi	
	Efficiency	47.6 %	
GLONASS	**Gain**	**Peak Gain**	1.5 dBi
		Average Gain across the band	1.2 dBi
		Gain Range across the band (min, max)	0.8 <–> 1.5 dBi
	Efficiency	**Peak Efficiency**	56.4 %
		Average Efficiency across the band	55.5 %
		Efficiency Range across the band (min, max)	54.4 – 56.4 %

Table 5 - Antenna Gain and Total Efficiency from the evaluation board port #2 (Figure 1) for BeiDou E1 (1561 MHz), GPS L1, Galileo E1 (1575 MHz), and GLONASS L1 (1598 – 1606 MHz) bands. Measures made in the Satimo STARGATE 32 anechoic chamber.

2.9. RECOMMENDED FOOTPRINT FOR THE SOLUTION

Assuming that the TRIO mXTEND™ chip antenna component NN03-310 is placed in the clearance area of the PCB, see below the recommended footprint dimensions, to provide operation from 824 to 960 MHz, 1710 to 2170 MHz through port #1, and 1561 MHz, 1575 MHz, and 1598 to 1606 MHz through port #2

Measure	mm
A	12.0
B	23.0
C	3.0
D	0.5
E	1.0
F	8.5
G	2.0
H	2.5
I	10.0
J	7.0

Tolerance:
±0.05mm

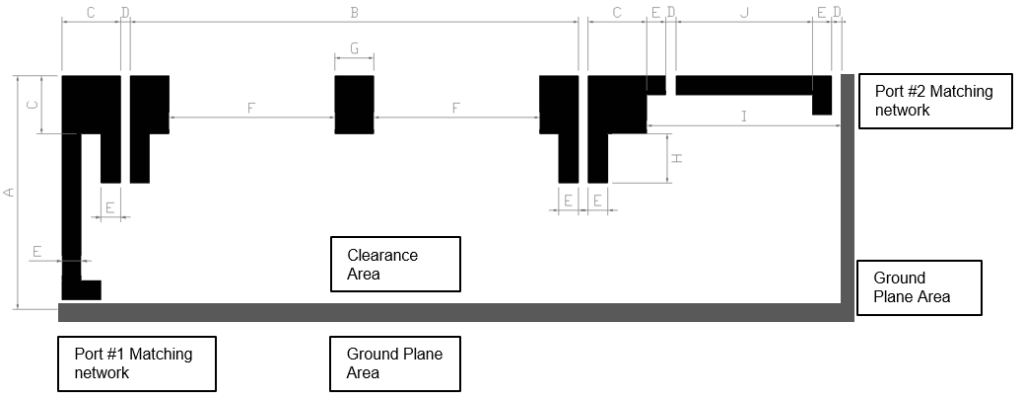


Figure 7 – Footprint dimensions for the single chip antenna component.

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

The TRIO mXTEND™ chip antenna component 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.

The TRIO mXTEND® chip antenna component and other Ignion products based on its proprietary Virtual Antenna™ technology are protected by one or more of the following Ignion patents.

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

Ignion products are protected by Ignion patents.

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

ISO 9001: 2015 Certified

ignion

Your innovation.
Accelerated.

Contact:
support@ignion.io
+34 935 660 710

Barcelona

Av. Alcalde Barnils, 64-68 Modul C, 3a pl.
Sant Cugat del Vallés
08174 Barcelona
Spain

Shanghai

Shanghai Bund Centre
18/F Bund Centre, 222 Yan'an Road East,
Huangpu District
Shanghai, 200002
China

New Dehli

New Delhi, Red Fort Capital Parsvnath Towers
Bhai Veer Singh Marg, Gole Market,
New Delhi, 110001
India

Tampa

8875 Hidden River Parkway
Suite 300
Tampa, FL 33637
USA