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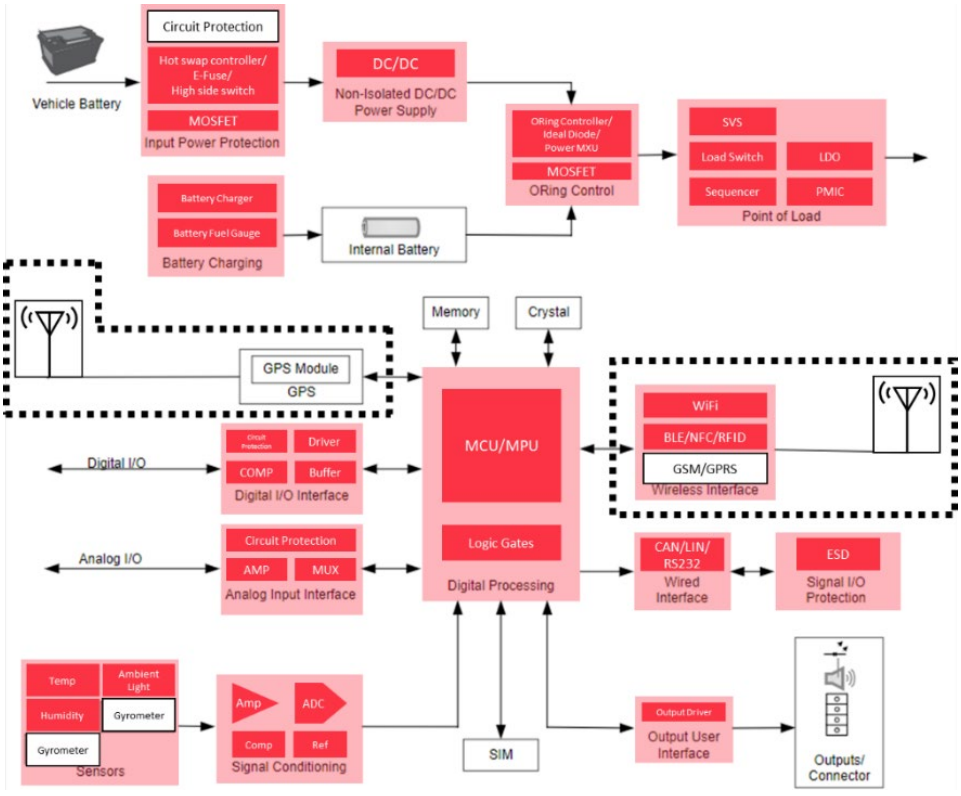
GPS, GLONASS and BeiDou in a single asset tracking antenna

APPLICATION NOTE
RUN mXTEND™ (NN02-224)

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 RUN mXTEND™ (NN02-224), our top performing antenna in asset tracking. This report will be based on GPS, GLONASS and BeiDou standards.

Navigate globally with RUN mXTEND™

- **Antenna Component:** RUN mXTEND™ NN02-224
- **Dimensions :** 12.0 mm x 3.0 mm x 2.4 mm
- **Frequency regions:** 1561 MHz, 1575 MHz, and 1598 MHz to 1606 MHz

With more than **80% of efficiency**, the new **RUN mXTEND™** chip antenna component covers the frequency ranges used for operating at the global navigation systems: **GPS**, **GLONASS** and **BeiDou**.

This new reference design illustrates a full satellite navigation performance, tested in two different evaluation board sizes, that allows location signal usability anywhere in the world.

The **miniature size** (12.0mm x 3.0mm x 2.4 mm) and the **high level of flexibility** of the standard component makes this solution one of the best options for any application to be developed where global navigation systems are involved. The RUN mXTEND™ provides operation in three frequency regions: **1561 MHz** (BeiDou E1 band), **1575 MHz** (GPS L1 band) and from **1598 MHz to 1606 MHz** (GLONASS L1 band).

The RUN 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.

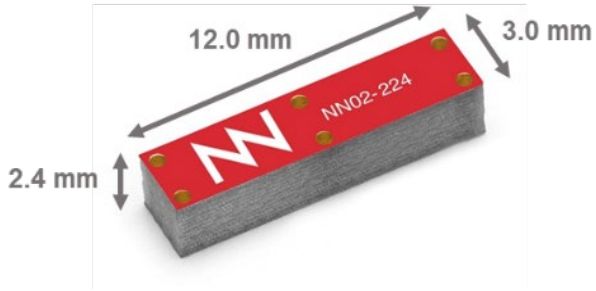
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement Nº 674491

TABLE OF CONTENTS

1. PRODUCT DESCRIPTION NN02-224

The RUN mXTEND™ antenna booster has been specifically designed for providing multiband performance in wireless devices enabling worldwide coverage. It is a multipurpose antenna solution capable of being adapted, with a high level of flexibility, to the antenna designer needs. 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. In particular, this application note illustrates how to use it for operating the global navigation systems: GPS, GLONASS and BeiDou.

TOP



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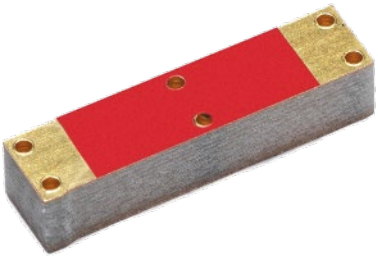


Material: The RUN mXTEND™ antenna booster is built on glass epoxy substrate.

APPLICATIONS

- GPS/GLONASS/BeiDou modules
- Navigators
- Track systems
- Handsets and Smartphones
- Tablets
- Digital Cameras
- Smart Watches

BENEFITS

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

The RUN 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 BOARD GPS/GLONASS/BeiDou

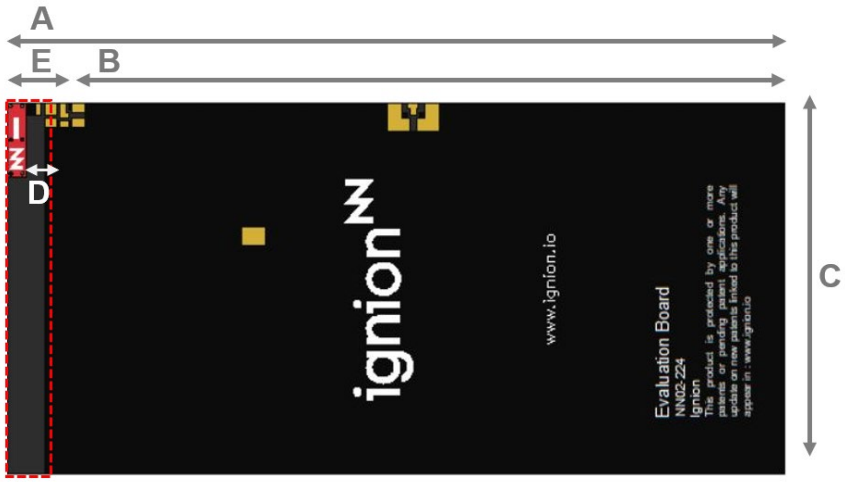
2.1. QUICK REFERENCE GUIDE

Technical features	1561 MHz	1575 MHz	1598 – 1606 MHz
Average Efficiency	> 75 %		> 80 %
Peak Gain	2.9 dBi	3.0 dBi	3.3 dBi
VSWR	< 1.5:1		
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 1 – Technical Features. Measures from the Evaluation Board. See Figure 1.

2.2. EVALUATION BOARD

This Evaluation Board EB_NN02-224-1561-1606 integrates a UFL cable to connect the RUN mXTEND™ antenna booster with the SMA connector. The RUN mXTEND™ provides operation in three frequency regions, 1561MHz (BeiDou E1 band), 1575 MHz (GPS L1 band) and from 1598 MHz to 1606 MHz (GLONASS L1 band), through a single input/output port.



Measure	mm
A	126.5
B	120
C	60
D	2.5
E	6.5

Tolerance: ±0.2 mm

D: 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: 6.5 mm x 60 mm (E x C)

Figure 1 – EB_NN02-224-1561-1606. Evaluation Board providing operation at BeiDou E1 band (1561 MHz), GPS L1 band (1575 MHz) and for GLONASS L1 band (from 1598 MHz to 1606 MHz).

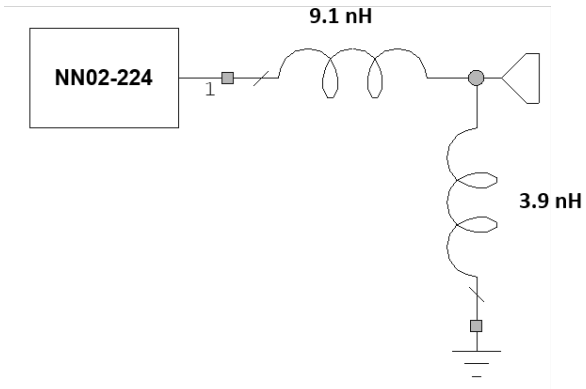
This product and its use are protected by at least one or more of the following patents PAT. US 9,130,259 B2; PAT. US 8,237,615 B2. Other domestic and international patents pending. Additional information about patents related to this product is available at www.ignion.io/virtual-antenna/.

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 RUN mXTEND™ antenna booster once the design is finished and 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). Please, if you need assistance contact support@ignion.io for more information related to the antenna booster matching service.

1561 MHz, 1575 MHz and 1598 – 1606 MHz



Value	Part Number
9.1 nH	LQW18AN9N1G80
3.9 nH	LQW15AN3N9B80

Figure 2 – Matching Network implemented in the evaluation board (Figure 1).

For additional information, please visit www.ignion.io or contact info@ignion.io.

If you need assistance to design your matching network, 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/

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2.4. VSWR AND TOTAL EFFICIENCY

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

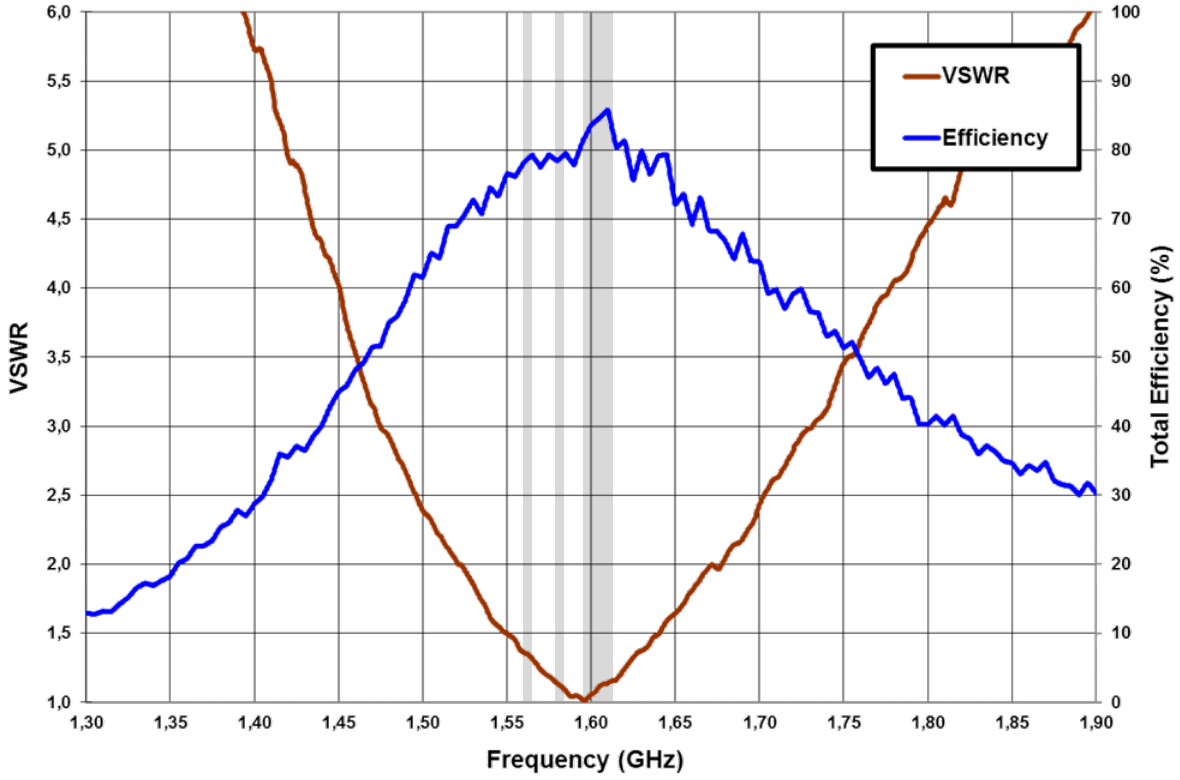
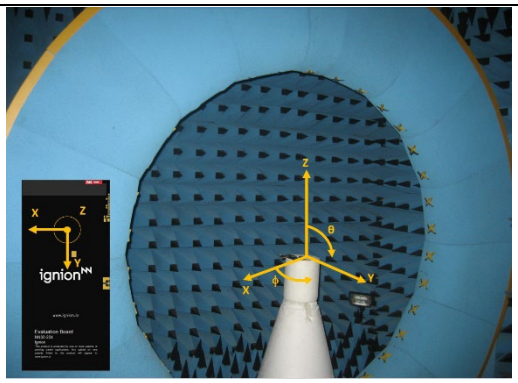
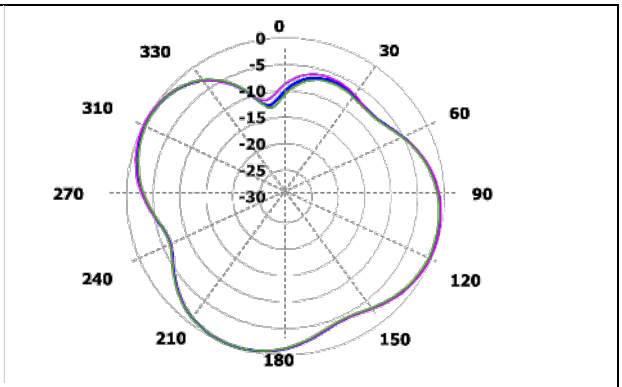


Figure 3 – VSWR and Total Efficiency for BeiDou E1 band (1561 MHz), GPS L1 band (1575 MHz) and GLONASS L1 band (1598 – 1606 MHz) (from the evaluation board (Figure 1)).

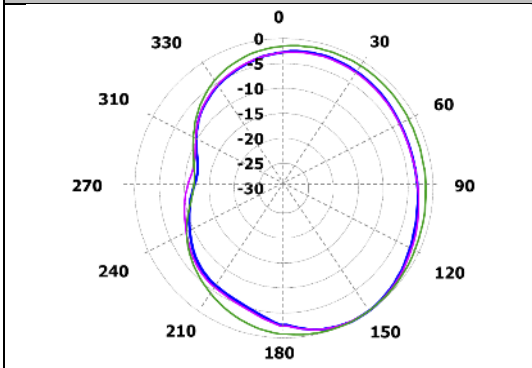
2.5. RADIATION PATTERNS (1561, 1575 and 1598-1606 MHz), GAIN AND EFFICIENCY



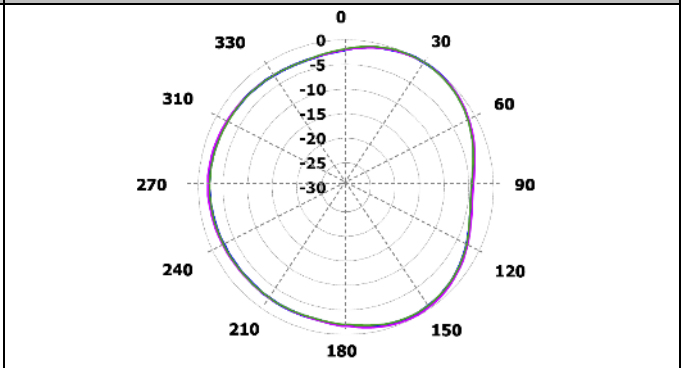
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 1.561 GHz, 1.575 GHz and 1.602 GHz



ϕ = 0º Plane XZ at 1.561 GHz, 1.575 GHz and 1.602 GHz



ϕ = 90º Plane YZ at 1.561 GHz, 1.575 GHz and 1.602 GHz

BeiDou	**Gain**		2.9 dBi
	Efficiency		78.4%
GPS	**Gain**		3.0 dBi
	Efficiency		79.3 %
GLONASS	**Gain**	**Peak Gain**	3.3 dBi
		Average Gain across the band	3.2 dBi
		Gain Range across the band (min, max)	3.1 **<–>** 3.3 dBi
	Efficiency	**Peak Efficiency**	84.9 %
		Average Efficiency across the band	83.8 %
		Efficiency Range across the band (min, max)	82.7 – 84.9 %

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

3. EVALUATION BOARD CR80 GPS/GLONASS/BeiDou

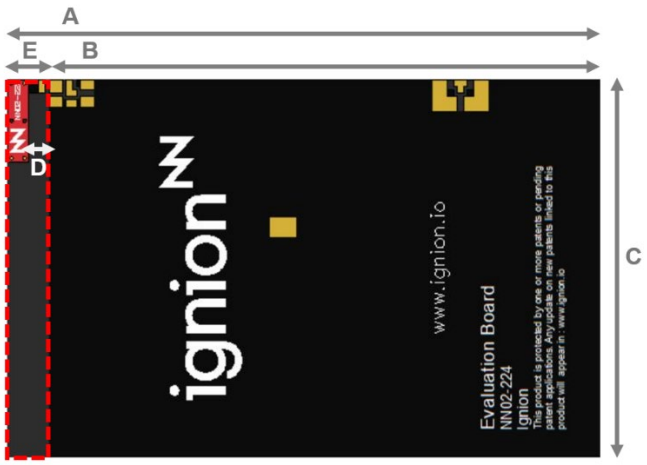
3.1. QUICK REFERENCE GUIDE

Technical features	1561 MHz	1575 MHz	1598 – 1606 MHz
Average Efficiency	> 80 %		> 85 %
Peak Gain	3.1 dBi	3.3 dBi	3.6 dBi
VSWR	< 1.5:1		
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 3 – Technical Features. Measures from the Evaluation Board. See Figure 4.

3.2. EVALUATION BOARD

This Evaluation Board EB_NN02-224-CR80-1561-1606 integrates a UFL cable to connect the RUN mXTEND™ antenna booster with the SMA connector. The RUN mXTEND™ provides operation in three frequency regions, 1561 MHz (BeiDou E1 band), 1575 MHz (GPS L1 band) and from 1598 MHz to 1606 MHz (GLONASS L1 band), through a single input/output port.



Measure	mm
A	86
B	79.5
C	54
D	2.5
E	6.5

Tolerance: ±0.2 mm

D: 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: 6.5 mm x 54 mm (E x C)

Figure 4 – EB_NN02-224-CR80-1561-1606 in CR80 standard format. Evaluation Board providing operation for BeiDou E1 band (1561 MHz), GPS L1 band (1575 MHz) and for GLONASS L1 band (from 1598 MHz to 1606 MHz).

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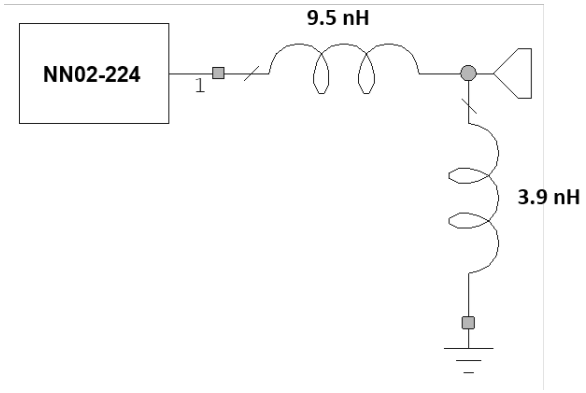
1561 MHz, 1575 MHz and 1598 – 1606 MHz



Value	Part Number
9.5 nH	LQW18AN9N5G80
3.9 nH	LQW15AN3N9B80

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

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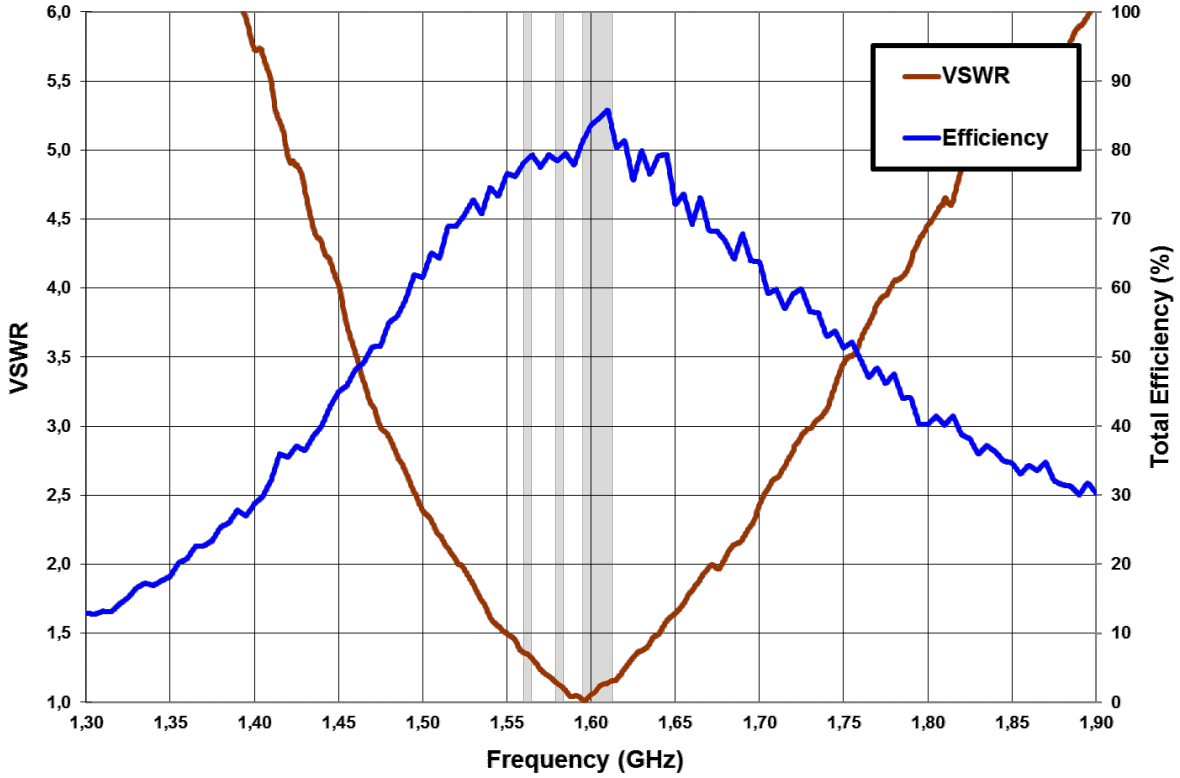
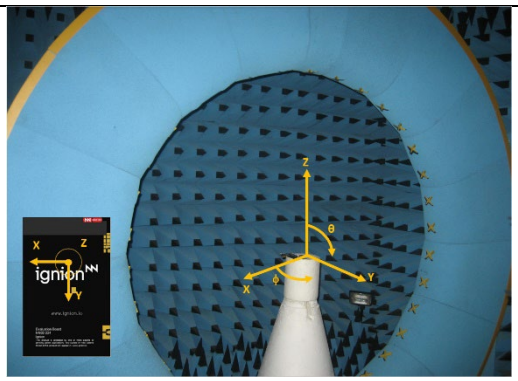


Figure 6 – VSWR and Total Efficiency for BeiDou E1 (1561 MHz), GPS L1 band (1575 MHz) and GLONASS L1 band (1598 – 1606 MHz) (from the evaluation board (Figure 4)).

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



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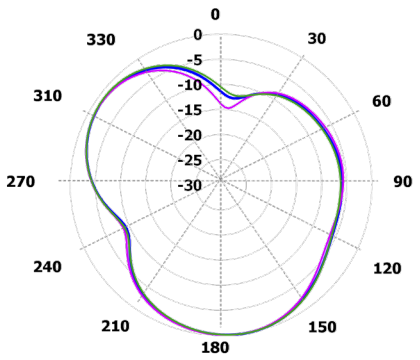
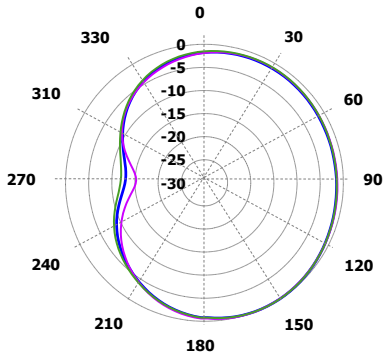
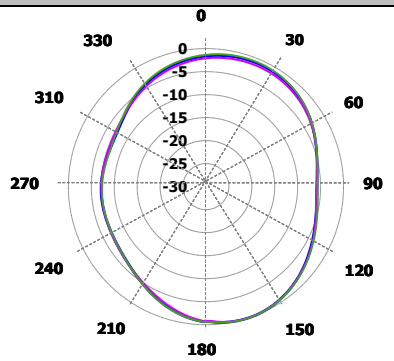


θ = 90º Plane XY at 1.561 GHz, 1.575 GHz and 1.602 GHz



ϕ = 0º Plane XZ at 1.561 GHz, 1.575 GHz and 1.602 GHz



ϕ = 90º Plane YZ at 1.561 GHz, 1.575 GHz and 1.602 GHz

BeiDou		**Gain**	3.1 dBi
		Efficiency	84.7 %
GPS		**Gain**	3.3 dBi
		Efficiency	84.9 %
GLONASS	**Gain**	**Peak Gain**	3.6 dBi
		Average Gain across the band	3.5 dBi
		Gain Range across the band (min, max)	3.4 **<–>** 3.6 dBi
	Efficiency	**Peak Efficiency**	88.7 %
		Average Efficiency across the band	87.6 %
		Efficiency Range across the band (min, max)	86.4 – 88.7 %

Table 4 – Antenna Gain and Total Efficiency from the evaluation board (Figure 4) for BeiDou E1 (1561 MHz), GPS L1 (1575 MHz) and GLONASS L1 (1598 – 1606 MHz) bands. Measures made in the Satimo STARGATE 32 anechoic chamber.

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