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The most integrated antenna for any asset tracking design

APPLICATION NOTE
RUN mXTEND[™] (NN02-224)

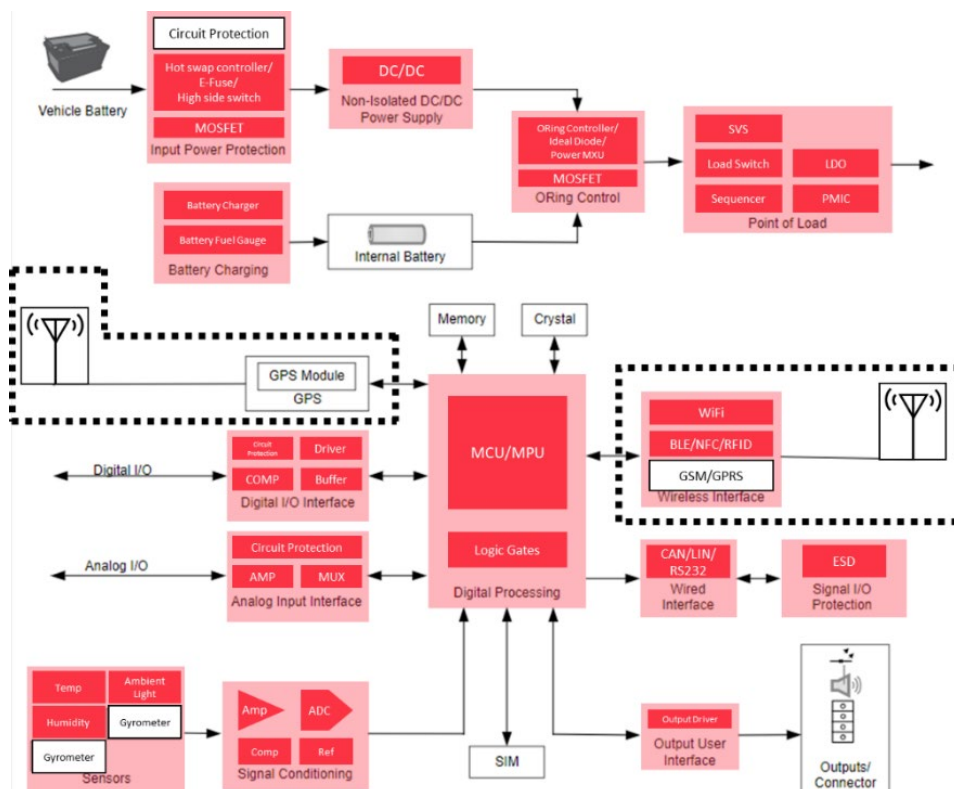
ASSET TRACKING – Asset Tracker

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 and 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 order 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™, one of our most versatile and best performing antennas. It is an antenna widely used for various IoT applications, with very good results in Asset Tracking.

RUN mXTEND[™] – Same antenna, any IoT platform

- **Product:** RUN mXTEND[™] NN02-224
- **Dimensions :** 12.0 mm x 3.0 mm x 2.4 mm
- **Frequency regions:** 863 - 928 MHz



We know you need your IoT device connecting everything as soon as possible. Our team has developed the RUN mXTEND[™] chip antenna component to enable a **quick development time of your wireless system**, reducing cost, design time and engineering effort.

The RUN mXTEND[™] antenna booster, and its versatility, is one of the best options to **go wireless having any type of IoT platform**. This chip antenna booster enables a suitable antenna performance for each device, **does not matter the size of the ground plane**, the same component enables worldwide coverage at all the IoT related communication standards.

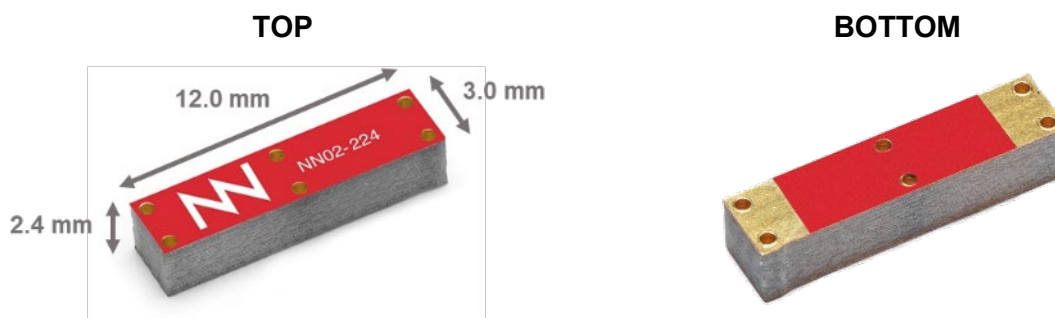
Find in this IoT application note how the same chip antenna component will fit your device regardless of the form factor and the size of the PCB board.

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1. PRODUCT DESCRIPTION NN02-224

The market for the Internet of Things continues to grow and the expanding diversity of IoT devices means product configurations are endless. For this application note we have tested the RUN mXTEND™ chip antenna component's (NN02-224) performance when mounted onto various sized ground planes. We show the impact of ground plane size on performance in order to provide the most relevant results for those who design IoT devices of various dimensions. Additionally, we illustrate how to use the RUN mXTEND™ chip antenna component for operating at the ISM bands, which are frequently used in IoT devices.



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

APPLICATIONS

- Smart Metering
- Smart City & Smart Building
- Industrial IoT
- Remote monitoring and control
- Sensors
- Personal & Asset Tracking
- Fleet management
- RFID
- Retail
- Security Systems
- Smart Home
- Medical

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 RUN mXTEND™ antenna booster (NN02-224) provides multiband performance in wireless devices throughout a large range of frequencies (698-960 MHz, 1710-2690 MHz and 3400-3800 MHz), enabling worldwide coverage and allowing operation in multiple IoT related communication standards such as NB-IoT, LoRa, Zigbee, Sigfox, Neul, Thread, Z-Wave, Weightless, all mobile GSM/UMTS/LTE bands for 2G, 3G, 4G, 5G, Bluetooth and WIFI. Based on Ignion's 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 – IoT devices are just one of the many environments where this tiny antenna can be transformational.

2. ONE ANTENNA, MANY DEVICES

2.1. PERFORMANCE IN DIFFERENT PCB SIZES

For demonstration purposes, the performance of the RUN mXTEND[™] chip antenna component is measured in different PCB boards within the 863-928 MHz frequency range as used in IoT standards such as NB-IoT, LoRa, Zigbee and Sigfox. Please notice that the RUN mXTEND[™] is able to cover a much wider range of frequencies and standards; if your IoT device is to operate in any other band within the 698MHz to 3800MHz range you are welcome to contact support@ignion.io for assistance.

Each PCB board in the following set-up integrates a UFL cable to connect the RUN mXTEND[™] antenna booster with a SMA connector so that VSWR and antenna efficiency can be tested. The following results cover a wide scope of ground plane sizes (length and width), ranging from 75mm x 54mm down to 40mm x 20mm.

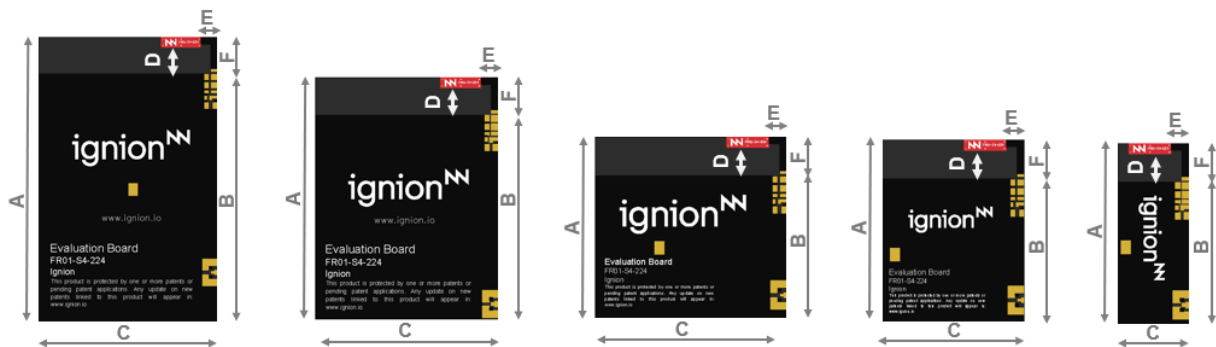


Figure 1 – Evaluation boards with different ground plane dimensions that provide operation from 863 MHz to 928 MHz.

Measure	mm
A	86 - 51
B	75 - 40
C	54 - 20
D	8.0
E	5.0
F	11.0

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: C x F mm

Tolerance: ±0.2 mm

2.2. VSWR AND EFFICIENCY

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

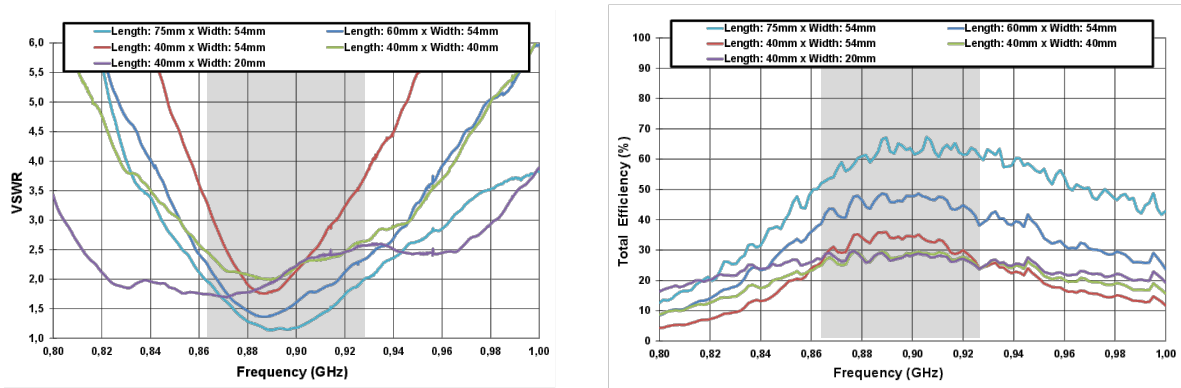


Figure 2 – VSWR and Total Efficiency for the 863 – 928 MHz frequency range (Figure 1).

Dimensions (B x C)	LFR (863 – 928 MHz)				
	η_a 863MHz	η_a 928MHz	Min	Max	Av. η_a
75 mm x 54 mm	50.8	59.7	50.8	67.3	61.2
60 mm x 54 mm	38.1	39.1	38.1	48.6	45.0
40 mm x 54 mm	25.3	24.4	23.9	35.9	31.7
40 mm x 40 mm	24.6	24.3	23.7	29.5	27.5
40 mm x 20 mm	27.1	24.5	23.7	29.7	27.4

Table 1 – Total efficiency (%) comparison considering the different dimensions.

2.3. MATCHING NETWORK

The matching network design and value components for each device and PCB size is provided here. While the antenna component and matching network design and topology remains the same, the value of the components will be adapted to every PCB size for an optimum performance. The specs of a Ignion standard product are measured in a reference evaluation board, to isolate the antenna performance from other system elements. 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. The matching network should be implemented in the ground plane area rather than the clearance area, this will provide a degree of freedom for tuning the RUN mXTEND[™] 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 RUN mXTEND[™] antenna component may require a fine tuning of the matching networks. To ensure optimal results, the use of high Q and tight tolerance components is highly recommended (Murata components).

If you need assistance, please contact support@ignion.io for more information related to our chip antenna component matching service.

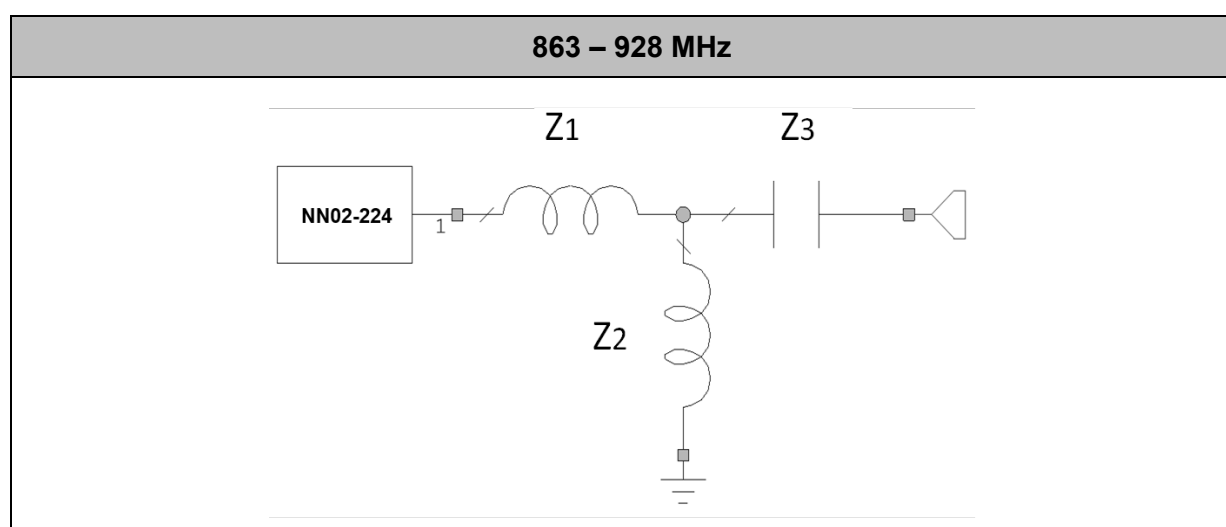


Figure 3 – Topology of matching network mounted for the different solutions.

Dimensions (B x C)	Z ₁	Z ₂	Z ₃
75 mm x 54 mm	24 nH	7.5 nH	1.8 pF
60 mm x 54 mm	25 nH	6.8 nH	1.8 pF
40 mm x 54 mm	25 nH	7.2 nH	1.5 pF
40 mm x 40 mm	27 nH	7.2 nH	2.1 pF
40 mm x 20 mm	27 nH	8.2 nH	2.0 pF

Table 2 – Values of the components for each different solution.

Value		Part Number
Z1	24 nH	LQW18AN24NG00
	25 nH	LQW18AN25NG80
	27 nH	LQW18AN27NG80
Z2	7.5 nH	LQW18AN7N5C80
	6.8 nH	LQW18AN6N8C10
	7.2 nH	LQW18AN7N2C80
	8.2 nH	LQW18AN8N2C80
Z3	1.8 pF	GJM1555C1H1R8WB01
	1.5 pF	GJM1555C1H1R5WB01
	2.1 pF	GJM1555C1H2R1WB01
	2.0 pF	GJM1555C1H2R0WB0

Table 3 – Values and part numbers of the components used for the matching networks for the cases with dimensions 75mm x 54mm, 60mm x 54mm, 40mm x 54mm, 40mm x 40mm, 40mm x 20mm.

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

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-charge¹ **Antenna Intelligence Cloud** design service (<https://ignion.io/antenna-intelligence/>), you will get your complete design report including a custom matching network for your device in 24h¹. 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/>

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

ISO 9001: 2015 Certified



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