ignion

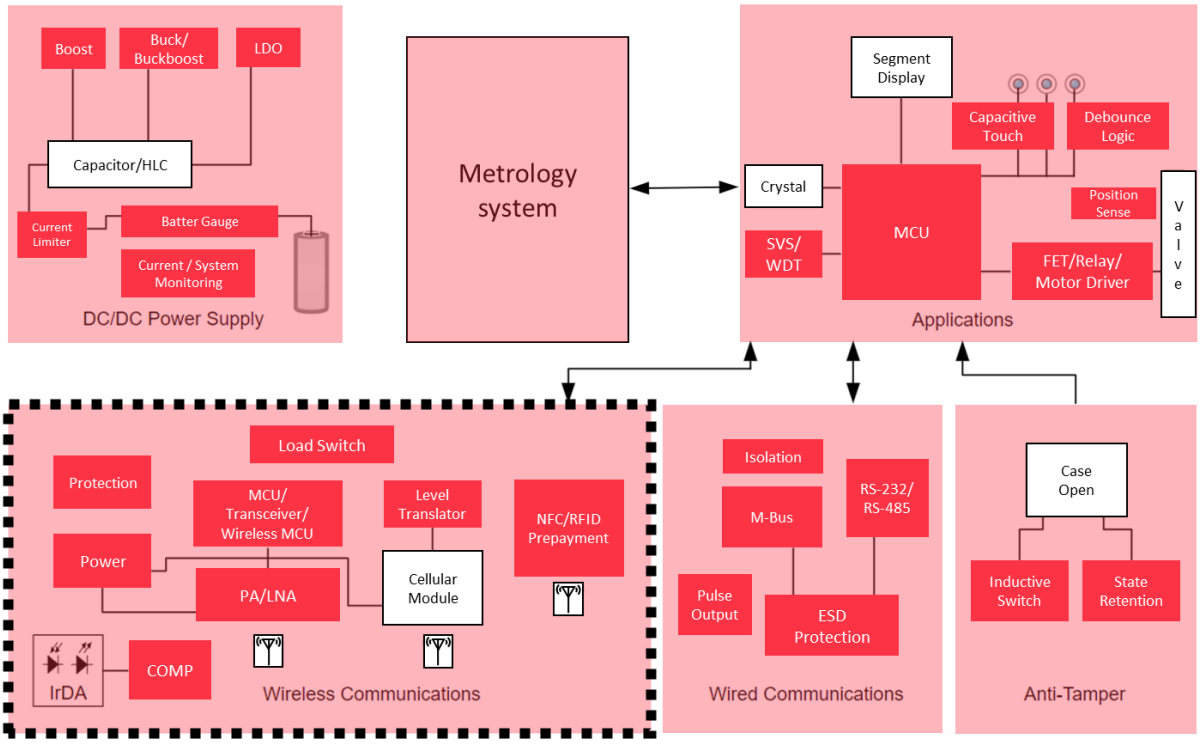
Your innovation.
Accelerated.

NB-IoT, LoRa, Zigbee or Sigfox in a single smart metering antenna

APPLICATION NOTE
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.

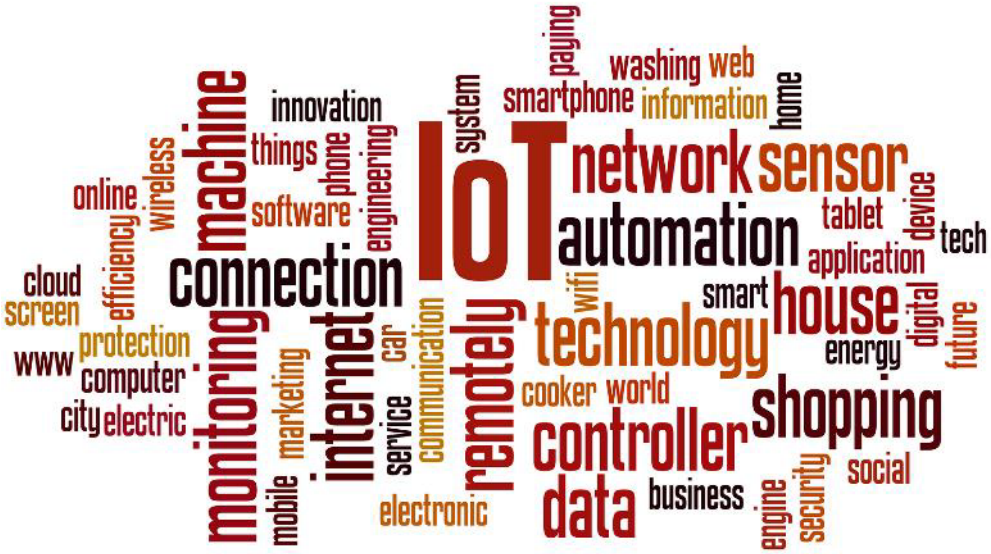
Antenna (Wireless Communications):
For optimal communication efficiency, the antenna's placement is crucial, therefore, its implementation within the device's design has to be in an early stage. That early implementation has to be done also because, usually, an antenna needs a clearance area in the PCB.
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), our top performing multiband antenna for Smart Metering on multiple IoT communication protocols.

RUN mXTEND™ –The antenna for IoT: NB-IoT, LoRa, Zigbee or Sigfox

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



Do you need an antenna for **NB-IoT**? Use the RUN mXTEND™. Do you need an antenna for **LoRa**? Use the RUN mXTEND™. Do you need an antenna for **Sigfox**? Use the RUN mXTEND™. Doubts about the selection of a **licensed or unlicensed IoT standard**? The RUN mXTEND™ will be the choice anyway.

Forget antenna size, antenna shape, antenna placement, even antenna frequency! Choosing the right antenna for your IoT applications will never be a challenge anymore, the antenna leaves the role of critical component and assumes one where the antenna becomes an **off-the-shelf** chip component **able to be tuned as needed**.

Our team has developed the RUN mXTEND™ antenna booster that enables worldwide full performance and connectivity in all the frequency bands of operation for the Internet of Things. The RUN mXTEND™ antenna booster, and its versatility, is one of the best options to **go wireless** having any type of IoT platform because **one antenna covers the IoT frequency bands.** Using the mXTEND™ family you will be part of a new technology that will **save** you **cost, design time** and **risk.**

Find in this IoT application note how the same chip antenna component will operate at the frequency band you need in the **smallest package** ever.

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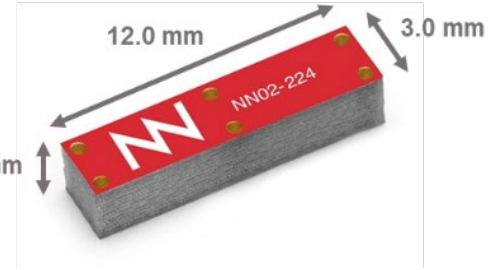
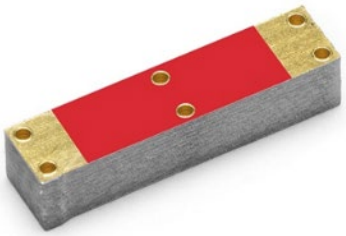
1. PRODUCT DESCRIPTION NN02-224

The market for the Internet of Things continues grow and the expanding diversity of IoT devices means product configurations are endless. For this application note we have tested the RUN mXTEND™ antenna booster´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™ antenna booster for operating at the ISM bands, which are frequently used in IoT devices.

TOP



BOTTOM



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' 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™ antenna booster component is measured in different PCB boards within the 863-928 MHz frequency range as used in IoT standards such as NB-IoT, LoRa, Zigbe 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.

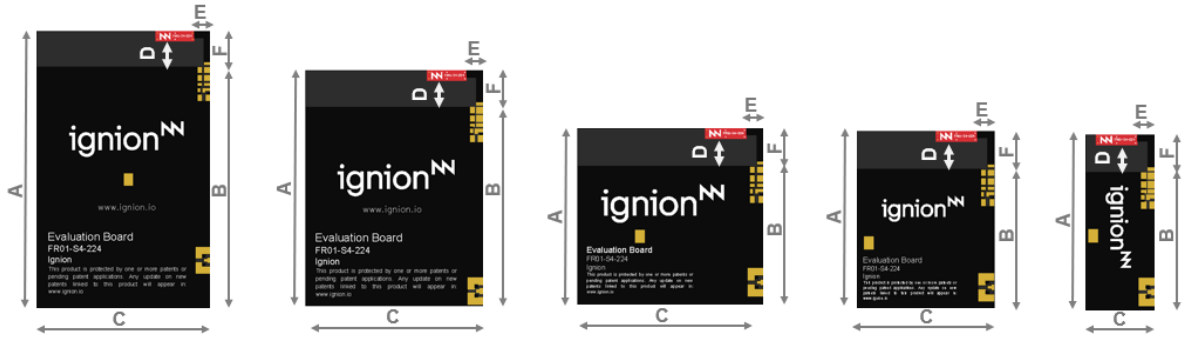


Figure 1 – Evaluation boards with different ground plane dimensions that provide operation from 863 MHz to 928 MHz.

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

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: C x F mm

2.2. VSWR AND EFFICIENCY

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

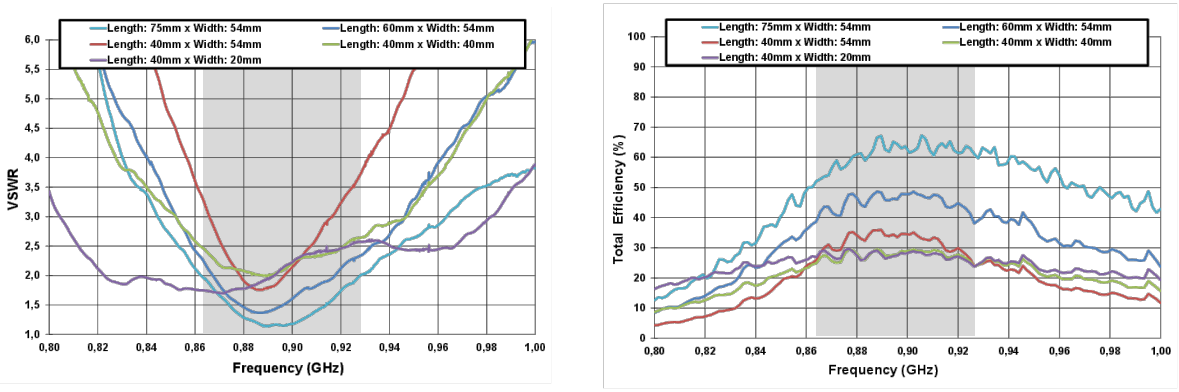


Figure 2 – VSWR and Total Efficiency for the 863 – 928 MHz frequency range (Figure 1).

	LFR (863 – 928MHz)				
Dimensions (B x C)	**$\eta_{a\ 863MHz}$**	**$\eta_{a\ 928MHz}$**	**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 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 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.

863 – 928 MHz

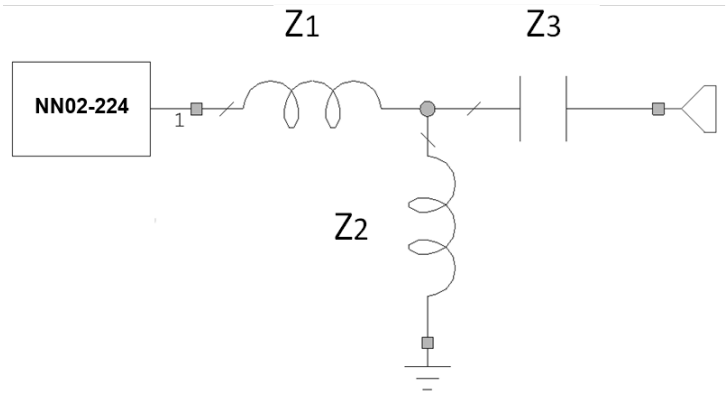


Figure 3 – Topology of matching network mounted for the different solutions.

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, 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/

[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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