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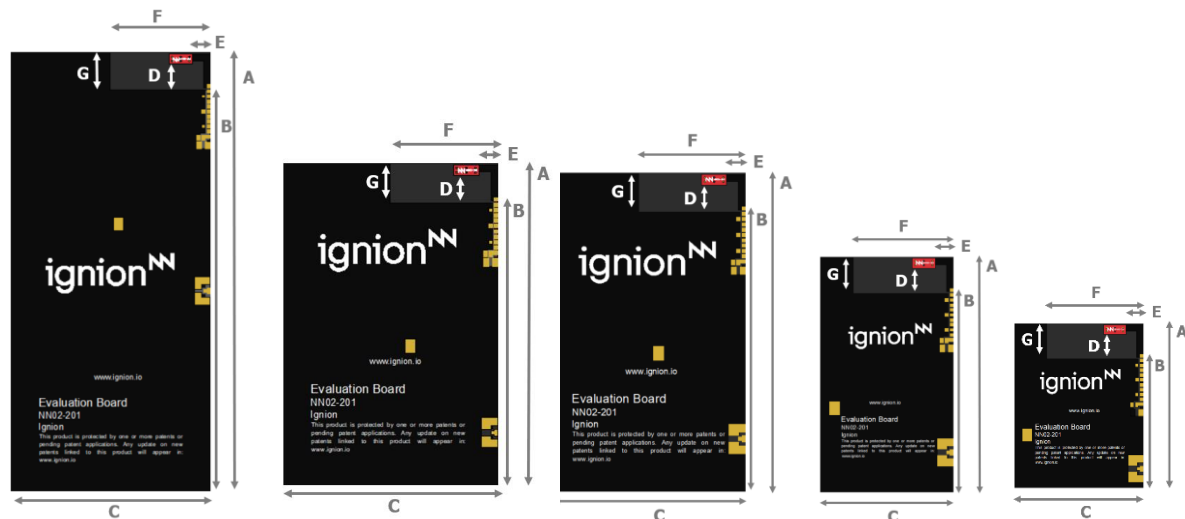
Your innovation.  
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# ONE mXTEND<sup>™</sup> : TINY ANTENNA THAT FITS IN ALL BOARDS

APPLICATION NOTE  
ONE mXTEND<sup>™</sup> (NN02-201)

## THE ONE mXTEND<sup>™</sup> TINY ANTENNA THAT FITS IN ALL BOARDS

- **Antenna Component:** ONE mXTEND<sup>™</sup> NN02-201
- **Dimensions:** 7.0 mm x 3.0 mm x 1.0 mm
- **Frequency regions:** 880-960 MHz, 1710-2170 MHz and 824-894 MHz, 1850-2170 MHz



**Use only one component  
regardless of the size and shape of your board**

A **unique component** can be used **for all the different board sizes**. Discover within this application note the performance of the ONE mXTEND<sup>™</sup> depending of different PCB boards.

Thanks to its miniature size, only 7.0 x 3.0 x 1.0 mm, this tiny antenna booster fits in about all the different platforms. With its tiny volume, **only 21mm<sup>3</sup>**, this **multiband** antenna enables **cellular IoT worldwide connectivity** in the smallest space ever.

Use this super slim booster at many different bands avoiding the usual problem with size restrictions. The same antenna can be used to cover selected frequency bands within the standards 2G, 3G, 4G and 5G all in one antenna package.

**Cellular IoT made simple: ONE mXTEND<sup>™</sup>.**

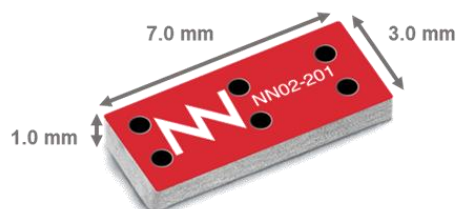
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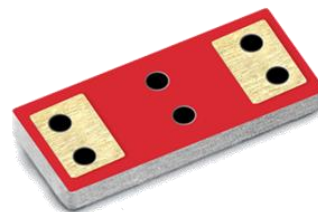
## 1. PRODUCT DESCRIPTION NN02-201

The IoT market is continuously growing and the set of IoT devices with many different requirements and form factors are endless. An antenna component capable of being easily adapted to all this configuration is presented herein. The ONE mXTEND<sup>™</sup> antenna booster has been specifically designed for providing multiband performance in wireless devices with small space requirements. It is a miniature antenna capable of being adapted, with a high level of flexibility, to the antenna designer needs. Featured by an extremely reduced package, the ONE mXTEND<sup>™</sup> is a versatile product capable of enabling 2G, 3G, 4G, and 5G coverage through the same single antenna package. This application note gathers the performance of the ONE mXTEND<sup>™</sup> antenna booster (NN02-201) when mounted onto various sized evaluation boards (EB). The configuration presented herein is tuned to provide operation in the 2G and 3G communication standards GSM850, GSM900, GSM1800/DCS, GSM1900/PCS and UMTS.

### TOP



### BOTTOM



**Material:** The ONE mXTEND<sup>™</sup> antenna booster is built on glass epoxy substrate.

### APPLICATIONS

- Asset Tracking
- Fleet Management
- Modules
- IoT
- Routers
- Handsets and smartphones
- Tablets and PCs
- Digital cameras
- Sensors
- Smartwatches and wearables

### BENEFITS

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

The ONE mXTEND<sup>™</sup> antenna booster belongs to a new generation of antenna solutions based on Virtual Antenna<sup>™</sup> technology owned by Ignion. This technology enables replacing conventional and custom antenna solutions by a new class of so-called antenna boosters, delivered in the form of a new range of miniature and off-the-shelf chip antenna components. These new chip antennas are by nature multiband and multipurpose, so they fit in a variety of wireless platforms to provide a wireless link at many different communication services. By using a Virtual Antenna<sup>™</sup> component the design becomes more predictable compared to a custom solution, making the whole process **faster, cheaper and easier**.

## 2. PERFORMANCE vs EVALUATION BOARD SIZE

### 2.1. EVALUATION BOARD

The performance of the ONE mXTEND™ antenna booster is measured in different EBs featured by different sizes. This application note is intended to illustrate on one hand, how the antenna performance varies according to the ground plane length of any printed circuit board (PCB), and on the other hand, how our ONE mXTEND™ antenna booster can be easily adapted to the different scenarios by simply adjusting the matching network components. The antenna part remains the same and the operating frequencies can be easily tuned through the matching network design. The following results cover a wide scope of EB sizes (length and width), ranging from 131mm x 60mm down to 51mm x 40mm (Figure 1).



| Measure | mm       |
|---------|----------|
| A       | 131 – 51 |
| B       | 120 – 40 |
| C       | 60 – 54  |
| D       | 8.0      |
| E       | 5.0      |
| F       | 30       |
| G       | 11       |

**Tolerance:** ±0.2 mm

**D:** Distance between the ONE mXTEND™ antenna booster and the ground plane.

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

**Clearance Area:** 30 mm x 11.0 mm (FxG)

**Figure 1** – Evaluation boards with different form factors and different EB sizes.

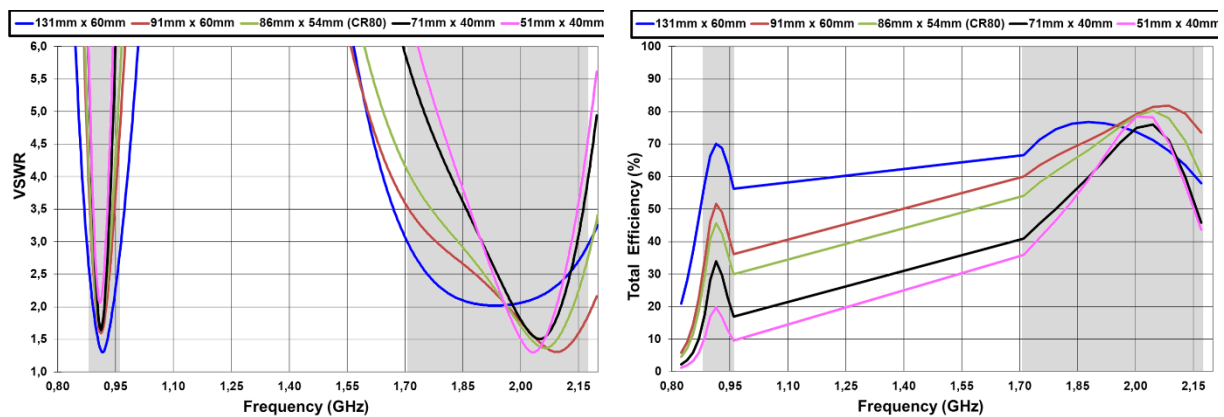
Please note that the ONE mXTEND™ is a versatile antenna solution able to cover other frequency ranges. If your IoT device is to operate in any other band, please contact to [support@ignion.io](mailto:support@ignion.io) for assistance.

## 2.2. VSWR AND EFFICIENCY

This section gathers the antenna performance in terms of VSWR (Voltage Standing Wave Ratio) and Total Efficiency results versus frequency (GHz) for the 2G, 3G communication standards used in Europe (EU) and USA.

### 2.2.1. 2G/3G EU BANDS

In this case, the matching network (Table 3) has been tuned to cover the European 2G and 3G communication standards in the frequency range of 880-960MHz and 1710-2170MHz.



**Figure 2** – VSWR and Total Efficiency for the 880 – 960 MHz frequency range and for the 1710 – 2170 MHz frequency range considering the different EB sizes (

Figure 1).

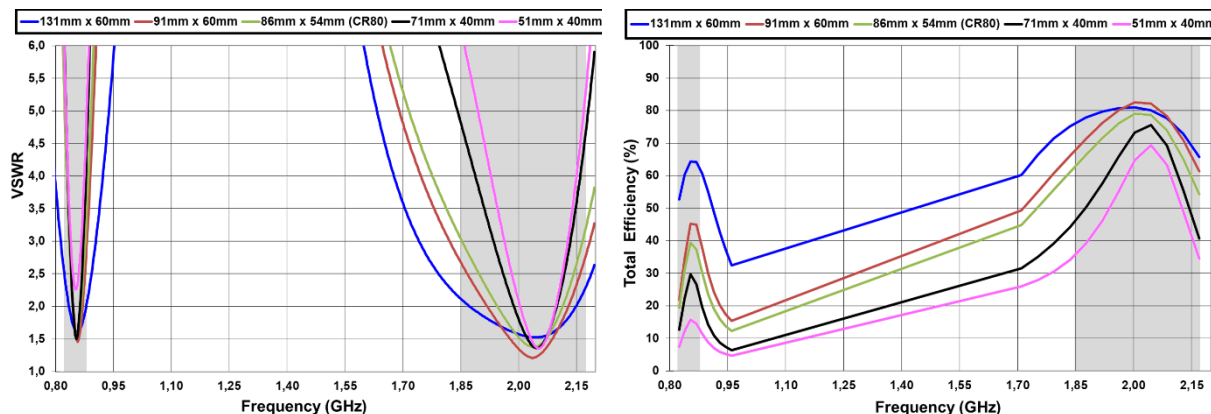
| A x C (mm)     | LFR (880 – 960MHz) |                 |      |      |              | HFR (1710 – 2170MHz) |                  |      |      |              |
|----------------|--------------------|-----------------|------|------|--------------|----------------------|------------------|------|------|--------------|
|                | $\eta_a$ 880MHz    | $\eta_a$ 960MHz | Min  | Max  | Av. $\eta_a$ | $\eta_a$ 1710MHz     | $\eta_a$ 2170MHz | Min  | Max  | Av. $\eta_a$ |
| 131 x 60       | 54.9               | 56.3            | 54.9 | 70.1 | 63.8         | 66.5                 | 57.9             | 57.9 | 76.7 | 71.0         |
| 91 x 60        | 30.9               | 36.1            | 30.9 | 51.3 | 43.3         | 60.0                 | 73.6             | 60.0 | 81.8 | 72.9         |
| 86 x 54 (CR80) | 26.4               | 29.9            | 26.4 | 45.6 | 37.4         | 54.1                 | 60.4             | 54.1 | 80.2 | 68.5         |
| 71 x 40        | 15.4               | 17.0            | 15.4 | 33.6 | 24.5         | 41.0                 | 45.9             | 41.0 | 75.9 | 59.6         |
| 51 x 40        | 9.1                | 9.7             | 9.1  | 19.6 | 14.2         | 36.0                 | 43.6             | 36.0 | 78.5 | 58.5         |

**Table 1** – Antenna efficiency comparison considering the different EB sizes (

Figure 1).

## 2.2.2. 2G/3G USA BANDS

In this case, the matching network has been tuned to cover the USA 2G and 3G communication standards in the frequency range of 824-894MHz and 1850-2170MHz.



**Figure 3** – VSWR and Total Efficiency for the 824 – 894 MHz frequency range and for the 1850 – 2170 MHz frequency range considering the different EB sizes (

Figure 1).

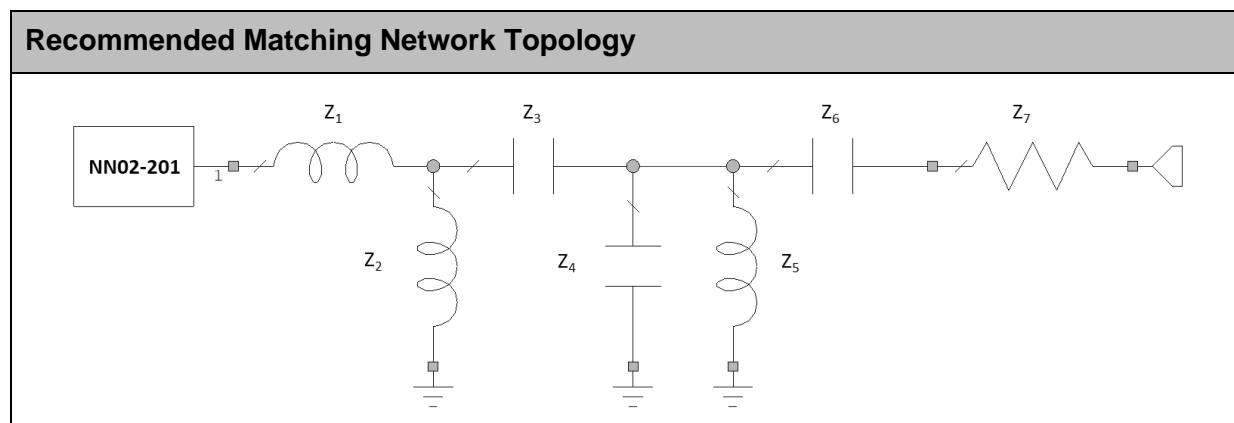
| A x C (mm)     | LFR (824 – 894MHz) |                 |      |      |              | HFR (1850 – 2170MHz) |                  |      |      |              |
|----------------|--------------------|-----------------|------|------|--------------|----------------------|------------------|------|------|--------------|
|                | $\eta_a$ 824MHz    | $\eta_a$ 894MHz | Min  | Max  | Av. $\eta_a$ | $\eta_a$ 1850MHz     | $\eta_a$ 2170MHz | Min  | Max  | Av. $\eta_a$ |
| 131 x 60       | 52.7               | 57.1            | 52.7 | 64.3 | 59.5         | 60.1                 | 65.8             | 60.1 | 80.8 | 76.9         |
| 91 x 60        | 21.8               | 32.8            | 21.8 | 45.1 | 35.7         | 68.0                 | 61.3             | 61.3 | 82.4 | 75.4         |
| 86 x 54 (CR80) | 19.3               | 26.0            | 19.3 | 39.3 | 30.1         | 62.9                 | 54.2             | 62.9 | 78.7 | 69.8         |
| 71 x 40        | 12.7               | 16.2            | 12.7 | 29.5 | 21.2         | 46.2                 | 40.7             | 40.7 | 75.5 | 60.5         |
| 51 x 40        | 7.4                | 9.8             | 7.4  | 15.4 | 11.9         | 35.9                 | 34.5             | 34.5 | 69.2 | 52.2         |

**Table 2** – Antenna efficiency comparison considering the different EB sizes.

## 2.3. MATCHING NETWORK

ONE mXTEND™ antenna booster needs a matching network to connect to your 2G and 3G receiver. As seen, the antenna performance depends on the ground plane size. This section describes the recommended matching network topology (Figure 4) and the resulting matching network configuration when measured in the different sized EBs (Figure 1). Please note that different devices with different form factors, ground planes and nearby components may need a different matching network.

If you need assistance to design your matching network beyond this application note, please contact [support@ignion.io](mailto:support@ignion.io), or try our free-of-charge<sup>1</sup> **NN Wireless Fast-Track** design service, you will get your chip antenna design including a custom matching network for your device in 24h<sup>1</sup>. Other information related to NN's range of R&D services is available at: <https://www.ignion.io/rdservices/>



**Figure 4** – Topology of matching network mounted at the different solutions.

The matching network topology (Figure 4) remains equal for all the analyzed EBs of different sizes (

**Figure 1**) and just the values of the matching network components must be adjusted to tune the antenna performance to the required operating frequency bands (sections 2.3.1 and 2.3.2). To ensure optimal results, the use of high-quality factor (Q) and tight tolerance components is highly recommended (e.g. Murata components).

Please note that the antenna performance is always conditioned by its operating environment so that different devices with different printed circuit board sizes, components nearby the antenna, LCD's, batteries, covers, connectors, etc. affect the antenna performance. Accordingly, 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 of the antenna element in the ground plane area, not in the clearance area. By tuning the matching network in your final design with your final surrounding components (batteries, displays, covers, etc.) you will be able to optimize the antenna performance without changing the antenna part.

<sup>1</sup> See terms and conditions for a free NN Wireless Fast-Track service in 24h at: <https://www.ignion.io/fast-track-project/>



### 2.3.1. 2G/3G EU BANDS

This section gathers the recommended values for operating the 2G and 3G European communication standards ranging from 880 – 960 MHz and 1710 – 2170 MHz (Table 3 and Table 4).

| A x C (mm)     | Z <sub>1</sub> | Z <sub>2</sub> | Z <sub>3</sub> | Z <sub>4</sub> | Z <sub>5</sub> | Z <sub>6</sub> | Z <sub>7</sub> |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| 131 x 60       | 10 nH          | 17 nH          | 1.1 pF         | 1.2 pF         | 16 nH          | 1.5 pF         | 3.0 nH         |
| 91 x 60        | 10 nH          | 17 nH          | 1.1 pF         | 1.1 pF         | 21 nH          | 1.2 pF         | 4.3 nH         |
| 86 x 54 (CR80) | 10 nH          | 17 nH          | 1.1 pF         | 1.2 pF         | 21 nH          | 1.2 pF         | 4.3 nH         |
| 71 x 40        | 10 nH          | 17 nH          | 1.1 pF         | 1.3 pF         | 25 nH          | 1.1 pF         | 4.3 nH         |
| 51 x 40        | 10 nH          | 17 nH          | 1.1 pF         | 1.3 pF         | 30 nH          | 1.2 pF         | 4.3 nH         |

**Table 3** – Values of the matching network components for the different EB sizes ranging from 131mm x 60mm down to 51mm x 40mm (

Figure 1).

| Value | Part Number                 |
|-------|-----------------------------|
| Z1    | 10 nH<br>LQW18AN10NG10      |
| Z2    | 17 nH<br>LQW15AN17NG80      |
| Z3    | 1.1 pF<br>GJM1555C1H1R1WB01 |
| Z4    | 1.2 pF<br>GJM1555C1H1R2WB01 |
|       | 1.1 pF<br>GJM1555C1H1R1WB01 |
|       | 1.3 pF<br>GJM1555C1H1R3WB01 |
| Z5    | 16 nH<br>LQW18AN16NG80      |
|       | 21 nH<br>LQW18AN21NG80      |
|       | 25 nH<br>LQW18AN25NG80      |
|       | 30 nH<br>LQW18AN30NG80      |
| Z6    | 1.5 pF<br>GJM1555C1H1R5WB01 |
|       | 1.2 pF<br>GJM1555C1H1R2WB01 |
|       | 1.1 pF<br>GJM1555C1H1R1WB01 |
| Z7    | 3.0 nH<br>LQW15AN3N0G80     |
|       | 4.3 nH<br>LQW18AN4N3G80     |

**Table 4** – Values and part numbers of the components used for the matching networks for the different EB sizes ranging from 131mm x 60mm down to 51mm x 40mm (

Figure 1).

## 2.3.2. 2G/3G USA BANDS

This section gathers the recommended values for operating the 2G and 3G USA communication standards ranging from 824 –894 MHz and 1850 – 2170 MHz (Table 5 and Table 6).

| A x C (mm)     | Z <sub>1</sub> | Z <sub>2</sub> | Z <sub>3</sub> | Z <sub>4</sub> | Z <sub>5</sub> | Z <sub>6</sub> | Z <sub>7</sub> |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| 131 x 60       | 11 nH          | 21 nH          | 0.7 pF         | 11 nH          | 1.2 pF         | 2.0 pF         | 2.7 nH         |
| 91 x 60        | 11 nH          | 21 nH          | 0.7 pF         | 18 nH          | 1.2 pF         | 1.7 pF         | 3.5 nH         |
| 86 x 54 (CR80) | 11 nH          | 21 nH          | 0.7 pF         | 20 nH          | 1.2 pF         | 1.9 pF         | 3.0 nH         |
| 71 x 40        | 12 nH          | 21 nH          | 0.7 pF         | 27 nH          | 1.3 pF         | 2.0 pF         | 3.3 nH         |
| 51 x 40        | 13 nH          | 21 nH          | 0.7 pF         | 27 nH          | 1.1 pF         | 2.2 pF         | 5.0 nH         |

**Table 5** – Values of the matching network components for the different EB sizes ranging from 131mm x 60mm down to 51mm x 40mm (

Figure 1).

| Value          | Part Number |                   |
|----------------|-------------|-------------------|
| Z <sub>1</sub> | 11 nH       | LQW18AN11NG80     |
|                | 12 nH       | LQW18AN12NG10     |
|                | 13 nH       | LQW18AN13NG80     |
| Z <sub>2</sub> | 21 nH       | LQW15AN21NG80     |
| Z <sub>3</sub> | 0.7 pF      | GJM1555C1HR70WB01 |
| Z <sub>4</sub> | 11 nH       | LQW18AN11NG80     |
|                | 18 nH       | LQW18AN18NG10     |
|                | 20 nH       | LQW18AN20NG00     |
|                | 27 nH       | LQW15AN27NG10     |
| Z <sub>5</sub> | 1.2 pF      | GJM1555C1H1R2WB01 |
|                | 1.3 pF      | GJM1555C1H1R3WB01 |
|                | 1.1 pF      | GJM1555C1H1R1WB01 |
| Z <sub>6</sub> | 2.0 pF      | GJM1555C1H2R0WB01 |
|                | 1.7 pF      | GJM1555C1H1R7WB01 |
|                | 1.9 pF      | GJM1555C1H1R9WB01 |
|                | 2.2 pF      | GJM1555C1H2R2WB01 |
| Z <sub>7</sub> | 2.7 nH      | LQW15AN2N7G80     |
|                | 3.5 nH      | LQW15AN3N5G80     |
|                | 3.0 nH      | LQW15AN3N0G80     |
|                | 3.8 nH      | LQW15AN3N8G80     |
|                | 3.3 nH      | LQW15AN3N3G80     |
|                | 5.0 nH      | LQW15AN5N0G80     |

**Table 6** –Values and part numbers of the components used for the matching networks for the different EB sizes ranging from 131mm x 60mm down to 51mm x 40mm (

Figure 1).

### Do you need more help with your antenna for your device?

Use our **NN Wireless Fast Track service** and get your ready-to-test antenna design specially thought for your platform **free of charge**<sup>1</sup> and in **24 hours**.

1. Fill out the form and submit it. Get confirmation email.
2. Reply to email. If you wish, attach any relevant design file.
3. Get your design in 24h.

<https://www.ignion.io/fast-track-project/>

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