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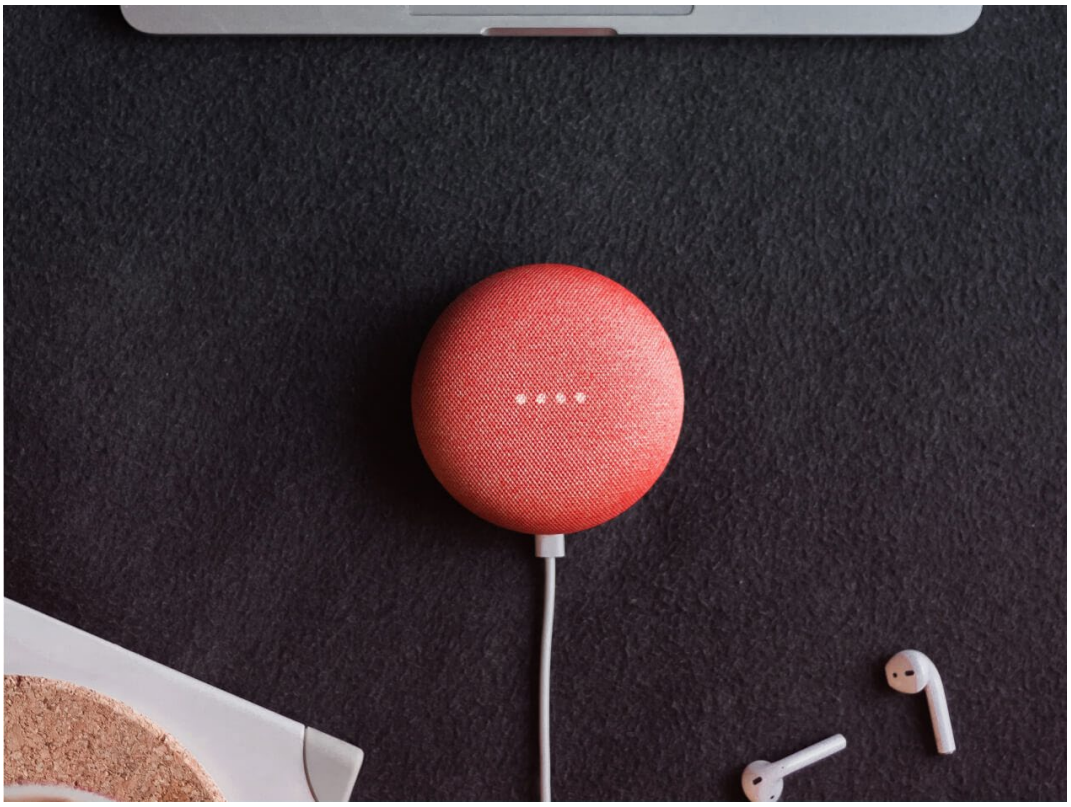
One antenna fits all: LoRa, Wi-SUN, Sigfox, Sidewalk & Z-Wave

APPLICATION NOTE
TRIO mXTEND™ (NN03-310)

One antenna fits all: LoRa, Wi-SUN, Sigfox, Sidewalk & Z-Wave

- **Product:** TRIO mXTEND™ NN03-310
- **Dimensions:** 30.0 mm x 3.0 mm x 1.0 mm
- **Frequency regions**: 863 – 928 MHz



Countless devices are leveraging protocols in the sub-GHz ISM frequency ranges, and they can easily get connected with just one antenna: TRIO mXTEND™

LoRa, Wi-SUN, Sigfox, Sidewalk & Z-Wave are currently some of the most popular protocols used in long range IoT devices. Ensuring optimized antenna performance is key to success in these applications. Different protocols with multiple frequency bands typically require multiple variants of antennas, causing headaches for device designers and manufacturers.

Lucky for them the TRIO mXTEND™ can be tuned to operate at all the frequencies used in LoRa, Wi-SUN, Sigfox, Sidewalk & Z-Wave removing the need to source and design different antennas in order to bring connectivity to each device and use case. The TRIO mXTEND™ is a thin pick and place component that can easily fit your next device design, while bringing predictable high RF performance.

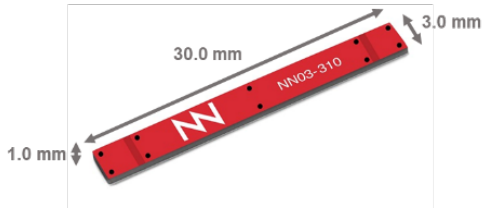
In this application note you will find information about the TRIO mXTEND™´s technical characteristics and learn about its performance in a range of commonly used PCB sizes and with varying clearance area sizes. We have carried out these tests so engineers can feel confident about the performance of this antenna component even before starting the design.

TABLE OF CONTENTS

1. PRODUCT DESCRIPTION OF THE NN03-310

The market for Internet of Things devices demanding long range connectivity continues to grow and the expanding diversity of these devices means that product configurations are endless. For this Application Note we have tested the performance of the TRIO mXTEND™ chip antenna component (NN03-310) when mounted onto a range of commonly used sized ground planes. We show the impact of ground plane size on performance to provide the most relevant data for those who design IoT devices of various dimensions.

TOP



BOTTOM

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

APPLICATIONS

- Smart Metering
- Smart City & Smart Buildings
- 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)
- Easy to tune and optimize

The TRIO mXTEND™ chip antenna (NN03-310) additionally provides multiband performance in wireless devices throughout a large range of frequencies (698-960 MHz, 1710-2690 MHz and 3400-3800 MHz), enabling devices to connect worldwide and allowing operation in multiple IoT protocols at the same time. This Application Note is focused on the ISM bands typically used in standards such as LoRa, Wi-SUN, Sigfox, Sidewalk & Z-Wave.

The TRIO mXTEND™ is a highly flexible chip antenna component that can be tuned at the frequency regions of interest through the proper adjustment of the matching network. This flexibility is highly beneficial as it removes the need to include different antenna parts in the same wireless device in order to use different wireless protocols, thus reducing the integration complexity while saving costs. The results presented herein show how the matching network should be configured for operation in the ISM bands in 863 – 928 MHz, while showing the corresponding performance with different PCB sizes.

2. ONE ANTENNA, MANY DEVICES

2.1. PERFORMANCE IN DIFFERENT PCB SIZES

For demonstration purposes, the performance of the TRIO mXTEND™ chip antenna component has been measured within the ISM frequency bands (863 – 870 MHz & 902 – 928 MHz), as used in many cellular IoT devices and in standards such as Sigfox, Sidewalk and LoRa. Several differently sized evaluation boards were used in order to show how size affects performance.

Each PCB board in the following set-up integrates a UFL cable to connect the TRIO mXTEND™ chip antenna component with an SMA connector so that VSWR and antenna efficiency can be tested. The following results cover a wide scope of PCB sizes (length (A) and width (C)) (Figure 1), ranging from 125mm x 50mm down to 54mm x 50mm.

If you require your IoT device to operate in a different standard or in other bands in the 698MHz to 3800MHz frequency range, you are welcome to contact support@ignion.io for assistance.

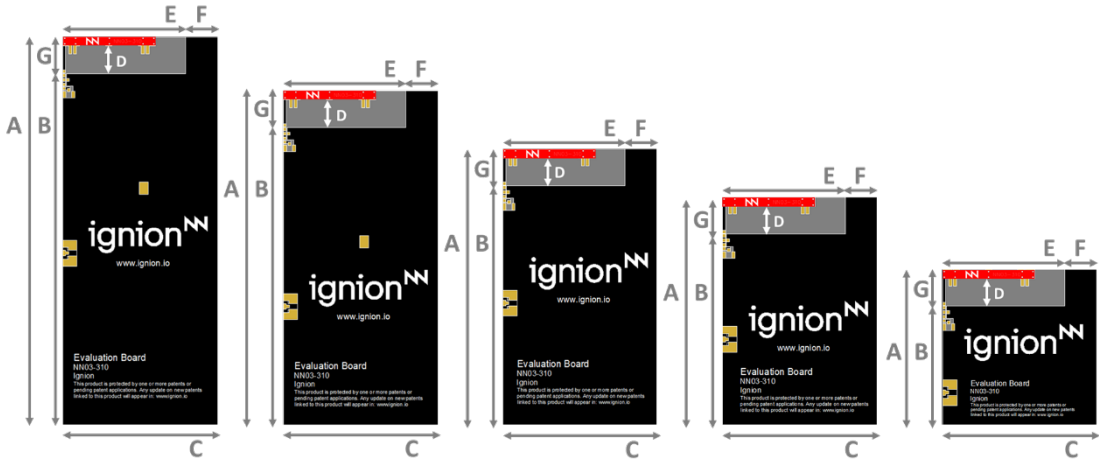


Figure 1 – Evaluation boards with different PCB dimensions that provide operation from 863MHz to 928 MHz.

Measure	mm
A	125 - 54
B	113 - 42
C	50
D	9
E	40
F	10
G	12

Tolerance: ±0.2 mm

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

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

Clearance area: 40mm x 12mm (ExG)

2.1.1. VSWR AND EFFICIENCY

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

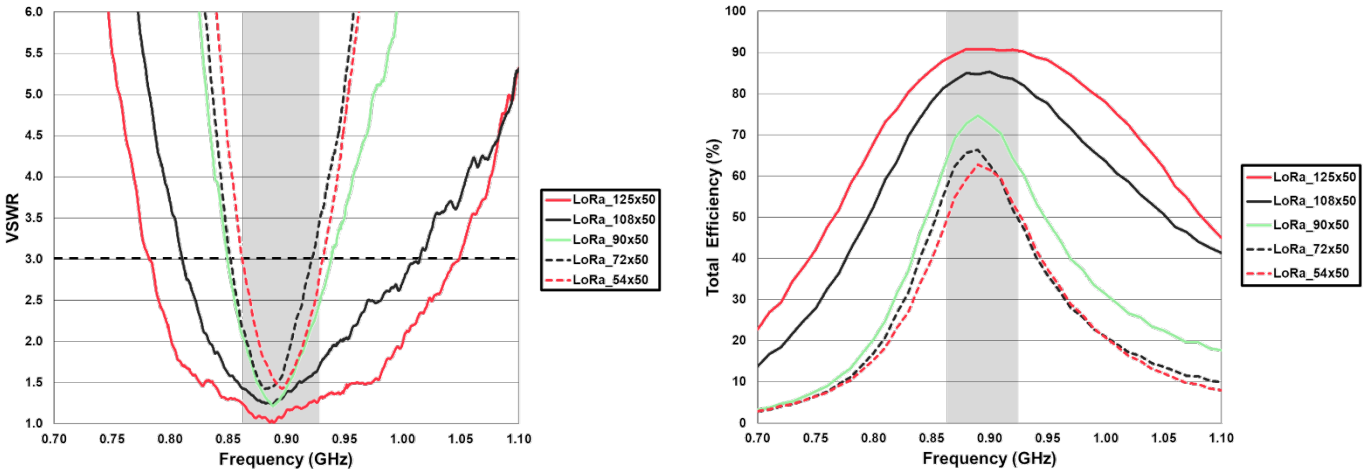


Figure 2 – VSWR and Total Efficiency for the 863 - 928 MHz frequency range. Graph dimensions in the legend refer to AxC (Figure 1).

	863 – 870 MHz					902 – 928 MHz				
PCB Dimensions (A x C)	**$\eta_{a\ 863\ MHz}$**	**$\eta_{a\ 870\ MHz}$**	**Min**	**Max**	**Av. η_a**	**$\eta_{a\ 902\ MHz}$**	**$\eta_{a\ 928\ MHz}$**	**Min**	**Max**	**Av. η_a**
125mm x 50mm	86.6	87.4	86.6	87.4	**87.0**	88.4	87.1	87.1	88.4	**87.8**
108mm x 50mm	81.9	83.2	81.9	83.2	**82.5**	85.2	82.2	82.2	85.2	**83.7**
90mm x 50mm	63.6	69.1	63.6	69.1	**66.3**	72.3	60.8	60.8	72.3	**66.3**
72mm x 50mm	57.1	62.4	57.1	62.4	**59.7**	62.2	47.8	47.8	62.2	**54.5**
54mm x 50mm	49.1	54.8	49.1	54.8	**51.9**	61.2	49.5	49.5	61.2	**55.0**

Table 1 – Total efficiency (%) comparison considering the different PCB sizes (Figure 1).

2.1.2. MATCHING NETWORK

The matching network design and value components for each device and PCB size are provided here. While the antenna component and matching network design and topology remain the same, the value of the components should be adapted to every PCB size for 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 incorporated 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 as this will provide a degree of freedom for tuning the TRIO mXTEND™ chip antenna component once the design is finished and all elements of the system (batteries, displays, covers, etc.) can be taken into consideration.

Please note that different devices with different ground planes and different components near the TRIO mXTEND™ chip 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 in designing your matching network beyond this application note, please contact support@ignion.io, or try our free-of-charge[1] **Fast Track** service, where you can get your chip antenna design including a custom matching network for your device in 24h[1]. Other information related to Ignion's range of R&D services is available at: https://www.ignion.io/rdservices/

Figure 3 – Matching network distribution

[1] See terms and conditions for a free Fast-Track service in 24h at: https://www.ignion.io/fast-track-project/

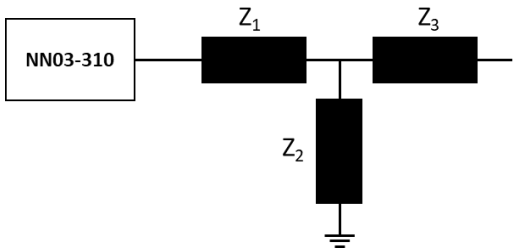
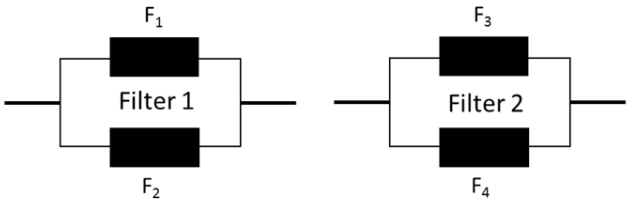
863 – 928 MHz	
MN Section a	
MN Section b	

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

Dimensions (B x C)	F_1	F_2	F_3	F_4	Z_1	Z_2	Z_3
125 mm x 50 mm	0Ω	Empty	0Ω	Empty	12nH	12nH	0Ω
108 mm x 50 mm	0Ω	Empty	0Ω	Empty	12nH	12nH	0Ω
90 mm x 50 mm	0Ω	Empty	0Ω	Empty	12nH	7.5nH	0Ω
72 mm x 50 mm	0Ω	Empty	0Ω	Empty	13nH	6.8nH	0Ω
54 mm x 50 mm	0Ω	Empty	0Ω	Empty	13nH	6.8nH	0Ω

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

Value		Part Number
F1	0Ω	Resistor
F2	-	
F3	0Ω	Resistor
F4	-	
Z1	12 nH	LQW18AN12NG80
	13 nH	LQW18AN13NG80
Z2	12 nH	LQW18AN12NG80
	7.5 nH	LQW18AN7N5C80
	6.8 nH	LQW18AN6N8C10
Z3	0 Ω	-

Table 3 – Values and part numbers of the components used for the matching networks for the PCBs with dimensions 125mm x 50mm, 108mm x 50mm, 90mm x 50mm, 72mm x 50mm and 54mm x 50mm.

2.2. PERFORMANCE WHEN THE CLEARANCE AREA IS REDUCED

For demonstration purposes, the performance of the TRIO mXTEND™ chip antenna component within the 863 - 928 MHz frequency range has been measured in various evaluation boards with the same size (125mm x 50mm) but with different clearance areas. The clearance area length was reduced three times, going from 50mm to 35mm.

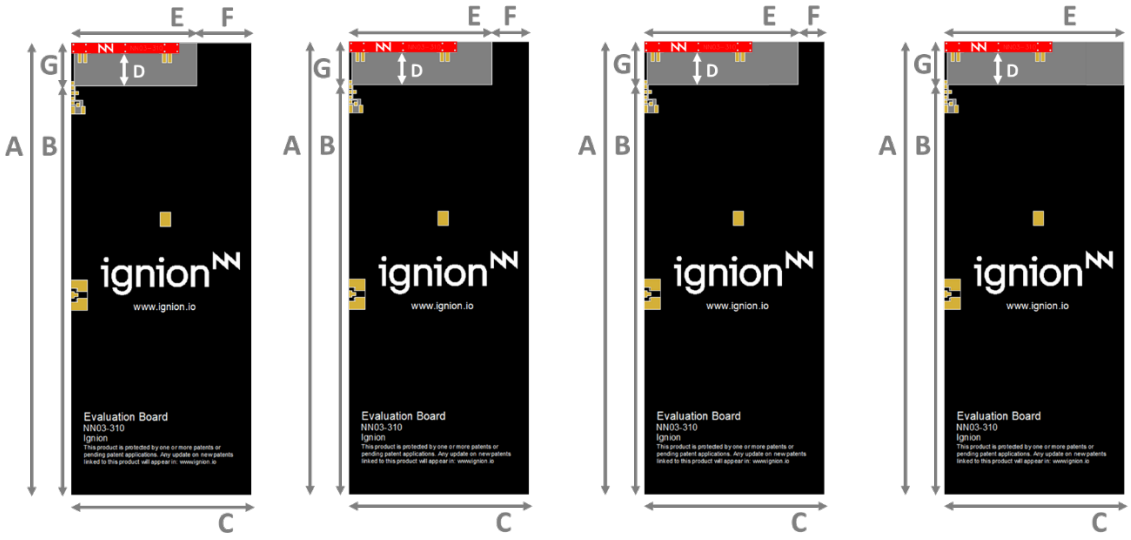


Figure 5 – Evaluation boards that provide operation from 863MHz to 928 MHz with different clearance area dimensions.

Measure	mm
A	125
B	113
C	50
D	9
E	35 – 50
F	15 – 0
G	12

Tolerance: ±0.2 mm

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

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

Clearance area: 35-40-45-50mm x 12mm (ExG)

2.2.1. VSWR AND EFFICIENCY

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

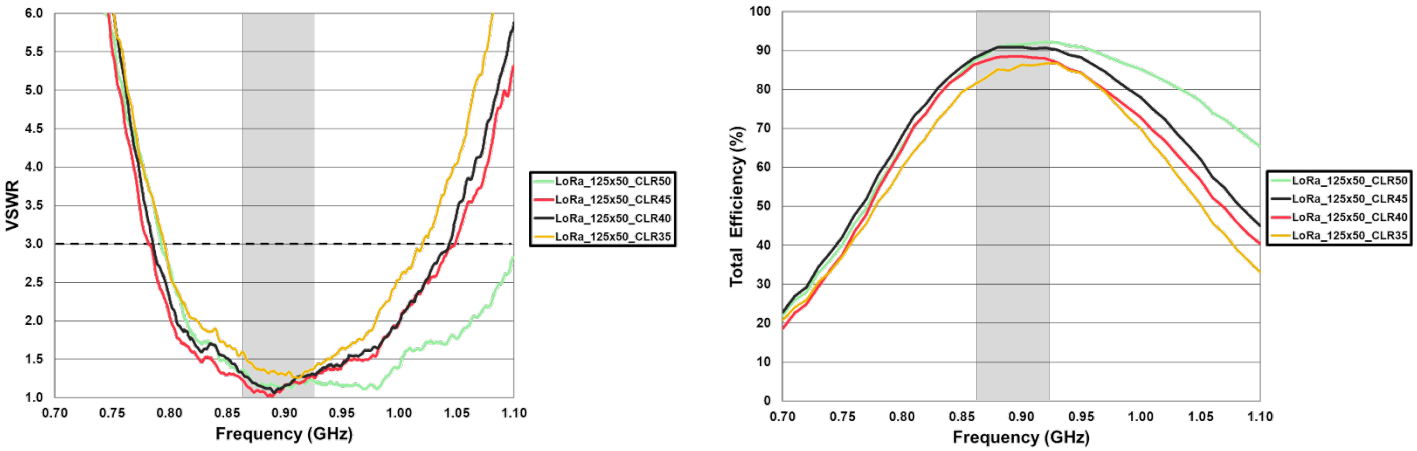


Figure 6 – VSWR and Total Efficiency for the 863 - 928 MHz frequency range. Graph dimensions in the legend refer to ExG (Figure 5).

	863 – 870 MHz					902 – 928 MHz				
Clearance area dimensions (E x G)	**$\eta_{a\ 863\ MHz}$**	**$\eta_{a\ 870\ MHz}$**	**Min**	**Max**	**Av. η_a**	**$\eta_{a\ 902\ MHz}$**	**$\eta_{a\ 928\ MHz}$**	**Min**	**Max**	**Av. η_a**
35mm x 12mm	81.6	83.0	81.6	83.0	**82.3**	86.3	86.7	86.3	86.7	**86.5**
40mm x 12mm	86.6	87.4	86.6	87.4	**87.0**	88.4	87.1	87.1	88.4	**87.8**
45mm x 12mm	88.4	89.5	88.4	89.5	**89.0**	90.8	90.3	90.3	90.8	**90.5**
50mm x 12mm	87.8	88.8	87.8	88.8	**88.3**	91.6	92.1	91.6	92.1	**91.8**

Table 4 – Total efficiency (%) comparison considering the different clearance area dimensions (Figure 5).

2.2.2. MATCHING NETWORK

The matching network design and value components for each device and PCB size are provided here. While the antenna component and matching network design and topology remain the same, the value of the components should 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 incorporated 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 as this will provide a degree of freedom for tuning the TRIO mXTEND™ chip antenna component once the design is finished, and all elements of the system (batteries, displays, covers, etc.) can be taken into consideration.

Please note that different devices with different ground planes and different components near the TRIO mXTEND™ chip 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 in designing your matching network beyond this application note, please contact support@ignion.io, or try our free-of-charge[1] **Fast Track** service where you can get your chip antenna design including a custom matching network for your device in 24h[2]. Other information related to Ignion's range of R&D services is available at: https://www.ignion.io/rdservices/

Figure 7 – Matching network distribution

[2] See terms and conditions for a free Fast Track service in 24h at: https://www.ignion.io/fast-track-project/

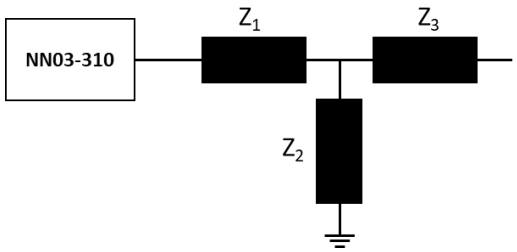
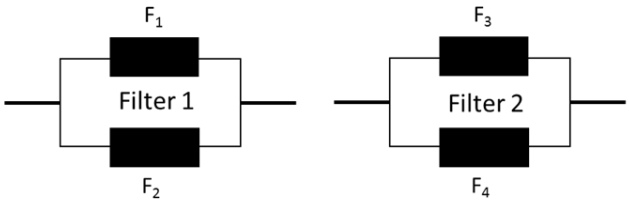
863 – 928 MHz	
MN Section a	
MN Section b	

Figure 8 – Topology of matching network mounted for the different solutions.

Dimensions (E x G)	F_1	F_2	F_3	F_4
35mm x 12mm	0Ω	-	0Ω	-
40mm x 12mm	0Ω	-	0Ω	-
45mm x 12mm	0Ω	-	0Ω	-
50mm x 12mm	0Ω	-	0Ω	-

Table 5 – Values of the components for each different solution.

Value		Part Number
F1	12 nH	LQW18AN12NG80
	12 nH	LQW18AN12NG80
	13 nH	LQW18AN13NG80
	12 nH	LQW18AN12NG80
F2	18 nH	LQW18AN18NG80
	12 nH	LQW18AN12NG80
	15 nH	LQW18AN15NG80
	18 nH	LQW18AN18NG80
F3	0 Ω	-
	0 Ω	-
	0 Ω	-
	0 Ω	-

Table 6 – Values and part numbers of the components used for the matching networks for the cases with clearance area dimensions 12mm x 35mm, 12mm x 40mm, 12mm x 45mm and 12mm x 50mm.

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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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