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TRIO mXTEND™ - Cellular Connectivity Across Diverse PCB Sizes

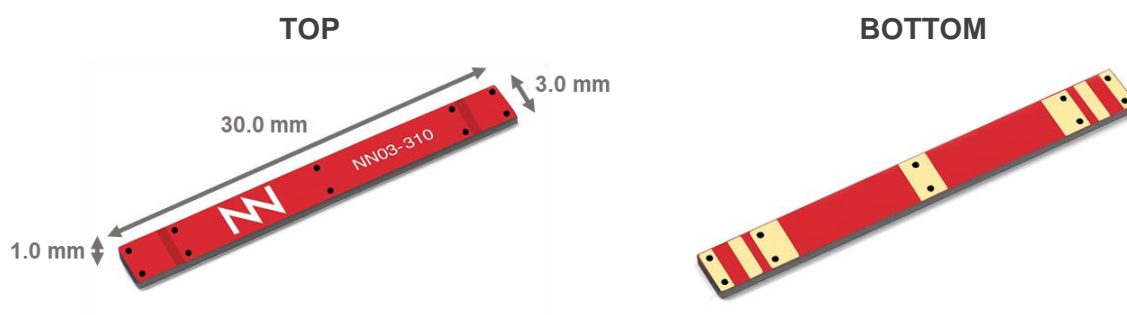
APPLICATION NOTE

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1. PRODUCT DESCRIPTION NN03-310

TRIO mXTEND[™] (NN03-310) is our top performing Virtual Antenna[®] product that covers the widest range of operating frequencies from 698 MHz up to 8.000 MHz in both cellular and unlicensed IoT wireless devices. In addition, TRIO mXTEND[™] enables embedding different radios of choice, such as, LTE-M, NB-IoT, GNSS, Bluetooth/Wi-Fi, and many more into a single component. The TRIO mXTEND[™] has the smallest footprint in the market for its class and combined with its 1 mm slim form factor, it makes an ideal component for high-performance even in small IoT devices.



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

APPLICATIONS

- Asset Tracking & Logistics
- Smart Metering
- Industrial IoT
- Notebooks/Tablets
- Health sensors
- Animal Trackers
- Security sensors
- Point of Sales
- Vending Machines
- Smart City sensors

2. EVALUATION BOARD FOR IoT

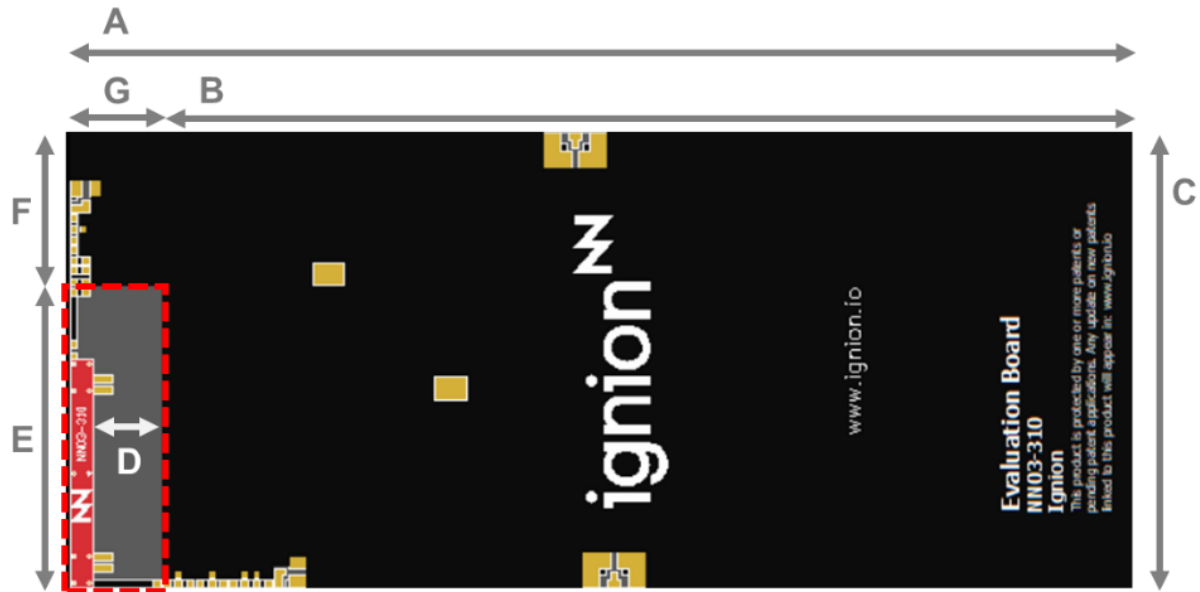
2.1. QUICK REFERENCE GUIDE

Technical features	698 – 960 MHz	1710 – 2690 MHz
Average Efficiency	> 55 %	> 65 %
Peak Gain	1.1 dBi	2.4 dBi
VSWR	< 3:1	
Radiation Pattern	Omnidirectional	
Polarization	Linear	
Weight (approx.)	0.25 g	
Temperature	-40 to +125 °C	
Impedance	50 Ω	
Dimensions (L x W x H)	30.0 mm x 3.0 mm x 1.0 mm	

Table 1 – Technical Features. Measures from the Evaluation Board. See Figure 6.

2.2. EVALUATION BOARD

This Evaluation Board (part number: EB_NN03-310-M) integrates one TRIO mXTEND™ chip antenna component to provide operation in two frequency regions, from 698 MHz to 960 MHz and from 1710 MHz to 2690 MHz. A UFL cable connects this single input/output port to the SMA connector.



Measure	mm
A	142
B	130
C	60
D	9
E	40
F	20
G	12

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: 60 mm x 11 mm (Cx F).

Figure 1 – EB_NN03-310-M. Evaluation Board for providing operation in 2 frequency ranges, 698 – 960MHz and 1710 – 2690MHz.

This product and/or its use is protected by at least one or more patents and patent applications. Please check related patent information at: [ignion patents](#).

2.2.1. 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 TRIO mXTEND™ Virtual Antenna® component once the design is finished and considering all elements of the system (batteries, displays, covers, etc.).

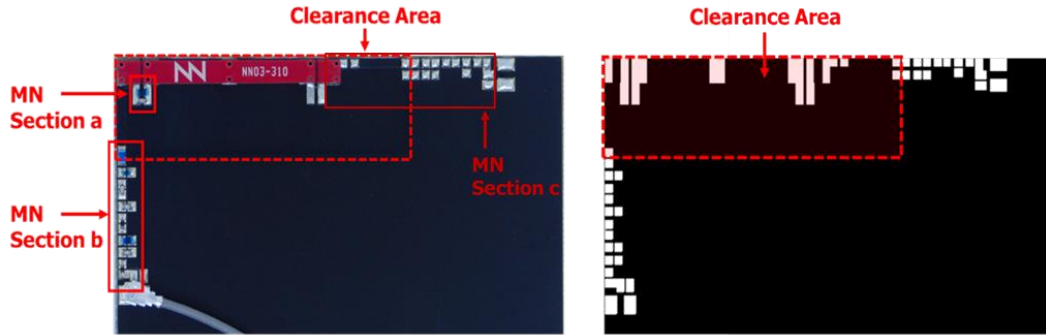


Figure 2 – Matching network distribution

Please notice that different devices with different ground planes and different components nearby the TRIO mXTEND™ chip antenna component may need a different matching network. To ensure optimal results, the use of high Q and tight tolerance components is highly recommended (Murata components).

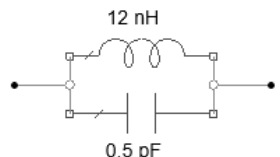
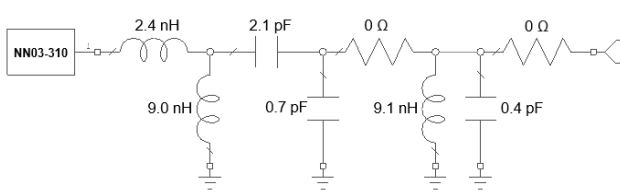
698 MHz – 960 MHz and 1710 MHz – 2690 MHz															
<p>MN Section a</p> 	<table border="1"> <thead> <tr> <th>Value</th> <th>Part Number</th> </tr> </thead> <tbody> <tr> <td>12 nH</td> <td>LQW18AN12NG10</td> </tr> <tr> <td>0.5 pF</td> <td>GJM1555C1HR50WB01</td> </tr> </tbody> </table>	Value	Part Number	12 nH	LQW18AN12NG10	0.5 pF	GJM1555C1HR50WB01								
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<p>MN Section b</p> 	<table border="1"> <thead> <tr> <th>Value</th> <th>Part Number</th> </tr> </thead> <tbody> <tr> <td>2.4 nH</td> <td>LQW18AN2N4C80</td> </tr> <tr> <td>9.0 nH</td> <td>LQW15AN9N0G80</td> </tr> <tr> <td>2.1 pF</td> <td>GJM1555C1H2R1WB01</td> </tr> <tr> <td>0.7 pF</td> <td>GJM1555C1HR70WB01</td> </tr> <tr> <td>9.1 nH</td> <td>LQW18AN9N1G80</td> </tr> <tr> <td>0.4 pF</td> <td>GJM1555C1HR40WB01</td> </tr> </tbody> </table>	Value	Part Number	2.4 nH	LQW18AN2N4C80	9.0 nH	LQW15AN9N0G80	2.1 pF	GJM1555C1H2R1WB01	0.7 pF	GJM1555C1HR70WB01	9.1 nH	LQW18AN9N1G80	0.4 pF	GJM1555C1HR40WB01
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0.4 pF	GJM1555C1HR40WB01														

Figure 3 – Matching network implemented in the Evaluation Board 1 port (Figure 1).

This matching network applies to this Evaluation Board. Other configurations would require a matching network adjustment. 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 [Oxion™ platform](#), which will get you a complete design report including a custom matching network for your device in 24h¹. Additional information related to Ignion's range of R&D services is available at: <https://ignion.io/rdservices/>.

2.2.2. VSWR AND TOTAL EFFICIENCY

VSWR (Voltage Standing Wave Ratio) is defined as the relation of transmitted and reflected standing waves of voltage in a radio frequency (RF) electrical transmission system.

Total Efficiency is a term used to **measure the ratio between the power supplied to the antenna and the radiated power of the system**. Total Efficiency measures the quantity of power from the RF module that is effectively radiated to the space.

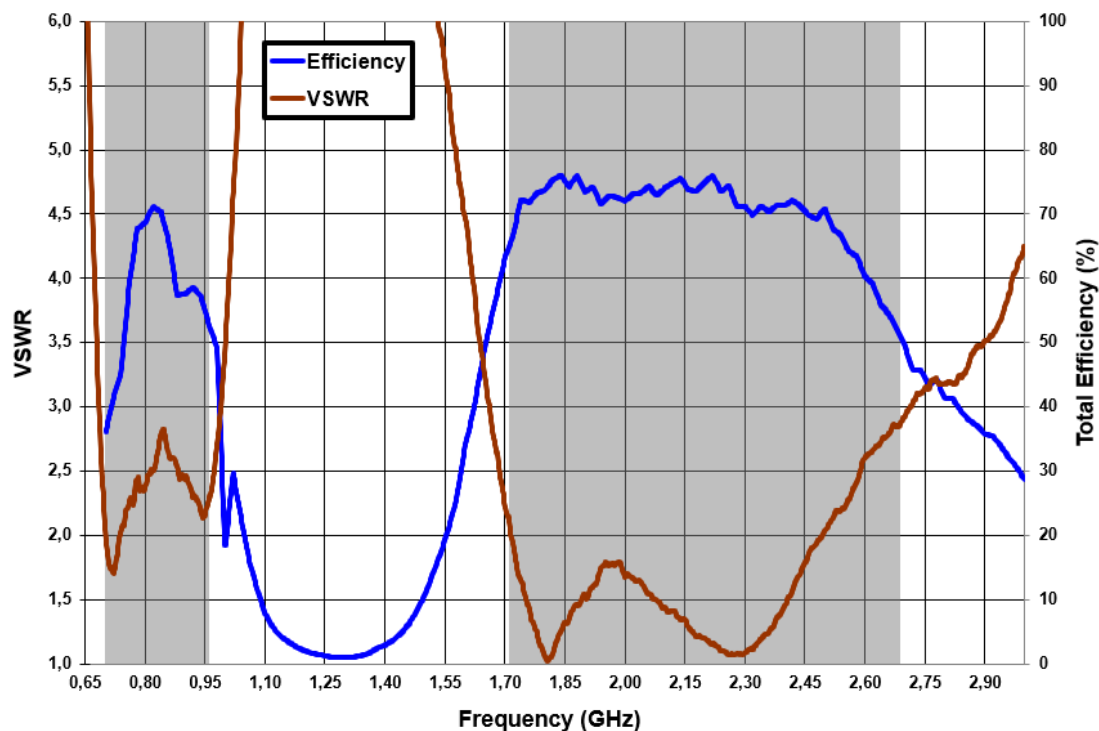


Figure 4 – VSWR and Total Efficiency for the 698 – 960 MHz frequency range and for the 1710 – 2690 MHz frequency range (from the Evaluation Board) (Figure 1).

2.3. RECOMMENDED ANTENNA FOOTPRINT FOR NN03-310

The TRIO mXTEND™ antenna component (NN03-310) can be placed close to a corner of the PCB. See below the recommended footprint dimensions when it is placed close to a corner of the PCB with the feeding line aligned with the longest side of the board according to the Evaluation Board (Figure 6).

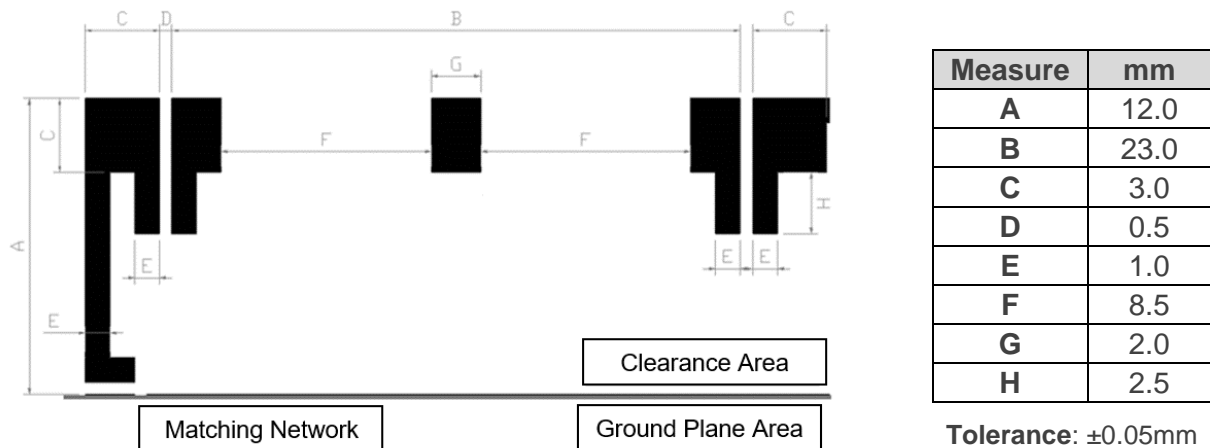


Figure 5 – Footprint dimensions for the single chip antenna component in one port configuration.

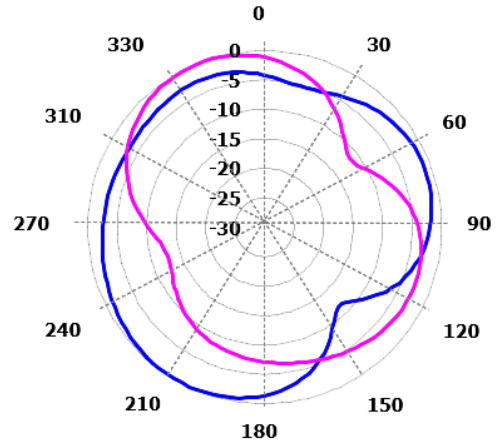
For additional support in the integration process, please contact support@ignion.io.

2.4. RADIATION PATTERNS (698 - 960 MHz), GAIN, AND EFFICIENCY

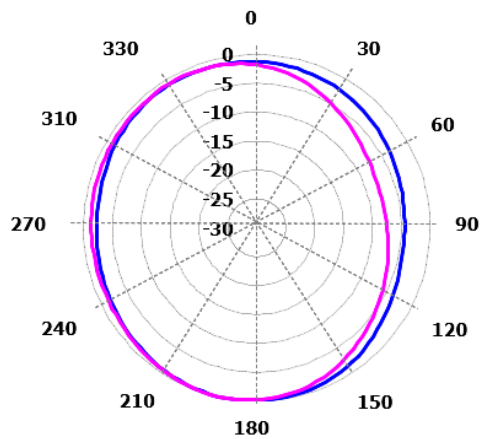
Measurement System Set-Up
Evaluation Board in Plane XY



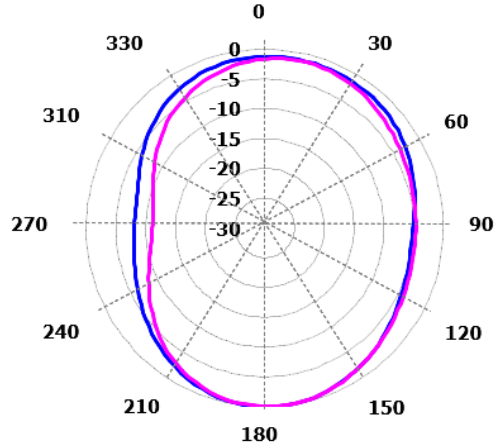
$\theta = 90^\circ$ Plane XY at 750 MHz and 890 MHz



$\phi = 0^\circ$ Plane XZ at 750 MHz and 890 MHz



$\phi = 90^\circ$ Plane YZ at 750 MHz and 890 MHz



Gain	Peak Gain	1.1 dBi
	Average Gain across the band	0.5 dBi
	Gain Range across the band (min, max)	-0.7 <-> 1.1 dBi
Efficiency	Peak Efficiency	71.1 %
	Average Efficiency across the band	58.8 %
	Efficiency Range across the band (min, max)	36.1 – 52.5 %

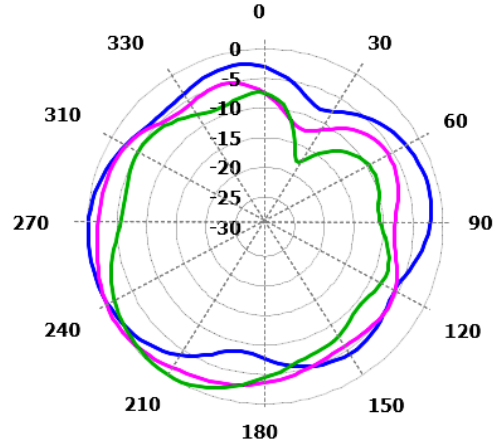
Table 2 – Antenna gain and total efficiency from the Evaluation Board (Figure 6) within the 698 – 960 MHz frequency range. Measures made in the Satimo STARGATE 32 anechoic chamber.

2.5. RADIATION PATTERNS (1710 - 2690 MHz), GAIN, AND EFFICIENCY

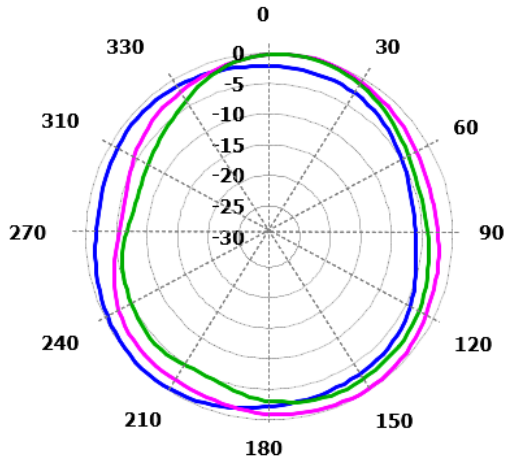
Measurement System Set-Up
Evaluation Board in Plane XY



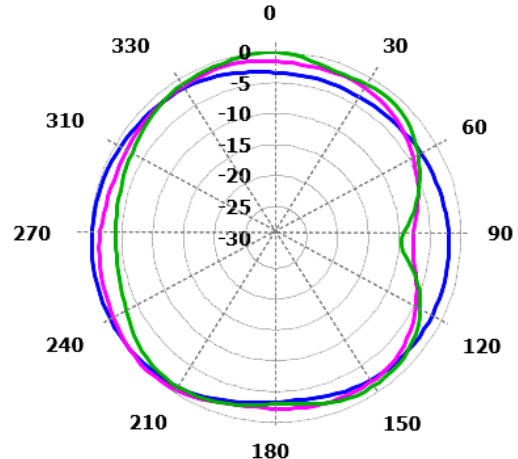
$\theta = 90^\circ$ Plane XY at 1.71 GHz, 2.2 GHz and 2.69 GHz



$\phi = 0^\circ$ Plane XZ at 1.71 GHz, 2.2 GHz and 2.69 GHz



$\phi = 90^\circ$ Plane YZ at 1.71 GHz, 2.2 GHz and 2.69 GHz



Gain	Peak Gain	2.4 dBi
	Average Gain across the band	1.8 dBi
	Gain Range across the band (min, max)	0.3 <--> 2.4 dBi
Efficiency	Peak Efficiency	76.0 %
	Average Efficiency across the band	70.4 %
	Efficiency Range across the band (min, max)	64.7 – 50.8 %

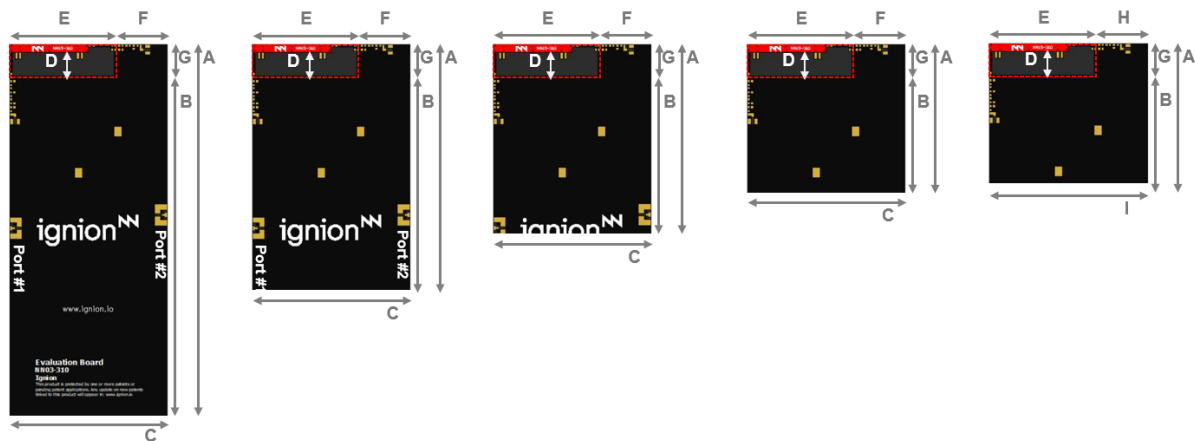
Table 3 – Antenna gain and total efficiency from the Evaluation Board (Figure 6) within the 1710 – 2690 MHz frequency range. Measures made in the Satimo STARGATE 32 anechoic chamber.

3. ONE ANTENNA, MANY DEVICES

For demonstration purposes, the performance of the TRIO mXTEND™ chip antenna component is measured in different evaluation boards within the 698 - 960 MHz and 1710 - 2690 MHz frequency range, as used in many cellular IoT devices. Please note that the TRIO mXTEND™ can cover a much wider range of communication standards such as GNSS and WiFi/BT through the same antenna package.

If your IoT device needs to operate in some additional standard or in some particular bands inside the 698MHz to 3800MHz frequency 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 TRIO mXTEND™ chip antenna component with a 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 6), ranging from 142mm x 60mm down to 50mm x 50mm.



Measure	mm
A	142 - 50
B	130 - 38
C	60
D	9
E	40
F	20
G	12
H	10
I	50

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)

Figure 6 – Evaluation boards with different PCB dimensions that provide operation from 698 MHz to 960 MHz and from 1710 MHz to 2690 MHz.

3.1. VSWR AND EFFICIENCY

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

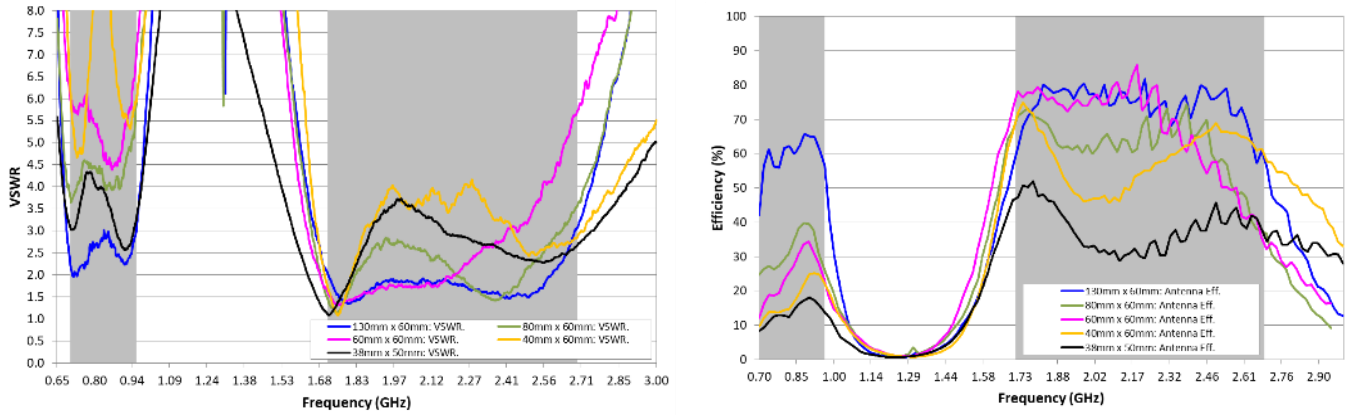


Figure 7 – VSWR and Total Efficiency for the 698 – 960 MHz and 1710 – 2690 MHz frequency range. Graph dimensions in the legend refer to BxC (Figure 6).

Ground Plane dimensions (B x C)	LFR (698 – 960 MHz)					HFR (1710 – 2690 MHz)				
	η_a 698 MHz	η_a 960 MHz	Min	Max	Av. η_a	η_a 1710 MHz	η_a 2690 MHz	Min	Max	Av. η_a
130mm x 60mm	42.0	56.5	42.0	65.7	60.1	59.1	58.5	57.3	78.8	74.3
80mm x 60mm	24.2	25.5	24.2	37.9	31.2	63.0	38.0	38.0	72.7	62.5
60mm x 60mm	12.2	24.0	12.0	34.4	25.0	69.9	41.8	41.1	85.9	68.9
40mm x 60mm	9.6	22.1	9.6	25.1	17.8	69.2	59.6	45.7	74.9	58.8
38mm x 50mm	8.4	13.8	8.4	18.0	14.0	46.9	36.1	28.7	52.0	38.2

Table 4 – Total efficiency (%) comparison considering the different PCB sizes (Figure 6).



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- Ignion is an ISO 9001:2015 certified company. All our antennas are lead-free and RoHS compliant.
- This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement N° 674491.



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