



**fractus**

Optimised Antennas  
for Wireless Devices

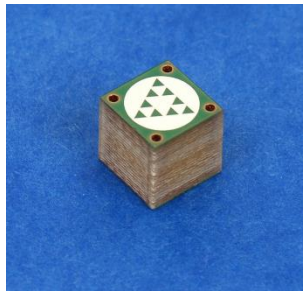
User Manual

# **Fractus mXTEND™ Antenna Booster**

**A standard antenna solution for mobile frequency bands**

GSM850, GSM900, GSM1800/DCS, GSM1900/PCS, UMTS  
LTE700, LTE800, LTE850, LTE900, LTE1700, LTE1800,  
LTE1900, LTE2000, LTE2100, LTE2300, LTE2500, and  
LTE2600

(LTE 1-10, LTE 12-20, LTE 23, LTE 25-30, LTE 33-41, LTE 44)



**mXTEND™ Antenna Booster  
FR01-S4-250**

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Fractus is an ISO 9001:2008 certified company. All our antennas are lead-free and RoHS compliant.





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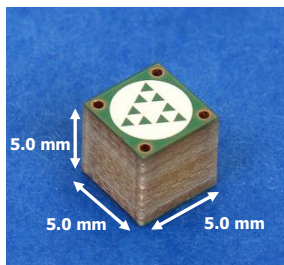
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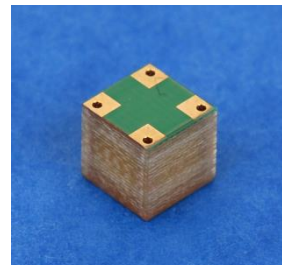


## 1. PRODUCT DESCRIPTION FR01-S4-250

The Fractus® mXTEND™ Antenna Booster has been specifically designed for providing multiband performance in wireless devices (in particular in mobile devices), enabling worldwide coverage by allowing operation in the communication standards GSM850, GSM900, GSM1800/DCS, GSM1900/PCS, UMTS, LTE700, LTE800, LTE850, LTE900, LTE1700, LTE1800, LTE1900, LTE2000, LTE2100, LTE2300, LTE2500, and LTE2600.



**TOP**



**BOTTOM**

### APPLICATIONS

- Handsets
- Smartphones
- Tablets
- Phablets
- Laptop PCs
- Netbooks
- Modules
- Routers
- eBooks

### 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 mXTEND™ Antenna Booster is intended to replace conventional antenna solutions by a miniature and standard component capable of enabling operation in the main mobile communication bands.

The mXTEND™ Antenna Booster belongs to a new generation of antenna solutions based on the Virtual Antenna™ technology developed by Fractus®. The technology is mainly focused on replacing conventional antenna solutions by miniature and standard components.



## 2. EVALUATION BOARDS 1 PORT (LTE700)

### 2.1. QUICK REFERENCE GUIDE

Technical features	Evaluation Board with UFL cables	Evaluation Board with coplanar transmission lines
Frequency Range	698 - 798 MHz	
Average Efficiency	> 45 %	> 40 %
Peak Gain	0.2 dBi	0.1 dBi
VSWR	< 3:1	
Radiation Pattern	Omnidirectional	
Polarization	Linear	
Weight (approx.)	0.25 g.	
Temperature	-40 to + 85 °C	
Impedance	50 Ω	
Dimensions (L x W x H)	5.0 mm x 5.0 mm x 5.0 mm	

**Table 1** – Technical features. Measures from the Evaluation Board (133 mm x 60 mm x 1 mm). See Figure 1. Note that for obtaining comparable results, a ground plane length larger than 100 mm is recommended.

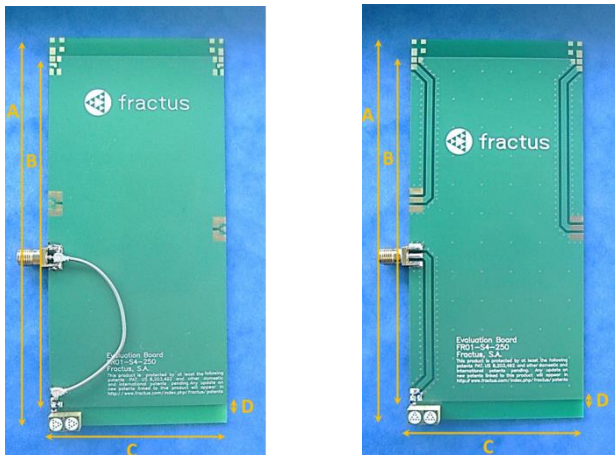
#### Comments:

- Note that in the Evaluation Boards (Figure 1), 2 mXTEND™ Antenna Boosters are placed together to provide operation at LTE700 (698-798 MHz). Please see Figure 29 for the recommended footprint.
- The efficiency measures (Figure 3 and Figure 4) are shown from 700 MHz due to the minimum frequency specifications of the Satimo STARGATE 32 anechoic chamber.
- Please contact [info@fractus.com](mailto:info@fractus.com) for more information related to the Antenna Booster matching service.



## 2.2. EVALUATION BOARDS 1 PORT (LTE700)

This section depicts two different Evaluation Boards. The first one is built with UFL cables to connect the mXTEND™ Antenna Booster with the SMA connector. The part number is EB\_FR01-S4-250-UFL1R-700 and it is shown in the left picture of the Figure 1. The second Evaluation Board is made with coplanar grounded transmission lines (traces on a PCB) to connect the mXTEND™ Antenna Booster with the SMA connector. The part number is EB\_FR01-S4-250-CPW1R-700 and it is shown in the right picture of the Figure 1.



Measure	mm
<b>A</b>	133
<b>B</b>	120
<b>C</b>	60
<b>D</b>	1.5

Tolerance: ±0.2 mm

**D:** Distance between the mXTEND™ Antenna Booster and the ground plane.

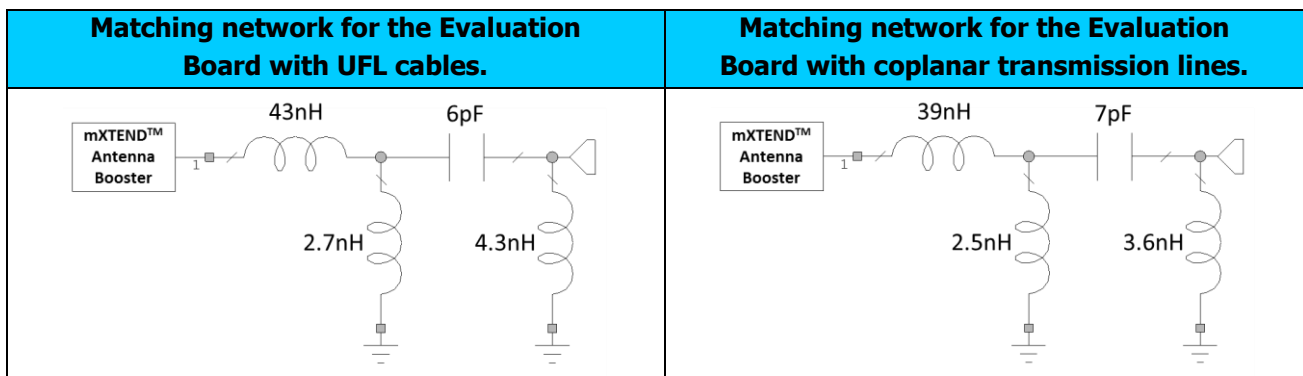
**Material:** The Evaluation Boards are built on FR4 substrate. Thickness is 1 mm.

**Figure 1** – Evaluation Boards providing operation at LTE700, 1 port configuration.

This product is protected by at least the following patent PAT. US 8,203,492 and other domestic and international patents pending. Any update on new patents linked to this product will appear in <http://www.fractus.com/index.php/fractus/patents>

### 2.2.1. MATCHING NETWORKS

The specs of a Fractus 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 to place 0402 pads 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 mXTEND™ Antenna Booster once the design is finished and taking into account all elements of the system. Please notice that different devices with different ground planes and components nearby the mXTEND™ Antenna Booster may need a different matching network. To ensure optimal results, the use of high Q and tight tolerance components is highly recommended (Murata components).

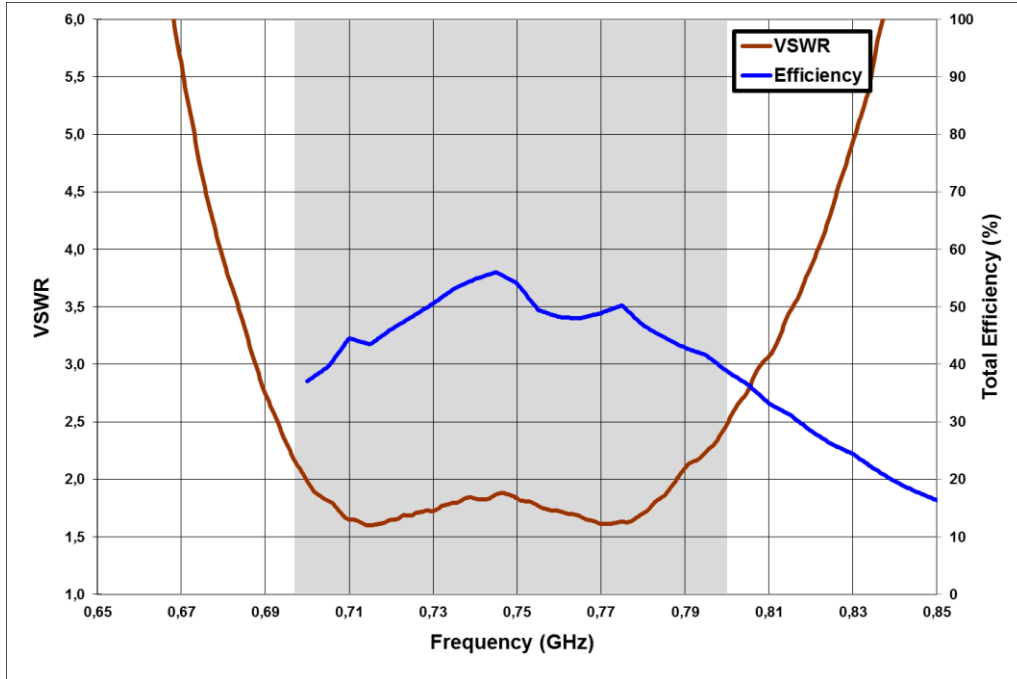


**Figure 2** – Matching networks for the LTE700, 1 port configuration.

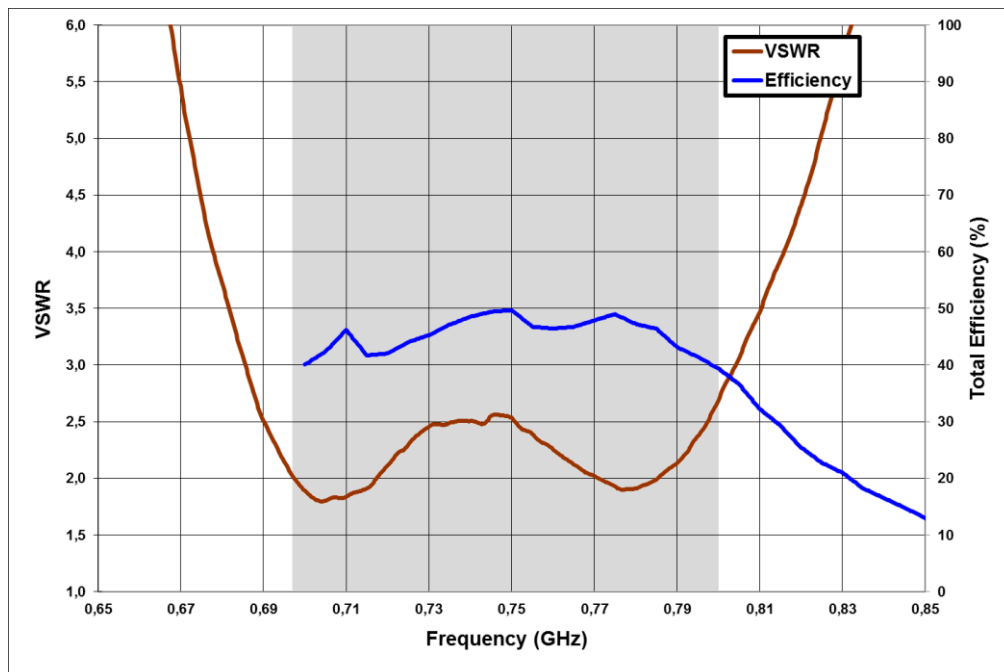


## 2.2.2. VSWR AND TOTAL EFFICIENCY FOR 1 PORT (LTE700)

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



**Figure 3** – VSWR and Total Efficiency for Evaluation Board with UFL cables.  
Part Number: EB\_FR01-S4-250-UFL1R-700.

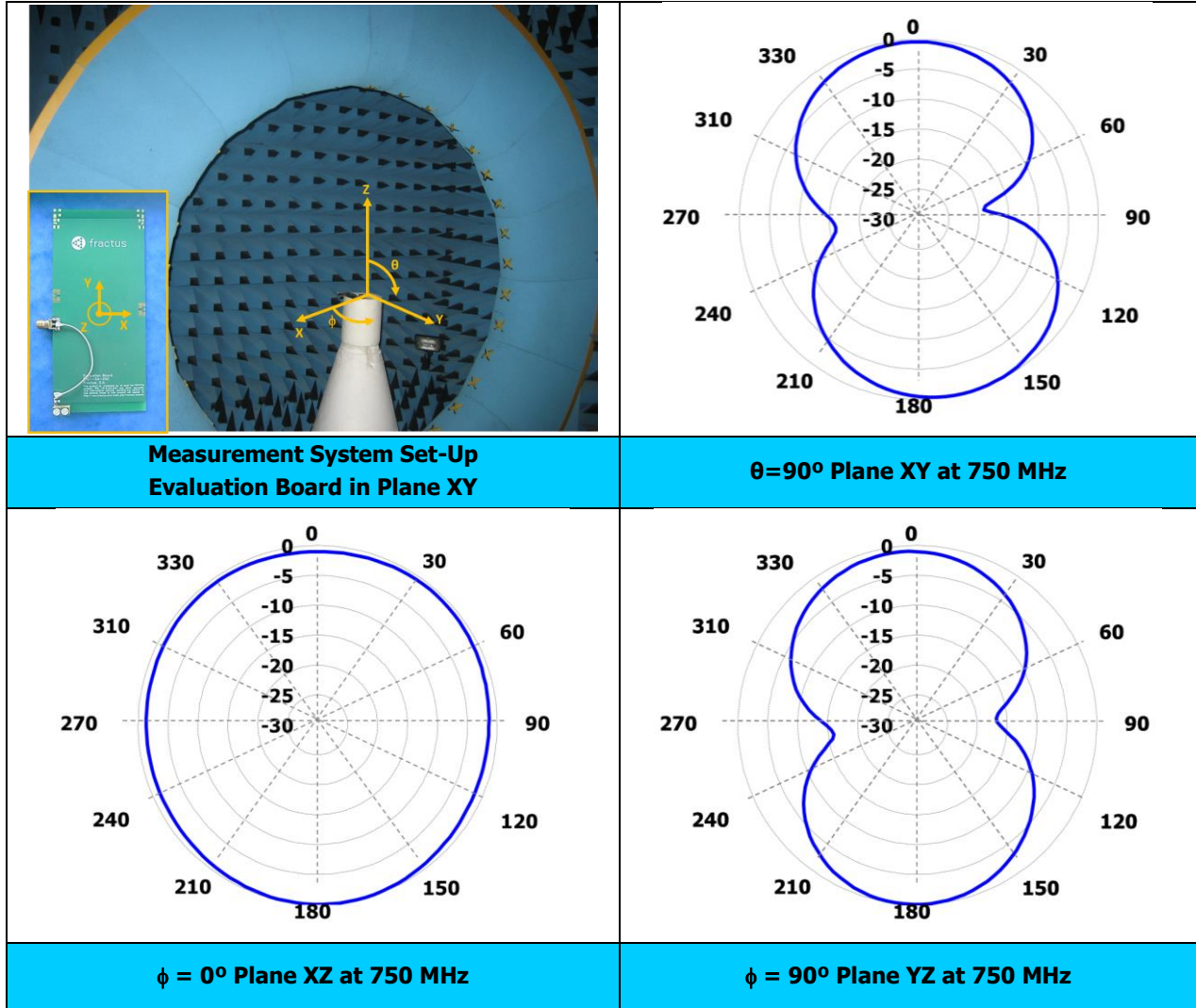


**Figure 4** – VSWR and Total Efficiency for the Evaluation Board with coplanar transmission lines.  
Part Number: EB\_FR01-S4-250-CPW1R-700.

**Note:** The Satimo STARGATE 32 anechoic chamber measures from 700 MHz.



**2.2.3. RADIATION PATTERNS (698 - 798 MHz), GAIN, AND EFFICIENCY**



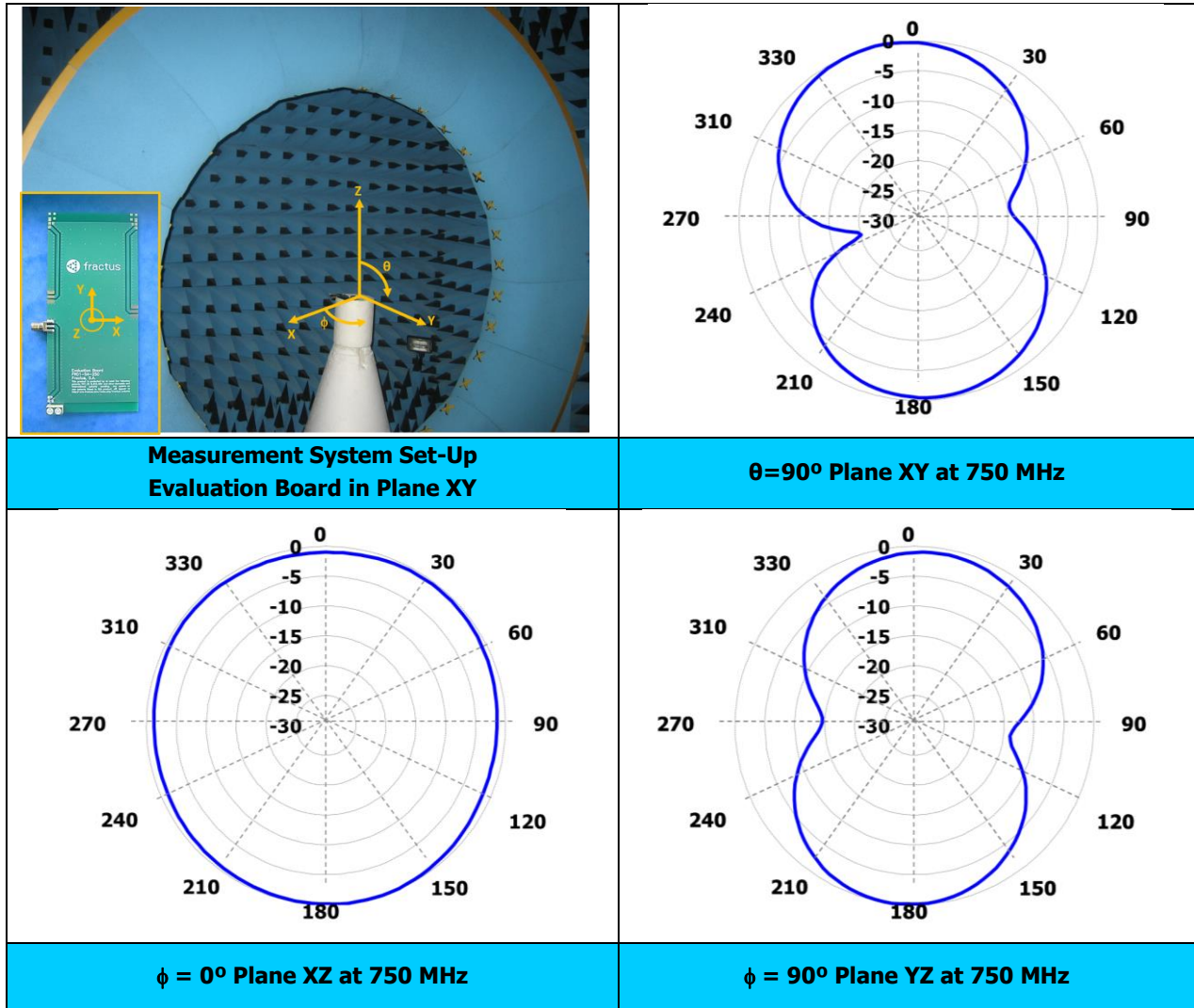
<b>Gain</b>	<b>Peak Gain</b>	0.2 dBi
	<b>Average Gain across the band</b>	-0.5 dBi
	<b>Gain Range across the band (min, max)</b>	-1.8 <-> 0.2 dBi
<b>Efficiency</b>	<b>Peak Efficiency</b>	56.0 %
	<b>Average Efficiency across the band</b>	47.6 %
	<b>Efficiency Range across the band</b>	37.1 - 56.0 %

**Table 2** – Antenna Gain and Total Efficiency for the Evaluation Board EB\_FR01-S4-250-UFL1R-700 within the 698-798 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.





**2.2.4. RADIATION PATTERNS (698 - 798 MHz), GAIN, AND EFFICIENCY**



<b>Gain</b>	<b>Peak Gain</b>	0.1 dBi
	<b>Average Gain across the band</b>	-0.7 dBi
	<b>Gain Range across the band (min, max)</b>	-1.4 <-> 0.1 dBi
<b>Efficiency</b>	<b>Peak Efficiency</b>	49.7%
	<b>Average Efficiency across the band</b>	45.7 %
	<b>Efficiency Range across the band</b>	40.1 - 49.7%

**Table 3** – Antenna Gain and Total Efficiency for the Evaluation Board EB\_FR01-S4-250-CPW1R-700 within the 698-798 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.



## 3. EVALUATION BOARDS 1 PORT (GSM850-GSM900)

### 3.1. QUICK REFERENCE GUIDE

Technical features	Evaluation Board with UFL cables	Evaluation Board with coplanar transmission lines
Frequency Range	824 - 960 MHz	
Average Efficiency	> 50 %	> 50 %
Peak Gain	1.0 dBi	1.2 dBi
VSWR	< 3:1	
Radiation Pattern	Omnidirectional	
Polarization	Linear	
Weight (approx.)	0.25 g.	
Temperature	-40 to + 85 °C	
Impedance	50 $\Omega$	
Dimensions (L x W x H)	5.0 mm x 5.0 mm x 5.0 mm	

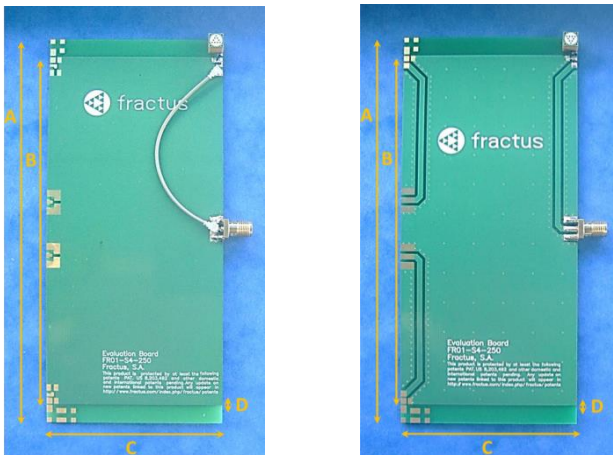
**Table 4** – Technical features. Measures from the Evaluation Board (133 mm x 60 mm x 1 mm). See Figure 5. Note that for obtaining comparable results, a ground plane length larger than 100 mm is recommended.

Please contact [info@fractus.com](mailto:info@fractus.com) for more information related to the Antenna Booster matching service.



### 3.2. EVALUATION BOARDS 1 PORT (GSM850-GSM900)

This section depicts two different Evaluation Boards. The first one is built with UFL cables to connect the mXTEND™ Antenna Booster with the SMA connector. The part number is EB\_FR01-S4-250-UFL1R-850 and it is shown in the left picture of the Figure 5. The second Evaluation Board is made with coplanar grounded transmission lines (traces on a PCB) to connect the mXTEND™ Antenna Booster with the SMA connector. The part number is EB\_FR01-S4-250-CPW1R-850 and it is shown in the right picture of the Figure 5.



Measure	mm
<b>A</b>	133
<b>B</b>	120
<b>C</b>	60
<b>D</b>	1.5

Tolerance: ±0.2 mm

**D:** Distance between the mXTEND™ Antenna Booster and the ground plane.

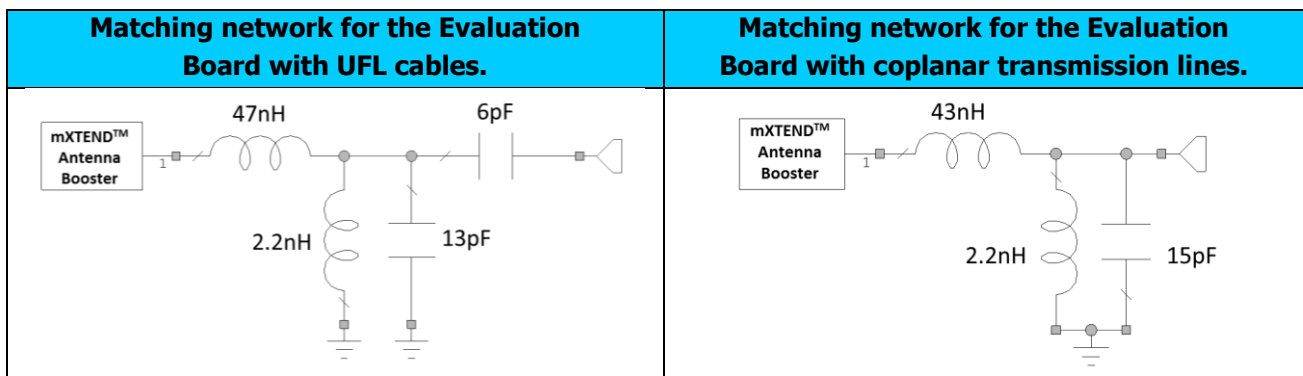
**Material:** The Evaluation Boards are built on FR4 substrate. Thickness is 1 mm.

**Figure 5** – Evaluation Boards providing operation at GSM850-GSM900, 1 port configuration.

This product is protected by at least the following patent PAT. US 8,203,492 and other domestic and international patents pending. Any update on new patents linked to this product will appear in <http://www.fractus.com/index.php/fractus/patents>

#### 3.2.1. MATCHING NETWORKS

The specs of a Fractus 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 to place 0402 pads 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 mXTEND™ Antenna Booster once the design is finished and taking into account all elements of the system. Please notice that different devices with different ground planes and components nearby the mXTEND™ Antenna Booster may need a different matching network. To ensure optimal results, the use of high Q and tight tolerance components is highly recommended (Murata components).

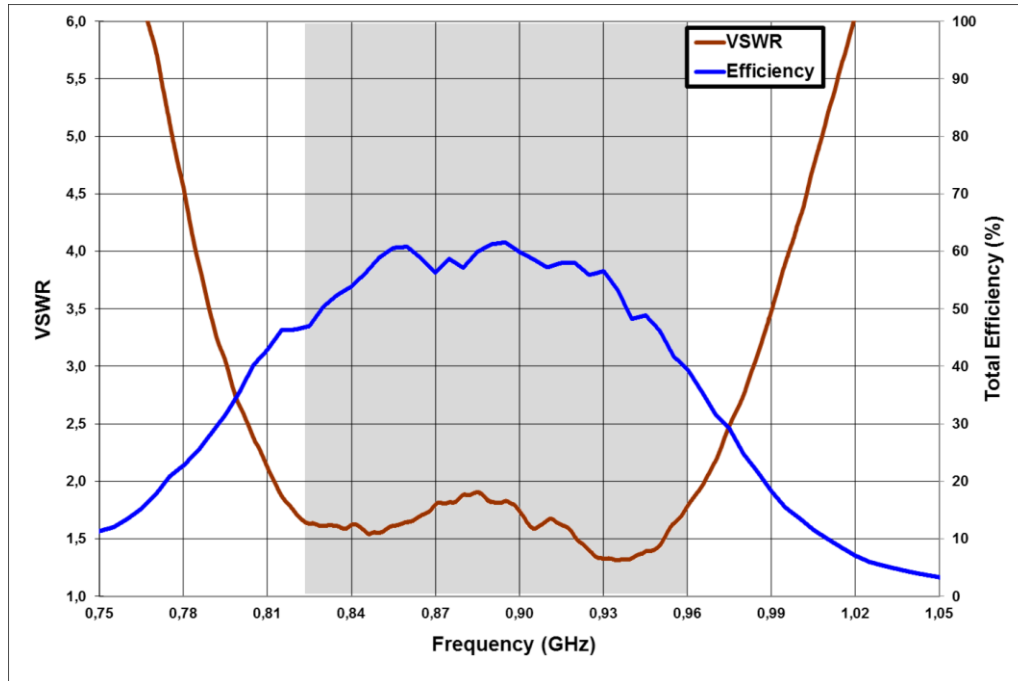


**Figure 6** – Matching networks for the GSM850-GSM900, 1 port configuration.

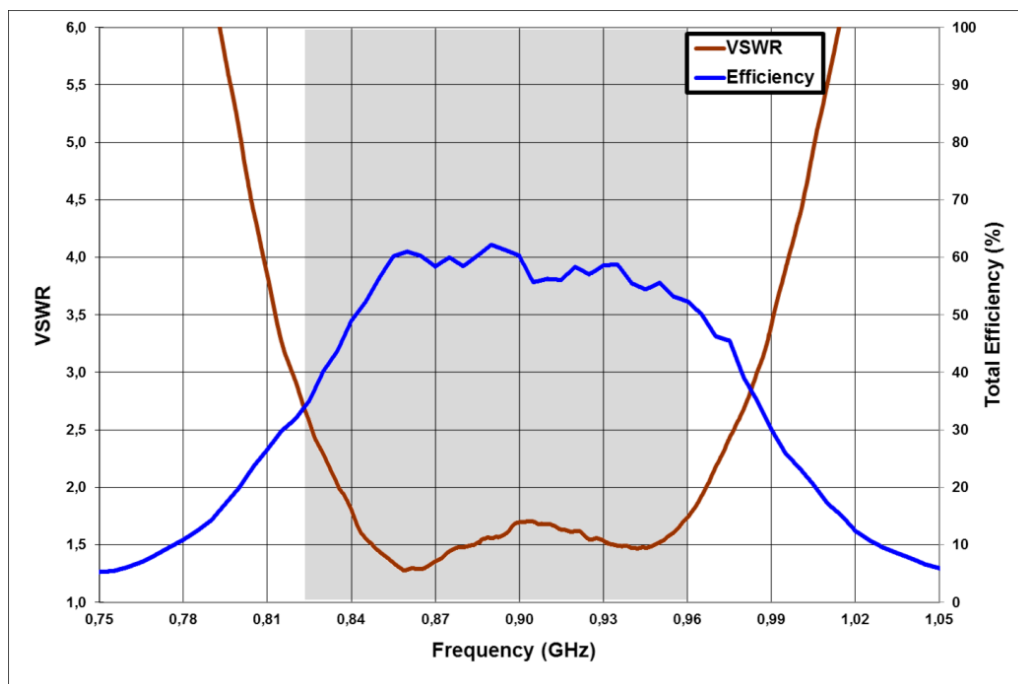


### 3.2.2. VSWR AND TOTAL EFFICIENCY FOR 1 PORT (GSM850-GSM900 MHz)

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



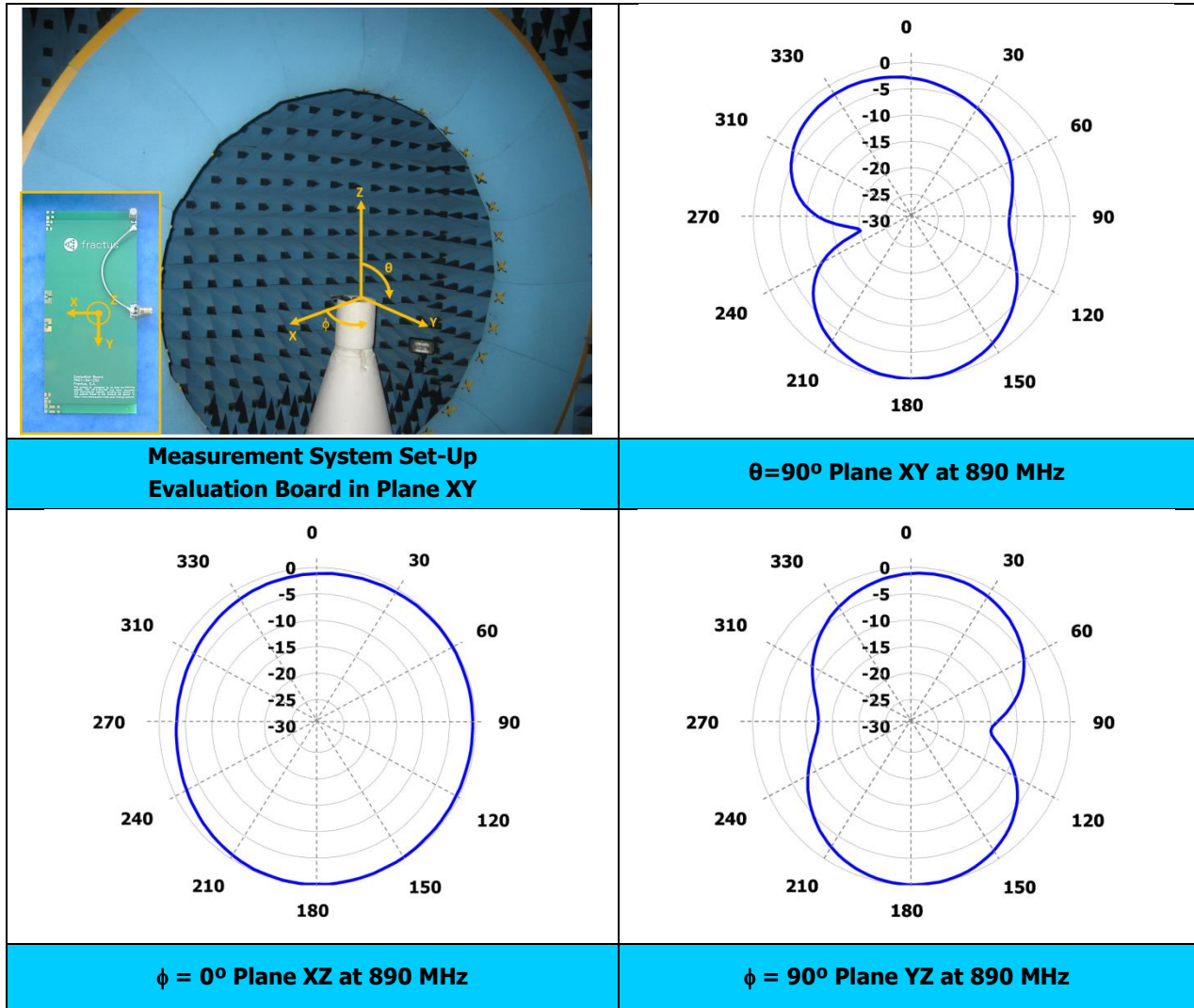
**Figure 7** – VSWR and Total Efficiency for Evaluation Board with UFL cables.  
Part Number: EB\_FR01-S4-250-UFL1R-850.



**Figure 8** - VSWR and Total Efficiency for the Evaluation Board with coplanar transmission lines.  
Part Number: EB\_FR01-S4-250-CPW1R-850.



**3.2.3. RADIATION PATTERNS (824 - 960 MHz), GAIN, AND EFFICIENCY**



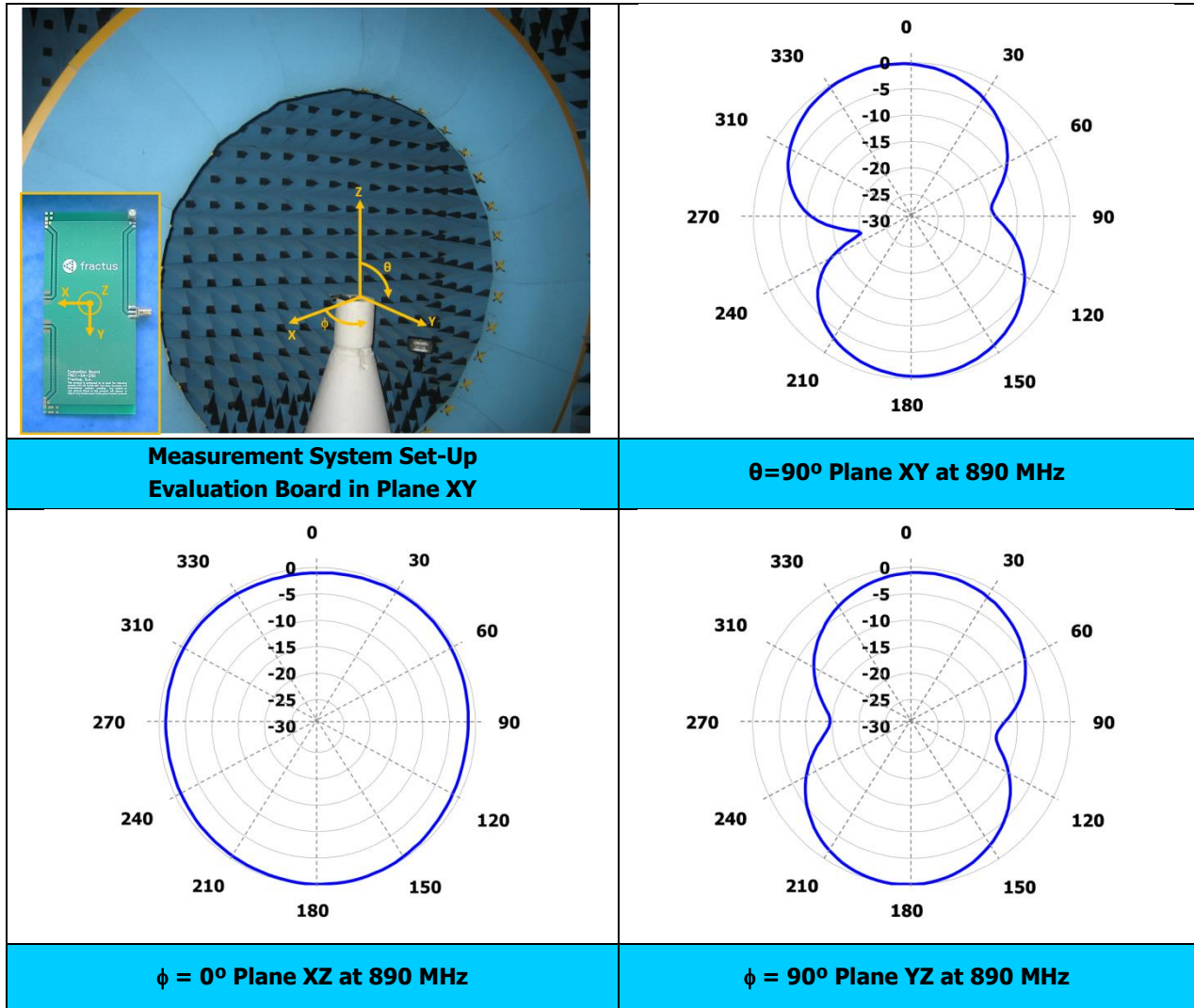
<b>Gain</b>	<b>Peak Gain</b>	1.0 dBi
	<b>Average Gain across the band</b>	0.3 dBi
	<b>Gain Range across the band (min, max)</b>	-1.2 <-> 1.0 dBi
<b>Efficiency</b>	<b>Peak Efficiency</b>	61.6 %
	<b>Average Efficiency across the band</b>	55.2 %
	<b>Efficiency Range across the band</b>	39.5 - 61.6 %

**Table 5** – Antenna Gain and Total Efficiency for the Evaluation Board EB\_FR01-S4-250-UFL1R-850 within the 824-960 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.





**3.2.4. RADIATION PATTERNS (824 - 960 MHz), GAIN, AND EFFICIENCY**



<b>Gain</b>	<b>Peak Gain</b>	1.2 dBi
	<b>Average Gain across the band</b>	0.5 dBi
	<b>Gain Range across the band (min, max)</b>	-1.3 <-> 1.2 dBi
<b>Efficiency</b>	<b>Peak Efficiency</b>	62.2 %
	<b>Average Efficiency across the band</b>	55.6 %
	<b>Efficiency Range across the band</b>	34.4 - 62.2 %

**Table 6** – Antenna Gain and Total Efficiency for the Evaluation Board EB\_FR01-S4-250-CPW1R-850 within the 824-960 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.



## 4. EVALUATION BOARDS 1 PORT (LTE1700-LTE2600)

### 4.1. QUICK REFERENCE GUIDE

Technical features	Evaluation Board with UFL cables	Evaluation Board with coplanar transmission lines
Frequency Range	1710 - 2690 MHz	
Average Efficiency	> 75 %	> 70 %
Peak Gain	3.3 dBi	2.8 dBi
VSWR	< 3:1	
Radiation Pattern	Omnidirectional	
Polarization	Linear	
Weight (approx.)	0.25 g.	
Temperature	-40 to + 85 °C	
Impedance	50 $\Omega$	
Dimensions (L x W x H)	5.0 mm x 5.0 mm x 5.0 mm	

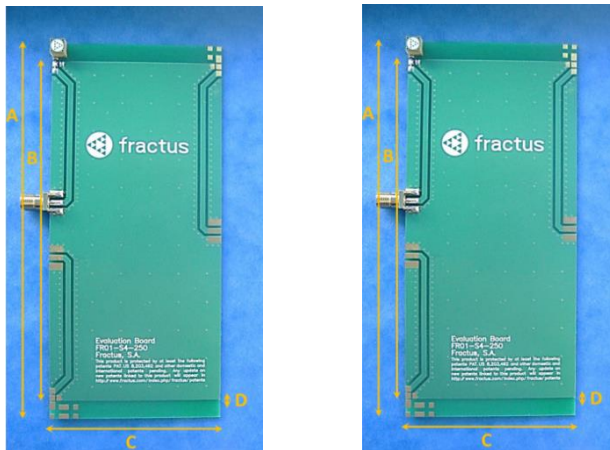
**Table 7** - Technical features. Measures from the Evaluation Board (133 mm x 60 mm x 1 mm). See pictures in Figure 9. Note that for obtaining comparable results, a ground plane length larger than 100 mm is recommended.

Please contact [info@fractus.com](mailto:info@fractus.com) for more information related to the Antenna Booster matching service.



## 4.2. EVALUATION BOARD 1 PORT (LTE1700-LTE2600)

This section depicts two different Evaluation Boards. The first one is built with UFL cables to connect the mXTEND™ Antenna Booster with the SMA connector. The part number is EB\_FR01-S4-250-UFL1R-1700 and it is shown in the left picture of the Figure 9. The second Evaluation Board is made with coplanar grounded transmission lines (traces on a PCB) to connect the mXTEND™ Antenna Booster with the SMA connector. The part number is EB\_FR01-S4-250-CPW1R-1700 and it is shown in the right picture of the Figure 9.



Measure	mm
<b>A</b>	133
<b>B</b>	120
<b>C</b>	60
<b>D</b>	1.5

Tolerance: ±0.2 mm

**D:** Distance between the mXTEND™ Antenna Booster and the ground plane.

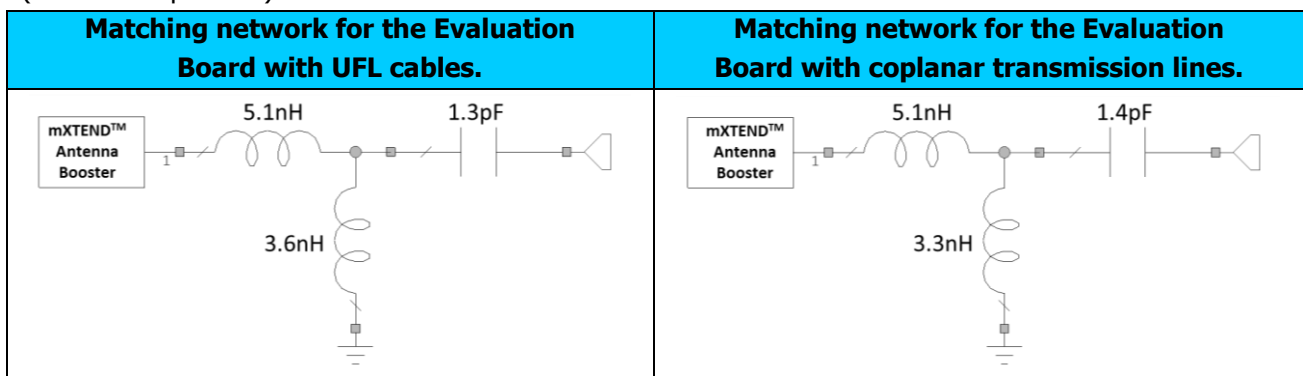
**Material:** The Evaluation Boards are built on FR4 substrate. Thickness is 1 mm.

**Figure 9** – Evaluation Boards providing operation at LTE1700-LTE2600, 1 port configuration.

This product is protected by at least the following patent PAT. US 8,203,492 and other domestic and international patents pending. Any update on new patents linked to this product will appear in <http://www.fractus.com/index.php/fractus/patents>

### 4.2.1. MATCHING NETWORK

The specs of a Fractus 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 to place 0402 pads 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 mXTEND™ Antenna Booster once the design is finished and taking into account all elements of the system. Please notice that different devices with different ground planes and components nearby the mXTEND™ Antenna Booster may need a different matching network. To ensure optimal results, the use of high Q and tight tolerance components is highly recommended (Murata components).



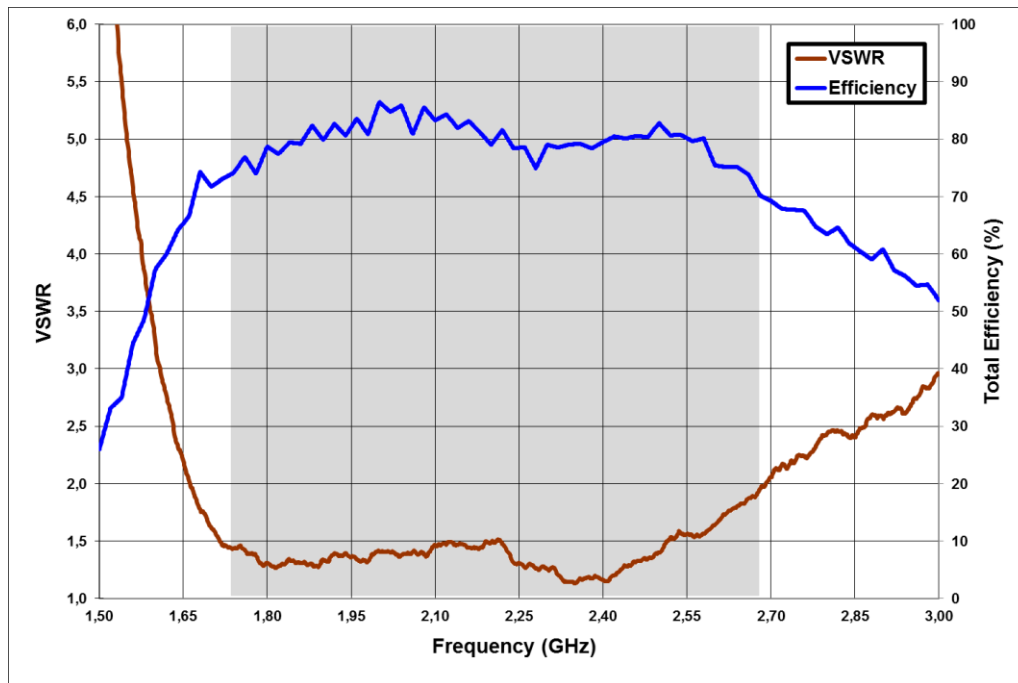
**Figure 10** – Matching networks for the LTE1700-LTE2600, 1 port configuration.



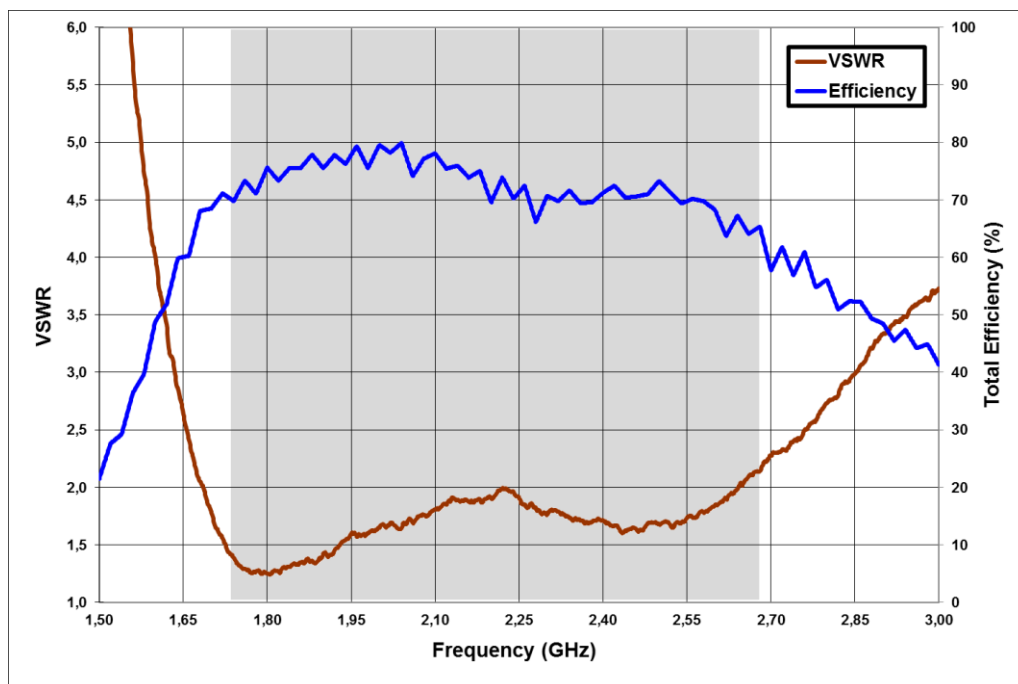


## 4.2.2. VSWR AND TOTAL EFFICIENCY 1 PORT (LTE1700–LTE2600)

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



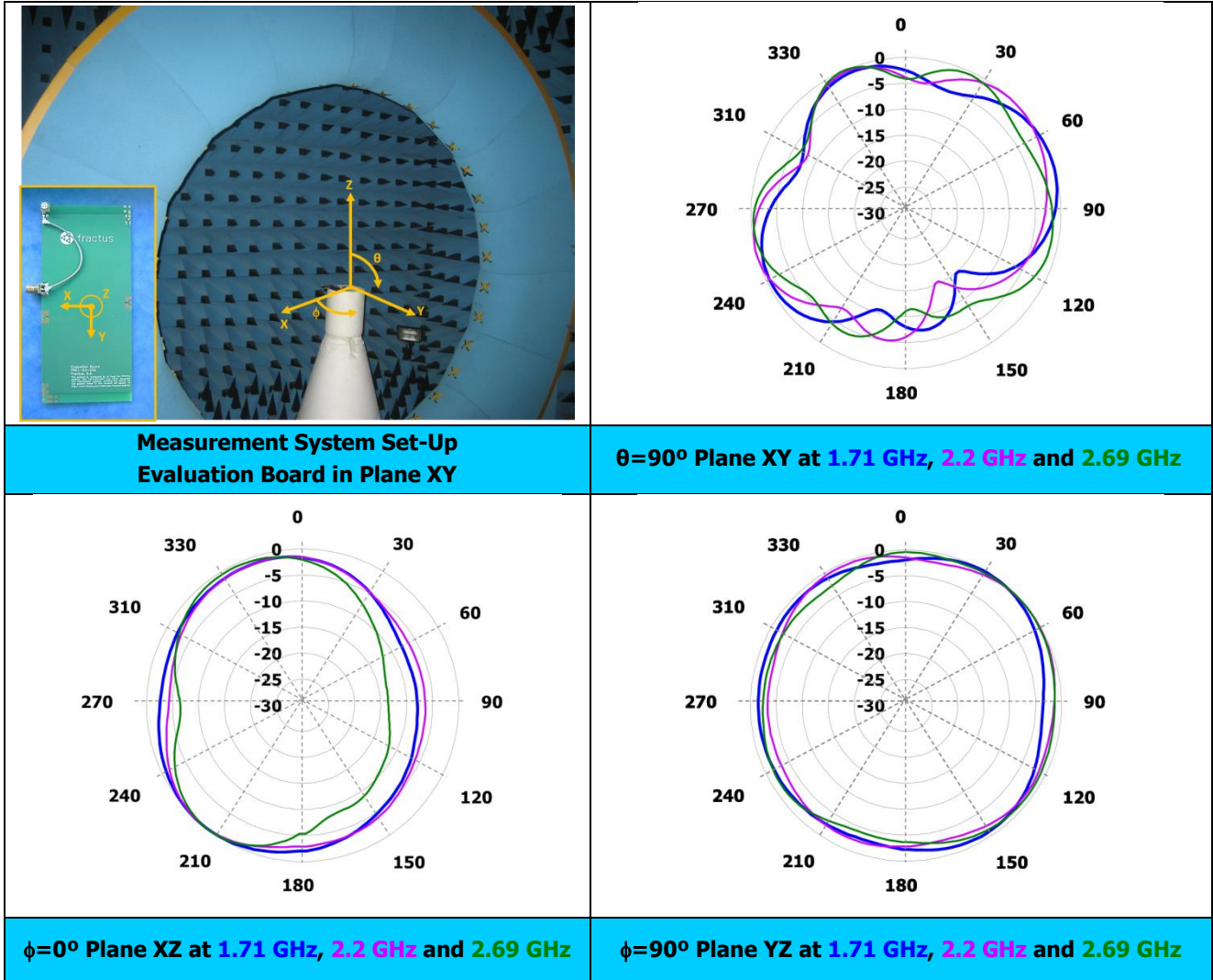
**Figure 11** – VSWR and Total Efficiency for Evaluation Board with UFL cables.  
Part Number: EB\_FR01-S4-250-UFL1R-1700.



**Figure 12** - VSWR and Total Efficiency for the Evaluation Board with coplanar transmission lines.  
Part Number: EB\_FR01-S4-250-CPW1R-1700.



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

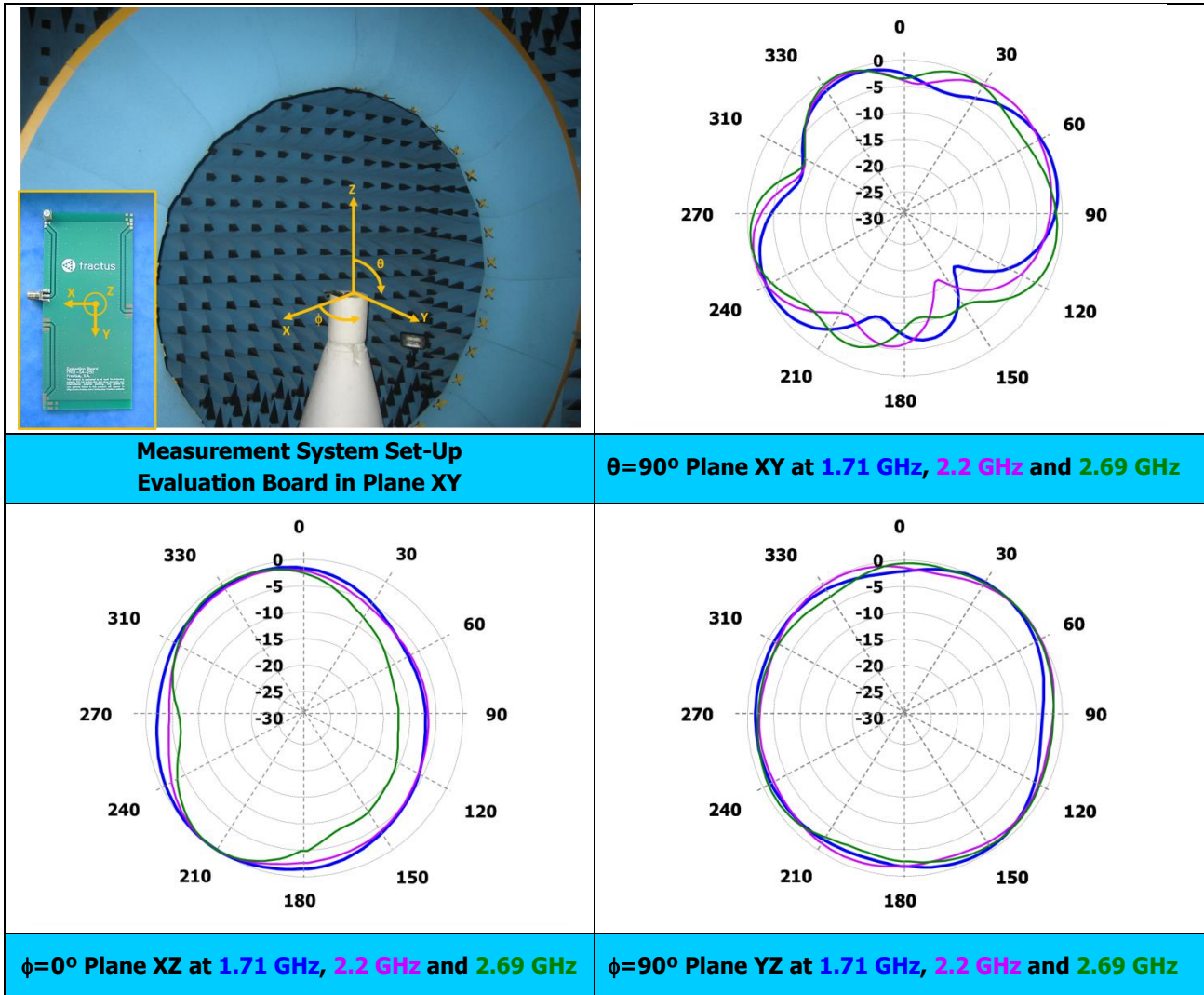


<b>Gain</b>	<b>Peak Gain</b>	3.3 dBi
	<b>Average Gain across the band</b>	2.6 dBi
	<b>Gain Range across the band (min, max)</b>	1.7 <-> 3.3 dBi
<b>Efficiency</b>	<b>Peak Efficiency</b>	86.4 %
	<b>Average Efficiency across the band</b>	79.6 %
	<b>Efficiency Range across the band</b>	69.7 - 86.4 %

**Table 8** – Antenna Gain and Total Efficiency for the Evaluation Board EB\_FR01-S4-250-UFL1R-1700 within the 1710-2690MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.



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



<b>Gain</b>	<b>Peak Gain</b>	2.8 dBi
	<b>Average Gain across the band</b>	2.2 dBi
	<b>Gain Range across the band (min, max)</b>	1.4 <-> 2.8 dBi
<b>Efficiency</b>	<b>Peak Efficiency</b>	79.9 %
	<b>Average Efficiency across the band</b>	72.6 %
	<b>Efficiency Range across the band</b>	61.7 - 79.9 %

**Table 9** – Antenna Gain and Total Efficiency for the Evaluation Board EB\_FR01-S4-250-CPW1R-1700 within the 1710-2690 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.



## 5. EVALUATION BOARDS 2 PORTS

### 5.1. QUICK REFERENCE GUIDE

Technical features	824 - 960 MHz		1710 - 2690 MHz	
	Evaluation Board with UFL cables	Evaluation Board with coplanar transmission lines	Evaluation Board with UFL cables	Evaluation Board with coplanar transmission lines
<b>Average Efficiency</b>	> 50 %	> 50 %	> 70 %	> 70 %
<b>Peak Gain</b>	1.4 dBi	1.3 dBi	3.6 dBi	2.8 dBi
<b>VSWR</b>	< 3:1			
<b>Radiation Pattern</b>	Omnidirectional			
<b>Polarization</b>	Linear			
<b>Weight (approx.)</b>	0.25 g.			
<b>Temperature</b>	-40 to + 85 °C			
<b>Impedance</b>	50 Ω			
<b>Dimensions (L x W x H)</b>	5.0 mm x 5.0 mm x 5.0 mm			

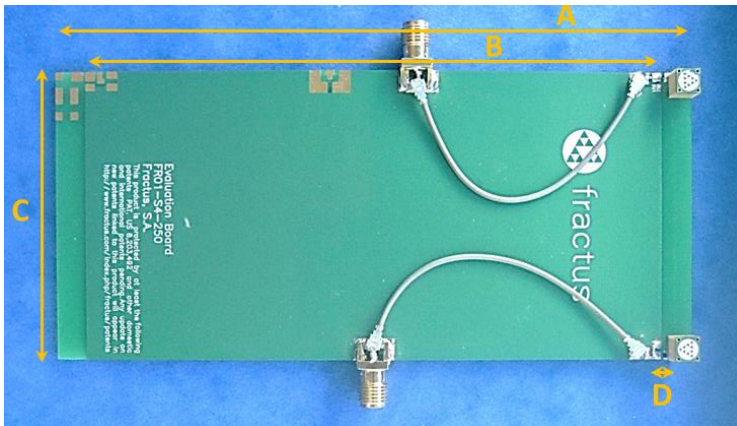
**Table 10** - Technical Features. Measures from the Evaluation Board (133 mm x 60 mm x 1 mm). See Figure 13 and Figure 16. Note that for obtaining comparable results, a ground plane length larger than 100 mm is recommended.

Please contact [info@fractus.com](mailto:info@fractus.com) for more information related to the Antenna Booster matching service.



### 5.2. EVALUATION BOARD 2 PORTS (UFL CABLES)

This Evaluation Board (part number: EB\_FR01-S4-250-UFL2R) integrates UFL cables to connect the mXTEND™ Antenna Booster with the SMA connector. It works from 824 MHz to 960 MHz and from 1710 MHz to 2690 MHz. In the next section (5.3) there is another version of the Evaluation Board where the connections are made through coplanar grounded transmission lines (traces on a PCB) to connect the mXTEND™ Antenna Booster with the SMA connector (part number: EB\_FR01-S4-250-CPW2R).



Measure	mm
<b>A</b>	133
<b>B</b>	120
<b>C</b>	60
<b>D</b>	1.5

Tolerance: ±0.2 mm

**D:** Distance between the mXTEND™ Antenna Booster and the ground plane.

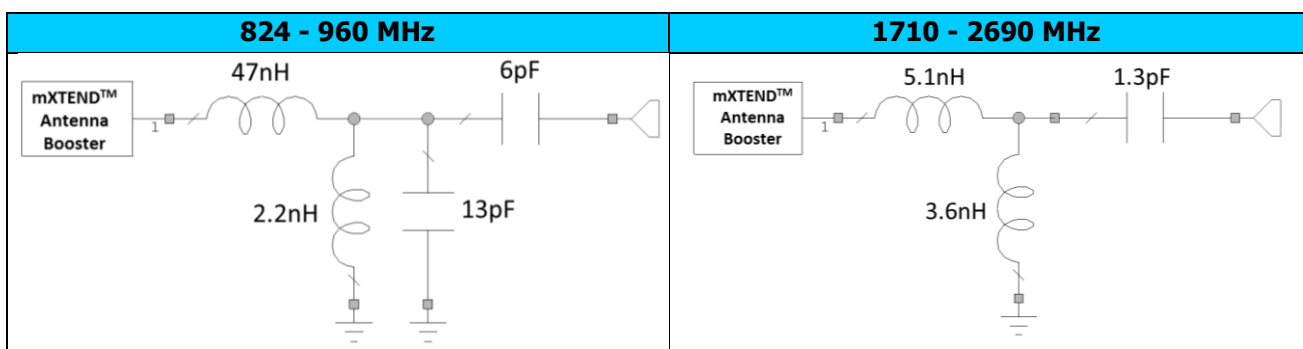
**Material:** The Evaluation Board is built on FR4 substrate. Thickness is 1 mm.

**Figure 13** – EB\_FR01-S4-250-UFL2R. Evaluation Board with UFL cables. From 824 MHz to 960 MHz and from 1710 MHz to 2690 MHz.

This product is protected by at least the following patents PAT. US 8,203,492, PAT. US 8,736,497, and other domestic and international patents pending. Any update on new patents linked to this product will appear in <http://www.fractus.com/index.php/fractus/patents>

#### 5.2.1. MATCHING NETWORK

The specs of a Fractus 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 to place 0402 pads 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 mXTEND™ Antenna Booster once the design is finished and taking into account all elements of the system. Please notice that different devices with different ground planes and components nearby the mXTEND™ Antenna Booster may need a different matching network. To ensure optimal results, the use of high Q and tight tolerance components is highly recommended (Murata components).

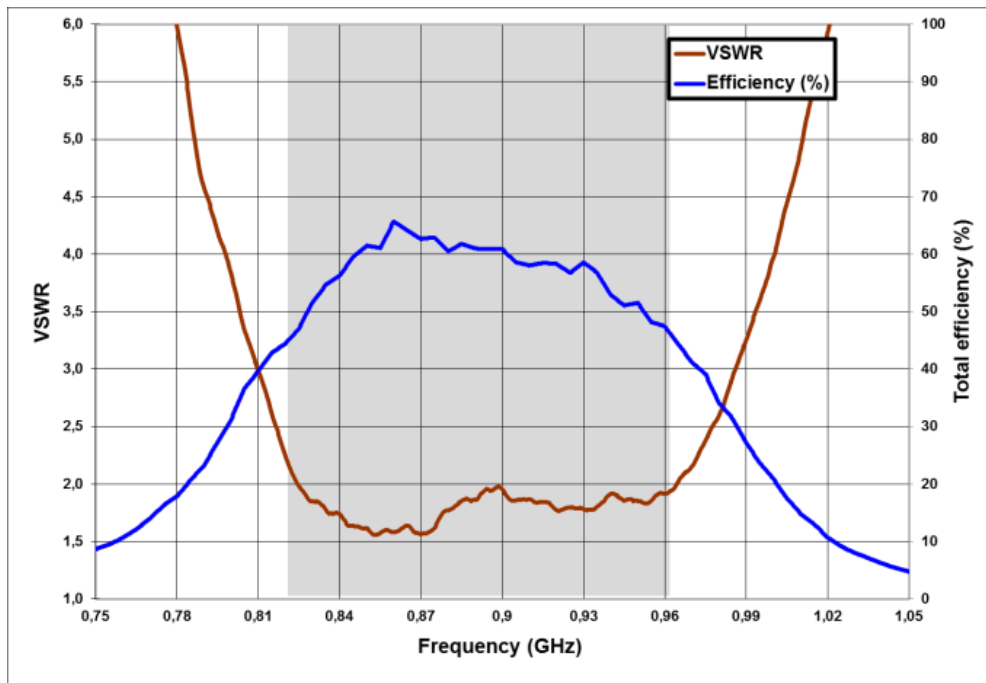


**Figure 14** – Matching networks for the 2 ports solution (Evaluation Board with UFL cables).

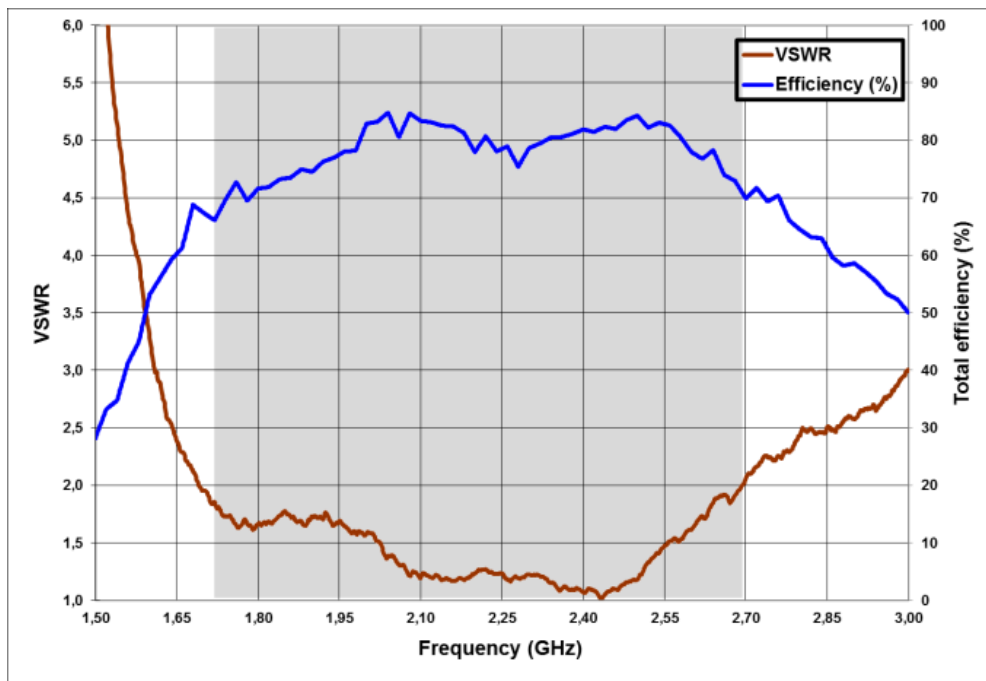


### 5.2.2. VSWR AND TOTAL EFFICIENCY

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



**Figure 15** – VSWR and Total Efficiency for the 824-960 MHz range (from the Evaluation Board with UFL cables (Figure 13)).

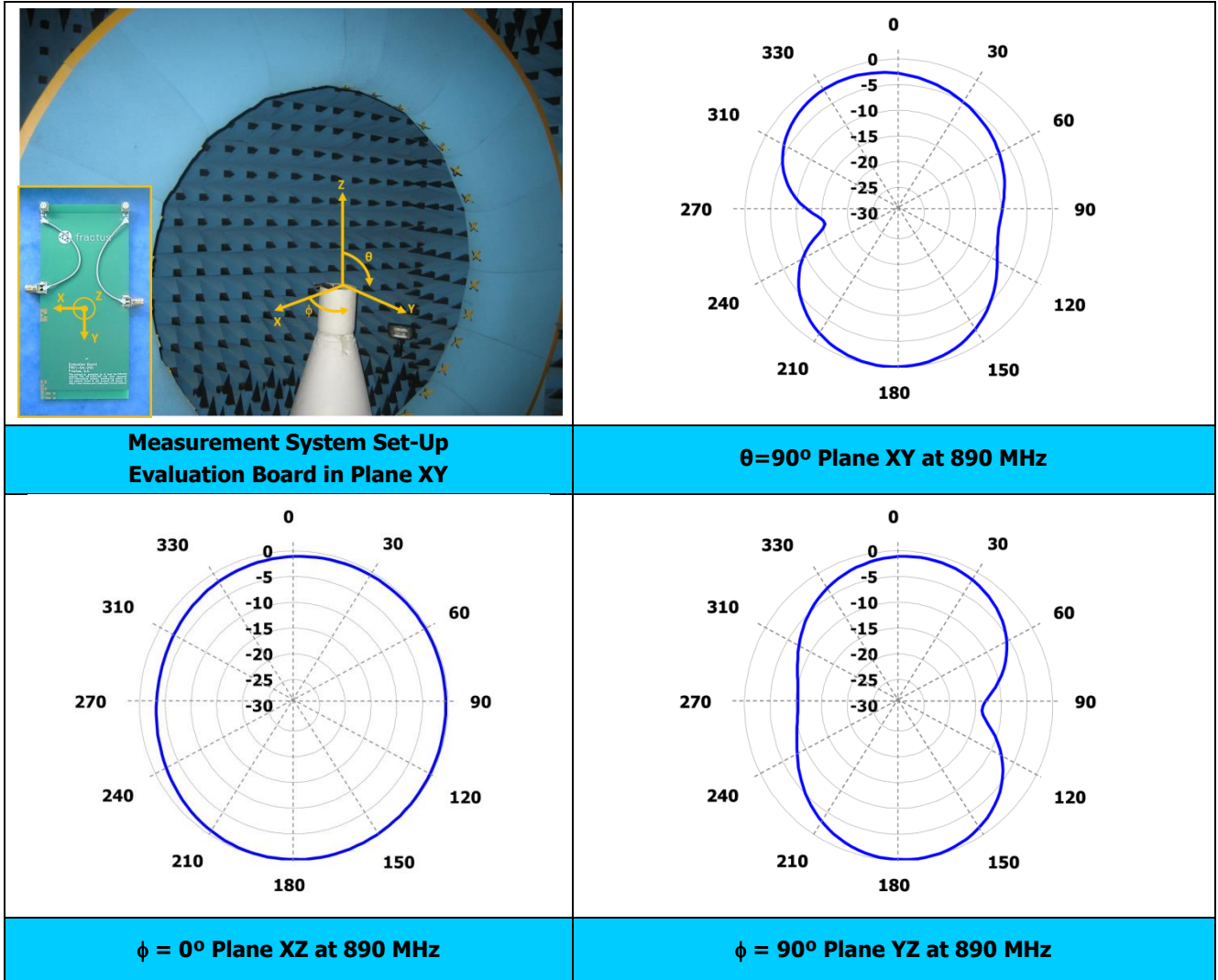


**Figure 16** – VSWR and Total Efficiency for the 1710-2690 MHz range (from the Evaluation Board with UFL cables (Figure 13)).





**5.2.3. RADIATION PATTERNS (824 - 960 MHz), GAIN, AND EFFICIENCY**

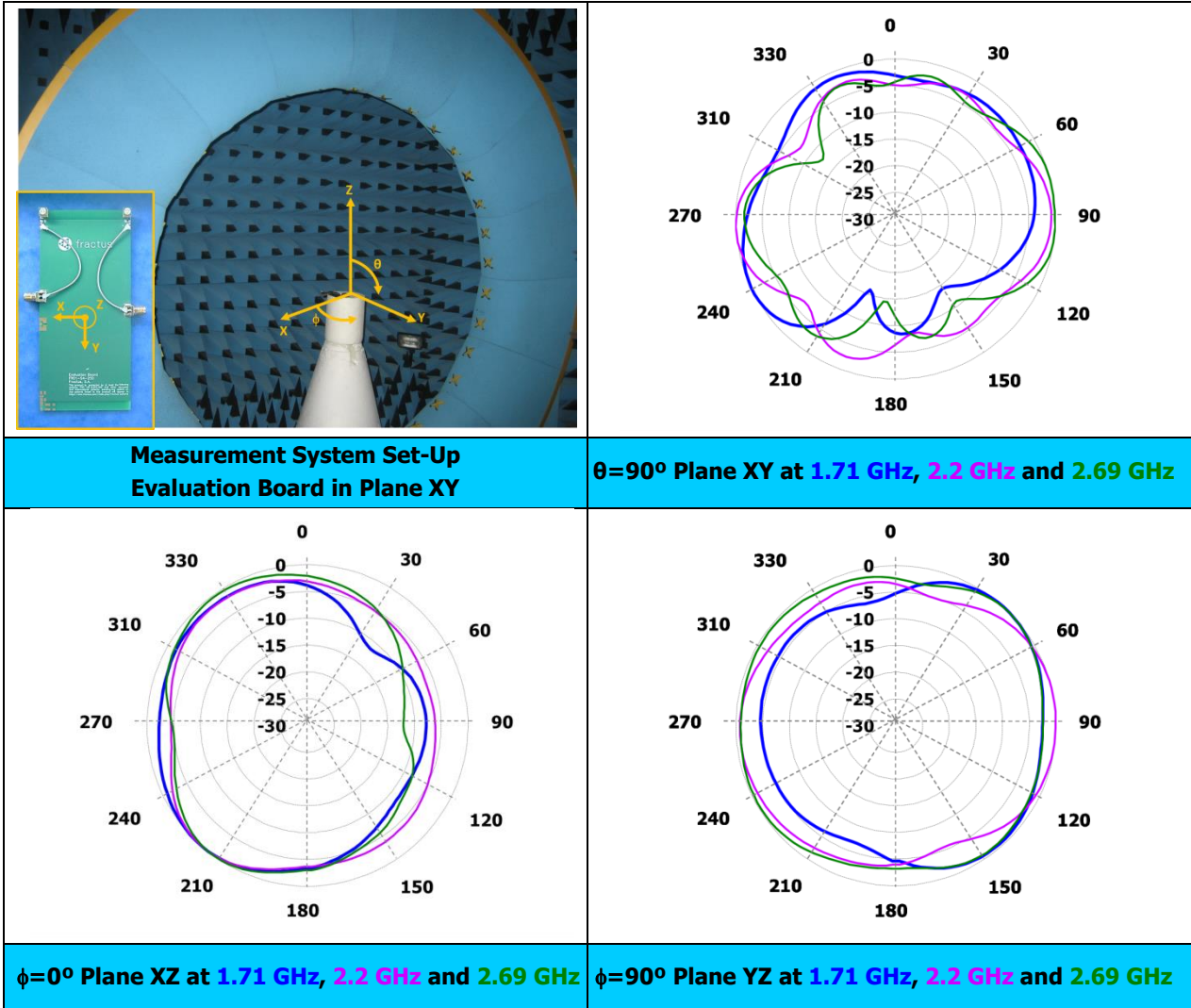


<b>Gain</b>	<b>Peak Gain</b>	1.4 dBi
	<b>Average Gain across the band</b>	0.5 dBi
	<b>Gain Range across the band (min, max)</b>	-0.4 <-> 1.4 dBi
<b>Efficiency</b>	<b>Peak Efficiency</b>	65.7 %
	<b>Average Efficiency across the band</b>	57.7 %
	<b>Efficiency Range across the band</b>	46.3 - 65.7 %

**Table 11**– Antenna Gain and Total Efficiency for the Evaluation Board EB\_FR01-S4-250-UFL2R within the 824-960 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.



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



<b>Gain</b>	<b>Peak Gain</b>	3.6 dBi
	<b>Average Gain across the band</b>	2.6 dBi
	<b>Gain Range across the band (min, max)</b>	1.8 <-> 3.6 dBi
<b>Efficiency</b>	<b>Peak Efficiency</b>	84.8 %
	<b>Average Efficiency across the band</b>	78.6 %
	<b>Efficiency Range across the band</b>	66.2 - 84.8 %

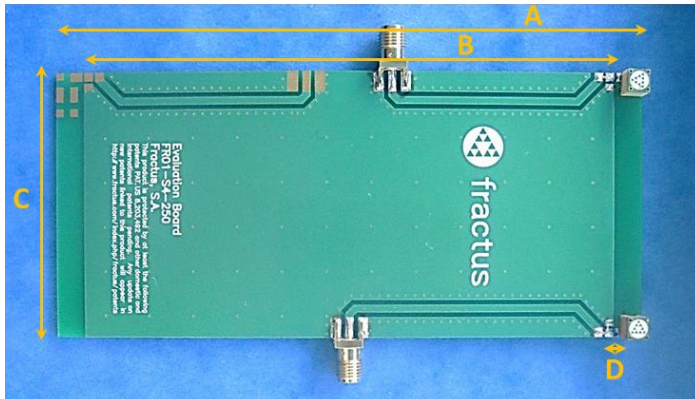
**Table 12** – Antenna Gain and Total Efficiency within the 1710-2690 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.





### 5.3. EVALUATION BOARD 2 PORTS (Coplanar grounded transmission lines)

This Evaluation Board (part number: EB\_FR01-S4-250-CPW2R) integrates coplanar grounded transmission lines to connect the mXTEND™ Antenna Booster with the SMA connector. It works from 824 MHz to 960 MHz and from 1710 MHz to 2690 MHz.



Measure	mm
A	133
B	120
C	60
D	1.5

Tolerance: ±0.2 mm

**D:** Distance between the mXTEND™ Antenna Booster and the ground plane.

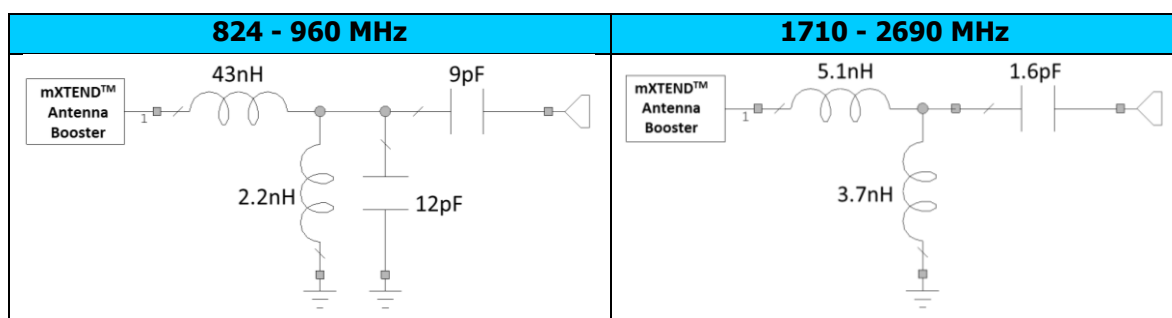
**Material:** The Evaluation Board is built on FR4 substrate. Thickness is 1 mm.

**Figure 16** – EB\_FR01-S4-250-CPW2R. Evaluation Board with coplanar grounded transmission lines. From 824 MHz to 960 MHz and from 1710 MHz to 2690 MHz.

This product is protected by at least the following patents PAT. US 8,203,492, PAT. US 8,736,497, and other domestic and international patents pending. Any update on new patents linked to this product will appear in <http://www.fractus.com/index.php/fractus/patents>

#### 5.3.1. MATCHING NETWORK

The specs of a Fractus 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 to place 0402 pads 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 mXTEND™ Antenna Booster once the design is finished and taking into account all elements of the system. Please notice that different devices with different ground planes and components nearby the mXTEND™ Antenna Booster may need a different matching network. To ensure optimal results, the use of high Q and tight tolerance components is highly recommended (Murata components).

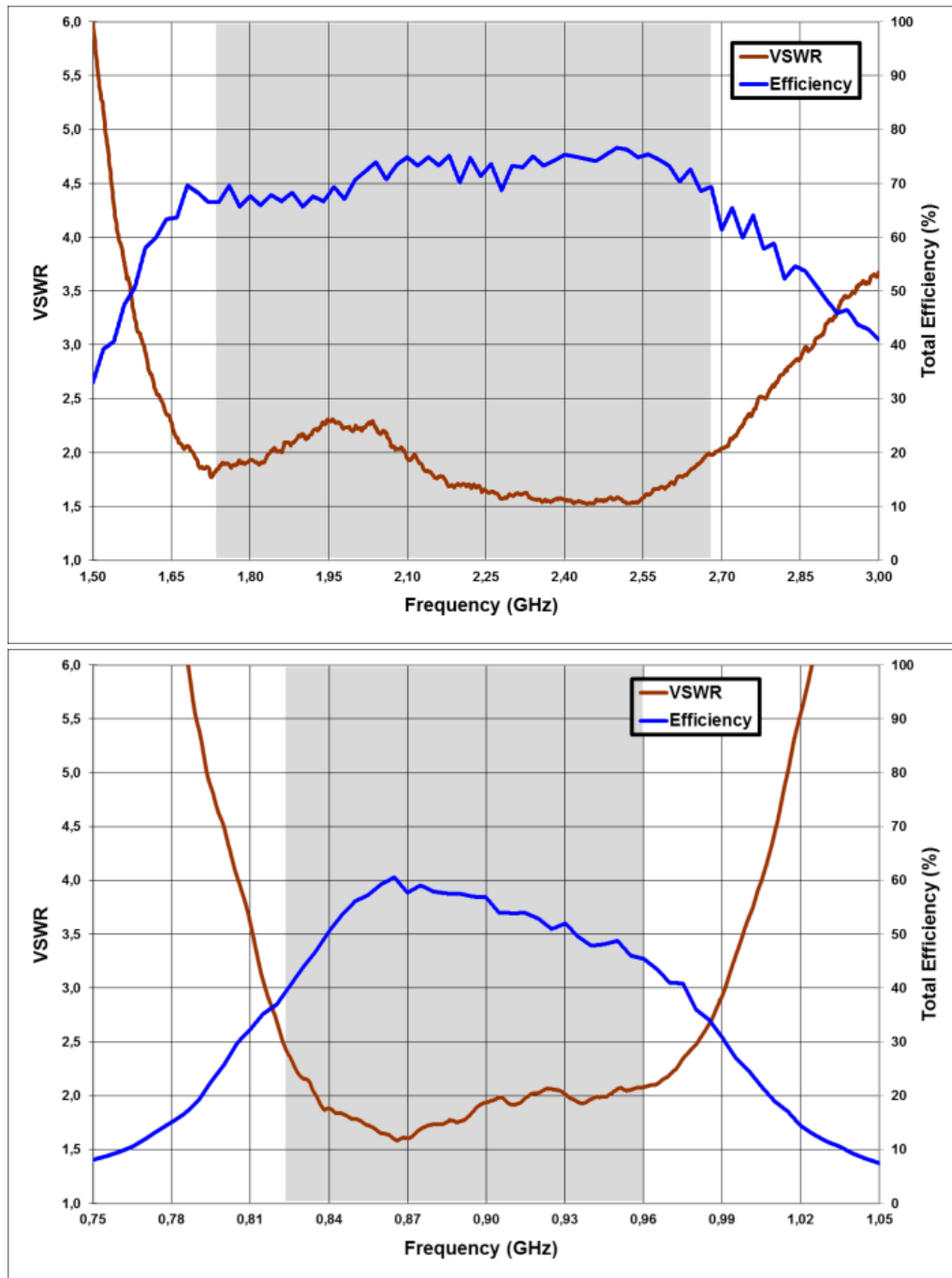


**Figure 17** – Matching networks for the 2 ports solution (Evaluation Board with coplanar transmission lines).



### 5.3.2. VSWR AND TOTAL EFFICIENCY

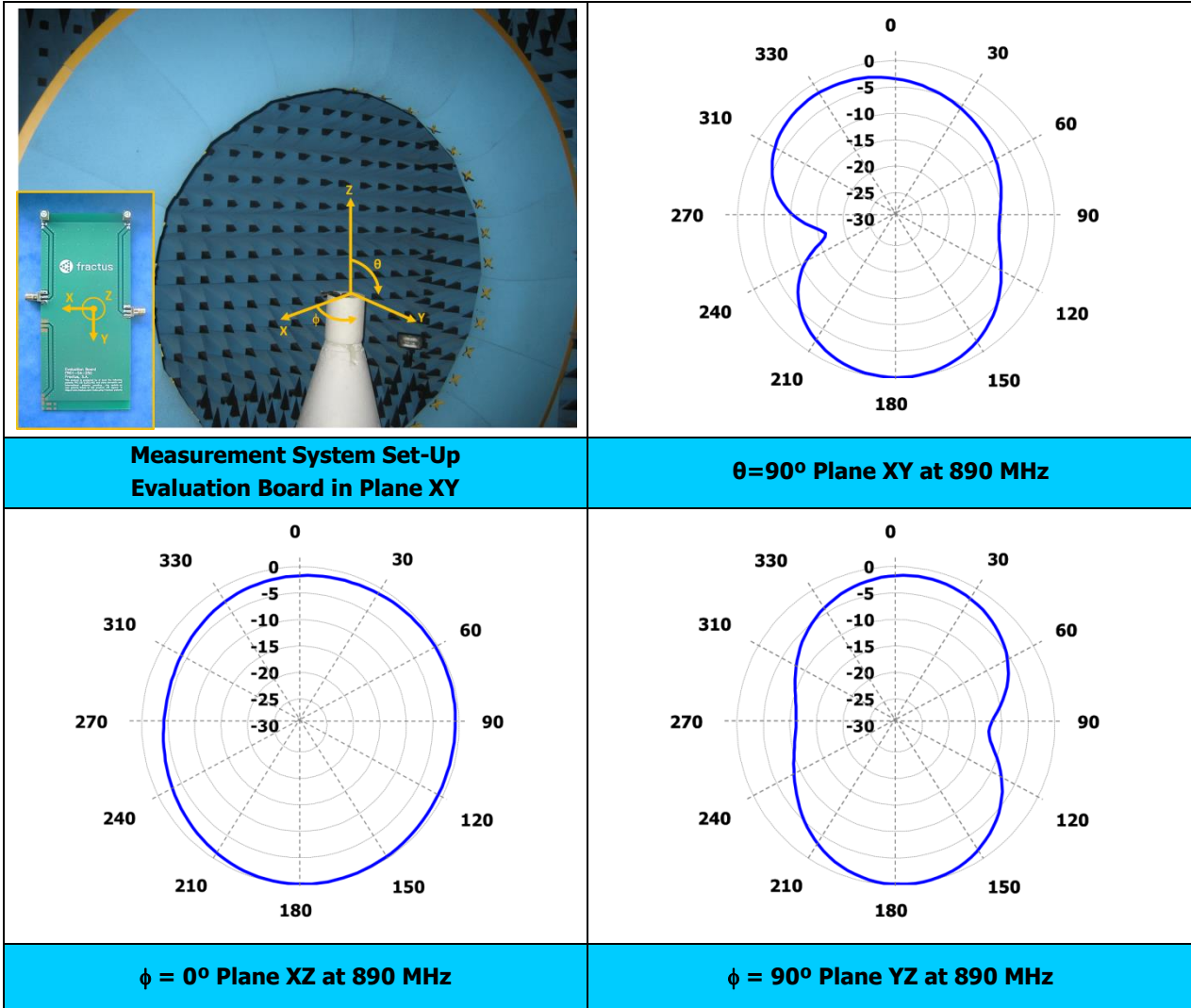
VSWR (Voltage Standing Wave Ratio) and Total Efficiency versus Frequency (GHz)



**Figure 18** – VSWR and Efficiency for the 824-960 MHz range and for the 1710-2690 MHz range from the Evaluation Board with coplanar transmission lines (Figure 16).



**5.3.3. RADIATION PATTERNS (824 - 960 MHz), GAIN, AND EFFICIENCY**

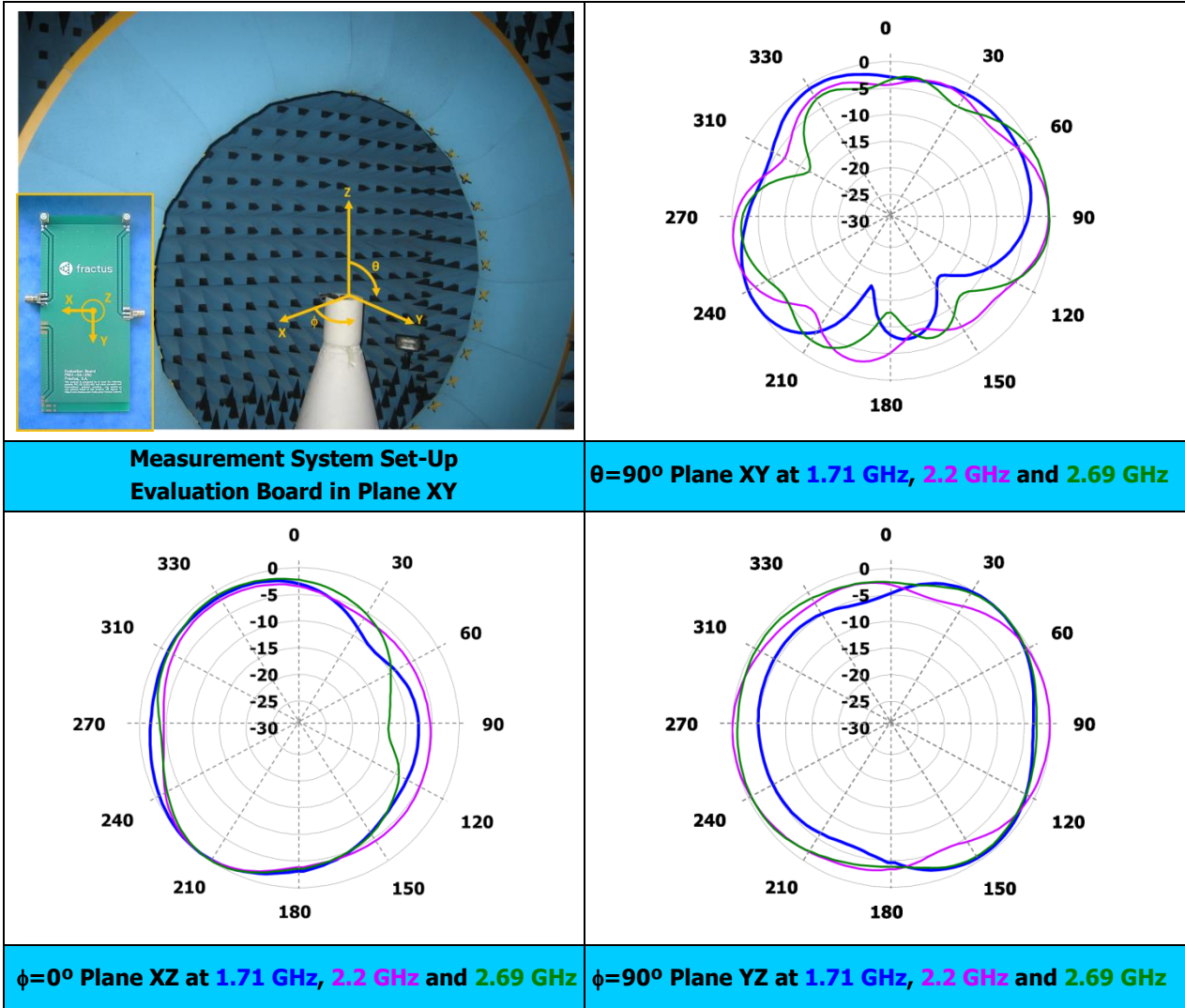


<b>Gain</b>	<b>Peak Gain</b>	1.3 dBi
	<b>Average Gain across the band</b>	0.3 dBi
	<b>Gain Range across the band (min, max)</b>	-0.8 <-> 1.3 dBi
<b>Efficiency</b>	<b>Peak Efficiency</b>	60.6 %
	<b>Average Efficiency across the band</b>	53.0 %
	<b>Efficiency Range across the band</b>	39.7 - 60.6 %

**Table 13** – Antenna Gain and Total Efficiency for the Evaluation Board EB\_FR01-S4-250-CPW2R within the 824-960 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.



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



<b>Gain</b>	<b>Peak Gain</b>	2.8 dBi
	<b>Average Gain across the band</b>	2.3 dBi
	<b>Gain Range across the band (min, max)</b>	1.6 <-> 2.8 dBi
<b>Efficiency</b>	<b>Peak Efficiency</b>	76.6 %
	<b>Average Efficiency across the band</b>	71.5 %
	<b>Efficiency Range across the band</b>	65.1 - 76.6 %

**Table 14** – Antenna Gain and Total Efficiency within the 1710-2690 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.



## 6. EVALUATION BOARDS 3 PORTS

### 6.1. QUICK REFERENCE GUIDE

#### 6.1.1. REFERENCE GUIDE FROM THE EVALUATION BOARD WITH UFL CABLES

Technical features	698 - 798 MHz	824 - 960 MHz	1710 - 2690 MHz
<b>Average Efficiency</b>	> 45 %	> 50 %	> 70 %
<b>Peak Gain</b>	0.6 dBi	0.6 dBi	3.2 dBi
<b>VSWR</b>	< 3:1		
<b>Radiation Pattern</b>	Omnidirectional		
<b>Polarization</b>	Linear		
<b>Weight (approx.)</b>	0.25 g.		
<b>Temperature</b>	-40 to + 85 °C		
<b>Impedance</b>	50 Ω		
<b>Dimensions (L x W x H)</b>	5.0 mm x 5.0 mm x 5.0 mm		

**Table 15** - Technical features. Measures from the Evaluation Board (133 mm x 60 mm x 1 mm). See Figure 19.

#### 6.1.2. REFERENCE GUIDE FROM THE EVALUATION BOARD WITH COPLANAR GROUNDED TRANSMISSION LINES

Technical features	698 - 798 MHz	824 - 960 MHz	1710 - 2690 MHz
<b>Average Efficiency</b>	> 40 %	> 45 %	> 70 %
<b>Peak Gain</b>	-0.2 dBi	1.0 dBi	3.4 dBi
<b>VSWR</b>	< 3:1		
<b>Radiation Pattern</b>	Omnidirectional		
<b>Polarization</b>	Linear		
<b>Weight (approx.)</b>	0.25 g.		
<b>Temperature</b>	-40 to + 85 °C		
<b>Impedance</b>	50 Ω		
<b>Dimensions (L x W x H)</b>	5.0 mm x 5.0 mm x 5.0 mm		

**Table 16** - Technical features. Measures from the Evaluation Board (133 mm x 60 mm x 1 mm). See Figure 23.

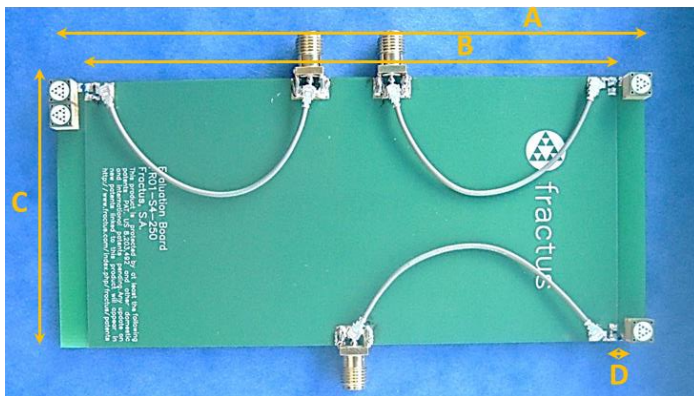


### Comments:

- Note that in the Evaluation Boards (Figure 19 and Figure 23), 2 mXTEND™ Antenna Boosters are placed together to provide operation at LTE700 (698-798 MHz). Please see Figure 29 for the recommended footprint.
- The efficiency measures (Figure 21 and Figure 25) are shown from 700 MHz due to the minimum frequency specifications of the Satimo STARGATE 32 anechoic chamber.
- Note that for obtaining comparable results, a ground plane length larger than 100 mm is recommended.
- Please contact [info@fractus.com](mailto:info@fractus.com) for more information related to the Antenna Booster matching service.

## 6.2. EVALUATION BOARD 3 PORTS (UFL CABLES)

This Evaluation Board (part number: EB\_FR01-S4-250-UFL3R) integrates UFL cables to connect the mXTEND™ Antenna Booster with the SMA connector. It works from 698 MHz to 798 MHz, from 824 MHz to 960 MHz, and from 1710 MHz to 2690 MHz. In the next section (6.3) there is another version of the Evaluation Board where the connections are made through coplanar grounded transmission lines (traces on a PCB) to connect the mXTEND™ Antenna Booster with the SMA connector (part number: EB\_FR01-S4-250-CPW3R).



Measure	mm
A	133
B	120
C	60
D	1.5

Tolerance: ±0.2 mm

**D:** Distance between the mXTEND™ Antenna Booster and the ground plane.

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

**Figure 19** – EB\_FR01-S4-250-UFL3R. Evaluation Board with UFL cables. 698 MHz to 798 MHz, 824 MHz to 960 MHz, and 1710 MHz to 2690 MHz.

This product is protected by at least the following patents PAT. US 8,203,492, PAT. US 8,736,497, and other domestic and international patents pending. Any update on new patents linked to this product will appear in <http://www.fractus.com/index.php/fractus/patents>

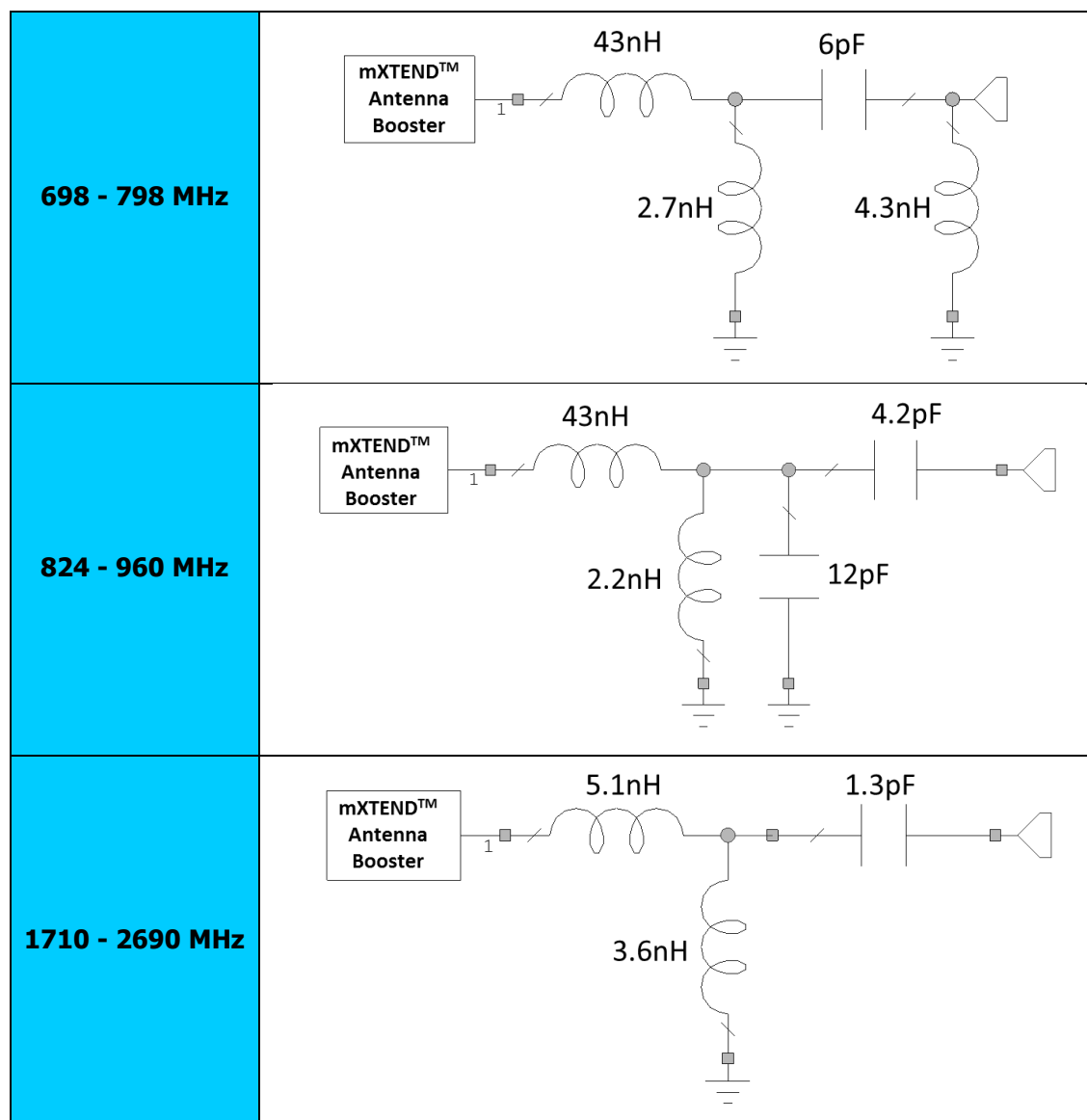




## 6.2.1. MATCHING NETWORK

The specs of a Fractus 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 to place 0402 pads 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 mXTEND™ Antenna Booster once the design is finished and taking into account all elements of the system.

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

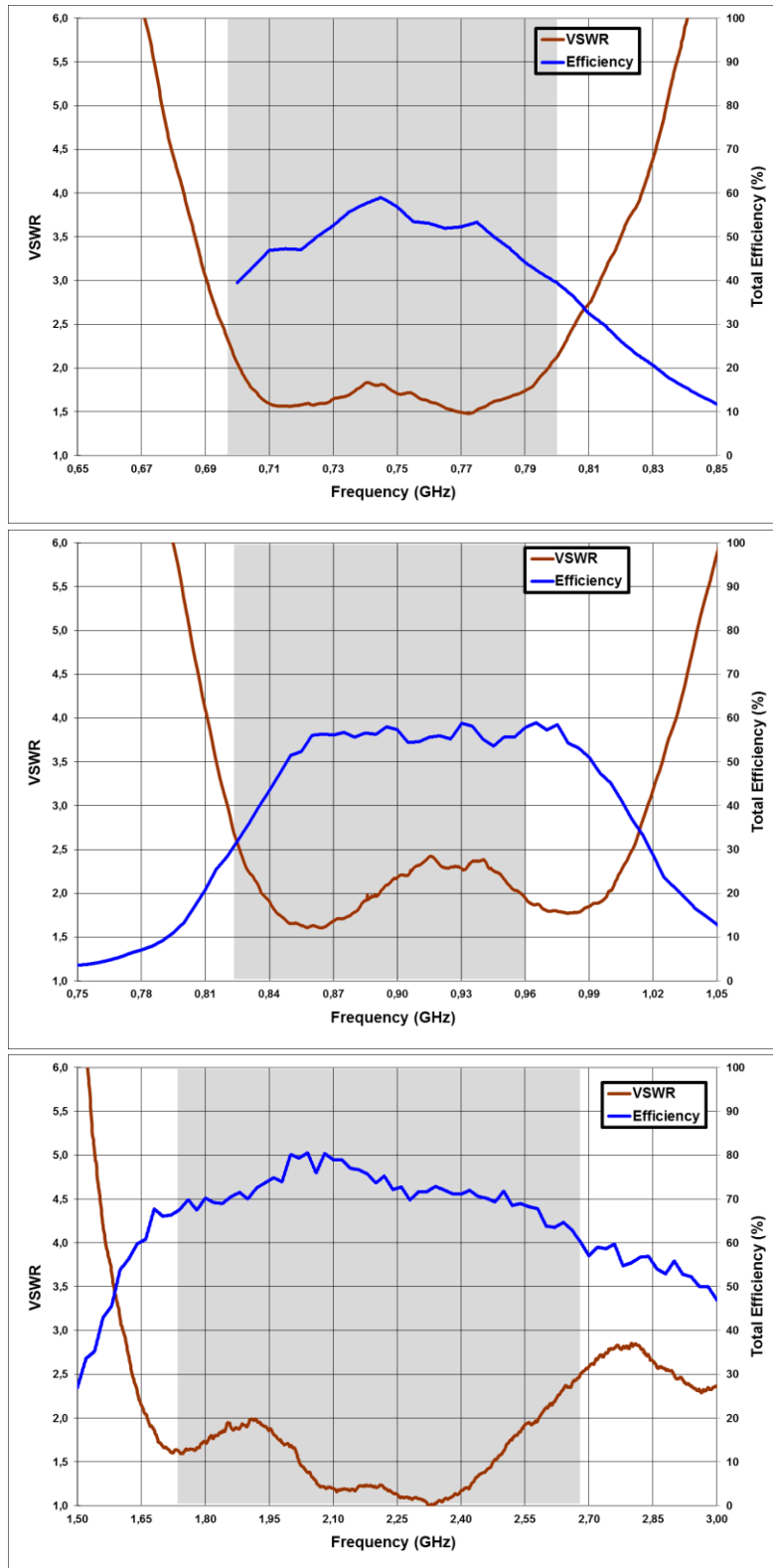


**Figure 20** - Matching networks for the 3 ports solution (Evaluation Board with UFL cables).



### 6.2.2. VSWR AND TOTAL EFFICIENCY

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

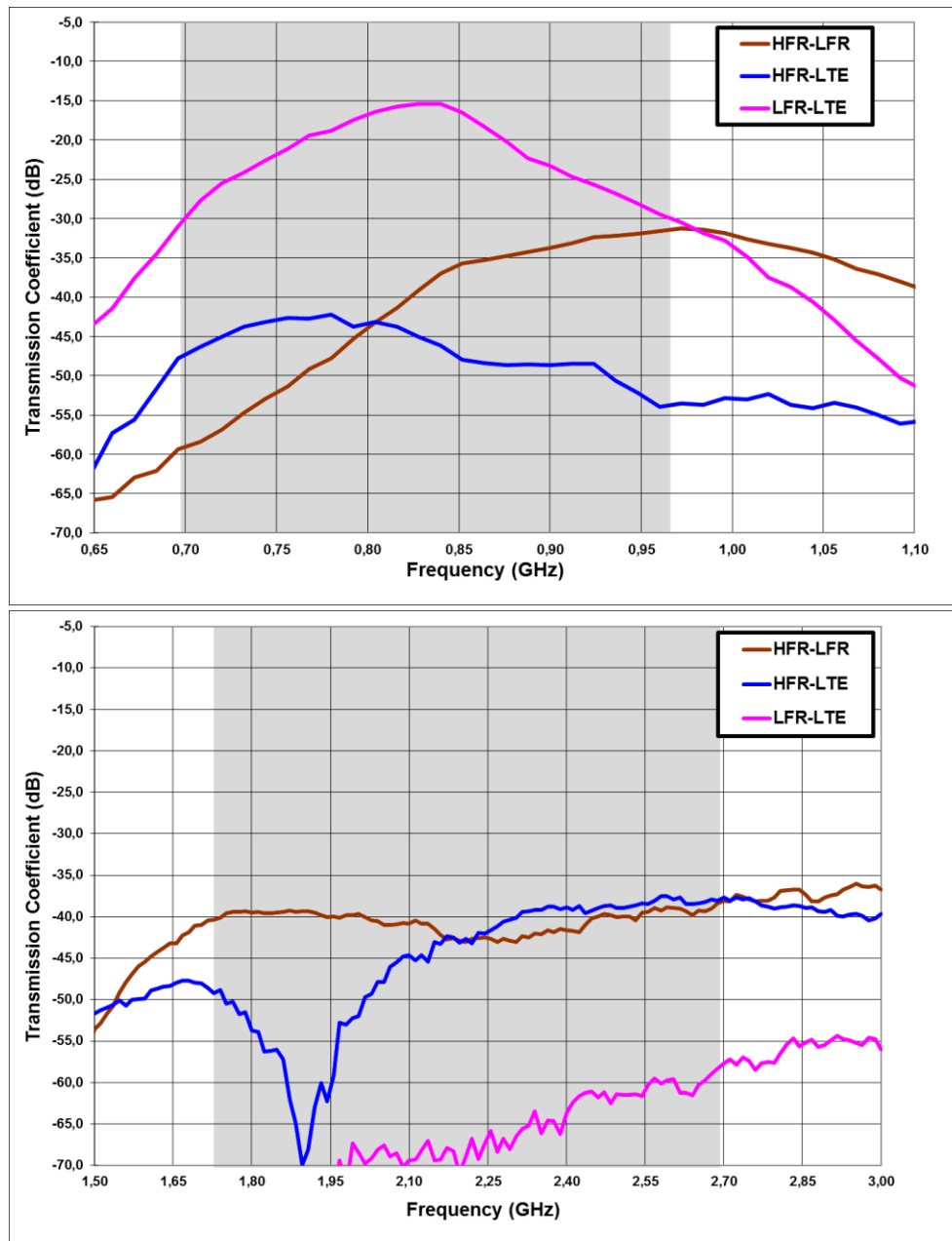


**Figure 21** – VSWR and Total Efficiency for the 698-798 MHz range, for 824-960 MHz range, and for the 1710-2690 MHz range (from the Evaluation Board with UFL cables (Figure 19)).





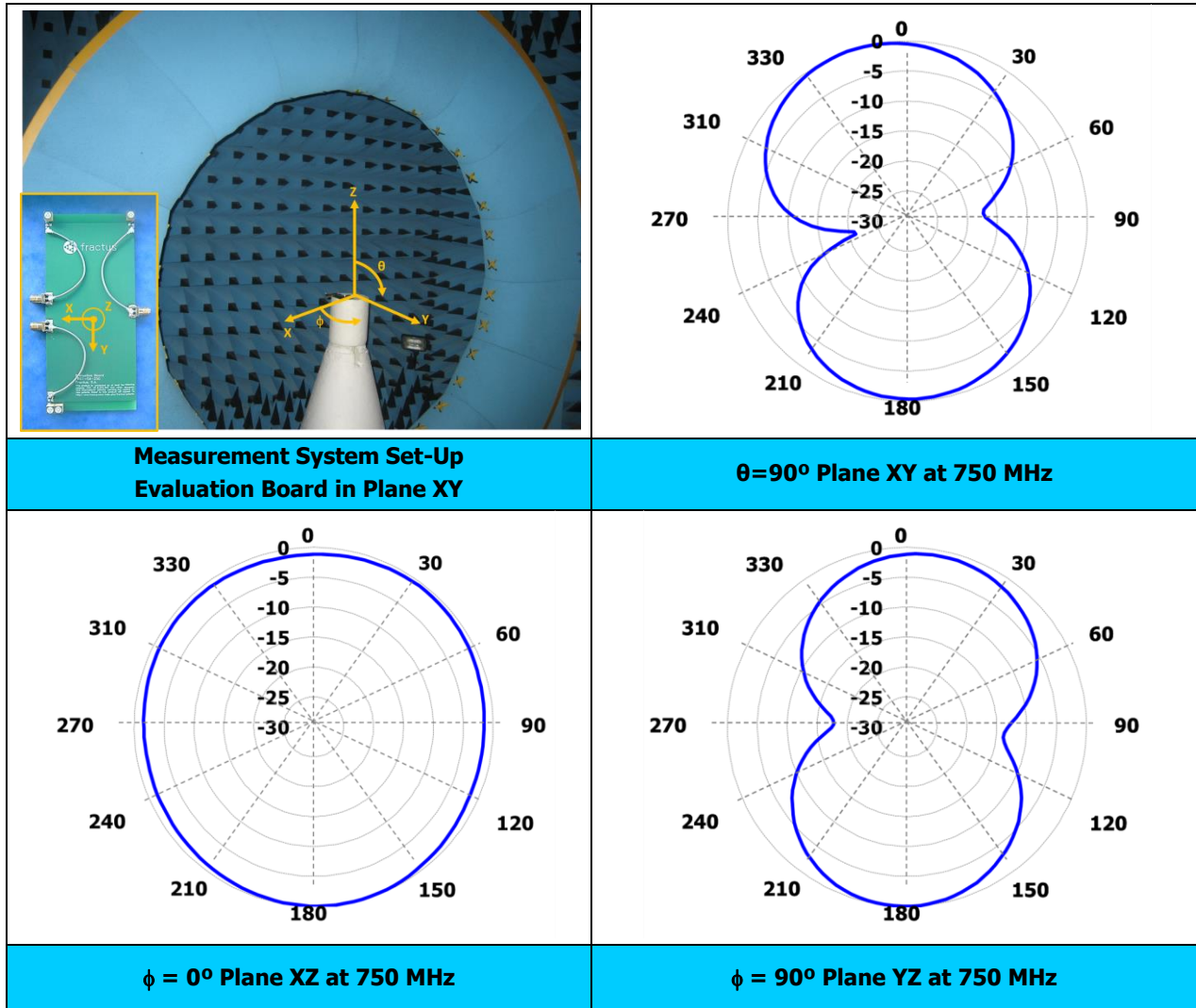
### 6.2.3. TRANSMISSION COEFFICIENT



**Figure 22** – Transmission coefficient for the 698-798 MHz range (LTE), for the 824-960 MHz range (LFR), and for the 1710-2690 MHz range (HFR) (from the Evaluation Board 3 ports with UFL cables) (Figure 19).



**6.2.4. RADIATION PATTERNS (698 - 798 MHz), GAIN, AND EFFICIENCY**

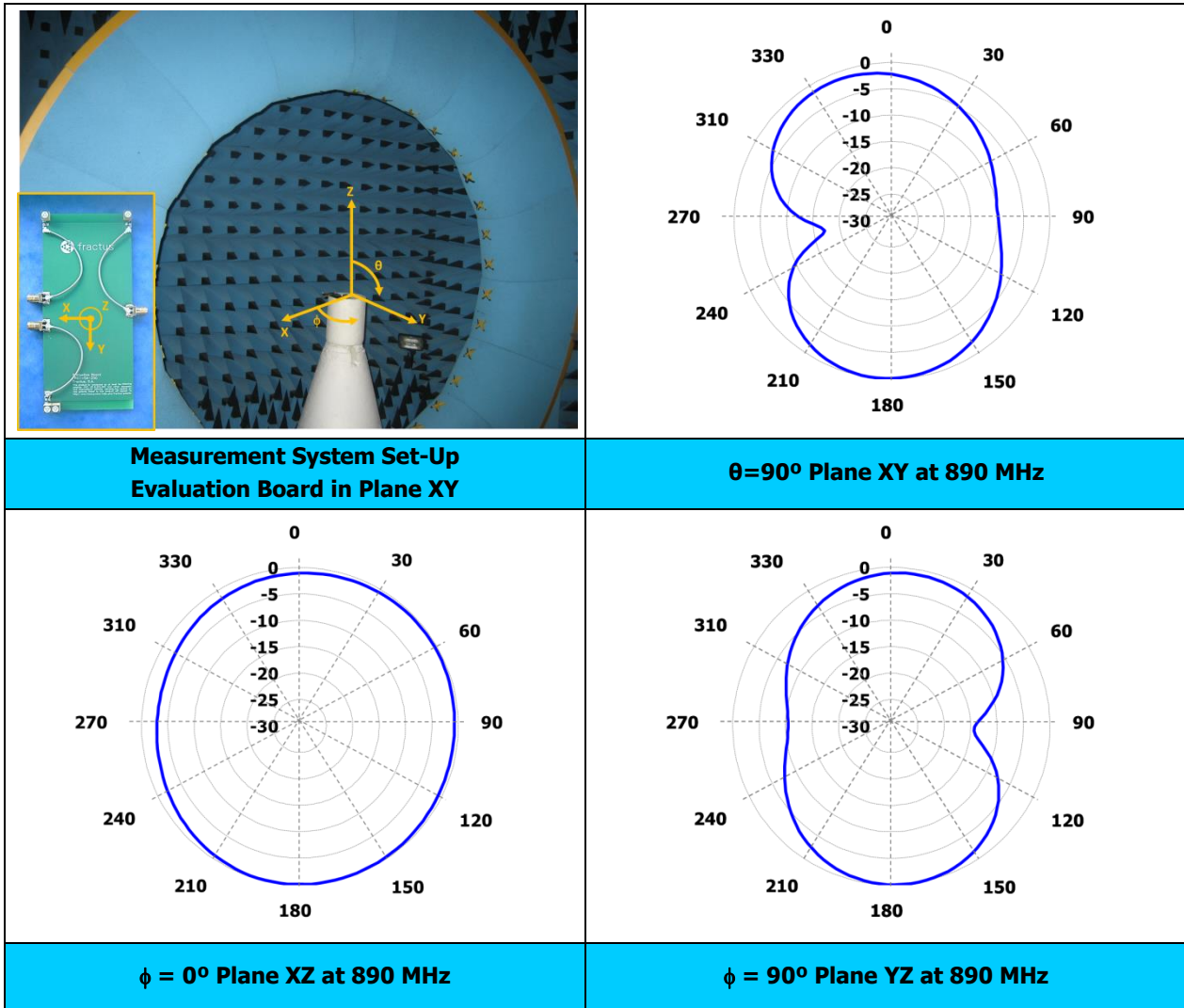


<b>Gain</b>	<b>Peak Gain</b>	0.6 dBi
	<b>Average Gain across the band</b>	-0.2 dBi
	<b>Gain Range across the band (min, max)</b>	-1.5 <-> 0.6 dBi
<b>Efficiency</b>	<b>Peak Efficiency</b>	59.0 %
	<b>Average Efficiency across the band</b>	50.3 %
	<b>Efficiency Range across the band</b>	39.5 - 59.0 %

**Table 17** – Antenna Gain and Total Efficiency for the Evaluation Board EB\_FR01-S4-250-UFL3R within the 698-798 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.



**6.2.5. RADIATION PATTERNS (824 - 960 MHz), GAIN, AND EFFICIENCY**

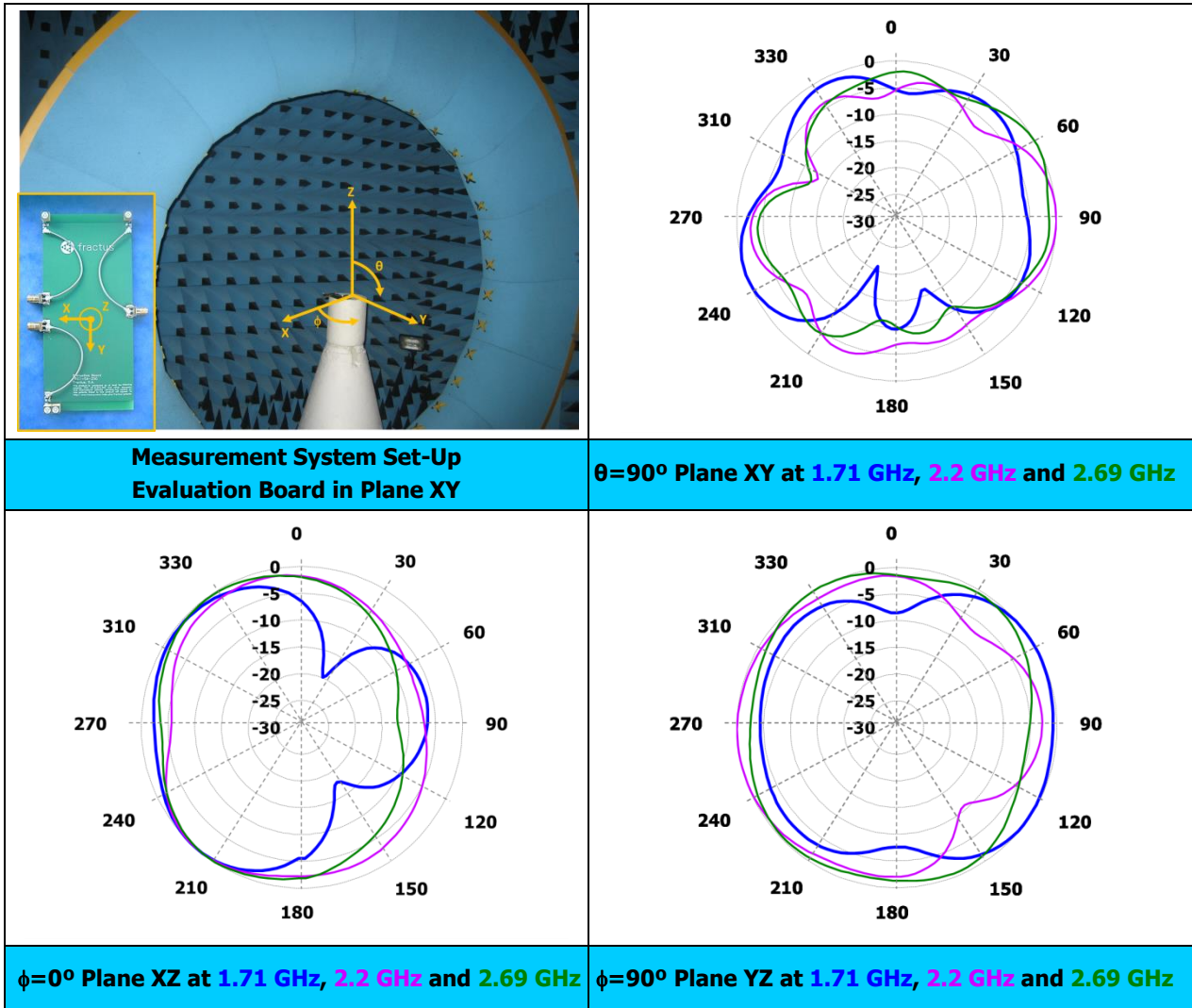


<b>Gain</b>	<b>Peak Gain</b>	0.6 dBi
	<b>Average Gain across the band</b>	0.0 dBi
	<b>Gain Range across the band (min, max)</b>	-2.1 <-> 0.6 dBi
<b>Efficiency</b>	<b>Peak Efficiency</b>	58.8 %
	<b>Average Efficiency across the band</b>	53.1 %
	<b>Efficiency Range across the band</b>	31.2 - 58.8 %

**Table 18** – Antenna Gain and Total Efficiency within the 824-960 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.



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



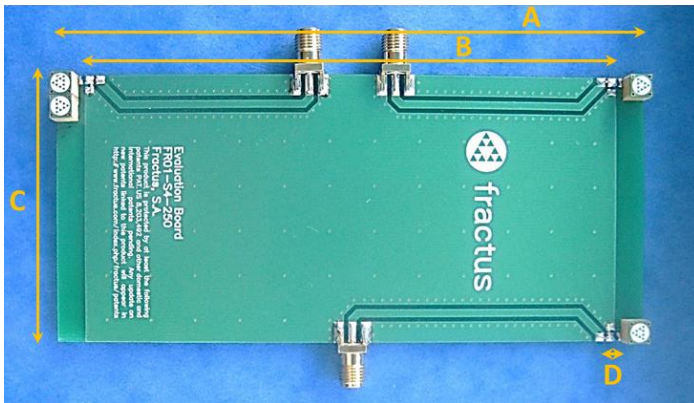
<b>Gain</b>	<b>Peak Gain</b>	3.2 dBi
	<b>Average Gain across the band</b>	2.5 dBi
	<b>Gain Range across the band (min, max)</b>	1.7 <-> 3.2 dBi
<b>Efficiency</b>	<b>Peak Efficiency</b>	80.5 %
	<b>Average Efficiency across the band</b>	71.5 %
	<b>Efficiency Range across the band</b>	58.5 - 80.5 %

**Table 19** – Antenna Gain and Total Efficiency within the 1710-2690 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.



## 6.3. EVALUATION BOARD 3 PORTS (Coplanar grounded transmission lines)

This Evaluation Board (part number: EB\_FR01-S4-250-CPW3R) integrates coplanar grounded transmission lines to connect the mXTEND™ Antenna Booster with the SMA connector. It works from 698 MHz to 798 MHz, from 824 MHz to 960 MHz, and from 1710 MHz to 2690 MHz.



Measure	mm
A	133
B	120
C	60
D	1.5

Tolerance: ±0.2 mm

**D:** Distance between the mXTEND™ Antenna Booster and the ground plane.

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

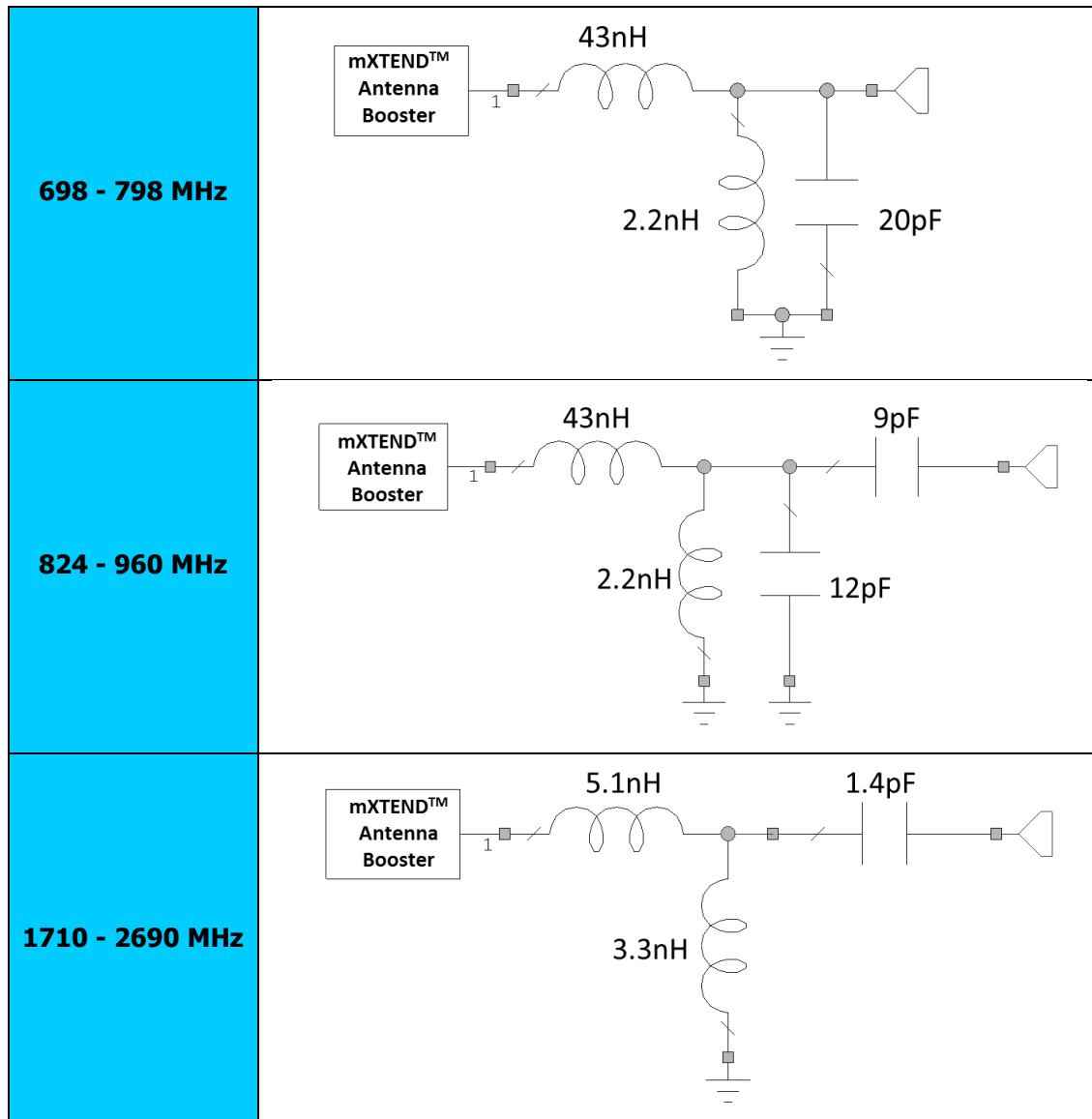
**Figure 23** – EB\_FR01-S4-250-CPW3R. Evaluation Board with coplanar grounded transmission lines. 698 MHz to 798 MHz, 824 MHz to 960 MHz, and 1710 MHz to 2690 MHz

This product is protected by at least the following patents PAT. US 8,203,492, PAT. US 8,736,497, and other domestic and international patents pending. Any update on new patents linked to this product will appear in <http://www.fractus.com/index.php/fractus/patents>

### 6.3.1. MATCHING NETWORK

The specs of a Fractus 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 to place 0402 pads 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 mXTEND™ Antenna Booster once the design is finished and taking into account all elements of the system.

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



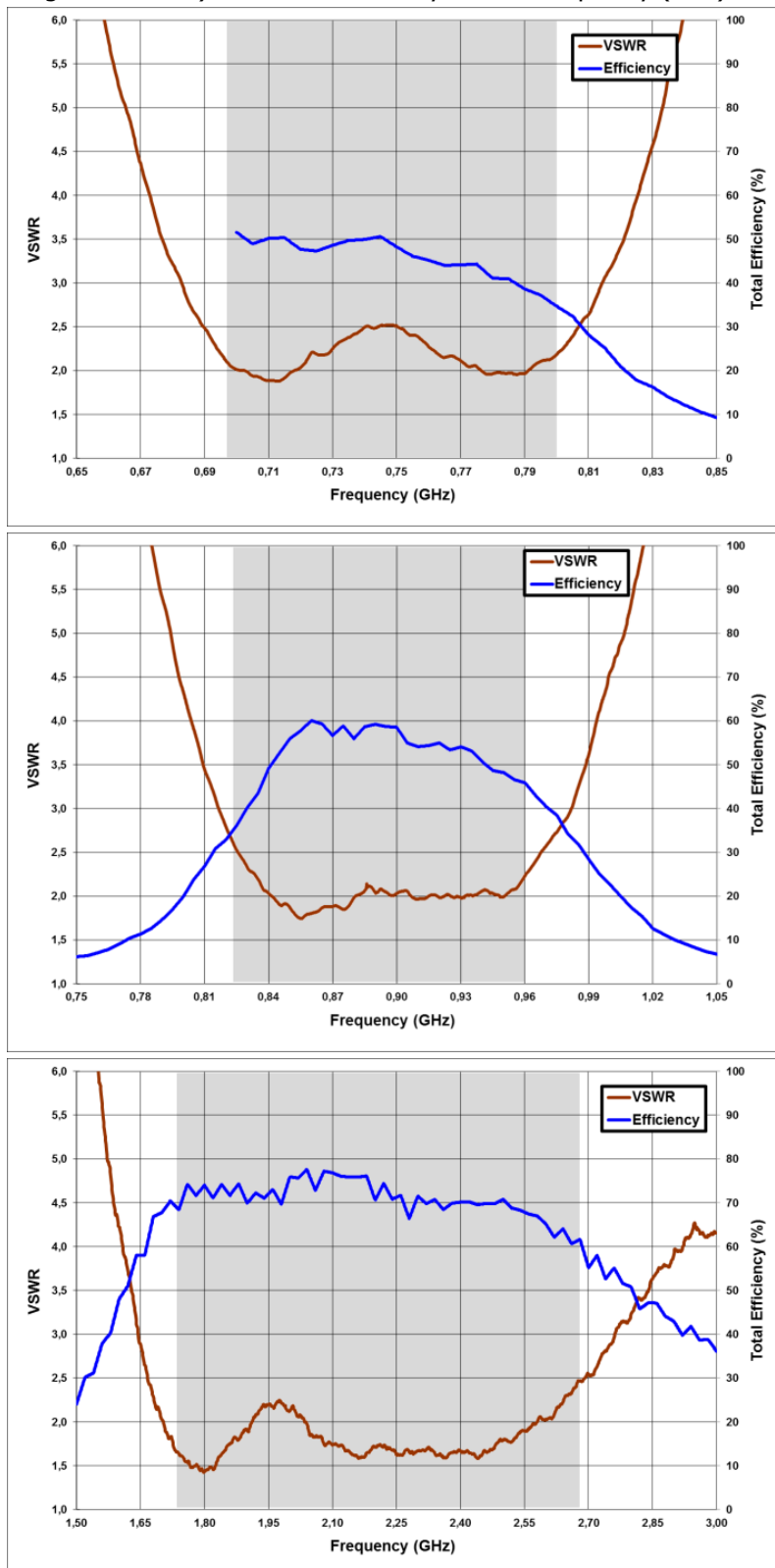
**Figure 24** – Matching networks for the 3 ports solution (Evaluation Board with coplanar transmission lines).





### 6.3.2. VSWR AND TOTAL EFFICIENCY

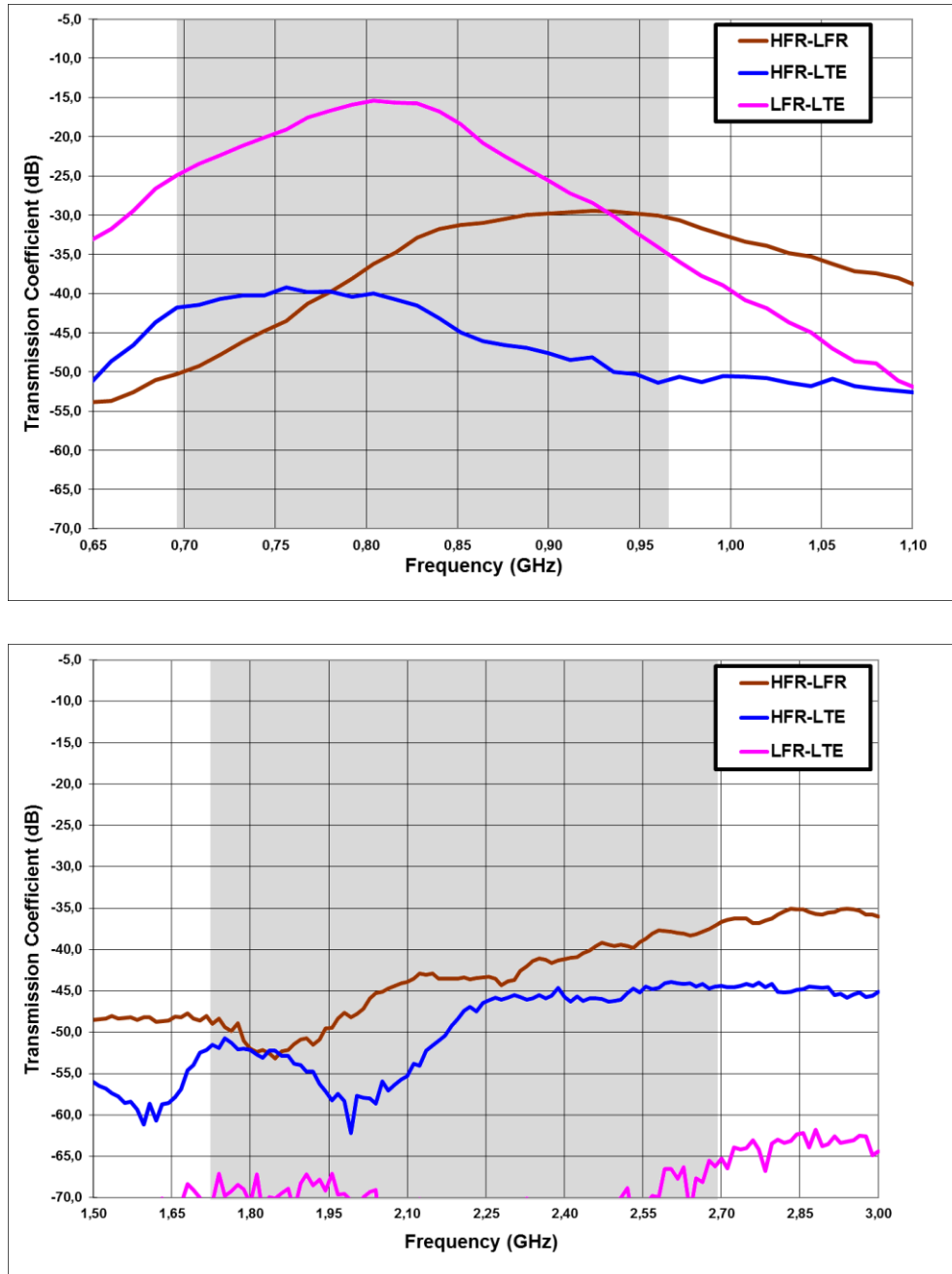
VSWR (Voltage Standing Wave Ratio) and Total Efficiency versus Frequency (GHz).



**Figure 25** – VSWR and Total Efficiency graph for the 698-798 MHz range, for 824-960 MHz range, and for the 1710-2690 MHz range (from the Evaluation Board with coplanar transmission lines (Figure 23).



### 6.3.3. TRANSMISSION COEFFICIENT

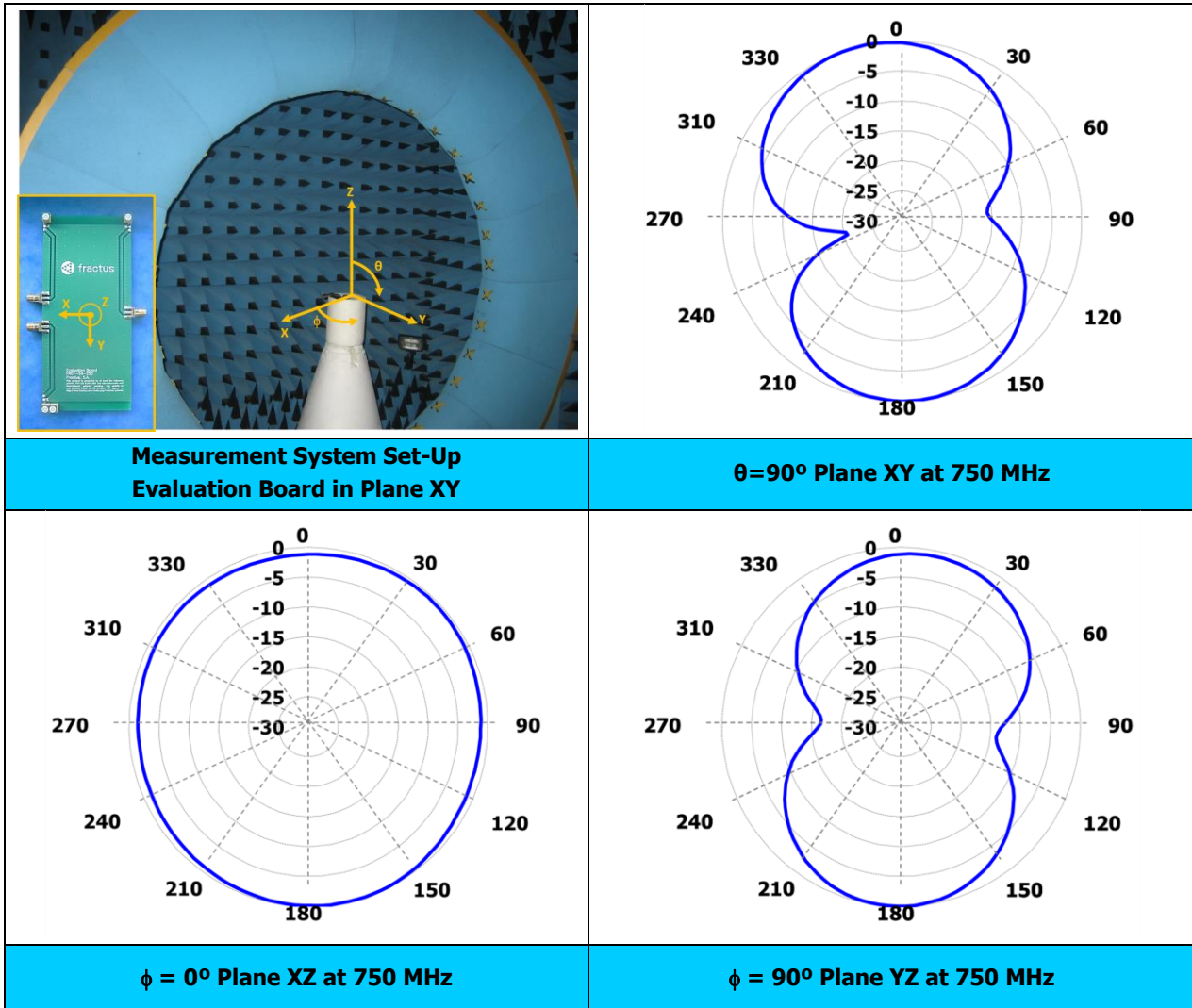


**Figure 26** – Transmission coefficient for the 698-798 MHz range (LTE), for the 824-960 MHz range (LFR), and for the 1710-2690 MHz range (HFR) (from the Evaluation Board with coplanar transmission lines (Figure 23)).





**6.3.4. RADIATION PATTERNS (698 - 798 MHz), GAIN, AND EFFICIENCY**

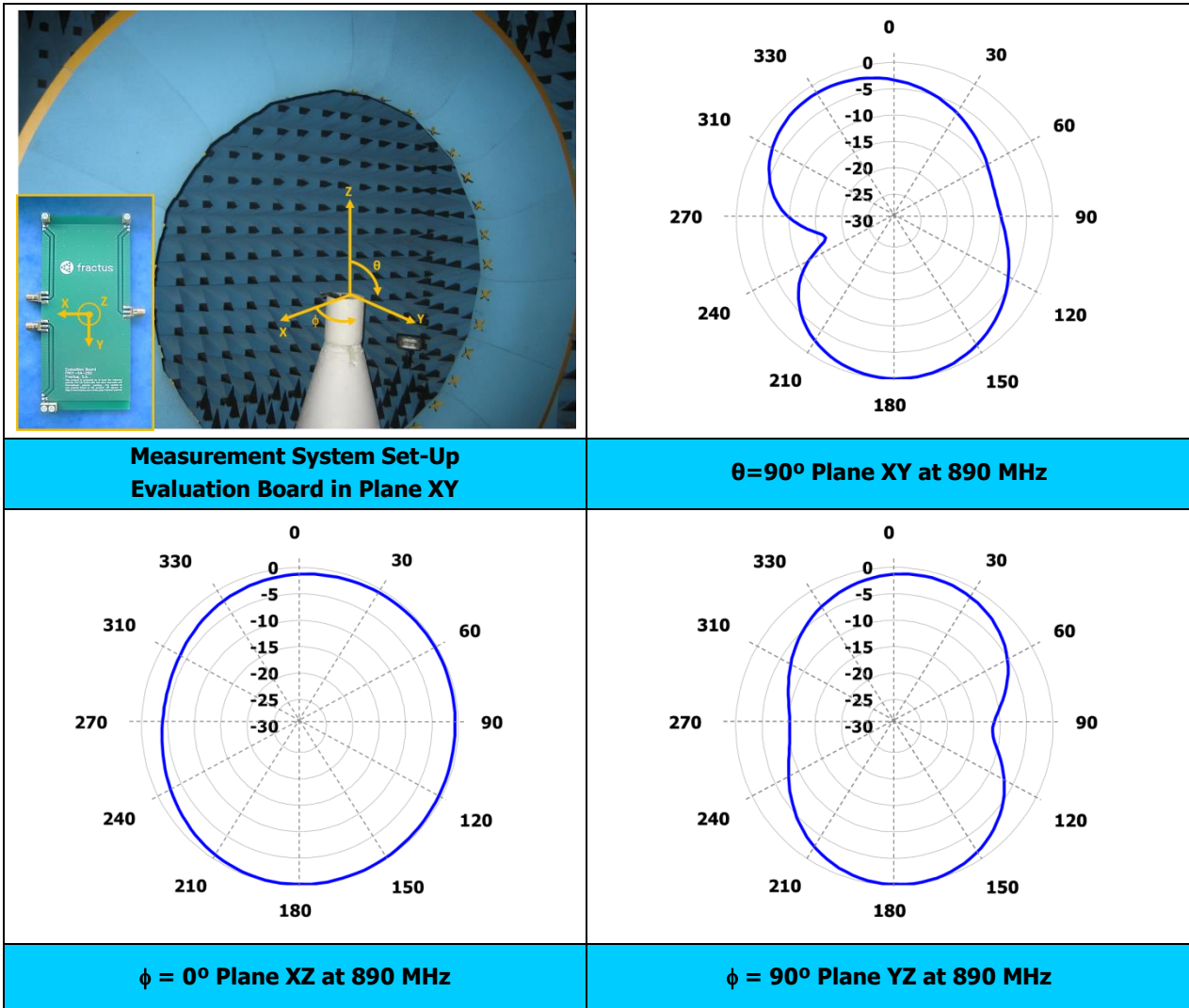


<b>Gain</b>	<b>Peak Gain</b>	-0.2 dBi
	<b>Average Gain across the band</b>	-0.5 dBi
	<b>Gain Range across the band (min, max)</b>	-1.5 <-> -0.2 dBi
<b>Efficiency</b>	<b>Peak Efficiency</b>	51.6 %
	<b>Average Efficiency across the band</b>	46.0 %
	<b>Efficiency Range across the band</b>	35.7 - 51.6 %

**Table 20** – Antenna Gain and Total Efficiency for the Evaluation Board EB\_FR01-S4-250-CPW3R within the 698-798 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.



**6.3.5. RADIATION PATTERNS (824 - 960 MHz), GAIN, AND EFFICIENCY**

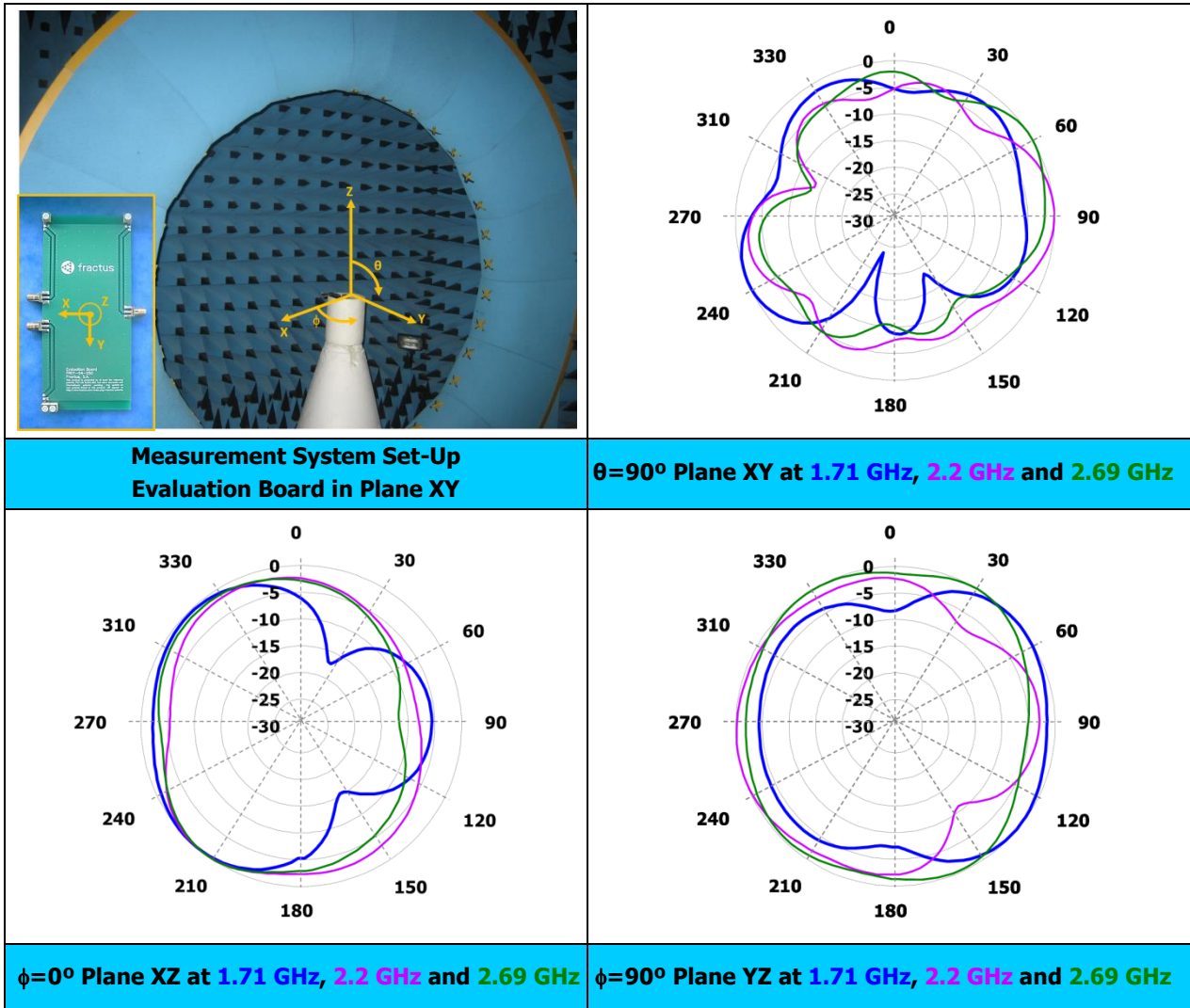


<b>Gain</b>	<b>Peak Gain</b>	1.0 dBi
	<b>Average Gain across the band</b>	0.1 dBi
	<b>Gain Range across the band (min, max)</b>	-1.4 <-> 1.0 dBi
<b>Efficiency</b>	<b>Peak Efficiency</b>	60.1 %
	<b>Average Efficiency across the band</b>	53.2 %
	<b>Efficiency Range across the band</b>	35.5 - 60.1 %

**Table 21** – Antenna Gain and Total Efficiency within the 824-960 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.



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



<b>Gain</b>	<b>Peak Gain</b>	3.4 dBi
	<b>Average Gain across the band</b>	2.8 dBi
	<b>Gain Range across the band (min, max)</b>	1.9 <-> 3.4 dBi
<b>Efficiency</b>	<b>Peak Efficiency</b>	77.6 %
	<b>Average Efficiency across the band</b>	70.9 %
	<b>Efficiency Range across the band</b>	58.2 - 70.9 %

**Table 22** – Antenna Gain and Total Efficiency within the 1710-2690 MHz range. Measures made in the Satimo STARGATE 32 anechoic chamber.



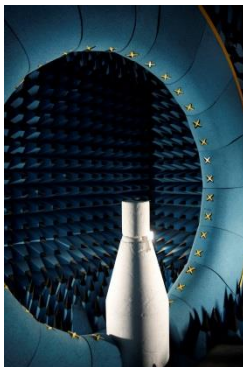
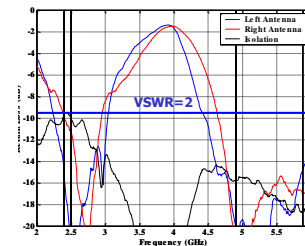
## 7. CAPABILITIES AND MEASUREMENT SYSTEMS

Fractus specialises in designing and manufacturing optimised antennas for wireless applications and providing our clients with RF expertise. We offer turn-key antenna products and antenna integration support to minimise your time requirement and maximize your return on investment during your product development efforts. We also provide our clients with the opportunity to leverage our in-house testing and measurement facilities to obtain accurate results quickly and efficiently.



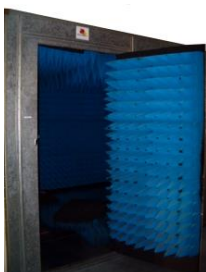
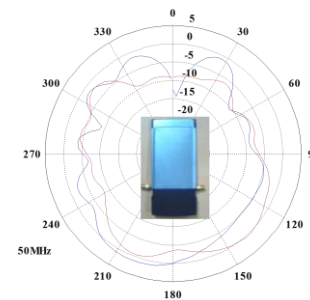
**Agilent E5071B**

VSWR  
&  
S Parameters



**SATIMO STARGATE 32**

Radiation  
Pattern  
&  
Efficiency

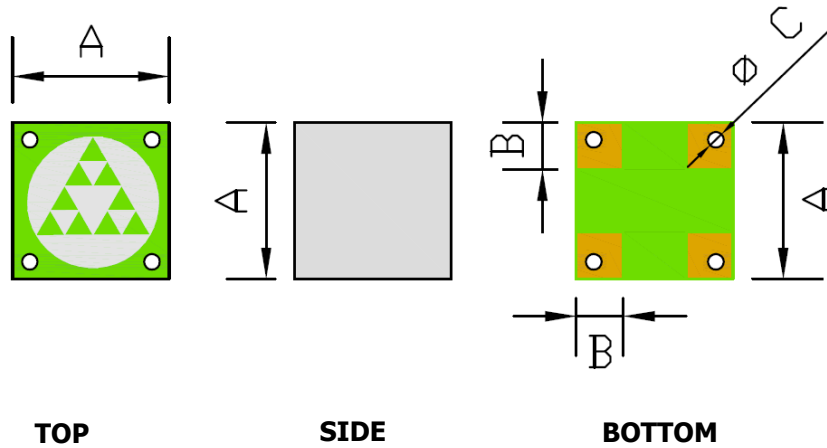


**Anechoic chambers and full equipped in-house lab**



## 8. MECHANICAL CHARACTERISTICS FR01-S4-250

### 8.1. DIMENSIONS, TOLERANCES, AND ROHS



**Figure 27** – mXTEND™ Antenna Booster dimensions and tolerances

Dimension	mm	Dimension	mm
<b>A</b>	5.0 + 0.2 - 0.1	<b>B</b>	1.5±0.1
<b>C</b>	0.5±0.1		

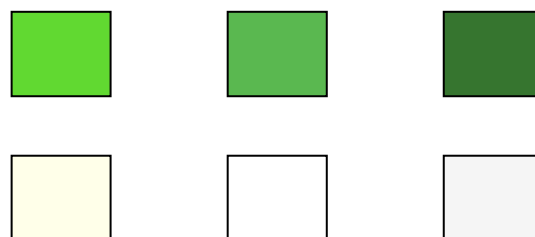
The 4 pads are fully symmetrical to mount it on the PCB.

The mXTEND™ Antenna Booster FR01-S4-250 is compliant with the restriction of the use of hazardous substances (**RoHS**).

The RoHS certificate can be downloaded from <http://www.fractus.com/index.php/fractus/documentation>

### 8.2. COLOUR RANGE FOR THE INK

The next figure shows the range of the colours in the mXTEND™ Antenna Booster:



**Acceptable colour range**

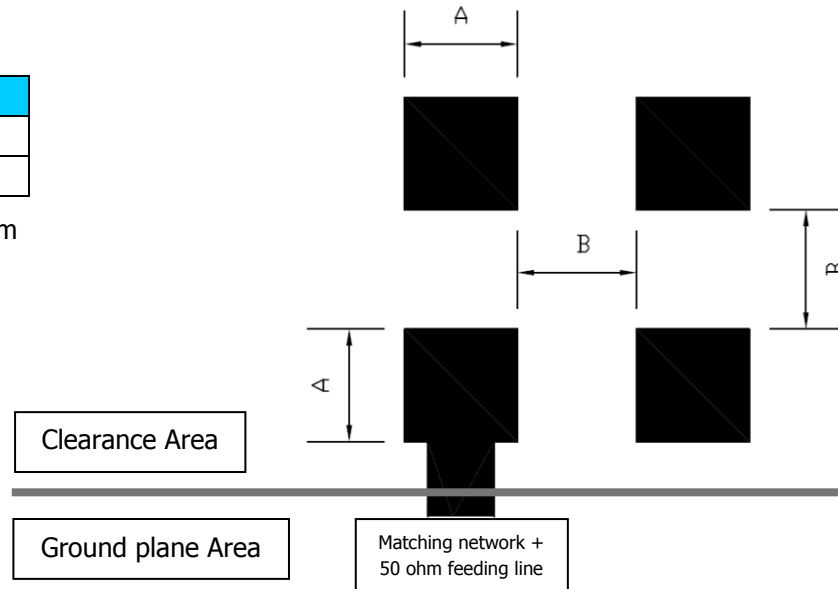


### 8.3. RECOMMENDED FOOTPRINT FOR THE FR01-S4-250

Assuming that the mXTEND™ Antenna Booster FR01-S4-250 is placed in the clearance area of the PCB, see below the recommended footprint dimensions.

Measure	mm
<b>A</b>	1.7
<b>B</b>	1.8

Tolerance:  $\pm 0.1$  mm



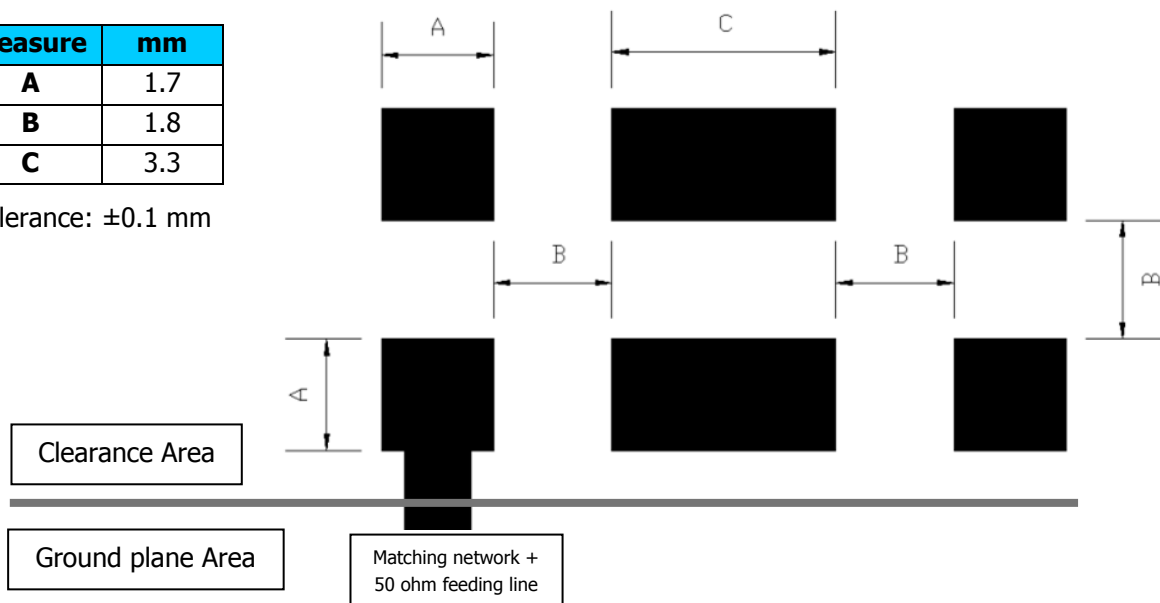
**Figure 28** – Footprint dimensions for the single booster

For additional support in the integration process, please contact [info@fractus.com](mailto:info@fractus.com)

### 8.4. RECOMMENDED FOOTPRINT FOR THE FR01-S4-250 DOUBLE BOOSTER.

Measure	mm
<b>A</b>	1.7
<b>B</b>	1.8
<b>C</b>	3.3

Tolerance:  $\pm 0.1$  mm



**Figure 29** – Footprint dimensions for the double booster

For additional support in the integration process, please contact [info@fractus.com](mailto:info@fractus.com)

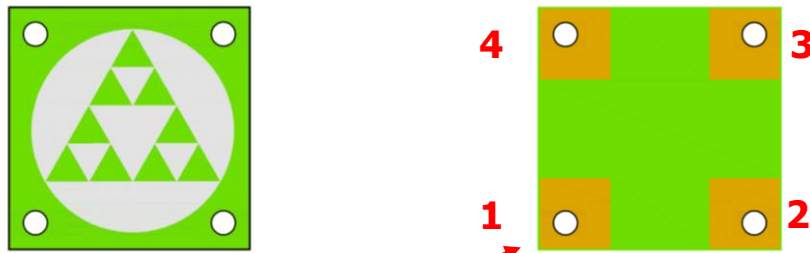




## 9. ASSEMBLY PROCESS

Figure 30 shows the back and front view of the mXTEND™ Antenna Booster FR01-S4-250. Due to the symmetry in the product configuration, the feeding pad can be any of the 4 pads.

**Mounting Pads (2, 3, 4):** solder the mXTEND™ Antenna Booster mounting pads to the soldering pads on the PCB. These pads must NOT be grounded.



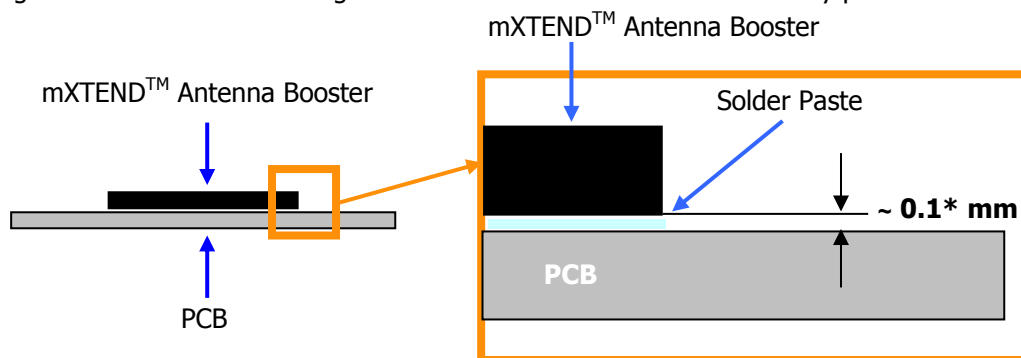
**Feed Pad (1):** The 4 pads are fully symmetrical. Once the feeding pad is selected (1), the other 3 pads became mounting pads. Align the feed pad with the feeding line on the PCB. See section 8.3.

**Figure 30** – Pads of the mXTEND™ Antenna Booster FR01-S4-250

As a surface mount device (SMD), the mXTEND™ Antenna Booster is compatible with industry standard soldering processes. The basic assembly procedure for the mXTEND™ Antenna Booster is as follows:

1. Apply a solder paste on the pads of the PCB. Place the mXTEND™ Antenna Booster on the board.
2. Perform a reflow process according to the temperature profile detailed in table 23, figure 30 (page 46)
3. After soldering the mXTEND™ Antenna Booster to the circuit board, perform a cleaning process to remove any residual flux. Fractus recommends conducting a visual inspection after the cleaning process to verify that all reflux has been removed.

The drawing below shows the soldering details obtained after a correct assembly process:



**Figure 31** - Soldering Details

**NOTE(\*):** Solder paste thickness after the assembly process will depend on the thickness of the soldering stencil mask. A stencil thickness equal or larger than **127 microns (5 mils)** is required.

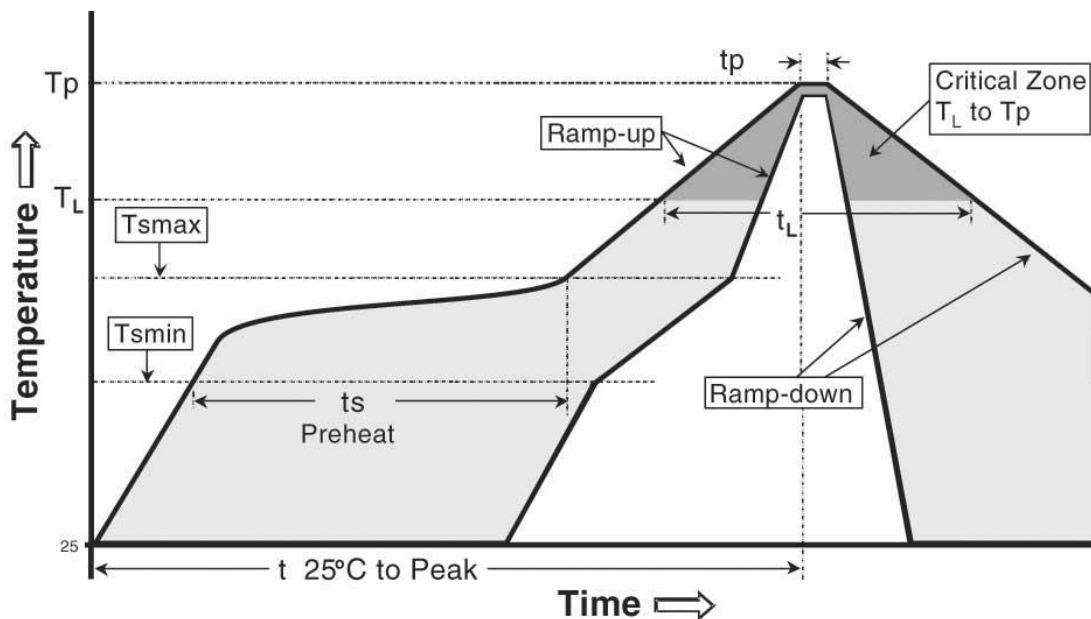


The mXTEND™ Antenna Booster FR01-S4-250 can be assembled following the Pb-free assembly process. According to the Standard **IPC/JEDEC J-STD-020C**, the temperature profile suggested is as follows:

Phase	Profile features	Pb-Free Assembly (SnAgCu)
<b>RAMP-UP</b>	Avg. Ramp-up Rate ( $T_{smax}$ to $T_p$ )	3 °C / second (max.)
<b>PREHEAT</b>	- Temperature Min ( $T_{smin}$ ) - Temperature Max ( $T_{smax}$ ) - Time ( $t_{smin}$ to $t_{smax}$ )	150 °C 200 °C 60-180 seconds
<b>REFLOW</b>	- Temperature ( $T_L$ ) - Total Time above $T_L$ ( $t_L$ )	217 °C 60-150 seconds
<b>PEAK</b>	- Temperature ( $T_p$ ) - Time ( $t_p$ )	260 °C 20-40 seconds
<b>RAMP-DOWN</b>	Rate	6 °C/second max.
<b>Time from 25 °C to Peak Temperature</b>		8 minutes max.

**Table 23**– Recommended soldering temperatures

Next graphic shows temperature profile (grey zone) for the mXTEND™ Antenna Booster assembly process reflow ovens.

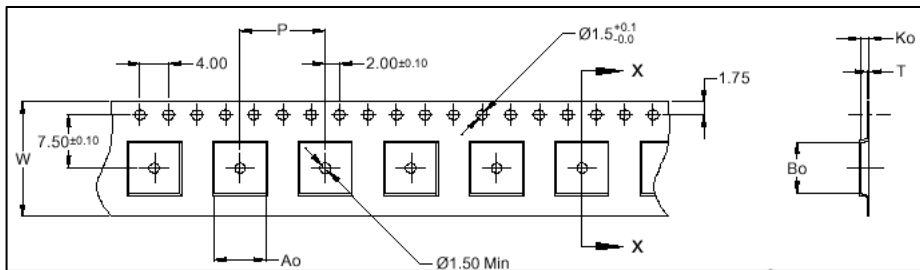


**Figure 32** – Temperature profile



## 10. PACKAGING

The mXTEND™ Antenna Booster FR01-S4-250 is delivered in tape and reel packaging.

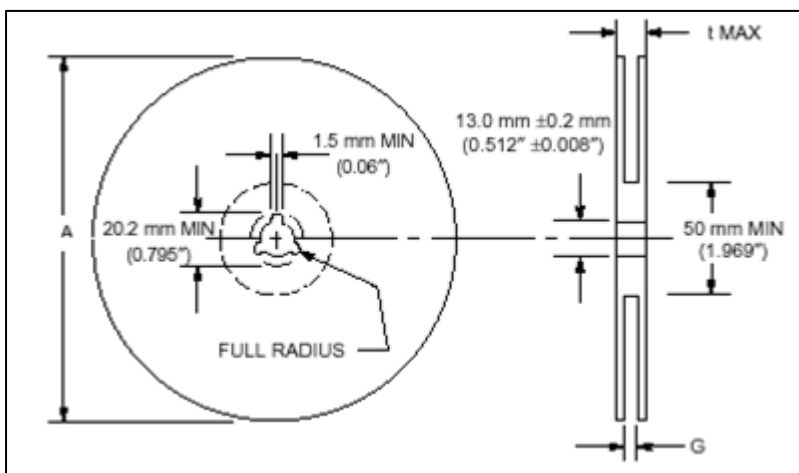


Measure	mm
<b>A0</b>	5.3±0.1
<b>B0</b>	5.3±0.1
<b>K0</b>	5.3±0.1
<b>W</b>	16.0±0.3
<b>P</b>	8.0±0.1
<b>T</b>	0.4±0.1

**Figure 33** – Tape dimensions



**Figure 34** – Image of the tape



Measure	mm
<b>A</b>	330 ± 1
<b>G</b>	17.5±0.2
<b>t max</b>	21.5±0.2

**Reel Capacity:** 1000 pcs

**Figure 35** – Reel Dimensions and Reel Capacity