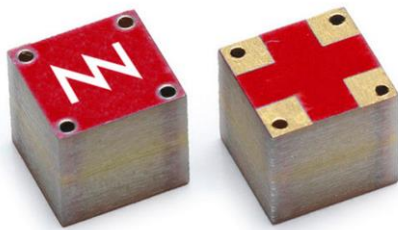


## CUBE mXTEND™ (FR01-S4-250) – A standard antenna solution for mobile frequency bands

Fractus Antennas specializes in enabling effective mobile communications. Using Fractus Antennas technology, we design and manufacture optimized antennas to make your wireless devices more competitive. Our mission is to help our clients develop innovative products and accelerate their time to market through our expertise in antenna design, testing and manufacturing.



CUBE mXTEND™ Antenna Booster

FR01-S4-250

Fractus Antennas products are protected by [Fractus Antennas patents](#).

All information contained within this document is property of Fractus Antennas and is subject to change without prior notice. Information is provided “as is” and without warranties. It is prohibited to copy or reproduce this information without prior approval.

Fractus Antennas is an ISO 9001:2015 certified company. All our antennas are lead-free and RoHS compliant.

ISO 9001: 2015 Certified



## INDEX OF CHAPTERS

1.	PRODUCT DESCRIPTION FR01-S4-250 .....	4
2.	EVALUATION BOARDS 1 PORT (698-798 MHz).....	5
3.	EVALUATION BOARDS 1 PORT (824-960 MHz).....	10
4.	EVALUATION BOARDS 1 PORT (1710-2690 MHz).....	15
5.	EVALUATION BOARDS 2 PORTS (824-960 MHz & 1710-2690 MHz) .....	20
6.	EVALUATION BOARDS 3 PORTS (698-798 MHz & 824-960 MHz & 1710-2690 MHz) ...	30
7.	CAPABILITIES AND MEASUREMENT SYSTEMS.....	45
8.	MECHANICAL CHARACTERISTICS FR01-S4-250.....	46
9.	ASSEMBLY PROCESS.....	48
10.	PACKAGING .....	51

## TABLE OF CONTENTS

1.	PRODUCT DESCRIPTION FR01-S4-250 .....	4
2.	EVALUATION BOARDS 1 PORT (698-798 MHz).....	5
2.1.	QUICK REFERENCE GUIDE .....	5
2.2.	EVALUATION BOARDS 1 PORT (698-798 MHz).....	5
3.	EVALUATION BOARDS 1 PORT (824-960 MHz).....	10
3.1.	QUICK REFERENCE GUIDE .....	10
3.2.	EVALUATION BOARDS 1 PORT (824-960 MHz).....	10
4.	EVALUATION BOARDS 1 PORT (1710-2690 MHz).....	15
4.1.	QUICK REFERENCE GUIDE .....	15
4.2.	EVALUATION BOARDS 1 PORT (1710-2690 MHz).....	15
5.	EVALUATION BOARDS 2 PORTS (824-960 MHz & 1710-2690 MHz).....	20
5.1.	QUICK REFERENCE GUIDE .....	20
5.2.	EVALUATION BOARD 2 ports (UFL cables).....	20
5.3.	EVALUATION BOARD 2 ports (Coplanar grounded transmission lines) .....	25
6.	EVALUATION BOARDS 3 PORTS (698-798 MHz & 824-960 MHz & 1710-2690 MHz) ...	30
6.1.	QUICK REFERENCE GUIDE .....	30
6.2.	EVALUATION BOARD 3 PORTS (UFL cables) .....	31
6.3.	EVALUATION BOARD 3 PORTS (Coplanar grounded transmission lines).....	38
7.	CAPABILITIES AND MEASUREMENT SYSTEMS.....	45
8.	MECHANICAL CHARACTERISTICS FR01-S4-250.....	46
8.1.	DIMENSIONS, TOLERANCES, AND RoHS .....	46
8.2.	COLOR RANGE FOR THE INK.....	46
8.3.	RECOMMENDED FOOTPRINT for the FR01-S4-250.....	47
8.4.	RECOMMENDED FOOTPRINT for the FR01-S4-250 double booster .....	47
9.	ASSEMBLY PROCESS.....	48
10.	PACKAGING .....	51

## 1. PRODUCT DESCRIPTION FR01-S4-250

The CUBE mXTEND™ Antenna Booster component 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.



**Material:** The CUBE mXTEND™ Antenna Booster is built on glass epoxy substrate.

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

## 2. EVALUATION BOARDS 1 PORT (698-798 MHz)

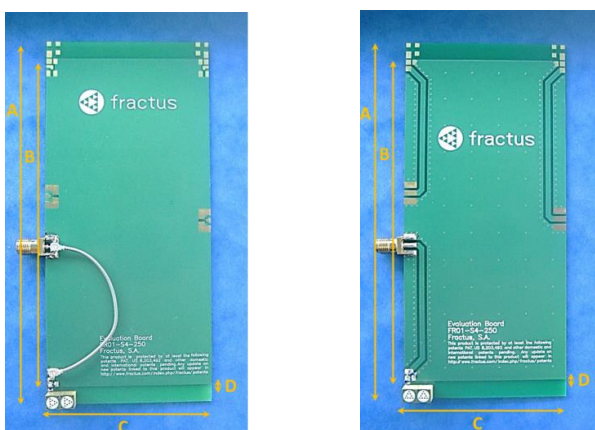
### 2.1. QUICK REFERENCE GUIDE

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. See Figure 1. Note that for obtaining comparable results, a ground plane length larger than 100 mm is recommended.

### 2.2. EVALUATION BOARDS 1 PORT (698-798 MHz)

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



Measure	mm
A	133
B	120
C	60
D	1.5

**Tolerance:** ±0.2 mm

**D:** Distance between the CUBE 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 [www.fractusantennas.com/virtual-antenna/](http://www.fractusantennas.com/virtual-antenna/).

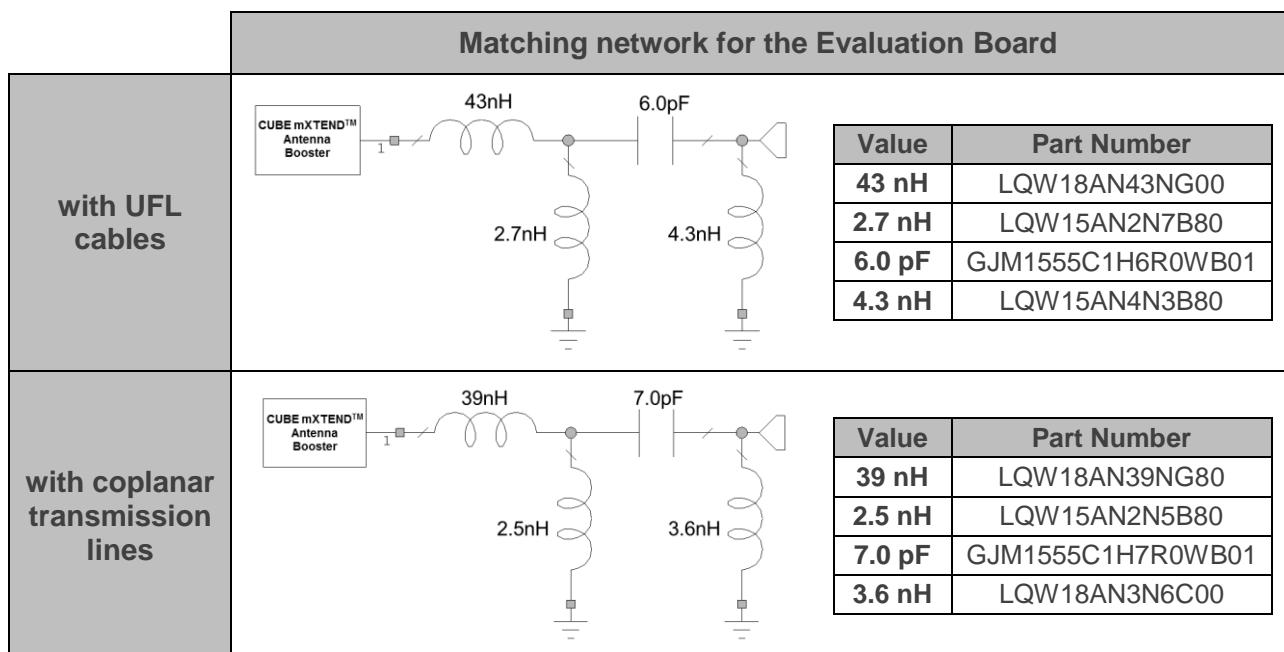
**Comments:**

- Note that in the Evaluation Boards (Figure 1), 2 CUBE 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@fractusantennas.com](mailto:info@fractusantennas.com) for more information related to the Antenna Booster matching service.

**2.2.1. MATCHING NETWORKS**

The specs of a Fractus Antennas 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 CUBE 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 CUBE 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 (698-798 MHz)

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

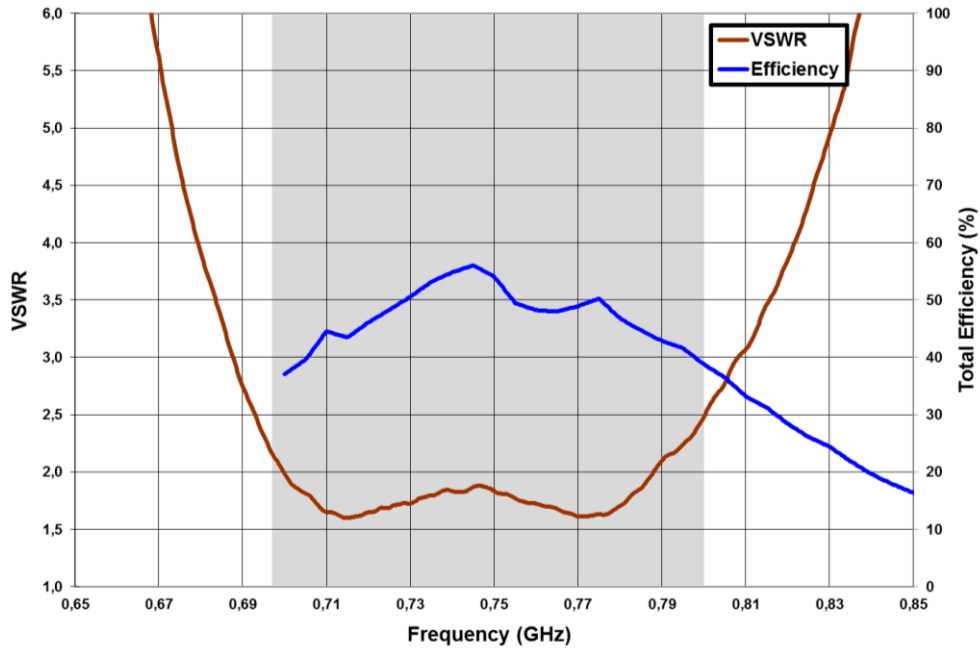


Figure 3 – VSWR and Total Efficiency for Evaluation Board with UFL cables.  
Part Number: EB\_FR01-S4-250-UFL1R-700.

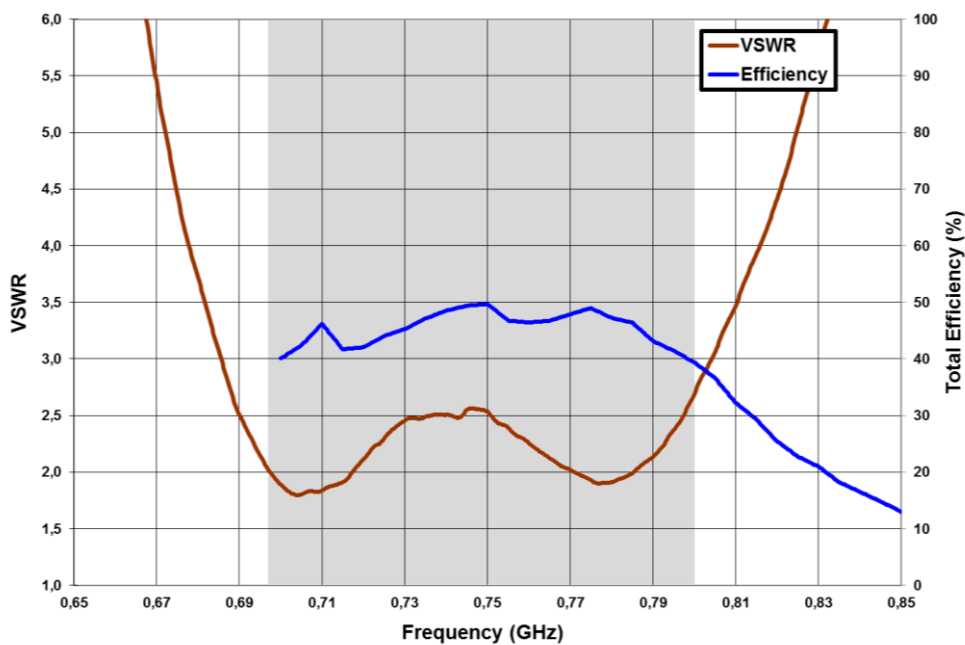
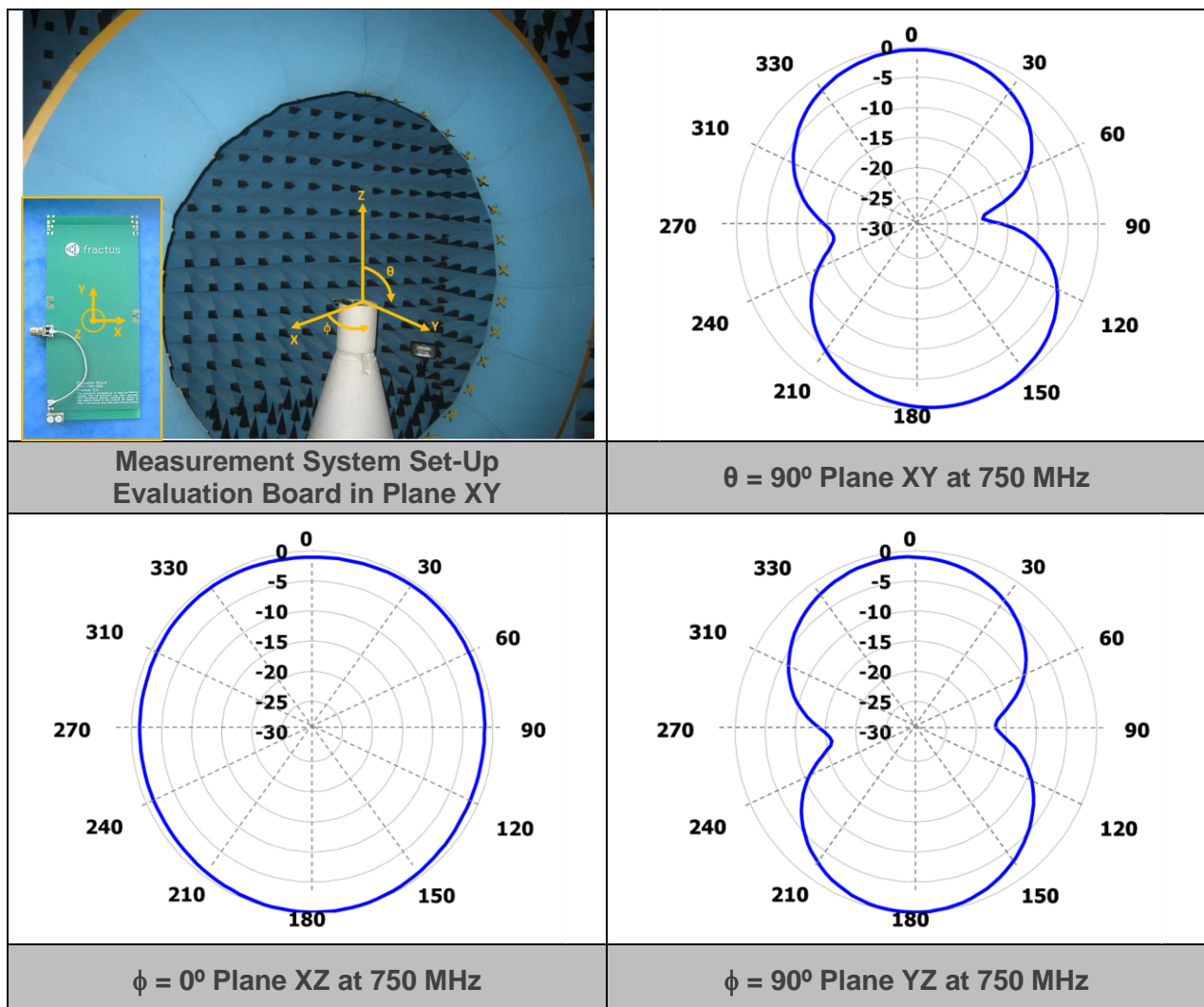


Figure 4 – VSWR and Total Efficiency for the Evaluation Board with coplanar transmission lines.  
Part Number: EB\_FR01-S4-250-CPW1R-700.

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

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

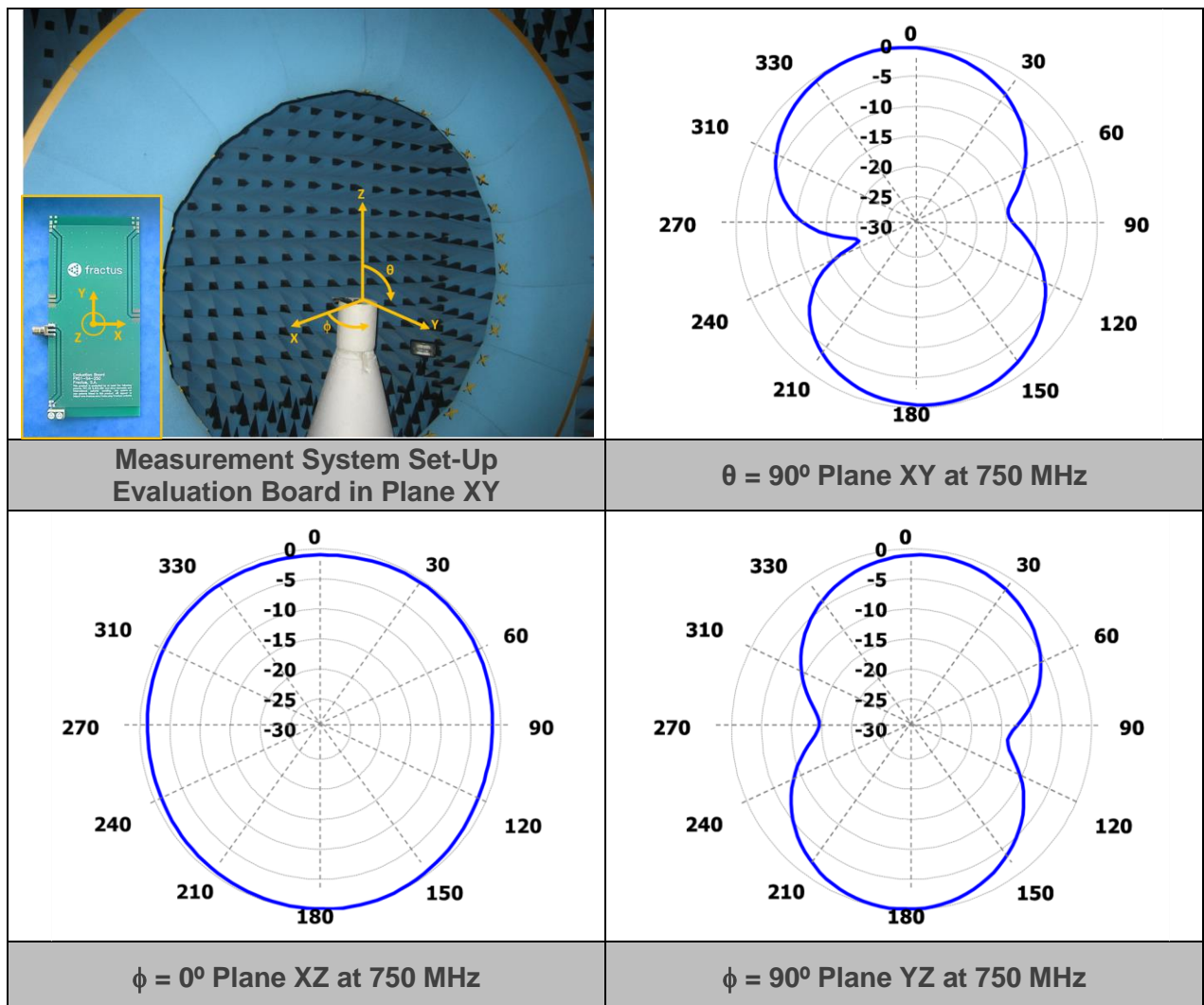


Gain	Peak Gain	0.2 dBi
	Average Gain across the band	-0.5 dBi
	Gain Range across the band (min, max)	-1.8 <-> 0.2 dBi
Efficiency	Peak Efficiency	56.0 %
	Average Efficiency across the band	47.6 %
	Efficiency Range across the band (min, max)	37.1 – 56.0 %

**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 (CPW lines)



Gain	Peak Gain	0.1 dBi
	Average Gain across the band	-0.7 dBi
	Gain Range across the band (min, max)	-1.4 <-> 0.1 dBi
Efficiency	Peak Efficiency	49.7%
	Average Efficiency across the band	45.7 %
	Efficiency Range across the band (min, max)	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 (824-960 MHz)

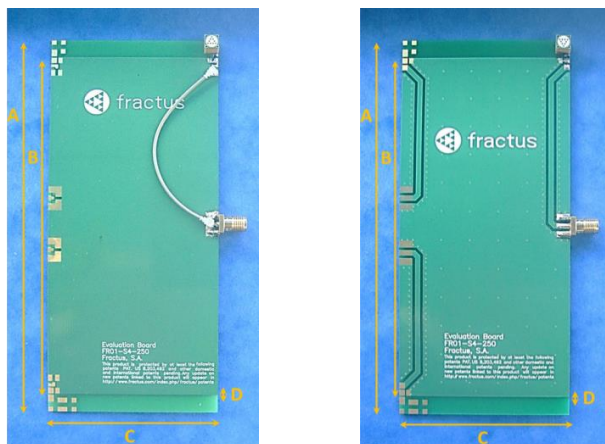
#### 3.1. QUICK REFERENCE GUIDE

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 Ω	
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. See Figure 5. Note that for obtaining comparable results, a ground plane length larger than 100 mm is recommended.

#### 3.2. EVALUATION BOARDS 1 PORT (824-960 MHz)

This section depicts two different Evaluation Boards. The first one is built with UFL cables to connect the CUBE 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 Figure 5. The second Evaluation Board is made with coplanar grounded transmission lines (traces on a PCB) to connect the CUBE 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 Figure 5.



Measure	mm
A	133
B	120
C	60
D	1.5

**Tolerance:** ±0.2 mm

**D:** Distance between the CUBE 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 [www.fractusantennas.com/virtual-antenna/](http://www.fractusantennas.com/virtual-antenna/).

3.2.1. MATCHING NETWORKS

The specs of a Fractus Antennas 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 CUBE 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 CUBE 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).

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

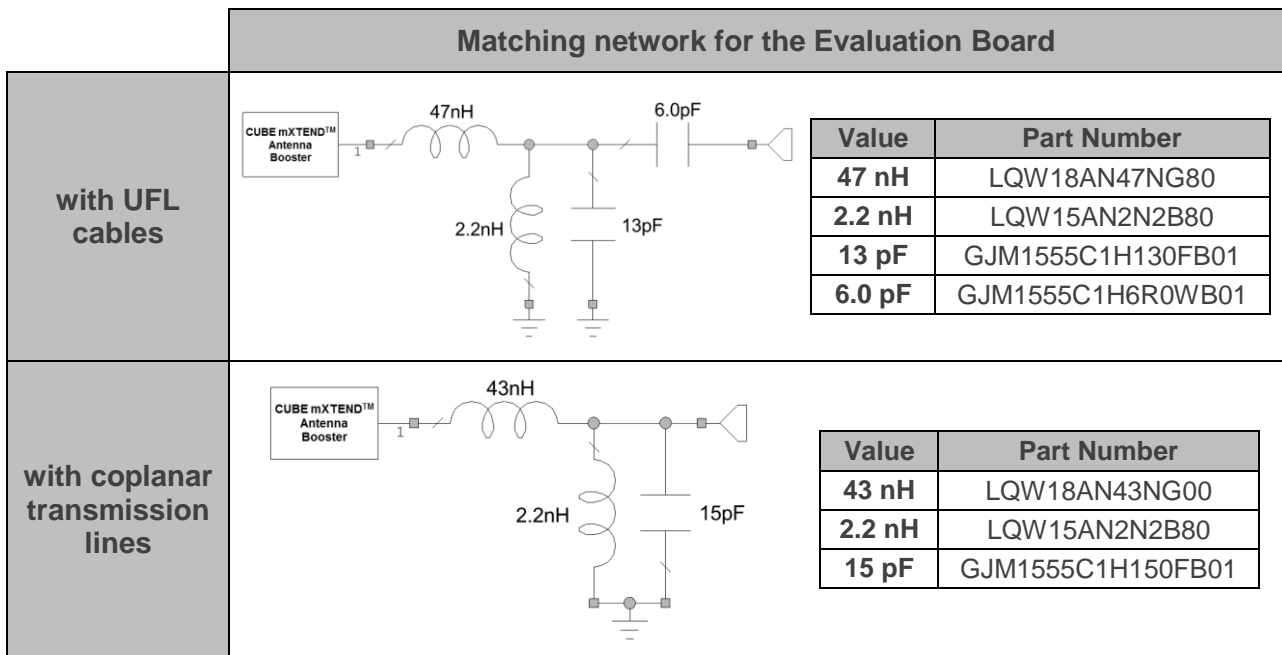


Figure 6 – Matching networks for the GSM850-GSM900, 1 port configuration.

3.2.2. VSWR and TOTAL Efficiency FOR 1 port (824-960 MHz)

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

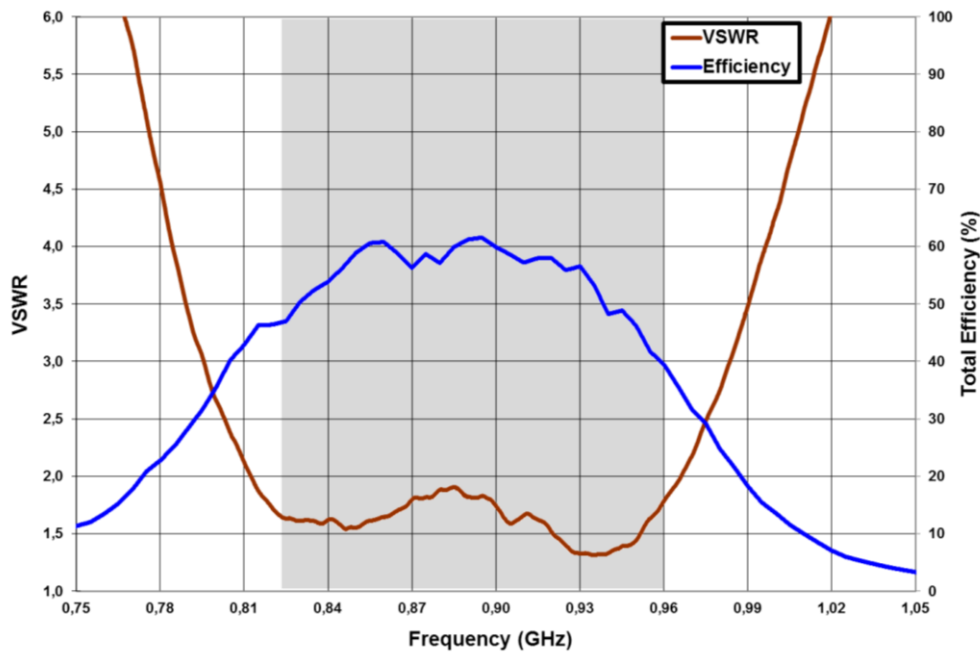


Figure 7 – VSWR and Total Efficiency for Evaluation Board with UFL cables.  
Part Number: EB\_FR01-S4-250-UFL1R-850.

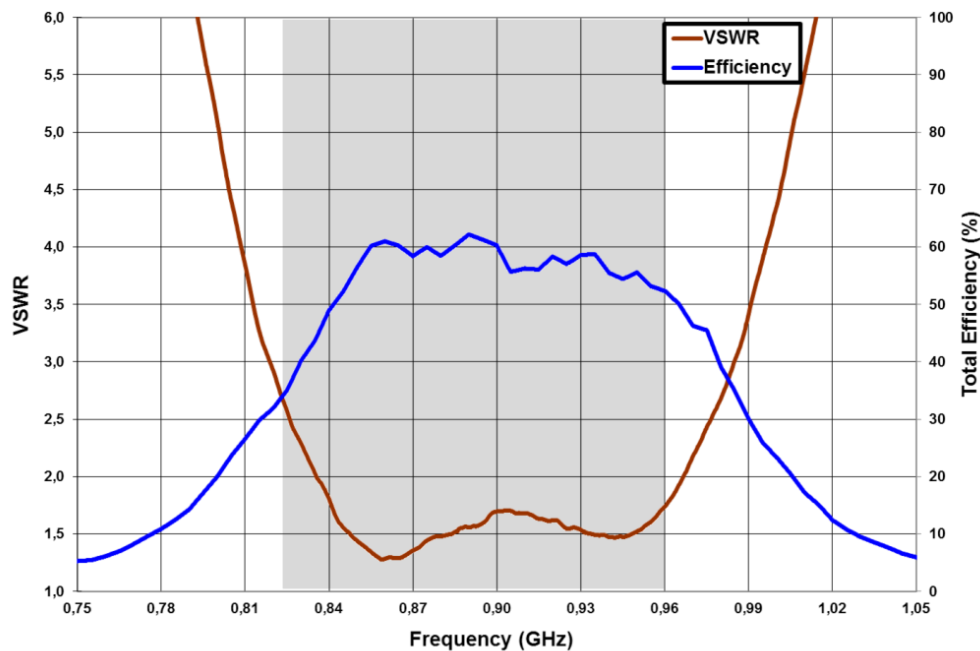
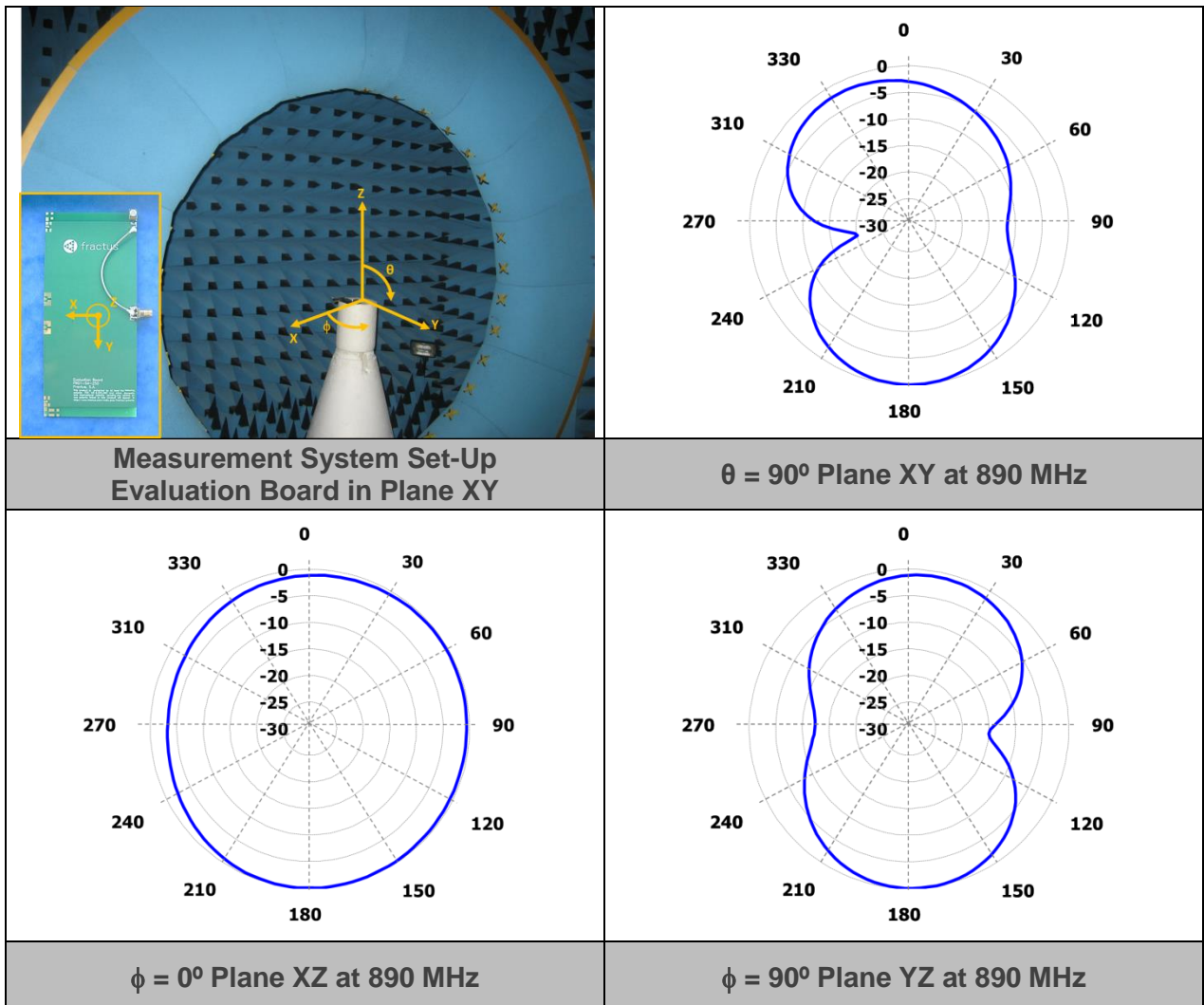


Figure 8 – VSWR and Total Efficiency for the Evaluation Board with coplanar transmission lines.  
Part Number: EB\_FR01-S4-250-CPW1R-850.

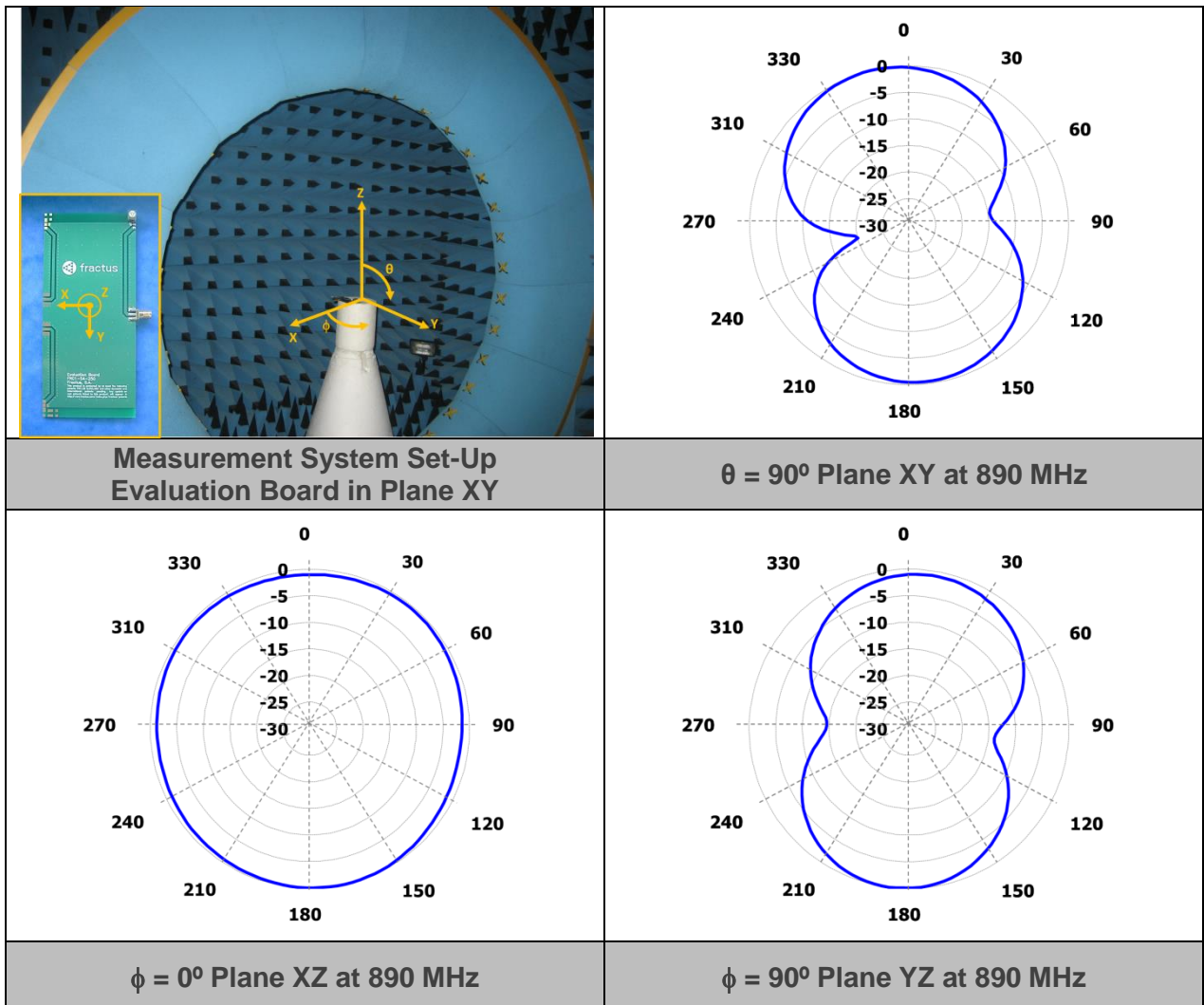
3.2.3. RADIATION PATTERNS (824-960 MHz), GAIN, AND EFFICIENCY (UFL cables)



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



<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 (min, max)</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 (1710-2690 MHz)

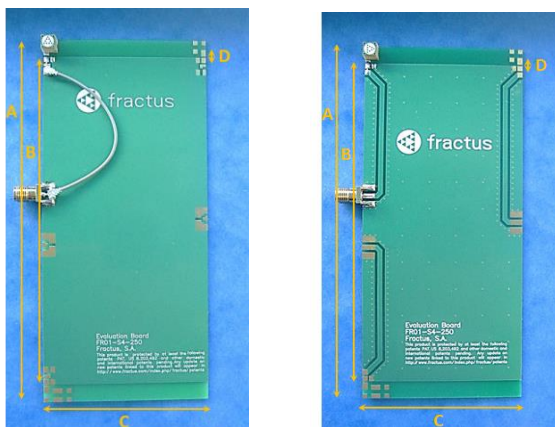
### 4.1. QUICK REFERENCE GUIDE

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 Ω	
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. See pictures in Figure 9. Note that for obtaining comparable results, a ground plane length larger than 100 mm is recommended.

### 4.2. EVALUATION BOARDS 1 PORT (1710-2690 MHz)

This section depicts two different Evaluation Boards. The first one is built with UFL cables to connect the CUBE 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 Figure 9. The second Evaluation Board is made with coplanar grounded transmission lines (traces on a PCB) to connect the CUBE 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 Figure 9.



Measure	mm
A	133
B	120
C	60
D	1.5

**Tolerance:** ±0.2 mm

**D:** Distance between the CUBE 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 [www.fractusantennas.com/virtual-antenna/](http://www.fractusantennas.com/virtual-antenna/).

4.2.1. MATCHING NETWORK

The specs of a Fractus Antennas 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 CUBE 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 CUBE 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).

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

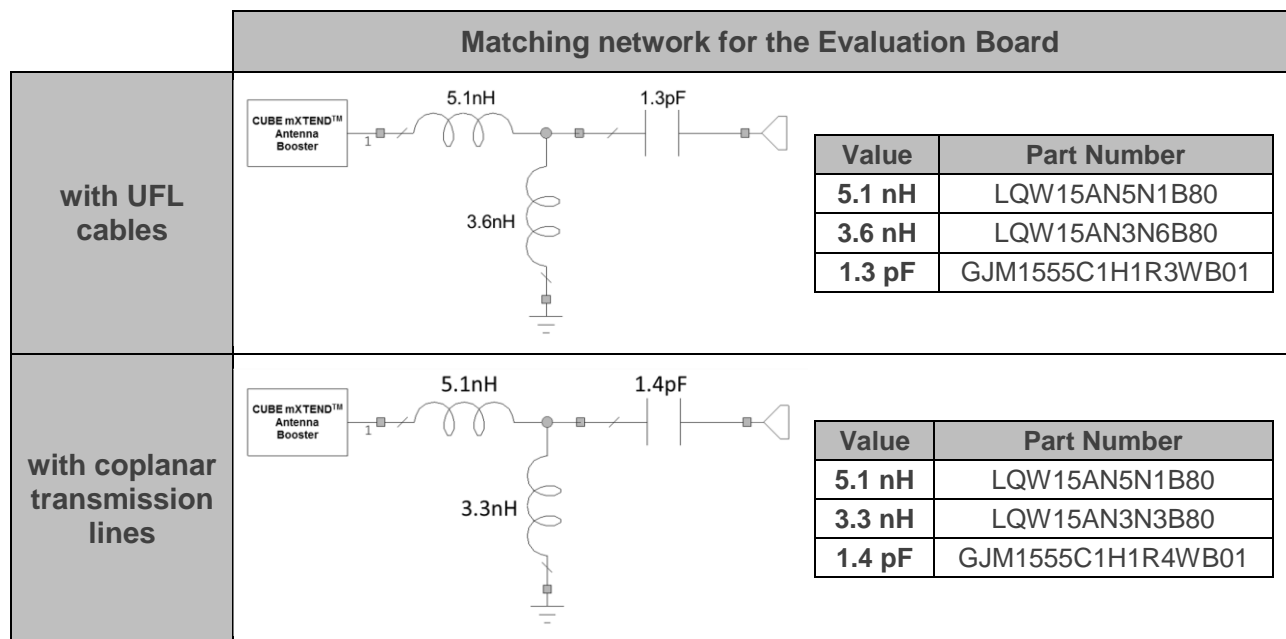


Figure 10 – Matching networks for the LTE1700-LTE2600, 1 port configuration.



4.2.2. VSWR and TOTAL Efficiency 1 port (1710-2690 MHz)

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

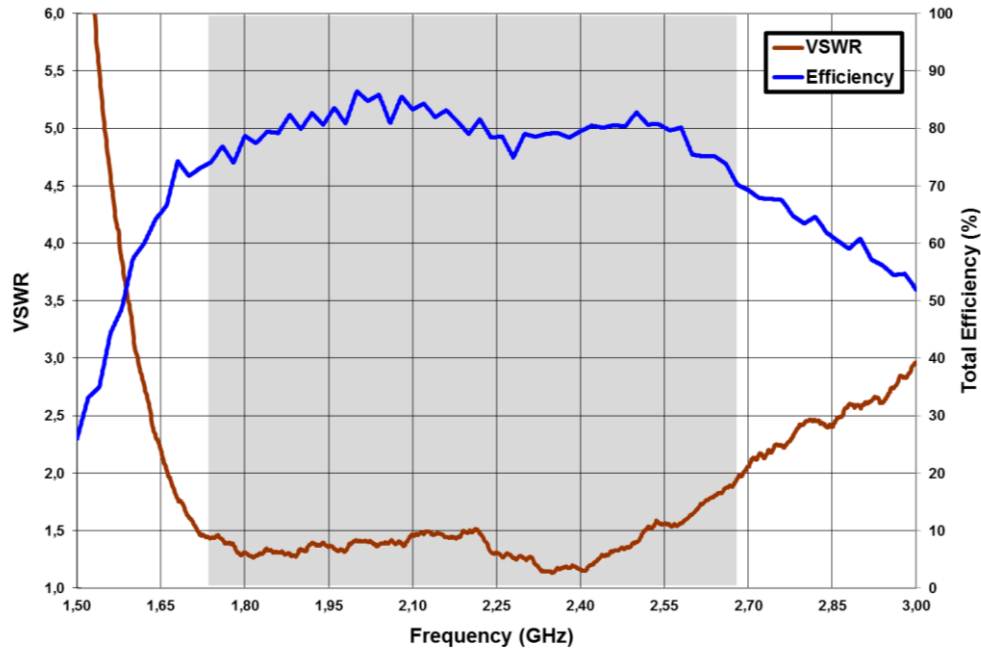


Figure 11 – VSWR and Total Efficiency for Evaluation Board with UFL cables.  
Part Number: EB\_FR01-S4-250-UFL1R-1700.

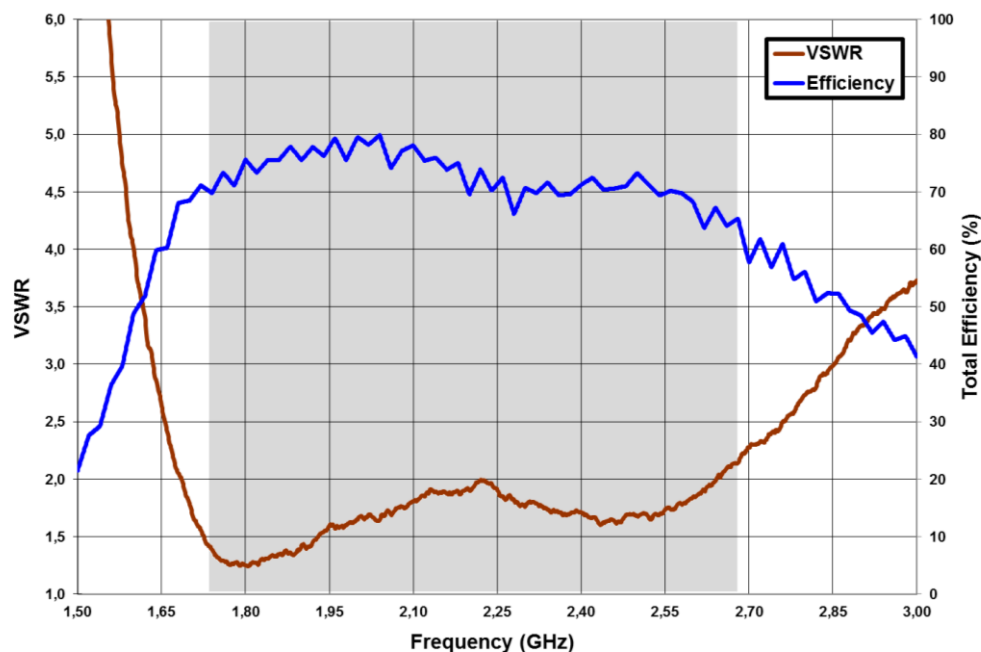
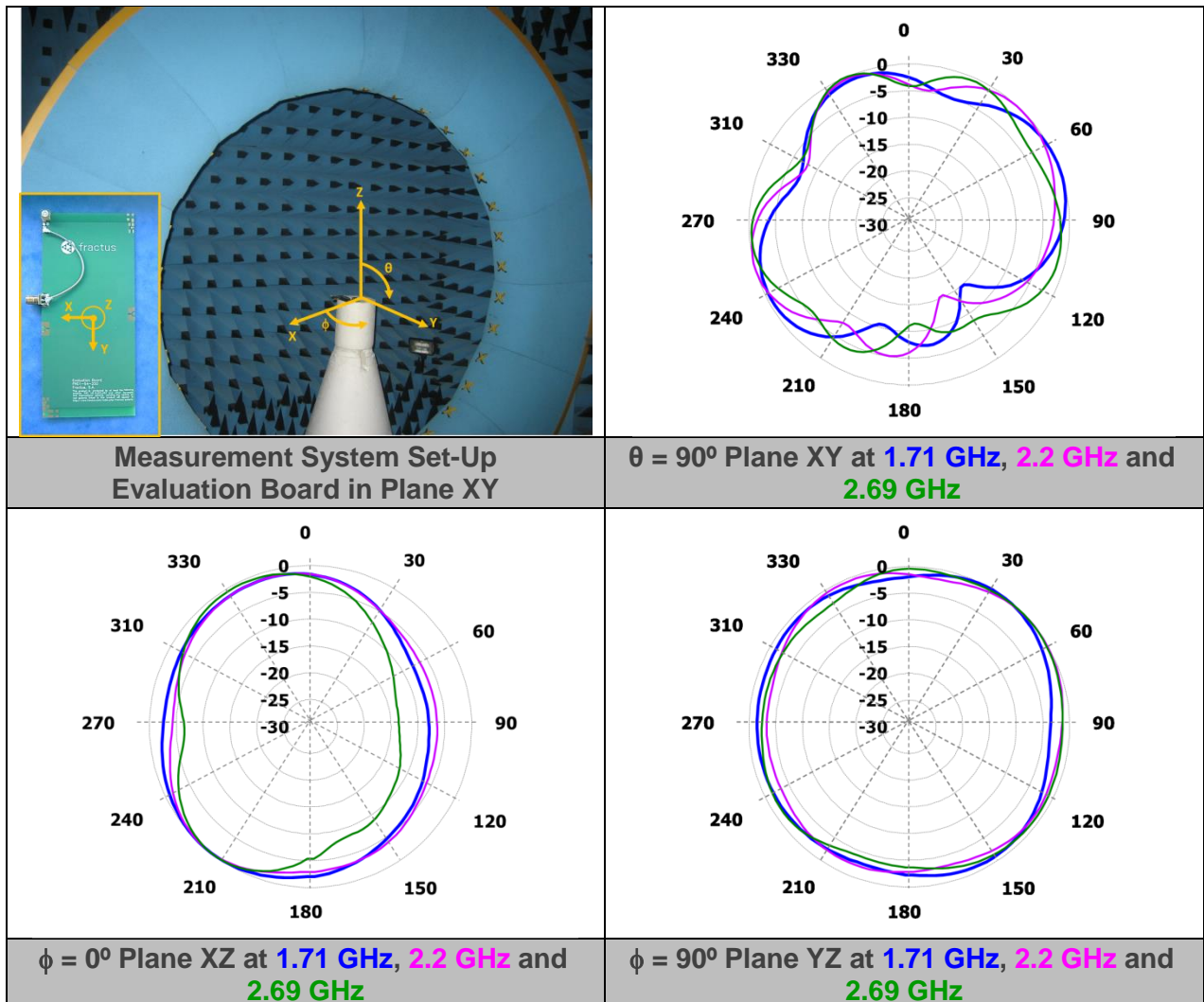


Figure 12 – VSWR and Total Efficiency for the Evaluation Board with coplanar transmission lines.  
Part Number: EB\_FR01-S4-250-CPW1R-1700.

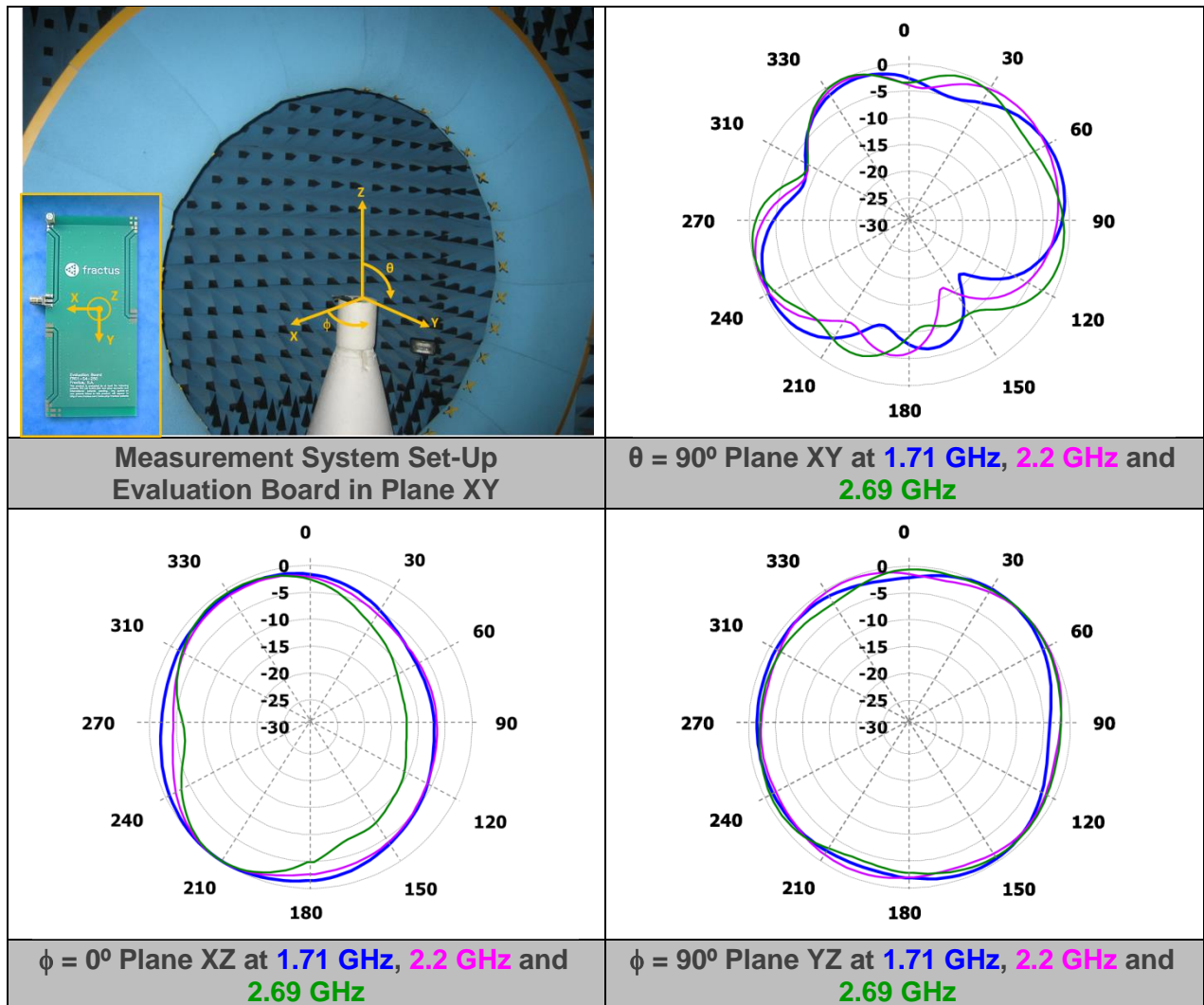
4.2.3. RADIATION PATTERNS (1710-2690 MHz), GAIN, AND EFFICIENCY (UFL cables)



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

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

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



Gain	Peak Gain	2.8 dBi
	Average Gain across the band	2.2 dBi
	Gain Range across the band (min, max)	1.4 <-> 2.8 dBi
Efficiency	Peak Efficiency	79.9 %
	Average Efficiency across the band	72.6 %
	Efficiency Range across the band (min, max)	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 (824-960 MHz & 1710-2690 MHz)

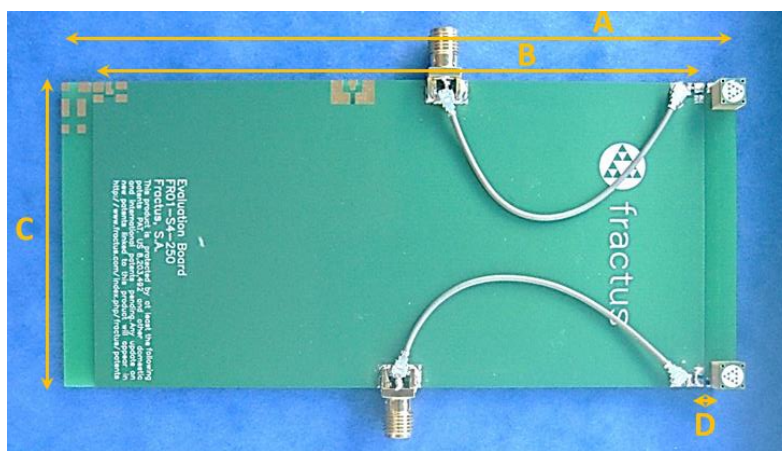
### 5.1. QUICK REFERENCE GUIDE

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
Average Efficiency	> 50 %	> 50 %	> 70 %	> 70 %
Peak Gain	1.4 dBi	1.3 dBi	3.6 dBi	2.8 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 10** – Technical Features. Measures from the Evaluation Board. See Figure 13 and Figure 16. Note that for obtaining comparable results, a ground plane length larger than 100 mm is recommended.

### 5.2. EVALUATION BOARD 2 ports (UFL cables)

This Evaluation Board (part number: EB\_FR01-S4-250-UFL2R) integrates UFL cables to connect the two CUBE mXTEND™ Antenna Boosters with the SMA connector. It works from 824 MHz to 960 MHz and from 1710 MHz to 2690 MHz. In the next section (0) 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 CUBE mXTEND™ Antenna Boosters with the SMA connector.



Measure	mm
A	133
B	120
C	60
D	1.5

**Tolerance:** ±0.2 mm

D: Distance between the CUBE 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.

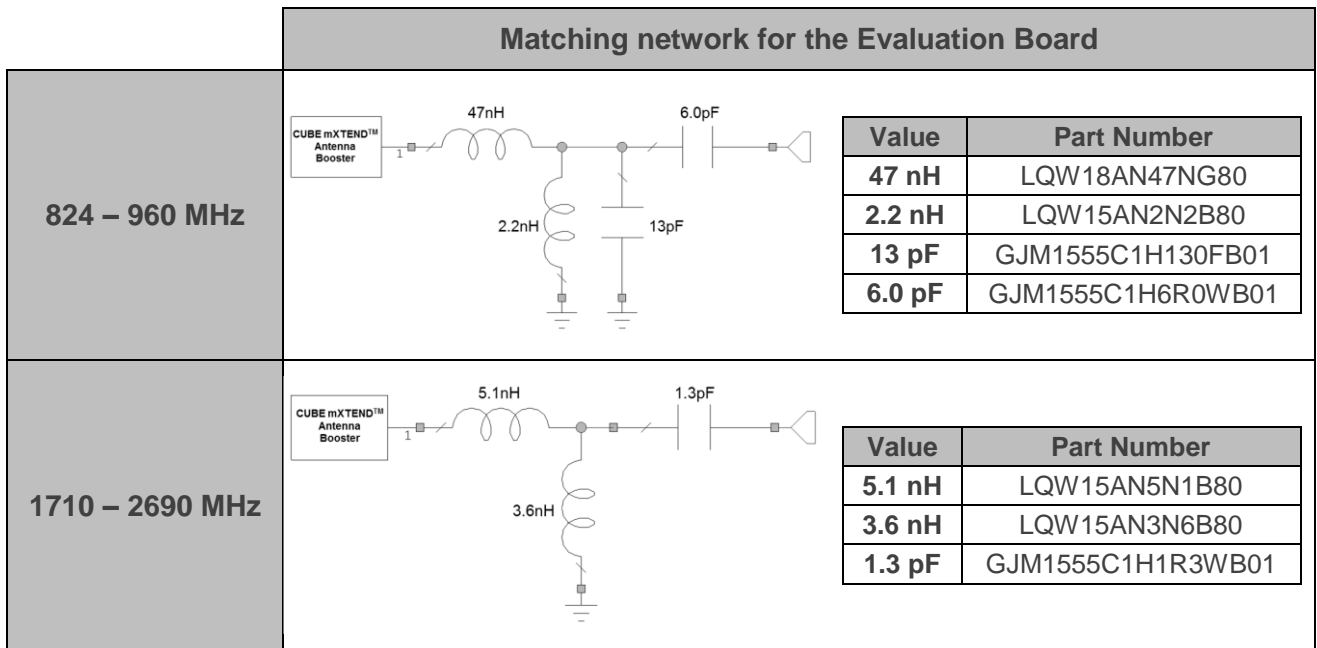
This product is protected by at least the following [patent](#) PAT. US 8,203,492 and other domestic and international patents pending. Any update on new patents linked to this product will appear in [www.fractusantennas.com/virtual-antenna/](http://www.fractusantennas.com/virtual-antenna/).

**5.2.1. MATCHING NETWORK**

The specs of a Fractus Antennas 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 CUBE 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 CUBE 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).

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



**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).

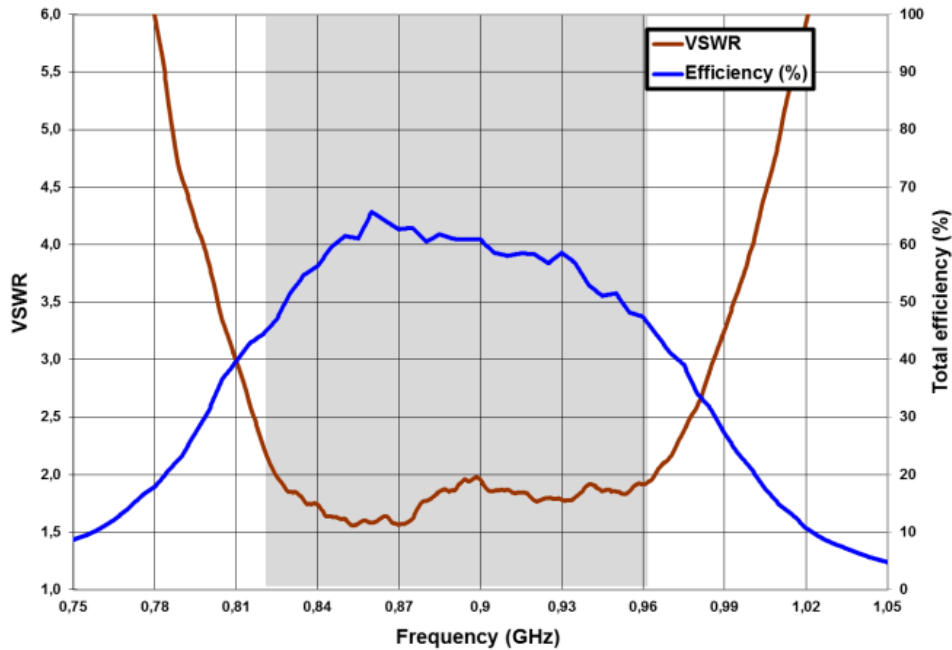


Figure 15 – VSWR and Total Efficiency for the 824 – 960 MHz range (from the Evaluation Board with UFL cables (Figure 13)).

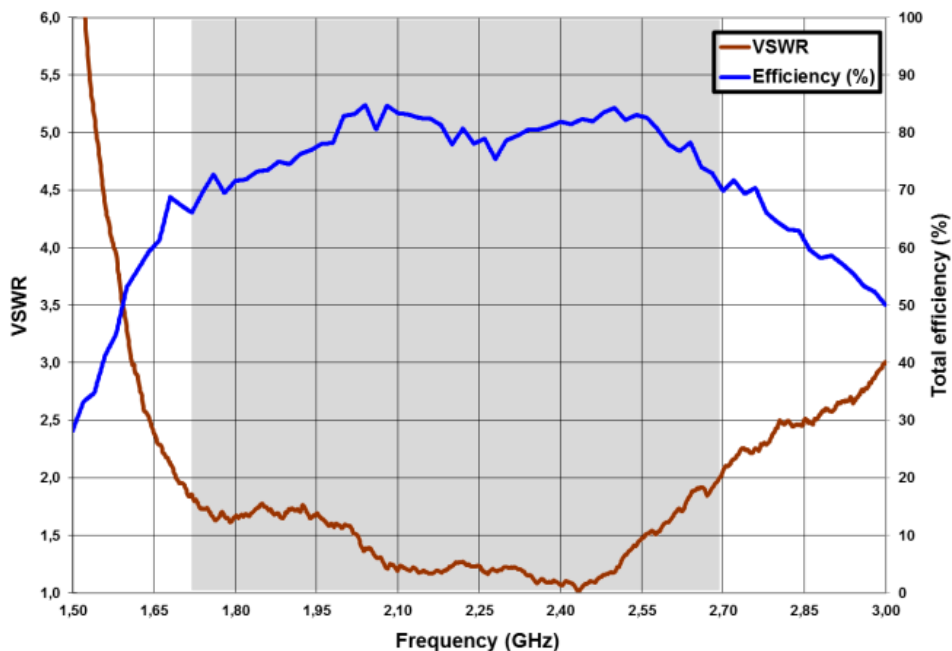
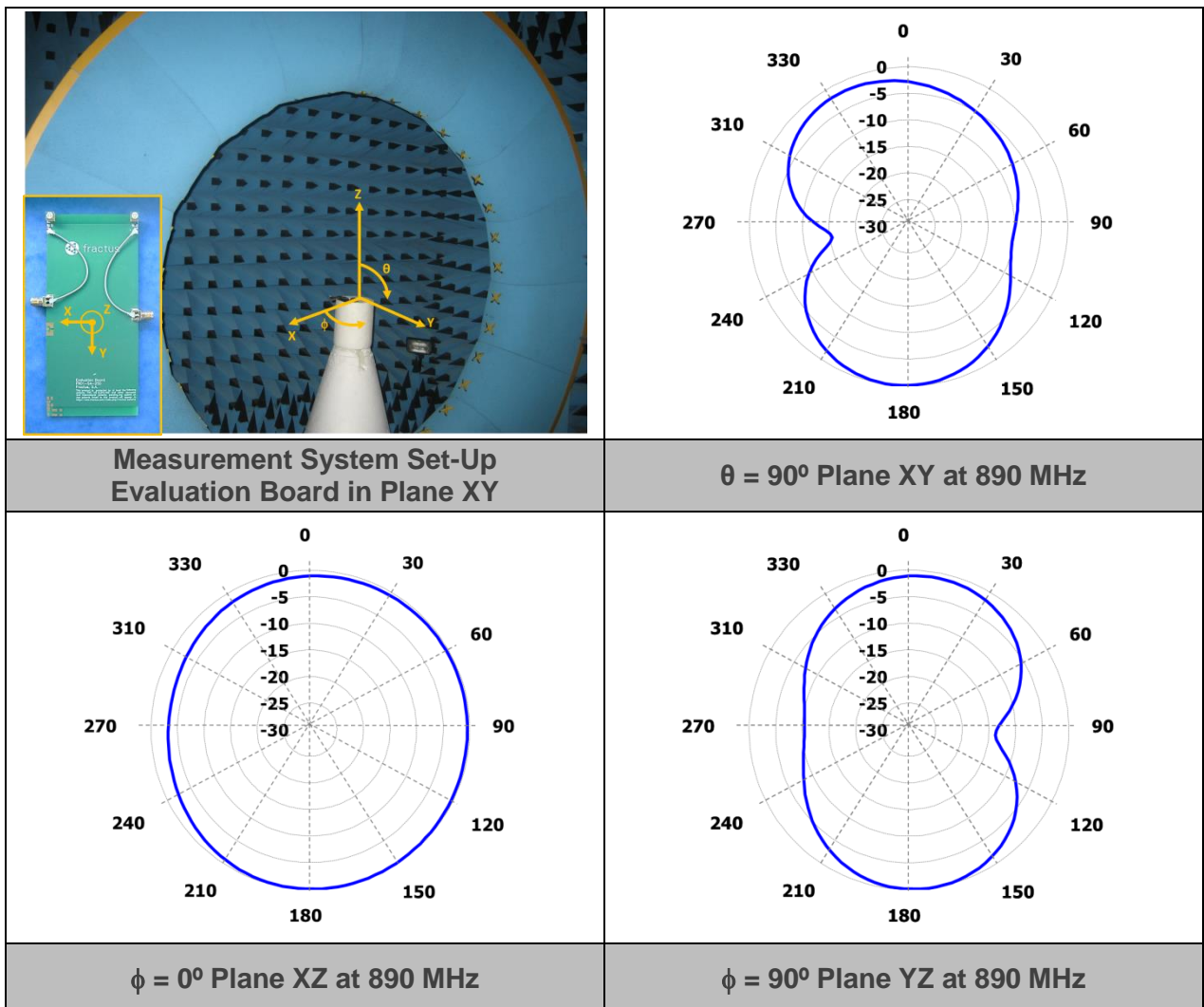


Figure 16 – VSWR and Total Efficiency for the 1710 – 2690 MHz range (from the Evaluation Board with UFL cables (Figure 13)).

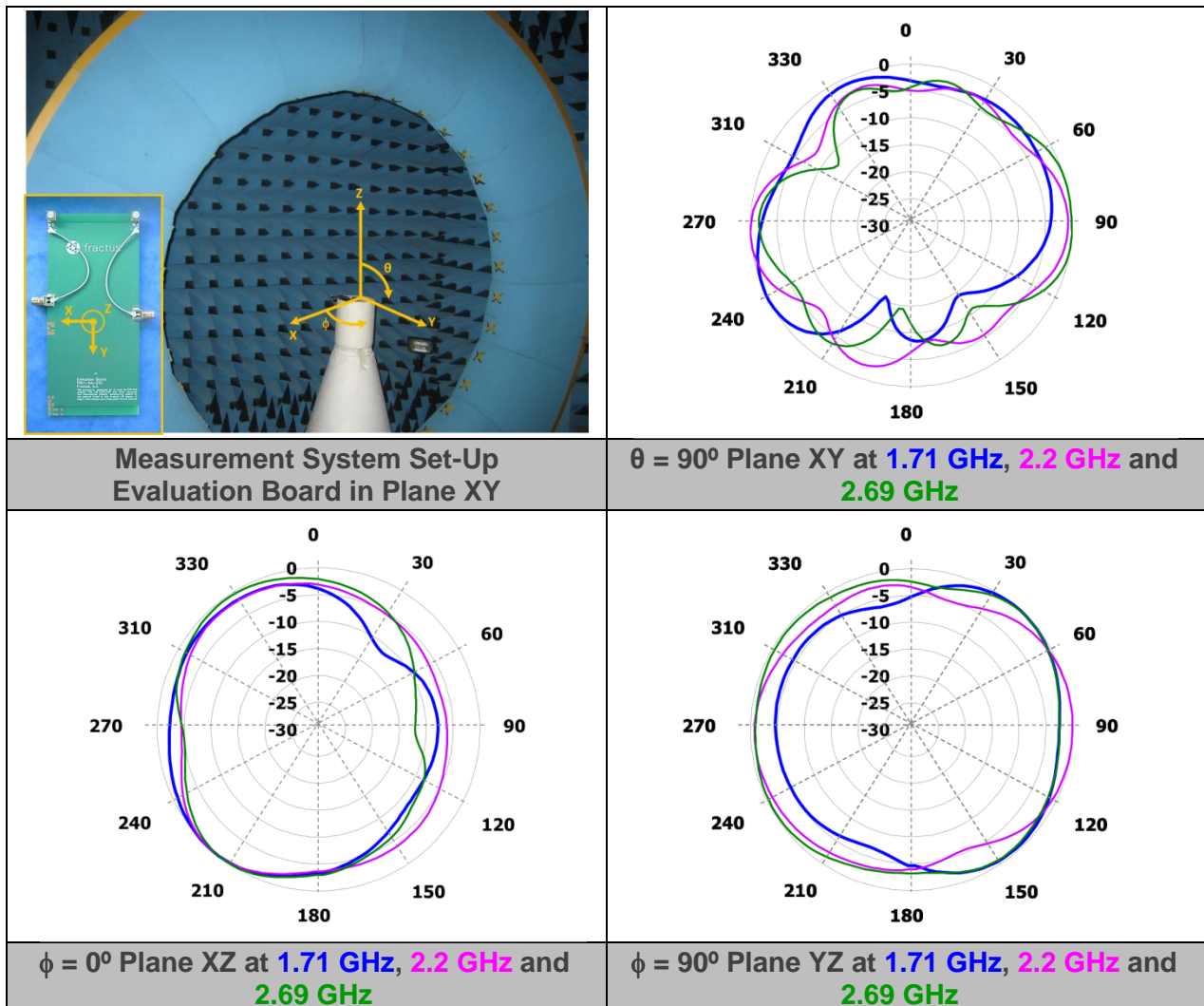
5.2.3. RADIATION PATTERNS (824-960 MHz), GAIN, AND EFFICIENCY



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



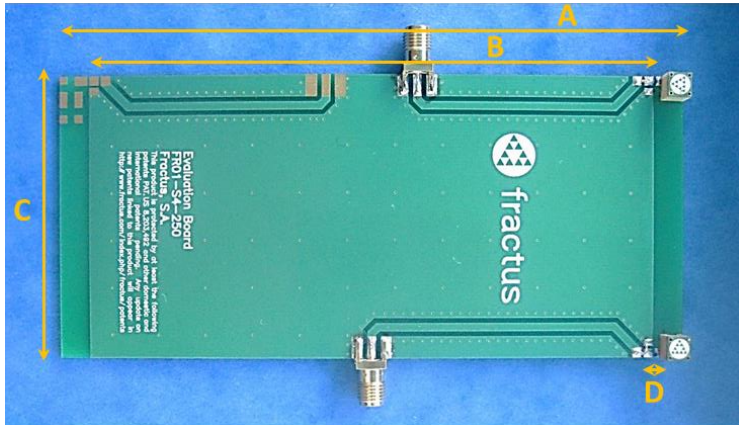
<b>Gain</b>	<b>Peak Gain</b>	3.6 dBi
	<b>Average Gain across the band</b>	2.6 dBi
	<b>Gain Range across the band (min, max)</b>	1.8 <--> 3.6 dBi
<b>Efficiency</b>	<b>Peak Efficiency</b>	84.8 %
	<b>Average Efficiency across the band</b>	78.6 %
	<b>Efficiency Range across the band (min, max)</b>	66.2 – 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 CUBE mXTEND™ Antenna Boosters 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 CUBE 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 [patent](#) 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 [www.fractusantennas.com/virtual-antenna/](http://www.fractusantennas.com/virtual-antenna/).

5.3.1. MATCHING NETWORK

The specs of a Fractus Antennas 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 CUBE 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 CUBE 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).

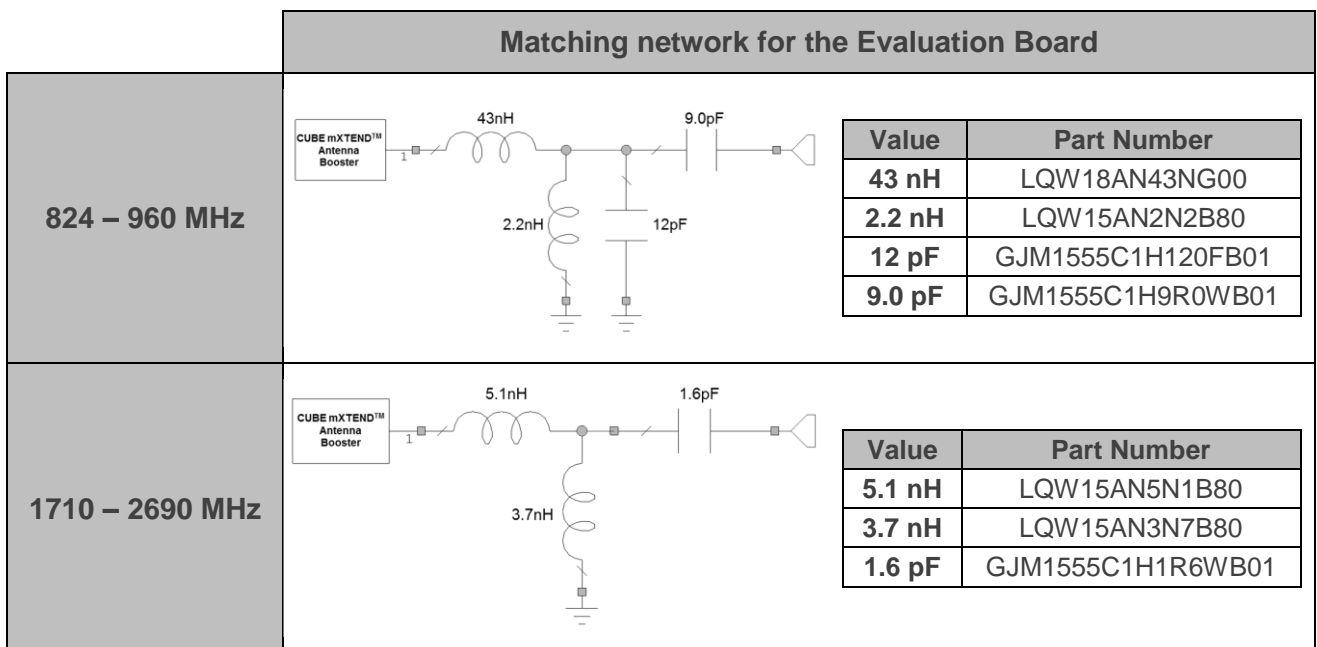


Figure 17 – Matching networks for the 2 ports solution (Evaluation Board with coplanar transmission lines).

5.3.2. VSWR and TOTAL Efficiency

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

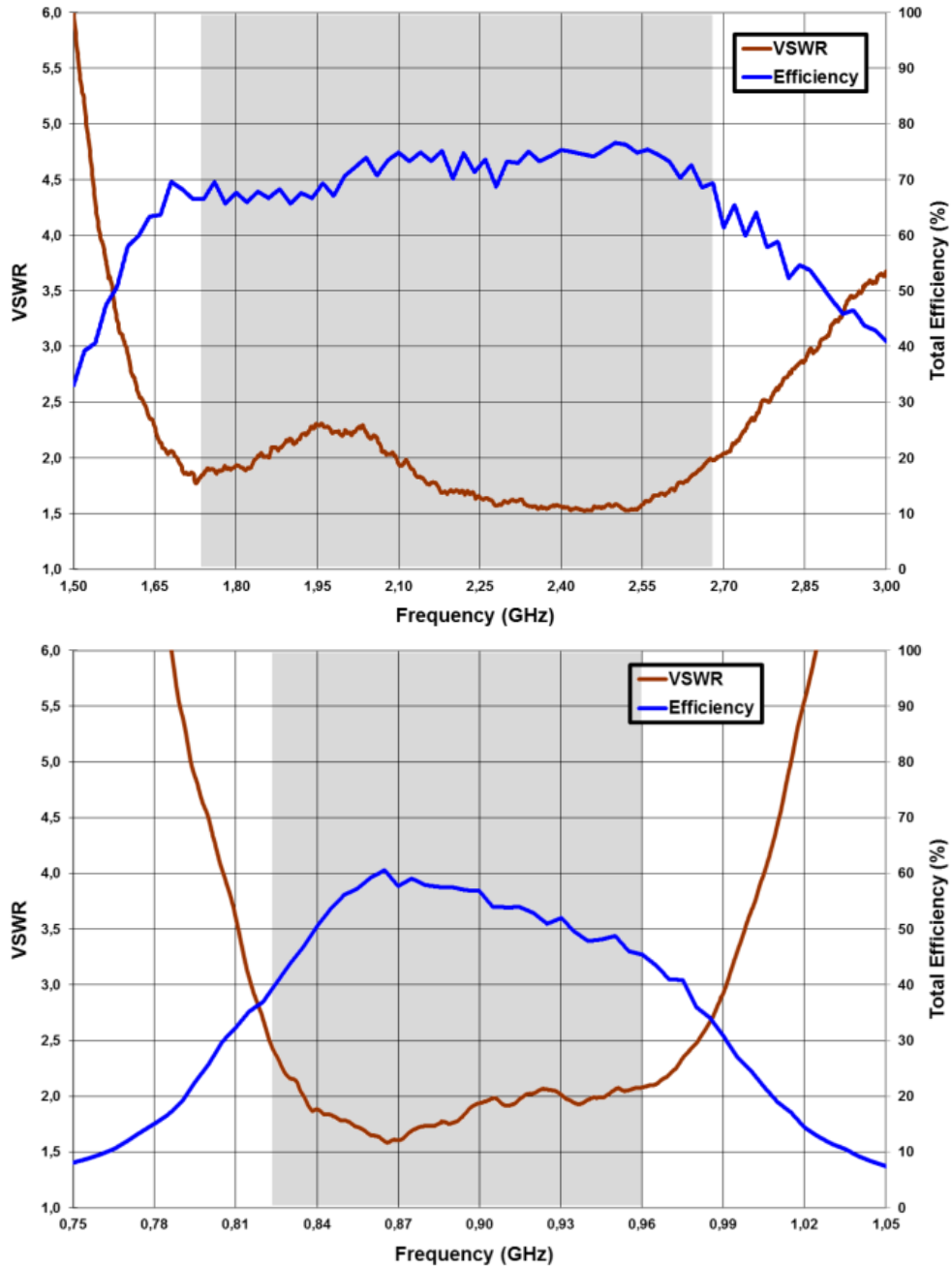
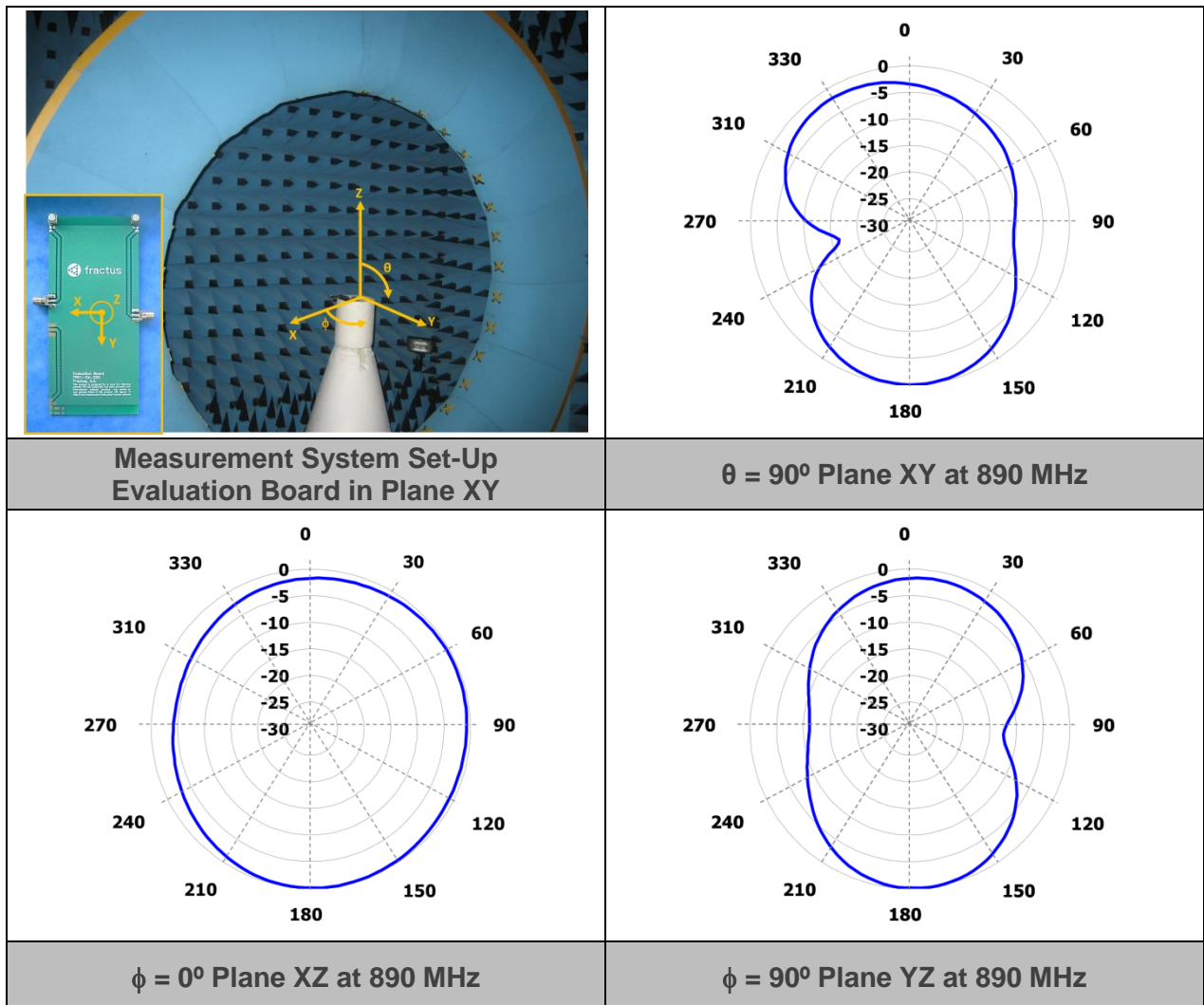


Figure 18 – VSWR and Efficiency for the 824 – 960 MHz range and for the 1710 – 2690 MHz range from the Evaluation Board with coplanar transmission lines (Figure 16).

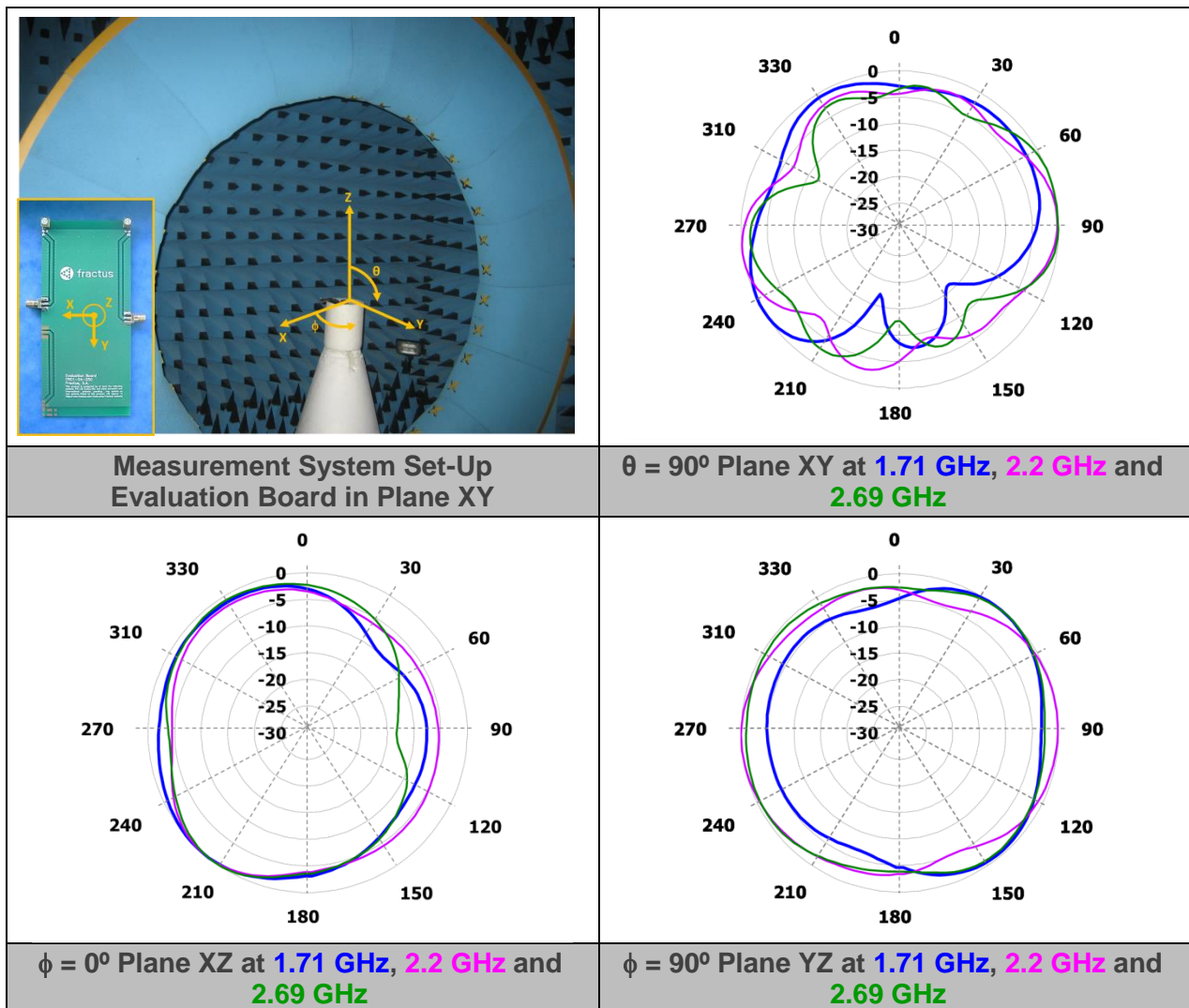
5.3.3. RADIATION PATTERNS (824-960 MHz), GAIN, AND EFFICIENCY



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



Gain	Peak Gain	2.8 dBi
	Average Gain across the band	2.3 dBi
	Gain Range across the band (min, max)	1.6 <-> 2.8 dBi
Efficiency	Peak Efficiency	76.6 %
	Average Efficiency across the band	71.5 %
	Efficiency Range across the band (min, max)	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 (698-798 MHz & 824-960 MHz & 1710-2690 MHz)

### 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
Average Efficiency	> 45 %	> 50 %	> 70 %
Peak Gain	0.6 dBi	0.6 dBi	3.2 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 15 – Technical features. Measures from the Evaluation Board. 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
Average Efficiency	> 40 %	> 45 %	> 70 %
Peak Gain	-0.2 dBi	1.0 dBi	3.4 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		

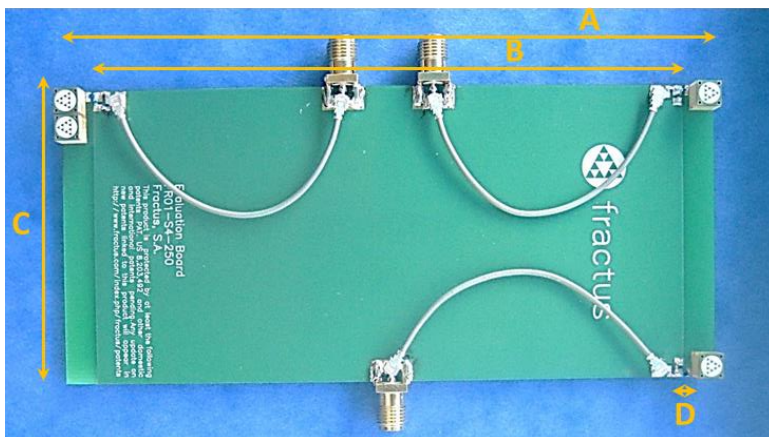
Table 16 – Technical features. Measures from the Evaluation Board. See Figure 23.

**Comments:**

- Note that in the Evaluation Boards (Figure 19 and Figure 23), 2 CUBE 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@fractusantennas.com](mailto:info@fractusantennas.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 CUBE mXTEND™ Antenna Boosters 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 (0) 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 CUBE mXTEND™ Antenna Boosters with the SMA connector.



Measure	mm
A	133
B	120
C	60
D	1.5

**Tolerance:** ±0.2 mm

**D:** Distance between the CUBE 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 [patent](#) 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 [www.fractusantennas.com/virtual-antenna/](http://www.fractusantennas.com/virtual-antenna/).

6.2.1. MATCHING NETWORK

The specs of a Fractus Antennas 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 CUBE 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 CUBE 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).

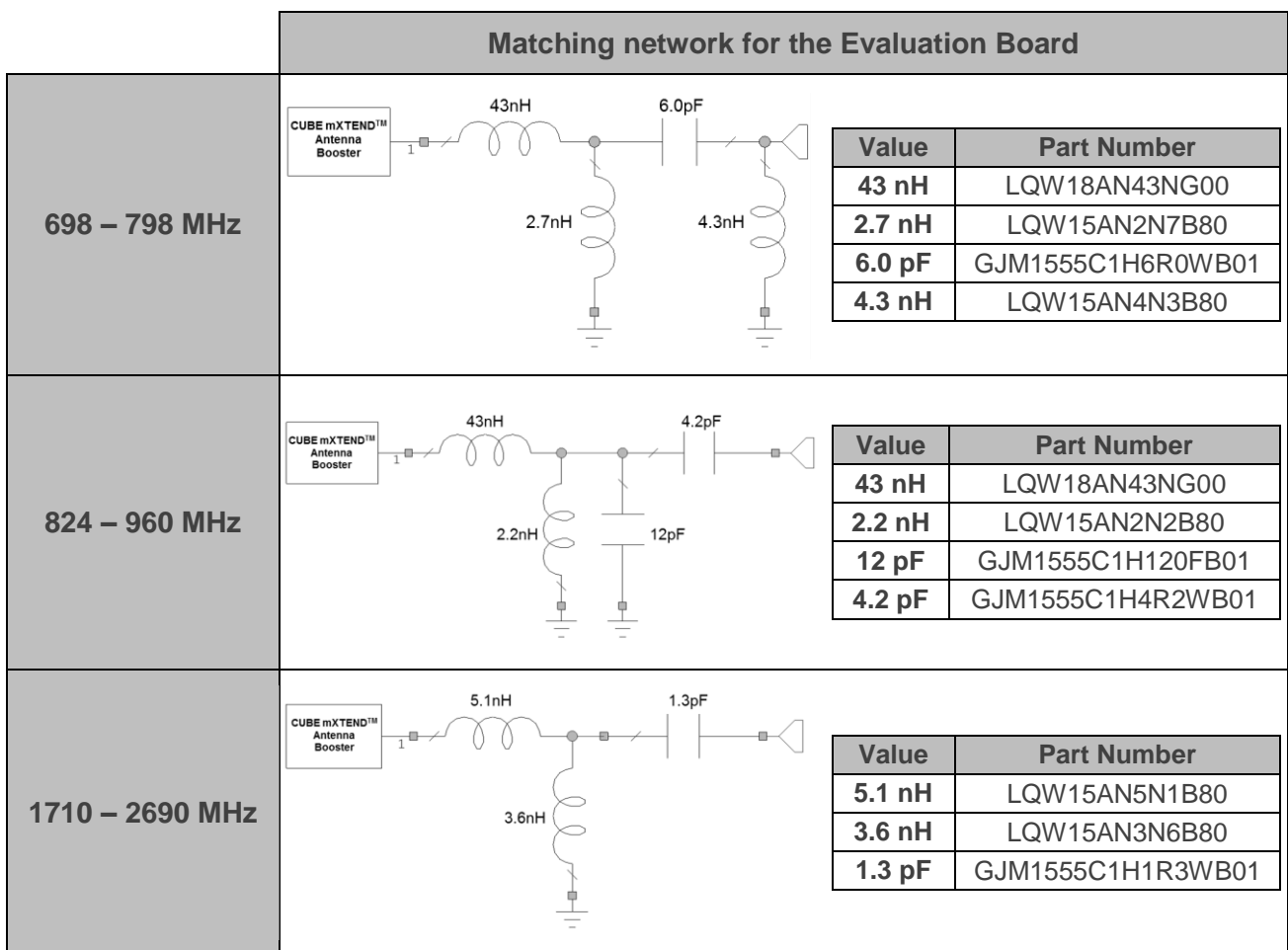


Figure 20 – Matching networks for the 3 ports solution (Evaluation Board with UFL cables).



6.2.2. VSWR and TOTAL Efficiency

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

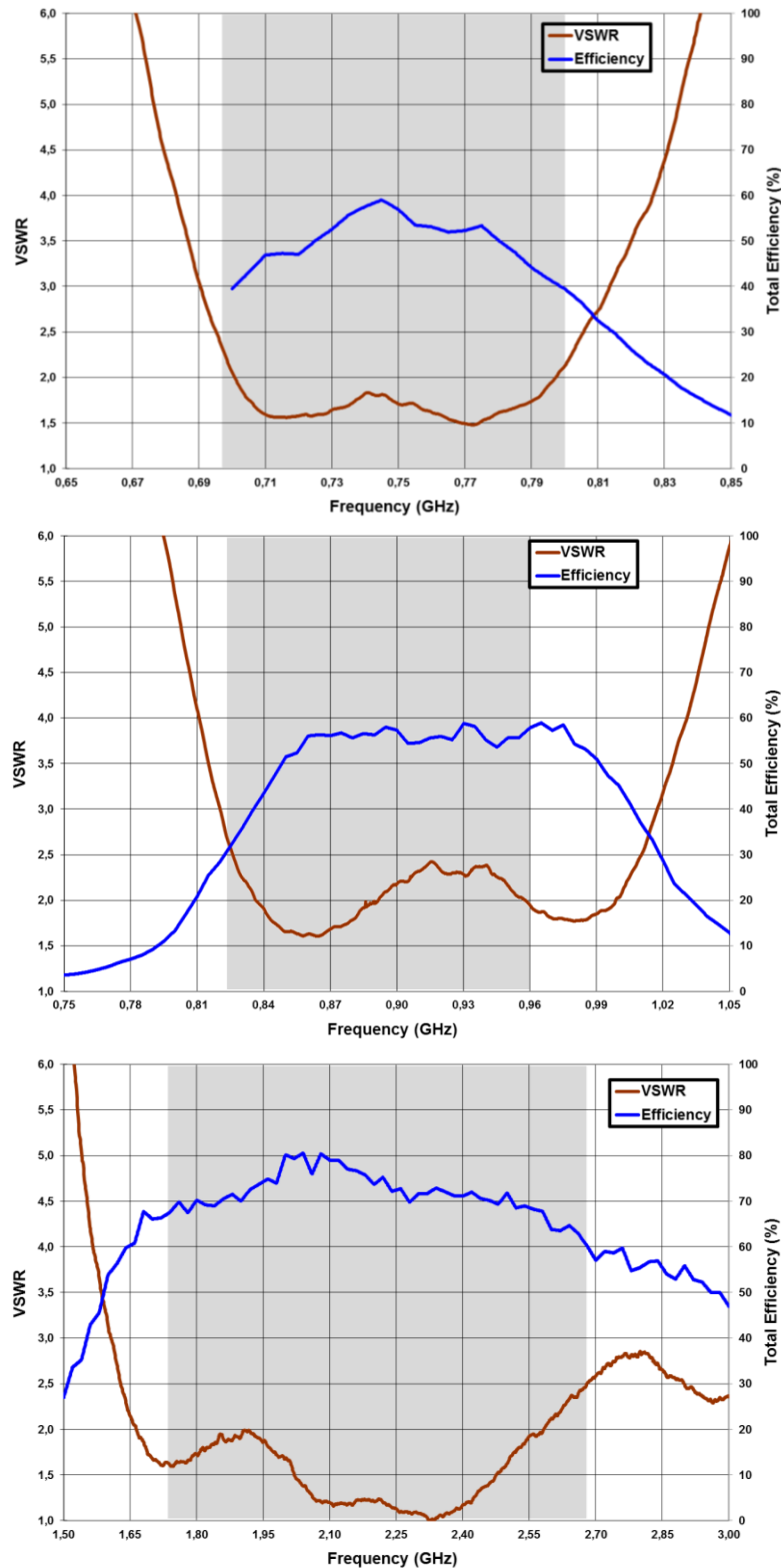
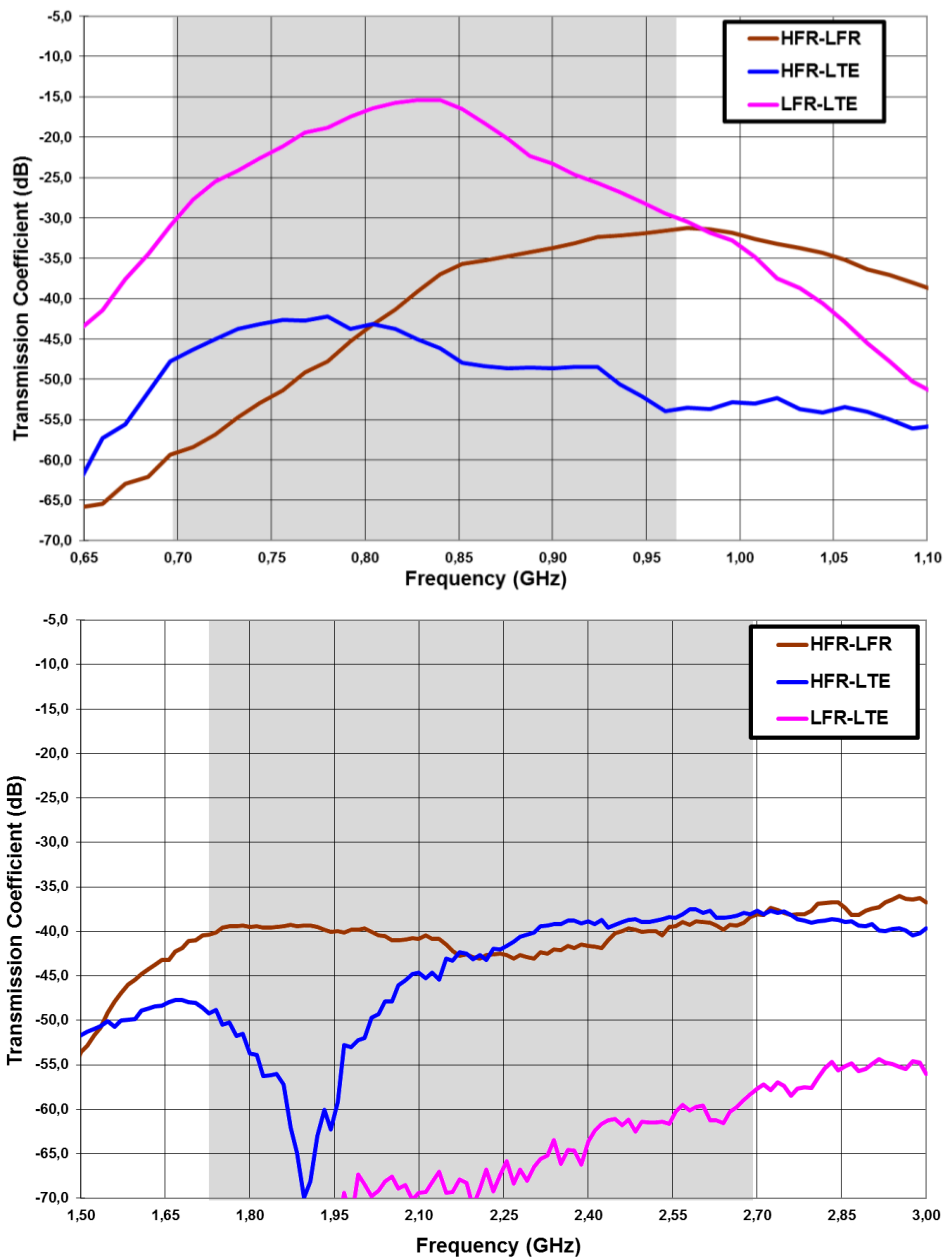


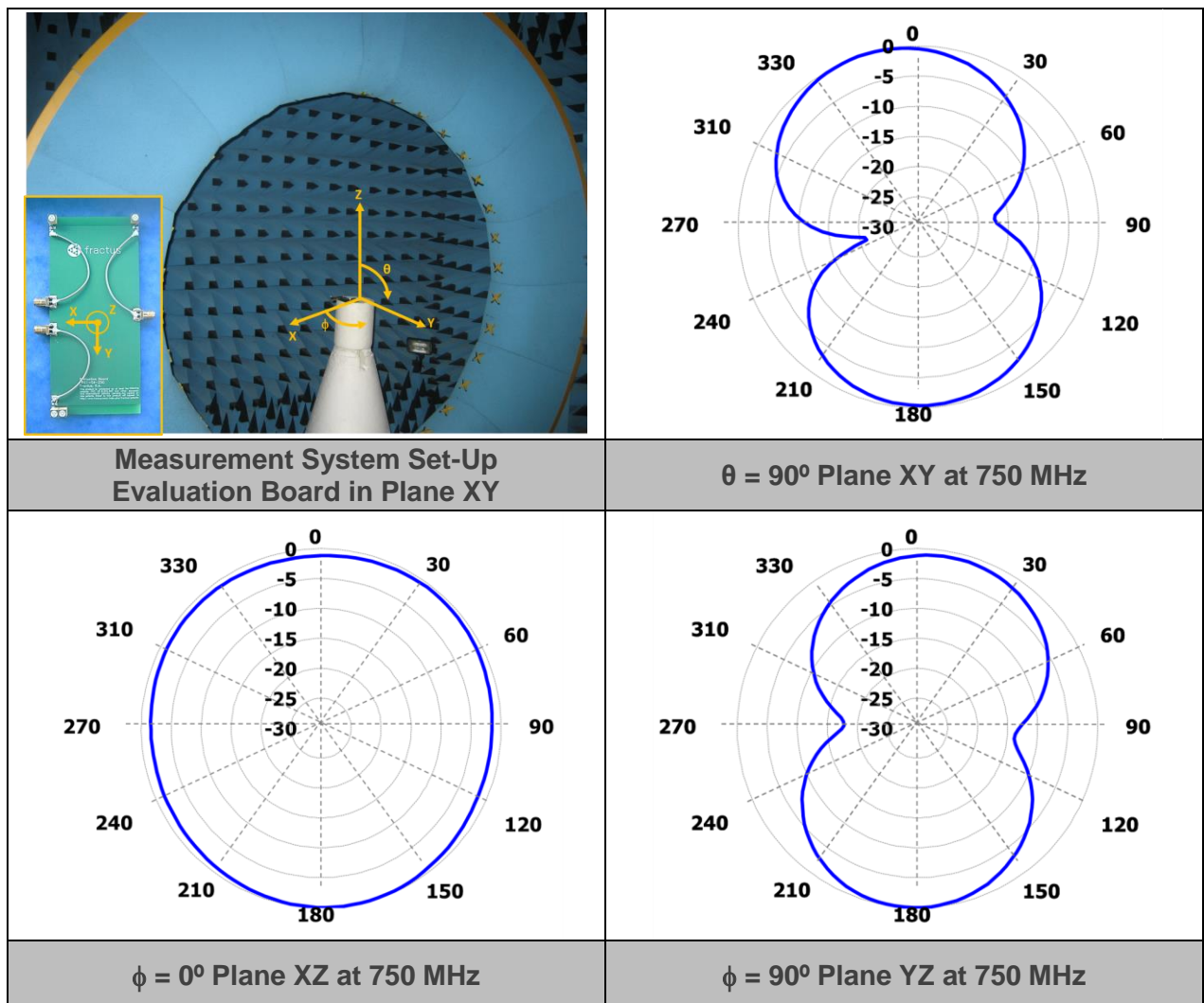
Figure 21 – VSWR and Total Efficiency for the 698 – 798 MHz range, for the 824 – 960 MHz range, and for the 1710 – 2690 MHz range (from the Evaluation Board with UFL cables (Figure 19)).

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).

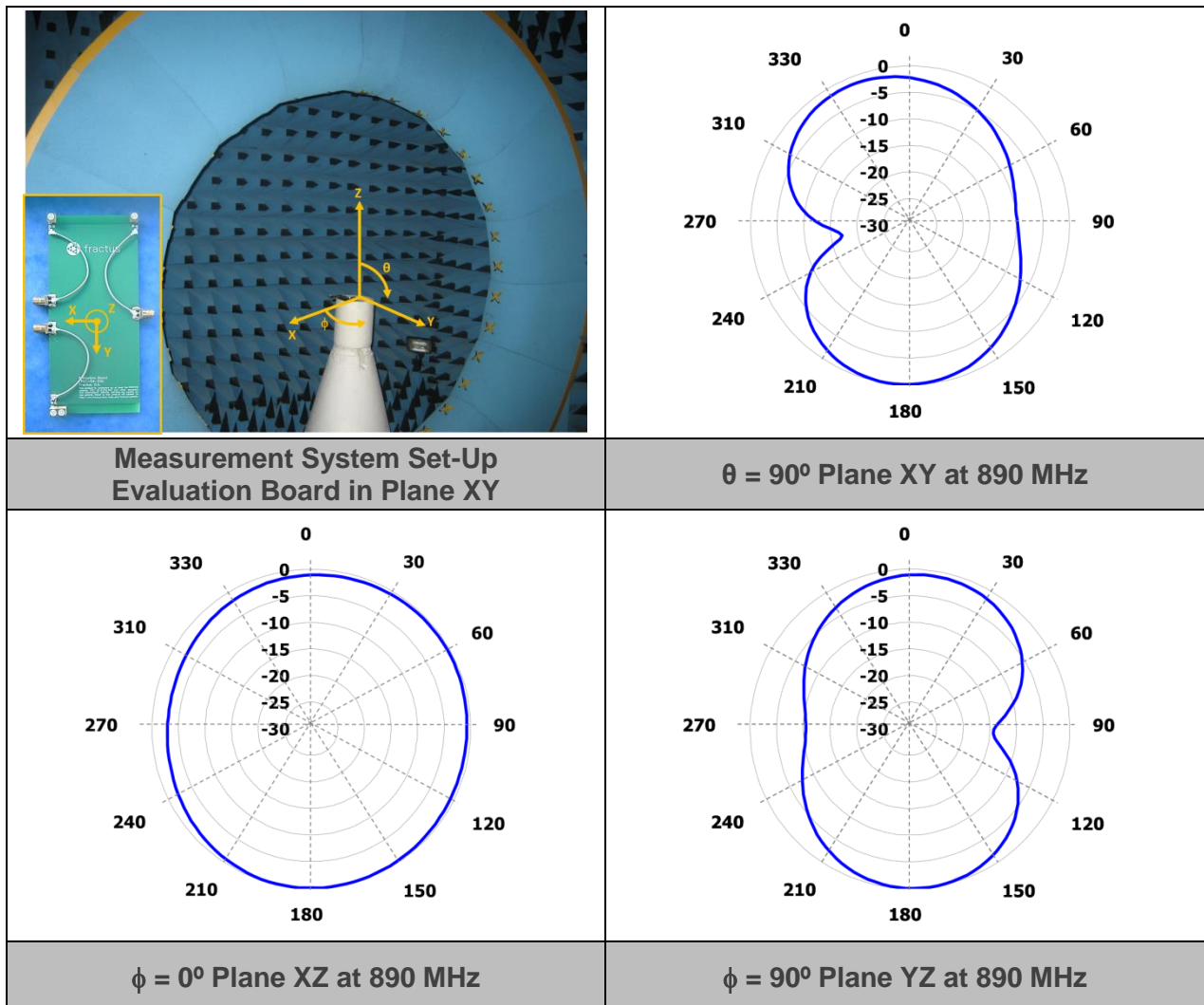
6.2.4. RADIATION PATTERNS (698-798 MHz), GAIN, AND EFFICIENCY



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

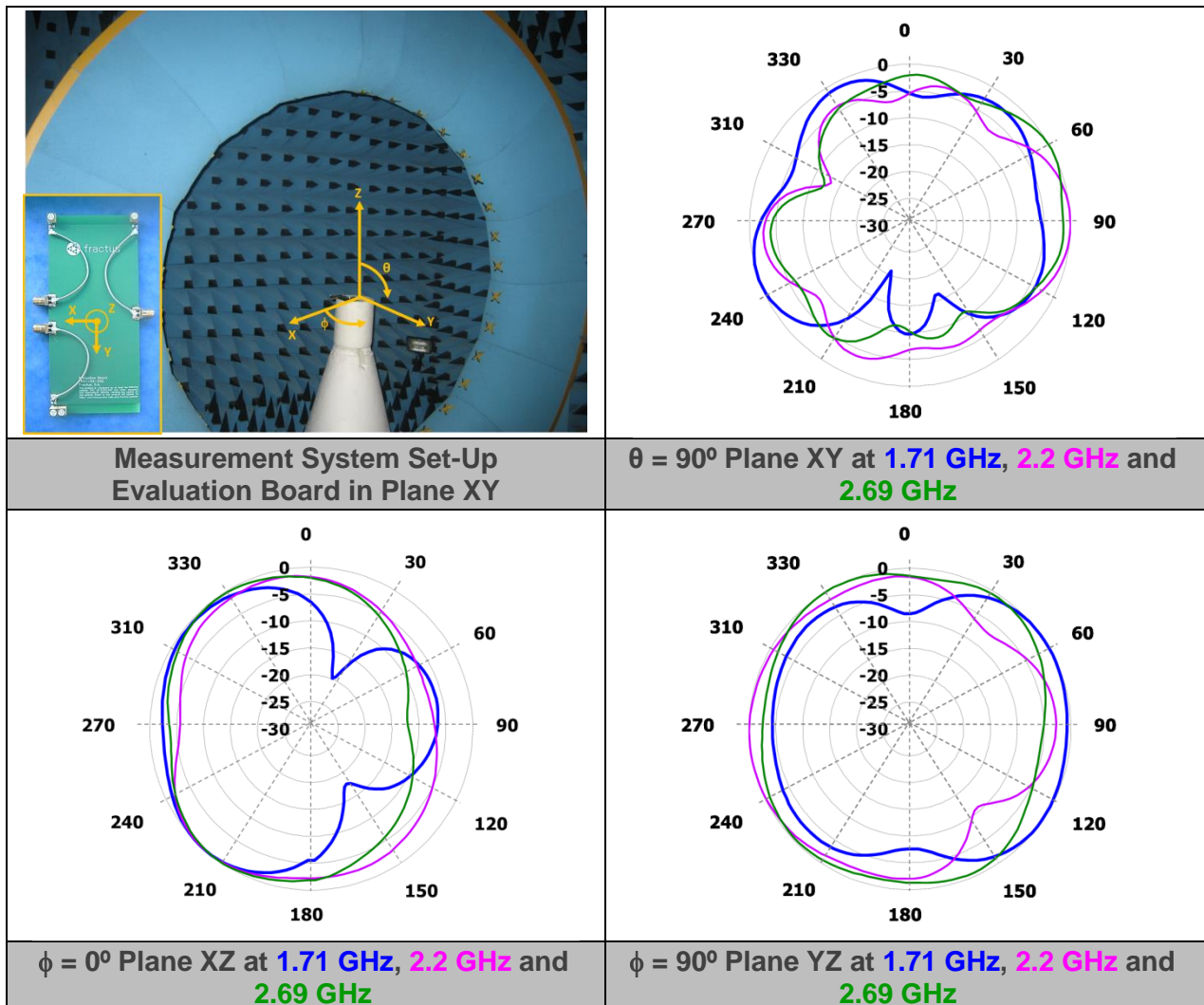
6.2.5. RADIATION PATTERNS (824-960 MHz), GAIN, AND EFFICIENCY



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

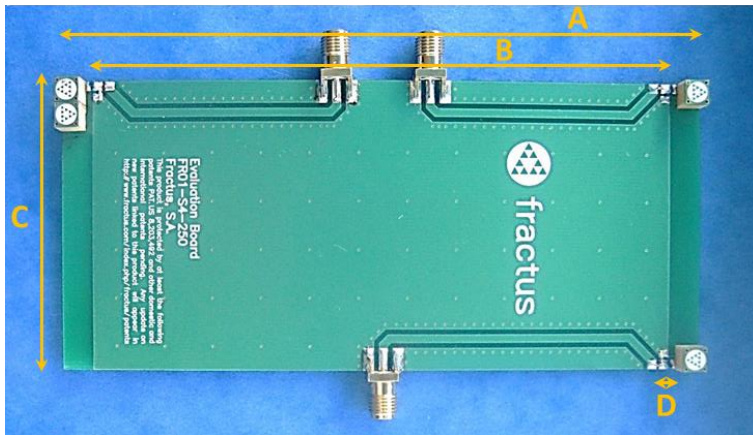


Gain	Peak Gain	3.2 dBi
	Average Gain across the band	2.5 dBi
	Gain Range across the band (min, max)	1.7 <-> 3.2 dBi
Efficiency	Peak Efficiency	80.5 %
	Average Efficiency across the band	71.5 %
	Efficiency Range across the band (min, max)	58.5 – 80.5 %

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 CUBE mXTEND™ Antenna Boosters 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 CUBE 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 [www.fractusantennas.com/virtual-antenna/](http://www.fractusantennas.com/virtual-antenna/).

6.3.1. MATCHING NETWORK

The specs of a Fractus Antennas 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 CUBE 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 CUBE 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).

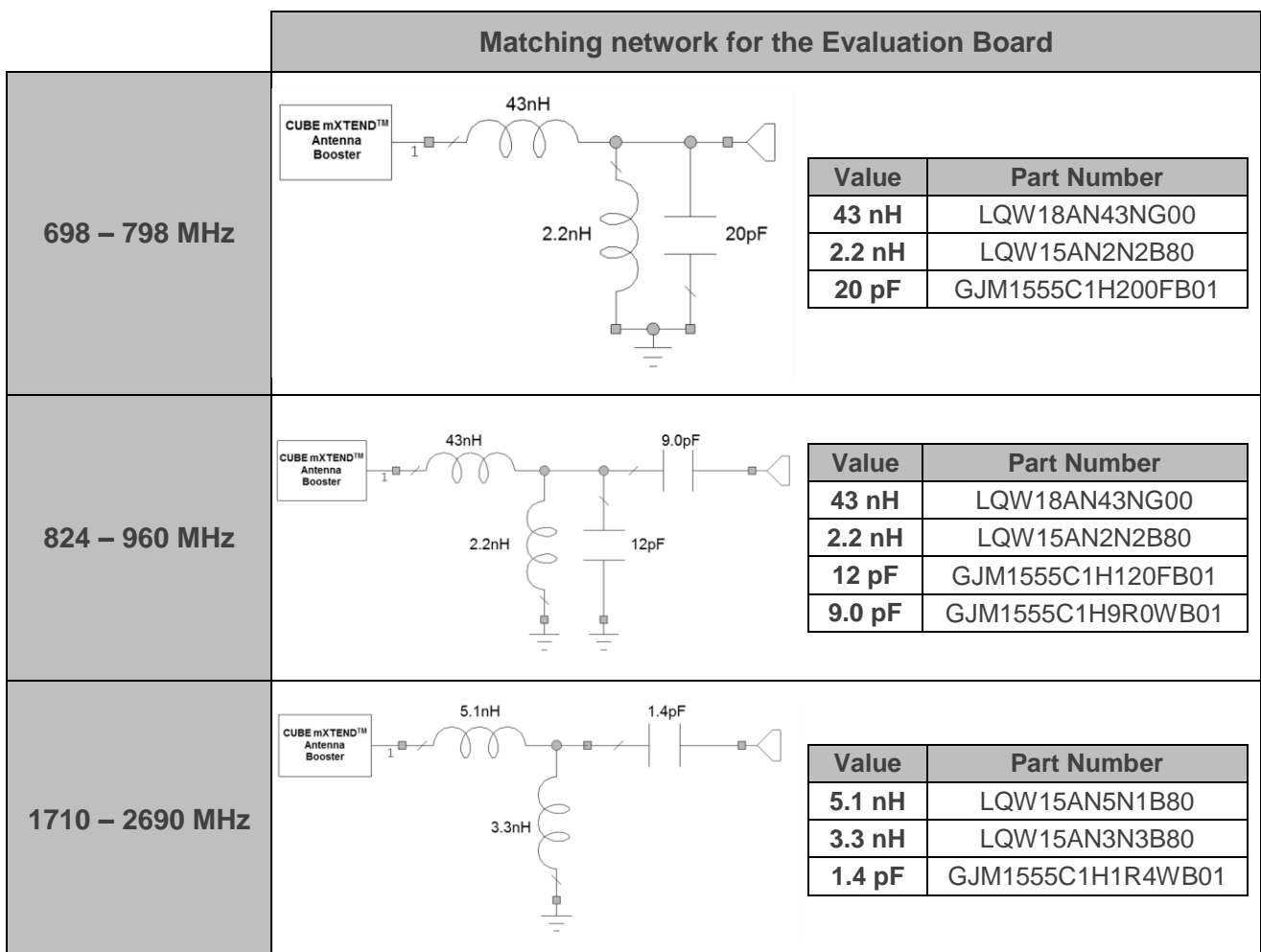


Figure 24 – Matching networks for the 3 ports solution (Evaluation Board with coplanar transmission lines).

6.3.2. VSWR and TOTAL Efficiency

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

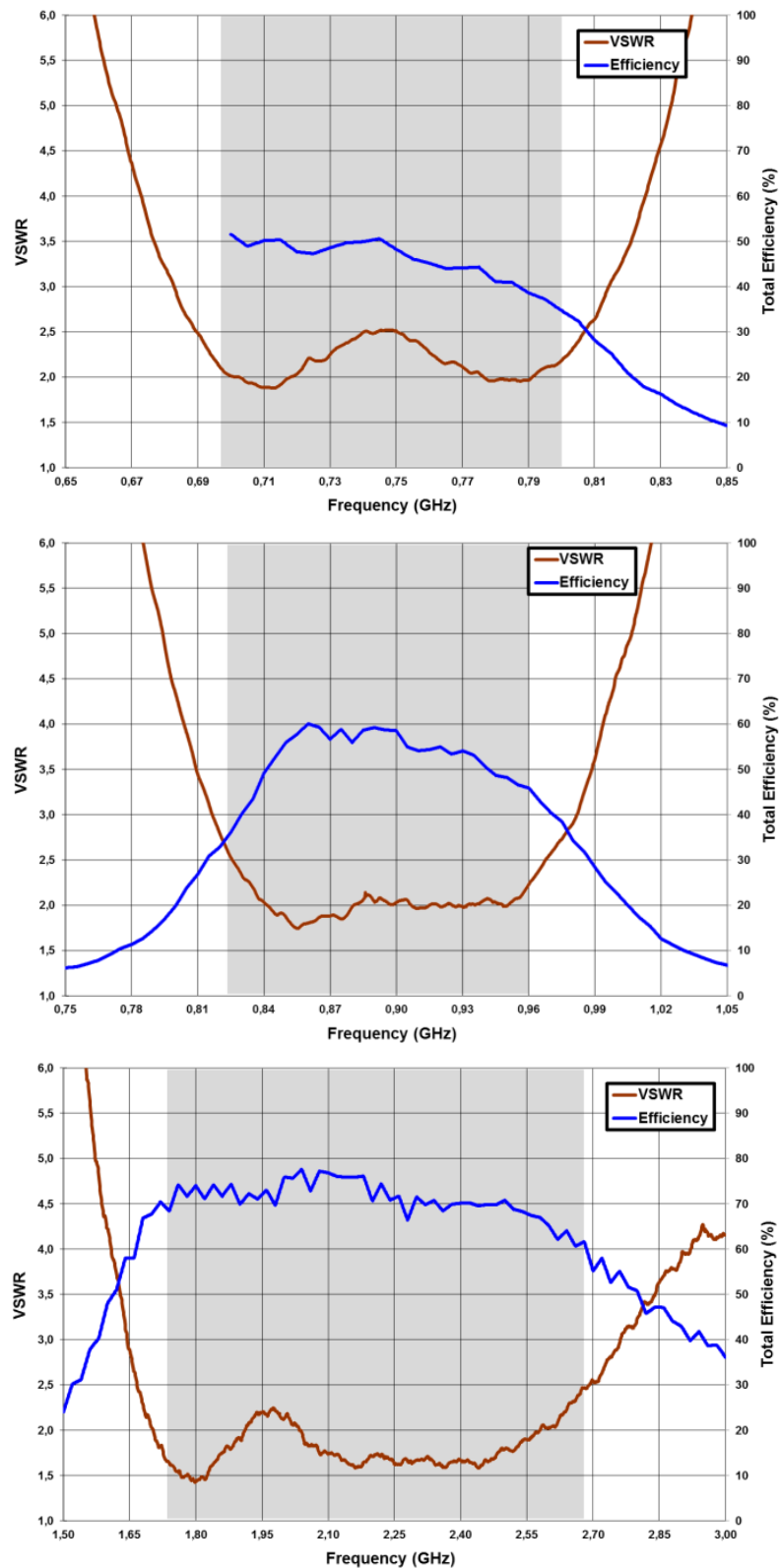
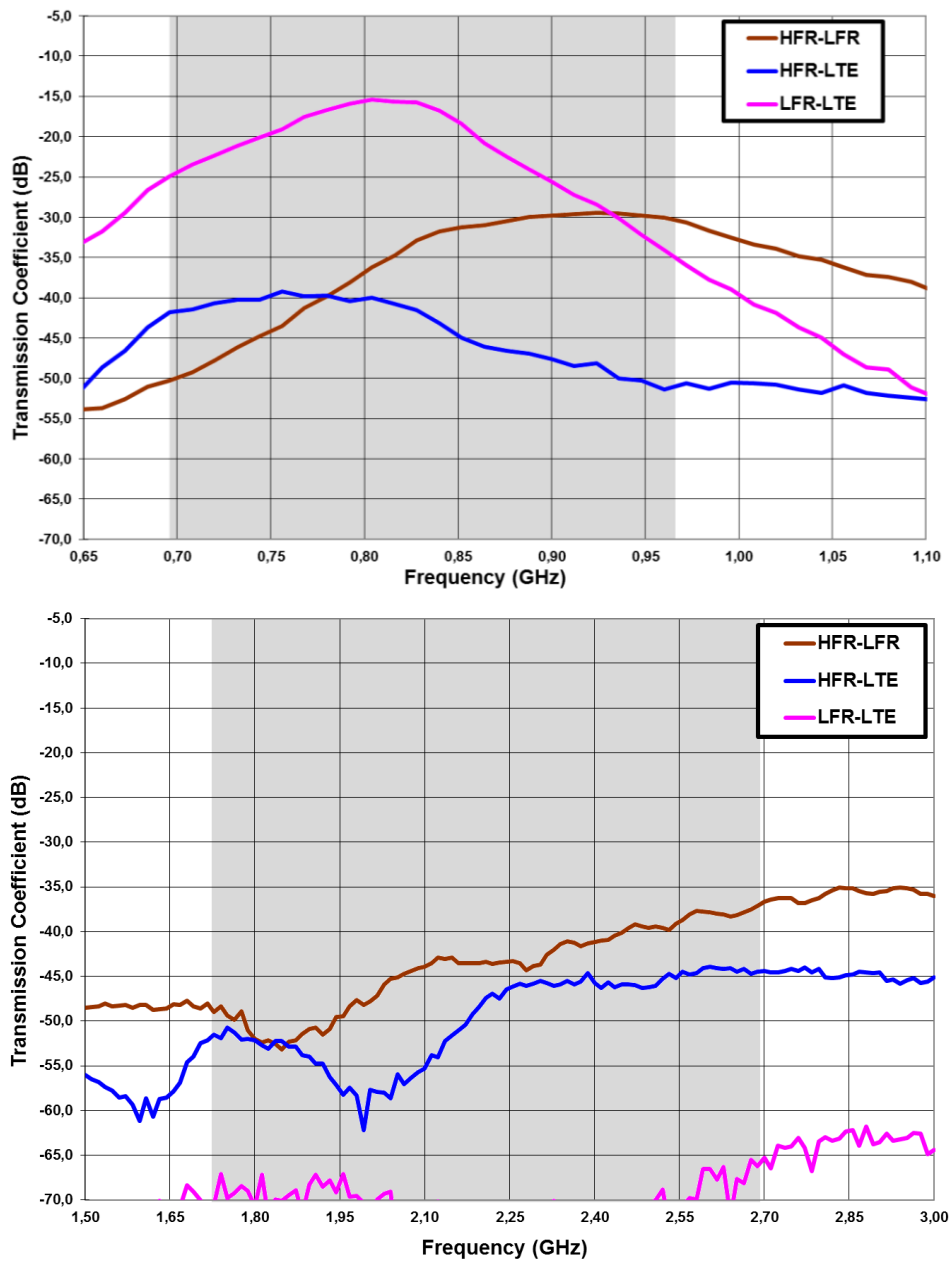


Figure 25 – VSWR and Total Efficiency graph for the 698 – 798 MHz range, for the 824 – 960 MHz range, and for the 1710 – 2690 MHz range (from the Evaluation Board with coplanar transmission lines (Figure 23).

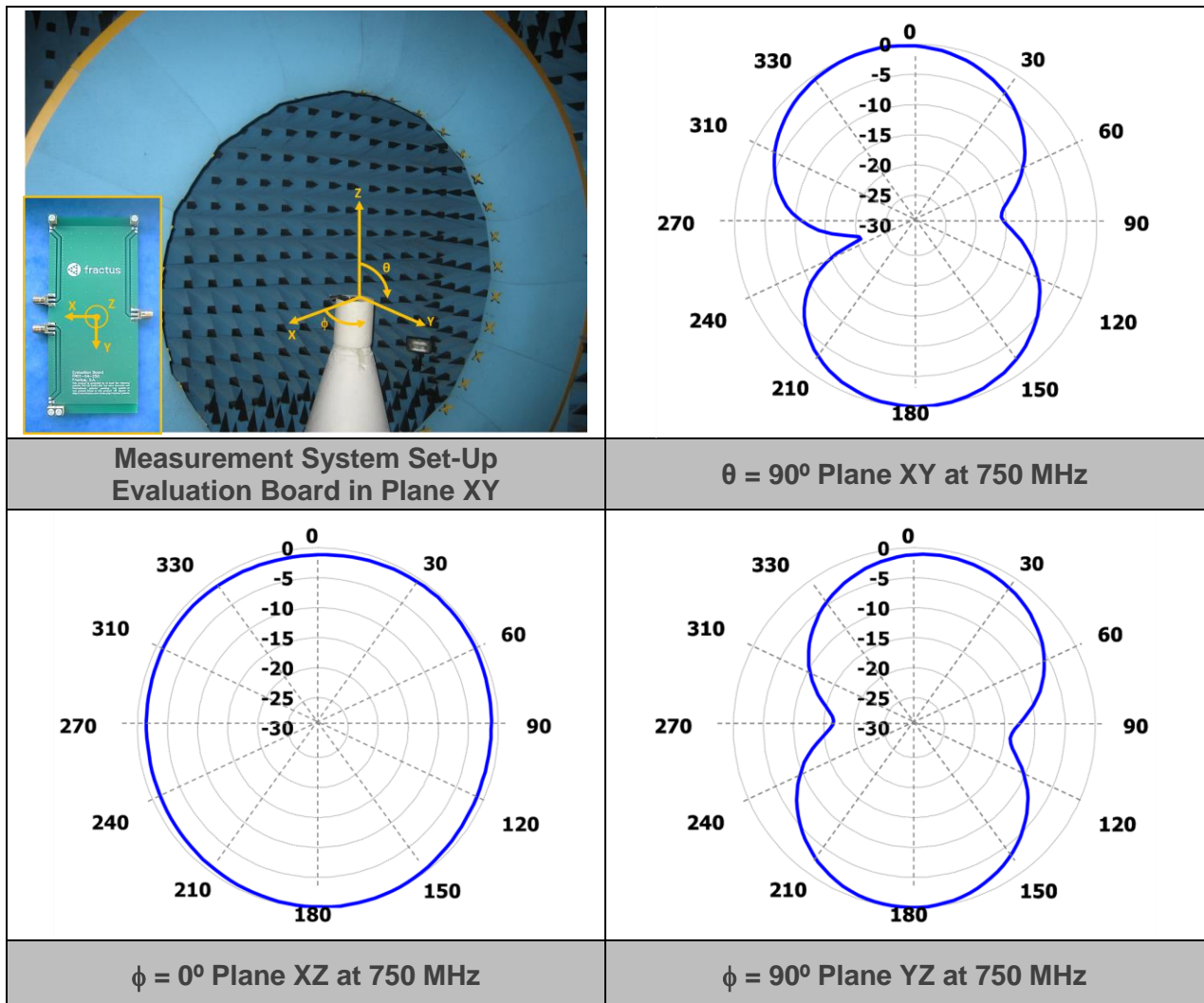


6.3.3. TRANSMISSION COEFFICIENT



**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)).

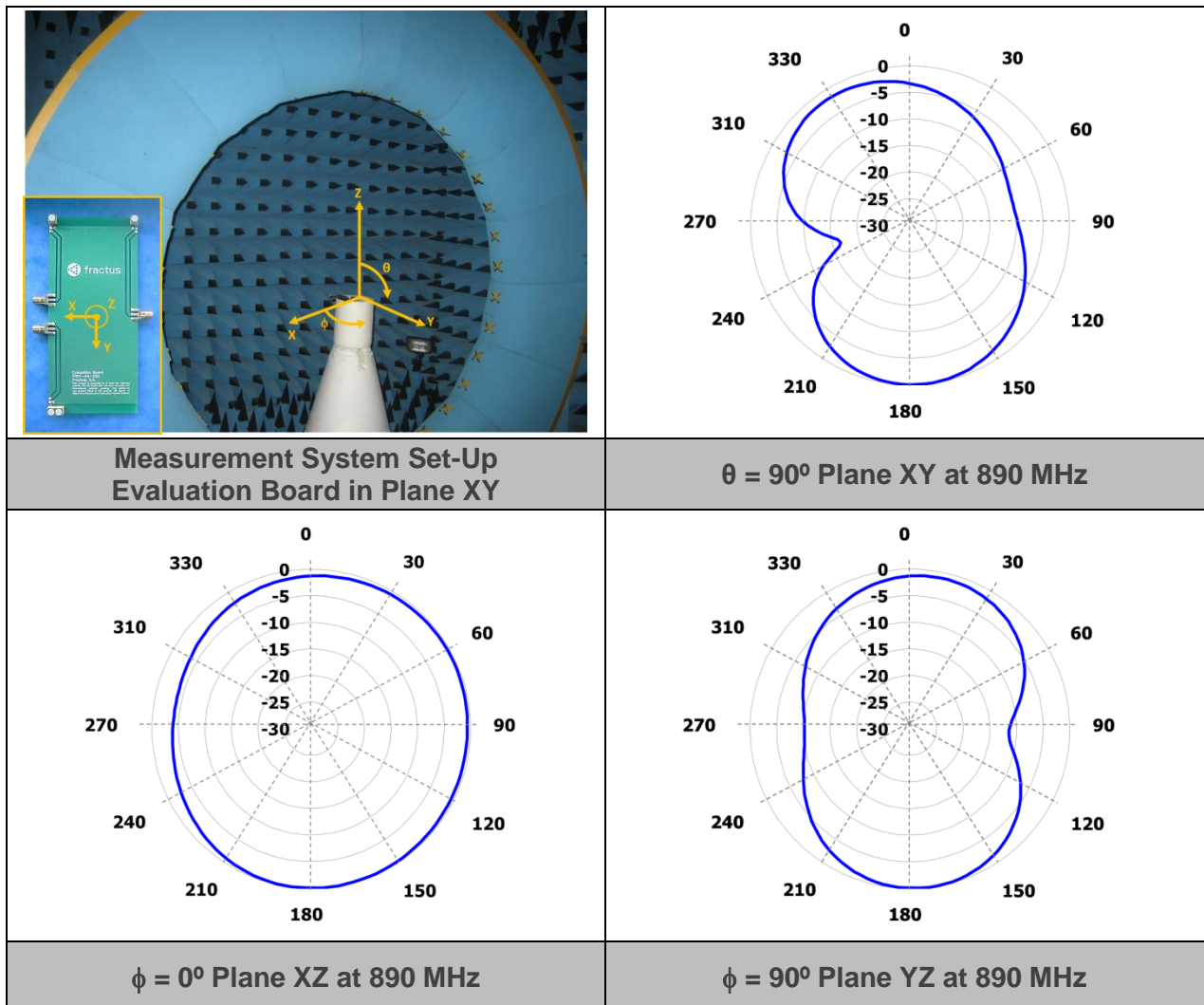
6.3.4. RADIATION PATTERNS (698-798 MHz), GAIN, AND EFFICIENCY



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

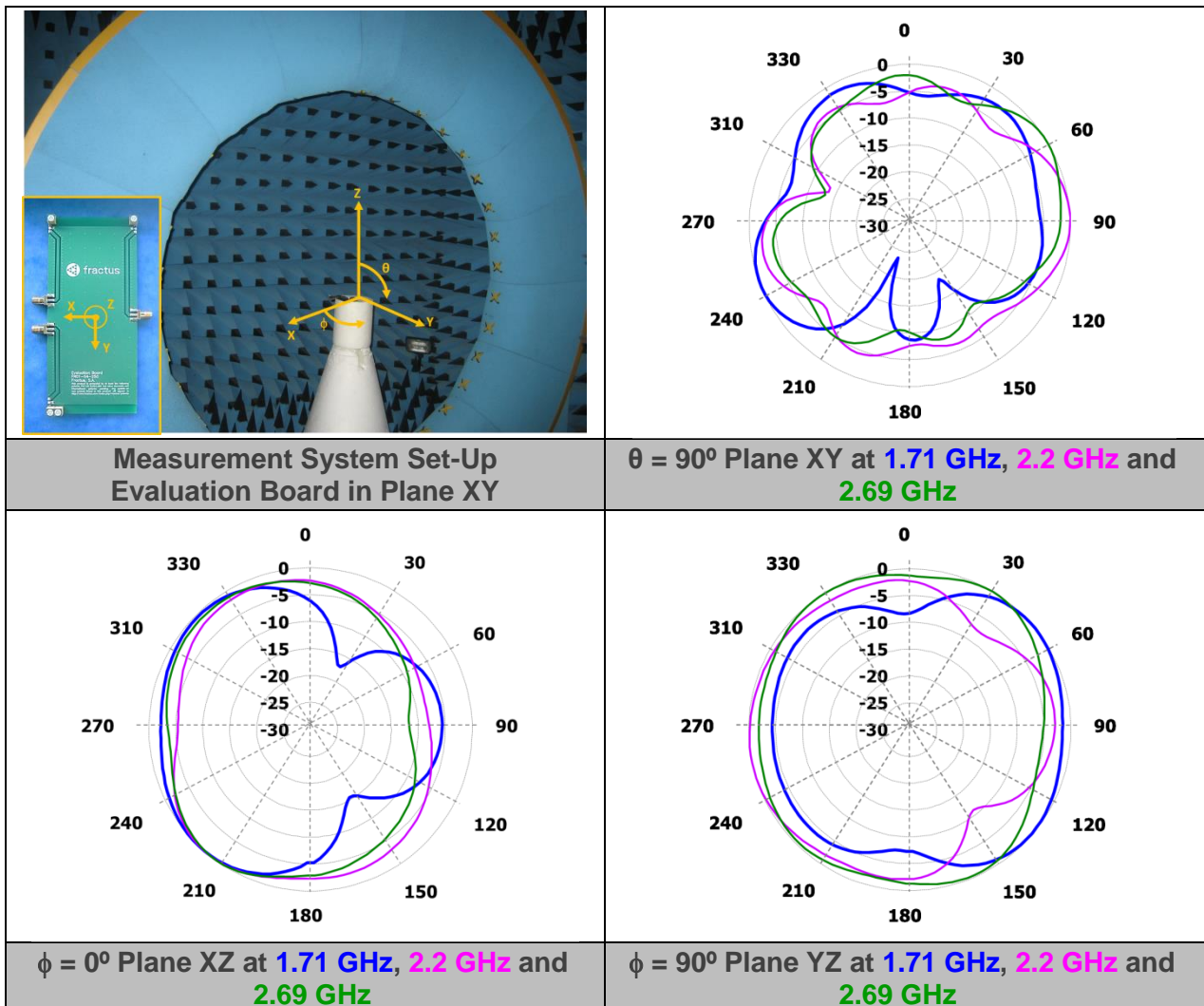
6.3.5. RADIATION PATTERNS (824-960 MHz), GAIN, AND EFFICIENCY



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



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

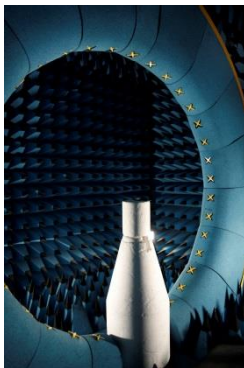
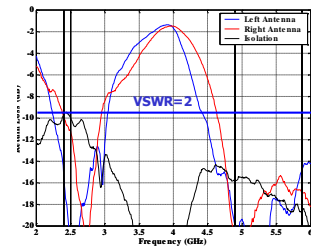
## 7. CAPABILITIES AND MEASUREMENT SYSTEMS

Fractus Antennas specializes in designing and manufacturing optimized antennas for wireless applications and providing our clients with RF expertise. We offer turn-key antenna products and antenna integration support to minimize 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.



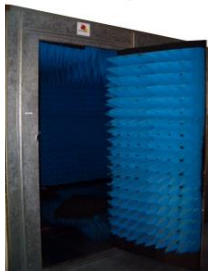
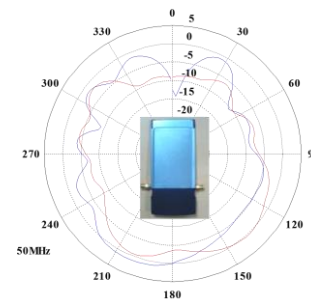
Agilent E5071B

VSWR  
&  
S Parameters



SATIMO STARGATE 32

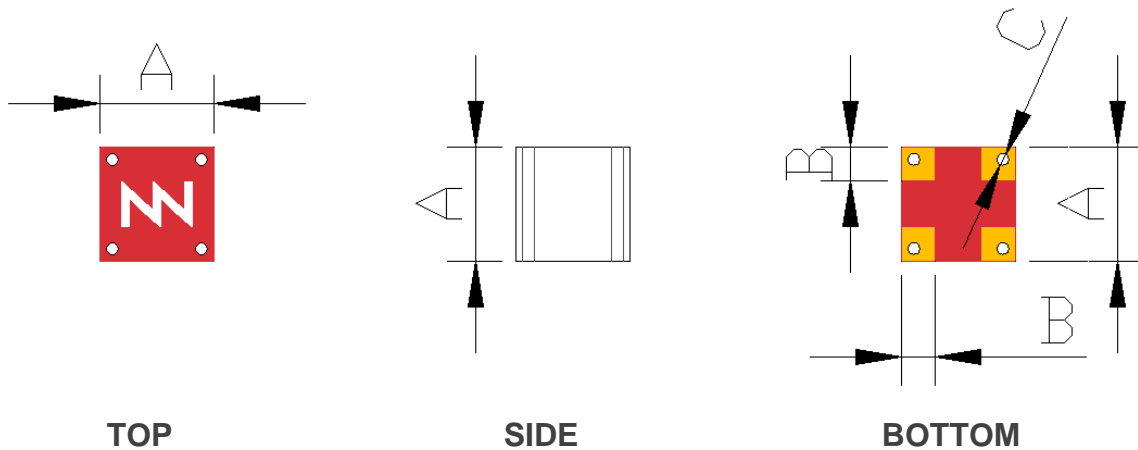
Radiation  
Pattern  
&  
Efficiency



Anechoic chambers and full equipped in-house lab

## 8. MECHANICAL CHARACTERISTICS FR01-S4-250

### 8.1. DIMENSIONS, TOLERANCES, AND RoHS



Dimension	mm	Dimension	mm
A	0.5 +0.2 -0.1	B	1.5 ± 0.1
C	0.5 ± 0.1		

Figure 27 – CUBE mXTEND™ Antenna Booster dimensions and tolerances.

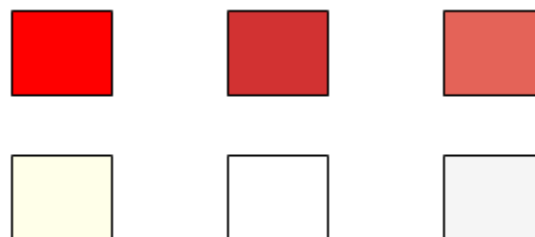
The 4 pads are fully symmetrical to mount it on the PCB.

The CUBE 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 [www.fractusantennas.com](http://www.fractusantennas.com).

### 8.2. COLOR RANGE FOR THE INK

Next figure shows the range of the colors in the CUBE mXTEND™ Antenna Booster:



Acceptable color range

**8.3. RECOMMENDED FOOTPRINT for the FR01-S4-250**

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

Measure	mm
A	1.7
B	1.8

Tolerance: ±0.1 mm

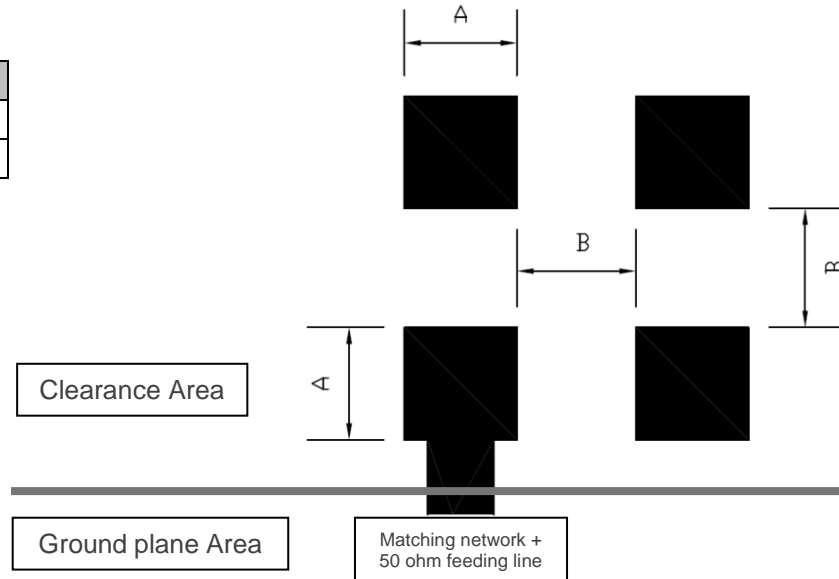


Figure 28 – Footprint dimensions for the single booster.

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

**8.4. RECOMMENDED FOOTPRINT for the FR01-S4-250 double booster**

Measure	mm
A	1.7
B	1.8
C	3.3

Tolerance: ±0.1 mm

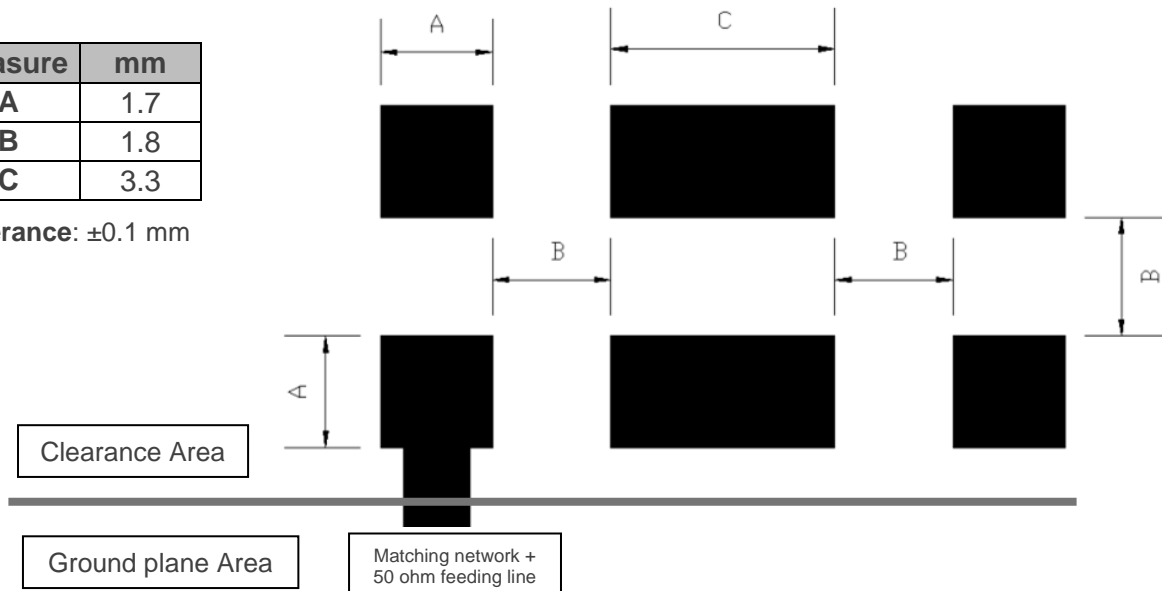


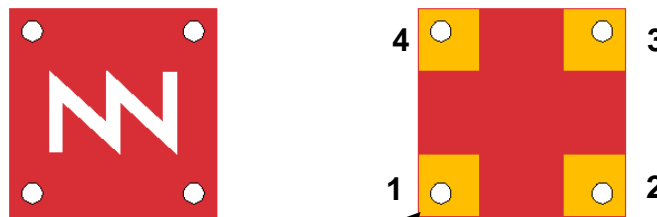
Figure 29 – Footprint dimensions for the double booster.

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

## 9. ASSEMBLY PROCESS

Figure 30 shows the back and front view of the CUBE 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 CUBE mXTEND™ Antenna Booster mounting pads to the soldering pads on the PCB. These pads must NOT be grounded.



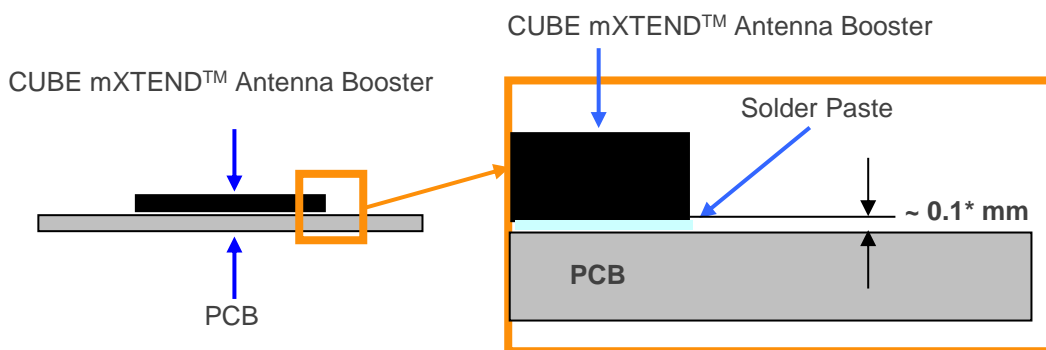
**Feed Pad (1):** The 4 pads are fully symmetrical. Once the feeding pad is selected (1), the other 3 pads become mounting pads. Align the feed pad with the feeding line on the PCB. See section 0.

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

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

1. Apply a solder paste on the pads of the PCB. Place the CUBE mXTEND™ Antenna Booster on the board.
2. Perform a reflow process according to the temperature profile detailed in Table 23, Figure 32 (page 50).
3. After soldering the CUBE mXTEND™ Antenna Booster to the circuit board, perform a cleaning process to remove any residual flux. Fractus Antennas 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.



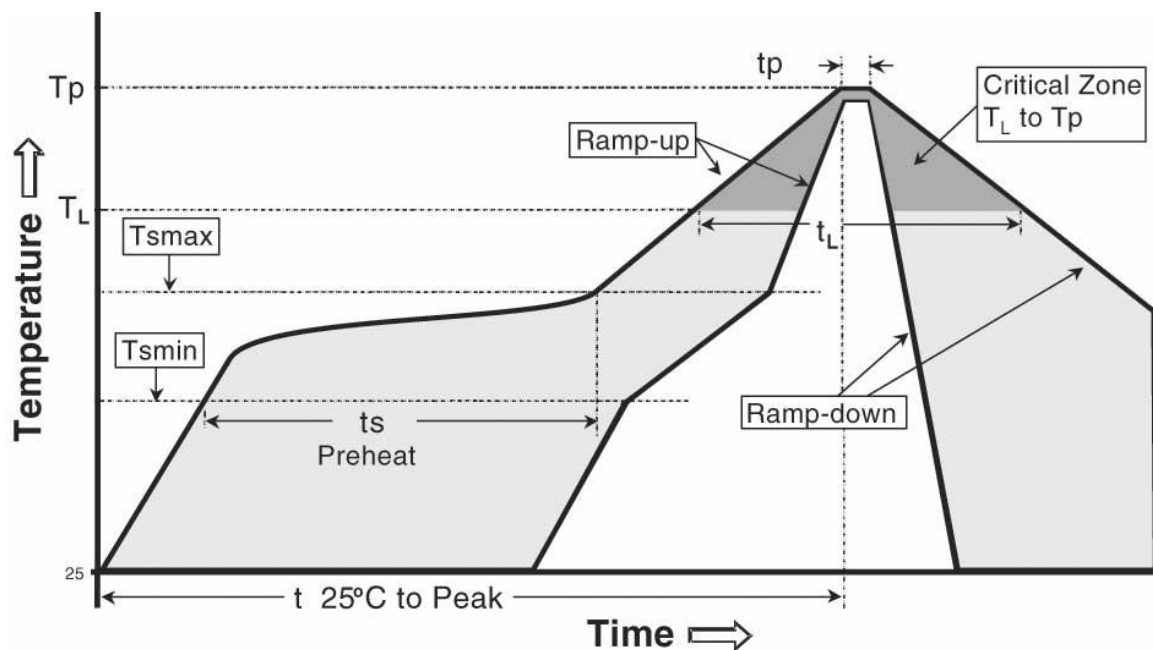
**NOTE(\*)**: Solder paste thickness after the assembly process will depend on the thickness of the soldering stencil mask. A stencil thickness equal or larger than **127 microns (5 mils)** is required.

The CUBE 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)
RAMP-UP	Avg. Ramp-up Rate (T <sub>smax</sub> to T <sub>p</sub> )	3 °C / second (max.)
PREHEAT	- Temperature Min (T <sub>smin</sub> ) - Temperature Max (T <sub>smax</sub> ) - Time (t <sub>smin</sub> to t <sub>smax</sub> )	150 °C 200 °C 60-180 seconds
REFLOW	- Temperature (T <sub>L</sub> ) - Total Time above T <sub>L</sub> (t <sub>L</sub> )	217 °C 60-150 seconds
PEAK	- Temperature (T <sub>p</sub> ) - Time (t <sub>p</sub> )	260 °C 20-40 seconds
RAMP-DOWN	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 CUBE mXTEND™ Antenna Booster assembly process reflow ovens.



**Figure 32** – Temperature profile.

### 10. PACKAGING

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

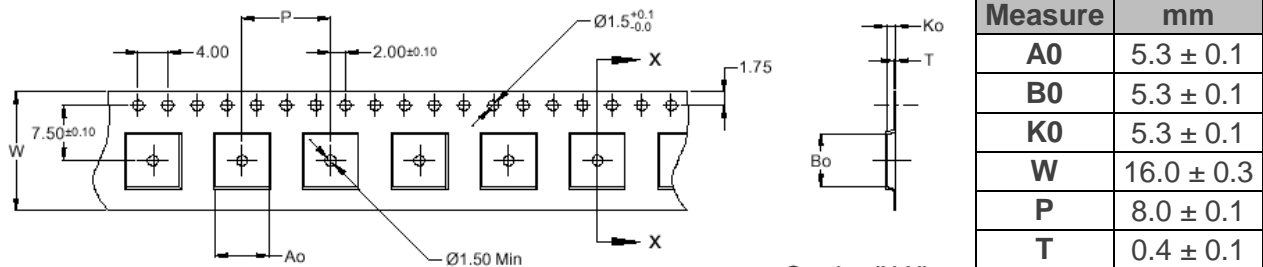
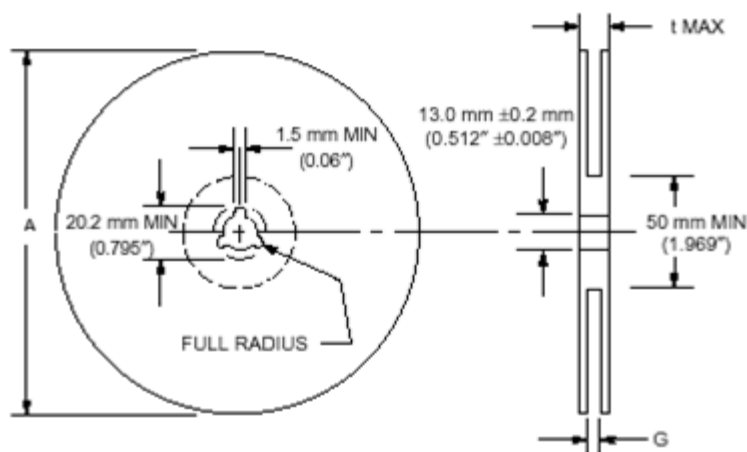


Figure 33 – Tape dimensions and Tolerances.



Figure 34 – Image of the tape.



Measure	mm
A	330 ± 1.0
G	17.5 ± 0.2
tMAX	21.5 ± 0.2

Reel Capacity: 1000 pcs

Figure 35 – Reel Dimensions and Capacity.

## X-ON Electronics

Largest Supplier of Electrical and Electronic Components

*Click to view similar products for [Antenna Development Tools](#) category:*

*Click to view products by [fractus antennas](#) manufacturer:*

Other Similar products are found below :

[0868AT43A0020-EB1SMA](#) [EVALBGSA141MN10TOBO1](#) [A10393-U1](#) [B5771-U1](#) [A10192-U1](#) [AEK-LTE-CER](#) [IOT-K](#) [SR4W035-EVB-1](#)  
[W3095-K](#) [W3070-K](#) [W3011A-K](#) [W3010-K](#) [W3008C-K](#) [LORA-K](#) [ISM-K](#) [A10472-U1](#) [REFLECTOR-EVB-1](#) [A10340-U1](#) [A10194-U1](#)  
[A10204-U1](#) [A5645H-EVB-1](#) [A5645-U1](#) [A5839-U1](#) [A5887H-EVB-1](#) [A6111-U1](#) [M20047-EVB-1](#) [SR42W001-U1](#) [SR42W009-U1](#) [SR4G008-](#)  
[U1](#) [SR4G053-EVB-1](#) [SR4I052-EVB-1](#) [SR4L034-EVB-1](#) [SR4L049-EVB-1](#) [SRC5G027-U1](#) [SRCW004-U1](#) [1001312-01](#) [M310220-01](#)  
[M620720-01](#) [M830120-01](#) [M830520-01](#) [P822601-01](#) [P822602-01](#) [EB\\_FR01-S4-224-CR80-2,4-5](#) [EB\\_FR01-S4-224-2,4-5](#) [EB\\_FR01-S4-224-](#)  
[CR80-868-915](#) [EB\\_FR01-S4-224-CR80-2400](#) [EB\\_FR01-S4-224-2400](#) [EB\\_FR01-S4-224-1B-2R-1P](#) [EB\\_FR01-S4-232-UFL2R-1P](#) [EB\\_FR01-](#)  
[S4-232-1B-2R-1P](#)