ignion

Your innovation.
Accelerated.

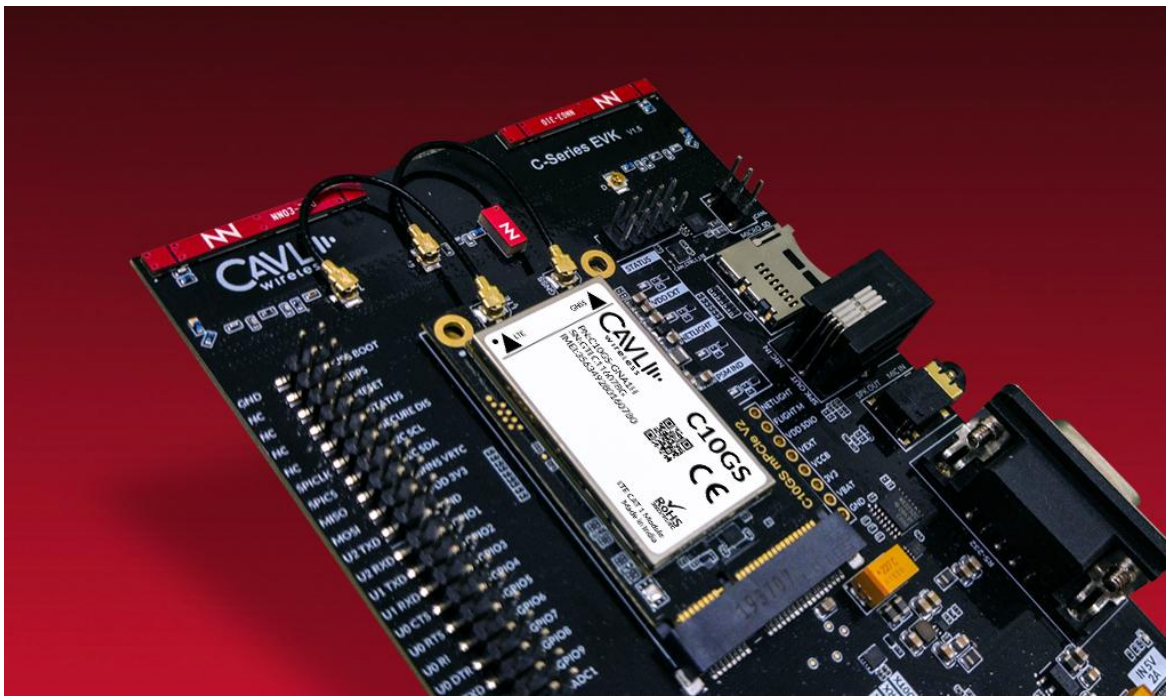
Antenna diversity for asset trackers: reliable LTE + GNSS with a backup antenna

APPLICATION NOTE

TRIO mXTEND™ (NN03-310)
DUO mXTEND™ (NN03-320)

IMPROVE THE PERFORMANCE AND RELIABILITY OF YOUR ASSET TRACKER WITH AN ANTENNA DIVERSITY SCHEME

- **Antennas:** TRIO mXTEND™ (NN03-310) and DUO mXTEND™ (NN03-320)
- **Dimensions:**
  - TRIO mXTEND™: 30.0 mm x 3.0 mm x 1.0 mm
  - DUO mXTEND™: 7.0 mm x 3.0 mm x 2.0 mm
- **Frequency regions:** 698-960 MHz, 1710-2690 MHz, 1561 MHz, 1575 MHz & 1598-1606 MHz



Reliability and **top performance** connectivity for asset tracker designs enabled by Virtual Antenna® technology

Ensure a consistent global connectivity by using an antenna main-diversity configuration. When you use an extra diversity scheme for your design, you can mitigate any wireless interruption as there is always an antenna component as a backup ready to offer the proper connectivity.

Improve your design reliability and performance specially in asset tracker designs, where you can´t control the exact location of the device. Use a combination of the best Virtual Antenna® components for top LTE connectivity and GNSS global coverage including BeiDou, GPS, Galileo, and GLONASS.

This Application Note explains how easy is to implement a tracking system with global LTE coverage in a main-diversity configuration and GNSS coverage, as well as a real implementation in a ready to use Device Development Kit by Cavli Wireless.

TABLE OF CONTENTS

1. PRODUCT DESCRIPTION 4

2. EVALUATION BOARD 5

2.1. QUICK REFERENCE GUIDE 5

2.2. EVALUATION BOARD 6

2.3. MATCHING NETWORK 7

2.4. VSWR AND TOTAL EFFICIENCY 9

2.5. TRANSMISSION COEFFICENT 10

2.6. RADIATION PATTERNS (698 – 960 MHz & 1710 – 2690 MHz) AND EFFICIENCY FOR MAIN ANTENNA 11

2.7. RADIATION PATTERNS (698 – 960 MHz & 1710 – 2690 MHz) AND EFFICIENCY FOR DIVERSITY ANTENNA 12

2.8. RADIATION PATTERNS (1561 MHz, 1575 MHz, 1598 - 1606 MHz) AND EFFICIENCY FOR GNSS 13

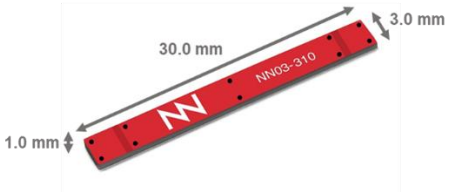
3.0 CASE STUDY: CAVLI C-SERIES DEV KIT 14

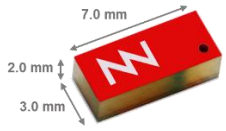
1. PRODUCT DESCRIPTION

TRIO mXTEND™ (NN03-310). **The ultra slim, top performance antenna**. It offers the major level of flexibility and top performance to operate any required frequency band inside any wireless device. TRIO mXTEND™ can operate the main mobile communication standards, enabling worldwide LTE coverage. Thanks to its 1mm height, it can be integrated into nearly all wireless platforms.

DUO mXTEND™(NN03-320). **Optimal multiport performance with no clearance beyond the footprint.** It delivers full GNSS performance while fitting into about every tracking device owing to its tiny form factor: only 7.0 mm x 3.0 mm x 2.0 mm. In addition, since DUO mXTEND™ does not need any clearance on the PCB ground beyond its antenna footprint, you can use the proximity area nearby the component to arrange other elements in the PCB, reducing the size of the overall tracking device. Featuring an omnidirectional radiation pattern, your device will be tracked, no matter its attitude and orientation with respect to the satellite constellation, making of DUO mXTEND™ your ideal component for tracking devices.

TOP





BOTTOM

Material: The TRIO mXTEND™ (left) and the DUO mXTEND™ (right) are built on glass epoxy substrate.

APPLICATIONS

- Tracking systems
- Navigation devices
- Smart meters (Gas, Electricity, Water...)
- Sensors
- GPS/GLONASS/BeiDou Modules

BENEFITS

- Top performance
- Multiband behaviour (worldwide standards)
- Off-the-Shelf Standard Product (no customization is required)

2. EVALUATION BOARD

2.1. QUICK REFERENCE GUIDE

Technical features TRIO mXTEND™ (NN03-310)	698 – 960 MHz	1710 – 2690 MHz
Average Efficiency	38.6 %	53.2 %
VSWR	< 4.6:1	
Radiation Pattern	Omnidirectional	
Polarization	Linear	
Weight (approx.)	0.25 g	
Temperature	-40 to +125 ºC	
Impedance	50 Ω	

Table 1 – Technical features for the 2G/3G/4G/5G bands. Measures from the Evaluation Board port #1 performing as **main antenna**. See Figure 1.

Technical features TRIO mXTEND™ (NN03-310)	698 – 960 MHz	1710 – 2690 MHz
Average Efficiency	35.3 %	55.2 %
VSWR	< 4.0:1	
Radiation Pattern	Omnidirectional	
Polarization	Linear	
Weight (approx.)	0.25 g	
Temperature	-40 to +125 ºC	
Impedance	50 Ω	

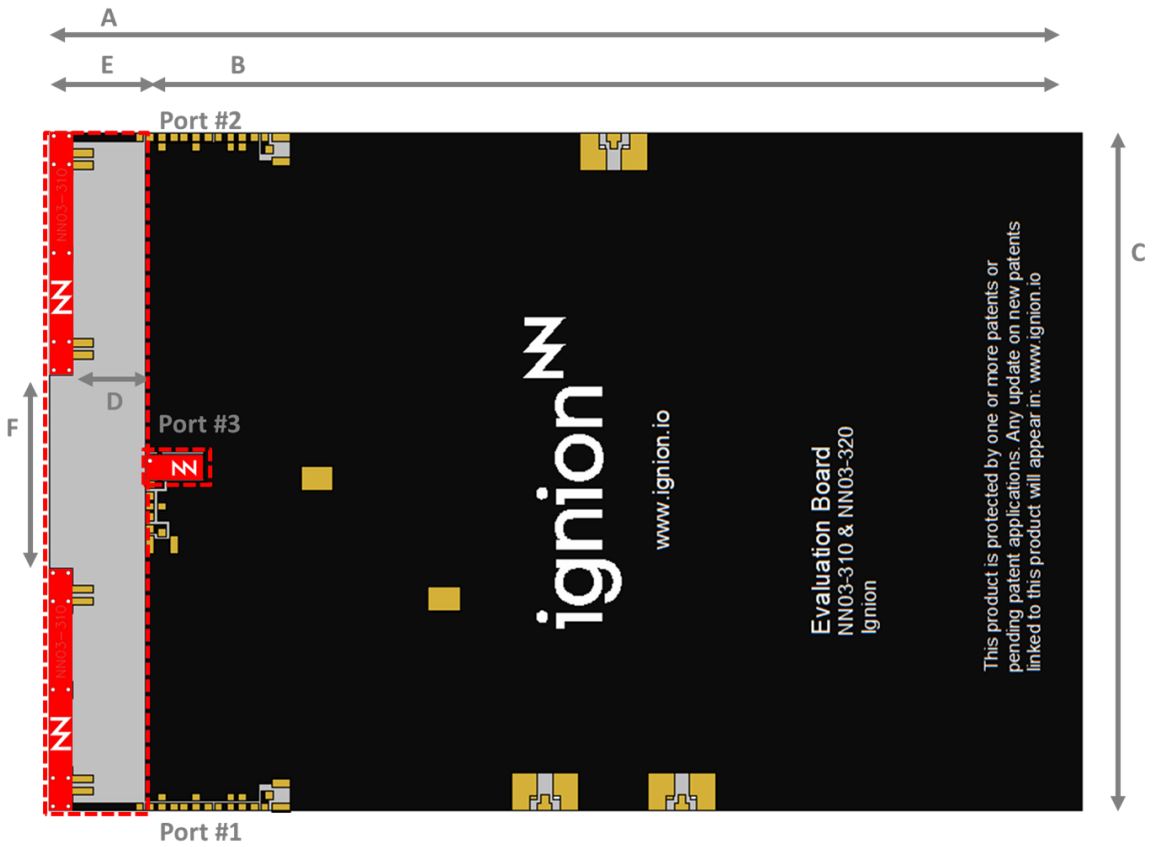
Table 2 – Technical features for the 2G/3G/4G/5G bands. Measures from the Evaluation Board port #2 performing as **diversity antenna**. See Figure 1.

Technical features DUO mXTEND™ (NN03-320)	1561 MHz	1575 MHz	1598 – 1606 MHz
Average Efficiency	> 63 %	> 64.3 %	> 56.7 %
VSWR	< 2.3:1		
Radiation Pattern	Omnidirectional		
Polarization	Linear		
Weight (approx.)	0.11 g		
Temperature	-40 to +125 ºC		
Impedance	50 Ω		

Table 3 – Technical Features for the GNSS bands (BeiDou, GPS, Galileo, and GLONASS). Measures from the Evaluation Board port #3 performing as GNSS antenna. See Figure 1.

2.2. EVALUATION BOARD

The Evaluation Board integrates two TRIO mXTEND™ components to provide operation from 698 to 960 MHz, 1710 to 2690 MHz through port #1 (main) and #2 (diversity), and the DUO mXTEND™ component to provide operation from 1561 MHz, 1575 MHz, and 1598 to 1606 MHz through port #3.



Measure	mm
A	126
B	114
C	85
D	9
E	12
F	24

Tolerance: ±0.2 mm

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

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

TRIO mXTEND™ clearance area: 85 mm x 12 mm (CxE)

DUO mXTEND™ clearance area: 0.5mm around antenna.

Figure 1 Evaluation Board to provide operation at 698 – 960MHz, 1710 – 2690MHz (port #1 and #2), and 1561MHz, 1575MHz, and 1598 – 1606MHz (port #3).

2.3. MATCHING NETWORK

Virtual Antenna® components need a matching network to connect to the module. This section describes the matching networks used for both TRIO mXTEND™ and the DUO mXTEND™ (Figure 1) and the resulting product specs when measured in the Evaluation Board (Table 1, Table 2, Table 3, Figure 5 and Figure 6).

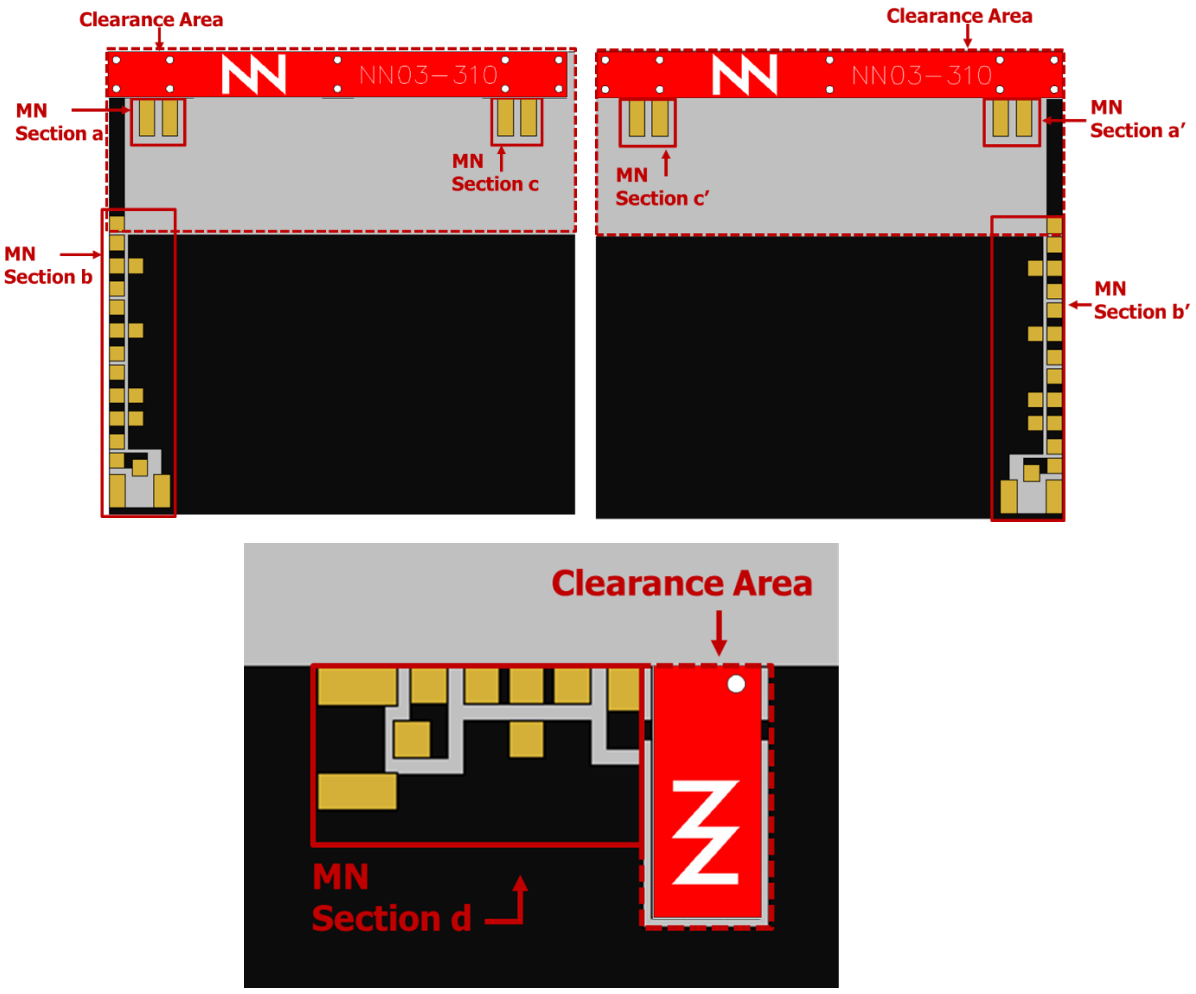
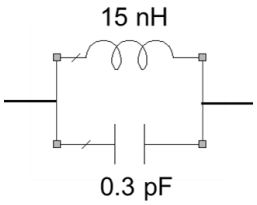


Figure 2 – Matching network distribution

698 MHz – 960 MHz and 1710 MHz – 2690 MHz

MN Section a/a‘

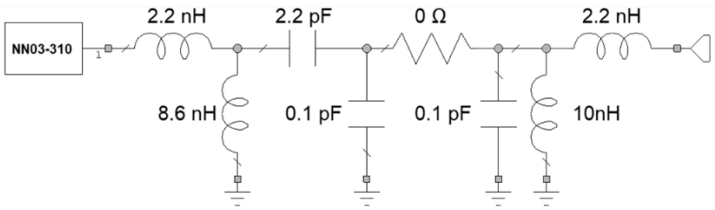


Value	Part Number
15 nH	LQW18AN15NG80
0.3 pF	GJM1555C1HR30WB01

MN Section c/c‘

Value	Part Number
0Ω	-

MN Section b/b‘

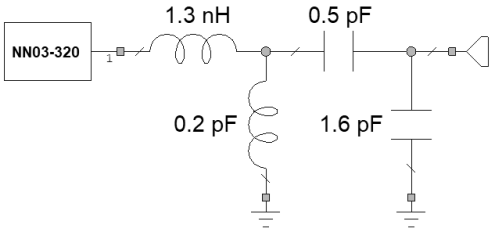


Value	Part Number
2.2 nH	LQW15AN2N2G80
8.6 nH	LQW15AN8N6G80
2.2 pF	GJM1555C1H2R2WB01
0.1 pF	GJM1555C1HR10WB01
0Ω	-
0.1 pF	GJM1555C1HR10WB01
10 nH	LQW15AN10NG80
2.2 nH	LQW15AN2N2G80

Figure 3 – Matching network implemented in the Evaluation Board port #1 and #2 (Figure 1).

1561MHz, 1575 MHz and 1598MHz – 1606MHz

MN Section d



Value	Part Number
1.3 nH	LQW15AN1N3C80
0.2 pF	GJM1555C1HR20WB01
0.5 pF	GJM1555C1HR50WB01
1.6 pF	GJM1555C1H1R6WB01

Figure 4 – Matching network implemented in the Evaluation Board port #3 (Figure 1).

Please notice that different devices with different ground planes and different components nearby the TRIO mXTEND™ or the DUO mXTEND™ components may need a different matching network. To ensure optimal results, the use of high Q and tight tolerance components is highly recommended (Murata components). If you need help designing your matching network beyond this application note, contact support@ignion.io or run your device through Oxion™ at https://oxion.ai, Ignion's free-of-charge[1] AI-powered antenna integration platform, for a custom matching network and a complete design report in 24h. Ignion's engineering services: https://ignion.io/design-center/engineering-support/

1 See terms and conditions for the free-of-charge Oxion™ service at: https://oxion.ai

2.4. VSWR AND TOTAL EFFICIENCY

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

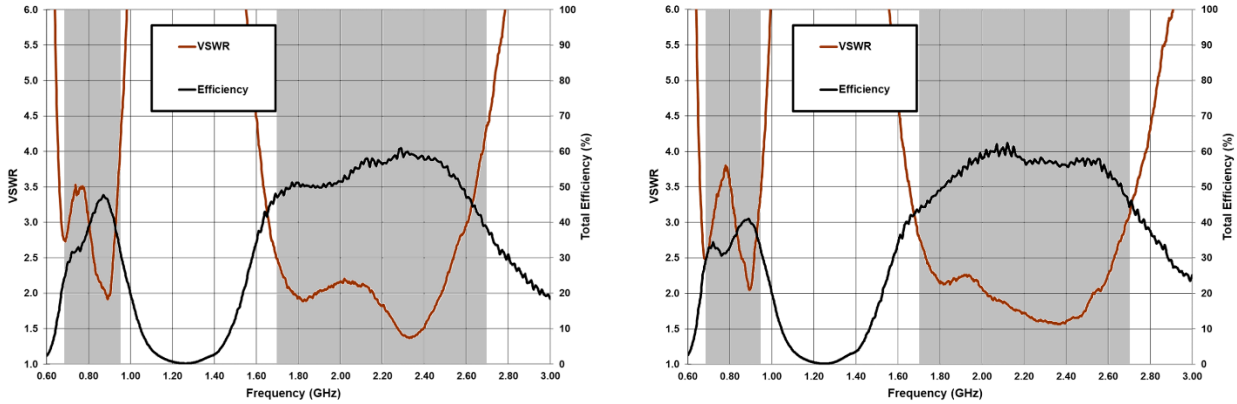


Figure 5 – VSWR and Total Efficiency for the 698 – 960 MHz frequency range and for the 1710 – 2690 MHz frequency range from the Evaluation Board, port #1 (Main) and port #2 (Diversity) from left to right (Figure 1).

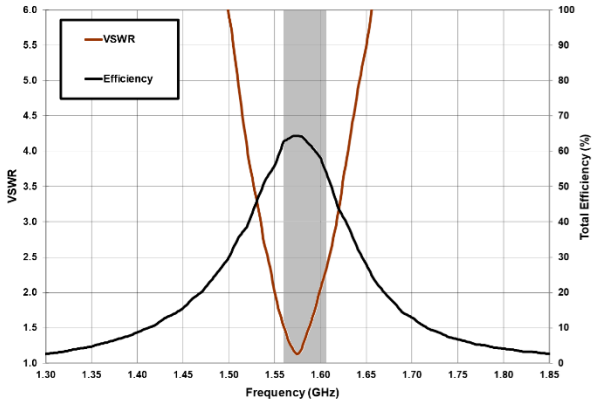


Figure 6 – VSWR and Total Efficiency for BeiDou E1 band (1561 MHz), GPS L1 band, Galileo E1 (1575 MHz), and GLONASS L1 band (1598 – 1606 MHz) (from the Evaluation Board, port #3) (Figure 1).

2.5. TRANSMISSION COEFFICENT

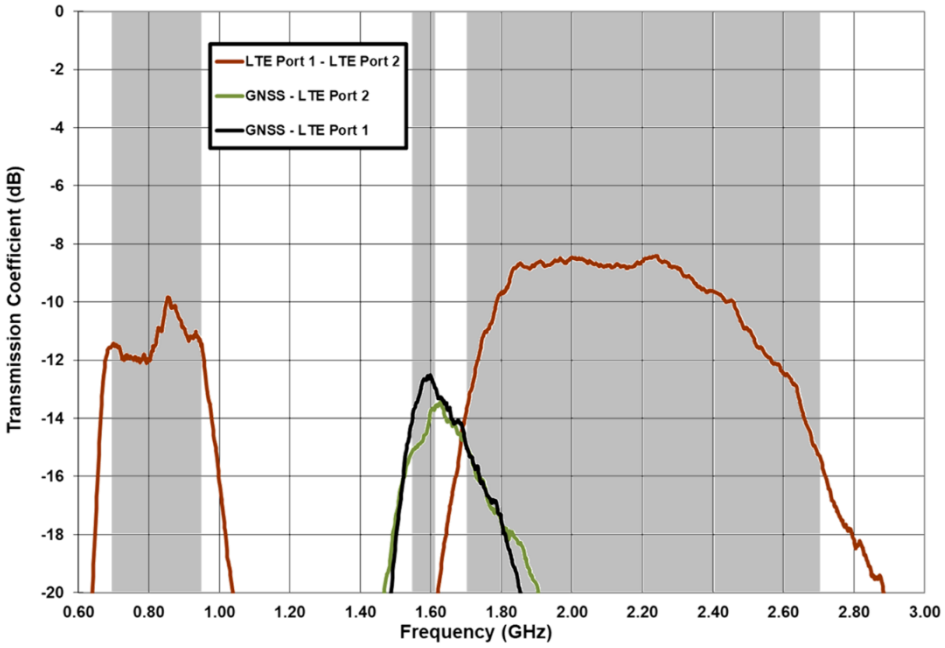
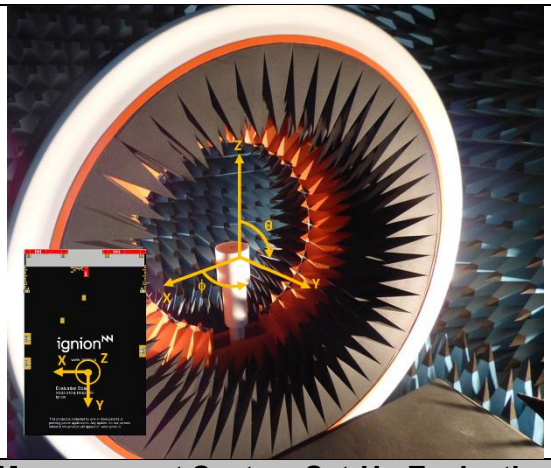
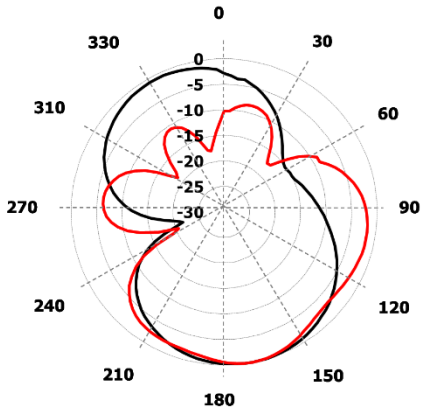


Figure 7 – Transmission coefficient between port #1 and port #2 (698 – 960 MHz and 1710 – 2690 MHz) and port #3 (1561 – 1606 MHz) from the Evaluation Board (Figure 1).

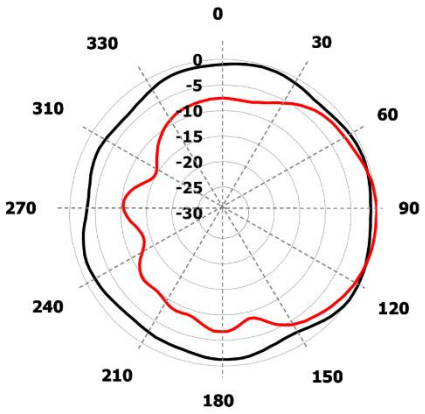
2.6. RADIATION PATTERNS (698 – 960 MHz & 1710 – 2690 MHz) AND EFFICIENCY FOR MAIN ANTENNA



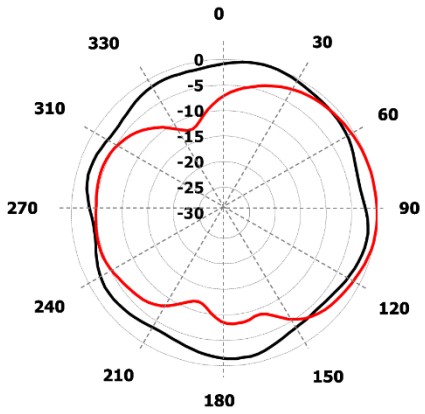
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 830 MHz and 2200 MHz



ϕ = 0º Plane XZ at 830 MHz and 2200 MHz



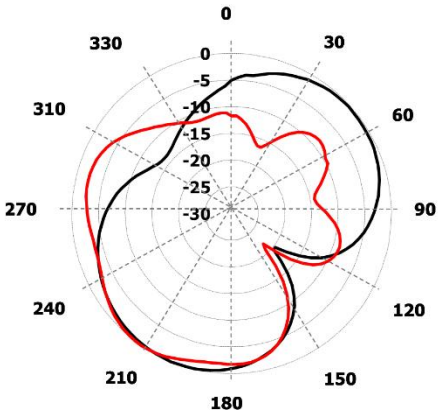
ϕ = 90º Plane YZ at 830 MHz and 2200 MHz

Efficiency (LFR)	**Peak Efficiency**	64.5 %
	Average Efficiency across the band	59.4 %
	Efficiency Range across the band (min, max)	52.2 – 64.5 %
Efficiency (HFR)	**Peak Efficiency**	64.5 %
	Average Efficiency across the band	59.4 %
	Efficiency Range across the band (min, max)	52.2 – 64.5 %

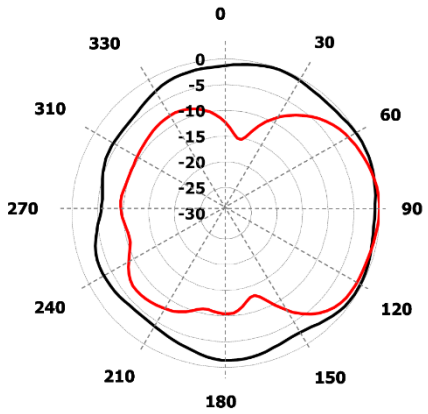
Table 4 - Total efficiency for the 698 – 960 MHz frequency range (LFR) and for the 1710 – 2690 MHz (HFR) frequency range from the Evaluation Board, port #1 (Main) (Figure 1). Measures made in the STARLAB anechoic chamber.

2.7. RADIATION PATTERNS (698 – 960 MHz & 1710 – 2690 MHz) AND EFFICIENCY FOR DIVERSITY ANTENNA

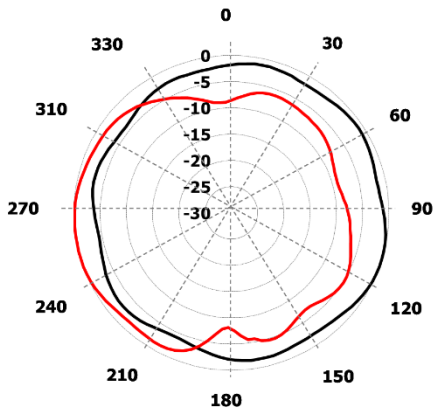
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 830 MHz and 2200 MHz



ϕ = 0º Plane XZ at 830 MHz and 2200 MHz

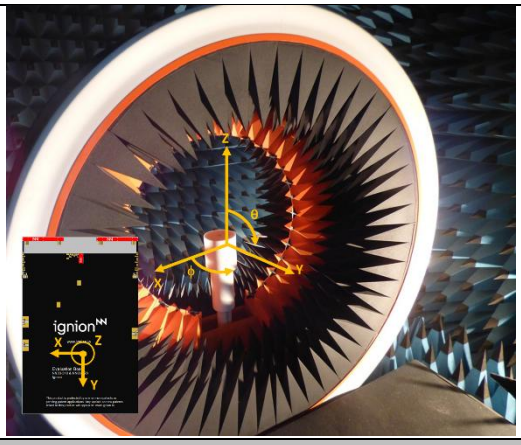


ϕ = 90º Plane YZ at 830 MHz and 2200 MHz

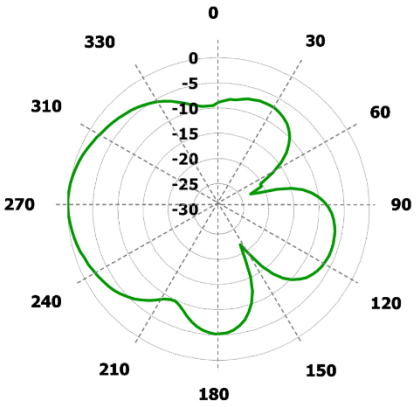
Efficiency LFR	**Peak Efficiency**	71.9 %
	Average Efficiency across the band	63.9 %
	Efficiency Range across the band (min, max)	49.7 – 71.9 %

Table 5 - Antenna gain and total efficiency from the Evaluation Board port #1 (Figure 1) within the 1710 – 2690 MHz frequency range. Measures made in the Satimo STARGATE 32 anechoic chamber.

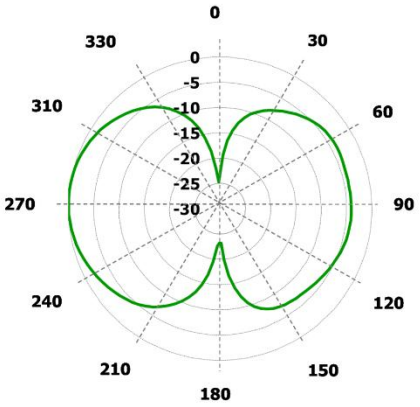
2.8. RADIATION PATTERNS (1561 MHz, 1575 MHz, 1598 - 1606 MHz) AND EFFICIENCY FOR GNSS



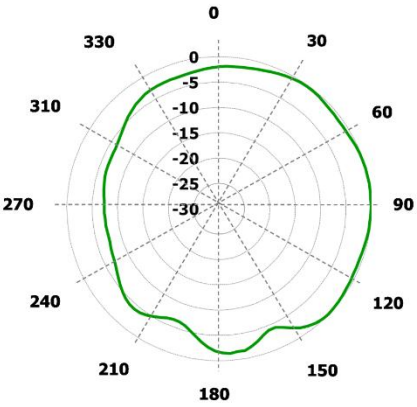
Measurement System Set-Up Evaluation Board in Plane XY



θ = 90º Plane XY at 1575 MHz



ϕ = 0º Plane XZ at 1575 MHz



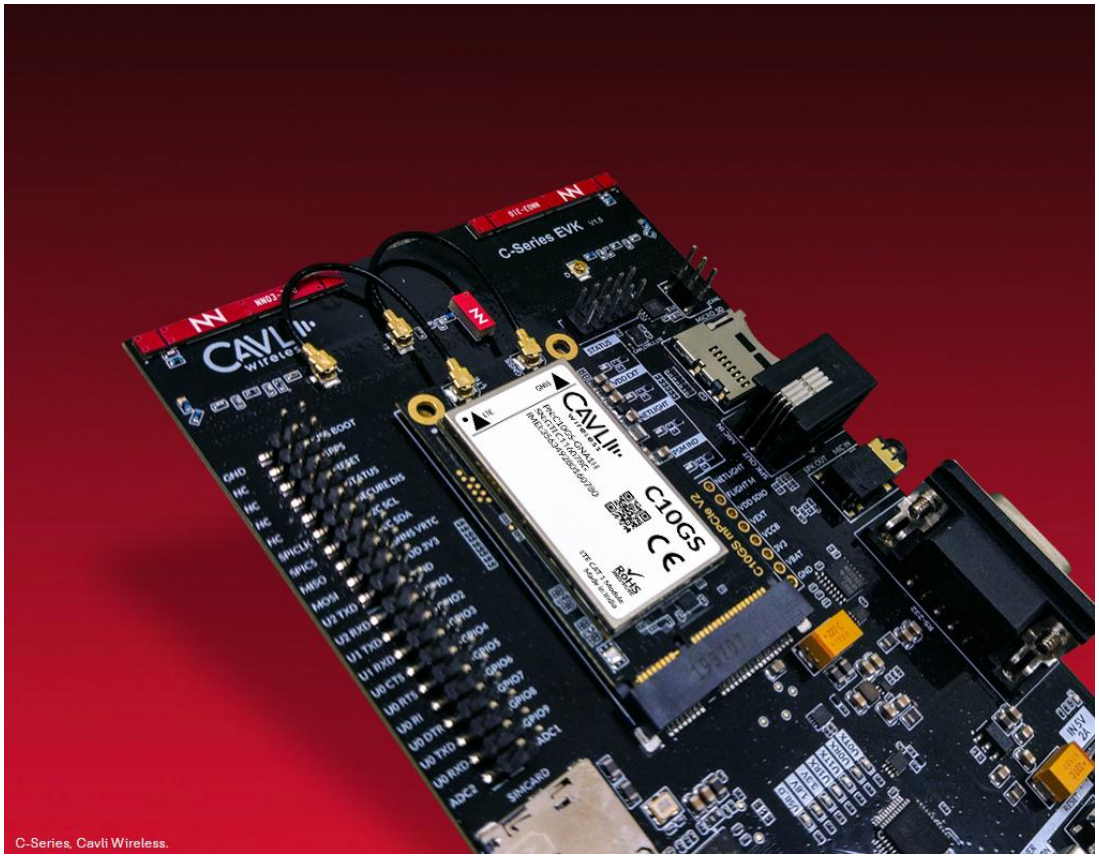
ϕ = 90º Plane YZ at 1575 MHz

BeiDou	**Efficiency**	41.4%	
GPS Galileo	**Efficiency**	47.6 %	
GLONASS	**Efficiency**	**Peak Efficiency**	56.4 %
		Average Efficiency across the band	55.5 %
		Efficiency Range across the band (min, max)	54.4 – 56.4 %

Table 6 - Antenna gain and total efficiency from the evaluation board port #2 (Figure 1) for BeiDou E1 (1561 MHz), GPS L1, Galileo E1 (1575 MHz), and GLONASS L1 (1598 – 1606 MHz) bands. Measures made in the Satimo STARGATE 32 anechoic chamber.

3.0 CASE STUDY: CAVLI WIRELESS C-SERIES DEV KIT

Cavli Wireless C-Series Dev Kit uses TRIO mXTEND™ (NN03-310) to provide global LTE coverage in a main-diversity configuration and it also covers the GNSS bands with DUO mXTEND™ (NN03-320).



Cavli Wireless is on a mission to get the next billion IoT devices smart connected with their unique proposition that combines all the basic building blocks of IoT connectivity management - the connectivity hardware, network access and the management cloud all into one single solution to bring to market the world's first 'Connectivity as a Service (CaaS)' bundling IoT hardware at zero cost. So, clients receive industry-grade IoT modules pre-loaded with global connectivity and then only pay for connectivity.

According to Tarun Thomas, COO of Cavli Wireless, Cavli's C-Series line of Smart Module evaluation kits uses the Ignion TRIO mXTEND™ antenna for their superior multi-band performance and small footprint. The TRIO mXTEND™ antenna with high efficiency on all global GSM/LTE bands provides our users to perform seamless integrations across multiple applications and use cases globally. Cavli also has a line of smart connected compute modules that are also powered by the TRIO mXTEND™ antennas and is positioned to help IoT product makers achieve rapid prototyping & go to market.

"The TRIO mXTEND™ antenna with high efficiency on all global GSM/LTE bands provide our users to perform seamless integrations across multiple applications and use cases globally." - Tarun Thomas, Chief Operating Officer, Cavli Wireless.

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

ISO 9001: 2015 Certified

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Accelerated.

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