

Unlicensed Transmitters: Approved Antennas List

<i>Manufacturer</i>	<i>Antenna</i>	<i>Description</i>	<i>Type</i>	<i>Peak Gain (dBi)</i>	<i>Min Cable loss (dB)</i>	Ω	<i>Connector Type</i>	<i>Notes</i>
Taoglas Limited	TI.93.A111	902MHz-928MHz	Monopole	-1.73	0	50	SMA-M	1
Linx Technologies	ANT-915-NUB-RPS	902MHz-928MHz	Monopole	-3.0	0	50	RP-SMA-M	

Antennas for integrated modules

<i>Manufacturer</i>	<i>Antenna</i>	<i>Description</i>	<i>Type</i>	<i>Peak Gain (dBi)</i>	<i>Min Cable loss (dB)</i>	Ω	<i>Connector Type</i>	<i>Notes</i>
Raspberry Pi Ltd.	PCB trace	PCB, WiFi, BLE	Trace	-2	0	50	Integral	
Taoglas Limited	GW.23.A151	2.4GHz, Wifi, BLE	Monopole	-1.41	0	50	RP-SMA-M	
Lumenier	Lumenier Duality DUAL-MOAX HD 2.4/5.8GHz Dual-Band High-Gain Antenna	2.4/5.8GHz Dual-Band High-Gain Antenna	Directional	5.9	0	50	RP-SMA	

Receive Only Antennas

<i>Manufacturer</i>	<i>Antenna</i>	<i>Description</i>	<i>Type</i>	<i>Peak Gain (dBi)</i>	<i>Min Cable loss (dB)</i>	Ω	<i>Connector Type</i>	<i>Notes</i>
Taoglas Limited	TS.16.0111	GPS, active	Module	2.3	0	50	SMA-M	

Notes:

1 Original antenna tested. Approved for use when this antenna is permanently bonded to the product upon sale of equipment.



TAOGLAS®



Datasheet

915MHz ISM Band Terminal Antenna

Part No:
TI.93.A111

Description

915MHz Terminal Antenna SMA Male Straight

Features:

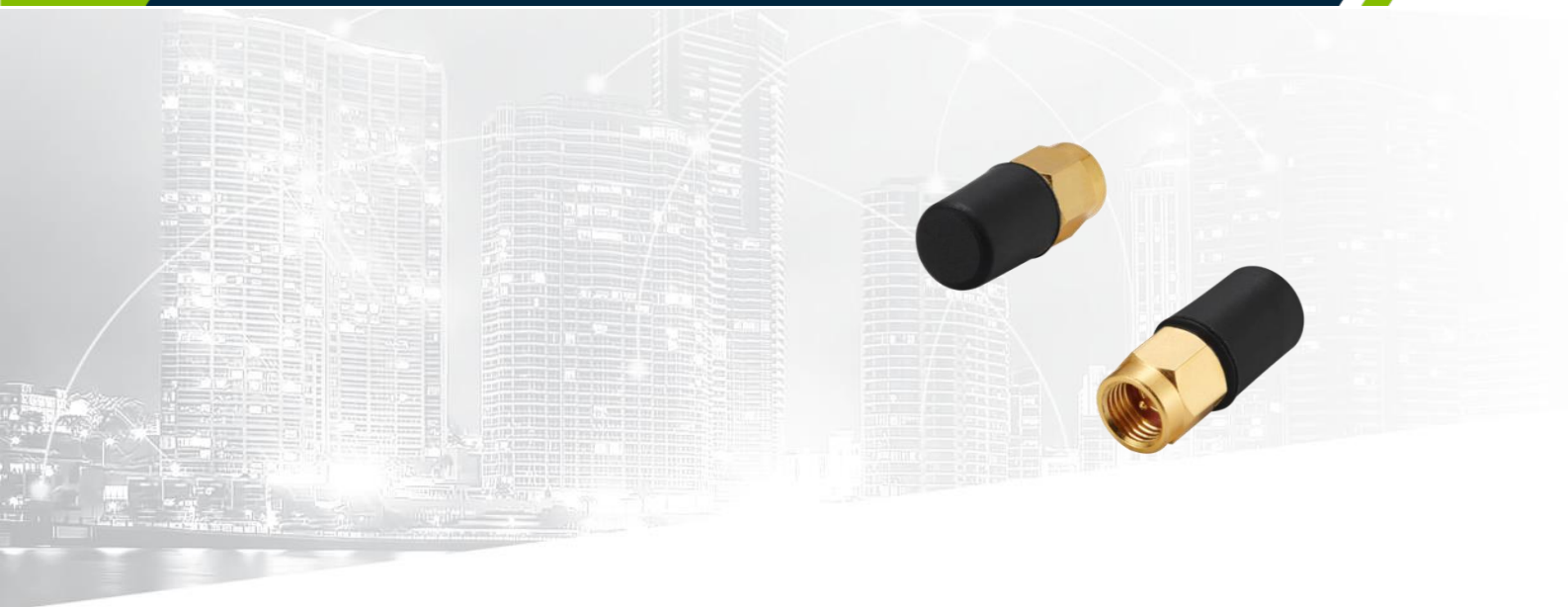
902-928MHz Band Operation
IP67 Waterproof Rated
Low-profile Terminal Antenna
SMA(M) Straight Connector
Dimensions: $\varnothing 8.9\text{mm}$ x 21mm
RoHS & Reach Compliant

1.	Introduction	2
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1. Introduction



The TI.93 is one of a range of super small form factor, lightweight, IP67 rated terminal mount antennas from Taoglas. It is ideal for wireless applications operating on ISM or LoRa bands covering 902-928MHz. Its robust silicone enclosure is engineered to perform in the most challenging of external environments when connecting IoT devices to smart grid and smart monitoring applications.

With its IP67 rating, the TI.93 can withstand dust, dirt, and even complete submersion in water, making it the perfect choice for any IoT application that demands both reliable connectivity and extreme durability. Whether you're connecting sensors for remote agricultural, monitoring equipment in industrial settings, or building the infrastructure for smart cities, the TI.93 is a great solution.

If you are looking for an antenna that's small, tough, and versatile, look no further than the TI.93. Contact your regional Taoglas Customer Services Team for more information or to discuss your project.

2. Specification

ISM Electrical							
Band		Efficiency (%)	Average Gain (dB)	Peak Gain (dBi)	Impedance	Polarization	Radiation Pattern
ISM 902-928MHz	In Free space	16.7	-7.78	-1.73	50 Ω	Linear	Omni
	On 15x9cm Ground plane (Long side)	62.2	-2.06	1.12			
	On 9x15cm Ground plane (Short side)	52.5	-2.80	2.06			

Mechanical	
Dimensions	ø8.9mm x 21mm
Weight	3.3g
Material	Silicone
Connector	SMA(M)

Environmental	
Operating Temperature	-40°C ~ +85°C
Waterproof Rating	IP67

3. Antenna Characteristics

3.1 Test Setup

AUT



Vector Network Analyzer

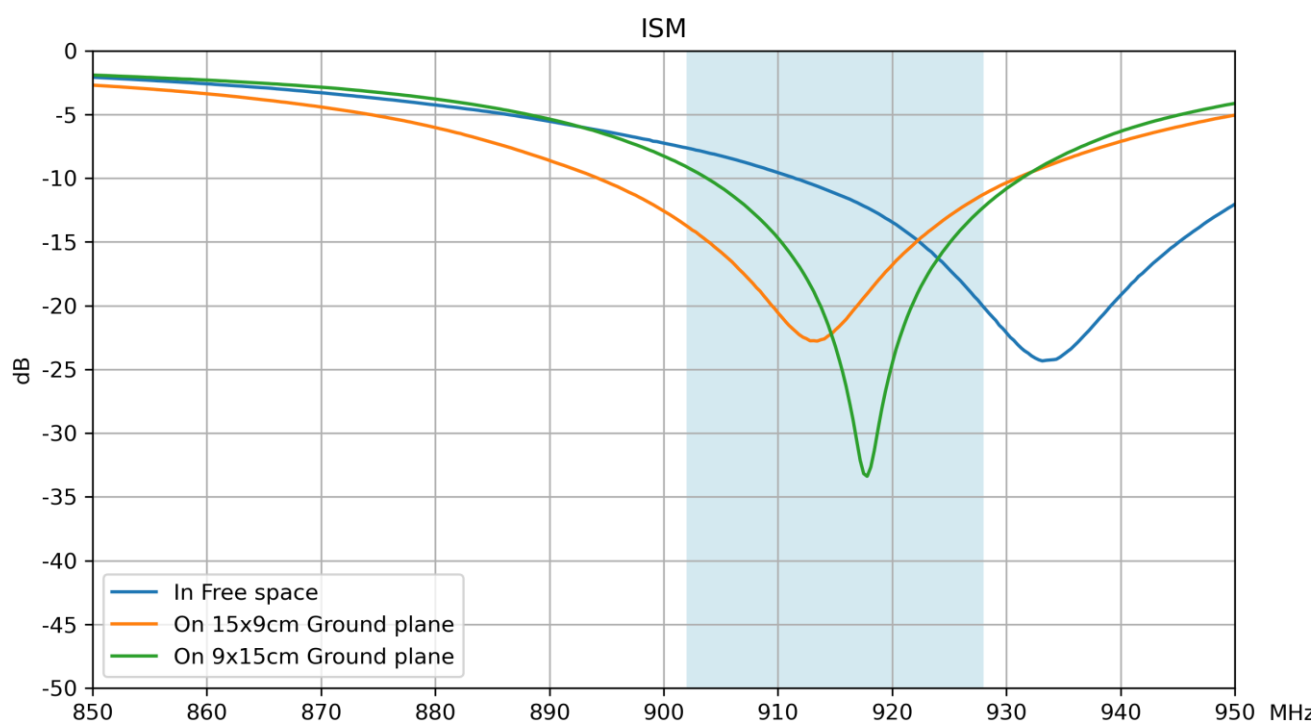


In Free Space

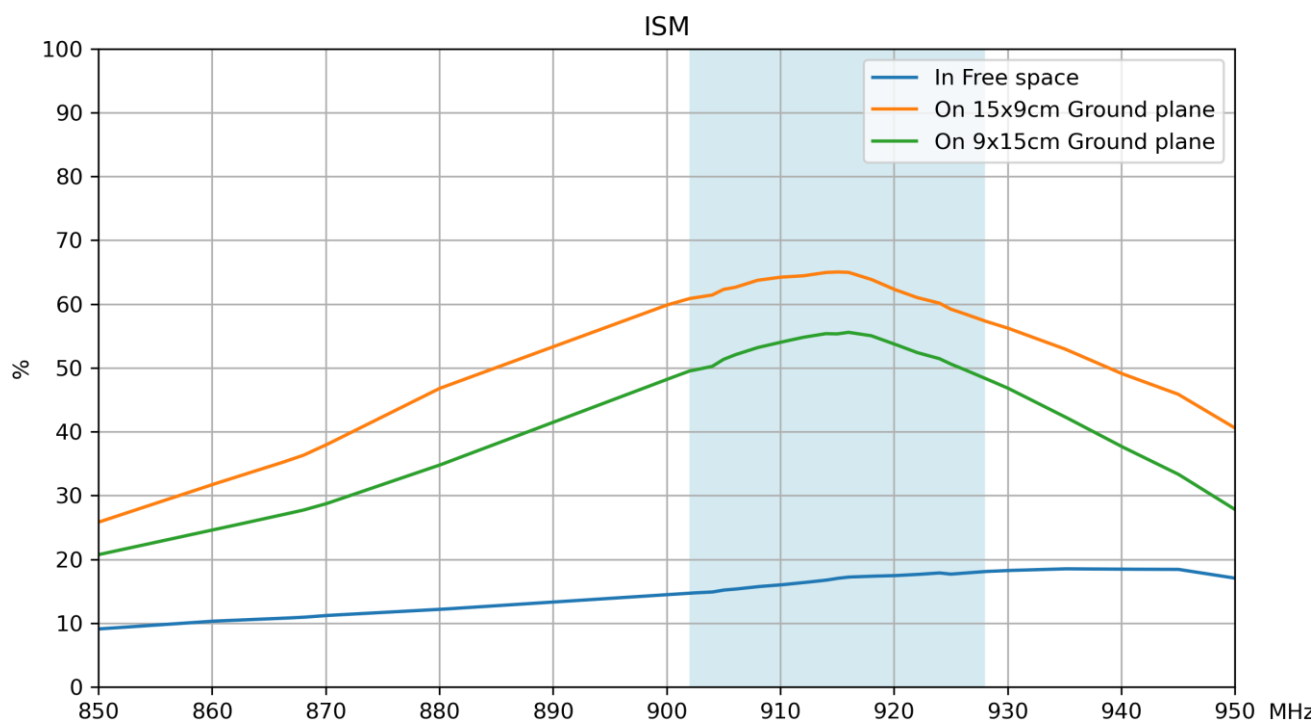
On 15x9cm Ground plane

On 9x15cm Ground plane

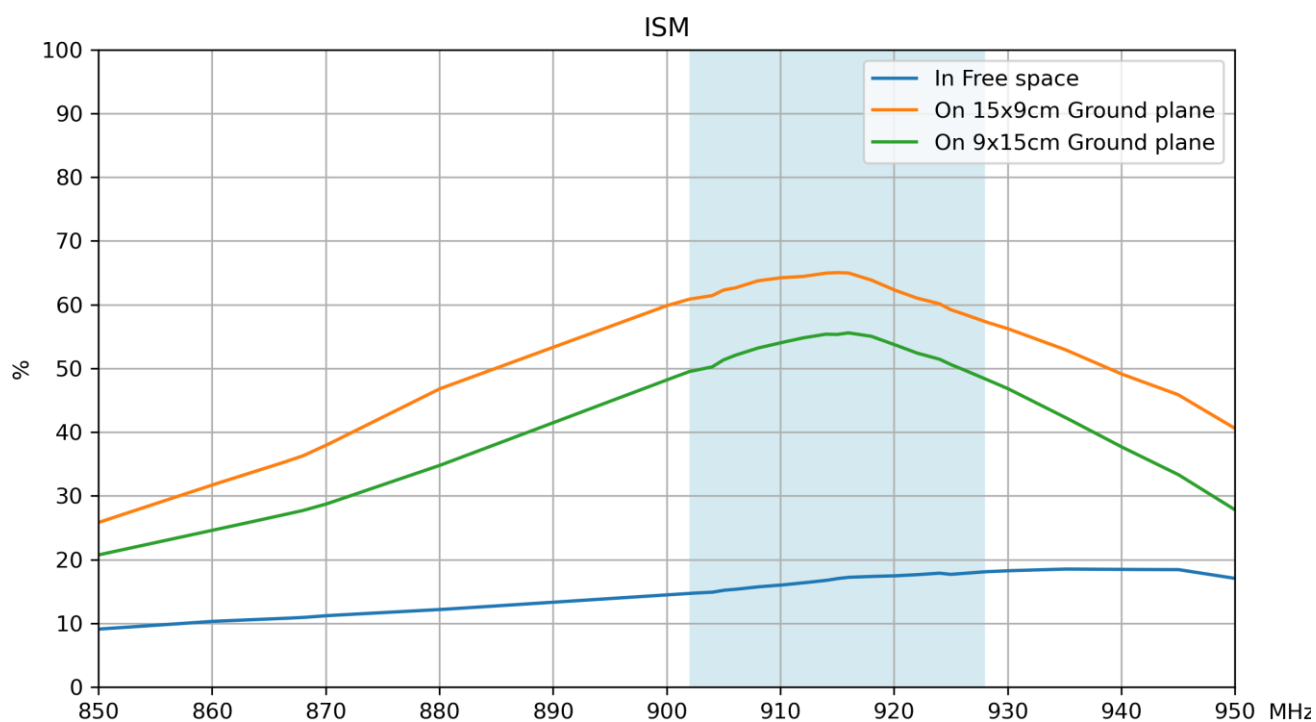
3.2 Return Loss



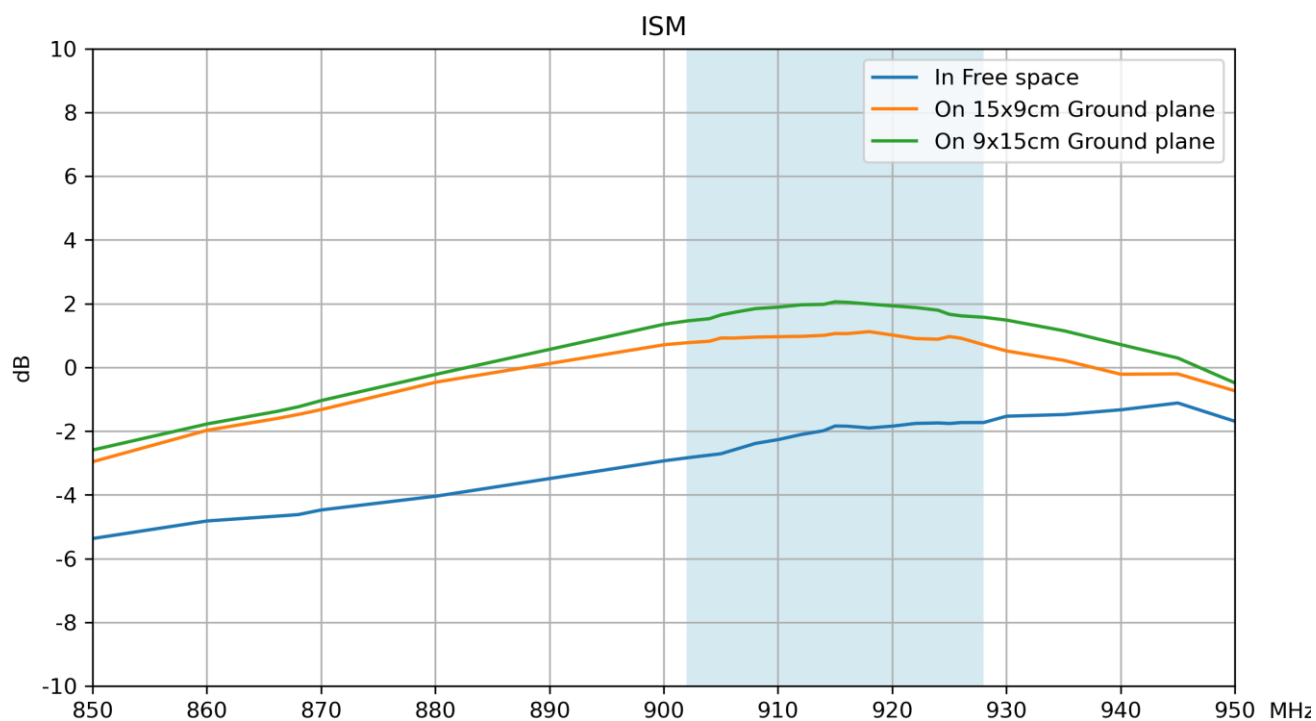
3.3 Efficiency



3.4 Average Gain

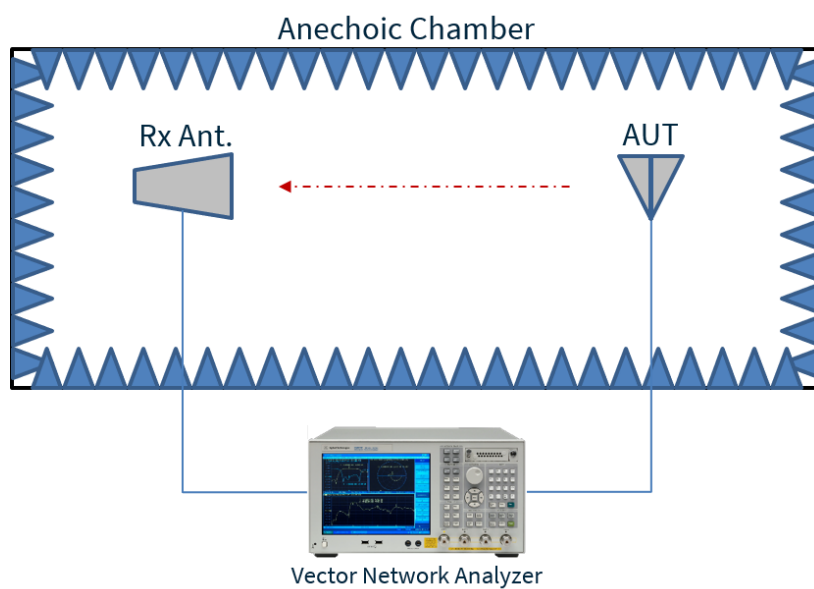


3.5 Peak Gain



4. Radiation Patterns

4.1 Test Setup

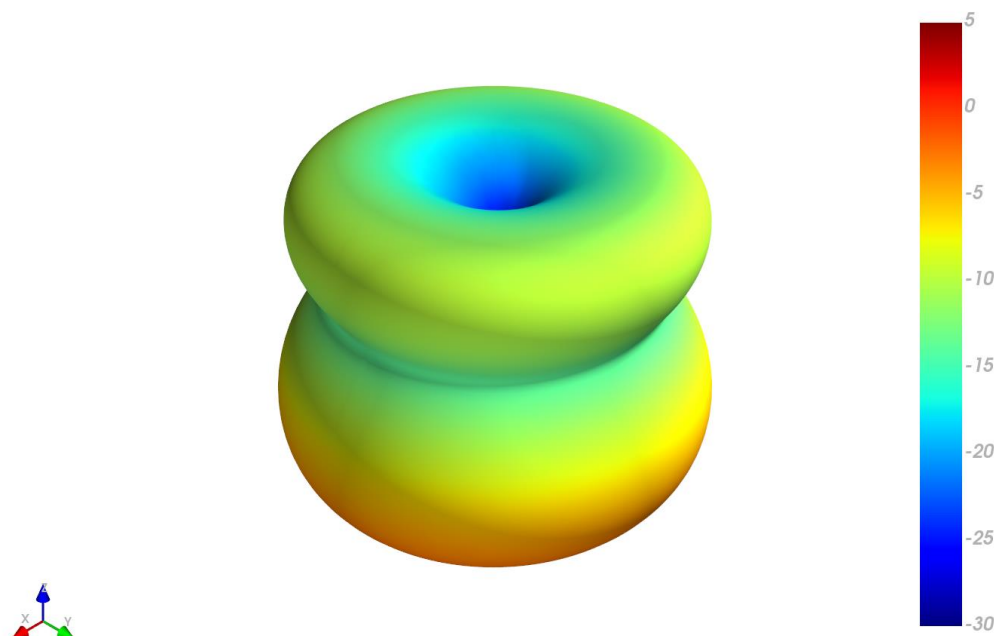


In Free Space

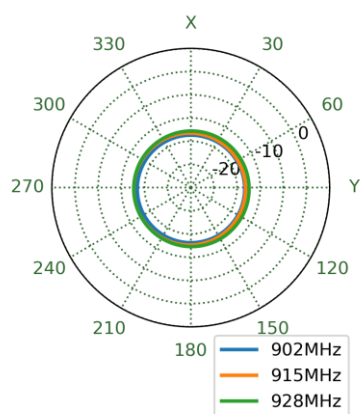
On 15x9cm Ground plane

On 9x15cm Ground plane

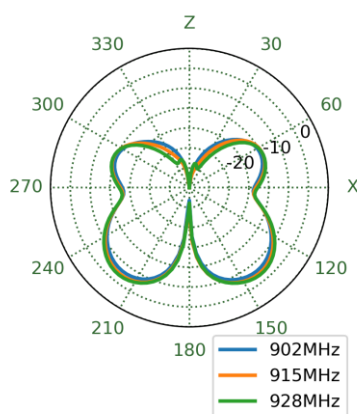
4.2 TI.93.A.111 - Patterns at 915 MHz in Free Space



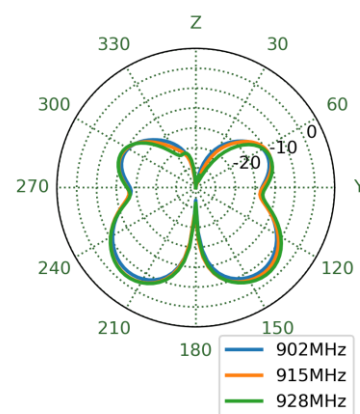
XZ Plane



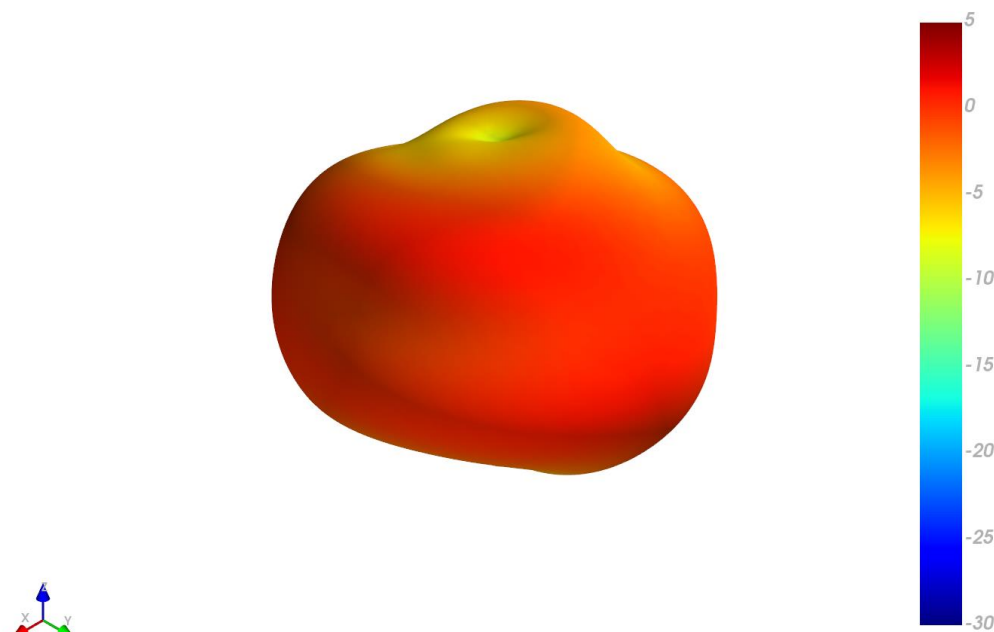
YZ Plane



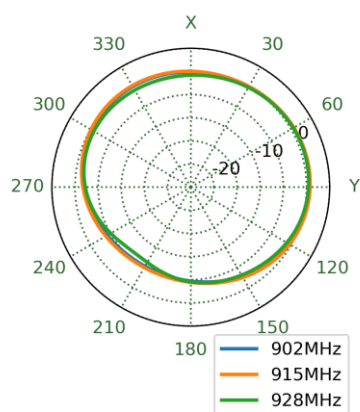
XY Plane



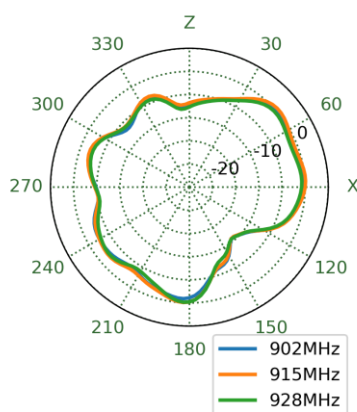
4.3 TI.93.A111 - Patterns at 915 MHz on 15x9cm ground plane



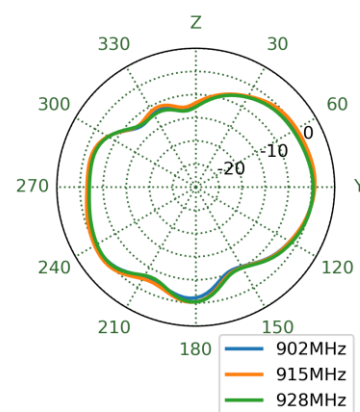
XZ Plane



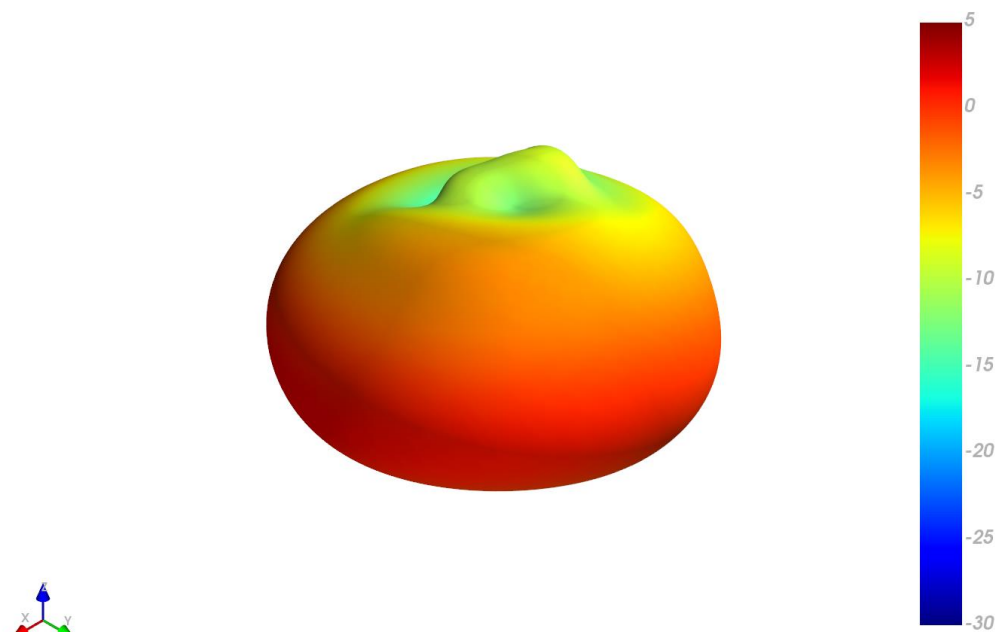
YZ Plane



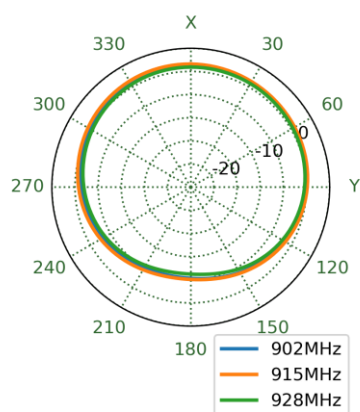
XY Plane



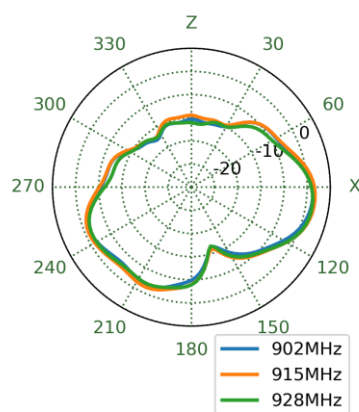
4.4 TI.93.A111- Patterns at 915 MHz on 9x15cm ground plane



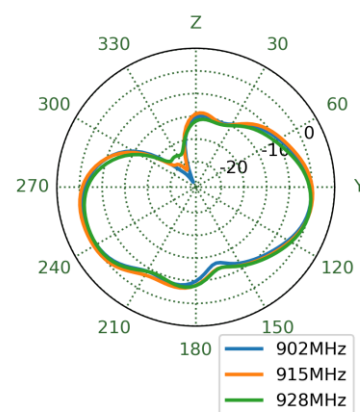
XZ Plane



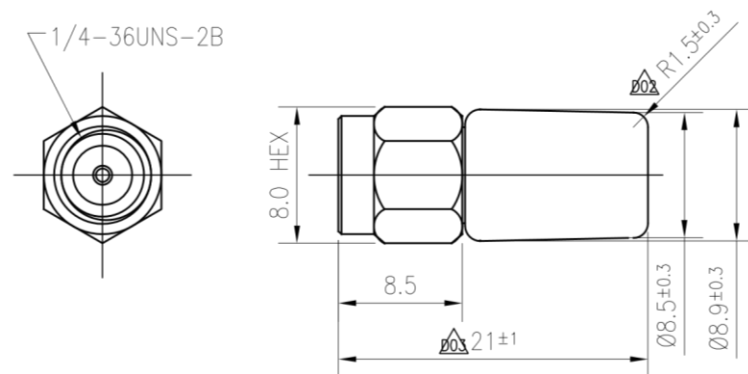
YZ Plane



XY Plane

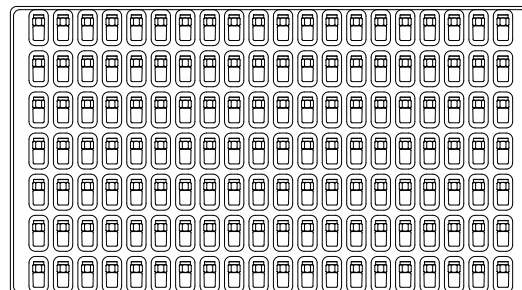


5. Mechanical Drawing

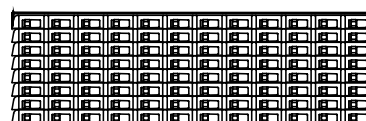
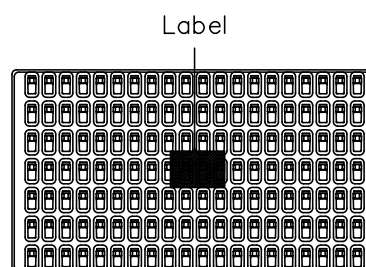


6. Packaging

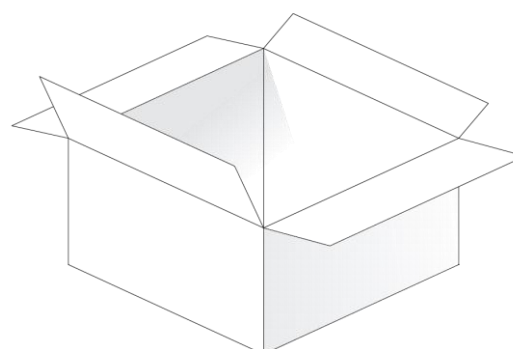
140pcs TI.93.A111 per Tray
Weight: 0.52Kg



8 SET per Tray
Weight: 4.2Kg



1120pcs per Carton
Dimensions: 425x240x130mm
Weight: 4.65Kg



Changelog for the datasheet

SPE-24-8-017– TI.93.A111

Revision: A (First Release)	
Date:	2024-01-19
Notes:	
Author:	Cesar Sousa

Previous Revisions

Revision:	
Date:	
Notes:	
Author:	



www.taoglas.com





ANT-915-NUB-ccc

915 MHz LPWA Whip Antenna

The ANT-915-NUB-ccc is an extremely compact whip-style antenna designed for sub-1 GHz and low-power, wide-area (LPWA) applications including LoRaWAN®, IoT, remote controls, and ISM band applications in the 902 MHz to 930 MHz range.

The ANT-915-NUB-ccc is a rugged monopole antenna with a length of less than 18 mm. The ANT-915-NUB-ccc may be used with metallic and non-metallic enclosures. The antenna connects using an SMA plug (male pin) or RP-SMA plug (female socket) connector.

FEATURES

- Performance at 902 MHz to 930 MHz
 - VSWR: ≤ 2.6
 - Peak Gain: 3.9 dBi
 - Efficiency: 38%
- Compact size
 - Height 17.7 mm (0.70 in)
 - Diameter 7.0 mm (0.28 in)
- AEC-Q200 Grade 2 compliance
- Omnidirectional radiation pattern
- SMA plug (male pin) or RP-SMA plug (female socket) connection

APPLICATIONS

- Low-power, wide-area (LPWA) applications
 - LoRaWAN®, ITU-T Y.4480
- ISM applications
- Drone Antenna
- FPV Antenna
- UAV Antenna
- Remote control, sensing and monitoring
 - Security systems
 - Industrial machinery
 - Automated equipment
 - AMR (automated meter reading)
- Internet of Things (IoT) devices
- Smart Home networking
- Hand-held devices

ORDERING INFORMATION

Part Number	Description
ANT-915-NUB-RPS	915 MHz LPWA whip antenna with RP-SMA plug (female socket) connector
ANT-915-NUB-SMA	915 MHz LPWA whip antenna with SMA plug (male pin) connector

Available from Linx Technologies and select distributors and representatives.

TABLE 1. ELECTRICAL SPECIFICATIONS

ANT-915-NUB	915 MHz		
Frequency Range	902 MHz to 930 MHz		
VSWR (max)	2.6		
Peak Gain (dBi)	3.9		
Average Gain (dBi)	-4.3		
Efficiency (%)	38		
Polarization	Linear	Radiation	Omnidirectional
Max Power	25 W	Wavelength	1/4-wave
Electrical Type	Monopole	Impedance	50 Ω

Electrical specifications and plots measured at the edge of a 102 mm x 102 mm (4 in x 4 in) reference ground plane.

TABLE 2. MECHANICAL SPECIFICATIONS

Parameter	Value
Connection	SMA plug (male pin), RP-SMA plug (female socket)
Dimensions	17.7 mm x Ø7.0 mm (0.70 in x Ø0.28 in)
Weight	2.9 g (0.10 oz)
Operating Temp. Range	-40 °C to +105 °C

PRODUCT DIMENSIONS

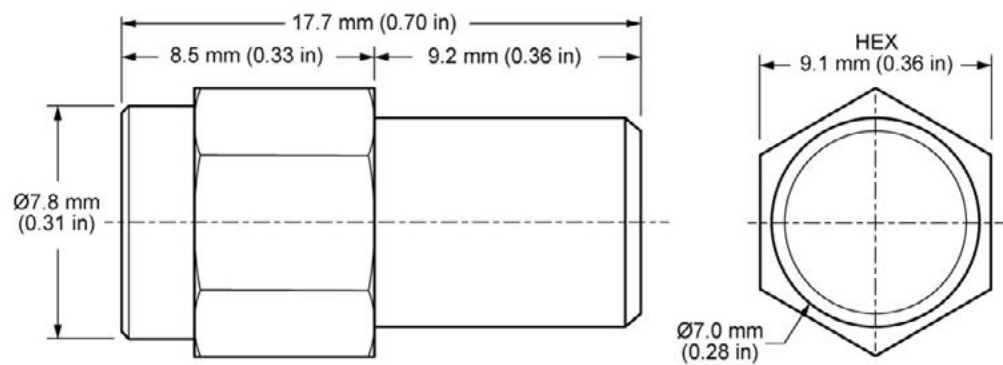


Figure 1. ANT-915-NUB-ccc Antenna Dimensions

PACKAGING INFORMATION

The ANT-915-NUB antenna is individually packaged in a sealed plastic bag, 50 pcs packed in a labeled clear polyethylene bag. Distribution channels may offer alternative packaging options.

COUNTERPOISE

Quarter-wave or monopole antennas require an associated ground plane counterpoise for proper operation. The size and location of the ground plane relative to the antenna will affect the overall performance of the antenna in the final design. When used in conjunction with a ground plane smaller than that used to tune the antenna, the center frequency typically will shift higher in frequency and the bandwidth will decrease. The proximity of other circuit elements and packaging near the antenna will also affect the final performance.

For further discussion and guidance on the importance of the ground plane counterpoise, please refer to Linx Application Note, *AN-00501: Understanding Antenna Specifications and Operation*.

ANTENNA ORIENTATION

The ANT-915-NUB-ccc antenna is characterized in two antenna orientations as shown in Figure 2. The antenna in a free space orientation characterizes use of an antenna attached to an enclosure-mounted connector which is connected by cable to a printed circuit board. Characterization at the edge of the ground plane (102 mm x 102 mm) provides insight into antenna performance when attached to a connector on a metal enclosure. The two orientations represent the most common end-product use cases.

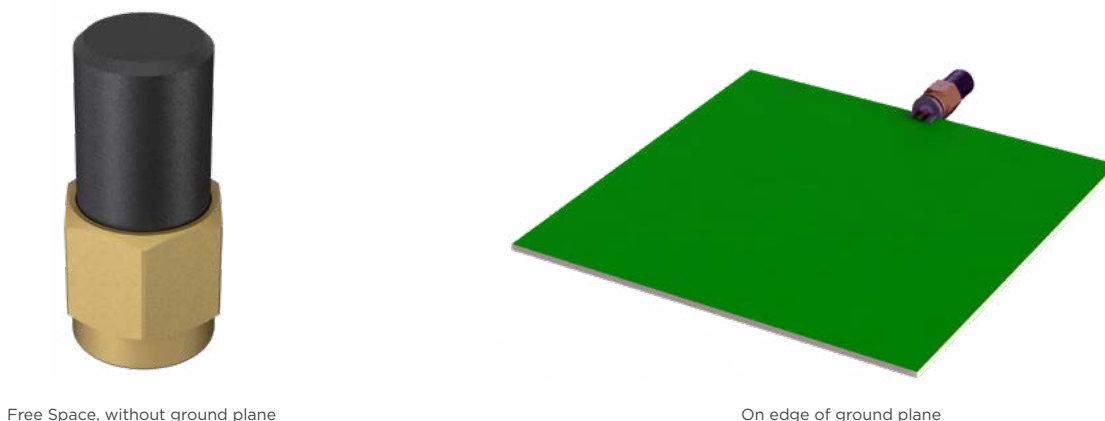


Figure 2. ANT-915-NUB-ccc Test Orientation

EDGE OF GROUND PLANE

The charts on the following pages represent data taken with the antenna oriented at the edge of the ground plane, as shown in Figure 3.



Figure 3. ANT-915-NUB-ccc on Edge of Ground Plane

VSWR

Figure 4 provides the voltage standing wave ratio (VSWR) across the antenna bandwidth. VSWR describes the power reflected from the antenna back to the radio. A lower VSWR value indicates better antenna performance at a given frequency. Reflected power is also shown on the right-side vertical axis as a gauge of the percentage of transmitter power reflected back from the antenna.

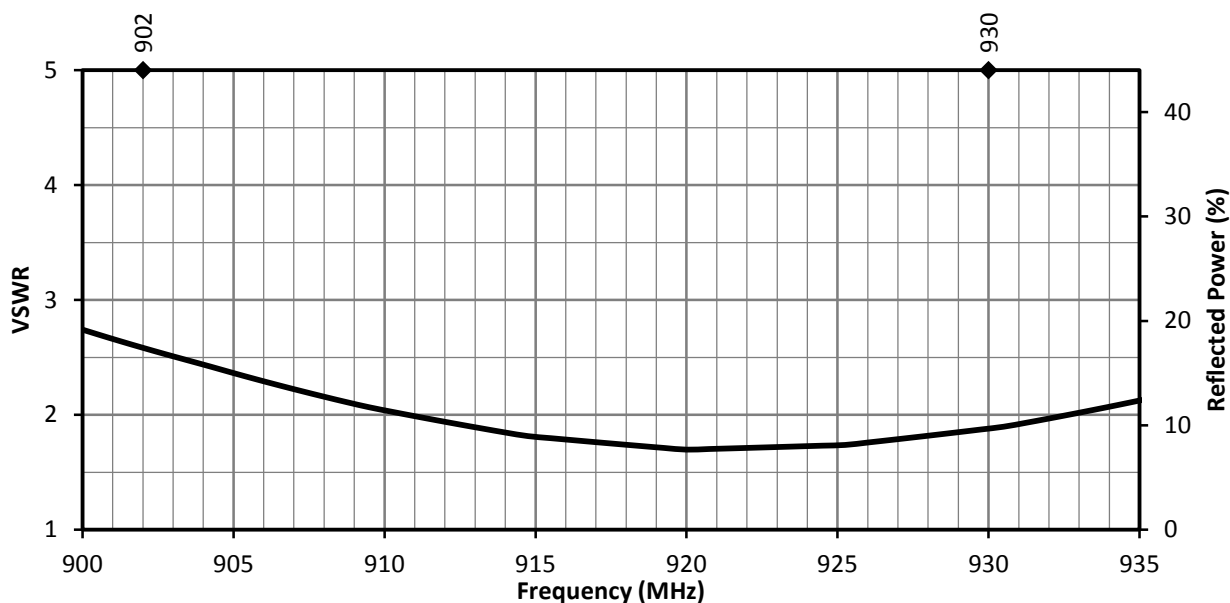


Figure 4. VSWR for ANT-915-NUB-ccc, Edge of ground Plane

RETURN LOSS

Return loss (Figure 5), represents the loss in power at the antenna due to reflected signals. Like VSWR, a lower return loss value indicates better antenna performance at a given frequency.

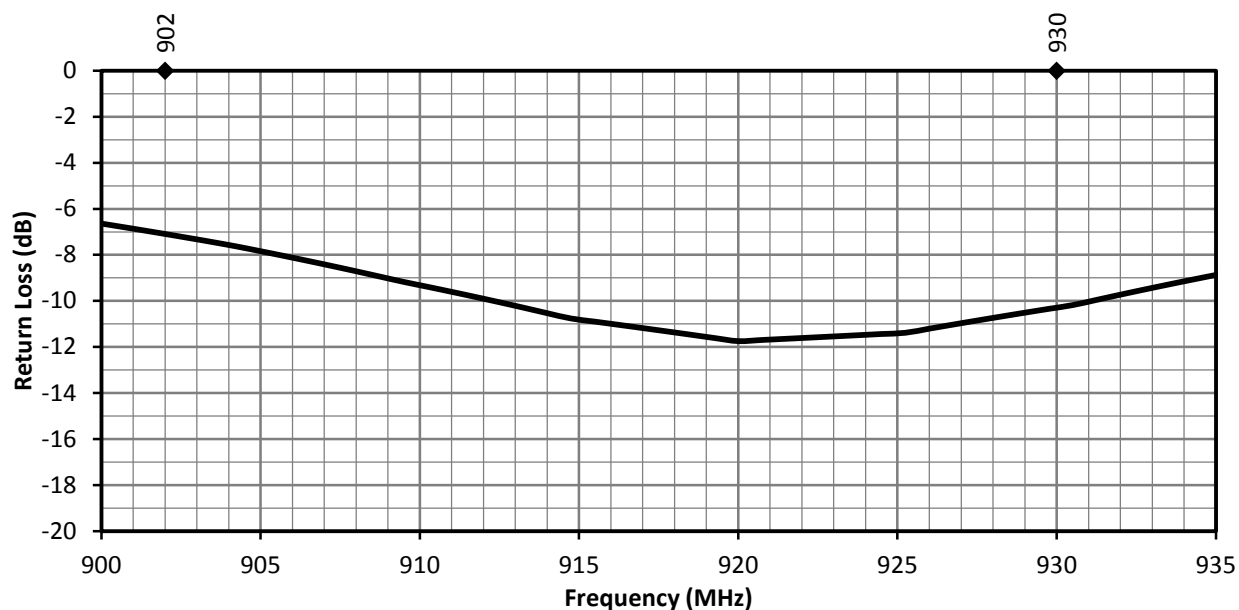


Figure 5. Return Loss for ANT-915-NUB-ccc, Edge of ground Plane

PEAK GAIN

The peak gain across the antenna bandwidth is shown in Figure 6. Peak gain represents the maximum antenna input power concentration across 3-dimensional space, and therefore peak performance, at a given frequency, but does not consider any directionality in the gain pattern.

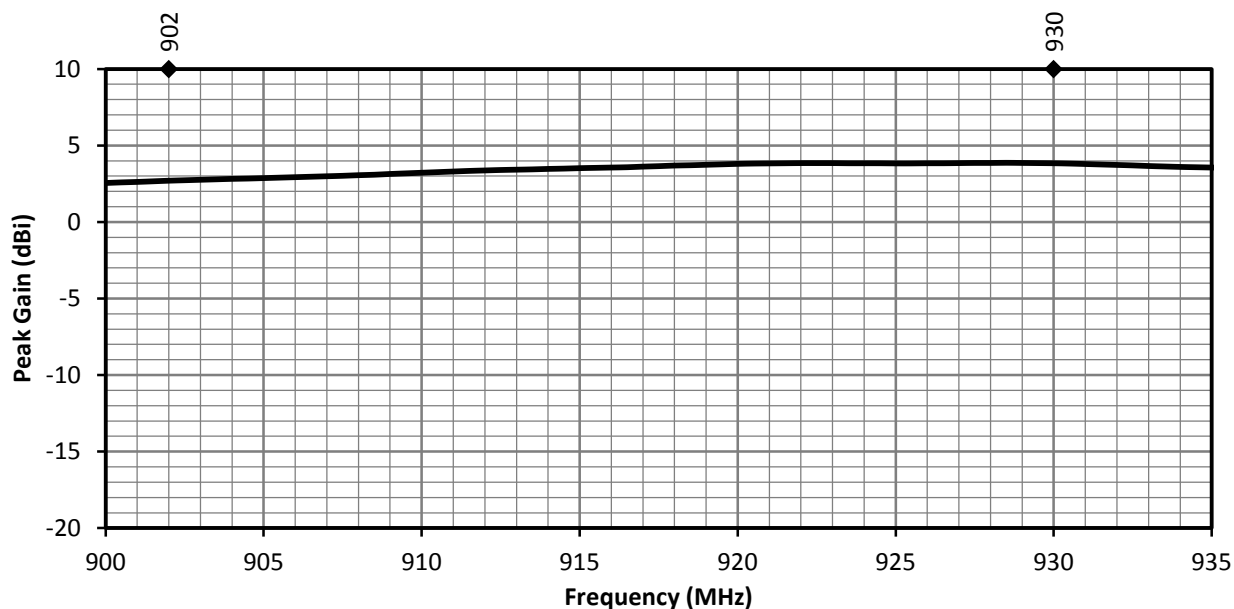


Figure 6. Peak Gain for ANT-915-NUB-ccc, Edge of ground Plane

AVERAGE GAIN

verage gain (Figure 7), is the average of all antenna gain in 3-dimensional space at each frequency, providing an indication of overall performance without expressing antenna directionality.

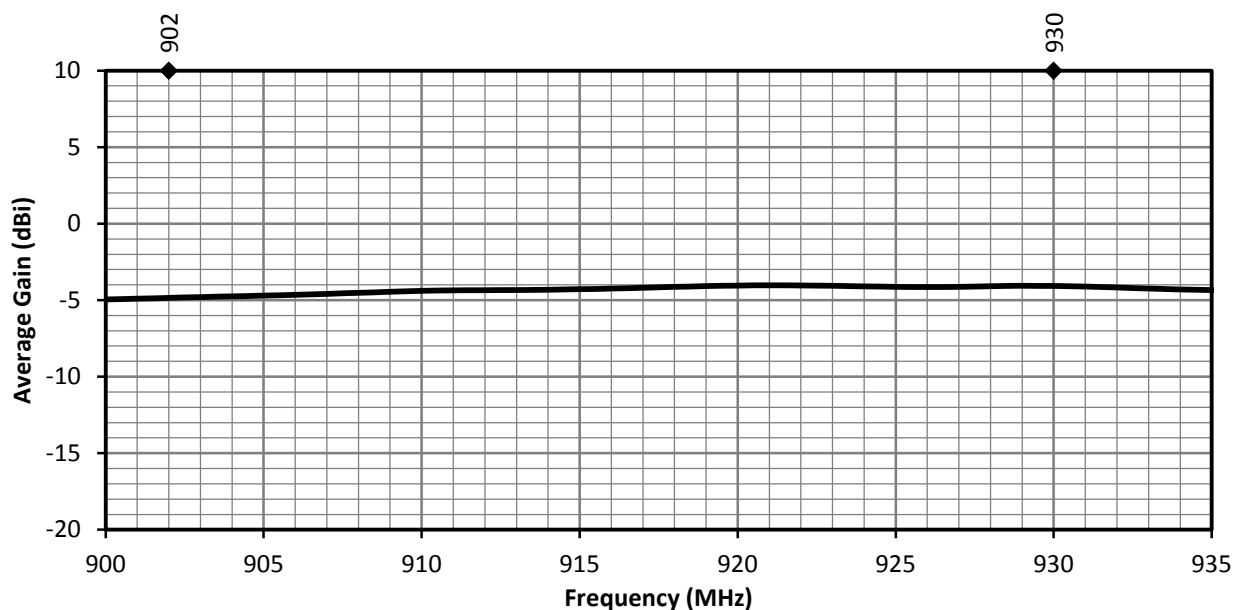


Figure 7. Antenna Average Gain for ANT-915-NUB-ccc, Edge of ground Plane

RADIATION EFFICIENCY

Radiation efficiency (Figure 8), shows the ratio of power delivered to the antenna relative to the power radiated at the antenna, expressed as a percentage, where a higher percentage indicates better performance at a given frequency.

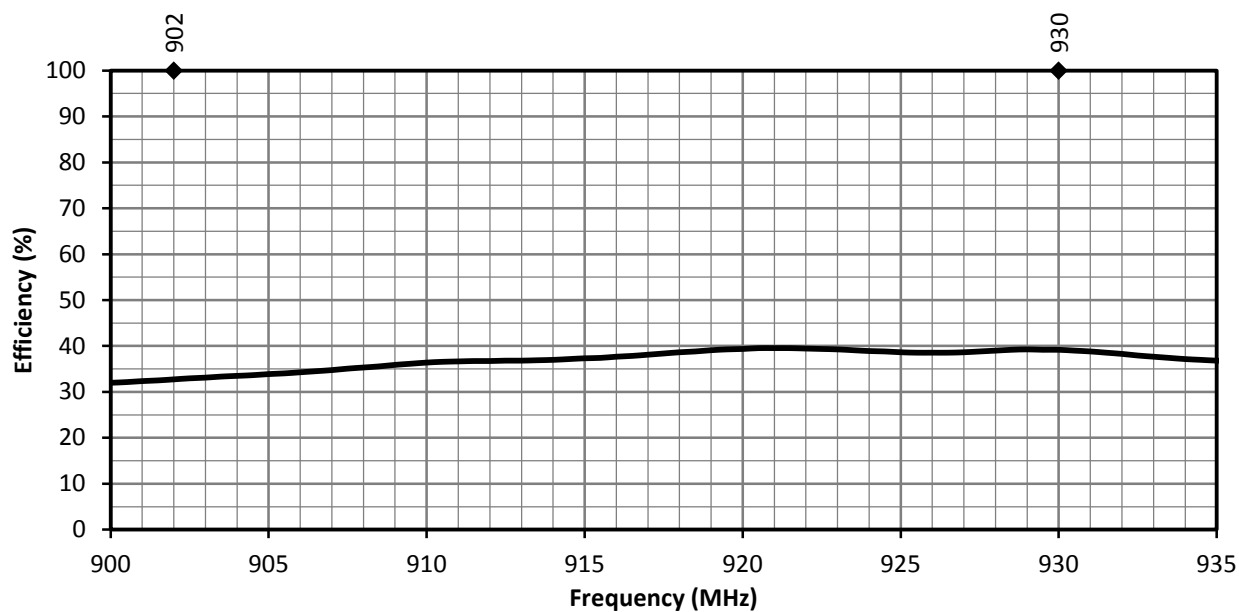
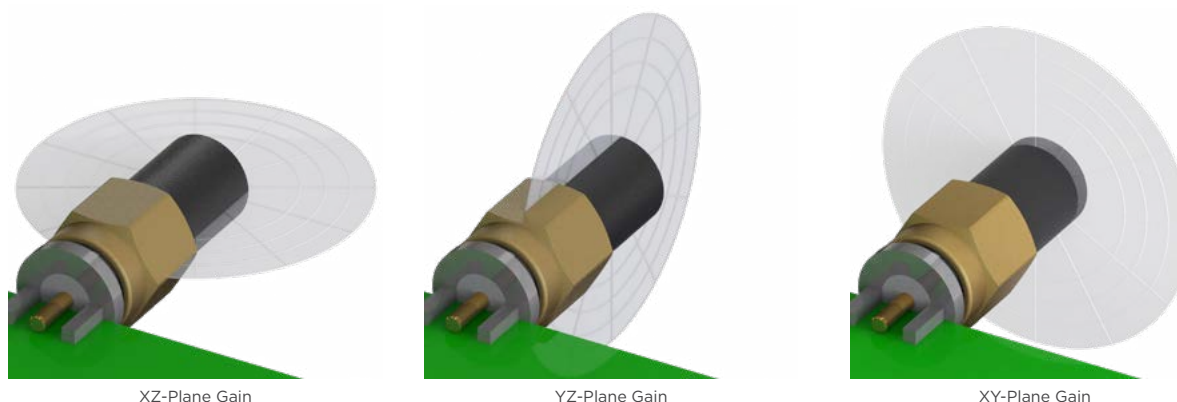


Figure 8. Antenna Radiation Efficiency for ANT-915-NUB-ccc, Edge of ground Plane

RADIATION PATTERNS

Radiation patterns provide information about the directionality and 3-dimensional gain performance of the antenna by plotting gain at specific frequencies in three orthogonal planes. Antenna radiation patterns (Figure 9), are shown using polar plots covering 360 degrees. The antenna graphic above the plots provides reference to the plane of the column of plots below it. Note: when viewed with typical PDF viewing software, zooming into radiation patterns is possible to reveal fine detail.

RADIATION PATTERNS - EDGE OF GROUND PLANE



902 MHz TO 930 MHz (915 MHz)

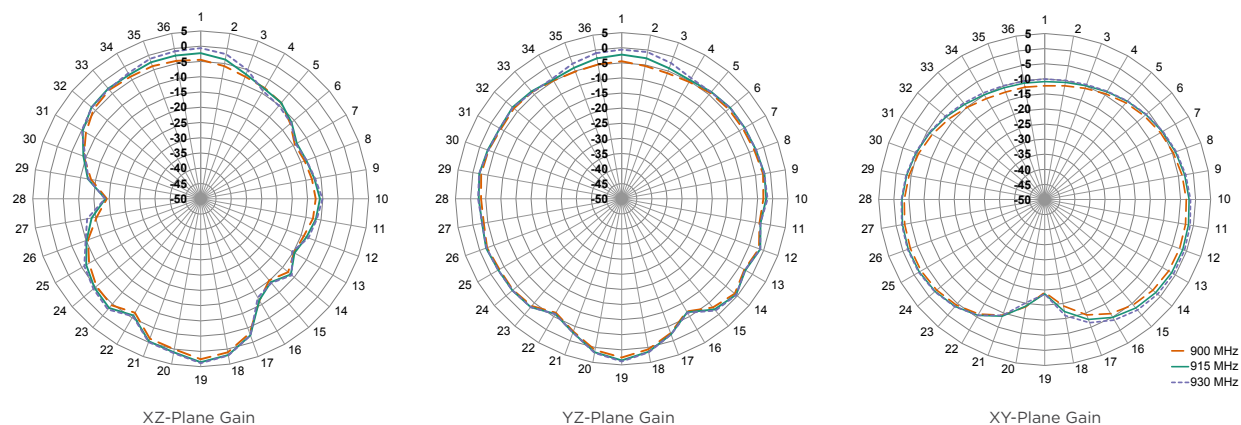


Figure 9. Radiation Patterns for ANT-915-NUB-ccc Antenna, Edge of ground Plane

FREE SPACE - NO GROUND PLANE

The charts on the following pages represent data taken with the antenna in free space, no ground plane, as shown in Figure 10.



Figure 10. ANT-8/9-IPW2-NP at Center of Ground Plane

VSWR

Figure 11 provides the voltage standing wave ratio (VSWR) across the antenna bandwidth. VSWR describes the power reflected from the antenna back to the radio. A lower VSWR value indicates better antenna performance at a given frequency. Reflected power is also shown on the right-side vertical axis as a gauge of the percentage of transmitter power reflected back from the antenna.

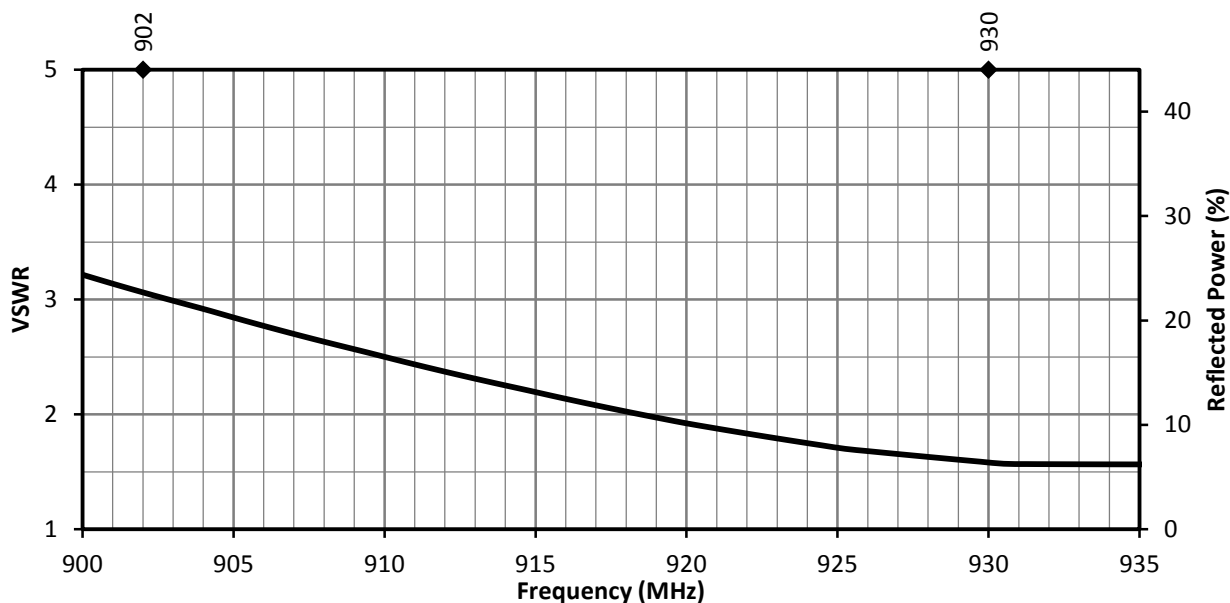


Figure 11. VSWR for ANT-915-NUB-ccc Antenna in Free Space

RETURN LOSS

Return loss (Figure 12), represents the loss in power at the antenna due to reflected signals. Like VSWR, a lower return loss value indicates better antenna performance at a given frequency.

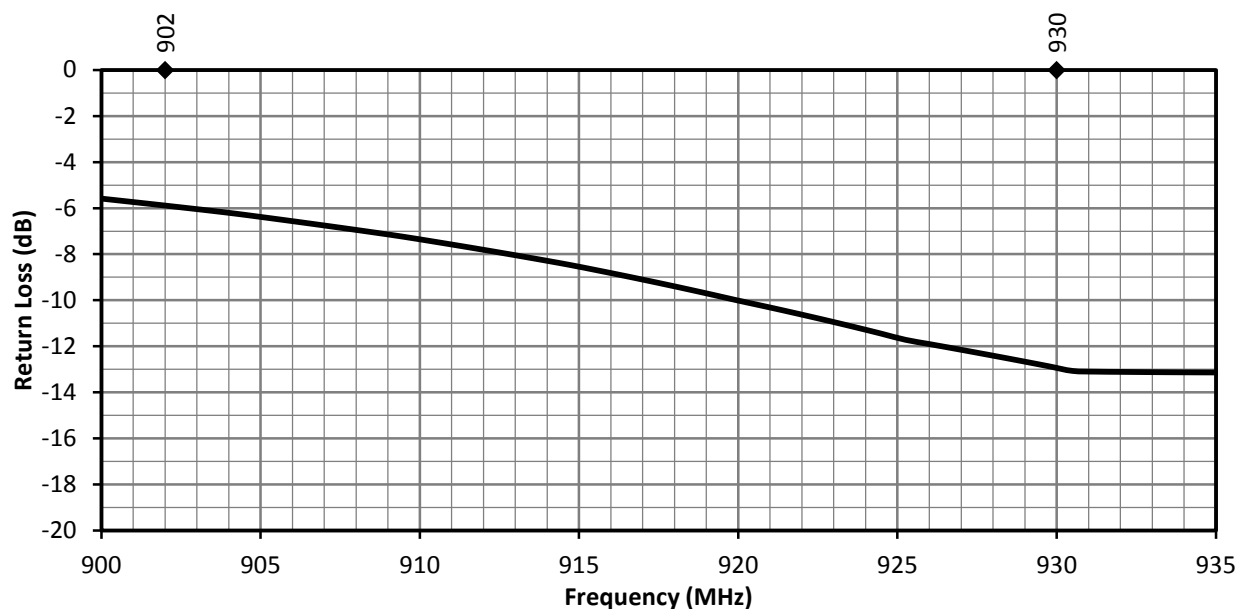


Figure 12. Return Loss for ANT-915-NUB-ccc Antenna in Free Space

PEAK GAIN

The peak gain across the antenna bandwidth is shown in Figure 13. Peak gain represents the maximum antenna input power concentration across 3-dimensional space, and therefore peak performance, at a given frequency, but does not consider any directionality in the gain pattern.

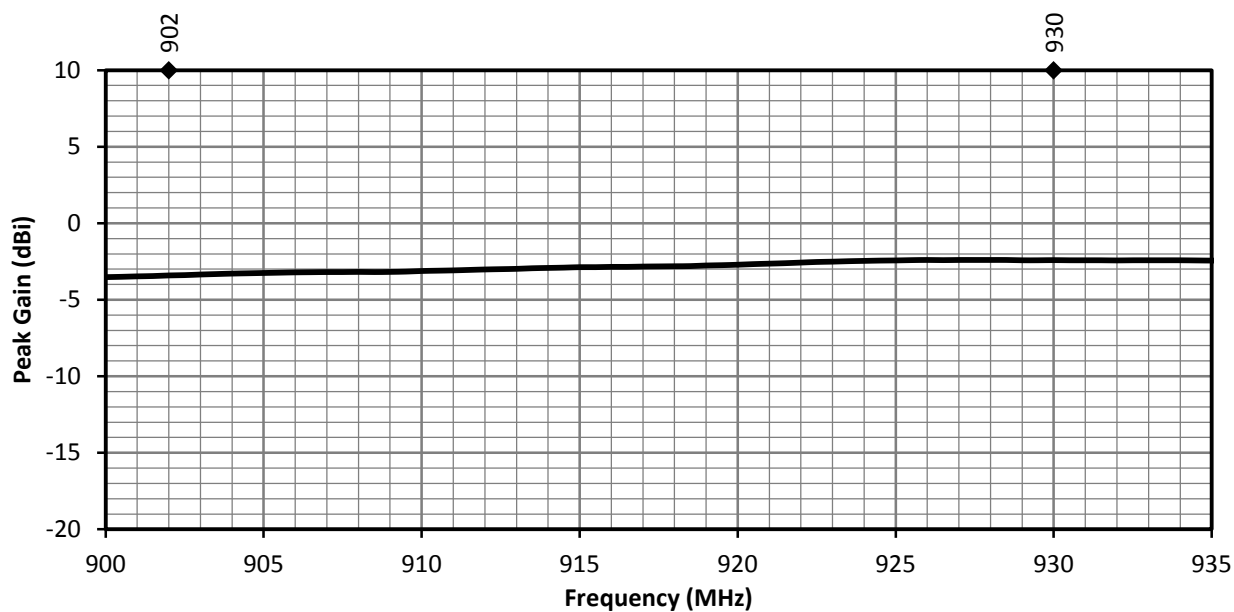


Figure 13. Peak Gain for ANT-915-NUB-ccc Antenna in Free Space

AVERAGE GAIN

Average gain (Figure 14), is the average of all antenna gain in 3-dimensional space at each frequency, providing an indication of overall performance without expressing antenna directionality.

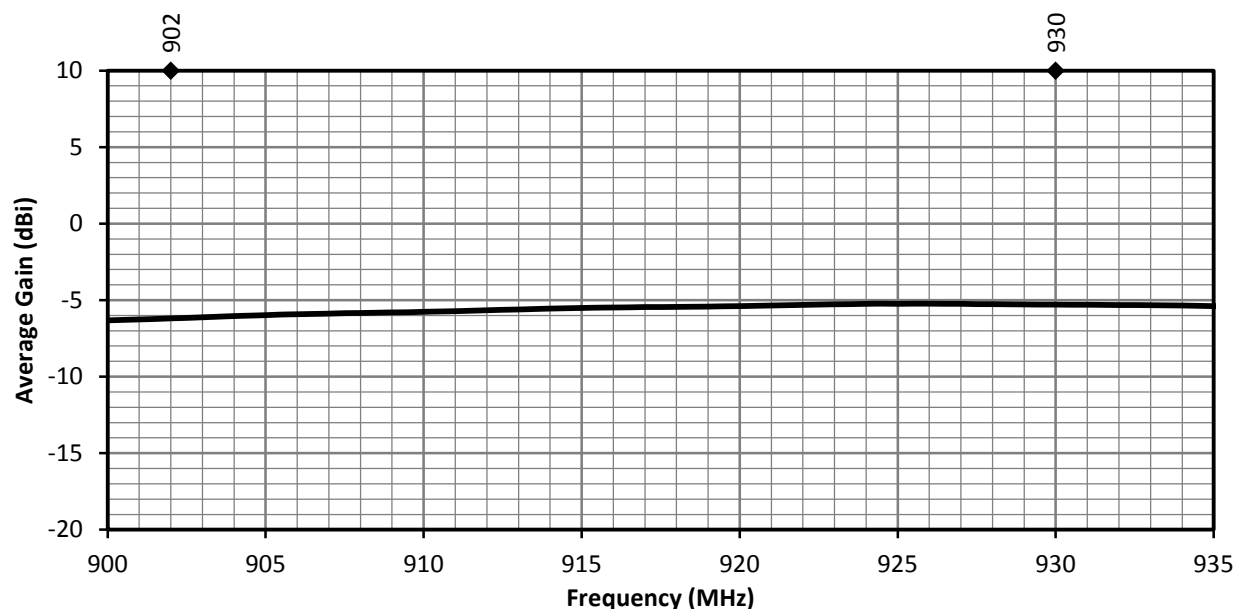


Figure 14. Antenna Average Gain for ANT-915-NUB-ccc Antenna in Free Space

RADIATION EFFICIENCY

Radiation efficiency (Figure 15), shows the ratio of power delivered to the antenna relative to the power radiated at the antenna, expressed as a percentage, where a higher percentage indicates better performance at a given frequency.

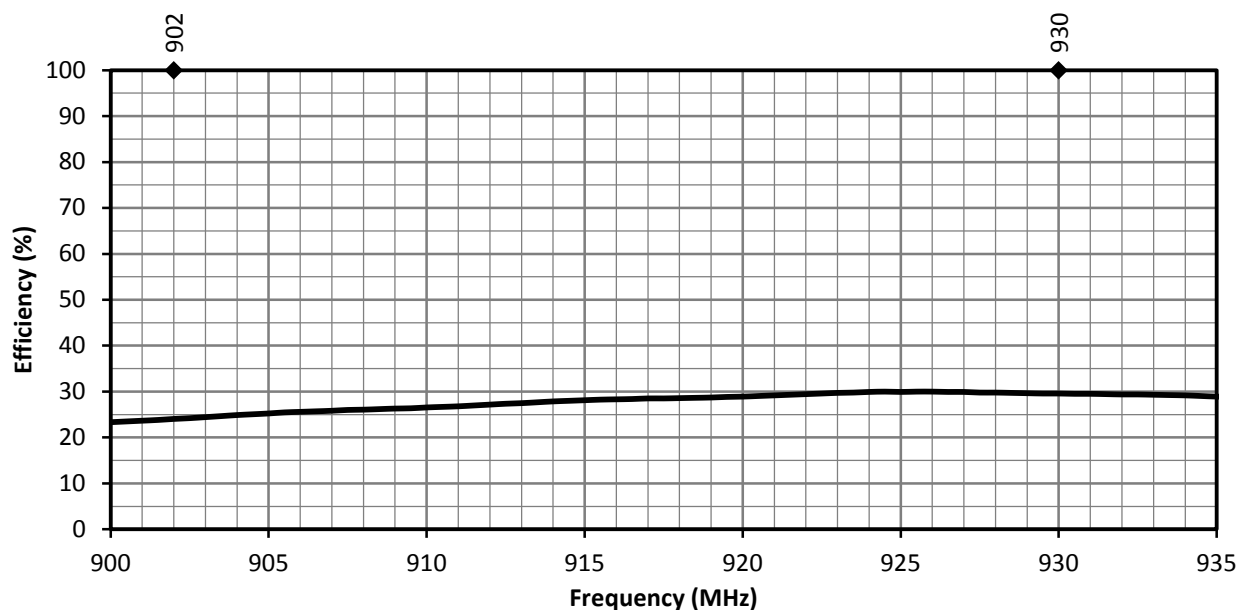


Figure 15. Antenna Radiation Efficiency for ANT-915-NUB-ccc Antenna in Free Space

RADIATION PATTERNS

Radiation patterns provide information about the directionality and 3-dimensional gain performance of the antenna by plotting gain at specific frequencies in three orthogonal planes. Antenna radiation patterns (Figure 16), are shown using polar plots covering 360 degrees. The antenna graphic above the plots provides reference to the plane of the column of plots below it. Note: when viewed with typical PDF viewing software, zooming into radiation patterns is possible to reveal fine detail.

RADIATION PATTERNS - FREE SPACE (NO GROUND PLANE)



902 MHz TO 930 MHz (915 MHz)

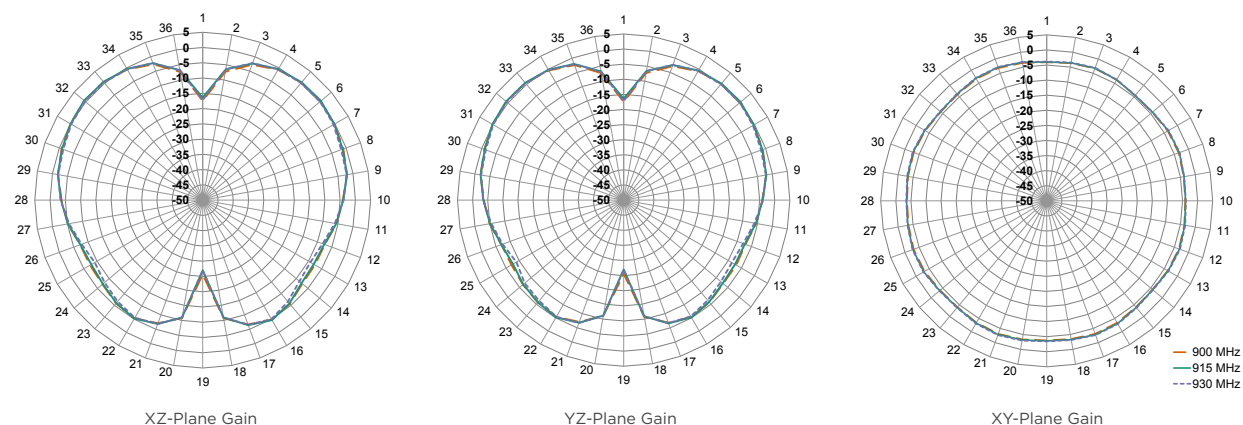


Figure 16. Radiation Patterns for ANT-915-NUB-ccc Antenna in Free Space

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