

AC16500 2.4 GHz Straight Whip Antenna

The Antenna Company AC16500 straight whip antennas provide a compact omnidirectional 2.4 GHz antenna solution for all ISM applications including Bluetooth®, BLE and ZigBee®.

The 60 mm long straight whip (“rubber duck”) antenna performs adjacent to a ground plane or in free space including non-metallic enclosures. Additionally, the antenna supports IP65 ingress protection for wet and dusty applications.

The AC16500 whip antennas are available with SMA or reverse-polarity SMA (RP-SMA) plug (male) connector.



AC16500-SMA 2.4 GHz 60 mm
Straight Whip Antenna

Features

- Very high efficiency
- IP65 ingress protection
- Dimensions: 60 mm x 8 mm
- Performance at 2.4 GHz to 2.485 GHz
 - VSWR: 1.7
 - Peak Gain: 3.0 (dBi)
 - Efficiency: 87%
- SMA and RP-SMA termination options

Applications

- 2.4 GHz ISM applications
 - Bluetooth
 - Bluetooth Low Energy (BLE)
 - ZigBee
 - Wi-Sun®
- Internet of Things (IoT) devices
- WLAN Gateways/Routers

Ordering Information

Part Number	Description
AC16500-SMA	SMA connector 2.4 GHz, 60 mm straight whip antenna
AC16500-RPS	RP-SMA connector 2.4 GHz, 60 mm straight whip antenna

Available from The Antenna Company (sales@antennacompany.com) and select distributors and representatives.

RF/Electrical Specifications

Parameter	Value
Frequency	2400 MHz to 2485 MHz
VSWR (max)	1.7
Peak Gain (dBi)	3.0
Average Gain (dBi)	-0.8
Average Efficiency (%)	84
Impedance	50 Ω
Polarization	Linear
Radiation Pattern	Omnidirectional
Wavelength	$\frac{1}{2}$ -wave
Max Power	10 W

Electrical specifications and plots measured with the antenna at the center of a 100 mm x 100 mm ground plane.

Mechanical Specifications

Parameter	Value
Connection	SMA, RP-SMA
Ingress Protection	IP65
Weight	3.3 g (0.12 oz)
Dimensions	30.5 mm x 8.0 mm (1.2 in x 0.31 in)

Antenna Dimensions

Figure 1 provides dimensions of the AC16500 antenna.

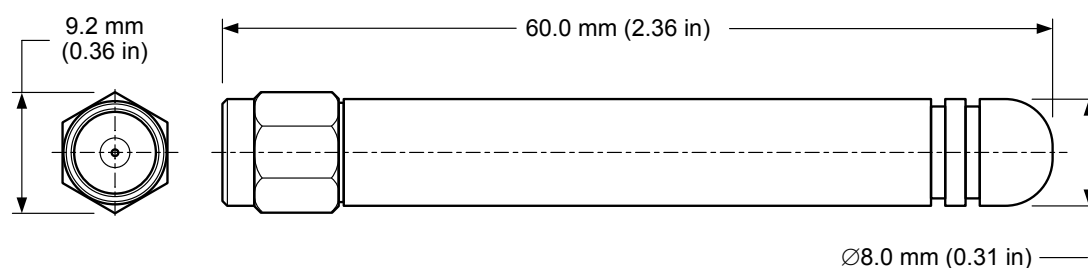
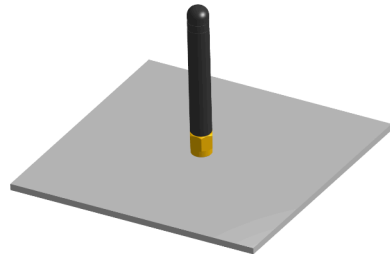


Figure 1. AC16500 Antenna Dimensions

Antenna Test Orientations

The AC16500 antenna is characterized in two antenna orientations as shown in Figure 2. Although the antenna does not require a ground plane to function, characterization on an adjacent ground plane (100 mm x 100 mm) provides insight into antenna performance when attached to a printed circuit board with ground plane. The antenna free space orientation characterizes use of an antenna attached to a non-metallic enclosure. These two orientations represent common end-product use cases.



Antenna at Center of Ground Plane



Antenna in Free space

Figure 2. AC16500 Antenna Test Orientations

Center of Ground Plane

The charts on the following pages represent data taken with the antenna oriented at the edge of a 100 mm x 100 mm ground plane as shown in Figure 3.

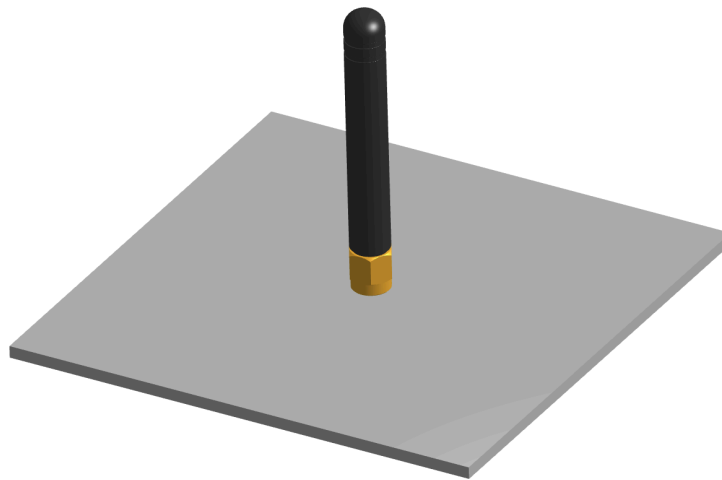


Figure 3. AC16500 Antenna at Center of Ground Plane

VSWR

Figure 4 provides the voltage standing wave ratio (VSWR) across the antenna bandwidth. VSWR characterizes the power reflected from the antenna back to the transmitter. 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 measure of the percentage of transmitter power reflected back from the antenna.

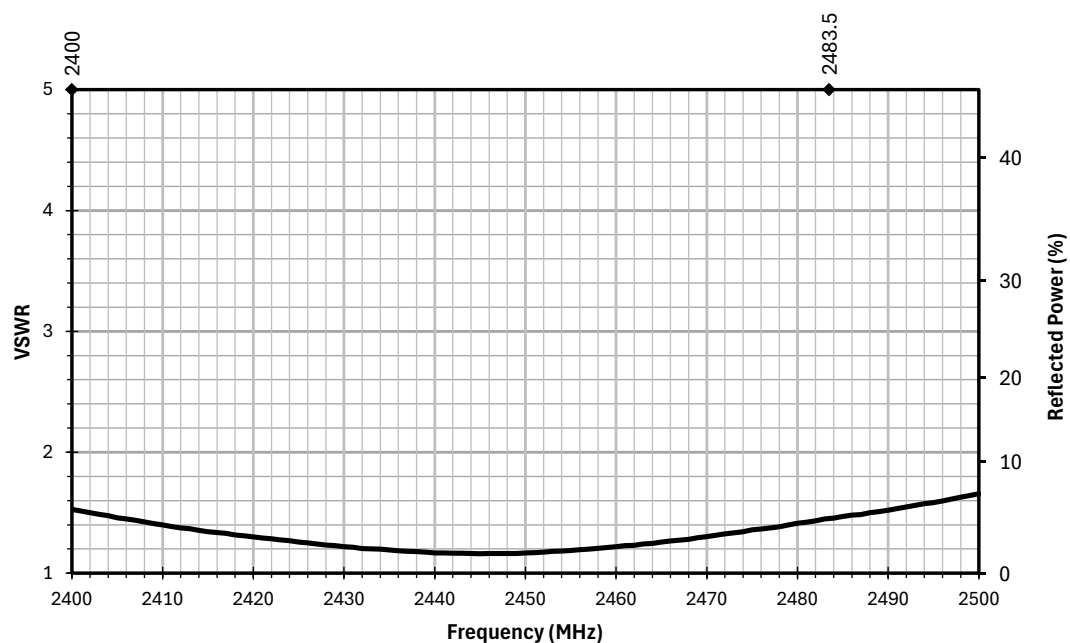


Figure 4. AC16500 Antenna VSWR at Center of Ground Plane

Return Loss

Return loss (Figure 5) represents the loss in power at the antenna due to reflected signals. A higher magnitude return loss indicates better performance. Return loss is the negative of input reflection coefficient, in decibels (dB), and the two values are often used interchangeably.

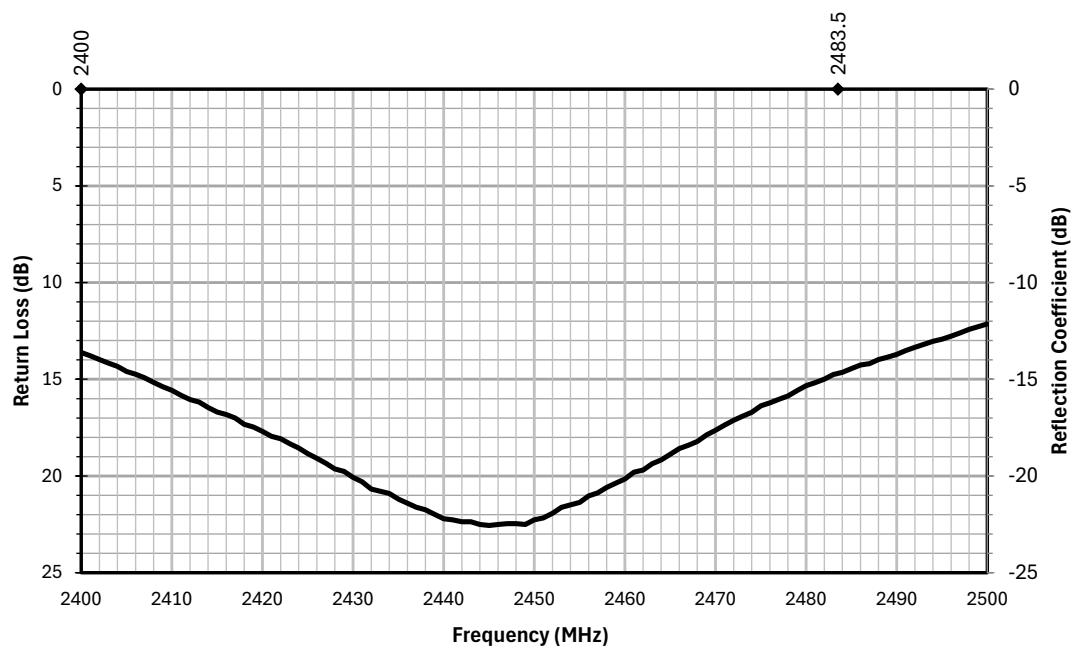


Figure 5. AC16500 Antenna Return Loss at Center of Ground Plane

Peak Gain

Peak gain (Figure 6) provides a measure of the maximum conversion of antenna input power to radio waves at a given frequency. Peak gain does not account for the directionality of gain in 3-dimensional space.

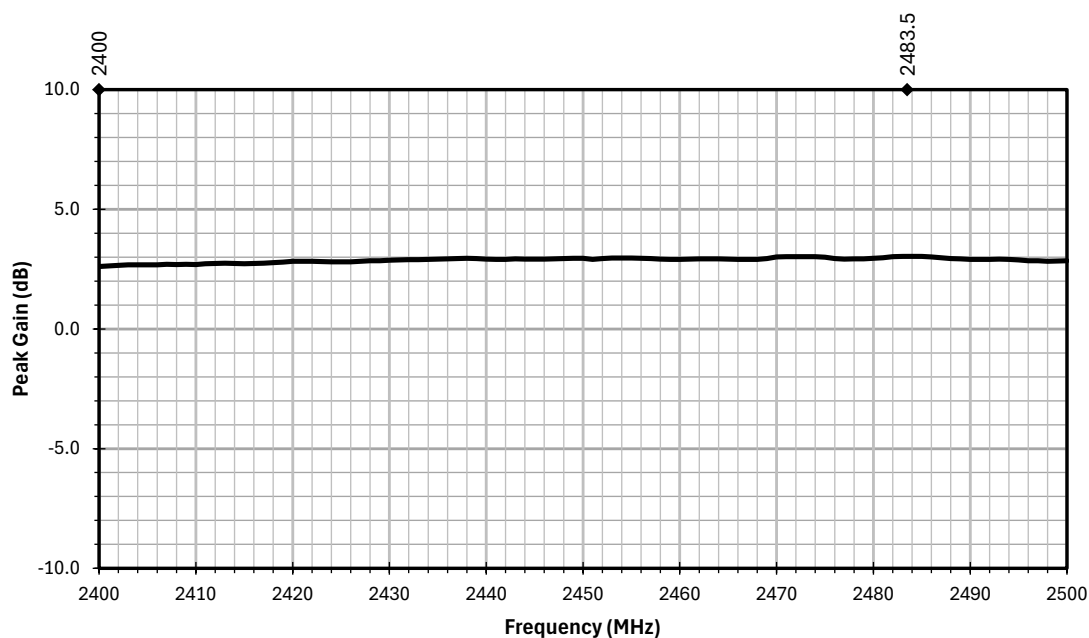


Figure 6. AC16500 Antenna Peak Gain at Center of Ground Plane

Average Gain

Average 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.

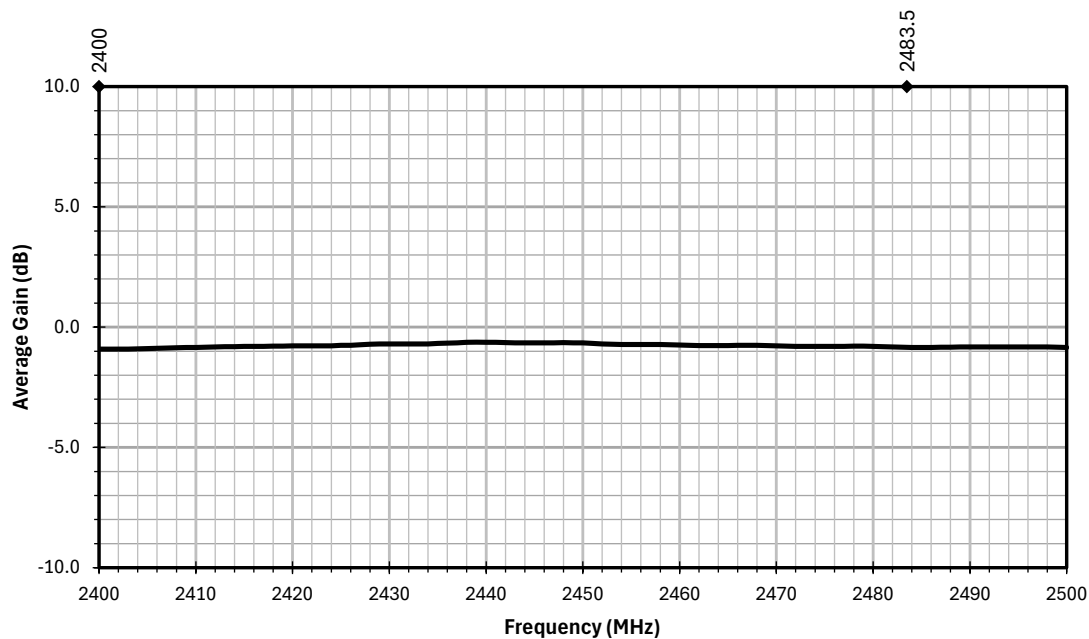


Figure 7. AC16500 Antenna Average Gain at Center of Ground Plane

Efficiency

Efficiency (Figure 8) is 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.

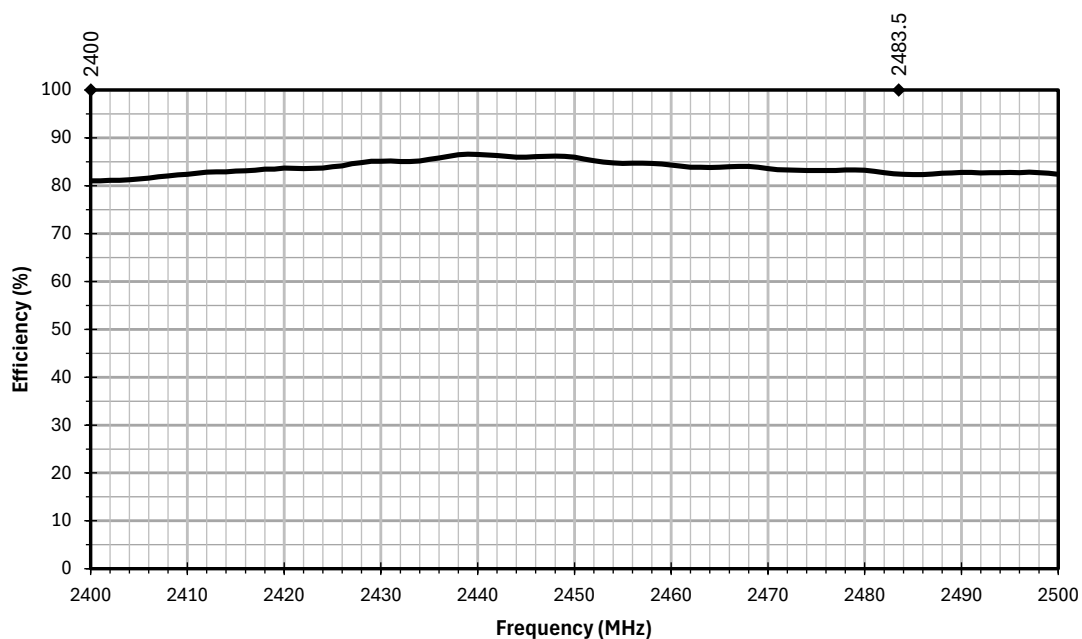
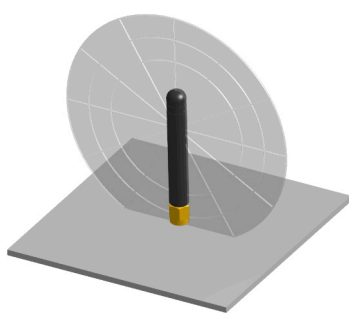


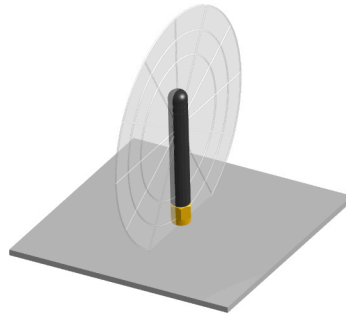
Figure 8. AC16500 Antenna Efficiency at Center of Ground Plane

Radiation Patterns - Center of Ground Plane

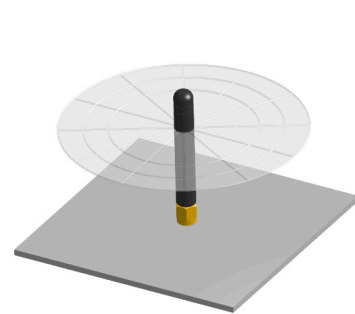
Radiation patterns provide information about the directional performance of the antenna by plotting gain in three orthogonal planes at the high-, low- and center-frequencies of an antenna frequency band. Antenna radiation patterns (Figure 9) are shown using polar plots covering 360 degrees with the plane of reference depicted above the plots. Note: when viewed with typical PDF viewing software, zooming into radiation patterns is possible to reveal fine detail.



XZ-Plane Gain

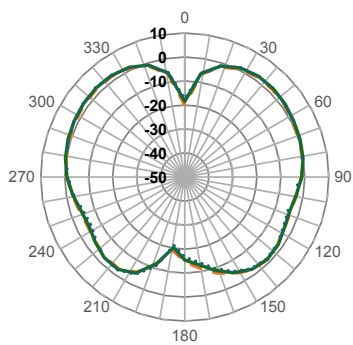


YZ-Plane Gain

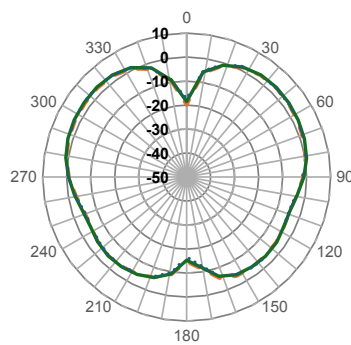


XY-Plane Gain

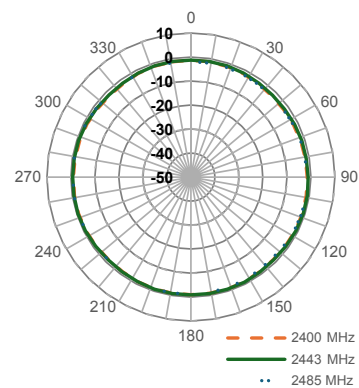
2400 MHz to 2485 MHz (2443 MHz)



XZ-Plane Gain



YZ-Plane Gain



XY-Plane Gain

Figure 9. Radiation Patterns for the AC16500 Antenna at Center of Ground Plane

Free Space, No Ground Plane

The charts on the following pages represent data taken with the antenna in free space as shown in Figure 10.



Figure 10. AC16500 Antenna in Free Space

VSWR

Figure 11 provides the voltage standing wave ratio (VSWR) across the antenna bandwidth. VSWR characterizes the power reflected from the antenna back to the transmitter. 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 measure of the percentage of transmitter power reflected back from the antenna.

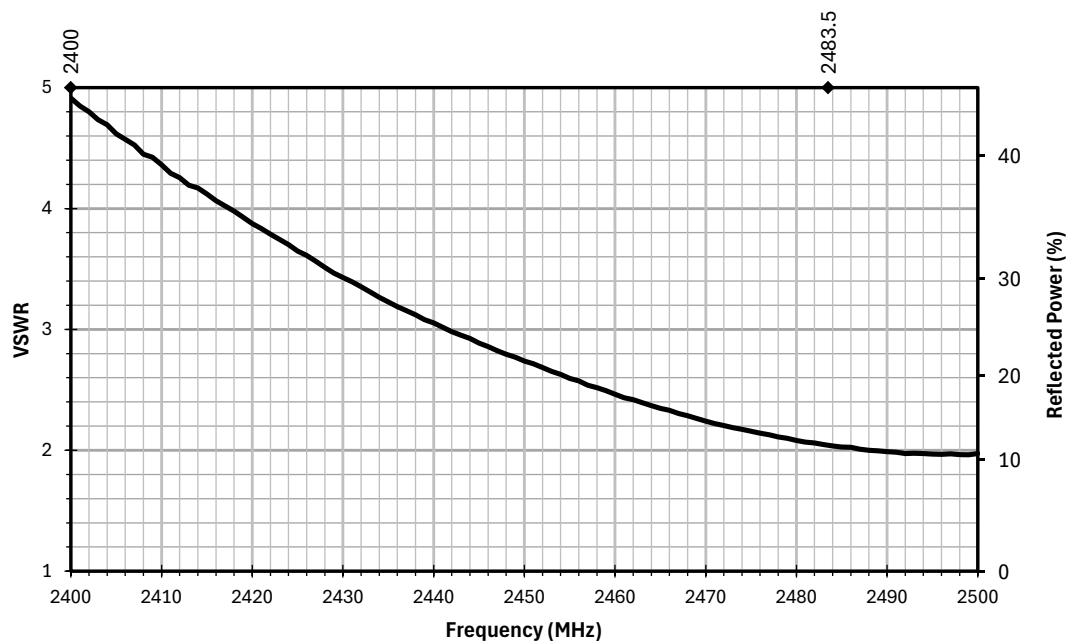


Figure 11. AC16500 Antenna VSWR in Free Space

Return Loss

Return loss (Figure 12) represents the loss in power at the antenna due to reflected signals. A higher magnitude return loss indicates better performance. Return loss is the negative of input reflection coefficient, in decibels (dB), and the two values are often used interchangeably.

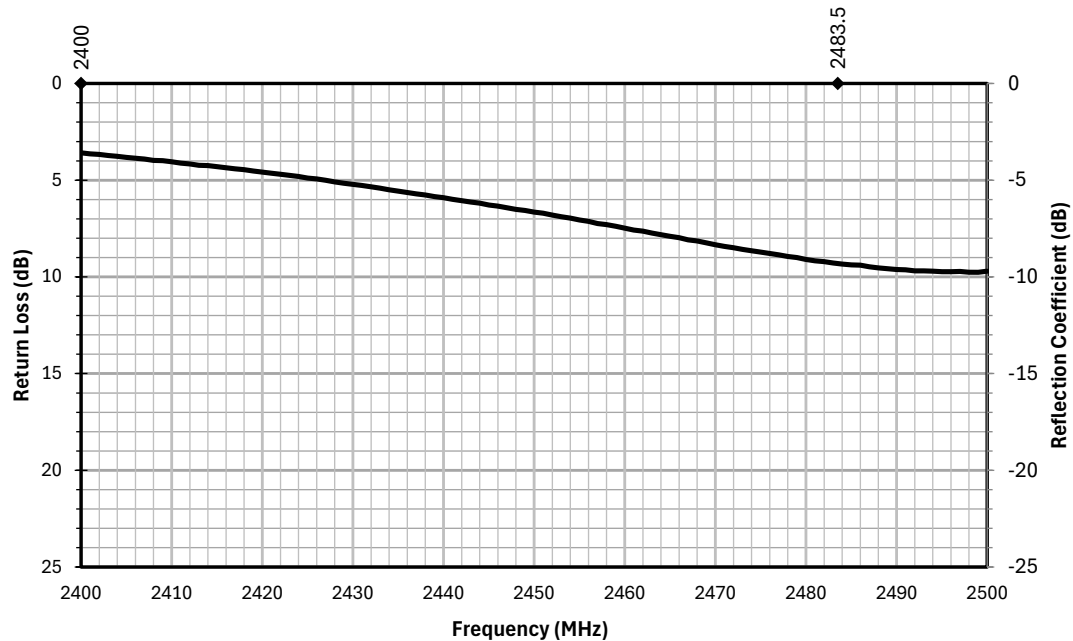


Figure 12. AC16500 Antenna Return Loss in Free Space

Peak Gain

Peak gain (Figure 13) provides a measure of the maximum conversion of antenna input power to radio waves at a given frequency. Peak gain does not account for the directionality of gain in 3-dimensional space.

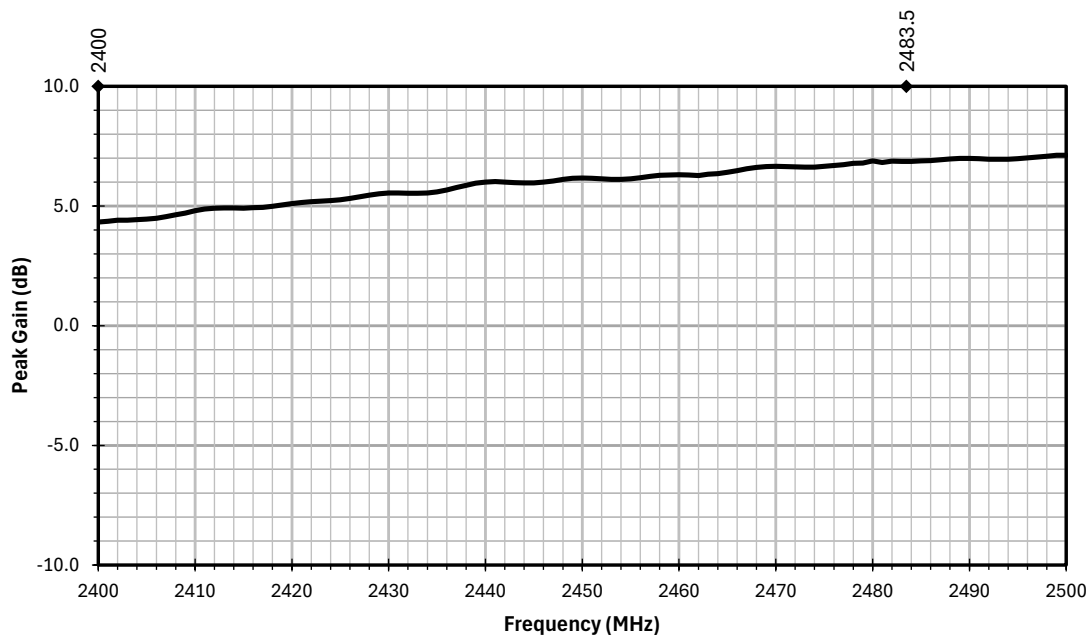


Figure 13. AC16500 Antenna Peak Gain in Free Space

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.

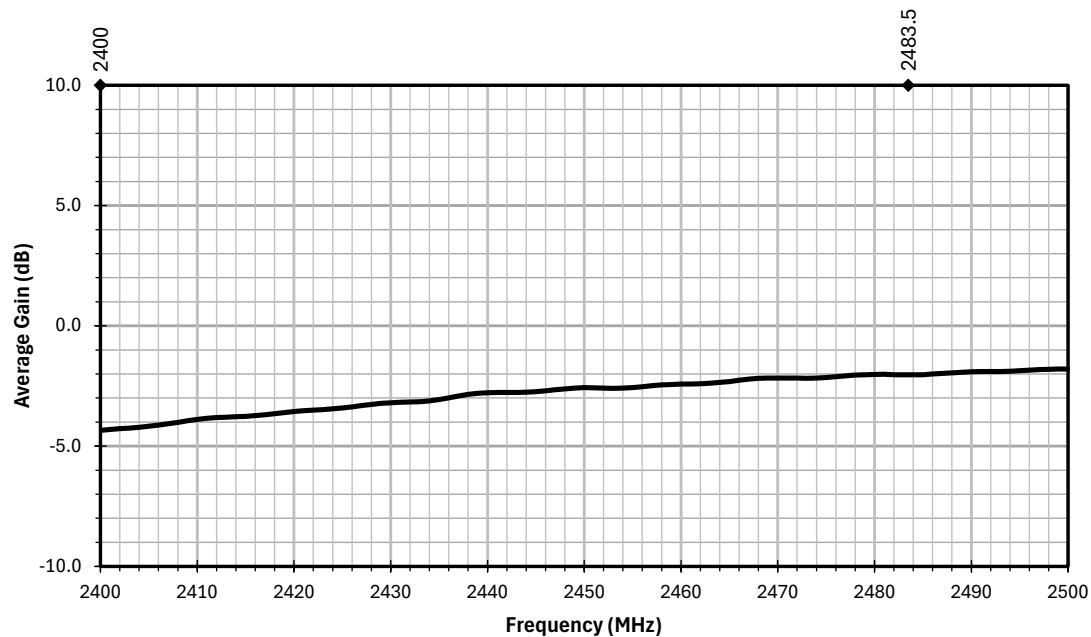


Figure 14. AC16500 Antenna Average Gain in Free Space

Efficiency

Efficiency (Figure 15) is 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.

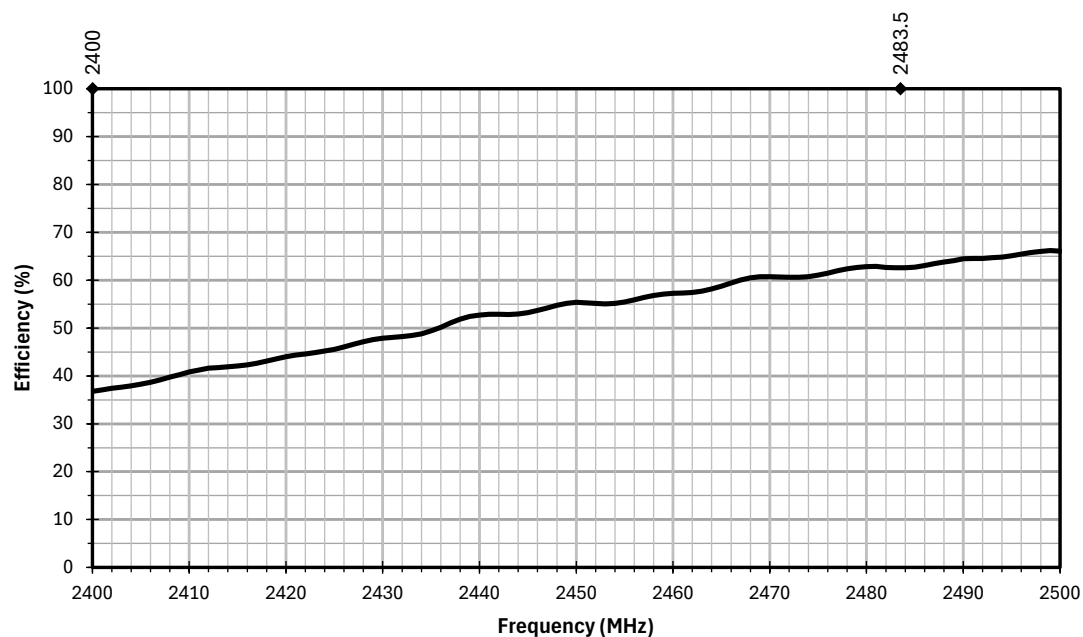


Figure 15. AC16500 Antenna Efficiency in Free Space

Radiation Patterns - Free Space

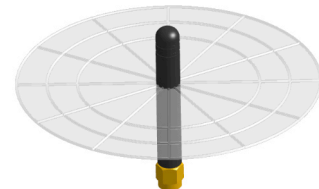
Radiation patterns provide information about the directional performance of the antenna by plotting gain in three orthogonal planes at the high-, low- and center-frequencies of an antenna frequency band. Antenna radiation patterns (Figure 16) are shown using polar plots covering 360 degrees with the plane of reference depicted above the plots. Note: when viewed with typical PDF viewing software, zooming into radiation patterns is possible to reveal fine detail.



XZ-Plane Gain

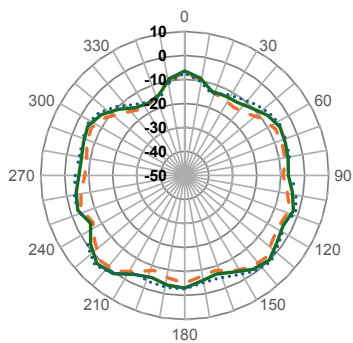


YZ-Plane Gain

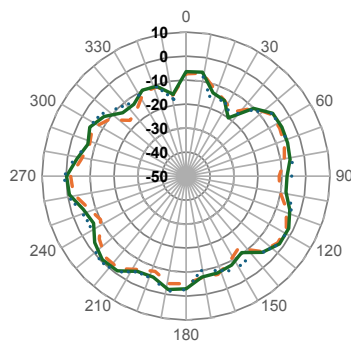


XY-Plane Gain

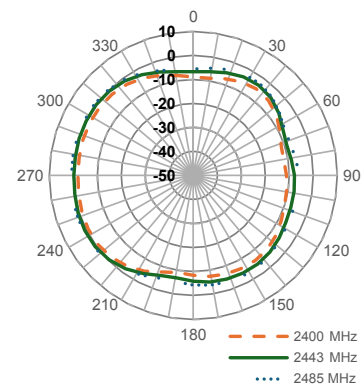
2400 MHz to 2485 MHz (2443 MHz)



XZ-Plane Gain



YZ-Plane Gain



XY-Plane Gain

Figure 16. Radiation Patterns for the AC16500 Antenna in Free Space

Packaging Information

The AC16500 antenna is individually packaged in a sealed polyethylene bag. 200 packaged antennas are sealed in a larger polyethylene bag. 10 large polyethylene bags are placed in a carton for a total of 2000 pcs. Carton dimensions are 360 mm x 280 mm x 260 mm (14.2 in x 11.0 in x 10.2 in).

Website: <http://www.antennacompany.com>
Offices: Eindhoven, The Netherlands
EMAIL: sales@antennacompany.com

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DOC# DS26201-087ANT

