Datasheet

AC97002
Cellular 5G/4G/LTE External Cabled Bar-Style Antenna

The AC97002 cellular 5G/4G/LTE bar antenna provides an external mount antenna solution for common cellular bands, including those for Cat-M1/LTE-M and NB-IoT cellular IoT applications.

The peel-and-stick adhesive backing makes the AC97002 antenna easy to mount on enclosures in any desired orientation. Mounting holes are provided for optional screw mounting.

Two versions for the AC97002 are offered to support various installations. The detachable cable version simplifies cabinet installation, requiring only a “cable-sized” hole for installation. The fixed cable version is IP65-rated for ingress protection. Both fixed and detachable cable types use RG174LL coaxial cable terminated with an easy-to-attach Fakra D connector. Various cable length options are available (See Ordering Information).

AC97002-150B Cellular 5G/4G/LTE antenna

Features

- Low profile (35 mm height) compact antenna
- Excellent multiband coverage including 698 to 960 MHz and 1700 to 2700 MHz
- Performance at 698 MHz to 960 MHz (free space)
  - VSWR: 3.0
  - Peak Gain: 3.9 dBi
  - Efficiency: 77%
- Suitable for mounting on metallic and non-metallic surfaces
- Multiple cable lengths (1 m, 1.5 m, 2 m and 3 m)
- Detachable cable version simplifies installation
- IP65 ingress protection (fixed cable versions)

Applications

- Worldwide 5G/4G/3G/2G cellular
- Cellular IoT
  - Cat-M1/LTE-M
  - NB-IoT
- Smart metering
- Smart utility infrastructure
- Asset management
- Tracking devices
- Vending machines

Ordering Information

Part Number	Description
AC97002-100	Cellular Antenna with 1 m (39.4 in) SMB* to Fakra D detachable cable
AC97002-150	Cellular Antenna with 1.5 m (59.0 in) SMB* to Fakra D detachable cable
AC97002-200	Cellular Antenna with 2 m (78.8 in) SMB* plug to Fakra D detachable cable
AC97002-100B	Cellular Antenna with fixed 1 m (39.4 in) cable with Fakra D termination
AC97002-150B	Cellular Antenna with fixed 1.5 m (59.0 in) cable with Fakra D termination
AC97002-200B	Cellular Antenna with fixed 2 m (78.8 in) cable with Fakra D termination

Available from The Antenna Company (sales@antennacompany.com) and select distributors and representatives.
* SMB connector is specially designed to mate with the provided SMB to Fakra D cable.

Electrical Specifications

Table 1. RF/Electrical Specifications

AC97002	Band 1	Band 2	Band 3	Band 4	Band 5	Band 6	Band 7
Frequency (MHz)	**698-803**	**791-960**	**832-1517**	**1427-1675**	**1695-2200**	**2300-2400**	**2483-2695**
VSWR (max)	3.0	2.4	3.7	3.1	1.8	1.6	2.1
Peak Gain (dBi)	3.9	3.9	3.8	4.0	3.3	3.3	4.0
Average Gain (dBi)	-1.8	-1.4	-3.0	-3.0	-2.3	-2.4	-2.7
Efficiency (%)	66	72	51	51	58	58	54
Cable Loss (dB/m)	0.77	0.79	0.80	1.17	1.23	1.53	1.75

Impedance	50 Ω
Polarization	Linear
Radiation Pattern	Omnidirectional
Wavelength	½-wave
Maximum Input Power	45 W
Electrical Type	Dipole

Electrical specifications and plots measured with the AC97002 in free space (1 meter cable).

Mechanical Specifications

Table 2. Mechanical Specifications

Parameter	Value
Antenna Connection (Termination)	Fakra D
Detachable Antenna-Cable Connector	SMB-type
SMB Connector Insertion Force	2.4 kG max.
SMB Connector Extraction Force	1.5 to 3.0 kG typ.
Coaxial Cable Type	RG-174/LL
Radome Material	ABS AG15A1-H (Light Grey)
Weight	AC97002-100 108 g (3.81 oz) AC97002-150 128 g (4.52 oz) AC97002-200 148 g (5.22 oz) AC97002-100B 118 g (4.16 oz) AC97002-150B 120 g (4.23 oz) AC97002-200B 122 g (7.05 oz)
Dimensions	170.0 mm x 45.0 mm x 35.5 mm (6.70 in x 1.80 in x 1.40 in)

Environmental Specifications

Table 3. Environmental Specifications

Parameter	Value
Operating Temp. Range	-20 °C to +85 °C (-4 °F to 185 °F)
Operating Relative Humidity	98% max.
Storage Temperature	-20 °C to +85 °C (-4 °F to 185 °F)
Storage Humidity	5% to 95% non-condensing
Ingress Protection (fixed cable version)	IP65
Impact Resistance	IK06
Flammability Rating	UL 94-HB
Salt Spray (fixed cable version)	MIL-STD 810F/ASTM B117
Wind Resistance	245 km/hr (152 mi/hr) max.

Antenna Dimensions

The dimensions for the AC97002 are shown below in Figure 1.

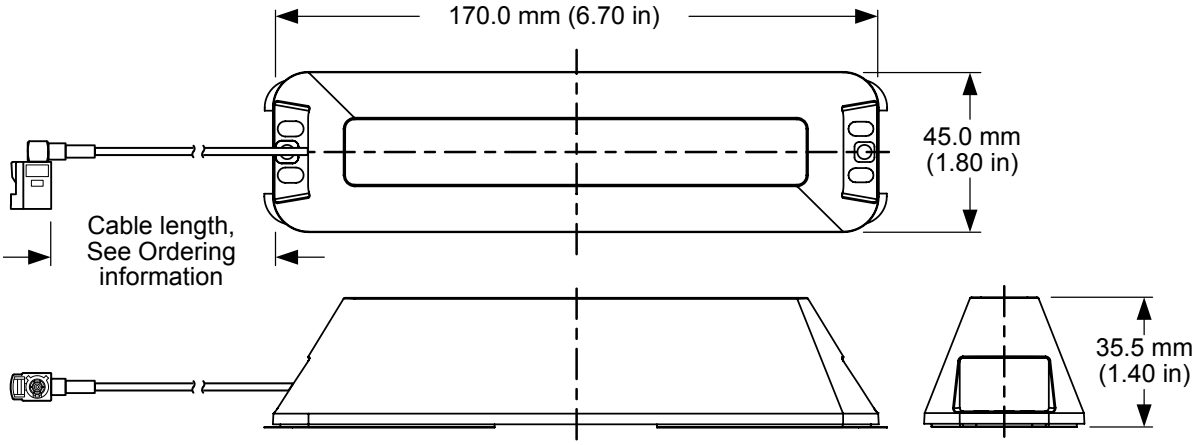
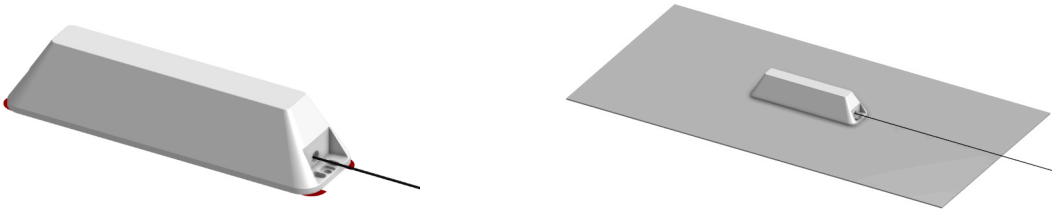


Figure 1. AC97002 Antenna Dimensions

Antenna Test Orientations

The AC97002 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 (600 mm x 300 mm) provides insight into antenna performance when attached directly on a metal enclosure. 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 in Free space Antenna on Ground Plane

Figure 2. AC97002 Antenna Test Orientations

Free Space, No Ground Plane

The charts on the following pages represent data taken with the antenna in free space as shown in Figure 3.

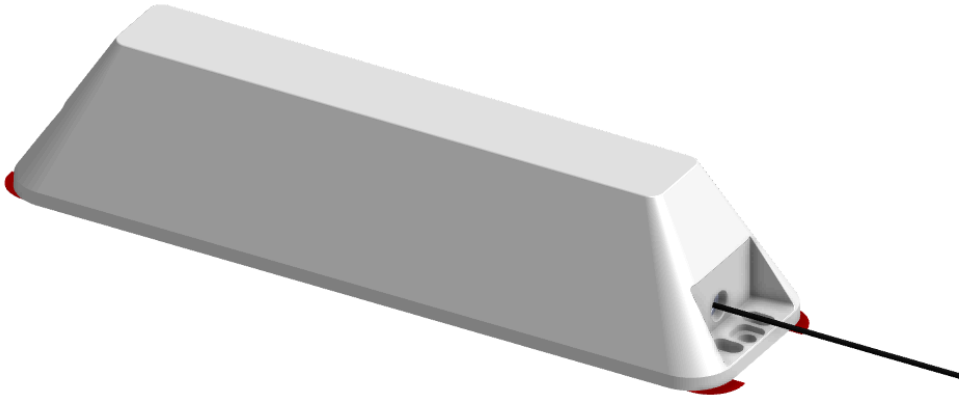


Figure 3. AC97002 Antenna, (Free Space), no Ground Plane

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.

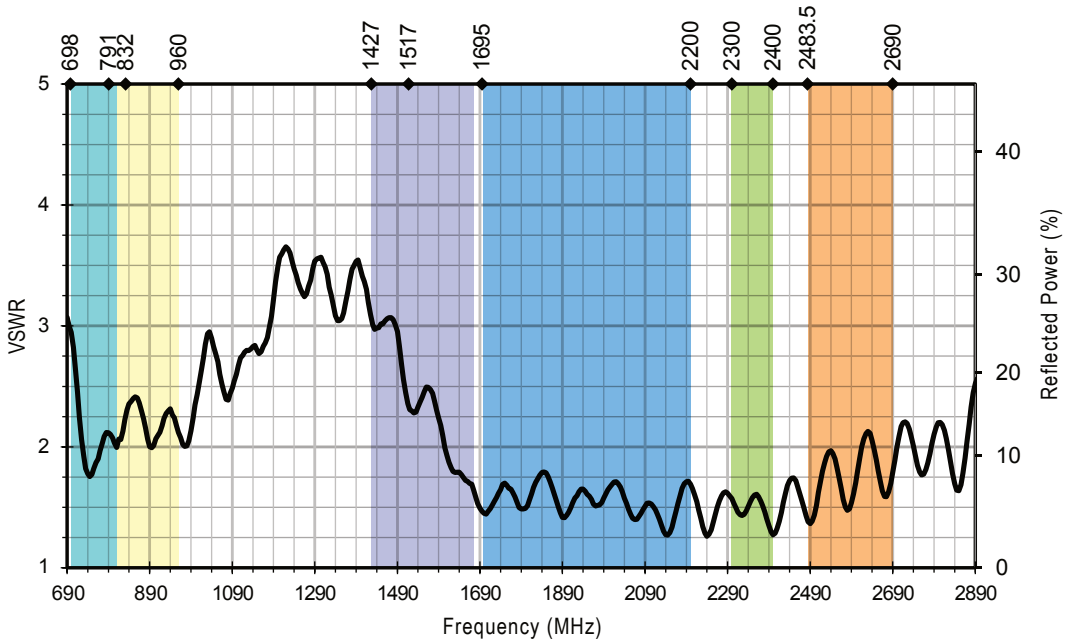


Figure 4. AC97002 Antenna VSWR, Free Space

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.

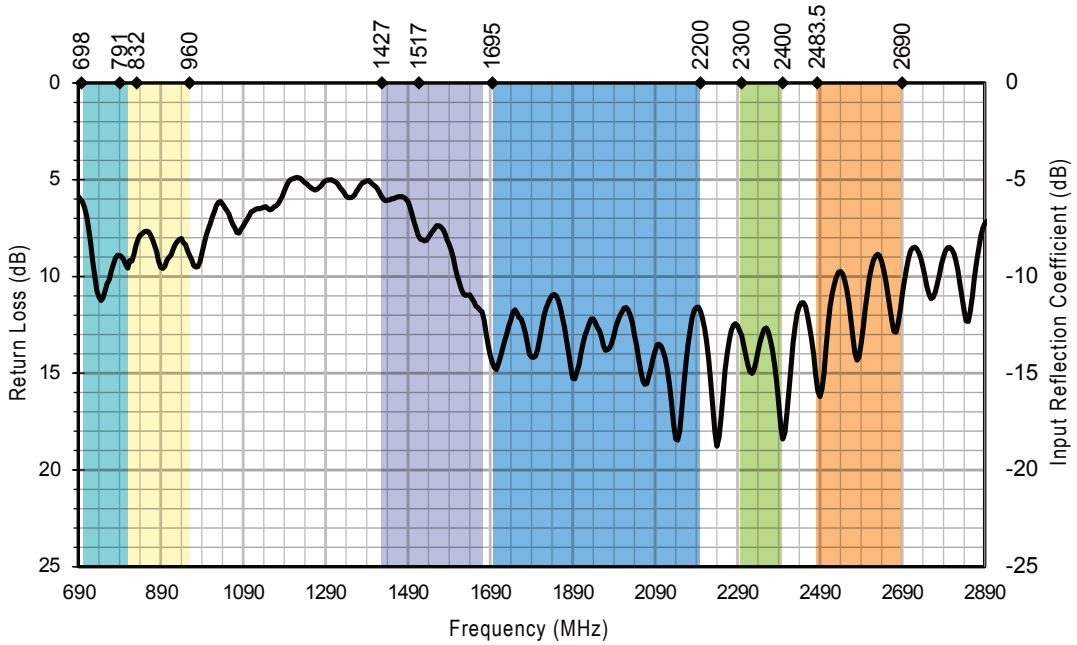


Figure 5. AC97002 Antenna Return Loss, Free Space

Peak Gain

Peak gain, (See 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.

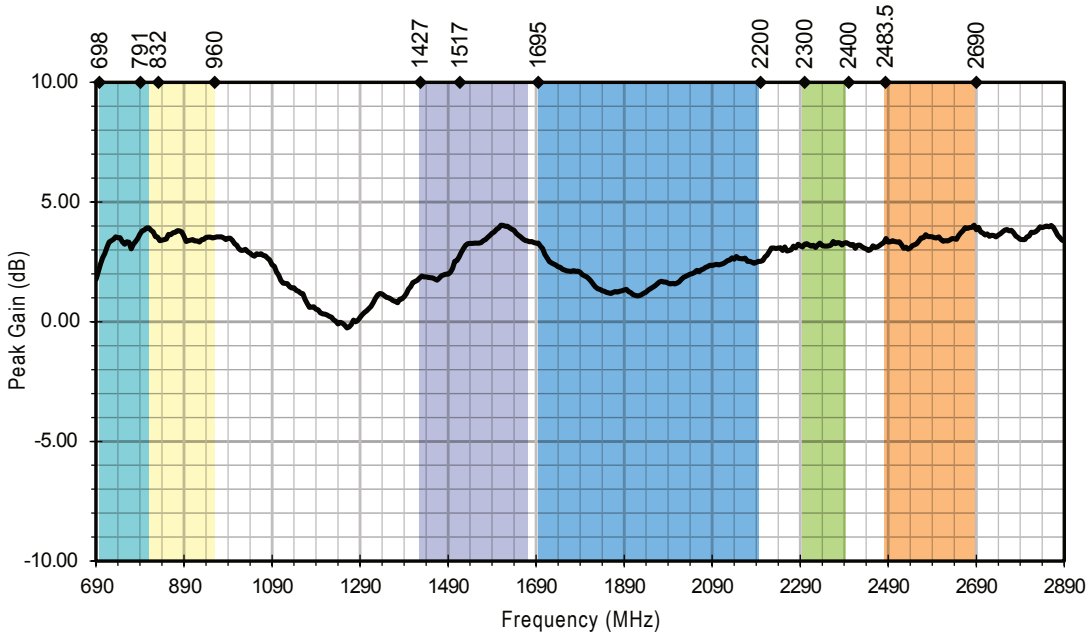


Figure 6. AC97002 Antenna Peak Gain, Free Space

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.

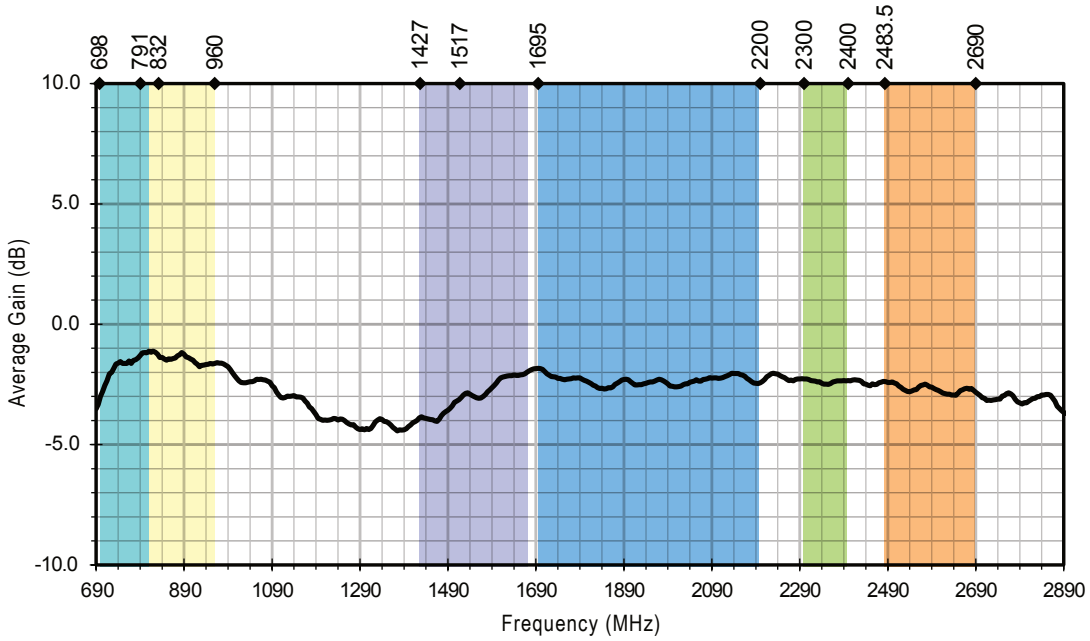


Figure 7. AC97002 Antenna Average Gain, Free Space

Radiation Efficiency

Radiation 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.

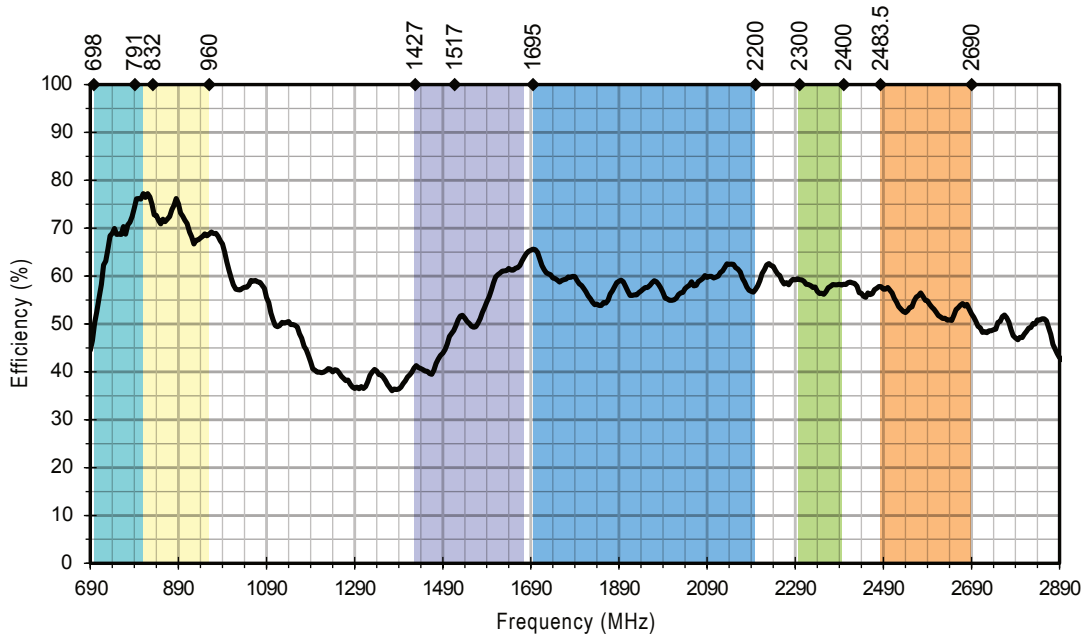
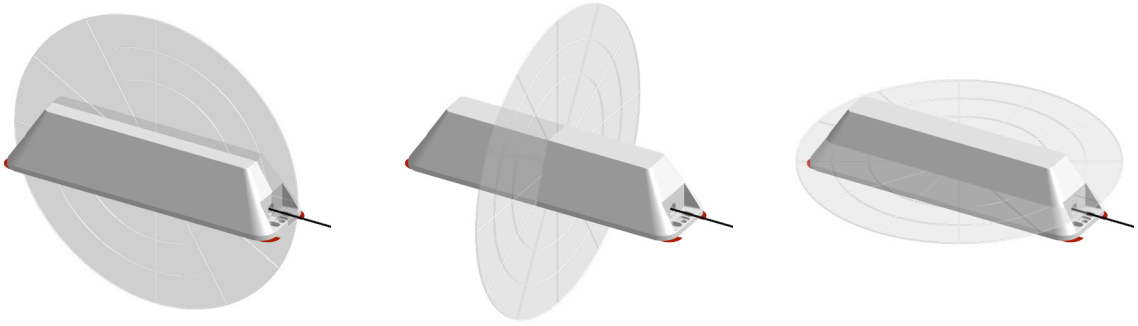


Figure 8. AC97002 Antenna Radiation Efficiency, Free Space

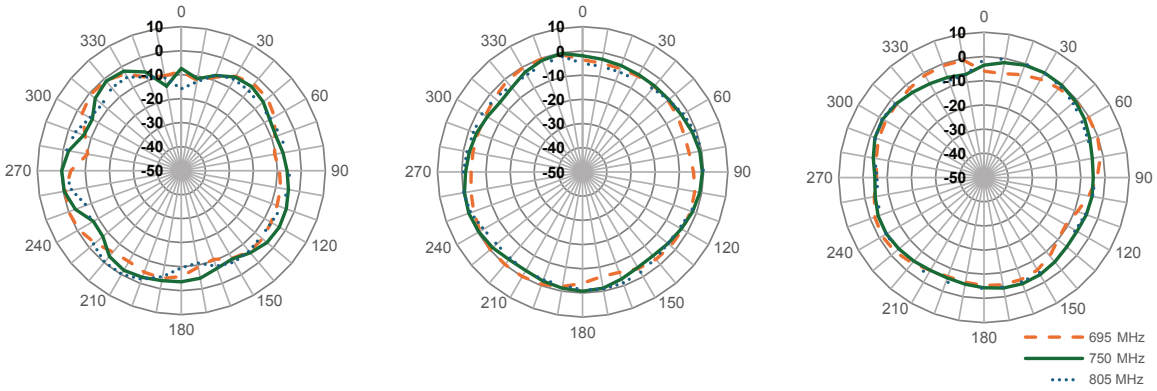
Radiation Patterns - Free Space

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 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.



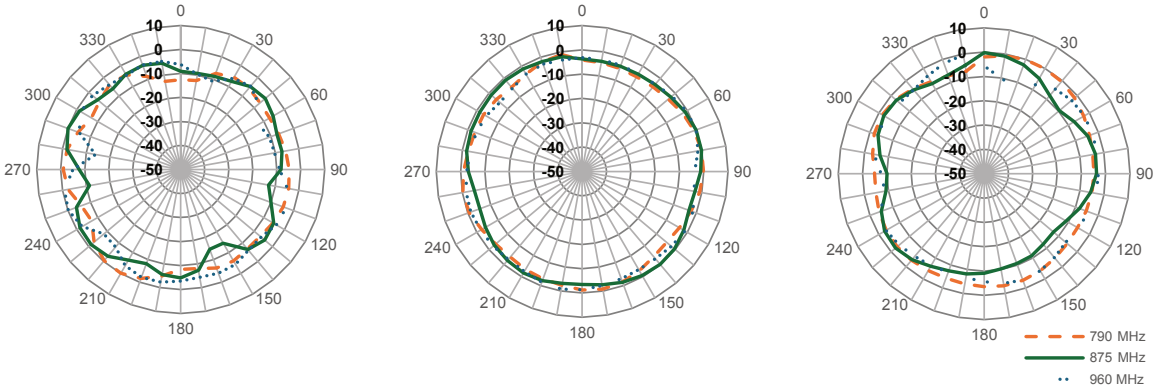
XZ-Plane Gain **YZ-Plane Gain** **XY-Plane Gain**

695 MHz to 805 MHz (750 MHz)



XZ-Plane Gain YZ-Plane Gain XY-Plane Gain

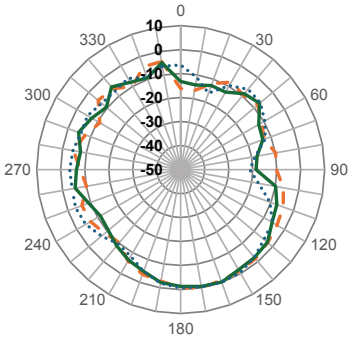
790 MHz to 960 MHz (875 MHz)



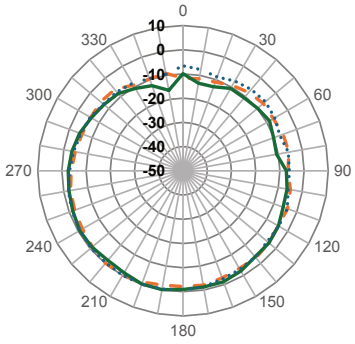
XZ-Plane Gain YZ-Plane Gain XY-Plane Gain

Radiation Patterns

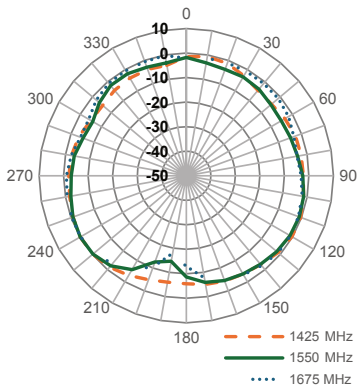
1425 MHz to 1675 MHz (1550 MHz)



XZ-Plane Gain

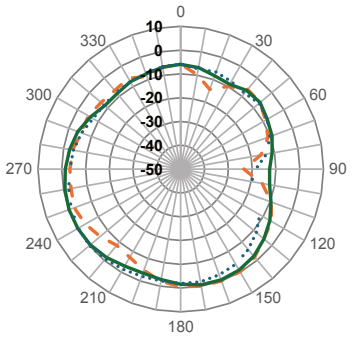


YZ-Plane Gain

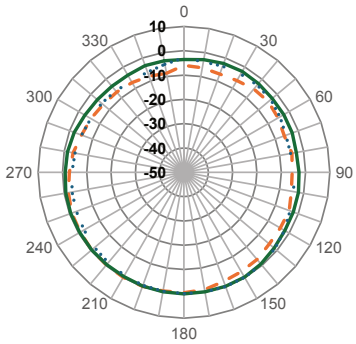


XY-Plane Gain

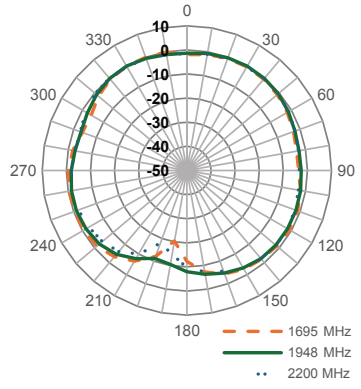
1695 MHz to 2200 MHz (1948 MHz)



XZ-Plane Gain

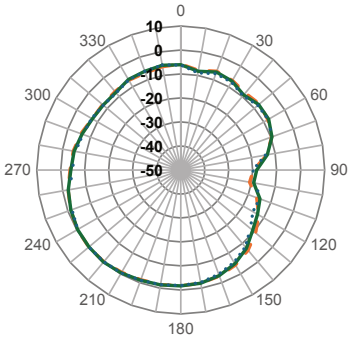


YZ-Plane Gain

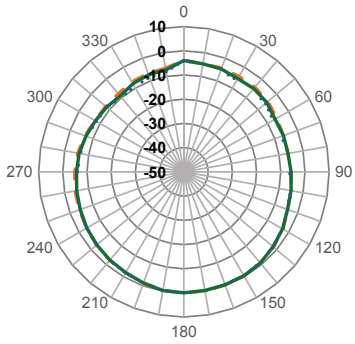


XY-Plane Gain

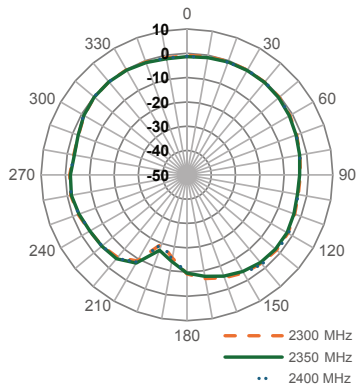
2300 MHz to 2400 MHz (2350 MHz)



XZ-Plane Gain



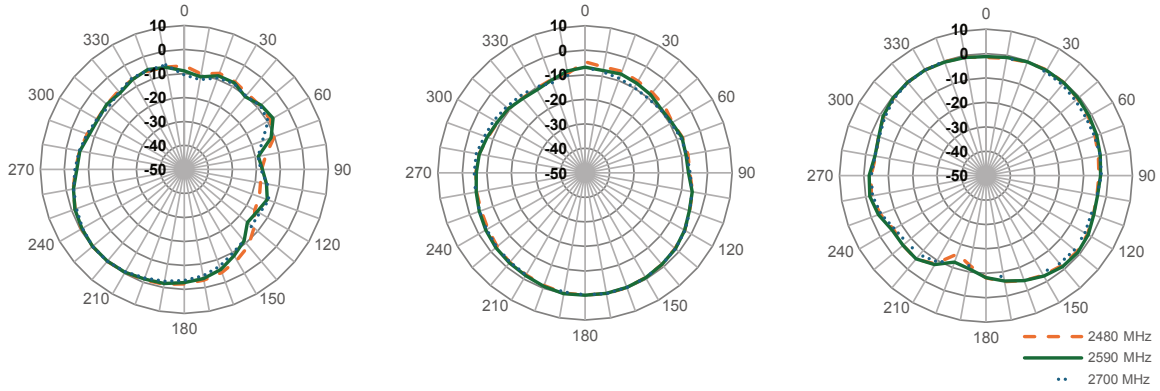
YZ-Plane Gain



XY-Plane Gain

Radiation Patterns

2480 MHz to 2700 MHz (2590 MHz)



XZ-Plane Gain YZ-Plane Gain XY-Plane Gain

Figure 9. Radiation Patterns for AC97002 Antenna in Free Space

On Ground Plane

The charts on the following pages represent data taken with the antenna oriented at the center of the 600 mm x 300 mm metal plate as shown in Figure 10.

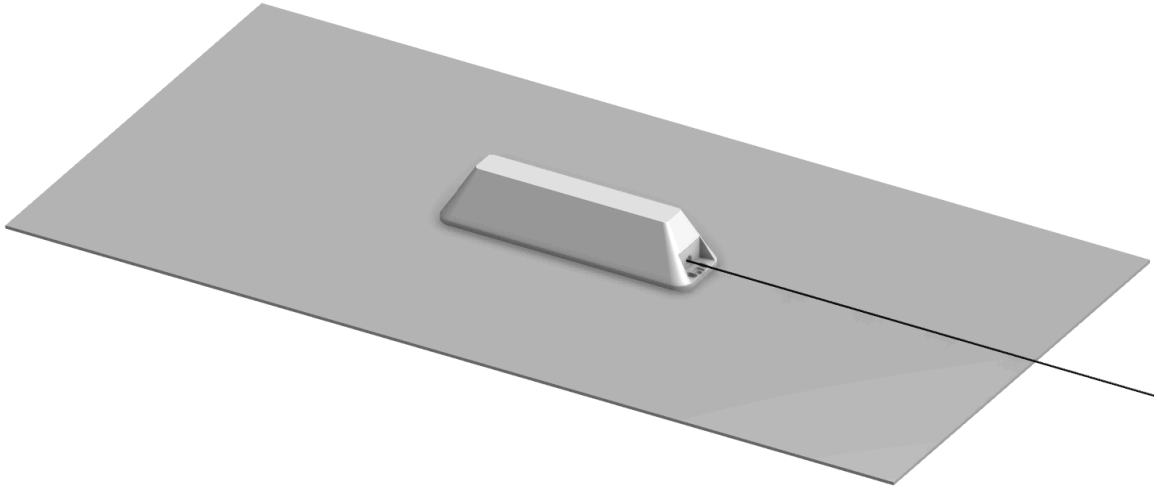


Figure 10. AC97002 Antenna On Ground Plane

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.

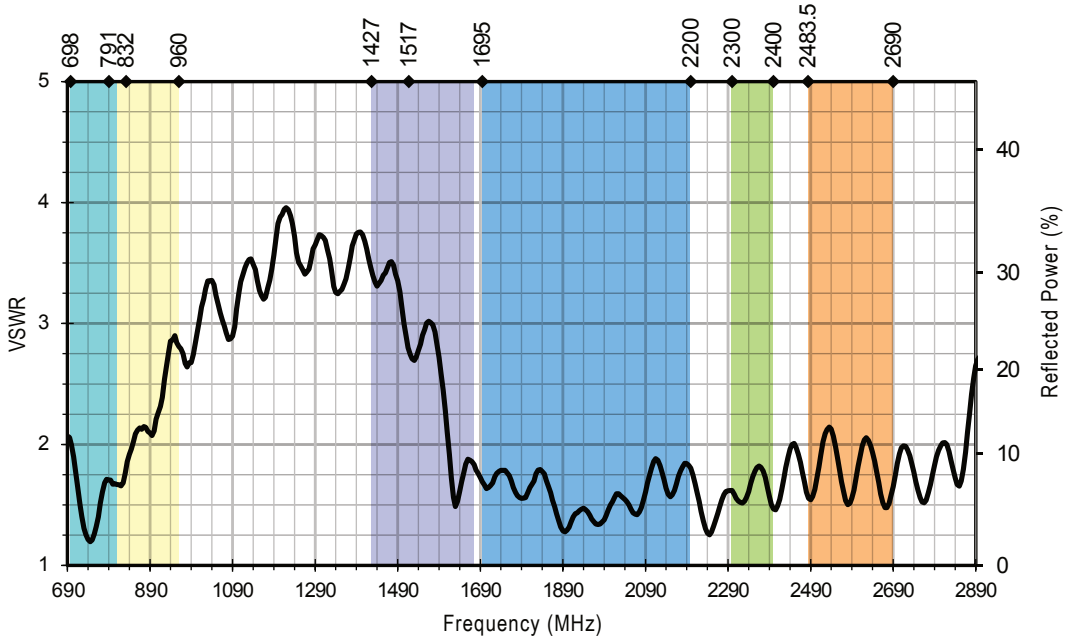


Figure 11. AC97002 Antenna VSWR on Ground Plane

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.

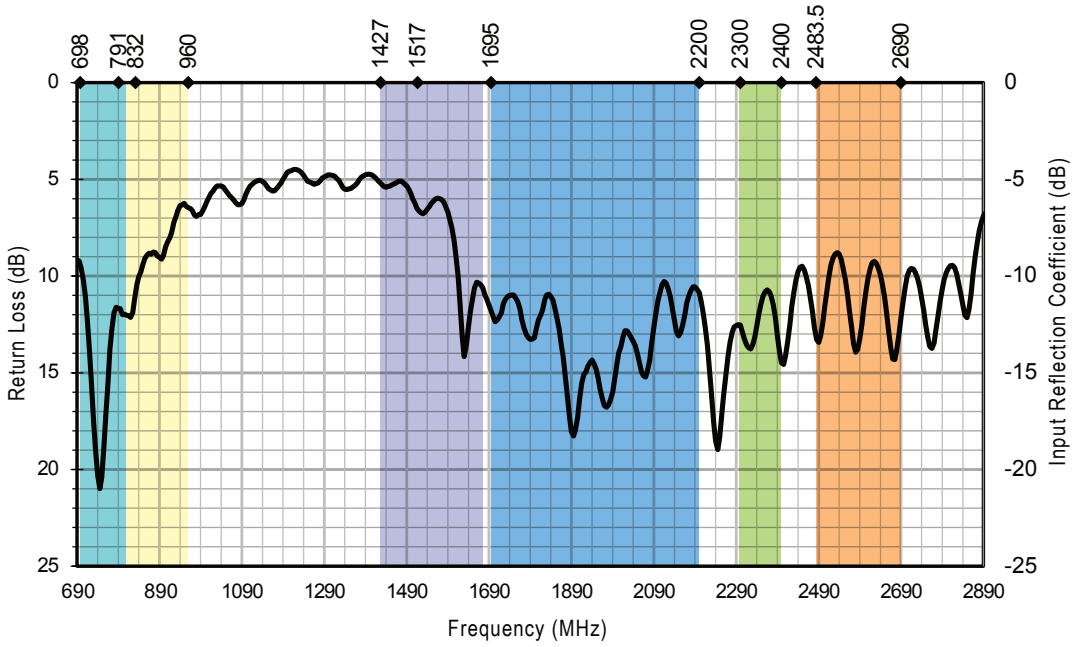


Figure 12. AC97002 Antenna Return Loss on Ground Plane

Peak Gain

Peak gain, (See 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.

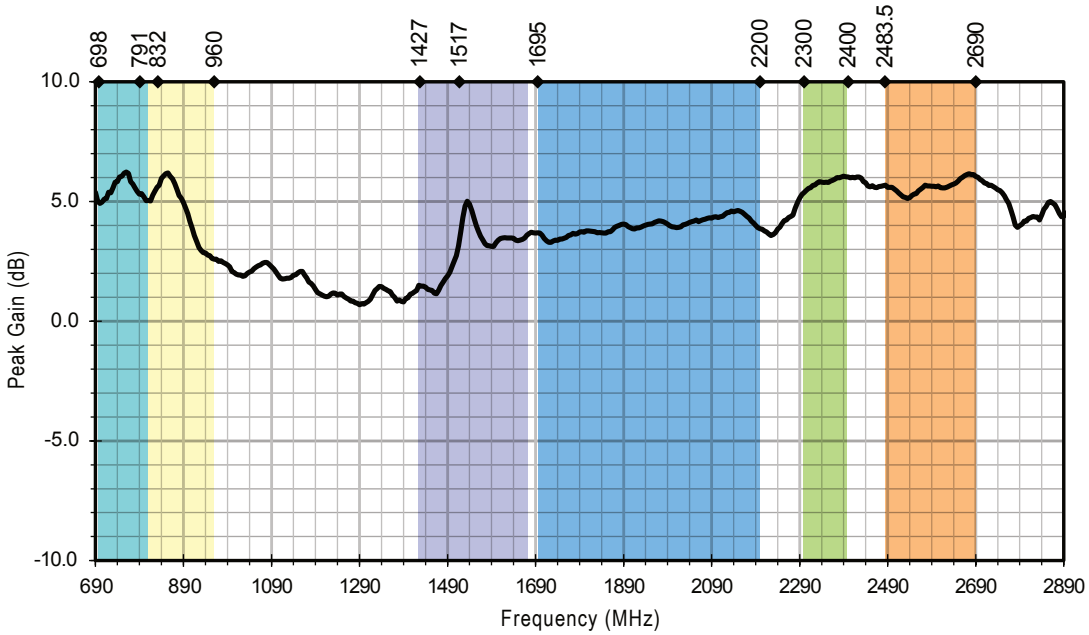


Figure 13. AC97002 Antenna Peak Gain on Ground Plane

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.

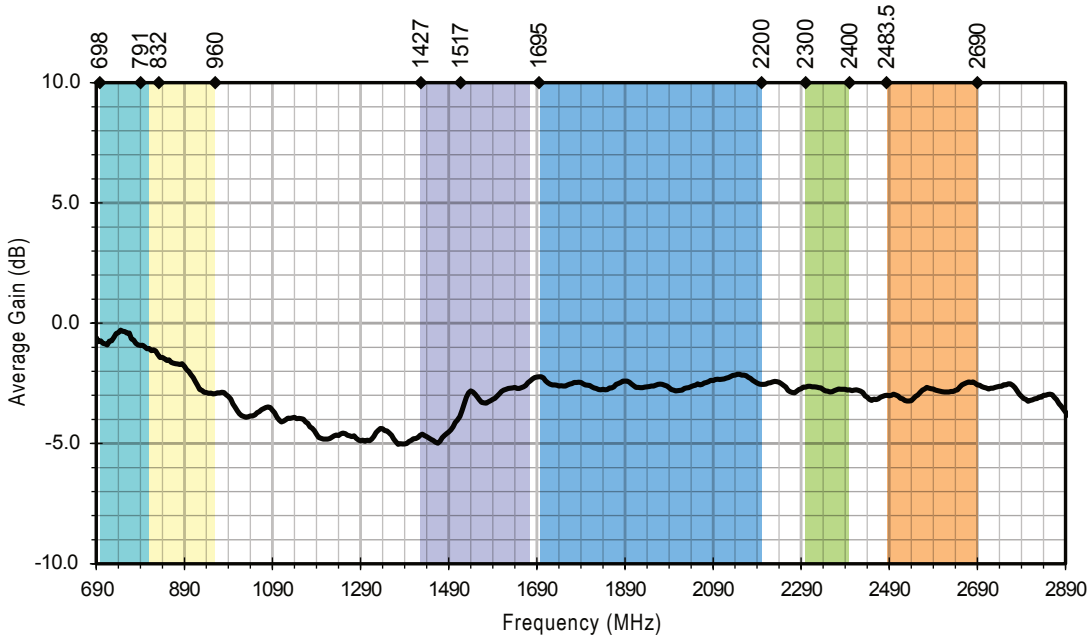


Figure 14. AC97002 Antenna Average Gain on Ground Plane

Radiation Efficiency

Radiation 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.

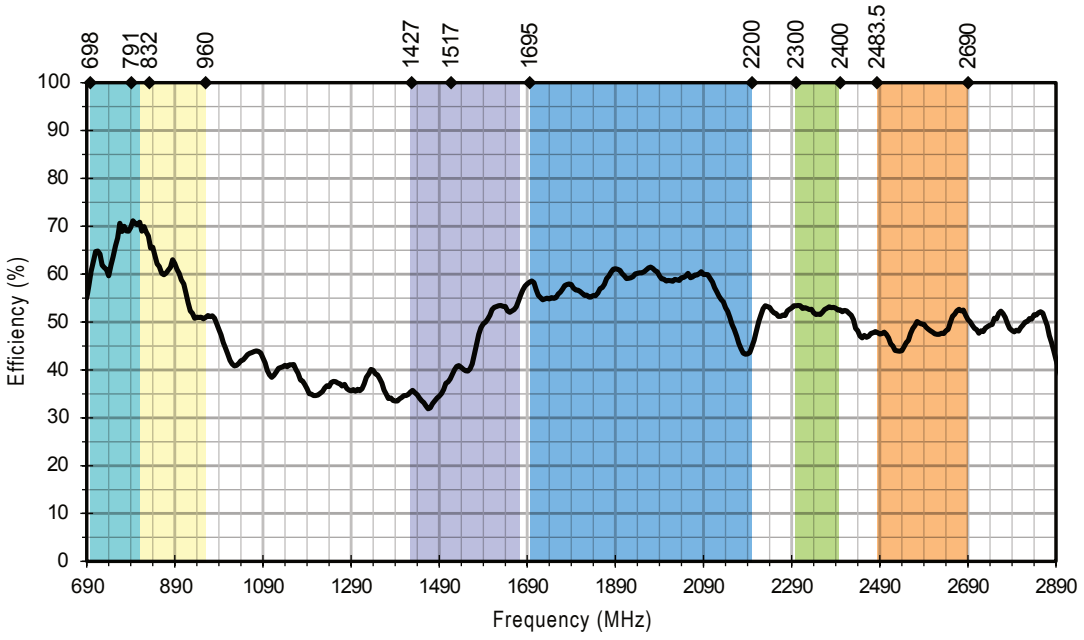
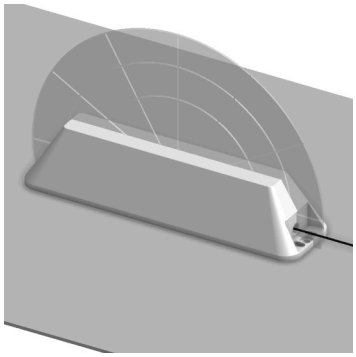


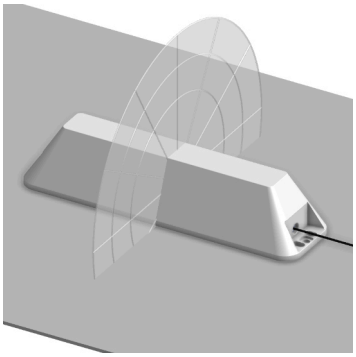
Figure 15. AC97002 Antenna Radiation Efficiency on Ground Plane

Radiation Patterns - On Ground Plane

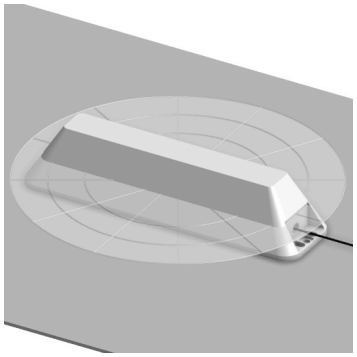
Radiation patterns provide information about the directional performance of the antenna by plotting gain in three orthogonal planes at the high-, low- and center-frequencies of an antenna frequency band. Antenna radiation patterns (Figure 16), are shown using polar plots covering 360 degrees with the 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

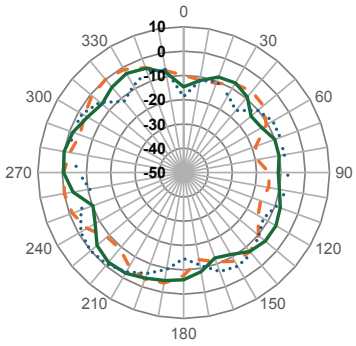


YZ-Plane Gain

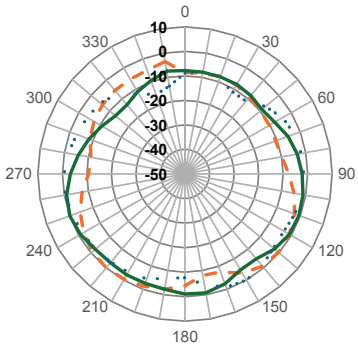


XY-Plane Gain

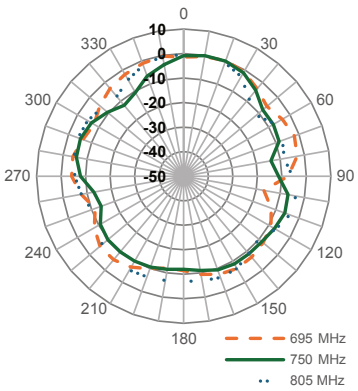
695 MHz to 805 MHz (750 MHz)



XZ-Plane Gain

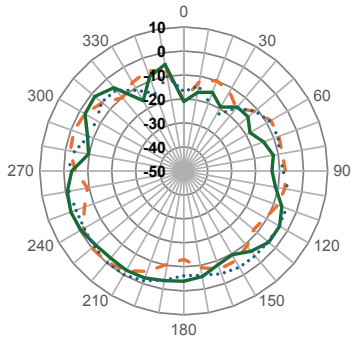


YZ-Plane Gain

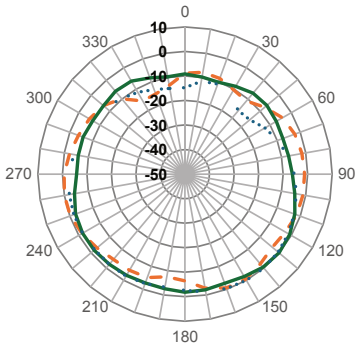


XY-Plane Gain

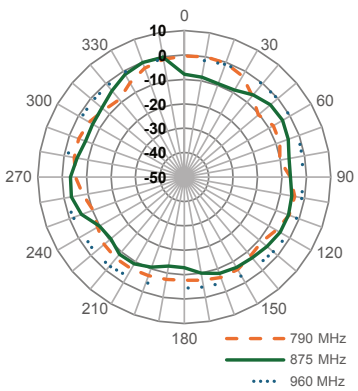
790 MHz to 960 MHz (875 MHz)



XZ-Plane Gain



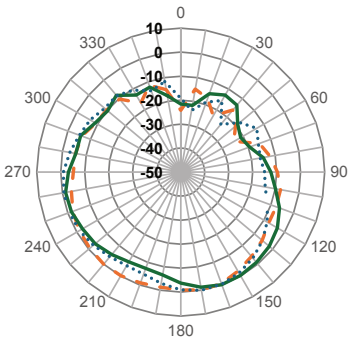
YZ-Plane Gain



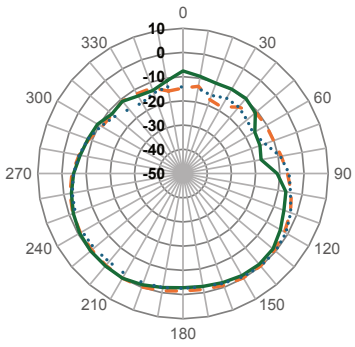
XY-Plane Gain

Radiation Patterns

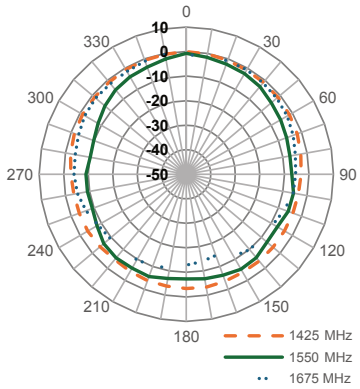
1425 MHz to 1675 MHz (1550 MHz)



XZ-Plane Gain

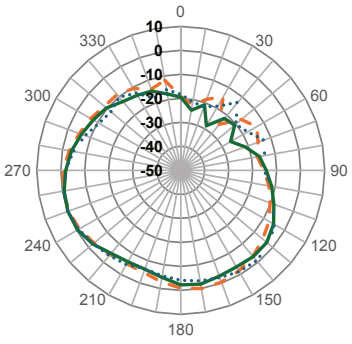


YZ-Plane Gain

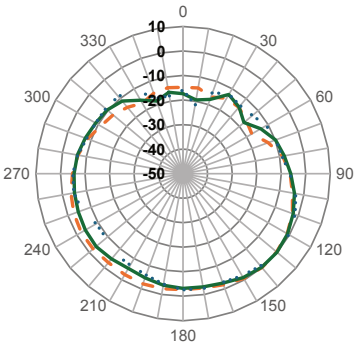


XY-Plane Gain

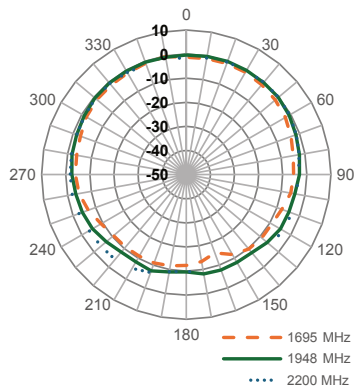
1695 MHz to 2200 MHz (1948 MHz)



XZ-Plane Gain

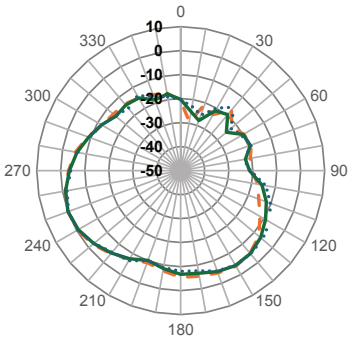


YZ-Plane Gain

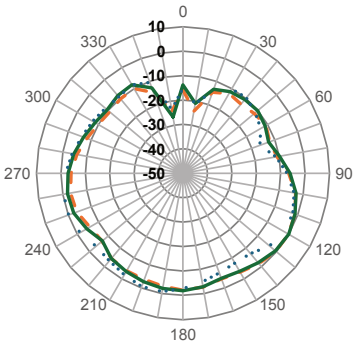


XY-Plane Gain

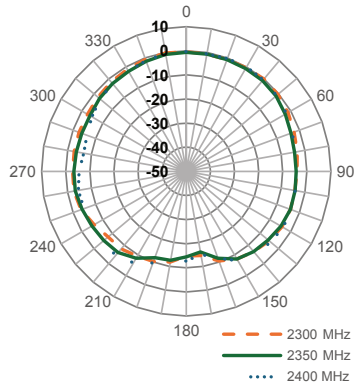
2300 MHz to 2400 MHz (2350 MHz)



XZ-Plane Gain



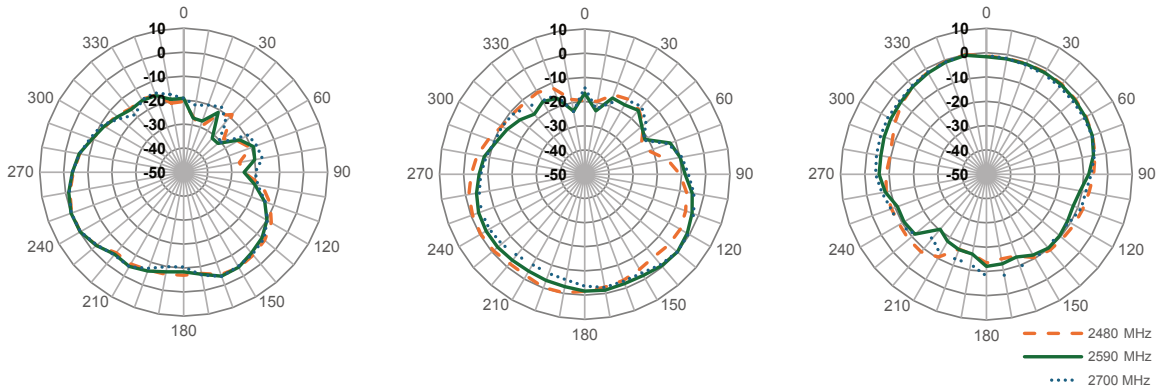
YZ-Plane Gain



XY-Plane Gain

Radiation Patterns

2480 MHz to 2700 MHz (2590 MHz)



XZ-Plane Gain YZ-Plane Gain XY-Plane Gain

Figure 16. Radiation Patterns for AC97002 Antenna on Ground Plane

Packaging Information

The AC97002 antennas are individually packaged in a bubble bag. If the cable is detachable, cable and antenna are placed in separate polyethylene bags before being combined in the bubble bag. Bagged antennas are placed in “honeycomb” divided pockets in a carton at 60 antennas per carton. Carton dimensions are 445 mm x 375 mm x 385 mm (17.5 in x 14.76 in x 15.16 in)

Regional Environmental Regulation Compliance

Table 4. Environmental Compliance Data

Region	Regulation	Reference
United States	US EPA Toxic Substances Control Act amended December 2020 Declaration	TSCA Section 6(h)
United States	California Proposition 65 Safe Drinking Water & Toxic Enforcement Act of 1986 Declaration	
European Union	RoHS 3	EU 2015/863
European Union	EU REACH	EU 1907/2006
Worldwide	Responsible Minerals Initiatives	
European Union	Persistent Organic Pollutants	(EU) 2019/1021
European Union	Packaging Directive	94/62/EC
European Union	PFOA Free	2006/122/ECOF

Antenna Definitions and Useful Formulas

VSWR - Voltage Standing Wave Ratio. VSWR is a unitless ratio that describes the power reflected from the antenna back to the radio. A lower VSWR value indicates better antenna performance at a given frequency. VSWR is easily derived from Return Loss.

$$\text{VSWR} = \frac{10^{\left[\frac{\text{Return Loss}}{20}\right]} + 1}{10^{\left[\frac{\text{Return Loss}}{20}\right]} - 1}$$

Return Loss - Return loss represents the loss in power at the antenna due to reflected signals, measured in decibels. A larger magnitude return loss value indicates better antenna performance at a given frequency. Return Loss is easily derived from VSWR.

$$\text{Return Loss} = -20 \log_{10}\left[\frac{\text{VSWR} - 1}{\text{VSWR} + 1}\right]$$

Efficiency (η) - The total power radiated from an antenna divided by the input power at the feed point of the antenna as a percentage.

Total Radiated Efficiency - (TRE) The total efficiency of an antenna solution comprising the radiation efficiency of the antenna and the transmitted (forward) efficiency from the transmitter.

$$\text{TRE} = \eta \cdot \left(1 - \left(\frac{\text{VSWR} - 1}{\text{VSWR} + 1}\right)^2\right)$$

Gain - The gain of an antenna is the ratio of its radiation intensity in a given direction (G) to the radiation intensity that would be obtained if the total power accepted by the antenna were radiated isotropically (identically in all directions). Realized gain is antenna gain accounting for input reflection and mismatch losses. Realized gain is typically labeled simply as “gain” in antenna datasheets.

$$G_{db} = 10 \log_{10}(G)$$

$$G_{dBd} = G_{dBi} - 2.51\text{dB}$$

Peak Gain - The highest antenna gain across all directions for a given frequency range. A directional antenna will have a very high peak gain compared to average gain.

Average Gain - The average gain across all directions for a given frequency range.

Maximum Power - The maximum signal power which may be applied to an antenna feed point, typically measured in watts (W).

Reflected Power - A portion of the forward power reflected back toward the amplifier due to a mismatch at the antenna port.

$$\left(\frac{\text{VSWR} - 1}{\text{VSWR} + 1}\right)^2$$

decibel (dB) - A logarithmic unit of measure of the power of an electrical signal.

decibel isotropic (dBi) - A comparative measure in decibels between an antenna under test and an isotropic radiator.

decibel relative to a dipole (dBd) - A comparative measure in decibels between an antenna under test and an ideal half-wave dipole.

Dipole - An ideal dipole comprises a straight electrical conductor measuring 1/2 wavelength from end to end connected at the center to a feed point for the radio.

Isotropic Radiator - A theoretical antenna which radiates energy equally in all directions as a perfect sphere.

Omnidirectional - Term describing an antenna radiation pattern that is uniform in all directions. An isotropic antenna is the theoretical perfect omnidirectional antenna. An ideal dipole antenna has a donut-shaped radiation pattern and other practical antenna implementations will have less perfect but generally omnidirectional radiation patterns which are typically plotted on three axes.

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