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Cascade Integrated Antenna Specification

Headline

This document outlines the performance and construction of the antennas integrated inside the Cascade Access Point.

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Revision History

Rev	Date	Author	Comment
1.0	5/8/2008	Steve Saliga	Initial Release, using measured prototype for electrical specs

1. Introduction

This document describes the set of specifications as well as the physical construction of the antennas integrated into the Cascade access point. There are three antennas to support the 2.4 GHz radio and three antennas to support the 5 GHz radio. All the antennas are inverted-F antennas. They are driven with 6-inch cables appropriate for use with connectors of the Hirose U.FL type. The basic features of these antennas are as follows:

- Omnidirectional antennas for indoor operation
- MIMO antennas to operate over both ISM bands, the 2.4 GHz band and the 5 GHz band.
- Peak gain is 4 dBi in the 2.4 GHz band and 3 dBi in the 5 GHz band.
- Antennas are inverted-F type, mounted directly to the housing.
- Antennas are driven by 6 inch cables with U.FL type connectors appropriate for use with the radios.

The antenna assemblies are formed from three pieces

1. Antenna element, designed by Cisco and fabricated by Bi-Link
2. Feed cable, fabricated by Hirose and AmphenolRF
3. Antenna feed eyelet, fabricated by Stimpson

The entire antenna assembly and test is done by both AmphenolRF and Hirose.

2. Physical Appearance

The actual antennas are designed to operate in either the 2.4 GHz band or the 5 GHz band. They are built from 21 mil thick tin-plated brass. They are oriented on the housing as shown in Figure 2.1. The placement has been chosen with mutliple constraints invloved:

- Fitting the antennas into the space allowed, including interference with the plastic cover as well as the radio board and AP motherboard beneath the antennas
- Spacing between in-band antennas at least ½-wavelength for MIMO operation
- Spacing between out-of-band antennas to provide at least 28 dB of isolation
- Minimal cost in fabrication and mounting method
- Ability to keep the top metal housing sealed in an RF sense while maintaining all other constraints, i.e., providing space underneath while keeping an RF seal as tight as possible
- Pattern smoothness between left and right sides of the AP
- Minimal gain

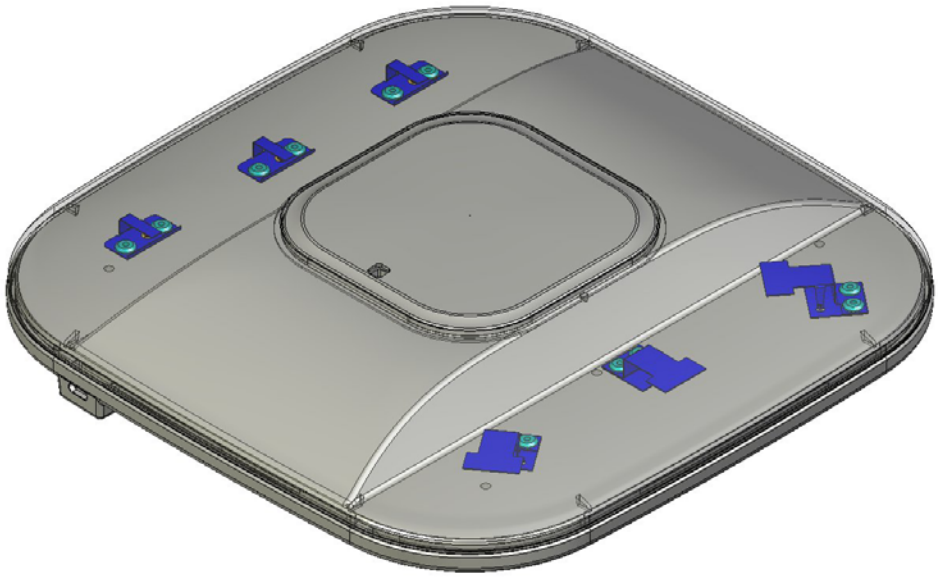

Figure 2.1
Cascade Housing Showing Locations of All Antennas

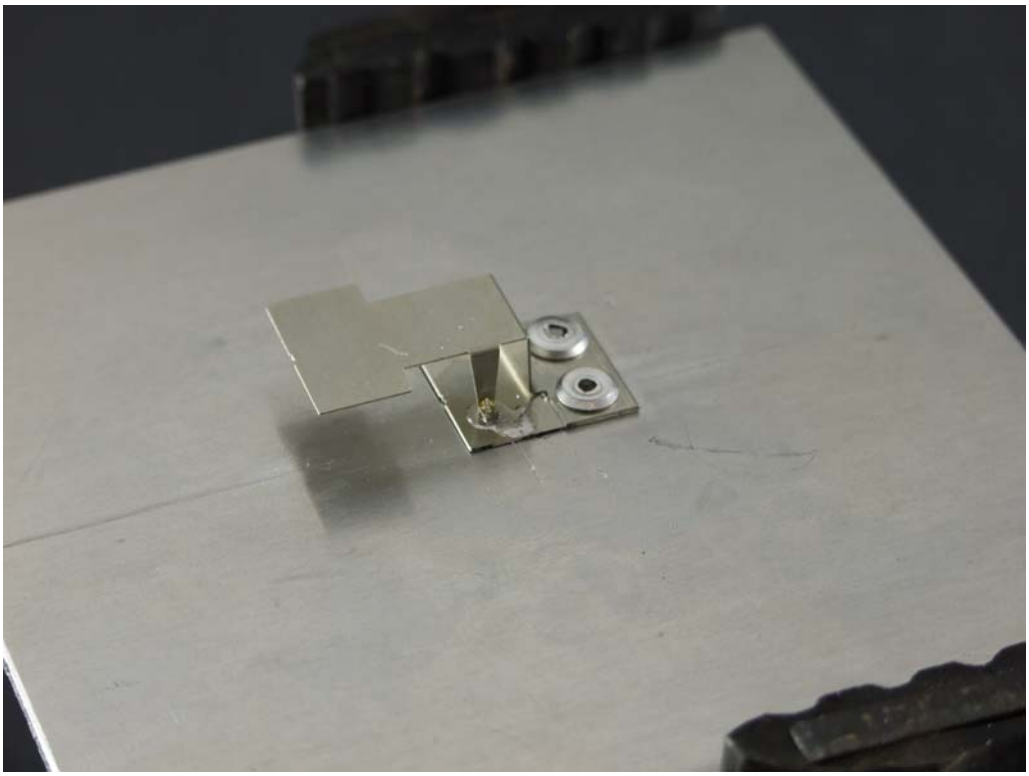

Figure 2.2
Closeup Photo of a Single 2.4 GHz Antenna

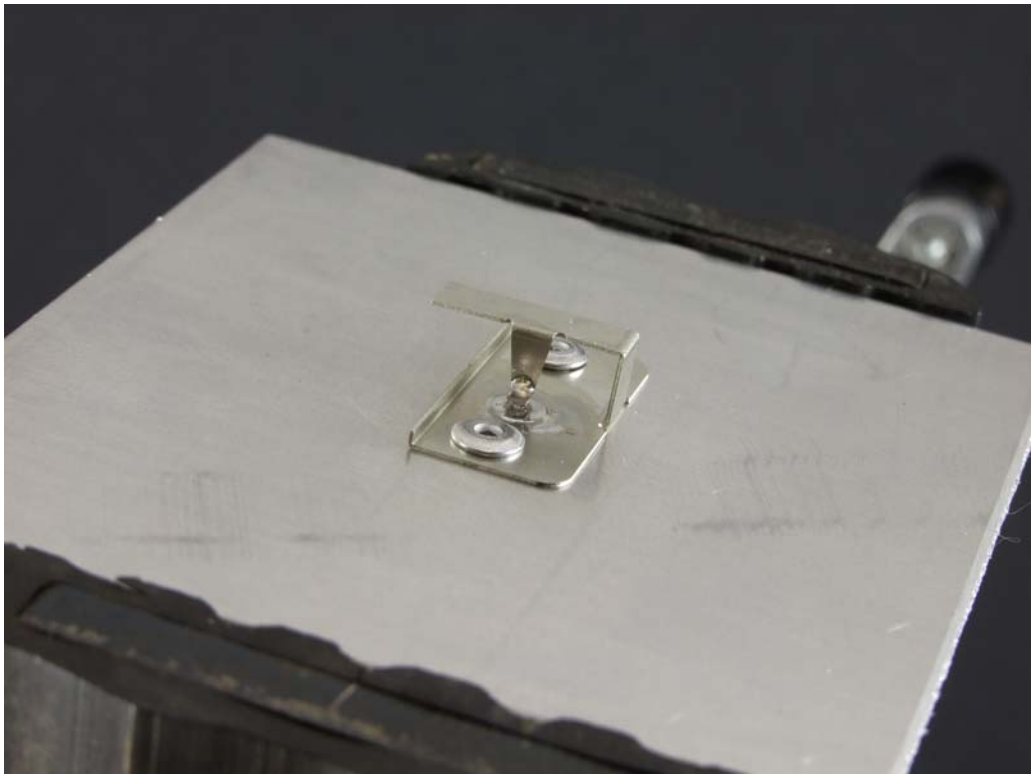

Figure 2.3
Closeup Photo of Single 5 GHz Antenna

The individual antennas are attached to the upper part of the housing using rivets as shown. The antenna feed is accomplished by inserting the cable through an "eyelet" underneath the antenna feed leg. The eyelet performs two important functions:

- Provides a uniform surface to which the braid of the cable can be soldered and then grounded to the top portion of the housing.
- Provides a method for closing the hole in the top part of the housing required for the insertion of the feed cable. Without this eyelet, a 4 mm hole would exist in housing for each antenna feed cable.

After the cable and eyelet are assembled with the antenna, the center conductor of the cable is soldered to the antenna feed leg then the eyelet is soldered to the grounded part of the antenna and the cable's braided outer conductor thus creating a single antenna/cable assembly.

3. Cascade Antenna Specifications

This section contains both the electrical and mechanical specs for the Cascade antenna elements. There is a table of electrical specifications and a table of mechanical specifications.

3.1. Antenna Electrical Specifications and Patterns

The electrical specifications for this antenna are summarized in Table 3.1.1 below. Azimuth and elevation plane patterns covering all the bands are shown in Figures 3.1.4. through 3.1.26. Note that the patterns include all cable loss as well as losses associated with a radome.

Cascade Antenna – Electrical Specifications					
Parameter		**Minimum**	**Typical**	**Max**	**Comments**
Antenna Type		Inverted-F, omnidirectional			
Operating Frequency	2.4 GHz	2400 MHz - 2500 MHz			
	5 GHz	5150 MHz - 5850 MHz			
Nominal Input Impedance	2.4 GHz		50 Ω		
	5 GHz		50 Ω		
VSWR	2.4 GHz			2:1	
	5 GHz			2:1	
Peak Gain	2.4 GHz		4 dBi		
	5 GHz		3 dBi		
Polarization		Linear			
Elevation-Plane 3-dB Bandwidth	2.4 GHz		120 degrees		
	5 GHz		120 degrees		
Azimuth Plane 3-dB Beamwidth		Omnidirectional			
Band-to-Band Isolation			28 dB		

Table 3.1.1
Chinook 4-Element Dual Band Antenna, Electrical Specifications

Patterns were measured in multiple planes. A general coordinate system is shown below in Figure 3.1.1. The antenna azimuth plane is also the horizonal plane of the product, the x-y plane. Elevation plane patterns were made along the long axis of each antenna, in many cases this corresponds to the x-z plane (or x-plane) of the product. However, in the cases of the upper and lower 2.4 GHz antennas, the antennas long axis does not coincide with one of the principal planes of the product. Elevation plane patterns were also made along the short axis of each antenna. Again, for most of the antennas, these plane cuts would be parallel to the product's y-z axis (y-plane). Only for the upper and lower 2.4 GHz antennas is this not the case.

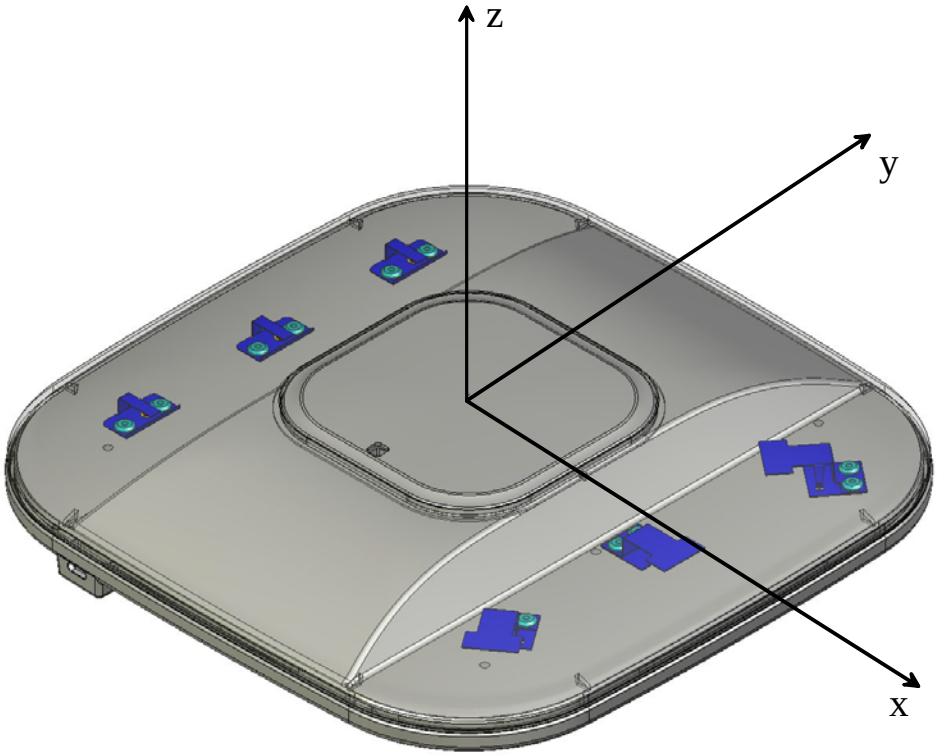

Figure 3.1.1
General Coordinate System for Cascade Antenna Measurements

It is also important to note that in all measurements, the antenna was facing opposite the measurement horn at 0-degrees. In the patterns that are shown, 0-degrees is actually the "back" of the product and 180-degrees is the front of the product. The antenna under test is rotated clock-wide so 90-degrees is antenna side of the product. In order to measure the long-axis of the upper and lower 2.4 GHz antennas, the product was positioned so that the long antenna axis was horizontal and example of which is shown in Figure 3.1.2. In order to the measure the narrow antenna axis, the product was positioned so that the antenna narrow axis was horizontal. This is illustrated in Figure 3.1.3

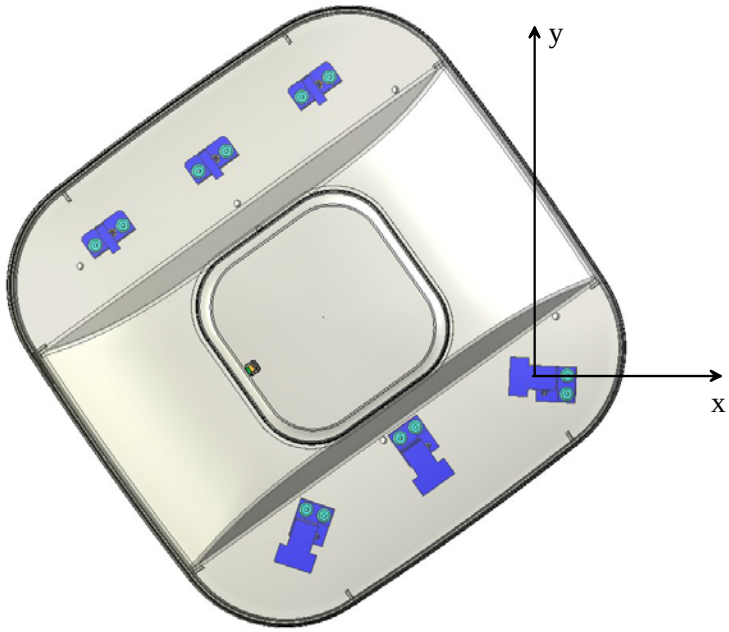

Figure 3.1.2
Cascade Product in Orientation for Measuring
Elevation Plane Pattern Along Antenna Long Plane

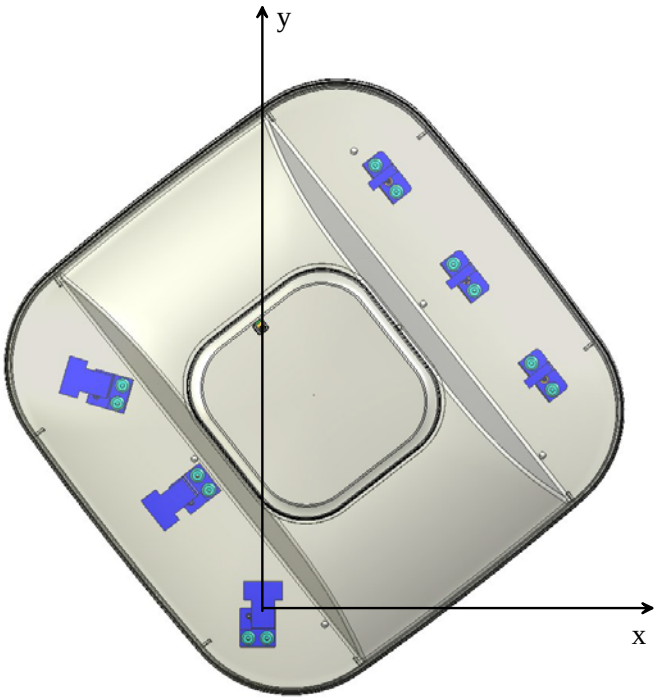

Figure 3.1.3
Cascade Product in Orientation for Measuring
Elevation Plane Pattern Along Antenna Narrow Plane

Antenna patterns for the 2.4 GHz antennas are shown in Figures 3.1.4 through 3.1.16. The 5 GHz antenna patterns are shown in Figures 3.1.17 through 3.1.25. These figures attempt to describe the complex antenna patterns resulting from these inverted-F antennas in the highly scattering environment of the upper part of the housing to which these antennas are mounted.

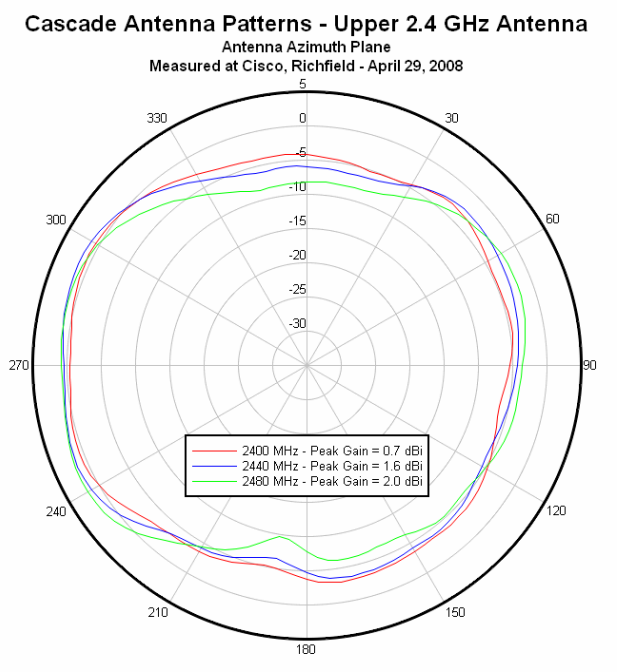

Figure 3.1.4
Cascade Antenna Patterns for the Upper 2.4 GHz Antenna, 2.4 GHz Antenna #1
Azimuth Plane Patterns

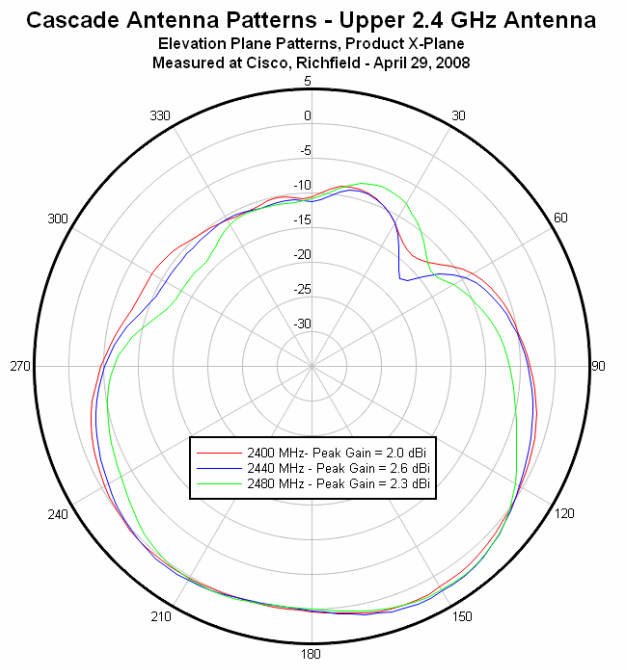

Figure 3.1.5
Casacade Antenna Patterns for the Upper 2.4 GHz Antenna, 2.4 GHz Antenna #1
Elevation Plane Patterns, Product X-Plane

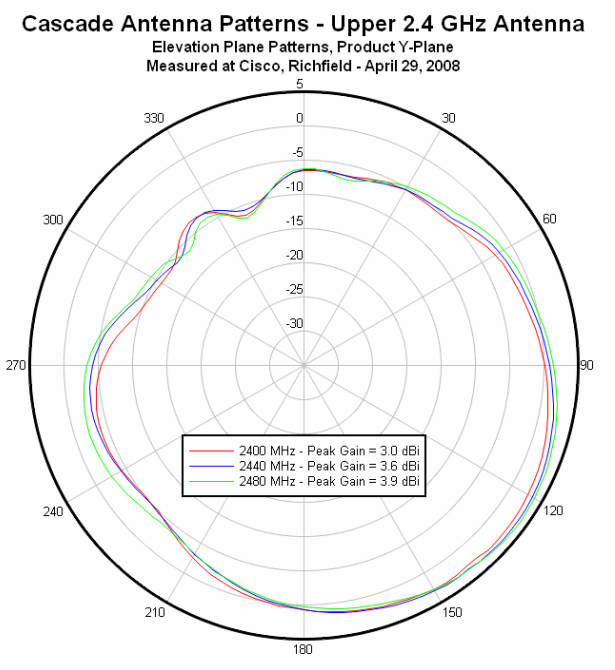

Figure 3.1.6
Casacade Antenna Patterns for the Upper 2.4 GHz Antenna, 2.4 GHz Antenna #1
Elevation Plane Patterns, Product Y-Plane

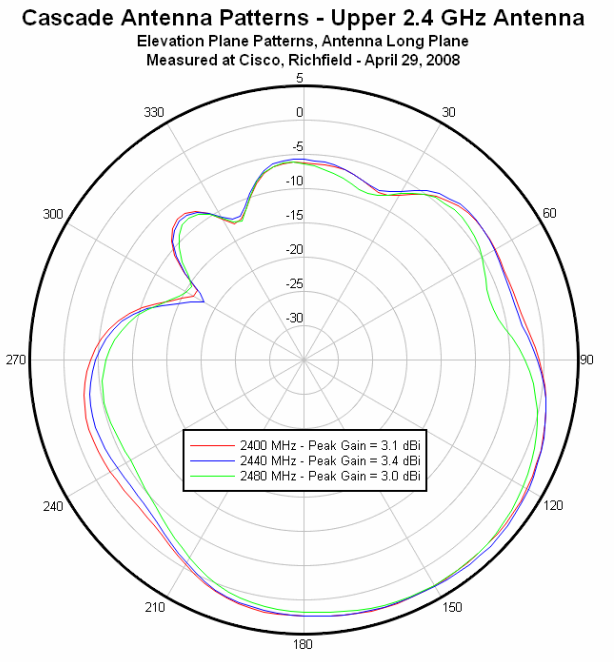

Figure 3.1.7
Casacade Antenna Patterns for the Upper 2.4 GHz Antenna, 2.4 GHz Antenna #1
Elevation Plane Patterns, Antenna Long Axis

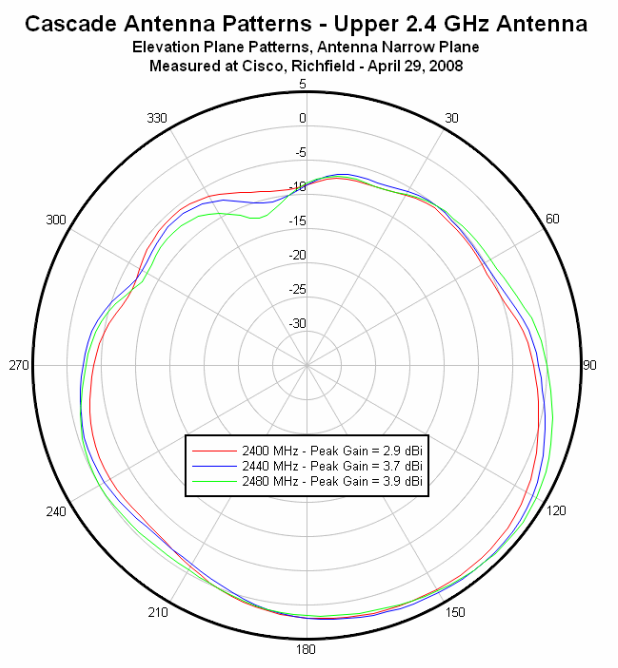

Figure 3.1.8
Casacade Antenna Patterns for the Upper 2.4 GHz Antenna, 2.4 GHz Antenna #1
Elevation Plane Patterns, Antenna Narrow Axis

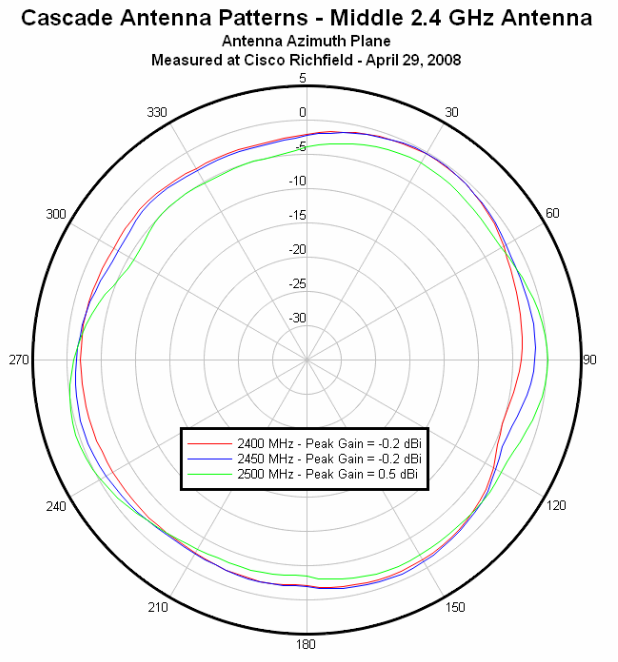

Figure 3.1.9
Cascade Antenna Patterns for the Middle 2.4 GHz Antenna, 2.4 GHz Antenna #2
Azimuth Plane Patterns

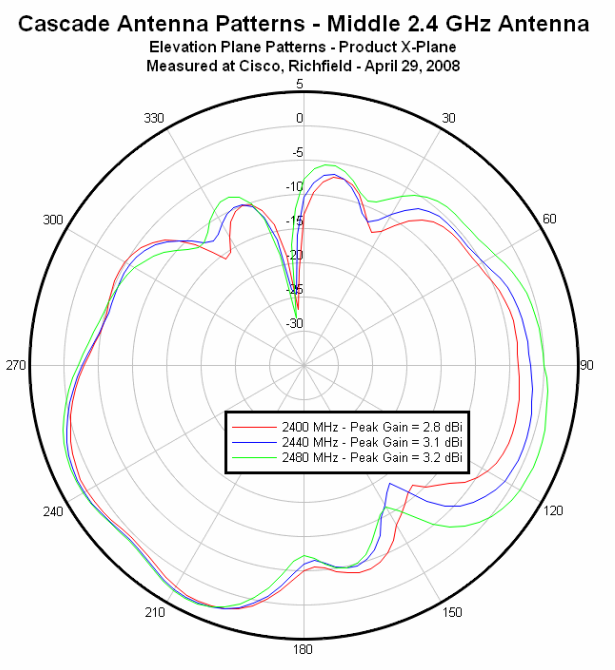

Figure 3.1.10
Casacade Antenna Patterns for the Middle 2.4 GHz Antenna, 2.4 GHz Antenna #2
Elevation Plane Patterns, Product X-Plane

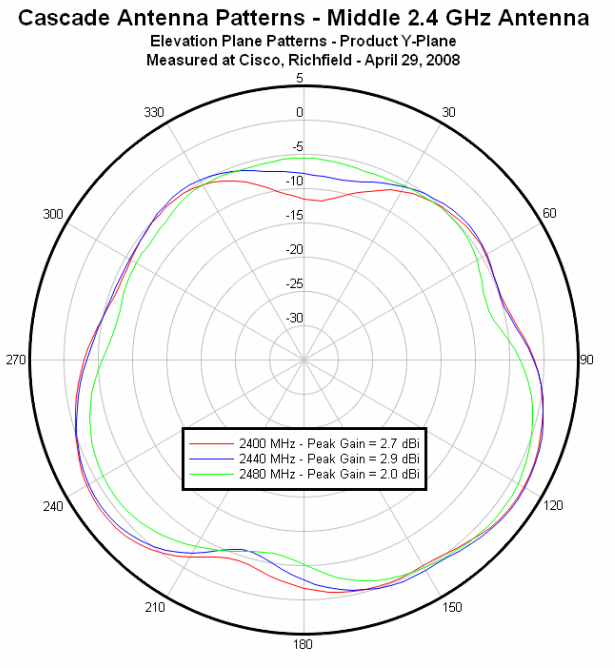

Figure 3.1.11
Casacade Antenna Patterns for the Middle 2.4 GHz Antenna, 2.4 GHz Antenna #2
Elevation Plane Patterns, Product Y-Plane

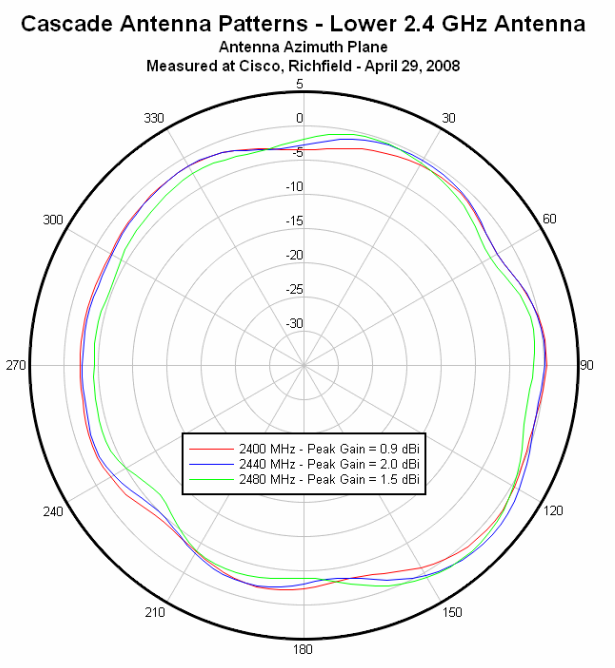

Figure 3.1.12
Cascade Antenna Patterns for the Lower 2.4 GHz Antenna, 2.4 GHz Antenna #3
Azimuth Plane Patterns

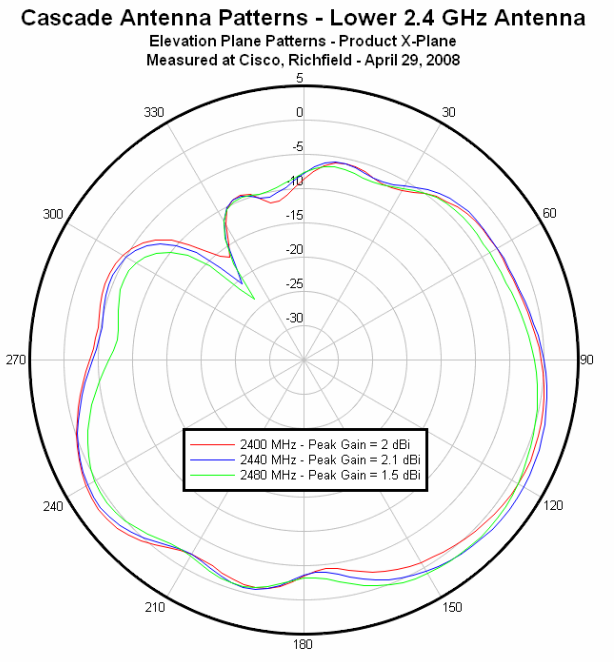

Figure 3.1.13
Casacade Antenna Patterns for the Lower 2.4 GHz Antenna, 2.4 GHz Antenna #3
Elevation Plane Patterns, Product X-Plane

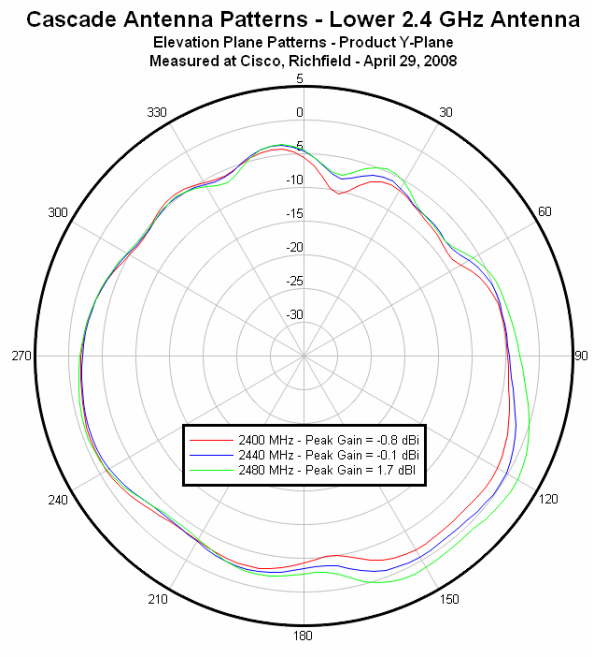

Figure 3.1.14
Casacade Antenna Patterns for the Lower 2.4 GHz Antenna, 2.4 GHz Antenna #3
Elevation Plane Patterns, Product Y-Plane

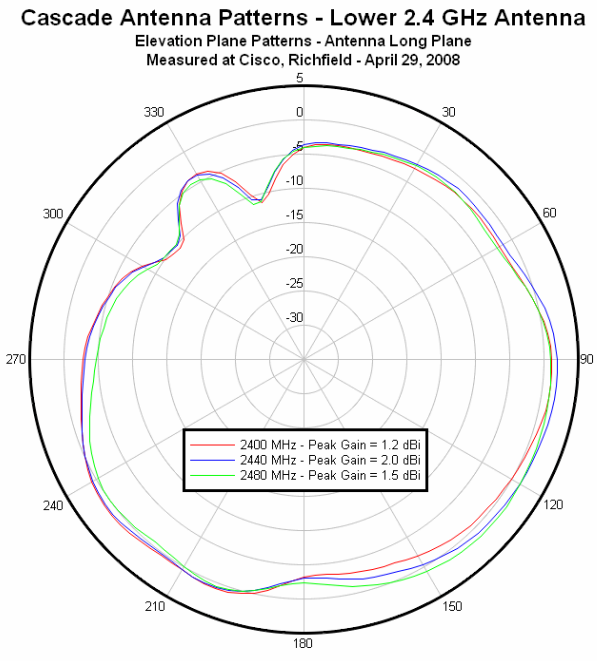

Figure 3.1.15
Casacade Antenna Patterns for the Lower 2.4 GHz Antenna, 2.4 GHz Antenna #3
Elevation Plane Patterns, Antenna Long Axis

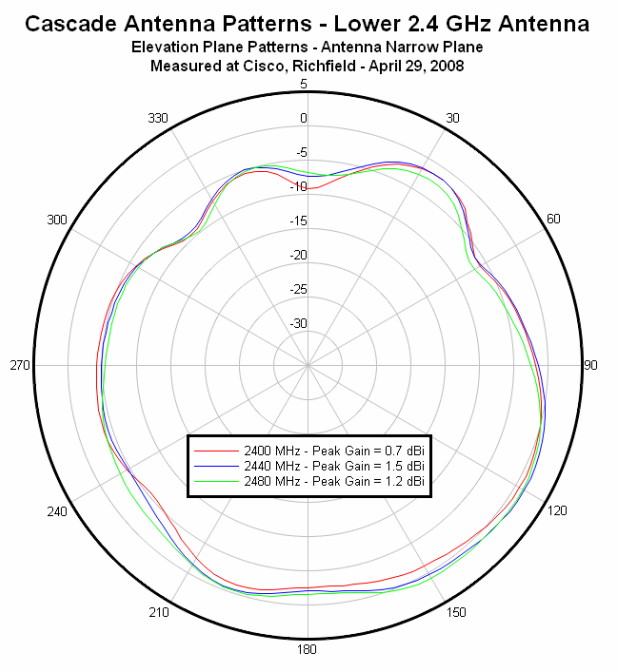

Figure 3.1.16
Casacade Antenna Patterns for the Lower 2.4 GHz Antenna, 2.4 GHz Antenna #3
Elevation Plane Patterns, Antenna Narrow Axis

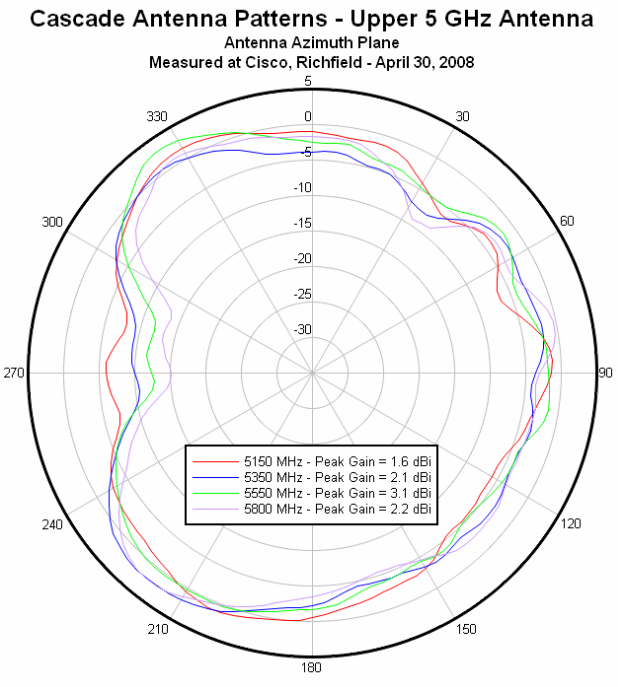

Figure 3.1.17
Casacade Antenna Patterns for the Upper 5 GHz Antenna, 2.4 GHz Antenna #1
Azimuth Plane Patterns

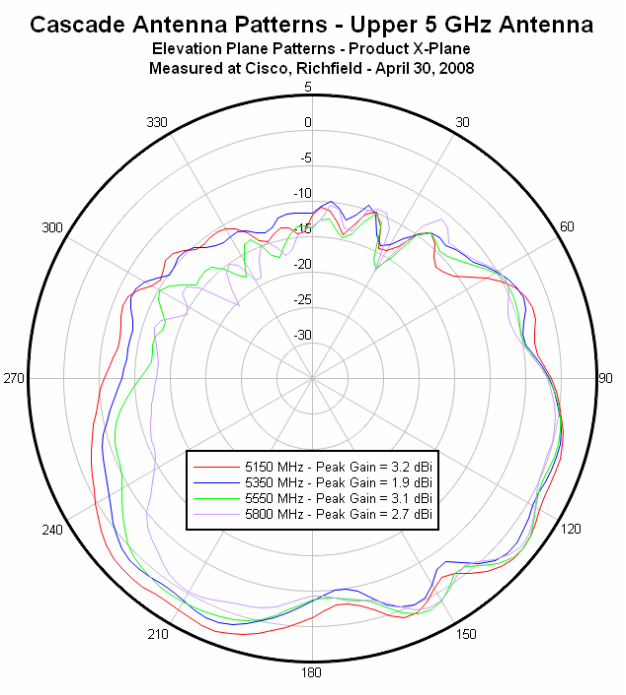

Figure 3.1.18
Casacade Antenna Patterns for the Upper 5 GHz Antenna, 5 GHz Antenna #1
Elevation Plane Patterns, Product X-Plane

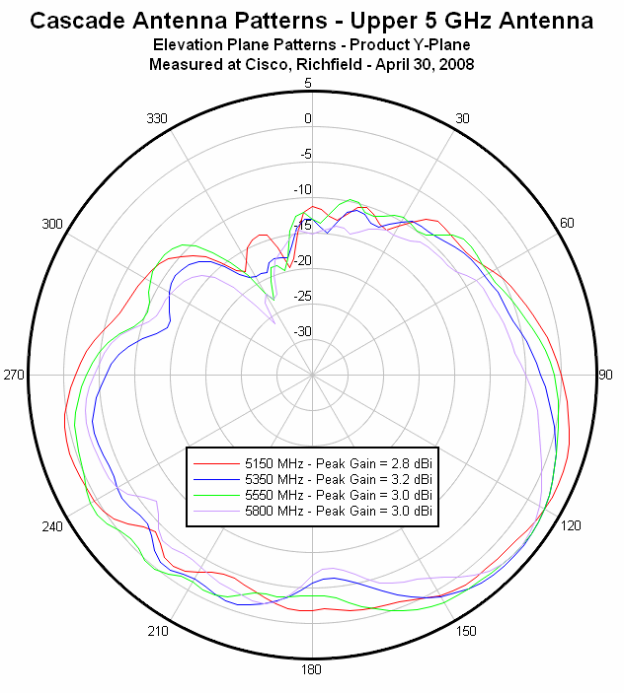

Figure 3.1.19
Casacade Antenna Patterns for the Upper 5 GHz Antenna, 5 GHz Antenna #1
Elevation Plane Patterns, Product Y-Plane

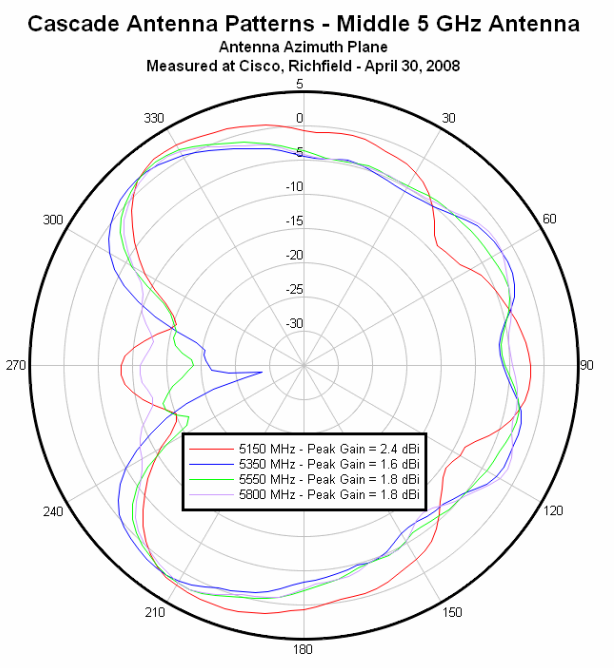

Figure 3.1.20
Casacade Antenna Patterns for the Middle 5 GHz Antenna, 5 GHz Antenna #2
Azimuth Plane Patterns

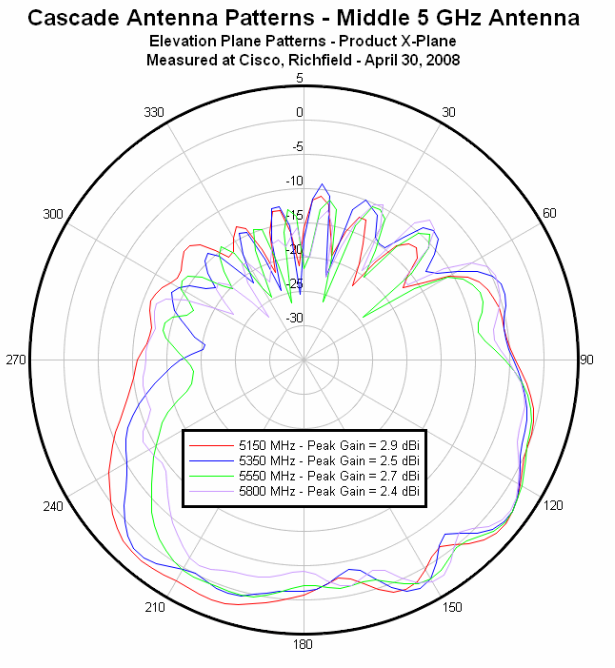

Figure 3.1.21
Casacade Antenna Patterns for the Middle 5 GHz Antenna, 5 GHz Antenna #2
Elevation Plane Patterns, Product X-Plane

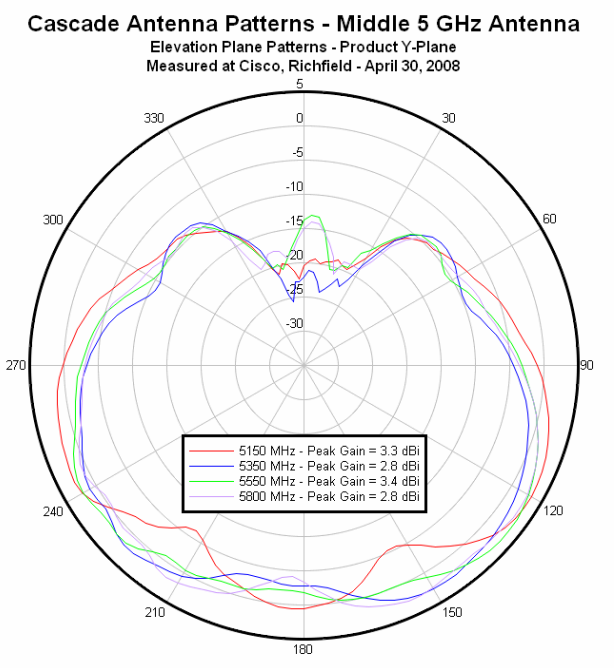

Figure 3.1.22
Casacade Antenna Patterns for the Middle 5 GHz Antenna, 5 GHz Antenna #2
Elevation Plane Patterns, Product Y-Plane

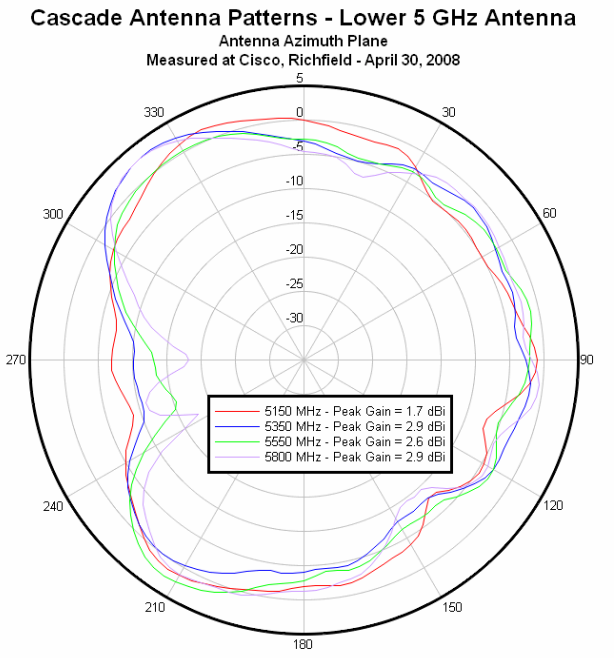

Figure 3.1.23
Casacade Antenna Patterns for the Lower 5 GHz Antenna, 5 GHz Antenna #3
Azimuth Plane Patterns

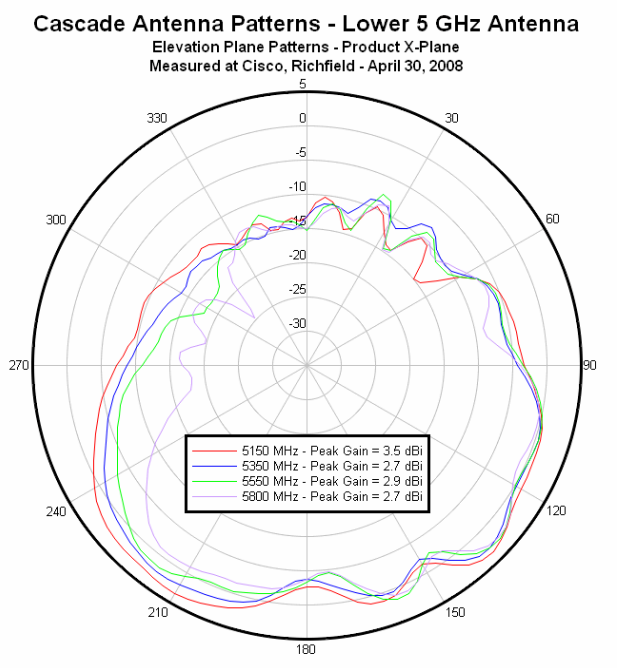

Figure 3.1.24
Casacade Antenna Patterns for the Lower 5 GHz Antenna, 5 GHz Antenna #3
Elevation Plane Patterns, Product X-Plane

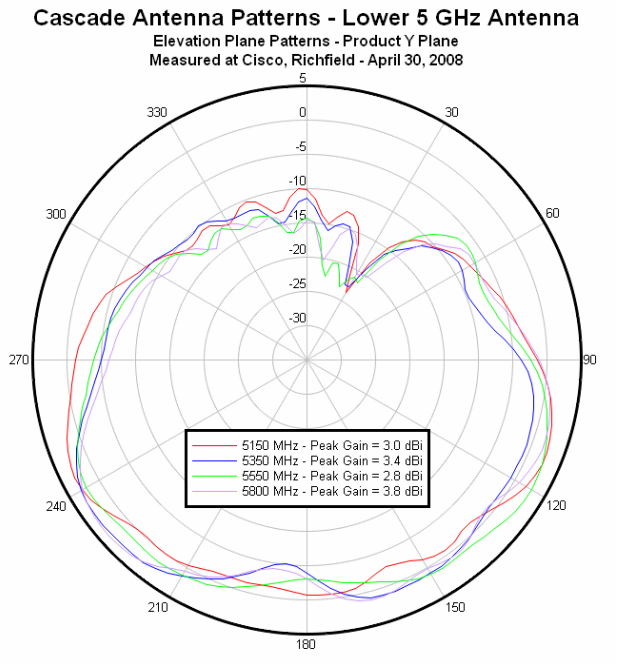

Figure 3.1.25
Casacade Antenna Patterns for the Lower 5 GHz Antenna, 5 GHz Antenna #3
Elevation Plane Patterns, Product Y-Plane

3.2.Antenna Mechanical and Environmental Specifications

The mechanical specifications will cover the physical appearance of the antenna as well as all mounting, cable and connectors. The mechanical and environmental specs are summarized in Table 3.2.1.

Cascade Antenna - Mechanical Specifications					
Parameter		**Minimum**	**Typical**	**Max**	**Comments**
Antenna Length	2.4 GHz		795 mils		
	5 GHz		540 mils		
Antenna Width	2.4 GHz		650 mils		
	5 GHz		157 mils		
Antenna Height	2.4 GHz		275 mils		
	5 GHz		221 mils		
Antenna Spacing	2.4 GHz	2.32 inches		2.48 inches	Center point to center point
	5 GHz		2 inches		Center point to center point
Antenna Material		Tin plated C770 Nickel Silver Alloy, 1/2 hard			Tin required to produce compatible surface with aluminum housing
Eyelet length		140 mils	130 mils	150 mils	
Eyelet ID		52 mils	53 mils	55 mils	
Eyelet Material		tin plated brass			Eyelet created according to Cisco drawing XX-XXXX
Mounting Method		Riveted to top half of aluminum housing			Aluminum rivets, 0.129 – 0.133 in hole size, 0.063 – 0.125 in grip range
Cable		Hirose U.FL-2LP-088-A or equivalent			Soldered to antenna and eyelet
Cable Length		5.75 inches	6 inches	6.25 inches	
Connector		Hirose U.FL or equivalent			

Table 3.2.1
Chinook 4-element Dual Band Antenna, Mechanical and Environmental Specifications