AP750UNe Access Point

Everest Networks, Inc.

FCC Compliance Testing of AP750UNe Access Point

of Multiple Transmitters with Multiple Outputs (MIMO) that are connected to Cross-polarized Antennas

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Revision History

Version	Change Summary	Author	Date
0.0	Document created, draft version	H. V. Nguyen	Mar. 6, 2024
1.0	Antenna gain adjusted for cable loss	H. V. Nguyen	Mar.12, 2024
2.0	Correction of V-pol and H-pol for PCB-33/34	H. V. Nguyen	May 22, 2024
3.0	Adding antenna ODM, Removing antenna photos	H. V. Nguyen	July 12, 2024

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1 Introduction

This document provides,

a) illustrations of the connection between radio transmitters and cross-polarized antennas,
b) explanations of polarization diversity (cross polarized antennas) and space orthogonality, and
c) calculations of directional gain for directional antenna panels of AP750UNe access point.

Conclusions are provided in section 6 and should be used as a guideline for setting antenna gain, TxBF array gain and maximum output conducted power (MOCP).

2 AP750UNe Antenna Panels, Radio Connection and Coverage

The antenna panels of AP750UNe are of microstrip patch antenna type. Each antenna panel, i.e. PCB-000033 and PCB-000034, has two (02) inputs that correspond to a vertical polarization (Vpol) and a horizontal polarization (Hpol).

AP750UNe access point has two (02) RF radios, i.e. Radio 1 and Radio 2. Each radio is a 2x2:2 multiple inputs multiple outputs (MIMO) and thus has two (02) RF chains, i.e. Ch_0, Ch_1. The association of RF radios to directional antenna panels is summarized in the below table.

Table 1: AP750UNe Radio connections to directional antenna panel

	U-NII frequency band	PCB-000033		PCB-000034	
		Vertical Polarization	Horizontal Polarization	Vertical Polarization	Horizontal Polarization
Radio 1	UNII-3			J2	J1
Radio 2	UNII-1+2a	AWJ2	AWJ1		

3 Radio 1 in U-NII-3 (5725MHz-5850MHz) band

3.1 Radio-Antenna Connection

The two (02) RF chains of Radio 1 are connected to the vertical and horizontal polarization of the PCB-000034 panel at port J2 and J1, respectively. The detail mapping of these connections is summarized in Table 1.

Figure 1a and Figure 1b show radiation patterns in elevation and azimuthal of PCB-000034 for Vertical polarization and Horizontal polarization, respectively. Antenna panel max gain in the U-NII-3 band is summarized in Table 2.

Table 2: Maximum gain of PCB-000034 panels in UNII-3 band

U-NII-3 Band	Vertical polarization	Horizontal polarization
PCB-000034	16.47 dBi	16.51 dBi

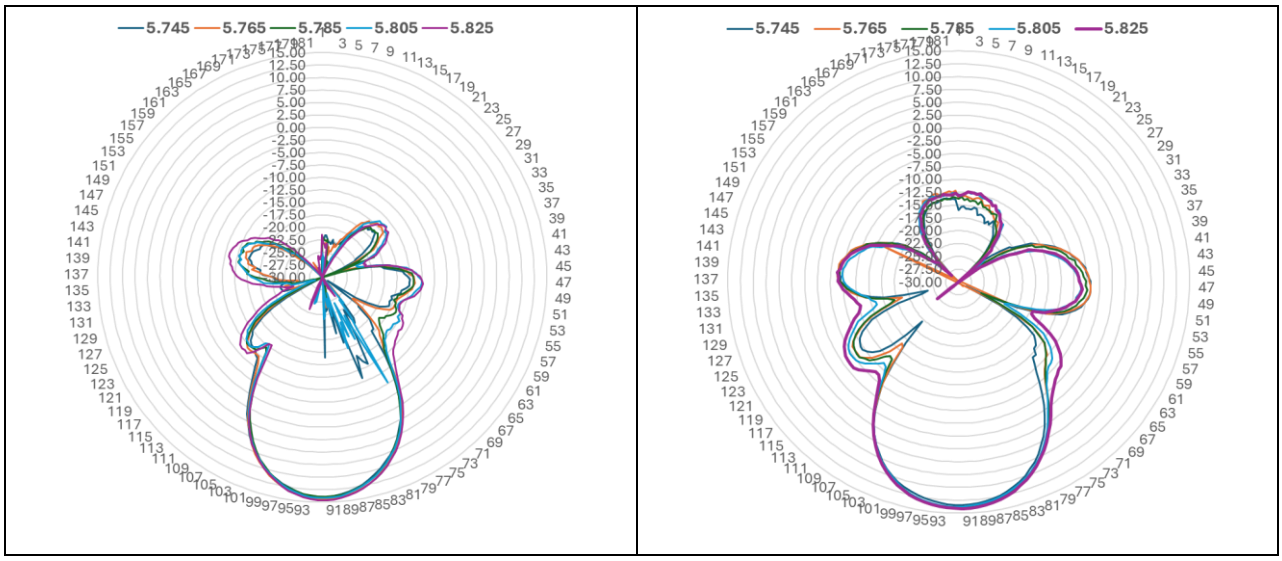

Figure 1a: Radiation patterns in elevation and azimuthal cuts of port J2 (vertical polarization) of PCB-000034 at various frequencies of U-NII-3 band.

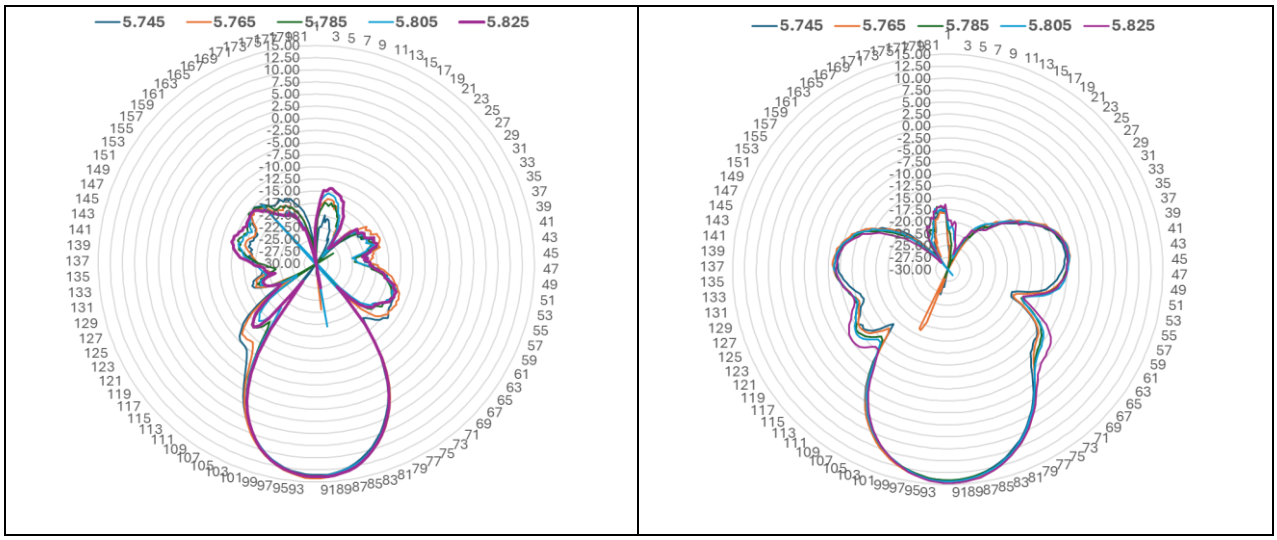

Figure 1b: Radiation patterns in elevation and azimuthal cuts of port J1 (horizontal polarization) of PCB-000034 at various frequencies of U-NII-3 band.

4 Radio 2 in U-NII-1/2a (5150-5350MHz) bands

4.1 Radio-Antenna Connection

The two (02) RF chains of Radio 2 are connected to the vertical and horizontal polarization of the PCB-000033 panel at port AWJ2 and AWJ1, respectively. The detail mapping of these connections is summarized in Table 1.

Figure 2a and Figure 2b show radiation patterns in elevation and azimuthal of PCB-000033 for Vertical polarization and Horizontal polarization, respectively. Antenna panel max gain in the U-NII-1/2a band is summarized in Table 3.

Table 3: Maximum gain PCB-000033 panel in U-NII-1 and 2a bands

U-NII-1/2a Band	Vertical polarization	Horizontal polarization
PCB-000033	16.84 dBi	16.52 dBi

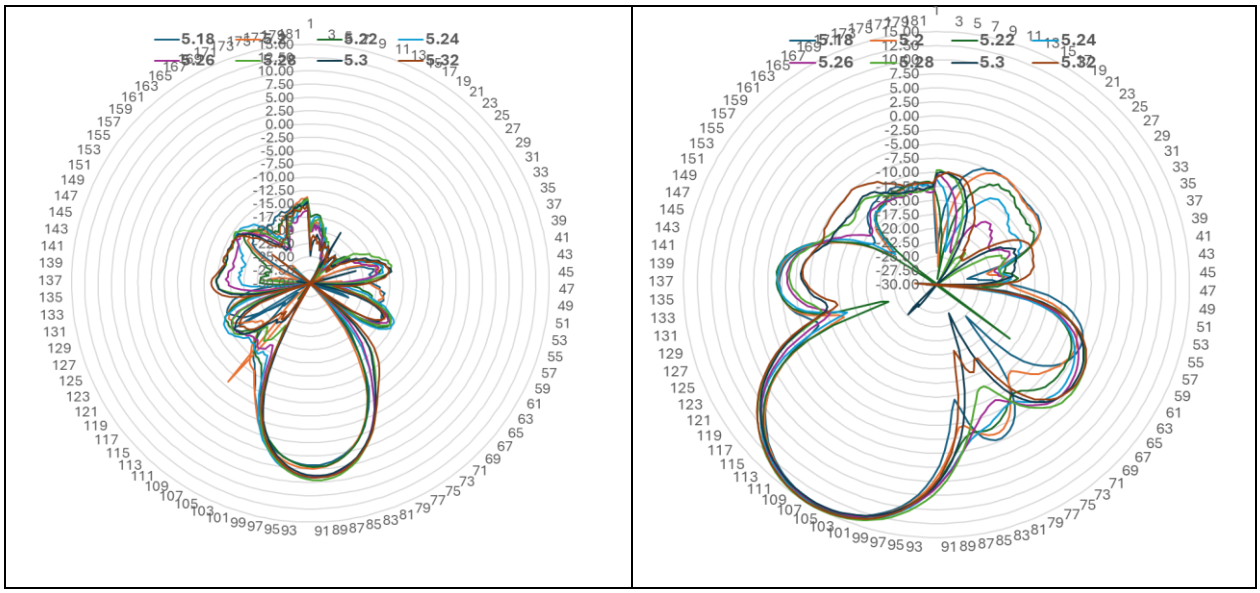

Figure 2a: Radiation patterns in elevation and azimuthal cuts of port AWJ2 (vertical polarization) of PCB-000033 at various frequencies of U-NII-1/2a bands.

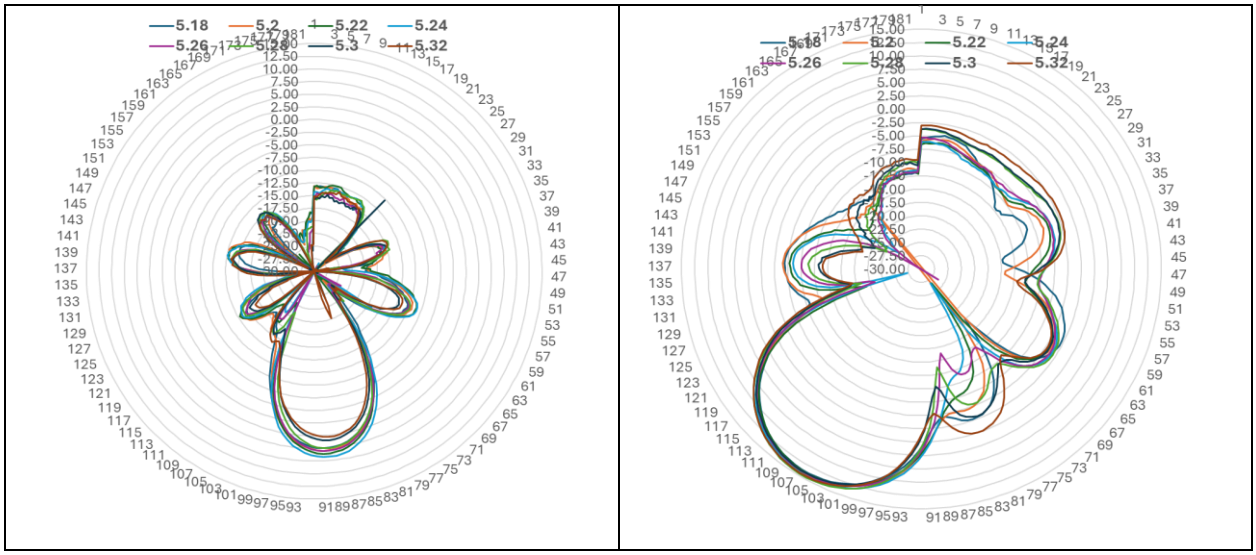

Figure 2b: Radiation patterns in elevation and azimuthal cuts of port AWJ1 (horizontal polarization) of PCB-000033 at various frequencies of U-NII-1/2a bands.

5 Cross-Polarized Antenna Operation

The two (02) RF ports of each radio is connected to a cross-polarized directional antenna panel, and thus they are orthogonal. Therefore, the directional gain DG = 0 dB for both PCB-000033 and PCB-000034.

6 Outdoor operation for U-NII-1 Band

For outdoor operation in the U-NII-1 Band, the maximum EIRP at any angle more than 30 degrees above horizon should be below 21 dBm. The AP750UNe will be professionally installed and mounted in structure beam/support/truss and facing downward. As per the AP750UNe installation guideline, the maximum installation angle is less than 45 degrees above the horizon. The maximum gain at any angle more than 30 degrees above horizon for the vertical and horizontal beam patterns are given in the table below

Table 4 shows the MOCP at individual antenna's port for the worst case scenario when TxBF is enable and disable for compliance with outdoor operation in U-NII-1 band.

Table 4: MOCP for TxBF disable and enable

Maximum gain of antenna panel in U-NII-1 band	Net Cable loss	Net Antenna Gain	Number of antenna panels operating in UNII1 band	TxBF gain in UNII1 band	MOCP at antenna port for outdoor FCC compliance in U-NII-1 band
-11.29 dBi	1.8 dB	-13.09 dBi	1	Disable	34.09 dBm
-11.29 dBi	1.8 dB	-13.09 dBi	1	Enable DG of TxBF = 0	34.09 dBm

The MOCP list in Table 4 is much larger than a normal operating output power (18 dBm) of Radio 2 operating in U-NII-1 bands. Therefore, AP750UNe meets the requirement for outdoor operation in U-NII-1 band.

7 Conclusions

Table 5 summarizes the antenna gain, array gain for different bands for AP750UNe. The net gain is the combined gain of the antenna and cable loss. The columns are defined as follows:

- **Tested net antenna gain**: this is the net gain of the antenna used for certification measurements
- **Certified antenna gain**: this is the antenna gain to be used to compute the Maximum Output Conducted Power (MOCP) at radio card.
- **TXBF/STBC/CCD gain:** array gains to be used to compute the MOCP at radio card for the various operating modes.

Table 5: AP750UNe

FCC Operating band	Number of RF ports	Tested Antenna gain	Cable loss	Tested net antenna gain	Certified net antenna gain	TXBF gain [dB]	STBC gain [dB]	CCD gain [dB]
U-NII-1 Band	2	16.52 dBi	1.8 dB	14.72 dBi	**15 dBi**	**0**	**0**	**0**
U-NII-2-A Band	2	16.84 dBi	1.8 dB	15.04 dBi	**15 dBi**	**0**	**0**	**0**
U-NII-3 Band	2	16.51 dBi	1.8 dB	14.71 dBi	**15 dBi**	**0**	**0**	**0**

8 References

[1] FCC document KDB 662911 D01 Multiple Transmitter Output v02r01, October 31, 2013

[2] FCC document KDB 662911 D02 MIMO with Cross-Polarized Antenna v01, October 25, 2011

Antenna manufacturer information

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