



Flir Habanero

Antenna Characterization

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Revision History

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Prepared:
Pär Berglund
Approved:
Jonas Strandell

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3 Acronyms, Abbreviations and Definitions

Table 1. Acronyms

Acronym	Description
WSI	Wireless System Integration

4 Introduction

This paper presents antenna measurements for the *Flir Habanero* thermal camera. The *Flir Habanero* camera is equipped with an internal dual band Wi-Fi antenna supporting the 2,4GHz and 5GHz frequency bands.



Figure 4-1 Flir Habanero thermal camera

5 Antenna measurements

The Wi-Fi antenna is verified in terms of *Voltage Standing Wave Ratio (VSWR)*, *antenna efficiency* and *radiation patterns*.

5.1 Voltage Standing Wave Ratio

Voltage Standing Wave Ratio (VSWR) is a measure of how well an antenna is impedance matched to the system impedance. A VSWR of one means a perfect match where all the available power is delivered to the antenna and an infinite VSWR means a short or an open circuit where all the energy is reflected.

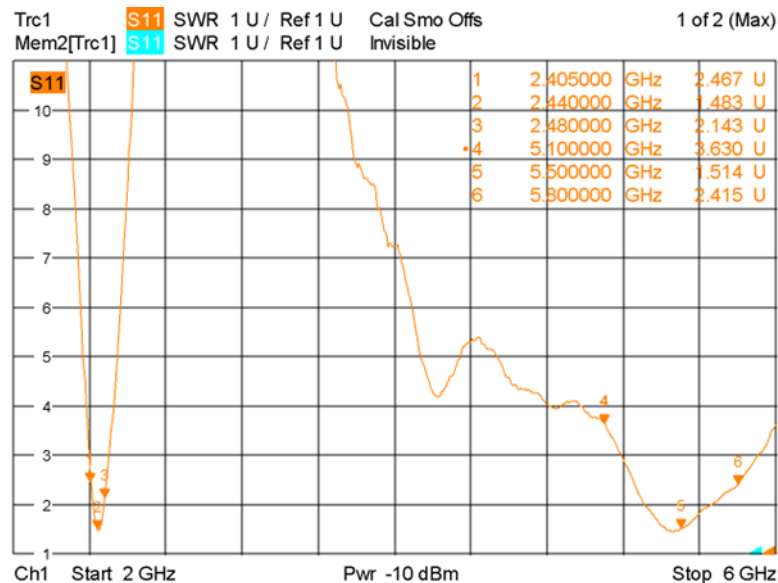


Figure 5-1 VSWR for the Flir Habanero Wi-Fi antenna

5.2 Antenna efficiency

The antenna efficiency measurements are carried out in a *scattered field chamber*. The antenna efficiency, ϵ_T , is the ratio of the power delivered at the 50 Ω antenna interface, P_t , relative to the power radiated from the antenna, $P_{radiated}$.

$$\epsilon_T = \frac{P_{radiated}}{P_t}$$

The antenna system efficiency can be expressed in dB or %, where 100% corresponds to 0dB.

Table 2 Antenna efficiency for Flir Habanero

Flir Habanero		
Freq [MHz]	Antenna efficiency	
	[%]	[dB]
2405	17	-7,6
2440	21	-6,7
2480	20	-6,9
5100	30	-5,2
5150	23	-6,4
5200	44	-3,6
5250	30	-5,2
5300	49	-3,1

5.3 Radiation patterns

The antenna radiation pattern measurements are carried out in an anechoic chamber. Radiation patterns are presented for three measurement planes: XY-, XZ- and YZ-planes with horizontal and vertical polarization of the receiving antenna. Radiation patterns for Total antenna gain which is defined as the sum of horizontal and vertical polarization is presented in Appendix A - Radiation patterns – total antenna gain

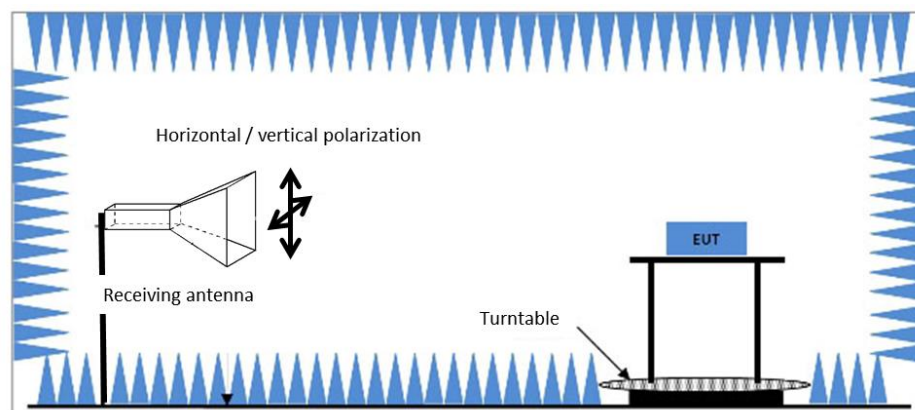


Figure 5-2 Antenna gain measurements with horizontal and vertical polarization of receiving antenna.



Figure 5-3 Measurement plane definition

2.4GHz band

Antenna radiation patterns Vertical polarization

Antenna radiation patterns Horizontal polarization

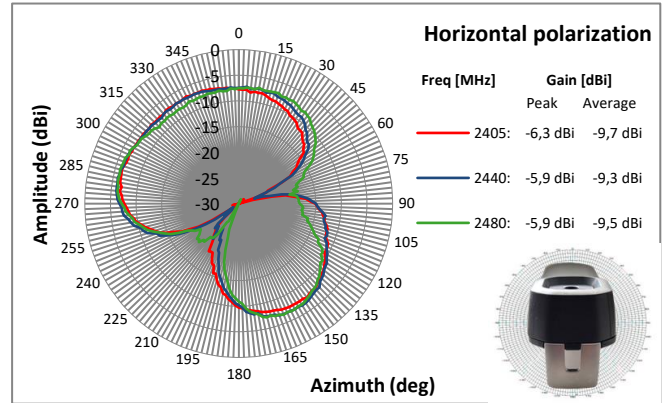
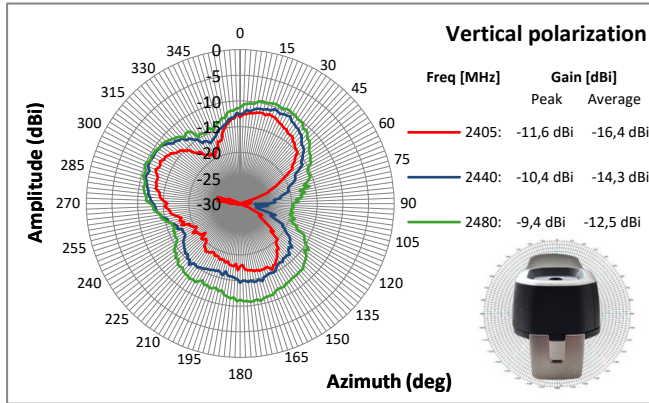


Figure 4 XY-plane for the Flir Habanero Wi-Fi antenna, 2,4GHz band. Vertical polarization of receiving antenna

Figure 5 XY-plane for the Flir Habanero Wi-Fi antenna, 2,4GHz band. Horizontal polarization of receiving antenna

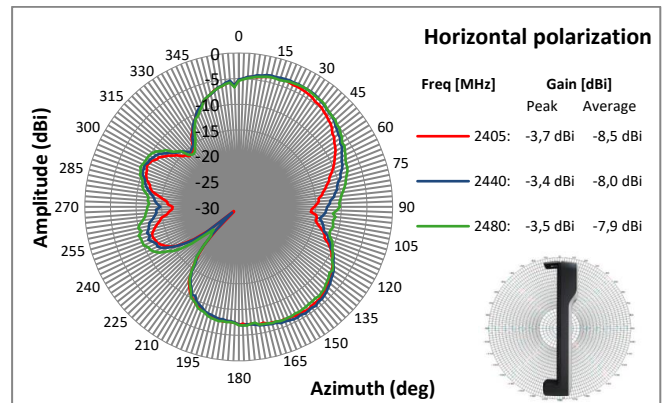
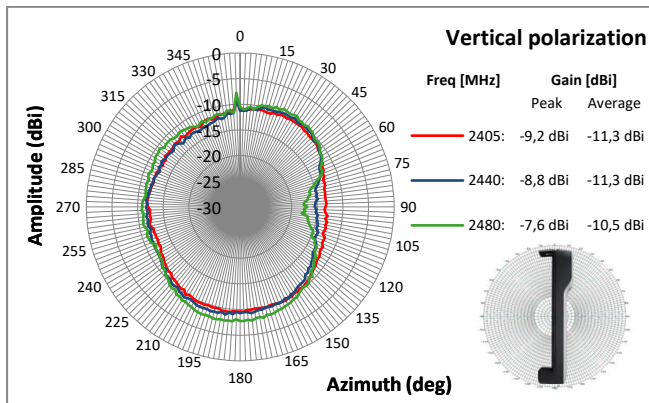


Figure 6 XZ-plane for the Flir Habanero Wi-Fi antenna, 2,4GHz band. Vertical polarization of receiving antenna

Figure 7 XZ-plane for the Flir Habanero Wi-Fi antenna, 2,4GHz band. Horizontal polarization of receiving antenna

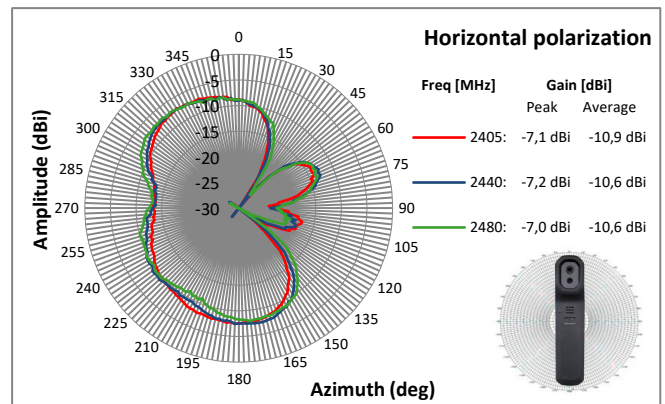
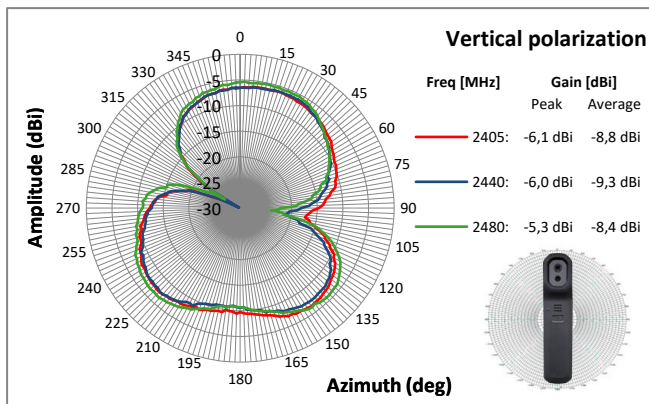


Figure 8 YZ-plane for the Flir Habanero Wi-Fi antenna, 2,4GHz band. Vertical polarization of receiving antenna

Figure 9 YZ-plane for the Flir Habanero Wi-Fi antenna, 2,4GHz band. Horizontal polarization of receiving antenna

5GHz band

Antenna radiation patterns Vertical polarization

Antenna radiation patterns Horizontal polarization

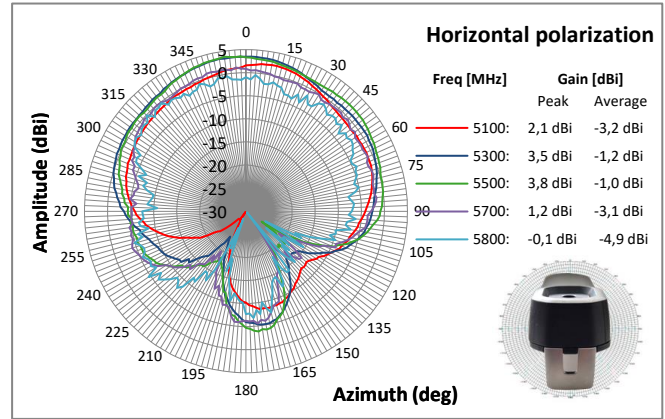
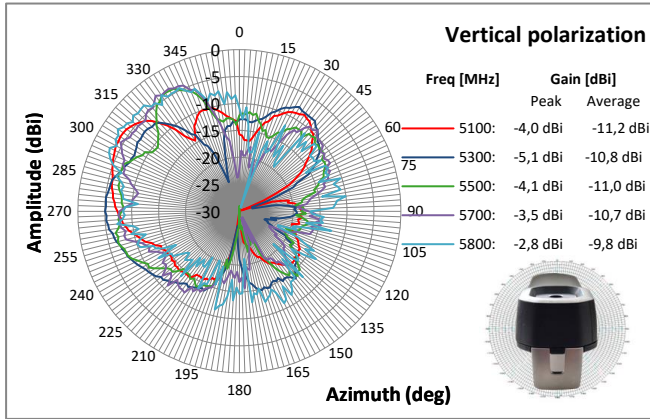


Figure 10 XY-plane for the Flir Habanero Wi-Fi antenna, 5GHz band. Vertical polarization of receiving antenna

Figure 11 XY-plane for the Flir Habanero Wi-Fi antenna, 5GHz band. Horizontal polarization of receiving antenna

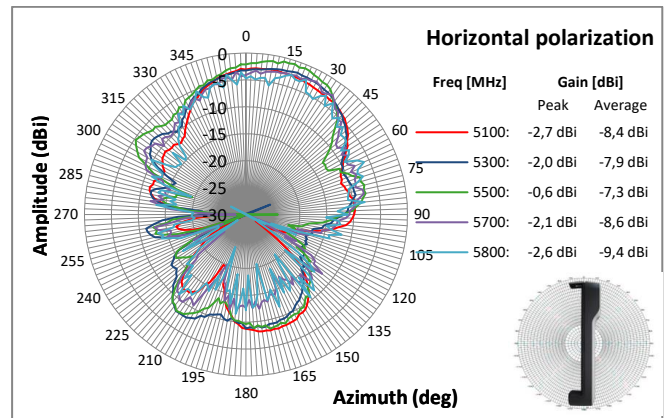
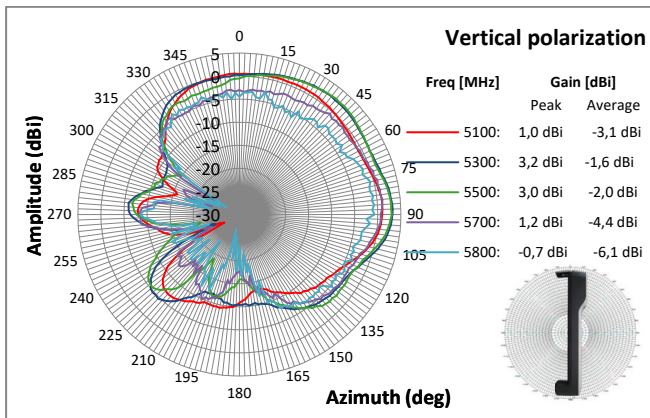


Figure 12 XZ-plane for the Flir Habanero Wi-Fi antenna, 5GHz band. Vertical polarization of receiving antenna

Figure 13 XZ-plane for the Flir Habanero Wi-Fi antenna, 5GHz band. Horizontal polarization of receiving antenna

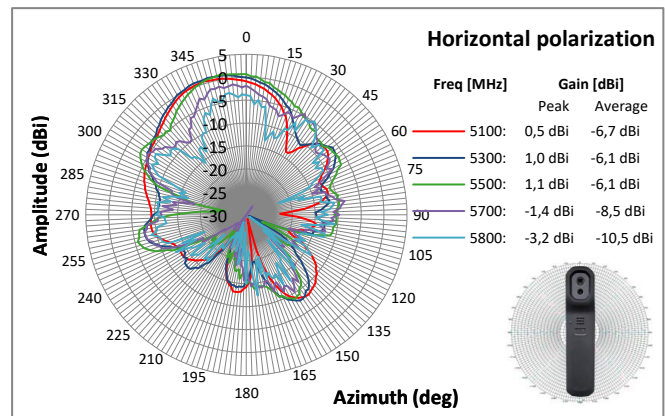
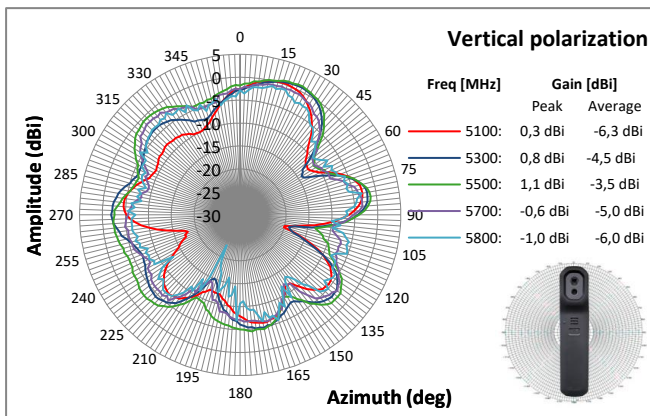


Figure 14 YZ-plane for the Flir Habanero Wi-Fi antenna, 5GHz band. Vertical polarization of receiving antenna

Figure 15 YZ-plane for the Flir Habanero Wi-Fi antenna, 5GHz band. Horizontal polarization of receiving antenna



5.4 Antenna peak gain

The antenna peak gain in each measurement plane for 2,4GHz and 5GHz is summarized in Table 3 and Table 4.

Table 3 Antenna peak gain for 2.4GHz frequency band.

Frequency band	XY-plane		YZ-plane		XZ-plane	
	Peak gain [dBi]	Polarization	Peak gain [dBi]	Polarization	Peak gain [dBi]	Polarization
2.4GHz	-5.9	Horizontal	-3.4	Horizontal	-5.3	Vertical

Table 4 Antenna peak gain for 5GHz frequency band.

Frequency band	XY-plane		YZ-plane		XZ-plane	
	Peak gain [dBi]	Polarization	Peak gain [dBi]	Polarization	Peak gain [dBi]	Polarization
5GHz	3.8	Horizontal	3.2	Vertical	1.1	Horizontal

6 Summary

The antenna performance for the *Flir Habanero* thermal camera has been characterized. Results for antenna VSWR, antenna efficiency and radiation patterns are presented.

Maximum antenna peak in horizontal/vertical polarization for the frequency bands 2.4 and 5GHz is measured to be:

2.4GHz: -3.4dBi

5GHz: 3.8dBi

Maximum total antenna peak gain for the frequency bands 2.4 and 5GHz is measured to be:

2.4GHz: -2.5dBi

5GHz: 3.9dBi

A. Radiation patterns – total antenna gain

The Total antenna gain G_{ANT} is defined as the sum of the horizontal G_{ANT-H} and vertical components G_{ANT-V} , i.e. a power-wise addition of the horizontal and vertical components.

$$G_{ANT} = 10 \log_{10} \left(10^{\frac{G_{ANT-H}}{10}} + 10^{\frac{G_{ANT-V}}{10}} \right)$$

2.4GHz band

Antenna radiation patterns - Total antenna gain

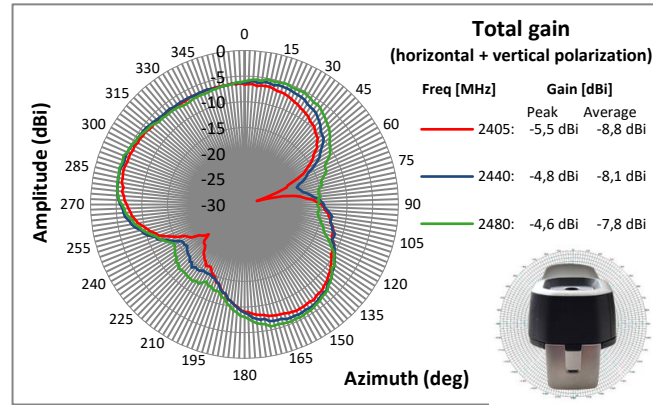


Figure 16 XY-plane for the Flir Habanero Wi-Fi antenna, 2,4GHz band. Total antenna gain (horizontal + vertical polarization)

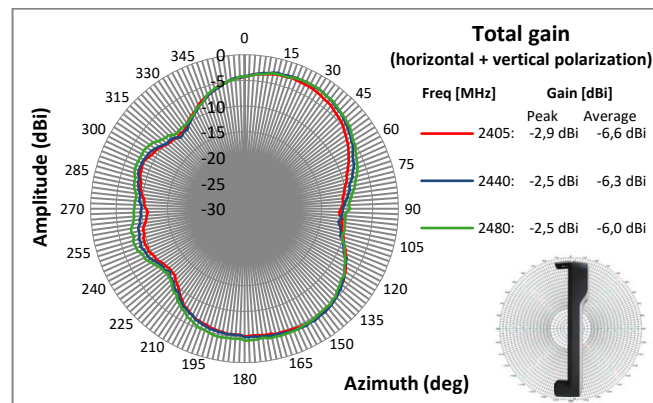


Figure 17 XZ-plane for the Flir Habanero Wi-Fi antenna, 2,4GHz band. Total antenna gain (horizontal + vertical polarization)

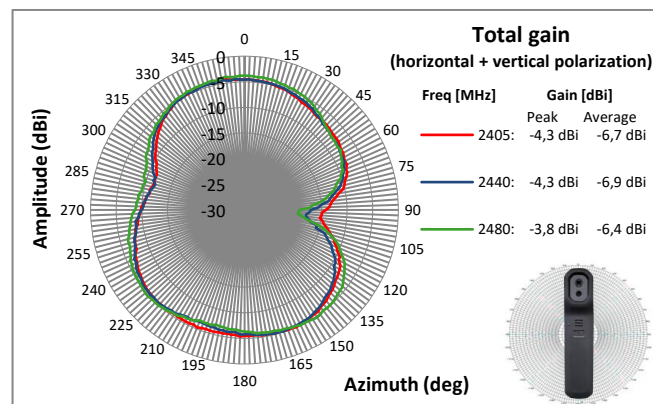


Figure 18 YZ-plane for the Flir Habanero Wi-Fi antenna, 2,4GHz band. Total antenna gain (horizontal + vertical polarization)

5GHz band

Antenna radiation patterns - Total antenna gain

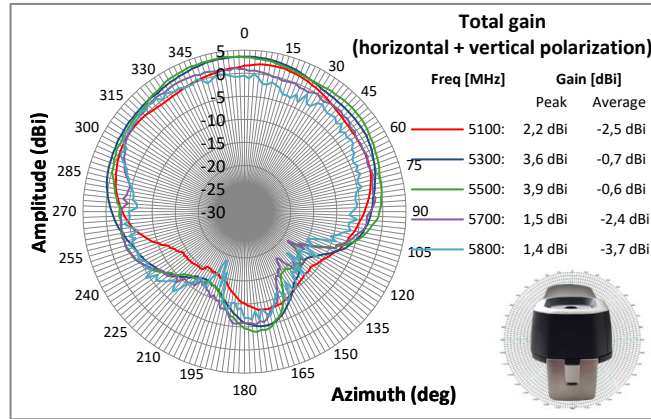


Figure 19 XY-plane for the Flir Habanero Wi-Fi antenna, 5GHz band. Total antenna gain (horizontal + vertical polarization)

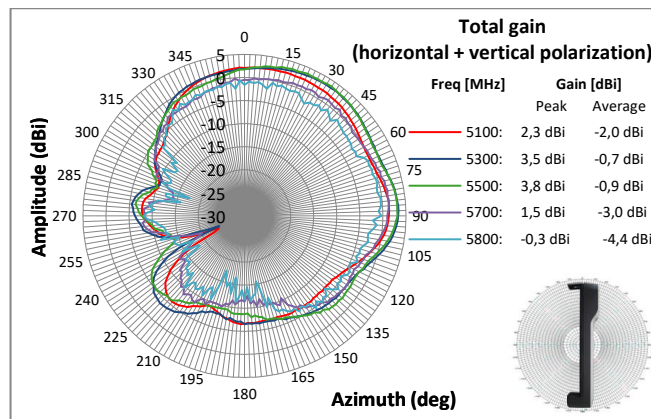


Figure 20 XZ-plane for the Flir Habanero Wi-Fi antenna, 5GHz band. Total antenna gain (horizontal + vertical polarization)

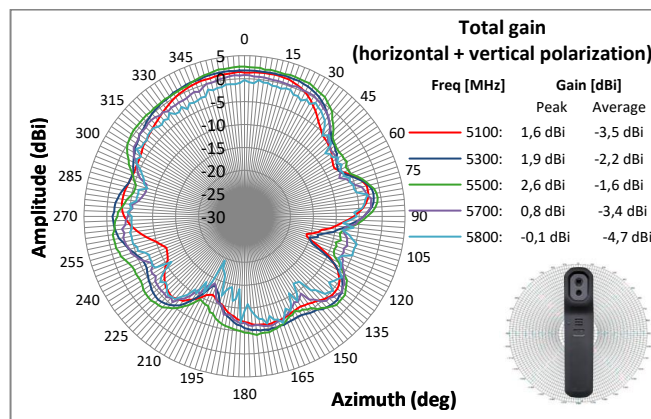


Figure 21 YZ-plane for the Flir Habanero Wi-Fi antenna, 5GHz band. Total antenna gain (horizontal + vertical polarization)