

PHF-095A3SNB

WiFi 7/6E & GNSS All-in-1 MIMO antenna

The Joymax PHF-095A3SNB-ccc antenna is a dome-style, panel-mount, MIMO (Multiple Input, Multiple Output) all-in-1 combo antenna supporting WiFi 7/6E and GNSS in high mobility connectivity applications. The product family includes multi-port solutions up to 3-ports along with different cable length and connector solution to suit major industrial, vehicular and smart traffic gateways application.

The antenna features IP67 rated waterproof design and attaches with an SMA Plug (male pin) connector for GNSS, and RP-SMA Plug (female socket) connector for WiFi. Custom coaxial cable and length is available based on customer project requirement.



Features

- WiFi & GNSS coverage from a single antenna
- Support 2.4 GHz, 5 GHz, 6 GHz for WiFi 7/6E application
- Omnidirectional radiation for WiFi
- Directional radiation for GNSS
- IP67 rated, waterproof design
- Low profile for vehicle roof installation
- Customizable cable length, connector

Applications

- WiFi/WLAN applications:
 - WiFi 7 (802.11be)
 - WiFi 6E (802.11ax)
 - WiFi 6 (802.11ax)
 - WiFi 5 (802.11ac)
 - WiFi 4 (802.11n)
- GNSS: Navigation, Location, Timing
- Fleet Management
- Smart Traffic Gateways

Ordering Information

Part Number	Description
PHF-095A3SNB-Q200	WiFi 7/6E x 2, GNSS x 1 MIMO antenna, 2M RG58 cable & SMA connector BLACK
PHF-095A2SNB-Q200	WiFi 7/6E x 1, GNSS x 1 MIMO antenna, 2M RG58 cable & SMA connector BLACK
THF-095A2SNB-Q200	WiFi 7/6E x 2 MIMO antenna, 2M RG58 cable & RP-SMA connector BLACK
PHF-095A3SNW-Q200	WiFi 7/6E x 2, GNSS x 1 MIMO antenna, 2M RG58 cable & SMA connector WHITE
PHF-095A2SNW-Q200	WiFi 7/6E x 1, GNSS x 1 MIMO antenna, 2M RG58 cable & SMA connector WHITE
THF-095A2SNW-Q200	WiFi 7/6E x 2 MIMO antenna, 2M RG58 cable & SMA connector WHITE

Available from Joymax Inc. and select distributors and representatives.

Table 1: Electrical Specifications

PHF-095A3SNB	WiFi / WLAN Band (MHz)		
Frequency Range	2400 ~ 2500	5150 ~ 5850	5925 ~ 7125
VSWR (Max)	1.4	3.1	3.0
Peak Gain (dBi)	3.1	3.5	3.3
Average Gain (dBi)	-1.4	-3.2	-3.6
Efficiency (%)	72	48	44
Polarization	Linear		
Radiation	Omni directional		
Max Power	5 W		
Wavelength	$\frac{1}{4}\lambda$		
Electrical Type	Monopole		
Impedance	50 Ω		

Electrical specifications and plots measured with the antenna hanging free with 0.3 meter long RG316 cable.

ATTENUATION FIGURES - RG316 (2.6 MM or 0.102 INCH DIAMETER) CABLES

Frequency Range (MHz)	698	960	1710	2650	3300	4400	5000	5850	7125
Cable Attenuation (dB/M)	< 0.8	< 1.0	< 1.3	< 1.4	< 1.5	< 1.8	< 2.0	< 2.2	< 2.7

	GNSS L1 Band (MHz)		
Frequency Range	1561	1575.42	1602
VSWR (Max)	1.4	1.7	1.3
Total Peak Gain (dBi)	35	34	30
Axial Ratio (dB)	4.8	3.7	10.7
Noise Figure (dB)	1.3	1.3	1.3
Polarization	RHCP		
Radiation	Directional		
Input Voltage	Typ. 3.3 V		
Power Consumption	Typ. 10 $\pm$ 2 mA @ 3.3 V		
Wavelength	$\frac{1}{2}\lambda$		
Electrical Type	Radiating Patch plus 2-stage LNA		
Impedance	50 Ω		
ESD Sensitivity	Low ESD sensitivity		

Electrical specifications and plots measured with the antenna hanging free with 0.3 meter long RG316 cable.

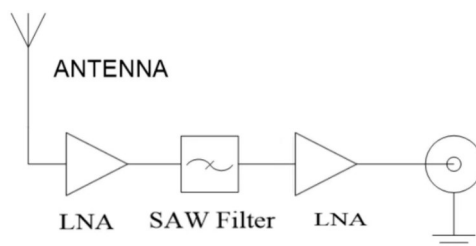
ATTENUATION FIGURES - RG316 (2.6 MM or 0.102 INCH DIAMETER) CABLES

Frequency Range (MHz)	698	960	1710	2650	3300	4400	5000	5850	7125
Cable Attenuation (dB/M)	< 0.8	< 1.0	< 1.3	< 1.4	< 1.5	< 1.8	< 2.0	< 2.2	< 2.7

Table 2: Mechanical Specifications

Parameter	Value
Number of Ports	2~3 port options available
Mounting Type	Permanent Panel Mount with Screw 5/8-24UNEF-2A
Mounting Hole	Diameter 0.63" (16 mm)
Cable Type	RG58 for WiFi, RG174 for GNSS
Cable Length	2M or Custom
Connection	SMA Plug (male pin) for GNSS, RP-SMA Plug (female socket) for WiFi
Baseplate Material	Aluminum
Radome Material	Polycarbonate + Acrylonitrile Butadiene Styrene (ABS)
Dimension	35 mm x $\varnothing$ 96 mm
Weight	322 g (11.4 oz)
Storage Temp.	-40°C to +85°C
Operating Temp.	-40°C to +85°C
Antenna Color	Black or White
Ingress Protection	IP67

Active GNSS Antenna LNA Block Diagrams

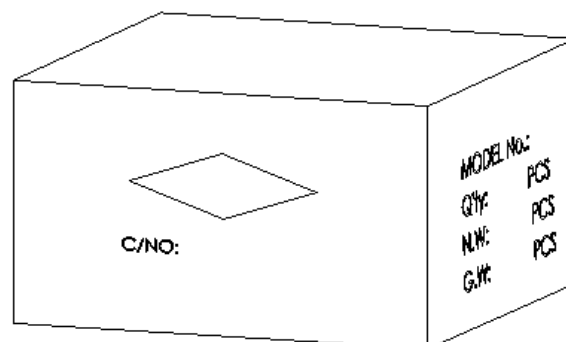


Packaging Information

The PHF-095A3SNB antennas are individually sealed in a clear plastic bag and packed into a small paper box as shown in **Figure 1**. 36 pcs per carton, 470mm x 435mm x 485 mm (18.5 in x 17.1 in x 19.1 in) with total weight 17.1 kgs (37.7 lb). Distribution channels may offer alternative packaging options.



1 pce antenna/ 1 box



36 pcs antenna/1 Carton

Figure 1. Antenna Packaging

Product Dimensions

Figure 2 provides dimensions of the PHF-095A3SNB in mm measurement unit. The antenna can be directly mounted on vehicle roof or L brackets through 5/8-24UNEF-2A thread screw. The standard antenna pack excludes L bracket kit.

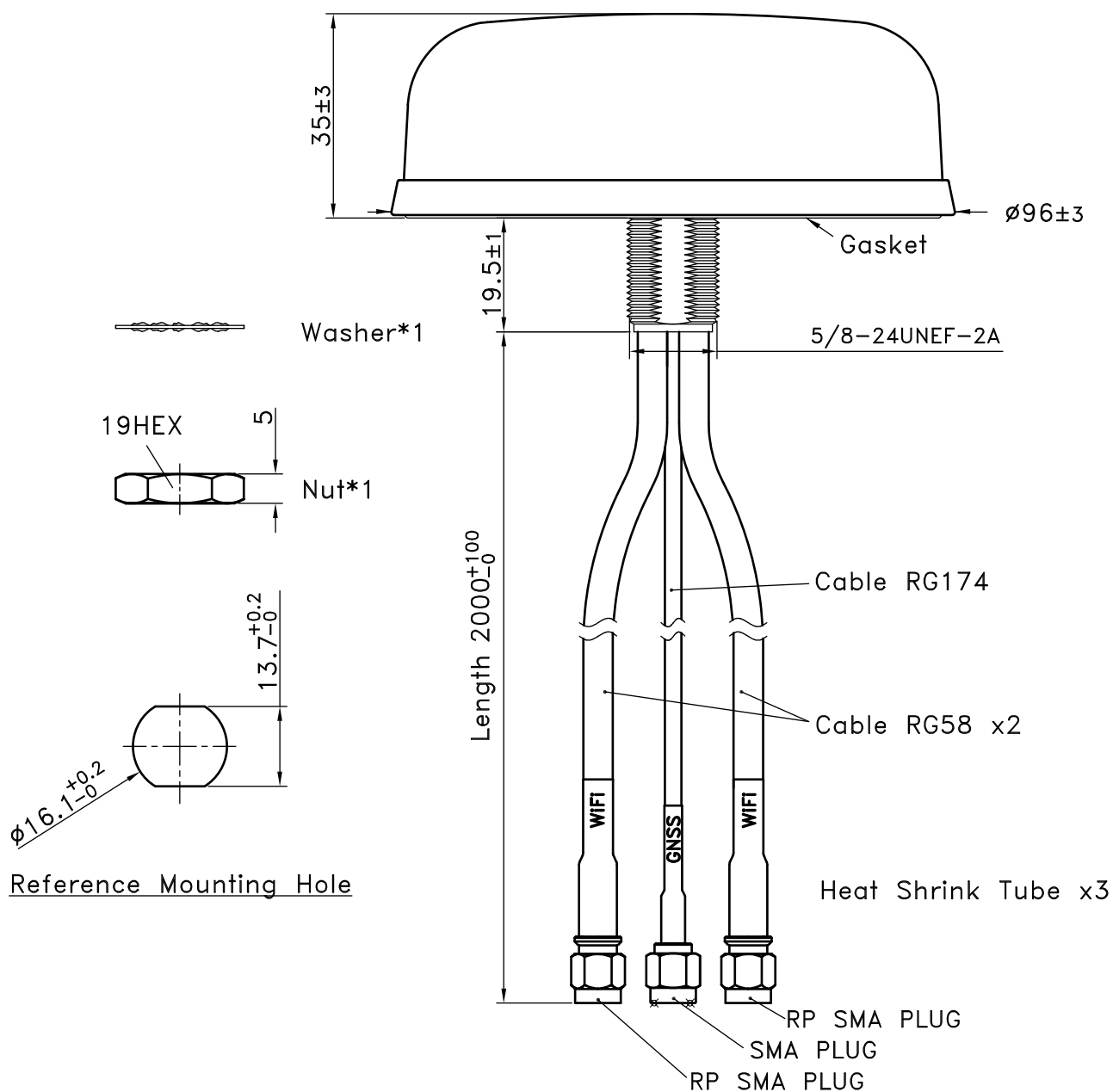


Figure 2. Antenna Dimensions

Antenna Installation

The PHF-095A3SNB antenna is designed to mount on vehicle roof directly (Panel Mount) or independent installation through L brackets as shown in **Figure 3**. The standard antenna pack excludes L bracket kit. Please contact Joymax Inc. or authorized distributor to order L bracket as needed.

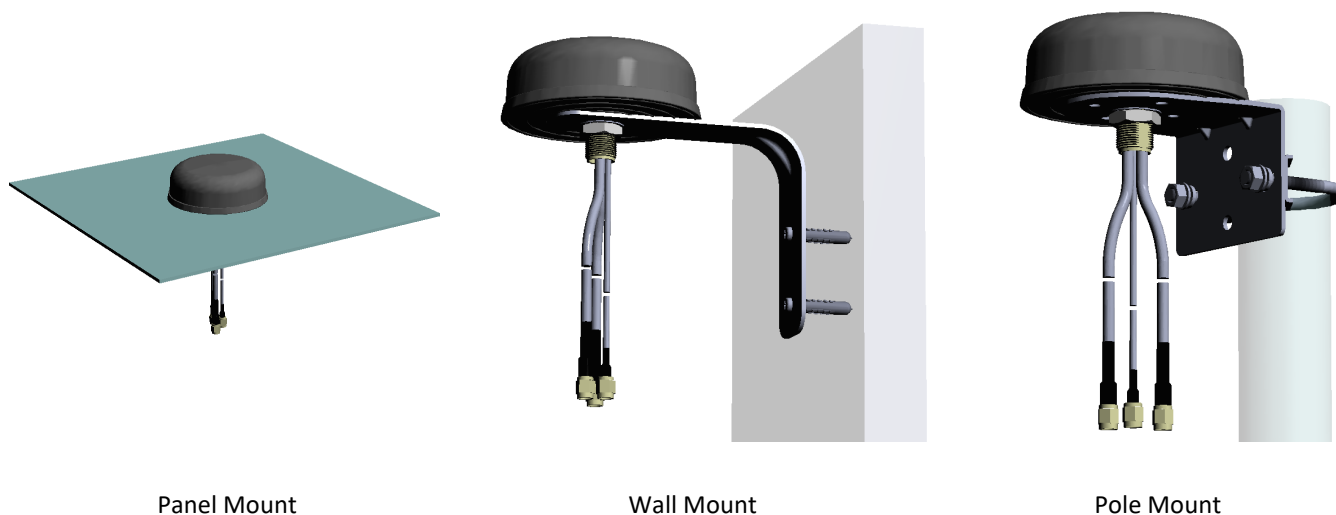


Figure 3. Antenna Installation

Antenna Test Setup

The PHF-095A3SNB antenna is tested with 0.3 meter long RG316 coaxial cable. The antenna test setup consists of direct mount on a 350 mm diameter metal plate - providing insight into antenna performance when attached to metal surfaces, and hanging free without ground plane respectively as shown in **Figure 4**.

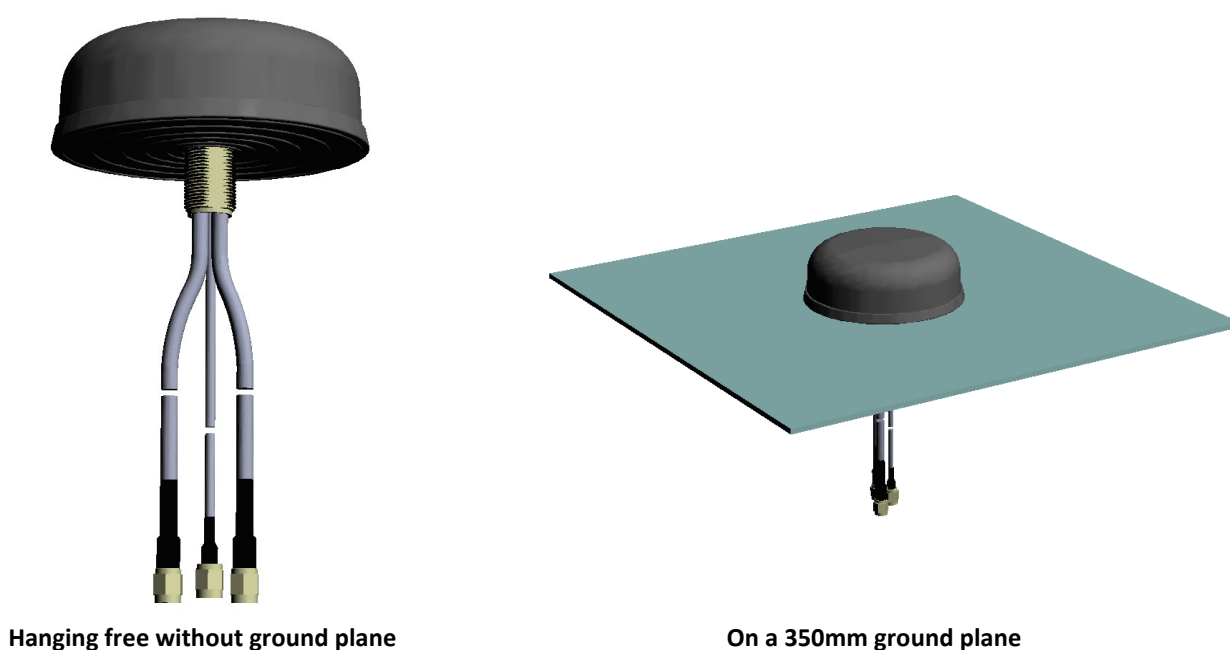


Figure 4. Antenna Test Setup

Antenna Test Setup, Hanging Free Without Ground Plane

The charts on the following pages represent data taken with the antenna hanging free without ground plane and with 0.3 meter long RG316 coaxial cable for WiFi, and 0.3 meter long RG316 coaxial cable for GNSS as shown in **Figure 5**.

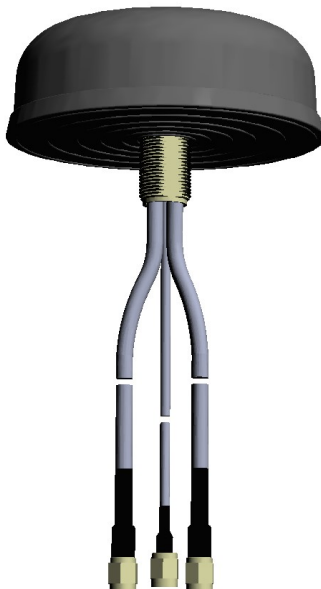


Figure 5. Antenna Hanging Free Without Ground Plane

VSWR, WiFi

Figure 6 provides the voltage standing wave ratio (VSWR) across the antenna bandwidth. VSWR is a function of the reflection coefficient, which describes the power reflected from the antenna back to the radio. 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 gauge of the percentage of transmitter power reflected back from the antenna.

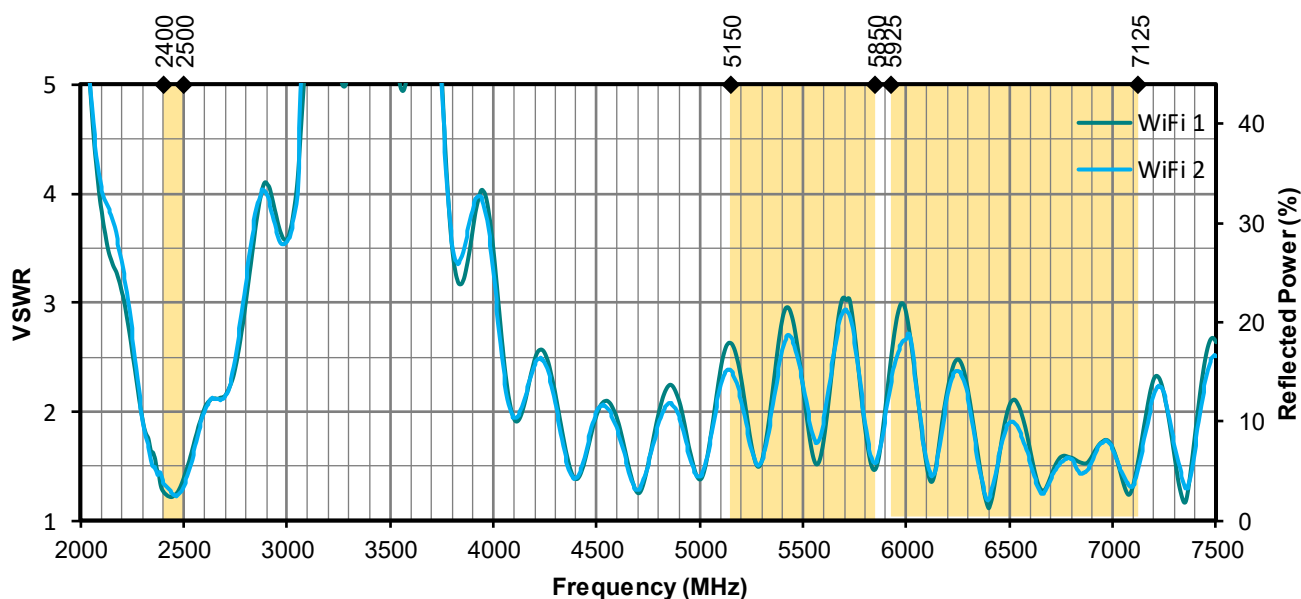


Figure 6. Antenna VSWR, WiFi

Return Loss, WiFi

Return loss (**Figure 7**), represents the loss in power at the antenna due to reflected signals. Like VSWR, a lower return loss value indicates better antenna performance at a given frequency.

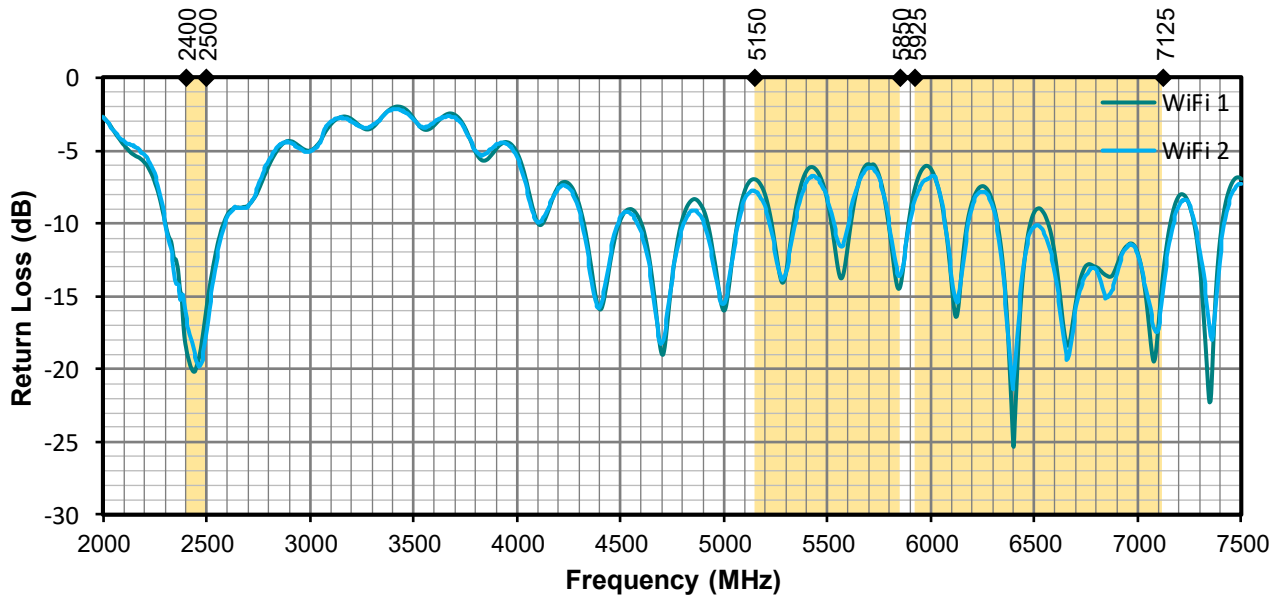


Figure 7. Antenna Return Loss, WiFi

Peak Gain, WiFi

The peak gain across the antenna bandwidth is shown in **Figure 8**. Peak gain represents the maximum antenna input power concentration across 3-dimensional space, and therefore peak performance at a given frequency, but does not consider any directionality in the gain pattern.

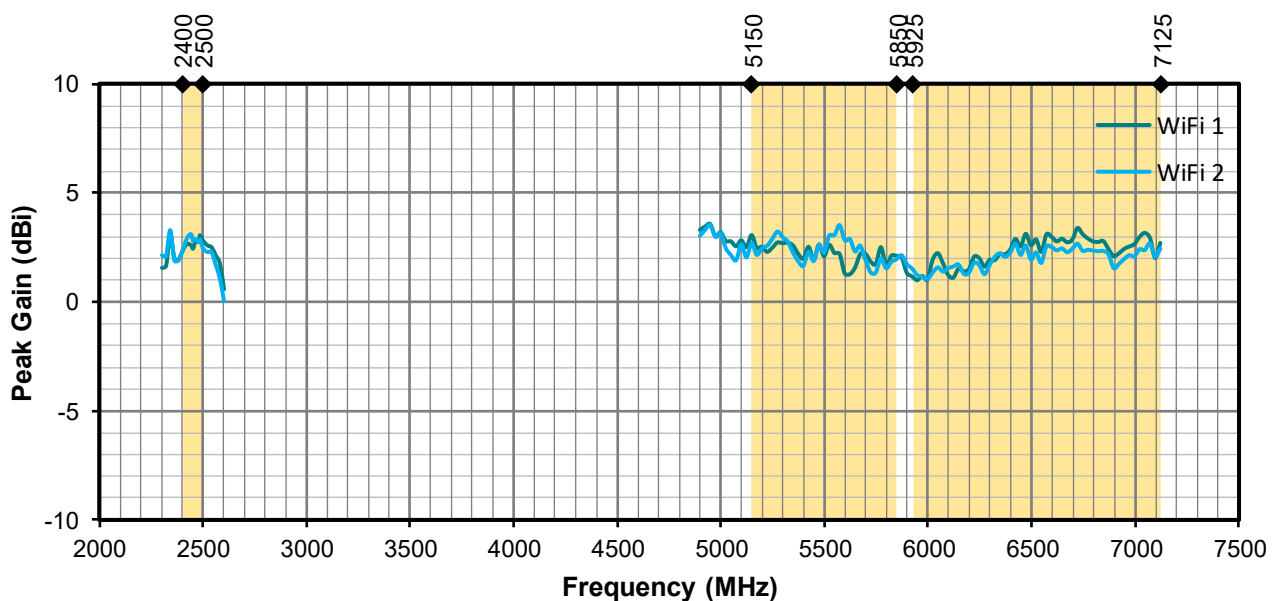


Figure 8. Antenna Peak Gain, WiFi

Average Gain, WiFi

Average gain (**Figure 9**), is the average of all antenna gain in 3-dimensional space at each frequency, providing an indication of overall performance without expressing antenna directionality.

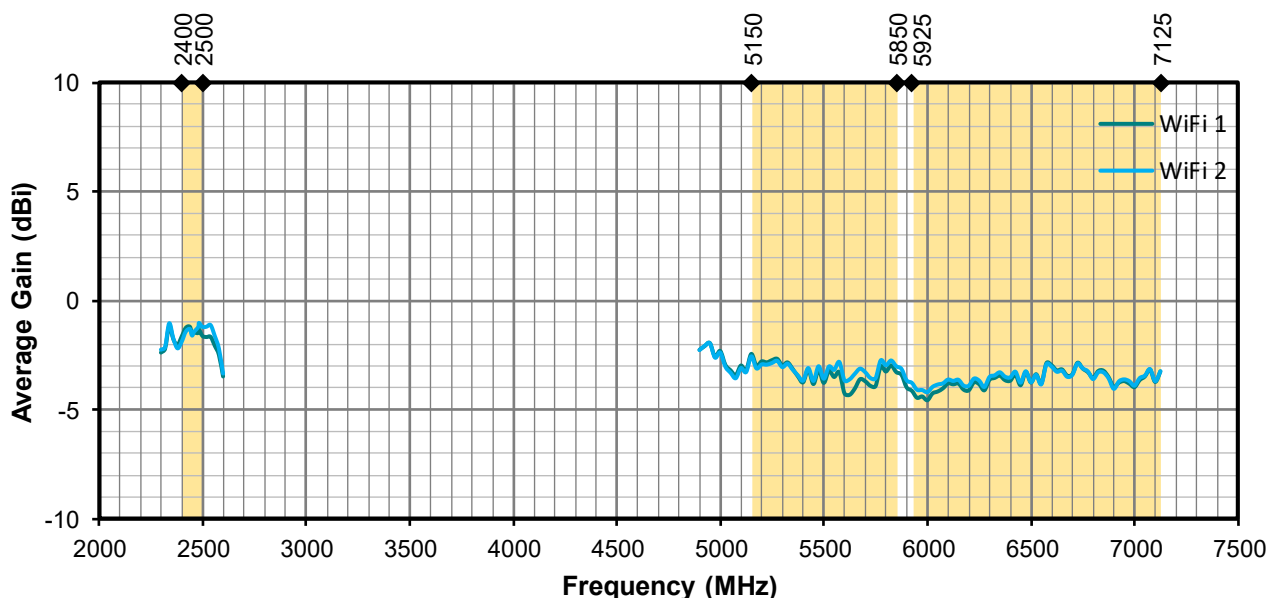


Figure 9. Antenna Average Gain, WiFi

Radiation Efficiency, WiFi

Radiation efficiency (**Figure 10**), shows the ratio of power radiated by the antenna relative to the power supplied to the antenna, expressed as a percentage, where a higher percentage indicates better performance at a given frequency. An ideal antenna has 100% efficiency. But in really world, usually an external antenna radiates only 50~60% of power supplied to it.

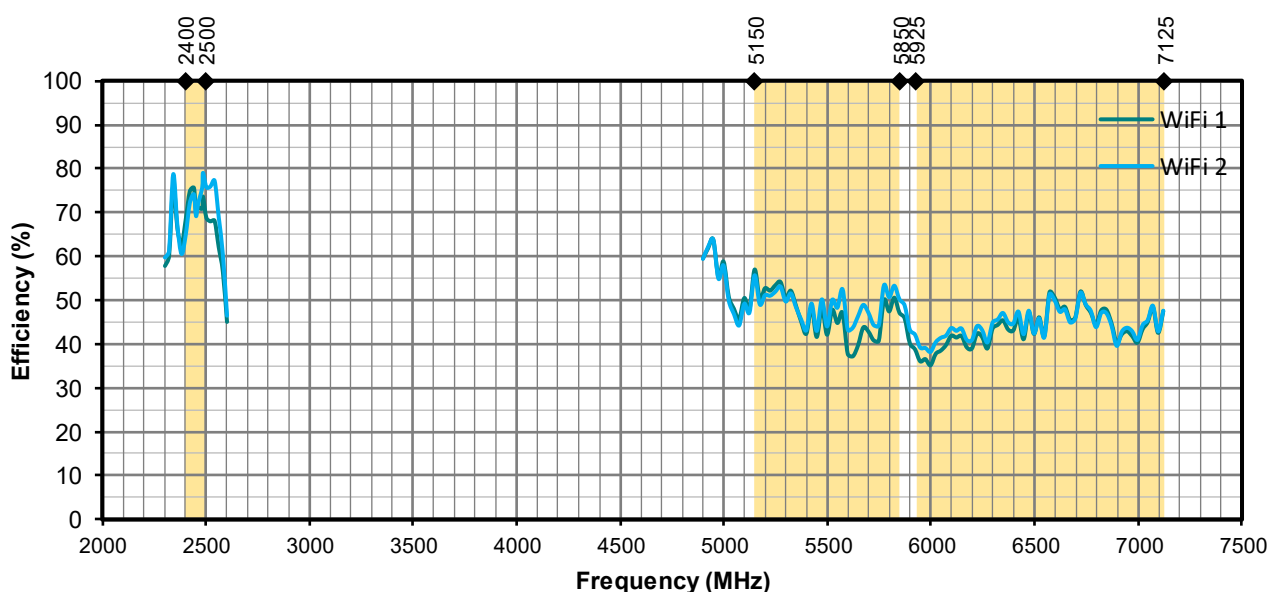


Figure 10. Antenna Efficiency, WiFi

Antenna Isolation, WiFi

Antenna isolation (**Figure 11**), is a measure of how easily one antenna will pick up radiation from another antenna. It provides information about power transfer between adjacent antennas. A lower antenna isolation value indicates lower interaction of adjacent antennas.

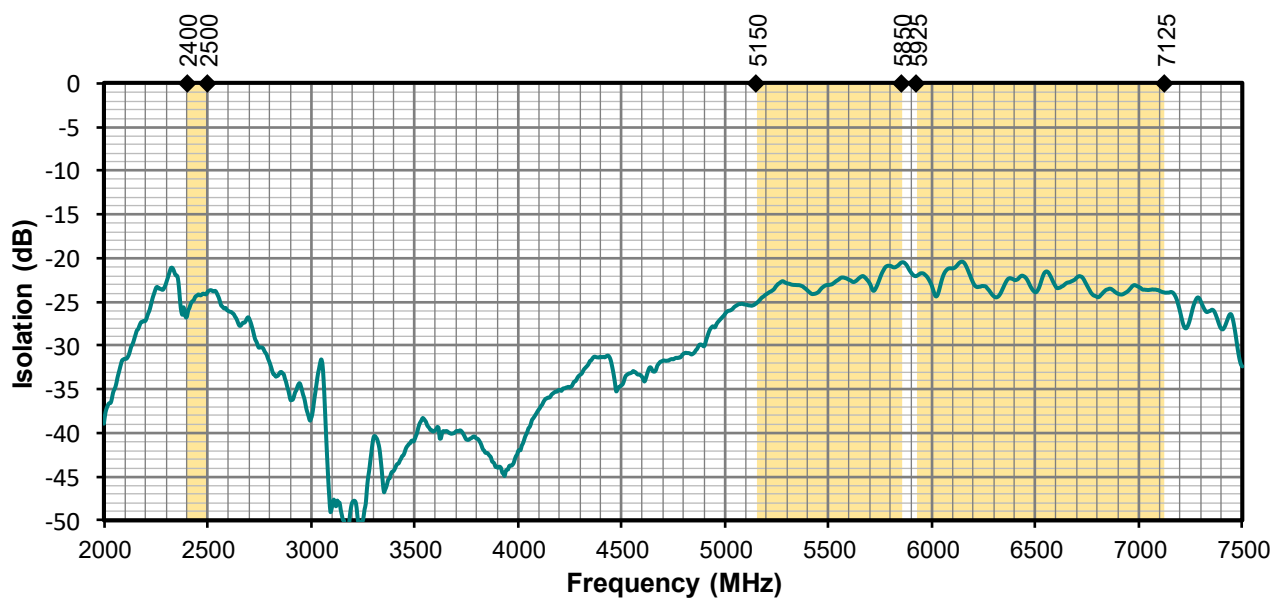


Figure 11. Antenna Isolation, WiFi

Radiation Patterns, WiFi

Radiation patterns provide information about the directionality and 3D gain performance of the antenna by plotting gain at specific frequencies in three orthogonal planes. Antenna radiation patterns for WiFi bands are shown in **Figure 12** using polar plots covering 360 degrees. The antenna graphic at the top of the page provides reference to the plane of the column of plots below it.



2400 MHz to 2500 MHz (2450 MHz)

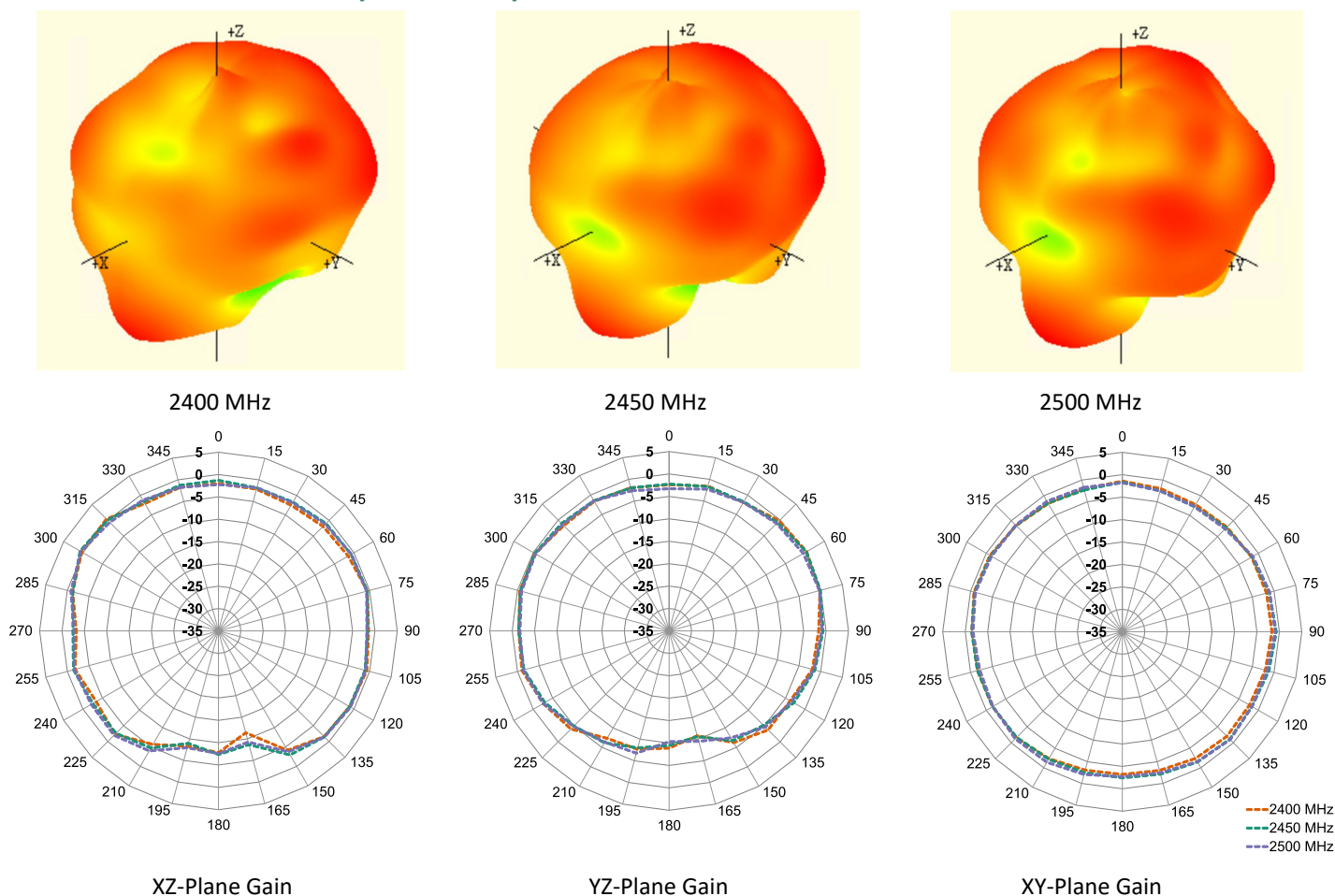
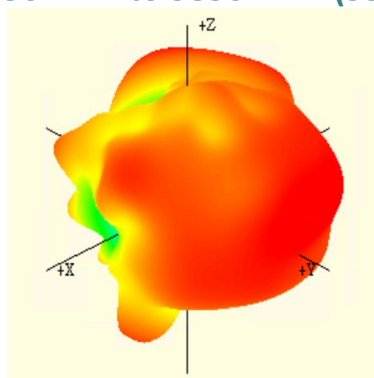
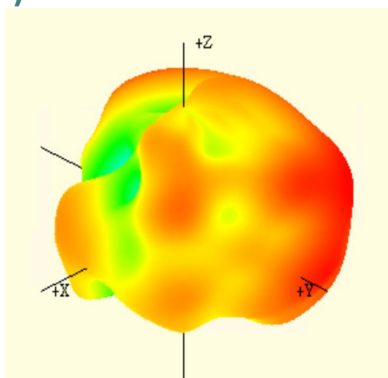


Figure 12. Antenna Radiation Patterns, WiFi

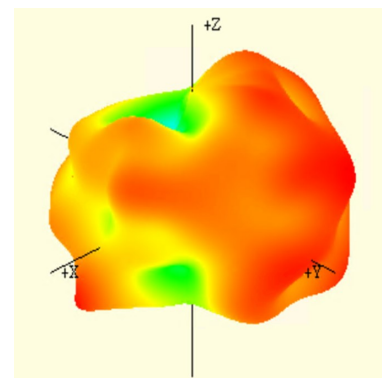
5150 MHz to 5850 MHz (5550 MHz)



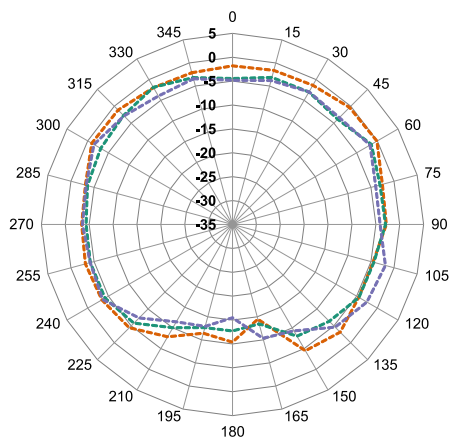
5150MHz



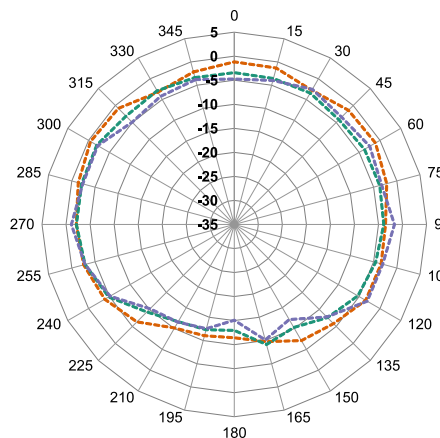
5500 MHz



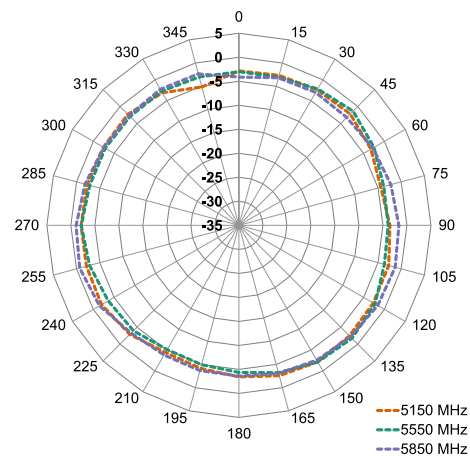
5850 MHz



XZ-Plane Gain

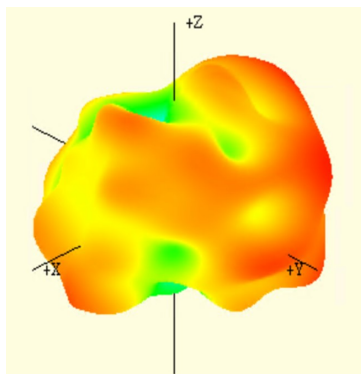


YZ-Plane Gain

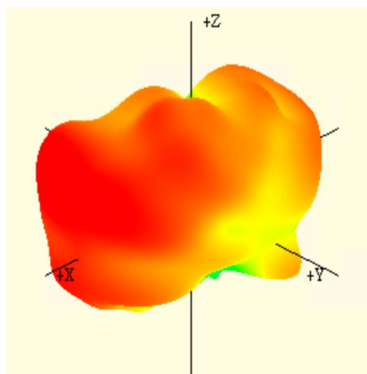


XY-Plane Gain

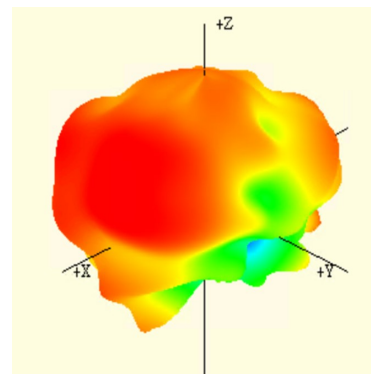
5925 MHz to 7125 MHz (6525 MHz)



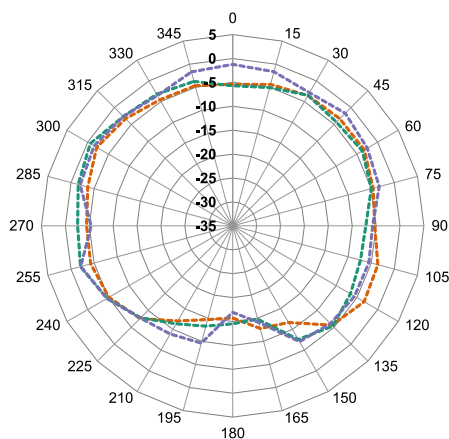
5925 MHz



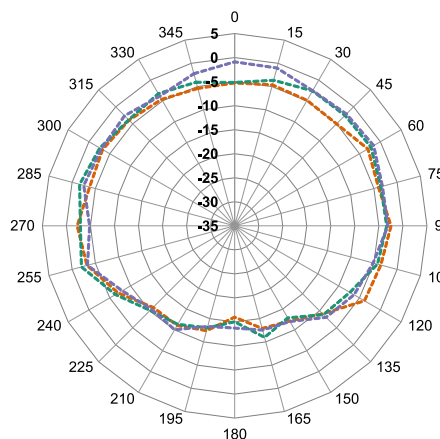
6525 MHz



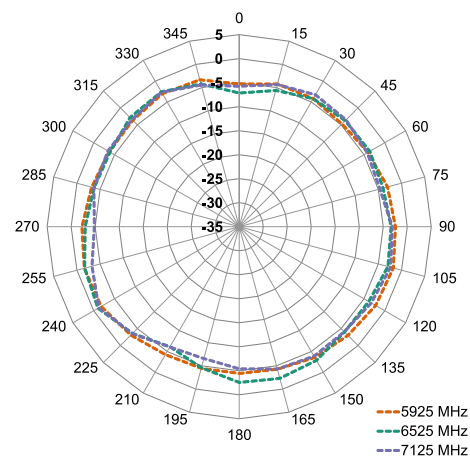
7125 MHz



XZ-Plane Gain



YZ-Plane Gain



XY-Plane Gain

VSWR, GNSS

Figure 13 provides the voltage standing wave ratio (VSWR) across the antenna bandwidth. VSWR is a function of the reflection coefficient, which describes the power reflected from the antenna back to the radio. 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 gauge of the percentage of transmitter power reflected back from the antenna.

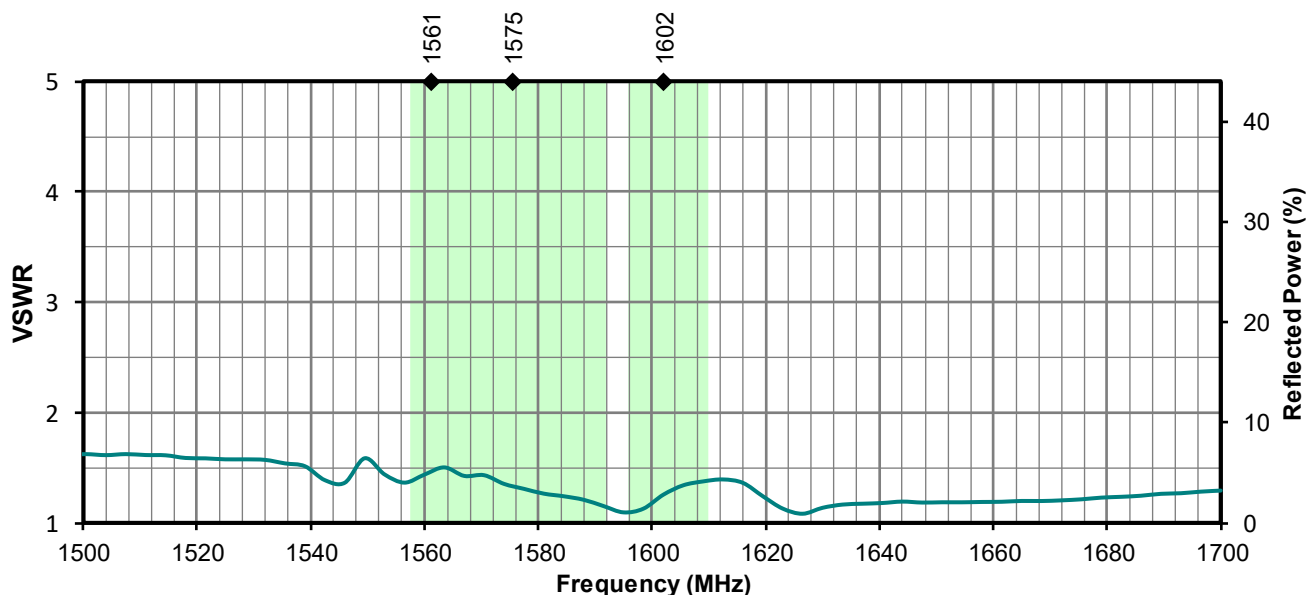


Figure 13. Antenna VSWR, GNSS

Return Loss, GNSS

Return loss (**Figure 14**), represents the loss in power at the antenna due to reflected signals. Like VSWR, a lower return loss value indicates better antenna performance at a given frequency.

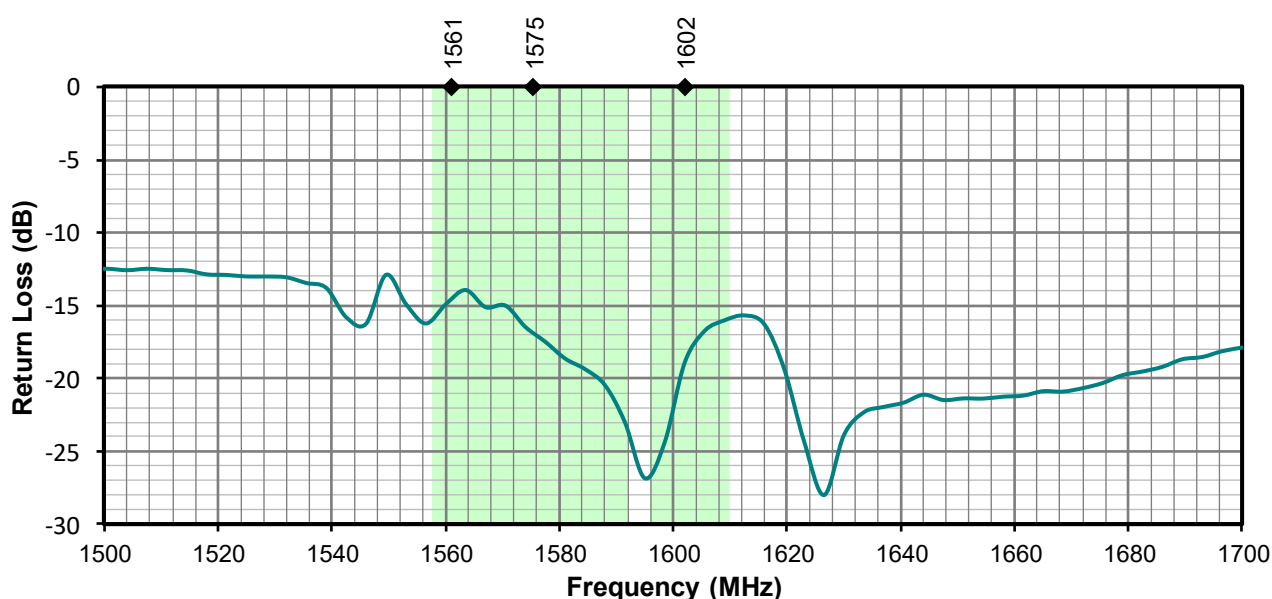


Figure 14. Antenna Return Loss, GNSS

Total Peak Gain, GNSS

The peak gain across the antenna bandwidth is shown in **Figure 15**. Peak gain represents the maximum antenna input power concentration across 3-dimensional space, and therefore peak performance at a given frequency, but does not consider any directionality in the gain pattern.

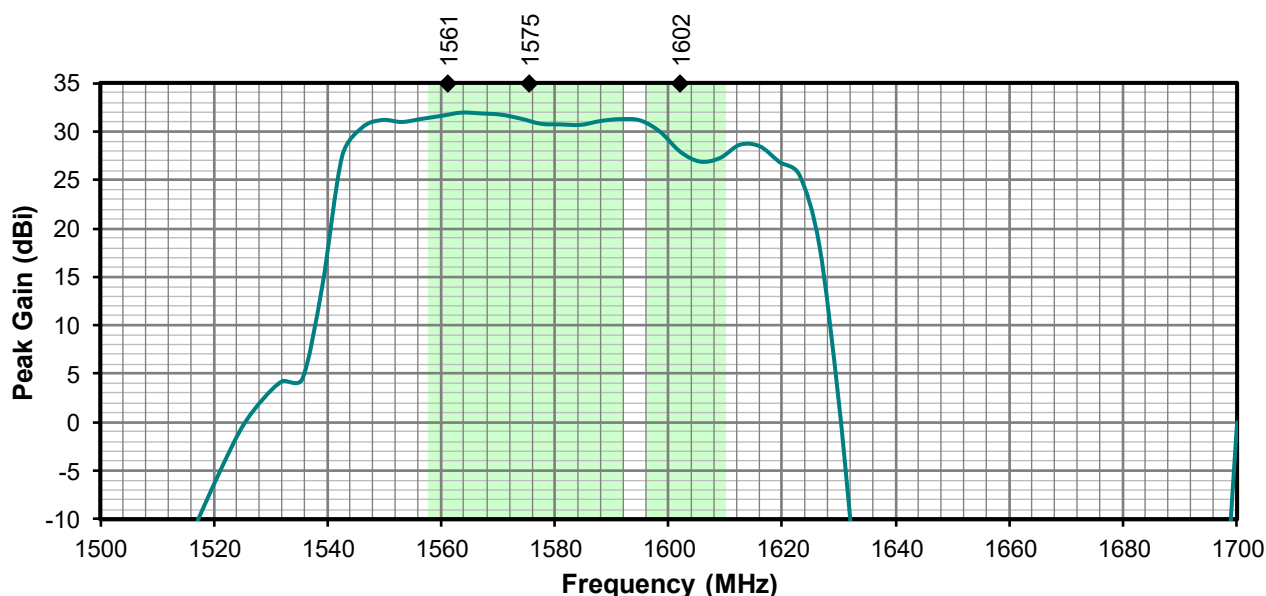


Figure 15. Antenna Total Peak Gain, GNSS

Noise Figure, GNSS

Noise Factor is the measure of degradation of the signal to noise ratio in a device. It is the ratio of the Signal to Noise Ratio at the input to the Signal to Noise Ratio at the output. The Noise Figure (**Figure 16**) is noise factor expressed in decibels (dB). The lower, the better. Less than **2 dB** might be considered an adequate Noise Figure value.

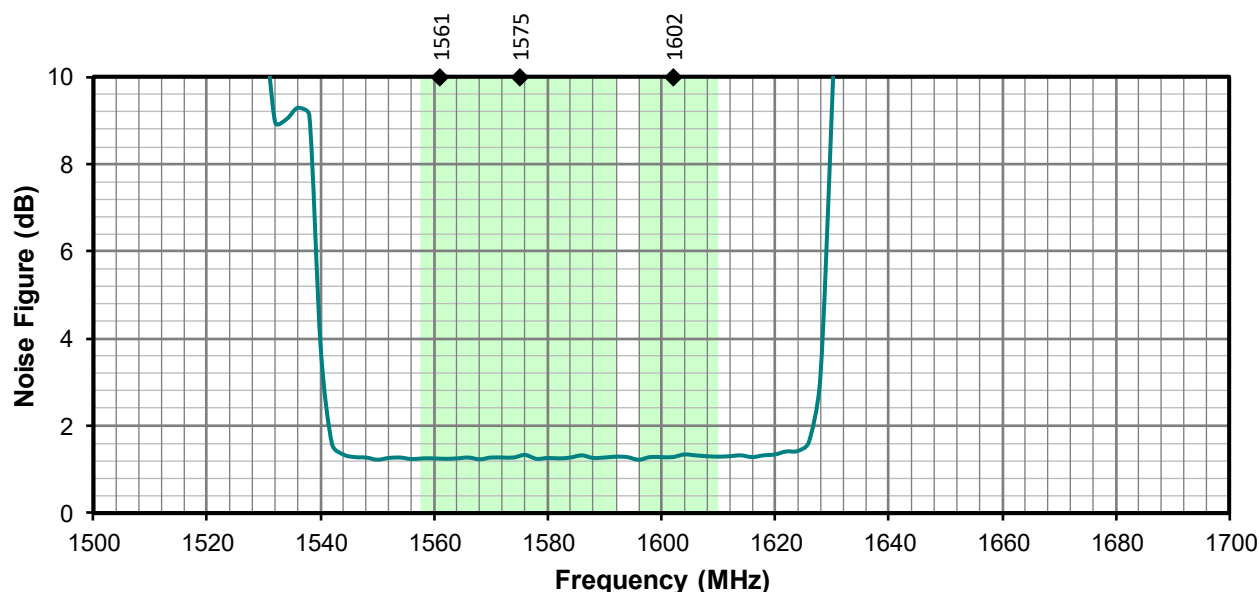


Figure 16. Noise Figure, GNSS

Axial Ratio, GNSS

Axial Ratio (**Figure 17**) is the ratio of orthogonal components of an E-field. A circularly polarized field is made up of two orthogonal E-field components of equal amplitude (and 90 degrees out of phase). Axial ratio provides a measure of the quality of antenna circular polarization, the lower the value (in dB), the better the circular polarization. The ideal value of the axial ratio for circularly polarized fields is **0 dB (1)**. In practice, no antenna is perfectly circular in polarization, less than **3 dB** might be an adequate value.

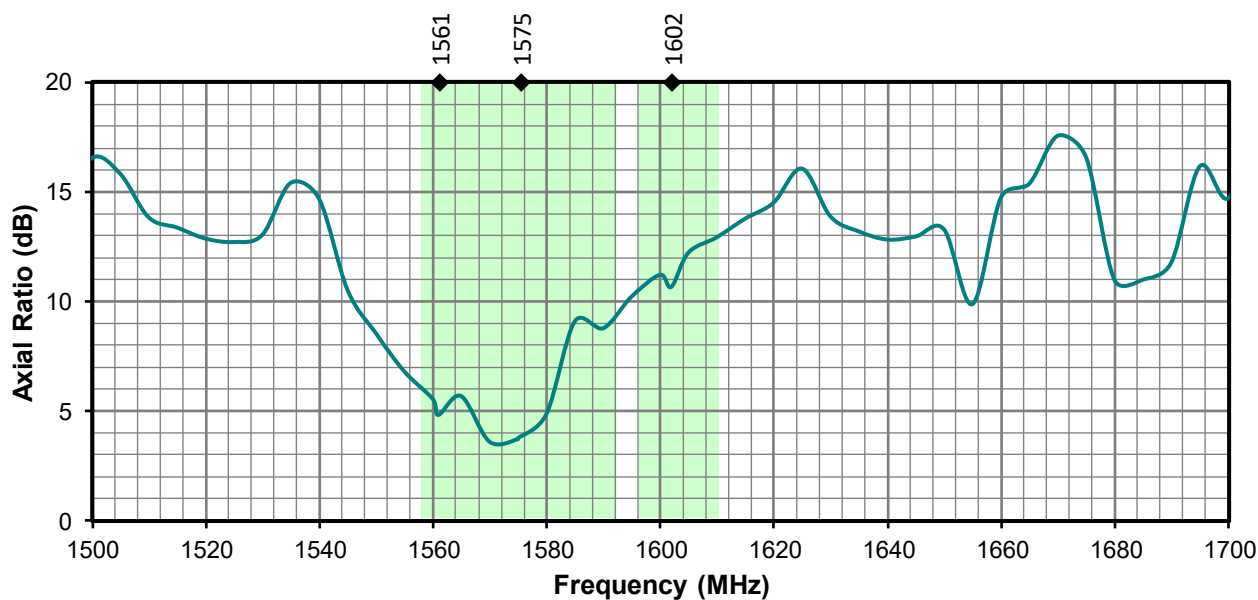
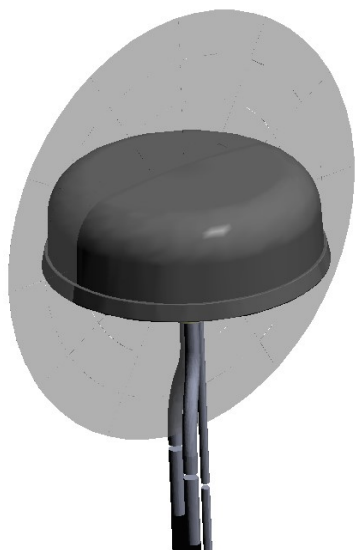


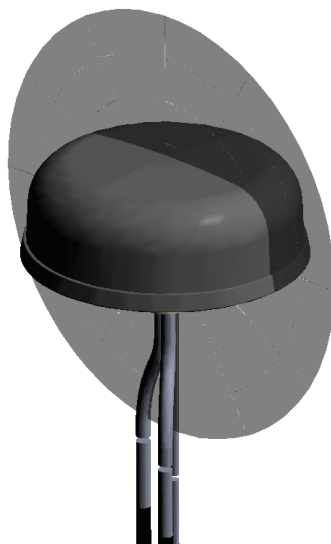
Figure 17. Axial Ratio, GNSS

Passive Antenna Radiation Patterns, GNSS

Radiation patterns provide information about the directionality and 3D gain performance of the antenna by plotting gain at specific frequencies in three orthogonal planes. Antenna radiation patterns for GNSS bands are shown in **Figure 18** using polar plots covering 360 degrees. The antenna graphic at the top of the page provides reference to the plane of the column of plots below it.



XZ-Plane Gain

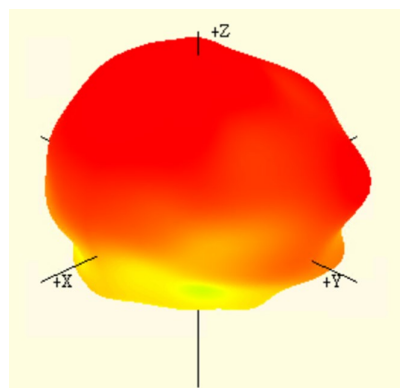


YZ-Plane Gain

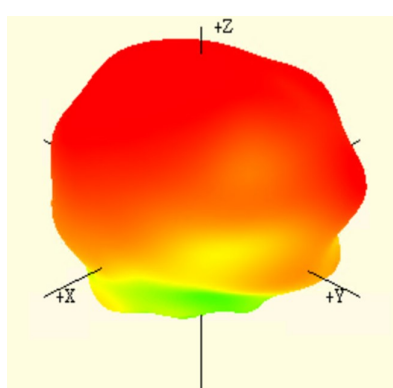


XY-Plane Gain

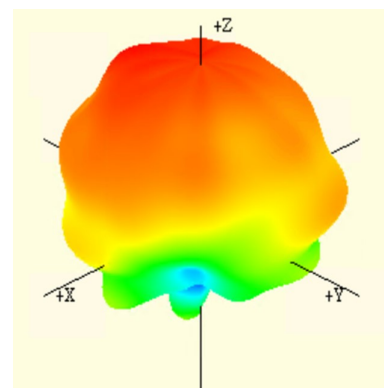
1561 MHz to 1602 MHz (1575.42 MHz)



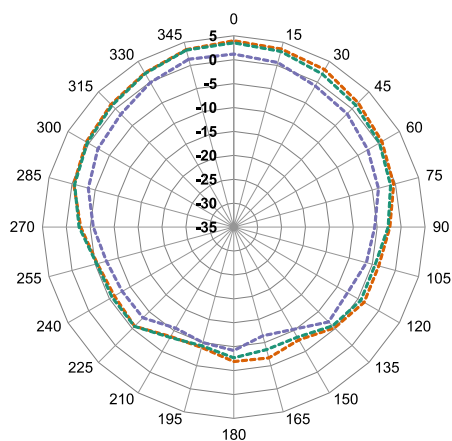
1561 MHz



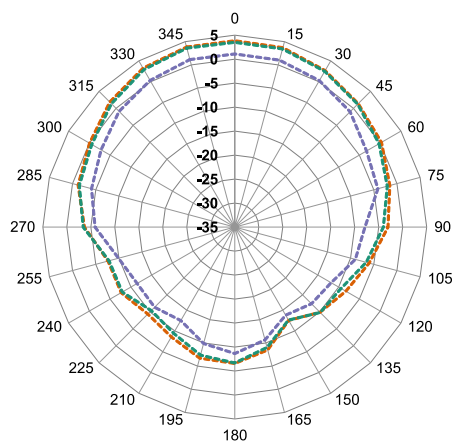
1575.42 MHz



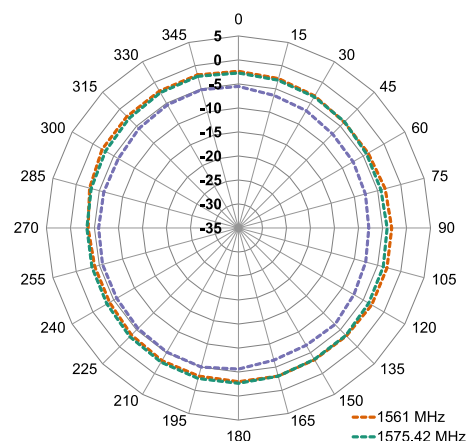
1602 MHz



XZ-Plane Gain



YZ-Plane Gain



XY-Plane Gain

Figure 18. Passive Antenna Radiation Patterns, GNSS

Antenna Test Setup, On a 350 mm Ground Plane

The charts on the following pages represent data taken with a 350 mm (13.78 in.) diameter metal plate - providing insight into antenna performance when attached to metal surfaces such as vehicle roof as shown in **Figure 19**. Connection is made to the radio through 0.3M long RG316 coaxial cables for WiFi, and 0.3M long RG316 coaxial cable for GNSS.

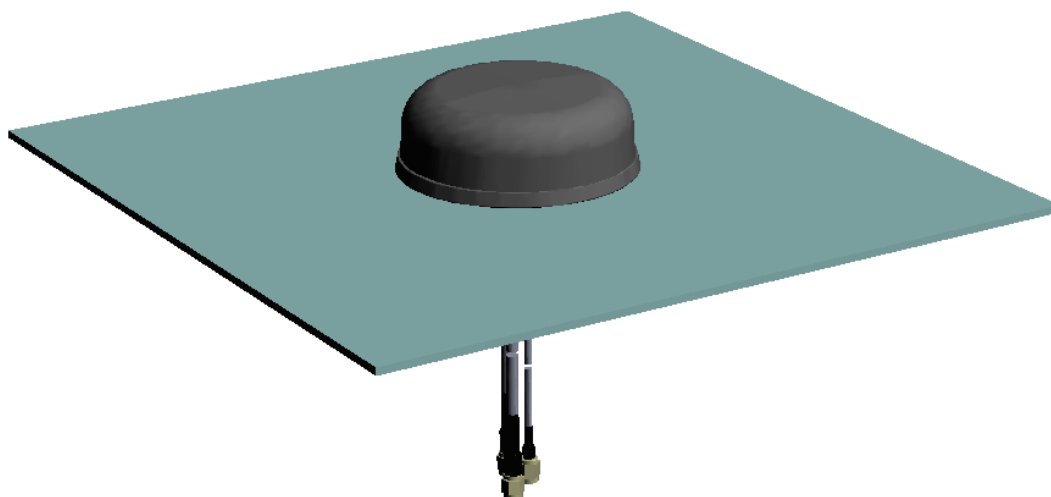


Figure 19. Antenna Test Setup - on a 350mm ground plane

VSWR, WiFi

Figure 20 provides the voltage standing wave ratio (VSWR) across the antenna bandwidth. VSWR is a function of the reflection coefficient, which describes the power reflected from the antenna back to the radio. 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 gauge of the percentage of transmitter power reflected back from the antenna.

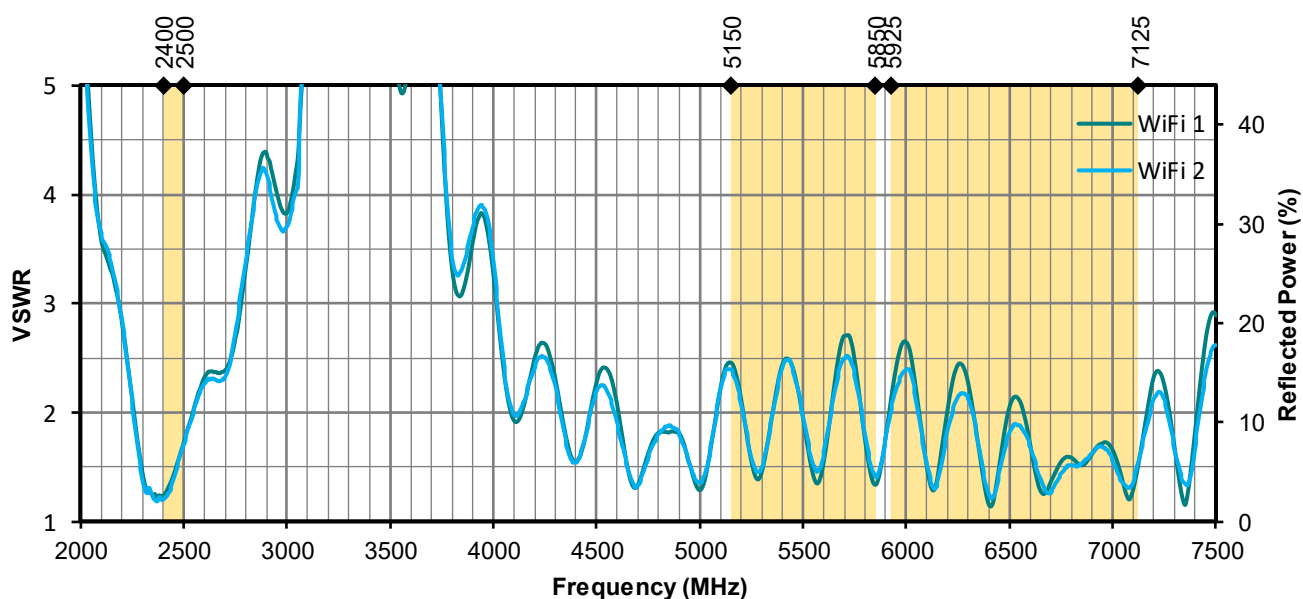


Figure 20. Antenna VSWR, WiFi

Return Loss, WiFi

Return loss (**Figure 21**), represents the loss in power at the antenna due to reflected signals. Like VSWR, a lower return loss value indicates better antenna performance at a given frequency.

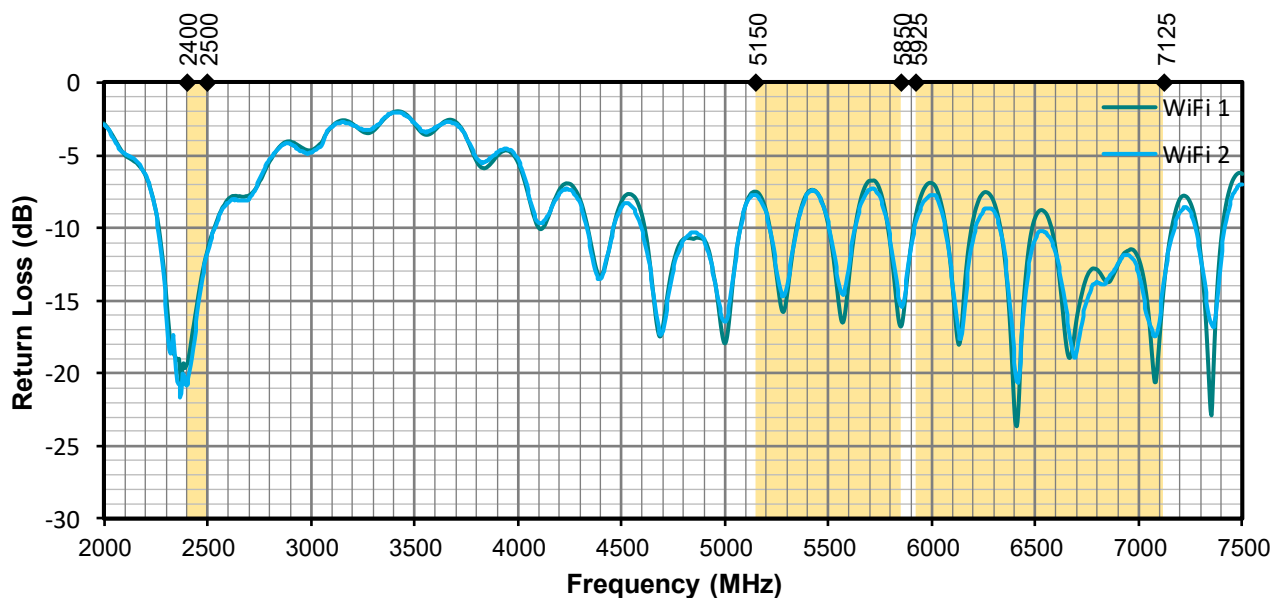


Figure 21. Antenna Return Loss, WiFi

Peak Gain, WiFi

The peak gain across the antenna bandwidth is shown in **Figure 22**. Peak gain represents the maximum antenna input power concentration across 3-dimensional space, and therefore peak performance at a given frequency, but does not consider any directionality in the gain pattern.

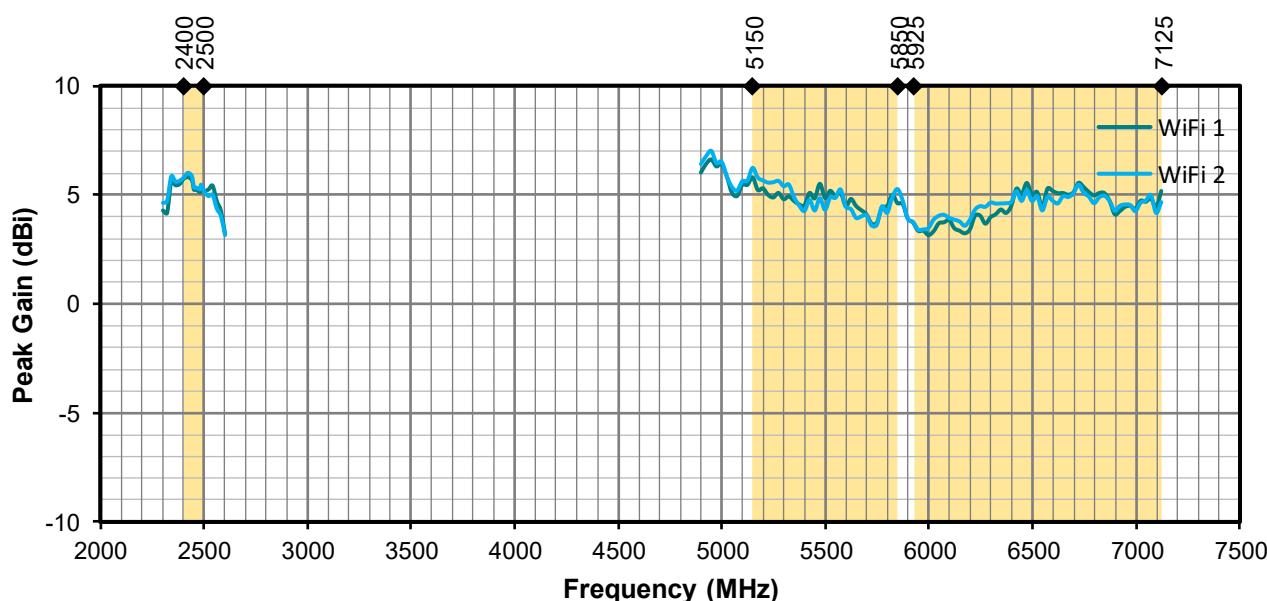


Figure 22. Antenna Peak Gain, WiFi

Average Gain, WiFi

Average gain (**Figure 23**), is the average of all antenna gain in 3-dimensional space at each frequency, providing an indication of overall performance without expressing antenna directionality.

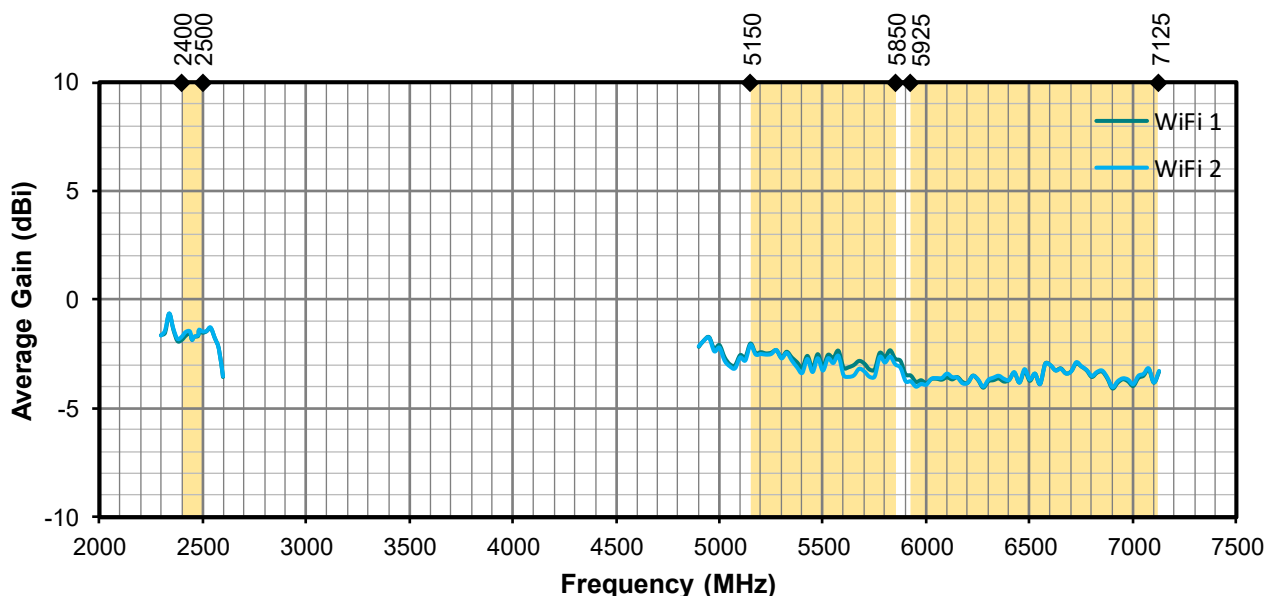


Figure 23. Antenna Average Gain, WiFi

Radiation Efficiency, WiFi

Radiation efficiency (**Figure 24**), shows the ratio of power radiated by the antenna relative to the power supplied to the antenna, expressed as a percentage, where a higher percentage indicates better performance at a given frequency. An ideal antenna has 100% efficiency. But in really world, usually an external antenna radiates only 50~60% of power supplied to it.

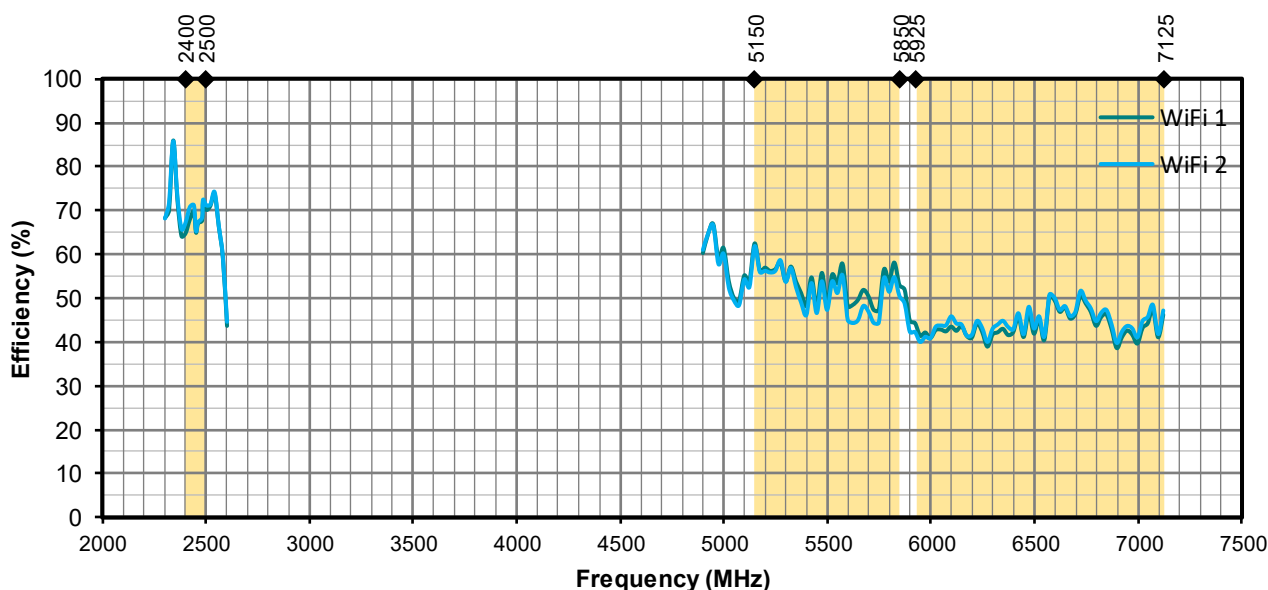


Figure 24. Antenna Efficiency, WiFi

Antenna Isolation, WiFi

Antenna isolation (**Figure 25**), is a measure of how easily one antenna will pick up radiation from another antenna. It provides information about power transfer between adjacent antennas. A lower antenna isolation value indicates lower interaction of adjacent antennas.

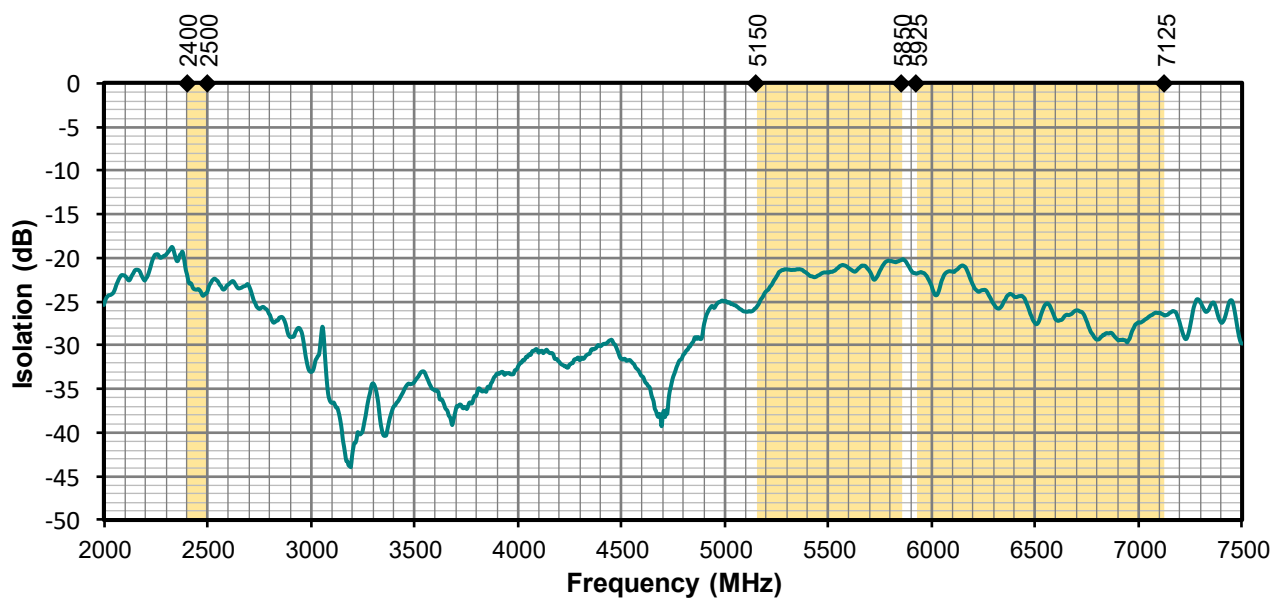
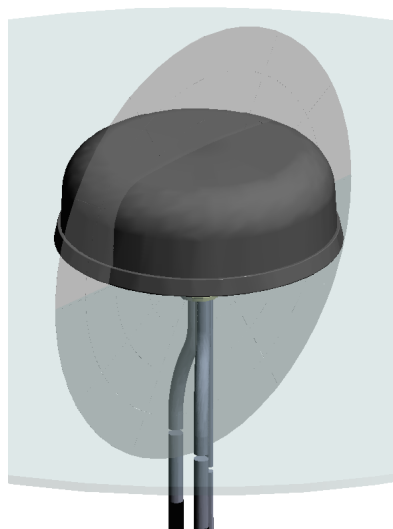


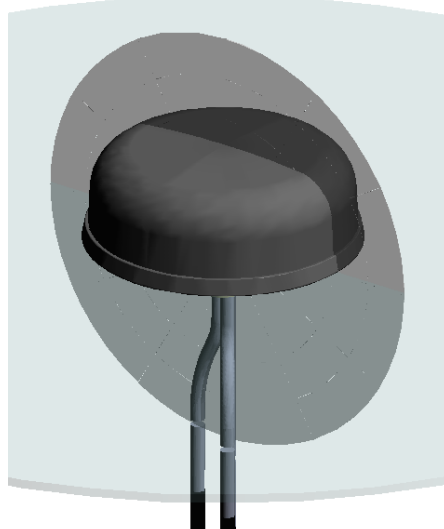
Figure 25. Antenna Isolation, WiFi

Radiation Patterns, WiFi

Radiation patterns provide information about the directionality and 3D gain performance of the antenna by plotting gain at specific frequencies in three orthogonal planes. Antenna radiation patterns for WiFi bands are shown in **Figure 26** using polar plots covering 360 degrees. The antenna graphic at the top of the page provides reference to the plane of the column of plots below it.



XZ-Plane Gain

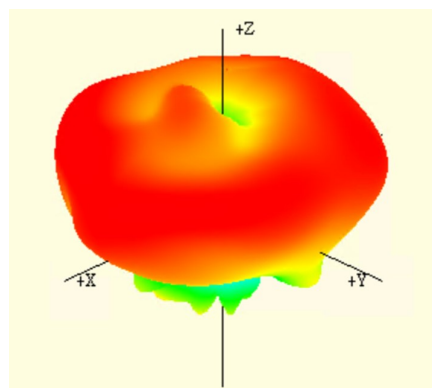


YZ-Plane Gain

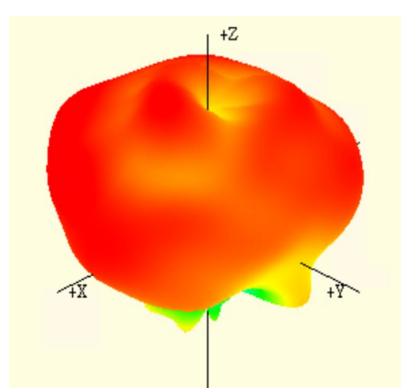


XY-Plane Gain

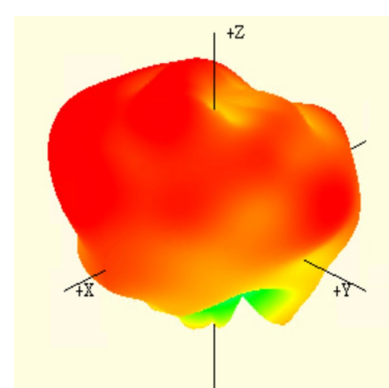
2400 MHz to 2500 MHz (2450 MHz)



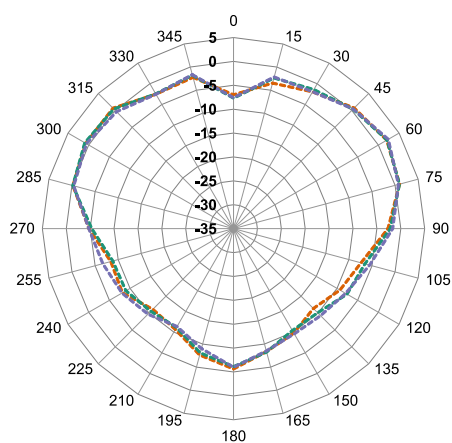
2400 MHz



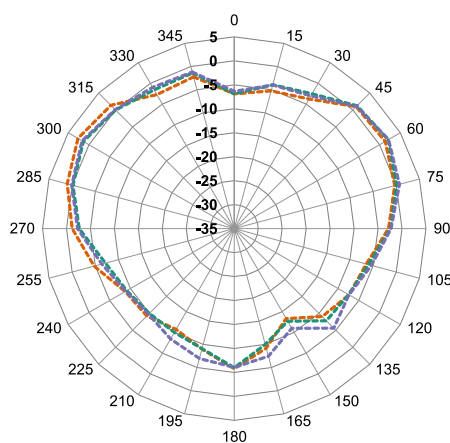
2450 MHz



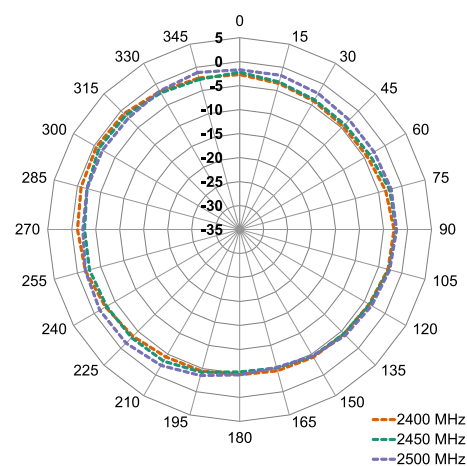
2500 MHz



XZ-Plane Gain



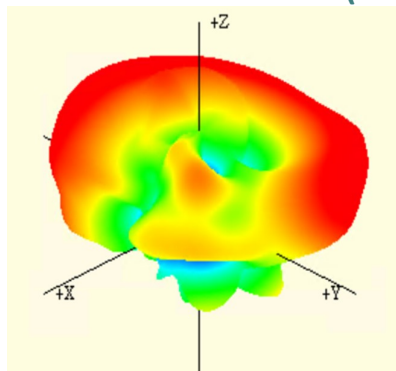
YZ-Plane Gain



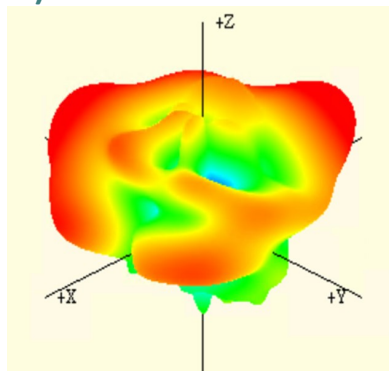
XY-Plane Gain

Figure 26. Antenna Radiation Patterns, WiFi with round plane

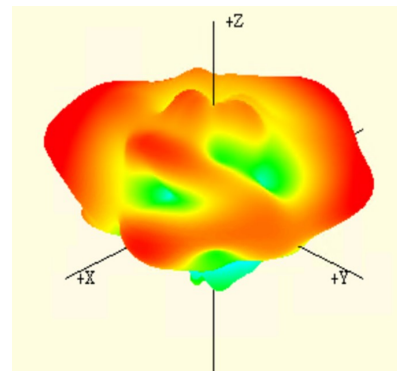
5150 MHz to 5850 MHz (5550 MHz)



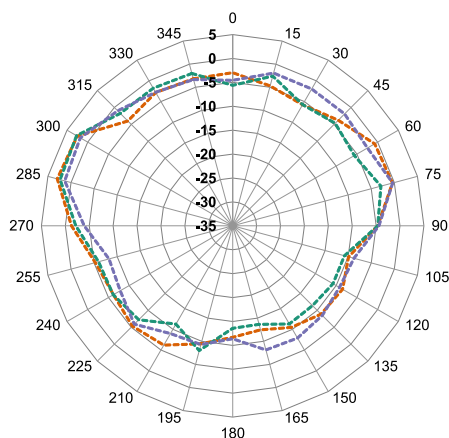
5150MHz



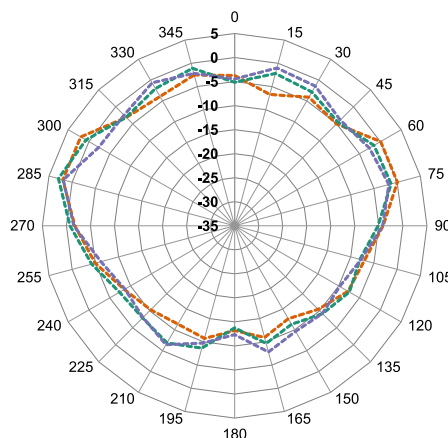
5500 MHz



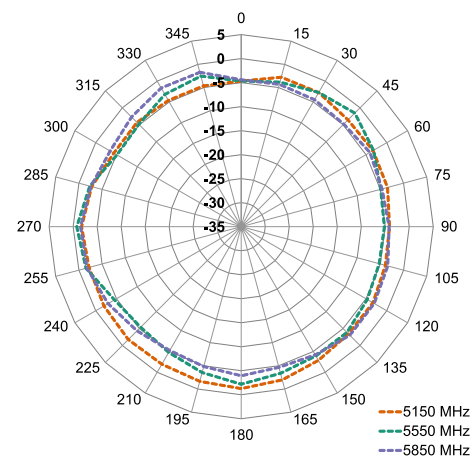
5850 MHz



XZ-Plane Gain

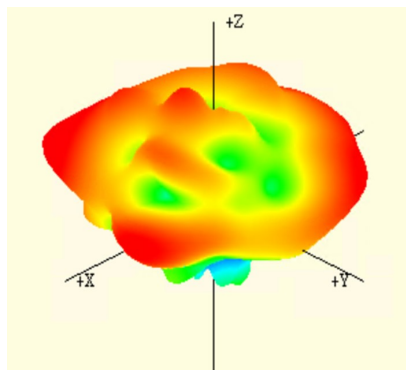


YZ-Plane Gain

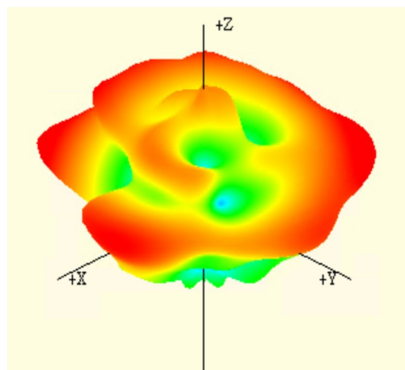


XY-Plane Gain

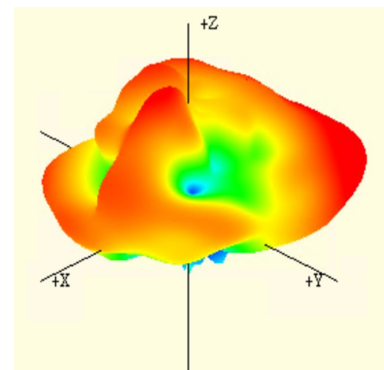
5925 MHz to 7125 MHz (6525 MHz)



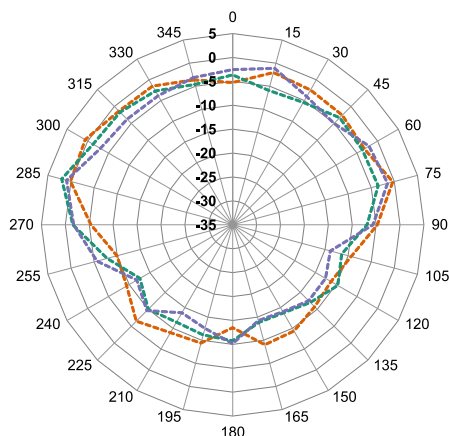
5925 MHz



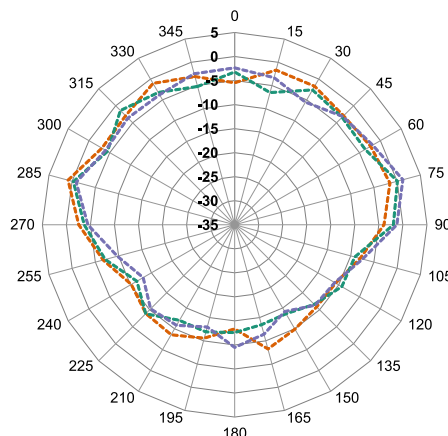
6525 MHz



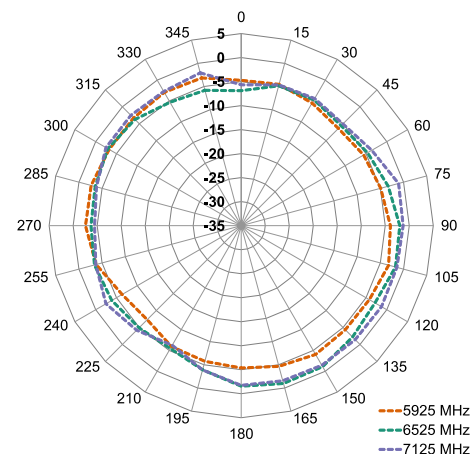
7125 MHz



XZ-Plane Gain



YZ-Plane Gain



XY-Plane Gain

VSWR, GNSS

Figure 27 provides the voltage standing wave ratio (VSWR) across the antenna bandwidth. VSWR is a function of the reflection coefficient, which describes the power reflected from the antenna back to the radio. 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 gauge of the percentage of transmitter power reflected back from the antenna.

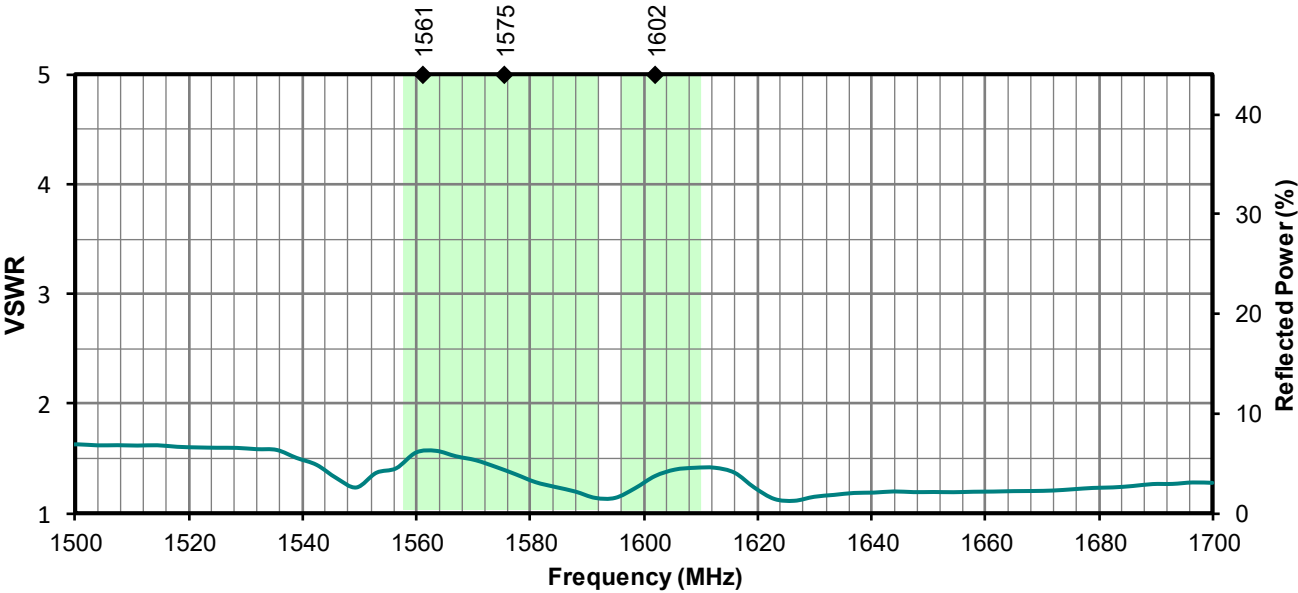


Figure 27. Antenna VSWR, GNSS

Return Loss, GNSS

Return loss (**Figure 28**), represents the loss in power at the antenna due to reflected signals. Like VSWR, a lower return loss value indicates better antenna performance at a given frequency.

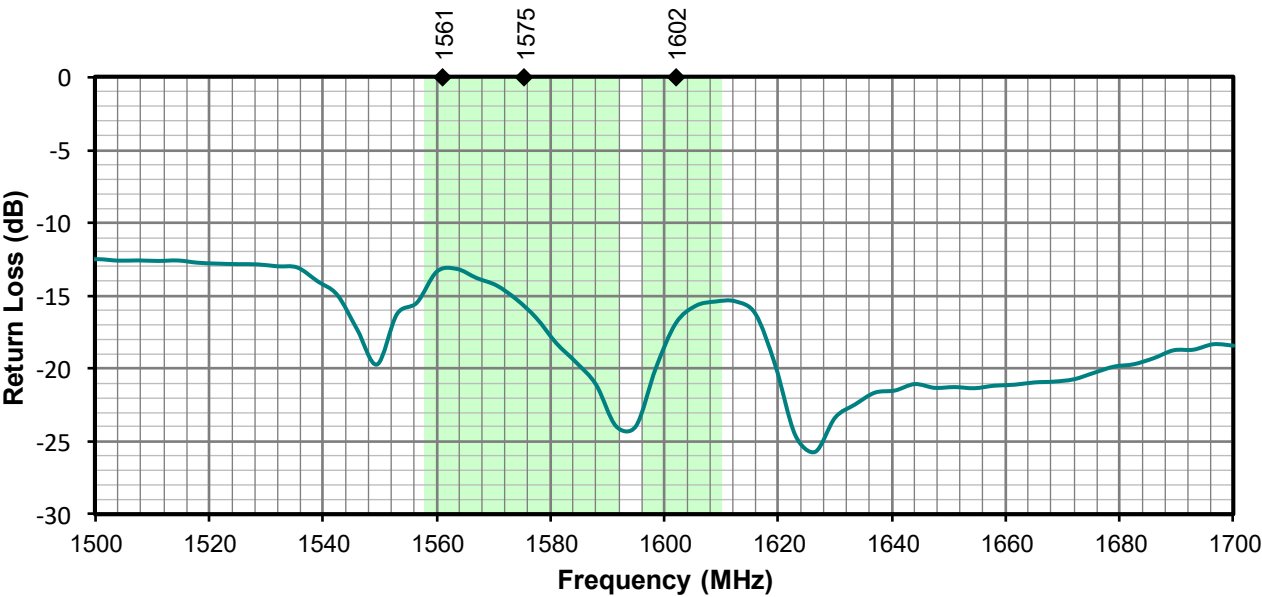


Figure 28. Antenna Return Loss, GNSS

Total Peak Gain, GNSS

The peak gain across the antenna bandwidth is shown in **Figure 29**. Peak gain represents the maximum antenna input power concentration across 3-dimensional space, and therefore peak performance at a given frequency, but does not consider any directionality in the gain pattern.

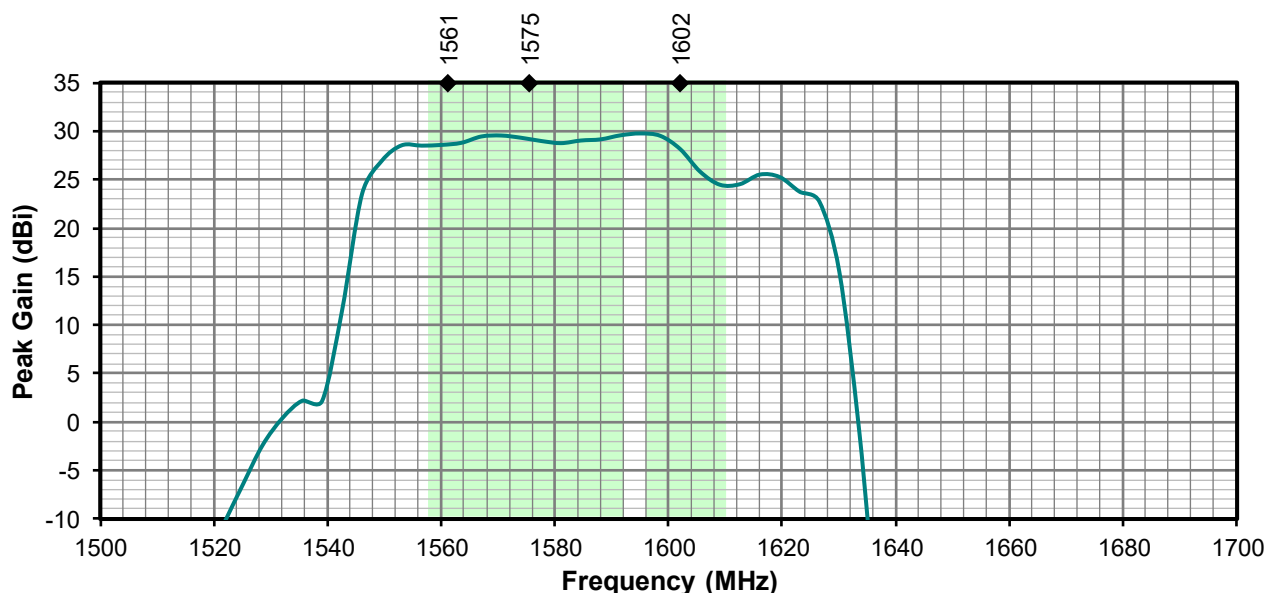


Figure 29. Total Peak Gain, GNSS

Noise Figure, GNSS

Noise Factor is the measure of degradation of the signal to noise ratio in a device. It is the ratio of the Signal to Noise Ratio at the input to the Signal to Noise Ratio at the output. The Noise Figure (**Figure 30**) is noise factor expressed in decibels (dB). The lower, the better. Less than **2 dB** might be considered an adequate Noise Figure value.

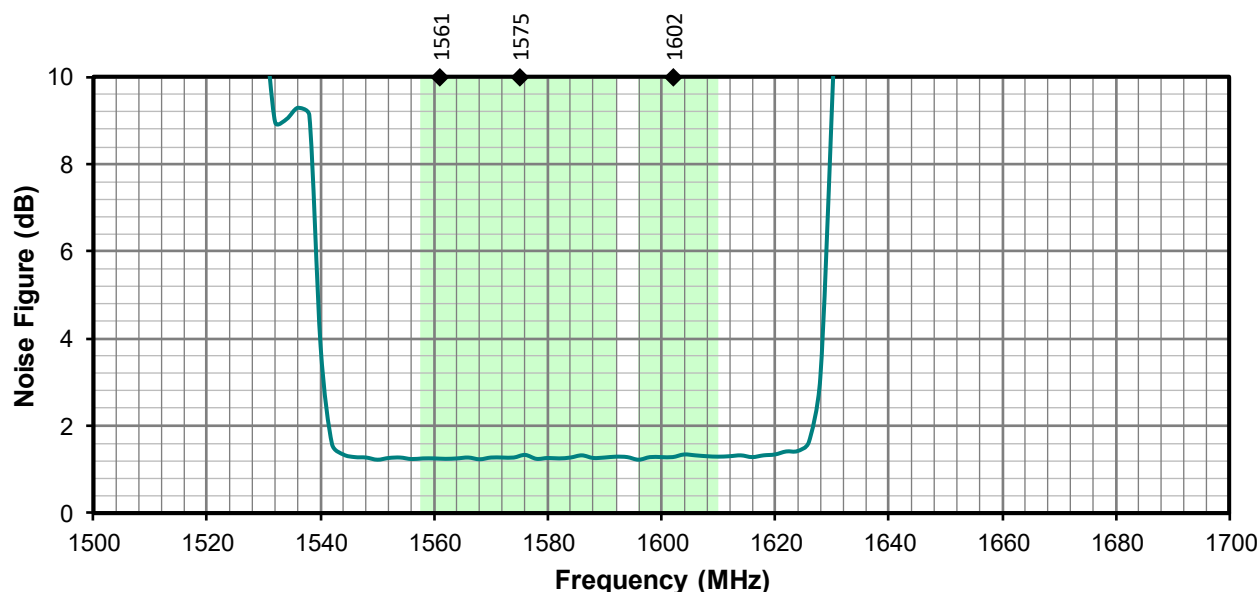


Figure 30. Noise Figure, GNSS

Axial Ratio, GNSS

Axial Ratio (**Figure 31**) is the ratio of orthogonal components of an E-field. A circularly polarized field is made up of two orthogonal E-field components of equal amplitude (and 90 degrees out of phase). Axial ratio provides a measure of the quality of antenna circular polarization, the lower the value (in dB), the better the circular polarization. The ideal value of the axial ratio for circularly polarized fields is **0 dB (1)**. In practice, no antenna is perfectly circular in polarization, less than **3 dB** might be an adequate value.

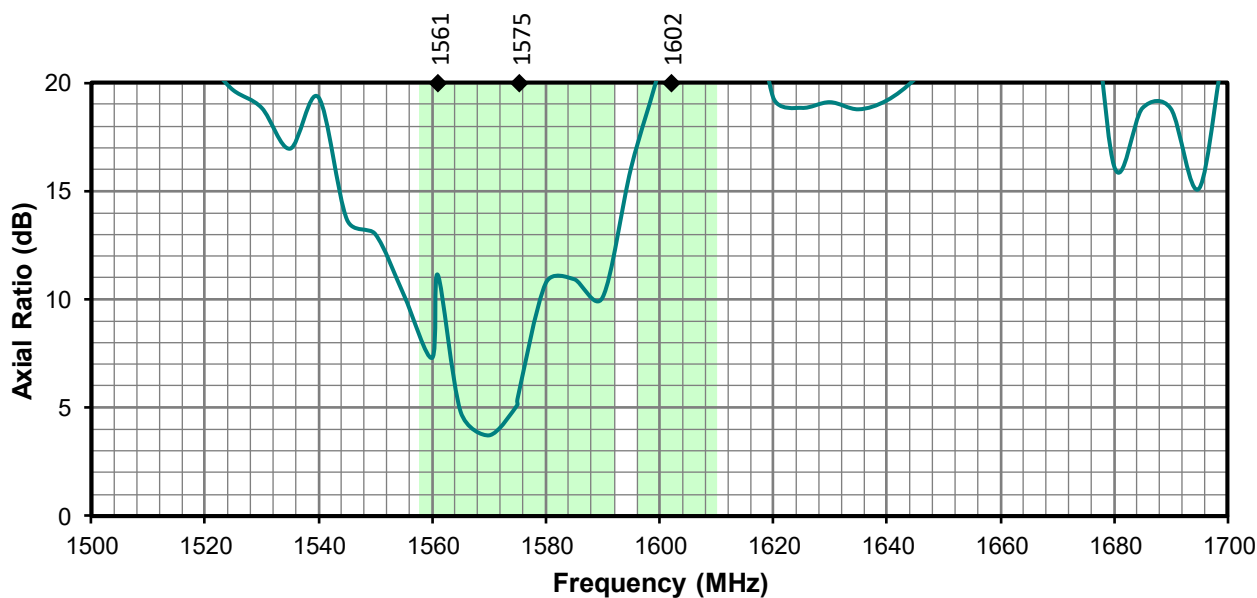
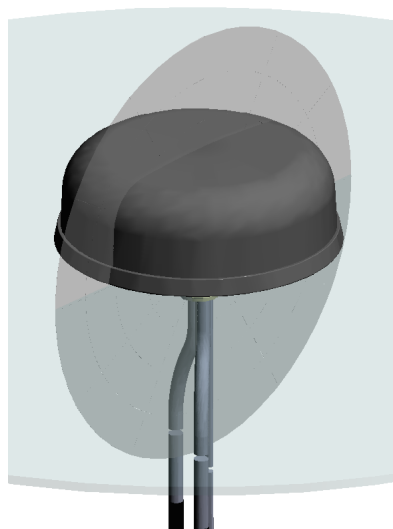


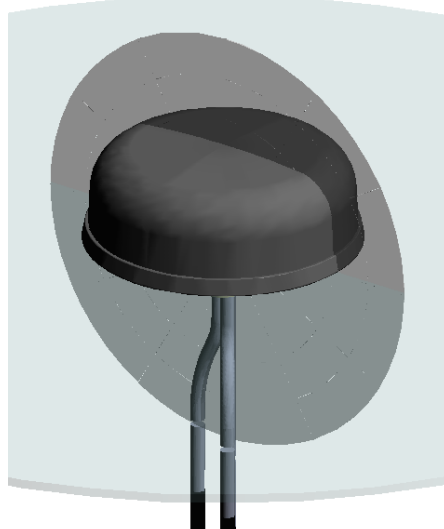
Figure 31. Axial Ratio, GNSS

Passive Antenna Radiation Patterns, GNSS

Radiation patterns provide information about the directionality and 3D gain performance of the antenna by plotting gain at specific frequencies in three orthogonal planes. Antenna radiation patterns with ground plane for GNSS bands are shown in **Figure 32** using polar plots covering 360 degrees. The antenna graphic at the top of the page provides reference to the plane of the column of plots below it.



XZ-Plane Gain

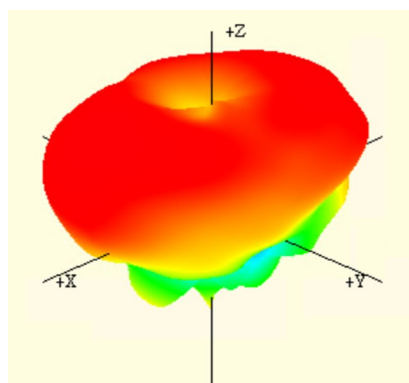


YZ-Plane Gain

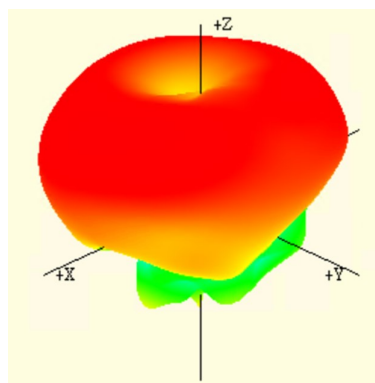


XY-Plane Gain

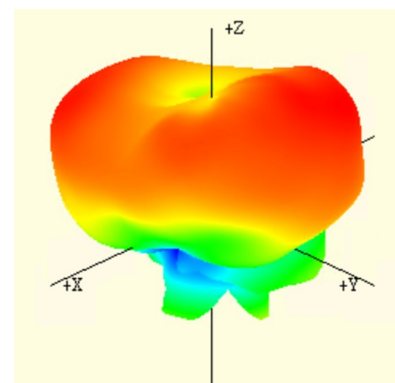
1561 MHz to 1602 MHz (1575.42 MHz)



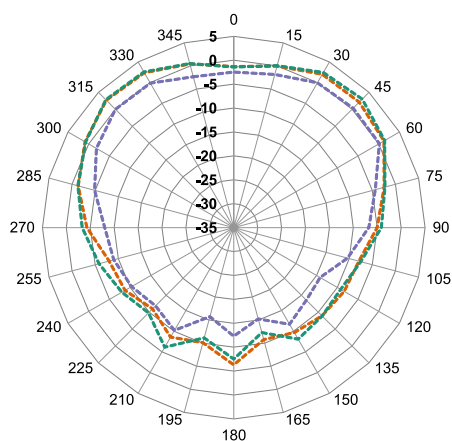
1561 MHz



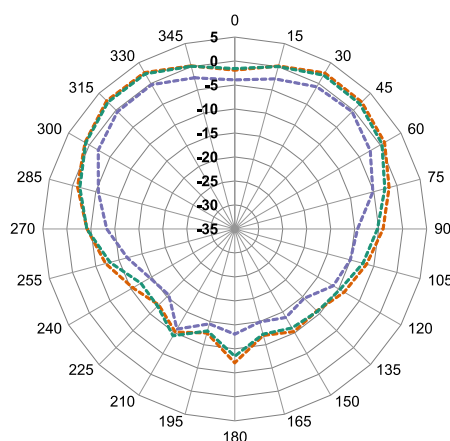
1575.42 MHz



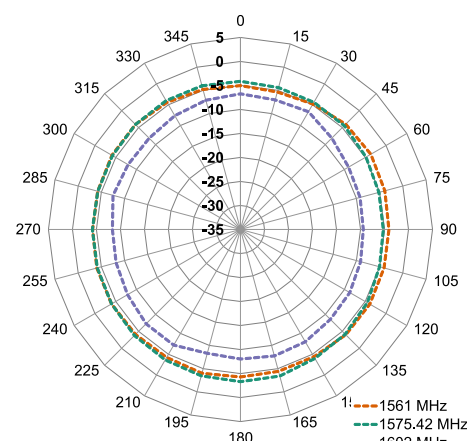
1602 MHz



XZ-Plane Gain



YZ-Plane Gain



XY-Plane Gain

Figure 32. Passive Antenna Radiation Patterns, GNSS with ground plane

Antenna FAQs

Q: What is an antenna?

An antenna is used for transmission or reception of radio signals in wireless communication.

Q: How do antennas work?

Electricity flowing into the transmitter antenna makes electrons vibrate up and down it, producing radio waves. The radio waves travel through the air at the speed of light. When the waves arrive at the receiver antenna, they make electrons vibrate inside it.

Q: Does antenna size matter?

A bigger antenna, properly designed, will always have more **gain** than a smaller one. And it will be the best kind of **gain**, much better than using a small antenna and simply over-amplifying it, because a small antenna just won't pull in truly weak signals like this gigantic one will.

Q: What is the advantage of external antennas?

External antennas usually offer **better bandwidth** and **high performance** due to the nature of their larger size. This often results in a higher rated **gain** (dBi) than their internal counterparts. Due to its smaller size, an internal antenna would not function well to support lower frequencies.

Ease of integration – an external antenna requires fewer design resources and shorter time to integrate to allow for a more rapid time-to-market. An internal antenna's performance is influenced by device environment – PCB ground plane, nearby metal part, and enclosure. That would require much more effort such as impedance matching network to complete antenna design.

Q: Why is most antenna impedance 50 Ohm?

50 Ohm is an industry standard of coax cables and power amplifiers. It was chosen as a tradeoff between maximum power handling for the transmit coax and the copper losses. The optimum would have been anyway in the range of **30 to 100 ohm** with average at 50 Ohm.

Q: Why does GNSS require RHCP (Right-hand-circularly-polarized) antennas?

Satellite's signal has a low power density, especially after propagating through the **atmosphere** (**ionosphere** affect radio wave). Polarized waves oscillate in more than one direction, which deliver satellite's signal to receiver on Earth surface more effectively.

MATING COMPONENTS: RF COAXIAL CONNECTOR AND CABLE ASSEMBLY

Part Number	Image	Connector 1 (Receptacle)	Connector 2 (Plug)	Cable Length		Cable Diameter (mm)
				mm	Inch	
CX-SACOMPA1W0020		RP-SMA Jack Male Pin Straight	MHF1	200	7.87	1.13
CX-SATOMFA1W0030		RP-SMA Jack Male Pin Straight	MHF4L	300	11.81	1.13
CT-SAD12X-006M		RP-SMA Jack Male Pin Straight	N/A	N/A	N/A	N/A
CT-SAD11X-006M		RP-SMA Jack Male Pin Right Angle	N/A	N/A	N/A	N/A
CX-SAS0MPA1W0007		SMA Jack Female Socket Straight	MHF1	70	2.76	1.13
CX-SAZ0MPA1W0020		SMA Jack Female Socket Straight	MHF1	200	7.87	1.13
CT-SAB11X-006M		SMA Jack Female Socket Right Angle	N/A	N/A	N/A	N/A
CT-SAB41X		SMA Jack Female Socket Straight	N/A	N/A	N/A	N/A

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