Datasheet

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PPF-165A5SNB

5G/LTE WiFi GNSS All-in-1 MIMO antenna

The Joymax PPF-165A5SNB antenna provides an all-in-1 MIMO solution supporting 5G New Radio FR1, LTE, Cellular IoT (LTE-M, NB-IoT), WiFi 7/6E and GNSS in high mobility connectivity applications with broad bandwidth coverage. The product family includes multi-port solutions up to 8-ports along with different cable length and connector solution to suit major vehicular and smart traffic gateways application.

The antenna features IP67 rated waterproof design, omnidirectional radiation design, attaches with an SMA Plug (male pin) connector for 5G/LTE & GNSS, and RP-SMA Plug (female socket) connector for WiFi. Custom coaxial cable and length is available based on customer project requirement.

Features

- 5G/LTE, CBRS, WiFi, GNSS coverage from a single antenna
- Support 5G NR FR1 with broad bandwidth from 617 MHz to 7125 MHz
- Omnidirectional radiation
- Ground plane independent
- IP67 rated, waterproof design
- Low profile for vehicle installation
- Customizable cable length, connector

Applications

- 5G NR FR1, 4G, 3G, 2G, CBRS
- Cellular IoT: LTE-M (Cat-M1), NB-IoT
- CBRS Private Network (3550 to 3700MHz)
- C-Band applications (3700 to 4200MHz)
- Public Safety networks (4940 to 4990MHz)
- WLAN / WiFi 7, 6E, 6, 5, 4
- GNSS: Navigation, Location, Timing
- Fleet Management
- Smart Traffic Gateways

Ordering Information

Part Number	Description
PPF-165A5SNB-B200	5G/LTE x 2, WiFi 7/6E x 2, GNSS x 1 MIMO antenna, 2M coaxial cable & SMA connector
PPF-165A5SNB-Q200	5G/LTE x 2, WiFi 7/6E x 2, GNSS x 1 MIMO antenna, 2M coaxial cable & SMA connector
PPF-165A3S3B-Q200	5G/LTE x 2, GNSS x 1 MIMO antenna, 2M coaxial cable & SMA connector
PPF-165A7SNB-Q200	5G/LTE x 2, WiFi 7/6E x 4, GNSS x1 MIMO antenna, 2M coaxial cable & SMA connector
ZPF-165A8SPB-Q200	5G/LTE x 4, WiFi 7/6E x 4 MIMO antenna, 2M coaxial cable & SMA connector
PPF-165A5S3B-Q200	WiFi 7/6E x 4, GNSS x 1 MIMO antenna, 2M coaxial cable & RP-SMA connector

Available from Joymax Electronics and select distributors and representatives.

Table 1: Electrical Specifications

PPF-165A5SNB	5G NR / LTE Band (MHz)						WiFi / WLAN Band		
Frequency Range	617 ~ 960	1710 ~ 2690	3300 ~ 4200	4400 ~ 5000	5150 ~ 5850	5925 ~ 7125	2400 ~ 2500	5150 ~ 5850	5925 ~ 7125
VSWR (Max)	4.7	2.1	2.0	1.6	1.7	2.3	2.0	1.5	1.9
Peak Gain (dBi)	3.8	4.9	3.3	3.7	2.9	0.2	2.5	3.3	2.2
Average Gain (dBi)	-3.3	-3.0	-4.6	-4.3	-5.0	-9.0	-5.0	-5.3	-6.8
Efficiency (%)	48	51	35	38	32	13	32	30	21
Polarization	Linear								
Radiation	Omni directional								
Max Power	5 W								
Wavelength	¼-λ								
Electrical Type	Monopole								
Impedance	50 Ω								

Electrical specifications and plots measured with the antenna mount on a 600 mm diameter ground plane with 2 meter RG58 cable.

ATTENUATION FIGURES - 5 MM (0.195 INCH) DIAMETER CABLES									
Frequency Range (MHz)	698	960	1710	2650	3300	4400	5000	5850	7125
Cable Attenuation (dB/M)	< 0.4	< 0.5	< 0.6	< 0.8	< 0.9	< 1.1	< 1.2	< 1.3	< 1.7

	GNSS L1 Band (MHz)		
Frequency Range	1561	1575.42	1602
VSWR (Max)	1.7	1.5	1.6
Total Peak Gain (dBi)	29.5	30.9	29.2
Axial Ratio (dB)	13.6	4.5	5.7
Noise Figure (dB)	1.2	1.3	1.3
Polarization	RHCP		
Radiation	Directional		
Input Voltage	Typ. 3.3 V		
Power Consumption	Typ. 10 ± 2 mA @ 3.3 V		
Wavelength	½-λ		
Electrical Type	Radiating Patch plus 2-stage LNA		
Impedance	50 Ω		
ESD Sensitivity	Low ESD sensitivity		

Electrical specifications and plots measured with the antenna mount on a 600 mm diameter ground plane with 2 meter RG174 cable.

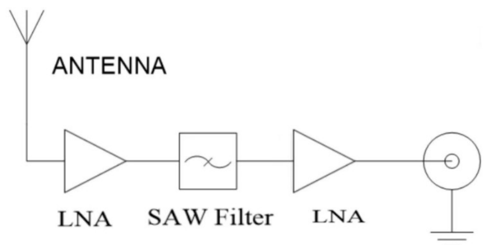
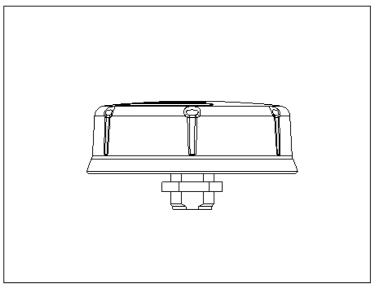


Table 2: Mechanical Specifications

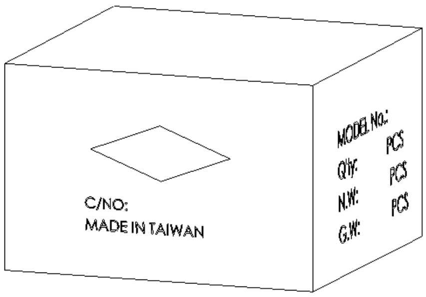
Parameter	Value
Number of Ports	3~8 port options available
Mounting Type	Permanent Panel Mount with Screw 1¼-18UNEF-2A
Mounting Hole	Diameter 1.26” (32 mm)
Cable Type	RG58 for 5G/LTE & WiFi, RG174 for GNSS
Cable Length	2M or Custom
Connection	SMA Plug (male pin) for 5G/LTE & GNSS, RP-SMA Plug (female socket) for WiFi
Baseplate Material	Aluminum
Radome Material	Polycarbonate + Acrylonitrile Butadiene Styrene (ABS)
Dimension	50 mm x ⌀ 141.3 mm
Weight	801 g
Storage Temp.	-40˚C to +85˚C
Operating Temp.	-40˚C to +85˚C
Antenna Color	Black
Ingress Protection	IP67

Packaging Information

The PPF-165A5SNB antennas are individually sealed in a clear plastic bag and packed into a small box as shown in **Figure 1**. 12 pcs per carton, 600 mm x 400 mm x 410 mm (23.6 in x 15.7 in x 16.1 in), total weight 14.5 kgs (32.0 lb). Distribution channels may offer alternative packaging options.



1 pce antenna/ 1 box



12 pcs antenna/1 Carton

Figure 1. Antenna Packaging

Product Dimensions

Figure 2 provides dimensions of the PPF-165A5SNB in mm measurement unit. The antenna can be directly mounted on device enclosure through 1¼-18UNEF-2A thread screw. The standard antenna pack excludes L bracket kit.

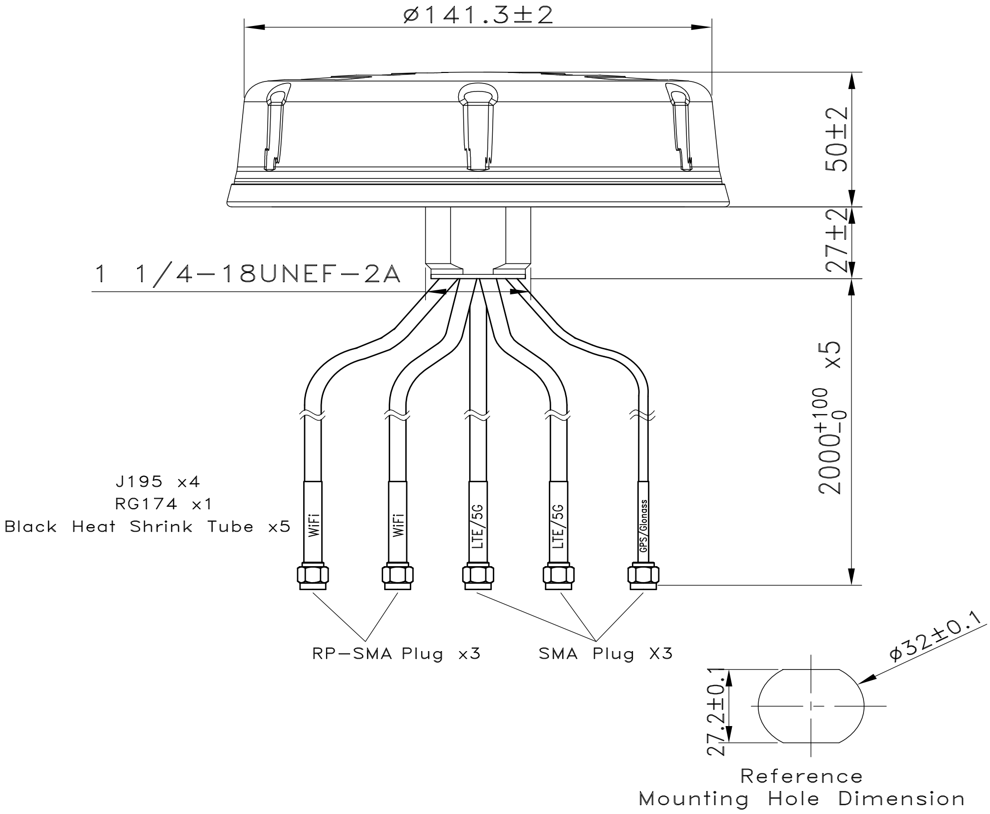
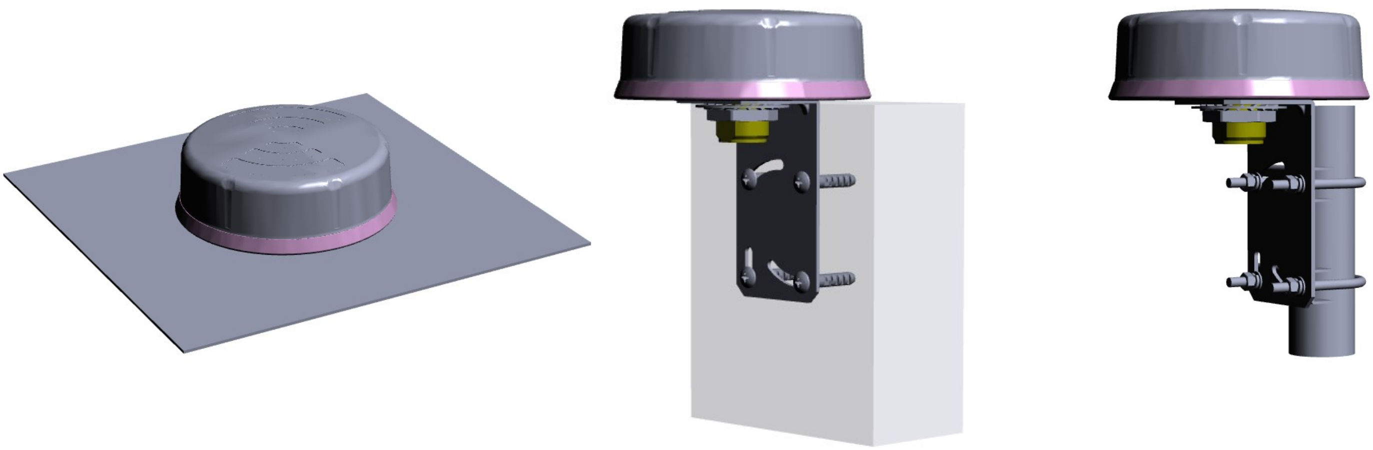


Figure 2. Antenna Dimensions

Antenna Installation

The PPF-165A5SNB antenna is designed to mount on device enclosure directly (Roof Mount) or independent installation through L brackets as shown in **Figure 3**. The standard antenna pack excludes L bracket kit. Please contact Joymax Electronics or authorized distributor to order L bracket as needed.



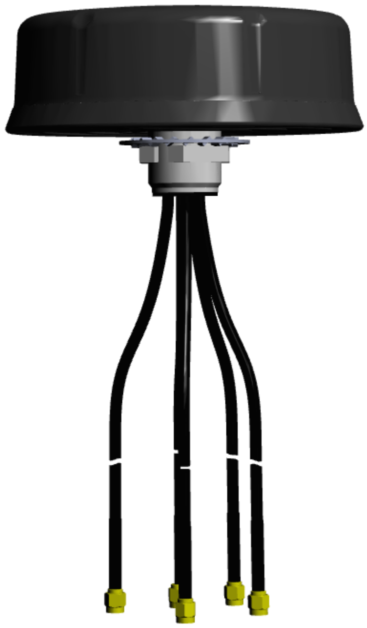
Roof Mount Wall Mount Pole Mount

Figure 3. Antenna Installation

Antenna Test Setup

The PPF-165A5SNB antenna is tested with 2 meter long coaxial cable. The antenna test setup consists of direct mount on a 600 mm diameter metal plate - providing insight into antenna performance when attached to a metal surfaces, and hanging free without ground plane respectively as shown in **Figure 4**. The charts on the following pages represent data taken with the antenna mount on ground plane.

With Ground Plane



Hanging Free, without Ground Plane

Figure 4. Antenna Test Setup

VSWR, 5G/LTE

Figure 5 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.

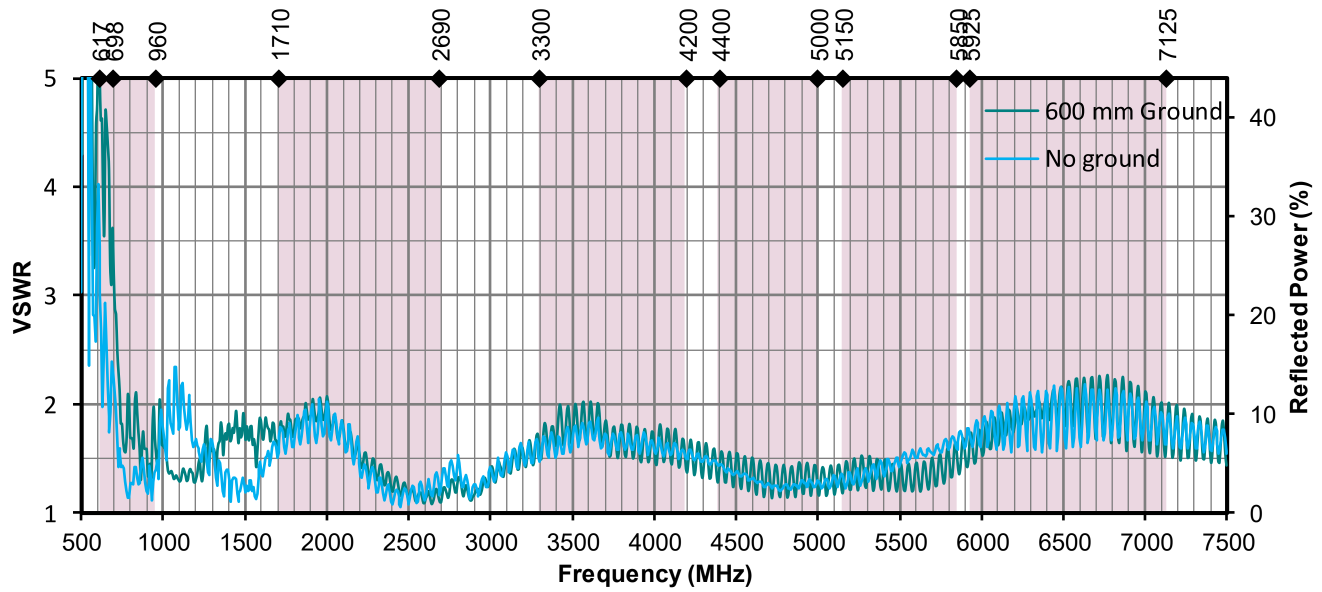


Figure 5. Antenna VSWR, 5G/LTE

Return Loss, 5G/LTE

Return loss (**Figure 6**), 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.

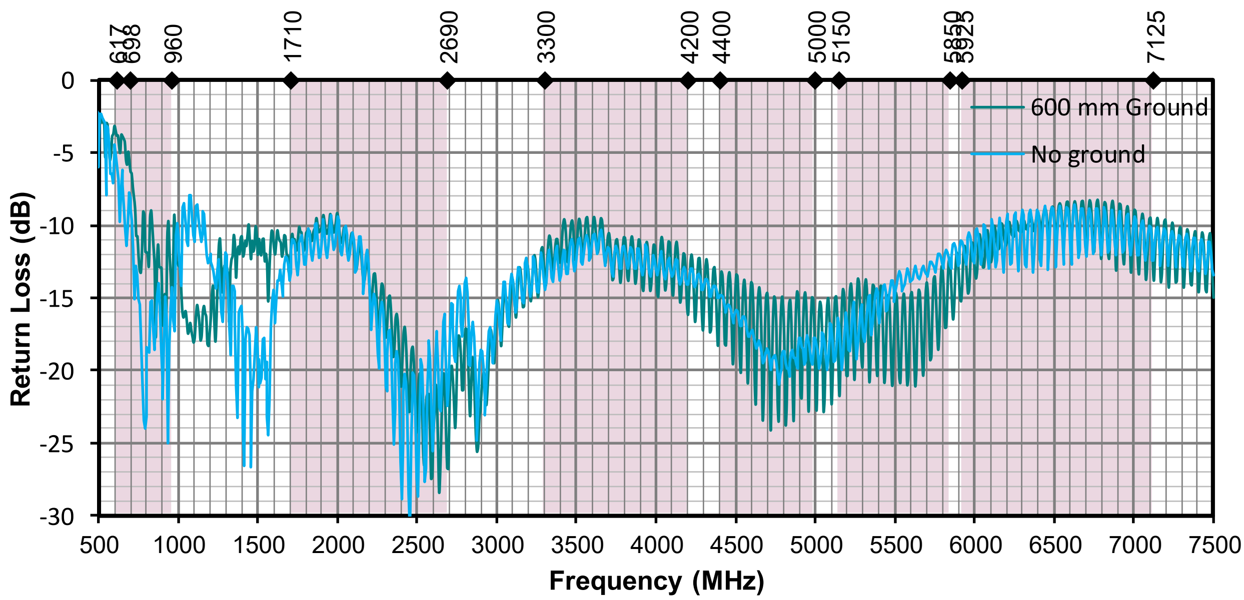


Figure 6. Antenna Return Loss, 5G/LTE

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Peak Gain, 5G/LTE

The peak gain across the antenna bandwidth is shown in **Figure 7**. 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.

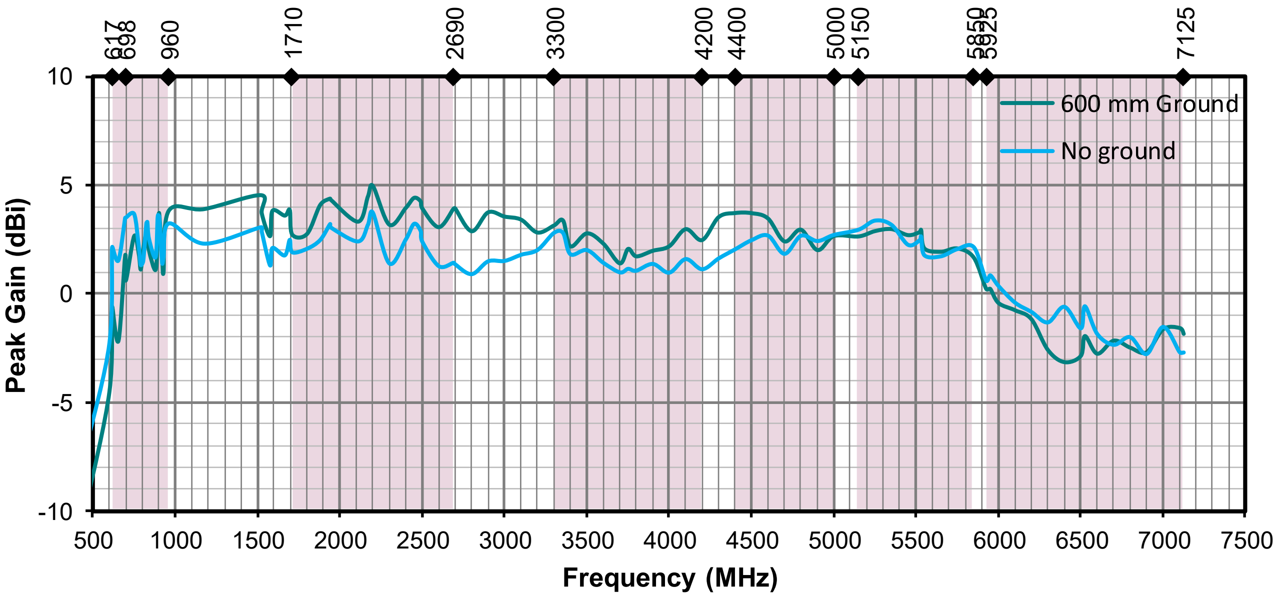

Figure 7. Antenna Peak Gain, 5G/LTE

Average Gain, 5G/LTE

Average gain (**Figure 8**), is the average of all antenna gain in 3-dimensional space at each frequency, providing an indication of overall performance without expressing antenna directionality.

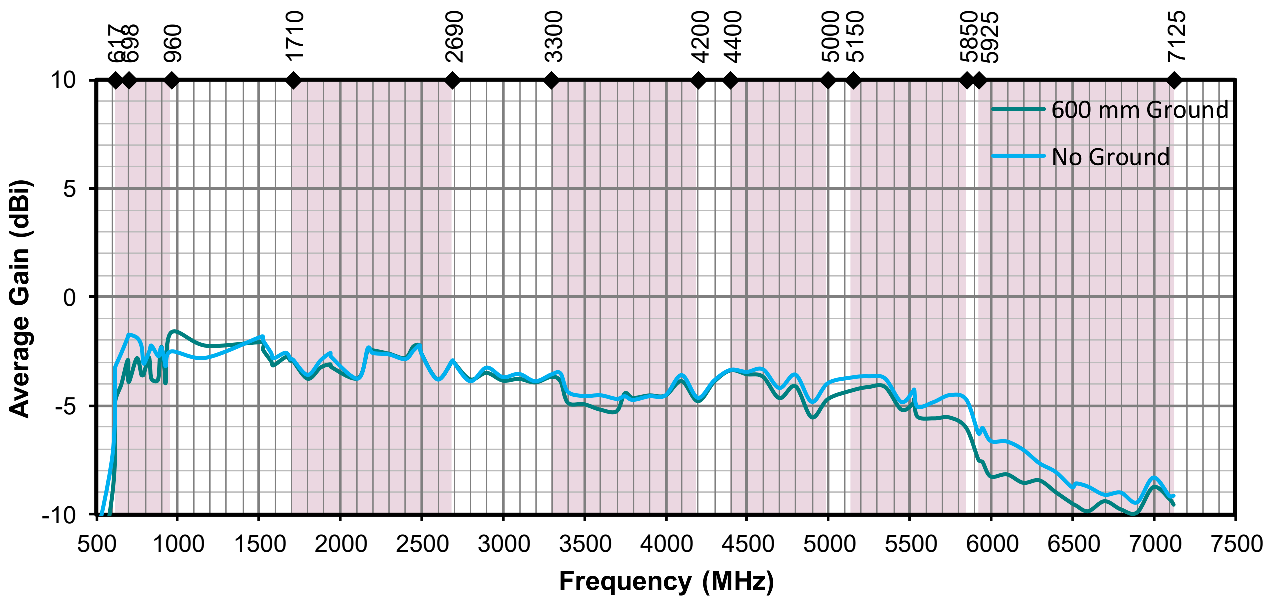

Figure 8. Antenna Average Gain, 5G/LTE

Radiation Efficiency, 5G/LTE

Radiation efficiency (**Figure 9**), 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.

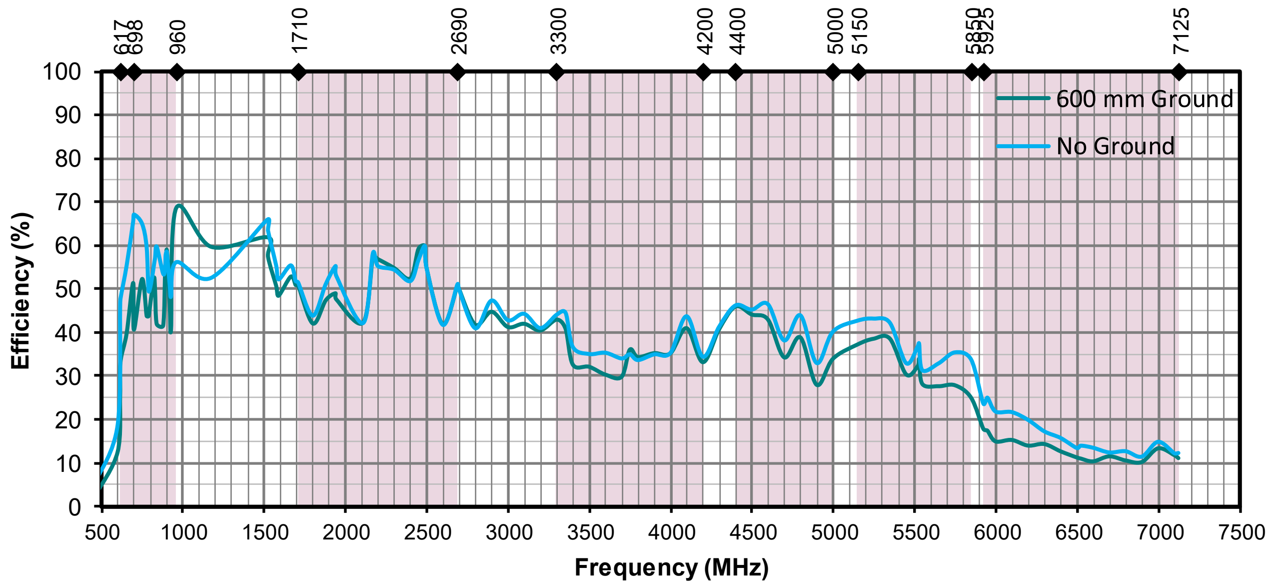

Figure 9. Antenna Efficiency, 5G/LTE

Antenna Isolation, 5G/LTE

Antenna isolation (**Figure 10**), 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.

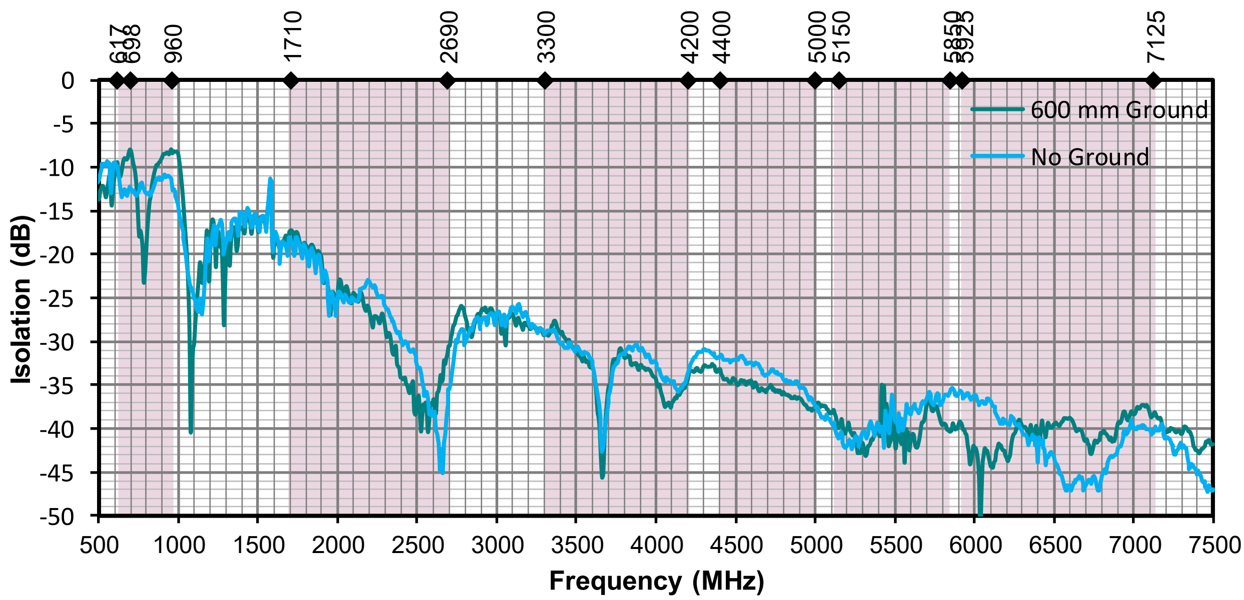

Figure 10. Antenna Isolation, 5G/LTE

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Radiation Patterns, 5G/LTE

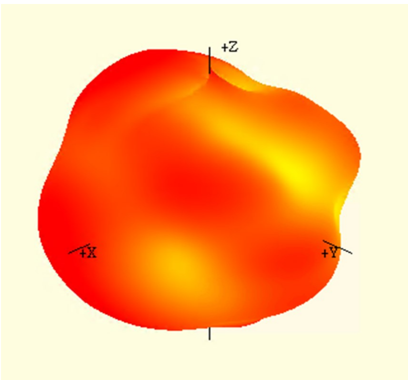
Radiation patterns provide information about the directionality and 3D gain performance of the antenna by plotting gain at specific frequencies in three orthogonal planes. Antenna radiation patterns with ground plane for 5G bands are shown in **Figure 11** using polar plots covering 360 degrees. The antenna graphic at the top of the page provides reference to the plane of the column of plots below it.

XZ-Plane Gain

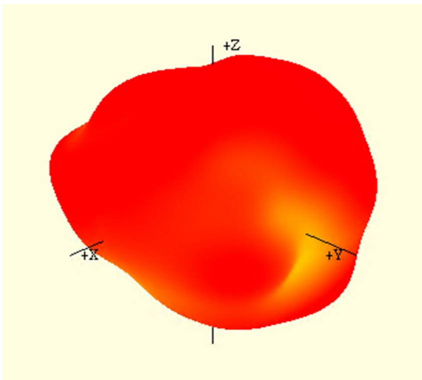
YZ-Plane Gain

XY-Plane Gain

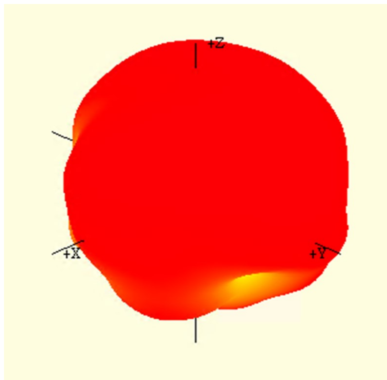
617 MHz to 960 MHz (778 MHz)



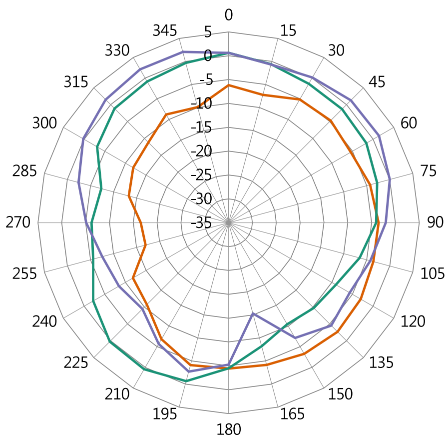
617 MHz



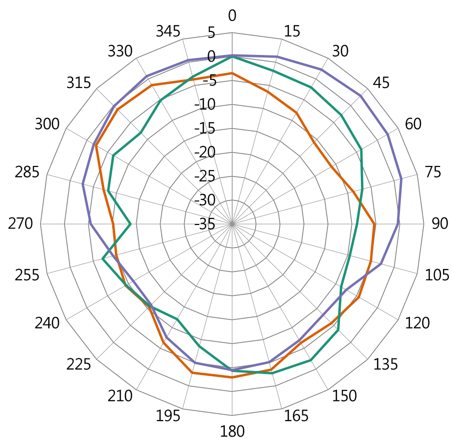
778 MHz



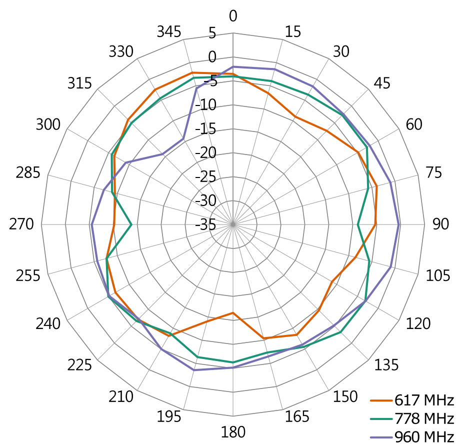
960 MHz



XZ-Plane Gain



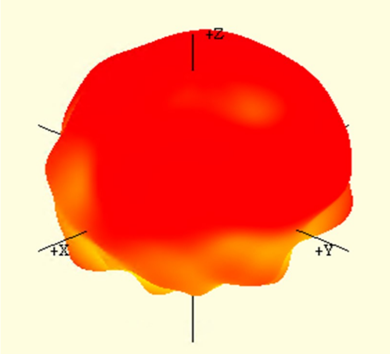
YZ-Plane Gain



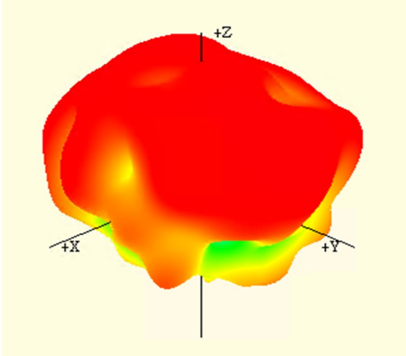
XY-Plane Gain

Figure 11. Antenna Radiation Patterns, 5G/LTE

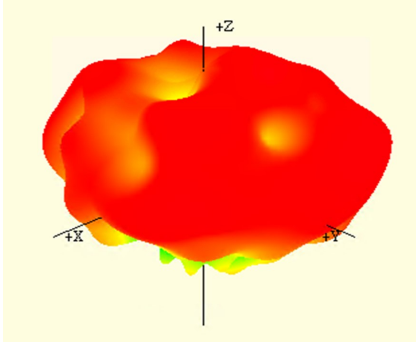
1710 MHz to 5000 MHz (3355 MHz)



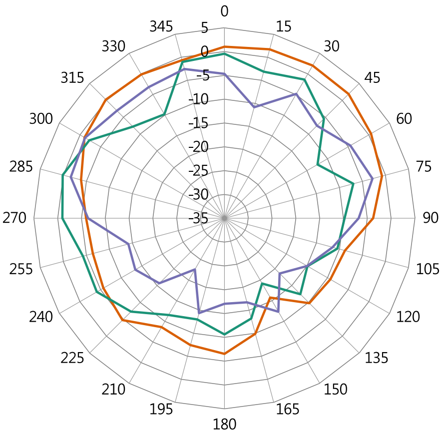
1710 MHz



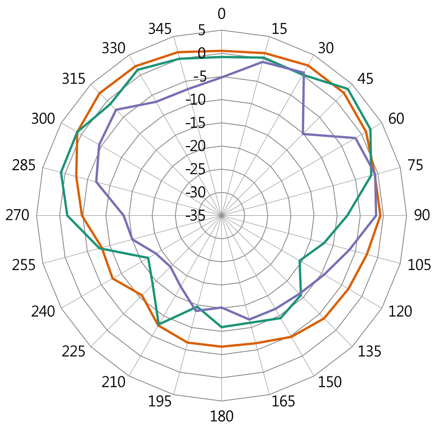
3355 MHz



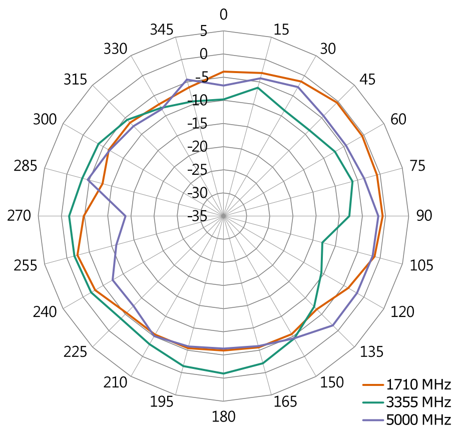
5000 MHz



XZ-Plane Gain

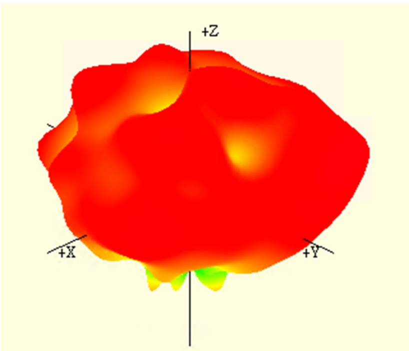


YZ-Plane Gain

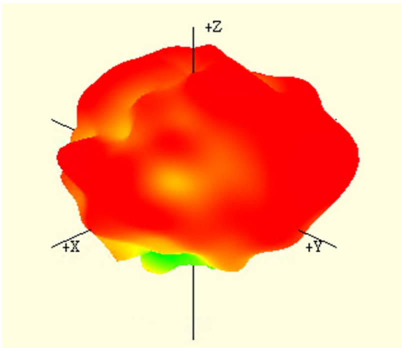


XY-Plane Gain

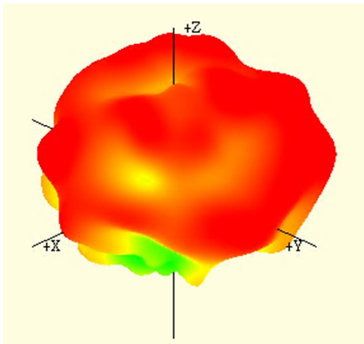
5150 MHz to 5850 MHz (5550 MHz)



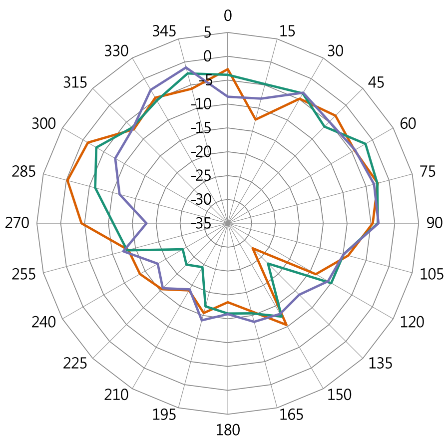
5150MHz



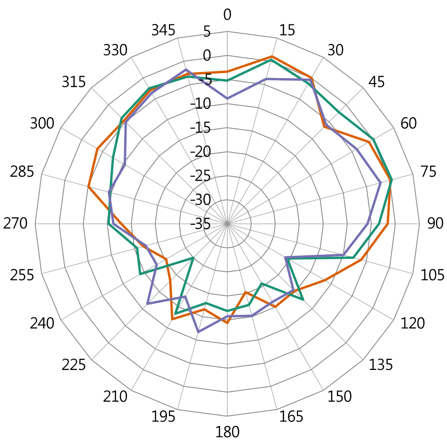
5500 MHz



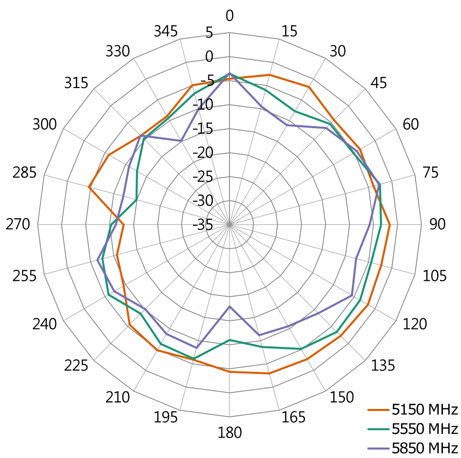
5850 MHz



XZ-Plane Gain



YZ-Plane Gain



XY-Plane Gain

5925 MHz to 7125 MHz (6525 MHz)

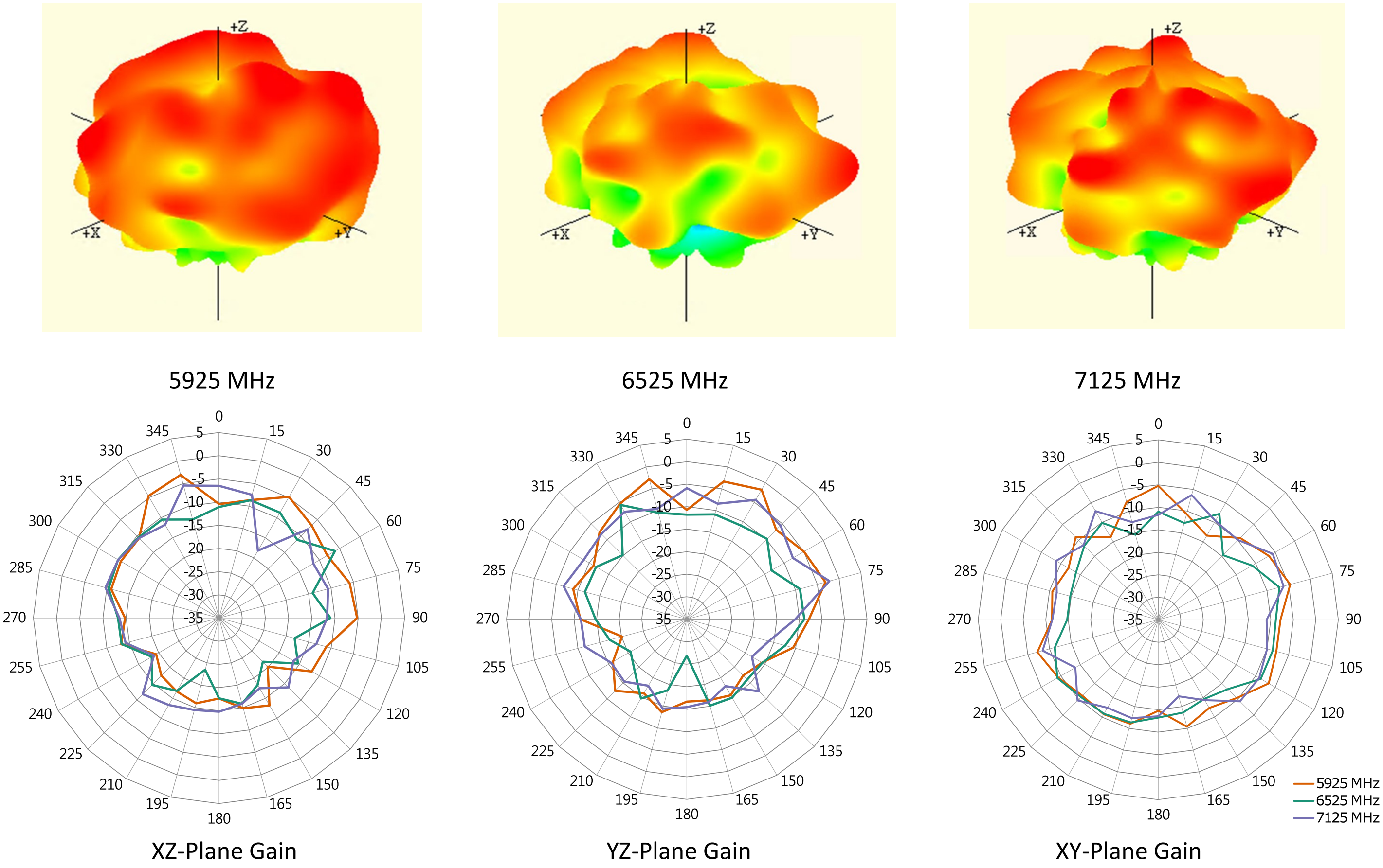


Figure 11-1. Antenna Radiation Patterns, 5G/LTE

VSWR, WiFi

Figure 12 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.

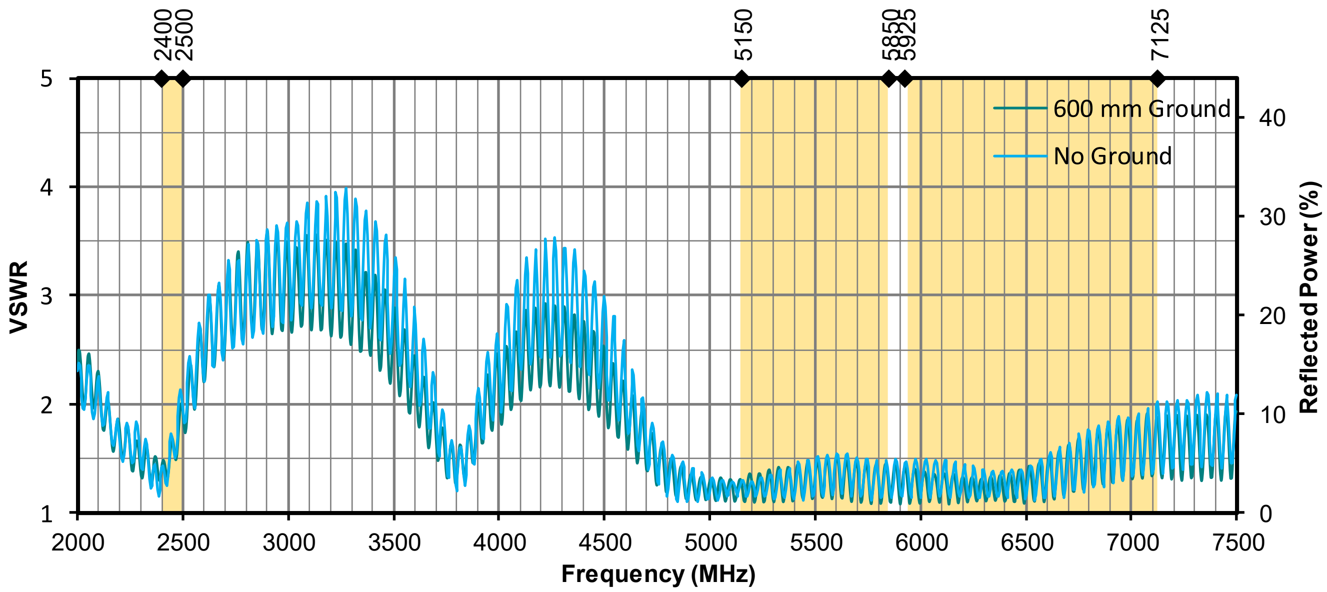


Figure 12. Antenna VSWR, WiFi

Return Loss, WiFi

Return loss (**Figure 13**), 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.

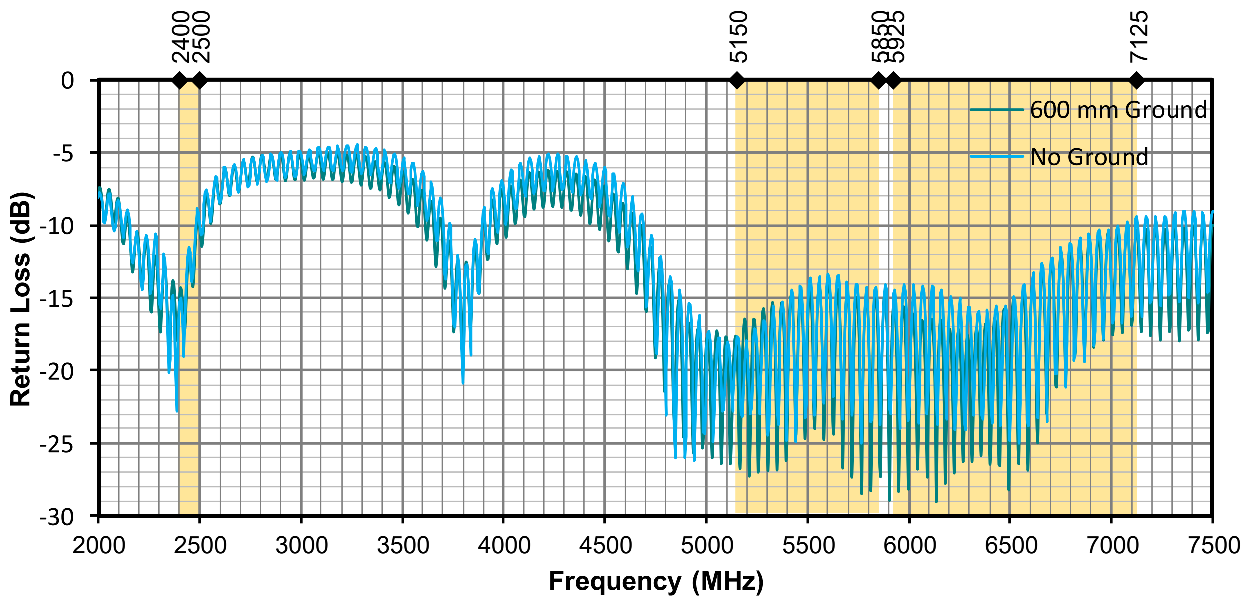


Figure 13. Antenna Return Loss, WiFi

Peak Gain, WiFi

The peak gain across the antenna bandwidth is shown in **Figure 14**. 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.

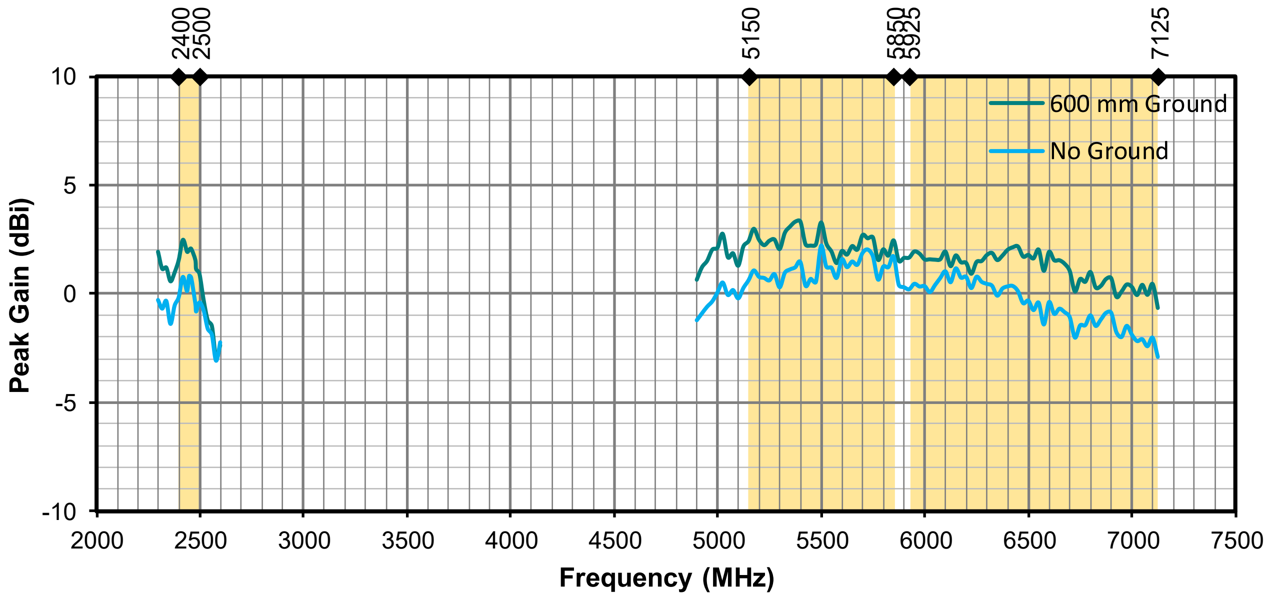


Figure 14. Antenna Peak Gain, WiFi

Average Gain, WiFi

Average gain (**Figure 15**), is the average of all antenna gain in 3-dimensional space at each frequency, providing an indication of overall performance without expressing antenna directionality.

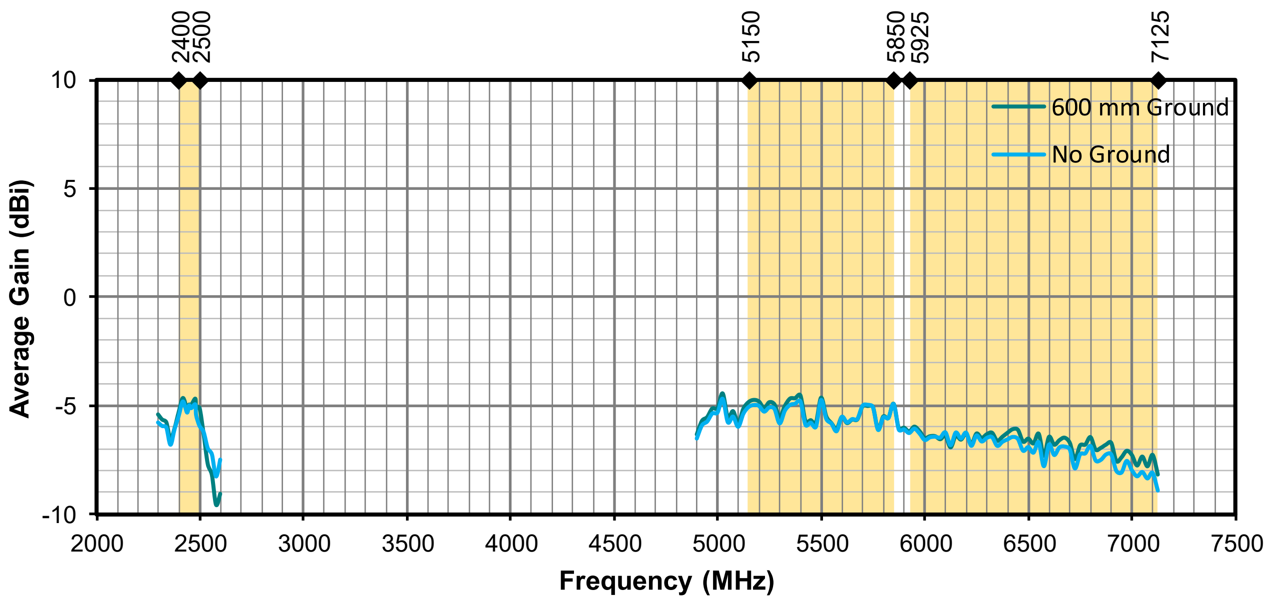


Figure 15. Antenna Average Gain, WiFi

Radiation Efficiency, WiFi

Radiation efficiency (**Figure 16**), 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.

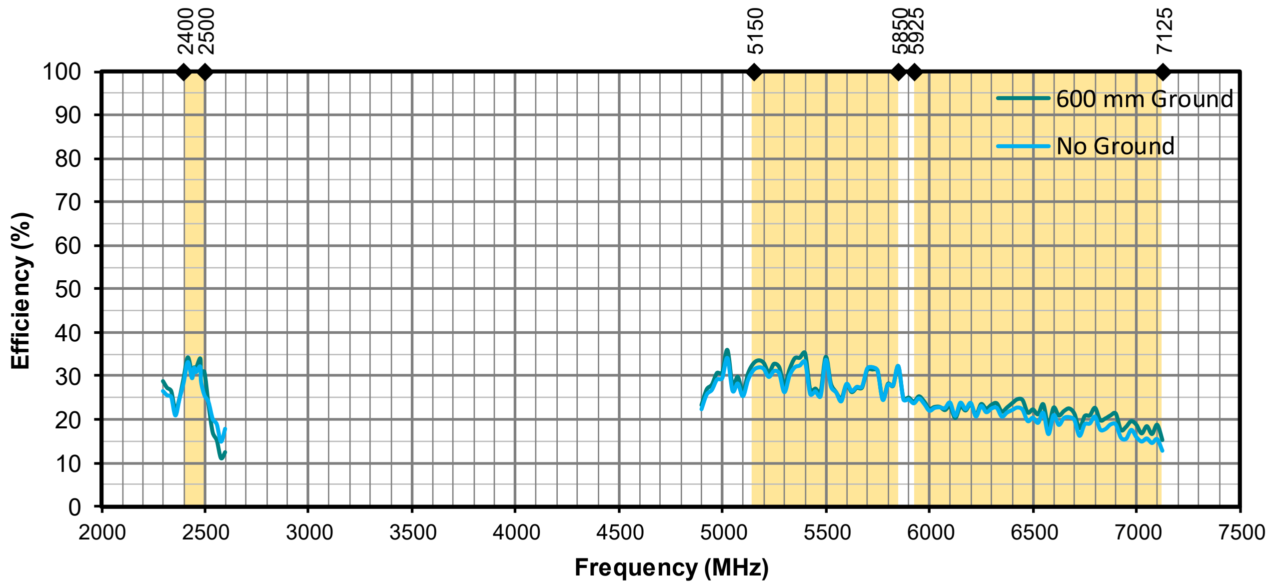


Figure 16. Antenna Efficiency, WiFi

Antenna Isolation, WiFi

Antenna isolation (**Figure 17**), 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.

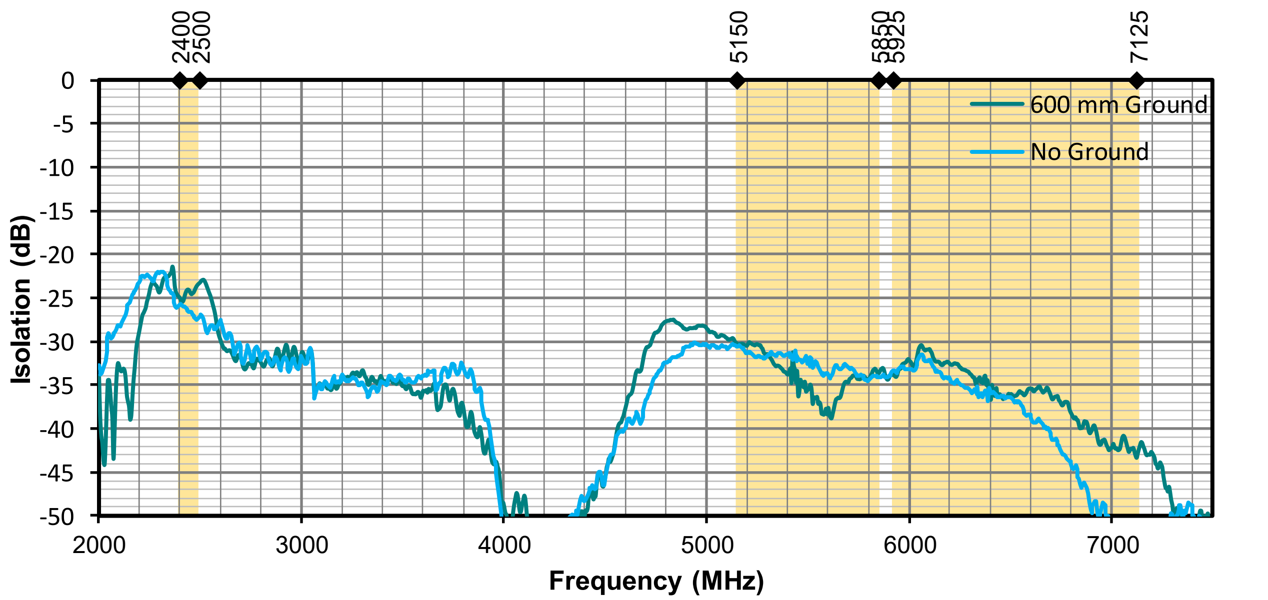


Figure 17. Antenna Isolation, WiFi

Radiation Patterns, WiFi

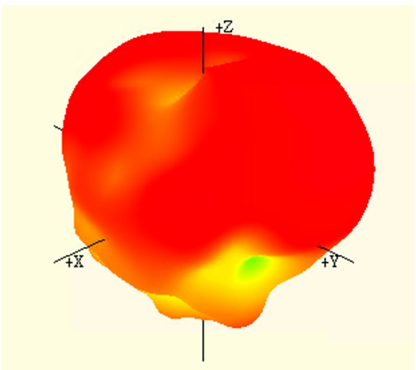
Radiation patterns provide information about the directionality and 3D gain performance of the antenna by plotting gain at specific frequencies in three orthogonal planes. antenna radiation patterns with ground plane for WiFi bands are shown in **Figure 18** using polar plots covering 360 degrees. The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

XZ-Plane Gain

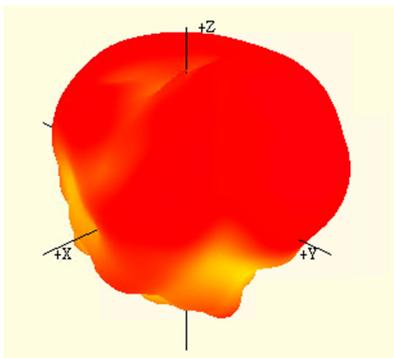
YZ-Plane Gain

XY-Plane Gain

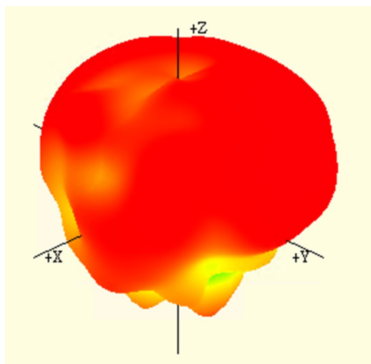
2400 MHz to 2500 MHz (2450 MHz)



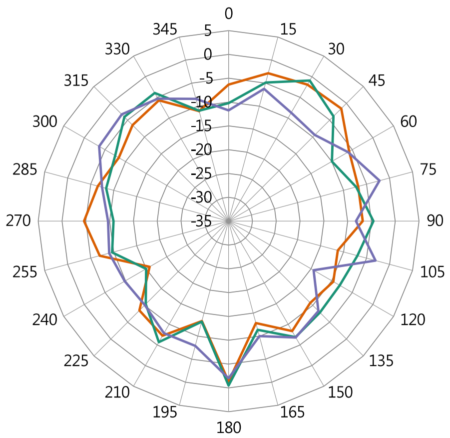
2400 MHz



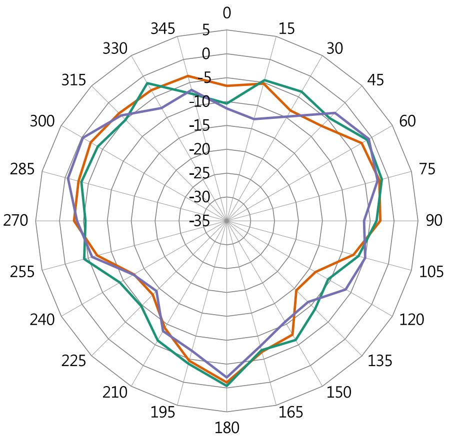
2450 MHz



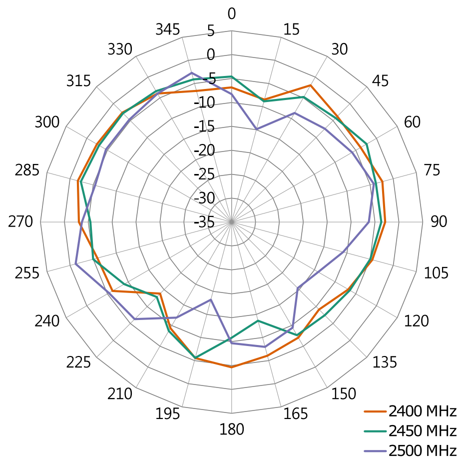
2500 MHz



XZ-Plane Gain



YZ-Plane Gain



XY-Plane Gain

Figure 18. Antenna Radiation Patterns, WiFi

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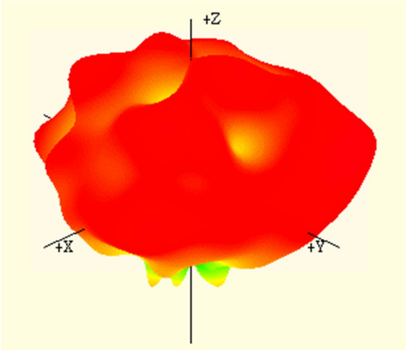
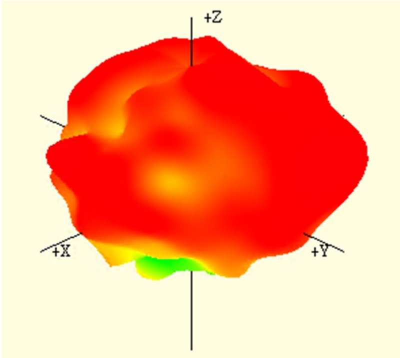
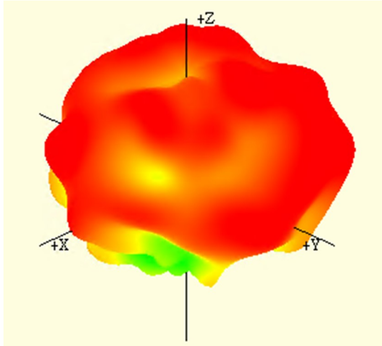
5150 MHz to 5850 MHz (5550 MHz)



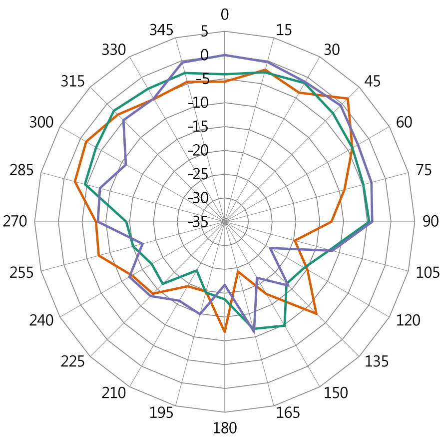
5150MHz



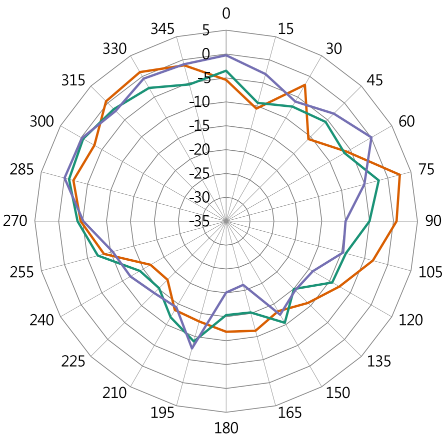
5500 MHz



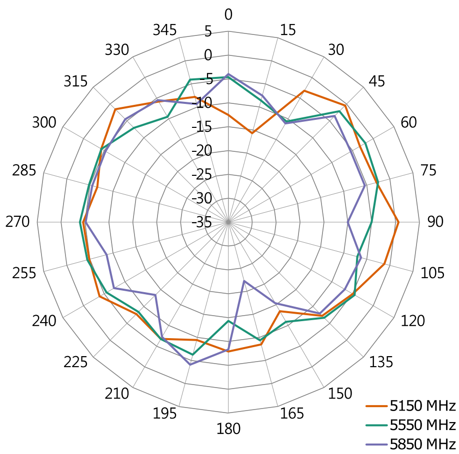
5850 MHz



XZ-Plane Gain

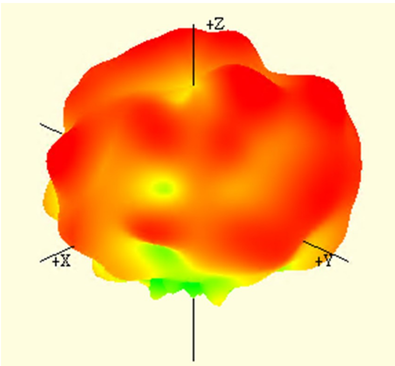


YZ-Plane Gain

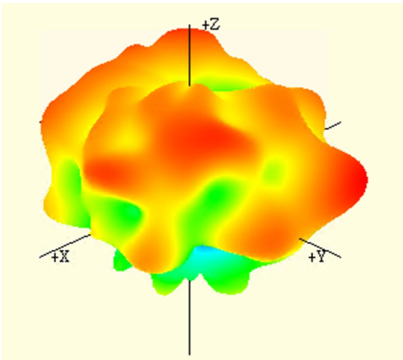


XY-Plane Gain

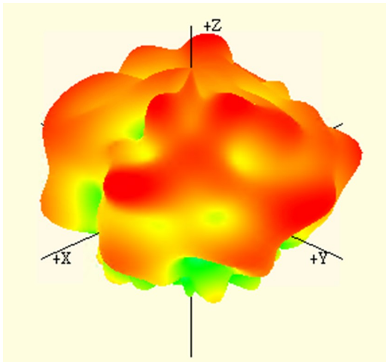
5925 MHz to 7125 MHz (6525 MHz)



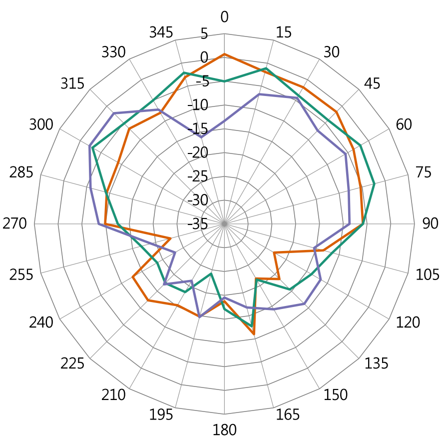
5925 MHz



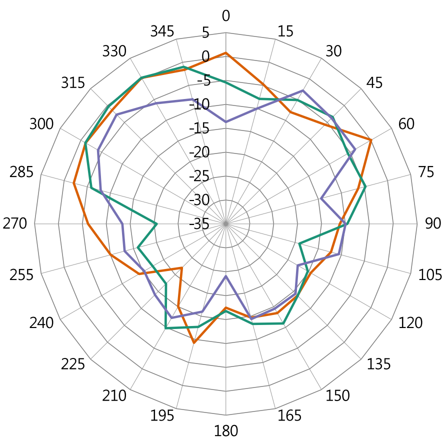
6525 MHz



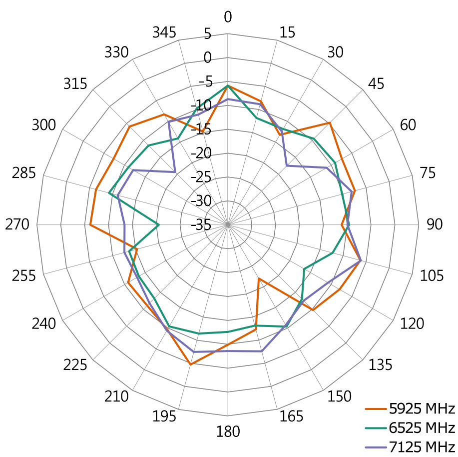
7125 MHz



XZ-Plane Gain



YZ-Plane Gain



XY-Plane Gain

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VSWR, GNSS

Figure 19 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.

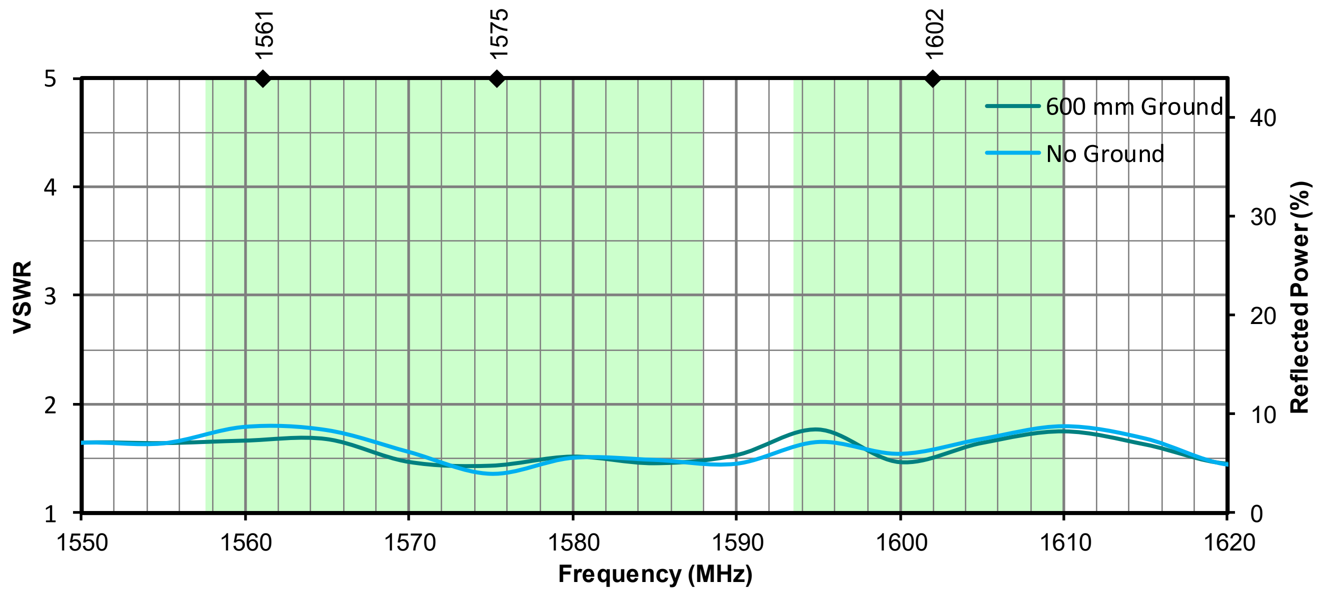


Figure 19. Antenna VSWR, GNSS

Return Loss, GNSS

Return loss (**Figure 20**), 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.

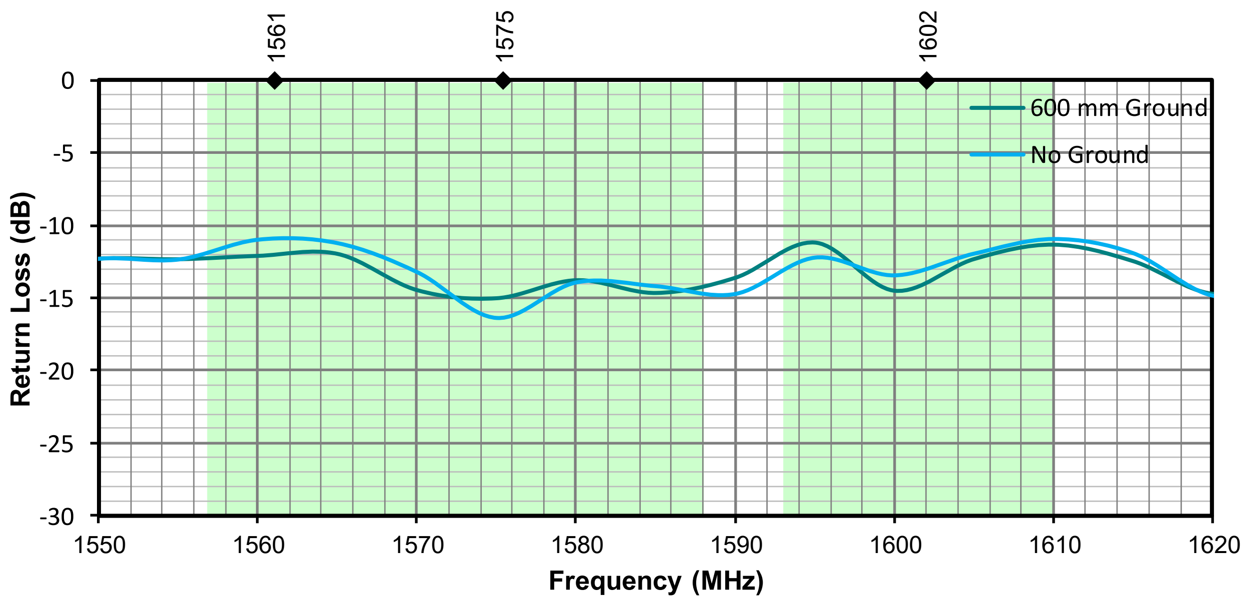


Figure 20. Antenna Return Loss, GNSS

Total Peak Gain, GNSS

The peak gain across the antenna bandwidth is shown in **Figure 21**. 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.

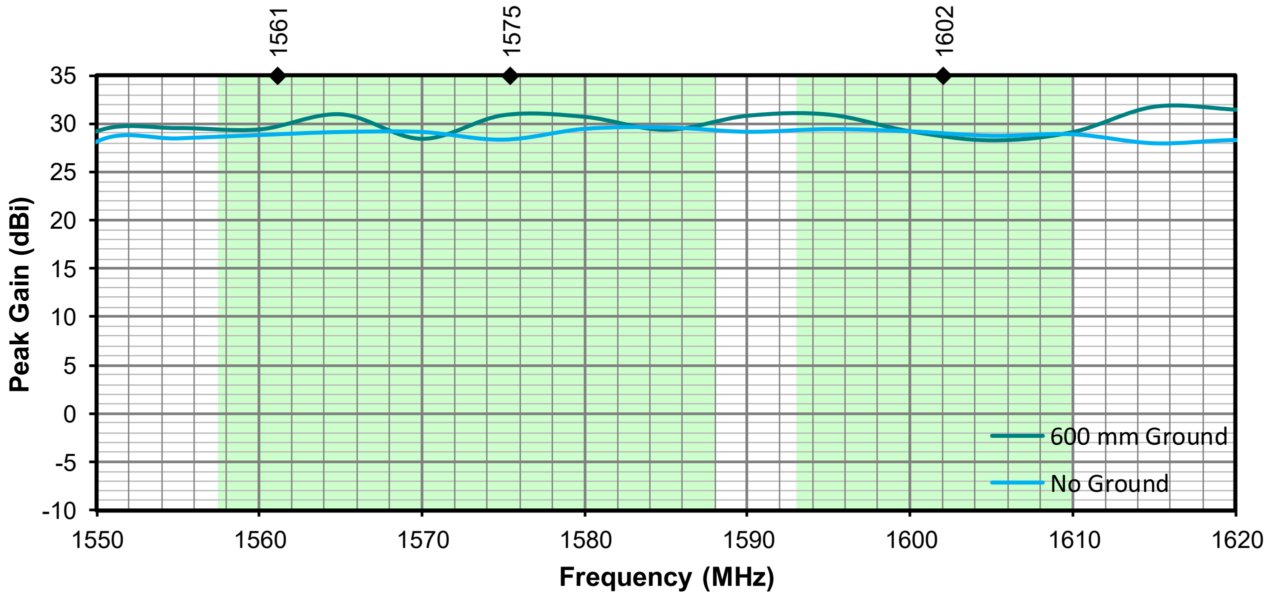


Figure 21. Antenna Total Peak Gain, GNSS

Axial Ratio, GNSS

Axial Ratio (**Figure 22**) 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.

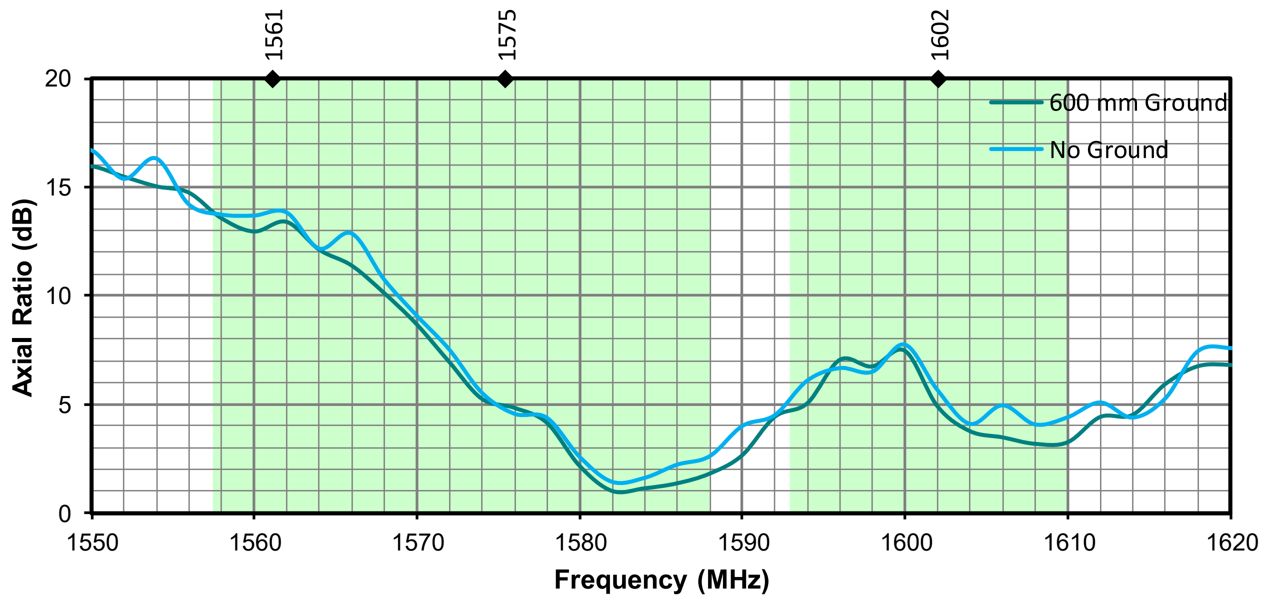


Figure 22. Antenna Axial Ratio, GNSS

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 23)** is noise factor expressed in decibels (dB). The lower, the better. Less than **2 dB** might be considered an adequate Noise Figure value.

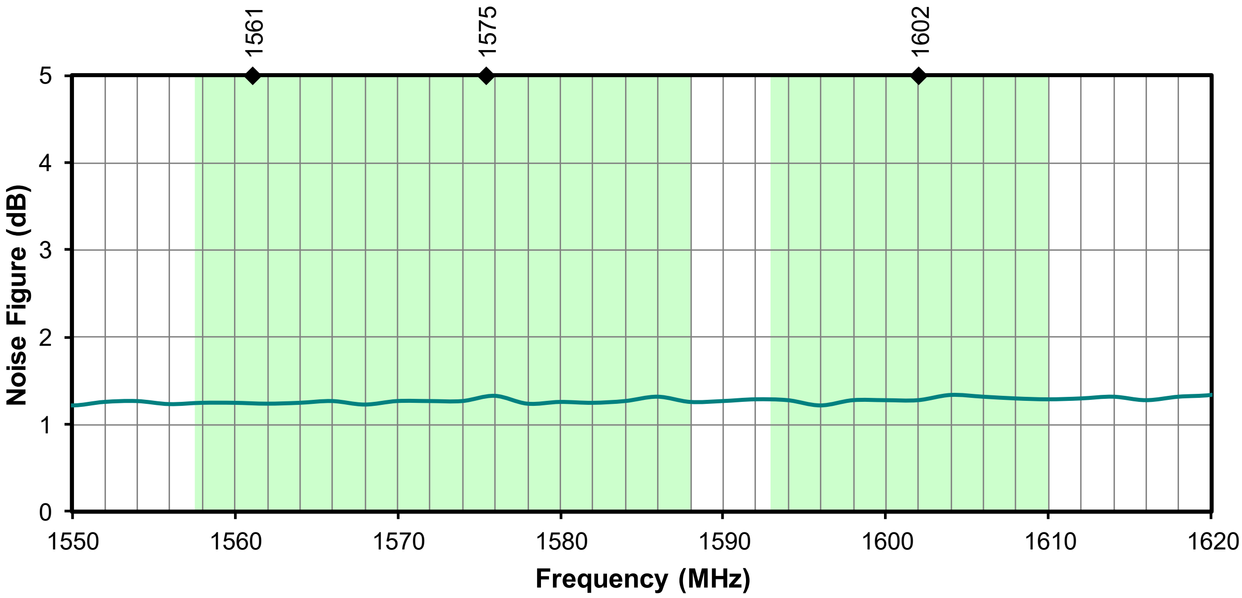


Figure 23. Antenna Noise Figure, GNSS

Passive Antenna Radiation Patterns, GNSS

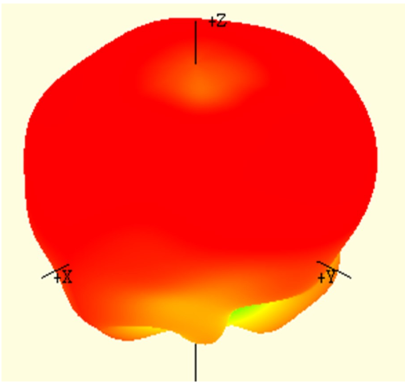
Radiation patterns provide information about the directionality and 3D gain performance of the antenna by plotting gain at specific frequencies in three orthogonal planes. Antenna radiation patterns with ground plane for GNSS bands are shown in **Figure 24** using polar plots covering 360 degrees. The antenna graphic at the top of the page provides reference to the plane of the column of plots below it.

XZ-Plane Gain

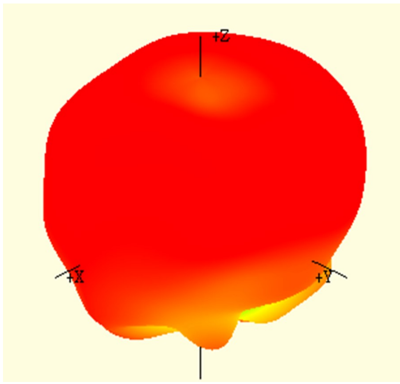
YZ-Plane Gain

XY-Plane Gain

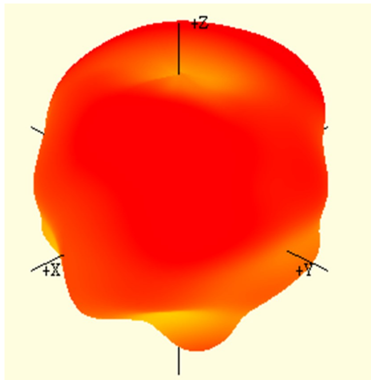
1561 MHz to 1602 MHz (1575.42 MHz)



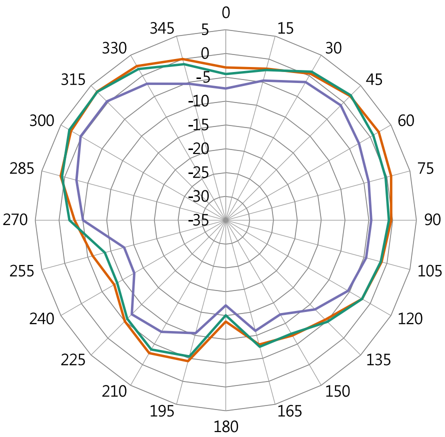
1561 MHz



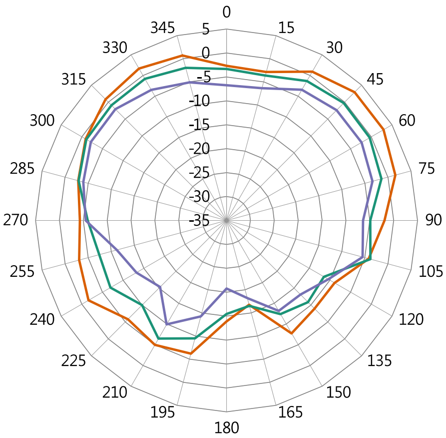
1575.42 MHz



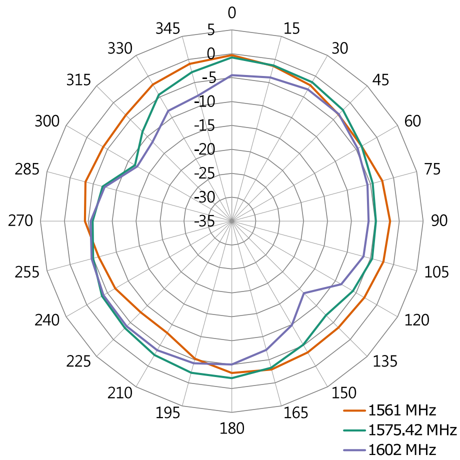
1602 MHz



XZ-Plane Gain



YZ-Plane Gain



XY-Plane Gain

Figure 24. Passive Antenna Radiation Patterns, GNSS

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-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 Straight	N/A	N/A	N/A	N/A
CT-SAB41X		SMA Jack Female Socket Right Angle	N/A	N/A	N/A	N/A

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