patch antenna elements & assemblies

SPECTRUM CONTROL INC.
A Control Products and Systems Company

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antenna solutions

Ceramic patch antennas are growing in popularity due to their low profile design and their effective balance of performance and price. At Spectrum Control we have developed a complete line of patch antennas that are designed to optimize the transmission and reception of signals for modern wireless products. Beyond the product itself, Spectrum Control offers world class technical support from our experienced engineering department… on a wavelength you can understand.

patch antenna applications

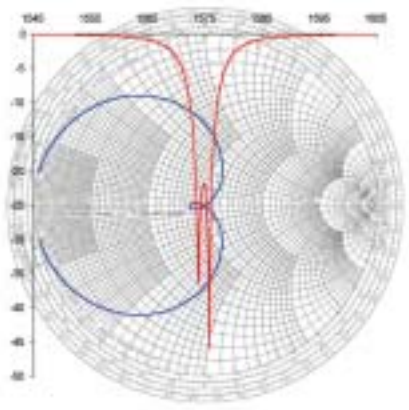
Satellite Based

- GPS Commercial (L1) & Military (L2)
- GlobalStar including AeroAstro SENS
- Iridium
- Inmarsat

Terrestrial Based

- ISM (Industry, Scientific & Medical)
- Zigbee
- Bluetooth
- RFID

Consult Factory other available applications

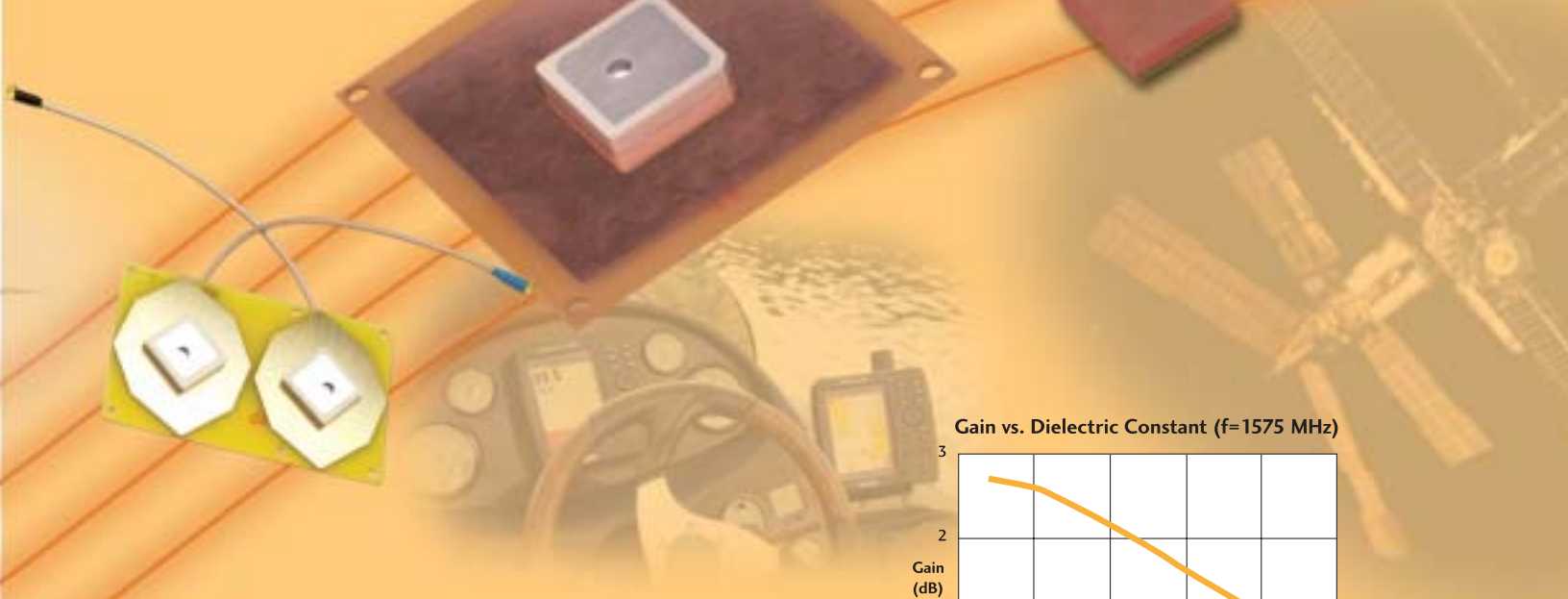


spectrum patch antenna attributes

- **Small Footprint:** Dimensions for antennas from 1 GHz to 3 GHz are from 13mm to 50mm square (excluding the ground plane).
- **Low Profile:** Antennas designed with higher dielectric values are typically <8mm in height and depending upon your bandwidth requirement can be as low as 4mm.
- **Lightweight:** These small antennas can be worn on people with little notice.
- **Versatile:** Antennas not only transmit and receive circularly polarized signals but also linearly polarized signals.
- **Low Cost:** Our antenna elements are very affordable in small and large volume.
- **Flexible:** Antennas can be tuned and optimized very easily making prototyping quick and cost effective.
- **Omni-directional:** Antenna radiation patterns provide excellent gain across all elevation angles but can also be manipulated for more focused requirements.
- **Performance:** These passive devices offer typical gain response from 0 dBi to 3 dBi for half-power beamwidths of 110 degrees. Gain at boresite (90 degrees elevation) can exceed 6 dBi depending upon the proper selection of a ground plane.
- **Military:** We have extensive experience in building hardened military designs.
- **Testing:** All of our products are tested 100% on custom testing systems to ensure quality performance.

prototyping

We can provide quick turn prototypes by using our on-site engineering lab to hand tune an existing design to meet your specific needs. For advanced designs, we utilize 3-D computer modeling to optimize antenna performance and provide expected real world results of high volume production.



Optimizing Performance

Don't trust your wireless reception to luck. Let us help you design it right the first time. Our engineering team is ready to help identify critical issues such as the board layout, ground plane size, mounting methods and port measurement that will influence the efficiency of the antenna. We'll look at the polarization and radiation patterns, gain, impedance matching and frequency tolerance to determine the ideal patch for your design. With our computer modeling abilities, we can quickly determine your best options. In addition, we also have an on-site anechoic chamber to validate performance. Our flexible manufacturing and testing processes allow us to easily accommodate the required adjustments to supply an optimized antenna.

Key Factors

Ground plane:

During the design process, consideration must be given to the size and configuration of the ground plane. The ground plane has substantial effects on the performance of the antenna. These effects include frequency shift, gain, axial ratio and radiation pattern. See additional ground plane optimization notes on pages 6 and 7.

Element Size:

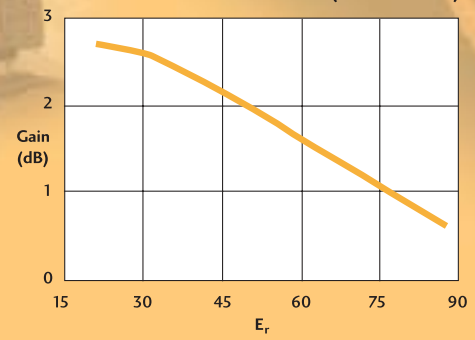
The amount of space available for the antenna element determines not only the material required but also the related performance that can be expected. The element size relates to the material that will be selected, the shape of the element, and the metallization pattern. Each of these has a substantial effect on electrical performance.

Assembly Configuration:

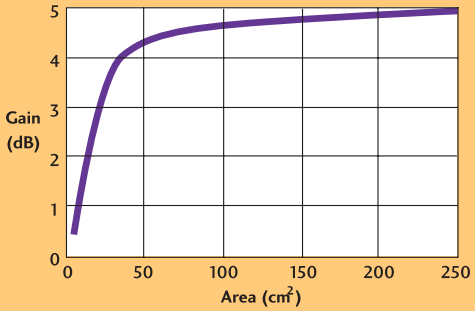
The final assembly configuration also affects element performance. The position of other components, etc. affects the overall performance of the element.

The items mentioned above are areas in which Spectrum Control's engineering staff can assist in developing an optimized antenna element to fit your needs.

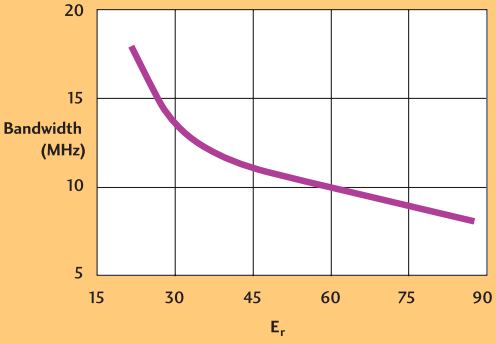
Gain vs. Dielectric Constant (f=1575 MHz)



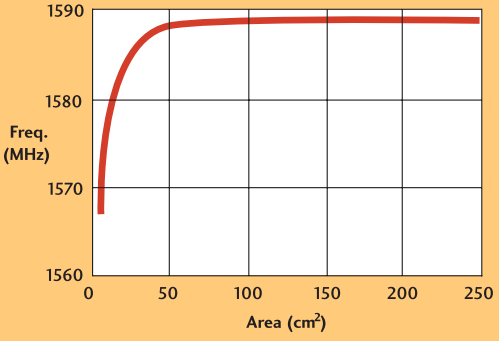
Gain vs. groundplane size (25 mm patch)



10 dB return loss bandwidth vs. dielectric constant (f = 1575 MHz)



Center frequency vs. groundplane size (25 mm patch)



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Patch Antenna Elements

Features

- Temperature stable (-40°C to +105°C)
- Low return loss
- Uniform dielectric constant
- Offset single-point feeding method
- Custom designs available (900 MHz to 5.8 GHz)
- Silver plated electrode and probe
- Surface mount
- 50 Ohm impedance
- RoHS parts available

RoHS COMPLIANT

Ordering Information - Standard Single Frequency Patch Element

PA	25	-	1575	-	008	S	A
Class	**Size**		**Center Frequency (MHz)**		**Bandwidth (MHz)**	**Configuration**	**Series**
Patch Antennas	2 digits in mm		Use 4 digits		Use 3 digits	**S** = Square	Assigned by factory

Application	Part #	Polarization	Center Frequency (MHz)	2:1 VSWR Bandwidth (MHz)	Gain (dB)	Tested ground plane (mm)	Reference Outlines
GPS	PA25-1575-008SA	RHCP	1575	20	2.5	35X35	B
GPS	PA25-1579-008SA	RHCP	1579	20	2.5	35X35	B
GPS-military (L2)	PA25-1227-008SA	RHCP	1227	20	0.0	60X60	B
GPS	PA18-1580-010SA	RHCP	1580	15	0.0	50X50	C
GPS	PA13-1580-005SA	RHCP	1580	8	2.5	30X30	D
Globalstar	PA25-1615-025SA	LHCP	1615	125	3.0	70X70	B
Iridium	PA25-1621-025SA	RHCP	1621	25	4.0	60X60	B
Inmarsat	PA25-1542-025SA	LHCP	1542	25	4.0	60X60	B
Inmarsat	PA25-1643-025SA	LHCP	1643	25	4.0	60X60	B
Inmarsat	PA45-1592-175SA	LHCP	1592	125	5.0	60X60	F
Satellite Radio	PA28-2345-025SA	LHCP	2345	60	4.0	45X45	A
Satellite Radio	PA25-2350-014SA	LHCP	2350	60	4.0	45X45	B
ISM	PA37-2400-050SA	RHCP or LHCP	2400	50	4.0	45X45	E
ISM	PA37-2450-150SA	RHCP or LHCP	2450	150	4.0	40X40	E
ISM	PA28-2450-120SA	RHCP or LHCP	2450	120	4.0	40X40	A
Satellite Radio	PA28-2370-014SA	LHCP	2370	60	4.0	45X45	A

To order RoHS versions, remove dashes in part number and add "LF" to the end of the part. Ex: PA251575008SALF (RoHS version)
Consult Factory for custom parts or optimized center frequencies for your specific applications.

Dual Frequency SMD Patch Element

Spectrum Control offers an innovative solution for dual frequency applications. Our individual SMD antennas can be mounted on an single ground plane to address both frequencies at once.

Part #	Application	Ground Plane Test Size (mm)	Reference Outline
PA451615-1575SA	Globalstar & GPS (Comm)	76X76	F
PA451621-1575SA	Iridium & GPS (Comm)	76X76	F

Consult Factory for full product details.

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Patch Antenna Elements

Reference Outlines

Figure A

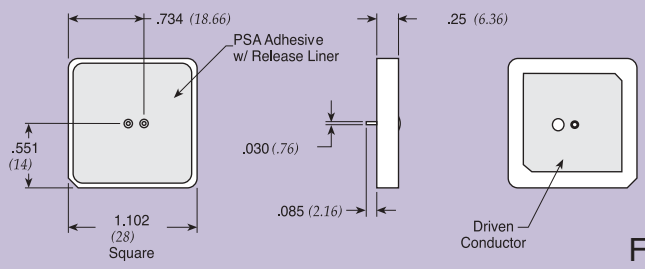


Figure B

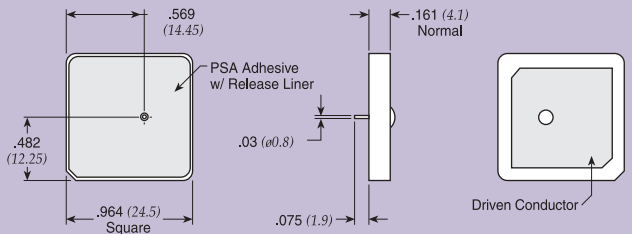


Figure C

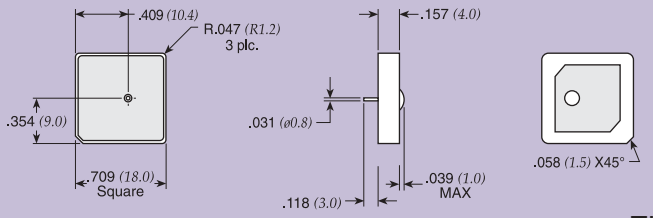


Figure D

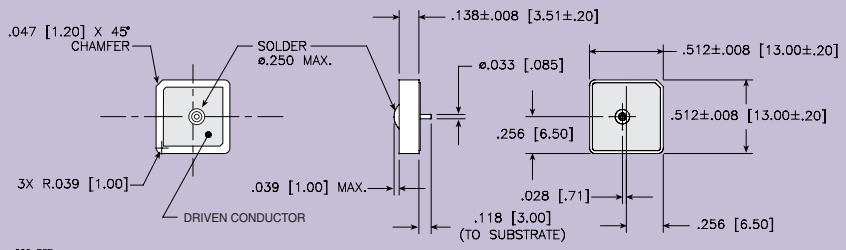


Figure E

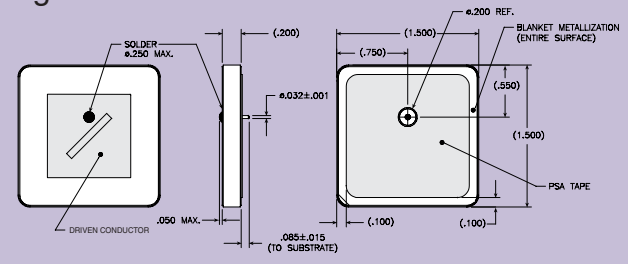
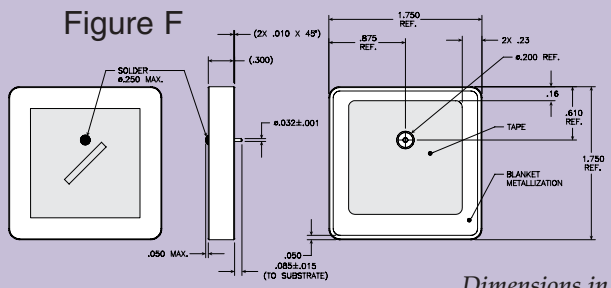


Figure F



Dimensions in inches (mm)

Note: See sales drawing for detailed specifications on each part.

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Patch Antenna Assembly Options

Features

- Available in partial assembly to complete "Plug-n-Play" assemblies
- Single or multi-frequency packages
- Optimized designs for peak performance
- 100% tested
- Custom designs
  - Flexibility on cable and connector selection
- Standard designs available
  - AeroAstro SENS
  - Globalstar
  - Iridium
  - GPS
- RoHS compatible parts available

Design Options

Spectrum Control can supply nearly any variation to meet your design needs, using the three general classifications of assemblies that we manufacture.

Our designs can be modified to meet your mechanical, cable length, connector and other specification. Each design is evaluated to provide an optimized performance to achieve maximum gain. *Please consult Factory with your specific details.*

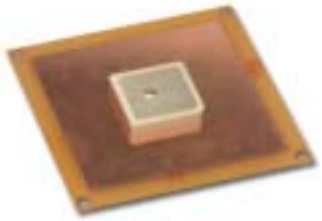
Antenna Design Considerations

Ground plane Optimization

Fundamental to the performance of a patch antenna is the interaction with the ground plane. The following is a brief overview of the interplay between the element and the ground plane. Consider the classic case of GPS reception, where it is likely that the customer may have the receiver in a less than an ideal environment (e.g. under trees, inside of buildings, various elevations) reducing the possibility of reception. "Off-the-Shelf" components do not address this concern, which why it is so important for the element to be designed for the ground plane. Increasing efficiency can reduce the cold start times and draw less power from the battery supply, in addition to the improving performance.

AC Series

Patch Antenna mounted on a ground plane with a connector mounted directly to the PCB. Standard connector is MMCX.

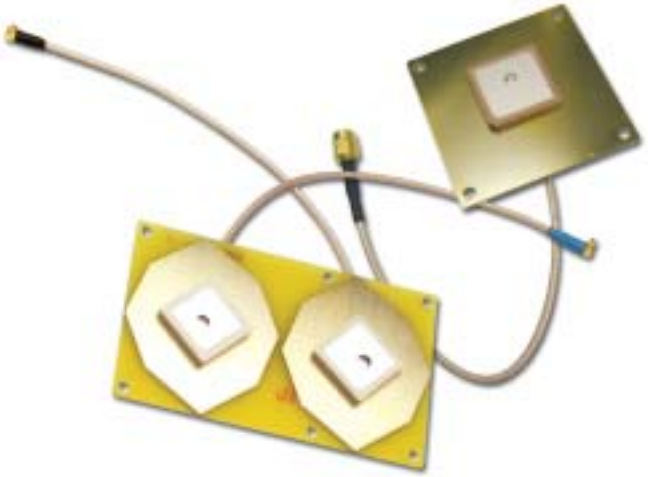


AR Series

Patch Antenna mounted on an optimized ground plane with a pigtail cable to a connector, which is tuned and packaged for the plastic radome that covers the complete assembly. Standard cable is RG-316 to MMCX or SMA connectors, others available.

AP Series

Patch Antenna mounted on a ground plane with a pigtail cable to a connector. Standard designs have 6" (15.2 cm) RG-316 cables, connector varies by application. Alternative lengths & connectors available.



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Antenna Design Considerations

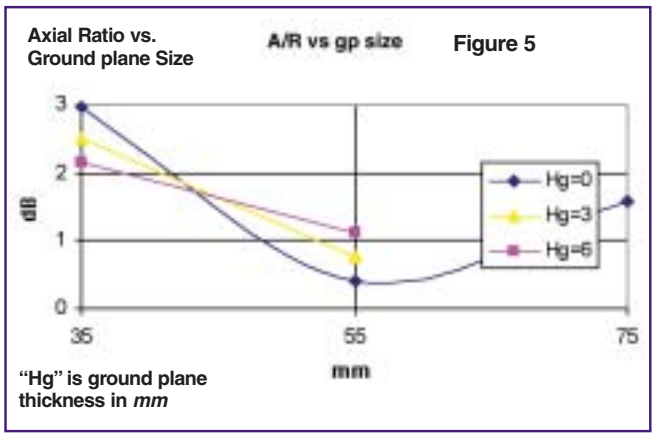
Figure 1 through 3 detail changes in ground plane sizes and the effect of the radiation pattern and the gain as shown via our computer modeling. Design enhancements that can be considered to improve performance include the use of a thicker ground plane. Figure 4 details the same 35mm plane as in Figure 1, however, it is thicker at 6 mm. This effectively improves the resultant directive gain. The front to back ratios have also improved, as well as pattern fullness or axial ratio measurement.

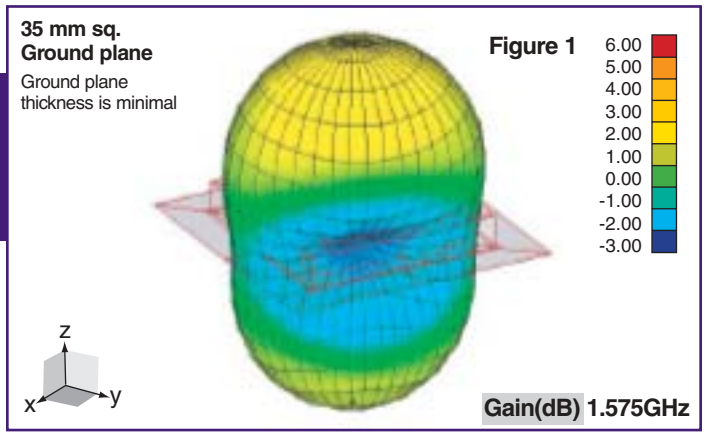
While it may be understood that a larger ground plane will improve the gain of an antenna, there may be a degradation of the axial ratio of the system if the element is not tuned for the ground plane. In Figure 5, the best axial ratio for the element under the test occurs with the 55 mm zero thickness ground plane. Proper evaluation and tuning can improve designs. Spectrum Control offers experienced engineering solutions to optimize your system. In addition to specialized design assistance, we also provide complete optimized assemblies.

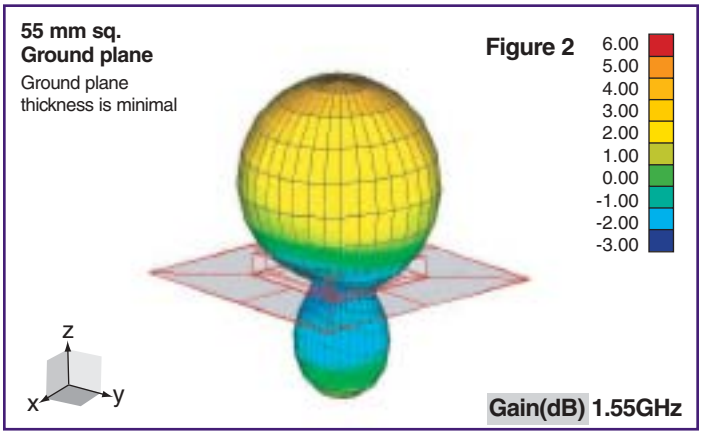
Additional Interaction Notes:

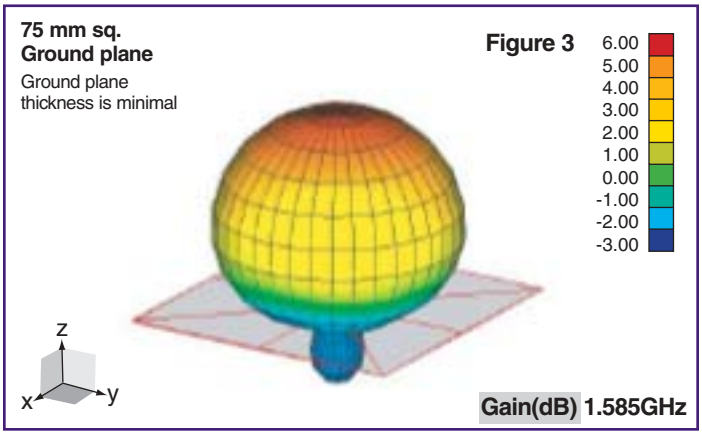
• **Center frequency shift:** A 13mm GPS element designed for a 70 mm GP will have a f_0 = 1580MHz by design. The same element on a 35 mm ground plane will have a f_0 =1569 MHz and on an effectively zero ground plane (13mm), the f_0 = 1549MHz.

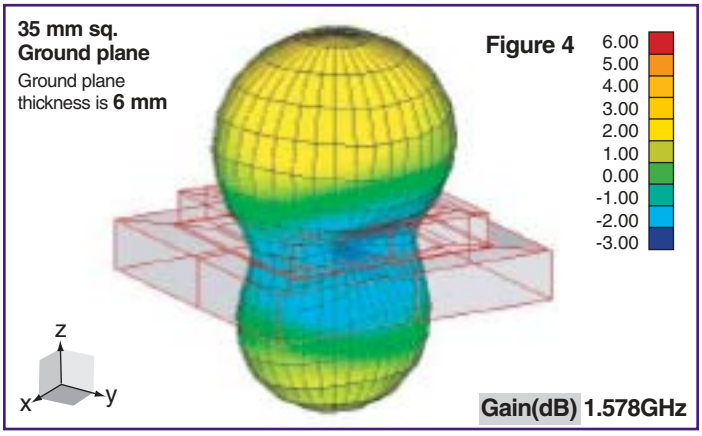
• **Radiation pattern nulls:** When a patch antenna is mounted off center on a ground plane, it will realize non-spherical radiation patterns. "Gain tilt" will occur as the radiation pattern will adjust toward the larger surface, and conversely be reduced on the smaller surface.











faq's

antenna handling & processing

What are the min & max temperatures for the antenna?

Operating: -40°C to +105°C
Storage: No min to +150°C

Can the antenna undergo reflow soldering?

Yes, the pin is attached with Sn62 on the Non-RoHS versions and Sn96 for RoHS versions. The adhesive is also designed to meet expected profiles. (Do not reflow the solder on the top surface for more than a duration of one minute – to avoid the risk dissolving the silver pattern.)

What surfaces are the adhesive compatible or incompatible with?

Anything that is well adhered to the substratum and clean. For example, if you place a patch antenna on standard copper FR-4 for longer than a few days, you will likely pull the silver electrode and some ceramic off the patch during removal. (The fired on silver electrode passes ~150 lbs/in^2.)

What sort of surface preparation is recommended before installing the antenna?

Clean, de-grease and dry. The pressure sensitive adhesive will continue the process of bonding to the substratum for days. NO OTHER ADHESIVES are needed…. they will lower the center frequency of the patch (for example, one more layer of adhesive would reduce the frequency by ~1.5MHz).

Will the performance be affected if a cover (radome) is placed above the patch and/or on the ground plane?

Yes, any covering of the antenna will change its performance characteristics. This would includes any solder mask or a conformal coating. The classic example is applying a radome (cover) over the part.

What are the recommended clearances for a radome?

Generally the radome should be a minimum of 10mm from the sides of the patch and 5mm above the patch element on the ground plane.

Does the ground plane affect the performance of the antenna?

Yes. The ground plane is a pivotal part of the antenna, and different sizes and thickness change performance. Please refer to the ground plane optimization section of this catalog.

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