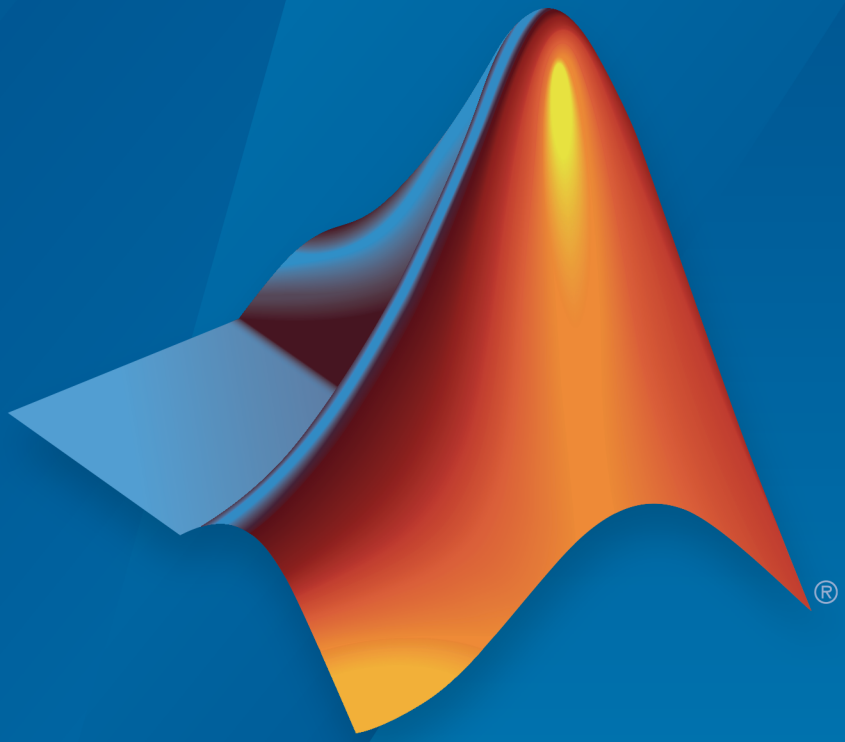
Antenna Toolbox™

Reference



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Antenna Toolbox™ Reference

Revision History

March 2015	Online only	New for Version 1.0 (R2015a)
September 2015	Online only	Revised for Version 1.1 (R2015b)
March 2016	Online only	Revised for Version 2.0 (R2016a)
September 2016	Online only	Revised for Version 2.1 (R2016b)
March 2017	Online only	Revised for Version 2.2 (R2017a)

Contents

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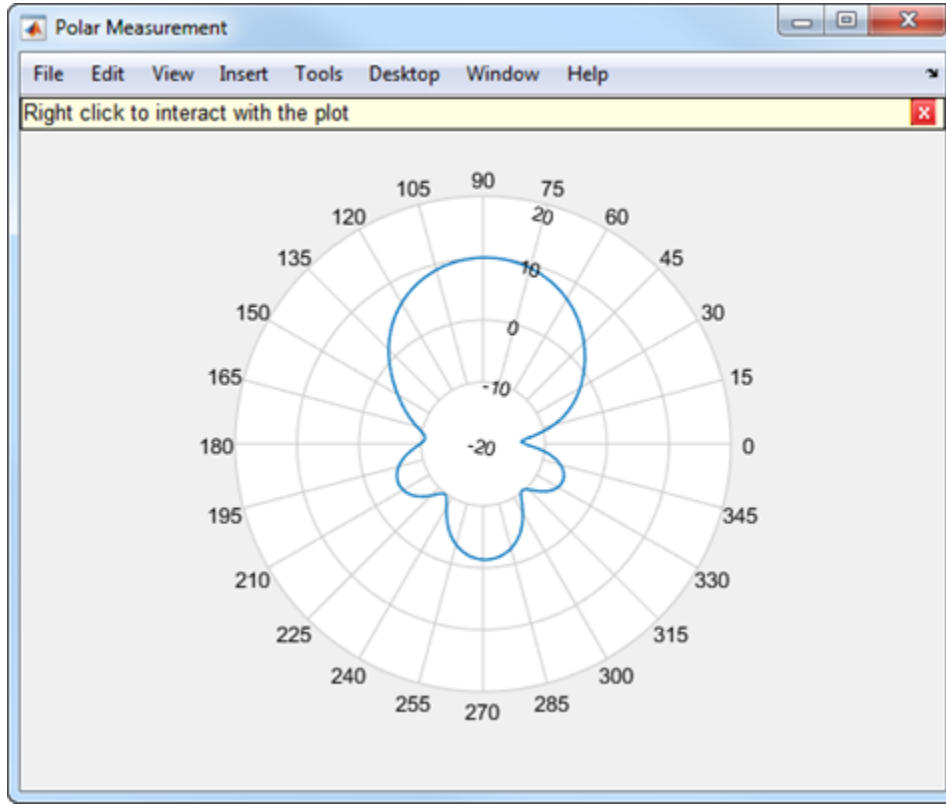
Antenna Classes — Alphabetical List

polarpattern class

Interactive plot of radiation patterns in polar format

Description



`polarpattern` class plots antenna or array radiation patterns in interactive polar format. You can also plot other types of polar data. Use these plots when interactive data visualization or measurement is required. Right-click the **Polar Measurement** window to change the properties, zoom in, or add more data to the plot.

Construction

`polarpattern` plots antenna or array radiation patterns and other types of data in polar format. `polarpattern` plots field value data of radiation patterns for visualization and measurement. Right-click the polar plot to interact.

`polarpattern(data)` creates a polar plot with magnitude values in the vector `d`. In this polar plot, angles are uniformly spaced on the unit circle, starting at `0` degrees.

`polarpattern(angle,magnitude)` creates a polar plot from a set of angle vectors and corresponding magnitudes. You can also create polar plots from multiple sets for angle vectors and corresponding sets of magnitude using the syntax: `polarpattern(angle1, magnitude1, angle2, magnitude2...)`.

`p = polarpattern( ___ )` returns an object handle that you can use to customize the plot or add measurements. You can specify any of the arguments from the previous syntaxes.

`p = polarpattern('gco')` returns an object handle from polar pattern in the current figure.

`polarpattern( ___ ,Name,Value)` creates a polar plot, with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding property value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values. To list all the property `Name,Value` pairs, use `details(p)`. To list all the property `Name,Value` pairs, use `details(p)`. You can use the properties to extract any data from the radiation pattern from the polar plot. For example, `p = polarpattern(data,'Peaks',3)` identifies and displays the three highest peaks in the pattern data.

For a list of properties, see PolarPattern Properties.

`polarpattern(ax, ___ )` creates a polar plot using axes handle, `ax` instead of the current axes handle.

Input Arguments

`data` — Antenna or array data

real length-*M* vector | real *M*-by-*N* matrix | real *N*-*D* array | complex vector or matrix

Antenna or array data, specified as one of the following:

- A real length-*M* vector, where *M* contains the magnitude values with angles assumed to be $\frac{(0:M-1)}{M}\times 360^\circ$ degrees.
- A real *M*-by-*N* matrix, where *M* contains the magnitude values and *N* contains the independent data sets. Each column in the matrix has angles taken from the vector $\frac{(0:M-1)}{M}\times 360^\circ$ degrees.
- A real *N*-*D* array, where *N* is the number of dimensions. Arrays with dimensions `2` and greater are independent data sets.
- A complex vector or matrix, where `data` contains Cartesian coordinates (*x*, *y*) of each point. *x* contains the real (`data`) and *y* contains the imaginary (`data`).

When data is in a logarithmic form, such as dB, magnitude values can be negative. In this case,`polarpattern` plots the smallest magnitude values at the origin of the polar plot and largest magnitude values at the maximum radius.

`angle` — Set of angles

vector in degrees

Set of angles, specified as a vector in degrees.

`magnitude` — Set of magnitude values

vector | matrix

Set of magnitude values, specified as a vector or a matrix. For a matrix of magnitude values, each column is an independent set of magnitude values and corresponds to the same set of angles.

Methods

`add`	Add data to existing polar plot
`addCursor`	Add cursor to polar plot angle
`animate`	Replace existing data with new data for animation

`createLabels`	Create legend labels
`findLobes`	Main, back and side lobe data
`replace`	Replace existing data with new data in polar plot
`showPeaksTable`	Show or hide peak marker table
`showSpan`	Show or hide angle span between two markers

Examples

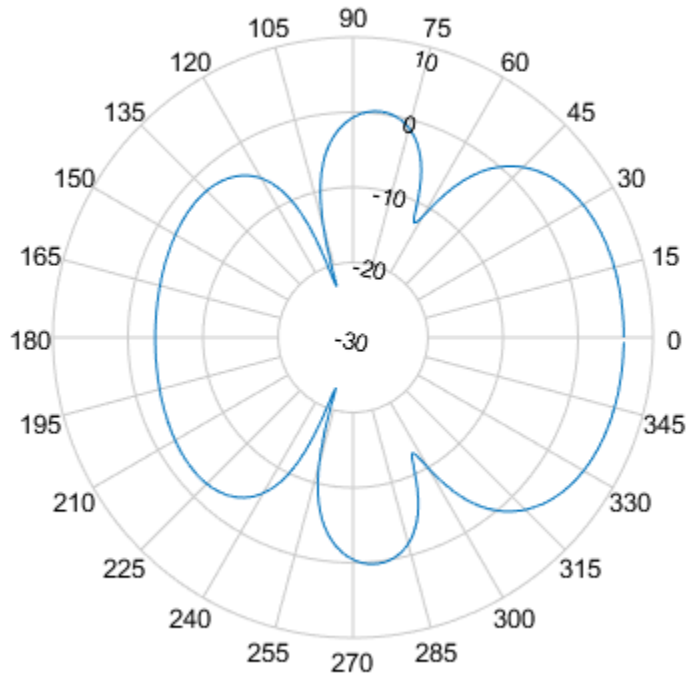
Polar Pattern for Vivaldi Antenna

Create a default Vivaldi antenna and calculate the directivity at 1.5 GHz.

```
v = vivaldi;
V = pattern(v,1.5e9,0,0:1:360);
```

Plot the polar pattern of the calculated directivity.

```
P = polarpattern(V);
```



Polar Pattern of Cavity Antenna

Create a default cavity antenna. Calculate the directivity of the antenna and write the data to `cavity.pln` using the msiwrite function.

```
c = cavity;
msiwrite(c,2.8e9,'cavity','Name','Cavity Antenna Specifications');
```

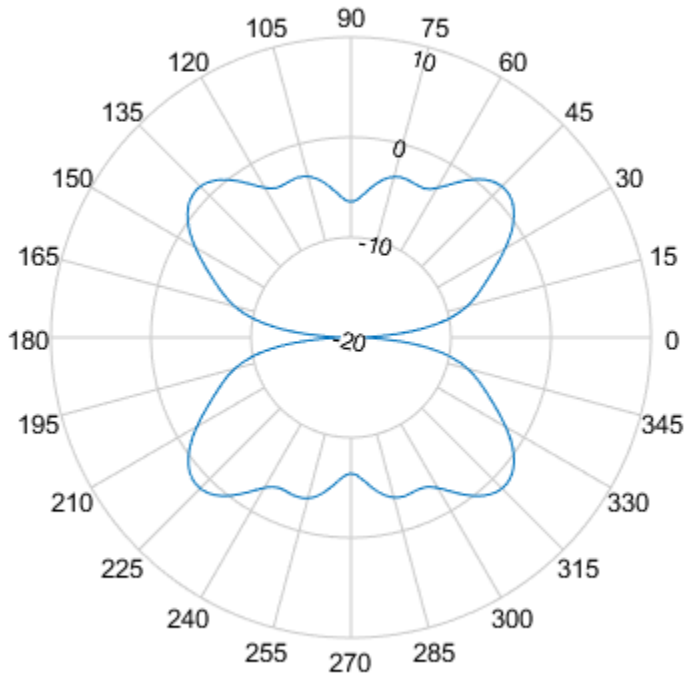
Read the cavity specification file into `Horizontal`, `Vertical`, and `Optional` structures using the msiread function.

```
[Horizontal,Vertical,Optional] = msiread('cavity.pln')
```

```
Horizontal =

  struct with fields:

    PhysicalQuantity: 'Gain'
           Magnitude: [360×1 double]
               Units: 'dBi'
             Azimuth: [360×1 double]
           Elevation: 0
           Frequency: 2.8000e+09
               Slice: 'Elevation'


Vertical =

  struct with fields:

    PhysicalQuantity: 'Gain'
           Magnitude: [360×1 double]
               Units: 'dBi'
             Azimuth: 0
           Elevation: [360×1 double]
           Frequency: 2.8000e+09
               Slice: 'Azimuth'


Optional =

  struct with fields:

         name: 'Cavity Antenna Specifications'
    frequency: 2.8000e+09
         gain: [1×1 struct]
```

Plot the polar pattern of the cavity at azimuth angles.

```
P = polarpattern(Horizontal.Azimuth,Horizontal.Magnitude);
```



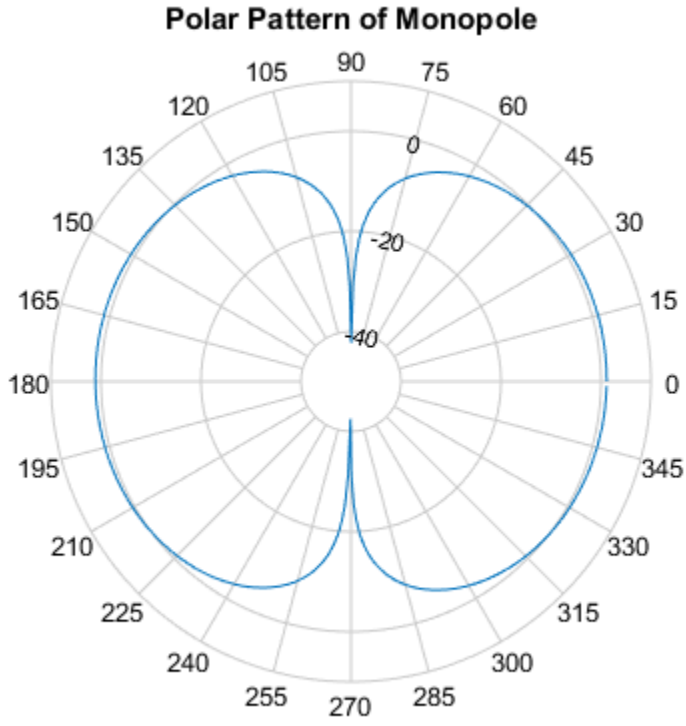
Add Title to Polar Plot

Create a default monopole antenna and calculate the directivity at 75 MHz.

```
m = monopole;
M = pattern(m,75e6,0,0:1:360);
```

Plot the polar pattern of the antenna.

```
P = polarpattern(M,'TitleTop','Polar Pattern of Monopole');
```



Polar Pattern Properties

Create a default dipole antenna and calculate the directivity at 75 MHz.

```
d = dipole;
D = pattern(d,75e6,0,0:1:360);
```

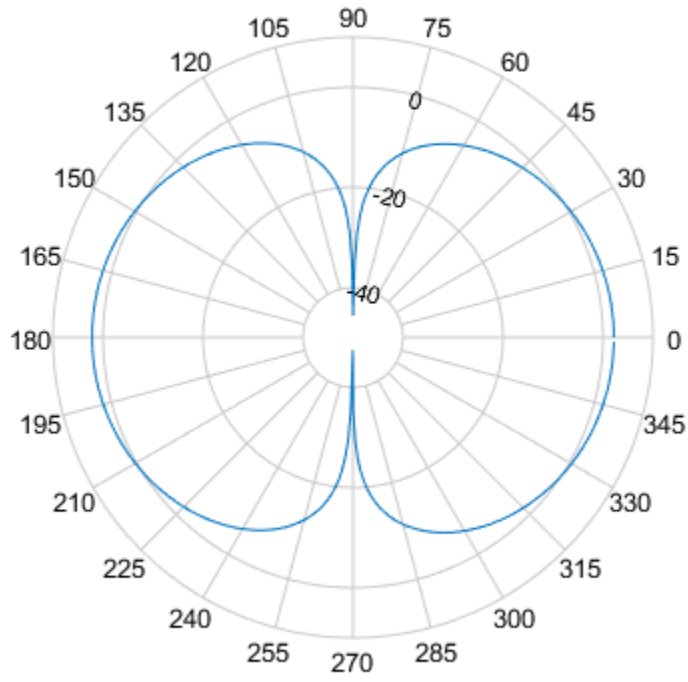
Plot the polar pattern of the antenna and display the properties of the plot.

```
P = polarpattern(D);
details(P)
```

```
  internal.polari handle with properties:
```

```
                    Interactive: 1
                   LegendLabels: ''
                 AntennaMetrics: 0
                      CleanData: 1
                      AngleData: [361×1 double]
                  MagnitudeData: [361×1 double]
                  IntensityData: []
                   AngleMarkers: [0×1 struct]
                  CursorMarkers: [0×1 struct]
                    PeakMarkers: [0×1 struct]
                  ActiveDataset: 1
                AngleLimVisible: 0
                  LegendVisible: 0
                           Span: 0
                       TitleTop: ''
                    TitleBottom: ''
                          Peaks: []
                       FontSize: 10
                   MagnitudeLim: [-50 10]
             MagnitudeAxisAngle: 75
                  MagnitudeTick: [-40 -20 0]
       MagnitudeTickLabelColor: 'k'
                      AngleLim: [0 360]
                 AngleTickLabel: {1×24 cell}
           AngleTickLabelColor: 'k'
    TitleTopFontSizeMultiplier: 1.1000
 TitleBottomFontSizeMultiplier: 0.9000
            TitleTopFontWeight: 'bold'
         TitleBottomFontWeight: 'normal'
        TitleTopTextInterpreter: 'none'
     TitleBottomTextInterpreter: 'none'
                TitleTopOffset: 0.1500
             TitleBottomOffset: 0.1500
                       ToolTips: 1
            MagnitudeLimBounds: [-Inf Inf]
   MagnitudeFontSizeMultiplier: 0.9000
       AngleFontSizeMultiplier: 1
                    AngleAtTop: 90
                AngleDirection: 'ccw'
               AngleResolution: 15
        AngleTickLabelRotation: 0
          AngleTickLabelFormat: '360'
       AngleTickLabelColorMode: 'contrast'
                  PeaksOptions: {}
```

```
      AngleTickLabelVisible: 1
                      Style: 'line'
                  DataUnits: 'dB'
               DisplayUnits: 'dB'
             NormalizeData: 0
          ConnectEndpoints: 0
        DisconnectAngleGaps: 0
                  EdgeColor: 'k'
                  LineStyle: '-'
                  LineWidth: 1
                   FontName: 'Helvetica'
              FontSizeMode: 'auto'
        GridForegroundColor: [0.8000 0.8000 0.8000]
        GridBackgroundColor: 'w'
           DrawGridToOrigin: 0
                GridOverData: 0
         GridAutoRefinement: 0
                  GridWidth: 0.5000
                GridVisible: 1
                   ClipData: 1
             TemporaryCursor: 1
            MagnitudeLimMode: 'auto'
    MagnitudeAxisAngleMode: 'auto'
          MagnitudeTickMode: 'auto'
MagnitudeTickLabelColorMode: 'contrast'
  MagnitudeTickLabelVisible: 1
              MagnitudeUnits: ''
              IntensityUnits: ''
                      Marker: 'none'
                  MarkerSize: 6
                      Parent: [1×1 Figure]
                    NextPlot: 'replace'
                  ColorOrder: [7×3 double]
             ColorOrderIndex: 1
                SectorsColor: [16×3 double]
                SectorsAlpha: 0.5000
                        View: 'full'
              ZeroAngleLine: 0
```



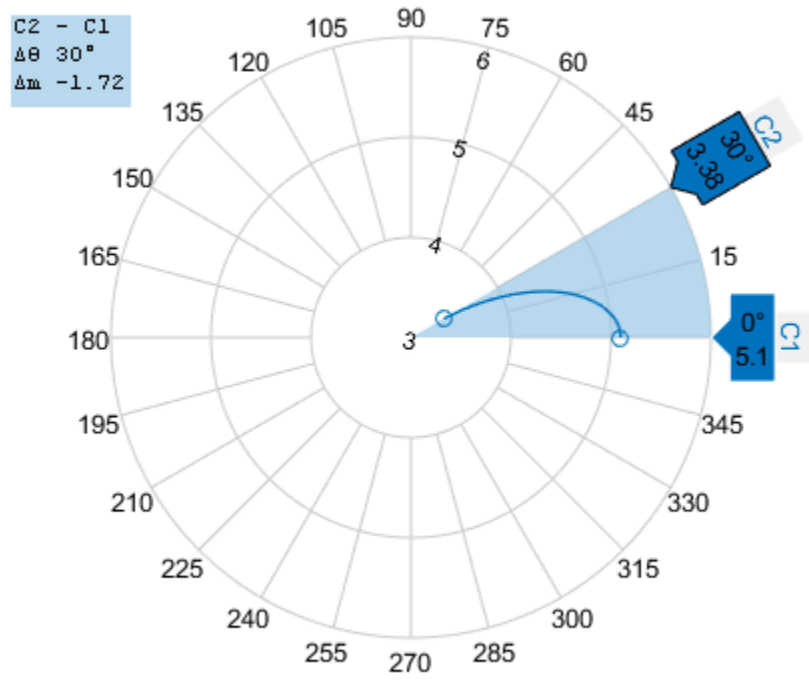
Remove -Inf and NaN Values in Antenna PolarPattern

Use `Clean Data` in `Antenna Metrics` to remove -inf and NaN values in a monopole antenna polar pattern. It is recommended to use `Clean Data` for partial data with -inf and NaN values.

```
m = monopole;
m.GroundPlaneLength = inf;
```

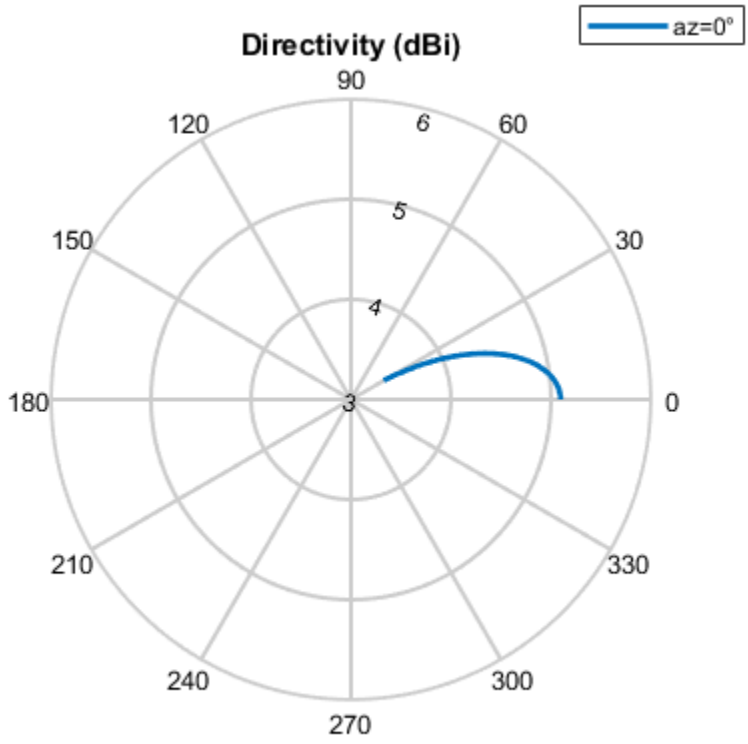
Plot the beamwidth of the antenna at 70 MHz.

```
figure;
beamwidth(m,70e6,0,-50:30)
```



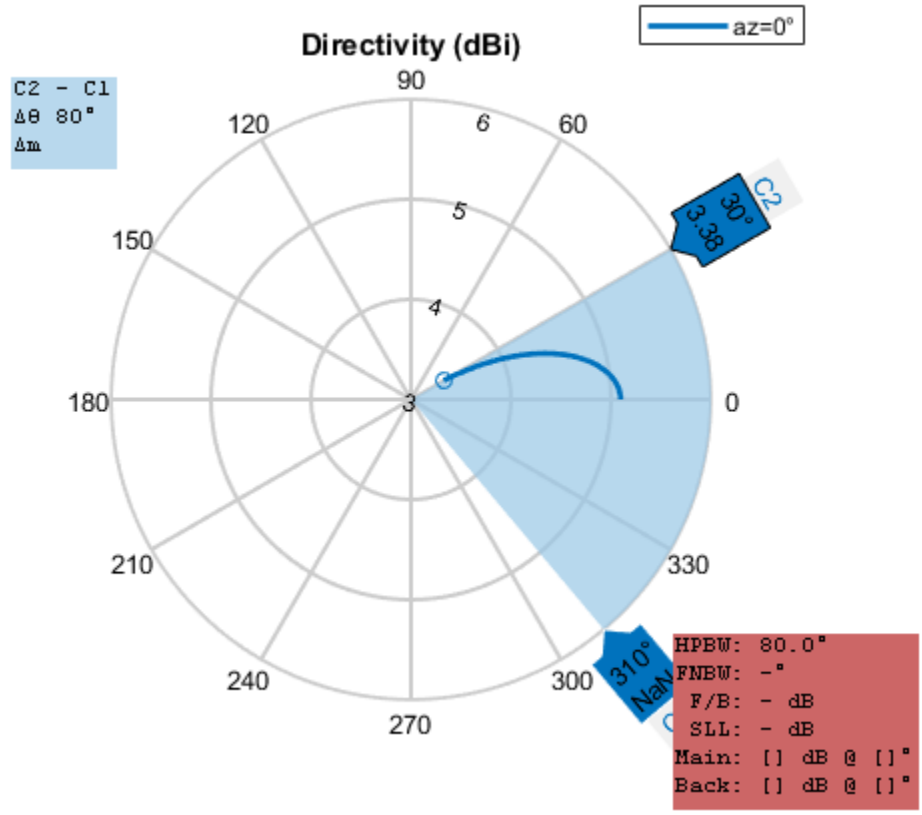
Plot the radiation pattern of the antenna at 70 MHz.

```
figure;
pattern(m,70e6,0,-50:30);
```



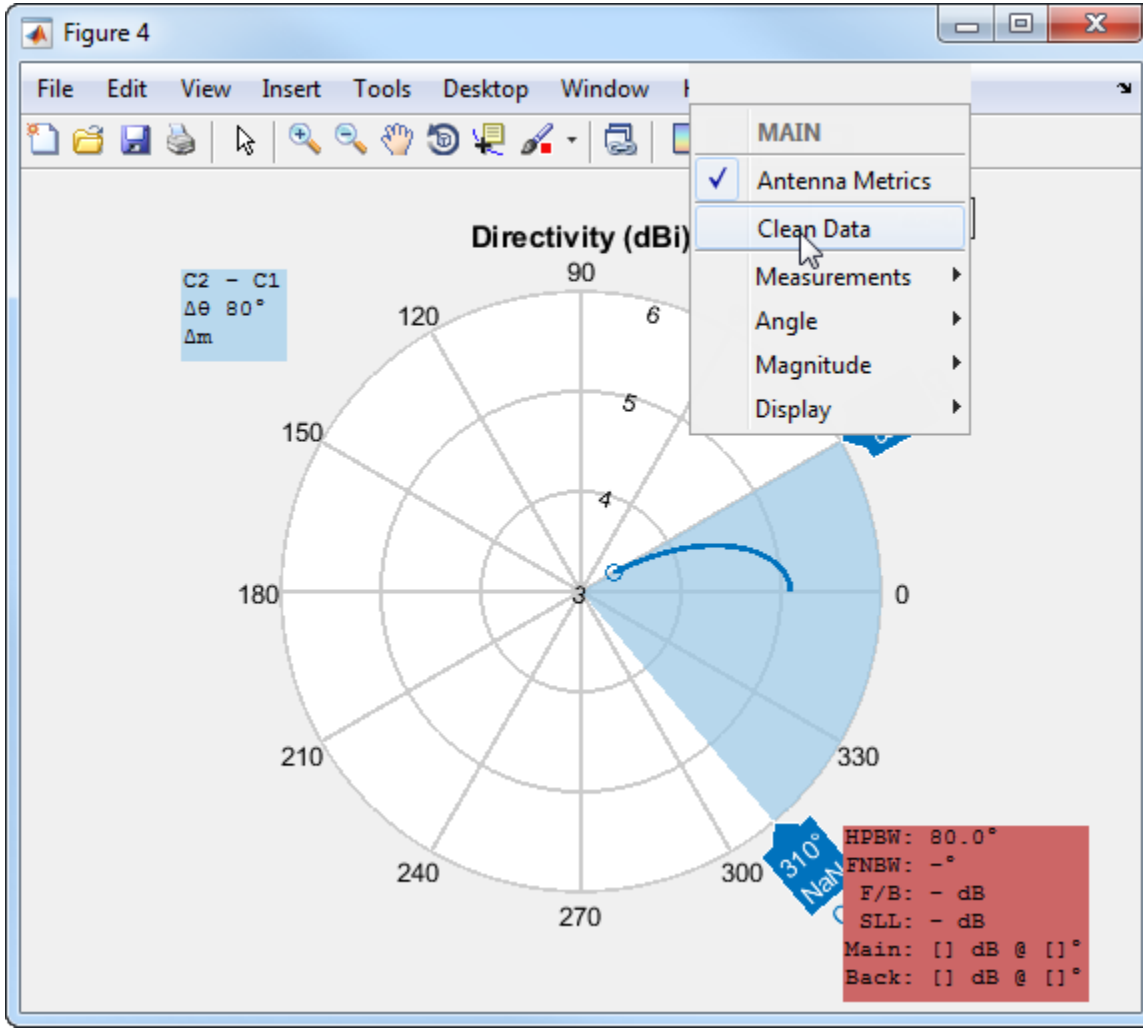
Use `polarpattern` to view antenna metrics of the radiation pattern.

```
P = polarpattern('gco');
P.AntennaMetrics = 1;
```

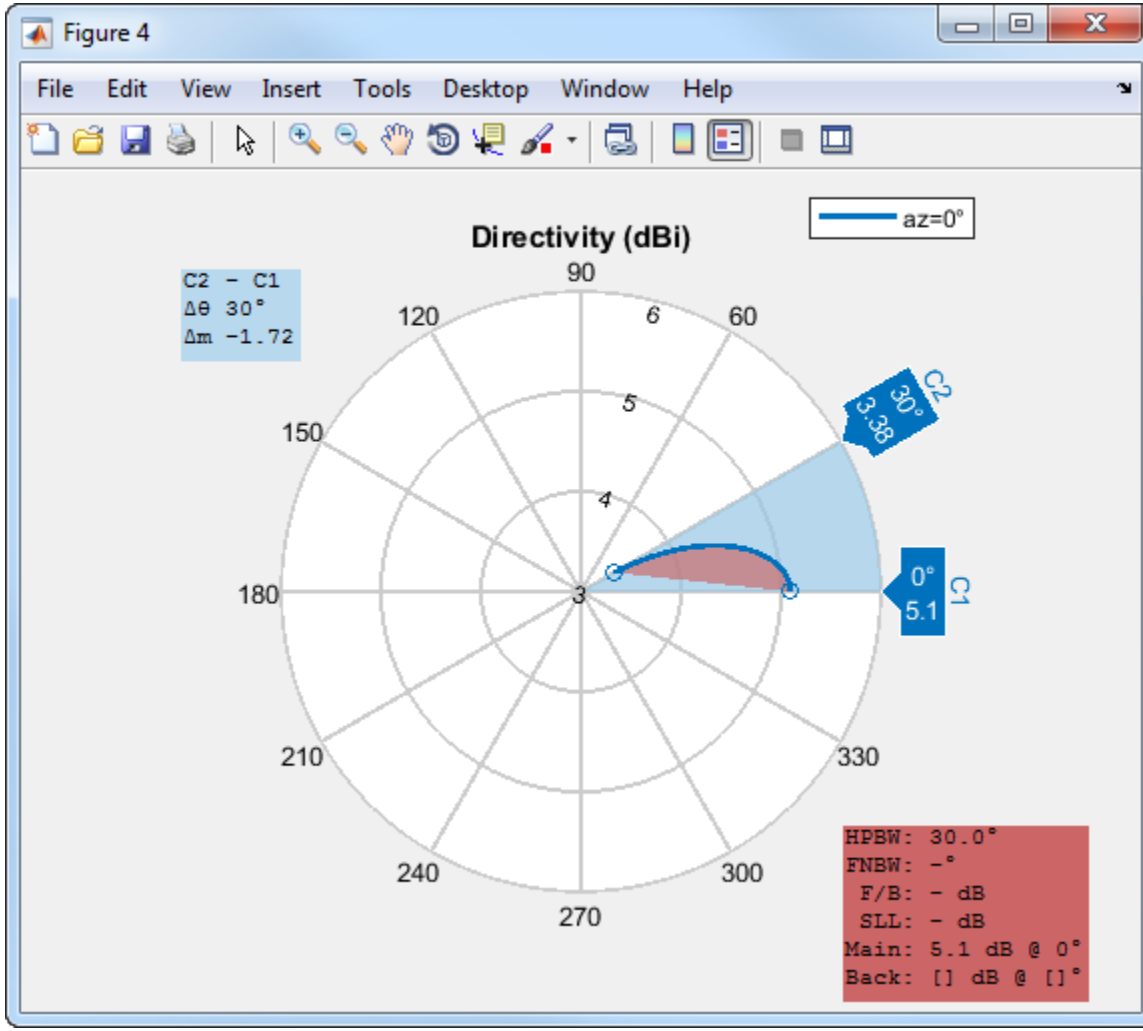


Compare the beamwidth plot and the polarpattern plot. You will see that Antenna Metrics does not represent the beamwidth correctly.

Use `Clean Data` to clean the -inf and NaN values.



After using `Clean Data`, you see that the polarpattern beamwidth calculation matches the beamwidth plot calculation.



- “Interact with Polar Plot”

See Also

Topics

"Interact with Polar Plot"

Introduced in R2016a

Antenna Objects — Alphabetical List

biquad

Create biquad antenna

Description

The `biquad` antenna is center fed and symmetric about its origin. The default length is chosen for an operating frequency of 2.8 GHz.

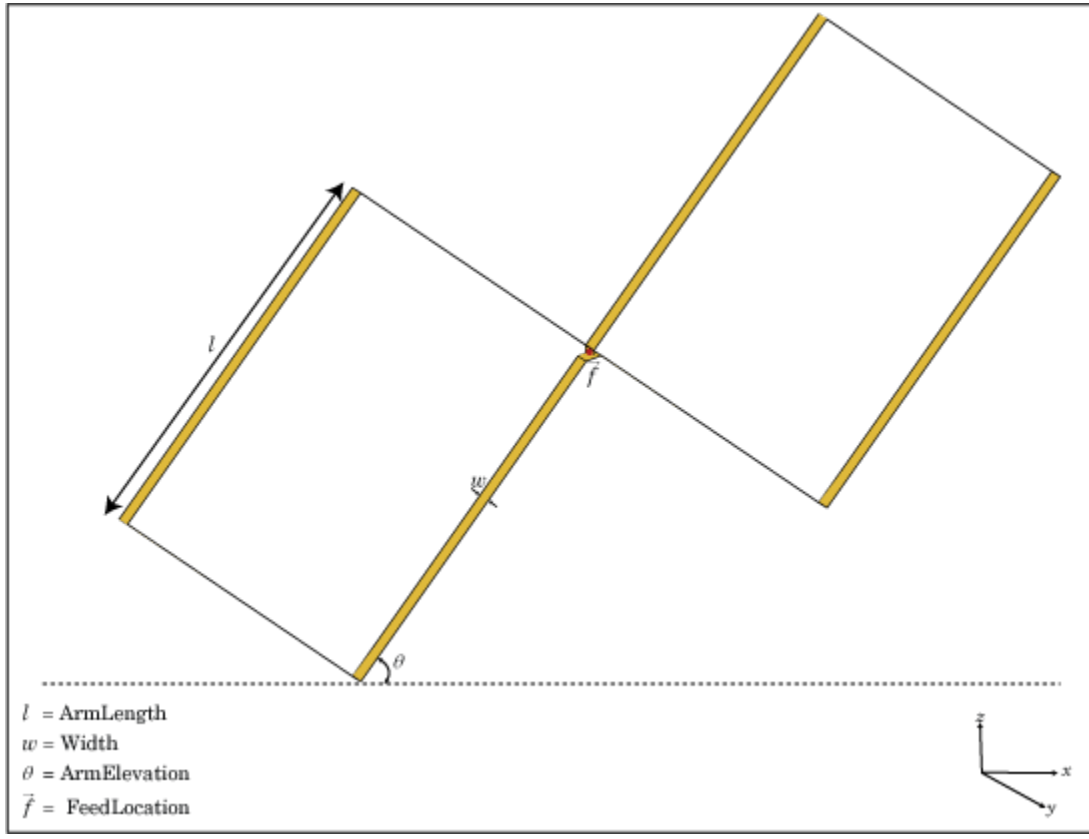
The width of the strip is related to the diameter an equivalent cylinder:

$$w = 2d = 4r$$

, where:

- d is the diameter of equivalent cylindrical dipole.
- r is the radius of equivalent cylindrical dipole.

For a given cylinder radius, use the `cylinder2strip` utility function to calculate the equivalent width. The default strip dipole is center-fed. The feed point coincides with the origin. The origin is located on the Y-Z plane.



Create Object

`bq = biquad` creates a biquad antenna.

`bq = biquad(Name,Value)` creates a biquad antenna with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'ArmLength'` — Length of two arms

0.0305 (default) | scalar in meters

Length of two arms, specified as the comma-separated pair consisting of `'ArmLength'` and a scalar in meters. The default length is chosen for an operating frequency of 2.8 GHz.

Example: `'ArmLength',0.0206`

Data Types: `double`

`'Width'` — Biquad arm width

1.0000e-03 (default) | scalar in meters

Biquad arm width, specified as the comma-separated pair consisting of `'Width'` and a scalar in meters.

Example: `'Width',0.006`

Data Types: `double`

`'ArmElevation'` — Angle formed by biquad arms to X-Y plane

45 (default) | scalar in degrees

Angle formed by biquad arms to the X-Y plane, specified as the comma-separated pair consisting of `'ArmElevation'` and a scalar in meters.

Example: `'ArmElevation', 50`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load'`, lumpedelement. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas

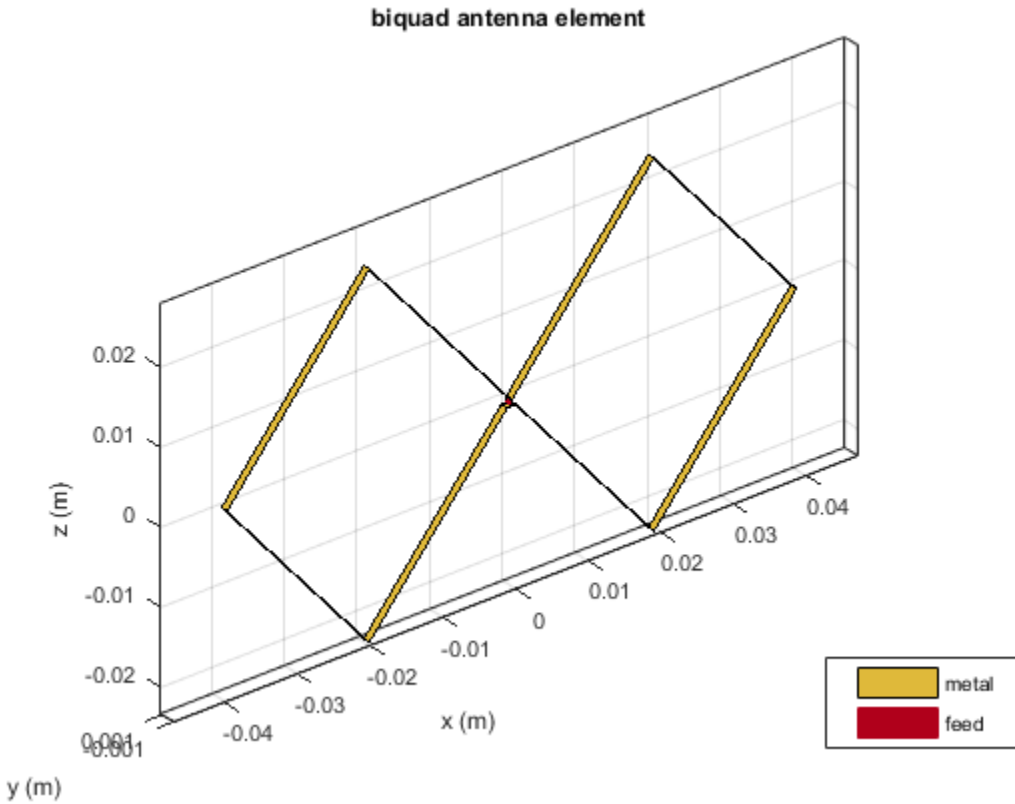
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

Examples

Create and View Biquad Antenna

Create a biquad antenna with arm angles at 50 degrees and view it.

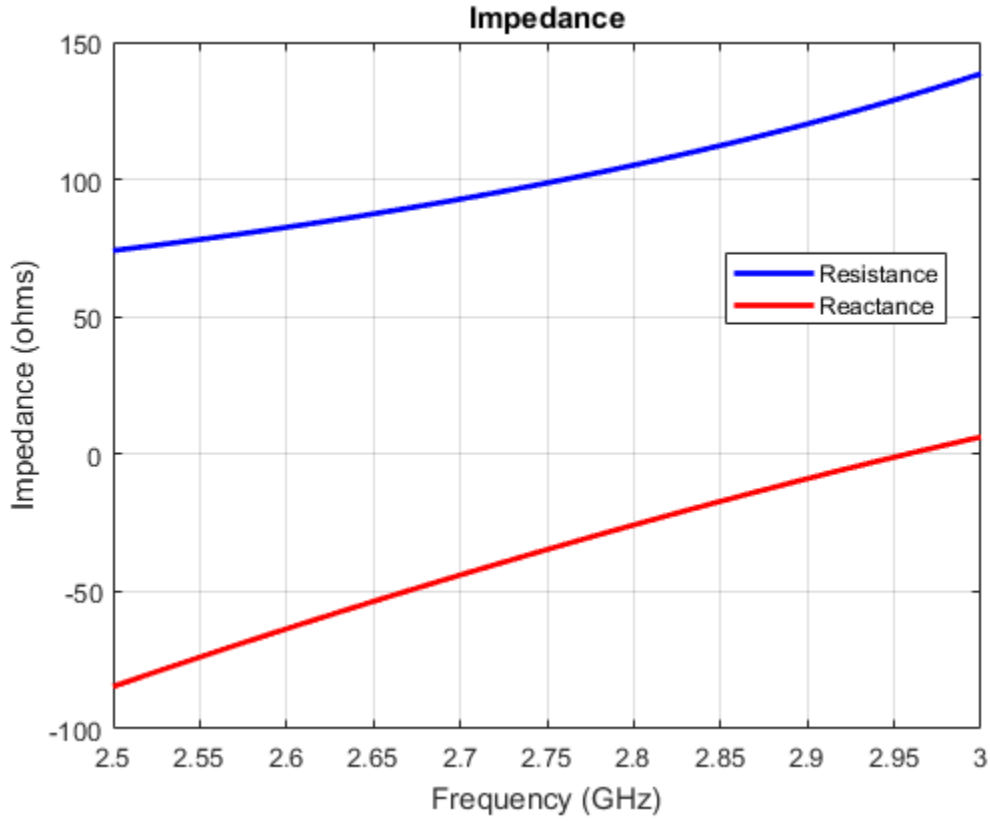
```
bq = biquad('ArmElevation',50);
show(bq)
```



Impedance of Biquad Antenna

Calculate the impedance of a biquad antenna over a frequency span 2.5GHz-3GHz.

```
bq = biquad('ArmElevation',50);
impedance(bq,linspace(2.5e9,3e9,51));
```



See Also

See Also

dipole | dipoleFolded | loopCircular

Topics

“Rotate Antenna and Arrays”

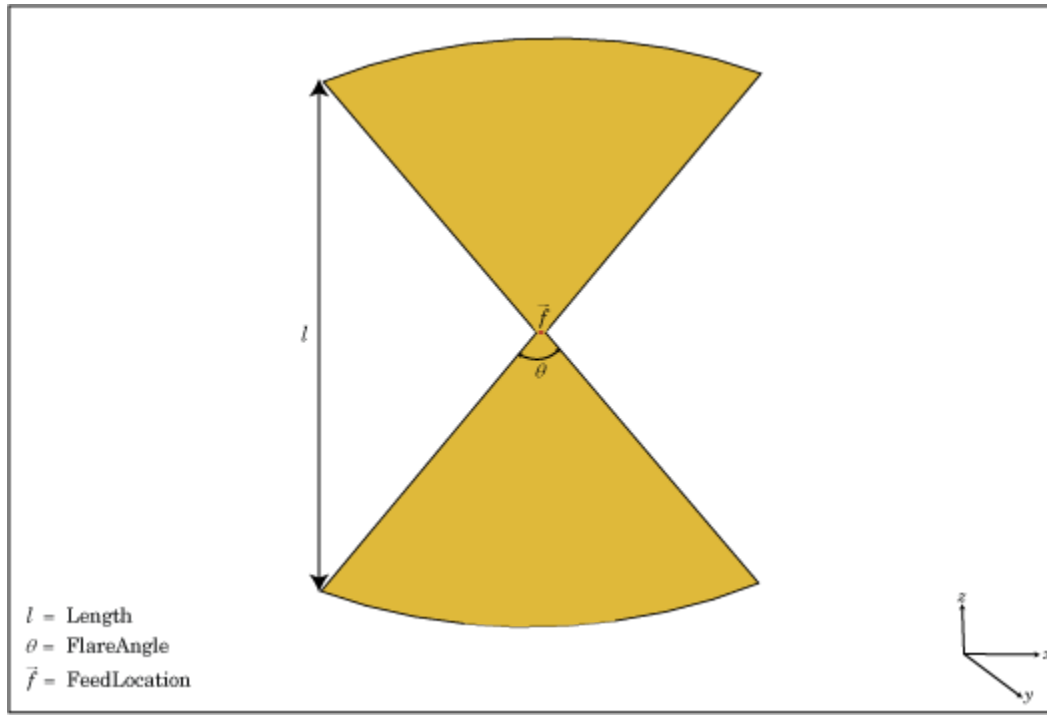
Introduced in R2015b

bowtieRounded

Create rounded bowtie dipole antenna

Description

The `bowtieRounded` object is a planar bowtie antenna, with rounded edges, on the Y–Z plane. The default rounded bowtie is center fed. The feed point coincides with the origin. The origin is located on the Y-Z plane.



Create Object

`br = bowtieRounded` creates a half-wavelength planar bowtie antenna with rounded edges.

`br = bowtieRounded(Name,Value)` creates a planar bowtie antenna with rounded edges, with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`Length` — Rounded bowtie length

0.2000 (default) | scalar in meters

Rounded bowtie length, specified as the comma-separated pair consisting of `'Length'` and a scalar in meters. By default, the length is chosen for the operating frequency of 490 MHz.

Example: `'Length',3`

Data Types: `double`

`FlareAngle` — Rounded bowtie flare angle

90 (default) | scalar in degrees

Rounded bowtie flare angle, specified as the comma-separated pair consisting of `'FlareAngle'` and a scalar in degrees.

Note: Flare angle should be less than 175 degrees and greater than 5 degrees.

Example: `'FlareAngle',80`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load'`, lumpedelement. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface

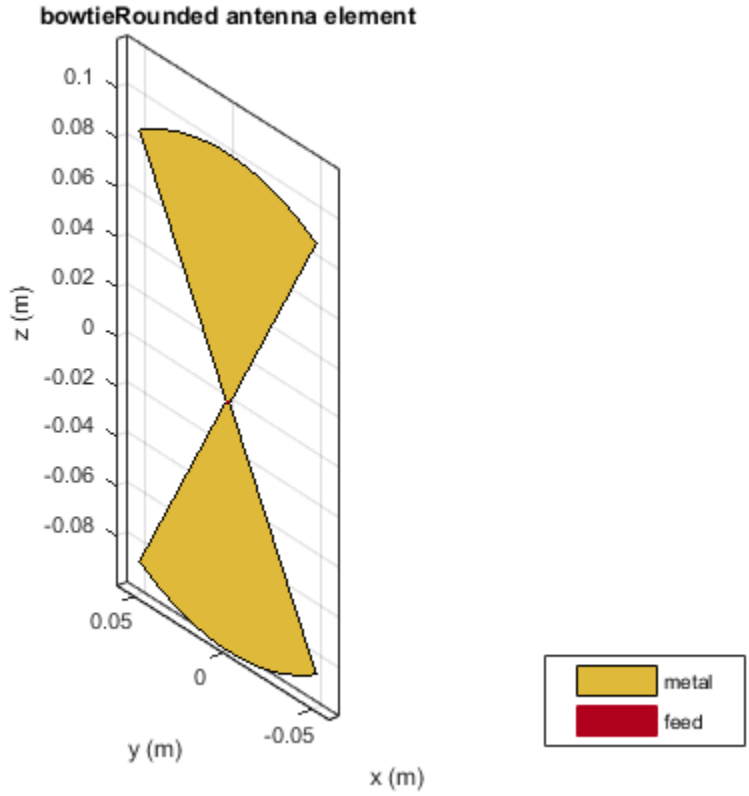
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

Examples

Create and View Center-Fed Rounded Bowtie Antenna

Create and view a center-fed rounded bowtie that has a flare angle of 60 degrees.

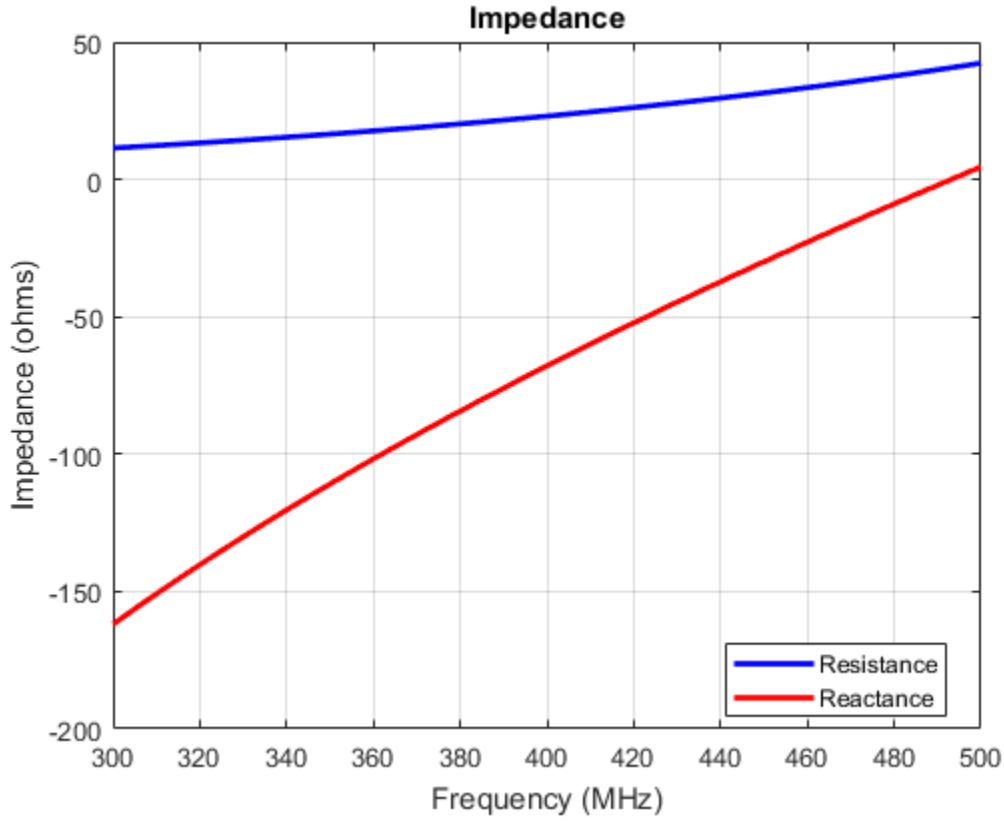
```
b = bowtieRounded('FlareAngle',60);
show(b);
```



Impedance of Rounded Bowtie Antenna

Calculate and plot the impedance of a rounded bowtie over a frequency range of 300MHz-500MHz.

```
b = bowtieRounded('FlareAngle',60);
impedance(b,linspace(300e6,500e6,51))
```



References

[1] Balanis, C.A.*Antenna Theory: Analysis and Design*.3rd Ed. New York: Wiley, 2005.

[2] Brown, G.H., and O.M. Woodward Jr. "Experimentally Determined Radiation Characteristics of Conical and Triangular Antennas". *RCA Review*. Vol.13, No.4, Dec.1952, pp. 425–452

See Also

See Also

bowtieTriangular | dipole | dipoleFolded

Topics

"Rotate Antenna and Arrays"

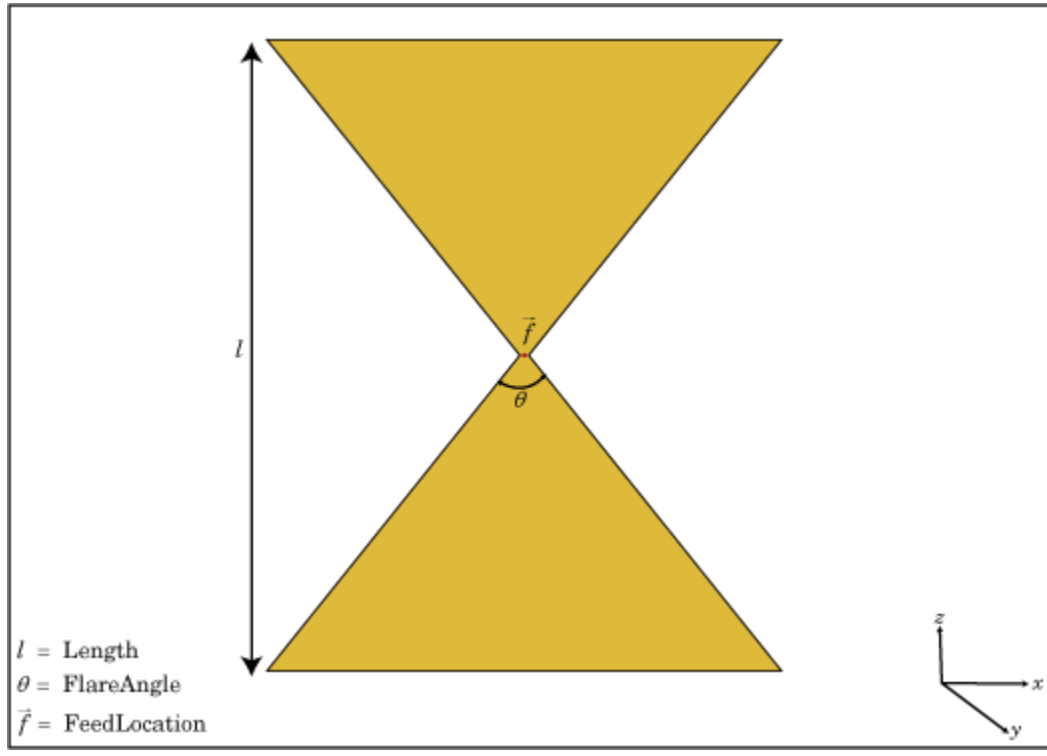
Introduced in R2015a

bowtieTriangular

Create planar bowtie dipole antenna

Description

The `bowtieTriangular` object is a planar bowtie antenna on the Y-Z plane. The default planar bowtie dipole is center-fed. The feed point coincides with the origin. The origin is located on the Y-Z plane.



Create Object

`bt = bowtieTriangular` creates a half-wavelength planar bowtie antenna.

`bt = bowtieTriangular(Name,Value)` creates a planar bowtie antenna with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`Length` — Planar bowtie length

0.2000 (default) | scalar in meters

Planar bowtie length, specified as the comma-separated pair consisting of `'Length'` and a scalar in meters. By default, the length is chosen for the operating frequency of 410 MHz.

Example: `'Length',3`

Data Types: `double`

`FlareAngle` — Planar bowtie flare angle

90 (default) | scalar in degrees

Planar bowtie flare angle near the feed, specified as the comma-separated pair consisting of `'FlareAngle'` and a scalar in meters.

Note: Flare angle should be less than 175 degrees and greater than 5 degrees.

Example: `'FlareAngle',80`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load'`, lumpedelement. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface

design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

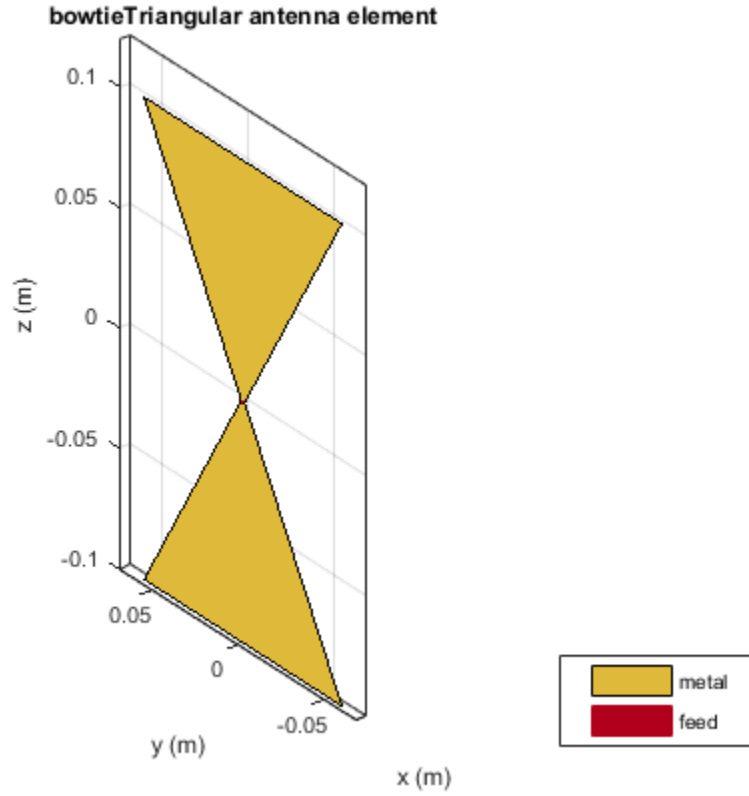
Examples

Create and View Center-Fed Planar Bowtie Antenna

Create and view a center-fed planar bowtie antenna that has a 60 degrees flare angle.

```
b = bowtieTriangular('FlareAngle',60)
show(b)
```

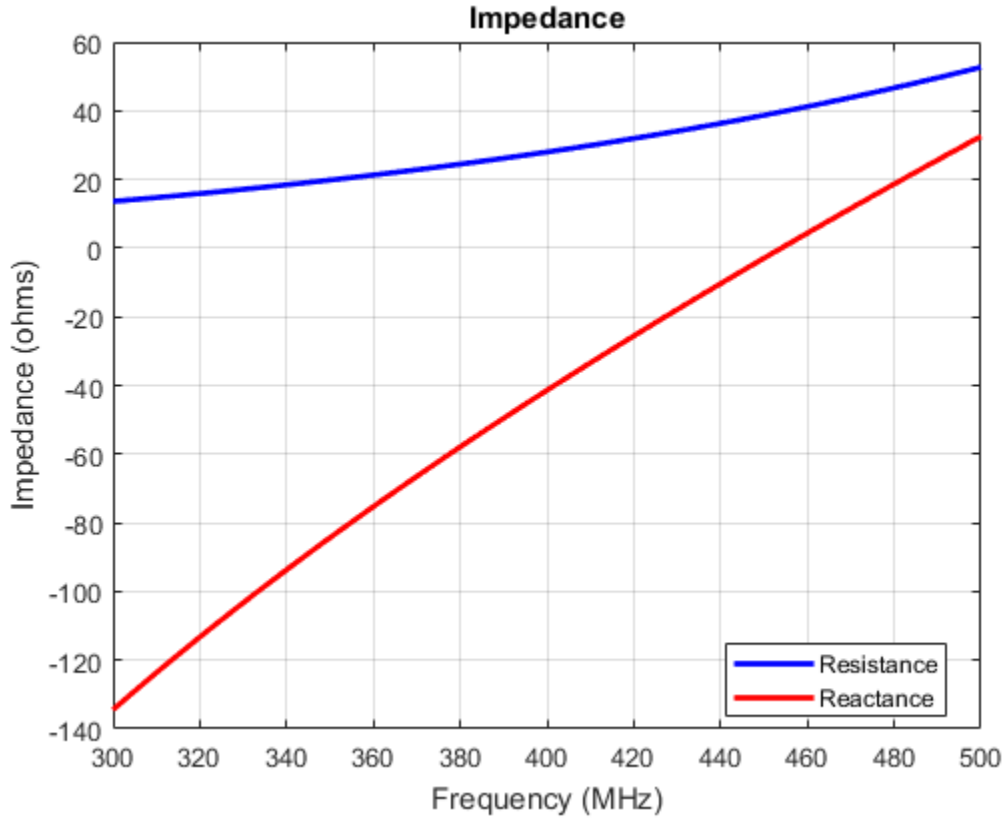
```
b =

  bowtieTriangular with properties:

       Length: 0.2000
    FlareAngle: 60
          Tilt: 0
      TiltAxis: [1 0 0]
          Load: [1×1 lumpedElement]
```



Impedance of Planar Bowtie Antenna

Calculate and plot the impedance of a planar bowtie antenna over a frequency range of 300MHz-500MHz.

```
b = bowtieTriangular('FlareAngle',60);
impedance(b,linspace(300e6,500e6,51))
```



References

[1] Balanis, C.A.*Antenna Theory: Analysis and Design*.3rd Ed. New York: Wiley, 2005.

[2] Brown, G.H., and O.M. Woodward Jr. "Experimentally Determined Radiation Characteristics of Conical and Triangular Antennas". *RCA Review*. Vol.13, No.4, Dec.1952, pp. 425–452

See Also

See Also

bowtieRounded | dipole | dipoleVee

Topics

“Rotate Antenna and Arrays”

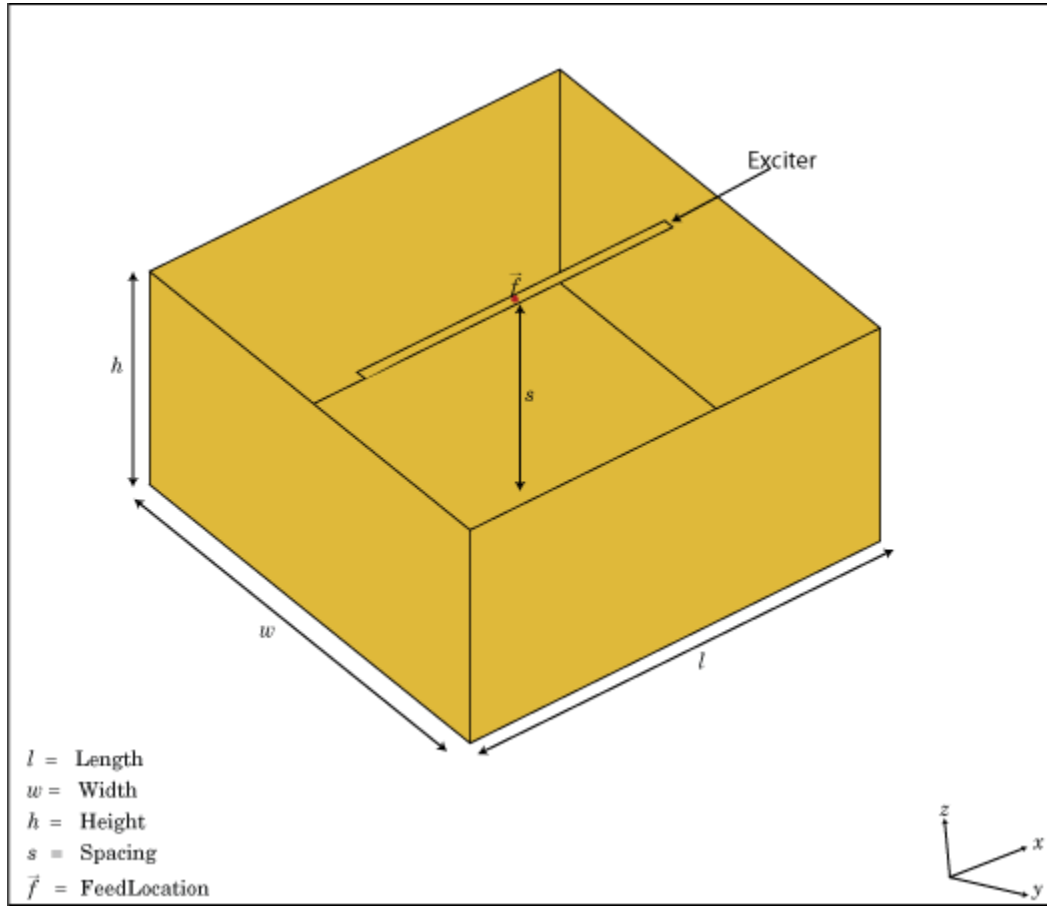
Introduced in R2015a

cavity

Create cavity-backed antenna

Description

The `cavity` object is a cavity-backed antenna located on the X-Y-Z plane. The default cavity antenna has a dipole as an exciter. The feed point is on the exciter.



Create Object

`c = cavity` creates a cavity backed antenna located on the X-Y-Z plane. By default, the dimensions are chosen for an operating frequency of 1 GHz.

`c = cavity(Name,Value)` creates a cavity-backed antenna, with additional properties specified by one or more name–value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`Exciter` — Antenna type used as exciter

`dipole` (default) | antenna element handle or antenna element

Antenna type used as an exciter, specified as the comma-separated pair consisting of `'Exciter'` and an antenna element handle or antenna element. Except reflector and cavity antenna elements, you can use all the single elements in the Antenna Toolbox™ as an exciter.

Example: `'Exciter',dipole`

`Substrate` — Type of dielectric material

'Air' (default) | dielectric material object handle | dielectric material from dielectric catalog

Type of dielectric material used as a substrate, specified as the comma-separated pair consisting of `'Substrate'` and dielectric material object handle or dielectric material from dielectric catalog. For more information refer, `dielectric`. For more information on dielectric substrate meshing, refer “Meshing”.

Example: `'Substrate','FR4'`

`Length` — Length of rectangular cavity along x-axis

0.2000 (default) | scalar in meters

Length of the rectangular cavity along the x-axis, specified as the comma-separated pair consisting of `'Length'` and a scalar in meters.

Example: `'Length',30e-2`

Data Types: `double`

`Width` — Width of rectangular cavity along y-axis

0.2000 (default) | scalar in meters

Width of the rectangular cavity along the y-axis, specified as the comma-separated pair consisting of `'Width'` and a scalar in meters.

Example: `'Width',25e-2`

Data Types: `double`

`Height` — Height of rectangular cavity along z-axis

0.0750 (default) | scalar in meters

Height of the rectangular cavity along the z-axis, specified as the comma-separated pair consisting of `'Height'` and a scalar in meters.

Example: `'Height',7.5e-2`

Data Types: `double`

`Spacing` — Distance between exciter and base of cavity

0.0750 (default) | scalar in meters

Distance between the exciter and the base of the cavity, specified as the comma-separated pair consisting of `'Spacing'` and a scalar in meters.

Example: `'Spacing',7.5e-2`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load'`, lumpedelement. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'EnableProbeFeed'` — Create probe feed from backing structure to exciter

`0` (default) | `1`

Create probe feed from backing structure to exciter, specified as the comma-separated pair consisting of `'EnableProbeFeed'` and `0` or `1`. By default, probe feed is not enabled.

Example: `'EnableProbeFeed',1`

Data Types: `double`

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna

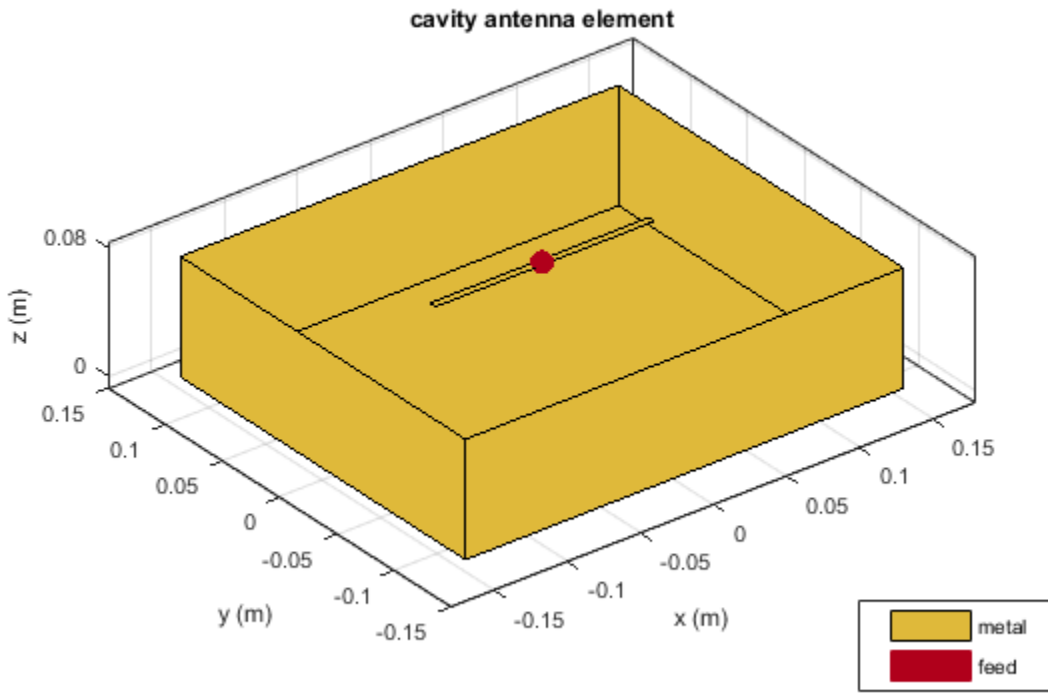
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

Examples

Create and View Cavity-Backed Antenna.

Create and view a cavity-backed dipole antenna with 30cm length, 25cm width, 7.5cm height and spaced 7.5cm from the bowtie for operation at 1GHz.

```
c = cavity('Length',30e-2, 'Width',25e-2,'Height',7.5e-2,'Spacing',7.5e-2);
show(c)
```



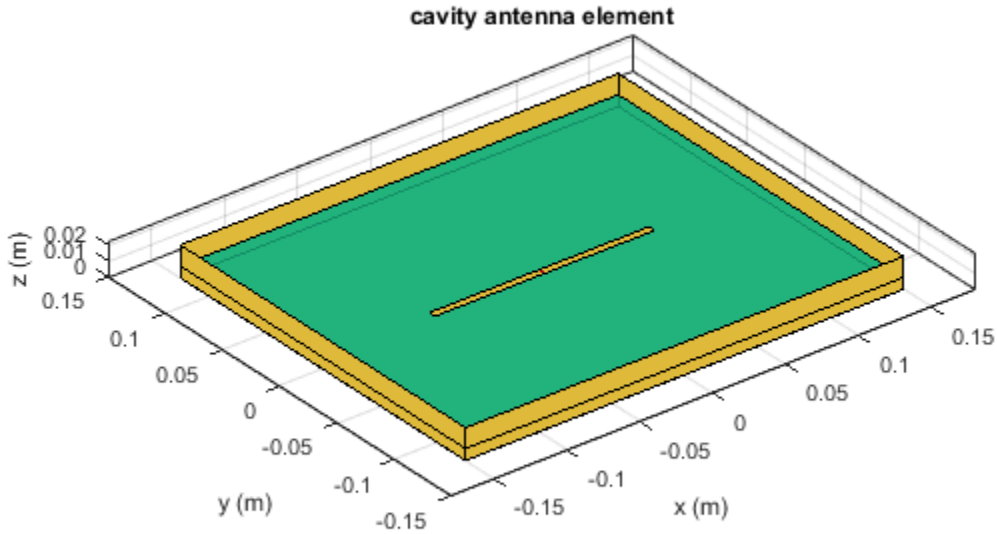
Radiation Pattern of Cavity-Backed Antenna

Create a cavity-backed antenna using a dielectric substrate **'FR4'**.

```
d = dielectric('FR4');
c = cavity('Length',30e-2,'Width',25e-2,'Height',20.5e-3,'Spacing',7.5e-3,...
    'Substrate',d)
show(c)
```

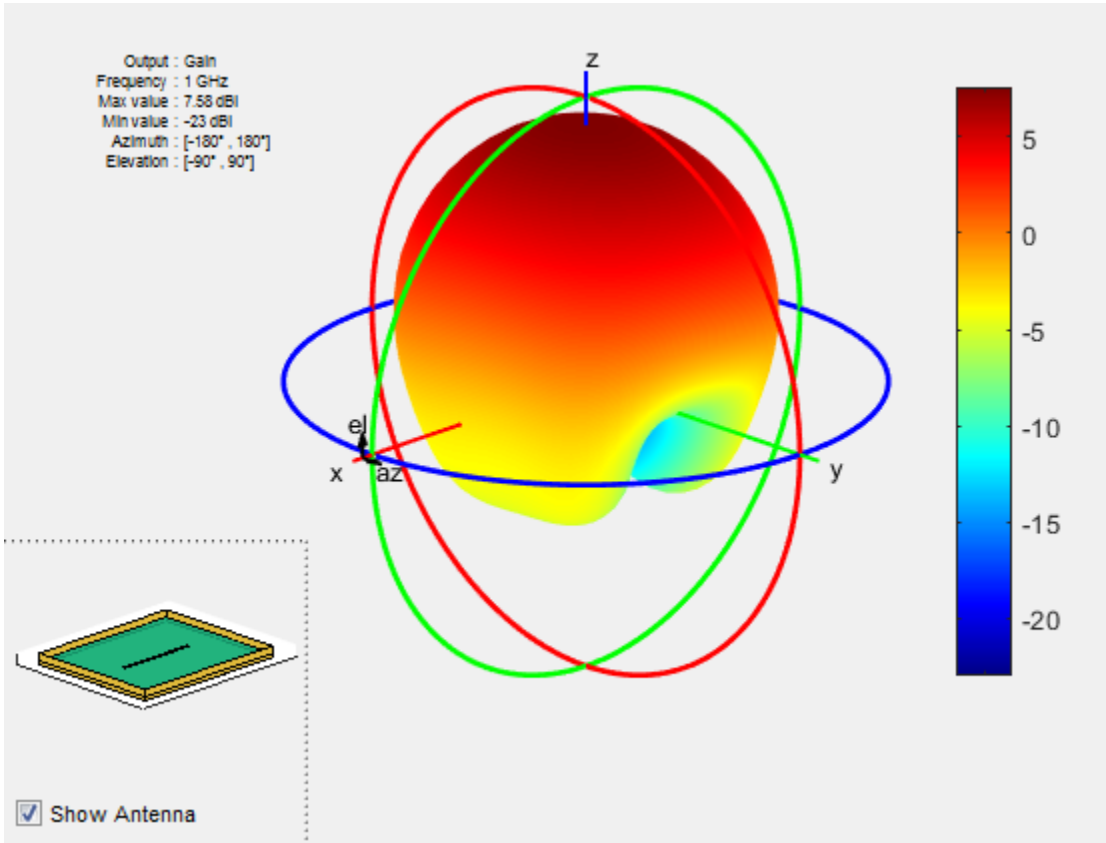
```
c =

  cavity with properties:
```

```
  Exciter: [1x1 dipole]
Substrate: [1x1 dielectric]
   Length: 0.3000
    Width: 0.2500
   Height: 0.0205
  Spacing: 0.0075
     Tilt: 0
 TiltAxis: [1 0 0]
```



Plot the radiation pattern of the antenna at a frequency of 1 GHz.

```
figure
pattern(c,1e9)
```



References

[1] Balanis, C.A.*Antenna Theory: Analysis and Design*.3rd Ed. New York: Wiley, 2005.

See Also

See Also

reflector | spiralArchimedean | spiralEquiangular

Topics

"Rotate Antenna and Arrays"

Introduced in R2015a

dipole

Create strip dipole antenna

Description

The `dipole` object is a strip dipole antenna on the Y-Z plane.

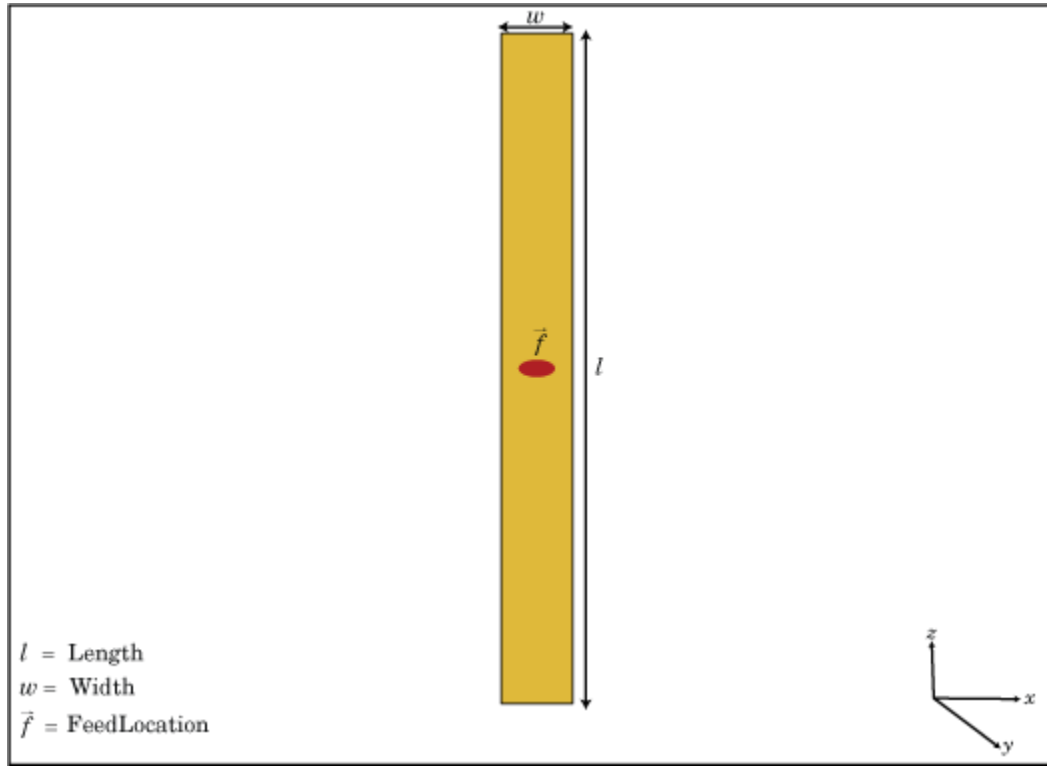
The width of the dipole is related to the diameter of an equivalent cylindrical dipole by the equation

$$w = 2d = 4r$$

where:

- d is the diameter of equivalent cylindrical dipole.
- r is the radius of equivalent cylindrical dipole.

For a given cylinder radius, use the `cylinder2strip` utility function to calculate the equivalent width. The default strip dipole is center-fed. The feed point coincides with the origin. The origin is located on the Y-Z plane.



Create Object

`d = dipole` creates a half-wavelength strip dipole antenna on the Y-Z plane.

`d = dipole(Name,Value)` creates a dipole antenna, with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties you do not specify retains their default values.

Properties

'Length' — Dipole length

2 (default) | scalar in meters

Dipole length, specified as the comma-separated pair consisting of 'Length' and a scalar in meters. By default, the length is chosen for an operating frequency of 75 MHz.

Example: 'Length',3

Data Types: double

'Width' — Dipole width

0.1000 (default) | scalar in meters

Dipole width, specified as the comma-separated pair consisting of 'Width' and a scalar in meters.

Note: Dipole width should be less than 'Length'/5 and greater than 'Length'/1001. [2]

Example: 'Width',0.05

Data Types: double

'FeedOffset' — Signed distance from center of dipole

0 (default) | scalar in meters

Signed distance from center of dipole, specified as the comma-separated pair consisting of 'FeedOffset' and a scalar in meters. The feed location is on Y-Z plane.

Example: 'FeedOffset',3

Data Types: double

'Load' — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of 'Load' and a lumped element object handle. For more information, see lumpedElement.

Example: 'Load',lumpedelement. lumpedelement is the object handle for the load created using lumpedElement.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

[1 0 0] (default) | three-element vector of Cartesian coordinates in meters

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A text input for simple rotations around the principal planes, X, Y, or Z.

For more information see,“Rotate Antenna and Arrays”

Example: `'TiltAxis', [0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double | char`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency

EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

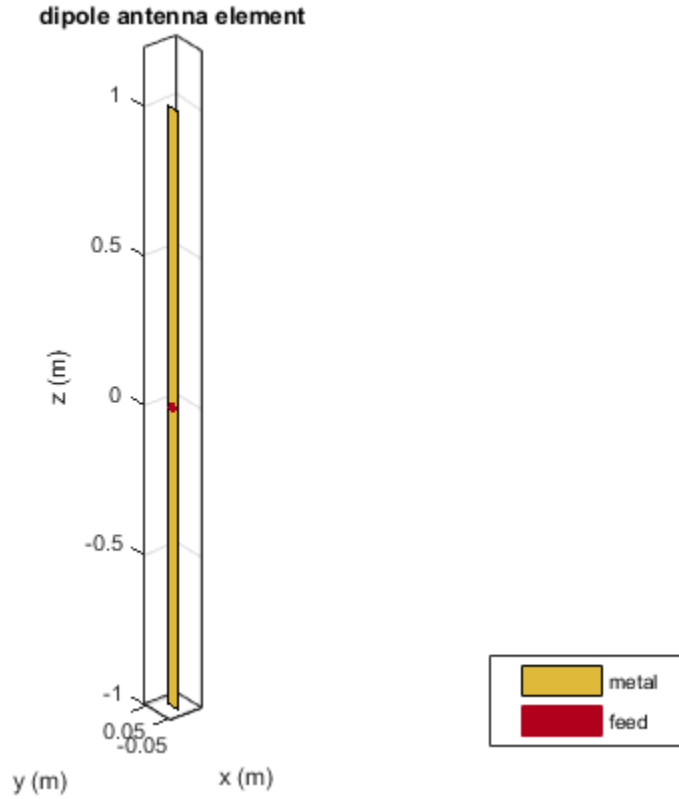
Examples

Create and View Dipole Antenna

Create and view a dipole with 2m length and 0.5m width.

```
d = dipole('Width',0.05)
show(d)
```

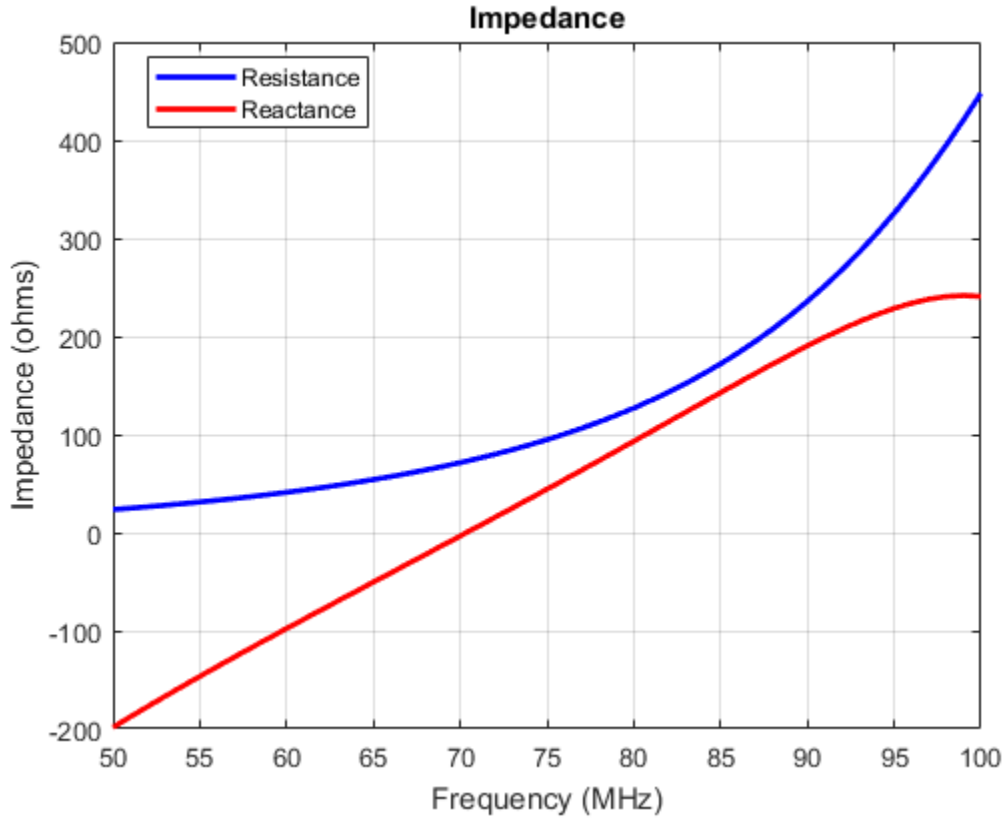
```
d =

  dipole with properties:

       Length: 2
        Width: 0.0500
    FeedOffset: 0
         Tilt: 0
      TiltAxis: [1 0 0]
         Load: [1×1 lumpedElement]
```



Impedance of Dipole Antenna

Calculate the impedance of a dipole over a frequency range of 50MHz - 100MHz.

```
d = dipole('Width',0.05);
impedance(d,linspace(50e6,100e6,51))
```



Infinite Reflector Backed Dielectric Substrate Antenna

Design a dipole antenna backed by a dielectric substrate and an infinite reflector.

Create a dipole antenna of length, 0.15 m, and width, 0.015 m.

```
d = dipole('Length',0.15,'Width',0.015, 'Tilt',90,'TiltAxis',[0 1 0]);
```

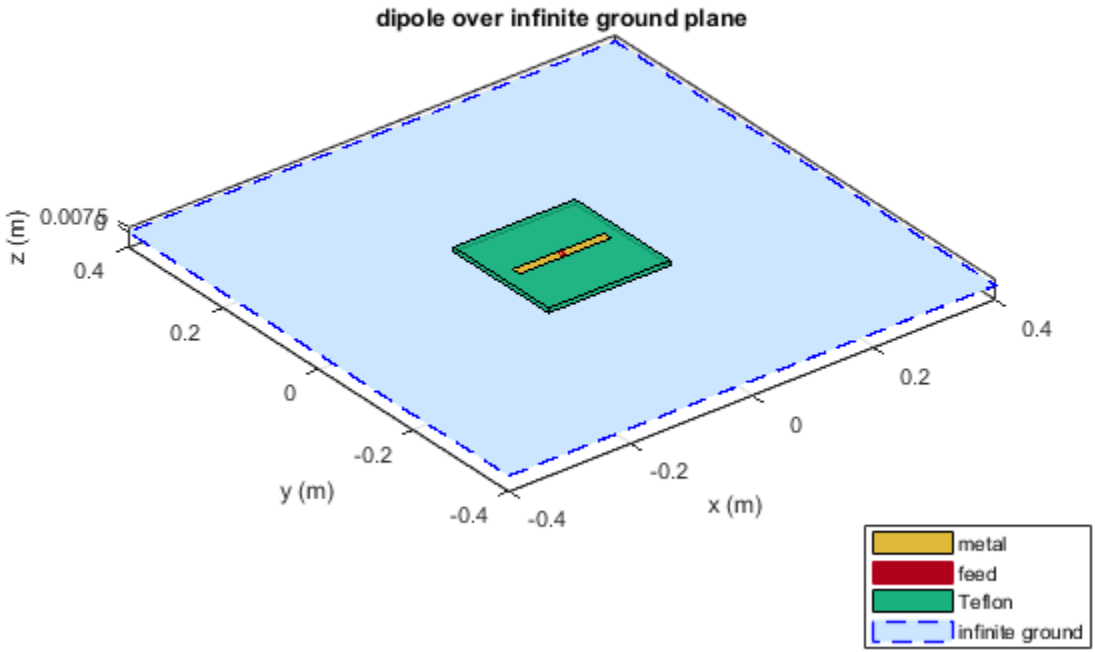
Create a reflector using the dipole antenna as an exciter and the diecltric, `teflon` as the substrate.

```
t = dielectric('Teflon')
rf = reflector('Exciter',d,'Spacing',7.5e-3,'Substrate',t);
```

```
t =

  dielectric with properties:

          Name: 'Teflon'
      EpsilonR: 2.1000
    LossTangent: 2.0000e-04
      Thickness: 0.0060

For more materials see <a href="matlab:openDielectricCatalog">catalog</a>
```

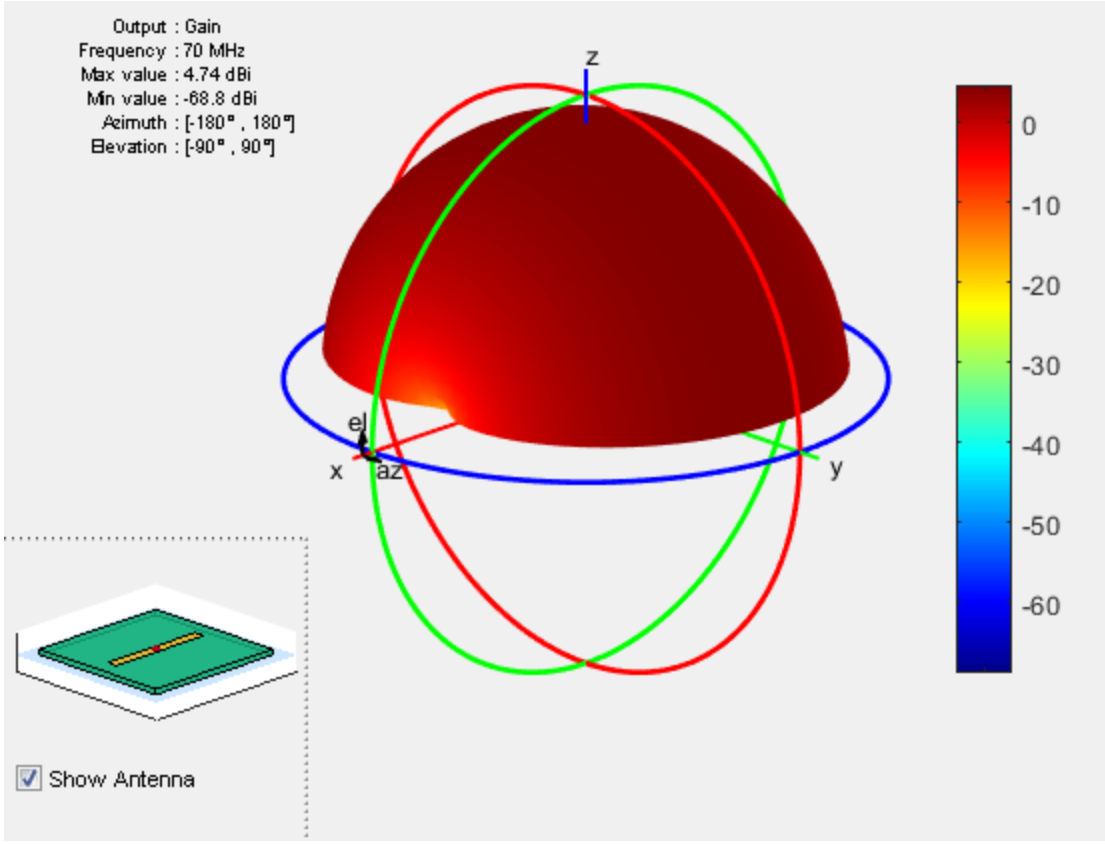
Set the groundplane length of the reflector to `inf`. View the structure.

```
rf.GroundPlaneLength = inf;
show(rf)
```



Calculate the radiation pattern of the antenna at 70 MHz.

```
pattern(rf,70e6)
```



References

[1] Balanis, C.A. *Antenna Theory: Analysis and Design*. 3rd Ed. New York: Wiley, 2005.

[2] Volakis, John. *Antenna Engineering Handbook*, 4th Ed. New York: Mcgraw-Hill, 2007.

See Also

See Also

`cylinder2strip` | loopCircular | monopole | slot

Topics

"Rotate Antenna and Arrays"

Introduced in R2015a

dipoleFolded

Create strip dipole antenna

Description

The `dipolefolded` object is a folded dipole antenna on the X-Y plane.

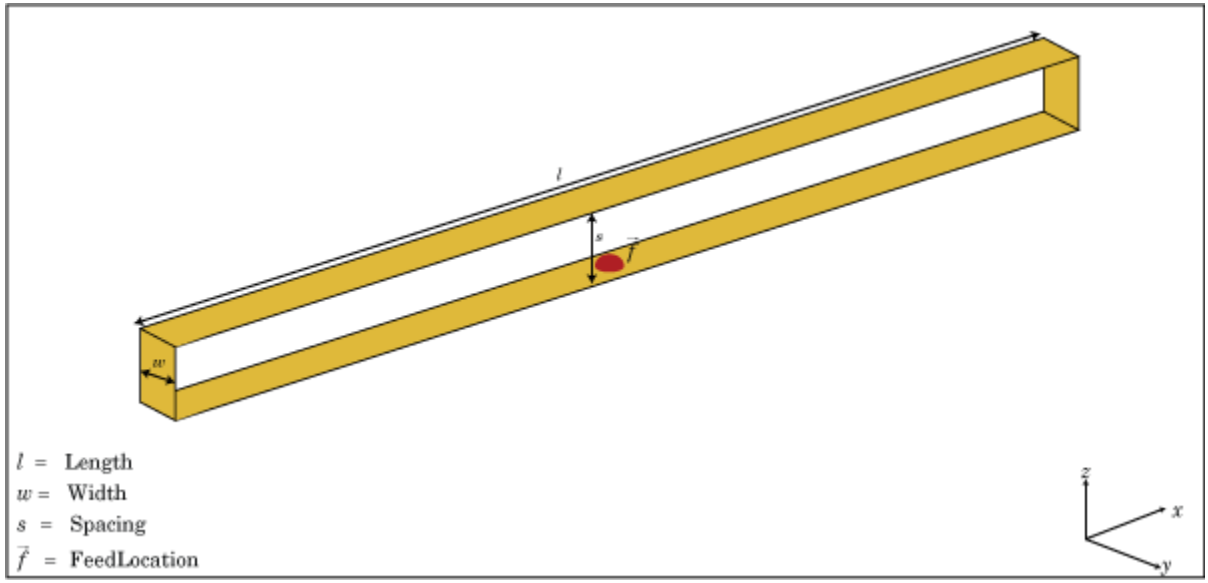
The width of the dipole is related to the diameter of an equivalent cylindrical dipole by the equation

$$w = 2d = 4r$$

, where

- d is the diameter of the equivalent cylindrical pole
- r is the radius of the equivalent cylindrical pole.

For a given cylinder radius, use the `cylinder2strip` utility function to calculate the equivalent width. The default folded dipole is center-fed. The feed point of the dipole coincides with the origin. The origin is located on the X-Y plane. When compared to the planar `dipole`, the folded dipole structure increases the input impedance of the antenna.



Create Object

`dF = dipoleFolded` creates a half-wavelength folded dipole antenna.

`dF = dipoleFolded(Name,Value)` creates a half-wavelength folded dipole antenna with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'Length'` — Folded dipole length

2 (default) | scalar in meters

Folded dipole length, specified as the comma-separated pair consisting of `'Length'` and a scalar in meters. By default, the length is chosen for an operating frequency of 70.5 MHz.

Example: `'Length',3`

Data Types: `double`

`'Width'` — Folded dipole width

0.0040 (default) | scalar in meters

Folded dipole width, specified as the comma-separated pair consisting of `'Width'` and a scalar in meters.

Note: Folded dipole width should be less than `'Length'`/20 and greater than `'Length'`/1001. [2]

Example: `'Width',0.05`

Data Types: `double`

`'Spacing'` — Shorting stub lengths at dipole ends

0.0245 (default) | scalar

Shorting stub lengths at dipole ends, specified as the comma-separated pair consisting of `'Spacing'` and a scalar in meters. The value must be less than `Length`/50.

Example: `'Spacing',3`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

[1 0 0] (default) | three-element vector of Cartesian coordinates in meters

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A text input for simple rotations around the principal planes, X, Y, or Z.

For more information see,"Rotate Antenna and Arrays"

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double | char`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array

returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

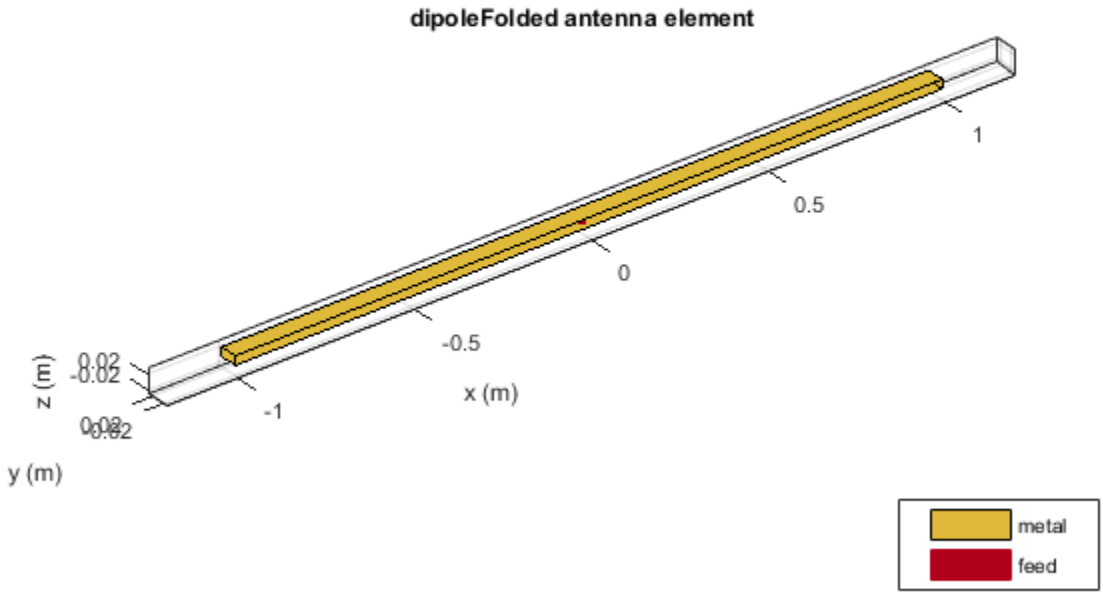
Examples

Create and View Folded Dipole Antenna

Create and view a folded dipole with 2m length and 0.05m width.

```
df = dipoleFolded('Length',2,'Width',0.05)
show(df)
```

```
df =

  dipoleFolded with properties:

      Length: 2
       Width: 0.0500
     Spacing: 0.0245
        Tilt: 0
    TiltAxis: [1 0 0]
        Load: [1×1 lumpedElement]
```



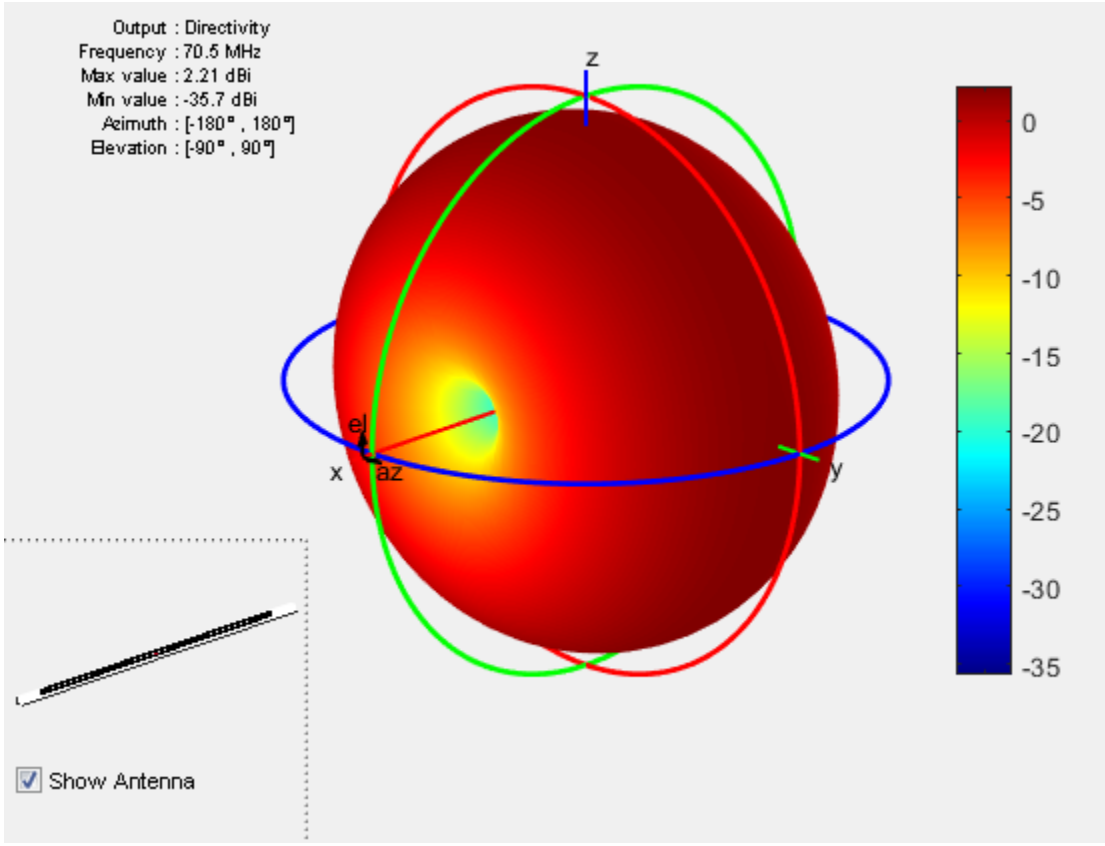
Raditaion Pattern of Folded Dipole Antenna

Plot the radiation pattern of a folded dipole at 70.5 MHz.

```
df = dipoleFolded
pattern(df, 70.5e6);
```

```
df =

  dipoleFolded with properties:

      Length: 2
       Width: 0.0180
```

```
      Spacing: 0.0245
         Tilt: 0
     TiltAxis: [1 0 0]
         Load: [1×1 lumpedElement]
```



References

[1] Balanis, C.A. *Antenna Theory: Analysis and Design*. 3rd Ed. New York: Wiley, 2005.

[2] Volakis, John. *Antenna Engineering Handbook*, 4th Ed. New York: Mcgraw-Hill, 2007.

See Also

See Also

bowtieTriangular | `cylinder2strip` | dipole | monopole

Topics

“Rotate Antenna and Arrays”

Introduced in R2015a

dipoleVee

Create V-dipole antenna

Description

The `dipoleVee` object is a planar V-dipole antenna in the X-Y plane.

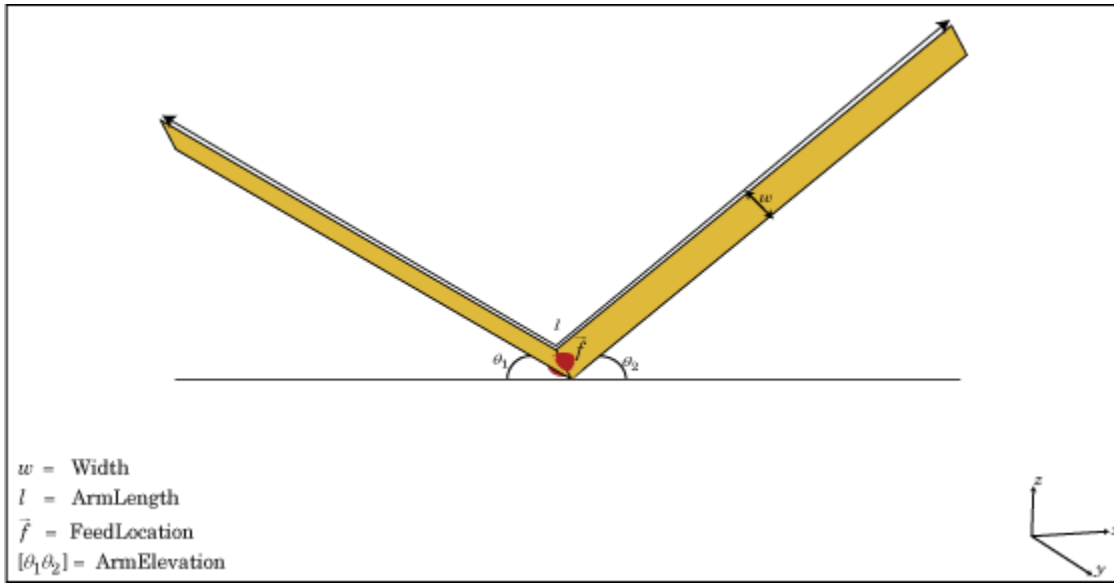
The width of the dipole is related to the circular cross-section by the equation

$$w = 2d = 4r$$

, where:

- d is the diameter of equivalent cylindrical pole
- r is the radius of equivalent cylindrical pole

For a given cylinder radius, use the `cylinder2strip` utility function to calculate the equivalent width. The V-dipole antenna is bent around the feed point. The default V-dipole is center-fed and is in the X-Y plane. The feed point of the V-dipole antenna coincides with the origin.



Create Object

`dv = dipoleVee` creates a half-wavelength V-dipole antenna.

`dv = dipoleVee(Name,Value)` creates a half-wavelength V-dipole antenna, with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'ArmLength'` — Length of two arms

[1 1] (default) | two-element vector in meters

Length of two arms, specified as the comma-separated pair consisting of `'ArmLength'` and a two-element vector in meters. By default, the arm lengths are chosen for an operating frequency of 75 MHz.

Example: `'ArmLength',[1,3]`

Data Types: `double`

`'Width'` — V-dipole arm width

0.1000 (default) | scalar in meters

V-dipole arm width, specified as the comma-separated pair consisting of `'Width'` and a scalar in meters.

Note: Dipole width should be less than `Total Arm Length`/5 and greater than `Total Arm Length`/1001. [2]

Example: `'Width',0.05`

Data Types: `double`

`'ArmElevation'` — Angle made by two arms about X-Y plane

[45 45] (default) | two-element vector in degrees

Angle made by two arms about X-Y plane, specified as the comma-separated pair consisting of `'ArmElevation'` and a two-element vector in degrees.

Example: `'ArmElevation',[55 35]`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

Examples

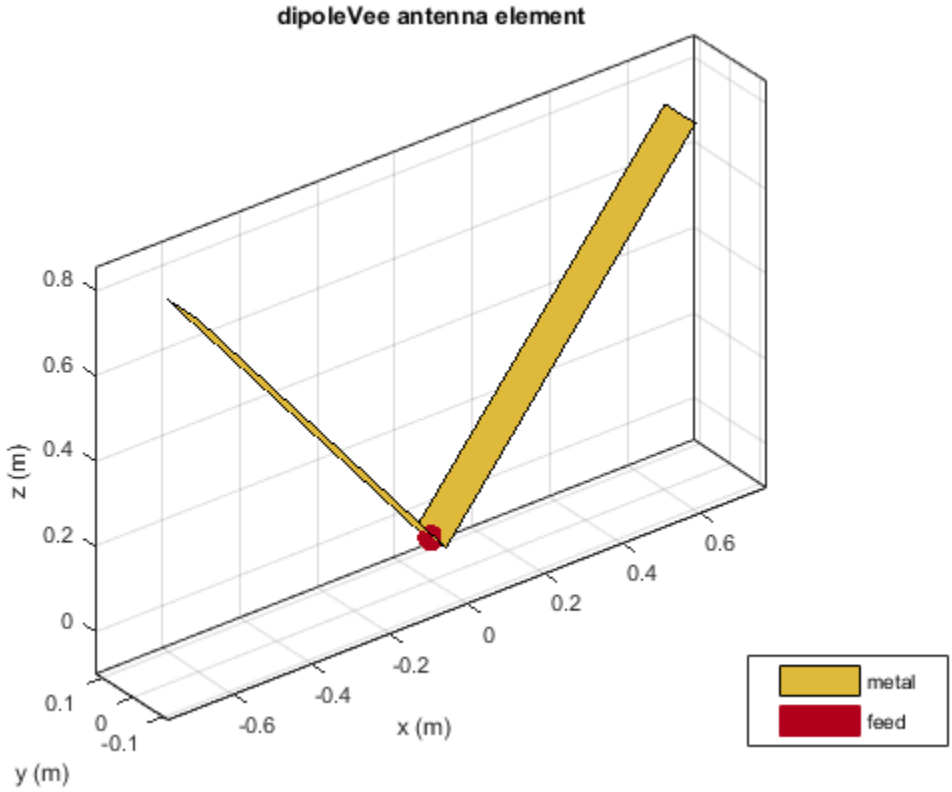
Create V-Dipole Antenna

Create and view a center-fed V-dipole that has 50 degree arm angles .

```
dv = dipoleVee('ArmElevation',[50 50])
show(dv)
```

```
dv =
```

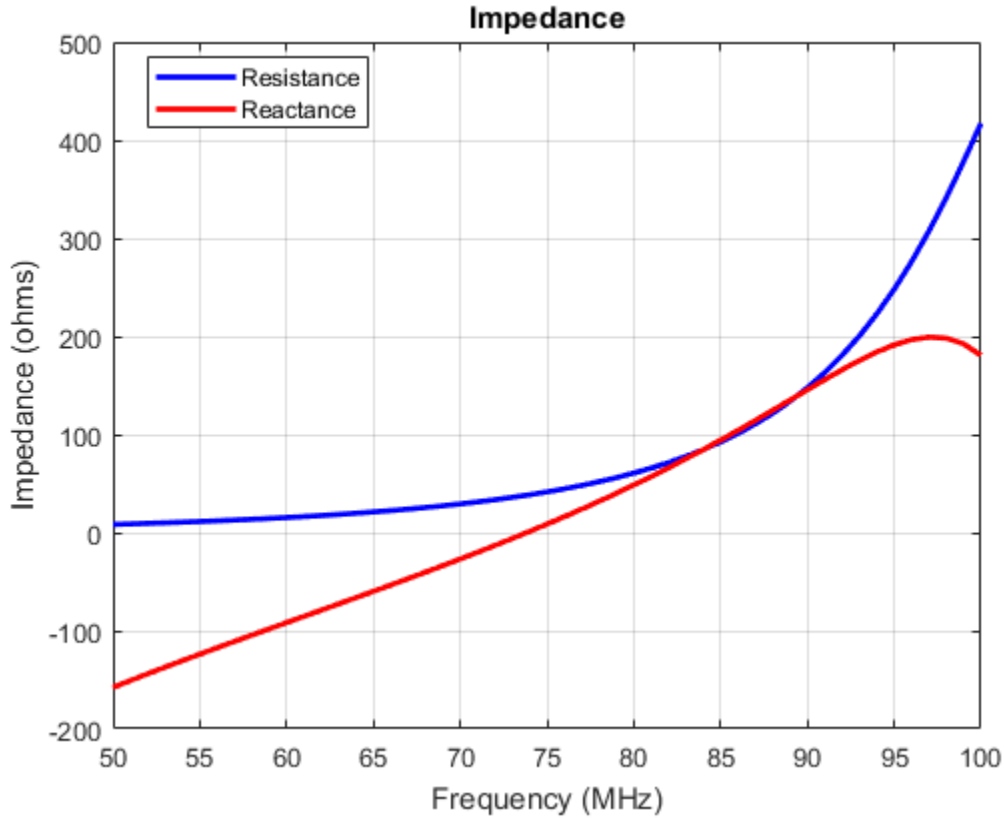
```
dipoleVee with properties:

     ArmLength: [1 1]
  ArmElevation: [50 50]
         Width: 0.1000
          Tilt: 0
      TiltAxis: [1 0 0]
          Load: [1×1 lumpedElement]
```



Impedance of V-Dipole Antenna

Calculate the impedance of a V-dipole antenna over the frequency range of 50MHz - 100MHz.

```
dv = dipoleVee('ArmElevation',[50 50]);
impedance(dv,linspace(50e6,100e6,51))
```



References

[1] Balanis, C.A. *Antenna Theory: Analysis and Design*. 3rd Ed. New York: Wiley, 2005.

[2] Volakis, John. *Antenna Engineering Handbook*. 4th Ed. New York: McGraw-Hill, 2007.

See Also

See Also

`cylinder2strip` | dipole | dipoleFolded | loopCircular

Topics

"Rotate Antenna and Arrays"

Introduced in R2015a

dipoleMeander

Create meander dipole antenna

Description

The `dipoleMeander` class creates a meander dipole antenna with four dipoles. The antenna is center fed and it is symmetric about its origin. The first resonance of meander dipole antenna is at 200 MHz.

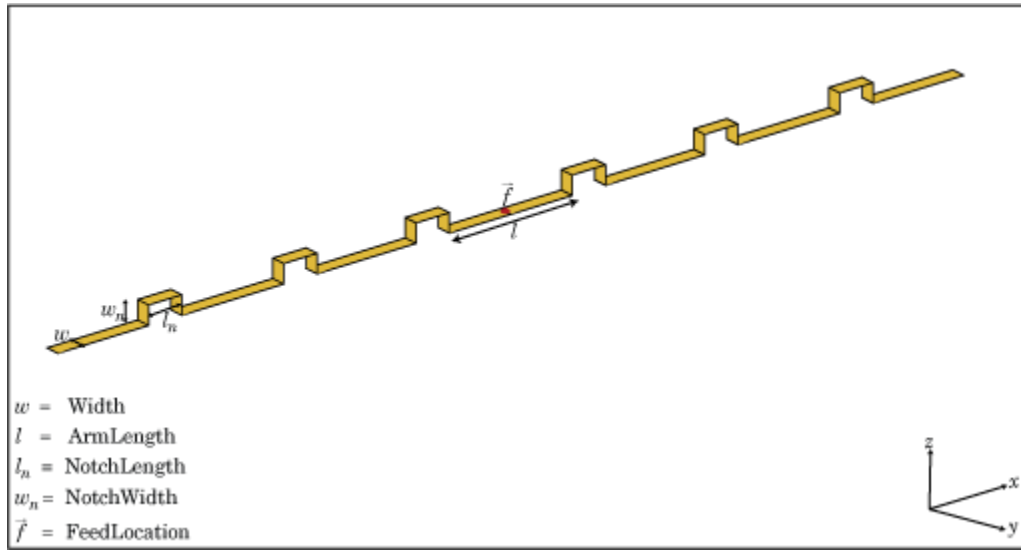
The width of the dipole is related to the diameter of an equivalent cylindrical dipole by the equation

$$w = 2d = 4r$$

, where:

- d is the diameter of equivalent cylindrical dipole.
- r is the radius of equivalent cylindrical dipole.

For a given cylinder radius, use the `cylinder2strip` utility function to calculate the equivalent width. The default strip dipole is center-fed. The feed point coincides with the origin. The origin is located on the X-Y plane.



Create Object

`dm = dipoleMeander` creates a meander dipole antenna with four dipoles.

`dm = dipoleMeander(Name,Value)` creates a meander dipole antenna with four dipoles, with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'Width'` — Dipole width

0.0040 (default) | scalar in meters

Dipole width, specified as the comma-separated pair consisting of `'Width'` and a scalar in meters.

Example: `'Width',0.05`

Data Types: `double`

'ArmLength' — Length of individual dipole arms

[0.0880 0.0710 0.0730 0.0650] (default) | vector in meters

Length of individual dipole arms, specified as the comma-separated pair consisting of 'ArmLength' and vector in meters. The total number of dipole arms generated is :

$$2 * N - 1$$

where N is the number of specified arm lengths.

Example: 'ArmLength',[0.6000 0.5000 1 0.4000]

Data Types: double

'NotchLength' — Notch length along length of antenna

0.0238 (default) | scalar in meters

Notch length along the length of the antenna, specified as the comma-separated pair consisting of 'NotchLength' and a scalar in meters.

For example, in a dipole meander antenna with seven stacked arms there are six notches.

Example: 'NotchLength',1

Data Types: double

'NotchWidth' — Notch width perpendicular to length of antenna

0.0238 (default) | scalar in meters

Notch width perpendicular to the length of the antenna, specified as the comma-separated pair consisting of 'NotchWidth' and a scalar in meters.

Example: 'NotchWidth',1

Data Types: double

'Load' — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of 'Load' and a lumped element object handle. For more information, see lumpedElement.

Example: 'Load',lumpedelement. lumpedelement is the object handle for the load created using lumpedElement.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface

design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

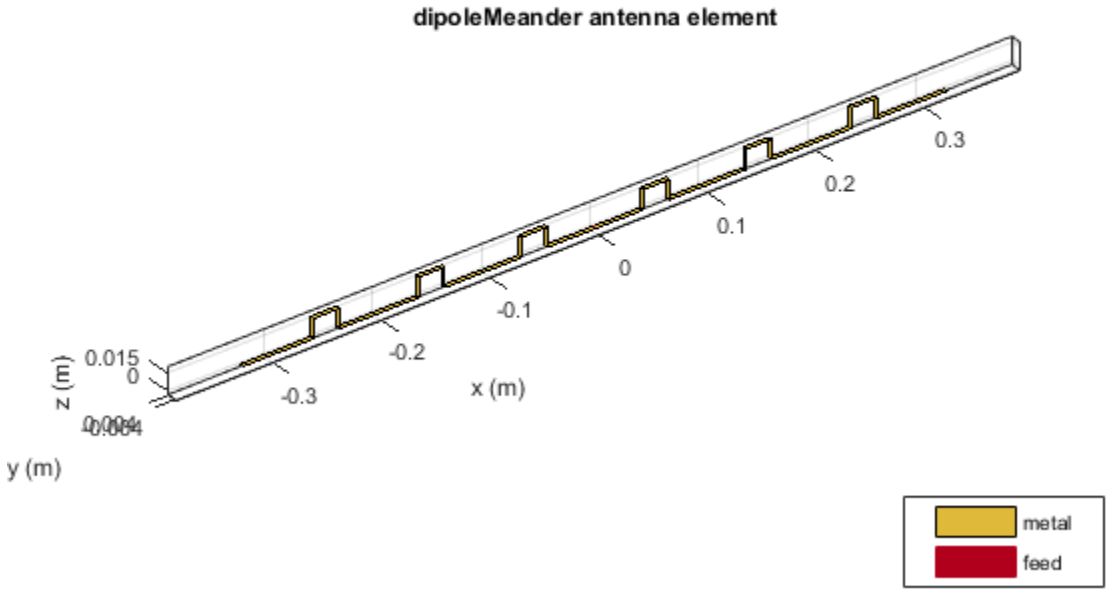
Examples

Create and View Meander Dipole Antenna

Create and view the default meander dipole antenna.

```
dm = dipoleMeander
show(dm)
```

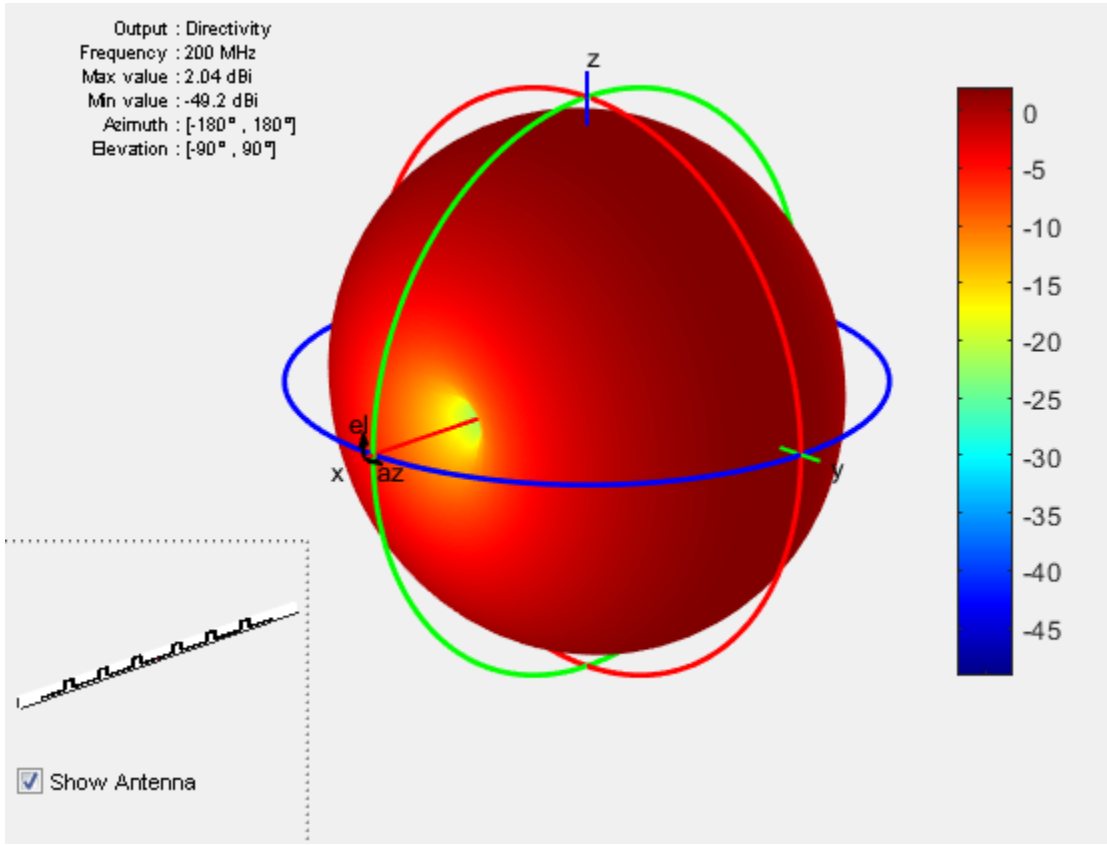
```
dm =

  dipoleMeander with properties:

         Width: 0.0040
     ArmLength: [0.0880 0.0710 0.0730 0.0650]
    NotchLength: 0.0238
     NotchWidth: 0.0170
           Tilt: 0
       TiltAxis: [1 0 0]
           Load: [1×1 lumpedElement]
```



Plot Radiation Pattern Of Meander Dipole Antenna

Plot the radiation pattern of meander dipole antenna at a 200MHz frequency.

```
dm = dipoleMeander;
pattern(dm,200e6)
```



References

[1] Balanis, C.A. *Antenna Theory: Analysis and Design*. 3rd Ed. New York: Wiley, 2005.

See Also

See Also

dipole | dipoleFolded | loopCircular

Topics

"Rotate Antenna and Arrays"

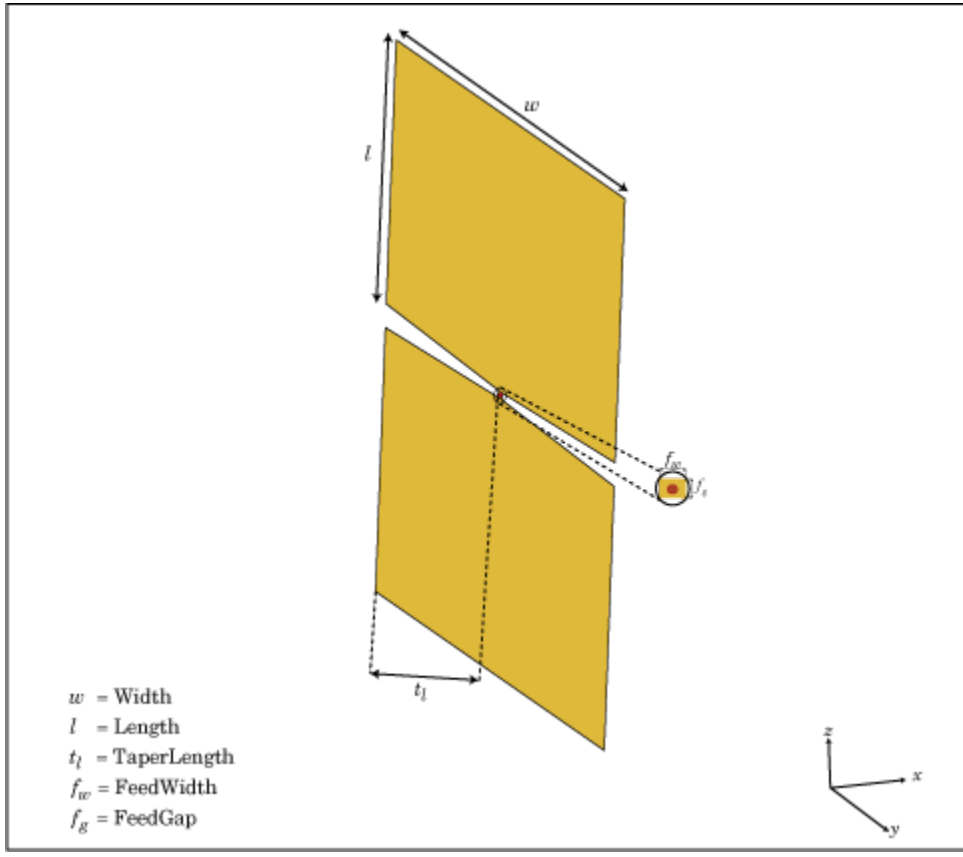
Introduced in R2015a

dipoleBlade

Create blade dipole antenna

Description

The `dipoleBlade` object is a wideband blade dipole antenna oriented along the X-Y plane.



The width of the dipole is related to the circular cross-section by the equation,

$$w = 2d = 4r$$

, where:

- d is the diameter of equivalent cylindrical pole
- r is the radius of equivalent cylindrical pole

For a given cylinder radius, use the `cylinder2strip` utility function to calculate the equivalent width.

Create Object

`db = dipoleBlade` creates a wideband blade dipole antenna on the X-Y plane.

`db = dipoleBlade(Name,Value)` creates a wideband blade dipole antenna, with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'Length'` — Blade dipole length

`0.1170` (default) | scalar in meters

Blade dipole length, specified as the comma-separated pair consisting of `'Length'` and a scalar in meters.

Example: `'Length',0.5`

Data Types: `double`

`'Width'` — Blade dipole width

`0.1400` (default) | scalar in meters

Blade dipole width, specified as the comma-separated pair consisting of `'Width'` and a scalar in meters.

Example: `'Width',0.2`

Data Types: `double`

`'TaperLength'` — Taper length

`0.1120` (default) | scalar in meters

Taper length, specified as the comma-separated pair consisting of `'TaperLength'` and a scalar in meters.

Example: `'TaperLength',0.500`

Data Types: `double`

`'FeedWidth'` — Blade dipole feed width

`0.0030` (default) | scalar in meters

Blade dipole feed width, specified as the comma-separated pair consisting of `'FeedWidth'` and a scalar in meters.

Example: `'FeedWidth',0.006`

Data Types: `double`

`'FeedGap'` — Blade dipole feed length or distance between the two wings of the dipole

`0.0030` (default) | scalar in meters

Blade dipole feed length or distance between the two wings of the dipole, specified as the comma-separated pair consisting of `'FeedGap'` and a scalar in meters.

Example: `'FeedGap',0.006`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas

impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

Examples

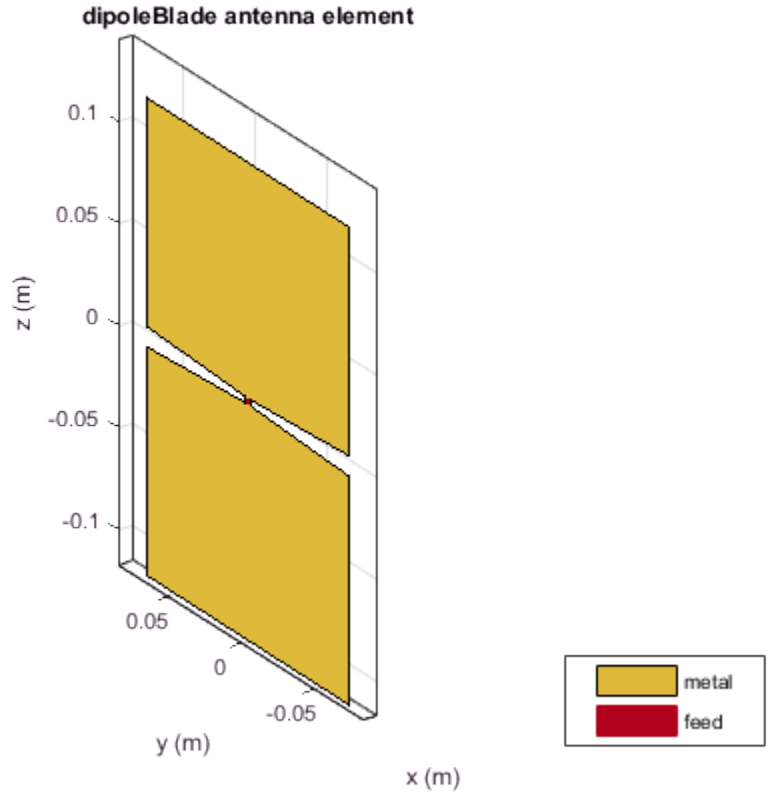
Default Blade Dipole and Radiation Pattern

Create and view a default blade dipole.

```
db = dipoleBlade
```

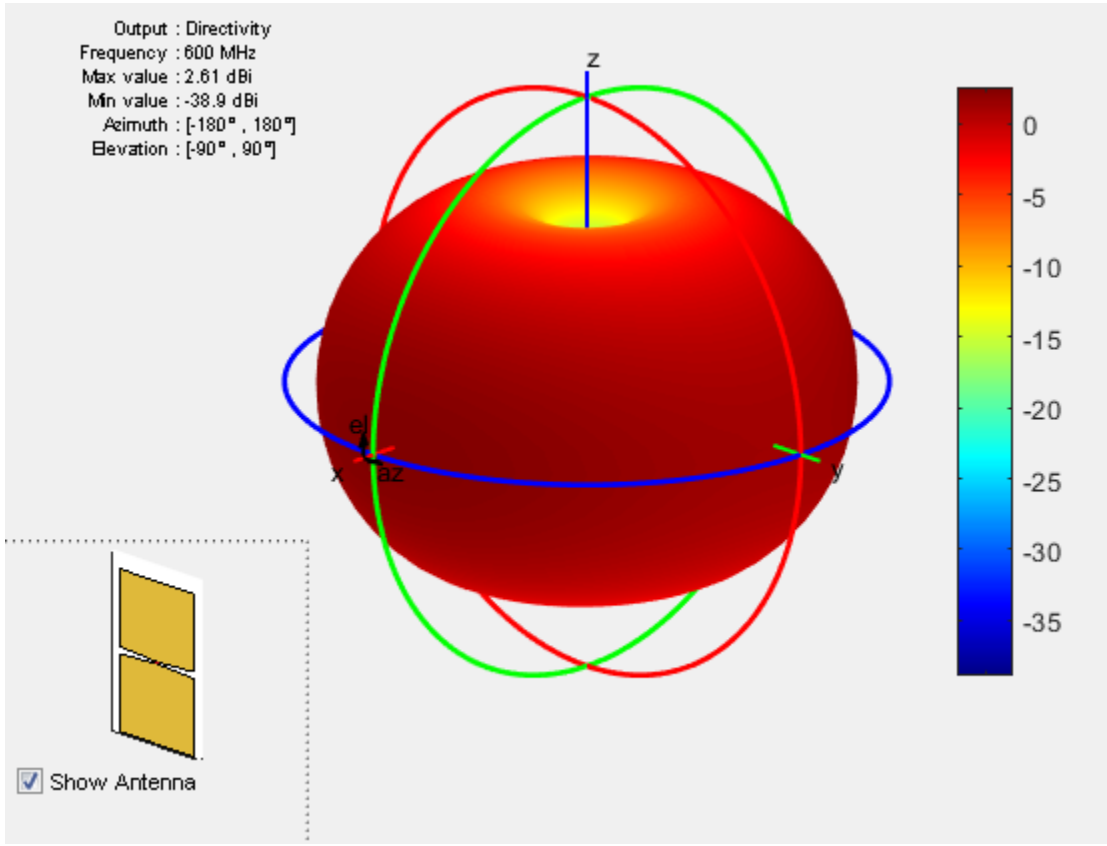
```
db =
  dipoleBlade with properties:

         Length: 0.1170
    TaperLength: 0.1120
          Width: 0.1400
      FeedWidth: 0.0030
        FeedGap: 0.0030
           Tilt: 0
       TiltAxis: [1 0 0]
           Load: [1×1 lumpedElement]
```

```
show(db);
```



Plot the radiation pattern of the blade dipole at 600 MHz.

```
pattern(db,600e6)
```



References

[1] Balanis, C.A. *Antenna Theory: Analysis and Design*. 3rd Ed. New York: Wiley, 2005.

[2] Volakis, John. *Antenna Engineering Handbook*. 4th Ed. New York: McGraw-Hill, 2007.

See Also

See Also

`cylinder2strip` | dipole | loopCircular | slot

Topics

"Rotate Antenna and Arrays"

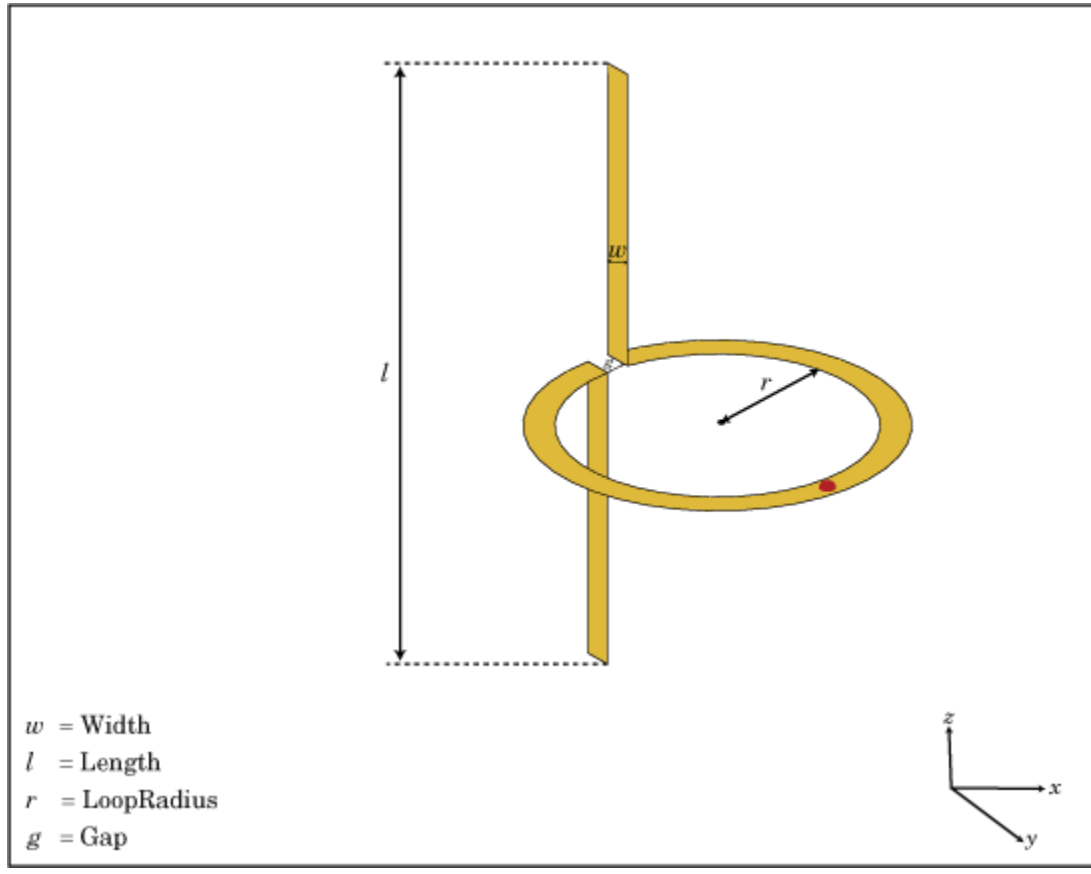
Introduced in R2017a

dipoleCycloid

Create cycloid dipole antenna

Description

The `dipoleCycloid` object is a half-wavelength cycloid dipole antenna. For the default cycloid dipole, the feed point is on the loop section. The default length is for an operating frequency of 48 MHz.



The width of the dipole is related to the circular cross-section by the equation

$$w = 2d = 4r$$

, where:

- d is the diameter of equivalent cylindrical pole
- r is the radius of equivalent cylindrical pole

For a given cylinder radius, use the `cylinder2strip` utility function to calculate the equivalent width.

Create Object

`dc = dipoleCycloid` creates a half-wavelength cycloid dipole antenna oriented along Z-axis.

`dc = dipoleCycloid(Name,Value)` creates a half-wavelength cycloid dipole antenna, with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'Length'` — Dipole length along z-axis

`1.2200` (default) | scalar in meters

Dipole length along z-axis, specified as the comma-separated pair consisting of `'Length'` and a scalar in meters. By default, the length is for an operating frequency of 48 MHz.

Example: `'Length',0.9`

Data Types: `double`

`'Width'` — Dipole width

`0.0508` (default) | scalar in meters

Dipole width, specified as the comma-separated pair consisting of `'Width'` and a scalar in meters.

Example: `'Width',0.09`

Data Types: `double`

`'LoopRadius'` — Circular loop radius in X-Y plane

`0.3100` (default) | scalar in meters

Circular loop radius in X-Y plane, specified as the comma-separated pair consisting of `'LoopRadius'` and a scalar in meters.

Example: `'LoopRadius',0.500`

Data Types: `double`

`'Gap'` — Gap of loop in X-Y plane

`0.0400` (default) | scalar in meters

Gap of loop in X-Y plane, specified as the comma-separated pair consisting of `'Gap'` and a scalar in meters.

Example: `'Gap',0.006`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure

meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

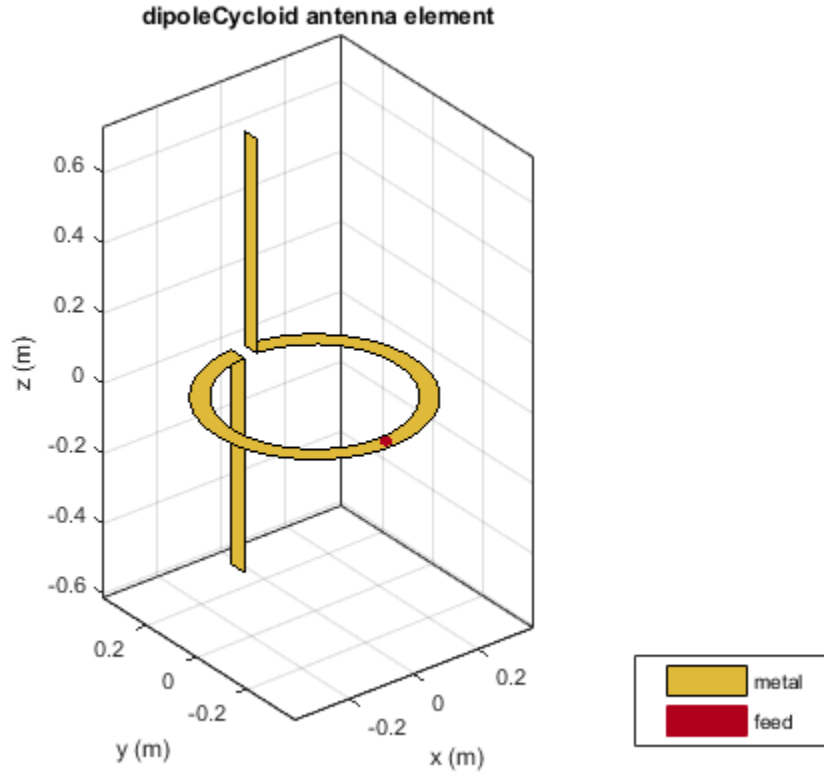
Examples

Default Cycloid Dipole

Create a default cyloid dipole antenna using the dipoleCycloid object and view it.

```
dc = dipoleCycloid
show(dc)
```

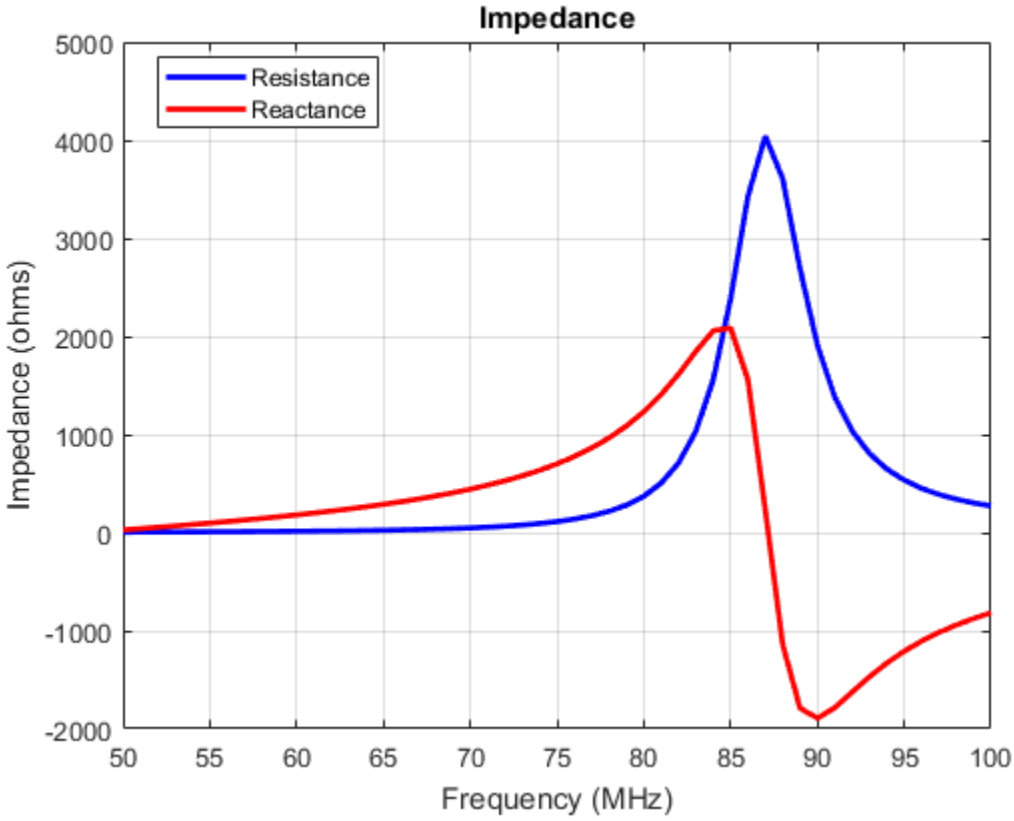
```
dc =

  dipoleCycloid with properties:

       Length: 1.2200
        Width: 0.0508
   LoopRadius: 0.3100
          Gap: 0.0400
         Tilt: 0
     TiltAxis: [1 0 0]
         Load: [1×1 lumpedElement]
```



Impedance of Cycloid Dipole

Calculate the impedance of a cyloid dipole of width, 0.05 m, over a frequency span of 50 MHz - 100 MHz.

```
d = dipoleCycloid('Width',0.05);
impedance(d,linspace(50e6,100e6,51))
```



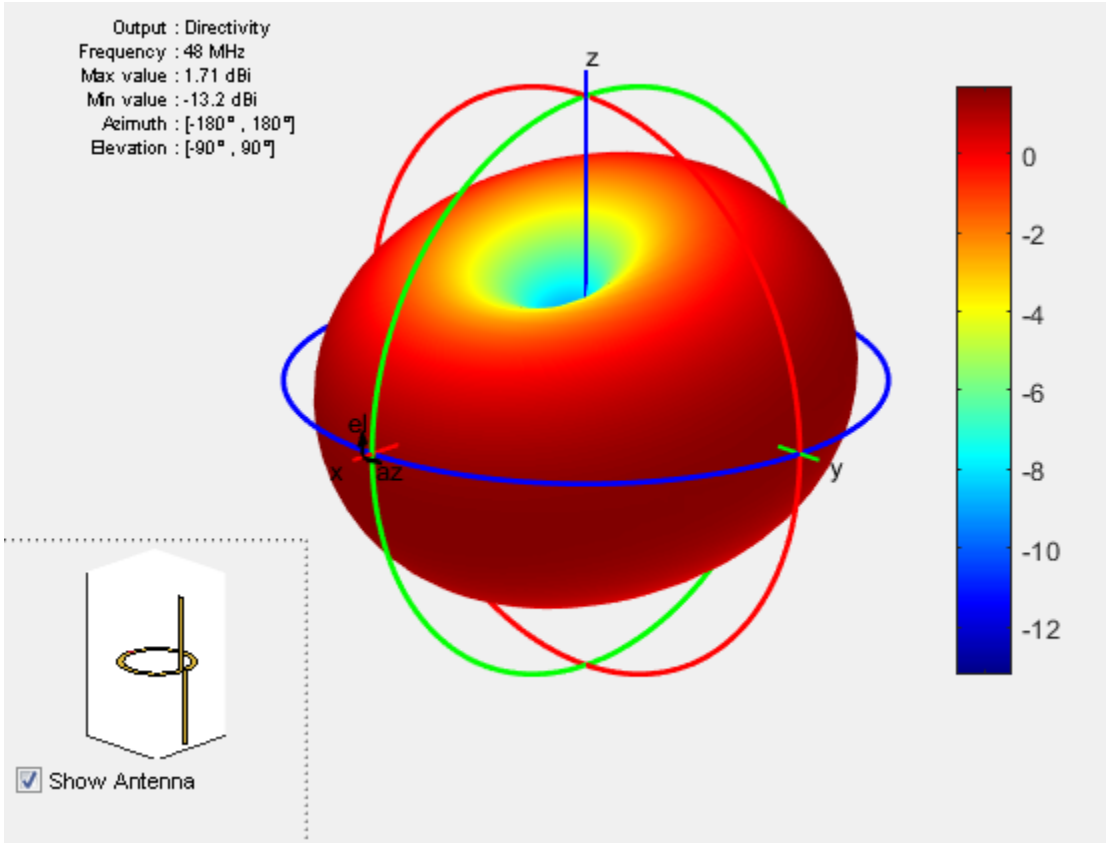
Radiation Pattern of Cycloid Dipole

Plot the radiation pattern of a cyloid dipole of width,0.05 m, at a frequency of 48 MHz.

```
d = dipoleCycloid('Width',0.05)
pattern(d,48e6)
```

```
d =

  dipoleCycloid with properties:

        Length: 1.2200
         Width: 0.0500
```

```
    LoopRadius: 0.3100
           Gap: 0.0400
          Tilt: 0
      TiltAxis: [1 0 0]
          Load: [1×1 lumpedElement]
```



References

[1] Balanis, C.A. *Antenna Theory: Analysis and Design*. 3rd Ed. New York: Wiley, 2005.

[2] Volakis, John. *Antenna Engineering Handbook*. 4th Ed. New York: McGraw-Hill, 2007.

See Also

See Also

`cylinder2strip` | dipole | loopCircular | slot

Topics

"Rotate Antenna and Arrays"

Introduced in R2017a

dipoleHelix

Create helical dipole antenna

Description

The `dipoleHelix` object is a helical dipole antenna. The antenna is typically center fed. You can move the feed along the antenna length using the feed offset property. Helical dipoles are used in satellite communications and wireless power transfers.

The width of the strip is related to the diameter of an equivalent cylinder by this equation

$$w = 2d = 4r$$

where:

- w is the width of the strip.
- d is the diameter of an equivalent cylinder.
- r is the radius of an equivalent cylinder.

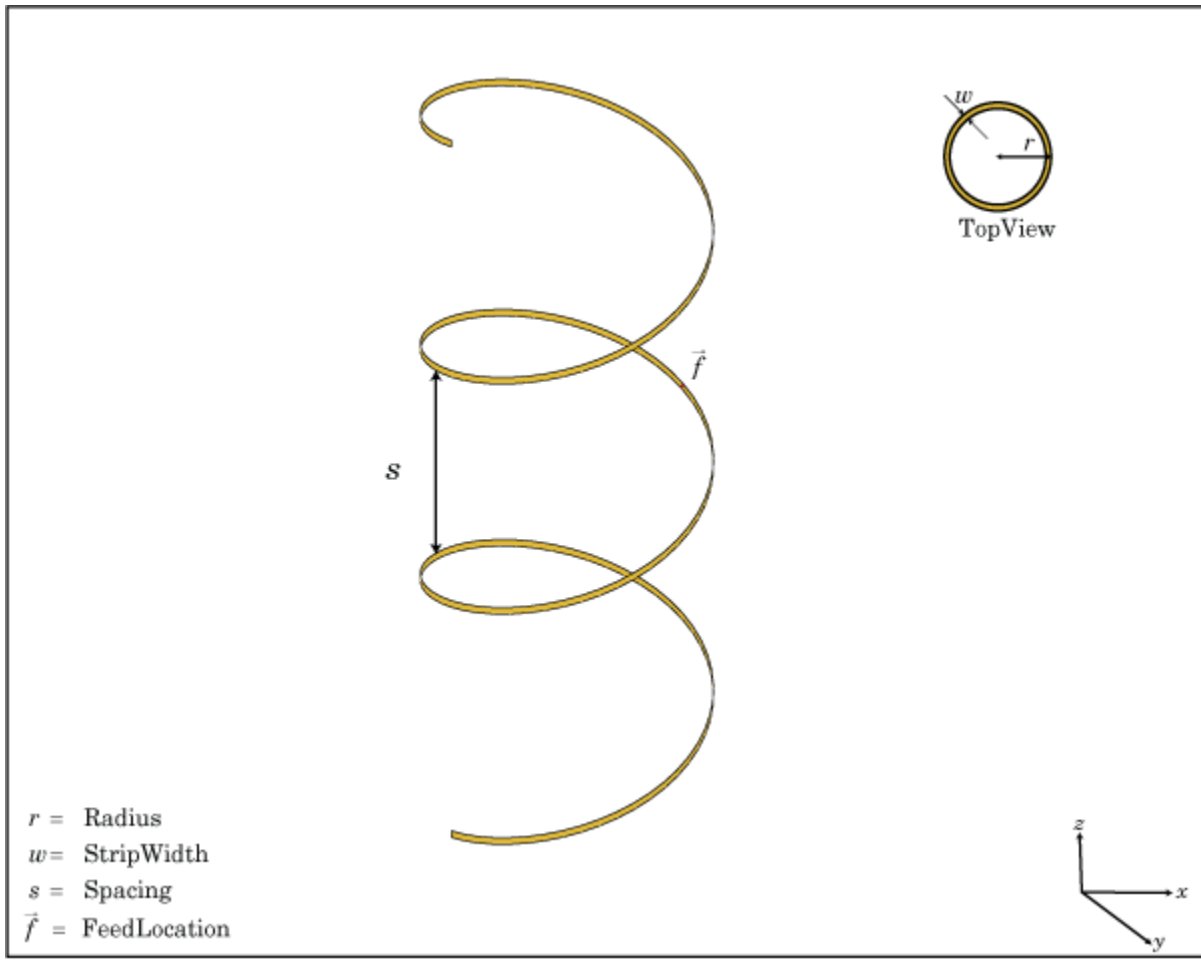
For a given cylinder radius, use the `cylinder2strip` utility function to calculate the equivalent width. The default helical dipole antenna is center-fed. The circular ground plane is on the X-Y plane. Commonly, helical dipole antennas are used in axial mode. In this mode, the helical dipole circumference is comparable to the operating wavelength, and has maximum directivity along its axis. In normal mode, the helical dipole radius is small compared to the operating wavelength. In this mode, the helical dipole radiates broadside, that is, in the plane perpendicular to its axis. The basic equation for the helical dipole antenna is:

$$x = r\cos(\theta)$$
$$y = r\sin(\theta)$$
$$z = S\theta$$

where:

- r is the radius of the helical dipole.
- θ is the winding angle.
- S is the spacing between turns.

For a given pitch angle in degrees, use the `helixpitch2spacing` utility function to calculate the spacing between the turns in meters.



Create Object

`dh = dipoleHelix` creates a helical dipole antenna. The default antenna operates around 2 GHz.

`dh = dipoleHelix(Name,Value)` creates a helical dipole antenna, with additional properties specified by one or more name–value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'Radius'` — Turn radius

`0.0220` (default) | scalar in meters

Turn radius, specified as the comma-separated pair consisting of `'Radius'` and a scalar in meters.

Example: `'Radius',2`

Data Types: `double`

`'Width'` — Strip width

`1.0000e-03` (default) | scalar in meters

Strip width, specified as the comma-separated pair consisting of `'Width'` and a scalar in meters.

Note: Strip width should be less than `'Radius'`/5 and greater than `'Radius'`/250. [4]

Example: `'Width',5`

Data Types: `double`

`'Turns'` — Number of turns of helical dipole

`3` (default) | scalar

Number of turns of the helical dipole, specified as the comma-separated pair consisting of `'Turns'` and a scalar.

Example: `'Turns',2`

Data Types: `double`

`'Spacing'` — Spacing between turns

`0.0350` (default) | scalar in meters

Spacing between turns, specified as the comma-separated pair consisting of `'Spacing'` and a scalar in meters.

Example: `'Spacing',1.5`

Data Types: `double`

`'WindingDirection'` — Direction of helical dipole turns (windings)

`'CCW'` (default) | `'CW'`

Direction of helical dipole turns (wingdings), specified as the comma-separated pair consisting of `'WindingDirection'` and `'CW'` or `'CCW'`.

Example: `'WindingDirection','CW'`

Data Types: `string`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'FeedOffset'` — Signed distance of feedpoint from origin

`0` (default) | two-element vector in meters

Signed distance from center along length and width of ground plane, specified as the comma-separated pair of `'FeedOffset'` and a two-element vector in meters. Use this property to adjust the location of the feedpoint relative to the ground plane and patch.

Example: `'FeedOffset',[0.01 0.01]`

Data Types: `double`

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure

meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

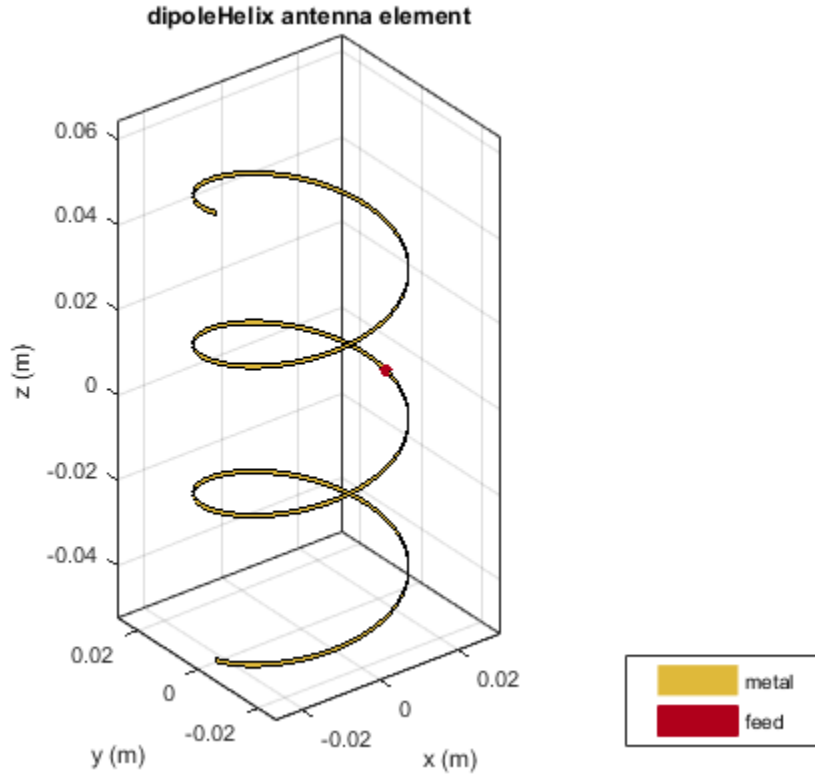
Examples

Helical Dipole Antenna

Create a default helical dipole antenna and view it.

```
dh = dipoleHelix
show(dh)
```

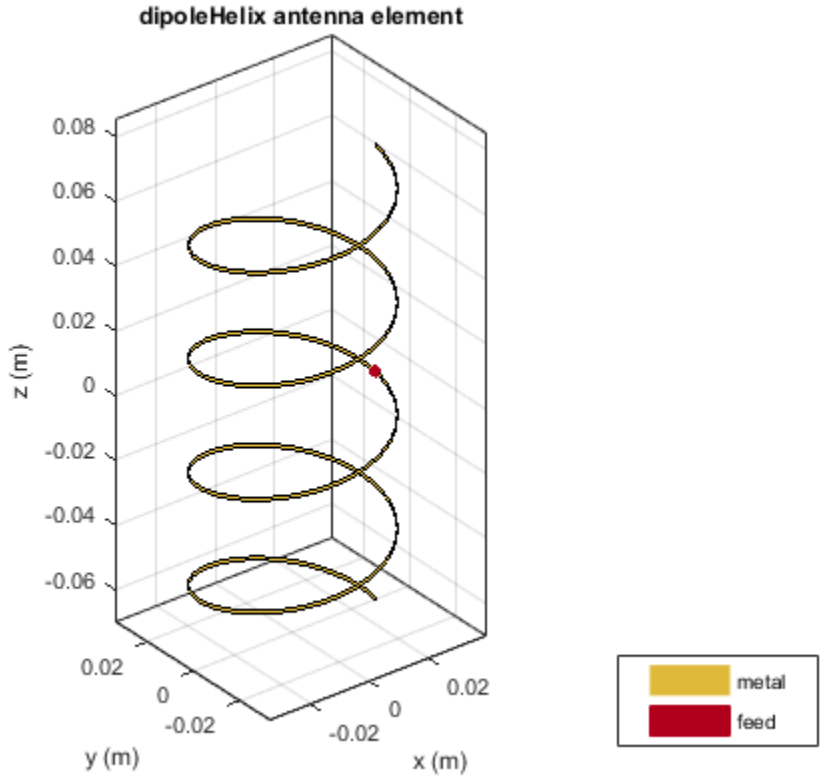
```
dh =

  dipoleHelix with properties:

             Radius: 0.0220
              Width: 1.0000e-03
              Turns: 3
            Spacing: 0.0350
    WindingDirection: 'CCW'
          FeedOffset: 0
                Tilt: 0
           TiltAxis: [1 0 0]
               Load: [1×1 lumpedElement]
```



Radiation Pattern of Helical Dipole

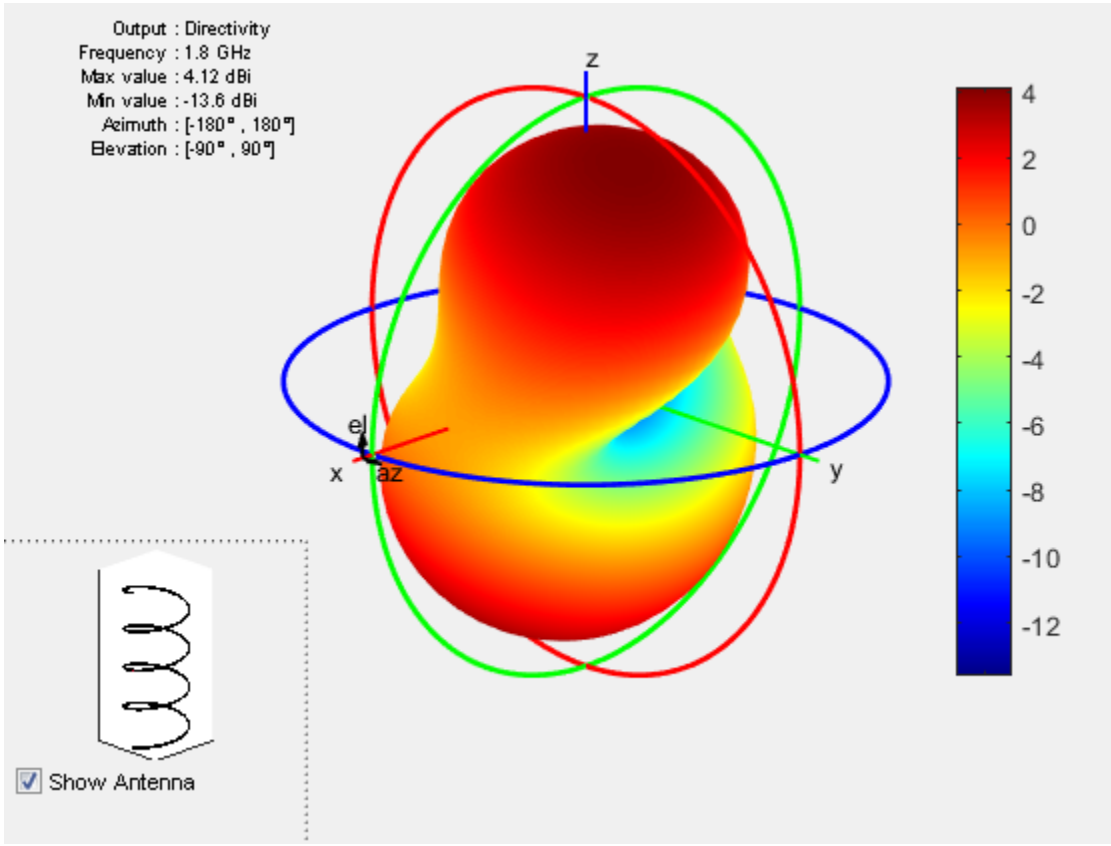
Create a four-turn helical dipole antenna with a turn radius of 28 mm and a strip width of 1.2 mm.

```
dh = dipoleHelix('Radius',28e-3,'Width',1.2e-3,'Turns',4);
show(dh)
```



Plot the radiation pattern of the helical dipole at 1.8 GHz.

```
pattern(dh, 1.8e9);
```



References

[1] Balanis, C. A. *Antenna Theory. Analysis and Design*. 3rd Ed. Hoboken, NJ: John Wiley & Sons, 2005.

[2] Volakis, John. *Antenna Engineering Handbook*. 4th Ed. New York: McGraw-Hill, 2007.

See Also

See Also

`cylinder2strip` | helix | `helixpitch2spacing` | monopole | pifa | spiralArchimedean

Topics

“Rotate Antenna and Arrays”

Introduced in R2016b

helix

Create helix antenna on ground plane

Description

The `helix` object is a helix antenna on a circular ground plane. The helix antenna is a common choice in satellite communication.

The width of the strip is related to the diameter of an equivalent cylinder by the equation

$$w = 2d = 4r$$

where:

- w is the width of the strip.
- d is the diameter of an equivalent cylinder.
- r is the radius of an equivalent cylinder.

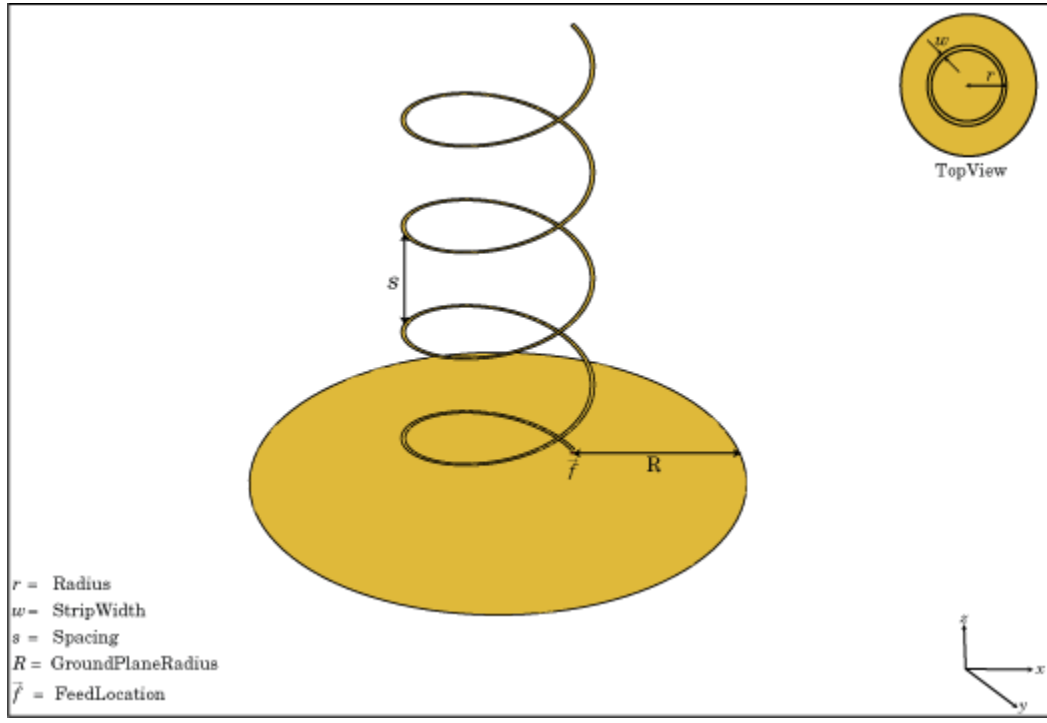
For a given cylinder radius, use the `cylinder2strip` utility function to calculate the equivalent width. The default helix antenna is end-fed. The circular ground plane is on the X-Y plane. Commonly, helix antennas are used in axial mode. In this mode, the helix circumference is comparable to the operating wavelength and the helix has maximum directivity along its axis. In normal mode, helix radius is small compared to the operating wavelength. In this mode, the helix radiates broadside, that is, in the plane perpendicular to its axis. The basic equation for the helix is

$$x = r\cos(\theta)$$
$$y = r\sin(\theta)$$
$$z = S\theta$$

where

- r is the radius of the helix.
- θ is the winding angle.
- S is the spacing between turns.

For a given pitch angle in degrees, use the `helixpitch2spacing` utility function to calculate the spacing between the turns in meters.



Create Object

`hx = helix` creates a helix antenna operating in axial mode. The default antenna operates around 2 GHz.

`hx = helix(Name,Value)` creates a helix antenna, with additional properties specified by one or more name–value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'Radius'` — Turn radius
0.0220 (default) | scalar in meters

Turn radius, specified as the comma-separated pair consisting of `'Radius'` and a scalar in meters.

Example: `'Radius',2`

Data Types: `double`

`'Width'` — Strip width

1.0000e-03 (default) | scalar in meters

Strip width, specified as the comma-separated pair consisting of `'Width'` and a scalar in meters.

Note: Strip width should be less than `'Radius'`/5 and greater than `'Radius'`/250. [4]

Example: `'Width',5`

Data Types: `double`

`'Turns'` — Number of turns of helix

3 (default) | scalar

Number of turns of the helix, specified as the comma-separated pair consisting of `'Turns'` and a scalar.

Example: `'Turns',2`

Data Types: `double`

`'Spacing'` — Spacing between turns

0.0350 (default) | scalar in meters

Spacing between turns, specified as the comma-separated pair consisting of `'Spacing'` and a scalar in meters.

Example: `'Spacing',1.5`

Data Types: `double`

`'WindingDirection'` — Direction of helix turns (windings)

`CW` | `CCW`

Direction of helix turns (wingdings), specified as the comma-separated pair consisting of `'WindingDirection'` and `CW` or `CCW`.

Example: `'WindingDirection',CW`

Data Types: `string`

`'GroundPlaneRadius'` — Ground plane radius

0.0750 (default) | scalar in meters

Ground plane radius, specified as the comma-separated pair consisting of `'GroundPlaneRadius'` and a scalar in meters. By default, the ground plane is on the X-Y plane and is symmetrical about the origin.

Example: `'GroundPlaneRadius',2.05`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.

- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

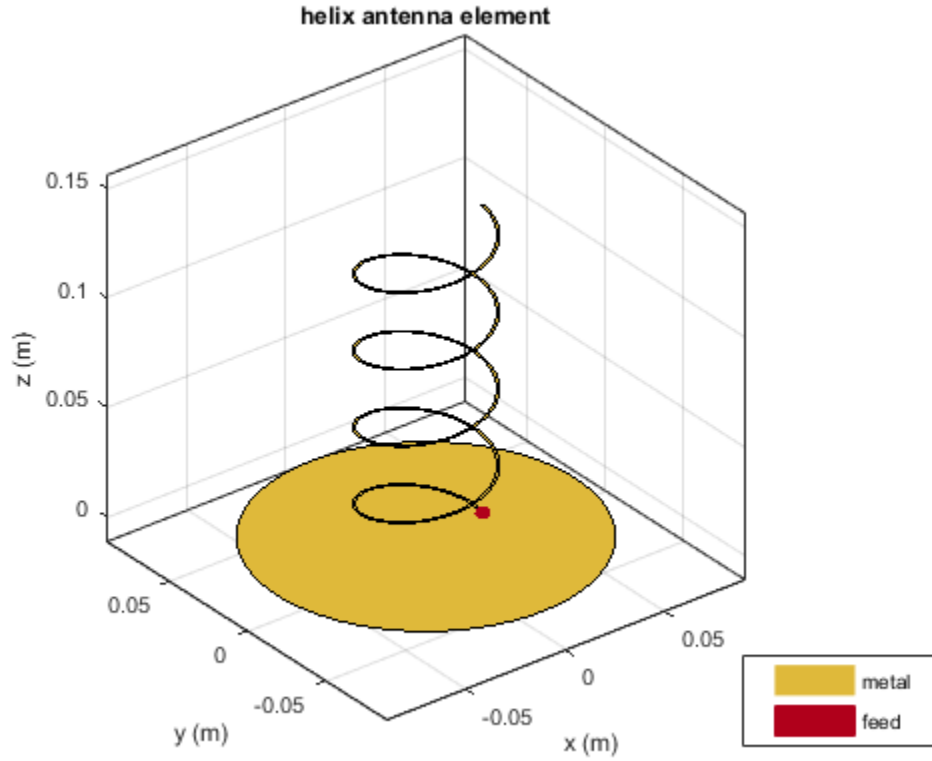
Examples

Create and View Helix Antenna

Create and view a helix antenna that has 28 mm turn radius, 1.2 mm strip width, and 4 turns.

```
hx = helix('Radius',28e-3,'Width',1.2e-3,'Turns',4)
show(hx)
```

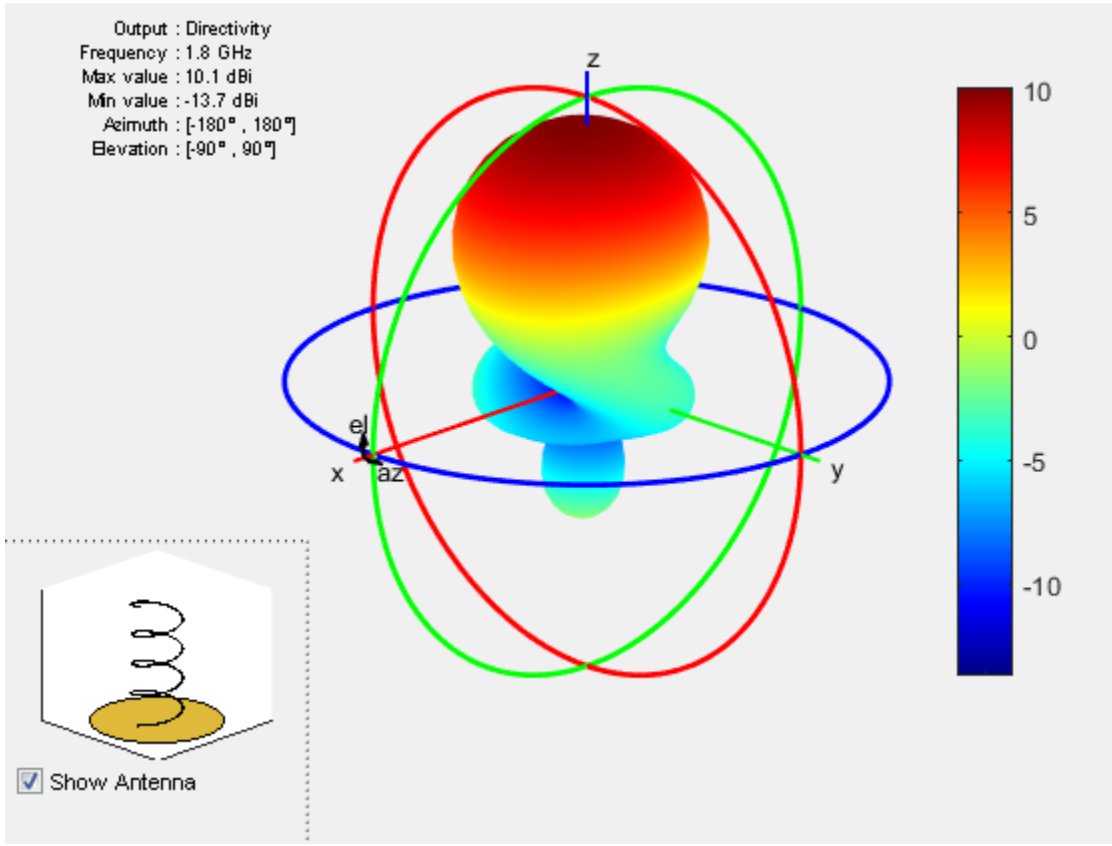
```
hx =

  helix with properties:

              Radius: 0.0280
               Width: 0.0012
               Turns: 4
             Spacing: 0.0350
    WindingDirection: 'CCW'
   GroundPlaneRadius: 0.0750
                Tilt: 0
            TiltAxis: [1 0 0]
                Load: [1×1 lumpedElement]
```



Radiation Pattern of Helix Antenna

Plot the radiation pattern of a helix antenna at a frequency of 1 GHz.

```
hx = helix('Radius',28e-3,'Width',1.2e-3,'Turns',4);
pattern(hx,1.8e9);
```



Calculate Spacing of Helix Antenna with Varying Radius

Calculate spacing of a helix that has a pitch of 12 degrees and a radius that varies from 20 mm to 22 mm in steps of 0.5 mm.

```
s = helixpitch2spacing(12,20e-3:0.5e-3:22e-3)
```

```
s =

    0.0267    0.0274    0.0280    0.0287    0.0294
```

References

[1] Balanis, C.A. *Antenna Theory. Analysis and Design*, 3rd Ed. New York: Wiley, 2005.

[2] Volakis, John. *Antenna Engineering Handbook*, 4th Ed. New York: Mcgraw-Hill, 2007.

[3] Zhang, Yan, Q. Ding, J. Chen, S. Lu, Z. Zhu and L. L. Cheng. "A Parametric Study of Helix Antenna for S-Band Satellite Communications." *9th International Symposium on Antenna Propagation and EM Thoery (ISAPE)*. 2010, pp. 193–196.

[4] Djordjevic, A.R., Zajic, A.G., Ilic, M. M., Stuber, G.L. "Optimization of Helical antennas (Antenna Designer's Notebook)" *IEEE Antennas and Propagation Magazine*. December, 2006, pp. 107, pp.115.

See Also

See Also

`cylinder2strip` | `helixpitch2spacing` | monopole | pifa | spiralArchimedean

Topics

"Rotate Antenna and Arrays"

Introduced in R2015a

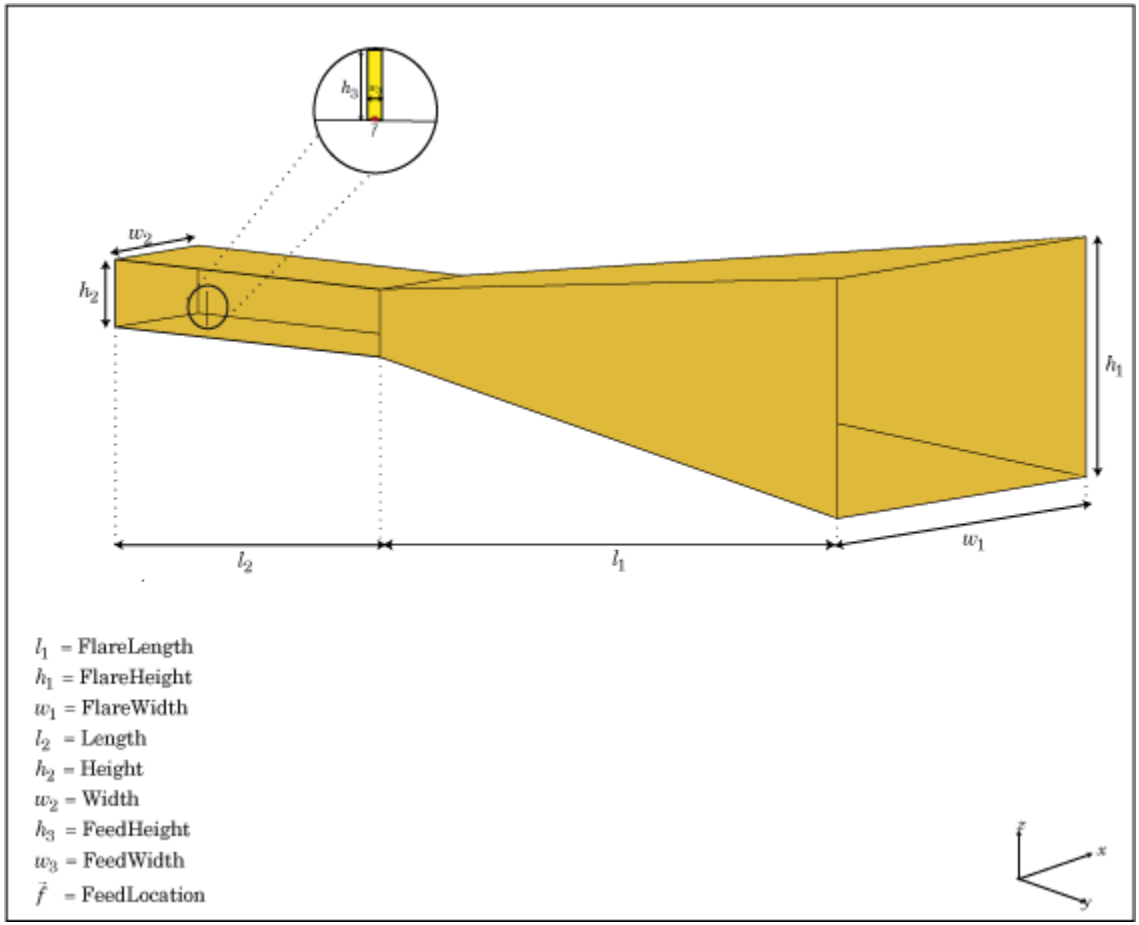
horn

Create horn antenna

Description

The `horn` object is a pyramidal horn antenna with a standard-gain, 15 dBi. The default horn antenna operates in the X-Ku band, which ranges from 10 GHz to 15 GHz. By default, the horn antenna feed is a WR-75 rectangular waveguide with an operating frequency at 7.87 GHz.

For a given flare angles of the horn and dimensions of the waveguide, use the `hornangle2size` utility function to calculate the equivalent flare width and flare height of the horn.



Create Object

`hr = horn` creates a standard-gain pyramidal horn antenna.

`hr = horn(Name,Value)` creates a horn antenna with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1,Value1,...,NameN,ValueN`. Properties not specified retain their default values.

Properties

`'FlareLength'` — Flare length of horn

`0.1020` (default) | scalar in meters

Flare length of horn, specified as the comma-separated pair consisting of `'FlareLength'` and a scalar in meters.

Example: `'FlareLength',0.35`

Data Types: `double`

`'FlareWidth'` — Flare width of horn

`0.0571` (default) | scalar in meters

Flare width of horn, specified as the comma-separated pair consisting of `'FlareWidth'` and a scalar in meters.

Example: `'FlareWidth',0.2`

Data Types: `double`

`'FlareHeight'` — Flare height of horn

`0.0338` (default) | scalar in meters

Flare height of horn, specified as the comma-separated pair consisting of `'FlareHeight'` and a scalar in meters.

Example: `'FlareHeight',0.15`

Data Types: `double`

`'Length'` — Rectangular waveguide length

`0.0500` (default) | scalar in meters

Rectangular waveguide length, specified as the comma-separated pair consisting of `'Length'` and a scalar in meters.

Example: `'Length',0.09`

Data Types: `double`

`'Width'` — Rectangular waveguide width

`0.0190` (default) | scalar in meters

Rectangular waveguide width, specified as the comma-separated pair consisting of `'Width'` and a scalar in meters.

Example: `'Width',0.05`

Data Types: `double`

`'Height'` — Rectangular waveguide height

`0.0095` (default) | scalar in meters

Rectangular waveguide height, specified as the comma-separated pair consisting of `'Height'` and a scalar in meters.

Example: `'Height',0.0200`

Data Types: `double`

`'FeedHeight'` — Height of feed

`0.0048` (default) | scalar in meters

Height of feed, specified as the comma-separated pair consisting of `'FeedHeight'` and a scalar in meters.

Example: `'FeedHeight',0.0050`

Data Types: `double`

`'FeedWidth'` — Width of feed

`1.0000e-04` (default) | scalar in meters

Width of feed, specified as the comma-separated pair consisting of `'FeedWidth'` and a scalar in meters.

Example: `'FeedWidth',5e-05`

Data Types: `double`

`'FeedOffset'` — Signed offset of feedpoint from center of ground plane

`[–0.0155 0]` (default) | two-element vector in meters

Signed offset from center of ground plane, specified as the comma-separated pair of `'FeedOffset'` and a two-element vector in meters.

Example: `'FeedOffset',[–0.0070 0.01]`

Data Types: `double`

'Load' — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of 'Load' and a lumped element object handle. For more information, see lumpedElement.

Example: 'Load',lumpedelement. lumpedelement is the object handle for the load created using lumpedElement.

'Tilt' — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of 'Tilt' and a scalar or vector in degrees.

Example: 'Tilt',90

Example: 'Tilt',[90 90 0]

Data Types: double

'TiltAxis' — Tilt axis of antenna

[1 0 0] (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | 'X' | 'Y' | 'Z'

Tilt axis of the antenna, specified as the comma-separated pair consisting of 'TiltAxis' and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: 'TiltAxis',[0 1 0]

Example: 'TiltAxis',[0 0 0;0 1 0]

Example: 'TiltAxis','Z'

Data Types: double

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

Examples

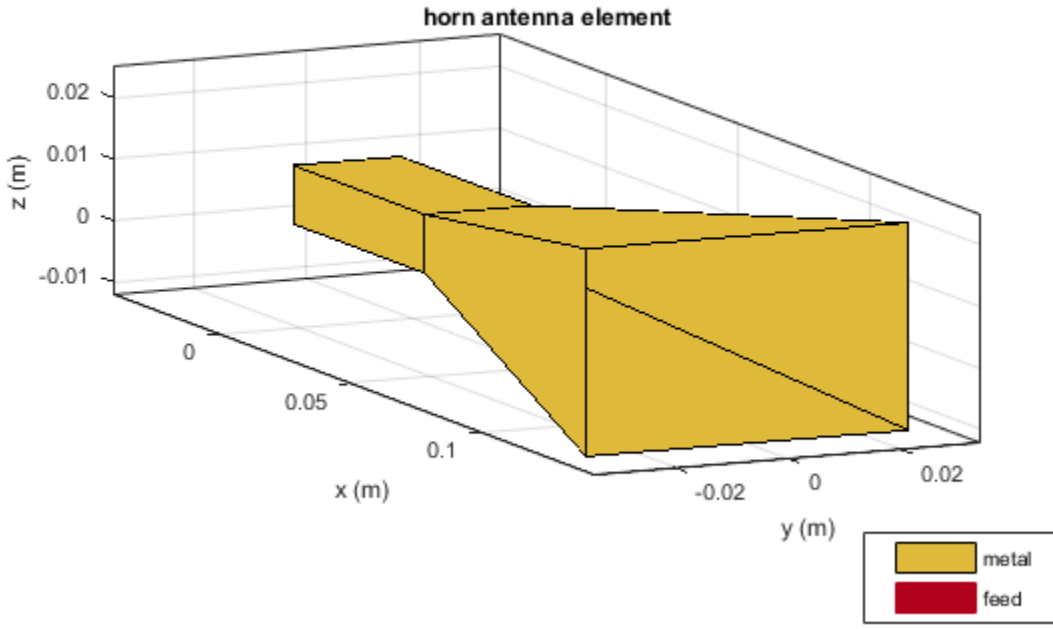
Default Horn Antenna

Create and view a default horn antenna.

```
h = horn
show(h)
```

```
h =

  horn with properties:

    FlareLength: 0.1020
     FlareWidth: 0.0571
    FlareHeight: 0.0338
```

```
    Length: 0.0500
     Width: 0.0190
    Height: 0.0095
 FeedWidth: 1.0000e-04
FeedHeight: 0.0048
FeedOffset: [-0.0155 0]
      Tilt: 0
  TiltAxis: [1 0 0]
      Load: [1×1 lumpedElement]
```



References

[1] Balanis, Constantine A.*Antenna Theory. Analysis and Design*. 3rd Ed. New York: John Wiley and Sons, 2005.

See Also

See Also

waveguide

Topics

"Rotate Antenna and Arrays"

Introduced in R2016a

invertedF

Create inverted-F antenna over rectangular ground plane

Description

The `invertedF` object is an inverted-F antenna mounted over a rectangular ground plane.

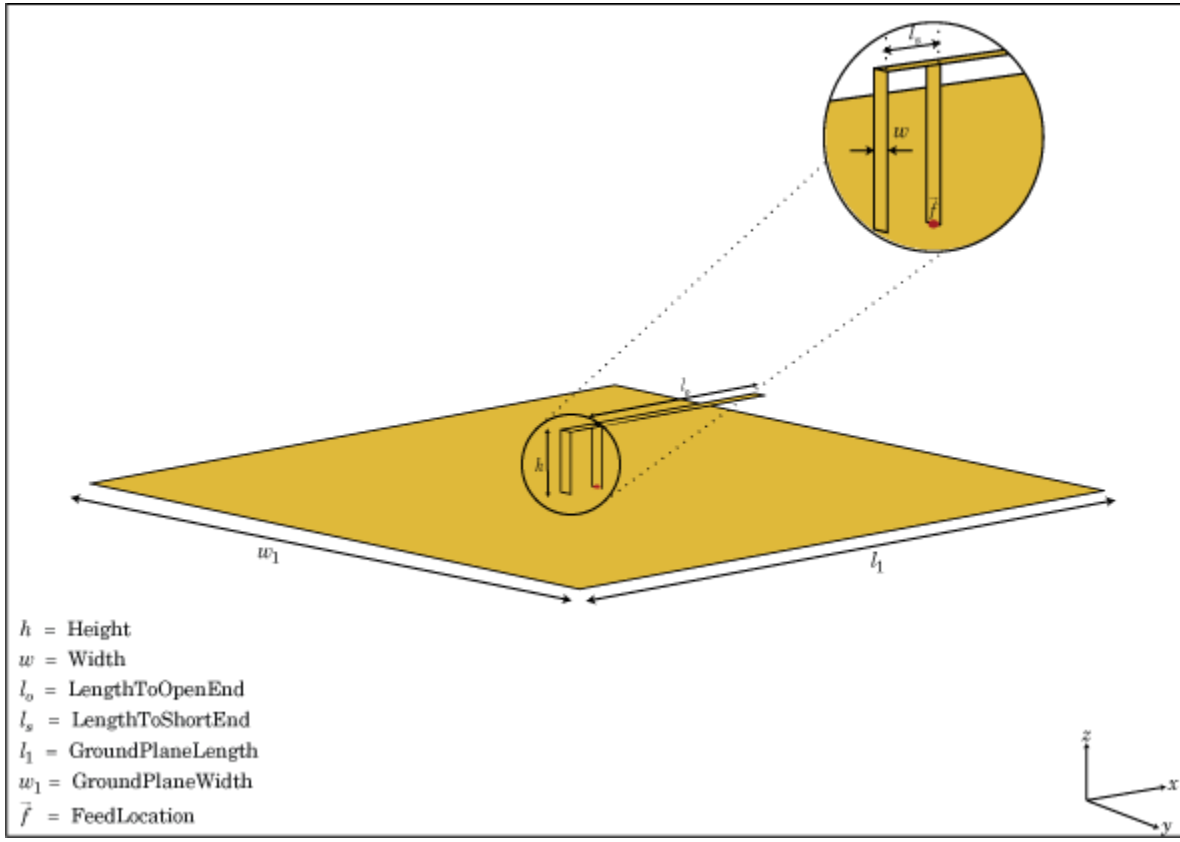
The width of the metal strip is related to the diameter of an equivalent cylinder by the equation

$$w = 2d = 4r$$

where:

- d is the diameter of equivalent cylinder
- r is the radius of equivalent cylinder

For a given cylinder radius, use the utility function `cylinder2strip` to calculate the equivalent width. The default inverted-F antenna is center-fed. The feed point coincides with the origin. The origin is located on the X-Y plane.



Create Object

`f = invertedF` creates an inverted-F antenna mounted over a rectangular ground plane. By default, the dimensions are chosen for an operating frequency of 1.7 GHz.

`f = invertedF(Name,Value)` creates an inverted-F antenna, with additional properties specified by one, or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, ..., `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'Height'` — Vertical element height along z-axis

0.0140 (default) | scalar in meters

Vertical element height along z-axis, specified as the comma-separated pair consisting of `'Height'` and a scalar in meters.

Example: `'Height',3`

Data Types: `double`

`'Width'` — Strip width

0.0020 (default) | scalar in meters

Strip width, specified as the comma-separated pair consisting of `'Width'` and a scalar in meters.

Note: Strip width should be less than `'Height'`/4 and greater than `'Height'`/1001. [2]

Example: `'Width',0.05`

Data Types: `double`

`'LengthToOpenEnd'` — Stub length from feed to open end

0.0310 (default) | scalar in meters

Stub length from feed to open end, specified as the comma-separated pair consisting of `'LengthToOpenEnd'` and a scalar in meters.

Example: `'LengthToOpenEnd',0.05`

`'LengthToShortEnd'` — Stub length from feed to shorting end

0.0060 (default) | scalar in meters

Stub length from feed to shorting end, specified as the comma-separated pair consisting of `'LengthToShortEnd'` and a scalar in meters.

Example: `'LengthToShortEnd',0.0050`

`'GroundPlaneLength'` — Ground plane length along x-axis

0.1000 (default) | scalar in meters

Ground plane length along x-axis, specified as the comma-separated pair consisting of `'GroundPlaneLength'` and a scalar in meters. Setting `'GroundPlaneLength'` to Inf, will use the infinite ground plane technique for antenna analysis.

Example: `'GroundPlaneLength',4`

Data Types: `double`

`'GroundPlaneWidth'` — Ground plane width along y-axis

0.1000 (default) | scalar in meters

Ground plane width along y-axis, specified as the comma-separated pair consisting of `'GroundPlaneWidth'` and a scalar in meters. Setting `'GroundPlaneWidth'` to Inf, will use the infinite ground plane technique for antenna analysis.

Example: `'GroundPlaneWidth',2.5`

Data Types: `double`

`'FeedOffset'` — Signed distance from center along length and width of ground plane

[0 0] (default) | two-element vector

Signed distance from center along length and width of ground plane, specified as the comma-separated pair of `'FeedOffset'` and a two-element vector.

Example: `'FeedOffset',[2 1]`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array

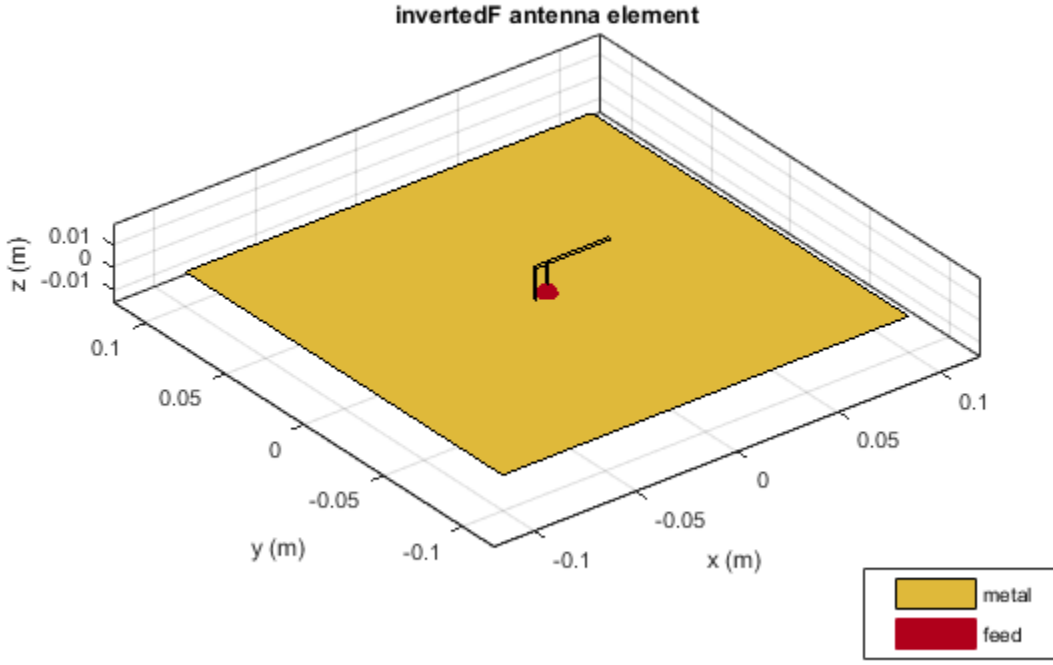
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

Examples

Create and View Inverted-F Antenna

Create and view an inverted-F antenna with 14mm height over a ground plane of dimensions 200mmx200mm.

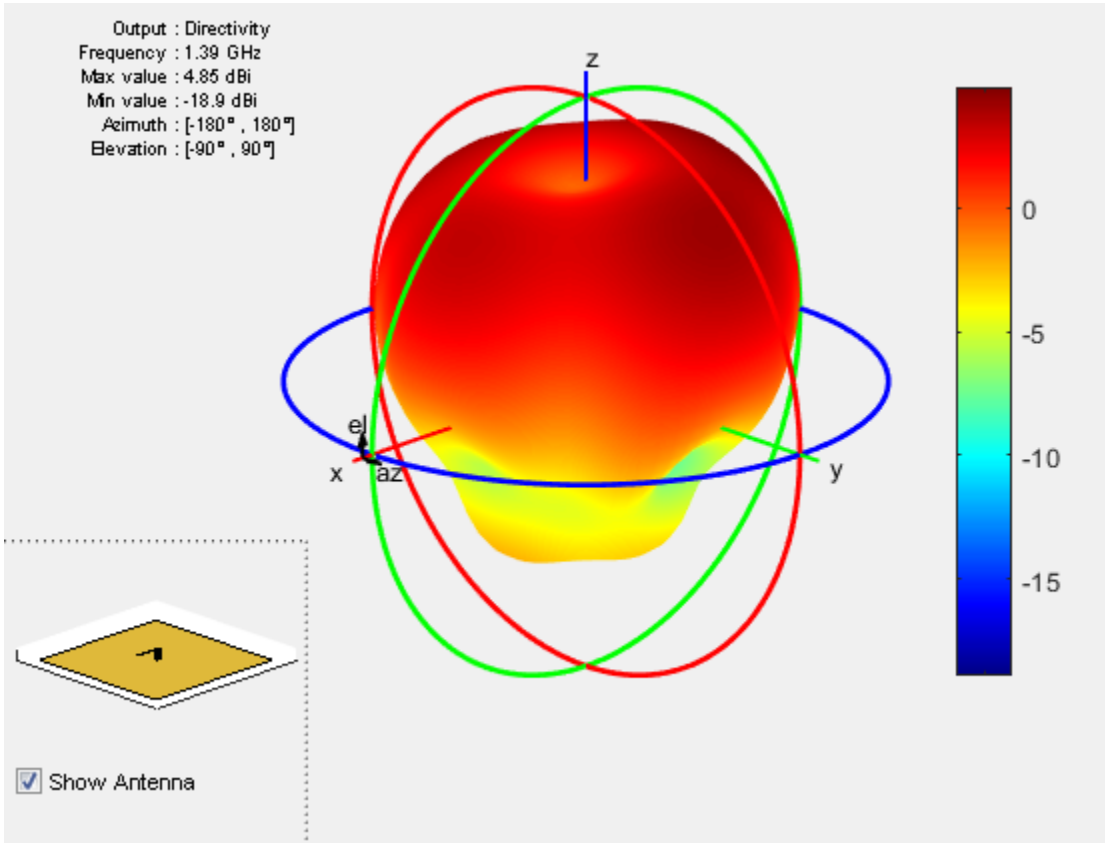
```
f = invertedF('Height',14e-3, 'GroundPlaneLength',200e-3,          ...
                  'GroundPlaneWidth',200e-3);
show(f)
```



Plot Radiation Pattern of Inverted-F

This example shows you how to plot the radiation pattern of an inverted-F antenna for a frequency of 1.3GHz.

```
f = invertedF('Height',14e-3, 'GroundPlaneLength', 200e-3,          ...
                  'GroundPlaneWidth', 200e-3);
pattern(f,1.39e9)
```



References

[1] Balanis, C.A. *Antenna Theory. Analysis and Design*, 3rd Ed. New York: Wiley, 2005.

[2] Volakis, John. *Antenna Engineering Handbook*, 4th Ed. New York: Mcgraw-Hill, 2007.

See Also

See Also

`cylinder2strip` | invertedL | patchMicrostrip | pifa

Topics

"Rotate Antenna and Arrays"

Introduced in R2015a

invertedL

Create inverted-L antenna over rectangular ground plane

Description

The `invertedL` object is an inverted-L antenna mounted over a rectangular ground plane.

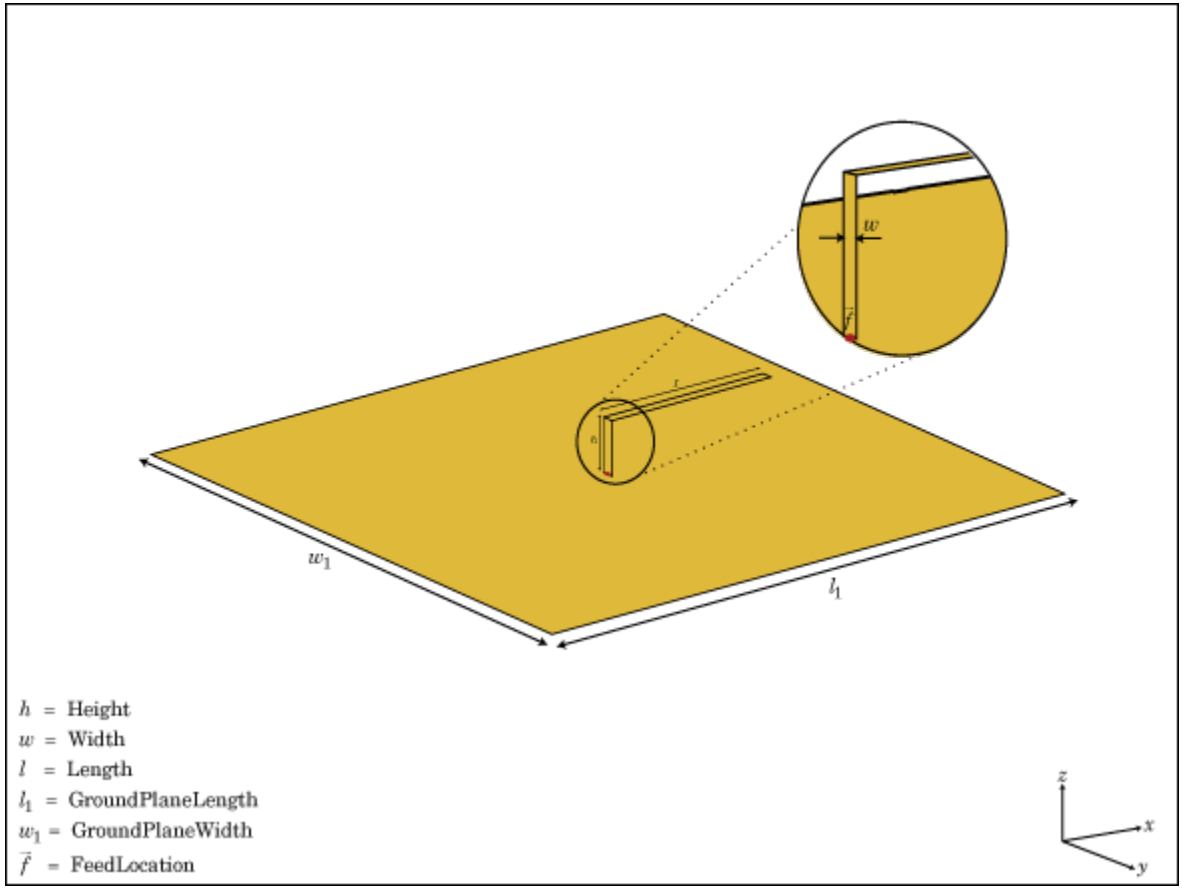
The width of the metal strip is related to the diameter of an equivalent cylinder by the equation

$$w = 2d = 4r$$

where:

- d = diameter of equivalent cylinder
- a = radius of equivalent cylinder

For a given cylinder radius, use the `cylinder2strip` utility function to calculate the equivalent width. The default inverted-L antenna is center-fed. The feed point coincides with the origin. The origin is located on the X-Y plane.



Create Object

`h = invertedL` creates an inverted-L antenna mounted over a rectangular ground plane. By default, the dimensions are chosen for an operating frequency of 1.7 GHz.

`h = invertedL(Name,Value)` creates an inverted-L antenna, with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

'Height' — Height of inverted element along z-axis

0.0140 (default) | scalar in meters

Height of inverted element along z-axis, specified as the comma-separated pair consisting of 'Height' and a scalar in meters.

Example: 'Height',3

Data Types: double

'Width' — Strip width

0.0020 (default) | scalar in meters

Strip width, specified as the comma-separated pair consisting of 'Width' and a scalar in meters.

Note: Strip width should be less than 'Height'/4 and greater than 'Height'/1001. [2]

Example: 'Width',0.05

Data Types: double

'Length' — Stub length along x-axis

0.0310 (default) | scalar in meters

Stub length along x-axis, specified as the comma-separated pair consisting of 'Length' and a scalar in meters.

Example: 'Length',0.01

'GroundPlaneLength' — Ground plane length along x-axis

0.1000 (default) | scalar in meters

Ground plane length along x-axis, specified as the comma-separated pair consisting of 'GroundPlaneLength' and a scalar in meters. Setting 'GroundPlaneLength' to Inf, uses the infinite ground plane technique for antenna analysis.

Example: 'GroundPlaneLength',4

Data Types: double

`'GroundPlaneWidth'` — Ground plane width along y-axis

0.1000 (default) | scalar in meters

Ground plane width along y-axis, specified as the comma-separated pair consisting of `'GroundPlaneWidth'` and a scalar in meters. Setting `'GroundPlaneWidth'` to `Inf`, uses the infinite ground plane technique for antenna analysis.

Example: `'GroundPlaneWidth',2.5`

Data Types: `double`

`'FeedOffset'` — Signed distance from center along length and width of ground plane

[0 0] (default) | two-element vector

Signed distance from center along length and width of ground plane, specified as the comma-separated pair of `'FeedOffset'` and a two-element vector.

Example: `'FeedOffset',[2 1]`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

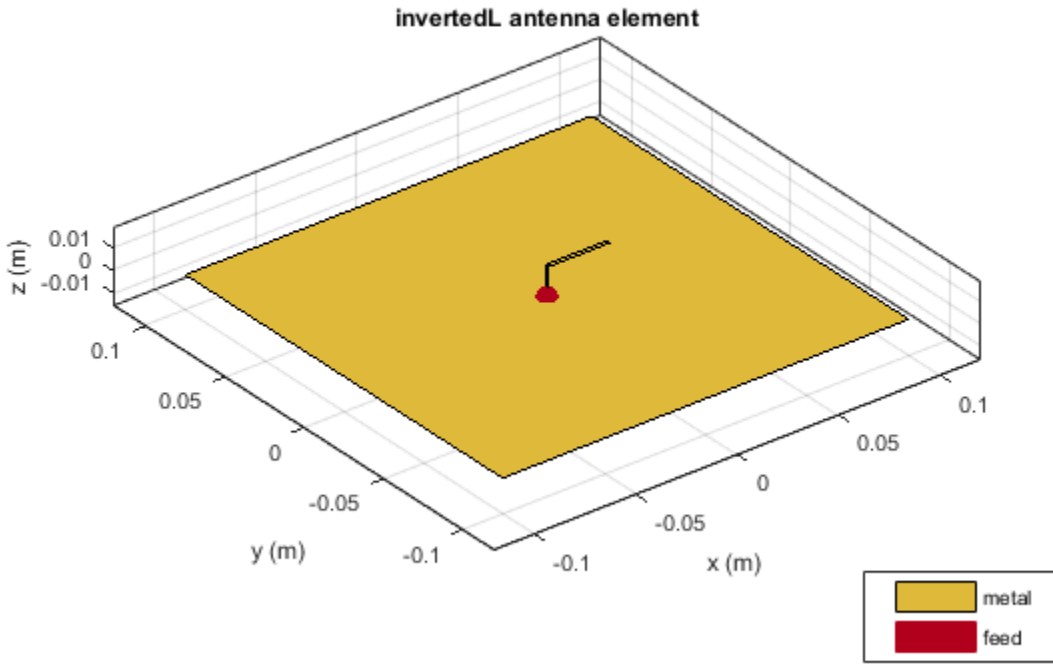
axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

Examples

Create and View Inverted-L Antenna

Create and view an inverted-L antenna that has 30mm length over a ground plane of dimensions 200mmx200mm.

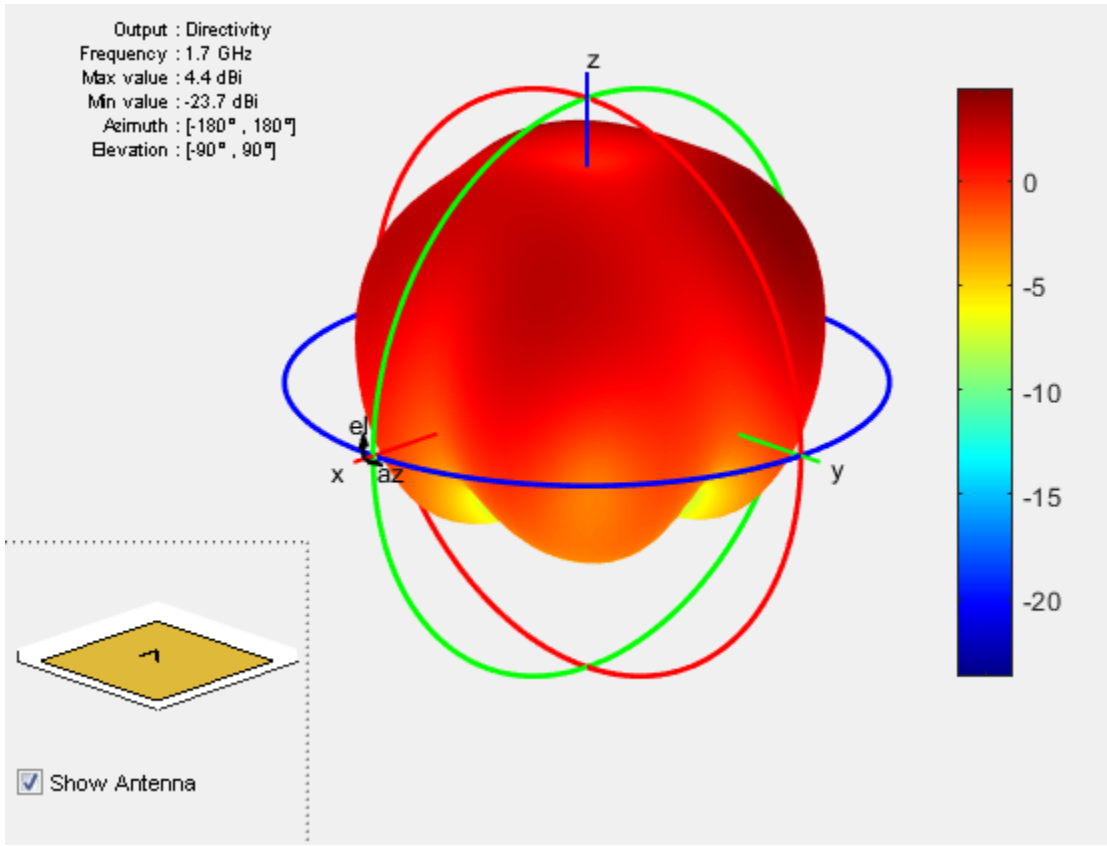
```
il = invertedL('Length',30e-3, 'GroundPlaneLength',200e-3,...
                'GroundPlaneWidth',200e-3);
show(il)
```



Radiation Pattern of Inverted-L Antenna

Plot the radiation pattern of an inverted-L at a frequency of 1.7GHz.

```
iL = invertedL('Length',30e-3, 'GroundPlaneLength',200e-3,...
                    'GroundPlaneWidth',200e-3);
pattern(iL,1.7e9)
```



References

[1] Balanis, C.A. *Antenna Theory. Analysis and Design*, 3rd Ed. New York: Wiley, 2005.

[2] Volakis, John. *Antenna Engineering Handbook*, 4th Ed. New York: Mcgraw-Hill, 2007.

See Also

See Also

`cylinder2strip` | invertedF | patchMicrostrip | pifa

Topics

"Rotate Antenna and Arrays"

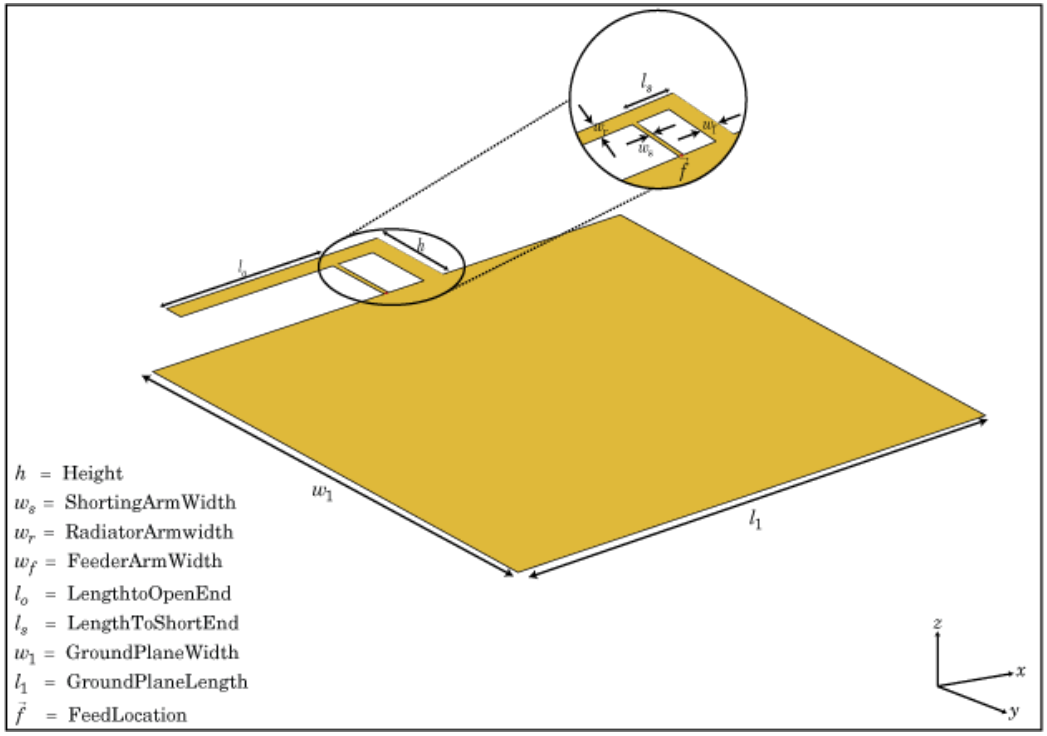
Introduced in R2015a

invertedFcoplanar

Create inverted-F antenna in same plane as rectangular ground plane

Description

The `invertedFcoplanar` object is a coplanar inverted-F antenna with a rectangular ground plane. By default, the dimensions are chosen for an operating frequency of 1.7 GHz. Coplanar inverted-F antennas are used in RFID tags and Internet of Things (IoT) applications. This antenna is an altered version of the inverted-F antenna, providing a low-profile antenna with more design parameters and a wider bandwidth.



Create Object

`fco = invertedFcoplanar` creates a coplanar inverted-F antenna with the rectangular ground plane. By default, the antenna dimensions are for an operating frequency of 1.7 GHz.

`fco = invertedF(Name,Value)` creates a coplanar inverted-F antenna, with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'RadiatorArmWidth'` — Width of radiating arm

`0.0040` (default) | scalar in meters

Width of radiating arm, specified as the comma-separated pair consisting of `'RadiatorArmWidth'`and a scalar in meters.

Example: `'RadiatorArmWidth',0.05`

Data Types: `double`

`'FeederArmWidth'` — Width of feeding arm

`1.0000e-03` (default) | scalar in meters

Width of feeding arm, specified as the comma-separated pair consisting of `'FeederArmWidth'` and scalar in meters.

Example: `'FeederArmWidth',0.05`

Data Types: `double`

`'ShortingArmWidth'` — Width of shorting arm

`0.0040` (default) | scalar in meters

Width of shorting arm, specified as the comma-separated pair consisting of `'ShortingArmWidth'` and a scalar in meters.

Example: `'ShortingArmWidth',1`

Data Types: `double`

'Height' — Height of antenna
0.0100 (default) | scalar in meters

Height of antenna from ground plane, specified as the comma-separated pair consisting of 'Height' and a scalar in meters.

Example: 'Height',0.0800

Data Types: double

'LengthToOpenEnd' — Length of stub from feed to open end
0.0350 (default) | scalar in meters

Length of the stub from feed to the open-end, specified as the comma-separated pair consisting of 'LengthToOpenEnd' and a scalar in meters.

Example: 'LengthToOpenEnd',0.050

Data Types: double

'LengthToShortEnd' — Length of stub from feed to shorting end
0.0100 (default) | scalar in meters

Length of the stub from feed to the shorting end, specified as the comma-separated pair consisting of 'LengthToShortEnd' and a scalar in meters.

Example: 'LengthToShortEnd',0.035

Data Types: double

'GroundPlaneLength' — Length of ground plane
0.0800 (default) | scalar in meters

Length of the ground plane, specified as the comma-separated pair consisting of 'GroundPlaneLength' and a scalar in meters.

Example: 'GroundPlaneLength',0.035

Data Types: double

'GroundPlaneWidth' — Width of ground plane
0.0700 (default) | scalar in meters

Width of the ground plane, specified as the comma-separated pair consisting of 'GroundPlaneWidth' and a scalar in meters.

Example: 'GroundPlaneWidth',0.035

Data Types: `double`

`'FeedOffset'` — Signed distance from center of ground plane

`0` (default) | scalar in meters

Signed distance from center of groundplane, specified as the comma-separated pair consisting of `'FeedOffset'` and a scalar in meters.

Example: `'FeedOffset',0.06`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of array

`0` (default) | scalar in degrees | vector in degrees

Tilt angle of an array, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.

- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
show	Display antenna or array structure
vswr	Voltage standing wave ratio of antenna

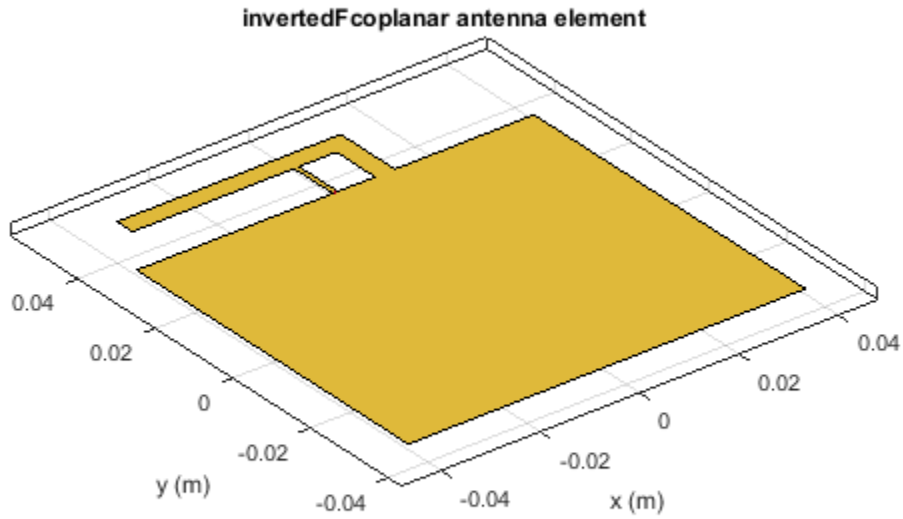
Examples

Coplanar Inverted-F Antenna

Create a default coplanar inverted-F antenna and view it.

```
fco = invertedFcoplanar
show(fco)
```

```
fco =

  invertedFcoplanar with properties:

     RadiatorArmWidth: 0.0040
       FeederArmWidth: 1.0000e-03
     ShortingArmWidth: 0.0040
      LengthToOpenEnd: 0.0350
     LengthToShortEnd: 0.0100
               Height: 0.0100
    GroundPlaneLength: 0.0800
     GroundPlaneWidth: 0.0700
           FeedOffset: 0
                 Tilt: 0
             TiltAxis: [1 0 0]
                 Load: [1×1 lumpedElement]
```



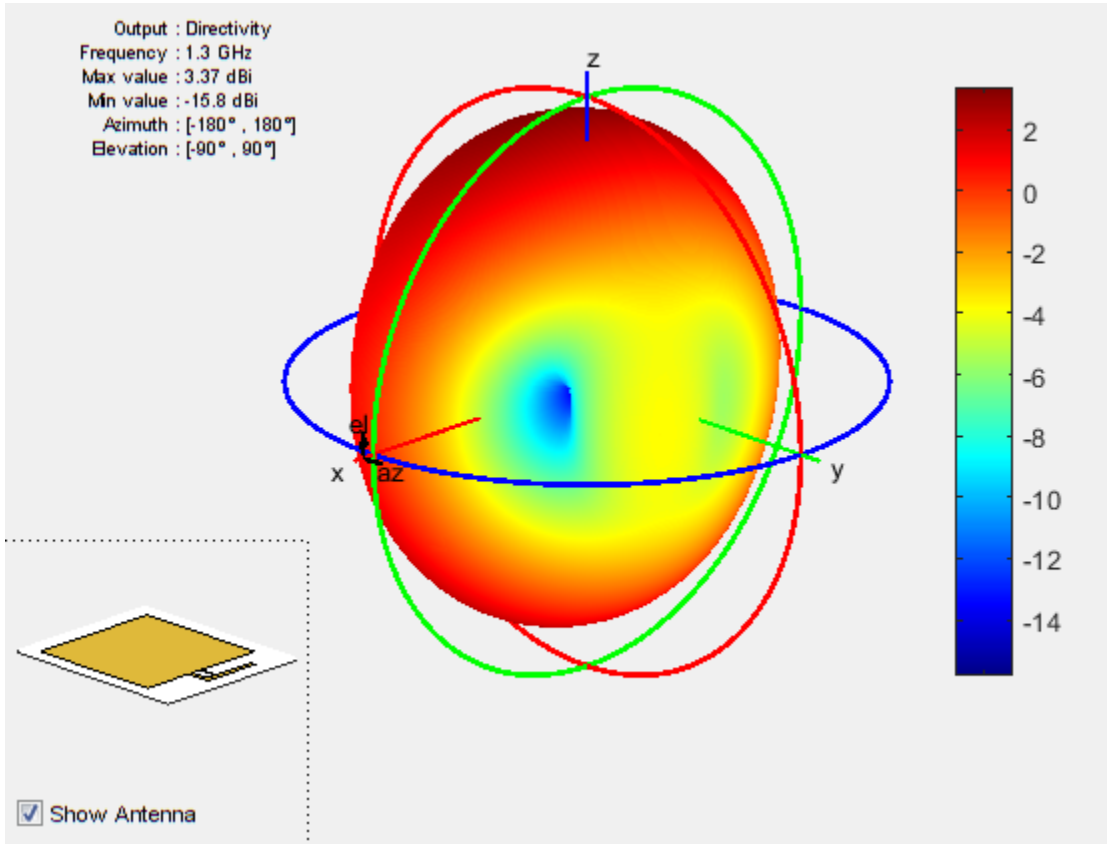
Radiation Pattern of Coplanar Inverted-F Antenna

Create a coplanar inverted-F antenna of height 0.014 m, ground plane length 0.1 m, and ground plane width 0.1 m.

```
fco = invertedFcoplanar('Height',14e-3,'GroundPlaneLength', 100e-3,  ...
                  'GroundPlaneWidth', 100e-3);
```

Plot the radiation pattern of the above antenna at 1.30 GHz.

```
pattern(fco,1.30e9)
```



References

[1] Balanis, C. A. *Antenna Theory. Analysis and Design*. 3rd Ed. Hoboken, NJ: John Wiley & Sons, 2005.

[2] Stutzman, W. L. and Gary A. Thiele. *Antenna Theory and Design*. 3rd Ed. River Street, NJ: John Wiley & Sons, 2013.

See Also

See Also

invertedF | invertedL | invertedLcoplanar

Topics

“Rotate Antenna and Arrays”

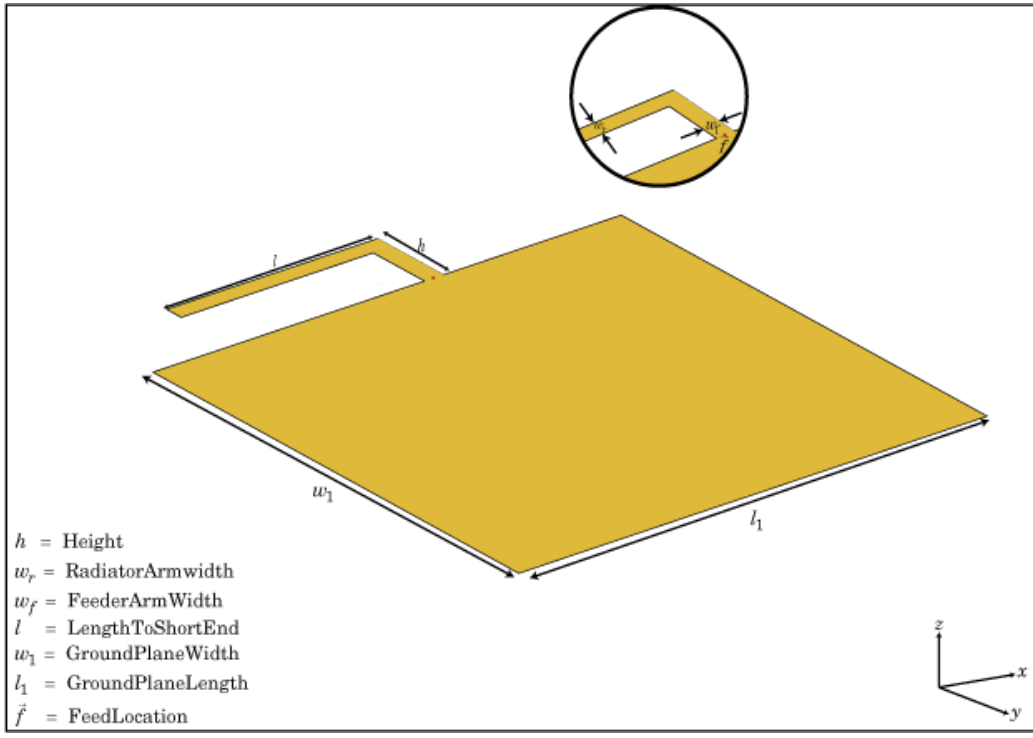
Introduced in R2016b

invertedLcoplanar

Create inverted-L antenna in same plane as rectangular ground plane

Description

The `invertedLcoplanar` object is a coplanar inverted-L antenna with the rectangular ground plane. By default, the dimensions are chosen for an operating frequency of 1.6 GHz. This antenna is used in applications that require low-profile narrow-bandwidth antennas, such as the transmitter for a garage door opener and Internet of Things (IoT) applications.



Create Object

`lco = invertedLcoplanar` creates a coplanar inverted-L antenna with the rectangular ground plane. By default, the antenna dimensions are for an operating frequency of 1.6 GHz.

`lco = invertedLcoplanar(Name,Value)` creates a coplanar inverted-L antenna, with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'RadiatorArmWidth'` — Width of radiating arm

`0.0020` (default) | scalar in meters

Width of radiating arm, specified as the comma-separated pair consisting of `'RadiatorArmWidth'`and a scalar in meters.

Example: `'RadiatorArmWidth',0.05`

Data Types: `double`

`'FeederArmWidth'` — Width of feeding arm

`0.0020` (default) | scalar in meters

Width of feeding arm, specified as the comma-separated pair consisting of `''FeederArmWidth'` and scalar in meters.

Example: `'FeederArmWidth',0.05`

Data Types: `double`

`'Height'` — Height of antenna

`0.0100` (default) | scalar in meters

Height of antenna from ground plane, specified as the comma-separated pair consisting of `'Height'` and a scalar in meters.

Example: `'Height',0.0800`

Data Types: `double`

`'Length'` — Length of stub from feed to open end

`0.0350` (default) | scalar in meters

Length of the stub from the feed to the open-end, specified as the comma-separated pair consisting of `'Length'` and a scalar in meters.

Example: `'Length',0.0800`

Data Types: `double`

`'GroundPlaneLength'` — Length of ground plane

`0.0800` (default) | scalar in meters

Length of the ground plane, specified as the comma-separated pair consisting of `'GroundPlaneLength'` and a scalar in meters.

Example: `'GroundPlaneLength',0.035`

Data Types: `double`

`'GroundPlaneWidth'` — Width of ground plane

`0.0700` (default) | scalar in meters

Width of the ground plane, specified as the comma-separated pair consisting of `'GroundPlaneWidth'` and a scalar in meters.

Example: `'GroundPlaneWidth',0.035`

Data Types: `double`

`'FeedOffset'` — Signed distance from center of ground plane

`0` (default) | scalar in meters

Signed distance from center of groundplane, specified as the comma-separated pair consisting of `'FeedOffset'` and a scalar in meters.

Example: `'FeedOffset',0.06`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of array

`0` (default) | scalar in degrees | vector in degrees

Tilt angle of an array, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface

design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
show	Display antenna or array structure
vswr	Voltage standing wave ratio of antenna

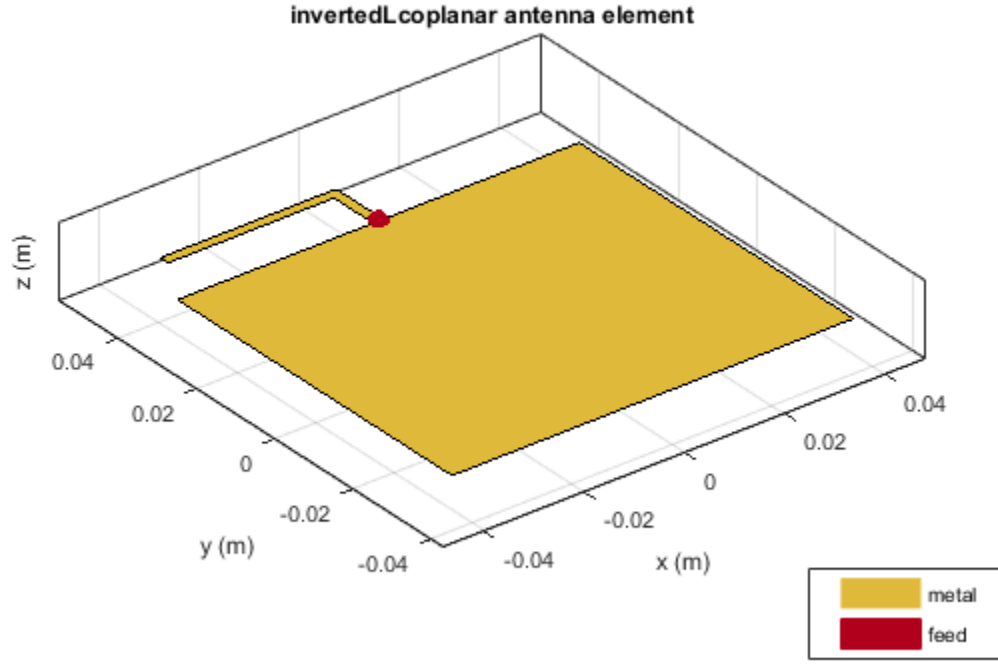
Examples

Coplanar Inverted-L Antenna

Create a default coplanar inverted-L antenna and view it.

```
lco =  invertedLcoplanar
show(lco)
```

```
lco =

  invertedLcoplanar with properties:

     RadiatorArmWidth: 0.0020
       FeederArmWidth: 0.0020
               Length: 0.0350
               Height: 0.0100
    GroundPlaneLength: 0.0800
     GroundPlaneWidth: 0.0700
           FeedOffset: 0
                 Tilt: 0
            TiltAxis: [1 0 0]
                Load: [1×1 lumpedElement]
```



Impedance of Coplanar Inverted-L Antenna

Create a coplanar inverted-L antenna of length 0.050 m, height 0.014m, ground plane length 0.1 m, and ground plane width 0.1 m.

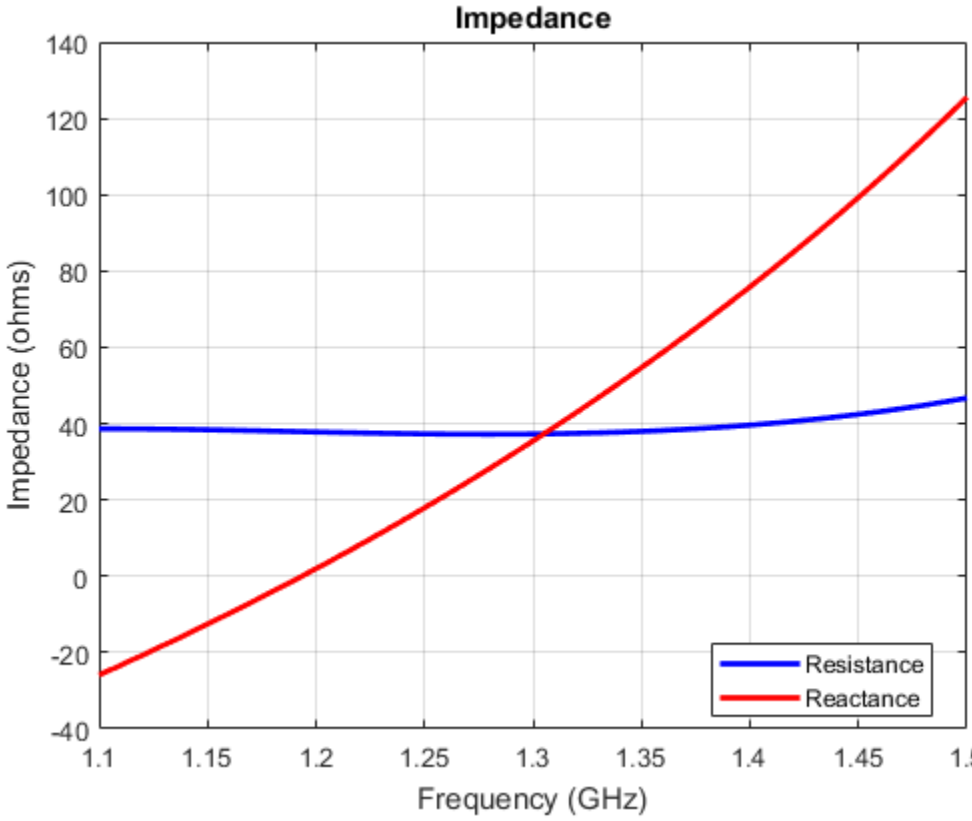
```
lco = invertedLcoplanar('Length',50e-3, 'Height',14e-3,...
    'GroundPlaneLength',100e-3,'GroundPlaneWidth',100e-3)
```

```
lco =

  invertedLcoplanar with properties:

     RadiatorArmWidth: 0.0020
```

```
       FeederArmWidth: 0.0020
               Length: 0.0500
               Height: 0.0140
    GroundPlaneLength: 0.1000
     GroundPlaneWidth: 0.1000
           FeedOffset: 0
                 Tilt: 0
            TiltAxis: [1 0 0]
                 Load: [1×1 lumpedElement]
```

Plot the impedance over 1.1 GHz to 1.5 GHz in steps of 10 MHz.

```
impedance(lco,1.1e9:10e6:1.5e9);
```



References

[1] Balanis, C. A. *Antenna Theory. Analysis and Design*. 3rd Ed. Hoboken, NJ: John Wiley & Sons, 2005.

[2] Stutzman, W. L. and Gary A. Thiele. *Antenna Theory and Design*. 3rd Ed. River Street, NJ: John Wiley & Sons, 2013.

See Also

See Also

invertedF | invertedFcoplanar | invertedL

Topics

"Rotate Antenna and Arrays"

Introduced in R2016b

loopCircular

Create circular loop antenna

Description

The `loopCircular` object is a planar circular loop antenna on the X-Y plane.

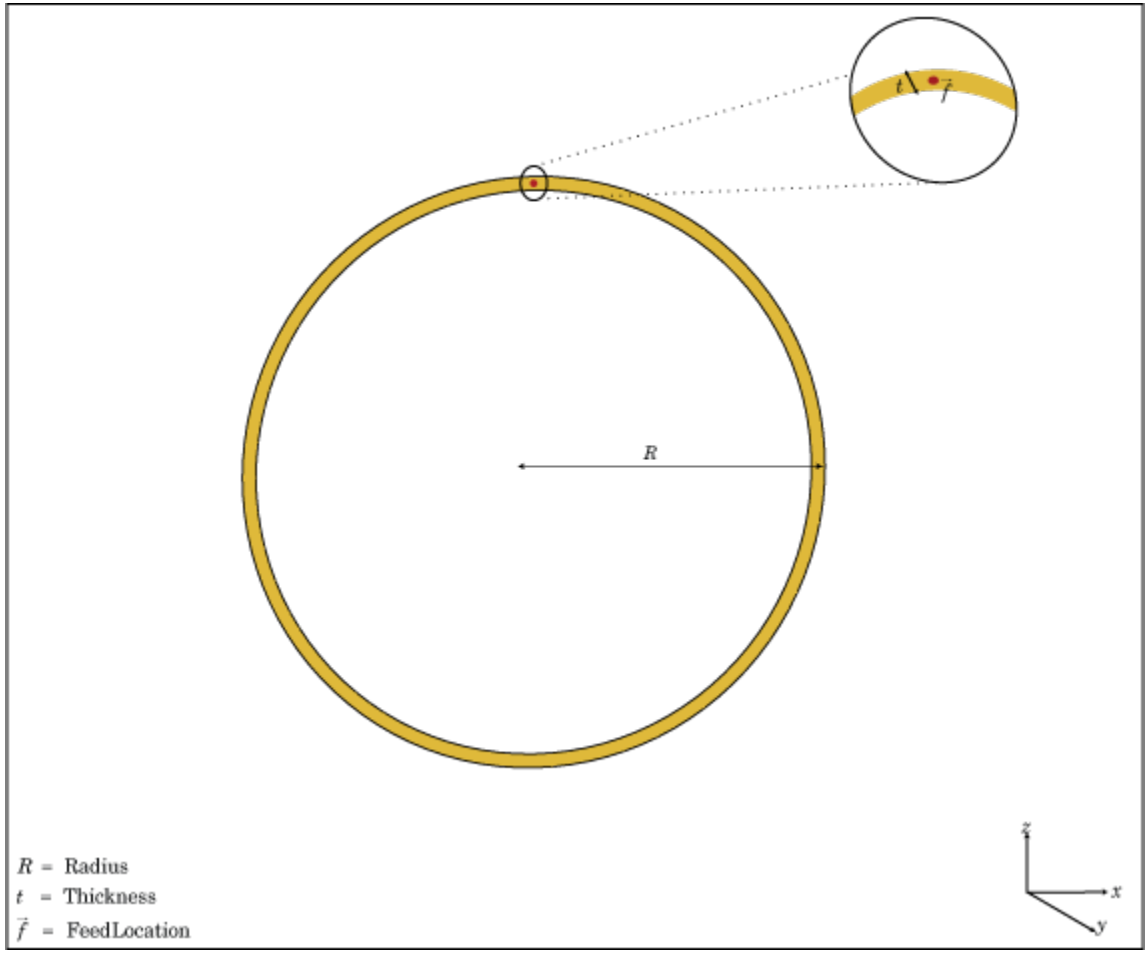
The thickness of the loop is related to the diameter of an equivalent cylinder loop by the equation

$$t = 2d = 4r$$

, where:

- d is the diameter of equivalent cylindrical loop
- r is the radius of equivalent cylindrical loop

For a given cylinder radius, use the `cylinder2strip` utility function to calculate the equivalent width. The default circular loop antenna is fed at the positive X-axis. The point of the X-axis is at the midpoint of the inner and outer radii.



Create Object

`h = loopCircular` creates a one wavelength circular loop antenna in the X-Y plane. By default, the circumference is chosen for the operating frequency 75 MHz.

`h = loopCircular(Name,Value)` creates a one wavelength circular loop antenna, with additional properties specified by one, or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-

value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'Radius'` — Outer radius of loop

0.6366 (default) | scalar in meters

Outer radius of loop, specified as the comma-separated pair consisting of `'Radius'` and a scalar in meters.

Example: `'Radius',3`

Data Types: `double`

`'Thickness'` — Thickness of loop

0.0200 (default) | scalar in meters

Thickness of loop, specified as the comma-separated pair consisting of `'Thickness'` and a scalar in meters.

Example: `'Thickness',2`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure

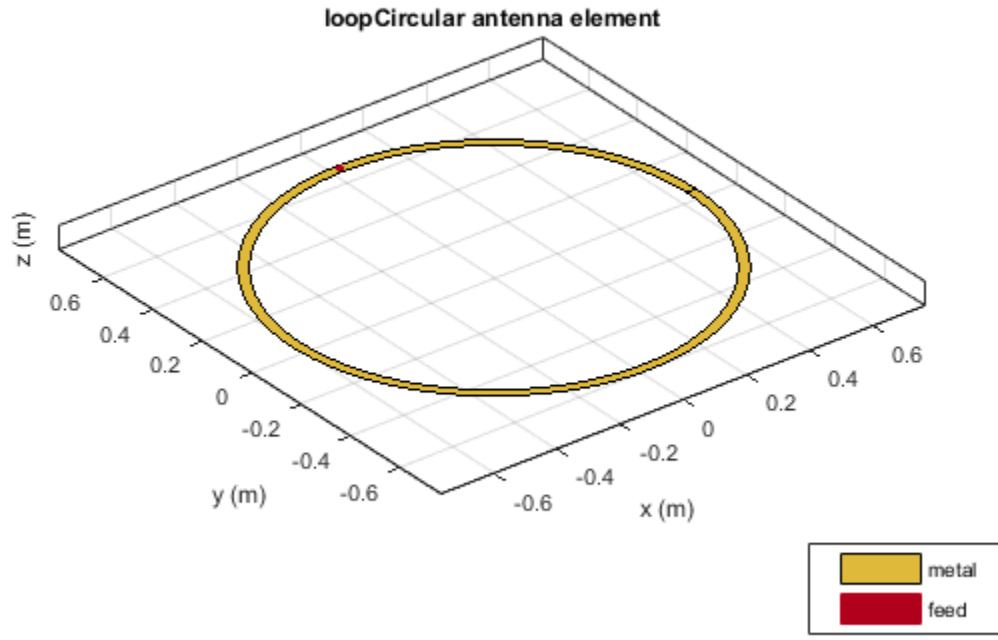
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

Examples

Create and View Circular Loop Antenna

Create and view a circular loop with 0.65 m radius and 0.01 m thickness.

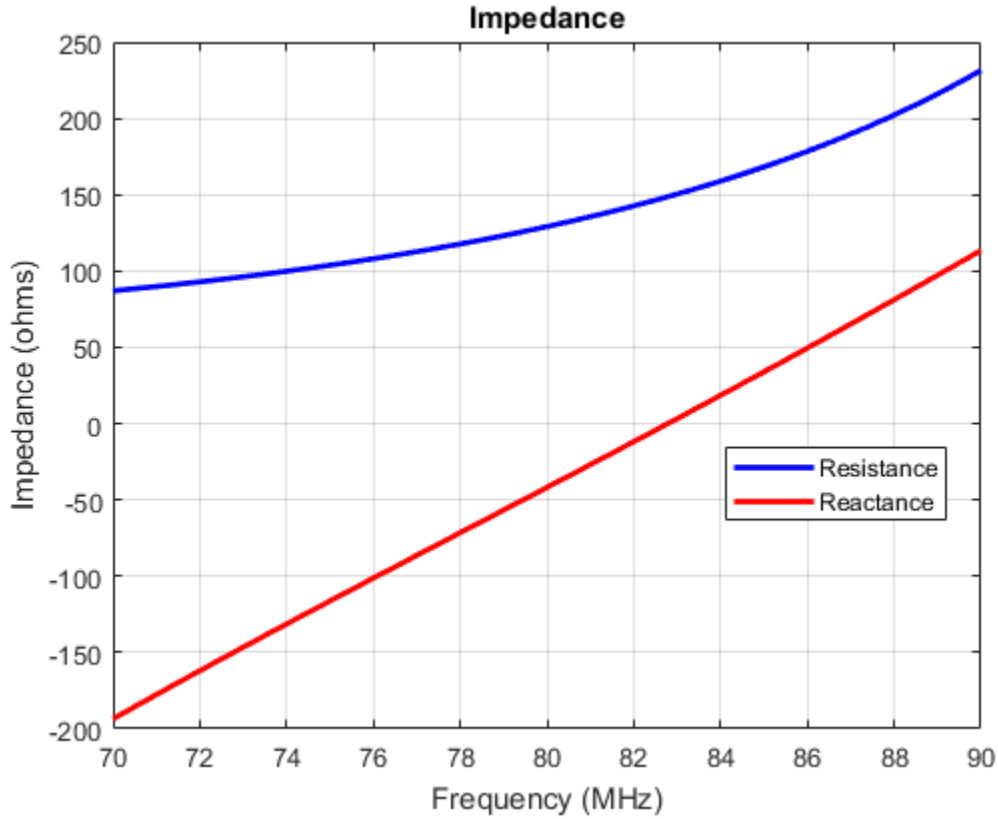
```
c = loopCircular('Radius',0.64,'Thickness',0.03);
show(c)
```



Impedance of Circular Loop Antenna

Calculate the impedance of a circular loop antenna over a frequency range of 70MHz-90MHz.

```
c = loopCircular('Radius',0.64,'Thickness',0.03);
impedance(c,linspace(70e6,90e6,31))
```



References

[1] Balanis, C.A. *Antenna Theory. Analysis and Design*, 3rd Ed. New York: Wiley, 2005.

See Also

See Also

dipole | loopRectangular | slot

Topics

"Rotate Antenna and Arrays"

Introduced in R2015a

loopRectangular

Create rectangular loop antenna

Description

The `loopRectangular` object is a rectangular loop antenna on the X-Y plane.

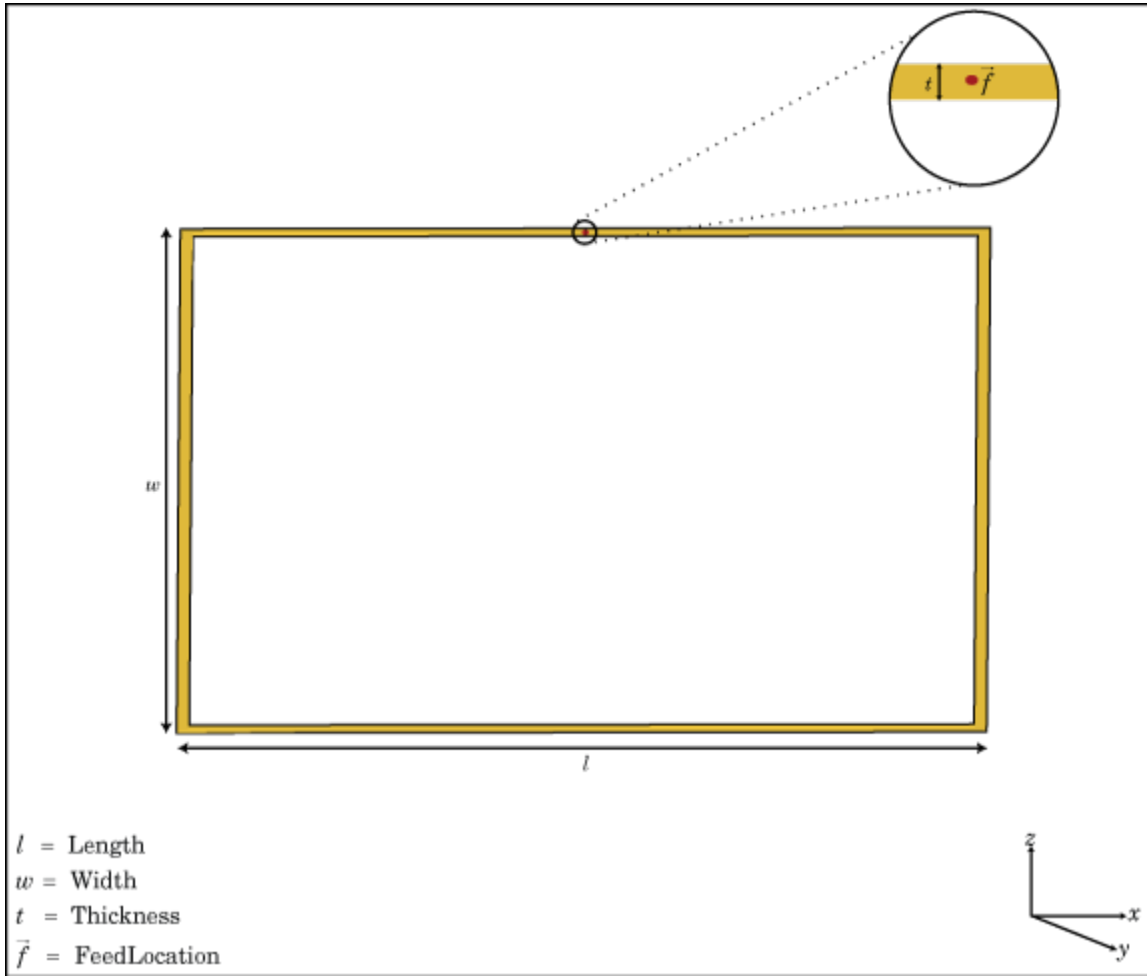
The thickness of the loop is related to the diameter of an equivalent cylinder loop by the equation

$$t = 2d = 4r$$

, where:

- d is the diameter of equivalent cylindrical loop
- r is the radius of equivalent cylindrical loop

For a given cylinder radius, use the `cylinder2strip` utility function to calculate the equivalent width. The default circular loop antenna is fed at the positive Y-axis. The point of the Y-axis is the midpoint of the inner and outer perimeter of the loop.



Create Object

`h = loopRectangular` creates a rectangular loop antenna in the X-Y plane. By default, the dimensions are chosen for the operating frequency 53 MHz.

`h = loopRectangular(Name,Value)` creates a rectangular loop antenna, with additional properties specified by one, or more name-value pair arguments. `Name` is the

property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retains their default values.

Properties

`'Length'` — Loop length along x-axis

2 (default) | scalar in meters

Loop length along x-axis, specified as the comma-separated pair consisting of `'Length'` and a scalar in meters.

Example: `'Length',3`

Data Types: `double`

`'Width'` — Loop width along y-axis

1 (default) | scalar in meters

Loop width along y-axis, specified as the comma-separated pair consisting of `'Width'`and a scalar in meters.

Example: `'Width',2`

Data Types: `double`

`'Thickness'` — Loop thickness

0.0100 (default) | scalar in meters

Loop thickness, specified as the comma-separated pair consisting of `'Thickness'` and a scalar in meters.

Example: `'Thickness',2`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface

current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

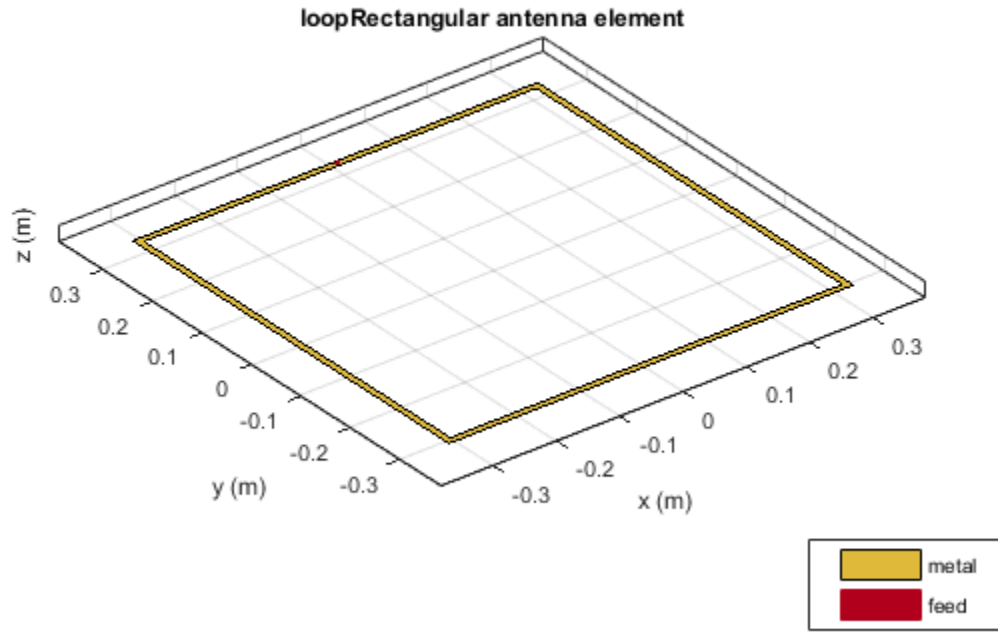
Examples

Create and View Rectangular Loop Antenna

Create and view a rectangular loop antenna with 0.64m length, 0.64m width.

```
r = loopRectangular('Length',0.64,'Width',0.64)
show(r)
```

```
r =

  loopRectangular with properties:

       Length: 0.6400
        Width: 0.6400
    Thickness: 0.0100
         Tilt: 0
     TiltAxis: [1 0 0]
         Load: [1×1 lumpedElement]
```



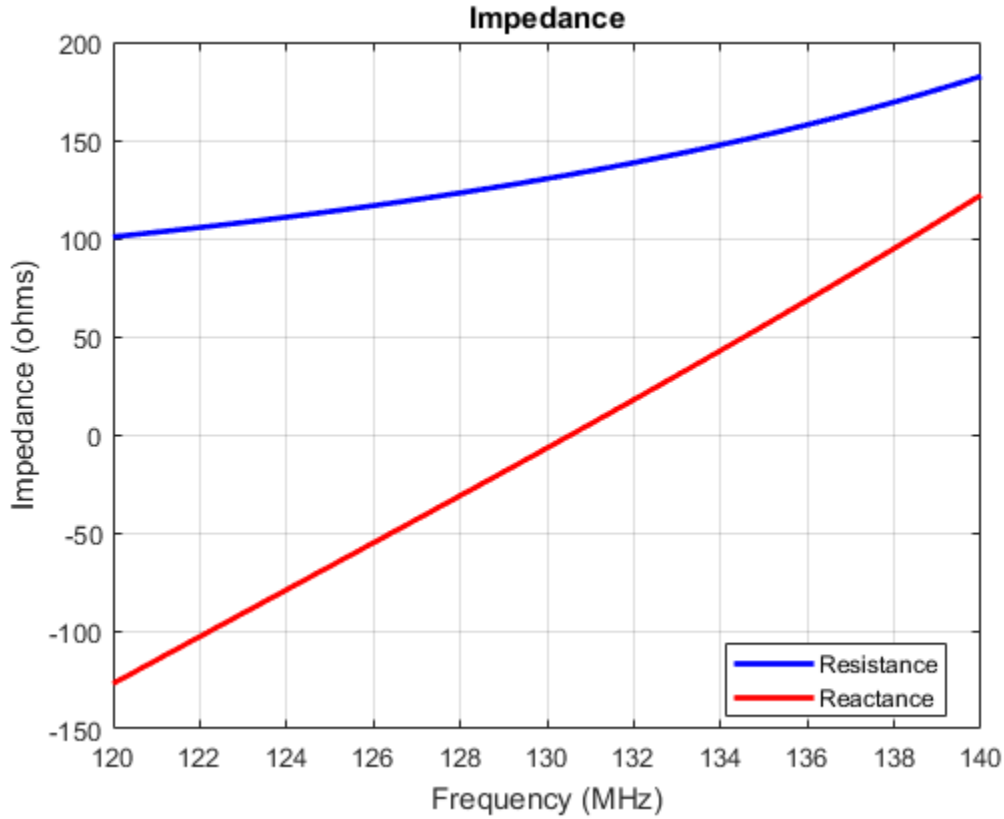
Impedance of Rectangular Loop Antenna

Calculate the impedance of a rectangular loop antenna over a frequency range of 120MHz-140MHz.

```
r = loopRectangular('Length',0.64,'Width',0.64)
impedance(r,linspace(120e6,140e6,31))
```

```
r =

  loopRectangular with properties:

       Length: 0.6400
```

```
    Width: 0.6400
Thickness: 0.0100
     Tilt: 0
 TiltAxis: [1 0 0]
     Load: [1×1 lumpedElement]
```



References

[1] Balanis, C.A. *Antenna Theory. Analysis and Design*, 3rd Ed. New York: Wiley, 2005.

See Also

See Also

dipole | loopCircular | monopole

Topics

"Rotate Antenna and Arrays"

Introduced in R2015a

monopole

Create monopole antenna over rectangular ground plane

Description

The `monopole` object is a monopole antenna mounted over a rectangular ground plane.

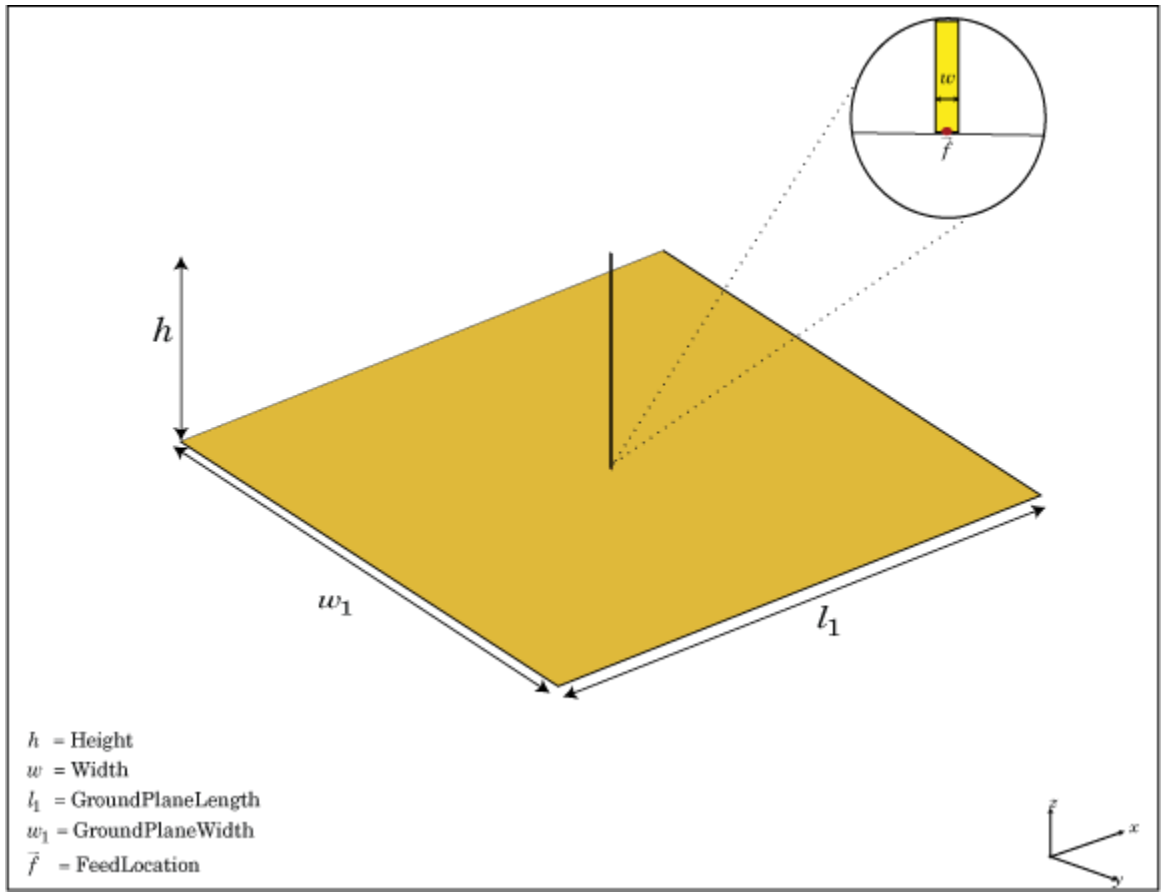
The width of the monopole is related to the diameter of an equivalent cylindrical monopole by the equation

$$w = 2d = 4r$$

, where:

- d is the diameter of equivalent cylindrical monopole
- r is the radius of equivalent cylindrical monopole.

For a given cylinder radius, use the `cylinder2strip` utility function to calculate the equivalent width. The default monopole is center-fed. The feed point coincides with the origin. The origin is located on the X-Y plane.



Create Object

`h = monopole` creates a quarter-wavelength monopole antenna.

`h = monopole(Name,Value)` creates a quarter-wavelength monopole antenna with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

'Height' — Height of vertical element along z-axis

1 (default) | scalar in meters

Height of vertical element along z-axis, specified as the comma-separated pair consisting of 'Height' and a scalar in meters. By default, the height is chosen for an operating frequency of 75 MHz.

Example: 'Height',3

Data Types: double

'Width' — Monopole width

0.1000 (default) | scalar in meters

Monopole width, specified as the comma-separated pair consisting of 'Width' and a scalar in meters.

Note: Monopole width should be less than 'Height'/4 and greater than 'Height'/1001. [2]

Example: 'Width',0.05

Data Types: double

'GroundPlaneLength' — Ground plane length along x-axis

2 (default) | scalar in meters

Ground plane length along x-axis, specified as the comma-separated pair consisting of 'GroundPlaneLength' and a scalar in meters. Setting 'GroundPlaneLength' to Inf, uses the infinite ground plane technique for antenna analysis.

Example: 'GroundPlaneLength',4

Data Types: double

'GroundPlaneWidth' — Ground plane width along y-axis

2 (default) | scalar in meters

Ground plane width along y-axis, specified as the comma-separated pair consisting of 'GroundPlaneWidth' and a scalar in meters. Setting 'GroundPlaneWidth' to Inf, uses the infinite ground plane technique for antenna analysis.

Example: `'GroundPlaneWidth',2.5`

Data Types: `double`

`'FeedOffset'` — Signed distance from center along length and width of ground plane

[0 0] (default) | two-element vector

Signed distance from center along length and width of ground plane, specified as the comma-separated pair of `'FeedOffset'` and a two-element vector.

Example: `'FeedOffset',[2 1]`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.

- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

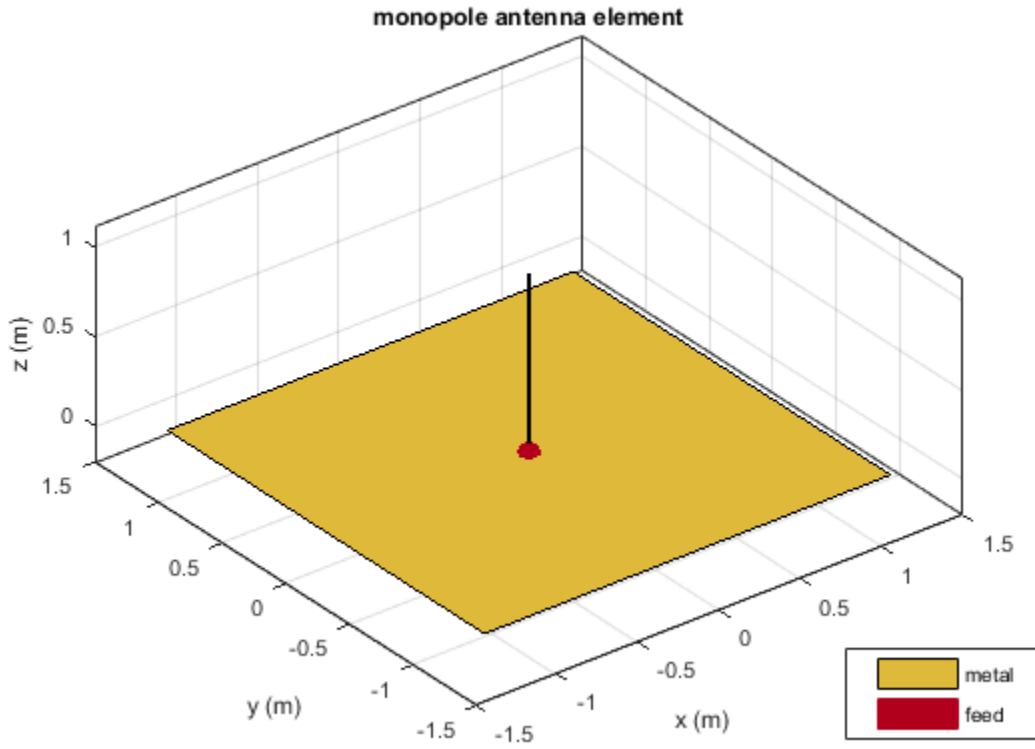
Examples

Create and View Monopole Antenna

Create and view a monpole of 1 m length, 0.01 m width and ground plane of dimensions 2.5mx2.5m.

```
m = monopole('GroundPlaneLength',2.5,'GroundPlaneWidth',2.5)
show(m)
```

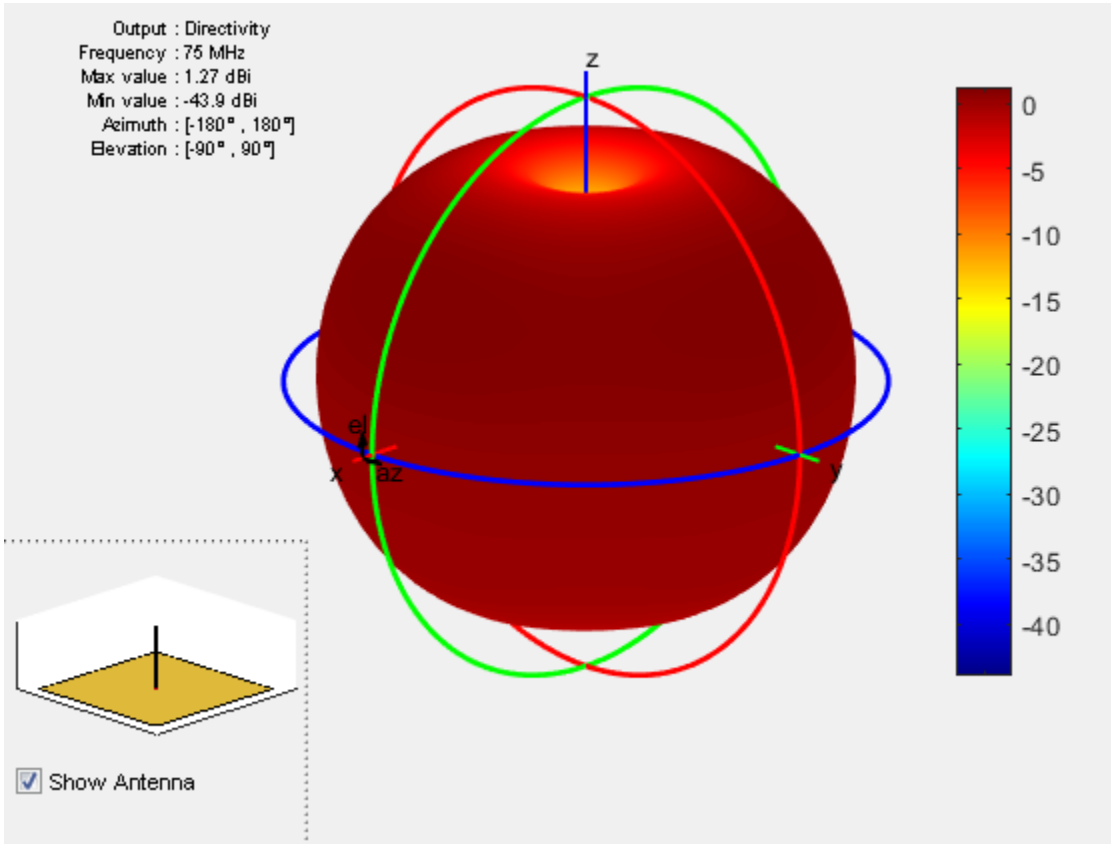
```
m =

  monopole with properties:

              Height: 1
               Width: 0.0100
    GroundPlaneLength: 2.5000
     GroundPlaneWidth: 2.5000
          FeedOffset: [0 0]
                Tilt: 0
            TiltAxis: [1 0 0]
                Load: [1×1 lumpedElement]
```



Radiation Pattern of Monopole Antenna

Radiation pattern of a monopole at a frequency of 75MHz.

```
m = monopole('GroundPlaneLength',2.5, 'GroundPlaneWidth',2.5);
pattern (m,75e6)
```



References

[1] Balanis, C.A. *Antenna Theory. Analysis and Design*, 3rd Ed. New York: Wiley, 2005.

[2] Volakis, John. *Antenna Engineering Handbook*, 4th Ed. New York: Mcgraw-Hill, 2007.

See Also

See Also

dipole | monopoleTopHat | patchMicrostrip

Topics

"Rotate Antenna and Arrays"

Introduced in R2015a

monopoleTopHat

Create capacitively loaded monopole antenna over rectangular ground plane

Description

The `monopoleTopHat` object is a top-hat monopole antenna mounted over a rectangular ground plane. The monopole always connects with the center of top hat. The top hat builds up additional capacitance to ground within the structure. This capacitance reduces the resonant frequency of the antenna without increasing the size of the element.

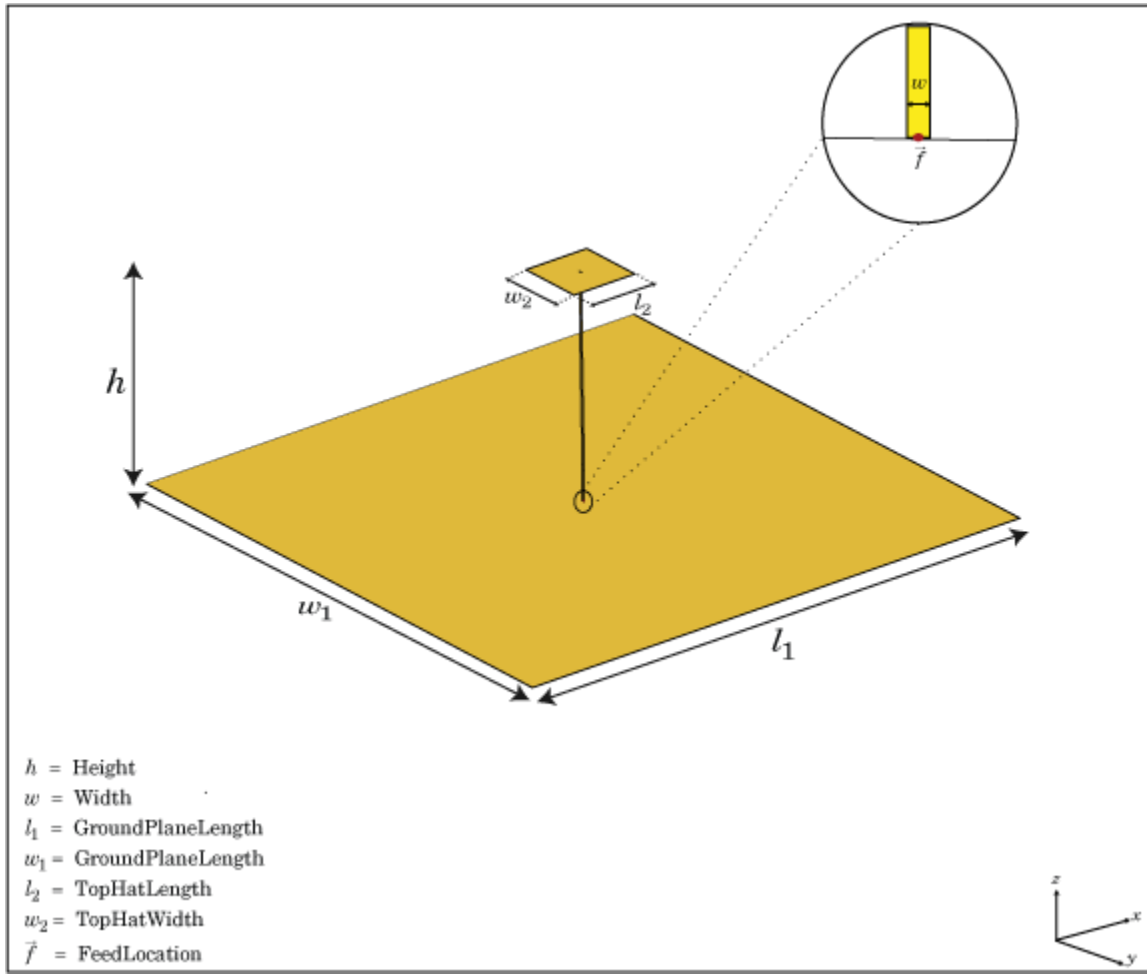
The width of the monopole is related to the diameter of an equivalent cylindrical monopole by the expression

$$w = 2d = 4r$$

,where:

- d is the diameter of equivalent cylindrical monopole
- r is the radius of equivalent cylindrical monopole.

For a given cylinder radius, use the `cylinder2strip` utility function to calculate the equivalent width. The default top-hat monopole is center-fed. The feed point coincides with the origin. The origin is located on the X-Y plane.



Create Object

`h = monopoleTopHat` creates a capacitively loaded monopole antenna over a rectangular ground plane.

`h = monopoleTopHat(Name,Value)` creates a capacitively loaded monopole antenna with additional properties specified by one or more name-value pair arguments. `Name` is

the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`,`...`, `NameN`, `ValueN`. Properties not specified retains their default values.

Properties

`'Height'` — Monopole height

1 (default) | scalar in meters

Monopole height, specified as the comma-separated pair consisting of `'Height'` and a scalar in meters. By default, the height is chosen for an operating frequency of 75 MHz.

Example: `'Height',3`

Data Types: `double`

`'Width'` — Monopole width

0.1000 (default) | scalar in meters

Monopole width, specified as the comma-separated pair consisting of `'Width'` and a scalar in meters.

Note: Monopole width should be less than `'Height'`/4 and greater than `'Height'`/1001. [2]

Example: `'Width',0.05`

Data Types: `double`

`'GroundPlaneLength'` — Ground plane length along x-axis

2 (default) | scalar in meters

Ground plane length along x-axis, specified as the comma-separated pair consisting of `'GroundPlaneLength'` and a scalar in meters. Setting `'GroundPlaneLength'` to `Inf`, uses the infinite ground plane technique for antenna analysis.

Example: `'GroundPlaneLength',4`

Data Types: `double`

`'GroundPlaneWidth'` — Ground plane width along y-axis

2 (default) | scalar in meters

Ground plane width along y-axis, specified as the comma-separated pair consisting of `'GroundPlaneWidth'` and a scalar in meters. Setting `'GroundPlaneWidth'` to `Inf`, uses the infinite ground plane technique for antenna analysis.

Example: `'GroundPlaneWidth',2.5`

Data Types: `double`

`'TopHatLength'` — Top hat length along x-axis

0.2500 (default) | scalar in meters

Top hat length along x-axis, specified as the comma-separated pair consisting of `'TopHatLength'` and a scalar in meters.

Example: `'TopHatLength',4`

Data Types: `double`

`'TopHatWidth'` — Top hat width along y-axis

0.2500 (default) | scalar in meters

Top hat width along y-axis, specified as the comma-separated pair consisting of `'TopHatWidth'` and a scalar in meters.

Example: `'TopHatWidth',4`

Data Types: `double`

`'FeedOffset'` — Signed distance from center along length and width of ground plane

[0 0] (default) | two-element vector

Signed distance from center along length and width of ground plane, specified as the comma-separated pair of `'FeedOffset'` and a two-element vector.

Example: `'FeedOffset',[2 1]`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface

design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

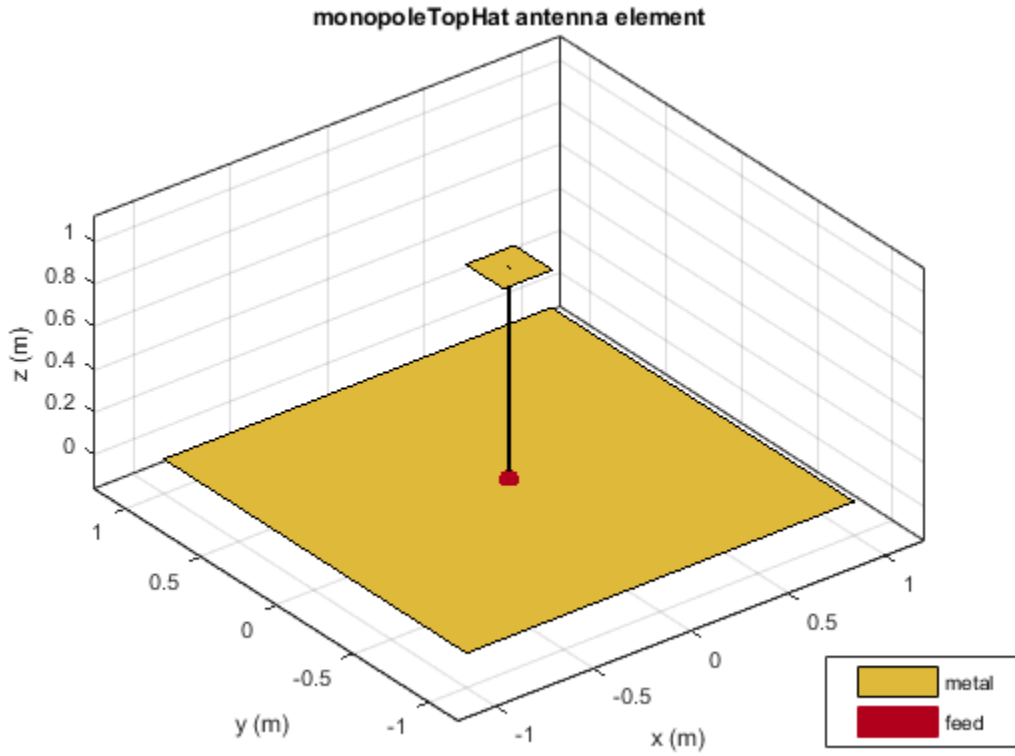
Examples

Create and View Top Hat Monopole.

Create and view a top hat monopole with 1 m length, 0.01 m width, groundplane dimensions 2mx2m and top hat dimensions 0.25mx0.25m.

```
th = monopoleTopHat
show(th)
```

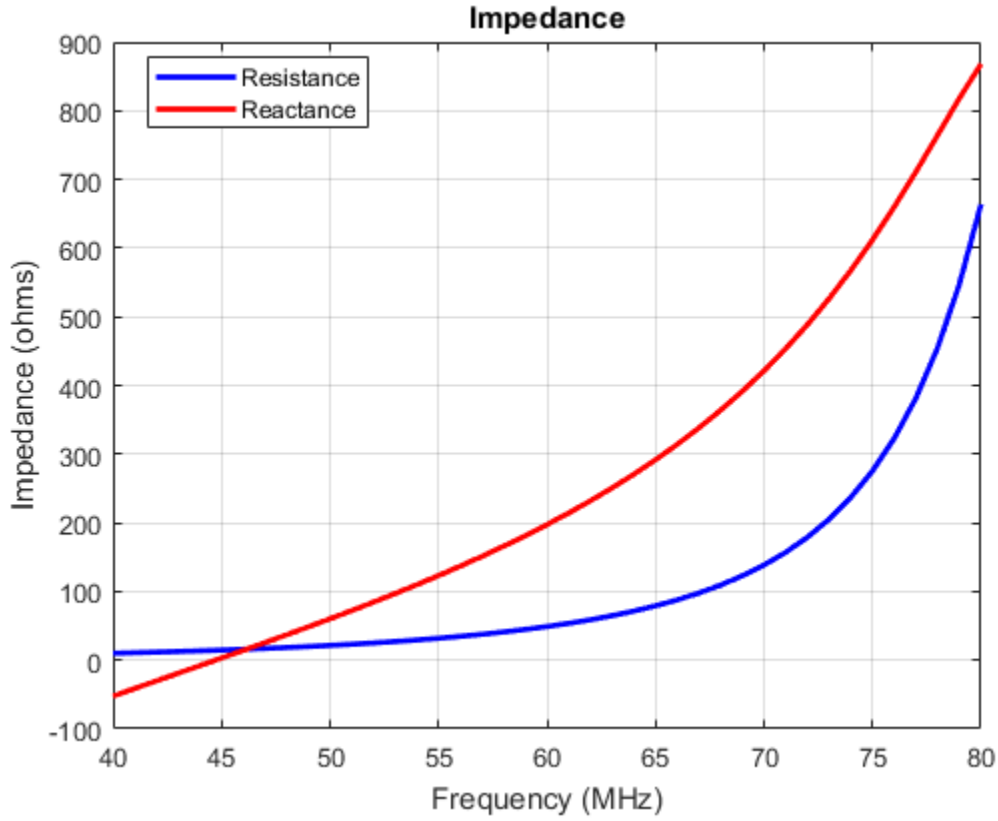
```
th =

  monopoleTopHat with properties:

              Height: 1
               Width: 0.0100
    GroundPlaneLength: 2
     GroundPlaneWidth: 2
         TopHatLength: 0.2500
          TopHatWidth: 0.2500
           FeedOffset: [0 0]
                 Tilt: 0
            TiltAxis: [1 0 0]
                 Load: [1×1 lumpedElement]
```



Calculate Impedance of Top Hat Monopole Antenna

Calculate and plot the impedance of a top hat monopole over a frequency range of 40MHz-80MHz.

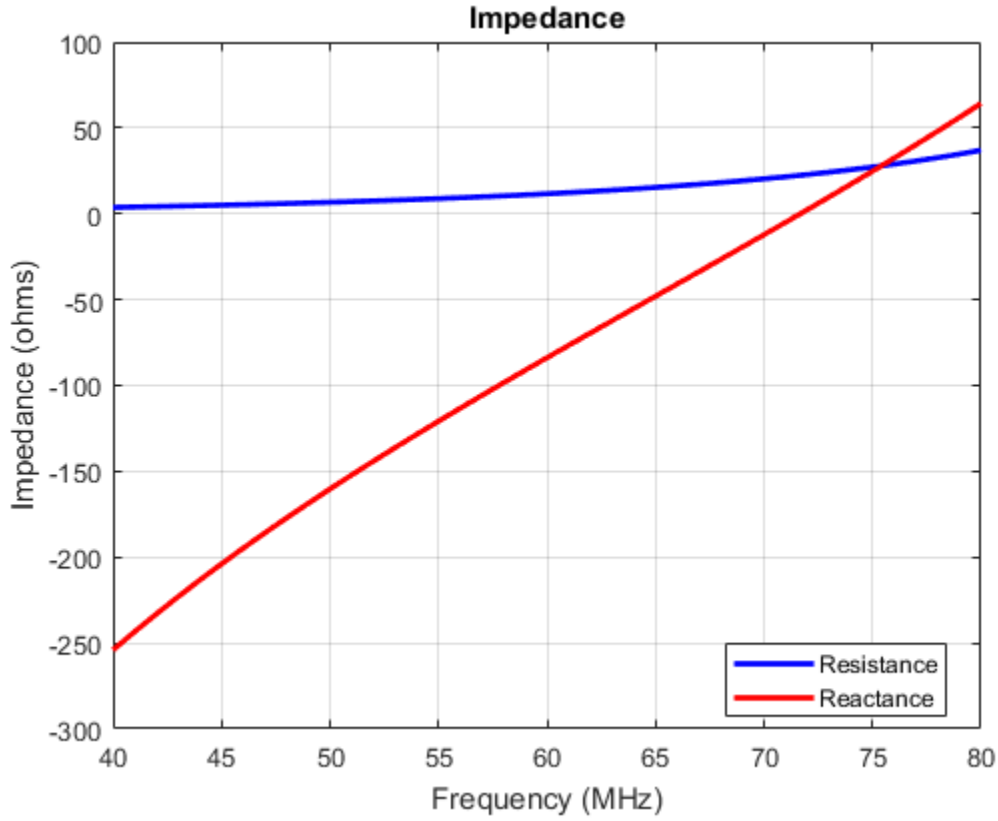
```
th = monopoleTopHat;
impedance(th,linspace(40e6,80e6,41));
```



Compare Impedance of Top Hat Monopole Antenna and Monopole Antenna

Impedance comparison between a monopole of similar dimensions and the top hat monopole in example 2.

```
m = monopole;
figure
impedance(m,linspace(40e6,80e6,41));
```



References

[1] Balanis, C.A. *Antenna Theory. Analysis and Design*, 3rd Ed. New York: Wiley, 2005.

[2] Volakis, John. *Antenna Engineering Handbook*, 4th Ed. New York: Mcgraw-Hill, 2007.

See Also

See Also

dipole | monopole | patchMicrostrip

Topics

"Rotate Antenna and Arrays"

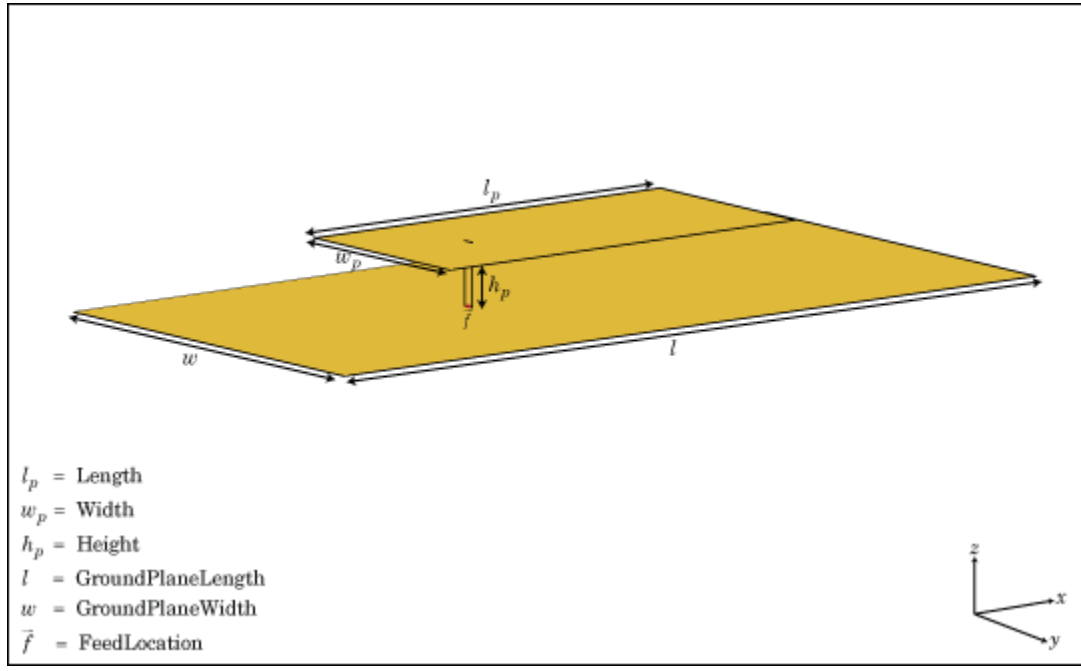
Introduced in R2015a

patchMicrostrip

Create microstrip patch antenna

Description

The `patchMicrostrip` object is a microstrip patch antenna. The default patch is centered at the origin. The feed point is along the length of the antenna.



Create Object

`pm = patchMicrostrip` creates a microstrip patch antenna.

`pm = patchMicrostrip(Name,Value)` creates a microstrip patch antenna, with additional properties specified by one or more name-value pair arguments. `Name` is the

property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'Length'` — Patch length along x-axis

0.0750 (default) | scalar in meters

Patch length, specified as the comma-separated pair consisting of `'Length'` and a scalar in meters. By default, the length is measured along the x-axis.

Example: `'Length',50e-3`

Data Types: `double`

`'Width'` — Patch width along the y-axis

0.0375 (default) | scalar in meters

Patch width, specified as the comma-separated pair consisting of `'Width'` and a scalar in meters. By default, the width is measured along the y-axis.

Example: `'Width',60e-3`

Data Types: `double`

`'Height'` — Height of substrate

0.0060 (default) | scalar in meters

Height of substrate, specified as the comma-separated pair consisting of `'Height'` and a scalar in meters.

Example: `'Height',37e-3`

Data Types: `double`

`Substrate` — Type of dielectric material

'Air' (default) | dielectric material object handle | dielectric material from dielectric catalog

Type of dielectric material used as a substrate, specified as the comma-separated pair consisting of `'Substrate'` and dielectric material object handle or dielectric material

from dielectric catalog. For more information refer, `dielectric`. For more information on dielectric substrate meshing, refer “Meshing”.

Note: The substrate dimensions must be lesser than the groundplane dimensions.

Example: `'Substrate','FR4'`

`'GroundPlaneLength'` — Ground plane length along x-axis

0.1500 (default) | scalar in meters

Ground plane length, specified as the comma-separated pair consisting of `'GroundPlaneLength'` and a scalar in meters. By default, ground plane length is measured along x-axis. Setting `'GroundPlaneLength'` to `Inf`, uses the infinite ground plane technique for antenna analysis.

Example: `'GroundPlaneLength',120e-3`

Data Types: `double`

`'GroundPlaneWidth'` — Ground plane width along y-axis

0.0750 (default) | scalar in meters

Ground plane width, specified as the comma-separated pair consisting of `'GroundPlaneWidth'` and a scalar in meters. By default, ground plane width is measured along y-axis. Setting `'GroundPlaneWidth'` to `Inf`, uses the infinite ground plane technique for antenna analysis.

Example: `'GroundPlaneWidth',120e-3`

Data Types: `double`

`'PatchCenterOffset'` — Signed distance from center along length and width of ground plane

[0 0] (default) | two-element vector in meters

Signed distance from center along length and width of ground plane, specified as the comma-separated pair consisting of `'PatchCenterOffset'` and a two-element vector in meters. Use this property to adjust the location of the patch relative to the ground plane.

Example: `'PatchCenterOffset',[0.01 0.01]`

Data Types: `double`

'FeedOffset' — Signed distance from center along length and width of ground plane

[–0.0187 0] (default) | two-element vector in meters

Signed distance from center along length and width of ground plane, specified as the comma-separated pair of 'FeedOffset' and a two-element vector. Use this property to adjust the location of the feedpoint relative to ground plane and patch.

Example: 'FeedOffset',[0.01 0.01]

Data Types: double

'Load' — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of 'Load' and a lumped element object handle. For more information, see lumpedElement.

Example: 'Load',lumpedelement. lumpedelement is the object handle for the load created using lumpedElement.

'Tilt' — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of 'Tilt' and a scalar or vector in degrees.

Example: 'Tilt',90

Example: 'Tilt',[90 90 0]

Data Types: double

'TiltAxis' — Tilt axis of antenna

[1 0 0] (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | 'X' | 'Y' | 'Z'

Tilt axis of the antenna, specified as the comma-separated pair consisting of 'TiltAxis' and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

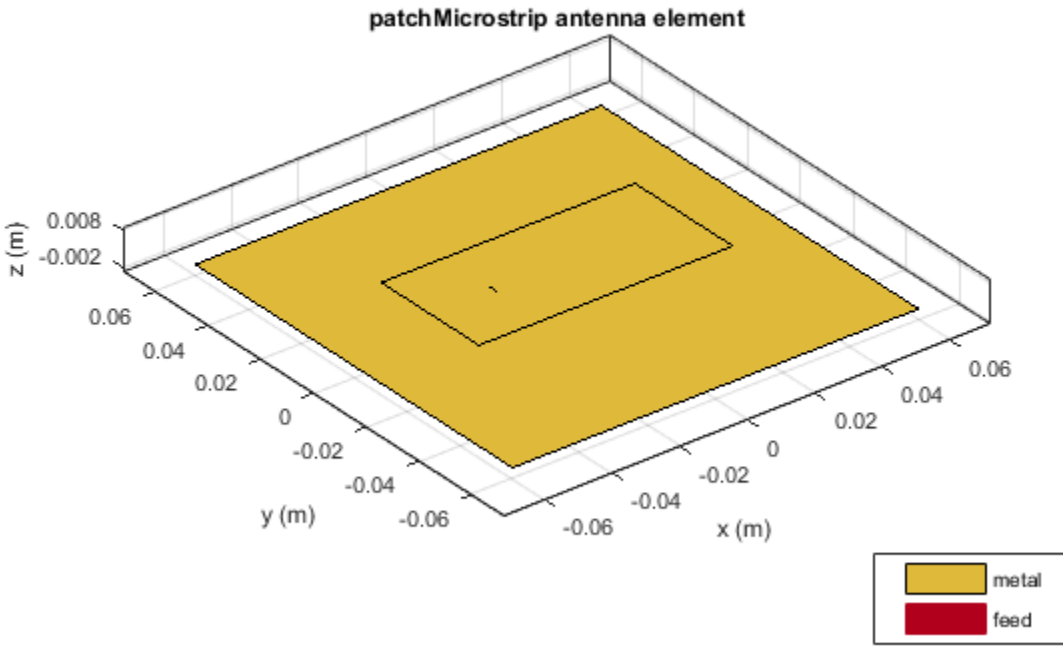
Examples

Create and View Microstrip Patch Antenna

Create and view a microstrip patch that has 75 mm length and 37.5 mm width over a 120 mm x 120 mm ground plane.

```
pm = patchMicrostrip('Length',75e-3, 'Width',37e-3,                ...
        'GroundPlaneLength',120e-3, 'GroundPlaneWidth',120e-3)

show (pm)
```

```
pm =

  patchMicrostrip with properties:

              Length: 0.0750
               Width: 0.0370
              Height: 0.0060
           Substrate: [1×1 dielectric]
    GroundPlaneLength: 0.1200
     GroundPlaneWidth: 0.1200
    PatchCenterOffset: [0 0]
          FeedOffset: [-0.0187 0]
                Tilt: 0
            TiltAxis: [1 0 0]
                Load: [1×1 lumpedElement]
```



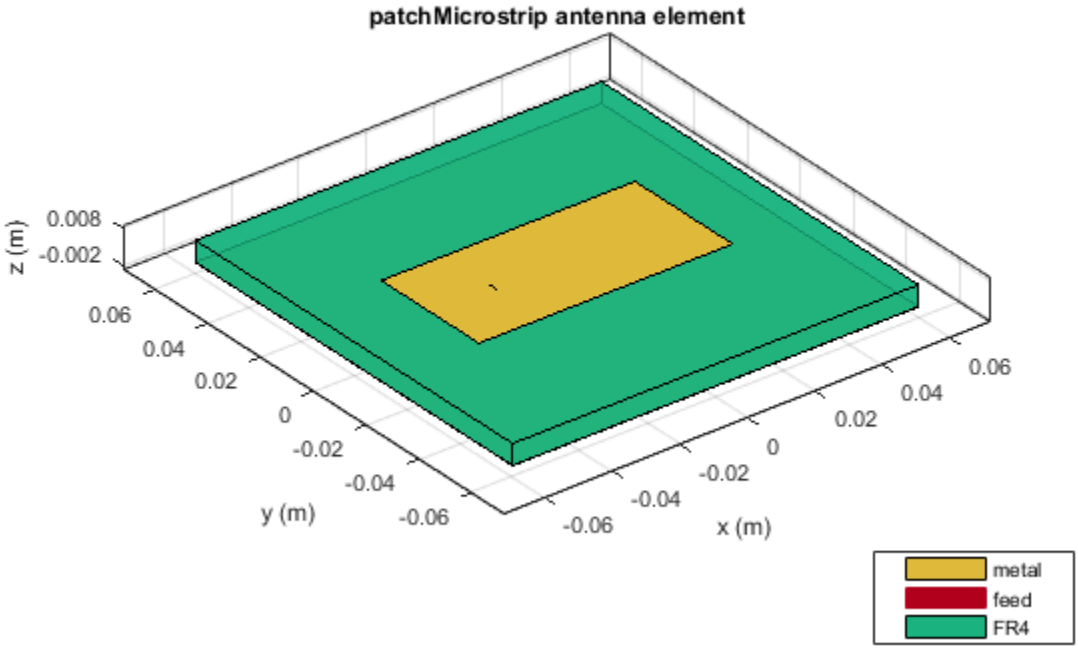
Radiation Pattern of Microstrip Patch Antenna

Create a microstrip patch antenna using **'FR4'** as the dielectric substrate.

```
d = dielectric('FR4');
pm = patchMicrostrip('Length',75e-3, 'Width',37e-3,                  ...
        'GroundPlaneLength',120e-3, 'GroundPlaneWidth',120e-3, ...
        'Substrate',d)
show(pm)
```

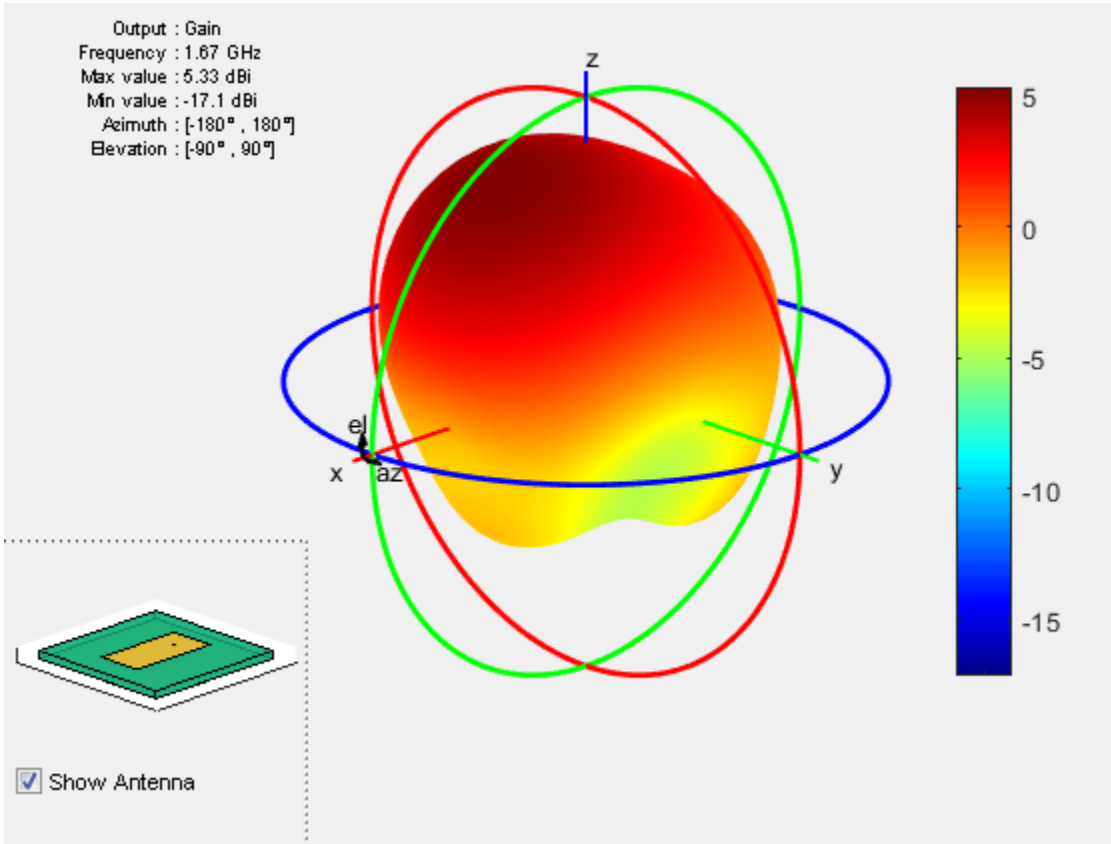
```
pm =

  patchMicrostrip with properties:
```

```
            Length: 0.0750
             Width: 0.0370
            Height: 0.0060
         Substrate: [1×1 dielectric]
GroundPlaneLength: 0.1200
 GroundPlaneWidth: 0.1200
PatchCenterOffset: [0 0]
       FeedOffset: [-0.0187 0]
             Tilt: 0
          TiltAxis: [1 0 0]
             Load: [1×1 lumpedElement]
```



Plot the radiation pattern of the antenna at a frequency of 1.67 GHz.

```
figure
pattern(pm,1.67e9)
```



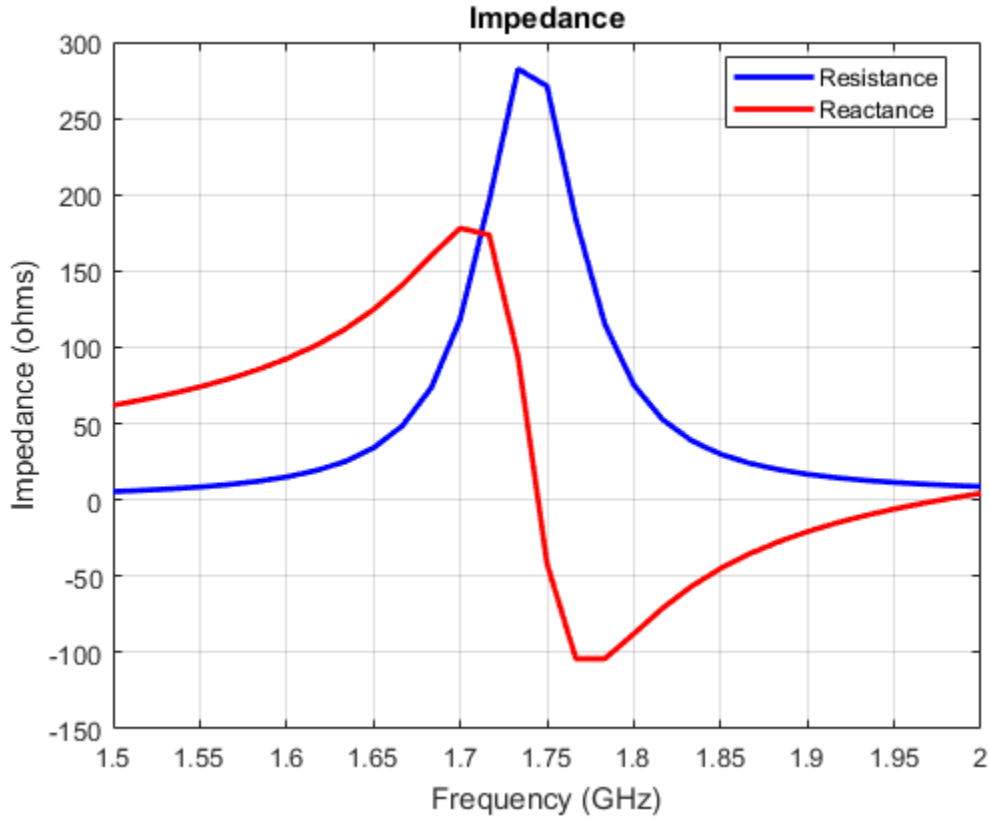
Impedance of Microstrip Patch Antenna

Calculate and plot the impedance of a microstrip patch antenna over a frequency range of 1.5-2 GHz.

```
pm = patchMicrostrip
impedance(pm,linspace(1.5e9,2e9,31));
```

```
pm =

  patchMicrostrip with properties:
```

```
           Length: 0.0750
            Width: 0.0375
           Height: 0.0060
        Substrate: [1×1 dielectric]
GroundPlaneLength: 0.1500
 GroundPlaneWidth: 0.0750
PatchCenterOffset: [0 0]
       FeedOffset: [-0.0187 0]
             Tilt: 0
         TiltAxis: [1 0 0]
             Load: [1×1 lumpedElement]
```



References

[1] Balanis, C.A. *Antenna Theory. Analysis and Design*, 3rd Ed. New York: Wiley, 2005.

See Also

See Also

pifa | vivaldi | yagiUda

Topics

"Rotate Antenna and Arrays"

Introduced in R2015a

planeWaveExcitation

Create plane wave excitation environment for antenna or array

Description

The `planeWaveExcitation` object creates an environment where a plane wave excites an antenna or array. Plane wave excitation is a scattering solution that solves the receiving antenna problem. By default, the antenna element is a dipole. The dipole is excited using a plane wave that travels along the positive x-axis having a z-polarization.

Create Object

`h = planeWaveExcitation` creates an environment where a plane wave excites the antenna or array. By default, the plane wave excites a dipole antenna.

`h = planeWaveExcitation(Name,Value)` returns a `planeWaveExcitation` environment, with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'Element'` — Antenna or array element

`dipole` (default) | object handle

Antenna or array element, specified as the comma-separated pair consisting of `'Element'` and an object handle.

Example: `'Element',linearArray`

`'Direction'` — Incidence of plane wave

`[1 0 0]` (default) | three-element real vector

Incidence of plane wave, specified as the comma-separated pair consisting of `'Direction'` and a three-element real vector.

Example: `'Direction',[0 0 1]`

Data Types: `double`

`'Polarization'` — Polarization of incident electric field

`[0 0 1]` (default) | three-element complex vector

Polarization of incident electric field in *x*, *y*, and *z* components, specified as the comma-separated pair consisting of `'Polarization'` and a three-element complex vector.

Example: `'Polarization',[0 1 0]`

Data Types: `double`

Object Functions

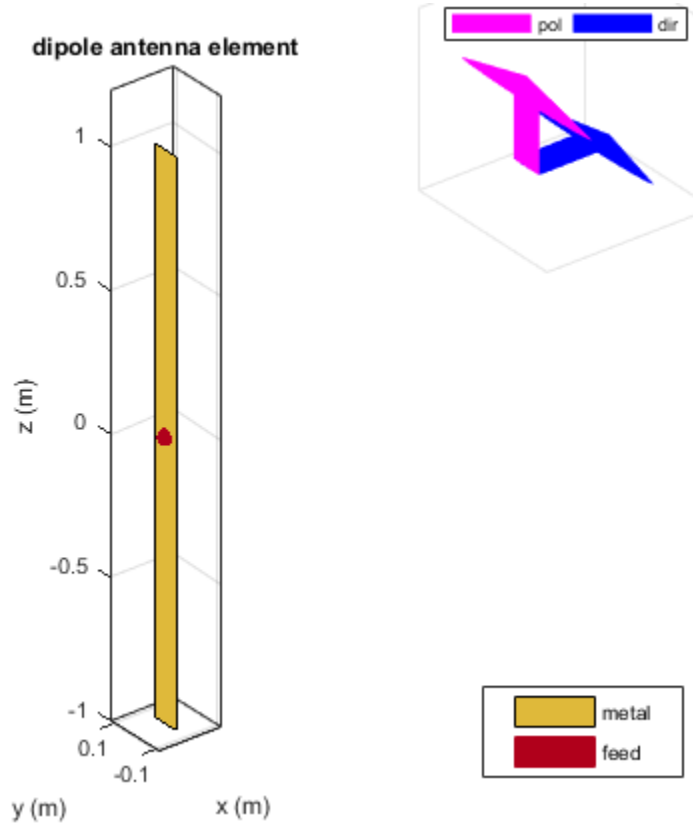
axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
EHfields	Electric and magnetic fields of antennas
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
show	Display antenna or array structure

Examples

Default Plane Wave Excitation

Excite a dipole antenna using a plane wave and view it.

```
h = planeWaveExcitation;
show(h)
```



The blue arrow shows the direction of propagation of the plane wave. By default, the direction is along the x-axis. The pink arrow shows polarization of the plane wave. By default, the polarization is perpendicular to the direction of propagation i.e along the z-axis.

Feed Current of Antenna Excited By Plane Wave.

Excite a dipole antenna using plane wave. Calculate the feed current at 70 MHz.

```
h = planeWaveExcitation
cur = feedcurrent(h, 70e6)
```

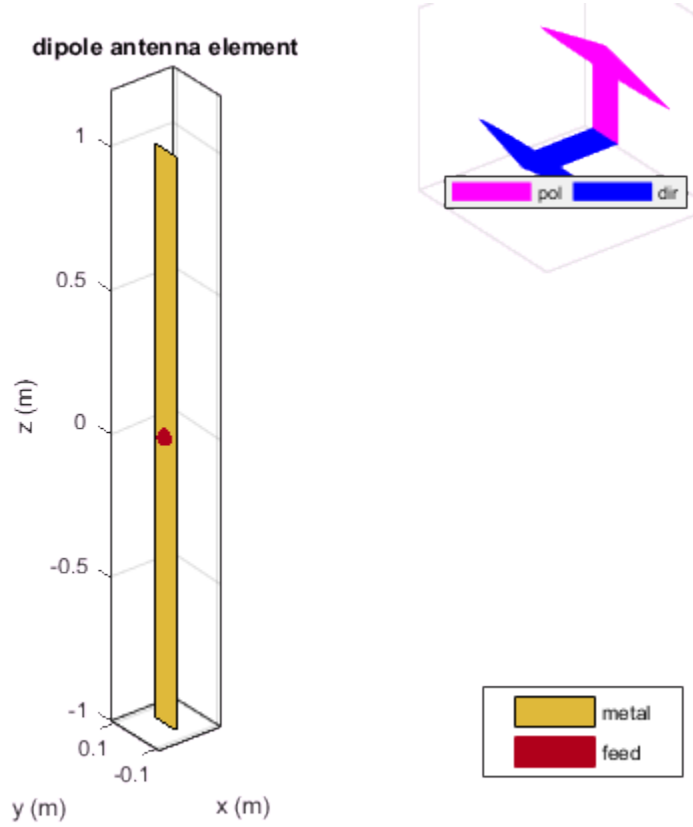
```
h =
```

```
  planeWaveExcitation with properties:

         Element: [1×1 dipole]
       Direction: [1 0 0]
    Polarization: [0 0 1]


cur =

   0.0181 - 0.0033i
```

Current Distribution On Antenna

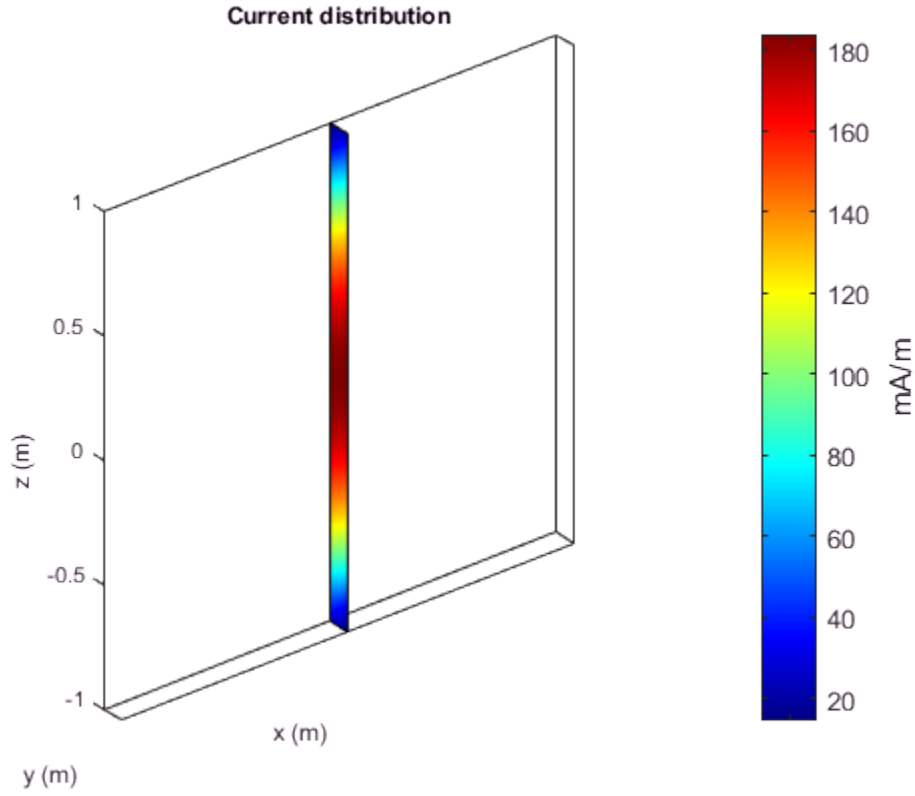
Excite a dipole antenna using a plane wave. The polarization of the wave is along the z-axis and the direction of propagation is along the negative x-axis. View the antenna.

```
p = planeWaveExcitation('Element', dipole, 'Direction', [-1 0 0], 'Polarization', [0 0
show(p);
```



Plot the current distribution on the dipole antenna at 70 MHz.

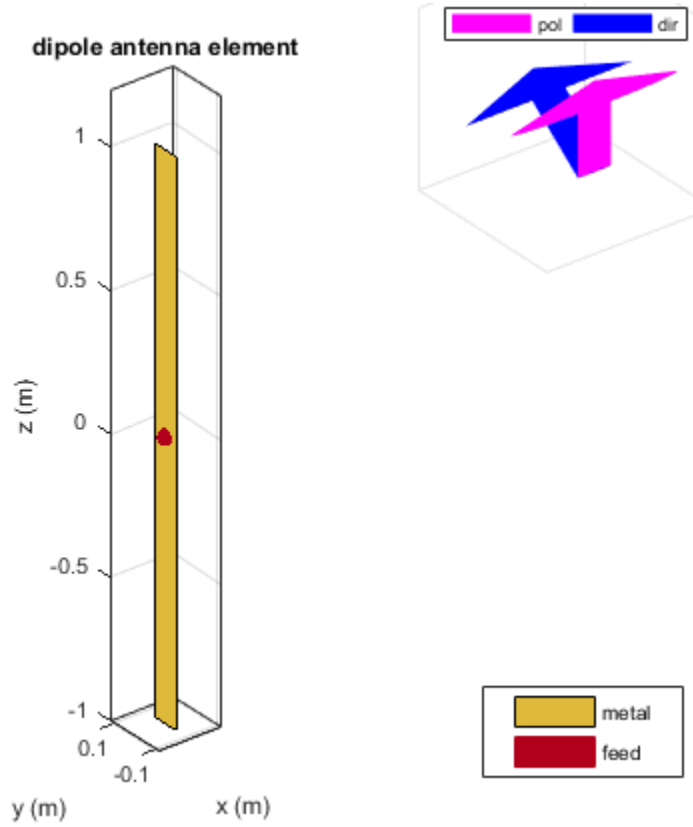
```
current(p, 70e6);
```



Antenna Excited By Plane Wave In Arbitary Direction

Consider a dipole excited by a plane wave.

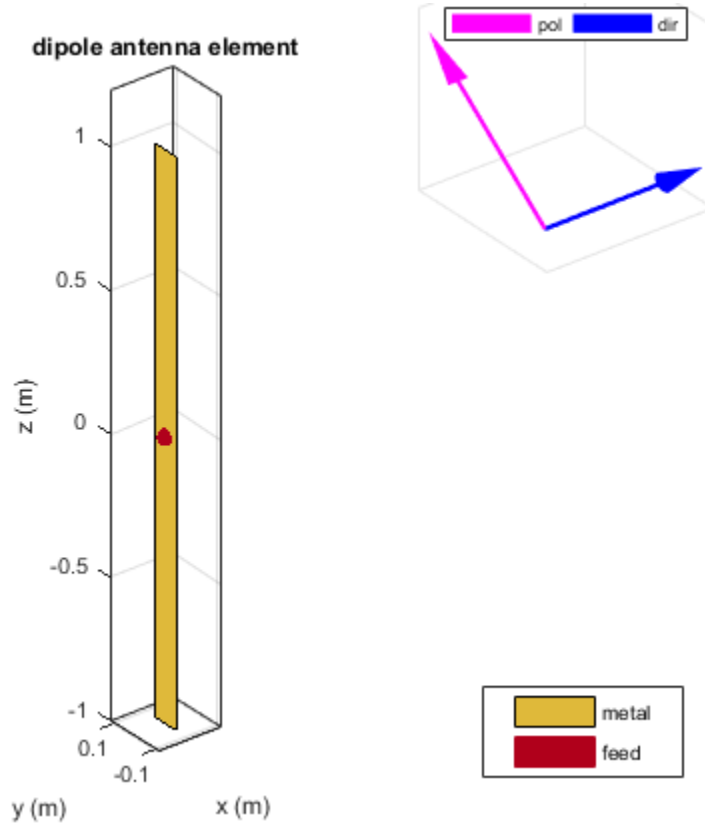
```
p = planeWaveExcitation;
p.Direction = [0 1 1];
show(p)
```



If you use the above option, any analysis of this antenna will error out as the polarization and direction vector are not orthogonal to each other.

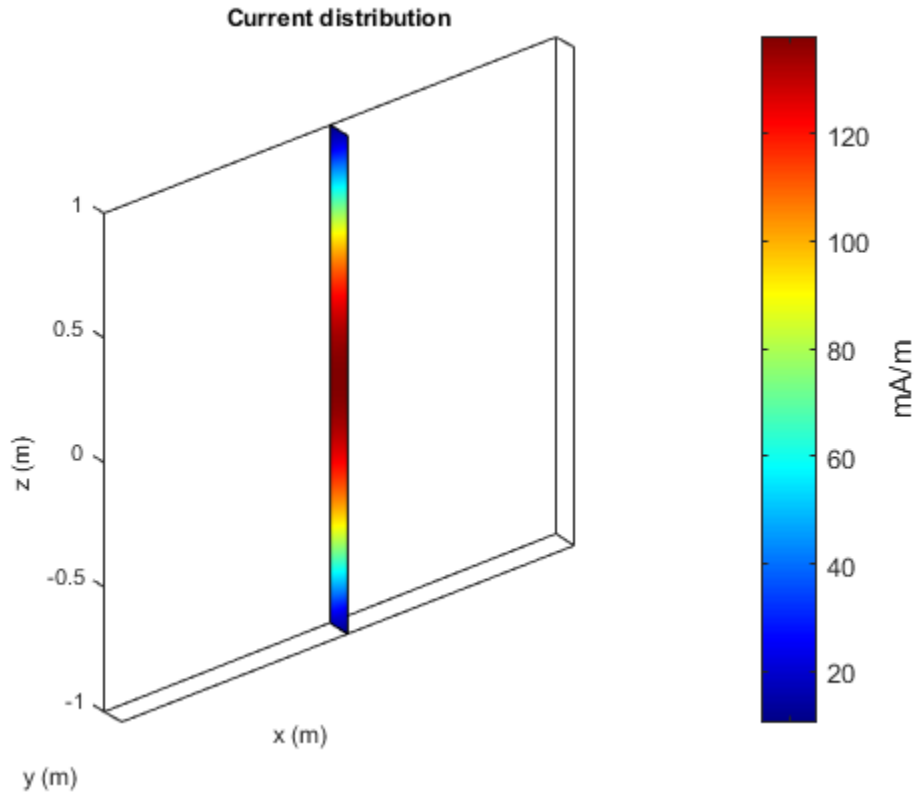
Use the cross product function to find the approprate polarization direction of such a wave.

```
p = planeWaveExcitation;
p.Polarization = cross(p.Direction, [0 1 1]);
show(p);
```



Calculate the current distribution of the antenna.

```
current(p,75e6);
```



References

[1] Balanis, C. A. *Antenna Theory. Analysis and Design*. 3rd Ed. Hoboken, NJ: John Wiley & Sons, 2005.

See Also

See Also

dipole | linearArray

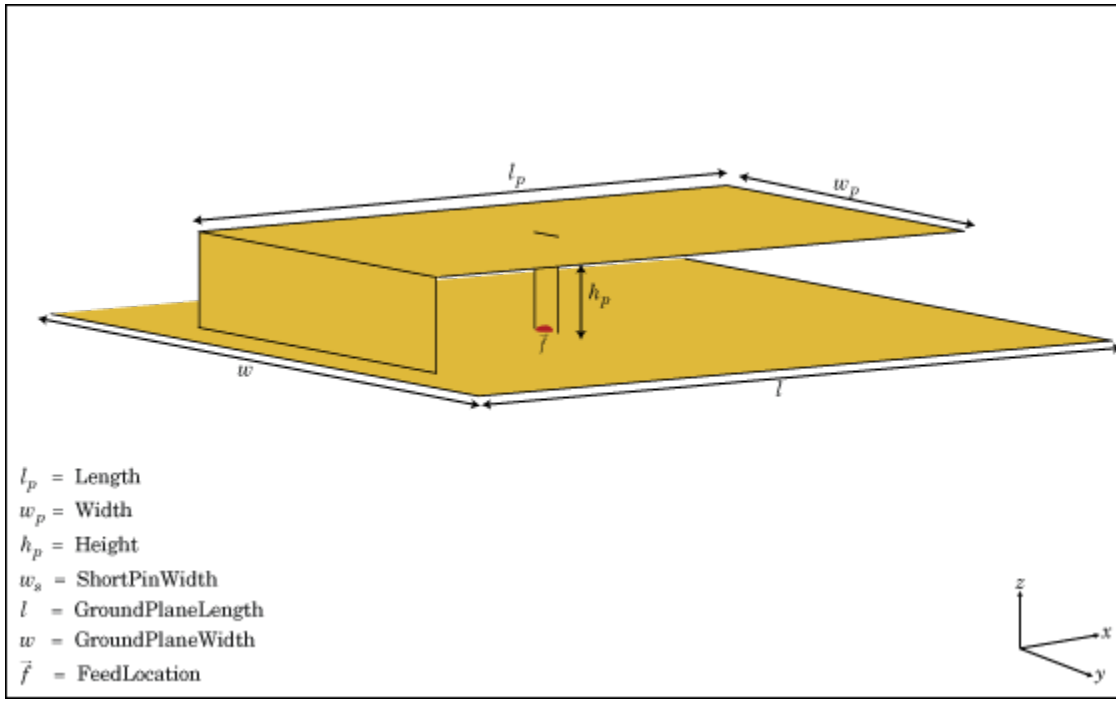
Introduced in R2017a

pifa

Create planar inverted-F antenna

Description

The `pifa` object is a planar inverted-F antenna. The default PIFA antenna is centered at the origin. The feed point is along the length of the antenna.



Create Object

`pf = pifa` class to create a planar inverted-F antenna.

`pf = pifa(Name,Value)` class to create a planar inverted-F antenna, with additional properties specified by one, or more name-value pair arguments. `Name` is the property

name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'Length'` — PIFA antenna length

0.0300 (default) | scalar in meters

PIFA antenna length, specified as the comma-separated pair consisting of `'Length'` and a scalar in meters. By default, the length is measured along the x-axis.

Example: `'Length',75e-3`

Data Types: `double`

`'Width'` — PIFA antenna width

0.0200 (default) | scalar in meters

PIFA antenna width, specified as the comma-separated pair consisting of `'Width'` and a scalar in meters. By default, the width is measured along the y-axis.

Example: `'Width',35e-3`

Data Types: `double`

`'Height'` — Height of substrate

0.0100 (default) | scalar in meters

Height of the substrate, specified as the comma-separated pair consisting of `'Height'` and a scalar in meters.

Example: `'Height',37e-3`

Data Types: `double`

`Substrate` — Type of dielectric material

'Air' (default) | dielectric material object handle | dielectric material from dielectric catalog

Type of the dielectric material used as a substrate, specified as the comma-separated pair consisting of `'Substrate'` and dielectric material object handle or dielectric material from dielectric catalog. For more information refer, `dielectric`. For more information on dielectric substrate meshing, refer “Meshing”.

Example: `'Substrate','FR4'`

`'GroundPlaneLength'` — Ground plane length

0.0360 (default) | scalar in meters

Ground plane length, specified as the comma-separated pair consisting of `'GroundPlaneLength'` and a scalar in meters. By default, ground plane length is measured along the x-axis. Setting `'GroundPlaneLength'` to `Inf`, uses the infinite ground plane technique for antenna analysis.

Example: `'GroundPlaneLength',3`

Data Types: `double`

`'GroundPlaneWidth'` — Ground plane width

0.0360 (default) | scalar in meters

Ground plane width, specified as the comma-separated pair consisting of `'GroundPlaneWidth'` and a scalar in meters. By default, ground plane width is measured along the y-axis. Setting `'GroundPlaneWidth'` to `Inf`, uses the infinite ground plane technique for antenna analysis.

Example: `'GroundPlaneWidth',2.5`

Data Types: `double`

`'PatchCenterOffset'` — Signed distance from center along length and width of ground plane

[0 0] (default) | two-element vector in meters

Signed distance from the center along length and width of the ground plane, specified as the comma-separated pair consisting of `'PatchCenterOffset'` and a two-element vector in meters. Use this property to adjust the location of the patch relative to the ground plane.

Example: `'PatchCenterOffset',[0.01 0.01]`

Data Types: `double`

`'ShortPinWidth'` — Shorting pin width of patch

0.0200 (default) | scalar in meters

Shorting pin width of patch, specified as the comma-separated pair consisting of `'ShortPinWidth'` and a scalar in meters. By default, the shorting pin width is measured along the y-axis.

Example: `'ShortPinWidth',3`

Data Types: `double`

`'FeedOffset'` — Signed distance of feedpoint from origin

[–0.0020 0] (default) | two-element vector in meters

Signed distance from center along length and width of ground plane, specified as the comma-separated pair of `'FeedOffset'` and a two-element vector. Use this property to adjust the location of the feedpoint relative to ground plane and patch.

Example: `'FeedOffset',[0.01 0.01]`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.

- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

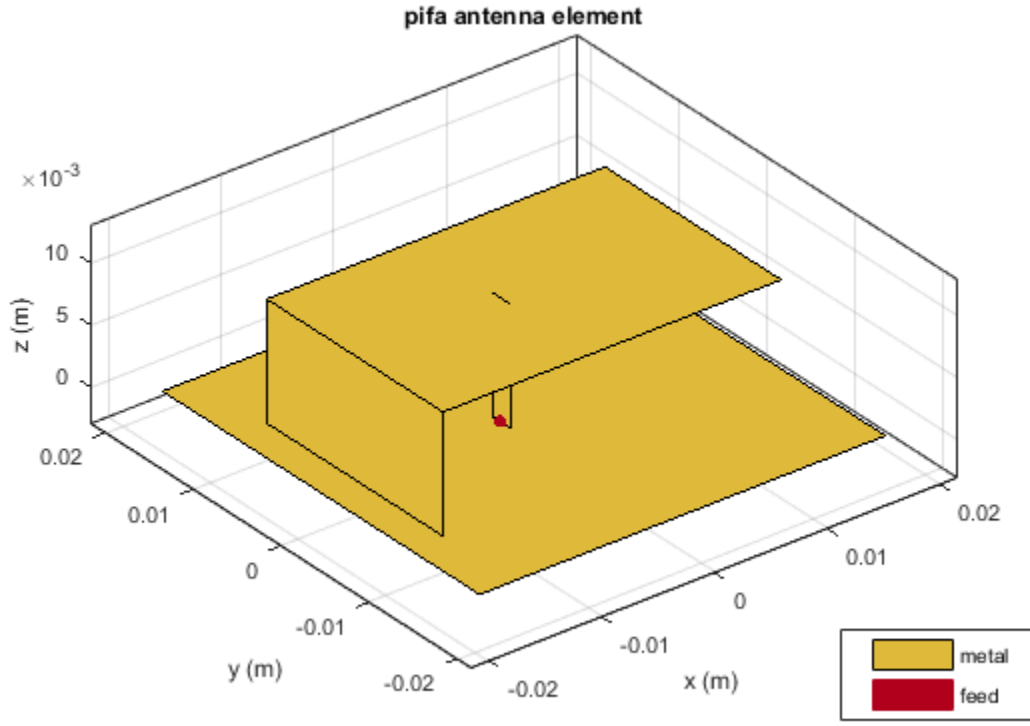
Examples

Create and View Planar Inverted-F Antenna(PIFA) Antenna

Create and view a PIFA antenna with 30mm length, 20mm width over a 35mm x 35mm ground plane, and feedpoint at (-2mm,0,0).

```
pf = pifa
show(pf)
```

```
pf =

  pifa with properties:

              Length: 0.0300
               Width: 0.0200
              Height: 0.0100
           Substrate: [1×1 dielectric]
    GroundPlaneLength: 0.0360
     GroundPlaneWidth: 0.0360
    PatchCenterOffset: [0 0]
        ShortPinWidth: 0.0200
           FeedOffset: [-0.0020 0]
                 Tilt: 0
            TiltAxis: [1 0 0]
                Load: [1×1 lumpedElement]
```



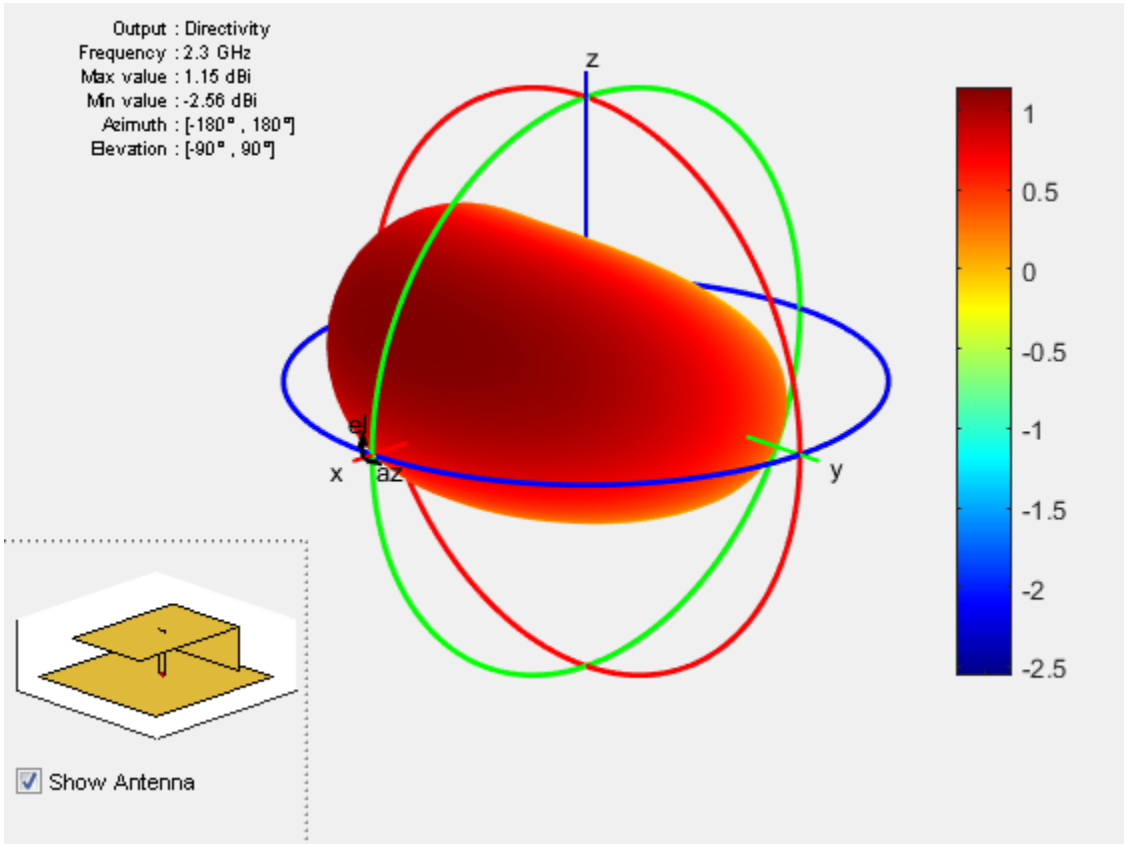
Radiation Pattern of PIFA Antenna

Plot the radiation pattern of a PIFA antenna at a frequency of 2.3 GHz.

```
pf = pifa('Length',30e-3, 'Width',20e-3, 'GroundPlaneLength',35e-3,...
         'GroundPlaneWidth',35e-3)
pattern(pf,2.3e9);
```

```
pf =

  pifa with properties:

              Length: 0.0300
               Width: 0.0200
```

```
           Height: 0.0100
        Substrate: [1×1 dielectric]
GroundPlaneLength: 0.0350
 GroundPlaneWidth: 0.0350
PatchCenterOffset: [0 0]
    ShortPinWidth: 0.0200
       FeedOffset: [-0.0020 0]
             Tilt: 0
         TiltAxis: [1 0 0]
             Load: [1×1 lumpedElement]
```



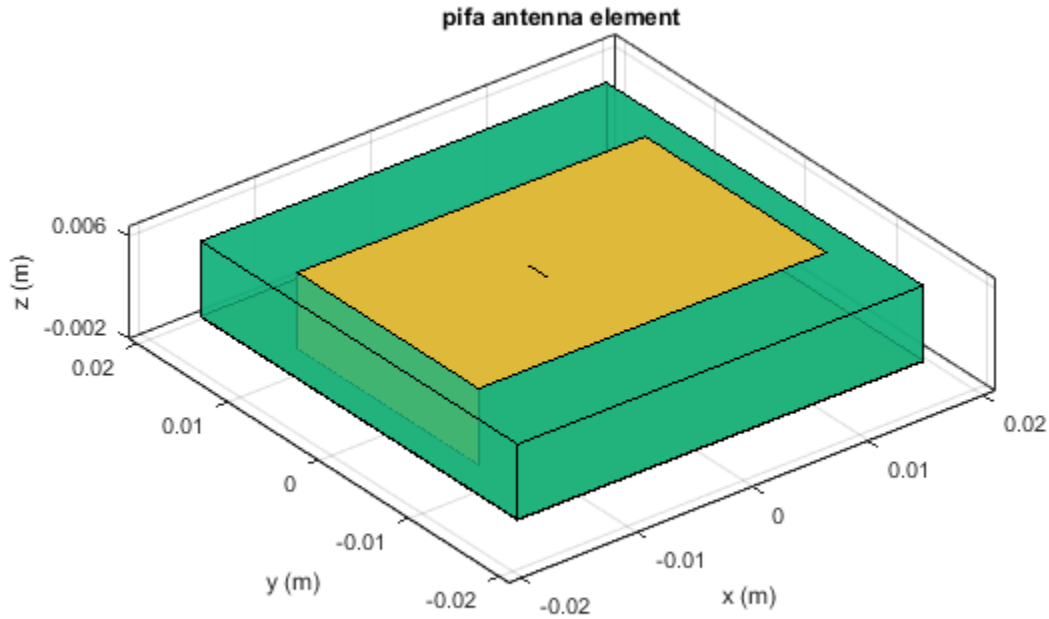
Impedance of PIFA Antenna

Create a PIFA antenna using a dielectric substrate **'RO4725JXR'**.

```
d = dielectric('RO4725JXR');
pf = pifa('Length',30e-3, 'Width',20e-3,'Height',0.0060, 'GroundPlaneLength',35e-3, ...
          'GroundPlaneWidth', 35e-3,'Substrate',d)
show(pf)
```

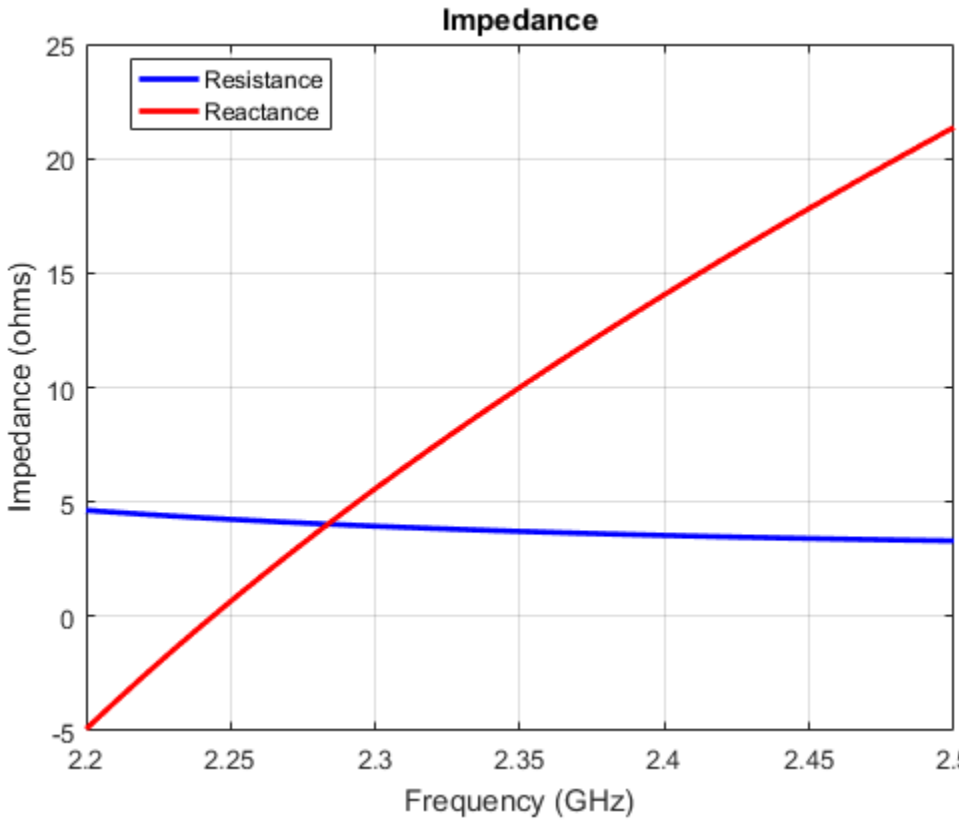
```
pf =

  pifa with properties:
```

```
            Length: 0.0300
             Width: 0.0200
            Height: 0.0060
         Substrate: [1x1 dielectric]
GroundPlaneLength: 0.0350
 GroundPlaneWidth: 0.0350
PatchCenterOffset: [0 0]
    ShortPinWidth: 0.0200
       FeedOffset: [-0.0020 0]
             Tilt: 0
         TiltAxis: [1 0 0]
```



Calculate the impedance of the antenna over a frequency range of 2-2.6 GHz.

```
impedance(pf,linspace(2.2e9,2.5e9,31));
```



References

[1] Balanis, C.A. *Antenna Theory. Analysis and Design*, 3rd Ed. New York: Wiley, 2005.

See Also

See Also

invertedF | invertedL | patchMicrostrip

Topics

"Rotate Antenna and Arrays"

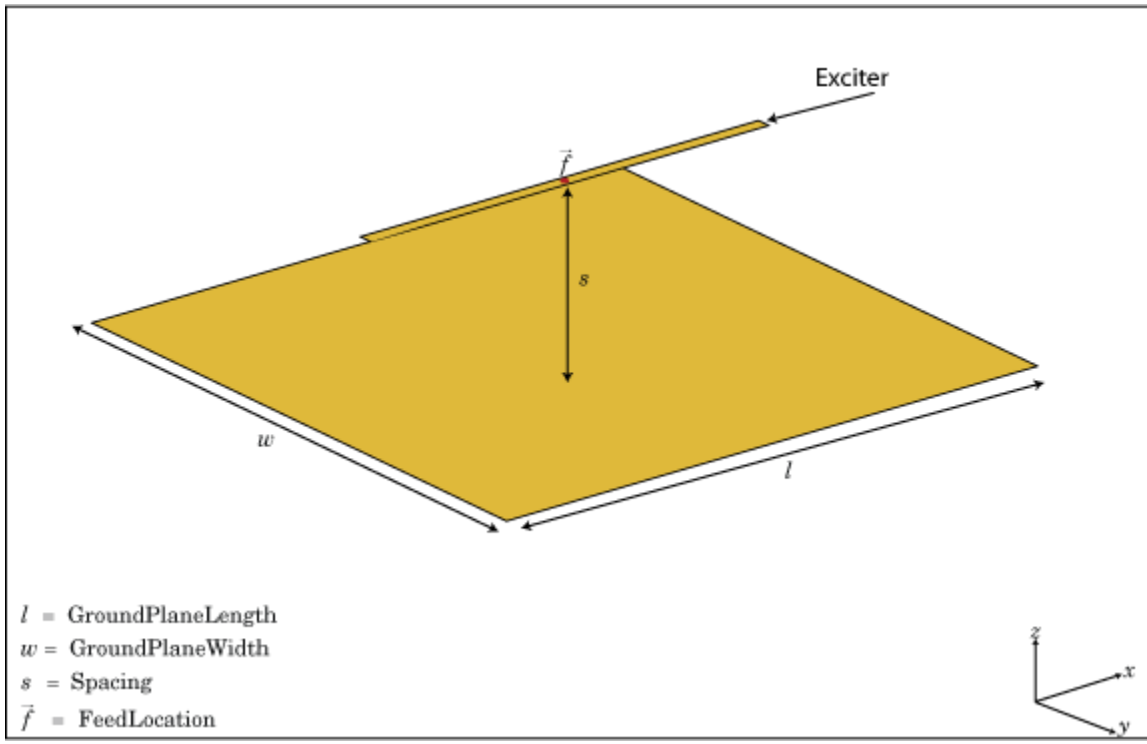
Introduced in R2015a

reflector

Create reflector-backed antenna

Description

The `reflector` object is a reflector-backed antenna on the X-Y-Z plane. The default reflector antenna uses a dipole as an exciter. The feed point is on the exciter.



Create Object

`rf = reflector` creates a reflector backed antenna located in the X-Y-Z plane. By default, dimensions are chosen for an operating frequency of 1 GHz.

`rf = reflector(Name,Value)` creates a reflector backed antenna, with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'Exciter'` — Antenna type used as exciter

`dipole` (default) | antenna element handle or antenna element

Antenna type used as an exciter, specified as the comma-separated pair consisting of `'Exciter'` and an antenna element handle or antenna element. Except reflector and cavity antenna elements, you can use all the single elements in the Antenna Toolbox as an exciter.

Example: `'Exciter',dipole`

`Substrate` — Type of dielectric material

'Air' (default) | dielectric material object handle | dielectric material from dielectric catalog

Type of dielectric material used as a substrate, specified as the comma-separated pair consisting of `'Substrate'` and dielectric material object handle or dielectric material from dielectric catalog. For more information refer, `dielectric`. For more information on dielectric substrate meshing, refer “Meshing”.

Note: The substrate dimensions must be lesser than the groundplane dimensions.

Example: `'Substrate','FR4'`

`'GroundPlaneLength'` — Reflector length along x-axis

0.2000 (default) | scalar in meters

Reflector length along the x-axis, specified as the comma-separated pair consisting of `'GroundPlaneLength'` and a scalar in meters. By default, ground plane length is measured along the x-axis. Setting `'GroundPlaneLength'` to`Inf`, uses the infinite ground plane technique for antenna analysis. You can also set the `'GroundPlaneLength'` to zero.

Example: `'GroundPlaneLength',3`

Data Types: `double`

`'GroundPlaneWidth'` — Reflector width along y-axis

0.2000 (default) | scalar in meters

Reflector width along the y-axis, specified as the comma-separated pair consisting of `'GroundPlaneWidth'` and a scalar in meters. By default, ground plane width is measured along the y-axis. Setting `'GroundPlaneWidth'` to`Inf`, uses the infinite ground plane technique for antenna analysis. You can also set the `'GroundPlaneWidth'` to zero.

Example: `'GroundPlaneWidth',2.5`

Data Types: `double`

`'Spacing'` — Distance between reflector and exciter

0.0750 (default) | scalar in meters

Distance between the reflector and the exciter, specified as the comma-separated pair consisting of `'Spacing'` and a scalar in meters. By default, the exciter is placed along the x-axis.

Example: `'Spacing',7.5e-2`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'EnableProbeFeed'` — Create probe feed from backing structure to exciter

`0` (default) | `1`

Create probe feed from backing structure to exciter, specified as the comma-separated pair consisting of `'EnableProbeFeed'` and `0` or `1`. By default, probe feed is not enabled.

Example: `'EnableProbeFeed',1`

Data Types: `double`

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna

charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

Examples

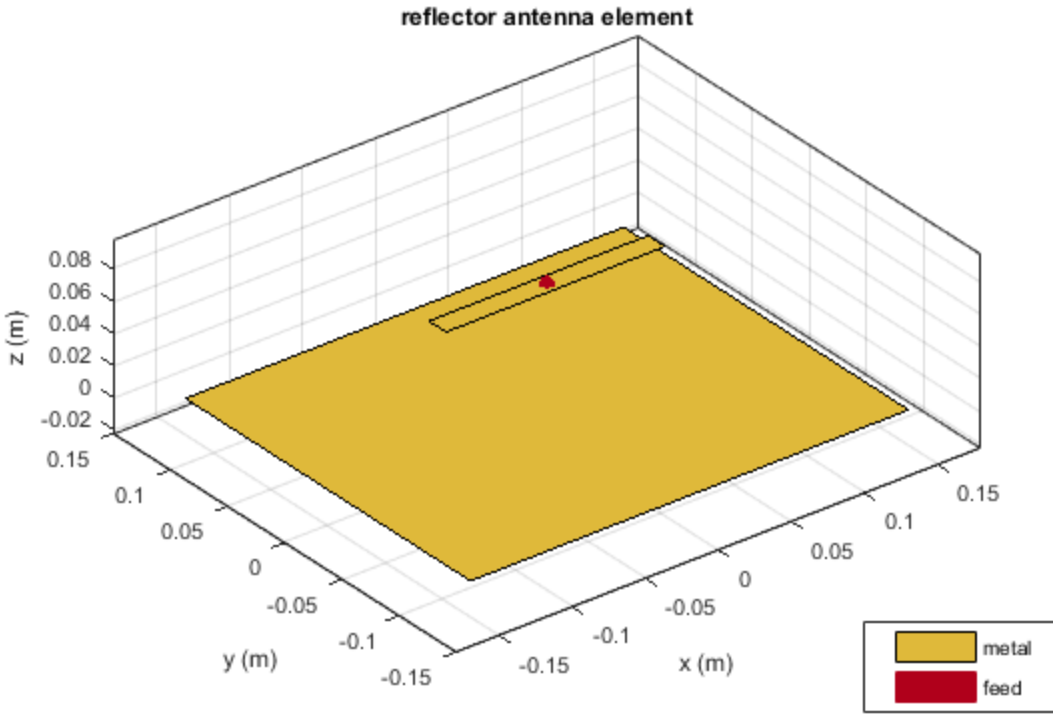
Create and View Reflector-Backed Dipole Antennna

Create a reflector backed dipole that has 30cm length, 25cm width and spaced 7.5cm from the dipole for operation at 1 GHz.

```
d = dipole('Length',0.15,'Width',0.015, 'Tilt',90,'TiltAxis',[0 1 0]);
rf = reflector('GroundPlaneLength',30e-2, 'GroundPlaneWidth',25e-2,...
               'Spacing',7.5e-2);
rf.Exciter = d
show(rf)
```

```
rf =

  reflector with properties:

             Exciter: [1×1 dipole]
           Substrate: [1×1 dielectric]
    GroundPlaneLength: 0.3000
```

```
GroundPlaneWidth: 0.2500
         Spacing: 0.0750
  EnableProbeFeed: 0
            Tilt: 0
        TiltAxis: [1 0 0]
            Load: [1×1 lumpedElement]
```

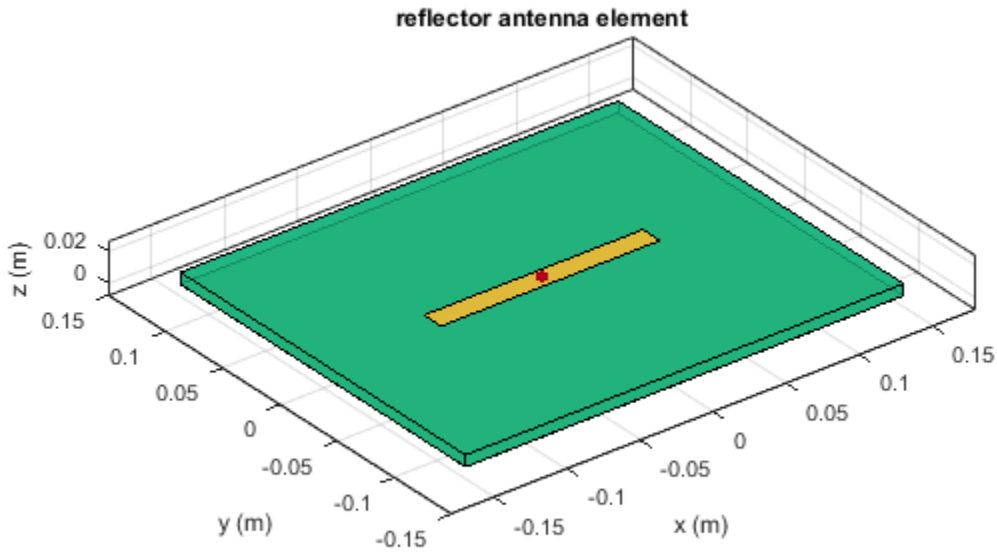


Radiation Pattern of Reflector Backed Antenna

Create a reflector backed dipole antenna using a dielectric substrate **'FR4'**.

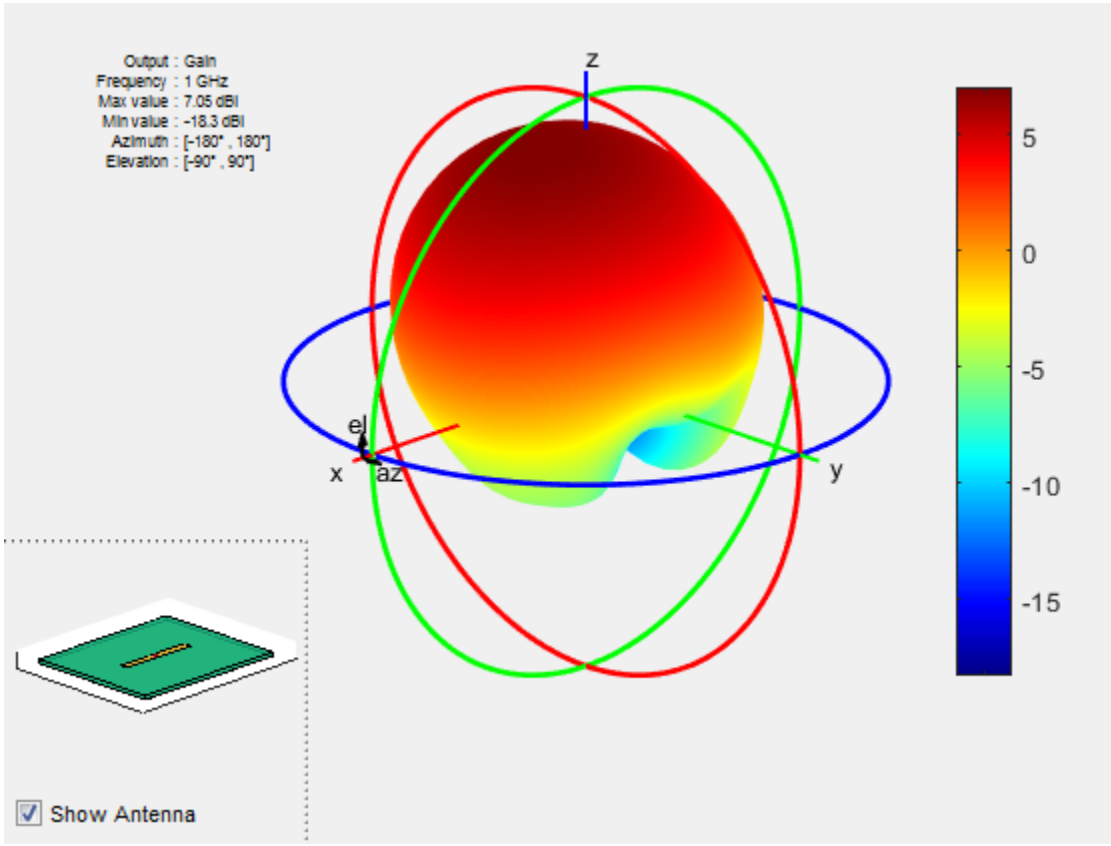
```
d = dielectric('FR4');
```

```
di = dipole('Length',0.15,'Width',0.015, 'Tilt',90,'TiltAxis','Y');
rf = reflector('GroundPlaneLength',30e-2, 'GroundPlaneWidth',25e-2, ...
               'Spacing',7.5e-3,'Substrate',d);
rf.Exciter = di;
show(rf)
```



Plot the radiation pattern of the antena at a frequency of 1 GHz.

```
figure
pattern(rf,1e9)
```



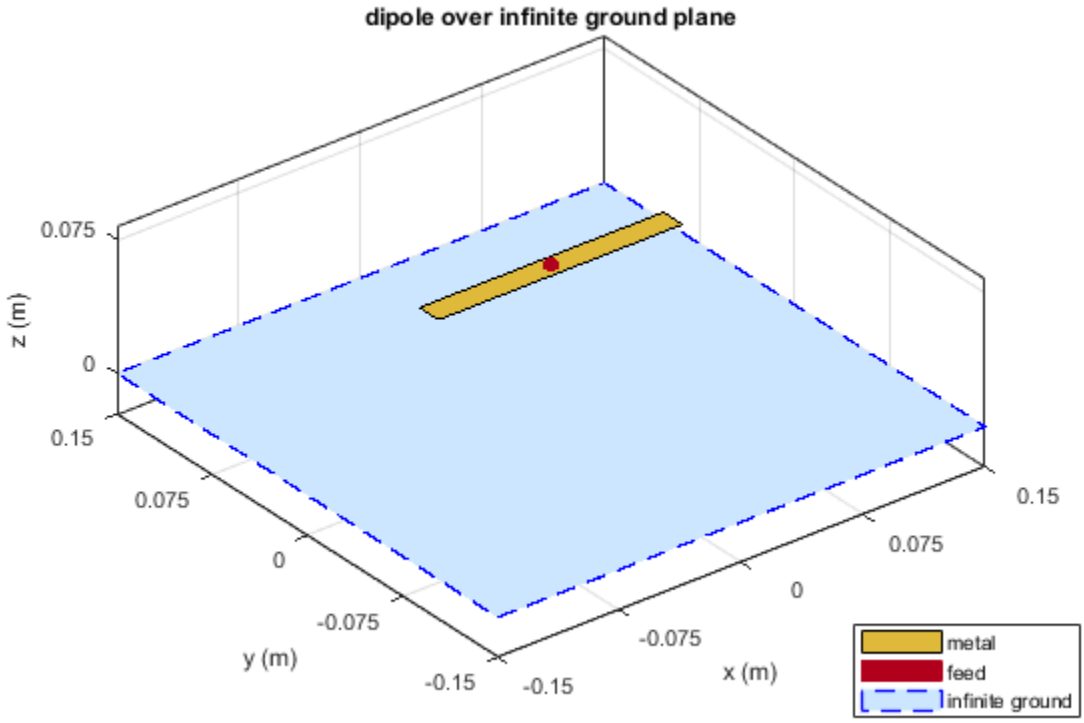
Create Reflector-Backed Antennna Over Infinite Ground Plane

Create a reflector backed dipole that has 30cm length, 25cm width and spaced 7.5cm from the dipole for operation at 1 GHz.

```
d = dipole('Length',0.15,'Width',0.015, 'Tilt',90,'TiltAxis',[0 1 0]);
rf = reflector('GroundPlaneLength',inf, 'GroundPlaneWidth',25e-2,...
               'Spacing',7.5e-2);
rf.Exciter = d
show(rf)
```

```
rf =
```

```
reflector with properties:

            Exciter: [1×1 dipole]
          Substrate: [1×1 dielectric]
  GroundPlaneLength: Inf
   GroundPlaneWidth: 0.2500
            Spacing: 0.0750
    EnableProbeFeed: 0
               Tilt: 0
           TiltAxis: [1 0 0]
               Load: [1×1 lumpedElement]
```



Antenna On Dilectric Substrate - Compare Gain Values

Compare the gain values of a dipole antenna in free space and dipole antenna on a substrate.

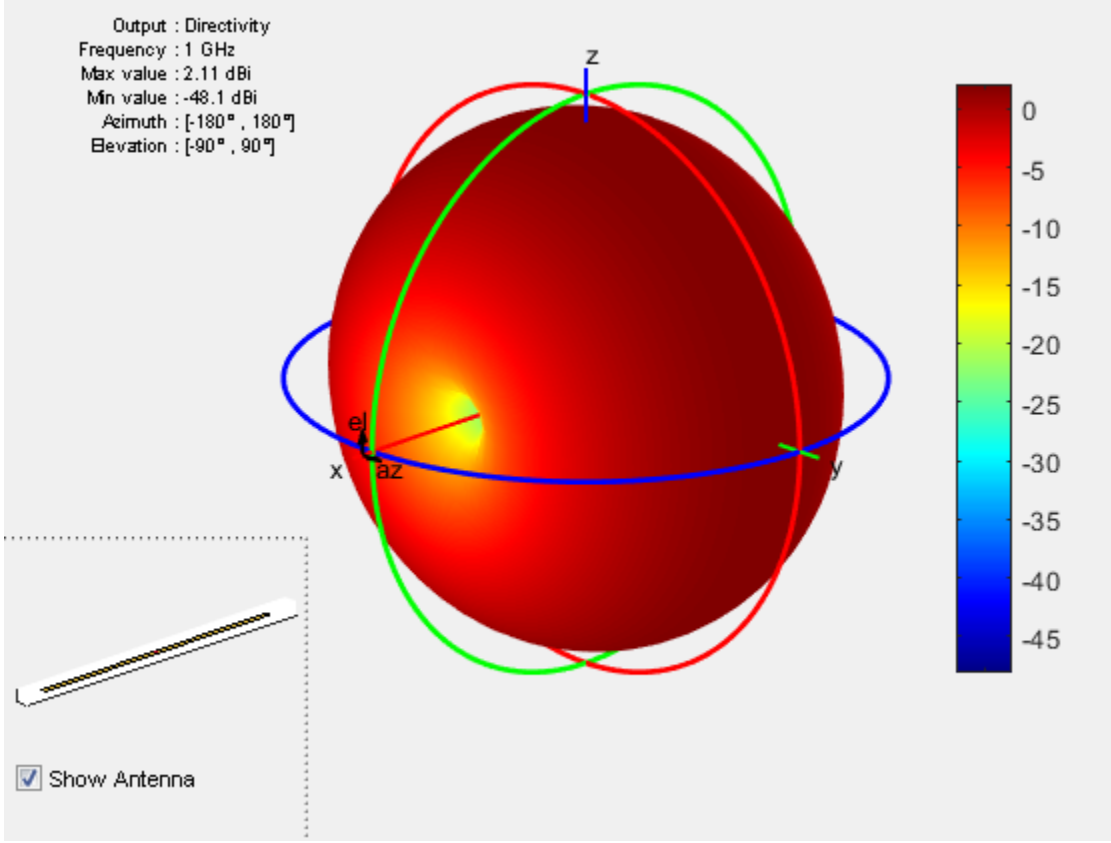
Design a dipole antenna at 1 GHz.

```
d = design(dipole,1e9);
l_by_w = d.Length/d.Width;
d.Tilt = 90;
d.TiltAxis = [0 1 0];
```

Plot the radiation pattern of the dipole in free space at 1GHz.

```
figure
```

```
pattern(d,1e9);
```



Use FR4 as the dielectric substrate.

```
t = dielectric('FR4')
eps_r = t.EpsilonR;
lambda_0 = physconst('lightspeed')/1e9;
lambda_d = lambda_0/sqrt(eps_r);
```

```
t =

  dielectric with properties:
```

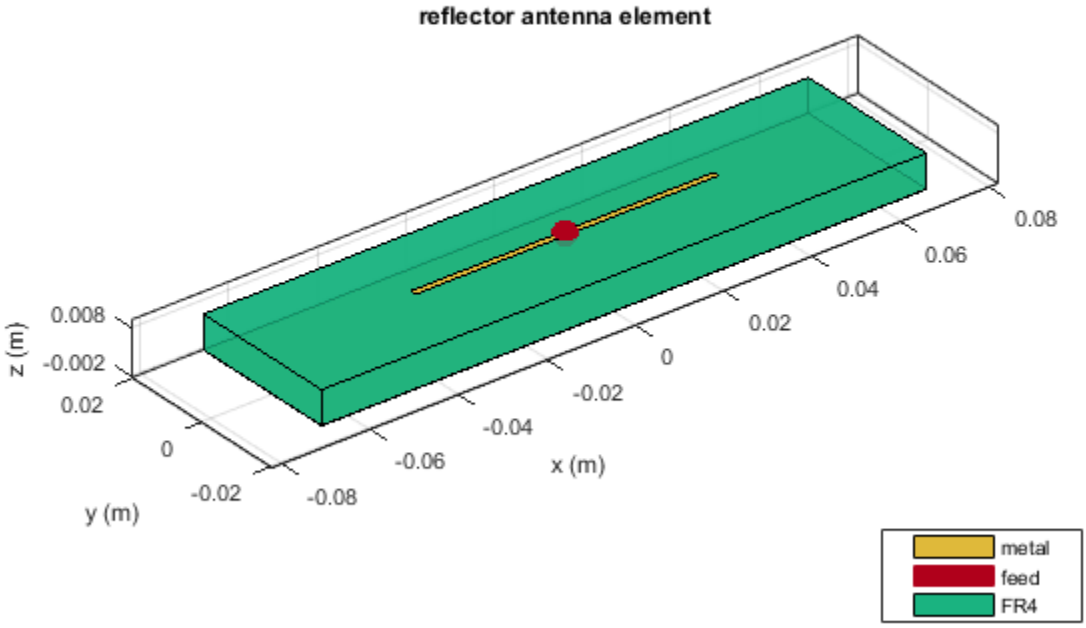
```
            Name: 'FR4'
        EpsilonR: 4.8000
    LossTangent: 0.0260
       Thickness: 0.0060

For more materials see <a href="matlab:openDielectricCatalog">catalog</a>
```

Adjust the length of the dipole based on the wavelength.

```
d.Length = lambda_d/2;
d.Width = d.Length/l_by_w;
```

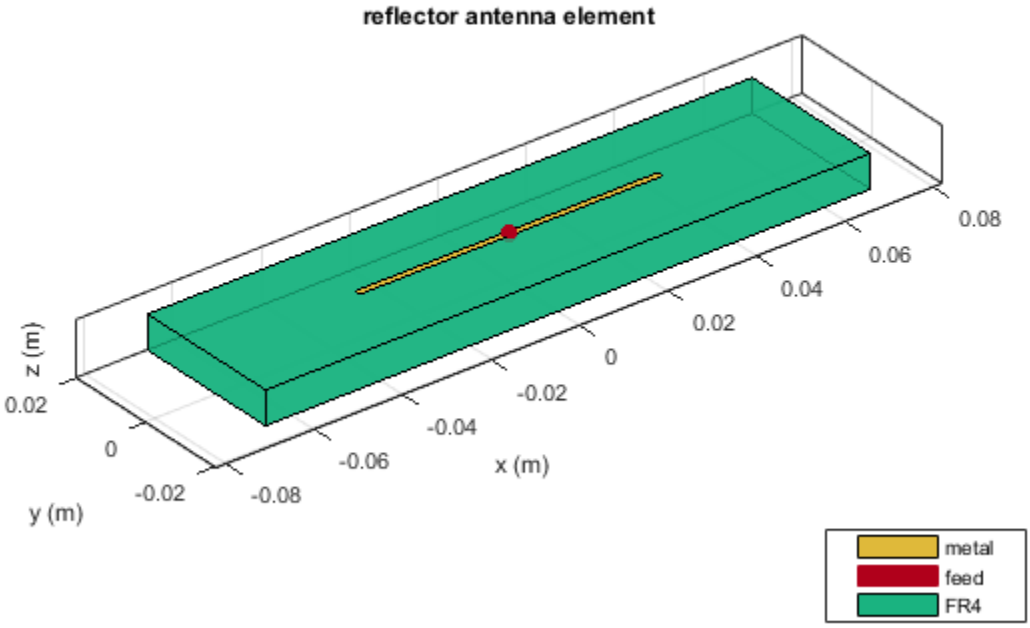
Design a reflector at 1 GHz with the dipole as the excitor and FR4 as the substrate.

```
rf = design(reflector,1e9);
rf = reflector('Exciter',d,'Spacing',7.5e-3,'Substrate',t);
rf.GroundPlaneLength = lambda_d;
rf.GroundPlaneWidth = lambda_d/4;
figure
show(rf)
```



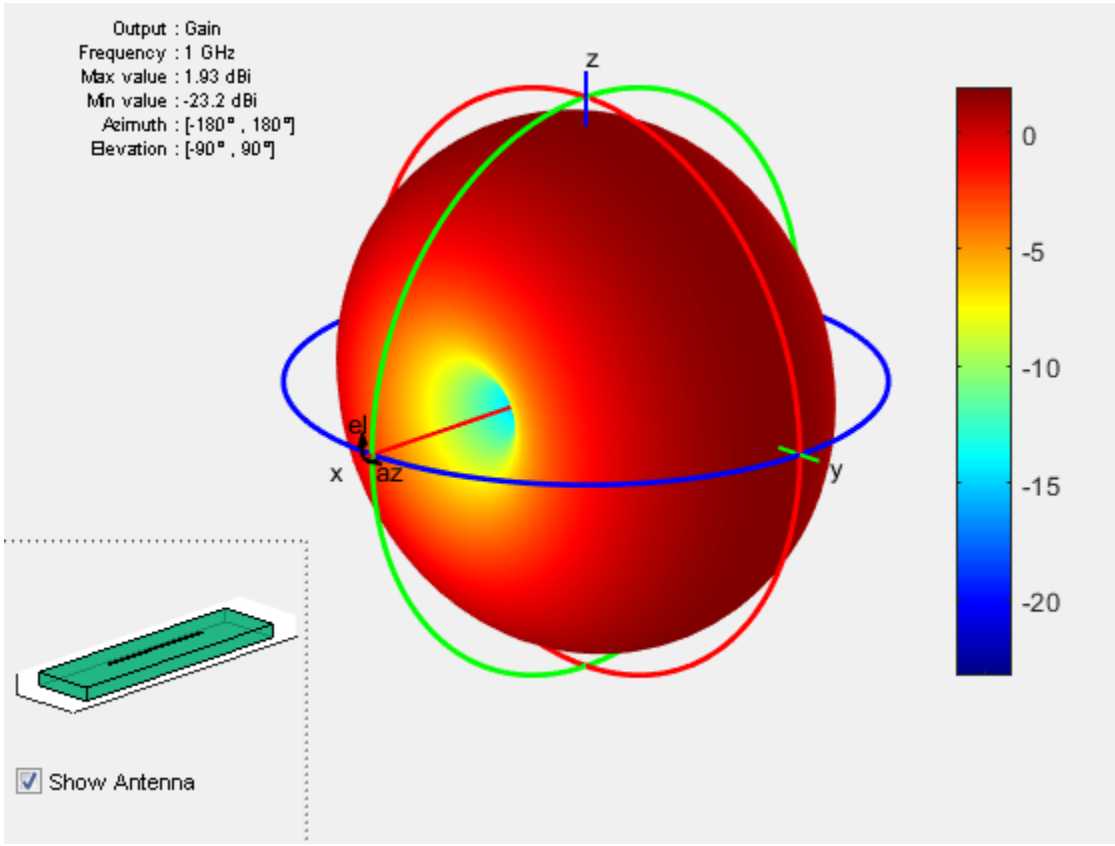
Remove the groundplane for plotting the gain of the dipole on the substrate.

```
rf.GroundPlaneLength = 0;
show(rf)
```



Plot the radiation pattern of the dipole on the substrate at 1 GHz.

```
figure
pattern(rf,1e9);
```



Compare the gain vlaues.

- Gain of the dipole in free space = 2.11 dBi
- Gain of the dipole on substrate = 1.93 dBi

References

[1] Balanis, C.A. *Antenna Theory. Analysis and Design*, 3rd Ed. New York: Wiley, 2005.

See Also

See Also

cavity | spiralArchimedean | spiralEquiangular

Topics

"Rotate Antenna and Arrays"

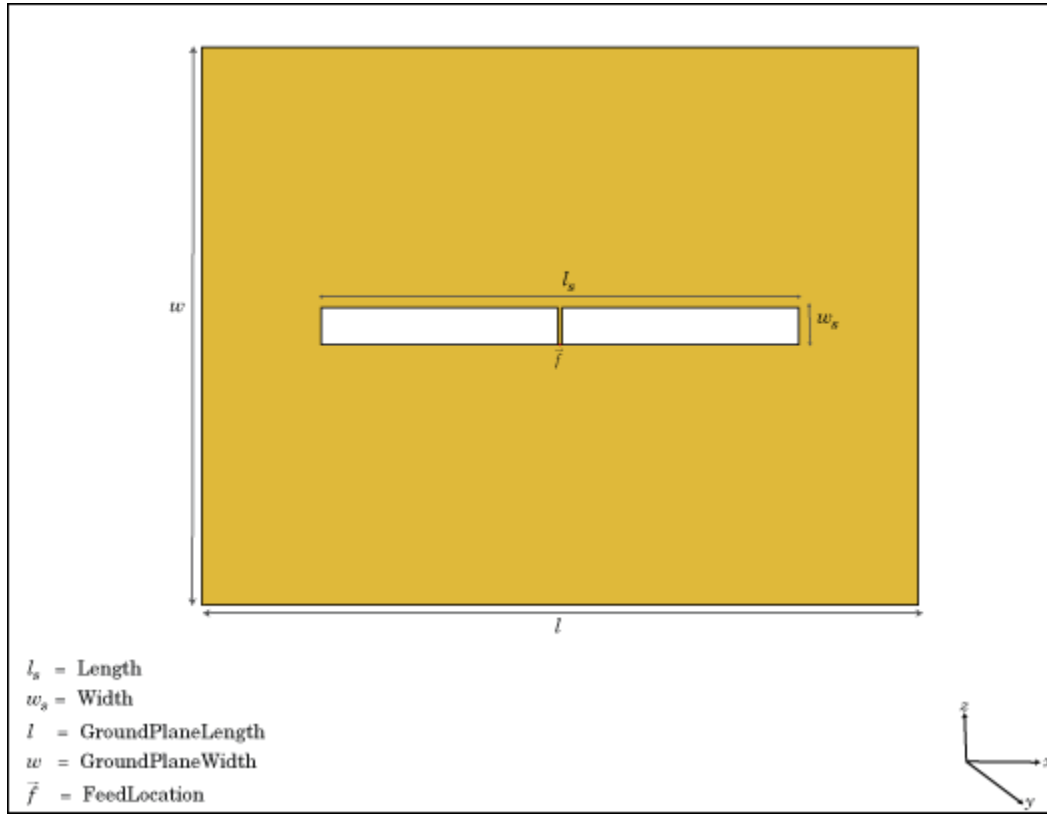
Introduced in R2015a

slot

Create rectangular slot antenna on ground plane

Description

The `slot` object is a rectangular slot antenna on a ground plane. The default slot has its first resonance at 130 MHz.



Create Object

`s = slot` creates a rectangular slot antenna on a ground plane.

`s = slot(Name,Value)` creates a rectangular slot antenna, with additional properties specified by one, or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain default values.

Properties

`'Length'` — Slot length

1 (default) | scalar in meters

Slot length, specified as the comma-separated pair consisting of `'Length'` and a scalar in meters.

Example: `'Length',2`

Data Types: `double`

`'Width'` — Slot width

0.1000 (default) | scalar in meters

Slot width, specified as the comma-separated pair consisting of `'Width'` and a scalar in meters.

Example: `'Width',0.02`

Data Types: `double`

`'SlotCenter'` — Slot antenna center

[0 0 0] (default) | three-element vector in Cartesian coordinates

Slot antenna center, specified as the comma-separated pair consisting of `'SlotCenter'` and a three-element vector in Cartesian coordinates.

Example: `'SlotCenter',[8 0 0]`

Data Types: `double`

`'GroundPlaneLength'` — Ground plane length

1.5000 (default) | scalar in meters

Ground plane length, specified as the comma-separated pair consisting of `'GroundPlaneLength'` and a scalar in meters. By default, the length is measured along the x-axis.

Example: `'GroundPlaneLength',3`

Data Types: `double`

`'GroundPlaneWidth'` — Ground plane width

1.5000 (default) | scalar in meters

Ground plane width, specified as the comma-separated pair consisting of `'GroundPlaneWidth'` and a scalar in meters. By default, the width is measured along the y-axis.

Example: `'GroundPlaneWidth',4`

Data Types: `double`

`'FeedOffset'` — Distance from center along x-axis

0 (default) | scalar in meters

Distance from center along x-axis, specified as the comma-separated pair consisting of `'FeedOffset'` and a scalar in meters. Offset from slot center is measured along the length.

Example: `'FeedOffset',3`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array

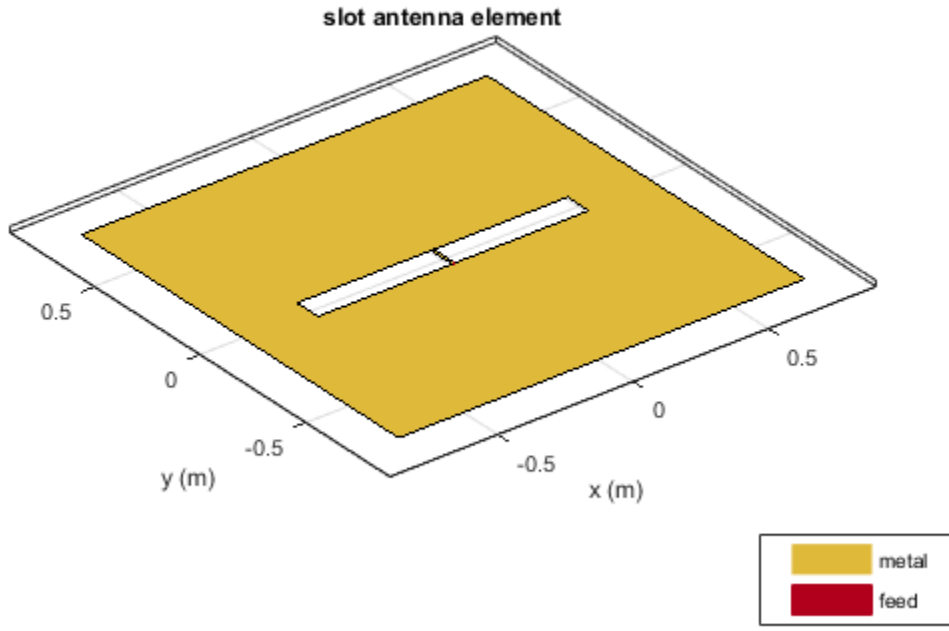
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

Examples

Create and View Slot Antenna

Create and view a slot antenna that has 1m length and 100mm width.

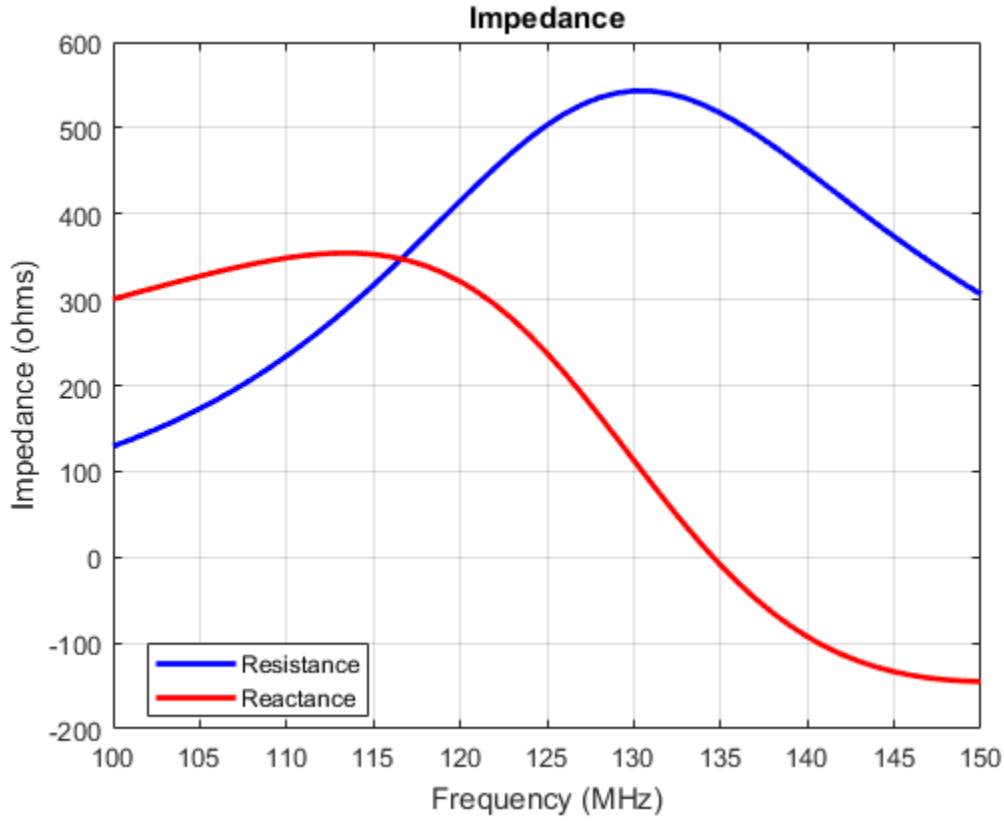
```
s = slot('Length',1,'Width',0.1);
show(s)
```



Impedance of Slot Antenna

Calculate and plot the impedance of a slot antenna over a frequency range of 100-150 MHz.

```
s = slot('Length',1,'Width',0.1);
impedance(s,linspace(100e6,150e6,51));
```



References

[1] Balanis, C.A. *Antenna Theory. Analysis and Design*, 3rd Ed. New York: Wiley, 2005.

See Also

See Also

pifa | vivaldi | yagiUda

Topics

"Rotate Antenna and Arrays"

Introduced in R2015a

spiralArchimedean

Create Archimedean spiral antenna

Description

The `spiralArchimedean` object is a planar Archimedean spiral antenna on the X-Y plane. The Archimedean spiral is always center fed and has two arms. The field characteristics of this antenna are frequency independent. A realizable spiral has finite limits on the feeding region and the outermost point of any arm of the spiral. The spiral antenna exhibits a broadband behavior. The outer radius imposes the low frequency limit and the inner radius imposes the high frequency limit. The arm radius grows linearly as a function of the winding angle.

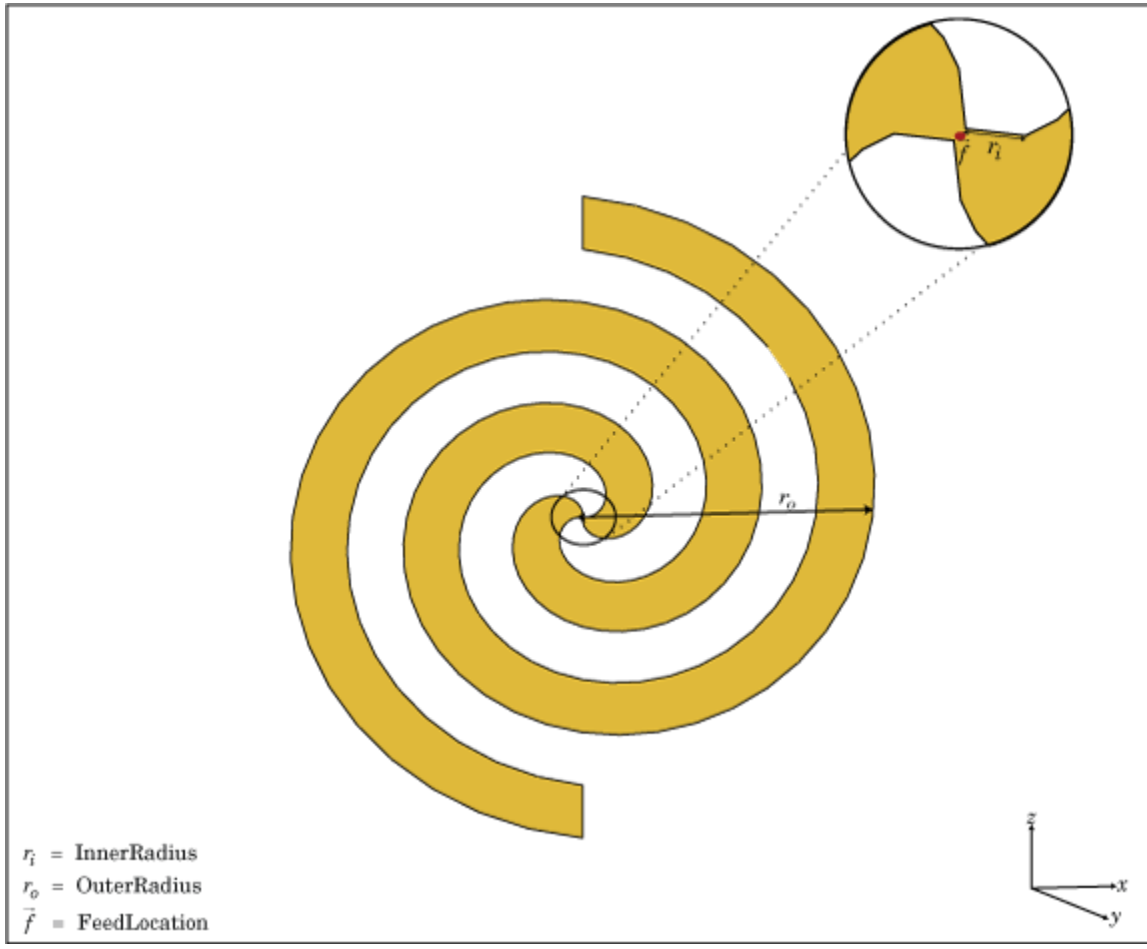
The equation of the Archimedean spiral is:

$$r = r_0 + a\phi$$

where:

- r_0 is the inner radius
- a is the growth rate
- ϕ is the winding angle of the spiral

Archimedean spiral antenna is a self complimentary structure, where the spacing between the arms and the width of the arms are equal. The default antenna is center fed. The feed point coincides with the origin. the origin is located in the X-Y plane.



Create Object

`sa = spiralArchimedean` creates a planar Archimedean spiral on the X-Y plane. By default, the antenna operates over a broadband frequency range of 3–5 GHz.

`sa = spiralArchimedean(Name,Value)` creates a planar Archimedean spiral, with additional properties specified by one, or more name–value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-

value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'Turns'` — Number of turns of spiral

1.5000 (default) | scalar

Number of turns of spiral, specified as the comma-separated pair consisting of `'Turns'` and a scalar.

Example: `'Turns',2`

Data Types: `double`

`'InnerRadius'` — Inner radius of spiral

5.0000e-04 (default) | scalar in meters

Spiral inner radius, specified as the comma-separated pair consisting of `'InnerRadius'` and a scalar in meters.

Example: `'InnerRadius',1e-3`

Data Types: `double`

`'OuterRadius'` — Outer radius of spiral

0.0398 (default) | scalar in meters

Outer radius of spiral, specified as a comma-separated pair consisting of `'OuterRadius'` and a scalar in meters.

Example: `'OuterRadius',1e-3`

Data Types: `double`

`'WindingDirection'` — Direction of spiral turns (windings)

`'CW'` | `'CCW'`

Direction of spiral turns (wingdings), specified as the comma-separated pair consisting of `'WindingDirection'` and `CW` or `CCW`.

Example: `'WindingDirection','CW'`

Data Types: `char`

'Load' — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of 'Load' and a lumped element object handle. For more information, see lumpedElement.

Example: 'Load',lumpedelement. lumpedelement is the object handle for the load created using lumpedElement.

'Tilt' — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of 'Tilt' and a scalar or vector in degrees.

Example: 'Tilt',90

Example: 'Tilt',[90 90 0]

Data Types: double

'TiltAxis' — Tilt axis of antenna

[1 0 0] (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | 'X' | 'Y' | 'Z'

Tilt axis of the antenna, specified as the comma-separated pair consisting of 'TiltAxis' and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: 'TiltAxis',[0 1 0]

Example: 'TiltAxis',[0 0 0;0 1 0]

Example: 'TiltAxis','Z'

Data Types: double

Object Functions

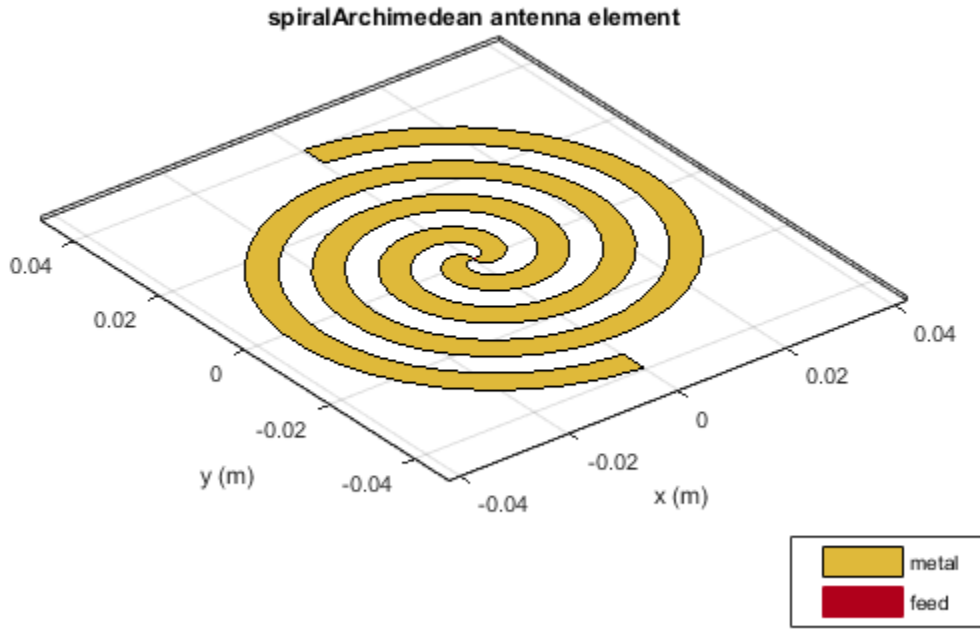
axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

Examples

Create and View Archimedean Spiral Antenna

Create and view a 2-turn Archimedean spiral antenna with a 1 mm starting radius and 40 mm outer radius.

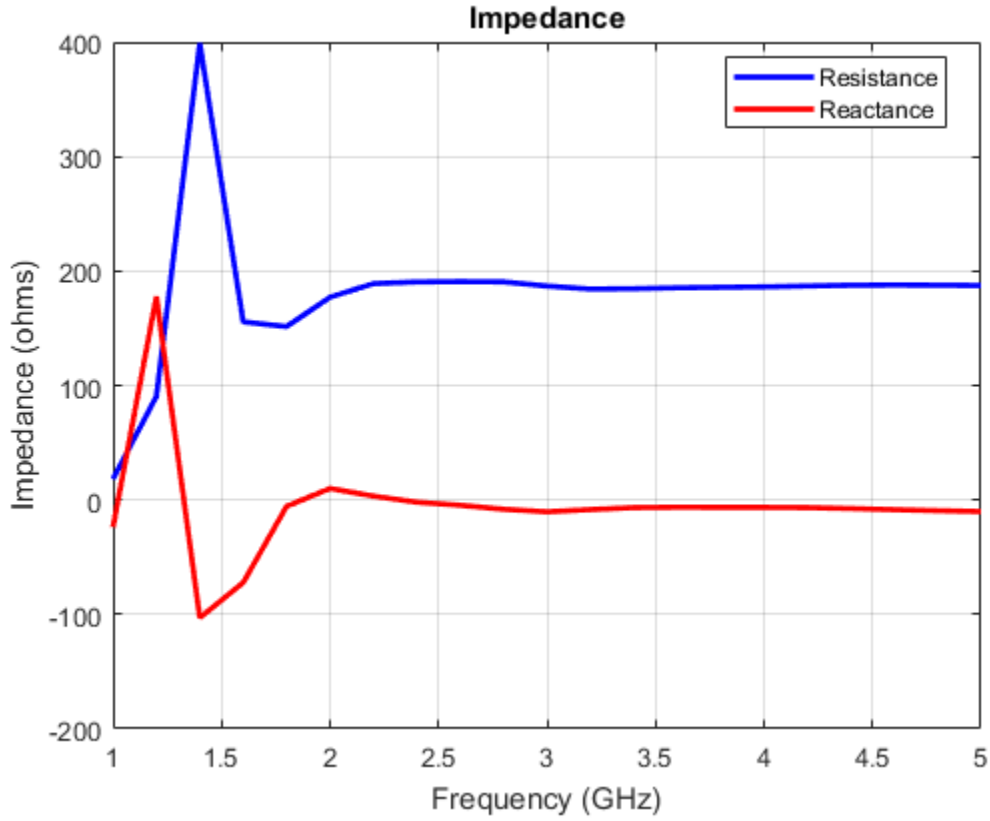
```
sa = spiralArchimedean('Turns',2, 'InnerRadius',1e-3, 'OuterRadius',40e-3);
show(sa)
```



Impedance of Archimedean Spiral Antenna

Calculate the impedance of an Archimedean spiral antenna over a frequency range of 1-5 GHz.

```
sa = spiralArchimedean('Turns',2, 'InnerRadius',1e-3, 'OuterRadius',40e-3);
impedance(sa, linspace(1e9,5e9,21));
```



References

[1] Balanis, C.A. *Antenna Theory. Analysis and Design*, 3rd Ed. New York: Wiley, 2005.

[2] Nakano, H., Oyanagi, H. and Yamauchi, J. "A Wideband Circularly Polarized Conical Beam From a Two-Arm Spiral Antenna Excited in Phase". *IEEE Transactions on Antennas and Propagation*. Vol. 59, No. 10, Oct 2011, pp. 3518-3525.

[3] Volakis, John. *Antenna Engineering Handbook*, 4th Ed. McGraw-Hill

See Also

See Also

helix | spiralEquiangular | yagiUda

Topics

“Rotate Antenna and Arrays”

Introduced in R2015a

spiralEquiangular

Create equiangular spiral antenna

Description

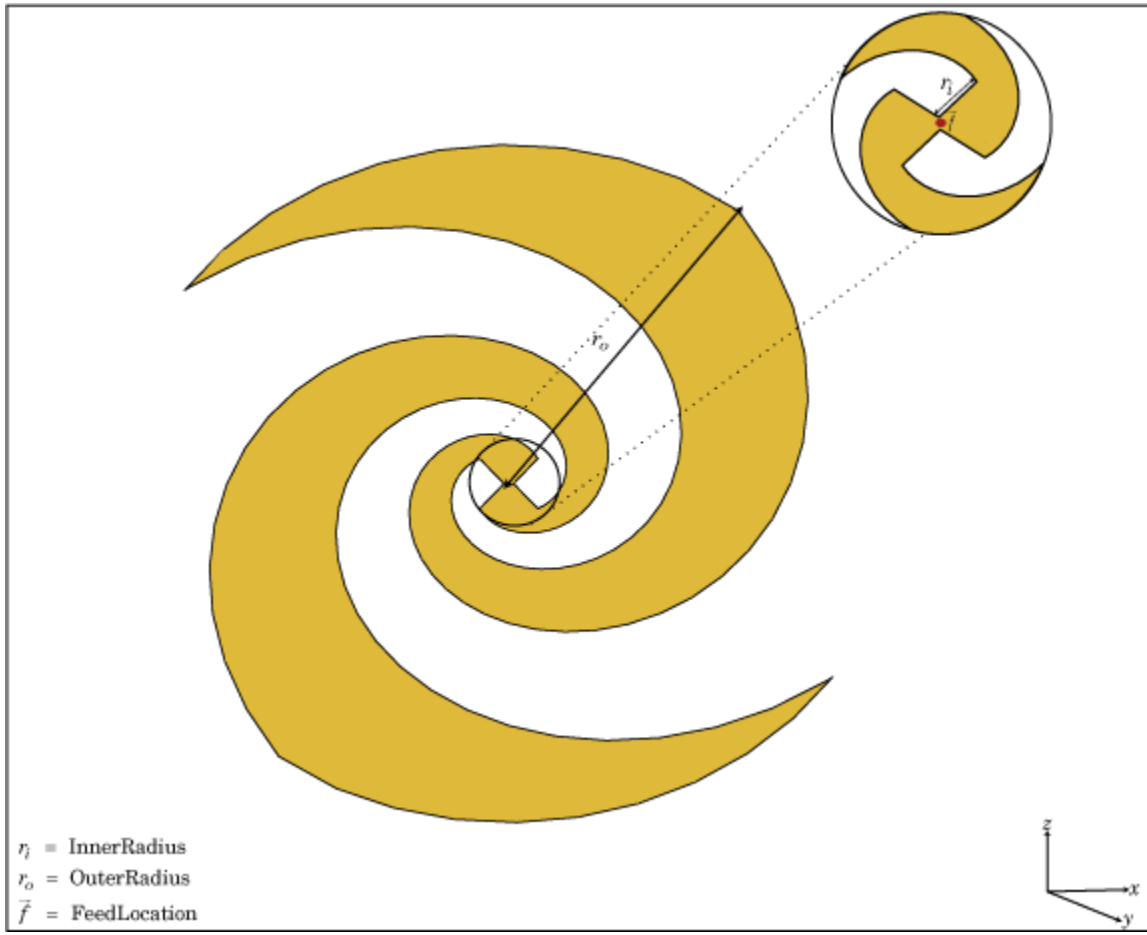
The `spiralEquiangular` object is a planar equiangular spiral antenna on the X-Y plane. The equiangular spiral is always center fed and has two arms. The field characteristics of the antenna are frequency independent. A realizable spiral has finite limits on the feeding region and the outermost point of any arm of the spiral. This antenna exhibits a broadband behavior. The outer radius imposes the low frequency limit and the inner radius imposes the high frequency limit. The arm radius grows linearly as a function of the winding angle. As a result, outer arms of the spiral are shaped to minimize reflections.

The equation of the equiangular spiral is:

$$r = r_0 e^{a\phi}$$

, where:

- r_0 is the starting radius
- a is the growth rate
- ϕ is the winding angle of the spiral



Create Object

`se = spiralEquiangular` creates a planar equiangular spiral in the X-Y plane. By default, the antenna operates over a broadband frequency 4–10 GHz.

`se = spiralEquiangular(Name,Value)` creates an equiangular spiral antenna, with additional properties specified by one, or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-

value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'GrowthRate'` — Equiangular spiral growth rate

0.3500 (default) | scalar

Equiangular spiral growth rate, specified as the comma-separated pair consisting of `'GrowthRate'` and a scalar.

Example: `'GrowthRate',1.2`

Data Types: `double`

`'InnerRadius'` — Inner radius of spiral

0.0020 (default) | scalar in meters

Inner radius of spiral , specified as the comma-separated pair consisting of `'InnerRadius'` and a scalar in meters.

Example: `'InnerRadius',1e-3`

Data Types: `double`

`'OuterRadius'` — Outer radius of spiral

0.0189 (default) | scalar in meters

Outer radius of spiral, specified as the comma-separated pair consisting of `'OuterRadius'` and a scalar in meters.

Example: `'OuterRadius',1e-3`

Data Types: `double`

`'WindingDirection'` — Direction of spiral turns (wingdings)

`'CW'` | `'CCW'`

Direction of spiral turns (wingdings), specified as the comma-separated pair consisting of `'WindingDirection'` and `CW` or `CCW`.

Example: `'WindingDirection','CW'`

Data Types: `char`

'Load' — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of 'Load' and a lumped element object handle. For more information, see lumpedElement.

Example: 'Load',lumpedelement. lumpedelement is the object handle for the load created using lumpedElement.

'Tilt' — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of 'Tilt' and a scalar or vector in degrees.

Example: 'Tilt',90

Example: 'Tilt',[90 90 0]

Data Types: double

'TiltAxis' — Tilt axis of antenna

[1 0 0] (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | 'X' | 'Y' | 'Z'

Tilt axis of the antenna, specified as the comma-separated pair consisting of 'TiltAxis' and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: 'TiltAxis',[0 1 0]

Example: 'TiltAxis',[0 0 0;0 1 0]

Example: 'TiltAxis','Z'

Data Types: double

Object Functions

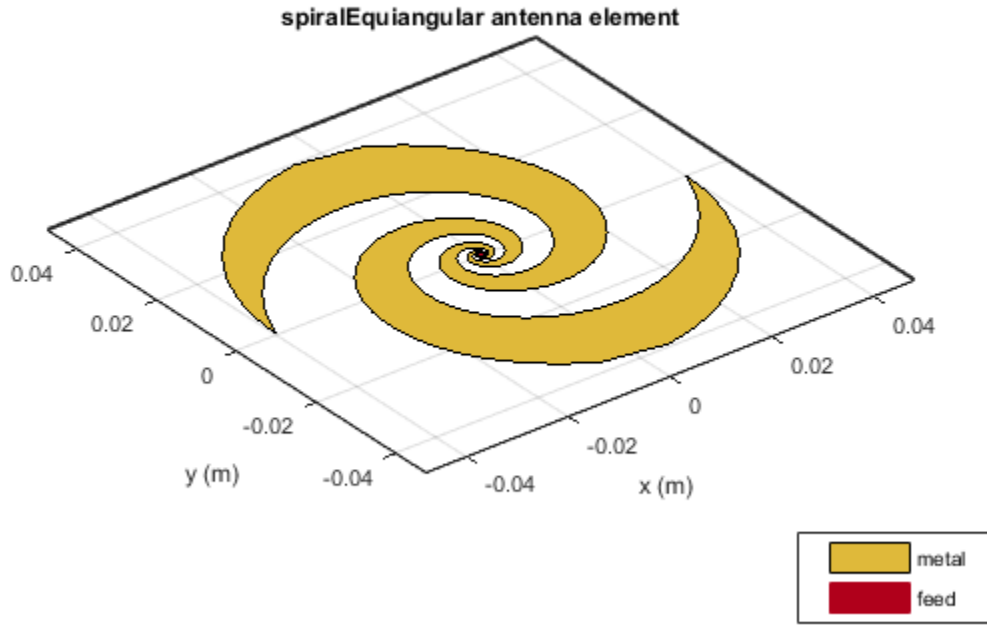
axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

Examples

Create and View Equiangular Spiral Antenna

Create and view an equiangular spiral antenna with 0.35 growth rate, 0.65 mm inner radius and 40 mm outer radius.

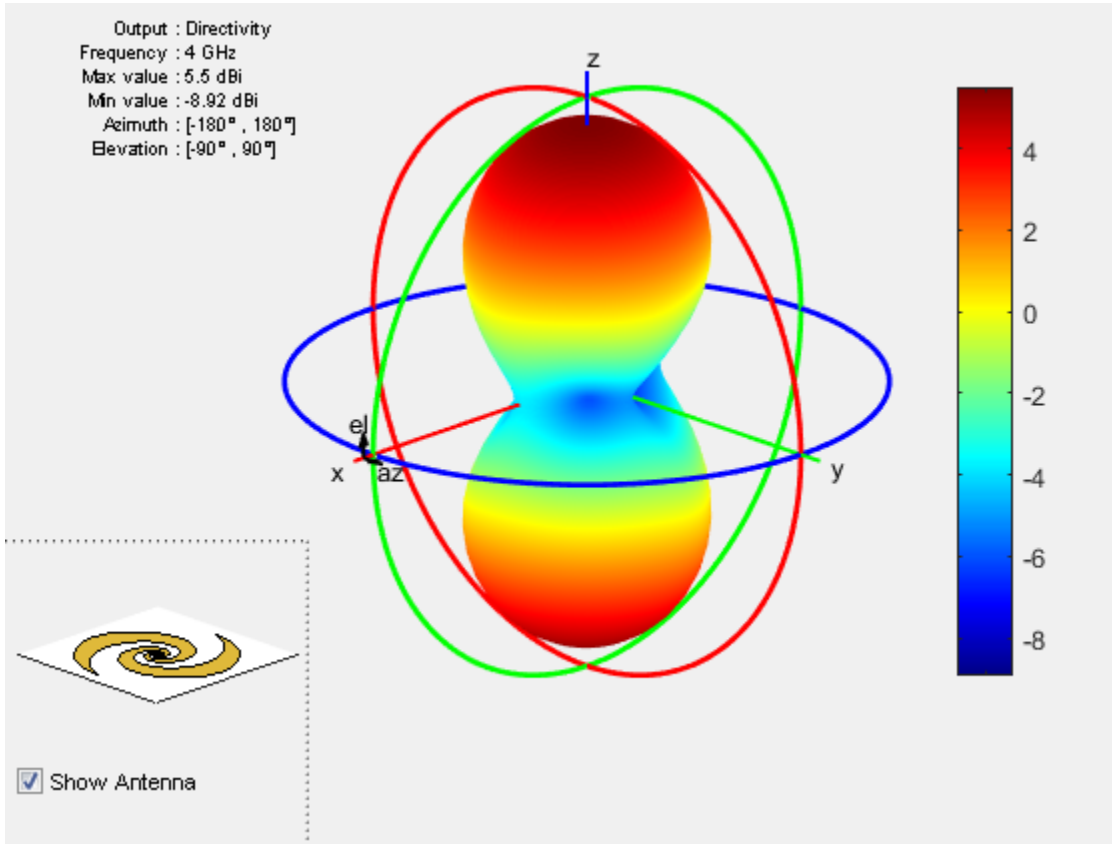
```
se = spiralEquiangular('GrowthRate',0.35, 'InnerRadius',0.65e-3,    ...
                       'OuterRadius',40e-3);
show(se)
```



Radiation Pattern of Equiangular Spiral Antenna

Plot the radiation pattern of equiangular spiral at a frequency of 4 GHz.

```
se = spiralEquiangular('GrowthRate',0.35, 'InnerRadius',0.65e-3, ...
                       'OuterRadius',40e-3);
pattern(se,4e9);
```



References

[1] Dyson, J. The equiangular spiral antenna." *IRE Transactions on Antennas and Propagation*. Vol.7, Number 2, pp. 181, 187, April 1959.

[2] Nakano, H., K.Kikkawa, N.Kondo, Y.Iitsuka, J.Yamauchi. "Low-Profile Equiangular Spiral Antenna Backed by an EBG Reflector." *IRE Transactions on Antennas and Propagation*. Vol. 57, No. 25, May 2009, pp. 1309–1318.

[3] McFadden, M., and Scott, W.R. "Analysis of the Equiangular Spiral Antenna on a Dielectric Substrate." *IEEE Transactions on Antennas and Propagation*. Vol. 55, No. 11, Nov. 2007, pp. 3163–3171.

[4] Violates, John *Antenna Engineering Handbook*, 4th Ed., McGraw-Hill.

See Also

See Also

cavity | spiralArchimedean | vivaldi

Topics

"Rotate Antenna and Arrays"

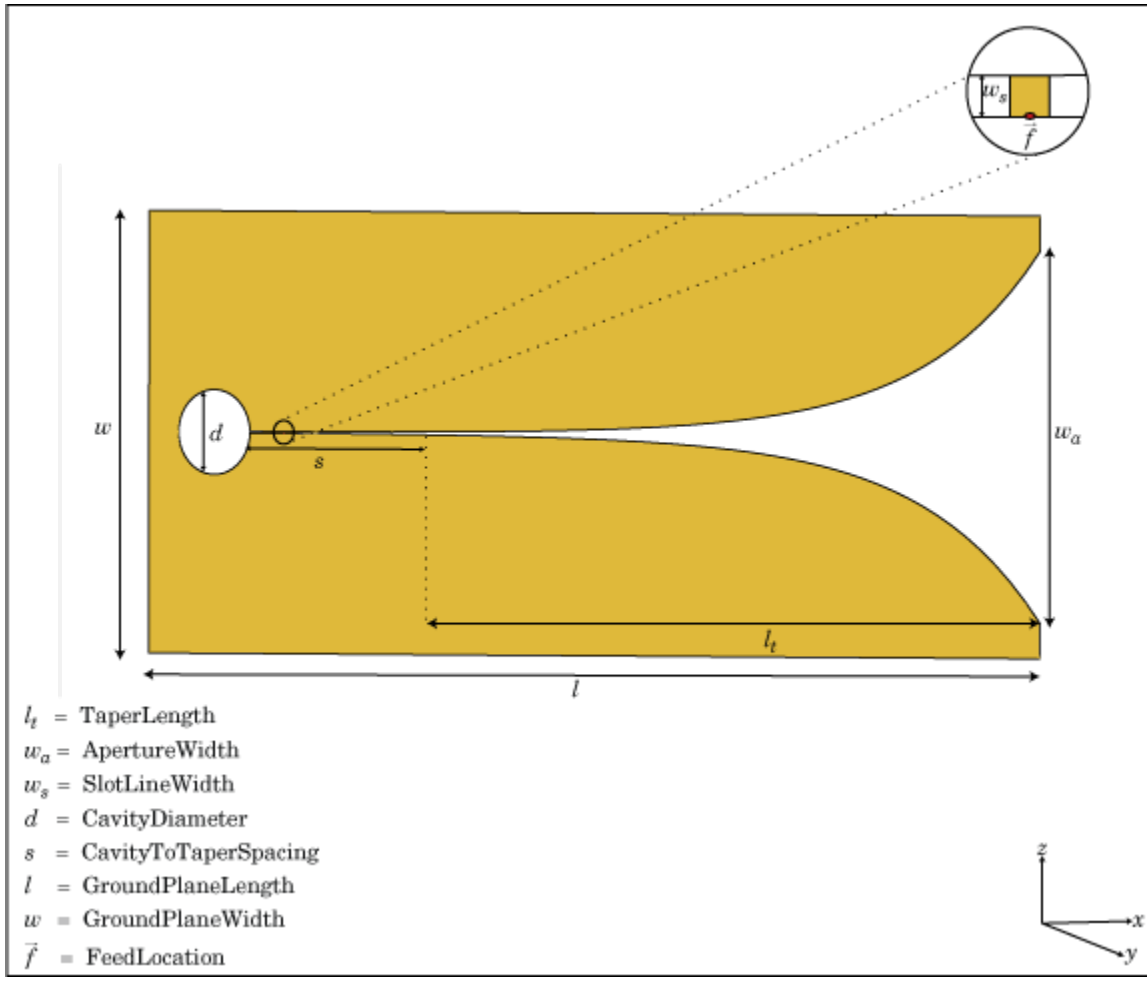
Introduced in R2015a

vivaldi

Create Vivaldi notch antenna on ground plane

Description

The `vivaldi` object is a Vivaldi notch antenna on a ground plane.



Create Object

`vi = vivaldi` creates a Vivaldi notch antenna on a ground plane. By default, the antenna operates at a frequency range of 1–2 GHz and is located in the X-Y plane.

`vi = vivaldi(Name,Value)` creates Vivaldi notch antenna, with additional properties specified by one, or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties you do not specify retains default values.

Properties

`'TaperLength'` — Taper length

0.2430 (default) | scalar in meters

Taper length of vivaldi, specified as the comma-separated pair consisting of `'TaperLength'` and a scalar in meters.

Example: `'TaperLength',2e-3`

`'ApertureWidth'` — Aperture width

0.1050 (default) | scalar in meters

Aperture width, specified as the comma-separated pair consisting of `'ApertureWidth'` and a scalar in meters.

Example: `'ApertureWidth',3e-3`

`'OpeningRate'` — Taper opening rate

25 (default) | scalar

Taper opening rate, specified as the comma-separated pair consisting of `'OpeningRate'` and a scalar.

Example: `'OpeningRate',0.3`

Data Types: `double`

`'SlotLineWidth'` — Slot line width

5.0000e-04 (default) | scalar in meters

Slot line width, specified as the comma-separated pair consisting of `'SlotLineWidth'` and a scalar in meters.

Example: `'SlotLineWidth',3`

Data Types: `double`

`'CavityDiameter'` — Cavity termination diameter

0.0240 (default) | scalar in meters

Cavity termination diameter, specified as the comma-separated pair consisting of `'CavityDiameter'` and a scalar in meters.

Example: `'CavityDiameter',2`

Data Types: `double`

`'CavityToTaperSpacing'` — Cavity to taper distance of transition

0.0230 (default) | scalar in meters

Cavity to taper distance of transition, specified as the comma-separated pair consisting of `'CavityToTaperSpacing'` and a scalar in meters. By default, this property is measured along x-axis.

Example: `'CavityToTaperSpacing',3`

Data Types: `double`

`'GroundPlaneLength'` — Ground plane length

0.3000 (default) | scalar in meters

Ground plane length, specified as the comma-separated pair consisting of `'GroundPlaneLength'` and a scalar in meters. By default, ground plane length is measured along the x-axis.

Example: `'GroundPlaneLength',2`

Data Types: `double`

`'GroundPlaneWidth'` — Ground plane width

0.1250 (default) | scalar in meters

Ground plane width, specified as the comma-separated pair consisting of `'GroundPlaneWidth'` and a scalar in meters. By default, ground plane width is measured along the y-axis.

Example: `'GroundPlaneWidth',4`

Data Types: `double`

`'FeedOffset'` — Distance from feed along x-axis

0 (default) | scalar in meters

Distance from feed along x-axis, specified as the comma-separated pair consisting of `'FeedOffset'` and a scalar in meters.

Example: `'FeedOffset',3`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.

- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

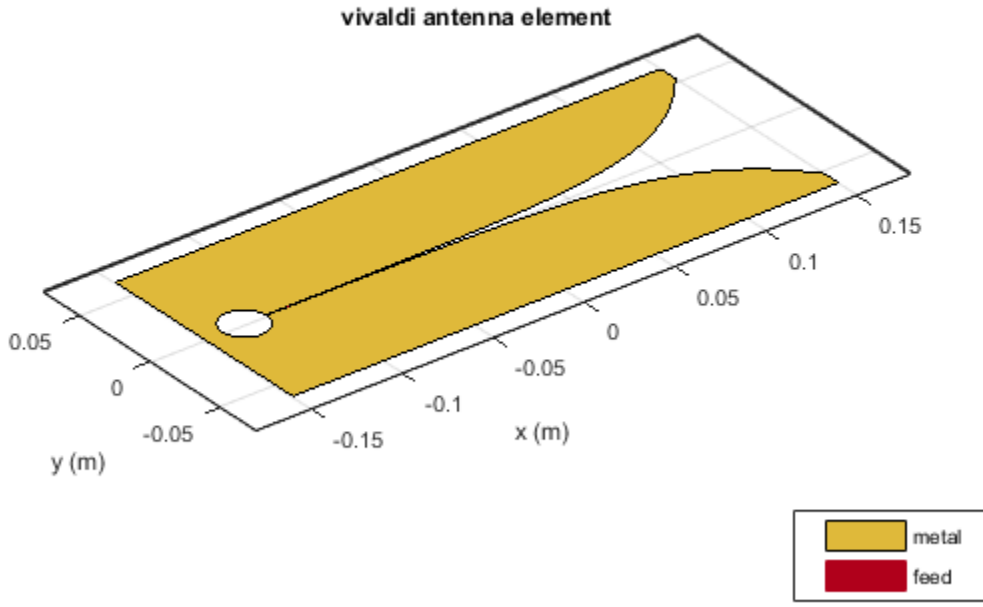
axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

Examples

Create and View Vivaldi Antenna

Create and view the default Vivaldi antenna.

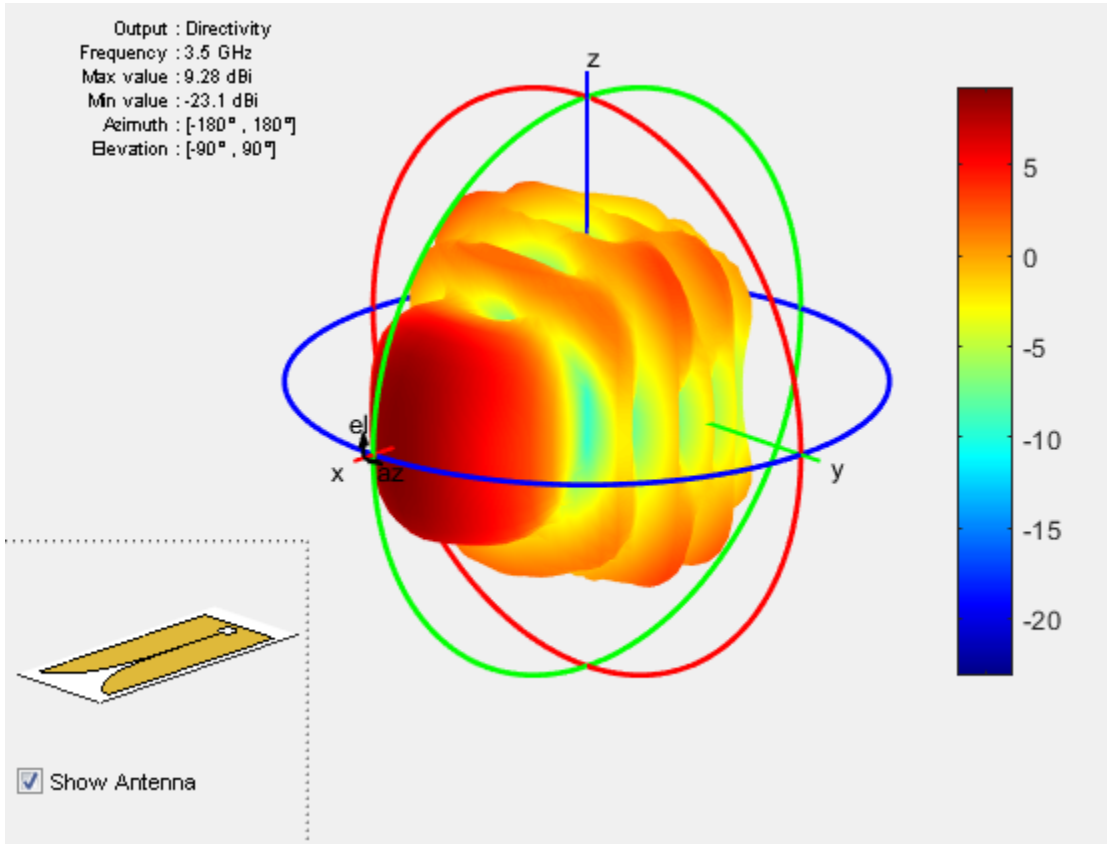
```
vi = vivaldi
show(vi);


vi =

  vivaldi with properties:

           TaperLength: 0.2430
         ApertureWidth: 0.1050
           OpeningRate: 25
         SlotLineWidth: 5.0000e-04
        CavityDiameter: 0.0240
  CavityToTaperSpacing: 0.0230
     GroundPlaneLength: 0.3000
      GroundPlaneWidth: 0.1250
            FeedOffset: -0.1045
                  Tilt: 0
              TiltAxis: [1 0 0]
                  Load: [1×1 lumpedElement]
```



Radiation Pattern of Vivaldi Antenna

Plot the radiation pattern of a vivaldi antenna for a frequency of 3.5 GHz.

```
vi = vivaldi;
pattern(vi,3.5e9);
```



References

[1] Balanis, C.A. *Antenna Theory. Analysis and Design*, 3rd Ed. New York: Wiley, 2005.

See Also

See Also

slot | spiralArchimedean | yagiUda

Topics

"Rotate Antenna and Arrays"

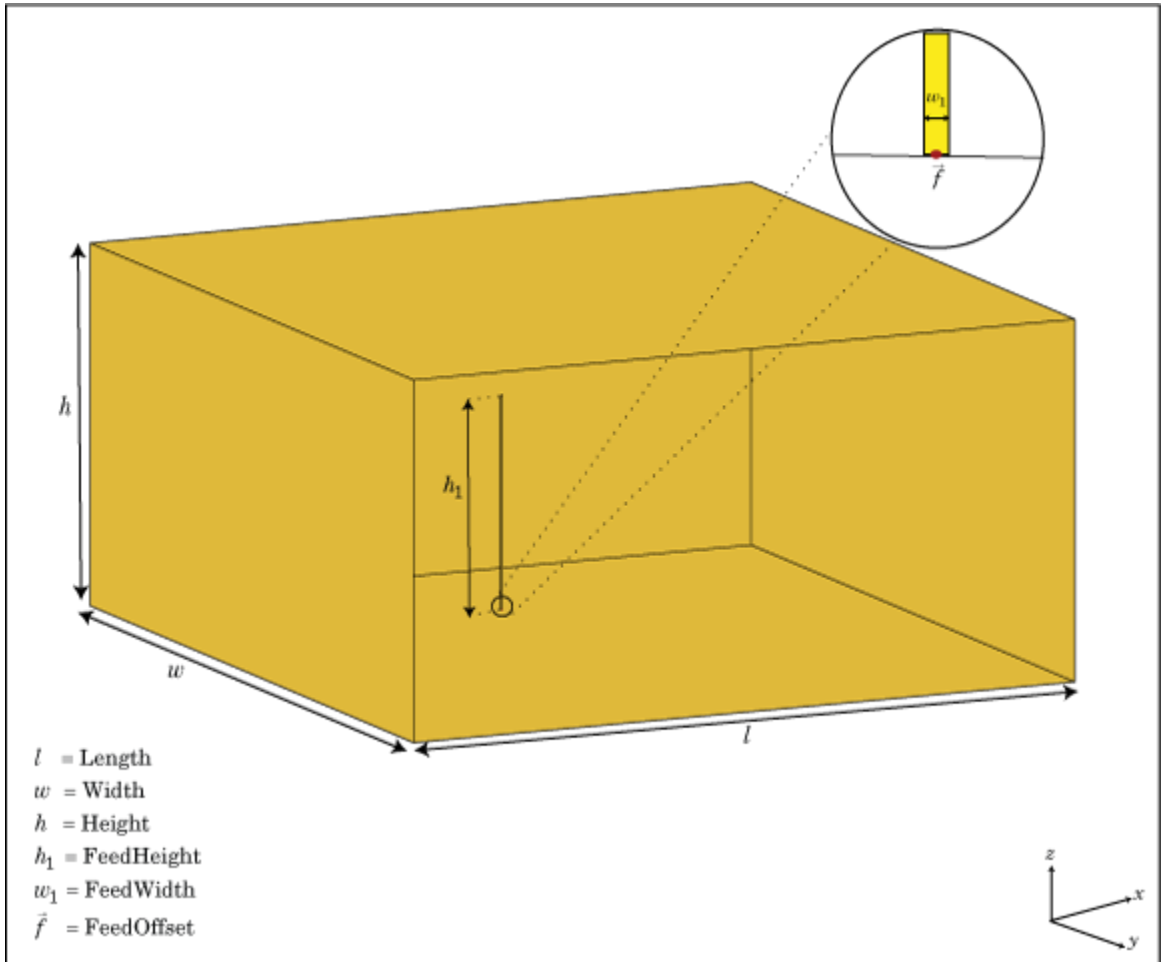
Introduced in R2015a

waveguide

Create rectangular waveguide

Description

The `waveguide` object is an open-ended rectangular waveguide. The default rectangular waveguide is the WR-90 and functions in the X-band. The X-band has a cutoff frequency of 6.5 GHz and ranges from 8.2 GHz to 12.5 GHz.



Create Object

`wg = waveguide` creates an open-ended rectangular waveguide.

`wg = waveguide(Name,Value)` creates a rectangular waveguide with additional properties specified by one, or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair

arguments in any order as `Name1,Value1,...,NameN,ValueN`. Properties not specified retain their default values.

Properties

`'FeedHeight'` — Height of feed

`0.0060` (default) | scalar in meters

Height of feed, specified as the comma-separated pair consisting of `'FeedHeight'` and a scalar in meters. By default, the feed height is chosen for an operating frequency of 12.5 GHz.

Example: `'FeedHeight',0.0050`

Data Types: `double`

`'FeedWidth'` — Width of feed

`6.0000e-05` (default) | scalar in meters

Width of feed, specified as the comma-separated pair consisting of `'FeedWidth'` and a scalar in meters.

Example: `'FeedWidth',5e-05`

Data Types: `double`

`'Length'` — Rectangular waveguide length

`0.0240` (default) | scalar in meters

Rectangular waveguide length, specified as the comma-separated pair consisting of `'Length'` and a scalar in meters. By default, the waveguide length is 1λ, where:

$$\lambda = c / f$$

- `c` = speed of light, `299792458` m/s
- `f` = operating frequency of the waveguide

Example: `'Length',0.09`

Data Types: `double`

`'Width'` — Rectangular waveguide width

`0.0229` (default) | scalar in meters

Rectangular waveguide width, specified as the comma-separated pair consisting of `'Width'` and a scalar in meters.

Example: `'Width',0.05`

Data Types: `double`

`'Height'` — Rectangular waveguide height

`0.0102` (default) | scalar in meters

Rectangular waveguide height, specified as the comma-separated pair consisting of `'Height'` and a scalar in meters.

Example: `'Height',0.0200`

Data Types: `double`

`'FeedOffset'` — Signed distance of feedpoint from center of ground plane

[–0.0060 0] (default) | two-element vector in meters

Signed distance of feedpoint from center of ground plane, specified as the comma-separated pair of `'FeedOffset'` and a two-element vector in meters. By default, the feed is at an offset of λ/4 from the shortened end on the X-Y plane.

Example: `'FeedOffset',[–0.0070 0.01]`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array

mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

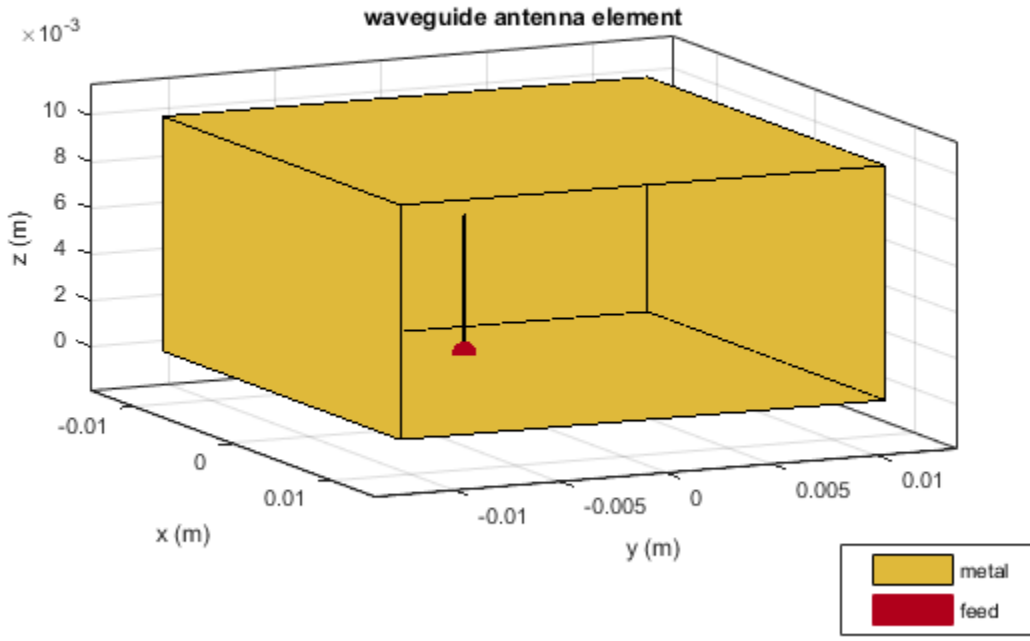
Examples

Default Rectangular Waveguide

Create a rectangular waveguide using default dimensions. Display the waveguide.

```
wg = waveguide
show(wg)
```

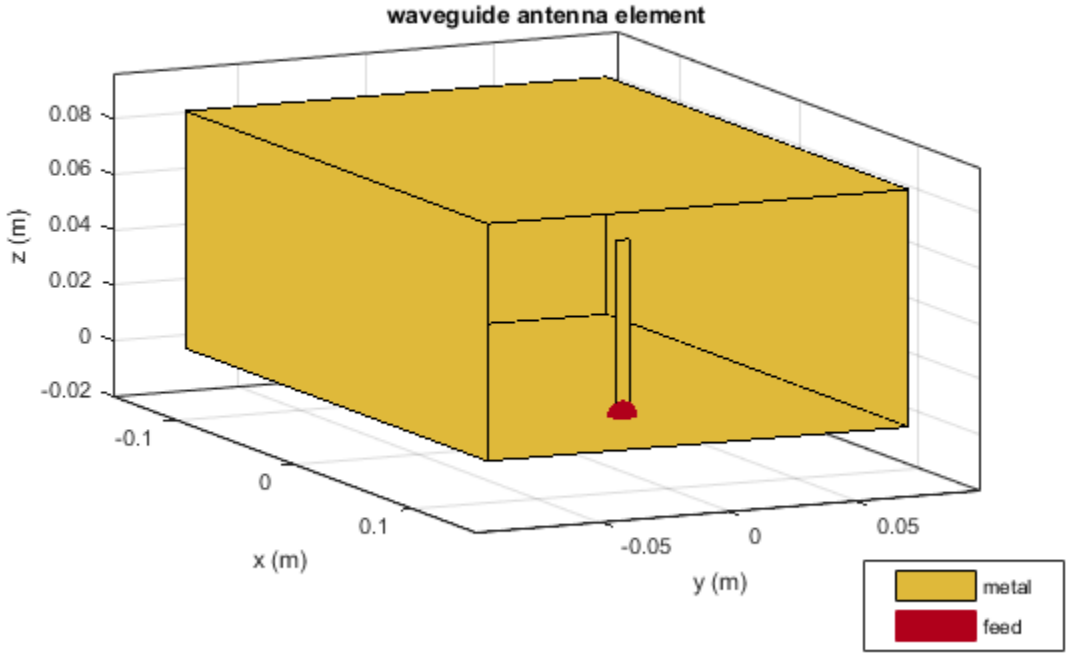
```
wg =

  waveguide with properties:

       Length: 0.0240
        Width: 0.0229
       Height: 0.0102
    FeedWidth: 6.0000e-05
   FeedHeight: 0.0060
   FeedOffset: [-0.0060 0]
         Tilt: 0
     TiltAxis: [1 0 0]
         Load: [1×1 lumpedElement]
```



Radiation Pattern of WR-650 Rectangular Waveguide

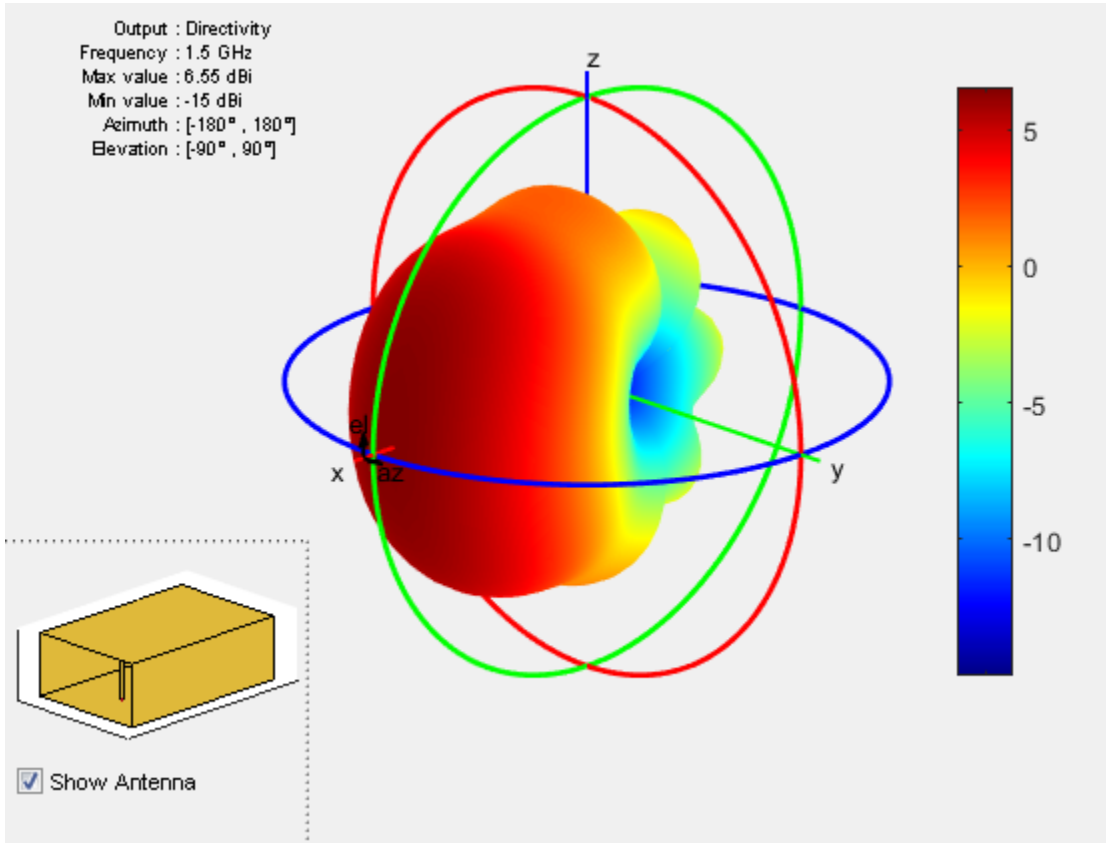
Create a WR-650 rectangular waveguide and display it.

```
wg = waveguide('Length',0.254,'Width',0.1651,'Height',0.0855,...
    'FeedHeight',0.0635,'FeedWidth',0.00508,'FeedOffset',[0.0635 0]);
show(wg)
```



Plot the radiation pattern of this waveguide at 1.5 GHz.

```
figure
pattern(wg,1.5e9)
```



References

[1] Balanis, Constantine A.*Antenna Theory. Analysis and Design*. 3rd Ed. New York: John Wiley and Sons, 2005.

See Also

See Also

horn

Topics

"Rotate Antenna and Arrays"

Introduced in R2016a

yagiUda

Create Yagi-Uda array antenna

Description

The `yagiUda` class creates a classic Yagi-Uda array comprised of an exciter, reflector, and *N*- directors along the z-axis. The reflector and directors create a traveling wave structure that results in a directional radiation pattern.

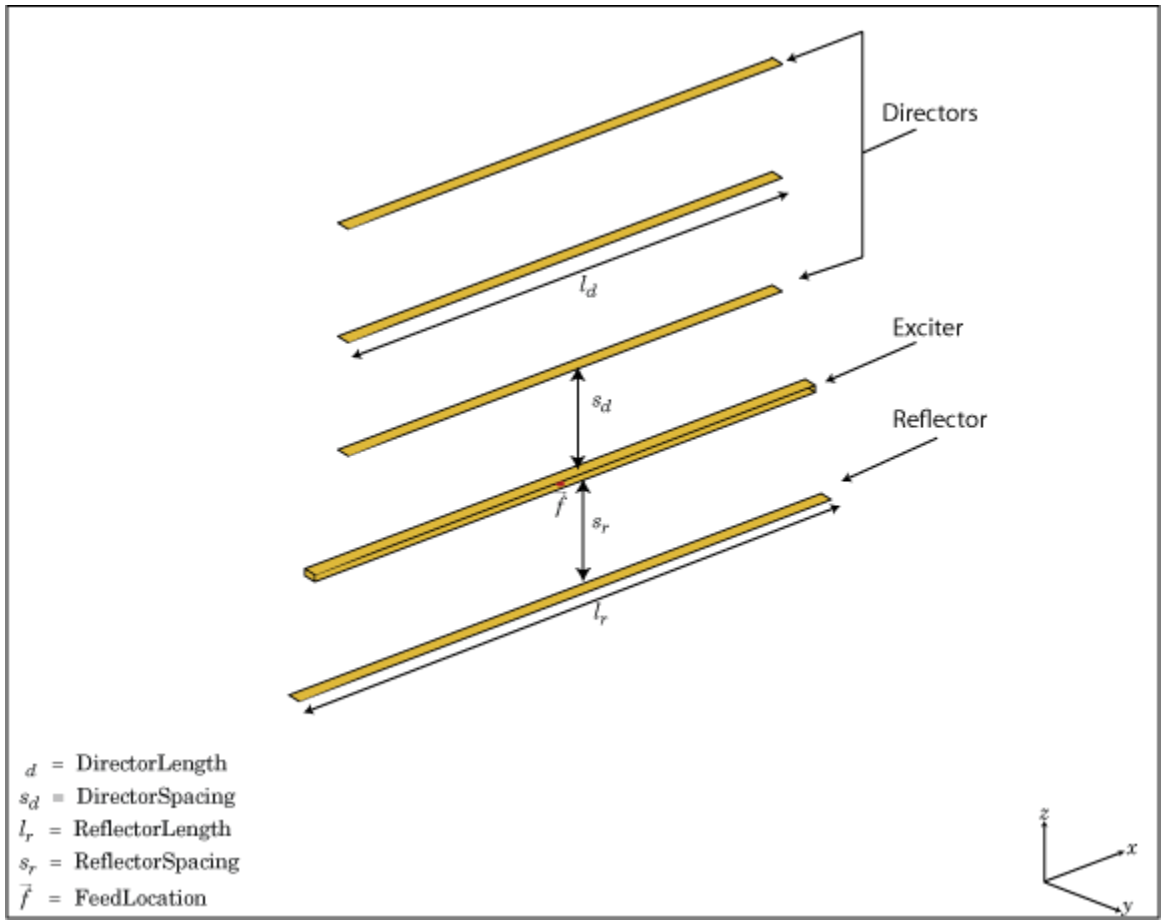
The exciter, reflector, and directors have equal widths and are related to the diameter of an equivalent cylindrical structure by the equation

$$w = 2d = 4r$$

where:

- d is the diameter of equivalent cylinder
- r is the radius of equivalent cylinder

For a given cylinder radius, use the `cylinder2strip` utility function to calculate the equivalent width. A typical Yagi-Uda antenna array uses folded dipole as an exciter, due to its high impedance. The Yagi-Uda is center-fed and the feed point coincides with the origin. In place of a folded dipole, you can also use a planar dipole as an exciter.



Create Object

`h = yagiUda` creates a half-wavelength Yagi-Uda array antenna along the Z-axis. The default Yagi-Uda uses folded dipole as three directors, one reflector and a folded dipole as an exciter. By default, the dimensions are chosen for an operating frequency of 300 MHz.

`h = yagiUda(Name,Value)` creates a half-wavelength Yagi-Uda array antenna, with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-

value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain default values.

Properties

`'Exciter'` — Antenna type used as exciter

dipoleFolded (default) | object

Antenna Type used as exciter, specified as the comma-separated pair consisting of `'Exciter'` and an antenna element handle or antenna element.

Example: `'Exciter',dipole`

`'NumDirectors'` — Total number of director elements

3 (default) | scalar

Total number of director elements, specified as the comma-separated pair consisting of `'NumDirectors'` and a scalar.

Note: Number of director elements should be less than or equal to 20.

Example: `'NumDirectors',13`

Data Types: `double`

`'DirectorLength'` — Director length

0.4080 (default) | scalar in meters | vector in meters

Director length, specified as the comma-separated pair consisting of `'DirectorLength'` and a scalar or vector in meters.

Example: `'DirectorLength',[0.4 0.5]`

Data Types: `double`

`'DirectorSpacing'` — Spacing between directors

0.3400 (default) | scalar in meters | vector in meters

Spacing between directors, specified as the comma-separated pair consisting of `'DirectorSpacing'` and a scalar or vector in meters.

Example: `'DirectorSpacing',[0.4 0.5]`

Data Types: `double`

`'ReflectorLength'` — Reflector length

0.5000 (default) | scalar in meters

Reflector length, specified as the comma-separated pair consisting of `'ReflectorLength'` and a scalar in meters.

Example: `'ReflectorLength',0.3`

Data Types: `double`

`'ReflectorSpacing'` — Spacing between exciter and reflector

0.2500 (default) | scalar in meters

Spacing between exciter and reflector, specified as the comma-separated pair consisting of `'ReflectorSpacing'` and a scalar in meters.

Example: `'ReflectorSpacing', 0.4`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load',lumpedelement`. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

'TiltAxis' — Tilt axis of antenna

[1 0 0] (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | 'X' | 'Y' | 'Z'

Tilt axis of the antenna, specified as the comma-separated pair consisting of 'TiltAxis' and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, "Rotate Antenna and Arrays"

Example: 'TiltAxis',[0 1 0]

Example: 'TiltAxis',[0 0 0;0 1 0]

Example: 'TiltAxis','Z'

Data Types: double

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array

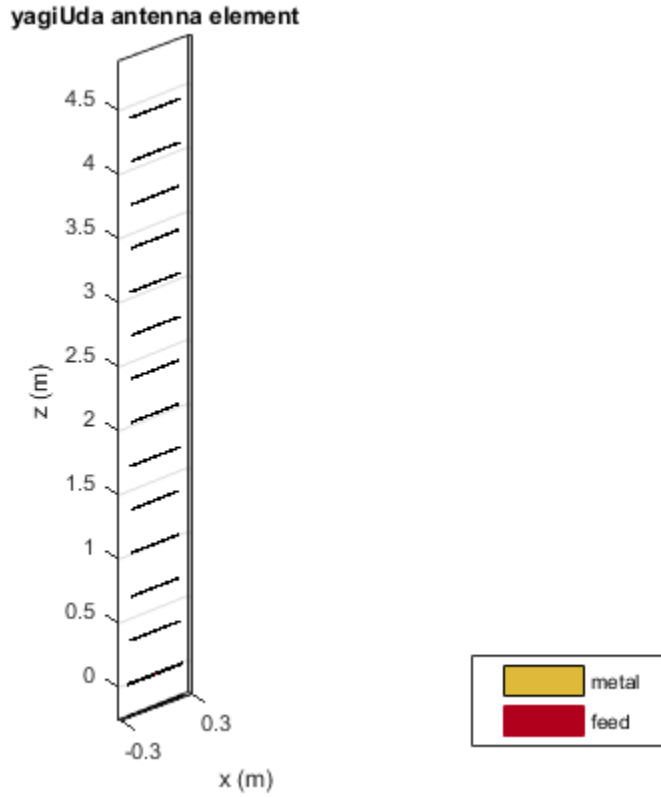
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

Examples

Create and View Yagi-Uda Array Antenna

Create and view a Yagi-Uda array antenna with 13 directors.

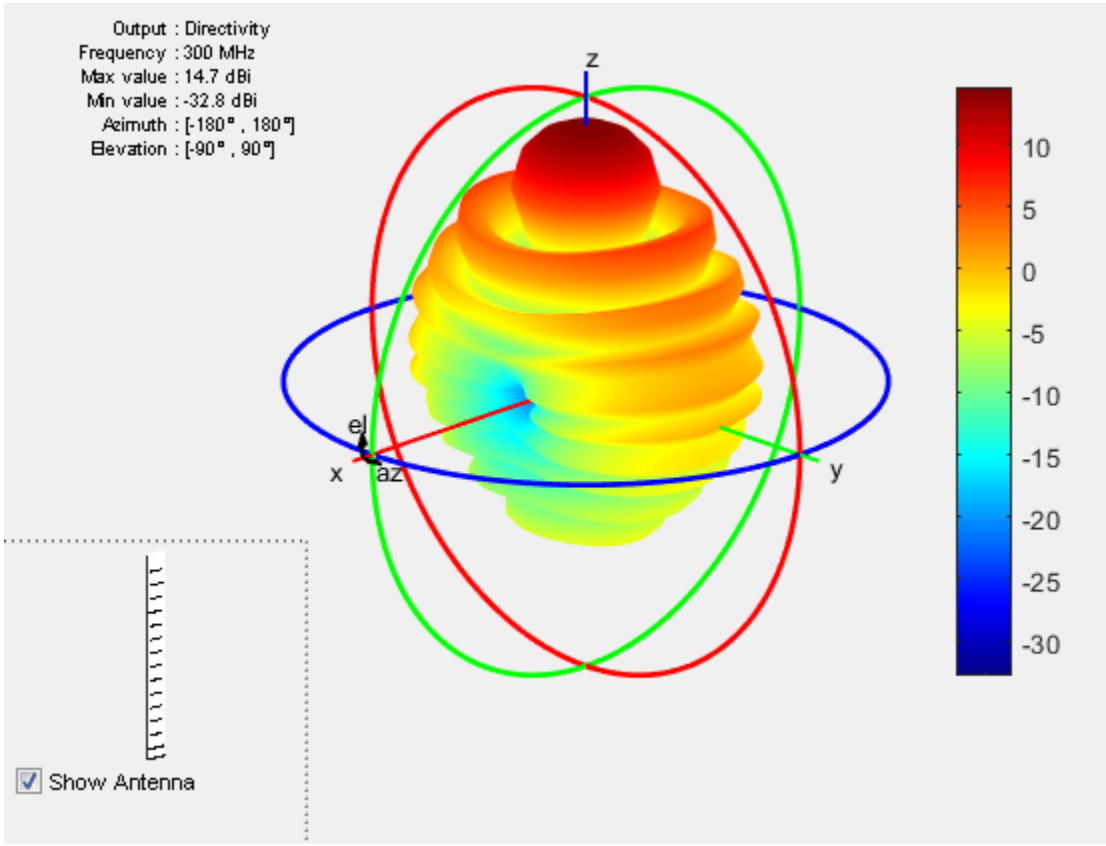
```
y = yagiUda('NumDirectors',13);
show(y)
```



Radiation Pattern of Yagi-Uda Array Antenna

Plot radiation pattern of a Yagi-Uda array antenna at a frequency of 30 0MHz.

```
y = yagiUda('NumDirectors',13);
pattern(y,300e6)
```



Calculate Cylinder to Strip Approximation

Calculate the width of the strip approximation to a cylinder of radius 20 mm.

```
w = cylinder2strip(20e-3)
```

```
w =

    0.0800
```

References

[1] Balanis, C.A. *Antenna Theory. Analysis and Design*, 3rd Ed. New York: Wiley, 2005.

See Also

See Also

`cylinder2strip` | dipole | dipoleFolded | slot

Topics

"Rotate Antenna and Arrays"

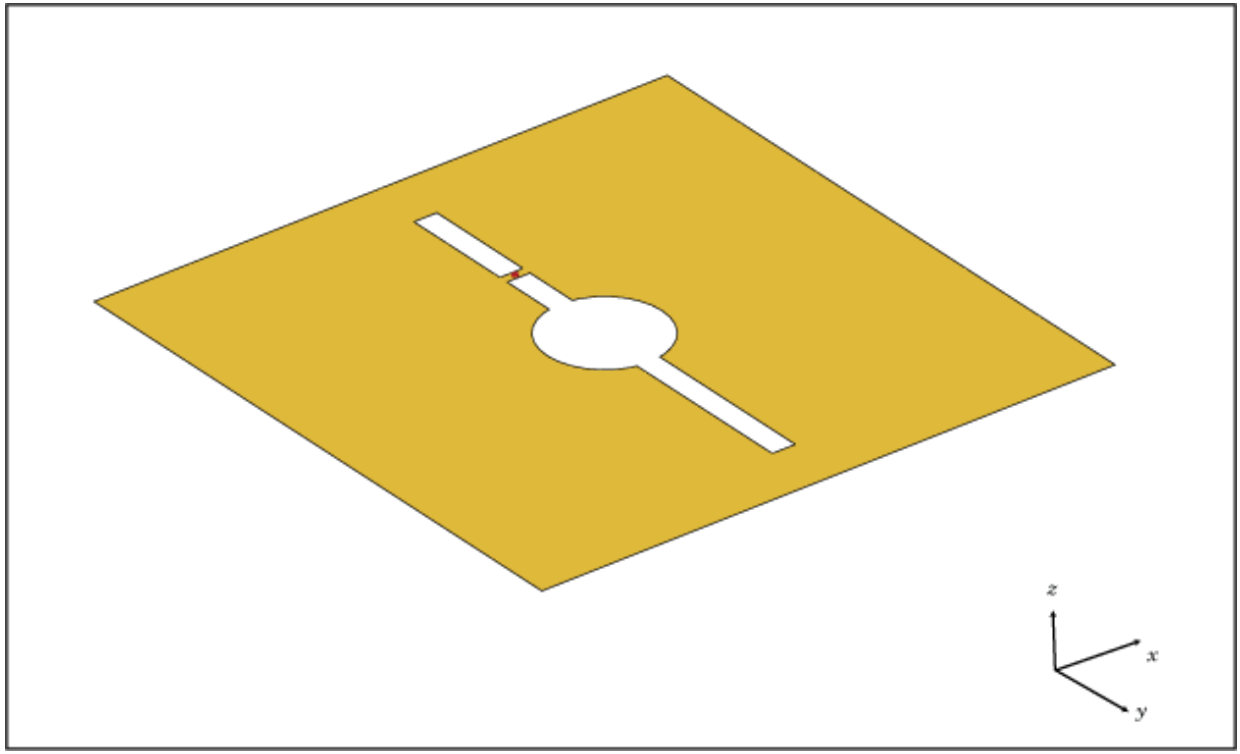
Introduced in R2015a

customAntennaGeometry

Create antenna represented by 2-D custom geometry

Description

The `customAntennaGeometry` object is an antenna represented by a 2-D custom geometry on the X-Y plane. Using `customAntennaGeometry`, you can import a planar mesh, define the feed for this mesh to create an antenna, analyze the antenna, and use it in finite or infinite arrays. The image shown is a custom slot antenna.



Create Object

`ca = customAntennaGeometry` creates a 2-D antenna represented by a custom geometry, based on the specified boundary.

`ca = customAntennaGeometry(Name,Value)` creates a 2-D planar antenna geometry, with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'Boundary'` — Boundary information in Cartesian coordinates

cell array in meters

Boundary information in Cartesian coordinates, specified as the comma-separated pair consisting of `'Boundary'`and a cell array in meters.

Data Types: `double`

`'Operation'` — Boolean operation performed on boundary list

`'P1'` (default) | character vector

Boolean operation performed on the boundary list, specified as the comma-separated pair consisting of `'Operation'` and a character vector.

Example: `'Operation','P1-P2'`

Data Types: `double`

`'FeedLocation'` — Antenna feed location in Cartesian coordinates

[0 0 0] (default) | three-element vector

Antenna feed location in Cartesian coordinates, specified as the comma-separated pair consisting of `'FeedLocation'` and a three-element vector. The three-element vector is the X, Y, and Z coordinates respectively.

Example: `'FeedLocation', [0 0.2 0]`

Data Types: `double`

`'FeedWidth'` — Width of feed section

`0.0100` (default) | scalar in meters

Width of feed section, specified as the comma-separated pair consisting of `'FeedWidth'` and a scalar in meters.

Example: `'FeedWidth',0.05`

Data Types: `double`

`'Load'` — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of `'Load'` and a lumped element object handle. For more information, see `lumpedElement`.

Example: `'Load'`, lumpedelement. `lumpedelement` is the object handle for the load created using `lumpedElement`.

`'Tilt'` — Tilt angle of array

`0` (default) | scalar in degrees | vector in degrees

Tilt angle of an array, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.

- A string input for simple rotations around the principle planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
show	Display antenna or array structure
vswr	Voltage standing wave ratio of antenna

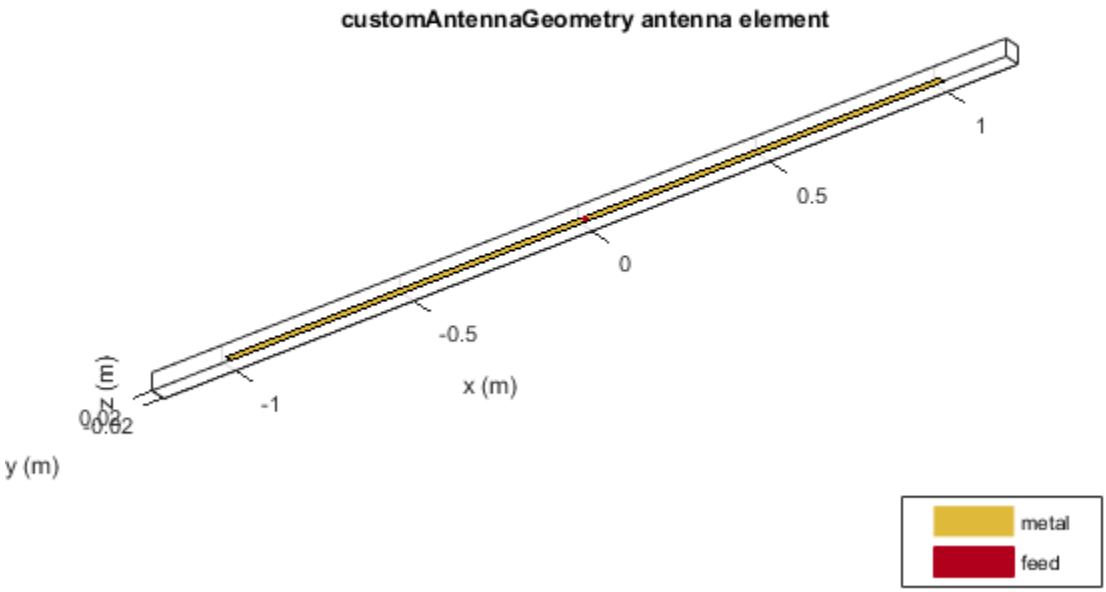
Examples

Custom Dipole Antenna

Create a custom dipole antenna and view it.

```
ca = customAntennaGeometry
show(ca)
```

```
ca =

  customAntennaGeometry with properties:

        Boundary: {[4×3 double]}
       Operation: 'P1'
    FeedLocation: [0 0 0]
       FeedWidth: 0.0200
            Tilt: 0
        TiltAxis: [1 0 0]
            Load: [1×1 lumpedElement]
```



Custom Slot Antenna

Create a custom slot antenna using three rectangles and a circle.

Make three rectangles of 0.5 m x 0.5 m, 0.02 m x 0.4 m and 0.03 m x 0.008 m.

```
pr = em.internal.makerectangle(0.5,0.5);
pr1 = em.internal.makerectangle(0.02,0.4);
pr2 = em.internal.makerectangle(0.03,0.008);
```

Make a circle of radius 0.05 m.

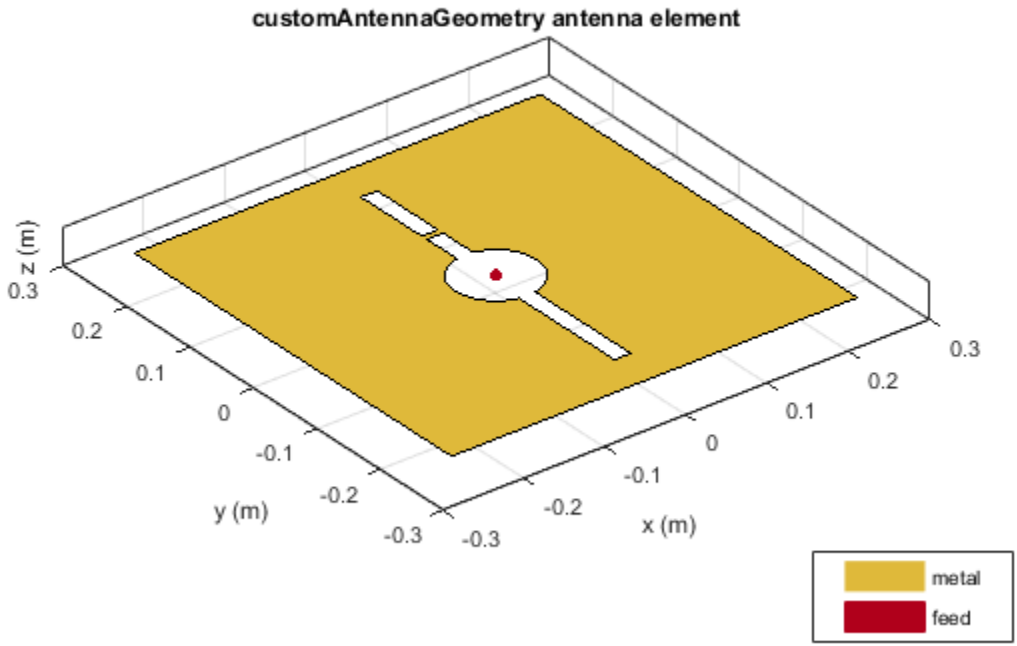
```
ph = em.internal.makecircle(0.05);
```

Translate the third rectangle to the X-Y plane using the coordinates [0 0.1 0].

```
pf = em.internal.translateshape(pr2,[0 0.1 0]);
```

Create a custom slot antenna element using the specified boundary shapes. Transponse pr, ph, pr1, and pf to make sure the boundary inputs are column vetor arrays.

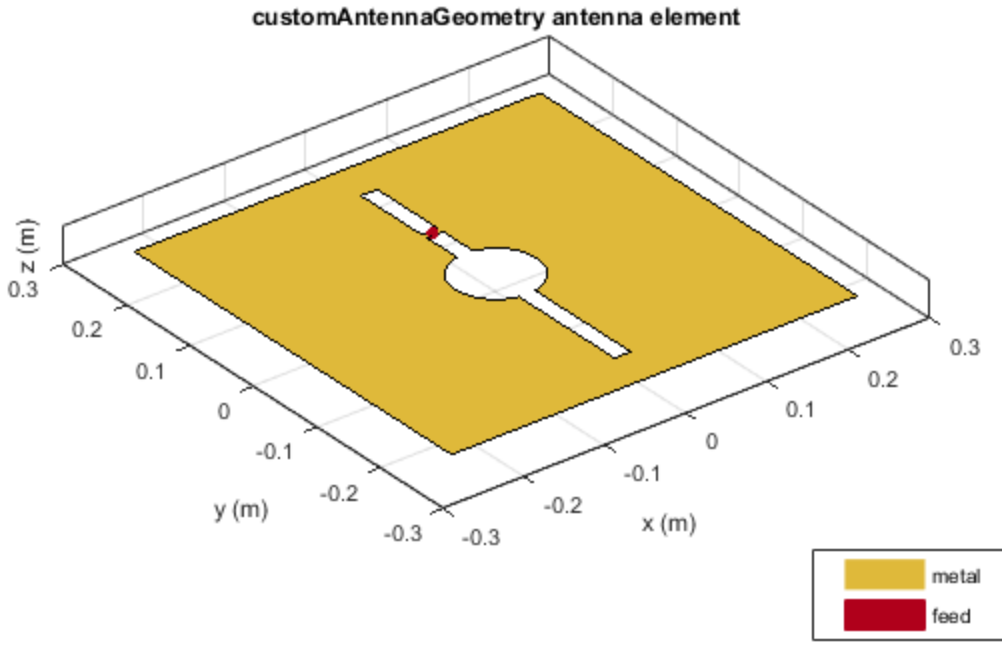
```
c = customAntennaGeometry('Boundary',{pr',ph',pr1',pf'},...
    'Operation','P1-P2-P3+P4');
figure;
show(c);
```



Move the feed location to new coordinates.

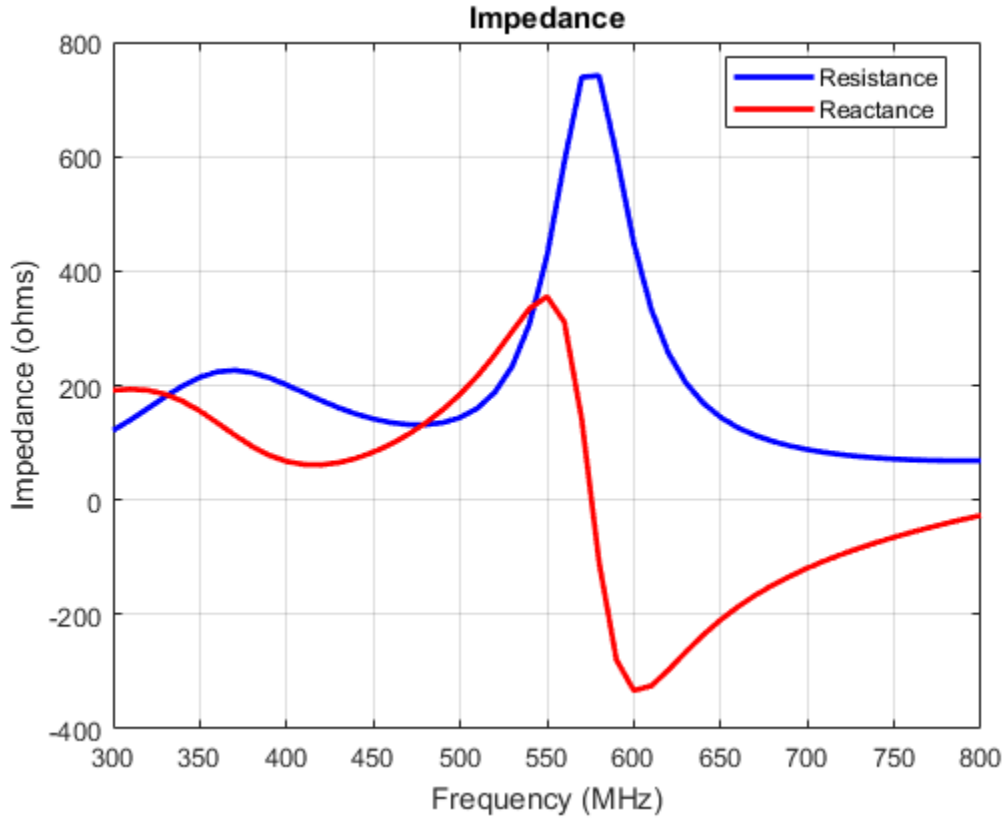
```
c.FeedLocation = [0,0.1,0];
```

```
figure;
show(c);
```



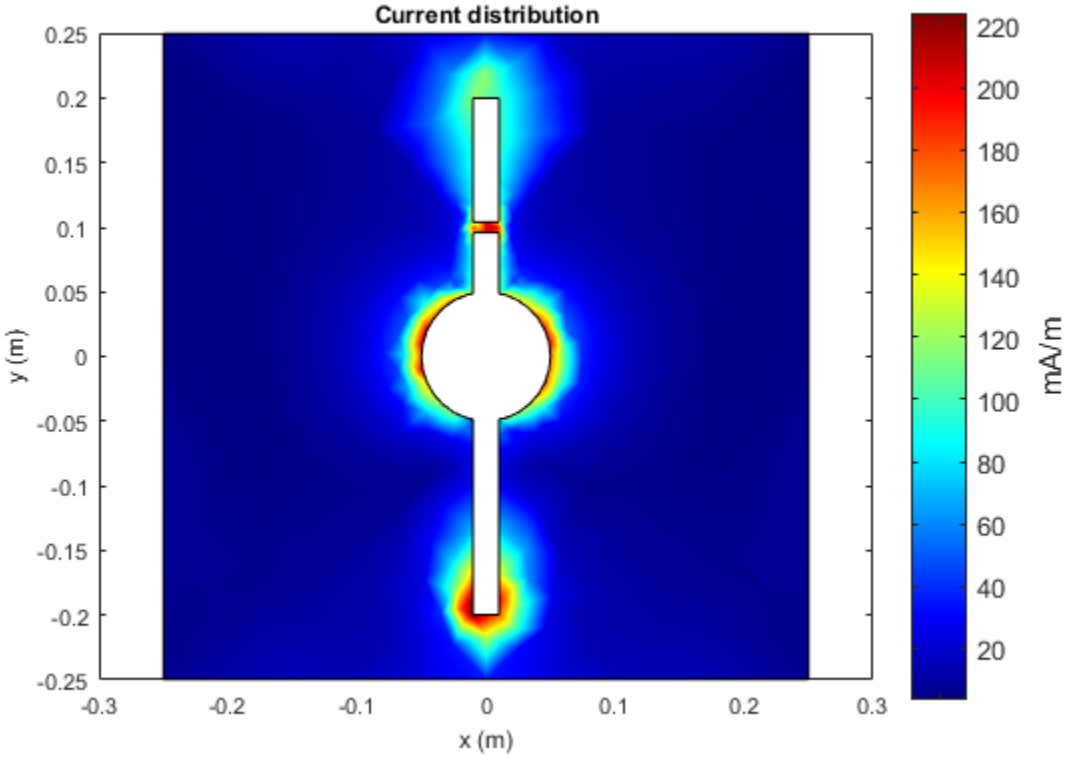
Analyze the impedance of the antenna from 300 MHz to 800 MHz.

```
figure;
impedance(c, linspace(300e6,800e6,51));
```



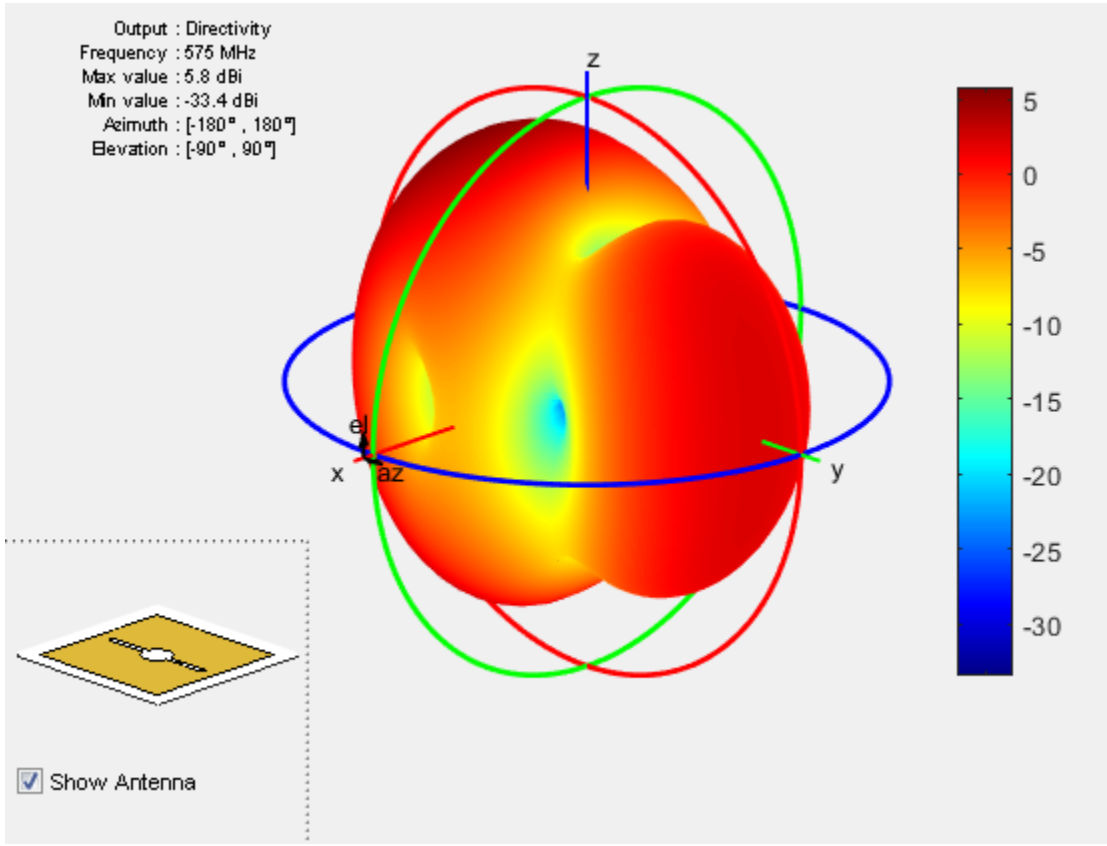
Analyze the current distribution of the antenna at 575 MHz.

```
figure;
current(c,575e6)
```



Plot the radiation pattern of the antenna at 575 MHz.

```
figure;
pattern(c,575e6)
```



References

[1] Balanis, C. A. *Antenna Theory. Analysis and Design*. 3rd Ed. Hoboken, NJ: John Wiley & Sons, 2005.

See Also

Topics

"Rotate Antenna and Arrays"

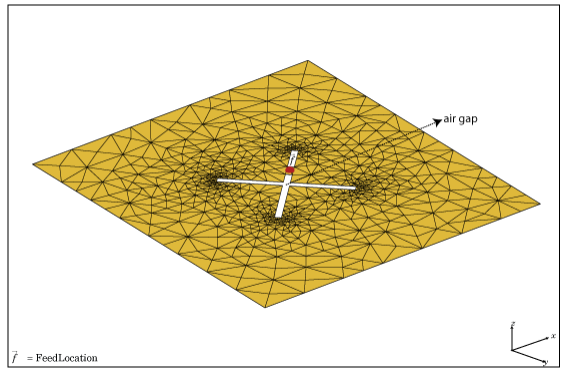
Introduced in R2016b

customAntennaMesh

Create 2-D custom mesh antenna on X-Y plane

Description

The `customAntennaMesh` object creates an antenna represented by a 2-D custom mesh on the X-Y plane. You can provide an arbitrary antenna mesh to the Antenna Toolbox and analyze this mesh as a custom antenna for port and field characteristics.



Create Object

Description

`customantenna = customAntennaMesh(points,triangles)` creates a 2-D antenna represented by a custom mesh, based on the specified points and triangles.

Input Arguments

`points` — Points in custom mesh

`2-by-N` or `3-by-N` integer matrix of Cartesian coordinates in meters

Points in a custom mesh, specified as a `2-by-N` or `3-by-N` integer matrix of Cartesian coordinates in meters. *N* is the number of points. In case you specify a `3x`*N* integer

matrix, the Z-coordinate must be zero or a constant value. This value sets the `'Points'` property in the custom antenna mesh.

Example: `[0 1 0 1;0 1 1 0]`

Data Types: `double`

`triangles` — Triangles in mesh

`4-by-M` integer matrix

Triangles in the mesh, specified as a `4-by-M` integer matrix. M is the number of triangles. The first three rows are indices to the points matrix and represent the vertices of each triangle. The fourth row is a domain number useful for identifying separate parts of an antenna. This value sets the `'Triangles'` property in the custom antenna mesh.

Data Types: `double`

Properties

`'Points'` — Points in custom mesh

`2-by-N` or `3-by-N` integer matrix of Cartesian coordinates in meters

Points in a custom mesh, specified as a `2-by-N` or `3-by-N` integer matrix of Cartesian coordinates in meters. N is the number of points.

Example: `[0.1 0.2 0]`

Data Types: `double`

`'Triangles'` — Triangles in mesh

`4-by-M` integer matrix

Triangles in the mesh, specified as a `4-by-M` integer matrix. M is the number of triangles.

Data Types: `double`

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of antenna

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, "Rotate Antenna and Arrays"

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

createFeed	Create feed location for custom antenna
axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure

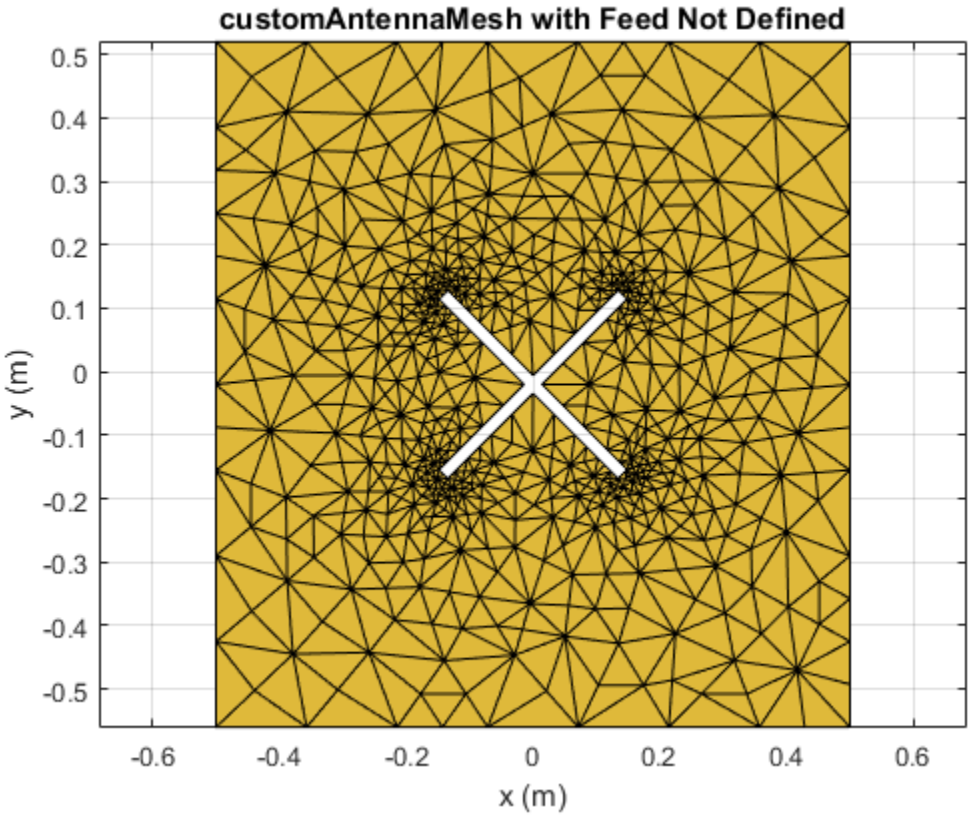
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
vswr	Voltage standing wave ratio of antenna

Examples

Custom Planar Mesh Antenna

Load a custom planar mesh. Create the antenna and antenna feed. View the custom planar mesh antenna and calculate the impedance at 100 MHz.

```
load planarmesh.mat;
c = customAntennaMesh(p,t);
show(c)
```




```
createFeed(c,[0.07,0.01],[0.05,0.05]);
Z = impedance(c,100e6)
```

```
Z =

   0.5377 +55.2703i
```

References

[1] Balanis, C.A. *Antenna Theory: Analysis and Design*. 3rd Ed. New York: Wiley, 2005.

See Also

See Also

cavity | reflector

Topics

“Rotate Antenna and Arrays”

Introduced in R2015b

pcbStack

Single-feed or multifeed PCB antenna

Description

The `pcbStack` object is a Single-feed or multifeed printed circuit board (PCB) antenna. Using the PCB stack, you can create antennas using single-layer or multilayer metal or metal-dielectric substrates. You can also use the PCB stack to create antennas with an arbitrary number of feeds and vias.

Create Object

`pcbant = pcbStack` creates a single-feed PCB antenna represented by air-filled substrate in between two metal layers.

`pcbant = pcbStack(Name,Value)` creates a PCB antenna, with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'Name'` — Name of PCB antenna

`'MyPCB'` (default) | character vector

Name of PCB antenna, specified as the comma-separated pair consisting of `'Name'` and a character vector.

Example: `'Name','PCBPatch'`

Data Types: `char`

`'Revision'` — Revision details of PCB antenna design

`'1.0'` (default) | character vector

Revision details of PCB antenna design, specified as the comma-separated pair consisting of `'Revision'` and a character vector.

Example: `'Revision','2.0'`

Data Types: `char`

`'BoardShape'` — Shape of PC board

`antenna.Rectangle` (default) | object handle

Shape of PC board, specified as the comma-separated pair consisting of `'BoardShape'` and a object handle. Rectangle is the only supported board shape.

Example: `'BoardShape',antenna.Rectangle`

`'BoardThickness'` — Thickness of PC board

`0.0100` (default) | positive scalar

Thickness of PC board, specified as the comma-separated pair consisting of `'BoardThickness'` and a positive scalar.

Example: `'BoardThickness',0.02000`

Data Types: `double`

`'Layers'` — Metal and dielectric layers

`{[1×1 antenna.Rectangle] [1×1 antenna.Rectangle]}` (default) | cell array of metal layer shapes and dielectric

Metal and dielectric layers, specified as the comma-separated pair consisting of `'Layers'` and a cell array of metal layer shapes and dielectric. You can specify one metal shape or one dielectric per layer starting with the top layer and proceeding down.

Data Types: `double`

`'FeedLocations'` — Feed locations for antenna in Cartesian coordinates

`[-0.0187 0 1 2]` (default) | *N* -by-3 or *N*-by-4 array

Feed locations for PCB antenna in Cartesian coordinates, specified as the comma-separated pair consisting of `'FeedLocations'` and *N* -by-3 or *N*-by-4 array. The arrays translate to the following:

- *N* -by-3 – [*x*, *y*, *Layer*]
- *N*-by-4 – [*x*, *y*, *SigLayer*, *GndLayer*]

Example: `'FeedLocations',[-0.0187 0 1 2]`

Data Types: `double`

`'FeedDiameter'` — Center pin diameter of feed connector

`1.0000e-03` (default) | positive scalar in meters

Center pin diameter of feed connector, specified as the comma-separated pair consisting of `'FeedDiameter'` and a positive scalar in meters.

Example: `'FeedDiameter',2.000e-04`

Data Types: `double`

`'ViaLocations'` — Electrical short locations for antenna in Cartesian coordinates

`[0 0 0]` (default) | real vector of size *M*-by-4 array

Electrical short locations for antenna in Cartesian coordinates, specified as the comma-separated pair consisting of, `'ViaLocations'` and a real vector of size *M*-by-4 array. The arrays translate to the following:

- *M*-by-4 – [*x*, *y*, *SigLayer*, *GndLayer*]

Example: `'ViaLocations',[0 -0.025 1 2]`

Data Types: `double`

`'ViaDiameter'` — Electrical shorting pin diameter between metal layers

positive scalar in meters

Electrical shorting pin diameter between metal layers, specified as the comma-separated pair consisting of `'ViaDiameter'` and a positive scalar in meters.

Example: `'ViaDiameter',1.0e-3`

Data Types: `double`

`'FeedVoltage'` — Magnitude voltage applied at the feeds

1 (default) | positive scalar in volts

Magnitude voltage applied at the feeds, specified as the comma-separated pair consisting of `'FeedVoltage'` and a positive scalar in volts.

Example: `'FeedVoltage',2`

Data Types: `double`

'FeedPhase' — Excitation phase at each feed

0 (default) | real vector in degrees

Excitation phase at each feed, specified as the comma-separated pair consisting of 'FeedPhase' and real vector in degrees.

Example: 'FeedPhase',2

Data Types: double

'Load' — Lumped elements

[1x1 LumpedElement] (default) | lumped element object handle

Lumped elements added to the antenna feed, specified as the comma-separated pair consisting of 'Load' and a lumped element object handle. For more information, see lumpedElement.

Example: 'Load',lumpedelement. lumpedelement is the object handle for the load created using lumpedElement.

'Tilt' — Tilt angle of antenna or array

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna or array, specified as the comma-separated pair consisting of 'Tilt' and a scalar or vector in degrees.

Example: 'Tilt',90

Example: 'Tilt',[90 90 0]

Data Types: double

'TiltAxis' — Tilt axis of antenna

[1 0 0] (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | 'X' | 'Y' | 'Z'

Tilt axis of the antenna, specified as the comma-separated pair consisting of 'TiltAxis' and one of the following:

- A three-element vector of Cartesian coordinates in meters. The first element is the origin and the third element is the Z-axis.
- Two three-element vectors of Cartesian coordinates, representing two points in space as . The antenna rotates along the line joining the two points space.

- X, Y, or Z representing simple rotations around the principal planes.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

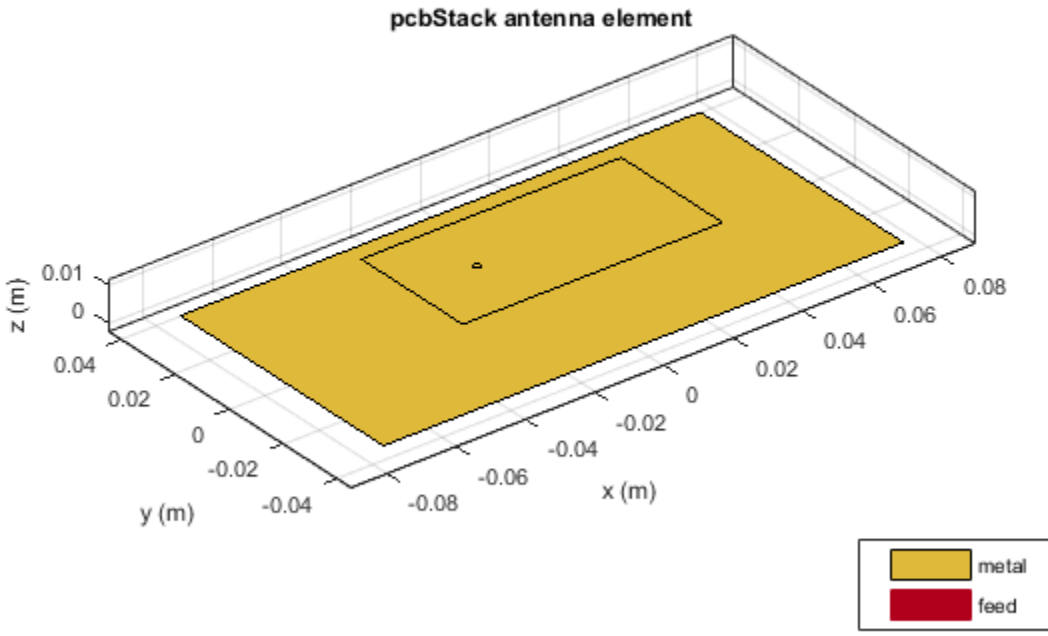
axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
show	Display antenna or array structure
vswr	Voltage standing wave ratio of antenna

Examples

Default PCB Antenna

Create and view a default PCB antenna.

```
p = pcbStack
show(p);


p =

  pcbStack with properties:

            Name: 'MyPCB'
        Revision: 'v1.0'
       BoardShape: [1×1 antenna.Rectangle]
    BoardThickness: 0.0100
           Layers: {[1×1 antenna.Rectangle]  [1×1 antenna.Rectangle]}
     FeedLocations: [-0.0187 0 1 2]
      FeedDiameter: 1.0000e-03
      ViaLocations: []
       ViaDiameter: []
       FeedVoltage: 1
         FeedPhase: 0
              Tilt: 0
          TiltAxis: [1 0 0]
              Load: [1×1 lumpedElement]
```



End loaded planar dipole

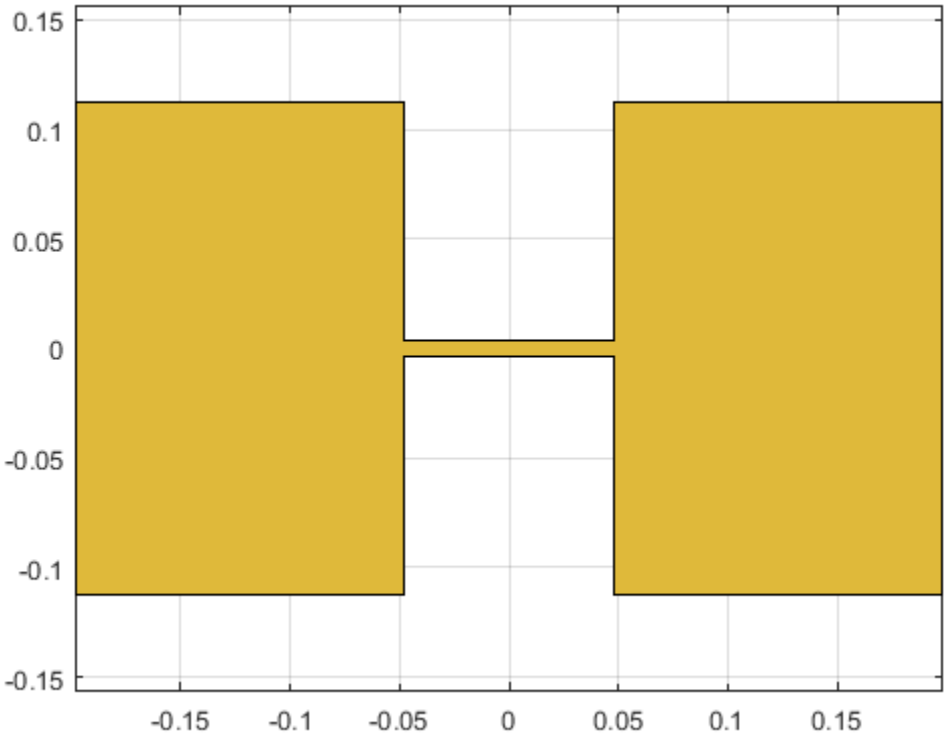
Setup parameters.

```
vp  = physconst('lightspeed');
f   = 850e6;
lambda = vp./f;
```

Build a planar dipole with capacitive loading at the ends.

```
L = 0.15;
W = 1.5*L;
stripL = L;
gapx = .015;
gapy = .01;
```

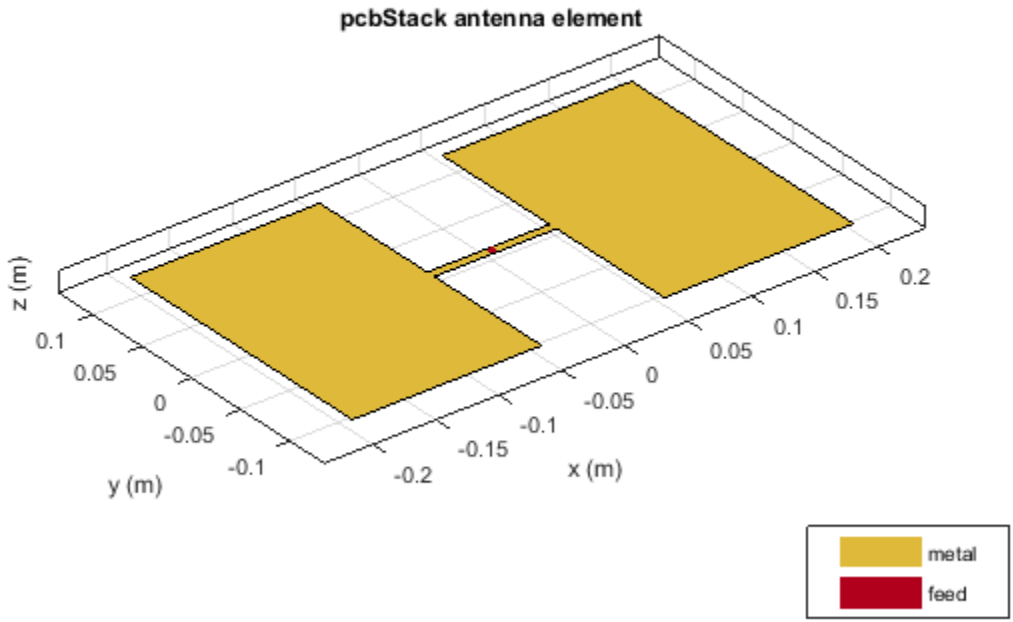
```
r1 = antenna.Rectangle('Center',[0,0],'Length',L,'Width',W,'Center',[lambda*0.35,0]);
r2 = antenna.Rectangle('Center',[0,0],'Length',L,'Width',W,'Center',[-lambda*0.35,0]);
r3 = antenna.Rectangle('Length',0.5*lambda,'Width',0.02*lambda,'NumPoints',2);
s = r1 + r2 + r3;
figure
show(s)
```



Assign the radiator shape to pcbStack and make the changes to the board shape and feed diameter properties.

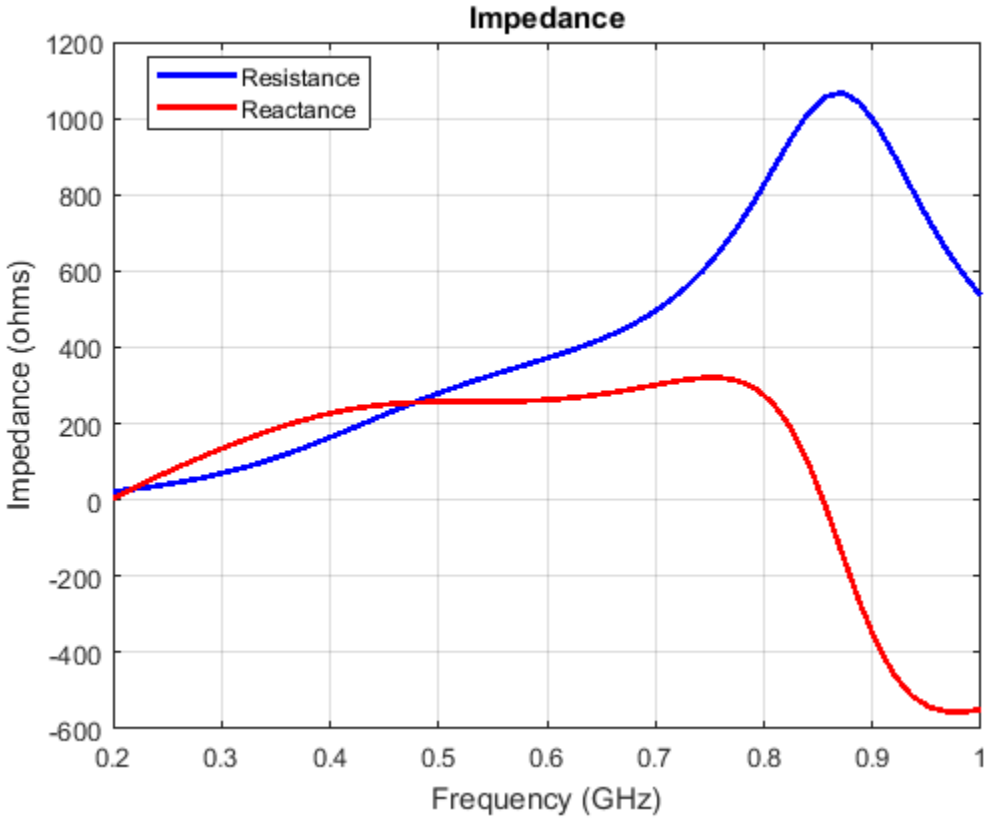
```
boardShape = antenna.Rectangle('Length',0.6,'Width',0.3);
p = pcbStack;
p.BoardShape = boardShape;
p.Layers = {s};
```

```
p.FeedDiameter = .02*lambda/2;
p.FeedLocations = [0 0 1];
figure
show(p)
```



Analyse the impedance of the antenna. Effect of the end-loading should result in the series resonance to be pushed lower in the band.

```
figure
impedance(p,linspace(200e6,1e9,51))
```



- "Design Variations On Microstrip Patch Antenna Using PCB Stack"

References

[1] Balanis, C. A. *Antenna Theory. Analysis and Design*. 3rd Ed. Hoboken, NJ: John Wiley & Sons, 2005.

[2] Stutzman, W. L. and Gary A. Thiele. *Antenna Theory and Design*. 3rd Ed. River Street, NJ: John Wiley & Sons, 2013.

See Also

See Also

customAntennaMesh | customArrayMesh

Topics

“Design Variations On Microstrip Patch Antenna Using PCB Stack”
“Rotate Antenna and Arrays”

Introduced in R2017a

Antenna Apps — Alphabetical List

Antenna Designer

Design, visualize, and analyze antennas

Description

The **Antenna Designer** app lets you design, visualize, and analyze antennas in the Antenna Toolbox library interactively.

Using this app, you can:

- Select antennas based on general properties or antenna perfromance.
- Visualize antennas based on frequency and frequency range.
- Analyze antennas based on radiation pattern, polarization, and bandwidth.
- Export selected and designed antennas as a variable to the MATLAB® workspace, as either live script or a function.

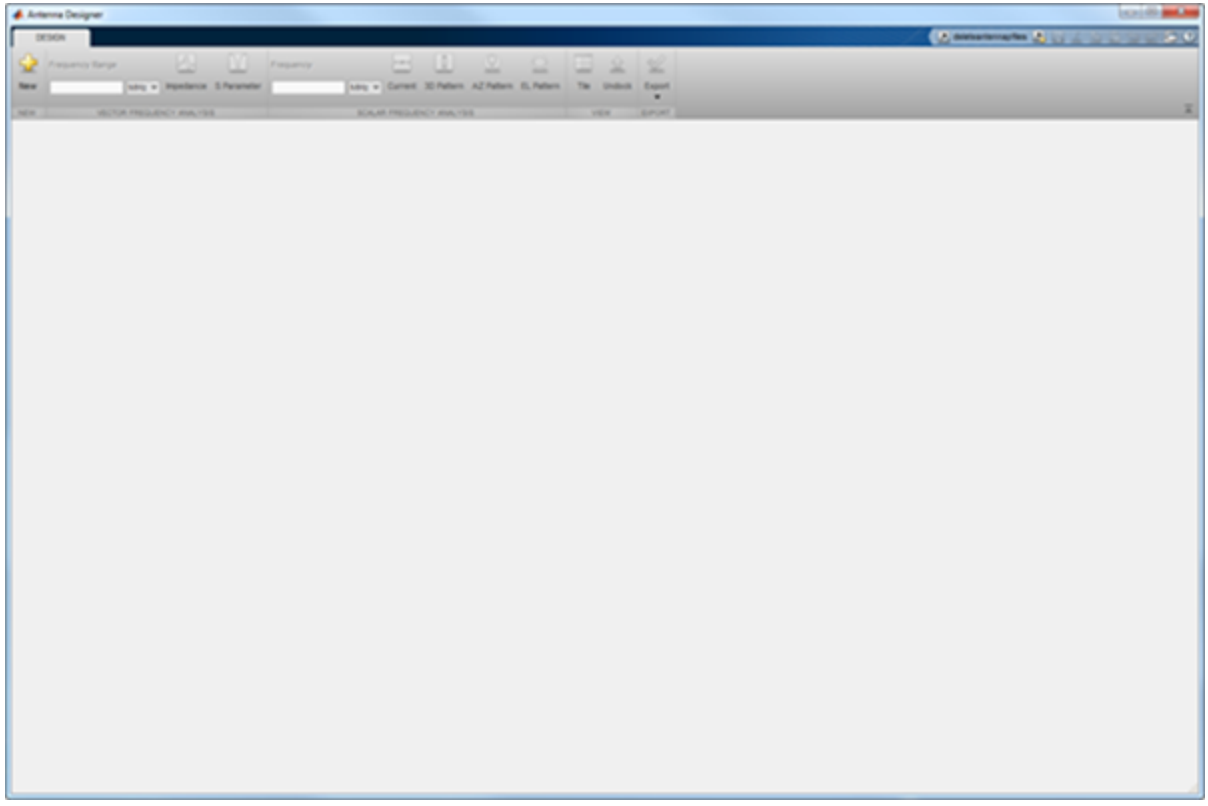
Open the Antenna Designer App

- MATLAB Toolstrip: In the **Apps** tab, under **Signal Processing and Communications**, click the app icon.
- MATLAB command prompt: Enter `antennaDesigner`.

Examples

Antenna Designer Canvas

The **Antenna Designer** opens a blank canvas.



1 Select and Visualize Antenna

- Click

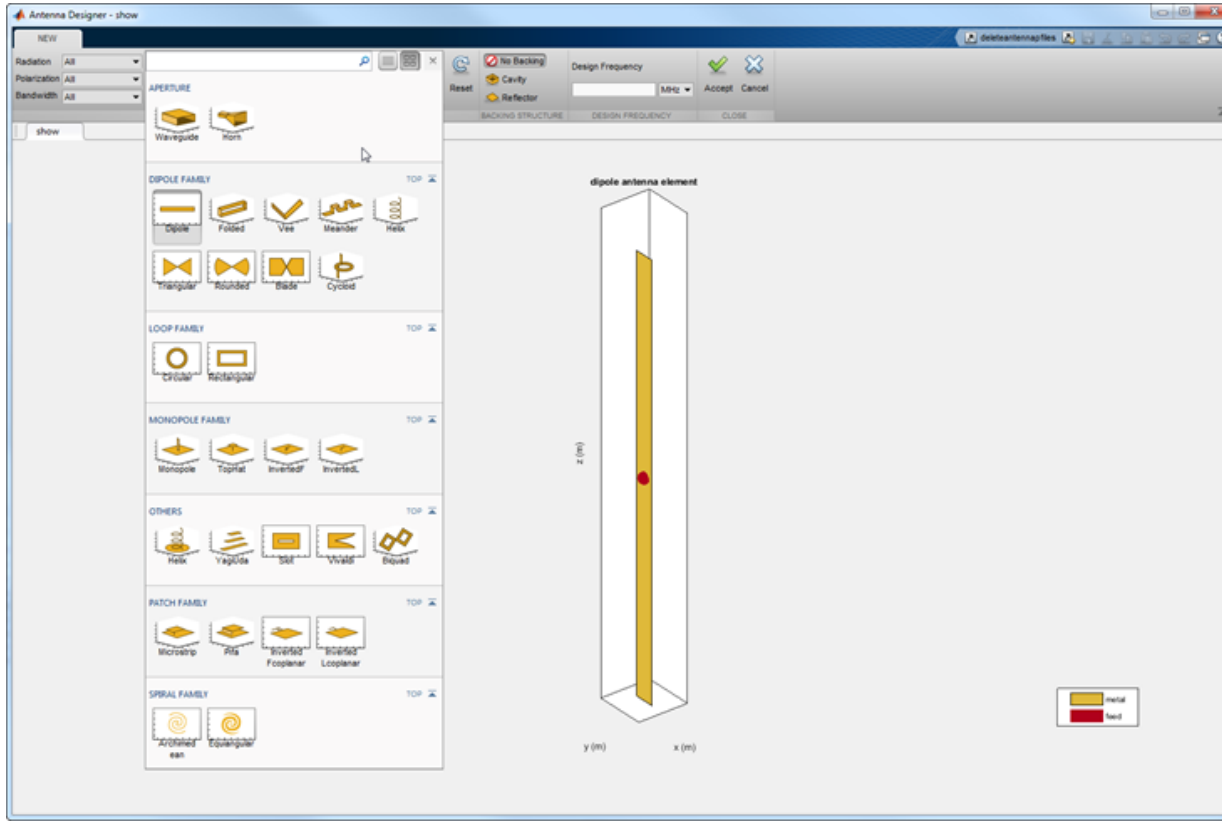
  in the canvas toolstrip to choose the antenna you want to analyze.
- The default antenna is a dipole antenna.

You can filter the antennas based on `Radiation` pattern, `Polarization`, and `Bandwidth`.

- Using the toolstrip you can also add **Cavity** backing, or **Reflector** backing to the antennas.
- You can also specify the **Design Frequency** of the antenna. Setting this value scales the antenna to resonate at the specified frequency. You can also tune the antenna using **Antenna Properties** tab during analysis.
- Use **Reset**, to go back to default settings.
- Use **Accept**, to analyze the antenna characteristics.
- Use **Cancel**, to start over.

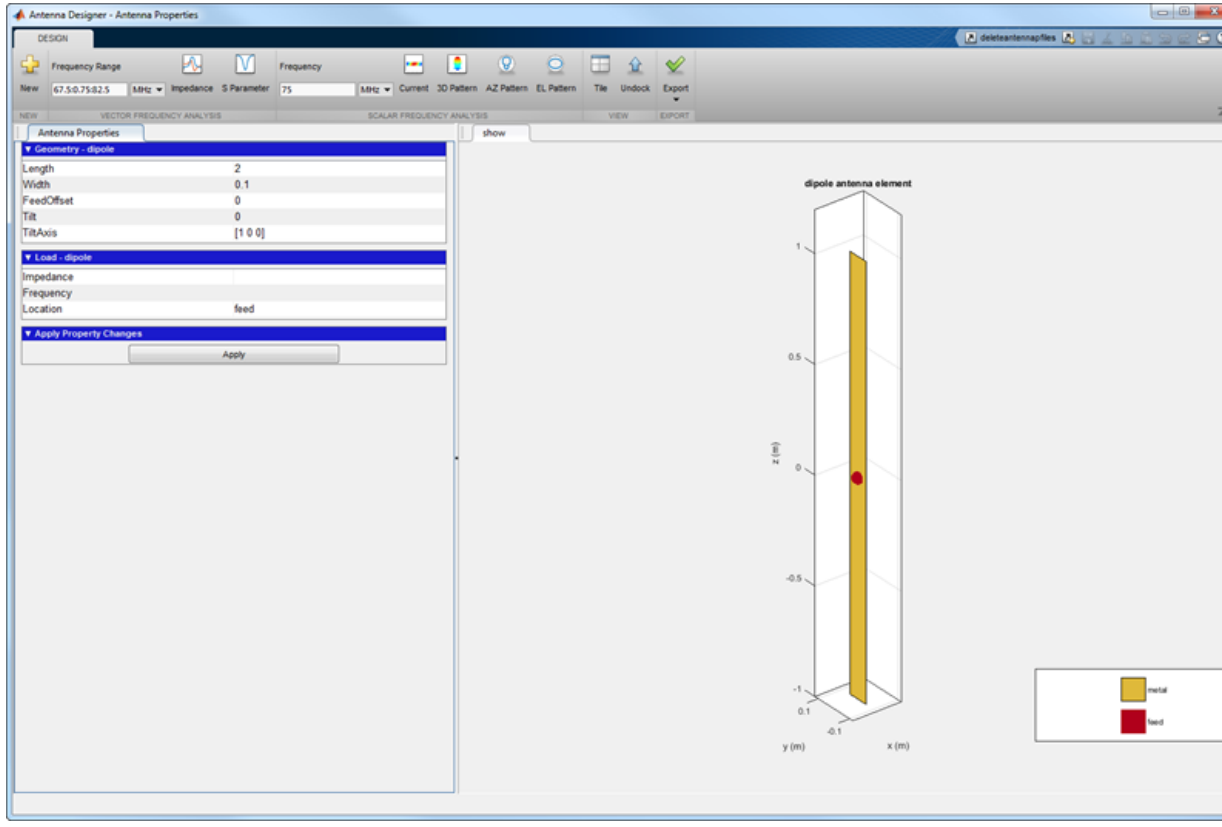
2 Antenna Gallery

- You can choose your antennas from the **Antenna Gallery**.



- The **Antenna Gallery** drop-down menu consists of: `APERTURE`, `DIPOLE FAMILY`, `LOOP FAMILY`, `MONOPOLE FAMILY`, `OTHERS`, `PATCH FAMILY`, and `SPIRAL FAMILY`.
- When you filter antennas based on `Radiation` pattern, `Polarization`, or `Bandwidth`, the antenna gallery greys out the antennas that do not belong to the chosen filter.

3 Analyze Antenna



You can plot the **Impedance** and **S Parameter** of the antenna based on the specified **Frequency Range** in Hz.

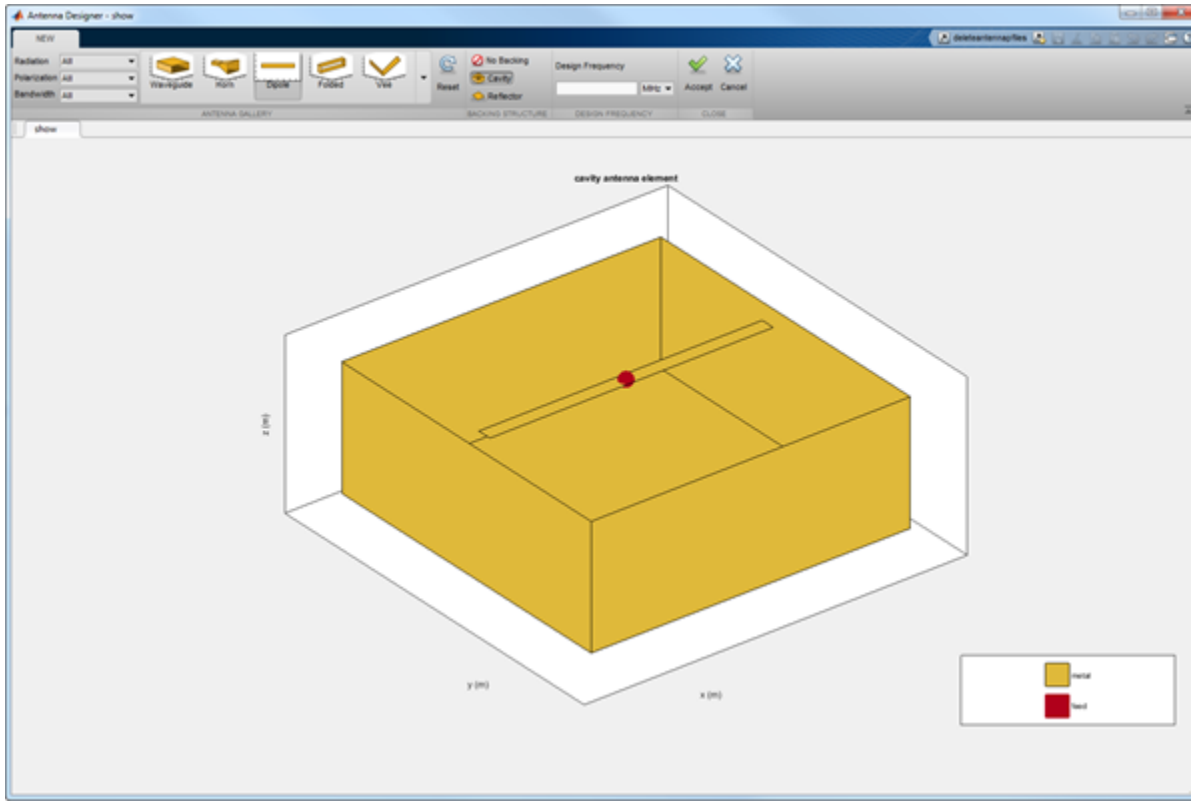
- You can visualize the **Current** distribution on the antenna based on the specified **Frequency** in Hz.
- You can visualize the **3D Pattern**, **AZ Pattern**, **EL Pattern** of the antenna based on the specified frequency. Here AZ stands for azimuth and EL stands for elevation.
- Use **Export** to view your antenna in MATLAB workspace or MATLAB script.
- Manually change the antenna properties using the **Antenna Properties** tab. In this tab, you can change the geometrical properties of the antenna, add a dielectric substrate to the antenna, and change the value and location of the load.

Plot Radiation Pattern of Cavity-Backed Dipole

Use the **Antenna Designer** app to plot the radiation pattern of a cavity-backed dipole antenna.

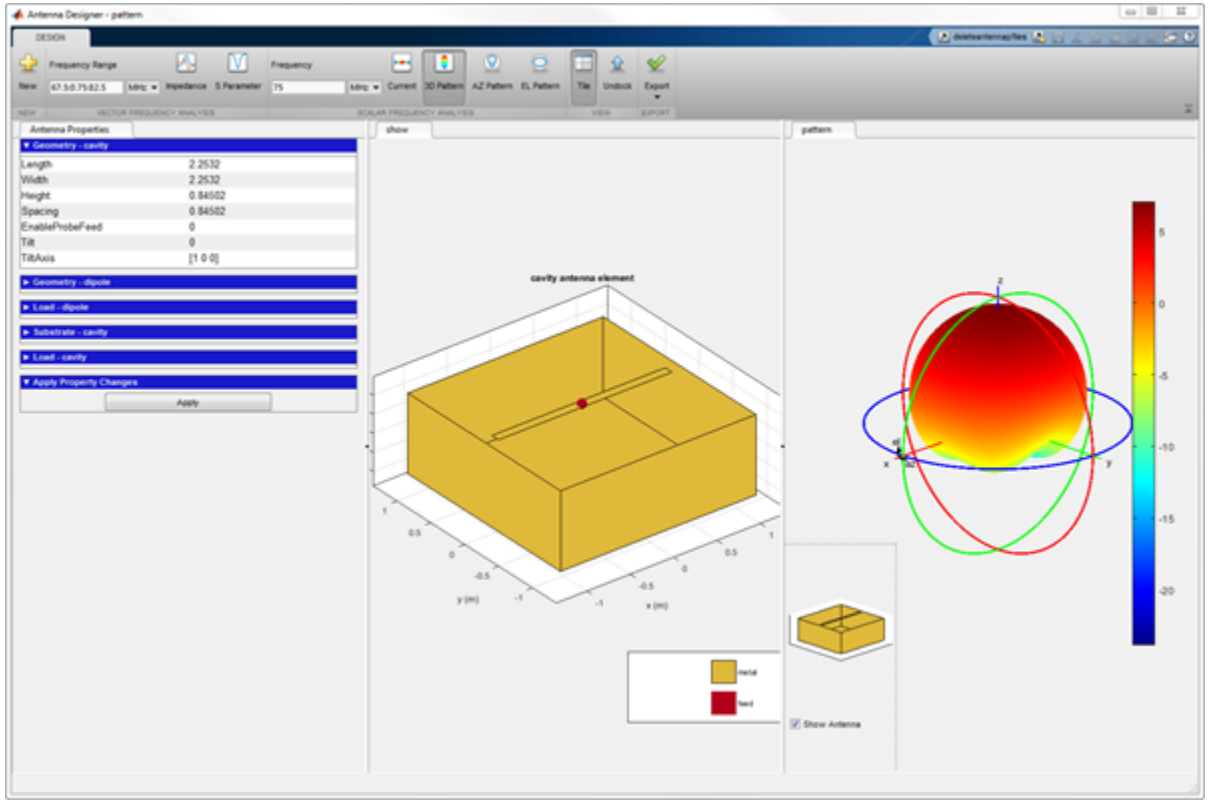
Open the app and click **New** to show the default dipole antenna.

In the **Backing Structure section,** click **Cavity** to create a cavity-backed dipole antenna.



Click **Accept.**

In **SCALAR FREQUENCY ANALYSIS**, click **3D Pattern** to calculate the radiation pattern of the cavity-backed dipole. The default frequency used is 75 MHz. Click **Tile** to view both the antenna and the radiation pattern.

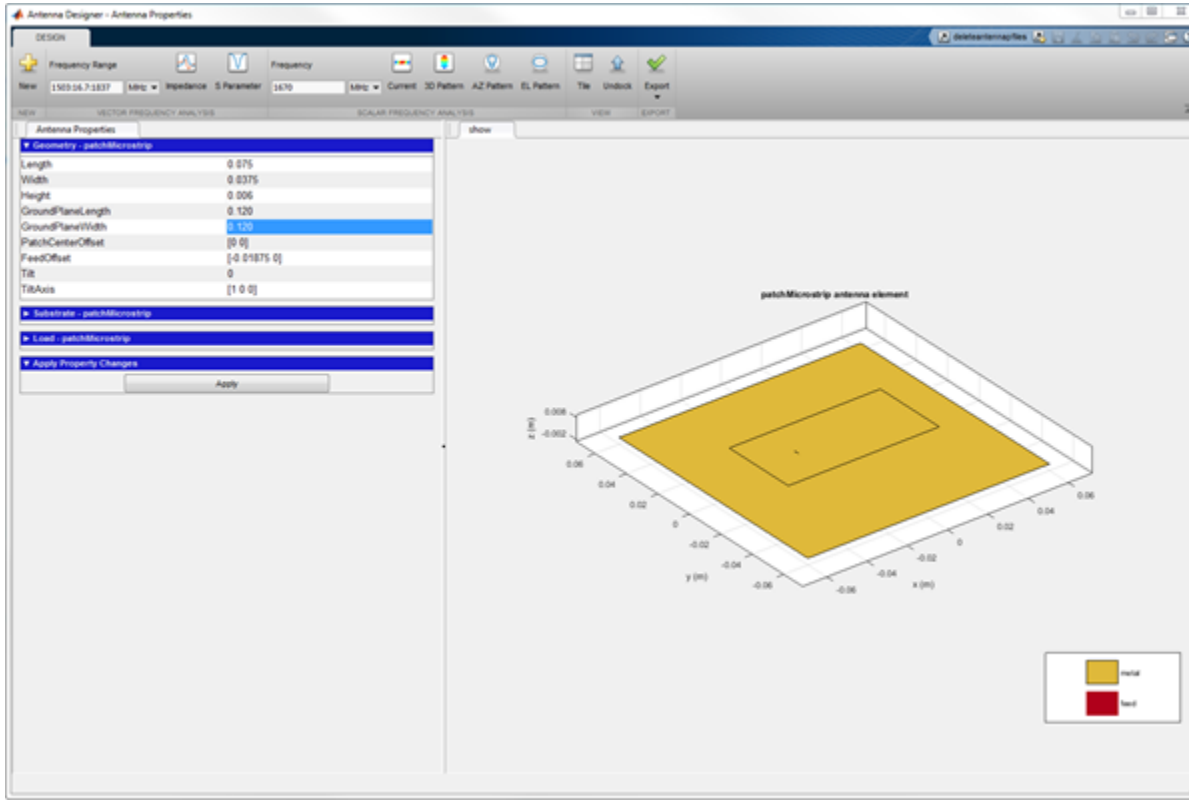


Analyze Patch Microstrip Antenna Having Dielectric Substrate

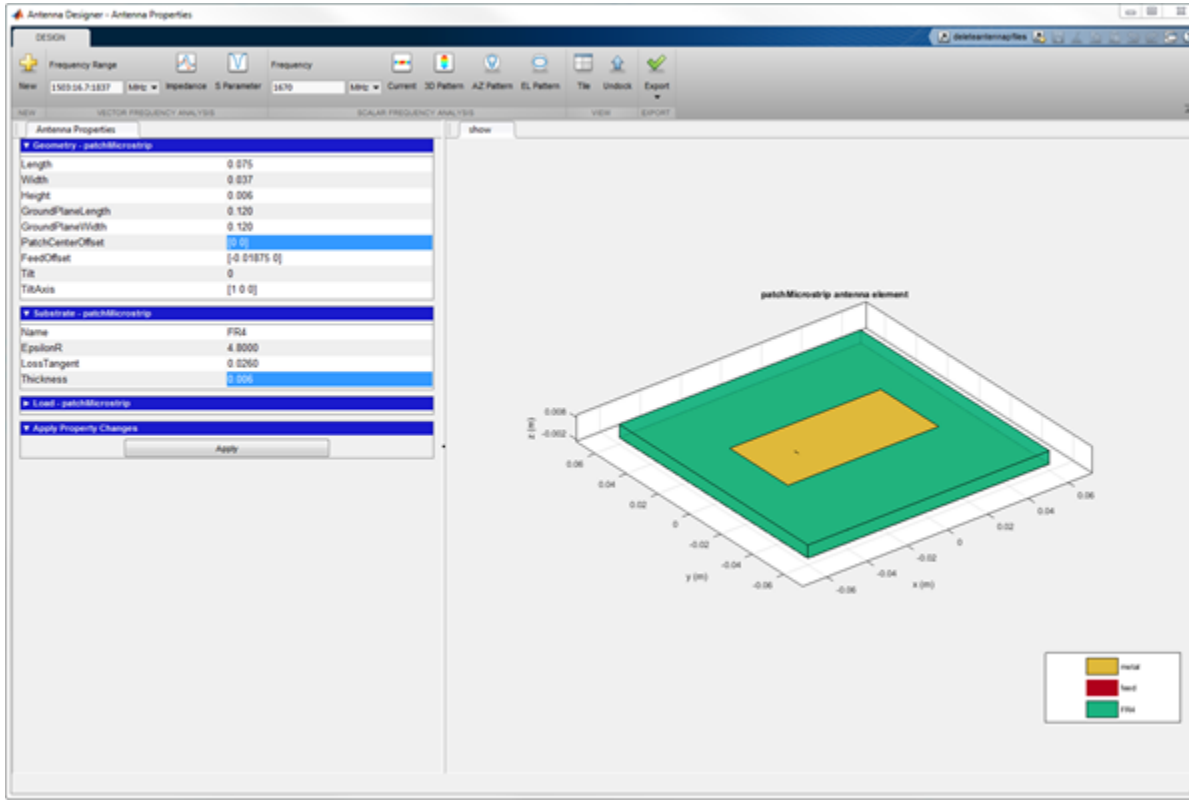
Use the **Antenna Designer** app to plot the radiation pattern of a patch microstrip antenna with a dielectric substrate.

Open the app and click **New**. In the **ANTENNA GALLERY** section, under **PATCH FAMILY**, click `Microstrip` Click **Accept**.

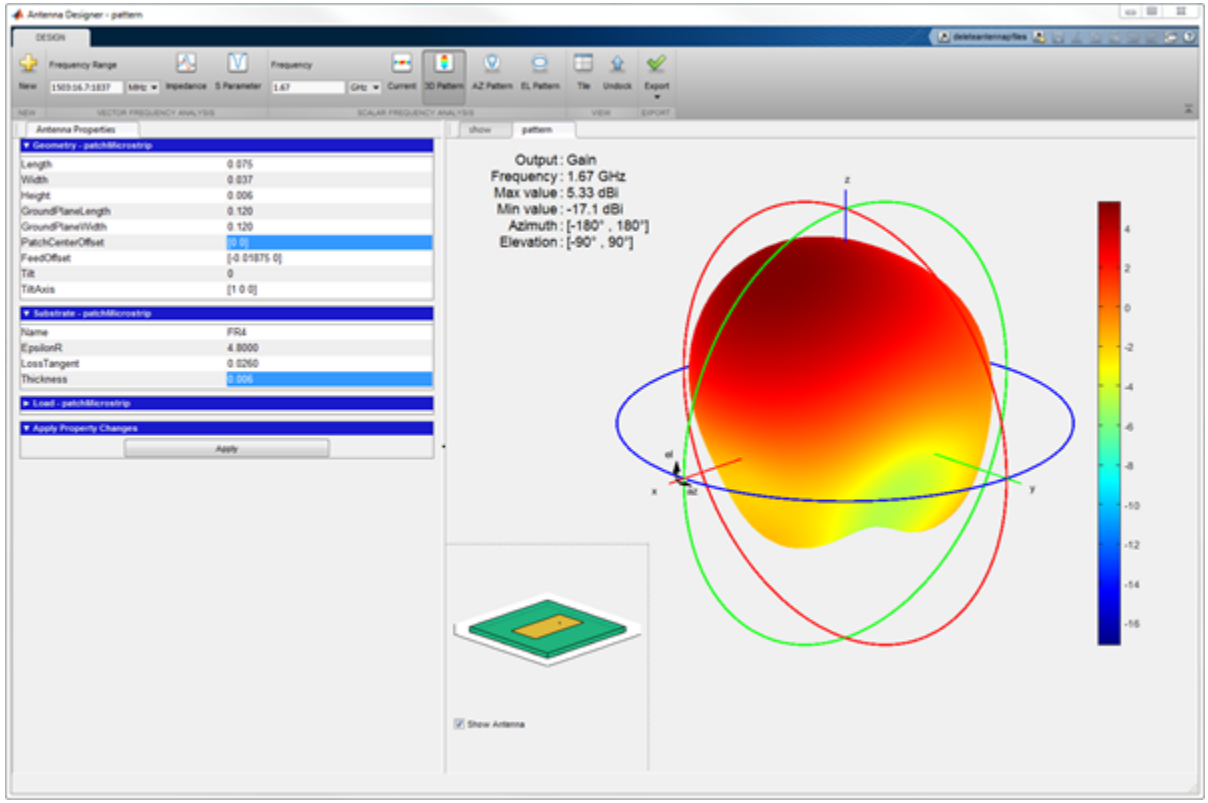
On the **Antenna Properties** tab, change the groundplane length and groundplane width to 0.120 m. Click **Apply** to see the changes.



Add an FR4 dielectric as a substrate to the patch microstrip antenna. To add the dielectric, open the **Substrate** section and set **Name** to FR4, **EpsilonR** to 4.8000, and **Loss Tangent** to 0.0260. Click **Apply** to see the antenna.



Click **3D Pattern** to plot the radiation patttern of the antenna at the default frequency of 1.67 GHz.



- “Antenna Design and Analysis Using Antenna Designer App”

Programmatic Use

`antennaDesigner` opens the **Antenna Designer** app, enabling you to design and analyze antennas present in the Antenna Toolbox library.

See Also

Topics

“Antenna Design and Analysis Using Antenna Designer App”

Introduced in R2017a

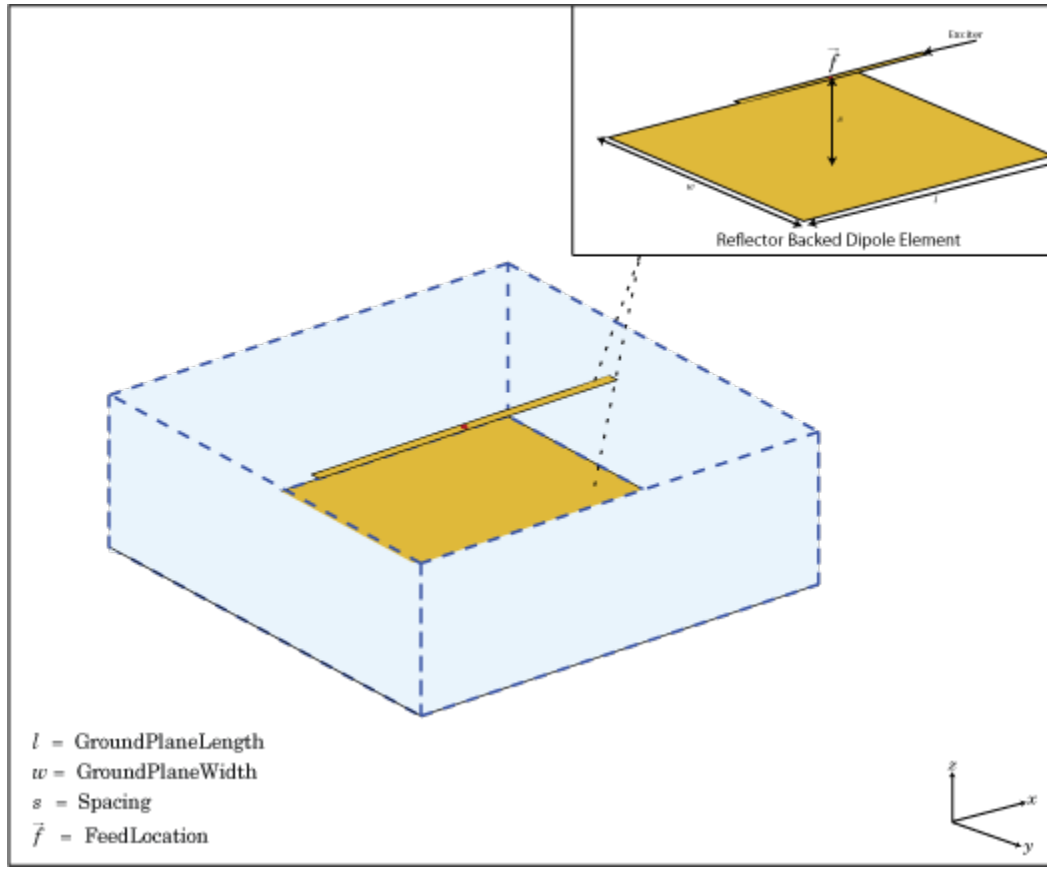
Array Objects— Alphabetical List

infiniteArray

Create 2-D custom mesh antenna on X-Y plane

Description

The `infiniteArray` object is an infinite antenna array in the X-Y plane. Infinite array models a single antenna element called the *unit cell*. Ground plane of the antennas specifies the boundaries of the unit cell. Antennas without a ground plane require a reflector. By default, the infinite array has reflected-backed dipoles as antenna elements. The default dimensions are chosen for an operating frequency of 1 GHz.



Create Object

Description

`infa = infiniteArray` creates an infinite antenna array in the X-Y plane.

`infa = infiniteArray(Name,Value)` creates an infinite antenna array with additional properties specified by one, or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1, Value1, ..., NameN, ValueN`. Properties not specified retain default values.

Properties

`'Element'` — Type of individual antenna elements in unit cell

reflector-backed dipole (default) | antenna object

Type of individual antenna elements in unit cell, specified as the comma-separated pair consisting of `'Element'` and an antenna object. Antennas without a groundplane is backed using a reflector. The ground plane size specifies the unit cell boundaries.

Example: `'Element',reflector`

`'ScanAzimuth'` — Scan direction in azimuth plane

0 (default) | scalar in degrees

Scan direction in azimuth plane, specified as the comma-separated pair consisting of `'ScanAzimuth'` and a scalar in degrees.

Example: `'ScanAzimuth',25`

Data Types: `double`

`'ScanElevation'` — Scan direction in elevation plane

0 (default) | scalar in degrees

Scan direction in elevation plane, specified as the comma-separated pair consisting of `'ScanElevation'` and a scalar in degrees.

Example: `'ScanElevation',80`

Data Types: `double`

Object Functions

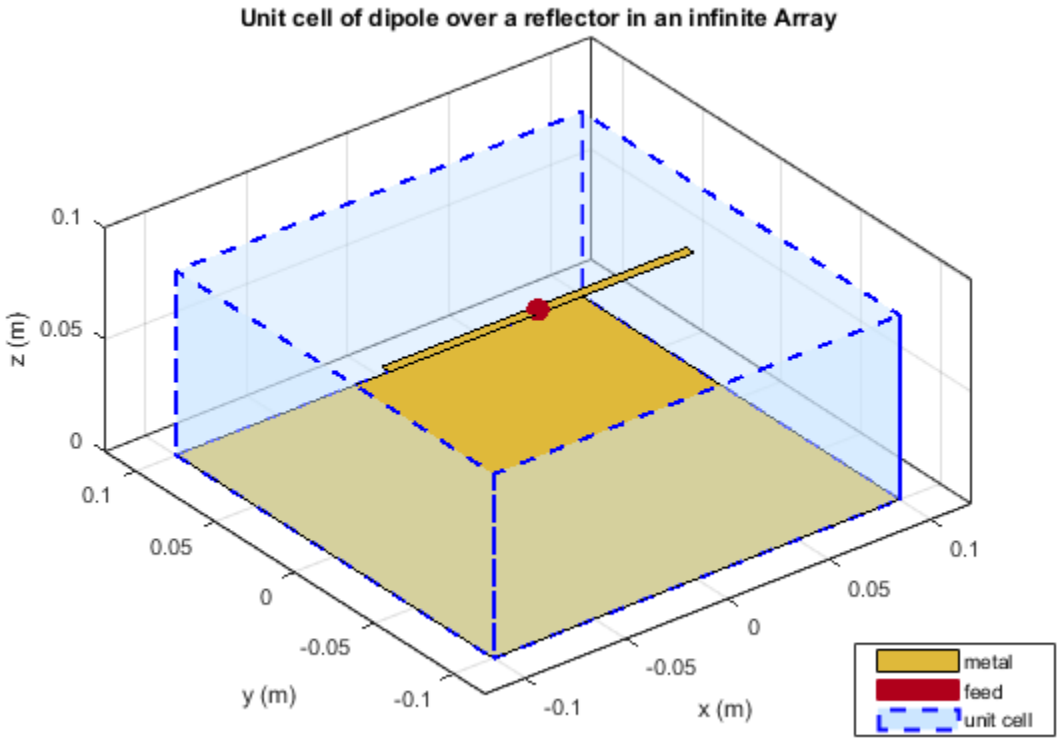
numSummationTerms	Change number of summation terms for calculating periodic Green's function

Examples

Infinite Array of Reflector-Backed Dipoles

Create an infinite array with reflector-backed dipoles as unit cells. Scan the array at boresight. Visualize the unit cell.

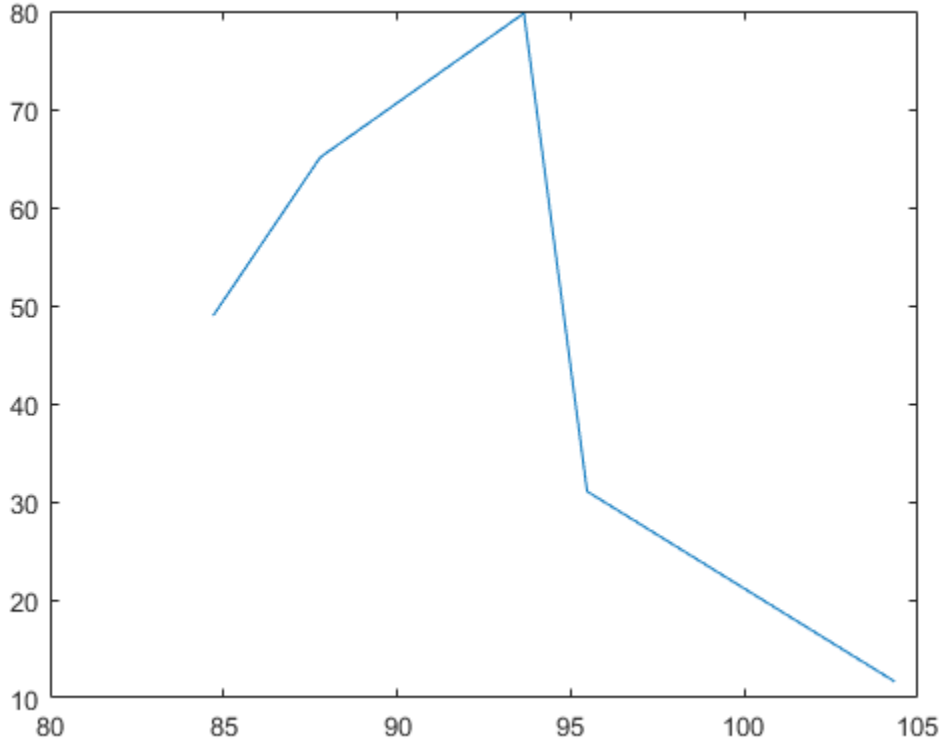
```
infa = infiniteArray('Element',reflector,'ScanAzimuth',0, ...
    'ScanElevation',90);
show(infa)
```



Scan Impedance of Infinite Array

Calculate the scan impedance of an infinite array at 1GHz. To calculate the impedance, scan the inifinite array from boresight to horizon in the elevation plane.

```
infa = infiniteArray;
theta0deg = linspace(0,90,5);
zscan = nan(1,numel(theta0deg));
    for j = 1:numel(theta0deg)
      infa.ScanElevation = theta0deg(j);
      zscan(1,j) = impedance(infa,1e9);
    end
 plot(zscan)
```



References

[1] Balanis, C.A. *Antenna Theory: Analysis and Design*. 3rd Ed. New York: Wiley, 2005.

See Also

See Also

circularArray | conformalArray | linearArray | rectangularArray

Topics

"Rotate Antenna and Arrays"

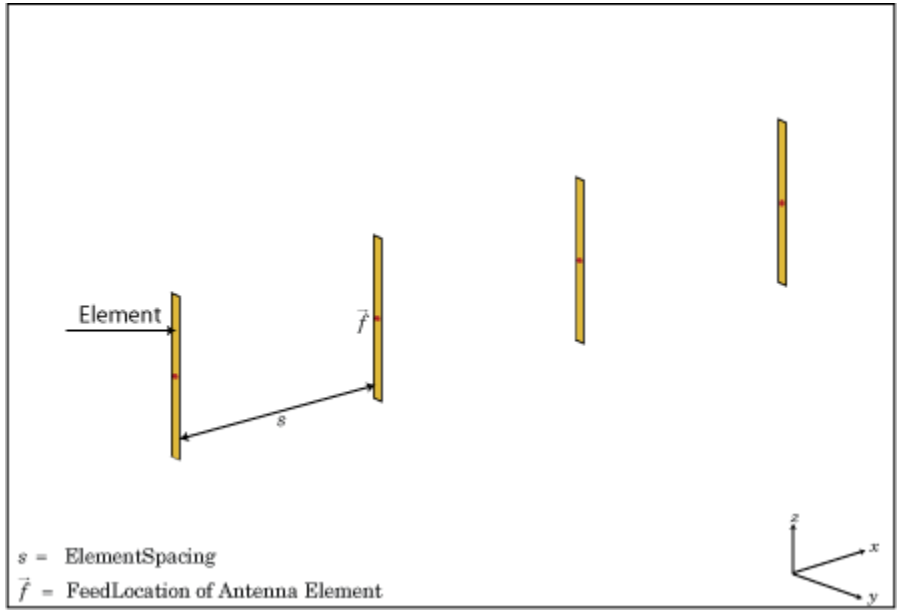
Introduced in R2015b

linearArray

Create linear antenna array

Description

The `linearArray` class creates a linear antenna array in the X-Y plane. By default, the linear array is a two-element dipole array. The dipoles are center fed. Each dipole resonates at 70 MHz when isolated.



Create Object

`la = linearArray` creates a linear antenna array in the X-Y plane.

`la = linearArray(Name,Value)` class to create a linear antenna array, with additional properties specified by one, or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-

value pair arguments in any order as `Name1`, `Value1`,`...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'Element'` — Individual antenna elements used in array

dipole (default) | antenna object

Individual antenna elements used in array, specified as the comma-separated pair consisting of `'Element'` and an antenna object.

Example: `'Element',monopole`

`'NumElements'` — Number of antenna elements in array

2 (default) | scalar

Number of antenna elements in array, specified as the comma-separated pair consisting of `'NumElements'` and a scalar.

Example: `'NumElements',4`

`'ElementSpacing'` — Spacing between antenna elements

2 (default) | scalar in meters | vector in meters

Spacing between antenna elements, specified as the comma-separated pair consisting of `'ElementSpacing'` and a scalar or vector in meters. By default, the dipole elements are spaced `2 m` apart.

Example: `'ElementSpacing',3`

Data Types: `double`

`'AmplitudeTaper'` — Excitation amplitude of antenna elements

1 (default) | scalar | vector

Excitation amplitude of antenna elements , specified as a the comma-separated pair consisting of `'AmplitudeTaper'` and a scalar or vector. Set the property value to `0` to model dead elements. This value corresponds to the excitation voltages for the elements in the array.

Example: `'AmplitudeTaper',3`

Data Types: `double`

`'Phaseshift'` — Phase shift for antenna elements

0 (default) | scalar in degrees | vector in degrees

Phase shift for antenna elements, specified as the comma-separated pair consisting of `'PhaseShift'` and a scalar or vector in degrees. This value corresponds to the excitation voltages for the elements in the array.

Example: `'PhaseShift',[3 3 0 0]`

Data Types: `double`

`'Tilt'` — Tilt angle of array

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of array

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

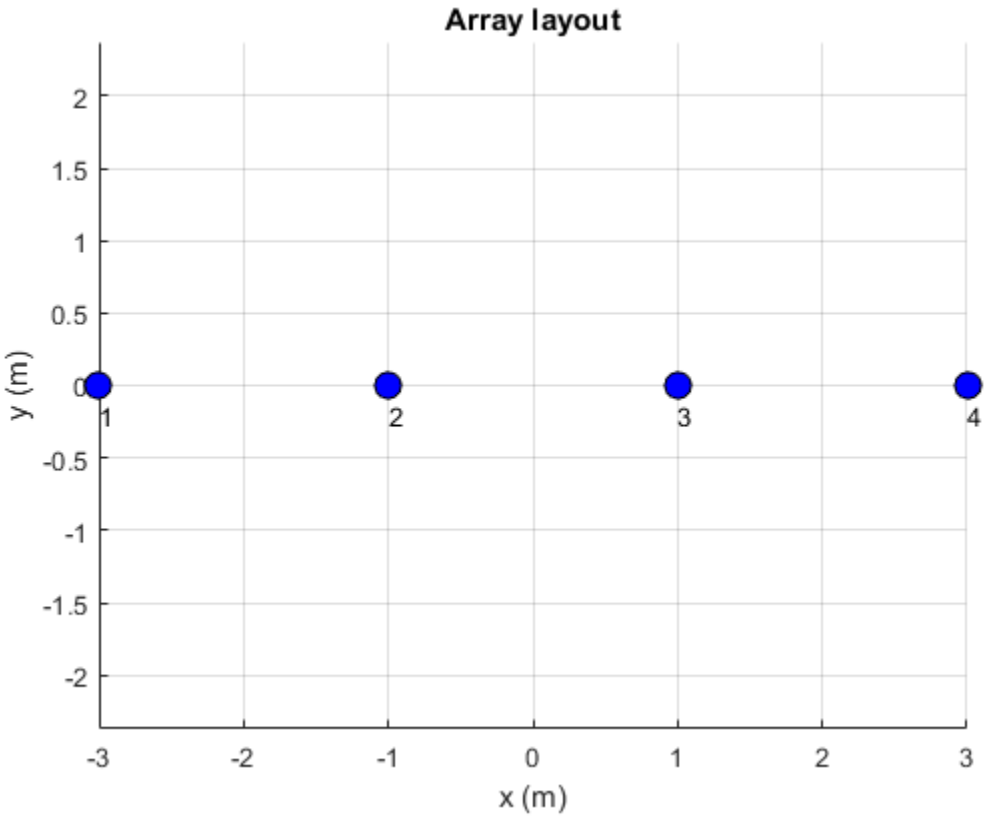
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
correlation	Correlation coefficient between two antennas in array
current	Current distribution on antenna or array surface
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object

Examples

Create and Plot Layout of Linear Array

Create a linear array of four dipoles and plot the layout of the array.

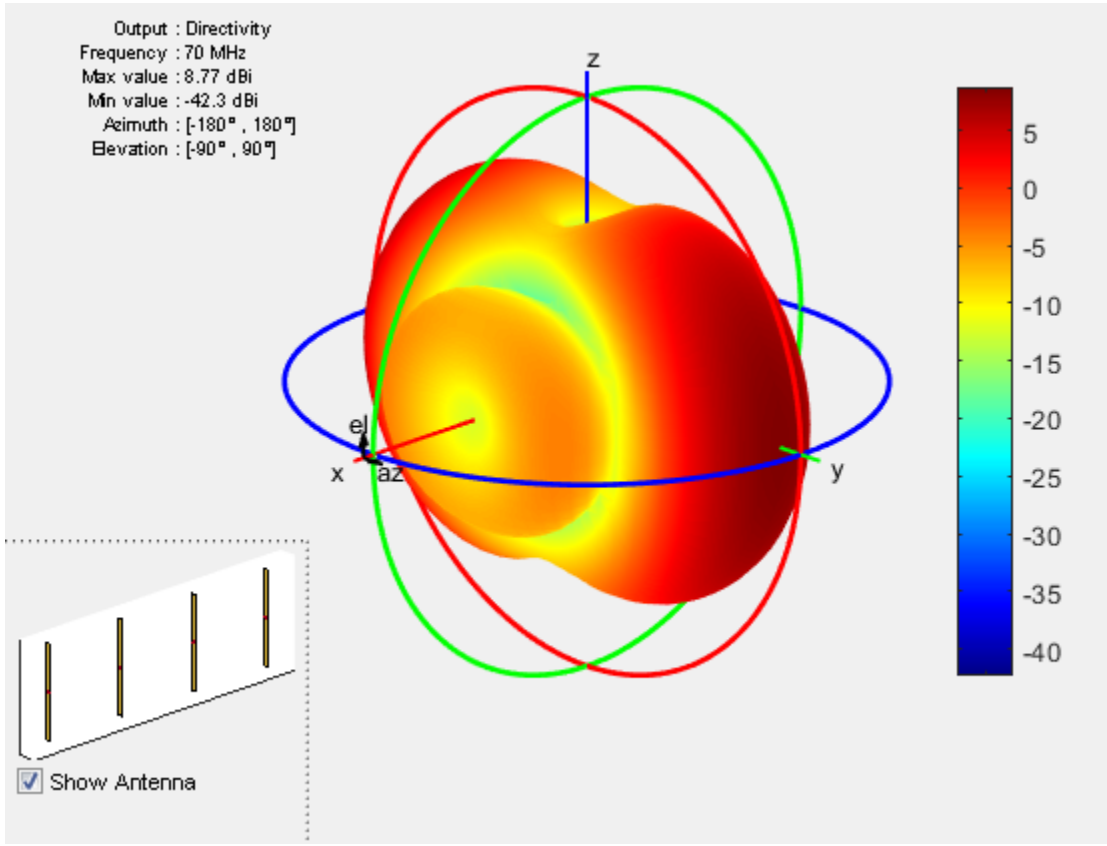
```
la = linearArray;
la.NumElements = 4;
layout(la);
```



Radiation Pattern of Linear Array

Plot the radiation pattern of a four element linear array of dipoles at a frequency 70MHz.

```
la = linearArray('NumElements',4);
pattern(la,70e6);
```



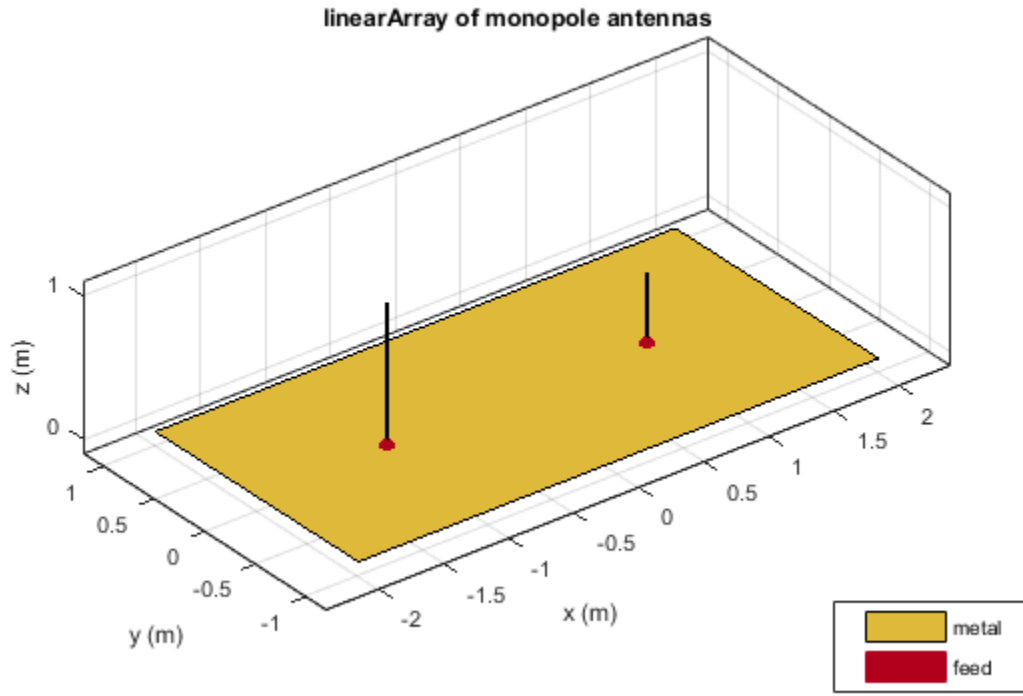
Linear Array Using Groundplane Antennas

Create a linear array of two monopoles.

```
m1 = monopole;
m2 = monopole('Height',0.5);
mla = linearArray
mla.Element = [m1,m2];
show(mla);
```

```
mla =

  linearArray with properties:
```

```
        Element: [1×1 dipole]
     NumElements: 2
  ElementSpacing: 2
  AmplitudeTaper: 1
      PhaseShift: 0
            Tilt: 0
        TiltAxis: [1 0 0]
```



References

[1] Balanis, C.A. *Antenna Theory. Analysis and Design*, 3rd Ed. New York: Wiley, 2005.

See Also

See Also

circularArray | conformalArray | infiniteArray | rectangularArray

Topics

"Rotate Antenna and Arrays"

Introduced in R2015a

conformalArray

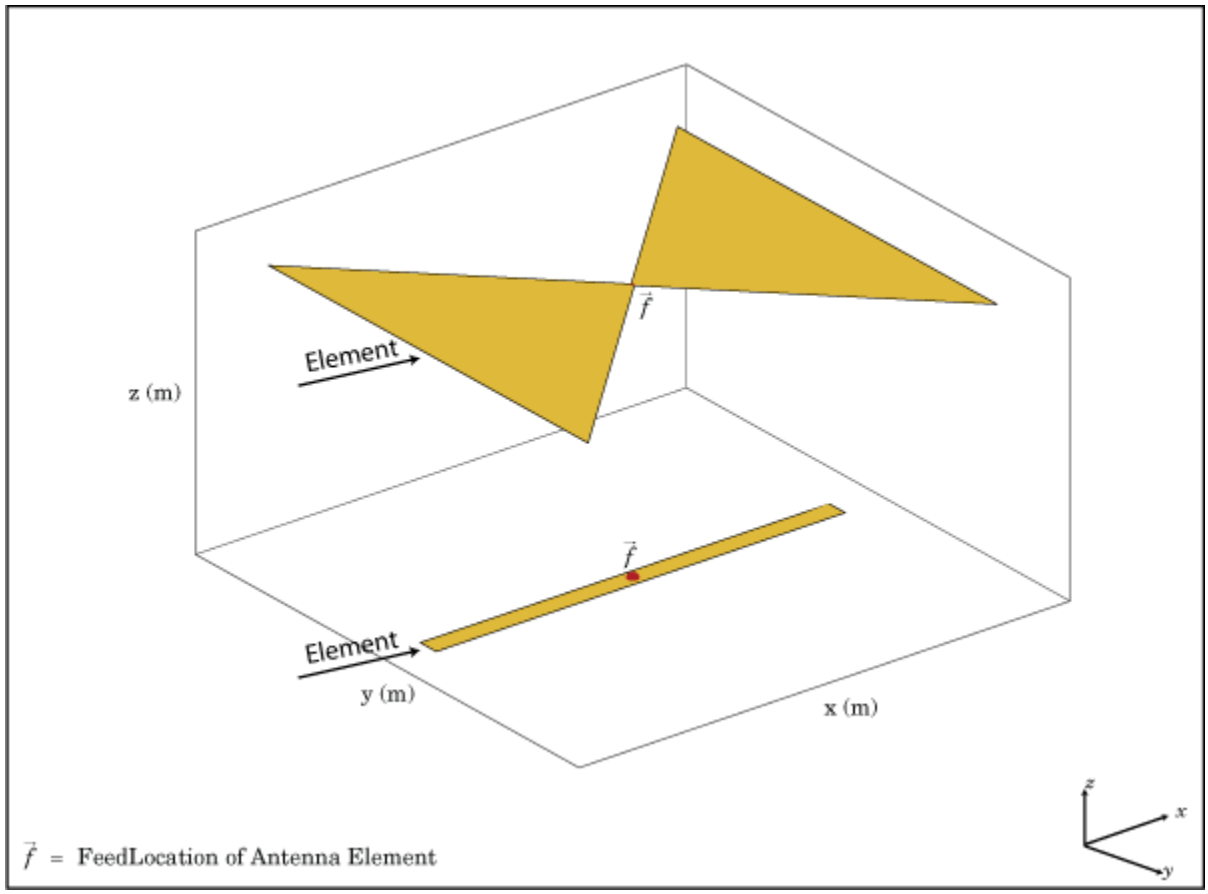
Create conformal antenna array

Description

The `conformalArray` class creates an antenna array using any element from the antenna library. You can also specify an array of any arbitrary geometry, such as a circular array, a nonplanar array, or an array with nonuniform geometry.

Conformal arrays are used in:

- Direction-finding systems that uses circular arrays or stacked circular arrays
- Aircraft systems due to surface irregularities or mechanical stress



Create Object

`ca = conformalArray` creates a conformal antenna array using the default antenna element, shape, and antenna positions.

`ca = conformalArray(Name,Value)` creates a conformal antenna array with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain default values.

Properties

'ElementPosition' — Position of feed or origin

[0 0 0; 0 0 0.1500] (default) | *M*-by-3 real matrix

Position of the feed or origin for each antenna element, specified as the comma-separated pair consisting of 'ElementPosition' and *M*-by-3 real matrix. *M* is the number of element positions. By default, *M* is 2. To specify additional antenna elements, add additional element positions in the conformal array.

Example: 'ElementPosition',[0.1 0.1 0.1; -0.1 -0.1 -0.1;0.2 0.0.2]

Data Types: double

'Element' — Individual antenna elements in array

scalar | array of handles | cell array of antenna object handles

Individual antenna elements in the array, specified as the comma-separated pair consisting of 'Element' and one of the following values:

- A scalar
- An array of handles
- Cell array of antenna object handles

By default, conformal array have two antenna elements, the dipole and the bowtie. To specify additional antenna elements, add additional element positions in the conformal array. You can add both balanced and unbalanced antennas to the same conformal array.

Example: m = monopole; h = conformalArray('Element', [m,m]). Creates a conformal array consisting of two monopoles antenna elements.

Example: d = dipole; mt = monopoleTopHat; h = conformalArray('Element', {d,mt}). Creates a conformal array consisting of a dipole antenna and a monopole tophat antenna.

Data Types: cell

'Reference' — Position reference for antenna element

'feed' (default) | 'origin'

Position reference for the antenna element, specified as the comma-separated pair consisting of 'Reference' and either 'origin' or 'feed'. For more information see "Position Reference" on page 4-35

Example: `'Reference','origin'`

Data Types: `char`

`'AmplitudeTaper'` — Excitation amplitude of antenna elements

1 (default) | scalar | nonnegative vector

Excitation amplitude of the antenna elements, specified as the comma-separated pair consisting of `'AmplitudeTaper'` and a scalar or a nonnegative vector. To model dead elements, set the property value to `0`.

Example: `'AmplitudeTaper',3`

Example: `'AmplitudeTaper',[3 0]`. Creates a two-element conformal array, where `3` and `0` are the excitations amplitudes of two elements.

Data Types: `double`

`'PhaseShift'` — Phase shift for antenna elements

0 (default) | scalar | real vector in degrees

Phase shift for antenna elements, specified as the comma-separated pair consisting of `'PhaseShift'` and a scalar or a real vector in degrees.

Example: `'PhaseShift',[-45 -45 45 45]`

Data Types: `double`

`'Tilt'` — Tilt angle of array

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of array

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
correlation	Correlation coefficient between two antennas in array
current	Current distribution on antenna or array surface
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object

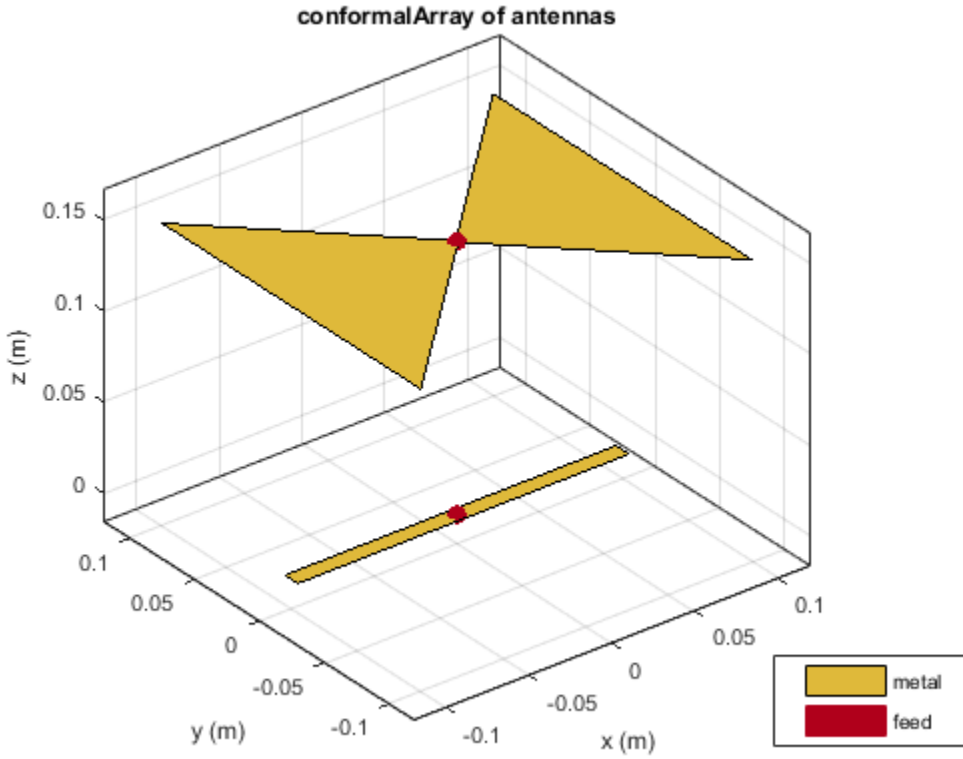
Examples

Default Conformal Array

Create a default conformal array.

```
c = conformalArray
show(c)
```

```
c =

  conformalArray with properties:

           Element: {[1×1 dipole]  [1×1 bowtieTriangular]}
    ElementPosition: [2×3 double]
         Reference: 'feed'
     AmplitudeTaper: 1
         PhaseShift: 0
               Tilt: 0
           TiltAxis: [1 0 0]
```



Circular Array of Dipoles

Define the radius and the number of elements for the array.

```
r = 2;
N = 12;
```

Create an array of 12 dipoles.

```
elem = repmat(dipole('Length',1.5),1,N);
```

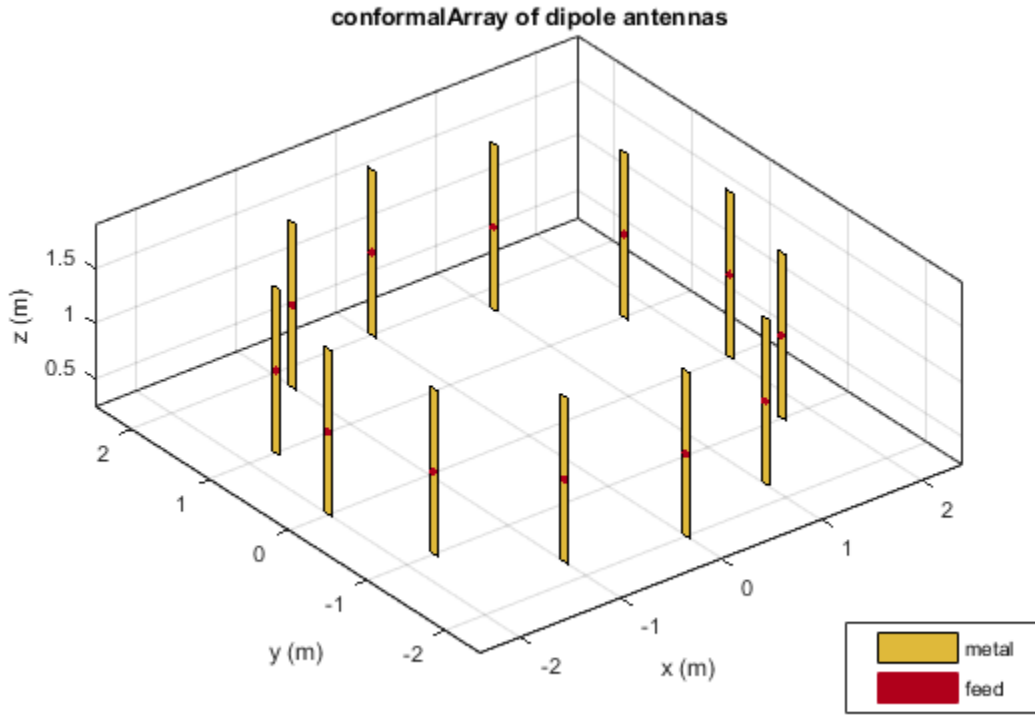
Define the x,y,z values for the element positions in the array.

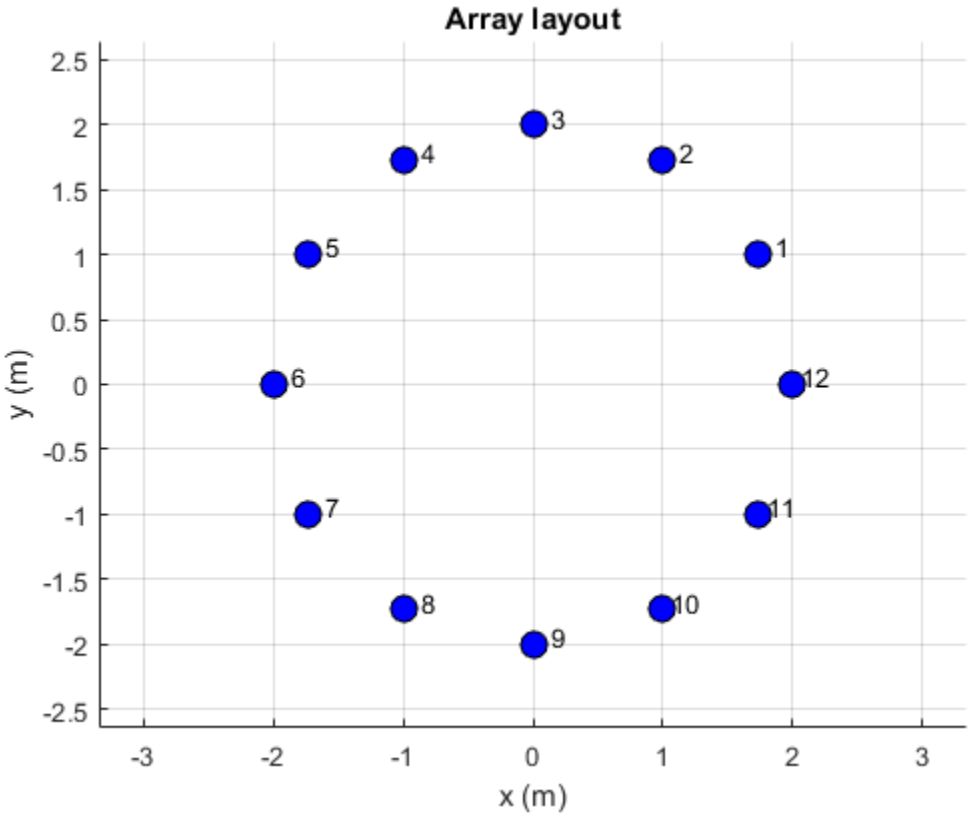
```
del_th = 360/N;
```

```
th = del_th:del_th:360;
x = r.*cosd(th);
y = r.*sind(th);
z = ones(1,N);
pos = [x;y;z];
```

Create a circular array using the defined dipoles and then visualize it. Display the layout of the array.

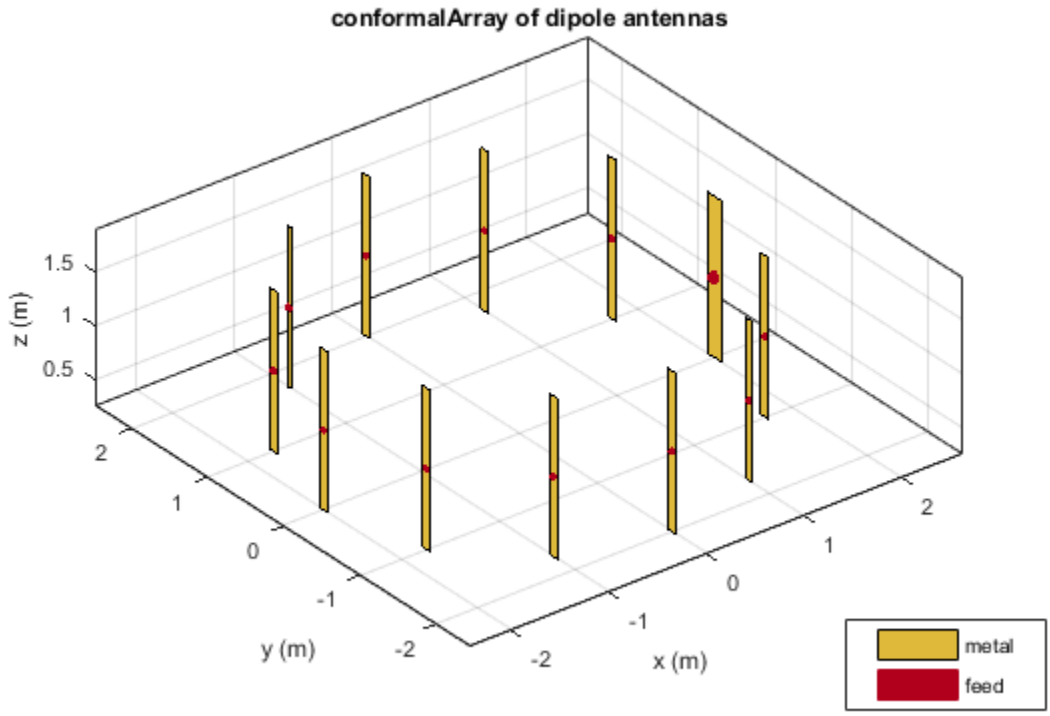
```
c = conformalArray('Element',elem,'ElementPosition',pos');
show(c)
figure
layout(c)
```





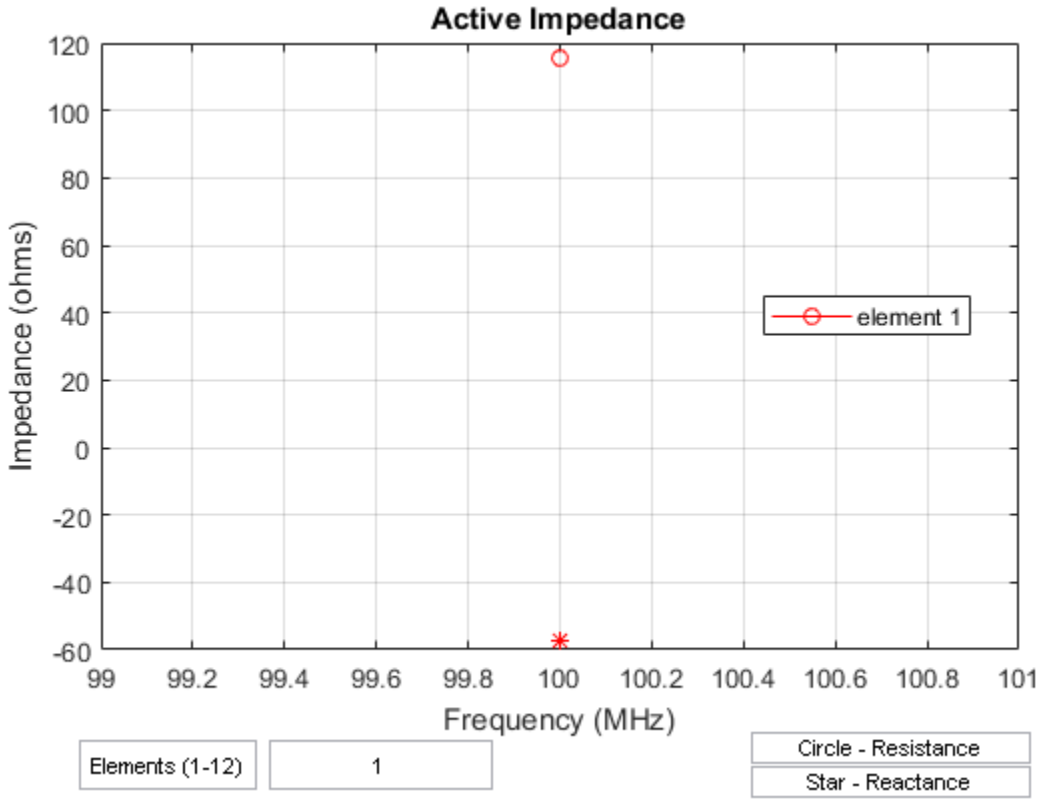
Change the width of the fourth and the twelfth element of the circular array. Visualize the new arrangement.

```
c.Element(4).Width = 0.05;
c.Element(12).Width = 0.2;
figure
show(c)
```

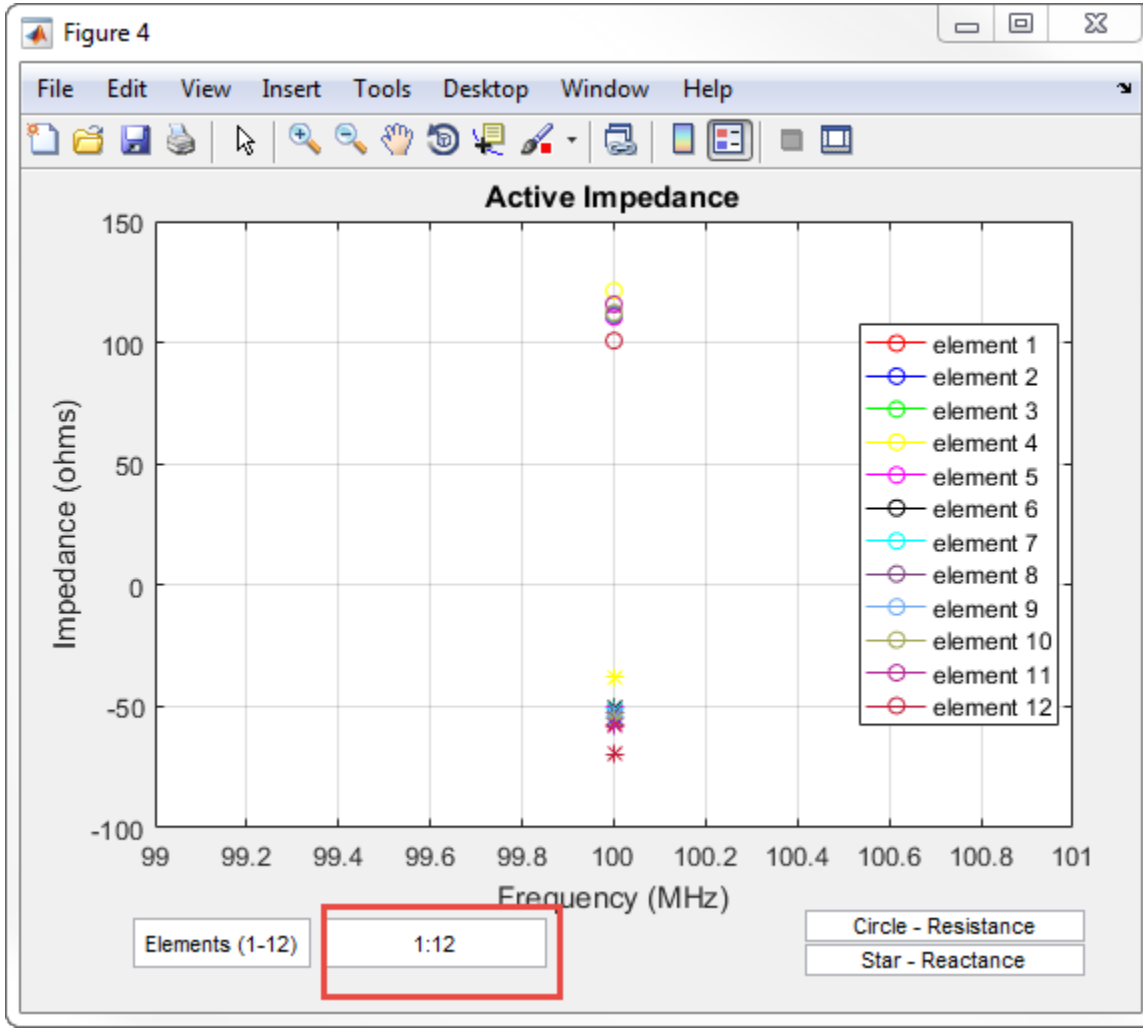


Calculate and plot the impedance of the circular array at 100 MHz.The plot shows the impedance of the first element in the array.

```
figure
impedance(c,100e6)
```



To view the impedance of all the elements in the array change the value from **1** to **1:12** as shown in the figure.



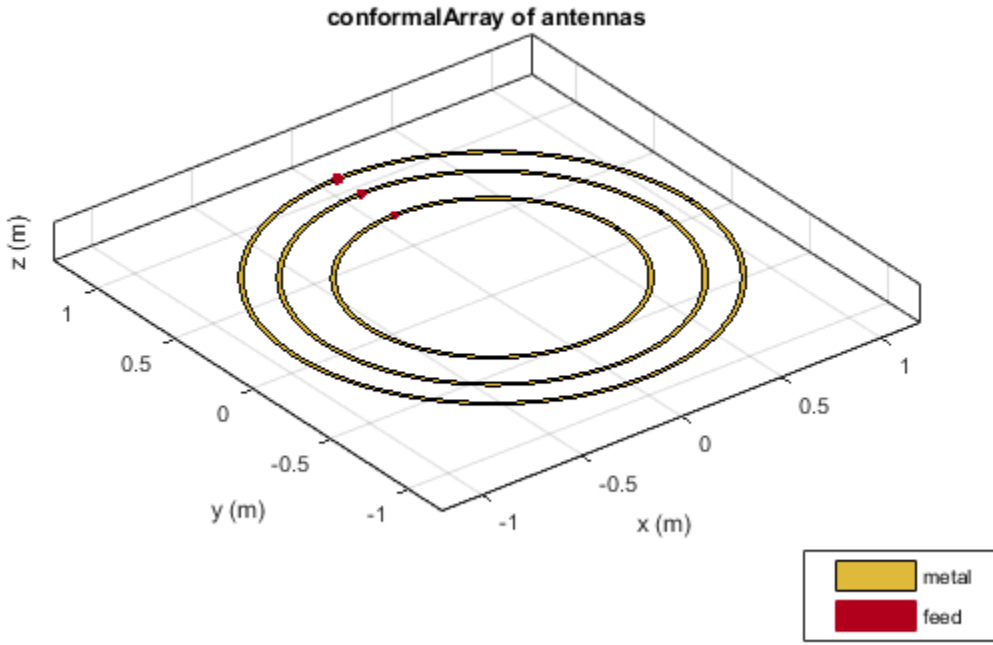
Radiation Pattern of Concentric Array of Circular Loop Antennas

Define three circular loop antennas of radii 0.6366 m(default), 0.85 m, and 1 m, repectively.

```
l1 = loopCircular;
l2 = loopCircular('Radius',0.85);
l3 = loopCircular('Radius',1);
```

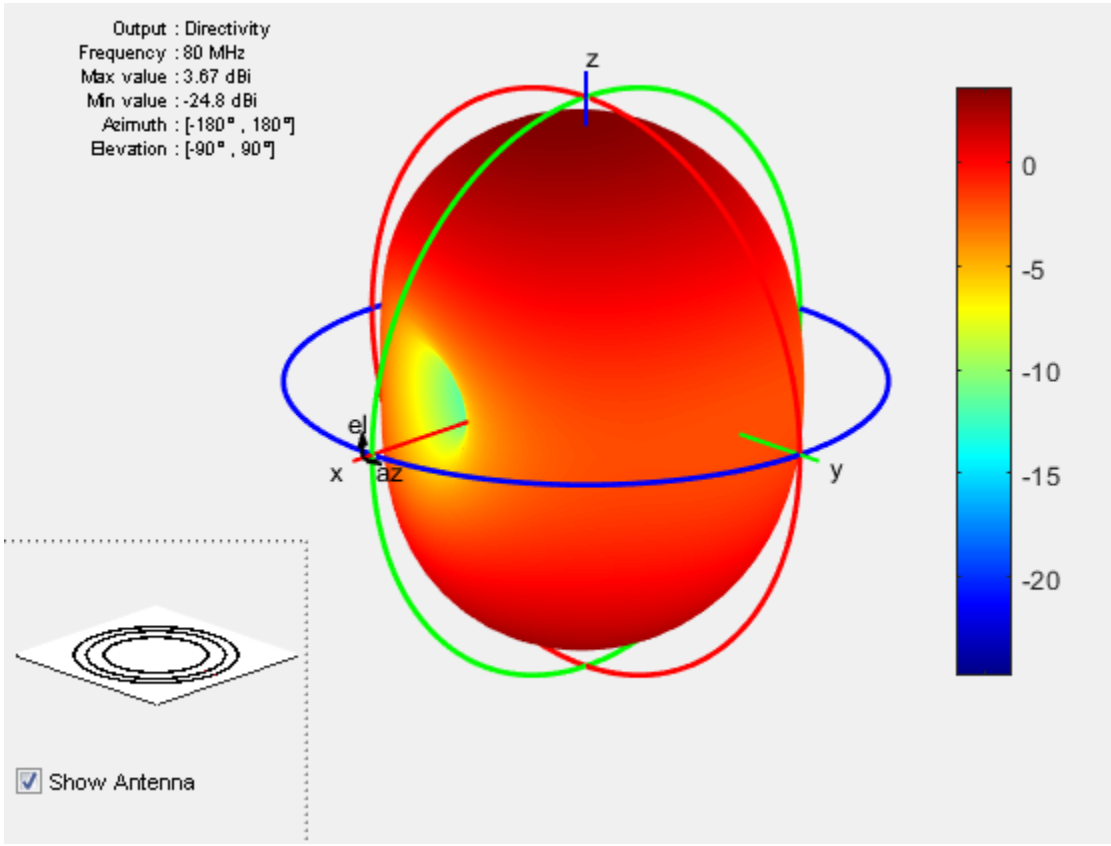
Create a concentric array that uses the origin of circular loop antennas as its position reference.

```
c = conformalArray('Element',{l1,l2,l3},'ElementPosition',[0 0 0;0 0 0;...
    0 0 0],'Reference','origin');
show(c)
```



Visualize the radiation pattern of the array at 80 MHz.

```
pattern(c,80e6)
```



Conformal Array Using Infinite Ground Plane Antenna

Create a dipole antenna to use in the reflector and the conformal array.

```
d = dipole('Length',0.13,'Width',5e-3,'Tilt',90,'TiltAxis','Y');
```

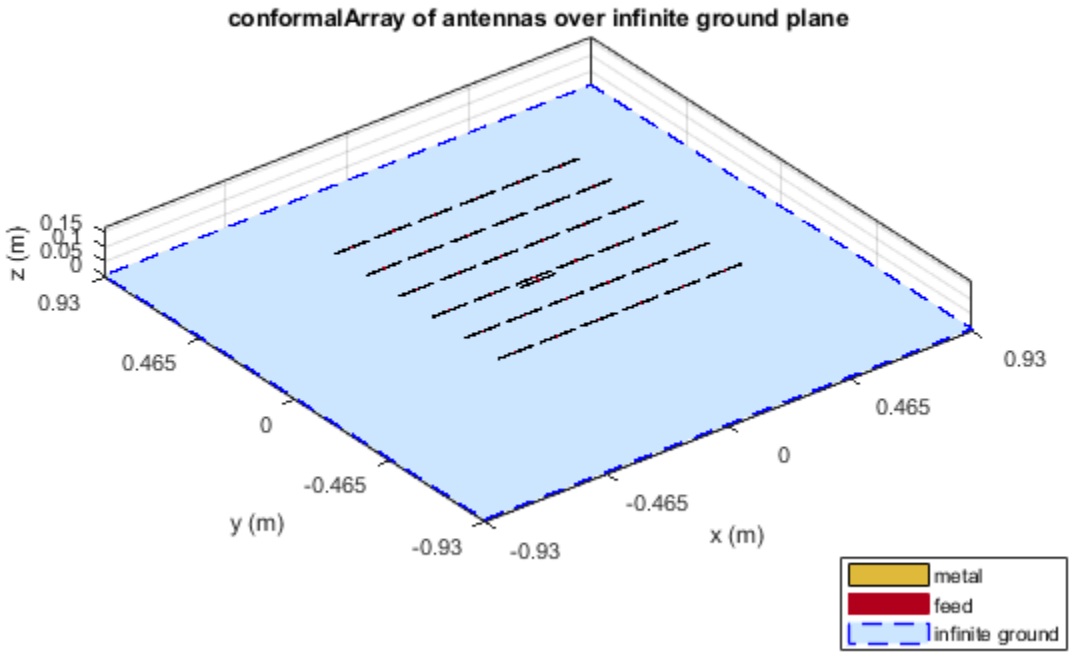
Create an infinite groundplane reflector antenna using the dipole as exciter.

```
rf = reflector('Exciter',d,'Spacing',0.15/2,'GroundPlaneLength',inf);
```

Create a conformal array using 36 dipole antennas and one infinite groundplane reflector antenna. View the array.

```
x = linspace(-0.4,0.4,6);
```

```
y = linspace(-0.4,0.4,6);
[X,Y] = meshgrid(x,y);
pos = [X(:) Y(:) 0.15*ones(numel(X),1)];
for i = 1:36
    element{i} = d;
end
element{37} = rf;
lwa = conformalArray('Element',element,'ElementPosition',[pos;0 0 0.15/2]);
show(lwa)
```



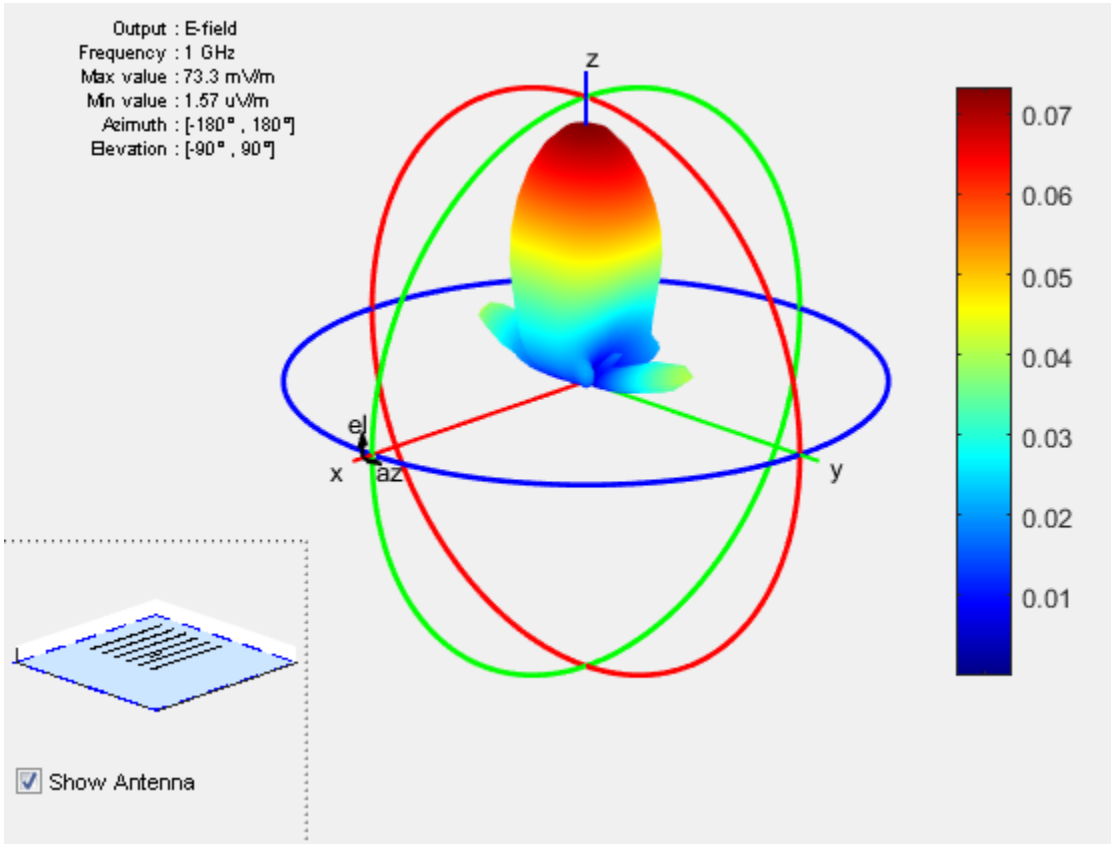
Drive only the reflector antenna with an amplitude of 1.

```
V = zeros(1,37);
V(end) = 1;
```

```
lwa.AmplitudeTaper = V;
```

Compute the radiation pattern of the conformal array.

```
figure
pattern(lwa,1e9,'Type','efield')
```



Conformal Array Using Dielectric Antennas

Create two patch microstrip antennas using dielectric substrate FR4. Tilt the second patch microstrip antenna by 180 degrees.

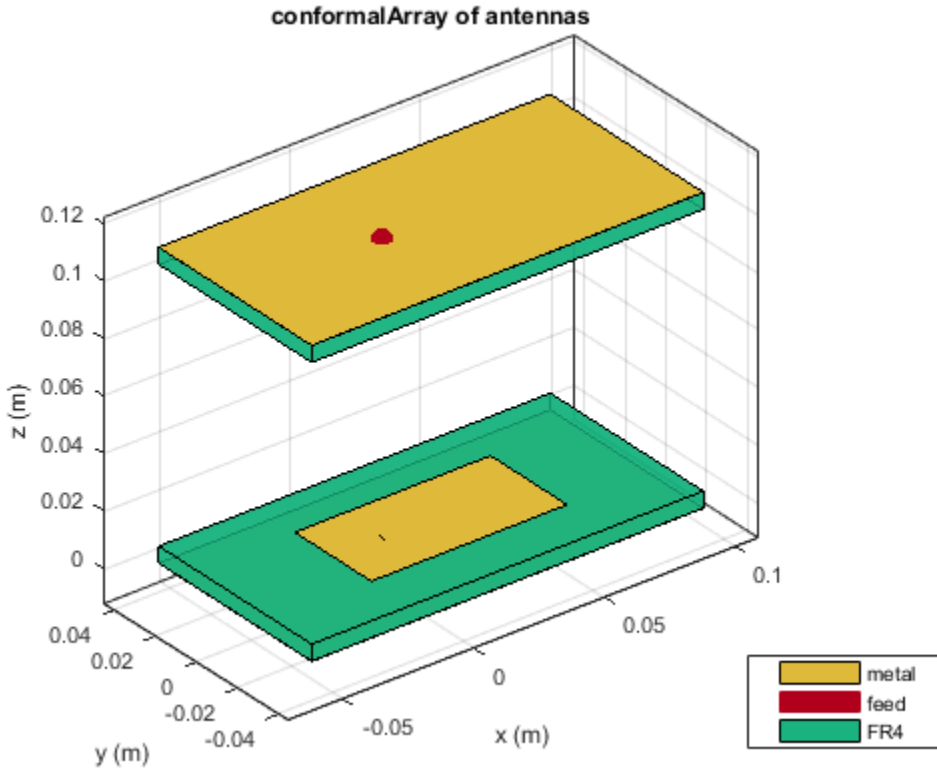
```
d = dielectric('FR4');
```

```
p1 = patchMicrostrip('Substrate',d);
p2 = patchMicrostrip('Substrate',d,'Tilt',180);
```

Create and view a conformal array using the two patch microstrip antennas placed 11 cm apart.

```
c = conformalArray('ElementPosition',[0 0 0;0 0 0.1100],'Element',{p1,p2})
show(c)
```

```
c =

  conformalArray with properties:

           Element: {[1×1 patchMicrostrip]  [1×1 patchMicrostrip]}
    ElementPosition: [2×3 double]
         Reference: 'feed'
     AmplitudeTaper: 1
         PhaseShift: 0
               Tilt: 0
          TiltAxis: [1 0 0]
```



Conformal Array Using Balanced and Unbalanced Antennas

Create a conformal array using dipole and monopole antennas.

```
c = conformalArray('Element', {dipole, monopole})
```

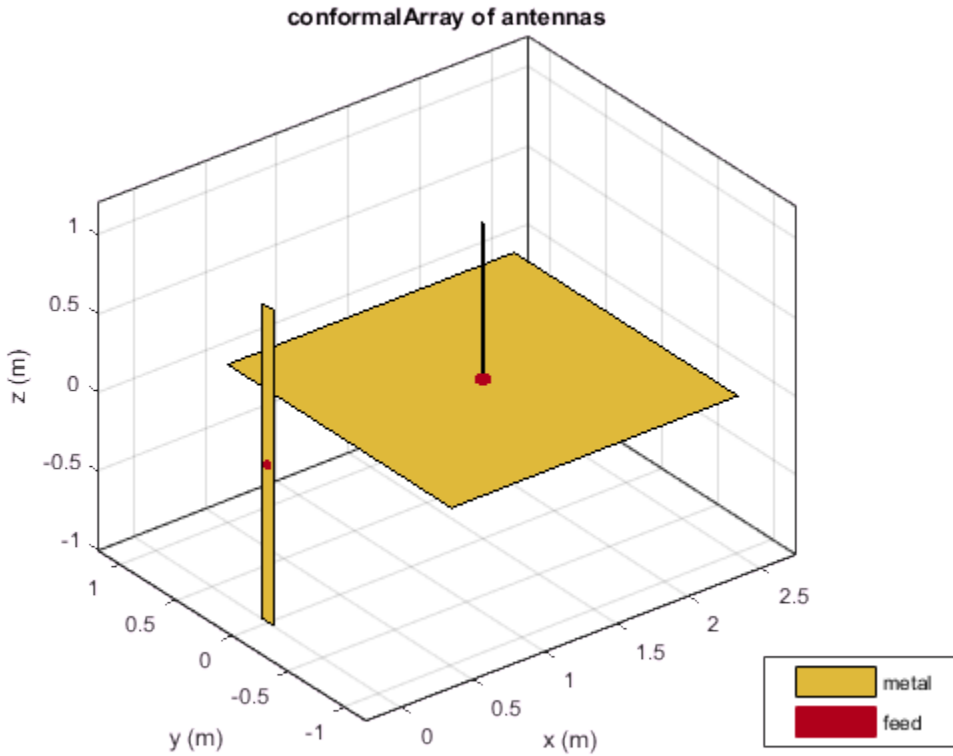
```
c =
  conformalArray with properties:

            Element: {[1×1 dipole]  [1×1 monopole]}
    ElementPosition: [2×3 double]
          Reference: 'feed'
     AmplitudeTaper: 1
         PhaseShift: 0
```

```
    Tilt: 0
TiltAxis: [1 0 0]
```

```
c.ElementPosition = [0 0 0; 1.5 0 0];
```

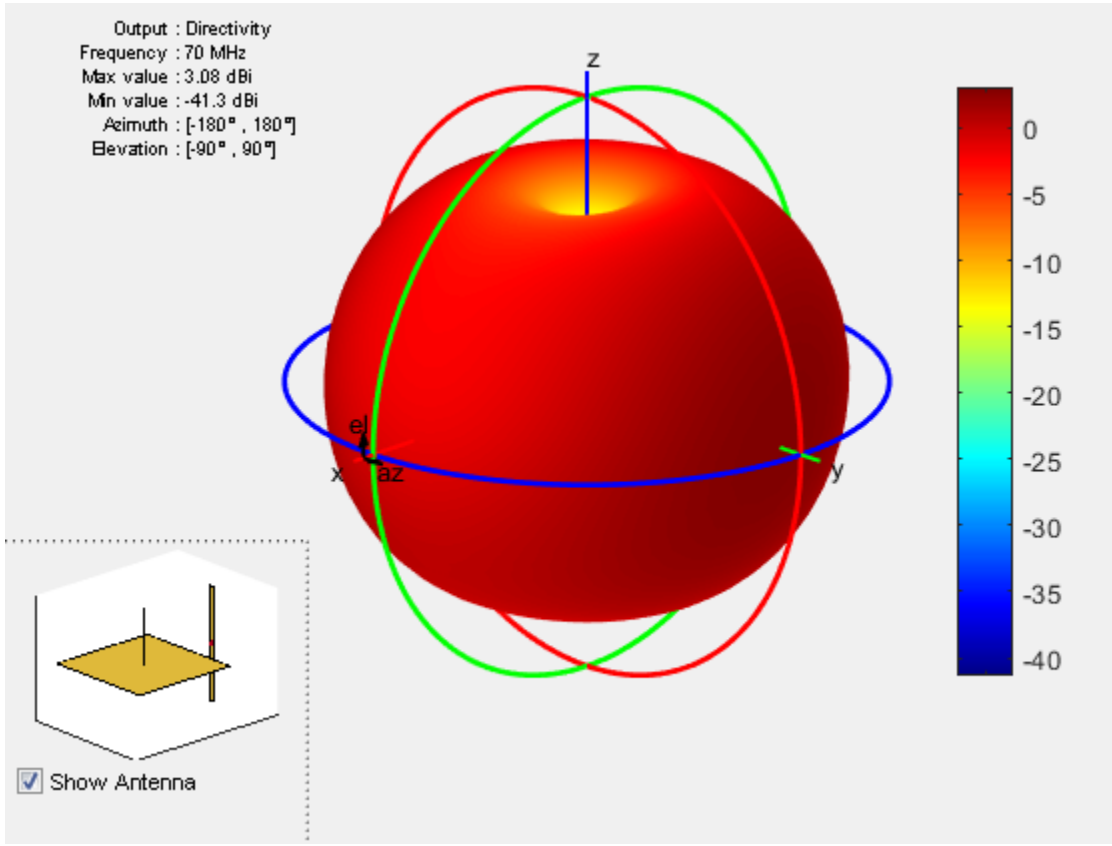
Visualize the array.

```
figure;
show(c);
```



Plot the radiation pattern of the array at 70 MHz.

```
pattern(c, 70e6)
```

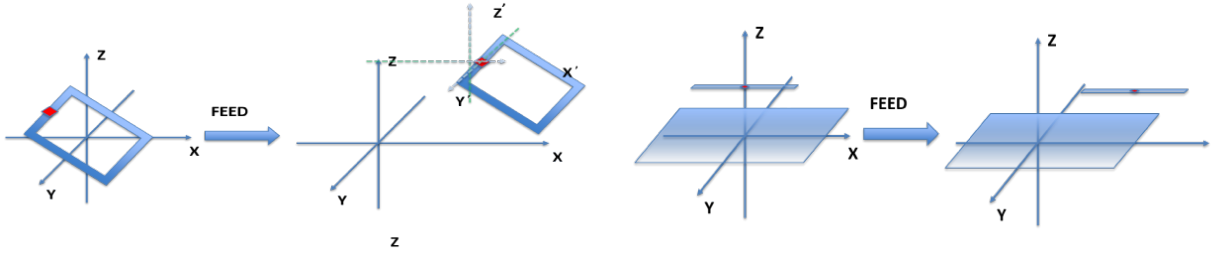


Definitions

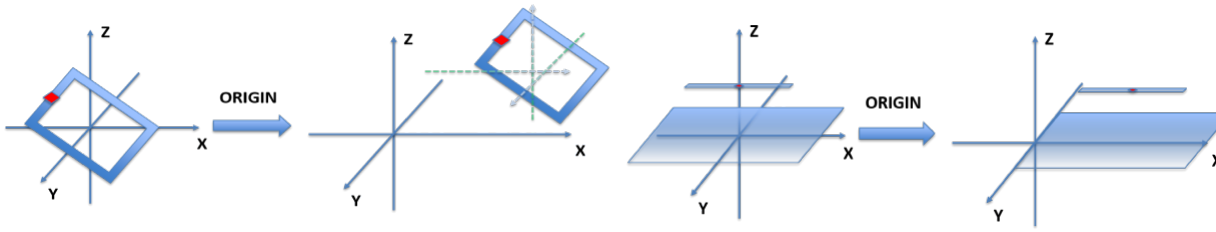
Position Reference

`'Reference'` property of `conformalArray` class defines the position reference of an antenna element in 3–D space. You can position the antenna by specifying the `Reference` property as `feed` or `origin`.

Choosing `feed` as the position reference moves the antenna element with so that the new feed location is at the specified coordinates. The loop rectangle antenna and reflector-backed antenna show the new position with respect to feed:



Choosing `origin` as the position reference moves the antenna element so that new antenna origin is at the specified coordinates. The loop rectangle antenna and reflector-backed antenna show the new position with respect to origin:



References

[1] Balanis, Constantine A. *Antenna Theory: Analysis and Design*. 3rd Ed. New York: John Wiley and Sons, 2005.

See Also

See Also

circularArray | infiniteArray | linearArray | rectangularArray

Topics

"Rotate Antenna and Arrays"

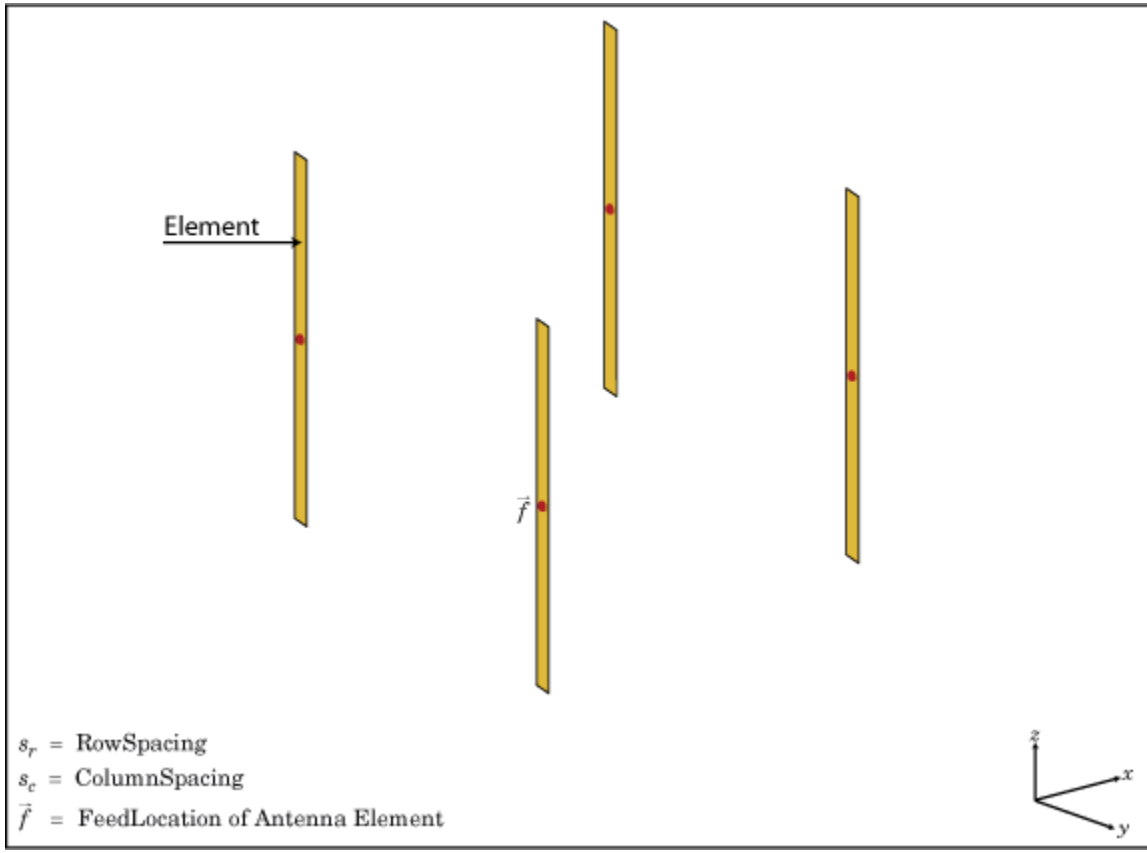
Introduced in R2016a

rectangularArray

Create rectangular antenna array

Description

The `rectangularArray` class creates a rectangular antenna array in the X-Y plane. By default, the rectangular array is a four-element dipole array in a 2 x 2 rectangular lattice. The dipoles are center-fed. Each dipole resonates at 70 MHz when isolated.



Create Object

`ra = rectangularArray` creates a rectangular antenna array in the X-Y plane.

`ra = rectangularArray(Name,Value)` creates a rectangular antenna array, with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain default values.

Properties

`'Element'` — Individual antenna elements used in array

dipole (default) | antenna object

Individual antenna elements used in array, specified as the comma-separated pair consisting of `'Element'` and an antenna object.

Example: `'Element',monopole`

`'Size'` — Number of antenna elements in row and column of array

[2 2] (default) | two-element vector

Number of antenna elements in row and column of array, specified as the comma-separated pair consisting of `'Size'` and a two-element vector.

Example: `'Size',[4 4]`

`'RowSpacing'` — Row spacing between two antenna elements

2 (default) | scalar in meters | vector in meters

Row spacing between two antenna elements, specified as the comma-separated pair consisting of `'RowSpacing'` and a scalar or vector in meters. By default, the antenna elements are spaced `2m` apart.

Example: `'RowSpacing',[5 6]`

Data Types: `double`

`'ColumnSpacing'` — Column spacing between two antenna elements

2 (default) | scalar in meters | vector in meters

Column spacing between two antenna elements, specified as the comma-separated pair consisting of `'ColumnSpacing'` and a scalar or vector in meters. By default, the antenna elements are spaced `2m` apart.

Example: `'ColumnSpacing',[3 4]`

Data Types: `double`

`'Lattice'` — Antenna elements spatial arrangement

`'Rectangular'` (default) | `"Triangular"`

Antenna elements spatial arrangement, specified as the comma-separated pair consisting of `'Lattice'` and a text input.

Example: `'Lattice',"Triangular"`

Data Types: `char`

`'AmplitudeTaper'` — Excitation amplitude of antenna elements

1 (default) | scalar | vector

Excitation amplitude of antenna elements , specified as a the comma-separated pair consisting of `'AmplitudeTaper'` and a scalar or vector. Set the property value to `0` to model dead elements.

Example: `'AmplitudeTaper',3`

Data Types: `double`

`'Phaseshift'` — Phase shift for antenna elements

0 (default) | scalar in degrees | vector in degrees

Phase shift for antenna elements, specified as the comma-separated pair consisting of `'PhaseShift'` and a scalar or vector in degrees.

Example: `'PhaseShift',[3 3 0 0]`

Data Types: `double`

`'Tilt'` — Tilt angle of array

0 (default) | scalar in degrees | vector in degrees

Tilt angle of antenna, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of array

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 1 0]`

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
correlation	Correlation coefficient between two antennas in array
current	Current distribution on antenna or array surface
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
pattern	Radiation pattern of antenna or array

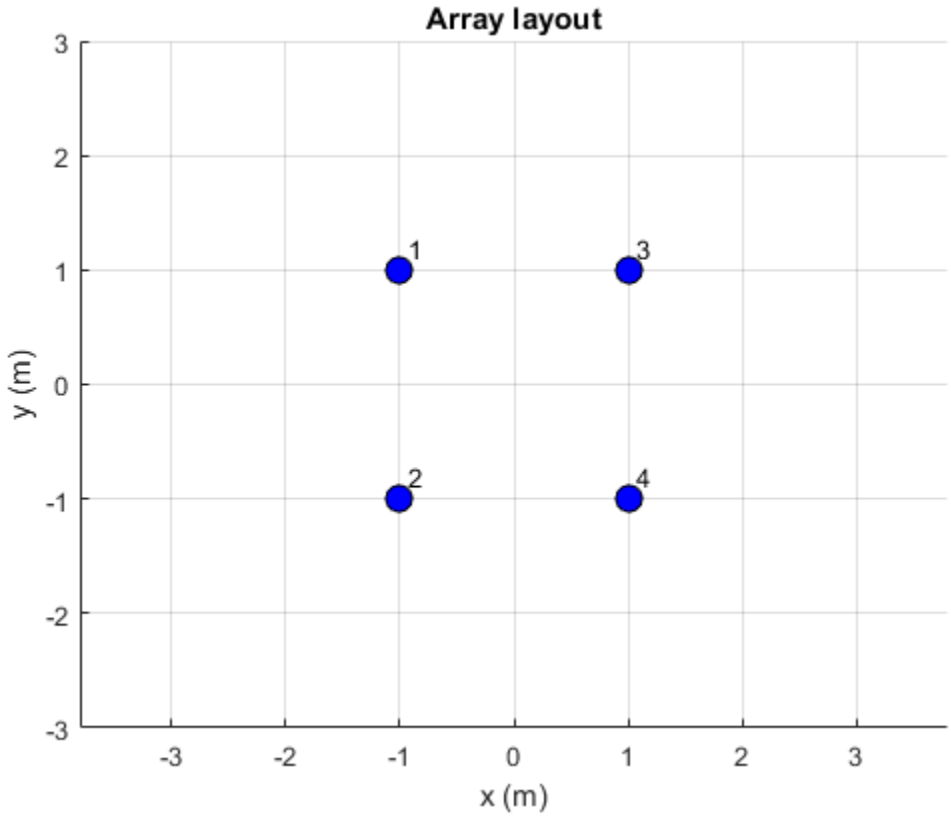
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object

Examples

Create and Plot Layout of Rectangular Array

Create and plot the layout of a rectangular array of four dipoles.

```
ra = rectangularArray;
ra.Size = [2 2];
layout(ra);
```



Calculate Scan Impedance of Rectangular Array

Calculate the scan impedance of a 2x2 rectangular array of dipoles at 70 MHz.

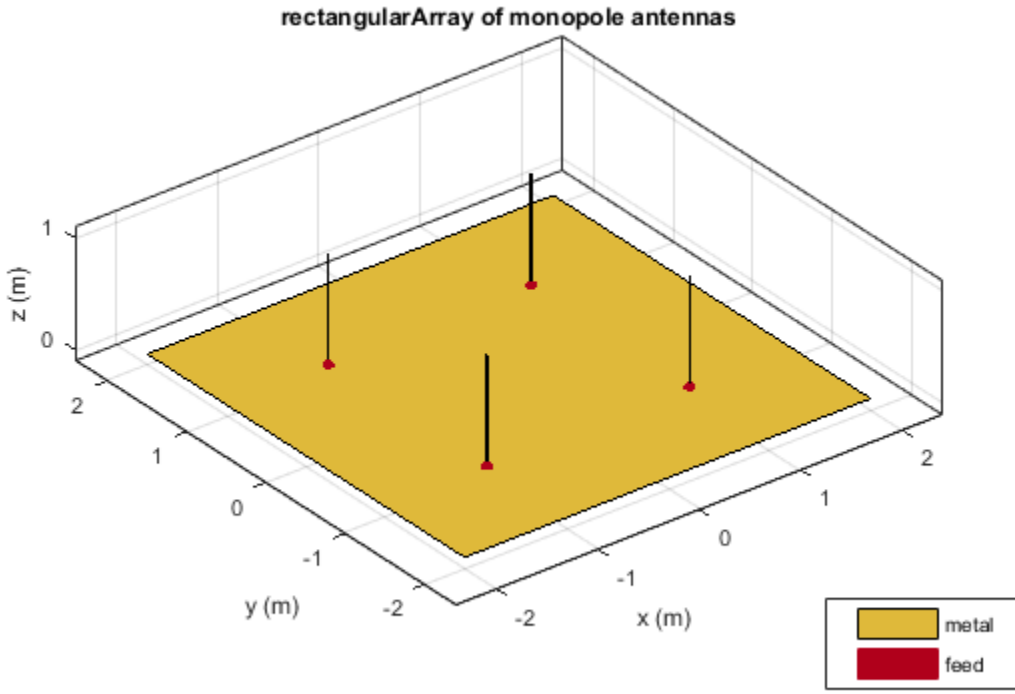
```
h = rectangularArray('Size',[2 2]);
Z = impedance(h,70e6)
```

```
Z =

  25.9763 -54.1987i  25.9763 -54.1995i  25.9763 -54.1987i  25.9763 -54.1995i
```

Rectangular Array Using Groundplane Antennas

Create a rectangular array of monopoles.

```
m1 = monopole;
mra = rectangularArray('Element',m1);
show(mra);
```



References

[1] Balanis, C.A. *Antenna Theory. Analysis and Design*, 3rd Ed. New York: Wiley, 2005.

See Also

See Also

circularArray | conformalArray | infiniteArray | linearArray

Topics

"Rotate Antenna and Arrays"

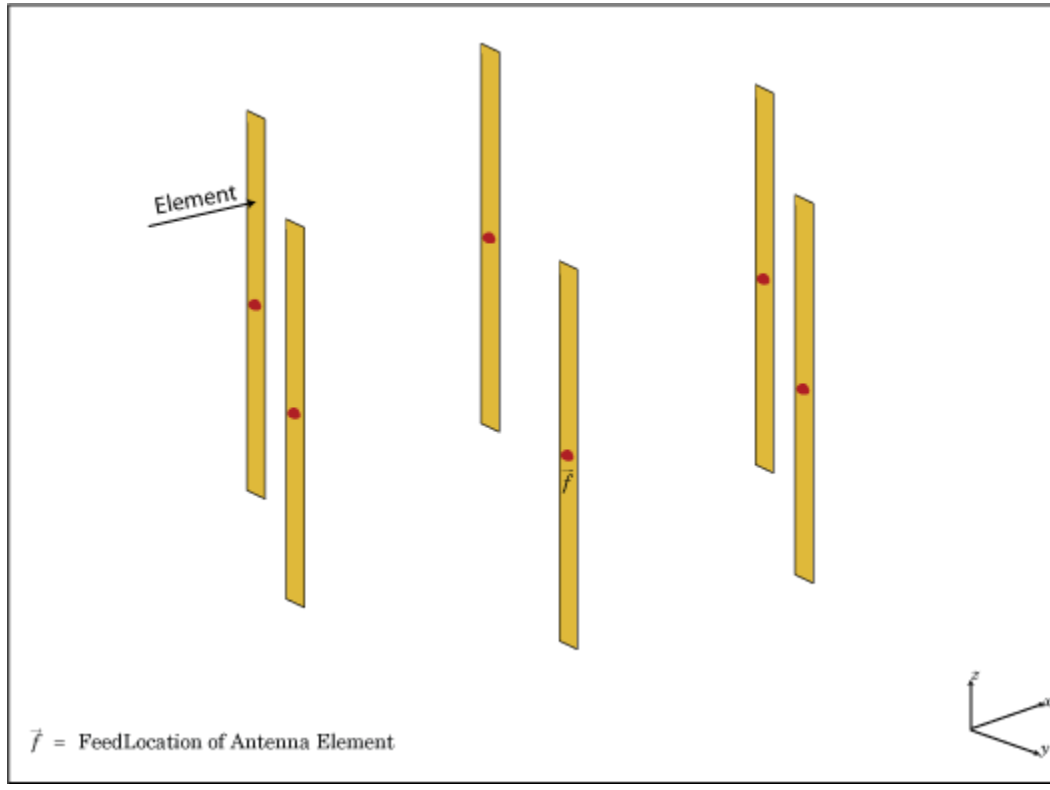
Introduced in R2015a

circularArray

Create circular antenna array

Description

The `circularArray` object is a circular antenna array. Circular arrays finds application in direction of arrival (DoA) systems. You can sue circular arrays to perform 2-D scanning, while lowering element counts. These arrays also have the ability for 360 degree scanning. The individual elements in the circular array are part of the same array environment. This property reduces the impact of edge effects and other coupling variation.



Create Object

`ca = circularArray` creates a circular antenna array in the X-Y plane.

`ca = circularArray(Name,Value)` class to create a circular antenna array, with additional properties specified by one, or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`,`...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'Element'` — Individual antenna type

`dipole` (default) | vector of antenna object handles

Individual antenna type, specified as a comma-separated pair consisting of `'Element'` and a vector of antenna object handles. This property supports scalar expansion.

Example: `'Element',[monopole,monopole]`

`'NumElements'` — Number of elements in array

`6` (default) | positive scalar integer

Number of elements in the array, specified as a comma-separated pair consisting of `'NumElements'` and a positive scalar integer. The elements in the array are arranged along the X-axis.

Example: `'NumElements',4`

Data Types: `double`

`'Radius'` — Radius of array

`1` (default) | positive scalar integer in meters

Radius of array, specified as a comma-separated pair consisting of `'Radius'` and a positive scalar integer in meters.

Example: `'Radius',0.4`

Data Types: `double`

`'AngleOffset'` — Starting angle offset for first element in array

`0` (default) | real scalar in degrees

Starting angle offset for first element in array, specified as a comma-separated pair consisting of `'AngleOffset'` and a real scalar in degrees.

Example: `'AngleOffset',8`

Data Types: `double`

`'AmplitudeTaper'` — Excitation amplitude for antenna elements in array

`1` (default) | real positive vector of size `'Element'`

Excitation amplitude for antenna elements in the array, specified as a comma-separated pair consisting of `'AmplitudeTaper'` and a real positive vector of size `'Element'`.

Example: `'AmplitudeTaper',[0 1]`

Data Types: `double`

`'PhaseShift'` — Phase shift for each element in array

`0` (default) | real vector of size `'Element'` in degrees

Phase shift for each element in the array, specified as a comma-separated pair consisting of `'PhaseShift'` and a real vector of size `'Element'` in degrees.

Example: `'PhaseShift',[0 2]`

Data Types: `double`

`'Tilt'` — Tilt angle of array

`0` (default) | scalar in degrees | vector in degrees

Tilt angle of an array, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of array

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the antenna, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the antenna rotates along the line joining the two points space.
- A string input for simple rotations around the principal planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

layout	Display array layout
show	Display antenna or array structure
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
correlation	Correlation coefficient between two antennas in array
current	Current distribution on antenna or array surface
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object

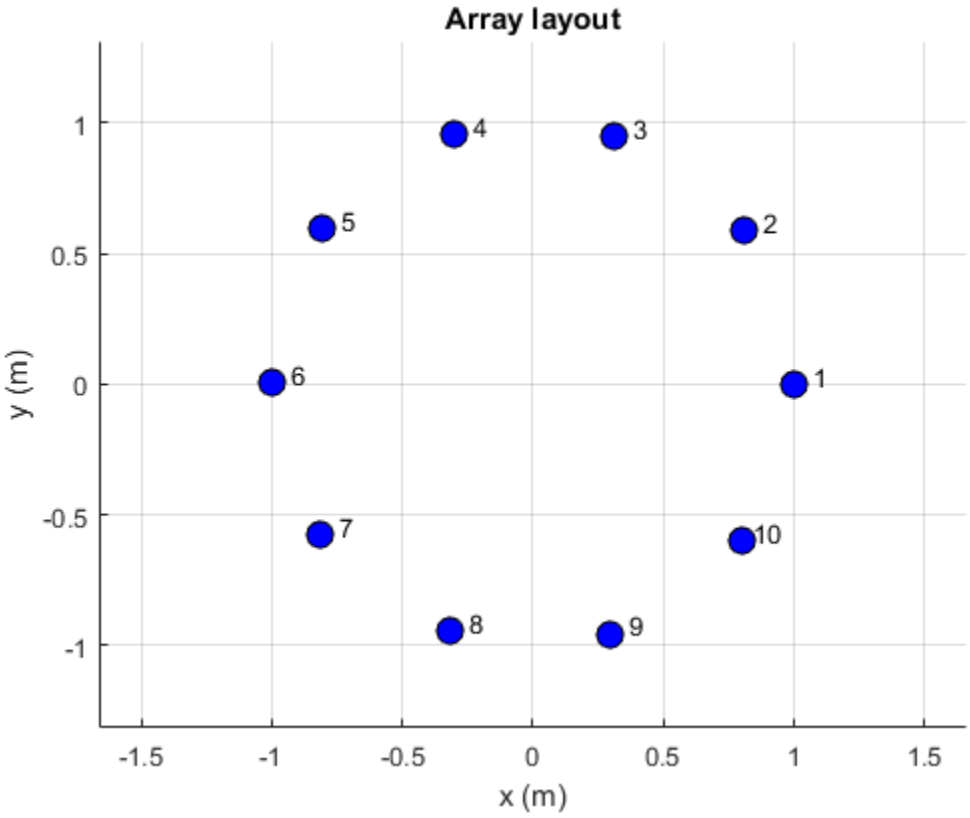
Examples

Plot Elevation Pattern of Circular Antenna Array

Create a circular antenna array using 10 antenna elements. View the layout of the antenna elements in the array.

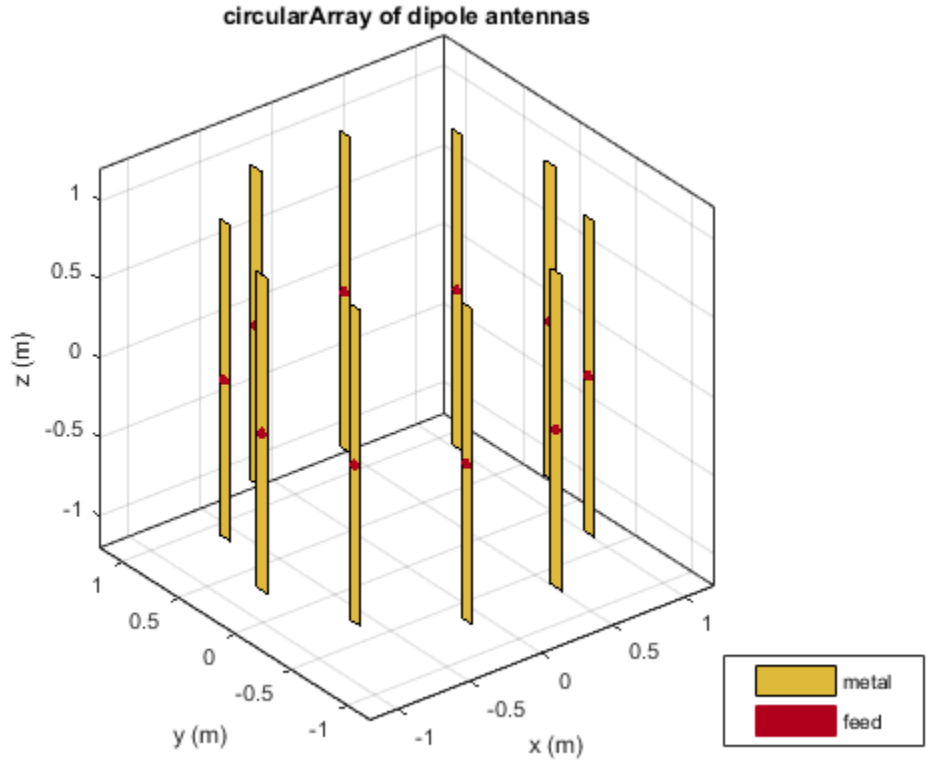
```
ca = circularArray('NumElements',10)
figure;
layout(ca)
```

```
ca =

  circularArray with properties:

          Element: [1×1 dipole]
       NumElements: 10
            Radius: 1
       AngleOffset: 0
    AmplitudeTaper: 1
        PhaseShift: 0
              Tilt: 0
         TiltAxis: [1 0 0]
```



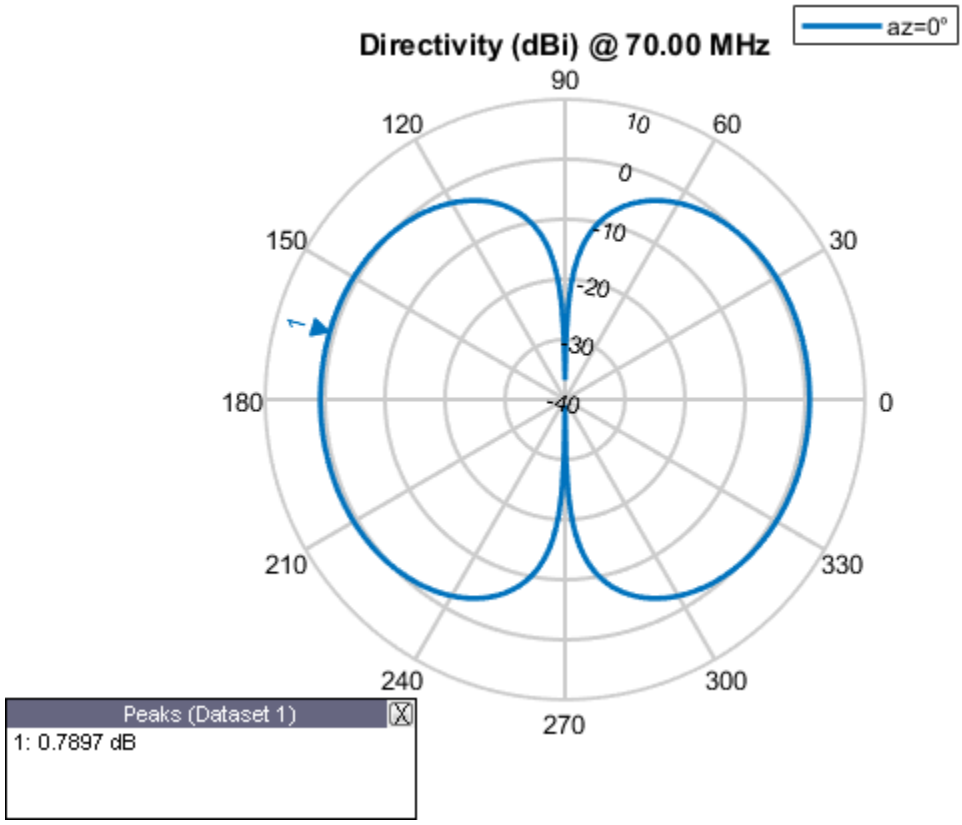
Display the array.

```
figure;
show(ca)
```



Plot the elevation pattern of the circular array at a frequency of 70 MHz.

```
figure;
patternElevation(ca,70e6)
```



See Also

See Also

conformalArray | infiniteArray | linearArray | rectangularArray

Topics

"Rotate Antenna and Arrays"

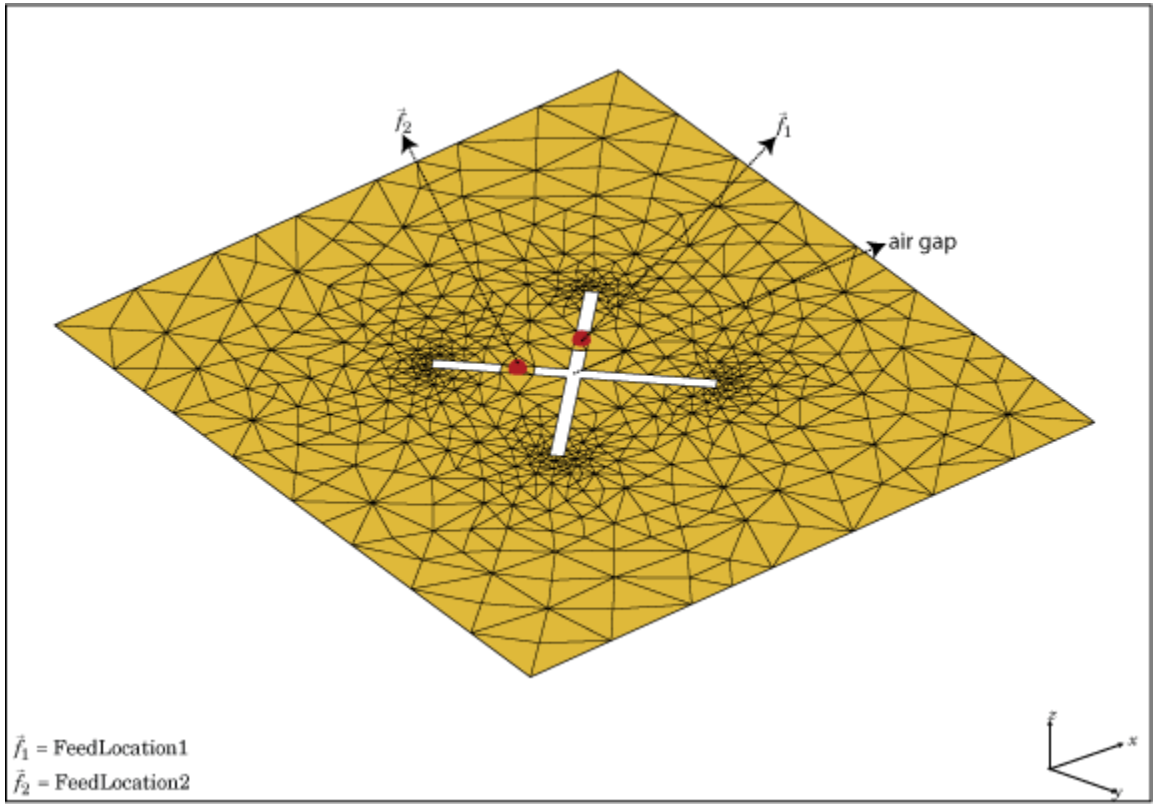
Introduced in R2016b

customArrayMesh

Create 2-D custom mesh antenna on X-Y plane

Description

The `customArrayMesh` object creates an array represented by a 2-D custom mesh on the X-Y plane. You can provide an arbitrary array mesh to the Antenna Toolbox and analyze this mesh as a custom array for port and field characteristics.



Create Object

Description

`customarray = customArrayMesh(points,triangles,numfeeds)` creates a 2-D array represented by a custom mesh, based on the specified points and triangles.

Input Arguments

`points` — Points in custom mesh

`2-by-N` or `3-by-N` matrix of Cartesian coordinates in meters

Points in custom mesh, specified as a `2-by-N` or `3-by-N` matrix of Cartesian coordinates in meters. *N* is the number of points. In case you specify a `3-by-N` integer matrix, the Z-coordinate must be zero or a constant value. This value sets the `'Points'` property in the custom array mesh.

Example: `load planarmesh.mat; c = customArrayMesh(p,t,4)`. Creates a custom array mesh from the points, `p`, extracted from the `planarmesh.mat` file.

Data Types: `double`

`triangles` — Triangles in mesh

`4-by-M` matrix

Triangles in the mesh, specified as a `4-by-M` matrix. *M* is the number of triangles. The first three rows are indices to the points matrix and represent the vertices of each triangle. The fourth row is a domain number useful for identifying separate parts of an array. This value sets the `'Triangles'` property in the custom array mesh.

Example: `load planarmesh.mat; c = customArrayMesh(p,t,4)`. Creates a custom array mesh from the triangles, `t`, extracted from the `planarmesh.mat` file.

Data Types: `double`

`numfeeds` — Number of feeding points in array

2 (default) | scalar

Number of feeding points in array, specified as a scalar. By default, the number of feed points are 2.

Example: `load planarmesh.mat; c = customArrayMesh(p,t,4)`. Creates a custom array mesh requiring 4 feed points.

Data Types: `double`

Properties

`'Points'` — Points in custom mesh

`2-by-N` or `3-by-N` matrix of Cartesian coordinates in meters

Points in a custom mesh, specified as a `2-by-N` or `3-by-N` matrix of Cartesian coordinates in meters. N is the number of points.

Data Types: `double`

`'Triangles'` — Triangles in mesh

`4-by-M` matrix

Triangles in the mesh, specified as a `4-by-M` matrix. M is the number of triangles.

Data Types: `double`

`'NumFeeds'` — Number of feeding points

scalar

Number of feeding points in the array, specified as a scalar.

Data Types: `double`

`'FeedLocation'` — Feed location of array

Cartesian coordinates in meters

Feed locations of array, specified as Cartesian coordinates in meters. Feed location is a read-only property. To create a feed for the 2–D custom mesh, use the `createFeed` method.

Data Types: `double`

`'AmplitudeTaper'` — Excitation amplitude of antenna elements

1 (default) | scalar | non-negative vector

Excitation amplitude of antenna elements, specified as the comma-separated pair consisting of `'AmplitudeTaper'` and a scalar or a non-negative vector. Set the property value to `0` to model dead elements.

Example: `'AmplitudeTaper',3`

Data Types: `double`

`'PhaseShift'` — Phase shift for antenna elements
0 (default) | scalar | real vector in degrees

Phase shift for antenna elements, specified as the comma-separated pair consisting of `'PhaseShift'` and a scalar or a real vector in degrees.

Example: `'PhaseShift',[3 3 0 0]`. Creates a custom array mesh of four antennas with phase shifts specified.

Data Types: `double`

Object Functions

createFeed	Create feed locations for custom array
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
correlation	Correlation coefficient between two antennas in array
current	Current distribution on antenna or array surface
EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object

Examples

Custom Array Mesh Impedance.

Load a custom mesh and create an array.

```
load planarmesh.mat;
c = customArrayMesh(p,t,2);
```

Create feeds for the custom array mesh.

```
createFeed(c,[0.07,0.01],[0.05,0.05], [-0.07,0.01],[-0.05,0.05])
```

Calculate the impedance of the array.

```
Z = impedance(c,1e9)
```

```
Z =

  35.6701 -35.4284i  35.9773 -24.7044i
```

References

[1] Balanis, C.A. *Antenna Theory: Analysis and Design*. 3rd Ed. New York: Wiley, 2005.

See Also

See Also

conformalArray | linearArray | rectangularArray

Topics

"Rotate Antenna and Arrays"

Introduced in R2015b

customArrayGeometry

Create array represented by 2-D custom geometry

Description

The `customArrayGeometry` object is an array represented by a 2-D custom geometry on the X-Y plane. You can use the `customArrayGeometry` to import a 2D custom geometry, define feeds to create an array element, and analyze the custom array.

Create Object

`cg = customArrayGeometry` creates a custom array represented by 2-D geometry on the X-Y plane, based on the specified boundary.

`ca = customArrayGeometry(Name,Value)` creates a 2-D array geometry, with additional properties specified by one or more name-value pair arguments. `Name` is the property name and `Value` is the corresponding value. You can specify several name-value pair arguments in any order as `Name1`, `Value1`, `...`, `NameN`, `ValueN`. Properties not specified retain their default values.

Properties

`'Boundary'` — Boundary information in Cartesian coordinates

cell array in meters

Boundary information in Cartesian coordinates, specified as the comma-separated pair consisting of `'Boundary'`and a cell array in meters.

Data Types: `double`

`'Operation'` — Boolean operation performed on boundary list

`'P1'` (default) | character vector

Boolean operation performed on the boundary list, specified as the comma-separated pair consisting of `'Operation'` and a character vector. operation set is; [`+`, `-`, `*`].

Example: `'Operation','P1-P2'`

Data Types: `double`

`'FeedLocation'` — Array element feed location in Cartesian coordinates

`[0 0 0]` (default) | three-element vector

Array element feed location in Cartesian coordinates, specified as the comma-separated pair consisting of `'FeedLocation'` and a three-element vector. The three elements represent the X, Y, and Z coordinates respectively.

Example: `'FeedLocation', [0 0.2 0]`

Data Types: `double`

`'FeedWidth'` — Width of feed for array elements

`0.0100` (default) | scalar in meters

Width of feed for array elements, specified as the comma-separated pair consisting of `'FeedWidth'` and a scalar in meters.

Example: `'FeedWidth',0.05`

Data Types: `double`

`'AmplitudeTaper'` — Excitation amplitude for array elements

`1` (default) | non-negative scalar | vector of non-negative scalars

Excitation amplitude for array elements, specified as the comma-separated pair consisting of `'AmplitudeTaper'` and a non-negative scalar or vector of non-negative scalars. Set property value to `0` to model dead elements.

Example: `'AmplitudeTaper',3`

Data Types: `double`

`'PhaseShift'` — Phase shift for array elements

`0` (default) | real scalar in degrees | real vector in degrees

Phase shift for array elements, specified as the comma-separated pair consisting of `'PhaseShift'` and a real scalar in degrees or a real vector in degrees.

Example: `'PhaseShift',[3 3 0 0]` specified the phase shift for custom array containing four elements.

Data Types: `double`

`'Tilt'` — Tilt angle of array

`0` (default) | scalar in degrees | vector in degrees

Tilt angle of an array, specified as the comma-separated pair consisting of `'Tilt'` and a scalar or vector in degrees.

Example: `'Tilt',90`

Example: `'Tilt',[90 90 0]`

Data Types: `double`

`'TiltAxis'` — Tilt axis of array

`[1 0 0]` (default) | three-element vector of Cartesian coordinates in meters | two three-element vector of Cartesian coordinates in meters | `'X'` | `'Y'` | `'Z'`

Tilt axis of the array, specified as the comma-separated pair consisting of `'TiltAxis'` and:

- A three-element vector of Cartesian coordinates in meters. In this case, the first element in the three-element vector is the origin and the third element is the Z-axis.
- Two points in space as three-element vectors of Cartesian coordinates. In this case, the array rotates along the line joining the two points space.
- A string input for simple rotations around the principle planes, X, Y, or Z.

For more information see, “Rotate Antenna and Arrays”

Example: `'TiltAxis',[0 0 0;0 1 0]`

Example: `'TiltAxis','Z'`

Data Types: `double`

Object Functions

axialRatio	Axial ratio of antenna
beamwidth	Beamwidth of antenna
charge	Charge distribution on antenna or array surface
current	Current distribution on antenna or array surface
design	Design prototype antenna for resonance at specified frequency

EHfields	Electric and magnetic fields of antennas
impedance	Input impedance of antenna; scan impedance of array
mesh	Mesh properties of antenna or array structure
meshconfig	Change mesh mode of antenna structure
pattern	Radiation pattern of antenna or array
patternAzimuth	Azimuth pattern of antenna or array
patternElevation	Elevation pattern of antenna or array
returnLoss	Return loss of antenna; scan return loss of array
sparameters	S-parameter object
show	Display antenna or array structure
vswr	Voltage standing wave ratio of antenna

Examples

Create Custom Slot Antenna Array

Create a custom array using `customArrayGeometry`.Visualize it and plot the impedance. Also, visualize the current distribution on the array.

Create a ground plane with a length of 0.6 m and a width of 0.5 m.

```
Lp  = 0.6;
Wp  = 0.5;
[~,p1]   = em.internal.makeplate(Lp,Wp,2,'linear');
```

Create slots on the ground plane with a length 0.05 m and a width of 0.4 m.

```
Ls  = 0.05;
Ws  = 0.4;
offset = 0.12;
[~,p2]   = em.internal.makeplate(Ls,Ws,2,'linear');
p3 = em.internal.translateshape(p2, [offset, 0, 0]);
p2 = em.internal.translateshape(p2, [-offset, 0, 0]);
```

Create a feed in between the slots on the ground plane.

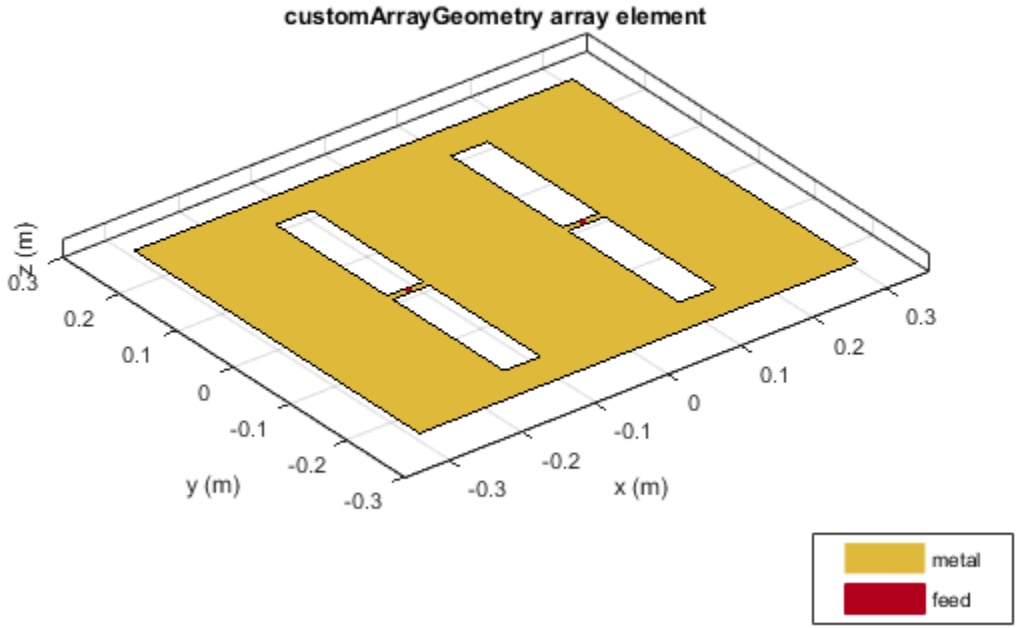
```
Wf  = 0.01;
[~,p4]   = em.internal.makeplate(Ls,Wf,2,'linear');
p5 = em.internal.translateshape(p4, [offset, 0, 0]);
p4 = em.internal.translateshape(p4, [-offset, 0, 0]);
```

Create an array using the slotted ground plane.

```
carray = customArrayGeometry;
carray.Boundary = {p1', p2', p3', p4', p5'};
carray.Operation= 'P1-P2-P3+P4+P5';
carray.NumFeeds = 2;
carray.FeedWidth= [0.01 0.01];
carray.FeedLocation = [-offset,0,0 ; offset,0,0];
```

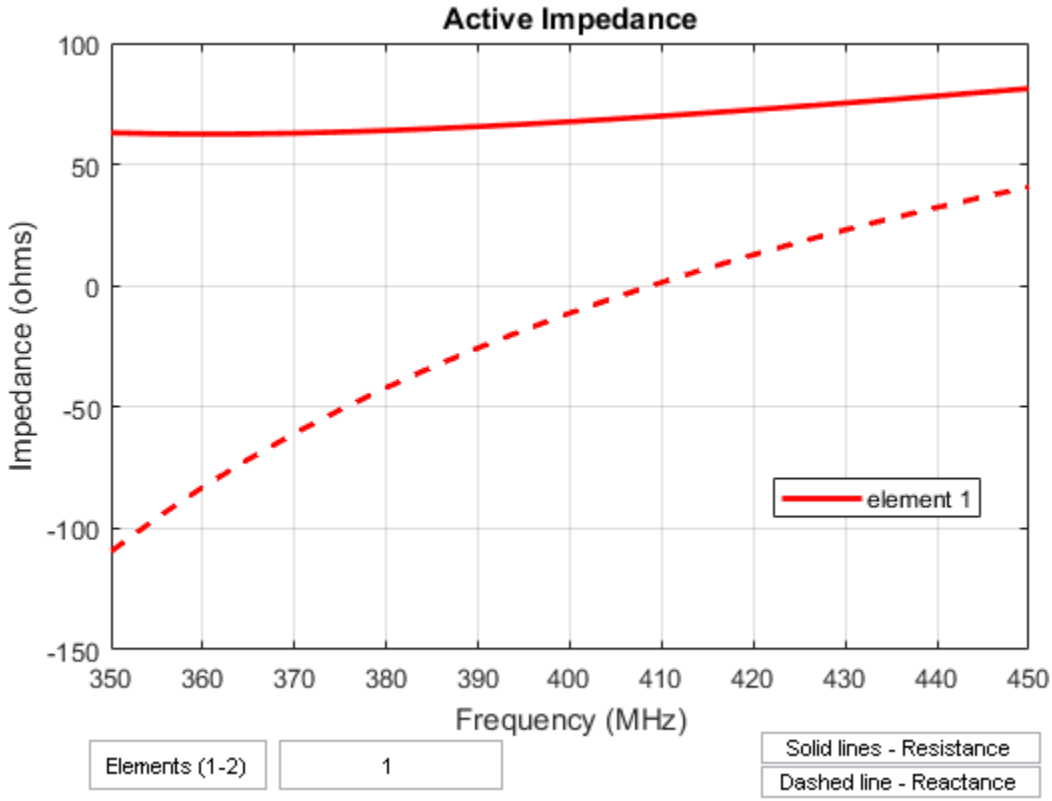
Visulaize the array.

```
figure; show(carray);
```



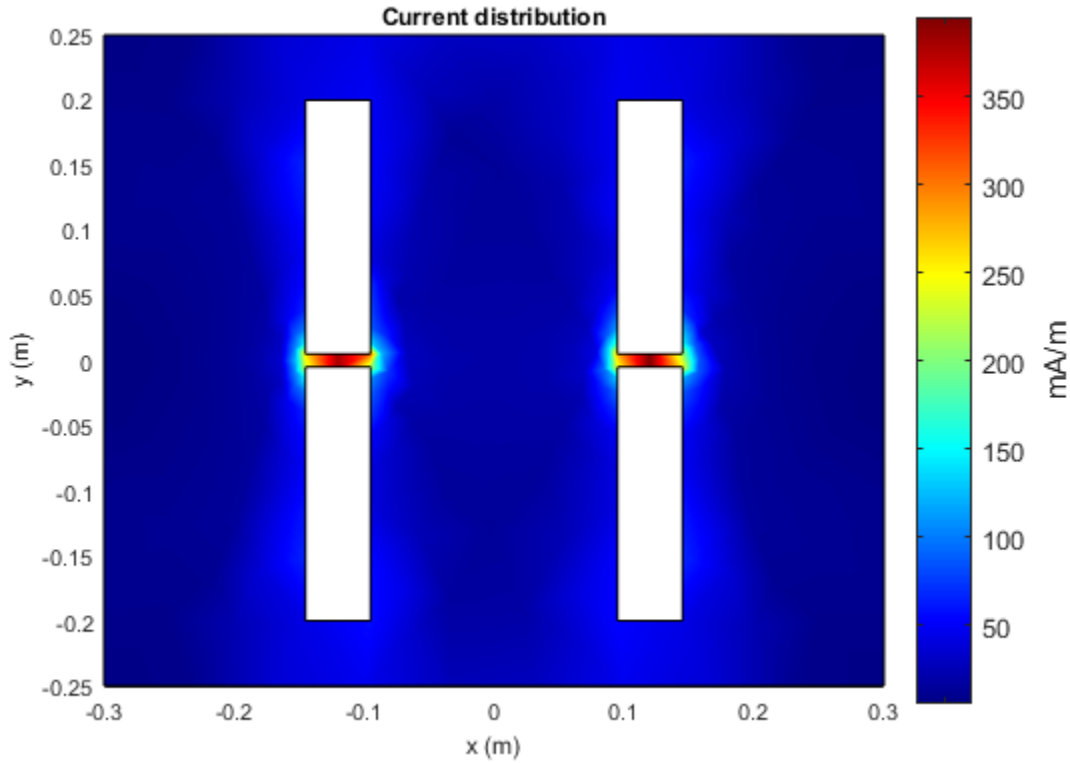
Calculate the impedance of the array using the frequency range of 350 MHz to 450 MHz.

```
figure; impedance(carray, 350e6:5e6:450e6);
```



Visulaize the current distribution on the array at 410 MHz.

```
figure; current(carray, 410e6);
```



References

[1] Balanis, C. A. *Antenna Theory. Analysis and Design*. 3rd Ed. Hoboken, NJ: John Wiley & Sons, 2005.

See Also

Topics

"Rotate Antenna and Arrays"

Introduced in R2017a

Methods — Alphabetical List

createFeed
impedance
sparameters
rfparam
rfplot
show
returnLoss
pattern
patternAzimuth
patternMultiply
patternElevation
current
charge
design
createFeed
EHfields
axialRatio
beamwidth
mesh
layout
lumpedElement
vswr
correlation
cylinder2strip
helixpitch2spacing
meshconfig
numSummationTerms
feedCurrent
fieldsCustom
patternCustom
msiread
msiwrite

dielectric
DielectricCatalog
hornangle2size
add
addCursor
animate
createLabels
findLobes
replace
showPeaksTable
showSpan
arrayFactor

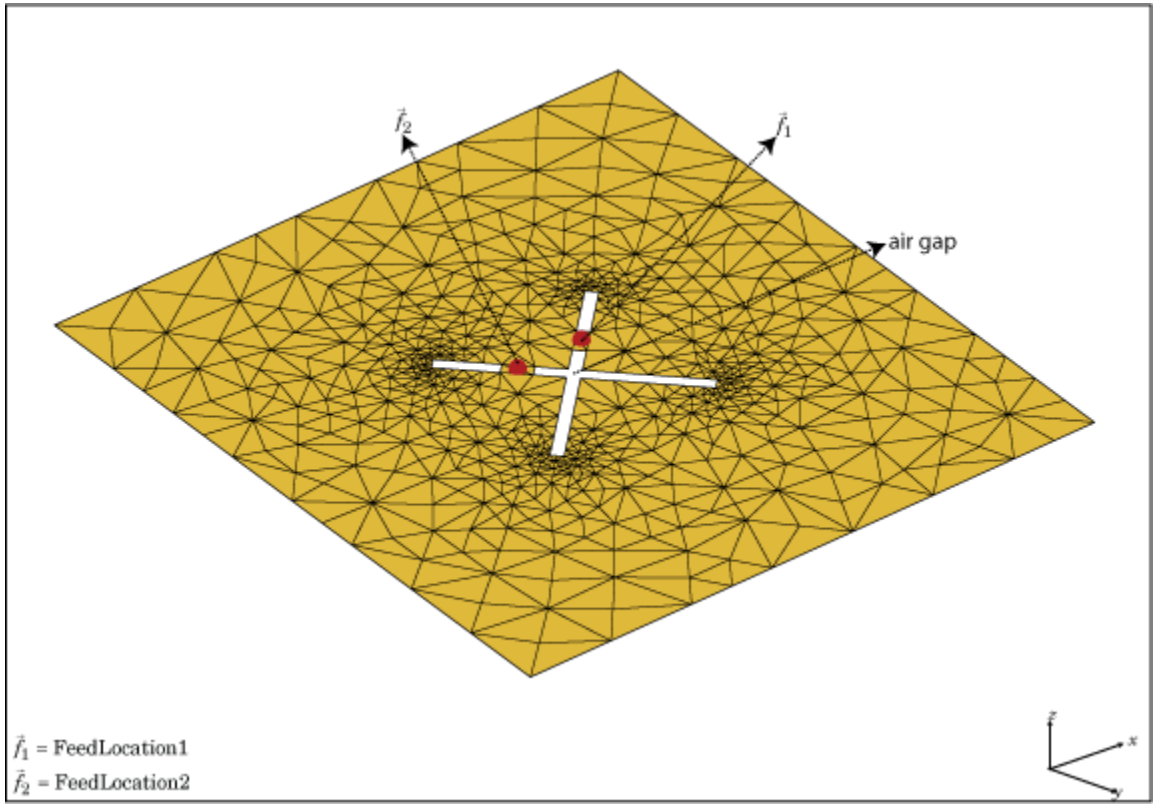
createFeed

Create feed locations for custom array

Syntax

```
createFeed(array)
createFeed(array,point1a,point1b,point2a,point2b,.....)
```

Description



`createFeed(array)` plots a custom array mesh in a figure window. From the figure window, you can specify feed locations by clicking on the mesh and create a custom array. To specify a region for the feed point, select two pairs of points, inside triangles on either side of the air gap.

`createFeed(array,point1a,point1b,point2a,point2b,.....)` creates the feed across the triangle edges identified by pairs of points (`point1a` and `point1b`, `point2a`, and `point2b`). After creating the feed, feed location is highlighted when you plot the resulting array mesh.

Input Arguments

`array` — Custom array mesh

scalar handle

Custom mesh array, specified as a scalar handle.

`point1a,point1b` — Point pairs to identify feed region

Cartesian coordinates in meters

Point pairs to identify feed region, specified as Cartesian coordinates in meters. Specify the points in the format $[x_1, y_1]$, $[x_2, y_2]$.

Example: `createFeed(c,[0.07,0.01],[0.05,0.05],[-0.07,0.01],[-0.05,0.05])`. Creates two pairs of feedpoints for a custom array mesh at the x-y coordinates specified.

Examples

Two–Feed Custom Array Mesh Using GUI

Create a custom array with two feeds.

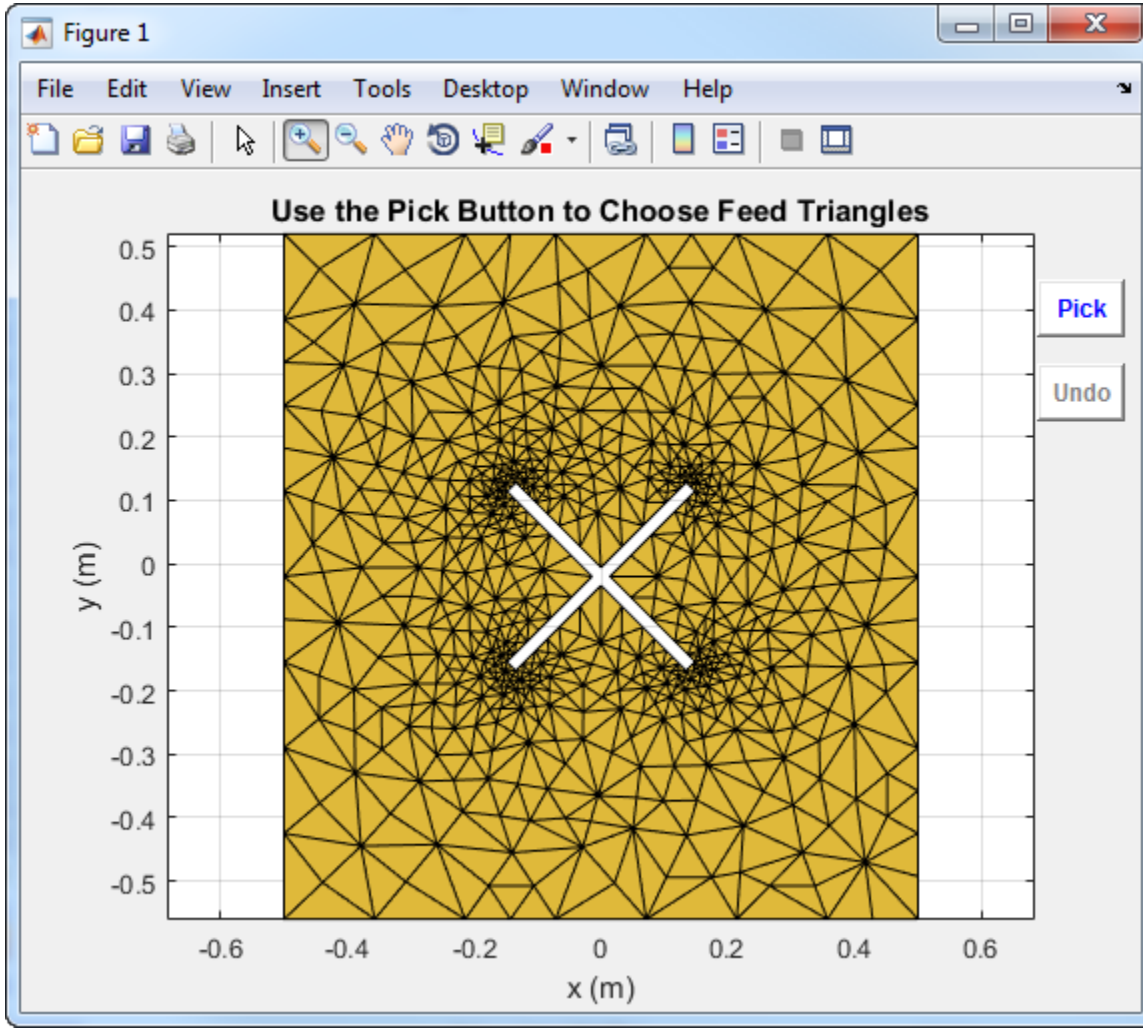
Load a 2-D custom mesh. Create a custom array using the points and triangles.

```
load planarmesh.mat;
c = customArrayMesh(p,t,2);
```

```
c =
  customArrayMesh with properties:

           Points: [3x658 double]
        Triangles: [4x1219 double]
         NumFeeds: 2
      FeedLocation: []
    AmplitudeTaper: 1
        PhaseShift: 0
              Tilt: 0
          TiltAxis: [1 0 0]
```

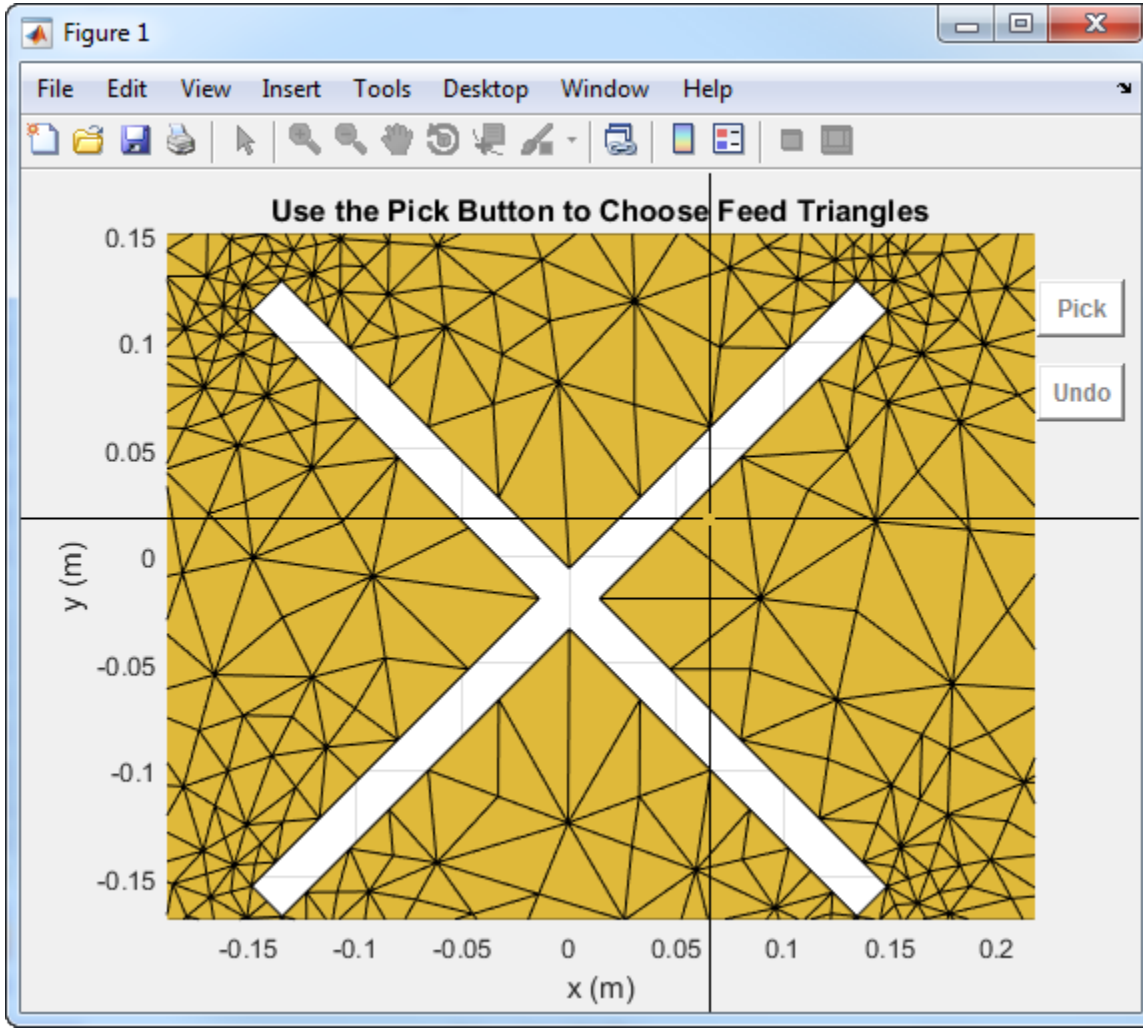
Use the `createFeed` function to view the array mesh structure. In this array mesh view, you see **Pick** and **Undo** buttons. The **Pick** button is highlighted.

```
createFeed(c)
```

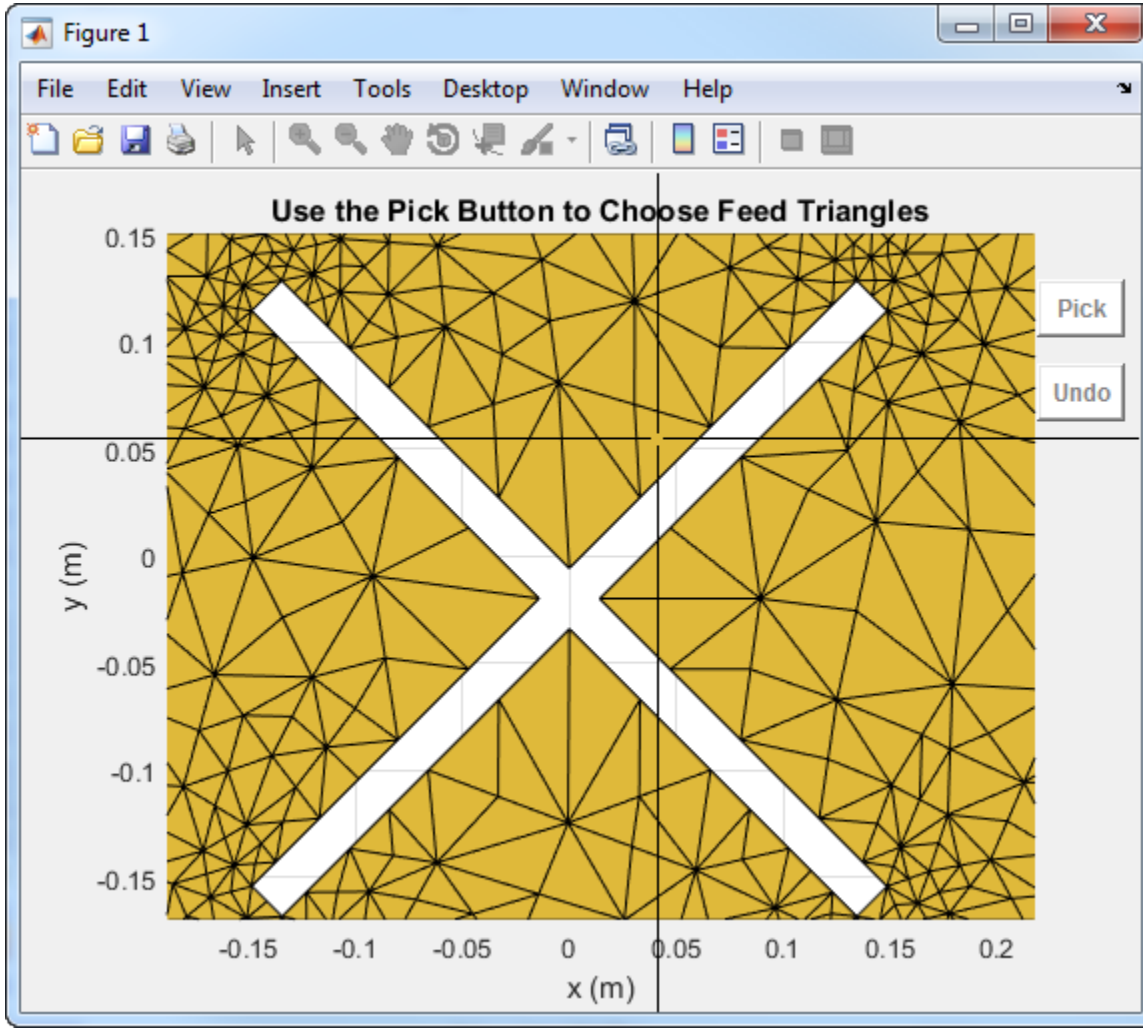


Click **Pick** to display the cross hairs. For an array with two feeds, select two pairs (four points) in the mesh. To specify a feed-region for the, zoom in and select two points each, one inside each triangle on either side of the air gap. Select the points using the cross hairs.

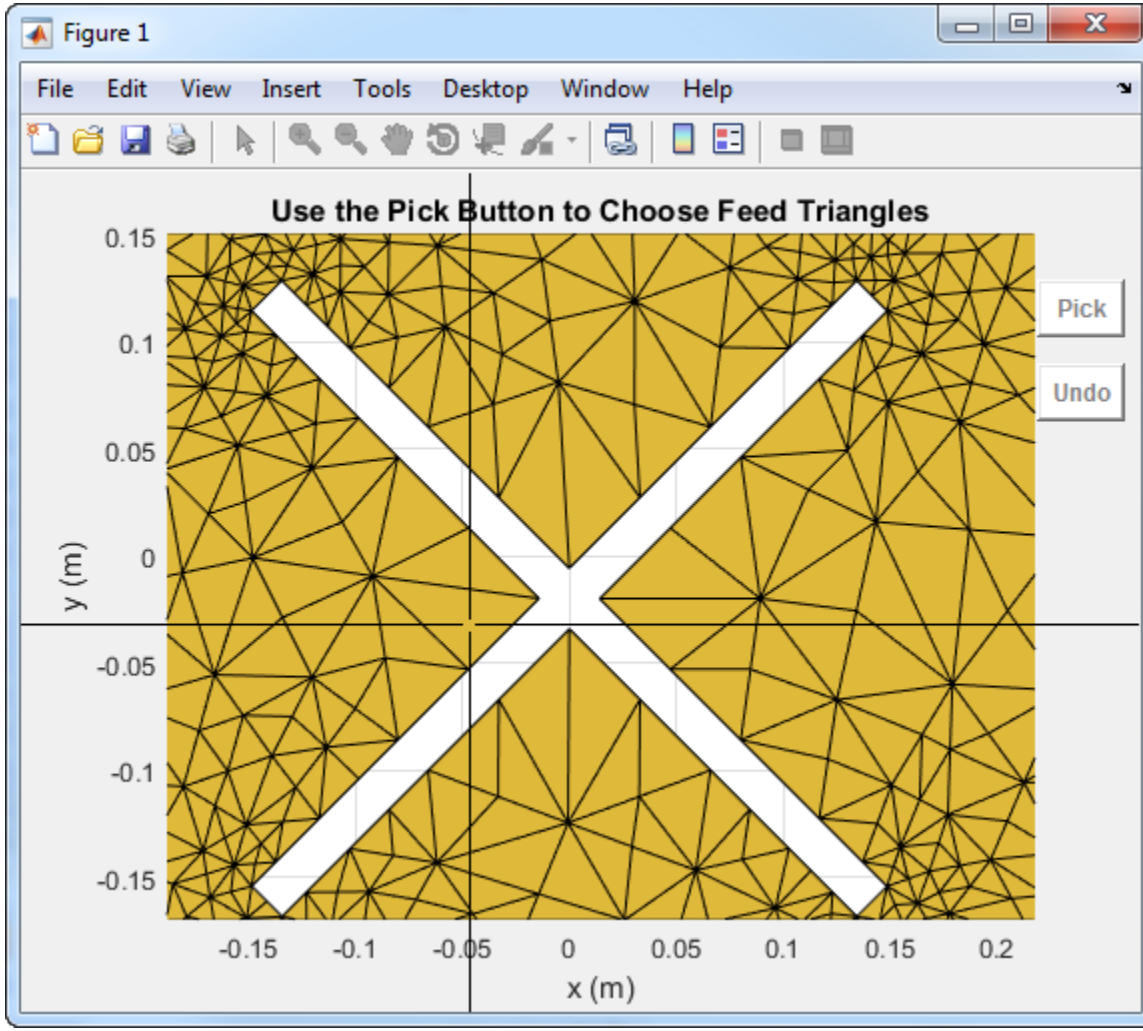
- Select the first triangle for feedpoint 1.



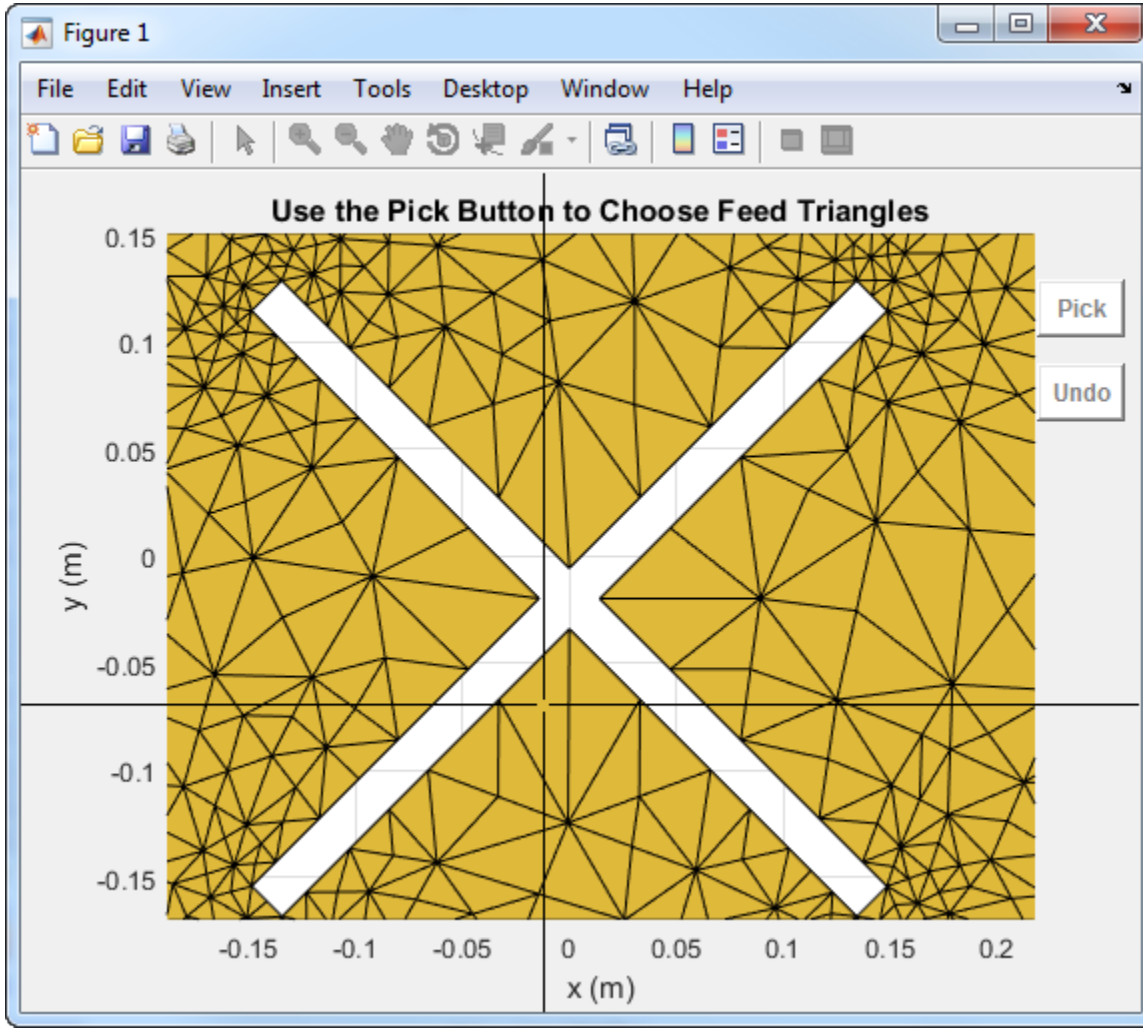
- Select the second triangle on the other side of the air gap for feedpoint 1.



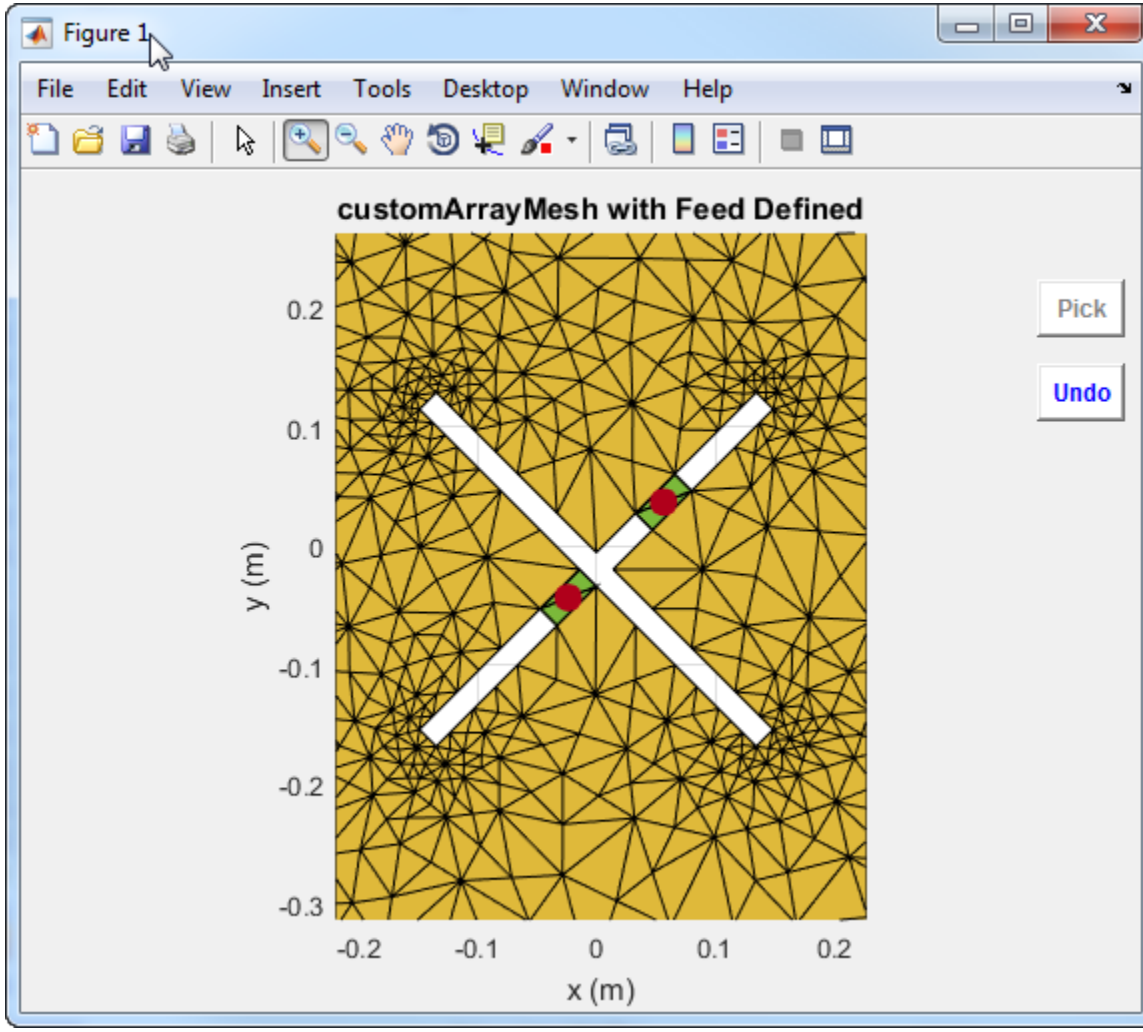
- Select first triangle for feedpoint 2.



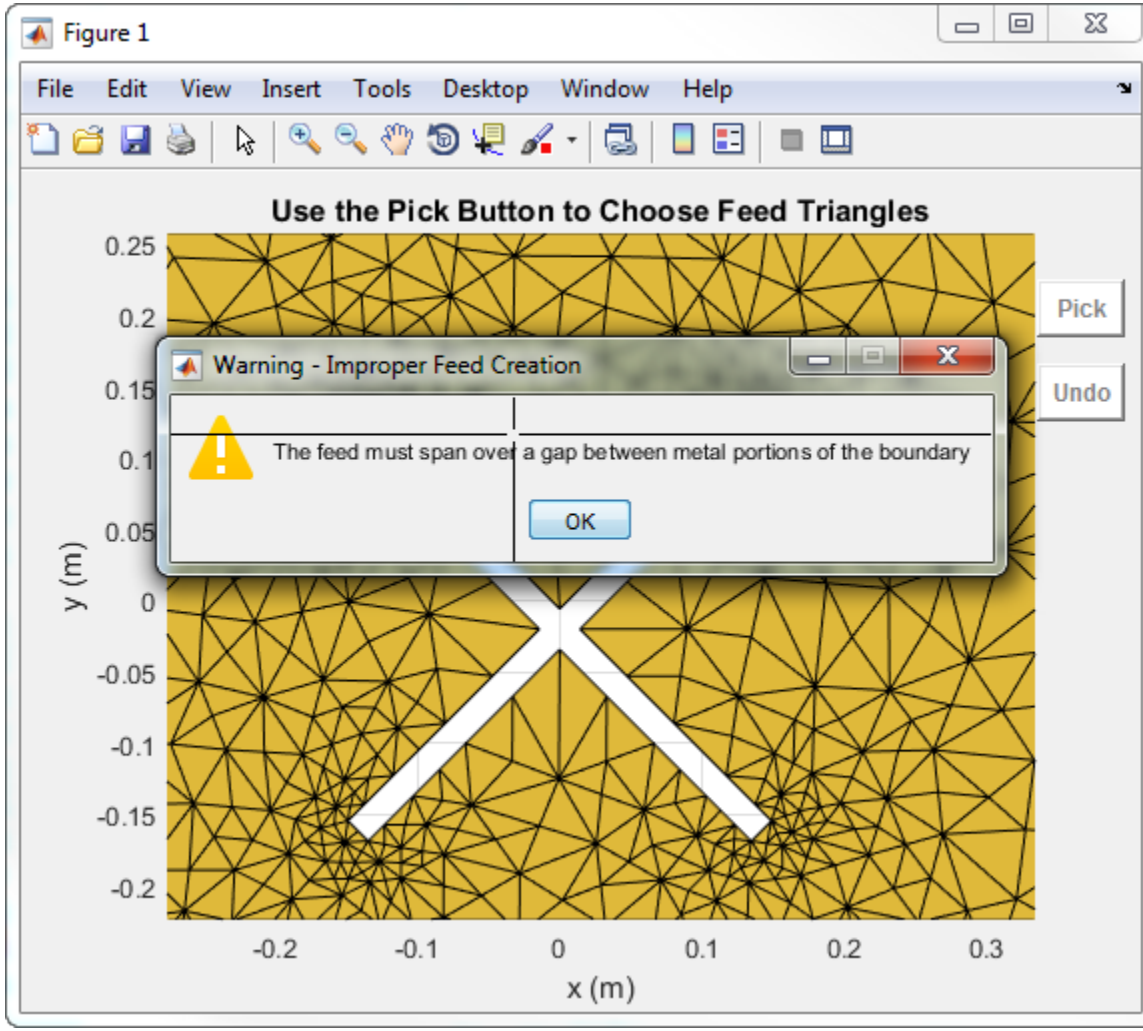
- Select the second triangle on the other side of the air gap for feedpoint 2.



Selecting the fourth triangle creates and displays the array feeds.



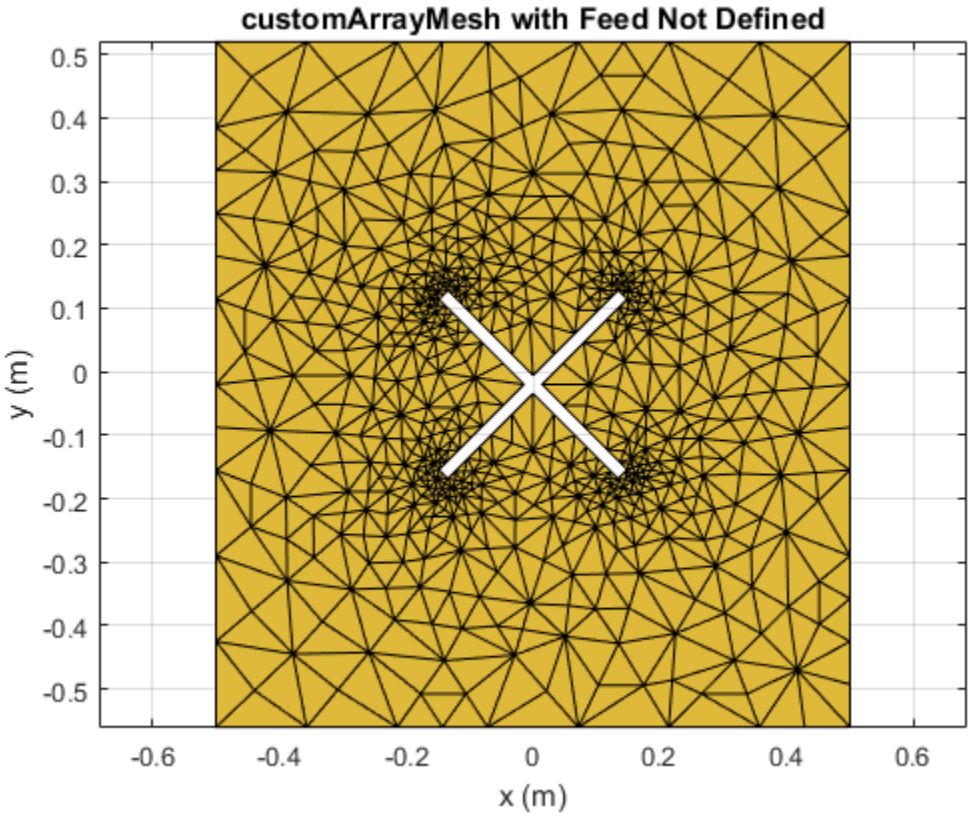
You must select the two triangles on either side of the air gap. Otherwise, the function displays an error message.



Create Feed for Custom Array Mesh

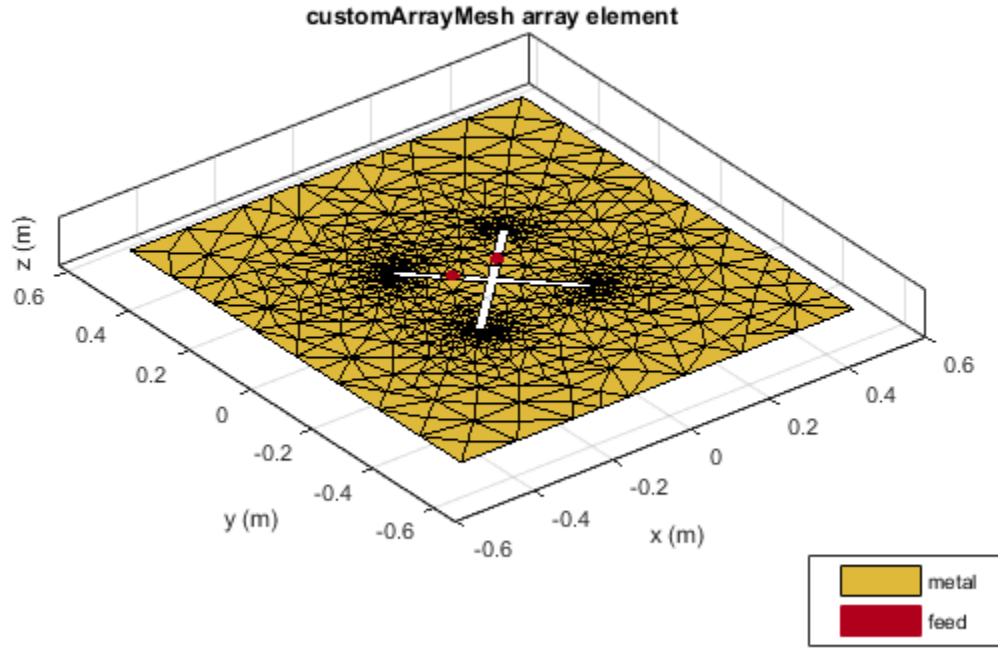
Load a custom mesh and create an array.

```
load planarmesh.mat;
c = customArrayMesh(p,t,2);
show(c)
```



Create feeds for the custom array mesh.

```
createFeed(c,[0.07,0.01],[0.05,0.05], [-0.07,0.01],[-0.05,0.05]);
show(c)
```



See Also

See Also

`returnLoss` | `sparameters`

Introduced in R2016a

impedance

Input impedance of antenna; scan impedance of array

Syntax

```
impedance(antenna,frequency)
z = impedance(antenna,frequency)

impedance(array,frequency,elementnumber)
z = impedance(array,frequency,elementnumber)
```

Description

`impedance(antenna,frequency)` calculates the input impedance of an antenna object and plots the resistance and reactance over a specified frequency.

`z = impedance(antenna,frequency)` returns the impedance of the antenna object, over a specified frequency.

`impedance(array,frequency,elementnumber)` calculates and plots the scan impedance of a specified antenna element in an array.

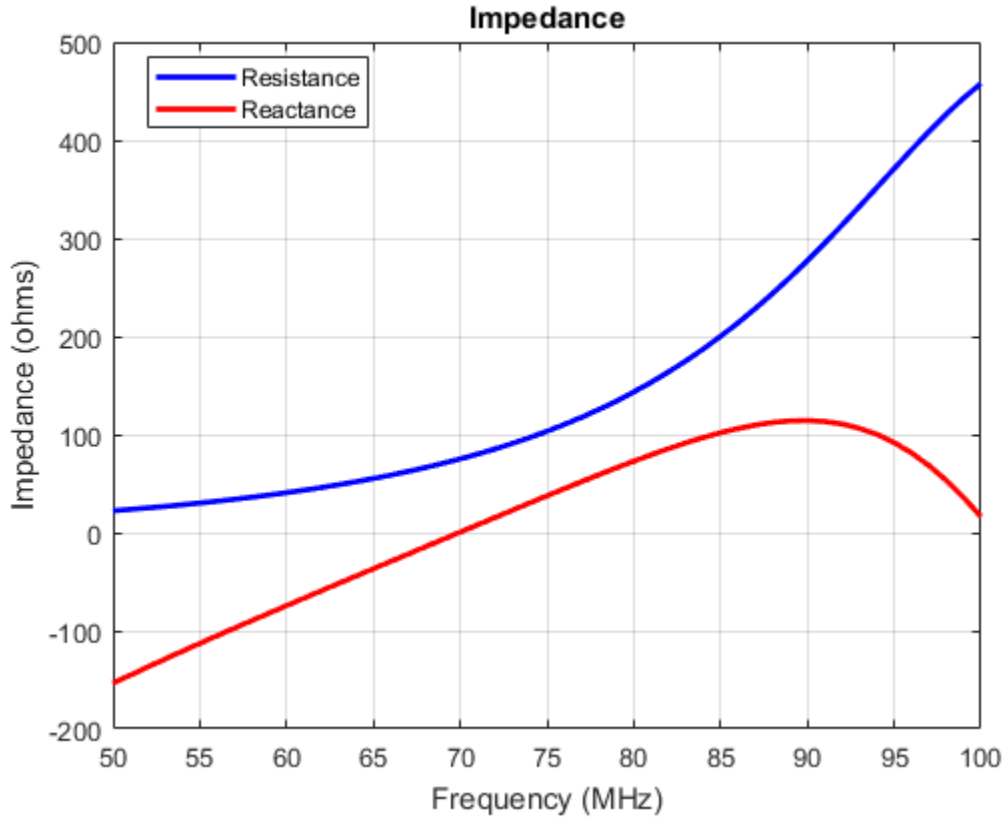
`z = impedance(array,frequency,elementnumber)` returns the scan impedance of a specified antenna element in an array.

Examples

Calculate and Plot Impedance of Antenna

Calculate and plot the impedance of a planar dipole antenna over a frequency range of 50MHz - 100MHz.

```
h = dipole;
impedance (h,50e6:1e6:100e6);
```



Calculate Scan Impedance of Array

Calculate scan impedance of default linear array over a frequency range of 50MHz to 100MHz.

```
h = linearArray;
z = impedance(h,50e6:1e6:100e6)
```

```
z =

   1.0e+02 *

   0.2751 - 1.6565i   0.2751 - 1.6565i
```

```
0.2864 - 1.5802i   0.2864 - 1.5802i
0.2979 - 1.5055i   0.2979 - 1.5055i
0.3097 - 1.4322i   0.3097 - 1.4322i
0.3218 - 1.3601i   0.3218 - 1.3601i
0.3343 - 1.2893i   0.3343 - 1.2893i
0.3471 - 1.2194i   0.3471 - 1.2194i
0.3603 - 1.1504i   0.3603 - 1.1504i
0.3739 - 1.0821i   0.3739 - 1.0821i
0.3879 - 1.0145i   0.3879 - 1.0145i
0.4024 - 0.9474i   0.4024 - 0.9474i
0.4175 - 0.8806i   0.4175 - 0.8806i
0.4331 - 0.8141i   0.4331 - 0.8141i
0.4493 - 0.7477i   0.4493 - 0.7477i
0.4663 - 0.6813i   0.4663 - 0.6813i
0.4840 - 0.6148i   0.4840 - 0.6148i
0.5025 - 0.5480i   0.5025 - 0.5480i
0.5219 - 0.4808i   0.5219 - 0.4808i
0.5424 - 0.4131i   0.5424 - 0.4131i
0.5640 - 0.3447i   0.5640 - 0.3447i
0.5869 - 0.2755i   0.5869 - 0.2755i
0.6111 - 0.2054i   0.6111 - 0.2054i
0.6370 - 0.1341i   0.6370 - 0.1341i
0.6645 - 0.0616i   0.6645 - 0.0616i
0.6941 + 0.0124i   0.6941 + 0.0124i
0.7258 + 0.0879i   0.7258 + 0.0879i
0.7599 + 0.1653i   0.7599 + 0.1653i
0.7969 + 0.2446i   0.7969 + 0.2446i
0.8369 + 0.3260i   0.8369 + 0.3260i
0.8805 + 0.4098i   0.8805 + 0.4098i
0.9281 + 0.4961i   0.9281 + 0.4961i
0.9801 + 0.5851i   0.9801 + 0.5851i
1.0374 + 0.6770i   1.0374 + 0.6770i
1.1004 + 0.7720i   1.1004 + 0.7720i
1.1701 + 0.8701i   1.1701 + 0.8701i
1.2475 + 0.9715i   1.2475 + 0.9715i
1.3336 + 1.0763i   1.3336 + 1.0763i
1.4298 + 1.1843i   1.4298 + 1.1843i
1.5375 + 1.2955i   1.5375 + 1.2955i
1.6585 + 1.4096i   1.6585 + 1.4096i
1.7948 + 1.5258i   1.7948 + 1.5258i
1.9488 + 1.6435i   1.9488 + 1.6435i
2.1232 + 1.7612i   2.1232 + 1.7612i
2.3208 + 1.8769i   2.3208 + 1.8769i
2.5451 + 1.9881i   2.5451 + 1.9881i
```

```
   2.7996 + 2.0906i   2.7996 + 2.0906i
   3.0878 + 2.1794i   3.0878 + 2.1794i
   3.4130 + 2.2473i   3.4130 + 2.2473i
   3.7776 + 2.2849i   3.7776 + 2.2849i
   4.1824 + 2.2807i   4.1824 + 2.2807i
   4.6248 + 2.2203i   4.6248 + 2.2203i
```

Input Arguments

`antenna` — Antenna or array object

scalar handle

Antenna object, specified as a scalar handle.

`array` — Array object

scalar handle

Array object, specified as a scalar handle.

`frequency` — Frequency range used to calculate impedance

vector in Hz

Frequency range to calculate impedance, specified as a vector in Hz.

Example: 50e6:1e6:100e6

Data Types: `double`

`elementnumber` — Antenna element number in array

scalar

Antenna element number in array, specified as a scalar.

Example: 1

Data Types: `double`

Output Arguments

`z` — Input impedance of antenna or scan impedance of array

complex number in ohms

Input impedance of antenna or scan impedance of array, returned as a complex number in ohms. The real part of the complex number indicates the resistance. The imaginary part of the complex number indicates the reactance.

See Also

See Also

`returnLoss`

Introduced in R2015a

sparameters

S-parameter object

Syntax

```
obj = sparameters(antenna,freq,Z0 )
obj = sparameters(array,freq,Z0 )
```

Description

`obj = sparameters(antenna,freq,Z0 )` calculates the complex s-parameters for an `antenna` object over specified frequency values and for a given reference impedance, `Z0`.

`obj = sparameters(array,freq,Z0 )` calculates the complex s-parameters for an `array` object over specified frequency values and for a given reference impedance, `Z0`.

Examples

Calculate S-Parameter Matrix For Antenna

Calculate the complex s-parameters for a default dipole at 70MHz frequency.

```
h = dipole
sparameters (h, 70e6)
```

```
h =

  dipole with properties:

        Length: 2
         Width: 0.1000
    FeedOffset: 0
          Tilt: 0
      TiltAxis: [1 0 0]
          Load: [1×1 lumpedElement]
```

```
ans =

  sparameters: S-parameters object

       NumPorts: 1
    Frequencies: 70000000
     Parameters: 0.2000 + 0.0042i
      Impedance: 50

  rfparam(obj,i,j) returns S-parameter Sij
```

Calculate S-parameter Matirx For Array

Calculate the complex s-parameters for a default rectangular array at 70MHz frequency.

```
h = rectangularArray;
sparameters(h,70e6)
```

```
ans =

  sparameters: S-parameters object

       NumPorts: 4
    Frequencies: 70000000
     Parameters: [4×4 double]
      Impedance: 50

  rfparam(obj,i,j) returns S-parameter Sij
```

Input Arguments

`antenna` — antenna object

scalar handle

Antenna object, specified as a scalar handle.

`array` — array object

scalar handle

Array object, specified as a scalar handle.

`freq` — S-parameter frequencies

vector of positive real numbers

S-parameter frequencies, specified as a vector of positive real numbers, sorted from smallest to largest. The function uses this input argument to set the value of the `Frequencies` property of `hs`.

`Z0` — Reference impedance

50 (default) | positive real scalar

Reference impedance in ohms, specified as a positive real scalar. The function uses this input argument to set the value of the `Impedance` property of `hs`. You cannot specify `Z0` if you are importing data from a file. The argument Z0 is optional and is stored in the `Impedance` property.

When making a deep copy of an S-parameter object, this input argument is not supported. To change the reference impedance of an S-parameters object, use `newref`.

Output Arguments

`obj` — S-parameter data

scalar handle

S-parameter data, returned as a scalar handle. `disp(hs)` returns the properties of the object:

- `NumPorts` — Number of ports, specified as an integer. The function calculates this value automatically when you create the object.
- `Frequencies` — S-parameter frequencies, specified as a *K*-by-1 vector of positive real numbers sorted from smallest to largest. The function sets this property from the `filename` or `freq` input arguments.
- `Parameters` — S-parameter data, specified as an *N*-by-*N*-by-*K* array of complex numbers. The function sets this property from the `filename` or `data` input arguments.
- `Impedance` — Reference impedance in ohms, specified as a positive real scalar. The function sets this property from the `filename` or `Z0` input arguments. If no reference impedance is provided, the function uses a default value of `50`.

See Also

See Also

`correlation` | `impedance` | `rfparam` | `rfplot`

rfparam

Extract vector of network parameters

Syntax

```
n_ij = rfparam(hnet,i,j)
abcd_vector = rfparam(habcd,abcdflag)
```

Description

`n_ij = rfparam(hnet,i,j)` extracts the network parameter vector (*i*,*j*) from the network parameter object, `hnet`.

`abcd_vector = rfparam(habcd,abcdflag)` extracts the *A*, *B*, *C*, or *D* vector from ABCD-parameter object, `habcd`.

Examples

Create Data Vector From S-Parameter Object

Read in the file default.s2p into an sparameters object and get the S21 value.

```
S = sparameters('default.s2p');
s21 = rfparam(S,2,1)
```

```
s21 =

  -0.6857 + 1.7827i
  -0.6560 + 1.7980i
  -0.6262 + 1.8131i
  -0.5963 + 1.8278i
  -0.5664 + 1.8422i
  -0.5363 + 1.8563i
  -0.5062 + 1.8700i
  -0.4760 + 1.8835i
  -0.4457 + 1.8966i
  -0.4152 + 1.9094i
  -0.3847 + 1.9219i
```

```
-0.3542 + 1.9339i
-0.3236 + 1.9455i
-0.2930 + 1.9566i
-0.2623 + 1.9674i
-0.2316 + 1.9779i
-0.2008 + 1.9882i
-0.1698 + 1.9983i
-0.1387 + 2.0084i
-0.1073 + 2.0185i
-0.0758 + 2.0286i
-0.0441 + 2.0387i
-0.0124 + 2.0488i
 0.0194 + 2.0588i
 0.0513 + 2.0687i
 0.0834 + 2.0785i
 0.1158 + 2.0882i
 0.1484 + 2.0977i
 0.1813 + 2.1072i
 0.2145 + 2.1164i
 0.2482 + 2.1256i
 0.2821 + 2.1344i
 0.3161 + 2.1430i
 0.3504 + 2.1513i
 0.3849 + 2.1595i
 0.4197 + 2.1676i
 0.4550 + 2.1757i
 0.4908 + 2.1839i
 0.5272 + 2.1922i
 0.5642 + 2.2007i
 0.6020 + 2.2095i
 0.6403 + 2.2186i
 0.6792 + 2.2281i
 0.7186 + 2.2377i
 0.7587 + 2.2476i
 0.7994 + 2.2575i
 0.8410 + 2.2675i
 0.8833 + 2.2774i
 0.9266 + 2.2871i
 0.9708 + 2.2967i
 1.0161 + 2.3061i
 1.0623 + 2.3152i
 1.1091 + 2.3243i
 1.1567 + 2.3333i
 1.2053 + 2.3423i
```

```
1.2551 + 2.3512i
1.3062 + 2.3600i
1.3588 + 2.3687i
1.4131 + 2.3774i
1.4691 + 2.3860i
1.5272 + 2.3944i
1.5870 + 2.4032i
1.6484 + 2.4123i
1.7115 + 2.4218i
1.7768 + 2.4313i
1.8443 + 2.4407i
1.9143 + 2.4497i
1.9871 + 2.4582i
2.0629 + 2.4659i
2.1419 + 2.4726i
2.2243 + 2.4782i
2.3101 + 2.4840i
2.3991 + 2.4911i
2.4918 + 2.4987i
2.5887 + 2.5060i
2.6900 + 2.5120i
2.7962 + 2.5161i
2.9077 + 2.5174i
3.0248 + 2.5150i
3.1481 + 2.5082i
3.2778 + 2.4961i
3.4155 + 2.4848i
3.5624 + 2.4786i
3.7185 + 2.4736i
3.8836 + 2.4662i
4.0576 + 2.4524i
4.2405 + 2.4287i
4.4322 + 2.3911i
4.6326 + 2.3359i
4.8415 + 2.2595i
5.0590 + 2.1579i
5.3116 + 2.0531i
5.6159 + 1.9604i
5.9571 + 1.8657i
6.3204 + 1.7550i
6.6908 + 1.6143i
7.0535 + 1.4295i
7.3937 + 1.1868i
7.6964 + 0.8720i
```

```
 7.9468 + 0.4711i
 8.1299 - 0.0298i
 8.3110 - 0.6357i
 8.5403 - 1.3306i
 8.7814 - 2.0977i
 8.9975 - 2.9196i
 9.1519 - 3.7795i
 9.2080 - 4.6601i
 9.1291 - 5.5445i
 8.8786 - 6.4155i
 8.4198 - 7.2560i
 7.7160 - 8.0490i
 6.8506 - 8.6946i
 5.9420 - 9.1242i
 5.0061 - 9.3672i
 4.0588 - 9.4532i
 3.1158 - 9.4116i
 2.1931 - 9.2719i
 1.3066 - 9.0637i
 0.4720 - 8.8165i
-0.2947 - 8.5596i
-0.9777 - 8.3228i
-1.5383 - 8.0622i
-1.9620 - 7.7264i
-2.2692 - 7.3328i
-2.4800 - 6.8992i
-2.6148 - 6.4430i
-2.6939 - 5.9818i
-2.7376 - 5.5332i
-2.7663 - 5.1147i
-2.8001 - 4.7441i
-2.8594 - 4.4387i
-2.9211 - 4.1801i
-2.9519 - 3.9375i
-2.9569 - 3.7102i
-2.9413 - 3.4973i
-2.9102 - 3.2982i
-2.8689 - 3.1120i
-2.8225 - 2.9379i
-2.7761 - 2.7753i
-2.7349 - 2.6234i
-2.7041 - 2.4813i
-2.6776 - 2.3487i
-2.6464 - 2.2251i
```

```
-2.6116 - 2.1099i
-2.5741 - 2.0022i
-2.5348 - 1.9015i
-2.4946 - 1.8069i
-2.4544 - 1.7178i
-2.4154 - 1.6335i
-2.3782 - 1.5531i
-2.3440 - 1.4761i
-2.3111 - 1.4026i
-2.2778 - 1.3333i
-2.2442 - 1.2679i
-2.2106 - 1.2060i
-2.1771 - 1.1474i
-2.1442 - 1.0918i
-2.1119 - 1.0388i
-2.0805 - 0.9882i
-2.0504 - 0.9396i
-2.0216 - 0.8929i
-1.9938 - 0.8481i
-1.9662 - 0.8054i
-1.9391 - 0.7647i
-1.9124 - 0.7258i
-1.8862 - 0.6887i
-1.8605 - 0.6532i
-1.8353 - 0.6190i
-1.8108 - 0.5861i
-1.7870 - 0.5543i
-1.7640 - 0.5235i
-1.7415 - 0.4938i
-1.7195 - 0.4652i
-1.6978 - 0.4378i
-1.6766 - 0.4114i
-1.6558 - 0.3860i
-1.6353 - 0.3615i
-1.6152 - 0.3377i
-1.5954 - 0.3147i
-1.5759 - 0.2924i
-1.5567 - 0.2706i
-1.5377 - 0.2493i
-1.5189 - 0.2286i
-1.5003 - 0.2086i
-1.4819 - 0.1892i
-1.4638 - 0.1704i
-1.4459 - 0.1523i
```

```
-1.4283 - 0.1349i
-1.4110 - 0.1182i
-1.3940 - 0.1022i
-1.3773 - 0.0869i
```

Input Arguments

`abcdflag` — ABCD-parameter index

`'A' | 'B' | 'C' | 'D'`

Flag that determines which ABCD parameters the function extracts, specified as `'A'`, `'B'`, `'C'`, or `'D'`.

`habcd` — 2-port ABCD parameters

ABCD parameter object

2-port ABCD parameters, specified as an RF Toolbox™ ABCD parameter object. When you specify `abcdflag`, you must also specify an ABCD parameter object.

`hnet` — Network parameters

network parameter object

Network parameters, specified as an RF Toolbox network parameter object.

`i` — Row index

positive integer

Row index of data to extract, specified as a positive integer.

`j` — Column index

positive integer

Column index of data to extract, specified as a positive integer.

Output Arguments

`n_ij` — Network parameters (*i, j*)

vector

Network parameters (*i, j*), returned as a vector. The `i` and `j` input arguments determine which parameters the function returns.

Example: `S_21 = rfparam(hs,2,1)`

`abcd_vector` — *A, B, C,* or *D*- parameters
vector

A, *B*, *C*, or *D*- parameters, returned as a vector. The `abcdflag` input argument determines which parameters the function returns. The function supports only 2-port ABCD parameters; thus, the output is always a vector.

Example: `a_vector = rfparam(habcd,'A');`

See Also

See Also

`rfinterp1` | `rfplot` | `rfplot` | `sparameters` | `sparameters`

rfplot

Plot S-parameter data

Syntax

```
rfplot(s_obj)
rfplot(s_obj,i,j)
rfplot( ___ ,lineSpec)
rfplot( ___ ,plotflag)
hline = rfplot( ___ )
```

Description

`rfplot(s_obj)` plots the magnitude in dB versus frequency of all S-parameters (S_{11}, S_{12} ... S_{NN}) on the current axis. `s_obj` must be an s-parameter object.

`rfplot(s_obj,i,j)` plots the magnitude of $S_{i,j}$, in decibels, versus frequency on the current axis.

`rfplot( ___ ,lineSpec)` plots S-parameters using optional line types, symbols, and colors specified by `linespec`.

`rfplot( ___ ,plotflag)` allows to specify the type of plot by using the `plotflag`.

`hline = rfplot( ___ )` plots the S-parameters and returns the column vector of handles to the line objects, `hline`.

Examples

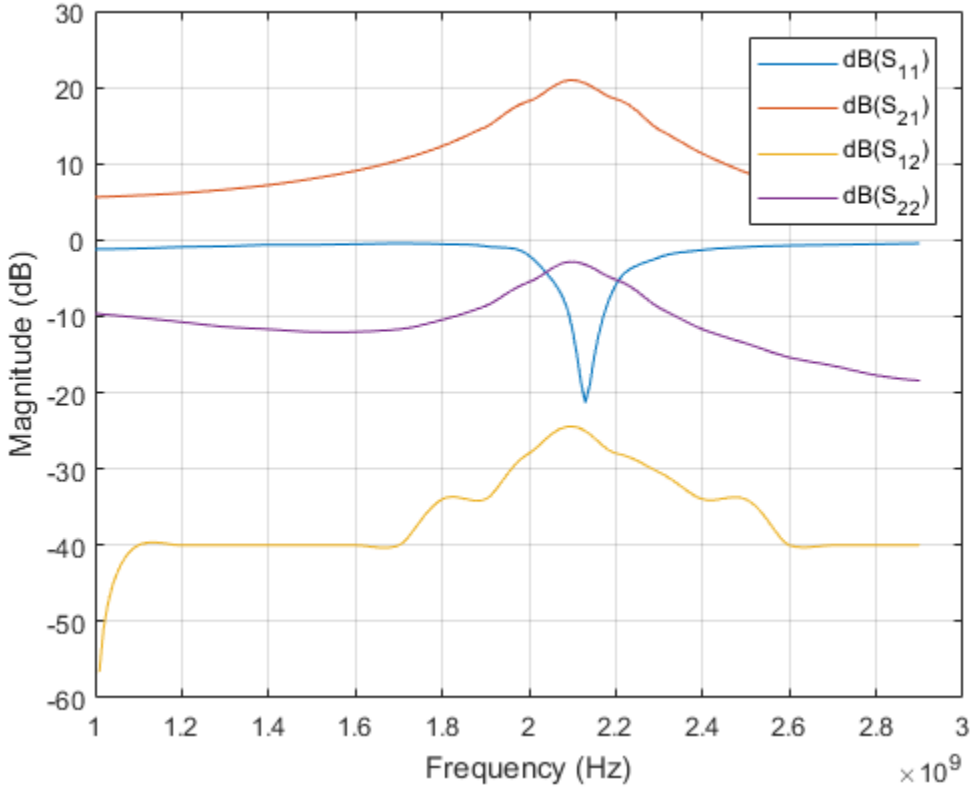
Plot S-Parameter Data Using rfplot

Create S-parameter

```
hs = sparameters('default.s2p');
```

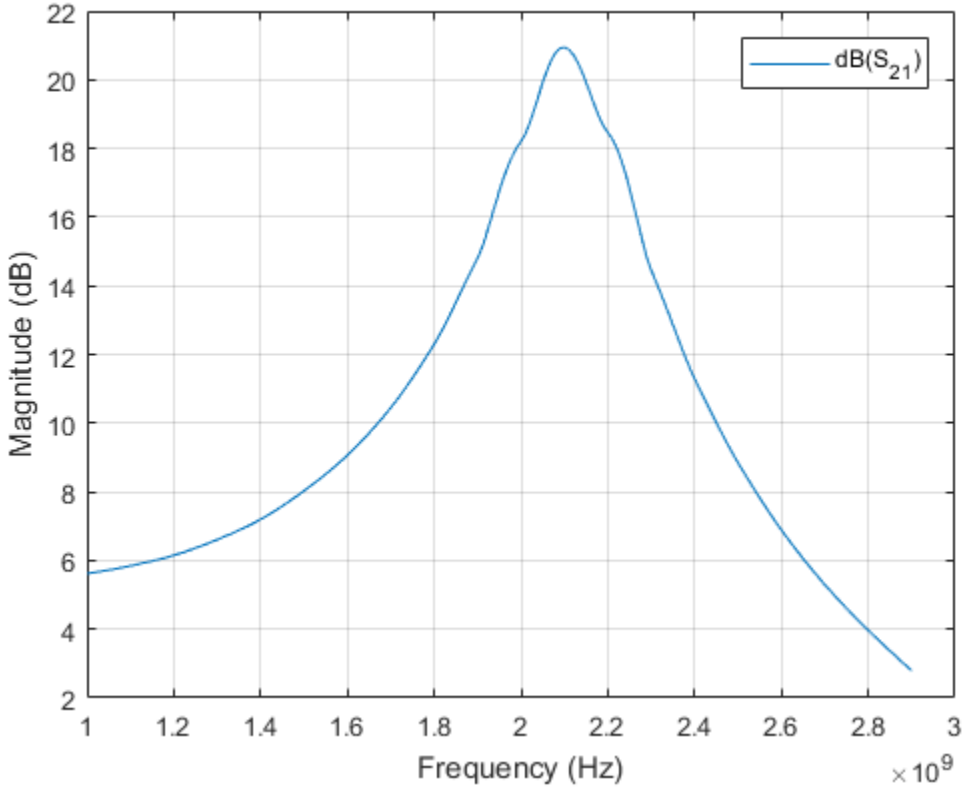
Plot all S-paramteres

```
figure;
rfplot(hs)
```



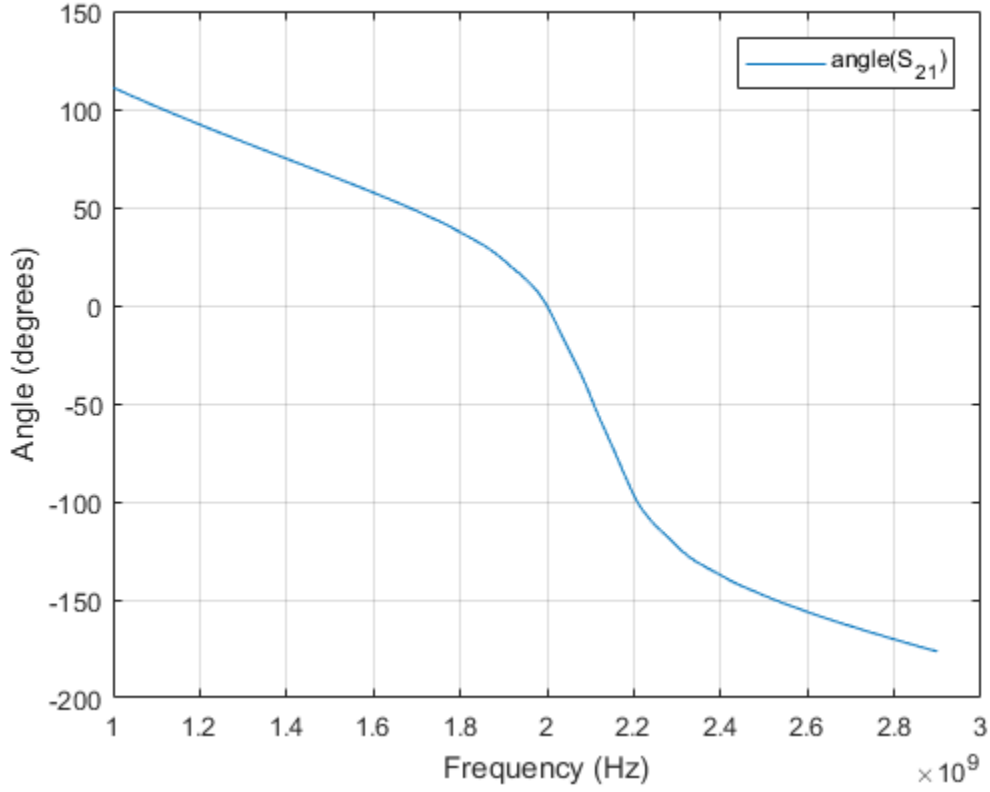
Plot S21

```
figure;
rfplot(hs,2,1)
```



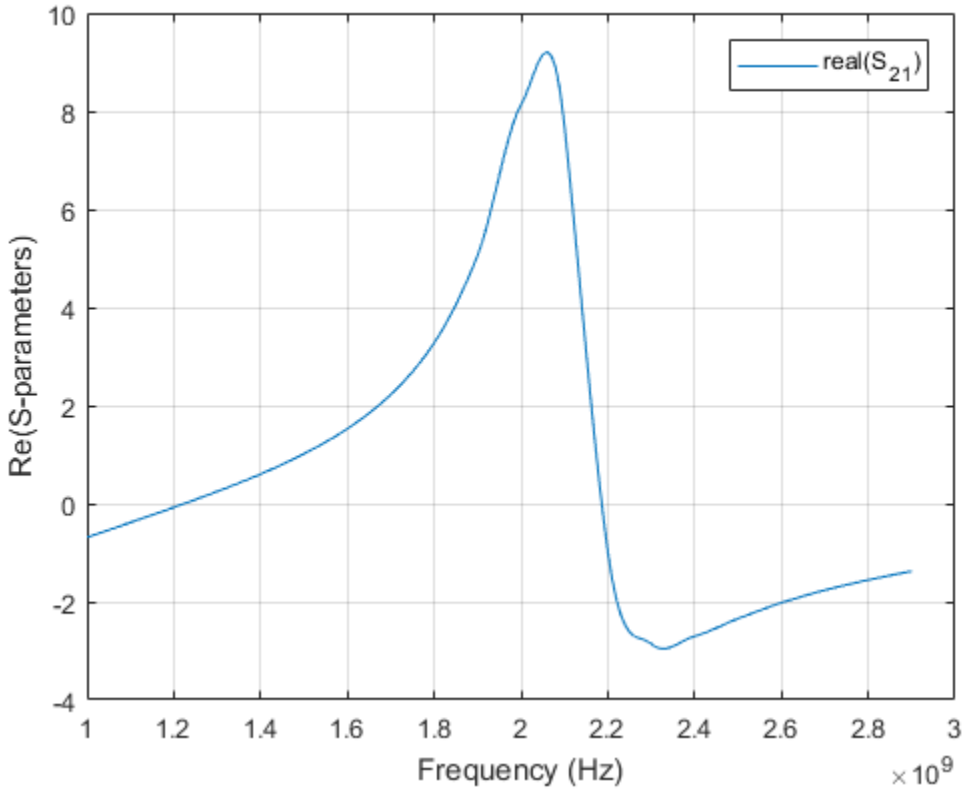
Plot the angle of S21 in degrees

```
rfplot(hs,2,1,'angle')
```



Plot the real part of S21

```
rfplot(hs,2,1,'real')
```



Input Arguments

`s_obj` — S-parameters

network parameter object

S-parameters, specified as an RF Toolbox network parameter object. To create this type of object, use the `sparameters` function.

`i` — Row index

positive integer

Row index of data to plot, specified as a positive integer.

`j` — Column index
positive integer

Column index of data to plot, specified as a positive integer.

`lineSpec` — Line specification
character array

Line specification, specified as a text input, that modifies the line types, symbols, and colors of the plot. The function takes text inputs in the same format as `plot` command. For more information on line specification values, see `linespec`.

Example: `'-or'`

`plotflag` — Plot types
`'db'` (default)

Plot types, specified as the following values: `'db'`, `'real'`, `'imag'`, `'abs'`, `'angle'`.

Example: `'angle'`

Output Arguments

`hline` — Line
line handle

Line containing the S-parameter plot, returned as a line handle.

See Also

See Also
`sparameters`

show

Display antenna or array structure

Syntax

```
show(object)
```

Description

`show(object)` displays the structure of an antenna or array object.

Examples

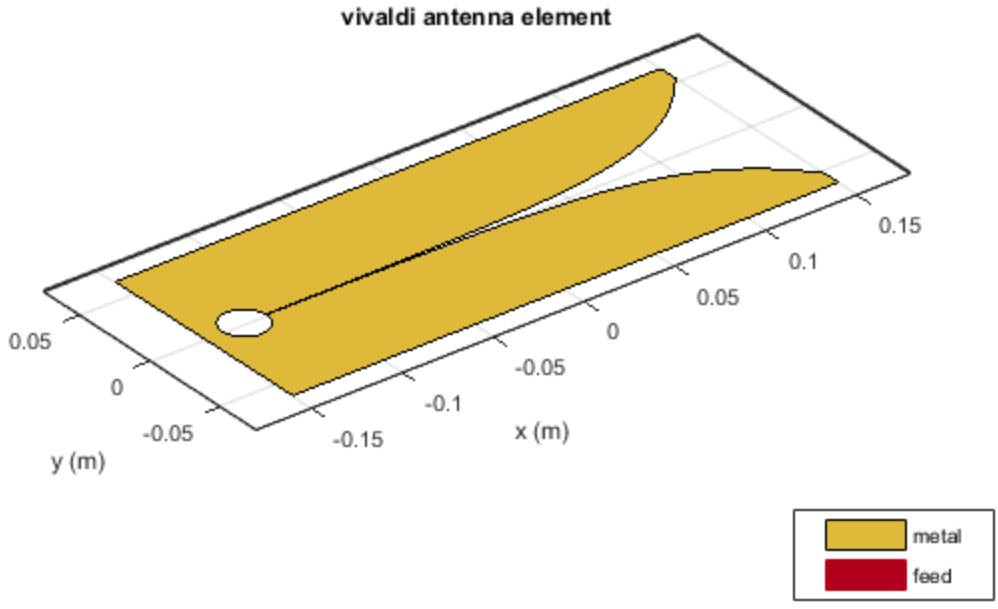
Display Antenna Structure

This example shows how to create a vivaldi antenna and display the antenna structure.

```
h = vivaldi
show(h)
```

```
h =

  vivaldi with properties:

            TaperLength: 0.2430
          ApertureWidth: 0.1050
            OpeningRate: 25
          SlotLineWidth: 5.0000e-04
         CavityDiameter: 0.0240
    CavityToTaperSpacing: 0.0230
       GroundPlaneLength: 0.3000
        GroundPlaneWidth: 0.1250
              FeedOffset: -0.1045
                    Tilt: 0
                TiltAxis: [1 0 0]
```

```
Load: [1×1 lumpedElement]
```



Input Arguments

`object` — Antenna or array object

scalar handle

Antenna or array object, specified as a scalar handle.

See Also

See Also

`layout` | `mesh`

Introduced in R2015a

returnLoss

Return loss of antenna; scan return loss of array

Syntax

```
returnLoss(antenna,frequency,z0)
rl = returnLoss(antenna ,frequency, z0)

returnLoss(array,frequency,elementnumber)
rl = returnLoss(array,frequency,elementnumber)
```

Description

`returnLoss(antenna,frequency,z0)` calculates and plots the return loss of an antenna, over a specified frequency and a given reference impedance, `z0`.

`rl = returnLoss(antenna ,frequency, z0)` returns the return loss of an antenna.

`returnLoss(array,frequency,elementnumber)` calculates and plots the scan return loss of a specified antenna element in an array.

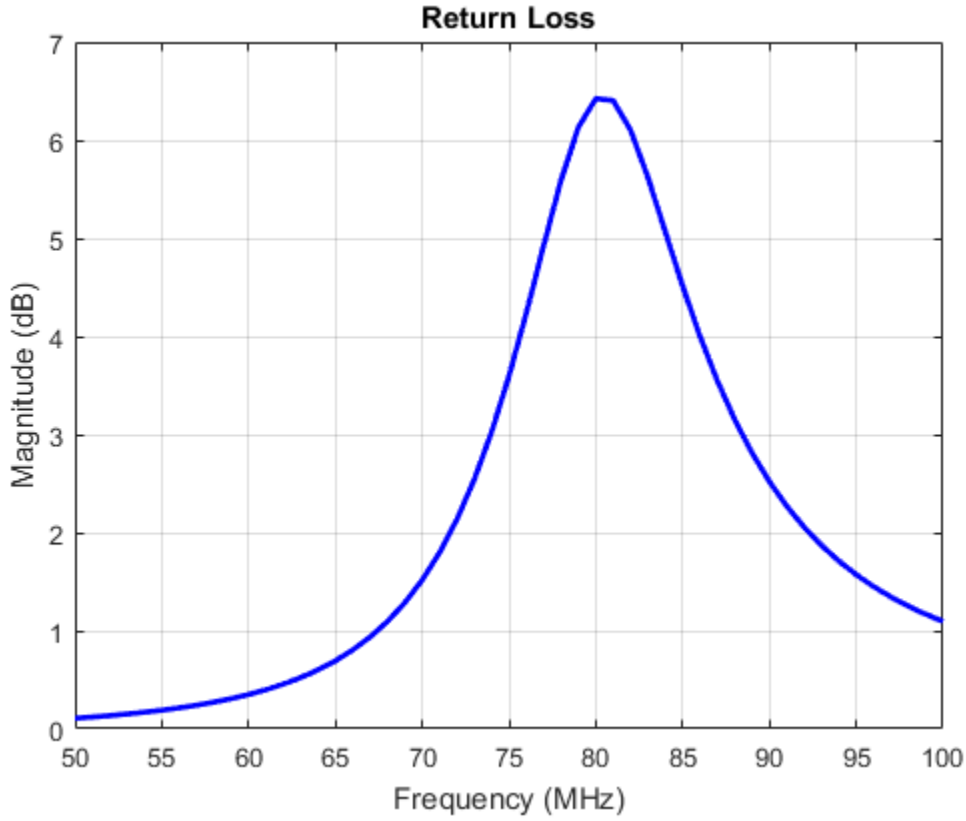
`rl = returnLoss(array,frequency,elementnumber)` returns the scan return loss of a specified antenna element in an array.

Examples

Calculate and Plot Return Loss of Antenna

This example shows how to calculate and plot the return loss of a circular loop antenna over a frequency range of 50MHz-100MHz.

```
h = loopCircular;
returnLoss (h, 50e6:1e6:100e6);
```



Input Arguments

`antenna` — Antenna object

scalar handle

Antenna object, specified as a scalar handle.

`array` — array object

scalar handle

Array object, specified as a scalar handle.

`frequency` — Frequency range used to calculate return loss

vector in Hz

Frequency range used to calculate return loss, specified as a vector in Hz.

Example: 50e6:1e6:100e6

Data Types: `double`

`z0` — Reference impedance

50 (default) | scalar in ohms

Reference impedance, specified as a scalar in ohms.

Example: 40

Data Types: `double`

`elementnumber` — Antenna element number in array

scalar

Antenna element number in array, specified as a scalar.

Example: 1

Data Types: `double`

Output Arguments

`rl` — Return loss of antenna object or scan return loss of array object

vector in dB

Return loss of antenna object or scan return loss of array object, returned as a vector in dB. The return loss is calculated using the formula

$$RL = 20\log 10\left|\frac{(Z - Z_0)}{(Z + Z_0)}\right|$$

where,

- Z = input impedance of antenna or scan impedance of array
- Z_0 = reference impedance

See Also

See Also

`EHfields` | `impedance` | `sparameters`

Introduced in R2015a

pattern

Radiation pattern of antenna or array

Syntax

```
pattern(object,frequency)
pattern(object,frequency,azimuth,elevation)
pattern( ___ ,Name,Value)

[fieldval,azimuth,elevation] = pattern(object,frequency)
[fieldval,azimuth,elevation] = pattern(object,frequency,azimuth,
elevation)
[fieldval,azimuth,elevation] = pattern( ___ ,Name,Value)
```

Description

`pattern(object,frequency)` plots the 3-D radiation pattern of an antenna or array object over a specified frequency.

`pattern(object,frequency,azimuth,elevation)` plots the radiation pattern of an antenna or array object using the specified `azimuth` and `elevation` angles.

`pattern( ___ ,Name,Value)` uses additional options specified by one or more Name, Value pair arguments. You can use any of the input arguments from previous syntaxes.

`[fieldval,azimuth,elevation] = pattern(object,frequency)` returns the field value of an antenna or array object over a specified frequency. `azimuth` and `elevation` are the angles at which the `pattern` function calculates the directivity.

`[fieldval,azimuth,elevation] = pattern(object,frequency,azimuth,elevation)` returns the fields value of an antenna or array object at specified frequency. `azimuth` and `elevation` are the angles at which the pattern function calculates the directivity.

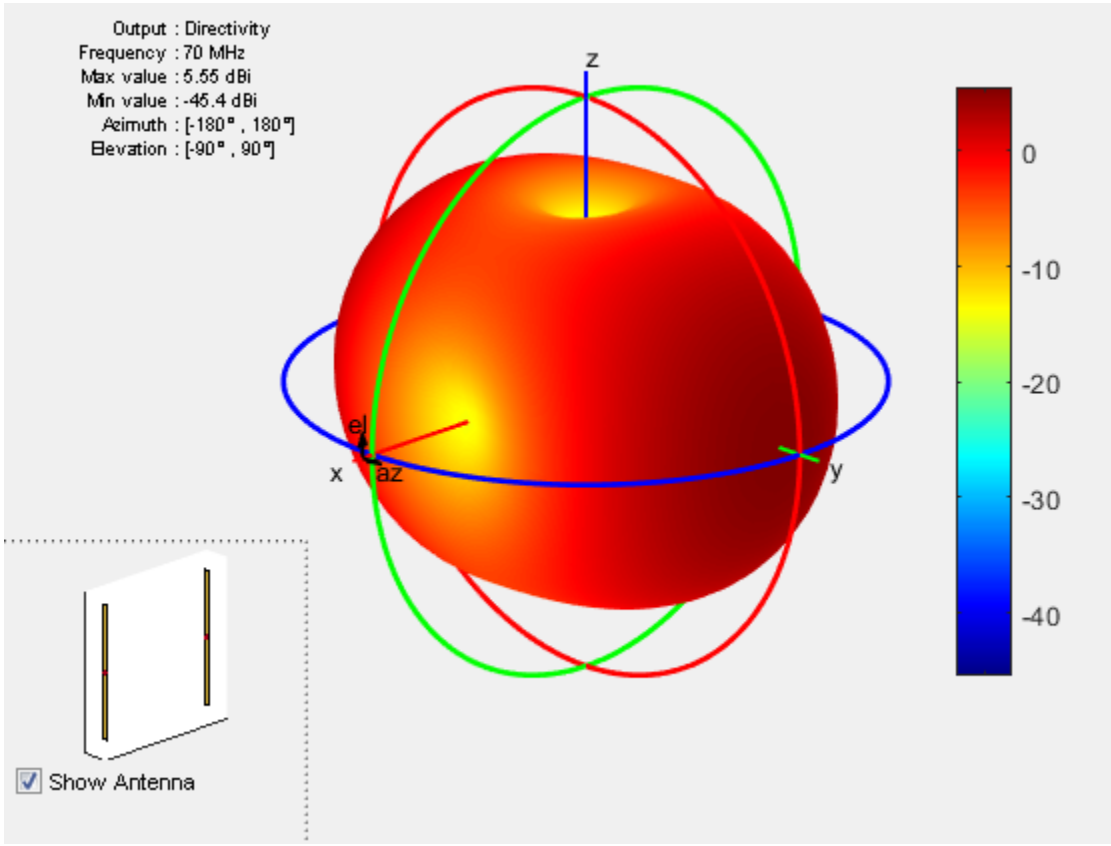
`[fieldval,azimuth,elevation] = pattern( ___ ,Name,Value)` uses additional options specified by one or more `Name,Value` pair arguments.

Examples

Calculate Radiation Pattern of Array

Calculate radiation pattern of default linear array for a frequency of 70 MHZ.

```
l = linearArray;
pattern(l,70e6)
```



Input Arguments

`object` — Antenna or array object

scalar handle

Antenna or array object, specified as a scalar handle.

`frequency` — Frequency used to calculate charge distribution

scalar in Hz

Frequency to calculate charge distribution, specified as a scalar in Hz.

Example: 70e6

Data Types: `double`

`azimuth` — Azimuth angle of antenna

–180:5:180 (default) | scalar in degrees | vector in degrees

Azimuth angle of the antenna, specified as a scalar or vector in degrees.

Example: 90

Data Types: `double`

`elevation` — Elevation angle of antenna

–90:5:90 (default) | scalar in degrees | vector in degrees

Elevation angle of the antenna, specified as a scalar or vector in degrees.

Example: 0:1:360

Data Types: `double`

Name-Value Pair Arguments

Specify optional comma-separated pairs of `Name,Value` pair arguments. `Name` is the argument name and `Value` is the corresponding value. `Name` must appear inside single quotes (`''`). You can specify several name and value pair arguments in any order as `Name1, Value1, ..., NameN, ValueN`.

Example: `'CoordinateSystem', 'uv'`

`'CoordinateSystem'` — Coordinate system of radiation pattern

`'polar'` (default) | `'rectangular'` | `'uv'`

Coordinate system of radiation pattern, specified as the comma-separated pair consisting of `'CoordinateSystem'` and one of these values: `'polar'`, `'rectangular'`, `'uv'`.

Example: `'CoordinateSystem', 'polar'`

Data Types: `char`

`'Type'` — Value to plot

`'directivity'` (default) | `'gain'` | `'efield'` | `'power'` | `'powerdb'`

Value to plot, specified as a comma-separated pair consisting of `'Type'` and one of these values:

- `'directivity'` – Radiation intensity in a given direction of antenna in dB
- `'gain'` – Radiation intensity in a given direction of antenna, when the antenna has a lossy substrate in dB
- `'efield'` – Electric field of antenna in volt/meter
- `'power'` – Antenna power in watts
- `'powerdb'` – Antenna power in dB

Example: `'Type'`, `'efield'`

Data Types: `char`

`'Normalize'` — Normalize field pattern

`true` (default) | `false` | boolean

Normalize field pattern, specified as the comma-separated pair consisting of `'Normalize'` and either `true` or `false`. For directivity patterns, this property is not applicable.

Example: `'Normalize'`, `false`

Data Types: `double`

`'PlotStyle'` — 2-D pattern display style

`'overlay'` (default) | `'waterfall'`

2-D pattern display style, specified as the comma-separated pair consisting of `'PlotStyle'` and one of these values:

- `'overlay'` – Overlay frequency data in a 2-D line plot
- `'waterfall'` – Plot frequency data in a waterfall plot

This property applies only when you call the function with no output arguments.

Example: `'PlotStyle'`, `'waterfall'`

Data Types: `char`

`'Polarization'` — Field polarization

`'H'` | `'V'` | `'RHCP'` | `'LHCP'`

Field polarization, specified as the comma-separated pair consisting of `'Polarization'` and one of these values:

- `'H'` – Horizontal polarization
- `'V'` – Vertical polarization
- `'RHCP'` – Right-hand circular polarization
- `'LHCP'` – Left-hand circular polarization

By default, you can visualize a combined polarization.

Example: `'Polarization', 'RHCP'`

Data Types: `char`

`'ElementNumber'` — Antenna element in array

scalar

Antenna element in array, specified as the comma-separated pair consisting of `'ElementNumber'` and scalar.

Example: `'ElementNumber',1`

Data Types: `double`

`'Termination'` — Impedance value for array element termination

50 (default) | scalar

Impedance value for array element termination, specified as the comma-separated pair consisting of `'Termination'` and scalar. The impedance value terminates other antenna elements of an array while calculating the embedded pattern of the required antenna.

Example: `'Termination',40`

Data Types: `double`

Output Arguments

`fieldval` — Field value of antenna

matrix

Field value of the antenna, returned as a matrix of one of the following values:

- `directivity` – Radiation intensity in a given direction of antenna in dB

- `gain` – Radiation intensity in a given direction of antenna, when the antenna has a lossy substrate in dB
- `efield` – Electric field of antenna in volt/meter
- `power` – Antenna power in watts
- `powerdb` – Antenna power in dB

Matrix size is number of elevation values multiplied by number of azimuth values.

`azimuth` — Azimuth angles over which directivity is calculated
vector in degrees

Azimuth angles over which directivity is calculated, returned as a vector in degrees.

`elevation` — Elevation angles over which directivity is calculated
vector in degrees

Elevation angles over which directivity is calculated, returned as a vector in degrees.

See Also

See Also
`current` | `EHfields`

Introduced in R2015a

patternAzimuth

Azimuth pattern of antenna or array

Syntax

```
patternAzimuth(object,frequency,elevation)
patternAzimuth(object,frequency,elevation,Name,Value)

directivity = patternAzimuth(object,frequency,elevation)
directivity = patternAzimuth(object,frequency,elevation,Name,Value)
```

Description

`patternAzimuth(object,frequency,elevation)` plots the 2-D radiation pattern of the antenna or array object over a specified frequency. Elevation values defaults to zero if not specified.

`patternAzimuth(object,frequency,elevation,Name,Value)` uses additional options specified by one or more `Name,Value` pair arguments.

`directivity = patternAzimuth(object,frequency,elevation)` returns the directivity of the antenna or array object over a specified frequency. Elevation values defaults to zero if not specified.

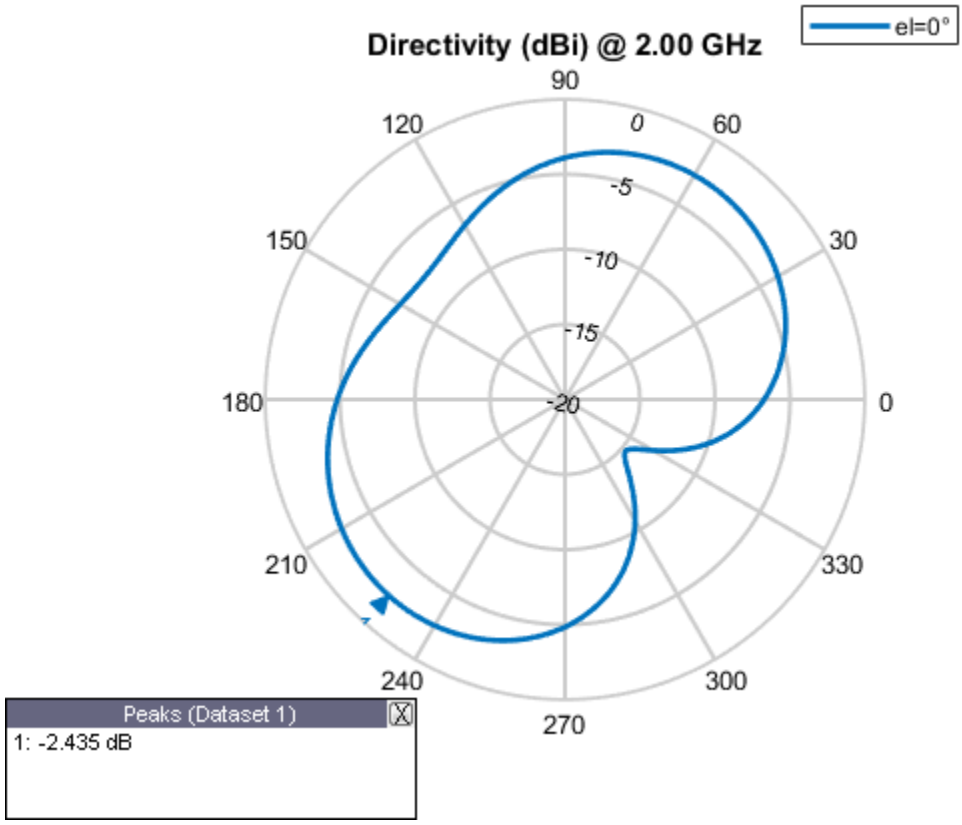
`directivity = patternAzimuth(object,frequency,elevation,Name,Value)` uses additional options specified by one or more `Name,Value` pair arguments.

Examples

Azimuth Radiation Pattern of Helix Antenna

Calculate and plot the azimuth radiation pattern of the helix antenna at 2 GHz.

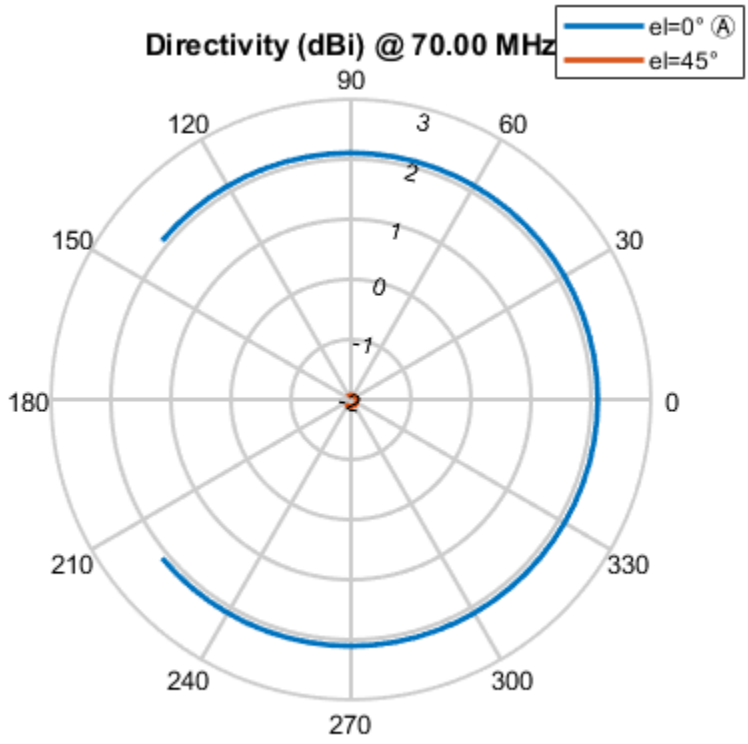
```
h = helix;
patternAzimuth(h,2e9);
```



Azimuth Radiation Pattern of Dipole Antenna

Calculate and plot the azimuth radiation pattern of the dipole antenna at 70 MHz at elevation values of 0 and 45.

```
d = dipole;
patternAzimuth(d,70e6,[0 45],'Azimuth',-140:5:140);
```



Input Arguments

`object` — antenna or array object
scalar handle

Antenna or array object, specified as a scalar handle.

`frequency` — Frequency used to calculate charge distribution
scalar in Hz

Frequency used to calculate charge distribution, specified as a scalar in Hz.

Example: 70e6

Data Types: `double`

`elevation` — Elevation angle values
vector in degrees

Elevation angle values, specified as a vector in degrees.

Example: `[0 45]`

Data Types: `double`

Name-Value Pair Arguments

Specify optional comma-separated pairs of `Name,Value` pair arguments. `Name` is the argument name and `Value` is the corresponding value. `Name` must appear inside single quotes (`''`). You can specify several name and value pair arguments in any order as `Name1, Value1, ..., NameN, ValueN`.

Example: `'Azimuth',2:2:340`

`'Azimuth'` — Azimuth angles of antenna
–180:1:180 (default) | vector in degrees

Azimuth angles of antenna, specified as the comma-separated pair consisting of `'Azimuth'` and a vector in degrees.

Example: `'Azimuth',2:2:340`

Data Types: `double`

Output Arguments

`directivity` — Antenna or array directivity
matrix in `dBi`

Antenna or array directivity, returned as a matrix in `dBi`. The matrix size id the product of number of elevation values and number of azimuth values.

See Also

See Also

pattern | patternElevation

Introduced in R2015a

patternMultiply

Radiation pattern of array using pattern multiplication

Syntax

```
patternMultiply(array,frequency)
patternMultiply(array,frequency,azimuth)
patternMultiply(array,frequency,azimuth, elevation)
patternMultiply( ___ ,Name,Value)

[fieldval,azimuth,elevation] = patternMultiply(array,frequency)
[fieldval,azimuth,elevation] = patternMultiply(array,frequency,
azimuth)
[fieldval,azimuth,elevation] = patternMultiply(array,frequency,
azimuth,elevation)
[fieldval,azimuth,elevation] = patternMultiply( ___ ,Name,Value)
```

Description

`patternMultiply(array,frequency)` plots the 3-D radiation pattern of the array object over a specified frequency. `patternMultiply` calculates the full array pattern without taking the effect of mutual coupling between the different array elements.

`patternMultiply(array,frequency,azimuth)` plots the radiation pattern of the array object for the given azimuth angles. Elevation angles retain default values.

`patternMultiply(array,frequency,azimuth, elevation)` plots the radiation pattern of the array object for the given azimuth and elevation angles.

`patternMultiply( ___ ,Name,Value)` uses additional options specified by one or more `Name,Value` pair arguments. Specify name-value pair arguments after all other input arguments.

`[fieldval,azimuth,elevation] = patternMultiply(array,frequency)` returns the field value such as the directivity of the lossless array in dBi or gain of the

lossy array in dBi at the specified frequency. The size of the field value matrix is number of elevation values x number of azimuth values.

`[fieldval,azimuth,elevation] = patternMultiply(array,frequency, azimuth)` returns the field value at the specified azimuth angles. Elevation angles retain default values.

`[fieldval,azimuth,elevation] = patternMultiply(array,frequency, azimuth,elevation)` returns the field value at the specified azimuth angles, and elevation angles.

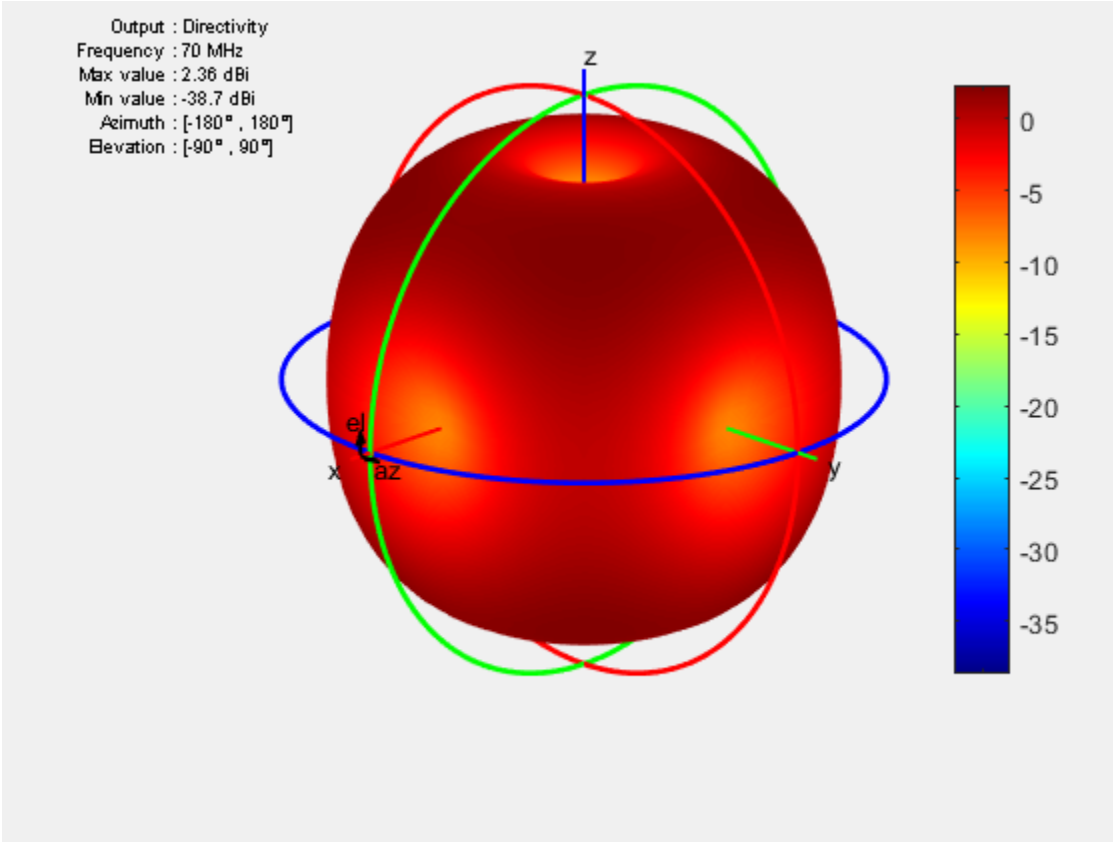
`[fieldval,azimuth,elevation] = patternMultiply( ___ ,Name,Value)` returns the field value using additional options specified by one or more `Name,Value` pair arguments. Specify name-value pair arguments after all other input arguments.

Examples

Radiation Pattern of Rectangular Array

Plot the radiation pattern of a default rectangular array at 70 MHz. Pattern multiplication does not take into consideration the effect of mutual coupling in array elements.

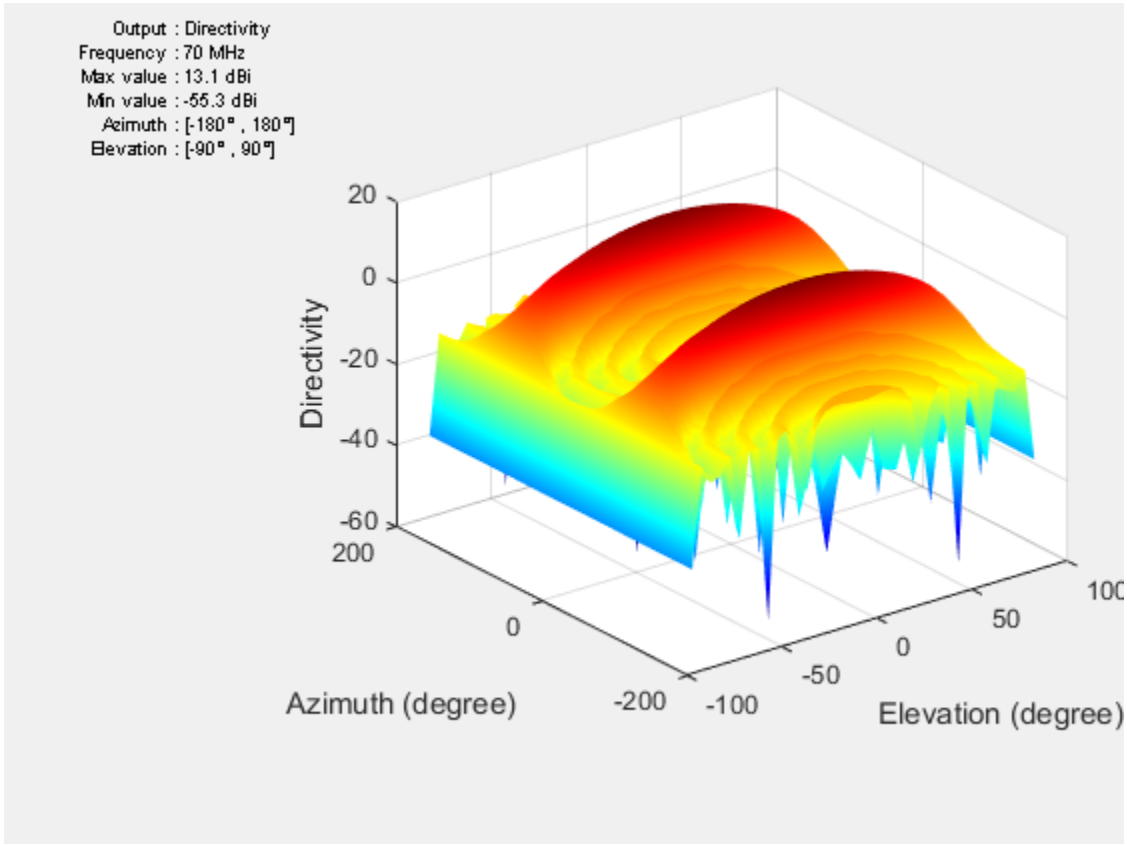
```
h = rectangularArray;
patternMultiply(h,70e6);
```



Radiation Pattern of Linear Array in Rectangular Coordinates

Plot the radiation pattern of a 10-element linear array at 70 MHz. Visualize the pattern using the rectangular coordinate system.

```
l = linearArray('NumElements',10);
patternMultiply(l,70e6,'CoordinateSystem','rectangular');
```



Input Arguments

`array` — Input antenna array

object handle

Array object, specified as an object handle.

Example: `r = rectangularArray; patternMultiply(r,70e6)`. Plot the pattern of a rectangular array.

`frequency` — Frequency used to calculate array pattern

scalar in Hz

Frequency used to calculate array pattern, specified as a scalar in Hz.

Example: `70e6`

Data Types: `double`

`azimuth` — Azimuth angle of antenna
`–180:5:180` (default) | vector in degrees

Azimuth angle of the antenna, specified as a vector in degrees.

Example: `–90:5:90`

Data Types: `double`

`elevation` — Elevation angle of antenna
`–90:5:90` (default) | vector in degrees

Elevation angle of the antenna, specified as a vector in degrees.

Example: `0:1:360`

Data Types: `double`

Name-Value Pair Arguments

Specify optional comma-separated pairs of `Name,Value` pair arguments. `Name` is the argument name and `Value` is the corresponding value. `Name` must appear inside single quotes (`''`). You can specify several name and value pair arguments in any order as `Name1, Value1, ..., NameN, ValueN`.

Example: `'CoordinateSystem', rectangular`

`'CoordinateSystem'` — Coordinate system of radiation pattern
`'polar'` (default) | `'rectangular'` | `'uv'`

Coordinate system of radiation pattern, specified as the comma-separated pair consisting of `'CoordinateSystem'` and one of these values: `'polar'`, `'rectangular'`, `'uv'`.

Example: `'CoordinateSystem', 'polar'`

Data Types: `char`

`'Type'` — Value to plot
`'directivity'` (default) | `'gain'` | `'efield'` | `'power'` | `'powerdb'`

Value to plot, specified as a comma-separated pair consisting of `'Type'` and one of these values:

- `'directivity'` – Radiation intensity in a given direction of antenna in dB
- `'gain'` – Radiation intensity in a given direction of antenna, when the antenna has a lossy substrate in dB
- `'efield'` – Electric field of antenna in volt/meter
- `'power'` – Antenna power in watts
- `'powerdb'` – Antenna power in dB

Example: `'Type'`, `'efield'`

Data Types: `char`

`'Normalize'` — Normalize field pattern

`true` (default) | `false` | boolean

Normalize field pattern, specified as the comma-separated pair consisting of `'Normalize'` and either `true` or `false`. For directivity patterns, this property is not applicable.

Example: `'Normalize'`, `false`

Data Types: `double`

`'Polarization'` — Field polarization

`'H'` | `'V'` | `'RHCP'` | `'LHCP'`

Field polarization, specified as the comma-separated pair consisting of `'Polarization'` and one of these values:

- `'H'` – Horizontal polarization
- `'V'` – Vertical polarization
- `'RHCP'` – Right-hand circular polarization
- `'LHCP'` – Left-hand circular polarization

By default, you can visualize a combined polarization.

Example: `'Polarization'`, `'RHCP'`

Data Types: `char`

Output Arguments

`fieldval` — Array directivity or gain

matrix in `dBi`

Array directivity or gain, returned as a matrix in `dBi`. The matrix size is the product of the number of elevation values and azimuth values.

`azimuth` — Azimuth angles

vector in degrees

Azimuth angle used to calculate field values, returned as a vector in degrees.

`elevation` — Elevation angles

vector in degrees

Elevation angles used to calculate field values, returned as a vector in degrees.

See Also

See Also

`pattern` | `patternElevation`

Introduced in R2017a

patternElevation

Elevation pattern of antenna or array

Syntax

```
patternElevation(object,frequency,azimuth)
patternElevation(object,frequency,azimuth,Name,Value)

directivity = patternElevation(object,frequency,azimuth)
directivity = patternElevation(object,frequency,azimuth,Name,Value)
```

Description

`patternElevation(object,frequency,azimuth)` plots the 2-D radiation pattern of the antenna or array object over a specified frequency. Azimuth values defaults to zero if not specified.

`patternElevation(object,frequency,azimuth,Name,Value)` uses additional options specified by one or more `Name, Value` pair arguments.

`directivity = patternElevation(object,frequency,azimuth)` returns the directivity of the antenna or array object at specified frequency. Azimuth values defaults to zero if not specified.

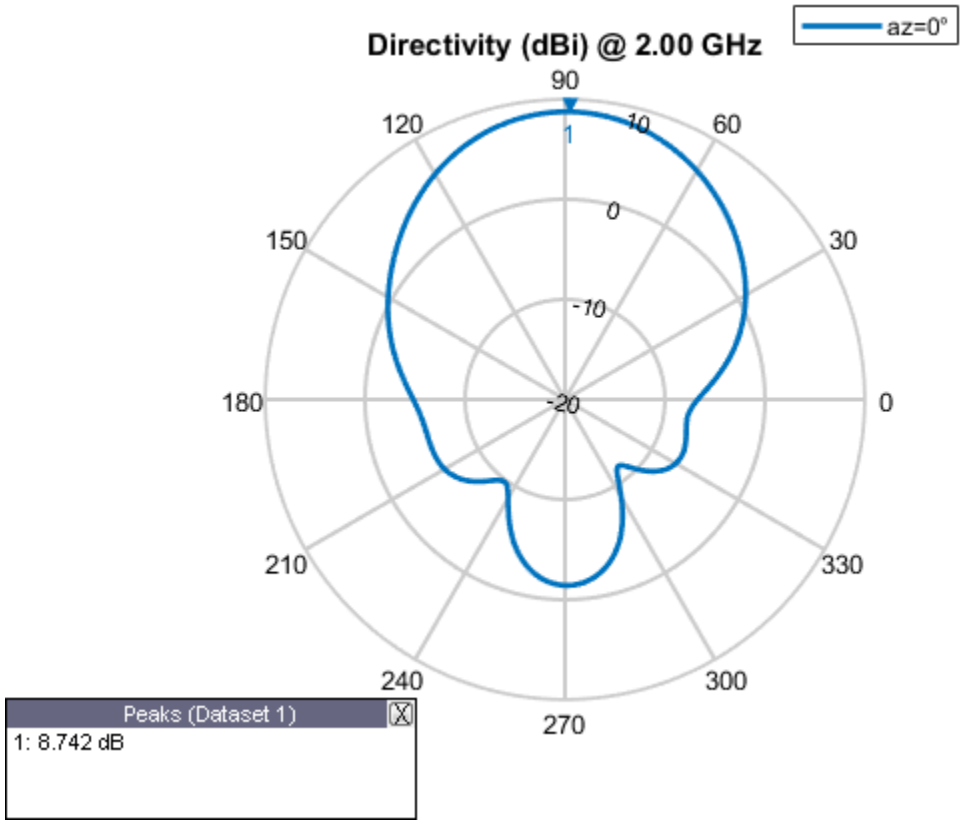
`directivity = patternElevation(object,frequency,azimuth,Name,Value)` uses additional options specified by one or more `Name, Value` pair arguments.

Examples

Elevation Radiation Pattern of Helix

Calculate and plot the elevation pattern of the helix antenna at 2 GHz.

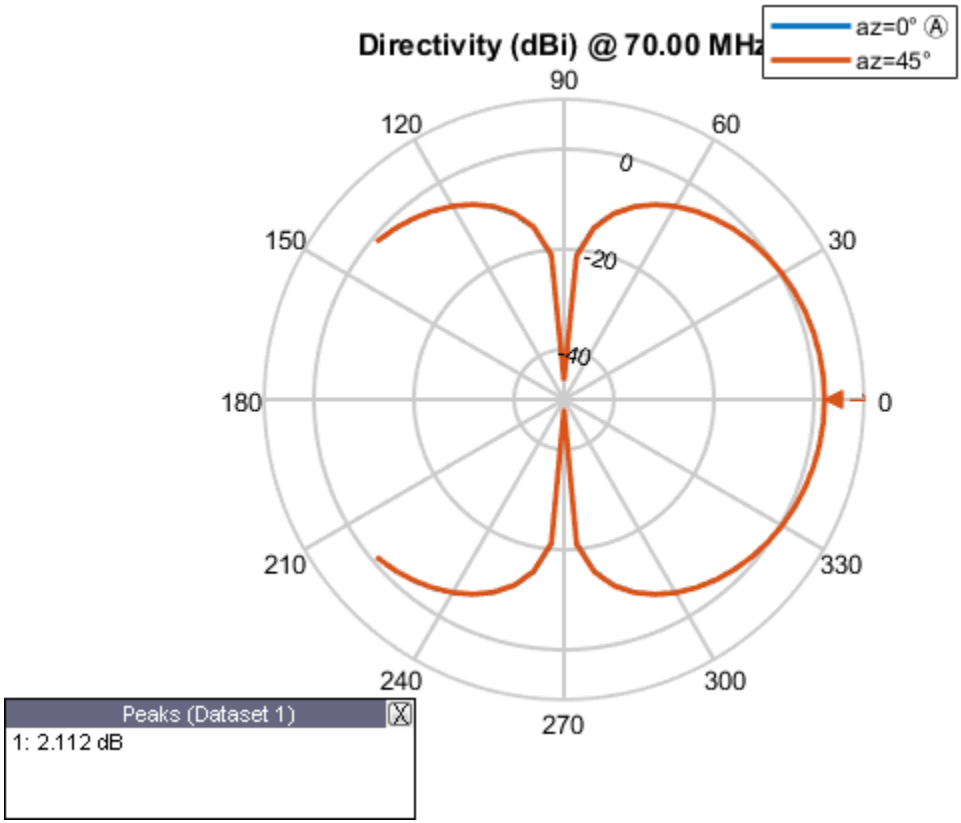
```
h = helix;
patternElevation (h, 2e9);
```



Elevation Radiation Pattern of Dipole Antenna

Calculate and plot the elevation radiation pattern of the dipole antenna at 70 MHz at elevation values of 0 and 45.

```
d = dipole;
patternElevation(d,70e6,[0 45],'Elevation',-140:5:140);
```



Input Arguments

`object` — Antenna or array object

scalar handle

Antenna or array object, specified as a scalar handle.

`frequency` — Frequency used to calculate charge distribution

scalar in Hz

Frequency used to calculate charge distribution, specified as a scalar in Hz.

Example: 70e6

Data Types: `double`

`azimuth` — Azimuth angle values
vector in degrees

Azimuth angle values, specified as a vector in degrees.

Example: `[0 45]`

Data Types: `double`

Name-Value Pair Arguments

Specify optional comma-separated pairs of `Name,Value` pair arguments. `Name` is the argument name and `Value` is the corresponding value. `Name` must appear inside single quotes (`''`). You can specify several name and value pair arguments in any order as `Name1, Value1, ..., NameN, ValueN`.

Example: `'Elevation'`, 0:1:360

`'Elevation'` — Elevation angles of antenna
–90:1:90 (default) | vector in degrees

Elevation angles of antenna, specified the comma-separated pair consisting of `'Elevation'` and a vector in degrees.

Example: `'Elevation'`, 0:1:360

Data Types: `double`

Output Arguments

`directivity` — Antenna or array directivity
matrix in `dBi`

Antenna or array directivity, returned as a matrix in `dBi`. The matrix size id the product of number of elevation values and number of azimuth values.

See Also

See Also

`pattern` | `patternAzimuth`

Introduced in R2015a

current

Current distribution on antenna or array surface

Syntax

```
current(object,frequency)

i = current(object,frequency)
```

Description

`current(object,frequency)` calculates and plots the absolute value of the current on the surface of an antenna or array object, at a specified frequency.

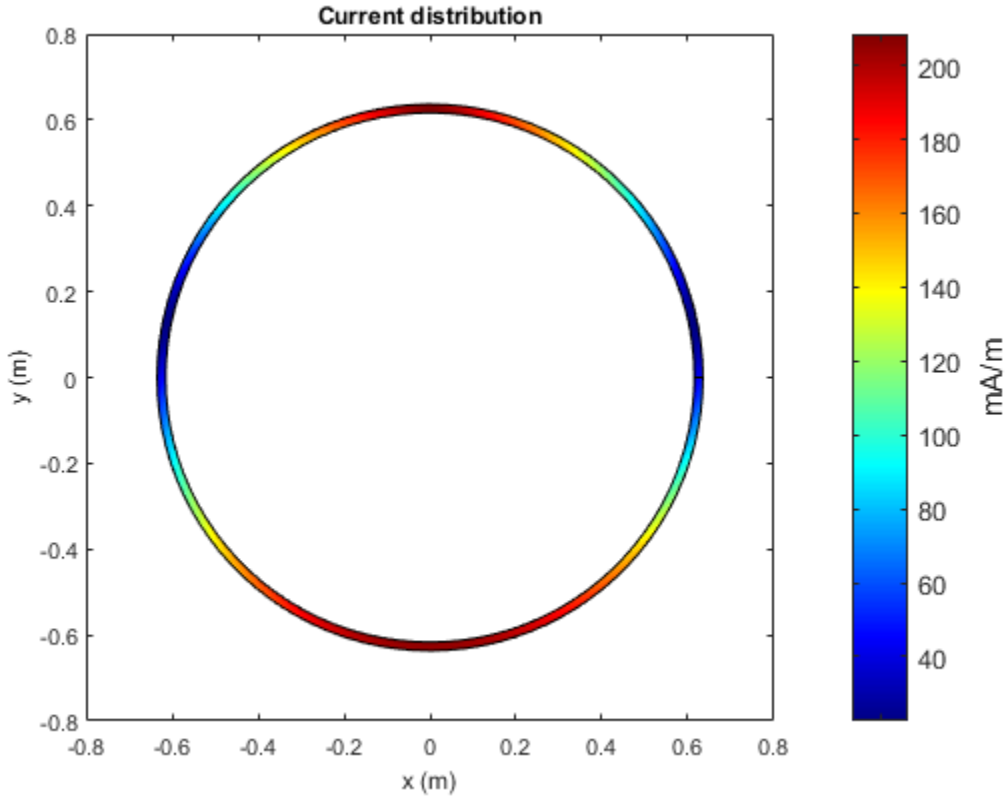
`i = current(object,frequency)` returns the x, y, z components of the current on the surface of an antenna or array object, at a specified frequency.

Examples

Calculate and Plot Current Distribution on Antenna Surface

Calculate and plot the current distribution for a circular loop antenna at 70MHz frequency.

```
h = loopCircular;
current(h,70e6);
```



Calculate Current Distribution of Array

Calculate the current distribution of a default rectangular array at 70MHz frequency.

```
h = rectangularArray;
i = current(h,70e6)
```

```
i =

  Columns 1 through 4

   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
   0.0039 + 0.0064i  -0.0017 - 0.0026i   0.0019 + 0.0033i  -0.0017 - 0.0028i
   0.0041 + 0.0067i   0.0160 + 0.0258i   0.0198 + 0.0320i   0.0274 + 0.0448i
```

```
Columns 5 through 8

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 0.0017 + 0.0030i  -0.0015 - 0.0024i   0.0015 + 0.0029i  -0.0013 - 0.0022i
 0.0310 + 0.0509i   0.0377 + 0.0625i   0.0409 + 0.0681i   0.0468 + 0.0787i

Columns 9 through 12

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 0.0014 + 0.0027i  -0.0010 - 0.0019i   0.0012 + 0.0025i  -0.0008 - 0.0016i
 0.0496 + 0.0838i   0.0546 + 0.0934i   0.0570 + 0.0980i   0.0611 + 0.1066i

Columns 13 through 16

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 0.0010 + 0.0022i  -0.0005 - 0.0013i   0.0007 + 0.0020i  -0.0003 - 0.0009i
 0.0629 + 0.1106i   0.0661 + 0.1180i   0.0674 + 0.1215i   0.0696 + 0.1277i

Columns 17 through 20

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 0.0004 + 0.0018i  -0.0001 - 0.0010i   0.0001 + 0.0013i  -0.0001 - 0.0066i
 0.0703 + 0.1306i   0.0716 + 0.1364i   0.0718 + 0.1381i   0.0719 + 0.1465i

Columns 21 through 24

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
-0.0001 - 0.0067i   0.0001 + 0.0013i  -0.0002 - 0.0011i   0.0003 + 0.0015i
 0.0719 + 0.1465i   0.0718 + 0.1381i   0.0715 + 0.1363i   0.0705 + 0.1308i

Columns 25 through 28

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
-0.0005 - 0.0013i   0.0006 + 0.0016i  -0.0007 - 0.0017i   0.0008 + 0.0019i
 0.0696 + 0.1278i   0.0675 + 0.1215i   0.0662 + 0.1181i   0.0630 + 0.1107i

Columns 29 through 32

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
-0.0009 - 0.0020i   0.0011 + 0.0021i  -0.0011 - 0.0022i   0.0013 + 0.0024i
 0.0611 + 0.1066i   0.0570 + 0.0980i   0.0547 + 0.0935i   0.0496 + 0.0838i

Columns 33 through 36
```

```
 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
-0.0013 - 0.0025i   0.0015 + 0.0026i  -0.0015 - 0.0027i   0.0017 + 0.0027i
 0.0469 + 0.0787i   0.0409 + 0.0680i   0.0378 + 0.0624i   0.0311 + 0.0509i

Columns 37 through 40

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
-0.0018 - 0.0031i   0.0018 + 0.0030i  -0.0017 - 0.0029i   0.0040 + 0.0063i
 0.0274 + 0.0447i   0.0198 + 0.0320i   0.0161 + 0.0259i   0.0042 + 0.0066i

Columns 41 through 44

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 0.0040 + 0.0064i  -0.0016 - 0.0027i   0.0020 + 0.0032i  -0.0016 - 0.0028i
 0.0042 + 0.0067i   0.0160 + 0.0258i   0.0198 + 0.0320i   0.0275 + 0.0448i

Columns 45 through 48

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 0.0018 + 0.0030i  -0.0014 - 0.0025i   0.0017 + 0.0029i  -0.0011 - 0.0022i
 0.0311 + 0.0509i   0.0378 + 0.0624i   0.0409 + 0.0681i   0.0468 + 0.0787i

Columns 49 through 52

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 0.0015 + 0.0027i  -0.0009 - 0.0019i   0.0013 + 0.0025i  -0.0007 - 0.0016i
 0.0496 + 0.0838i   0.0547 + 0.0934i   0.0570 + 0.0980i   0.0611 + 0.1066i

Columns 53 through 56

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 0.0010 + 0.0022i  -0.0005 - 0.0013i   0.0008 + 0.0020i  -0.0002 - 0.0009i
 0.0629 + 0.1106i   0.0661 + 0.1180i   0.0674 + 0.1214i   0.0696 + 0.1277i

Columns 57 through 60

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 0.0005 + 0.0018i  -0.0001 - 0.0010i   0.0001 + 0.0013i  -0.0000 - 0.0066i
 0.0703 + 0.1306i   0.0716 + 0.1364i   0.0718 + 0.1381i   0.0719 + 0.1465i

Columns 61 through 64

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
```

```
-0.0001 - 0.0067i   0.0001 + 0.0013i  -0.0002 - 0.0011i   0.0003 + 0.0015i
 0.0719 + 0.1465i   0.0717 + 0.1381i   0.0715 + 0.1363i   0.0705 + 0.1308i

Columns 65 through 68

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
-0.0005 - 0.0013i   0.0005 + 0.0016i  -0.0007 - 0.0016i   0.0008 + 0.0019i
 0.0696 + 0.1278i   0.0675 + 0.1215i   0.0662 + 0.1181i   0.0630 + 0.1107i

Columns 69 through 72

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
-0.0010 - 0.0020i   0.0010 + 0.0021i  -0.0012 - 0.0022i   0.0012 + 0.0024i
 0.0611 + 0.1066i   0.0570 + 0.0980i   0.0547 + 0.0935i   0.0496 + 0.0838i

Columns 73 through 76

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
-0.0014 - 0.0025i   0.0014 + 0.0026i  -0.0016 - 0.0027i   0.0015 + 0.0028i
 0.0468 + 0.0787i   0.0409 + 0.0681i   0.0377 + 0.0625i   0.0310 + 0.0509i

Columns 77 through 80

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
-0.0019 - 0.0031i   0.0017 + 0.0030i  -0.0018 - 0.0029i   0.0039 + 0.0063i
 0.0274 + 0.0447i   0.0198 + 0.0320i   0.0161 + 0.0259i   0.0041 + 0.0066i

Columns 81 through 84

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 0.0039 + 0.0064i  -0.0017 - 0.0026i   0.0019 + 0.0033i  -0.0017 - 0.0028i
 0.0041 + 0.0067i   0.0160 + 0.0258i   0.0198 + 0.0320i   0.0274 + 0.0448i

Columns 85 through 88

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 0.0017 + 0.0030i  -0.0015 - 0.0024i   0.0015 + 0.0029i  -0.0013 - 0.0022i
 0.0310 + 0.0509i   0.0377 + 0.0625i   0.0409 + 0.0681i   0.0468 + 0.0787i

Columns 89 through 92

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 0.0014 + 0.0027i  -0.0010 - 0.0019i   0.0012 + 0.0025i  -0.0008 - 0.0016i
 0.0496 + 0.0838i   0.0546 + 0.0934i   0.0570 + 0.0980i   0.0611 + 0.1066i
```

```
Columns 93 through 96

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 0.0010 + 0.0022i  -0.0005 - 0.0013i   0.0007 + 0.0020i  -0.0003 - 0.0009i
 0.0629 + 0.1106i   0.0661 + 0.1180i   0.0674 + 0.1215i   0.0696 + 0.1277i

Columns 97 through 100

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 0.0004 + 0.0018i  -0.0001 - 0.0010i   0.0001 + 0.0013i  -0.0001 - 0.0066i
 0.0703 + 0.1306i   0.0716 + 0.1364i   0.0718 + 0.1381i   0.0719 + 0.1465i

Columns 101 through 104

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
-0.0001 - 0.0067i   0.0001 + 0.0013i  -0.0002 - 0.0011i   0.0003 + 0.0015i
 0.0719 + 0.1465i   0.0718 + 0.1381i   0.0715 + 0.1363i   0.0705 + 0.1308i

Columns 105 through 108

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
-0.0005 - 0.0013i   0.0006 + 0.0016i  -0.0007 - 0.0017i   0.0008 + 0.0019i
 0.0696 + 0.1278i   0.0675 + 0.1215i   0.0662 + 0.1181i   0.0630 + 0.1107i

Columns 109 through 112

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
-0.0009 - 0.0020i   0.0011 + 0.0021i  -0.0011 - 0.0022i   0.0013 + 0.0024i
 0.0611 + 0.1066i   0.0570 + 0.0980i   0.0547 + 0.0935i   0.0496 + 0.0838i

Columns 113 through 116

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
-0.0013 - 0.0025i   0.0015 + 0.0026i  -0.0015 - 0.0027i   0.0017 + 0.0027i
 0.0469 + 0.0787i   0.0409 + 0.0680i   0.0378 + 0.0624i   0.0311 + 0.0509i

Columns 117 through 120

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
-0.0018 - 0.0031i   0.0018 + 0.0030i  -0.0017 - 0.0029i   0.0040 + 0.0063i
 0.0274 + 0.0447i   0.0198 + 0.0320i   0.0161 + 0.0259i   0.0042 + 0.0066i

Columns 121 through 124
```

```
 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 0.0040 + 0.0064i  -0.0016 - 0.0027i   0.0020 + 0.0032i  -0.0016 - 0.0028i
 0.0042 + 0.0067i   0.0160 + 0.0258i   0.0198 + 0.0320i   0.0275 + 0.0448i

Columns 125 through 128

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 0.0018 + 0.0030i  -0.0014 - 0.0025i   0.0017 + 0.0029i  -0.0011 - 0.0022i
 0.0311 + 0.0509i   0.0378 + 0.0624i   0.0409 + 0.0681i   0.0468 + 0.0787i

Columns 129 through 132

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 0.0015 + 0.0027i  -0.0009 - 0.0019i   0.0013 + 0.0025i  -0.0007 - 0.0016i
 0.0496 + 0.0838i   0.0547 + 0.0934i   0.0570 + 0.0980i   0.0611 + 0.1066i

Columns 133 through 136

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 0.0010 + 0.0022i  -0.0005 - 0.0013i   0.0008 + 0.0020i  -0.0002 - 0.0009i
 0.0629 + 0.1106i   0.0661 + 0.1180i   0.0674 + 0.1214i   0.0696 + 0.1277i

Columns 137 through 140

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 0.0005 + 0.0018i  -0.0001 - 0.0010i   0.0001 + 0.0013i  -0.0000 - 0.0066i
 0.0703 + 0.1306i   0.0716 + 0.1364i   0.0718 + 0.1381i   0.0719 + 0.1465i

Columns 141 through 144

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
-0.0001 - 0.0067i   0.0001 + 0.0013i  -0.0002 - 0.0011i   0.0003 + 0.0015i
 0.0719 + 0.1465i   0.0717 + 0.1381i   0.0715 + 0.1363i   0.0705 + 0.1308i

Columns 145 through 148

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
-0.0005 - 0.0013i   0.0005 + 0.0016i  -0.0007 - 0.0016i   0.0008 + 0.0019i
 0.0696 + 0.1278i   0.0675 + 0.1215i   0.0662 + 0.1181i   0.0630 + 0.1107i

Columns 149 through 152

 0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
```

```
 -0.0010 - 0.0020i   0.0010 + 0.0021i  -0.0012 - 0.0022i   0.0012 + 0.0024i
  0.0611 + 0.1066i   0.0570 + 0.0980i   0.0547 + 0.0935i   0.0496 + 0.0838i

Columns 153 through 156

  0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 -0.0014 - 0.0025i   0.0014 + 0.0026i  -0.0016 - 0.0027i   0.0015 + 0.0028i
  0.0468 + 0.0787i   0.0409 + 0.0681i   0.0377 + 0.0625i   0.0310 + 0.0509i

Columns 157 through 160

  0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
 -0.0019 - 0.0031i   0.0017 + 0.0030i  -0.0018 - 0.0029i   0.0039 + 0.0063i
  0.0274 + 0.0447i   0.0198 + 0.0320i   0.0161 + 0.0259i   0.0041 + 0.0066i
```

Input Arguments

`object` — Antenna or array object

scalar handle

Antenna or array object, specified as a scalar handle.

`frequency` — Frequency used to calculate current distribution

scalar in Hz

Frequency to calculate current distribution, specified as a scalar in Hz.

Example: 70e6

Data Types: `double`

Output Arguments

`i` — *x*, *y*, *z* components of current distribution

3-by-*n* complex matrix in A/m

x, *y*, *z* components of current distribution, returned as a 3-by-*n* complex matrix in A/m. The value of the current is calculated on every triangle mesh on the surface of an antenna or array.

See Also

See Also

`axialRatio` | `charge`

Introduced in R2015a

charge

Charge distribution on antenna or array surface

Syntax

```
charge(object,frequency)

c = charge(object,frequency)
```

Description

`charge(object,frequency)` calculates and plots the absolute value of the charge on the surface of an antenna or array object surface at a specified frequency.

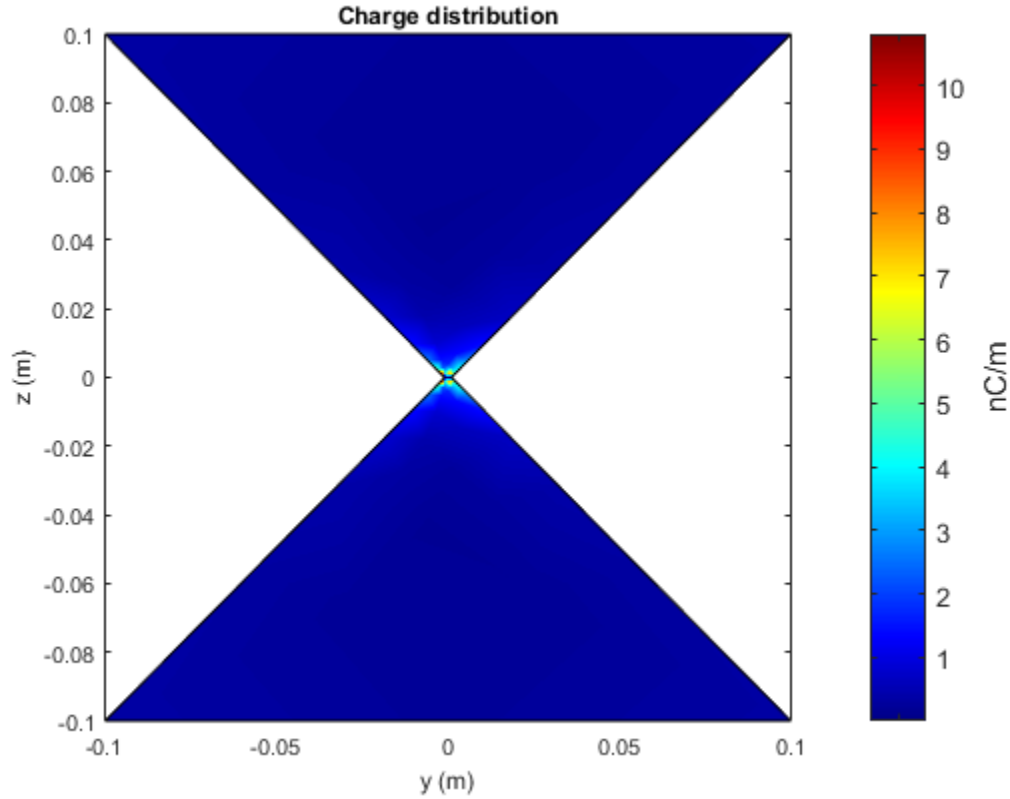
`c = charge(object,frequency)` returns a vector of charges in C/m on the surface of an antenna or array object, at a specified frequency.

Examples

Calculate and Plot Charge Distribution on Antenna Surface

Calculate and plot the charge distribution on a bowtieTriangular antenna at 70MHz frequency.

```
h = bowtieTriangular;
charge (h, 70e6);
```



Calculate Charge Distribution of Array

Calculate charge distribution of linear array at 70 MHz frequency.

```
h = linearArray;
h.NumElements = 4;
C = charge(h,70e6);
```

Input Arguments

`object` — Antenna or array object

scalar handle

Antenna or array object, specified as a scalar handle.

`frequency` — Frequency used to calculate charge distribution

scalar in Hz

Frequency used to calculate charge distribution, specified as a scalar in Hz.

Example: 70e6

Data Types: `double`

Output Arguments

c — Complex charges

1x*n* vector in C/m

Complex charges, returned as a 1x*n* vector in C/m. This value is calculated on every triangle mesh on the surface of antenna or array.

See Also

See Also

`current` | `EHfields`

Introduced in R2015a

design

Design prototype antenna for resonance at specified frequency

Syntax

```
ant = design(antenna,frequency)
```

Description

`ant = design(antenna,frequency)` designs any antenna object from the antenna library to resonate at the specified frequency.

Examples

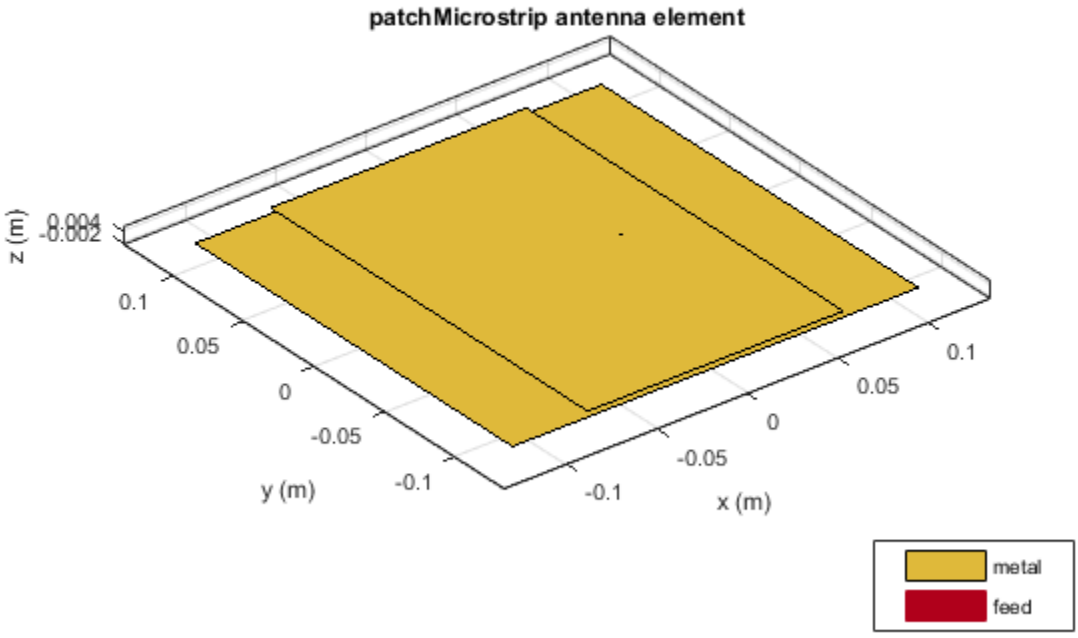
Prototype Antenna Design

Design a prototype microstrip patch antenna that resonates at a frequency of 1 GHz.

```
p = design(patchMicrostrip,1e9)
show(p)
```

```
p =

  patchMicrostrip with properties:

              Length: 0.1417
               Width: 0.2248
              Height: 0.0030
           Substrate: [1×1 dielectric]
    GroundPlaneLength: 0.2248
     GroundPlaneWidth: 0.2248
    PatchCenterOffset: [0 0]
          FeedOffset: [0.0354 0]
                Tilt: 0
```

```
    TiltAxis: [1 0 0]
        Load: [1×1 lumpedElement]
```



Calculate the impedance of the above antenna at the same freqeuncy.

```
Z = impedance(p,1e9)
```

```
Z =

  42.7956 - 4.4152i
```

Input Arguments

`antenna` — Antenna object

scalar handle

Antenna object from antenna library, specified as a scalar handle.

Example: `dipole`

`frequency` — Resonant frequency of antenna

real positive scalar

Resonant frequency of antenna, specified as a real positive scalar.

Example: `55e6`

Output Arguments

`ant` — Antenna object with specified reference frequency

scalar handle

Antenna object with specified reference frequency, returned as a scalar handle.

See Also

See Also

`show`

Introduced in R2016b

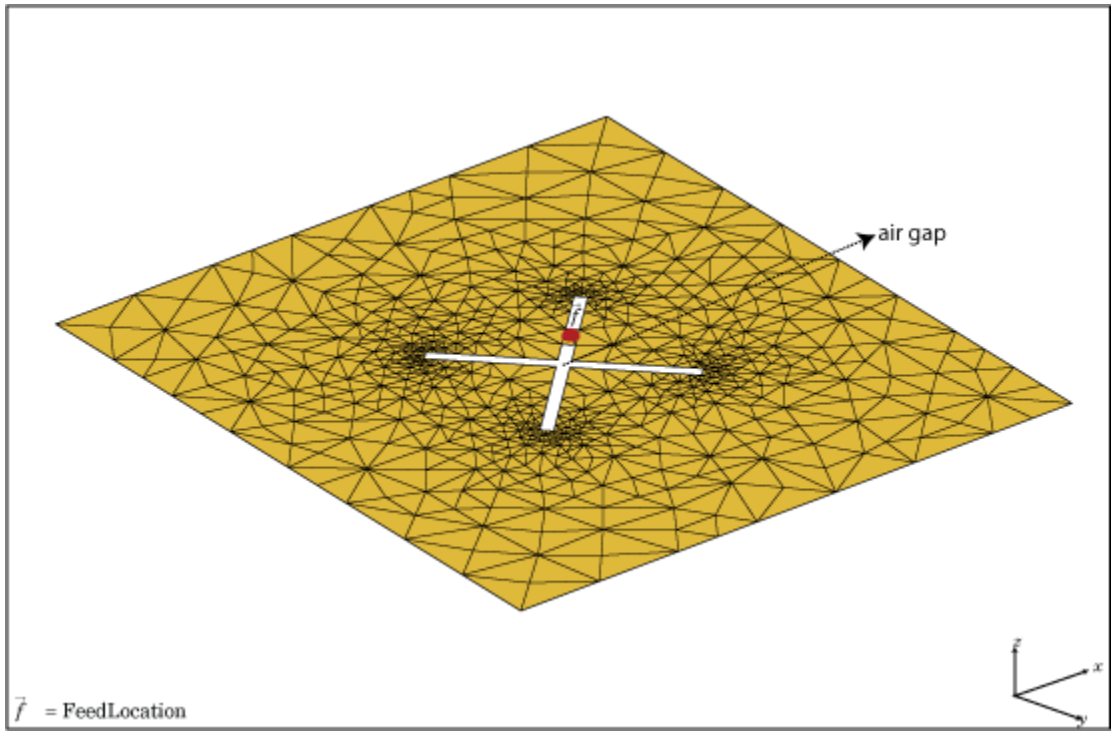
createFeed

Create feed location for custom antenna

Syntax

```
createFeed(antenna)
createFeed(antenna,point1,point2)
```

Description



`createFeed(antenna)` plots a custom antenna mesh in a figure window. From the figure window, you can specify a feed location for the mesh and create a custom antenna.

To specify a region for the feed point, select two points, inside triangles on either side of the air gap or inside triangles that share a common edge.

`createFeed(antenna,point1,point2)` creates the feed across the triangle edges identified by `point1` and `point2`. After the feed is created, when you plot the resulting antenna mesh the feed location is highlighted.

Input Arguments

`antenna` — Custom antenna mesh

scalar handle

Custom mesh antenna, specified as a scalar handle.

`point1,point2` — Points to identify feed region

Cartesian coordinates in meters

Points to identify feed region, specified as Cartesian coordinates in meters. Specify the points in the format $[x_1, y_1]$, $[x_2, y_2]$.

Example: `createFeed(c,[0.07,0.01],[0.05,0.05]);`

Examples

Create Feed for Custom Mesh Antenna Using Air Gap between Triangles

Load a 2-D custom mesh. Create a custom antenna using the points and triangles.

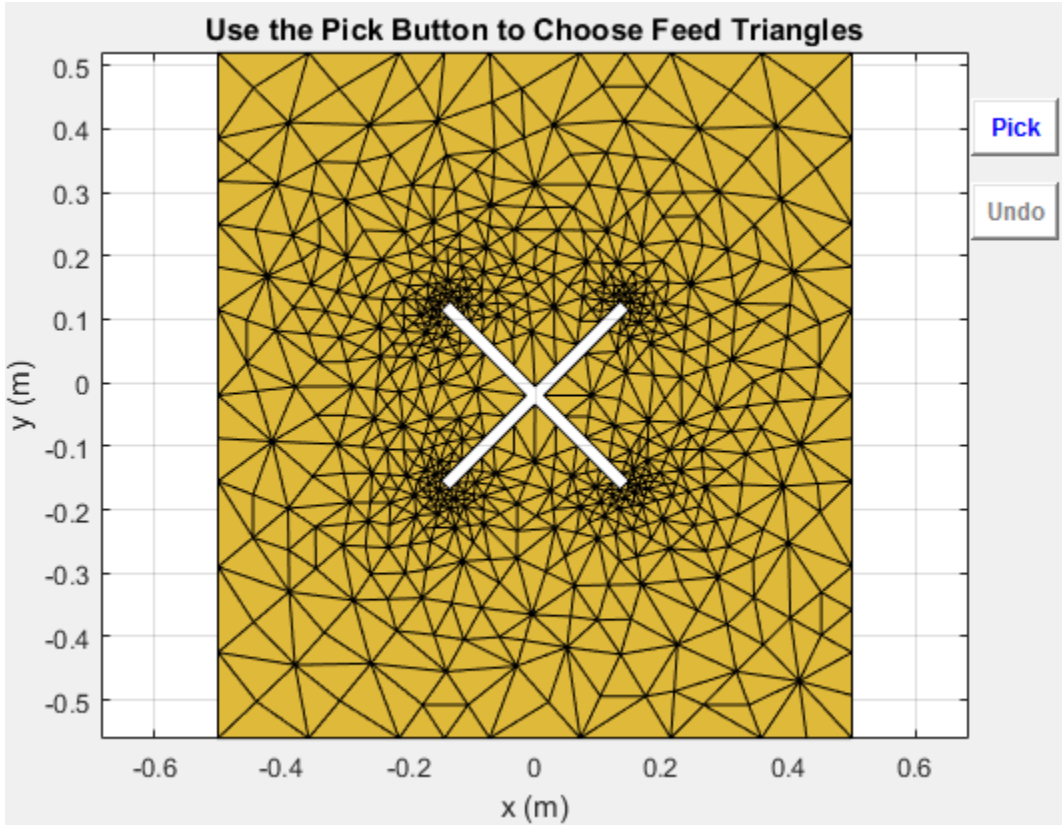
```
load planarmesh.mat
c = customAntennaMesh(p,t)
```

```
c =

  customAntennaMesh with properties:

          Points: [3x658 double]
       Triangles: [4x1219 double]
    FeedLocation: []
```

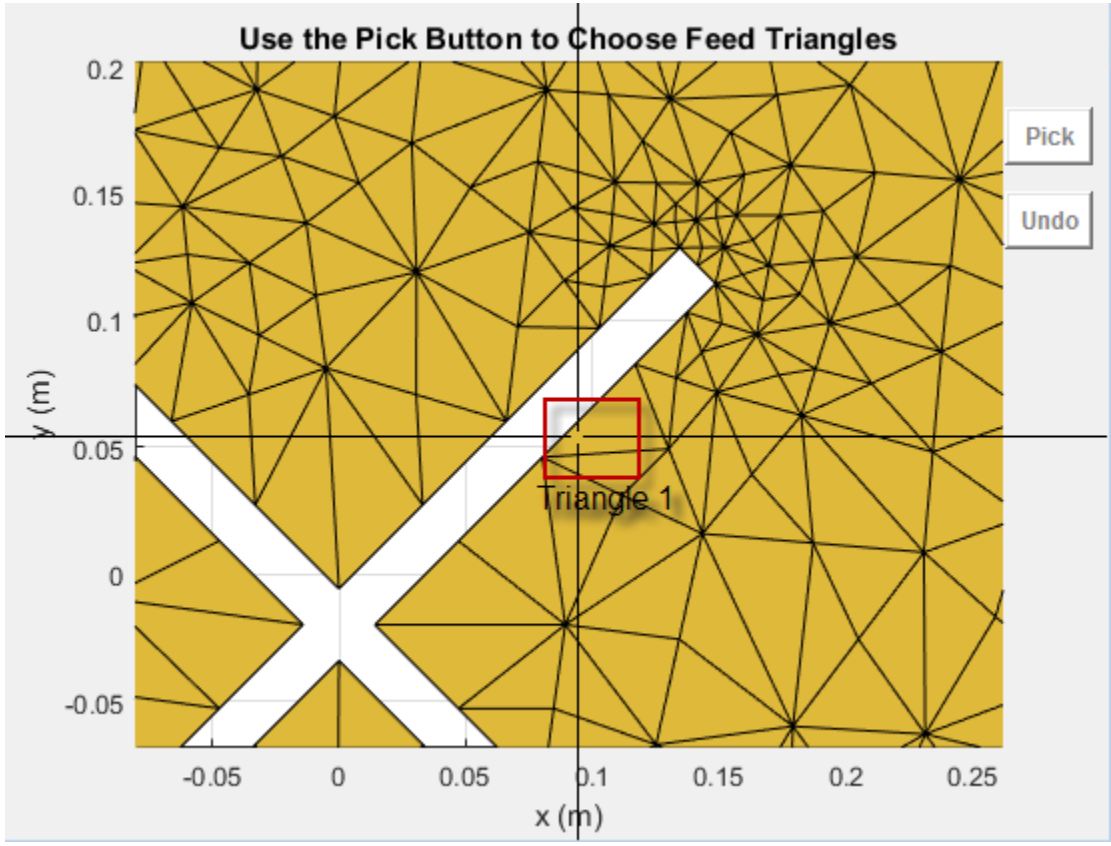
```
        Tilt: 0
    TiltAxis: [1 0 0]
```

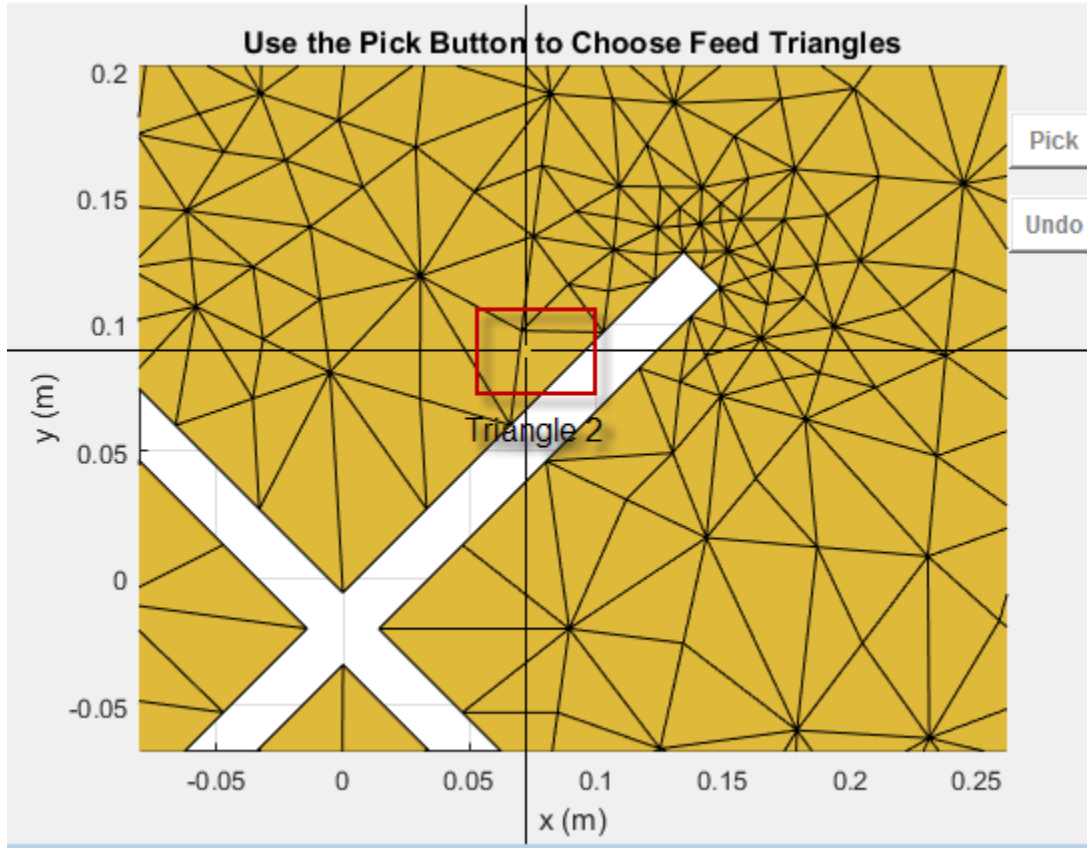
Use the `createFeed` function to view the antenna mesh structure. In this antenna mesh view, you see **Pick** and **Undo** buttons. The **Pick** button is highlighted.

```
createFeed(c)
```

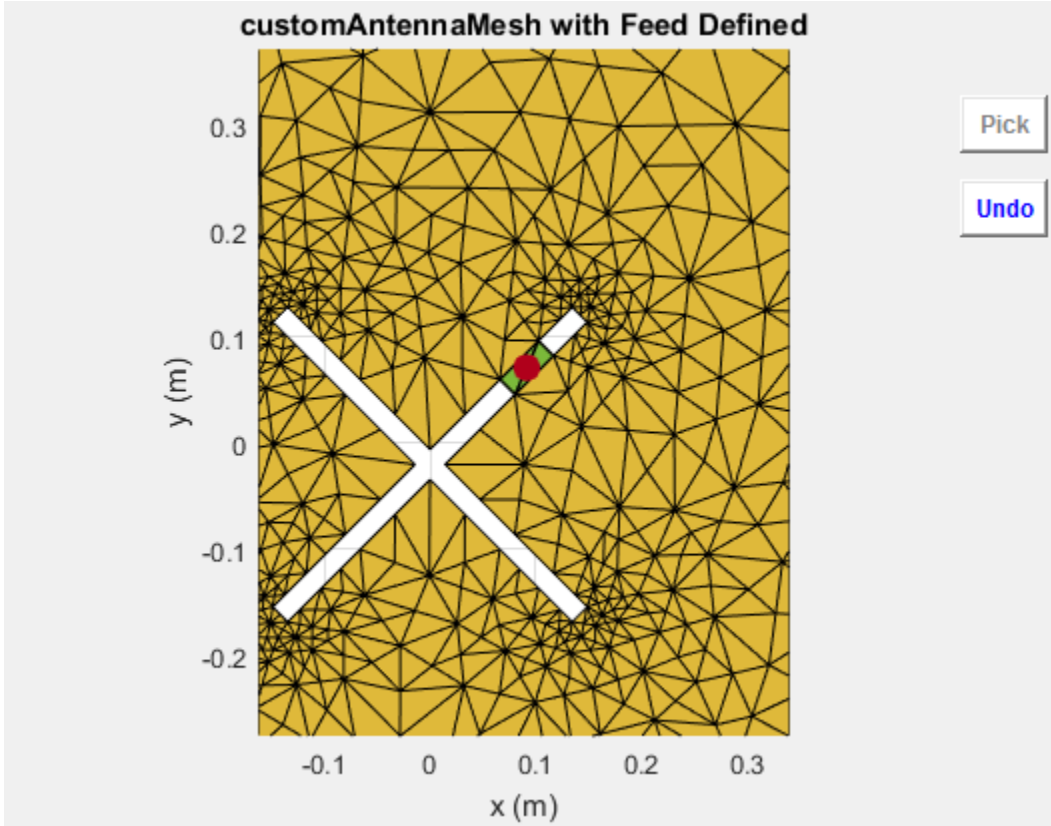


Click **Pick** to display the cross-hairs. To specify a region for the feed point, zoom in and select two points, one inside each triangle on either side of the air gap. Select the points using the crosshairs.


Use the Pick Button to Choose Feed Triangles
Pick
Undo
Triangle 1
0.2
0.15
0.1
0.05
0
-0.05
y (m)
-0.05
0
0.05
0.1
0.15
0.2
0.25
x (m)



Selecting the second triangle creates and displays the antenna feed.



Create Feed for Custom Mesh Antenna Using Triangles Sharing Edge

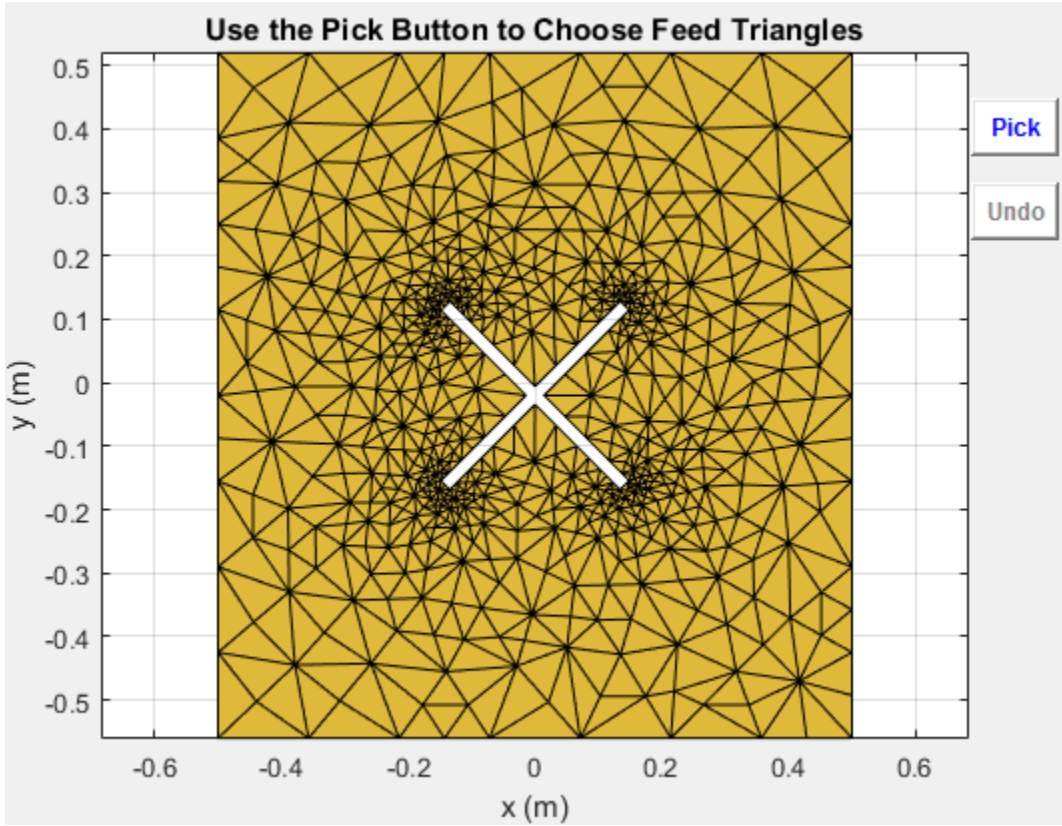
Load a 2-D custom mesh. Create a custom antenna using the points and triangles.

```
load planarmesh.mat
c = customAntennaMesh(p,t)

c =

  customAntennaMesh with properties:

         Points: [3x658 double]
      Triangles: [4x1219 double]
    FeedLocation: []
```

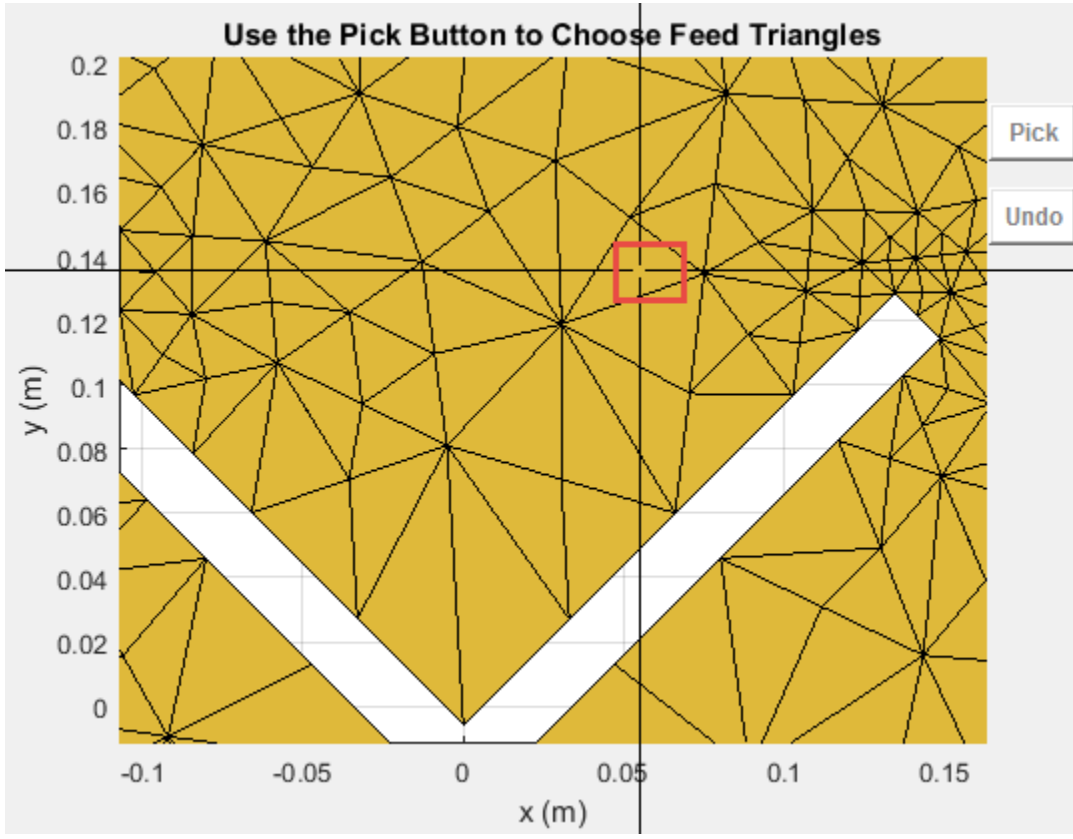
```
        Tilt: 0
    TiltAxis: [1 0 0]
```

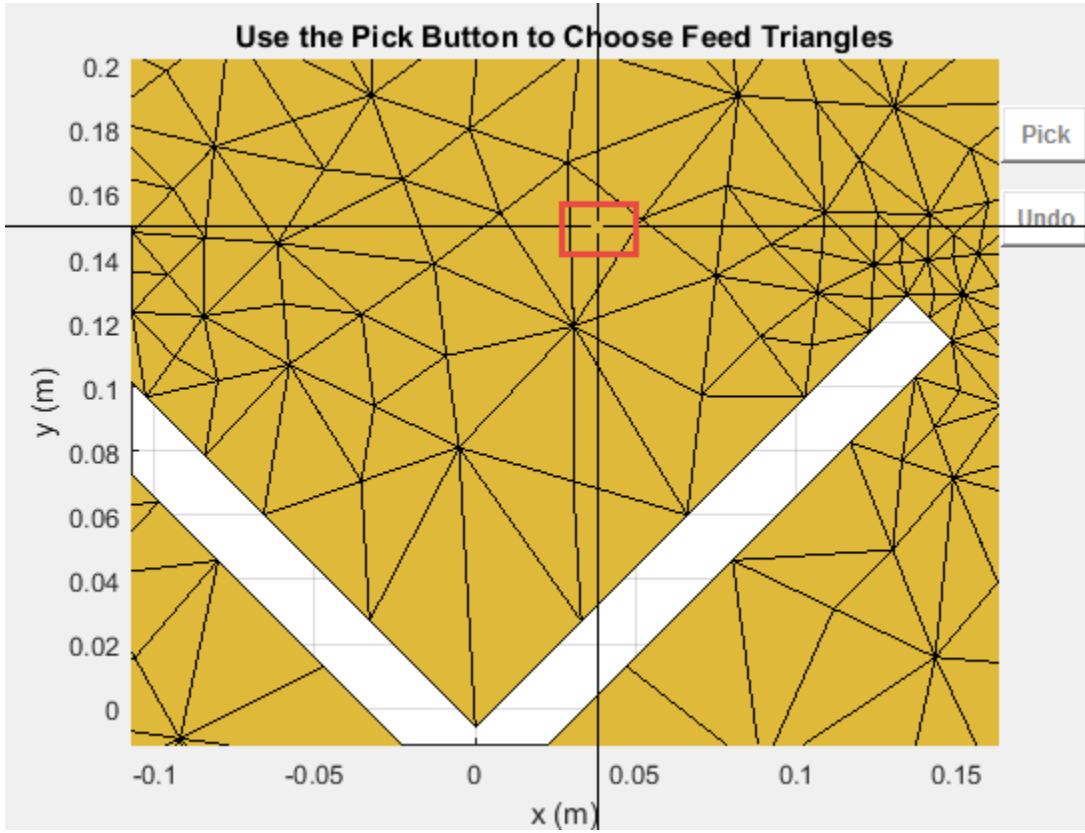
Use the `createFeed` function to view the antenna mesh structure. In this antenna mesh view, you see **Pick** and **Undo** buttons. The **Pick** button is highlighted.

```
createFeed(c)
```

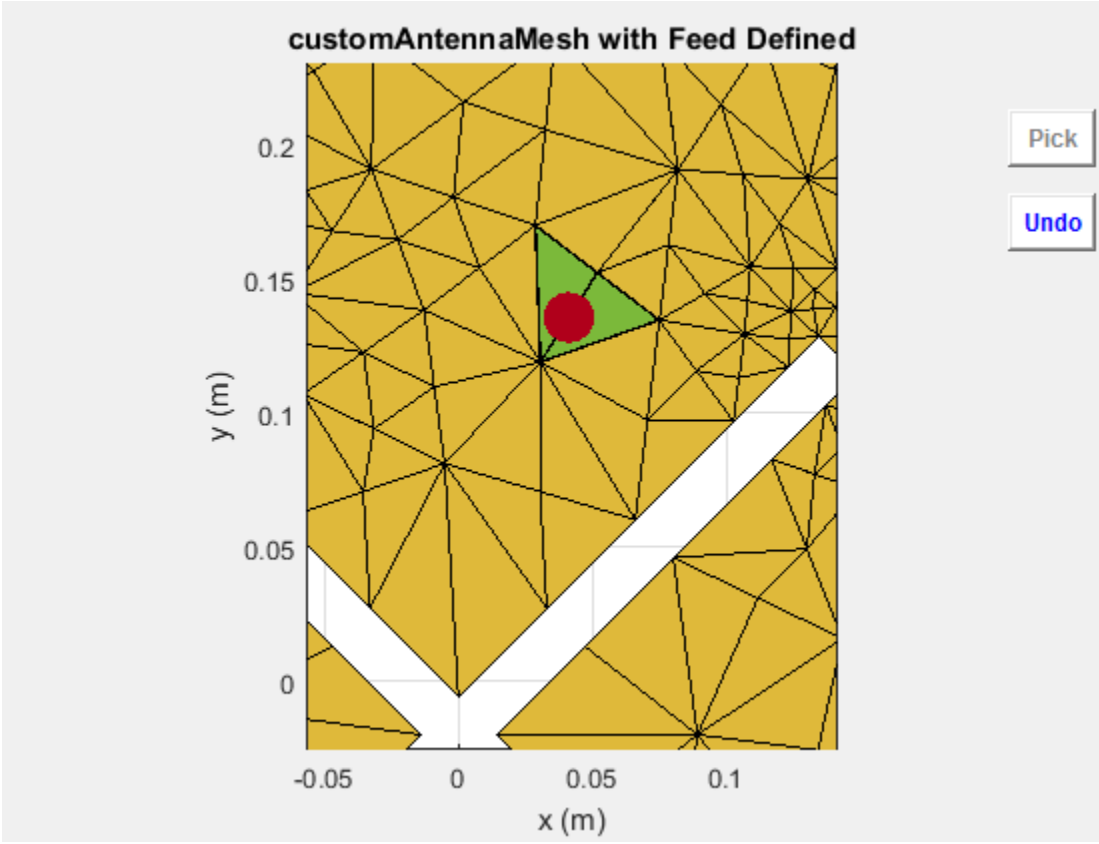


Click **Pick** to display the cross-hairs. To specify a region for the feed point, zoom in and select two points, one inside each triangle sharing an edge. Select the points using the cross-hairs.


Use the Pick Button to Choose Feed Triangles
Pick
Undo
y (m)
x (m)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
-0.1
-0.05
0
0.05
0.1
0.15



Selecting the second triangle creates and displays the antenna feed.



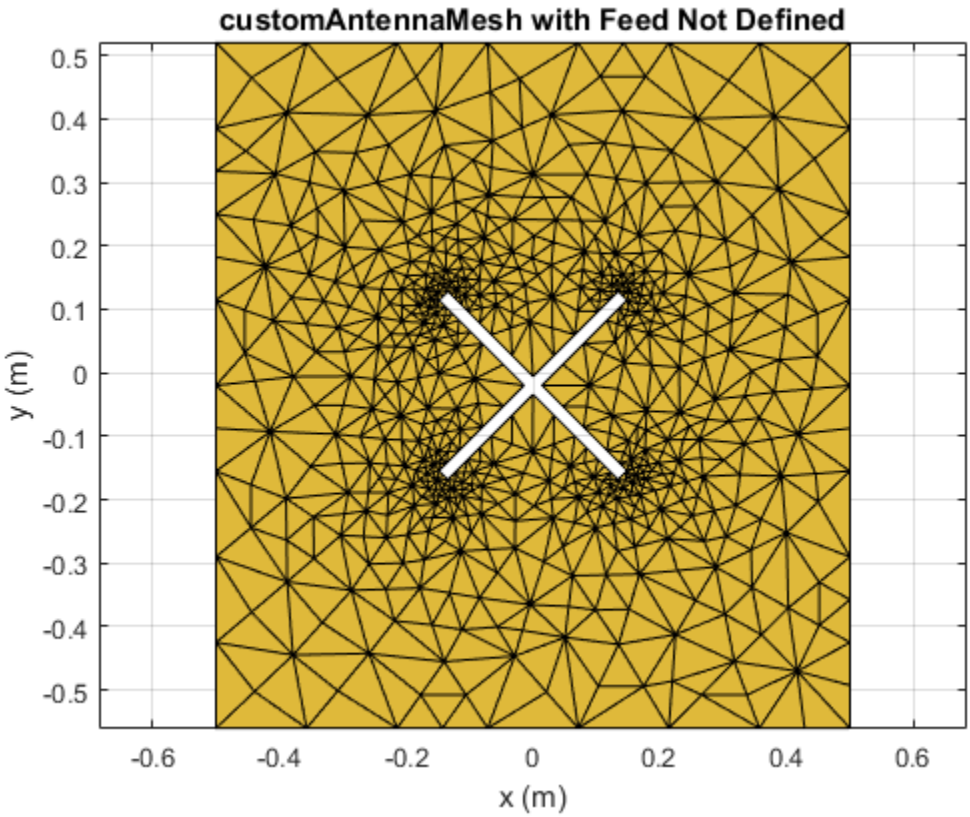
Create Feed for Custom Antenna Mesh

Load a 2-D custom mesh using the planarmesh.mat. Create a custom antenna using the points and triangles.

```
load planarmesh.mat
c = customAntennaMesh(p,t)
show (c)
```

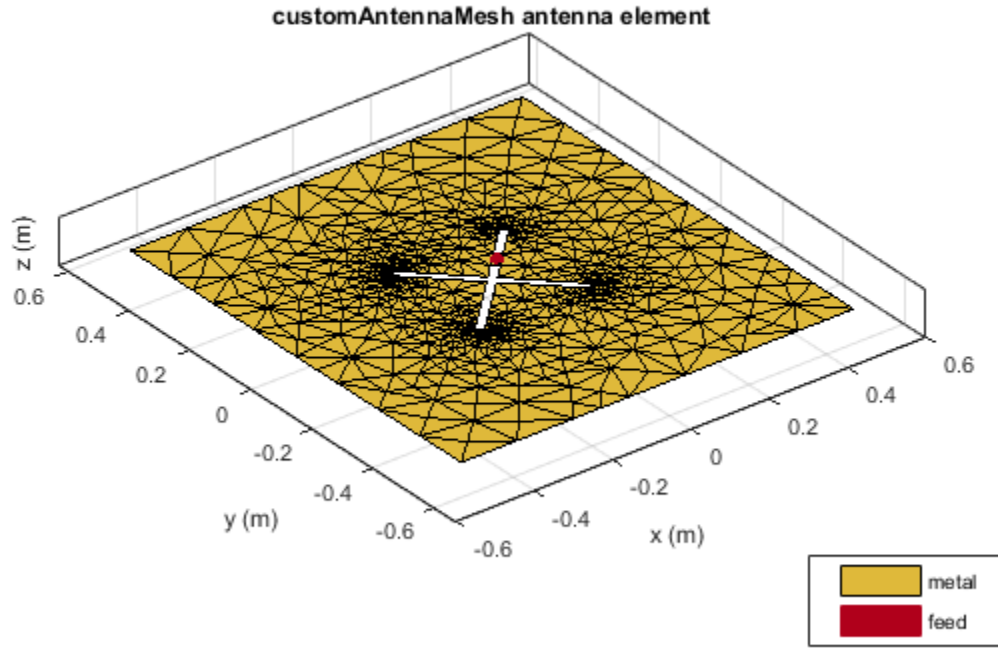
```
c =

  customAntennaMesh with properties:
```

```
          Points: [3×658 double]
       Triangles: [4×1219 double]
    FeedLocation: []
            Tilt: 0
        TiltAxis: [1 0 0]
            Load: [1×1 lumpedElement]
```



Create the feed for the custom antenna across the points (0.07,0.01) and (0.05,0.05) meters respectively.

```
createFeed(c,[0.07,0.01],[0.05,0.05])
show(c)
```



See Also

See Also

`returnLoss` | `sparameters`

Introduced in R2015b

EHfields

Electric and magnetic fields of antennas

Syntax

```
[e,h] = EHfields(object,frequency)
EHfields(object,frequency)

[e,h] = EHfields(object,frequency,points)
EHfields(object, frequency, points)

EHfields( ___ ,Name,Value)
```

Description

`[e,h] = EHfields(object,frequency)` calculates the *x*, *y*, and *z* components of electric field and magnetic field of an antenna or array object at a specified frequency.

`EHfields(object,frequency)` plots the electric and magnetic field vectors at specified frequency values and at specified points in space.

`[e,h] = EHfields(object,frequency,points)` calculates the *x*, *y*, and *z* components of electric field and magnetic field of an antenna or array object. These fields are calculated at specified points in space and at a specified frequency.

`EHfields(object, frequency, points)` plots the electric and magnetic field vectors at specified frequency values and at specified points in space.

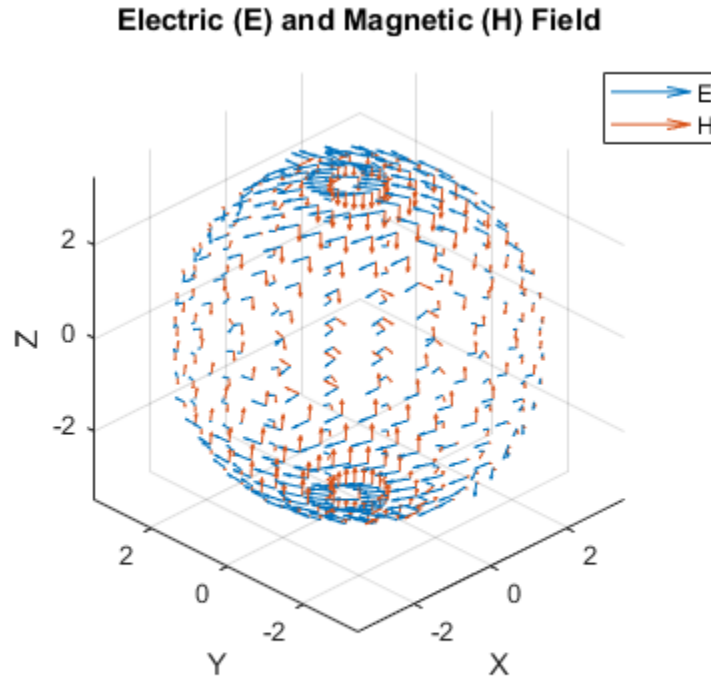
`EHfields( ___ ,Name,Value)` plots the electric and magnetic field vectors with additional options specified by one or more `Name Value` pair arguments using any of the preceding syntaxes.

Examples

Plot E and H Fields of Antenna

Plot electric and magnetic fields of a default Archimedean spiral antenna.

```
h = spiralArchimedean;
EHfields(h,4e9)
```



Calculate EH Fields of Antenna

Calculate electric and magnetic fields at a point 1m along the z-axis from an Archimedean spiral antenna.

```
h = spiralArchimedean;
[e,h] = EHfields(h,4e9,[0;0;1])
```

```
e =
```

```
  -0.4283 - 0.2675i
  -0.3047 + 0.4377i
   0.0000 - 0.0000i


h =

   0.0008 - 0.0012i
  -0.0011 - 0.0007i
  -0.0000 - 0.0000i
```

Plot Electric and Magentic Field Vector of Antenna

Create an Archimedean spiral antenna. Plot electric and magnetic field vector at the z = 1cm plane from the antenna.

```
h = spiralArchimedean;
```

Define points on a rectangular grid in the X-Y plane.

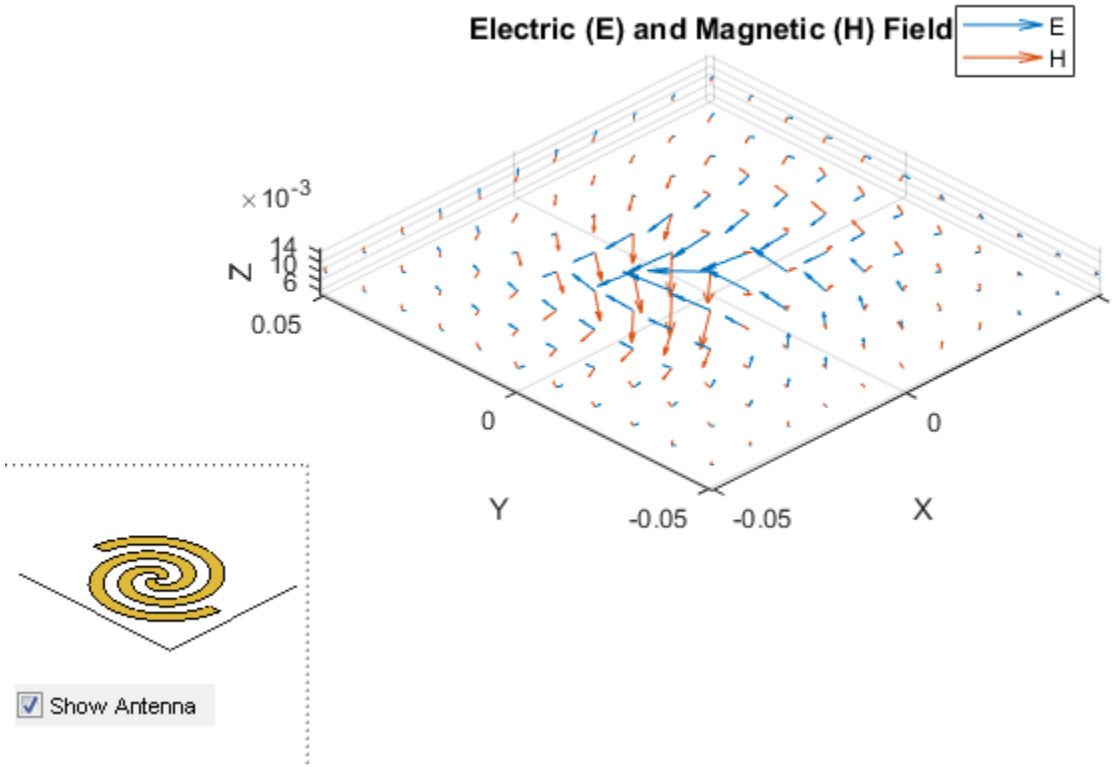
```
[X,Y] = meshgrid(-.05:.01:.05,-.05:.01:.05);
```

Add a z-offset of 0.01.

```
p = [X(:)';Y(:)';.01*ones(1,prod(size(X)))];
```

Plot electric and magnetic field vector at the z = 1cm plane. from the antenna

```
EHfields (h,4e9,p)
```



Input Arguments

`object` — Antenna or array object

scalar handle

Antenna or array object, specified as a scalar handle.

Example: `h = spiralArchimedean`

Data Types: `function_handle`

`frequency` — Frequency used to calculate electric and magnetic fields

scalar in Hz

Frequency used to calculate electric and magnetic fields, specified as a scalar in Hz.

Example: 70e6

Data Types: `double`

`points` — Cartesian coordinates of points in space

3-by-*p* complex matrix

Cartesian coordinates of points in space, specified as a 3-by-*p* complex matrix. *p* is the number of points at which to calculate the `E-H` field.

Example: `[0;0;1]`

Data Types: `double`

Name-Value Pair Arguments

Specify optional comma-separated pairs of `Name,Value` arguments. `Name` is the argument name and `Value` the corresponding value. `Name` must appear inside single quotes (`''`). You can specify several name and value pair arguments in any order as `Name1,Value1,...,NameN,ValueN`.

Example: `'ScaleFields',[2 0.5]` specifies scalar values of the electric and magnetic fields

`'ScaleFields'` — Value by which to scale electric and magnetic fields

two-element vector

Value by which to scale the electric and magnetic fields, specified as the comma-separated pair consisting of `'ScaleFields'` and a two-element vector. The first element scales the E field and the second element scales the H-field. A value of `2` doubles the relative length of either field. A value of `0.5` to halves the length of either field. A value of `0` plots either field without automatic scaling.

Example: `'ScaleFields',[2 0.5]`

Data Types: `double`

`'ViewField'` — Field to display

`'E' | 'H'`

Field to display, specified as the comma-separated pair consisting of `'ViewField'` and a text input. `'E'` displays the electric field and `'H'` displays the magnetic field.

Example: `'ViewField', 'E'`

Data Types: `char`

Output Arguments

e — *x*, *y*, *z* components of electrical field

3-by-*p* complex matrix in V/m

x, *y*, *z* components of electrical field, returned as 3-by-*p* complex matrix in V/m. The dimension *p* is the Cartesian coordinates of points in space.

h — *x*, *y*, *z* components of magnetic field

3-by-*p* complex matrix in H/m

x, *y*, *z* components of magnetic field, returned as a 3-by-*p* complex matrix in H/m. The dimension *p* is the Cartesian coordinates of points in space.

See Also

See Also

`axialRatio` | `beamwidth`

Introduced in R2015a

axialRatio

Axial ratio of antenna

Syntax

```
ar= axialRatio(antenna,frequency,azimuth,elevation)
```

Description

`ar= axialRatio(antenna,frequency,azimuth,elevation)` returns the axial ratio of an antenna, over the specified frequency, and in the direction specified by, `azimuth` and `elevation`.

Examples

Calculate Axial Ratio of Antenna

Calculate the axial ratio of an equiangular spiral antenna at azimuth=0 and elevation=0.

```
s  = spiralEquiangular;
ar = axialRatio(s,3e9,0,0)
```

```
ar =

   Inf
```

Input Arguments

`antenna` — Antenna object

scalar handle

Antenna object, specified as a scalar handle.

`frequency` — Frequency used to calculate axial ratio
scalar in Hz

Frequency used to calculate axial ratio, specified as a scalar in Hz.

Example: 70e6

Data Types: `double`

`azimuth` — Azimuth angle of antenna
scalar in degrees

Azimuth angle of antenna, specified as a scalar in degrees.

`elevation` — Elevation angle of antenna
scalar in degrees

Elevation angle of antenna, specified as a scalar in degrees.

Output Arguments

`ar` — Axial ratio of antenna
scalar in dB

Axial ratio of antenna, returned as a scalar in dB.

See Also

See Also
`beamwidth` | `pattern`

Introduced in R2015a

beamwidth

Beamwidth of antenna

Syntax

```
beamwidth(antenna,frequency,azimuth,elevation)
[bw] = beamwidth(antenna,frequency,azimuth,elevation,dBdown)

[bw,angles] = beamwidth(____)
```

Description

`beamwidth(antenna,frequency,azimuth,elevation)` plots the beamwidth of the input antenna at a specified frequency. The beamwidth is the angular separation at which the magnitude of the directivity pattern decreases by a certain value from the peak of the main beam. The directivity decreases in the direction specified by azimuth and elevation angles of the antenna.

`[bw] = beamwidth(antenna,frequency,azimuth,elevation,dBdown)` returns the beamwidth of the antenna at a specified `dBdown` value from the peak of the radiation pattern's main beam.

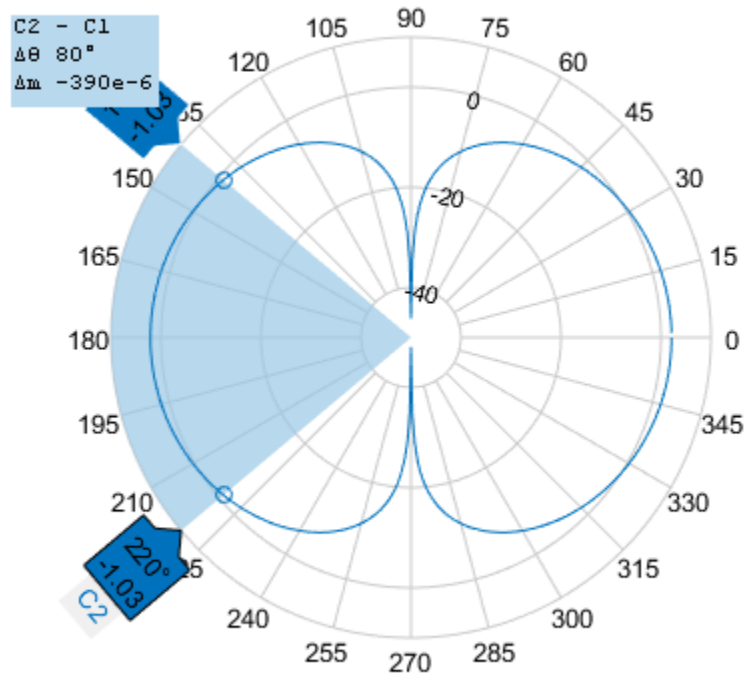
`[bw,angles] = beamwidth(____)` returns the beamwidth and angles (points in a plane) using any input arguments from previous syntaxes.

Examples

Plot Beamwidth of Dipole Antenna

Plot the beamwidth for a dipole antenna at azimuth=0 and elevation=1:1:360 (x-z plane)

```
d  = dipole;
beamwidth(d,70e6,0,1:1:360);
```



Calculate Beamwidth and Angles of Antenna

Calculate the beamwidth of a helix antenna and the angles of the beamwidth. The antenna has an azimuth angle of 1:1:360 degrees, an elevation angle of 0 degrees on the X-Y plane, and a dBdown value of 5 dB.

```
hx = helix;
[bw,angles] = beamwidth(hx,2e9,1:1:360,0,5)
```

```
bw =

    140
```

```
angles =

   147   287
```

Input Arguments

`antenna` — Antenna object

scalar handle

Antenna object, specified as a scalar handle.

`frequency` — Frequency used to calculate beamwidth

scalar in Hz

Frequency to calculate beamwidth, specified as a scalar in Hz.

Example: 70e6

Data Types: `double`

`azimuth` — Azimuth angle of antenna

scalar in degrees | vector in degrees

Azimuth angle of the antenna, specified as a scalar or vector in degrees. If the elevation angle is specified as a vector, then the azimuth angle must be a scalar.

Example: 3

Data Types: `double`

`elevation` — Elevation angle of antenna

scalar in degrees | vector in degrees

Elevation angle of the antenna, specified as a scalar or vector in degrees. If the azimuth angle is specified as a vector, then the elevation angle must be a scalar.

Example: 1:1:360

Data Types: `double`

`dBdown` — Power point from peak of main beam of antenna

3 (default) | scalar in dB

Power point from peak of main beam of antenna, specified as a scalar in dB.

Example: 5

Data Types: `double`

Output Arguments

bw — Beamwidth of antenna

scalar in degrees

Beamwidth of antenna, returned as a scalar in degrees.

`angles` — Points on plane

vector in degrees

Points on plane used to measure beamwidth, returned as a vector in degrees.

See Also

See Also

`axialRatio` | `pattern`

Introduced in R2015a

mesh

Mesh properties of antenna or array structure

Syntax

```
mesh(object,Name,Value)
```

Description

`mesh(object,Name,Value)` changes and plots the mesh structure of an antenna or array object, using additional options specified by the name-value pair. You can also determine the number of unknowns from the number of basis functions in the output.

Examples

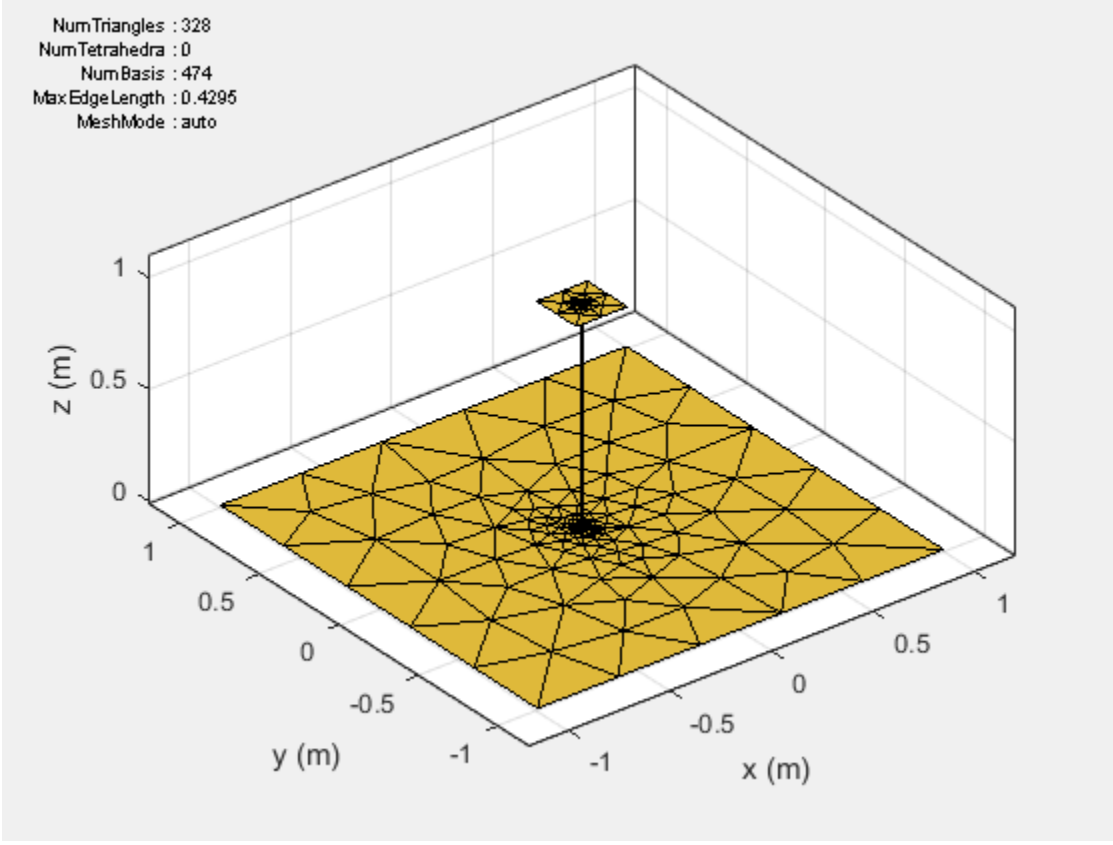
View Mesh Structure of Antenna

Create and view the mesh structure of a top hat monopole antenna with Maximum edge length of 0.1 m.

```
h = monopoleTopHat;
i = impedance(h,75e6)
mesh(h)
m = mesh(h)
```

```
i =

   2.7245e+02 + 6.0930e+02i


m =

  struct with fields:

     NumTriangles: 328
```

```
NumTetrahedra: 0
     NumBasis: 474
MaxEdgeLength: 0.4295
     MeshMode: 'auto'
```



Input Arguments

`object` — Antenna or array object

scalar handle

Antenna or array object, specified as a scalar handle.

Name-Value Pair Arguments

Specify optional comma-separated pairs of `Name,Value` pair arguments. `Name` is the argument name and `Value` is the corresponding value. `Name` must appear inside single quotes (' '). You can specify several name and value pair arguments in any order as `Name1, Value1, ..., NameN, ValueN`.

Example: 'MaxEdgeLength', 0.1

`'MaxEdgeLength'` — Maximum edge length of triangles in mesh

scalar

Maximum edge length of triangles in mesh, specified as a comma-separated pair consisting of `'MaxEdgeLength'` and a scalar. All triangles in the mesh have sides less than or equal to the `'MaxEdgeLength'`.

See Also

See Also

`show`

Introduced in R2015a

layout

Display array layout

Syntax

```
layout(array)
```

Description

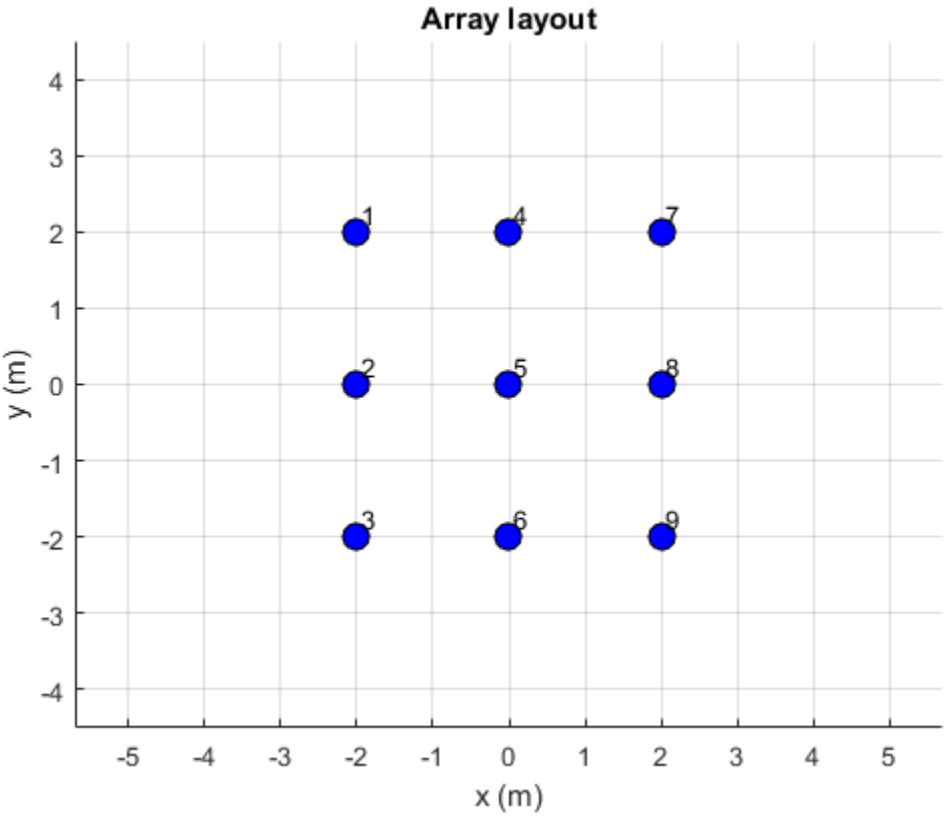
`layout(array)` displays the layout of the array object. The circles in the layout corresponds to antenna feed points within the array.

Examples

Display Array Layout on X-Y Plane

Create and view a 3x3 rectangular array layout on the X-Y plane.

```
h = rectangularArray('Size',[3 3]);
layout(h)
```



Input Arguments

`array` — Array object

scalar handle

Array object, specified as a scalar handle.

See Also

See Also

show

Introduced in R2015a

lumpedElement

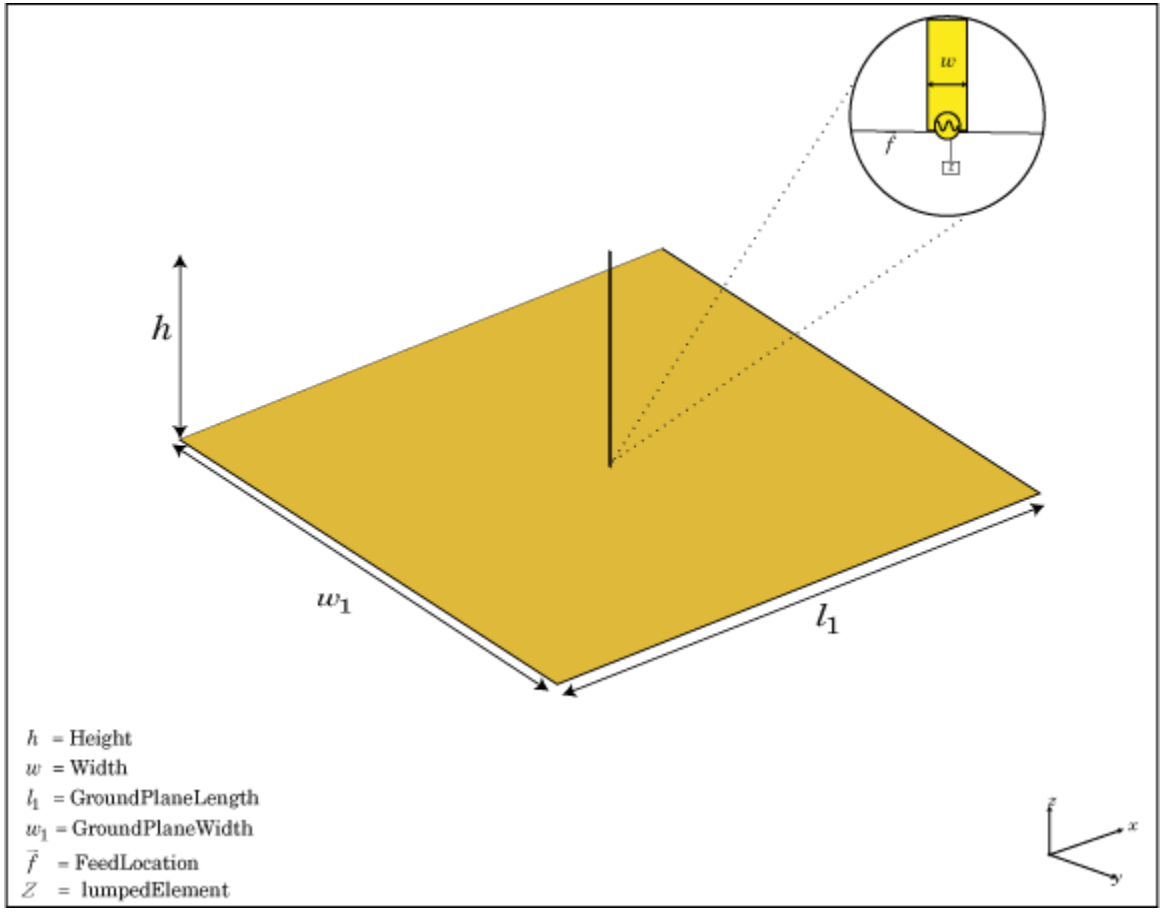
Lumped element circuit to load antenna

Syntax

```
le = lumpedElement
le = lumpedElement(Name,Value)
```

Description

`le = lumpedElement` creates a lumped element circuit. The default value is an empty `lumpedElement` object.



When you load an antenna using a lumped resistor, capacitor, or inductor, the electrical properties of the antennas changes. These lumped elements are typically added to the antenna feed. You can use lumped elements to increase the bandwidth of the antenna without increasing the size of the antenna.

`le = lumpedElement(Name,Value)` returns the lumped element circuit based on the properties specified by one or more `Name,Value` pair arguments.

Examples

Antenna Using Frequency Independent Load

Create a resistor with 50 Ohms of impedance. Any pure resistive load has a nonvariable impedance when the frequency changes.

```
le = lumpedElement('Impedance',50);
```

Create a dipole antennna. Calculate the impedance of the antenna without loading the antenna.

```
d = dipole;
i1 = impedance(d,70e6)
```

```
i1 =

  74.9942 + 0.6559i
```

Load the antenna using frequency-independent resistor. Calculate the impedance of the antenna. frequency-independent resistor.

```
d.Load = le;
i1e1 = impedance(d,70e6)
```

```
i1e1 =

   1.2499e+02 + 6.5594e-01i
```

Change the frequency to 85 MHz and calculate the impedance of the antenna.

```
ile2 = impedance(d,85e6)
```

```
ile2 =

   1.9852e+02 + 1.0270e+02i
```

Antenna With Two Loads at Arbitary Locations

Create a dipole antenna using one load at antenna feed and one load at location above the antenna feed.

Create a dipole antenna.

```
d = dipole;
```

Create a two lumped elements to load athe dipole antenna.

One lumped element of impedance, `50 Ohms`, loads the antenna at the feed.

```
l1 = lumpedElement('Impedance', complex(50, -20), 'Location', 'feed');
```

The second lumped element of complex impedance, `50+ j*20 Ohms`, loads the antenna at the top. Locate the load half distance from the feed.

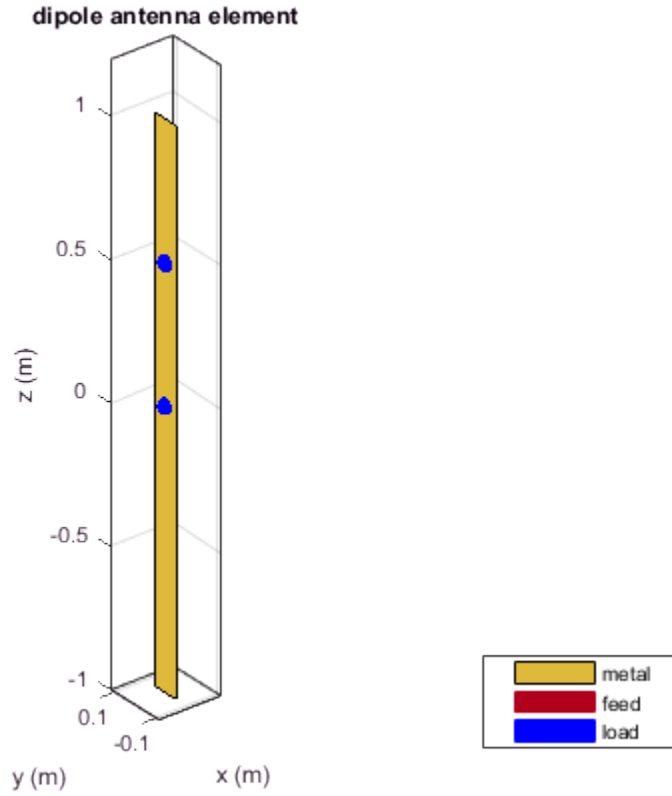
```
l2 = lumpedElement('Impedance', complex(50, -20), 'Location', [0 0 0.5]);
```

Add the two loads to the dipole antenna.

```
 d.Load = [l1, l2];
```

View the dipole antenna.

```
show(d);
```



Input Arguments

Name-Value Pair Arguments

Specify optional comma-separated pairs of `Name,Value` arguments. `Name` is the argument name and `Value` is the corresponding value. `Name` must appear inside single quotes (`' '`). You can specify several name and value pair arguments in any order as `Name1,Value1,...,NameN,ValueN`.

Example: `'Frequency',2e9`

`'Impedance'` — Complex impedance of circuit

real or complex vector of Z-parameters in ohms

Complex impedance of circuit, specified as the comma-separated pair consisting of `'Impedance'` and a real or complex vector of z-parameters in ohms.

Example: `'Impedance',complex(75,30)` specifies a complex impedance of `75+i30`.

Data Types: `double`

`'Frequency'` — Frequency of operation

real vector in Hz

Frequency of operation, specified as the comma-separated pair consisting of `'Frequency'` and a real vector in Hz.

Example: `'Frequency',[10e6,20e6,30e6]`

Data Types: `double`

`'Location'` — Location of load

`[0 0 0]` (default) | Cartesian coordinates

Location of load, specified as the comma-separated pair consisting of `'Location'` and Cartesian coordinates. By default, the location of the load is antenna feed or `[0 0 0]`.

Example: `'Location',[0 0 0.5]`

Data Types: `double`

Output Arguments

`le` — Lumped element

`lumpedElement` object

Lumped element, returned as a `lumpedElement` object. The real part of the complex number indicates the resistance. The imaginary part of the complex number indicates the reactance.

See Also

See Also

`dielectric`

Introduced in R2016b

vswr

Voltage standing wave ratio of antenna

Syntax

```
vswr(antenna,frequency,z0)
vswrant = vswr(antenna,frequency,z0)
```

Description

`vswr(antenna,frequency,z0)` calculates and plots the voltage standing wave ratio of an antenna, over specified frequency range, and given reference impedance, `z0`.

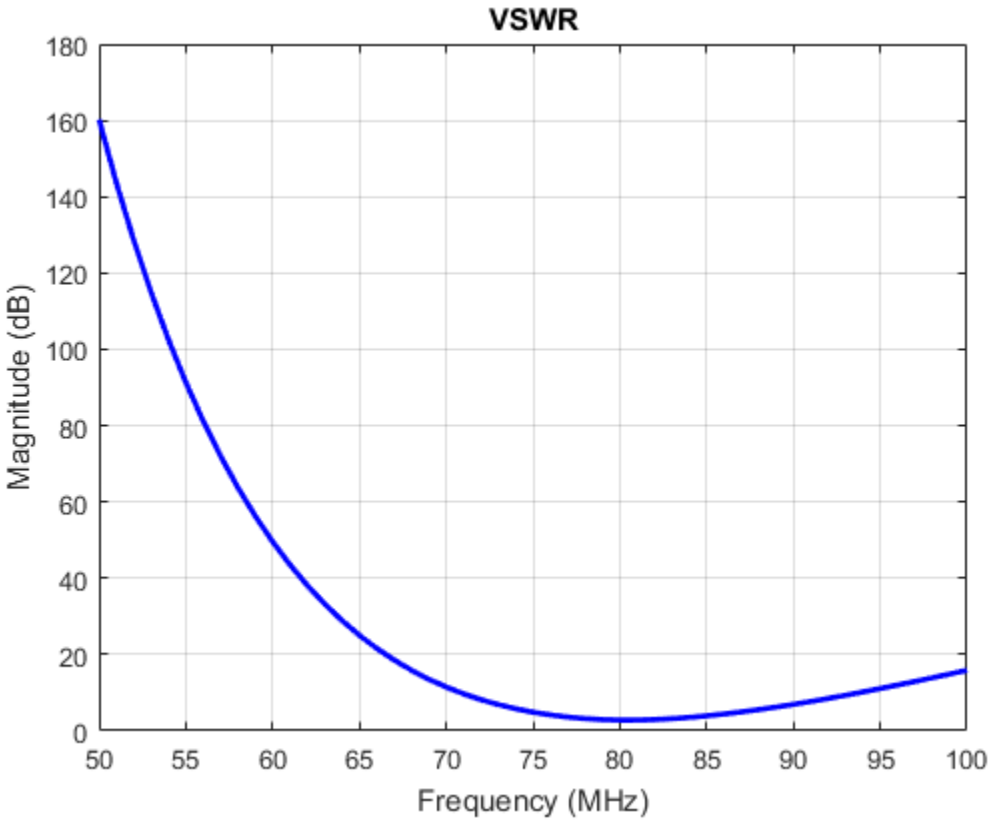
`vswrant = vswr(antenna,frequency,z0)` returns the vswr of the antenna.

Examples

Plot VSWR of Antenna

Plot vswr (voltage standing wave ratio) of a circular loop antenna.

```
h = loopCircular;
vswr(h,50e6:1e6:100e6,50)
```



Calculate VSWR of Antenna

Calculate vswr (voltage standing wave ratio) of a helix antenna.

```
h = helix;
hvswr = vswr(h,2e9:1e9:4e9,50)
```

```
hvswr =

    3.6021    6.6244    3.2850
```

Input Arguments

`antenna` — Antenna object

scalar handle

Antenna object, specified as a scalar handle.

`frequency` — Frequency range used to calculate VSWR

vector in Hz

Frequency range used to calculate VSWR, specified as a vector in Hz. The minimum value of frequency must be 1 kHz.

Example: 50e6:1e6:100e6

Data Types: `double`

`z0` — Reference impedance

50 (default) | scalar in dB

Reference impedance, specified as a scalar in dB.

Output Arguments

`vswrant` — Voltage standing wave ratio

vector in dB

Voltage standing wave ratio, returned as a vector in dB.

See Also

See Also

`impedance`

Introduced in R2015a

correlation

Correlation coefficient between two antennas in array

Syntax

```
correlation(array,frequency,elem1,elem2,z0)
rho = correlation(array,frequency,elem1,elem2,z0)
```

Description

`correlation(array,frequency,elem1,elem2,z0)` calculates and plots the correlation coefficient between two antenna elements, `elem1` and `elem2` of an array. The correlation values are calculated for a specified frequency and impedance and for a specified impedance `z0`.

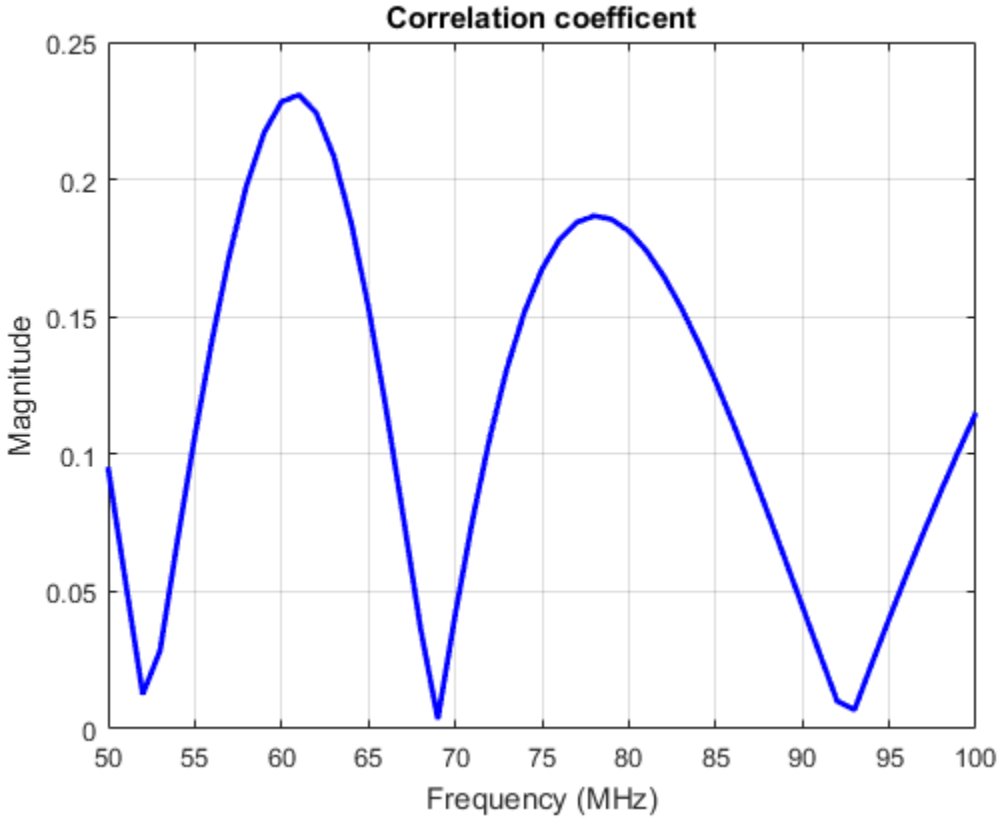
`rho = correlation(array,frequency,elem1,elem2,z0)` returns the correlation coefficient between two antenna elements, `elem1` and `elem2` of an array.

Examples

Plot Correlation of Array

Plot the correlation between 1 and 2 antenna elements in a default linear array over a frequency range of 50MHz to 100MHz.

```
h = linearArray;
correlation (h,50e6:1e6:100e6,1,2);
```



Calculate Correleation Coeffecient of Array

Calculate correlation coeffecient of default rectangular array at a frequency range of 50MHz to 100MHz.

```
h = rectangularArray;
rho = correlation (h, 50e6:1e6:100e6, 1, 2)
```

```
rho =

    0.1377
    0.1081
    0.0782
```

```
0.0477
0.0165
0.0156
0.0486
0.0822
0.1153
0.1463
0.1725
0.1912
0.1999
0.1977
0.1850
0.1635
0.1355
0.1030
0.0675
0.0301
0.0084
0.0474
0.0862
0.1235
0.1578
0.1868
0.2081
0.2195
0.2193
0.2076
0.1859
0.1568
0.1236
0.0892
0.0559
0.0252
0.0022
0.0261
0.0466
0.0641
0.0789
0.0914
0.1020
0.1110
0.1186
0.1252
0.1309
```

```
0.1359
0.1403
0.1442
0.1478
```

Input Arguments

`array` — Array object

scalar handle

Array object, specified as a scalar handle.

`frequency` — Frequency range used to calculate correlation

vector in Hz

Frequency range used to calculate correlation, specified as a vector in Hz.

Example: 50e6:1e6:100e6

Data Types: `double`

`elem1,elem2` — Antenna elements in an array

scalar handle

Antenna elements in an array, specified as a scalar handle.

`z0` — Reference impedance

50 (default) | scalar in ohms

Reference impedance, specified as a scalar in ohms.

Example: 70

Data Types: `double`

Output Arguments

`rho` — Correlation coefficient between two antenna elements of an array

vector

Correlation coefficient between two antenna elements of an array, returned as a vector.

See Also

See Also

`impedance` | `returnLoss` | `sparameters`

Introduced in R2015a

cylinder2strip

Cylinder equivalent width approximation

Syntax

```
w = cylinder2strip(r)
```

Description

`w = cylinder2strip(r)` calculates the equivalent width of a strip approximation for a cylinder cross section.

Examples

Calculate Cylinder to Strip Approximation

Calculate the width of the strip approximation to a cylinder of radius 20 mm.

```
w = cylinder2strip(20e-3)
```

```
w =

    0.0800
```

Input Arguments

r — Cylindrical cross-section radius

scalar in meters | vector in meters

Cylindrical cross-section radius, specified as a scalar or vector in meters.

Example: 20e-3

Output Arguments

w — Equivalent width of strip

scalar | vector

Equivalent width of strip, returned as a scalar or vector.

See Also

See Also

`helixpitch2spacing`

Introduced in R2015a

helixpitch2spacing

Spacing between turns of helix

Syntax

```
s = helixpitch2spacing(a,r)
```

Description

`s = helixpitch2spacing(a,r)` calculates the spacing between the turns of a helix antenna given the pitch angle, `a`, and the radius of the helix, `r`.

Examples

Calculate Spacing Between Helix Turns

Calculate spacing for helix with pitch varying from 12 degrees to 14 degrees in steps of 0.5 and 20 mm radius.

```
s = helixpitch2spacing(12:0.5:14,20e-3)
```

```
s =

    0.0267    0.0279    0.0290    0.0302    0.0313
```

Calculate Spacing for Helix with Varying Pitch

Calculate spacing for helix with pitch varying from 12 degrees to 14 degrees in steps of 0.5 and radius 20 mm.

```
s = helixpitch2spacing(12:0.5:14,20e-3)
```

```
s =
```

```
    0.0267    0.0279    0.0290    0.0302    0.0313
```

Calculate Spacing of Helix Antenna with Varying Radius

Calculate spacing of a helix that has a pitch of 12 degrees and a radius that varies from 20 mm to 22 mm in steps of 0.5 mm.

```
s = helixpitch2spacing(12,20e-3:0.5e-3:22e-3)
```

```
s =

    0.0267    0.0274    0.0280    0.0287    0.0294
```

Calculate Spacing of Helix with Varying Pitch and Radius

Calculate spacing for helix with pitch varying from 12 degrees to 14 degrees in steps of 0.5 and radius varying from 20mm to 22mm in steps of 0.5.

```
s = helixpitch2spacing(12:0.5:14,20e-3:0.5e-3:22e-3)
```

```
s =

    0.0267    0.0286    0.0305    0.0324    0.0345
```

Input Arguments

a — Pitch angle of helix

scalar in meters | vector in meters

Pitch angle of helix, specified as a scalar or vector in meters.

Example: 12:0.5:14

r — Radius of helix

scalar in meters | vector in meters

Radius of helix, specified as a scalar or vector in meters.

Example: 20e-3

Note: If the pitch angle and radius are both vectors, then their lengths must be equal.

Output Arguments

s — Spacing between helix turns

scalar in meters | vector in meters

Spacing between helix turns, returned as a scalar or vector in meters.

See Also

See Also

`cylinder2strip`

Introduced in R2015a

meshconfig

Change mesh mode of antenna structure

Syntax

```
meshconfig(antenna,mode)
```

Description

`meshconfig(antenna,mode)` changes the meshing mode of the antenna according to the text input mode.

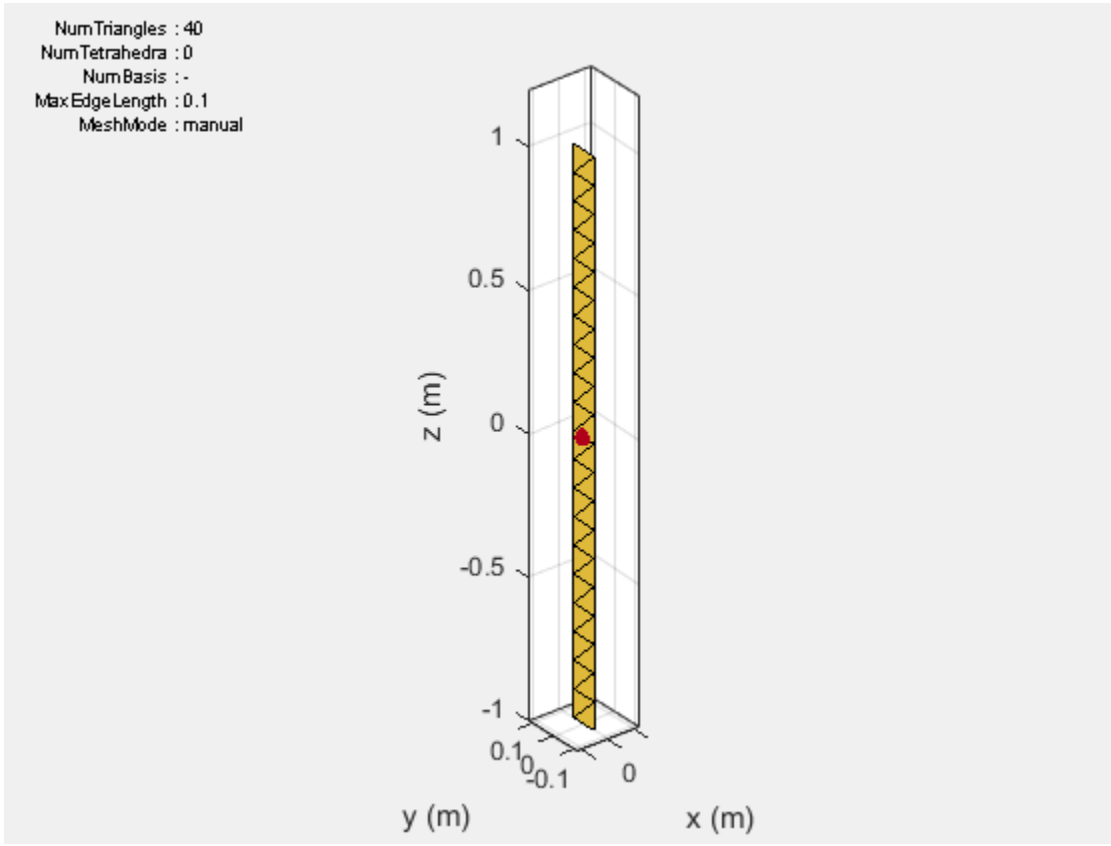
Examples

Change Mesh Configuration of Antenna

Change the mesh configuration of a dipole antenna from auto (default) to manual mode.

```
h = dipole;
meshconfig(h,'manual')
mesh(h,'MaxEdgeLength',0.1)
```

```
ans =

  struct with fields:

     NumTriangles: 0
    NumTetrahedra: 0
         NumBasis: []
    MaxEdgeLength: []
         MeshMode: 'manual'
```



Input Arguments

`antenna` — Antenna object

scalar handle

Antenna object, specified as a scalar handle.

`mode` — Meshing mode

`'auto'` (default) | `'manual'`

Meshing mode, specified as `'auto'` or `'manual'`.

Data Types: `char`

See Also

See Also

`mesh` | `show`

Introduced in R2015a

numSummationTerms

Change number of summation terms for calculating periodic Green's function

Syntax

```
numSummationTerms(array,num)
```

Description

`numSummationTerms(array,num)` changes the number of summation terms used to calculate periodic Green's function of the infinite array. This method calculates $2*num+1$ of the periodic Green's function. The summation is carried out from –`num` to +`num`. A higher number of terms results in better accuracy but increases the overall computation time.

Input Arguments

`array` — Infinite array

scalar handle

Infinite array, specified as a scalar handle.

`num` — Number to calculate summation terms

10 (default) | scalar

Number to calculate summation terms, specified as a scalar. The summation is carried out from –`num` to +`num`.

Example: 50

Examples

Change Number of Summation Terms in Infinite Array

Create an infinite array with the scan elevation at 45 degrees. Calculate the scan impedance. By default, the number of summation terms used is 21.

```
h = infiniteArray('ScanElevation',45);
s = impedance(h,1e9)


s =

  93.6494 +79.7794i
```

Change the number of summation terms to 51. Calculate the scan impedance again.

```
numSummationTerms(h,25)
s = impedance(h,1e9)


s =

  93.8121 +79.8081i
```

Change the number of terms to 101. Increasing the number of summation terms results in a more accurate scan impedance. However, the time required to calculate the scan impedance increases.

```
numSummationTerms(h,50)
s = impedance(h,1e9)


s =

  93.8622 +79.8103i
```

See Also

See Also

`beamwidth` | `pattern`

Topics

"Infinite Arrays"

Introduced in R2015b

feedCurrent

Calculate current at feed for antenna or array excited by plane wave

Syntax

```
feedCurrent(obj,frequency)
```

Description

`feedCurrent(obj,frequency)` calculates the current at the feed for an antenna or array object at a specified frequency. The feed current when multiplied by the antenna impedance gives the voltage across the antenna.

Examples

Feed Current of Monopole Antenna Excited By Plane Wave.

Excite a monopole antenna using plane wave. Calculate the feed current at 75 MHz.

```
h = planeWaveExcitation('Element',monopole, 'Direction',[1 0 0])
cur = feedCurrent(h,75e6)
```

```
h =

  planeWaveExcitation with properties:

         Element: [1×1 monopole]
       Direction: [1 0 0]
    Polarization: [0 0 1]


cur =

   0.0132 - 0.0133i
```

Input Arguments

`obj` — Antenna or array object

object handle

Antenna or array object, specified as an object handle.

`frequency` — Frequency to calculate feed current

scalar integer in Hz

Frequency to calculate feed current, specified as a scalar integer in Hz.

See Also

See Also

`current`

Introduced in R2017a

fieldsCustom

Plot electric or magnetic fields of antenna

Syntax

```
fieldsCustom(fields,points)
fieldsCustom(fields,points,scalefield)
qobj = fieldsCustom( ___ )

fieldsCustom(axeshandle, ___ )
```

Description

`fieldsCustom(fields,points)` plots electric or magnetic field vectors, `fields`, at specified points in space, `points`, in the current axes.

`fieldsCustom(fields,points,scalefield)` scales the field arrows by a scalar value, `scalefield`.

`qobj = fieldsCustom( ___ )` returns the quiver object, using either of the previous syntaxes.

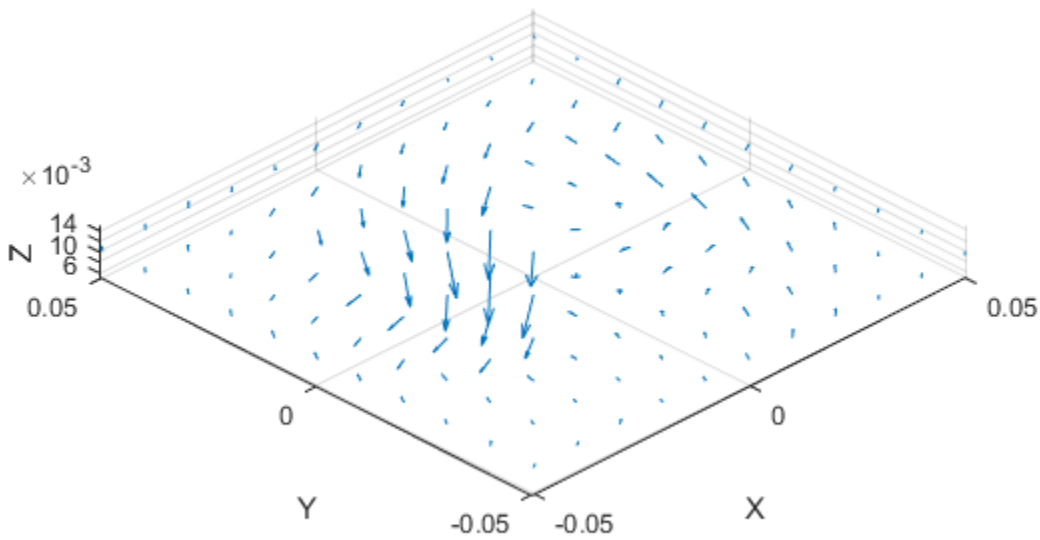
`fieldsCustom(axeshandle, ___ )` plots into the axes specified by `axeshandle` instead of the current axes.

Examples

Visualize Magnetic Field of Antenna

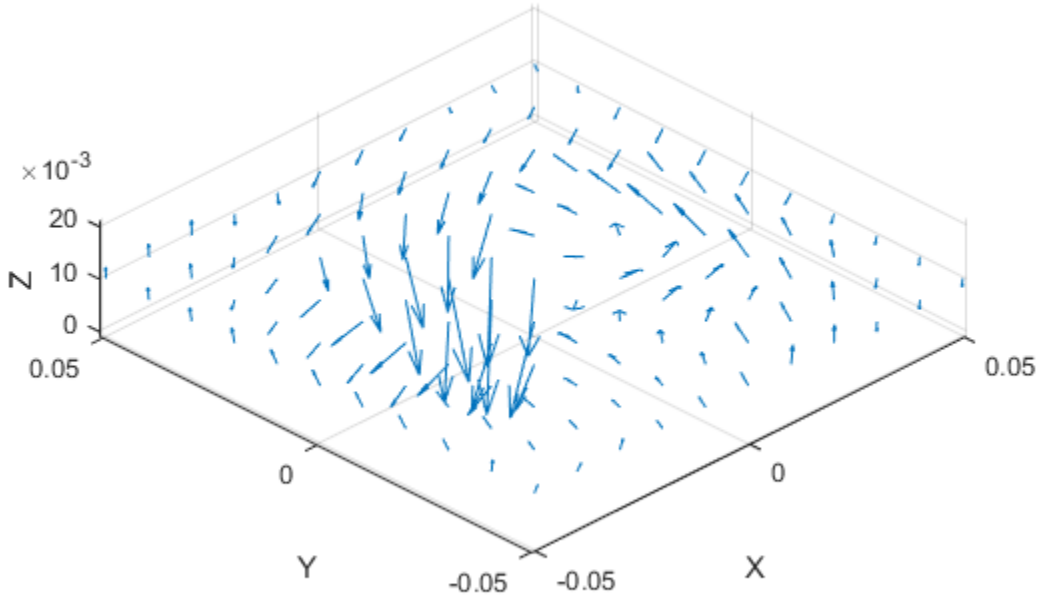
Load and visualize the magnetic field data available in the file `fielddata.mat`.

```
load fielddata
fieldsCustom(H,p)
```



Scale the magnetic field arrows by a factor of 2.

```
figure
fieldsCustom(H,p,2)
```



Input Arguments

`fields` — Electric or magnetic field vectors

3-by-*p* complex matrix

Electric or magnetic field vectors, specified as a 3-by-*p* complex matrix. *p* is the number of points in space.

Data Types: `double`

`points` — x, y, z coordinates in space

3-by-*p* real matrix

`x`, `y`, `z` coordinates in space, specified as a 3-by-p real matrix. p is the number of points in space.

Data Types: `double`

`axeshandle` — Axes object
object handle

Axes object, specified as an object handle.

Data Types: `char`

`scalefield` — Value by which to scale field arrows
0.9 (default) | scalar

Value by which to scale the field arrows, specified as a scalar. A value of `2` doubles the relative length of the field arrows. A value of `0.5` halves the length of the field arrows. A value of `0` plots the field arrows without automatic scaling.

Example: `2`

Data Types: `double`

Output Arguments

`qobj` — Electric or magnetic field plot
quiver object handle

Electric or magnetic field plot, returned as quiver object handle.

See Also

See Also
`EHfields` | `pattern` | `patternCustom`

Introduced in R2016a

patternCustom

Plot radiation pattern

Syntax

```
patternCustom(magE,theta,phi)
patternCustom(magE,theta,phi,Name,Value)
hplot = patternCustom( ___ )
```

Description

`patternCustom(magE,theta,phi)` plots the 3-D radiation pattern of an antenna magnitude, `magE` over the specified `phi` and `theta` angle vectors.

`patternCustom(magE,theta,phi,Name,Value)` uses additional options specified by one or more `Name,Value` pair arguments.

`hplot = patternCustom( ___ )` returns handles of the lines or surface in the figure window. This syntax accepts any combination of arguments from the previous syntaxes

Examples

Visualize 3-D Electric Field Pattern of Dipole

Calculate the magnitude, azimuth, and elevation angles of a dipole's electric field at 75 MHz.

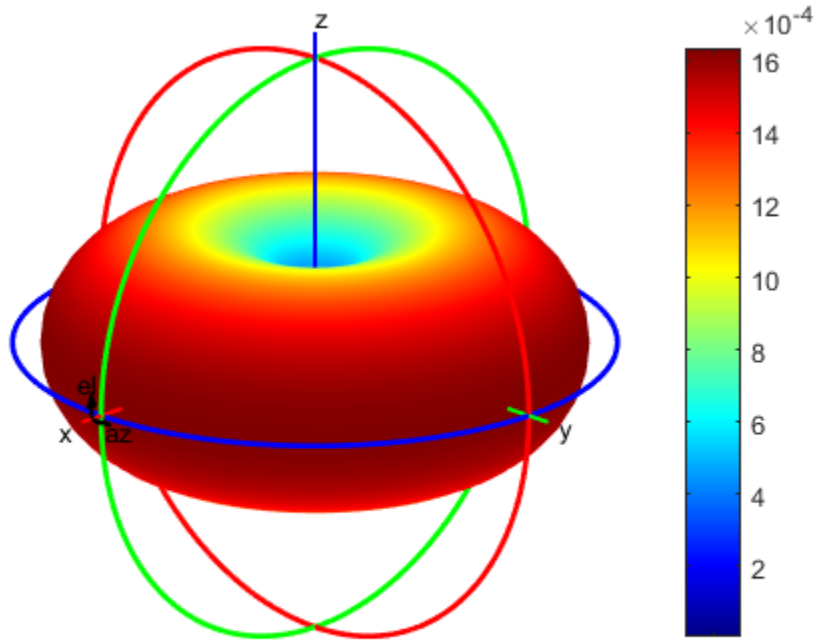
```
d = dipole;
[efield,az,el] = pattern(d, 75e6,'Type','efield');
```

Extract the theta and phi angles of the electric field magnitude of the antenna.

```
phi = az';
theta = (90-el);
MagE = efield';
```

Plot the 3-D electric field pattern.

```
patternCustom(MagE,theta,phi);
```



Visualize 2-D Radiation Patterns of Helix Directivity

Calculate the magnitude, azimuth, and elevation angles of a helix's directivity at 2 GHz.

```
h = helix;
[D,az,el] = pattern(h,2e9);
```

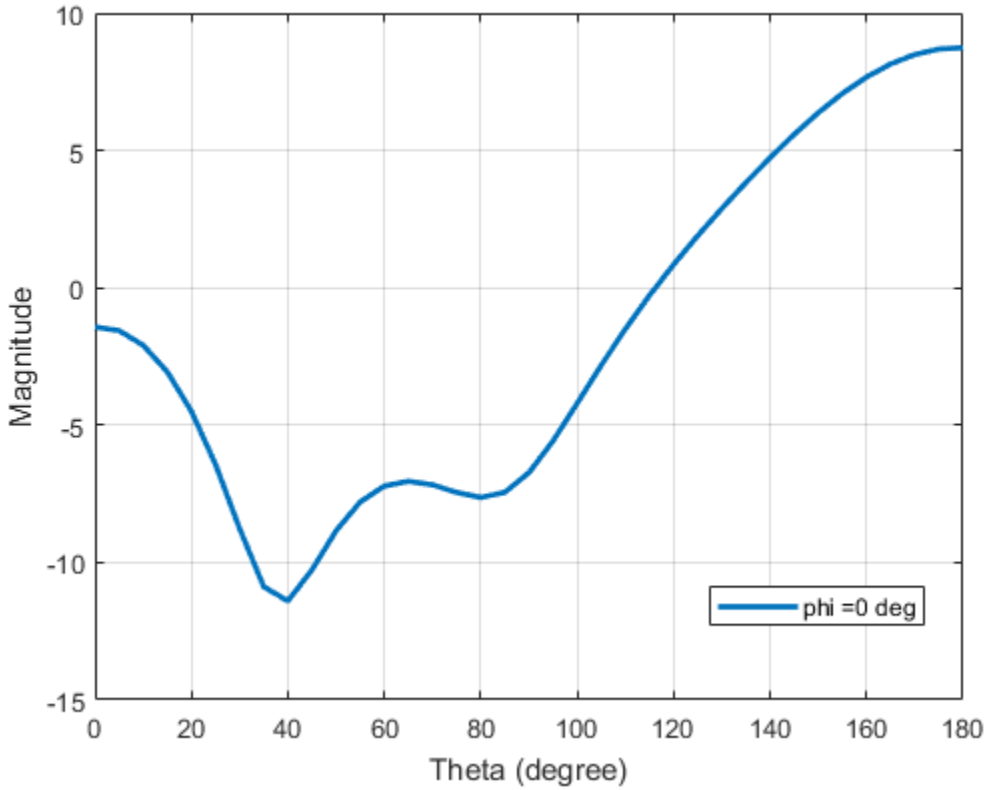
Extract theta and phi angles of the directivity magnitude.

```
phi = az';
```

```
theta = (90-el);
MagE = D';
```

Plot 2-D phi slice of the antenna in rectangular coordinates.

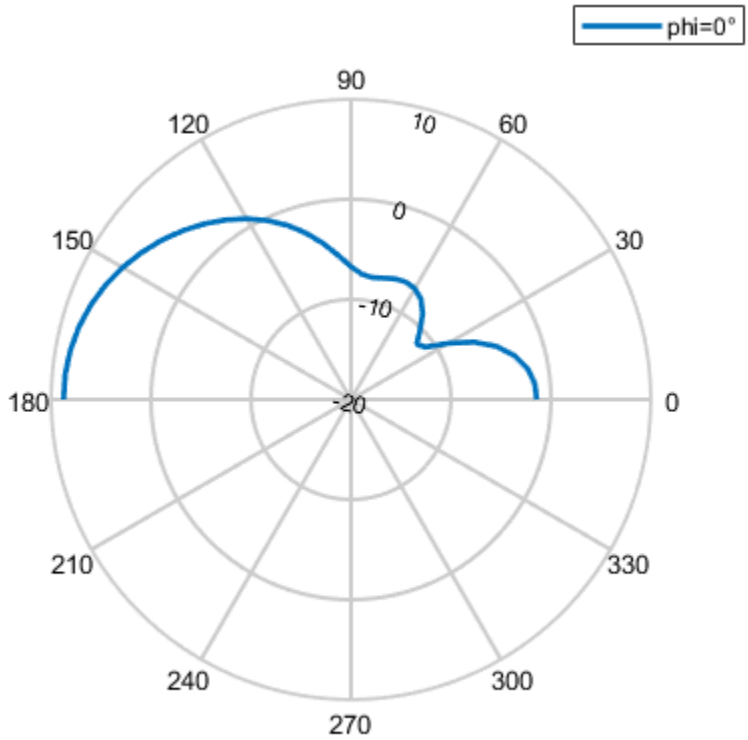
```
figure;
patternCustom(MagE,theta,phi,'CoordinateSystem','rectangular',...
    'Slice','phi','SliceValue',0);
```



Plot 2-D phi slice of the antenna in polar coordinates.

```
figure;
patternCustom(MagE, theta, phi,'CoordinateSystem','polar',...
```

```
'Slice','phi','SliceValue',0);
```



Visualize Radiation Patterns from Antenna Data File

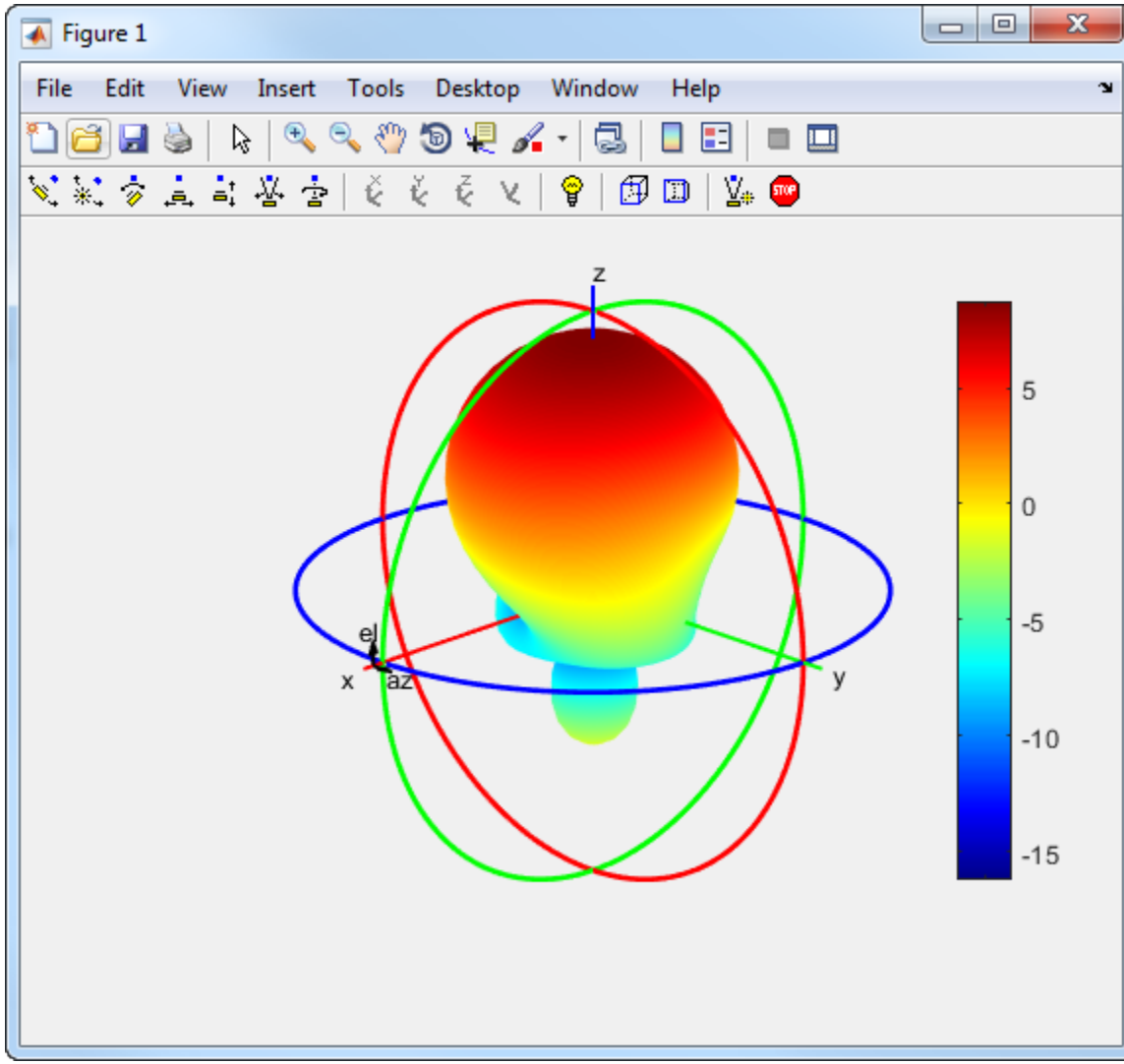
Consider a helix antenna data file in `.csv` format. This file contains the magnitude of the antenna directivity in `phi` and `theta` angles. Read the file .

Read the `.csv` data file.

```
helixdata = csvread('antennadata_test.csv',1,0);
```

Use `patternCustom` to extract the magnitude of directivity, and the `phi`, and `theta` angle values. Plot the 3-D polar radiation pattern.

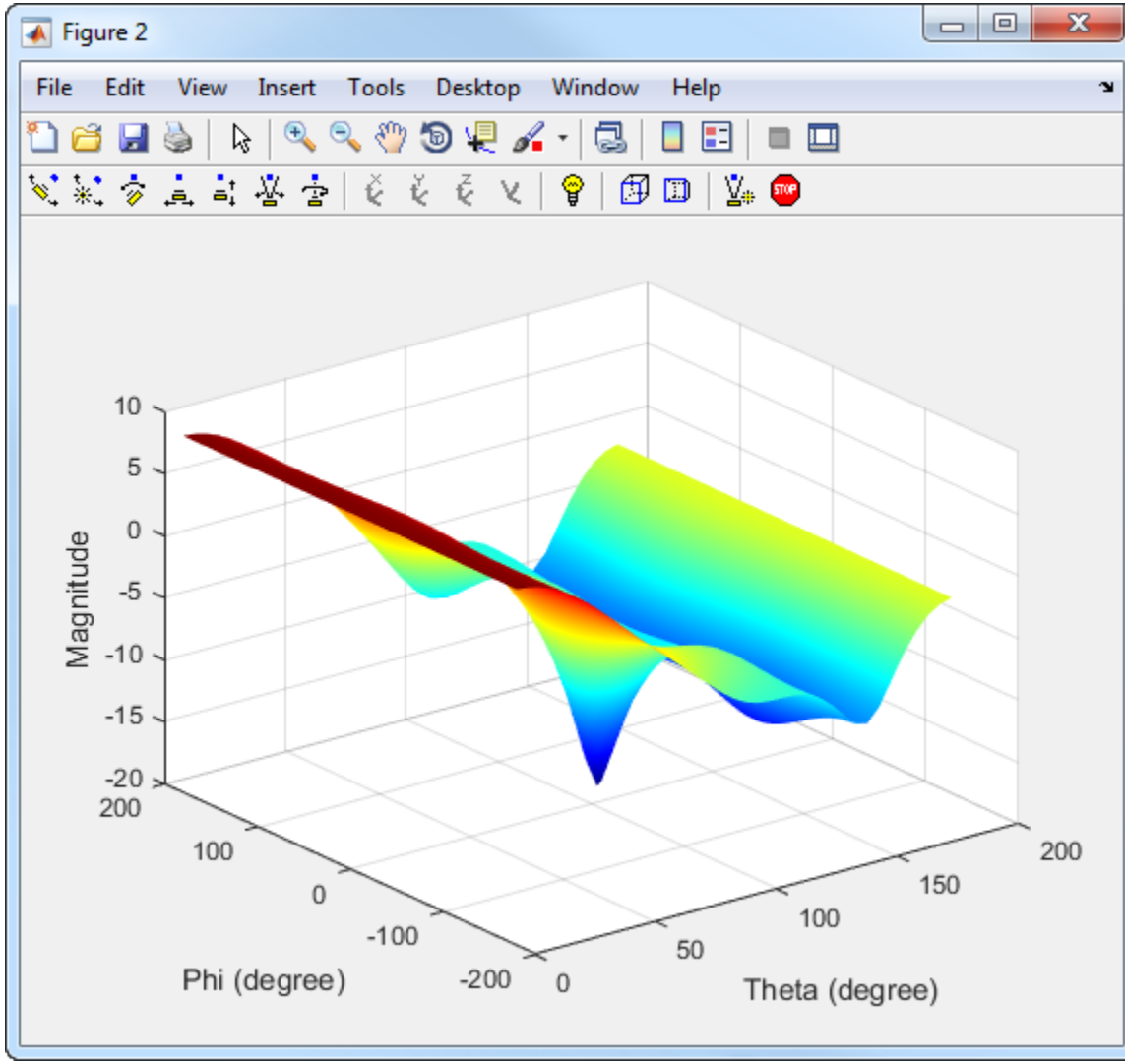
```
patternCustom(helixdata(:,3),helixdata(:,2),helixdata(:,1));
```



Use the same data to plot the 3-D rectangular radiation pattern.

```
figure
patternCustom(helixdata(:,3),helixdata(:,2),helixdata(:,1),...
```

```
'CoordinateSystem','rectangular');
```



Input Arguments

`magE` — Magnitude of plotted quantity
real vector | matrix

Magnitude of plotted quantity, specified as one of the following:

- A *N*-by-1 real vector . *N* is the same size as the `theta` and `phi` angle vectors.
- A *M*-by-*R* matrix. *M* is the same size as the `theta` angle vector and *R* is the same size as the `phi` angle vector.

Data quantities plotted include directivity, E-fields, H-fields, or power of an antenna or array object.

Data Types: `double`

`theta` — Theta angles in spherical coordinates
vector in degrees

Theta angles in spherical coordinates, specified as a vector in degrees.

Data Types: `double`

`phi` — Phi angles in spherical coordinates
vector in degrees

Phi angles in spherical coordinates, specified as a vector in degrees.

Data Types: `double`

Name-Value Pair Arguments

Specify optional comma-separated pairs of `Name,Value` arguments. `Name` is the argument name and `Value` is the corresponding value. `Name` must appear inside single quotes (`' '`). You can specify several name and value pair arguments in any order as `Name1,Value1,...,NameN,ValueN`.

Example: `'CoordinateSystem','rectangular'`

`'CoordinateSystem'` — Coordinate system of radiation pattern
`'polar'` (default) | `'rectangular'`

Coordinate system of radiation pattern, specified as the comma-separated pair consisting of `'CoordinateSystem'` and one of these values: `'polar'`, `'rectangular'`.

Example: `'CoordinateSystem','polar'`

Data Types: `char`

`'Slice'` — Plane to visualize 2-D data

`'theta'` | `'phi'`

Plane to visualize 2-D data, specified as a comma-separated pair consisting of `'Slice'` and `'theta'` or `'phi'`.

Example: `'Slice','phi'`

Data Types: `char`

`'SliceValue'` — Angle values for slice

scalar | vector

Angle values for slice, specified as a comma-separated pair consisting of `'SliceValue'` and a scalar or a vector.

Output Arguments

`hplot` — Lines or surfaces in figure window

object handle

Lines or surfaces in figure window, returned as object handle.

See Also

See Also

`EHfields` | `fieldsCustom` | `pattern`

Introduced in R2016a

msiread

Read MSI planet antenna file

Syntax

```
msiread(fname)
[horizontal] = msiread(fname)
[horizontal,vertical] = msiread(fname)
[horizontal,vertical,optional] = msiread(fname)
```

Description

`msiread(fname)` reads an MSI planet antenna file in `.pln`, or `.msi` formats.

`[horizontal] = msiread(fname)` reads the file and returns a structure containing horizontal gain data.

`[horizontal,vertical] = msiread(fname)` reads the file and returns structures containing horizontal and vertical gain data.

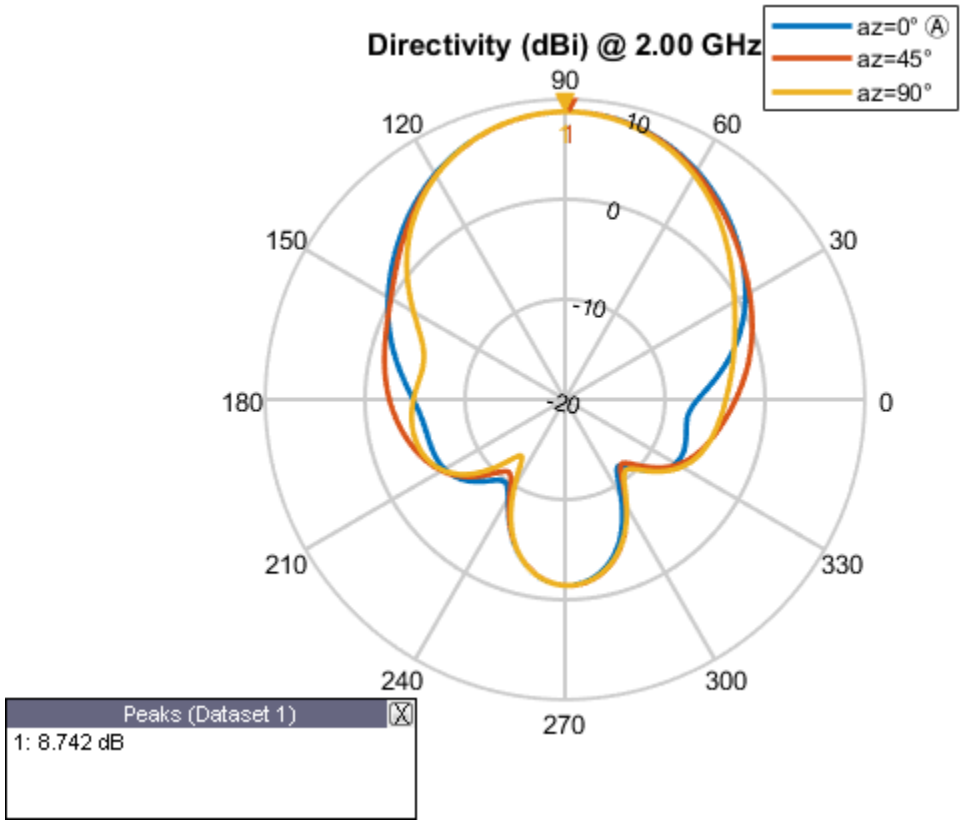
`[horizontal,vertical,optional] = msiread(fname)` reads the file and returns structures containing horizontal gain data, vertical gain data, and all additional data in the file.

Examples

Write and Read MSI Antenna Data File

Create a helix antenna and plot the elevation pattern at 2 GHz.

```
h = helix;
patternElevation(h,2e9,[0 45 90],'Elevation',0:1:360);
```



Write the elevation pattern of the helix antenna in an MSI Planet Antenna file.

```
msiwrite(h,2e9,'helix','Name','Helix Antenna Specifications')
```

The msiwrite function saves a file named helix.plnto the default MATLAB™ folder.

```
NAME Helix Antenna Specifications
FREQUENCY 2000.0
GAIN 8.74 dBi
HORIZONTAL 360
0.00 13.56
1.00 13.48
2.00 13.39
3.00 13.30
```

```
4.00 13.22
5.00 13.13
```

Read the MSI antenna data file created.

```
msiread helix.pln
```

```
ans =

  struct with fields:

    PhysicalQuantity: 'Gain'
           Magnitude: [360×1 double]
               Units: 'dBi'
             Azimuth: [360×1 double]
           Elevation: 0
           Frequency: 2.0000e+09
               Slice: 'Elevation'
```

Read Horizontal, Vertical and Optional Data from Antenna File

Read horizontal, vertical and optional data from the antenna data file **Test_file_demo.pln**.

```
[Horizontal,Vertical,Optional] = msiread('Test_file_demo.pln')
```

```
Horizontal =

  struct with fields:

    PhysicalQuantity: 'Gain'
           Magnitude: [360×1 double]
               Units: 'dBd'
             Azimuth: [360×1 double]
           Elevation: 0
           Frequency: 659000000
               Slice: 'Elevation'


Vertical =

  struct with fields:
```

```
    PhysicalQuantity: 'Gain'
           Magnitude: [360×1 double]
               Units: 'dBd'
             Azimuth: 0
           Elevation: [360×1 double]
           Frequency: 659000000
               Slice: 'Azimuth'


Optional =

  struct with fields:

              name: 'Sample.pln'
              make: 'Sample 4DR-16-2HW'
         frequency: 659000000
           h_width: 180
           v_width: 7.3000
    front_to_back: 34
              gain: [1×1 struct]
              tilt: 'MECHANICAL'
     polarization: 'POL_H'
          comment: 'Ch-45 0 deg dt'
     scaling_mode: 'AUTOMATIC'
```

- “Read, Visualize and Write MSI Planet Antenna Files”

Input Arguments

`fname` — Name of MSI file

character vector

Name of MSI file, specified as a character vector. The files must be a `.pln` or `.msi` format.

Output Arguments

`horizontal` — Horizontal gain data

structure

Horizontal gain data, returned as a structure containing the following fields:

- `PhysicalQuantity` — Quantity specified in the MSI file, returned as one of the values: `'E-field'`, `'H-field'`, `'directivity'`, `'power'`, `'powerdB'`, or `'Gain'`.
- `Magnitude` — Magnitude values of the quantity specified in the MSI file, returned as a real vector of size *N*–by–1 where *N* is same size as `theta` and `phi` angles.
- `Units` — Units of the quantity specified in the MSI file, returned as one of the values: `'dBi'`, `'dB'`, `'V/m'`, `'watts'`, or `'dBd'`.
- `Azimuth` — Azimuth angles specified in the MSI file, returned as a scalar or a vector in degrees.
- `Elevation` — Elevation angles specified in the MSI file, returned as a scalar or a vector in degrees.
- `Frequency` — Frequency specified in the MSI file, returned as a scalar or a vector in Hertz.
- `Slice` — Type of data set variation, returned as text. The variations are `'Azimuth'` or `'Elevation'`.

`vertical` — Vertical gain data

structure

Vertical gain data, returned as a structure containing the following fields:

- `PhysicalQuantity` — Quantity specified in the MSI file, returned as one of the values: `'E-field'`, `'H-field'`, `'directivity'`, `'power'`, `'powerdB'`, or `'Gain'`.
- `Magnitude` — Magnitude values of the quantity specified in the MSI file, returned as a real vector of size *N*–by–1 where *N* is same size as `theta` and `phi` angles.
- `Units` — Units of the quantity specified in the MSI file, returned as one of the values: `'dBi'`, `'dB'`, `'V/m'`, `'watts'`, or `'dBd'`.
- `Azimuth` — Azimuth angles specified in the MSI file, returned as a scalar or a vector in degrees.
- `Elevation` — Elevation angles specified in the MSI file, returned as a scalar or a vector in degrees.
- `Frequency` — Frequency specified in the MSI file, returned as a scalar or a vector in Hertz.
- `Slice` — Type of data set variation, returned as text. The variations are `Azimuth` or `Elevation`.

`optional` — Additional data

structure

Additional data, returned as a structure containing (but not limited to): `Name`, `Make`, `Frequency`, `H_width`, `V_width`, `Front_to_back`, `Gain`, `Tilt`, `Polarization`, `Comment`.

See Also

See Also

`msiwrite`

Topics

"Read, Visualize and Write MSI Planet Antenna Files"

Introduced in R2016a

msiwrite

Write data in MSI planet antenna file format

Syntax

```
msiwrite(fname,dataslice1,dataslice2)
msiwrite(fname,dataslice1,dataslice2,optional)

msiwrite(objname,frequency,fname)
msiwrite(objname,frequency,fname,Name,Value)
```

Description

`msiwrite(fname,dataslice1,dataslice2)` writes the data from structures `dataSlice1` and `dataSlice2` to an MSI planet antenna file called `fname`.

`msiwrite(fname,dataslice1,dataslice2,optional)` writes the data from structures `dataSlice1`, `dataSlice2`, and `optional` to an MSI planet antenna file called `fname`.

`msiwrite(objname,frequency,fname)` writes calculated data of an antenna or array object at a specified frequency to an MSI planet antenna file called `fname`.

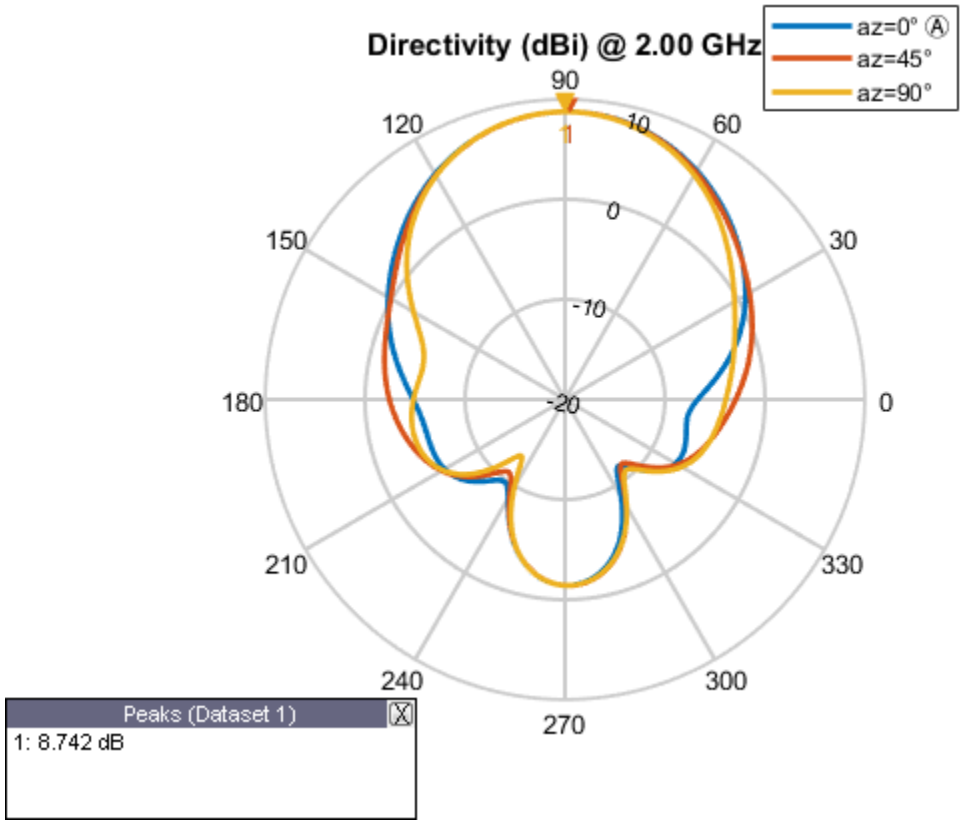
`msiwrite(objname,frequency,fname,Name,Value)` uses additional options specified by one or more `Name,Value` pair arguments.

Examples

Write and Read MSI Antenna Data File

Create a helix antenna and plot the elevation pattern at 2 GHz.

```
h = helix;
patternElevation(h,2e9,[0 45 90],'Elevation',0:1:360);
```



Write the elevation pattern of the helix antenna in an MSI Planet Antenna file.

```
msiwrite(h,2e9,'helix','Name','Helix Antenna Specifications')
```

The msiwrite function saves a file named helix.plnto the default MATLAB™ folder.

```
NAME Helix Antenna Specifications
FREQUENCY 2000.0
GAIN 8.74 dBi
HORIZONTAL 360
0.00 13.56
1.00 13.48
2.00 13.39
3.00 13.30
```

```
4.00 13.22
5.00 13.13
```

Read the MSI antenna data file created.

```
msiread helix.pln
```

```
ans =

  struct with fields:

    PhysicalQuantity: 'Gain'
           Magnitude: [360×1 double]
               Units: 'dBi'
             Azimuth: [360×1 double]
           Elevation: 0
           Frequency: 2.0000e+09
               Slice: 'Elevation'
```

- "Read, Visualize and Write MSI Planet Antenna Files"

Input Arguments

`fname` — Name of MSI file

`.pln` (default) | character vector

Name of MSI file, specified as a character vectorBy default, `msiwrite` writes the MSI planet antenna file that has a `.pln` format.

`dataslice1` — Horizontal or vertical gain data

structure

Horizontal or vertical gain data, specified as a structure containing the following fields:

- `PhysicalQuantity` — Measured quantity in the MSI file: `E-field`, `H-field`, `directivity`, `power`, `powerdB`, or, `gain`.
- `Magnitude` — Magnitude values of the measured quantity.
- `Units` — Units of the measured quantity.
- `Azimuth` — Azimuth angles.

- `Elevation` — Elevation angles.
- `Frequency` — Frequency of operation.
- `Slice` — Type of data set variation: `Azimuth`, or `Elevation`.

`dataslice2` — Horizontal or vertical gain data
structure

Horizontal or vertical gain data, specified as a structure containing the following fields:

- `PhysicalQuantity` — Measured quantity in the MSI file: `E-field`, `H-field`, `directivity`, `power`, `powerdB`, or, `gain`.
- `Magnitude` — Magnitude values of the measure quantity.
- `Units` — Units of the measured quantity.
- `Azimuth` — Azimuth angles.
- `Elevation` — Elevation angles.
- `Frequency` — Frequency of operation.
- `Slice` — Type of data set variation: `Azimuth`, or `Elevation`.

`optional` — Additional data
structure

Additional data, specified as a structure containing the following fields: `Name`, `Make`, `Frequency`, `H_width`, `V_width`, `Front_to_back`, `Gain`, `Tilt`, `Polarization`, `Comment`.

`objname` — Antenna or array object
antenna or array handle

Antenna or array object, specified as an antenna or array handle.

`frequency` — Frequency of operation of antenna or array object
positive numeric scalar

Frequency of operation of antenna or array object, specified as a positive numeric scalar.

Name-Value Pair Arguments

Specify optional comma-separated pairs of `Name,Value` arguments. `Name` is the argument name and `Value` is the corresponding value. `Name` must appear inside single

quotes (' '). You can specify several name and value pair arguments in any order as `Name1,Value1,...,NameN,ValueN`.

Example: `'Comment', 'horn antenna'`

`'Name'` — Title of file

character vector

Title of file in the first line, specified as the comma-separated pair consisting of `'Name'` and a character vector.

Example: `'Name', 'Designed Helix Antenna in MATLAB'`

Data Types: `char`

`'Comment'` — Comments about antenna or array data file

character array

Comments about an antenna or array data file, specified as the comma-separated pair consisting of `'Comment'` and a character array.

Example: `'Comment', 'This antenna is for space simulations.'`

Data Types: `char`

See Also

See Also

`msiread`

Topics

"Read, Visualize and Write MSI Planet Antenna Files"

Introduced in R2016a

dielectric

Dielectric material for use as substrate

Syntax

```
d = dielectric(material)
d = dielectric(Name,Value)
```

Description

`d = dielectric(material)` returns dielectric materials for use as a substrate in antenna elements.

`d = dielectric(Name,Value)` returns dielectric materials, based on the properties specified by one or more `Name,Value` pair arguments.

Examples

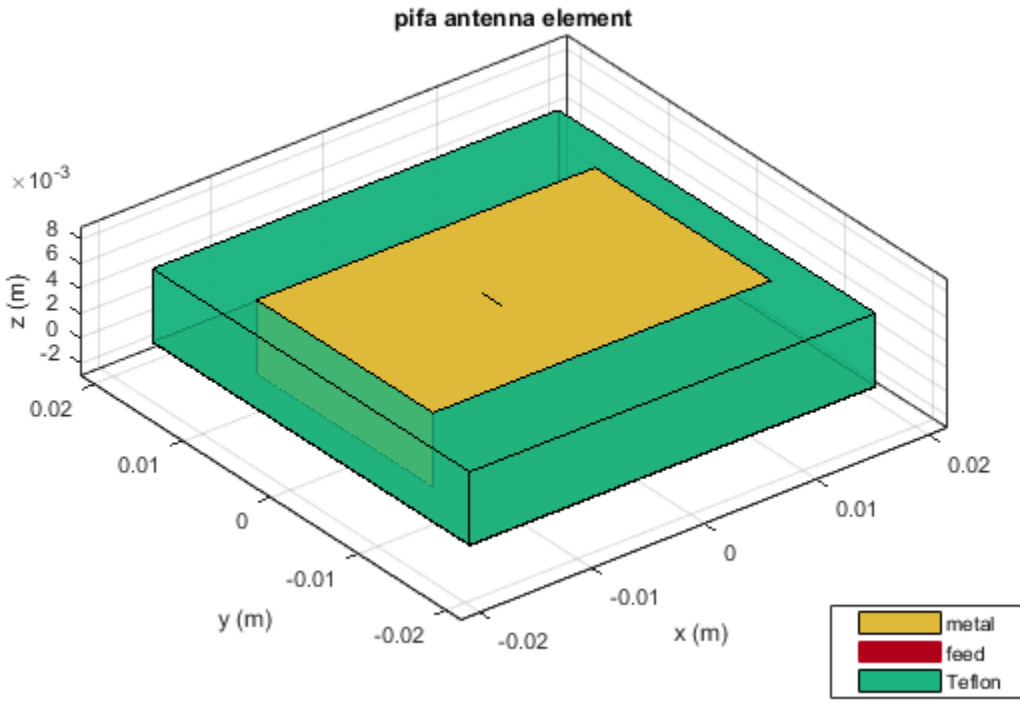
PIFA Antenna with Dielectric Substrate

Use a Teflon dielectric material as a substrate for a PIFA antenna. View the antenna.

```
d = dielectric('Teflon')
p = pifa('Height',0.0060,'Substrate',d)
show(p)
```

```
d =

  dielectric with properties:

          Name: 'Teflon'
      EpsilonR: 2.1000
    LossTangent: 2.0000e-04
      Thickness: 0.0060

For more materials see <a href="matlab:openDielectricCatalog">catalog</a>

p =
```

```
pifa with properties:

            Length: 0.0300
             Width: 0.0200
            Height: 0.0060
         Substrate: [1×1 dielectric]
  GroundPlaneLength: 0.0360
   GroundPlaneWidth: 0.0360
  PatchCenterOffset: [0 0]
      ShortPinWidth: 0.0200
         FeedOffset: [-0.0020 0]
               Tilt: 0
           TiltAxis: [1 0 0]
               Load: [1×1 lumpedElement]
```



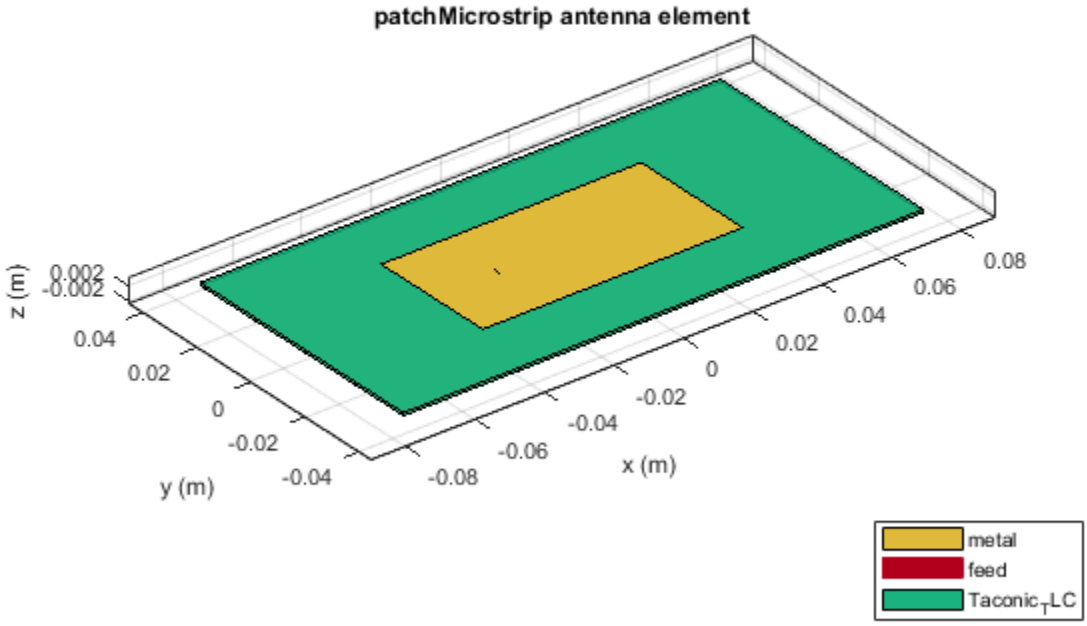
Custom Dielectric Properties

Create a patch microstrip antenna using a substrate with a relative permittivity of 2.70, a loss tangent of 0.002 and a thickness of 0.008 m. View the antenna.

```
t = dielectric('Name','Taconic_TLC','EpsilonR',2.70,'LossTangent',0.002,...
    'Thickness',0.0008);
p = patchMicrostrip('Height',0.0008,'Substrate',t)
show(p)
```

```
p =

  patchMicrostrip with properties:
```

```
           Length: 0.0750
            Width: 0.0375
           Height: 8.0000e-04
        Substrate: [1×1 dielectric]
GroundPlaneLength: 0.1500
 GroundPlaneWidth: 0.0750
PatchCenterOffset: [0 0]
       FeedOffset: [-0.0187 0]
             Tilt: 0
         TiltAxis: [1 0 0]
             Load: [1×1 lumpedElement]
```



Patch Antenna with Air Gap between Groundplane and Dielectric

Create a microstrip patch antenna.

```
p = patchMicrostrip;
```

```
For properties of air and teflon dielectrics use Dielectric Catalog.
```

```
openDielectricCatalog
```

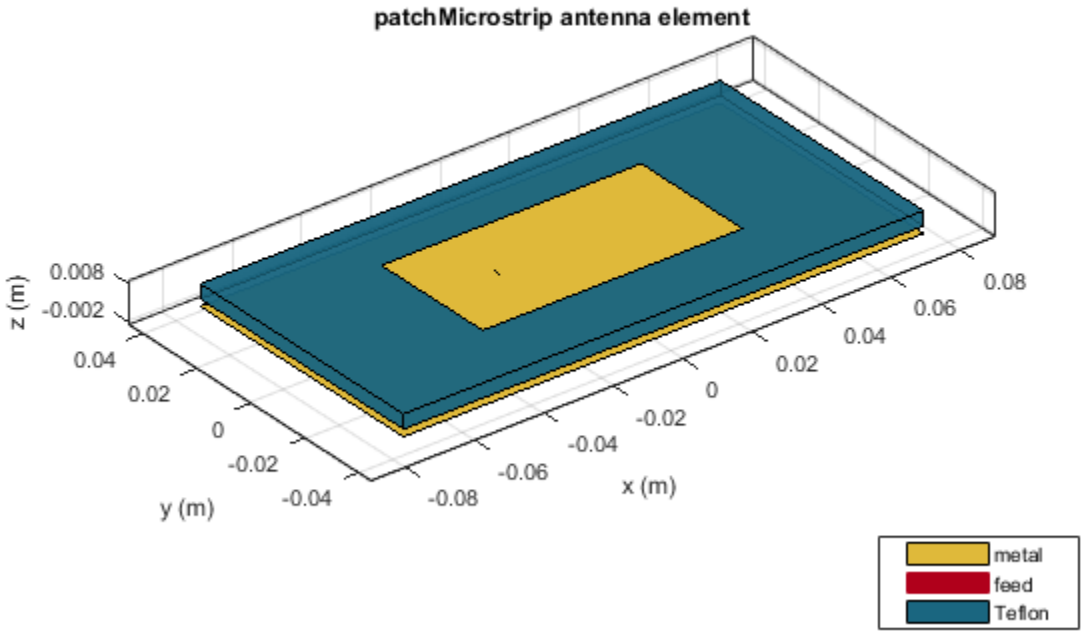
	Name	Relative_Permittivity	Loss_Tangent	Frequency	Comments
1	Air	1	0	1.0000e+009	
2	FR4	4.8000	0.0260	100.0000e+0...	
3	Teflon	2.1000	2.0000e-04	100.0000e+0...	
4	Foam	1.0300	1.5000e-04	50.0000e+006	
5	Polystyrene	2.5500	1.0000e-04	100.0000e+0...	
6	Plexiglas	2.5900	0.0068	10.0000e+009	
7	Fused quartz	3.7800	1.0000e-04	10.0000e+009	
8	E glass	6.2200	0.0023	100.0000e+0...	
9	RO4725JXR	2.5500	0.0022	2.5000e+009	
10	RO4730JXR	3	0.0023	2.5000e+009	
11	TMM3				

Use Teflon as a dielectric substrate.There is an air gap between the patch groundplane and the dielectric.

```
sub = dielectric('Name',{'Air','Teflon'},'EpsilonR',[1 2.1],...
    'Thickness',[.002 .004],'LossTangent',[0 2e-04]);
```

Add the substrate to the patch antenna.

```
p.Substrate = sub;
figure
show(p)
```



Three Layer Dielectric Substrate between Patch and Ground Plane

Create a microstrip patch antenna.

```
p = patchMicrostrip;
```

For dielectric properties, use the Dielectric Catalog.

```
openDielectricCatalog
```

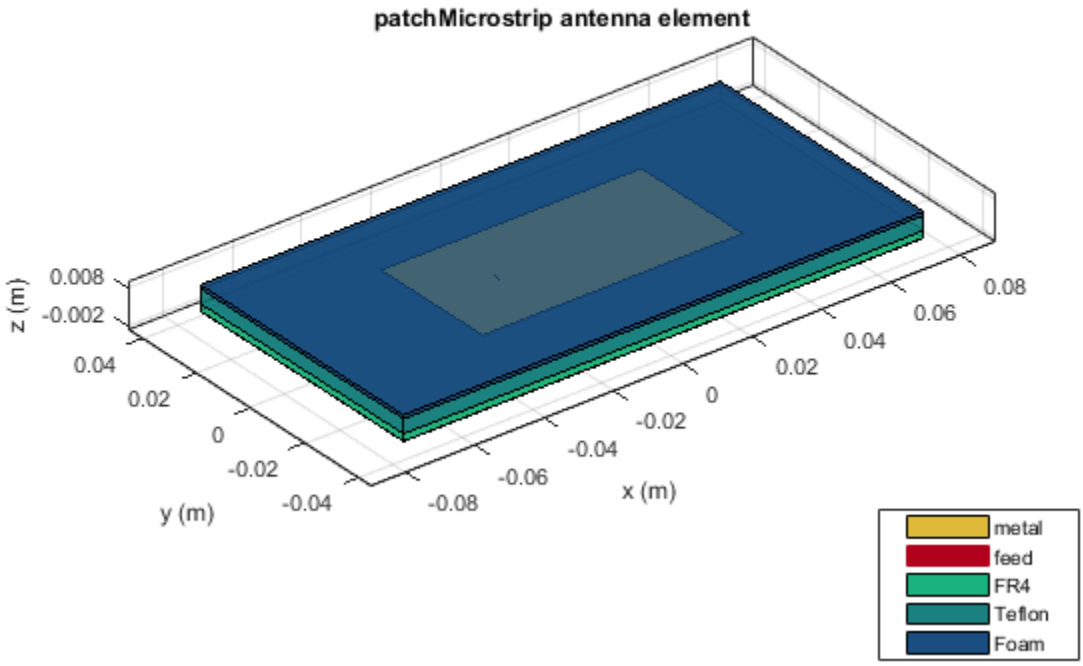
	Name	Relative_Permittivity	Loss_Tangent	Frequency	Comments
1	Air	1	0	1.0000e+009	
2	FR4	4.8000	0.0260	100.0000e+0...	
3	Teflon	2.1000	2.0000e-04	100.0000e+0...	
4	Foam	1.0300	1.5000e-04	50.0000e+006	
5	Polystyrene	2.5500	1.0000e-04	100.0000e+0...	
6	Plexiglas	2.5900	0.0068	10.0000e+009	
7	Fused quartz	3.7800	1.0000e-04	10.0000e+009	
8	E glass	6.2200	0.0023	100.0000e+0...	
9	RO4725JXR	2.5500	0.0022	2.5000e+009	
10	RO4730JXR	3	0.0023	2.5000e+009	
11	TMM3	3.4500	0.0020	10.0000e+009	

Use FR4, Teflon and Foam as the three layers of the substrate.

```
sub = dielectric('Name',{'FR4','Teflon','Foam'},'EpsilonR',...
    [4.80 2.10 1.03],'Thickness',[0.002 0.004 0.001],...
    'LossTangent',[0.0260 2e-04 1.5e-04]);
```

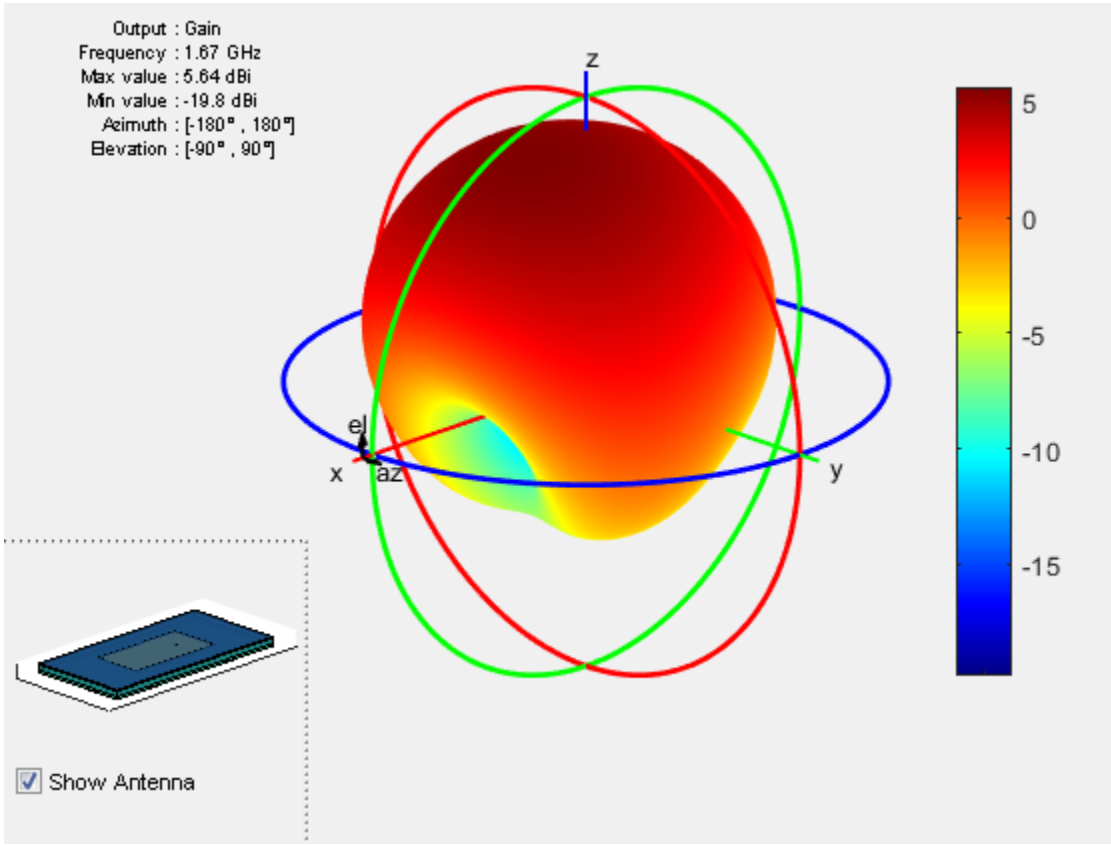
Add the three layer substrate to the patch antenna.

```
p.Substrate = sub;
figure
show(p)
```



Plot the radiation pattern of the antenna.

```
figure
pattern(p,1.67e9)
```



Infinite Reflector Backed Dielectric Substrate Antenna

Design a dipole antenna backed by a dielectric substrate and an infinite reflector.

Create a dipole antenna of length, 0.15 m, and width, 0.015 m.

```
d = dipole('Length',0.15,'Width',0.015, 'Tilt',90,'TiltAxis',[0 1 0]);
```

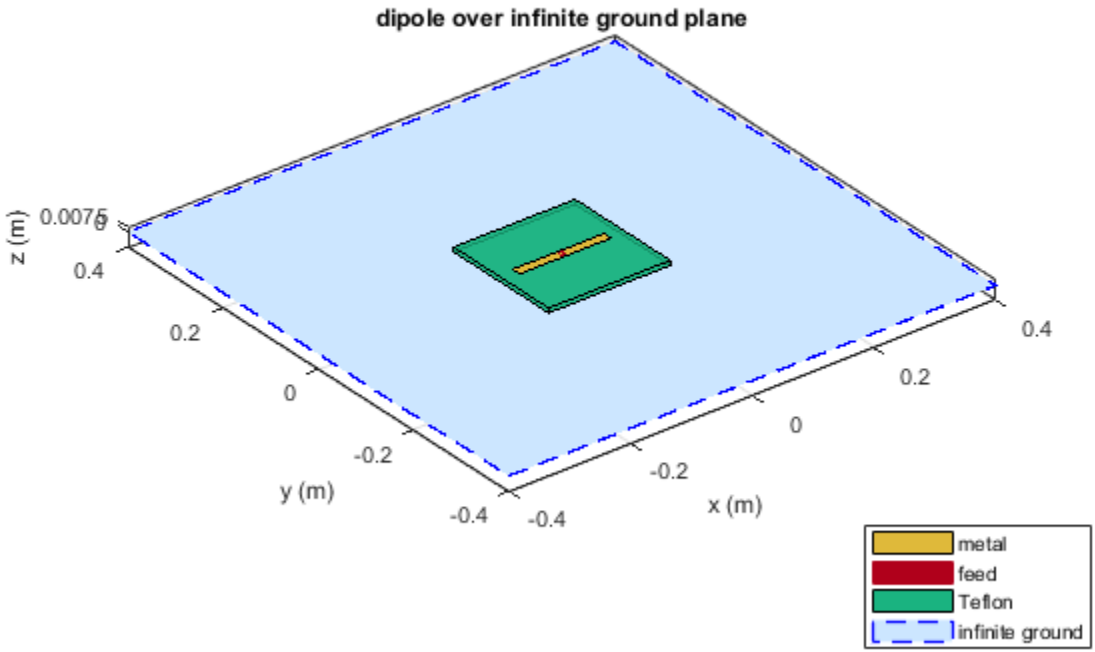
Create a reflector using the dipole antenna as an exciter and the diecltric, `teflon` as the substrate.

```
t = dielectric('Teflon')
rf = reflector('Exciter',d,'Spacing',7.5e-3,'Substrate',t);
```

```
t =

  dielectric with properties:

          Name: 'Teflon'
       EpsilonR: 2.1000
    LossTangent: 2.0000e-04
      Thickness: 0.0060

For more materials see <a href="matlab:openDielectricCatalog">catalog</a>
```

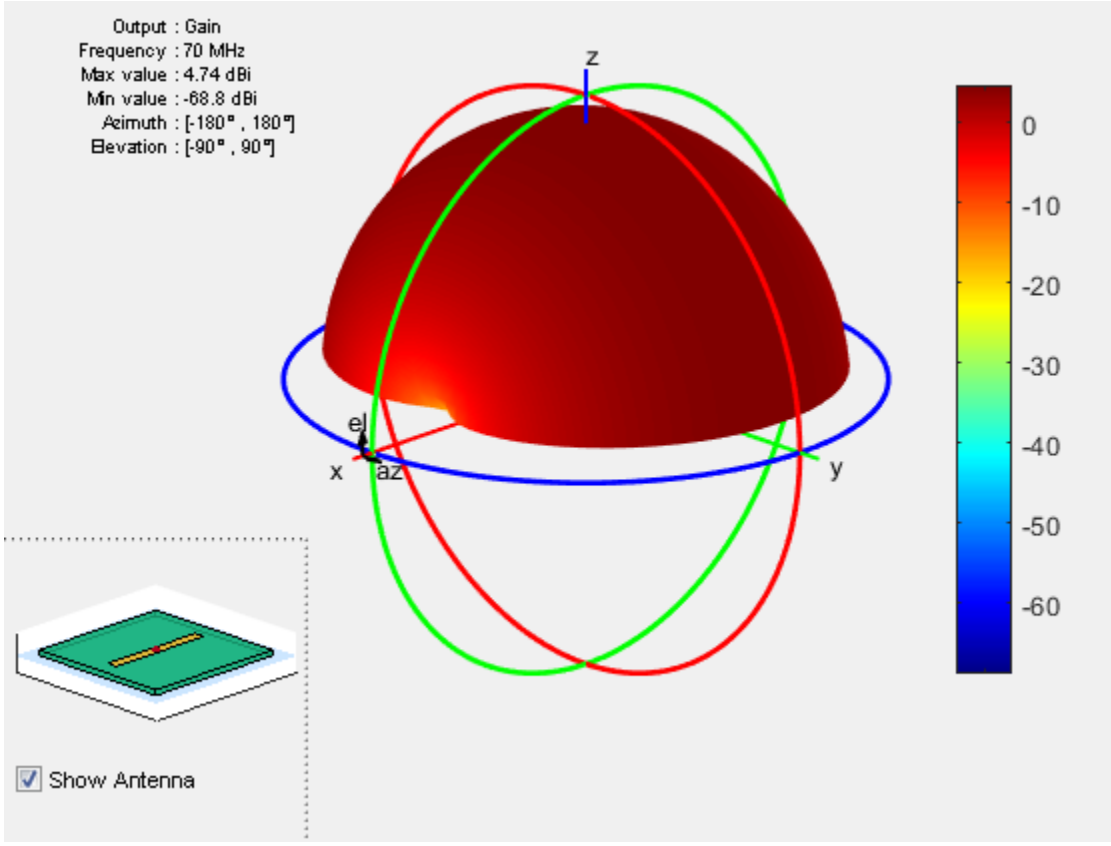
Set the groundplane length of the reflector to `inf`. View the structure.

```
rf.GroundPlaneLength = inf;
show(rf)
```



Calculate the radiation pattern of the antenna at 70 MHz.

```
pattern(rf,70e6)
```



Antenna On Dilectric Substrate - Compare Gain Values

Compare the gain values of a dipole antenna in free space and dipole antenna on a substrate.

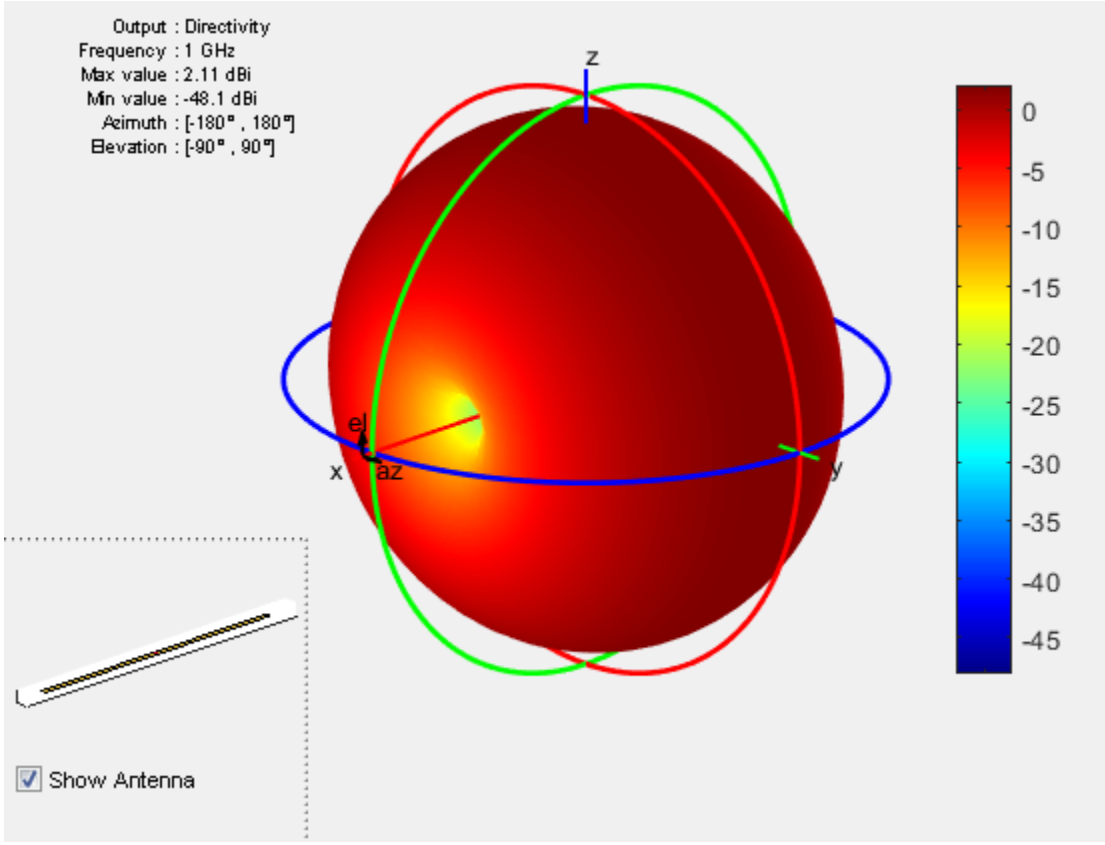
Design a dipole antenna at 1 GHz.

```
d = design(dipole,1e9);
l_by_w = d.Length/d.Width;
```

```
d.Tilt = 90;
d.TiltAxis = [0 1 0];
```

Plot the radiation pattern of the dipole in free space at 1GHz.

```
figure
pattern(d,1e9);
```



Use FR4 as the dielectric substrate.

```
t = dielectric('FR4')
eps_r = t.EpsilonR;
lambda_0 = physconst('lightspeed')/1e9;
```

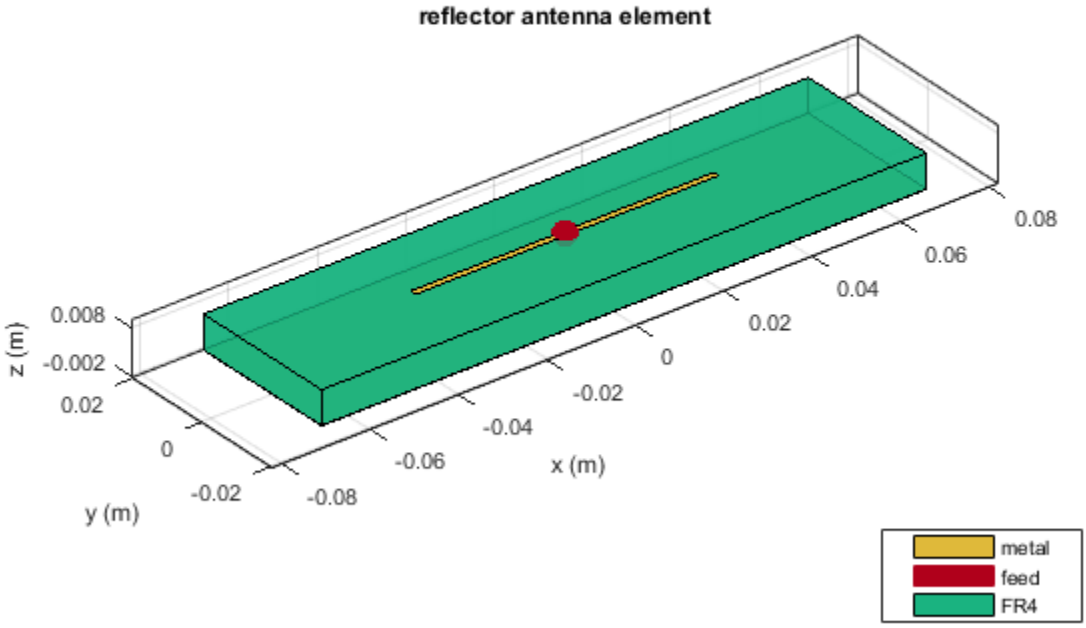
```
lambda_d = lambda_0/sqrt(eps_r);


t =

  dielectric with properties:

          Name: 'FR4'
       EpsilonR: 4.8000
    LossTangent: 0.0260
      Thickness: 0.0060

For more materials see <a href="matlab:openDielectricCatalog">catalog</a>
```

Adjust the length of the dipole based on the wavelength.

```
d.Length = lambda_d/2;
d.Width = d.Length/l_by_w;
```

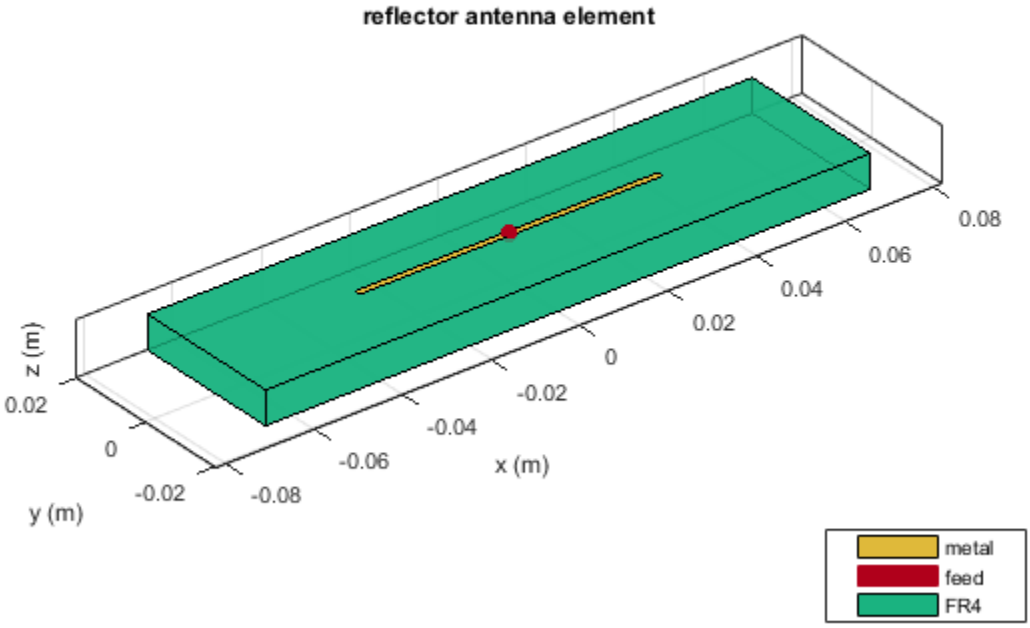
Design a reflector at 1 GHz with the dipole as the excitor and FR4 as the substrate.

```
rf = design(reflector,1e9);
rf = reflector('Exciter',d,'Spacing',7.5e-3,'Substrate',t);
rf.GroundPlaneLength = lambda_d;
rf.GroundPlaneWidth = lambda_d/4;
figure
show(rf)
```



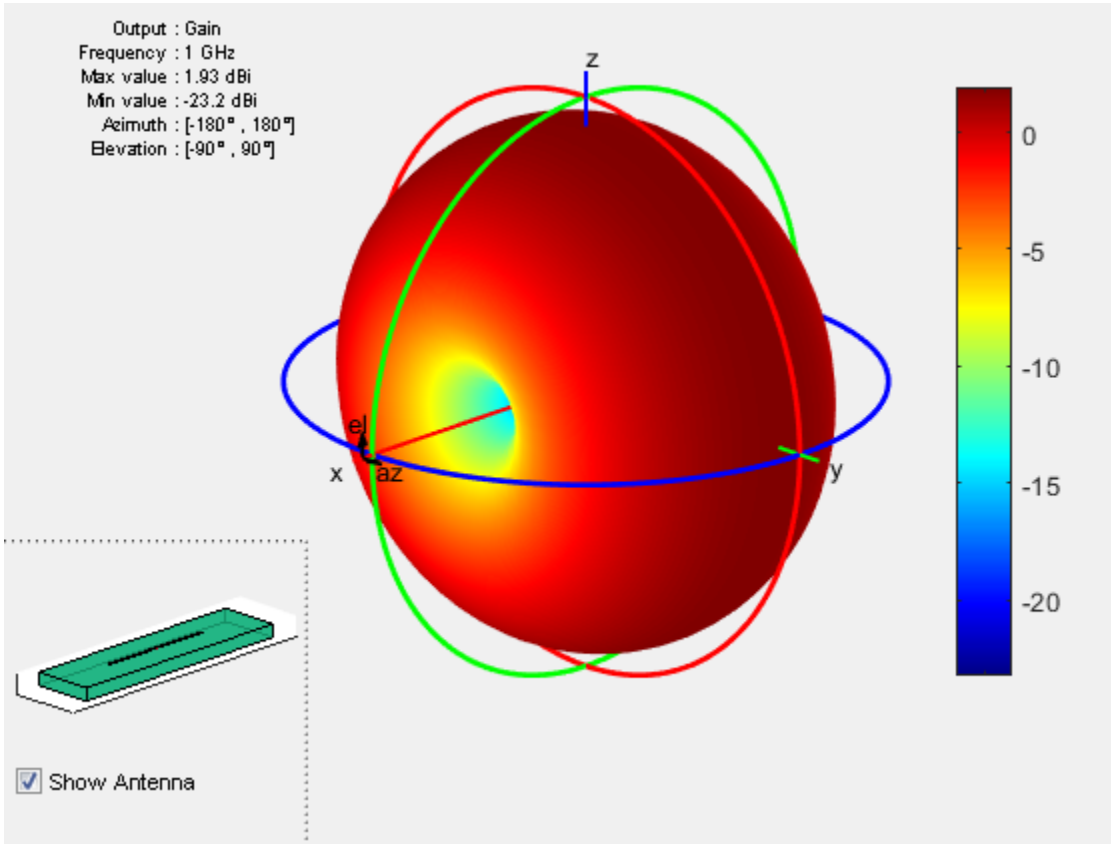
Remove the groundplane for plotting the gain of the dipole on the substrate.

```
rf.GroundPlaneLength = 0;
show(rf)
```



Plot the radiation pattern of the dipole on the substrate at 1 GHz.

```
figure
pattern(rf,1e9);
```



Compare the gain vlaues.

- Gain of the dipole in free space = 2.11 dBi
- Gain of the dipole on substrate = 1.93 dBi

Input Arguments

`material` — Material from dielectric catalog

`'Air'` (default)

Material from the dielectric catalog, specified as one of the values from the `DielectricCatalog`.

Example: 'FR4'

Data Types: char

Name-Value Pair Arguments

Specify optional comma-separated pairs of Name,Value arguments. Name is the argument name and Value is the corresponding value. Name must appear inside single quotes (' '). You can specify several name and value pair arguments in any order as Name1,Value1,...,NameN,ValueN.

Example: 'Name','Air'

'Name' — Name of dielectric material

character vector

Name of the dielectric material you want to specify in the output, specified as the comma-separated pair consisting of 'Name' and a character vector.

Example: 'Name','Taconic_TLC'

Data Types: char

'EpsilonR' — Relative permittivity of dielectric material

1 | vector

Relative permittivity of the dielectric material, specified as the comma-separated pair consisting of 'EpsilonR' and vector.

Example: 'EpsilonR',4.8000

Data Types: double

'LossTangent' — Loss in dielectric material

0 (default) | vector

Loss in the dielectric material, specified as the comma-separated pair consisting of 'LossTangent' and vector.

Example: 'LossTangent',0.0260

Data Types: double

'Thickness' — Thickness of dielectric material

0.0060 (default) | vector in meters

Thickness of the dielectric material along default z-axis, specified as the comma-separated pair consisting of `'Thickness'` and vector in meters. This property applies only when you call the function with no output arguments.

Example: `'Thickness', 0.05`

Data Types: `double`

Output Arguments

d — Dielectric material

object handle

Dielectric material, returned as an object handle. You can use the dielectric material object handle to add dielectric material to an antenna.

See Also

See Also

`DielectricCatalog`

Topics

"Antenna Toolbox Limitations"

Introduced in R2016a

DielectricCatalog

Catalog of dielectric materials

Syntax

```
dc = DielectricCatalog
```

Description

`dc = DielectricCatalog` creates an object handle for the dielectric catalog.

- To open the dielectric catalog, use `open(dc)`
- To know the properties of a dielectric material from the dielectric catalog, use `s = find(dc,name)`.

Examples

Use Dielectric Catalog Element in Cavity

Open the dielectric catalog.

```
dc = DielectricCatalog;
open(dc)
```

	Name	Relative_Permittivity	Loss_Tangent	Frequency	Comments
1	Air	1	0	1.0000e+009	
2	FR4	4.8000	0.0260	100.0000e+0...	
3	Teflon	2.1000	2.0000e-04	100.0000e+0...	
4	Foam	1.0300	1.5000e-04	50.0000e+006	
5	Polystyrene	2.5500	1.0000e-04	100.0000e+0...	
6	Plexiglas	2.5900	0.0068	10.0000e+009	
7	Fused quartz	3.7800	1.0000e-04	10.0000e+009	
8	E glass	6.2200	0.0023	100.0000e+0...	
9	RO4725JXR	2.5500	0.0022	2.5000e+009	
10	RO4730JXR	3	0.0023	2.5000e+009	
11	TMM3	3.4500	0.0020	10.0000e+009	

List the properties of the dielectric material `Foam`.

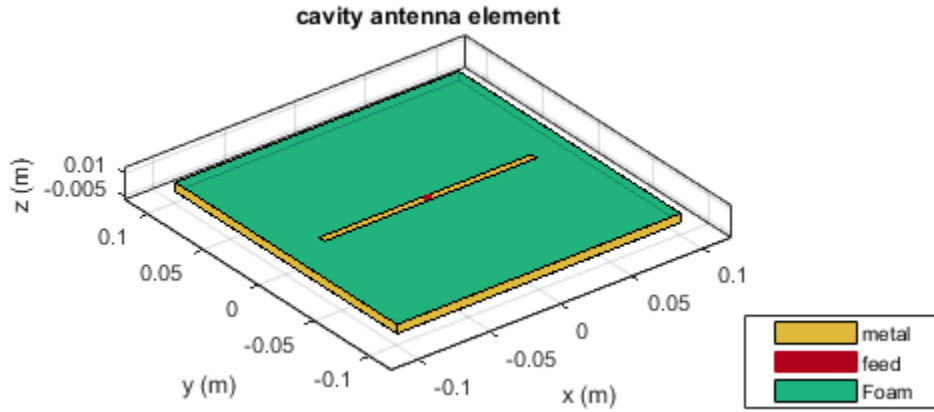
```
s = find(dc,'Foam')
```

```
s =

  struct with fields:

                    Name: 'Foam'
    Relative_Permittivity: 1.0300
             Loss_Tangent: 1.5000e-04
                Frequency: 50000000
                 Comments: ''
```

Use the material Foam as a dielectric in a cavity antenna of height and spacing, 0.0060 m.

```
d = dielectric('Foam');
c = cavity('Height',0.0060,'Spacing',0.0060,'Substrate',d)
show (c)
```

```
c =

  cavity with properties:

            Exciter: [1×1 dipole]
          Substrate: [1×1 dielectric]
             Length: 0.2000
              Width: 0.2000
             Height: 0.0060
            Spacing: 0.0060
      EnableProbeFeed: 0
               Tilt: 0
           TiltAxis: [1 0 0]
               Load: [1×1 lumpedElement]
```



Input Arguments

name — Name of dielectric material

`'Air'` (default) | character vector

Name of a dielectric material from the dielectric catalog, specified as a character vector.

Example: `'FR4'`

Data Types: `char`

dc — Dielectric catalog

object handle

Dielectric catalog, specified as an object handle.

Data Types: `char`

Output Arguments

dc — Dielectric catalog

object handle

Dielectric catalog, returned as an object handle.

s — Parameters of dielectric material
structure

Parameters of a dielectric material from the dielectric catalog, returned as a structure.

See Also

See Also
`dielectric`

Introduced in R2016a

hornangle2size

Equivalent flare width and height from flare angles

Syntax

```
[flarewidth,flareheight]= horn2angle(width,height,flarelength,
angleE,angleH)
```

Description

`[flarewidth,flareheight]= horn2angle(width,height,flarelength, angleE,angleH)` calculates the equivalent `flarewidth` and `flareheight` for a rectangular horn antenna from its flare angles, `angleE`, and `angleH`.

Examples

Calculate Flare Width and Flare Height of Horn Antenna

Calculate the flare width and the flare height of a horn antenna with

- Width of the waveguide = 0.0229 m
- Height of the waveguide = 0.0102 m
- Flare length of the horn = 0.2729 m
- Flare angle in the E-plane = 12.2442 degrees
- Flare angle in the H-plane = 14.4712 degrees

```
width = 0.0229;
height = 0.0102;
flarelength = 0.2729;
angleE = 12.2442;
angleH = 14.4712;
[flarewidth,flareheight] = hornangle2size(width,height,flarelength,...
                           angleE,angleH)
```

```
flarewidth =

    0.1638


flareheight =

    0.1286
```

Input Arguments

`width` — Rectangular waveguide width

scalar in meters

Rectangular waveguide width, specified as the comma-separated pair consisting of `'Width'` and a scalar in meters.

Data Types: `double`

`height` — Rectangular waveguide height

scalar in meters

Rectangular waveguide height, specified as the comma-separated pair consisting of `'Height'` and a scalar in meters.

Data Types: `double`

`flarelength` — Flare length of horn

scalar in meters

Flare length of horn, specified as the comma-separated pair consisting of `'FlareLength'` and a scalar in meters.

Data Types: `double`

`angleE` — Flare angle in E-plane

scalar in degrees

Flare angle in E-plane of the horn, specified as a scalar in degrees.

Data Types: `double`

`angleH` — Flare angle in H-plane

scalar in meters

Flare angle in H-plane of the horn, specified as a scalar in degrees.

Data Types: `double`

Output Arguments

`flarewidth` — Flare width of horn

scalar in meters

Flare width of horn, returned as a scalar in meters.

Data Types: `double`

`flareheight` — Flare height of horn

scalar in meters

Flare height of horn, returned as a scalar in meters.

Data Types: `double`

See Also

Introduced in R2016a

add

Class: polarpattern

Add data to polar plot

Syntax

```
add(p,d)
add(p,angle,magnitude)
```

Description

`add(p,d)` adds new antenna data to the polar plot, `p` based on the real amplitude values, `data`.

`add(p,angle,magnitude)` adds data sets of `angle` vectors and corresponding `magnitude` matrices to polar plot `p`.

Input Arguments

`p` — Polar plot

scalar handle

Polar plot, specified as a scalar handle.

`data` — Antenna or array data

real length-*M* vector | real *M*-by-*N* matrix | real *N*-*D* array | complex vector or matrix

Antenna or array data, specified as one of the following:

- A real length-*M* vector, where *M* contains the magnitude values with angles assumed to be $\frac{(0:M-1)}{M}\times 360^{\circ}$ degrees.

- A real *M*-by-*N* matrix, where *M* contains the magnitude values and *N* contains the independent data sets. Each column in the matrix has angles taken from the vector $\frac{(0:M-1)}{M}\times 360^{\circ}$ degrees. The set of each angle can vary for each column.
- A real *N*-*D* array, where *N* is the number of dimensions. Arrays with dimensions `2` and greater are independent data sets.
- A complex vector or matrix, where `data` contains Cartesian coordinates (*(x,y)* of each point. *x* contains the real part of `data` and *y* contains the imaginary part of `data`.

When data is in a logarithmic form such as dB, magnitude values can be negative. In this case,`polarpattern` plots the lowest magnitude values at the origin of the polar plot and highest magnitude values at the maximum radius.

`angle` — Set of angles

vector in degrees

Set of angles, specified as a vector in degrees.

`magnitude` — Set of magnitude values

vector | matrix

Set of magnitude values, specified as a vector or a matrix. For a matrix of magnitude values, each column is an independent set of magnitude values and corresponds to the same set of angles.

Examples

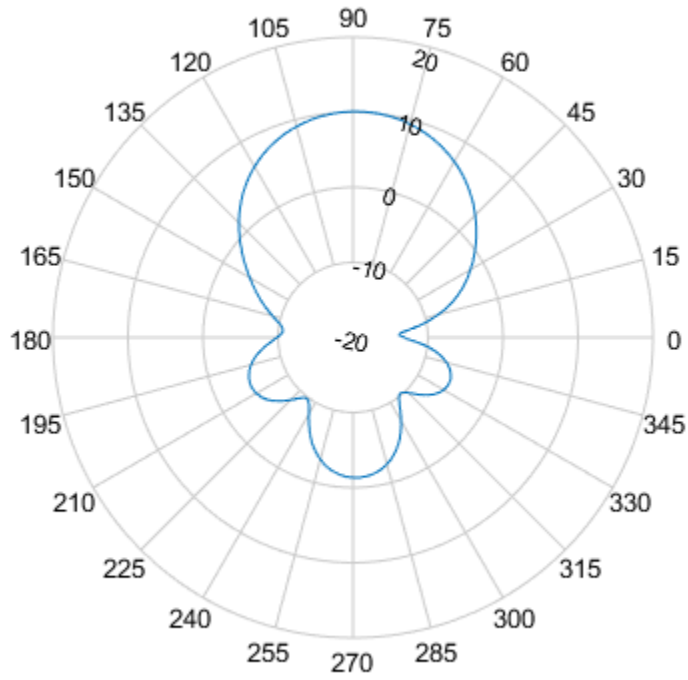
Add Data To Polar Plot

Create a helix antenna that has 28 mm radius, a 1.2 mm width, and 4 turns. Calculate the directivity of the antenna at 1.8 GHz.

```
hx = helix('Radius',28e-3,'Width',1.2e-3,'Turns',4);
H = pattern(hx, 1.8e9,0,0:1:360);
```

Plot the polar pattern.

```
P = polarpattern(H);
```

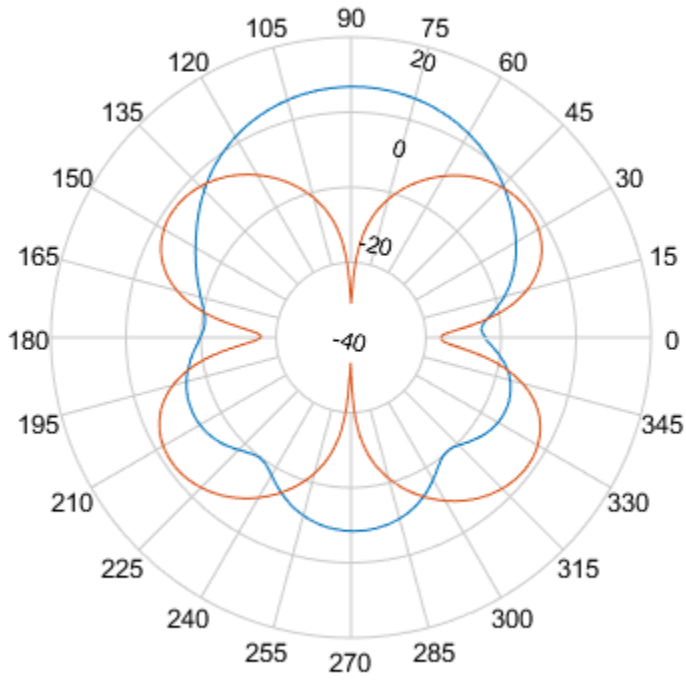


Create a dipole antenna and calculate the directivity at 270 MHz.

```
d = dipole;
D = pattern(d,270e6,0,0:1:360);
```

Add the directivity of the dipole to the existing polar plot of helix antenna.

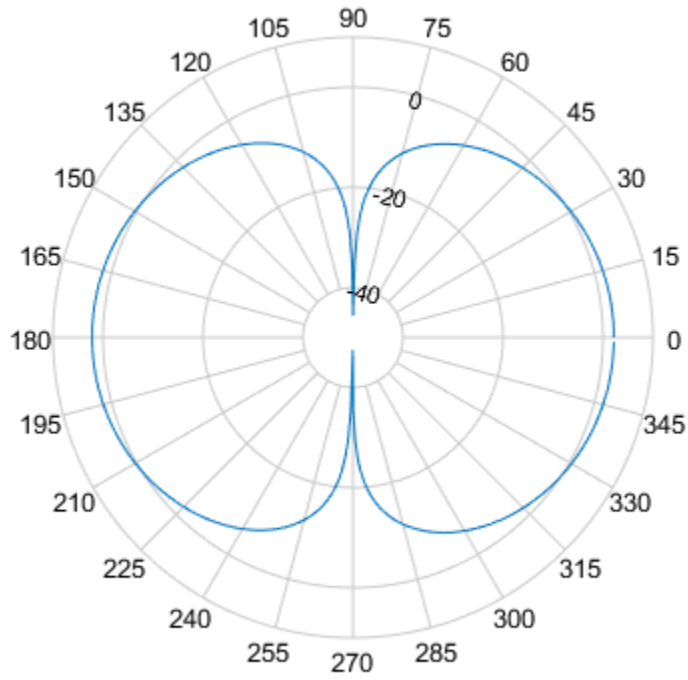
```
add(P,D);
```



Add Angle and Magnitude Data to Polar Pattern

Create a dipole and plot the polar pattern of its directivity at 75 MHz.

```
d = dipole;
D = pattern(d,75e6,0,0:1:360);
P = polarpattern(D);
```



Create a cavity antenna. Calculate the directivity of the antenna at 1 GHz. Write the directivity of the antenna to `cavity.pln` using the msiwrite function.

```
c = cavity;
msiwrite(c,1e9,'cavity','Name','Cavity Antenna Specifications');
```

Read the data from `cavity.pln` to `Horizontal`, `Vertical` and `Optional` structures using the msiread function.

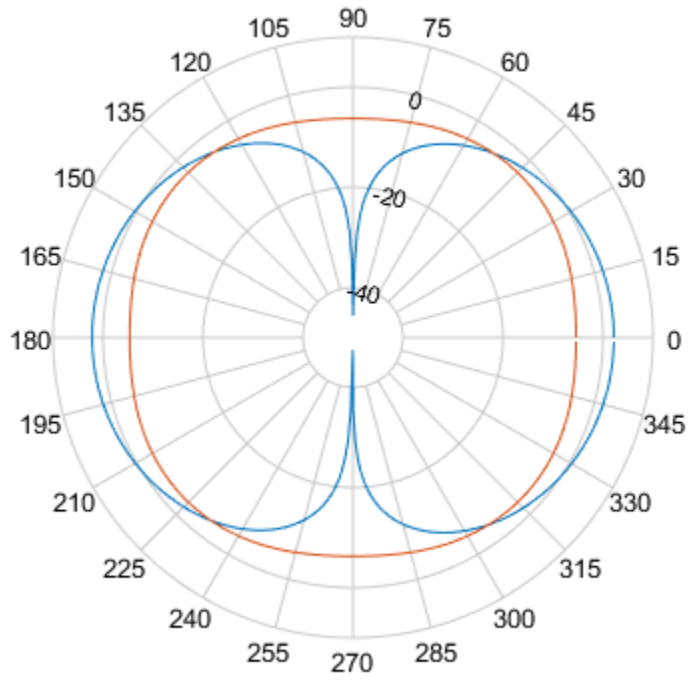
```
[Horizontal,Vertical,Optional] = msiread('cavity.pln')
```

```
Horizontal =
```

```
  struct with fields:

    PhysicalQuantity: 'Gain'
           Magnitude: [360×1 double]
               Units: 'dBi'
             Azimuth: [360×1 double]
           Elevation: 0
           Frequency: 1.0000e+09
               Slice: 'Elevation'


Vertical =

  struct with fields:

    PhysicalQuantity: 'Gain'
           Magnitude: [360×1 double]
               Units: 'dBi'
             Azimuth: 0
           Elevation: [360×1 double]
           Frequency: 1.0000e+09
               Slice: 'Azimuth'


Optional =

  struct with fields:

         name: 'Cavity Antenna Specifications'
    frequency: 1.0000e+09
         gain: [1×1 struct]
```

Add horizontal directivity data of the cavity antenna to the exisiting polar pattern of the dipole.

```
add(P,Horizontal.Azimuth,Horizontal.Magnitude);
```



See Also

See Also

`addCursor` | `animate` | `createLabels` | `findLobes` | `replace` | `showPeaksTable` | `showSpan`

Introduced in R2016a

addCursor

Class: polarpattern

Add cursor to polar plot angle

Syntax

```
addCursor(p,angle)
addCursor(p,angle,index)
id = addCursor( ___ )
```

Description

`addCursor(p,angle)` adds a cursor to the active polar plot, `p`, at the data point closest to the specified `angle`. Angle units are in degrees.

The first cursor added is called `'C1'`, the second `'C2'`, and so on.

`addCursor(p,angle,index)` adds a cursor at a specified data set `index`. `index` can be a vector of indices.

`id = addCursor( ___ )` returns a cell array with one ID for each cursor created. You can specify any of the arguments from the previous syntaxes.

Input Arguments

`p` — Polar plot

scalar handle

Polar plot, specified as a scalar handle.

`angle` — Angle values

scalar in degrees | vector in degrees

Angle values at which the cursor is added, specified as a scalar or a vector in degrees.

`index` — Data set index
scalar | vector

Data set index, specified as a scalar or a vector.

Examples

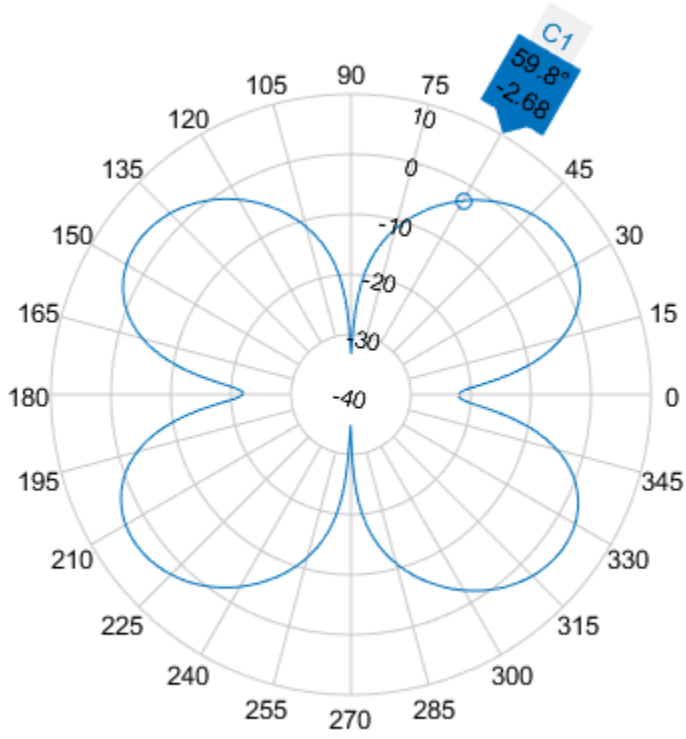
Add Cursor to Plot

Create a dipole antenna and calculate its directivity at 270 MHz.

```
d = dipole;
D = pattern(d,270e6,0,0:1:360);
```

Add a cursor to the polar plot at approximately 60 degrees.To place the cursor at 60 degrees, move it there by placing the pointer on the cursor and dragging.

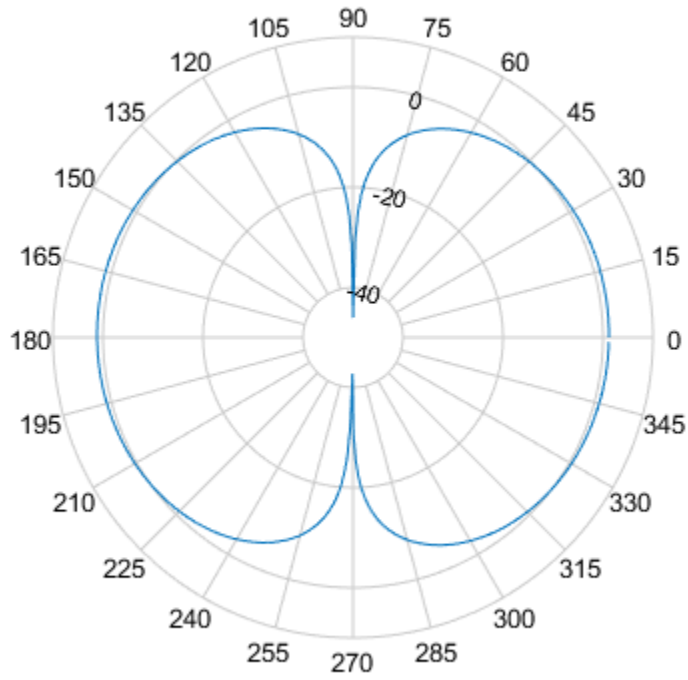
```
p = polarpattern(D);
addCursor(p,60);
```



Add Cursors to Two Data Sets

Create a top-hat monopole and plot its directivity at 75 MHz.

```
m = monopoleTopHat;
M = pattern(m,75e6,0,0:1:360);
P = polarpattern(M);
```

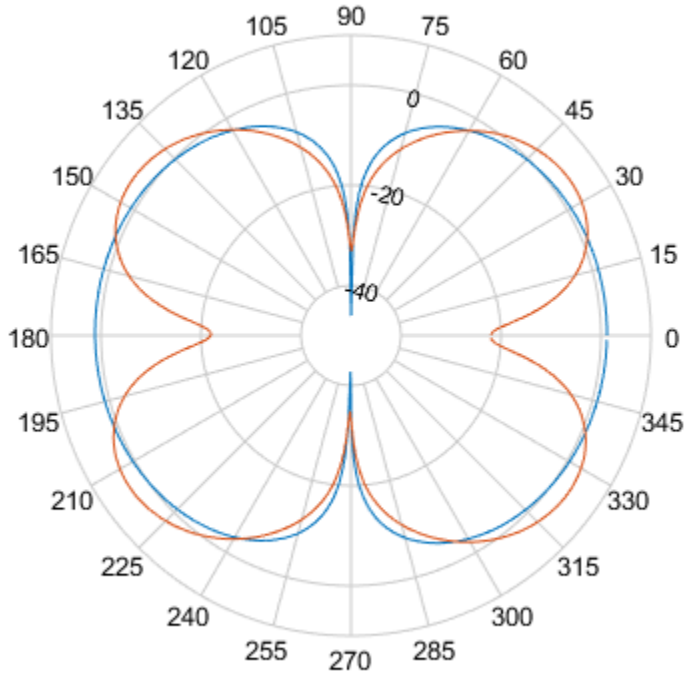


Create a dipole antenna and calculate its directivity at 270 MHz.

```
d = dipole;
D = pattern(d,270e6,0,0:1:360);
```

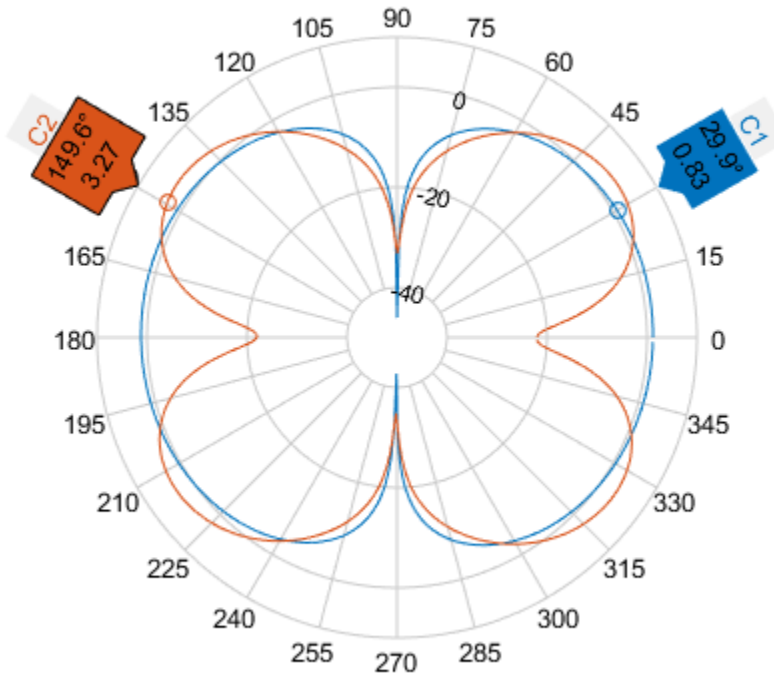
Add the directivity pattern of the dipole to the polar plot of the top-hat monopole.

```
add(P,D);
```



Add a cursor at approximately 30 degrees to the top-hat monopole polar pattern (data set 1) and at approximately 150 degrees to the dipole polar pattern (data set 2).

```
addCursor(P,[30 150],[1 2]);
```



See Also

See Also

`add` | `animate` | `createLabels` | `findLobes` | `replace` | `showPeaksTable` | `showSpan`

Introduced in R2016a

animate

Class: polarpattern

Replace existing data with new data for animation

Syntax

```
animate(p,data)
animate(p,angle,magnitude)
```

Description

`animate(p,data)` removes all the current data from polar plot, `p` and adds new data, based on real amplitude values, `data`.

`animate(p,angle,magnitude)` removes all the current data polar plot, `p` and adds new data sets of angle vectors and corresponding magnitude matrices.

Input Arguments

p — Polar plot

scalar handle

Polar plot, specified as a scalar handle.

data — Antenna or array data

real length-*M* vector | real *M*-by-*N* matrix | real *N*-*D* array | complex vector or matrix

Antenna or array data, specified as one of the following:

- A real length-*M* vector, where *M* contains the magnitude values with angles assumed to be $\frac{(0:M-1)}{M}\times 360^{\circ}$ degrees.

- A real *M*-by-*N* matrix, where *M* contains the magnitude values and *N* contains the independent data sets. Each column in the matrix has angles taken from the vector $\frac{(0:M-1)}{M}\times 360^\circ$ degrees. The set of each angle can vary for each column.
- A real *N*-*D* array, where *N* is the number of dimensions. Arrays with dimensions `2` and greater are independent data sets.
- A complex vector or matrix, where `data` contains Cartesian coordinates (*(x,y)* of each point. *x* contains the real part of `data` and *y* contains the imaginary part of `data`.

When data is in a logarithmic form such as dB, magnitude values can be negative. In this case,`polarpattern` plots the lowest magnitude values at the origin of the polar plot and highest magnitude values at the maximum radius.

`angle` — Set of angles

vector in degrees

Set of angles, specified as a vector in degrees.

`magnitude` — Set of magnitude values

vector | matrix

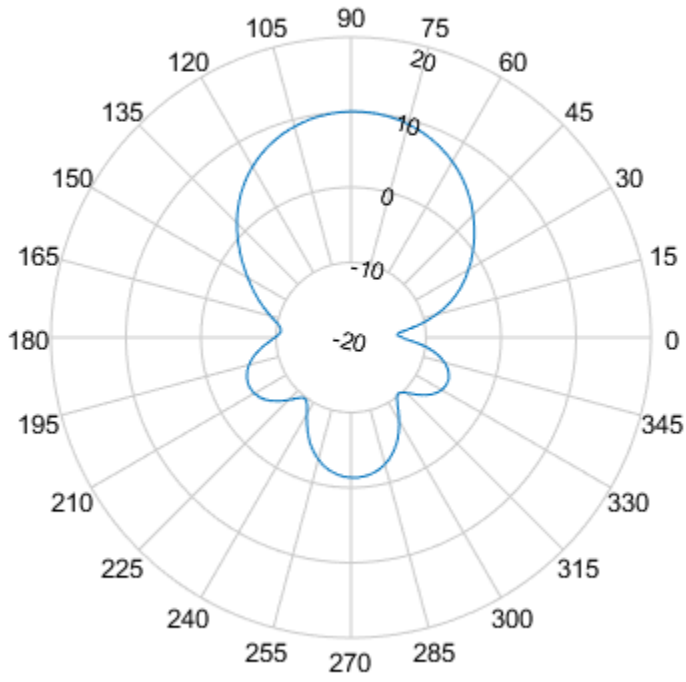
Set of magnitude values, specified as a vector or a matrix. For a matrix of magnitude values, each column is an independent set of magnitude values and corresponds to the same set of angles.

Examples

Replace Existing Polar Plot Data For Animation

Create a helix antenna that has a 28 mm radius, a 1.2 mm width, and 4 turns. Plot the directivity of the antenna at 1.8 GHz.

```
hx = helix('Radius',28e-3,'Width',1.2e-3,'Turns',4);
H = pattern(hx, 1.8e9,0,0:1:360);
P = polarpattern(H);
```

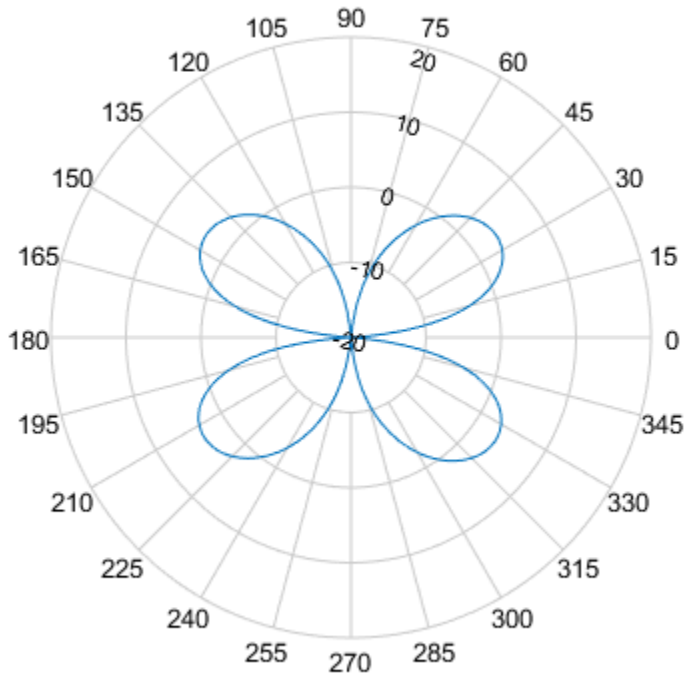


Create a dipole antenna and calculate its directivity at 270 MHz.

```
d = dipole;
D = pattern(d,270e6,0,0:1:360);
```

Replace the existing polar plot of the helix antenna with the directivity of the dipole using the `animate` method.

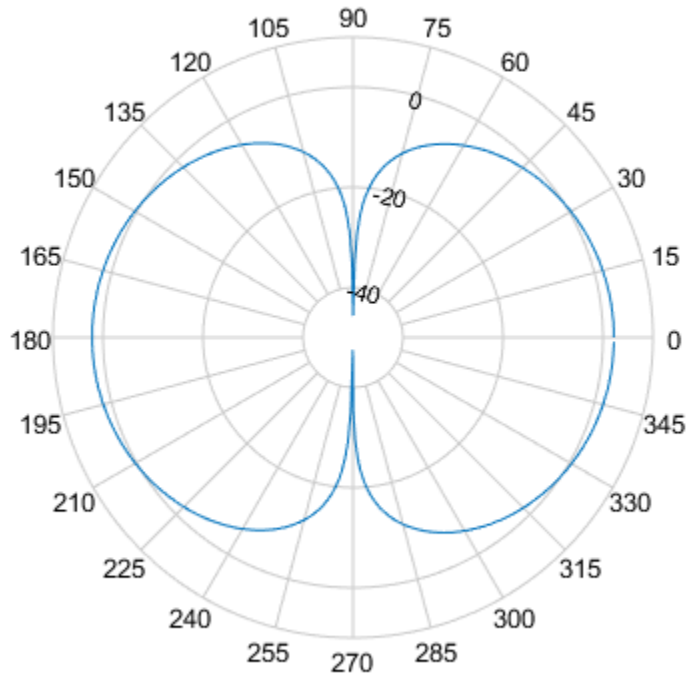
```
animate(P,D);
```



Animate Using Cavity Data

Create a default dipole antenna and plot the polar pattern of its directivity at 1 GHz.

```
d = dipole;
D = pattern(d,75e6,0,0:1:360);
P = polarpattern(D);
```



Create a default cavity antenna. Calculate the directivity of the antenna and write the data to `cavity.pln` using the msiwrite function.

```
c = cavity;
msiwrite(c,2.8e9,'cavity','Name','Cavity Antenna Specifications');
```

Read the cavity specifications file into `Horizontal`, `Vertical` and `Optional` structures using the msiread function.

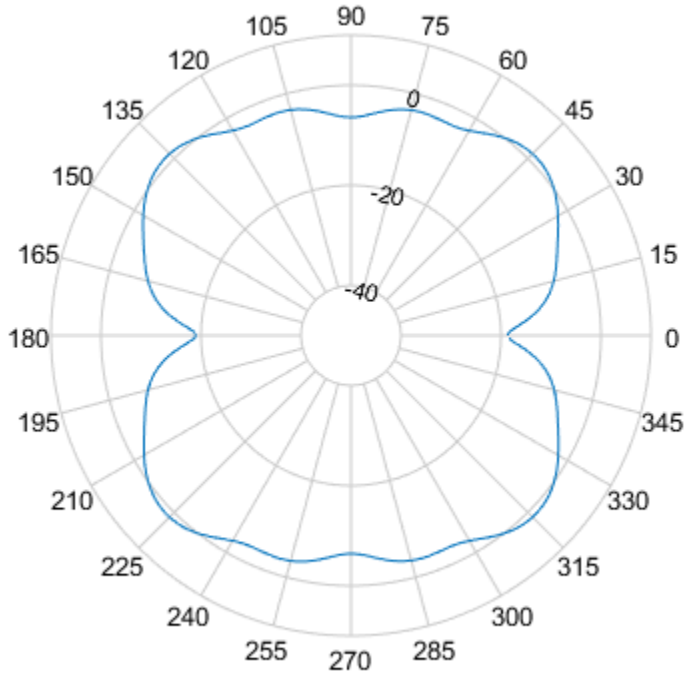
```
[Horizontal,Vertical,optional]= msiread('cavity.pln')
```

```
Horizontal =
```

```
  struct with fields:

    PhysicalQuantity: 'Gain'
           Magnitude: [360×1 double]
               Units: 'dBi'
             Azimuth: [360×1 double]
           Elevation: 0
           Frequency: 2.8000e+09
               Slice: 'Elevation'


Vertical =

  struct with fields:

    PhysicalQuantity: 'Gain'
           Magnitude: [360×1 double]
               Units: 'dBi'
             Azimuth: 0
           Elevation: [360×1 double]
           Frequency: 2.8000e+09
               Slice: 'Azimuth'


optional =

  struct with fields:

         name: 'Cavity Antenna Specifications'
    frequency: 2.8000e+09
         gain: [1×1 struct]
```

Replace data from the dipole antenna with data from cavity antenna.

```
animate(P,Horizontal.Azimuth,Horizontal.Magnitude);
```



See Also

See Also

`add` | `addCursor` | `createLabels` | `findLobes` | `replace` | `showPeaksTable` | `showSpan`

Introduced in R2016a

createLabels

Class: polarpattern

Create legend labels for polar plot

Syntax

```
createLabels(p,format,array)
```

Description

`createLabels(p,format,array)` adds the specified `format` label to each `array` of the polar plot `p`. The labels are stored as a cell array in the `LegendLabels` property of `p`.

Input Arguments

`p` — Polar plot

scalar handle

Polar plot, specified as a scalar handle.

`format` — Format for legend label

cell array

Format for legend label added to the polar plot, specified as a cell array. For more information on legend label format see, `legend`.

Data Types: `char`

`array` — Values to apply to `format`

array

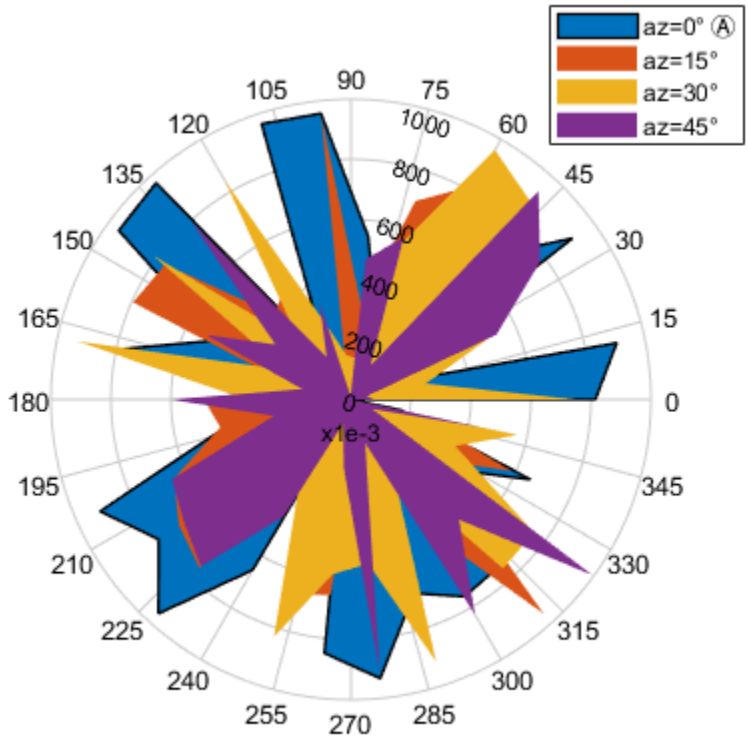
Values to apply to `format` , specified as an array. The values can be an array of angles or array of magnitude.

Examples

Add Legend Label to Polar Plot

Create a polar plot of unique values. Generate a legend label for this plot.

```
p = polarpattern(rand(30,4),'Style','filled');
createLabels(p,'az=%d#deg',0:15:45)
```



See Also

See Also

`add` | `addCursor` | `animate` | `findLobes` | `replace` | `showPeaksTable` | `showSpan`

Introduced in R2016a

findLobes

Class: polarpattern

Main, back, and side lobe data

Syntax

```
L = findLobes(p)
L = findLobes(p,index)
```

Description

`L = findLobes(p)` returns a structure, `L`, defining the main, back, and side lobes of the antenna or array radiation pattern in the specified polar plot, `p`.

`L = findLobes(p,index)` returns the radiation pattern lobes from the data set specified in `index`.

Input Arguments

`p` — Polar plot

scalar handle

Polar plot, specified as a scalar handle.

`index` — Index of data set

scalar

Index of data set, specified as a scalar.

Examples

Find Main, Back, and Side Lobes

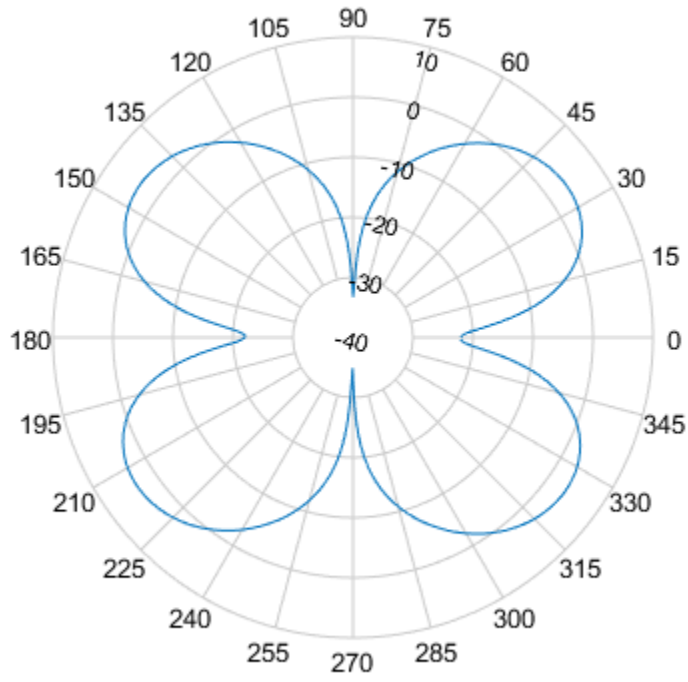
Create a dipole antenna and calculate its directivity at 270 MHz.

```
d = dipole;
D = pattern(d,270e6,0,0:1:360);
```

Create a polar plot of the dipole directivity. Find the main, back, and side lobes of the dipole antenna.

```
p = polarpattern(D);
L = findLobes(p)
```

```
L =

  struct with fields:

     mainLobe: [1×1 struct]
     backLobe: [1×1 struct]
    sideLobes: [1×1 struct]
           FB: 0.0073
          SLL: 0
         HPBW: 30.9141
         FNBW: 90.7479
        FBIdx: [36 216.5000]
       SLLIdx: [36 146]
      HPBWIdx: [22 53]
      HPBWAng: [20.9418 51.8560]
      FNBWIdx: [361 91]
```



Inspect main, back, and side lobe data.

```
MainLobe = L.mainLobe
BackLobe = L.backLobe
SideLobe = L.sideLobes
```

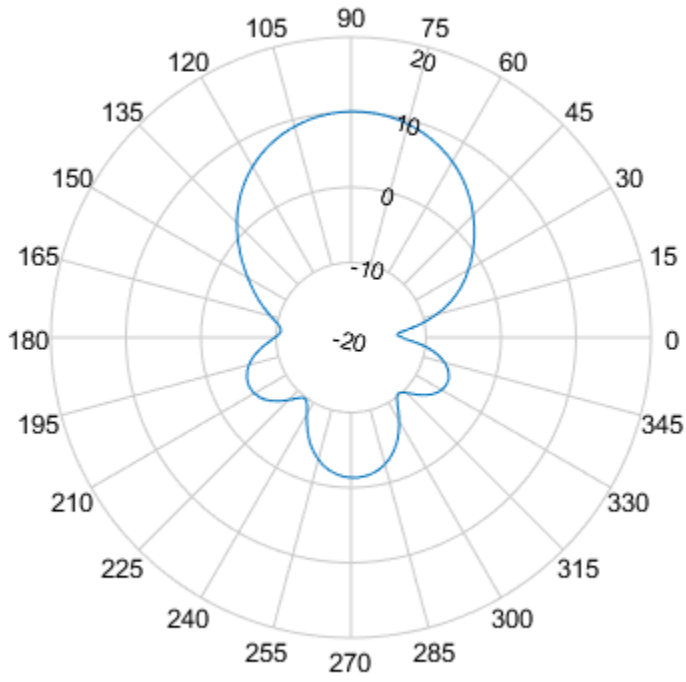
```
MainLobe =

  struct with fields:

        index: 36
    magnitude: 3.6587
        angle: 34.9030
```

```
       extent: [361 91]


BackLobe =

  struct with fields:

    magnitude: 3.6514
        angle: -145.0970
       extent: [181 271]
        index: 216.5000


SideLobe =

  struct with fields:

        index: 146
    magnitude: 3.6587
        angle: 144.5983
       extent: [2×2 double]
```

Find Lobes in Two Data Sets

Create a helix antenna that has a 28 mm radius, a 1.2 mm width, and 4 turns. Calculate and plot the directivity of the antenna at 1.8 GHz.

```
hx = helix('Radius',28e-3,'Width',1.2e-3,'Turns',4);
H = pattern(hx, 1.8e9,0,0:1:360);
P = polarpattern(H);
```

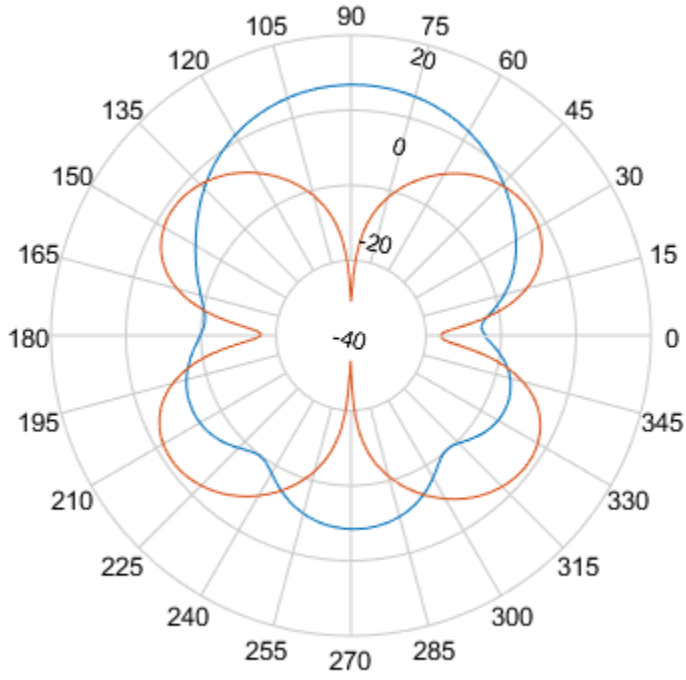


Create a dipole antenna and calculate the directivity at 270 MHz.

```
d = dipole;
D = pattern(d,270e6,0,0:1:360);
```

Add the directivity of the dipole to the existing polar plot.

```
add(P,D);
```



Find the main, back, and side lobes of helix antenna.

```
L = findLobes(P,1)
```

```
L =

  struct with fields:

     mainLobe: [1×1 struct]
     backLobe: [1×1 struct]
    sideLobes: [1×1 struct]
           FB: 11.4645
          SLL: 11.4110
```

```
    HPBW: 56.8421
    FNBW: 171.5235
   FBIdx: [90 270.5000]
  SLLIdx: [90 273]
 HPBWIdx: [61 118]
 HPBWAng: [59.8338 116.6759]
 FNBWIdx: [4 176]
```

See Also

See Also

add | addCursor | animate | createLabels | replace | showPeaksTable | showSpan

Introduced in R2016a

replace

Class: polarpattern

Replace polar plot data with new data

Syntax

```
replace(p,data)
replace(p,angle,magnitude)
```

Description

`replace(p,data)` removes all data from polar plot, `p` and adds new data based on real amplitude values, `data`.

`replace(p,angle,magnitude)` removes all the current data and adds new data sets of angle vectors and corresponding magnitude matrices to the polar plot, `p`.

Input Arguments

p — Polar plot

scalar handle

Polar plot, specified as a scalar handle.

data — Antenna or array data

real length-*M* vector | real *M*-by-*N* matrix | real *N*-*D* array | complex vector or matrix

Antenna or array data, specified as one of the following:

- A real length-*M* vector, where *M* contains the magnitude values with angles assumed to be $\frac{(0:M-1)}{M}\times 360^{\circ}$ degrees.

- A real *M*-by-*N* matrix, where *M* contains the magnitude values and *N* contains the independent data sets. Each column in the matrix has angles taken from the vector $\frac{(0:M-1)}{M}\times 360^\circ$ degrees. The set of each angle can vary for each column.
- A real *N*-*D* array, where *N* is the number of dimensions. Arrays with dimensions `2` and greater are independent data sets.
- A complex vector or matrix, where `data` contains Cartesian coordinates (*(x,y)* of each point. *x* contains the real part of `data` and *y* contains the imaginary part of `data`.

When data is in a logarithmic form such as dB, magnitude values can be negative. In this case,`polarpattern` plots the lowest magnitude values at the origin of the polar plot and highest magnitude values at the maximum radius.

`angle` — Set of angles

vector in degrees

Set of angles, specified as a vector in degrees.

`magnitude` — Set of magnitude values

vector | matrix

Set of magnitude values, specified as a vector or a matrix. For a matrix of magnitude values, each column is an independent set of magnitude values and corresponds to the same set of angles.

Examples

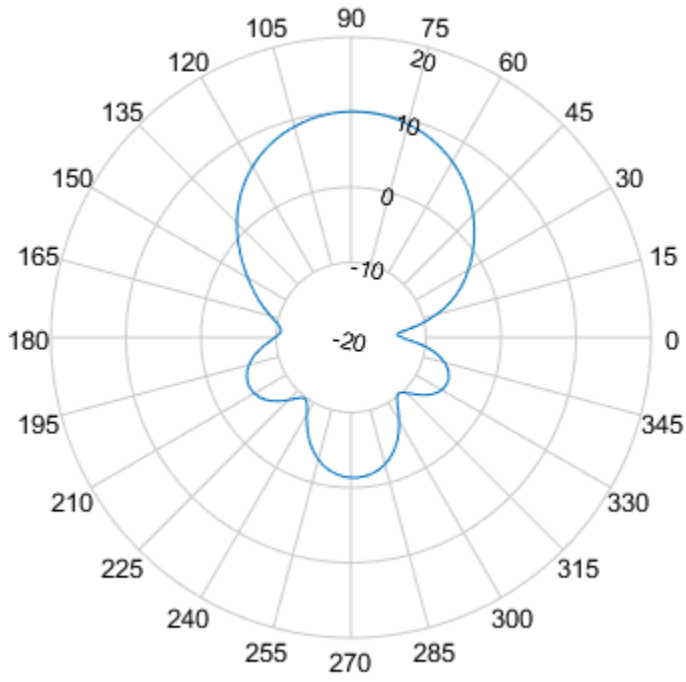
Replace Polar Plot Data with New Data

Create a helix antenna that has a 28 mm radius, a 1.2 mm width, and 4 turns. Calculate the directivity of the antenna at 1.8 GHz.

```
hx = helix('Radius',28e-3,'Width',1.2e-3,'Turns',4);
H = pattern(hx, 1.8e9,0,0:1:360);
```

Plot the polar pattern.

```
P = polarpattern(H);
```

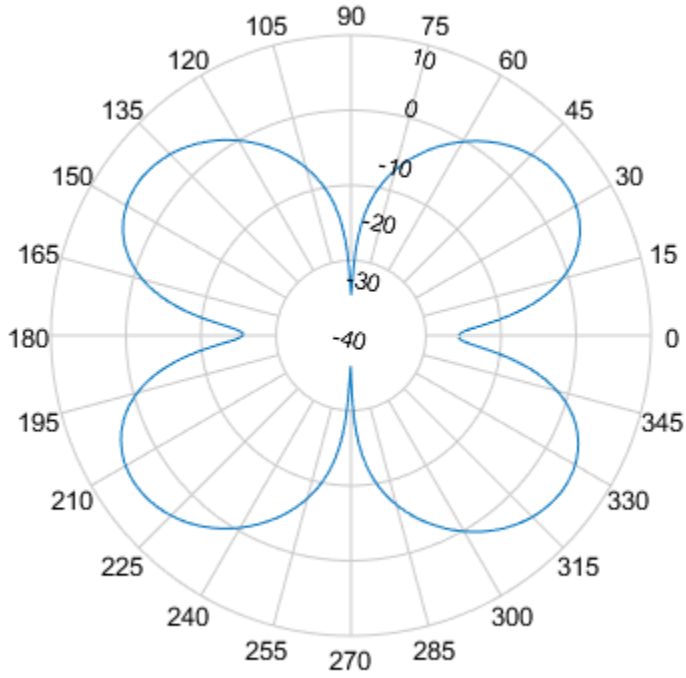


Create a dipole antenna and calculate its directivity at 270 MHz.

```
d = dipole;
D = pattern(d,270e6,0,0:1:360);
```

Replace the existing polar plot of the helix antenna with the directivity of the dipole.

```
replace(P,D);
```



See Also

See Also

`add` | `addCursor` | `animate` | `createLabels` | `findLobes` | `showPeaksTable` | `showSpan`

Introduced in R2016a

showPeaksTable

Class: polarpattern

Show or hide peak marker table

Syntax

```
showPeaksTable(p,vis)
```

Description

`showPeaksTable(p,vis)` shows or hides a table of the peak values. By default, the peak values table is visible.

Input Arguments

p — Polar plot

scalar handle

Polar plot, specified as a scalar handle.

vis — Show or hide peaks table

0 | 1

Show or hide peaks table, specified as 0 or 1.

Examples

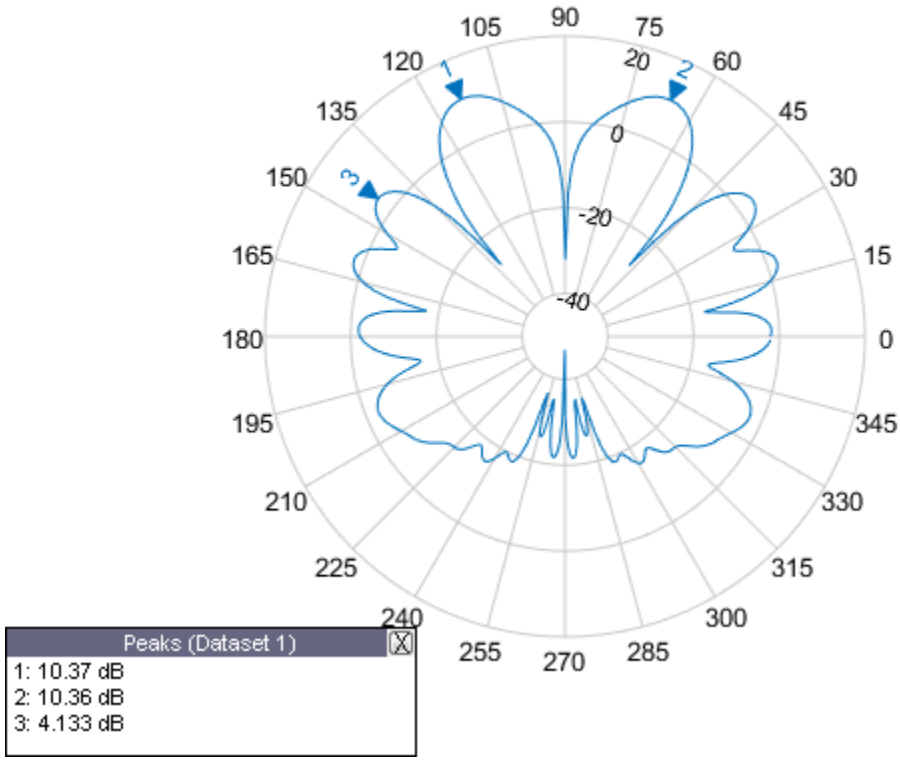
Peaks of Antenna in Polar Pattern

Create a monopole antenna and calculate the directivity at 1 GHz.

```
m = monopole;
M = pattern(m,1e9,0,0:1:360);
```

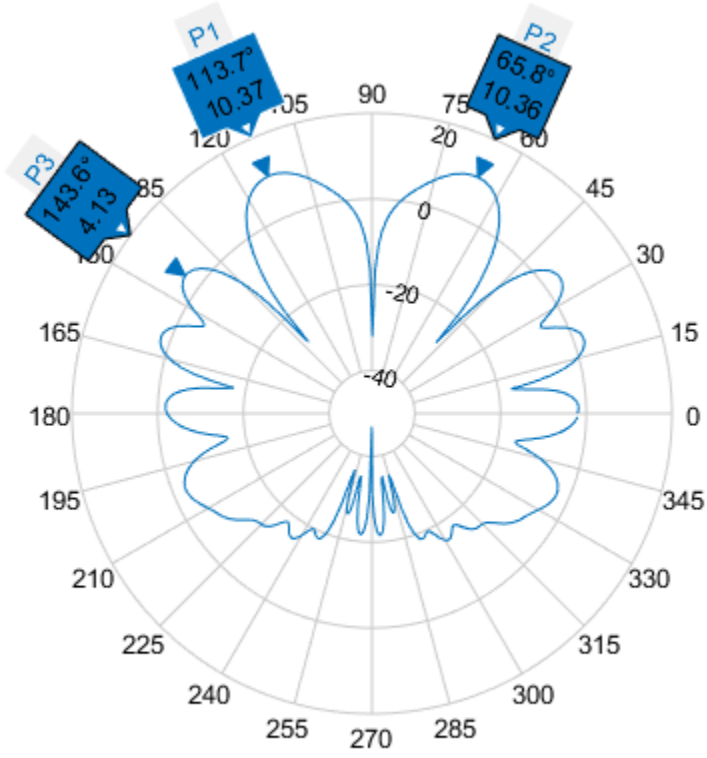
Plot the polar pattern and show three peaks of the antenna. When creating a `polarpattern` plot, if you specify the Peaks property, the peaks table is displayed by default.

```
P = polarpattern(M,'Peaks',3);
```



Hide the table. When the peaks table is hidden, the peak markers display the peak values.

```
showPeaksTable(P,0);
```



See Also

See Also

`add` | `addCursor` | `animate` | `createLabels` | `findLobes` | `replace` | `showSpan`

Introduced in R2016a

showSpan

Class: polarpattern

Show or hide angle span between two markers

Syntax

```
showSpan(p,id1,id2)
showSpan(p,id1,id2,true)
showSpan(p,vis)
showSpan(p)
d = showSpan( ___ )
```

Description

`showSpan(p,id1,id2)` displays the angle span between two angle markers, `id1` and `id2`. The angle span is calculated counterclockwise.

`showSpan(p,id1,id2,true)` automatically reorders the angle markers such that the initial angle span is less than or equal to 180° counterclockwise.

`showSpan(p,vis)` sets angle span visibility by setting `vis` to `true` or `false`.

`showSpan(p)` toggles the angle span display on and off.

`d = showSpan( ___ )` returns angle span details in a structure, `d` using any of the previous syntaxes.

Input Arguments

p — Polar plot

scalar handle

Polar plot, specified as a scalar handle.

`id1,id2` — Cursor or peak marker identifiers

character vector

Cursor or peak marker identifiers, specified as character vector. Adding cursors to the polar plot creates cursor marker identifiers. Adding peaks to the polar plot creates peak marker identifiers.

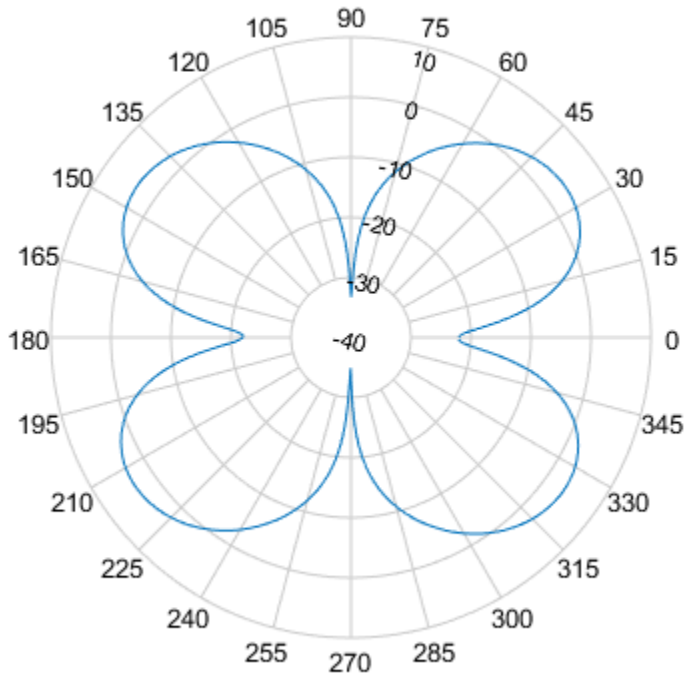
Example: `showspan(p,'C1','C2')`. Displays the angle span between cursors, `C1` and `C2` in polar plot, `p`.

Examples

Show Angle Span

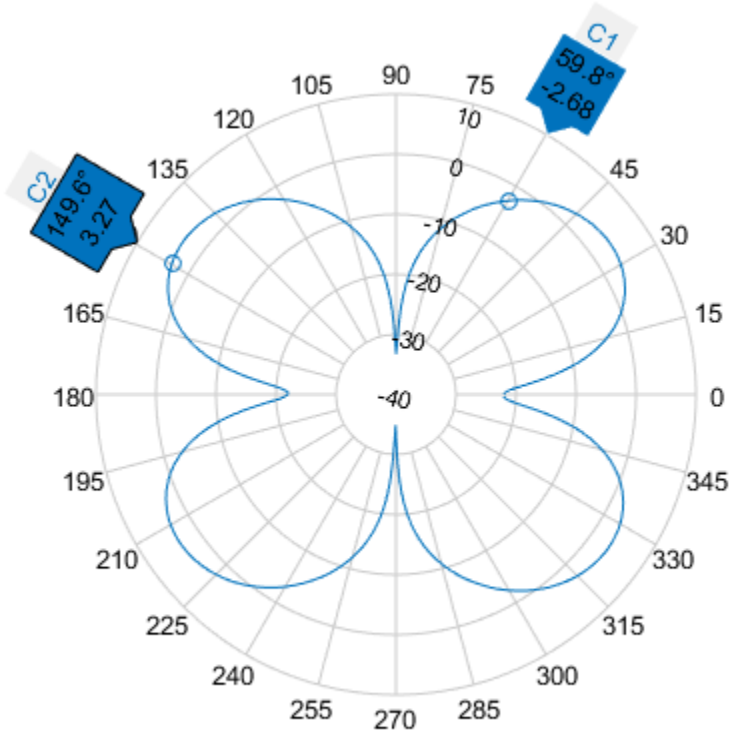
Create a dipole antenna and plot the directivity at 270 MHz.

```
d = dipole;
D = pattern(d,270e6,0,0:1:360);
p = polarpattern(D);
```



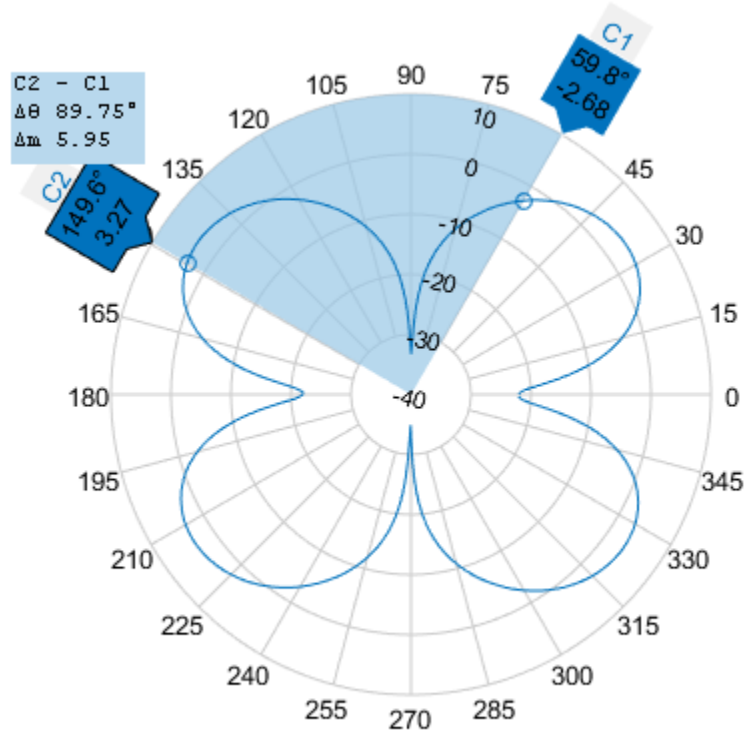
Add cursors to the polar plot at approximately 60 and 150 degrees.

```
addCursor(p,[60 150]);
```



Show the angle span between the two angles.

```
showSpan(p,'C1','C2');
```



See Also

See Also

`add` | `addCursor` | `animate` | `createLabels` | `findLobes` | `replace` | `showPeaksTable`

Introduced in R2016a

arrayFactor

Array factor in dB

Syntax

```
arrayFactor(object,frequency)
arrayFactor(object,frequency,azimuth,elevation)
arrayFactor( ___ ,Name,Value)

[af] = arrayFactor(object,frequency)
[af,azimuth,elevation] = arrayFactor(object,frequency,azimuth,
elevation)
[af,azimuth,elevation] = arrayFactor( ___ ,Name,Value)
```

Description

`arrayFactor(object,frequency)` plots the 3-D array factor over the specified frequency value in dB.

`arrayFactor(object,frequency,azimuth,elevation)` plots the array factor over the specified frequency, azimuth, and elevation values.

`arrayFactor( ___ ,Name,Value)` plots the array factor using additional options specified by one or more `Name,Value` pair arguments. Specify name-value pair arguments after all other input arguments.

`[af] = arrayFactor(object,frequency)` returns the 3-D array factor over the specified frequency value.

`[af,azimuth,elevation] = arrayFactor(object,frequency,azimuth,elevation)` returns the array factor at the specified frequency, azimuth, and elevation values.

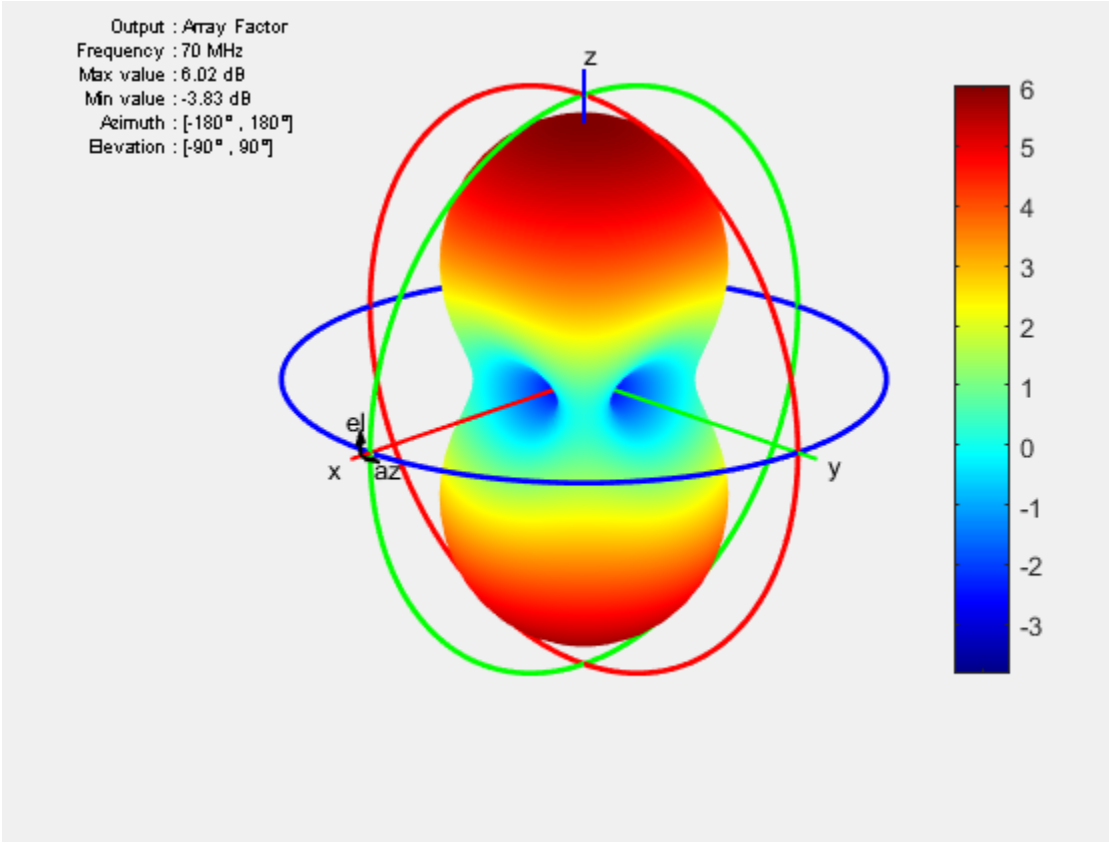
`[af,azimuth,elevation] = arrayFactor( ___ ,Name,Value)` returns the array factor using additional options specified by one or more `Name,Value` pair arguments. Specify name-value pair arguments after all other input arguments.

Examples

Plot Array Factor

Plot the array factor of a default rectangular array at a frequency of 70 MHz.

```
ra = rectangularArray;
arrayFactor(ra,70e6);
```



Input Arguments

`object` — Input antenna array

object handle

Input antenna array object, specified as an object handle.

Example: `r = rectangularArray; arrayFactor (r,70e6)`. Calculates the array factor of a rectangular array.

`frequency` — Frequency value used to calculate array factor

scalar in Hz

Frequency value used to calculate array factor, specified as a scalar in Hz.

Example: `70e6`

Data Types: `double`

`azimuth` — Azimuth angle of antenna

`–180:5:180` (default) | vector in degrees

Azimuth angle of the antenna, specified as a vector in degrees.

Example: `–90:5:90`

Data Types: `double`

`elevation` — Elevation angle of antenna

`–90:5:90` (default) | vector in degrees

Elevation angle of the antenna, specified as a vector in degrees.

Example: `0:1:360`

Data Types: `double`

Name-Value Pair Arguments

Specify optional comma-separated pairs of `Name,Value` pair arguments. `Name` is the argument name and `Value` is the corresponding value. `Name` must appear inside single quotes (`''`). You can specify several name and value pair arguments in any order as `Name1, Value1, ..., NameN, ValueN`.

Example: `'CoordinateSystem', rectangular`

`'CoordinateSystem'` — Coordinate system of array factor

`'polar'` (default) | `'rectangular'` | `'uv'`

Coordinate system of array factor, specified as the comma-separated pair consisting of `'CoordinateSystem'` and one of these values: `'polar'`, `'rectangular'`, `'uv'`.

Example: `'CoordinateSystem', 'polar'`

Data Types: `char`

Output Arguments

`af` — Array factor

matrix in dB

Array factor, returned as a matrix in dB. The matrix size is the product of number of elevation values and number of azimuth values.

`azimuth` — Azimuth values

vector in degrees

Azimuth values used to calculate the array factor, returned as a vector in degrees.

`elevation` — Elevation values

vector in degrees

Elevation values used to calculate the array factor, returned as a vector in degrees.

See Also

See Also

`feedCurrent` | `pattern` | `patternMultiply`

Introduced in R2017a

Properties — Alphabetical List

PolarPattern Properties

Control appearance and behavior of polar plot

Description

Polar pattern properties control the appearance and behavior of the polar pattern object. By changing property values, you can modify certain aspects of the polar plot. To change the default properties use: .

```
p = polarpattern(____,Name,Value)
```

To view all the properties of the polar pattern object use:

```
details(p)
```

You can also interact with the polar plot to change the properties. For more information, see “Interact with Polar Plot”.

Antenna Metrics

`'AntennaMetrics'` — Show antenna metric
`0` (default) | `1`

Show antenna metrics, specified as a comma-separated pair consisting of `'AntennaMetrics'` and `0` or `1`. Antenna metric displays main, back, and side lobes of antenna/array pattern passed as input.

Data Types: `logical`

`'Peaks'` — Maximum number of peaks to compute for each data set
positive integer | vector of integers

Maximum number of peaks to compute for each data set, specified as a comma-separated pair consisting of `'Peaks'` and a positive scalar or vector of integers.

Data Types: `double`

Angle Properties

`'AngleAtTop'` — Angle at top of polar plot
`90` (default) | scalar in degrees

Angle at the top of the polar plot, specified as a comma-separated pair consisting of `'AngleAtTop'` and a scalar in degrees.

Data Types: `double`

`'AngleLim'` — Visible polar angle span

`[0 360]` (default) | 1-by-2 vector of real values

Visible polar angle span, specified as a comma-separated pair consisting of `'AngleLim'` and a 1-by-2 vector of real values.

Data Types: `double`

`'AngleLimVisible'` — Show interactive angle limit cursors

`0` (default) | `1`

Show interactive angle limit cursors, specified as a comma-separated pair consisting of `'AngleLimVisible'` and `0` or `1`.

Data Types: `logical`

`'AngleDirection'` — Direction of increasing angle

`'ccw'` (default) | `'cw'`

Direction of increasing angle, specified as a comma-separated pair consisting of `'AngleDirection'` and `'ccw'` (counterclockwise) or `'cw'` (clockwise).

Data Types: `char`

`'AngleResolution'` — Number of degrees between radial lines

`15` (default) | scalar in degrees

Number of degrees between radial lines depicting angles in the polar plot, specified as a comma-separated pair consisting of `'AngleResolution'` and a scalar in degrees.

Data Types: `double`

`'AngleTickLabelRotation'` — Rotate angle tick labels

`0` (default) | `1`

Rotate angle tick labels, specified as a comma-separated pair consisting of `'AngleTickLabelRotation'` and `0` or `1`.

Data Types: `logical`

`'AngleTickLabelVisible'` — Show angle tick labels

`1` (default) | `0`

Show angle tick labels, specified as a comma-separated pair consisting of `'AngleTickLabelVisible'` and `0` or `1`.

Data Types: `logical`

`'AngleTickLabelFormat'` — Format for angle tick labels

`360` (default) | `180`

Format for angle tick labels, specified as a comma-separated pair consisting of `'AngleTickLabelFormat'` and `360` degrees or `180` degrees.

Data Types: `double`

`'AngleFontSizeMultiplier'` — Scale factor of angle tick font

`1` (default) | numeric value greater than zero

Scale factor of angle tick font, specified as a comma-separated pair consisting of `'AngleFontSizeMultiplier'` and a numeric value greater than zero.

Data Types: `double`

`'Span'` — Show angle span measurement

`0` (default) | `1`

Show angle span measurement, specified as a comma-separated pair consisting of `'Span'` and `0` or `1`.

Data Types: `logical`

`'ZeroAngleLine'` — Highlight radial line at zero degrees

`0` (default) | `1`

Highlight radial line at zero degrees, specified as a comma-separated pair consisting of `'ZeroAngleLine'` and `0` or `1`.

Data Types: `logical`

`'DisconnectAngleGaps'` — Show gaps in line plots with nonuniform angle spacing

`1` (default) | `0`

Show gaps in line plots with nonuniform angle spacing, specified as a comma-separated pair consisting of `'DisconnectAngleGaps'` and `0` or `1`.

Data Types: `logical`

Magnitude Properties

`'MagnitudeAxisAngle'` — Angle of magnitude tick label radial line

`75` (default) | real scalar in degrees

Angle of magnitude tick label radial line, specified as a comma-separated pair consisting of `'MagnitudeAxisAngle'` and real scalar in degrees.

Data Types: `double`

`'MagnitudeTick'` — Magnitude ticks

`[0 0.2 0.4 0.6 0.8]` (default) | 1-by-N vector

Magnitude ticks, specified as a comma-separated pair consisting of `'MagnitudeTick'` and a 1-by-N vector, where N is the number of magnitude ticks.

Data Types: `double`

`'MagnitudeTickLabelVisible'` — Show magnitude tick labels

`1` (default) | `0`

Show magnitude tick labels, specified as a comma-separated pair consisting of `'MagnitudeTickLabelVisible'` and `0` or `1`.

Data Types: `logical`

`'MagnitudeLim'` — Minimum and maximum magnitude limits

`[0 1]` (default) | two-element vector of real values

Minimum and maximum magnitude limits, specified as a comma-separated pair consisting of `'MagnitudeLim'` and a two-element vector of real values.

Data Types: `double`

`'MagnitudeLimMode'` — Determine magnitude dynamic range

`'auto'` (default) | `'manual'`

Determine magnitude dynamic range, specified as a comma-separated pair consisting of `'MagnitudeLimMode'` and `'auto'` or `'manual'`.

Data Types: `char`

'MagnitudeAxisAngleMode' — Determine angle for magnitude tick labels

'auto' (default) | 'manual'

Determine angle for magnitude tick labels, specified as a comma-separated pair consisting of 'MagnitudeAxisAngleMode' and 'auto' or 'manual'.

Data Types: char

'MagnitudeTickMode' — Determine magnitude tick locations

'auto' (default) | 'manual'

Determine magnitude tick locations, specified as a comma-separated pair consisting of 'MagnitudeTickMode' and 'auto' or 'manual'.

Data Types: char

'MagnitudeUnits' — Magnitude units

'dB' | 'dBLoss'

Magnitude units, specified as a comma-separated pair consisting of 'MagnitudeUnits' and 'db' or 'dBLoss'.

Data Types: char

'MagnitudeFontSizeMultiplier' — Scale factor of magnitude tick font

0.9000 (default) | numeric value greater than zero

Scale factor of magnitude tick font, specified as a comma-separated pair consisting of 'MagnitudeFontSizeMultiplier' and a numeric value greater than zero.

Data Types: double

Miscellaneous Properties

'NormalizeData' — Normalize each data trace to maximum value

0 (default) | 1

Normalize each data trace to maximum value, specified as a comma-separated pair consisting of 'NormalizeData' and 0 or 1.

Data Types: logical

'ConnectEndpoints' — Connect first and last angles

0 (default) | 1

Connect first and last angles, specified as a comma-separated pair consisting of `'ConnectEndpoints'` and `0` or `1`.

Data Types: `logical`

`'Style'` — Style of polar plot display

`'line'` (default) | `'filled'`

Style of polar plot display, specified as a comma-separated pair consisting of `'Style'` and `'line'` or `'filled'`.

Data Types: `char`

`'TemporaryCursor'` — Create temporary cursor

`0` (default) | `1`

Create a temporary cursor, specified as a comma-separated pair consisting of `'TemporaryCursor'` and `0` or `1`.

Data Types: `logical`

`'ToolTips'` — Show tool tips

`1` (default) | `0`

Show tool tips when you hover over a polar plot element, specified as a comma-separated pair consisting of `'ToolTips'` and `0` or `1`.

Data Types: `logical`

`'ClipData'` — Clip data to outer circle

`0` (default) | `1`

Clip data to outer circle, specified as a comma-separated pair consisting of `'ClipData'` and `0` or `1`.

Data Types: `logical`

`'NextPlot'` — Directive on how to add next plot

`'replace'` (default) | `'new'` | `'add'`

Directive on how to add next plot, specified as a comma-separated pair consisting of `'NextPlot'` and one of the values in the table:

Property Value	Effect
`'new'`	Creates a figure and uses it as the current figure.
`'add'`	Adds new graphics objects without clearing or resetting the current figure.
`'replace'`	Removes all axes objects and resets figure properties to their defaults before adding new graphics objects.

Legend and Title Properties

`'LegendLabels'` — Data tables for legend annotation

character vector | cell array of character vectors

Data tables for legend annotation, specified as a comma-separated pair consisting of `'LegendLabels'` and a character vector or cell array of character vectors.

Data Types: `char`

`'LegendVisible'` — Show legend label

`0` (default) | `1`

Show legend label, specified as a comma-separated pair consisting of `'LegendVisible'` and `0` or `1`.

Data Types: `logical`

`'TitleTop'` — Title to display above the polar plot

character vector

Title to display above the polar plot, specified as a comma-separated pair consisting of `'TitleTop'` and a character vector.

Data Types: `char`

`'TitleBottom'` — Title to display below the polar plot

character vector

Title to display below the polar plot, specified as a comma-separated pair consisting of `'TitleBottom'` and a character vector.

Data Types: `char`

`'TitleTopOffset'` — Offset between top title and angle ticks

`0.1500` (default) | scalar

Offset between top title and angle ticks, specified as a comma-separated pair consisting of `'TitleTopOffset'` and a scalar. The value must be in the range `[-0.5,0.5]`.

Data Types: `double`

`'TitleBottomOffset'` — Offset between bottom title and angle ticks

`0.1500` (default) | scalar

Offset between bottom title and angle ticks, specified as a comma-separated pair consisting of `'TitleBottomOffset'` and a scalar. The value must be in the range `[-0.5,0.5]`.

Data Types: `double`

`'TitleTopFontSizeMultiplier'` — Scale factor of top title font

`1.1000` (default) | numeric value greater than zero

Scale factor of top title font, specified as a comma-separated pair consisting of `'TitleTopFontSizeMultiplier'` and a numeric value greater than zero.

Data Types: `double`

`'TitleBottomFontSizeMultiplier'` — Scale factor of bottom title font

`0.9000` (default) | numeric value greater than zero

Scale factor of bottom title font, specified as a comma-separated pair consisting of `'TitleBottomFontSizeMultiplier'` and a numeric value greater than zero.

Data Types: `double`

`'TitleTopFontWeight'` — Thickness of top title font

`'bold'` (default) | `'normal'`

Thickness of top title font, specified as a comma-separated pair consisting of `'TitleTopFontWeight'` and `'bold'` or `'normal'`.

Data Types: `char`

`'TitleBottomFontWeight'` — Thickness of bottom title font

`'normal'` (default) | `'bold'`

Thickness of bottom title font, specified as a comma-separated pair consisting of `'TitleBottomFontWeight'` and `'bold'` or `'normal'`.

Data Types: `char`

`'TitleTopTextInterpreter'` — Interpretation of top title characters

`'none'` (default) | `'tex'` | `'latex'`

Interpretation of top title characters, specified as a comma-separated pair consisting of `'TitleTopTextInterpreter'` and:

- `'tex'` — Interpret using a subset of TeX markup
- `'latex'` — Interpret using LaTeX markup
- `'none'` — Display literal characters

TeX Markup

By default, MATLAB supports a subset of TeX markup. Use TeX markup to add superscripts and subscripts, modify the text type and color, and include special characters in the text.

This table lists the supported modifiers when the `TickLabelInterpreter` property is set to `'tex'`, which is the default value. Modifiers remain in effect until the end of the text, except for superscripts and subscripts which only modify the next character or the text within the curly braces `{}`.

Modifier	Description	Example
`^{ }`	Superscript	`'text^{superscript}'`
`_{ }`	Subscript	`'text_{subscript}'`
`\bf`	Bold font	`'\bf text'`
`\it`	Italic font	`'\it text'`
`\sl`	Oblique font (rarely available)	`'\sl text'`
`\rm`	Normal font	`'\rm text'`
`\fontname{specifier}`	Set `specifier` as the name of a font family to change the font style. You can use this with other modifiers.	`'\fontname{Courier} text'`

Modifier	Description	Example
`\fontsize{specifier}`	Set `specifier` as a scalar numeric value to change the font size.	`'\fontsize{15} text'`
`\color{specifier}`	Set `specifer` as one of these colors: `red`, `green`, `yellow`, `magenta`, `blue`, `black`, `white`, `gray`, `darkGreen`, `orange`, or `lightBlue`.	`'\color{magenta} text'`
`\color[rgb] {specifier}`	Set `specifier` as a three-element RGB triplet to change the font color.	`'\color[rgb] {0,0.5,0.5} text'`

LaTeX Markup

To use LaTeX markup, set the `TickLabelInterpreter` property to `'latex'`. The displayed text uses the default LaTeX font style. The `FontName`, `FontWeight`, and `FontAngle` properties do not have an effect. To change the font style, use LaTeX markup within the text.

The maximum size of the text that you can use with the LaTeX interpreter is 1200 characters. For multiline text, the maximum size reduces by about 10 characters per line.

For more information about the LaTeX system, see The LaTeX Project website at http://www.latex-project.org/.

Data Types: `char`

`'TitleBottomTextInterpreter'` — Interpretation of bottom title characters

`'none'` (default) | `'tex'` | `'latex'`

Interpretation of bottom title characters, specified as a comma-separated pair consisting of `'TitleBottomTextInterpreter'` and:

- `'tex'` — Interpret using a subset of TeX markup
- `'latex'` — Interpret using LaTeX markup
- `'none'` — Display literal characters

TeX Markup

By default, MATLAB supports a subset of TeX markup. Use TeX markup to add superscripts and subscripts, modify the text type and color, and include special characters in the text.

This table lists the supported modifiers when the `TickLabelInterpreter` property is set to `'tex'`, which is the default value. Modifiers remain in effect until the end of the text, except for superscripts and subscripts which only modify the next character or the text within the curly braces `{}`.

Modifier	Description	Example
`^{ }`	Superscript	`'text^{superscript}'`
`_{ }`	Subscript	`'text_{subscript}'`
`\bf`	Bold font	`'\bf text'`
`\it`	Italic font	`'\it text'`
`\sl`	Oblique font (rarely available)	`'\sl text'`
`\rm`	Normal font	`'\rm text'`
`\fontname{specifier}`	Set `specifier` as the name of a font family to change the font style. You can use this with other modifiers.	`'\fontname{Courier} text'`
`\fontsize{specifier}`	Set `specifier` as a scalar numeric value to change the font size.	`'\fontsize{15} text'`
`\color{specifier}`	Set `specifer` as one of these colors: `red`, `green`, `yellow`, `magenta`, `blue`, `black`, `white`, `gray`, `darkGreen`, `orange`, or `lightBlue`.	`'\color{magenta} text'`
`\color[rgb] {specifier}`	Set `specifier` as a three-element RGB triplet to change the font color.	`'\color[rgb] {0,0.5,0.5} text'`

LaTeX Markup

To use LaTeX markup, set the `TickLabelInterpreter` property to `'latex'`. The displayed text uses the default LaTeX font style. The `FontName`, `FontWeight`, and `FontAngle` properties do not have an effect. To change the font style, use LaTeX markup within the text.

The maximum size of the text that you can use with the LaTeX interpreter is 1200 characters. For multiline text, the maximum size reduces by about 10 characters per line.

For more information about the LaTeX system, see The LaTeX Project website at http://www.latex-project.org/.

Data Types: `char`

Grid Properties

`'GridOverData'` — Draw grid over data plots

`0` (default) | `1`

Draw grid over data plots, specified as a comma-separated pair consisting of `'GridOverData'` and `0` or `1`.

Data Types: `logical`

`'DrawGridToOrigin'` — Draw radial lines within innermost circle

`0` (default) | `1`

Draw radial lines within innermost circle of the polar plot, specified as a comma-separated pair consisting of `'DrawGridToOrigin'` and `0` or `1`.

Data Types: `logical`

`'GridAutoRefinement'` — Increase angle resolution

`0` (default) | `1`

Increase angle resolution in the polar plot, specified as a comma-separated pair consisting of `'GridAutoRefinement'` and `0` or `1`. This property increases angle resolution by doubling the number of radial lines outside each magnitude.

Data Types: `logical`

'GridWidth' — Width of grid lines

0.5000 (default) | positive scalar

Width of grid lines, specified as a comma-separated pair consisting of 'GridWidth' and a positive scalar.

Data Types: double

'GridVisible' — Show grid lines

1 (default) | 0

Show grid lines, including magnitude circles and angle radii, specified as a comma-separated pair consisting of 'GridVisible' and 0 or 1.

Data Types: logical

'GridForeGroundColor' — Color of foreground grid lines

[0.8000 0.8000 0.8000] (default) | 'none' | character vector of color names

Color of foreground grid lines, specified as a comma-separated pair consisting of 'GridForeGroundColor' and an RGB triplet, character vector of color names, or 'none'.

An RGB triplet is a three-element row vector whose elements specify the intensities of the red, green, and blue components of the color. The intensities must be in the range [0,1]; for example, [0.4 0.6 0.7]. This table lists the long and short color name options and the equivalent RGB triplet values.

Long Name	Short Name	RGB Triplet
'yellow'	'y'	[1 1 0]
'magenta'	'm'	[1 0 1]
'cyan'	'c'	[0 1 1]
'red'	'r'	[1 0 0]
'green'	'g'	[0 1 0]
'blue'	'b'	[0 0 1]
'white'	'w'	[1 1 1]
'black'	'k'	[0 0 0]

Data Types: double | char

`'GridBackGroundColor'` — Color of background grid lines

`'w'` (default) | character vector of color names | `'none'`

Color of background grid lines, specified as a comma-separated pair consisting of `'GridBackGroundColor'` and an RGB triplet, character vector of color names, or `'none'`.

An RGB triplet is a three-element row vector whose elements specify the intensities of the red, green, and blue components of the color. The intensities must be in the range `[0,1]`; for example, `[0.4 0.6 0.7]`. This table lists the long and short color name options and the equivalent RGB triplet values.

Long Name	Short Name	RGB Triplet
`'yellow'`	`'y'`	`[1 1 0]`
`'magenta'`	`'m'`	`[1 0 1]`
`'cyan'`	`'c'`	`[0 1 1]`
`'red'`	`'r'`	`[1 0 0]`
`'green'`	`'g'`	`[0 1 0]`
`'blue'`	`'b'`	`[0 0 1]`
`'white'`	`'w'`	`[1 1 1]`
`'black'`	`'k'`	`[0 0 0]`

Data Types: `double` | `char`

Marker, Color, Line, and Font Properties

`'Marker'` — Marker symbol

`'none'` (default) | character vector of symbols

Marker symbol, specified as a comma-separated pair consisting of `'Marker'` and either `'none'` or one of the symbols in this table. By default, a line does not have markers. Add markers at selected points along the line by specifying a marker.

Value	Description
`'o'`	Circle
`'+'`	Plus sign

Value	Description
'*'	Asterisk
'.'	Point
'x'	Cross
'square' or 's'	Square
'diamond' or 'd'	Diamond
'^'	Upward-pointing triangle
'v'	Downward-pointing triangle
'>'	Right-pointing triangle
'<'	Left-pointing triangle
'pentagram' or 'p'	Five-pointed star (pentagram)
'hexagram' or 'h'	Six-pointed star (hexagram)
'none'	No markers

'MarkerSize' — Marker size

6 (default) | positive value

Marker size, specified as a comma-separated pair consisting of 'MarkerSize' and a positive value in point units.

Data Types: double

'ColorOrder' — Colors to use for multiline plots

seven predefined colors (default) | three-column matrix of RGB triplets

Colors to use for multiline plots, specified as a comma-separated pair consisting of 'ColorOrder' and a three-column matrix of RGB triplets. Each row of the matrix defines one color in the color order.

Data Types: double

'ColorOrderIndex' — Next color to use in color order

1 (default) | positive integer

Next color to use in color order, specified as a comma-separated pair consisting of 'ColorOrderIndex' and a positive integer. New plots added to the axes use colors based on the current value of the color order index.

Data Types: `double`

`'EdgeColor'` — Color of data lines

`'k'` (default) | RGB triplet vector

Color of data lines, specified as a comma-separated pair consisting of `'EdgeColor'` and a character vector of color names or RGB triplet vector.

An RGB triplet is a three-element row vector whose elements specify the intensities of the red, green, and blue components of the color. The intensities must be in the range `[0,1]`; for example, `[0.4 0.6 0.7]`. This table lists the long and short color name options and the equivalent RGB triplet values.

Long Name	Short Name	RGB Triplet
`'yellow'`	`'y'`	`[1 1 0]`
`'magenta'`	`'m'`	`[1 0 1]`
`'cyan'`	`'c'`	`[0 1 1]`
`'red'`	`'r'`	`[1 0 0]`
`'green'`	`'g'`	`[0 1 0]`
`'blue'`	`'b'`	`[0 0 1]`
`'white'`	`'w'`	`[1 1 1]`
`'black'`	`'k'`	`[0 0 0]`

Data Types: `double` | `char`

`'LineStyle'` — Line style of the plot

`'-'` (default) | `'--'` | `':'` | `'-.'` | `'none'`

Line style of the plot, specified as a comma-separated pair consisting of `'LineStyle'` and one of the symbols in the table:

Symbol	Line Style	Resulting Line
`'-'`	Solid line	————
`'--'`	Dashed line	- — — — —
`':'`	Dotted line	.....

Symbol	Line Style	Resulting Line
`'-.'`	Dash-dotted line	
`'none'`	No line	No line

`'LineWidth'` — Line width of plot
1 (default) | positive scalar

Line width of the plot, specified as a comma-separated pair consisting of `'LineWidth'` and a positive scalar.

`'FontSize'` — Font size of text in plot
10 (default) | positive scalar

Font size of text in the plot, specified as a comma-separated pair consisting of `'FontSize'` and a positive scalar.

`'FontSizeAutoMode'` — Set font size
`'auto'` (default) | `'manual'`

Set font size, specified as a comma-separated pair consisting of `'FontSizeAutoMode'` and `'auto'` or `'manual'`.

Data Types: `char`

See Also

See Also
“Interact with Polar Plot”