Antenna Toolbox™

Reference

MATLAB®

R2015b

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Antenna Toolbox™ Reference

Revision History

March 2015	Online only	New for Version 1.0 (R2015a)
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Contents

1 Antenna Classes — Alphabetical List

2 Array Classes — Alphabetical List

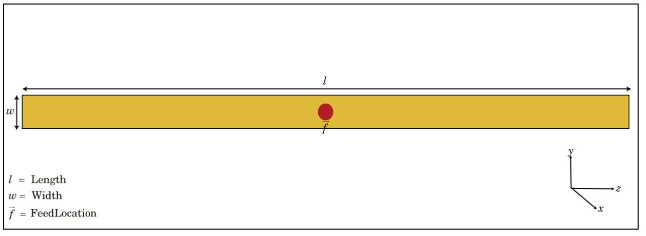
3 Methods — Alphabetical List

Antenna Classes — Alphabetical List

dipole class

Create strip dipole antenna

Description



The `dipole` class creates 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.

Construction

`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`

`'Tilt'` — Tilt angle of antenna
0 (default) | scalar in degrees

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

Example: `'Tilt'`,90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

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

Data Types: `double`

Definitions

To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, “Rotate Antenna Elements”.

Examples

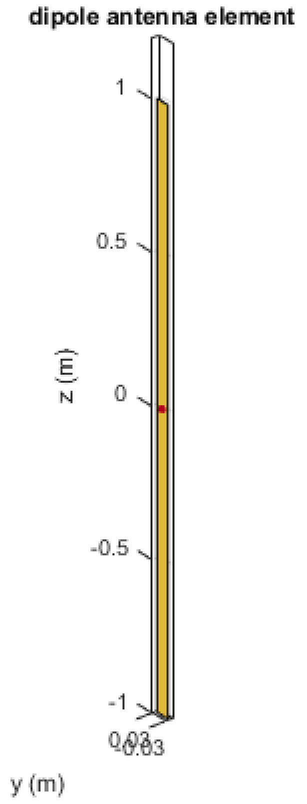
Create and View Dipole Antenna

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

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

```
d =

  dipole with properties:
```

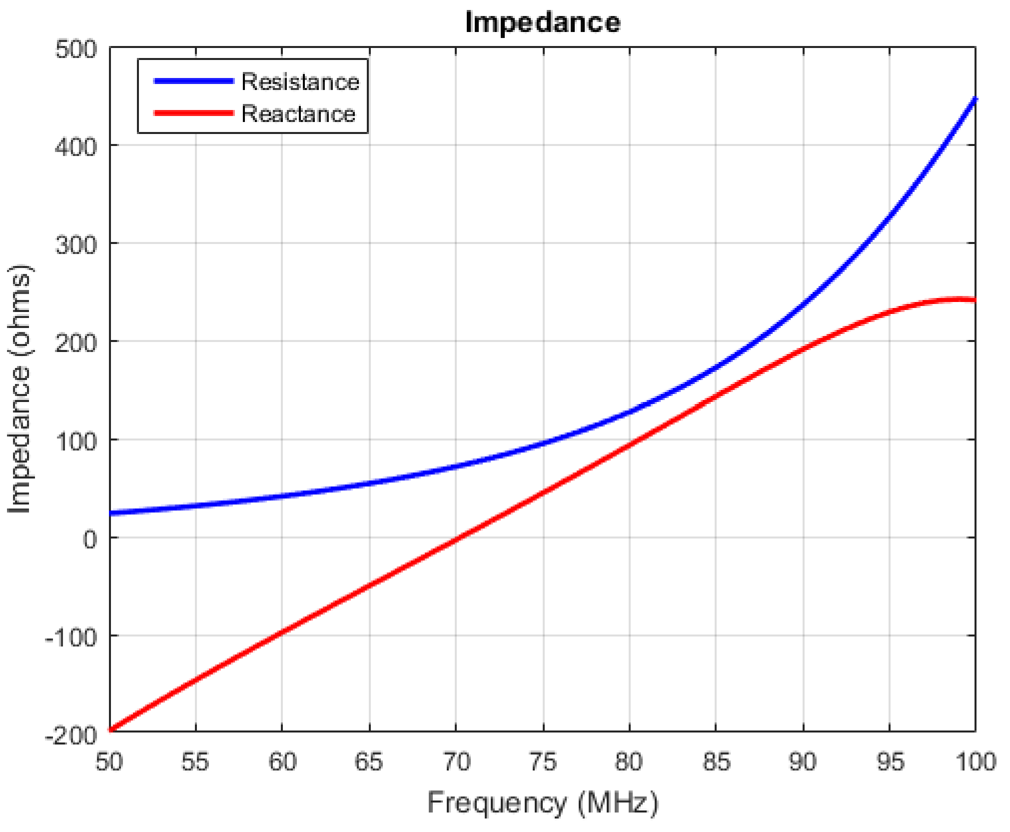
```
      Length: 2
       Width: 0.0500
  FeedOffset: 0
        Tilt: 0
    TiltAxis: [1 0 0]
```



Calculate Impedance of Dipole

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

```
d = dipole('Width',0.05);
impedance(d,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

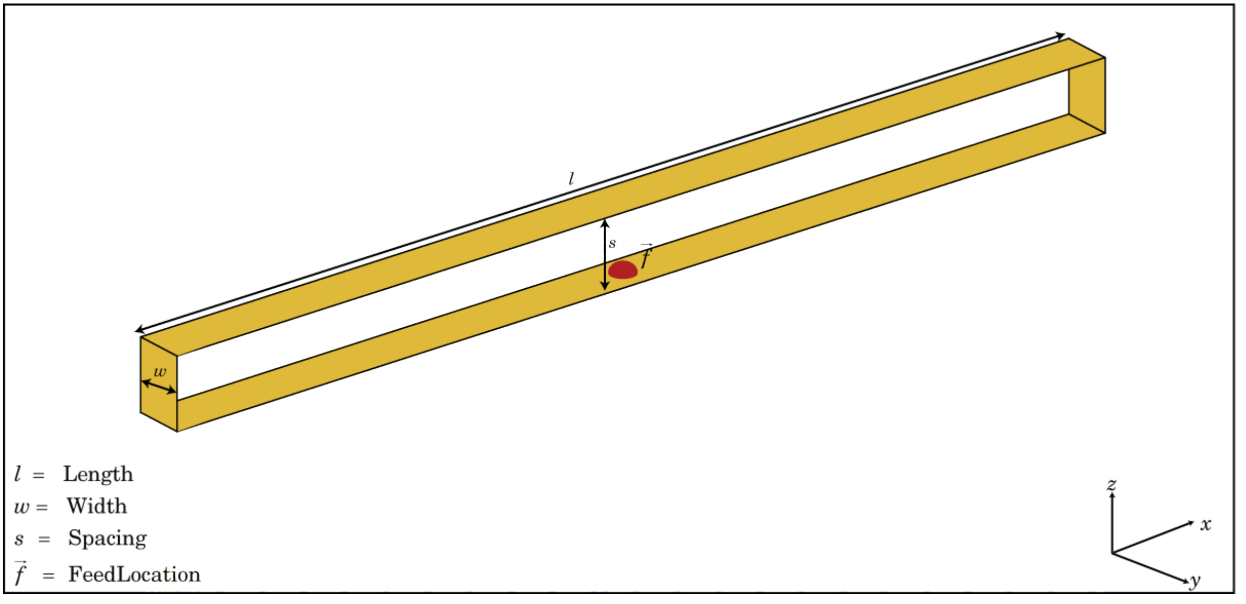
monopole | loopCircular | slot | `cylinder2strip`

Introduced in R2015a

dipoleFolded class

Create folded dipole antenna

Description



The `dipolefolded` class creates 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.

Construction

`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`

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees

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

Example: `'Tilt'`, 90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

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

Data Types: `double`

Definitions

To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, “Rotate Antenna Elements”.

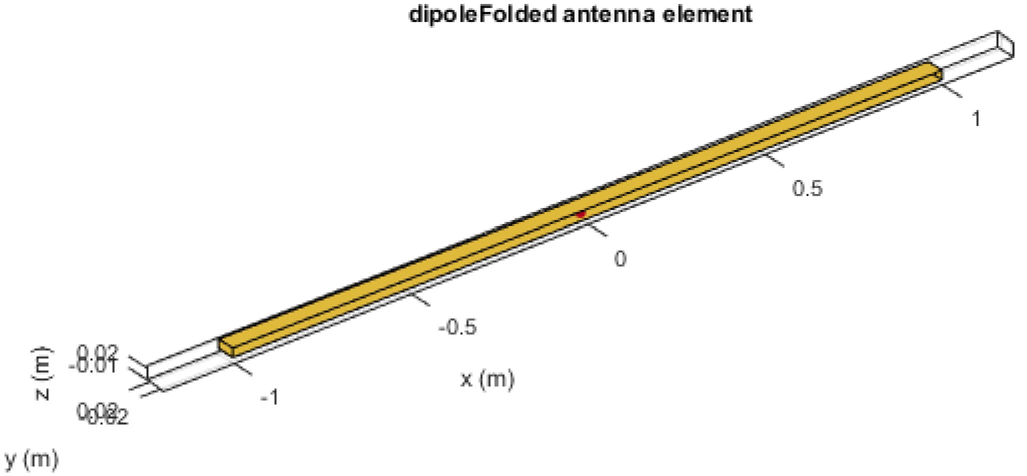
Examples

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]
```



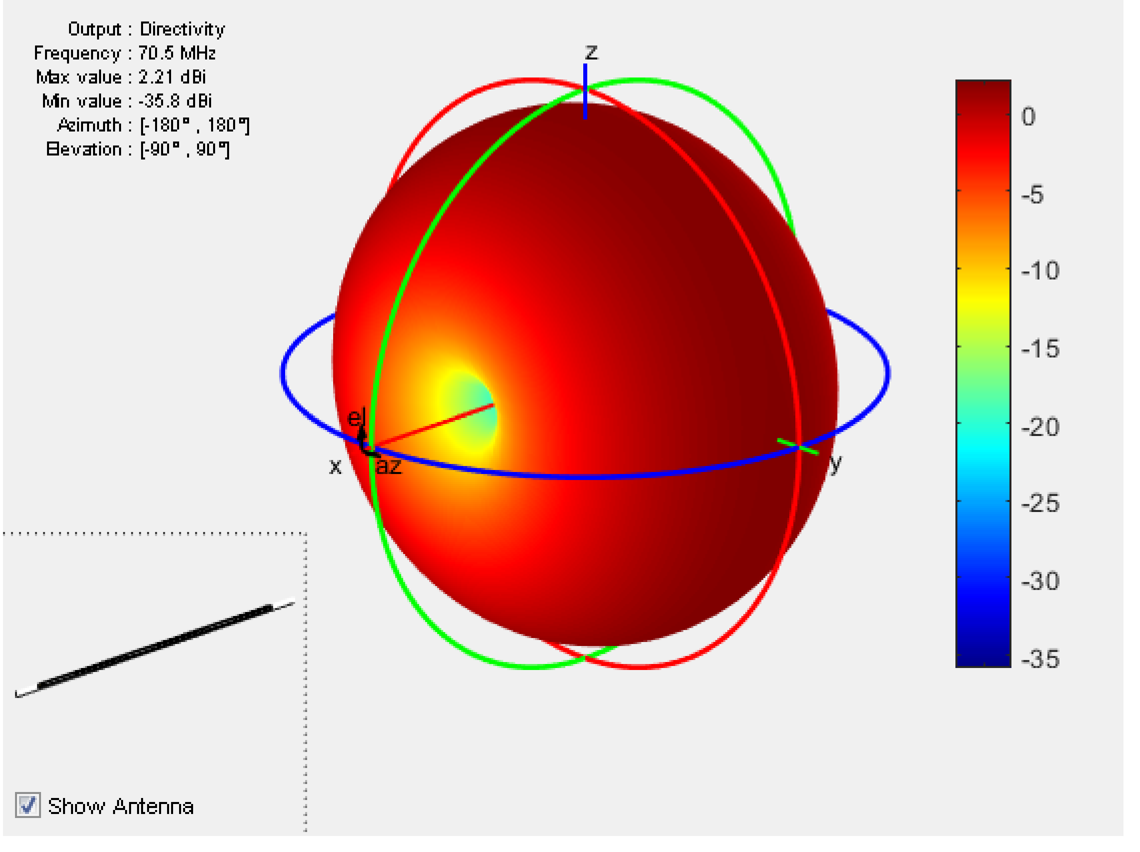
Raditaion Pattern of Folded Dipole Antenna

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]
```



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

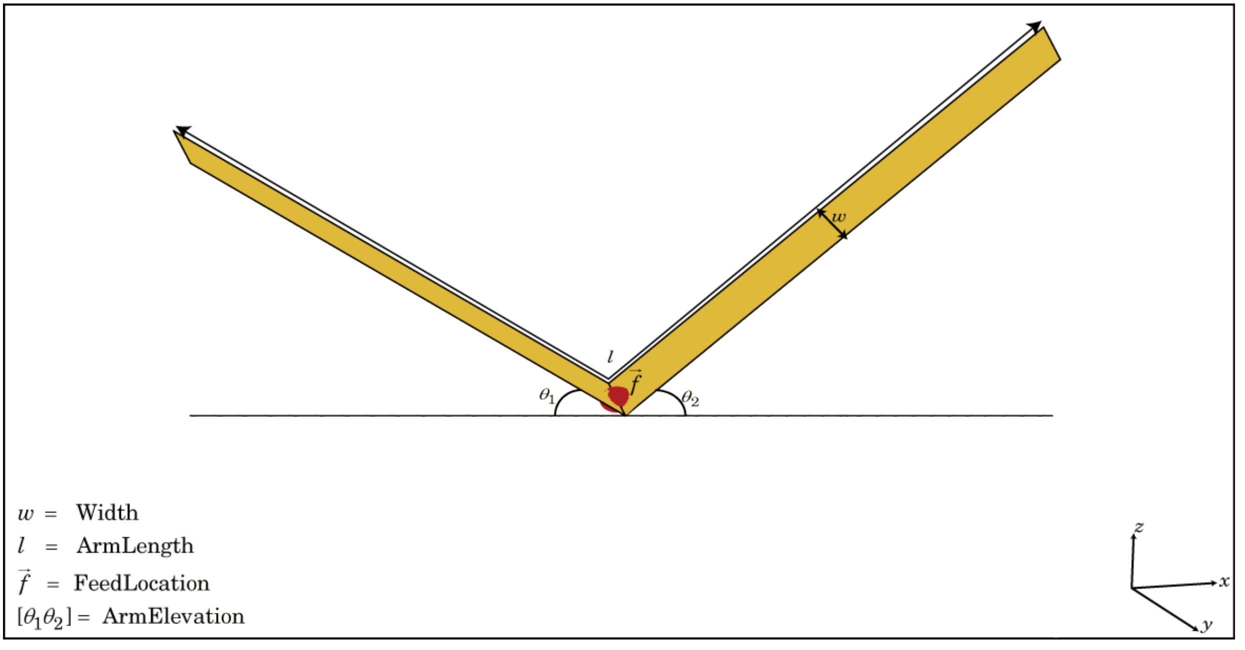
bowtieTriangular | dipole | monopole | `cylinder2strip`

Introduced in R2015a

dipoleVee class

Create V-dipole antenna

Description



The `dipoleVee` class creates 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.

Construction

`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`

`'Tilt'` — Tilt angle of antenna
0 (default) | scalar in degrees

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

Example: `'Tilt'`,90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

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

Data Types: `double`

Definitions

To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, "Rotate Antenna Elements".

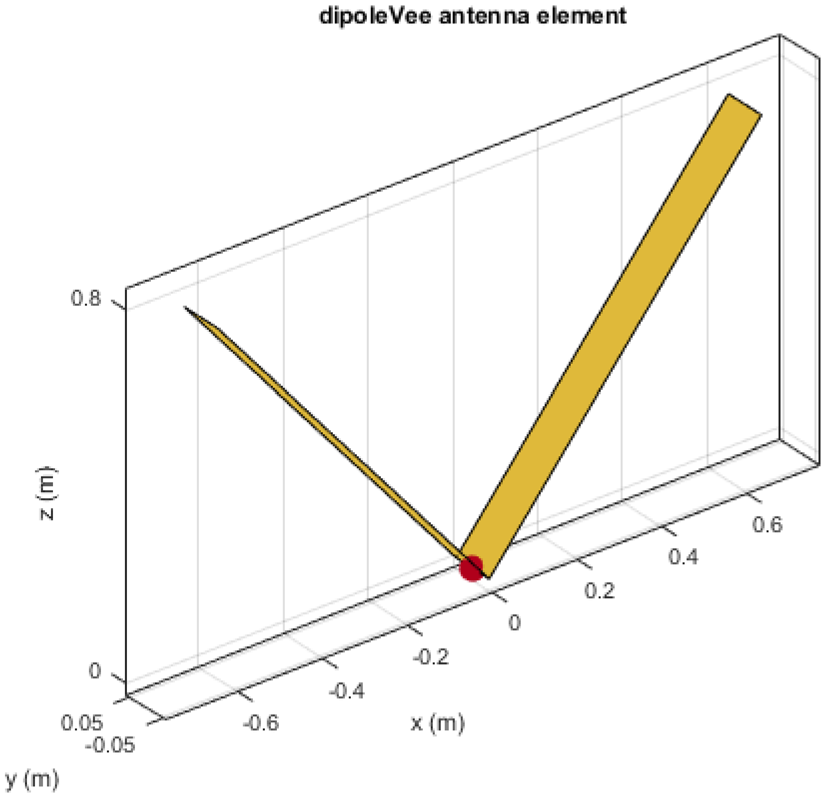
Examples

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)
```

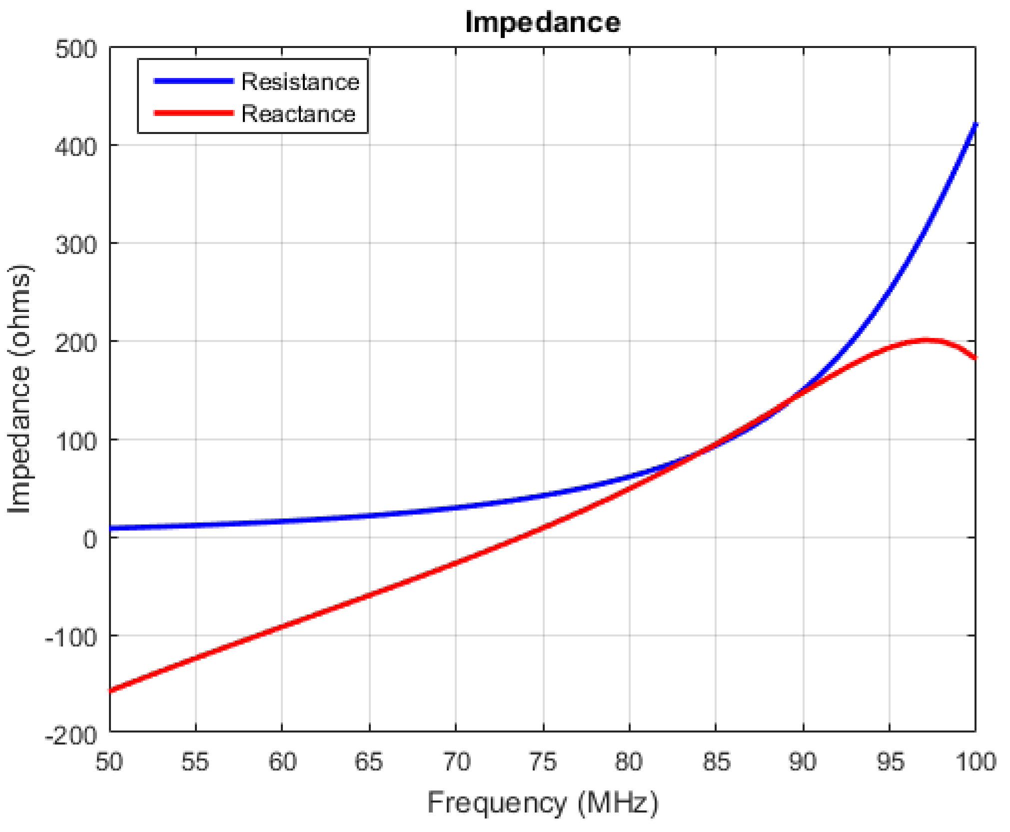
```
dv =

  dipoleVee with properties:

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



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

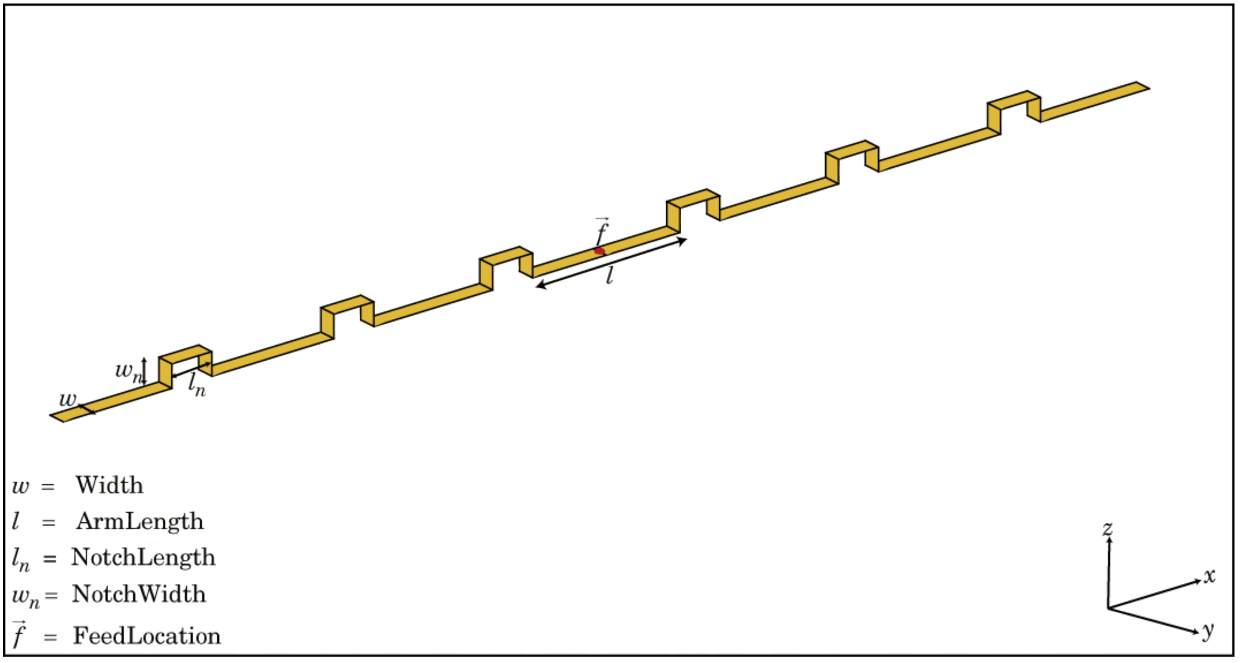
dipole | dipoleFolded | loopCircular | `cylinder2strip`

Introduced in R2015a

dipoleMeander class

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 Y-Z plane.

Construction

`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`

`'Tilt'` — Tilt angle of antenna
0 (default) | scalar in degrees

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

Example: `'Tilt'`,90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

Example: 'TiltAxis',[1 0 0]

Data Types: double

Definitions

To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, "Rotate Antenna Elements".

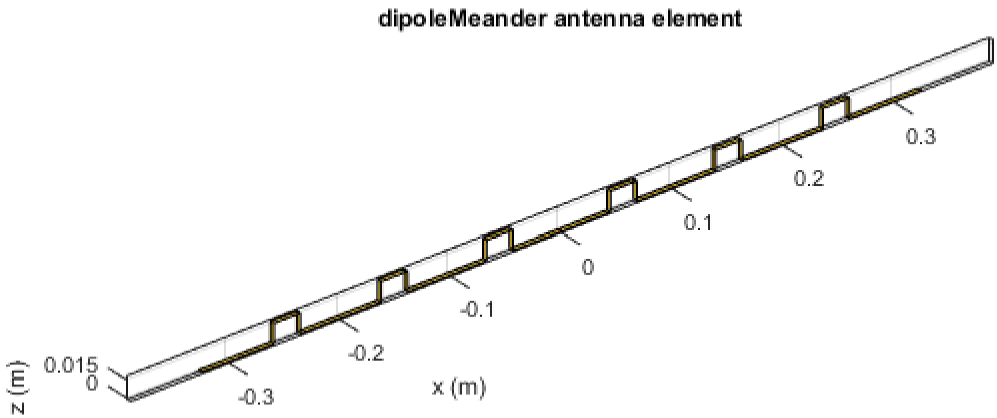
Examples

Create and View Meander Dipole Antenna

Create and view the default meander dipole antenna.

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

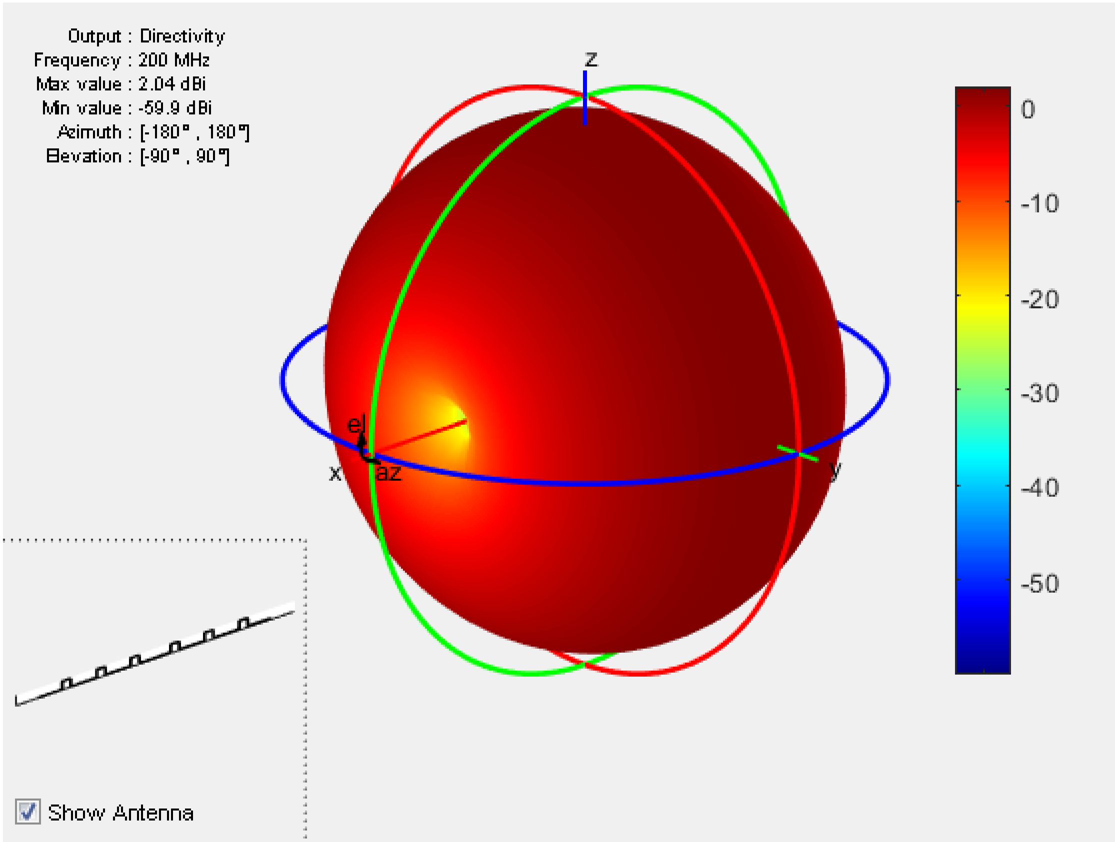
```
dm =

  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]
```



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

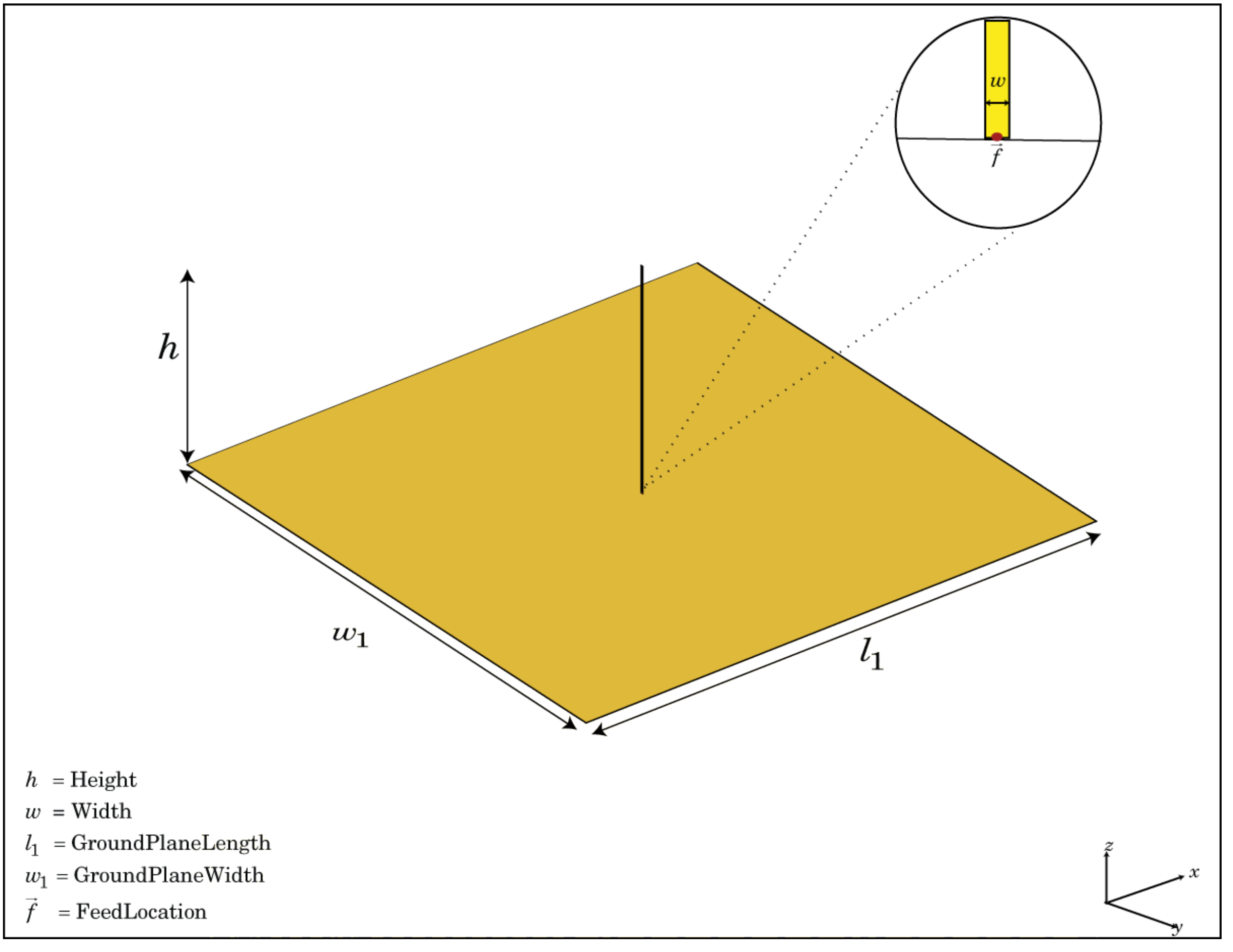
dipole | dipoleFolded | loopCircular

Introduced in R2015a

monopole class

Create monopole antenna over rectangular ground plane

Description



The `monopole` class creates 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.

Construction

`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`

`'Tilt'` — Tilt angle of antenna
0 (default) | scalar in degrees

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

Example: `'Tilt'`,90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

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

Data Types: `double`

Definitions

To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, “Rotate Antenna Elements”.

Examples

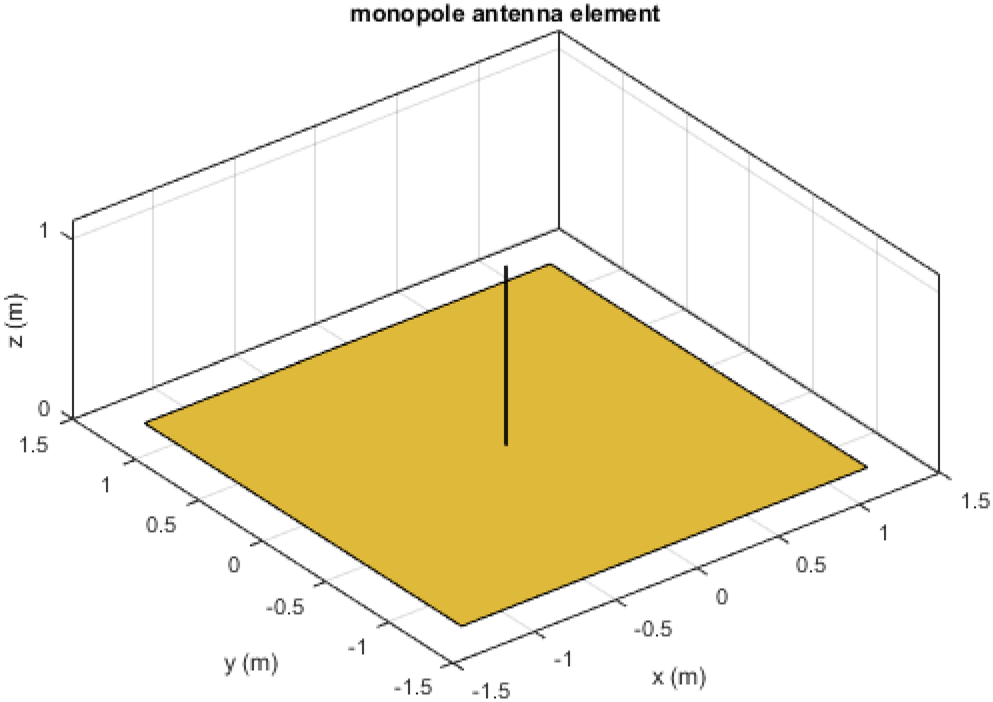
Create and View Monopole Antenna

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 =
```

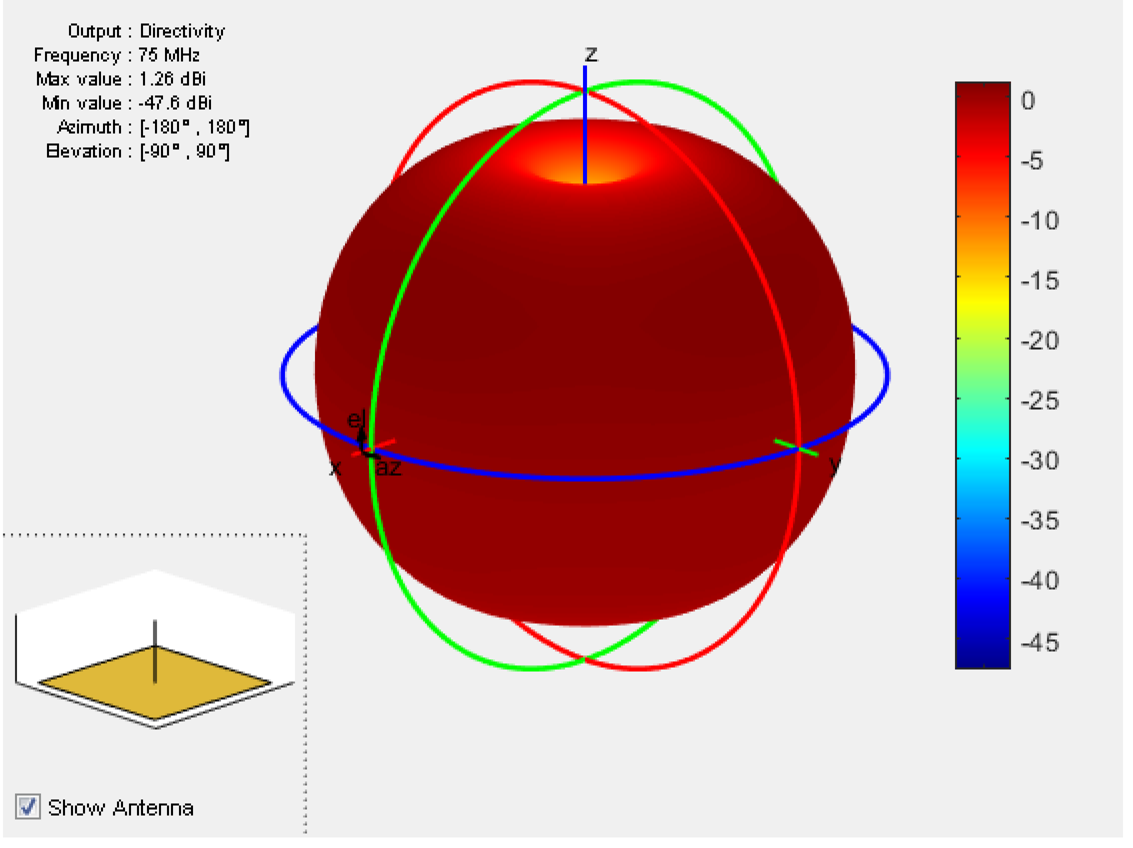
```
monopole with properties:

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



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

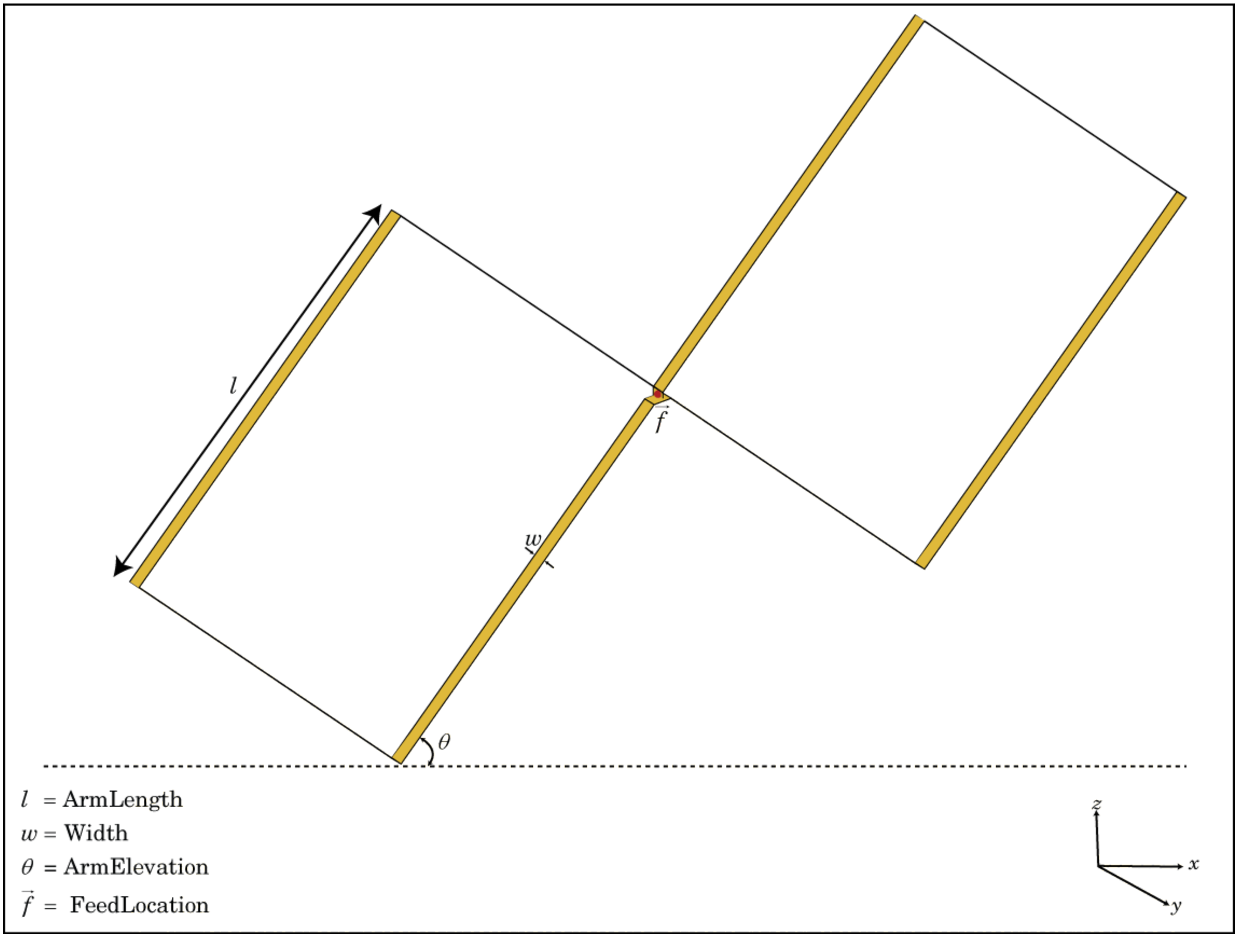
dipole | patchMicrostrip | monopoletophat

Introduced in R2015a

biquad class

Create biquad antenna

Description



The `biquad` class creates a biquad antenna. The 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:

$$w = 2d = 4r$$

- 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.

Construction

`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`

`'Tilt'` — Tilt angle of antenna
0 (default) | scalar in degrees

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

Example: `'Tilt'`,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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

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

Data Types: `double`

Definitions

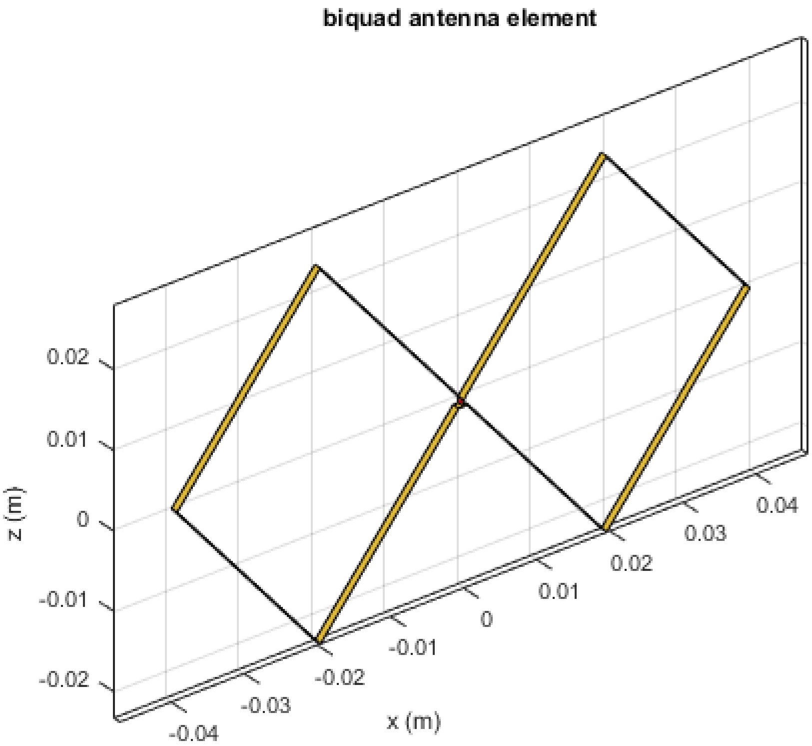
To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, “Rotate Antenna Elements”.

Examples

Create and View Biquad Antenna

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

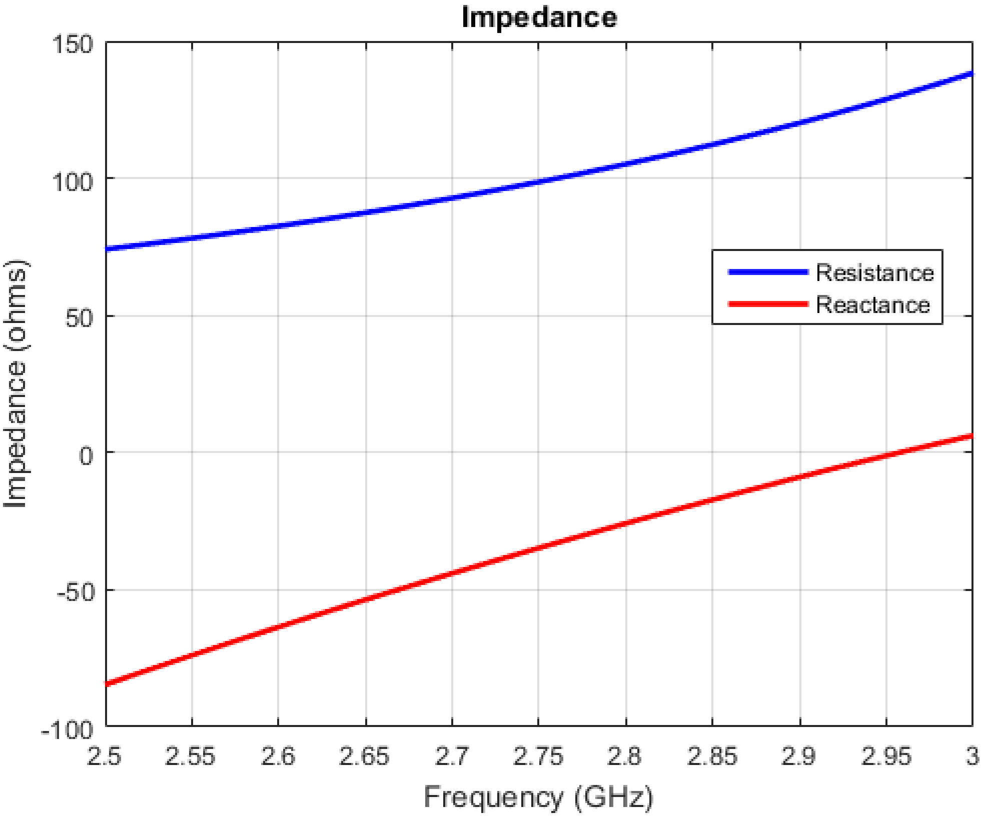
```
bq = biquad('ArmElevation',50);
show(bq)
```



Impedance of Biquad Antenna

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

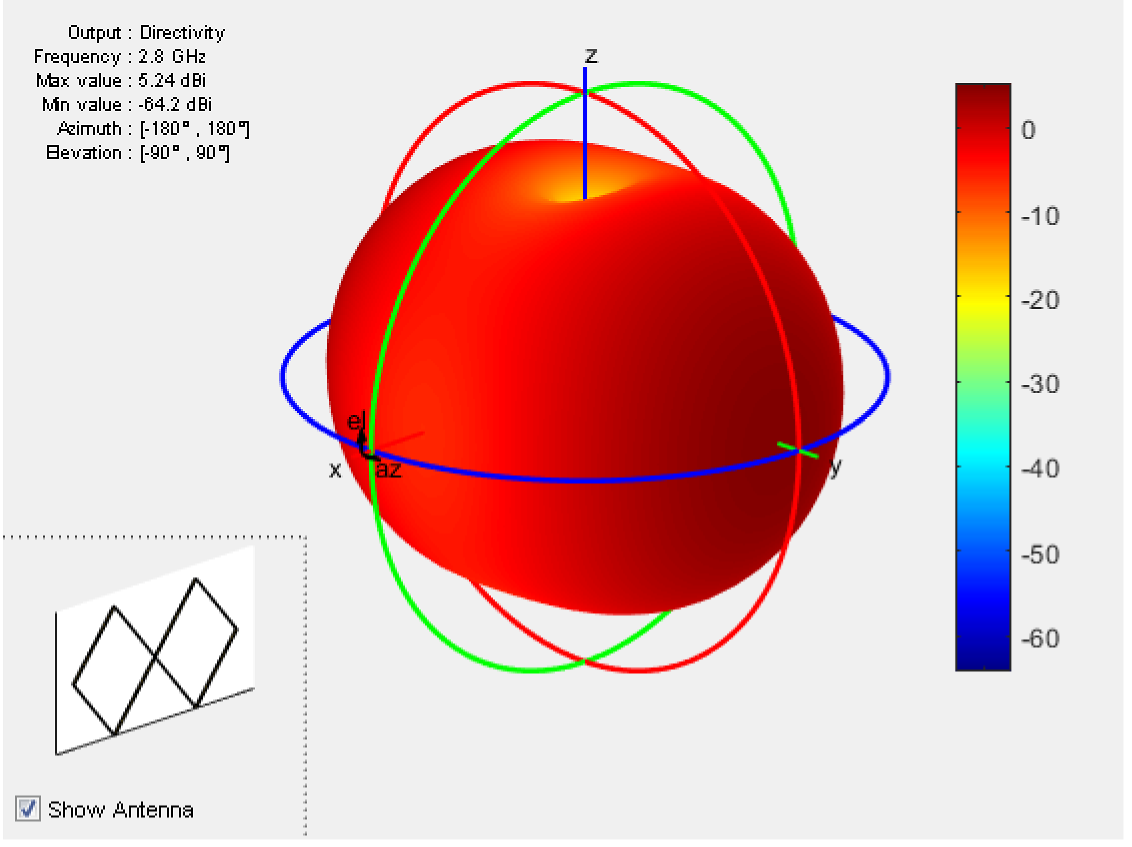
```
bq = biquad('ArmElevation',50);
impedance(bq,linspace(2.5e9,3e9,51));
```



Radiation Pattern of Biquad Antenna

Calculate the radiation pattern of a biquad antenna at a frequency of 2.8 GHz.

```
bq = biquad('ArmElevation',50);
pattern(bq, 2.8e9)
```



See Also

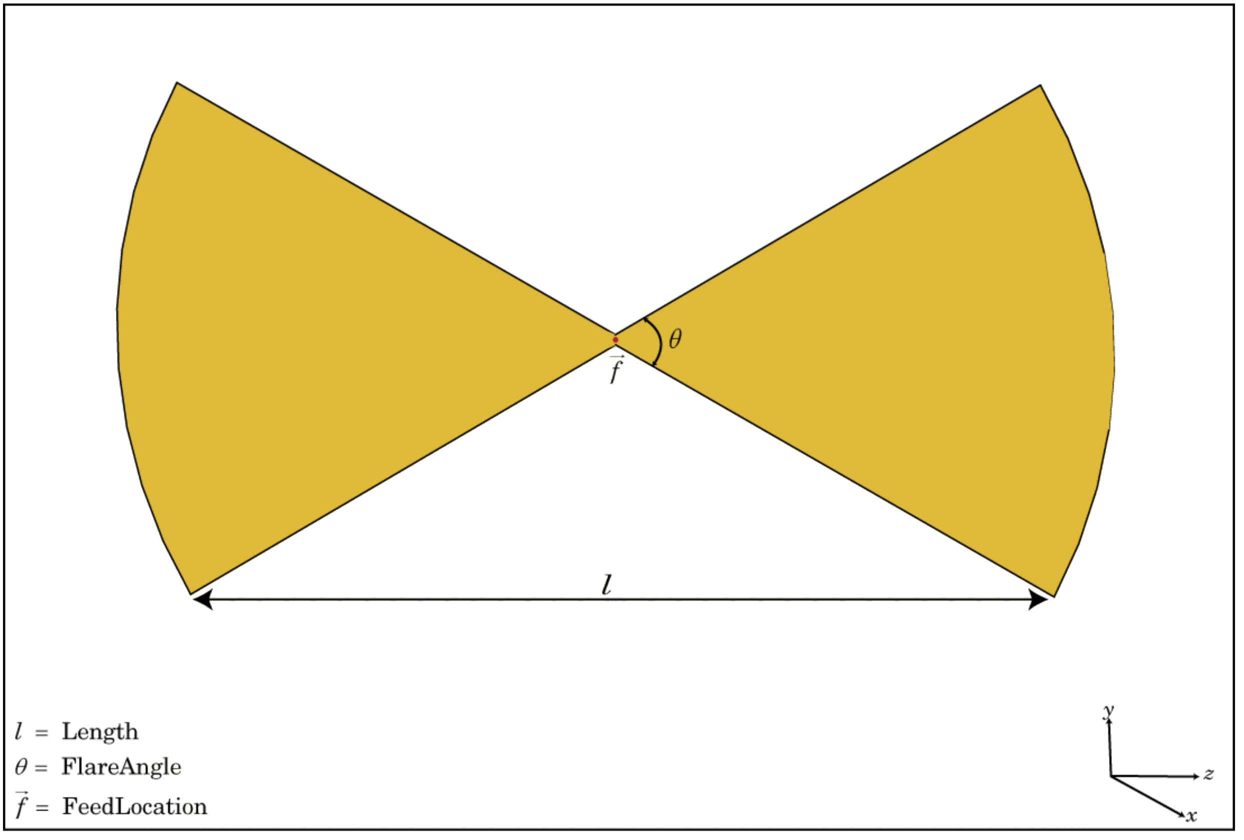
dipole | dipoleFolded | loopCircular

Introduced in R2015b

bowtieRounded class

Create rounded bowtie dipole antenna

Description



The `bowtieRounded` class creates 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.

Construction

`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`

`Tilt` — Tilt angle of antenna

0 (default) | scalar in degrees

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

Example: `'Tilt'`, 90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

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

Data Types: `double`

Definitions

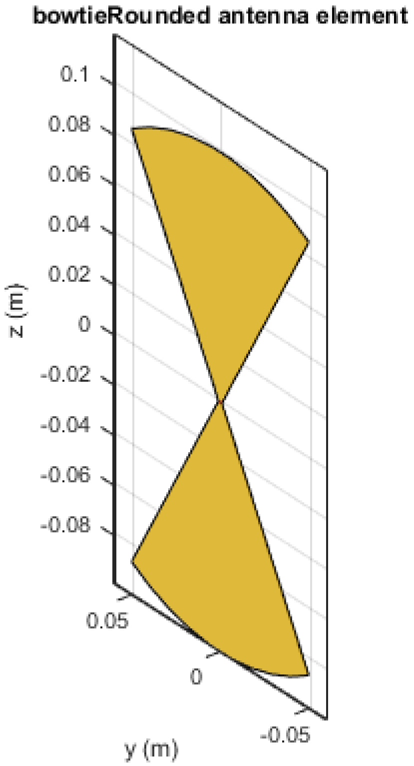
To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, “Rotate Antenna Elements”.

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.

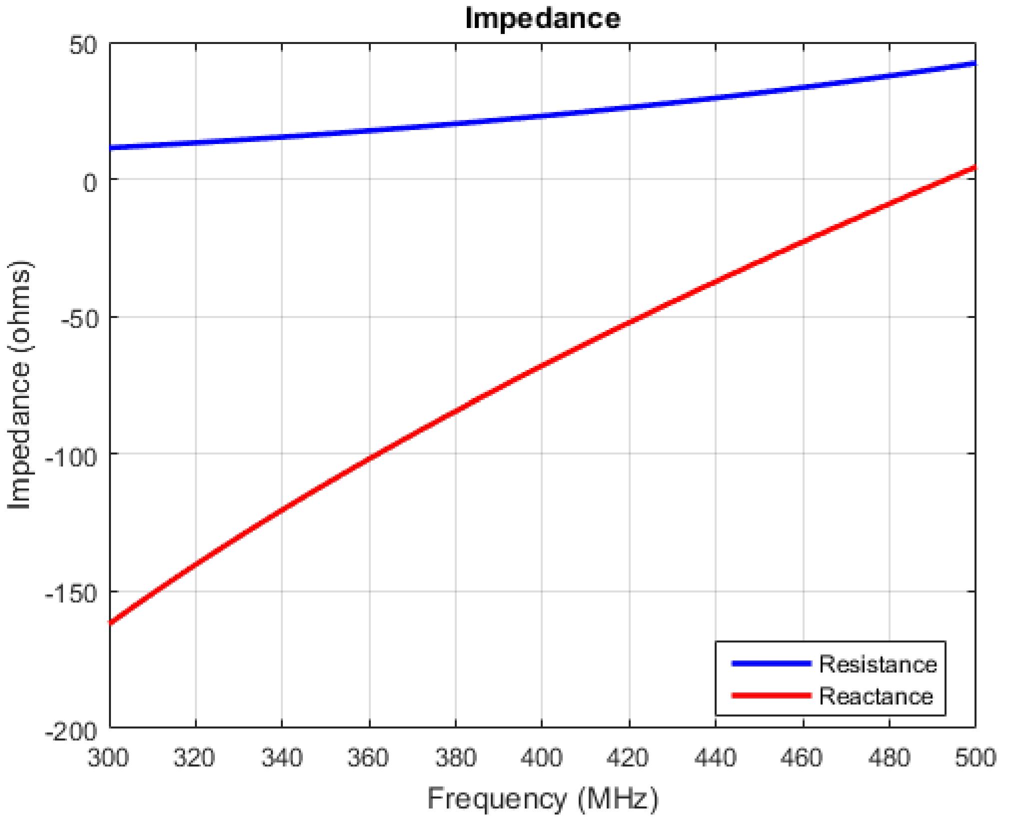
```
b = bowtieRounded('FlareAngle',60);
show(b);
```



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

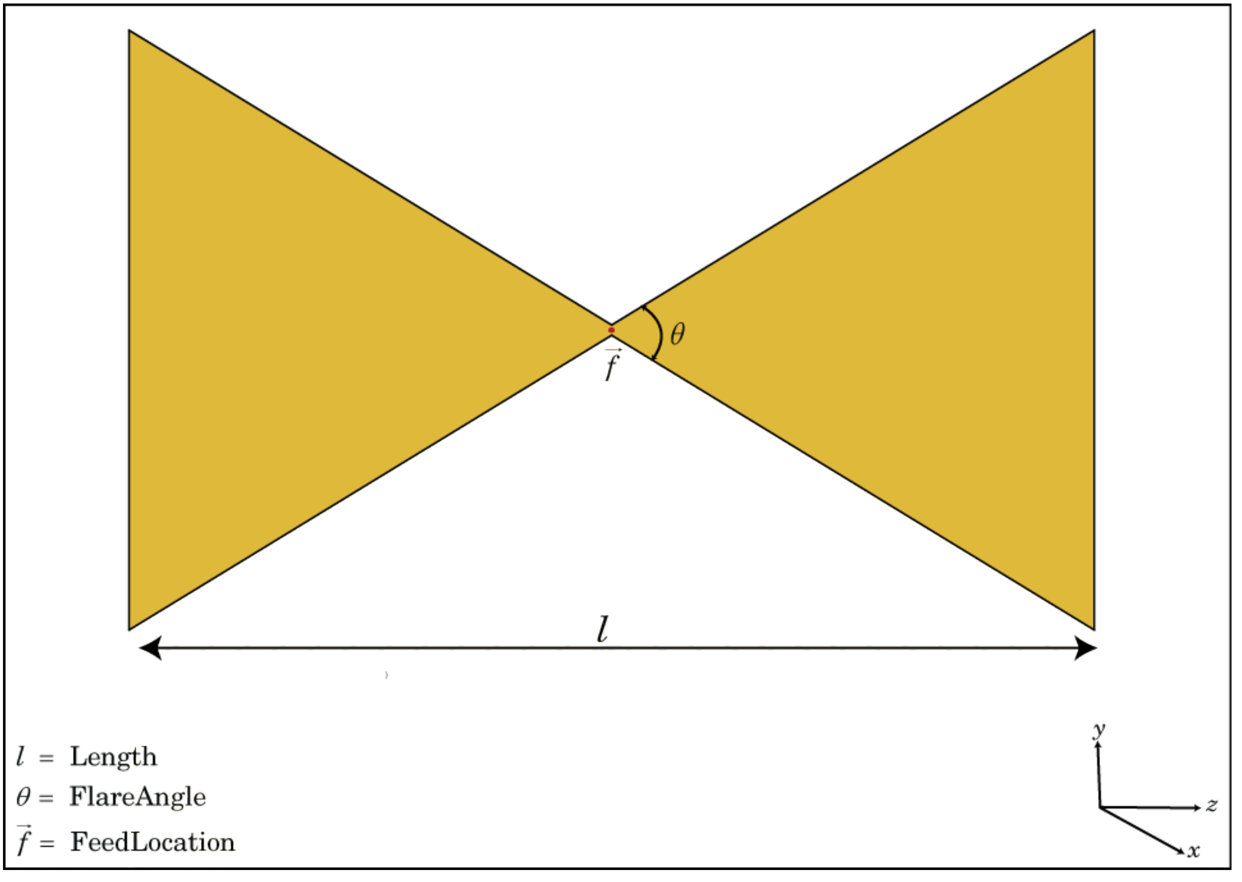
dipole | dipoleFolded | bowtieTriangular

Introduced in R2015a

bowtieTriangular class

Create planar bowtie dipole antenna

Description



The `bowtieTriangular` class creates 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.

Construction

`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`

`Tilt` — Tilt angle of antenna
0 (default) | scalar in degrees

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

Example: `'Tilt'`,90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

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

Data Types: `double`

Definitions

To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, “Rotate Antenna Elements”.

Examples

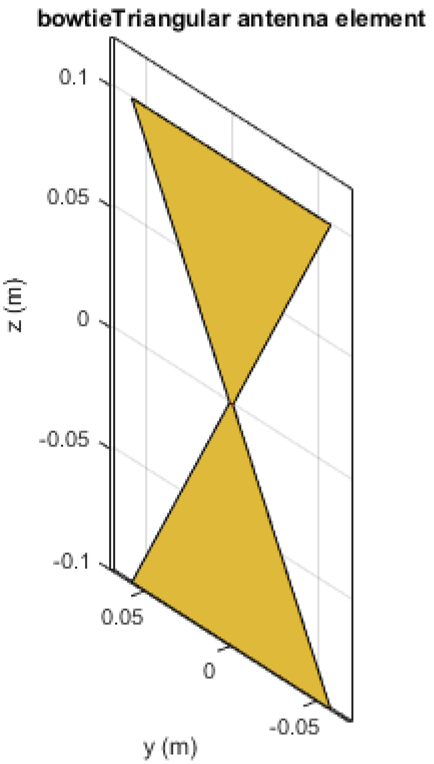
Create and View Center-Fed Planar Bowtie Antenna

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
```

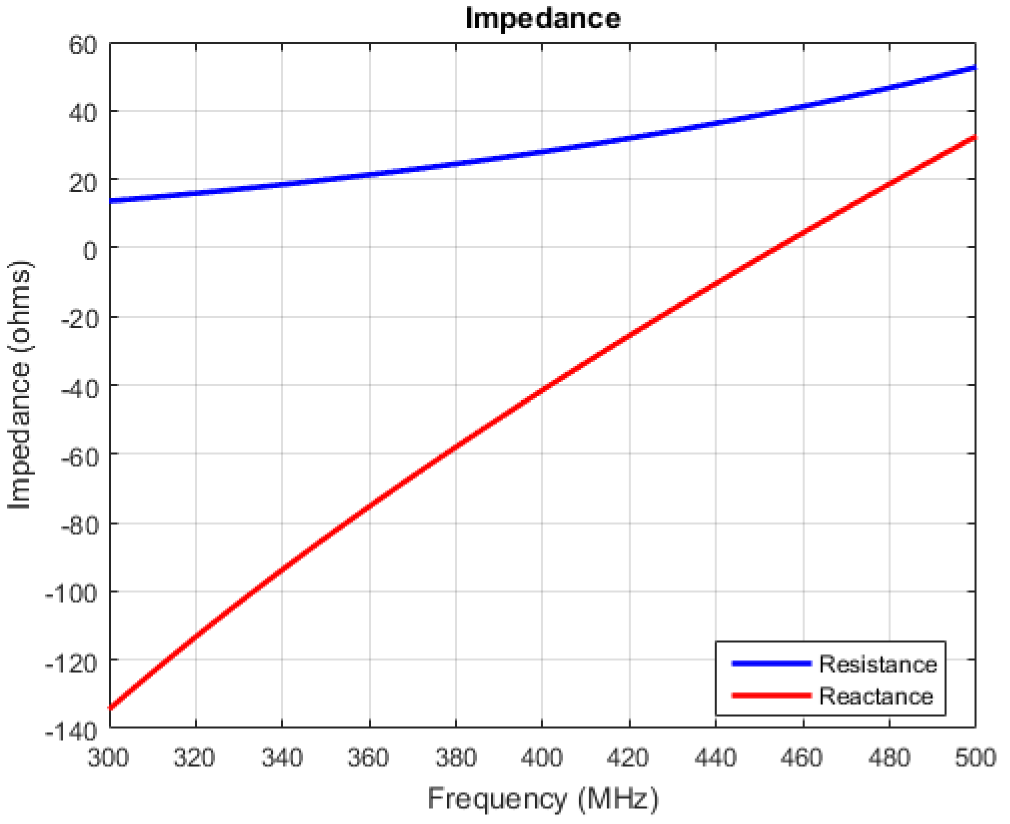
```
    FlareAngle: 60
          Tilt: 0
      TiltAxis: [1 0 0]
```



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

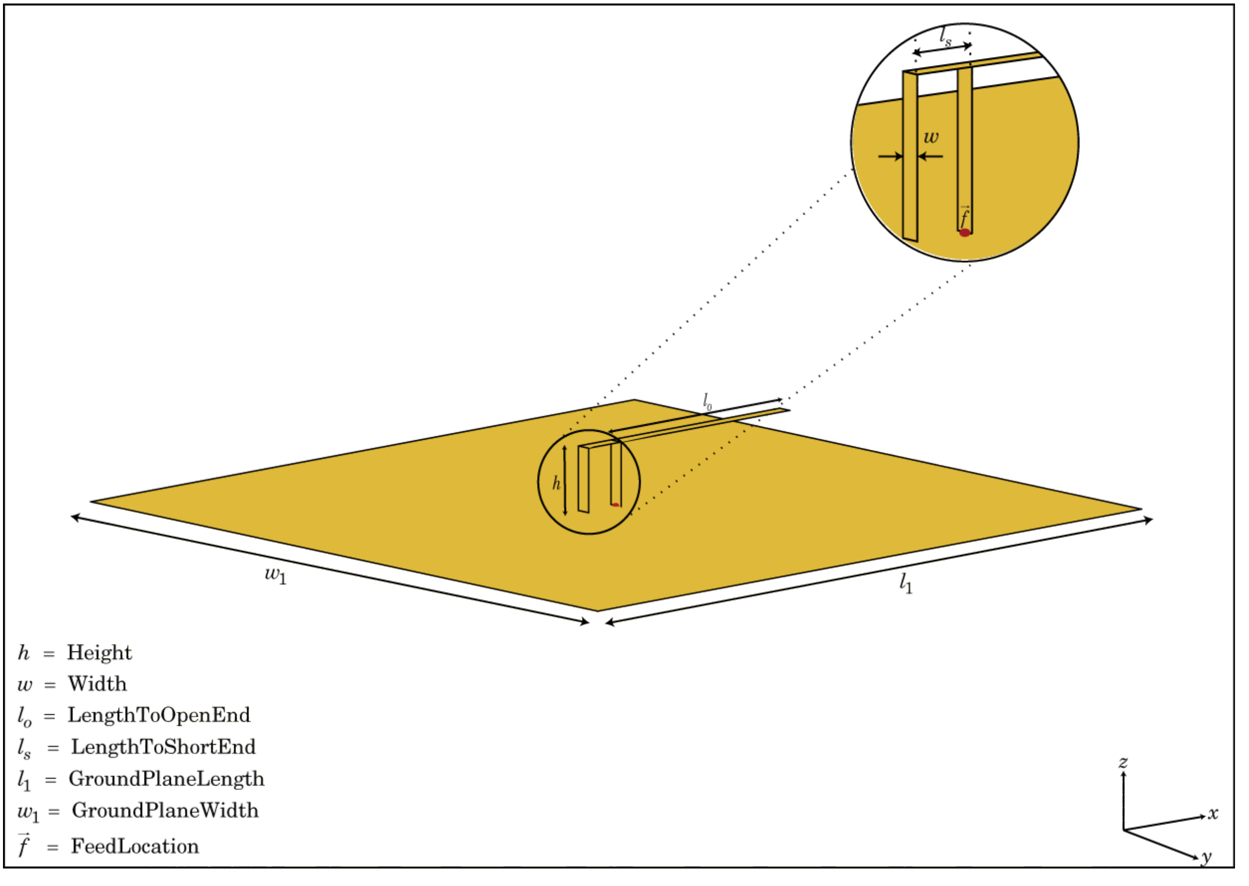
dipole | dipoleVee | bowtieRounded

Introduced in R2015a

invertedF class

Create inverted-F antenna over rectangular ground plane

Description



The `invertedF` class creates 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.

Construction

`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

'Tilt' — Tilt angle of antenna
0 (default) | scalar in degrees

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

Example: 'Tilt',90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

Example: 'TiltAxis',[1 0 0]

Data Types: double

Definitions

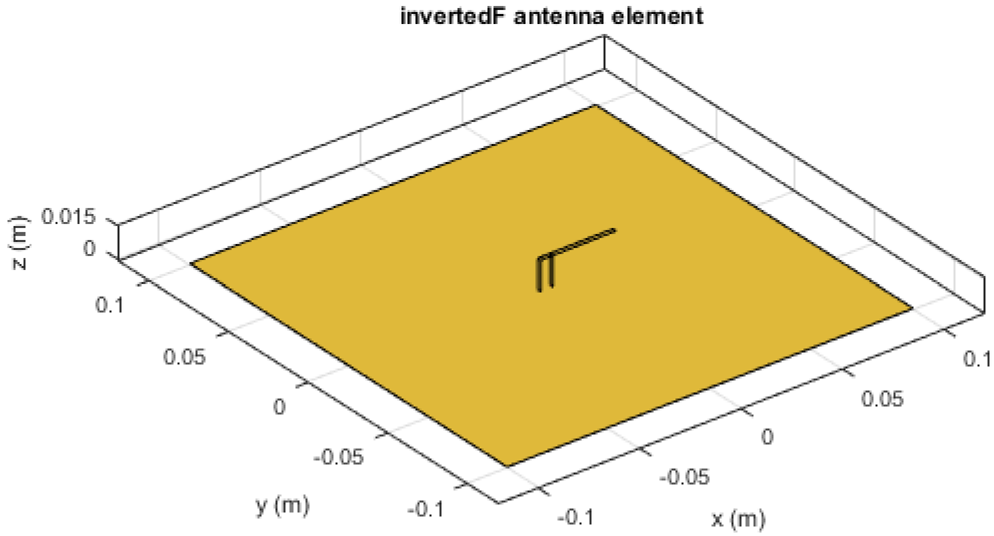
To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, “Rotate Antenna Elements”.

Examples

Create and View Inverted-F Antenna

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

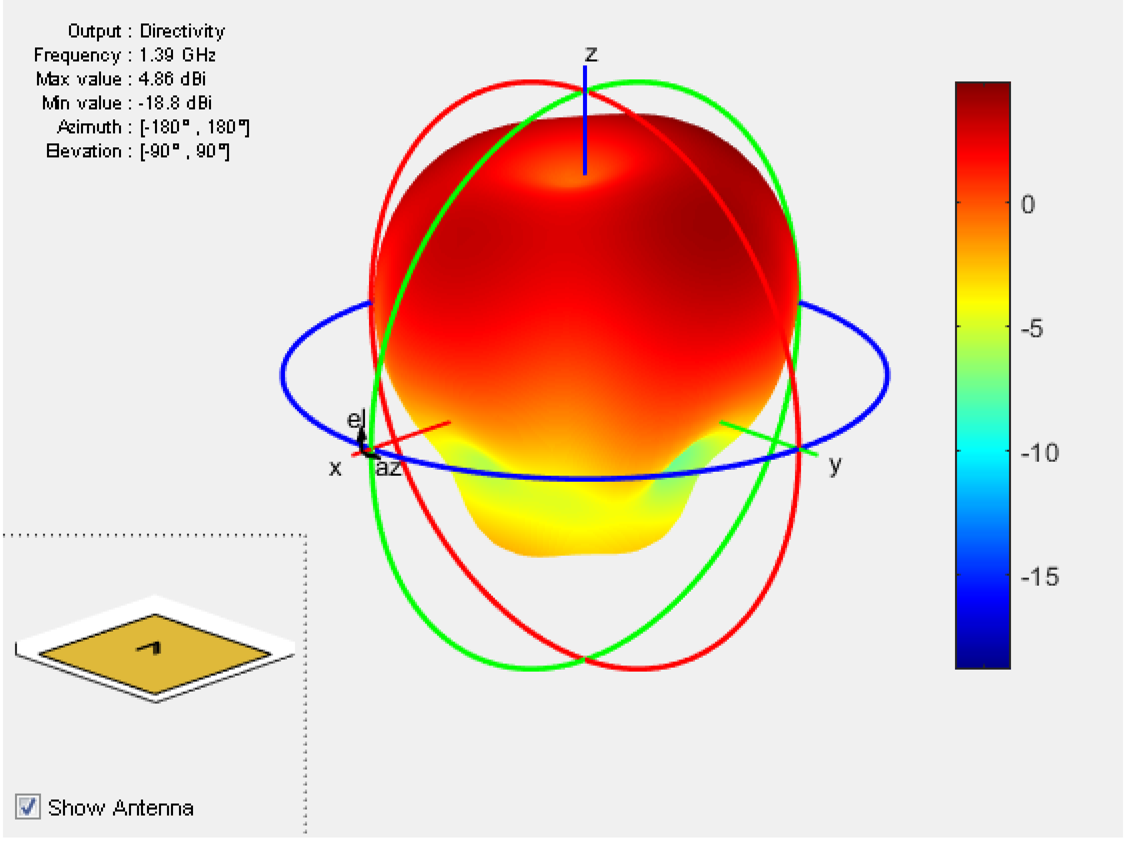
```
f = invertedF('Height',14e-3, 'GroundPlaneLength',200e-3,          ...
                  'GroundPlaneWidth',200e-3);
show(f)
```



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

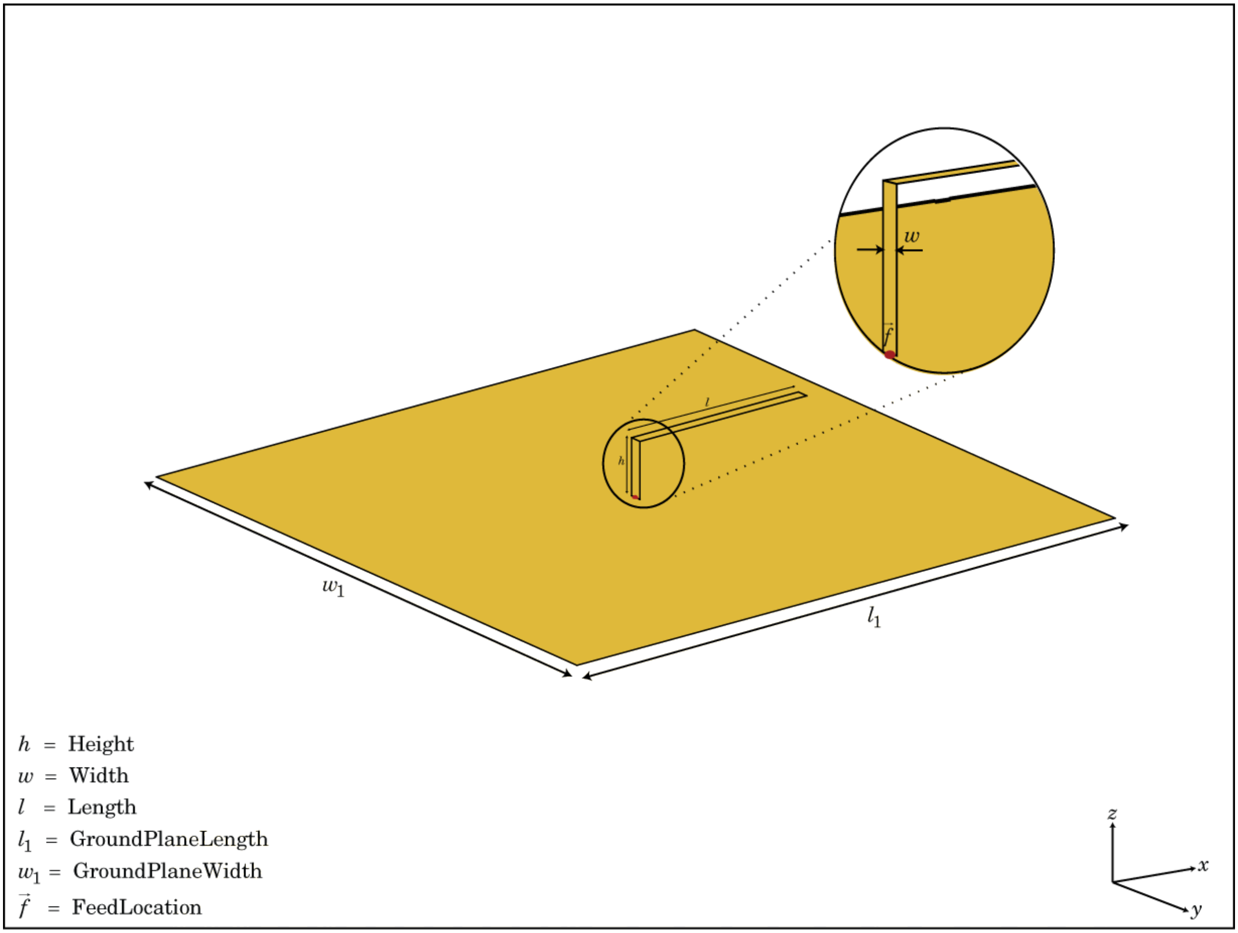
pifa | patchMicrostrip | `cylinder2strip` | invertedF

Introduced in R2015a

invertedL class

Create inverted-L antenna over rectangular ground plane

Description



The `invertedF` class creates 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.

Construction

`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`

`'Tilt'` — Tilt angle of antenna
0 (default) | scalar in degrees

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

Example: `'Tilt'`,90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

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

Data Types: `double`

Definitions

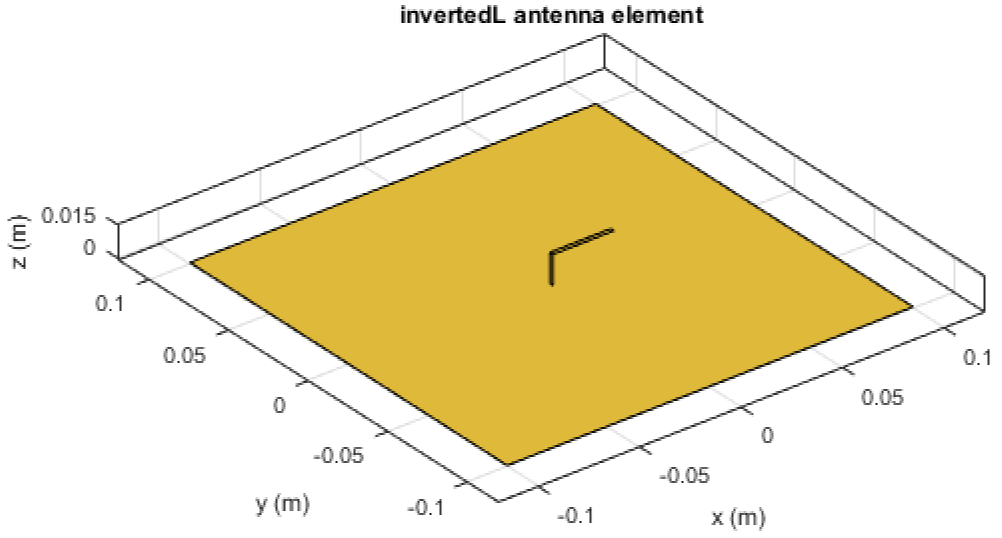
To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, “Rotate Antenna Elements”.

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.

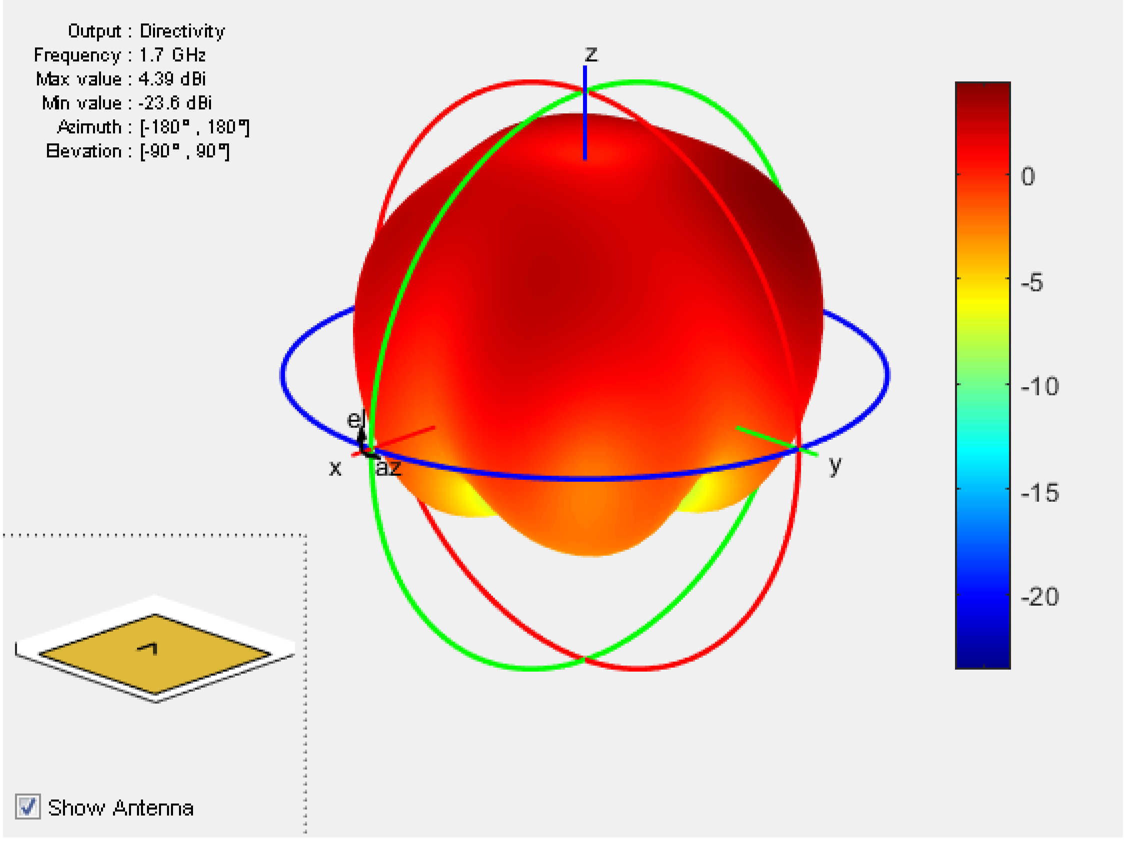
```
il = invertedL('Length',30e-3, 'GroundPlaneLength',200e-3,...
                    'GroundPlaneWidth',200e-3);
show(il)
```



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

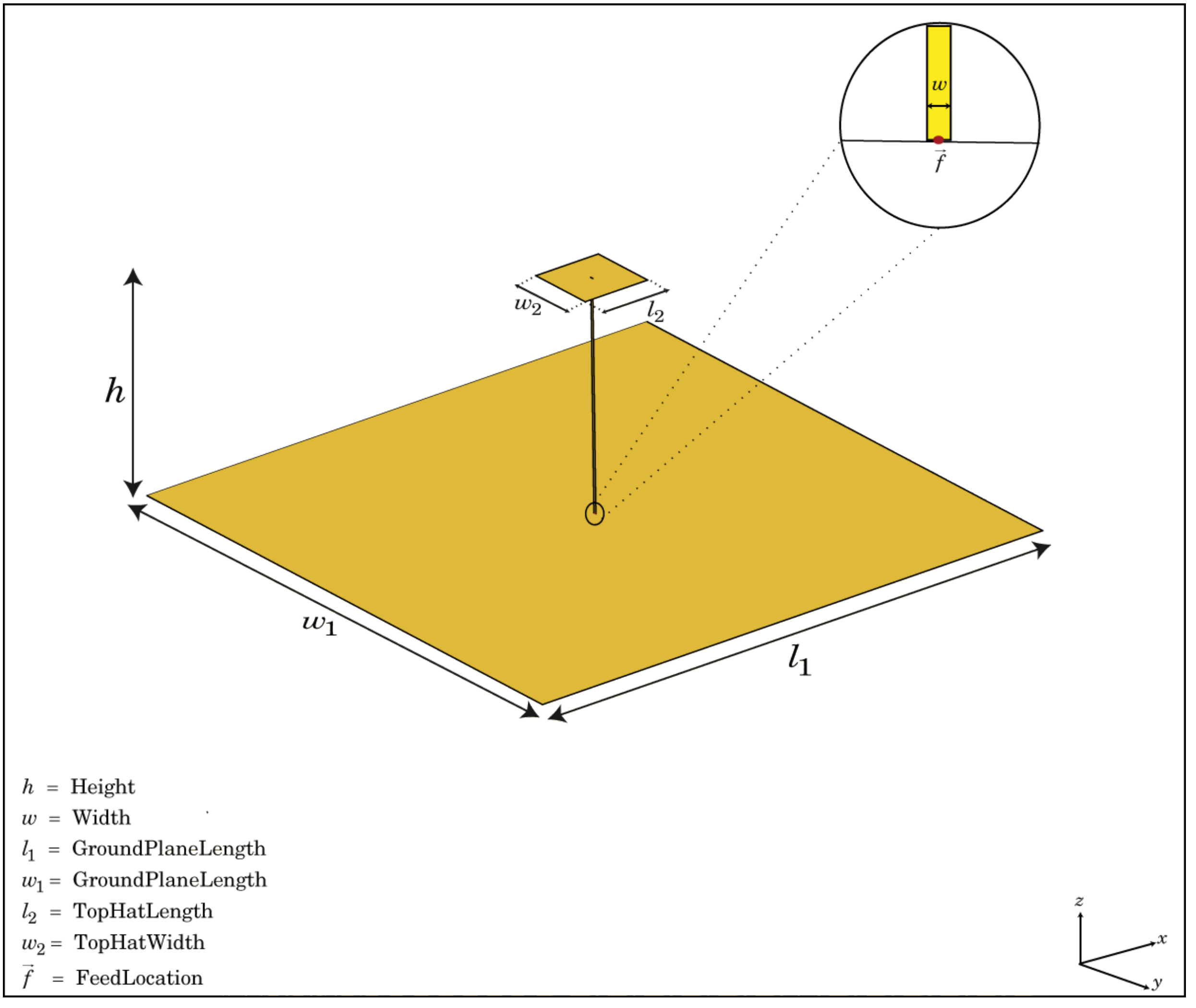
vivaldi | invertedF | `cylinder2strip` | monopole

Introduced in R2015a

monopoleTopHat class

Create capacitively loaded monopole antenna over rectangular ground plane

Description



The `monopoleTopHat` class creates 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.

Construction

`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

'Tilt' — Tilt angle of antenna

0 (default) | scalar in degrees

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

Example: 'Tilt',90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

Example: 'TiltAxis',[1 0 0]

Data Types: double

Definitions

To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, “Rotate Antenna Elements”.

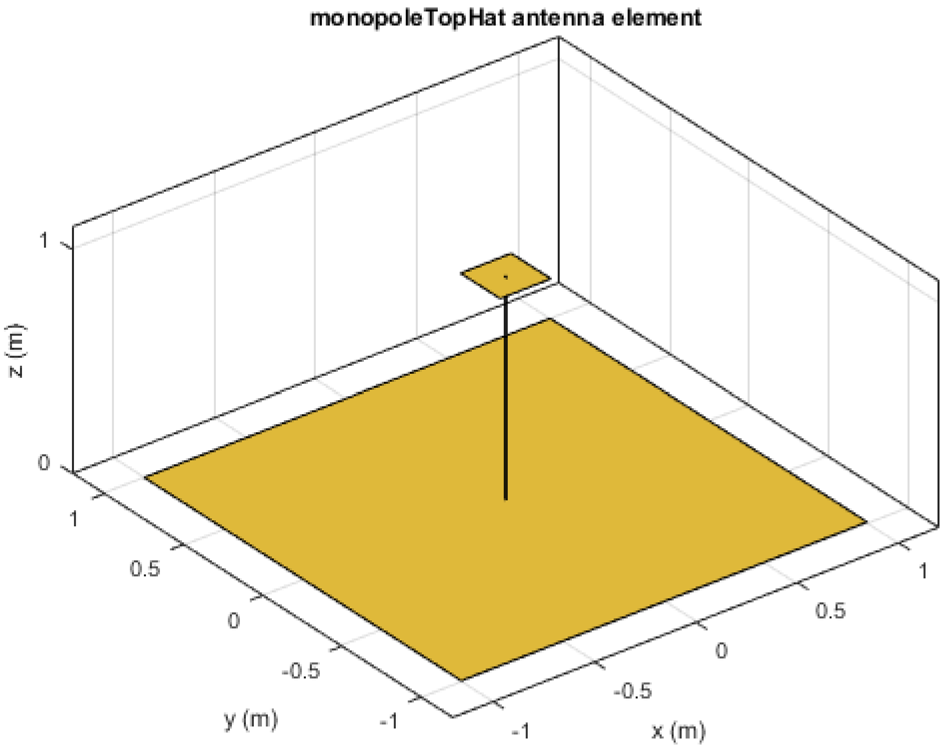
Examples

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)
```

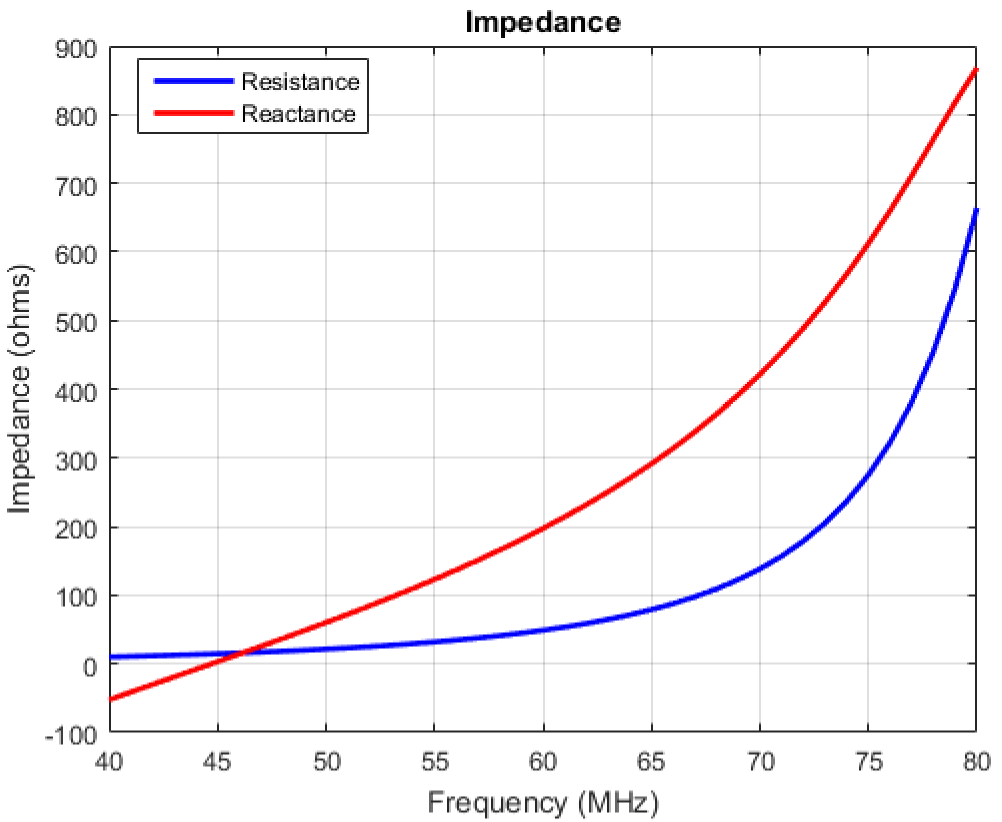
```
th = 

  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]
```



Calculate Impedance of Top Hat Monopole Antenna

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

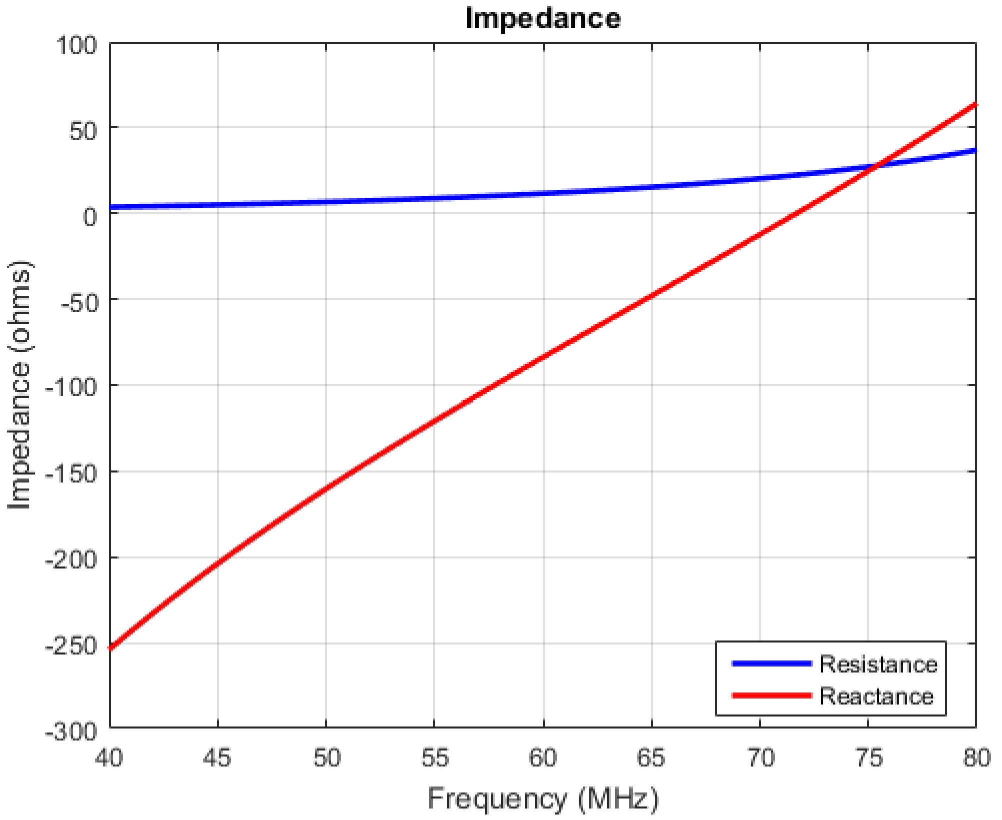
```
th = monopoleTopHat;
impedance(th,linspace(40e6,80e6,41));
```



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

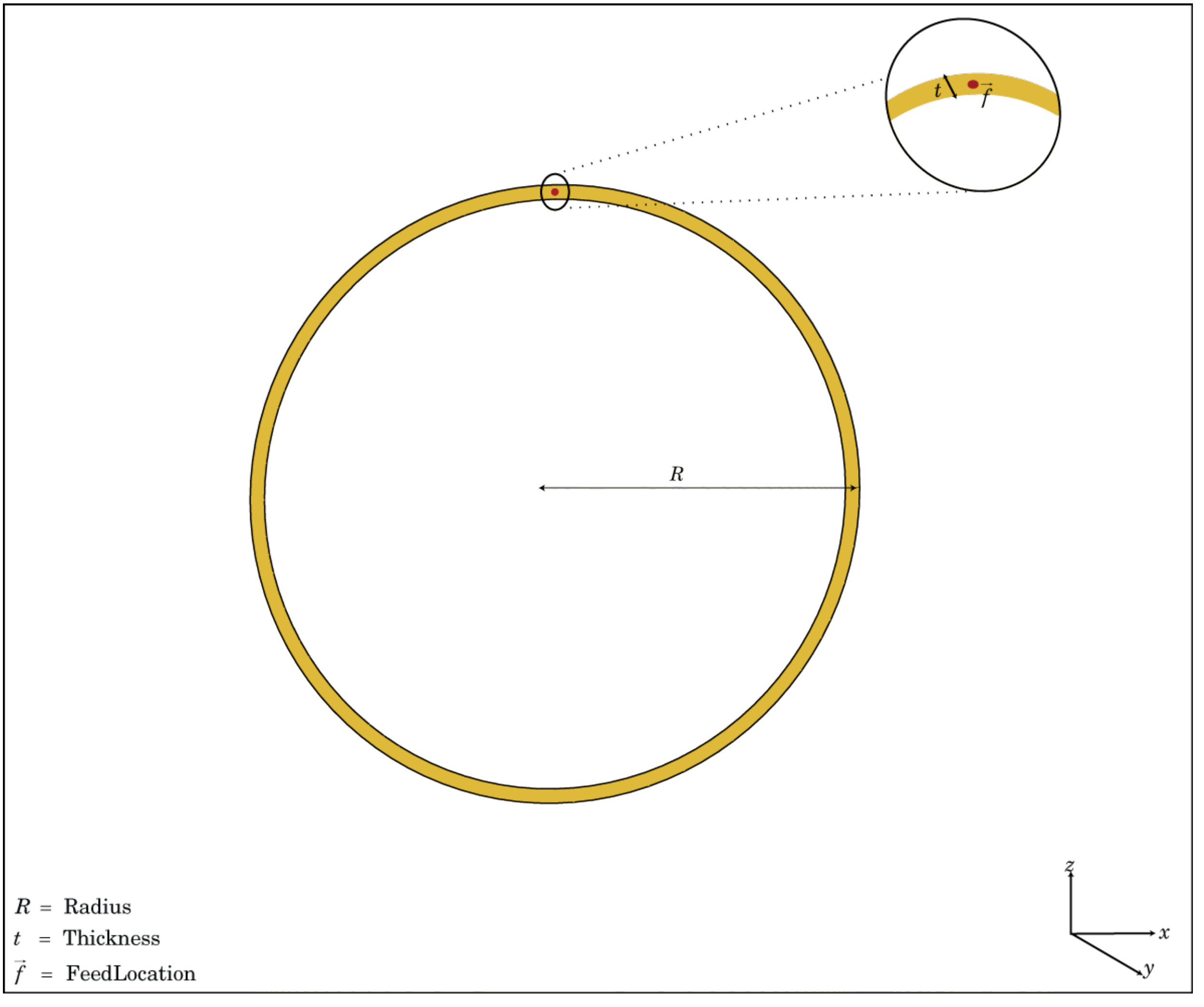
dipole | loopCircular | monopoletophat

Introduced in R2015a

loopCircular class

Create circular loop antenna

Description



The `loopCircular` class creates 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.

Construction

`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`

`'Tilt'` — Tilt angle of antenna
0 (default) | scalar in degrees

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

Example: `'Tilt'`,90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

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

Data Types: `double`

Definitions

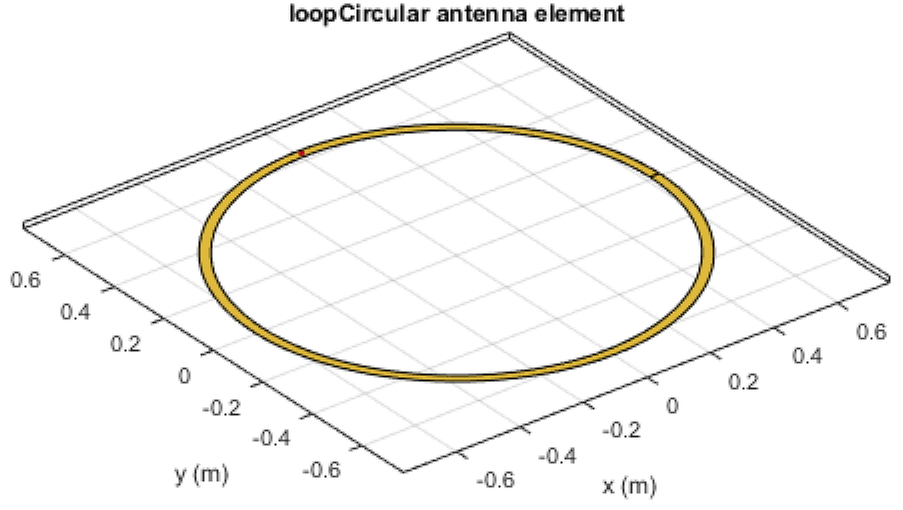
To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, “Rotate Antenna Elements”.

Examples

Create and View Circular Loop Antenna

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

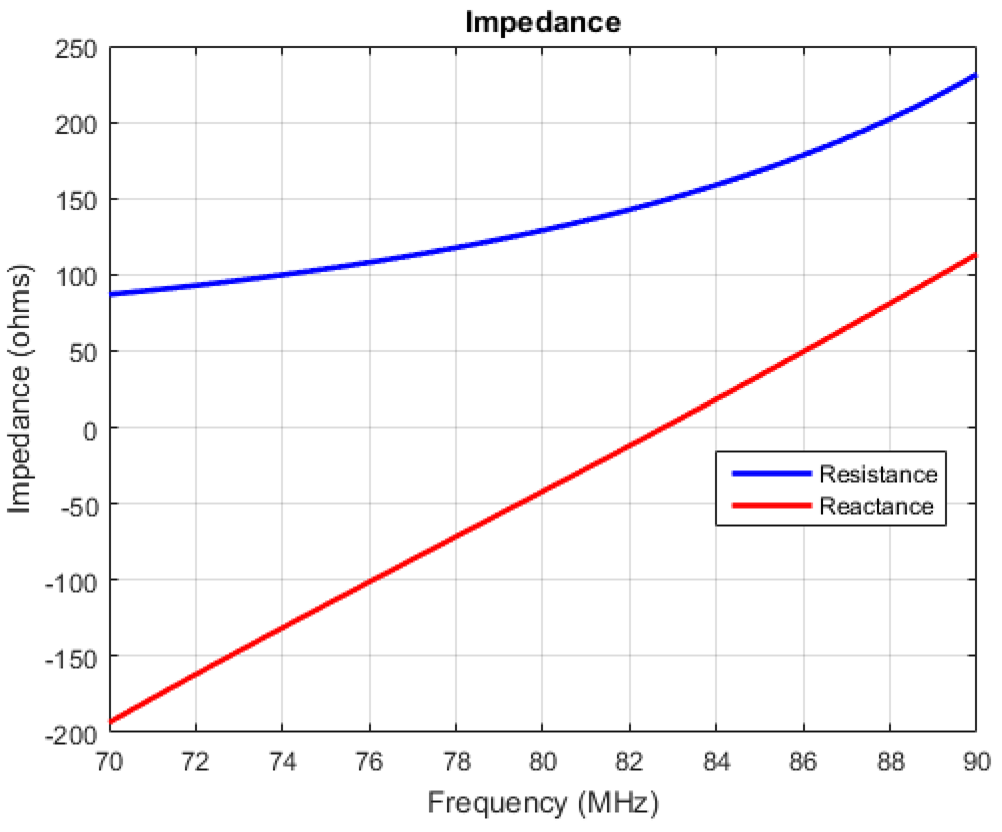
```
c = loopCircular('Radius',0.64,'Thickness',0.03);
show(c)
```



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

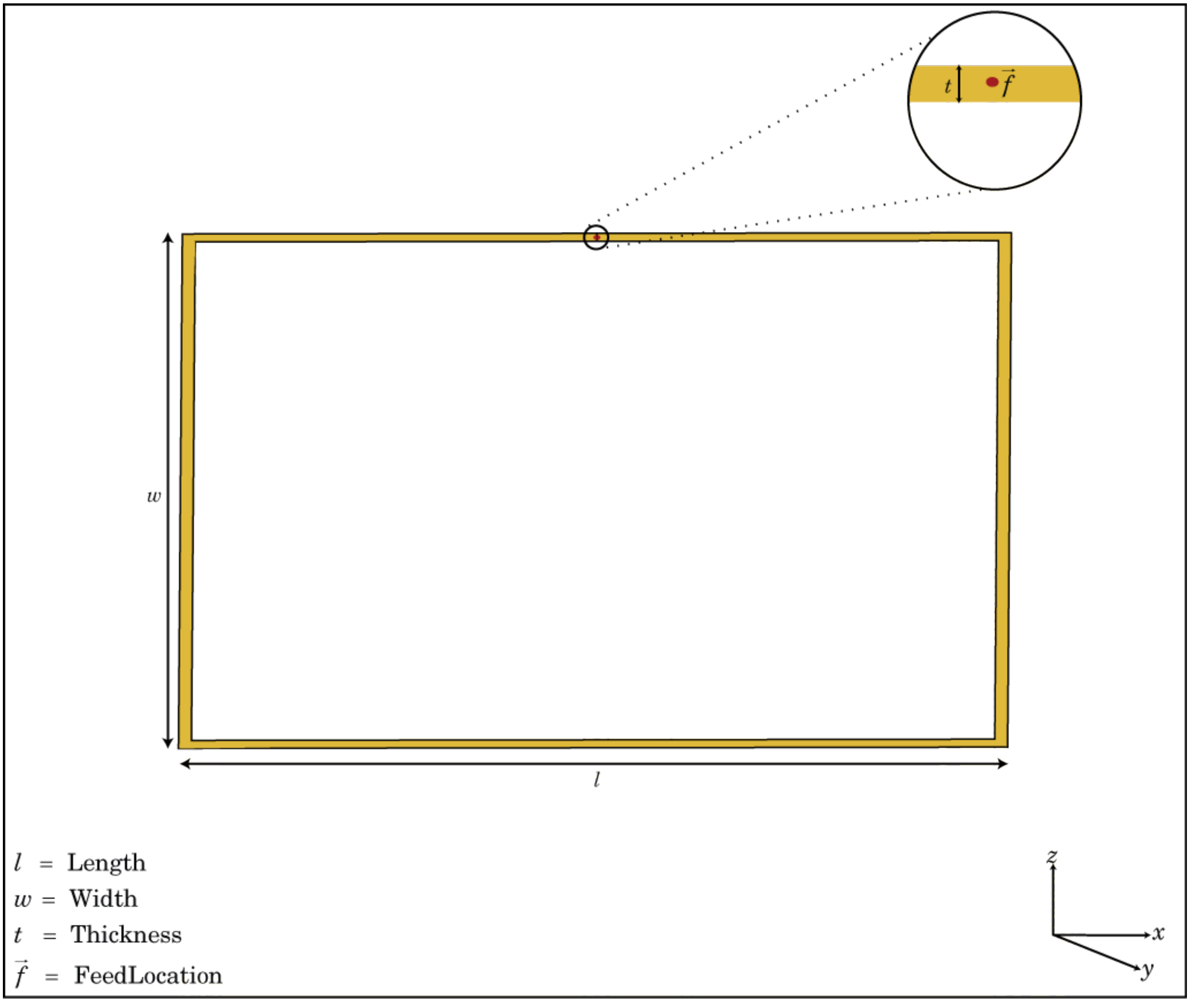
loopRectangular | dipole | slot

Introduced in R2015a

loopRectangular class

Create rectangular loop antenna

Description



The `loopRectangular` class creates 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.

Construction

`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`

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees

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

Example: `'Tilt'`,90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

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

Data Types: `double`

Definitions

To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, "Rotate Antenna Elements".

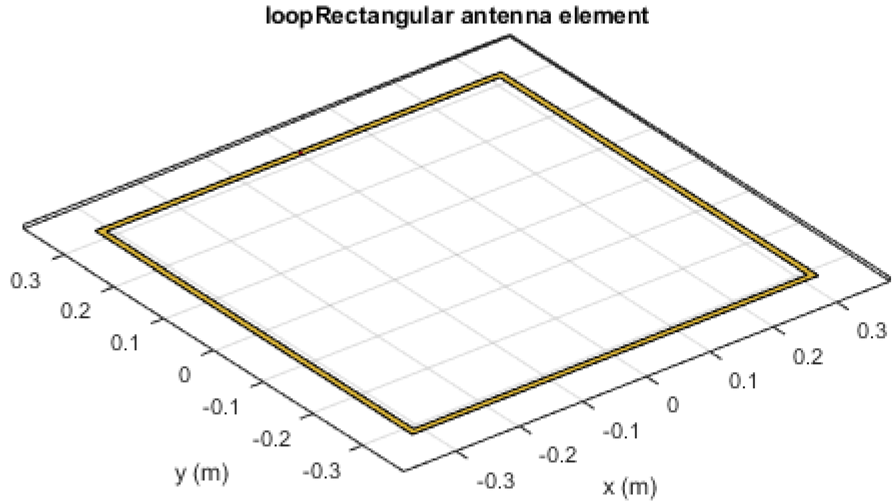
Examples

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]
```



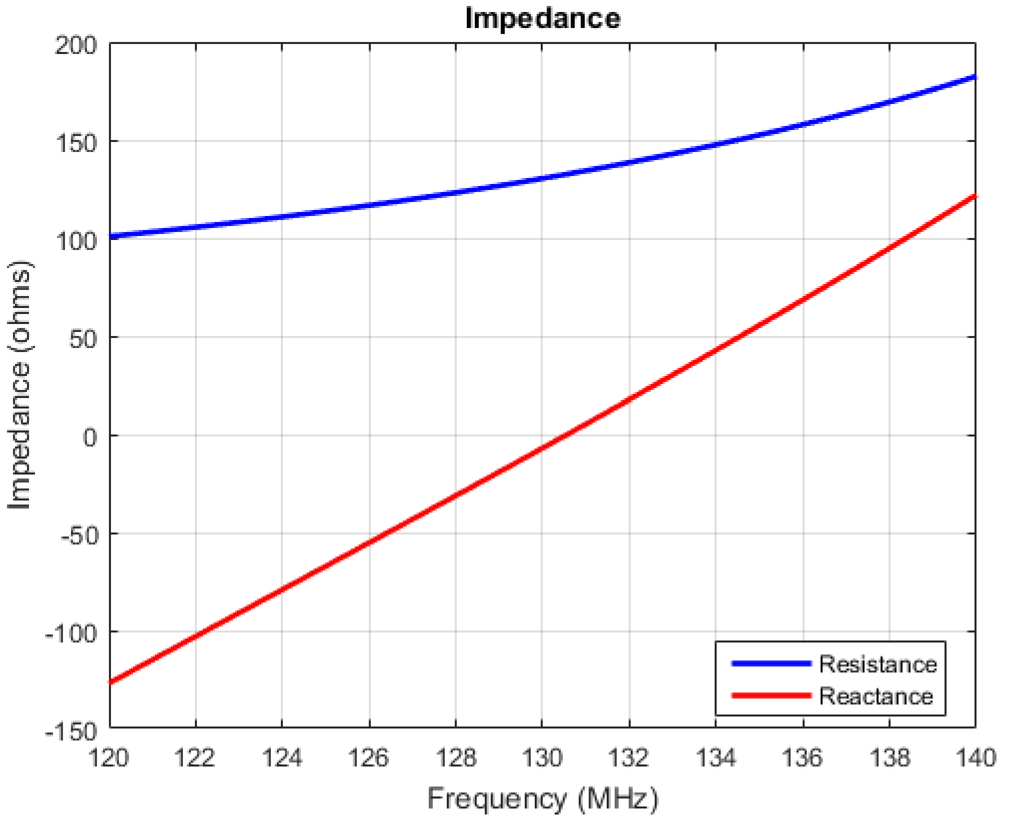
Impedance of Rectangular Loop Antenna

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]
```



References

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

See Also

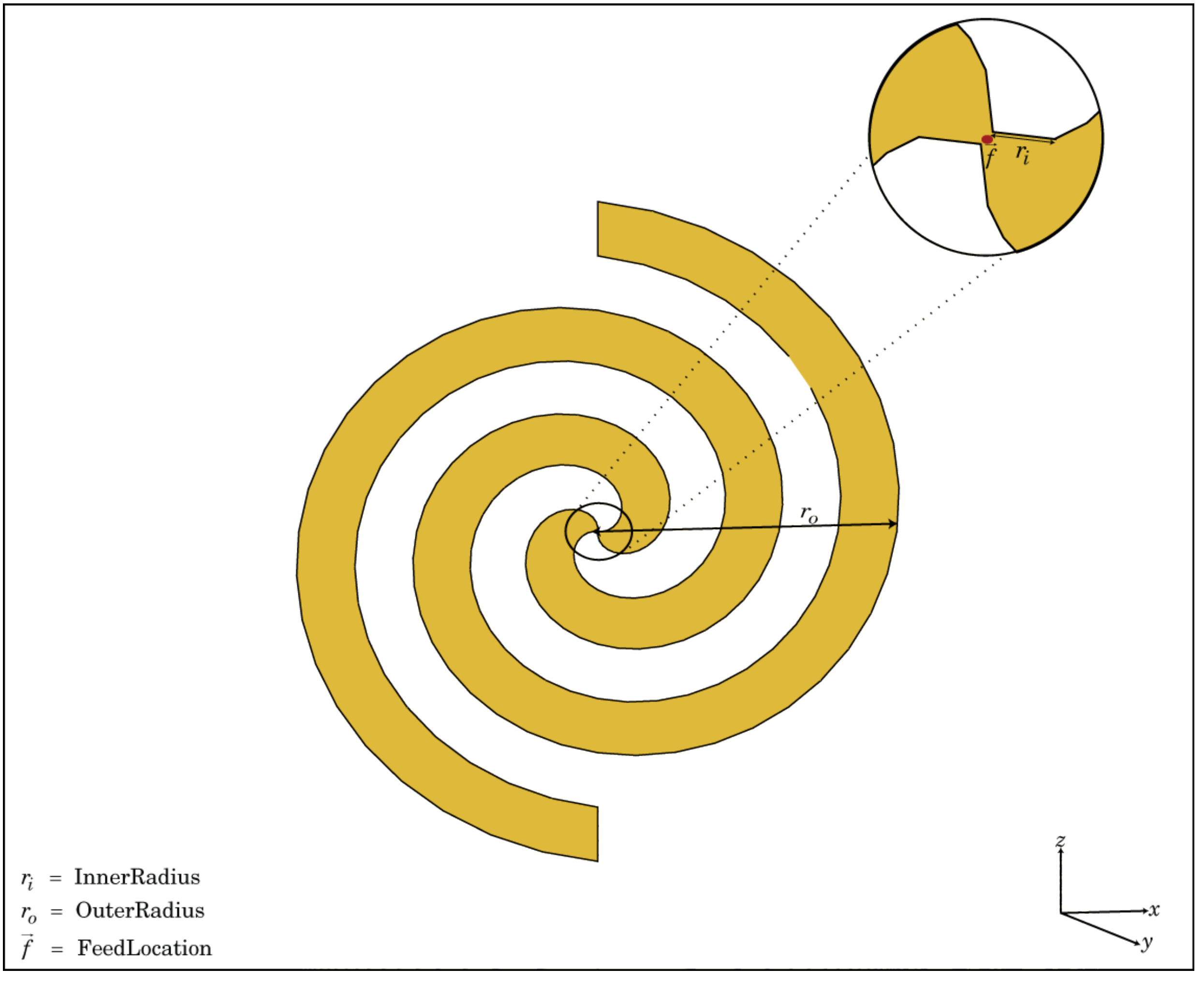
loopCircular | dipole | monopole | `cylinder2strip`

Introduced in R2015a

spiralArchimedean class

Create Archimedean spiral antenna

Description



The `spiralArchimedean` class creates 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 radius is measured from the center. 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.

Construction

`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`

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees

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

Example: `'Tilt'`,90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

Example: 'TiltAxis',[1 0 0]

Data Types: double

Definitions

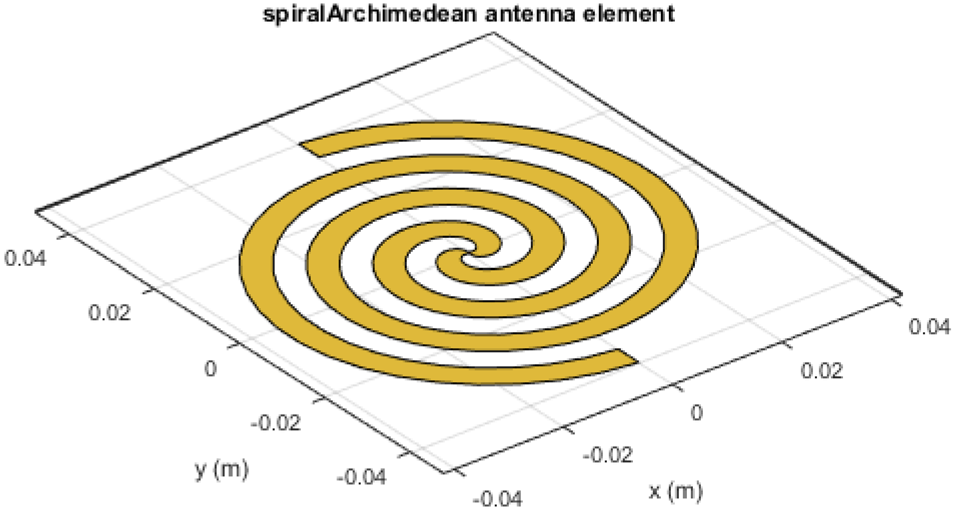
To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, “Rotate Antenna Elements”.

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.

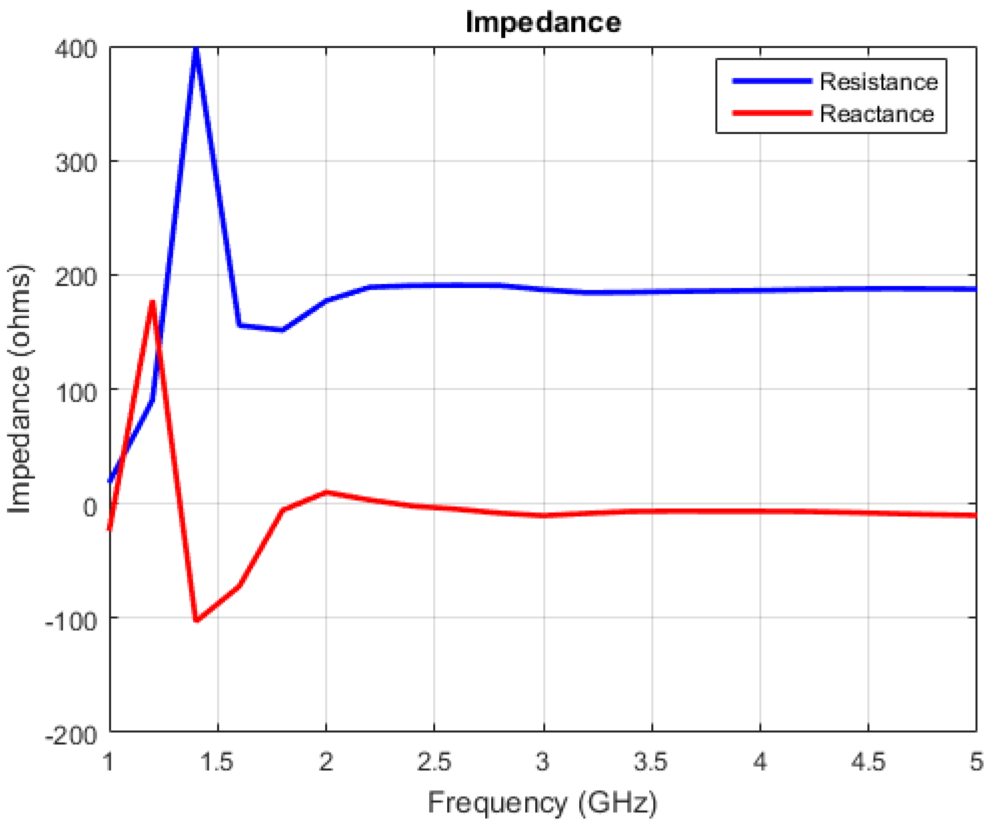
```
sa = spiralArchimedean('Turns',2, 'InnerRadius',1e-3, 'OuterRadius',40e-3);
show(sa)
```



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

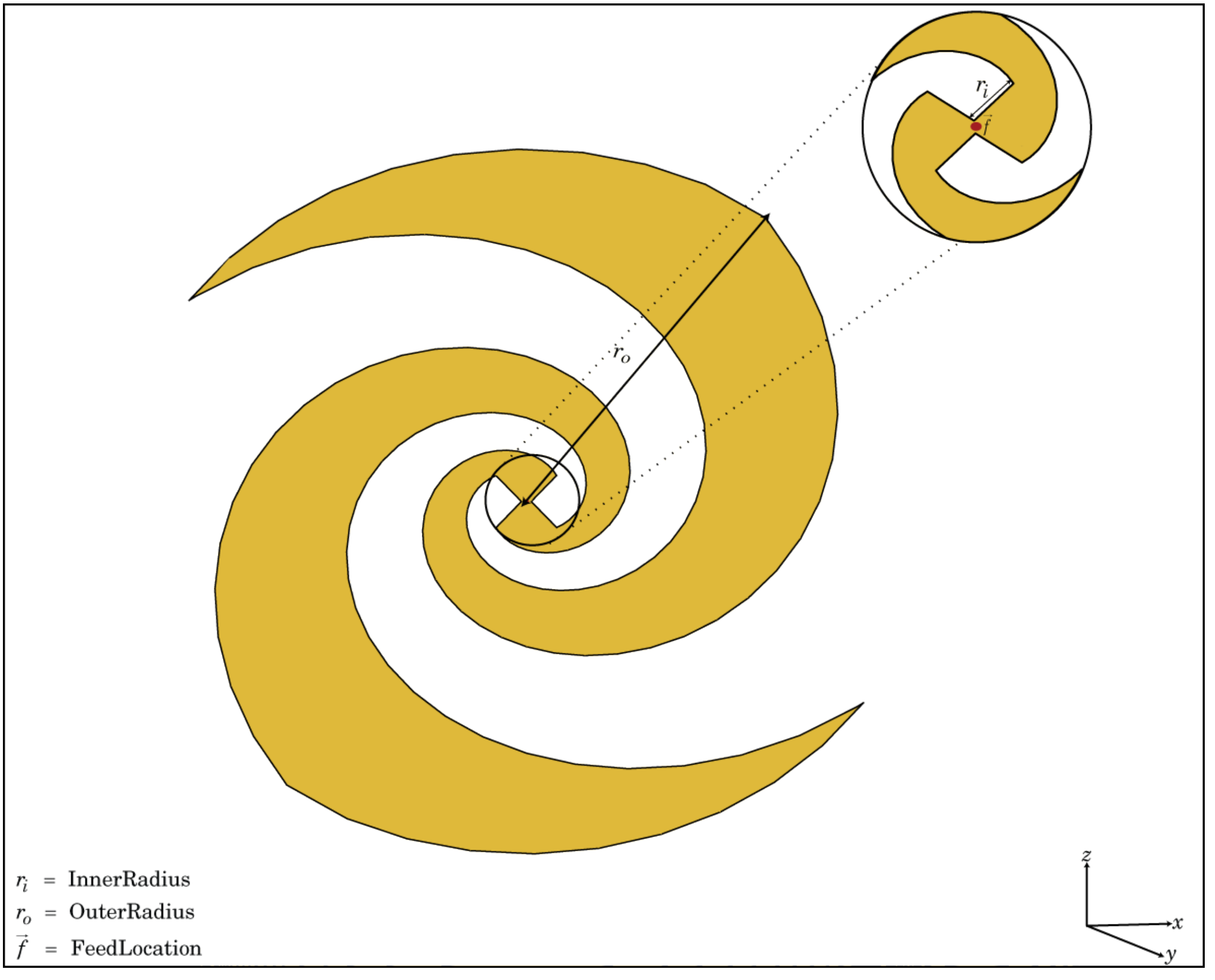
spiralEquiangular | helix | yagiUda

Introduced in R2015a

spiralEquiangular class

Create equiangular spiral antenna

Description



The `spiralEquiangular` class creates 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

Construction

`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

'Tilt' — Tilt angle of antenna
0 (default) | scalar in degrees

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

Example: 'Tilt',90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

Example: 'TiltAxis',[1 0 0]

Data Types: double

Definitions

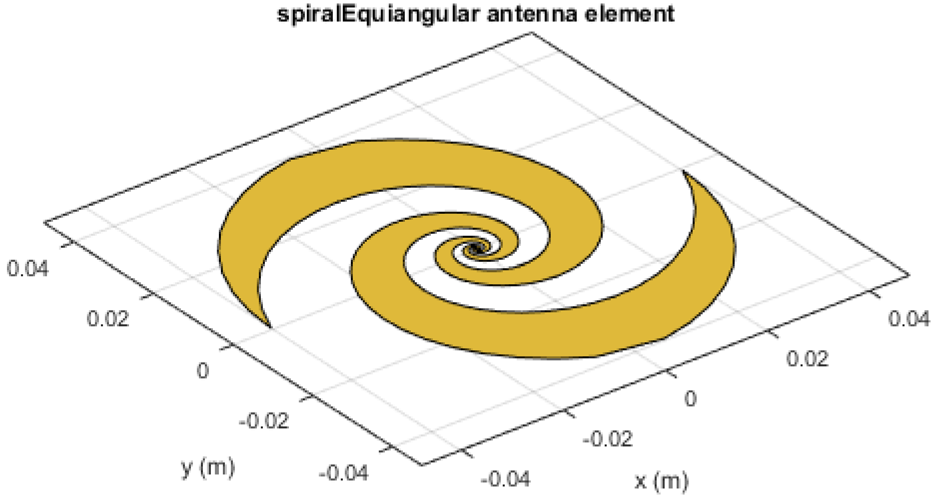
To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, “Rotate Antenna Elements”.

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.

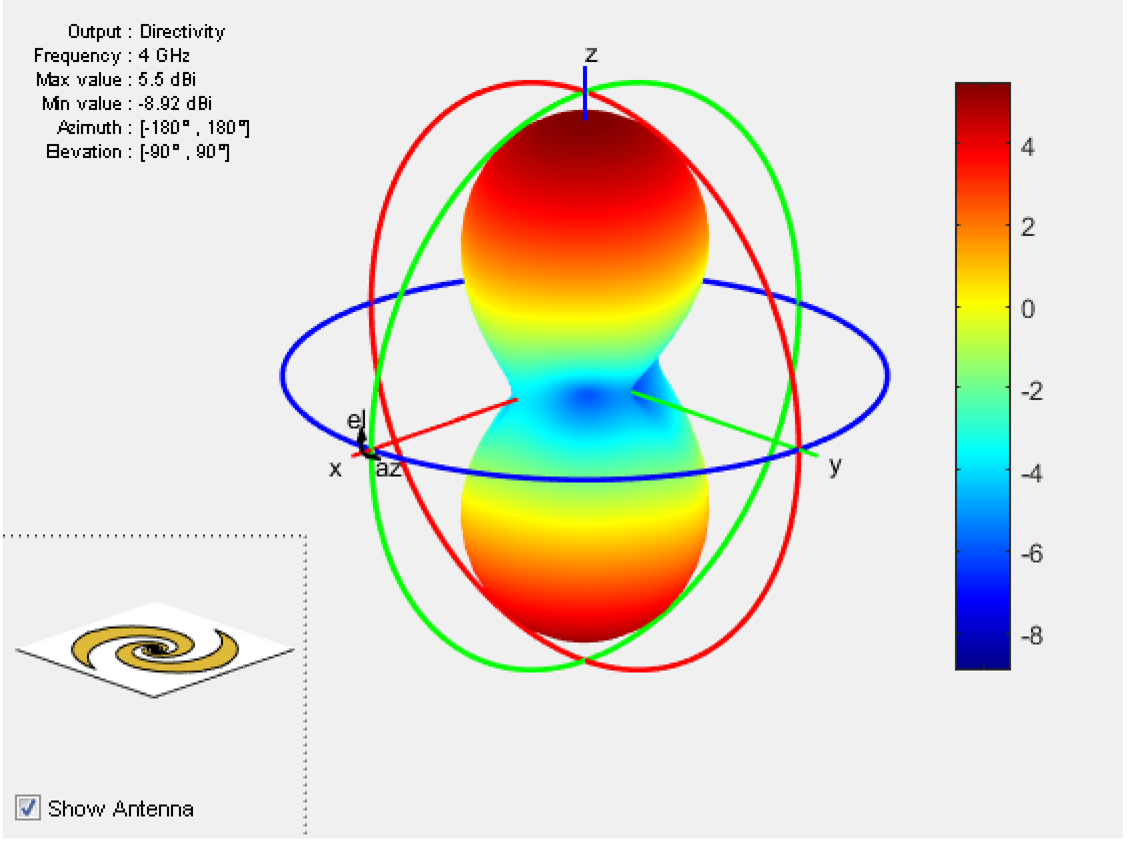
```
se = spiralEquiangular('GrowthRate',0.35, 'InnerRadius',0.65e-3,    ...
                        'OuterRadius',40e-3);
show(se)
```



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

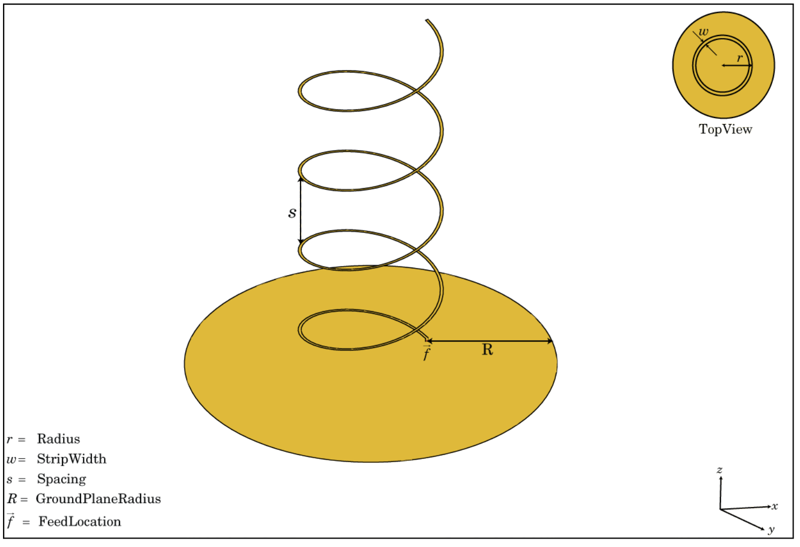
vivaldi | cavity | spiralArchimedean

Introduced in R2015a

helix class

Create helix antenna on ground plane

Description



The `helix` class creates 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.

Construction

`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

'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`

`'Tilt'` — Tilt angle of antenna
0 (default) | scalar in degrees

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

Example: `'Tilt'`,90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

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

Data Types: `double`

Definitions

To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, “Rotate Antenna Elements”.

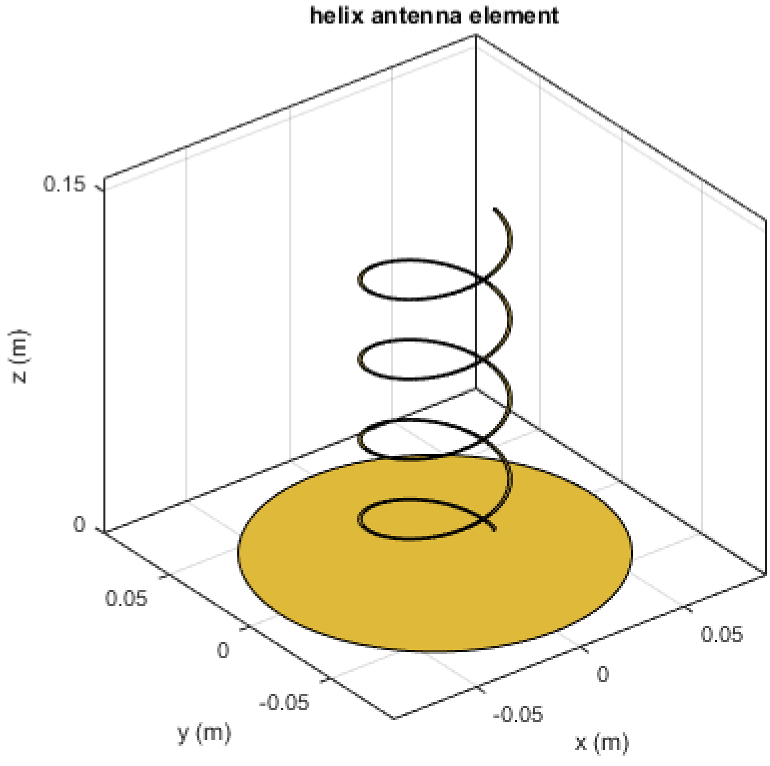
Examples

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)
```

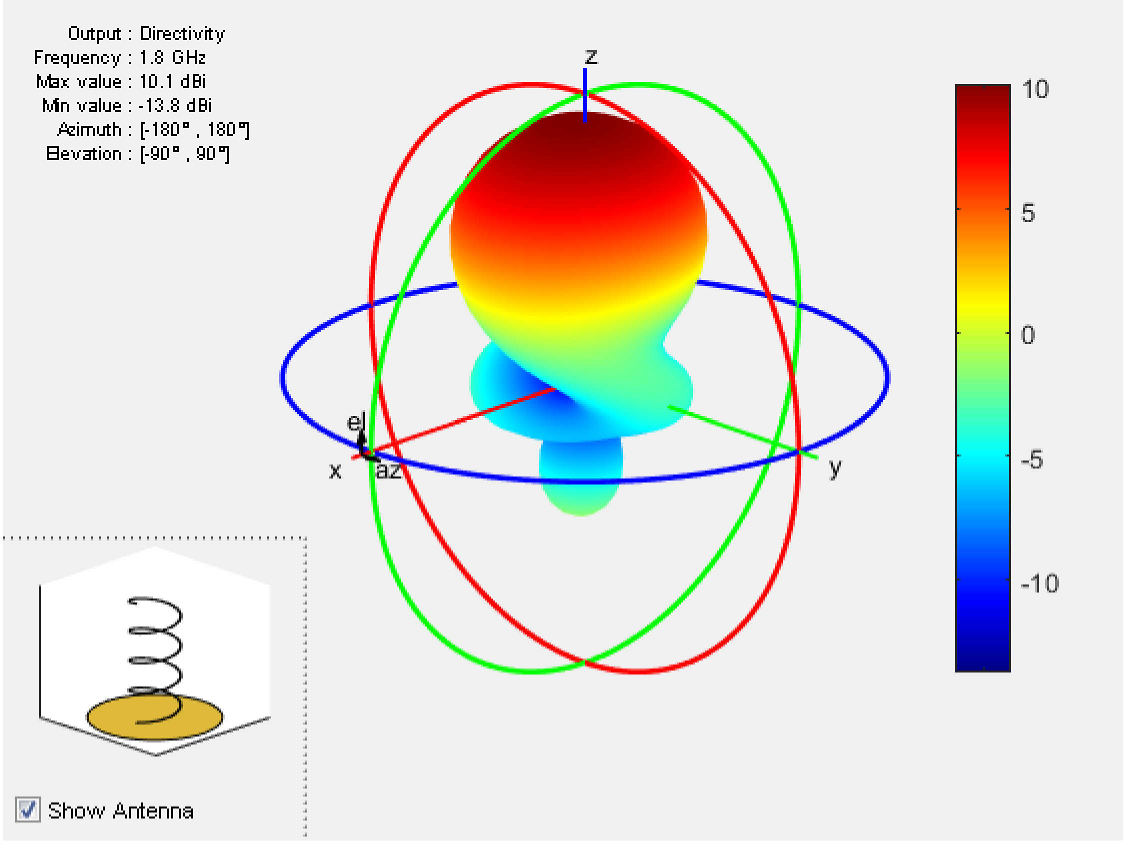
```
hx =

  helix with properties:

               Radius: 0.0280
                Width: 0.0012
                Turns: 4
              Spacing: 0.0350
    GroundPlaneRadius: 0.0750
                 Tilt: 0
             TiltAxis: [1 0 0]
```



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

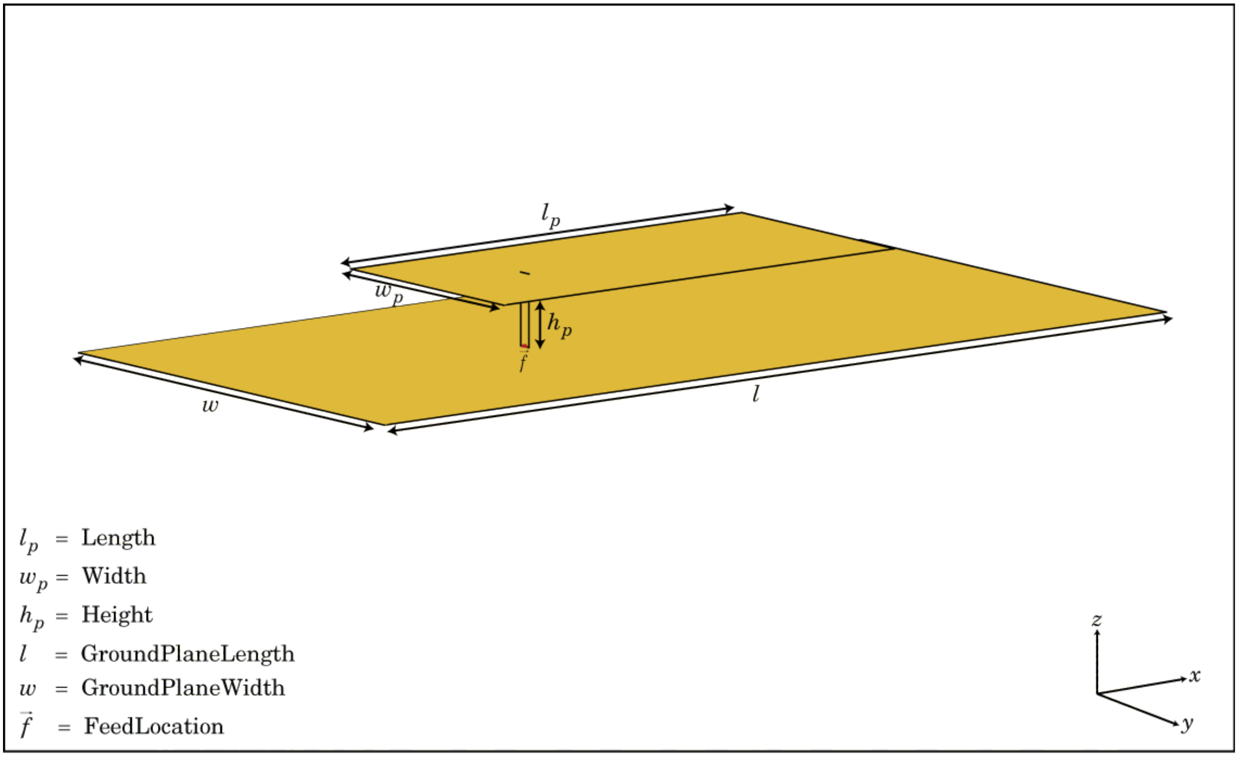
`cylinder2strip` | `helixpitch2spacing` | monopole | pifa | spiralArchimedean

Introduced in R2015a

patchMicrostrip class

Create microstrip patch antenna

Description



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

Construction

`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

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`

`'GroundPlaneLength'` — Ground plane length

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
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

'Tilt' — Tilt angle of antenna
0 (default) | scalar in degrees

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

Example: `'Tilt'`,90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

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

Data Types: `double`

Definitions

To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, “Rotate Antenna Elements”.

Examples

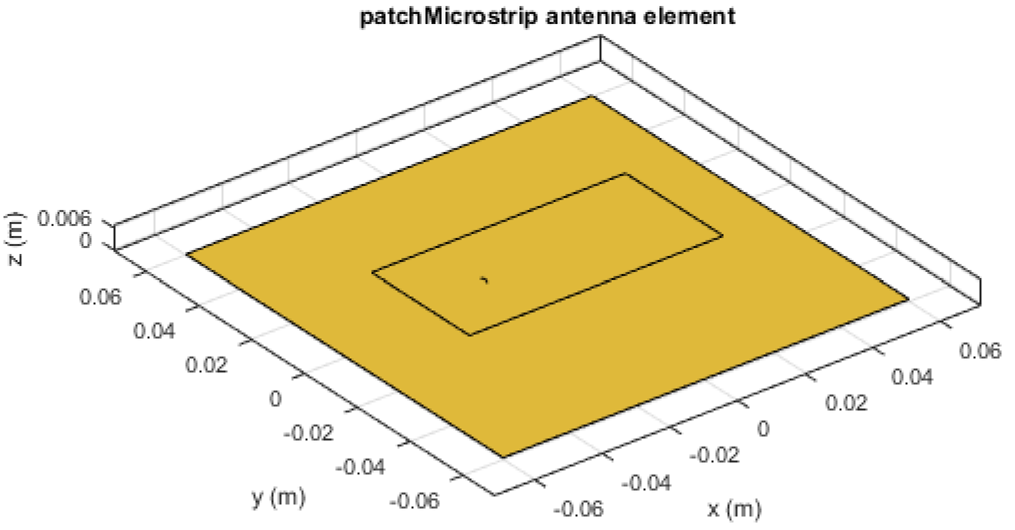
Create and View Microstrip Patch Antenna

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
    GroundPlaneLength: 0.1200
     GroundPlaneWidth: 0.1200
    PatchCenterOffset: [0 0]
           FeedOffset: [-0.0187 0]
                Tilt: 0
            TiltAxis: [1 0 0]
```



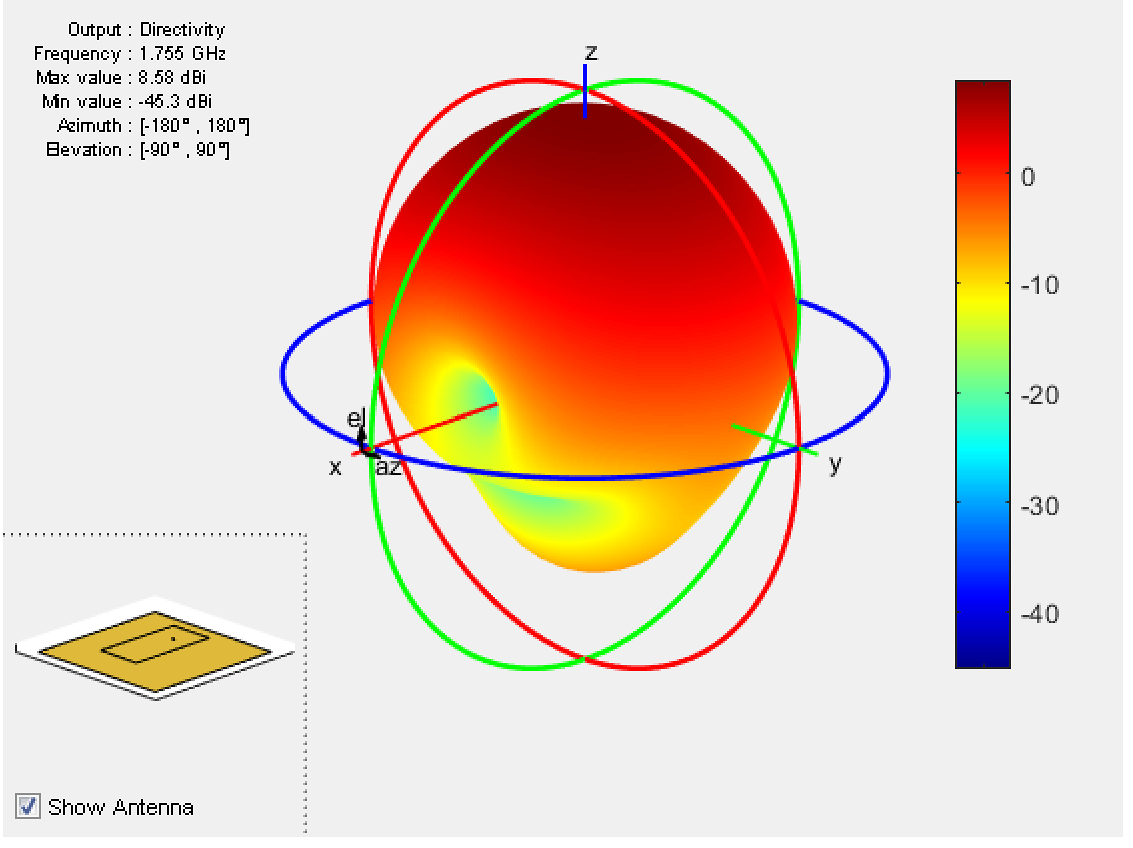
Radiation Pattern of Microstrip Patch Antenna

Plot the radiation pattern of a microstrip patch antenna at a frequency of 1.75 GHz.

```
pm = patchMicrostrip('Length',75e-3, 'Width',37e-3,             ...
        'GroundPlaneLength',120e-3, 'GroundPlaneWidth',120e-3)

pattern(pm,1.755e9)
```

```
pm =

  patchMicrostrip with properties:

               Length: 0.0750
```

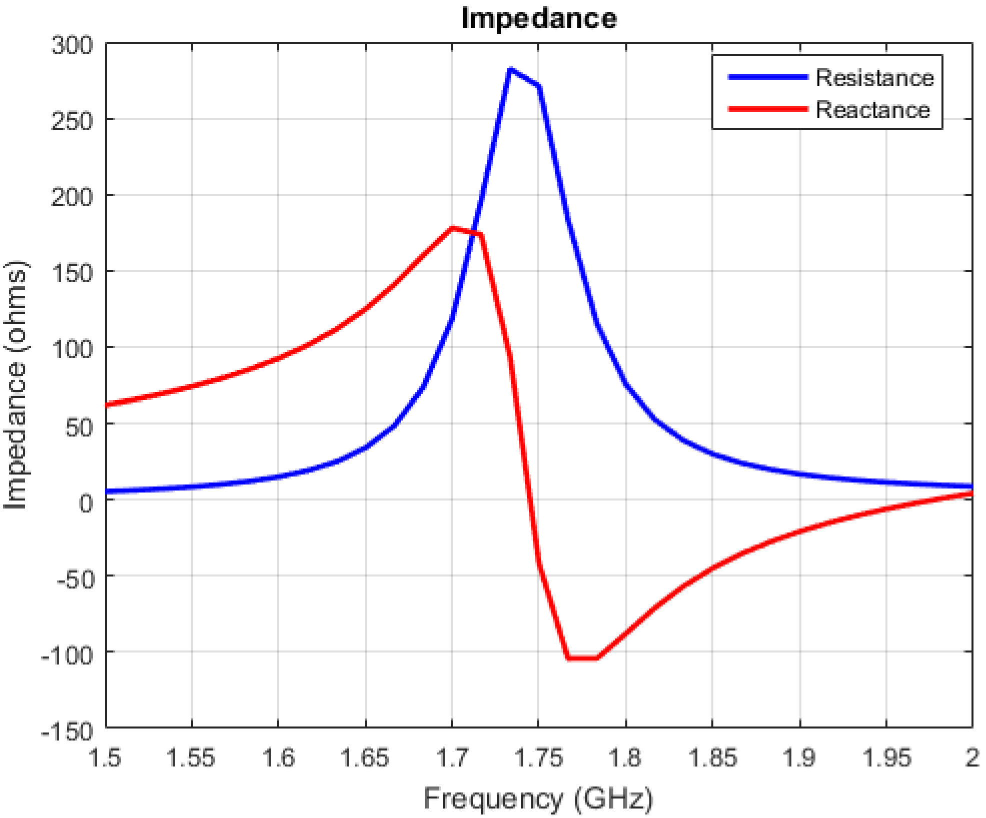
```
               Width: 0.0370
              Height: 0.0060
   GroundPlaneLength: 0.1200
    GroundPlaneWidth: 0.1200
   PatchCenterOffset: [0 0]
          FeedOffset: [-0.0187 0]
                Tilt: 0
            TiltAxis: [1 0 0]
```



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
    GroundPlaneLength: 0.1500
     GroundPlaneWidth: 0.0750
    PatchCenterOffset: [0 0]
           FeedOffset: [-0.0187 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

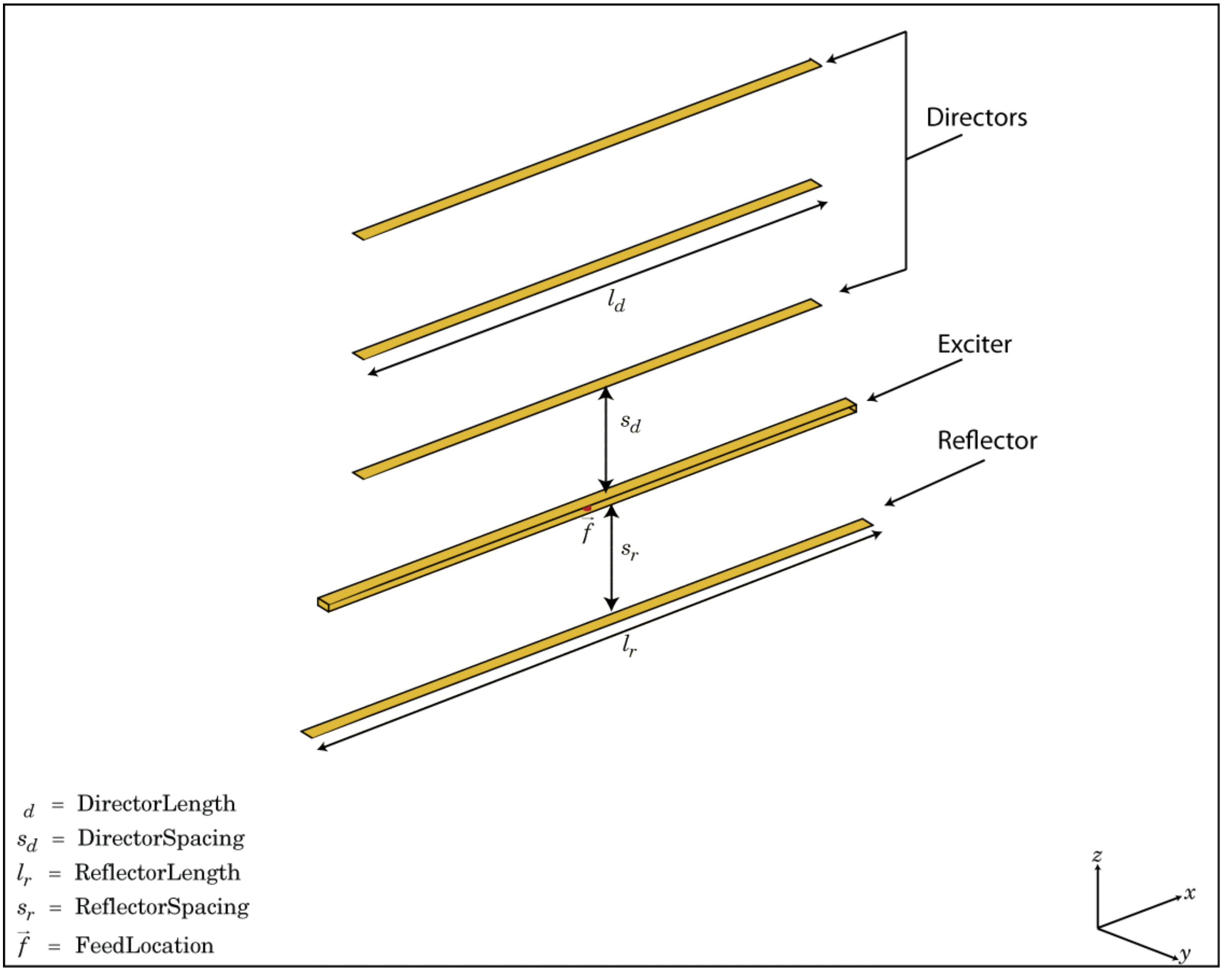
vivaldi | yagiUda | pifa

Introduced in R2015a

yagiUda class

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.

Construction

`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`

`'Tilt'` — Tilt angle of antenna
0 (default) | scalar in degrees

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

Example: `'Tilt'`,90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

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

Data Types: `double`

Definitions

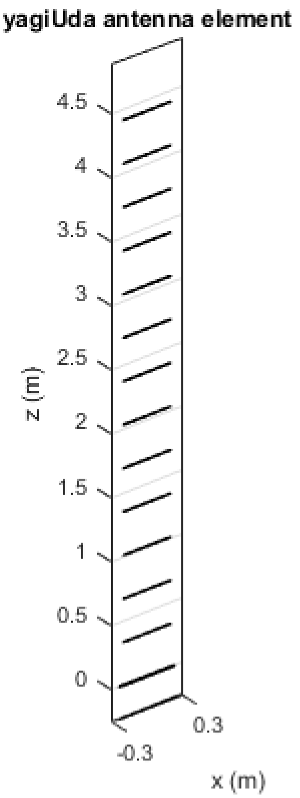
To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, “Rotate Antenna Elements”.

Examples

Create and View Yagi-Uda Array Antenna

Create and view a Yagi-Uda array antenna with 13 directors.

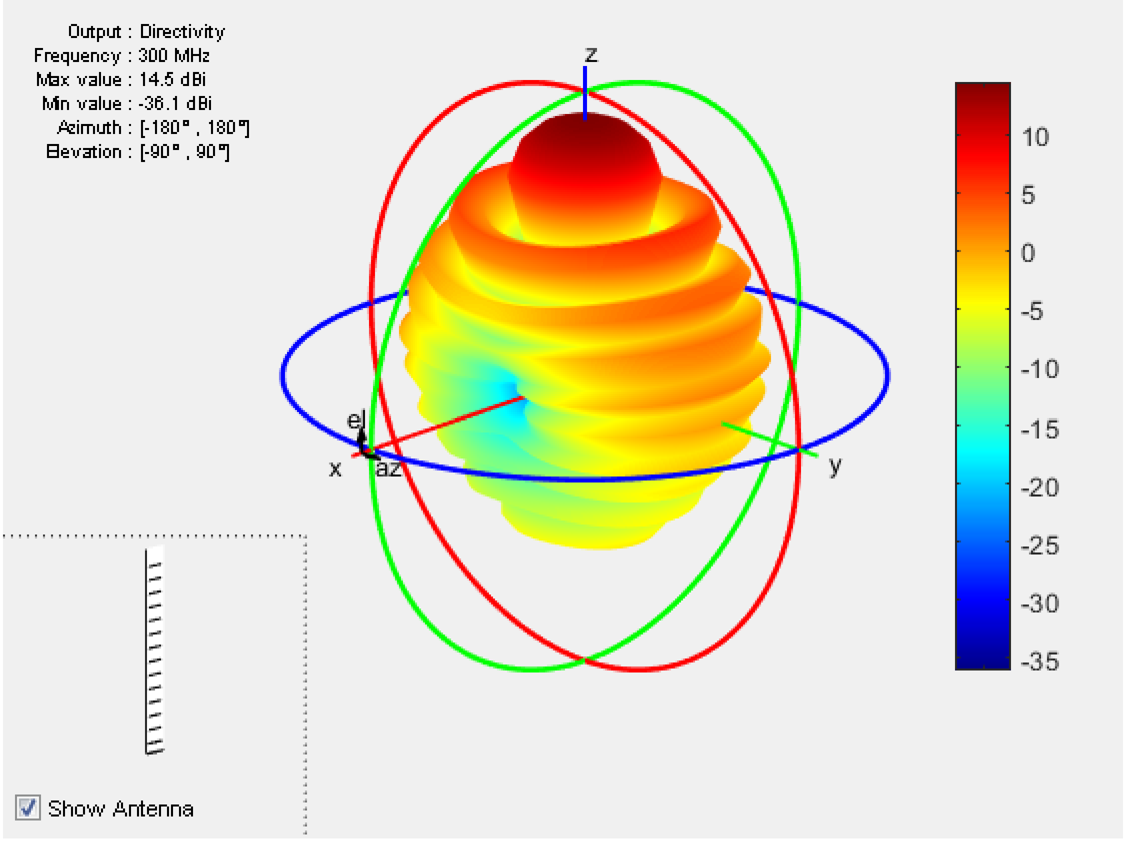
```
y = yagiUda('NumDirectors',13);
show(y)
```



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

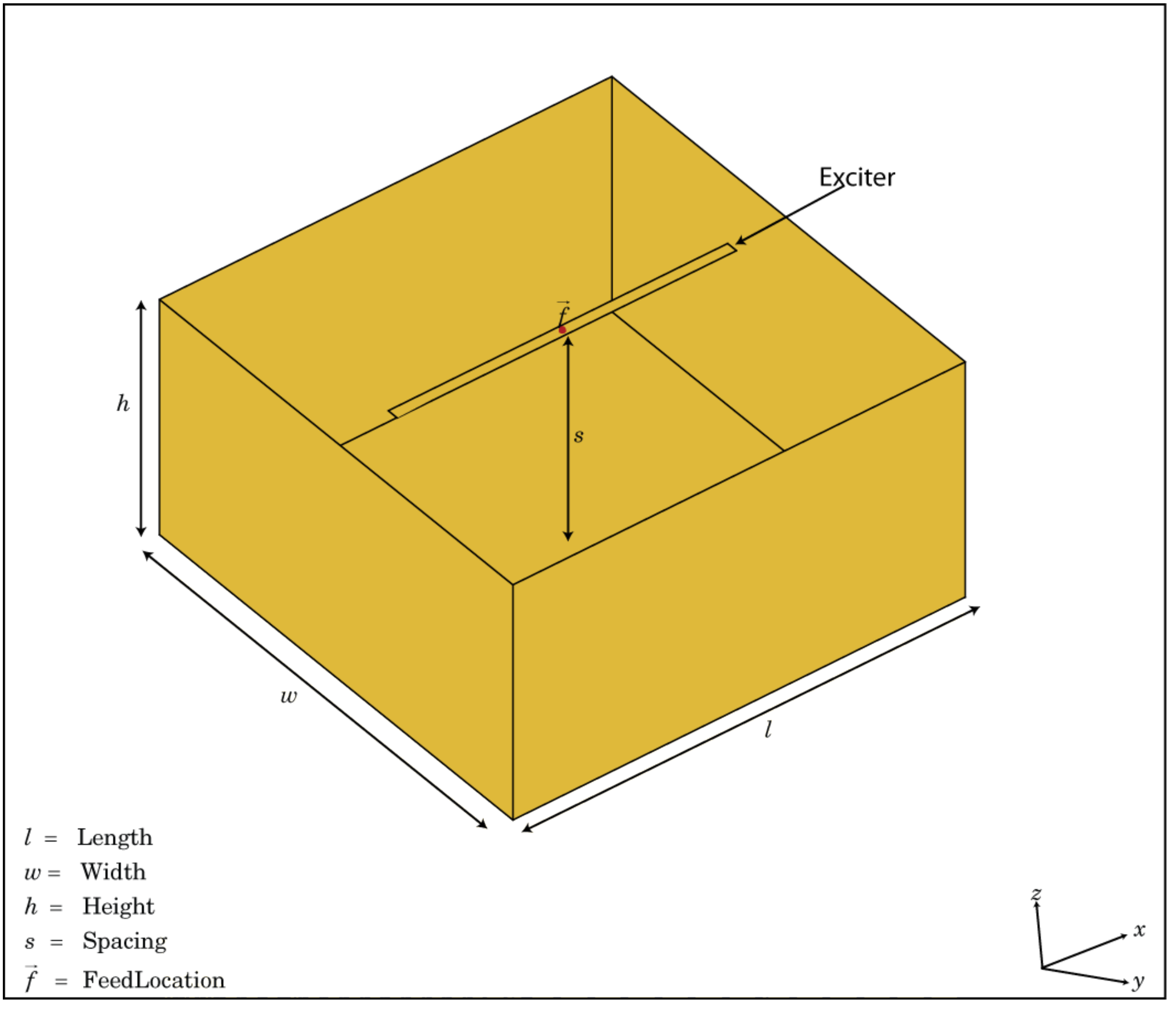
dipoleFolded | slot | `cylinder2strip` | dipole

Introduced in R2015a

cavity class

Create cavity-backed antenna

Description



The `cavity` class creates a cavity-backed antenna located on the X-Y plane. The default cavity antenna has a dipole as an exciter. The feed point is at the origin.

Construction

`c = cavity` creates a cavity backed antenna located on the X-Y 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
[1x1 dipole] (default) | antenna element handle or antenna element

Antenna type used as 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

`Length` — Length of rectangular cavity along x-axis
0.2000 (default) | scalar in meters

Length of rectangular cavity along 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 x-axis
0.2000 (default) | scalar in meters

Width of rectangular cavity along x-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 rectangular cavity along 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 exciter and base of cavity, specified as the comma-separated pair consisting of `'Spacing'` and a scalar in meters.

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

Data Types: `double`

`Tilt` — Tilt angle of antenna

0 (default) | scalar in degrees

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

Example: `'Tilt'`, 90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

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

Data Types: `double`

Definitions

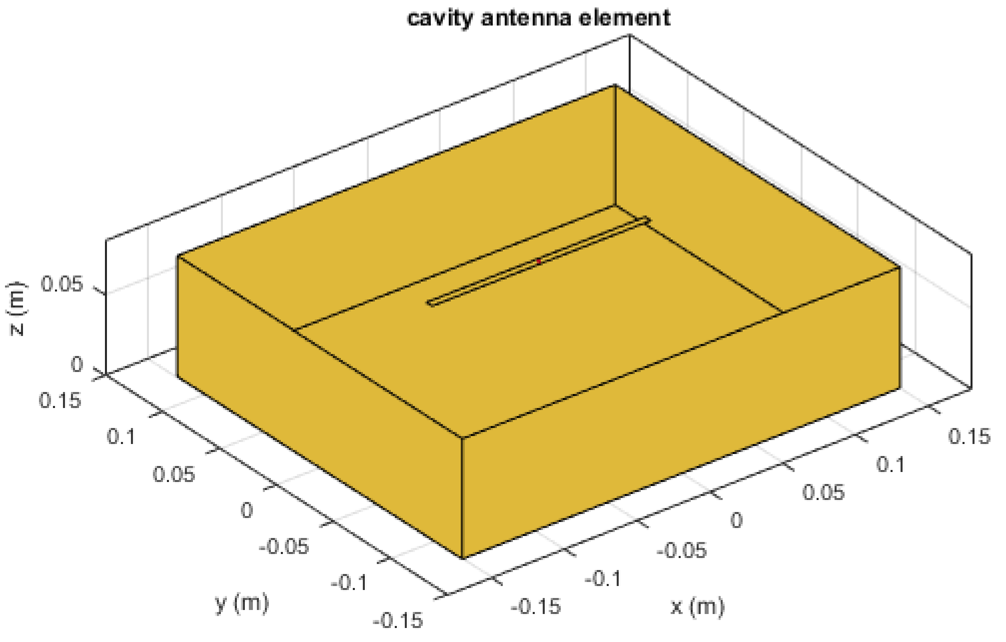
To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, “Rotate Antenna Elements”.

Examples

Create and View Cavity-Backed Antenna.

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

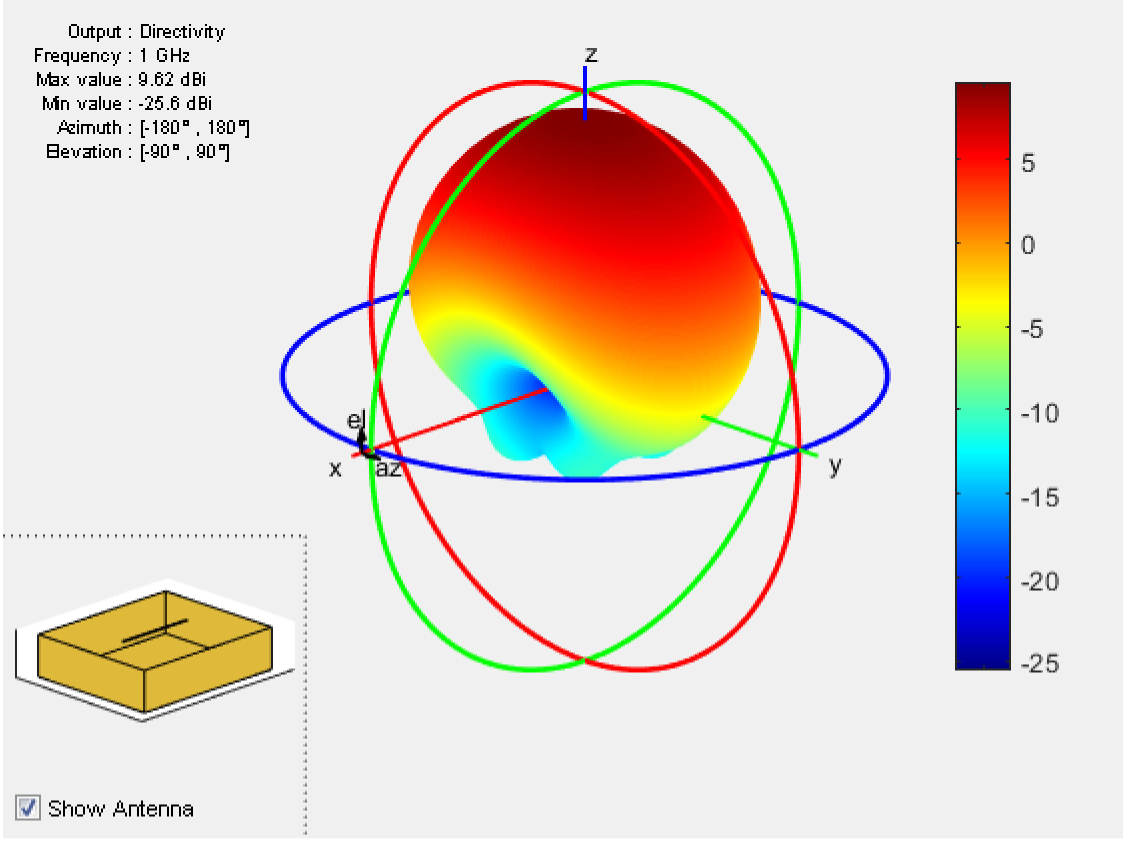
```
c = cavity('Length',30e-2, 'Width',25e-2,'Height',7.5e-2,'Spacing',7.5e-2);
show(c)
```



Radiation Pattern of Cavity-Backed Antenna

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

```
c = cavity('Length',30e-2,'Width',25e-2,'Height',7.5e-2,'Spacing',7.5e-2);
pattern(c,1e9)
```



References

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

See Also

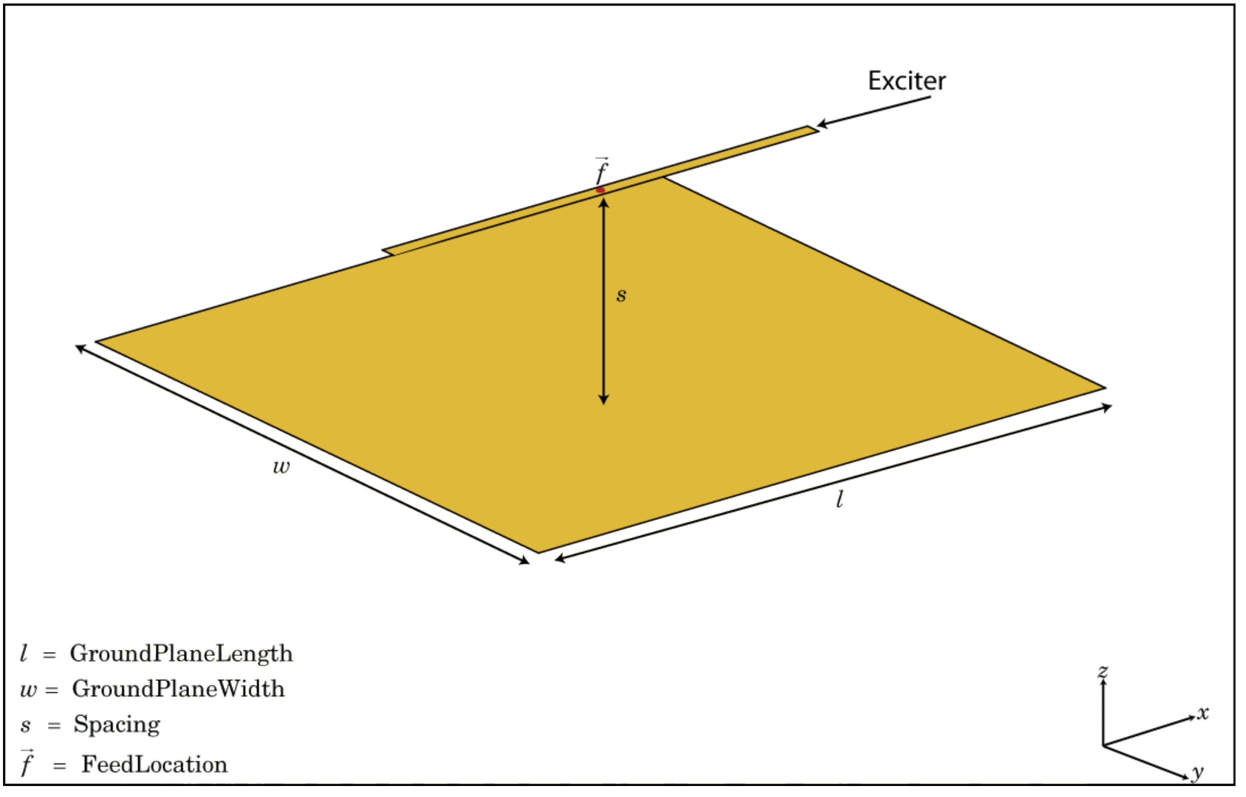
spiralArchimedean | reflector | spiralEquiangular

Introduced in R2015a

reflector class

Create reflector-backed antenna

Description



The `reflector` class creates a reflector-backed antenna located on the X-Y plane. The default reflector antenna uses a dipole as an exciter. The feed point is at the origin.

Construction

`rf = reflector` creates a reflector backed antenna located in the X-Y 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
[1x1 dipole] (default) | antenna element handle or antenna element

Antenna type used as 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

`'GroundPlaneLength'` — Reflector length along x-axis
0.2000 (default) | scalar in meters

Reflector length along 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.

Example: `'GroundPlaneLength'`,3

Data Types: `double`

`'GroundPlaneWidth'` — Reflector width along y-axis
0.2000 (default) | scalar in meters

Reflector width along 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.

Example: 'GroundPlaneWidth',2.5

Data Types: double

'Spacing' — Distance between reflector and exciter

0.0750 (default) | scalar in meters

Distance between reflector and 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

'Tilt' — Tilt angle of antenna

0 (default) | scalar in degrees

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

Example: 'Tilt',90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

Example: 'TiltAxis',[1 0 0]

Data Types: double

Definitions

To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, "Rotate Antenna Elements".

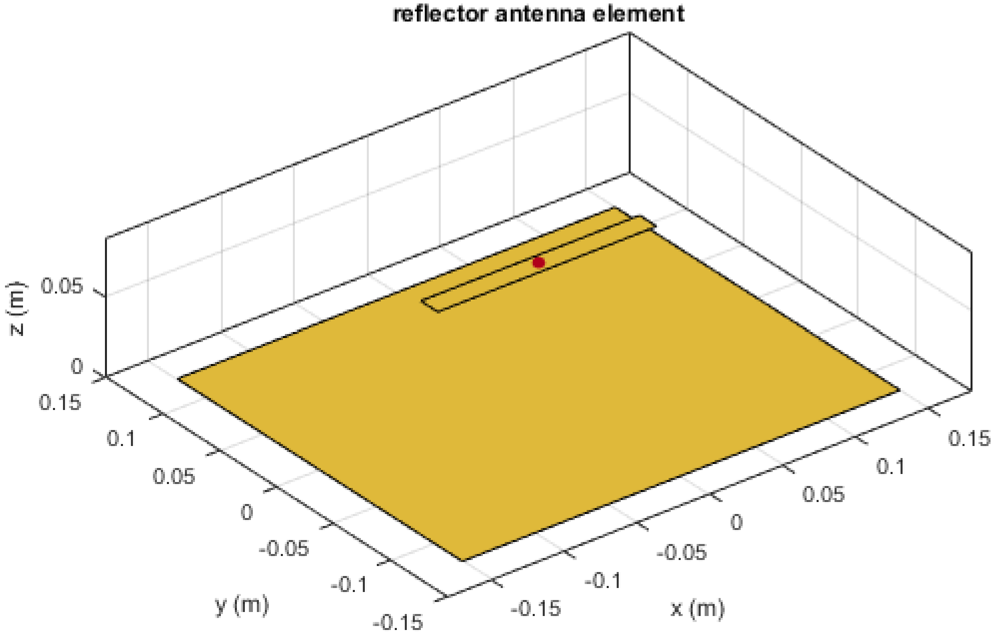
Examples

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)
```

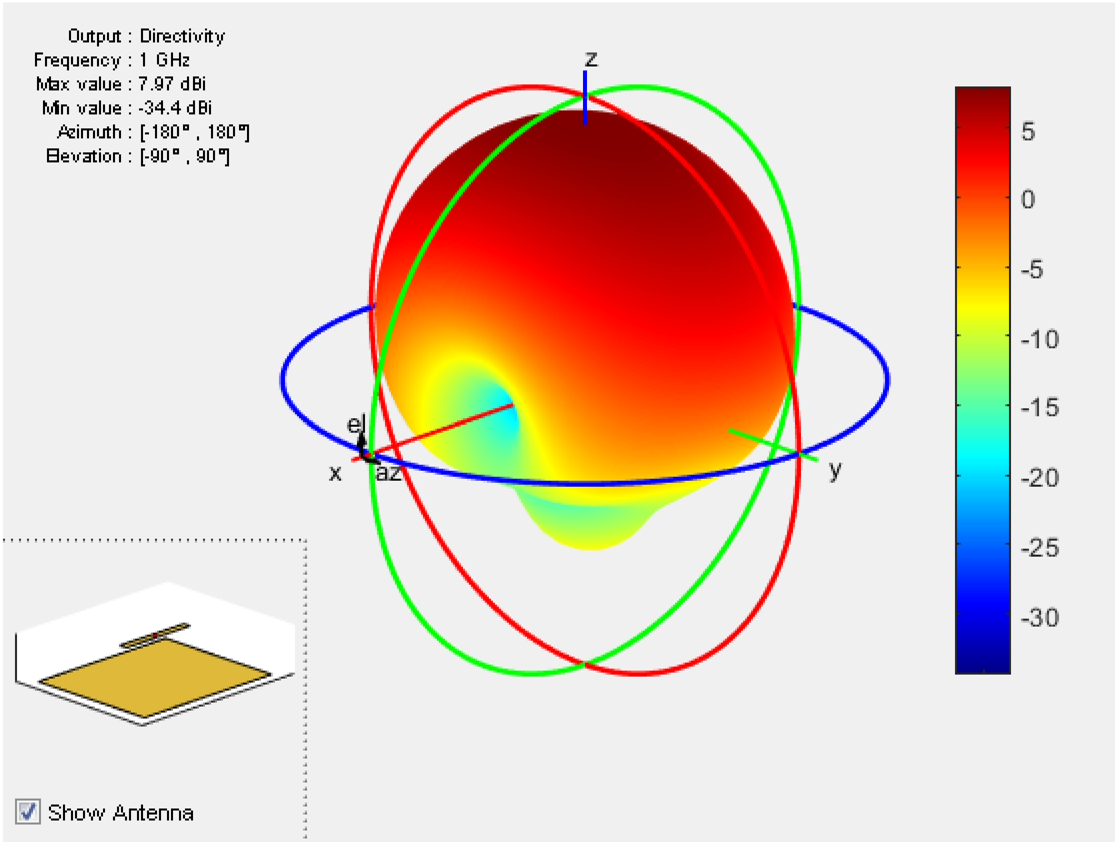
```
rf =

  reflector with properties:

              Exciter: [1x1 dipole]
    GroundPlaneLength: 0.3000
     GroundPlaneWidth: 0.2500
              Spacing: 0.0750
                 Tilt: 0
             TiltAxis: [1 0 0]
```



Radiation Pattern of Reflector Backed Antenna

Plot the radiation pattern of the reflector backed antena created at a frequency of 1 GHz.

```
d = dipole('Length',0.15,'Width',0.015, 'Tilt',90,'TiltAxis','Y');
rf = reflector('GroundPlaneLength',30e-2, 'GroundPlaneWidth',25e-2, ...
               'Spacing',7.5e-2);
rf.Exciter = d;
pattern(rf,1e9)
```



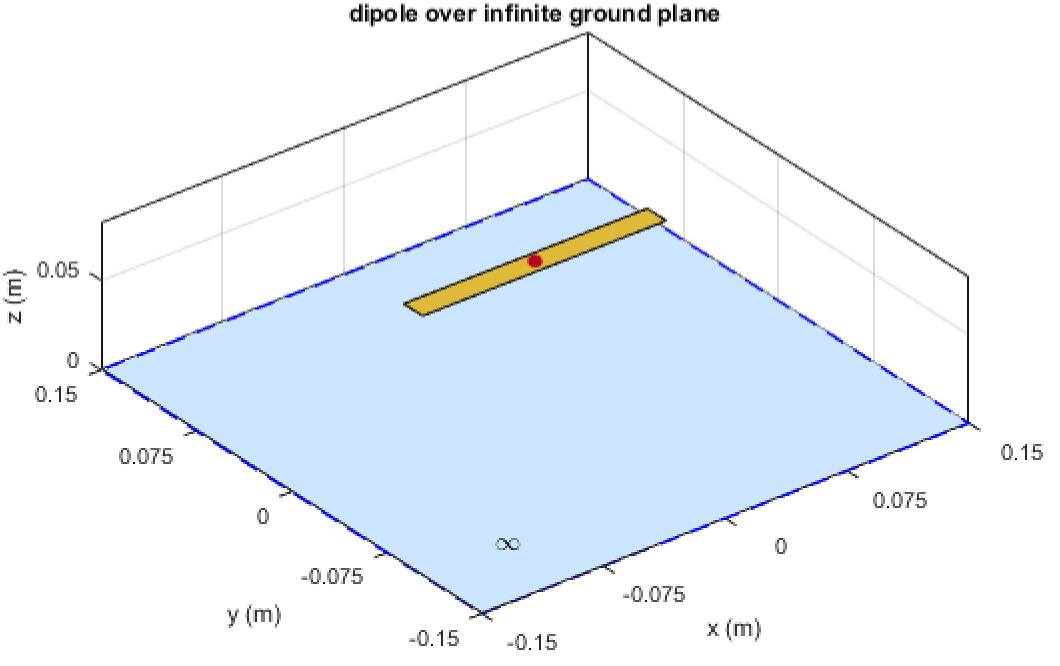
Create Reflector-Backed Antennna Over Infinite Ground Plane

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: [1x1 dipole]
   GroundPlaneLength: Inf
    GroundPlaneWidth: 0.2500
             Spacing: 0.0750
                Tilt: 0
            TiltAxis: [1 0 0]
```



References

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

See Also

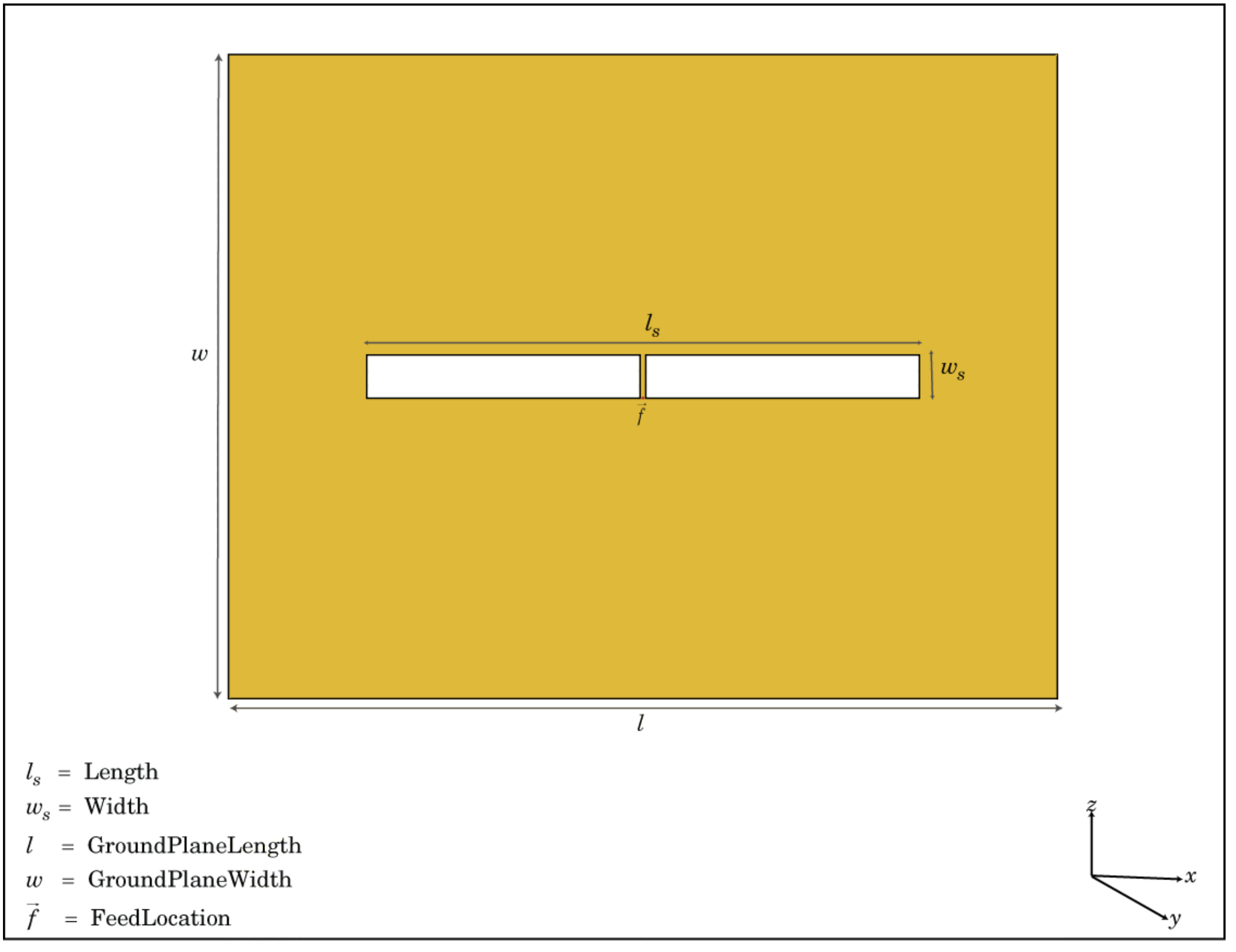
spiralArchimedean | cavity | spiralEquiangular

Introduced in R2015a

slot class

Create rectangular slot antenna on ground plane

Description



The `slot` class creates a rectangular slot antenna on a ground plane. The default slot has its first resonance at 130 MHz.

Construction

`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'`,0.2

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

'Tilt' — Tilt angle of antenna
0 (default) | scalar in degrees

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

Example: 'Tilt',90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

Example: 'TiltAxis',[1 0 0]

Data Types: double

Definitions

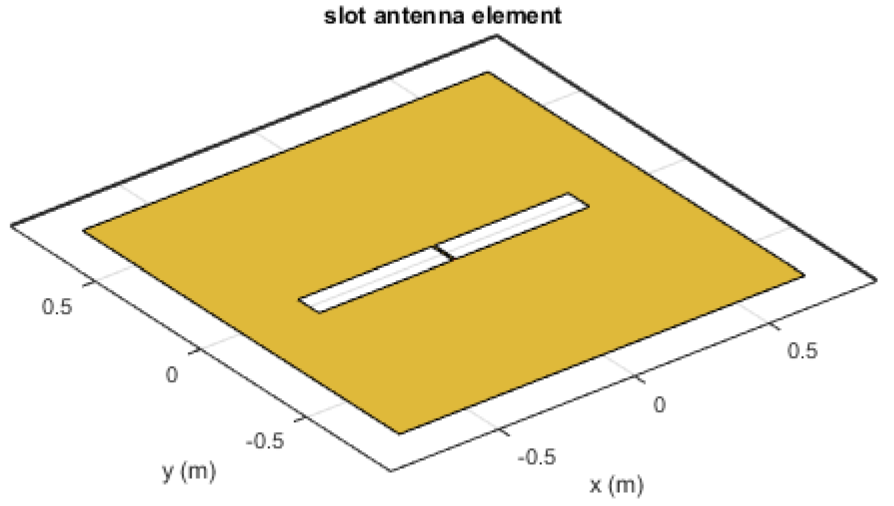
To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, “Rotate Antenna Elements”.

Examples

Create and View Slot Antenna

Create and view a slot antenna that has 1m length and 100mm width.

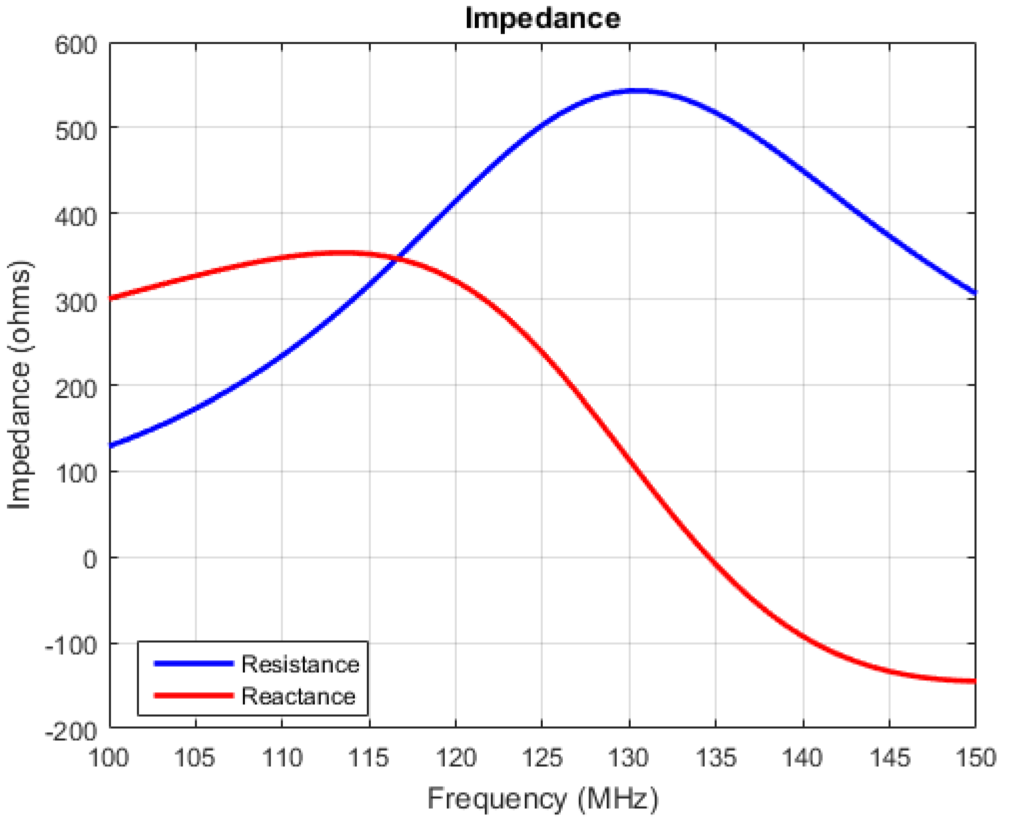
```
s = slot('Length',1,'Width',0.1);
show(s)
```



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

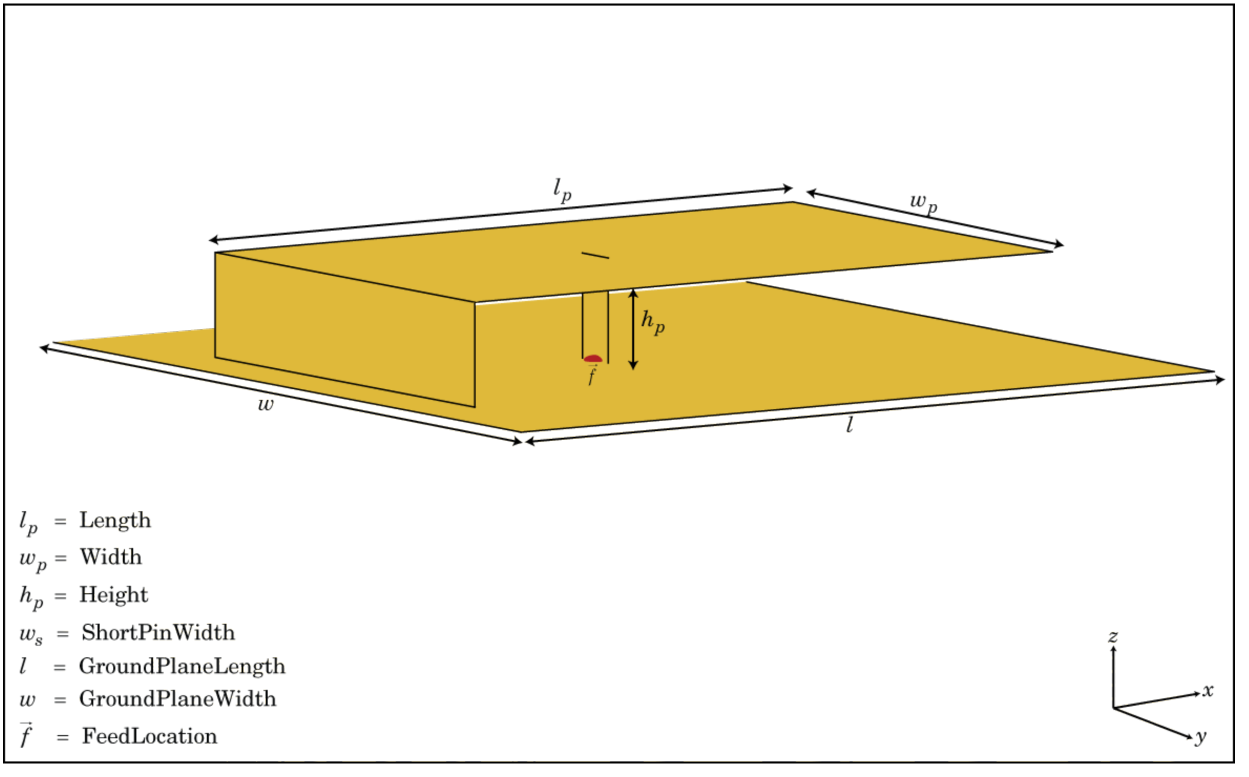
vivaldi | yagiUda | pifa

Introduced in R2015a

pifa class

Create planar inverted-F antenna

Description



The `pifa` class creates a planar inverted-F antenna. The default PIFA antenna is centered at the origin. The feed point is along the length of the antenna.

Construction

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

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

Data Types: `double`

`'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 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

'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`

`'Tilt'` — Tilt angle of antenna

0 (default) | scalar in degrees

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

Example: `'Tilt'`,90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

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

Data Types: `double`

Definitions

To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, “Rotate Antenna Elements”.

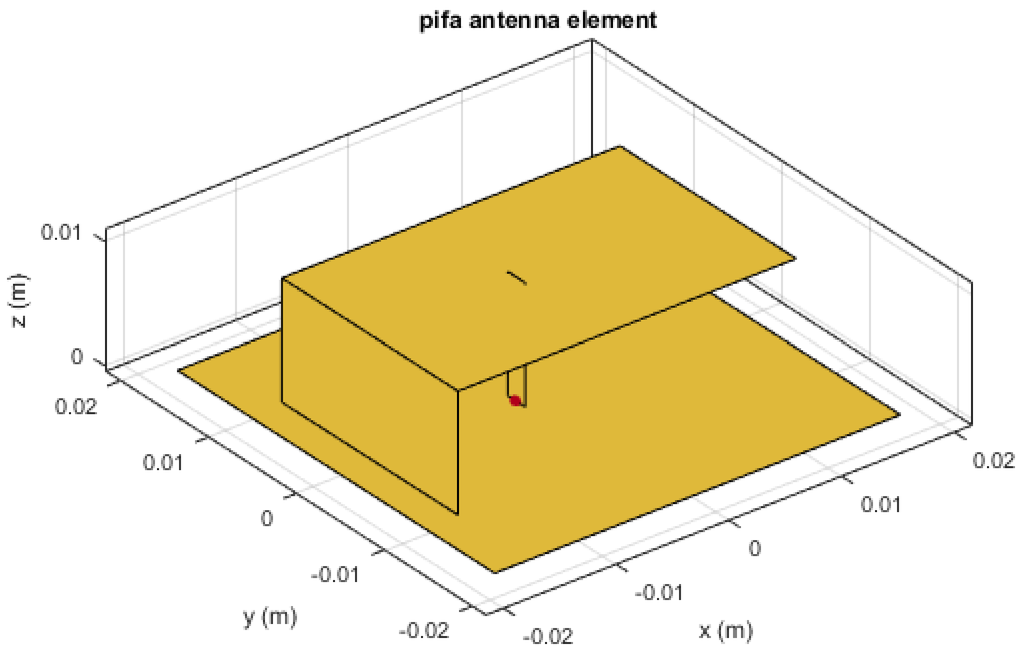
Examples

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
    GroundPlaneLength: 0.0360
     GroundPlaneWidth: 0.0360
    PatchCenterOffset: [0 0]
        ShortPinWidth: 0.0200
           FeedOffset: [-0.0020 0]
                 Tilt: 0
             TiltAxis: [1 0 0]
```



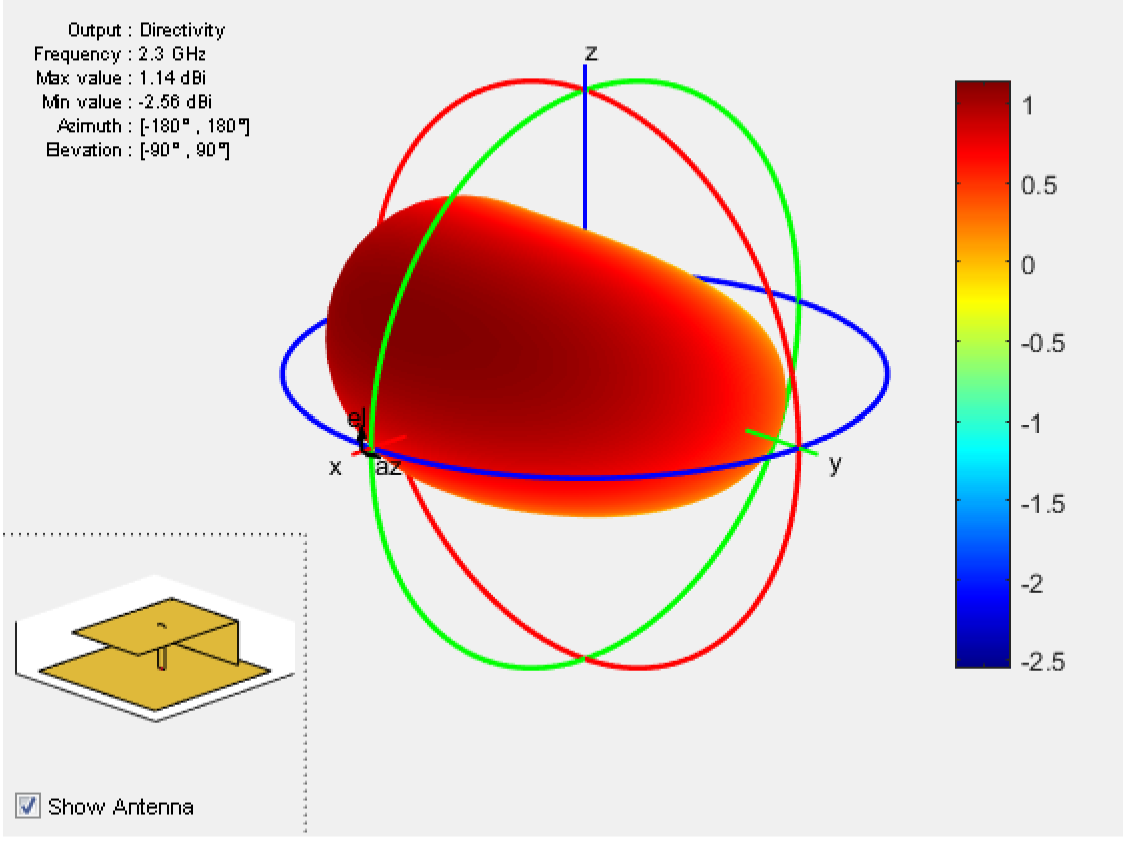
Radiation Pattern of PIFA Antenna

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
```

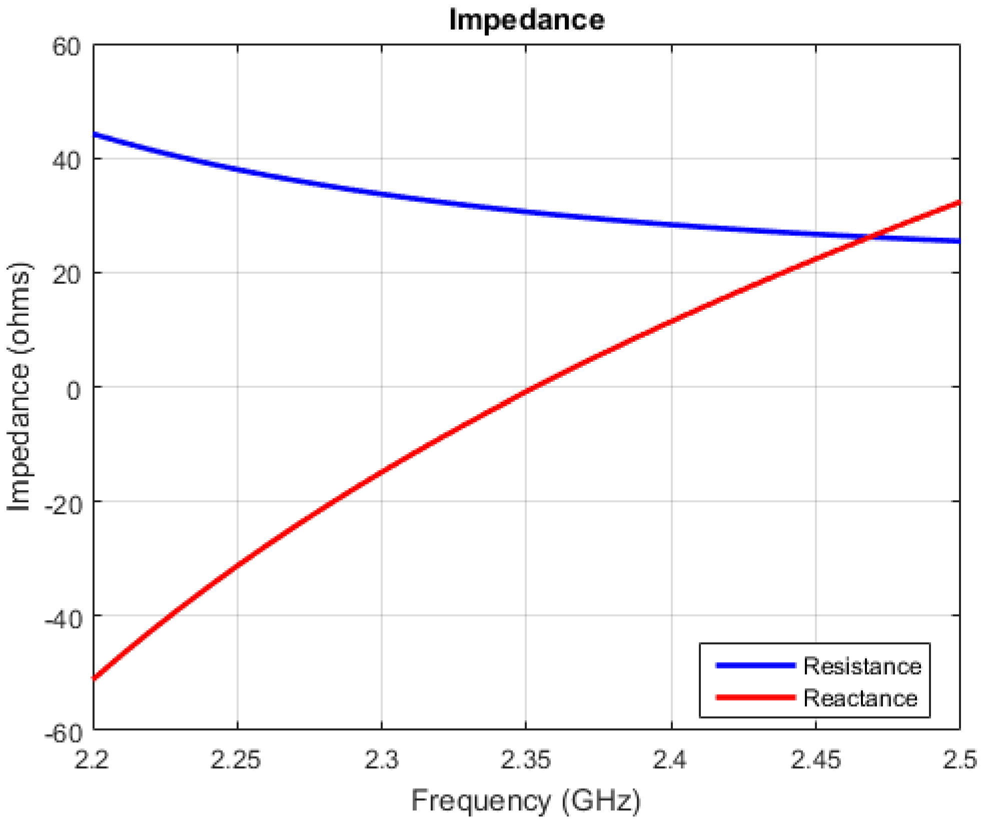
```
              Width: 0.0200
             Height: 0.0100
  GroundPlaneLength: 0.0350
   GroundPlaneWidth: 0.0350
  PatchCenterOffset: [0 0]
      ShortPinWidth: 0.0200
         FeedOffset: [-0.0020 0]
               Tilt: 0
           TiltAxis: [1 0 0]
```



Impedance of PIFA Antenna

Calculate impedance of PIFA antenna over a frequency range of 2-2.6 GHz.

```
pf = pifa('Length',30e-3, 'Width',20e-3, 'GroundPlaneLength',35e-3, ...
          'GroundPlaneWidth', 35e-3);
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

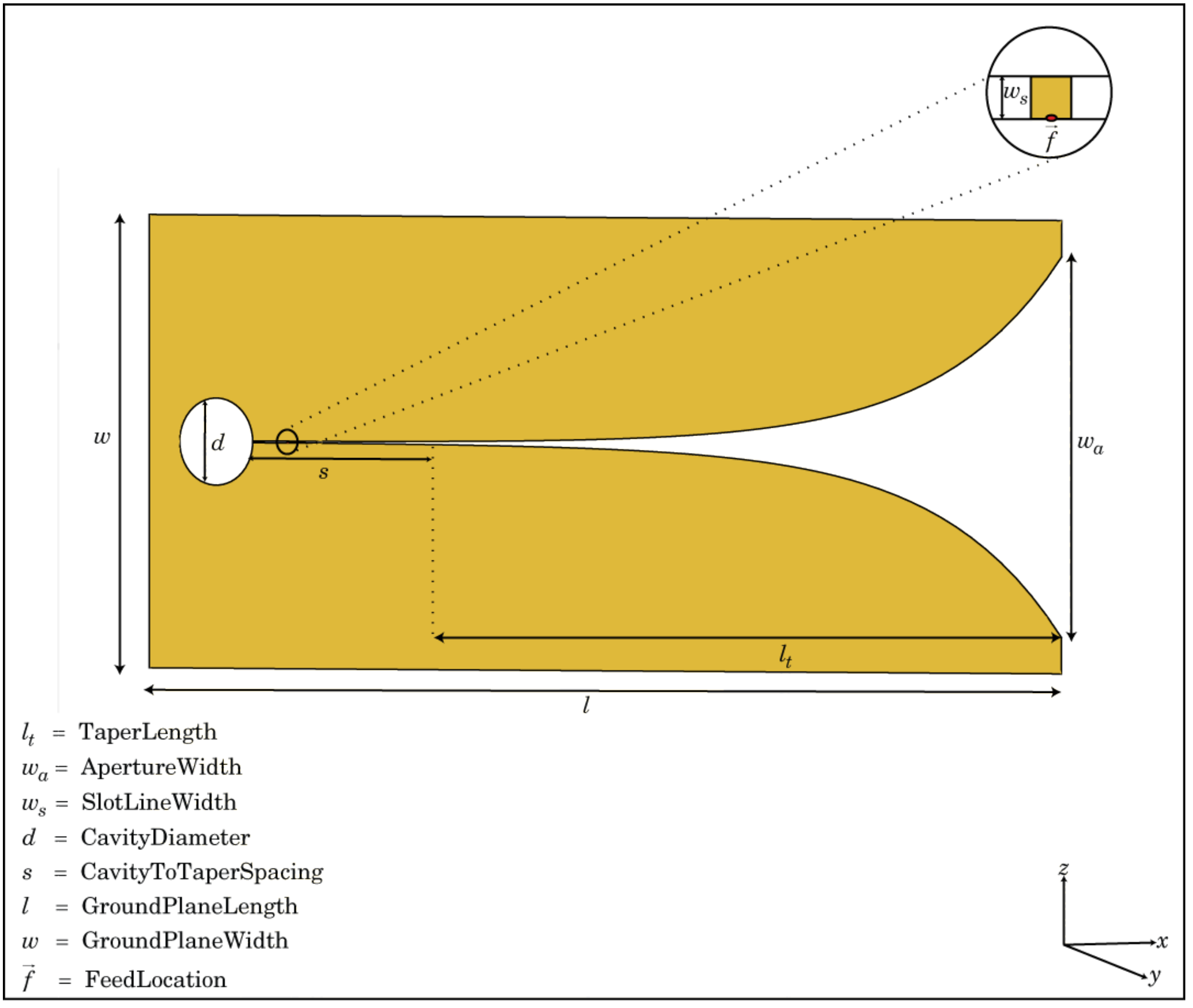
invertedF | invertedL | patchMicrostrip

Introduced in R2015a

vivaldi class

Create Vivaldi notch antenna on ground plane

Description



The `vivaldi` class creates a Vivaldi notch antenna on a ground plane.

Construction

`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
0.2500 (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'`,3

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

'Tilt' — Tilt angle of antenna
0 (default) | scalar in degrees

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

Example: 'Tilt',90

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.

You can also specify the axis by providing two points in space as three-element vectors of Cartesian coordinates. Tilt axis is the line joining the two points in the direction specified from the first point to the second point.

You can specify X, Y, or Z as string inputs for simple rotations.

Example: 'TiltAxis',[1 0 0]

Data Types: double

Definitions

To rotate antenna elements in Antenna Toolbox™, use the *Tilt* and *TiltAxis* property. For more information please refer, “Rotate Antenna Elements”.

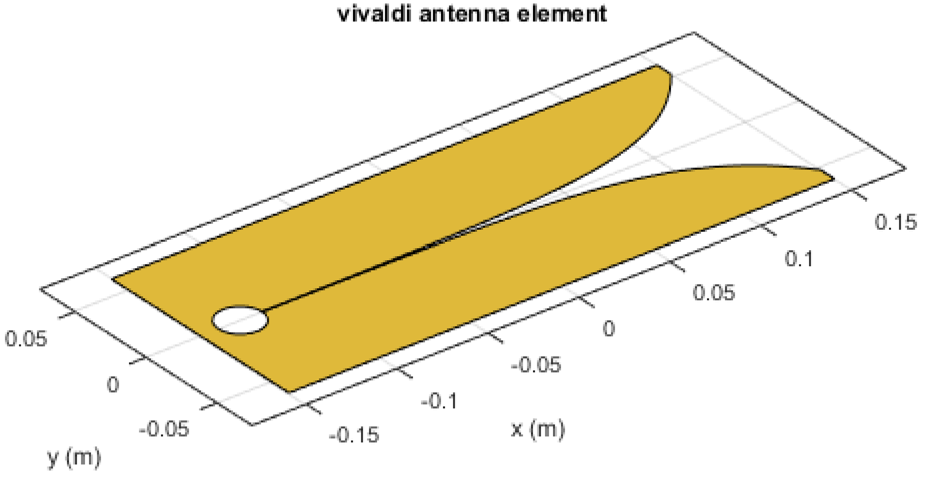
Examples

Create and View Vivaldi Antenna

Create and view the default Vivaldi antenna.

```
vi = vivaldi
show(vi);
```

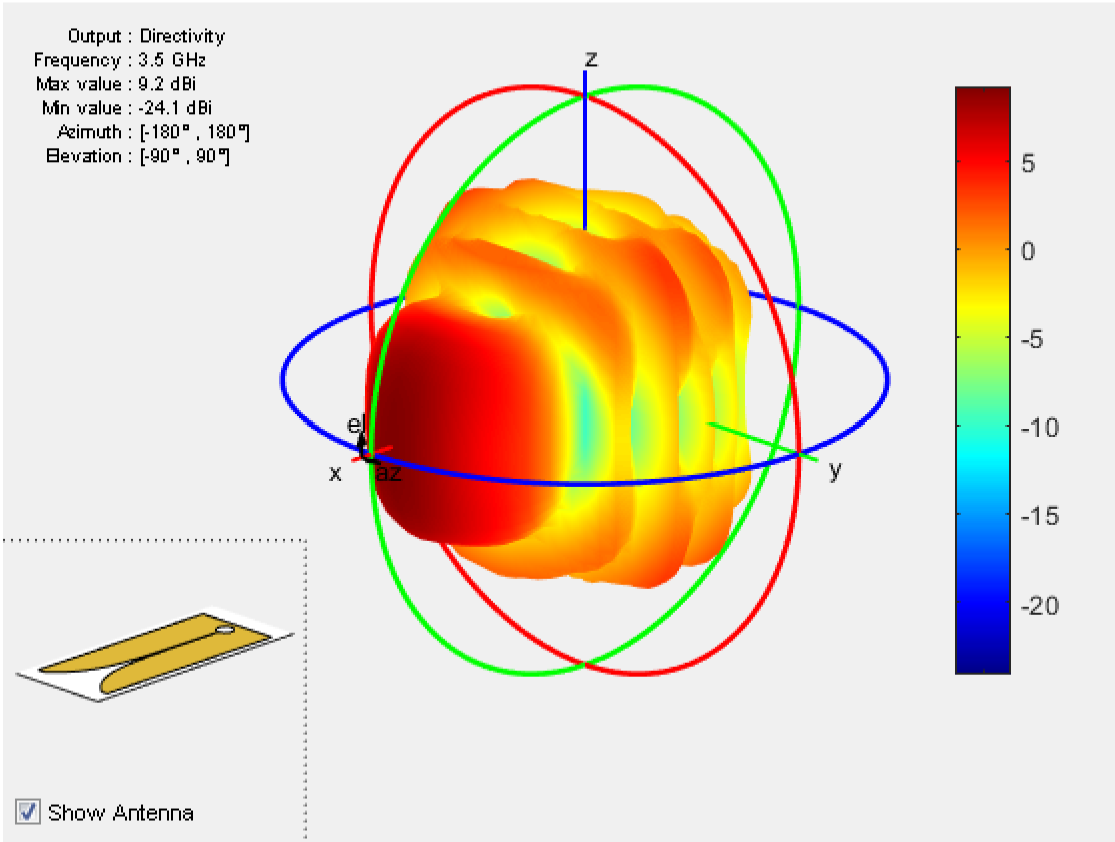
```
vi = 

  vivaldi with properties:

              TaperLength: 0.2430
            ApertureWidth: 0.1050
              OpeningRate: 0.2500
            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]
```



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

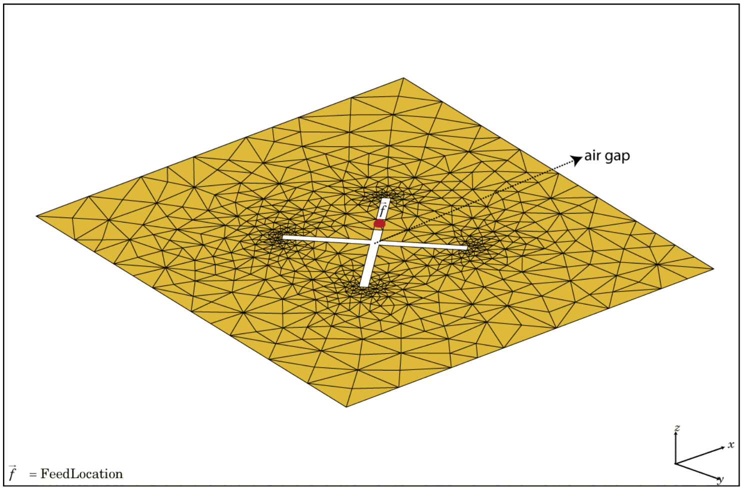
spiralArchimedean | slot | yagiUda

Introduced in R2015a

customAntennaMesh class

Create 2-D custom mesh antenna on X-Y plane

Description



The `customAntennaMesh` class 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.

Construction

`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 `3xN` 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

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

Example: 'Tilt',0

Data Types: double

'TiltAxis' — Tilt axis of antenna

[1 0 0] (default) | three-element vector

Tilt axis of the antenna, specified as the comma-separated pair consisting of 'TiltAxis' and a three-element vector.

Example: 'TiltAxis',[1 0 0]

Data Types: double

'FeedLocation' — Feed location for antenna

Cartesian coordinates in meters

Feed location for antenna, 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

Methods

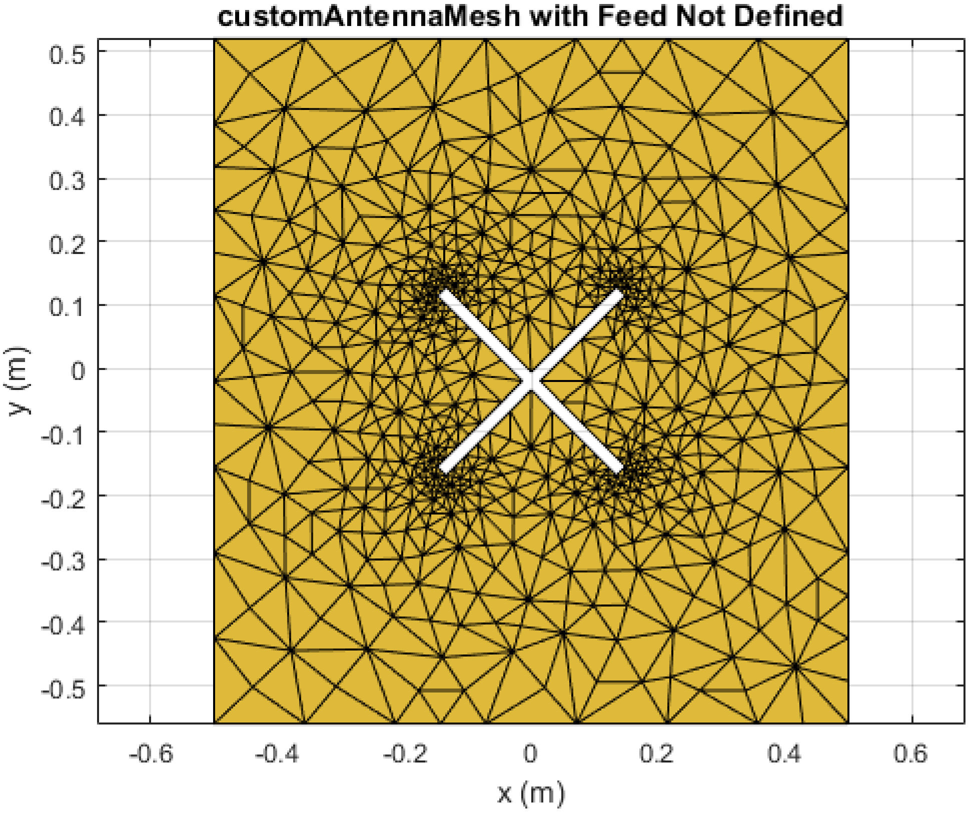
createFeed	Create feed location for custom antenna

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
```

See Also

reflector | cavity

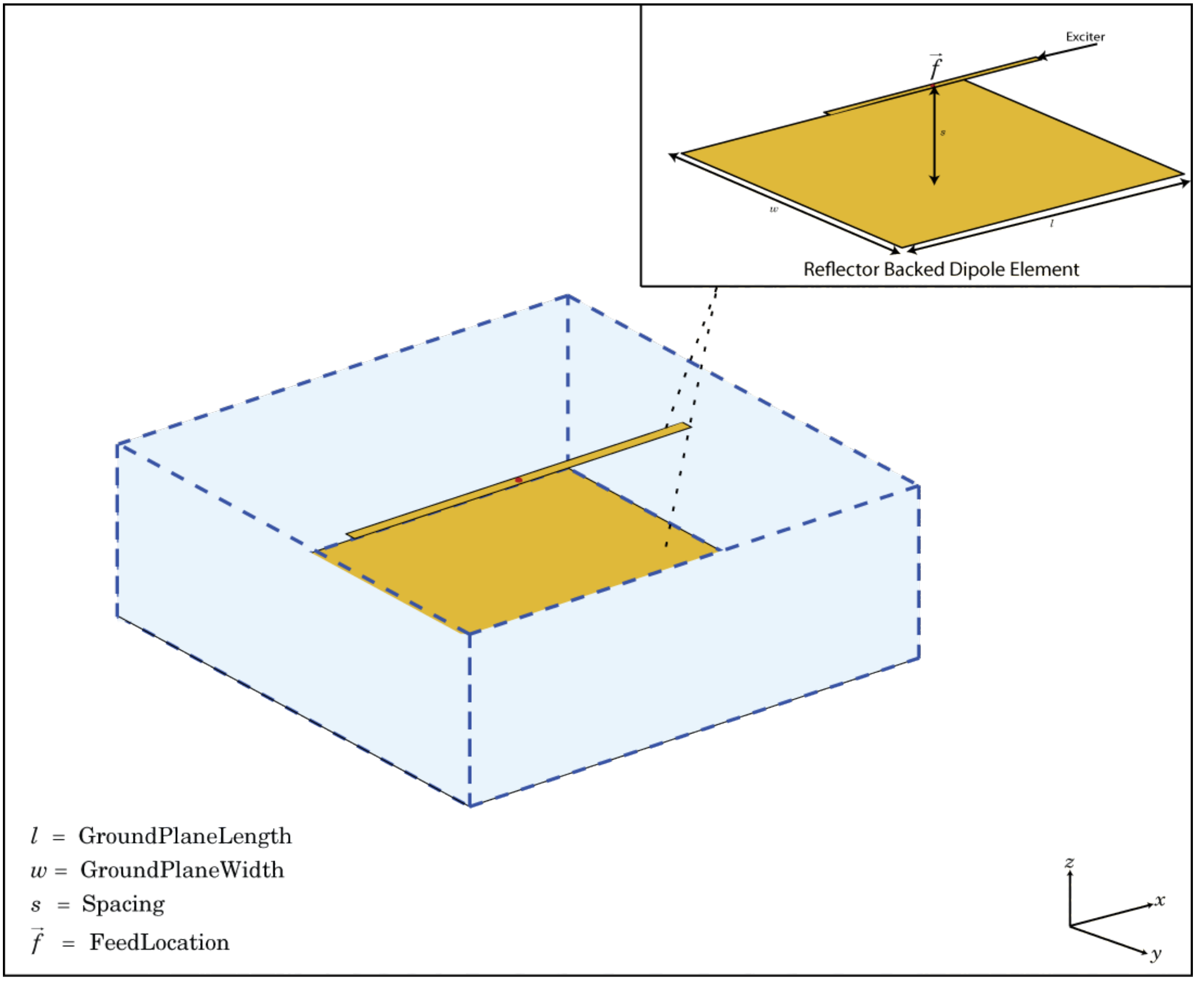
Introduced in R2015b

Array Classes — Alphabetical List

infiniteArray class

Create infinite antenna array

Description



The `infiniteArray` class creates 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.

Construction

`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`

Methods

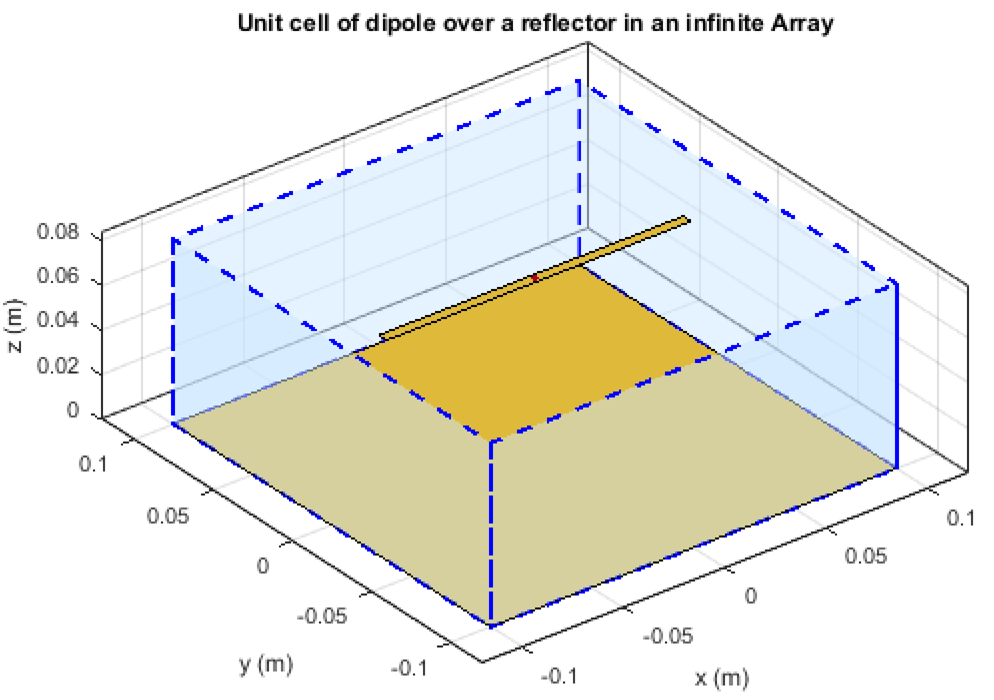
`numSummationTerms`	Modify the number of summation terms for calculating periodic Green's function

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.

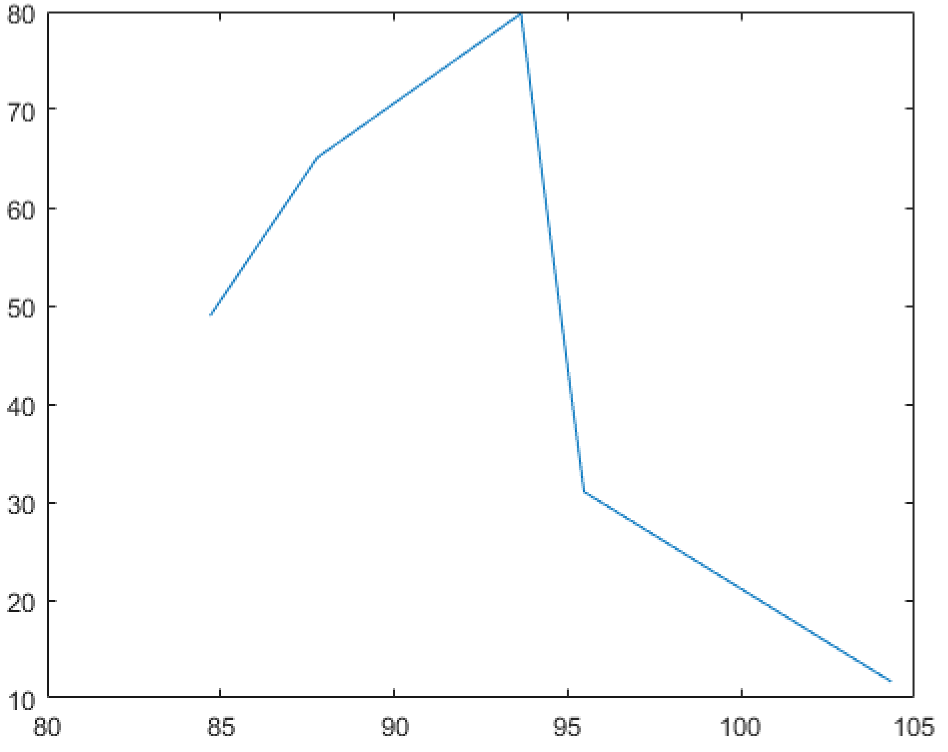
```
infa = infiniteArray('Element',reflector,'ScanAzimuth',0, ...
    'ScanElevation',90);
show(infa)
```



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

linearArray | rectangularArray

More About

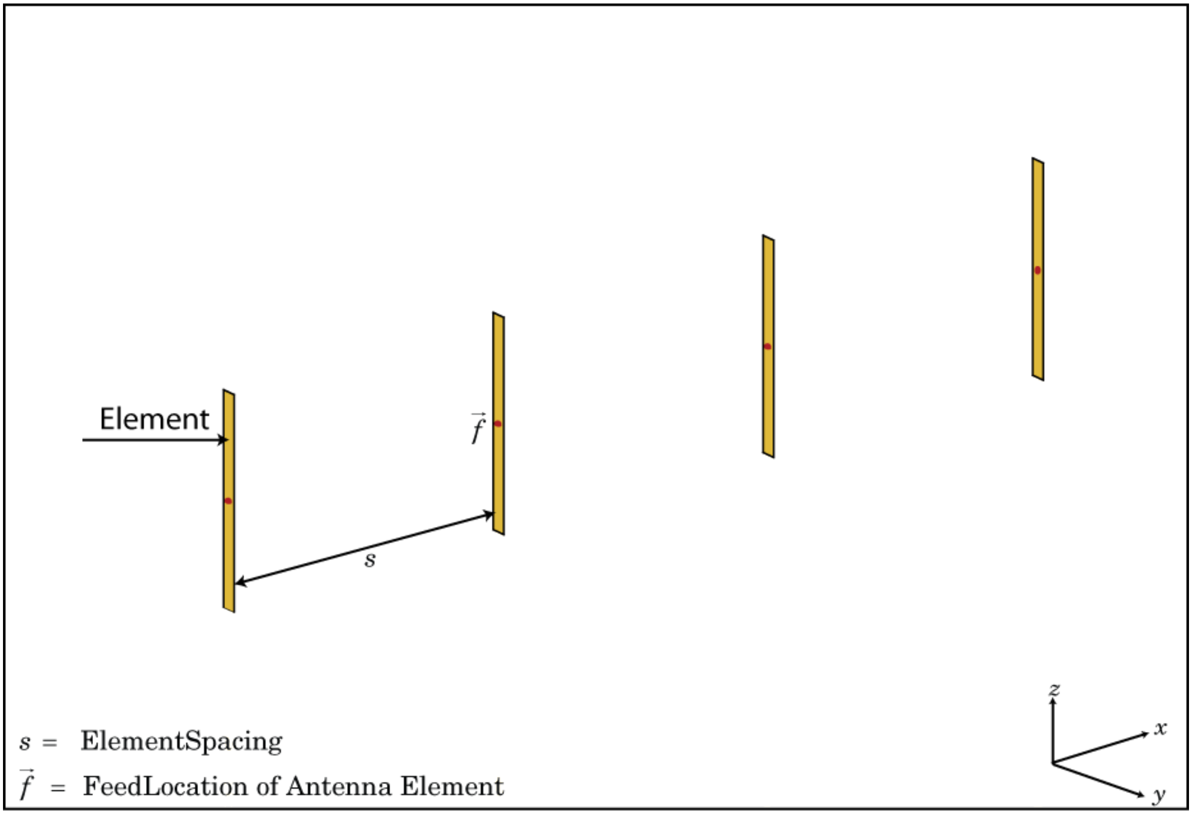
- "Infinite Arrays"

Introduced in R2015b

linearArray class

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.

Construction

`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.

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]

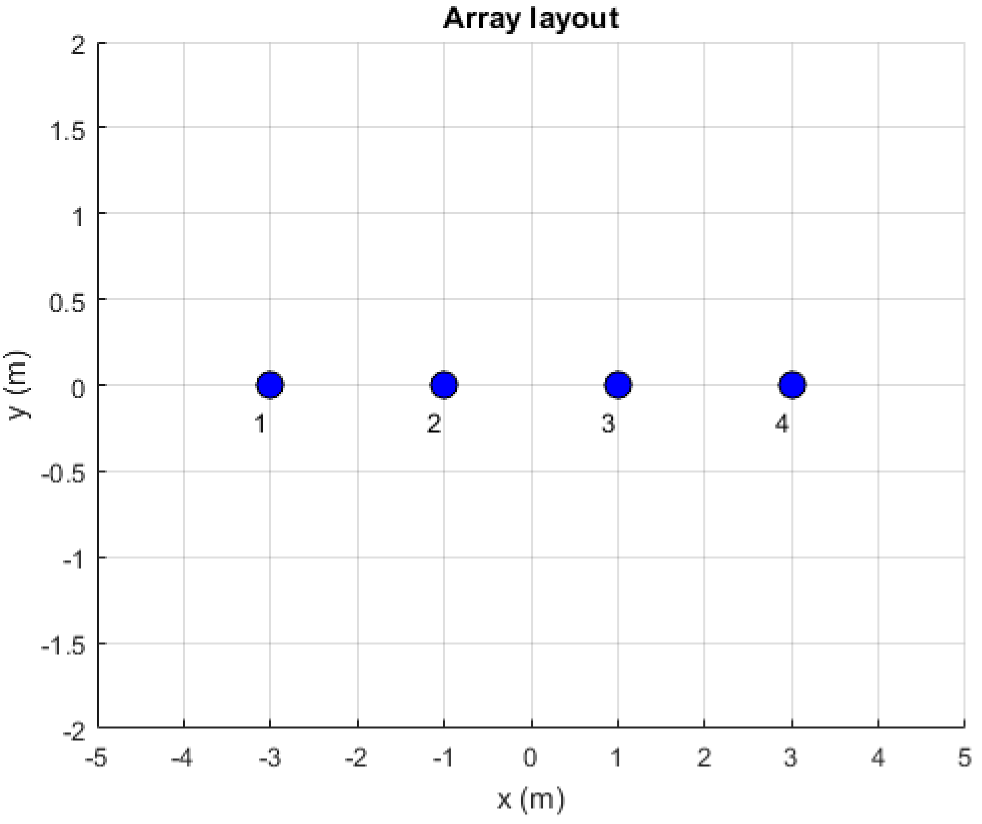
Data Types: double

Examples

Create and Plot Layout of Linear Array

Create a linear array of four dipoles and plot the layout of the array.

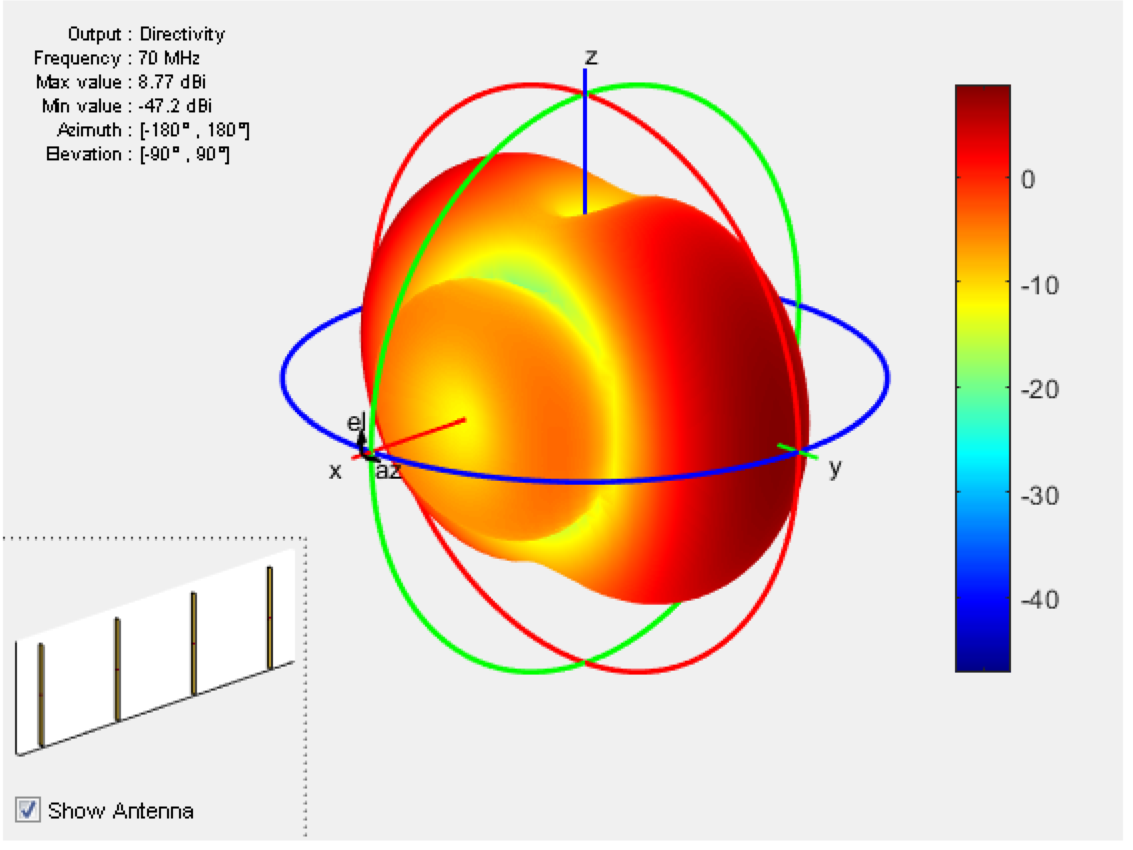
```
la = linearArray;
la.NumElements = 4;
layout(la);
```



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);
```



References

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

See Also

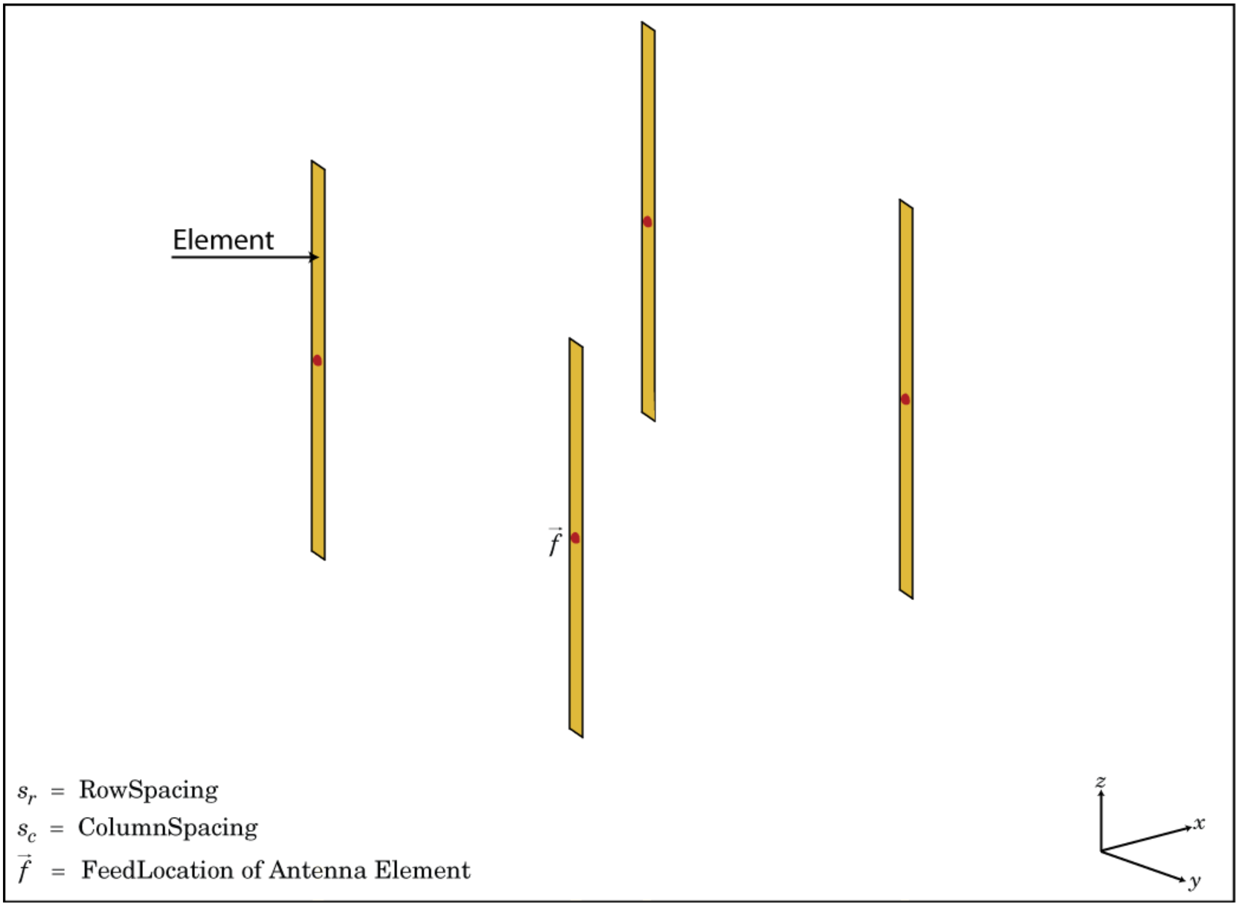
rectangularArray | infiniteArray

Introduced in R2015a

rectangularArray class

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.

Construction

`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' | string

Antenna elements spatial arrangement, specified as the comma-separated pair consisting of 'Lattice' and a string.

Example: 'Lattice',Triangular

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.

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]

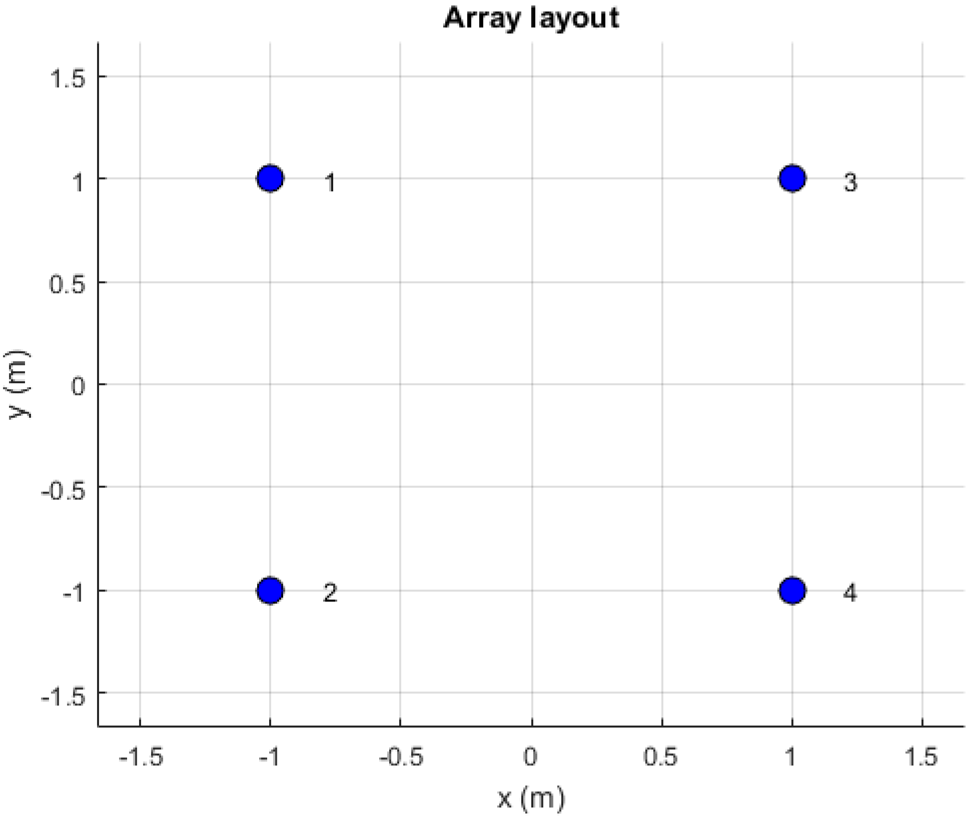
Data Types: double

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 -54.1988i  25.9763 -54.1995i  25.9763 -54.1988i  25.9763 -54.1995i
```

References

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

See Also

linearArray | infiniteArray

Introduced in R2015a

Methods — Alphabetical List

impedance
sparameters
rfparam
rfplot
show
returnLoss
pattern
patternAzimuth
patternElevation
current
charge
createFeed
EHfields
axialRatio
beamwidth
mesh
layout
vswr
correlation
cylinder2strip
helixpitch2spacing
meshconfig
numSummationTerms

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.

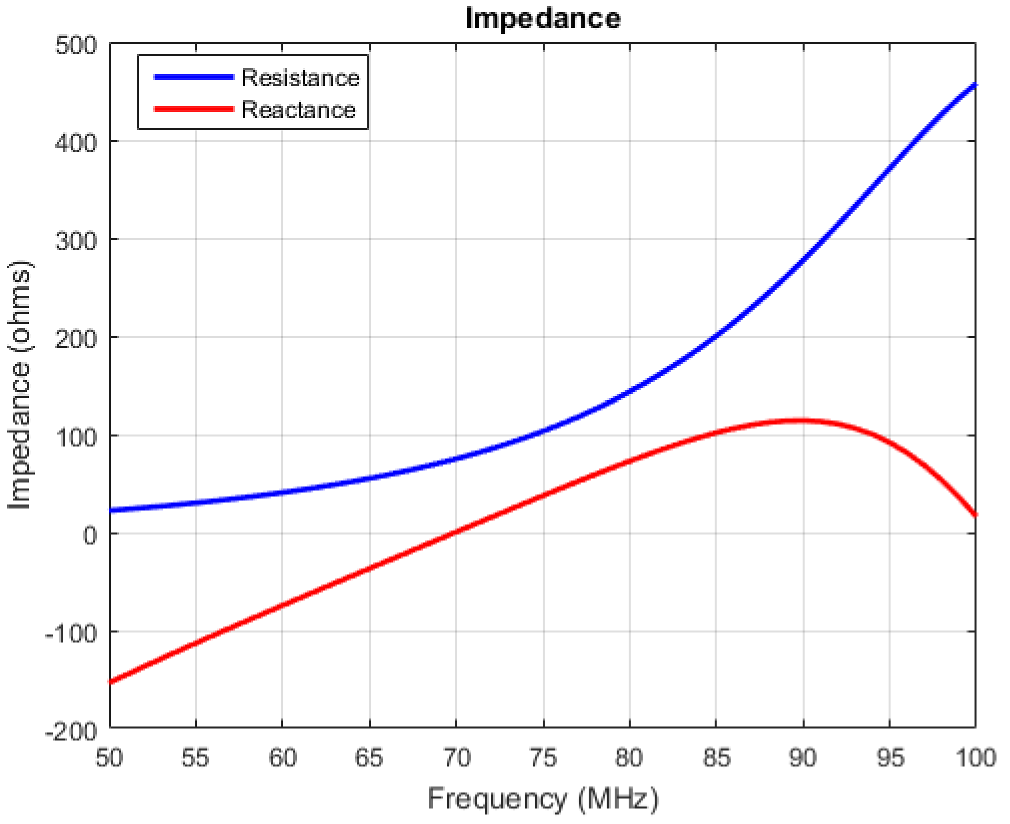
`z = impedance(array,frequency,elementnumber)` returns the scan impedance of a specified antenna element in an array.

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

`returnLoss`

Introduced in R2015a

sparameters

Create 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)
```

```
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: [4x4 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 will be 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

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

`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

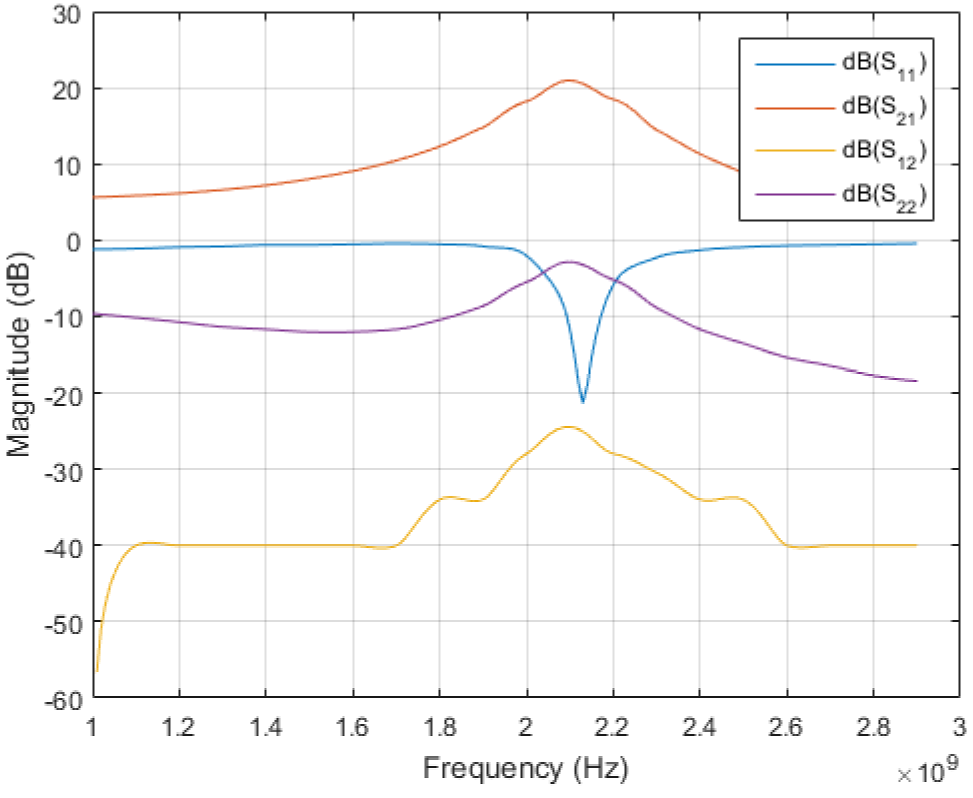
Plot S-Parameter Data Using rfplot

Create S-parameter

```
hs = sparameters('default.s2p');
```

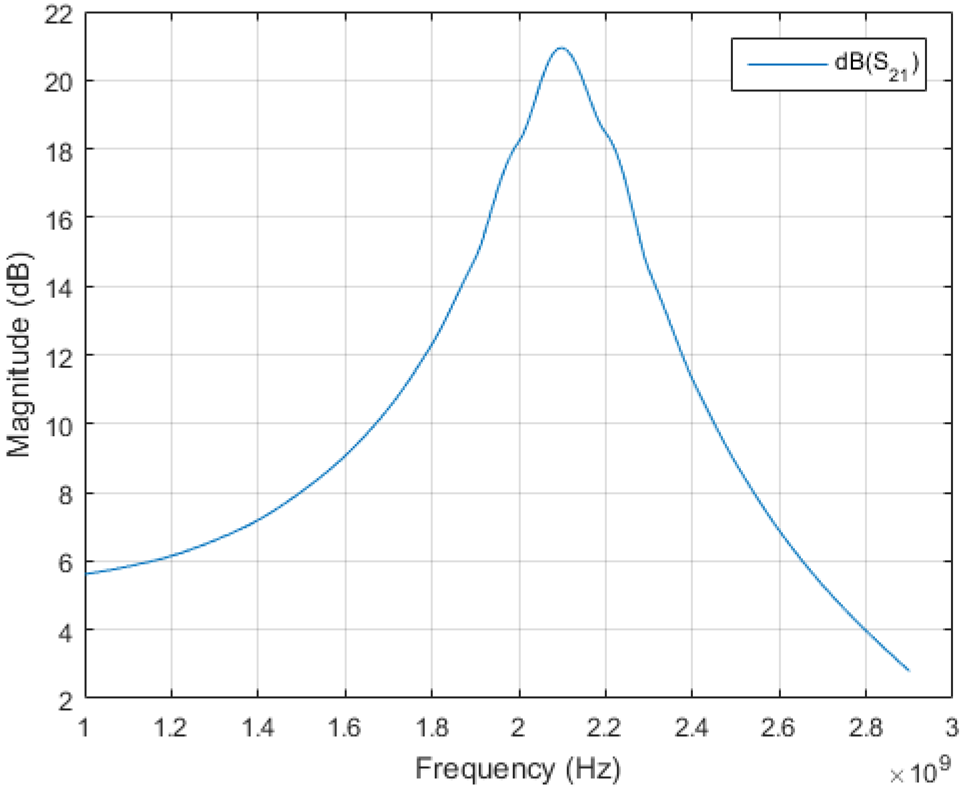
Plot all S-paramteres

```
figure;
rfplot(hs)
```



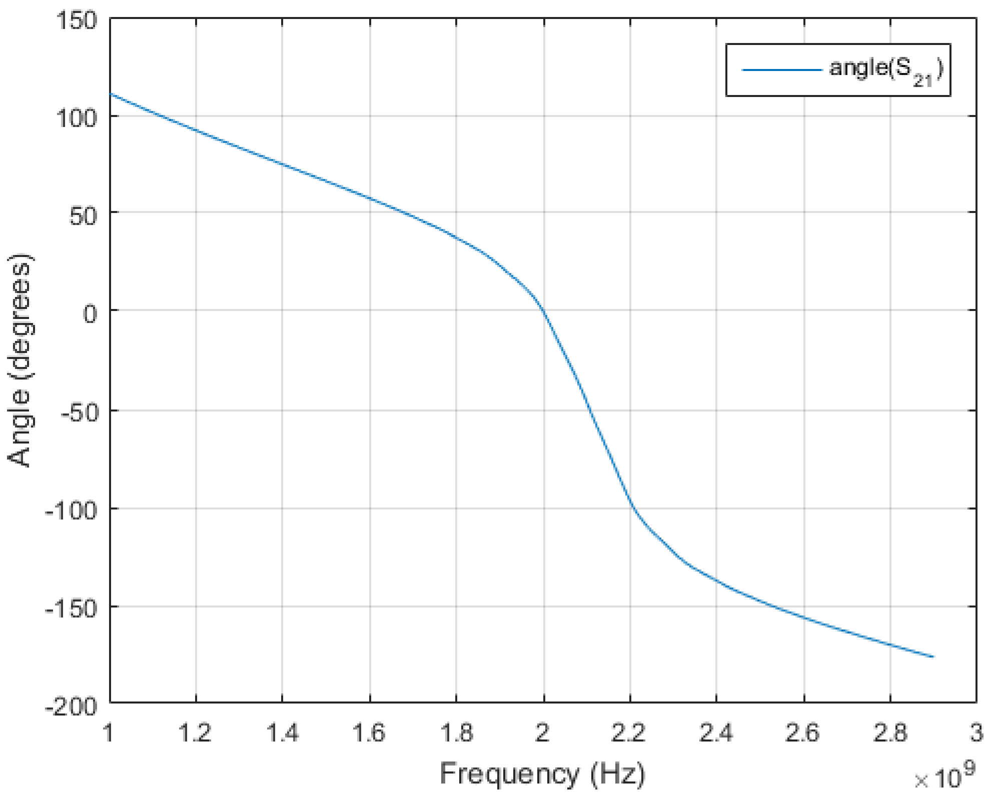
Plot S21

```
figure;
rfplot(hs,2,1)
```



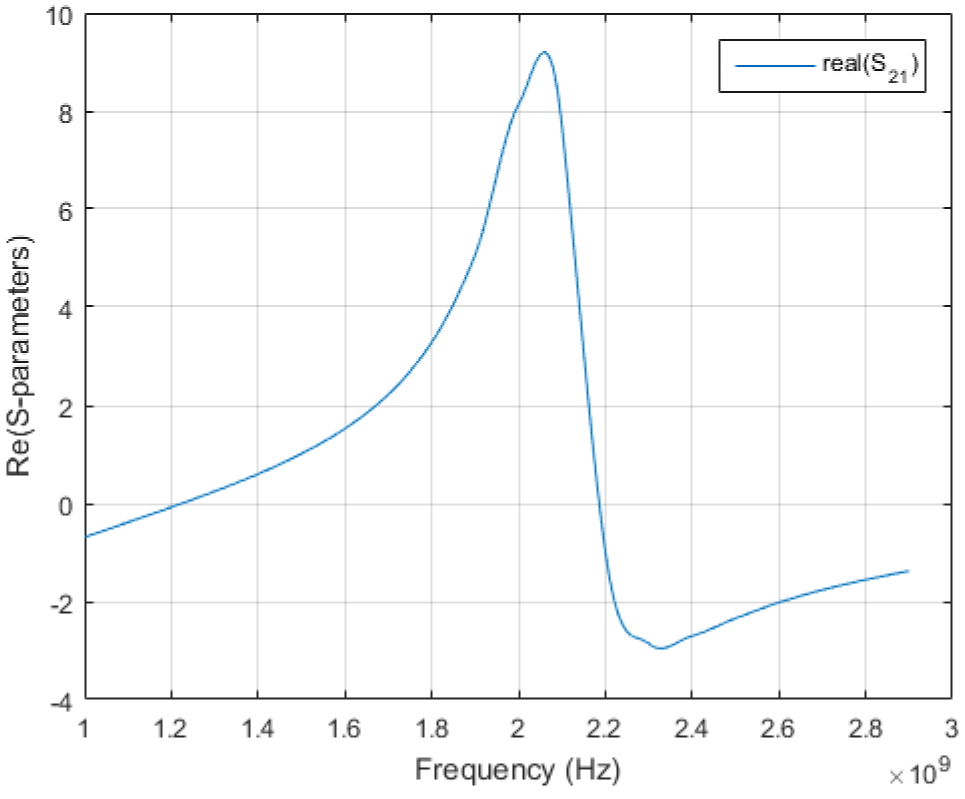
Plot the angle of S21 in degrees

```
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 string

Line specification, specified as a character string, that modifies the line types, symbols, and colors of the plot. The function takes string specifiers in the same format as `plot` command. For more information on line specification strings, see `linespec`.

Example: `'-or'`

`plotflag` — Plot types
`'db'` (default) | character string

Plot types, specified as a character string. The valid plot flags are `'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

`sparameters`

show

Display antenna or array structure

Syntax

```
show(object)
```

Description

`show(object)` displays the structure of an antenna or array object.

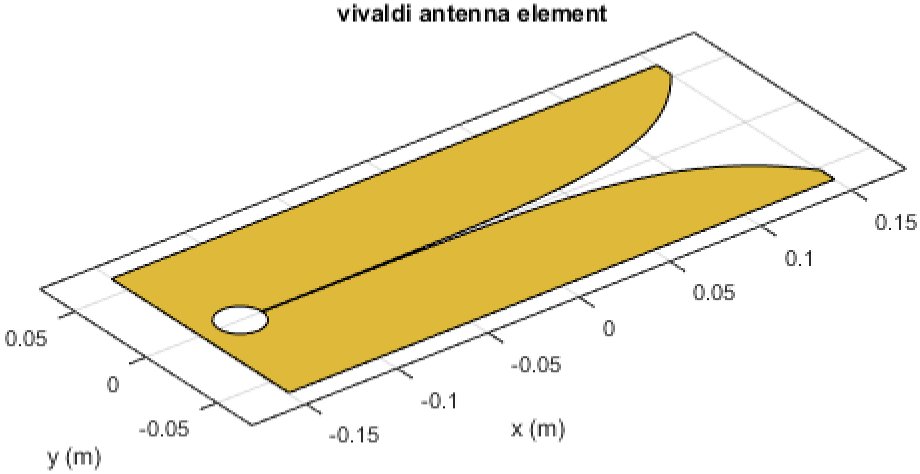
Examples

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: 0.2500
          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]
```



Input Arguments

`object` — Antenna or array object
scalar handle

Antenna or array object, specified as a scalar handle.

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)

retunrLoss(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.

`retunrLoss(array,frequency,elementnumber)` calculates and plots the scan return loss of a specified antenna element in an array.

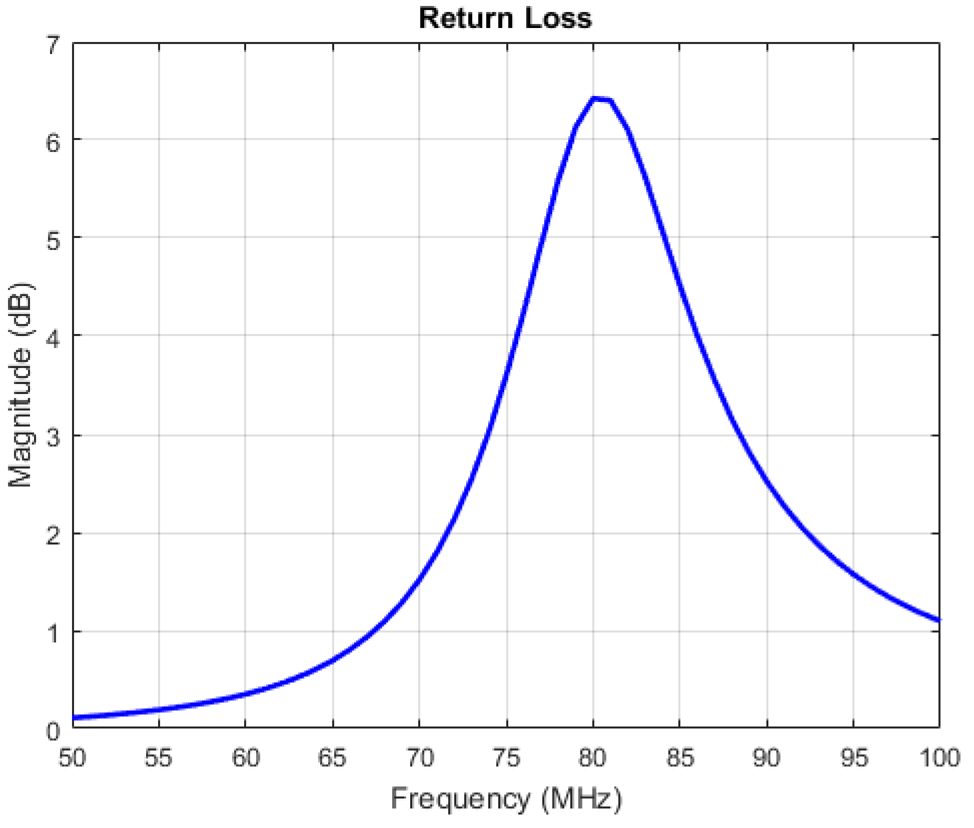
`rl = returnLoss(array,frequency,elementnumber)` returns the scan return loss of a specified antenna element in an array.

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

`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)

[directivity,azimuth,elevation] = pattern(object,frequency)
[directivity,azimuth,elevation] = pattern(object,frequency,azimuth,
elevation)
[directivity,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.

`[directivity,azimuth,elevation] = pattern(object,frequency)` returns the directivity of an antenna or array object over a specified frequency. `azimuth` and `elevation` are the angles at which the `pattern` function calculates the directivity.

`[directivity,azimuth,elevation] = pattern(object,frequency,azimuth, elevation)` returns the directivity of an antenna or array object at specified frequency. `azimuth` and `elevation` are the angles at which the pattern function calculates the directivity.

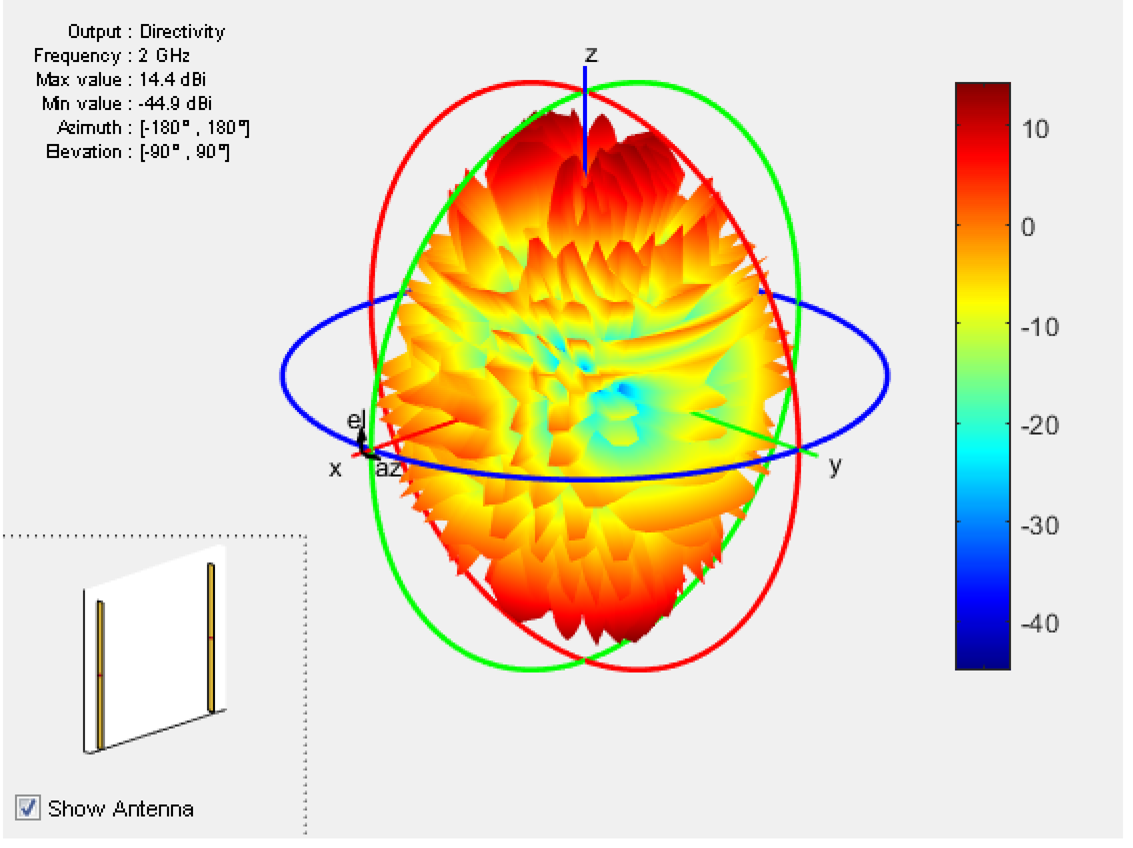
`[directivity,azimuth,elevation] = pattern( ___ ,Name,Value)`uses additional options specified by one or more `Name,Value` pair arguments.

Examples

Calculate Radiation Pattern of Array

Calculate radiation pattern of default linear array for a frequency of 2 GHz.

```
l = linearArray;
pattern(l,2e9)
```



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 strings: `'polar'`, `'rectangular'`, `'uv'`.

Example: `'CoordinateSystem'`, `'polar'`

Data Types: `char`

`'Type'` — Value to plot
`'directivity'` (default) | `'efield'` | `'power'` | `'powerdb'` | string

Value to plot, specified as a comma-separated pair consisting of `'Type'` and one of these strings:

- `'directivity'` – Radiation intensity in a given direction of antenna
- `'efield'` – Electric field of antenna
- `'power'` – Antenna power in watts
- `'powerdb'` – Antenna power in dB

Example: `'Type'`, `'efield'`

Data Types: `char`

`'Normalize'` — Normalize filed 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 strings:

- `'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'` | string

Field polarization, specified as the comma-separated pair consisting of `'Polarization'` and one of these strings:

- `'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

directivity — Antenna or array directivity
matrix in dBi

Antenna or array directivity, returned as a matrix in dBi. The matrix size is the product of the number of elevation values and the 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

`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.

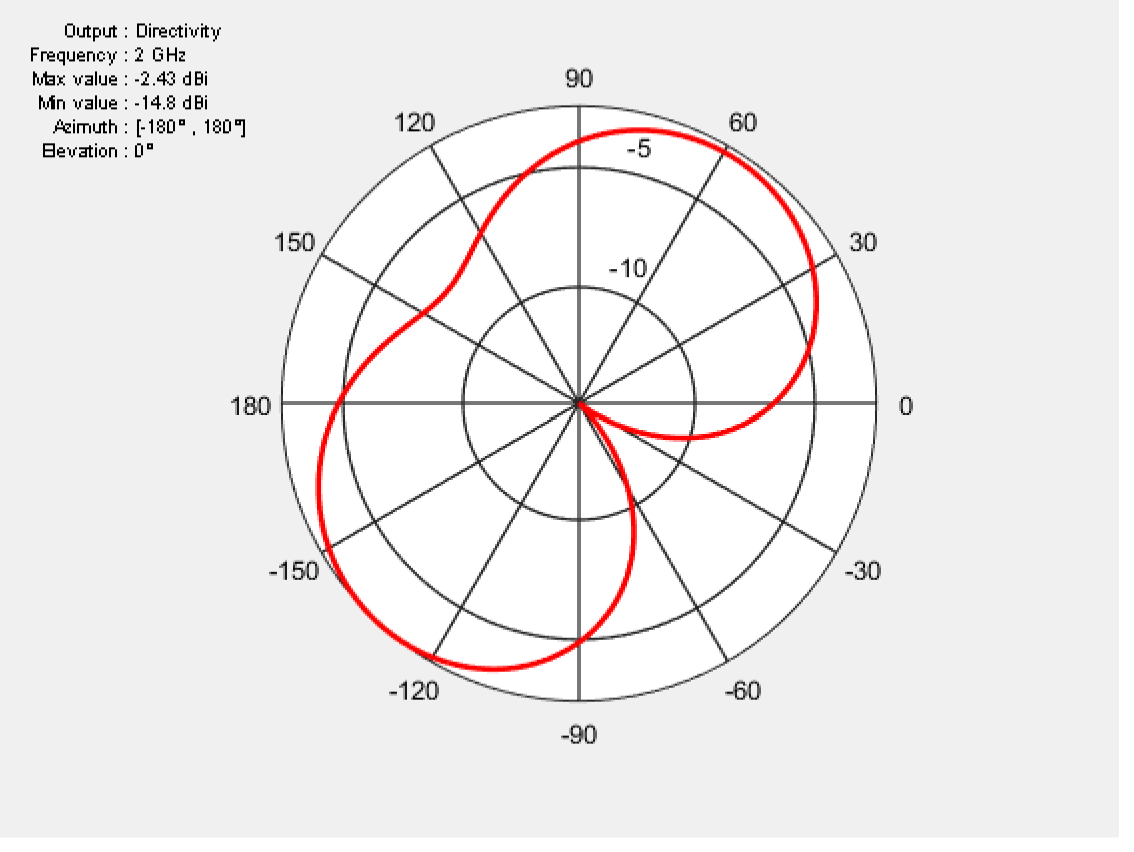
`directivity = patternAzimuth(object,frequency,elevation,Name,Value)` uses additional options specified by one or more `Name,Value` pair arguments.

Examples

Azimuth Radiation Pattern of Helix Antenna

Calculate and plot the azimuth radiation pattern of the helix antenna at 2 GHz.

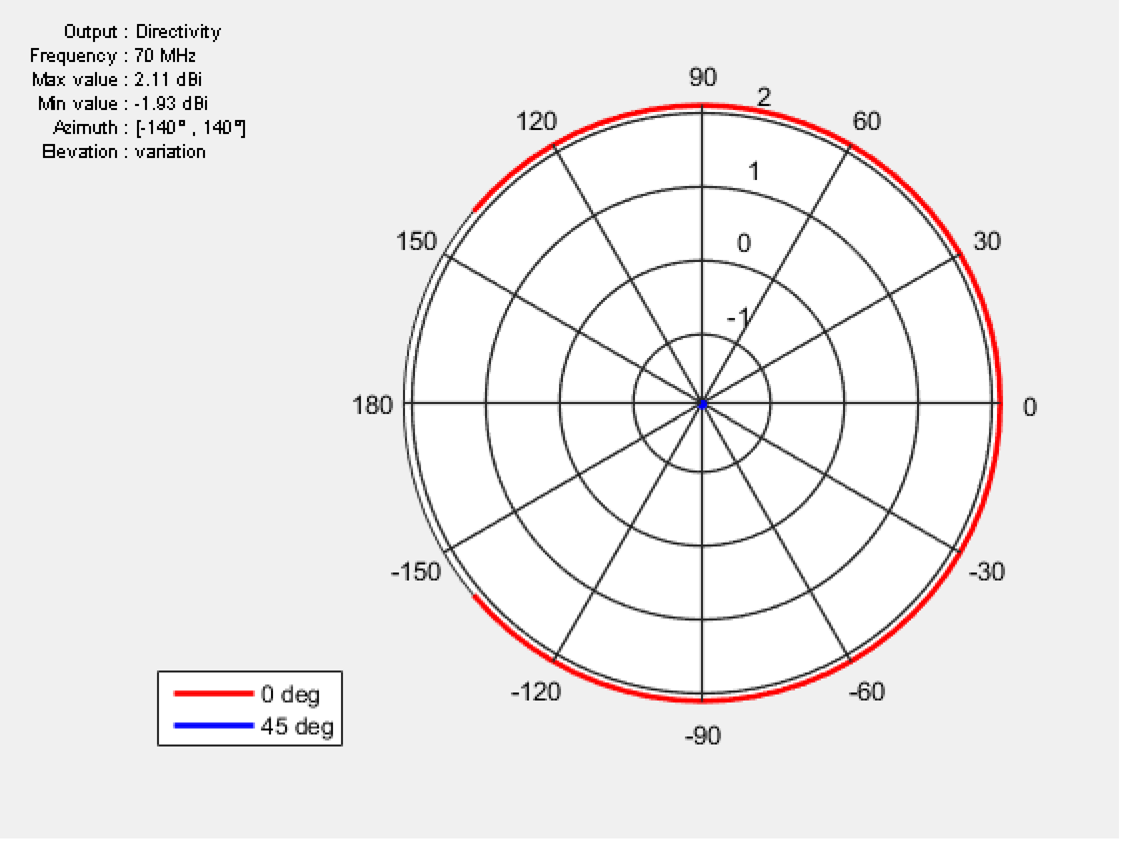
```
h = helix;
patternAzimuth(h,2e9);
```



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

`pattern` | `patternElevation`

Introduced in R2015a

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.

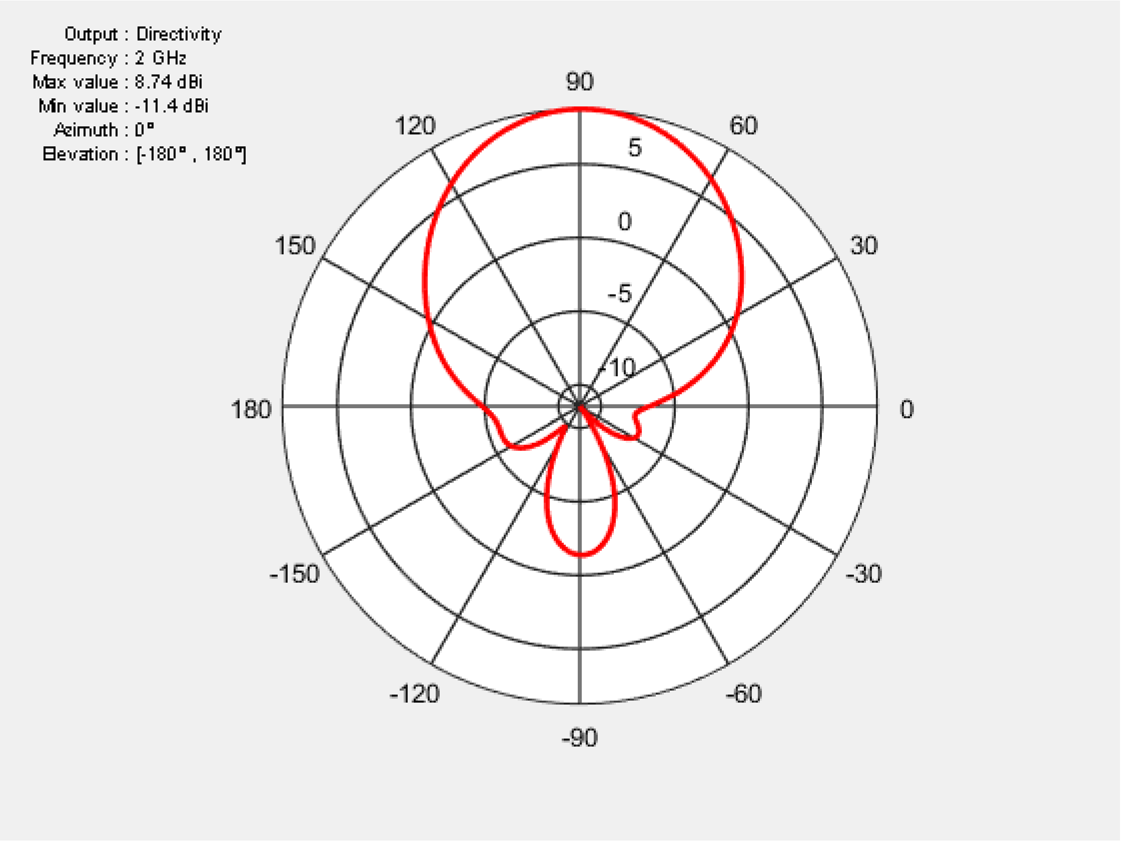
`directivity = patternElevation(object,frequency,azimuth,Name,Value)` uses additional options specified by one or more `Name, Value` pair arguments.

Examples

Elevation Radiation Pattern of Helix

Calculate and plot the elevation pattern of the helix antenna at 2 GHz.

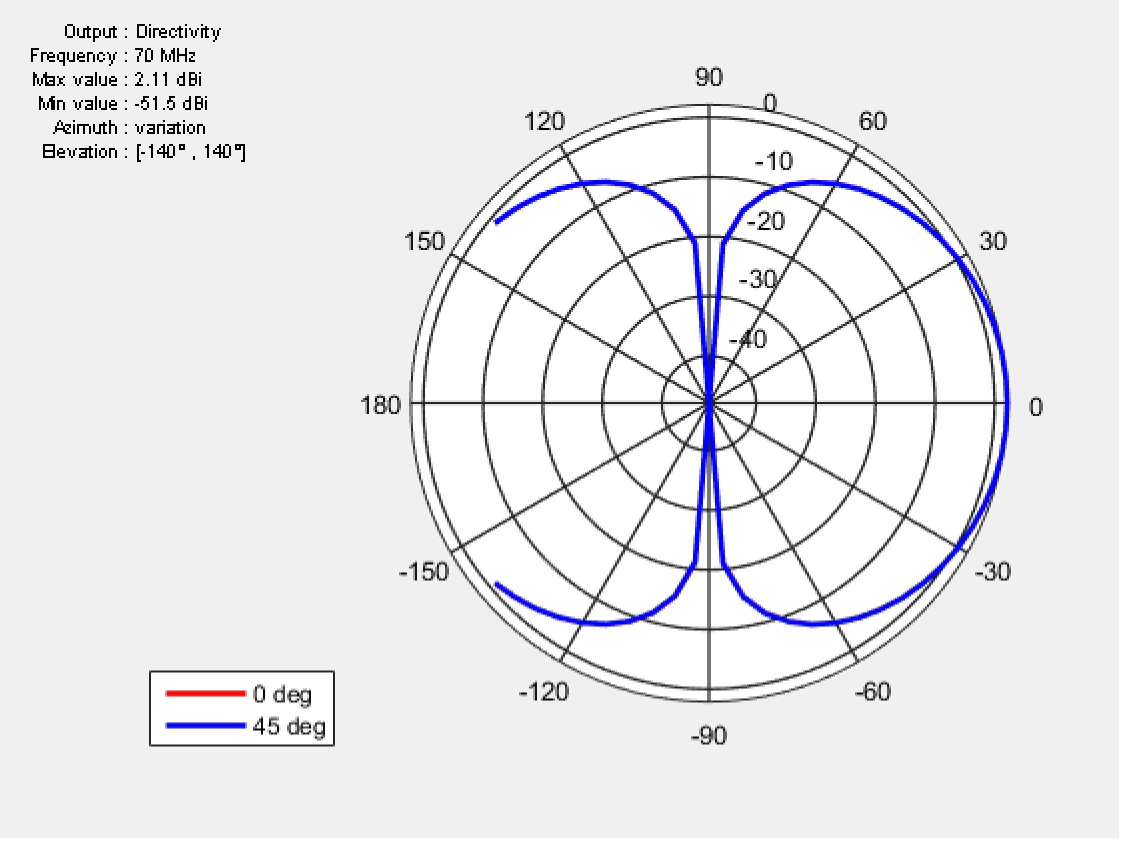
```
h = helix;
patternElevation (h, 2e9);
```



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

`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.

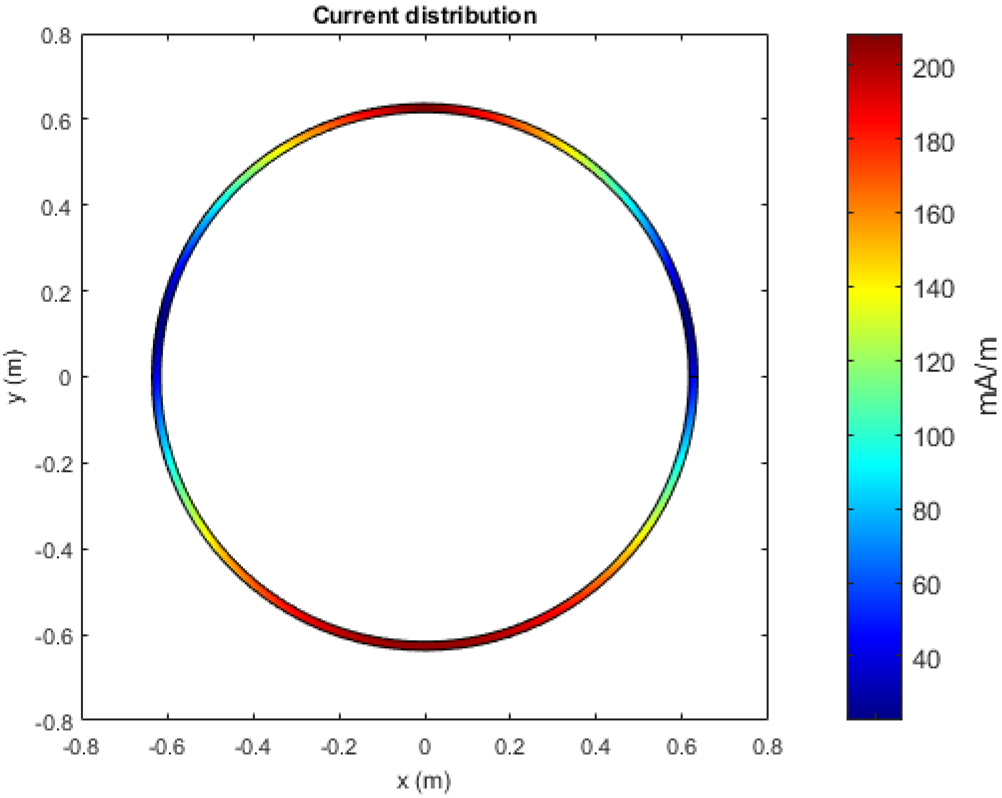
`i = current(object,frequency)` returns the x, y, z components of the current on the surface of an antenna or array object, at a specified frequency.

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 defualt 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

`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.

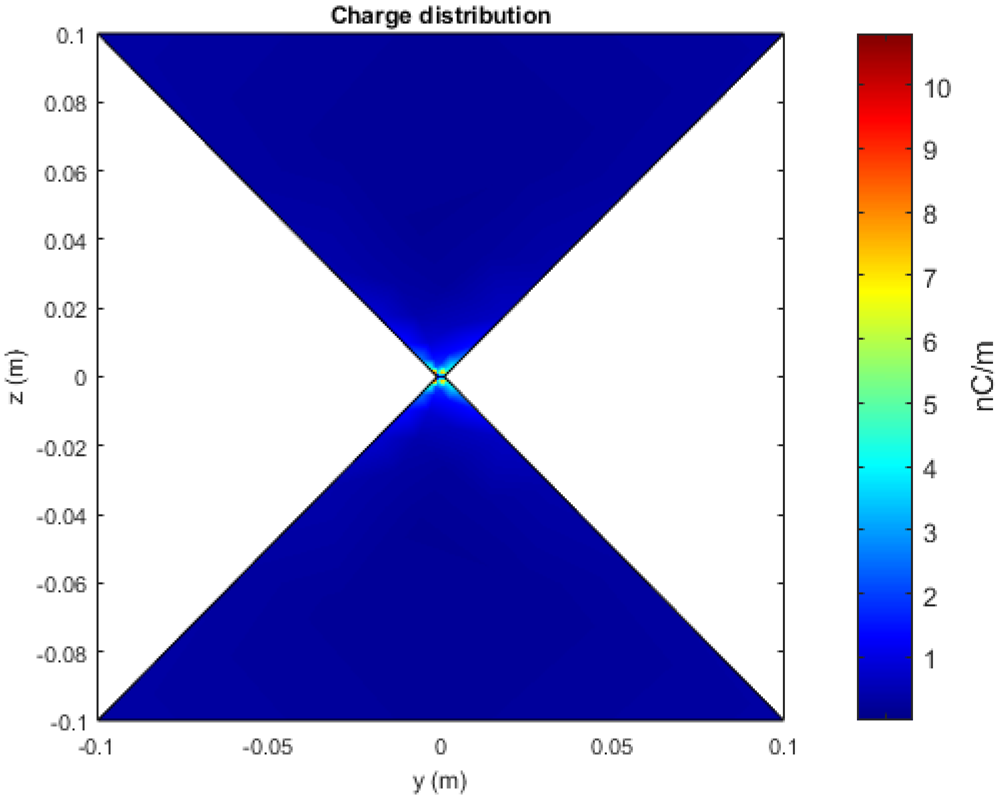
`c = charge(object,frequency)` returns a vector of charges in C/m on the surface of an antenna or array object, at a specified frequency.

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)
```

```
C =

   1.0e-08 *

  Columns 1 through 4
```

```
-0.0159 + 0.1008i  -0.0070 + 0.0414i  -0.0098 + 0.0492i  -0.0083 + 0.0424i

Columns 5 through 8

-0.0103 + 0.0440i  -0.0083 + 0.0359i  -0.0110 + 0.0402i  -0.0085 + 0.0301i

Columns 9 through 12

-0.0117 + 0.0357i  -0.0086 + 0.0245i  -0.0123 + 0.0307i  -0.0086 + 0.0186i

Columns 13 through 16

-0.0130 + 0.0251i  -0.0085 + 0.0126i  -0.0144 + 0.0191i  -0.0082 + 0.0065i

Columns 17 through 20

-0.0167 + 0.0114i  -0.0109 + 0.0034i  -0.0171 + 0.0016i  -0.0898 + 0.0013i

Columns 21 through 24

 0.0905 - 0.0015i   0.0160 - 0.0016i   0.0115 - 0.0048i   0.0156 - 0.0078i

Columns 25 through 28

 0.0100 - 0.0119i   0.0126 - 0.0137i   0.0102 - 0.0177i   0.0115 - 0.0201i

Columns 29 through 32

 0.0101 - 0.0240i   0.0109 - 0.0255i   0.0098 - 0.0293i   0.0105 - 0.0311i

Columns 33 through 36

 0.0095 - 0.0349i   0.0101 - 0.0357i   0.0092 - 0.0400i   0.0095 - 0.0401i

Columns 37 through 40

 0.0090 - 0.0467i   0.0091 - 0.0446i   0.0076 - 0.0448i   0.0155 - 0.0990i

Columns 41 through 44

-0.0492 + 0.1082i  -0.0207 + 0.0445i  -0.0260 + 0.0527i  -0.0222 + 0.0455i

Columns 45 through 48
```

```
-0.0248 + 0.0472i  -0.0201 + 0.0385i  -0.0243 + 0.0431i  -0.0184 + 0.0323i

Columns 49 through 52

-0.0234 + 0.0383i  -0.0166 + 0.0262i  -0.0224 + 0.0328i  -0.0147 + 0.0199i

Columns 53 through 56

-0.0213 + 0.0269i  -0.0126 + 0.0134i  -0.0206 + 0.0204i  -0.0103 + 0.0069i

Columns 57 through 60

-0.0204 + 0.0122i  -0.0120 + 0.0037i  -0.0176 + 0.0017i  -0.0902 + 0.0014i

Columns 61 through 64

 0.0909 - 0.0016i   0.0166 - 0.0017i   0.0131 - 0.0051i   0.0181 - 0.0083i

Columns 65 through 68

 0.0139 - 0.0127i   0.0171 - 0.0146i   0.0160 - 0.0189i   0.0181 - 0.0215i

Columns 69 through 72

 0.0179 - 0.0257i   0.0193 - 0.0273i   0.0194 - 0.0313i   0.0207 - 0.0333i

Columns 73 through 76

 0.0210 - 0.0374i   0.0218 - 0.0382i   0.0224 - 0.0429i   0.0227 - 0.0430i

Columns 77 through 80

 0.0244 - 0.0501i   0.0238 - 0.0479i   0.0224 - 0.0480i   0.0483 - 0.1062i

Columns 81 through 84

-0.0492 + 0.1082i  -0.0207 + 0.0445i  -0.0260 + 0.0527i  -0.0222 + 0.0455i

Columns 85 through 88

-0.0248 + 0.0472i  -0.0201 + 0.0385i  -0.0243 + 0.0431i  -0.0184 + 0.0323i

Columns 89 through 92
```

```
-0.0234 + 0.0383i  -0.0166 + 0.0262i  -0.0224 + 0.0328i  -0.0147 + 0.0199i

Columns 93 through 96

-0.0213 + 0.0269i  -0.0126 + 0.0134i  -0.0206 + 0.0204i  -0.0103 + 0.0069i

Columns 97 through 100

-0.0204 + 0.0122i  -0.0120 + 0.0037i  -0.0176 + 0.0017i  -0.0902 + 0.0014i

Columns 101 through 104

 0.0909 - 0.0016i   0.0166 - 0.0017i   0.0131 - 0.0051i   0.0181 - 0.0083i

Columns 105 through 108

 0.0139 - 0.0127i   0.0171 - 0.0146i   0.0160 - 0.0189i   0.0181 - 0.0215i

Columns 109 through 112

 0.0179 - 0.0257i   0.0193 - 0.0273i   0.0194 - 0.0313i   0.0207 - 0.0333i

Columns 113 through 116

 0.0210 - 0.0374i   0.0218 - 0.0382i   0.0224 - 0.0429i   0.0227 - 0.0430i

Columns 117 through 120

 0.0244 - 0.0501i   0.0238 - 0.0479i   0.0224 - 0.0480i   0.0483 - 0.1062i

Columns 121 through 124

-0.0159 + 0.1008i  -0.0070 + 0.0414i  -0.0098 + 0.0492i  -0.0083 + 0.0424i

Columns 125 through 128

-0.0103 + 0.0440i  -0.0083 + 0.0359i  -0.0110 + 0.0402i  -0.0085 + 0.0301i

Columns 129 through 132

-0.0117 + 0.0357i  -0.0086 + 0.0245i  -0.0123 + 0.0307i  -0.0086 + 0.0186i

Columns 133 through 136
```

```
  -0.0130 + 0.0251i  -0.0085 + 0.0126i  -0.0144 + 0.0191i  -0.0082 + 0.0065i

  Columns 137 through 140

  -0.0167 + 0.0114i  -0.0109 + 0.0034i  -0.0171 + 0.0016i  -0.0898 + 0.0013i

  Columns 141 through 144

   0.0905 - 0.0015i   0.0160 - 0.0016i   0.0115 - 0.0048i   0.0156 - 0.0078i

  Columns 145 through 148

   0.0100 - 0.0119i   0.0126 - 0.0137i   0.0102 - 0.0177i   0.0115 - 0.0201i

  Columns 149 through 152

   0.0101 - 0.0240i   0.0109 - 0.0255i   0.0098 - 0.0293i   0.0105 - 0.0311i

  Columns 153 through 156

   0.0095 - 0.0349i   0.0101 - 0.0357i   0.0092 - 0.0400i   0.0095 - 0.0401i

  Columns 157 through 160

   0.0090 - 0.0467i   0.0091 - 0.0446i   0.0076 - 0.0448i   0.0155 - 0.0990i
```

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

`current` | `EHfields`

Introduced in R2015a

createFeed

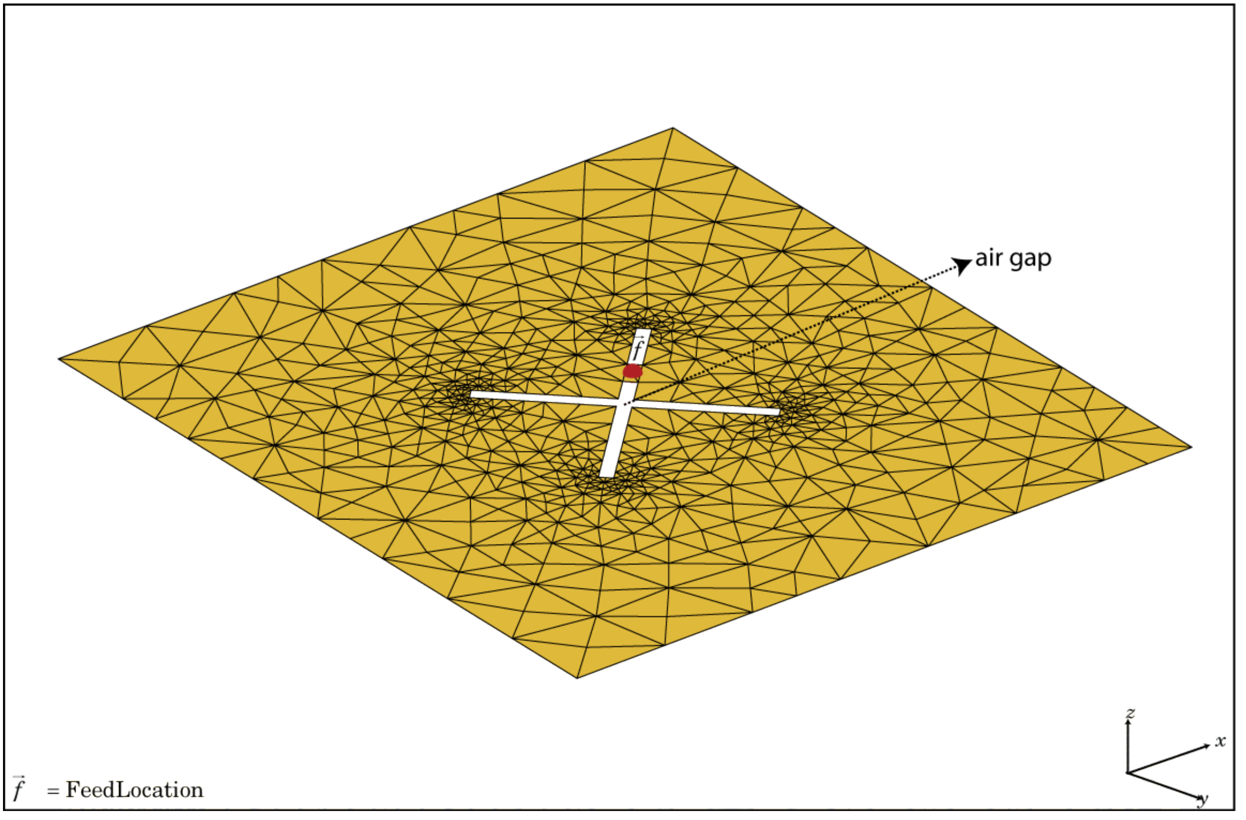
Class: customAntennaMesh

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.

`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 GUI

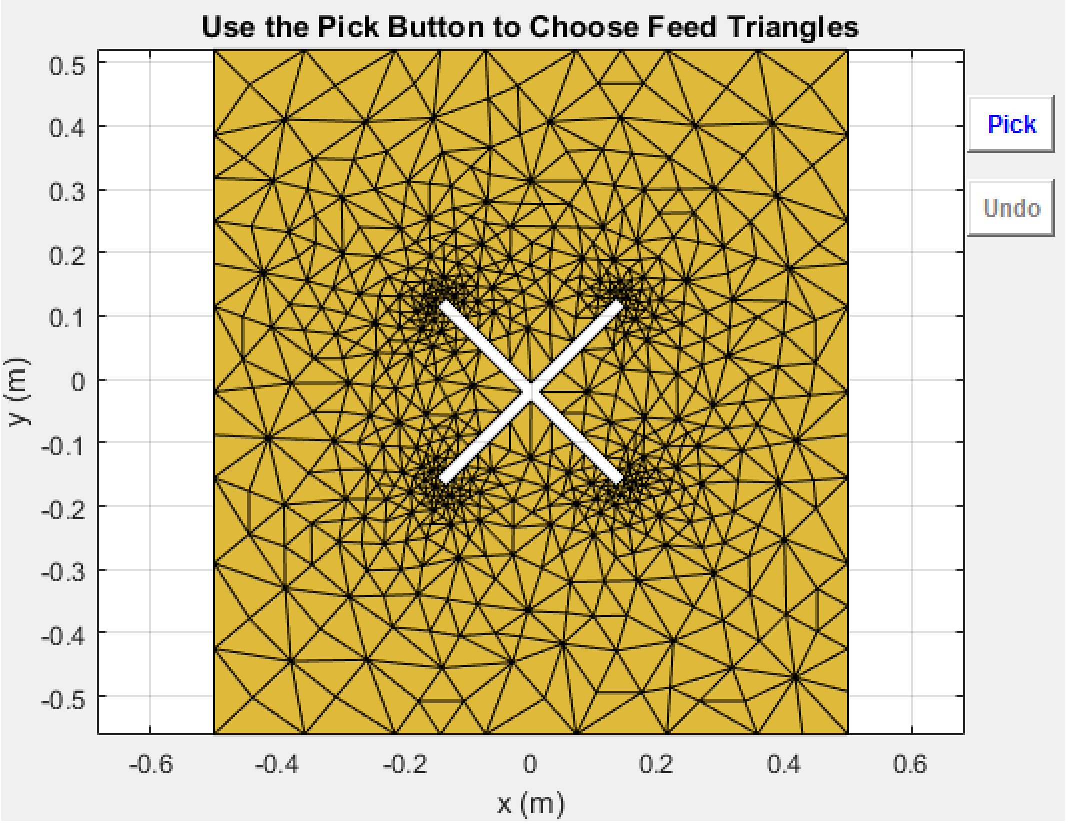
Load a 2-D custom mesh. Create a custom antenna using the points and triangles.

```
load planarmesh.mat
c = customAntennaMesh(p,t)
```

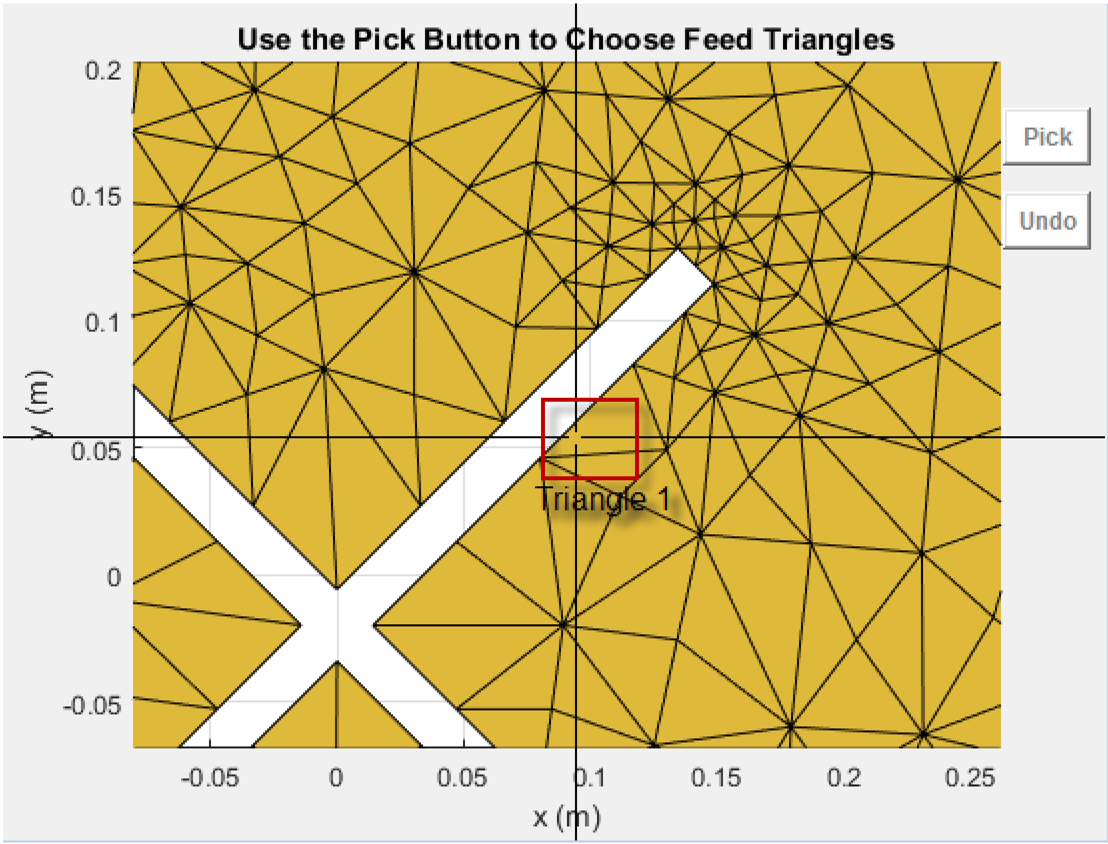
```
c = 

  customAntennaMesh with properties:

          Points: [3x658 double]
       Triangles: [4x1219 double]
    FeedLocation: []
            Tilt: 0
        TiltAxis: [1 0 0]
```

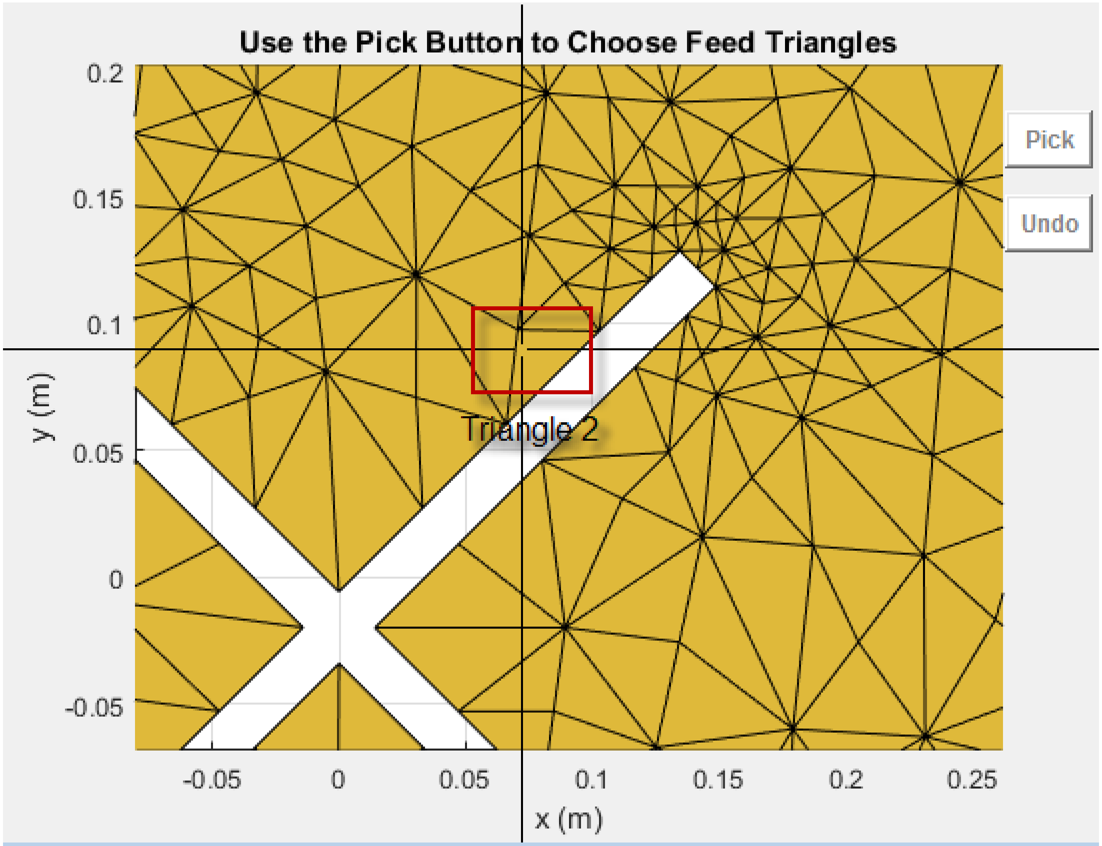
Use the `createFeed` function to view the antenna mesh structure. In this antenna mesh view, you will see **Pick** and **Undo** buttons. The **Pick** button is highlighted.

```
createFeed(c)
```



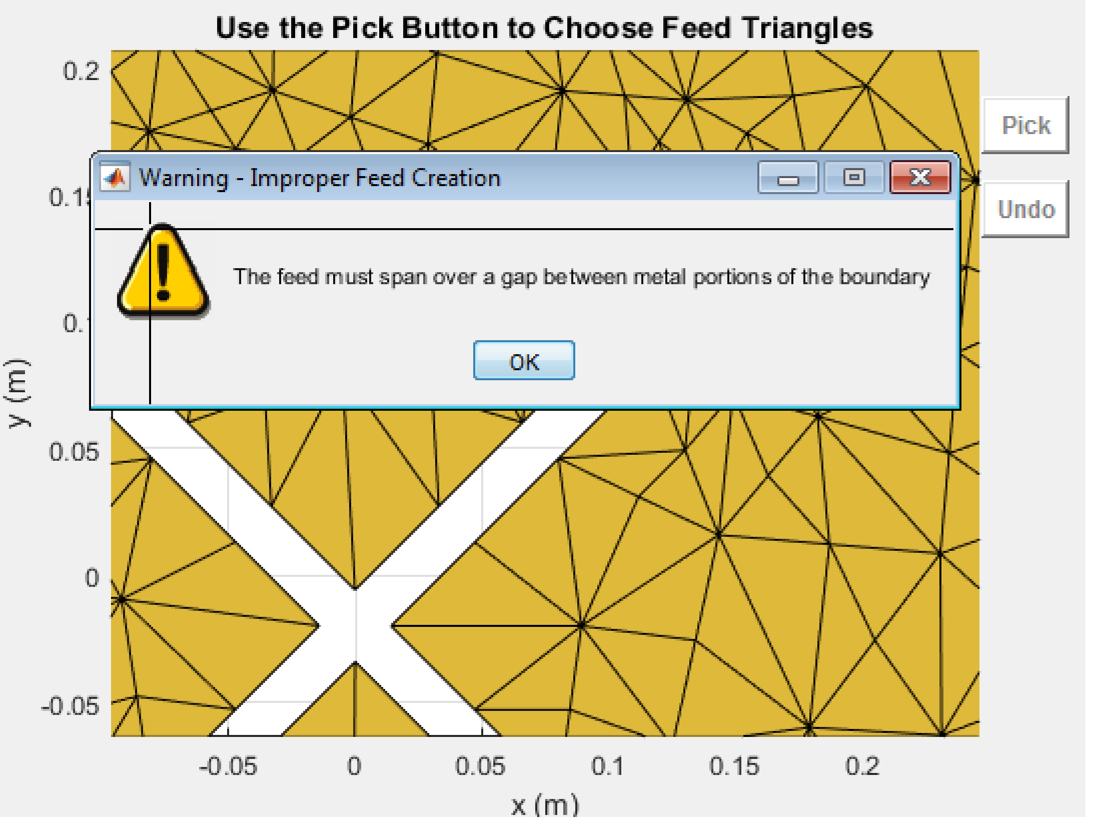
Click **Pick** to display the crosshairs. To specify a region for the feed point, zoom in and select two points, one inside each triangle on either side of the air gap. Select the points using the crosshairs.


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.

You must select the two triangles on either side of the air gap. Otherwise, the function displays an error message.



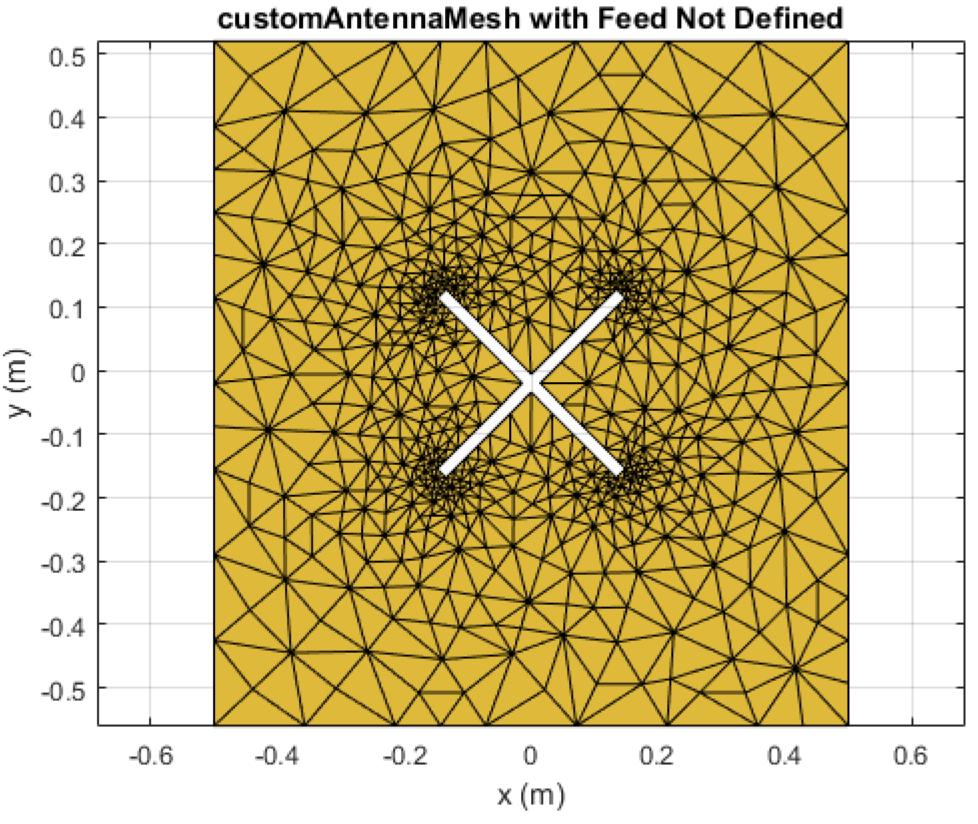
Create Feed for Custom Antenna Mesh

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)
```

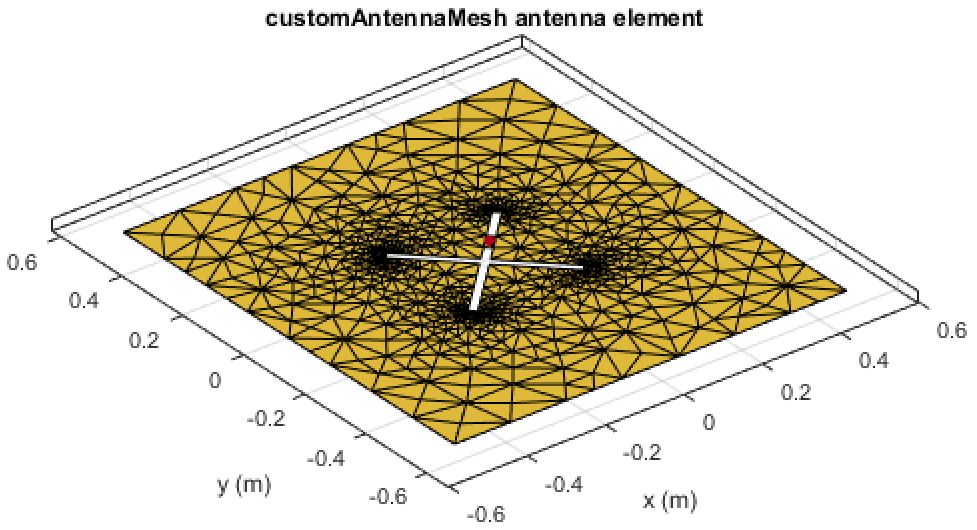
```
c =

  customAntennaMesh with properties:
```

```
       Points: [3x658 double]
    Triangles: [4x1219 double]
 FeedLocation: []
         Tilt: 0
     TiltAxis: [1 0 0]
```



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

`returnLoss` | `sparameters`

Introduced in R2015b

EHfields

Electric and magnetic fields of antennas

Syntax

```
[e,h] = EHfields(object,frequency,points)
```

```
EHfields(object, frequency, points)
EHfields(object,frequency,points,Name,Value)
```

Description

`[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(object,frequency,points,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

Calculate E and H 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.

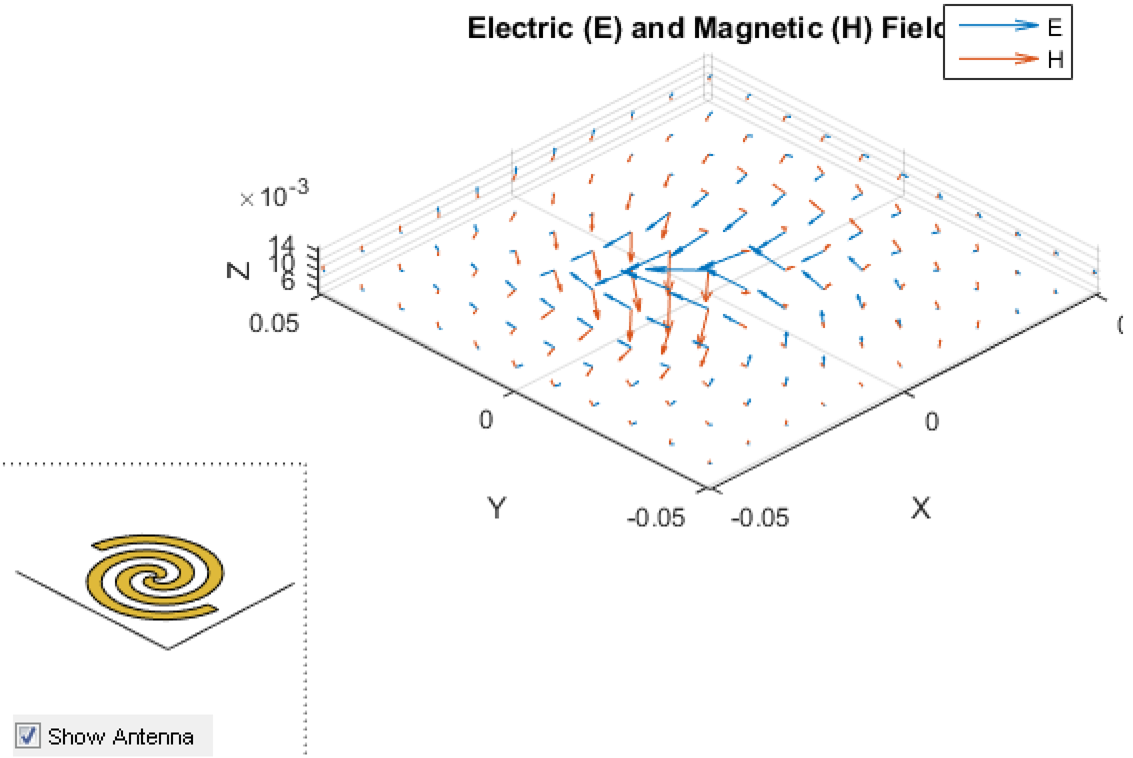
```
[X,Y] = meshgrid(-.05:.01:.05,-.05:.01:.05);
```

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
string | `E` | `H`

Field to display, specified as the comma-separated pair consisting of `'ViewField'` and a string. `'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

`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 =

   63.7929
```

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
`beamwidth` | `pattern`

Introduced in R2015a

beamwidth

Beamwidth of antenna

Syntax

```
[bw] = beamwidth(antenna,frequency,azimuth,elevation)
[bw] = beamwidth(antenna,frequency,azimuth,elevation,dBdown)

[bw,angles] = beamwidth(____)
```

Description

`[bw] = beamwidth(antenna,frequency,azimuth,elevation)` returns 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

Calculate Beamwidth for Antenna

Calculate the beamwidth for a helix at frequency=2GHz, azimuth=0, elevation=1:1:360 (x-z plane).

```
h  = helix;
[BW] = beamwidth(h,2e9,0,1:1:360,5)
```

```
BW =
```

```
    90
```

Calculate Beamwidth and Angles of Beamwidth of Antenna

Calculate the beam width for an helix at azimuth=1;1:360, elevation=0 (x-z plane) and dBdown=5.

```
h = helix;
[bw,angles] = beamwidth(h,2e9,1:1:360,0,5)
```

```
bw =

   139


angles =

   148   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

`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.

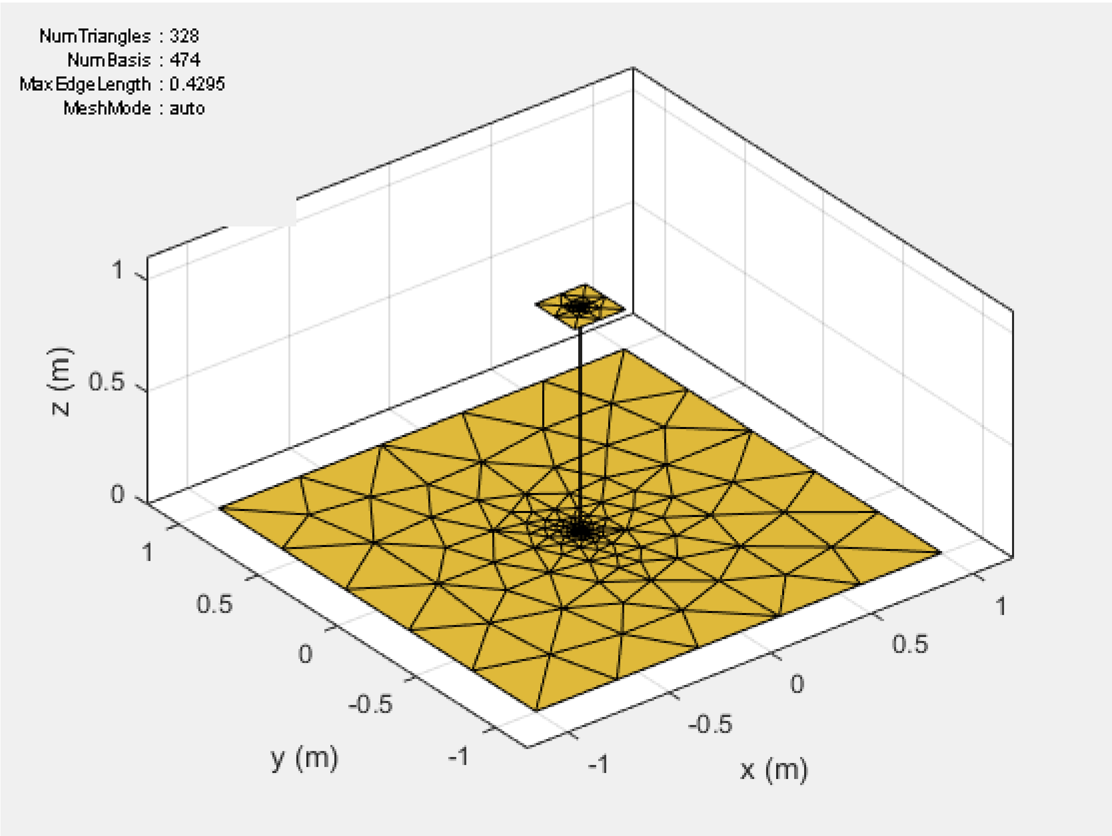
Examples

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 =

   2.7251e+02 + 6.0939e+02i


m =

     NumTriangles: 328
         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

`show`

Introduced in R2015a

layout

Display array layout

Syntax

```
layout(array)
```

Description

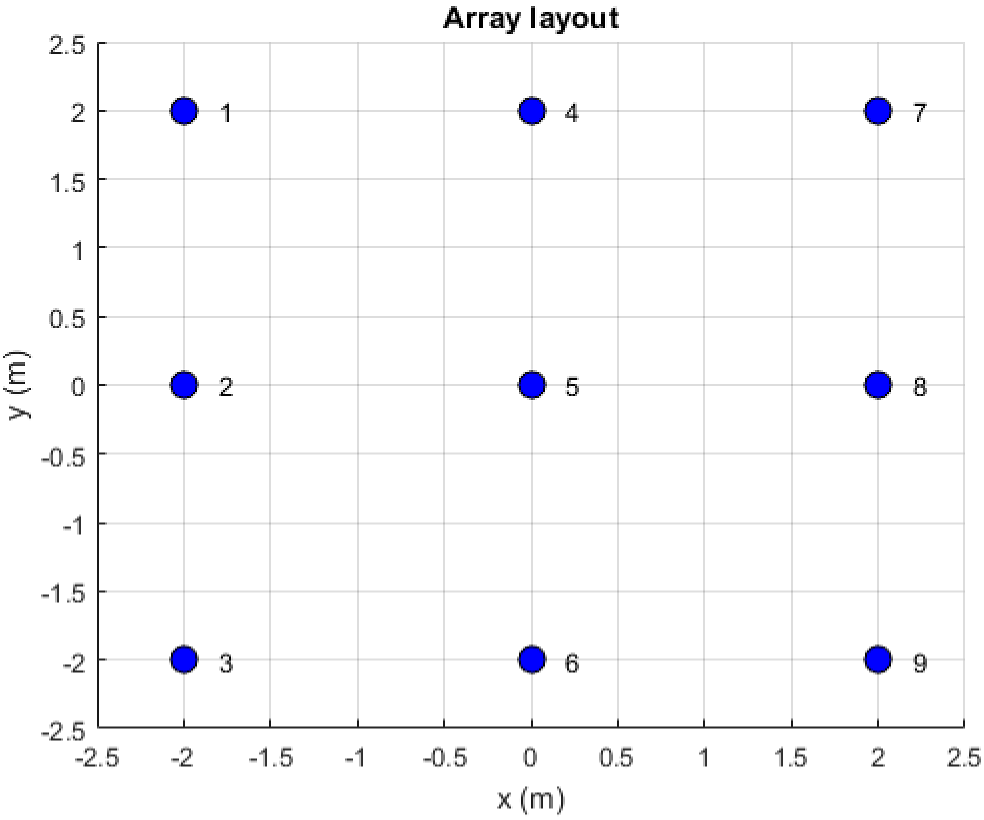
`layout(array)` displays the layout of the array object. The circles in the layout corresponds to antenna feed points within the array.

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

`show`

Introduced in R2015a

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`.

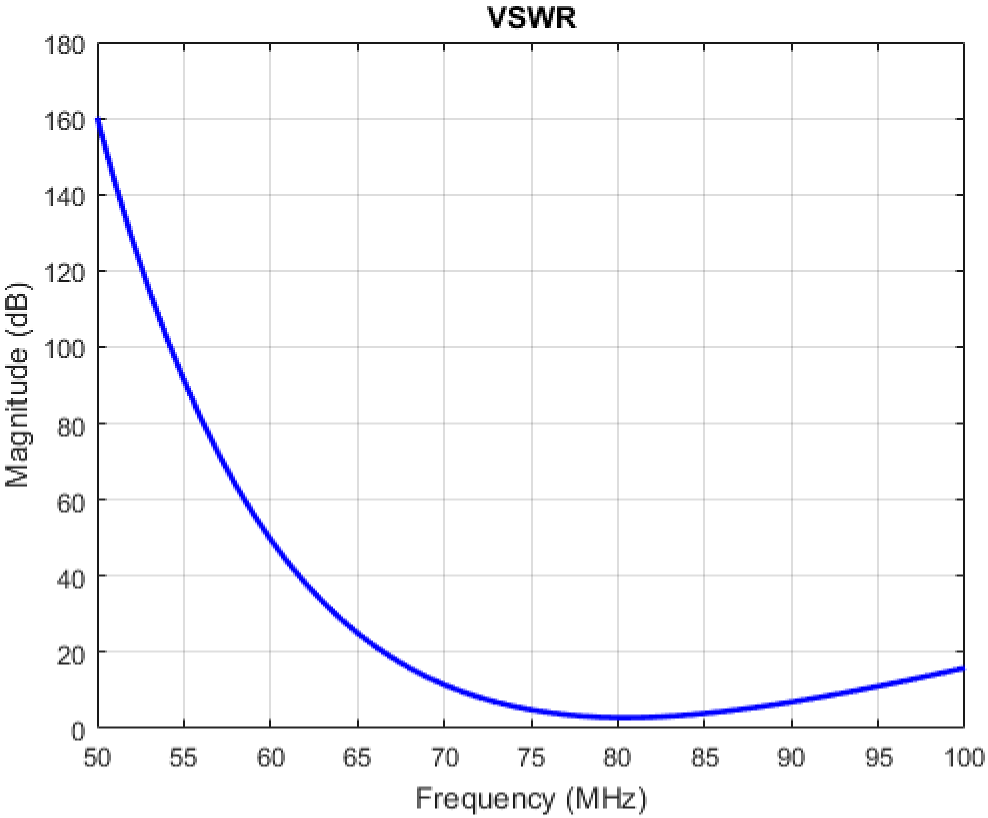
`vswrant = vswr(antenna,frequency,z0)` returns the vswr of the antenna.

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 =

    3.5995    6.6134    3.2752
```

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.

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

`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`.

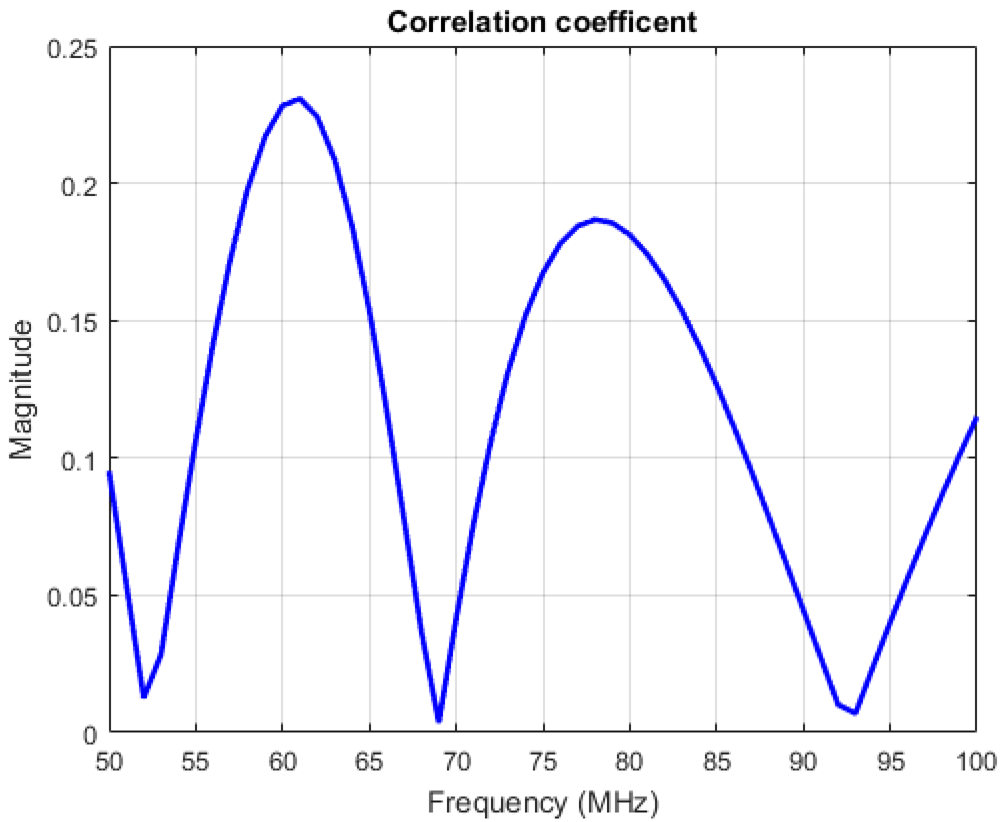
`rho = correlation(array,frequency,elem1,elem2,z0)` returns the correlation coefficient between two antenna elements, `elem1` and `elem2` of an array.

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

`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

`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

`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 string input mode.

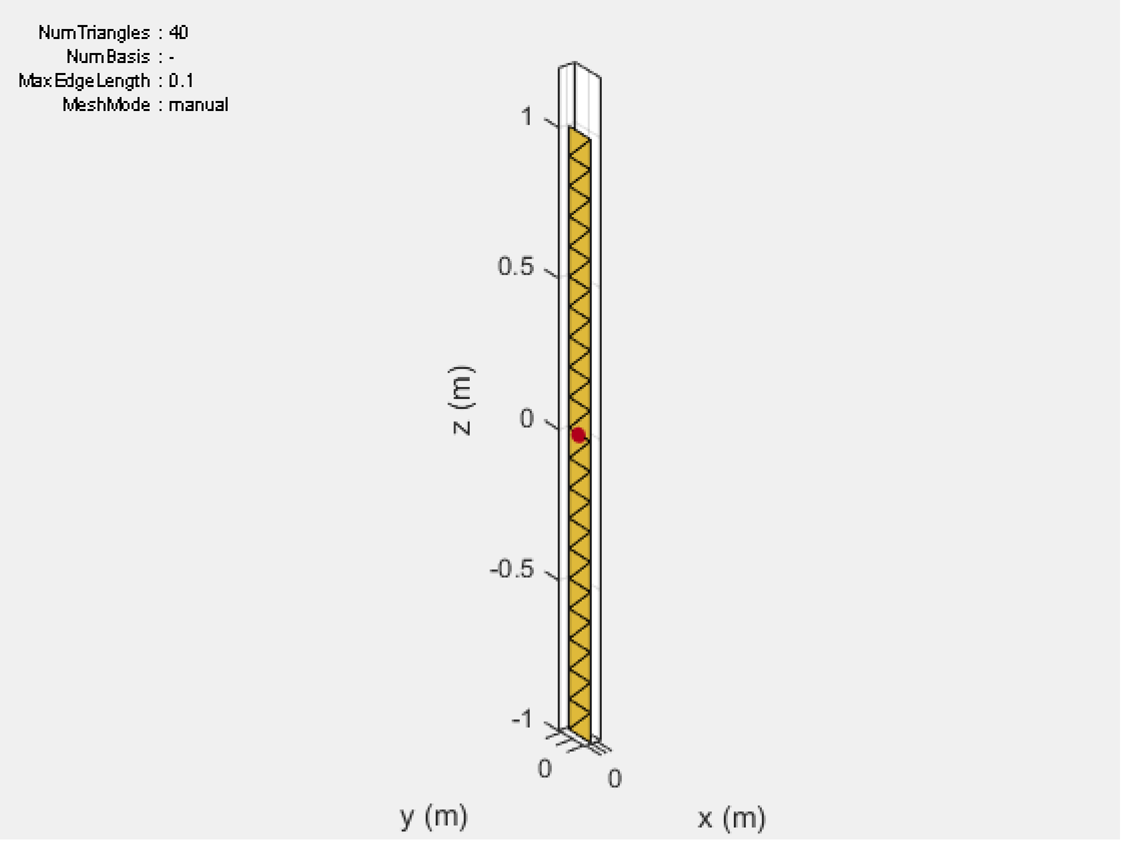
Examples

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 =

     NumTriangles: []
         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'`.

See Also

`mesh` | `show`

Introduced in R2015a

numSummationTerms

Class: infiniteArray

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

beamwidth | pattern

More About

- “Infinite Arrays”

Introduced in R2015b