MICROSTRIP ANTENNA

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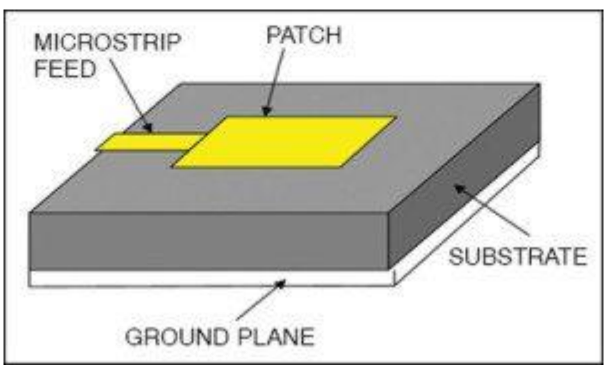
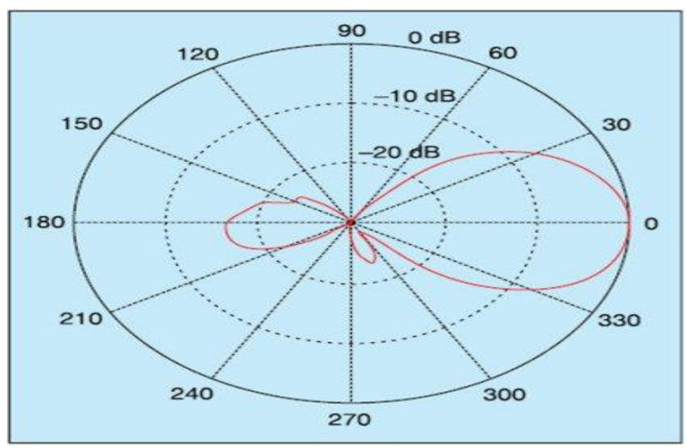
MICROSTRIP ANTENNA :

Microstrip antenna is one of the most popular types of printed antenna. It plays a very significant role in today's world of wireless communication systems. Microstrip antennae are very simple in construction using a conventional microstrip fabrication technique. Microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate (FR4) that has a ground plane (Cu) on the other side as shown in Figure below :

The patch is generally made up of a conducting material such as copper or gold and can take any possible shape like rectangular,





circular, triangular, elliptical or some other common shape. The radiating patch and the feed lines are usually photo-etched on the dielectric substrate.

Microstrip patch antennae radiate primarily because of the fringing fields between the patch edge and the ground plane. For good antenna performance, a thick dielectric substrate having a low dielectric constant (<6) is desirable since it provides higher efficiency, larger bandwidth and better radiation. However, such a configuration leads to larger antenna size.

In order to design a compact microstrip patch antenna, a substrate with a higher dielectric constant (<12) must be used, which results in lower efficiency and narrower bandwidth. Hence a compromise must be reached between antenna dimensions and antenna performance. Excitation guides the electromagnetic energy source to the patch, generating negative charges around the feed point and positive charges on the other part of the patch. This difference in charges creates electric fields in the antenna that are responsible for radiations from the patch antenna.

Three types of electromagnetic waves are radiated. The first part is radiated into space, which is ‘useful’ radiation. The second part is diffracted waves, which are reflected back into space between the patch and the ground plane, contributing to the actual power transmission. The last part of the wave remains trapped in the dielectric substrate due to total reflection at the air-dielectric separation surface. The waves trapped in the substrate are generally undesirable.

MICROSTRIP ANTENNA TYPES

- Microstrip patch antenna,
- Microstrip dipoles,
- Printed slot antenna
- Microstrip travelling-wave antenna.

POLARIZATION AND RADIATION PATTERN :

The polarisation of an antenna is determined by the wave radiated in a given direction that is identical to the direction of the electric field. The instantaneous electric field vector traces a figure in time. This figure is usually an ellipse that has special cases. If the path of the electric field vector follows a line, the antenna is said to be linearly polarised. If the electric field vector rotates in a circle, it is called circularly polarised. To characterise the polarisation, axial ratio is used. It is defined by the following relationship:

$$T = \frac{\text{Large diameter of the ellipse}}{\text{Small diameter of the ellipse}}$$

Polarisation is said to be linear if $T \to \infty$ or $T = 0$, and circular if $T = 1$.

There are two sub-types of linear polarisation: Vertical polarisation and horizontal polarisation. When 'E' field vector of the EM wave is perpendicular to the earth, the EM wave is said to be vertically polarised. When 'E' field vector of the EM wave is parallel to the earth, the EM wave is said to be horizontally polarised.

TABLE II

Comparison of Various Types of Microstrip Antennae

Characteristics	Microstrip patch antenna	Microstrip slot/ travelling-wave antenna	Printed dipole antenna
Profile	Thin	Thin	Thin
Fabrication	Very easy	Easy	Easy
Polarisation	Both linear and circular	Both linear and circular	Linear
Dual-frequency operation	Possible	Possible	Possible
Shape flexibility	Any shape	Mostly rectangular and circular shape	Rectangular and triangular
Spurious radiation	Exists	Exists	Exists
Bandwidth	2-50 per cent (resonant frequency)	5-30 per cent (resonant frequency)	30 per cent (resonant frequency)

The radiation pattern is a graphical depiction of the relative field strength transmitted from or received by the antenna. Antenna radiation patterns are taken at one frequency, one polarisation and one plane cut. Patterns are usually presented in polar or rectilinear form with a dB strength scale. These are normalised to the maximum graph value of 0 dB and directivity is given for the antenna. This means that if side-lobe level from the radiation pattern were down -13 dB, and directivity of the antenna was 4 dB, side-lobe gain would be -9 dB.

ADVANTAGES

- Low weight
- Low cost
- Ease of installation

DISADVANTAGES

- Low effiency
- Narrow bandwidth

APPLACTIONS

Communication-based applications. Microstrip patch antenna finds several applications in wireless communication. For example, satellite communication requires circularly polarised radiation patterns, which can be realised using either square or circular patch microstrip antenna. In global positioning satellite (GPS) systems, circularly polarised microstrip antennae are used. They are very compact in size and quite expensive due to their positioning.

Microstrip antennae are also used in the fields of RFID (radio frequency identification), mobile communication and healthcare. Basically, an RFID system consists of a tag and a reader. Generally, it uses frequencies between 30 Hz and 5.8 GHz.

In telemedicine application, microstrip antennae operate at 2.45 GHz. Wearable microstrip antennae are suitable for wireless body area network. An antenna having gain of 6.7 dB and front-to-back ratio of 11.7 dB, and resonating at 2.45 GHz is suitable for telemedicine applications.

The IEEE 802.16 standard is known as WiMax (worldwide interoperability for microwave access). It can reach up to 48km (30-mile) radius with data rate of 70 Mbps. Microstrip antennae can resonate at more than one frequency. Therefore these can be used in WiMax-based communication equipment.

Some communication-based applications of microstrip patch antennae are radio altimeters, command and control systems, remote sensing and environmental instrumentation, feed elements in complex antennae, satellite navigation receivers, mobile radio, integrated antennae, biomedical radiators and intruder alarms, Doppler and other radars, and satellite communication and direct broadcast services.

CODE WITH OUTPUT FIGURES :

```
PMS=patchMicrostrip;
PMS=patchMicrostrip('Length',75e-3,'Width',37e-3,'GroundPlaneLength',120e-3,'GroundPlaneWidth',120e-3);
show(PMS)
pause(2);
%Create and view a microstrip patch with specified parameters.
d=dielectric('FR4');
PMS=patchMicrostrip('Length',75e-3,'Width',37e-3, 'GroundPlaneLength',120e-3,'GroundPlaneWidth',120e-3,'Substrate',d);
figure; show(PMS)
pause(2);
%Create a microstrip patch antenna using 'FR4' as the dielectric substrate.
figure; pattern(PMS,1.67e9)
pause(2);
%Plot the radiation pattern of the antenna at a frequency of 1.67 GHz
d = dielectric('FR4');
PMS=patchMicrostrip('Substrate',d);
figure; show(PMS)
%Create a microstrip patch antenna using 'FR4' as the dielectric substrate.
figure; impedance(PMS,linspace(0.5e9,1e9,11));
%Calculate and plot the impedance of the antenna over the specified frequency range

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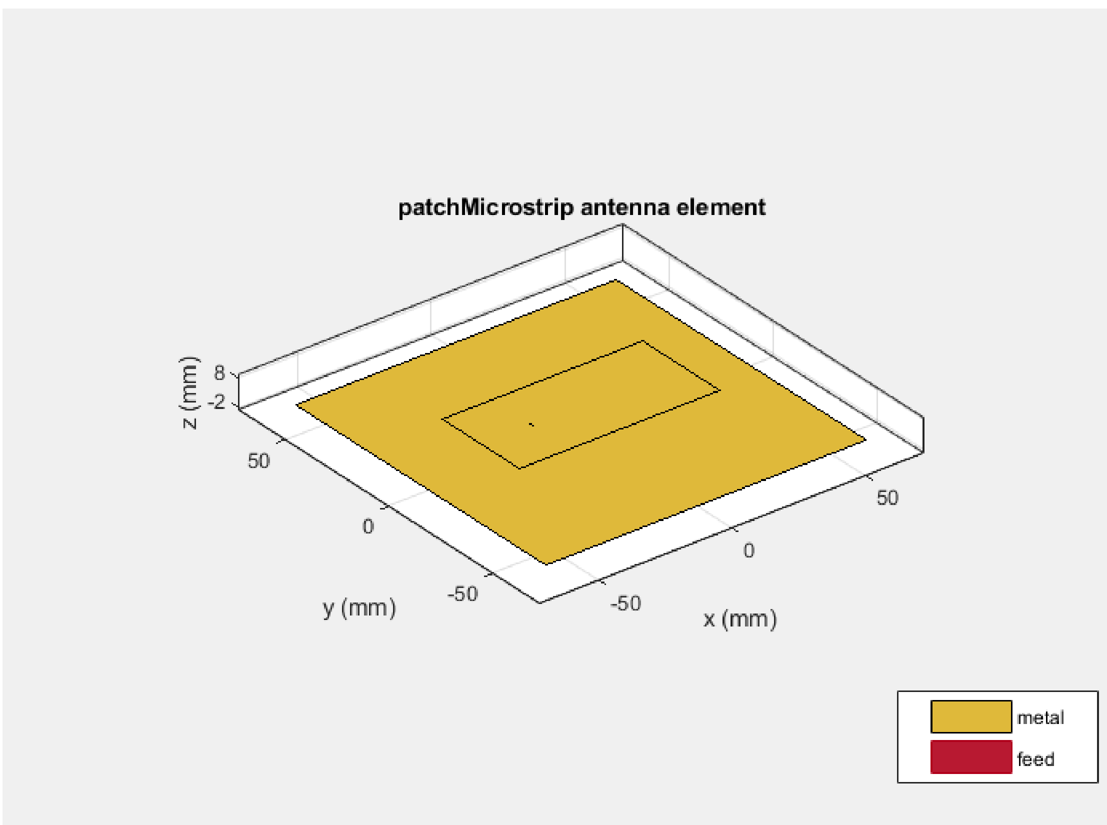
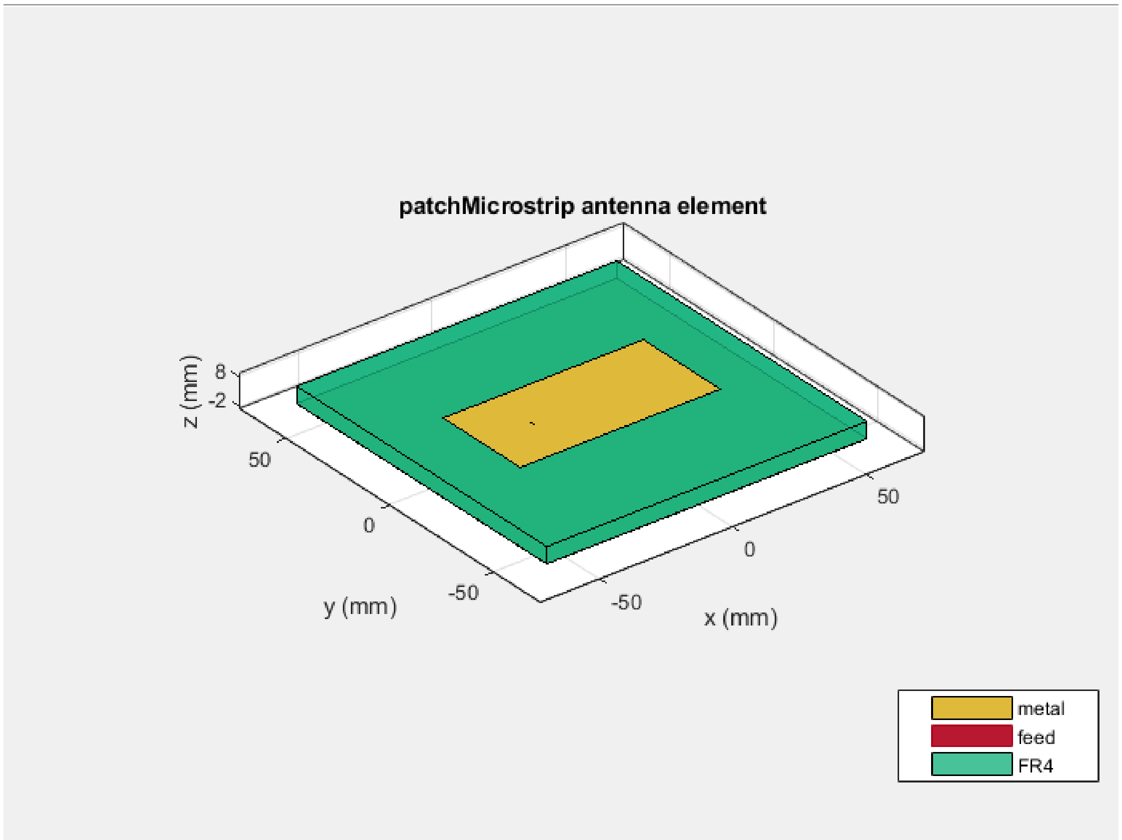
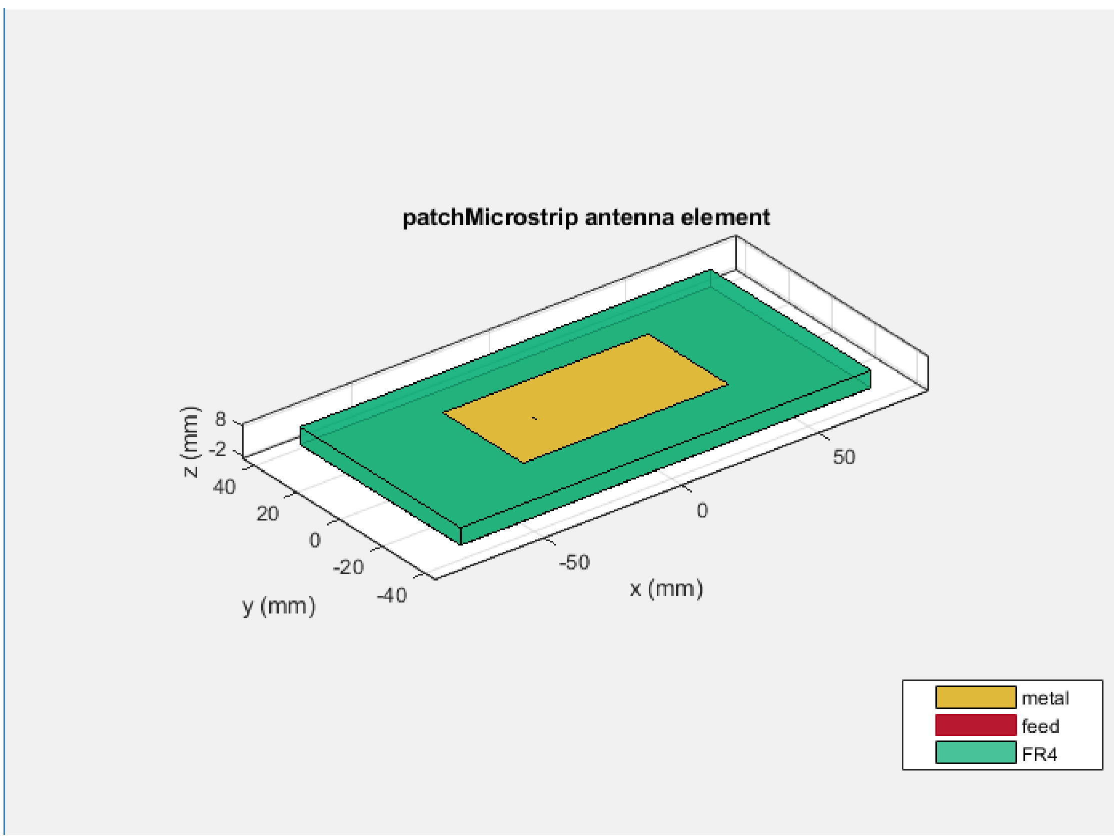
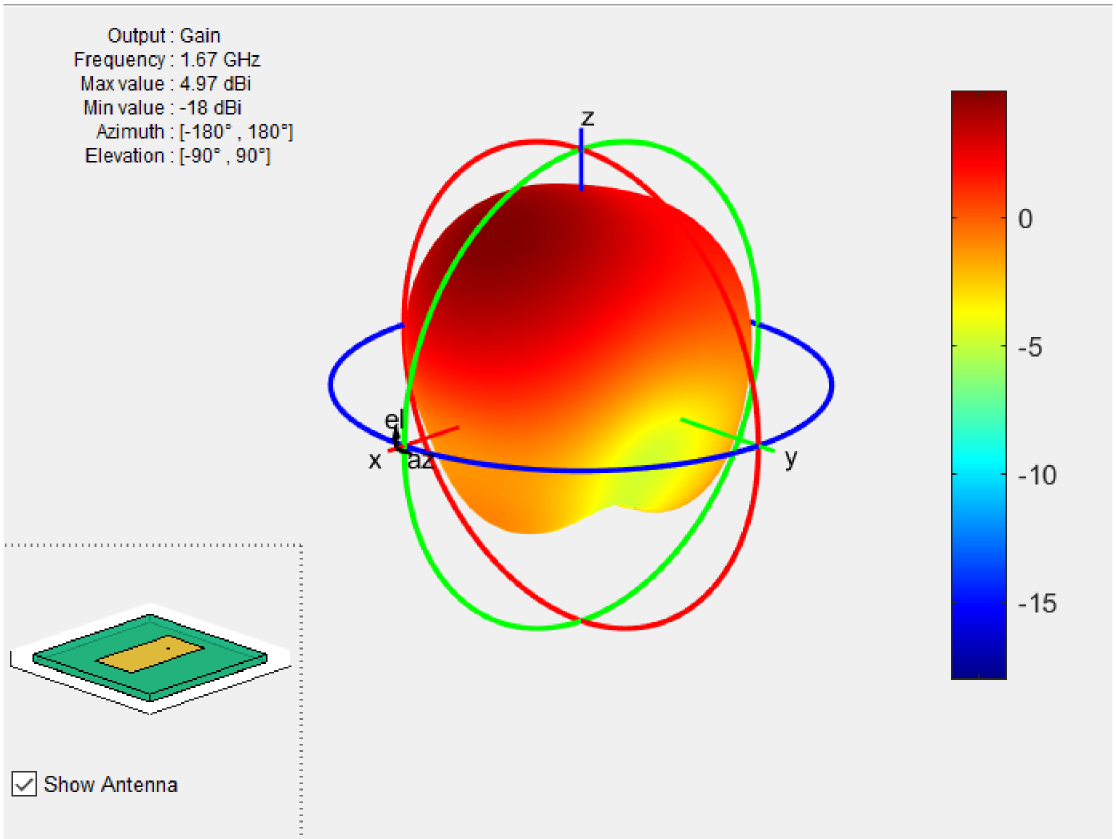
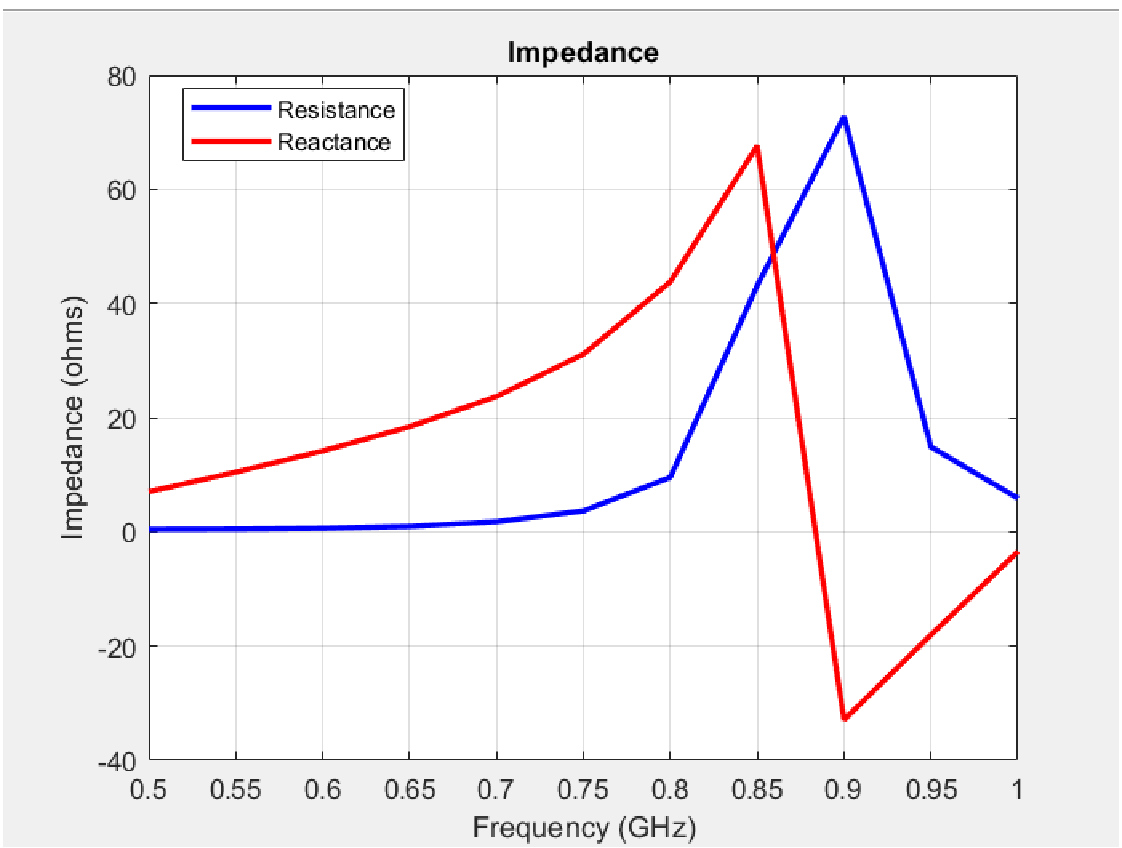



patchMicrostrip antenna element
z (mm)
8
-2
50
0
-50
y (mm)
-50
0
50
x (mm)
metal
feed
FR4


patchMicrostrip antenna element
z (mm)
8
-2
40
20
0
-20
-40
y (mm)
-50
0
50
x (mm)
metal
feed
FR4



Output : Gain
Frequency : 1.67 GHz
Max value : 4.97 dBi
Min value : -18 dBi
Azimuth : [-180° , 180°]
Elevation : [-90° , 90°]
z
el
x
az
y
0
-5
-10
-15
Show Antenna



Impedance
Resistance
Reactance
80
60
40
20
0
-20
-40
Impedance (ohms)
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
0.95
1
Frequency (GHz)