Microstrip Antennas

Applications

- Spacecraft, satellite, and missile applications
- Mobile, radio, and wireless communications

Requirements

- Small size and weight
- Low cost and high performance
- Ease of installation
- Aerodynamic profile

To meet these requirements, microstrip antennas can be used

Characteristics

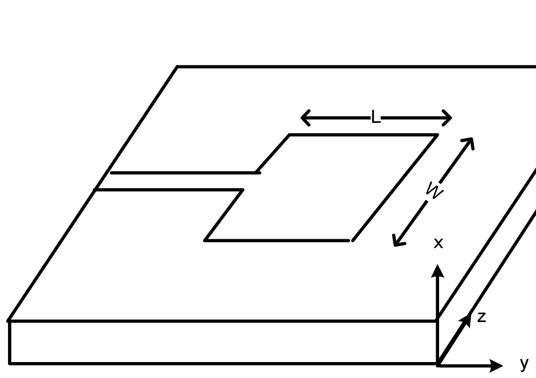
- Low profile
- Conformable to planar and nonplanar surfaces
- Simple and inexpensive to manufacture using modern printed circuit technology
- Mechanically robust
- Compatible with monolithic microwave integrated circuit (MMIC) design

Major Operational Disadvantages

- Low efficiency
- Low power
- High Q
- Narrow bandwidth
- Poor polarization purity
- Poor scan performance
- Surface waves (in contrast to space waves which yield the required radiation)

Basic Characteristics of a Microstrip Patch Antenna

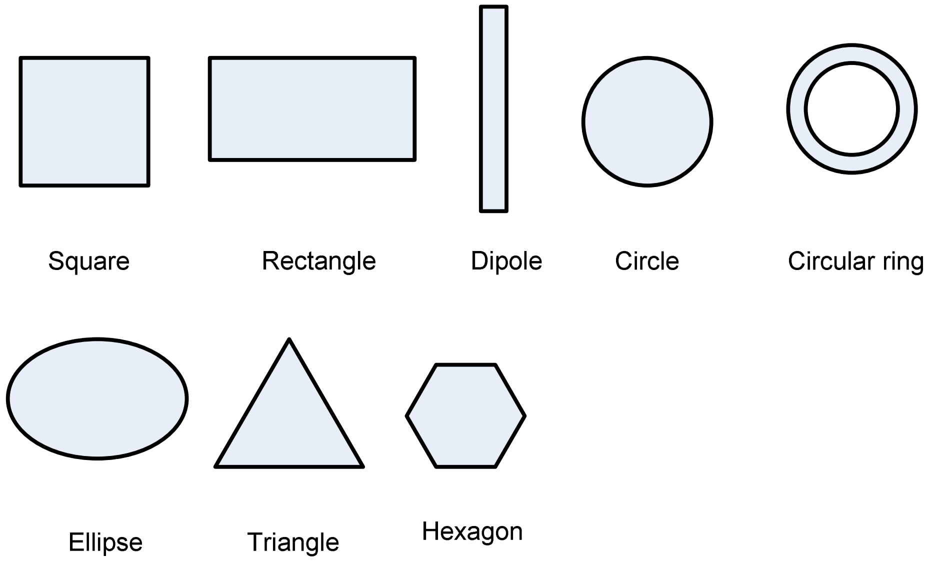
- t is the thickness of the patch, which is very small ($t << \lambda_o$) where λ_o is the free space wavelength
- h is the thickness of the dielectric substrate, which is very small ($h << \lambda_o$) usually $0.003\lambda_o \le h \le 0.05\lambda_o$



- Usually the patch is designed such that maximum radiation is normal to the patch (broadside radiator). This is achieved by adjusting the mode (or field configuration) of excitation beneath the patch.
- Endfire radiation is also possible by adjusting the mode of excitation.
- For rectangular patches, length L is usually selected in the range ($\lambda_o / 3 < L < \lambda_o / 2$).
- The dielectric material forming the substrate has dielectric constant in the range ($2.2 < \varepsilon_o < 12$).
- Desirable substrates for antenna performance are thick substrates with ε_o in the lower range (towards the 2.2 end) because they provide better efficiency and large bandwidth and possess loosely bound field for radiation, but at the expense of larger element size.
- On the other hand, thin dielectric with high ε_o leads to better microwave circuit performance and smaller element size, accompanied with low radiation efficiency and smaller bandwidth.
- Microstrip antennas are usually integrated with microwave circuits. Therefore a compromise has to be reached between good antenna performance and good microwave circuit design.

Radiating Elements

- Radiating patches may be square, rectangular, thin strip (dipole), circular, elliptical, triangular, or any other shape.
- Square, rectangular, dipole and circular are the most common types because of ease of analysis and fabrication.



- Linear and circular polarization are possible with either single elements or arrays of microstrip antennas.
- Arrays of microstrip antennas can be used to introduce scanning capabilities and greater directivities.

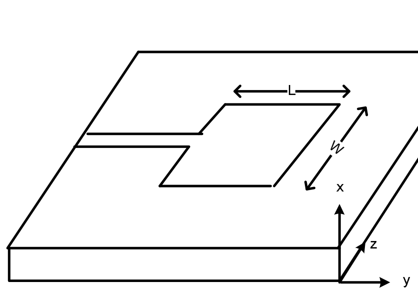
Feeding methods

There are many feeding configurations to feed microstrip patch elements and arrays. The four most common methods are:

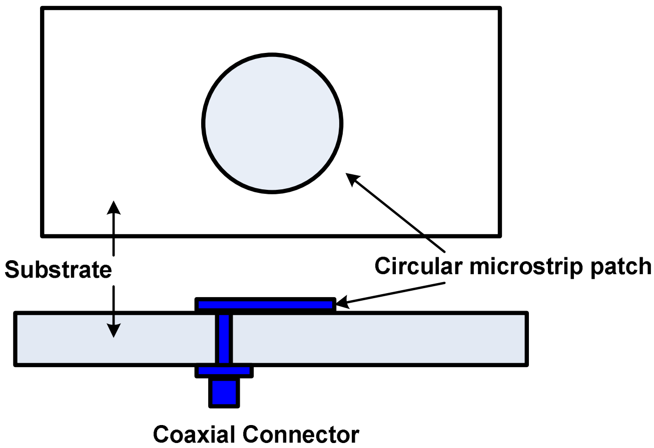
- Microstrip transmission line
- Coaxial probe
- Aperture coupline
- Proximity coupling

The microstrip line feed is easy to fabricate and simple to match but on the other hand, it has a narrow bandwidth. It also has high tendency to generate surface waves that reduces the efficiency, especially for thick substrate.

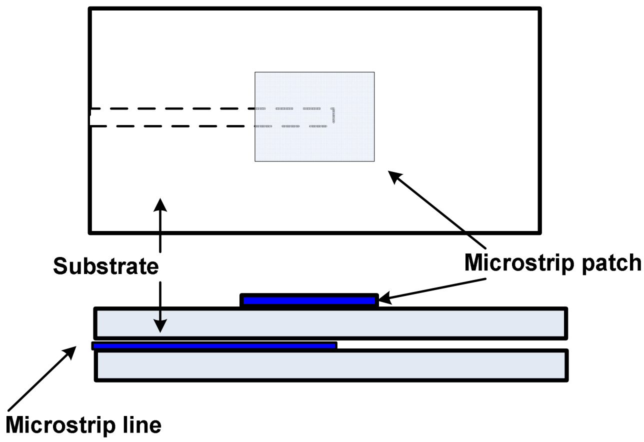
The coaxial probe feed is also easy to fabricate and match and has less spurious radiation. It also has narrow bandwidth and more difficult to analyse and model.



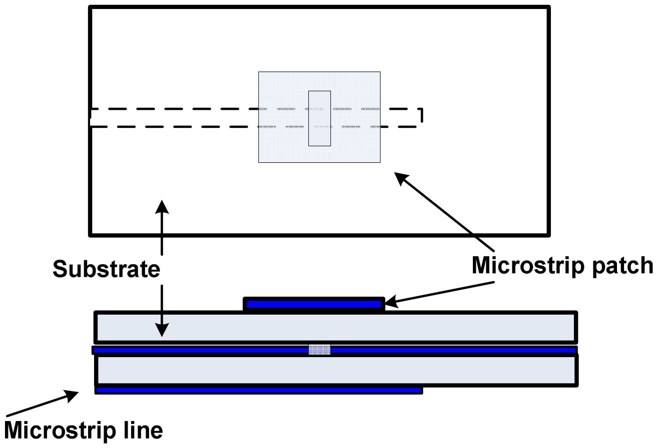
Microstrip line feed



Coaxial probe feed



Proximity coupled feed



Aperture coupled feed

Both line and probe feeds possess inherent asymmetries which generate higher order modes which produce cross polarized radiation.

The proximity coupled and aperture coupled feeds overcome this difficulty by reducing the cross polarization.