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Antenna & Propagation

Microstrip Antenna

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Chapter Synopsis

In this chapter, the student will be exposed to the introduction of most popular antenna design recent year, microstrip. The features of microstrip antenna, the advantages and disadvantages of this antenna and related calculation in designing rectangular mictrostrip antenna.

Teaching Outcome

At the end of this course student should be able to:

- ❑ Understand the features of microstrip antenna.
- ❑ Learn the advantages and disadvantages of microstrip antenna.
- ❑ Learn the feed method of microstrip antenna.
- ❑ Design the rectangular microstrip antenna.

Outline

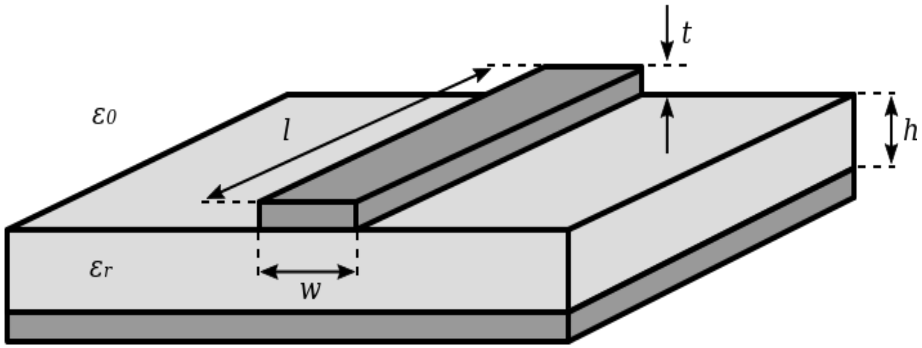
- Introduction
- Feeding Methods
- Transmission Line Model
- Rectangular Microstrip Design

Introduction

- The microstrip antenna is also called as patch antenna.
- The main requirement are the thickness and conformability to the surface.
- This antenna is directly printed on the circuit board (PCB board).
- Due to advancements of technology, this microwave antenna become more popular.
- Basically, microstrip antenna is constructed using a metallic patch suspended over a ground plane.
- The pattern printed on a dielectric substrate .
- It have many of shapes like square, rectangular, triangular, circular, elliptical, circular ring and many more.

Dimensions View

- The dimensional view of a stripline on a dielectric substrate

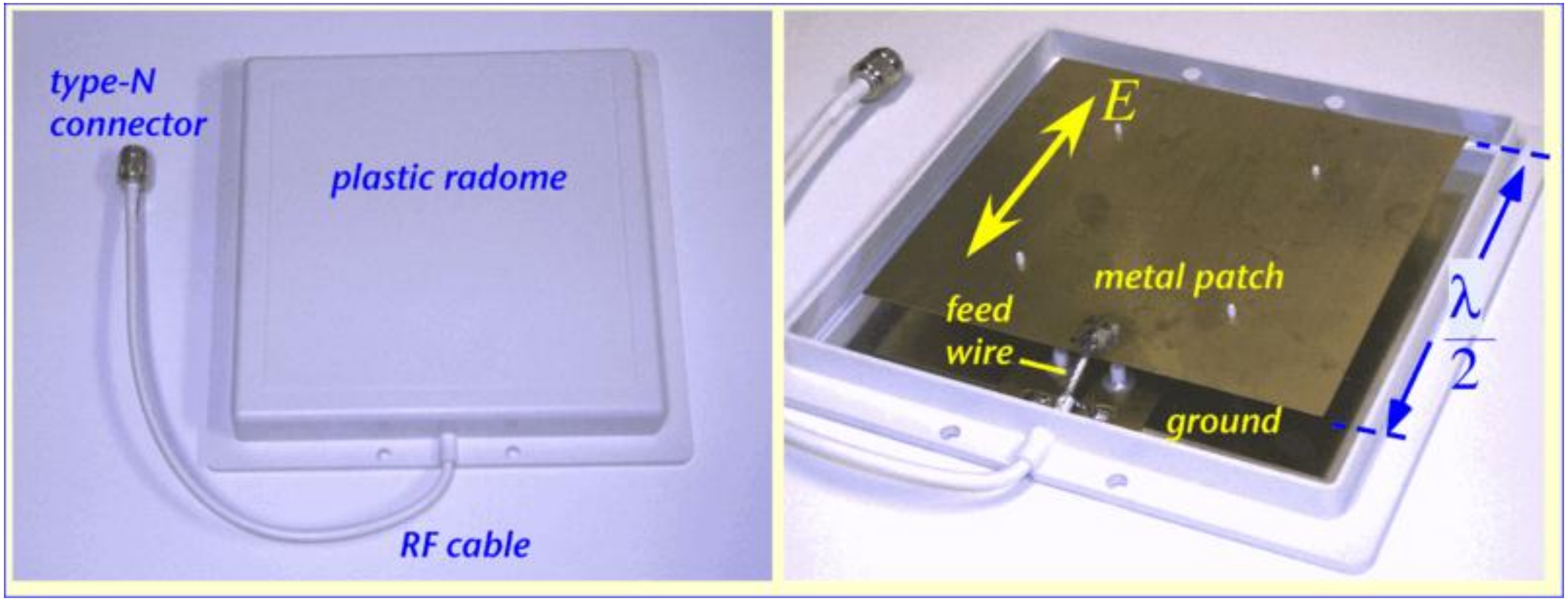


Parameter	Description
w	Width of Patch
l	Length of Patch
h	Height of Substrate
t	Tickness of Patch
ε_r	Permittivity of dielectric
ε_o	Permittivity of free space

Source:Commons.wikimedia.org

Example

- Image below shows the microstrip antenna that enclosed in a plastic enclosure to protect from sort of damage.



Source: Wikimedia Commons By Daniel M. Dobkin

Common Features

- A thin and flat metallic region (also known as patch)
- A dielectric substrate
- A ground plane which is much larger than patch
- A feed network: supplied power to the antenna

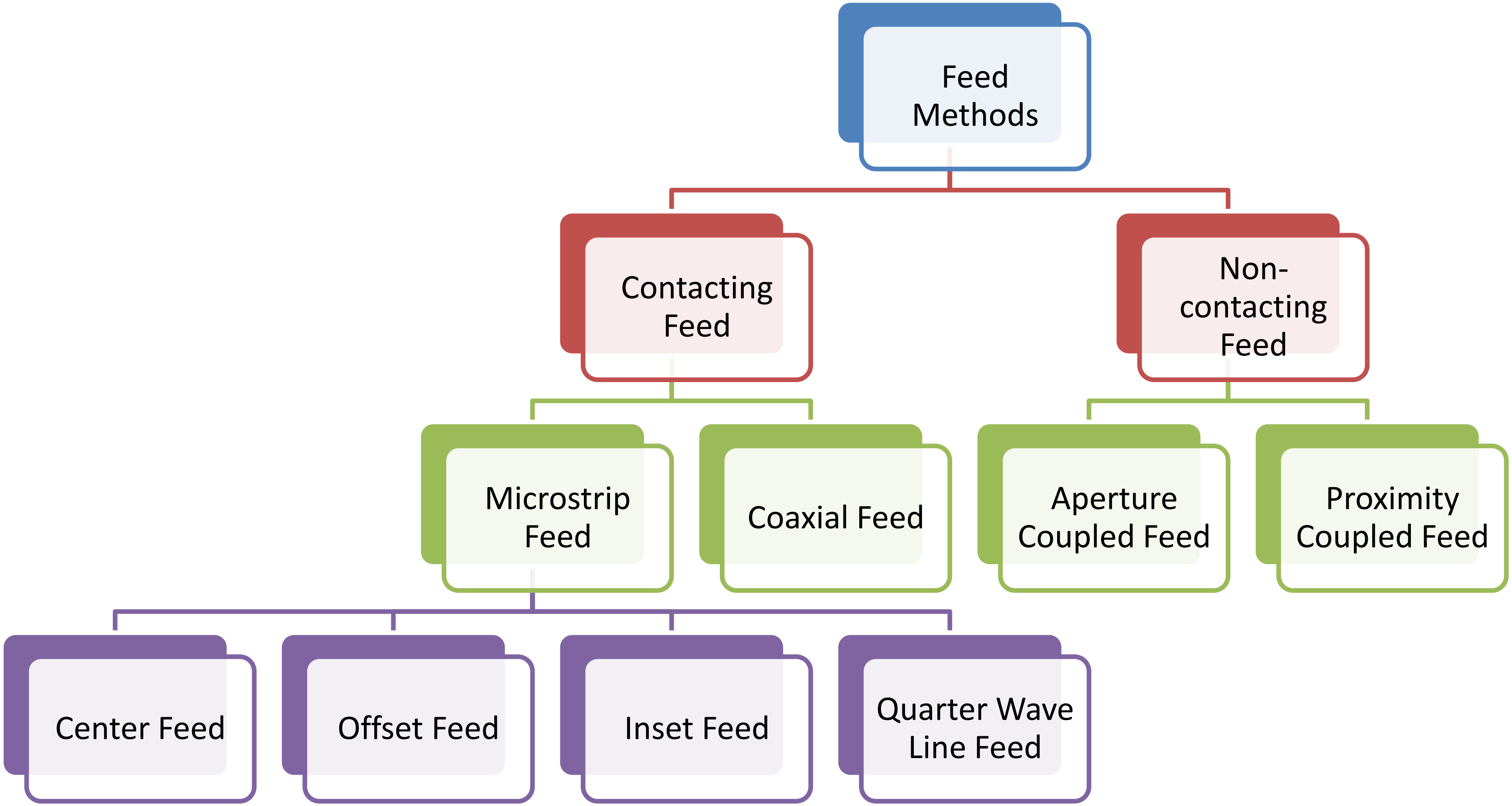
The Advantages

1. Low profile antenna: smaller size, light in weight.
2. Easily laminated to the metallic surface.
3. Low cost
4. Most suitable option where thickness and conformability to the surface are the requirements.
5. Very versatile, it can be designed by variety types of patterns and polarizations

The Disadvantages

1. Low gain and low efficiency
2. Narrow bandwidth of operation
3. Lower power handling capacity
4. Impractical for low frequencies
5. Poor end fire radiatiors.

Feed Methods



Designing of Rectangular Microstrip Antennas

- For effective radiation of the microstrip antenna:

i. Height : h<<< λo usually 0.003 λo≤h≤0.05 λo above a ground plane.

ii. Radiation Pattern:
   - its pattern maximum is normal to the patch (broadside radiator).
   - properly choosing the mode (field configuration) of excitation beneath the patch.

iii. Length: L is usually λo/3 < L < λo/2

iv. Substrate, 2.2 ≤εr≤12.

Thick substrate whose lower dielectric constant provides good antenna performance (better efficiency, larger bandwidth, loosely bound field for radiation into space) but at the expense of larger element size

Related Equations

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{w}\right]^{\frac{1}{2}}$$

$$Z_o = \frac{120\pi}{\sqrt{\varepsilon_{ref}\left[\frac{w_o}{h} + 1.393 + 0.677\ln(\frac{w_o}{h} + 1.444)\right]}}$$

$$W = \frac{v_o}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{eff} + 0.3)\left[\frac{W}{h} + 0.264\right]}{(\varepsilon_{eff} - 0.258)\left[\frac{W}{h} + 0.8\right]}$$

$$L = \frac{c}{2f_r\sqrt{\;}} - 2\Delta L$$

$$G_1 = \frac{W}{120\lambda_o}\left[1 - \frac{1}{24}(k_o h)^2\right]$$

$$R_{in(y=y_o)} = R_{in(y=0)}cos^2\frac{\pi}{L}y_0$$

$$R_{in} = \frac{1}{2(G_1 \pm G_{12})}$$

$$R_{in} = \frac{1}{2G_1}$$

References

[1] C.A. Balanis:"Antenna Theory: Analysis & Design", John Wiley & Sons, 2012.

[2] Stutzman and Thiele, *Antenna Theory and Design*, John Wiley, 2012.

[3] T. A. Milligan, "Modern Antenna Design" John Wiley, 2nd edition, 2005.

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