Experiment No. - 4

Aim- To study the Microstrip and Coaxial feeding technique

Materials Required - CST Software

Theory-

Microstrip Feeding Technique -

Microstrip feed is a widely used technique in microwave and RF (radio frequency) engineering for feeding signals to antennas and other passive devices like filters and couplers. It involves a transmission line constructed on a dielectric substrate, typically with a conductive strip on one side and a ground plane on the other.

In summary, microstrip feeds are a fundamental building block in microwave and RF engineering, providing a means to efficiently transport and couple RF signals in various applications, especially those requiring planar and compact designs. Proper design and optimization of microstrip feeds are essential for achieving desired performance characteristics in these systems.

Coaxial Feeding Technique -

Coaxial feeding is a widely employed technique in the field of electronics and telecommunications. It relies on a specially designed coaxial cable, comprising an inner conductor enveloped by an insulating material and shielded by an outer conductor. This construction serves a fundamental purpose: transmitting electrical signals and power while minimizing interference. The inner conductor carries the signal, while the outer conductor acts as a protective shield, guarding against external electromagnetic disturbances. This technology finds extensive application, from delivering cable TV signals to homes to facilitating high-speed internet connections. Coaxial feeding offers the advantages of low signal loss over long distances and reliable protection from interference, making it a staple in many communication systems. However, it is important to note that coaxial cables do have bandwidth limitations compared to other technologies like optical fiber, and they can be bulkier and less flexible in certain applications.

Formula -

Microstrip Feeding:

1. Microstrip Line Characteristic Impedance (Z):

$$Z = \frac{87}{\sqrt{\epsilon_{\text{eff}}}} \ln\left(\frac{5.98h}{w+1.7t}\right)$$

Where:

Z is the characteristic impedance of the microstrip line.

ϵeff is the effective dielectric constant of the microstrip line.

h is the substrate thickness.

w is the width of the microstrip line.

t is the thickness of the microstrip conductor.

2. Microstrip Patch Resonant Frequency (f):

$$f = \frac{c}{2\sqrt{\epsilon_{\text{eff}}}} \sqrt{\frac{1}{(l+0.6w)}}$$

Where:

f is the resonant frequency of the microstrip patch antenna.

c is the speed of light.

ϵeff is the effective dielectric constant of the microstrip patch.

l is the effective electrical length of the microstrip patch.

w is the width of the microstrip patch.

Coaxial Feeding:

1. Coaxial Line Characteristic Impedance (Z):

$$Z = \frac{60}{\sqrt{\epsilon_r}} \ln\left(\frac{D}{d}\right)$$

Where:

Z is the characteristic impedance of the coaxial line.

ϵr is the relative permittivity of the dielectric material between the inner and outer conductors.

D is the outer diameter of the coaxial line.
d is the inner diameter of the coaxial line.

2. Velocity of Propagation (v):

$$v = \frac{c}{\sqrt{\epsilon_r}}$$

Where:
v is the velocity of propagation.
c is the speed of light.
ϵr is the relative permittivity of the dielectric material between the inner and outer conductors.

Procedure -

Microstrip Feeding -

Designing a microstrip-fed antenna using CST Microwave Studio (CST MWS) or similar electromagnetic simulation software involves several steps. Below is a general procedure for designing a microstrip-fed antenna, along with measurements you can perform in CST:

Step 1: Define Specifications

Determine the operating frequency (f0) of the antenna.
Specify the desired radiation pattern characteristics (e.g., gain, beamwidth).
Decide on the antenna type (e.g., patch antenna, microstrip dipole, microstrip slot antenna).
Choose the substrate material properties (permittivity and loss tangent).
Determine the feed type (e.g., microstrip line feed, coaxial feed, aperture-coupled feed).
Step 2: Initial Design
Create a new project in CST MWS.
Choose the appropriate solver and set up the simulation environment (e.g., 3D, frequency domain).

Start with an initial antenna design based on your specifications.

Step 3: Simulation and Optimization

Simulate the initial design to obtain the antenna's radiation pattern, impedance matching, and other relevant characteristics.

Use the optimization tools in CST to fine-tune the antenna parameters (e.g., patch dimensions, microstrip line width, feed position) to meet your specifications.

Iterate the optimization process until the desired antenna performance is achieved.

Step 4: Manufacturing and Fabrication

Once you have a finalized design, export the layout or design specifications for fabrication. This may include generating Gerber files for PCB fabrication or detailed drawings for other manufacturing methods.

Select the appropriate substrate material and thickness for constructing the microstrip-fed antenna.

Step 5: Simulation Validation

Import the fabricated antenna structure into CST MWS for validation.

Simulate the fabricated antenna to compare the actual performance with the simulated results.

Adjust any discrepancies between simulation and measurement by fine-tuning the physical design if necessary.

Coaxial Feeding -

Designing an antenna with coaxial feeding using CST Microwave Studio (CST MWS) or similar electromagnetic simulation software involves several steps. Below is a general procedure for designing an antenna with coaxial feeding, along with measurements you can perform in CST:

Step 1: Define Specifications

Determine the operating frequency (f0) of the antenna.

Specify the desired radiation pattern characteristics (e.g., gain, beamwidth).

Decide on the antenna type (e.g., dipole, patch, horn, or any other type).

Choose the substrate material properties (permittivity and loss tangent, if applicable).

Define the coaxial feed characteristics (e.g., connector type, feed position).

Step 2: Initial Design

Create a new project in CST MWS.

Choose the appropriate solver and set up the simulation environment (e.g., 3D, frequency domain).

Start with an initial antenna design based on your specifications, including the geometry and position of the coaxial feed.

Step 3: Simulation and Optimization

Simulate the initial design to obtain the antenna's radiation pattern, impedance matching, and other relevant characteristics.

Use the optimization tools in CST to fine-tune the antenna parameters (e.g., dimensions, feed position) to meet your specifications.

Iterate the optimization process until the desired antenna performance is achieved.

Step 4: Manufacturing and Fabrication

Once you have a finalized design, export the layout or design specifications for fabrication. This may include generating manufacturing drawings or specifying material properties.

Select the appropriate materials and fabrication methods for constructing the antenna and the coaxial feed.

Step 5: Simulation Validation

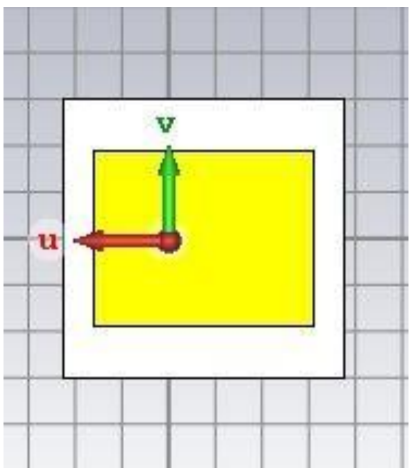
Import the fabricated antenna structure (including the coaxial feed) into CST MWS for validation.

Simulate the fabricated antenna to compare the actual performance with the simulated results.

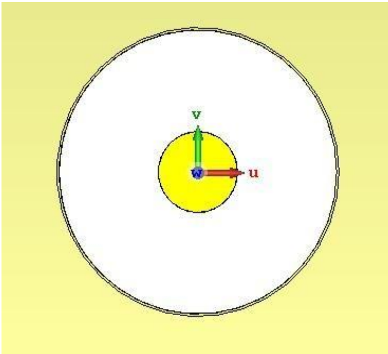
Adjust any discrepancies between simulation and measurement by fine-tuning the physical design if necessary.

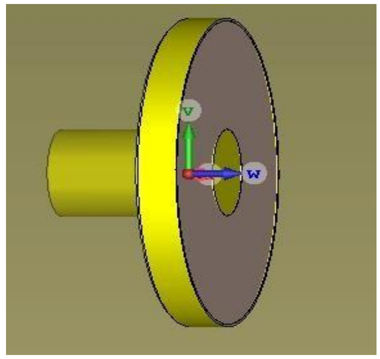
Design -

Microstrip Feeding Technique -



Coaxial Feeding Technique -





Conclusion -

In conclusion, both microstrip and coaxial feeding techniques are essential and widely used methods for transmitting electrical signals and power in various electronic and telecommunication applications. Each technique has its own set of advantages and disadvantages, making them suitable for different scenarios.