EC8651- Transmission Lines and RF Systems

MODELS

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

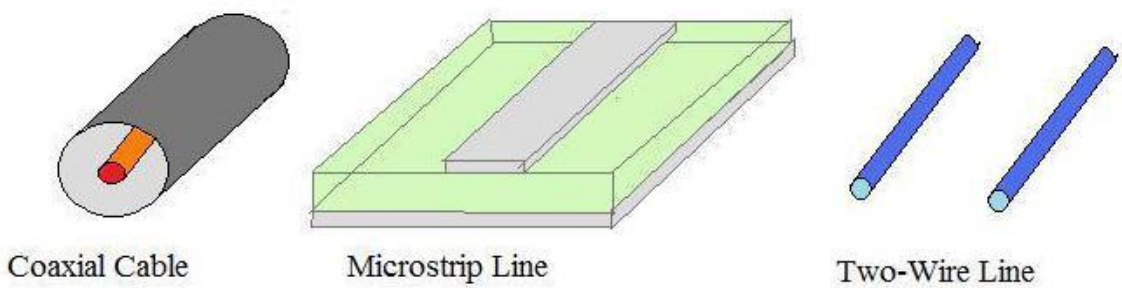
GRT INSTITUTE OF ENGINEERING AND TECHNOLOGY,TIRUTTANI

UNIT I TRANSMISSION LINE THEORY

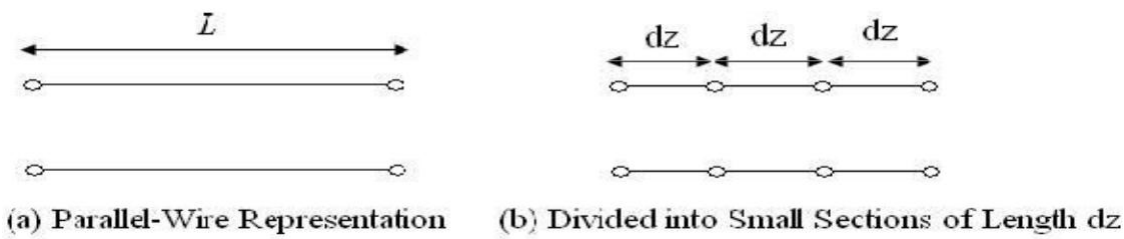
1.GENERAL THEORY OF TRANSMISSION LINES

General solution of the transmission line:

Examples of common transmission lines include the coaxial cable, the microstrip line which commonly feeds patch/microstrip antennas, and the two wire line:



To understand transmission lines, we'll set up an equivalent circuit to model and analyze them. To start, we'll take the basic symbol for a transmission line of length L and divide it into small segments:

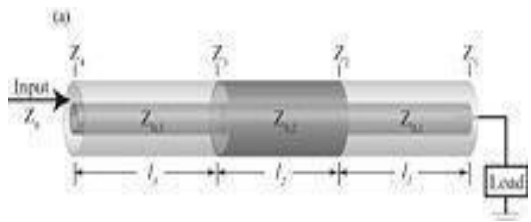


Then we'll model each small segment with a small series resistance, series inductance, shunt conductance, and shunt capcitance:

INPUT AND TRANSFER IMPEDANCE:

If the load impedance is not equal to the source impedance, then all the power that are transmitted from the source will not reach the load end and hence some power is wasted. This is represented as impedance mismatch condition. So for proper maximum power transfer, the impedances in the sending and receiving end are matched. This is called impedance matching.

Stepped transmission line



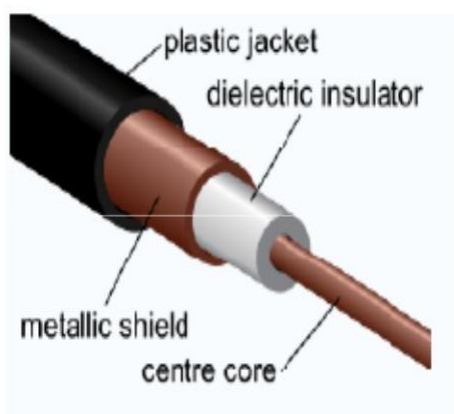
UNIT – II HIGH FREQUENCY TRANSMISSION LINES

2.1 TRANSMISSION LINE EQUATIONS A RADIO FREQUENCIES

There are two main forms of line at high frequency, namely

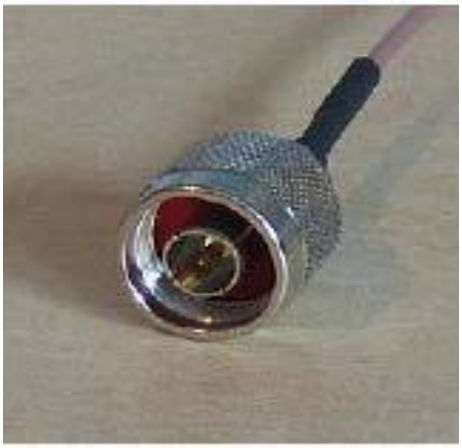
- Open wire line
- Coaxial line
- At Radio Frequency G may be considered zero
- Skin effect is considerable
- Due to skin effect L>>R

Coaxial cable differs from other shielded cable used for carrying lower frequency signals such as audio signals, in that the dimensions of the cable are controlled to produce a repeatable and predictable conductor spacing needed to function efficiently as a radio frequency transmission line.



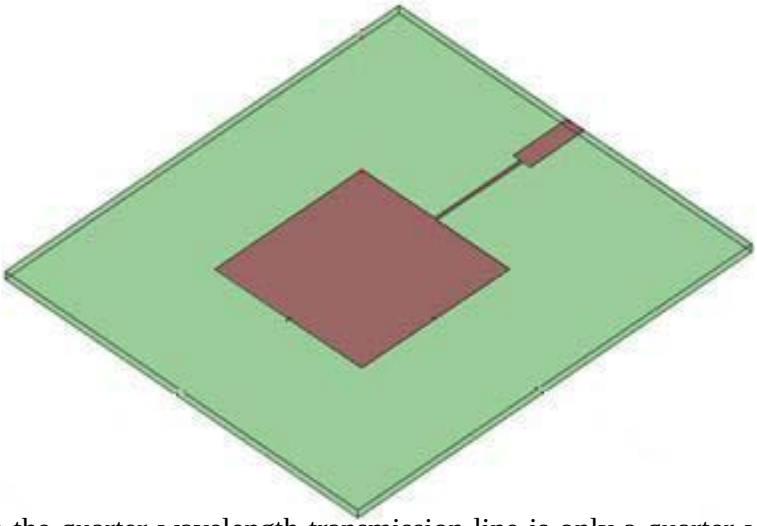
Coaxial cable cutaway

Connectors



A coaxial connector (male N-type). Coaxial connectors are designed to maintain a coaxial form across the connection and have the same well-defined impedance as the attached cable. Connectors are often plated with high-conductivity metals such as silver or gold. Due to the skin effect, the RF signal is only carried by the plating and does not penetrate to the connector body. Although silver oxidizes quickly, the silver oxide that is produced is still conductive. While this may pose a cosmetic issue, it does not degrade performance.

UNIT – III IMPEDANCE MATCHING IN HIGH FREQUENCY LINES

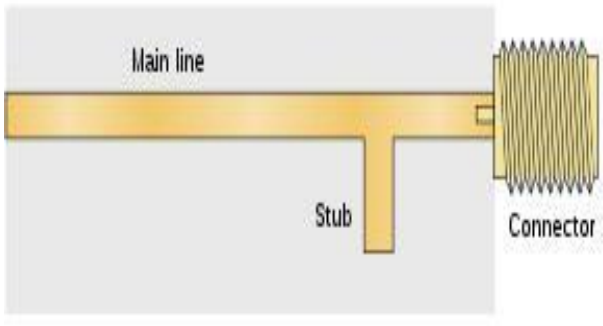


Because the quarter-wavelength transmission line is only a quarter-wavelength at a single frequency, this is a narrow-band matching technique

An important application of the quarter wave matching section is to a couple a transmission line to a resistive load such as an antenna .The quarter –wave matching section

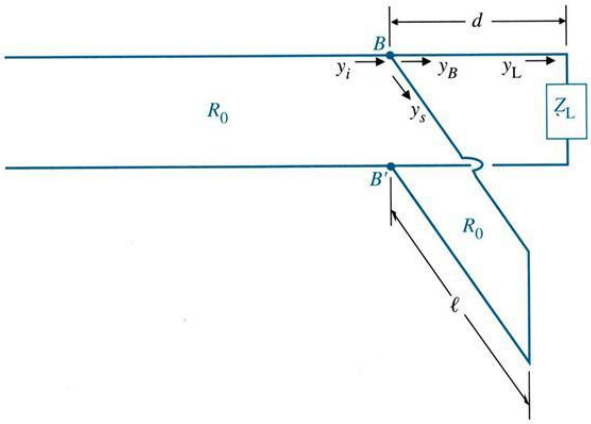
then must be designed to have a characteristic impendence Ro so chosen that the antenna resistance Ra is transformed to a value equal to the characteristic impendence Ra of the transmission line

Stub matching



Single stub impedance matching:

• Single-stub method for impedance matching : an arbitrary load impedance can be matched to a transmission line by placing a single short-circuited stub in parallel with the line at a suitable location



Impedance matching by single-stub method.

Double stub matching is preferred over single stub due to following disadvantages of single stub.

1. Single stub matching is useful for a fixed frequency .So as frequency changes the location of single stub will have to be changed.
2. The single stub matching system is based on the measurement of voltage minimum .Hence for coxial line it is very difficult to get such voltage minimum, without using slotted line section.

3.3 SMITH CHART, SOLUTIONS OF PROBLEMS USING SMITH

CHART Smith Chart:

The Smith Chart is a fantastic tool for visualizing the impedance of a transmission line and antenna system as a function of frequency. Smith Charts can be used to increase understanding of transmission lines and how they behave from an impedance viewpoint. Smith Charts are also extremely helpful for impedance matching, as we will see. The Smith Chart is used to display a real antenna's impedance when measured on a Vector Network Analyzer (VNA).

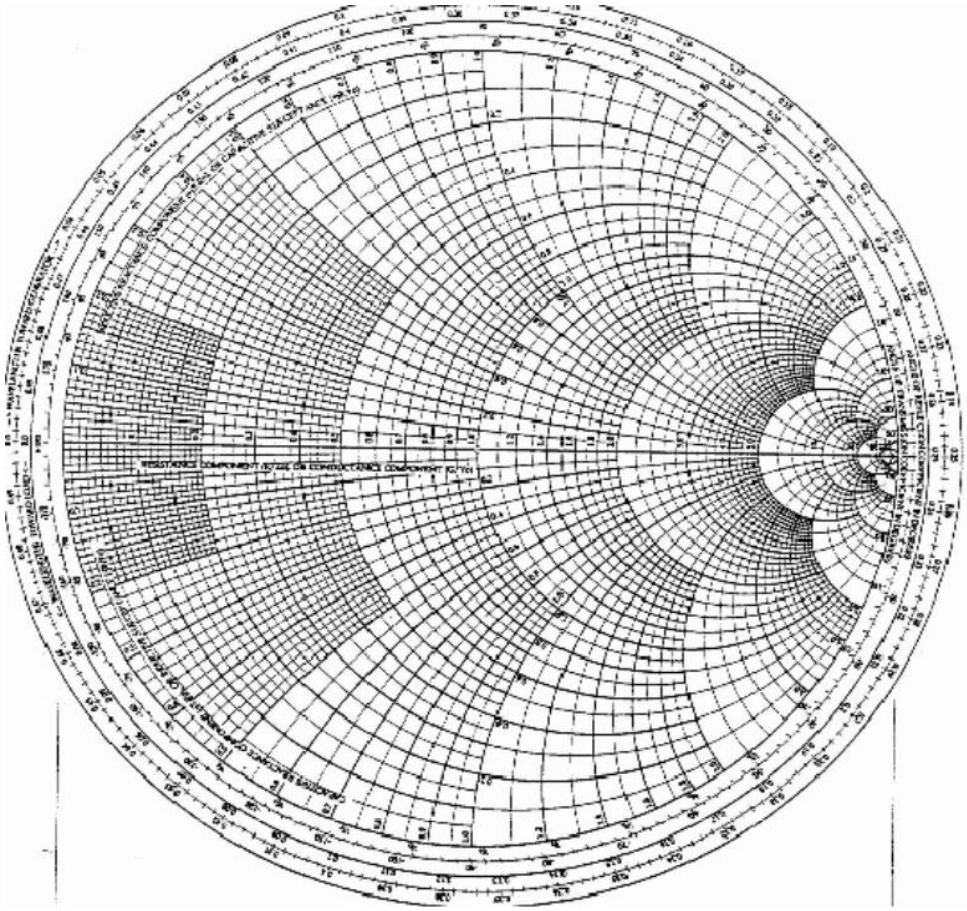


Figure 1. The basic Smith Chart.

version of the Smith Chart known as the immitance Smith Chart, which is twice as complicated, but also twice as useful. But for now, just admire the Smith Chart and its curvy elegance. This section of the antenna theory site will present an intro to the Smith Chart basics.

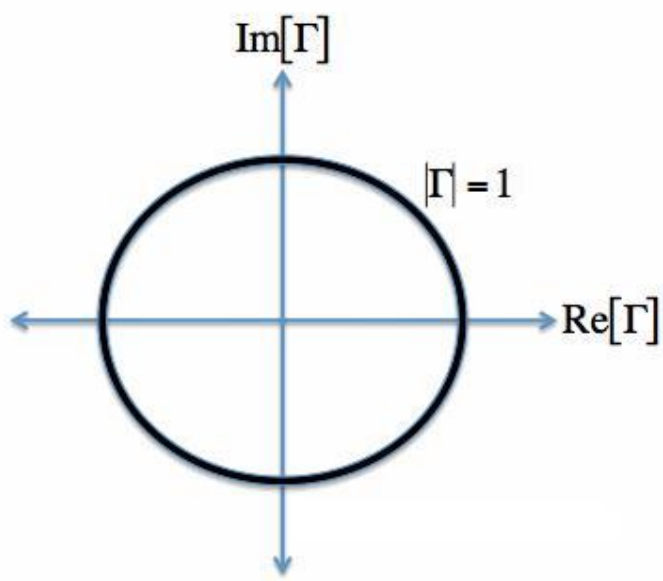


Figure 2. The Complex Reflection Coefficient must lie somewhere within the unit circle.

Normalized Load Impedance

To make the Smith Chart more general and independent of the characteristic impedance Z0 of the transmission line, we will normalize the load impedance ZL by Z0 for all future plots:

$$z_L = \frac{Z_L}{Z_0} = \frac{1+\Gamma}{1-\Gamma}$$

see complex math primer.) The constant reactance curve, defined by Im[zL]=-1 is shown in Figure 2:

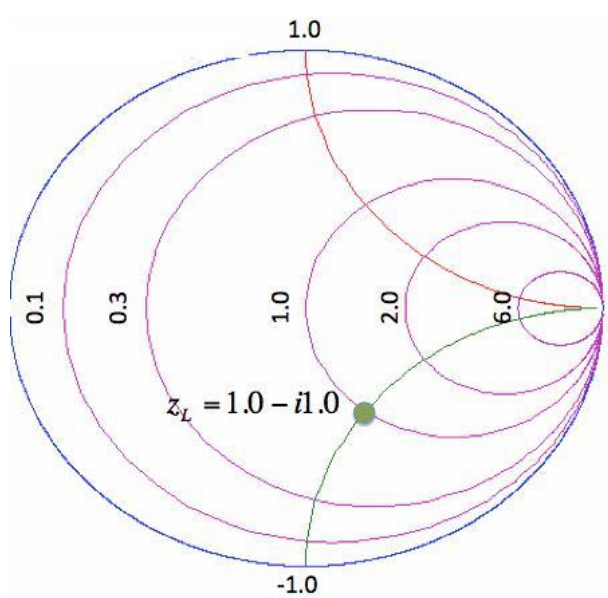


Figure 2. Constant Reactance Curve for zL = R - i.

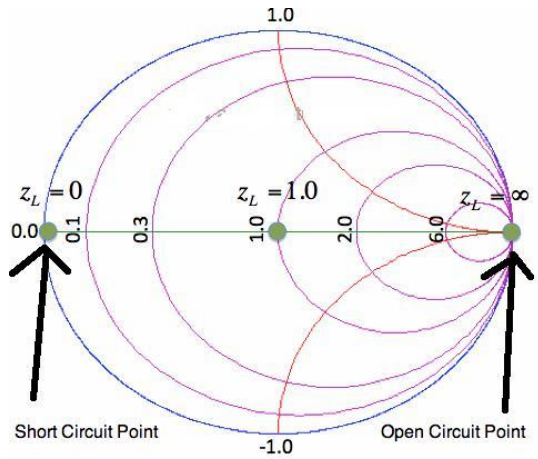


Figure 3. Constant Reactance Curve for zL=R. The reactance curve given by Im[zL]=0 is a

The point on the far right in Figure 3 is given by zL = infinity. This is the open circuit location. Again, the magnitude of is 1, so all power is reflected at this point, as expected. Finally, we'll add a bunch of constant reactance curves on the Smith Chart, as shown in Figure 4.

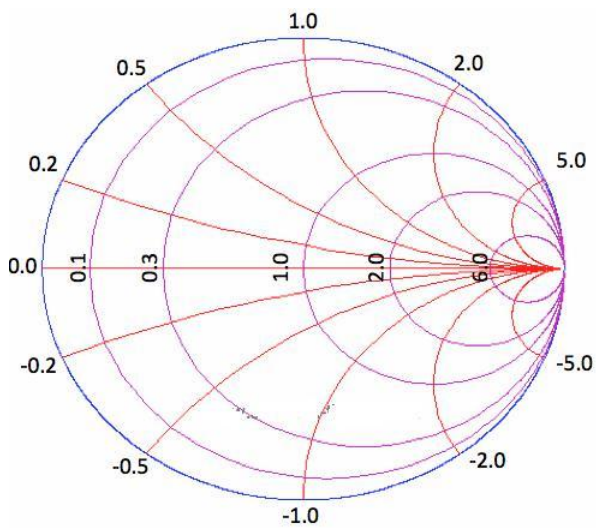


Figure 4. Smith Chart with Reactance Curves and Resistance Circles.

Applications of smith Chart:

Plotting an impedance

Measurement of VSWR

Measurement of reflection coefficient (magnitude and phase)

Measurement of input impedance of the line

• It is used to find the input impendence and input admittance of the line.

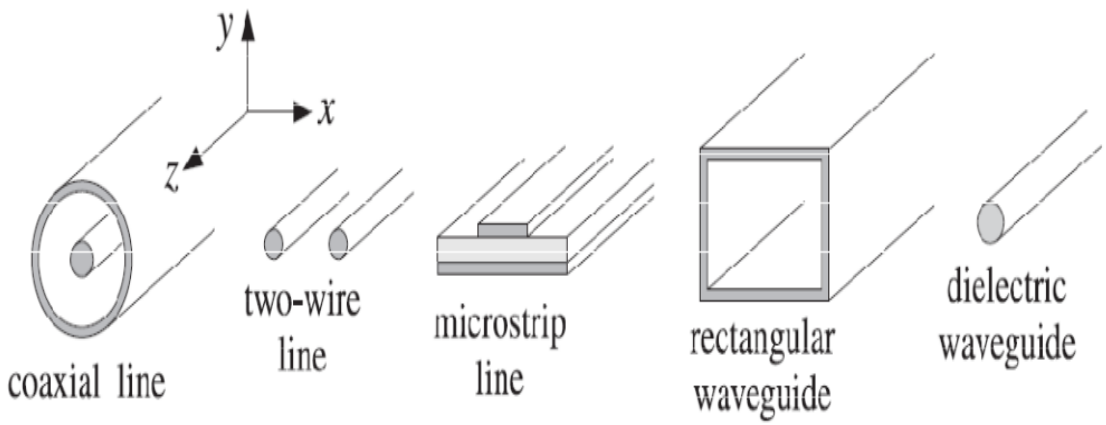
• The smith chart may also be used for lossy lines and the locus of points on a line then follows a spiral path towards the chart center, due to attenuation.

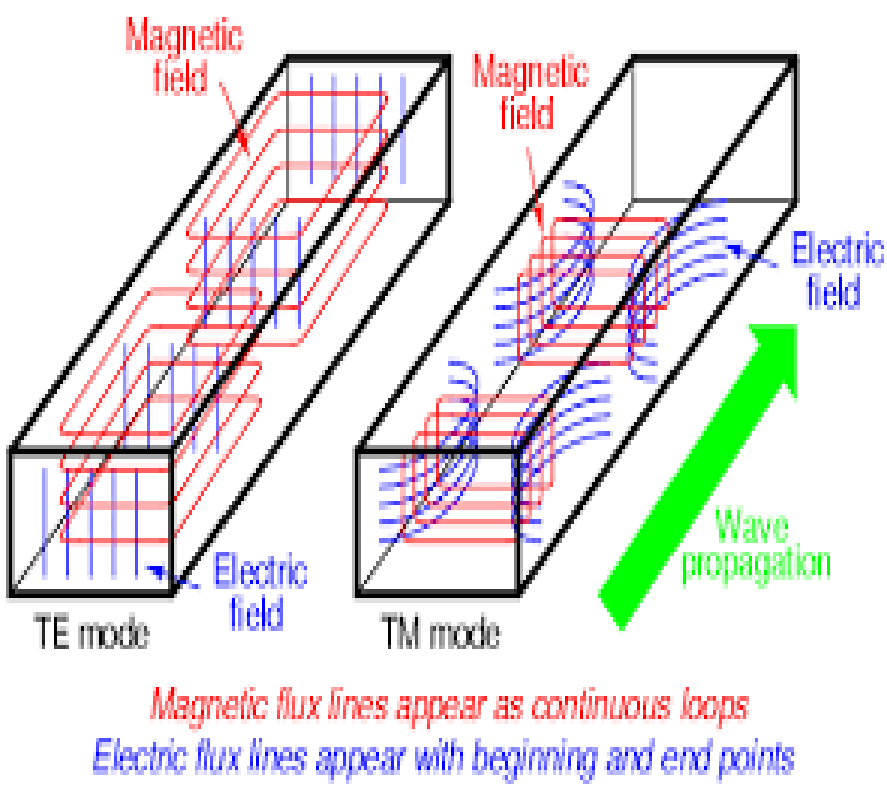
• In single stub matching.

UNIT - IV WAVEGUIDES

5.1 General Wave behaviors along uniform, Guiding structures

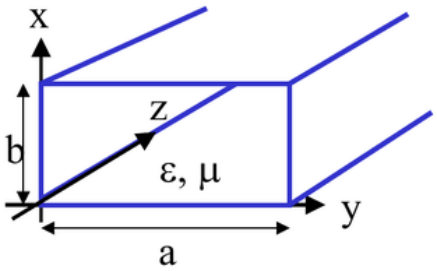
• In practice, the choice of structure is dictated by: (a) the desired operating frequency band, (b) the amount of power to be transferred, and (c) the amount of transmission losses that can be tolerated.



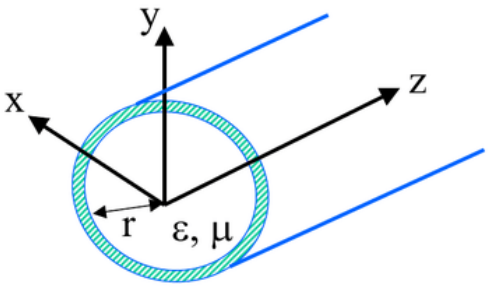


Waveguides

At high frequencies, the loss of electromagnetic waves traveling along transmission lines due to conductor resistance and radiation leakage becomes exceedingly large. To alleviate this problem, hollow waveguides can be used. We will study the rectangular waveguide as a typical example.

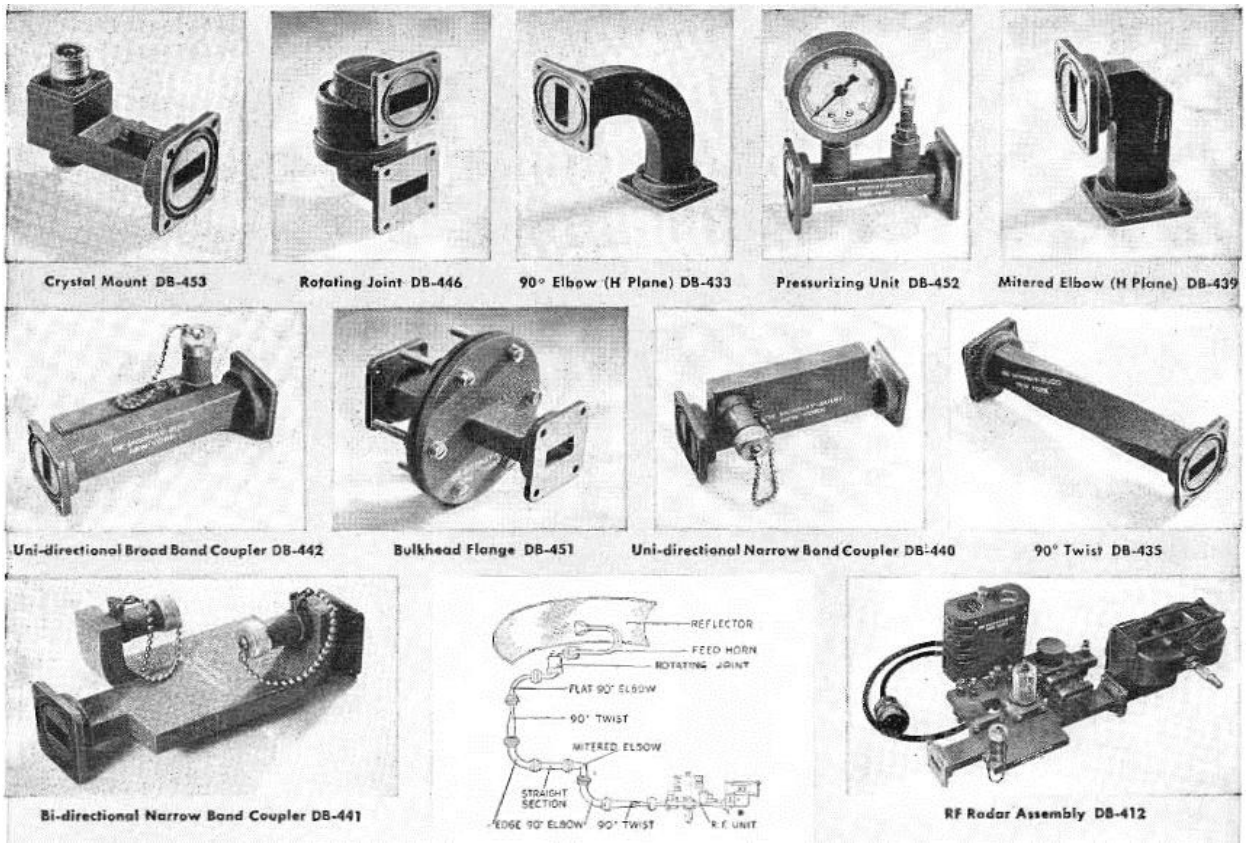


Rectangular waveguide



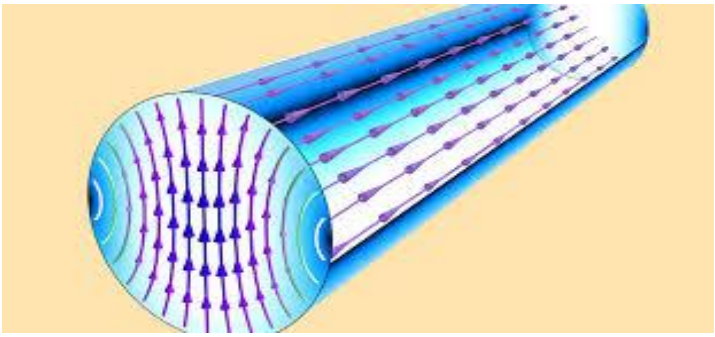
Circular waveguide

MODULS OF WAVEGUIDE

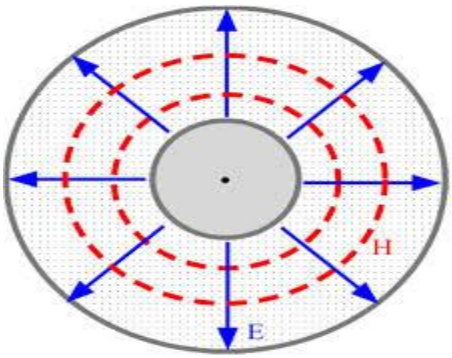


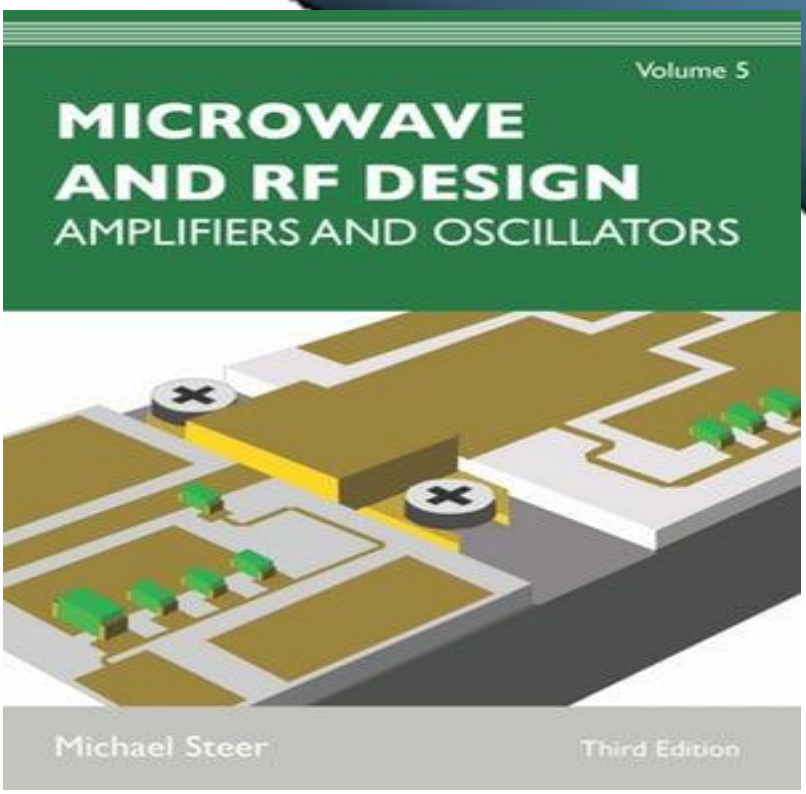
CIRCULAR WAVEGUIDE

CIRCULE MODULE RF MODE



CIRCULE AND COAXIAL WAVE GUIDE

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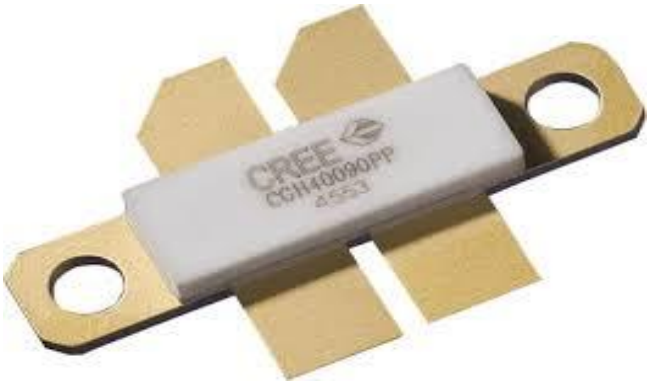
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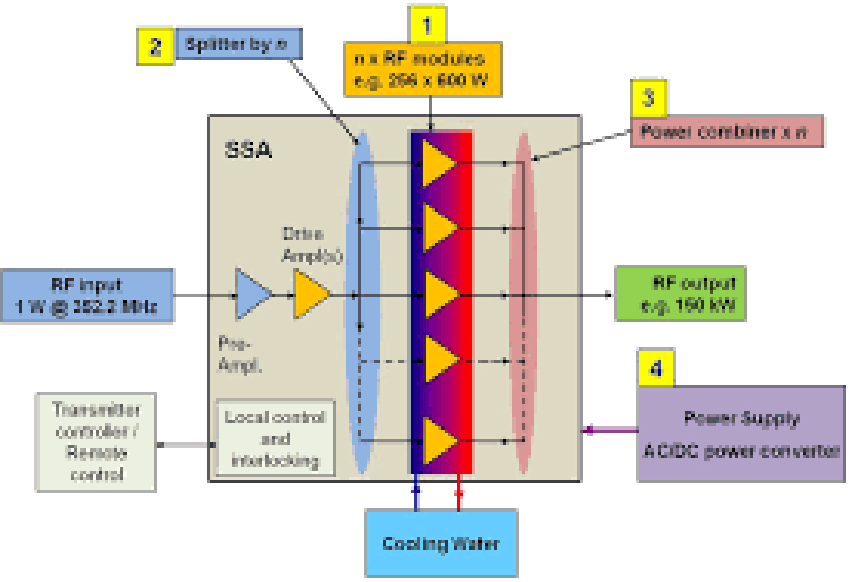
RF SOLID STATE AMPLIFIER



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