Introduction

A gap waveguide is a type of waveguide that uses a small gap between two parallel conductive plates to guide electromagnetic waves. The gap is typically on the order of the wavelength of the electromagnetic waves, and the width of the gap is much smaller than the length of the waveguide. The conductive plates are typically made of metal, and are often coated with a thin layer of metal to reduce loss.

The gap waveguide operates on the principle of confinement of electromagnetic waves within a small gap between two parallel metal plates. The plates act as a conducting boundary and the gap serves as the dielectric medium. The electromagnetic waves are guided through the gap by the total internal reflection of the waves at the metal-dielectric interface. This mode of propagation is known as the TEM mode (Transverse Electric and Magnetic mode).

One of the advantages of gap waveguide is that it can have very low loss because the metal plates are highly conductive, so energy is not absorbed by the waveguide structure. This makes it an attractive option for microwave and millimeter-wave applications. Additionally, gap waveguides can be integrated with other types of waveguides, such as microstrip and coplanar waveguides, to create hybrid structures for a wide range of applications.

Gap waveguides are widely used in microwave and millimeter-wave applications such as microwave communication systems, microwave filters, power dividers, and antenna feed systems. They are also used in millimeter-wave imaging systems, such as those used in medical imaging and security scanners. Gap waveguides are also used in scientific research, such as in the study of plasmas and in the development of advanced materials.

In summary, a gap waveguide is a type of waveguide that uses a small gap between two parallel conductive plates to guide electromagnetic waves, with low loss and wide applications on microwave and millimeter-wave.

Design of Simple Gap Waveguide

First, we use a rectangular cuboid as a vacuum. Its dimensions are:

Length = 80 mm, Width = 23 mm, Height = 12 mm.

Then we set pins in the two sides of rectangular waveguide. We know PEC pins, acts like a PMC in metamaterial field. Pins dimensions are:

Length = 1 mm, Width = 1mm, Height = 10 mm.

First, we set one pin. Then we use Duplicate Along Line tool in HFSS to shape other pins.

For excitation we use coaxial cable which its inner part is longer and is out of the outer part. Inner and outer radiuses are 0.42 mm and 1mm respectively. The excitation sheets are located at the top of cables.

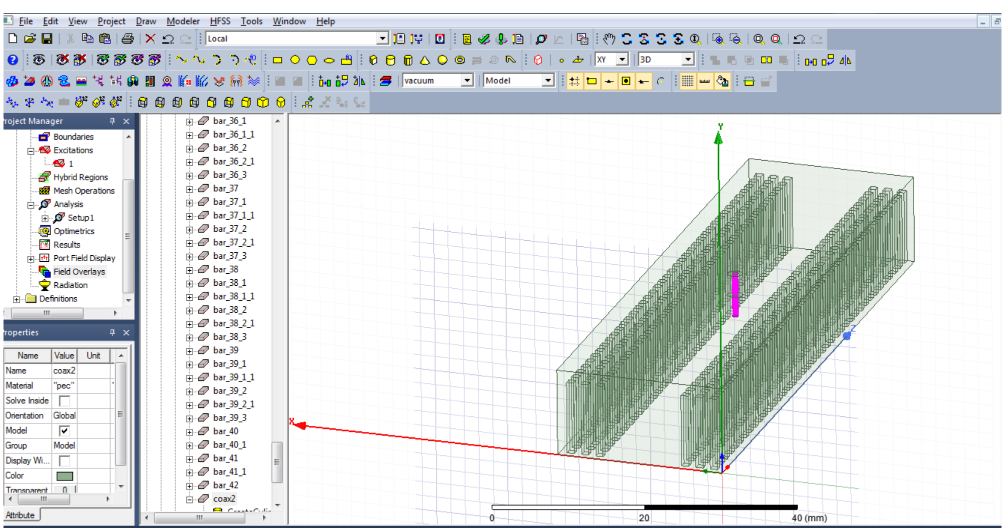

Figure 1

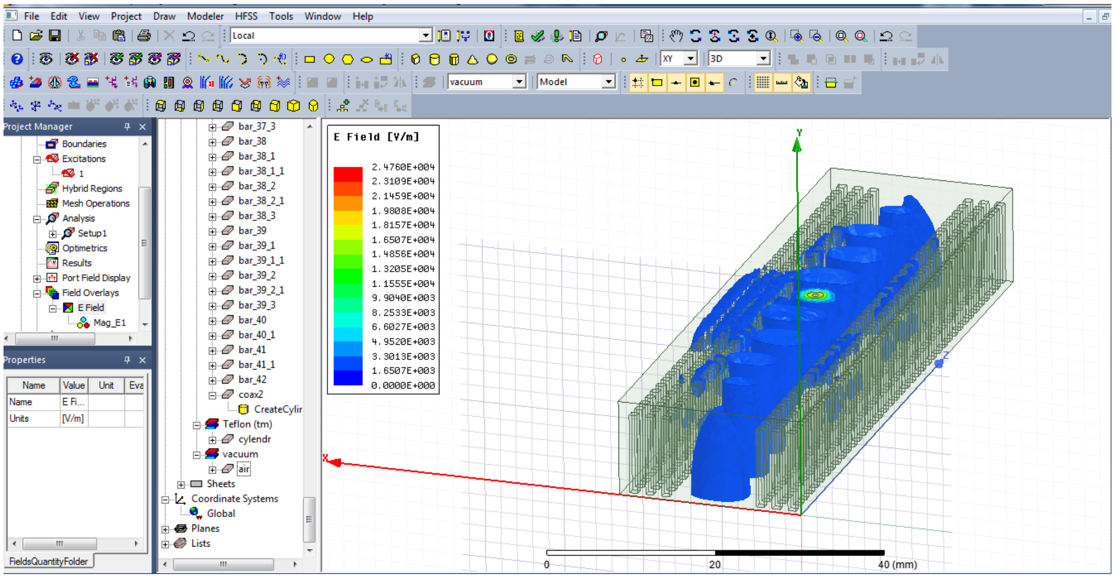

Figure 2. Electric Field Distribution

Design two adjacent Gap Waveguides

We put two gap waveguides next to each other. Divide the waveguide with conductive pins to act like PMC. The height of pin is smaller than waveguide. So, the electric and magnetic field can pass from one section to another. Quiescent point is at 24 GHz.

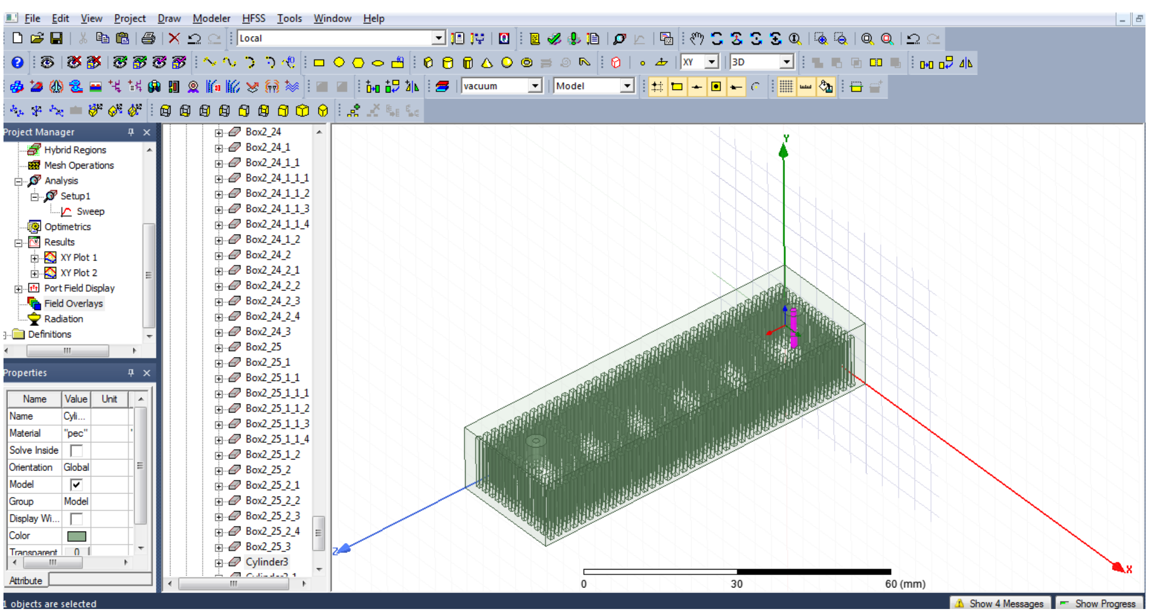

Figure 3. Structure of Waveguide

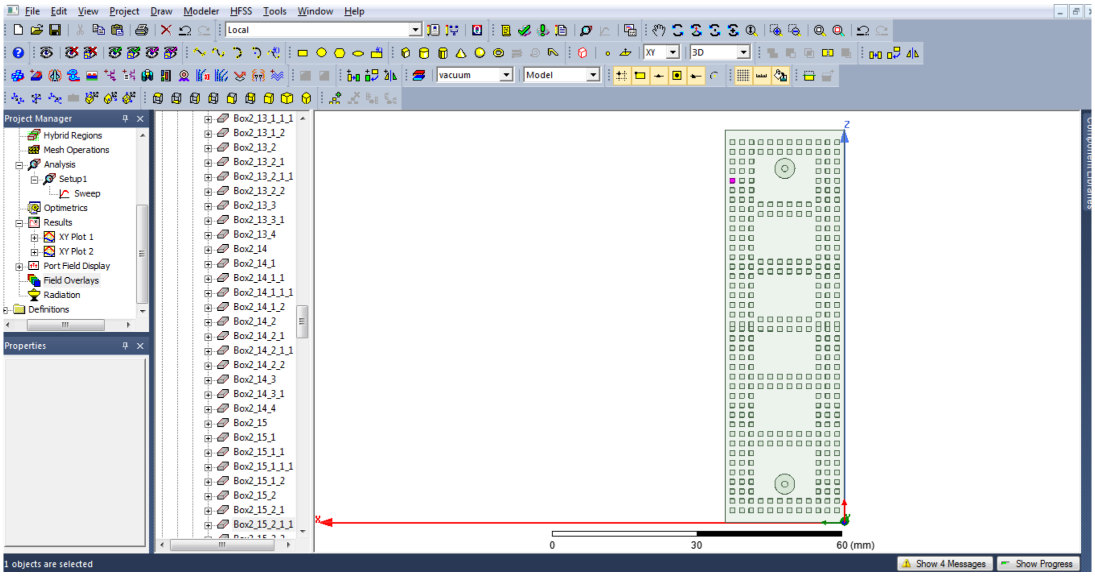

Figure 4. Picture from top of the waveguide

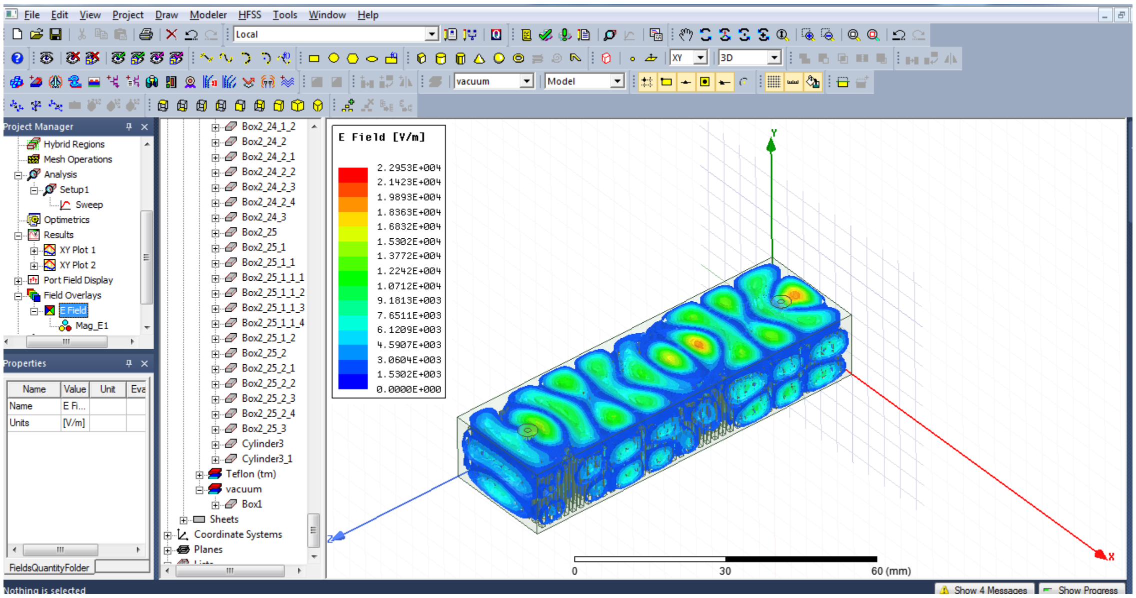

Figure 5. Electric Field Distribution

S-parameters are shown in figures 6 and 7, in range of 24 GHz to 25 GHz. We see that S21 is almost equal 1 in range of 24 GHz to 24.5 GHz. So, we can consider it as a filter which passes this frequency interval without attenuation.

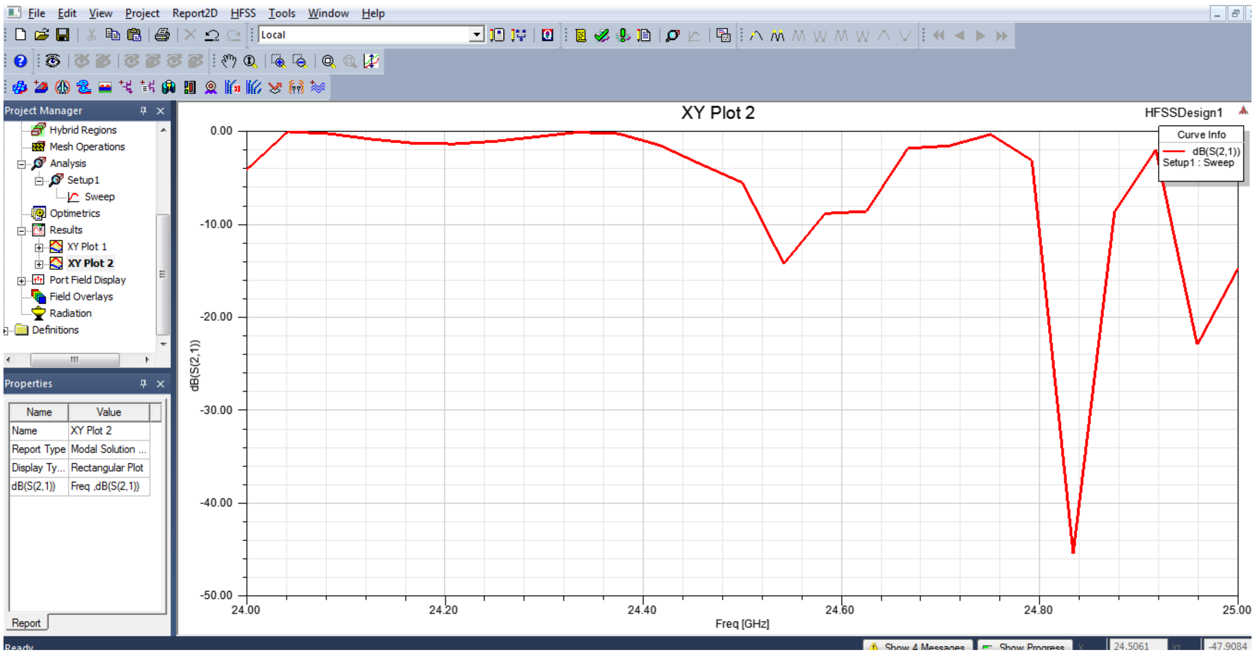

Figure 6.

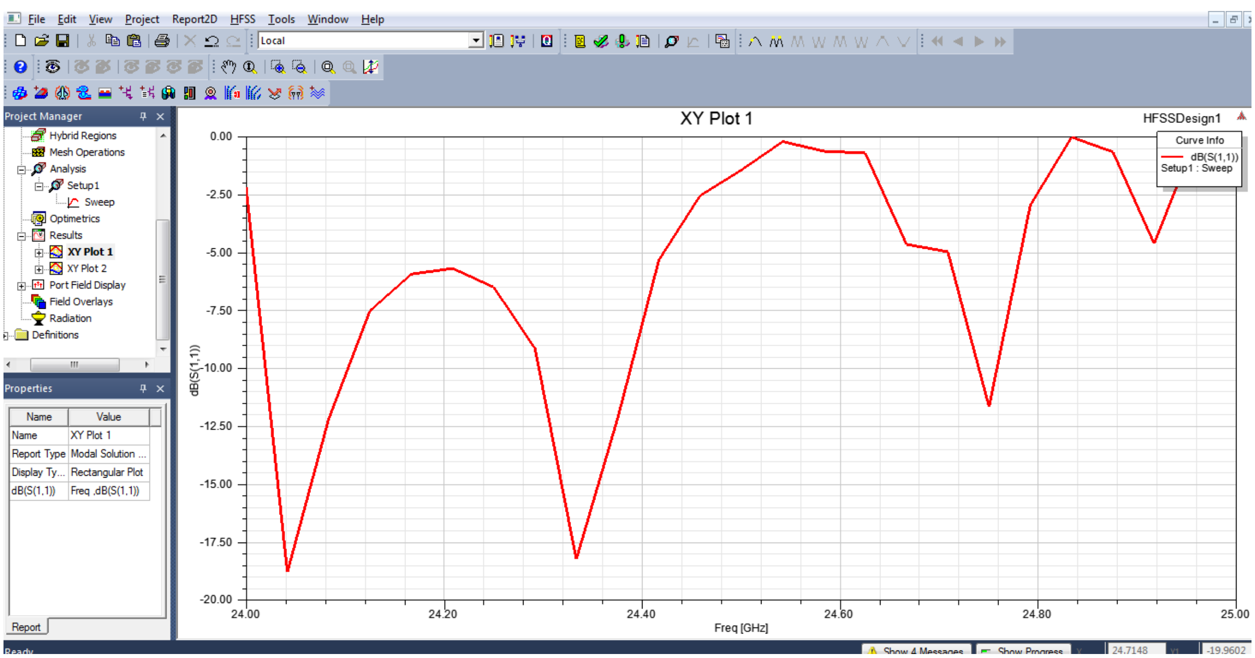

Figure 7.