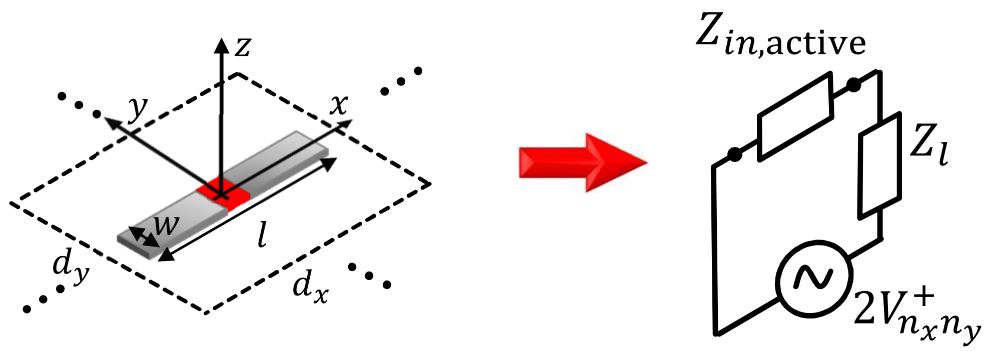
EE4580 Quasi Optical Systems

Matlab exercise: Active input impedance

Daniele Cavallo

Let us consider a doubly-periodic infinite array of dipoles in free space



The active input impedance for a dipole array in free space can be expressed as

$$z_{in,\text{active}} = -\frac{1}{d_x d_y} \sum_{m_x=-\infty}^{\infty} \sum_{m_y=-\infty}^{\infty} G^{ej}_{xx,FS}(k_{xm}, k_{ym}) |I(k_{xm})|^2 \left|J_t(k_{ym})\right|^2$$

where

$$I(k_x) = \frac{2\mathrm{k}_0 \left(\cos\left(\frac{k_x l}{2}\right) - \cos\left(\frac{k_0 l}{2}\right)\right)}{(k_0^2 - k_x^2)\sin\left(k_0 \frac{l}{2}\right)}, \qquad J_t(k_y) = \mathrm{sinc}\left(\frac{k_y w}{2}\right)$$

As an example, the geometrical parameters are

```
dx    = 15e-3;
dy    = 15e-3;
```

```
w     = 3e-3;
l     = 13.5e-3;
```

1) Implement the expression of the active input impedance in Matlab and plot the variation of real and imaginary part with the frequency (in the range 5-15 GHz) for

- Case 1
```
Theta = 0;
Phi   = 0;
```
- Case 2
```
Theta = 30*pi/180;
Phi   = 0;
```

---

2) Plot also the variation with frequency of the
   - Active reflection coefficient normalized to a proper Z_L
   - Fundamental mode of $z_{in,\mathrm{active}}$: Z_{00}
   - Higher order modes of $z_{in,\mathrm{active}}$: Z_{ho}

---

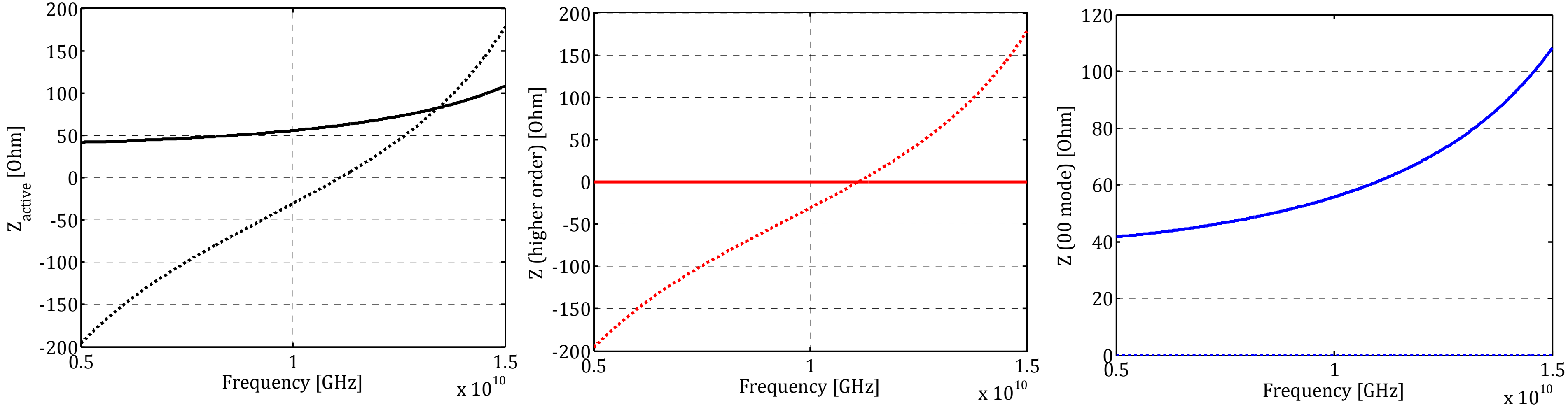
3) Are these quantities complex, real or imaginary and why?

---

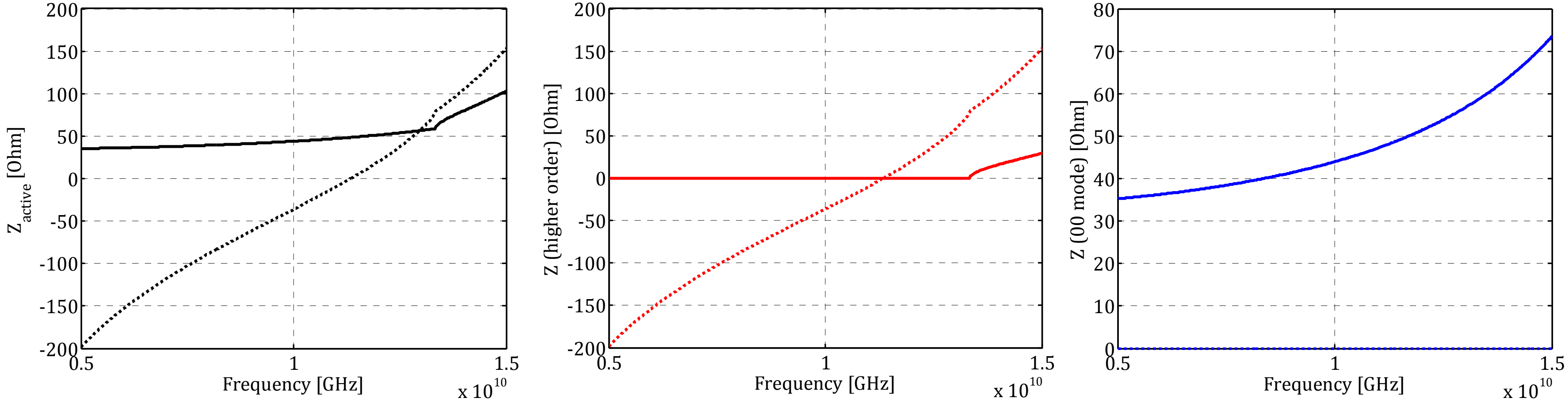
4) At what frequency do you expect to find a grating lobe for Case 2? How do the impedance curves change at this frequency?

Results

Theta = 0; Phi = 0;



Theta = 30*pi/180; Phi = 0;



- A grating lobe appears at 13.33 GHz for case 2. We expected that from the condition $f = \frac{c}{d_x}\left(\frac{1}{\sin\theta+1}\right) = 2 * 10^{10} = 13.3$ GHz.
- At this frequency the higher-order sum become also real, since one other Floquet mode has entered the visible region (propagative)
- The fundamental mode for lower frequency decrease of a factor $\cos\theta$. This is due to projection. For TE scanning Z increases by $\frac{1}{\cos\theta}$.