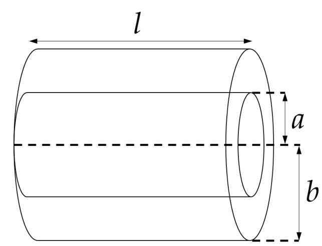
# Coaxial Capacitor Datasheet

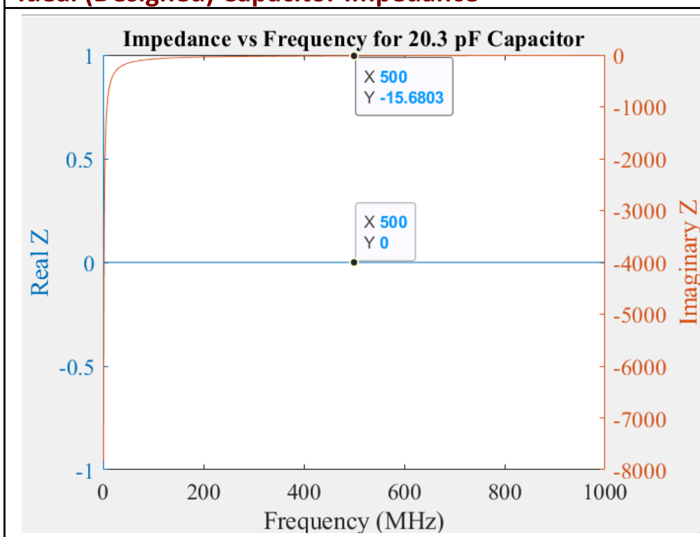
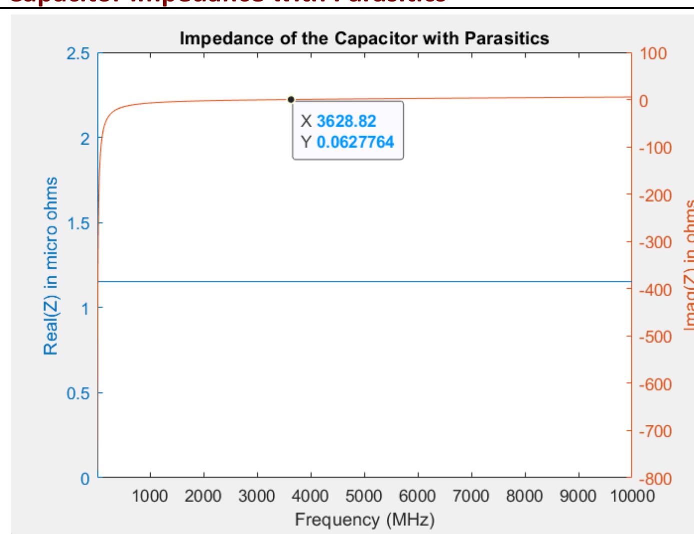
## ECEN 322 Team 17

**Designers:** Daniel Pasket, Joey Sheng-Kai See, Joaquin Salas, Otabek Mavlonov

| Specifications | |
|---|---|
| Capacitance Value in pF (Design) | 20.3 pF |
| Dielectric Material | Mykroy/Mycalex (Mica) 600 |
| Dielectric Constant | 6.8 |
| Dielectric Breakdown Strength (with units) | 1.65e7 $\frac{V}{m}$ |
| Maximum Operating Voltage (kV) | 8.25 kV |

| Dimensions | | |
|---|---|---|
| Inner Radius, $a$ (cm) | 0.5 cm |  |
| Outer Radius, $b$ (cm) | 0.55 cm | |
| Length, $l$ (cm) | 0.5115 cm | |
| Total Volume of Capacitor | 0.4861 $cm^3$ | |



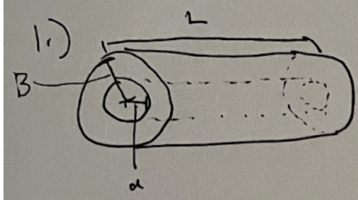
| Performance | |
|---|---|
| Self-Resonance Frequency | 3600 MHz |
| Ideal (Designed) Capacitor Impedance | Capacitor Impedance with Parasitics |
|  |  |

**(a) Statement on division of work between team members**

(i) Until part 5, we all worked together but independently to ensure that our calculations were correct and ensure various checks of our data. In part 5, we incorporated the values that we calculated from the previous parts. For part 6, Joaquin and Joey were responsible for independently completing the task and then comparing with each other's plots at the end to ensure that the answers were correct. For part 7, Otabek and Daniel were responsible for independently completing the task and then checking with each other at the end to ensure that the answers were correct.

**(b) Derivation of capacitance of the coaxial capacitor**

1.)




Assume a $q_1$ is present on the inner conductor such that $q_1$ is the amount of charge present at the surface of the conductor per unit length (in L's direction)

$q_{Tot}$ on inner conductor $= 2\pi a L q_1$

for $a<r<b$ and $L>>a$

Surface area of enclosing cylinder surface $= 2\pi r L$

By Gauss's Law $\bar{D} = \frac{q_{Tot}}{SA} = \frac{2\pi L a q_1}{2\pi L r}$

$= \frac{a q_1}{r}$, $\bar{D} = \varepsilon \bar{E}$, $\bar{E} = \bar{D}/\varepsilon$, $V = -\int_a^b \bar{E} d$

$\bar{E} = \frac{a q_1}{\varepsilon r}$ $\quad V = -\int_a^b \frac{a q_1}{\varepsilon r} dr$

$= -\frac{a q_1}{\varepsilon} \ln(b/a)$

$C = |Q/V|$

$Q_{tot} = 2\pi L a q_1$

$V = -\frac{a q_1}{\varepsilon} \ln(b/a)$

$$C = \left| \frac{2\pi L a q_1}{-\frac{a q_1 \ln(b/a)}{\varepsilon}} \right|$$

$$C = \left| \frac{-2\pi L \varepsilon}{\ln(b/a)} \right| = \frac{2\pi L \varepsilon}{\ln(b/a)}$$

using $l$ instead of $L$ for length, (L was used for readability purposes)

$$\boxed{C = \frac{2\pi l \varepsilon}{\ln(b/a)}}$$

**(c) <u>Work showing how you designed the capacitor</u>**

2.) Team # = 17

Capacitance to be designed ~~#~~ = 13.5 + 17(.4) = 20.3 pF

3.) $\varepsilon_r = 6.8$ ~~[illegible]~~

$E_{DS} = 16.5$ kV/mm $= 16.5e6$ V/m $= 1.65e7$ V/m

4.) $$C = \frac{2\pi \varepsilon l}{\ln(b/a)} = \frac{2\pi \varepsilon_r \varepsilon_0 l}{\ln(b/a)}$$

$$\frac{C}{2\pi \varepsilon_r \varepsilon_0} = \frac{l}{\ln(b/a)}$$

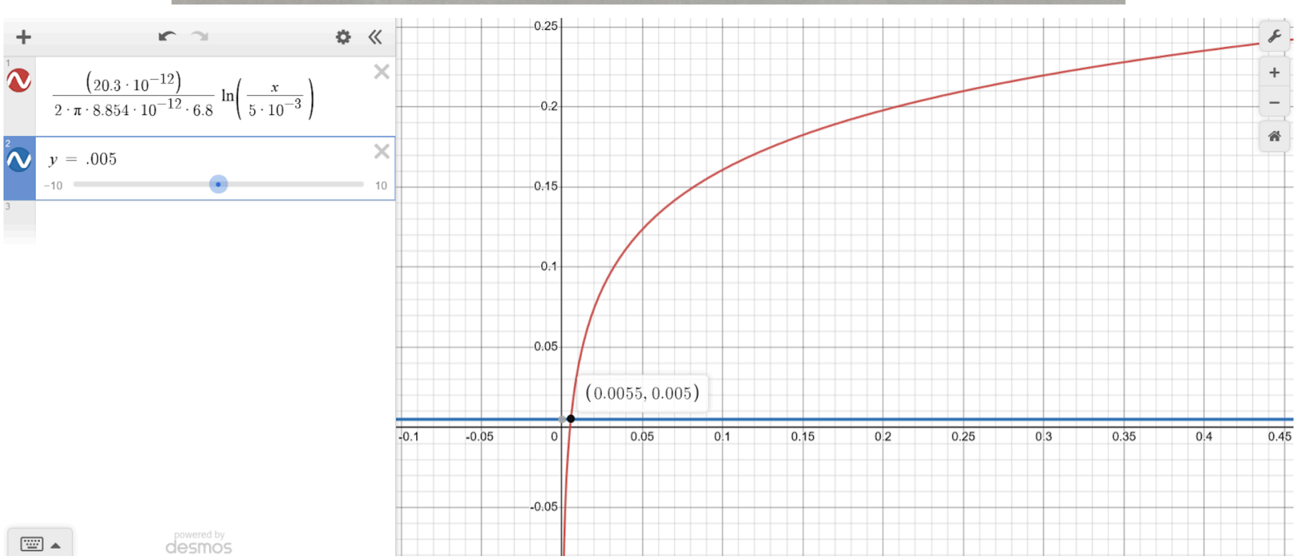
assume a = 5 mm to make function dependent on ~~#~~ only $l$ and b

$$l = \frac{C \ln(b/a)}{2\pi \varepsilon_r \varepsilon_0}$$

Using Desmos to find b such that $l \approx 5$ mm, we set b = 5.5 mm

$l = 5.115$ mm

a = 5 mm, b = 5.5 mm $l = 5.115$ mm



**(d) Code for plotting ideal impedance**

```
f = 10^6:10^5:10^9; %Frequency in Hz
f_MHz = f./10^6; %Frequency in MHz for Pretty Plotting
Z = 1./(f*(2*pi*1i*20.3*10^-12)); % Value of Z from Z = 1/(jwC)

%Prettyifying it
title("Impedance vs Frequency for 20.3 pF Capacitor")
fontsize(14,"points")
fontname("Times New Roman")

%Plotting Real
yyaxis left;
plot(f_MHz,real(Z));
xlabel('Frequency (MHz)');
ylabel('Real Z');

%Plotting Imaginary
yyaxis right;
plot(f_MHz,imag(Z));
ylabel('Imaginary Z');
```