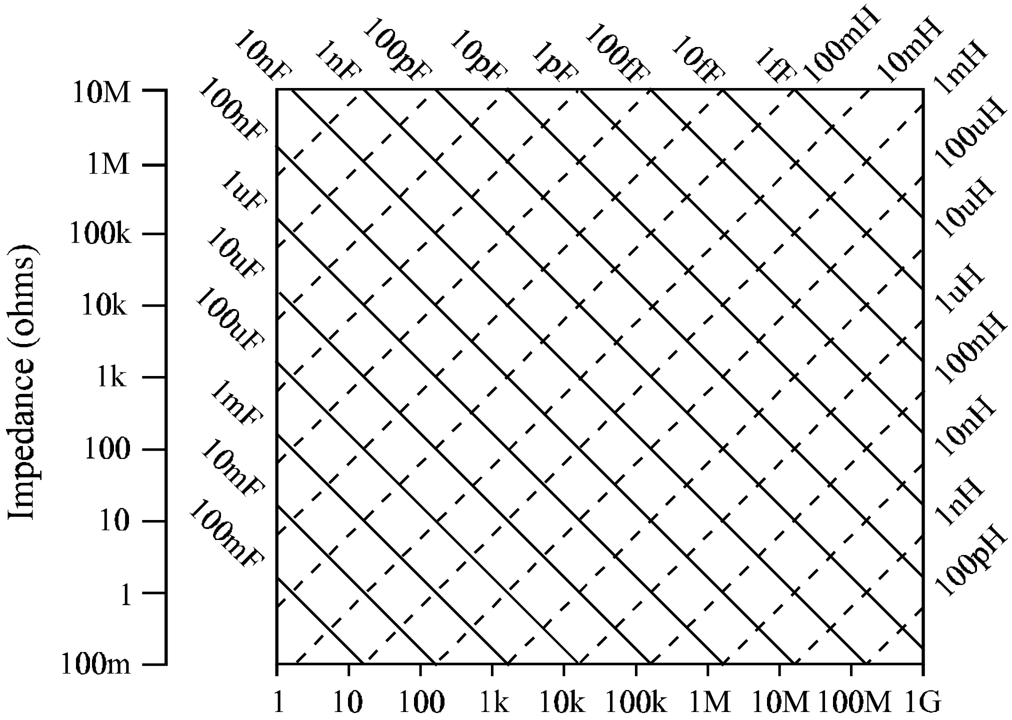
RF Behavior of Passive Components

- Conventional circuit analysis
  - R is frequency independent
  - Ideal inductor: $X_L = jwL$
  - Ideal capacitor: $X_C = 1/wC$

- **Evaluation**
  - Impedance chart

Impedance Chart

(impedance of C & L vs frequency)



$Z_C = 1/(2\pi f C)$

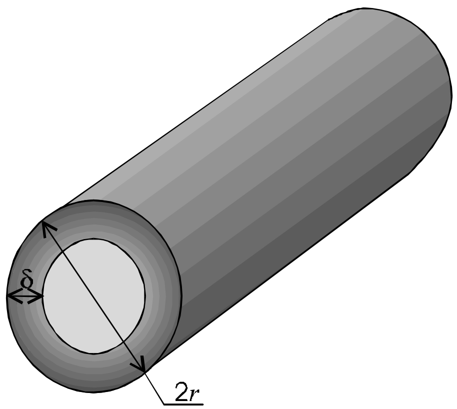
$Z_L = 2\pi f L$

How does a wire behave at high frequency?

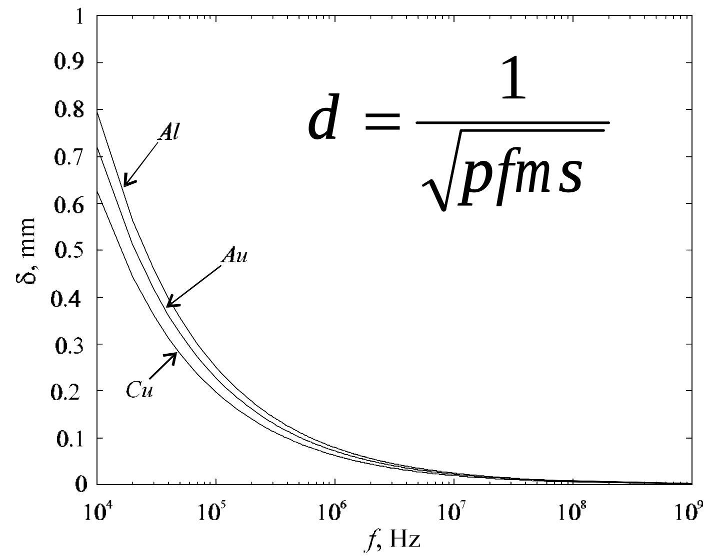
- Example: Resistor

$$R_{DC} = \frac{l}{pa^2 s}$$

$$R / R_{DC} = \frac{a}{2d} \qquad wL / R_{DC} = \frac{a}{2d}$$

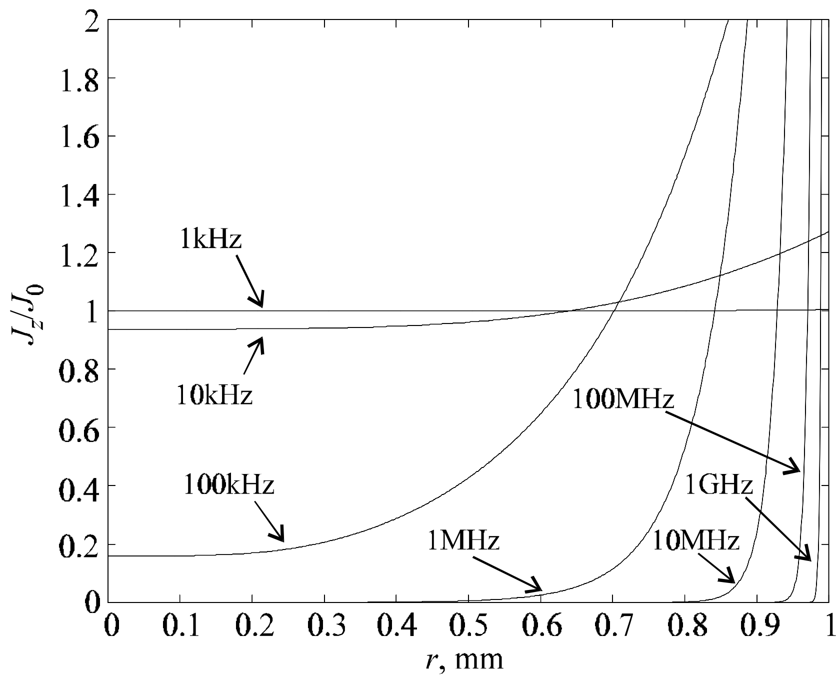


$$d = \frac{1}{\sqrt{pfms}}$$



High frequency results in skin-effect whereby current flow is pushed to the outside

How exactly is the current distribution as a function of frequency?

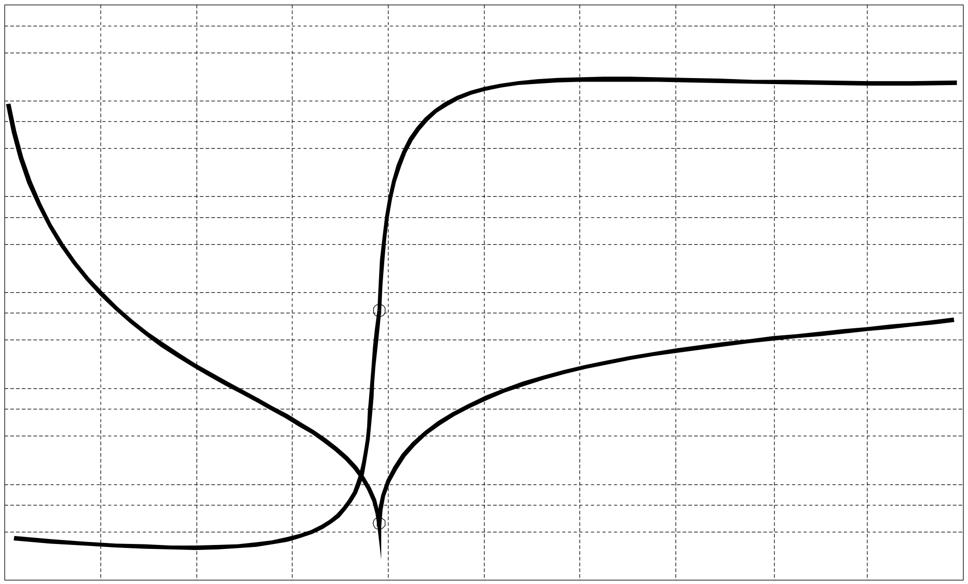


- Low frequency shows uniform current distribution
- medium to high frequency pushes current to the outside
- RF "sees" current completely restricted to surface

Impedance Measurement Example

Capacitor going through resonance

A: |Z| B: Θ   MKR 63 200 000.000 Hz
A MAX 50.00 Ω   MAG 47.2113 mΩ
B MAX 100.0 deg   PHASE 659.015 mdeg



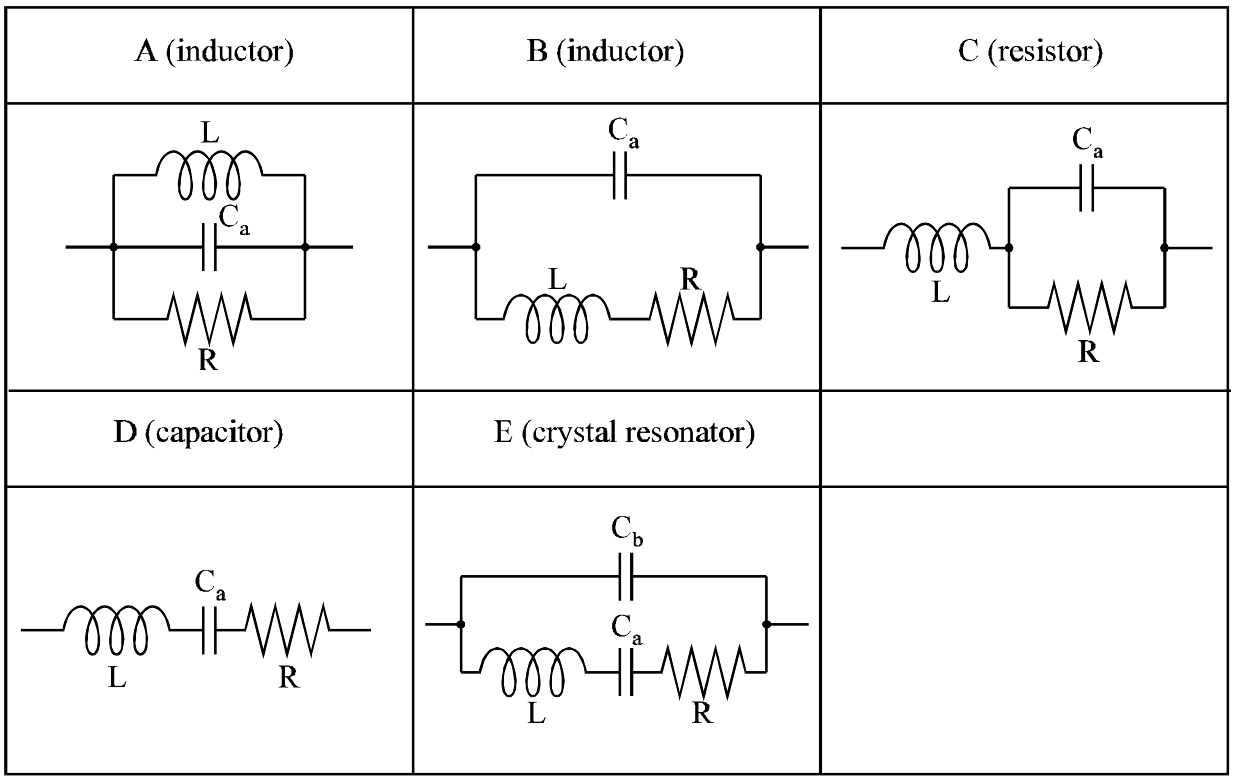
A MIN 20.00 mΩ   START 10 000 000.000 Hz
B MIN -100.0 deg   STOP 150 000 000.000 Hz

Capacitor Characteristics

Equivalent Circuit Analysis

EQUIVALENT CIRCUIT MODEL

Selected : D



EQV R 38.6346 mΩ

EQV L 2.19795 nH

EQV C_a 82.1028 nF

EQV C_b F