

# Parallel Plate Capacitance Calculator

Chris Haji-Michael

<http://www.sunshadow.co.uk/chris.htm>

This sheet is used to calculate the capacitance obtained from parallel plate capacitors using three different formulas from the VLSI handbook, CRC press.

The Area (A) = Width \* Length  
 The graph below is drawn for Length = 10um  
 Thickness = thickness of the metal

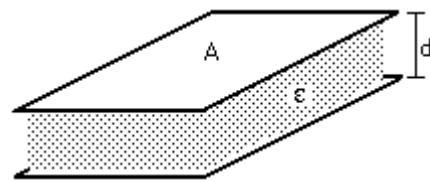
$$\mu\text{m} := 10^{-6} \text{ m} \quad \text{nm} := 10^{-9} \text{ m} \quad \epsilon_0 := 8.854187817 \cdot 10^{-12} \cdot \frac{\text{farad}}{\text{m}}$$

$$d := 8 \cdot \mu\text{m}$$

$$\epsilon_r := 4.1$$

$$\text{Thickness} := 200\text{nm}$$

$$\text{fF} := 10^{-15} \text{ F}$$



## Conventional

$$\text{ConventionalC}(\text{Width}, \text{Length}) := \frac{\epsilon_r \cdot \epsilon_0 \cdot \text{Width} \cdot \text{Length}}{d}$$

## Yuan's Formula

$$\text{YuanC}(\text{Width}, \text{Length}) := \epsilon_r \cdot \epsilon_0 \cdot \left[ \frac{\text{Width}}{d} + \frac{2 \cdot \pi}{\ln \left[ 1 + \left( \frac{2 \cdot d}{\text{Thickness}} \right) \left( 1 + \sqrt{1 + \frac{\text{Thickness}}{d}} \right) \right]} - \frac{\text{Thickness}}{2 \cdot d} \right] \cdot \text{Length}$$

## Sakurai's Formula

$$\text{SakuraiC}(\text{Width}, \text{Length}) := \epsilon_r \cdot \epsilon_0 \cdot \left[ \frac{\text{Width}}{d} + 0.15 \cdot \frac{\text{Width}}{d} + 2.8 \cdot \left( \frac{\text{Thickness}}{d} \right)^{0.222} \right] \cdot \text{Length}$$

## Meijs & Fokkema Formula

$$\text{MFC}(\text{Width}, \text{Length}) := \epsilon_r \cdot \epsilon_0 \cdot \left[ \frac{\text{Width}}{d} + 0.77 + 1.06 \cdot \left[ \left( \frac{\text{Width}}{d} \right)^{0.25} + \left( \frac{\text{Thickness}}{d} \right)^{0.5} \right] \right] \cdot \text{Length}$$

## Average Capacitance & Calculation of Error

$$\text{AverageC}(\text{Width}, \text{Length}) := \frac{1}{4} \left( \text{ConventionalC}(\text{Width}, \text{Length}) + \text{YuanC}(\text{Width}, \text{Length}) + \text{SakuraiC}(\text{Width}, \text{Length}) + \text{MFC}(\text{Width}, \text{Length}) \right)$$

This graph shows the capacitance for a 500um x 1um track on an IC spaced 8um from the substrate which is assumed to be a ground plane. At these dimensions the conventional capacitance equation does not work because of the large fringing affect.

Width := 0.5·μm, 1·μm.. 3·μm

