Capacitors

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Parallel-plate capacitor

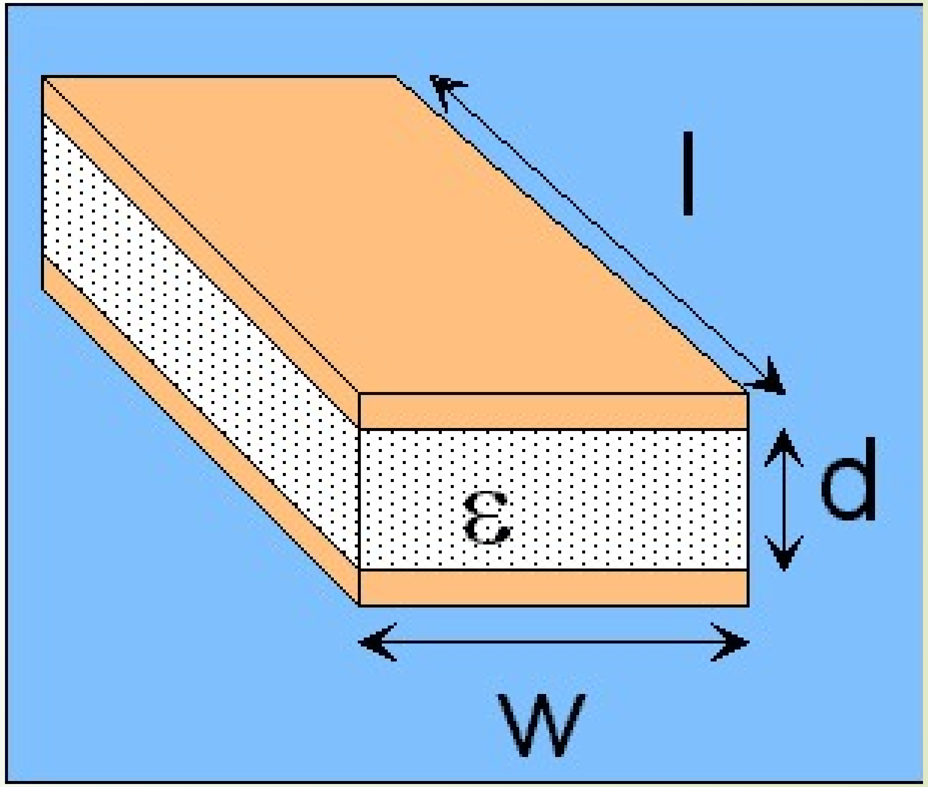
$$c = l \cdot \varepsilon \cdot \frac{w}{d}$$

The equation assumes that there are no significant fringing fields or

$$d \ll l$$

$$d \ll w$$

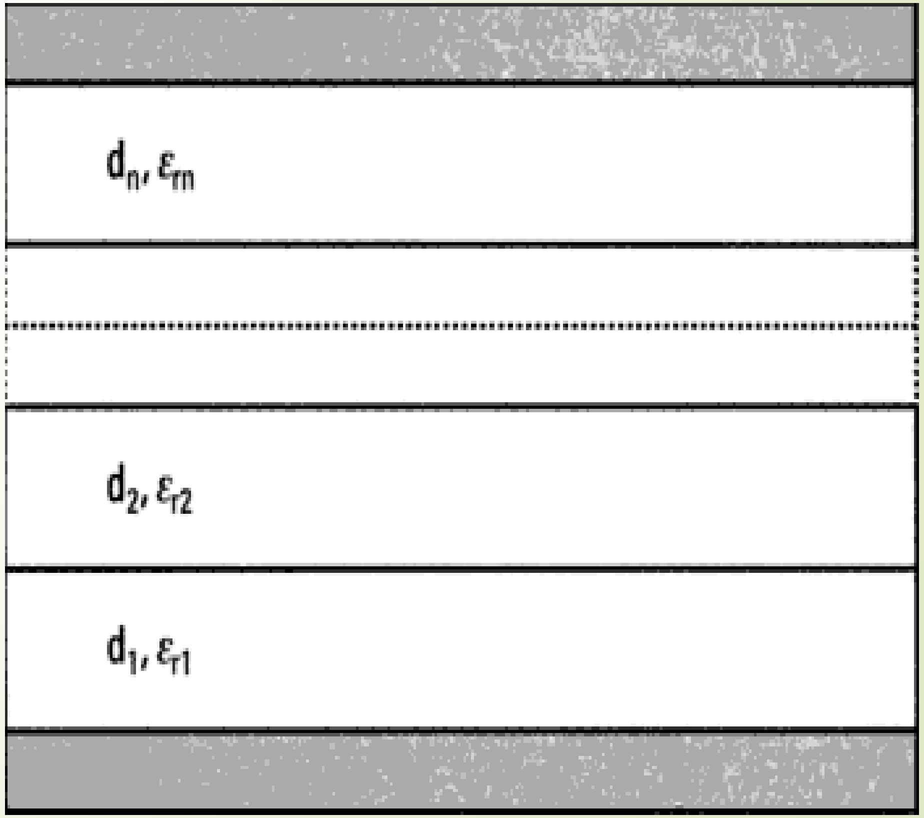
$$\varepsilon_r \gg \varepsilon_0$$



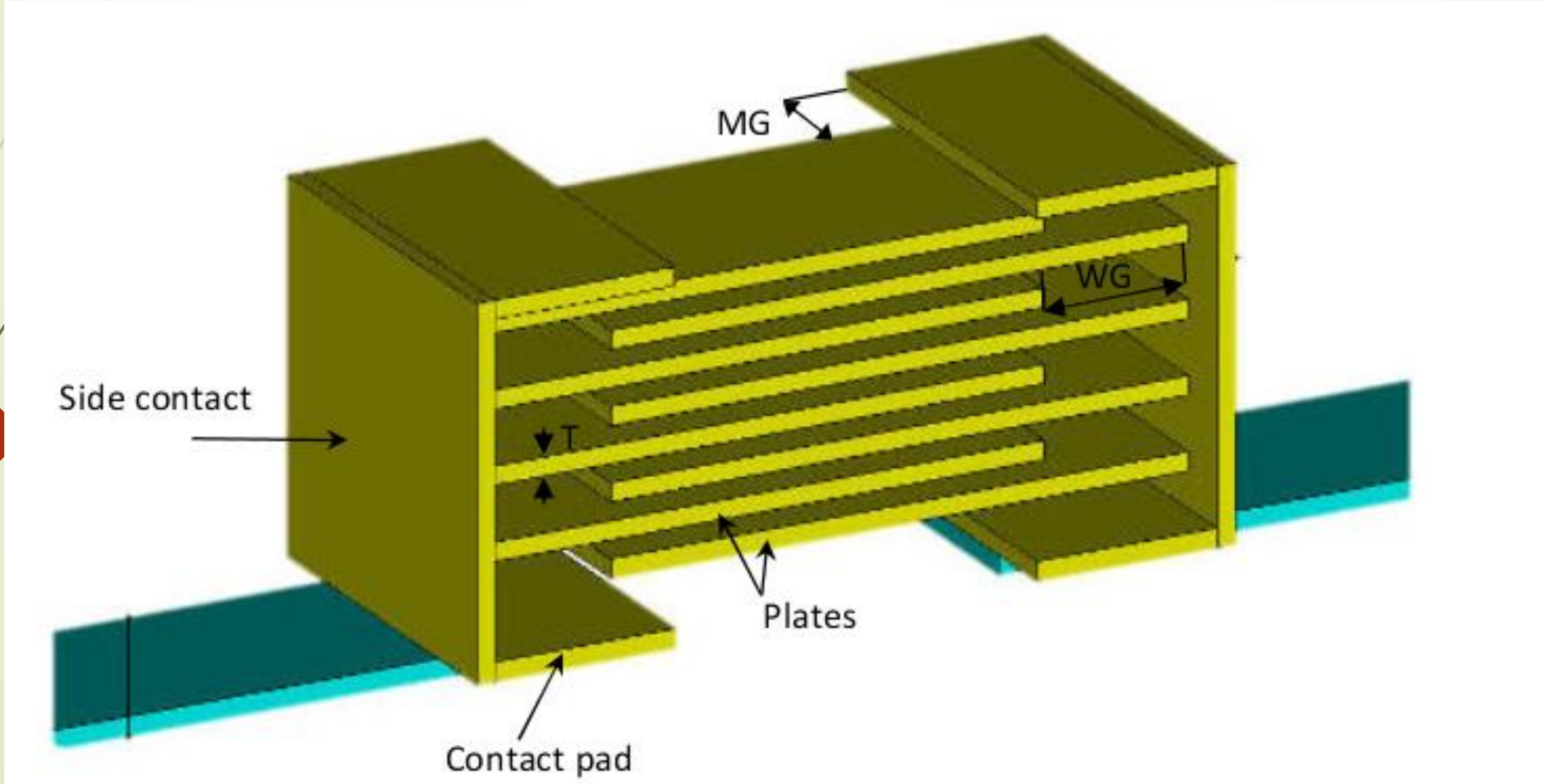
Multilayer dielectric parallel plate capacitor

$$\varepsilon_{r,layered} = \left(\sum_{n=1}^{all\ layers} \frac{d_n}{d_t \cdot \varepsilon_{r,n}} \right)^{-1}$$

$$c = \varepsilon_{r,layered} \cdot \frac{A}{d_t}$$



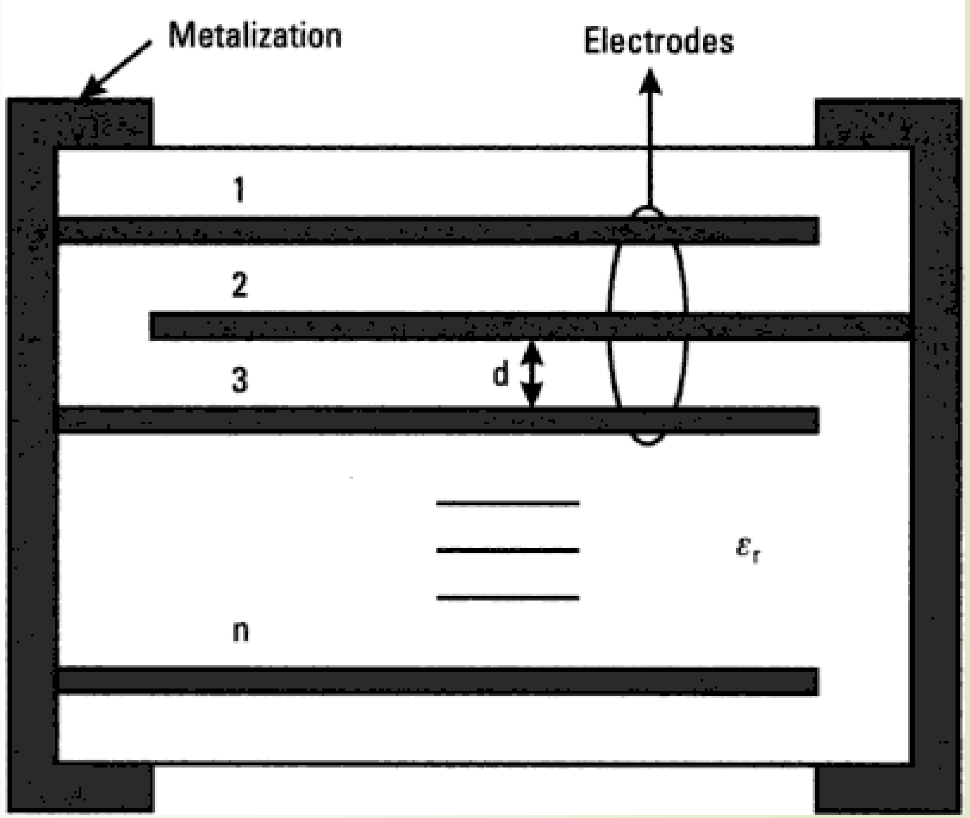
Multilayer capacitor



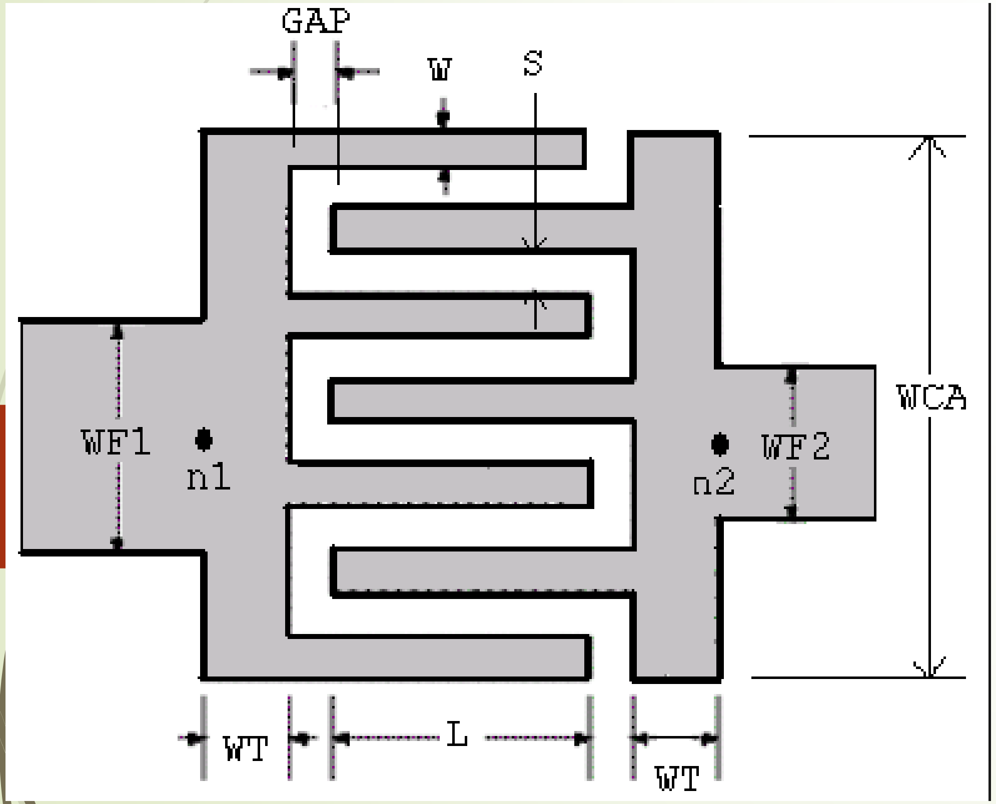
$$C = \frac{0.2249\varepsilon_r A(n-1)}{d}\ (pF)$$

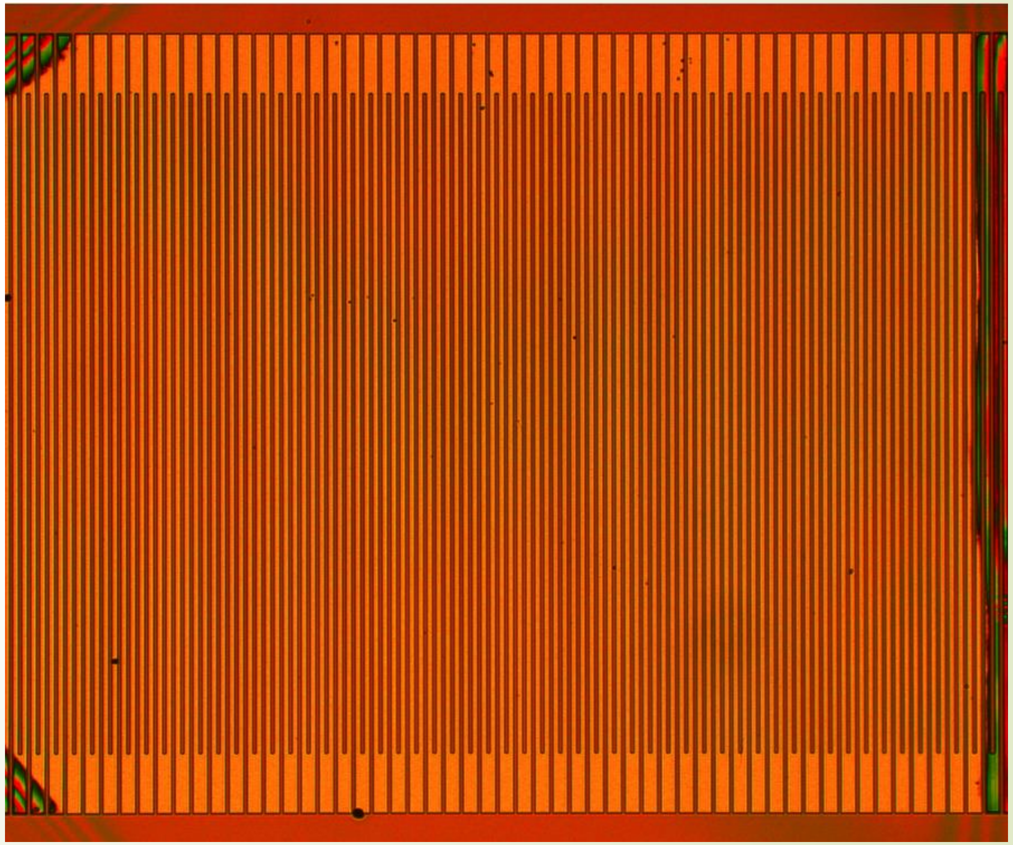
Where

A=area of plates in square inches
n=number of conductor layers
d=plate spacing



Interdigital capacitor





Model 1

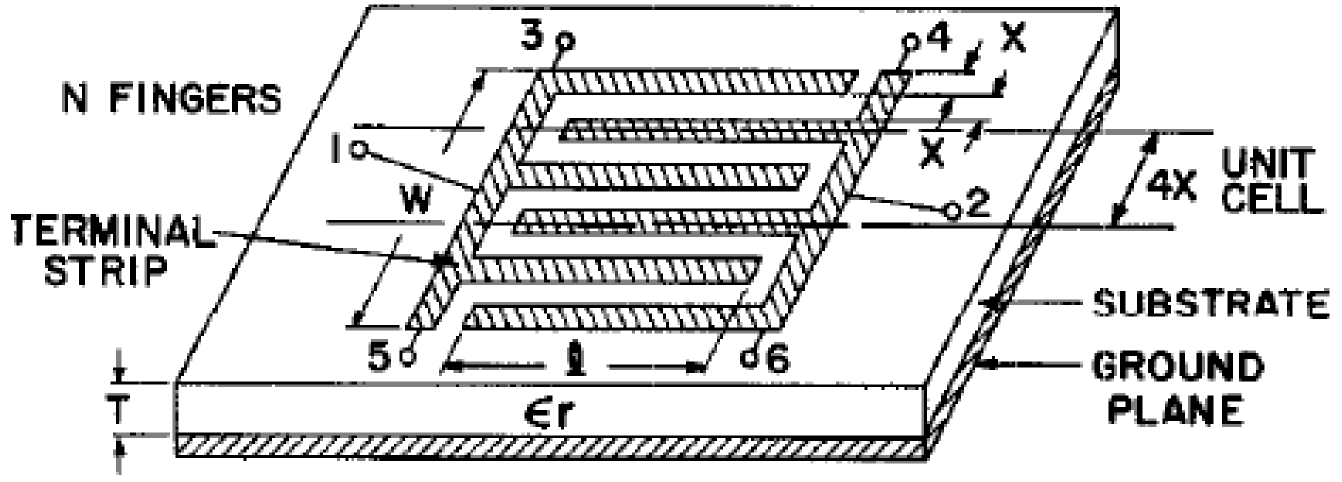
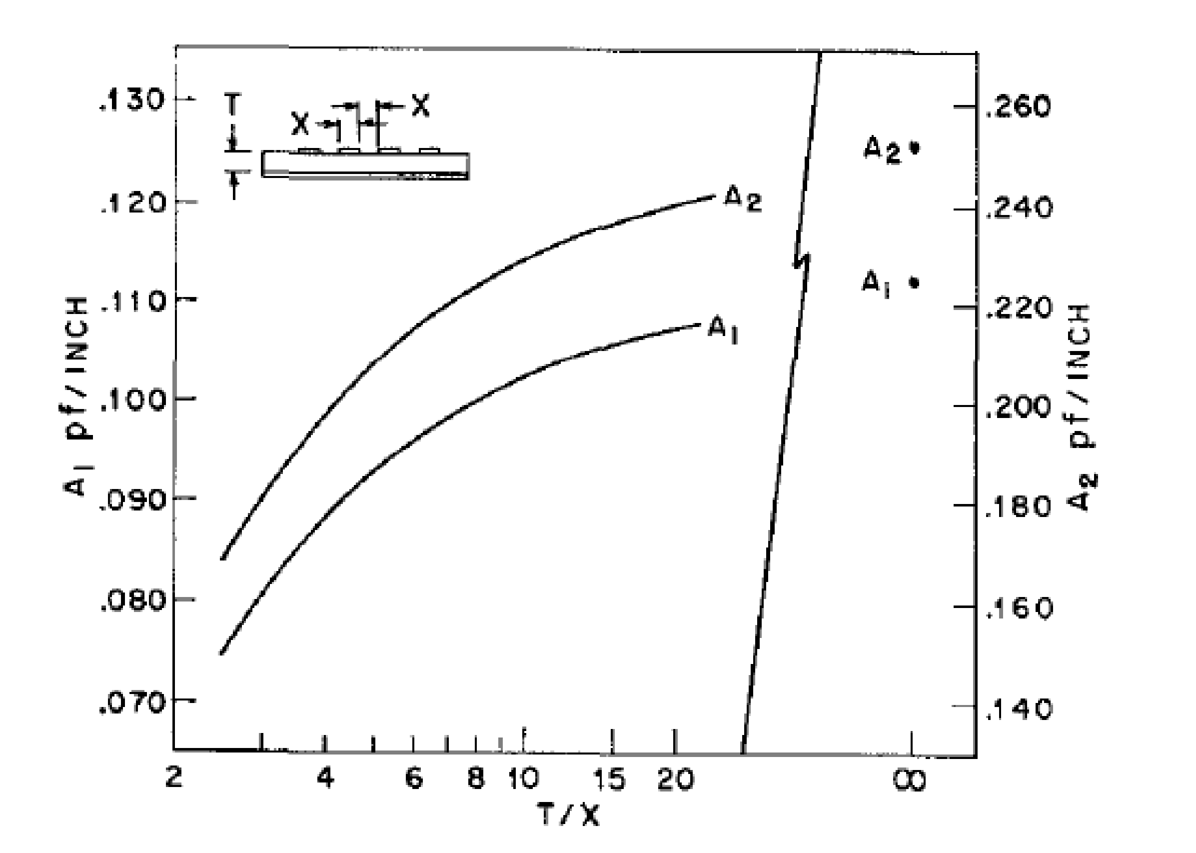


Fig. 1. Interdigital capacitor.

$$C = \frac{\varepsilon_r + 1}{d} \cdot l \cdot [(N-3)A_1 + A_2]\ (pF/in)$$

Valid only When

$$g = x,$$
$$h > \frac{w}{N},$$



Generally, A_1, A_2 can be considered as two constants.

The equations is valid to better than 0.35% for

$$3 \leq \frac{t}{x}$$

For our pattern

$$g = x = 10\mu m$$

$$h > \frac{w}{N} = \frac{5mm}{250} = 0.02mm$$

$$3 \leq \frac{t}{x} = \frac{100nm}{10\mu m} = 0.01$$

and

$$l = 2.4mm,$$

$$N = 250,$$

$$\varepsilon_r = 10,$$

$$A_1 = 0.1111 pF/inch$$

$$A_2 = 0.249 pF/inch$$

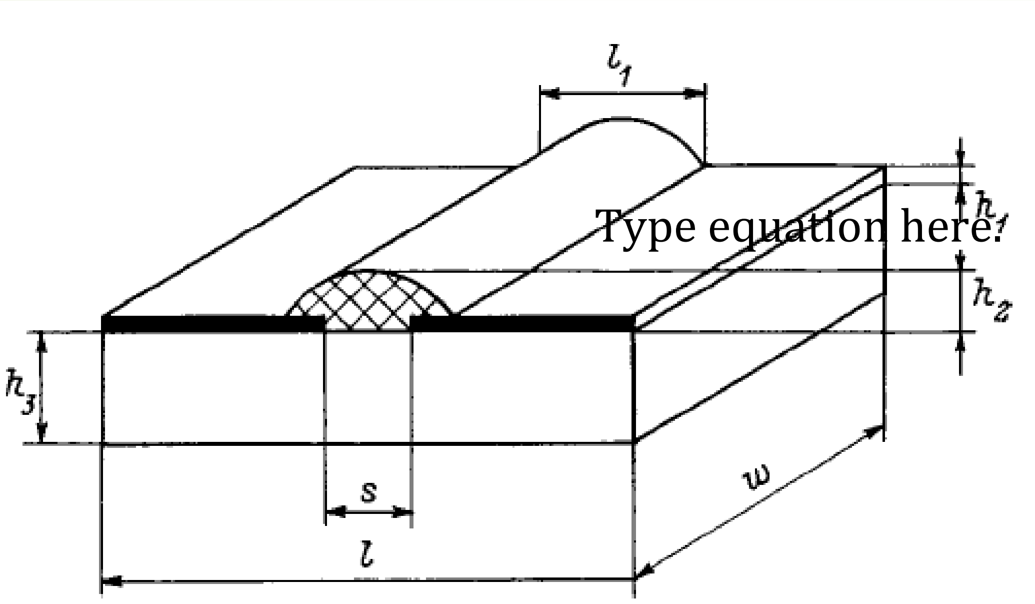
We get

C=146.2069 $pF/inch$

Or,

C=146.2069 $pF/inch$*0.1969in=28.7809pF

Model 2



Type equation here.

$$C = (N-1)\varepsilon_0 w \cdot \left\{ \frac{2}{\pi}\left[\ln\left(\frac{w}{s}\right)+1\right] + \frac{\varepsilon_3 - 1}{\pi}\ln\left(16\frac{h_3+h_2}{\pi s}\right) + \frac{\varepsilon_2 - 1}{\frac{s}{h_2}+\frac{4}{\pi}ln2\sqrt{1+\frac{2\varepsilon_2}{\alpha h_2}}} \right\}$$

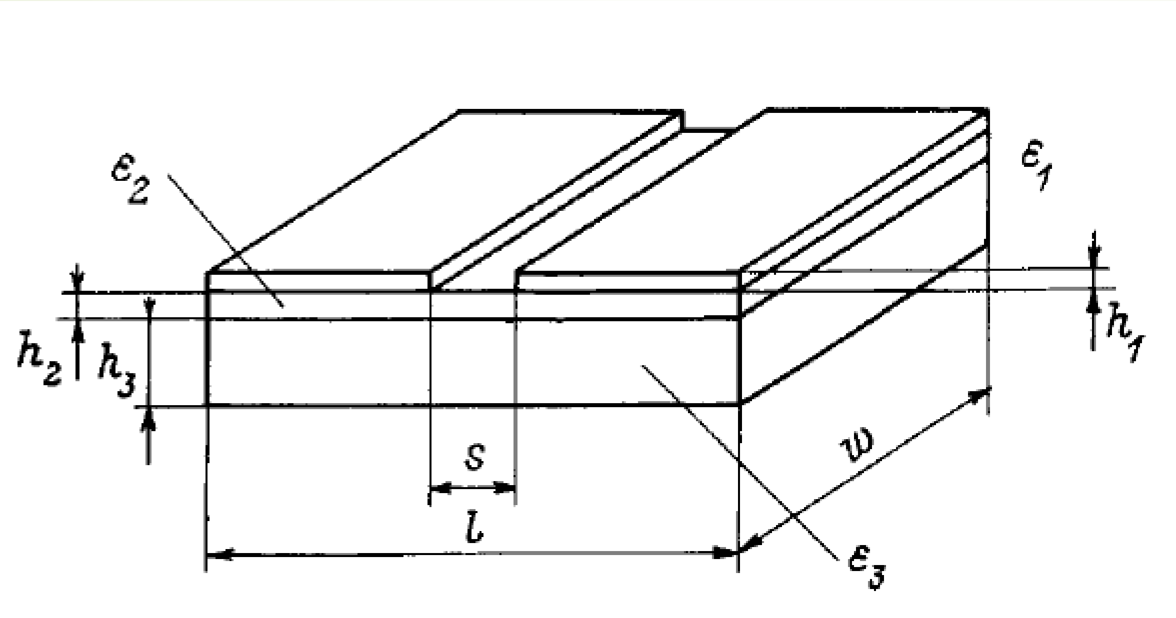
For our pattern

$$g = s = 10\mu m, w = 2.4mm$$
$$h_2 = 100nm, h_3 = 0.5mm$$
$$l = 30\mu m \qquad ,$$
$$N = 250,$$
$$\varepsilon_3 = 10$$
$$\varepsilon_2 = 100$$

We get

C=53.1Pf

Model 3



$$C = (N-1)\varepsilon_0 w \cdot \left\{ \frac{2}{\pi}\ln(4l/s) + \frac{\varepsilon_3 - 1}{\pi}\ln\left(16\frac{h_3 + h_2}{\pi s}\right) + \frac{\varepsilon_2 - 3}{\frac{s}{h_2} + \frac{4}{\pi} ln2\sqrt{1 + \frac{2\varepsilon_2}{\alpha h_2}}} \right\}$$

For our pattern

$$g = s = 10\mu m, w = 2.4mm$$
$$h_2 = 50nm, h_3 = 0.5mm$$
$$l = 30\mu m \quad ,$$
$$N = 250,$$
$$\mathcal{E}_3 = 10$$
$$\mathcal{E}_2 = 100$$

We get

C=44.9Pf

Thanks!