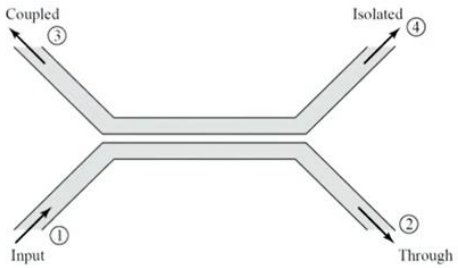
Coupled Line Directional Coupler (CLDC)



For Input at Port 1:

Port 2 is Directly Coupled Port or Through Port

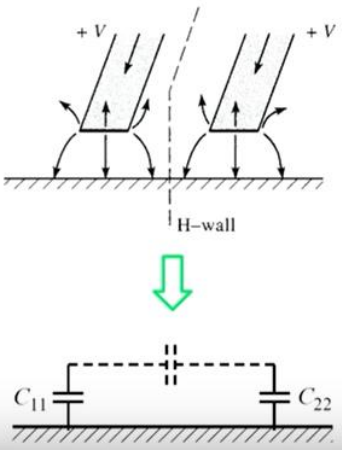
Port 3 is Coupled Port ($|S_{31}|$ may be -10 dB to -30 dB)

Port 4 is Isolated Port ($|S_{41}|$ should be as large as possible)

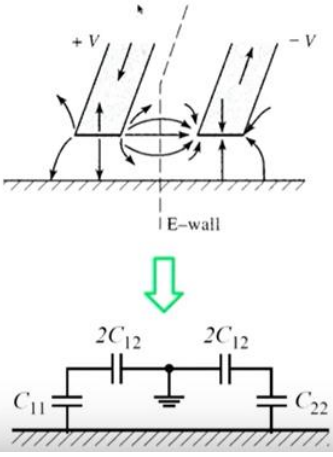
S

CLDC – Even and Odd Modes

Even Mode Excitation



Odd Mode Excitation



CLDC – Analysis and Design

Coupling (C) is maximum for $l = \lambda/4$. For desired C:

$$Z_{0_e} = Z_0 \sqrt{\frac{1+C}{1-C}}$$

$$Z_{0_o} = Z_0 \sqrt{\frac{1-C}{1+C}}$$

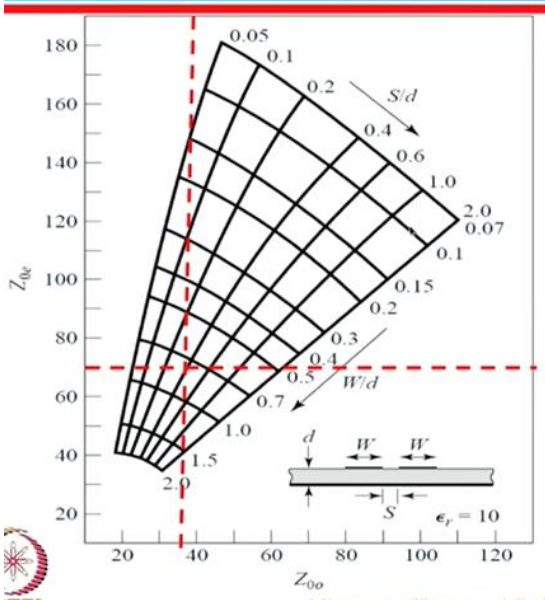
$$Z_0 = \sqrt{Z_{0_e} \times Z_{0_o}}$$

For Z_0 = 50 Ω

Coupling C (dB)	Numeric value of C	Z_{0e} (Ω)	Z_{0o} (Ω)
-6	0.5	86.6	28.9
-10	0.316	69.4	36.0
-20	0.1	55.3	45.2
-30	0.0316	51.6	48.4

Where Z_{0e} and Z_{0o} are even and odd mode characteristic impedances.

Coupled Microstrip Line - Z_{0e} and Z_{0o}



Plot for Z_{0e} and Z_{0o} for $Z_0 = 50\ \Omega$ and $\varepsilon_r = 10$

As s/d increases,

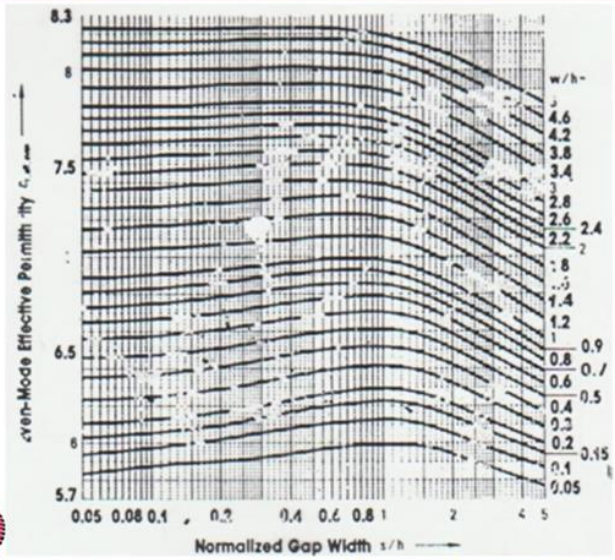
Z_{0e} decreases and Z_{0o} increases

As w/d increases, both Z_{0e} and Z_{0o} decrease.

For 10 dB coupling, $Z_{0e} = 69.4\ \Omega$ and $Z_{0o} = 36\ \Omega$.

From graph: w/d = 0.75 and s/d = 0.4

Coupled Microstrip Line – Even Mode ε_e



Plot for Even Mode ε_e for $\varepsilon_r = 9.6$

As w/h increases, ε_e increases.

As s/h increases, ε_e decreases.

Microstrip Line CLDC (C = – 20 dB)

f = 800 - 1000 MHz

$\varepsilon_r = 4.4$, h = 0.8mm, tanδ = 0.02

Length $l = \lambda/4 = 46$ mm

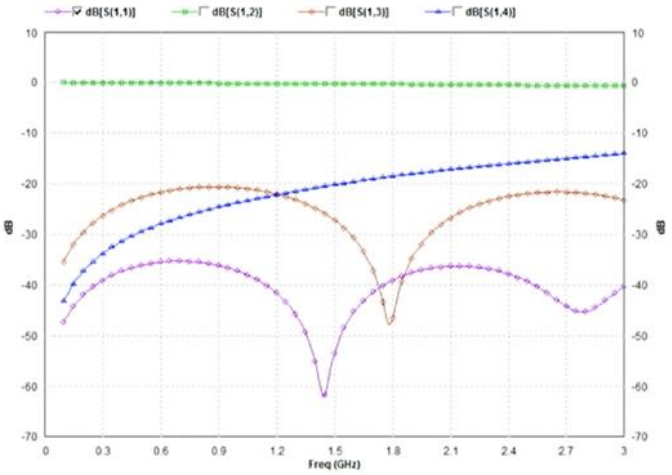
Width = 1.5 mm, Gap = 1 mm

Coupling is max. for $l = \lambda/4$ and $3\lambda/4$ and min. for $l = 2\lambda/4 = \lambda/2$

$|S_{11}| \leq$ -35 dB

$|S_{21}| \approx$ -0.2 dB

$|S_{31}| = C \approx$ - 20.6 dB



$|S_{41}| = I = -23$ dB at 900 MHz. Directivity = |C – I| is very poor.