Coupled-Line Couplers

Two transmission lines in **proximity** to each other will **couple** power from one line into another.

This proximity will **modify** the electromagnetic fields (and thus modify voltages and currents) of the propagating wave, and therefore **alter** the **characteristic impedance** of the transmission line!

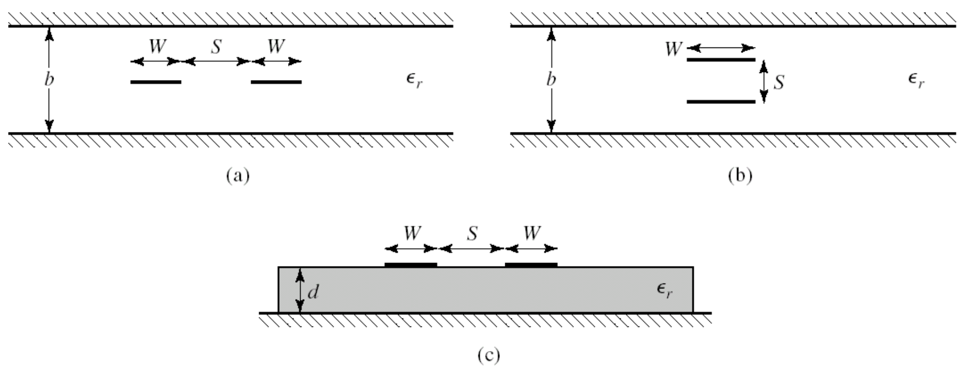


Figure 7.26 (p. 337)
Various coupled transmission line geometries. (a) Coupled stripline (planar, or edge-coupled). (b) Coupled stripline (stacked, or broadside-coupled). (c) Coupled microstrip.

Generally, speaking, we find that this transmission lines are **capacitively coupled** (i.e., it appears that they are connected by a capacitor):

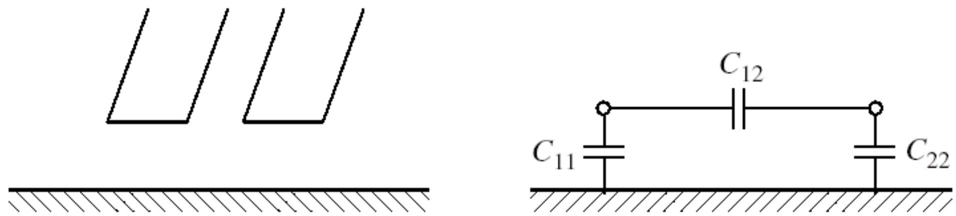
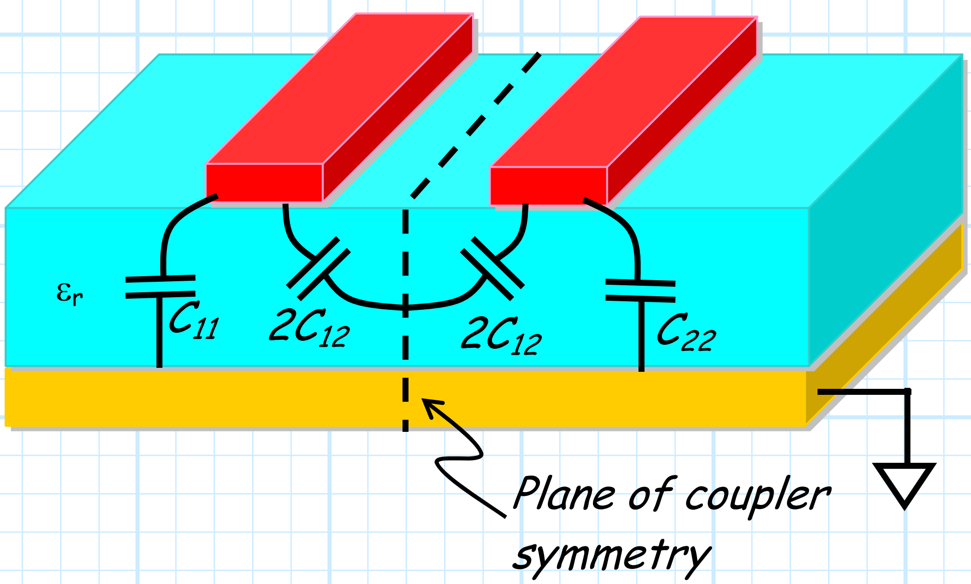


Figure 7.27 (p. 337)
A three-wire coupled transmission line and its equivalent capacitance network.

If the two transmission lines are **identical** (and they typically are), then $C_{11} = C_{22}$.

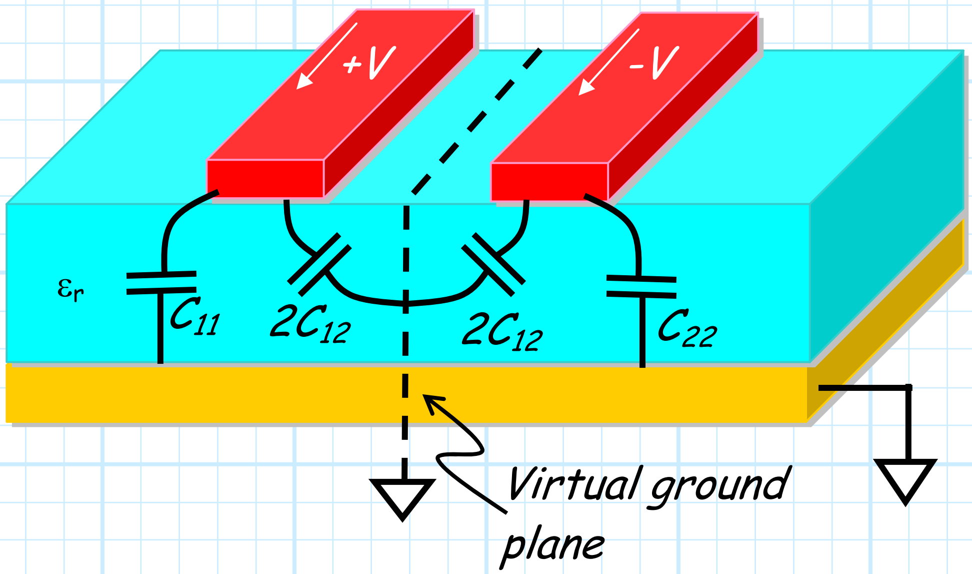
Likewise, if the two transmission lines are identical, then a plane of circuit **symmetry** exists. As a result, we can analyze this circuit using **odd/even mode** analysis!



Note we have divided the C_{12} capacitor into **two series** capacitors, each with at value 2 C_{12}.

Odd Mode

If the incident wave along the two transmission lines are **opposite** (i.e., equal magnitude but 180° out of phase), then a virtual **ground plane** is created at the plane of circuit symmetry.



Thus, the capacitance per unit length of each transmission line, in the **odd** mode, is thus:

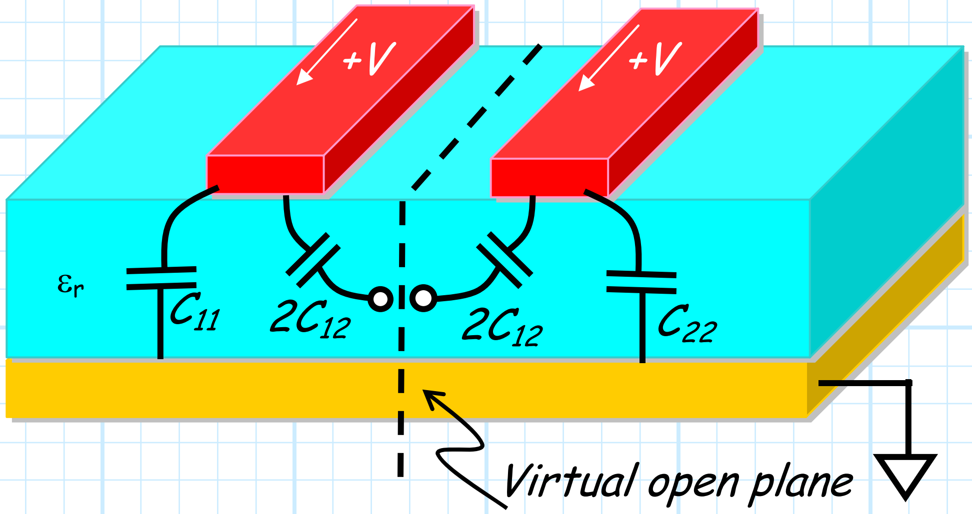
$$C_o = C_{11} + 2C_{12} = C_{22} + 2C_{12}$$

and thus its characteristic impedance is:

$$Z_0^o = \sqrt{\frac{L}{C_o}}$$

Even Mode

If the incident wave along the two transmission lines are **equal** (i.e., equal magnitude and phase), then a **virtual open** plane is created at the plane of circuit symmetry.



Note the $2C_{12}$ capacitors have been "**disconnected**", and thus the capacitance per unit length of each transmission line, in the **even** mode, is thus:

$$C_e = C_{11} = C_{22}$$

and thus its characteristic impedance is:

$$Z_0^e = \sqrt{\frac{L}{C_e}}$$