7.2 – The T-Junction Power Divider

Reading Assignment: *pp. 315-318*

Three-port couplers are also known as T-**Junction** Couplers, or T-Junction Dividers.

HO: THE T-JUNCTION COUPLER

We will study **three** standard T-Junction couplers:

HO: THE RESISTIVE DIVIDER

HO: THE LOSSLESS DIVIDER

HO: CIRCULATORS

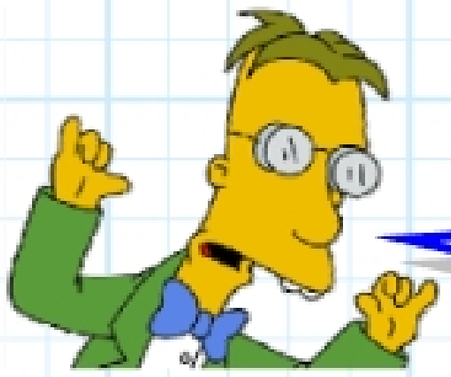
Now let's consider a 3dB power divider from another viewpoint; let's consider the **scattering matrix** of a (nearly) **ideal** 3dB power divider.

HO: THE (NEARLY) IDEAL POWER DIVIDER

This ideal 3dB power divider **can** be constructed! It is the **Wilkinson Power Divider**—the subject of the next section.

The T-Junction Coupler

Say we desire a **matched** and **lossless** 3-port coupler.



*Wait a minute! I already told you that a matched, lossless, reciprocal **3-port** device of **any** kind is a **physical impossibility**!*

Absolutely true! Our desire in this case will be **unfulfilled**. There are, however, a few designs that come **close**.

1. **The Lossless Divider** – As the name states, this coupler is lossless. It is likewise reciprocal, and thus is **not matched**.

2. **The Resistive Divider** – As the name implies, this coupler **is lossy**. However, it is both matched and reciprocal.

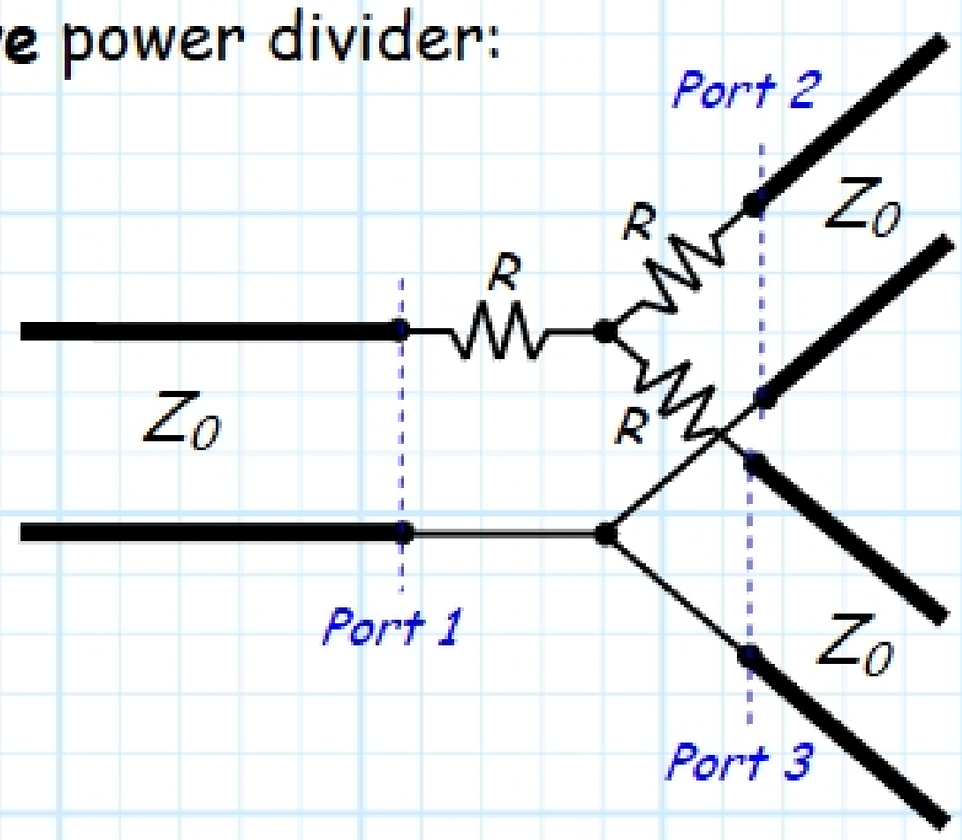
3. **The Circulator** – This three-port coupler is both matched and (ideally) lossy. This of course means that it is **not reciprocal**!

4. **The Wilkinson Divider** - Like the resistive divider, it is matched and reciprocal, and thus **is lossy**. However, it is lossy in a way that is not apparent when power is **divided** (i.e., power can be divided **without loss**).

As a result, the Wilkinson Power Divider is in most ways as **ideal** a T-junction as there is. Accordingly, it has its very **own section** in your textbook!

The Resistive Divider

Consider the **resistive** power divider:

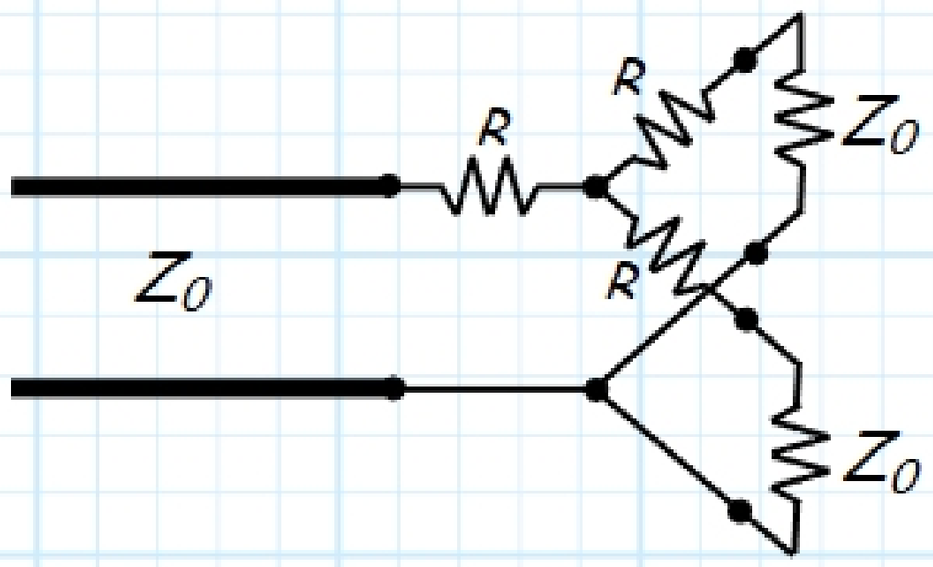


This symmetric power divider will be matched at port 1 **if** R is selected as:

$$Z_0 = R + (R + Z_0) \| (R + Z_0)$$

$$= R + \frac{R + Z_0}{2}$$

$$= 1.5R + \frac{Z_0}{2}$$



Solving this equation, we find that port 1 is matched **if**:

$$R = \frac{Z_0}{3}$$