

## D. Antenna Impedance

An antenna, like any other microwave device, has an **input impedance**. Although there are typically **no** resistors used antenna designs, an antenna impedance better have a **real** (resistive) component!

### HO: Antenna Impedance

Antenna resistance has two components; the most important of which is the **radiation resistance**.

### HO: Radiation Resistance

Given that antennas are **not** perfectly efficient, we find that a more useful, applicable, and measurable parameter than directivity is **antenna gain**.

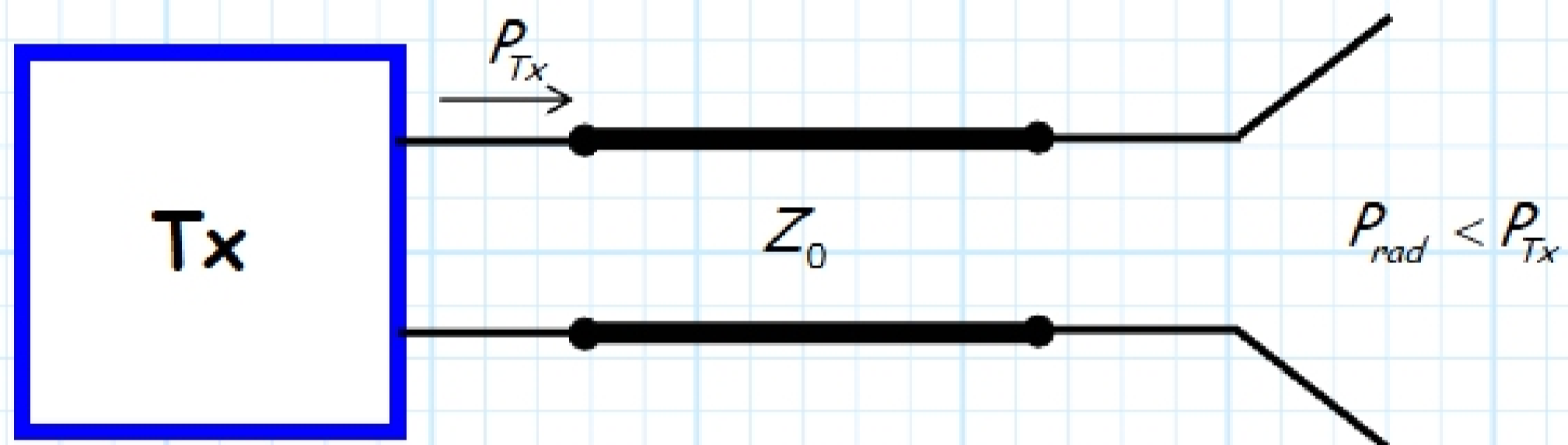
### HO: Antenna Gain

# Antenna Impedance

**Q:** *Is the radiated power equal to the available power ( $P_{Tx}$ ) of the transmitter?*

**A:** **Ideally** it is! If  $P_{rad} \neq P_{Tx}$ , then some power is being wasted. However, the **perfectly** ideal case of  $P_{rad} = P_{Tx}$  is **not** possible.

As a result, we find that  $P_{rad}$  will always be less (at least a little) than the available power  $P_{Tx}$ . However, we find for well-designed antenna that  $P_{rad}$  will be very close to available power  $P_{Tx}$ .



**Q:** *Why isn't the radiated power equal to the available power of the transmitter? What happens to this available power?*

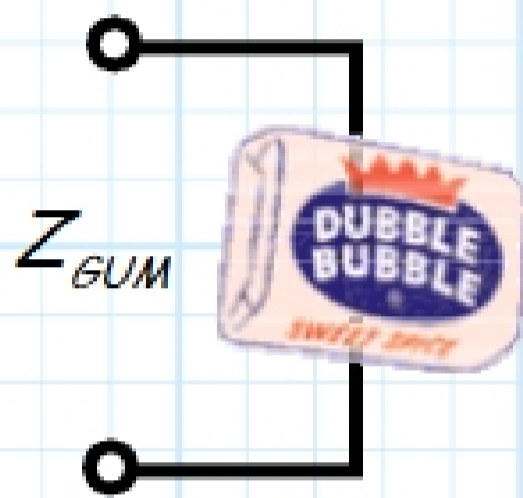
**A:** One of two things, either:

1. Power is **reflected** at the antenna.
2. Power is turned to heat in a **lossy** antenna.

Let's consider the **first** phenomenon first.

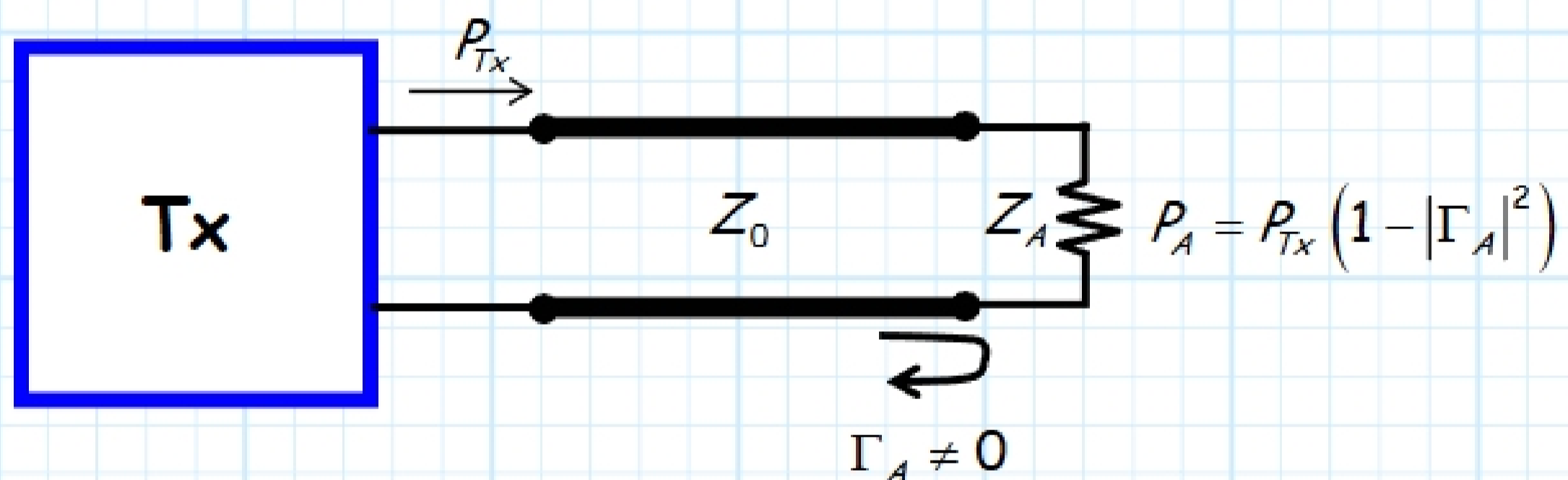
Power is **reflected** at the antenna if the antenna impedance  $Z_A$  is **not matched** to the transmission line.

**Q:** *Antenna impedance? Does an antenna have an impedance?*



**A:** An antenna is a one-port device—**every** one-port device has an impedance!

The antenna impedance acts as the **load** at the end of a transmission line. If  $Z_A \neq Z_0$ , then power will be **reflected**, and the power delivered to the antenna ( $P_A$ ) will be **less** than the transmitter available power:



Thus, **all** the available power is delivered to the antenna **only** if its impedance is:

$$Z_A = Z_0 \Rightarrow \Gamma_A = 0$$

**Q:** *Huh?? Characteristic impedance is a **real** value. If  $Z_A = Z_0$ , then the antenna impedance is purely resistive. Wouldn't a resistor make a particularly **bad** antenna?*