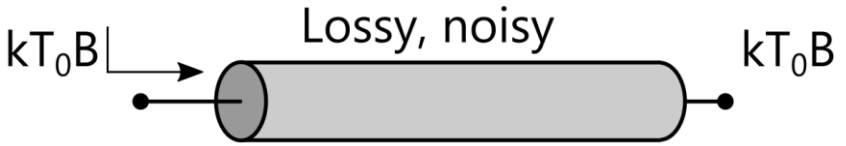
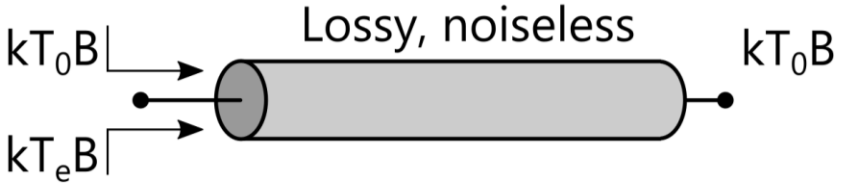
Noise temperature of an attenuator

- Consider a piece of cable (**loss L**) at rest at room **temperature T_0**
- We will only consider a finite frequency **bandwidth B**
- The noise (AWGN) that is present at the cable input has a power of kT_0B
- The cable introduces its own noise, for the signals traveling from the input to the output. This noise can be described with an **equivalent noise temperature T_e**. This temperature is not physical – it cannot be measured. To quantify this added noise, the analysis procedure is the following:
  - We fictionally remove the noise added in the cable, and place an **equivalent noise source at the input!**
  - The attenuation (loss) of the cable is preserved, but it does not introduce any noise
- **Key point**: Since all cable parts are at room temperature, the output noise must also be equal to kT_0B in both cases!

(a)



(b)



- When the input noise (external + equivalent) passes through the cable, it is attenuated by the loss *L*, and we get:

$$\frac{kT_0B}{L} + \frac{kT_eB}{L} = kT_0B$$

- After several simple steps we get:

$$T_0 + T_e = LT_0 \quad \Rightarrow \quad \boxed{T_e = (L-1)T_0}$$

[1] John A. Richards, Radio Wave Propagation, Springer, 2008. section 5.7. pp. 62.
https://link.springer.com/content/pdf/10.1007%2F978-3-540-77125-8.pdf