

First-Order Response

Mechanical Engineering

One time constant describes the whole step response, landmarks and all.

A first-order system answers a step with an exponential set by one number: its time constant.

$$G(s) = K \div (\tau s + 1) \cdot \text{settling} \approx 4\tau$$

At one time constant

The definition of τ .

63.2% of the way

At three time constants

Often called settled.

95% of the way

At five time constants

Practically there.

99.3% of the way

THE COMMON MISTAKE

✗ **Reading τ as the time to reach the final value**

✓ **τ is the 63.2% time**

The exponential never actually reaches its final value. Settling is always defined against a stated band, usually 2% or 5%.

The final value is K times the step size. Identify τ from a step test rather than from the data sheet.