# The main functions of an AVR
## Automatic Voltage Regulator

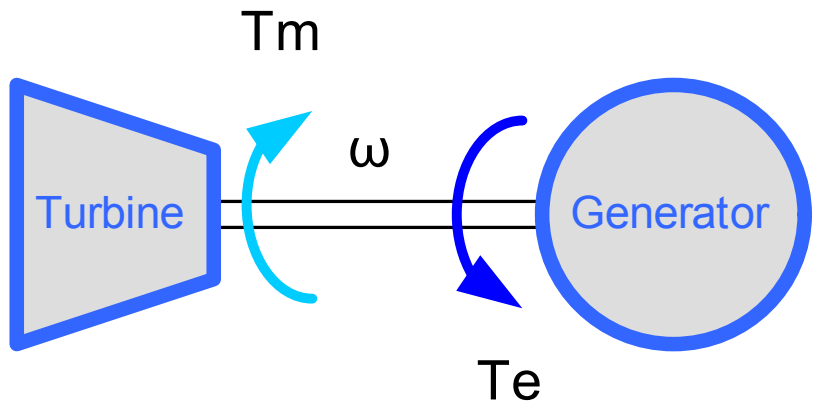
State-of-the-art excitation systems are equipped with fast acting voltage regulators:

- **Advantages:**
  - Fast acting voltage control and reactive power support
  - Providing synchronizing torque component
- **Disadvantage:**
  - Introducing negative damping torque component

- **Solution** to the reduced damping torque problem
  - Power System Stabilizers

# Model of a single Generator connected to Grid

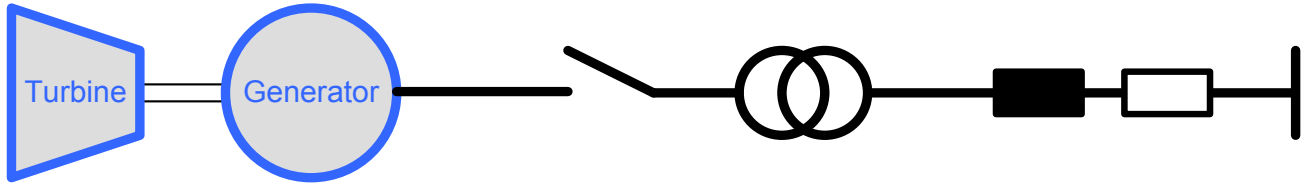
## Turbine and Generator Mechanics




| | |
|---|---|
| Turbine driving torque | Tm |
| Generator braking torque | Te |
| Mechanical rotational speed | ω |

# Model of a single Generator connected to Grid

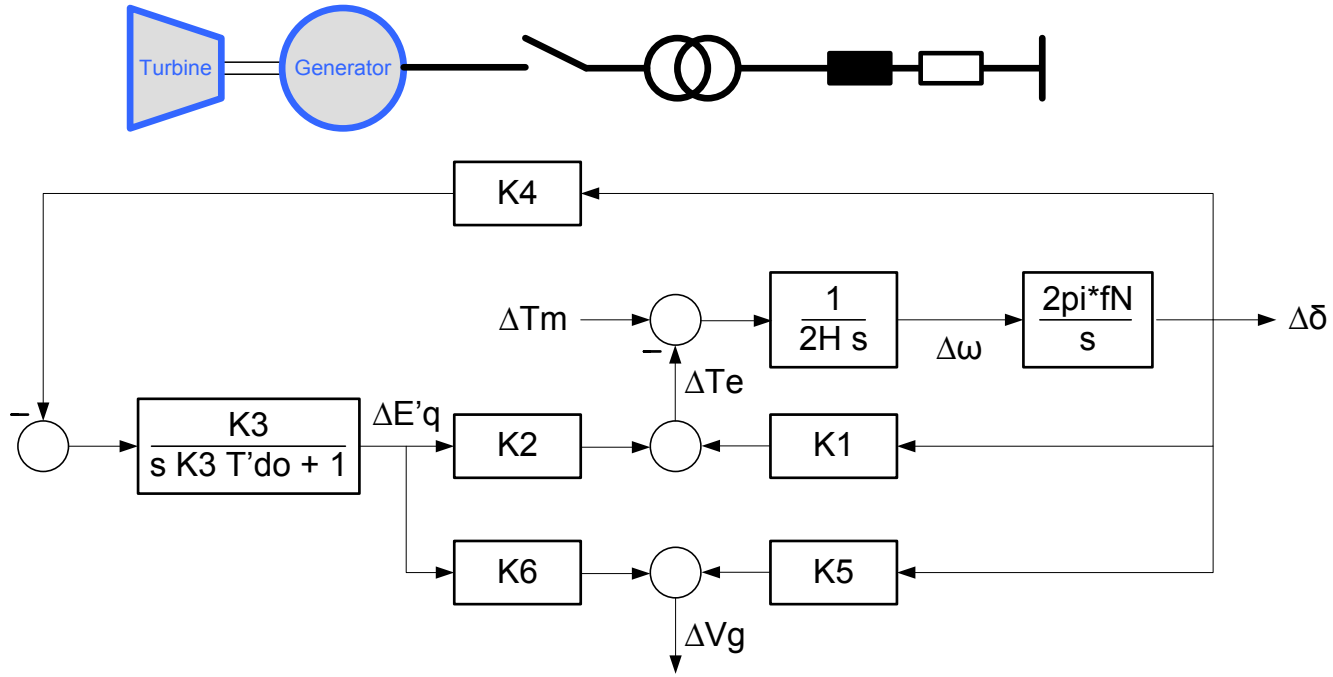
## Turbine and Generator Connection to Grid




Turbine + Generator
Generator breaker
Step-up transformer
Transmission line
Infinite bus (constant voltage)

# Model of a single Generator connected to Grid

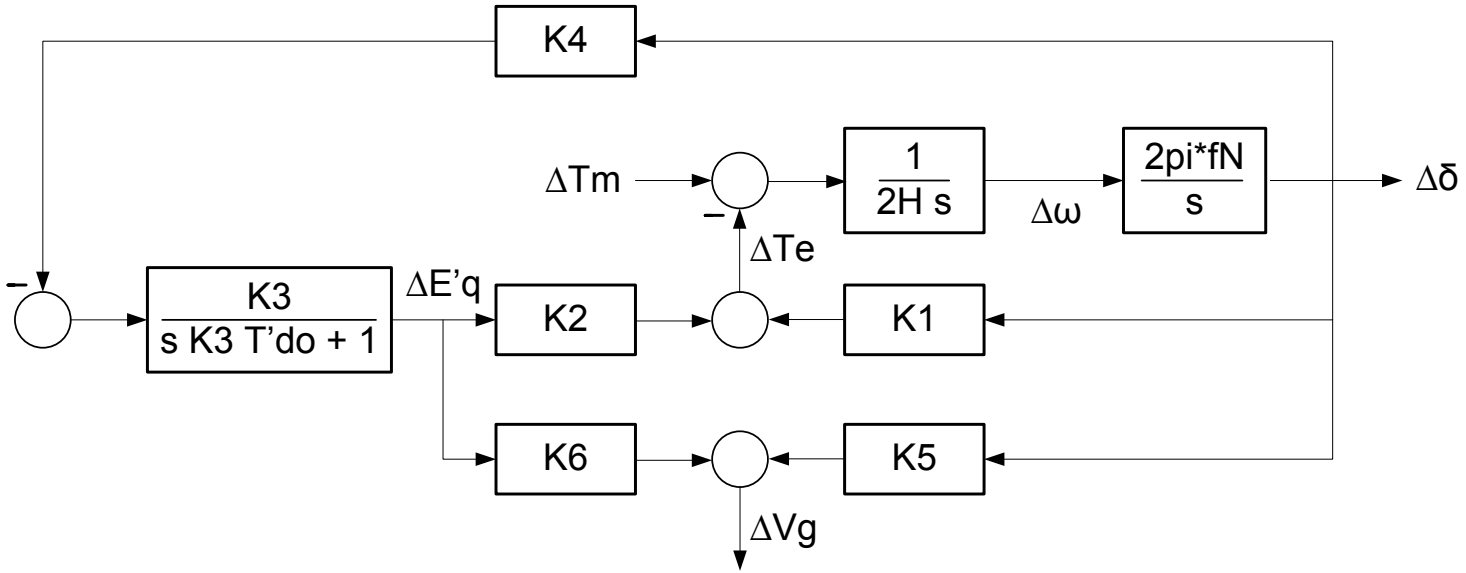
## Turbine and Generator connected to Grid




A single generator connected to a large grid can be represented by the Phillips-Heffron model
(assuming constant field voltage and mechanical torque)

# Model of a single Generator connected to Grid

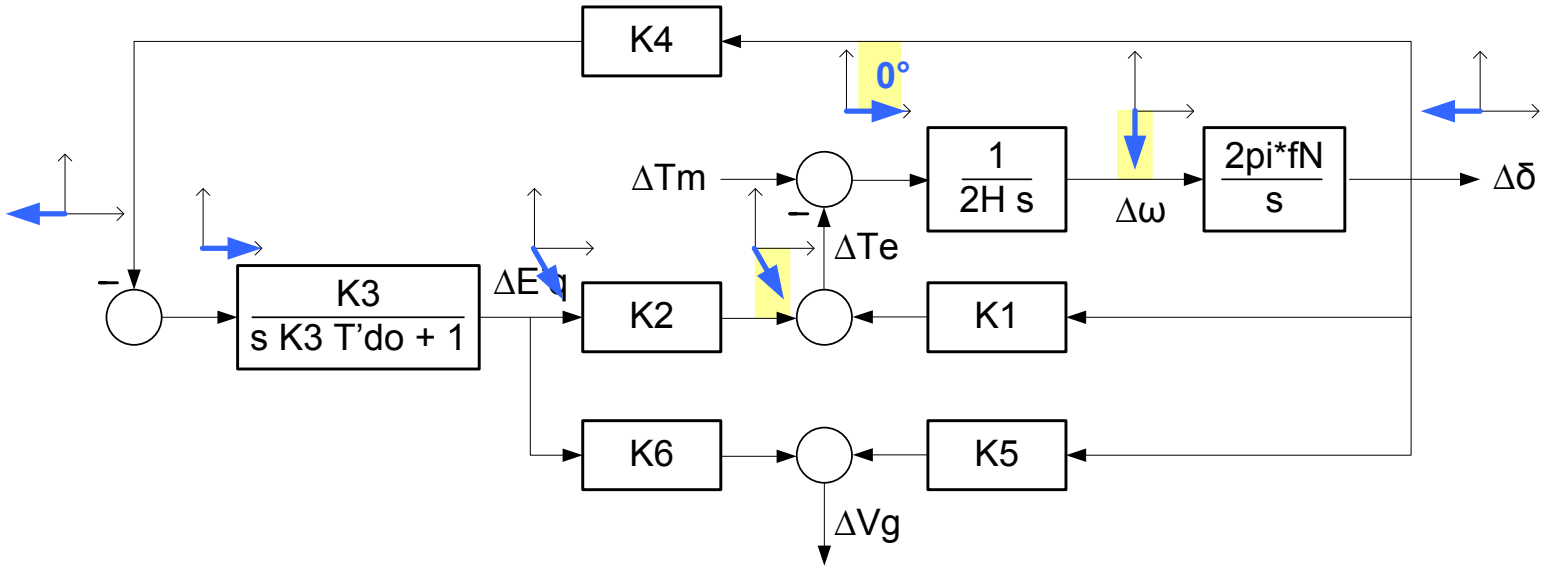
## Linearized Model at certain Operating Point




A single generator connected to a large grid can be represented by the Phillips-Heffron model
(assuming constant field voltage and mechanical torque)

# Model of a single Generator connected to Grid

## Torque Disturbance Impact



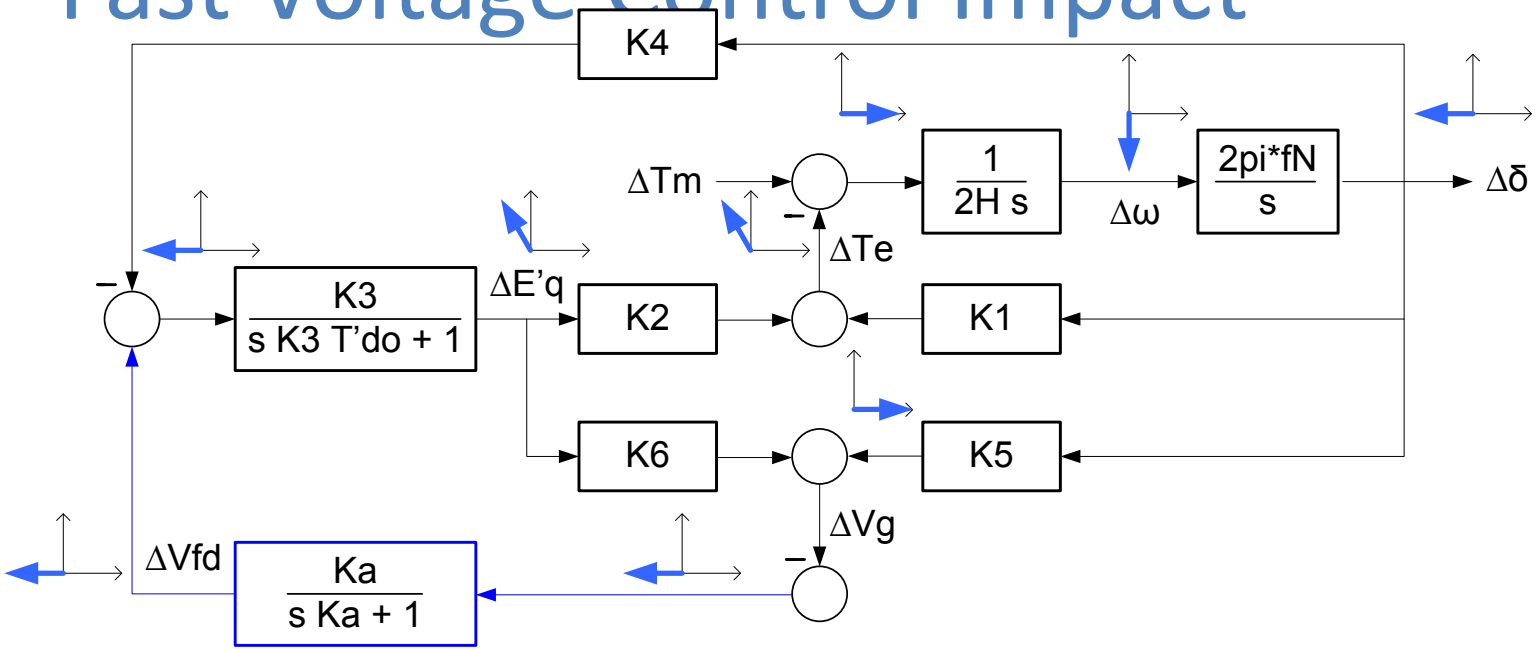

Harmonic Phasor Representation

Torque equilibrium disturbance

Electric torque produces natural positive damping

# Model of a single Generator connected to Grid

## Fast Voltage Control Impact



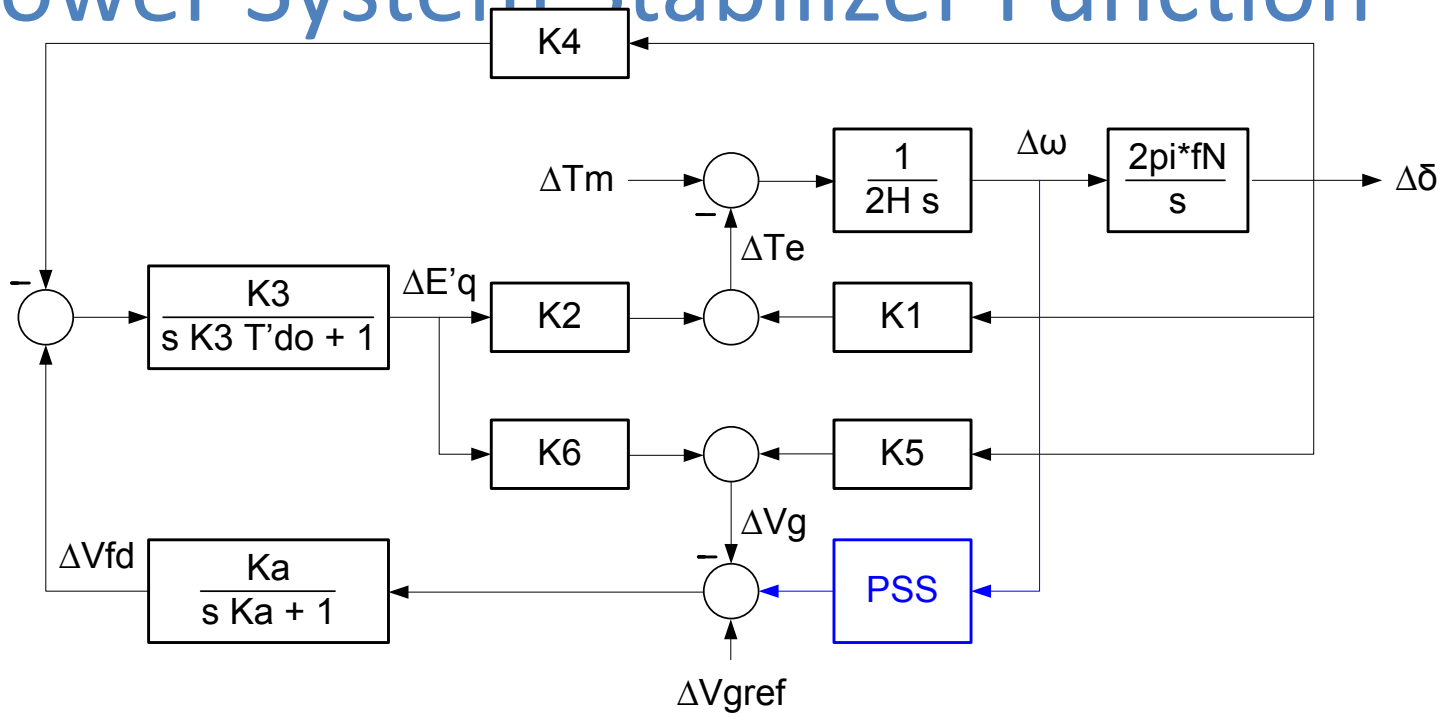

Harmonic Phasor Representation Generator plus AVR

Electric torque form AVR function produces

negative damping torque

# Model of a single Generator connected to Grid

## Power System Stabilizer Function




Power System Stabilizer (PSS)

- Band limited damping torque contribution
- Speed estimator from electrical voltage and current signals