

Induction Motor Simulations in Different Reference Frames and Model Reductions

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Examine the effects of varying system frequency on simulated motor frequency and power

Create driving waveform

- Frequency ramp down/up

Calculate driving voltage

- Stationary reference frame
- Fixed 60 Hz reference frame
- System frequency reference frame

Simulations

Simulate detailed model equations (in Krause text)

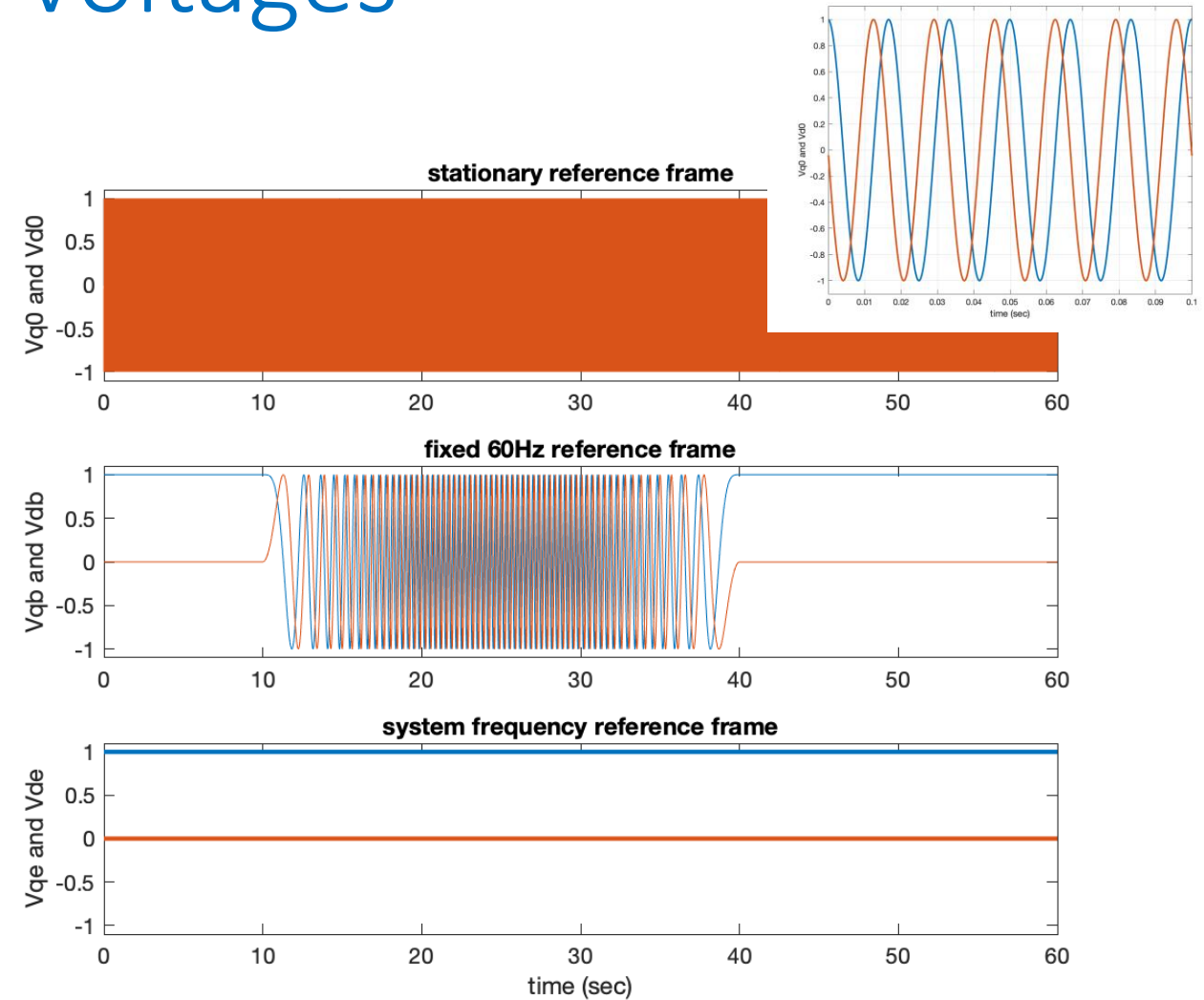
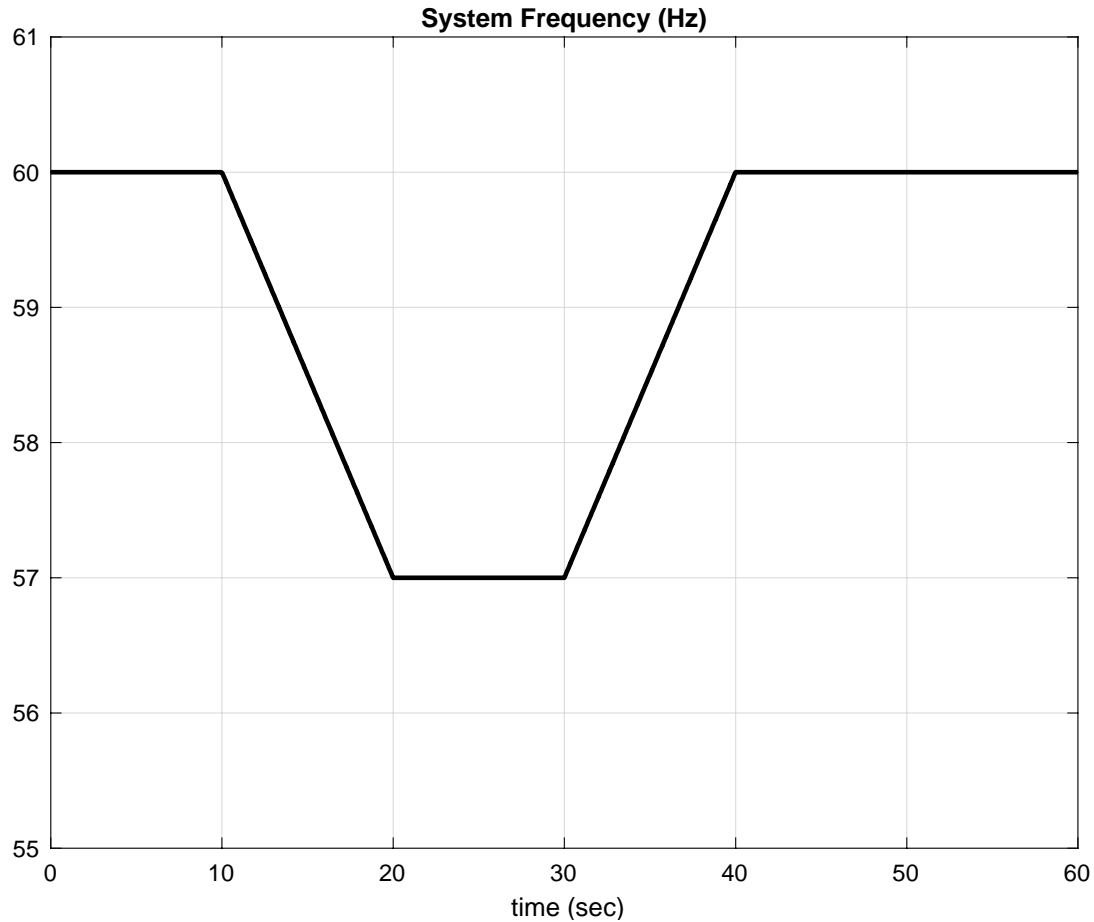
- Stationary reference frame
- Fixed 60 Hz reference frame
- System frequency reference frame

Observe calculated values, in particular

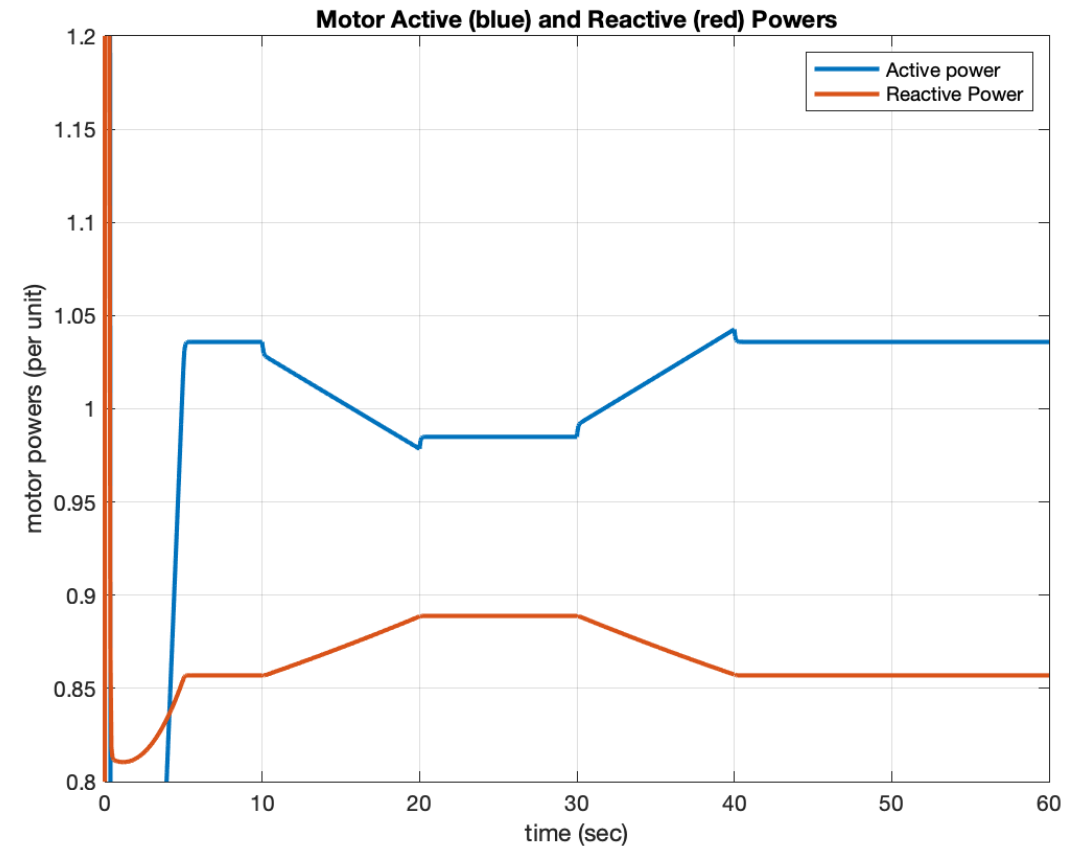
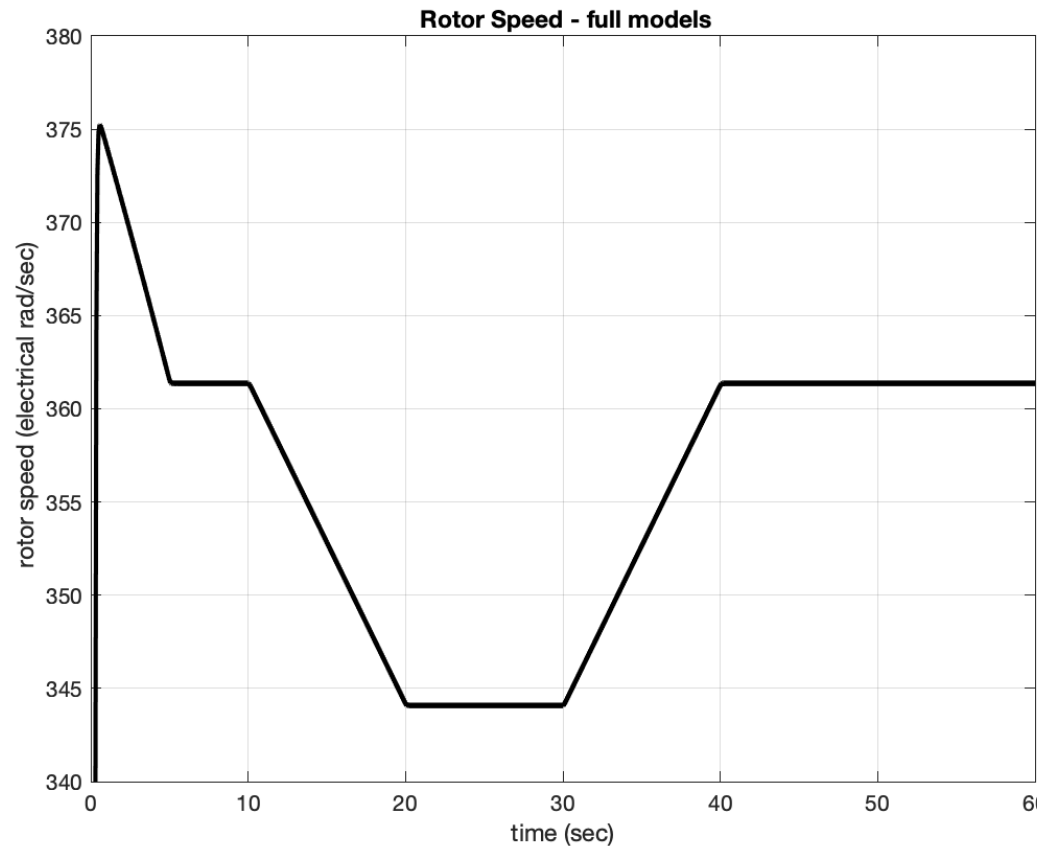
- Rotor speed
- Machine power

The simulation results should be independent of reference frame

Applied frequency and Voltages



Simulated Rotor Speed, Active and Reactive Powers

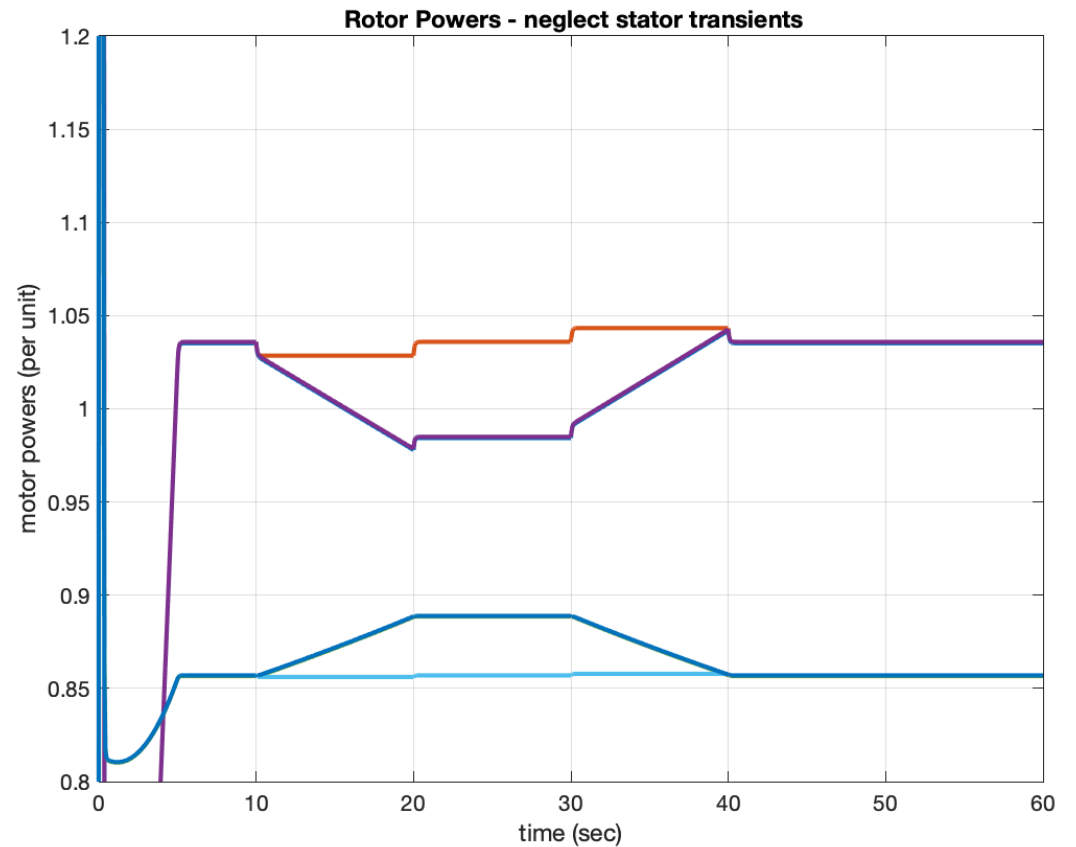
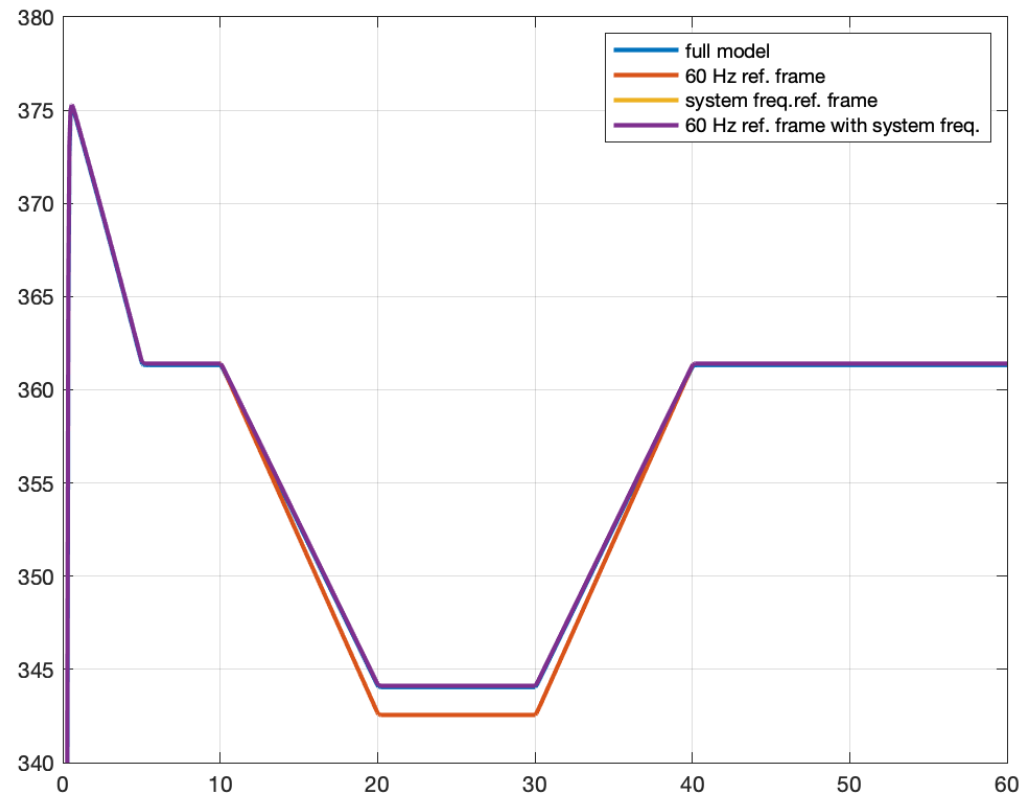


Reduced-Order Models

- Neglect Stator Transients by neglecting derivative terms (or more properly by applying singular perturbation technique).
- Compare 4 models:
 1. Full Model, no reductions, for reference
 2. Neglect Stator Transients, fixed 60 Hz reference frame
 3. Neglect Stator Transients, system frequency reference frame
 4. Hybrid. Equations and driving voltage from fixed 60 Hz reference frame, stator algebraic equations use system frequency instead.

Result: All simulations work well except the fixed 60 Hz reference frame.

Neglect Stator Transients



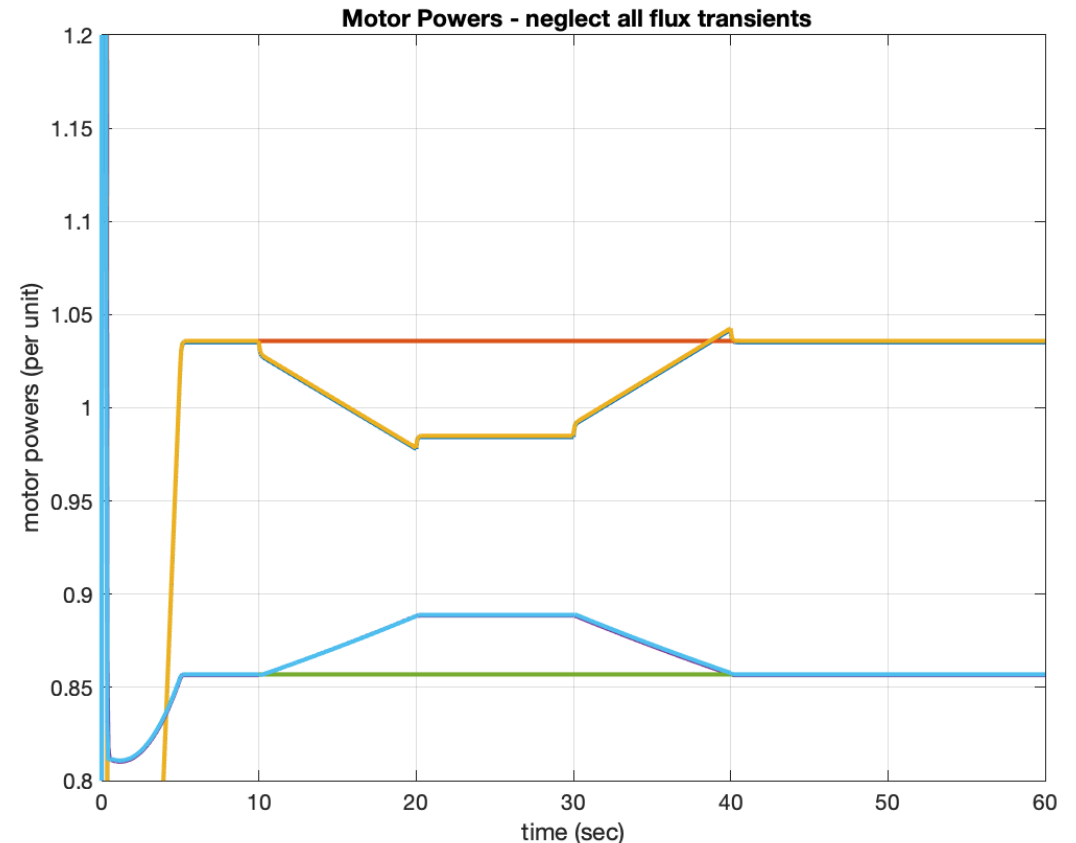
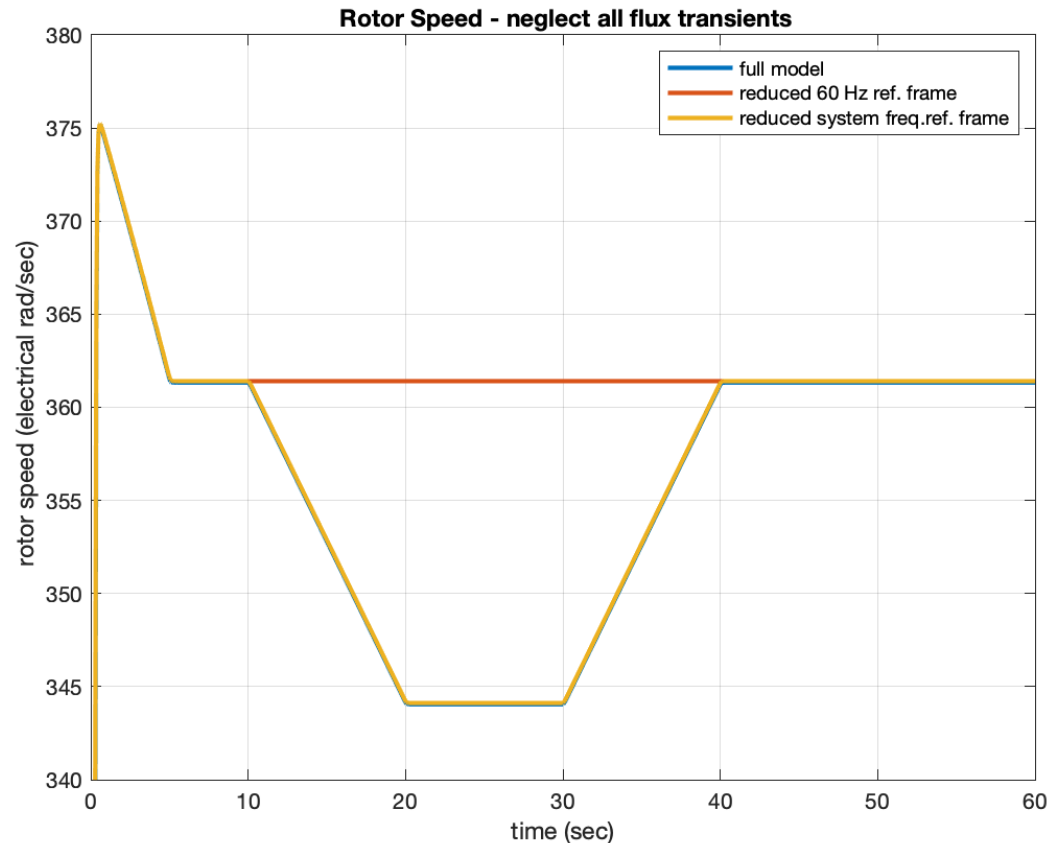
Result: All simulations work well except the fixed 60 Hz reference frame.

Reduced-Order Models

- Neglect **all flux transients** by neglecting derivative terms (singular perturbation techniques questionable).
- Compare 4 models:
 1. Full Model, no reductions, for reference
 2. Neglect Stator Transients, fixed 60 Hz reference frame
 3. Neglect Stator Transients, system frequency reference frame
 4. Hybrid. Equations and driving voltage from fixed 60 Hz reference frame, stator equations use system frequency instead.

Result: All simulations work well except the fixed 60 Hz reference frame.

Neglect All Flux Transients



Result: All simulations work well except the fixed 60 Hz reference frame. Note that the disturbances were not fast, rotor flux dynamics could be important for other events.