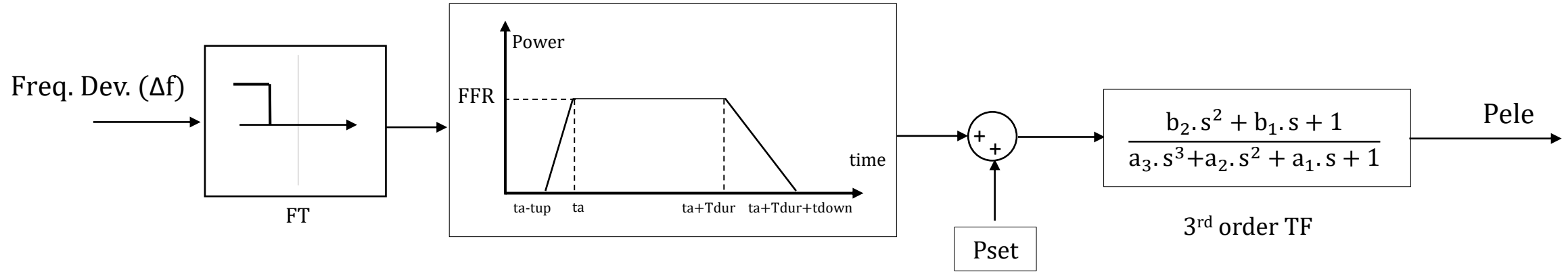


Alqueva – Variable speed model for FFR (with and without SPPS)

Block Diagram for FFR provision



Alqueva – Variable speed model for FFR (with and without SPPS)

Model's input signals, output signals and parameters

Input signals:

- Δf – grid frequency deviation from setpoint, given by $f_{\text{grid}} - f_{\text{set}}$ (p.u.)
- P_{set} – active power setpoint (p.u.)

Output signals:

- P_{ele} – electrical active power (p.u.)

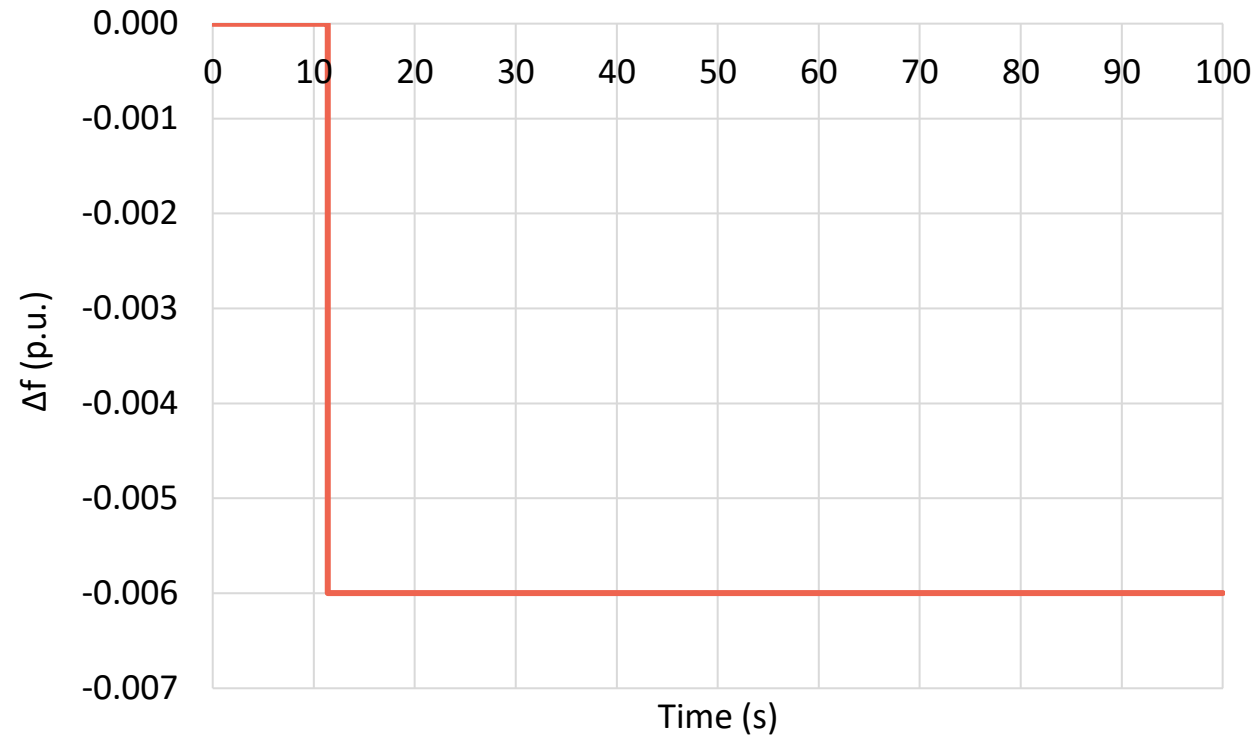
Parameters:

- FT – frequency deviation threshold (p.u.)
- FFR – FFR capacity (p.u.)
- t_a – full activation time (s)
- T_{dur} – support duration time (s)
- a_1, a_2, a_3, b_1, b_2 – 3rd order transfer function parameters
- t_{up} – Ramp up time (s)
- t_{down} – Ramp down time (s)

Alqueva – Variable speed model for FFR (with and without SPPS)

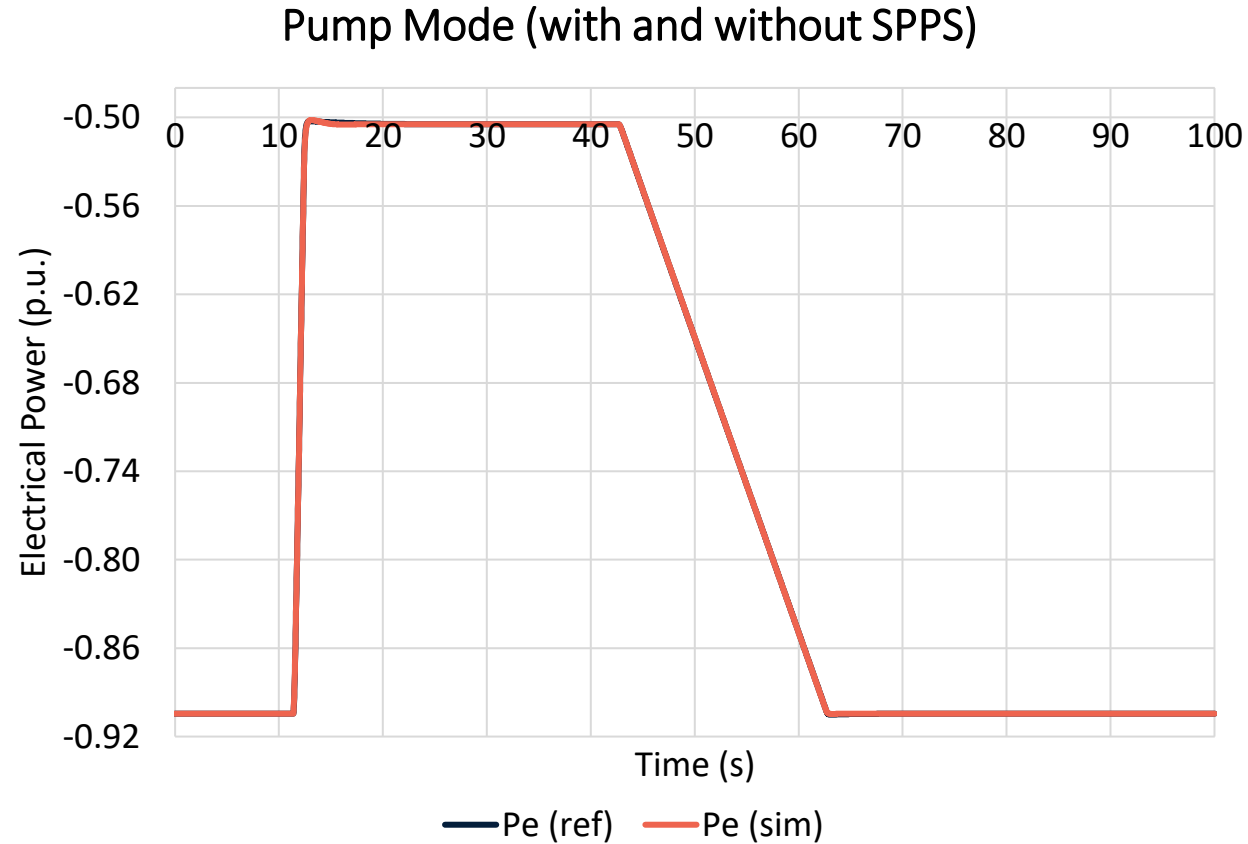
FFR input signal

FFR input signal: frequency deviation step from 0 to -300 mHz



Alqueva – Variable speed model for FFR (with and without SPPS)

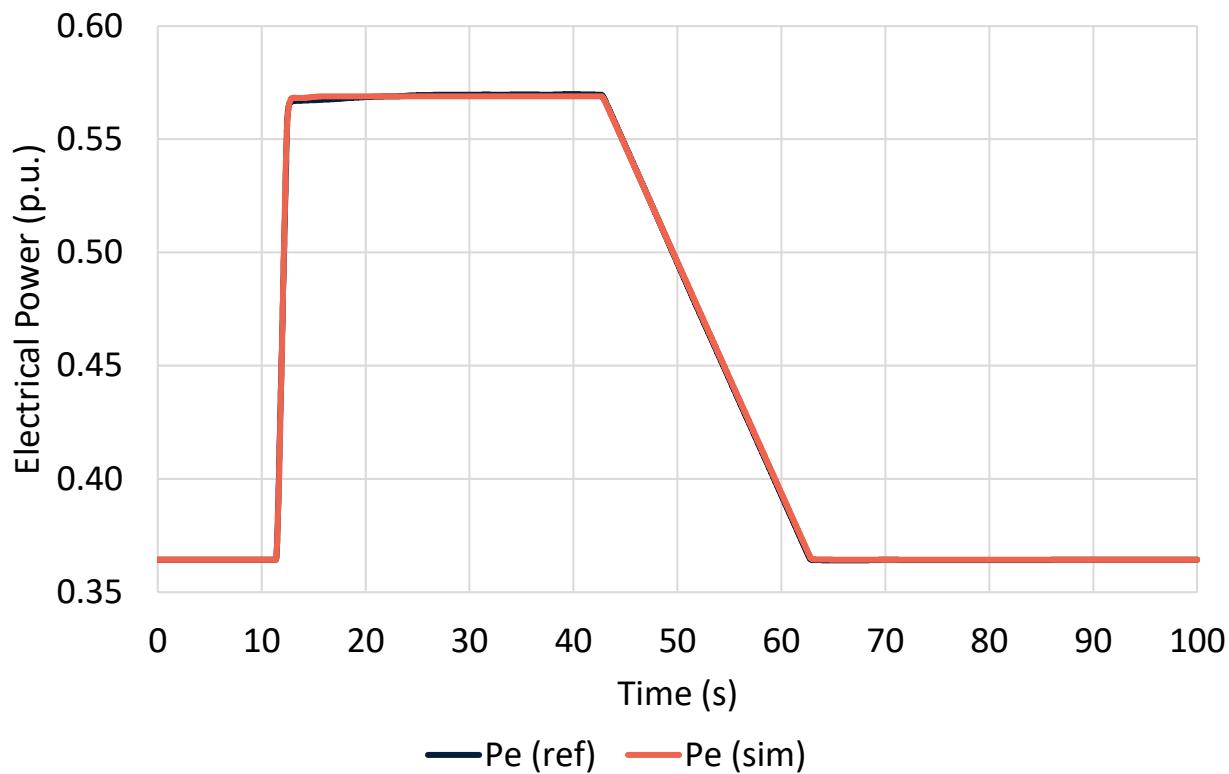
FFR service provision



Alqueva – Variable speed model for FFR (with and without SPPS)

FFR service provision

Turbine Mode (without SPPS)



Turbine Mode (with SPPS)

