Effiziente Reglerentwicklung für leistungselektronische Anwendungen

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System Design of a DC Power Supply

AC  Fuse  EMI filter  Rectifier  Power Factor Correction Preregulator  DC-DC Converter  DC  DC-Link

Supervisory Logic  PWM Generators  Controllers  Filters  ADCs  Sensors

EMI filter  Rectifier  Power Factor Correction Preregulator  DC-DC Converter  DC-Link
Design Challenges

- Complex system with several feedback loops
- Mutual influences from electronics and controls

- Control and plant model in one environment enables
  - System simulation for behavioral analysis
  - Design of control strategies

- Classical control design based on linearized plant model
Linearization Concepts

- Plant modeled as Simulink Blockdiagram (based on ODEs)
  - Relatively simple to linearize
  - Hard to describe a complex electronic circuit

- Plant modeled as schematic (SimPowerSystems)
  - Much more intuitive to model
  - Linearization with tool support

Challenge is the switching behavior of Power Electronics
Averaging switching behavior

- Average Model without switching is necessary for control design
- Manual derivation is often difficult
- Use System Identification Methods to get a linearized description with average behavior for specific operating point
- Apply uncorrelated random sequences or step function on input
- Sample rate is PWM frequency to average the switching behavior on output

Random Stimuli
- DutyCycle
- Load
- Input Voltage

Plant

Averaged Outputs

Linearized Description
Plant Identification from Simulation Data & Control Design
Conclusion

- Power Electronic Devices
  - consist of Electronics HW and Control Algorithms
  - contain switching elements that are traditionally difficult to linearize for Control Design

- System Identification Techniques can be used to extract linear equations from the schematic directly

- Control design is possible without manual creation of average models
Plant Identification from Simulation Data

1. Use the Identify New Plant option in the PID tuner.
Plant Identification from Simulation Data (1)

2. Choose **Simulate Data** to obtain I/O results from the simulation model.

3. Set up a Step Response test with the following characteristics:
   - Sample Time \( (T_f) \)
   - Offset \( (T_\Delta) \)
   - Onset Lag \( (u_0) \)
   - Amplitude \( (A) \)
Run the simulation to obtain the identification data.

Select Underdamped Pair as the model structure and use the interactive handles to fit the model to the data.