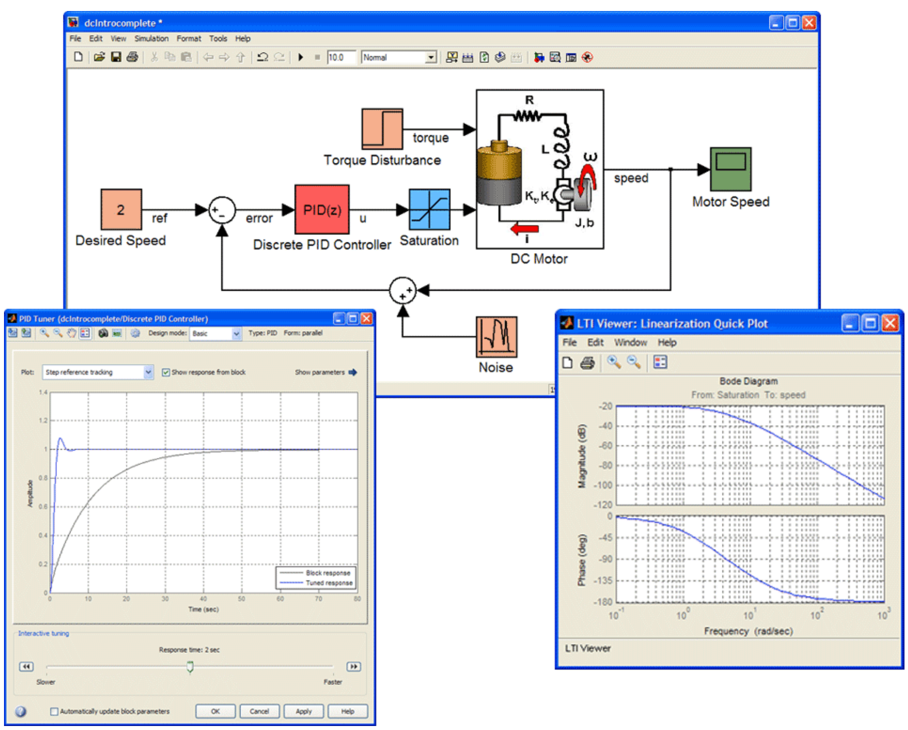
Simulink Control Design 3.0

Compute PID gains, linearize models, and design control systems

Simulink Control Design™ lets you design and analyze control systems modeled in Simulink®. You can automatically tune the gains of PID controllers to meet performance requirements. With this product you can also nonintrusively find operating points and compute exact linearizations of Simulink models at various operating conditions. Simulink Control Design provides tools for computing simulation-based frequency responses without modifying your model. A GUI lets you design and analyze arbitrary control structures modeled in Simulink, such as cascaded, prefilter, regulation, and multiloop architectures.

Key Features

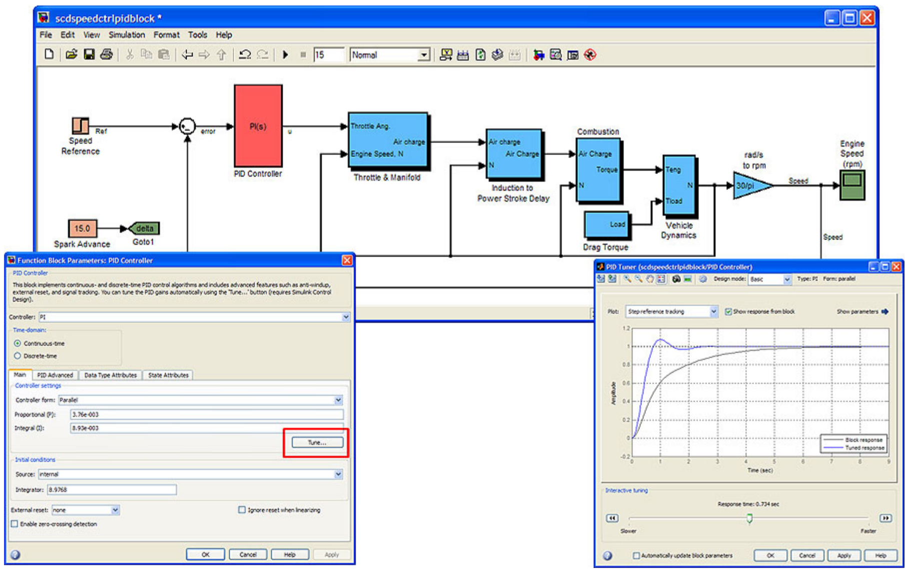
- Automatic tuning of PID Controller blocks from the Simulink library
- Nonintrusive operating point calculation (trimming) and linearization of Simulink models
- Simulation-based computation of a Simulink model's frequency response
- Graphical and automated tuning of arbitrary control systems within Simulink
- Numerical optimization of compensators to meet time-domain and frequency-domain requirements (with Simulink Design Optimization™)
- Command-line interface for developing automated linearization scripts and performing batch linearization



Designing and analyzing control systems with Simulink Control Design. A control system modeled in Simulink (top), the PID Tuner GUI (left), and the Bode diagram of the open-loop transfer function (right).

Tuning PID Controllers

Simulink Control Design provides automatic gain tuning capabilities for Simulink PID Controller blocks. Initial tuning of a PID controller is accomplished with a single click. The product uses a proprietary tuning method that computes the PID gains based on the closed-loop performance that you desire. An initial controller is suggested based on an analysis of your system dynamics. You can then interactively adjust the response time in the GUI. Advanced options are available to tune the PID controller by specifying the desired bandwidth and phase margin. The GUI also provides several plots that you can use to analyze the controller behavior. For example, you can use a step reference tracking plot or an open-loop Bode plot to compare the performance of the current design with the design corresponding to initial gain values.



Using Simulink Control Design to automatically tune the gains of the PID Controller block (red, top). To automatically compute PID controller gains, you open the PID Controller block mask (left) and press the "Tune..." button. The PID Tuner GUI (right) opens up with an automatically tuned design.

Trimming and Linearizing Simulink Models

Trimming the Model

Linear control design typically requires you to consider multiple operating points to account for the various setpoints of a nonlinear model. Simulink Control Design provides a GUI to determine model operating points. You can:

- Calculate operating points from user-defined setpoints using numerical optimization
- Take operating point snapshots at specific times or events during simulation

These operating points can be used to initialize a simulation at steady state or as a basis for linearization and control design.

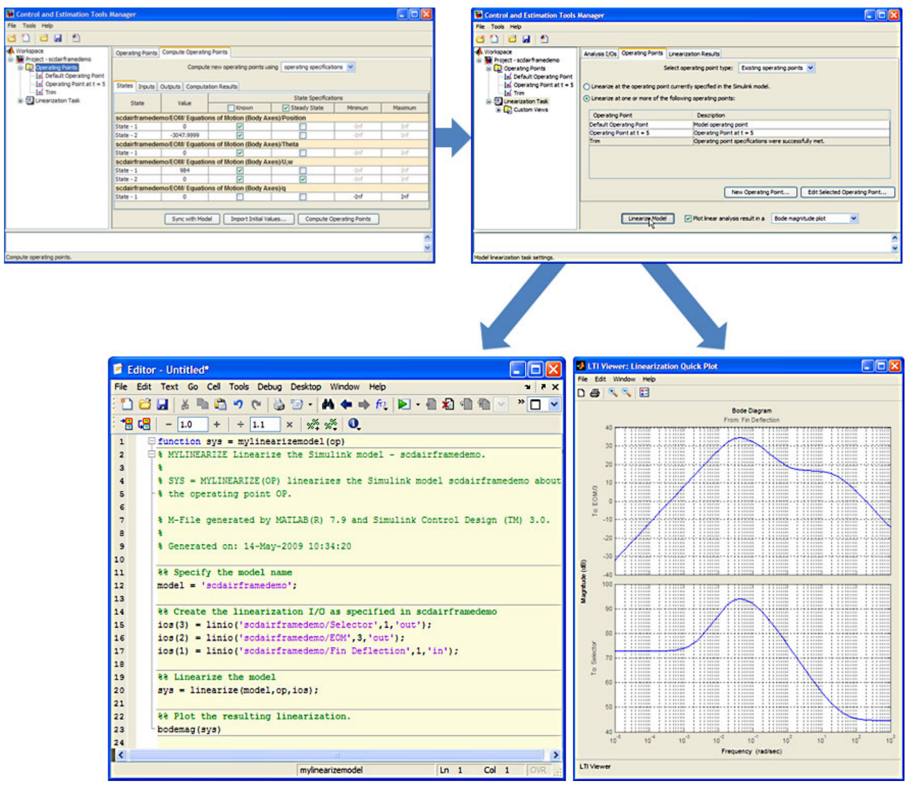
Linearizing the Model

With Simulink Control Design you can linearize continuous, discrete, and multirate Simulink models. Using graphical signal annotations to specify loop opening and linearization inputs and outputs, you can linearize the whole model, a portion of the model, or a single block or subsystem. The signal annotations can be used for open-and closed-loop analysis. The annotations and analysis are nonintrusive and do not affect your model's simulation behavior.

Simulink Control Design automatically computes the linearized model and lets you visualize the results in a step response plot or Bode diagram. A Linearization Inspector is provided to visualize the impact of each block in your Simulink model on the linearization. You can fine-tune your results by specifying the linear behavior of any number of blocks in your model. The linear behavior can be specified as a matrix gain or LTI model, giving you flexibility to linearize Simulink models containing discontinuities or event-based components, such as Stateflow® charts or pulse-width modulation signal-based systems.

When working with Robust Control Toolbox™, you can compute an uncertain linear model by specifying uncertain values for transfer functions and gains directly in the model. The resulting uncertain linear model can be used to study the impact of uncertainty on the stability and performance of your control system.

All of these tools have a command-line API to write scripts for batch mode trimming and linearization. You can write these scripts yourself or automatically create MATLAB® code from the GUI.



Linearizing the model with Simulink Control Design. You can trim your model at a specific simulation time or operating condition (upper left), linearize it at any of the calculated operating points (upper right), inspect linearization results in the LTI Viewer (lower right), and automatically create MATLAB code from the GUI (lower left).

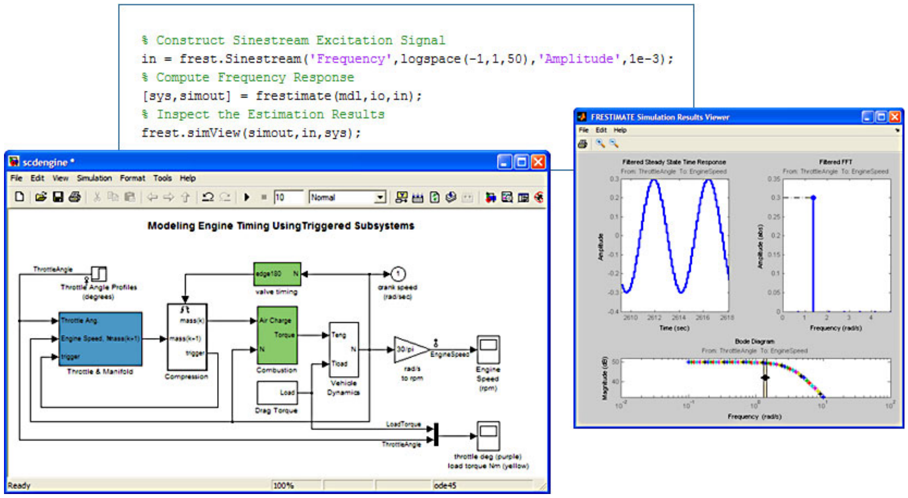
Computing the Frequency Response of the Model

Simulink Control Design provides tools for the simulation-based computation of a model's frequency response. You can use these tools to:

- Verify the results of a linearization.

- Compute the model's frequency response when linearization techniques are not appropriate, such as with models described by strong discontinuities or event-based dynamics.
- Study the effects of excitation signal amplitude on a nonlinear system's gain and phase characteristics.

Simulink Control Design helps you construct the excitation signals, such as sine sweeps or chirp signals; run the simulations; collect the data; and calculate and plot the model's frequency response. The algorithms used to compute the frequency response are designed to minimize the simulation time and support the Accelerator and Rapid Accelerator modes in Simulink to speed up the overall computation.



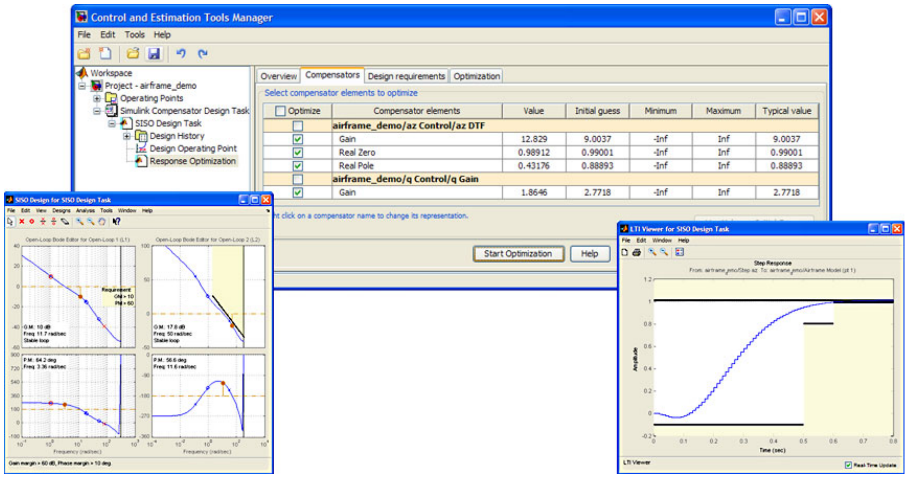
Computing the frequency response of the model. Simulink Control Design provides functions (top) for simulation-based computation of the frequency response (right) of a model (left).

Designing and Analyzing Control Systems in Simulink

Simulink Control Design provides a GUI for tuning control loops directly in Simulink, using the graphical and automated tuning capabilities of Control System Toolbox™. You can use any control architecture that you build in Simulink that is linearizable. Tunable Simulink blocks include Gain, Transfer Function, Zero-Pole, State-Space, and PID Controller. Simulink Control Design automatically identifies the relevant control loops for the tuned blocks and launches a preconfigured session of the single-input/single-output (SISO) Design Tool.

You can use the SISO Design Tool to:

- Graphically tune multiple, continuous, or discrete SISO loops.
- Observe loop interactions and coupling effects while tuning parameters.
- Compute compensator designs using systematic design algorithms such as proprietary Robust Response Time PID tuning, Ziegler-Nichols PID tuning, IMC design, or LQG design.
- Optimize the control loops to meet time-domain and frequency-domain design requirements (requires Simulink Design Optimization).
- Directly tune Simulink block parameters, including PID gains, zero-pole-gain representations, and masked blocks.
- Examine the closed-loop response such as a reference trajectory or the ability of a control system to reject a disturbance at any portion of a model.
- Write the tuned parameter values back to your Simulink model for verification with the full nonlinear system.



Optimizing a multiloop control system to simultaneously meet frequency-domain requirements (left) and time-domain requirements (right). The controller parameters to be optimized are specified in a GUI (top).

Resources

Product Details, Demos, and System Requirements
www.mathworks.com/products/simcontrol

Trial Software
www.mathworks.com/trialrequest

Sales
www.mathworks.com/contactsales

Technical Support
www.mathworks.com/support

Online User Community
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Training Services
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