

Control System Toolbox™

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Summary by Version

This table provides quick access to what's new in each version. For clarification, see "Using Release Notes" on page 2.

Version (Release)	New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
Latest Version V8.1 (R2008a)	Yes Details	No	Bug Reports	Printable Release Notes: PDF Current product documentation
V8.0.1 (R2007b)	Yes Details	No	Bug Reports	No
V8.0 (R2007a)	Yes Details	No	Bug Reports	No
V7.1 (R2006b)	Yes Details	No	Bug Reports	No
V7.0 (R2006a)	Yes Details	No	Bug Reports	No
V6.2.1 (R14SP3)	No	No	Bug Reports	No
V6.2 (R14SP2)	Yes Details	No	Fixed bugs	No
V6.1 (R14SP1)	No	No	Fixed bugs	No
V6.0 (R14)	Yes Details	Yes Summary	Fixed bugs	No

Version (Release)	New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
V5.2.1 (R13SP2)	No	No	No bug fixes	No
V5.2 (R13)	Yes Details	No	Fixed bugs	No

Using Release Notes

Use release notes when upgrading to a newer version to learn about:

- New features
- Changes
- Potential impact on your existing files and practices

Review the release notes for other MathWorks™ products required for this product (for example, MATLAB® or Simulink®) for enhancements, bugs, and compatibility considerations that also might impact you.

If you are upgrading from a software version other than the most recent one, review the release notes for all interim versions, not just for the version you are installing. For example, when upgrading from V1.0 to V1.2, review the release notes for V1.1 and V1.2.

What's in the Release Notes

New Features and Changes

- New functionality
- Changes to existing functionality

Version Compatibility Considerations

When a new feature or change introduces a reported incompatibility between versions, the **Compatibility Considerations** subsection explains the impact.

Compatibility issues reported after the product is released appear under Bug Reports at the MathWorks Web site. Bug fixes can sometimes result in incompatibilities, so you should also review the fixed bugs in Bug Reports for any compatibility impact.

Fixed Bugs and Known Problems

The MathWorks offers a user-searchable Bug Reports database so you can view Bug Reports. The development team updates this database at release time and as more information becomes available. This includes provisions for any known workarounds or file replacements. Information is available for bugs existing in or fixed in Release 14SP2 or later. Information is not available for all bugs in earlier releases.

Access Bug Reports using your MathWorks Account.

Version 8.1 (R2008a) Control System Toolbox™ Software

This table summarizes what's new in Version 8.1 (R2008a):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
Yes Details below	No	Bug Reports	Printable Release Notes: PDF Current product documentation

New change introduced in this version:

Updated Error and Warning Message System

The Control System Toolbox error and warning IDs and messages have been updated. If you use error and warning IDs in your code, you must update your code to reflect the new IDs.

Version 8.0.1 (R2007b) Control System Toolbox™ Software

This table summarizes what's new in Version 8.0.1 (R2007b):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
Yes Details below	No	Bug Reports	No

New change introduced in this version:

Updated and Expanded Demos

The Control System Toolbox™ demos have been reformatted and expanded to include more examples and content. Demos in the following categories now have new and improved content:

- Getting Started with LTI Models
- Discretization and Sampling Rate Conversions
- How to Get Accurate Results

To open the Control System Toolbox demos, type

```
demo toolbox control
```

at the MATLAB® prompt.

Version 8.0 (R2007a) Control System Toolbox™ Software

This table summarizes what's new in Version 8.0 (R2007a):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
Yes Details below	No	Bug Reports	No

New features and changes introduced in this version are

- “Analysis of Time Delay Systems Now Fully Supported” on page 6
- “New and Updated Automated Tuning Methods” on page 7
- “New Tustin and Prewarp Options for d2d Function” on page 7

Analysis of Time Delay Systems Now Fully Supported

Control System Toolbox™ software now lets you:

- Model, simulate, and analyze any interconnection of linear systems with delays, such as systems containing feedback loops with delays.
- Exactly analyze and simulate control systems with long delays. You can evaluate control strategies, such as Smith Predictor and PID control for first-order-plus-dead-time plants.
- Use new commands for modeling state-space models with delays including: `delayss`, `getDelayModel`, and `setDelayModel`.

For more information, see the section on time delays in the Control System Toolbox documentation.

New and Updated Automated Tuning Methods

Control System Toolbox software now provides the following new and updated automated tuning methods:

- New Singular Frequency Based Tuning lets you design PID compensators for both stable and unstable plants.
- New H-infinity Loop Shaping lets you find compensators based on a desired open-loop bandwidth or loop shape. This feature requires Robust Control Toolbox™ software.
- Updated Internal Model Control (IMC) Tuning now supports unstable plants.

For more information, see the section on automated tuning in the Control System Toolbox documentation.

New Tustin and Prewarp Options for d2d Function

The d2d function now includes the following new options for the resampling method:

- 'tustin'—Performs Bilinear (Tustin) approximation
- 'prewarp'—Performs Tustin approximation with frequency prewarping

For more information, see the d2d reference pages.

Version 7.1 (R2006b) Control System Toolbox™ Software

This table summarizes what's new in Version 7.1 (R2006b):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
Yes Details below	No	No bug fixes	No

New features and changes introduced in this version are

- “New Loop Configurations in the SISO Design Tool” on page 8
- “New Design Requirements” on page 8

New Loop Configurations in the SISO Design Tool

Two new loop configurations are available from the SISO Design Tool. See [Modifying Block Diagram Structure](#) for more information.

New Design Requirements

The LTI Viewer now supports step response and upper/lower time bound design requirements. See [Adding Design Requirements to the LTI Viewer](#) for more information.

Version 7.0 (R2006a) Control System Toolbox™ Software

This table summarizes what's new in Version 7.0 (R2006a):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
Yes Details below	No	No bug fixes	No

New features and changes introduced in this version are

- “SISO Design Tool” on page 9
- “LTI Viewer Enhancements” on page 10
- “LTI Objects” on page 10
- “Numerical Algorithms” on page 12

SISO Design Tool

The SISO Design Tool now provides one-click automated tuning using systematic algorithms such as Ziegler-Nichols PID tuning, IMC design, and LQG design. In addition, you can calculate low-order approximations of the IMC/LQG compensators to keep the control system complexity low.

Compensator Optimization Is Now Supported

If you have installed Simulink® Response Optimization™ software, you can now optimize the compensator parameters inside the SISO Design Tool GUI. You can specify time- and frequency-domain requirements on SISO Design Tool plots such as bode and step, and use numerical optimization algorithms to automatically tune your compensator to meet your requirements. See the Simulink Response Optimization documentation for more details.

Improved Compensator Editor

The Compensator Editor used to edit the numerical values of poles and zeros has been upgraded to better handle common control components such as lead/lag and notch filters.

Multi-Loop Compensator Design Support

Many control systems involve multiple feedback loops, some of which are coupled and need joint tuning. The SISO Design Tool now lets you analyze and tune multi-loop configurations. You can focus on a specific loop by opening signals to remove the effects of other loops, gain insight into loop interactions, and jointly tune several SISO loops.

SISO Design Tool Fully Integrated with the Controls & Estimation Tools Manager

To improve workflow and better leverage other tools, such as Simulink® Control Design™ software and Simulink Response Optimization software, the SISO Design Tool is now fully integrated with the Controls & Estimation Tools Manager (CETM). This provides a signal environment for the design and tuning of compensators.

When you open the SISO Design Tool, the CETM also opens with a SISO Design Task. Many SISO Design Tool features, such as importing models, changing loop configurations, etc., have been moved to the SISO Design Task in CETM. In addition, related tasks such as Simulink® based Tuning and Compensator Optimization are seamlessly integrated with the SISO Design Task. See the *Control System Toolbox™ Getting Started Guide* for details on the new work flow.

LTI Viewer Enhancements

The LTI Viewer now lets you plot the response of a system to user-defined input signals (`lsim`) and initial conditions (`initial`). A new GUI lets you select input signals from a signal generator library, or import signal data from a variety of file formats.

LTI Objects

Descriptor and Improper State-Space Models Fully Supported

There is now full support for descriptor state-space models with a singular E matrix. This now lets you build state-space representations, such as PID, and manipulate improper models with the superior accuracy of state-space

computations. In previous versions, only descriptor models with a nonsingular E matrix were supported.

New Commands to Calculate Time Response Metrics

The new `stepinfo` and `lsiminfo` commands compute time-domain performance metrics, such as rise time, settling time, and overshoot. You can use these commands to write scripts that automatically verify or optimize such performance requirements. Previously, these metrics were available only from response plots.

Simplified System Interconnections Using I/O Channel Names

The commands `connect`, `feedback`, `series`, `parallel`, and `lft` now let you connect systems by matching names of I/O channels. A helper function, `sumblek`, has also been added to simplify the specification of summing junctions. Altogether this considerably simplifies the task of deriving models for complicated block diagrams. In previous releases, only index-based system connection was supported.

Changes in the Representation of I/O Delays in State-Space Models

The `ioDelay` property is deprecated from state-space models. Instead, these models have a new property called `InternalDelay` for logging all delays that cannot be pushed to the inputs or outputs. Driving this change is the switch to a representation of delays in terms of delayed differential equations rather than frequency response. See *Time Delays in the Control System Toolbox* documentation for more details on internal delays, and `ss/getdelaymodel` for details on the new internal representation of state-space models with delays.

New Name Property for LTI Objects

This new property lets you attach a name (string) to a given LTI model. The specified name is reflected in response plots.

New Commands and Operations for LTI Objects

The new `exp` command simplifies the creations of continuous-time transfer functions with delays. For more information, type `help lti/exp` at the MATLAB® prompt.

The `frd` object has the following new methods:

- `fcats` — Concatenates one or more FRD models along the frequency dimension (data merge).
- `fselect` — Selects frequency points or range in `frd` model.
- `fnorm` — Calculates pointwise peak gain of `frd` model.

The `.*` operation is supported for transfer functions and zero-pole-gain objects. This allows you to perform element-by-element multiplication of MIMO models.

Numerical Algorithms

There have been several major improvements in the Control System Toolbox numerical algorithms, many of which benefit the upgraded SISO Design Tool:

- New scaling algorithm that maximizes accuracy for badly scaled state-space models
- Performance improvement in time and frequency response computations through MEX-files
- More accurate computations of the zero-pole-gain and transfer function representations of a state-space model
- More accurate state-space representations of zero-pole-gain models
- Better handling of nonminimal modes in model reduction commands (`balred`, `balreal`)
- `canon` now computes a block modal form for A matrices that are not diagonalizable or are nearly defective
- Exact phase computation for zero-pole-gain models in `bode` and `nichols`
- Accurate handling of improper models using the descriptor state-space representation

Version 6.2.1 (R14SP3) Control System Toolbox™ Software

This table summarizes what's new in Version 6.2.1 (R14SP3):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
No	No	Bug Reports	No

Version 6.2 (R14SP2) Control System Toolbox™ Software

This table summarizes what's new in Version 6.2 (R14SP2):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
Yes Details below	No	Fixed bugs	No

New features and changes introduced in this version are

- “Command-Line API for Customizing Plots” on page 14
- “Constraint Types for SISO Design” on page 14
- “Bode and Nichols Plots Have Additional Options” on page 15
- “Model-Approximation and Order-Reduction Commands” on page 15

Command-Line API for Customizing Plots

The Control System Toolbox™ software now provides a command-line API for customizing units, labels, limits, and other plot options. You can now change default plot options before generating a plot, or modify plot properties after creation.

For a detailed description of the commands, see the Control System Toolbox documentation.

Constraint Types for SISO Design

You can now create

- Single piecewise linear constraints for root-locus and Bode plots
- Gain/phase exclusion regions for Nichols plots

Design constraints are displayed as shaded regions.

Bode and Nichols Plots Have Additional Options

When editing Bode and Nichols plots, you can now

- Set the lower limit of the magnitude manually.
- Adjust the phase offsets by multiples of 360 degrees to facilitate comparing multiple responses.

Model-Approximation and Order-Reduction Commands

New commands have been added for model approximation and order reduction:

- `hsvd` computes and plots the Hankel singular values.
- `balred` computes low-order approximations using a numerically stable, balancing-free algorithm. You can perform multiple order reductions with a single command.

Version 6.1 (R14SP1) Control System Toolbox™ Software

This table summarizes what's new in Version 6.1 (R14SP1):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
No	No	Fixed bugs	No

Version 6.0 (R14) Control System Toolbox™ Software

This table summarizes what's new in Version 6.0 (R14):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
Yes Details below	Yes—Details labeled as Compatibility Considerations , below. See also Summary on page 23.	Fixed bugs Details below	No

New features and changes introduced in this version are

- “Linearization Tools Moved to Simulink® Control Design™ Software” on page 17
- “Enhanced Numerical Algorithms” on page 18
- “Support for Model Order Reduction Is Improved” on page 18
- “Modal Decompositions Commands Expanded” on page 18
- “Fixed Bugs” on page 19

Linearization Tools Moved to Simulink® Control Design™ Software

The LTI Viewer interface with the Simulink® linearization tools has been moved from the Control System Toolbox™ product to the Simulink® Control Design™ product.

If you have Simulink Control Design software installed on your system, type `slview` to open the Linear Analysis Tool.

Compatibility Considerations

To perform linearization, you must install Simulink Control Design software. You can no longer perform this function using Control System Toolbox software.

Enhanced Numerical Algorithms

The numerical engine has been overhauled to leverage the state-of-the-art LAPACK and SLICOT libraries, resulting in faster and more accurate computations. This upgrade benefits the following areas:

- Computation of system zeros (zero, ss to tf or zpk conversions)
- Lyapunov and Riccati solvers (lyap, dlyap, care, dare)
- Model order reduction (balreal and modred)

This release also introduces several new foundation algorithms, including:

- Square-root solvers for stable Lyapunov equations (lyapchol and dlyapchol)
- Block diagonalization algorithm (bdschur)
- Commands for reordering eigenvalues in Schur decompositions (ordschur and ordqz). These commands are part of the MATLAB® product.

Support for Model Order Reduction Is Improved

The support for model order reduction has been significantly improved:

- balreal now leverages the new square-root Lyapunov solvers for greater robustness, accuracy, and performance.
- Reduction of unstable or marginally stable systems is now supported.

Modal Decompositions Commands Expanded

New commands have been added for additive modal decompositions:

- stabsep separates the stable and unstable modes of a system.
- modsep performs modal decompositions into N arbitrary regions.

Fixed Bugs

The following bugs were fixed in this release:

- Issues with frequency-unit conversions in the LTI Viewer
- allmargin issues for some discrete models with poles near $z=1$
- Empty sigma plot for MIMO system with zero gain between some I/O pairs
- Issues with rlocus command applied to improper systems

Version 5.2.1 (R13SP2) Control System Toolbox™ Software

This table summarizes what's new in Version 5.2.1 (R13SP2):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
No	No	No fixed bugs	No

Version 5.2 (R13) Control System Toolbox™ Software

This table summarizes what's new in Version 5.2 (R13):

New Features and Changes	Version Compatibility Considerations	Fixed Bugs and Known Problems	Related Documentation at Web Site
Yes Details below	No	Fixed bugs Details below	V5.2 product documentation

New features and changes introduced in this version are

- “Response Plots” on page 21
- “Importing in the LTI Viewer” on page 22
- “SISO Design Tool” on page 22
- “c2d Function Is Enhanced” on page 23
- “Fixed Bugs” on page 23

Response Plots

New features for response plots include

- Normalization of time plots for easy trend comparison.
- Display of driving input signal in linear simulation (lsim) plots.
- Standard zooming for all response plots.
- The **Full View** right-click menu.
- Ability to toggle magnitude and phase displays in Bode plots.
- In Bode plots, a modified phase-correction algorithm that produces consistent phase at $w=\text{Inf}$ and is robust to perturbations of the pole/zero structure at the origin.
- Displaying only positive frequencies in Nyquist plots.
- A new function, `iopzmap`, that plots the transfer poles and zeros for each I/O pair in a MIMO system.

Importing in the LTI Viewer

The following are new features and enhancement in the LTI Viewer.

Models with Unequal Number of I/Os Can Be Imported

The LTI Viewer no longer restricts importing models with unequal numbers of inputs and/or an unequal numbers of outputs. You can import any combination of LTI models into the viewer.

Import and Export Dialog Boxes Easier to Use

The import and export dialog boxes are now easier to use.

System Identification Toolbox™ Models Can Be Imported

The LTI Viewer now imports System Identification Toolbox™ SISO models. The noise model is automatically discarded and the `idmodel` is converted to ZPK format.

Zoom Property in the LTI Viewer Right-Click Menu Is Removed

The zoom property in the LTI Viewer right-click menu has been removed. You can access this functionality from the new toolbar.

SISO Design Tool

The following are new features in the SISO Design tool.

Additional Feedback Structures

The SISO Design tool supports two new feedback structures:

- Feedforward configuration
- Cascade configuration with filter **F** in the minor loop

All the usual functionality (e.g., graphical tuning of **F** and **G**) is available in the new feedback structures.

Analysis Menu

The SISO Design tool contains a new **Analysis** menu that raises **Loop Responses** under **Tools** to the top level. New plots available from this menu are

- Input disturbance rejection
- Output disturbance rejection

Linked LTI Viewers Are Dynamically Updated

LTI Viewers that are linked to the SISO Design tool update response plots in real-time during mouse-driven compensator tuning. This is the default behavior. To deactivate this feature, clear the **Real-Time Update** check box in the linked LTI Viewer. In this case, plots update only when you release the mouse button.

System Identification Toolbox™ Models Can Be Imported

The SISO Design tool now imports System Identification Toolbox SISO models. The noise model is automatically discarded and the `idmodel` is converted to ZPK format.

Reworked Store and Retrieve Windows

A new window, the **Design Archive**, combines both store and retrieve functions within a single, more-intuitive GUI.

Nichols Plots

You can now trace the frequency by placing your mouse cursor over the Nichols contour.

c2d Function Is Enhanced

The `c2d` function has a new impulse-invariant discretization method that guarantees matching continuous and discrete responses for pulse inputs.

Fixed Bugs

The following bugs were fixed in this release:

allmargin

The `allmargin` function converts ZPK models to TF format only when there is an algebraic loop in your system. This change ensures that the SISO Design tool can correctly diagnose closed-loop stability (open loop is always in ZPK format).

dlinmod

The `dlinmod` function now correctly linearizes all multirate discrete or hybrid (continuous and discrete) Simulink® models when using Jacobian-based linearization.

place

Formerly, bad edge cases in the orthogonalization loop caused a divide by zero in the `place` function. This is no longer the case.

Compatibility Summary for Control System Toolbox™ Software

This table summarizes new features and changes that might cause incompatibilities when you upgrade from an earlier version, or when you use files on multiple versions. Details are provided with the description of the new feature or change.

Version (Release)	New Features and Changes with Version Compatibility Impact
Latest Version V8.1 (R2008a)	None
V8.0.1 (R2007b)	None
V8.0 (R2007a)	None
V7.1 (R2006b)	None
V7.0 (R2006a)	None
V6.2.1 (R14SP3)	None
V6.2 (R14SP2)	None
V6.1 (R14SP1)	None
V6.0 (R14)	See the Compatibility Considerations subheading for this new feature or change: <ul style="list-style-type: none"> “Linearization Tools Moved to Simulink® Control Design™ Software” on page 17
V5.2.1 (R13SP2)	None
V5.2 (R13)	None