System Identification Steps

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Use this help file to learn about System Identification steps.

Subpalette	Description
Import-Export Model	Use the Import-Export Model steps to save or load a model.
<u>Model</u> Analysis	Use the Model Analysis steps to analyze the model you create.
<u>Model</u> Estimation	Use the Model Estimation steps to estimate a model by using stimulus and response signals you load.
Preprocessing	Use the Preprocessing steps to detrend, normalize, split, and rebuild missing stimulus and response signals.

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Import-Export Model

Owning Palette: System Identification Steps

Use the Import-Export Model steps to save or load a model.

Convert to Control Design Model

Converts a model that you created with the LabVIEW System Identification Assistant to a state-space, transfer function, or zero-polegain model that you can use with the LabVIEW Control Design Assistant.

Parameter	Description
Model to Convert	Specifies the System Identification model you want to convert to a Control Design model.
Control Design Model Type	Specifies the type of Control Design model you want to create. You can select Transfer Function , State-Space , or Zero-Pole-Gain .

Load System Identification Model

Retrieves a system identification model from a LabVIEW SignalExpress project model file (.sim) and displays information about the model.

Parameter	Description
File path	Specifies the path of the model you want to load.
Model Information	 Contains the following options: Model type—Displays the type of model. Sampling rate—Displays the sampling rate of the discrete system model. Stimulus Signal—Displays the name of the stimulus signal used to create the model. Response Signal—Displays the name of the response signal used to create the model. Notes—Displays the comments for the model.

Save System Identification Model

Saves a system identification model to a LabVIEW SignalExpress project model file (.sim).

Parameter	Description
Model	Specifies the estimated model you want to save to a .sim file.
File Path	Specifies the path to the location where you want to save the model.
Additional notes to save with model	Specifies the comments for a model.

Model Analysis

Owning Palette: System Identification Steps

Use the Model Analysis steps to analyze the model you create.

Bode Analysis

Computes a Bode plot for a system model. This step computes the frequency response function (FRF) for one input-output pair of a system model. The step then produces the FRF on XY graphs as Bode magnitude and Bode phase plots.

Parameter	Description
Bode magnitude plot	Displays the Bode magnitude plot of the FRF and the confidence level.
Bode phase plot	Displays the Bode phase plot of the FRF and the confidence level.
Input Model	 Contains the following option: Model—Specifies the estimated model to use for Bode analysis.
Configuration	 Contains the following options: Input source—Specifies the input source type to compute the transfer function. You can select stimulus or noise.
	 Graph Settings—Contains the following option: Confidence level—Specifies the confidence interval of the FRF. The confidence radius equals confidence level times the standard deviations of the FRF. The default is 99%.
	 Magnitude unit—Specifies the type of scaling used for the magnitude axis. You can choose from the following scaling types:
	 dB (default) linear
	 Frequency Information—Contains the following options: Start frequency—Specifies the starting frequency of the data plot. The default is

10m. - End frequency —Specifies the end frequency of the data plot. The default is 500m.
 Number of bins—Specifies the number of frequency points at which frequency responses are computed. The default is 1000.
 Interval type—Specifies the type of scaling used for the frequency axis, or x-axis. You can choose from the following scaling types: logarithmic (default) linear

Model Simulation

Simulates the system response by stimulating the system identified model. Use this step to determine if the response the model calculates is intuitively correct and accurate given the estimation data.

Parameter	Description
Model Input	Displays the input stimulus signal the step uses for simulation.
Model Output	Displays the simulated model output.
Inputs	 Contains the following options: Model—Specifies the model to use for simulation. Stimulus Signal—Specifies the stimulus input to apply to the model.
Noise	 Contains the following option: Add Noise—Adds noise to the system for simulating the model. Contains the following options: Noise Type—Specifies the type of noise you want to generate. You can select one of the following noise types: Uniform White (default) Gaussian White Periodic Random Amplitude—Specifies the maximum absolute value that the noise signal can have. The default is 4.0. Seed—Resets the noise sample generator seed when the seed is less than zero. The default is 0.

Model Validation

Parameter	Description
Response Signals	Displays the response signals of the system.
Error Signal	Displays the error signal of the system.
MSE	Returns the mean square error between the Response Signal and the predicted signal.
Input Signals	 Contains the following options: Model—Specifies the estimated model to use for validation. Stimulus Signal—Specifies the stimulus input to apply to the model. Response Signal—Specifies the output response from the model.
Settings	 Contains the following option: Prediction Step—Determines the number of samples the model uses to estimate the response without any correction. The prediction correction is based on the actual response of the system. You cannot enter a value less than or equal to zero for Prediction Step. The default is 1.

Performs *k*-step-ahead prediction on a system model.

Nyquist Analysis

Computes a Nyquist plot for a system model. This step computes the frequency response function (FRF) for one input-output pair of a system model. The step then presents the FRF with the real part versus the imaginary part, or Nyquist plot.

Parameter	Description
Nyquist plot	Displays the Nyquist plot of the system model.
Input Model	Contains the following option:
	 Model—Specifies the estimated model to use for Nyquist analysis.
Configuration	Contains the following options:
	 Input source—Specifies the input source type to compute the transfer function. You can select stimulus or noise.
	 Graph Settings—Contains the following option:
	 Confidence level—Specifies the confidence interval of the FRF. The confidence radius equals confidence level times the standard deviations of the FRF. The default is 99%.
	 Magnitude unit—Specifies the type of scaling used for the magnitude axis. You can choose from the following scaling types:
	• dB (default)
	• linear
	 Frequency Information—Contains the following options:
	 Start frequency—Specifies the starting frequency of the Nyquist plot. The default is 0.01.
	 End frequency—Specifies the end frequency of the Nyquist plot. The default is 0.5.
1	1

 Number of bins—Specifies the number of frequency points at which frequency responses are computed. The default is 1000.
 Interval type—Specifies the type of scaling used for the frequency axis, or x-axis. You can choose from the following scaling types: Iogarithmic (default) linear

Pole-Zero Analysis

Computes a pole-zero plot for a system model. This step computes the locations and confidence areas of the zeros and poles for one inputoutput pair of a system model.

Parameter	Description
Pole-Zero Plot	Displays the pole-zero plot of the system model.
Input Model	 Contains the following option: Model—Specifies the estimated model to use for pole-zero analysis.
Configuration	 Contains the following options: Input source—Specifies the input source type to compute the transfer function. You can select stimulus or noise. Graph Settings—Contains the following option: Confidence level—Specifies the confidence area of the pole-zero location. The confidence radius equals confidence level times the standard deviations of the FRF. The default is 99%.

Residual Analysis

Computes and analyzes the prediction error and correlation indices for the response output of a system model.

Parameter	Description
Prediction Error	Displays the waveform of the one-step-ahead prediction error of the response of the system.
Auto Correlation	Displays the autocorrelation of Prediction Error .
Cross Correlation	Displays the cross correlation of Prediction Error and Stimulus Signal .
Inputs	 Contains the following options: Model—Specifies the system model to use for residual analysis. Stimulus Signal—Specifies the stimulus input to apply to the model. Response Signal—Specifies the output response from the model.

Model Estimation

Owning Palette: <u>System Identification Steps</u>

Use the Model Estimation steps to estimate a model by using stimulus and response signals you load.

Estimate Frequency Response

Estimates the frequency response of an unknown system using the spectral analysis method.

Parameter	Description
Bode Magnitude	Displays the Bode magnitude of the estimated frequency response of the unknown system.
Bode Phase	Displays the Bode phase of the estimated frequency response of the unknown system.
Input Signals	 Contains the following options: Stimulus signal—Specifies the stimulus input to apply to the model. Response signal—Specifies the output response from the model.
Estimation Parameters	 Contains the following option: Setup—Contains the following options: Window length—Specifies the length of window used in spectral computation. The value of Window length controls the tradeoff between bias and variance of the frequency response estimation. The larger the Window length, the larger the variance and the smaller the bias. Number of bins—Specifies the number of frequency points at which the step computes the frequency responses. The default is 256. Frequency in log—Uses the logarithmic interval for the computed frequency points when you place a checkmark in the checkbox. Otherwise, the step equally spaces the computed frequency points. Magnitude in dB—Uses decibels for the magnitude response when you place a checkbox. Otherwise, the magnitude response when you place a checkbox.

Estimate Impulse Response

Estimates the impulse response of an unknown system by using the prewhitening-based correlation analysis method.

Parameter	Description
Impulse Response	Displays the estimated impulse response of the unknown system.
Input Signals	 Contains the following options: Stimulus signal—Specifies the stimulus input to apply to the model. Response signal—Specifies the output response from the model.
Estimation Parameters	 Contains the following option: Setup—Contains the following options: AR order—Specifies the order of the AR model to use for prewhitening. The default is 1. Number of points—Specifies the number of points to compute in the impulse response. The default is 256.

Parametric Estimation

Estimates the parameters of an AR model, ARX model, ARMAX model, output-error (OE) model, Box Jenkins (BJ) model, general linear (GL) model, or a state-space (SS) model for an unknown system.

Parameter	Description
Simulation Error	Displays the difference between the actual and simulated system responses.
Response Signals	Displays the actual and simulated system responses.
Input Signals and Model Type	 Contains the following options: Stimulus signal—Specifies the stimulus input to apply to the model. Response signal—Specifies the output response from the model. Type—Specifies the type of model you want to estimate. You can select one of the following model types: AR ARX (default) ARMAX Output-Error Box Jenkins General Linear State-Space Estimation method—Specifies the method to estimate the AR model. This option is available only if you select AR from the Type pull-down menu. You can select one of the following methods: Forward-Backward Least Squares (default) Yule Walker Burg Lattice Principal Component

Model	Contains the following options:
Order	 Set ranges for orders—Specifies whether you
Settings	define a range of system orders. If you place a checkmark in this checkbox, the step replaces the unique value options with the following options:
	- Estimate—Estimates the values of the
	orders of the coefficients of the system
	model within the ranges you specify. You
	can click this button if you place a
	checkmark in the Set ranges for orders
	ARMAX Output-Error Box lenkins or
	General Linear from the Type pull-down
	menu on the Input Signals and Model
	Type tab.
	- Min A order—Specifies the minimum value
	of the order of the A coefficients of the
	system model. This option appears if you
	place a checkmark in the Set ranges for
	ARMAX Output-Error Box Jenkins or
	General Linear from the Type pull-down
	menu on the Input Signals and Model
	Type tab. The default is 1.
	- Max A order—Specifies the maximum
	value of the order of the A coefficients of the
	system model. This option appears if you
	orders checkbox and you select AP APX
	ARMAX Output-Frror Box Jenkins or
	General Linear from the Type pull-down
	menu on the Input Signals and Model
	Type tab. The default is 1.
	- Min B order—Specifies the minimum value
	of the order of the B coefficients of the
	system model. This option appears if you
	place a checkmark in the Set ranges for orders checkbox and you select AP APY

ARMAX, Output-Error, Box Jenkins, or General Linear from the Type pull-down menu on the Input Signals and Model Type tab. The default is 1.

- Max B order—Specifies the maximum value of the order of the B coefficients of the system model. This option appears if you place a checkmark in the Set ranges for orders checkbox and you select AR, ARX, ARMAX, Output-Error, Box Jenkins, or General Linear from the Type pull-down menu on the Input Signals and Model Type tab. The default is 1.
- Min F order—Specifies the minimum value of the order of the F coefficients of the system model. This option appears if you place a checkmark in the Set ranges for orders checkbox and you select AR, ARX, ARMAX, Output-Error, Box Jenkins, or General Linear from the Type pull-down menu on the Input Signals and Model Type tab. The default is 1.
- Max F order—Specifies the maximum value of the order of the F coefficients of the system model. This option appears if you place a checkmark in the Set ranges for orders checkbox and you select AR, ARX, ARMAX, Output-Error, Box Jenkins, or General Linear from the Type pull-down menu on the Input Signals and Model Type tab. The default is 1.
- Min C order—Specifies the minimum value of the order of the C coefficients of the system model. This option appears if you place a checkmark in the Set ranges for orders checkbox and you select AR, ARX, ARMAX, Output-Error, Box Jenkins, or General Linear from the Type pull-down

menu on the **Input Signals and Model Type** tab. The default is 1.

- Max C order—Specifies the maximum value of the order of the C coefficients of the system model. This option appears if you place a checkmark in the Set ranges for orders checkbox and you select AR, ARX, ARMAX, Output-Error, Box Jenkins, or General Linear from the Type pull-down menu on the Input Signals and Model Type tab. The default is 1.
- Min D order—Specifies the minimum value of the order of the D coefficients of the system model. This option appears if you place a checkmark in the Set ranges for orders checkbox and you select AR, ARX, ARMAX, Output-Error, Box Jenkins, or General Linear from the Type pull-down menu on the Input Signals and Model Type tab. The default is 1.
- Max D order—Specifies the maximum value of the order of the D coefficients of the system model. This option appears if you place a checkmark in the Set ranges for orders checkbox and you select AR, ARX, ARMAX, Output-Error, Box Jenkins, or General Linear from the Type pull-down menu on the Input Signals and Model Type tab. The default is 1.
- Min delay—Specifies minimum value of the delay of the system model. This option appears if you place a checkmark in the Set ranges for orders checkbox and you select AR, ARX, ARMAX, Output-Error, Box Jenkins, or General Linear from the Type pull-down menu on the Input Signals and Model Type tab. The default is 0.
- Max delay—Specifies maximum value of

the delay of the system model. This option appears if you place a checkmark in the **Set ranges for orders** checkbox and you select **AR, ARX, ARMAX, Output-Error, Box Jenkins**, or **General Linear** from the **Type** pull-down menu on the **Input Signals and Model Type** tab. The default is 0.

- Min Number of states—Specifies the minimum number of states in the system model. The value of Min Number of states must be greater than 0 and less than or equal to Max Number of states. This option appears if you place a checkmark in the Set ranges for orders checkbox and you select State-Space from the Type pull-down menu on the Input Signals and Model Type tab. The default is 1.
- Max Number of states—Specifies the maximum number of states in the system model. The value of Max Number of states must be greater than 0 and greater than or equal to Min Number of states. This option appears if you place a checkmark in the Set ranges for orders checkbox and you select State-Space from the Type pull-down menu on the Input Signals and Model Type tab. The default is 1.
- A order—Specifies the order of the A coefficients of the system model. This option appears if you select AR, ARX, ARMAX, Output-Error, Box Jenkins, or General Linear from the Type pull-down menu on the Input Signals and Model Type tab. The default is 1.
- B order—Specifies the order of the B coefficients of the system model. This option appears if you select AR, ARX, ARMAX, Output-Error, Box Jenkins, or General Linear from the Type pull-down menu on the Input Signals and Model Type tab. The default

	 is 1. F order—Specifies the order of the F coefficients of the system model. This option appears if you select AR, ARX, ARMAX, Output-Error, Box Jenkins, or General Linear from the Type pull-down menu on the Input Signals and Model Type tab. The default is 1. C order—Specifies the order of the C coefficients of the system model. This option appears if you select AR, ARX, ARMAX, Output-Error, Box Jenkins, or General Linear from the Type pull-down menu on the Input Signals and Model Type tab. The default is 1. D order—Specifies the order of the D coefficients of the system model. This option appears if you select AR, ARX, ARMAX, Output-Error, Box Jenkins, or General Linear from the Type pull-down menu on the Input Signals and Model Type tab. The default is 1. D order—Specifies the order of the D coefficients of the system model. This option appears if you select AR, ARX, ARMAX, Output-Error, Box Jenkins, or General Linear from the Type pull-down menu on the Input Signals and Model Type tab. The default is 1. delay—Specifies the delay of the system model. This option appears if you select AR, ARX, ARMAX, Output-Error, Box Jenkins, or General Linear from the Type pull-down menu on the Input Signals and Model Type tab. The default is 0. Number of states—Specifies the number of states in the system model. The value of Number of states in the system model. The value of Number of states in the system model. The value of Number of states in the system model. The value of Number of states in the system model. The value of Number of states in the system model. The value of Number of states in the linput Signals and Model Type tab. The default is 0.
Estimation Results	Displays a table of estimated values for the system model. These values are based on the Akaike's Final Prediction- Error (FPE), Akaike's Information Theoretic (AIC), or Minimum Description Length (MDL) criterion. Refer to the <i>LabVIEW System Identification Toolkit Help</i> for information about the FPE, AIC, and MDL criteria.

Preprocessing

Owning Palette: System Identification Steps

Use the Preprocessing steps to detrend, normalize, split, and rebuild missing stimulus and response signals.

Detrend Data

Removes mean and linear steady-state trends from stimulus and response signals.

Parameter	Description
Stimulus Signals	Displays the stimulus signal before and after the detrending process.
Response Signals	Displays the response signal before and after the detrending process.
Input Signals	 Contains the following options: Stimulus signal—Specifies the stimulus input to apply to the model. Response signal—Specifies the output response from the model.
Detrend Settings	 Contains the following options: Trend type—Specifies the method this step uses to remove steady-state trends from the stimulus and response signals. You can select one of the following trend types: mean (default) linear Define trend breakpoints—Specifies whether this step uses piecewise points for detrending. Use the array to define the location in the signal where you

Normalize Data

Normalizes the stimulus and response signals so their mean and standard deviation are 0 and 1, respectively.

Parameter	Description
Stimulus Signals	Displays the stimulus signal before and after the normalizing process. The graph automatically scales the x-axis by default.
Response Signals	Displays the response signal before and after the normalizing process. The graph automatically scales the x-axis by default.
Input Signals	 Contains the following options: Stimulus signal—Specifies the stimulus input to apply to the model. Response signal—Specifies the output response from the model.
Mean Source Configuration	 Contains the following options: Stimulus mean source—Specifies the mean value this step uses to normalize the stimulus signal. The default is Auto calculated. Contains the following options: Auto calculated—Specifies that the step automatically calculates the mean to normalize the stimulus signal. User specified—Enables you to specify the mean to normalize the stimulus signal. The default is 0. Value from another block—Specifies a mean from another signal to normalize the stimulus signal. Response mean source—Specifies the mean value this step uses to normalize the response signal. The default is Auto calculated. Contains the following options: Auto calculated—Specifies the mean

	 automatically calculates the mean to normalize the response signal. User specified—Enables you to specify the mean to normalize the response signal. The default is 0. Value from another block—Specifies a mean from another signal to normalize the response signal.
Standard Deviation Source Configuration	 Contains the following options: Stimulus standard deviation source— Specifies the standard deviation value this step uses to normalize the stimulus signal. The default is Auto calculated. Contains the following options: Auto calculated—Specifies that the step automatically calculates the standard deviation to normalize the stimulus signal. User specified—Enables you to specify the standard deviation to normalize the stimulus signal. The default is 0. Value from another block—Specifies a standard deviation from another signal to normalize the stimulus signal. Response standard deviation source— Specifies the standard deviation value this step uses to normalize the response signal. The default is Auto calculated. Contains the following options: Auto calculated—Specifies that the step automatically calculates the standard deviation to normalize the response signal. User specified—Enables you to specify the standard deviation to normalize the response signal. User specified—Enables you to specify the standard deviation to normalize the response signal. The default is 0.

 Value from another block—Specifies a
standard deviation from another signal to
normalize the response signal.

Rebuild Missing Data

Rebuilds outliers and missing data in the stimulus and response signals of the model.

Parameter	Description
Original Signal	Displays the input Stimulus Signal and Response Signal . You can move the upper and lower limit lines on the graph. The graph automatically scales the x-axis by default.
Processed Signal	Displays the processed Stimulus Signal and Response Signal . You can move the upper and lower limit lines on the graph. The graph automatically scales the x-axis by default.
Input Signals	 Stimulus Signal—Specifies the stimulus input to apply to the system. You can select any signal
	you use before the Rebuild Missing Data step in the project.
	 Response Signal—Specifies the output response from the system. You can select any signal you use before the Rebuild Missing Data step in the project.
Configuration	Contains the following options:
	 Use same limits for both signals—Specifies whether to use the same limits for both the raw stimulus signal and the raw response signal. Specify upper limit—Rebuilds data above the upper limit you specify. Includes the following option:
	 Upper Limit—Specifies the value of the upper limit. The default is infinity.
	 Specify lower limit—Rebuilds data below the lower limit you specify. Includes the following option:
	 Lower Limit—Specifies the value of the lower limit. The default is negative

Split Data

Divides stimulus and response signals into two sections. You can use each section for model estimation and validation, respectively.

Parameter	Description
Stimulus Signal	Displays the stimulus signal before and after the split.
Response Signal	Displays the response signal before and after the split.
Configuration	 Contains the following options: Stimulus Signal—Specifies the stimulus input to apply to the model. Response Signal—Specifies the output response from the model. Split Position—Specifies the length of the first portion of the stimulus and response signals as a percentage of the length of the original signals. The default is 50.