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Generic Table Screen

Many of the VehicleSim (VS) math model equations involve algebraic relationships used to calculate a variable from values of one or two other variables in the model. These relationships are represented with *configurable functions* that can be set at runtime to use various calculation methods such as table lookup, linear coefficients, or constants. About half of the calculations performed in a simulation run involve configurable functions.

Most of the configurable functions are specified using custom screens, with each screen dedicated to a specific function (e.g., damper force as a function of compressive speed). However, the models also include many functions for relationships that are usually set to zero, or represented by linear coefficients. When nonlinear data are available, these features can be used to obtain more fidelity in the simulations.

Unlike most of the libraries in a VS product, each dataset in this library can represent a different kind of data. This is possible because the keywords sent to the simulation math models are an important part of the dataset.

This screen serves two purposes. First, it provides a familiar interface for specifying properties for built-in functions that do not have associated screens in the GUI. For example, about 20 suspension compliances are normally represented with linear coefficients in CarSim, but the effects are represented by configurable functions to enable nonlinear effects to be included if tabular data values are available. Use this screen to specify these nonlinear compliance properties.

A second purpose of this screen is to support configurable functions that are not built in, but are defined at runtime using the `DEFINE_TABLE` VS command.

Obtaining Keywords for an Existing Configurable Function

If you are using this screen to specify properties of an existing configurable function, you need to specify a few keywords associated with the function.

In order to find these keywords, you will typically look in an echo file generated by the VS solver program. To do this:

1. Go to the **Run Control Screen** (Home).
2. Make a new dataset by duplicating an existing run.
3. Check the box to **Show more options on this screen** (1) (Figure 1) and **Advanced settings** (2), to view the miscellaneous yellow field (3).
4. Enter a line of data: `OPT_ECHO_ALL_PARS 1`. This instructs the VS solver to show information about all existing parameters and configurable functions, even if they are not used in the run.

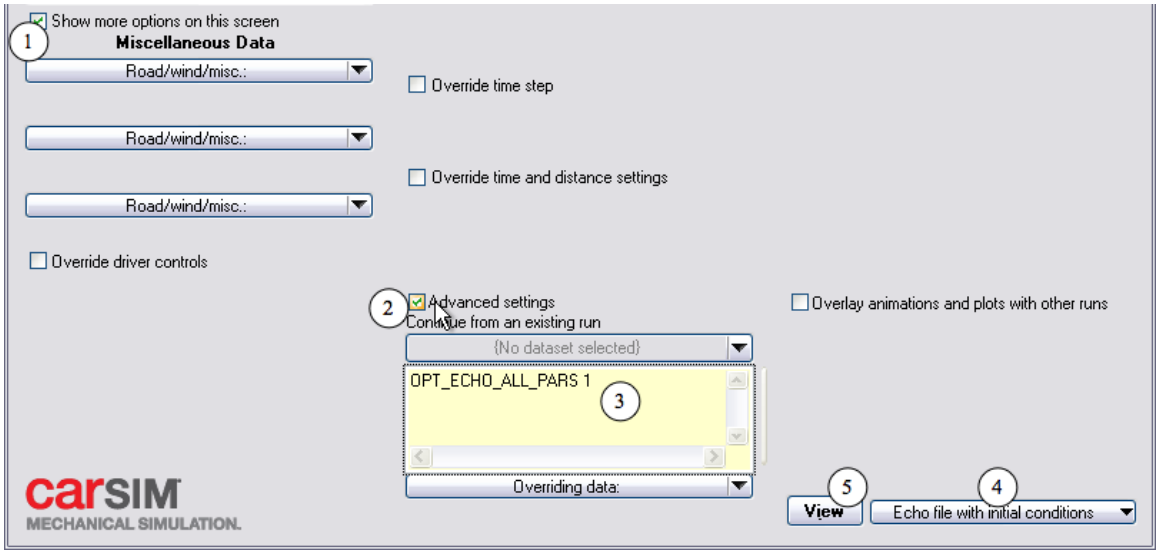

Figure 1. Make a run to find all parameters and configurable function in the math model.

5. Run the simulation.
6. Use the drop-down control to select **Echo file with initial conditions** (4).
7. Click the **View** button (5) to view the echo file generated when the run was made.

For example, Figure 2 shows part of an echo file generated in CarSim that shows information about the tire lateral relaxation length function. It gives the root name of the function (`L_RELAX_Y`), states that the function calculates relaxation length from two independent variables (slip angle and load), and lists the main calculation options. It also gives the root name for a secondary function (`L_RELAX_Y_FZ`) that can be used to define the dependency on Fz.

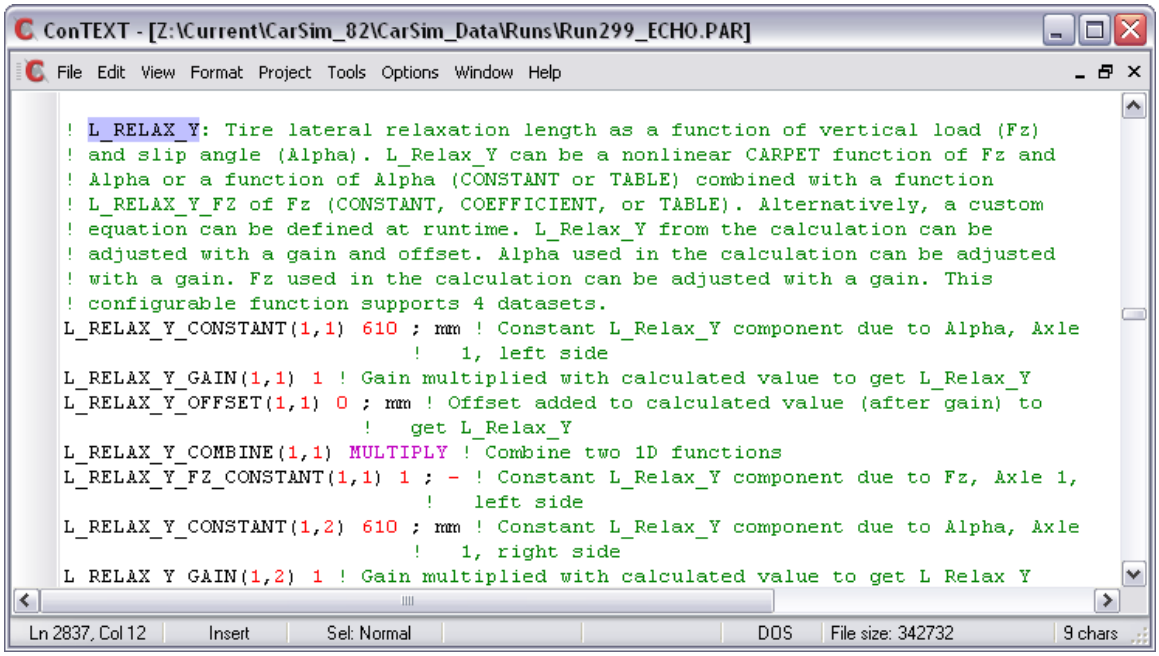

Figure 2. Echo file showing information about tire relaxation length.

Generic Table

Figure 3 shows how the **Generic** Table screen might be used for the configurable function that defines tire lateral relaxation length.

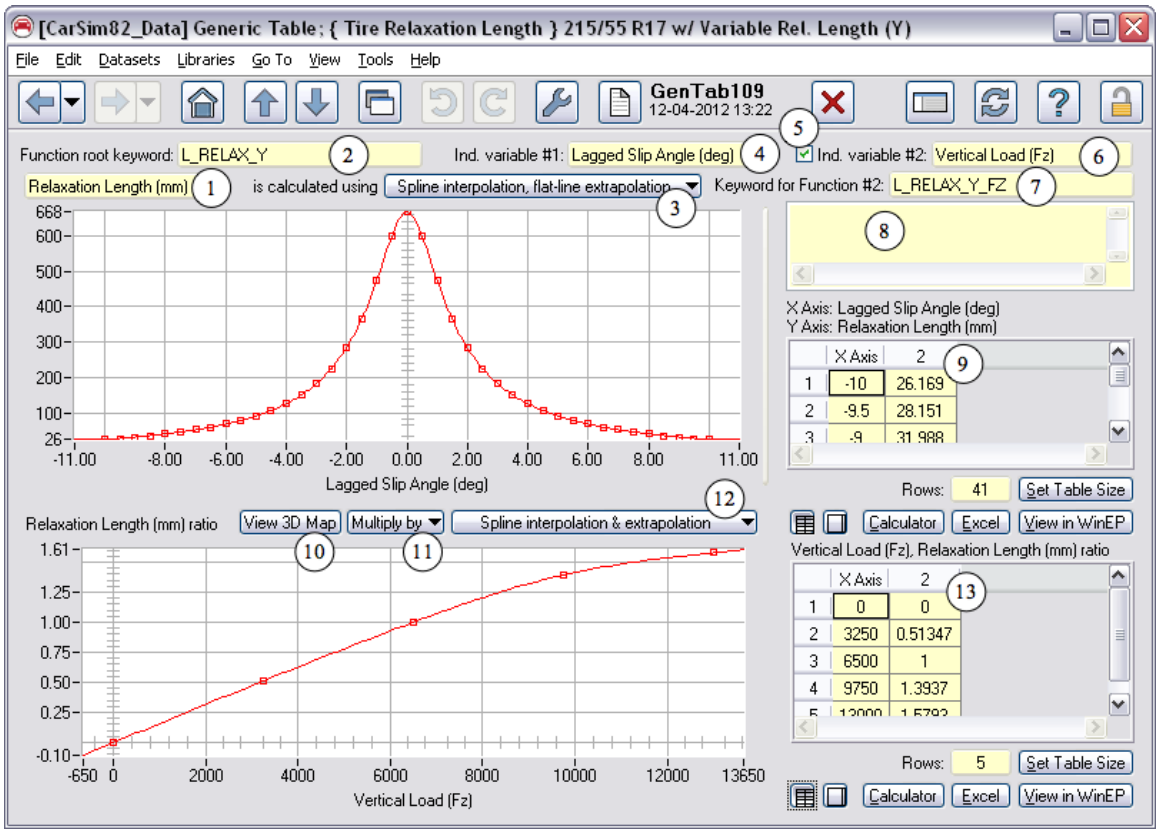

*Figure 3. The **Generic Table** screen.*

Most of the controls on this screen for editing and viewing the configurable function data are standard and are described in the document *VehicleSim Browser Reference Manual*. Additional data fields are provided on this screen to customize the dataset.

(1) Name of the variable calculated by the configurable function. The math models do not use this label; it is a comment field provided as a means for documenting the information on the screen. Notice that it appears in the headings over tabular data ((9) and (13)) and in the title for the vertical axis of the bottom plot.

(2) Root keyword (function name). This name is required for a VS solver to make use of the dataset. If the math model does not recognize the keyword in this field, then the data will not be used.

In this case, the root name `L_RELAX_Y` was found from the echo file shown in Figure 2.

(3) Drop-down list of calculation methods. Use this control to select the method for calculating the output variable (1). This selection also affects the appearance of the screen, as is the case with other screens with tabular data (Figure 4).

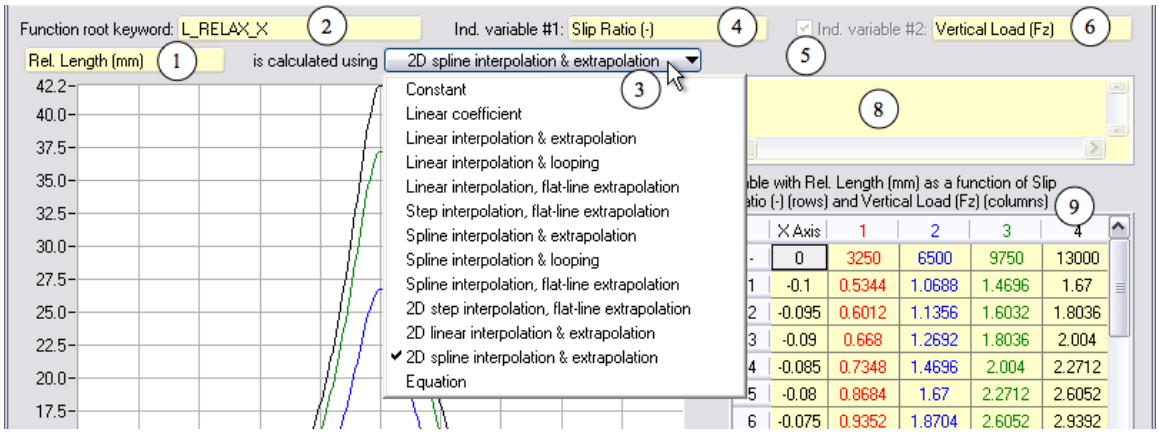

Figure 4. Appearance of screen when 2D calculation method is selected.

1. If a constant or linear coefficient is chosen, the table and plot are hidden and a yellow data field is shown for providing the single value (constant or coefficient). If the checkbox for a second variable is also checked (5), then settings are shown in the lower part of the screen for handling the sensitivity to the second independent variable (6).

2. If an interpolation method is chosen that is not 2D, then a table is shown (9) for entering pairs of numbers (X and Y axis, Figure 3) and a plot is shown. If the checkbox for a second variable is also checked (5), then settings are shown in the lower part of the screen for handling the sensitivity to the second independent variable (6). 2D interpolation options are visible only when the second variable option is checked (5).

3. If a 2D interpolation method is chosen (Figure 4), then a single table (9) is shown for entering columns and rows and multiple plots are shown (one for each value of the secondary independent variable (6)). In this case, the checkbox for a second variable is automatically checked and the control is dimmed (5). (The control is dimmed because the choice of a 2D method requires a second independent variable.) All settings for handling the sensitivity to the second independent variable with a separate function are hidden because the 2D table covers the influence of the second variable.

For any selected calculation method, the keyword for the configurable function will be the specified root keyword (2) combined with a suffix based on the selected calculation method (3). The calculation methods and associated keyword suffixes are fully described in the document *VS Math Models Reference Manual*.

(4) Name of the first independent variable. The math models do not use this label; it is a comment field provided as a means for documenting the information on the screen. Notice that it also appears on the horizontal axis of the top plot and in the heading over the top table (9).

(5) Checkbox to indicate whether there is a second independent variable. When checked, the adjacent field (6) is shown. Other controls might also be shown, if needed to describe the

calculation method. The significance of this checkbox depends on the type of calculation selected from the drop-down control (3) as described previously.

(6) Name of the second independent variable. The math models do not use this label; it is a comment field provided as a means for documenting the information on the screen. Notice that it also appears on the horizontal axis of the bottom plot (if there is one) and in the heading over the tabular data (13).

This field is shown only when two conditions are satisfied: (1) there is a secondary variable (5), and (2) a 2D interpolation method is not chosen (3).

(7) Root name of secondary function used to calculate the influence of the secondary variable. For the example shown in Figure 3, this is `L_RELAX_Y_FZ`. This field is shown whenever the drop-down control (12) is visible; otherwise, it is hidden.

(8) Miscellaneous field. Use this to provide VS commands or parameters to define the context of the data. For example, you might put in the line `IAXLE 2` to associate the dataset with the second axle suspension in the math model.

Another possible use for this field is to define a new function with the VS command `DEFINE_TABLE` such as:

```
DEFINE_TABLE MY_FUNC
```

If this is done, then the name of the new functions (e.g., `MY_FUNC`) should also be specified as the root keyword (2).

(9) Numerical values used to create a 1D or 2D table (based on the selected calculation method (3)). If it is a 1D table, then values of the primary independent variable go in column 1 and values of the dependent variable in column 2. If it is a 2D table, the top row has values of the secondary independent variable (column variable), the first column has values of the primary independent variable (row variable), and the rest of the cells have values of the dependent variable.

This table has the same behavior as the table used in most screens that are used to set up a configurable function. In this case, notice that the heading above the table uses the names provided as comments on the screen: (1), (4), and (6) (if a 2D interpolation method is chosen, as shown in Figure 4).

As with other tables, it can be presented in two styles: (1) a spreadsheet (as shown), and (2) as a scrollable text field with the numbers in each row (line of text) separated by commas.

The table is not shown if a constant or linear coefficient is specified (3).

(10) Button for viewing the combination of two functions with a 3D map (Figure 5). This button is only visible if two tables are shown ((9) and (13)). It operates by calculating the output using the two tables and the method for combining them that is selected with the drop-down control (11).

(11) Drop-down control to define how the secondary function is combined with the primary function (Figure 3). This control is shown when the adjacent drop-down list of methods is

visible (12), and is used to select the method for combining two separate functions (one for each independent variable). The two options are **add** and **multiply**.

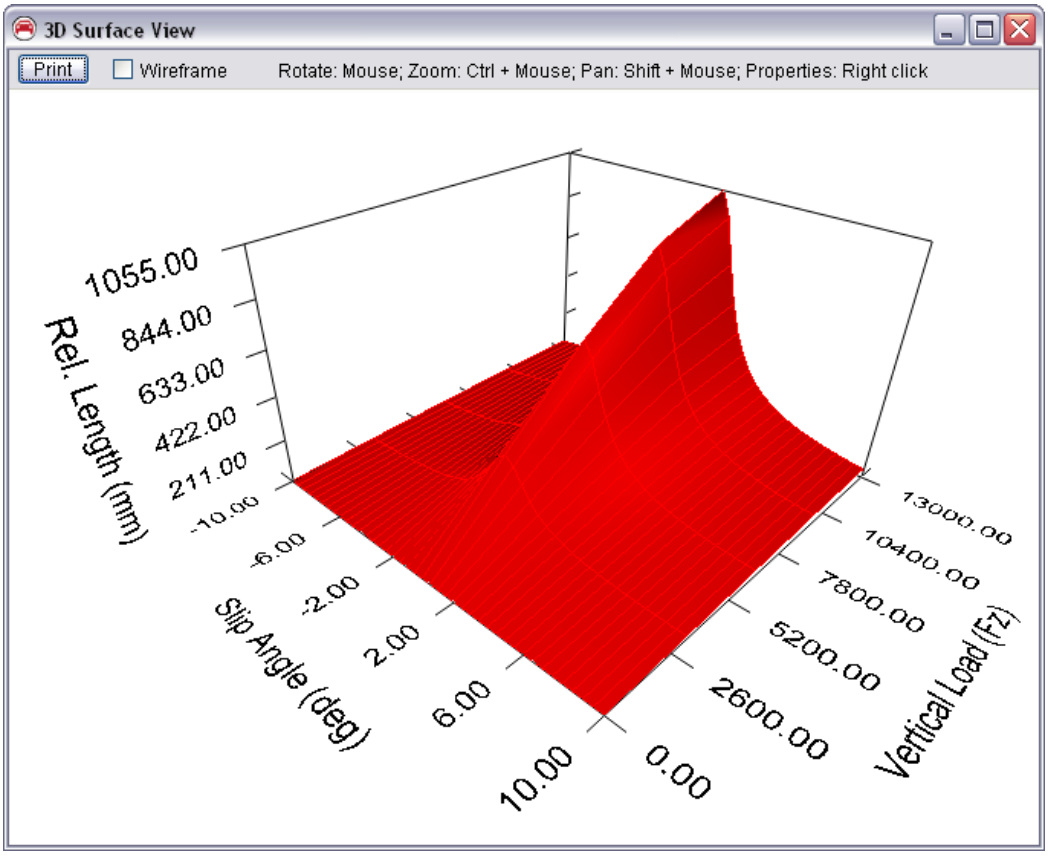

Figure 5. Graphical view of combination of two configurable functions.

(12) Drop-down list of calculation methods for the secondary function (Figure 3). This control is shown only when the calculation method selected for the primary function (3) is not 2D interpolation or equation, and the box is checked for a second independent variable (5). The list of options covers all of those in the top drop-down list (3), with the exceptions of the 2D methods and the equation option.

(13) Numerical values used to create a 1D table. Values of the secondary independent variable go in column 1. If the primary and secondary functions are added (as chosen with the drop-down control (11)), then values of a component of the dependent variable go in column 2. On the other hand, if values of the two functions are multiplied together, then values of a ratio go in column 2 (e.g., Figure 3).

As with the top table, notice that the heading above this table uses the names provided as comments on the screen: (1) and (6). If this table defined a multiplier function (see the drop-down control (11)), the heading indicates that values of ratios should be provided.

Table Conversions

When switching between interpolation modes, the VehicleSim Browser will attempt to transform your existing data as table dimensions are necessarily added or removed.

1. When changing from a constant value to a 1D or 2D table, the constant value will be applied to all independent variable table cells.
2. When changing from a linear coefficient to a 1D or 2D table, the coefficient value will be used as the slope of a line over a [0, 1] interval, intersecting zero.
3. When changing to a 2D table, the Browser will insert a column of zeros associated with the secondary independent variable at zero, and existing data will be moved to a column associated with the secondary independent variable at 1.
4. When changing from a 2D table to a 1D table, the multiple columns will be collapsed, and only the last table column will be used for all independent variable data.