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Calculator: Symbolic

The Calculator is a tool to help generate tables. It is available from the **Libraries** and **Tools** menus and provides the same capabilities as the calculator button on most screens with tables, with the advantage that the equations used to generate values for X and Y axes can be saved in the database. However, this screen is limited to 1D tables with a single independent variable; use the calculator tool to manipulate 2D tables with two independent variables.

Discussion

This screen (Figure 1) does not directly feed numbers to the VS Solvers. To use the data in a simulation run, you must transfer the numbers to the appropriate data screen via copy and paste.

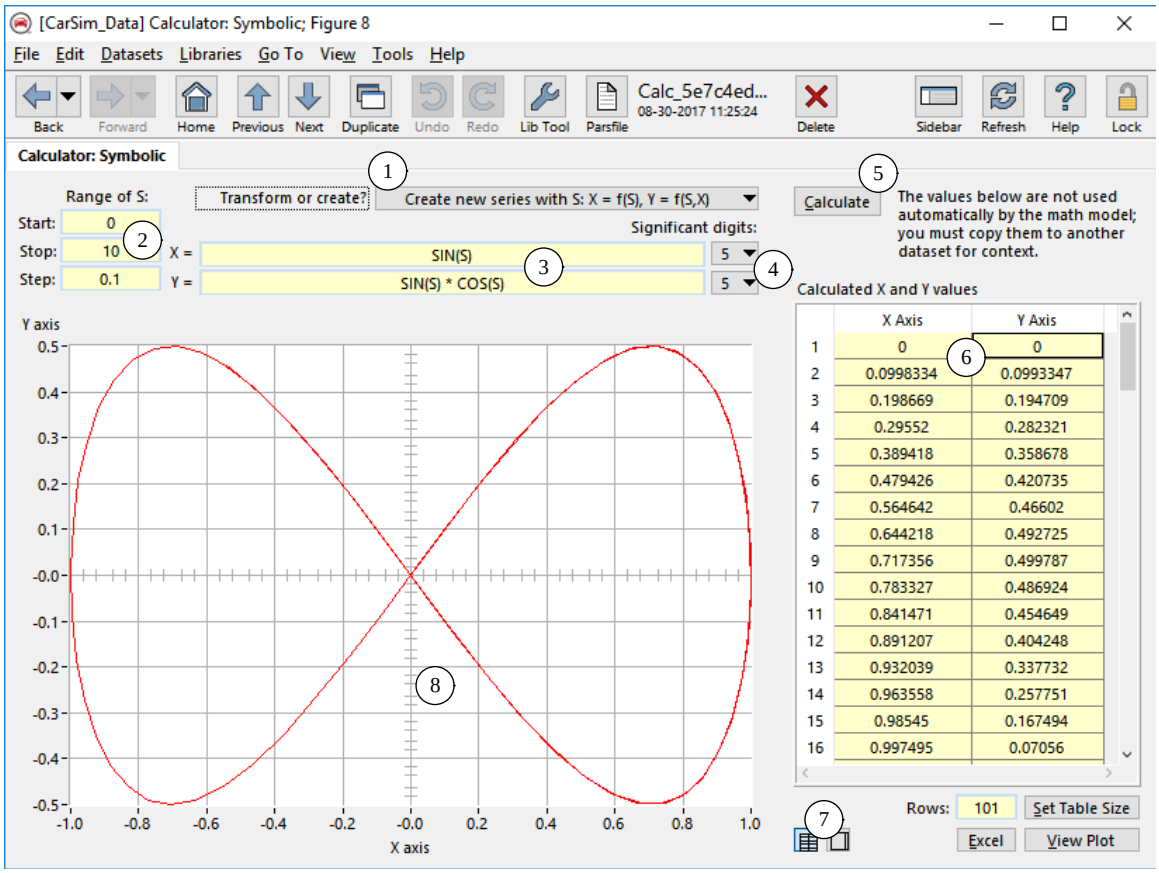

Figure 1. Use the Calculator to generate new tabular data.

This screen has four modes for performing calculations, selected from the drop-down control (1) (Figure 2). The first three are described in this section; the clothoid option is described later.

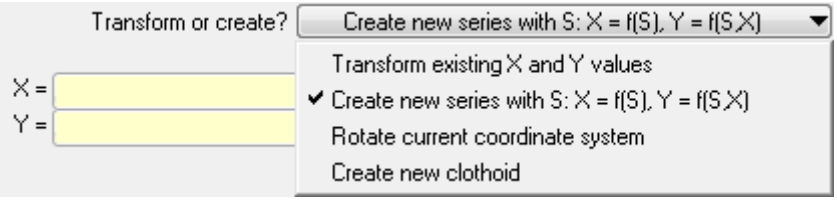

Figure 2. Options to perform calculations.

Create New Data

To create new data from scratch, you would typically perform these steps:

1. Make sure the drop-down list (1) is set to create new series of X and Y values
2. Specify equations for the X and/or Y values as functions of independent variable S (3), and set the number of significant digits that will be used for the calculated values (4).
3. Specify the start, stop, and interval values for S (2).
4. Click the **Calculate** button (5), and confirm from the plot (8) that the calculations met your expectations.
5. Copy the resulting numerical data (6) to the clipboard.
6. Navigate to the screen in the database with the table where you will use the new data.
7. Paste the data into the table.

Transform Existing Data

To transform existing data, you will typically perform these steps:

1. Start from a data screen with tabular data to be transformed.
2. Copy all or part of a table to the clipboard.
3. Navigate to the **Calculator: Symbolic** screen (this screen), and make a new dataset if there is not one already created for the transformation of interest.
4. Paste the data into the spreadsheet on this screen (6). It is sometimes easier to set the table display to the plain text field instead of the spreadsheet, to avoid problems with the number of rows not being large enough. The controls in the lower-right portion of the screen are the same as used on most screens with tables (7).
5. Make sure the drop-down list (1) is set to transform existing data (Figure 2).
6. Specify transformation equations for the X and/or Y values (3), and confirm the number of significant digits that will be used for the calculated values (4).
7. Click the **Calculate** button (5), and confirm from the plot (8) that the calculations met your expectations.
8. Copy the resulting numerical data (6) to the clipboard.
9. Click the **Back** button to return to the screen from where the tabular data were originally obtained in step 2.

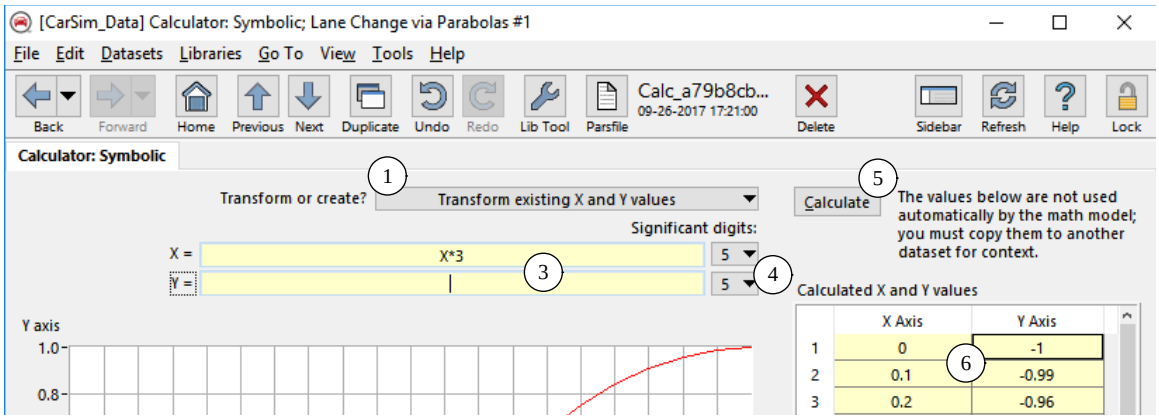

Figure 3. Use the Calculator to transform existing tabular data.

10. Paste the transformed data into the table.

Rotate Existing Data

To rotate existing data, you would typically perform these steps:

1. Start from a data screen with tabular data to be transformed.
2. Copy all or part of a table to the clipboard.
3. Navigate to the **Calculator: Symbolic** screen (this screen).
4. Paste the data into the spreadsheet on this screen (6). (It is sometimes easier to set the table display to the plain text field instead of the spreadsheet, to avoid problems with the number of rows not being large enough. The controls in the lower-right portion of the screen are the same as used on most screens with tables (7).)
5. Make sure the drop-down list (1) is set to rotate the current coordinate system (Figure 4).

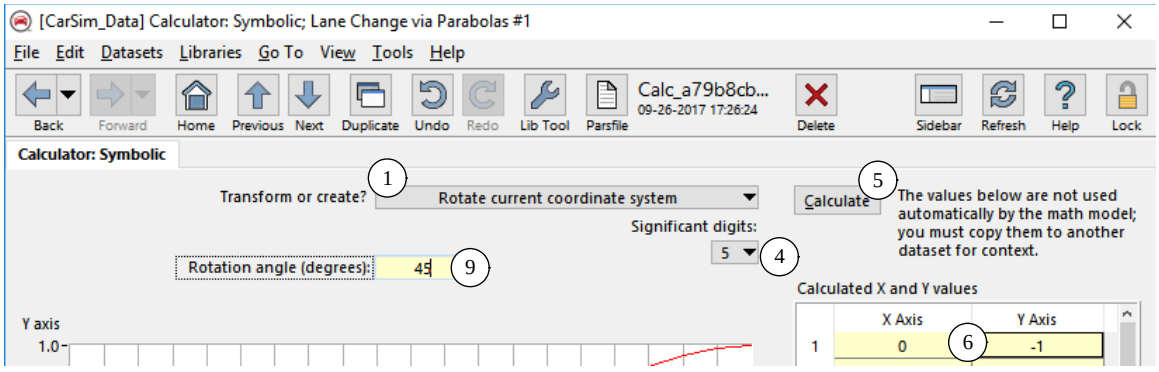

Figure 4. Use the Calculator to rotate existing tabular data.

6. Specify the angle in degrees (9) by which you want to rotate the data. The data are transformed to show a counter-clockwise rotation when looking at the plot.
7. Click the **Calculate** button (5), and confirm from the plot that the calculations meet your expectations.

8. Copy the resulting numerical data (6) to the clipboard.
9. Click the **Back** button to return to the screen from where the tabular data were originally obtained in step 2.
10. Paste the transformed data into the table.

User Settings and Controls

(1) Drop-down list for setting the calculator mode for transforming existing data, creating new series, or rotating the table (Figure 2). The first three options were described in the previous subsection. If the option is set to create new series, then three fields for defining a series of values for an independent variable S are shown (2) (Figure 1), while if the option is set to rotate the table, only the rotation field (9) is shown (Figure 4).

(2) Range of S fields. If the drop-down list is set to create a new series of values, then these three fields are made visible. S is an arbitrary independent variable that will be incremented in a linear series with the specified interval, starting with the specified value, and stopping when the specified upper limit is reached.

(3) Optional equations for defining X and Y values.

If the drop-down list (1) is set to create new data, then both fields must be given equations to define X and Y as functions of the independent variable S.

If the drop-down list (1) is set to transform existing data, then either of these fields can be left blank to leave the data intact. Enter an equation to transform the existing data using the built-in operators and functions as described in the next section.

(4) Number of significant digits. All calculations are done with double precision (64 bits), with about 12 significant digits. However, the numbers written into the table can be rounded off for easier reading and to save space, when such high precision is not necessary.

Most of the tables require that the X values all be unique and appear in ascending order. Be sure that round-off does not produce identical X values in sequential rows; this will cause an error in the VS Solver in most cases. (One exception is when X-Y coordinates are used to define paths for road reference lines or driver targets; in these cases, the X values do not have to be in an increasing sequence.)

(5) Calculate button. Click to apply the equations. The new values are plotted graphically (8) and the numerical values are shown in the table (6).

(6) A table with two columns of numbers. The table can be viewed either in spreadsheet or plain text, according to the selected style buttons at the bottom of the screen (7).

(7) The controls in the lower-right portion of the screen are the same as used on most screens with tables. There are buttons for setting spreadsheet or plain text display, transferring data to Excel, and plotting the data with VS Visualizer. See the document *VehicleSim Browser Reference Manual* for more information about the standard table controls.

(8) Graph of the values in the second column in the table plotted against the values in the first column.

(9) Rotation angle field. If the drop-down list (1) is set to rotate the current coordinate system, this field is visible. Enter an angle in degrees by which to rotate the table counter-clockwise around the origin.

Calculator Functions

The calculator recognizes the symbols `X`, `Y`, `PI` (3.141592…), `S`, `G` (9.80665), and `DR` (180/π = 57.29…), along with the basic arithmetic operators (+, -, *, /, ^) and functions listed in Table 1 that are common for scientific and engineering calculations.

Table 1. Basic math functions supported in the VS calculator.

Function	**Description**
`ABS(X)`	Absolute value
`FABS(X)`	Absolute value
`ACOS(X)`	Arc-cosine
`ADD(X, Y)`	X + Y
`ASIN(X)`	Arc-sine
`ATAN(X)`	Arc-tan with result ± π/2
`ATAN2(X, Y)`	Arc-tan(X,Y) with result ± π
`CEIL(X)`	Smallest integer ≥ X
`FLOOR(X)`	Largest integer ≤ X
`FIX(X)`	Truncate to integer closer to zero
`FMOD(X, Y)`	Remainder of X/Y
`COS(X)`	Cosine function
`COSH(X)`	Hyperbolic cosine function
`DIV(X, Y)`	X/Y
`EXP(X)`	e^X
`LOG(X)`	Natural log (base e)
`LOG10(X)`	Base 10 log function
`MAX(X, Y)`	Maximum of two arguments
`MIN(X, Y)`	Minimum of two arguments
`NINT(X)`	Nearest integer to X
`MUL(X, Y)`	X*Y
`POW(X, Y)`	X^Y
`POWER(X, Y)`	X^Y
`RAND(X)`	Pseudo-random number (X is ignored)
`SRAND(X)`	Pseudo-random number with X as seed
`SIN(X)`	Sine function
`SINH(X)`	Hyperbolic sine function
`SIGN(X, Y)`	If Y > 0 Then |X| Else –|X|

Table 1. Basic math functions supported in the VS calculator.

Function	Description
`SQRT(X)`	Square root
`SUB(X, Y)`	X–Y
`TAN(X)`	Tangent function
`TANH(X)`	Hyperbolic tangent function
`IF_GT_0_THEN(X, Y, Z)`	If X > 0 Then Y Else Z
`IF_NOT_0_THEN(X, Y, Z)`	If X ≠ 0 Then Y Else Z

All functions take double-precision arguments and return double-precision values.

Create a Clothoid

If you select the option to create a clothoid, the screen shows specialized parameters (Figure 5).

⑩ The heading is an initial heading of the clothoid at the origin.

⑪ Rate is the rate of curvature along the clothoid path. This can be any positive of negative number and will, respectively, produce either a clockwise or counter clockwise clothoid.

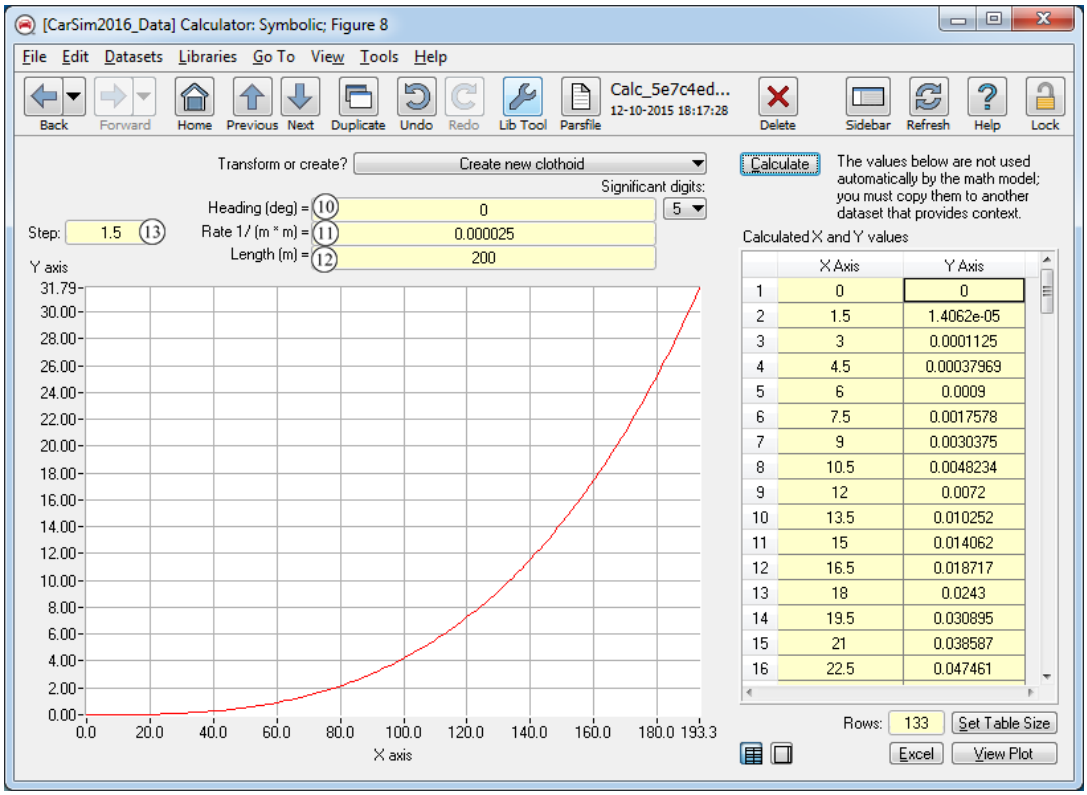

Figure 5. Creating a clothoid.

⑫ Total length of clothoid in meters.

⑬ Step is the distance between each set of calculated coordinates.