

How do I use the Equation Builder and Table function?

The Equation Builder is WinSPC's tool for creating equations. Equations are sometimes used to calculate values, limits and targets for a variable, and even can be used in user-defined tests and triggers.

Displaying the Equation Builder

You can use the Equation Builder to develop an equation for any of the following...

URL, USL, Target, LSL, LRL – Open the Properties window for the variable that you would like to build the equation for. Click on the Advance button. Select the Equation radio button for the limit or target and click the Equation Builder icon beside that button. The Equation Builder icon consists simply of three dots. The Equation Builder icon consists simply of three dots [...]. Calculate Variables - Open the Properties window for the variable that you would like to build the equation for. Click on the Advance button. Select the Settings tab. Check the Calculated checkbox and then click the Equation button. Sample Level Test - In the Administrator window, double-click on a User-Defined sample level test. When this is done, the name given to the dialog box that appears is Sample Level Test Setup. Other than this name, this dialog box is identical to the Equation Builder. Trigger Setup - - In the Administrator window, double-click the Control Test Template and select a test in the left pane and click the green plus sign [+] near the upper right of the dialog box. When this is done, the name given to the dialog box that appears is Sample Level Test Setup. Other than this name, this dialog box is identical to the Equation Builder. The following triggers have the equation builder option to choose from : Log, E-Mail, Message Box, Serial Message, File, Poke DDE Item, Set OLE Auto Property, and Write OPC Item. After you have made one of the above selections, click on the Insert Equation... button.

Building an Equation

In the Equation Builder (see Figure 1), from the Functions, Operators, Statistics and Variables lists, double-click the function, operator, statistic or variable you want to appear first in the equation. This copies the function, operator, statistic or variable to the right of Result = in the Calculation Text area. If preferred, you may drag-and-drop a list item to the Calculation Text area or enter the equation using your keyboard. If you enter the equation using your keyboard, notice that, as the characters you type match list items, those items become highlighted. Once only one highlighted item remains, pressing the [Space Bar] auto-fills the remaining characters of that item into your equation. Double-click other functions, operators, statistics and variables as appropriate in the order in which you want them to appear in the equation. If desired, create an interpolation table by completing the Creating and using a Look-Up table procedure below. Click the OK.

Creating and using a Look-Up table

A look-up table is a table used to match an input value with a standard set of predefined values.

In the Equation Builder that is displayed, click the Table button (see Figure 2). In the Table Editor that is displayed, single-click the first cell in the A value of column and enter a value that, upon collection, will be replaced by a pre-defined value. Single-click the first cell of the Results in column and enter a value that which the variable value is to be replaced. Repeat the preceding two steps for other and pre-defined values as desired. Notice that, as you do, a curve is displayed and updated in the right half of the Table Editor. If, at any point, you want to edit a previously entered value, single-click the cell and enter the new value. If, at any point, you want to delete an input value and its corresponding predefined value, single-click either value, and click the Delete button in the lower left corner. If, at any point, you want to edit a previously entered value,

single-click the cell and enter the new value. If, at any point, you want to delete an input value and its corresponding predefined value, single-click either value and click the Delete button in the lower left corner. Click the OK. The Table Editor closes and the value pairs you entered in the table are copied to the Calculation Text pane of the Equation Builder, the first item of the pair being the variable value and the second being the pre-defined value. Double-click on the function, from the Functions list, that you want to use with the look-up table. The applicable options are:

Lookup: When a variable value is collected or calculated during Data Collection, this function scans the values in the extrapolation table's A value of column for that value. If a match is found, it returns the matching pre-defined value. If a match isn't found, it returns 0 (zero). LookupNearest: This function works similarly to the Lookup function but returns the value nearest to the input value if a matching value isn't found.

LinearInterpolate: This method uses the intercept of straight lines between points defined in the Table Editor.

Points beyond the start and end points will be in a straight line. CubicInterpolate: This method use the intercept of a smooth curve (cubic spine interpolation) between points defined in the Table Editor. Points beyond the start and end points will be in a straight line. IsExtrapolated: Returns 1 (True) if the result was extrapolated from the table. It will return 0 (False) if it was not extrapolated from the table (Value was in the table). IsInTable: Returns 1 (True) if the value is in the table, else it returns 0 (False) if it is not in the table.

Double-click the opening parenthesis "(" from the Operators list. Alternately the opening parenthesis can be entered from the keyboard. Double-click the name of the variable, from the Variables list, to which the interpolation will be applied. Double-click the closing parenthesis ")" from the Operators list. Alternately the closing parenthesis can be entered from the keyboard.

Click the OK button to exit the Equation Builder.

Understanding the Equation Builder Statistics

FUNCTIONS LIST: The mathematical functions that can be selected and used in an equation. The following table lists and explains the available functions.

Function	Explanation
Abs	Absolute value of a variable.
ACos	Arc Cosine
ASin	Arc Sine
ATan	Arc Tangent
Cos	Cosine
CubicInterpolate	Creates a smooth curve between points defined in the Interpolation Table Editor. Points extrapolated beyond the start and end points will be in a straight line.
Do	Conditional branching Do While.....
Else	Conditional branching If... Then... Else
End	Halts execution of calculation.
Exp	Exponent.
False	Logical operator
If	Condition operator If...Then...Else...Endif
IsExtrapolated	Returns a value of 1 (True) if a value is extrapolated from data in an Interpolation Table, otherwise it returns a value 0 (False).
IsInTable	Returns a value of 1 (True) if value is contained in an Interpolation Table, otherwise it returns a value 0 (False).
Let	Assigns a variable.
LinearInterpolate	Creates a straight line between points defined in the Interpolation Table Editor. Points extrapolated beyond the start and end points will be in a straight line.

Ln	Natural logarithm (base e) of x.
Log	Logarithm (base 10) of x.
Lookup	Looks up the value at a specified location within a table.
LookupNearest	Checks a table to see if the value is listed. If not, it then extrapolates a value based on the last two values at the appropriate end of the table.
Mod	MOD returns the remainder when the first parameter is divided by the second parameter.
Pi	Mathematical constant = 3.1415926...
Result	Define the result of the calculation.
Sign	Returns -1 for numbers less than 0, 0 for 0, and 1 for numbers greater than 0.
Sin	Trig function Sine
Table	Creates a table containing the listed data
Tan	Trig function Tangent.
Then	Condition operator. If...Then...Else...Endif
True	Logical operator.
Violation	Defines the terms of the Test.
Wend	Conditional operator Do while..... Wend

OPERATORS LIST: The mathematical operators that can be selected and used in an equation. The following table lists and explains the available operators.

Operator	Explanation
-	Subtraction.
(Opening parenthesis.
)	Closing parenthesis.
*	Multiplication.
.	Must be followed by a stat name (i.e. x.mean).
.Bar	Used to find the average value of a stat (i.e. x.R.Bar).
Previous[]	Used to find the value of a stat of a previous subgroup (i.e. Previous[2].R = R from 2 subgroups back).
.Product	Used to find the value of a stat of an associated variable (i.e. x.Product.Mean {where x is a characteristic}).
/	Division.
And	Logical operator.
Not	Logical operator.
Or	Logical operator.
[Opening bracket.
]	Closing bracket.
^	Exponential (to the power of)
	Alternate for absolute value (i.e. abs(x) or x).
+	Addition.
<	Less Than.
<=	Less Than Or Equal To.
<>	Not Equal To.
=	Equal To.
>	Greater Than.
>=	Greater Than Or Equal To.

STATISTICS LIST: The SPC-related statistics that can be selected and used in an equation. The following table lists and explains the available statistics.

Statistics	Explanation
Avg	Average of all of the individual values.
Cm	Machine capability
Cp	Process Capability
Cpk	Process Capability Index
Cpkm	Process Capability Index (Adjusting)
Cpl	Process Capability Index Lower
Cpm	Process Capability (Adjusting)
Cpu	Process Capability Index Upper
Cr	Process Capability ratio
CuSum	Cumulative Sum Slope
Diff	Difference between X and Target for subgroup size of 1 for short run statistics
DiffMR	Moving Range of the Diff statistic and depends on the SubRangeSize for short run stats
Diff-bar	Difference between XBar and Target for subgroup size of greater than 1 for short run statistics
Diff-barR	Range of the Diff bar statistic for short run statistics
EWMA	Exponentially Weighted Moving Average
EWMS	Exponentially Weighted Mean Square
EWMV	Exponentially Weighted Moving Variance
EW RMS	Exponentially Weighted Root Mean Square
IndW	W statistic for individuals
IndWStar	WStar statistic for individuals
Kurtosis	Peakedness of the probability distribution
Lambda	The exponential weighting factor used by all of the exponentially weighted charts as set in Variable Setup
LCL	Lower Control Limit
LotSize	Fixed Lot Size setting for an attribute
LRL	Lower Reasonable Limit
LSL	Lower Specification Limit
Max	Maximum value in a subgroup
Mean	Average of the samples in the current subgroup
Median	Middle value
Min	Minimum value in a subgroup
MR	Moving Range
Mu	Population Mean
NumSigma	s value set in the Variable Setup (Default = 3)
Pm	Machine Performance
Pp	Process Performance
Ppk	Process Performance Index
Ppkm	Process Performance Index (Adjusting)
Ppl	Process Performance Index Lower
Ppm	Process Performance (Adjusting)
Ppu	Process Performance Index Upper
Pr	Process Ratio
PriCL	Primary Chart Center Line
PriLCL	Primary Chart Lower Control Limit
PriUCL	Primary Chart Upper Control Limit
PZI	[Average - Lower Spec Limit] / Standard Deviation in a Subgroup

PZMin	The minimum between PZl or Pzu
PZu	[Upper Spec Limit - Average] / Standard Deviation in a Subgroup
R	Range in a subgroup
S	Standard Deviation in a subgroup
SecCL	Secondary Chart Center Line
SecLCL	Secondary Chart Lower Control Limit
SecUCL	Secondary Chart Upper Control Limit
Sigma	Process variability based on a control chart
Skew	Skewness - measure of the asymmetry of the probability distribution
SpecType	Specification Type in Variable Setup 0=Bilateral, 1=Unilateral Upper, 2=Unilateral Lower
SSquared	S2 - Squared deviations around the mean
StationSubGroupNumber	Sub-group Number for data collection station
StdDev	Standard Deviation
SubGroupSize	Sub-group Size
SubRangeSize	Sub-range Size
	Sub-group Number in database
Target	Nominal value
UCL	Upper control limit.
URL	Upper reasonable limit.
USL	Upper specification limit.
W	Range divided by Sigma
WStar	Range divided by R Bar
Z	Z score (or standard normal distribution)
Zl	Z distribution Lower
ZMin	Z distribution Minimum
ZStar	Z distribution Star
ZStar-bar	Z distribution Star-bar
Zu	Z distribution Upper
Z-bar	Z distribution Average

<https://knowledgebase.winspc.com/questions/208/>

SystemSubGroupNumber