

Process Capability and Process Performance Indices

The Six Sigmas Process Capability Index and Process Performance Index are indicators of a process's ability to produce output with the specification limits. More generally speaking, it's an indicator of how likely a particular data stream is to stay within its set bounds.

Assuming the process output (i.e. the Info360 data stream we're reviewing) has a normal distribution, the indices can be determined using the following equations:

$$C_p, P_p = \frac{USL - LSL}{6\sigma}$$

$$C_{pk}, P_{pk} = \min \left[\frac{USL - \bar{x}}{3\sigma}, \frac{\bar{x} - LSL}{3\sigma} \right]$$

where USL and LSL are the Upper and Lower Specification Limits respectively. The mean and standard deviation are calculated with the following equations, where N is handled differently between Process Capability and Process Performance:

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^2}$$

$$\bar{x} = \frac{1}{N} \sum_{i=1}^N x_i$$

Index	N =
Cp, Cpk	N represents the recent number of periods based on user input
Pp, Ppk	N represents all available data from the data stream

Cpk vs Ppk - What should I use?

Process Capability is generally performed on processes that are already under statistical control, while Process Performance is used in other cases.

In general, Water system data is not under statistical control, however we make Cp and Cpk available since past data may become invalid in regards to current operations.

What do the indices mean?

The index is an indicator of how far within the bounds the data and its natural scatter will occur. A value of 1 generally means that the thresholds are at three standard deviations from the mean. For a normal distribution, the data will fall within the bounds about 99.7% of the time.

A higher value is better. A negative value (Cpk only) means that the mean falls outside the bounds.

Pp vs Ppk - Generally you should include the "k"

Cp and Pp are a measure of the spread of the data compared to the available range; these can be used if you assume that the mean is centered between the USL and LSL. Cpk and Ppk are a more conservative indicator that accounts for bias in the mean. When the mean is not centered between the USL and LSL, the Cpk will be lower than the Cp. Cpk cannot be higher than the Cp.



Note:

These equations assume process output is approximately normally distributed.

Parameter	Description
Input Data*	Defines the time series data fed into the function. This can be a sensor ID or another function.
Period	Number of data intervals considered in the function. *Only applicable to Cp and Cpk. Pp and Ppk don't have this input.
Lower Limit	Lower specification limit
Upper Limit	Upper specification limit

*Input data is optional in most cases. If Info360 detects that the first input is time series data, it will be applied to the function. Otherwise, the current active sensor's data will be used, which is often the case in Reference Charts.

Example Usage as an Expression:

Cpk(60,10,20) - Outputs an index of how likely the current data stream will stay between 10 and 20 based on the past 60 data points.

Ppk(10,20) - Outputs and index of how likely the current data stream will stay between 10 and 20 based on all available historic data.

Examples Reference Chart:

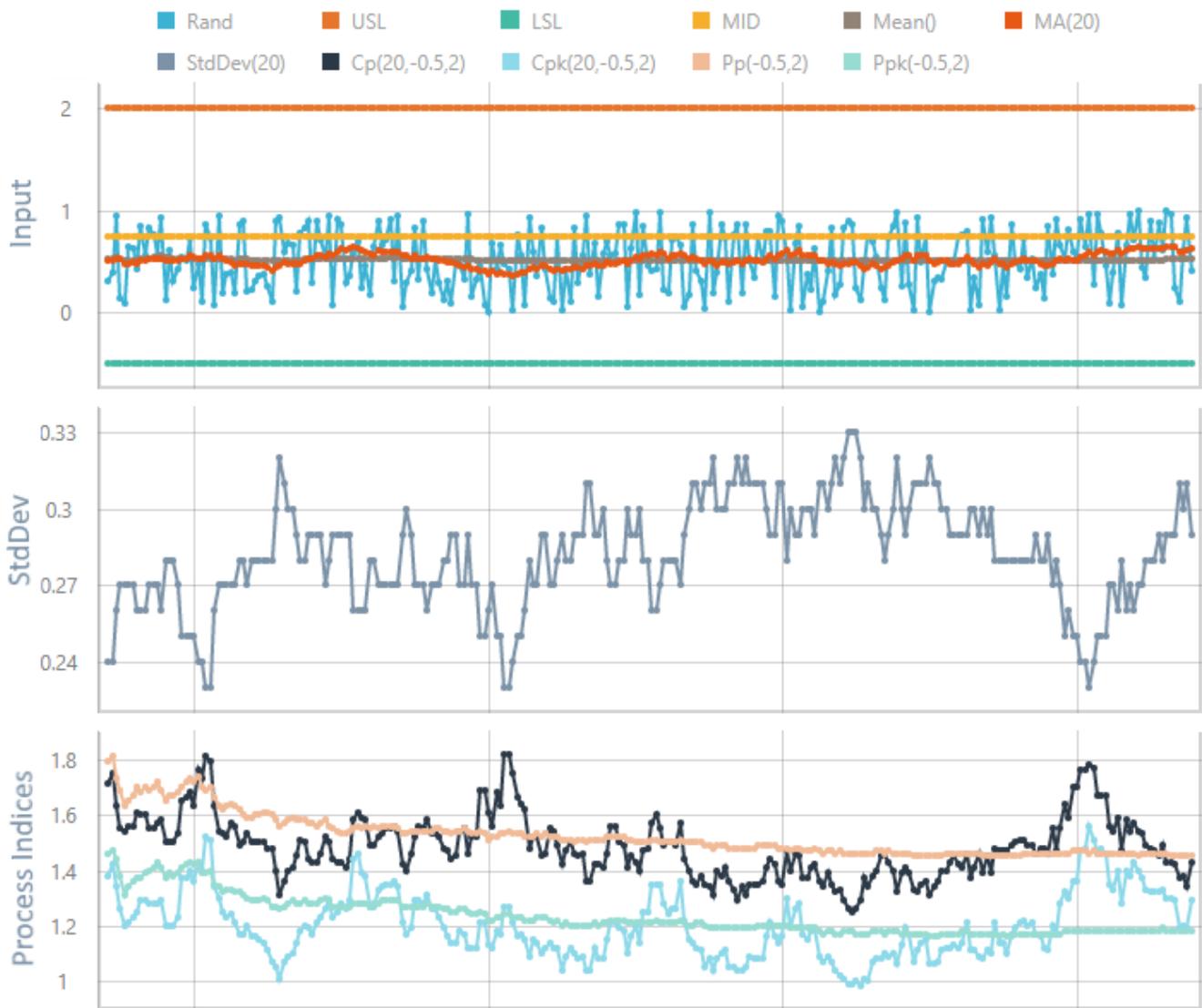
The following example analyzes how likely the input data of Random(0,1) will remain between the bounds of -0.5 and 2. Of course, we know that the outputs from this function will always occur between 0 and 1.

In the top chart, we plot our USL, LSL, and the MID line for reference which is the mid point between the USL and LSL.

Mean() and MA(20) are plotted together to show the difference between short term trends from the long term trend. This difference plays out between the Process Capability and Process Performance indices.

StdDev is plotted in the middle panel for reference.

The bottom panel shows the four indices, which all remain above 1. Cp and Cpk vary more over time, while Pp and Ppk remain more consistent. Also the Cpk and Ppk are consistently lower than the Cp and Pp since the mean is biased lower than the mid point between the USL and LSL.



For information on setting up custom equations and syntax, please refer to [Analytical Functions](#).