Summary

This Statlet assists analysts in determining how large samples should be when constructing capability control charts. Capability control charts monitor processes which have been shown to be stable and capable of producing results that yield small numbers of nonconformities.

Capability control charts may be constructed for:

2. The long-term capability index $P_p$.
3. The short-term capability index $C_{pk}$.
4. The long-term capability index $P_{pk}$.
5. The proportion of nonconforming items.
6. The rate of nonconformities.

For more information on such charts, refer to the documents titled Capability Control Charts for Variables and Capability Control Charts for Attributes.

Sample StatFolio: capchartdesign.sgp
Sample Data
None.

Analysis Window

To execute the procedure, select *Statlets – Sampling – Capability Control Chart Design* from the Statgraphics menu. This will display an analysis window similar to that shown below:

It is assumed that a total of $n$ observations will be collected from the process being monitored at each time period in order to create the capability control chart. The $n$ observations may be collected by obtaining $n$ individual samples, each of size 1, or $m$ subgroups may be collected which when combined yield $n$ observations. The purpose of the procedure is to determine a reasonable value for $n$.

The toolbar contains a number of controls that allow you to specify desired options:

- **Parameter to be estimated**: the parameter to be plotted on the capability control chart. The list includes capability indices, the proportion of nonconforming items, and the rate of nonconformities.

- **Estimated subgroup sigma**: for short-term capability indices such as $C_p$ and $C_{pk}$, the method used to estimate the short-term within-subgroup standard deviation. This field is ignored if the “Subgroups per sample” field is set to 1, which indicates that data will be collected as individuals rather than in subgroups.
- **Subgroups per sample**: the number of subgroups collected at each time period. If the data will be collected as individuals, set this field to “1”.

- **Base sample size on**: specifies the goal from among the following choices:
  1. **Power**: indicates that the sample size should be determined in order to control the power of the chart. “Power” is defined as the probability that a plotted value will be outside of the control limits when the parameter being charted actually equals the “Alternative value”.
  2. **Average run length**: indicates that the sample size should be determined in order to control the average number of samples that need to be collected before a plotted value falls outside of the control limits when the parameter being charted suddenly shifts to the “Alternative value”.

- **Centerline**: the location of the centerline of the capability control chart. This value is considered to be the standard value where the process is normally assumed to operate.

- **Alpha risk**: the probability that a plotted value will fall outside of the control limits when the actual value of the parameter being plotted equals the value specified by the centerline. A standard “3-sigma” control chart has an alpha risk equal to 0.27% if two-sided and 0.135% if one-sided.

- **Alternative value**: the value of the parameter being plotted at which the power or average run length will be controlled.

- **Power**: if **Base sample size on** is set to “Power”, the probability that a plotted value will be outside of the control limits when the parameter being charted actually equals the “Alternative value”.

- **ARL**: if **Base sample size on** is set to “Average run length”, the average number of samples that will need to be collected before a plotted value falls outside of the control limits when the parameter being charted suddenly shifts to the “Alternative value”.

- **Chart type**: whether the chart has both upper and lower control limits or only one limit.

- **Options**: displays a dialog box with additional options:
The Options dialog box is used to control the minimum value, maximum value, and increment of the Statlet scrollbars. It also specifies:

- **Maximum n**: the largest sample size considered. If the specified conditions cannot be satisfied at that \( n \), no solution is given.

- **Show alternative hypothesis**: whether or not the alert probability at the alternative hypothesis is displayed on the graph.

**Example**

The window displayed earlier shows the solution to the following problem:

“Find the sample size \( n \) required to create a capability control chart for \( C_{pk} \) with only a lower control limit (LCL). Assume that the data will be collected as individuals and that the short-term sigma will be estimated using the average moving range. The expected value of \( C_{pk} = 1.5 \). At that value, we desire a false alarm probability of 0.1\%. Collect enough data that there will be a 90\% chance of getting an alert (a point below the lower control limit) if the actual \( C_{pk} \) falls to 1.0.”

**Output**

The output of the Statlet shows several important results:

1. The title of the graph shows the **sample size** \( n \) required to meet the specified conditions. For the example, a sample of \( n = 60 \) observations is required.
2. The plotted **OC (Operating Characteristic) curve** shows the probability of getting a point at or above the LCL as a function of the true value of $C_{pk}$.

3. The calculated probability of getting an alert is displayed at the specified value of the alternative hypothesis. In the example, the probability of getting a point at or above the LCL when $C_{pk} = 1.0$ is approximately 9.96%.

**Calculations**

Information about the calculations performed may be found in the following PDF documents:

1. *Capability Control Charts for Variables*

2. *Capability Control Charts for Attributes*

The required sample size is determined by starting at $n = 3$ and increasing it until the specified conditions are met.