Process Capability Cp, Cpk and Expected Defects

Process capability indices Cp, Cpk, Cpu and Cpl from specification limits, mean and standard deviation, with expected ppm out of specification.

Method: Process capability ratios (Montgomery, Introduction to Statistical Quality Control, 7th ed. (Wiley, 2012), ch. 8)

Input parameters

Unit system: SI

Parameter	Value	Unit
Upper specification limit	10.500	
Lower specification limit	9.5000	
Process mean	10.100	
Process standard deviation	0.10000	

Calculated results

Parameter	Value	Unit
Potential capability	1.6667	
Upper capability	1.3333	
Lower capability	2.0000	
Actual capability	1.3333	
Expected out of specification (ppm)	31.672	

Notes for this case

• Assumes a stable, normally distributed process; σ should be the within-subgroup estimate. Cpk of 1.33 is a common minimum; 1.67 for critical features.

Formula and method

$$C_p = \frac{USL - LSL}{6\sigma}, \quad C_{pk} = \min\left(\frac{USL - \mu}{3\sigma}, \frac{\mu - LSL}{3\sigma}\right)$$

$$ppm = 10^6\left[1 - \Phi(3C_{pu}) + \Phi(-3C_{pl})\right], \quad \Phi(z) = \frac{1}{2}\left[1 + \operatorname{erf}(z/\sqrt{2})\right]$$

Variables

USL	Upper specification limit	-
LSL	Lower specification limit	-
μ	Process mean	-
σ	Process standard deviation	-
C_p	Potential capability	-
C_{pu}	Upper capability	-
C_{pl}	Lower capability	-
C_{pk}	Actual capability	-
ppm	Expected out of specification (ppm)	-

Method and standards

Capability ratios.

Assumptions and limits

- Normal, stable process.

References

• Process capability ratios (Montgomery, Introduction to Statistical Quality Control, 7th ed. (Wiley, 2012), ch. 8)

Report details

Report reference	FCC-QCXY-V6B9 (the same inputs always give the same reference)
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Release checks	2 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/general/geometry/process-capability-cp-cpk

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.