

SPC X-bar and R Control Chart

How-to guide: what the workbook does, how to use it and what every number means.

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SPC X-bar and R Control Chart

Log subgroups of measurements and get X-bar and R control limits, both charts and every out-of-control signal named in words as you type.

For: Quality engineers, process engineers, cell leaders and operators running SPC on a measured characteristic.

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Quick start

1. On Setup, name the characteristic and its unit, and set the subgroup size (2 to 5), the number of baseline subgroups and the run-rule length.
2. On Subgroups, add one row per subgroup: subgroup number, date and the readings in time order.
3. Read the Signal column: anything other than In control names the rule that fired. Write the cause and action in Notes.
4. Open the Dashboard for the X-bar and R charts of the latest 30 subgroups and the current limits.
5. Once the baseline is stable, keep the baseline count fixed so new subgroups are judged against it.

What is in the workbook

Start Here	Read this first: what the workbook does and how to use it.
Setup	The characteristic, its unit, the subgroup size, the baseline and the run rule. Constants are public SPC constants.
Subgroups	One row per subgroup, readings in time order. Mean, range and the Signal column update as you type.
Dashboard	X-bar and R charts of the latest 30 subgroups, the control limits and every signal in words.
Method	How every number is calculated, with assumptions, limits and sources.
Verify	Self-check: the workbook's formulas recomputed on fixed inputs against an independent reference.

What each number means

Quantity	How it is calculated	Units
Mean	Average of the subgroup's readings; blank unless exactly n readings are filled in.	unit
Range	Largest reading minus smallest reading in the subgroup.	unit
Baseline	The first N subgroups by subgroup number (Setup; 0 = all). Only baseline subgroups with n readings set the limits.	subgroups

Quantity	How it is calculated	Units
Grand mean (X-double-bar)	Average of the baseline subgroup means. Centre line of the X-bar chart.	unit
Average range (R-bar)	Average of the baseline subgroup ranges. Centre line of the R chart.	unit
Within sigma estimate	R-bar / d2, with d2 for the subgroup size (2.326 for n = 5).	unit
X-bar control limits	X-double-bar +/- 3 x sigma / sqrt(n). The same as X-double-bar +/- A2 x R-bar with A2 = 3 / (d2 sqrt n); the printed A2 (0.577 for n = 5) is this value rounded.	unit
R control limits	Upper = D4 x R-bar, lower = D3 x R-bar (D3 = 0 for n up to 6, so the lower limit is 0).	unit
Side	Helper column: +1 when the mean is above the centre line, -1 below, 0 on it.	+1/-1
Signal	First rule that fires: reading count not n; duplicate number; mean above UCL or below LCL; range above the R UCL; run of RunLen subgroups (Setup, default 7) on one side of the centre line, ending at this one. Otherwise In control.	words
Subgroups with a signal	Subgroups with a number minus those whose Signal is In control.	subgroups

Assumptions, limitations, sources and the self-check (the Verify sheet, which recomputes the workbook's formulas on fixed test inputs) are in the workbook. The last page shows the Dashboard with the example data for Ashby Components, a fictional business.

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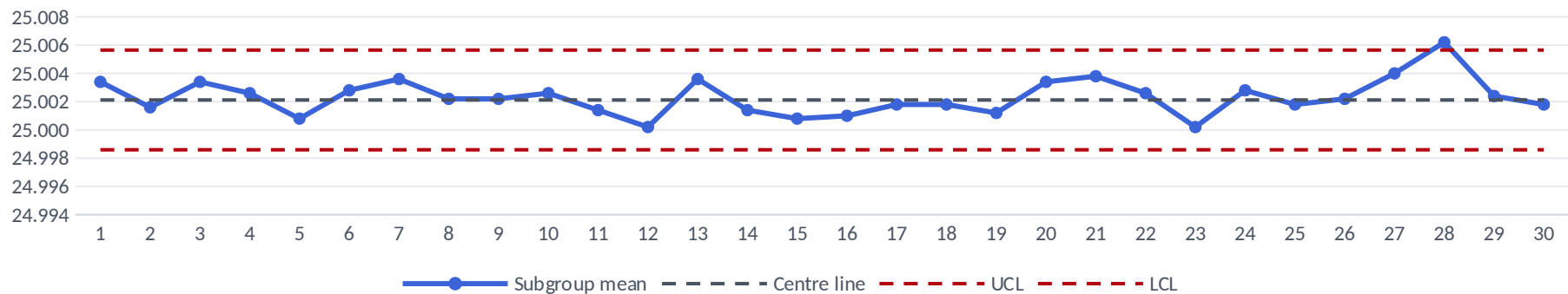
X-bar and R charts of the latest 30 subgroups, the control limits and every signal in words.

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Bearing journal diameter, OP30 (example) | Ashby Components, Cell 3 (example) | n = 5, limits from subgroups up to no. 25 (25 subgroups)

SUBGROUPS WITH A SIGNAL	GRAND MEAN (mm)	AVERAGE RANGE (mm)	WITHIN SIGMA, EST. (mm)
1	25.0021	0.0061	0.0026
Limit 0	X-bar centre line, baseline subgroups	R chart centre line	R-bar / d2
Out of limits			

X-bar chart: subgroup means



R chart: subgroup ranges

