

Statistical formulas

Control charts for Variables

Statistical calculations

Average \bar{X} =
$$\bar{X} = \frac{\sum X_i}{n}$$

Capability C_p =

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

Standard deviation =
$$\sigma = \frac{\sqrt{\sum (X_i - \bar{X})^2}}{n-1}$$

Capability C_{pk} =

$$C_{pk} = \frac{\min(USL - \bar{X}, \bar{X} - LCL)}{3\sigma}$$

$$C_{pk} = \frac{\min(\bar{X} - LCL, USL - \bar{X})}{3\sigma}$$

Average R (Range) =
$$\bar{R} = \frac{\sum R_i}{n}$$

$$Z_{USL} = \frac{USL - \bar{X}}{\sigma}$$

$$Z_{LSL} = \frac{LSL - \bar{X}}{\sigma}$$

Control limits \bar{X} =
$$UCL_{\bar{X}} = \bar{X} + 3\sigma$$

$$LCL_{\bar{X}} = \bar{X} - 3\sigma$$

USL = Upper specification limit
LSL = Lower specification limit

Coeff. of Variation (%) =
$$\frac{\sigma \times 100}{\bar{X}}$$

$UCL_{\bar{X}}$ = Upper control limit \bar{X}
 $LCL_{\bar{X}}$ = Lower control limit \bar{X}
 UCL_R = Upper control limit R
 LCL_R = Lower control limit R

$$\sum X_i = X_1 + X_2 + X_3 + \dots + X_n$$

$$\sum R_i = R_1 + R_2 + R_3 + \dots + R_n$$

Control limits

X - R Charts

X - s Charts

Control limits \bar{X} =
$$UCL_{\bar{X}} = \bar{X} + A_2 \bar{R}$$

$$LCL_{\bar{X}} = \bar{X} - A_2 \bar{R}$$

Control limits \bar{X} =
$$UCL_{\bar{X}} = \bar{X} + A_3 \bar{s}$$

$$LCL_{\bar{X}} = \bar{X} - A_3 \bar{s}$$

Control limits R =
$$UCL_R = D_4 \bar{R}$$

$$LCL_R = D_3 \bar{R}$$

Control limits R =
$$UCL_R = B_4 \bar{s}$$

$$LCL_R = B_3 \bar{s}$$

Standard deviation =
$$\sigma = \bar{R} / d_2$$

Standard deviation =
$$\sigma = \bar{s} / c_4$$

Charts for Individuals

Median Charts

Control limits \bar{X} =
$$UCL_{\bar{X}} = \bar{X} + E_2 \bar{R}$$

$$LCL_{\bar{X}} = \bar{X} - E_2 \bar{R}$$

Control limits \bar{X} =
$$UCL_{\bar{X}} = \bar{X} + A_2 \bar{R}$$

$$LCL_{\bar{X}} = \bar{X} - A_2 \bar{R}$$

Control limits R =
$$UCL_R = D_4 \bar{R}$$

$$LCL_R = D_3 \bar{R}$$

Control limits R =
$$UCL_R = D_4 \bar{R}$$

$$LCL_R = D_3 \bar{R}$$

Standard deviation =
$$\sigma = \bar{R} / d_2$$

Standard deviation =
$$\sigma = \bar{R} / d_2$$

Statistical alarms

Western Electric rules

Zone A =

Target + 2 σ	▶	UCLx
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Zone B =

Target + σ	▶	Target + 2 σ
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Zone C =

Target	▶	Target + σ
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Target - 2 σ	▶	LCLx
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Target - σ	▶	Target - 2 σ
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Target	▶	Target - σ
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- ▶ One single point above the UCLx
- ▶ 2 points out of 3 in zone A
- ▶ 4 points out of 5 in zone B
- ▶ 8 consecutive points in zone C
- ▶ One single point below the LCLx
- ▶ One single point above the UCLR

Western Electric rules

