

## GR&R Test Type

**Note:** For the mathematical formulas to display properly in this help file, please download and install the free [MathPlayer](#). Once this is installed, refresh this topic. The page displays the math formulas in blue text. Click on these formulas displays them in a slightly larger size.

This test type produces a GR&R Report by the average and range method. The resulting GR&R Report breaks down variation into repeatability and reproducibility, or gage capability statistics. The analysis estimates the variation and percent of variation for the total measurement system, as well as repeatability, reproducibility and part-to-part variation.

This test type produces a report with the following sections:

### SUMMARY

Each GR&R Report contains a SUMMARY section listing:

**RBAR** (operator trace value): The range means for each operator

**RBARBAR**: The mean of the range for all operators

**UCLR**: The upper control limit range

A **judgment** stating whether or not range subgroups are in control

**XBAR** (operator trace value): The individual means for each operator

**DIFFXBAR**: The difference between the individual means

### Variation Table

The Variation Table for this test type lists **Variation**, **% of Total Variation**, and **% of Tolerance** for each of the following values:

**EV**: Repeatability or equipment variation, calculated by multiplying the average range by the constant K1. Refer to Table D3 in Quality Control and Industrial Statistics by Acheson J. Duncan, fifth edition, for the calculations used to determine the value of K1.

$$RBARRBAR \times K1$$

$$K1 = \frac{CalcBase}{d_2(m, g)}$$

where *CalcBase* = either 5.15 or 6.0 (depending on whether you have set your CONFIGURE options to use the American or European standard; American is the default.)

*m* = number of trials and *g* = parts x operators (number of parts multiplied by the number of operators)

**AV**: Reproducibility or appraiser variation, calculated by multiplying the maximum average operator difference by the constant K2. Refer to Table D3 in Quality Control and Industrial Statistics by Acheson J. Duncan, fifth edition, for the calculations used to determine the value of K2.

$$\sqrt{AV = (DIFXBAR \times K2)^2 - \frac{EV^2}{(np \times nt)}}$$

where  $np$  stands for "number of points" and  $nt$  stands for "number of trials"

$$K2 = \frac{CalcBase}{d_2.(m, g)}$$

where  $m$  = number of operators and  $g = 1$

**RR:** The measurement system variation for repeatability and reproducibility, calculated by adding the sum of the square of the equipment variation and the square of the appraiser variation, and taking the square root.

$$R \& R = \sqrt{(EV)^2 + (AV)^2}$$

**PV:** The part-to-part variation, calculated by multiplying the range of part averages by the constant K3. Refer to Table D3 in Quality Control and Industrial Statistics by Acheson J. Duncan, fifth edition, for the calculations used to determine the value of K3.

$$PV = PartRange \times K3$$

where  $PartRange$  is the range of the average part measurements.

$$K3 = \frac{CalcBase}{d_2.(m, g)}$$

where  $m$  = number of parts and  $g = 1$

### Judgment

**Judgment:** This column displays in the Variation Table only if you have set the report's configure options to Show Judgment. A rating of the process's variation will display as either GOOD, FAIR, or POOR.

- GOOD -  $\% \frac{RR}{TV} < 10$

- FAIR -  $10 < \% \frac{RR}{TV} < 30$

- POOR -  $\% \frac{RR}{TV} > 30$

$\% \frac{RR}{TV}$  is the percent of the total variation that is caused by variation in repeatability and reproducibility.

### Calculations

If you set the configure options for the report to Show Calculations, the values for EV, AV, RR, PV, TV and Tolerances will appear on the report.

**TV:** The total variation, calculated by summing the square of both the repeatability and reproducibility (R&R) variation and the part-to-part variation (PV) and taking the square root.

$$TV = \sqrt{(R \& R^2 + PV^2)}$$

**Tolerances:** The upper and lower tolerances.

*Refer to the information described earlier in this topic for explanations of EV, AV, RR, and PV.*

### Data Requirements

Reports using the GR&R test type have the following data requirements. Adequate trace values exist in the selected data for these trace fields.

$$2 \leq \text{operators} \leq 5$$

$$5 \leq \text{parts} \leq 15$$

$$2 \leq \text{parts} \leq 5$$

**Note:** If operators = 2, parts = 5, and trials = 1, the short form of the GR&R test will be used.

---

[Back to Top](#) | [Send Feedback on this Topic](#)