Gauge R&R study — bore micrometer MIC-014

All records

CAPSULEM8
CM8-210 · Gauge R&R Study
August 9, 2026

%GRR OF STUDY VARIATION
29.3 %
Marginal — at or under 10 % acceptable, at or under 30 % marginal

%GRR OF TOLERANCE
29.6 %
6 × GRR 0.0296 against a band of 0.1000

WHAT DOMINATES
Appraiser
repeatability 0.0027 · reproducibility 0.0042 — look at training and the work instruction

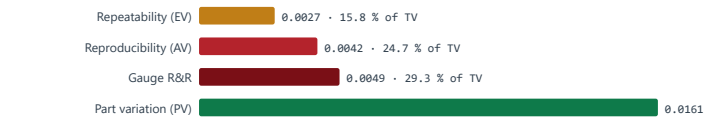
DISTINCT CATEGORIES
4
5 or more is usually required — this system sorts the parts into 4 groups

STUDY DESIGN
5 × 2 × 2
smaller than the usual 10 × 3 × 2 — treat the result as indicative · 20 readings

APPRAISER SPREAD
0.0060
largest minus smallest appraiser mean across 2 appraisers — this is what drives reproducibility

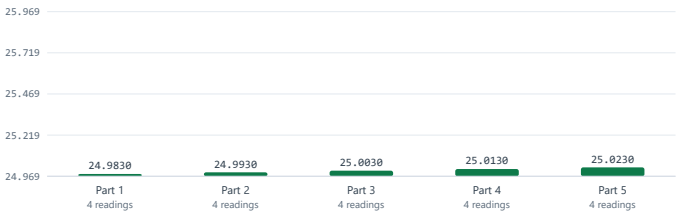
20 of 20 record(s) included. All records. Amounts in USD.

Where the variation comes from



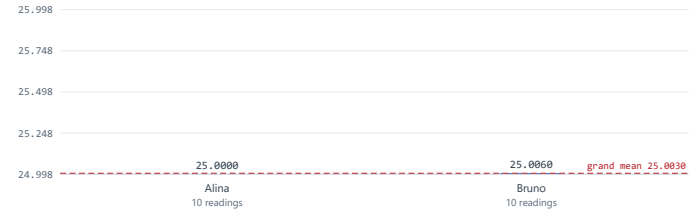
Gauge R&R is repeatability and reproducibility combined; part variation is the real difference between the parts. You want the part bar long and the other three short. Because the components combine as squares rather than by adding up, repeatability and reproducibility will not sum to the R&R bar, and R&R and part variation will not sum to 100 per cent — that is the arithmetic, not an error. Gauge R&R is repeatability and reproducibility combined; part variation is the real difference between the parts. You want the part bar long and the other three short. Because the components combine as squares rather than by adding up, repeatability and reproducibility will not sum to the R&R bar, and R&R and part variation will not sum to 100 per cent — that is the arithmetic, not an error.

Part average by part



A wide spread here is good: the study parts are supposed to differ, because part variation is the yardstick the measurement error is measured against. Parts picked from one hour of one shift will look identical, the part variation will collapse and %GRR will look far worse than the gauge deserves. The axis starts just below the lowest part average so the differences are visible — read the printed values, not the bar heights. A wide spread here is good: the study parts are supposed to differ, because part variation is the yardstick the measurement error is measured against. Parts picked from one hour of one shift will look identical, the part variation will collapse and %GRR will look far worse than the gauge deserves. The axis starts just below the lowest part average so the differences are visible — read the printed values, not the bar heights.

Appraiser mean against the grand mean



Each appraiser measured the same parts the same number of times, so their means should agree. A bar clearly off the dashed line is a bias: that appraiser reads consistently high or low. Bias is a training, work-instruction or part-holding problem, and it is usually the cheapest part of a bad R&R to fix. Each appraiser measured the same parts the same number of times, so their means should agree. A bar clearly off the dashed line is a bias: that appraiser reads consistently high or low. Bias is a training, work-instruction or part-holding problem, and it is usually the cheapest part of a bad R&R to fix.

Repeatability cell by cell

Each bar is one appraiser measuring one part twice or three times — the range between those readings, and nothing else. The long bars are where repeatability is actually being lost, and they are worth looking at individually: one bad cell usually means one awkward part, one loose fixture or one moment of hesitation rather than a bad gauge. Each bar is one appraiser measuring one part twice or three times — the range between those readings, and nothing else. The long bars are where repeatability is actually being lost, and they are worth looking at individually: one bad cell usually means one awkward part, one loose fixture or one moment of hesitation rather than a bad gauge.

R&R summary

MEASURE	SYMBOL	VALUE	% OF TV	HOW IT IS CALCULATED
Mean of the cell ranges	R-bar	0.0030	–	Mean of the 10 part × appraiser ranges
Repeatability — equipment variation	EV	0.0027	15.8 %	R-bar 0.0030 × K1 0.8862 (2 trials)
Appraiser spread	X-diff	0.0060	–	Largest minus smallest of the 2 appraiser means
Reproducibility — appraiser variation	AV	0.0042	24.7 %	√((X-diff × K2 0.7071)² − EV² ÷ (5 parts × 2 trials))
Gauge R&R	GRR	0.0049	29.3 %	√(EV² + AV²)
Range of the part averages	R-part	0.0400	–	Largest minus smallest of the 5 part averages
Part variation	PV	0.0161	95.6 %	R-part × K3 0.4030 (5 parts)
Total variation	TV	0.0169	100.0 %	√(GRR² + PV²) from this study
%GRR of tolerance	—	29.6 %	–	6 × GRR 0.0296 ÷ tolerance 0.1000 × 100
Number of distinct categories	ndc	4	–	floor(1.41 × PV ÷ GRR) — 5 or more is usually required
Verdict against your thresholds		**Marginal**	**29.3 %**	**At or under 10 % acceptable · at or under 30 % marginal · above that not acceptable — measured against study variation**

Measurements

PART	APPRAISER	T1	T2	T3	RANGE	CELL AVERAGE
1	Alina	24.9780	24.9820	–	0.0040	24.9800
1	Bruno	24.9850	24.9870	–	0.0020	24.9860
2	Alina	24.9910	24.9890	–	0.0020	24.9900
2	Bruno	24.9940	24.9980	–	0.0040	24.9960
3	Alina	25.0020	24.9980	–	0.0040	25.0000
3	Bruno	25.0050	25.0070	–	0.0020	25.0060
4	Alina	25.0090	25.0110	–	0.0020	25.0100
4	Bruno	25.0180	25.0140	–	0.0040	25.0160
5	Alina	25.0220	25.0180	–	0.0040	25.0200
5	Bruno	25.0270	25.0250	–	0.0020	25.0260
R-bar	**mean of the cell ranges**				**0.0030**	**from 10 cells**

Measurement register

STUDY	GAUGE	CHARACTERISTIC	PART	APPRAISER	TRIAL	READING	DATE	READING LABEL
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	1	Alina	1	24.9780	2026-07-31	P1 Alina T1
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	2	Alina	1	24.9910	2026-07-31	P2 Alina T1
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	3	Alina	1	25.0020	2026-07-31	P3 Alina T1
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	4	Alina	1	25.0090	2026-07-31	P4 Alina T1
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	5	Alina	1	25.0220	2026-07-31	P5 Alina T1
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	1	Bruno	1	24.9850	2026-07-31	P1 Bruno T1
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	2	Bruno	1	24.9940	2026-07-31	P2 Bruno T1
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	3	Bruno	1	25.0050	2026-07-31	P3 Bruno T1

STUDY	GAUGE	CHARACTERISTIC	PART	APPRAISER	TRIAL	READING	DATE	READING LABEL
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	4	Bruno	1	25.0180	2026-07-31	P4 Bruno T1
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	5	Bruno	1	25.0270	2026-07-31	P5 Bruno T1
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	1	Alina	2	24.9820	2026-07-31	P1 Alina T2
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	2	Alina	2	24.9890	2026-07-31	P2 Alina T2
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	3	Alina	2	24.9980	2026-07-31	P3 Alina T2
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	4	Alina	2	25.0110	2026-07-31	P4 Alina T2
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	5	Alina	2	25.0180	2026-07-31	P5 Alina T2
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	1	Bruno	2	24.9870	2026-07-31	P1 Bruno T2
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	2	Bruno	2	24.9980	2026-07-31	P2 Bruno T2
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	3	Bruno	2	25.0070	2026-07-31	P3 Bruno T2
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	4	Bruno	2	25.0140	2026-07-31	P4 Bruno T2
Bore gauge MIC-014 R&R	Bore micrometer MIC-014	Bore diameter, mm (25.00 ±0.05)	5	Bruno	2	25.0250	2026-07-31	P5 Bruno T2

Notes

Sample study — five parts, two appraisers, two trials. That is a valid design for the average and range method but smaller than the usual ten parts, three appraisers and two trials, so the result is indicative. Note that reproducibility exceeds repeatability here: the two appraisers do not agree with each other more than the gauge disagrees with itself, which points at method and training rather than at the instrument. Replace every reading with your own before relying on anything on this page.

This is the average and range method, and it is honest about what that means. The constants it uses assume the standard study design — five to ten parts, two or three appraisers, two or three trials, every part measured by every appraiser the same number of times — and they are approximations even then. A study run with fewer than ten parts and three appraisers gives a rough estimate of the measurement error, not a measurement of it: with five parts and two appraisers the part variation rests on two extreme part averages, and one unusual part moves every percentage on this page. The method also folds any part-by-appraiser interaction into reproducibility, so it cannot tell you that one appraiser struggles with one particular part. Every figure here is indicative and depends entirely on the study being run properly — random order, the same physical parts, appraisers who cannot see their previous readings. It is a calculation and record-keeping aid, not a gauge calibration, not a certificate of conformity, and not a substitute for your customer's or your accreditation body's own required method.