STATlum

TB-20261112

Software Test Report

STATlum calculations recomputed against the published examples of the MSA Reference Manual (4th edition), VDA Volume 5 and Bosch Booklet No. 10

PROGRAM	VERSION	TEST RUN
STATlum	0.5.0-beta.1	12 November 2026
SOURCE REVISION	RUNTIME	REPORT
e5fe42d	.NET 10.0.402	TB-20261112

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Overview

Three test cases per method. A test case is passed when every figure compared lies within the permitted deviation.

METHOD	TEST 1	TEST 2	TEST 3
MSA 1 Measuring system on a reference standard	passed **MSA1-01** Heft 10	passed **MSA1-02** Heft 10	passed **MSA1-03** AIAG
MSA 2 Gage R&R with appraiser influence	passed **MSA2-01** AIAG + Heft 10	passed **MSA2-02** AIAG + Heft 10	passed **MSA2-03** Heft 10
MSA 3 Gage R&R without appraiser influence	passed **MSA3-01** Heft 10	passed **MSA3-02** AIAG + Heft 10	passed **MSA3-03** Heft 10
MSA 4 Stability	passed **MSA4-01** Heft 10	passed **MSA4-02** AIAG	passed **MSA4-03** Heft 10
MSA 5 Linearity and bias	passed **MSA5-01** AIAG	passed **MSA5-02** VDA 5	passed **MSA5-03** Heft 10
MSA 6 Attribute agreement against reference	passed **MSA6-01** AIAG	passed **MSA6-02** AIAG	passed **MSA6-03** Heft 10
MSA 7 Agreement of appraisers and signal detection	passed **MSA7-01** AIAG	passed **MSA7-02** Heft 10	passed **MSA7-03** Heft 10
MSA 7A Automatic test system	passed **MSA7A-01** AIAG + Heft 10	passed **MSA7A-02** AIAG + Heft 10	passed **MSA7A-03** AIAG + Heft 10
VDA 5 Uncertainty of measuring system and measurement process	passed **VDA5-01** VDA 5	passed **VDA5-02** VDA 5	passed **VDA5-03** VDA 5
Bosch Heft 10 Proof of capability per booklet 10	passed **H10-01** Heft 10	passed **H10-02** Heft 10	passed **H10-03** Heft 10

Approach

Scope	The calculations of all STATlum methods are tested: MSA 1 to MSA 7A, VDA 5 and the proof of capability per Bosch Booklet No. 10. The subject is the calculation core (Statlum.Core), from which the results page, the report and the export take their figures.
Test cases and sources	Every test case takes measured values and results from a numerical example of the source. Measured values come from the printed tables; expected values are the results printed there. Where an example only gives constants and rules (MSA3-02, MSA3-03), the expected value is formed from the measured values with these constants; the test case says so. Several cases use the same measured values in different methods, for example the AIAG attribute data in MSA 6, MSA 7, MSA 7A and booklet 10.
Test path	Most test cases create a study in the STATlum project format (configuration and measured values as in a saved project file) and evaluate it along the same calculation path as the program's results page. The proof of capability per booklet 10 combines several studies of the same characteristic. Only the table of factors for the control limits (MSA4-03) tests a function of the calculation core directly.
Permitted deviation	A figure agrees when it equals the source after rounding to the places printed there, i.e. it deviates by at most half a unit of the last printed place. Where the source reuses rounded intermediate values (for example the K factors of the average and range method), the permitted deviation is derived from that rounding and justified at the figure. Ratings, yes/no statements and texts must be equal.
Rating	A test case is passed when all its figures agree.
Limits	The test shows agreement with the chosen examples, not correctness for every conceivable input. Not covered are the user interface, import, the printed layout of reports and functions that do not occur in the examples (such as the F test of the linear model).

Sources

1. AIAG: Measurement Systems Analysis, Reference Manual, 4th edition, 2010
2. VDA Volume 5: Capability of Measurement Processes, 2nd edition 2010, updated July 2011
3. Robert Bosch GmbH: Quality Management in the Bosch Group, Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019

MSA 1

Measuring system on a reference standard — 3 / 3 passed

MSA1-01 — passed

Type 1 study on a reference standard, two-sided tolerance

Source	Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	Section 4.1, form for procedure 1, p. 11
Data	50 measurements on a 6.002 mm standard, tolerance 0.060 mm (5.970 to 6.030), resolution 0.001 mm
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED
Mean	6.00090	6.0009000	0	± $5 \cdot 10^{-6}$
Standard deviation s	0.00099488	0.0009948849	$4.9 \cdot 10^{-9}$	± $5 \cdot 10^{-9}$
Bias $\lvert\bar{x} - xm\rvert$ Booklet: magnitude 0.0011000	0.0011	0.001100	0	± $5 \cdot 10^{-5}$
Cg	2.01	2.0103	$2.8 \cdot 10^{-4}$	± 0.005
Cgk	1.64	1.6417	0.0017	± 0.005
Cg, lower confidence limit	1.61	1.6123	0.0023	± 0.005
Cg, upper confidence limit	2.41	2.4083	–0.0017	± 0.005
Cgk, lower confidence limit	1.30	1.3038	0.0038	± 0.005
Cgk, upper confidence limit	1.98	1.9796	$-3.5 \cdot 10^{-4}$	± 0.005
%RE	1.67	1.6667	–0.0033	± 0.005
Tmin (Cg) Booklet uses s = 0.000995 (rounded) here: 39.9 · 0.000995 = 0.039701	0.039701	0.03969591	$-5.1 \cdot 10^{-6}$	± $2 \cdot 10^{-5}$
Tmin (Cgk)	0.050696	0.05069591	$-9.3 \cdot 10^{-8}$	± $5 \cdot 10^{-7}$
Tmin (RE)	0.020000	0.02000000	0	± $5 \cdot 10^{-7}$
Bias test: significant	yes	yes		equal
Verdict Booklet: “test system capable”	capable	capable		equal

MSA1-02

passed

Type 1 study, one-sided limit without natural limit: acceptance limit

Source	Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	Annex B, form for pull-off force, p. 42; section 4.1 and annex C.3
Data	50 measurements on an 80 N standard, lower limit only (LSL 70 N), resolution 0.1 N, calibration uncertainty 0.2 N
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
Mean	80.524	80.52400	0	± $5 \cdot 10^{-4}$	✓
Standard deviation s	0.4182	0.418237	$3.7 \cdot 10^{-5}$	± $5 \cdot 10^{-5}$	✓
Factor k (target Cg 1.33)	4	4	0	± 0.5	✓
Acceptance limit LSL_0 [N] Booklet uses s rounded to 4 places (4 · 0.00005)	72.3968	72.396949	$1.5 \cdot 10^{-4}$	± $2 \cdot 10^{-4}$	✓
Bias test: significant	yes	yes		equal	✓

$LSL_0 = LSL + (\bar{x} - xm) + 4 \cdot s + Ucal = 70 + 0.524 + 4 \cdot 0.4182 + 0.2$

MSA1-03

passed

Bias, independent sample method

Source	AIAG: Measurement Systems Analysis, Reference Manual, 4th edition (2010)
Reference	Chapter III, section B, tables III-B 1 and III-B 2, pp. 90 to 92
Data	15 measurements on a part with reference value 6.00; reference spread 6 × 2.5 = 15 (expected process standard deviation σ = 2.5 per manual)
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
Number of measurements	15	15	0	± 0.5	✓
Mean	6.0067	6.006667	$-3.3 \cdot 10^{-5}$	± $5 \cdot 10^{-5}$	✓
Repeatability standard deviation σr	0.2120	0.212020	$2 \cdot 10^{-5}$	± $5 \cdot 10^{-5}$	✓
Bias	0.0067	0.006667	$-3.3 \cdot 10^{-5}$	± $5 \cdot 10^{-5}$	✓
Standard error σb	0.0547	0.054743	$4.3 \cdot 10^{-5}$	± $5 \cdot 10^{-5}$	✓
T statistic	0.12	0.1218	0.0018	± 0.005	✓
Degrees of freedom	14	14	0	± 0.5	✓
95 % confidence interval, lower limit	−0.1107	−0.110746	$-4.6 \cdot 10^{-5}$	± $5 \cdot 10^{-5}$	✓
95 % confidence interval, upper limit	0.1241	0.124079	$-2.1 \cdot 10^{-5}$	± $5 \cdot 10^{-5}$	✓
Bias significant Manual: zero lies within the confidence interval	no	no		equal	✓
%EV	8.5	8.481	−0.019	± 0.05	✓

MSA 2

Gage R&R with appraiser influence

3 / 3 passed

MSA2-01

passed

Gage R&R, average and range method (ARM)

Source	AIAG: Measurement Systems Analysis, Reference Manual, 4th edition (2010); Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	AIAG figure III-B 16, p. 119; booklet 10 annex D.3, p. 53
Data	10 parts, 3 appraisers, 3 trials each (AIAG figure III-B 15); no tolerance, reference total variation
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
EV (booklet D.3)	0.20186	0.2018627	$2.7 \cdot 10^{-6}$	$\pm 5 \cdot 10^{-6}$	✓
AV (booklet D.3)	0.22968	0.2296829	$2.9 \cdot 10^{-6}$	$\pm 5 \cdot 10^{-6}$	✓
GRR (booklet D.3)	0.30578	0.3057822	$2.2 \cdot 10^{-6}$	$\pm 5 \cdot 10^{-6}$	✓
PV (booklet D.3)	1.10445	1.1044529	$2.9 \cdot 10^{-6}$	$\pm 5 \cdot 10^{-6}$	✓
TV (booklet D.3)	1.14600	1.1460013	$1.3 \cdot 10^{-6}$	$\pm 5 \cdot 10^{-6}$	✓
EV (AIAG) AIAG uses $\bar{R}$ = 0.3417 (rounded)	0.20188	0.2018627	$-1.7 \cdot 10^{-5}$	$\pm 3 \cdot 10^{-5}$	✓
PV (AIAG) AIAG uses K3 = 0.3146 and R_p = 3.511 (rounded, footnote 50)	1.10456	1.1044529	$-1.1 \cdot 10^{-4}$	$\pm 2 \cdot 10^{-4}$	✓
%EV of total variation AIAG 17.62 %, booklet 17.61 %	17.62	17.6145	−0.0055	± 0.01	✓
%AV of total variation	20.04	20.0421	0.0021	± 0.005	✓
%GRR of total variation	26.68	26.6825	0.0025	± 0.005	✓
%PV of total variation Booklet 96.37 %, AIAG 96.38 %	96.37	96.3745	0.0045	± 0.01	✓
Ndc (1.41 · PV/GRR, truncated) AIAG: ndc = 5.094 → 5	5	5	0	± 0.5	✓

MSA2-02

passed

Gage R&R, analysis of variance (ANOVA)

Source	AIAG: Measurement Systems Analysis, Reference Manual, 4th edition (2010); Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	AIAG appendix A, tables A 3 to A 5, pp. 197 and 198; booklet 10 annex D.2, pp. 49 to 51
Data	Data as MSA2-01; interaction pooled at α = 0.05 as in the booklet; tolerance T = 8 (booklet, note 2)
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
SS parts	88.3619	88.361934	$3.4 \cdot 10^{-5}$	$\pm 5 \cdot 10^{-5}$	✓
SS appraisers	3.1673	3.167262	$-3.8 \cdot 10^{-5}$	$\pm 5 \cdot 10^{-5}$	✓
SS interaction	0.3590	0.358982	$-1.8 \cdot 10^{-5}$	$\pm 5 \cdot 10^{-5}$	✓

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED
SS repeatability	2.7589	2.758933	$3.3 \cdot 10^{-5}$	$\pm 5 \cdot 10^{-5}$
SS total	94.6471	94.647112	$1.2 \cdot 10^{-5}$	$\pm 5 \cdot 10^{-5}$
F parts	492.29	492.2914	0.0014	± 0.005
F appraisers	79.41	79.4060	−0.004	± 0.005
F interaction	0.434	0.43372	$-2.8 \cdot 10^{-4}$	$\pm 5 \cdot 10^{-4}$
Interaction pooled	yes	yes		equal
F parts, without interaction (booklet)	245.614	245.61391	$-9 \cdot 10^{-5}$	$\pm 5 \cdot 10^{-4}$
F appraisers, without interaction (booklet)	39.617	39.61725	$2.5 \cdot 10^{-4}$	$\pm 5 \cdot 10^{-4}$
EV	0.199933	0.19993318	$1.8 \cdot 10^{-7}$	$\pm 5 \cdot 10^{-7}$
AV	0.226838	0.22683752	$-4.8 \cdot 10^{-7}$	$\pm 5 \cdot 10^{-7}$
GRR (booklet D.2) AIAG 0.302373 from rounded variances	0.30237	0.3023715	$1.5 \cdot 10^{-6}$	$\pm 5 \cdot 10^{-6}$
PV	1.042327	1.04232749	$4.9 \cdot 10^{-7}$	$\pm 5 \cdot 10^{-7}$
TV	1.0853	1.085300	$-4.4 \cdot 10^{-7}$	$\pm 5 \cdot 10^{-5}$
GRR, contribution to total variance Booklet 7.76 %, AIAG 7.8 %	7.76	7.7622	0.0022	± 0.005
%PV of total variation	96.04	96.0405	$5.3 \cdot 10^{-4}$	± 0.005
%GRR of tolerance (6·GRR/T)	22.68	22.6779	−0.0021	± 0.005
Ndc (AIAG: 1.41 · 6.25/1.81 = 4.87 → 4)	4	4	0	± 0.5
Rating %GRR Booklet: 10 % < %GRR ≤ 30 %, conditionally capable	conditionally capable	conditionally capable		equal

MSA2-03

passed

Procedure 2 with appraiser influence, ANOVA

Source	Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	Section 4.2, form for procedure 2, p. 14
Data	10 parts, 3 appraisers, 2 trials each, tolerance 0.060 mm, resolution 0.001 mm; rulebook booklet 10
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED
EV	0.0015348	0.001534782	$-1.8 \cdot 10^{-8}$	$\pm 5 \cdot 10^{-8}$
AV	0.00093169	0.0009316950	$5 \cdot 10^{-9}$	$\pm 5 \cdot 10^{-9}$
GRR	0.0017954	0.001795442	$4.2 \cdot 10^{-8}$	$\pm 5 \cdot 10^{-8}$
PV	0.019515	0.01951509	$8.6 \cdot 10^{-8}$	$\pm 5 \cdot 10^{-7}$
TV	0.019598	0.01959750	$-5 \cdot 10^{-7}$	$\pm 5 \cdot 10^{-7}$
%EV	15.35	15.3478	−0.0022	± 0.005
%AV	9.32	9.3169	−0.0031	± 0.005

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
%GRR	17.95	17.9544	0.0044	± 0.005	✓
%PV	195.15	195.1509	$8.6 \cdot 10^{-4}$	± 0.005	✓
Ndc (√2 · PV/GRR, rounded)	15	15	0	± 0.5	✓
EV, lower 95 % confidence limit	0.0012799	0.001279887	$-1.3 \cdot 10^{-8}$	$\pm 5 \cdot 10^{-8}$	✓
EV, upper 95 % confidence limit	0.0019174	0.001917401	$8.6 \cdot 10^{-10}$	$\pm 5 \cdot 10^{-8}$	✓
Verdict Booklet: “test system conditionally capable (RE, %GRR)”	conditionally capable	conditionally capable		equal	✓

MSA 3

Gage R&R without appraiser influence

3 / 3 passed

MSA3-01

passed

Procedure 3 without appraiser influence, ANOVA

Source	Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	Section 4.3, form for procedure 3, p. 17
Data	25 parts, 2 measurements each, tolerance 0.060 mm, resolution 0.001 mm; rulebook booklet 10
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
EV = GRR	0.0014697	0.001469694	$-6.2 \cdot 10^{-9}$	$\pm 5 \cdot 10^{-8}$	✓
PV	0.017701	0.01770080	$-2 \cdot 10^{-7}$	$\pm 5 \cdot 10^{-7}$	✓
TV	0.017762	0.01776171	$-2.9 \cdot 10^{-7}$	$\pm 5 \cdot 10^{-7}$	✓
%GRR	14.70	14.6969	−0.0031	± 0.005	✓
%PV	177.01	177.0080	−0.002	± 0.005	✓
Ndc	17	17	0	± 0.5	✓
GRR, lower 95 % confidence limit	0.0011526	0.001152618	$1.8 \cdot 10^{-8}$	$\pm 5 \cdot 10^{-8}$	✓
GRR, upper 95 % confidence limit	0.0020288	0.002028778	$-2.2 \cdot 10^{-8}$	$\pm 5 \cdot 10^{-8}$	✓
Smallest tolerance for capable (%GRR ≤ 10 %)	0.088	0.08820	$2 \cdot 10^{-4}$	$\pm 5 \cdot 10^{-4}$	✓
Verdict Booklet: “test system conditionally capable (%RE, %GRR)”	conditionally capable	conditionally capable		equal	✓

MSA3-02

passed

Repeatability per appraiser, average and range method

Source	AIAG: Measurement Systems Analysis, Reference Manual, 4th edition (2010); Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	AIAG figure III-B 15, p. 118 ($\bar{R}$ and $\bar{x}$ per appraiser); booklet 10 annexes D.3 and D.4, pp. 53 and 54 (K1 = 0.5908)
Data	Series of one appraiser each from MSA2-01 as three studies without appraiser influence (10 parts, 3 measurements each); expected EV = $\bar{R}$ · K1
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
EV appraiser A ($\bar{R}$ = 0.184) $\bar{R}$ and K1 printed to 3 and 4 places	0.1087072	0.108710423	$3.2 \cdot 10^{-6}$	$\pm 3 \cdot 10^{-4}$	✓
EV appraiser B ($\bar{R}$ = 0.513) as above	0.3030804	0.303089385	$9 \cdot 10^{-6}$	$\pm 3.2 \cdot 10^{-4}$	✓
EV appraiser C ($\bar{R}$ = 0.328) as above	0.1937824	0.193788145	$5.7 \cdot 10^{-6}$	$\pm 3.1 \cdot 10^{-4}$	✓

MSA3-03

passed

Procedure 3, average and range method with 25 parts

Source	Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	Annex D.4, procedure 3: constants K1 = 0.8862 and K3 = 0.2504, p. 54; data form p. 17
Data	Data as MSA3-01, evaluated by ARM; expected EV = $\bar{R}$ · K1 and PV = R_p · K3 with $\bar{R}$ and R_p from the data
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
EV = $\bar{R}$ · 0.8862 K1 printed to 4 places	0.00141792	0.0014179620	$4.2 \cdot 10^{-8}$	$\pm 8 \cdot 10^{-8}$	✓
PV = R_p · 0.2504 K3 printed to 4 places; STATlum computes d2* = 3.99396 from the distribution of the range, the booklet gives 3.99377, both give K3 = 0.2504	0.0152744	0.015273062	$-1.3 \cdot 10^{-6}$	$\pm 3 \cdot 10^{-6}$	✓
AV (no appraiser influence)	0.000000	0.00000000	0	$\pm 5 \cdot 10^{-7}$	✓

For more than 20 parts, table C 1 of the MSA manual gives no d2*; STATlum then computes it from the distribution of the range.

MSA 4

Stability 3 / 3 passed

MSA4-01 passed

Procedure 5, stability chart with control limits per booklet 10

Source	Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	Section 4.5.1, form for procedure 5, p. 23; annex F
Data	25 subgroups of 3 measurements on a 6.002 mm standard, σ = T/40 = 0.0015 mm, confidence level 99 %, two-sided
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
Centre line x̄ chart	6.002	6.00200	0	± $5 \cdot 10^{-4}$	✓
Upper control limit x̄ chart	6.00423	6.0042307	$7.3 \cdot 10^{-7}$	± $5 \cdot 10^{-6}$	✓
Lower control limit x̄ chart	5.99977	5.9997693	$-7.3 \cdot 10^{-7}$	± $5 \cdot 10^{-6}$	✓
Upper control limit s chart	0.003453	0.00345271	$-2.9 \cdot 10^{-7}$	± $5 \cdot 10^{-7}$	✓
Centre line s chart	0.001329	0.00132934	$3.4 \cdot 10^{-7}$	± $5 \cdot 10^{-7}$	✓
Lower control limit s chart	0.000106	0.00010620	$2 \cdot 10^{-7}$	± $5 \cdot 10^{-7}$	✓
Subgroups with violations Booklet: no violation	0	0	0	± 0.5	✓

MSA4-02

passed

Location against the reference value via the stability study (individual values)

Source	AIAG: Measurement Systems Analysis, Reference Manual, 4th edition (2010)
Reference	Chapter III, section B, tables III-B 1 and III-B 2, pp. 90 to 92
Data	Data as MSA1-03 as an individuals chart (15 points in time), reference value 6.00
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
Mean	6.0067	6.006667	$-3.3 \cdot 10^{-5}$	$\pm 5 \cdot 10^{-5}$	✓
Bias	0.0067	0.006667	$-3.3 \cdot 10^{-5}$	$\pm 5 \cdot 10^{-5}$	✓
Standard error σb	0.0547	0.054743	$4.3 \cdot 10^{-5}$	$\pm 5 \cdot 10^{-5}$	✓
T statistic	0.12	0.1218	0.0018	± 0.005	✓
Degrees of freedom	14	14	0	± 0.5	✓
95 % confidence interval, lower limit	−0.1107	−0.110746	$-4.6 \cdot 10^{-5}$	$\pm 5 \cdot 10^{-5}$	✓
95 % confidence interval, upper limit	0.1241	0.124079	$-2.1 \cdot 10^{-5}$	$\pm 5 \cdot 10^{-5}$	✓
Bias significant	no	no		equal	✓

The manual shows the bias test on the independent sample; STATlum performs it in the stability study with a reference value. Data as MSA1-03, different calculation path.

MSA4-03

passed

Factors of the control limits for s chart and individuals chart

Source	Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	Annex F, tables of the factors u_p, B′Eun, B′Eob and E′E, pp. 64 and 65
Data	Sample sizes n = 2 to 15, 20 and 25; confidence levels 99.73 % and 99 %, two-sided and one-sided
Test path	Function of the calculation core, without a study

Factors from STATlum, rounded to three places as in the booklet. 196 values compared, 195 within ± 0.0005; deviations see remark.

	two-sided 99.73 %			two-sided 99 %			one-sided 99.73 %			one-sided 99 %		
n	B′Eun	B′Eob	E′E	B′Eun	B′Eob	E′E	B′Eun	B′Eob	E′E	B′Eun	B′Eob	E′E
u_p		3.000			2.576			2.782			2.326	
2	0.002	3.205	3.205	0.006	2.807	2.807	0.003	3.000	3.000	0.013	2.576	2.575
3	0.037	2.571	3.320	0.071	2.302	2.935	0.052	2.432	3.121	0.100	2.146	2.712
4	0.100	2.283	3.399	0.155	2.069	3.023	0.126	2.172	3.205	0.196	1.945	2.806
5	0.163	2.110	3.460	0.227	1.927	3.090	0.194	2.016	3.269	0.273	1.822	2.877
6	0.218	1.991	3.509	0.287	1.830	3.143	0.252	1.908	3.320	0.333	1.737	2.934
7	0.266	1.903	3.550	0.336	1.758	3.188	0.300	1.829	3.363	0.381	1.674	2.981
8	0.306	1.835	3.585	0.376	1.702	3.227	0.341	1.767	3.399	0.421	1.625	3.022
9	0.341	1.780	3.615	0.410	1.657	3.260	0.376	1.717	3.431	0.454	1.585	3.057
10	0.371	1.735	3.642	0.439	1.619	3.290	0.405	1.675	3.460	0.482	1.552	3.089
11	0.398	1.697	3.667	0.464	1.587	3.317	0.431	1.640	3.485	0.506	1.523	3.117
12	0.422	1.664	3.689	0.486	1.560	3.341	0.454	1.610	3.509	0.527	1.499	3.143

13	0.443	1.635	3.709	0.506	1.536	3.363	0.475	1.584	3.530	0.545	1.478	3.166
14	0.461	1.609	3.728	0.524	1.515	3.383	0.493	1.560*	3.549	0.562	1.459	3.187
15	0.479	1.587	3.745	0.539	1.496	3.402	0.509	1.540	3.567	0.577	1.443	3.207
20	0.545	1.502	3.817	0.600	1.425	3.480	0.573	1.462	3.642	0.634	1.380	3.289
25	0.591	1.446	3.872	0.642	1.378	3.539	0.617	1.411	3.699	0.673	1.338	3.351

* B′Eob, n = 14, one-sided 99.73 %: Booklet 1.561; recomputed independently $\sqrt{(\chi^2(0.9973;\,13)/13)} = 1.56049$, i.e. 1.560: rounding in the booklet's table

The factors enter the control limits of the stability study per booklet 10 (MSA4-01).

MSA 5

Linearity and bias

3 / 3 passed

MSA5-01

passed

Linearity and bias, regression of the bias on the reference value

Source	AIAG: Measurement Systems Analysis, Reference Manual, 4th edition (2010)
Reference	Chapter III, section B, table III-B 4 and figure III-B 3, pp. 98 to 101
Data	5 parts with reference values 2 to 10, 12 measurements each; process variation 6.00
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
Slope a	−0.131667	−0.13166667	$3.3 \cdot 10^{-7}$	± $5 \cdot 10^{-7}$	✓
Intercept b	0.736667	0.73666667	$-3.3 \cdot 10^{-7}$	± $5 \cdot 10^{-7}$	✓
Coefficient of determination R^2	0.714	0.71432	$3.2 \cdot 10^{-4}$	± $5 \cdot 10^{-4}$	✓
T statistic of the slope	−12.043	−12.04256	$4.4 \cdot 10^{-4}$	± $5 \cdot 10^{-4}$	✓
T statistic of the intercept	10.158	10.15752	$-4.8 \cdot 10^{-4}$	± $5 \cdot 10^{-4}$	✓
Critical t value (58 df, 0.975)	2.00172	2.0017175	$-2.5 \cdot 10^{-6}$	± $5 \cdot 10^{-6}$	✓
Degrees of freedom	58	58	0	± 0.5	✓
Bias part 1 (reference 2)	0.491667	0.49166667	$-3.3 \cdot 10^{-7}$	± $5 \cdot 10^{-7}$	✓
Bias part 2 (reference 4)	0.125	0.12500	0	± $5 \cdot 10^{-4}$	✓
Bias part 3 (reference 6)	0.025	0.02500	0	± $5 \cdot 10^{-4}$	✓
Bias part 4 (reference 8)	−0.29167	−0.2916667	$3.3 \cdot 10^{-6}$	± $5 \cdot 10^{-6}$	✓
Bias part 5 (reference 10)	−0.61667	−0.6166667	$3.3 \cdot 10^{-6}$	± $5 \cdot 10^{-6}$	✓
Verdict Manual: linearity problem (|t_a| > t)	not linear	not linear		equal	✓

MSA5-02

passed

Linearity with six standards and large scatter

Source	VDA Volume 5: Capability of Measurement Processes, 2nd edition 2010 (updated July 2011)
Reference	Section 5.2.2.2, table 9 and regression function, p. 61
Data	6 standards with reference values 0 to 30 mm, 5 measurements each; tolerance 30 mm
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
Intercept b	−0.6176	−0.617574	$2.6 \cdot 10^{-5}$	± $5 \cdot 10^{-5}$	✓
Slope of the measured values (1 + slope of the bias)	0.9183	0.918261	$-3.9 \cdot 10^{-5}$	± $5 \cdot 10^{-5}$	✓

VDA 5 states the regression of the measured values ($\hat{y} = -0.6176 + 0.9183 \cdot x$); STATlum regresses the bias $\hat{y} - x$, so its slope is smaller by 1.

MSA5-03

passed

Procedure 4, linearity per AIAG with five reference parts

Source	Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	Annex E.1, first example with test results, p. 61
Data	5 reference parts 2.001 to 10.002 mm, 12 measurements each; confidence level 95 %
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
|t| of the slope	1.271	1.27115	$1.5 \cdot 10^{-4}$	$\pm 5 \cdot 10^{-4}$	✓
|t| of the intercept	1.519	1.51935	$3.5 \cdot 10^{-4}$	$\pm 5 \cdot 10^{-4}$	✓
Critical t value (58 df, 95 %)	2.002	2.00172	$-2.8 \cdot 10^{-4}$	$\pm 5 \cdot 10^{-4}$	✓
Test of the slope Booklet: deviation from 0 not significant	not significant	not significant		equal	✓
Test of the intercept Booklet: deviation from 0 not significant	not significant	not significant		equal	✓

The tolerance is not given in the example; the study requires limits (here 0 to 12 mm), they do not enter the tested values. STATlum does not evaluate the additionally recommended F test of the linear model (F_LM = 16.055); it is not part of the test.

MSA 6

Attribute agreement against reference

3 / 3 passed

MSA6-01

passed

Appraiser agreement with reference: effectiveness and confidence intervals

Source	AIAG: Measurement Systems Analysis, Reference Manual, 4th edition (2010)
Reference	Chapter III, section C, tables III-C 1 and III-C 5, pp. 134 and 139
Data	50 parts, 3 appraisers, 3 trials each, reference decision per part (1 = good, 0 = bad)
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
Within appraiser A [%] (42 of 50)	84	84	0	± 0.5	✓
Within appraiser B [%] (45 of 50)	90	90	0	± 0.5	✓
Within appraiser C [%] (40 of 50)	80	80	0	± 0.5	✓
Appraiser A, lower 95 % limit [%]	71	70.89	–0.11	± 0.5	✓
Appraiser A, upper 95 % limit [%]	93	92.83	–0.17	± 0.5	✓
Appraiser B, lower 95 % limit [%]	78	78.19	0.19	± 0.5	✓
Appraiser B, upper 95 % limit [%]	97	96.67	–0.33	± 0.5	✓
Appraiser C, lower 95 % limit [%]	66	66.28	0.28	± 0.5	✓
Appraiser C, upper 95 % limit [%]	90	89.97	–0.03	± 0.5	✓
Appraiser A vs reference [%]	84	84	0	± 0.5	✓
Appraiser B vs reference [%]	90	90	0	± 0.5	✓
Appraiser C vs reference [%]	80	80	0	± 0.5	✓
All appraisers vs reference [%] (39 of 50)	78	78	0	± 0.5	✓
All vs reference, lower 95 % limit [%]	64	64.04	0.039	± 0.5	✓
All vs reference, upper 95 % limit [%] exact limit 88.5 %; the manual rounds to 89 %	89	88.47	–0.53	± 0.6	✓

MSA6-02

passed

Miss rate, false alarm rate and Cohen's kappa against the reference

Source	AIAG: Measurement Systems Analysis, Reference Manual, 4th edition (2010)
Reference	Chapter III, section C, tables III-C 4 and III-C 7, pp. 138 and 140
Data	Data as MSA6-01; good class “1” (acceptable)
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
Miss rate appraiser A [%]	6.3	6.250	–0.05	± 0.05	✓
Miss rate appraiser B [%]	6.3	6.250	–0.05	± 0.05	✓
Miss rate appraiser C [%]	12.5	12.500	0	± 0.05	✓
False alarm rate appraiser A [%]	4.9	4.902	0.002	± 0.05	✓
False alarm rate appraiser B [%]	2.0	1.961	–0.039	± 0.05	✓
False alarm rate appraiser C [%]	8.8	8.824	0.024	± 0.05	✓
Kappa A vs reference	0.88	0.8788	–0.0012	± 0.005	✓
Kappa B vs reference	0.92	0.9230	0.003	± 0.005	✓
Kappa C vs reference	0.77	0.7740	0.004	± 0.005	✓

MSA6-03

passed

Fleiss' kappa per appraiser and of all appraisers against the reference

Source	Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	Section 5.2, form for procedure 7, p. 30; annex G.2, pp. 67 to 70 (data per AIAG, table III-C 1)
Data	Data as MSA6-01 (appraisers Müller, Mayer, Huber = A, B, C); rulebook booklet 10
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
Kappa A vs reference	0.8802	0.880236	$3.6 \cdot 10^{-5}$	$\pm 5 \cdot 10^{-5}$	✓
Kappa B vs reference	0.9226	0.922612	$1.2 \cdot 10^{-5}$	$\pm 5 \cdot 10^{-5}$	✓
Kappa C vs reference	0.7747	0.774703	$3.2 \cdot 10^{-6}$	$\pm 5 \cdot 10^{-5}$	✓
Kappa all appraisers vs reference	0.8592	0.859184	$-1.6 \cdot 10^{-5}$	$\pm 5 \cdot 10^{-5}$	✓

MSA 7

Agreement of appraisers and signal detection

3 / 3 passed

MSA7-01

passed

Agreement between appraisers, Cohen's kappa

Source	AIAG: Measurement Systems Analysis, Reference Manual, 4th edition (2010)
Reference	Chapter III, section C, tables III-C 2, III-C 3 and III-C 5, pp. 136 to 139
Data	Data as MSA6-01 without reference; consensus of the appraisers
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
Kappa A vs B	0.86	0.8629	0.0029	± 0.005	✓
Kappa A vs C	0.78	0.7761	−0.0039	± 0.005	✓
Kappa B vs C	0.79	0.7880	−0.002	± 0.005	✓
Agreement of all appraisers [%] (39 of 50)	78	78	0	± 0.5	✓
Lower 95 % limit [%]	64	64.04	0.039	± 0.5	✓

MSA7-02

passed

Procedure 7, Fleiss' kappa within and between appraisers

Source	Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	Section 5.2, form for procedure 7, p. 30; annex G.2
Data	Data as MSA6-01 with reference, consensus; rulebook booklet 10 (capable from 0.9, conditionally from 0.7, minimum of all values)
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
Kappa within A (Müller)	0.7600	0.760000	0	± $5 \cdot 10^{-5}$	✓
Kappa within B (Mayer)	0.8451	0.845073	$-2.7 \cdot 10^{-5}$	± $5 \cdot 10^{-5}$	✓
Kappa within C (Huber)	0.7029	0.702911	$1.1 \cdot 10^{-5}$	± $5 \cdot 10^{-5}$	✓
Kappa between appraisers	0.7936	0.793606	$5.7 \cdot 10^{-6}$	± $5 \cdot 10^{-5}$	✓
Smallest kappa	0.703	0.703		equal	✓
Verdict Booklet: 0.7 ≤ κ < 0.9, conditionally capable	conditionally capable	conditionally capable		equal	✓

MSA7-03

passed

Procedure 6, signal detection at the tolerance limits (analytic)

Source	Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	Section 5.1, form for procedure 6, p. 27
Data	50 reference parts with reference value, 6 decisions each, limits 3.5625 and 3.6375 mm (T = 0.075 mm)
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
Uncertainty zone at the lower limit d_LSL	0.024	0.02400	0	± $5 \cdot 10^{-4}$	✓
Uncertainty zone at the upper limit d_USL	0.016	0.01600	0	± $5 \cdot 10^{-4}$	✓
Mean uncertainty zone d	0.020	0.02000	0	± $5 \cdot 10^{-4}$	✓
%GRR = d / T	26.67	26.6667	−0.0033	± 0.005	✓
Verdict Booklet: 10 % < %GRR ≤ 30 %	conditionally capable	conditionally capable		equal	✓

MSA 7A

Automatic test system

3 / 3 passed

MSA7A-01

passed

Automatic test system with three runs (decisions of appraiser A)

Source	AIAG: Measurement Systems Analysis, Reference Manual, 4th edition (2010); Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	AIAG tables III-C 1, III-C 5 and III-C 7, pp. 134 to 140; booklet 10 form for procedure 7, p. 30
Data	The three trials of appraiser A (table III-C 1) as results of an automatic test system on 50 parts with reference; rulebook booklet 10
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
Agreement of the runs [%]	84	84	0	± 0.5	✓
Lower 95 % limit [%]	71	70.89	−0.11	± 0.5	✓
Upper 95 % limit [%]	93	92.83	−0.17	± 0.5	✓
Agreement with reference [%]	84	84	0	± 0.5	✓
Miss rate [%]	6.3	6.250	−0.05	± 0.05	✓
False alarm rate [%]	4.9	4.902	0.002	± 0.05	✓
Fleiss' kappa within (booklet)	0.7600	0.760000	0	$\pm 5 \cdot 10^{-5}$	✓
Fleiss' kappa vs reference (booklet)	0.8802	0.880236	$3.6 \cdot 10^{-5}$	$\pm 5 \cdot 10^{-5}$	✓

The published values per appraiser hold unchanged for a test device that delivers the same three series of decisions; the calculation path without appraiser is tested.

MSA7A-02

passed

Automatic test system with three runs (decisions of appraiser B)

Source	AIAG: Measurement Systems Analysis, Reference Manual, 4th edition (2010); Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	AIAG tables III-C 1, III-C 5 and III-C 7, pp. 134 to 140; booklet 10 form for procedure 7, p. 30
Data	The three trials of appraiser B (table III-C 1) as results of an automatic test system on 50 parts with reference; rulebook booklet 10
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
Agreement of the runs [%]	90	90	0	± 0.5	✓
Lower 95 % limit [%]	78	78.19	0.19	± 0.5	✓
Upper 95 % limit [%]	97	96.67	−0.33	± 0.5	✓
Agreement with reference [%]	90	90	0	± 0.5	✓
Miss rate [%]	6.3	6.250	−0.05	± 0.05	✓
False alarm rate [%]	2.0	1.961	−0.039	± 0.05	✓
Fleiss' kappa within (booklet)	0.8451	0.845073	$-2.7 \cdot 10^{-5}$	$\pm 5 \cdot 10^{-5}$	✓
Fleiss' kappa vs reference (booklet)	0.9226	0.922612	$1.2 \cdot 10^{-5}$	$\pm 5 \cdot 10^{-5}$	✓

The published values per appraiser hold unchanged for a test device that delivers the same three series of decisions; the calculation path without appraiser is tested.

MSA7A-03

passed

Automatic test system with three runs (decisions of appraiser C)

Source	AIAG: Measurement Systems Analysis, Reference Manual, 4th edition (2010); Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	AIAG tables III-C 1, III-C 5 and III-C 7, pp. 134 to 140; booklet 10 form for procedure 7, p. 30
Data	The three trials of appraiser C (table III-C 1) as results of an automatic test system on 50 parts with reference; rulebook booklet 10
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
Agreement of the runs [%]	80	80	0	± 0.5	✓
Lower 95 % limit [%]	66	66.28	0.28	± 0.5	✓
Upper 95 % limit [%]	90	89.97	−0.03	± 0.5	✓
Agreement with reference [%]	80	80	0	± 0.5	✓
Miss rate [%]	12.5	12.500	0	± 0.05	✓
False alarm rate [%]	8.8	8.824	0.024	± 0.05	✓
Fleiss' kappa within (booklet)	0.7029	0.702911	$1.1 \cdot 10^{-5}$	$\pm 5 \cdot 10^{-5}$	✓
Fleiss' kappa vs reference (booklet)	0.7747	0.774703	$3.2 \cdot 10^{-6}$	$\pm 5 \cdot 10^{-5}$	✓

The published values per appraiser hold unchanged for a test device that delivers the same three series of decisions; the calculation path without appraiser is tested.

VDA 5

Uncertainty of measuring system and measurement process

3 / 3 passed

VDA5-01

passed

Capability of the measuring system with one standard

Source	VDA Volume 5: Capability of Measurement Processes, 2nd edition 2010 (updated July 2011)
Reference	Section 5.2.2.1, table 8, figures 11 and 12, pp. 56 and 57
Data	50 measurements on a 6.002 mm standard, tolerance 0.060 mm, resolution 0.001 mm, U_CAL = 0.002 mm with k = 2
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
U_RE	0.000289	0.00028868	$-3.2 \cdot 10^{-7}$	$\pm 5 \cdot 10^{-7}$	✓
U_CAL	0.00100	0.0010000	0	$\pm 5 \cdot 10^{-6}$	✓
U_EVR	0.000995	0.00099488	$-1.2 \cdot 10^{-7}$	$\pm 5 \cdot 10^{-7}$	✓
U_BI	0.000635	0.00063509	$8.5 \cdot 10^{-8}$	$\pm 5 \cdot 10^{-7}$	✓
U_MS	0.00155	0.0015470	$-3 \cdot 10^{-6}$	$\pm 5 \cdot 10^{-6}$	✓
U_MS (k = 2)	0.00309	0.0030939	$3.9 \cdot 10^{-6}$	$\pm 5 \cdot 10^{-6}$	✓
%RE	1.67	1.6667	−0.0033	± 0.005	✓
Q_MS [%]	10.31	10.3132	0.0032	± 0.005	✓
Minimum tolerance TOL_MIN-UMS	0.0413	0.041253	$-4.7 \cdot 10^{-5}$	$\pm 5 \cdot 10^{-5}$	✓
Rank u_CAL	1	1	0	± 0.5	✓
Rank u_EVR	2	2	0	± 0.5	✓
Rank u_BI	3	3	0	± 0.5	✓

The measured values are the same as in the procedure 1 form of Bosch booklet 10 (MSA1-01).

VDA5-02

passed

Measuring system with three standards (bolt hole)

Source	VDA Volume 5: Capability of Measurement Processes, 2nd edition 2010 (updated July 2011)
Reference	Annex F.1, measured values and figures pp. 111 and 112
Data	3 standards (30.0076, 30.0050, 30.0025 mm) with 10 measurements each, tolerance 0.005 mm, resolution 0.0001 mm, U_CAL = 0.000026 mm with k = 2
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
U_RE	0.0000289	0.000028868	$-3.2 \cdot 10^{-8}$	$\pm 5 \cdot 10^{-8}$	✓
U_CAL	0.0000130	0.000013000	0	$\pm 5 \cdot 10^{-8}$	✓
U_EVR (largest value of the standards)	0.0000738	0.000073786	$-1.4 \cdot 10^{-8}$	$\pm 5 \cdot 10^{-8}$	✓
U_BI (largest value of the standards)	0.0000635	0.000063509	$8.5 \cdot 10^{-9}$	$\pm 5 \cdot 10^{-8}$	✓
U_MS	0.0000982	0.000098218	$1.8 \cdot 10^{-8}$	$\pm 5 \cdot 10^{-8}$	✓
U_MS (k = 2)	0.000196	0.00019644	$4.4 \cdot 10^{-7}$	$\pm 5 \cdot 10^{-7}$	✓
%RE	2.00	2.0000	0	± 0.005	✓
Q_MS [%]	7.86	7.8574	−0.0026	± 0.005	✓
Minimum tolerance TOL_MIN-UMS	0.00262	0.0026191	$-8.5 \cdot 10^{-7}$	$\pm 5 \cdot 10^{-6}$	✓

VDA5-03

passed

Measurement process with operator influence (bolt hole)

Source	VDA Volume 5: Capability of Measurement Processes, 2nd edition 2010 (updated July 2011)
Reference	Annex F.1, measured values p. 112, budget and result p. 113
Data	Measuring system as VDA5-02; plus 10 production parts, 3 operators, 2 trials each, evaluated by ANOVA
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
U_AV	0.0000892	0.000089190	$-1 \cdot 10^{-8}$	$\pm 5 \cdot 10^{-8}$	✓
U_EVO	0.000151	0.00015134	$3.4 \cdot 10^{-7}$	$\pm 5 \cdot 10^{-7}$	✓
U_IA pooled	yes	yes		equal	✓
U_MP	0.000187	0.00018724	$2.4 \cdot 10^{-7}$	$\pm 5 \cdot 10^{-7}$	✓
U_MP (k = 2)	0.000374	0.00037449	$4.9 \cdot 10^{-7}$	$\pm 5 \cdot 10^{-7}$	✓
Q_MP [%]	14.98	14.9794	$-5.5 \cdot 10^{-4}$	± 0.005	✓
Minimum tolerance TOL_MIN-UMP	0.00250	0.0024966	$-3.4 \cdot 10^{-6}$	$\pm 5 \cdot 10^{-6}$	✓
Rank u_EVO	1	1	0	± 0.5	✓
Rank u_AV	2	2	0	± 0.5	✓
Rank u_BI	4	4	0	± 0.5	✓
Rank u_CAL	6	6	0	± 0.5	✓

Bosch Heft 10

Proof of capability per booklet 10

3 / 3 passed

H10-01

passed

Proof of capability, continuous characteristic with operator influence and stability

Source	Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	Sections 2 and 3 (figures 2 to 4); forms for procedures 1, 2 and 5, pp. 11, 14 and 23
Data	Characteristic body diameter 6.000 ± 0.030 mm; studies as MSA1-01, MSA2-03 and MSA4-01
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
Procedure 1 Booklet: capable (Cg 2.01, Cgk 1.64)	capable	capable		equal	✓
Procedure 2 Booklet: conditionally capable (%GRR 17.95 %)	conditionally capable	conditionally capable		equal	✓
Procedure 5 no violation of the control limits	capable	capable		equal	✓
Overall verdict the worst procedure decides	conditionally capable	conditionally capable		equal	✓
Procedures met	2 of 3	2 of 3		equal	✓

The ratings of the individual procedures are printed in the booklet's forms; the overall verdict follows the booklet's rule (section 2) that the worst procedure decides.

H10-02

passed

Proof of capability, continuous characteristic without operator influence

Source	Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	Sections 2 and 3 (figures 2 to 4); forms for procedures 1 and 3, pp. 11 and 17
Data	Characteristic as H10-01; studies as MSA1-01 and MSA3-01
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
Procedure 1	capable	capable		equal	✓
Procedure 3 Booklet: conditionally capable (%GRR 14.70 %)	conditionally capable	conditionally capable		equal	✓
Overall verdict	conditionally capable	conditionally capable		equal	✓
Procedures met	1 of 2	1 of 2		equal	✓

The ratings of the individual procedures are printed in the booklet's forms; the overall verdict follows the booklet's rule (section 2) that the worst procedure decides.

H10-03

passed

Proof of capability, discrete characteristic (procedure 7)

Source	Robert Bosch GmbH: Booklet No. 10, Capability of Measurement and Test Processes, edition 11.2019
Reference	Section 2 (figure 5), section 5.2, form for procedure 7, p. 30
Data	Visual inspection, 50 reference parts, 3 appraisers, 3 runs each; study as MSA7-02
Test path	Study in the project format, evaluated along the program's own calculation path (results page and report)

FIGURE	SOURCE	STATLUM	DEVIATION	PERMITTED	
Procedure 7 (minimum of all κ = 0.7029) Booklet: overall result conditionally capable	conditionally capable	conditionally capable		equal	✓
Overall verdict	conditionally capable	conditionally capable		equal	✓