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STEPHAN CONRAD - QUALITÄTSFORUM - 2025-04-02

# MSA – VDA 5 – SPC
# Was kommt auf uns zu?

## Ein Ausblick auf die harmonisierten Handbücher von VDA und AIAG

VDA | QMC
5
Qualitätsmanagement in der Automobilindustrie
Mess- und Prüfprozesse
Eignung, Planung und Management
Measurement Systems Analysis
MSA
Fourth Edition

2025-04-01

www.testotis.de

# STEPHAN CONRAD

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- SConrad@testotis.de, +49 151 72848406

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1994 - 1995 MATTEL

1996 - 2008 Q-DAS

2008 - 2017 TEQ

2017 - 2024 HEXAGON MANUFACTURING INTELLIGENCE, Q-DAS, VOLUME GRAPHICS

11/2024 - today Testo Industrial Services GmbH testo

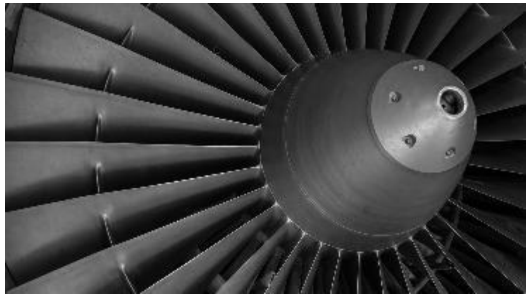
2008 - today DIN **DIN NA 147-00-02 AA** Angewandte Statistik Mirror Comm. ISO/TC 69

2021 - today ISO **Chair ISO/TC 69/SC 4** Applications of statistical methods in product and process management

2019 - today VDA QMC Verband der Automobilindustrie Qualitäts-Management-Center
- VDA 5
- VDA SPC
- PG AIAG Harmonisierung

30 years of quality management and production excellence

Automotive



Aerospace

Medical / Pharma

Operational Excellence

# Statistical Process Control - Harmonisierung

- Begriffsdefinition

**Statistical Process Control / Statistische ProzessLenkung / Statistische ProzessRegelung**

Tätigkeiten, die darauf ausgerichtet sind, mittels statistischer Verfahren…

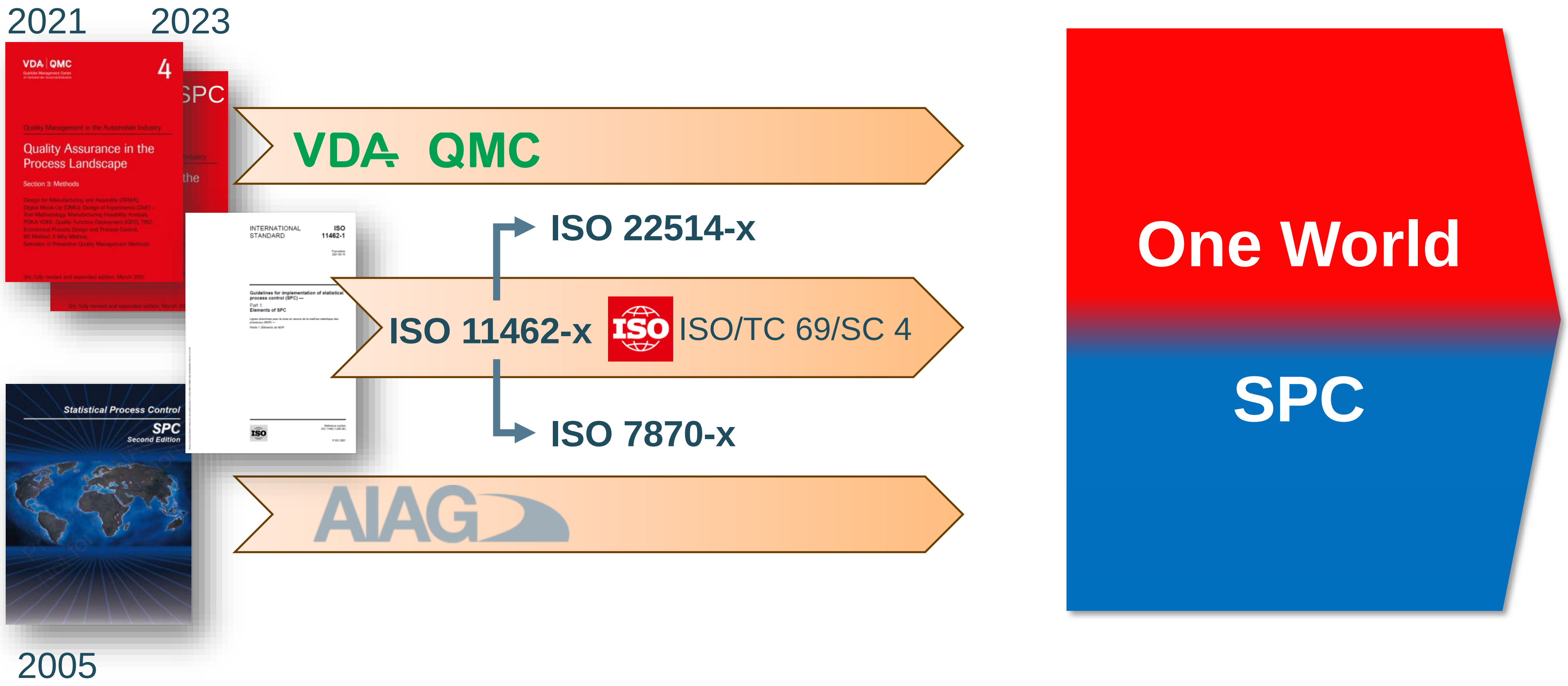
… die **Streuung zu verringern**,

… das **Wissen über den Prozess zu verbessern** und

… den **Prozess in der gewünschten Weise zu lenken**

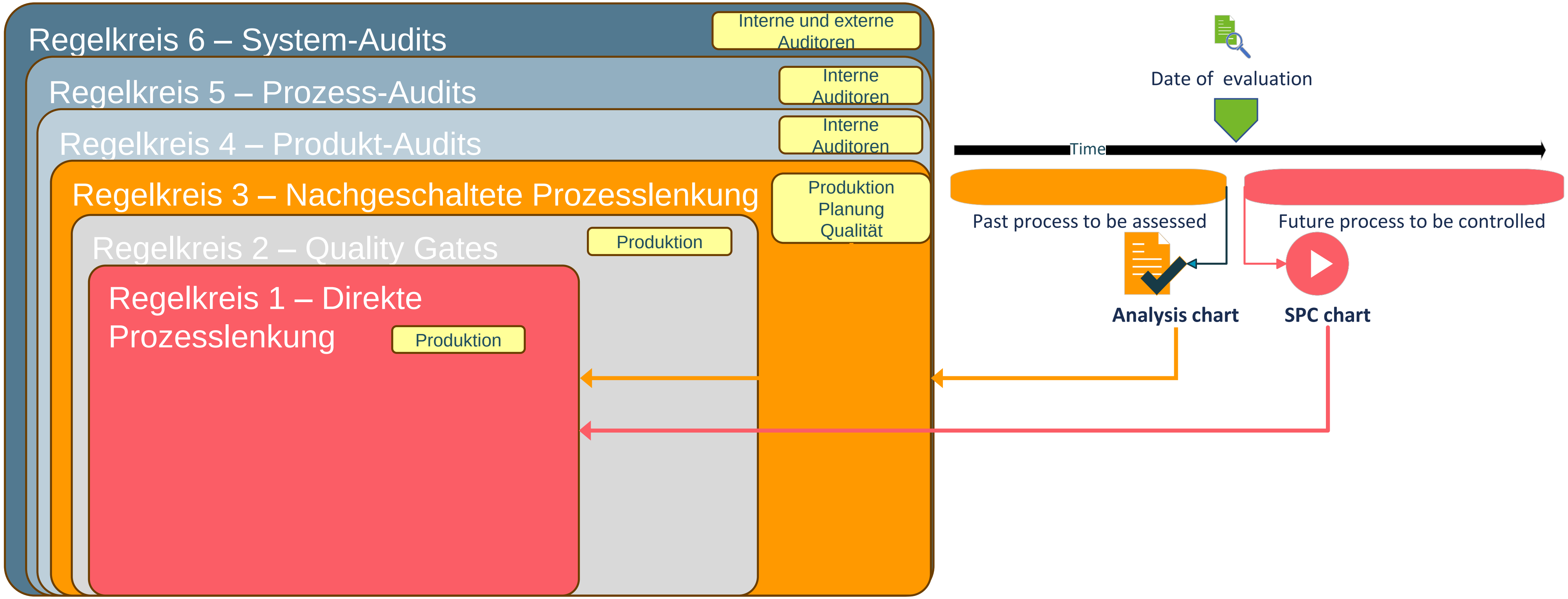
*DIN ISO 3534-2 (Begriffe und Formelzeichen – Angewandte Statistik)*

# Statistical Process Control - Harmonisierung


2021
2023
VDA QMC
4
Quality Management in the Automobile Industry
Quality Assurance in the Process Landscape
Section 3: Methods
SPC
INTERNATIONAL STANDARD
ISO 11462-1
Guidelines for implementation of statistical process control (SPC) —
Part 1:
Elements of SPC
ISO
Statistical Process Control
SPC
Second Edition
2005
VDA QMC
ISO 22514-x
ISO 11462-x
ISO
ISO/TC 69/SC 4
ISO 7870-x
AIAG
One World
SPC

# Statistical Process Control - Harmonisierung

- Verschiedene Regelkreise / Feedback Loops



Regelkreis 6 – System-Audits

Interne und externe Auditoren

Regelkreis 5 – Prozess-Audits

Interne Auditoren

Regelkreis 4 – Produkt-Audits

Interne Auditoren

Regelkreis 3 – Nachgeschaltete Prozesslenkung

Produktion
Planung
Qualität

Regelkreis 2 – Quality Gates

Produktion

Regelkreis 1 – Direkte Prozesslenkung

Produktion

Date of evaluation

Time

Past process to be assessed

Future process to be controlled

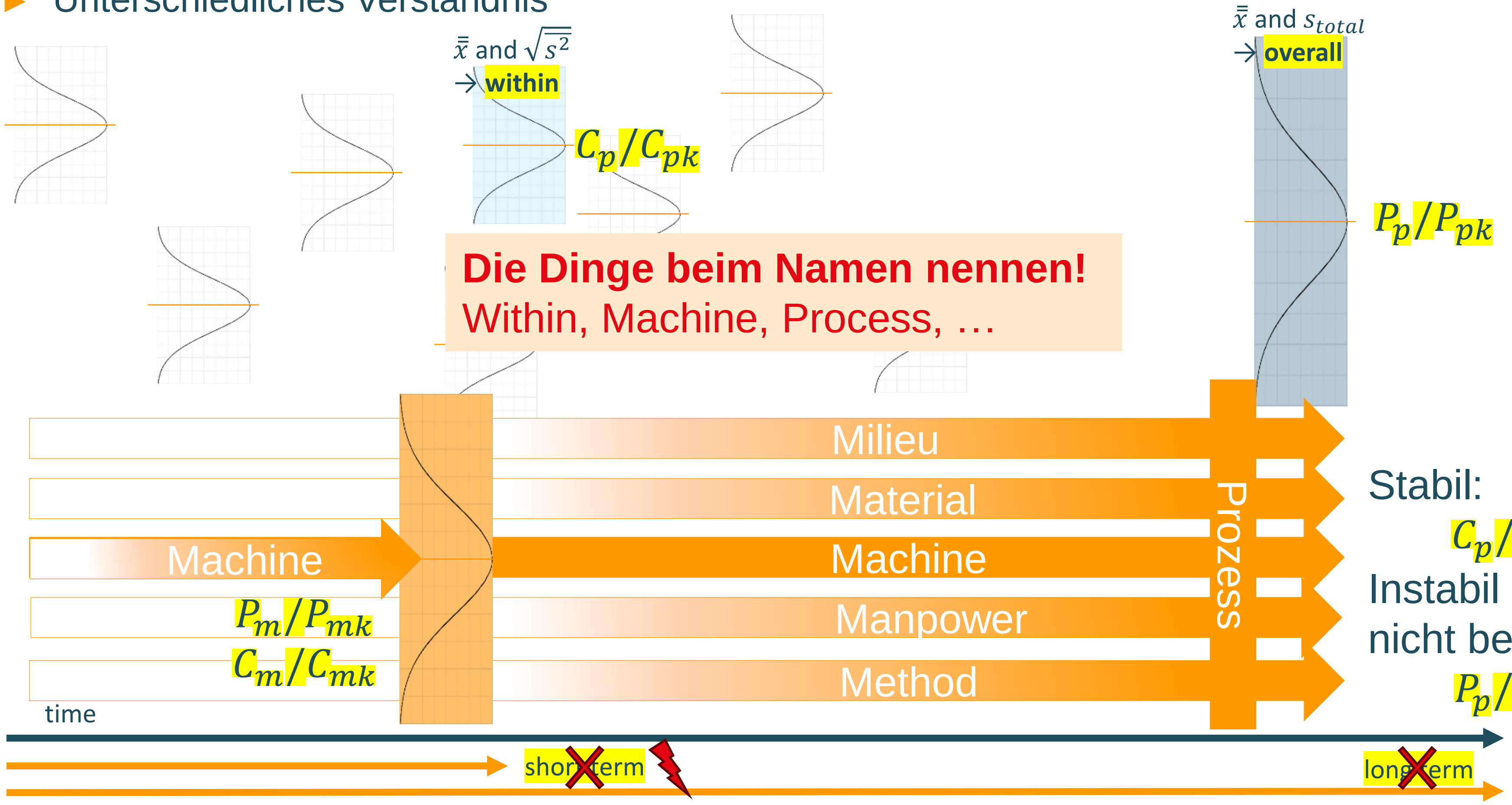
**Analysis chart**

**SPC chart**

UNTERSCHIEDLICHES VERSTÄNDNIS

# Statistical Process Control - Harmonisierung

- Unterschiedliches Verständnis


$\bar{\bar{x}}$ and $\sqrt{s^2}$
→ within
$C_p/C_{pk}$
$\bar{\bar{x}}$ and $s_{total}$
→ overall
$P_p/P_{pk}$
Milieu
Material
Machine
Machine
Manpower
Method
Prozess
$P_m/P_{mk}$
$C_m/C_{mk}$
time
~~short term~~
~~long term~~

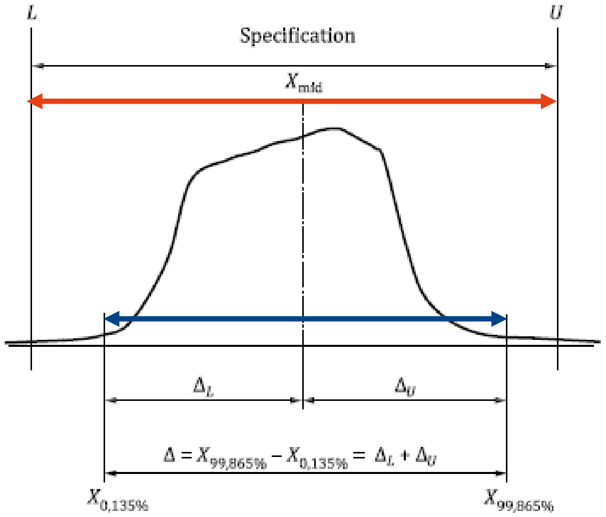
**Die Dinge beim Namen nennen!**
Within, Machine, Process, …

Stabil:
$C_p/C_{pk}$
Instabil oder nicht bewertet:
$P_p/P_{pk}$

## QUANTILE METHOD VS. Z-METHOD (ÜBERSCHREITUNGSANTEILMETHODE)

# Statistical Process Control - Harmonisierung

- Herausforderungen


L
U
Specification
$X_{mid}$
$\Delta_L$
$\Delta_U$
$\Delta = X_{99,865\%} - X_{0,135\%} = \Delta_L + \Delta_U$
$X_{0,135\%}$
$X_{99,865\%}$

Process performance index:

$$P_p = \frac{U-L}{\Delta}$$

Lower process performance index:

$$P_{pk_L} = \frac{X_{mid}-L}{\Delta_L}$$

Upper process performance index:

$$P_{pk_U} = \frac{U-X_{mid}}{\Delta_U}$$

Minimum process performance index:

$$P_{pk} = \min\left(P_{pk_L}, P_{pk_U}\right)$$

Capability index:

$$C_p = \frac{U-L}{\Delta}$$

Lower capability index:

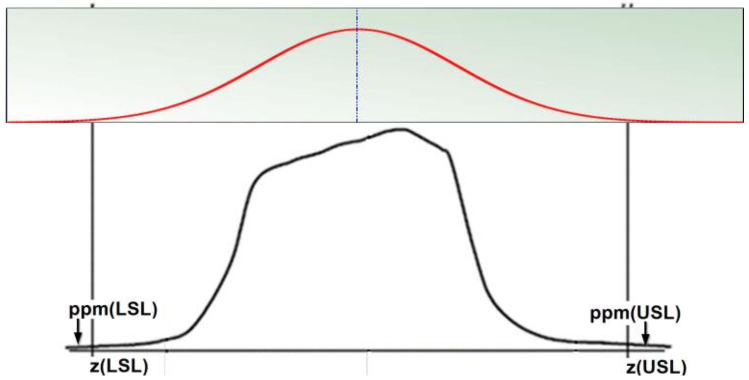
$$C_{pk_L} = \frac{X_{mid}-L}{\Delta_L}$$

Upper capability index:

$$C_{pk_U} = \frac{U-X_{mid}}{\Delta_U}$$

Minimum capability index:

$$C_{pk} = \min\left(C_{pk_L}, C_{pk_U}\right)$$


ppm(LSL)
ppm(USL)
z(LSL)
z(USL)

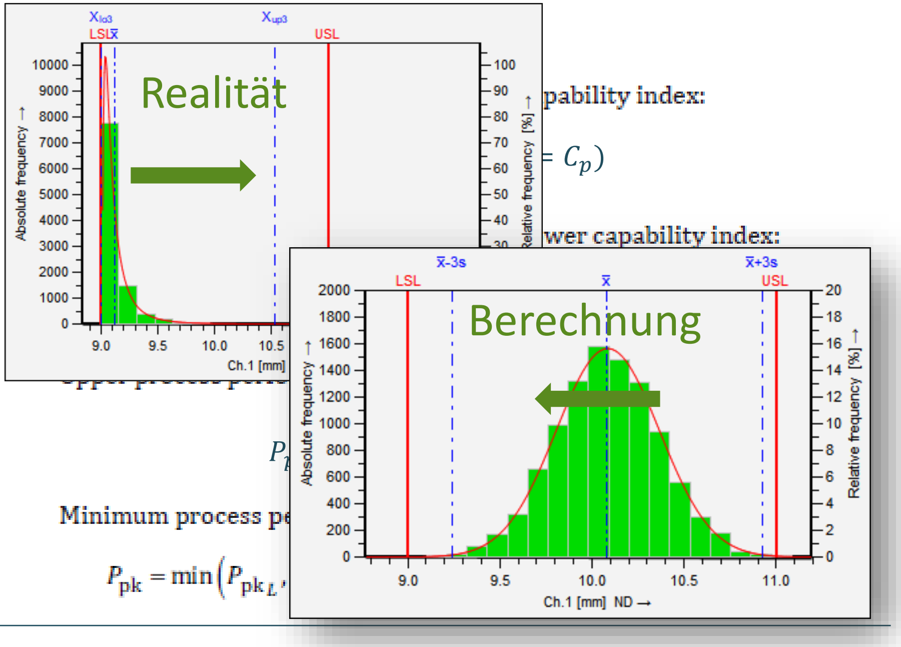
pability index:

$= C_p)$

wer capability index:

Minimum process pe

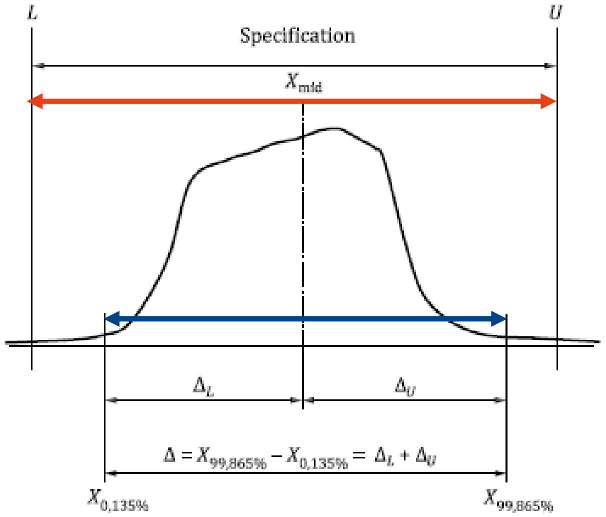
$P_{pk} = \min\left(P_{pk_L},\right.$



QUANTILE METHOD VS. Z-METHOD (ÜBERSCHREITUNGSANTEILMETHODE)

# Statistical Process Control - Harmonisierung

- Herausforderungen



Process performance index:

$$P_p = \frac{U-L}{\Delta}$$

Capability index:

$$C_p = \frac{U-L}{\Delta}$$

Lower process performance index:

$$P_{pk_L} = \frac{X_{mid}-L}{\Delta_L}$$

Lower capability index:

$$C_{pk_L} = \frac{X_{mid}-L}{\Delta_L}$$

Upper process performance index:

$$P_{pk_U} = \frac{U-X_{mid}}{\Delta_U}$$

Upper capability index:

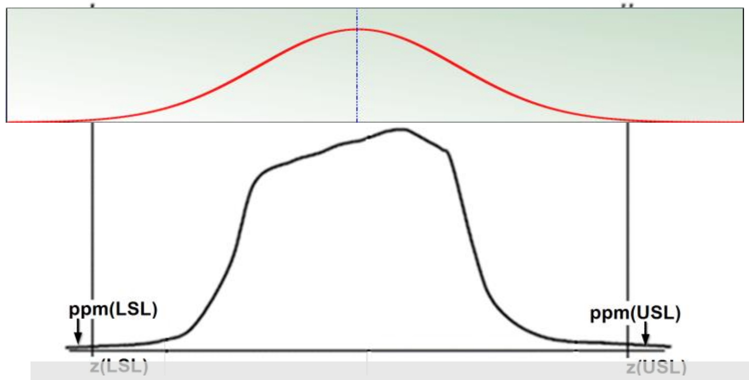
$$C_{pk_U} = \frac{U-X_{mid}}{\Delta_U}$$

Minimum process performance index:

$$P_{pk} = \min\left(P_{pk_L}, P_{pk_U}\right)$$

Minimum capability index:

$$C_{pk} = \min\left(C_{pk_L}, C_{pk_U}\right)$$



1991 Standard bei Daimer Benz

Seit 1996 bei OEMs „ausgestorben“

2002 in DIN 55319 noch enthalten

2007 in ISO 22747 noch enthalten, aber Anwendbarkeit stark begrenzt

2011 aus ISO 22514-2 entfernt

Weiterhin genutzt in ISO 22514-5 für attributive Daten

Process performance index:

Capability index:

$$P_p = \frac{z(USL)-z(LSL)}{6} \ (\ldots = C_p)$$

Lower process performance index:

Lower capability index:

$$P_{pk_L} = \frac{z(LSL)}{3} \ (\ldots = C_{pk_L})$$

Upper process performance index:

Upper capability index:

$$P_{pk_U} = \frac{z(USL)}{3} \ (\ldots = C_{pk_U})$$

Minimum process performance index:

Minimum capability index:

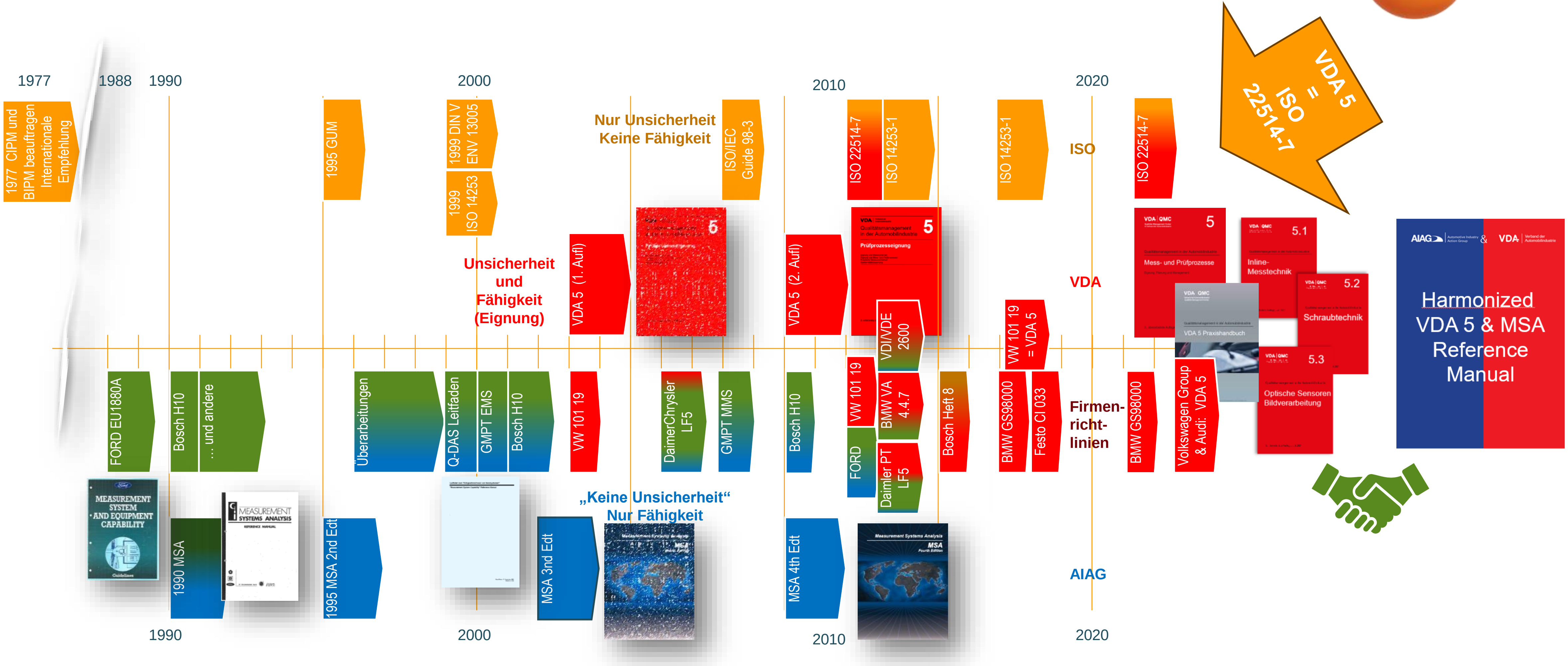
$$P_{pk} = \min\left(P_{pk_L}, P_{pk_U}\right)$$

$$C_{pk} = \min\left(C_{pk_L}, C_{pk_U}\right)$$

# AGENDA

- HISTORISCHE ENTWICKLUNG
- DAS VDA 5-KONZEPT
- GRUNDLEGENDE UNTERSCHIEDE MSA - VDA 5
- GRUNDLEGENDE GLEICHHEITEN MSA - VDA 5
- BEWERTUNG MESSSYSTEM
- BEWERTUNG MESSPROZESS
- WAS SIE BEI DEN MSA-METHODEN VERMISSEN WERDEN
- NÄCHSTE SCHRITTE

# Historische Entwicklung



1977 1988 1990 2000 2010 2020

**ISO**

1977 CIPM und BIPM beauftragen Internationale Empfehlung

1995 GUM

1999 DIN V ENV 13005

1999 ISO 14253

**Nur Unsicherheit**
**Keine Fähigkeit**

ISO/IEC Guide 98-3

ISO 22514-7

ISO 14253-1

ISO 14253-1

ISO 22514-7

VDA 5
=
ISO
22514-7

**VDA**

**Unsicherheit und Fähigkeit (Eignung)**

VDA 5 (1. Aufl)

VDA 5 (2. Aufl)

VDA
Qualitätsmanagement in der Automobilindustrie
Prüfprozesseignung
5

VDI/VDE 2600

VW 101 19 = VDA 5

VDA | QMC 5
Qualitätsmanagement in der Automobilindustrie
Mess- und Prüfprozesse

VDA | QMC 5.1
Inline-Messtechnik

VDA QMC
VDA 5 Praxishandbuch

VDA | QMC 5.2
Schraubtechnik

VDA | QMC 5.3
Optische Sensoren Bildverarbeitung

AIAG Automotive Industry Action Group & VDA Verband der Automobilindustrie
Harmonized VDA 5 & MSA Reference Manual

**Firmen-richt-linien**

FORD EU1880A

Bosch H10

… und andere

Überarbeitungen

Q-DAS Leitfaden

GMPT EMS

Bosch H10

VW 101 19

DaimlerChrysler LF5

GMPT MMS

Bosch H10

VW 101 19

FORD

BMW VA 4.4.7

Daimler PT LF5

Bosch Heft 8

BMW GS98000

Festo CI 033

BMW GS98000

Volkswagen Group & Audi: VDA 5

**AIAG**

MEASUREMENT SYSTEM AND EQUIPMENT CAPABILITY
Guidelines

1990 MSA

MEASUREMENT SYSTEMS ANALYSIS
REFERENCE MANUAL

1995 MSA 2nd Edt

**„Keine Unsicherheit“**
**Nur Fähigkeit**

MSA 3nd Edt

Measurement Systems Analysis
MSA

MSA 4th Edt

Measurement Systems Analysis
MSA
Fourth Edition

1990 2000 2010 2020

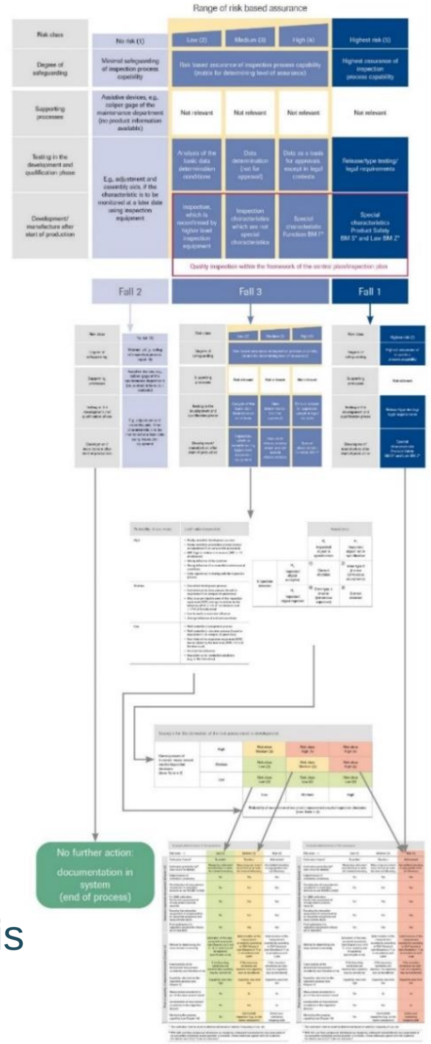
# Heutiger Stand der Technik

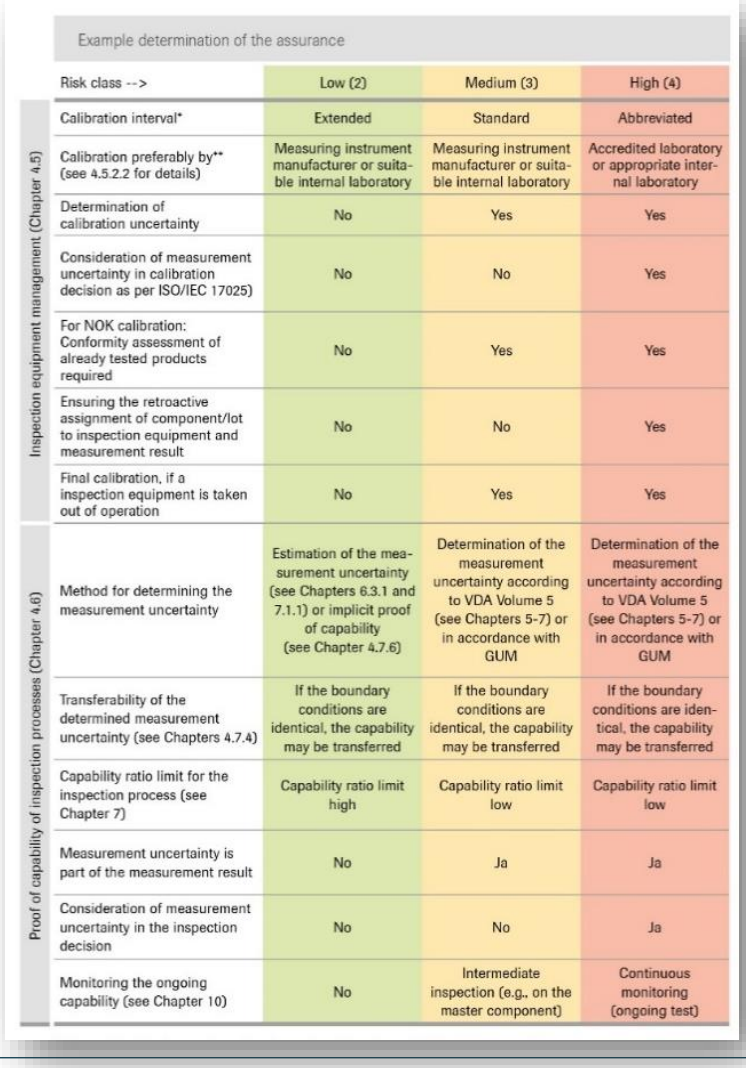
| ISO/IEC Guide 98 (GUM)<br>ISO 14253-1 | VDA Band 5 (3. Edition)<br>ISO 22514-7 | Firmenrichtlinien MSA<br>(„what you really do …“) | AIAG MSA 4th Edition | |
|---|---|---|---|---|
| | | | Reihenfolge sortiert für den Vergleich der Verfahren | Reihenfolge wie in AIAG MSA |
| **ISO/IEC Guide 98** (GUM)<br>- Kombinierte Standardunsicherheit$u_c$<br>- Freiheitsgrade **f**<br>- Erweiterte Messunsicherheit**U**<br>*“It may therefore be necessary to develop particular standards based on this Guide that deal with the problems peculiar to specific fields of measurement or with the various uses of quantitative expressions of uncertainty.”*<br>*“Although this Guide provides a framework for assessing uncertainty, it cannot substitute for*<br>- *critical thinking,*<br>- *intellectual honesty and*<br>- *professional skill.”* | Eignung Mess-System $Q_{MS}$<br>Berücksichtigung von Verfahren 1, Linearität und anderen Vorkenntnissen | Verfahren 1 – **Cg/Cgk** | Signifikanztest für Bias (QRK oder Stichprobe) ⛈ | Stabilität ☀ |
| | | Linearität (normalerweise verstanden als Veränderung des Bias über T) | Signifikanztest für Linearität (Achsen-abschnitt und Steigung) ⛈ | Signifikanztest für Bias (QRK) ⛈ |
| | Eignung Mess-Prozess $Q_{MP}$<br>Berücksichtigung der Methoden 2 und 3, der Temperatur, des Messobjekts (Formabweichungen), mehrerer Messstellen, der (Kurzzeit-)Stabilität und anderer Vorkenntnisse | Verfahren 2 - **%GRR** | Gage R&R ☀ und/oder ndc ⛈ (Vorzugsweise in Bezug auf den Fertigungsprozess) | Signifikanztest für Bias (Stichprobe) ⛈ |
| | | Verfahren 3 - **%GRR** | | Signifikanztest für Linearität (Achsen-abschnitt und Steigung) ⛈ |
| | | Stabilität | Stabilität ☀ | ☀ ⛈ Gage R&R and/or ndc |
| | | (Keine Einflüsse aus der Umgebung, Messobjekt, …) ⛈ | (Keine Einflüsse aus der Umgebung, Messobjekt, …) ⛈ | |
| Entscheidungsregeln für die Feststellung der Konformität oder Nichtkonformität mit Spezifikationen | Entscheidungsregeln für die Feststellung der Konformität oder Nichtkonformität mit Spezifikationen | Keine Messunsicherheit - keine Entscheidungsregeln ⛈ | Keine Messunsicherheit - keine Entscheidungsregeln ⛈ | |

VDA 5 VORGEHENSWEISE

# Vorarbeiten und Konsequenzen

- Risikobasierter Ansatz
- Risiko identifizieren
- Risikoklasse definieren
- Anforderungen an Kalibrierung und Eignungsnachweis


Range of risk based assurance
Risk class
No risk (1)
Low (2)
Medium (3)
High (4)
Highest risk (5)
Degree of safeguarding
Supporting processes
Not relevant
Not relevant
Not relevant
Not relevant
Testing in the development and qualification phase
Development/ manufacture after start of production
Fall 2
Fall 3
Fall 1
No further action: documentation in system (end of process)

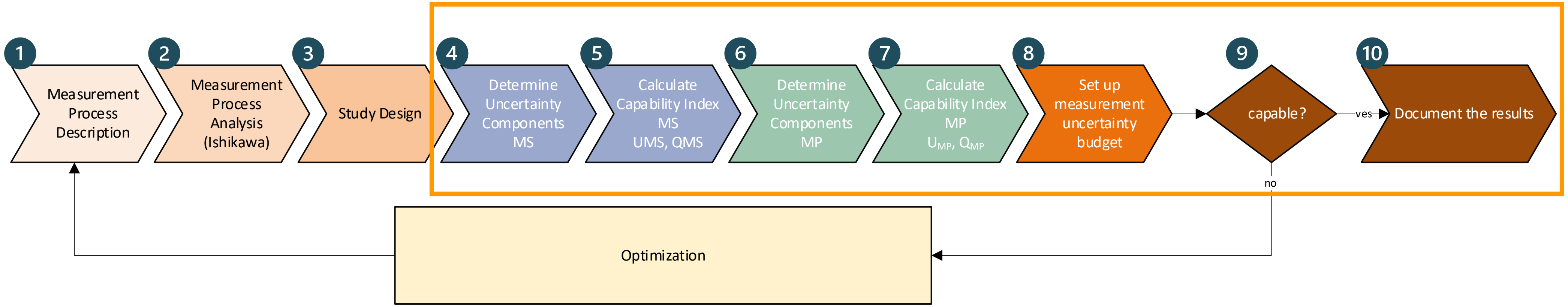


Example determination of the assurance

| | Risk class --> | Low (2) | Medium (3) | High (4) |
|---|---|---|---|---|
| Inspection equipment management (Chapter 4.5) | Calibration interval* | Extended | Standard | Abbreviated |
| | Calibration preferably by** (see 4.5.2.2 for details) | Measuring instrument manufacturer or suitable internal laboratory | Measuring instrument manufacturer or suitable internal laboratory | Accredited laboratory or appropriate internal laboratory |
| | Determination of calibration uncertainty | No | Yes | Yes |
| | Consideration of measurement uncertainty in calibration decision as per ISO/IEC 17025) | No | No | Yes |
| | For NOK calibration: Conformity assessment of already tested products required | No | Yes | Yes |
| | Ensuring the retroactive assignment of component/lot to inspection equipment and measurement result | No | No | Yes |
| | Final calibration, if a inspection equipment is taken out of operation | No | Yes | Yes |
| Proof of capability of inspection processes (Chapter 4.6) | Method for determining the measurement uncertainty | Estimation of the measurement uncertainty (see Chapters 6.3.1 and 7.1.1) or implicit proof of capability (see Chapter 4.7.6) | Determination of the measurement uncertainty according to VDA Volume 5 (see Chapters 5-7) or in accordance with GUM | Determination of the measurement uncertainty according to VDA Volume 5 (see Chapters 5-7) or in accordance with GUM |
| | Transferability of the determined measurement uncertainty (see Chapters 4.7.4) | If the boundary conditions are identical, the capability may be transferred | If the boundary conditions are identical, the capability may be transferred | If the boundary conditions are identical, the capability may be transferred |
| | Capability ratio limit for the inspection process (see Chapter 7) | Capability ratio limit high | Capability ratio limit low | Capability ratio limit low |
| | Measurement uncertainty is part of the measurement result | No | Ja | Ja |
| | Consideration of measurement uncertainty in the inspection decision | No | No | Ja |
| | Monitoring the ongoing capability (see Chapter 10) | No | Intermediate inspection (e.g., on the master component) | Continuous monitoring (ongoing test) |

# VDA 5 General Procedure

- Proof of Capability/Suitability



1 Measurement Process Description

2 Measurement Process Analysis (Ishikawa)

3 Study Design

4 Determine Uncertainty Components MS

5 Calculate Capability Index MS $U_{MS}$, $Q_{MS}$

6 Determine Uncertainty Components MP

7 Calculate Capability Index MP $U_{MP}$, $Q_{MP}$

8 Set up measurement uncertainty budget

9 capable?

yes

no

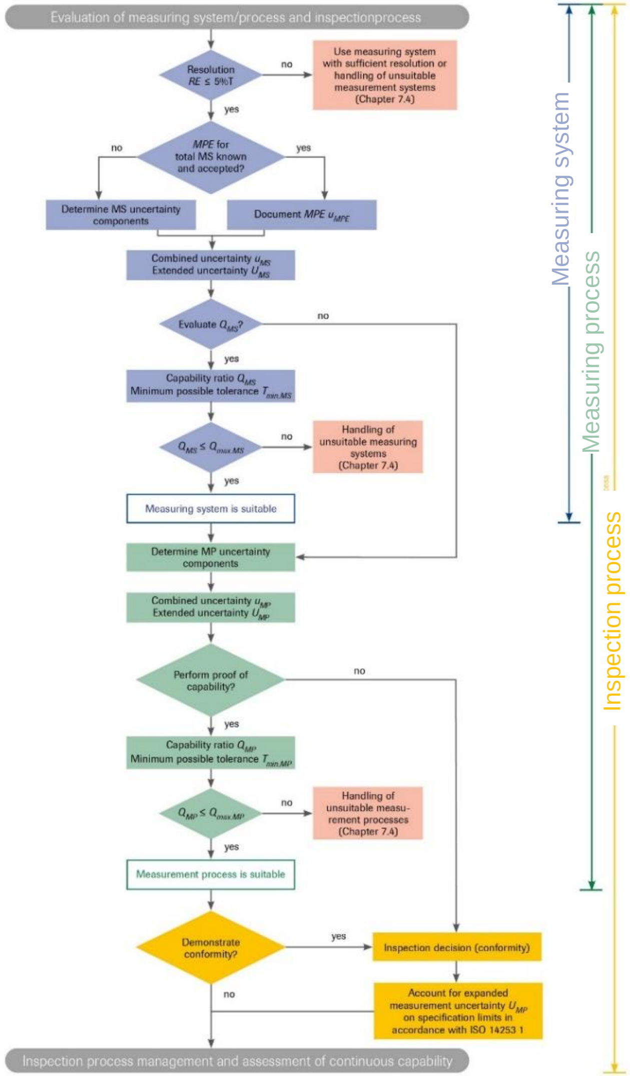
10 Document the results

Optimization

VDA 5 VORGEHENSWEISE

# Strukturierte Analyse der Unsicherheit in 3 Schritten

- Messsystem
  - Unsicherheitsabschätzung
    - Methode **B** durch Wissen („**B**estens **b**ekannt“)
    - Methode **A** durch Experimente („**A**lles **a**usprobieren“) → Experiment MS
  - Messunsicherheit $U_{MS}$
  - Fähigkeitsquotient $Q_{MS}$
- Messprozess (inkl. Messsystem)
  - Unsicherheitsabschätzung
    - Methode **B** durch Wissen („**B**estens **b**ekannt“)
    - Methode **A** durch Experimente („**A**lles **a**usprobieren“) → Experiment MP
  - Messunsicherheit $U_{MP}$
  - Fähigkeitskennzahl $Q_{MP}$
- Konformitätsprüfung
  - Schutzabstand nach ISO 14253-1 und anderen

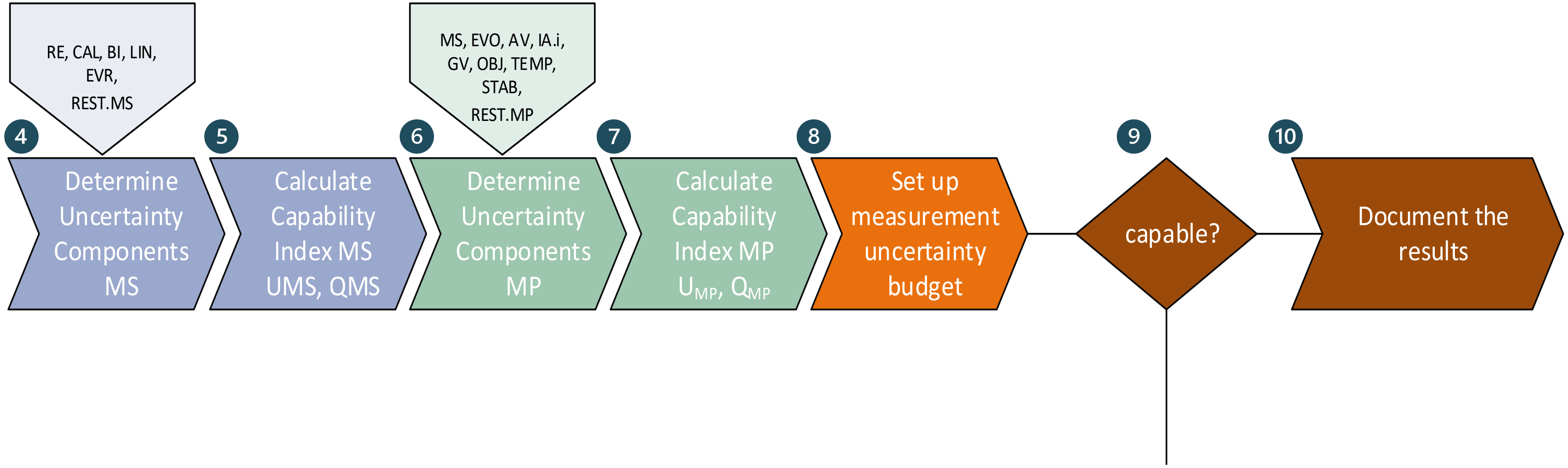

Evaluation of measuring system/process and inspectionprocess
Resolution $RE \leq 5\%T$
no
Use measuring system with sufficient resolution or handling of unsuitable measurement systems (Chapter 7.4)
yes
$MPE$ for total MS known and accepted?
no
yes
Determine MS uncertainty components
Document $MPE$ $u_{MPE}$
Combined uncertainty $u_{MS}$ Extended uncertainty $U_{MS}$
Evaluate $Q_{MS}$?
no
yes
Capability ratio $Q_{MS}$ Minimum possible tolerance $T_{min,MS}$
$Q_{MS} \leq Q_{max,MS}$
no
Handling of unsuitable measuring systems (Chapter 7.4)
yes
Measuring system is suitable
Determine MP uncertainty components
Combined uncertainty $u_{MP}$ Extended uncertainty $U_{MP}$
Perform proof of capability?
no
yes
Capability ratio $Q_{MP}$, Minimum possible tolerance $T_{min,MP}$
$Q_{MP} \leq Q_{max,MP}$
no
Handling of unsuitable measurement processes (Chapter 7.4)
yes
Measurement process is suitable
Demonstrate conformity?
yes
Inspection decision (conformity)
no
Account for expanded measurement uncertainty $U_{MP}$ on specification limits in accordance with ISO 14253 1
Inspection process management and assessment of continuous capability
Measuring system
Measuring process
Inspection process

Graphic taken or adapted from
VDA Volume 5 3rd edition
2021

# VDA 5 Allgemeiner Ablauf

## Nachweis der Eignung

| | |
|---|---|
| RE | Auflösung der Anzeige |
| CAL | Kalibrierunsicherheit |
| BI | Bias |
| LIN | Linearität (Veränderung des Bias) |
| EVR | Wiederholpräzision an Referenzteilen |
| REST.MS | |
| EVO | Wiederholpräzision an Objekten |
| AV | Vergleichbarkeit der Bediener |
| IA(.i) | Wechselwirkung(en) |
| GV | Vergleichbarkeit Messmittel/Messpunkte |
| OBJ | Inhomogenität des Messobjekts |
| TEMP | Temperatureinflüsse |
| STAB | (Kurzzeit-)Stabilität |
| REST.MP | |



RE, CAL, BI, LIN, EVR, REST.MS

MS, EVO, AV, IA.i, GV, OBJ, TEMP, STAB, REST.MP

4 Determine Uncertainty Components MS

5 Calculate Capability Index MS UMS, QMS

6 Determine Uncertainty Components MP

7 Calculate Capability Index MP $U_{MP}$, $Q_{MP}$

8 Set up measurement uncertainty budget

9 capable?

10 Document the results

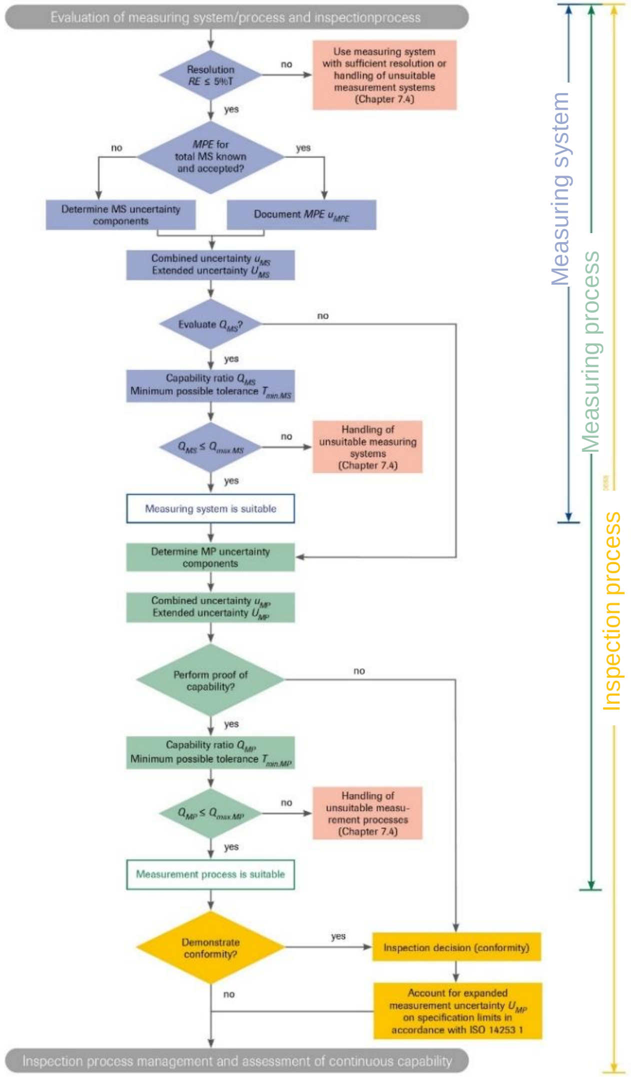
VDA 5 VORGEHENSWEISE

# Strukturierte Analyse der Unsicherheit in 3 Schritten

- Messsystem
  - Unsicherheitsabschätzung
    - Methode **B** durch Wissen („**B**estens **be**kannt“)
    - Methode **A** durch Experimente („**A**lles **aus**probieren“)

      → Experiment MS
  - Messunsicherheit $U_{MS}$
  - Fähigkeitsquotient $Q_{MS}$
- Messprozess (inkl. Messsystem)
  - Unsicherheitsabschätzung
    - Methode **B** durch Wissen („**B**estens **be**kannt“)
    - Methode **A** durch Experimente („**A**lles **aus**probieren“)

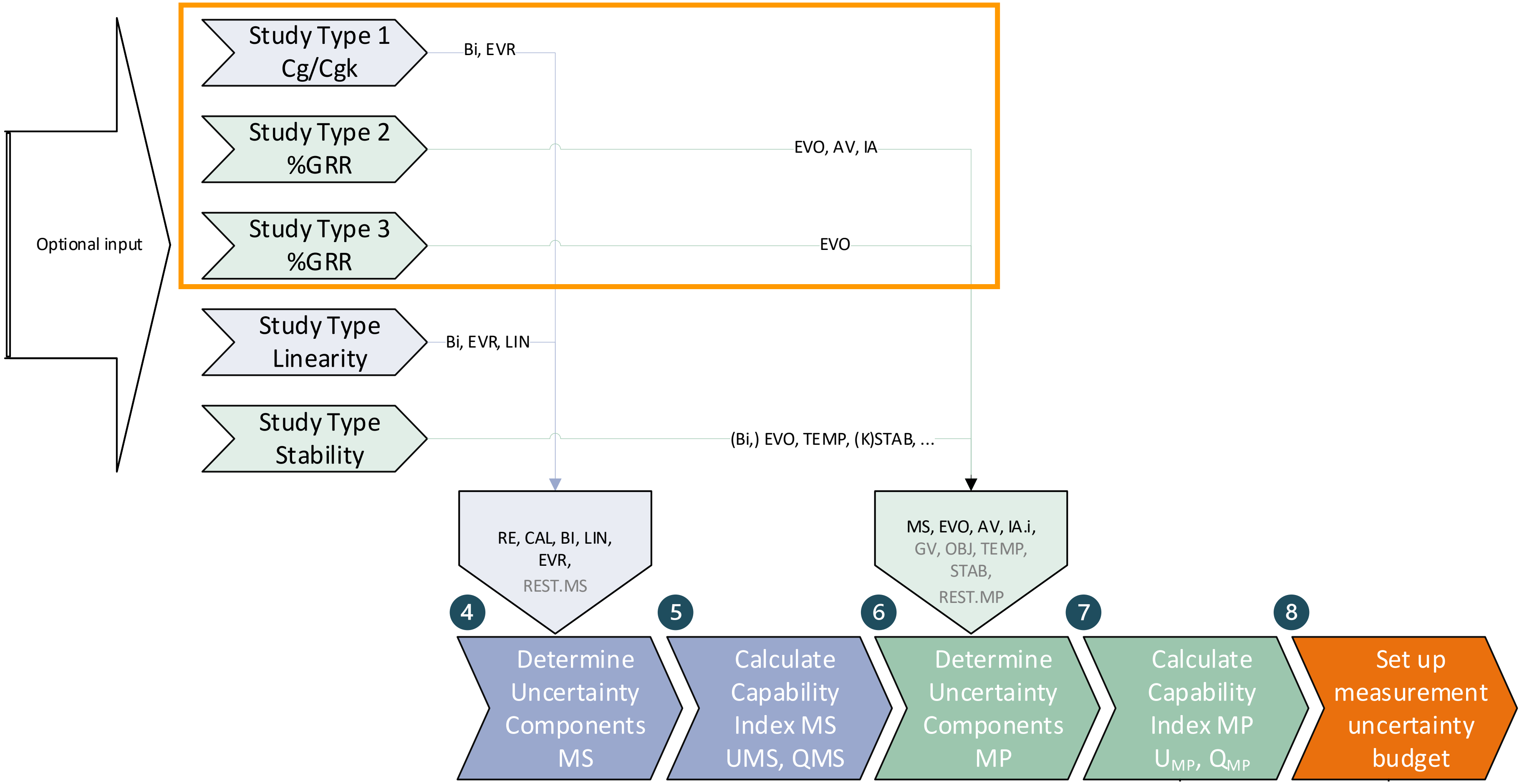
      → Experiment MP
  - Messunsicherheit $U_{MP}$
  - Fähigkeitskennzahl $Q_{MP}$
- Konformitätsprüfung
  - Schutzabstand nach ISO 14253-1 und anderen


Evaluation of measuring system/process and inspectionprocess
Resolution $RE \leq 5\%T$
no
Use measuring system with sufficient resolution or handling of unsuitable measurement systems (Chapter 7.4)
yes
MPE for total MS known and accepted?
no
yes
Determine MS uncertainty components
Document MPE $u_{MPE}$
Combined uncertainty $u_{MS}$ Extended uncertainty $U_{MS}$
Evaluate $Q_{MS}$?
no
yes
Capability ratio $Q_{MS}$ Minimum possible tolerance $T_{min,MS}$
$Q_{MS} \leq Q_{max,MS}$
no
Handling of unsuitable measuring systems (Chapter 7.4)
yes
Measuring system is suitable
Determine MP uncertainty components
Combined uncertainty $u_{MP}$ Extended uncertainty $U_{MP}$
Perform proof of capability?
no
yes
Capability ratio $Q_{MP}$ Minimum possible tolerance $T_{min,MP}$
$Q_{MP} \leq Q_{max,MP}$
no
Handling of unsuitable measurement processes (Chapter 7.4)
yes
Measurement process is suitable
Demonstrate conformity?
yes
Inspection decision (conformity)
no
Account for expanded measurement uncertainty $U_{MP}$ on specification limits in accordance with ISO 14253 1
Inspection process management and assessment of continuous capability
Measuring system
Measuring process
Inspection process

Graphic taken or adapted from VDA Volume 5 3rd edition 2021

# VDA 5 Allgemeiner Ablauf

## Nachweis der Eignung – Die experimentellen Versuche gleichen den MSA-Verfahren


Optional input
Study Type 1 Cg/Cgk
Bi, EVR
Study Type 2 %GRR
EVO, AV, IA
Study Type 3 %GRR
EVO
Study Type Linearity
Bi, EVR, LIN
Study Type Stability
(Bi,) EVO, TEMP, (K)STAB, ...
RE, CAL, BI, LIN, EVR, REST.MS
MS, EVO, AV, IA.i, GV, OBJ, TEMP, STAB, REST.MP
4
Determine Uncertainty Components MS
5
Calculate Capability Index MS UMS, QMS
6
Determine Uncertainty Components MP
7
Calculate Capability Index MP UMP, QMP
8
Set up measurement uncertainty budget

# Beurteilung des Messsystems

-11.839
ZERO / ABS
ON / OFF

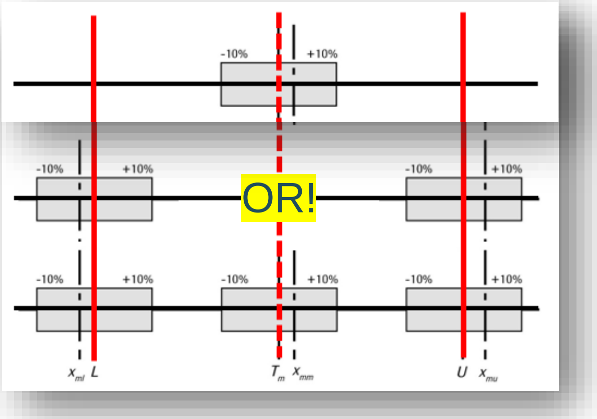
akkreditiert durch die / accredited by the
**Deutsche Akkreditierungsstelle GmbH**
als Kalibrierlaboratorium im / as calibration laboratory in the
**Deutschen Kalibrierdienst** DKD

Kalibrierschein
Calibration certificate

Kalibrierzeichen
Calibration mark

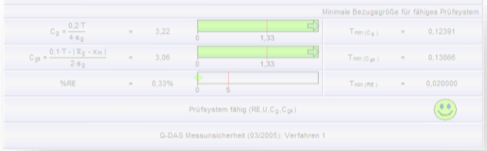
MUSTER
2014-04

Check $RE$ und $U_{CAL}$



$BI$ und $EVR$

$C_g/C_{gk}$

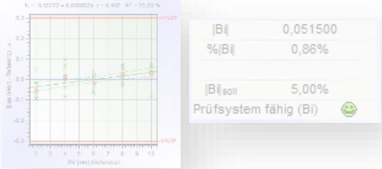


| | | | | Minimale Bezugsgröße für fähiges Prüfsystem | | |
|---|---|---|---|---|---|---|
| $C_g = \frac{0{,}2 \cdot T}{4 \cdot s_g}$ | = | 3,22 | | $T_{min\,(C_g)}$ | = | 0,12391 |
| $C_{gk} = \frac{0{,}1 \cdot T - \lvert \bar{X}_g - X_m \rvert}{2 \cdot s_g}$ | = | 3,06 | | $T_{min\,(C_{gk})}$ | = | 0,13866 |
| %RE | = | 0,33% | | $T_{min\,(RE)}$ | = | 0,020000 |

Prüfsystem fähig (RE,U,$C_g$,$C_{gk}$)

Q-DAS Messunsicherheit (03/2005): Verfahren 1

$Lin/Bi_{max}$

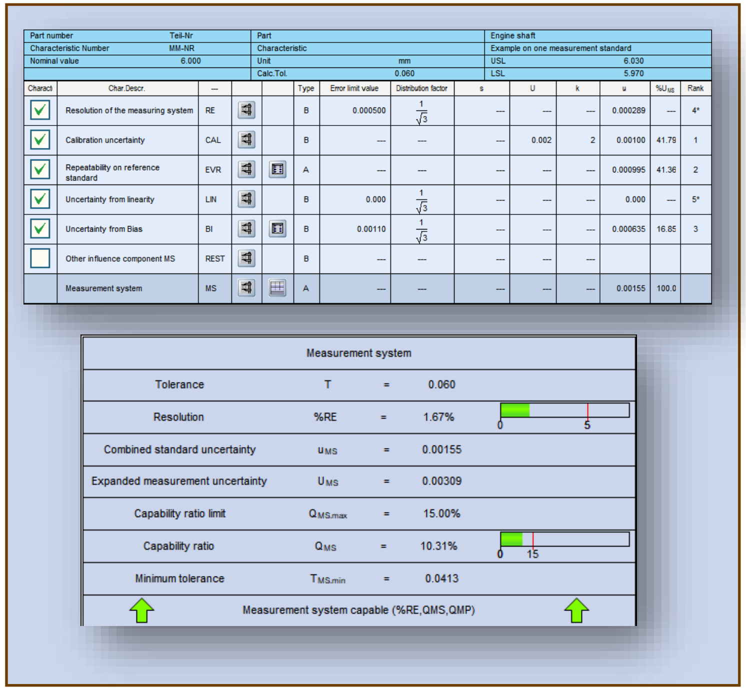


| | |
|---|---|
| \|Bi\| | 0,051500 |
| %\|Bi\| | 0,86% |
| | |
| $\lvert Bi \rvert_{soll}$ | 5,00% |
| Prüfsystem fähig (Bi) | |

$RE$
$U_{CAL}$

$BI$
$EVR$

$LIN$
$BI_{max}$
$EVR$



| Part number | Teil-Nr | Part | | Engine shaft | |
|---|---|---|---|---|---|
| Characteristic Number | MM-NR | Characteristic | | Example on one measurement standard | |
| Nominal value | 6.000 | Unit | mm | USL | 6.030 |
| | | Calc.Tol. | 0.060 | LSL | 5.970 |

| Charact | Char.Descr. | --- | | | Type | Error limit value | Distribution factor | s | U | k | u | $\%U_{MS}$ | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ☑ | Resolution of the measuring system | RE | | | B | 0.000500 | $\frac{1}{\sqrt{3}}$ | --- | --- | --- | 0.000289 | --- | 4* |
| ☑ | Calibration uncertainty | CAL | | | B | --- | --- | --- | 0.002 | 2 | 0.00100 | 41.79 | 1 |
| ☑ | Repeatability on reference standard | EVR | | | A | --- | --- | --- | --- | --- | 0.000995 | 41.36 | 2 |
| ☑ | Uncertainty from linearity | LIN | | | B | 0.000 | $\frac{1}{\sqrt{3}}$ | --- | --- | --- | 0.000 | --- | 5* |
| ☑ | Uncertainty from Bias | BI | | | B | 0.00110 | $\frac{1}{\sqrt{3}}$ | --- | --- | --- | 0.000635 | 16.85 | 3 |
| ☐ | Other influence component MS | REST | | | B | --- | --- | --- | --- | --- | | | |
| | Measurement system | MS | | | A | --- | --- | --- | --- | --- | 0.00155 | 100.0 | |

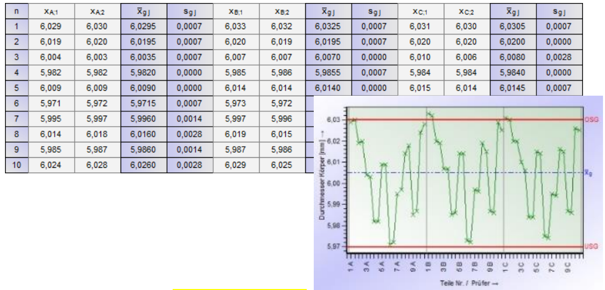
| Measurement system | | | | |
|---|---|---|---|---|
| Tolerance | T | = | 0.060 | |
| Resolution | %RE | = | 1.67% | |
| Combined standard uncertainty | $u_{MS}$ | = | 0.00155 | |
| Expanded measurement uncertainty | $U_{MS}$ | = | 0.00309 | |
| Capability ratio limit | $Q_{MS.max}$ | = | 15.00% | |
| Capability ratio | $Q_{MS}$ | = | 10.31% | |
| Minimum tolerance | $T_{MS.min}$ | = | 0.0413 | |

Measurement system capable (%RE,QMS,QMP)

Wird für VDA 5 nicht benötigt, macht aber das Leben einfacher und liefert Ergebnisse für MSA-Unternehmen...

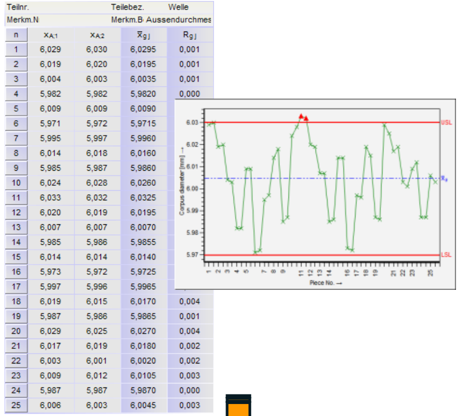
MESSSYSTEM

# Bewertung des Messprozesses



| n | $x_{A;1}$ | $x_{A;2}$ | $\bar{x}_{g\,j}$ | $s_{g\,j}$ | $x_{B;1}$ | $x_{B;2}$ | $\bar{x}_{g\,j}$ | $s_{g\,j}$ | $x_{C;1}$ | $x_{C;2}$ | $\bar{x}_{g\,j}$ | $s_{g\,j}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6,029 | 6,030 | 6,0295 | 0,0007 | 6,033 | 6,032 | 6,0325 | 0,0007 | 6,031 | 6,030 | 6,0305 | 0,0007 |
| 2 | 6,019 | 6,020 | 6,0195 | 0,0007 | 6,020 | 6,019 | 6,0195 | 0,0007 | 6,020 | 6,020 | 6,0200 | 0,0000 |
| 3 | 6,004 | 6,003 | 6,0035 | 0,0007 | 6,007 | 6,007 | 6,0070 | 0,0000 | 6,010 | 6,006 | 6,0080 | 0,0028 |
| 4 | 5,982 | 5,982 | 5,9820 | 0,0000 | 5,985 | 5,986 | 5,9855 | 0,0007 | 5,984 | 5,984 | 5,9840 | 0,0000 |
| 5 | 6,009 | 6,009 | 6,0090 | 0,0000 | 6,014 | 6,014 | 6,0140 | 0,0000 | 6,015 | 6,014 | 6,0145 | 0,0007 |
| 6 | 5,971 | 5,972 | 5,9715 | 0,0007 | 5,973 | 5,972 | | | | | | |
| 7 | 5,995 | 5,997 | 5,9960 | 0,0014 | 5,997 | 5,996 | | | | | | |
| 8 | 6,014 | 6,018 | 6,0160 | 0,0028 | 6,019 | 6,015 | | | | | | |
| 9 | 5,985 | 5,987 | 5,9860 | 0,0014 | 5,987 | 5,986 | | | | | | |
| 10 | 6,024 | 6,028 | 6,0260 | 0,0028 | 6,029 | 6,025 | | | | | | |

ODER!

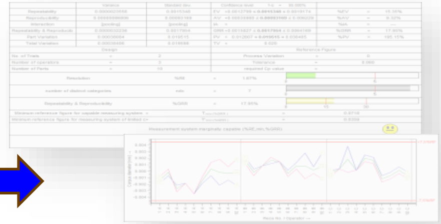


Teilnr. Teilebez. Welle
Merkm.N Merkm.B Aussendurchmes

| n | $x_{A;1}$ | $x_{A;2}$ | $\bar{x}_{g\,j}$ | $R_{g\,j}$ |
|---|---|---|---|---|
| 1 | 6,029 | 6,030 | 6,0295 | 0,001 |
| 2 | 6,019 | 6,020 | 6,0195 | 0,001 |
| 3 | 6,004 | 6,003 | 6,0035 | 0,001 |
| 4 | 5,982 | 5,982 | 5,9820 | 0,000 |
| 5 | 6,009 | 6,009 | 6,0090 | |
| 6 | 5,971 | 5,972 | 5,9715 | |
| 7 | 5,995 | 5,997 | 5,9960 | |
| 8 | 6,014 | 6,018 | 6,0160 | |
| 9 | 5,985 | 5,987 | 5,9860 | |
| 10 | 6,024 | 6,028 | 6,0260 | |
| 11 | 6,033 | 6,032 | 6,0325 | |
| 12 | 6,020 | 6,019 | 6,0195 | |
| 13 | 6,007 | 6,007 | 6,0070 | |
| 14 | 5,985 | 5,986 | 5,9855 | |
| 15 | 6,014 | 6,014 | 6,0140 | |
| 16 | 5,973 | 5,972 | 5,9725 | |
| 17 | 5,997 | 5,996 | 5,9965 | |
| 18 | 6,019 | 6,015 | 6,0170 | 0,004 |
| 19 | 5,987 | 5,986 | 5,9865 | 0,001 |
| 20 | 6,029 | 6,025 | 6,0270 | 0,004 |
| 21 | 6,017 | 6,019 | 6,0180 | 0,002 |
| 22 | 6,003 | 6,001 | 6,0020 | 0,002 |
| 23 | 6,009 | 6,012 | 6,0105 | 0,003 |
| 24 | 5,987 | 5,987 | 5,9870 | 0,000 |
| 25 | 6,006 | 6,003 | 6,0045 | 0,003 |

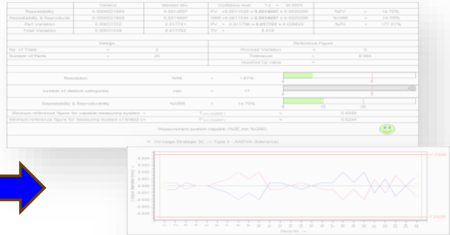
*%GRR Type 2*

*EVO*
*AV*
*IA*



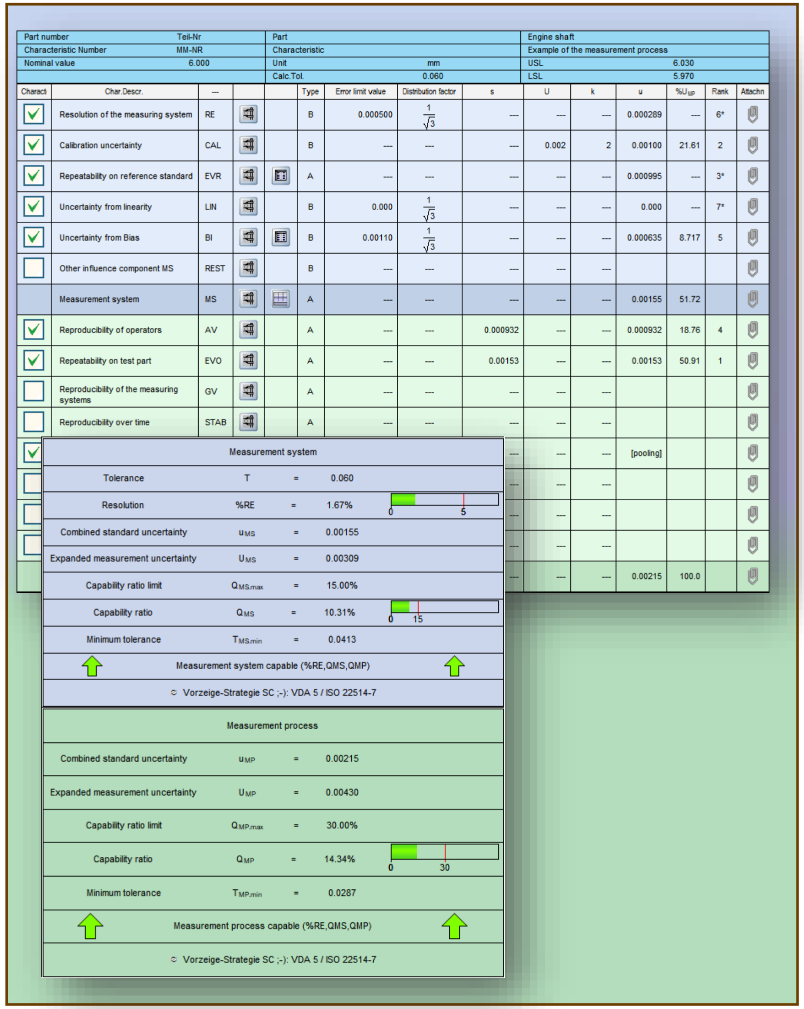
*%GRR Type 3*

*EVO*



*EVO*
*AV*
*IA*

*EVO*



| | | | |
|---|---|---|---|
| Part number Teil-Nr | Part | Engine shaft | |
| Characteristic Number MM-NR | Characteristic | Example of the measurement process | |
| Nominal value 6.000 | Unit mm | USL | 6.030 |
| | Calc.Tol. 0.060 | LSL | 5.970 |

| Charact | Char.Descr. | — | | | Type | Error limit value | Distribution factor | s | U | k | u | %$U_{MP}$ | Rank | Attachn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ☑ | Resolution of the measuring system | RE | | | B | 0.000500 | $\frac{1}{\sqrt{3}}$ | --- | --- | --- | 0.000289 | --- | 6* | |
| ☑ | Calibration uncertainty | CAL | | | B | --- | --- | --- | 0.002 | 2 | 0.00100 | 21.61 | 2 | |
| ☑ | Repeatability on reference standard | EVR | | | A | --- | --- | --- | --- | --- | 0.000995 | --- | 3* | |
| ☑ | Uncertainty from linearity | LIN | | | B | 0.000 | $\frac{1}{\sqrt{3}}$ | --- | --- | --- | 0.000 | --- | 7* | |
| ☑ | Uncertainty from Bias | BI | | | B | 0.00110 | $\frac{1}{\sqrt{3}}$ | --- | --- | --- | 0.000635 | 8.717 | 5 | |
| ☐ | Other influence component MS | REST | | | B | --- | --- | --- | --- | --- | | | | |
| | Measurement system | MS | | | A | --- | --- | --- | --- | --- | 0.00155 | 51.72 | | |
| ☑ | Reproducibility of operators | AV | | | A | --- | --- | 0.000932 | --- | --- | 0.000932 | 18.76 | 4 | |
| ☑ | Repeatability on test part | EVO | | | A | --- | --- | 0.00153 | --- | --- | 0.00153 | 50.91 | 1 | |
| ☐ | Reproducibility of the measuring systems | GV | | | A | --- | --- | --- | --- | --- | | | | |
| ☐ | Reproducibility over time | STAB | | | A | --- | --- | --- | --- | --- | | | | |
| ☑ | | | | | | | | --- | --- | --- | [pooling] | | | |
| ☐ | | | | | | | | --- | --- | --- | | | | |
| ☐ | | | | | | | | --- | --- | --- | | | | |
| ☐ | | | | | | | | --- | --- | --- | | | | |
| | | | | | | | | --- | --- | --- | 0.00215 | 100.0 | | |

| Measurement system | | | | |
|---|---|---|---|---|
| Tolerance | $T$ | = | 0.060 | |
| Resolution | %RE | = | 1.67% | 0 5 |
| Combined standard uncertainty | $u_{MS}$ | = | 0.00155 | |
| Expanded measurement uncertainty | $U_{MS}$ | = | 0.00309 | |
| Capability ratio limit | $Q_{MS,max}$ | = | 15.00% | |
| Capability ratio | $Q_{MS}$ | = | 10.31% | 0 15 |
| Minimum tolerance | $T_{MS,min}$ | = | 0.0413 | |
| Measurement system capable (%RE,QMS,QMP) | | | | |
| Vorzeige-Strategie SC ;-): VDA 5 / ISO 22514-7 | | | | |

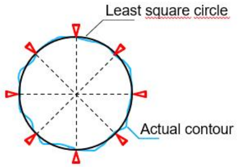
| Measurement process | | | | |
|---|---|---|---|---|
| Combined standard uncertainty | $u_{MP}$ | = | 0.00215 | |
| Expanded measurement uncertainty | $U_{MP}$ | = | 0.00430 | |
| Capability ratio limit | $Q_{MP,max}$ | = | 30.00% | |
| Capability ratio | $Q_{MP}$ | = | 14.34% | 0 30 |
| Minimum tolerance | $T_{MP,min}$ | = | 0.0287 | |
| Measurement process capable (%RE,QMS,QMP) | | | | |
| Vorzeige-Strategie SC ;-): VDA 5 / ISO 22514-7 | | | | |

Wird für VDA 5 nicht benötigt, macht aber das Leben einfacher und liefert Ergebnisse für MSA-Unternehmen...

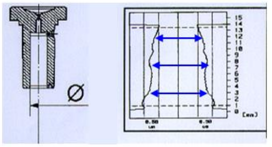
WAS SIE BEI DEN MSA-METHODEN VERMISSEN WERDEN

# Fehlende Komponenten

- Messobjekt
- Umwelt
- …


Least square circle
Actual contour

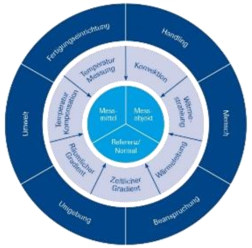
Diameter/Roundness

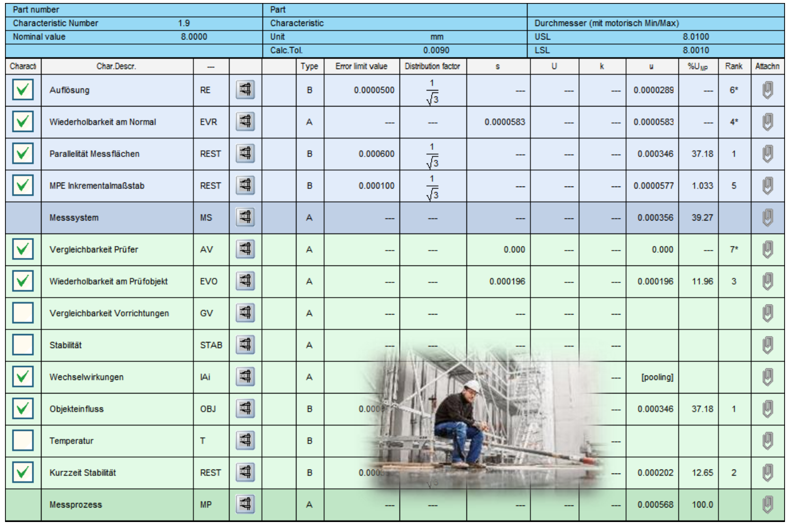


Diameter/Ballooning

VDA 5
umfasst
alle relevanten Unsicherheiten
des Messprozesses

- Bei reinen MSA-Methoden bleibt …
  - … der vollständige Messprozess weiterhin unbekannt
  - … die Frage weiterhin unbeantwortet, ob „dieser Messprozess in dieser Situation sinnvoll ist?“
  - Beispiel: Mit der Mikrometerschraube gemessener Durchmesser zur Überprüfung einer Passbohrung


Fertigungseinrichtung
Handling
Mensch
Beanspruchung
Umgebung
Umwelt
Temperatur Messung
Konvektion
Wärme-strahlung
Wärmeleitung
Zeitlicher Gradient
Räumlicher Gradient
Temperatur Kompensation
Mess-mittel
Mess-objekt
Referenz/ Normal



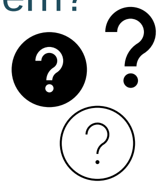
| | | | | | |
|---|---|---|---|---|---|
| Part number | | Part | | | |
| Characteristic Number | 1.9 | Characteristic | | Durchmesser (mit motorisch Min/Max) | |
| Nominal value | 8.0000 | Unit | mm | USL | 8.0100 |
| | | Calc.Tol. | 0.0090 | LSL | 8.0010 |

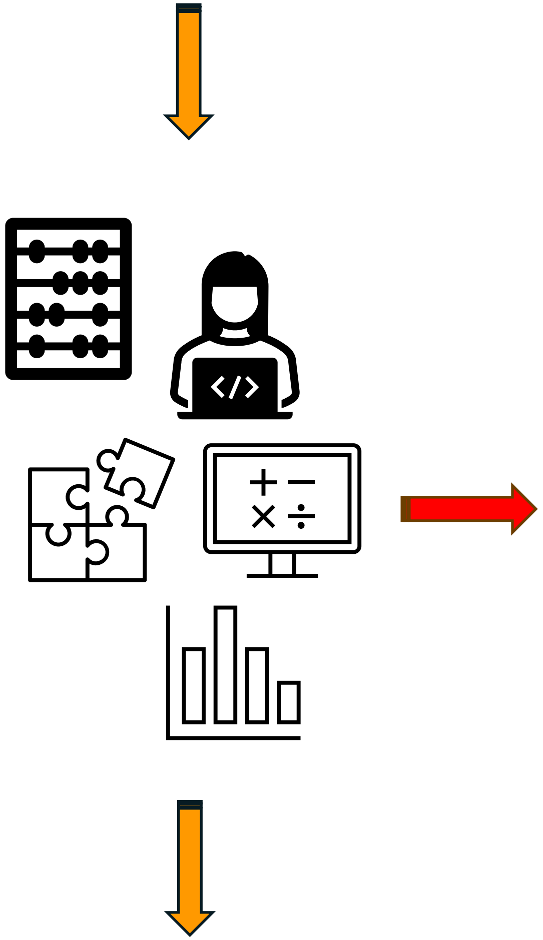
| Charact | Char.Descr. | --- | | | Type | Error limit value | Distribution factor | s | U | k | u | %U$_{MP}$ | Rank | Attachn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ☑ | Auflösung | RE | | | B | 0.0000500 | $\frac{1}{\sqrt{3}}$ | --- | --- | --- | 0.0000289 | --- | 6* | 📎 |
| ☑ | Wiederholbarkeit am Normal | EVR | | | A | --- | --- | 0.0000583 | --- | --- | 0.0000583 | --- | 4* | 📎 |
| ☑ | Parallelität Messflächen | REST | | | B | 0.000600 | $\frac{1}{\sqrt{3}}$ | --- | --- | --- | 0.000346 | 37.18 | 1 | 📎 |
| ☑ | MPE Inkrementalmaßstab | REST | | | B | 0.000100 | $\frac{1}{\sqrt{3}}$ | --- | --- | --- | 0.0000577 | 1.033 | 5 | 📎 |
| | Messsystem | MS | | | A | --- | --- | --- | --- | --- | 0.000356 | 39.27 | | 📎 |
| ☑ | Vergleichbarkeit Prüfer | AV | | | A | --- | --- | 0.000 | --- | --- | 0.000 | --- | 7* | 📎 |
| ☑ | Wiederholbarkeit am Prüfobjekt | EVO | | | A | --- | --- | 0.000196 | --- | --- | 0.000196 | 11.96 | 3 | 📎 |
| ☐ | Vergleichbarkeit Vorrichtungen | GV | | | A | --- | --- | --- | --- | --- | | | | 📎 |
| ☐ | Stabilität | STAB | | | A | --- | --- | --- | --- | --- | | | | 📎 |
| ☑ | Wechselwirkungen | IAi | | | A | [illegible] | [illegible] | [illegible] | [illegible] | --- | [pooling] | | | 📎 |
| ☑ | Objekteinfluss | OBJ | | | B | [illegible] | [illegible] | [illegible] | [illegible] | --- | 0.000346 | 37.18 | 1 | 📎 |
| ☐ | Temperatur | T | | | B | [illegible] | [illegible] | [illegible] | [illegible] | --- | | | | 📎 |
| ☑ | Kurzzeit Stabilität | REST | | | B | [illegible] | [illegible] | [illegible] | [illegible] | --- | 0.000202 | 12.65 | 2 | 📎 |
| | Messprozess | MP | | | A | --- | --- | --- | --- | --- | 0.000568 | 100.0 | | 📎 |

WAS SIE BEI DEN MSA-METHODEN VERMISSEN WERDEN

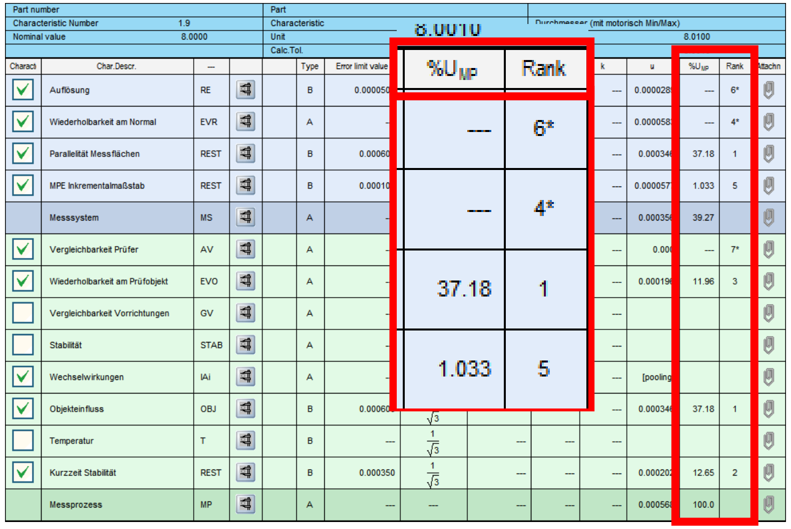
# Ein Korb voller Antworten, aber keine Lösung

- MSA-Methoden:
  - $\%RE = 4{,}8\%$
  - $C_g = 1{,}37$
  - $C_{gk} = 1{,}29$
  - $Bi_{max} = 4{,}2\%$
  - Test auf Sig Bi: signifikant
  - Test auf Steigung: nicht signifikant
  - Test auf Achsenabschnitt: signifikant
  - $\%GRR = 19\%$
- Was kann man verbessern?
- Was hat den größten Einfluss?





VDA 5
klare Übersicht
Unsicherheit in der gemessenen Dimension
Rangbildung und %-Anteil an $U_{MP}$



Part number
Characteristic Number 1.9
Nominal value 8.0000
Part
Characteristic
Durchmesser (mit motorisch Min/Max)
Unit
8.0100
Calc.Tol.
8.0010

| %U_MP | Rank |
|---|---|
| --- | 6* |
| --- | 4* |
| 37.18 | 1 |
| 1.033 | 5 |

| Charact | Char.Descr. | --- | Type | Error limit value | k | u | %U_MP | Rank |
|---|---|---|---|---|---|---|---|---|
| ☑ | Auflösung | RE | B | 0.000050 | --- | 0.000028 | --- | 6* |
| ☑ | Wiederholbarkeit am Normal | EVR | A | - | --- | 0.000058 | --- | 4* |
| ☑ | Parallelität Messflächen | REST | B | 0.00060 | --- | 0.000346 | 37.18 | 1 |
| ☑ | MPE Inkrementalmaßstab | REST | B | 0.00010 | --- | 0.000057 | 1.033 | 5 |
|  | Messsystem | MS | A | - | --- | 0.000356 | 39.27 |  |
| ☑ | Vergleichbarkeit Prüfer | AV | A | - | --- | 0.000 | --- | 7* |
| ☑ | Wiederholbarkeit am Prüfobjekt | EVO | A | - | --- | 0.000196 | 11.96 | 3 |
| ☐ | Vergleichbarkeit Vorrichtungen | GV | A | - | --- |  |  |  |
| ☐ | Stabilität | STAB | A | - | --- |  |  |  |
| ☑ | Wechselwirkungen | IAi | A | - | --- | [pooling |  |  |
| ☑ | Objekteinfluss | OBJ | B | 0.00060 | --- | 0.000346 | 37.18 | 1 |
| ☐ | Temperatur | T | B | --- | --- |  |  |  |
| ☑ | Kurzzeit Stabilität | REST | B | 0.000350 | --- | 0.000202 | 12.65 | 2 |
|  | Messprozess | MP | A | --- | --- | 0.000568 | 100.0 |  |

WHAT YOU WILL MISS WITH THE MSA METHODS

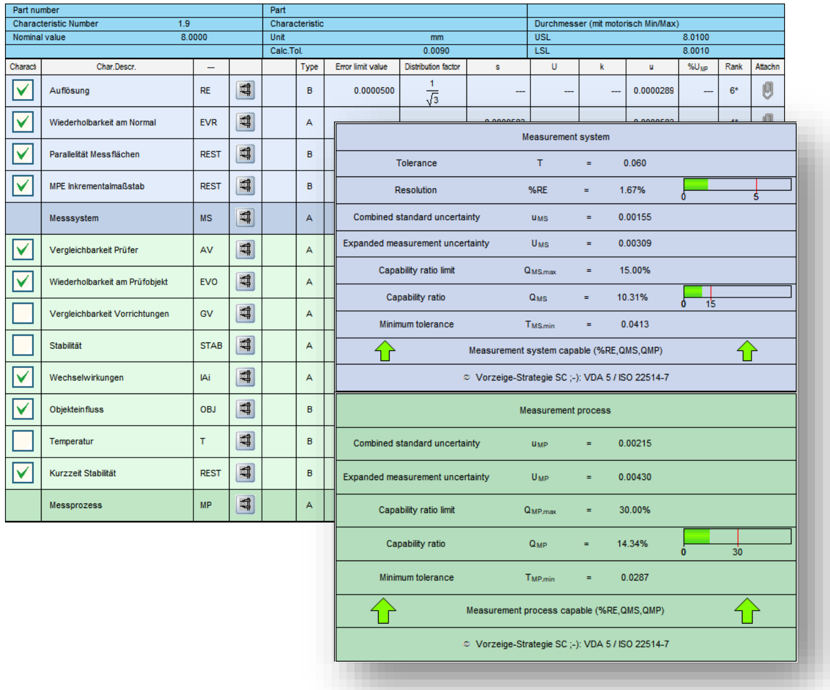
# Ein Korb voller Antworten, aber keine klare Zuordung

- MSA-Methoden:
  - $\%RE = 4{,}8\%$
  - $C_g = 1{,}37$
  - $C_{gk} = 1{,}29$
  - $Bi_{max} = 4{,}2\%$
  - Test auf Sig Bi: signifikant
  - Test auf Steigung: nicht signifikant
  - Test auf Achsenabschnitt: signifikant
  - $\%GRR = 19\%$

- Was kann man verbessern?
- Was hat den größten Einfluss?

VDA 5

Unterscheidung der Auswirkungen auf Messsystem und Messprozess



| | | | |
|---|---|---|---|
| Part number | | Part | |
| Characteristic Number | 1.9 | Characteristic | Durchmesser (mit motorisch Min/Max) |
| Nominal value | 8.0000 | Unit mm | USL 8.0100 |
| | | Calc.Tol. 0.0090 | LSL 8.0010 |

| Charact | Char.Descr. | --- | Type | Error limit value | Distribution factor | s | U | k | u | $\%U_{MP}$ | Rank | Attachn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ☑ | Auflösung | RE | B | 0.0000500 | $\frac{1}{\sqrt{3}}$ | --- | --- | --- | 0.0000289 | --- | 6* | |
| ☑ | Wiederholbarkeit am Normal | EVR | A | | | | | | | | | |
| ☑ | Parallelität Messflächen | REST | B | | | | | | | | | |
| ☑ | MPE Inkrementalmaßstab | REST | B | | | | | | | | | |
| | Messsystem | MS | A | | | | | | | | | |
| ☑ | Vergleichbarkeit Prüfer | AV | A | | | | | | | | | |
| ☑ | Wiederholbarkeit am Prüfobjekt | EVO | A | | | | | | | | | |
| ☐ | Vergleichbarkeit Vorrichtungen | GV | A | | | | | | | | | |
| ☐ | Stabilität | STAB | A | | | | | | | | | |
| ☑ | Wechselwirkungen | IAi | A | | | | | | | | | |
| ☑ | Objekteinfluss | OBJ | B | | | | | | | | | |
| ☐ | Temperatur | T | B | | | | | | | | | |
| ☑ | Kurzzeit Stabilität | REST | B | | | | | | | | | |
| | Messprozess | MP | A | | | | | | | | | |

**Measurement system**

Tolerance $T$ = 0.060

Resolution $\%RE$ = 1.67%

Combined standard uncertainty $u_{MS}$ = 0.00155

Expanded measurement uncertainty $U_{MS}$ = 0.00309

Capability ratio limit $Q_{MS,max}$ = 15.00%

Capability ratio $Q_{MS}$ = 10.31%

Minimum tolerance $T_{MS,min}$ = 0.0413

Measurement system capable (%RE,QMS,QMP)

Vorzeige-Strategie SC ;-): VDA 5 / ISO 22514-7

**Measurement process**

Combined standard uncertainty $u_{MP}$ = 0.00215

Expanded measurement uncertainty $U_{MP}$ = 0.00430

Capability ratio limit $Q_{MP,max}$ = 30.00%

Capability ratio $Q_{MP}$ = 14.34%

Minimum tolerance $T_{MP,min}$ = 0.0287

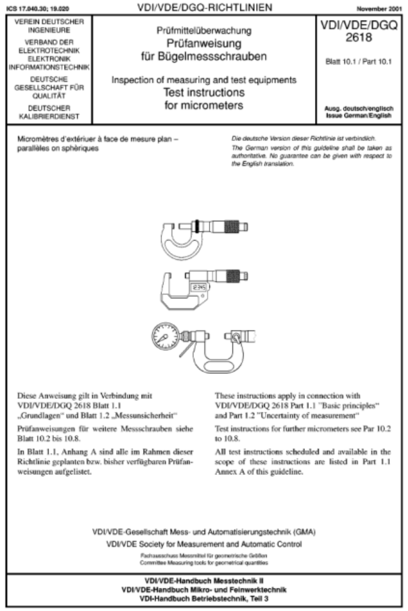
Measurement process capable (%RE,QMS,QMP)

Vorzeige-Strategie SC ;-): VDA 5 / ISO 22514-7

WAS SIE BEI DEN MSA-METHODEN VERMISSEN WERDEN

# Verwendung von MPE anstelle eines Experiments MS

- MSA-Methoden:
  - Messungen durchführen!
  - Nur Methode A
  - Keine Methode B
- VDA 5
  - Nutze Methode B
  - Vorwissen einbeziehen
  - Keine Verpflichtung zur Durchführung von Versuchen



ICS 17.040.30; 19.020 VDI/VDE/DGQ-RICHTLINIEN November 2001

VEREIN DEUTSCHER INGENIEURE
VERBAND DER ELEKTROTECHNIK ELEKTRONIK INFORMATIONSTECHNIK
DEUTSCHE GESELLSCHAFT FÜR QUALITÄT
DEUTSCHER KALIBRIERDIENST

Prüfmittelüberwachung
Prüfanweisung
für Bügelmessschrauben

Inspection of measuring and test equipments
Test instructions
for micrometers

VDI/VDE/DGQ
2618

Blatt 10.1 / Part 10.1

Ausg. deutsch/englisch
Issue German/English

Micromètres d'extériuer à face de mesure plan – parallèles on sphèriques

*Die deutsche Version dieser Richtlinie ist verbindlich.*

*The German version of this guideline shall be taken as authoritative. No guarantee can be given with respect to the English translation.*

Diese Anweisung gilt in Verbindung mit VDI/VDE/DGQ 2618 Blatt 1.1 „Grundlagen" und Blatt 1.2 „Messunsicherheit"

Prüfanweisungen für weitere Messschrauben siehe Blatt 10.2 bis 10.8.

In Blatt 1.1, Anhang A sind alle im Rahmen dieser Richtlinie geplanten bzw. bisher verfügbaren Prüfanweisungen aufgelistet.

These instructions apply in connection with VDI/VDE/DGQ 2618 Part 1.1 "Basic principles" and Part 1.2 "Uncertainty of measurement"

Test instructions for further micrometers see Par 10.2 to 10.8.

All test instructions scheduled and available in the scope of these instructions are listed in Part 1.1 Annex A of this guideline.

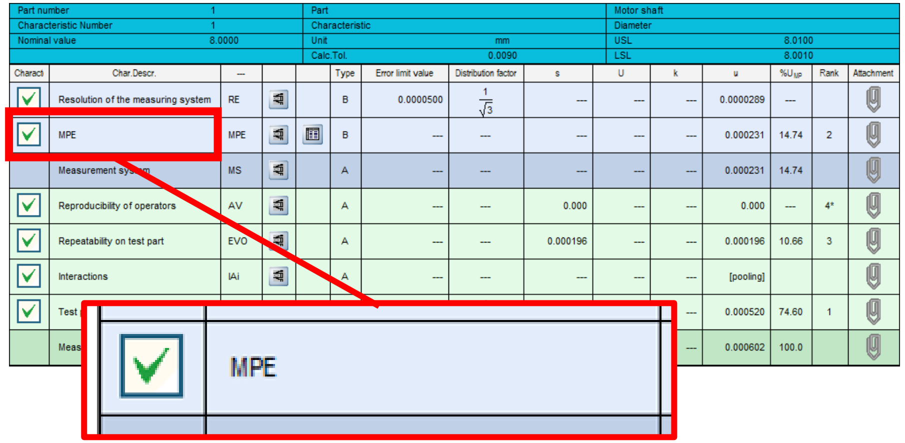
VDI/VDE-Gesellschaft Mess- und Automatisierungstechnik (GMA)
VDI/VDE Society for Measurement and Automatic Control
Fachausschuss Messmittel für geometrische Größen
Committee Measuring tools for geometrical quantities

**VDI/VDE-Handbuch Messtechnik II**
**VDI/VDE-Handbuch Mikro- und Feinwerktechnik**
**VDI-Handbuch Betriebstechnik, Teil 3**

VDA 5

MPE anstelle von Unsicherheitskomponenten verwenden

Vorauswahl des Messsystems



| | | | | | |
|---|---|---|---|---|---|
| Part number | 1 | Part | | Motor shaft | |
| Characteristic Number | 1 | Characteristic | | Diameter | |
| Nominal value | 8.0000 | Unit | mm | USL | 8.0100 |
| | | Calc.Tol. | 0.0090 | LSL | 8.0010 |

| Characti | Char.Descr. | --- | | | Type | Error limit value | Distribution factor | s | U | k | u | %$U_{MP}$ | Rank | Attachment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ☑ | Resolution of the measuring system | RE | | | B | 0.0000500 | $\frac{1}{\sqrt{3}}$ | --- | --- | --- | 0.0000289 | --- | | |
| ☑ | MPE | MPE | | | B | --- | --- | --- | --- | --- | 0.000231 | 14.74 | 2 | |
| | Measurement system | MS | | | A | --- | --- | --- | --- | --- | 0.000231 | 14.74 | | |
| ☑ | Reproducibility of operators | AV | | | A | --- | --- | 0.000 | --- | --- | 0.000 | --- | 4* | |
| ☑ | Repeatability on test part | EVO | | | A | --- | --- | 0.000196 | --- | --- | 0.000196 | 10.66 | 3 | |
| ☑ | Interactions | IAi | | | A | --- | --- | --- | --- | --- | [pooling] | | | |
| ☑ | Test | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | --- | 0.000520 | 74.60 | 1 | |
| | Meas | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | --- | 0.000602 | 100.0 | | |

☑ MPE

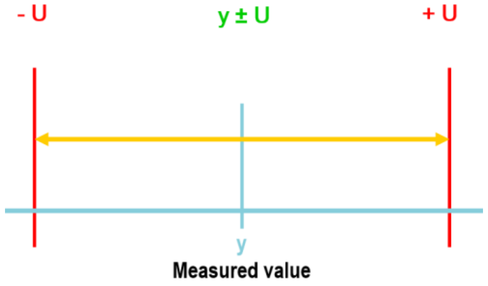
WAS SIE BEI DEN MSA-METHODEN VERMISSEN WERDEN

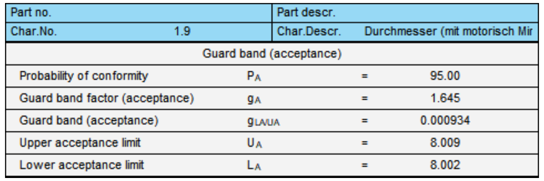
# Messunsicherheit –<br>in Übereinstimmung mit Normenforderungen

- MSA-Methoden:
  - Keine Messunsicherheit
    - Keine Guard Bands
    - Keine Konformitätsprüfung
    - Kein Wissen über Präzision und Genauigkeit eines Messwerts

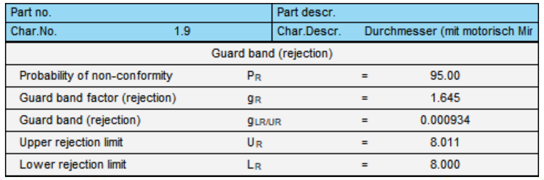
- → Normforderungen nicht erfüllbar:
  - ISO 10012
  - ISO 14253-1 (GPS)
  - ISO/IEC Guide 98-4
  - JCGM 106
  - …

VDA 5
Unsicherheit→ Klare Aussage zum wahren Wert
Guard Bands für Annahme/ Rückweisung
Entspricht den internationalen Normen

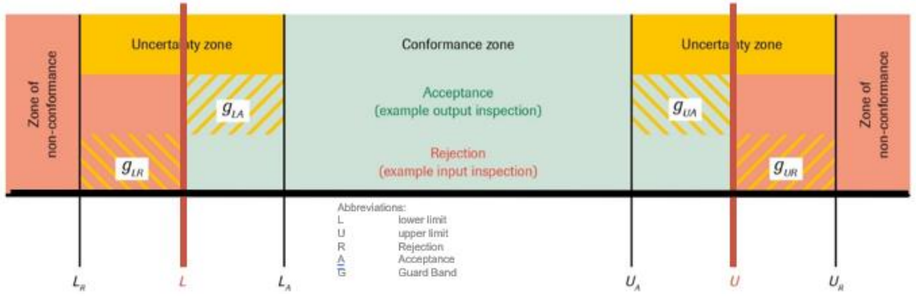

- U
y ± U
+ U
y
Measured value



| | | | |
|---|---|---|---|
| Part no. | | Part descr. | |
| Char.No. 1.9 | | Char.Descr. | Durchmesser (mit motorisch Mir |
| Guard band (acceptance) | | | |
| Probability of conformity | $P_A$ | = | 95.00 |
| Guard band factor (acceptance) | $g_A$ | = | 1.645 |
| Guard band (acceptance) | $g_{LA/UA}$ | = | 0.000934 |
| Upper acceptance limit | $U_A$ | = | 8.009 |
| Lower acceptance limit | $L_A$ | = | 8.002 |



| | | | |
|---|---|---|---|
| Part no. | | Part descr. | |
| Char.No. 1.9 | | Char.Descr. | Durchmesser (mit motorisch Mir |
| Guard band (rejection) | | | |
| Probability of non-conformity | $P_R$ | = | 95.00 |
| Guard band factor (rejection) | $g_R$ | = | 1.645 |
| Guard band (rejection) | $g_{LR/UR}$ | = | 0.000934 |
| Upper rejection limit | $U_R$ | = | 8.011 |
| Lower rejection limit | $L_R$ | = | 8.000 |

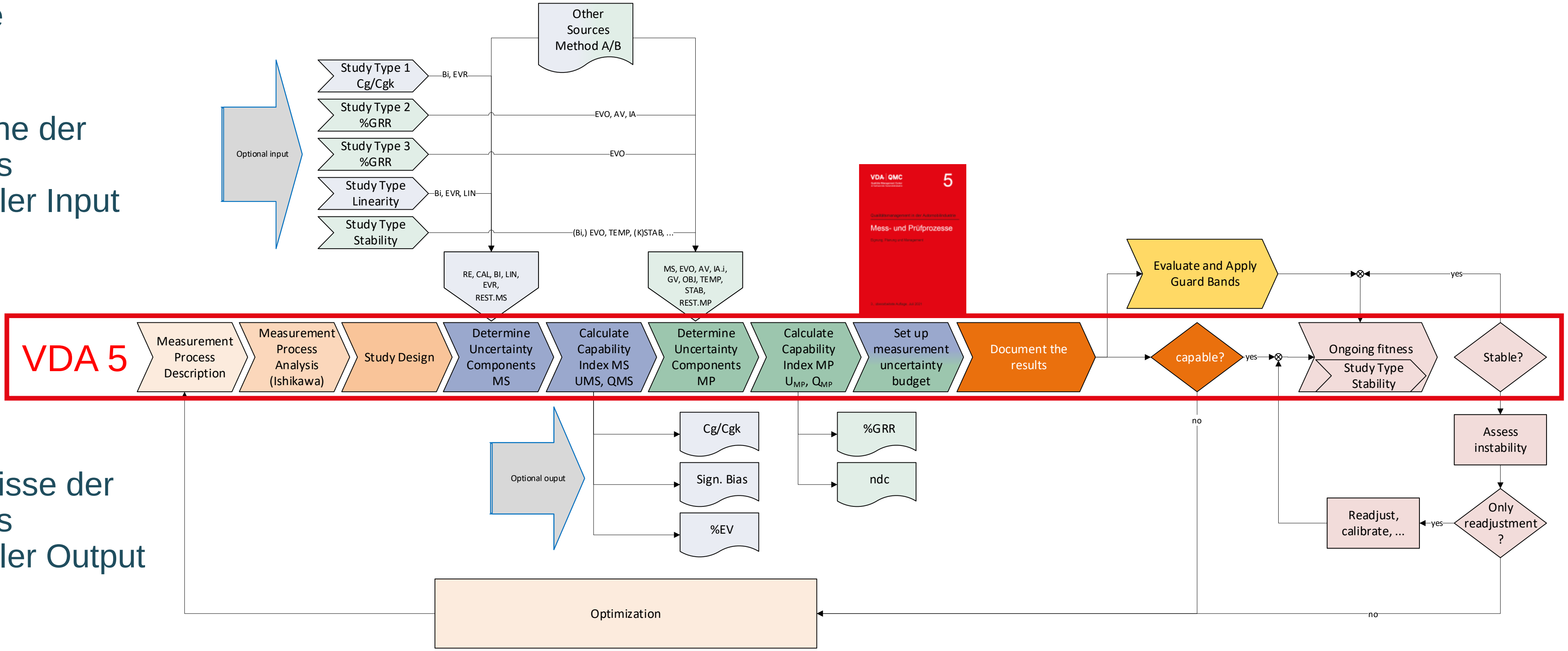

Zone of non-conformance
Uncertainty zone
Conformance zone
Uncertainty zone
Zone of non-conformance
$g_{LA}$
Acceptance
(example output inspection)
$g_{UA}$
$g_{LR}$
Rejection
(example input inspection)
$g_{UR}$
$L_R$
$L$
$L_A$
$U_A$
$U$
$U_R$

Abbreviations:
L lower limit
U upper limit
R Rejection
A Acceptance
G Guard Band

ZUSAMMENFASSUNG

# VDA 5 und AIAG MSA – Be prepared …

- VDA 5 als Leitlinie
- Versuche der MSA als optionaler Input
- Ergebnisse der MSA als optionaler Output



Other Sources Method A/B
Optional input
Study Type 1 Cg/Cgk
Bi, EVR
Study Type 2 %GRR
EVO, AV, IA
Study Type 3 %GRR
EVO
Study Type Linearity
Bi, EVR, LIN
Study Type Stability
(Bi,) EVO, TEMP, (K)STAB, ...
RE, CAL, BI, LIN, EVR, REST.MS
MS, EVO, AV, IA.i, GV, OBJ, TEMP, STAB, REST.MP
VDA | QMC
5
Mess- und Prüfprozesse
VDA 5
Measurement Process Description
Measurement Process Analysis (Ishikawa)
Study Design
Determine Uncertainty Components MS
Calculate Capability Index MS UMS, QMS
Determine Uncertainty Components MP
Calculate Capability Index MP $U_{MP}$, $Q_{MP}$
Set up measurement uncertainty budget
Document the results
Evaluate and Apply Guard Bands
capable?
yes
no
Ongoing fitness
Study Type Stability
Stable?
yes
Assess instability
Only readjustment ?
yes
no
Readjust, calibrate, ...
Optional ouput
Cg/Cgk
Sign. Bias
%EV
%GRR
ndc
Optimization

ZUSAMMENFASSUNG

# VDA 5 und AIAG MSA - harmonizing the future

- VDA 5 erfüllt die aktuellen Anforderungen der wichtigsten internationalen Normen
- VDA 5 gibt eine vollständige Darstellung der Unsicherheiten - MSA konzentriert sich auf einzelne Komponenten
- Grundlegende Experimente für $Q_{MS}/C_g/C_{gk}$ und $Q_{MP}/\%\mathrm{GRR}$ können weitgehend gleich gestaltet werden → Ergebnisse können nach Bedarf berechnet werden
- VDA 5 Experimente können für weitere Informationen erweitert werden
- Messprozessmodelle des VDA 5 ermöglichen die Übernahme des MSA-Konzepts

- Einige wichtige Fragen bleiben durch die MSA unbeantwortet:
  Unsicherheit, Unsicherheits-Budget, Eignung des Messprozesses

- Die AIAG hat erklärt, die ISO-Terminologie und Definition zu übernehmen.
- Harmonisierung ist ein klarer Wunsch und erklärtes Ziel von VDA und AIAG

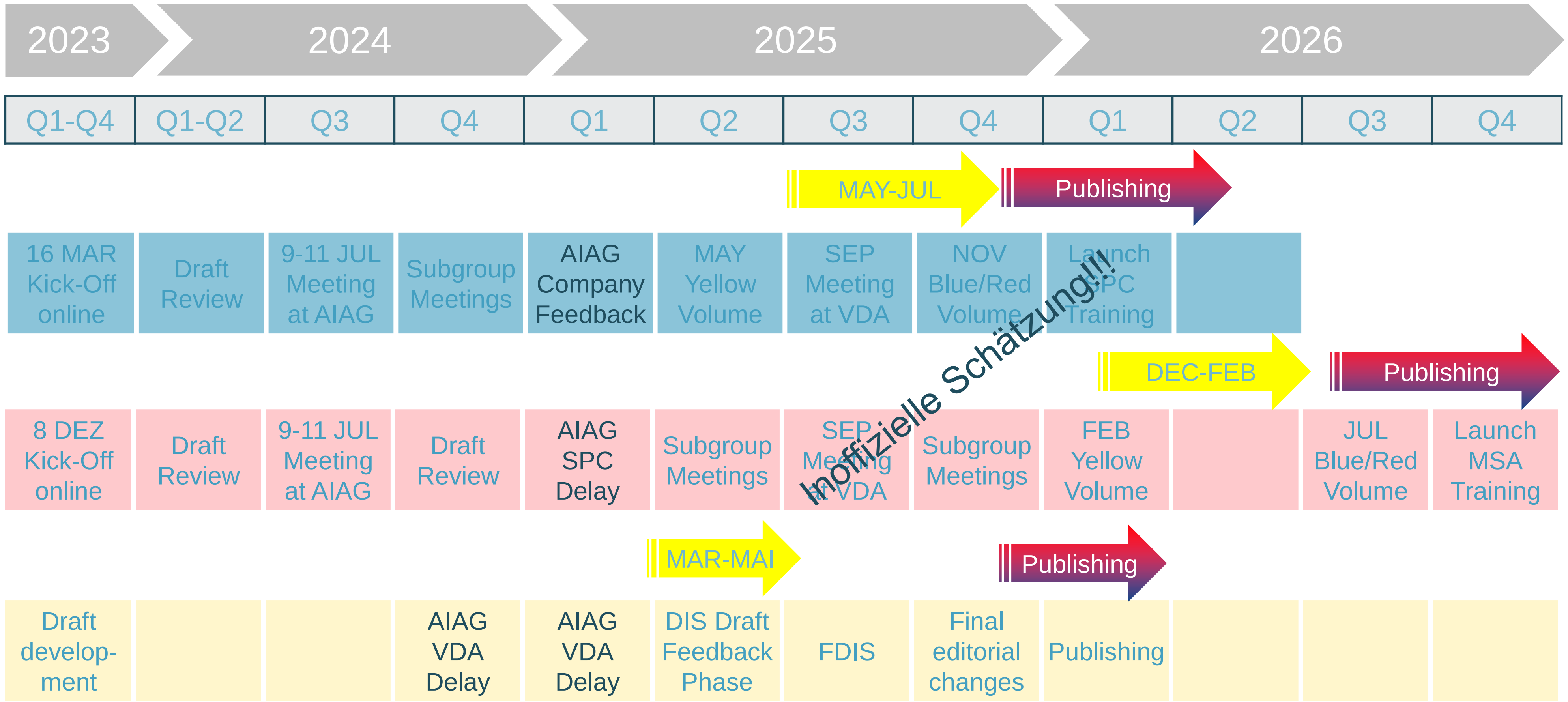
# Roadmap Harmonization AIAG VDA SPC + MSA/VDA 5

- Timeplanning, Status SEP 2024

| | 2023 | | |
|---|---|---|---|
| | Q1-Q4 | Q1-Q2 | Q4 |
| AIAG/VDA SPC Document Plan | 16 MAR Kick-Off online | Draft Review | |
| AIAG/VDA MSA Document Plan | 8 DEZ Kick-Off online | Draft Review | |
| ISO 11462-1 Document Plan | Draft develop-ment | | |

# Roadmap Harmonization AIAG VDA SPC + MSA/VDA 5

- Timeplanning, Status APR 2025



| | 2023 | 2024 | 2024 | 2024 | 2025 | 2025 | 2025 | 2025 | 2026 | 2026 | 2026 | 2026 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Q1-Q4 | Q1-Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| | | | | | | | MAY-JUL | Publishing | | | | |
| AIAG/VDA SPC Document Plan | 16 MAR Kick-Off online | Draft Review | 9-11 JUL Meeting at AIAG | Subgroup Meetings | AIAG Company Feedback | MAY Yellow Volume | SEP Meeting at VDA | NOV Blue/Red Volume | Launch SPC Training | | | |
| | | | | | | | | | DEC-FEB | | Publishing | |
| AIAG/VDA MSA Document Plan | 8 DEZ Kick-Off online | Draft Review | 9-11 JUL Meeting at AIAG | Draft Review | AIAG SPC Delay | Subgroup Meetings | SEP Meeting at VDA | Subgroup Meetings | FEB Yellow Volume | | JUL Blue/Red Volume | Launch MSA Training |
| | | | | | | MAR-MAI | | Publishing | | | | |
| ISO 11462-1 Document Plan | Draft develop-ment | | | AIAG VDA Delay | AIAG VDA Delay | DIS Draft Feedback Phase | FDIS | Final editorial changes | Publishing | | | |

Inoffizielle Schätzung!!!

QUESTIONS AND ANSWERS

# VDA 5 and AIAG MSA - harmonizing the future

**Stephan Conrad**