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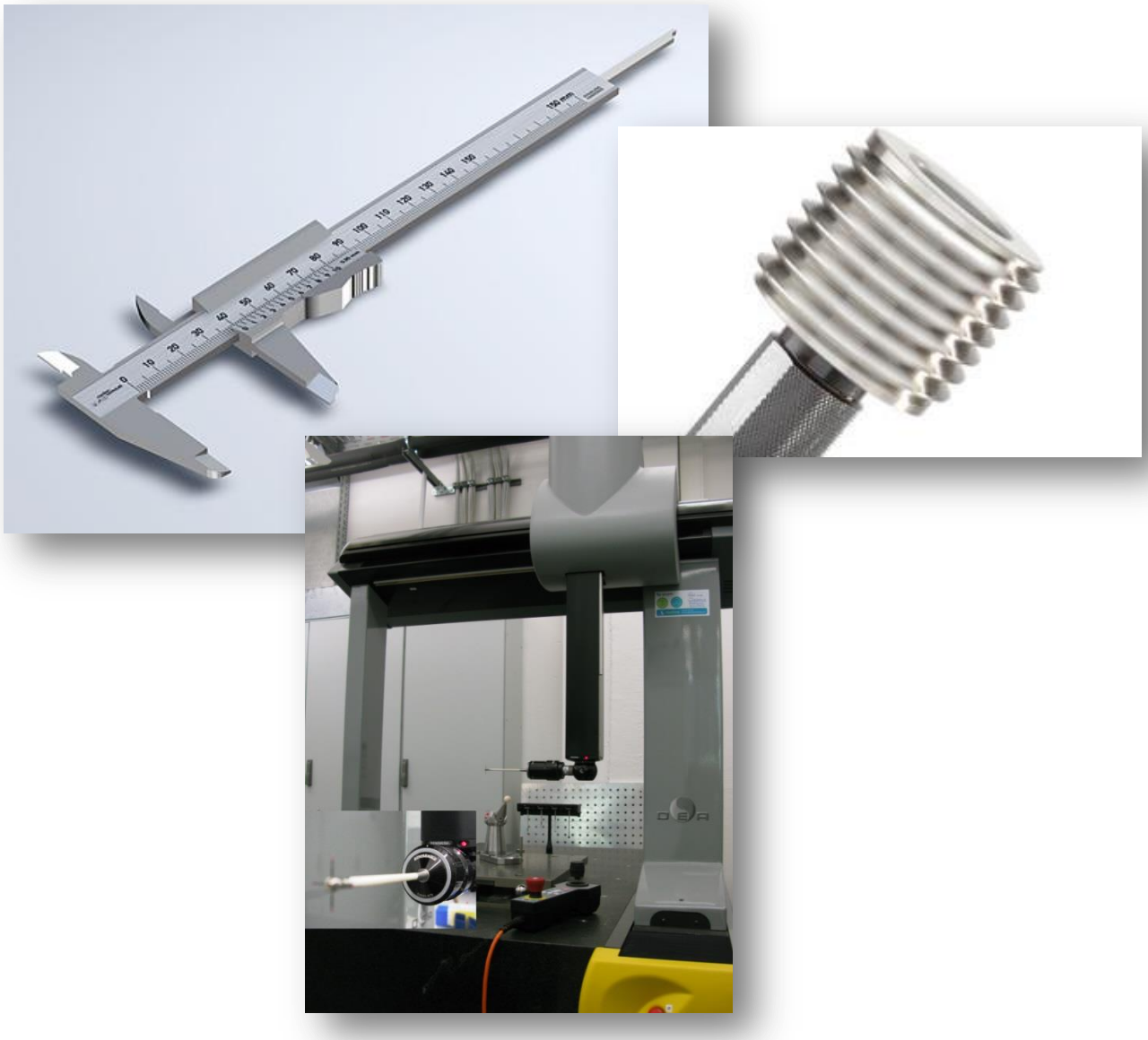
Instructions for determining measurement data



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Content

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1. Purpose

The purpose of these instructions is to provide comparable and transparent measurement results as well as measuring methods used by Hansgrohe, suppliers and the head of measurement service.

It is mandatory to adhere to these instructions.

2. Scope of application

These instructions must be used for all measurement values for which no special arrangements have been defined.

3. Basics

Clear and part-specific guidelines for measurement schemes are determined and documented during advanced quality planning (AQP).

The equipment used for testing must be selected depending on the tolerance range of the feature to be tested, the material and the dimensional stability. “For economical testing it [...] may often be advisable to first use a less exact but time- and cost-saving test procedure and only in cases of doubt (measurement value near limit value) use a more precise test procedure. [...]”[1]

The employee carrying out the testing must have the relevant qualifications and must have access to the required measuring equipment. As a matter of principle, the test equipment used must be documented referring to each particular feature in the initial sample test report (ISTR) (client as well as supplier).

The choice of test equipment (example: see appendix) for first sampling (PPAP, production part approval process) and serial testing must be performed in an identical way to the AQP at Hansgrohe SE.

If no specifications are stipulated on the technical drawing, the alignments and references selected must be documented in the ISTR.

In case of deviations from the shape specified with regard to roundness, for example, it is advisable to mention the point of measurement.

Deviations from these guidelines are permissible; however, they must be documented.

[1] HENZOLD, Georg, 2011. Form und Lage. 3., überarbeitete Auflage. Berlin: Beuth Verlag GmbH. ISBN 978-3-410-21196-9; author’s translation

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4. Applicable documents and standards

- DIN EN ISO 8015, Geometrical Product Specification (GPS) – Fundamentals – Concepts, Principles and Rules

- DIN EN ISO 14405, Geometrical Product Specification (GPS) – Dimensional Tolerancing

- Envelope requirement according to DIN ISO 8015 6.1 Envelope requirements:
  „For a single feature either a cylindrical surface or a feature established by two parallel plane surfaces (feature of size) the envelope requirement may be applied. The requirement means that the envelope of perfect shape at maximum material size of the feature shall not be violated.
  The envelope requirement may be indicated either
  - by the symbol E placed after the linear tolerance (see figure 3a)
  - by reference to an appropriate standard which invokes the envelope requirement without additional drawing specification.“[2]

  (Example: see appendix)

- Abbreviations for specification modifiers for linear size are to be taken from DIN EN ISO 14405-1 (table 1).

- DIN EN ISO 5459, Geometrical Product Specification (GPS) – Geometrical Tolerancing – Datums and Datum Systems (ISO 5459:2011); English version EN ISO 5459:2011

- HG 770, Guidelines for First Sampling

5. Definitions

- Non-dimensionally stable parts:
  „Part[s] which deform[s] to an extent that in the free state is beyond the dimensional and/or geometrical tolerances on the drawing“[3]

- Dimensionally stable parts:
  Parts that won’t deform physically after production

- Measurement point (MP):
  A measurement point defines the exact location for performing the measurement on the part.

- Measurement location (MS): A measurement location consists of two measurement points (possibly opposite).

[2] DEUTSCHES INSTITUT FÜR NORMUNG E.V., 1986. *DIN ISO 8015: Tolerierungsgrundsatz.* Berlin: Beuth, 00.06.1986; author’s translation
[3] DEUTSCHES INSTITUT FÜR NORMUNG E.V., 1994. *DIN ISO 10579 Geometrical product specification – Dimensioning and tolerancing – Non-rigid parts (ISO 10579:2010 including COR 1:2011); English Version EN ISO 10579:2013.* Berlin: Beuth, 00.03.1994

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6. Measurement instructions

Conventional measurements (e.g. with calipers) must be documented by naming min-max-values while circumscribed and inscribed features must be named when using measuring machines (e.g. 3D, optical).

a. Cylinder / Diameter

The two-point measurement (LP) applies for measuring diameters of dimensionally stable parts. The evaluation of non-dimensionally stable parts follows the values for GG and roundness/min-max.

Toleration	Tolerance range	Distance between MP	Amount of MPs
General tolerance			≥ 4
Tolerated features	< 0.2 mm	< 5 mm	≥ 8
	≥ 0.2 mm	≤ 10 mm	≥ 8

The amount of measurement points is calculated by using the following formula:

$$Amount\ of\ MPs = \frac{diameter \times \pi}{distance\ between\ MP}$$

When calculating the amount of MPs it must be noted that an odd result has to be **rounded up to the next higher, even number** due to two-point measurement.

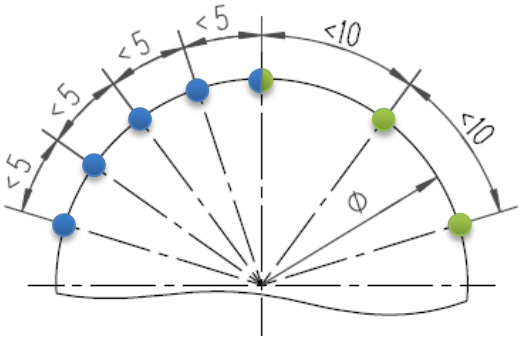

Figure 1: measurement points on diameters

Following guidelines are valid for testing a cylinder's diameter on different planes:

Cylinder length [mm]	Amount of planes	Measurement location
< 4	1	centered
4 – 10	2	1 mm from edge
10 – 50	3	1 mm from edge + centered
50 – 150	Min. 3 having max. 25 mm distance	1 mm from edge + max. each 25 mm
> 150	2 + by arrangement	1 mm from edge + by arrangement

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b. Prisms

For testing the depth of prisms (see figure 2), the measurement points along the parallel running lateral edges are determined by the following table:

Toleration	Tolerance range	Distance between MP	Amount of MPs
General tolerance			≥ 4
Tolerated features	< 0.2 mm	< 5 mm	≥ 8
	≥ 0.2 mm	≤ 10 mm	≥ 8

Additionally, the depth is tested on several planes:

Prism length [mm]	Amount of planes	Measurement location
< 4	1	centered
4 – 10	2	1 mm from edge
10 – 50	3	1 mm from edge + centered
50 – 150	Min. 3 having max. 25 mm distance	1 mm from edge + max. each 25 mm
> 150	2 + by arrangement	1 mm from edge + by arrangement

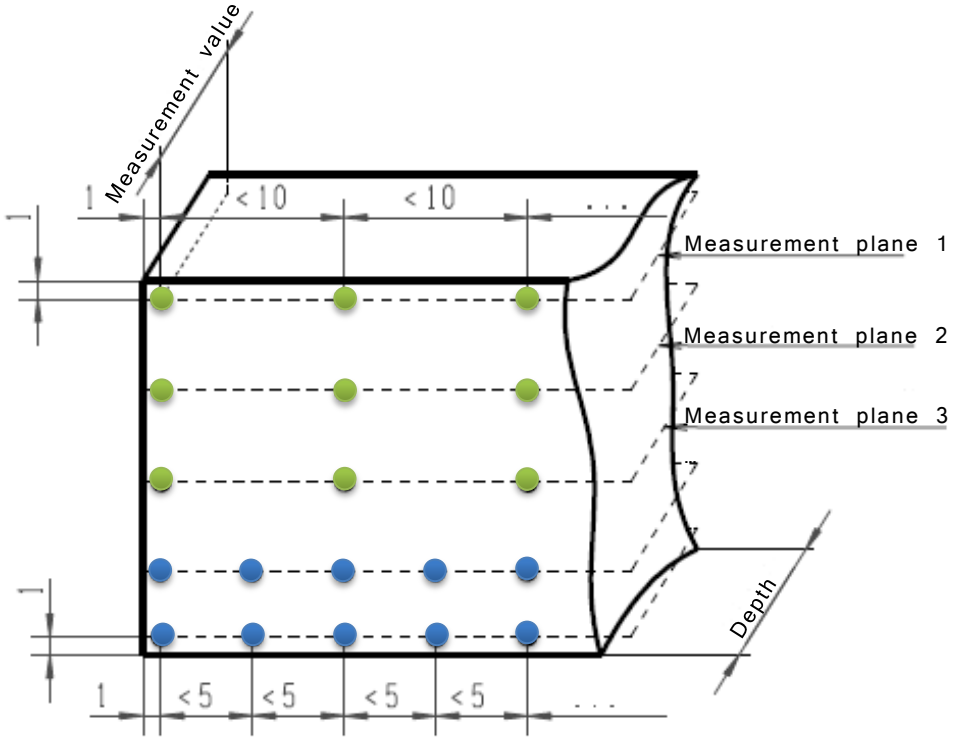

Figure 2: measurement locations on prisms

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c. Datums

„A datum is a theoretically exact reference geometry; it is defined by a plane, a straight line or a point, or a combination thereof. “[4]

Datum planes are to be established as *tangent contact surfaces*.[5]
Datums from circular elements are made up of GG unless otherwise specified (AQP/drawing).

If the datums cannot be clearly identified from the drawing, the measurement procedure of the same must be documented.

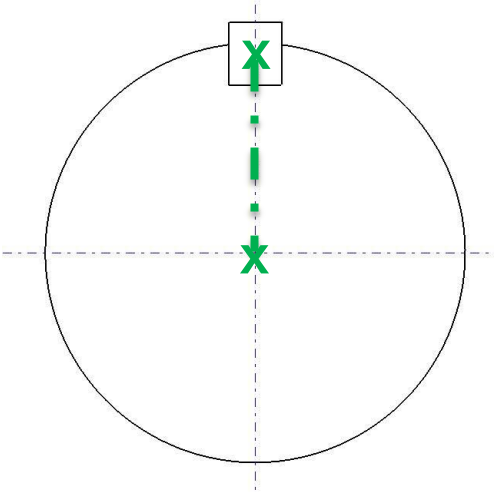

Figure 3: Example of a twist

7. Measurement discrepancies

Measurement discrepancies are deviations of measurement values between client and supplier of about 20% of the tolerance range regarding the exact same feature. (Example: see appendix)

If a discrepancy occurs, the result should be checked by using different testing equipment / different method. The equipment and the method used must be documented in every case where there is a measurement discrepancy.
To evaluate the deviating geometry element it is advisable to record information about the measurement results (e.g. attaching measurement protocols).

[4] DEUTSCHES INSTITUT FÜR NORMUNG E.V., 2013. *DIN EN ISO 5459: Geometrical product specification (GPS) – Geometrical tolerancing – Datums and datum systems (ISO 5459:2011)*; *English Version EN ISO 5459:2011.* Berlin: Beuth, 00.05.2013
[5] Vgl. DEUTSCHES INSTITUT FÜR NORMUNG E.V., 2013. *DIN EN ISO 5459: Geometrical product specification (GPS) – Geometrical tolerancing – Datums and datum systems (ISO 5459:2011)*; *English version EN ISO 5459:2011.* Berlin: Beuth, 00.05.2013

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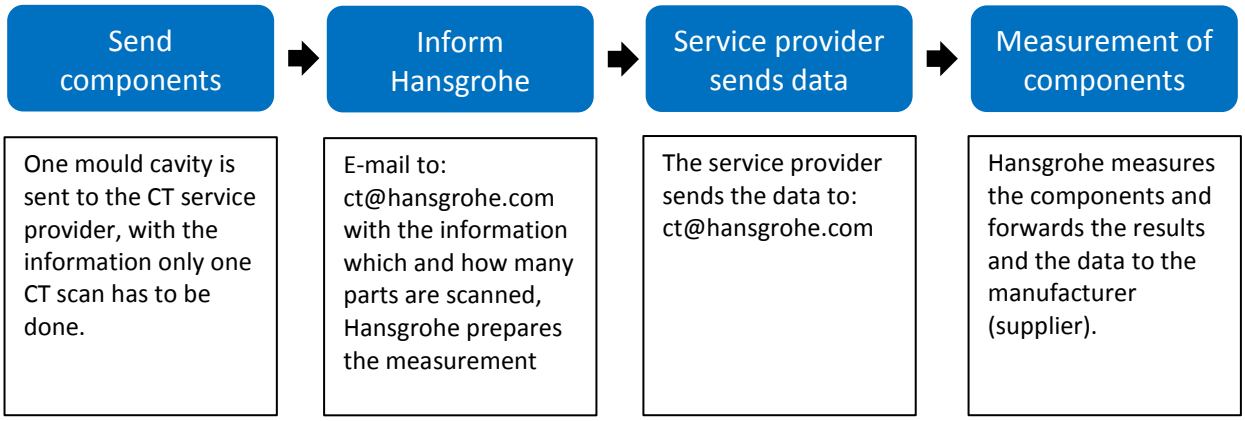
8. CT Measurement

If a CT measurement is required for a component and the manufacturer (supplier) is not able to do this by himself, a service provider must be commissioned to prepare the CT scan. In order to guarantee a correct measuring procedure, Hansgrohe takes over the evaluation (measurement) of the CT data components. The service provider is only responsible for the execution of the scan and not for the evaluation of the CT data (measurement).

The optimal procedure is as follows:



This guarantees the evaluation of the CT data (measurement) according to specifications and saves a cost-intensive measurement.

Recommended service providers:

- **PROPLAS GmbH**
  Freudenstädter Str. 39
  72280 Dornstetten

  Tel.: +49 (0)7443 240 804-0
  Fax: +49 (0)7443 240 804-44
  E-Mail: ct@proplas.de

- **Hachtel Werkzeugbau GmbH & Co. KG**
  Schelmenstraße 42
  73431 Aalen

  Tel. (0 73 61) 37 04 - 33
  Fax (0 73 61) 37 04 - 40
  E-Mail: info@fg-hachtel.com

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9. Appendix

- Example of choice of test equipment:

„Derivation of testable tolerances according to the Golden Rule of Metrology

1. Caliper 150 mm according to DIN 862 [5]

The error limits are specified depending on measuring length and scale interval in the standard. The limit value for a device with a tenth Vernier scale is 0.05 mm, so the testable tolerance is 0.5 mm. The limit value for a digital caliper with hundredth display is 0.02 mm for a length of 100 mm (above 0.03). The testable tolerance is 0.2 mm (0.3).

2. Outside micrometer 0-25 mm according to DIN 863 Part 1 [6]

Here, the limit values for the deviation range are given. The derivation in the measuring range can be positive as well as negative and in each case reach the limit value, but not on both sides at the same time. The deviation range therefore indicates the error limit at the same time. The deviation range for the considered measurement range is 4 µm, the testable tolerance is then 0.04 mm. “[6]

Remark:

In order to reduce the number of mistakes, the Golden Rule suggests the measurement uncertainty to be at maximum a tenth of the tolerance: max. Tolerance / 10.

Sometimes max. Tolerance / 5 will do as well.

The ratio should not be higher or the risk of mistakes may increase markedly.

- Example of envelope requirement:

„Envelope requirement for a cylindrical shaped element:

a) Drawing specification:

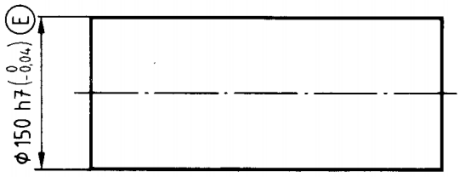


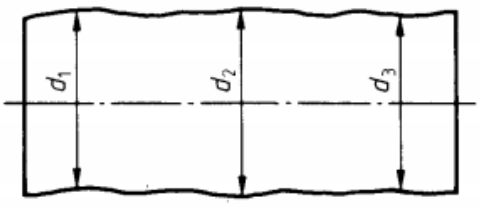
Figure 3 a.

b) Functional requirements:

- The cylinder surface must not break the geometrical ideal envelope of the maximum material measurement of ø 150.
- No local actual dimension may be smaller than ø 149.96.

The part must fulfil the following requirements:

- Each local actual diameter of the shaft must be within the dimensional tolerance of 0.04 and therefore between ø 150 and ø 149.96 (see figure 3 b).



d_1, d_2, d_3: local actual diameter from ø 149,96 to 150 mm (figure 3 b).“[7]

[6] HERNLA, Dr.-Ing. Michael, 1996: *Messunsicherheit und Fähigkeit* [online]. S. 2 [Zugriff am 18.11.2015] Verfügbar unter: http://dr-hernla.de/Hernla%20QZ%201996%20Messunsicherheit.pdf; author’s translation

[7] DEUTSCHES INSTITUT FÜR NORMUNG E.V., 1986. *DIN ISO 8015: Tolerierungsgrundsatz.* Berlin: Beuth, 00.06.; author’s translation

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- Example of measurement discrepancies:
  For a tolerance range of 0.4 mm (± 0.2 mm) the measurement discrepancy must not be higher than 0.08 mm. If the measurement values differ more than 0.08 mm, a measurement discrepancy exists.

- Abbreviations for measuring equipment:

3-D	KMG	CMM
BMS	Bügelmessschraube	micrometer
NBMS	Nutenbügelmessschraube	micrometer
DM	Dickenmessgerät	thickness measuring gauge
EM	Endmaß	gauge block
GWD-LD	Gewinde-Lehrdorn	thread plug gauge
GWD-LR	Gewinde-Lehrring	thread ring gauge
HM	Höhenmessgerät	height gauge
HOM	Rauheitsmessgerät	surface roughness tester
IMG	Innenmessgerät	bore gauge
ISNT	Innenschnelltaster	inside calipers
IRHD	Härtemessgerät	hardness tester
LD	Lehrdorn	plug gauge
LR	Lehrring	ring gauge
MS	Messschieber	caliper
MUS	Messuhr im Stativ	dial gauge
MV	Messvorrichtung (z.B.Messaufnahme)	measuring fixture
OPT	Optisches Messgerät	optical device
PM	Prüfstift	pin
PRJ	Profilprojektor	profile projector
PV	Prüfvorrichtung	measuring fixture
RDL	Radienlehre	radius gauge
RL	Rachenlehre	caliper gauge
SIP	Visuelle Prüfung	visual check
STCKL	Stecklehre	plug gauge
STULD	Stufenlehrdorn	staged plug gauge
TM	Tiefenmaß	depht gauge
W	Winkelmesser	angle meter
RVZ-LD	Verzahnungslehrdorn	plug gauge
RVZ-LR	Verzahnungslehrring	ring gauge