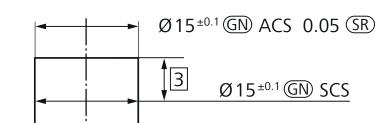
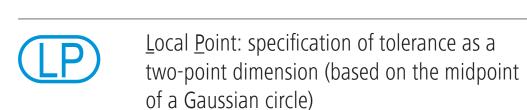
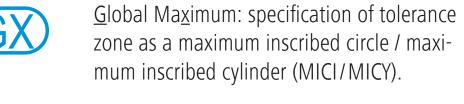
Sizes and modifiers

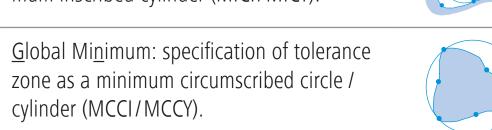
Sizes are dimensions of enclosed geometric features, e.g. diameter of cylinders and circles or distances of parallel surfaces. The type of tolerance specification can be stipulated here by indicating modifiers.

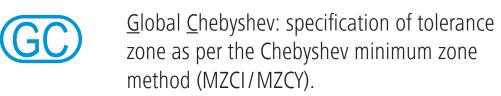






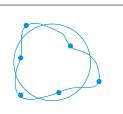








as a Gauss best fit (LSCI/LSCY).



So-called rank-order sizes can be indicated as a supplement to the modifiers:

SX	Statistical Maximum: largest value of the measured values	•	•		•	•	• ,
SN	Statistical Minimum: smallest value of the measured values	•	•		•	•	• ,
SA	<u>S</u> tatistical <u>A</u> verage: mean value of the measured values	•	•	0	•	•	•
SM	<u>S</u> tatistical <u>M</u> edian: median of the measured values	•	•		•	•	•
SR	<u>S</u> tatistical <u>R</u> ange: range of the measured values	•	•		•	•	

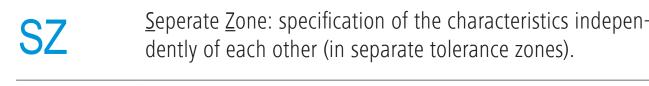
Additional information give rules for specification. Corresponding measuring strategies can be derived from these:

<u>S</u>tatistical Mi<u>d</u>-Range: mean value

ACS	Any Cross Section: specification in any (possible) circular section.
202	<u>Specific Cross Section: specification only in the circular sec-</u>

tion (usually indicated by a theoretical dimension). Any Longitudinal Section: specification in each (possible) lon-

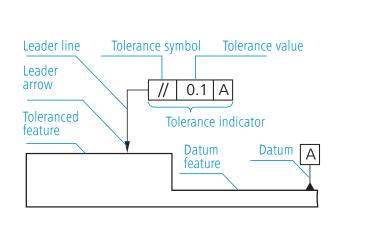


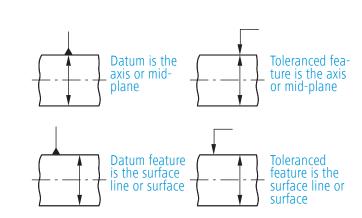




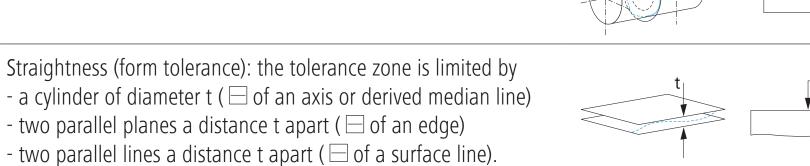
Form and location tolerances

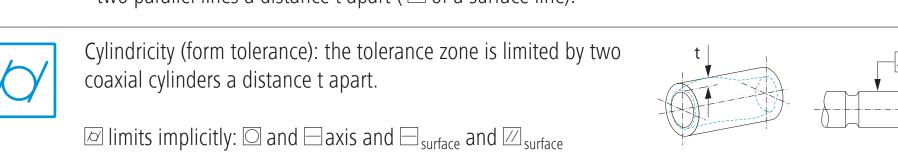
Form tolerances limit the deviations of an individual feature from its geometrically ideal form. Orientation, location and runout tolerances limit the errors of the mutual location of two or more features. One or more features can be specified as datum features.





Roundness (form tolerance): the tolerance zone is limited in the section plane perpendicular to the measuring axis by two conce tric circles a distance t apart.

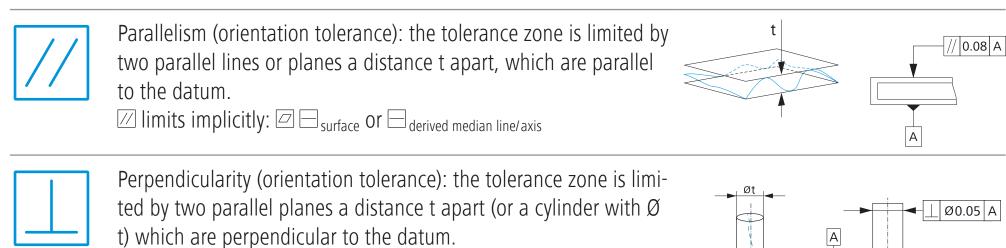


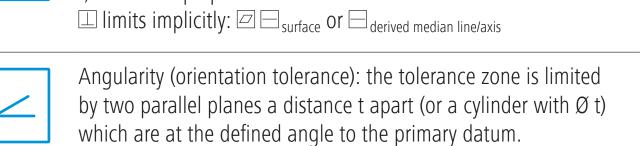


Flatness (form tolerance): the tolerance zone is limited by two parallel planes a distance t apart.



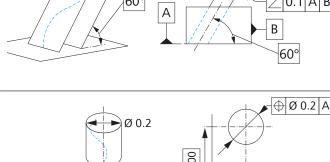
Unlike form tolerances, location tolerances almost always require one or multiple datums:

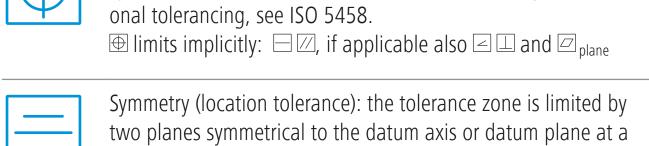




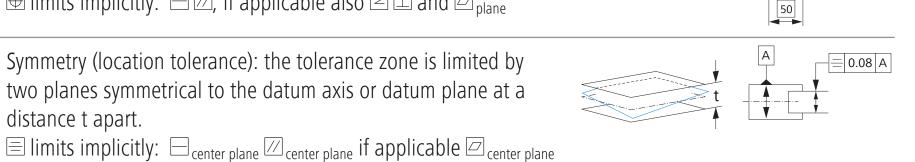
Position (location tolerance): the tolerance zone is limited by a

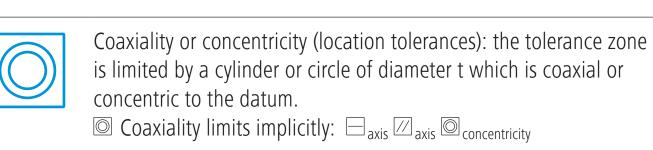
cylinder in nominal position (for position with \varnothing sign). For additi-





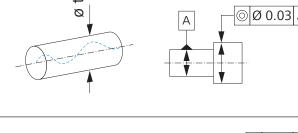
 \square limits implicitly: \square \square surface or \square derived median line/axis

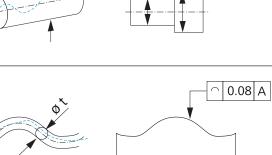


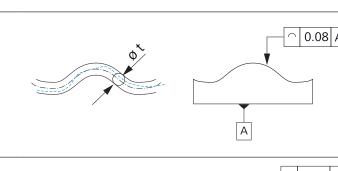


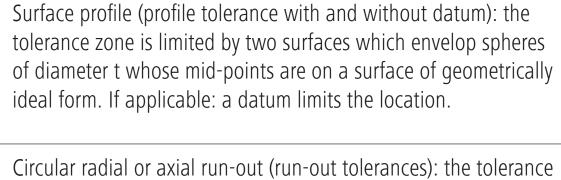
form. If applicable: a datum limits the position

tance t apart, which are located by datum A-B.







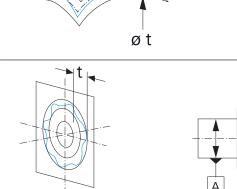


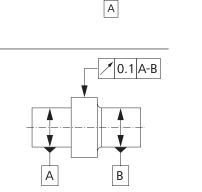
zone is limited by two concentric circles or parallel planes a dis-

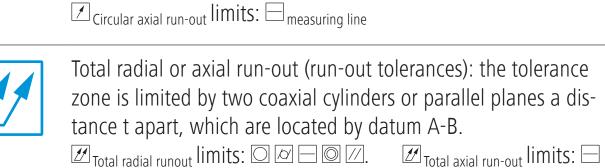
Line profile (profile tolerance with and without datum): the to-

diameter t whose mid-points are on a line of geometrically ideal

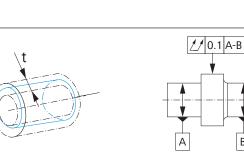
lerance zone is limited by two curves which envelop circles of



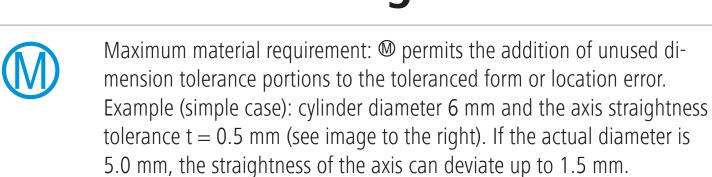


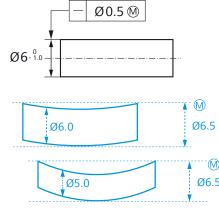


Circular radial run-out limits:



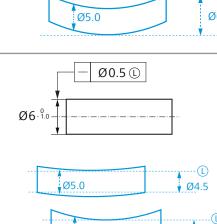
Additional drawing entries



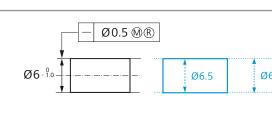


mension tolerance portions (away from the material side) to the toleranced form or location error.

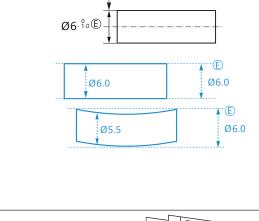
Example (simple case): cylinder diameter 6 mm and axis straightness tolerance t = 0.5 mm (see image to the right). If the actual diameter is 6.0 mm, the straightness of the axis can deviate up to 1.5 mm.



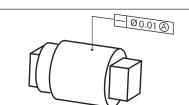
Reciprocity requirement: the R-requirement enables the "reversal" of M or \mathbb{O} , i.e. the addition of unused form and location tolerances to the dimension tolerance.



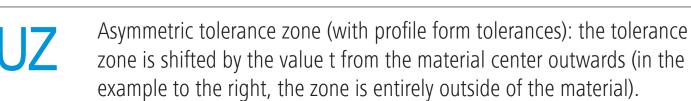
Envelope requirement: as per ISO 8015, dimension tolerances and form and location tolerances must always be viewed independently of each other. By inputing © on the dimension tolerance, the entire tolerance width, including form deviations, are limited to the dimensional tolerance. Thus, in the example to the right, the external envelope (dimension+form) may not exceed the diameter of 6.0 mm. If this is already utilized, e.g. by the dimensional tolerance, no more form deviations may occur.

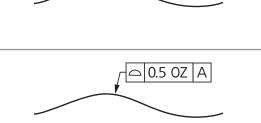


Axis as a toleranced feature: to illustrate that not the surface but rather the axis or center plane (center line) should be toleranced, a @ can be input in the drawing (in 3D drawings necessary).



Free state: the tolerance of the (elastic or plastic, non-rigid) workpiece is defined in the unfixtured state (only formed by gravity), as per ISO

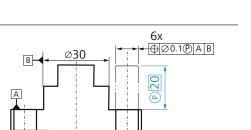




0.5 UZ +0.25 A

Asymmetric tolerance zone (with profile form tolerances): the tolerance zone is shifted by a non specified value away from the material center. So OZ (offset zone) only tolerances form, location and orientation, not size. Projected tolerance zone: the tolerance zone has been moved by t entire-

ly outside of the workpiece in order to inspect the locations relevant for



Datum and tolerance direction limitations

><	Datum feature only acts as an orientation feature. The position coordinates are not considered.	⊕ Ø 0.2 A ><
[PL]	<u>Pl</u> ane: datum feature only functions as a plane. Other parameters of the datum feature (e.g. origin coordinates) are not considered.	Ф 0.6 A[SL]
[SL]	Straight Line: datum feature functions only as a straight line. Other parameters of the datum feature (e.g. origin coordinates) are not considered.	
[PT]	Point: datum feature functions only as a point. Other parameters of the datum feature (e.g. orientation information) are not considered.	<u>12°</u>
(//B)	Orientation Plane indicator: Indicates an additional orientation of the tolerance zone. In the example to the right, the parallelism is only toleranced parallel to the datum B.	// 0.03 A \// B
(//B	Intersection plane indicator: Specifies the section plane in which the tolerance is defined In the example, parallelism is only toleranced perpendicular to B.	// 0.03 A <u>ЦВ</u>
K↔L	Tolerance zone limitation: the tolerance must be observed only in the area between K and L.	K ← L - 0.5
K↔L	Continuously variable tolerance zone: the tolerance width changes from 0.3 mm (with K) linear up to 0.5 mm (with L).	K ← L - 0.3 - 0.5
t/	Tolerance zone limitation: the tolerance must contain the value 0.5 in every section of the length 100 (in the example to the right).	<u> </u>
P	All Around: the profile tolerance applies to all line and surface features surrounding the entire workpiece in the viewing plane.	⊕ □ 0.03
O///B	Collection Plane: the collection plane defines, in connection with the "All around" symbol, a set of individual geometry elements that are toleranced together.	ф—// 0.3 A // В

here: shop.metrology.zeiss.com

All Over: the profile tolerance applies to all (marked) line and surface

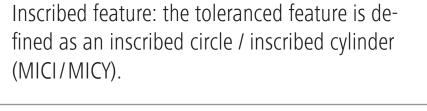
features surrounding the entire workpiece.

There is additional information on geometric product specifications (and the differences to the ASME standardization) in the seminars and books of the ZEISS Metrology Academy. Books can be ordered

₽ □ 0.03

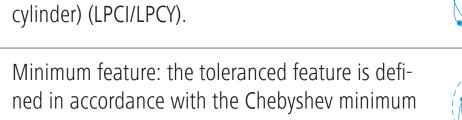
Tolerance indications for associations and filters

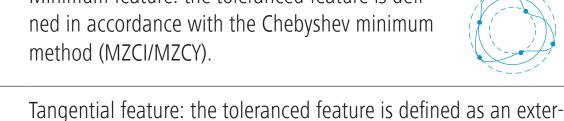
In addition, indications can be made in the tolerance indicator for the association (calculated best fit) of the features and for filtering, e.g. // 0.1 X G50- A or \bigcirc 0.1 N S150–50 or \bigcirc 0.1 F3. The following applies:

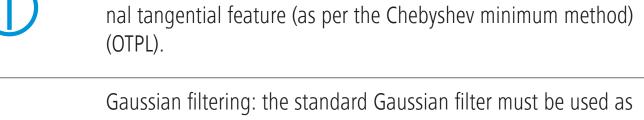






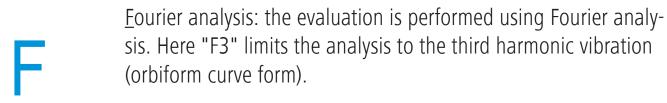






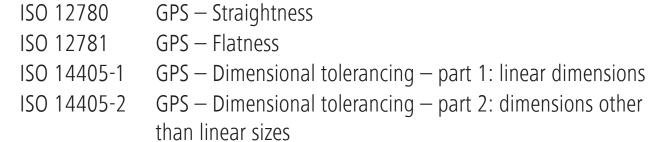






Important ISO standards for the GPS

ISO 1101	GPS — tolerances of form, orientation, location and run-out
ISO 1660	GPS — Profile tolerancing
ISO 2692	Form and position tolerancing, maximum material requirement
ISO 5458	GPS — Position tolerancing
ISO 5459	GPS — Datum and datum systems
ISO 8015	GPS — Geometric tolerancing — Fundamentals —
	Concepts, principles, rules
ISO 10579	GPS — Dimensioning and tolerancing — non-rigid parts
ISO 12180	GPS — Cylindricity



GPS – Roundness



Altered Default: If a different standard or work standard becomes applicable for a technical drawing in addition to the GPS standards (or if these are replaced), this can be performed in the tolerance box by adding the "AD Name of the particular stan-

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