

FORM

STRAIGHTNESS

ISO 1101

Definition
The tolerance zone is limited in the measuring plane by two parallel straight lines a distance T apart.

Examples
Any generating line of a tolerated cylinder surface shall be contained between two parallel, straight lines 0.1 apart.
Any 200 portion of any generating line of the tolerated cylinder surface shall be contained between two parallel, straight lines 0.1 apart.

Note
See ISO 1101 for further straightness tolerances.

FLATNESS

ISO 1101

Definition
The tolerance zone is limited by two parallel planes a distance T apart.

Example
The tolerated surface shall be contained between two parallel planes 0.08 apart.

ROUNDNESS

ISO 1101

Definition
The tolerance zone is limited in the measuring plane which is perpendicular to the axis by two concentric circles a distance T apart.

Example
The circumference of any cross section of the tolerated cylinder surface shall be contained between two concentric circles 0.1 apart.

ANGULAR SECTOR

still to be defined by standards

Definition
The tolerance zone is limited in the measuring plane which is perpendicular to the axis by two concentric circles a distance T apart. The tolerated circumference shall be contained within the tolerance zone in any angular sector starting from the profile center and featuring any width.

Example
The "local" roundness deviation shall be smaller than 0.012 in any angular sector starting from the profile center and featuring a width of 15°.

Note
The roundness deviation as per ISO 1101 may be larger; if necessary, it can be tolerated separately.

CYLINDRICITY

ISO 1101

Definition
The tolerance zone is limited by two coaxial cylinders a distance T apart.

Example
The tolerated cylindrical surface shall be contained between two coaxial cylinders 0.1 apart.

PROFILE OF ANY LINE

ISO 1101

Definition
The tolerance zone is limited by two lines which envelope circles of diameter T , the centers of which are situated on a line of ideal geometrical shape.

Example
In each section parallel to the plane of projection, the tolerated profile shall be contained between two lines which envelope circles of diameter 0.04, the centers of which are situated on a line of ideal geometrical shape.

SURFACE PROFILE

ISO 1101

Definition
The tolerance zone is limited by two surfaces enveloping spheres of diameter T , the centers of which are situated on a surface having the true geometrical form.

Example
The considered surface shall be contained between two surfaces enveloping spheres of diameter 0.02 the centers of which are situated on a surface having the true geometrical form.

Note
The parallelism deviation may be larger; if necessary, it can be tolerated separately.

CONICITY

still to be defined by standards

Definition
The tolerance zone is limited by two straight lines a distance T apart and parallel to the datum. What is to be contained within the tolerance zone is not the entire profile that has been assessed but that portion of the LSU line computed for the entered measuring length.

Example
Each portion of the LSU line calculated for the entered measuring length on the tolerated generating line shall be contained between two straight lines 0.04 apart and parallel to the opposite generating line.

Note
The parallelism deviation may be larger; if necessary, it can be tolerated separately.

LOCATION — ORIENTATION

PARALLELISM

ISO 1101

Definition
The tolerance zone is limited in the measuring plane by two parallel lines a distance T apart and parallel to the datum.

Example
Any generating line of the tolerated surface shall be contained between two parallel lines 0.1 apart and parallel to the datum surface A.

Note
See ISO 1101 for further parallelism tolerances.

PERPENDICULARITY

ISO 1101

Definition
The tolerance zone is limited in the measuring plane by two parallel, straight lines a distance T apart and perpendicular to the datum.

Example
Any generating line of the tolerated cylinder surface shall be contained between two parallel lines 0.1 apart and perpendicular to the datum surface.

Note
See ISO 1101 for further perpendicularity tolerances.

ANGULARITY

ISO 1101

Definition
The tolerance zone is limited by two parallel planes a distance T apart and inclined at the specified angle to the datum.

Example
The tolerated surface shall be contained between two parallel planes 0.05 apart which are inclined at 12° to the datum axis A.

LOCATION — POSITION

POSITION

ISO 1101

Definition
If the tolerance value is preceded by the Φ sign the tolerance zone is limited by a cylinder of diameter T , the axis of which is in the theoretically exact position of the tolerated element.

Example
The axis of the tolerated bore shall be contained within a cylinder of diameter 0.02, the axis of which is in the theoretically exact position with respect to the surfaces B and C.

Note
See ISO 1101 for the positional tolerance of a point or a plane.

CONCENTRICITY/ COAXIALITY

ISO 1101

Definition (Coaxiality)
The tolerance zone is limited by a cylinder of diameter T , the axis of which coincides with the datum axis.

Example (Coaxiality)
The axis of the tolerated cylinder shall be contained within a cylinder of diameter 0.08 the axis of which coincides with the datum A.

Note
See ISO 1101 for concentricity tolerances.

SYMMETRY

ISO 1101

Definition
The tolerance zone is limited by two parallel and symmetric to the datum axis or the datum plane and are a distance T apart.

Example
The median plane of a slot shall be contained between two parallel planes which are 0.08 apart and symmetrically disposed to the median plane with respect to the datum feature A.

Note
See ISO 1101 for symmetry tolerances of a line or an axis.

LOCATION — RUN-OUT

RADIAL RUN-OUT

ISO 1101

Definition
The tolerance zone is limited in the measuring plane which is perpendicular to the axis by two concentric circles a distance T apart, the common center of which lies on the datum axis.

Example
The circumference of any cross section of the tolerated cylinder surface shall be contained between concentric circles 0.1 apart, the common center of which lies on the datum axis formed by A and B.

Note
When taking the measurement, the workpiece has to be turned about the datum axis. See ISO 1101 for axial run out tolerances in any or a specified direction.

TOTAL RUN-OUT

ISO 1101

Definition
(Total axial run-out) The tolerance zone is limited by two parallel planes a distance T apart and perpendicular to the datum axis.

Example
(Total axial run-out) The tolerated surface shall be contained between two parallel planes 0.1 apart and perpendicular to the datum axis D.

Note
When taking the measurement, the workpiece has to be turned about the datum axis several times. Workpiece and measuring instrument have to move radially to each other. See ISO 1101 for total radial run-out tolerances.

GENERAL NOTES

on form and location tolerances

The **form and location tolerance** of a feature (surface, axis, point or median plane) defines the zone within which every point of this feature is to be contained.

Depending on the feature to be tolerated and the manner in which it is dimensioned, the **tolerance zone** is one of the following:

- The area within a circle
- The area between two concentric circles
- The area between two parallel, straight lines
- The area between two equidistant lines
- The space between two parallel planes
- The space between two equidistant surfaces
- The space within a cylinder
- The space between two coaxial cylinders
- The space within a parallelepiped

It is necessary to define a **datum** indicating the exact location of the tolerance zone for location tolerances. A datum is a theoretically exact, geometrical feature (e.g. an axis, plane, straight line, etc.); datums can be based on one or several **datum features**.

The **toleranced feature** may have any form, location or orientation within the tolerance zone, unless a more restrictive specification is given.

The unit of measurement for the **tolerance value T** is the same as for workpiece dimensions. If not otherwise specified, the tolerance applies to the whole length or surface of the tolerated feature.

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GENERAL TOLERANCES [mm]

for machined workpieces, ISO 2768, Part 2

Tolerance class	Tolerance class H						Tolerance class L					
	Nom. length	>10	>30	>100	>300	>1000	Nom. length	>10	>30	>100	>300	>1000
—	10	30	100	300	1000	3000	10	30	100	300	1000	3000
—	0.02	0.05	0.1	0.2	0.3	0.4	—	0.1	0.2	0.4	0.8	1.2
—		0.2	0.3	0.4	0.5		—	0.6	1	1.5	2	
—			0.5				—	0.6	1	1.5	2	
—			0.1				—		0.5			

Tolerance class K

Nom. length	>10	>30	>100	>300	>1000
—	0.05	0.1	0.2	0.4	0.6
—		0.4	0.6	0.8	1
—			0.6	0.8	1
—				0.2	

Roundness
The general roundness tolerance is the minimum formed by the diameter tolerance and the general run-out tolerance.

Parallelism
The general parallelism tolerance is the maximum formed by the dimensional tolerance and the general straightness/flatness tolerance.

FORMTESTER — EVALUATION METHODS

Regression straight line (Gaussian straight line)
Mean line laid through the measured profile such that the sum of the squares of all profile deviations is minimum. (LSL = Least Squares Line)

Regression parabola
Mean parabola (2nd order) laid through the measured profile such that the sum of the squares of all profile deviations is minimum.

Edge identification
The position of a profile interruption (edge) is determined. The profile is evaluated up to the edge according to LSL.

Regression circle (Gaussian circle)
Circle laid through the measured polar profile such that the sum of the squares of all profile deviations is minimum. (LSC = Least Squares Circle)

Circular zone with minimum radial separation
Concentric circles enclosing the measured polar profile and having the least radial separation. (MZC = Minimum Circles)

Minimum circumscribed circle
Smallest possible circle which can be fitted around the measured polar profile. (MCC = Minimum Circumscribed Circle)

Maximum inscribed circle
Largest possible circle which can be fitted within the measured polar profile. (MIC = Maximum Inscribed Circle)

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