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Straight cylindrical involute splines — Metric module, side fit —

Part 1: **Generalities**

Cannelures cylindriques droites à flancs en développante — Module métrique, à centrage sur flancs — Partie 1: Généralités

ICS: 21.120.30

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 14, *Shafts of machinery and accessories*.

This second edition cancels and replaces the first edition (ISO 4156-1:2005).

The main changes compared to the previous edition includes:

— Figure 15 has been revised,

— Table 14 to 17 have been revised and moved to Annex A.

A list of all parts in the ISO 4156 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

ISO 4156 provides the data and indications necessary for the design, manufacture and inspection of straight (non-helical) side-fitting cylindrical involute splines.

Straight cylindrical involute splines manufactured in accordance with ISO 4156 are used for clearance, sliding and interference connections of shafts and hubs. They contain all the necessary characteristics for the assembly, transmission of torque, and economic production.

The nominal pressure angles are 30°, 37,5° and 45°. For electronic data processing purposes, the form of expression 37,5° has been adopted instead of 37°30'. ISO 4156 establishes a specification based on the following modules:

— for pressure angles of 30° and 37,5° the module increments are

  0,5; 0,75; 1; 1,25; 1,5; 1,75; 2; 2,5; 3; 4; 5; 6; 8; 10

— for pressure angle of 45° the module increments are

  0,25; 0,5; 0,75; 1; 1,25; 1,5; 1,75; 2; 2,5

Straight cylindrical involute splines — Metric module, side fit — Part 1: Generalities

1 Scope

This part of ISO 4156 provides the data and indications necessary for the design and manufacture of straight (non-helical) side-fitting cylindrical involute splines.

Limiting dimensions, tolerances, manufacturing errors and their effects on the fit between connecting coaxial spline elements are defined in the equations and given in the tables. Unless otherwise specified, linear dimensions are expressed in millimetres and angular dimensions in degrees.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1101, *Geometrical Product Specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out*

ISO 4156-2, *Straight cylindrical involute splines — Metric module, side fit — Part 2: Dimensions*

ISO 4156-3, *Straight cylindrical involute splines — Metric module, side fit — Part 3: Inspection*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
spline joint
connecting, coaxial elements that transmit torque through the simultaneous engagement of equally spaced teeth situated around the periphery of a cylindrical external member with similar spaced mating spaces situated around the inner surface of the related cylindrical internal member

3.2
involute spline
member of spline joint having teeth or spaces that have involute flank profiles

3.3
internal spline
spline formed on the inner surface of a cylinder

3.4
external spline
spline formed on the outer surface of a cylinder

3.5
fillet
concave surface of the tooth or space connecting the involute flank and the root circle

NOTE For generated splines this curved surface, as generated, varies and cannot be properly specified by a radius of any given value. For splines formed directly by a tool (e.g. broached, net formed) the fillet may be specified as a true radius.

3.6
fillet root spline
spline having a tooth or space profile in which the opposing involute flanks are connected to the root circle (D_{ei} or D_{ie} diameter) by a single fillet

3.7
flat root spline
spline having a tooth or space profile in which each of the opposing involute flanks are connected to the root circle (D_{ei} or D_{ie} diameter) by a fillet

3.8
module
m
ratio of the circular pitch, expressed in millimetres, to the number π (or the ratio of the pitch diameter expressed in millimetres, to the number of teeth)

3.9
pitch circle
reference circle from which all normal spline dimensions are derived, and the circle on which the specified pressure angle has its nominal value

3.10
pitch diameter
D
diameter of the pitch circle, in millimetres, equal to the number of teeth multiplied by the module

3.11
pitch point
intersection of the spline tooth profile with the pitch circle

3.12
circular pitch
p
length of arc of the pitch circle between two consecutive pitch points of left- (or right-) hand flanks, which has a value of the number π multiplied by the module

3.13
pressure angle
α
acute angle between a radial line passing through any point on a tooth flank and the tangent plane to the flank at that point

3.14
standard pressure angle
α_D
pressure angle at the specified pitch point

3.15
base circle
circle from which Involute spline tooth profiles are generated

3.16
base diameter
D_b
diameter of the base circle

3.17
base pitch
p_b
arc length of the base circle between two consecutive corresponding flanks

3.18
major circle
outermost (largest) circle of the external or internal spline

3.19
major diameter
D_{ee}, D_{ei}
diameter of the major circle

3.20
minor circle
innermost (smallest) circle of the external or internal spline

3.21
minor diameter
D_{ie}, D_{ii}
diameter of the minor circle

3.22
form circle
circle used to define the depth of involute profile control

NOTE In the case of an external spline it is located near and above the minor diameter, and on an internal spline near and below the major diameter.

3.23
form diameter
D_{Fe}, D_{Fi}
diameter of the form circle

3.24
depth of engagement
radial distance from the minor circle of the internal spline to the major circle of the external spline, minus corner clearance and/or chamfer depth

3.25
basic (circular) space width or tooth thickness at the pitch diameter
E or S
for 30°, 37,5° and 45° pressure angle splines, half the circular pitch

3.26
actual space width
practically measured circular space width, on the pitch circle, of any single space width within the limit values E_{max} and E_{min}

3.27
effective space width
E_v
space width where an imaginary perfect external spline would fit without clearance or interference, given by the size of the tooth thickness of this external spline, considering engagement of the entire axial length of the splined assembly

NOTE The minimum effective space width ($E_{v\,min}$, always equal to E) of the internal spline is always basic, as shown in Table 3.

3.28
actual tooth thickness
practically measured circular tooth thickness, on the pitch circle, of any single tooth within the limit values S_{max} and S_{min}

3.29
effective tooth thickness
S_v
tooth thickness where an imaginary perfect internal spline would fit without clearance or interference, given by the size of the space width of this internal spline, considering engagement of the entire axial length of the splined assembly

3.30
effective clearance
c_v
⟨looseness or interference⟩ effective space width of the internal spline minus the effective tooth thickness of the external spline

NOTE For looseness, c_v is positive; for interference, c_v is negative.

3.31
theoretical clearance
c
⟨looseness or interference⟩ actual space width of the internal spline minus the actual tooth thickness of the external spline

NOTE It does not define the effective fit between internal and external spline, because of the effect of deviations.

3.32
form clearance
c_F
radial clearance between the form diameter of the internal spline and the major diameter of the external spline, or between the minor diameter of the internal spline and the form diameter of the external spline

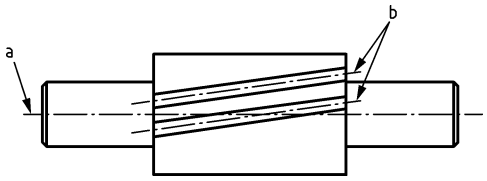
NOTE It allows eccentricity of their respective pitch circles.

3.33
total pitch deviation
F_p
absolute value of the difference between the greatest positive and negative deviations from the theoretical spacing

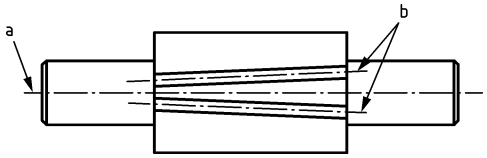
3.34
total profile deviation
F_α
absolute value of the difference between the greatest positive and negative deviations from the theoretical tooth profile, measured normal to the flanks

3.35
total helix deviation
F_β
absolute value of the difference between the two extreme deviations from the theoretical direction parallel to the reference axis

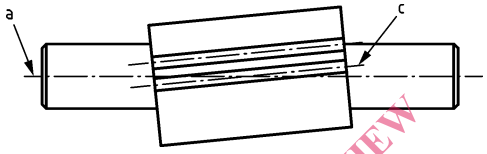
NOTE This includes parallelism and alignment deviations, see Figure 1.



a) Helix deviation



b) Parallelism deviation



c) Alignment deviation

Key

[a] Reference axis

[b] Centreline of teeth

[c] Effective spline axis

Figure 1 — Helix deviations

3.36
parallelism deviation
deviation of parallelism of a single spline tooth to any other single spline tooth

See Figure 1 b).

3.37
alignment deviation
deviation of the effective spline axis with respect to the reference axis

See Figure 1 c).

3.38
out-of-roundness
deviation of the spline from a true circular configuration

3.39
effective deviation
accumulated effect of the spline deviations on the fit with the mating part

3.40
deviation allowance
λ
permissible deviation between minimum actual and minimum effective space width or maximum effective and maximum actual tooth thickness

3.41
machining tolerance
T
permissible deviation between maximum actual and minimum actual space width or tooth thickness

3.42
effective clearance tolerance
T_v
permissible deviation between maximum effective and minimum effective space width or tooth thickness

3.43
total tolerance
$T + \lambda$
machining tolerance plus the deviation allowance

3.43.1
total tolerance
⟨internal spline⟩ difference between the minimum effective space width and the maximum actual space width

3.43.2
total tolerance
⟨external spline⟩ difference between the maximum effective tooth thickness and the minimum actual tooth thickness

3.44
basic dimension
numerical value to describe the theoretically exact size, shape or location of a feature

NOTE It is the basis from which permissible deviations are established by tolerances.

3.45
auxiliary dimension
dimension, without tolerance, given for information purposes only, for the determination of the useful production and control dimensions

4 Symbols, subscripts and abbreviated terms

4.1 General symbols

The general symbols used to designate the various spline terms and dimensions are given below.

b	Spline length	mm
c_F	Form clearance	mm
c_v	Effective clearance (looseness or interference)	µm