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(JGMA/JSA)

**Cylindrical gears—ISO system of
flank tolerance classification—
Part 1: Definitions and allowable
values of deviations relevant to
flanks of gear teeth**

ICS 21.200

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Gear Manufacturers Association (JGMA)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently **JIS B 1702-1:1998** is replaced with this Standard.

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JIS B 1702 series consists of the following 3 parts:

- JIS B 1702-1 *Cylindrical gears—ISO system of flank tolerance classification—Part 1: Definitions and allowable values of deviations relevant to flanks of gear teeth*
- JIS B 1702-2 *Cylindrical gears—ISO system of accuracy—Part 2: Definitions and allowable values of deviations relevant to radial composite deviations and runout information*
- JIS B 1702-3 *Cylindrical gears—The accuracy—Part 3: Definitions and allowable values of deviations relevant to corresponding flanks of the gear teeth and radial composite deviations of injection molding plastic gears*

Cylindrical gears—ISO system of flank tolerance classification—Part 1: Definitions and allowable values of deviations relevant to flanks of gear teeth

Introduction

This Japanese Industrial Standard has been prepared based on the second edition of **ISO 1328-1** published in 2013 with some modifications of the technical contents to reflect the actualities in Japan.

The portions given sidelines or dotted underlines are the matters in which the contents of the corresponding International Standard have been modified. A list of modifications with the explanations is given in Annex JA.

1 Scope

This Standard establishes a tolerance classification system relevant to manufacturing and conformity assessment of tooth flanks of individual cylindrical involute gears. It specifies definitions for gear flank tolerance terms, the structure of the flank tolerance class system, and allowable values. Eleven flank tolerance classes are defined, numbered 1 to 11. Formulae for tolerances are provided in **6.3**. These tolerances are applicable to the following ranges:

- $5 \leq z \leq 1\,000$
- $5\text{ mm} \leq d \leq 15\,000\text{ mm}$
- $0.5\text{ mm} \leq m_n \leq 70\text{ mm}$
- $4\text{ mm} \leq b \leq 1\,200\text{ mm}$
- $\beta \leq 45^\circ$

where,

d is the reference diameter (see **JIS B 0102-1**);

m_n is the normal module;

b is the facewidth (axial);

z is the number of teeth;

β is the helix angle.

Surface texture is not considered in this Standard. For additional information on surface texture, see **ISO/TR 10064-4**.

NOTE : The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 1328-1:2013 *Cylindrical gears—ISO system of flank tolerance classification—Part 1: Definitions and allowable values of deviations relevant to flanks of gear teeth* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 0102-1 *Vocabulary of gear terms—Part 1: Definitions related to geometry*

NOTE : Corresponding International Standard: ISO 1122-1:1998 *Vocabulary of gear terms—Part 1: Definitions related to geometry* (MOD)

JIS B 0121 *International gear notation—Symbols for geometrical data*

NOTE : Corresponding International Standard: ISO 701:1998 *International gear notation—Symbols for geometrical data* (MOD)

JIS B 1702-2 *Cylindrical gears—ISO system of accuracy—Part 2: Definitions and allowable values of deviations relevant to radial composite deviations and runout information*

NOTE : Corresponding International Standard: ISO 1328-2:1997 *Cylindrical gears—ISO system of accuracy—Part 2: Definitions and allowable values of deviations relevant to radial composite deviations and runout information* (IDT)

ISO/TR 10064-1 *Code of inspection practice—Part 1: Inspection of corresponding flanks of gear teeth*

ISO 16610-1 *Geometrical product specifications (GPS)—Filtration—Part 1: Overview and basic concepts*

ISO 16610-21 *Geometrical product specifications (GPS)—Filtration—Part 21: Linear profile filters: Gaussian filters*

ISO 21771 *Gears—Cylindrical involute gears and gear pairs—Concepts and geometry*

3 Terms and definitions

For the purposes of this Standard, the terms and definitions given in **JIS B 0102-1**, **ISO 21771**, and the following apply.

NOTE : Some of the symbols and terminology contained in this Standard might differ from those used in other documents and standards.

3.1 General

3.1.1 measurement diameter, d_m

diameter of the circle concentric with the datum axis where the probe is in contact with the tooth flanks during the measurement of helix, pitch or tooth thickness deviations

NOTE 1 The measurement diameter is usually near the middle of the flank.

NOTE 2 See ISO/TR 10064-3.

3.1.2 profile form filter cutoff, λ_α

wavelength where 50 % of the amplitude of the involute profile measurement data is transmitted as a result of the Gaussian low-pass filter, thereby including only longer wavelength deviations

NOTE : See 5.4.6 and Annex C.

3.1.3 helix form filter cutoff, λ_β

wavelength where 50 % of the amplitude of the helix measurement data is transmitted as a result of the Gaussian low-pass filter, thereby including only longer wavelength deviations

NOTE : See 5.4.6 and Annex C.

3.1.4 roll path length

linear distance along a base tangent line from its contact with the base circle to the given point on the involute profile in the transverse plane

NOTE 1 Roll path length is an alternative to roll angle for specification of selected diameter positions on an involute profile.

NOTE 2 See ISO 21771, 4.3.8.

3.1.5 length of path of contact, g_α

roll path length from the start of active profile, N_t , to the tip form diameter, or to the point where contact stops due to undercut on the mating part (end of active profile)

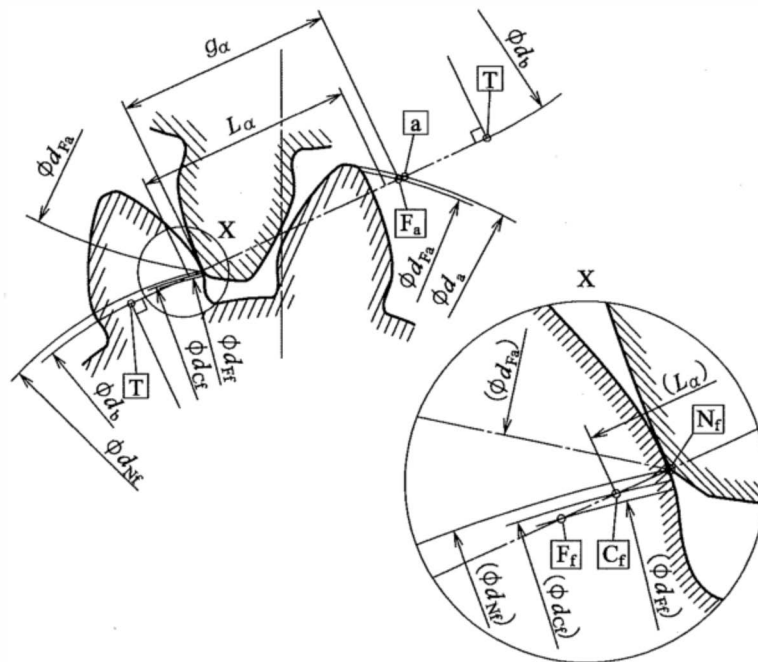
NOTE : See Figure 1.

3.1.6 datum axis

axis to which the gear details, and in particular the pitch, profile and helix tolerances, are defined

NOTE 1 The datum axis of the gear is defined by the datum surfaces.

NOTE 2 See ISO/TR 10064-3.



L_a evaluation length

a tip

C_f profile control

F_a tip form

F_f root form

N_f start of active profile

T tangency to base circle

— · — · — · — : line of action

g_a length of path of contact

d_a tip diameter

d_b base

d_{Cr} profile control

d_{Fa} tip form, where tip break starts

d_{Ff} root form, where involute starts

d_{Nf} start of active profile

NOTE : Diameters on mating gear have the same symbols, but different values.

Figure 1 Diameters and roll path length for an external gear pair

3.2 Pitch deviations

3.2.1 individual single pitch deviation, f_{pi}

algebraic difference between the actual pitch and the corresponding theoretical pitch in the transverse plane on the measurement circle of the gear

NOTE 1 It corresponds to the displacement of any tooth flank from its theoretical position relative to the corresponding flank of an adjacent tooth.

NOTE 2 For the left flanks, as well as for the right flanks, there are as many values of f_{pi} as there are teeth.

NOTE 3 See Figure 2 and 5.4.8.6.1.

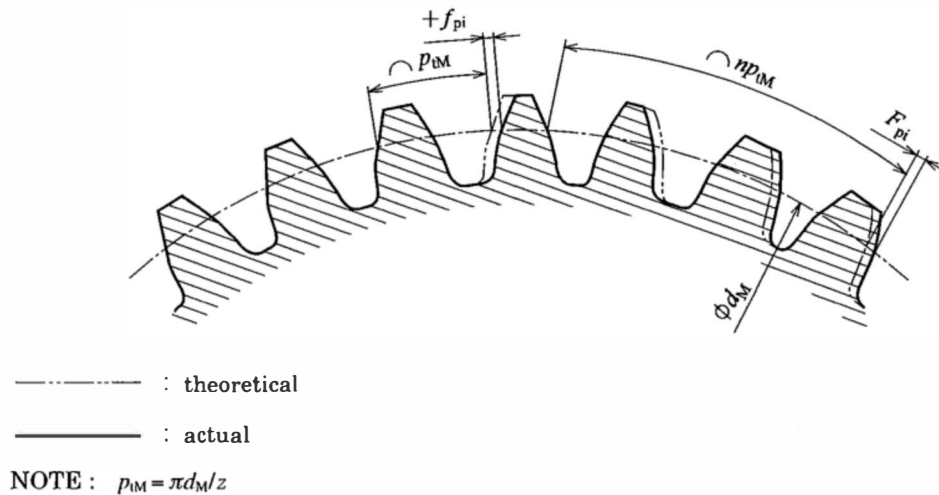


Figure 2 Pitch deviations

3.2.2 single pitch deviation, f_p

maximum absolute value of all the individual single pitch deviations (3.2.1) observed

NOTE : $f_p = \max |f_{pi}|$

3.2.3 individual cumulative pitch deviation, F_{pi}

algebraic difference, over a sector of n adjacent pitches, between the length and the theoretical length of the relevant arc

NOTE 1 n varies from 1 to z ; for the left flanks, as well as the right flanks, there are as many values of F_{pi} as there are teeth.

NOTE 2 In theory, it is equal to the algebraic sum of the individual single pitch deviations (3.2.1) of the same n pitches.

NOTE 3 See Figure 2 and Annex D.

3.2.4 total cumulative pitch deviation, F_p

largest algebraic difference between the individual cumulative pitch deviation (3.2.3) values for a specified flank obtained for all the teeth ($n = 1$ to z) of a gear

NOTE : $F_p = \max . F_{pi} - \min . F_{pi}$

3.3 Profile deviations

3.3.1 General

3.3.1.1 profile control diameter, d_{cf}

specified diameter beyond which the tooth profile is required to conform to the specified design profile (3.3.2.1)

NOTE 1 If not specified, the start of active profile diameter, d_{nf} , is used as the profile control diameter. See 5.5 b).

NOTE 2 See Figures 1 and 3.

3.3.1.2 tip form diameter, d_{Fa}

unless otherwise specified, tip diameter minus twice the tip corner radius or chamfer

NOTE 1 This is the minimum specified diameter for external gears or maximum specified diameter for internal gears where the tip break (start of tip chamfer or tip corner radius) can occur.

NOTE 2 Without tip corner chamfer or tip corner radius, the tip form diameter is equal to the tip diameter.

NOTE 3 See Figures 1 and 3.

3.3.1.3 measured profile

portion of the tooth flank along which the probe is in contact during the profile measurement, which shall include the profile control diameter (3.3.1.1) and the tip form diameter (3.3.1.2)

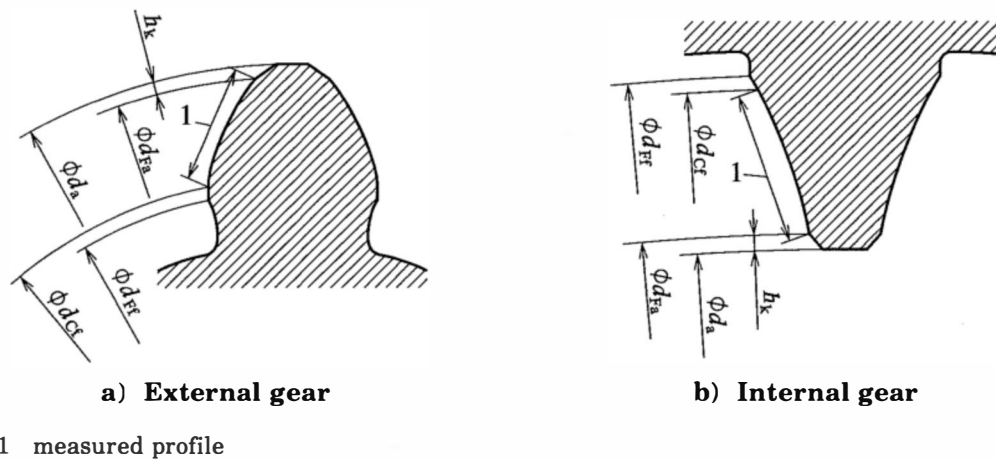


Figure 3 Measured profile

3.3.1.4 profile evaluation range

section of the measured profile (3.3.1.3) starting at the profile control diameter (3.3.1.1), d_{cr} , and, unless otherwise specified, ending at 95 % of the length to the tip form diameter (3.3.1.2), d_{Fa}

NOTE : See Figures 4 to 8, 5.4.8.2 and ISO 21771.

3.3.1.5 profile evaluation length, L_a

roll path length (3.1.4) of the profile evaluation range (3.3.1.4) in a transverse plane

NOTE :. See Figure 1.

3.3.1.6 profile deviation

amount by which a measured profile (3.3.1.3) deviates from the design profile (3.3.2.1)

NOTE : See Figure 1.

3.3.2 Analysis of profile deviations

3.3.2.1 design profile

profile specified by the designer in a diagram where one axis has modifications from a pure involute and the other axis has the roll length along the tangent to the base circle

NOTE 1 When the design profile is not specified, it is an unmodified involute and appears as a straight line. In Figures 4 to 8, the design profiles are shown as broken-chain (dotted) lines.

NOTE 2 See Figures 4 to 8.

3.3.2.2 mean profile line

line (or curve) that represents the shape of the design profile (3.3.2.1), but aligned with the measured trace over the profile evaluation range (3.3.1.4)

NOTE : See 5.4.8.2.

3.3.2.3 profile deviation, total, F_α

distance between two facsimiles of the design profile (3.3.2.1) which enclose the measured profile (3.3.1.3) over the profile evaluation range (3.3.1.4)

NOTE : See Figures 4 to 8 and 5.4.8.2.

3.3.2.4 profile form deviation, $f_{f\alpha}$

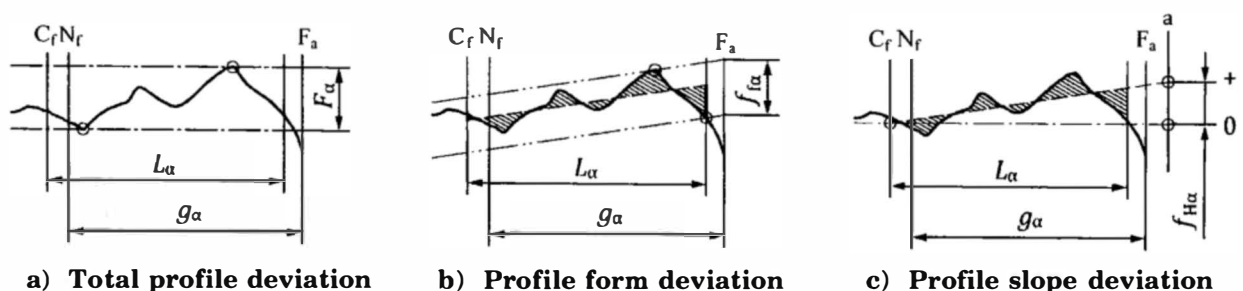
distance between two facsimiles of the mean profile line (3.3.2.2) which enclose the measured profile (3.3.1.3) over the profile evaluation range (3.3.1.4)

NOTE : See Figures 4 to 8 and 5.4.8.2.

3.3.2.5 profile slope deviation, $f_{H\alpha}$

distance between two facsimiles of the design profile which intersect the extrapolated mean profile line at the profile control diameter, C_r , and the tip diameter

NOTE : See Figures 4 to 8 and 5.4.8.2.



— measured profile
 facsimile of design profile
 - - - - - mean profile line
 - - - - - facsimile of mean profile line

Points on line of action
 C_r profile control
 N_r start of active profile
 F_a tip form, where tip break starts
 a tip

Figure 4 Profile deviations with unmodified involute

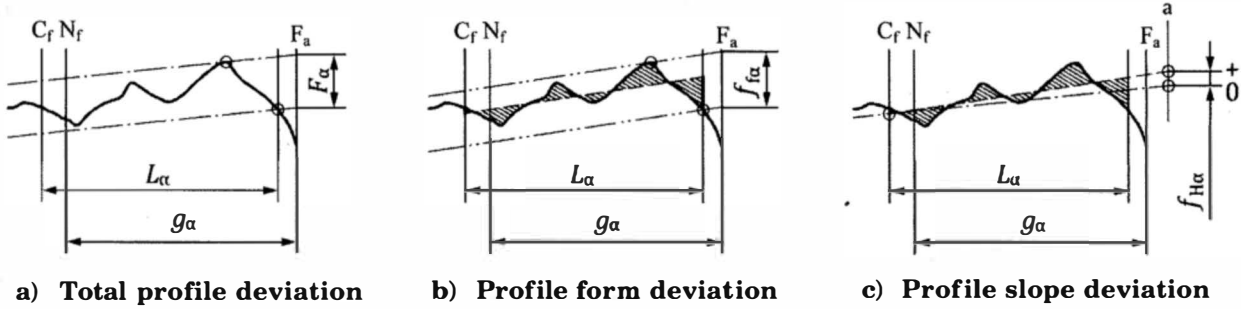


Figure 5 Profile deviations with pressure angle modified

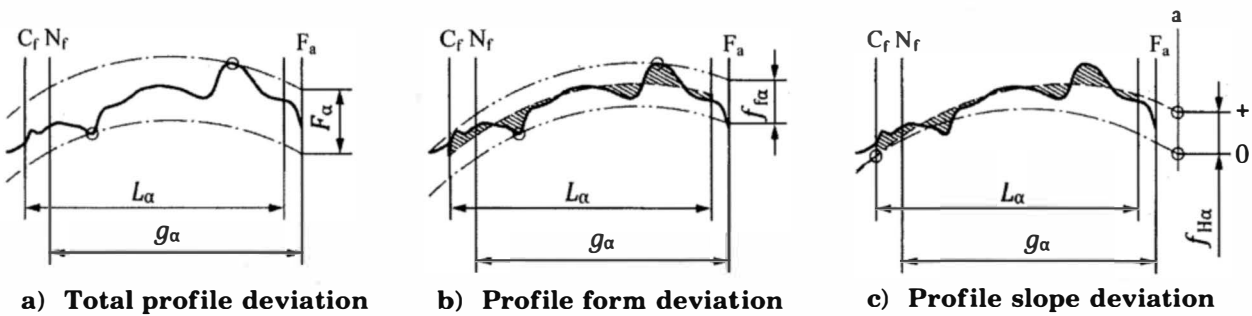


Figure 6 Profile deviations with profile crowning modification

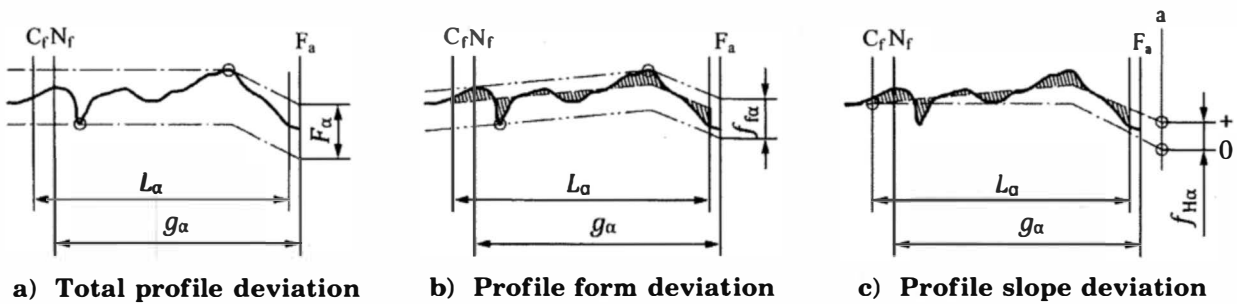


Figure 7 Profile deviations with profile modified with tip relief

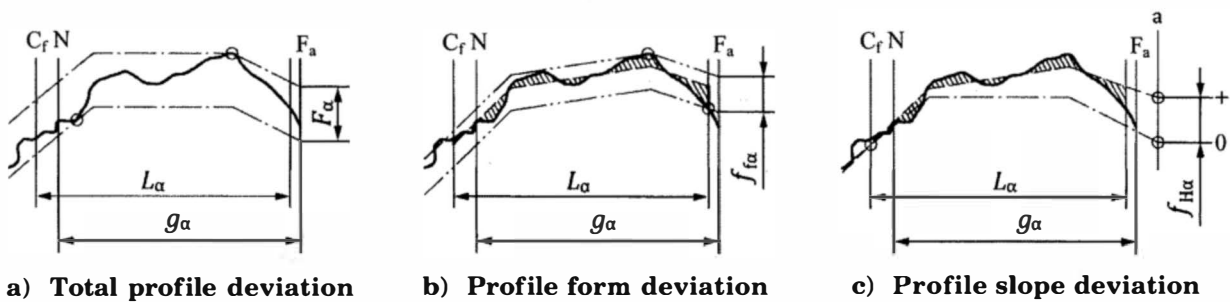


Figure 8 Profile deviations with profile modified with tip and root relief

3.4 Helix deviations

3.4.1 General

3.4.1.1 measured helix

full flank between the end faces or, if present, the start of end chamfers, rounds, or other modification intended to exclude that portion of the tooth from engagement, along which the probe is in contact during the helix measurement

3.4.1.2 helix evaluation range

unless otherwise specified, flank area shortened in the axial direction at each end by the smaller of 5 % of the facewidth or the length equal to one module

NOTE 1 It is the responsibility of the gear designer to ensure that the helix evaluation range is adequate for the application.

NOTE 2 See 5.4.8.4.

3.4.1.3 helix evaluation length, L_β

axial length of the helix evaluation range (3.4.1.2)

3.4.1.4 helix deviation

amount by which a measured helix (3.4.1.1) deviates from the design helix (3.4.2.1)

NOTE : See Figures 9 to 13.

3.4.2 Analysis of helix deviations

3.4.2.1 design helix

helix specified by the designer in a diagram where one axis has modifications from a pure helix and the other axis has the facewidth

NOTE 1 When not specified, it is an unmodified helix.

NOTE 2 See Figures 9 to 13.

3.4.2.2 mean helix line

line (or curve) that represents the shape of the design helix (3.4.2.1), but aligned with the measured trace

NOTE : See 5.4.8.4.

3.4.2.3 helix deviation, total, F_β

distance between two facsimiles of the design helix (3.4.2.1) which enclose the measured helix (3.4.1.1) over the helix evaluation range (3.4.1.2)

NOTE : See Figures 9 to 13 and 5.4.8.4.

3.4.2.4 helix form deviation, $f_{i\beta}$

distance between two facsimiles of the mean helix line (3.4.2.2), which enclose the measured helix (3.4.1.1) over the helix evaluation range (3.4.1.2)

NOTE : See Figures 9 to 13 and 5.4.8.4.

3.4.2.5 helix slope deviation, $f_{H\beta}$

distance between two intersections at the end face II, one with the facsimile of the design helix which intersects the extrapolated mean helix line at the end face I and another with the extrapolated mean helix line

NOTE : See Figures 9 to 13 and 5.4.8.4.

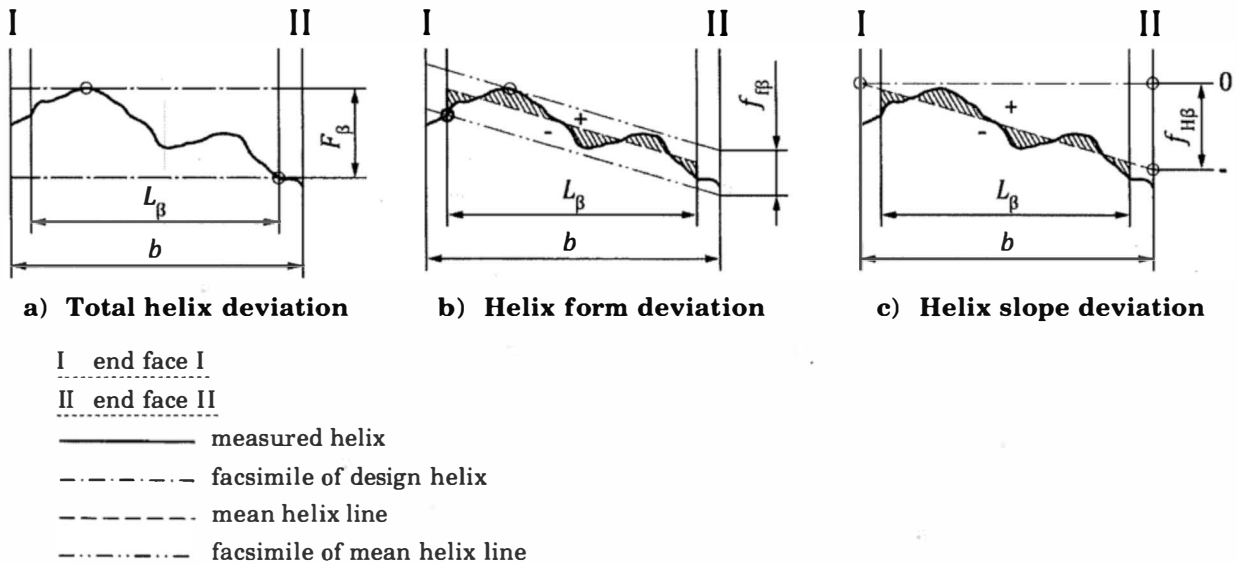


Figure 9 Helix deviations with unmodified helix

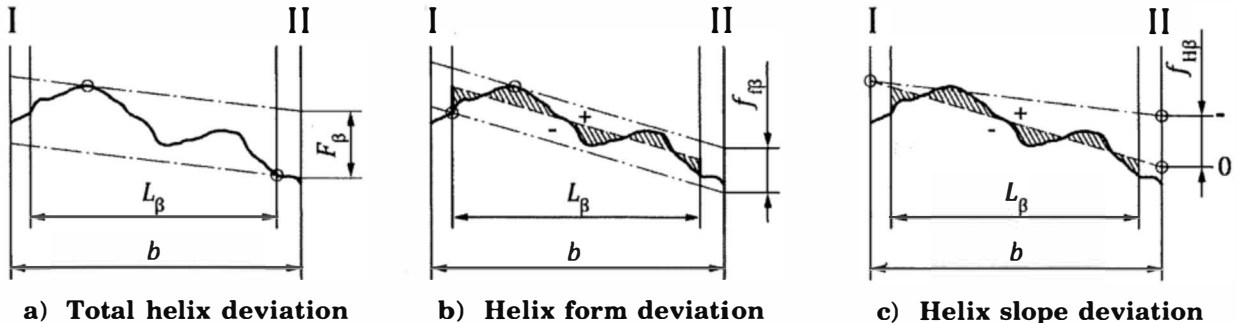


Figure 10 Helix deviations with helix angle modification

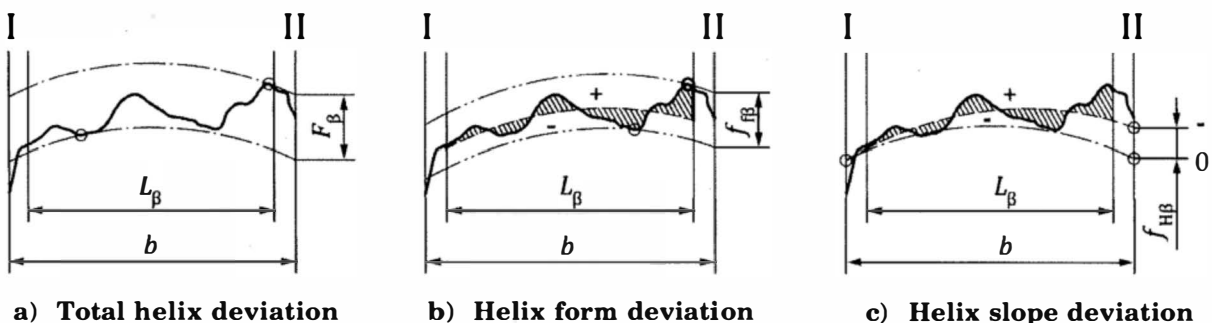


Figure 11 Helix deviations with helix crowning modification

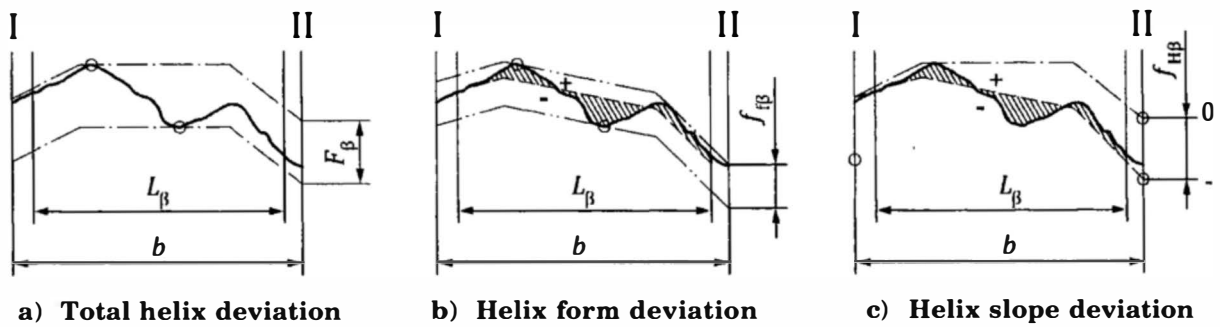


Figure 12 Helix deviations with helix end relief

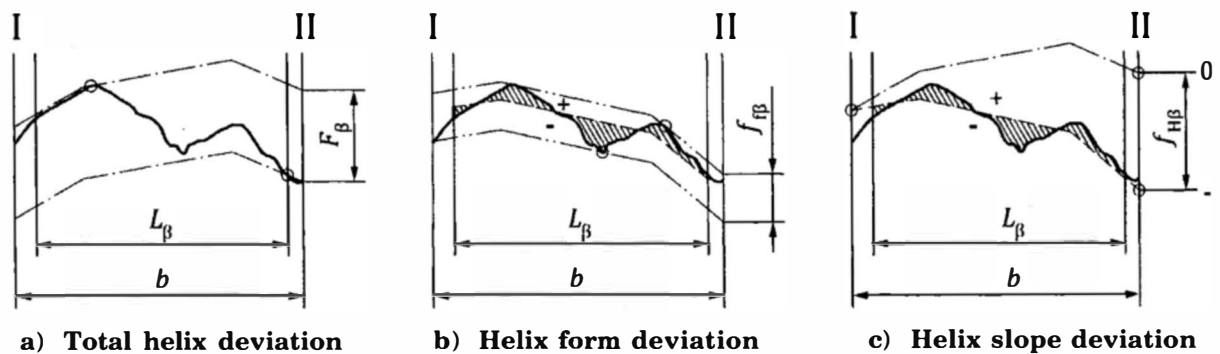


Figure 13 Helix deviations with modified helix angle with end relief

4 Symbols and units

The symbols and units shall be as specified in **JIS B 0121**, and Table 1.

Table 1 Symbols

Symbol	Term	Unit
A	Flank tolerance class	—
b	Facewidth (axial)	mm
C_f	Profile control	—
C_{ta}	Amount of tip relief	μm
C_{rt}	Amount of root relief	μm
c_p	Contact pattern evaluation	—
d	Reference diameter	mm
d_a	Tip diameter	mm
d_b	Base diameter	mm
d_{Cf}	Profile control diameter	mm
d_{fa}	Tip form diameter	mm
d_{fr}	Root form diameter	mm
d_M	Measurement diameter	mm
d_{Ne}	Start of active profile diameter	mm
F_a	Tip form	—

Table 1 (continued)

Symbol	Term	Unit
F_r	Root form	—
F_i''	Radial composite deviation, tooth-to-tooth ^{a)}	μm
F_{is}	Single flank composite deviation, total	μm
F_{isT}	Single flank composite tolerance, total	μm
F_p	Cumulative pitch deviation, total	μm
F_{pi}	Cumulative pitch deviation, individual	μm
F_{pk}	Sector pitch deviation	μm
F_{pkT}	Sector pitch tolerance	μm
F_{pT}	Cumulative pitch (index) tolerance, total	μm
F_{pSk}	Pitch span deviation	μm
F_r	Runout	μm
F_α	Profile deviation, total	μm
$F_{\alpha T}$	Profile tolerance, total	μm
F_β	Helix deviation, total	μm
$F_{\beta T}$	Helix tolerance, total	μm
$f_{i\alpha}$	Profile form deviation	μm
$f_{i\alpha T}$	Profile form tolerance	μm
$f_{i\beta}$	Helix form deviation	μm
$f_{i\beta T}$	Helix form tolerance	μm
$f_{H\alpha}$	Profile slope deviation	μm
$f_{H\alpha T}$	Profile slope tolerance	μm
$f_{H\beta}$	Helix slope deviation	μm
$f_{H\beta T}$	Helix slope tolerance	μm
f_i''	Radial composite deviation, tooth-to-tooth ^{a)}	μm
f_{is}	Single flank composite deviation, tooth-to-tooth	μm
f_{isT}	Single flank composite tolerance, tooth-to-tooth	μm
f_p	Single pitch deviation	μm
f_{pi}	Single pitch deviation (individual)	μm
f_{pT}	Single pitch tolerance	μm
f_u	Adjacent pitch difference	μm
f_{ui}	Adjacent pitch difference, individual	μm
f_{uT}	Adjacent pitch difference tolerance	μm
g_α	Length of path of contact	mm
h_k	Tip corner chamfer	mm
k	Number of pitches in a sector	—
L_{am}	Middle profile zone	mm
L_{an}	Tip relief zone	mm