IS 3681 (1995): Gears - Cylindrical Gears - Accuracies [PGD 31: Bolts, Nuts and Fasteners Accessories]

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भारतीय मानक

गियर — बेलनाकार गियर — परिशुद्धताएँ

(पहला पुनरीक्षण)

Indian Standard

GEARS — CYLINDRICAL GEARS — ACCURACIES

(First Revision)

UDC 621·833·1 : 620·178·151·4

BUREAU OF INDIAN STANDARDS
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Price Group 14

Gears Sectional Committee, LM 13

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Gears Sectional Committee had been approved by the Light Mechanical Engineering Division Council.

This standard was first published in 1966. In the revision of this standard the committee considered the availability of the ISO standards for tolerances as well as the other National Standards. While examining various standards, the committee felt that the Indian Gear Industry was following the provisions contained in the DIN standards. The committee felt that the tolerances specified in ISO 1328 : 1975 'Parallel involute gears — ISO system of accuracy' are quite wide for two flanked working deviation, concentricity deviation and pitch span deviation. Additionally, there is a large spread in their relationship to the other tolerances. From the work programme of ISO/TC 60, it has been noted that ISO 1328 : 1975 is under revision and the indications are that the ISO standards would be greatly influenced by the revised DIN standards for tolerances. In view of the above considerations the committee decided to refer the following DIN standards in revising IS 3681 : 1966:

DIN 3960-1987	Definitions, parameters and equations for involute cylindrical gears and gear pairs
DIN 3961-1978	Tolerances for cylindrical gear teeth, bases
DIN 3962 (Part 1) : 1978	Tolerances for cylindrical gear teeth, Part 1 Tolerances for deviations of individual parameters
DIN 3962 (Part 2) : 1978	Tolerances for cylindrical gear teeth, Part 2 Tolerances for tooth trace deviations
DIN 3962 (Part 3) : 1978	Tolerances for cylindrical gear teeth, Part 3 Tolerances for pitch span deviations
DIN 3963 : 1978	Tolerances for cylindrical gear teeth, tolerances for working deviations
DIN 3964 : 1980	Deviations of shaft centre distances and shaft position — Tolerances of costing for cylindrical gears
DIN 3967 : 1978	System of gearfits — Backlash and tooth thickness allowances — Tooth thickness tolerances — Principles

In the revision symbols, definitions and notations have been aligned with the ISO system which is also the case for the DIN standards referred above. In addition, information on tolerance families and test groups for function groups and teeth quality has been given.

Apart from this, it has been established in practice that for the same module, the profile deviations do not become larger with increasing diameter (increasing number of teeth). The profile tolerance therefore remain only module-dependent and not diameter-dependent. In view of this, the total profile deviation pitch span deviation, pitch span deviation over 1/8th of periphery, tooth trace from deviation and tooth trace total deviation have been redefined in accordance with ISO 1328 : 1975.

IS 7504 : 1995 Gears — Cylindrical gears — Accuracies — Methods of inspection (*first revision*) may be referred for inspection procedure.

The following standards shall be withdrawn consequent to the publication of this standard since the content of these standards are covers in this standard:

IS 4058 : 1967	Accuracy requirements for coarse quality low speed gears
IS 4059 : 1967	Accuracy requirements for medium quality medium speed gears
IS 4702 : 1968	Accuracy requirements for high precision gears
IS 4725 : 1968	Accuracy requirements for precision gears

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

GEARS — CYLINDRICAL GEARS — ACCURACIES
(First Revision)

1 SCOPE

1.1 This Indian Standard covers the general accuracy for cylindrical gears of involute, modified involute flank forms, comprising of gears with straight or inclined teeth for connecting parallel shafts.

1.2 This standard also covers the tolerances for gear teeth on cylindrical gears of module 1 to 70 and with reference circle diameter up to 10 000 mm, graded in 12 gear tooth qualities. The tolerances apply regardless of the pressure angle.

In the case of racks, the tolerances for their teeth shall not exceed those for the teeth of the mating gear. If the details of mating gear is not known the rack length should be taken equal to the circumference of the mating gears.

NOTE — This standard has been based on the assumption that the gears shall be suitably supported on shafts of ample size and shall be provided with efficient thrust bearings where required; and they shall be effectively lubricated.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

IS No.	*Title*
919 (Part 2) : 1993	ISO System of limits and fits: Part 2 Tables of standard tolerance grades and limit deviations for holes and shafts (*first revision*)
2535 : 1978	Basic rack and modules for cylindrical gears for general engineering and heavy engineering (*second revision*)

3 DEFINITIONS, NOTATIONS AND SYMBOLS FOR TOLERANCES

3.1 Symbols

a''	—	Radial pitch distance (double flank pitch distance)
b	—	Face width
d	—	Reference circle diameter
d_b	—	Base circle diameter
d_M	—	Measuring circle diameter
f_f	—	Profile form error
f_{fw}	—	Profile waviness
f'_i	—	Single flank tooth to tooth composite error
f''_i	—	Double flank tooth to tooth composite error
f_p	—	Individual pitch error
f_{pe}	—	Base pitch error
f_u	—	Tooth to tooth pitch error
$f_{H\alpha}$	—	Profile angle error
$f_{H\beta}$	—	Flank line angle error
$f_{\beta f}$	—	Longitudinal form error
$f_{\beta\omega}$	—	Flank line waviness
$f_{\Sigma\beta}$	—	Axes skew over length, L_G
$f_{\Sigma\delta}$	—	Axes inclination over length, L_G
j_t	—	Theoritical backlash
$j_{t\,Max}$	—	Maximum circumferential backlash
$j_{t\,Min}$	—	Minimum circumferential backlash
k	—	Number of teeth measured
m	—	Module
m_n	—	Normal plane module
P_b	—	Pitch on the base diameter
s	—	Tooth thickness
s_{Max}	—	Maximum tooth thickness on the reference cylinder
s_{Min}	—	Minimum tooth thickness on the reference cylinder
x	—	Profile correction factor
z	—	Number of teeth
z_v	—	Virtual number of teeth
A, B, C	—	Test groups
A_{ae}	—	Upper centre distance allowance
A_{ai}	—	Lower centre distance allowance
A_{sne}	—	Upper allowance of tooth thickness in normal section
A_{sni}	—	Lower allowance of tooth thickness in normal section
A_{ste}	—	Upper allowance of tooth thickness in transverse section
A_{sti}	—	Lower allowance of tooth thickness in transverse section
F_f	—	Total profile error
F'_i	—	Single flank total composite error

F''_i	—	Double flank total composite error
F_p	—	Total cumulative pitch error
F_{pk}	—	Cumulative pitch error over k pitches
$F_{pz}/8$	—	Cumulative pitch error over 1/8 of the periphery
F_r	—	Radial runout
F_β	—	Total alignment error
G, L, N, T	—	Function groups
L	—	Length of arc on reference circle
L_G	—	Centre distance between bearings (nominal value), mm
M	—	Tooth width
R_p	—	Range of pitch errors
R_s	—	Tooth thickness fluctuation
TRA	—	Bearing surface
T_a	—	Centre distance tolerance
T_s	—	Tooth thickness tolerance
ΣA_{sne}	—	Sum of the upper allowances of tooth thickness of gear pair in the normal section
ΣA_{sni}	—	Sum of the lower allowances of tooth thickness of gear pair in the normal section
ΣA_{ste}	—	Sum of the upper allowances of tooth thickness of gear pair in the transverse section
ΣA_{sti}	—	Sum of the lower allowances of tooth thickness of gear pair in the transverse section
α	—	Pressure angle
α_n	—	Normal pressure angle
α_t	—	Transverse pressure angle
α_{wt}	—	Transverse working pressure angle
β	—	Helix angle
β_b	—	Base helix angle
Δj_a	—	Backlash modification through centre distance tolerance
Δj_{ae}	—	Backlash modification through upper centre distance tolerance
Δj_{ai}	—	Backlash modification through lower centre distance tolerance
Δj_f	—	Backlash modification through gear tooth individual errors
$\Delta j_{\Sigma\beta}$	—	Backlash modification through non-parallelism of bore-axes

3.2 Definitions of Errors

3.2.1 *Profile Form Error, f_f*

The profile form error of a tooth flank is the distance between the two involutes of the actual base circle which touch and envelope the actual profile within the profile test region taking into account the desired modifications from the involute form. The profile form error, covers also the depth of the profile waviness.

3.2.2 *Profile Waviness, f_{fw}*

A profile error, that is, periodically repeated with the working angle is called 'Profile waviness'. It is denoted by the wave depth and the wave length. In a test graph as shown in Fig. 1, the profile form error f_f is the measurement taken perpendicular to the paper feed direction between the lines $B'B'$ and $B''B''$, which are parallel to the actual involute BB. Line BB is drawn to average the involute curve which touches the test curve within the profile test region.

3.2.3 *Profile Angle Error, $f_{H\alpha}$*

The profile angle error, $f_{H\alpha}$ is the distance between the two nominal profiles which cut the involutes of the actual base circle at the start and end points of the profile test region respectively.

The profile angle error, $f_{H\alpha}$ is generally given in µm as the linear dimension correlated to the profile test region. The profile angle error $f_{H\alpha}$ is positive when the involute of the actual base circle rises in the direction of increasing pitch lengths with respect to the nominal profile and is negative when the involute of the actual base circle sinks in the direction of increasing pitch lengths towards the side of the material.

In a test graph as shown in Fig. 1, the profile angle error $f_{H\alpha}$ is the measurement taken perpendicular to the paper feed direction between the lines $C'C'$ and $C''C''$, parallel to AA, which cut the line BB at the start and end point of the profile test region.

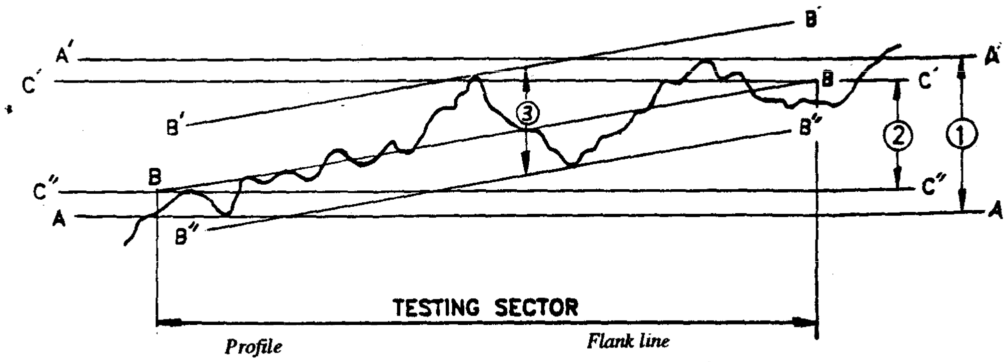
3.2.4 *Total Profile Error, F_f*

The total profile error, F_f of a tooth flank is the distance between the two nominal profiles which touch and envelop the tooth flank within the profile test region.

In Fig. 1, the total profile error F_f is the measurement made perpendicular to the paper feed direction between the parallel lines AA and $A'A'$ drawn in the direction of the paper feed within the profile test region through the extreme points of the test graph.

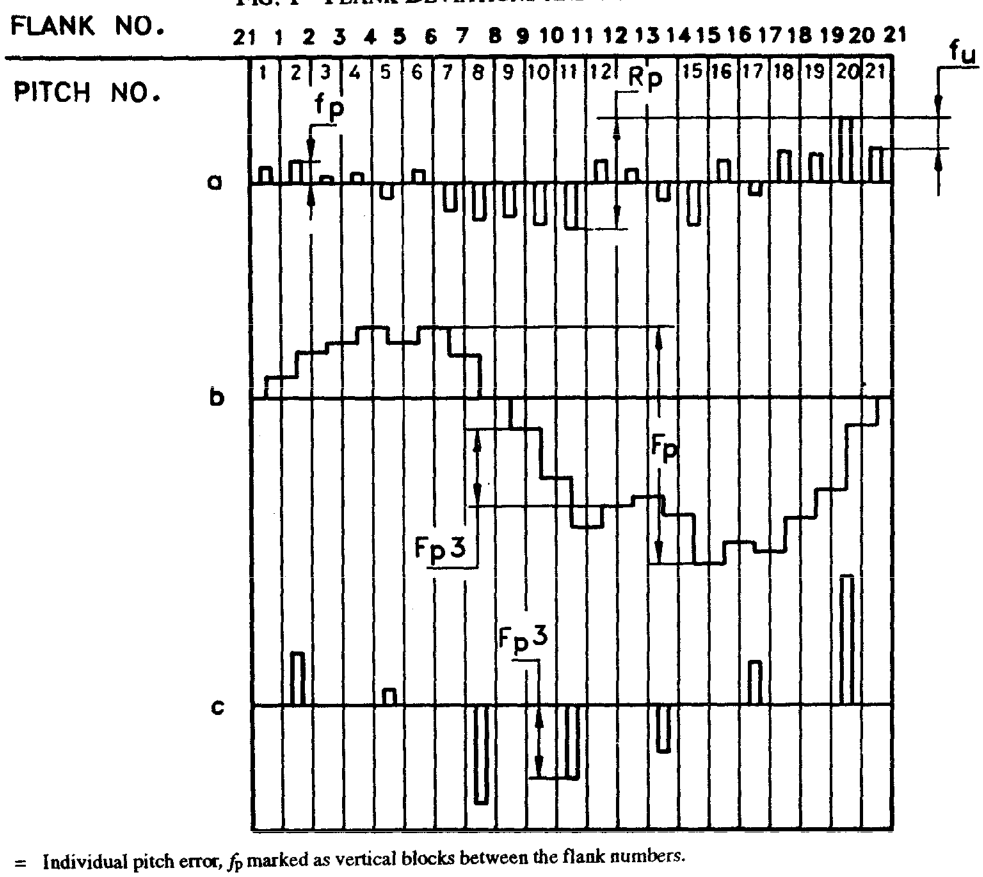
3.2.5 *Circular Pitch Errors*

Circular pitch errors called as pitch errors in short, are measured on the reference circle or any other circle as close to it as possible and concentric with the gear axis. The difference between the measuring circle diameter, d_M and the reference circle diameter, d influences the measurement of error by the factor d_M/d and these errors are generally negligible. The measured values are also affected by the eccentricity of the teeth and profile form errors. Figure 2 shows the representation of pitch errors.



	Profile	Flank line
①	Total profile error, F_f	Total alignment error, F_β
②	Profile angle error, $f_{H\alpha}$	Flank line angle error, $f_{H\beta}$
③	Profile form error, f_f	Longitudinal form error, $f_{\beta f}$
BB	Intermediate actual profile	Intermediate actual flank line
AA, A'A'	Nominal profile	Nominal-flank lines which envelop the actual flank
B'B', B"B"	Actual profile	Actual helical lines which envelop the actual flank
C'C', C"C"	Nominal profile	Nominal flank lines which cut the actual flank lines at the beginning and end point of the test range

FIG. 1 FLANK DEVIATIONS AND TEST GRAPH



a = Individual pitch error, f_p marked as vertical blocks between the flank numbers.

R_p — Range of pitch error.

f_u — Tooth to tooth pitch error.

b = Total cumulative pitch error referred to flank 21.

F_p — Total cumulative pitch error.

c = Cumulative pitch error over intervals of every three teeth, $F_p 3$ ($k = 3$) shown as vertical blocks in the middle of the flanks.

FIG. 2 REPRESENTATION OF PITCH ERROR (FOR EXAMPLE : $z = 21$)

3.2.6 *Individual Pitch Error,* f_p

Individual pitch error (adjacent pitch error) is the difference between the actual value of a single transverse pitch and the nominal transverse pitch.

3.2.7 *Cumulative Pitch Error,* F_{pk}

Cumulative pitch error is the deviation of the actual dimension of a pitch interval over k individual pitches from the corresponding nominal value. If the error of measurement is sufficiently small, the cumulative pitch error is obtained also as the algebraic sum of the k individual pitch errors contained in the interval

$$F_{pk} = \sum_{k} f_p$$

3.2.8 *Cumulative Pitch Error Over 1/8 of Periphery,* $F_{pz}/8$

Cumulative pitch error $F_{pz}/8$ is the cumulative pitch error over an interval of 1/8 of the circumference of the gear ($k = z/8$).

3.2.9 *Total Cumulative Pitch Error,* F_p

The maximum cumulative pitch error in a gear is called the total cumulative pitch error. It is indicated without sign and is obtained from the cumulative pitch errors as the difference between the algebraic maximum value and the algebraic minimum value.

3.2.10 *Range of Pitch Errors,* R_p

The range of pitch errors R_p is the difference between the maximum and minimum actual values of the transverse pitches of the right or left flanks of a gear.

3.2.11 *Tooth to Tooth Pitch Error,* f_u

The tooth to tooth pitch error is the difference between the actual values of two successive right or left transverse pitches.

Tooth to tooth pitch errors are directly obtained from circular pitch measurements as difference of the measurements of two neighbouring pitches.

3.2.12 *Base Pitch Error,* f_{pe}

Base pitch error is the difference between the actual nominal values of the base pitch. Deviations, measured in the transverse plane are denoted by f_{pet} and in the normal plane by f_{pen}.

3.2.13 *Tooth Thickness Fluctuation,* R_s

The tooth thickness error is the difference between the maximum and minimum tooth thickness 's' of a gear

$$R_s = s_{Max} - s_{Min}$$

3.2.14 *Total Alignment Error,* F_β

The total alignment error of a tooth flank is the distance between the two nominal flank lines which touch and envelop the tooth flank within the flank line test region.

In Fig. 1, the total alignment error F_β is the distance measured perpendicular to the paper feed direction, between the parallel lines AA and $A'A'$ which are drawn in the direction of the paper feed within the flank line test region through the extreme points of test graphs.

3.2.15 *Longitudinal Form Error,* $f_{\beta f}$

The longitudinal form error of a tooth flank is the distance between the two helix lines with the actual lead which touch and envelop the actual flank line within the flank line test region taking into account the desired modifications from the helix line form. The longitudinal form error also covers the depth of the flank line waviness.

3.2.16 *Flank Line Waviness,* $f_{\beta\omega}$

Flank line waviness is the flank line form error, repeating periodically over the face width. It is characterized by the depth and length of the wave.

In a test graph as shown in Fig. 1, the longitudinal form error $f_{\beta f}$ is the dimension, perpedicular to the direction of the paper feed, between the lines $B'B'$ and $B''B''$ which are parallel to the averaging actual flank line BB and touch the test graph within the flank line test region.

3.2.17 *Flank Line Angle Error,* $f_{H\beta}$

The flank line angle error is the distance, on a transverse section plane, between the two nominal flank lines which cut the helix line with the actual lead at the start and end points of the flank line test region. The flank line angle error is generally indicated as the linear dimension in µm, co-related to the flank line test region.

In a test graph as shown in Fig. 1, the flank line angle error $f_{H\beta}$ is the distance measured perpendicular to the direction of the paper feed, between the lines $C'C'$ and $C''C''$ which are parallel to the line AA and cut the line BB at the start and end point of the flank line test region.

3.2.18 *Radial Runout,* F_r

Radial runout is the radial positional difference of a measuring piece (ball, cylinder or wedge) placed successively in all the tooth spaces, which touches the tooth flanks near the reference circle (pitch circle), while the gear is free to rotate on its axis.

3.2.19 *Single Flank Total Composite Error,* F'_i

Single flank total composite error is the fluctuation of the actual rotating postions with respect to the nominal rotating positions. It is given as the difference between the maximum advancing and retarding rotating positions with respect to a start value within a test rotation (*see* Fig. 3).

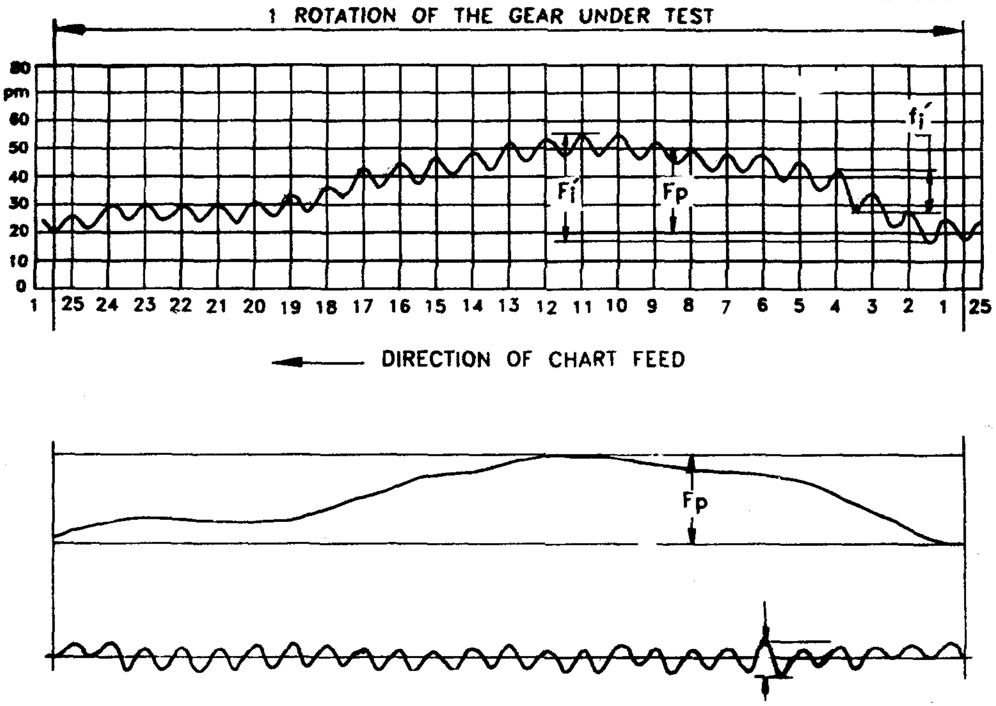


FIG. 3 SINGLE FLANK TOTAL COMPOSITE ERROR DIAGRAM

3.2.20 *Single Flank Tooth to Tooth Composite Error, f_i'*

Single flank tooth to tooth composite error is the maximum difference that occurs in the rotating position deviations within a rotating angle corresponding to the period of a tooth contact (*see* Fig. 3).

From single flank total composite error diagram (*see* Fig. 3) pitch errors can be determined. Total cumulative pitch error is the long wave component of the test diagram. This component can be obtained by drawing an averaging line thereby suppressing the short wave components. The averaging line has sinusoidal shape. The total cumulative pitch error F_p is the perpendicular distance between the highest and the lowest points of the averaging line.

Individual pitch errors f_p are the short wave components of the test diagram. They are given by the perpendicular distance between the highest and the lowest points in the short wave component of the graph drawn on linear averaging line.

3.2.21 *Double Flank Total Composite Error, F_i''*

Double flank total composite error is the difference between the maximum and minmum working centre distance within one test run of the gears always having two flank contact (*see* Fig. 4).

3.2.22 *Double Flank Tooth to Tooth Composite Error, f_i''*

Double flank tooth to tooth composite error is the maximum difference of the working centre distance that occurs within a turning angle corresponding to the period of a tooth contact (*see* Fig. 4).

From double flank total composite error diagram (*see* Fig. 4) radial runout error F_r can be determined. Radial runout error is the long wave component of the test diagram. This component can be obtained by drawing averaging line thereby suppressing the short wave components. The radial runout error F_r is then the distance between highest and lowest points of the averaging line.

4 BASIC RACK AND MODULES

The profile of the basic rack and the series of modules for cylindrical gears shall be as specified in IS 2535 : 1978.

5 CLASSIFICATION OF GEARS (SYSTEM OF TOLERANCES)

5.1 Various gears errors that are to be controlled/checked for different functional requirements and gear quality are tabulated in Table 1. For this purpose, on the basis of required function, gear drives are classified into four functional groups.

5.2 Application of Tolerance Families

Whenever a particular gear requires a general service property without taking special functional requirements into account (function group N), a single gear tooth quality is prescribed, for example quality 8. In other cases, fulfilment of the requirements of a specific function group will be stipulated. In such cases the letter symbol of the function group must be quoted along with the required gear tooth qualtiy.

Table 1 Function Groups of the Deviations
(*Clause* 5.1)

Function Groups		Important Deviations[1)]
G	Uniformity of the transmission of movement	F'_i f'_i F_p F''_i F_r f''_i
L	Smooth running and dynamic load capacity	f'_i f_p (f_{pe}) f''_i F_f $f_{H\beta}$ F_p (F_r)
T	Static load capacity	f_{pe} $f_{H\beta}$ TRA
N	No indication of the function	F''_i $f_{H\beta}$ F_f f''_i

[1)] Besides these deviations there are, of course, other factors also on which the operational properties are dependent. For instance, the smooth running depends also on speed and load and the load capacity depends on surface finish, the material and its conditions. It will, therefore, be necessary to make non-geometric requirements, for instance, specific hardness values or specific sound pressure level under given operating conditions.

For example :

— G8 means parameters for uniformity of transmission of motion (G) in gear tooth quality 8.

— L7 means parameters for smooth running (L) in gear tooth quality 7.

5.3 Quality Testing and Test Groups

Once the tolerances are selected based on functional requirements, it is not necessary to check all the gear errors when a specific function of the gear drive is defined. A definite 'functional group' can therefore be tested by means of different measuring instruments. Errors grouped under such a functional group is called the 'Test group'. Table 2 gives test groups A, B and C for each of the functional groups G, L, T and N and the quality of gears 1 to 12.

a) Test group A is best suited but requires measuring instruments which are not normally and readily available.

b) Test group B contains normally recommended gear errors to be checked which test the function indirectly with measuring instruments which are normally available.

c) Test group C, facilitates checking in a still indirect manner compared to checking with test group B.

The scope of test procedures denoted by symbols in Table 2 is given in Table 3.

6 TOLERANCE DATA

Tolerances are given in the following tables:

Tolerance for	*Refer to*
Profile form error, f_f	Table 4
Profile angle error, $f_{H\alpha}$	Table 4
Total profile error, F_f	Table 4
Individual pitch error, f_p	Table 4
Cumulative pitch error over 1/8 of periphery, $F_{pz}/8$	Table 4
Total cumulative pitch error, F_p	Table 4
Tooth to tooth pitch error, f_u	Table 4
Base pitch error, f_{pe}	Table 4
Tooth thickness error, R_s	Table 4

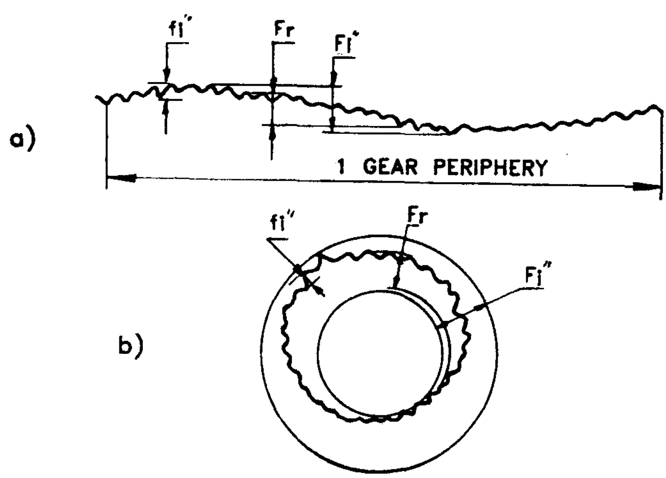


FIG. 4 DOUBLE FLANK TOTAL COMPOSITE ERROR DIAGRAM

Table 2 Errors for Test Groups for the Function Groups and Teeth Qualities
(*Clause* 5.3)

Function Group	*G*, Uniformity of Transmission			*L*, Smooth Running and Dynamic Load Capacity			*T*, Static Load Capacity			*N*, No Indication of Function		
Test Group	A	B	C	A	B	C	A	B	C	A	B	C
Teeth quality 1												
2	$F'_i\ R_s$			$F'_i\ F_\beta$	$F_p\ F_f\ F_\beta$		$F'_i\ F_\beta$	$f_{pe}\ F_f\ F_\beta$	f_{pe} TRA	$F'_i\ R_s$	$F_p\ R_s$ $F_f\ F_\beta$	$f_{pe}\ R_s$ $F_f\ F_\beta$
3	$F'_i\ R_s$			$F'_i\ F_\beta$	$F_p\ F_f\ F_\beta$		$F'_i\ F_\beta$	$f_{pe}\ F_f\ F_\beta$	f_{pe} TRA	$F'_i\ R_s$	$F_p\ R_s$ $F_f\ F_\beta$	$f_{pe}\ R_s$ $F_f\ F_\beta$
4	$F'_i\ R_s$	$F_p\ F_f\ F_\beta$		$F'_i\ F_\beta$	$F_p\ F_f\ F_\beta$	$f_{pe}\ F_f$ TRA	$f_{pe}\ F_f\ F_\beta$	f_{pe} TRA	F''_i TRA	$F'_i\ R_s$	$F''_i\ F_f\ F_\beta$	$f_{pe}\ R_s$ TRA
5	$F'_i\ R_s$	$F_p\ F_f\ F_\beta$	$f_{pe}\ F_f\ F_\beta$	$F'_i\ F_\beta$	$F_p\ F_f\ F_\beta$	$f_{pe}\ R_s$ TRA	$f_{pe}\ F_f\ F_\beta$	f_{pe} TRA	F''_i TRA	$F'_i\ R_s$	$F''_i\ F_f\ F_\beta$	$f_{pe}\ R_s$ TRA
6	$F'_i\ R_s$	$F_p\ F_f\ F_\beta$	$f_{pe}\ F_f\ F_\beta$	$F_p\ F_f\ F_\beta$	$F''_i\ F_f\ F_\beta$	$f_{pe}\ R_s$ TRA	$f_{pe}\ F_f\ F_\beta$	f_{pe} TRA	F''_i TRA	$F'_i\ R_s$	$F''_i\ F_f\ F_\beta$	$f_{pe}\ R_s$ TRA
7	$F_p\ F_f\ F_\beta$	$f_{pe}\ F_f\ F_\beta$	$f_{pe}\ F_\beta$	$F_p\ F_f\ F_\beta$	$F''_i\ F_f\ F_\beta$	$f_{pe}\ R_s$	f_{pe} TRA	F'_i TRA	f_p TRA	$F''_i\ F_f\ F_\beta$	F''_i TRA	$f_{pe}\ R_s$
8	$F_p\ F_f\ F_\beta$	$f_{pe}\ F_f\ F_\beta$	$f_{pe}F_\beta$	$F_p\ F_f\ F_\beta$	$F''_i\ F_f\ F_\beta$	$f_{pe}\ R_s$	f_{pe} TRA	F''_i TRA	f_p TRA	$F''_i\ F_f\ F_\beta$	F''_i TRA	$f_{pe}\ R_s$
9					$F''_i\ F_f\ F_\beta$	$f_{pe}\ R_s$	f_{pe} TRA	F''_i TRA	f_p TRA	F''_i TRA	F''_i	f_{pe}
10					$F''_i\ F_f\ F_\beta$	$f_{pe}\ R_s$	f_{pe}	f''_i	f_p	F''_i TRA	F''_i	f_{pe}
11							f_{pe}	f''_i	f_p	F''_i	f_{pe}	R_s
12										F''_i	f_{pc}	R_s

If double flank total composite error test including the centre distance testing is not carried out, then the above mentioned test should always be supplemented by a radial run out test and a tooth thickness test (as chord, face width or ball/roller measurement).

Table 3 List of Test Methods Indicated in Table 2 by Symbols
(*Clause* 5.3)

Symbol	Test Method	Tolerance to be adhered to by
F'_i	Single flank total composite error testing	F'_i and f'_i
f'_i	Single flank tooth to tooth composite error teting	f'_i
F''_i	Double flank total composite error testing	F''_i, f''_i, a'' (if Ts is not tested)
Rs	Testing of the tooth thickness error.	Rs
TRA	Zone of contact testing	TRA
F_β	Alignment testing	F_β, $f_{H\beta}$, $f_{\beta f}$
F_f	Profile testing	F_f, $f_{H\alpha}$, f_f
F_p	Total pitch error testing	F_p, $F_{pz/8}$
f_p	Pitch single error testing	f_p, f_u
f_{pe}	Base pitch error testing	f_{pe}

Tolerance for	*Refer to*
Radial runout, F_r	Table 4
Single flank total composite error, F'_i	Table 5
Single flank tooth to tooth composite error, f'_i	Table 5
Double flank total composite error, F''_i	Table 5
Double flank tooth to tooth composite error, f''_i	Table 5
Total alignment error, F_β	Table 6
Longitudinal form error, $f_{\beta f}$	Table 6
Flankline angle error, $f_{H\beta}$	Table 6
Cumulative pitch error, F_{pk}	Fig. 5

7 TOLERANCES AND ALLOWANCES ON TOOTH THICKNESS, CENTRE DISTANCE TOLERANCES AND BACKLASH

7.0 General

To facilitate use of this standard the calculation of backlash of tooth thickness allowances has been included (*see* **7.5**).

The backlash system of fits for gear pair allows the limiting allowances and tolerances referred to their prevailing mounting arrangements, non-parallelism of the bore axes and gear tooth individual errors.

The system of fits is defined as a tooth thickness system of fits in the normal section on the reference cylinder.

The normal section is chosen because the necessary tooth thickness tolerance in the normal section is independent of the helix angle. The normal section is also chosen for metrological reasons, since the normal chordal tooth thickness and the base tangent length are measured in the normal section.

The calculation of the allowances, however, is made over the transverse section, since on the finished gear transmission, the backlash is measured as circumferential backlash (*see* **7.5**).

The system of fits provides for safeguarding the minimum backlash and limiting the maximum backlash.

The reference basis of the system of fits is the zero-play condition at the nominal centre distance, with nominal addendum modification and with error free components.

The backlash value says nothing about the quality of the gear teeth although, on the otherhand, the different gear tooth qualities demand given tooth thickness allowances in order to ensure the requisite or permissible backlash.

7.1 Backlash

The minimum backlâsh is determined by the upper tooth thickness allowances.

The maximum backlash is determined by the lower tooth thickness allowances which result from the upper allowances and the tooth thickness tolerances.

The minimum and maximum backlash do not correspond to the sum of the allowances because a whole series of factors alters the backlash (*see* **7.5**).

7.1.1 *Theoretical Backlash*

The theoretical backlash j_t results from the tooth thickness allowances converted to the transverse section and from the converted allowances of the centre distance.

7.1.2 *Acceptance Backlash*

The acceptance backlash is the backlash obtained with the unloaded gear transmission at reference temperature when one of the gears is rotated against the other. It is usually smaller than the theoretical backlash, since the backlash reducing factors generally outweigh the factors tending to increase the backlash. Backlash reducing factors are, for example, errors in the gear teeth and also form and position errors.

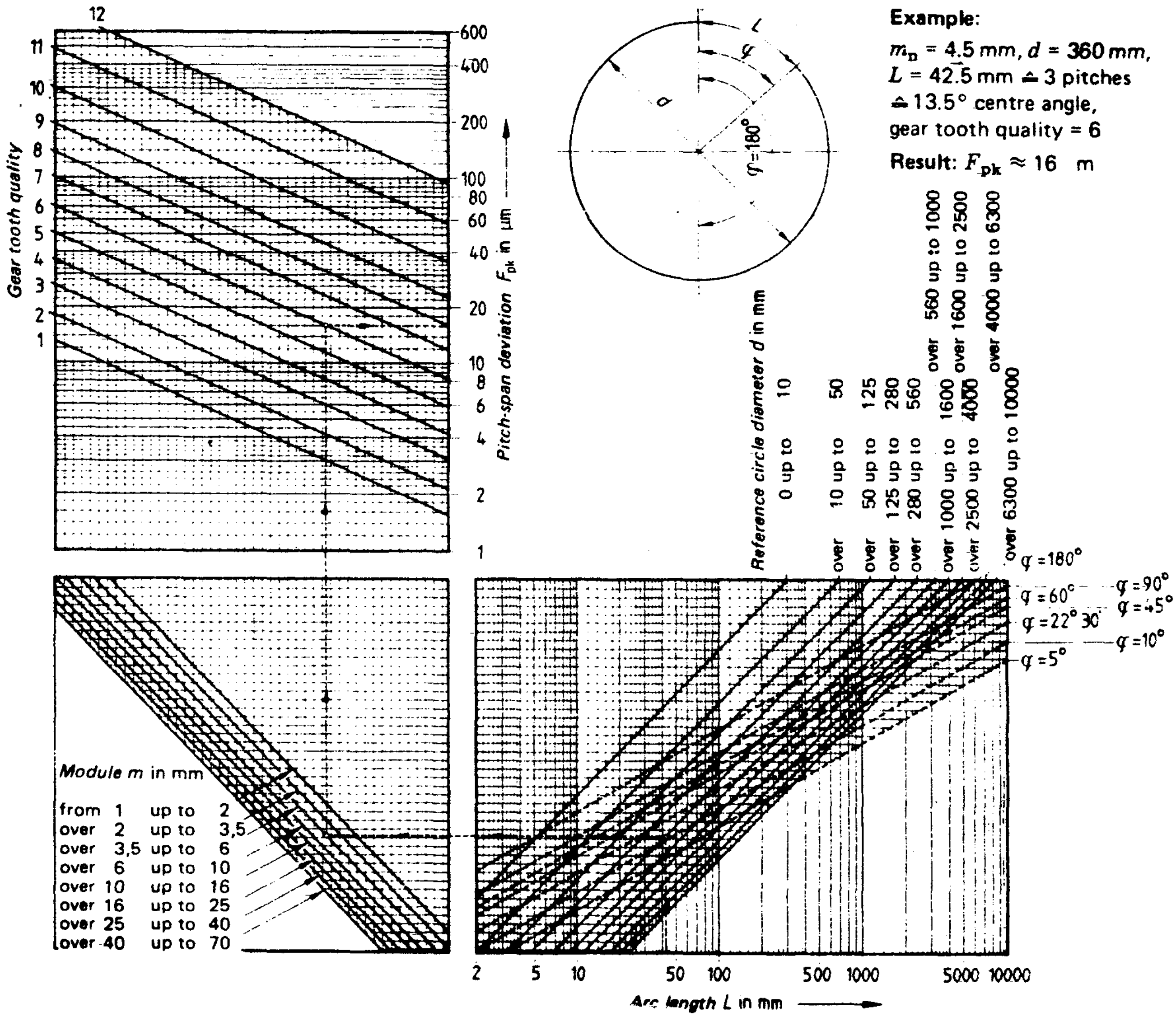


FIG. 5 DETERMINATION OF CUMULATIVE PITCH ERROR, F_{pk}

7.2 Tooth Thickness Allowances and Tooth Thickness Tolerances

Normally, the tooth thickness allowances and tooth thickness tolerances can be found directly from Tables 7 and 8 on the basis of existing experience, such that, as a rule, the upper allowances for each gear should be at least as large (numerical value) as the lower allowance of the housing centre distance (without converting).

7.2.1 *Upper Allowances*

The upper allowances are to be taken from Table 7 corresponding to the reference diameter and allowance series. Their choice is largely independent of the gear tooth quality. As a rule for transmissions of the same kind, it is possible to choose the upper allowance for the pinion and gear from a single allowance series. It is also permissible, however, to select values from different allowance series.

7.2.2 *Lower Allowances*

The lower allowances are obtained by combining the upper allowances with the tooth thickness tolerances. Since the upper and lower allowances are always negative, the amount of tolerance has to be deducted from the upper allowance.

7.2.3 *Tooth Thickness Tolerances*

The tooth thickness tolerances are to be found from Table 8. The tooth thickness tolerance must be at least twice as large as the permissible tooth thickness fluctuation, R_s. In order to distinguish clearly from the gear tooth qualities, the tolerance series have been given the number 21 to 30, the preferred series being 24 to 27.

7.3 Centre Distance Allowance and Axes Parallelism for Cylindrical Gears

7.3.1 *Centre Distance Allowance*

For centre distance allowance A_a, ISO tolerance zone j_s 5 to 11 as per IS 919 (Part 2) : 1993 are used. Centre distance allowances (upper allowance $+A_{ae}$ and lower allowance $-A_{ai}$) are given in Table 9.

The centre distance toleracne T_a is given by :

$$T_a = A_{ae} + A_{ai}$$

7.3.2 *Axes Parallelism Tolerance*

The axes parallelism tolerances, that is inclination of axes $f_{\Sigma\delta}$ and skewing of axes $f_{\Sigma\beta}$ are grouped according to R10 preferred number series under accuracy classes 1 to 12. They are dependent upon the centre distance between the bearings. The accuracy classes of parallelism tolerances are drawn considering the accuracy class of the gear, however, this accuracy class need not be same as the accuracy class of the gear and same class need not be selected for inclination of axis and skewing of axes. The tolerances of these two parameters, are given in Table 10.

The parallelism accuracy class and the values of $f_{\Sigma\delta}$ and $f_{\Sigma\beta}$ should be indicated in the drawings.

7.4 Calculation of Tooth Thickness Allowances and Backlash

7.4.1 *Relation Between Backlash and Allowances*

In contrast with cylindrical fits, the backlash arising with gear tooth fits cannot be calculated directly from the allowances; since various backlash modifying factors are effective. Conversly, if a specific minimum or maximum backlash is required, this amount cannot simply be distributed over the allowances, but instead, the backlash modifying effects have to be taken into account in the calculation.

7.4.2 *Backlash Modifying Effects*

a) *Centre distance tolerance of the housing*

   Though this tolerance; the backlash is reduced or increased since there is a change in the theoretical centre distance.

b) *Non-parallelism of bore axes in the housing*

   The non-parallelism of the bore axes in the housing may consist of axial inclination and axial skew. Axial inclination does not need to be taken into account because, it is not allowed to exceed the centre distance tolerances and is thus covered by these. Axial skew is always backlash reducing.

c) *Gear tooth individual errors*

   Gear tooth individual errors may act differently at the circumference of the gear. In each case, however, a backlash reduction is effective at one or more points in case of individual tooth trace, profile and pitch errors and also with tooth thickness fluctuations. These errors are, in some cases inter-related, so that a summation of the maximum allowable values never occurs.

7.5 Calculation of Backlash

7.5.1 *Determining the Theoretical Backlash*

The upper tooth thickness allowances A_{sne} are selected based on the reference diameter and allowance series from Table 7.

The tooth thickness T_{sn} are selected based on the reference diameter and tolerance series from Table 8.

a) Sum of the upper allowances of tooth thickness of gear pair in the normal section.

   $$\Sigma A_{sne} = A_{sne1} + A_{sne2}$$

   (1 refers to pinion and 2 refers to gear)

b) Sum of the lower allowances of tooth thickness of gear pair in the normal section,

   $$\Sigma A_{sni} = A_{sni1} + A_{sni2}$$
   $$= (A_{sne1} - T_{sn1}) + (A_{sne2} - T_{sn2})$$

c) Sum of the upper allowances of tooth thickness of gear pair in the transverse section,

$$\Sigma A_{ste} = \frac{\Sigma A_{sne}}{\cos\beta}$$

d) Sum of the lower allowances of tooth thickness of gear pair in the transverse section,

$$\Sigma A_{sti} = \frac{\Sigma A_{sni}}{\cos\beta}$$

e) Backlash modification through centre distance tolerance, Δj_a

In the calculation, the least favourable allowance has to be taken as the basis each time and given the appropriate sign. This means A_{ai} for the minimum backlash and A_{ae} for the maximum backlash in the case of external gear pairs, and A_{ae} for the minimum backlash and A_{ai} for the maximum backlash in case of internal gear pairs. Refer Table 9 for A_{ae} and A_{ai}.

$$\Delta j_a = 2 \,.\, A_a \,.\, \frac{\tan\alpha_n}{\cos\beta}$$

Backlash modification through lower centre distance tolerance,

$$\Delta j_{ai} = 2 \,.\, A_{ai} \,.\, \frac{\tan\alpha_n}{\cos\beta}$$

Backlash modification through upper centre distance tolerance,

$$\Delta j_{ae} = 2 \,.\, A_{ae} \,.\, \frac{\tan\alpha_n}{\cos\beta}$$

f) Theoretical backlash,

$$j_t = -\Sigma A_{st} + \Delta j_a$$

Minimum theoretical backlash,

$$j_{t\,Min} = -\Sigma A_{ste} + \Delta j_{ai}$$

Maximum theoretical backlash,

$$j_{t\,Max} = -\Sigma A_{sti} + \Delta j_{ae}$$

7.5.2 *Determining the Acceptance Backlash*

Backlash modifying effects such as temperature rise, swelling or contraction, position, form and dimensional errors of components and elasticity are left out of consideration when determining the acceptance backlash.

a) *Minimum backlash*

Backlash modification through non-parallelism of bore axes,

$$\Delta j_{\Sigma\beta} = -f_{\Sigma\beta} \,.\, \frac{b}{L_G}$$

$f_{\Sigma\beta}$ is selected from Table 10.

Backlash modification through gear tooth individual errors, Δj_F is determined from Table 11. Δj_{F1} refers to pinion and Δj_{F2} to gear.

The minimum backlash is determined from the equation

$$j_{t\,Min} = -\Sigma A_{ste} - \sqrt{\Delta j_{ai}^2 + \Delta j^2_{\Sigma\beta} + \Delta j^2_{F1} + \Delta j^2_{F2}}$$

b) *Maximum backlash*

The maximum backlash is determined from the equation.

$$j_{t\,Max} = -\Sigma A_{sti} \pm \sqrt{|P|}$$

where

$$P = -(\Delta j_{ae})^2 + (\Delta j_{\Sigma\beta})^2 + \left(\frac{\Delta j_{F1}}{2}\right)^2 + \left(\frac{\Delta j_{F2}}{2}\right)^2$$

The inidvidual backlash modifications are to be inserted with the signs determined for them. If the value of P is negative, use minus sign in front of square root and if P is positive use plus sign.

7.5.3 *Example for the Calculation of Backlash*

	Gear	*Pinion*
No. of teeth	75	24
Normal module, mm	3.5	3.5
Profile correction factor	+0.858 7	+0.9
Pressure angle	20°	20°
Helix angle	20° (R)	20° (L)
Quality grade	5	5
Face width, mm	68	
Centre distance, mm	190Js7	
Distance between the bearings, over which axes inclination and skewness are measured, mm (housing width)	340	
Tooth thickness allowance series	*f*	
Tooth thickness tolerance series	22	
Axes parallelism class	7	

Upper allowances of tooth thickness

From Table 7

$$A_{sne1} = -19\ \mu m$$
$$A_{sne2} = -26\ \mu m$$

Sum of the upper allowances of tooth thickness in the normal section:

$$\Sigma A_{sne} = A_{sne1} + A_{sne2} = -19 - 26 = -45\ \mu m$$

Lower allowances of tooth thickness

From Table 8 .

Tooth thickness tolerances $T_{sn1} = 10\ \mu m$

$T_{sn2} = 12\ \mu m$

Sum of the lower allowances of tooth thickness in the normal section:

$$\Sigma A_{sni} = (A_{sne1} - T_{sn1}) + (A_{sne2} - T_{sn2})$$
$$= (-19-10) + (-26-12)$$
$$= -67\ \mu m$$

Sum of the upper allowances of tooth thickness in the transverse section:

$$\Sigma A_{ste} = \frac{\Sigma A_{sne}}{\cos \beta}$$
$$= -\frac{45}{\cos 20} = -47.88\ \mu m$$

Sum of the lower allowances of tooth thickness in the transverse section:

$$\Sigma A_{sti} = \frac{\Sigma A_{sni}}{\cos \beta}$$
$$= -\frac{67}{\cos 20} = -71.29\ \mu m$$

Backlash modification through centre distance tolerance:

From Table 9

$A_{ae} = +23\ \mu m$

$A_{ai} = -23\ \mu m$

Backlash modification through lower centre distance tolerance:

$$\Delta j_{ai} = 2 . A_{ai} \frac{\tan \alpha_n}{\cos \beta}$$
$$= 2(-23) \frac{\tan 20}{\cos 20}$$
$$= -17.81\ \mu m$$

Backlash modification through upper acentre distance tolerance:

$$\Delta j_{ae} = 2 . A_{ae} . \frac{\tan \alpha_n}{\cos \beta}$$
$$= 2(+23) \frac{\tan 20}{\cos 20}$$
$$= 17.81\ \mu m$$

Theoretical backlash

Minimum theoretical backlash:

$$j_{t\,Min} = -\Sigma A_{ste} + \Delta j_{ai}$$
$$= -(-47.88) - 17.81$$
$$= 30.07\ \mu m$$

Maximum theoretical backlash:

$$j_{t\,Max} = -\Sigma A_{sti} + \Delta j_{ae}$$
$$= -(-71.29) + 17.81$$
$$= 89.1\ \mu m$$

Determining the acceptance backlash

Backlash modification through non-parallelism of bore axes

$$\Delta j_{\Sigma\beta} = -f_{\Sigma\beta} \frac{b}{L_G}$$

From Table 10

$$f_{\Sigma\beta} = 40\ \mu m$$
$$\Delta j_{\Sigma\beta} = -40 \times \frac{68}{340}$$
$$= -8\ \mu m$$

Backlash modification through gear tooth individual errors:

From Table 11

$\Delta j_{F1} = 14\ \mu m$

$\Delta j_{F2} = 14\ \mu m$

Acceptance backlash

Minimum acceptance backlash

$$j_{t\,Min} = -\Sigma A_{ste} - \sqrt{\Delta j_{ai}^2 + \Delta j_{\Sigma\beta}^2 + \Delta j^2_{F1} + \Delta j^2_{F2}}$$
$$= -(-47.88) - \sqrt{(-17.81)^2 + 8^2 + 14^2 + 14^2}$$
$$= 47.88 - 27.806$$
$$= 20.07\ \mu m$$

Maximum acceptance backlash

$$j_{t\,Max} = -\Sigma A_{sti} \pm \sqrt{|P|}$$
$$P = -(\Delta j_{ae})^2 + (\Delta j_{\Sigma\beta})^2 + \left(\frac{\Delta j_{F1}}{2}\right)^2 + \left(\frac{\Delta j_{F2}}{2}\right)^2$$
$$= -(17.81)^2 + 8^2 + 7^2 + 7^2$$
$$= -155.196$$

Since the value of P is negative minus sign is to be used in front of the square root in the formula

$$j_{t\,Max} = -(-71.29) - \sqrt{155.196}$$
$$= 58.83\ \mu m$$

Theoretical backlash

Minimum = 30.07 µm

Maximum = 89.1 µm

Acceptance backlash

Minimum = 20.07 µm

Maximum = 58.83 µm

Table 4 Tolerance Data
(Clause 6)

Normal module from 1 to 2 mm.

Tolerances in µm.

Deviation	Gear Tooth Quality					
	1	2	3	4	5	6
f_f	1	1.5	2	3	4.5	6
$f_{H\alpha}$	1	1.5	2	3	4	5
F_f	1.5	2	3	4	6	8

Reference circle diameter d in mm.	Deviation																	
	f_p, f_{pe}						f_u						F_p					
Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
up to 10	1	1.5	2.5	3	4.5	6	1.5	2	3	4	5.5	8	2.5	4	5	7	10	14
over 10 to 50	1	1.5	2.5	3.5	5	7	1.5	2	3	4.5	6	9	3.5	5	7	10	14	18
over 50 to 125	1.5	2	2.5	4	5	7	2	2.5	3	5	6	9	4.5	6	9	14	18	25
over 125 to 280	1.5	2	3	4	5.5	8	2	2.5	3.5	5	7	10	5	8	11	16	20	28
over 280 to 560	1.5	2	3	4.5	6	8	2	2.5	3.5	5.5	8	10	6	9	12	18	25	32
over 560 to 1 000	2	2.5	3.5	5	7	9	2.5	3	4	6	9	11	7	10	14	20	28	36
over 1 000 to 1 600	2	2.5	4	5	8	10	2.5	3	4.5	6	10	12	8	11	16	20	32	40
over 1 600 to 2 500	2	3	4	6	8	11	2.5	3.5	5	7	10	14	8	12	16	22	32	45
over 2 500 to 4 000	2.5	3.5	4.5	6	9	12	3	4	5	8	11	16	9	14	18	25	36	50
over 4 000 to 6 300	2.5	3.5	5	7	10	14	3	4.5	6	9	12	18	10	14	20	28	40	56
over 6 300 to 10 000	2.8	4.0	6	8	11	16	3.5	5	7	10	14	20	11	16	22	28	40	63

Reference circle diameter d in mm.	Deviation																	
	$F_{pz}/8$						F_r						R_s					
Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
up to 10	1.5	2	3	4	6	8	2	3	3.5	5.5	8	11	1	1.5	2.5	3.5	4.5	7
over 10 to 50	2	3	5	4	6	8	2.5	3.5	5	7	10	14	1.5	2	3	4.5	6	8
over 50 to 125	3	4	6	8	11	16	3	4	6	8	12	16	2	2.5	3.5	5	7	10
over 125 to 280	3	5	7	9	12	16	3.5	5	7	9	14	18	2	3	4.5	6	8	12
over 280 to 560	4	5.5	8	11	14	22	4	5.5	8	11	16	22	2.5	3.5	5	7	10	14
over 560 to 1 000	4.5	6	9	12	16	25	4.5	6	9	12	18	25	3	4	5.5	8	11	14
over 1 000 to 1 600	5	7	10	14	18	25	5	7	10	14	18	28	3	4.5	6	8	12	16
over 1 600 to 2 500	5	7	10	14	20	28	5	7	10	14	20	28	3.5	4.5	7	9	12	18
over 2 500 to 4 000	6	8	11	16	22	32	5.5	8	11	16	22	32	3.5	5	7	10	14	20
over 4 000 to 6 300	6	9	12	18	25	36	6	9	12	18	25	36	4	5	7	10	14	20
over 6 300 to 10 000	7	9	14	18	28	36	7	10	14	20	28	40	4	5.5	8	11	16	22

Table 4 (*Continued*)

Normal module from 1 to 2 mm.

Tolerances in μm.

Deviation	Gear Tooth Quality					
	7	8	9	10	11	12
f_f	9	12	16	28	45	71
$f_{H\alpha}$	7	10	14	22	36	56
F_f	12	16	22	36	56	90

Reference circle diameter d in mm.	Deviation →	f_p, f_{pe}						f_u						F_p					
	Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12	7	8	9	10	11	12
	up to 10	9	12	18	28	45	71	11	16	22	36	56	90	20	25	36	56	90	160
	over 10 to 50	9	14	18	28	50	80	11	18	22	36	63	100	28	36	50	80	140	220
	over 50 to 125	10	14	20	32	50	80	12	18	25	40	63	100	32	50	63	110	180	280
	over 125 to 280	11	16	22	36	56	90	14	20	25	45	71	110	40	56	80	125	200	320
	over 280 to 560	12	16	22	36	56	100	16	20	25	45	71	125	45	63	90	140	220	360
	over 560 to 1 000	14	18	25	40	63	100	16	22	32	50	80	125	50	71	100	160	250	400
	over 1 000 to 1 600	14	20	28	45	71	110	18	25	36	56	90	140	56	80	110	180	280	450
	over 1 600 to 2 500	16	22	32	50	80	125	20	28	40	63	100	160	63	90	125	200	320	500
	over 2 500 to 4 000	18	25	36	56	90	140	22	32	45	71	100	180	71	100	140	220	360	560
	over 4 000 to 6 300	20	28	40	63	100	160	25	36	50	80	125	200	80	110	160	250	400	630
	over 6 300 to 10 000	22	32	45	71	110	180	28	40	56	90	140	220	80	125	180	280	450	710

Reference circle diameter d in mm.	Deviation →	$F_{pz}/8$						F_r						R_s					
	Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12	7	8	9	10	11	12
	up to 10	12	16	22	36	63	90	16	22	32	45	63	80	9	12	18	25	36	50
	over 10 to 50	18	25	32	50	90	140	20	28	40	56	80	110	12	16	22	32	45	63
	over 50 to 125	22	32	40	71	110	180	22	32	45	63	90	125	14	20	28	40	56	80
	over 125 to 280	25	36	50	80	125	200	28	36	56	71	110	160	16	22	32	45	63	90
	over 280 to 560	28	40	56	90	140	220	32	45	63	90	125	180	18	25	36	50	71	100
	over 560 to 1 000	32	45	63	100	160	250	36	50	71	100	140	200	20	28	40	56	80	110
	over 1 000 to 1 600	36	50	71	110	180	280	36	56	80	110	160	220	22	32	45	63	90	125
	over 1 600 to 2 500	40	56	80	125	200	320	40	56	80	110	160	220	25	36	50	71	100	140
	over 2 500 to 4 000	45	63	90	140	220	360	45	63	90	125	180	250	28	40	56	80	110	140
	over 4 000 to 6 300	50	71	100	160	250	400	50	71	100	140	200	280	28	40	56	80	110	160
	over 6 300 to 10 000	50	71	100	180	280	450	56	80	110	160	220	320	32	45	63	90	125	180

Table 4 (*Continued*)

Normal module from 2 to 3.55 mm.

Tolerances in μm.

Deviation	Gear Tooth Quality					
	1	2	3	4	5	6
f_f	1.5	2	3	4	6	8
$f_{H\alpha}$	1	1.5	2	3	4.5	6
F_f	2	3	4	5	7	10

Reference circle diameter *d* in mm.	Deviation: f_p, f_{pe}						f_u						F_p					
Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
over 10 to 50	1	2	2.5	3.5	5	7	1.5	2.5	3	4.5	6	9	4	6	8	11	16	20
over 50 to 125	1.5	2	2.5	3.5	5	7	2	2.5	3	4.5	6	9	5	7	10	14	20	28
over 125 to 280	1.5	2	3	4	6	8	2	2.5	3.5	5	8	10	6	8	12	16	22	32
over 280 to 560	1.5	2	3	4	6	8	2	2.5	3.5	5	8	10	7	10	14	18	25	36
over 560 to 1 000	1.5	2.5	3.5	4.5	6	9	2	3	4.5	5.5	8	11	8	11	16	20	28	40
over 1 000 to 1 600	2	3	4	5	7	11	2.5	3.5	5	7	9	12	9	12	18	22	32	45
over 1 600 to 2 500	2	3	4.5	6	8	12	2.5	3.5	5.5	8	10	14	9	12	18	25	36	50
over 2 500 to 4 000	2.5	3.5	5	7	9	14	3	4	6	9	11	16	10	14	20	28	40	56
over 4 000 to 6 300	2.5	3.5	5	7	10	14	3	4.5	7	9	14	18	11	16	22	32	40	63
over 6 300 to 10 000	2.8	4	6	8	12	16	3.5	5.5	8	11	16	22	12	16	22	32	45	63

Reference circle diameter *d* in mm.	Deviation: $F_{pz}/8$						F_r						R_s					
Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
over 10 to 50	2.5	3.5	5	7	10	16	3	4	5.5	8	11	16	2	2.5	3.5	5	7	10
over 50 to 125	3	4	6	9	12	18	3.5	5	7	10	14	20	2	3	4.5	6	8	12
over 125 to 280	4	5	7	10	14	20	4	5.5	8	11	16	22	2.5	3.5	5	7	10	14
over 280 to 560	4.5	6	8	12	16	22	4.5	6	9	12	18	25	3	4	5.5	8	11	16
over 560 to 1 000	5	7	9	14	18	25	5	7	10	14	20	28	3	4.5	6	9	12	18
over 1 000 to 1 600	5	8	10	14	20	28	5.5	8	11	16	22	32	3.5	5	7	10	14	20
over 1 600 to 2 500	6	8	11	16	22	32	6	8	12	16	25	32	4	5.5	8	11	14	20
over 2 500 to 4 000	6	9	12	18	25	36	7	9	14	18	25	36	4.5	6	8	12	16	22
over 4 000 to 6 300	7	9	14	18	28	36	7	10	14	20	28	40	4.5	6	8	12	16	25
over 6 300 to 10 000	7	10	14	20	28	40	8	11	16	22	32	45	5	7	9	14	18	25

Table 4 (*Continued*)

Normal module from 2 to 3.55 mm.

Tolerances in µm.

Deviation	Gear Tooth Quality					
	7	8	9	10	11	12
f_f	11	16	22	36	56	90
$f_{H\alpha}$	9	12	18	28	45	71
F_f	14	20	28	45	71	110

Reference circle diameter d in mm.	Deviation																	
	f_p, f_{pe}						f_u						F_p					
Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12	7	8	9	10	11	12
over 10 to 50	10	14	20	32	50	80	12	18	25	40	63	100	28	40	56	90	140	250
over 50 to 125	10	14	20	32	50	80	12	18	25	40	63	100	36	50	71	125	180	320
over 125 to 280	11	16	22	36	56	90	14	20	28	45	71	110	45	63	90	140	220	360
over 280 to 560	12	16	22	36	56	90	16	20	28	45	71	110	50	71	100	160	250	400
over 560 to 1 000	12	18	25	40	63	100	16	22	32	50	80	125	56	80	110	180	280	450
over 1 000 to 1 600	14	22	28	45	71	125	18	25	36	56	90	160	63	90	125	200	320	500
over 1 600 to 2 500	16	25	32	50	80	140	20	28	40	63	100	180	71	100	140	220	360	560
over 2 500 to 4 000	18	25	36	56	90	140	22	32	45	71	110	180	80	110	160	250	400	630
over 4 000 to 6 300	20	25	40	63	100	160	25	36	50	80	125	200	80	125	160	250	400	630
over 6 300 to 10 000	28	32	45	71	110	180	28	40	63	100	160	250	90	125	180	280	450	710

Reference circle diameter d in mm.	Deviation																	
	$F_{pz}/8$						F_r						R_s					
Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12	7	8	9	10	11	12
over 10 to 50	20	25	36	56	90	140	22	32	45	63	90	125	14	20	28	36	56	71
over 50 to 125	25	32	45	71	125	180	28	40	56	80	110	160	16	22	32	45	63	90
over 125 to 280	28	40	56	90	140	220	32	45	63	90	125	180	20	28	36	50	71	100
over 280 to 560	32	45	63	100	160	250	36	50	71	100	140	180	22	32	40	56	80	110
over 560 to 1 000	36	50	71	110	180	280	40	56	80	110	160	220	25	36	45	63	90	125
over 1 000 to 1 600	40	56	80	125	200	320	45	63	90	125	180	250	28	36	50	71	100	140
over 1 600 to 2 500	45	63	90	140	220	360	50	71	100	140	200	280	28	40	56	80	110	160
over 2 500 to 4 000	50	71	90	160	250	400	50	71	100	140	200	280	32	45	63	90	125	180
over 4 000 to 6 300	56	71	110	180	280	450	56	80	110	160	220	320	32	45	63	90	140	180
over 6 300 to 10 000	56	80	110	180	280	450	63	90	125	180	250	360	36	50	71	100	140	200

Table 4 (*Continued*)

Normal module from 3.55 to 6 mm.

Tolerances in µm.

Deviation	Gear Tooth Quality					
	1	2	3	4	5	6
f_f	2	3	4	5	7	10
$f_{H\alpha}$	1.5	2	3	4	5.5	7
F_f	2.5	3.5	5	7	9	12

Gear Tooth Quality →	Deviation																	
	f_p, f_{pe}						f_u						F_p					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Reference circle diameter *d* in mm.																		
over 10 to 50	1.5	2	3	4	6	8	2	2.5	4	5	8	10	1	6	8	12	16	22
over 50 to 125	1.5	2	3	4	6	9	2	2.5	4	5	8	11	5	8	10	16	20	28
over 125 to 280	1.5	2.5	3.5	4.5	7	9	2	3	4	5.5	9	11	6	9	12	18	25	36
over 280 to 560	2	2.5	3.5	5	7	10	2.5	3	4.5	6	9	12	7	10	14	20	28	40
over 560 to 1 000	2	3	4	5.5	8	11	2.5	4	5	7	10	14	8	12	16	22	32	45
over 1 000 to 1 600	2	3	4	6	8	12	2.5	4	5	8	10	16	9	12	18	25	36	50
over 1 600 to 2 500	2.5	3	4.5	6	9	12	3	4	5.5	8	11	16	10	14	20	28	36	56
over 2 500 to 4 000	2.5	3.5	5	7	10	14	3	4.5	6	9	12	18	11	16	22	32	40	63
over 4 000 to 6 300	3	4	5.5	8	11	16	3.5	5	7	10	14	20	12	16	22	32	45	63
over 6 300 to 10 000	3.5	4.5	6	9	12	18	4	5.5	8	11	16	22	12	18	25	36	50	71

Gear Tooth Quality →	Deviation																	
	$F_{pz}/8$						F_r						R_s					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Reference circle diameter *d* in mm.																		
over 10 to 50	2.5	4	5	7	10	14	3	4.5	7	9	14	18	2	3	4	6	8	11
over 50 to 125	3	5	7	9	14	18	4	5.5	8	11	16	22	2.5	3.5	5	7	10	14
over 125 to 280	4	6	8	11	16	22	4.5	6	9	12	18	25	3	4	5.5	8	11	16
over 280 to 560	5	6	9	14	18	25	5	7	10	14	20	28	3	4.5	6	9	12	18
over 560 to 1 000	5	7	10	14	20	28	5.5	8	11	16	22	32	3.5	5	7	10	14	20
over 1 000 to 1 600	6	8	11	16	22	32	6	9	12	18	25	36	4	5.5	8	11	16	22
over 1 600 to 2 500	6	9	12	18	25	36	7	10	14	20	28	40	4.5	6	9	12	16	25
over 2 500 to 4 000	7	10	14	20	25	36	7	10	14	20	28	40	5	7	9	12	18	25
over 4 000 to 6 300	7	10	14	20	28	40	8	11	16	22	32	45	5	7	9	14	18	28
over 6 300 to 10 000	8	11	16	22	32	45	9	12	18	25	36	50	5	7	10	14	20	28

Table 4 *(Continued)*

Normal Module from 3.55 to 6 mm.

Tolerances in µm.

Deviation	Gear Tooth Quality					
	7	8	9	10	11	12
f_f	14	20	28	45	71	125
$f_{H\alpha}$	10	14	20	32	50	80
F_f	18	25	36	56	90	140

Reference circle diameter d in mm.	Deviation																	
	f_p, f_{pe}						f_u						F_p					
Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12	7	8	9	10	11	12
over 10 to 50	11	16	22	36	56	90	14	20	28	45	71	110	32	45	63	100	160	250
over 50 to 125	12	16	25	40	63	100	16	20	32	50	80	125	40	56	80	125	200	320
over 125 to 280	12	18	25	40	63	100	16	22	32	50	80	125	45	71	90	140	250	360
over 280 to 560	14	20	28	45	71	110	18	25	36	56	90	140	56	80	110	180	280	450
over 560 to 1 000	16	20	28	45	75	125	20	25	36	56	90	160	63	90	125	200	320	500
over 1 000 to 1 600	16	22	32	50	80	125	20	28	40	63	100	160	71	100	140	220	360	560
over 1 600 to 2 500	18	25	36	56	90	140	22	32	45	71	110	180	71	110	140	250	360	630
over 2 500 to 4 000	20	28	40	63	100	160	25	36	50	80	125	200	80	125	160	250	400	630
over 4 000 to 6 300	22	32	45	71	110	180	28	40	56	90	140	220	90	125	180	280	450	710
over 6 300 to 10 000	25	36	50	80	125	200	32	45	63	100	160	250	100	140	200	320	500	800

Reference circle diameter d in mm.	Deviation																	
	$F_{pz}/8$						F_r						R_s					
Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12	7	8	9	10	11	12
over 10 to 50	20	28	40	63	100	160	25	36	50	71	100	140	16	22	32	45	63	90
over 50 to 125	28	36	50	80	125	200	32	45	63	90	125	180	20	28	36	50	71	100
over 125 to 280	36	45	56	100	160	250	36	50	71	100	140	200	22	32	45	63	80	110
over 280 to 560	36	50	71	110	180	280	40	56	80	110	160	220	25	36	50	71	90	125
over 560 to 1 000	40	56	80	125	200	320	45	63	90	125	180	250	28	36	56	80	100	140
over 1 000 to 1 600	40	63	90	140	220	360	50	71	100	140	200	280	32	40	63	80	110	160
over 1 600 to 2 500	45	63	90	140	250	400	56	80	110	160	220	320	32	45	63	90	125	180
over 2 500 to 4 000	50	71	100	160	250	400	56	80	110	160	220	320	36	50	71	100	140	200
over 4 000 to 6 300	56	80	110	180	280	450	63	90	125	180	250	360	36	56	71	110	160	220
over 6 300 to 10 000	63	90	125	200	320	500	71	100	140	200	280	400	40	56	80	110	160	220

Table 4 (*Continued*)

Normal module from 6 to 10 mm.

Tolerances in μm.

Deviation	Gear Tooth Quality					
	1	2	3	4	5	6
f_f	2.5	3.5	5	7	10	14
$f_{H\alpha}$	2	2.5	3.5	5	7	9
F_f	3	4	6	8	12	16

Reference circle diameter d in mm.	Deviation																	
	f_p, f_{pe}						f_u						F_p					
Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
over 10 to 50	2	2.5	3.5	5	7	10	2.5	3	4.5	6	9	12	4.5	6	9	14	18	25
over 50 to 125	2	2.5	3.5	5	7	10	2.5	3	4.5	6	9	12	6	8	11	16	22	32
over 125 to 280	2	2.5	4	5.5	8	11	2.5	3	5	7	10	14	7	10	14	20	25	36
over 280 to 560	2	3	4	6	8	11	2.5	3.5	5	8	10	14	8	11	16	22	28	40
over 560 to 1 000	2.5	3	4.5	6	9	11	3	3.5	5.5	8	11	14	9	12	18	25	32	45
over 1 000 to 1 600	2.5	3.5	5	7	9	12	3	4.5	6	9	11	16	10	14	18	28	36	50
over 1 600 to 2 500	2.5	3.5	5	7	10	14	3	4.5	6	9	12	18	11	15	22	28	40	56
over 2 500 to 4 000	3	4	5.5	8	11	16	3.5	5	7	10	14	20	12	16	22	32	45	63
over 4 000 to 6 300	3	4.5	6	9	12	18	4	5.5	8	11	16	22	12	18	25	36	50	71
over 6 300 to 10 000	3.5	5	7	10	14	20	4.5	6	9	12	18	25	14	20	28	40	56	80

Reference circle diameter d in mm.	Deviation																	
	$F_{pz}/8$						F_r						R_s					
Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
over 10 to 50	3	4	6	8	11	16	3.5	5.5	8	11	16	22	2.5	3.5	5	7	9	14
over 50 to 125	4	5	7	10	14	20	4.5	6	9	12	18	25	3	4	5.5	8	11	16
over 125 to 280	4.5	6	8	12	16	22	5	7	10	14	20	28	3.5	4.5	6	9	12	18
over 280 to 560	5	7	10	14	18	28	5.5	8	11	16	22	32	3.5	5	7	10	14	20
over 560 to 1000	6	8	11	16	20	28	6	9	12	18	25	36	4	5.5	8	11	16	22
over 1 000 to 1 600	6	9	12	18	22	32	7	10	14	20	28	40	4.5	6	9	12	18	25
over 1 600 to 2 500	7	9	14	20	25	36	8	11	16	22	32	45	5	7	10	14	18	25
over 2 500 to 4 000	7	10	14	20	28	40	8	12	16	22	32	45	5.5	7	10	14	20	28
over 4 000 to 6 300	8	11	16	22	32	45	9	12	18	25	36	50	5.5	7	11	14	22	28
over 6 300 to 10 000	9	12	18	25	32	50	10	14	20	28	40	56	6	8	12	16	22	32

Table 4 (*Continued*)

Normal module from 6 to 10 mm.

Tolerances in μm.

Deviation	Gear Tooth Quality					
	7	8	9	10	11	12
f_f	20	28	40	63	100	160
$f_{H\alpha}$	12	18	25	40	63	100
F_f	22	32	45	71	110	180

Reference circle diameter d in mm.	Deviation																	
	f_p, f_{pe}						f_u						F_p					
Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12	7	8	9	10	11	12
over 10 to 50	12	18	25	40	63	110	16	22	32	50	80	140	32	45	71	110	180	280
over 50 to 125	14	20	28	45	71	110	18	25	36	56	90	140	45	63	90	140	220	360
over 125 to 280	14	20	28	45	71	125	18	25	36	56	90	160	56	71	100	160	250	400
over 280 to 560	16	22	32	50	80	125	20	28	40	63	100	160	63	80	110	180	280	450
over 560 to 1 000	16	25	32	56	90	140	20	28	40	71	110	180	71	90	125	200	320	500
over 1 000 to 1 600	18	25	36	56	90	140	22	32	45	71	110	180	71	100	140	220	360	560
over 1 600 to 2 500	20	28	40	63	100	160	25	36	50	80	125	200	80	110	160	250	400	630
over 2 500 to 4 000	22	32	45	71	110	180	28	36	50	80	140	220	90	125	180	280	450	710
over 4 000 to 6 300	25	32	50	80	125	200	32	45	63	100	160	250	100	140	200	320	500	800
over 6 300 to 10 000	28	36	56	90	140	220	32	50	71	110	180	280	110	160	220	360	560	900

Reference circle diameter d in mm.	Deviation																	
	$F_{pz}/8$						F_r						R_s					
Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12	7	8	9	10	11	12
over 10 to 50	22	32	45	71	110	180	32	40	63	80	125	160	18	25	36	50	71	100
over 50 to 125	28	40	56	90	140	220	36	50	71	100	140	200	22	32	45	63	80	110
over 125 to 280	32	45	63	100	160	250	40	56	80	110	160	220	25	36	50	71	90	125
over 280 to 560	36	50	71	110	180	280	45	63	90	125	180	250	28	40	56	80	110	140
over 560 to 1 000	40	56	80	125	200	320	50	71	100	140	200	280	32	45	63	80	125	160
over 1 000 to 1 600	45	63	90	140	220	360	56	80	110	160	220	320	34	50	63	90	125	180
over 1 600 to 2 500	50	71	100	160	250	400	63	90	125	160	250	320	36	50	71	100	140	200
over 2 500 to 4 000	56	80	110	180	280	450	63	90	125	180	250	360	40	56	80	110	160	220
over 4 000 to 6 300	63	90	125	200	320	500	71	100	140	200	280	400	40	56	80	125	160	250
over 6 300 to 10 000	71	100	140	220	360	560	80	110	160	220	320	450	45	63	90	125	180	250

Table 4 *(Continued)*

Normal module from 10 to 16 mm.

Tolerances in μm.

Deviation	Gear Tooth Quality 1	2	3	4	5	6
f_f	3	4.5	6	9	12	18
$f_{H\alpha}$	2	3	4	6	8	12
F_f	4	5.5	8	11	16	22

Reference circle diameter d in mm.	Deviation f_p, f_{pe}						f_u						F_p					
Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
over 50 to 125	2.5	3	4.5	6	9	12	3	4	5.5	8	11	16	6	9	12	18	25	32
over 125 to 280	2.5	3.5	4.5	6	9	12	3	4.5	5.5	8	11	16	7	10	14	20	28	40
over 280 to 560	2.5	3.5	5	7	10	14	3	4.5	6	9	12	18	8	12	16	22	32	45
over 560 to 1 000	2.5	4	5	7	10	14	3	5	6	9	12	18	10	14	18	25	36	50
over 1 000 to 1 600	3	4	5.5	8	11	16	4	5	7	10	14	20	11	16	20	28	40	56
over 1 600 to 2 500	3	4	6	8	12	16	4	5	7	10	16	20	12	16	22	32	45	63
over 2 500 to 4 000	3.5	4.5	7	9	12	18	4.5	5.5	8	11	16	22	14	18	25	36	50	71
over 4 000 to 6 300	3.5	5	7	10	14	20	4.5	6	9	12	18	25	14	18	28	36	56	71
over 6 300 to 10 000	4	5.5	8	11	16	22	5	7	10	14	20	28	14	20	28	40	56	80

Reference circle diameter d in mm.	Deviation $F_{pz}/8$						F_r						R_s					
Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
over 50 to 125	4	5	8	11	16	22	5	7	10	14	20	28	3	4.5	6	9	12	18
over 125 to 280	5	6	9	14	18	25	5.5	8	11	16	22	32	3.5	5	7	10	14	20
over 280 to 560	5	7	10	16	20	28	6	9	12	18	25	36	4	6	8	11	16	22
over 560 to 1 000	6	8	12	18	22	32	7	10	14	20	28	40	4.5	6	9	12	18	25
over 1 000 to 1 600	7	9	14	18	25	36	8	11	16	22	32	45	5	7	10	14	20	28
over 1 600 to 2 500	7	10	14	20	28	40	8	12	16	25	32	45	5.5	8	11	14	20	28
over 2 500 to 4 000	8	11	16	22	32	45	9	12	18	25	36	50	6	8	12	16	22	32
over 4 000 to 6 300	8	12	16	25	32	45	10	14	20	28	40	56	6	8	12	16	12	32
over 6 300 to 10 000	9	12	18	25	36	50	11	16	22	32	45	63	6	9	12	18	25	36

Table 4 *(Continued)*

Normal module from 10 to 16 mm.

Tolerances in µm.

Deviation	Gear Tooth Quality					
	7	8	9	10	11	12
f_f	25	36	50	80	125	200
$f_{H\alpha}$	16	22	32	50	80	125
F_f	28	40	56	90	140	250

Reference circle diameter *d* in mm.	Deviation																	
	f_p, f_{pe}						f_u						F_p					
Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12	7	8	9	10	11	12
over 50 to 125	18	25	32	56	90	140	22	32	40	63	110	140	45	63	90	140	220	360
over 125 to 280	18	25	36	56	90	140	22	32	45	71	110	180	56	80	110	180	280	450
over 280 to 560	20	28	36	56	90	160	25	36	45	71	110	200	63	90	125	200	320	500
over 560 to 1 000	20	28	40	63	100	160	25	36	50	80	125	200	71	100	140	220	360	560
over 1 000 to 1 600	22	32	40	63	110	180	28	36	50	80	140	220	80	110	160	250	400	630
over 1 600 to 2 500	22	32	45	71	110	180	28	40	56	90	140	220	90	125	180	280	450	710
over 2 500 to 4 000	25	36	50	80	125	200	32	45	63	100	160	250	100	140	180	320	500	800
over 4 000 to 6 300	28	40	56	90	140	220	36	50	71	110	180	280	110	140	220	360	560	900
over 6 300 to 10 000	28	40	63	100	160	250	36	56	80	125	200	320	110	160	220	360	560	900

Reference circle diameter *d* in mm.	Deviation																	
	$F_{pz}/8$						F_r						R_s					
Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12	7	8	9	10	11	12
over 50 to 125	28	40	56	90	140	250	40	56	80	110	160	220	25	36	50	71	100	140
over 125 to 280	36	50	71	110	180	280	45	63	90	125	180	250	28	40	56	80	110	160
over 280 to 560	40	56	80	125	200	320	50	71	100	140	200	280	32	45	63	90	125	160
over 560 to 1 000	45	63	90	140	220	360	56	80	110	160	220	320	36	50	71	100	140	180
over 1 000 to 1 600	50	71	100	160	250	400	63	90	125	180	250	360	36	56	71	100	140	200
over 1 600 to 2 500	56	80	110	180	280	450	71	90	140	180	280	360	40	56	80	110	160	220
over 2 500 to 4 000	63	90	110	200	320	500	71	100	140	200	280	400	45	63	90	125	180	250
over 4 000 to 6 300	63	90	140	220	320	500	80	110	160	220	320	450	45	63	90	125	180	250
over 6 300 to 10 000	71	100	140	220	360	550	90	125	180	250	360	500	50	71	100	140	200	280

Table 4 *(Continued)*

Normal module from 16 to 25 mm.

Tolerances in µm.

Deviation	Gear Tooth Quality					
	1	2	3	4	5	6
f_f	4	6	8	12	16	22
$f_{H\alpha}$	3	4	5.5	8	11	16
F_f	5	7	10	14	20	28

Reference circle diameter d in mm.	Deviation																	
	f_p, f_{pe}						f_u						F_p					
Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
over 125 to 280	3	4	6	8	11	16	4	5	8	10	14	20	8	11	16	22	32	40
over 280 to 560	3	4.5	6	8	12	16	4	5.5	8	10	16	20	9	14	18	25	36	45
over 560 to 1 000	3	4.5	6	9	12	18	4	5.5	8	11	16	22	10	14	20	28	40	56
over 1 000 to 1 600	3.5	5	7	9	14	18	4.5	6	9	11	16	22	11	16	22	32	45	56
over 1 600 to 2 500	3.5	5	7	10	14	20	4.5	6	9	12	18	25	12	18	25	36	50	63
over 2 500 to 4 000	4	5.5	8	11	14	20	5	7	10	14	18	25	14	20	28	40	56	71
over 4 000 to 6 300	4	5.5	8	11	16	22	5	7	10	14	20	28	14	20	28	40	56	80
over 6 300 to 10 000	4.5	6	9	12	18	25	5.5	8	11	16	22	32	16	22	32	45	63	90

Reference circle diameter d in mm.	Deviation																	
	$F_{pz}/8$						F_r						R_s					
Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
over 125 to 280	5	7	10	14	18	28	6	9	12	18	25	36	4	6	8	11	16	22
over 280 to 560	6	8	11	16	22	32	7	10	14	20	28	40	4.5	7	9	12	18	25
over 560 to 1 000	6	9	14	18	25	36	8	11	16	22	32	45	5	7	10	14	20	28
over 1 000 to 1 600	7	10	14	20	28	36	9	12	18	25	36	50	5.5	8	11	16	22	32
over 1 600 to 2 500	8	11	16	22	28	40	9	14	18	25	36	50	6	8	12	16	22	32
over 2 500 to 4 000	8	12	18	25	32	45	10	14	20	28	40	56	7	9	12	18	25	36
over 4 000 to 6 300	9	12	18	25	36	50	11	16	22	32	45	63	7	10	14	18	25	36
over 6 300 to 10 000	10	14	20	28	40	56	12	16	25	32	50	71	7	10	14	20	28	40

Table 4 (*Continued*)

Normal module from 16 to 25 mm.

Tolerances in µm.

Deviation	Gear Tooth Quality					
	7	8	9	10	11	12
f_f	32	45	63	110	160	250
$f_{H\alpha}$	22	28	40	71	110	180
F_f	40	56	80	125	200	320

Reference circle diameter d in mm.	Deviation																	
	f_p, f_{pe}						f_u						F_p					
Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12	7	8	9	10	11	12
over 125 to 280	22	32	45	71	110	180	28	40	56	90	140	220	56	80	110	180	280	450
over 280 to 560	22	32	45	71	110	180	28	40	56	90	140	220	71	90	125	200	320	560
over 560 to 1 000	25	36	50	80	125	200	32	45	63	100	160	250	80	110	140	220	360	630
over 1 000 to 1 600	25	36	50	80	125	200	32	45	63	100	160	250	90	110	160	250	400	710
over 1 600 to 2 500	28	40	56	80	140	220	36	50	71	110	180	280	90	125	180	280	450	750
over 2 500 to 4 000	28	40	56	90	140	220	36	50	71	110	180	280	100	140	200	320	500	800
over 4 000 to 6 300	32	45	63	100	160	250	40	56	80	125	200	320	110	160	220	360	560	900
over 6 300 to 10 000	32	50	63	110	180	280	40	56	80	125	220	360	125	180	250	360	630	1000

Reference circle diameter d in mm.	Deviation																	
	$F_{pz}/8$						F_r						R_s					
Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12	7	8	9	10	11	12
over 125 to 280	36	50	71	110	180	280	50	71	100	140	200	280	32	45	63	90	125	160
over 280 to 560	40	63	80	140	220	320	56	80	110	160	220	320	36	50	71	100	140	180
over 560 to 1 000	50	71	90	140	250	360	63	90	125	180	250	360	40	56	80	110	140	200
over 1 000 to 1 600	56	71	100	160	250	400	71	100	140	200	280	400	40	56	80	110	160	220
over 1 600 to 2 500	56	80	110	180	280	450	71	100	140	200	280	400	45	63	90	125	180	250
over 2 500 to 4 000	63	90	125	200	320	500	80	110	160	220	320	450	50	71	100	140	180	280
over 4 000 to 6 300	71	100	140	220	360	560	90	125	180	250	360	500	50	71	100	140	200	280
over 6 300 to 10 000	80	110	140	250	400	630	100	140	200	280	360	560	56	80	110	160	200	280

Table 4 *(Continued)*

Normal module from 25 to 40 mm.

Tolerances in µm.

Deviation	Gear Tooth Quality					
	1	2	3	4	5	6
f_f	6	8	11	16	22	32
$f_{H\alpha}$	4	5.5	8	10	14	20
F_f	7	10	14	20	25	36

Reference circle diameter d in mm.	Deviation: f_p, f_{pe}						f_u						F_p					
Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
over 125 to 280	4	5.5	8	11	15	22	5	7	10	14	20	28	8	12	16	22	32	45
over 280 to 560	4	6	8	11	16	22	5	8	10	14	20	28	10	14	18	28	36	50
over 560 to 1 000	4	6	8	12	16	22	5	8	10	16	20	28	11	16	20	32	40	56
over 1 000 to 1 600	4.5	6	9	12	18	25	5.5	8	11	16	22	32	12	18	25	32	45	63
over 1 600 to 2 500	4.5	7	9	12	18	25	5.5	9	11	16	22	32	12	18	25	36	50	71
over 2 500 to 4 000	5	7	10	14	20	25	6	9	12	16	25	32	14	20	28	40	56	80
over 4 000 to 6 300	5	7	10	14	20	28	6	9	12	18	25	36	16	22	32	45	63	90
over 6 300 to 10 000	5.5	7	11	14	20	28	7	9	14	18	25	36	16	22	32	45	63	90

Reference circle diameter d in mm.	Deviation: $F_{pz}/8$						F_r						R_s					
Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
over 125 to 280	5	7	10	14	20	28	7	10	14	20	28	40	4.5	7	9	12	18	25
over 280 to 560	6	9	12	16	22	32	8	11	16	22	32	45	5	7	10	14	20	28
over 560 to 1 000	7	10	14	18	25	36	9	12	18	25	36	50	5.5	8	11	16	22	32
over 1 000 to 1 600	8	11	16	20	28	40	10	14	20	28	40	56	6	9	12	18	25	32
over 1 600 to 2 500	8	12	16	22	32	45	10	14	20	28	40	56	7	9	12	18	25	36
over 2 500 to 4 000	9	12	18	25	36	50	11	16	22	32	45	63	7	10	14	20	28	40
over 4 000 to 6 300	9	12	18	25	36	56	12	18	25	36	50	71	7	10	14	20	28	40
over 6 300 to 10 000	10	14	20	28	40	56	14	18	25	36	50	71	8	12	16	22	32	45

Table 4 *(Continued)*

Normal module from 25 to 40 mm.

Tolerances in µm.

Deviation	Gear Tooth Quality					
	7	8	9	10	11	12
f_f	45	63	80	140	220	360
$f_{H\alpha}$	28	40	56	90	140	220
F_f	56	71	100	160	250	400

	Deviation																	
	f_p, f_{pe}						f_u						F_p					
Reference circle diameter d in mm. / Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12	7	8	9	10	11	12
over 125 to 280	28	40	56	90	140	250	36	50	71	110	180	320	63	90	125	200	320	500
over 280 to 560	32	45	63	100	160	250	40	56	80	125	200	320	71	100	140	220	360	560
over 560 to 1 000	32	45	63	100	160	250	40	56	80	125	200	320	80	110	160	250	400	630
over 1 000 to 1 600	32	45	63	100	160	280	40	56	80	125	200	360	90	125	180	280	450	750
over 1 600 to 2 500	36	50	71	110	180	280	45	63	90	140	220	360	100	140	200	320	500	800
over 2 500 to 4 000	36	50	71	110	180	280	45	63	90	140	220	360	110	160	220	360	560	850
over 4 000 to 6 300	40	56	71	125	200	320	50	71	100	160	250	400	125	180	220	360	560	1 000
over 6 300 to 10 000	40	56	80	125	200	320	50	71	100	160	250	400	125	180	250	400	630	1 000

	Deviation																	
	$F_{pz}/8$						F_r						R_s					
Reference circle diameter d in mm. / Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12	7	8	9	10	11	12
over 125 to 280	40	56	80	125	200	320	56	80	110	160	220	320	36	50	71	100	140	200
over 280 to 560	45	63	90	140	220	360	63	90	125	180	250	360	40	56	80	110	160	220
over 560 to 1 000	50	71	100	160	250	400	71	100	140	200	280	400	45	63	80	125	160	220
over 1 000 to 1 600	56	80	110	180	280	450	80	110	160	220	320	450	45	63	90	125	180	250
over 1 600 to 2 500	63	90	125	200	320	500	80	110	160	220	320	450	50	71	100	140	200	280
over 2 500 to 4 000	71	100	140	220	360	560	90	125	180	250	360	500	56	80	110	140	200	280
over 4 000 to 6 300	71	100	140	220	360	630	100	140	200	280	400	560	56	80	110	160	220	280
over 6 300 to 10 000	80	110	160	250	400	630	100	140	200	280	400	560	63	90	110	160	220	320

Table 4 *(Continued)*

Normal module from 40 to 70 mm.

Tolerances in μm.

Deviation	Gear Tooth Quality	
	5	5
f_f	32	45
$f_{H\alpha}$	22	28
F_f	36	50

	Deviation																	
	f_p, f_{pe}						f_u						F_p					
Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Reference circle diameter *d* in mm.																		
over 125 to 280	6	8	12	16	22	32	7	10	14	20	28	40	9	12	18	25	36	50
over 280 to 560	6	8	12	16	22	32	8	10	14	20	28	40	10	14	20	28	40	56
over 560 to 1 000	6	8	12	16	22	32	8	10	14	20	28	40	12	16	22	32	45	63
over 1 000 to 1 600	6	9	12	16	25	32	8	10	16	22	28	40	14	18	25	36	50	71
over 1 600 to 2 500	6	9	12	18	25	36	8	12	16	22	32	45	14	20	28	40	56	80
over 2 500 to 4 000	7	10	14	18	25	36	8	12	16	22	32	45	16	22	32	45	63	80
over 4 000 to 6 300	7	10	14	20	25	36	9	12	18	25	32	45	18	25	36	45	63	90
over 6 300 to 10 000	7	10	14	20	28	36	9	12	18	25	36	50	18	25	36	50	71	100

	Deviation																	
	$F_{pz}/8$						F_r						R_s					
Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Reference circle diameter *d* in mm.																		
over 125 to 280	6	8	12	16	22	32	8	12	16	25	32	50	6	7	10	14	20	28
over 280 to 560	7	9	12	18	25	36	9	14	18	25	36	50	6	8	12	16	22	32
over 560 to 1 000	7	10	14	20	28	40	10	14	20	28	40	56	6	9	12	18	22	32
over 1 000 to 1 600	8	12	16	22	32	45	11	16	22	32	45	63	7	10	12	18	25	36
over 1 600 to 2 500	9	12	18	25	36	50	12	16	22	32	45	63	7	10	14	20	28	36
over 2 500 to 4 000	10	14	20	28	36	50	12	18	25	36	50	71	7	12	16	22	28	40
over 4 000 to 6 300	10	14	20	28	40	56	14	20	28	40	56	80	8	12	16	22	32	45
over 6 300 to 10 000	12	16	22	32	45	63	14	20	28	40	56	80	9	14	18	25	36	50

Table 4 *(Concluded)*

Normal module from 40 to 70 mm.

Tolerances in µm.

Deviation	Gear Tooth Quality					
	7	8	9	10	11	12
f_f	63	90	125	200	320	500
$f_{H\alpha}$	40	56	80	125	200	320
F_f	71	100	140	220	360	560

	Deviation																	
	f_p, f_{pe}						f_u						F_p					
Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12	7	8	9	10	11	12
Reference circle diameter *d* in mm.																		
over 125 to 280	45	63	80	140	220	360	56	80	110	180	280	450	71	100	125	200	360	560
over 280 to 560	45	63	90	140	220	360	56	80	110	180	280	450	80	110	160	250	400	630
over 560 to 1 000	45	63	90	140	220	360	56	80	110	180	280	450	90	125	180	280	450	710
over 1 000 to 1 600	45	63	90	140	220	360	56	80	110	180	280	450	100	140	180	320	500	800
over 1 600 to 2 500	50	63	90	140	250	400	63	80	125	180	320	500	110	140	200	320	560	850
over 2 500 to 4 000	50	71	100	160	250	400	63	90	125	180	320	500	110	160	220	360	560	900
over 4 000 to 6 300	50	71	100	160	250	400	63	90	125	220	320	500	125	180	250	400	630	1000
over 6 300 to 10 000	56	80	110	180	280	450	71	100	140	220	360	560	140	200	280	450	710	1100

	Deviation																	
	$F_{pz}/8$						F_r						R_s					
Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12	7	8	9	10	11	12
Reference circle diameter *d* in mm.																		
over 125 to 280	45	63	80	140	220	360	71	90	140	180	280	360	40	56	80	110	160	200
over 280 to 560	50	71	100	160	250	400	71	100	140	200	280	400	45	56	90	110	160	220
over 560 to 1 000	56	80	110	180	280	450	80	110	160	220	320	450	45	63	90	125	180	250
over 1 000 to 1 600	63	80	110	200	280	500	90	125	180	250	360	500	50	71	100	140	200	280
over 1 600 to 2 500	71	90	125	220	320	560	90	125	180	250	360	500	56	80	100	140	200	280
over 2 500 to 4 000	71	100	140	220	360	560	100	140	200	280	400	560	56	80	110	160	220	320
over 4 000 to 6 300	80	110	160	250	400	630	110	160	220	320	450	630	63	90	125	180	250	360
over 6 300 to 10 000	90	125	180	280	450	710	110	160	220	320	450	630	71	100	140	180	250	360

Table 5 Tolerance Data

(*Clause* 6)

Normal module from 1 to 2 mm.

Tolerances in µm.

Gear Tooth Quality →	Deviation											
	F''_i						f''_i					
Reference circle diameter *d* in mm.	1	2	3	4	5	6	1	2	3	4	5	6
up to 10	2.5	3.5	5	7	9	14	1	1	1.5	2.5	3	4.5
over 10 up to 50	3	4.5	6	9	12	16	1	1.5	2.5	3.5	4.5	6
over 50 up to 125	4	5	7	10	14	20	1.5	2	3	4	6	8
over 125 up to 280	4.5	6	9	12	16	25	2	2.5	3.5	5	7	10
over 280 up to 560	5	7	10	14	20	28	2	3	4	6	8	12
over 560 up to 1 000	5.5	8	11	16	22	32	2.5	3.5	5	7	10	14
over 1 000 up to 1 600	6	9	12	18	25	32	3	4	5.5	8	11	14
over 1 600 up to 2 500	7	10	14	18	28	36	3	4.5	6	8	12	16
over 2 500 up to 4 000	8	11	14	20	28	40	3.5	5	7	9	14	18
over 4 000 up to 6 300	8	11	16	22	32	45	3.5	5	7	10	14	20
over 6 300 up to 10 000	9	12	18	25	36	50	4	6	8	12	16	22

Gear Tooth Quality →	Deviation											
	F'_i						f'_i					
Reference circle diameter *d* in mm.	1	2	3	4	5	6	1	2	3	4	5	6
up to 10	3	4.5	6	9	12	18	2	2.5	3.5	5	7	10
over 10 up to 50	4	5.5	8	11	16	22	2	2.5	4	5.5	7	10
over 50 up to 125	5	7	10	14	18	25	2	3	4	5.5	8	11
over 125 up to 280	5.5	8	11	16	22	28	2	3	4	5.5	8	11
over 280 up to 560	6	9	12	16	25	32	2	3	4	6	8	12
over 560 up to 1 000	7	10	14	18	25	36	2.5	3	4.5	6	9	12
over 1 000 up to 1 600	7	10	14	20	28	40	2.5	3.5	4.5	7	9	12
over 1 600 up to 2 500	8	11	16	22	32	45	2.5	3.5	5	7	10	14
over 2 500 up to 4 000	9	12	16	25	32	45	2.5	4	5.5	7	10	14
over 4 000 up to 6 300	9	12	18	25	36	50	3	4	5.5	8	11	16
over 6 300 up to 10 000	10	14	20	28	40	56	3	4.5	6	9	12	18

Table 5 (*Continued*)

Normal module from 1 to 2 mm.

Tolerances in µm.

		Deviation											
		F''_i						f''_i					
	Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12
Reference circle diameter *d* in mm.	up to 10	18	25	36	50	71	100	6	9	12	18	25	36
	over 10 up to 50	22	32	45	63	90	125	9	12	18	25	36	50
	over 50 up to 125	28	40	56	80	110	160	12	16	22	32	45	63
	over 125 up to 280	32	45	63	90	125	180	14	20	28	36	56	71
	over 280 up to 560	36	50	71	100	140	200	16	22	32	45	63	90
	over 560 up to 1 000	45	63	80	110	160	220	18	25	36	50	71	100
	over 1 000 up to 1 600	45	63	90	125	180	250	20	28	40	56	80	110
	over 1 600 up to 2 500	50	71	100	140	200	280	22	32	45	63	90	125
	over 2 500 up to 4 000	56	80	110	160	220	320	25	36	50	71	100	140
	over 4 000 up to 6 300	63	90	125	180	250	360	28	40	56	80	110	160
	over 6 300 up to 10 000	71	100	140	200	280	400	32	45	63	90	125	180

		Deviation											
		F'_i						f'_i					
	Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12
Reference circle diameter *d* in mm.	up to 10	25	32	45	80	125	200	14	20	28	45	71	110
	over 10 up to 50	32	45	63	100	160	250	14	20	28	45	71	110
	over 50 up to 125	36	50	71	110	180	280	16	22	28	45	80	125
	over 125 up to 280	40	56	80	125	200	320	16	22	32	50	80	125
	over 280 up to 560	45	63	90	140	220	360	16	22	32	50	80	140
	over 560 up to 1 000	50	71	100	160	250	400	18	25	32	56	90	140
	over 1 000 up to 1 600	56	80	110	180	280	450	18	25	36	56	90	140
	over 1 600 up to 2 500	63	80	125	180	320	500	18	28	36	63	100	160
	over 2 500 up to 4 000	63	90	125	200	320	500	20	28	40	63	100	160
	over 4 000 up to 6 300	71	100	140	220	360	560	22	32	45	71	110	180
	over 6 300 up to 10 000	80	110	160	250	400	630	25	36	50	80	125	200

Table 5 *(Continued)*

Normal module over 2 up to 3.55 mm.

Tolerances in µm.

	Deviation											
	F''_i						f''_i					
Gear Tooth Quality → / Reference circle diameter d in mm.	1	2	3	4	5	6	1	2	3	4	5	6
over 10 up to 50	3.5	5	7	10	14	18	1.5	2	3	4	5.5	8
over 50 up to 125	4	6	8	11	16	22	1.5	2.5	3.5	5	7	9
over 125 up to 280	5	7	9	14	18	25	2	3	4	5.5	8	11
over 280 up to 560	5	8	11	14	20	28	2.5	3.5	4.5	6	9	12
over 560 up to 1 000	6	9	12	16	22	32	2.5	3.5	5	7	10	14
over 1 000 up to 1 600	7	9	14	18	25	36	3	4	6	8	11	16
over 1 600 up to 2 500	7	10	14	20	28	40	3.5	4.5	6	9	12	18
over 2 500 up to 4 000	8	11	16	22	32	45	3.5	5	7	10	14	20
over 4 000 up to 6 300	9	12	18	25	36	50	4	5.5	8	11	16	22
over 6 300 up to 10 000	9	14	18	28	36	50	4.5	6	9	12	18	25

	Deviation											
	F'_i						f'_i					
Gear Tooth Quality → / Reference circle diameter d in mm.	1	2	3	4	5	6	1	2	3	4	5	6
over 10 up to 50	4.5	7	9	12	18	25	2.5	3	4.5	6	9	12
over 50 up to 125	5.5	8	11	16	22	28	2.5	3.5	4.5	6	9	12
over 125 up to 280	6	9	12	18	25	32	2.5	3.5	4.5	7	9	12
over 280 up to 560	7	10	14	20	25	36	2.5	3.5	5	7	10	14
over 560 up to 1 000	8	11	16	22	28	40	2.5	3.5	5	7	10	14
over 1 000 up to 1 600	8	12	16	22	32	45	2.5	4	5.5	7	10	14
over 1 600 up to 2 500	9	12	18	25	36	50	3	4	5.5	8	11	16
over 2 500 up to 4 000	10	14	18	25	36	50	3	4	6	8	12	16
over 4 000 up to 6 300	10	14	20	28	40	56	3.5	4.5	6	9	12	18
over 6 300 up to 10 000	11	16	22	32	45	63	3.5	5	7	10	14	18

Table 5 (*Continued*)

Normal module over 2 up to 3.55 mm.

Tolerances in µm.

Reference circle diameter *d* in mm.	Gear Tooth Quality →	Deviation											
		F''_i						f''_i					
		7	8	9	10	11	12	7	8	9	10	11	12
over 10 up to 50		25	36	50	71	100	140	11	14	20	28	40	56
over 50 up to 125		32	45	63	90	125	160	14	18	25	36	50	71
over 125 up to 280		36	50	71	100	140	200	16	22	32	40	56	80
over 280 up to 560		40	56	80	110	160	220	18	25	36	50	71	100
over 560 up to 1 000		45	63	90	125	180	250	20	28	40	56	80	110
over 1 000 up to 1 600		50	71	100	140	200	280	22	32	45	63	90	125
over 1 600 up to 2 500		56	80	110	160	220	280	25	36	50	71	100	140
over 2 500 up to 4 000		63	90	125	160	250	320	28	40	56	80	100	160
over 4 000 up to 6 300		71	100	140	200	280	400	32	45	63	90	125	180
over 6 300 up to 10 000		71	110	140	220	280	400	36	50	71	100	140	200

Reference circle diameter *d* in mm.	Gear Tooth Quality →	Deviation											
		F'_i						f'_i					
		7	8	9	10	11	12	7	8	9	10	11	12
over 10 up to 50		36	50	71	110	180	280	18	25	32	50	90	140
over 50 up to 125		40	56	80	125	200	320	18	25	36	56	90	140
over 125 up to 280		45	63	90	140	250	360	18	25	36	56	90	140
over 280 up to 560		50	71	100	160	250	400	18	25	36	56	90	160
over 560 up to 1 000		56	80	110	180	280	450	20	28	40	63	100	160
over 1 000 up to 1 600		63	90	125	200	320	500	20	28	40	63	100	160
over 1 600 up to 2 500		71	90	125	220	320	560	22	32	40	71	110	180
over 2 500 up to 4 000		71	100	140	220	360	560	22	32	45	71	110	180
over 4 000 up to 6 300		80	110	160	250	400	630	25	36	50	80	125	200
over 6 300 up to 10 000		90	125	180	280	450	710	28	36	56	90	140	220

Table 5 (*Continued*)

Normal module over 3.55 up to 6 mm.

Tolerances in µm.

Reference circle diameter *d* in mm.	Gear Tooth Quality →	Deviation F''_i 1	2	3	4	5	6	Deviation f''_i 1	2	3	4	5	6
	over 10 up to 50	4	5.5	8	11	14	20	1.5	2.5	3	4.5	6	9
	over 50 up to 125	4.5	6	9	12	18	25	2	3	4	5.5	8	11
	over 125 up to 280	5	7	10	14	20	28	2.5	3	4.5	6	9	12
	over 280 up to 560	6	8	12	16	22	32	2.5	3.5	5	7	10	14
	over 560 up to 1 000	7	9	12	18	25	36	3	4	6	8	11	16
	over 1 000 up to 1 600	7	10	14	20	28	40	3	4.5	6	9	12	18
	over 1 600 up to 2 500	8	11	16	22	32	40	3.5	5	7	10	14	18
	over 2 500 up to 4 000	9	12	18	25	32	45	4	5.5	8	11	16	22
	over 4 000 up to 6 300	9	12	18	25	36	50	4	6	8	12	16	22
	over 6 300 up to 10 000	10	14	20	28	40	56	4.5	6	9	12	18	25

Reference circle diameter *d* in mm.	Gear Tooth Quality →	Deviation F'_i 1	2	3	4	5	6	Deviation f'_i 1	2	3	4	5	6
	over 10 up to 50	5.5	7	10	14	20	28	2.5	4	5.5	7	10	14
	over 50 up to 125	6	9	12	18	25	32	3	4	5.5	8	11	14
	over 125 up to 280	7	10	14	20	28	36	3	4	5.5	8	11	16
	over 280 up to 560	8	11	16	22	28	40	3	4	6	8	11	16
	over 560 up to 1 000	9	12	16	22	32	45	3	4.5	6	8	12	16
	over 1 000 up to 1 600	9	12	18	25	36	50	3	4.5	6	9	12	18
	over 1 600 up to 2 500	10	14	20	28	40	56	3.5	4.5	6	9	14	18
	over 2 500 up to 4 000	11	14	20	28	40	56	3.5	5	7	10	14	18
	over 4 000 up to 6 300	11	16	22	32	45	63	3.5	5	7	10	14	20
	over 6 300 up to 10 000	12	16	25	32	45	63	4	5.5	8	11	16	22

Table 5 *(Continued)*

Normal module over 3.55 up to 6 mm.

Tolerances in µm.

Reference circle diameter d in mm.	Deviation	F''_i						f''_i					
	Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12
	over 10 up to 50	32	40	56	80	110	160	12	18	25	36	50	63
	over 50 up to 125	36	50	71	100	140	180	14	20	28	40	56	80
	over 125 up to 280	40	56	80	110	160	200	18	25	32	45	63	90
	over 280 up to 560	45	63	90	125	180	250	20	28	40	56	71	110
	over 560 up to 1 000	50	71	100	140	200	280	22	32	45	60	80	125
	over 1 000 up to 1 600	56	80	110	140	200	280	25	36	50	63	90	125
	over 1 600 up to 2 500	63	80	110	160	220	320	28	36	50	71	100	140
	over 2 500 up to 4 000	63	90	125	180	250	360	32	40	56	80	110	160
	over 4 000 up to 6 300	71	100	140	200	280	400	32	45	63	90	125	180
	over 6 300 up to 10 000	80	110	160	220	320	450	36	50	71	100	140	200

Reference circle diameter d in mm.	Deviation	F'_i						f'_i					
	Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12
	over 10 up to 50	40	56	80	125	200	320	20	28	40	63	100	160
	over 50 up to 125	45	63	90	140	250	360	20	28	40	63	110	160
	over 125 up to 280	52	71	100	160	250	400	22	32	40	71	110	160
	over 280 up to 560	56	80	110	180	280	450	22	32	45	71	110	180
	over 560 up to 1 000	63	90	125	200	320	500	22	32	45	71	110	180
	over 1 000 up to 1 600	71	100	140	220	360	560	25	32	50	71	125	200
	over 1 600 up to 2 500	71	100	140	220	360	630	25	36	50	80	125	200
	over 2 500 up to 4 000	80	110	160	250	400	630	25	36	50	80	125	200
	over 4 000 up to 6 300	90	125	180	280	450	710	28	40	56	90	140	220
	over 6 300 up to 10 000	90	140	180	280	450	710	32	45	63	100	160	250

Table 5 (*Continued*)

Normal module over 6 up to 10 mm.

Tolerances in µm.

		Deviation											
		F''_i						f''_i					
Gear Tooth Quality →		1	2	3	4	5	6	1	2	3	4	5	6
Reference circle diameter *d* in mm.	over 10 up to 50	4.5	6	9	12	16	22	2	3	4	5	7	10
	over 50 up to 125	5	7	10	14	20	28	2.5	3	4.5	6	9	12
	over 125 up to 280	6	8	11	16	22	32	2.5	3.5	5	7	10	14
	over 280 up to 560	6	9	12	18	25	36	3	4	5.5	8	11	16
	over 560 up to 1 000	7	10	14	20	28	40	3	4.5	6	9	12	18
	over 1 000 up to 1 600	8	11	16	22	32	40	3.5	5	7	10	14	18
	over 1 600 up to 2 500	8	12	16	22	32	45	4	5.5	7	10	14	20
	over 2 500 up to 4 000	9	14	18	25	36	50	4	6	8	11	16	22
	over 4 000 up to 6 300	10	14	20	28	40	56	4.5	6	9	12	18	25
	over 6 300 up to 10 000	11	16	22	28	40	63	5	7	10	14	20	28

		Deviation											
		F'_i						f'_i					
Gear Tooth Quality →		1	2	3	4	5	6	1	2	3	4	5	6
Reference circle diameter *d* in mm.	over 10 up to 50	6	9	12	16	22	32	3.5	4.5	7	9	12	18
	over 50 up to 125	7	10	14	20	28	40	3.5	5	7	9	14	18
	over 125 up to 280	8	11	16	22	32	45	3.5	5	7	10	14	18
	over 280 up to 560	9	12	18	25	32	45	3.5	5	7	10	14	20
	over 560 up to 1 000	10	14	18	25	36	50	3.5	5	7	10	14	20
	over 1 000 up to 1 600	10	14	20	28	40	56	4	5	7	10	14	20
	over 1 600 up to 2 500	11	16	22	32	40	56	4	5.5	8	11	16	22
	over 2 500 up to 4 000	12	16	22	32	45	63	4	6	8	11	16	22
	over 4 000 up to 6 300	12	18	25	36	50	71	4	6	8	12	16	22
	over 6 300 up to 10 000	14	18	25	36	50	71	4.5	6	9	12	18	25

Table 5 *(Continued)*

Normal module over 6 up to 10 mm.

Tolerances in µm.

Reference circle diameter d in mm.	Gear Tooth Quality →	Deviation F''_i 7	8	9	10	11	12	Deviation f''_i 7	8	9	10	11	12
	over 10 up to 50	32	45	63	90	125	180	14	20	28	40	56	80
	over 50 up to 125	40	56	71	110	140	200	18	25	32	45	63	90
	over 125 up to 280	45	63	80	120	160	250	20	28	40	56	71	100
	over 280 up to 560	50	71	100	140	180	250	22	32	45	63	80	125
	over 560 up to 1 000	56	71	110	140	200	280	25	32	50	63	90	125
	over 1 000 up to 1 600	56	80	110	160	250	320	28	36	50	71	100	140
	over 1 600 up to 2 500	63	90	125	180	250	360	28	40	56	80	110	160
	over 2 500 up to 4 000	71	100	140	180	280	360	32	45	63	90	125	180
	over 4 000 up to 6 300	80	110	160	220	320	450	36	50	71	100	140	200
	over 6 300 up to 10 000	80	125	160	250	320	450	40	56	80	110	160	220

Reference circle diameter d in mm.	Gear Tooth Quality →	Deviation F'_i 7	8	9	10	11	12	Deviation f'_i 7	8	9	10	11	12
	over 10 up to 50	45	63	90	140	220	360	25	36	50	80	125	200
	over 50 up to 125	56	71	100	160	280	450	25	36	50	80	125	200
	over 125 up to 280	63	80	110	180	280	500	25	36	50	80	125	220
	over 280 up to 560	63	90	125	200	320	500	28	36	50	80	140	220
	over 560 up to 1 000	71	100	140	220	360	560	28	40	56	90	140	220
	over 1 000 up to 1 600	80	110	160	250	400	630	28	40	56	90	140	220
	over 1 600 up to 2 500	80	110	160	250	400	630	28	40	56	90	140	250
	over 2 500 up to 4 000	90	125	180	280	450	710	32	45	63	100	160	250
	over 4 000 up to 6 300	100	140	200	320	500	800	32	45	63	100	160	250
	over 6 300 up to 10 000	100	140	200	320	500	800	36	50	71	110	180	280

Table 5 (*Continued*)

Normal module over 10 up to 16 mm.

Tolerances in µm.

		Deviation											
		F''_i						f''_i					
Gear Tooth Quality →		1	2	3	4	5	6	1	2	3	4	5	6
Reference circle diameter *d* in mm.	over 50 up to 125	5.5	8	11	16	22	32	2.5	3.5	5	7	10	14
	over 125 up to 280	6	9	12	18	25	36	3	4	6	8	11	16
	over 280 up to 560	7	10	14	20	28	40	3.5	4.5	6	9	12	18
	over 560 up to 1 000	8	11	16	22	28	40	3.5	5	7	10	14	20
	over 1 000 up to 1 600	8	12	16	22	32	45	4	5.5	8	11	14	20
	over 1 600 up to 2 500	9	12	18	25	36	50	4	6	8	11	16	22
	over 2 500 up to 4 000	10	14	20	28	40	56	4.5	6	9	12	18	25
	over 4 000 up to 6 300	10	14	20	28	40	56	4.5	7	9	14	18	28
	over 6 300 up to 10 000	11	16	22	32	45	63	5	7	10	14	20	28

		Deviation											
		F'_i						f'_i					
Gear Tooth Quality →		1	2	3	4	5	6	1	2	3	4	5	6
Reference circle diameter *d* in mm.	over 50 up to 125	8	11	16	22	32	45	4.5	6	9	12	16	22
	over 125 up to 280	9	12	18	25	36	50	4.5	6	9	12	16	25
	over 280 up to 560	10	14	20	28	40	56	4.5	6	9	12	18	25
	over 560 up to 1 000	11	16	22	28	40	56	4.5	6	9	12	18	25
	over 1 000 up to 1 600	12	16	22	32	45	63	4.5	6	9	12	18	25
	over 1 600 up to 2 500	12	18	25	36	45	63	5	7	10	14	18	25
	over 2 500 up to 4 000	14	18	25	36	50	71	5	7	10	14	20	28
	over 4 000 up to 6 300	14	20	28	40	56	80	5	7	10	14	20	28
	over 6 300 up to 10 000	14	20	28	40	56	80	5.5	8	11	14	22	28

Table 5 *(Continued)*

Normal module over 10 up to 16 mm.

Tolerances in μm.

Reference circle diameter d in mm.	Deviation	F''_i						f''_i					
	Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12
	over 50 up to 125	45	63	80	125	160	250	20	28	40	56	80	110
	over 125 up to 280	50	71	90	125	180	250	22	32	45	63	90	125
	over 280 up to 560	56	71	100	140	200	280	25	36	50	71	90	125
	over 560 up to 1 000	56	80	110	160	250	320	28	36	50	71	100	140
	over 1 000 up to 1 600	63	90	125	180	250	360	28	40	56	80	110	160
	over 1 600 up to 2 500	71	100	140	180	250	360	32	45	63	90	125	160
	over 2 500 up to 4 000	71	100	140	200	280	400	36	50	63	90	125	180
	over 4 000 up to 6 300	80	110	160	220	320	450	36	56	71	110	160	220
	over 6 300 up to 10 000	90	125	180	250	360	500	40	56	80	110	160	220

Reference circle diameter d in mm.	Deviation	F'_i						f'_i					
	Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12
	over 50 up to 125	63	90	125	200	320	500	32	45	63	100	160	250
	over 125 up to 280	71	100	140	220	360	560	32	45	63	100	160	280
	over 280 up to 560	71	100	140	220	360	630	32	45	63	110	180	280
	over 560 up to 1 000	80	110	160	250	400	630	36	50	71	110	180	280
	over 1 000 up to 1 600	90	125	180	280	450	710	36	50	71	110	180	280
	over 1 600 up to 2 500	90	125	180	280	450	710	36	50	71	110	180	280
	over 2 500 up to 4 000	100	140	200	320	500	800	36	50	71	125	180	320
	over 4 000 up to 6 300	110	160	220	360	560	900	40	56	80	125	200	320
	over 6 300 up to 10 000	110	160	220	360	560	900	40	63	80	125	200	320

Table 5 (*Continued*)

Normal module over 16 up to 25 mm.

Tolerances in µm.

Reference circle diameter *d* in mm.	Deviation	F''_i						f''_i					
	Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6
	over 50 up to 125	6	9	12	18	25	36	3	4.5	6	8	12	16
	over 125 up to 280	7	10	14	20	28	36	3.5	4.5	7	9	12	18
	over 280 up to 560	8	11	16	22	28	40	3.5	5	7	10	14	20
	over 560 up to 1 000	9	12	16	22	32	45	4	5.5	8	11	16	22
	over 1 000 up to 1 600	9	12	18	25	36	50	4.5	6	8	12	16	22
	over 1 600 up to 2 500	10	14	20	28	40	56	4.5	6	9	12	18	25
	over 2 500 up to 4 000	11	14	20	28	40	56	5	7	10	14	20	28
	over 4 000 up to 6 300	11	16	22	32	45	63	5	7	10	14	20	28
	over 6 300 up to 10 000	12	18	25	36	50	71	5.5	8	11	16	22	32

Reference circle diameter *d* in mm.	Deviation	F'_i						f'_i					
	Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6
	over 50 up to 125	9	12	18	25	36	50	5.5	8	11	16	22	32
	over 125 up to 280	10	14	20	28	40	56	5.5	8	11	16	22	32
	over 280 up to 560	11	16	22	32	45	63	6	8	11	16	22	32
	over 560 up to 1 000	12	18	25	32	45	63	6	8	12	16	22	32
	over 1 000 up to 1 600	14	18	25	36	50	71	6	8	12	16	22	32
	over 1 600 up to 2 500	14	20	28	40	56	71	6	9	12	16	25	32
	over 2 500 up to 4 000	14	20	28	40	56	80	6	9	12	18	25	32
	over 4 000 up to 6 300	16	22	32	45	63	90	6	9	12	18	25	36
	over 6 300 up to 10 000	16	22	32	45	63	90	7	9	14	18	25	36

Table 5 *(Continued)*

Normal module over 16 up to 25 mm.

Tolerances in µm.

Gear Tooth Quality →	Deviation F''_i						Deviation f''_i					
Reference circle diameter d in mm.	7	8	9	10	11	12	7	8	9	10	11	12
over 50 up to 125	50	71	90	125	180	250	22	32	45	63	90	125
over 125 up to 280	56	71	100	140	200	280	25	36	50	71	100	140
over 280 up to 560	56	80	110	160	250	320	28	40	56	80	110	140
over 560 up to 1 000	63	90	125	180	250	360	32	40	56	80	110	160
over 1 000 up to 1 600	71	100	140	200	280	360	32	45	63	90	110	160
over 1 600 up to 2 500	71	100	140	200	280	400	36	50	71	100	140	180
over 2 500 up to 4 000	80	110	160	220	320	450	36	50	71	100	140	200
over 4 000 up to 6 300	90	125	180	250	360	500	40	56	80	110	160	220
over 6 300 up to 10 000	100	140	200	280	400	560	45	63	90	125	180	250

Gear Tooth Quality →	Deviation F'_i						Deviation f'_i					
Reference circle diameter d in mm.	7	8	9	10	11	12	7	8	9	10	11	12
over 50 up to 125	71	100	140	220	360	560	40	56	80	140	220	320
over 125 up to 280	80	110	160	250	400	630	45	63	80	140	220	360
over 280 up to 560	90	125	160	280	450	710	45	63	90	140	220	360
over 560 up to 1 000	90	125	180	280	450	710	45	63	90	140	220	360
over 1 000 up to 1 600	100	140	200	320	500	800	45	63	90	140	220	360
over 1 600 up to 2 500	110	140	200	320	500	800	45	63	90	140	220	360
over 2 500 up to 4 000	110	160	220	360	560	900	45	63	90	140	250	400
over 4 000 up to 6 300	125	180	250	400	630	1 000	50	71	100	160	250	400
over 6 300 up to 10 000	125	180	250	400	630	1 000	50	71	100	160	250	400

Table 5 *(Continued)*

Normal module over 25 up to 40 mm.

Tolerances in μm.

Reference circle diameter d in mm.	Deviation											
	F''_i						f''_i					
Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6
over 125 up to 280	8	11	16	22	32	45	4	5.5	8	11	16	22
over 280 up to 560	9	12	16	25	32	45	4	6	8	12	16	22
over 560 up to 1 000	9	14	18	25	36	50	4.5	6	9	12	18	25
over 1 000 up to 1 600	10	14	20	28	40	56	5	7	10	14	18	25
over 1 600 up to 2 500	11	16	22	28	40	56	5	7	10	14	20	28
over 2 500 up to 4 000	12	16	25	32	45	63	5.5	8	11	16	22	32
over 4 000 up to 6 300	12	18	25	36	50	71	5.5	8	11	16	22	32
over 6 300 up to 10 000	14	18	25	36	50	71	6	9	12	18	25	36

Reference circle diameter d in mm.	Deviation											
	F'_i						f'_i					
Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6
over 125 up to 280	12	18	25	32	45	63	8	11	14	20	28	40
over 280 up to 560	14	18	25	36	50	71	8	11	14	20	28	40
over 560 up to 1 000	14	20	28	40	56	80	8	11	16	22	28	40
over 1 000 up to 1 600	16	22	28	40	56	80	8	11	16	22	32	40
over 1 600 up to 2 500	16	22	32	45	63	90	8	11	16	22	32	45
over 2 500 up to 4 000	16	25	32	45	63	90	8	11	16	22	32	45
over 4 000 up to 6 300	18	25	36	50	71	100	8	11	16	22	32	45
over 6 300 up to 10 000	18	25	36	50	71	100	8	12	16	25	32	45

Table 5 (*Continued*)

Normal module over 25 up to 40 mm.

Tolerances in µm.

Reference circle diameter d in mm.	Deviation											
	F''_i						f''_i					
Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12
over 125 up to 280	56	80	110	160	220	320	28	40	56	80	110	160
over 280 up to 560	63	90	125	180	250	360	32	45	63	90	125	180
over 560 up to 1 000	71	100	140	200	280	400	36	45	71	90	125	180
over 1 000 up to 1 600	80	110	160	200	280	400	36	50	71	100	140	200
over 1 600 up to 2 500	80	110	160	250	320	450	40	56	80	110	140	200
over 2 500 up to 4 000	90	125	180	250	320	450	45	56	80	110	160	220
over 4 000 up to 6 300	100	140	200	280	400	560	45	63	90	125	180	250
over 6 300 up to 10 000	100	140	200	280	400	560	50	71	100	140	200	280

Reference circle diameter d in mm.	Deviation											
	F'_i						f'_i					
Gear Tooth Quality →	7	8	9	10	11	12	7	8	9	10	11	12
over 125 up to 280	90	125	180	280	450	710	56	80	110	180	280	450
over 280 up to 560	100	140	200	320	500	800	56	80	110	180	280	450
over 560 up to 1 000	110	160	220	320	560	800	56	80	110	180	280	450
over 1 000 up to 1 600	110	160	220	360	560	900	56	80	110	180	280	500
over 1 600 up to 2 500	125	160	250	360	630	900	63	80	125	180	320	500
over 2 500 up to 4 000	125	180	250	400	630	1 000	63	90	125	200	320	500
over 4 000 up to 6 300	140	200	280	450	710	1 100	63	90	125	200	320	500
over 6 3000 up to 10 000	140	200	280	450	710	1 100	63	90	125	200	320	500

Table 5 (*Continued*)

Normal module over 40 up to 70 mm.

Tolerances in µm.

Reference circle diameter d in mm.	Deviation F''_i 1	2	3	4	5	6	Deviation f''_i 1	2	3	4	5	6
Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6
over 125 up to 280	9	12	18	25	36	50	4.5	6	9	12	18	25
over 280 up to 560	10	14	20	28	36	56	5	7	10	14	20	28
over 560 up to 1 000	10	14	20	28	40	56	5	7	10	14	20	28
over 1 000 up to 1 600	11	16	22	32	45	63	5.5	8	11	16	22	32
over 1 600 up to 2 500	12	16	22	32	45	63	5.5	8	11	16	22	32
over 2 500 up to 4 000	12	18	25	36	50	71	6	9	12	18	25	36
over 4 000 up to 6 300	14	18	28	36	56	71	6	9	12	18	25	36
over 6 300 up to 10 000	14	20	28	40	56	80	7	10	14	20	28	40

Reference circle diameter d in mm.	Deviation F'_i 1	2	3	4	5	6	Deviation f'_i 1	2	3	4	5	6
Gear Tooth Quality →	1	2	3	4	5	6	1	2	3	4	5	6
over 125 up to 280	14	20	28	40	56	80	10	14	20	28	40	56
over 280 up to 560	16	22	32	45	63	90	11	14	22	28	40	56
over 560 up to 1 000	16	25	32	45	63	90	11	16	22	32	40	63
over 1 000 up to 1 600	18	25	36	50	71	100	11	16	22	32	45	63
over 1 600 up to 2 500	18	25	36	50	71	100	11	16	22	32	45	63
over 2 500 up to 4 000	20	28	40	56	80	110	11	16	22	32	45	63
over 4 000 up to 6 300	20	28	40	56	80	110	11	16	22	32	45	63
over 6 300 up to 10 000	22	32	45	63	90	125	11	16	22	32	45	63

Table 5 (*Concluded*)

Normal module over 40 up to 70 mm.

Tolerances in µm.

Reference circle diameter d in mm.	Gear Tooth Quality →	F''_i 7	F''_i 8	F''_i 9	F''_i 10	F''_i 11	F''_i 12	f''_i 7	f''_i 8	f''_i 9	f''_i 10	f''_i 11	f''_i 12
	over 125 up to 280	71	100	140	200	280	400	36	50	71	100	140	200
	over 280 up to 560	80	110	160	220	320	450	40	56	80	110	160	220
	over 560 up to 1 000	80	110	160	220	320	450	40	56	80	110	160	220
	over 1 000 up to 1 600	90	125	180	250	360	500	45	63	90	125	180	250
	over 1 600 up to 2 500	90	125	180	250	360	500	45	63	90	125	180	250
	over 2 500 up to 4 000	100	140	200	280	400	560	50	71	100	140	200	280
	over 4 000 up to 6 300	110	160	220	280	400	630	50	71	100	140	200	280
	over 6 300 up to 10 000	110	160	220	320	450	630	56	80	110	160	220	320

Reference circle diameter d in mm.	Gear Tooth Quality →	F'_i 7	F'_i 8	F'_i 9	F'_i 10	F'_i 11	F'_i 12	f'_i 7	f'_i 8	f'_i 9	f'_i 10	f'_i 11	f'_i 12
	over 125 up to 280	110	160	220	360	560	900	80	110	160	250	400	630
	over 280 up to 560	125	180	250	400	630	1 000	80	125	160	250	400	630
	over 560 up to 1 000	125	180	250	400	630	1 000	80	125	160	250	400	630
	over 1 000 up to 1 600	140	200	280	450	710	1 100	90	125	180	280	450	710
	over 1 600 up to 2 500	140	200	280	450	710	1 100	90	125	180	280	450	710
	over 2 500 up to 4 000	160	220	320	500	800	1 250	90	125	180	280	450	710
	over 4 000 up to 6 300	160	220	320	500	800	1 250	90	125	180	280	450	710
	over 6 300 up to 10 000	180	250	360	560	900	1 400	90	125	180	280	450	710

Table 6 Tolerance Data

(Clause 6)

Tolerances in µm.

Deviation F_β, $f_{H\beta}$, $f_{\beta f}$

Facewidth b in mm.	Gear Tooth Quality	1	2	3	4	5	6	7	8	9	10	11	12
	up to 20	2.5 2 1.5	3.5 2.5 2.5	4.5 3 3	5.5 4 3.5	7 6 4.5	9 8 5.5	13 11 7	18 16 9	28 25 14	45 36 25	71 56 40	110 90 63
	over 20 up to 40	3 2 2	4 2.5 3	5 3.5 4	6 4.5 5	8 6.5 6	10 9 7	15 13 9	20 18 12	32 28 18	50 40 28	80 63 45	125 100 71
	over 40 up to 100	4 2.5 3	5 3 4	6 4 5	8 5 6	10 7 7	12 10 9	18 14 12	25 20 18	40 28 28	63 45 45	100 71 63	160 110 110
	over 100 up to 160	5 3 4	6 3.5 5	8 4.5 7	10 6 8	12 8 9	16 11 12	22 16 16	32 22 25	50 32 40	80 50 63	125 80 100	200 125 160
	over 160	5 3 4	6 3.5 5	8 4.5 7	10 6 8	12 8 9	16 11 12	22 16 16	32 22 25	50 32 40	80 50 63	125 80 100	200 125 160

Table 7 Upper Tooth Thickness Allowances A_{sne} in μm

(*Clauses* 7.2.1 *and* 7.5.1)

Reference Diameter (mm)		Allowance Series										
over	up to	a	ab	b	bc	c	cd	d	e	f	g	h
–	10	- 100	- 85	- 70	- 58	- 48	- 40	- 33	- 22	- 10	- 5	0
10	50	- 135	- 110	- 95	- 75	- 65	- 54	- 44	- 30	- 14	- 7	0
50	125	- 180	- 150	- 125	- 105	- 85	- 70	- 60	- 40	- 19	- 9	0
125	280	- 250	- 200	- 170	- 140	- 115	- 95	- 80	- 56	- 26	- 12	0
280	560	- 330	- 280	- 230	- 190	- 155	- 130	- 110	-75	- 35	- 17	0
560	1 000	- 450	- 370	- 310	- 260	- 210	- 175	- 145	- 100	- 48	- 22	0
1 000	1 600	- 600	- 500	- 420	- 340	- 290	- 240	- 200	- 135	- 64	- 30	0
1 600	2 500	- 820	- 680	- 560	- 460	- 390	- 320	- 270	- 180	- 85	- 41	0
2 500	4 000	- 1 100	- 920	- 760	- 620	- 520	- 430	- 360	- 250	- 115	- 56	0
4 000	6 300	- 1 500	- 1 250	- 1 020	- 840	- 700	- 580	- 480	- 330	- 155	- 75	0
6 300	10 000	- 2 000	- 1 650	- 1 350	- 1 150	- 940	- 780	- 640	- 450	- 210	- 100	0

Table 8 Tooth Thickness Tolerances T_{sn} in μm

(*Clauses* 7.2.1 *and* 7.5.1)

Reference Diameter (mm)		Tolerance Series									
over	up to	21	22	23	24	25	26	27	28	29	30
–	10	3	5	8	12	20	30	50	80	130	200
10	50	5	8	12	20	30	50	80	130	200	300
50	125	6	10	16	25	40	60	100	160	250	400
125	280	8	12	20	30	50	80	130	200	300	500
280	560	10	16	25	40	60	100	160	250	400	600
560	1 000	12	20	30	50	80	130	200	300	500	800
1 000	1 600	16	25	40	60	100	160	250	400	600	1 000
1 600	2 500	20	30	50	80	130	200	300	500	800	1 300
2 500	4 000	25	40	60	100	160	250	400	600	1 000	1 600
4 000	6 300	30	50	80	130	200	300	500	800	1 300	2 000
6 300	10 000	40	60	100	160	250	400	600	1 000	1 600	2 400

Table 9 Centre Distance Allowance A_{ae} and A_{ai} in µm

(*Clause* 7.3.1)

	Axes parallelism class 1 to 3						
		Axes parallelism class 4 to 6					
			Axes parallelism class 7 to 9				
				Axes parallelism class 10 to 12			
	ISO - Tolerance Js						
Centre distance (nominal value), mm	5	6	7	8	9	10	11
over 10 upto 18	+ 4 - 4	+ 5.5 - 5.5	+ 9 - 9	+ 13.5 - 13.5	+ 21.5 - 21.5	+ 35 - 35	+ 55 - 55
over 18 upto 30	+ 4.5 - 4.5	+ 6.5 - 6.5	+ 10.5 - 10.5	+ 16.5 - 16.5	+ 26 - 26	+ 42 - 42	+ 65 - 65
over 30 upto 50	+ 5.5 - 5.5	+ 8 - 8	+ 12.5 - 12.5	+ 19.5 - 19.5	+ 31 - 31	+ 50 - 50	+ 80 - 80
over 50 upto 80	+ 6.5 - 6.5	+ 9.5 - 9.5	+ 15 - 15	+ 23 - 23	+ 37 - 37	+ 60 - 60	+ 95 - 95
over 80 upto 120	+ 7.5 - 7.5	+ 11 - 11	+ 17.5 - 17.5	+ 27 - 27	+ 43.5 - 43.5	+ 70 - 70	+ 110 - 110
over 120 upto 180	+ 9 - 9	+ 12.5 - 12.5	+ 20 - 20	+ 31.5 - 31.5	+ 50 - 50	+ 80 - 80	+ 125 - 125
over 180 upto 250	+ 10 - 10	+ 14.5 - 14.5	+ 23 - 23	+ 36 - 36	+ 57.5 - 57.5	+ 92.5 - 92.5	+ 145 - 145
over 250 upto 315	+ 11.5 - 11.5	+ 16 - 16	+ 26 - 26	+ 40.5 - 40.5	+ 65 - 65	+ 105 - 105	+ 160 - 160
over 315 upto 400	+ 12.5 - 12.5	+ 18 - 18	+ 28.5 - 28.5	+ 44.5 - 44.5	+ 70 - 70	+ 115 - 115	+ 180 - 180
over 400 upto 500	+ 13.5 - 13.5	+ 20 - 20	+ 31.5 - 31.5	+ 48.5 - 48.5	+ 77.5 - 77.5	+ 125 - 125	+ 200 - 200
over 500 upto 630	+ 14 - 14	+ 22 - 22	+ 35 - 35	+ 55 - 55	+ 87 - 87	- 140 - 140	+ 220 - 220
over 630 upto 800	+ 16 - 16	+ 25 - 25	+ 40 - 40	+ 62 -62	+ 100 - 100	+ 160 -160	+ 250 - 250
over 800 upto 1 000	+ 18 - 18	+ 28 - 28	+ 45 - 45	+ 70 - 70	+ 115 - 115	+ 180 - 180	+ 280 - 280
over 1 000 upto 1 250	+ 21 - 21	+ 33 - 33	+ 52 - 52	+ 82 - 82	+ 130 - 130	+ 210 - 210	+ 330 - 330
over 1 250 upto 1 600	+ 25 - 25	+ 39 - 39	+ 62 - 62	+ 97 - 97	+ 155 - 155	+ 250 - 250	+ 390 - 390
over 1 600 upto 2 000	+ 30 - 30	+ 46 - 46	+ 75 - 75	+ 115 - 115	+ 185 - 185	+ 300 - 300	+ 460 - 460
over 2 000 upto 2 500	+ 35 - 35	+ 55 - 55	+ 87 - 87	+ 140 - 140	+ 220 - 220	+ 350 - 350	+ 550 - 550
over 2 500 upto 3 150	+ 43 - 43	+ 67 - 67	+ 105 - 105	+ 165 - 165	+ 270 - 270	+ 430 - 430	+ 675 - 675

Table 10 Tolerance for Inclination of Axes $f\Sigma\beta$ and Axes Skewnwss $f\Sigma\delta$ in μm
(*Clause* 7.5.21)

		Axes Parallelism Class											
		1	2	3	4	5	6	7	8	9	10	11	12
Centre distance between bearings (nominal value) L_G, mm	up to 50	5	6	8	10	12	16	20	25	32	40	50	63
	over 50 up to 125	6	8	10	12	16	20	25	32	40	50	63	80
	over 125 up to 280	8	10	12	16	20	25	32	40	50	63	80	100
	over 280 up to 560	10	12	16	20	25	32	40	50	63	80	100	125
	over 560 up to 1 000	12	16	20	25	32	40	50	63	80	100	125	160
	over 1 000 up to 1 600	16	20	25	32	40	50	63	80	100	125	160	200
	over 1 600 up to 2 500	20	25	32	40	50	63	80	100	125	160	200	250
	over 2 500 up to 3 150	25	32	40	50	63	80	100	125	160	200	250	320

Table 11 Rounded Values of Δj_F in μm
(*Clause* 7.5.2)

Module (mm)		Gear Tooth Quality											
over	up to	1	2	3	4	5	6	7	8	9	10	11	12
1	2	4	6	7	10	13	17	24	34	51	82	130	210
2	3.55	5	6	8	10	14	18	24	36	54	86	136	218
3.55	6	5	7	9	12	15	19	27	40	60	94	150	236
6	10	6	8	11	14	19	25	34	51	75	120	187	300
10	16	7	9	13	17	23	31	41	59	86	138	216	362
16	25	8	11	15	20	28	38	52	75	108	171	289	434
25	40	10	14	19	26	34	48	66	94	135	214	339	536

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