

Specification for

Straight cylindrical involute splines: metric module, side fit —

Part 1: Dimensions and tolerances —

Addendum 1: Inspection

UDC 621.824.44

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

BSI
Documents

AVA

Document Sharing Hub

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Machinery and Components Standards Policy Committee (MCE/-) to Technical Committee MCE/2, upon which the following bodies were represented:

- British Gear Association
- British Pump Manufacturers' Association
- Federation of British Engineers Tool Manufacturers
- Lloyds Register of Shipping
- Society of Motor Manufacturers and Traders Ltd.

This British Standard, having been prepared under the direction of the Machinery and Components Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 15 March 1993

© BSI 05-2000

The following BSI references relate to the work on this standard:
Committee reference MCE/2
Draft for comment 89/75654 DC

ISBN 0 580 21668 3

Amendments issued since publication

Amd. No.	Date	Comments

Contents

	Page
Committees responsible	Inside front cover
National foreword	vii
Section 3. Inspection	
15 Scope	1
16 Reference temperature	1
17 Inspection with limit gauges	1
18 Manufacturing tolerances for spline gauges	5
19 Length of measuring part of gauges	9
20 Grips of spline gauges	11
21 Values of variation allowances of spline gauges	11
22 Dimensions, designation and marking of gauges	12
23 Analytical inspection	23
24 Conversion of circle divisions into angle values	34
25 Inspection dimensions	35
Figure 16 — Relationship between the dimensions of the parts and gauges used	3
Figure 17 — Active length and length of engagement	4
Figure 18 — Cumulation of gauge variation allowances	12
Figure 19 — GO composite ring gauge	13
Figure 20 — Tapered tooth master plug gauge for GO composite ring gauge	14
Figure 21 — NOT GO two-sector ring gauge	15
Figure 22 — Tapered tooth master plug gauge for NOT GO two-sector ring gauge	16
Figure 23 — NOT GO composite ring gauge	17
Figure 24 — Tapered tooth master plug gauge for NOT GO composite ring gauge	18
Figure 25 — GO composite plug gauge	19
Figure 26 — NOT GO two-sector plug gauge	20
Figure 27 — NOT GO composite plug gauge	21
Figure 28 — Double plain gauge	22
Figure 29 — GO or NOT GO plain ring	22
Figure 30 — Graph of residual variation	25
Figure 31 — Measuring method	26
Figure 32 — Measurement results	26
Figure 33 — Theoretical representation	27
Figure 34 — External spline	29
Figure 35 — Internal spline	29
Figure 36 — Measurement over two pins	30
Figure 37 — Measurement between two pins	31
Figure 38 — Calculation of K_e	32
Figure 39 — Calculation of K_i	32
Figure 40	33
Figure 41 — Minimum tangential dimension	33
Figure 42 — Maximum tangential dimension	33
Table 117 — Inspection methods	2
Table 118 — Manufacturing tolerances for gauges — Unique grade	5
Table 119 — Manufacturing tolerances for gauges — Grades other than the unique grade	6

	Page
Table 120 — Positions of gauge tolerances	7
Table 121 — Values of dimensional tolerances of spline gauges for the recommended grade	8
Table 122 — Measuring part of ring gauges — Minimum length	9
Table 123 — Measuring part of plug gauges — Minimum length	10
Table 124 — Variation allowances of spline gauges	11
Table 125 — Dimensions and tolerances of GO composite ring gauges	13
Table 126 — Dimensions and tolerances of tapered tooth master plug gauges for GO composite ring gauges	14
Table 127 — Dimensions and tolerances of NOT GO two-sector ring gauges	15
Table 128 — Number of sector teeth	16
Table 129 — Dimensions and tolerances of tapered tooth master plug gauges for NOT GO two-sector ring gauges	16
Table 130 — Dimensions and tolerances of NOT GO composite ring gauges	17
Table 131 — Dimensions and tolerances for tapered tooth master plug gauges for NOT GO composite ring gauges	18
Table 132 — Dimensions and tolerances of GO composite plug gauges	19
Table 133 — Dimensions and tolerances of NOT GO two-sector plug gauges	20
Table 134 — Number of sector teeth	20
Table 135 — Dimensions and tolerances of NOT GO composite plug gauges	21
Table 136 — Measurement results	25
Table 137 — Results of inspection	25
Table 138 — Pin and ball accuracies and pin measuring length	28
Table 139 — Conversion of circle divisions into angle values	34
<i>Internal splines</i>	
Table 140 — Inspection dimensions M_{Ri} 30 degree pressure angle — Flat root or fillet root — Module = 0.50	36
Table 141 — Inspection dimensions M_{Ri} 30 degree pressure angle — Flat root or fillet root — Module = 0.75	37
Table 142 — Inspection dimensions M_{Ri} 30 degree pressure angle — Flat root or fillet root — Module = 1.00	38
Table 143 — Inspection dimensions M_{Ri} 30 degree pressure angle — Flat root or fillet root — Module = 1.25	39
Table 144 — Inspection dimensions M_{Ri} 30 degree pressure angle — Flat root or fillet root — Module = 1.50	40
Table 145 — Inspection dimensions M_{Ri} 30 degree pressure angle — Flat root or fillet root — Module = 1.75	41
Table 146 — Inspection dimensions M_{Ri} 30 degree pressure angle — Flat root or fillet root — Module = 2.00	42
Table 147 — Inspection dimensions M_{Ri} 30 degree pressure angle — Flat root or fillet root — Module = 2.50	43
Table 148 — Inspection dimensions M_{Ri} 30 degree pressure angle — Flat root or fillet root — Module = 3.00	44
Table 149 — Inspection dimensions M_{Ri} 30 degree pressure angle — Flat root or fillet root — Module = 4.00	45
Table 150 — Inspection dimensions M_{Ri} 30 degree pressure angle — Flat root or fillet root — Module = 5.00	46

	Page
Table 151 — Inspection dimensions M_{Ri} 30 degree pressure angle — Flat root or fillet root — Module = 6.00	47
Table 152 — Inspection dimensions M_{Ri} 30 degree pressure angle — Flat root or fillet root — Module = 8.00	48
Table 153 — Inspection dimensions M_{Ri} 30 degree pressure angle — Flat root or fillet root — Module = 10.00	49
Table 154 — Inspection dimensions M_{Ri} 37.5 degree pressure angle — Fillet root — Module = 0.50	50
Table 155 — Inspection dimensions M_{Ri} 37.5 degree pressure angle — Fillet root — Module = 0.75	51
Table 156 — Inspection dimensions M_{Ri} 37.5 degree pressure angle — Fillet root — Module = 1.00	52
Table 157 — Inspection dimensions M_{Ri} 37.5 degree pressure angle — Fillet root — Module = 1.25	53
Table 158 — Inspection dimensions M_{Ri} 37.5 degree pressure angle — Fillet root — Module = 1.50	54
Table 159 — Inspection dimensions M_{Ri} 37.5 degree pressure angle — Fillet root — Module = 1.75	55
Table 160 — Inspection dimensions M_{Ri} 37.5 degree pressure angle — Fillet root — Module = 2.00	56
Table 161 — Inspection dimensions M_{Ri} 37.5 degree pressure angle — Fillet root — Module = 2.50	57
Table 162 — Inspection dimensions M_{Ri} 37.5 degree pressure angle — Fillet root — Module = 3.00	58
Table 163 — Inspection dimensions M_{Ri} 37.5 degree pressure angle — Fillet root — Module = 4.00	59
Table 164 — Inspection dimensions M_{Ri} 37.5 degree pressure angle — Fillet root — Module = 5.00	60
Table 165 — Inspection dimensions M_{Ri} 37.5 degree pressure angle — Fillet root — Module = 6.00	61
Table 166 — Inspection dimensions M_{Ri} 37.5 degree pressure angle — Fillet root — Module = 8.00	62
Table 167 — Inspection dimensions M_{Ri} 37.5 degree pressure angle — Fillet root — Module = 10.00	63
Table 168 — Inspection dimensions M_{Ri} 45 degree pressure angle — Fillet root — Module = 0.25	64
Table 169 — Inspection dimensions M_{Ri} 45 degree pressure angle — Fillet root — Module = 0.50	65
Table 170 — Inspection dimensions M_{Ri} 45 degree pressure angle — Fillet root — Module = 0.75	66
Table 171 — Inspection dimensions M_{Ri} 45 degree pressure angle — Fillet root — Module = 1.00	67
Table 172 — Inspection dimensions M_{Ri} 45 degree pressure angle — Fillet root — Module = 1.25	68
Table 173 — Inspection dimensions M_{Ri} 45 degree pressure angle — Fillet root — Module = 1.50	69
Table 174 — Inspection dimensions M_{Ri} 45 degree pressure angle — Fillet root — Module = 1.75	70
Table 175 — Inspection dimensions M_{Ri} 45 degree pressure angle — Fillet root — Module = 2.00	71
Table 176 — Inspection dimensions M_{Ri} 45 degree pressure angle — Fillet root — Module = 2.50	72

	Page
<i>External splines</i>	
Table 177 — Inspection dimensions M_{Re} 30 degree pressure angle — Flat root or fillet root — Module = 0.50	73
Table 178 — Inspection dimensions M_{Re} 30 degree pressure angle — Flat root or fillet root — Module = 0.75	74
Table 179 — Inspection dimensions M_{Re} 30 degree pressure angle — Flat root or fillet root — Module = 1.00	75
Table 180 — Inspection dimensions M_{Re} 30 degree pressure angle — Flat root or fillet root — Module = 1.25	76
Table 181 — Inspection dimensions M_{Re} 30 degree pressure angle — Flat root or fillet root — Module = 1.50	77
Table 182 — Inspection dimensions M_{Re} 30 degree pressure angle — Flat root or fillet root — Module = 1.75	78
Table 183 — Inspection dimensions M_{Re} 30 degree pressure angle — Flat root or fillet root — Module = 2.00	79
Table 184 — Inspection dimensions M_{Re} 30 degree pressure angle — Flat root or fillet root — Module = 2.50	80
Table 185 — Inspection dimensions M_{Re} 30 degree pressure angle — Flat root or fillet root — Module = 3.00	81
Table 186 — Inspection dimensions M_{Re} 30 degree pressure angle — Flat root or fillet root — Module = 4.00	82
Table 187 — Inspection dimensions M_{Re} 30 degree pressure angle — Flat root or fillet root — Module = 5.00	83
Table 188 — Inspection dimensions M_{Re} 30 degree pressure angle — Flat root or fillet root — Module = 6.00	84
Table 189 — Inspection dimensions M_{Re} 30 degree pressure angle — Flat root or fillet root — Module = 8.00	85
Table 190 — Inspection dimensions M_{Re} 30 degree pressure angle — Flat root or fillet root — Module = 10.00	86
Table 191 — Inspection dimensions M_{Re} 37.5 degree pressure angle — Fillet root — Module = 0.50	87
Table 192 — Inspection dimensions M_{Re} 37.5 degree pressure angle — Fillet root — Module = 0.75	88
Table 193 — Inspection dimensions M_{Re} 37.5 degree pressure angle — Fillet root — Module = 1.00	89
Table 194 — Inspection dimensions M_{Re} 37.5 degree pressure angle — Fillet root — Module = 1.25	90
Table 195 — Inspection dimensions M_{Re} 37.5 degree pressure angle — Fillet root — Module = 1.50	91
Table 196 — Inspection dimensions M_{Re} 37.5 degree pressure angle — Fillet root — Module = 1.75	92
Table 197 — Inspection dimensions M_{Re} 37.5 degree pressure angle — Fillet root — Module = 2.00	93
Table 198 — Inspection dimensions M_{Re} 37.5 degree pressure angle — Fillet root — Module = 2.50	94
Table 199 — Inspection dimensions M_{Re} 37.5 degree pressure angle — Fillet root — Module = 3.00	95
Table 200 — Inspection dimensions M_{Re} 30 degree pressure angle — Fillet root — Module = 4.00	96
Table 201 — Inspection dimensions M_{Re} 37.5 degree pressure angle — Fillet root — Module = 5.00	97

	Page
Table 202 — Inspection dimensions M_{Re} 37.5 degree pressure angle — Fillet root — Module = 6.00	98
Table 203 — Inspection dimensions M_{Re} 37.5 degree pressure angle — Fillet root — Module = 8.00	99
Table 204 — Inspection dimensions M_{Re} 37.5 degree pressure angle — Fillet root — Module = 10.00	100
Table 205 — Inspection dimensions M_{Re} 45 degree pressure angle — Fillet root — Module = 0.25	101
Table 206 — Inspection dimensions M_{Re} 45 degree pressure angle — Fillet root — Module = 0.50	102
Table 207 — Inspection dimensions M_{Ri} 30 degree pressure angle — Fillet root — Module = 0.75	103
Table 208 — Inspection dimensions M_{Ri} 45 degree pressure angle — Fillet root — Module = 1.00	104
Table 209 — Inspection dimensions M_{Ri} 45 degree pressure angle — Fillet root — Module = 1.25	105
Table 210 — Inspection dimensions M_{Ri} 45 degree pressure angle — Fillet root — Module = 1.50	106
Table 211 — Inspection dimensions M_{Ri} 45 degree pressure angle — Fillet root — Module = 1.75	107
Table 212 — Inspection dimensions M_{Ri} 45 degree pressure angle — Fillet root — Module = 2.00	108
Table 213 — Inspection dimensions M_{Ri} 45 degree pressure angle — Fillet root — Module = 2.50	109
Table 214 — Inspection dimensions W 30 degree pressure angle — Flat root or fillet root — Module = 0.50	110
Table 215 — Inspection dimensions W 30 degree pressure angle — Flat root or fillet root — Module = 0.75	111
Table 216 — Inspection dimensions W 30 degree pressure angle — Flat root or fillet root — Module = 1.00	112
Table 217 — Inspection dimensions W 30 degree pressure angle — Flat root or fillet root — Module = 1.25	113
Table 218 — Inspection dimensions W 30 degree pressure angle — Flat root or fillet root — Module = 1.50	114
Table 219 — Inspection dimensions W 30 degree pressure angle — Flat root or fillet root — Module = 1.75	115
Table 220 — Inspection dimensions W 30 degree pressure angle — Flat root or fillet root — Module = 2.00	116
Table 221 — Inspection dimensions W 30 degree pressure angle — Flat root or fillet root — Module = 2.50	117
Table 222 — Inspection dimensions W 30 degree pressure angle — Flat root or fillet root — Module = 3.00	118
Table 223 — Inspection dimensions W 30 degree pressure angle — Flat root or fillet root — Module = 4.00	119
Table 224 — Inspection dimensions W 30 degree pressure angle — Flat root or fillet root — Module = 5.00	120
Table 225 — Inspection dimensions W 30 degree pressure angle — Flat root or fillet root — Module = 6.00	121
Table 226 — Inspection dimensions W 30 degree pressure angle — Flat root or fillet root — Module = 8.00	122
Table 227 — Inspection dimensions W 30 degree pressure angle — Flat root or fillet root — Module = 10.00	123

	Page
Table 228 — Inspection dimensions <i>W</i> 37.5 degree pressure angle — Fillet root — Module = 0.50	124
Table 229 — Inspection dimensions <i>W</i> 37.5 degree pressure angle — Fillet root — Module = 0.75	125
Table 230 — Inspection dimensions <i>W</i> 37.5 degree pressure angle — Fillet root — Module = 1.00	126
Table 231 — Inspection dimensions <i>W</i> 37.5 degree pressure angle — Fillet root — Module = 1.25	127
Table 232 — Inspection dimensions <i>W</i> 37.5 degree pressure angle — Fillet root — Module = 1.50	128
Table 233 — Inspection dimensions <i>W</i> 37.5 degree pressure angle — Fillet root — Module = 1.75	129
Table 234 — Inspection dimensions <i>W</i> 37.5 degree pressure angle — Fillet root — Module = 2.00	130
Table 235 — Inspection dimensions <i>W</i> 37.5 degree pressure angle — Fillet root — Module = 2.50	131
Table 236 — Inspection dimensions <i>W</i> 37.5 degree pressure angle — Fillet root — Module = 3.00	132
Table 237 — Inspection dimensions <i>W</i> 37.5 degree pressure angle — Fillet root — Module = 4.00	133
Table 238 — Inspection dimensions <i>W</i> 37.5 degree pressure angle — Fillet root — Module = 5.00	134
Table 239 — Inspection dimensions <i>W</i> 37.5 degree pressure angle — Fillet root — Module = 6.00	135
Table 240 — Inspection dimensions <i>W</i> 37.5 degree pressure angle — Fillet root — Module = 8.00	136
Table 241 — Inspection dimensions <i>W</i> 37.5 degree pressure angle — Fillet root — Module = 10.00	137
Table 242 — Inspection dimensions <i>W</i> 45 degree pressure angle — Fillet root — Module = 0.25	138
Table 243 — Inspection dimensions <i>W</i> 45 degree pressure angle — Fillet root — Module = 0.50	139
Table 244 — Inspection dimensions <i>W</i> 45 degree pressure angle — Fillet root — Module = 0.75	140
Table 245 — Inspection dimensions <i>W</i> 45 degree pressure angle — Fillet root — Module = 1.00	141
Table 246 — Inspection dimensions <i>W</i> 45 degree pressure angle — Fillet root — Module = 1.25	142
Table 247 — Inspection dimensions <i>W</i> 45 degree pressure angle — Fillet root — Module = 1.50	143
Table 248 — Inspection dimensions <i>W</i> 45 degree pressure angle — Fillet root — Module = 1.75	144
Table 249 — Inspection dimensions <i>W</i> 45 degree pressure angle — Fillet root — Module = 2.00	145
Table 250 — Inspection dimensions <i>W</i> 45 degree pressure angle — Fillet root — Module = 2.50	146
List of references	Inside back cover

National foreword

This Addendum to this British Standard has been prepared under the direction of the Machinery and Components Standards Policy Committee. It is identical with ISO 4156:1981/Amendment 1:1992 *Straight cylindrical involute splines — Metric module, side fit — Generalities, dimensions and inspection: Amendment 1: Section 3: Inspection*, which was prepared by Technical Committee ISO/TC 14 of the International Organization for Standardization (ISO) and in the development of which the United Kingdom played an active part.

Cross-references

International Standard	Corresponding British Standard
	BS 4500 <i>ISO limits and fits</i>
ISO 286-1:1988	Section 1.1:1990 <i>Specification for bases of tolerances, deviations and fits</i> (Identical)
ISO 286-2:1988	Section 1.2:1990 <i>Tables of commonly used tolerance and grades and limit deviations for holes and shafts</i> (Identical)

The Technical Committee has reviewed the provisions of ISO 3670:1979, to which normative reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard.

Textual error. When adopting the text of the International Standard, the textual error given below was discovered. It has been marked in the text and has been reported to the International Organization for Standardization (ISO) in a proposal to amend the text of the International Standard.

In the heading of Table 163

“30 degree” should read “37.5 degree”.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to viii, pages 1 to 146, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

WARNING

Some of the symbols used in this addendum could seem to have two meanings. For instance *Z* means either the number of teeth (as is customary in the ISO Standards for spline or gears) or the distance between the centre of the tolerance zone of new GO gauges for shafts and the GO workpiece limit (see ISO/R 1938).

The authors have not thought it necessary to distinguish them, since the context will always preclude any ambiguity.

Section 3. Inspection

15 Scope

This addendum provides guidance and data necessary for the inspection of straight (non-helical) cylindrical involute splines.

16 Reference temperature

The standard reference temperature for industrial length measurements is 20 °C. The dimensional requirements for parts and gauges are defined at that temperature and inspection shall also normally be carried out at that same temperature.

If measurements are taken at another temperature, the results shall be corrected using the expansion coefficients of parts and gauges respectively.

Unless otherwise specified, all measurements shall be made under zero measuring load.

If measurements are made under a non-zero load, the results shall be corrected accordingly. However, such correction is not required for comparison measurements made with the same comparison means and under the same measuring load, between similar components of the same material and with the same surface condition.

17 Inspection with limit gauges

17.1 Introduction

The procedures for inspection of straight cylindrical involute splines are defined below for cases where use is made of limit gauges. However, it is not mandatory to use such gauges and direct measurement is acceptable provided that this method has been agreed by the parties concerned under conditions to be defined so as to meet the requirements of this addendum.

By convention, a part is deemed acceptable when its splines are found satisfactory using gauges meeting the requirements of this addendum, which is the authority for gauging. Consequently, the choice of gauge shall be agreed between customer and manufacturer in the contract, so that, if the customer uses his own gauges for acceptance purposes, they shall be close enough to the prescribed external limits not to reject splines already deemed acceptable by the manufacturer's gauges. In case of dispute, both the manufacturer and the customer shall make their gauges available to each other for checking on their own premises. In the event of a continuing dispute, the gauges shall be referred to a calibration authority recognized by the two parties.

17.2 Inspection methods

Three methods of inspection are provided in Table 120, "Positions of gauge tolerances", for gauge inspection of splines:

- the "standard method";
- the "alternative method A";
- the "alternative method B".

The selected method of inspection shall be described explicitly.

These different methods of inspection on the NOT GO side lead to the following conclusions for H/h fit:

Table 117 — Inspection methods

Inspection method ^a	Theoretical maximum clearance between mating parts (zero-form variation)	Maximum variation of form in each part (zero clearance)
Standard	$2(T + \lambda)$	$T + \lambda$
A	$2T$	$T + \lambda$
B	$2T$	Undetermined
^a In the rest of this addendum, the terms “standard method”, “method A” and “method B” are used for simplicity’s sake.		

For fits other than H/h, the theoretical maximum clearance will vary as a function of the fundamental deviations.

17.2.1 Inspection on the GO side

In the three above-mentioned methods, GO composite gauges are used to check

- that the effective limits of space width or tooth thicknesses are not exceeded on the GO side, to ensure the desired fit;
- the form diameter of the part, thus ensuring that the desired tolerances are respected for the full specified involute depth.

17.2.2 Inspection on the NOT GO side

17.2.2.1 Standard method

In the “standard method”, NOT GO sector spline gauges with sector teeth check the actual limits of space width or tooth thickness at the minimum material conditions of the parts.

17.2.2.2 Method A

In “method A”, two types of NOT GO gauges are provided:

- one covers NOT GO sector spline gauges which check (as for the “standard method”) the actual limits of space width or tooth thickness at the minimum material conditions of the parts;
- the other covers NOT GO composite spline gauges which check the effective limits of space width or tooth thickness to ensure the desired conditions of use (variation allowances are in this case checked globally).

17.2.2.3 Method B

In “method B”, NOT GO composite gauges check (as for “method A”) the effective limits of space width or tooth thickness not to be exceeded on the NOT GO side (the actual limits of space width or tooth thickness at the minimum material condition of parts are not checked in this case).

17.2.2.4 Control using measuring pins or balls

Control using measuring pins or balls is permissible instead of NOT GO sector ring or plug gauges.

17.2.3 GO and NOT GO inspection of diameter at tooth top (D_{ii} or D_{ee})

All these inspection methods require measuring the tooth top (internal minor diameter, D_{ii} , or external major diameter, D_{ee}) using GO and NOT GO plain (plug or ring) gauges or other acceptable measuring devices.

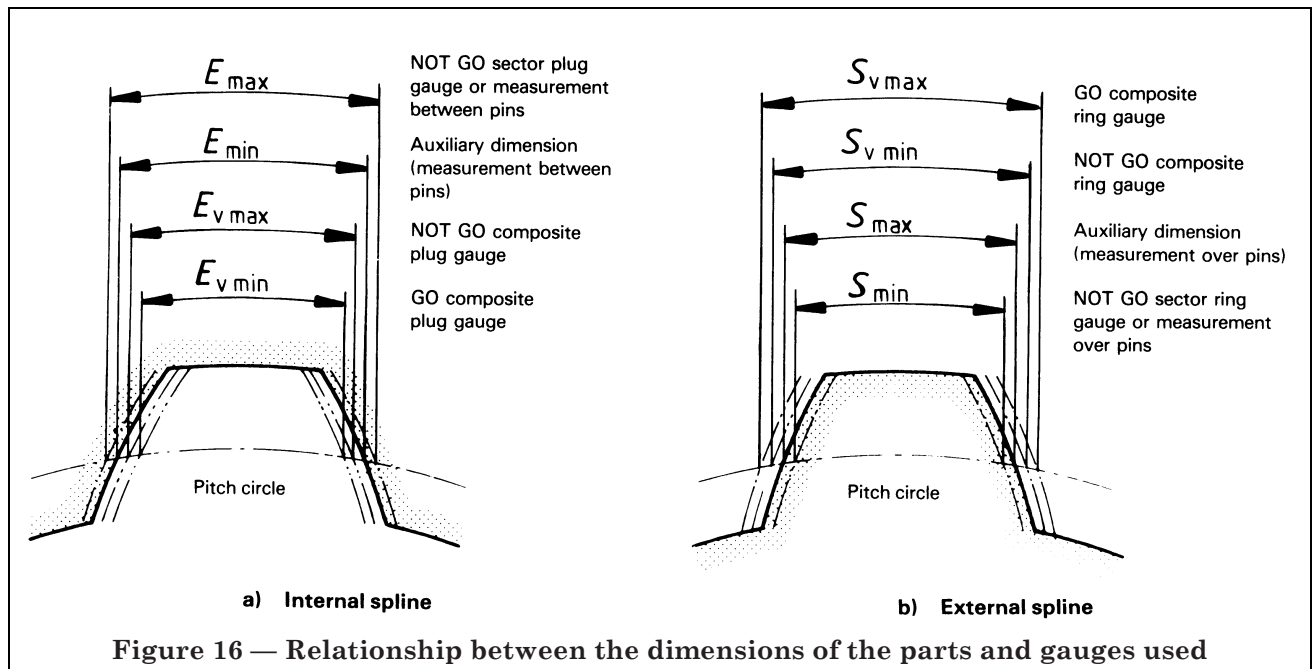
17.3 Additional inspection

Checking splines using a GO composite spline (plug or ring) gauge does not identify, if a part is rejected by the gauge, the defective dimensional elements causing the rejection.

If such cases are required to be reported, additional inspection (specifically instructed) must be made by analytical inspection (see clause 23) of separate dimensional measurement of actual space width or tooth thickness using two balls or pins, total cumulative pitch variation, total profile variation, and lead variation.

The choice between balls or pins for space width or tooth thickness measurement shall be specified.

Because of the difference in flank contact and of spline tooth lead variations or surface condition, measuring balls and pins will probably not provide the same measurement results for space width or tooth thickness.



17.4 Influence of the “active spline length” and of the “length of engagement” [see Figure 17 a) and Figure 17 b)]

The definitions of length of engagement, g_y , and of active length, g_w , are given in clause 2.

Since check gauges are often shorter than the parts to be checked, the “active length” and “length of engagement” may influence the maximum permissible alignment of splines (parallelism error of the splines with respect to the axis).

If the “length of engagement” is smaller than or equal to half the pitch diameter, and if the “active length” is equal to the “length of engagement”, alignment variations of splines can generally, unless otherwise specified, be included in the total tolerances ($T + \lambda$) (defined in clause 6), and checked simultaneously by limit gauges according to the inspection methods specified in 17.2.1, 17.2.2 and 17.2.3.

In the case where the “length of engagement” is greater than half the pitch diameter and the “active length” is greater than or equal to the “length of engagement”, it might be necessary to prescribe spline alignment tolerances independent of the total tolerance ($T + \lambda$); these tolerances may then have to be checked separately by “analytical inspection”.

If particular spline alignment tolerances are specified, account should be taken that they should generally be proportionally all the smaller since the “active length” or the “length of engagement” or both will be greater.

17.5 Conditions for use of gauges

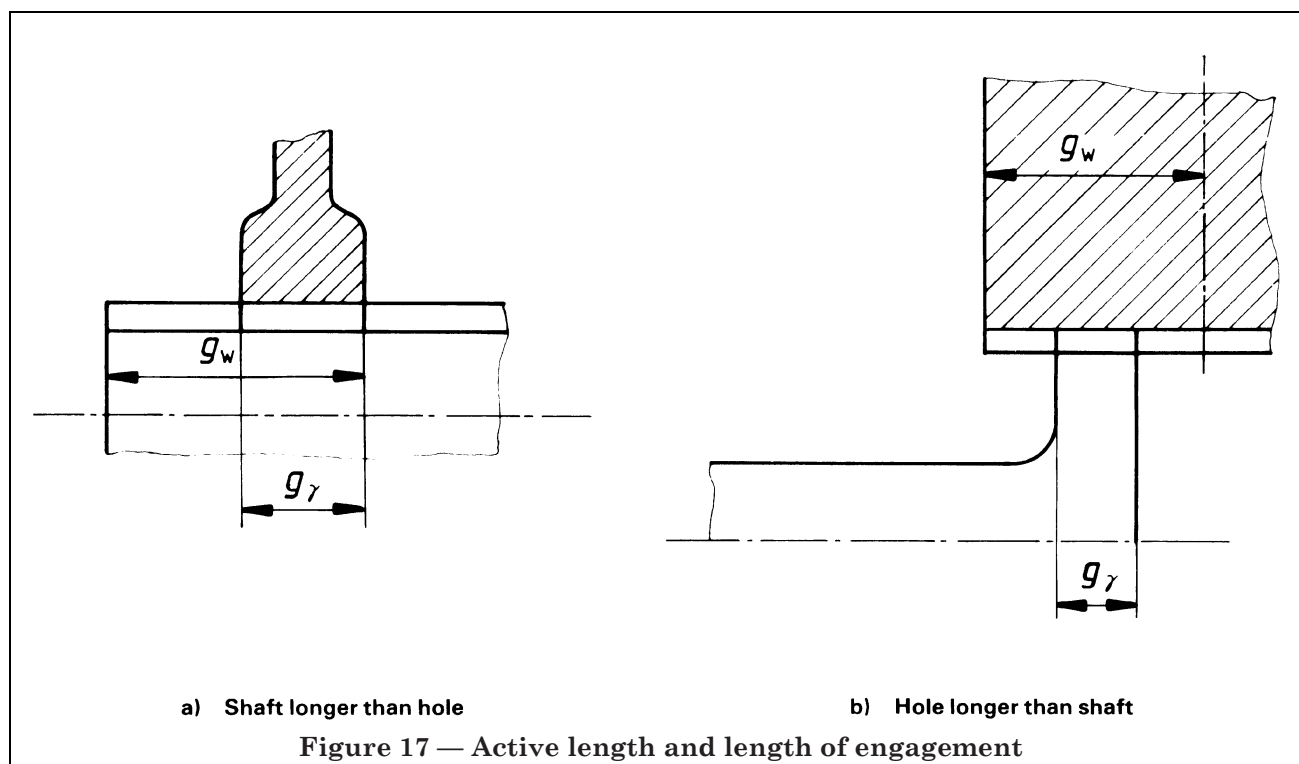
17.5.1 GO side

GO composite gauges (spline ring or plug) shall pass over the specified spline length without forcing. The gauge weight or a specified load may be used.

A small movement may be imparted to the gauge in order to minimize the effects of friction.

17.5.2 NOT GO side

NOT GO gauges are used in the same way as the gauges for checking plain cylindrical parts; checking is made at least in three angular positions as equally distributed as possible.



17.6 Limiting dimensions of use for gauges

Practical use for gauges is limited by gauge weight and dimensions.

Parts with a pitch diameter $D \leq 180$ mm can normally be checked by limit gauges.

Parts with a pitch diameter $D > 180$ mm can be checked by limit gauge only if agreed between the customer and the supplier. Wherever possible, the weight of the gauge shall not exceed 10 kg.

17.7 Inspection of gauges

17.7.1 Dimensional inspection

17.7.1.1 The actual dimensions of composite or sector spline plug gauges are normally checked by direct measurement and by balls or plain cylindrical pins. The choice between balls or pins checking shall be specified explicitly and checking shall involve all tooth spaces.

It should be noted that due to their geometry, measuring balls or pins do not integrate the defects of checked parts in an equivalent manner, especially surface condition or lead variations.

17.7.1.2 The dimensions of composite or sector splines ring gauges are normally checked by “master” composite plug gauges and by balls or plain cylindrical pins.

“Master” plug gauges are tapered on one side of all teeth and are themselves normally checked by direct measurement and by balls in well-defined planes.

17.7.1.3 Plain (ring or plug) gauges are checked in the same conditions as those gauges used for plain cylindrical part inspection.

17.7.2 Inspection of gauge variation allowance

Gauges may show total index variations, total profile variation, and lead variation.

If these variations should be checked, this can be done by “analytical inspection” (see clause 23) which allows inspection of each variation separately. In principle, analytical inspection only applies to plug gauges or “master” plug gauges. It can apply to ring gauges only in the case where no “master” plug gauge is available for checking.

It should be noted that this analytical inspection of ring gauges is more severe than inspection by “master” plug gauge because of the fact that variation allowances are inspected independently of dimensions, which may lead at the maximum material condition limits to the rejection of ring gauges which would otherwise have been accepted by a “master” plug gauge.

18 Manufacturing tolerances for spline gauges

This addendum specifies a unique grade for spline gauges, based upon the spline tolerance class 6.

Manufacturing tolerances for GO and NOT GO gauges and for wear limits on the GO side are given in Table 118 to Table 121.

NOTE 1 Table 118 to Table 121 concern especially actual limits of gauge space width or gauges tooth thickness.

NOTE 2 Form errors of gauges are always independent of dimensional tolerances. Their individual values are indicated in Table 124 and their cumulated values (E , E_1) in Table 118 to Table 121.

NOTE 3 In the limiting cases where gauges are manufactured at the maximum material condition, form errors lead to a displacement of the limits of acceptance of the parts.

18.1 Positions of tolerance zone and wear limits in relation to the limits of the part to be checked

The relative positions are shown in terms of diagrams in Table 120.

NOTE A wear limit is required and provided only for GO gauges.

18.2 Values for gauge tolerances

The definition of the range of the dimensional tolerance zone for space width and tooth thickness of gauges is based on the same principle as for the total tolerance ($T + \lambda$) of the parts in tolerance class 6 (see clause 6).

Gauge tolerances are based on the ISO fundamental tolerances (IT) of grades 3 to 5, as given in Table 118.

Table 118 — Manufacturing tolerances for gauges — Unique grade

Unique tolerance grade applicable to parts of tolerance class	Tolerance qualities of part	Tolerances							
		for plug gauges				for ring gauges			
		H^a	E^c	Z^b	Y^d	H_1^a	E_1^c	Z_1^b	Y_1^d
4	IT6 ^a + IT9 ^b	GO plug gauge				GO ring gauge			
5	IT7 ^a + IT10 ^b	IT3	—	IT5	$\frac{IT3}{2}$	IT4	—	IT5	$\frac{IT4}{2}$
6	IT8 ^a + IT11 ^b	NOT GO plug gauge				NOT GO ring gauge			
7	IT9 ^a + IT12 ^b	IT3	—	—	—	IT4	—	—	—
^a Tolerance based on pitch diameter. ^b Tolerance based on theoretical space width or tooth thickness, see note 2 below. ^c For the calculation of E and E_1 , see note 1 below. ^d $Y = H/2$ and $Y_1 = H_1/2$; tolerance based on pitch diameter, see note 3 below.									

NOTE 1 Values given for H and H_1 (dimensional tolerances of the gauges) are in accordance with those given in ISO/R 1938, *ISO system of limits and fits — Part 2: Inspection of plain workpieces*.

E and E_1 (cumulative form tolerances of the gauges) are calculated from the equation:

$$E \text{ or } E_1 = 0,6 \sqrt{(\text{profile variation})^2 + (\text{index variation})^2 + (\text{lead variation})^2}$$

applied to Table 124, taking account of the measuring length of gauges given in Table 122 and Table 123. The values of E and E_1 given in Table 121 are rounded values.

NOTE 2 The values given for Z and Z_1 (corresponding to the position of the GO gauge tolerance zone, in relation to the GO limit of the workpiece; see Table 120) are the part of the gauge tolerance which is based on the theoretical space width or tooth thickness.

NOTE 3 The values given for Y and Y_1 (corresponding to the displacement, outside the GO workpiece limit, of the wear limit of gauge; see Table 120) have been selected respectively equal to $H/2$ and $H_1/2$.

18.3 Special provisions

18.3.1 If agreed between customer and manufacturer, gauges of grades other than the unique grade can be created, in accordance with ISO/R 1938 and taking account of the tolerance class of the part to be checked, as shown in Table 119.

Table 119 — Manufacturing tolerances for gauges — Grades other than the unique grade

Tolerance grades applicable to parts of tolerance class	Tolerance qualities of the part	Tolerances							
		for plug gauges				for ring gauges			
		H^a	E^c	Z^{be}	Y^{de}	H_1^a	E_1^c	Z_1^{be}	Y_1^{de}
4	IT6 ^a + IT9 ^b	IT2	—	IT3	$\frac{IT2}{2}$	IT3	—	IT4	$\frac{IT3}{2}$
5	IT7 ^a + IT10 ^b	IT3	—	IT3	$\frac{IT3}{2}$	IT3	—	IT4	$\frac{IT3}{2}$
6	IT8 ^a + IT11 ^b	IT3	—	IT5	$\frac{IT3}{2}$	IT4	—	IT5	$\frac{IT4}{2}$
7	IT9 ^a + IT12 ^b	IT3	—	IT5	$\frac{IT3}{2}$	IT4	—	IT5	$\frac{IT4}{2}$

^a Tolerance based on pitch diameter.
^b Tolerance based on theoretical space width or tooth thickness, see note 2 in 18.2.
^c For the calculation of E and E_1 , see note 1 in 18.2.
^d $Y = H/2$ and $Y_1 = H_1/2$; tolerance based on pitch diameter, see note 3 in 18.2.
^e For GO gauges only.

18.3.2 Spline gauges with a pitch diameter $D > 180$ mm shall be created according to the same rules as stated above.

However, for the part of the gauge tolerance based on the pitch diameter, a shift of the NOT GO gauge tolerance zone and of the wear limit of the GO gauge with respect to the checked limits of pieces shall be taken into account.

The shift, for which values α for plug gauges and α_1 for ring gauges are given in ISO/R 1938, is intended to compensate measuring uncertainties of gauges.

Table 120 — Positions of gauge tolerances

Piece			Gauge			
	Actual	Effective	Normal method	Method A	Method B	Master plug size
$E_{\max}$ (actual space width)						
$E_{\min}$			See 17.2.2.4			
$E_{v\max}$						
$E_{v\min}$ (effective space width)						
$S_{v\max}$ (effective tooth thickness)		$C_{v\max}$ $C_{v\min}$				
$S_{v\min}$						
$S_{\max}$						
$S_{\min}$ (actual tooth thickness)			See 17.2.2.4			

Table 121 — Values of dimensional tolerances of spline gauges for the recommended grade

Tolerances in micrometres

Pitch diameter D mm	GO and NOT GO plug gauges					GO and NOT GO ring gauges				
	Tolerance	Theoretical circular space width, E (mm)				Tolerance	Theoretical circular tooth thickness, S (mm)			
		$0 < E \leq 3$	$3 < E \leq 6$	$6 < E \leq 10$	$10 < E \leq 18$		$0 < S \leq 3$	$3 < S \leq 6$	$6 < S \leq 10$	$10 < S \leq 18$
$1 \leq D \leq 3$	H E Z Y	2 5 4 1				H_1 E_1 Z_1 Y_1	3 5 4 1,5			
$3 < D \leq 10$	H E Z Y	2,5 5 4 1,25				H_1 E_1 Z_1 Y_1	4 5 4 2			
$10 < D \leq 18$	H E Z Y	3 5 4 1,5	3 5 5 1,5			H_1 E_1 Z_1 Y_1	5 5 4 2,5	5 5 5 2,5		
$18 < D \leq 30$	H E Z Y	4 5 4 2	4 5 5 2	4 5 6 2		H_1 E_1 Z_1 Y_1	6 5 4 3	6 5 5 3	6 5 6 3	
$30 < D \leq 50$	H E Z Y	4 5 4 2	4 5 5 2	4 5 6 2	4 5 8 2	H_1 E_1 Z_1 Y_1	7 5 4 3,5	7 5 5 3,5	7 5 6 3,5	7 5 8 3,5
$50 < D \leq 80$	H E Z Y	5 5 4 2,5	5 5 5 2,5	5 5 6 2,5	5 5 8 2,5	H_1 E_1 Z_1 Y_1	8 5 4 4	8 5 5 4	8 5 6 4	8 5 8 4
$80 < D \leq 100$	H E Z Y	6 5 4 3	6 5 5 3	6 5 6 3	6 5 8 3	H_1 E_1 Z_1 Y_1	10 5 4 5	10 5 5 5	10 5 6 5	10 5 8 5
$100 < D \leq 120$	H E Z Y	6 6 4 3	6 6 5 3	6 6 6 3	6 6 8 3	H_1 E_1 Z_1 Y_1	10 6 4 5	10 6 5 5	10 6 6 5	10 6 8 5
$120 < D \leq 150$	H E Z Y	8 6 4 4	8 6 5 4	8 6 6 4	8 6 8 4	H_1 E_1 Z_1 Y_1	12 6 4 6	12 6 5 6	12 6 6 6	12 6 8 6
$150 < D \leq 180$	H E Z Y	8 7 4 4	8 7 5 4	8 7 6 4	8 7 8 4	H_1 E_1 Z_1 Y_1	12 7 4 4	12 7 5 4	12 7 6 4	12 7 8 4
	Corresponding standardized modules (mm)									
		0,25 0,5 0,75 1 1,25 1,5 1,75	2 2,5 3	4 5 6	8 10		0,25 0,5 0,75 1 1,25 1,5 1,75	2 2,5 3	4 5 6	8 10

19 Length of measuring part of gauges

19.1 GO or NOT GO gauges

The values given for the minimum length of the measuring part of GO or NOT GO plain or spline gauges are those in ISO 3670, *Blanks for plug gauges and handles (taper lock and trilock) and ring gauges — Design and general dimensions*.

The length of the composite GO gauges shall comply with ISO 3670. In the case where the length of engagement is greater than 1,5 times the value given in Table 122 or Table 123, the active length of the GO composite spline plug or ring gauge should be increased. A gauge length of 75 % of the length of engagement is usually satisfactory. This shall be subject to prior agreement between purchaser and manufacturer.

NOTE GO and NOT GO spline gauges may include a non-measuring part (plain cylindrical part or chamfer) intended for making gauge entrance easier.

**Table 122 — Measuring part of ring gauges —
Minimum length**

Dimensions in millimetres

Pitch diameter of splines D	Minimum length of spline or plain ring gauges	
	GO	NOT GO
$1 \leq D \leq 2,5$	6	4
$2,5 < D \leq 5$	10	5
$5 < D \leq 10$	12	8
$10 < D \leq 15$	14	10
$15 < D \leq 20$	16	12
$20 < D \leq 25$	18	14
$25 < D \leq 32$	20	16
$32 < D \leq 40$	24	18
$40 < D \leq 50$	32	20
$50 < D \leq 60$	32	20
$60 < D \leq 70$	32	24
$70 < D \leq 80$	32	24
$80 < D \leq 90$	32	24
$90 < D \leq 100$	32	24
$100 < D \leq 110$	40	24
$110 < D \leq 120$	40	24
$120 < D \leq 140$	45	24
$140 < D \leq 180$	50	30

Table 123 — Measuring part of plug gauges — Minimum length

Dimensions in millimetres

Pitch diameter of splines D	Minimum length of spline or plain plug gauges	
	GO	NOT GO
$1 \leq D \leq 3$	6,5	4,5
$3 < D \leq 6$	8	6
$6 < D \leq 10$	10	7
$10 < D \leq 14$	12	8
$14 < D \leq 18$	14	10
$18 < D \leq 24$	16	12
$25 < D \leq 30$	18	14
$30 < D \leq 40$	20	15
$40 < D \leq 50$	25	18
$50 < D \leq 65$	30	18
$65 < D \leq 80$	35	25
$80 < D \leq 90$	35	25
$90 < D \leq 95$	35	25
$95 < D \leq 100$	35	25
$100 < D \leq 110$	35	25
$110 < D \leq 120$	40	25
$120 < D \leq 140$	45	30
$140 < D \leq 180$	50	30

19.2 Tapered tooth master plug gauges**19.2.1 GO master gauges**

The length of the measuring part of the GO master plug gauge shall be determined taking into account the following cumulative elements:

- a lead length corresponding to the minimum length of the measuring part of the checked GO ring;
- a checking length, function of the mating side taper of the GO master plug gauge (see 17.7.1.2) and of the range of the dimensional tolerance of the checked GO ring;
- a wear length, function of the side taper of the GO master plug gauge and of the range of the wear tolerance of the checked GO ring.

19.2.2 NOT GO master gauges

The length of the measuring part of the NOT GO master plug gauge (composite or sector) shall be determined based on the following cumulative elements:

- a lead length, corresponding to the minimum length of the measuring part of the checked NOT GO ring;
- a checking length, function of the mating side taper of the NOT GO master plug gauge and of the range of the dimensional tolerance of the checked NOT GO ring.

19.3 Spline gauges of pitch diameters $D > 180$ mm

For spline gauges having a pitch diameter $D > 180$ mm it is advisable to choose a measuring length equal to

- 30 % of the pitch diameter for GO gauges;
- 20 % of the pitch diameter for NOT GO gauges.

20 Grips of spline gauges

The grips of spline gauges shall be those currently permitted in ISO 3670 for plain or threaded gauges of similar dimensions.

Plug gauges of pitch diameter $D \leq 50$ mm may be integral.

21 Values of variation allowances of spline gauges

The variations of form checked on spline gauges are the same as those checked on corresponding parts, i.e.:

- total cumulative pitch variation (index variations);
- total profile variation;
- total lead variation.

Whatever the accuracy of the gauge, the values accepted for variation allowances are those indicated in Table 124.

NOTE GO spline gauges may show a plain cylindrical thoroughly machined proof diameter intended for possible inspection of the radial run-out of the gauge teeth and the product run-out (after the part has been mounted on the gauge).

Table 124 — Variation allowances of spline gauges

Tolerances in micrometres

Pitch diameter D mm	Total profile variation (see 23.2.2)	Total index variation (see 23.2.1)	Total lead variation for a measuring length of the gauge		Radial run-out (see note)	
			less than or equal to 25 mm (see 23.2.3)	greater than 25 mm (see 23.2.3)	Ring	Plug
$D \leq 100$	5	5	3	5	10	7
$100 < D \leq 150$	5	8	3	5	15	10
$150 < D \leq 180$	5	10	—	5	15	10

NOTE Inspection made with respect to the centre line for plugs, with respect to a cylindrical external band for rings. The cumulative amount of profile variation, index variation and lead variation is given by the value E or E_1 (see note 1 in 18.2).

21.1 Cumulation of variation allowances

The cumulation of gauge variation allowances shall be considered as follows (see Figure 18).

- On the control circle, the envelope of the total profile variation measured over 360° and defined by arc AB shall always lie within the envelope of the total index variation measured over 360° and defined by arc CD.
- The lead variation shall be checked independently of all the above-mentioned variations, over the whole measuring length of the gauge at the control circle level.

21.2 Spline gauges of pitch diameters $D > 180$ mm

For spline gauges having a pitch diameter $D > 180$ mm it is advisable to choose the following values for the variation allowances:

- total profile variation: 7 μm
- total index variation: 12 μm
- total lead variation: 8 μm

For cumulated variation allowances, see clause 21.1.

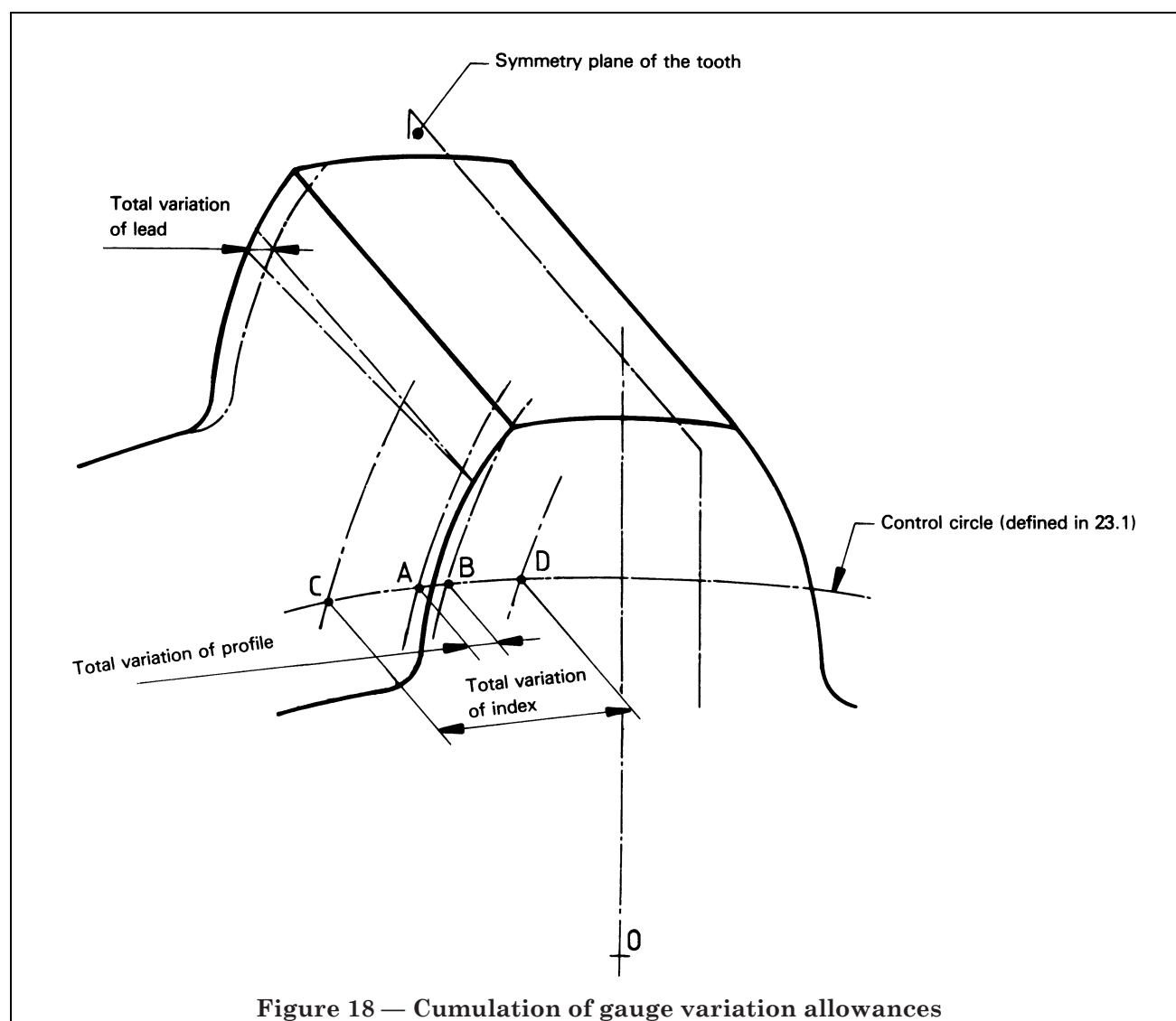


Figure 18 — Cumulation of gauge variation allowances

22 Dimensions, designation and marking of gauges

The dimensions, designation and marking of gauges are specified in 22.1 to 22.3.

22.1 Inspection of external splines

22.1.1 GO composite ring gauge

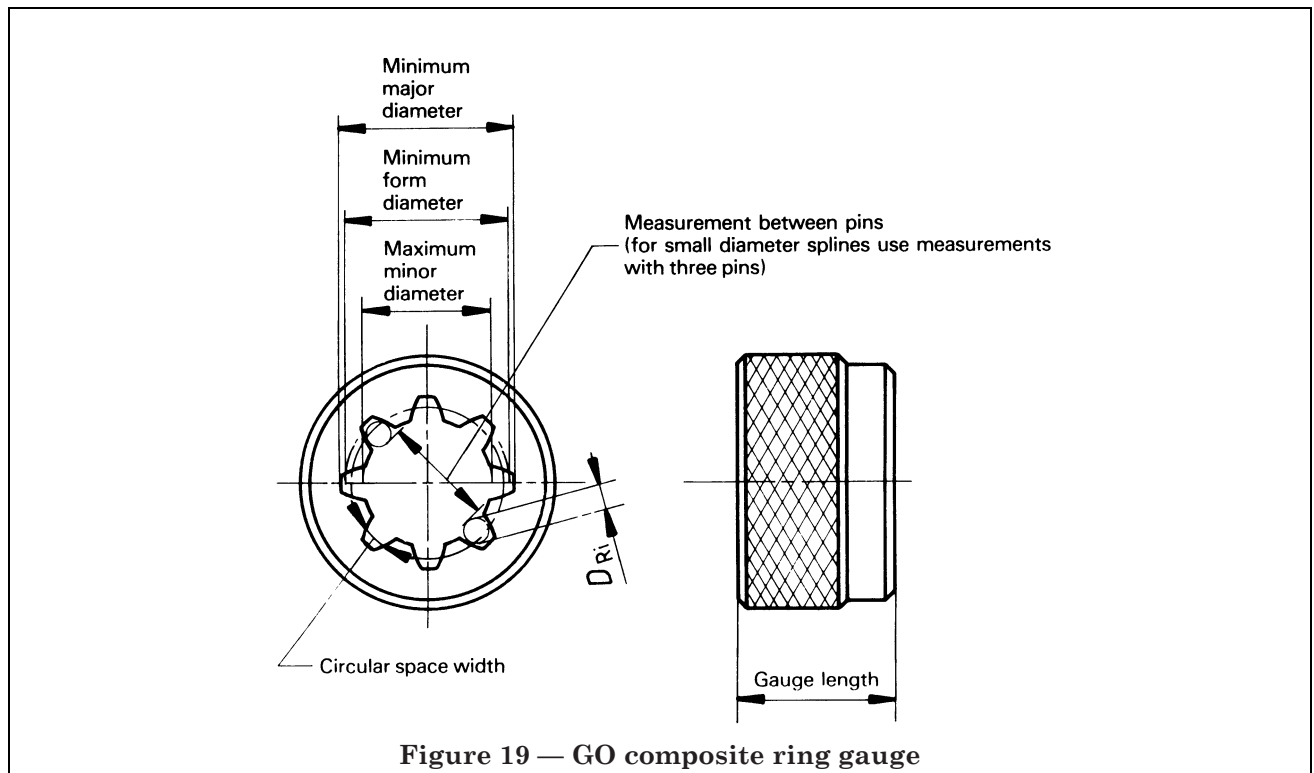


Figure 19 — GO composite ring gauge

Table 125 — Dimensions and tolerances of GO composite ring gauges

Gauge dimensions	Formulas	Manufacturing tolerances
Pitch diameter	D	K7 ^b $-Z_1 \pm H_1/2$
Minimum major diameter	$D_{ee \max} + 2 c_F^a + 0,1 m$	
Minimum form diameter	$D_{ee \max} + 2 c_F$	
Maximum minor diameter	$D_{Fe \max}$	
Circular space width at pitch diameter	$S_{v \max} = S$ displaced by the amount of the fundamental deviation of the part	
New gauge	$S_{v \max} = S - c_{v \min}$	
Wear limit	$S_{v \max} + Y_1$	
Variation of form	E_1	
Pin diameter	D_{Ri} (the same as for corresponding internal spline)	
Measurement between pins: New gauge	see 23.3.4.1.2	
Worn gauge	see 23.3.4.1.2	
The minimum major diameter shall clear the pin diameter. Calibrating length of the ring, see Table 122.		
NOTE See Table 121 for the values of H_1 , Z_1 , Y_1 and E_1 .		
^a $c_F = 0,1 m$		
^b See ISO 286, ISO system of limits and fits.		

Gauge designation

Taking the example from 12.3, a GO composite ring for external spline

EXT 24Z $\times$ 2,5 m $\times$ 30R $\times$ 5f ISO 4156

shall be marked

GO 24Z $\times$ 2,5 m $\times$ 30R $\times$ 5f ISO 4156

22.1.2 Tapered tooth master plug gauge for GO composite ring gauge

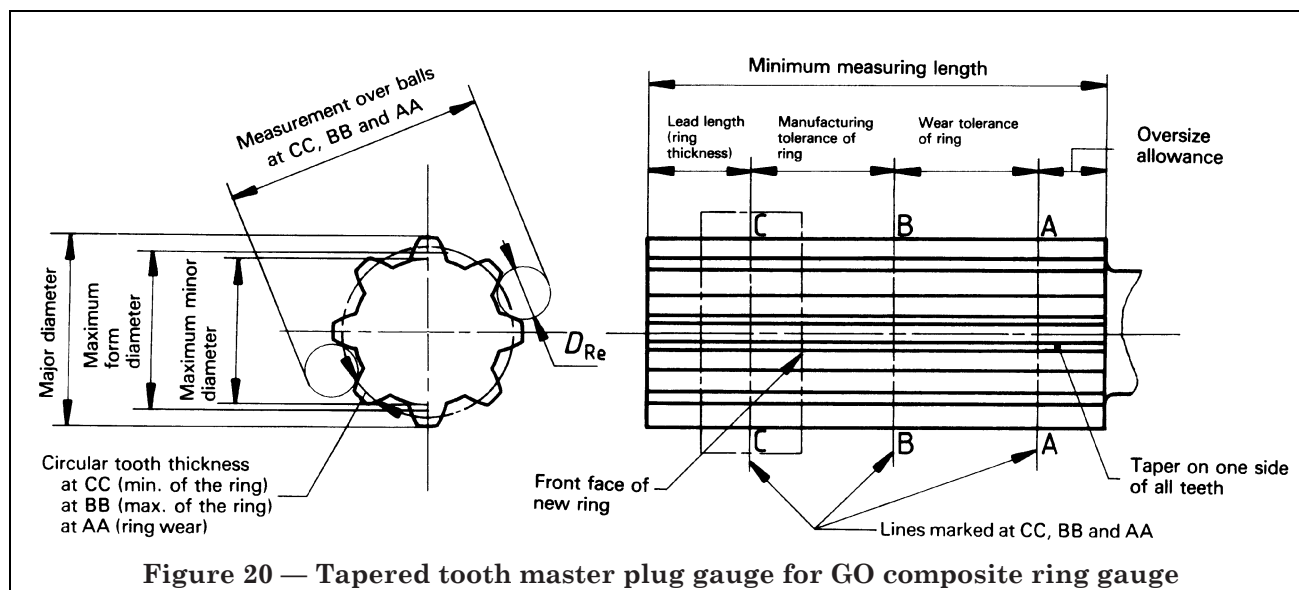


Figure 20 — Tapered tooth master plug gauge for GO composite ring gauge

Table 126 — Dimensions and tolerances of tapered tooth master plug gauges for GO composite ring gauges

Gauge dimensions	Formulas	Manufacturing tolerances
Pitch diameter	D	h8 ^b
Major diameter	$D_{\text{ee min}} - 2\ c_{\text{F}}^{\text{a}}$	
Maximum form diameter	$D_{\text{Fe max}} - 0,1\ m$	
Circular tooth thickness		
at CC (minimum of the ring)	$S_{\text{v max}} - Z_1 - H_1/2$	
at BB (maximum of the ring)	$S_{\text{v max}} - Z_1 + H_1/2$	
at AA (ring wear)	$S_{\text{v max}} + Y_1$	
Variation of form	E_1	
Taper on one side	0,02 % min.	
Maximum minor diameter	$D_{\text{Fe max}} - 2\ c_{\text{F}}$	
Ball diameter	D_{Re} (the same as for corresponding external spline)	
Measurement over balls	see 23.3.4.1.1	
The maximum minor diameter shall clear the ball diameter.		
NOTE See Table 121 for the values of H_1 , Z_1 , Y_1 and E_1 .		
^a $c_{\text{F}} = 0,1\ m$		
^b See ISO 286, <i>ISO system of limits and fits</i> .		

Gauge designation

Taking the example from 12.3, a master plug gauge for ring

GO 24Z × 2,5 m × 30R × 5f ISO 4156

shall be marked

master GO ring 24Z × 2,5 m × 30R × 5f ISO 4156

(or master GO ring may be replaced by M.G.R.)

22.1.3 NOT GO two-sector ring gauge

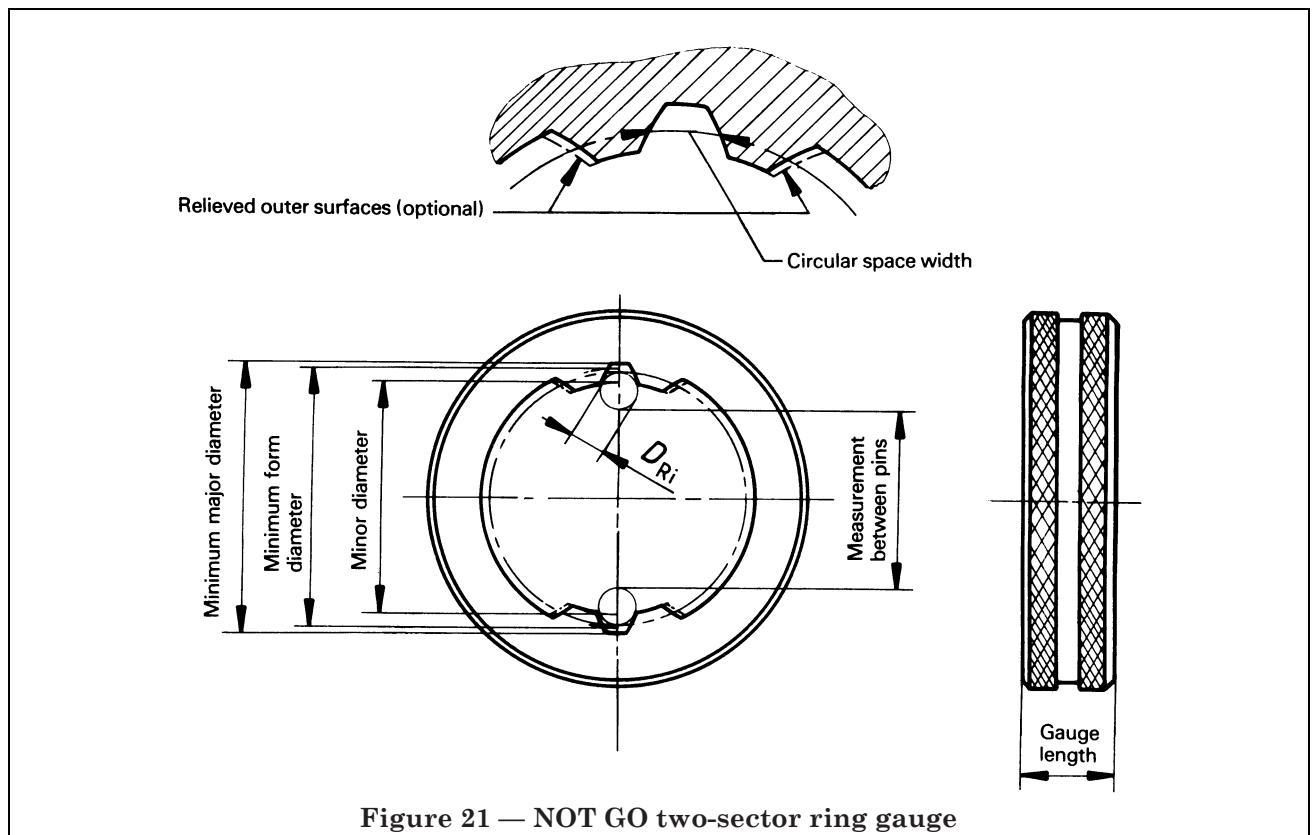


Figure 21 — NOT GO two-sector ring gauge

Table 127 — Dimensions and tolerances of NOT GO two-sector ring gauges

Gauge dimensions	Formulas	Manufacturing tolerances
Pitch diameter	D	
Minimum major diameter	$D_{ee \max} + 2 c_F^a + 0,1 m$	
Minimum form diameter	$D_{ee \max} + 2 c_F$	
Minor diameter	$\frac{D + 2 D_{Fe \max}}{3}$	JS8 ^b
Variation of form	E_1	
Circular space width at pitch diameter	$S_{\min}$	$\pm H_1/2$
Pin diameter	D_{Ri} (the same as for corresponding internal part)	
Measurement between pins	see 23.3.4.1.2	
The minimum major diameter shall clear the pin diameter. Calibrating length of ring, see Table 122.		
NOTE See Table 121 for the values of H_1 and E_1 .		
^a $c_F = 0,1 m$		
^b See ISO 286, ISO system of limits and fits.		

Gauge designation

Taking the example from 12.3, a NOT GO sector ring gauge for external splines

EXT 24Z $\times$ 2,5 m $\times$ 30R $\times$ 5f ISO 4156

shall be marked

NOT GO 24Z $\times$ 2,5 m $\times$ 30R $\times$ 5f ISO 4156

Number of sector teeth

Table 128 — Number of sector teeth

Total number of product teeth, Z	$6 < Z \leq 30$	$31 < Z \leq 44$	$45 < Z \leq 58$	$59 < Z \leq 72$	$73 < Z \leq 86$	$87 < Z \leq 100$	$Z > 100$
Number of space widths in each sector	2	3	4	5	6	7	$0,075 Z$

22.1.4 Tapered tooth master plug gauge for NOT GO two-sector ring gauge

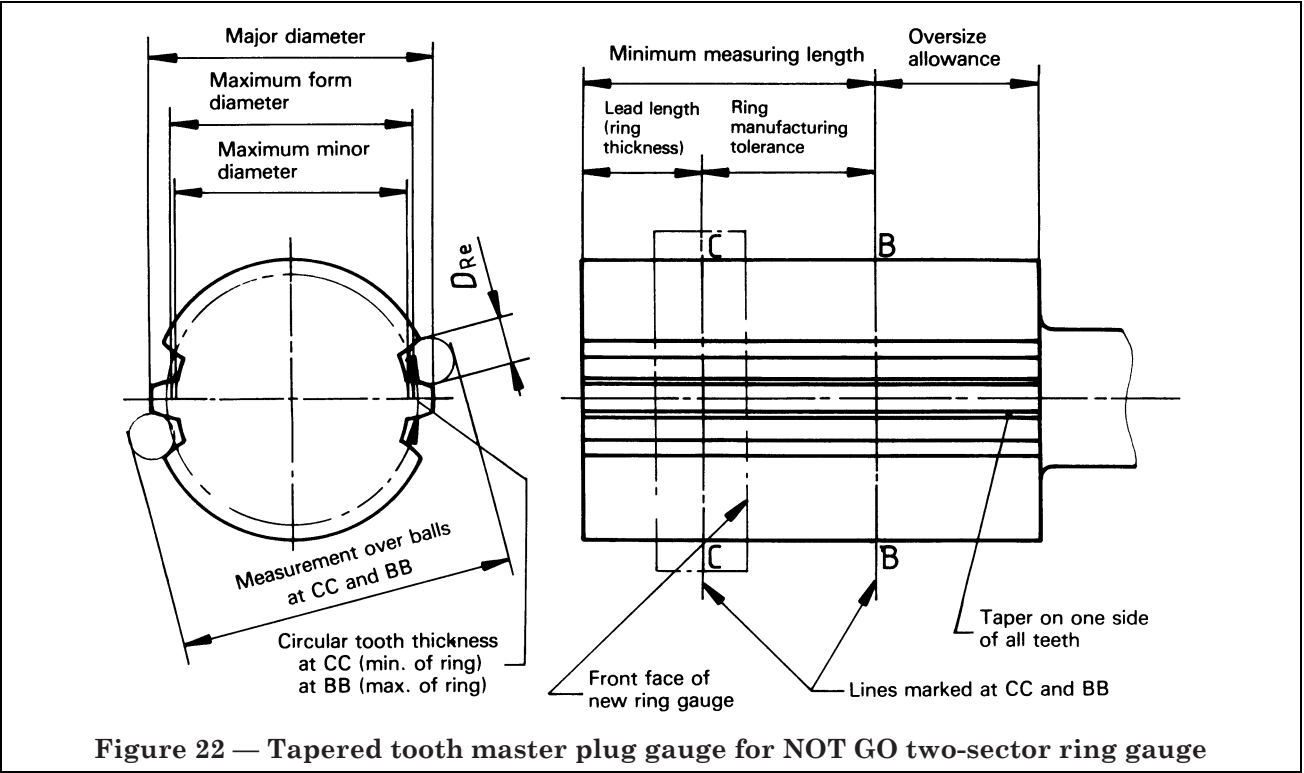


Figure 22 — Tapered tooth master plug gauge for NOT GO two-sector ring gauge

Table 129 — Dimensions and tolerances of tapered tooth master plug gauges for NOT GO two-sector ring gauges

Gauge dimensions	Formulas	Manufacturing tolerances
Pitch diameter	D	h8 ^b
Major diameter	$D_{ee\ min} - 2\ c_F^a$	
Maximum form diameter	$\frac{D + 2\ D_{Fe\ max}}{3} - 0,1\ m$	
Circular tooth thickness at CC (minimum of ring) at BB (maximum of ring)	$S_{min} - H_1/2$ $S_{min} + H_1/2$	
Variation of form	E_1	
Taper on one side	0,02 % min.	
Maximum minor diameter	$\frac{D + 2\ D_{Fe\ max}}{3} - 0,2\ m$	
Ball diameter	D_{Re} (the same as for corresponding external spline)	
Measurement over balls	see 23.3.4.1.1	
The maximum minor diameter shall clear the ball diameter.		
NOTE See Table 121 for the values of H_1 and E_1 .		
^a $c_F = 0,1\ m$		
^b See ISO 286, <i>ISO system of limits and fits</i> .		

Gauge designation

Taking the example from 12.3, a master plug gauge for sector ring

NOT GO 24Z $\times$ 2,5 m $\times$ 30R $\times$ 5f ISO 4156

shall be marked

master NOT GO ring 24Z $\times$ 2,5 m $\times$ 30R $\times$ 5f ISO 4156

(or master NOT GO ring may be replaced by M.N.G.R.)

Number of sector teeth

The number of teeth of each master plug gauge sector shall always be equal to the number of space widths of each sector of the checked NOT GO ring.

22.1.5 NOT GO composite ring gauge

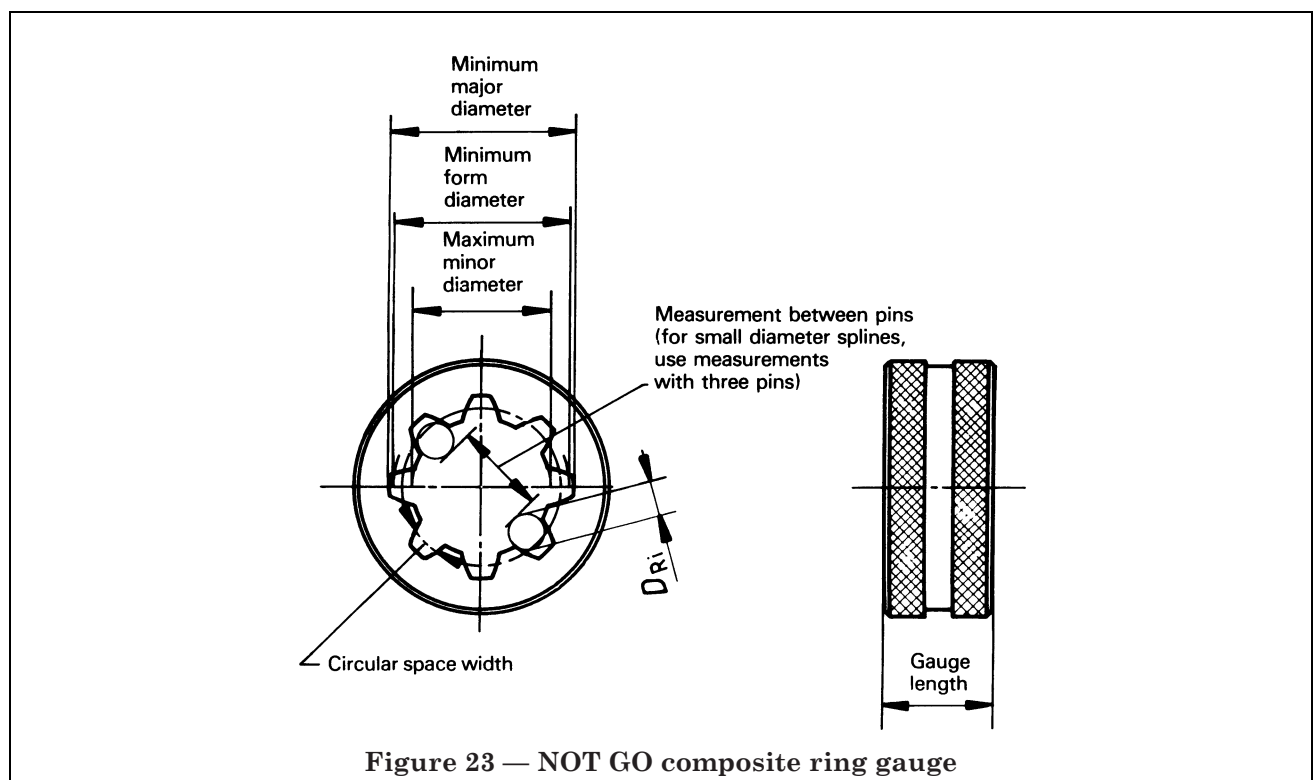


Figure 23 — NOT GO composite ring gauge

Table 130 — Dimensions and tolerances of NOT GO composite ring gauges

Gauge dimensions	Formulas	Manufacturing tolerances
Pitch diameter	D	
Minimum major diameter	$D_{ee\ max} + 2 c_F^a + 0,1\ m$	
Minimum form diameter	$D_{ee\ max} + 2 c_F$	
Maximum minor diameter	$\frac{D + 2 D_{Fe\ max}}{3}$	JS8 ^b
Circular space width at pitch diameter	$S_{min} + \lambda$	$\pm H_1/2$
Variation of form	E_1	
Pin diameter	D_{Ri} (the same as for hub pin)	
Measurement between pins	see 23.3.4.1.2	
The minimum major diameter shall clear the pin diameter.		
Calibrating length of ring: see Table 122.		
NOTE See Table 121 for the values of H_1 and E_1 .		
^a $c_F = 0,1\ m$		
^b See ISO 286, ISO system of limits and fits.		

Gauge designation

Taking the example from 12.3, a NOT GO composite ring gauge for external splines

EXT 24Z × 2,5 m × 30R × 5f ISO 4156

shall be marked

NOT GO 24Z × 2,5 m × 30R × 5f ISO 4156

22.1.6 Tapered tooth master plug gauge for NOT GO composite ring gauge

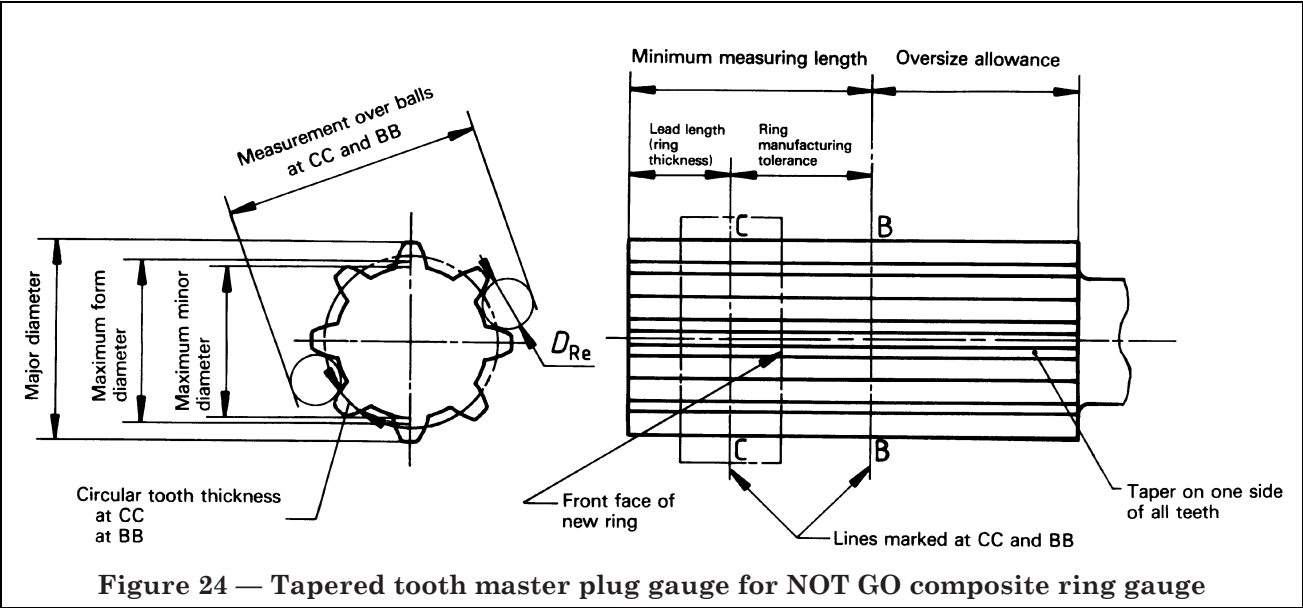


Table 131 — Dimensions and tolerances of tapered tooth master plug gauges for NOT GO composite ring gauges

Gauge dimensions	Formulas	Manufacturing tolerances
Pitch diameter	D	$h8^b$
Major diameter	$D_{ee\ min} - 2\ c_F^a$	
Maximum form diameter	$\frac{D + 2\ D_{Fe\ max}}{3} - 0,1\ m$	
Circular tooth thickness at CC (minimum of ring)	$S_{v\ min} - H_1/2$	
at BB (maximum of ring)	$S_{v\ min} + H_1/2$	
Taper on one side	0,02 % min.	
Maximum minor diameter	$\frac{D + 2\ D_{Fe\ max}}{3} - 0,2\ m$	
Variation of form	E_1	
Ball diameter	D_{Re} (same as for the corresponding external spline)	
Measurement over balls	see 23.3.4.1.1	
The maximum minor diameter shall clear the ball diameter.		
NOTE See Table 121 for the values of H_1 and E_1 .		
^a $c_F = 0,1\ m$		
^b See ISO 286, ISO system of limits and fits.		

Gauge designation

Taking the example from 12.3, a master plug gauge for composite ring

NOT GO 24Z $\times$ 2,5 m $\times$ 30R $\times$ 5f ISO 4156

shall be marked

master NOT GO ring 24Z $\times$ 2,5 m $\times$ 30R $\times$ 5f ISO 4156

(or master NOT GO ring may be replaced by M.N.G.R.)

22.2 Inspection of internal splines

22.2.1 Go composite plug gauge

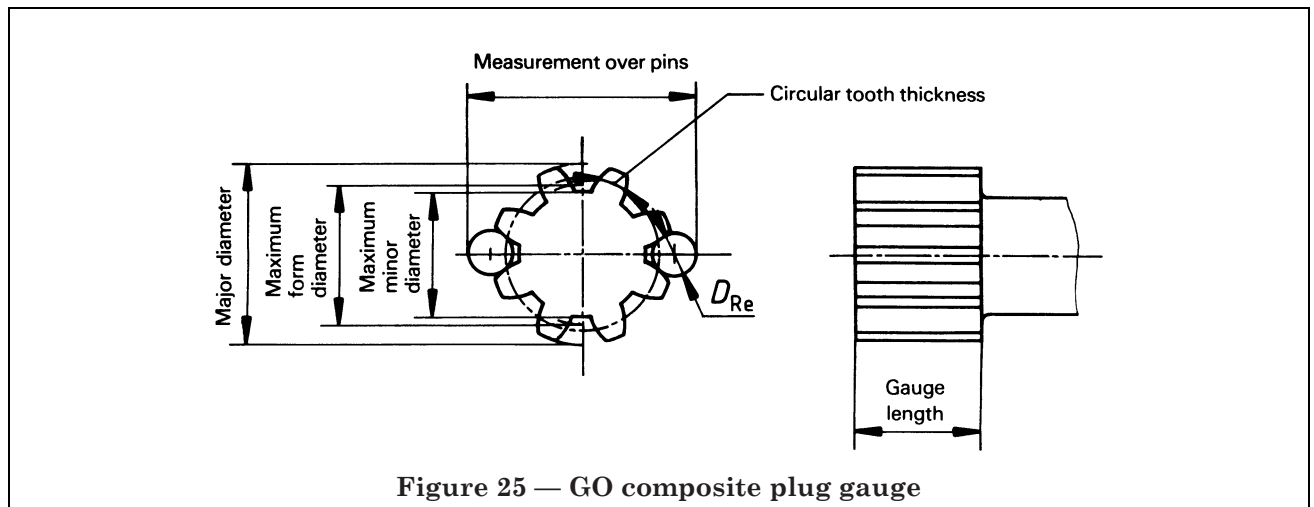


Figure 25 — GO composite plug gauge

Table 132 — Dimensions and tolerances of GO composite plug gauges

Gauge dimensions	Formulas	Manufacturing tolerances
Pitch diameter	D	k7 ^b
Major diameter	$D_{\text{Fi min}}$	
Maximum form diameter	$D_{\text{ii min}} - 2\ c_{\text{F}}^{\text{a}}$	
Maximum minor diameter	$D_{\text{ii min}} - 2\ c_{\text{F}} - 0,1\ m$	
Circular tooth thickness at pitch diameter:		+ $Z \pm H/2$
New gauge	$E_{\text{v min}}$	
Wear limit	$E_{\text{v min}} - Y$	
Variation of form	E	
Pin diameter	D_{Re} (same as for the corresponding external spline)	
Measurement over pins: New gauge	see 23.3.4.1.1	
Worn gauge	see 23.3.4.1.1	
The maximum minor diameter shall clear the form diameter and the pin diameter.		
Calibrating length of the plug: see Table 123.		
NOTE See Table 121 for the values of H , Z , Y and E .		
^a $c_{\text{F}} = 0,1\ m$		
^b See ISO 286, <i>ISO system of limits and fits</i> .		

Gauge designation

Taking the example from 12.3, a GO composite plug gauge for internal splines

INT 24Z $\times$ 2,5 m $\times$ 30R $\times$ 5H ISO 4156

shall be marked

GO 24Z $\times$ 2,5 m $\times$ 30R $\times$ 5H ISO 4156

22.2.2 NOT GO two-sector plug GAUGE

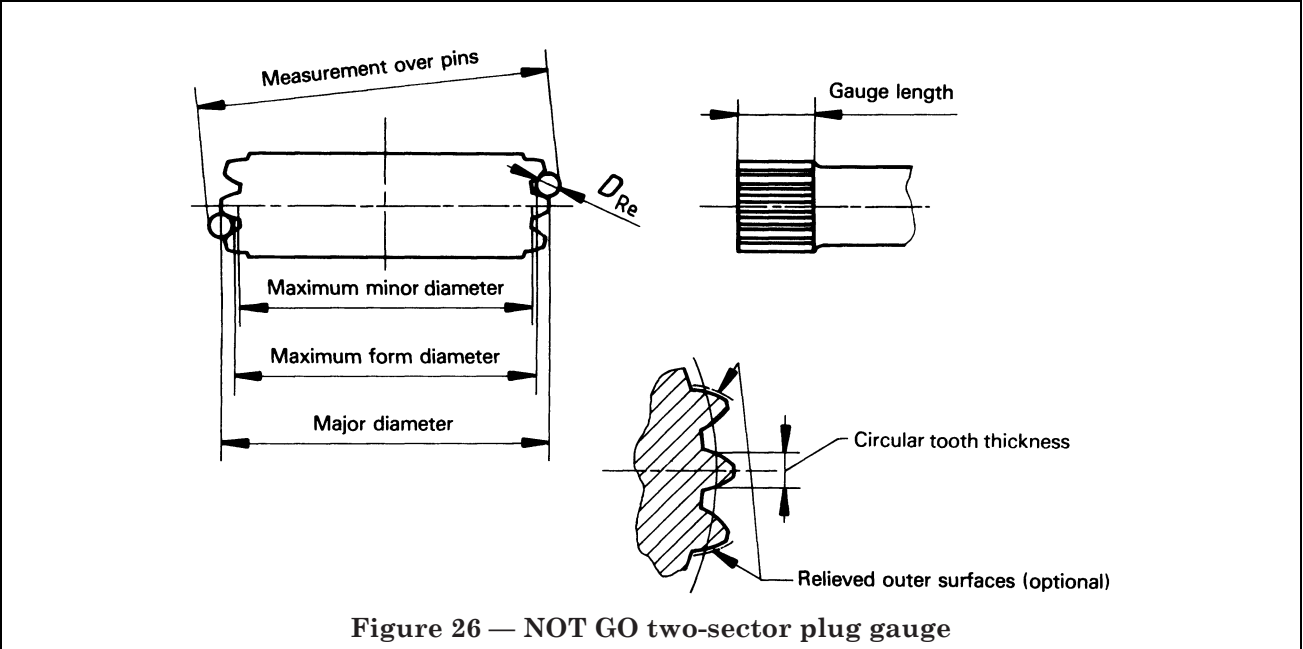


Table 133 — Dimensions and tolerances of NOT GO two-sector plug gauges

Gauge dimensions	Formulas	Manufacturing tolerances
Pitch diameter	D	$js8^b$ $\pm H/2$
Major diameter	$\frac{D + 2 D_{Fi \min}}{3}$	
Maximum form diameter	$D_{ii \min} - 2 c_F^a$	
Maximum minor diameter	$D_{ii \min} - 2 c_F - 0,1 m$	
Circular tooth thickness at pitch diameter	$E_{\max}$	
Variation of form	E	
Pin diameter	D_{Re} (the same as for corresponding external product)	
Measurement over pins	see 23.3.4.1.1	
The maximum minor diameter shall clear the pin diameter.		
Plug calibrating length: see Table 123.		
NOTE See Table 121 for the values of H and E .		
^a $c_F = 0,1 m$		
^b See ISO 286, <i>ISO system of limits and fits</i> .		

Gauge designation

Taking the example from 12.3, a NOT GO sector plug gauge for internal spline

INT 24Z × 2,5 m × 30R × 5H ISO 4156
shall be marked

NOT GO 24Z × 2,5 m × 30R × 5H ISO 4156
Number of sector teeth

Table 134 — Number of sector teeth

Total number of product teeth, Z	$6 < Z \leq 30$	$31 < Z \leq 44$	$45 < Z \leq 58$	$59 < Z \leq 72$	$73 < Z \leq 86$	$87 < Z \leq 100$	$Z > 100$
Number of teeth in each sector	2	3	4	5	6	7	$0,075 Z$

22.2.3 NOT GO composite plug gauge

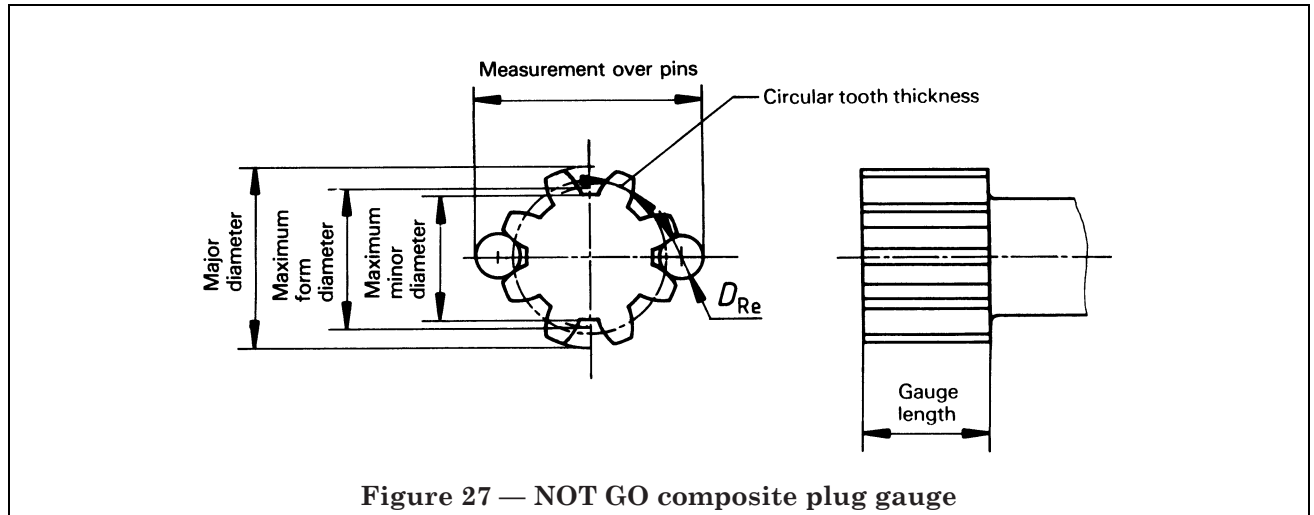


Figure 27 — NOT GO composite plug gauge

Table 135 — Dimensions and tolerances of NOT GO composite plug gauges

Gauge dimensions	Formulas	Manufacturing tolerances
Pitch diameter	D	
Major diameter	$\frac{D + 2 D_{Fi \min}}{3}$	$js8^b$
Maximum form diameter	$D_{ii \min} - 2 c_F^a$	
Maximum minor diameter	$D_{ii \min} - 2 c_F - 0,1 m$	
Circular tooth thickness at pitch diameter	$E_{\max} - \lambda$	$\pm H/2$
Variation of form	E	
Pin diameter	D_{Re} (the same as for corresponding external spline)	
Measurement over pins	see 23.3.4.1.1	
The maximum minor diameter shall clear the pin diameter.		
Plug calibrating length: see Table 123.		
NOTE See Table 121 for the values of H and E .		
^a $c_F = 0,1 m$		
^b See ISO 286, <i>ISO system of limits and fits</i> .		

Gauge designation

Taking the example from 12.3, a NOT GO composite plug gauge for internal spline

INT 24Z $\times$ 2,5 m $\times$ 30R $\times$ 5H ISO 4156

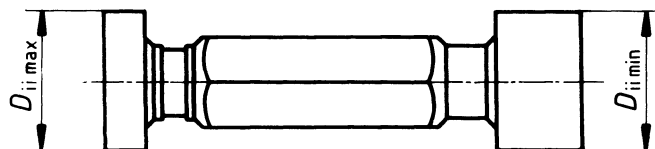
shall be marked

NOT GO 24Z $\times$ 2,5 m $\times$ 30R $\times$ 5H ISO 4156

22.3 Inspection with plain gauges for internal and external splines

22.3.1 Inspection of minor diameter — internal spline

Double plain gauge for toleranced minor diameter (D_{ii}) inspection of internal splines



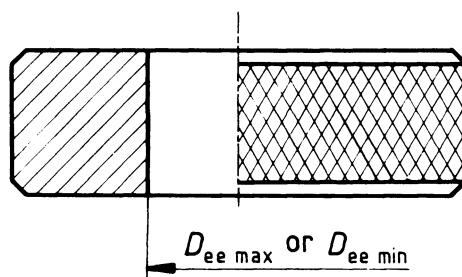
H10 for $0,25 < m < 0,75$
H11 for $1 < m < 1,75$
H12 for $2 < m < 10$

Figure 28 — Double plain gauge

Gauge blanks: in accordance with ISO 3670.

22.3.2 Inspection of major diameter — external spline

GO plain ring and NOT GO plain ring for toleranced major (D_{ee}) diameter inspection of external splines



h10 for $0,25 < m < 0,75$
h11 for $1 < m < 1,75$
h12 for $2 < m < 10$

Figure 29 — GO or NOT GO plain ring

Gauge blanks: in accordance with ISO 3670.

22.3.3 Gauge designation

Taking the example from 12.3, a double plain gauge (TLD) for internal spline

INT 24Z $\times$ 2,5 m $\times$ 30R $\times$ 5H ISO 4156

or a GO (or NOT GO) plain ring for external spline

EXT 24Z $\times$ 2,5 m $\times$ 30R $\times$ 5f ISO 4156

shall be marked

DII H10 or DII H11 or DII H12

GO DEE h10 or GO DEE h11 or GO DEE h12

NOT GO DEE h10 or NOT GO DEE h11 or NOT GO DEE h12

23 Analytical inspection

Analytical inspection is characterized by the fact that it consists of an inspection element by element of each dimensional or variation of form.

Analytical inspection allows each variation to be evaluated separately (whereas inspection with limit gauges is a “composite” inspection) and thus permits, in case a part is rejected by the gauge, identification of the element(s) of this part causing rejection.

Analytical inspection as described below mainly concerns:

- a) the analytical control of variations of form (total profile variation, total index variation, total lead variation);
- b) the measurement over pins (for external splines) or between pins (for internal splines);
- c) the measurement over k number of teeth (for external splines).

NOTE Analytical inspection applies to both parts and gauges.

23.1 General

Analytical inspection is the measurement of individual dimensions and variations.

It allows checking of roundness and concentricity if required. It also allows, when inspecting the profile, the checking of form diameters and the tooth tip chamfers.

Inspection need not be carried out at the pitch diameter, provided it occurs at a well defined circle, to be determined by agreement between the purchaser and the supplier and indicated in the inspection report.

Other inspection methods than those specified below can be used but in case of dispute only those specified in 23.2 and 23.3 shall be used as reference.

23.2 Measurement of spline variations

The effect of these variations is dealt with in clause 9.

23.2.1 Total index variation

Index variations are the variations in the spacing of all corresponding tooth profiles from theoretical spacing with respect to the arbitrarily selected tooth side in the corresponding flanks series.

The total index variation is the sum of the absolute values of the two greatest variations of opposite sign (this value of total index variation includes excentricity) (see 8.3).

The total index variation may be measured directly or obtained indirectly by measuring circular pitch variations, which are the variations from the theoretical pitch variations.

The measurement of circular pitch variations is of little value for splines unless converted to total index variation.

23.2.1.1 Index variation of tooth profiles is not identical with the index variation of the centrelines of spaces or teeth. Measurement of either variation is acceptable, since only a percentage of the total index variation is assumed to be reflected in the fit. Where readings must be repeatable, it is necessary to describe in detail the manner of inspection. Measurements taken on the centreline of internal spaces and external teeth may be more suitable for determining the effective variation since they are not influenced by space width and tooth thickness variations. Furthermore, determination of the spacing of tooth profiles permits contact analysis and separate inspection of drive and coast sides. Index variation is usually measured normal to the tooth surface as shown in Figure 31 b). This practice yields readings smaller than the variation at the pitch circle [see Figure 31 a)] but is generally accepted.

23.2.1.2 The total index variation may be inspected directly by means of precision indexing devices. Readings may be recorded as shown in Figure 32. However, the readings may be affected by excentricity. It is therefore useful to dissociate index variation from excentricity of the splines as a whole and a proposed method is described below.

When recordings are taken (as shown on Figure 32) on perfect splines rotated about an axis offset from their true axis, the apparent error due to the excentricity is given by

$$E_r \cos(i\varepsilon_z + \beta)$$

where

E_r is the excentric radial offset;

ε_z is the theoretical angular pitch $\varepsilon_z = \left(\frac{360}{Z} \right)$;

β is a phase angle relating the inclination of the offset E_r and the position of the first tooth measured;

i is an integer defining the tooth considered and has values 0, 1, 2, ..., $Z - 1$.

For an actual group of splines, the most probable values of E_r and β can be determined by a harmonic analysis of the measured variation curve (see Figure 32).

Such an analysis will yield the values of the coefficients of a Fourier series; the general form can be written

$$f_n(i) = A_0 + A_1 \cos(i\varepsilon_z) + B_1 \sin(i\varepsilon_z) + A_2 \cos(2i\varepsilon_z) + B_2 \sin(2i\varepsilon_z) + \dots$$

Only A_0 , A_1 and B_1 are needed to separate index and excentricity errors, given by

$$\tan \beta = \frac{-B_1}{A_1}$$

$$E_r = \frac{A_1}{\cos \beta} = \frac{-B_1}{\sin \beta} = \sqrt{A_1^2 + B_1^2}$$

(Some computer harmonic analysis programs may give E_r and β directly.)

A_0 is the mean height of the measured variation curve and shall be subtracted from each measurement for direct comparison with the excentricity effect as indicated in the following example.

Example:

12-tooth splines with measured index variation, as shown in Figure 32.

$$\varepsilon_z = 360^\circ/12 = 30^\circ$$

From a harmonic analysis (see Figure 32) it follows that:

$$A_0 = 2$$

$$A_1 = 2,805 \ 4$$

$$B_1 = -5,011 \ 2$$

hence

$$\tan \beta = 1,786 \ 27$$

$$E_r = 5,743$$

$$\beta = 60,758 \ 8^\circ$$

and the following table can now be drawn up.

Table 136 — Measurement results

Values in micrometres

Number of teeth	Measured variation F_p	Measured variation in relation to A_0	Influence of eccentricity $E_r \cos(i\varepsilon_z + \beta)$ measured from mean height	Residual index variation ^a
0	+ 4	+ 2	+ 2,8	− 0,8
1	+ 6	+ 4	− 0,08	+ 4,08
2	0	− 2	− 2,94	+ 0,94
3	− 6	− 8	− 5,01	− 2,99
4	− 2	− 4	− 5,14	+ 1,14
5	− 6	− 8	− 4,94	− 3,06
6	− 2	− 4	− 2,81	− 1,19
7	+ 4	+ 2	+ 0,08	+ 1,92
8	+ 10	+ 8	+ 2,94	+ 5,06
9	+ 4	+ 2	+ 5,01	− 3,01
10	+ 6	+ 4	+ 5,14	− 1,14
11	+ 6	+ 4	+ 4,34	− 0,34

^a Residual index variation = $F_p - A_0 - E_r \cos(i\varepsilon_z + \beta)$

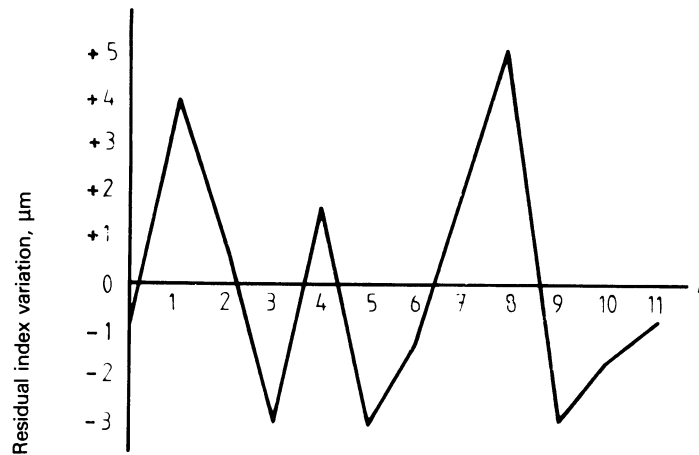
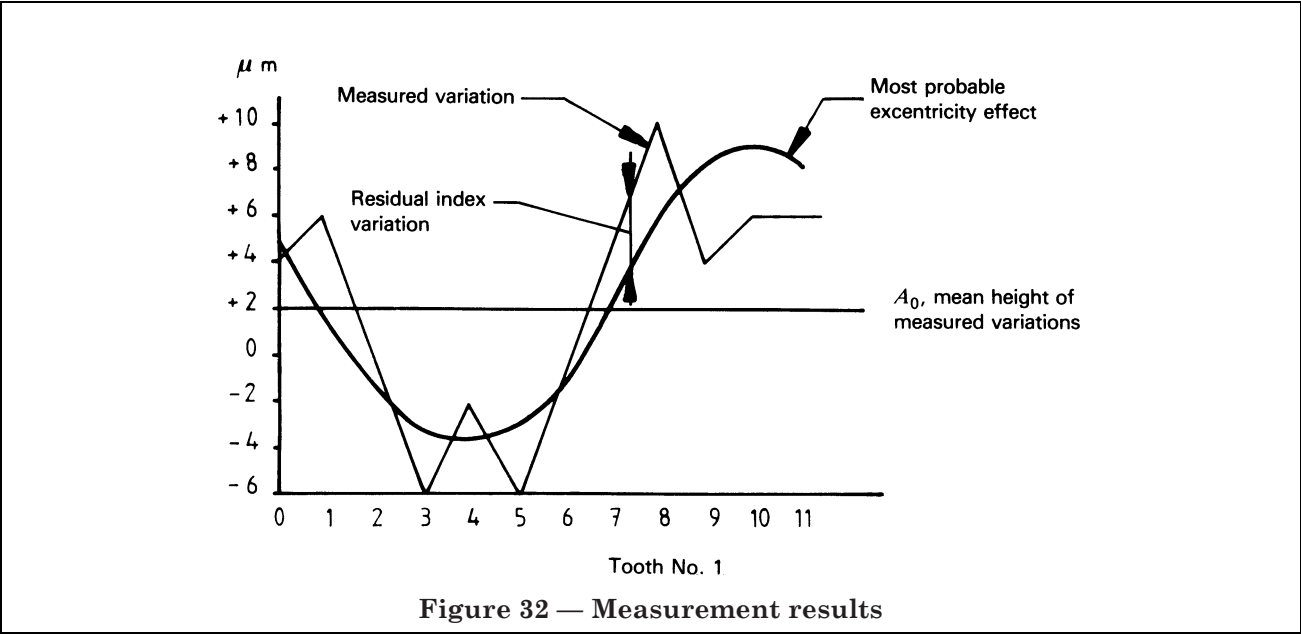
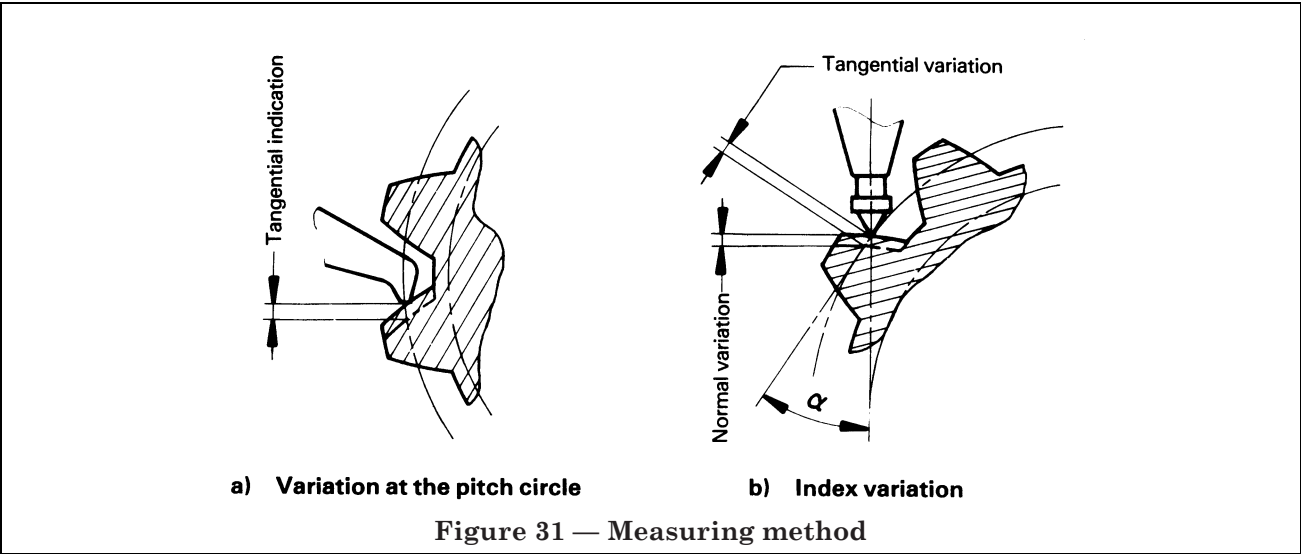


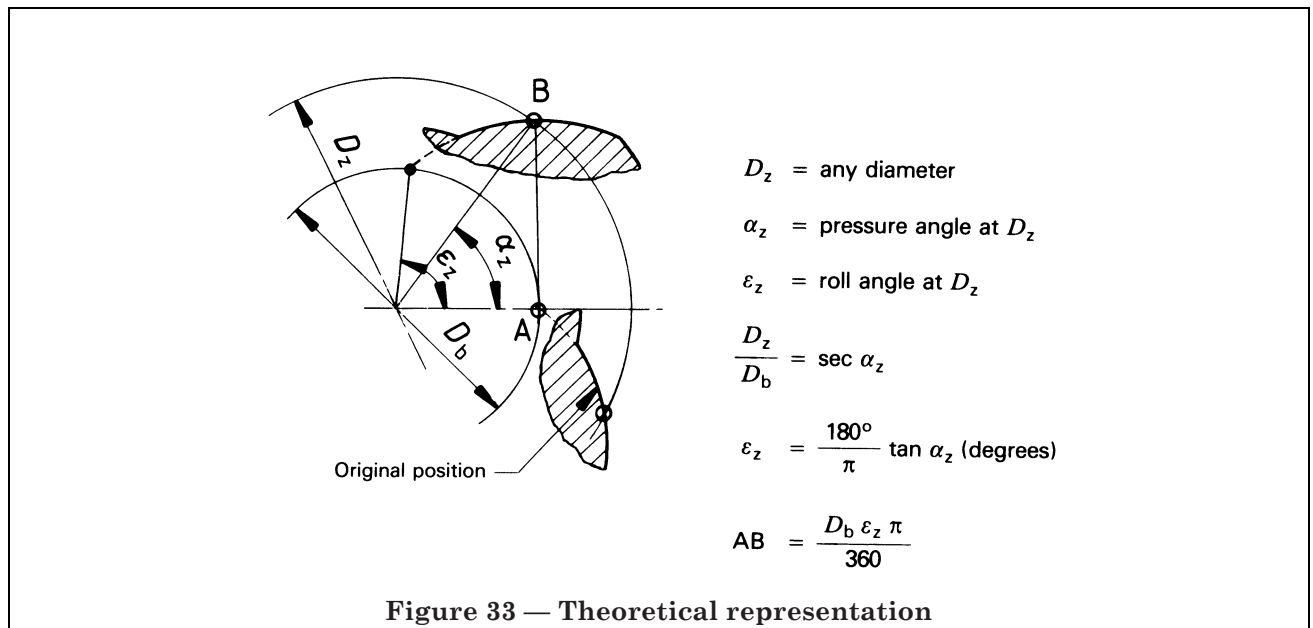
Figure 30 — Graph of residual variation

Table 137 — Results of inspection

Values in micrometres

Excentricity	5,743
Maximum residual variation, positive	5,06
Maximum residual variation, negative	− 3,06
Maximum deviation	8,12





23.2.1.3 The total index variation can be determined indirectly by measuring the actual circular pitches on the control circles and recording their deviations with respect to the theoretical control circular pitch (see Figure 32).

The theoretical control circular pitch is the arithmetical mean of all actual circular pitches measured on the control circle.

The total index variation examined indirectly according to the above method in fact determines an “apparent” index variation including other variations as well.

23.2.2 Total profile variation

The total profile variation is the sum of the absolute values of the two greatest positive and negative profile variations (see 8.4 and Figure 7).

The total profile variation is determined by recording the positive or negative deviation of the actual profiles over involute portions included between the two form diameters with respect to a theoretical involute plotted in accordance with the principles of Figure 33.

The machines for checking the involute profile are currently based on these principles.

23.2.3 Total lead variation

The total lead variation is the sum of the absolute values of the two greatest positive and negative deviations in spline side direction with respect to the theoretical direction (see 8.5).

The total lead variation is determined by recording the positive or negative deviations of side direction at the control circle level over the whole spline length, in accordance with the principle of Figure 31 a) and Figure 31 b).

The machines for checking the actual lead variation are currently based on these principles.

The “negative” or “positive” direction of recorded deviations shall be defined by agreement between the purchaser and the supplier and indicated in the inspection report, if any.

23.3 Measurement with pins (or balls)

Actual space widths or tooth thicknesses are checked using plain cylindrical pins or balls.

The values given below correspond to measurements with two pins or two balls (see clause 26 for H/h fit class).

23.3.1 Selection of pins (or balls)

The pin or ball diameter shall be selected from the preferred number series R40¹⁾ at a value equal to or immediately greater than the diameter tangent to the two adjacent profiles (corresponding to the minimum actual tooth thickness $S_{\min}$ or the maximum actual space width $E_{\max}$, of tolerance grade 7) at the level of the mean diameter between the maximum major diameter, external spline ($D_{\text{ee max}}$), and the minimum minor diameter, internal spline ($D_{\text{ii min}}$).

In cases where it is not possible to select a size of pin or ball from Table 140 to Table 250, the size chosen shall satisfy the conditions of contact required for satisfactory measurements. The size to be used shall be subject to prior agreement between purchaser and manufacturer.

The mean diameter is equal to $\frac{D_{\text{ee max}} + D_{\text{ii min}}}{2}$ with

- for the internal spline, $D_{\text{ii min}}$ corresponding always to the fundamental deviation h for the shaft, whatever the assembly fit;
- for the external spline, $D_{\text{ee max}}$ corresponding to the fundamental deviation selected for the shaft.

In some cases it will be necessary to make a flat on the pin or ball to avoid the contact on the bottom of splines.

NOTE Pins or balls for internal splines will not necessarily have the same diameter or flat as those for external splines.

The choice between ball or pin inspection shall be specified explicitly. Ball inspection is preferred.

It should be noted that due to their geometry, measuring balls or pins do not integrate checked part variations in the same way, and especially surface conditions or lead variations.

Pin and ball accuracies are given in Table 138 with the length of the pin measuring part as a function of pin diameter.

Table 138 — Pin and ball accuracies and pin measuring length

Values in millimetres

Nominal diameter of pins or balls (D_{Re} or D_{Ri})	Tolerances on diameter (including all variations)	Pin measuring length
$0,32 \leq D_{\text{Re}} \text{ or } D_{\text{Ri}} \leq 1$	$\pm 0,001$	20 ± 5
$1,06 \leq D_{\text{Re}} \text{ or } D_{\text{Ri}} \leq 5$		30 ± 5
$5,3 \leq D_{\text{Re}} \text{ or } D_{\text{Ri}} \leq 15$		40 ± 5
$16 \leq D_{\text{Re}} \text{ or } D_{\text{Ri}} \leq 25$		50 ± 5
$D_{\text{Re}} \text{ or } D_{\text{Ri}} \geq 26,5$	$\pm 0,001\ 5$	60 ± 5

23.3.2 Use and marking of pins

Pins shall be usable over their whole length in any area of the spline length to be checked.

They shall be marked with their nominal diameter.

¹⁾ See ISO 3, Preferred numbers — Series of preferred numbers.

23.3.3 Calculation of pin (or ball) diameter (D_{Re} or D_{Ri})

23.3.3.1 External spline

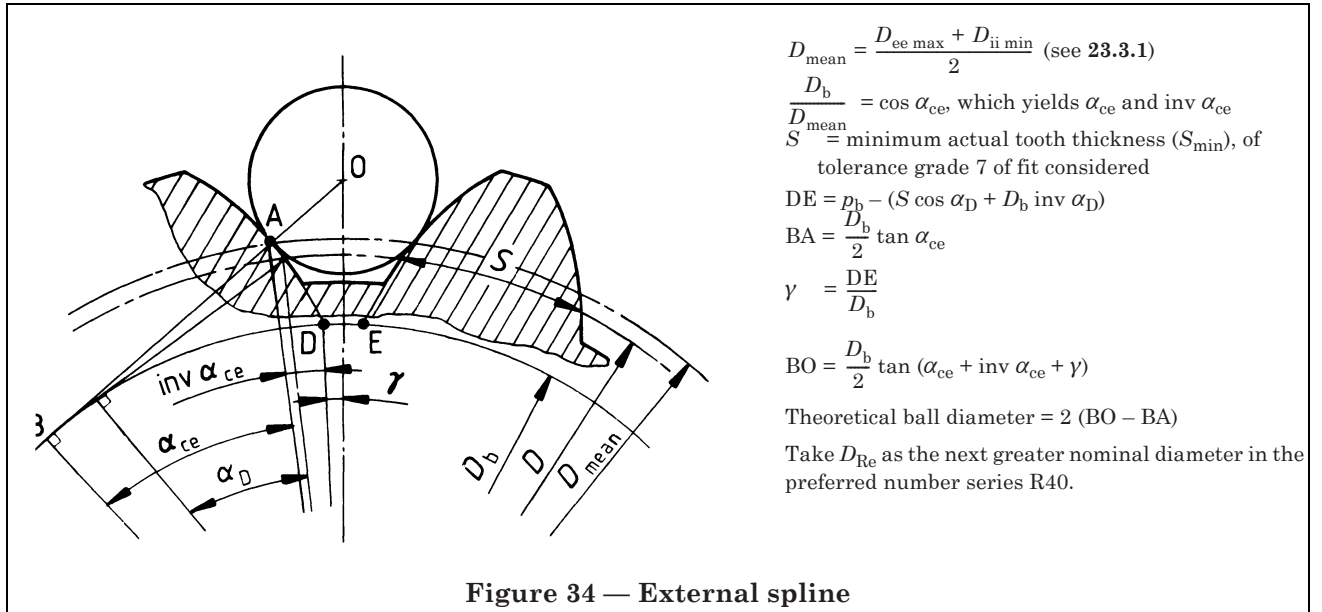


Figure 34 — External spline

23.3.3.2 Internal spline

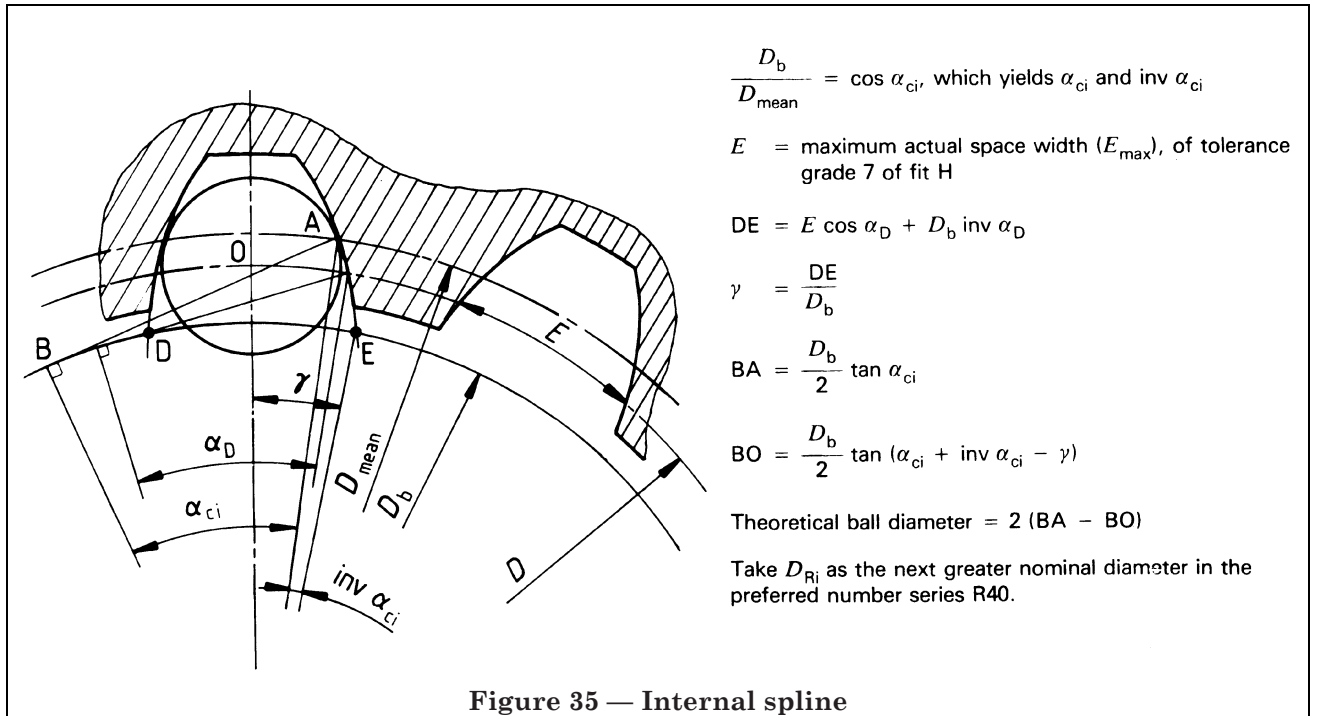


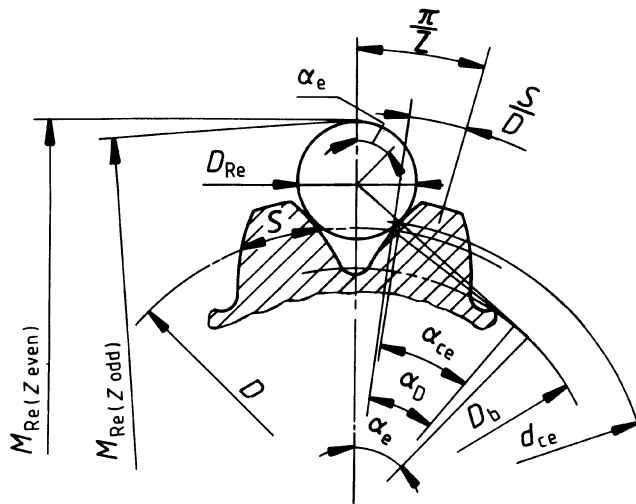
Figure 35 — Internal spline

23.3.4 Calculation of dimensions for pin (or ball) inspection (Part and gauge inspection)

23.3.4.1 Exact calculation

23.3.4.1.1 Measurement over two pins — External splines (M_{Re})

S = actual circular tooth thickness to be checked



D_{Re} = pin diameter — see value in inspection dimension tables

$$\text{inv } \alpha_e = \frac{S}{D} + (\text{inv } \alpha_D + \frac{D_{Re}}{D_b} - \frac{\pi}{Z})$$

give α_e in degrees, to five decimal places*

$$M_{Re} \text{ (for } Z \text{ even)} = \frac{D_b}{\cos \alpha_e} + D_{Re} \text{ or } = D_b \sec \alpha_e + D_{Re}$$

$$M_{Re} \text{ (for } Z \text{ odd)} = \frac{D_b \cos \frac{90^\circ}{Z}}{\cos \alpha_e} + D_{Re} \text{ or}$$

$$= (D_b \cos \frac{90^\circ}{Z}) \sec \alpha_e + D_{Re}$$

$$\tan \alpha_{ce} = \tan \alpha_e - \frac{D_{Re}}{D_b}$$

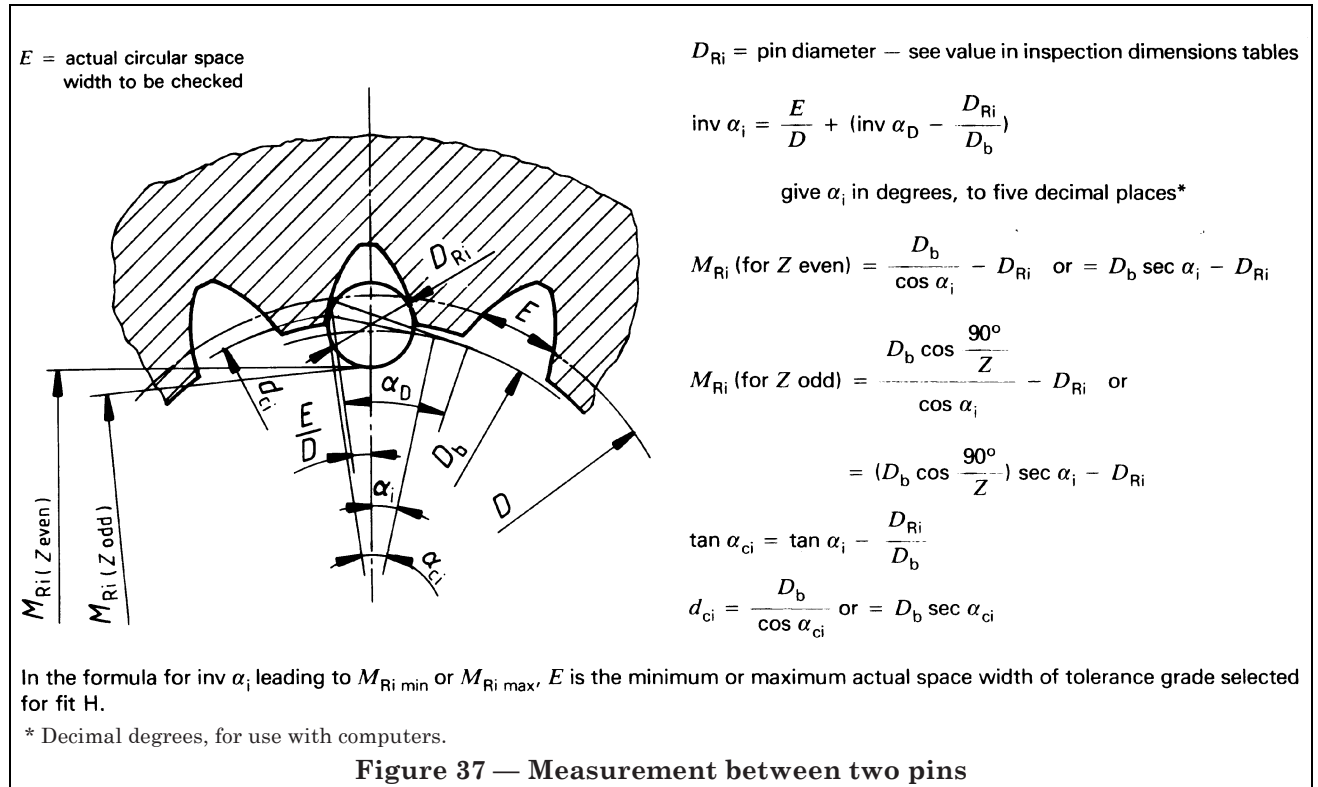
$$d_{ce} = \frac{D_b}{\cos \alpha_{ce}} \text{ or } = D_b \sec \alpha_{ce}$$

In the formula for $\text{inv } \alpha_e$ leading to $M_{Re \text{ min}}$ or $M_{Re \text{ max}}$, S is the minimum or maximum actual tooth thickness of tolerance grade selected for the fit considered.

* Decimal degrees, for use with computers.

Figure 36 — Measurement over two pins

23.3.4.1.2 Measurement between two pins — Internal splines (M_{Ri})



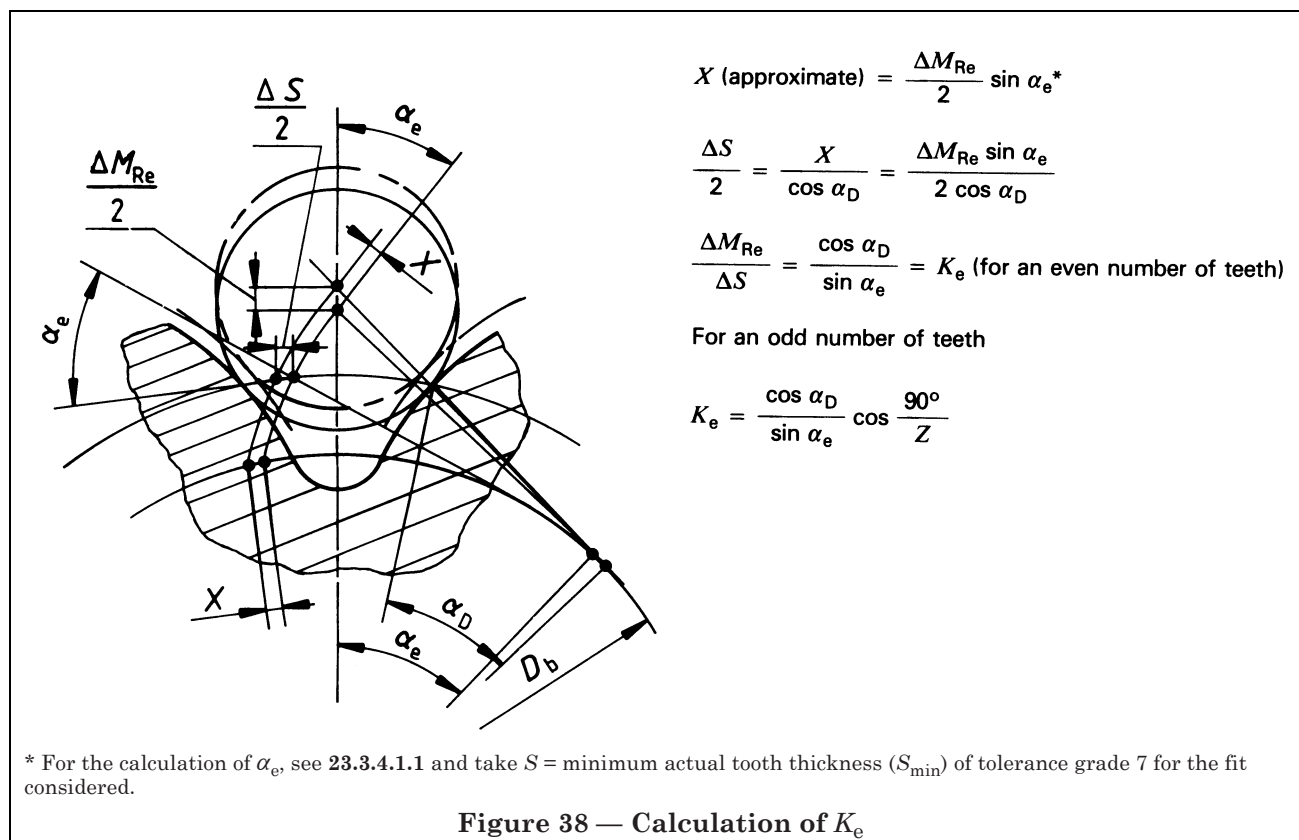
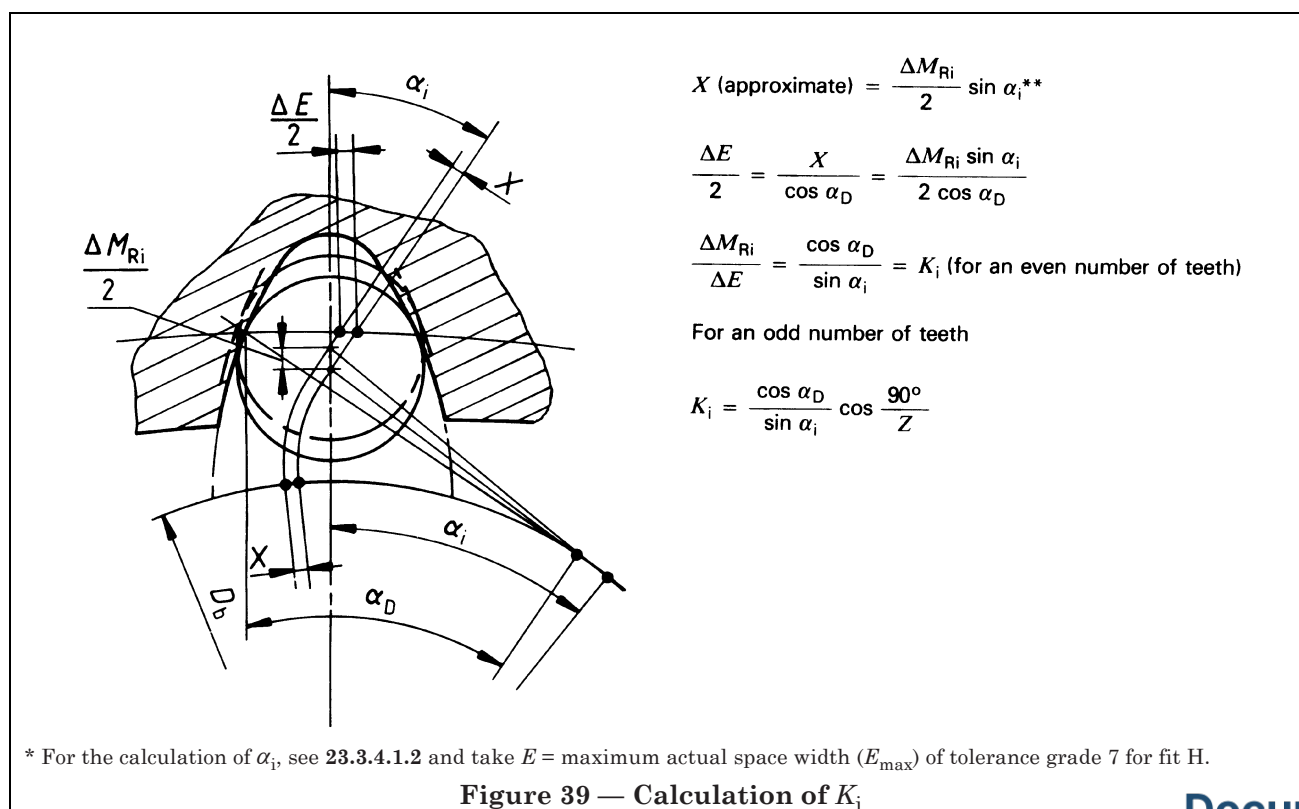
23.3.4.2 Approximation factor

23.3.4.2.1 General

See 8.7.2.2 e).

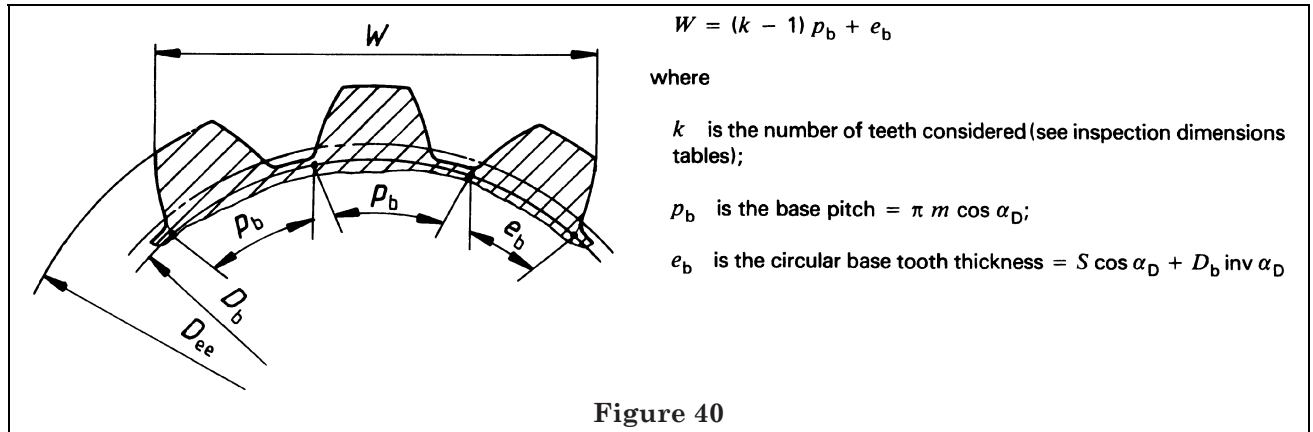
The approximation factor (K_e for external splines, K_i for internal splines) is the variation of inspection dimensions with respect to the variation of corresponding tooth thicknesses or space widths.

The use of factors K_e or K_i leads to values of inspection dimensions which are all the more accurate since the tooth thickness or space width to be checked are closer to the minimal actual tooth thickness values ($S_{\min}$) or the maximum actual space width values ($E_{\max}$) of tolerance grade 7 for the fit considered.

23.3.4.2.2 Calculation of the approximation factor K_e 23.3.4.2.3 Calculation of the approximation factor K_i 

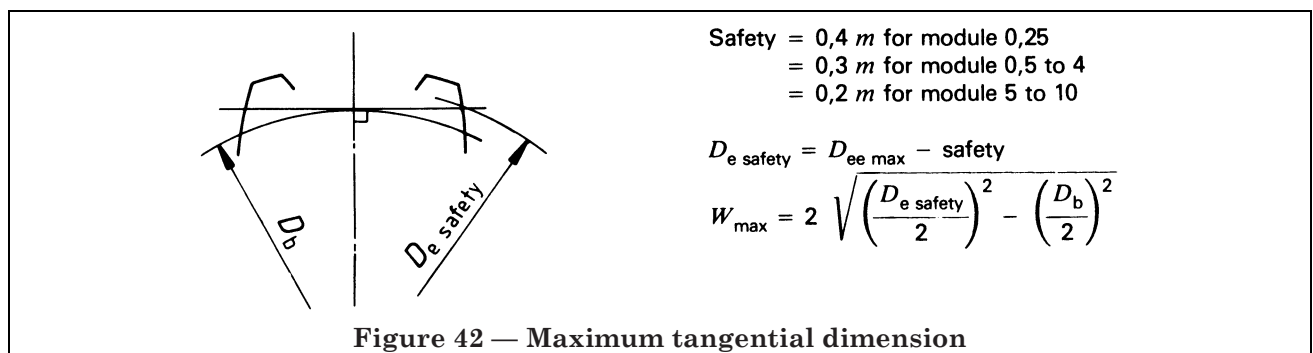
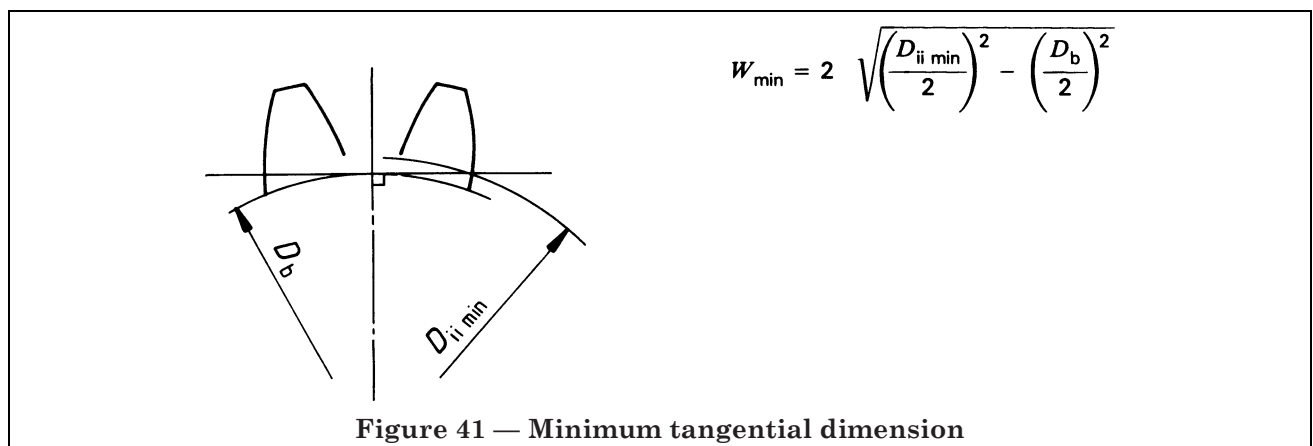
23.4 Measurement over k teeth — External splines (W)

23.4.1 Calculation of W



For the calculation of W , use S = the minimum or maximum actual tooth thickness of the tolerance grade chosen for the fit considered.

23.4.2 Choice of k



$$\frac{W_{\max} - e_b}{p_b} = \dots = k_p \text{ (integer)}$$

Check that $p_b (k_p) + e_b \geq W_{\min}$ ²⁾

- If this condition is not satisfied, then it is impossible to take a dimension over k teeth.
- If this condition is satisfied, then $k = k_p + 1$

²⁾ For the calculation of p_b , see 23.4.1.

For the calculation of k_p and $W_{\min}$, use S = minimum actual tooth thickness ($S_{\min}$) of tolerance grade 7 for the fit considered.

24 Conversion of circle divisions into angle values

Table 139 — Conversion of circle divisions into angle values

Z number of divisions	90°/Z Degrees	cos (90°/Z) a	360°/Z Degrees	Z number of divisions	90°/Z Degrees	cos (90°/Z) a	360°/Z Degrees
1				51	1,764 705 9	0,999 525 7	7,058 823 5
2				52	1,730 769 2		6,923 076 9
3				53	1,698 113 2	0,999 560 8	6,792 452 8
4				54	1,666 666 7		6 666 666 7
5	18	0,951 056 5	72	55	1,636 363 6	0,999 592 2	6,545 454 6
6	15		60	56	1,607 142 8		6,428 571 4
7	12,857 142 8	0,974 927 9	51,428 571 2	57	1,578 947 4	0,999 620 3	6,315 789 5
8	11,25		45	58	1,551 724 1		6,206 896 5
9	10	0,984 807 8	40	59	1,525 423 7	0,999 645 6	6,101 694 9
10	9		36	60	1,5		6
11	8,181 818 1	0,989 821 4	32,727 272 5	61	1,475 409 8	0,999 668 5	5,901 639 3
12	7,5		30	62	1,451 612 9		5,806 451 6
13	6,923 076 9	0,992 708 9	27,692 307 7	63	1,428 571 4	0,999 689 2	5,714 285 7
14	6,428 571 4		25 714 285 6	64	1,406 25		5,625
15	6	0,994 521 9	24	65	1,384 615 4	0,999 708	5,538 461 6
16	5,625		22,5	66	1,363 636 4		5,454 545 4
17	5,294 117 6	0,995 734 2	21,176 470 5	67	1,343 283 6	0,999 725 2	5,373 134 3
18	5		20	68	1,323 529 4		5,294 117 6
19	4,736 842 1	0,996 584 5	18,947 368 4	69	1,304 347 8	0,999 740 9	5,217 391 3
20	4,5		18	70	1,285 714 3		5,142 857 1
21	4,285 714 3	0,997 203 8	17 142 857 1	71	1,267 605 6	0,999 755 3	5,070 422 5
22	4,090 909 1		16,363 636 3	72	1,25		5
23	3,913 043 5	0,997 668 8	15,652 173 9	73	1,232 876 7	0,999 768 5	4,931 506 8
24	3,75		15	74	1,216 216 2		4,864 864 8
25	3,6	0,998 026 7	14,4	75	1,2	0,999 780 7	4,8
26	3,461 538 5		13,846 153 9	76	1,184 210 5		4,736 842 1
27	3,333 333 3	0,998 308 2	13,333 333 4	77	1,168 831 2	0,999 791 9	4,675 324 7
28	3,214 285 7		12,857 142 8	78	1,153 846 2		4,615 384 6
29	3,103 448 3	0,998 533 4	12,413 793 1	79	1,139 240 5	0,999 802 3	4,556 962
30	3		12	80	1,125		4,5
31	2,903 225 8	0,998 716 5	11,612 903 2	81	1,111 111 1	0,999 812	4,444 444 4
32	2,812 5		11,25	82	1,097 561		4,390 243 9
33	2,727 272 7	0,998 867 3	10,909 090 9	83	1,084 337 4	0,999 820 9	4,337 349 4
34	2,647 058 8		10,588 235 3	84	1,071 428 6		4,285 714 3
35	2,571 428 6	0,998 993 1	10,285 714 3	85	1,058 823 5	0,999 829 2	4,235 294 1
36	2,5		10	86	1,046 511 6		4,186 046 5
37	2,432 432 4	0,999 099	9,729 729 8	87	1,034 482 8	0,999 837	4,137 931
38	2,368 421		9,473 684 2	88	1,022 727 3		4,090 909 1
39	2,307 692 3	0,999 189	9,230 769 3	89	1,011 236	0,999 844 3	4,044 943 8
40	2,25		9	90	1		4
41	2,195 121 9	0,999 266 2	8,780 487 8	91	0,989 011	0,999 851	3,956 044
42	2,142 857 1		8,571 428 5	92	0,978 260 9		3,913 043 5
43	2,093 023 3	0,999 332 8	8,372 093 1	93	0,967 741 9	0,999 857 4	3,870 967 7
44	2,045 454 5		8,181 818 1	94	0,957 446 8		3,829 787 2
45	2	0,999 390 8	8	95	0,947 368 4	0,999 863 3	3,789 473 7
46	1,956 521 7		7,826 086 9	96	0,937 5		3,75
47	1,914 893 6	0,999 441 6	7,659 574 4	97	0,927 835 1	0,999 868 9	3,711 340 7
48	1,875		7,5	98	0,918 367 3		3,673 469 4
49	1,836 734 7	0,999 486 2	7,346 938 8	99	0,909 090 9	0,999 874 1	3,636 363 6
50	1,8		7,2	100	0,9		3,6

^a For Z odd only.

^a For Z odd only.

25 Inspection dimensions

The inspection dimension tables in this addendum correspond to splines with spline fit class H/h, which has a minimum effective clearance equal to zero. Selection of a spline fit class having a different deviation allowance requires adjustment to the external spline dimensions (see 8.7.2.2) and, consequently, to the corresponding inspection dimensions, M_{Re} and W (see 23.3.4.1.1 and 23.4.1).

25.1 Measurement between two pins — Internal splines (M_{Ri})

Table 140 to Table 153 give measurements between two pins, M_{Ri} , for internal splines with 30° pressure angle flat root side fit or fillet root side fit for tolerance classes 4, 5, 6 and 7 and for fundamental deviation H.

Table 154 to Table 167 give measurements between two pins, M_{Ri} , for internal splines with 37,5° pressure angle fillet root side fit for tolerance classes 4, 5, 6 and 7 and for fundamental deviation H.

Table 168 to Table 176 give measurements between two pins, M_{Ri} , for internal splines with 45° pressure angle fillet root side fit for tolerance classes 4, 5, 6 and 7 and for fundamental deviation H.

25.2 Measurement over two pins — External splines (M_{Re})

Table 177 to Table 190 give measurements over two pins, M_{Re} , for external splines 30° pressure angle flat root side fit or fillet root side fit for tolerance classes 4, 5, 6 and 7 and for fundamental deviation h.

Table 191 to Table 204 give measurements over two pins, M_{Re} , for external splines with 37,5° pressure angle fillet root side fit for tolerance classes 4, 5, 6 and 7 and for fundamental deviation h.

Table 205 to Table 213 give measurements over two pins, M_{Re} , for external splines with 45° pressure angle fillet root side fit for tolerance classes 4, 5, 6 and 7 and for fundamental deviation h.

25.3 Measurement over k teeth — External splines (W)

Table 214 to Table 227 give measurements over k teeth, W , for external splines with 30° pressure angle flat root side fit or fillet root side fit for tolerance grades 4, 5, 6 and 7 and for fundamental deviation h.

Table 228 to Table 241 give measurements over k teeth, W , for external splines with 37,5° pressure angle fillet root side fit for tolerance classes 4, 5, 6 and 7 and for fundamental deviation h.

Table 242 to Table 250 give measurements over k teeth, W , for external splines with 45° pressure angle fillet root side fit for tolerance classes 4, 5, 6 and 7 and for fundamental deviation h.

25.4 Inspection dimension values

The inspection dimension values in part 3 of this amendment are calculated from the formulas given in 23.3.3, 23.3.4 and 23.4.

Table 140 — Inspection dimensions M_{Ri}

Side fit internal splines — Fundamental deviation H
30 degree pressure angle — Flat root or fillet root — Module = 0.50

$E_{v \min}$ = minimum effective circular space width = 0.785

Z	D_{Ri}	Measurement between two pins, M_{Ri} (checking of dimensions E_{min} and E_{max}) for tolerance grades								K_i
Number of teeth	Pin diameter	4 H		5 H		6 H		7 H		Approximation factor
		min. (aux)	max.	min. (aux)	max.	min. (aux)	max.	min. (aux)	max.	
6	0.90	*****	*****	*****	*****	*****	*****	*****	1.700	21.6564
7	0.90	*****	*****	*****	*****	*****	*****	*****	2.180	2.9902
8	0.90	*****	*****	*****	*****	*****	*****	*****	2.774	2.5753
9	0.95	*****	*****	*****	*****	*****	2.673	*****	3.020	3.2992
10	0.95	*****	*****	*****	*****	*****	3.487	*****	3.606	2.7873
11	0.95	*****	3.832	3.771	3.895	3.827	3.968	3.881	4.069	2.4999
12	0.95	4.376	4.426	4.396	4.473	4.423	4.537	4.463	4.631	2.3729
13	0.95	4.865	4.906	4.881	4.948	4.903	5.006	4.938	5.095	2.2544
14	0.95	5.427	5.464	5.444	5.503	5.462	5.559	5.495	5.646	2.1979
15	0.95	5.902	5.938	5.916	5.975	5.936	6.028	5.967	6.112	2.1305
16	1.00	6.245	6.286	6.261	6.328	6.284	6.387	6.319	6.480	2.2980
17	1.00	6.729	6.766	6.744	6.806	6.765	6.863	6.798	6.952	2.2235
18	1.00	7.215	7.249	7.231	7.289	7.249	7.405	7.341	7.492	2.1812
19	1.00	7.705	7.769	7.769	7.826	7.788	7.881	7.819	7.967	2.1316
20	1.00	8.203	8.227	8.207	8.263	8.226	8.326	8.261	8.356	2.1047
21	1.00	8.773	8.805	8.786	8.841	8.805	8.894	8.835	8.974	2.0695
22	1.00	9.306	9.338	9.312	9.374	9.338	9.426	9.367	9.510	2.0506
23	1.00	9.768	9.818	9.799	9.852	9.817	9.904	9.847	9.987	2.0244
24	1.00	10.316	10.347	10.329	10.382	10.347	10.433	10.376	10.512	2.0102
25	1.00	10.797	10.827	10.809	10.862	10.827	10.913	10.856	10.995	1.9897
26	1.00	11.323	11.354	11.336	11.389	11.354	11.439	11.383	11.521	1.9789
27	1.00	11.805	11.835	11.818	11.869	11.835	11.919	11.864	12.001	1.9634
28	1.00	12.330	12.360	12.342	12.394	12.360	12.444	12.389	12.524	1.9481
29	1.00	12.812	12.842	12.825	12.875	12.842	12.926	12.871	13.007	1.9342
30	1.00	13.335	13.364	13.347	13.398	13.365	13.448	13.393	13.530	1.9331
31	1.00	13.818	13.847	13.831	13.881	13.848	13.931	13.877	14.012	1.9219
32	1.00	14.339	14.368	14.351	14.402	14.369	14.452	14.398	14.533	1.9161
33	1.00	14.823	14.852	14.836	14.886	14.854	14.936	14.881	15.017	1.9063
34	1.00	15.343	15.372	15.326	15.406	15.373	15.455	15.401	15.537	1.9017
35	1.06	15.628	15.658	15.641	15.693	15.659	15.744	15.688	15.824	1.8958
36	1.06	16.147	16.177	16.160	16.212	16.178	16.263	16.208	16.347	1.8941
37	1.06	16.633	16.663	16.647	16.697	16.665	16.748	16.694	16.833	1.8932
38	1.06	17.152	17.181	17.165	17.215	17.183	17.267	17.212	17.351	1.8930
39	1.06	17.638	17.667	17.651	17.702	17.669	17.753	17.698	17.838	1.8928
40	1.06	18.155	18.184	18.168	18.219	18.186	18.270	18.216	18.354	1.8917
41	1.06	18.643	18.671	18.655	18.706	18.674	18.757	18.703	18.841	1.8907
42	1.06	19.159	19.187	19.172	19.222	19.189	19.273	19.219	19.357	1.8905
43	1.06	19.646	19.675	19.659	19.710	19.678	19.761	19.706	19.844	1.8903
44	1.06	20.162	20.190	20.175	20.224	20.193	20.276	20.223	20.360	1.8901
45	1.06	20.649	20.678	20.663	20.713	20.681	20.764	20.711	20.849	1.8890
46	1.06	21.164	21.193	21.177	21.227	21.194	21.278	21.225	21.363	1.8859
47	1.06	21.653	21.681	21.666	21.716	21.684	21.767	21.714	21.851	1.8806
48	1.06	22.166	22.195	22.180	22.229	22.198	22.281	22.228	22.366	1.8774
49	1.06	22.656	22.684	22.669	22.718	22.687	22.770	22.717	22.854	1.8770
50	1.06	23.169	23.197	23.183	23.231	23.201	23.283	23.231	23.368	1.8701
51	1.06	23.659	23.686	23.671	23.721	23.690	23.772	23.719	23.857	1.8658
52	1.06	24.171	24.199	24.184	24.233	24.203	24.285	24.232	24.370	1.8634
53	1.06	24.660	24.688	24.674	24.723	24.693	24.775	24.723	24.860	1.8654
54	1.06	25.173	25.201	25.186	25.236	25.205	25.287	25.235	25.372	1.8653
55	1.06	25.662	25.691	25.676	25.726	25.696	25.777	25.725	25.863	1.8653
56	1.06	26.175	26.203	26.188	26.237	26.207	26.289	26.237	26.375	1.8516
57	1.06	26.665	26.693	26.678	26.727	26.697	26.779	26.727	26.864	1.8484
58	1.06	27.177	27.204	27.190	27.238	27.209	27.290	27.238	27.377	1.8464
59	1.06	27.667	27.695	27.680	27.729	27.700	27.782	27.730	27.866	1.8436
60	1.06	28.177	28.206	28.192	28.240	28.211	28.292	28.240	28.378	1.8418
61	1.06	28.669	28.696	28.683	28.731	28.702	28.783	28.732	28.869	1.8390
62	1.06	29.179	29.207	29.194	29.242	29.213	29.294	29.243	29.380	1.8390
63	1.06	29.671	29.698	29.684	29.733	29.704	29.785	29.733	29.871	1.8347
64	1.06	30.181	30.208	30.194	30.244	30.214	30.295	30.244	30.381	1.8334
65	1.06	30.671	30.700	30.686	30.734	30.705	30.786	30.735	30.873	1.8310
66	1.06	31.182	31.210	31.195	31.244	31.215	31.296	31.246	31.383	1.8297
67	1.06	31.674	31.701	31.687	31.736	31.707	31.789	31.737	31.875	1.8274
68	1.06	32.184	32.211	32.197	32.245	32.216	32.298	32.247	32.384	1.8253
69	1.06	32.675	32.702	32.689	32.737	32.708	32.789	32.739	32.877	1.8239
70	1.06	33.184	33.212	33.199	33.247	33.218	33.299	33.249	33.387	1.8228
71	1.06	33.676	33.703	33.690	33.739	33.710	33.791	33.741	33.879	1.8208
72	1.06	34.185	34.213	34.199	34.248	34.219	34.301	34.250	34.388	1.8199
73	1.06	34.677	34.705	34.692	34.741	34.712	34.793	34.742	34.881	1.8179
74	1.06	35.187	35.214	35.200	35.249	35.220	35.302	35.252	35.390	1.8170
75	1.06	35.679	35.706	35.693	35.742	35.713	35.794	35.743	35.881	1.8153
76	1.06	36.187	36.214	36.202	36.250	36.221	36.303	36.253	36.390	1.8144
77	1.06	36.680	36.706	36.694	36.743	36.714	36.795	36.746	36.883	1.8127
78	1.06	37.189	37.215	37.202	37.251	37.222	37.304	37.254	37.392	1.8118
79	1.06	37.681	37.709	37.696	37.744	37.715	37.797	37.747	37.886	1.8109
80	1.06	38.189	38.215	38.204	38.252	38.224	38.305	38.255	38.393	1.8095
81	1.06	38.682	38.709	38.696	38.745	38.717	38.797	38.749	38.887	1.8079
82	1.06	39.191	39.218	39.204	39.253	39.224	39.306	39.256	39.395	1.8072
83	1.06	39.683	39.710	39.698	39.746	39.718	39.799	39.749	39.888	1.8058
84	1.06	40.191	40.217	40.205	40.254	40.226	40.308	40.257	40.396	1.8051
85	1.06	40.684	40.710	40.698	40.747	40.719	40.800	40.751	40.889	1.8038
86	1.06	41.191	41.218	41.206	41.255	41.227	41.309	41.259	41.397	1.8030
87	1.06	41.684	41.711	41.700	41.747	41.720	41.802	41.753	41.891	1.8017
88	1.06	42.192	42.219	42.206	42.255	42.228	42.309	42.259	42.398	1.8012
89	1.06	42.686	42.713	42.700	42.749	42.721	42.802	42.752	42.892	1.7999
90	1.06	43.193	43.219	43.208	43.256	43.229	43.310	43.261	43.400	1.7993
91	1.06	43.686	43.714	43.701	43.750	43.722	43.804	43.754	43.894	1.7981
92	1.06	44.194	44.221	44.209	44.257	44.229	44.311	44.261	44.400	1.7976
93	1.06	44.687	44.714	44.702	44.750	44.722	44.804	44.754	44.895	1.7965
94	1.06	45.194	45.221	45.209	45.258	45.230	45.311	45.263	45.403	1.7959
95	1.06	45.689	45.715	45.703	45.752	45.724	45.806	45.756	45.897	1.7949
96	1.06	46.195	46.221	46.209	46.257	46.231	46.312	46.264	46.403	1.7943
97	1.06	46.689	46.716	46.704	46.752	46.726	46.807	46.758	46.898	1.7933
98	1.06	47.196	47.223	47.210	47.260	47.232	47.313	47.265	47.405	1.7928
99	1.06	47.691	47.717	47.705	47.753	47.726	47.807	47.759	47.899	1.7919
100	1.06	48.196	48.223	48.212	48.259	48.233	48.314	48.266	48.404	1.79

Table 141 — Inspection dimensions M_{Ri}

Side fit internal splines — Fundamental deviation H
30 degree pressure angle — Flat root or fillet root — Module = 0.75

$E_{v \min}$ = minimum effective circular space width = 1.178

Z	D_{Ri}	Measurement between two pins, M_{Ri} (checking of dimensions E_{min} and E_{max}) for tolerance grades								K_i
Number of teeth	Pin diameter	4 H		5 H		6 H		7 H		Approximation factor
		min. (aux)	max.	min. (aux)	max.	min. (aux)	max.	min. (aux)	max.	
6	1.32	*****	*****	*****	*****	*****	*****	*****	2.600	8.0716
7	1.32	*****	*****	*****	*****	*****	3.147	*****	3.305	2.9664
8	1.32	*****	3.915	*****	3.998	*****	3.890	*****	4.208	2.5663
9	1.40	*****	*****	*****	*****	*****	4.055	*****	4.537	3.4857
10	1.40	*****	*****	*****	5.174	*****	5.284	*****	5.417	2.8514
11	1.40	5.791	5.860	5.816	5.919	5.849	5.998	5.897	6.113	2.5391
12	1.40	6.676	6.728	6.694	6.779	6.720	6.849	6.760	6.917	2.4017
13	1.40	7.394	7.440	7.410	7.485	7.433	7.551	7.460	7.652	2.2740
14	1.40	8.230	8.273	8.245	8.316	8.267	8.379	8.301	8.478	2.2165
15	1.40	8.939	8.980	8.954	9.021	8.974	9.081	9.007	9.178	2.1468
16	1.40	9.759	9.799	9.773	9.838	9.793	9.898	9.825	9.993	2.1128
17	1.40	10.468	10.506	10.482	10.545	10.501	10.603	10.532	10.698	2.0672
18	1.40	10.900	10.942	10.916	10.988	10.938	11.053	10.973	11.157	2.2607
19	1.40	11.620	11.661	11.636	11.705	11.657	11.768	11.697	11.870	2.2009
20	1.40	12.428	12.468	12.443	12.511	12.464	12.573	12.497	12.673	2.1656
21	1.50	13.148	13.187	13.162	13.228	13.183	13.289	13.216	13.388	2.1239
22	1.50	13.949	13.986	13.962	14.027	13.983	14.088	14.015	14.186	2.0996
23	1.50	14.669	14.706	14.683	14.746	14.703	14.806	14.734	14.903	2.0691
24	1.50	15.463	15.499	15.477	15.540	15.497	15.600	15.530	15.696	2.0453
25	1.50	16.184	16.220	16.198	16.260	16.218	16.319	16.250	16.415	2.0215
26	1.50	16.974	17.010	16.988	17.050	17.008	17.109	17.040	17.205	2.0142
27	1.50	17.697	17.733	17.711	17.771	17.729	17.830	17.760	17.925	1.9954
28	1.50	18.484	18.519	18.498	18.556	18.514	18.617	18.546	18.712	1.9840
29	1.50	19.208	19.243	19.222	19.282	19.241	19.343	19.272	19.435	1.9693
30	1.50	19.992	20.027	20.005	20.066	20.025	20.124	20.059	20.218	1.9600
31	1.50	20.716	20.751	20.730	20.790	20.750	20.848	20.781	20.942	1.9482
32	1.50	21.498	21.532	21.512	21.571	21.532	21.629	21.563	21.724	1.9413
33	1.50	22.224	22.258	22.239	22.297	22.258	22.355	22.289	22.449	1.9307
34	1.50	23.004	23.038	23.018	23.076	23.037	23.134	23.069	23.228	1.9247
35	1.50	23.731	23.765	23.745	23.804	23.765	23.861	23.796	23.955	1.9153
36	1.50	24.509	24.542	24.523	24.581	24.543	24.639	24.574	24.734	1.9102
37	1.50	25.237	25.270	25.251	25.309	25.271	25.366	25.302	25.461	1.9023
38	1.50	26.013	26.046	26.027	26.085	26.047	26.143	26.078	26.238	1.8975
39	1.50	26.741	26.775	26.751	26.809	26.771	26.866	26.801	26.966	1.8909
40	1.50	27.517	27.550	27.531	27.589	27.551	27.646	27.583	27.741	1.8873
41	1.50	28.247	28.280	28.261	28.319	28.281	28.376	28.313	28.471	1.8811
42	1.50	29.020	29.053	29.032	29.091	29.053	29.148	29.085	29.243	1.8777
43	1.50	29.745	29.778	29.756	29.814	29.776	29.871	29.808	29.966	1.8722
44	1.50	30.523	30.556	30.538	30.595	30.558	30.652	30.590	30.747	1.8695
45	1.50	31.255	31.288	31.270	31.326	31.289	31.384	31.321	31.479	1.8645
46	1.50	32.026	32.058	32.041	32.097	32.061	32.156	32.093	32.251	1.8620
47	1.50	32.758	32.791	32.773	32.829	32.793	32.888	32.825	32.983	1.8571
48	1.50	33.529	33.561	33.543	33.601	33.564	33.658	33.596	33.754	1.8521
49	1.50	34.301	34.333	34.315	34.372	34.335	34.429	34.367	34.525	1.8512
50	1.50	35.031	35.063	35.045	35.102	35.066	35.160	35.099	35.256	1.8491
51	1.60	35.765	35.796	35.780	35.836	35.799	35.894	35.833	35.990	1.8455
52	1.60	36.533	36.566	36.549	36.604	36.569	36.662	36.601	36.758	1.8437
53	1.60	37.308	37.340	37.322	37.378	37.343	37.436	37.375	37.532	1.8402
54	1.60	38.035	38.067	38.050	38.106	38.071	38.164	38.104	38.261	1.8385
55	1.60	38.770	38.801	38.785	38.841	38.806	38.899	38.839	38.996	1.8354
56	1.50	39.537	39.569	39.552	39.608	39.572	39.667	39.606	39.763	1.8340
57	1.50	40.273	40.304	40.287	40.343	40.307	40.402	40.342	40.498	1.8311
58	1.50	41.039	41.071	41.053	41.109	41.075	41.169	41.108	41.266	1.8299
59	1.50	41.775	41.806	41.789	41.845	41.811	41.904	41.844	41.999	1.8257
60	1.50	42.540	42.571	42.555	42.611	42.577	42.670	42.610	42.766	1.8257
61	1.50	43.276	43.308	43.291	43.347	43.313	43.406	43.347	43.504	1.8233
62	1.50	44.042	44.074	44.057	44.113	44.078	44.172	44.113	44.270	1.8220
63	1.50	44.778	44.810	44.791	44.847	44.815	44.909	44.849	45.006	1.8199
64	1.50	45.543	45.576	45.558	45.615	45.580	45.674	45.615	45.771	1.8189
65	1.50	46.279	46.311	46.295	46.351	46.317	46.411	46.351	46.509	1.8166
66	1.50	47.045	47.077	47.061	47.116	47.082	47.175	47.116	47.273	1.8157
67	1.50	47.782	47.814	47.797	47.853	47.819	47.913	47.853	48.011	1.8137
68	1.50	48.557	48.577	48.562	48.618	48.584	48.677	48.618	48.774	1.8127
69	1.50	49.284	49.314	49.299	49.355	49.321	49.415	49.355	49.514	1.8108
70	1.50	49.734	49.766	49.749	49.806	49.772	49.867	49.806	49.966	1.8356
71	1.60	50.472	50.504	50.487	50.545	50.510	50.605	50.545	50.705	1.8333
72	1.60	51.236	51.266	51.250	51.307	51.274	51.369	51.310	51.468	1.8321
73	1.60	52.006	52.036	52.020	52.077	52.044	52.139	52.080	52.238	1.8300
74	1.60	52.777	52.807	52.791	52.848	52.815	52.910	52.851	52.971	1.8288
75	1.60	53.475	53.507	53.491	53.548	53.514	53.609	53.550	53.709	1.8269
76	1.60	54.238	54.270	54.254	54.310	54.277	54.372	54.312	54.473	1.8257
77	1.60	55.007	55.037	55.021	55.078	55.044	55.139	55.080	55.238	1.8239
78	1.60	55.740	55.771	55.755	55.812	55.779	55.874	55.815	55.973	1.8228
79	1.60	56.478	56.510	56.493	56.549	56.516	56.611	56.553	56.711	1.8202
80	1.60	57.241	57.271	57.255	57.313	57.281	57.375	57.316	57.473	1.8202
81	1.60	57.981	58.011	57.996	58.053	58.021	58.113	58.056	58.217	1.8185
82	1.60	58.743	58.773	58.758	58.814	58.782	58.874	58.817	58.979	1.8176
83	1.60	59.481	59.513	59.499	59.555	59.522	59.617	59.557	59.717	1.8152
84	1.60	60.243	60.274	60.260	60.316	60.283	60.378	60.320	60.480	1.8142
85	1.60	60.983	61.013	61.000	61.055	61.024	61.119	61.061	61.219	1.8139
86	1.60	61.745	61.775	61.761	61.817	61.785	61.878	61.822	61.983	1.8129
87	1.60	62.484	62.517	62.500	62.557	62.525	62.619	62.562	62.723	1.8115
88	1.60	63.245	63.276	63.261	63.319	63.286	63.380	63.323	63.484	1.8108
89	1.60	63.986	64.016	64.002	64.061	64.027	64.124	64.067	64.224	1.8095
90	1.60	64.747	64.777	64.763	64.819	64.788	64.881	64.825	64.986	1.8087
91	1.60	65.488	65.519	65.505	65.559	65.527	65.621	65.564	65.727	1.8074
92	1.60	66.247	66.278	66.264	66.321	66.290	66.383	66.327	66.486	1.8069
93	1.60	67.009	67.039	67.025	67.081	67.050	67.143	67.087	67.247	1.8056
94	1.60	67.748	67.780	67.765	67.821	67.790	67.883	67.827	67.988	1.8046
95	1.60	68.491	68.520	68.507	68.562	68.532	68.624	68.568	68.729	1.8038
96	1.60	69.250	69.280	69.268	69.322	69.292	69.385	69.328	69.488	1.8033
97	1.60	69.991	70.021	70.009	70.064	70.033	70.127	70.070	70.230	1.8020
98	1.60	70.751	70.781	70.769	70.824	70.793	70.886	70.830	70.990	1.8015
99	1.60									

Table 142 — Inspection dimensions M_{Ri}

Side fit internal splines — Fundamental deviation H
30 degree pressure angle — Flat root or fillet root — Module = 1.00

$E_{v \min}$ = minimum effective circular space width = 1.571

Z	D_{Ri}	Measurement between two pins, M_{Ri} (checking of dimensions E_{min} and E_{max}) for tolerance grades								K_i
Number of teeth	Pin diameter	4 H		5 H		6 H		7 H		Approximation factor
		min. (aux)	max.	min. (aux)	max.	min. (aux)	max.	min. (aux)	max.	
6	1.70	*****	*****	*****	*****	*****	3.533	*****	3.713	3.0934
7	1.80	*****	*****	*****	*****	*****	3.533	*****	3.713	3.0934
8	1.80	*****	5.441	*****	6.034	5.909	6.136	5.993	6.273	3.5047
10	1.80	7.098	7.163	7.120	7.222	7.150	7.304	7.194	7.428	2.5116
11	1.80	8.051	8.104	8.069	8.155	8.093	8.228	8.132	8.341	2.3293
12	1.80	9.185	9.234	9.201	9.281	9.224	9.350	9.260	9.450	2.2505
13	1.90	9.699	9.757	9.719	9.813	9.746	9.892	9.789	10.015	2.4796
14	1.90	10.826	10.878	10.844	10.930	10.869	11.004	10.908	11.122	2.3739
15	1.90	11.877	11.827	11.796	11.876	11.819	11.947	11.856	12.060	2.2736
16	1.90	12.877	12.922	12.892	12.969	12.915	13.039	12.950	13.149	2.2198
17	1.90	13.827	13.870	13.842	13.915	13.863	13.983	13.898	14.090	2.1591
18	1.90	14.907	14.950	14.873	14.944	14.894	15.008	14.927	15.167	2.1268
19	1.90	15.858	15.900	15.873	15.944	15.894	16.008	15.927	16.114	2.0853
20	1.90	16.929	16.970	16.944	17.013	16.964	17.078	16.997	17.183	2.0634
21	1.90	17.881	17.922	17.896	17.965	17.917	18.028	17.949	18.132	2.0333
22	1.90	18.944	18.984	18.959	19.027	18.979	19.089	19.010	19.198	2.0178
23	1.90	19.900	19.939	19.914	19.981	19.933	20.044	19.965	20.148	1.9848
24	1.90	20.956	20.996	20.971	21.037	20.992	21.101	21.024	21.204	1.9833
25	1.90	21.915	21.953	21.930	21.995	21.949	22.057	21.982	22.160	1.9652
26	1.90	22.966	23.005	22.981	23.046	23.002	23.109	23.034	23.211	1.9563
27	1.90	23.927	23.965	23.942	24.006	23.962	24.068	23.994	24.170	1.9416
28	1.90	24.975	25.012	24.989	25.054	25.009	25.116	25.042	25.219	1.9343
29	1.90	25.937	25.975	25.952	26.016	25.973	26.078	26.004	26.180	1.9222
30	1.90	26.982	27.019	26.996	27.060	27.017	27.122	27.049	27.224	1.9164
31	1.90	27.946	27.984	27.961	28.025	27.981	28.087	28.013	28.189	1.9060
32	2.00	28.922	28.959	28.937	29.000	28.956	29.062	28.988	29.163	1.8956
33	2.00	29.898	29.935	29.913	29.976	29.932	29.990	29.916	30.091	1.8852
34	2.00	30.874	30.911	30.889	30.952	30.908	31.014	30.940	31.115	1.8748
35	2.00	31.850	31.887	31.865	31.928	31.884	31.990	31.916	32.091	1.8644
36	2.00	32.826	32.863	32.844	32.907	32.863	32.969	32.895	33.070	1.8540
37	2.00	33.802	33.839	33.819	33.882	33.838	33.944	33.870	34.045	1.8436
38	2.00	34.778	34.815	34.798	34.861	34.817	34.923	34.849	35.024	1.8332
39	2.00	35.754	35.791	35.774	35.827	35.783	35.889	35.815	35.990	1.8228
40	2.00	36.730	36.767	36.750	36.803	36.759	36.865	36.791	36.966	1.8124
41	2.00	37.706	37.743	37.726	37.779	37.735	37.841	37.767	37.942	1.8020
42	2.00	38.682	38.719	38.702	38.755	38.711	38.817	38.743	38.918	1.7916
43	2.00	39.658	39.695	39.678	39.731	39.687	39.793	39.719	39.894	1.7812
44	2.00	40.634	40.671	40.654	40.707	40.663	40.769	40.695	40.870	1.7708
45	2.00	41.610	41.647	41.630	41.683	41.639	41.745	41.671	41.846	1.7604
46	2.00	42.586	42.623	42.609	42.662	42.618	42.724	42.650	42.825	1.7500
47	2.00	43.562	43.599	43.585	43.638	43.594	43.700	43.626	43.801	1.7396
48	2.00	44.538	44.575	44.561	44.614	44.570	44.676	44.602	44.777	1.7292
49	2.00	45.514	45.551	45.537	45.590	45.546	45.652	45.578	45.753	1.7188
50	2.00	46.490	46.527	46.513	46.566	46.522	46.628	46.554	46.729	1.7084
51	2.00	47.466	47.503	47.490	47.543	47.499	47.605	47.531	47.706	1.6980
52	2.00	48.442	48.479	48.466	48.519	48.475	48.581	48.507	48.682	1.6876
53	2.00	49.418	49.455	49.445	49.498	49.454	49.560	49.486	49.661	1.6772
54	2.00	50.394	50.431	50.422	50.475	50.431	50.537	50.463	50.638	1.6668
55	2.00	51.370	51.407	51.398	51.451	51.407	51.513	51.439	51.614	1.6564
56	2.00	52.346	52.383	52.374	52.427	52.383	52.489	52.415	52.590	1.6460
57	2.00	53.322	53.359	53.350	53.403	53.359	53.465	53.391	53.566	1.6356
58	2.00	54.298	54.335	54.326	54.379	54.335	54.441	54.367	54.542	1.6252
59	2.00	55.274	55.311	55.302	55.355	55.311	55.417	55.343	55.518	1.6148
60	2.00	56.250	56.287	56.278	56.331	56.287	56.393	56.319	56.494	1.6044
61	2.00	57.226	57.263	57.254	57.307	57.263	57.369	57.295	57.470	1.5940
62	2.00	58.202	58.239	58.230	58.283	58.239	58.345	58.271	58.446	1.5836
63	2.00	59.178	59.215	59.206	59.259	59.215	59.321	59.247	59.422	1.5732
64	2.00	60.154	60.191	60.182	60.235	60.191	60.297	60.223	60.398	1.5628
65	2.00	61.130	61.167	61.158	61.211	61.167	61.273	61.199	61.374	1.5524
66	2.00	62.106	62.143	62.134	62.187	62.143	62.249	62.175	62.350	1.5420
67	2.00	63.082	63.119	63.110	63.163	63.119	63.225	63.151	63.326	1.5316
68	2.00	64.058	64.095	64.086	64.139	64.095	64.201	64.127	64.302	1.5212
69	2.00	65.034	65.071	65.062	65.115	65.071	65.177	65.103	65.278	1.5108
70	2.00	66.010	66.047	66.038	66.091	66.047	66.153	66.079	66.254	1.5004
71	2.00	66.986	67.023	67.014	67.067	67.023	67.129	67.055	67.230	1.4900
72	2.00	67.962	68.000	67.950	68.003	67.950	68.069	67.995	68.170	1.4796
73	2.00	68.938	68.975	68.966	69.019	68.975	69.081	69.007	69.182	1.4692
74	2.00	69.914	70.000	69.900	70.003	69.900	70.069	70.000	70.175	1.4588
75	2.00	70.890	71.000	70.876	71.003	70.876	71.045	70.976	71.151	1.4484
76	2.00	71.866	72.000	71.852	72.003	71.852	72.025	71.956	72.131	1.4380
77	2.00	72.842	73.000	72.828	73.003	72.828	73.037	72.968	73.143	1.4276
78	2.00	73.818	74.000	73.804	74.003	73.804	74.057	73.988	74.163	1.4172
79	2.00	74.794	75.000	74.780	75.003	74.780	75.065	74.996	75.171	1.4068
80	2.00	75.770	76.000	75.756	76.003	75.756	76.085	76.016	76.191	1.3964
81	2.00	76.746	77.000	76.732	77.003	76.732	77.113	77.044	77.219	1.3860
82	2.00	77.722	78.000	77.708	78.003	77.708	78.137	78.068	78.243	1.3756
83	2.00	78.698	79.000	78.684	79.003	78.684	79.177	79.108	79.283	1.3652
84	2.00	79.674	80.000	79.660	80.003	79.660	80.201	80.132	80.307	1.3548
85	2.00	80.650	81.000	80.636	81.003	80.636	81.197	81.128	81.303	1.3444
86	2.00	81.626	82.000	81.612	82.003	81.612	82.225	82.156	82.331	1.3340
87	2.00	82.602	83.000	82.588	83.003	82.588	83.253	83.184	83.359	1.3236
88	2.00	83.578	84.000	83.564	84.003	83.564	84.273	84.204	84.379	1.3132
89	2.00	84.554	85.000	84.540	85.003	84.540	85.317	85.248	85.423	1.3028
90	2.00	85.530	86.000	85.516	86.003	85.516	86.337	86.268	86.443	1.2924
91	2.00	86.506	87.000	86.492	87.003	86.492	87.377	87.308	87.483	1.2820
92	2.00	87.482	88.000	87.468	88.003	87.468	88.397	88.328	88.503	1.2716
93	2.00	88.458	89.000	88.444	89.003	88.444	89.425	89.356	89.531	1.2612
94	2.00	89.434	90.000	89.420	90.003	89.420	90.441	90.372	90.547	1.2508
95	2.00	90.410	91.000	90.396	91.003	90.396	91.469	91.400	91.575	1.2