BRITISH STANDARD

BS ISO
4378-4:2009

Plain bearings — Terms, definitions, classification and symbols

Part 4: Basic symbols

ICS 01.040.21; 21.100.10

BSI
British Standards

National foreword

This British Standard is the UK implementation of ISO 4378-4:2009.

The UK participation in its preparation was entrusted to Technical Committee MCE/12, Plain bearings.

A list of organizations represented on this committee can be obtained on request to its secretary.

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 4378-4 was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 6, *Terms and common items*.

This second edition cancels and replaces the first edition (ISO 4378-4:1997) and ISO 7904-1:1995, which have been technically revised.

ISO 4378 consists of the following parts, under the general title *Plain bearings — Terms, definitions, classification and symbols*:

— *Part 1: Design, bearing materials and their properties*

— *Part 2: Friction and wear*

— *Part 3: Lubrication*

— *Part 4: Basic symbols*

— *Part 5: Application of symbols*

Introduction

As there is a large number of multiple designations in the domain of plain bearings, there is a considerable risk of error in the interpretation of standards and technical literature. This uncertainty leads to the continuous addition of supplementary designations, which only serves to increase the misunderstanding.

This part of ISO 4378 is an attempt to elaborate a uniform basic system of symbols.

INTERNATIONAL STANDARD **ISO 4378-4:2009(E)**

Plain bearings — Terms, definitions, classification and symbols —

Part 4: Basic symbols

1 Scope

This part of ISO 4378 defines basic symbols for use in the field of plain bearings. Additional signs are also defined for use as superscripts and subscripts.

The characters employed are drawn from the Latin and Greek alphabets, Arabic numerals and other signs, for example points, commas, horizontal lines or asterisks. In the simplest case, an application symbol consists of the basic character alone; in the most complex, of the basic character with subscripts and superscripts (additional signs).

For the purposes of international applicability, all basic symbols and additional signs have been derived from English words, and designations used in technical literature up to now have been adopted as far as possible. Wide conformity of the symbols for all types of plain bearings has been attempted.

This classification is established for use in calculations and technological and geometrical determinations, as well as in the quality assurance of plain bearings.

Quantities having a fixed value for a certain construction are designated by capital letters, where possible. Depending on the special field of application, the basic characters specified are for stand-alone use or appropriately combined with additional signs, where necessary, to minimize the risk of confusion; multiple designations can be avoided by suitable indexing with additional signs.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4378-5, *Plain bearings — Terms, definitions, classification and symbols — Part 5: Application of symbols*

3 Basic characters

Basic characters consist of one or, in exceptional cases, two capital or lower-case letters.

Variables shall be in italic typeface, abbreviations shall be in Roman typeface.

EXAMPLE N = rotational speed, VG = Viscosity Grade.

4 Additional signs

4.1 Subscripts

Subscripts may consist of one, two or three letters, digits or letter/digit combinations. In general, the first letter of a subscript corresponds to the first letter of the English concept, which is referred to by the subscript. Subsequent letters shall also follow this concept. The expressions used should be as short as possible.

When the signs correspond to a variable, they shall be in italic typeface; when they refer to an abbreviation, they shall be in Roman typeface.

EXAMPLE c = circular, cr = critical, cal = calculated.

If subscripts are combined, they shall be separated by means of commas but without a space between. For example, the permissible minimum lubricant film thickness at the transition to mixed friction would then be designated as $h_{\mathrm{lim,tr}}$. As such expressions are rather awkward, use of substitute expressions in these cases is also permitted, such as one single letter or (better still) one digit as subscript which has not yet been used, e.g. h_1 instead of $h_{\mathrm{lim,tr}}$.

4.2 Superscripts

Superscripts shall consist of points, lines, commas, asterisks or other characteristic signs. A maximum of two superscripts are permitted per letter symbol.

EXAMPLE $\overline{u}^{*}$

5 Application and distinction by means of basic characters, subscripts and superscripts

Angles and directions of rotation are defined positively as rotating in a left-hand (anticlockwise) direction; the same applies to rotational frequencies and peripheral and angular velocities.

A parameter is represented by the basic character with an asterisk (*), e.g. F* for the bearing force parameter. If the bearing force parameter of a journal bearing is to be distinguished from that of a thrust bearing, this can be done using the designation F_{r}* or F_{ax}*. However, if several different bearing force parameters are used, they can be distinguished in the relevant standard or publication by appropriate subscripts, e.g. 1, 2, 3.

6 Symbols and terms

6.1 General

The following listings are not necessarily complete. They may be enlarged, if necessary.

NOTE Some letters of the Roman and Greek alphabet have not yet been used. Nevertheless, for the sake of completeness, these letters are also included below.

6.2 Basic characters of the Roman alphabet

The basic characters of the Roman alphabet include the following:

A area, elongation at fracture

a distance, acceleration, thermal diffusivity, inertia factor

B width parallel to the sliding surface, normal to the direction of motion (breadth);

b width parallel to the sliding surface, normal to the direction of motion or flow (breadth);

C clearance, circumference, chamfer, concentration

c specific heat capacity, stiffness

D diameter

d diameter, distance, depth, damping

E Young's modulus (modulus of elasticity)

e eccentricity (distance between the centre points or the centre axes of two shaped elements)

F force, load, load-carrying capacity

f friction factor (coefficient of friction), deflection, function, frequency

G shear modulus

g acceleration due to gravity

H height, hardness

h height, depth, thickness, gap

I geometrical moment of inertia

i $\sqrt{-1}$

J mass moment of inertia

j $\sqrt{-1}$

K coefficient, constant, factor, parameter, auxiliary variable

k heat transition coefficient

L length; length parallel to the sliding surface, in the direction of motion

l length, length in the circumferential direction or in the direction of flow, exponent

M moment, mixing factor

m mass, preload

N rotational speed (rotational frequency) (revolutions per time unit)

Nu Nusselt number

n number

O point of origin, centre, centreline, order of magnitude

o N/A

P power, heat flow

Pr Prandtl number

p pressure, surface pressure

Q flow rate (volume flow)

q flow rate (volume flow)

R radius, roughness (surface finish), resistance, material strength

Re Reynolds number

r radius, coordinate in radial direction

S safety factor, displacement amplitude (mechanical oscillation), S number (special form of reciprocal Sommerfeld number So)

So Sommerfeld number (special form of bearing force parameter F^*)

SP switching period

s wall thickness, lining thickness, displacement

T temperature

Ta Taylor number

t time, thickness, wall thickness, lining thickness

U surface velocity in x- or φ-direction, sliding velocity, circumferential speed

u velocity component in x- or φ-direction, deformation in x-direction

V volume, surface velocity in y-direction

VG viscosity grade

VI viscosity index

v velocity component in y-direction, deformation in y-direction

W surface velocity in z-direction, work (energy)

w velocity component in z-direction, deformation in z-direction

X Cartesian coordinate

x Cartesian coordinate, distance

Y Cartesian coordinate

y Cartesian coordinate, distance

Z Cartesian coordinate, number, necking after fracture

z Cartesian coordinate, coordinate in axial direction, distance

6.3 Basic characters of the Greek alphabet

The basic characters of the Greek alphabet include the following.

As there is a risk of confusion with the corresponding Roman letters, the following Greek letters have not been specified: A, B, E, Z, H, I, K, M, N, O, o, P, T, Y, X.

α angle, coefficient, heat transfer coefficient, coefficient of thermal expansion, viscosity coefficient

β angle, temperature/viscosity coefficient

Γ N/A

γ angle

Δ difference, tolerance, change

δ angle

ε relative eccentricity, relative strain

ζ hydraulic resistance coefficient, nozzle coefficient

η dynamic viscosity

Θ N/A

θ angle, angular coordinate

ι N/A

κ resistance ratio

Λ N/A

λ thermal conductivity

μ relative bearing stiffness, relative shaft flexibility; friction factor (coefficient of friction), dynamic viscosity

ν kinematic viscosity, Poisson's ratio

Ξ N/A

ξ restrictor ratio

Π N/A

π circular constant (Ludolph's number) (π = 3,141 592 ...)

ρ density

Σ N/A

σ normal stress, standard deviation

τ shearing stress

υ N/A

Φ dissipation function, sliding surface utilization ratio ($0 < \Phi < 1$)

φ angular coordinate

χ N/A

Ψ N/A

ψ relative clearance

Ω angular span

ω angular speed ($\omega = 2\pi N$)

7 Additional signs

7.1 Subscripts

A area

a average (for surface finish)

abs absolute

amb ambient

ax axial

B bearing, bearing shell, bush, bushing, segment (pad), sliding surface

Bu Bunsen

b spherical (ball)

C thrust collar (thrust bearing)

CG centre of gravity

c circumferential

cal calculation

cl coolant, cooling, cooler, heat exchanger

cor correction

cp capillary

cr critical

ct contact

cv convection

D diameter

d	depth
d	damping, dissipation
dr	dry
dyn	dynamic
dw	downwards
EHD	elastohydrodynamic
e	eigen, eigenfrequency
el	elastic
eff	effective
en	entrance
ex	exit
exc	excitation
F	force, load
f	friction
fi	fixed
fil	fill
fl	flange
flo	floating
G	groove
g	weight, gravity
gl	glass transition
gr	grease
H	housing
h	height, depth, thickness
h	horizontal, gap
hd	hydrodynamic
hs	hydrostatic
I	insulation
i	inside
i	count subscript for direction of journal bearing force

J	journal
JR	Jeffcott Rotor (symmetrical one-mass rotor)
j	count subscript
K	N/A
k	count subscript for direction of journal bearing motion
L	lubricant, lubrication
l	linear
l	length
ld	loaded
lam	laminar
lan	land
le	leading edge
lim	limiting value
lo	loose
lq	liquid
m	mean value, mixed friction
man	manufacturing
max	maximum
me	metal
min	minimum
mnt	mounting
ms	measurement
N	rotational speed (rotational frequency) (revolutions per time unit)
n	normal, normal to surface
nom	nominal value
O	point of origin, centre, centreline
o	outside
opt	optimum
orf	orifice
osc	oscillation

P	pocket, profile
Pu	pump
p	pressure
pa	parasitic
pl	plastic
Q	flow rate (volume flow)
q	N/A
R	radius
r	radial, radial direction
red	reduced
rel	relative
res	resulting
rev	reversible
ri	ring
rot	rotation
rsn	resonance
S	cross-section
s	solid
sc	static
sf	side flow rate
sh	shaft
sl	sliding
sn	stationary
sp	spring
sq	squeezing
str	start
stp	stop
sup	support
T	temperature, tube
t	time

tan	tangential
te	trailing edge
th	thermal, heat
tl	taper land thrust bearing
tot	total
tr	transition
tur	turbulent
U	N/A
u	unbalance
uld	unloaded
up	upwards
V	volume
v	vertical
var	variable
vt	ventilation
W	N/A
w	wear
wav	waviness
wed	wedge
X	X-axis
x	x-direction
Y	Y-axis
y	y-direction
Z	Z-axis
z	z-direction, axial direction, ten point average (for surface finish)
θ	angle
λ	heat conduction
φ	circumferential direction
0	count subscript, reference value, initial value

1 count subscript, count subscript for x-direction, reference value

2 count subscript, count subscript for y-direction

3 count subscript, count subscript for z-direction

4 count subscript

5 count subscript

6 count subscript

7 count subscript

8 count subscript

9 count subscript

20 value at 20 °C

7.2 Superscripts

The superscripts, shown using X, are the following:

$\boldsymbol{X}$, $\vec{X}$ vector

X^* parameter, characteristic (non-dimensional ratio of dimensional physical quantities)

$\bar{X}$ average value, specific value

X' derivative of X with respect to direction

$\dot{X}$ derivative of X with respect to time

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BSI Group
Headquarters 389
Chiswick High Road,
London, W4 4AL, UK
Tel +44 (0)20 8996 9001
Fax +44 (0)20 8996 7001
www.bsigroup.com/
standards