BS EN 847-2:2013

BSI Standards Publication

Tools for woodworking — Safety requirements

Part 2: Requirements for the shank of shank mounted milling

bsi.

...making excellence a habit.™

National foreword

This British Standard is the UK implementation of EN 847-2:2013. It supersedes BS EN 847-2:2001 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MTE/23, Woodworking machines.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

ISBN 978 0 580 75761 7

ICS 79.120.10

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 October 2013.

Amendments issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 847-2

October 2013

ICS 79.120.10

Supersedes EN 847-2:2001

English Version

Tools for woodworking - Safety requirements - Part 2: Requirements for the shank of shank mounted milling

Outils pour le travail du bois - Prescriptions de sécurité - Partie 2: Prescriptions pour les queues des fraise à queue

Maschinen-Werkzeuge für Holzbearbeitung - Sicherheitstechnische Anforderungen - Teil 2: Anforderungen für den Schaft von Fräswerkzeugen

This European Standard was approved by CEN on 10 August 2013.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 847-2:2013: E

Contents

Page

Foreword

This document (EN 847-2:2013) has been prepared by Technical Committee CEN/TC 142 “Woodworking machines - Safety”, the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2014, and conflicting national standards shall be withdrawn at the latest by April 2014.

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

This document supersedes EN 847-2:2001.

The following table contains a list of modifications from the previous edition.

EN 847-2:2001	EN 847-2:2013	Reason
1 Scope	1 Scope: Precision of the indent New paragraph: applies also for shank tools with a cutting diameter of less than 16 mm	ed/te
3 Quantities and units	3 Terms and definitions	ed
5 Tool marking	5 Safety requirements: 5.1 General requirements for cylindrical shank 5.2 Stability of the shank of the shank mounted tools 5.3 Stability of HSK mounted tools	te (missing requirements)
6 Safety requirements	6 Tool marking Changed symbol for the free shank length	te
Annex A: Method of measuring the eccentricity at clamping devices	Annex A: Examples of calculation	ed
Annex B: Example of calculation	Annex B: Method of measuring the eccentricity at clamping devices	ed
	New: Bibliography	ed

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

The content of this European Standard is aimed at eliminating hazards which can lead to overloading of the shank of shank mounted milling tools for woodworking by excessive rotational speeds.

1 Scope

This European Standard specifies the determination of the maximum speed for given eccentricity at clamping devices for the shank strength of milling tools with cylindrical and taper shank. It also specifies the marking of the tool. Bore mounted tools which are mounted on an arbour should be considered as a shank mounted tool.

This European Standard complements EN 847-1 and applies also for shank tools with a cutting diameter of less than 16 mm.

2 Normative references

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

EN 847-1:2013, *Tools for woodworking — Safety requirements — Part 1: Milling tools, circular saw blades*

EN ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction (ISO 12100:2010)*

ISO 1940-1, *Mechanical vibration — Balance quality requirements for rotors in a constant (rigid) state — Part 1: Specification and verification of balance tolerances*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 847-1:2013 and the following apply.

3.1
7/24 shank
SK
type of toolholder with a 7/24 cone ratio taper that contacts the spindle on two surfaces

Note 1 to entry: Toolholder with a 7/24 cone ratio taper; see Bibliography.

3.2
hollow taper shank
HSK
type of toolholder with a short hollow taper with a high positioning accuracy and high grade of rigidity that contacts the spindle on two surfaces

Note 1 to entry: Toolholder with 1:1,09 cone ratio hollow taper shank; see Bibliography.

3.3
arbour
device to mount in or on the spindle of a machine tool, and which is designed to carry and drive a bore type cutting tool

4 List of significant hazards

Table 1 shows the list of significant hazards.

Table 1 — List of significant hazards

Hazard according to EN ISO 12100:2010	Condition or causes of hazard related to the tool	Corresponding clause of EN 847-2
Mechanical hazards due to: Inadequacy of mechanical strength	Breaking of the tool	5
Vibration	Dynamic unbalance of tool	5
Variations in the rotational speed of tools	Breaking of the tool	5

5 Safety requirements

5.1 General requirements for cylindrical shank

The minimum value for the clamping length $l_{e\,min}$ shall be as given in Table 2.

Table 2 — Minimum clamping length $l_{e\,min}$

$d_2 \leq 10$ mm	10 mm < d_2 < 25 mm	$d_2 \geq 25$ mm
$l_{e\,min} = 20$ mm	$l_{e\,min} = 2 \cdot d_2$ (mm)	$l_{e\,min} = 1{,}8 \cdot d_2$ (mm)

The tolerance of the shank diameter d_2 shall be h6 for $d_2 \geq 12$ mm and h8 for $d_2 < 12$ mm. The method of measuring the eccentricity e_m at clamping devices, as given in Annex B, shall be used.

5.2 Stability of the shank of mounted tools

Every shank of a mounted milling tool shall be calculated with the quantities and units as shown in Figure 1a) (with $d = d_2$).

If the shank mounted milling tool is clamped in a taper holder, the cone strength shall be calculated with the quantities and units as shown in Figure 1b) (with $d = d_3$).

If tools are mounted on a taper shank, the shank strength of the clamping diameter shall be calculated with the quantities and units as shown in Figure 1c) with

$l_e = l_g$

$l_0 = 0$

$d_4 = 1{,}4 \cdot d_{arbour}$ ($d_{arbour} \leq 50$mm)

$d_4 = 20 + d_{arbour}$ ($d_{arbour} > 50$mm)

NOTE 1 Clamping systems:

— with axial clamping force [Fa] $d = d_4$;

— without axial clamping force [Fa] $d = d_{arbour}$.

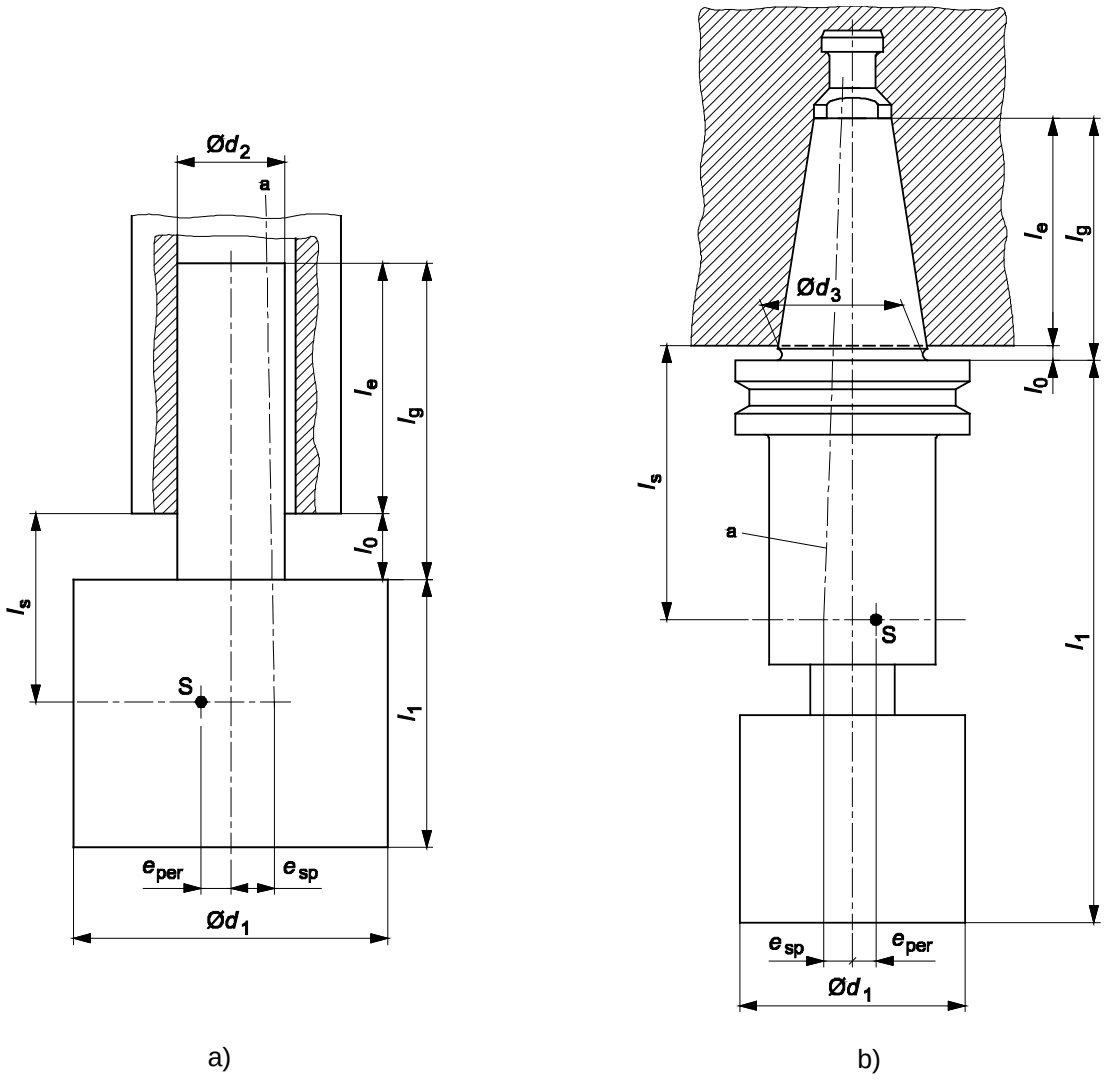
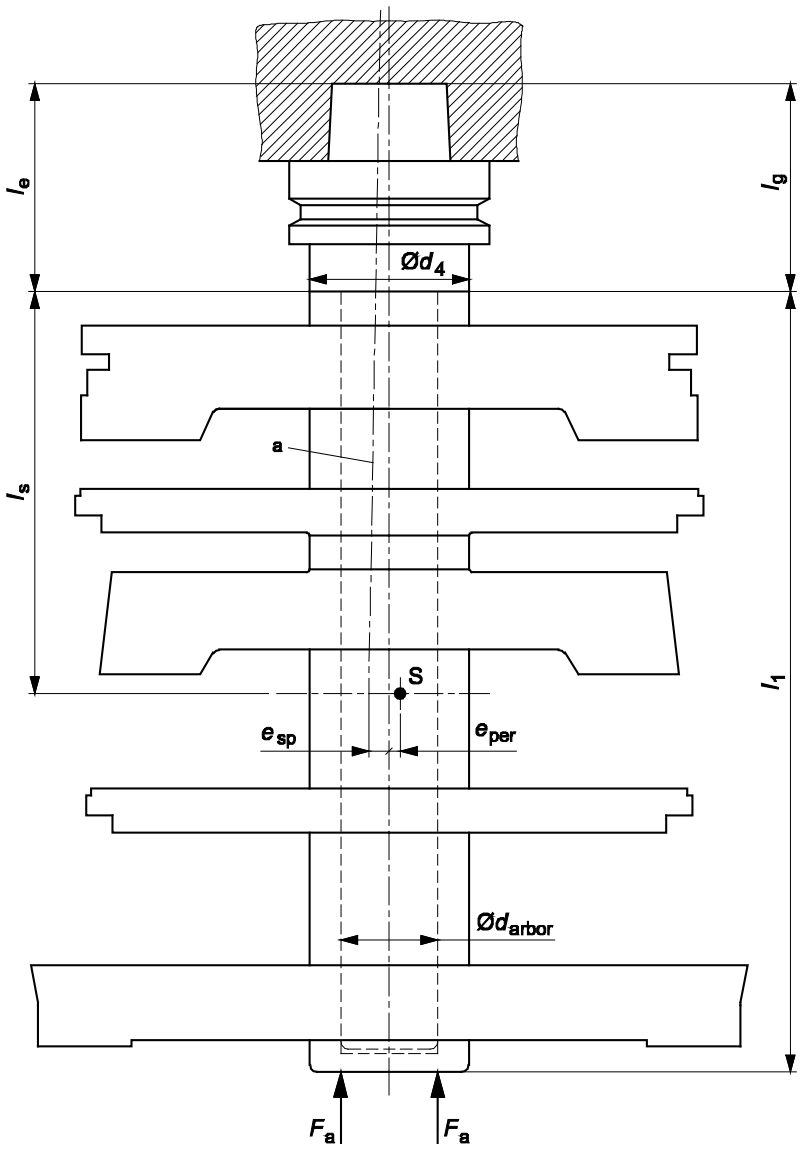


Figure 1 — Quantities for calculation of n_{shank} *(1 of 2)*



c)

Key

a axis of rotation

Figure 1 — Quantities for calculation of n_{shank} *(2 of 2)*

For balance quality, see EN 847-1:2013, Table 5.

For calculation of n with a given e_{sp} the following formula applies:

$$n_{shank} = \frac{30}{\sqrt{f_S} \cdot \pi} \cdot \frac{-G + \sqrt{G^2 + \frac{W \cdot \sigma_W}{m^* \cdot l_S} \cdot \left(e_{sp} + \frac{W \cdot \sigma_W \cdot l_S^2}{3 \cdot E \cdot I} \right) \cdot 10^6}}{e_{sp} + \frac{W \cdot \sigma_W \cdot l_S^2}{3 \cdot E \cdot I}} \quad (1)$$

For calculation of e_{sp} with a given n the following formula applies:

$$e\text{sp} = \frac{1}{n} \cdot \left[\left(\frac{30}{\sqrt{f_S} \cdot \pi} \right)^2 \cdot \frac{W \cdot \sigma_W}{m^* \cdot l_S \cdot n} \cdot 10^6 - \frac{30 \cdot G}{\pi} \right] \cdot \frac{W \cdot \sigma_W \cdot l_S^2}{3 \cdot E \cdot I} \quad (2)$$

$$e_{per} = \frac{30 \cdot G}{\pi \cdot n_{shank}} \quad (3)$$

The mass m_{cut} of the tool components related to the centre of gravity S in the area of l_0 + l_1, is given in Figure 1.

$$m^* = f \cdot m_{cut} \quad (4)$$

$$f = 0{,}04 + 0{,}17 \cdot \ln (m_{cut}) \quad (5)$$

This is an empiric formula of which the result is only valid between 0,6 and 0,9. If the result is less than 0,6 use 0,6, and if the result is greater than 0,9 use 0,9. The form factor takes into account the deviation of the actual form (e.g. gullet; flattening) from the solid body form of the tool without shank.

NOTE 2 The expression "ln (m_{cut})" is the natural logarithm of mass of the tool without shank.

$$I = \pi \cdot \frac{d^4}{64} \quad (6)$$

$$l_0 = l_g - l_e \quad (7)$$

If known the real mass can be used in place of the reduced mass.

$$W = \pi \cdot \frac{d^3}{32} \quad (8)$$

EXAMPLE Figure 2 and Formula (9) give an example for the calculation of the distance l_s.

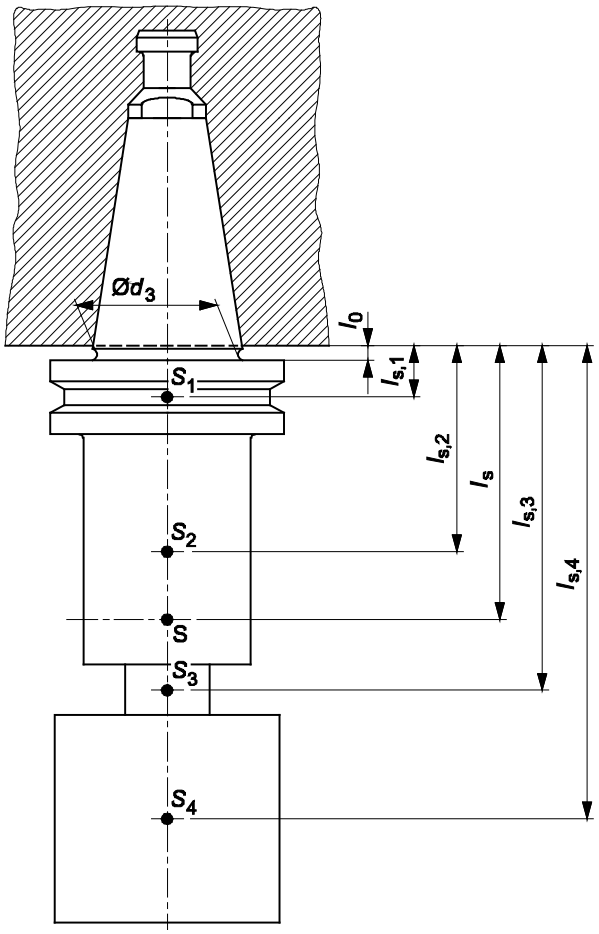


Figure 2 — Distances of the gravity centres of the tool components

$$l_S = \frac{m_1 \cdot l_{S,1} + m_2 \cdot l_{S,2} + m_3 \cdot l_{S,3} + m_4 \cdot l_{S,4}}{m_1 + m_2 + m_3 + m_4} \quad (9)$$

Table 3 — Stability of the shank of the shank mounted tools — Quantities and units

Quantity	Description	Unit
d	diameter a) shank diameter d_2 b) cone diameter d_3 c) with axial force d_4: calculated; without axial force: d_{arbour}	mm
d_1	tool diameter	mm
d_2	shank diameter, see Figure 1a)	mm
d_3	cone diameter, see Figure 1b)	mm
d_4	calculated hub diameter, see Figure 1c)	mm
d_{arbour}	shank diameter of the arbour, see Figure 1c)	mm
E	modulus of elasticity	N mm^{-2}
e_{per}	permissible gravity centre displacement	mm
e_{sp}	eccentricity at clamping device [a]	mm
f	form factor	
f_s	safety factor ($f_S = 4$)	./.
F_a	axial clamping force, see Figure 1c)	N
G	product of the permissible eccentricity and the angular velocity according to ISO 1940-1	mm s^{-1}
I	second moment of area	mm^4
l_1	height of tool components	mm
l_0	free shank length	mm
l_s	distance of gravity centre measured from the end of the clamping device	mm
l_e	clamping length	mm
l_g	total length of shank	mm
m_{cut}	mass of the tool components related to the centre of gravity S in the area of l_0 + l_1, see Figure 1a) to Figure 1c)	
m*	reduced mass of the tool	g
n	operational speed	min^{-1}
n_{shank}	maximum permissible rotational speed with regard to shank strength	min^{-1}
S	centre of gravity	
W	section modulus	mm^3
σ_w	fatigue strength under reversed bending stresses of shank material	N mm^{-2}
ρ	density of shank material	g mm^{-3}

[a] It is intended to determine mean values for stationary routing machines and hand held routing machines by concluding serial tests in order to provide the designer with safety indications and to reduce hazards.

For general use n_{shank} shall be calculated for e_{sp} = 0,1 mm and for tools used on NC- and CNC-machines n_{shank} shall be calculated for e_{sp} = 0,06. In other cases the value of e_{sp} shall be taken according to the formula.

NOTE 3 The safety requirements for the shank strength are fulfilled when, using the given tool sizes and material characteristics with defined free shank length l_0, gravity centre displacement e_{per} and eccentricity at clamping device e_{sp}, the maximum permissible rotational speed for the shank n_{shank} is not exceeded during operation. The cutting force is not significant in comparison with the centrifugal force. Therefore, the cutting force has not been taken into account.

For the operation of complex shank mounted milling tools it has to be considered that the maximum permissible operational speed may not exceed the lower value of the two maximum speed values for the shank strength (n_{shank}) as well as the strength to overspeed load (n_{max}) in accordance with EN 847-1:2013, 5.1.4.1.

5.3 Stability of HSK mounted tools

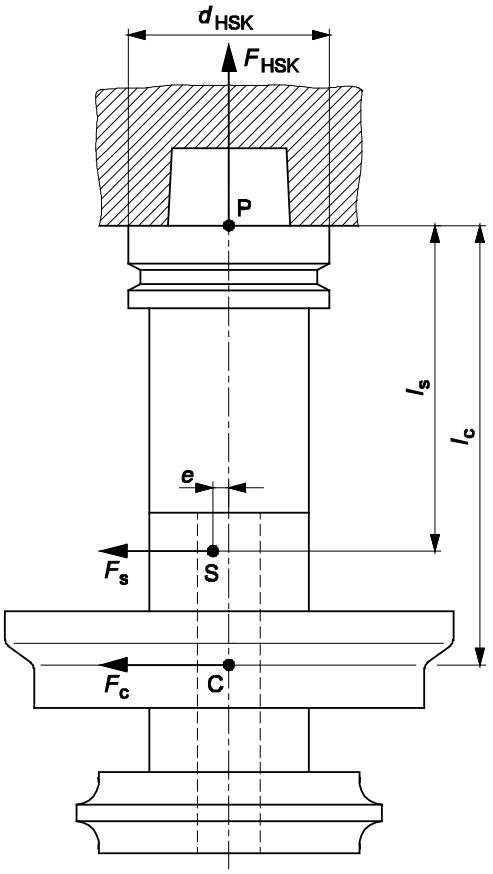


Figure 3 — Quantities for calculation of n_{HSK}

If more than one tool is mounted on an HSK-arbour the tool with the highest value F_C x l_C should be used for the calculation of n_{HSK}.

For calculation of n_{HSK} the following formula applies:

$$n_{HSK} = \frac{30}{\sqrt{f_S} \cdot \pi} \cdot 10^3 \cdot \sqrt{\frac{F_{HSK} \cdot \frac{d_{HSK}}{2} - F_c \cdot l_c}{m \cdot e \cdot l_s}} \quad (10)$$

$$e = e_{HSK} + e_M + e_T \quad (11)$$

$$e_{HSK} = \frac{2 \cdot (l_s \cdot t_p)}{d_{HSK}} + t_r \quad (12)$$

$$e_{\mathrm{M}} = \frac{D_{\mathrm{b\,max}} - d_{s\,\mathrm{min}}}{2} \tag{13}$$

$$e_{\mathrm{T}} = \frac{G}{\omega} = \frac{G_{\mathrm{T}} \cdot 30}{\pi \cdot n_{\mathrm{max}}} \tag{14}$$

If F_{c} is unknown, F_{c} can be calculated according to EN 847-1:

$F_{\mathrm{c}} = F_{\mathrm{m}} \cdot b_1$

F_{m} = *50 N/mm* (for tools with a cutting radius $r_1 \leq 20$ mm)

$$F_{\mathrm{m}} = \frac{30 \cdot P_{\mathrm{Mot}}}{r_1 \cdot b_1 \cdot n_{\mathrm{max}} \cdot \pi} \cdot 10^6 \text{ (for tools with a cutting radius } r_1 > 20 \text{ mm)} \tag{15}$$

Alternative F_{c} can be calculated as transmissible force according to the spindle power:

$$F_{\mathrm{c}} = \frac{P_{\mathrm{c}}}{v_{\mathrm{c}}} \approx \frac{30 \cdot P_{\mathrm{Mot}}}{\pi \times r_1 \cdot n_{\mathrm{max}}} \cdot 10^6 \tag{16}$$

Table 4 — Stability of HSK mounted tools — Quantity and units

Quantity	Description	Unit
C	resulting working point of the cutting forces reduced to the tool axis	./.
b_1	cutting width according to EN 847-1	mm
$D_{b\,max}$	maximum bore diameter (e.g. tool bore)	mm
d_{HSK}	nominal diameter of the HSK (e.g. HSK-F63: d_{HSK} = 63 mm)	mm
$d_{s\,min}$	minimum shaft diameter (e.g. arbour)	mm
e	gravity centre displacement of the complete tool (worst case)	mm
e_{HSK}	eccentricity of the tool caused by the tolerances of the HSK	mm
e_M	eccentricity of the tool caused by mounting tolerances between bore and arbour	mm
e_T	gravity centre displacement of the mounted tool caused by unbalancing	mm
F_c	cutting force	N
F_m	specific cutting force	N/mm
F_{HSK}	clamping force of the HSK (guideline values are given in DIN 69893)	N
f_S	safety factor (f_S = 4)	./.
G	product of the permissible eccentricity and the angular velocity according to ISO 1940-1	mm s^{-1}
l_c	axial distance of the working point of the cutting force from the face stop of the HSK	mm
l_s	distance of the gravity centre from the face stop of the HSK	mm
m	total mass of the complete tool (individual tools, arbour, spacers, HSK)	g
n_{HSK}	maximum permissible rotational speed of the HSK interface	min^{-1}
n_{max}	maximum rotational speed of the tool according to EN 847-1	min^{-1}
R_1	cutting radius according to EN 847-1	mm
S	centre of gravity	./.
t_p	planarity tolerance of the face stop of the HSK according to DIN 69893	mm
t_r	run-out tolerance of the HSK according to DIN 69893	mm
P	working point of the insertion force on the HSK	./.
P_c	cutting power	kW
P_{Mot}	spindle motor power	kW

6 Tool marking

Tool marking shall include the following items:

a) The maximum rotational speed n_{max} or n_{shank} according to EN 847-1:2013, 5.1.4, whichever is the lower;

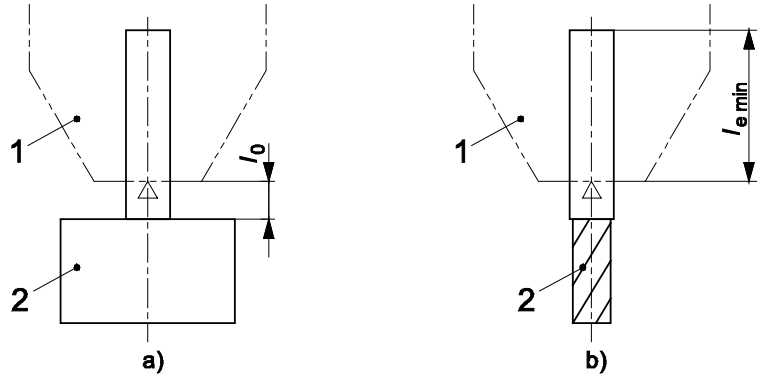
b) the permissible eccentricity e;

EXAMPLE Tool marking example for list items a) and b): "n_{max} 12 000 e 0,06".

c) the free shank length l_0 or the minimum clamping length $l_{e\,min}$ according to Figure 4:

1) if $n_{shank} < n_{max}$: the free shank length l_0,

2) if $n_{shank} \geq n_{max}$: the minimum clamping length $l_{e\,min}$ (see Table 2).



Key

1	chuck
2	tool
l_0	free shank length
$l_{e\,min}$	minimum clamping length

Figure 4 — Marking of the maximum free shank length

Annex A
(informative)

Examples of calculation

A.1 Example of a calculation of n_{shank}

See Figure 1a).

Table A.1 — Calculation of n_{shank}

Description	Quantity	Value	Unit
Shank diameter	d_2	25	mm
Total shank length	l_g	80	mm
Free shank length	l_0	25	mm
Tool diameter	d_1	125	mm
Tool height	l_1	40	mm
Form factor	f	0,9	
Mass of cutting part	$f \cdot m_{cut}$	3 468,02	g
Reduced total mass	m^*	3 492,11	g
Distance of gravity centre	l_s	45	mm
G for balance quality grade G 40 for complex tools	G	40	mm s^{-1}
Fatigue strength under reversed stresses	σ_w	340	N mm^{-2}
Eccentricity at clamping device	e_{sp}	0,1	mm
Modulus of elasticity (steel)	E	210 000	N mm^{-2}
Density (steel)	ρ	0,007 85	g mm^{-3}
Permissible maximum rotational speed	n_{shank}	19 098	min^{-1}

A.2 Example of a calculation of n_{HSK}

See Figure 3.

Table A.2 — Calculation of n_{HSK}

Description	Quantity	Value	Unit
Safety factor	f_S	4	
Clamping force of HSK	F_{HSK}	11 000	N
Nominal diameter of HSK	d_{HSK}	63,00	mm
Cutting force	F_c	500	N
Axial distance of cutting force	l_c	250,00	mm
Total mass of tool	m	8 000	g
Gravity centre displacement	e	0,040 0	mm
Axial distance of gravity centre	l_s	200,00	mm
Maximum rotational speed of HSK	n_{HSK}	8 883	min^{-1}

Annex B
(informative)

Method of measuring the eccentricity at clamping devices

The diameter of the test mandrel is the nominal diameter of the clamping device.

For the test mandrel the following shall apply:

a) test mandrel diameter tolerance: h6/h8 in accordance with Clause 5;

b) test mandrel cylindricity: 0,002 mm;

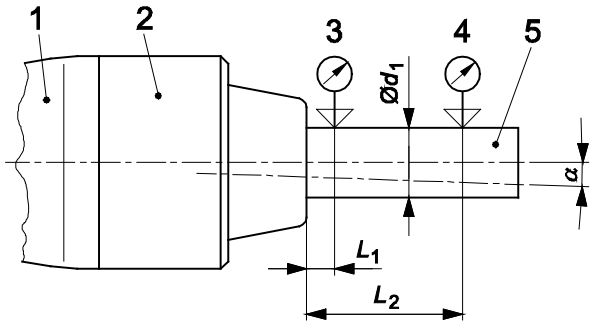
c) test mandrel straightness: 0,002 mm;

d) test mandrel roundness: 0,002 mm;

e) surface without longitudinal marks;

f) surface roughness: max. R_z = 4 µm;

g) surface hardness: 58 + 3 HRC.



Key
1 driving spindle/clamping device shank
2 clamping device
3 test point 1
4 test point 2
5 test mandrel

L_1 = 10 mm
L_2 = (l_g + l_1) - l_e
with l_g, l_1 and l_e, see Figure 1a)
t_1 run-out at test point 1
t_2 run-out at test point 2
α angular deviation

Figure B.1 — Illustration of the measuring method

Eccentricity: $e_m = \frac{t1^+ t2}{4}$ (B.1)

The eccentricity e_m shall be $\leq e_{sp}$.

Bibliography

[1] ISO 297, *7/24 tapers for tool shanks for manual changing*

[2] ISO 7388-1, *Tool shanks with 7/24 taper for automatic tool changers — Part 1: Dimensions and designation of shanks of forms A, AD, AF, U, UD and UF*

[3] ISO 7388-2, *Tool shanks with 7/24 taper for automatic tool changers — Part 2: Dimensions and designation* of *shanks of forms J, JD and JF*

[4] ISO 12164-1, *Hollow taper interface with flange contact surface — Part 1: Shanks — Dimensions*

This page deliberately left blank

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

Useful Contacts:

Customer Services
Tel: +44 845 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 845 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

bsi.

...making excellence a habit.™