3.7 Precision shafts

Ewellix precision shafts are high quality linear guide products for linear ball bearing use. Precision shafts have exceptionally high dimensional stability and are designed for long service life.

Shafts are induction hardened and ground, round steel bars, dimensionally made for the Ewellix linear ball bearing range. Precision shaft tolerances have a direct impact on the operating clearance of a linear bearing system. The hardness of the shaft plays a significant role in the rating life calculation. As shafts are the "inner ring of the linear bearing", the quality of these shafts matters for the safety and service life of your machines and devices.

Ewellix's shaft range supports nearly every linear ball bearing application in material, dimensions and variants. The shafts are manufactured at long lengths to have best service and availability. Ewellix has defined standard shaft machinings and designated them as ESSC (Ewellix Standard Shaft Configurations) for convenient selection and order handling (↳**chapter3.7.7**).

3.7.1 Shaft types and material

Shaft type		Material description	Steel designation		Size range	Hardness	Surface roughness Ra	Diameter tolerance	Factor for hardness of shaft [2]	
–			EN	AISI	mm	HRC	µm	-	f_h	f_{h0}
LJM	solid	high grade steel	1.1213 (Cf53) [1]	1055	3 – 80	62 ±2	0,3	h6	1,00	1,00
LJMR	solid	high alloy stainless steel	1.4112 (X90CrMoV18) [1]	440B	3 – 60	54 ±2	0,3	h6	0,69	0,582
LJMS	solid	high alloy stainless steel	1.4034 (X46Cr13) [1]	420	5 – 60	53 ±2	0,3	h6	0,66	0,532
LJMH	solid	high grade steel, hard chrome plated, ca. 10 µm	1.1213 (Cf53) [1]	1055	5 – 80	62 ±2	0,3	h7	1,00	1,00
LJT	hollow	high grade steel	1.0601 (C60) [1]	1060	12 – 80	62 ±2	0,3	h6	1,00	1,00

[1] or equal
[2] valid for minimal hardness values

3.7.2 Shaft hardness and depth

All Ewellix precision shafts are induction hardened. The hardness mainly depends on the material. The hardness per shaft type and the factors for hardness, influencing the rating life, are listed in **chapter 3.7.1**. The hardness depth is linked to the shaft size. Ewellix has defined the minimum hardness depths per shaft size in the table below. The hardness depth may also be higher than indicated in the table, please consider that influence on the machinability of the shafts. The ends of uncut shafts in production length may deviate in hardness and dimensional accuracy.

Hardness depths of shafts

Shaft diameter from mm	up to	Hardness depth min.
3	10	0,4
12	16	0,6
20	30	0,9
40	50	1,5
60	80	2,2

Please be aware that all tolerances as well as the hardness and roughness of shafts have a great impact on the service life of your linear ball bearings. The influence is explained in the linear bearing rating life calculations in **chapter 2.2.3**.

3.7.3 Shaft corrosion resistance and protection

The Ewellix linear ball bearing range is available as a stainless steel variant in most types. The shaft range offers different types of high alloy stainless steel material or corrosion protection. Three types of material for corrosion protection are available:

a) LJMR, a high alloy stainless steel shaft with high hardness, good wear resistance. This material is resistant to moderately aggressive media. This material is best for long corrosion resistance at high service life.

b) LJMS, a high alloy stainless steel shaft like LJMR but with less hardness. This material is best for economic corrosion and media resistance.

c) LJMH, a hard chrome plated, high grade steel shaft with excellent surface hardness due to the chrome layer. The corrosion resistance is along the chrome layer and does not exist at the cut surfaces. This material has medium corrosion resistance along the outside shape of the shaft.

Corrosion protection and packaging

Ewellix precision shafts are treated with a rust inhibiting preservative that must be removed before the shafts are installed. Depending on size and quantity, precision shafts are supplied in cardboard or wooden boxes that offer maximum protection during transport. Please contact us for special freight conditions, like overseas shipping.

3.7.4 Precision shaft length

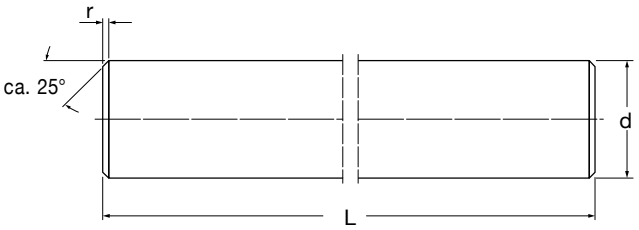
Maximum length and general length tolerance per shaft type

Shaft diameter mm	Maximum length [1] LJM	LJMR	LJMS	LJMH	LJT	Length tolerance for maximum length
3 [2]	1 000	300	–	–	–	±1,5
4 [2]	3 000	3 000	–	–	–	±1,5
5	3 000	3 000	–	3 000	–	±1,5
6	3 000	3 000	3 000	3 000	–	±1,5
8	3 000	3 000	3 000	3 000	–	±1,5
10	3 000	3 000	3 000	3 000	–	±1,5
12	6 000	6 000	6 000	6 000	6 000	±1,5
14	6 000	6 000	6 000	6 000	–	±1,5
16	6 000	6 000	6 000	6 000	6 000	±1,5
20	6 000	6 000	6 000	6 000	6 000	±1,5
25	6 000	6 000	6 000	6 000	6 000	±1,5
30	6 000	6 000	6 000	6 000	6 000	±1,5
40	6 000	6 000	6 000	6 000	6 000	±1,5
50	6 000	6 000	6 000	6 000	6 000	±1,5
60	6 000	6 000	6 000	6 000	6 000	±1,5
80	6 000	–	–	6 000	6 000	±1,5

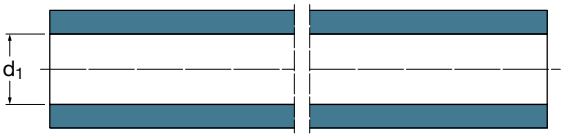
[1] Maximum shaft length with both ends cut, means no deviation of hardness or dimensional accuracy.

[2] Only available as ESSC 2, see **chapter 3.7.7**

3.7.5 Technical data of precision shafts



Picture shows solid shaft with shafting standard ESSC 3



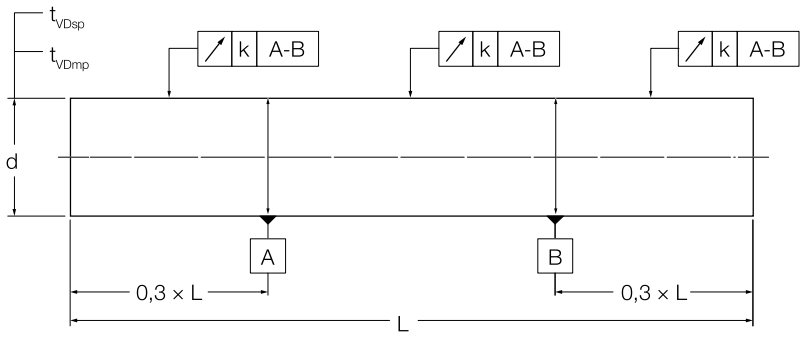
Picture shows hollow shaft with shafting standard ESSC 1

Dimensions			Mass		Moment of inertia		Cross sectional area		Designation				
			Solid shaft	Hollow shaft	Solid shaft	Hollow shaft	Solid shaft	Hollow shaft	Solid shaft				Hollow shaft
d	d_1	r [1]											
mm			kg/m		cm^4		mm^2		–				
3	–	0,4	0,06	–	0,0004	–	7,1	–	LJM 3	LJMR 3	–	–	–
4	–	0,4	0,1	–	0,0013	–	12,6	–	LJM 4	LJMR 4	–	–	–
5	–	0,8	0,15	–	0,0031	–	19,6	–	LJM 5	LJMR 5	–	LJMH 5	–
6	–	0,8	0,22	–	0,0064	–	28,3	–	LJM 6	LJMR 6	LJMS 6	LJMH 6	–
8	–	0,8	0,39	–	0,02	–	50,3	–	LJM 8	LJMR 8	LJMS 8	LJMH 8	–
10	–	0,8	0,62	–	0,049	–	78,5	–	LJM 10	LJMR 10	LJMS 10	LJMH 10	–
12	4	1	0,89	0,79	0,102	0,1	113	101	LJM 12	LJMR 12	LJMS 12	LJMH 12	LJT 12
14	–	1	1,21	–	0,189	–	154	–	LJM 14	LJMR 14	LJMS 14	LJMH 14	–
16	7	1	1,58	1,28	0,322	0,31	201	163	LJM 16	LJMR 16	LJMS 16	LJMH 16	LJT 16
20	14	1,5	2,47	1,25	0,785	0,597	314	160	LJM 20	LJMR 20	LJMS 20	LJMH 20	LJT 20
25	16 [2]	1,5	3,86	2,35	1,92	1,64	491	305	LJM 25	LJMR 25	LJMS 25	LJMH 25	LJT 25
30	18 [2]	1,5	5,55	3,5	3,98	3,46	707	453	LJM 30	LJMR 30	LJMS 30	LJMH 30	LJT 30
40	28 [2]	2	9,86	4,99	12,6	9,96	1 260	685	LJM 40	LJMR 40	LJMS 40	LJMH 40	LJT 40
50	30	2	15,4	9,91	30,7	27,7	1 960	1 350	LJM 50	LJMR 50	LJMS 50	LJMH 50	LJT 50
60	36	2,5	22,2	14,2	63,6	57,1	2 830	1 920	LJM 60	LJMR 60	LJMS 60	LJMH 60	LJT 60
80	57	2,5	39,5	19,43	201	153	5 030	2 565	LJM 80	–	–	LJMH 80	LJT 80

[1] The values r given in that table represent the minimum values of r.
[2] d_1 can deviate from the given value. Please enquire if necessary

3.7.6 Tolerances of precision shafts

All Ewellix precision shafts are supplied in high quality tolerance h6 as standard. Only hard chrome plated shafts LJMH are supplied in tolerance h7. The accuracy of dimensions and form are in the table below. When shafts are annealed and machined, there may be slight deviations from the values provided in the tables for those sections. The length tolerance of shafts cut to length is ±1,5 mm as standard.



Definition of shaft tolerances is according to ISO 13012-1

Shaft	**Accuracy of dimension and form**									
Nominal diameter	Shafts in tolerance h6					Shafts in tolerance h7				
d mm	$t_{\Delta ds}$ upper limit µm	lower limit	t_{VDsp}	t_{VDmp}	k run-out µm/m	$t_{\Delta ds}$ upper limit µm	lower limit	t_{VDsp}	t_{VDmp}	k run-out µm/m
3	0	–6	3	4	150	0	–10	4	6	150
4	0	–8	4	5	150	0	–12	5	8	150
5	0	–8	4	5	150	0	–12	5	8	150
6	0	–8	4	5	150	0	–12	5	8	150
8	0	–9	4	6	120	0	–15	6	9	120
10	0	–9	4	6	120	0	–15	6	9	120
12	0	–11	5	8	100	0	–18	8	11	100
14	0	–11	5	8	120	0	–18	8	11	120
16	0	–11	5	8	100	0	–18	8	11	100
20	0	–13	6	9	100	0	–21	9	13	100
25	0	–13	6	9	100	0	–21	9	13	100
30	0	–13	6	9	100	0	–21	9	13	100
40	0	–16	7	11	100	0	–25	11	16	100
50	0	–16	7	11	100	0	–25	11	16	100
60	0	–19	8	13	100	0	–30	13	19	100
80	0	–19	8	13	100	0	–30	13	19	100

3.7.7 Machined precision shafts

Ewellix Shaft Standard Configuration - ESSC

For machined shafts, Ewellix has defined standard configurations widely used in linear ball bearing applications. It mainly specifies how both shaft ends and solutions with radial holes for shaft support look like. These standard choices have to be mentioned in the ordering key of a shaft. For example, the designation for a shaft with 20 mm diameter cut to a length of 1,5 m and with chamfers, is LJM 20x1500 ESSC 2. For customised shaft solutions according to customer drawing, the suffix is ESSC 10 in the ordering key.

Precision shafts with radial holes

For open type linear ball bearings, shafts with radial holes mounted on shaft supports are needed. Ewellix has defined a design standard for radial threads and distances for easy documentation and the definition of a connection of shafts with shaft supports. Shaft supports are shown in **chapter 3.6.6**. The radial holes may be either positioned to fit Ewellix shaft supports (suffix ESSC 6) or as specified by the customer (suffix ESSC 7). Also, use the values for thread size and depth from adjacent tables when creating your own shaft design. Ewellix shafts with radial holes are not annealed at the drilling position. The thread is cut in the hardened and ground shaft to avoid any changes in hardness or dimensional accuracy.

Jointed precision shafts

In case shafts longer than the maximum length (↳ **chapter 3.7.4**) are needed, Ewellix can supply jointed shafts on request. Screwed joints are recommended for unsupported shafts. Plug and socket joints are used with supported shafts. Ewellix takes great care to provide accurately machined joints, e.g. regarding concentricity, as they are vital for smooth transitions at the joints.

A customer drawing with details and defined joint positions is necessary to handle a request or order. The ordering key suffix for a customised solution is ESSC 10.

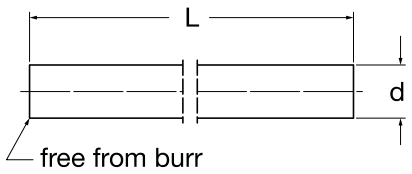
Dimensions of front side threads ESSC 4 and 5

d mm	G –	L_5 mm
8	M4	10
10	M4	10
12	M5	12,5
14	M5	12,5
16	M6	15
20	M8	20
25	M10	25
30	M10	25
40	M12	30
50	M16	40
60	M20	50
80	M24	60

ESSC definitions

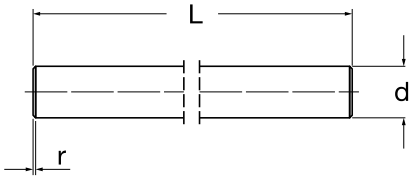
ESSC 1

- Shaft cut to length and deburred
- Length tolerance ±1,5 mm



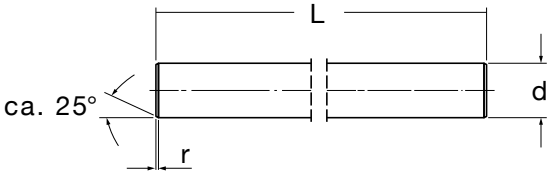
ESSC 2

- Shaft cut to length with chamfer
- Chamfer with r value of minimum 1 mm
- Length tolerance ±1,5 mm



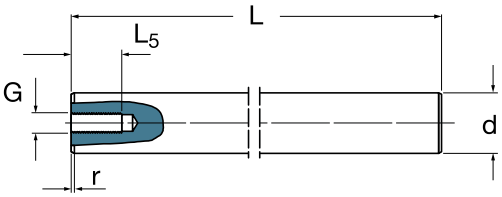
ESSC 3

- Shaft cut to length with chamfer ca. 25°
- With machined front surface 90°
- Length tolerance ±0,1 mm up to 3 m length
- Chamfer with r value according to **chapter 3.7.5**



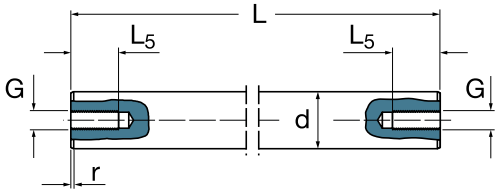
ESSC 4

- Shaft cut to length with chamfer
- With machined front surface 90°
- Length tolerance ±0,1 mm up to 3 m length
- Chamfer with r value according to **chapter 3.7.5**
- With one axial thread; dimensions according table



ESSC 5

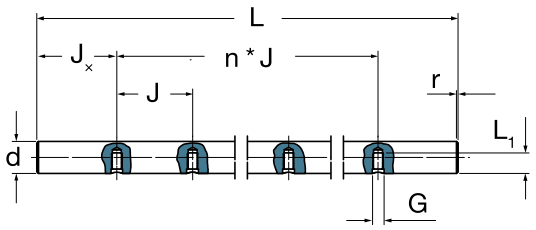
- Shaft cut to length with chamfer
- With machined front surface 90°
- Length tolerance ±0,1 mm up to 3 m length
- Chamfer with r value according to **chapter 3.7.5**
- With two axial threads; dimensions according table



Delivery times depend on the shaft machining:
ESSC 1-3 usually within 10 days
ESSC 4-8 usually within 20 days

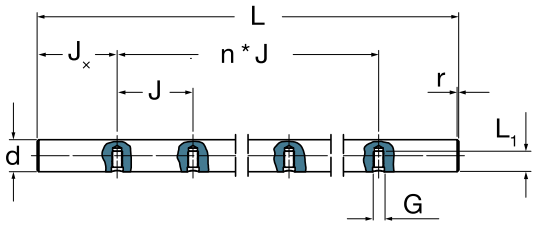
ESSC 6

- Shaft cut to length with chamfer
- Chamfer with r value of minimum 1 mm
- Length tolerance ±1,5 mm
- Shaft with radial threads for LRCB shaft supports
- First radial thread position at $J_x = J/2$



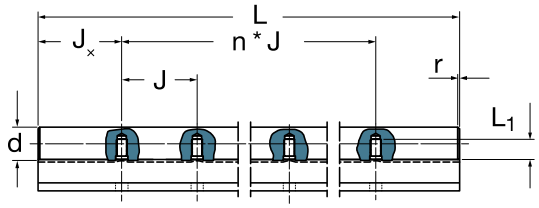
ESSC 7

- Shaft cut to length with chamfer
- Chamfer with r value of minimum 1 mm
- Length tolerance ±1,5 mm
- Shaft with radial threads
- Dimension J and J_x as specified in customer's drawing



ESSC 8

- Shaft cut to length with chamfer
- Chamfer with r value of minimum 1 mm
- Length tolerance ±1,5 mm
- Shaft with radial threads for LRCB shaft supports
- First radial thread position at $J_x = J/2$
- Shaft fully supported and mounted with LRCB shaft supports



ESSC 10

- Shaft according customer drawing

Dimensions of radial threads ESSC 6, 7 and 8

d mm	G	L_1	J	J_x
8	–	–	–	–
10	–	–	–	–
12	M4	8	75	37,5
14	–	–	–	–
16	M5	9,5	100	50
20	M6	13	100	50
25	M8	14	120	60
30	M10	18	150	75
40	M10	20	200	100
50	M12	23	200	100
60	M14	28	300	150
80	M16	33	300	150