TOOLFLEX®

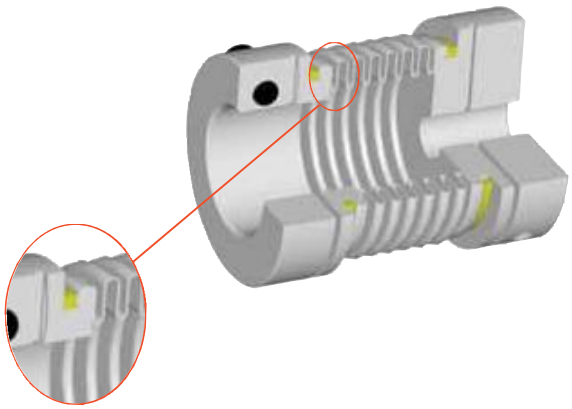
Backlash-free torsionally rigid metal bellow-type couplings

TOOLFLEX® Metal bellow-type couplings

Backlash-free, torsionally stiff and maintenance-free coupling

The **TOOLFLEX®** is a coupling system that has proven successfully many times (metal bellow-type coupling). Its most important features are the good compensation for displacements (axial, radial and angular), the high torsional stiffness as well as the easy and fast assembly of the clamping hub.

Examples of applications:
Machine tools, positioning systems (e. g. ball roll spindles with high pitch), indexing tables, planet gears with low transmissions for precise positioning



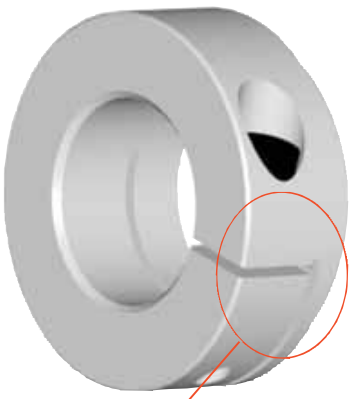
Proven joint procedure, ensuring:

- non-positive, backlash-free connection of the aluminium hubs with the multilayer bellows made from stainless steel
- safe torque transmission of „every“ bellow layer into the hub
- fatigue strength in high temperature ranges up to max. 280 °C and in case of influences of media or critical operating conditions

Proven shaft-hub connection

Clamping hubs with two slots, ensuring:

- easy assembly of the clamping hubs through radial clamping screw
- no deformation of the bellow when tightening the clamping screw by two slots in the hub
- bore tolerance „F7“ for easier assembly onto the shaft



clamping hub with two slots

TOOLFLEX® Metal bellow-type couplings

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Coupling selection

Normally the **TOOLFLEX®** is selected according to the nominal torque (T_{KN}) shown in the list of technical data, like all other coupling systems. In all cases the torque (T_{KN}) must exceed the maximum torque to be transmitted. This should mainly be considered in connection with servo motors because their accelerating torques both positive and negative can exceed the nominal torque of the coupling by a significant amount.

Judgement calculation

$$T_{AS}\ [Nm] = 9550 \cdot \frac{P_{max}}{n}$$

$$T_{KN}\ [Nm] \geq T_{AS/LS} \cdot k$$

P_{max} = max. engine performance [kW]
n = engine speed [min^{-1}]
T_{AS} = peak torque of the engine [Nm]
T_{LS} = peak torque of load side [Nm]
k = operating factor

k = 1.5 with uniform movement, k = 2 with ununiform movement, k = 2.5 - 4 with shocking movement

For drives in machine tools (servo motors) k values of 1.5 - 2 must be used.

When selecting servo motors the calculations are made with the torque values of the engine suppliers and not with P_{max}. When dimensioning the coupling please use the respective data of the manufacturer considering the servo controller to be used.

Accelerating torque (drive side / load side)

$$T_{KN} > T_S$$

$$T_S = T_{AS} \cdot m_A \cdot k \qquad T_S = T_{LS} \cdot m_L \cdot k$$

$$m_A = \frac{J_L}{J_A + J_L} \qquad m_L = \frac{J_A}{J_A + J_L}$$

T_S = accelerating torque (drive or driven side)
m_A = drive-side shock
m_L = driven-side shock
J_A = moment of inertia of the drive side
J_L = moment of inertia of the driven side

Torsional stiffness

Transmission error of the metal bellow due to torsional strain

$$\varphi = \frac{180 \cdot T_{AS}}{\pi \cdot C_T}$$

φ = torsional angle [degrees]
C_T = torsional stiffness of the coupling [m/rad]

Natural frequency

The natural frequency of the coupling must be above or below the frequency of the unit. Valid for the mechanical spare model of the 2-mass-system:

$$f_e = \frac{1}{2 \cdot \pi} \sqrt{C_T \cdot \frac{J_L + J_A}{J_L \cdot J_A}}\ [Hz]$$

f_e = frequency of the 2-mass-system [s^{-1}]
f_r = exciting frequency of the drive [s^{-1}]

Valid in practice: $f_e \geq 2 \cdot f_r$

Note:

In case of values exceeding T_{KN} only limited alternating load figures are possible. In this torque range there can be remaining deformations of the bellow and fatigue fractures can occur.

TOOLFLEX® Metal bellow-type couplings

Basic programme

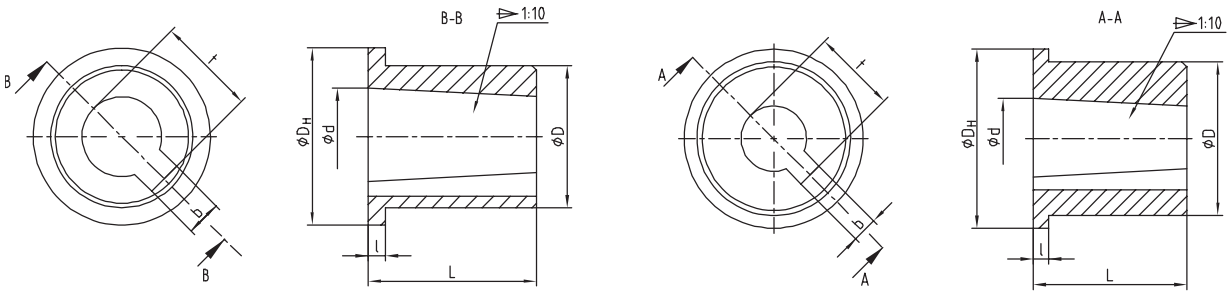
Basic programme TOOLFLEX® miniature

Size	Hub design	Finish bore [mm] according to ISO fit F7														
		∅2	∅3	∅4	∅5	∅6	∅6,35	∅7	∅8	∅9	∅9,5	∅10	∅11	∅12	∅14	∅16
5	1.1	●	●	●	●											
7	1.1		●	●	●	●		●	●							
	2.5		●	●	●	●	●	●								
9	1.1			●	●	●		●	●	●		●				
	2.5		●	●	●	●	●	●	●	●						
12	1.1				●	●		●	●			●				
	2.5				●	●	●		●	●		●	●	●		

Basic programme TOOLFLEX® M and S

Size	Pilot bore	Finish bore [mm] according to ISO fit F7																												
		∅5	∅6	∅6,35	∅7	∅8	∅9	∅10	∅11	∅12	∅14	∅15	∅16	∅18	∅19	∅20	∅22	∅24	∅25	∅28	∅30	∅32	∅35	∅38	∅40	∅42	∅45	∅48	∅50	∅55
16	●	●	●	●	●	●	●	●	●	●	●		●																	
20	●							●	●	●	●	●	●	●	●	●															
30	●										●	●	●	●	●	●	●	●	●	●										
38	●														●	●	●	●	●	●	●	●	●	●						
45	●																		●	●	●	●	●	●	●	●	●			
55	●																					●	●	●	●	●	●	●	●	●

Type M and S sleeve dimensions for FANUC engines



Size 1 Size 2

Sleeve size	Dimensions [mm]								Notice
	L	l	D_H	D	$d^{+0,05}$	b^{JS9}	$t^{+0,1}$	Taper	
1	16	2	20	16	10,9	4	12,2	1:10	For TOOLFLEX® size 16-20
2	30	3	35	30	15,8	5	17,9	1:10	For TOOLFLEX® size 30-45

Basic programme TOOLFLEX® KN

Size	Pilot bore	Finish bore [mm] according to ISO fit F7																	
		∅14	∅15	∅16	∅18	∅19	∅20	∅22	∅24	∅25	∅28	∅30	∅32	∅35	∅38	∅40	∅42	∅45	∅48
30	●	●	●	●	●	●	●	●											
38	●	●	●	●	●	●	●	●	●	●	●								
45	●				●	●	●	●	●	●	●	●	●	●	●				
55	●										●	●	●	●	●	●	●	●	●

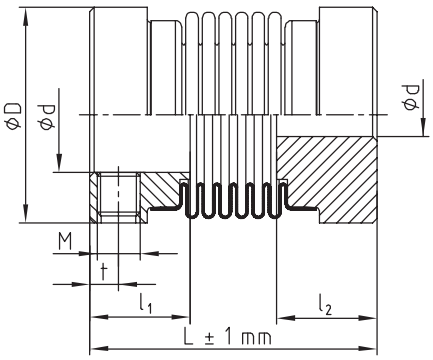
● Standard bore
Further dimensions on request

TOOLFLEX® Metal bellow-type couplings

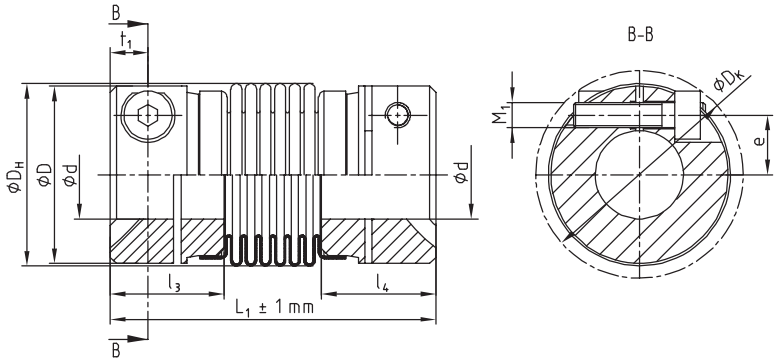
Backlash-free, torsionally stiff and maintenance-free coupling

Miniature couplings

- Backlash-free, torsionally stiff
- Maintenance-free
- Low mass moment of inertia
- Easy assembly due to tolerance F7
- Temperature range - 30 °C to + 100 °C
- Finish bore from Ø 6 mm also available with feather key acc. To DIN 6885 sheet 1 – JS9



TOOLFLEX® Type 1.1



TOOLFLEX® Type 2.5

TOOLFLEX®		Technical data of type with fixing screw (type 1.1)													
		Torque	Dimensions [mm]								Perm. displacements			Torsional stiffness	Weight 4)
			Finish bore		General			Fixing screw							
Size	Design 1/2)	T_{KN} [Nm]	$d_{min.}$	$d_{max.}$	D_H	L	l_1; l_2	M	t	number 3) z	Axial [mm]	Radial [mm]	Angular [degrees]	[Nm/rad]	[kg]
5	S	0,1	2	5	10	15 1)	6	M2	1,8	1	0,30	0,10	0,7	97	0,0027
	M					17 2)					0,40	0,15	1,0	75	0,003
7	S	1,0	3	8	15	18 1)	7	M3	2,0	1	0,30	0,10	0,7	390	0,005
	M					20 2)					0,40	0,15	1,0	300	0,006
9	S	1,5	4	10	20	21 1)	8	M3	2,5	2	0,35	0,15	1,0	750	0,010
	M					24 2)					0,50	0,20	1,5	580	0,011
12	S	2,0	5	14	25	27,5 1)	11	M4	2,8	2	0,40	0,15	1,0	1270	0,017
	M					31 2)					0,60	0,20	1,5	980	0,019

Circumferential speed v_{max}= 25 m/s

TOOLFLEX®		Technical data of type with clamping screw (type. 2.5)														
		Torque	Dimensions [mm]										Perm. displacements			Torsional stiffness	Weight 4)
			Finish bore		General			Clamping screw									
Size	Design 1/2)	T_{KN} [Nm]	$d_{min.}$	$d_{max.}$	D_H	L_1	l_3; l_4	M_1	t_1	e	D_K	T_A [Nm]	Axial [mm]	Radial [mm]	Angular [degrees]	[Nm/rad]	[kg]
7	S	1,0	3	7	15	24 1)	9	M2	3,2	5,0	16,5	0,37	0,3	0,1	0,7	390	0,007
	M					26 2)							0,4	0,15	1,0	300	0,008
9	S	1,5	3	9	20	30 1)	11	M2,5	3,5	7,1	21,5	0,76	0,35	0,15	1,0	750	0,014
	M					33 2)							0,5	0,2	1,5	580	0,015
12	S	2,0	4	12	25	34,5 1)	13	M3	4,0	8,5	26,5	1,34	0,4	0,15	1,0	1270	0,025
	M					38 2)							0,6	0,2	1,5	980	0,027

1) Design S = 4 shafts 2) Design M = 6 shafts 3) Quantity each hub, from size 9: 2x120° offset
4) Figures refer to the complete coupling with max. bores
Circumferential speed v_{max}= 20 m/s

Note:
The coupling must be selected in a way that the nominal torque exceeds the maximum torque to be transmitted (accelerating or peak torque). In case of values exceeding T_{KN} (collision, trouble) only limited alternating load figures are possible. In this torque range there can be permanent deformation of the bellow and fatigue fractures can occur.

Order form:

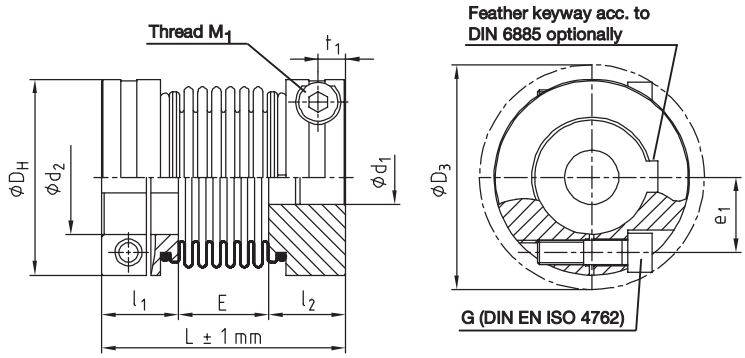
TOOLFLEX® 7 M	2.5	d - Ø4	2.5	d - Ø6
Coupling size	Hub design	Finish bore component 1	Hub design	Finish bore component 2

TOOLFLEX® Metal bellow-type couplings

Backlash-free, torsionally stiff and maintenance-free coupling

Type M

- Backlash-free, torsionally stiff
- Non-positive bellow-hub connection
- Frictionally engaged clamping hubs
- Maintenance-free
- Suitable for high temperatures due to flanged insert connection (max. 280 °C)
- Well-resistant to corrosion due to bellow made from stainless steel and aluminium clamping hubs
- Finish bore from Ø 6 mm also available with feather key acc. To DIN 6885 sheet 1 – JS9



TOOLFLEX® Size	Dimensions [mm]										
	Finish bore		General				Clamping screws				
	$d_{min.}$	$d_{max.}$	L	l_1; l_2	E	D_H	M_1	D_3	t_1	e_1	T_A [Nm]
16	5	16	49	17,0	15	32	M4	35,0	5	12,0	2,9
20	8	20	62	21,5	19	40	M5	43,5	6	14,5	6
30	10	30	72	23,0	26	55	M6	58,0	7	19	10
38	14	38	81	25,5	30	65	M8	72,6	9	25	25
45	14	45	103	32,0	39	83	M10	89,0	11	30	49
55 [3]	20	55	125	40,0	45	100	M12	106,0	14	37	120

TOOLFLEX® Size	Torque	Speed	Technical data							
	T_{KN} [Nm]	n [1] [min^{-1}]	Moment of inertia [2] [$x10^{-6}kgm^2$]	Torsional stiffness [Nm/rad]	Axial spring stiffness [N/mm]	Radial spring stiffness [N/mm]	Perm. displacements			Mass [2] [$x10^{-3}kg$]
							Axial [mm]	Radial [mm]	Angular [degrees]	
16	5	14900	7	3050	29	92	±0,5	0,20	1,5	61
20	15	11950	31	6600	42	126	±0,6	0,20	1,5	144
30	35	8700	117	14800	65	155	±0,8	0,25	2,0	306
38	65	7350	254	24900	72	212	±0,8	0,25	2,0	448
45	150	5750	1011	64000	88	492	±1,0	0,30	2,0	1125
55 [3]	340	4800	5157	96100	107	598	±1,0	0,30	2,0	3300

TOOLFLEX® Size	Bore range and respective torques of frictional engagement of the clamping hub [Nm]																								
	Ø5	Ø6	Ø7	Ø8	Ø9	Ø10	Ø11	Ø12	Ø14	Ø15	Ø16	Ø18	Ø19	Ø20	Ø24	Ø25	Ø28	Ø30	Ø32	Ø35	Ø38	Ø40	Ø42	Ø45	Ø50	Ø55
16	8,5	8,8	9,1	9,4	9,7	9,9	10,2	10,5	11,1	11,4	11,7															
20				17,6	18,1	18,6	19,0	19,5	20,5	21,0	21,4	22,4	22,9	23,3												
30							33	34	35	36	36,4	38	38,5	39	42	42,5	44,5	46								
38												84	85	87	92	93	97	99	101	105	109					
45														157	165	167	173	177	181	187	193	197	200	206		
55 [3]															397	401	413	421	429	441	453	462	470	482	502	522

1) With v= 25 m/s 2) Figures refer to the complete coupling with max. bores 3) Hubs from steel welded with bellow

Note:
The coupling must be selected in a way that the nominal torque exceeds the maximum torque to be transmitted (accelerating or peak torque). In case of values exceeding T_{KN} (collision, trouble) only limited alternating load figures are possible. In this torque range there can be permanent deformation of the bellow and fatigue fractures can occur.

Order form:

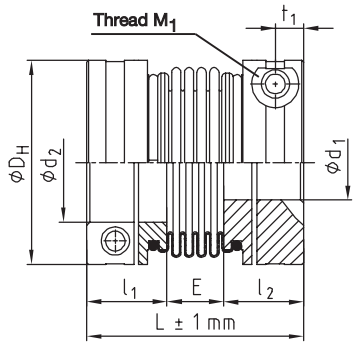
TOOLFLEX® 30 M	d_1 - Ø25	d_2 - Ø30
Coupling size	Finish bore Component 1	Finish bore Component 2

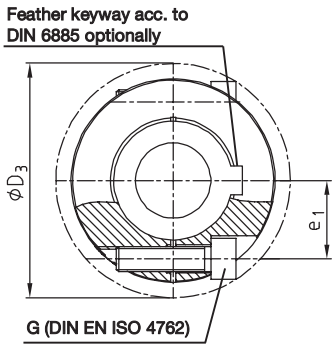
TOOLFLEX® Metal bellow-type couplings

Backlash-free, torsionally stiff and maintenance-free coupling

Type S

- Short design
- Higher stiffness of torsion spring
- Lower mass moment of inertia
- Finish bore from Ø 6 mm also available with feather key acc. To DIN 6885 sheet 1 – JS9





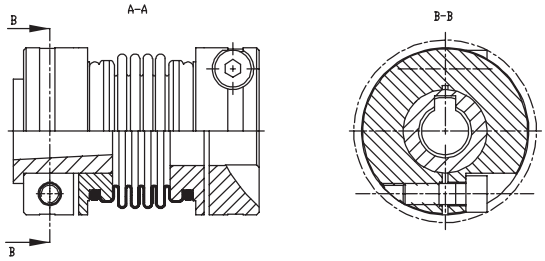
TOOLFLEX® Size	Dimensions [mm]										
	Finish bore		General				Clamping screws				
	$d_{min.}$	$d_{max.}$	L	l_1; l_2	E	D_H	M_1	D_3	t_1	e_1	T_A [Nm]
16	5	16	45	17,0	11	32	M4	35,0	5	12,0	2,9
20	8	20	55	21,5	12	40	M5	43,5	6	14,5	6
30	10	30	63	23,0	17	55	M6	58,0	7	19	10
38	14	38	69	25,5	18	65	M8	72,6	9	25	25
45	14	45	86,5	32,0	22,5	83	M10	89,0	11	30	49
55 [3]	20	55	111	40,0	31	100	M12	106,0	14	37	120

TOOLFLEX® Size	Torque	Speed	Technical data							
							Perm. displacements			Mass [2]
	T_{KN} [Nm]	n [1] [min^{-1}]	Moment of inertia [2] [$x10^{-6}kgm^2$]	Torsional stiffness [Nm/rad]	Axial spring stiffness [N/mm]	Radial spring stiffness [N/mm]	Axial [mm]	Radial [mm]	Angular [degrees]	[$x10^{-3}kg$]
16	5	14900	10	4500	43	138	±0,3	0,15	1,0	61
20	15	11950	30	9600	63	189	±0,4	0,15	1,0	121
30	35	8700	114	17800	97	233	±0,5	0,20	1,5	243
38	65	7350	243	37400	108	318	±0,6	0,20	1,5	351
45	150	5750	933	95800	132	738	±0,9	0,25	1,5	824
55 [3]	340	4800	5036	144100	160	894	±1,0	0,25	1,5	3213

1) With v= 25 m/s 2) Figures refer to the complete coupling with max. bores 3) Hubs from steel welded with bellow

Info:
Torques of frictional engagement of the clamping hub shown under Type M (page 124)

Other designs: Type for FANUC-Motors



Order form:

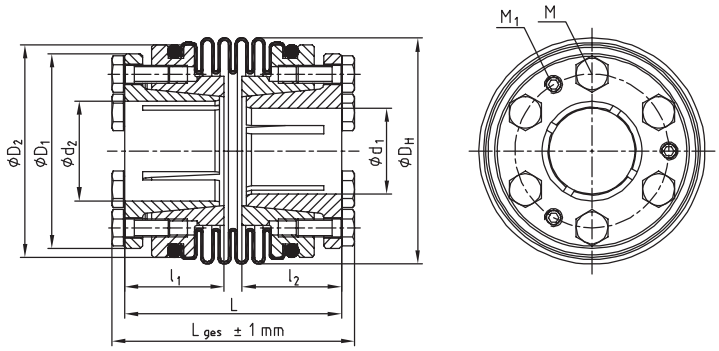
TOOLFLEX® 30 S	d_1 - Ø25	d_2 - Ø30
Coupling size	Finish bore Component 1	Finish bore Component 2

TOOLFLEX® Metal bellow-type couplings

Backlash-free, torsionally stiff and maintenance-free coupling

Type KN

- Backlash-free, torsionally stiff
- Non-positive bellow-hub connection
- High friction torques
- Maintenance-free
- Good properties of concentric running with high speeds
- Maximum speed up to 40 m/s circumferential speed



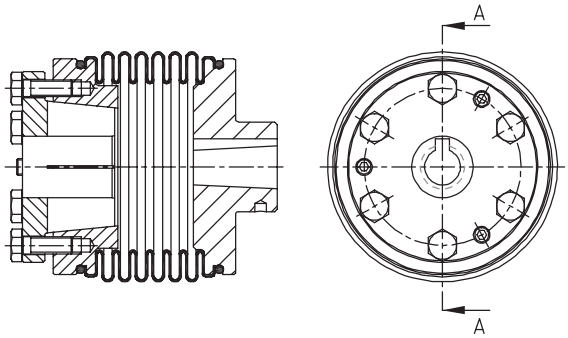
TOOLFLEX® S-KN

TOOLFLEX® Size	Torque	Dimensions [mm]																
		Finish bore		L		Lges.						Clamping screw			Pull-off threads			
	T_{KN} [Nm]	$d_{min.}$	$d_{max.}$	4 shafts 1)	6 shafts 2)	4 shafts 1)	6 shafts 2)	l_1; l_2	D_H	D_1	D_2	M	T_A [Nm]	Number z	M_1	Number z	T_{A1} 4) [Nm]
30	35	12	22	48	57	54	63	22	50	43	47	M4	2,9	12	M4	6	1,2
38	65	12	28	56	68	63	75	26	60,5	52	56	M5	6	12	M5	6	1,4
45	150	15	40	74,5	91	82,5	99	34	82	68	77	M6	14	12	M6	6	3
55 3)	340	15	56	95,5	109	106	120	40	97	95	95	M8	35	12	M8	6	6

TOOLFLEX® Size	Bore range d and the corresponding transmittable torques T_R of frictional engagement of the clamping hub [Nm]																			
	Ø12	Ø14	Ø15	Ø16	Ø19	Ø20	Ø24	Ø25	Ø28	Ø30	Ø32	Ø35	Ø38	Ø40	Ø42	Ø45	Ø48	Ø50	Ø55	Ø56
30	37	50	58	66	71	79														
38	52	71	81	92	130	103	149	161	202											
45		113	130	147	208	230	332	230	288	331	376	451	531	589						
55 3)			174	198	279	309	445	483	606	696	792	585	690	764	843	967	1101	1194	1445	1498

1) Design S = 4 shafts 2) Design M = 6 shafts 3) Hubs from steel welded with bellow
4) After assembly of the clamping screws (M) tighten the pull-off thread (M_1) to the torque T_{A1} indicated.

Other designs: TOOLFLEX® KN for FANUC engines



Order form:

TOOLFLEX® 38 S-KN	d_1 - Ø15	d_2 - Ø22
Coupling size	Finish bore component 1	Finish bore component 2

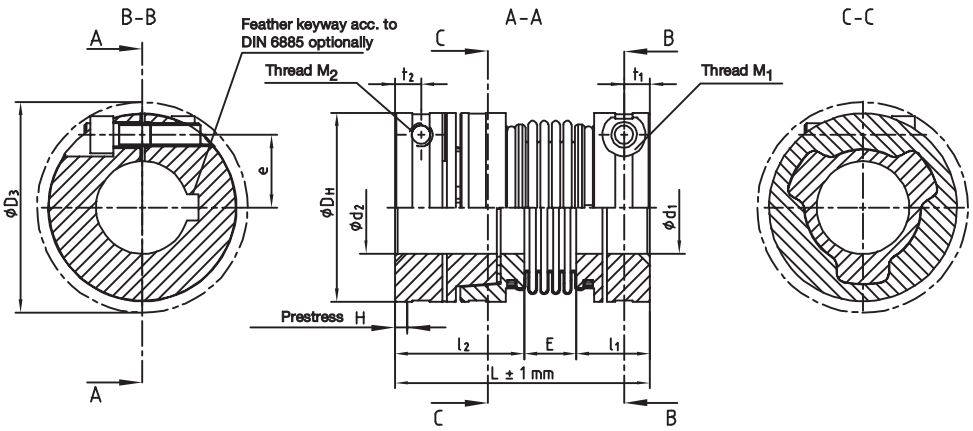
TOOLFLEX® PI (Plug-In)

Backlash-free, torsionally stiff and maintenance-free coupling

Plug-in metal bellow-type coupling

- Axial plug-in
- Backlash-free, torsionally stiff
- Maintenance-free
- Suitable for high temperatures due to flanged insert connection
- Well-resistant to corrosion due to bellow made from stainless steel and aluminium clamping hubs
- Optionally type M (6 shafts)
  - higher perm. displacements

  or Type S (4 shafts, short design)
  - higher stiffness of torsion spring
  - lower mass moment of inertia



TOOLFLEX®		Dimensions [mm]													
		General									Clamping screws				
Size	Design	$d_1;d_2$ min.	d_1 max.	d_2 max.	L 1)	l_1	l_2	E	D_H	H	$M_1;M_2$	D_3	e	$t_1;t_2$	T_A [Nm]
20	S	8	20	20	67,0	21,5	33,5	12,0	40	0,5 - 1	M5	43,5	14,5	6	6
	M				74,0			19,0							
30	S	10	30	28	73,5	23,0	33,5	17,0	55	0,5 - 1	M6	58,0	19,0	7	10
	M				82,5			26,0							
38	S	14	38	32	87,5	25,5	44,0	18,0	65	0,5 - 1,5	M8	72,6	25,0	9	25
	M				99,5			30,0							
45	S	14	45	42	96,0	32,0	41,5	22,5	83	0,5 - 1,5	M10	89,0	30,0	11	49
	M				112,5			39,0							

TOOLFLEX®		Torque	Speed	Technical Data						Mass 2)
				Moment of inertia 2)	Torsional stiffness	Axial spring stiffness	Radial spring stiffness	Perm. displacements		
Size	Design	T_{KN} [Nm]	n 3) [min^{-1}]	[$x10^{-6}kgm^2$]	[Nm/rad]	[N/mm]	[N/mm]	Radial [mm]	Angular [degrees]	[$x10^{-3}kg$]
20	S	15	11950	37	9600	63	189	0,15	1,0	149
	M			38	6600	42	126	0,20	1,5	155
30	S	35	8700	140	17800	97	233	0,20	1,5	294
	M			145	14800	65	155	0,25	2,0	313
38	S	65	7350	329	37400	108	318	0,20	1,5	496
	M			346	24900	72	212	0,25	2,0	520
45	S	150	5750	1031	95800	132	738	0,25	1,5	930
	M			1127	64000	88	492	0,30	2,0	1000

TOOLFLEX®	Transmittable friction torque of clamping hubs ∅d_1/∅d_2																			
Size	∅8	∅9	∅10	∅11	∅12	∅14	∅15	∅16	∅18	∅19	∅20	∅24	∅25	∅28	∅30	∅32	∅35	∅38	∅40	∅42
20	17,6	18,1	18,6	19,0	19,5	20,5	21,0	21,4	22,4	22,9	23,3									
30				33,0	34,0	35,0	36,0	36,4	38,0	38,5	39,0	42,0	42,5	44,5	46					
38									84,0	85,0	87,0	92,0	93,0	97,0	99,0	101,0				
45											157,0	165,0	167,0	173,0	177,0	181,0	187,0	193,0	197,0	200,0

1) When being plugged in

2) Figures refer to the complete coupling with max. bores

3) With v= 25 m/s

Order form:

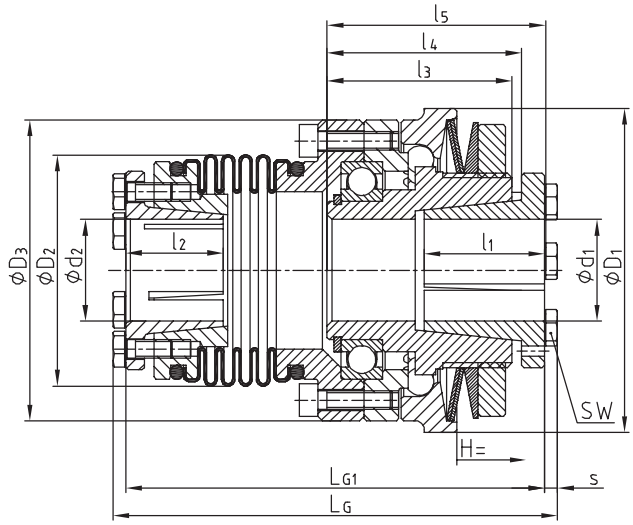
TOOLFLEX® 30 PI-S	d_1 - ∅22	d_2 - ∅18
Coupling size	Finish bore Component 1	Finish bore Component 2

TOOLFLEX® Metal bellow-type couplings

Backlash-free, torsionally stiff and maintenance-free coupling

With KTR-SI Compact safety system

- Backlash-free safety coupling with degressive spring characteristic
- Accurate disconnection with a high repeating accuracy
- Accurate, backlash-free torque transmission even in case of wear
- Comfortable setting subject to torque scale on the coupling
- Mounting flange with ball bearing
- Hardened ratchet surfaces for a long service life
- Backlash-free shaft-hub-connection subject to taper bush
- Available either as design M (6 shafts) or design S (4 shafts, short design)



TOOLFLEX® S-KN with KTR-SI Compact

TOOLFLEX® S-KN 1) Size	KTR-SI Compact Size	max. speed [min⁻¹]	TOOLFLEX® S-KN Torque [Nm]	KTR-SI Compact Torque [Nm]		Dimensions [mm]				
				T1	T2	d_1 max.	d_2 max.	D_1	L_G 2)	L_{G1} 2)
30	01	4000	35	3-14	6-28	25	22	70	96	90,5
38	0	3000	65	9-35	18-70	30	28	85	109	102,0
45	1	2500	150	19-65	38-130	40	40	100	145	137,5
55	2	2000	340	35-110	80-220	50	56	115	170	159,5

TOOLFLEX® S-KN 1) Size	KTR-SI Compact Size	Dimensions [mm]									
		D_2	D_3	l_1	l_2	l_3	l_4	l_5	s	SW_1	H
30	01	50,0	65	26	22	40	42,0	47	2,8	7	1,2
38	0	60,5	80	31	26	46	49,0	56	4,0	7	1,5
45	1	82,0	95	40	34	57	60,0	67	4,0	8	1,8
55	2	97,0	110	29	40	63	68,5	73	3,5	10	2,0

1) Optionally available with clamping hub
2) Depending on the design (M with 6 shafts or S with 4 shafts) of TOOLFLEX®

Order form:

KTR-SI Compact	1	45	DK	T2	d_1 ∅ 40	d_2 ∅ 40	100 Nm
Coupling type	KTR-SI Compact Size	TOOLFLEX S-KN Size	Design	Arrangement of disk springs	Bore KTR-SI Compact [mm]	Bore TOOLFLEX S-KN [mm]	Ratchet torque set [Nm]