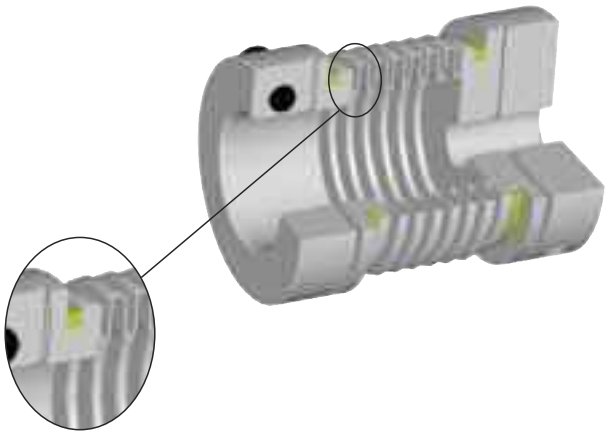
Coupling description

General Description
TOOLFLEX® – couplings are designed to transmit torque between drive and driven components via metallic bellows. The combination of these components provides high torsional stiffness, zero-backlash and accommodation of misalignment. This product is available in a variety of mounting configurations to meet your specific needs.



TOOLFLEX® is available with a variety of shaft mounting options. It accommodates shafts up to 2.188 inches and a maximum nominal torque of 3,009 lb-in for high-pitch ball screws, indexing tables and low-ratio gearboxes. As defined by the metallic construction, TOOLFLEX® couplings are suitable for elevated temperature ranges up to 392 °F (200°C). Together, these features reduce the maintenance required during the life-cycle of the coupling even in tough environments.

Function and Design
TOOLFLEX® - couplings suitable for horizontal or vertical applications are constructed in a variety of geometries providing a torsionally stiff, zero-backlash platform optimizing the balance between low-inertia, coupling performance and application requirements. The bellows design allows for misalignment and high ambient temperatures while remaining torsionally stiff.

The bellows of the TOOLFLEX® coupling is connected via mechanical means thus ensuring uniform torque transmission throughout. Bellows are produced from high-grade stainless steel for corrosion resistance and improved performance. The double-slit cross-clamp connection provides assembly ease with a single radial clamping bolt without deformation of the bellow when tightening the clamping bolt. For applications requiring higher transmittable friction torque capacity, the design KN option with taper hubs can be used.

Clamping hub with two slots

Designs

Design M and S

Design KN

Design PI

Design CF

Coupling selection

TOOLFLEX® couplings are selected to the nominal torque (T_{KN}) of the application and like other coupling systems, the torque (T_{KN}) must exceed the maximum torque to be transmitted (accelerating or peak torque). This relationship should always be considered in servo motor applications because their acceleration torque can far exceed the nominal torque of the coupling. In applications with values exceeding T_{KN} (collision, misuse) only limited alternating load figures are possible. In this torque range, there can be permanent deformation of the bellow and fatigue fractures can occur.

Description	Symbol	Definition or explanation
Rated torque of coupling	T_{KN}	Torque that can continuously be transmitted over the entire permissible speed range
Peak torque of machine	T_S	Peak torque on the coupling
Peak torque on the driving side	T_{AS}	Peak torque with torque shock on the driving side, e. g. breakdown torque of the electric motor
Peak torque of load side	T_{LS}	Peak torque with torque shock on load side, e. g. braking
Moment of inertia	$J_{A/L}$	Total of moments of inertia existing on the driving or load side referring to the coupling speed
Rotational inertia coefficient of driving side	m_A	Factor taking into account the mass distribution with shocks and vibrations produced on the driving side
Rotational inertia coefficient of load side	m_L	Factor taking into account the mass distribution with shocks and vibrations produced on the load side

Description	Symbol	Definition or explanation
max. engine performance	$P_{max.}$	max power in HP (kW) which the engine may produce.
engine speed	n	Rated speed in rpm of the engine
Torsional angle	w	Transmission error of the metal bellow due to torsional strain
Torsional stiffness	C_T	Torsional stiffness of the coupling in Nm/rad. For data see tables shown on the following pages.
Frequency of the 2-mass-system	f_e	in s^{-1}
Eexciting frequency of the drive	f_r	in s^{-1}
Operating factor	k	k = 1.5 with uniform movement k = 2,0 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.

Determine Coupling Size

The size of the coupling must be selected so that the following conditions are met.

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

$$T_{KN}\ [\text{lb-in}] = 63{,}025 \cdot \frac{P_{max}\ [\text{lb-in}]}{n\ [\text{rpm}]}$$

When selecting servo motors the calculations are made with the torque values published by the motor suppliers and not with $P_{max.}$ When dimensioning the coupling, please use the respective manufacturer's recommendations for selecting the servo controller.

Accelerating torque (drive side / load side)

$$T_{KN} > T_S$$

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

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

Inspection of torsional stiffness

$$w = \frac{180 \cdot T_{AS}}{p \cdot C_T}$$

Inspection of resonance frequency

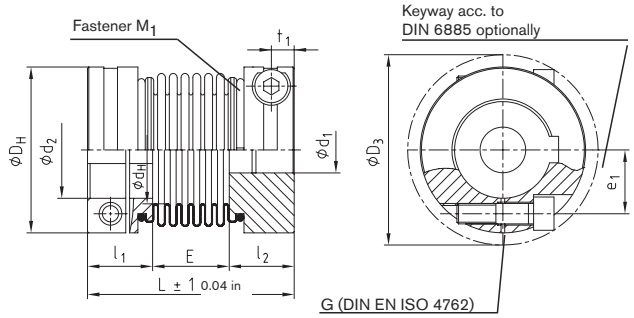
The natural frequency of the coupling must be above or below the frequency of the unit. Valid for the mechanical spare model of the 2-mass-system:

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

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

Design M with clamping hubs

- Zero-backlash, reduced maintenance, torsionally stiff
- Machined hubs mechanical bellow connection – Low inertia, good dynamic properties
- Clamping hubs available as standard
- Suitable for high temperatures up to +392 °F (200 °C)
- All metallic construction, stainless bellows helps resist corrosion
- Installation instructions available at www.ktr.com



TOOLFLEX® Design M

Size	Dimensions [in]											
	Bore		General					Fasteners				
	$d_{min.}$	$d_{max.}$	L	l_1; l_2	E	D_H	d_H	M_1	D_3	t_1	e_1	T_A [lb-in]
7	0.063	0.250	1.02	0.35	0.31	0.59	0.35	M4	0.65	0.13	0.20	3
9	0.063	0.313	1.26	0.43	0.39	0.79	0.47	M4	0.85	0.14	0.28	7
12	0.063	0.438	1.50	0.51	0.47	0.98	0.63	M4	1.04	0.16	0.33	12
16	0.188	0.625	1.93	0.67	0.59	1.26	0.79	M4	1.38	0.20	0.47	26
20	0.313	0.813	2.44	0.85	0.75	1.57	1.06	M5	1.71	0.24	0.57	53
30	0.375	1.188	2.83	0.91	1.02	2.17	1.30	M6	2.28	0.28	0.75	89
38	0.563	1.500	3.19	1.00	1.18	2.56	1.65	M8	2.86	0.35	0.98	221
42	0.563	1.625	3.74	1.18	1.38	2.76	1.81	M8	3.00	0.35	1.06	221
45	0.563	1.750	4.06	1.26	1.54	3.27	2.28	M10	3.50	0.43	1.18	434
55 [3]	0.813	2.188	4.92	1.57	1.77	3.94	2.87	M12	4.17	0.55	1.46	1,062

TOOLFLEX® Design M technical data

Size	Bellow-hub connection	Torque T_{KN} [lb-in]	Speed n [1] [rpm]	Moment of inertia [2] [x 10^{-6} lb-in-sec^2]	Torsional stiffness C_T [lb-in/rad]	Axial spring stiffness [lbf/in	Radial spring stiffness [lbf/in]	Allowable misalignments			Weight[2] [lb]
								Axial [in]	Parallel [in]	Angular [degrees]	
7	Bonded	8	31,800	2.7	2,655	-	-	±0.02	0.006	1.0	0.02
9		13	23,800	8.9	5,134	-	-	±0.02	0.008	1.5	0.03
12		17	19,100	24	8,674	-	-	±0.02	0.008	1.5	0.06
16	Crimped	44	14,900	89	26,996	166	525	±0.02	0.008	1.5	0.13
20		132	11,950	283	58,417	240	720	±0.02	0.008	1.5	0.32
30		309	8,700	1,089	130,995	371	885	±0.03	0.010	2	0.67
38		575	7,350	2,319	220,390	411	1,211	±0.03	0.010	2	0.99
42		840	6,820	3,779	323,062	457	1,902	±0.03	0.010	2	1.15
45		1,327	5,750	9,028	566,464	503	2,810	±0.04	0.012	2	2.48
55 [4]		3,009	4,800	45,299	850,581	611	3,415	±0.04	0.012	2	7.28

Inch equivalent bores and corresponding transmittable torques of the clamping hub design 2.5 [lb-in]

Size	0.125	0.188	0.219	0.281	0.344	0.375	0.438	0.500	0.563	0.656	0.750	0.813	0.969	1.125	1.188	1.281	1.500	1.594	1.781	2.188
7	8.0	8.6	9.2	10.4																
9	16.6	17.5	18.5	20.4	21.4	22.3														
12		30.8	32.3	35.2	36.7	38.1	41.1	42.5												
16			75.0	80.2	82.8	85.3	90.5	93.1	98	103										
20					156	160	168	172	181	189	202	206								
30							293	299	311	323	341	346	370	394	406					
38									701	723	756	767	810	854	876	898	964			
42									745	767	799	810	854	898	920	942	1,008	1,029		
45												1,959	2,057	2,155	2,204	2,253	2,400	2,449	2,572	
55 [3]													3,513	3,656	3,728	3,799	4,014	4,086	4,265	4,624

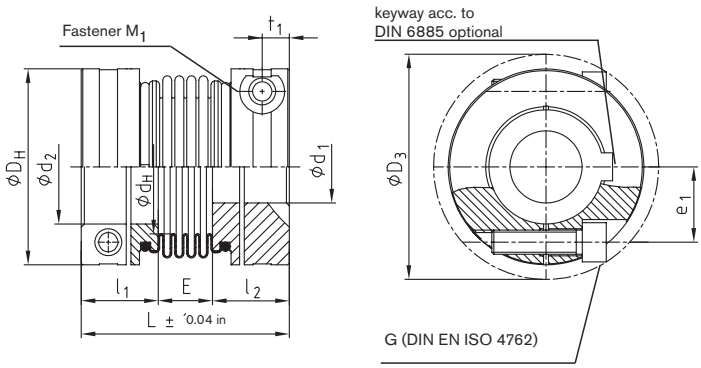
[1] Maximum peripheral speed V_{max}= 984 in/s (25 m/s)
[2] Calculated as complete coupling with maximum bores
[3] Steel hubs and welded bellow connection

Order form:

TOOLFLEX® 30 M	⌀25	⌀30
Coupling Size	Bore	Bore

Design S with clamping

- Zero-backlash, reduced maintenance, torsionally stiff
- Machined hubs mechanical bellow connection – Low inertia, good dynamic properties
- Clamping hubs available as standard
- Suitable for high temperatures up to +392 °F (200 °C)
- Short design increases torsional spring stiffness
- All metallic construction, stainless bellows helps resist corrosion
- Installation instructions available at www.ktr.com



TOOLFLEX® Design S

Size	Dimensions [in]											
	Bore		General					Clamping Screws				
	$d_{min.}$	$d_{max.}$	L	l_1; l_2	E	D_H	d_H	M_1	D_3	t_1	e_1	T_A [lb-in]
7	0.063	0.250	0.94	0.35	0.24	0.59	0.35	M4	0.65	0.13	0.20	3
9	0.063	0.313	1.14	0.43	0.28	0.79	0.47	M4	0.85	0.14	0.28	7
12	0.125	0.438	1.36	0.51	0.333	0.98	0.63	M4	1.04	0.16	0.33	12
16	0.188	0.625	1.77	0.67	0.43	1.26	0.79	M4	1.38	0.20	0.47	26
20	0.313	0.813	2.17	0.85	0.47	1.57	1.06	M5	1.71	0.24	0.57	53
30	0.375	1.188	2.48	0.91	0.67	2.17	1.30	M6	2.28	0.28	0.75	89
38	0.438	1.500	2.72	1.00	0.71	2.56	1.65	M8	2.86	0.35	0.98	221
42	0.563	1.625	3.31	1.18	0.94	2.76	1.81	M8	3.00	0.35	1.06	221
45	0.563	1.750	3.41	1.26	0.89	3.27	2.28	M10	3.50	0.43	1.18	434
55 [3]	0.813	2.188	4.37	1.57	1.22	3.94	2.87	M12	4.17	0.55	1.46	1,062

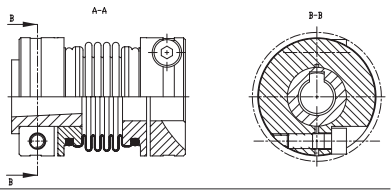
TOOLFLEX® Design S technical data

Size	Bellow-hub connection	Torque T_{KN} [1] [lb-in]	Speed n [2] [rpm]	Moment of inertia [3] [x10^{-6} lb-in-sec^2]	Torsional stiffness C_T [lb-in/rad]	Axial spring stiffness [lbf/in]	Radial spring stiffness [lbf/in]	Allowable misalignments			Mass [3] [lb]
								Axial ± [in]	Radial [in]	Angular [degrees]	
7	Bonded	8	31,800	2.3	3,452	51	148	±0.01	0.004	0.7	0.02
9		13	23,800	8.6	6,638	69	188	±0.01	0.006	1.0	0.03
12		17	19,100	23	11,241	91	217	±0.02	0.006	1.0	.006
16	Crimped	44	14,900	80	39,830	166	525	±0.01	0.006	1.0	0.13
20		132	11,950	266	84,970	240	720	±0.02	0.006	1.5	0.27
30		309	8,700	1,009	157,548	371	885	±0.02	0.008	1.5	0.54
38		575	7,350	2,168	331,027	411	1,211	±0.02	0.008	1.5	0.77
42		841	6,820	3,505	484,150	457	1,902	±0.02	0.008	1.5	1.07
45		1,327	5,750	82,403	847,926	503	2,810	±0.04	0.010	1.5	2.00
55 [3]		3,009	4,800	44,220	1,275,429	611	3,415	±0.04	0.010	1.5	7.00

[1] For selection please see page 141 [2] With V = 25 m/s
[3] Figures refer to the complete coupling with max. bores
[4] Hubs from steel welded with bellow
Hub design 2.5 = clamping hub without keyway, Hub design 2.6 = clamping hub with keyway

Info:
Torques of frictional engagement of the clamping hub shown under Design M (page 142)

Special designs:
TOOLFLEX® for FANUC motors

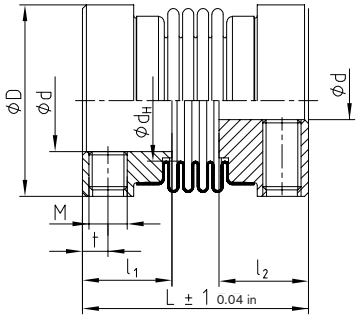


Order form:

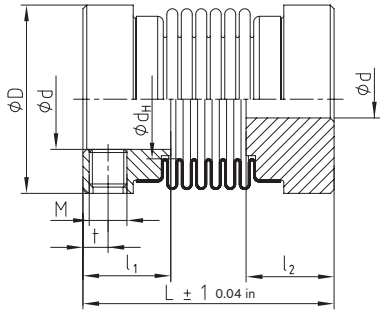
TOOLFLEX® 30 S	⌀25	⌀30
Coupling size	Bore	Bore

Design S/M with set screw

- Zero-backlash, reduced maintenance, torsionally stiff
- Machined aluminum hubs – Low inertia, good dynamic properties
- Temperature range - 22 °F to + 212 °F
- Suited for measuring drives requiring a zero-backlash connection in small envelope
- approved to EC Standard 94/9/EC (designs 1.0 and 2.1)
- Installation instructions available at www.ktr.com



TOOLFLEX® S Design 1.1



TOOLFLEX® M Design 1.1

Technical data of design with Setscrew (design 1.1)

Size	Design[1/2]	Bellow hub connection	Torque T_{KN}[3] [lb-in]	Dimensions [in] Bore $d_{min.}$	Bore $d_{max.}$	General D_H	General d_H	General L	General $l_1; l_2$	Setscrew M	Setscrew t	Setscrew number[4] z	Allowable misalignments Axial [in]	Allowable misalignments Parallel [in]	Allowable misalignments Angular [degrees]	Torsional stiffness C_T [lb-in/rad]	Weight[5] [lb]
5	S	Bonded	0.8	0.063	0.188	0.39	0.24	0.59	0.24	M2	0.07	1	±0.012	0.004	0.7	859	0.006
	M							0.67					±0.016	0.006	1.0	664	0.007
7	S		8.8	0.063	0.313	0.59	0.35	0.71	0.28	M3	0.08	1	±0.012	0.004	0.7	3,452	0.011
	M							0.79					±0.016	0.006	1.0	2,655	0.013
9	S		13	0.125	0.375	0.79	0.47	0.83	0.31	M3	0.09	2	±0.014	0.006	1.0	6,638	0.022
	M							0.94					±0.020	0.008	1.5	5,134	0.024
12	S		17	0.188	0.563	0.98	0.63	1.08	0.43	M4	0.11	2	±0.016	0.006	1.0	11,241	0.037
	M							1.22					±0.024	0.008	1.5	8,674	0.042
16	S	Crimped	44	0.188	0.688	1.26	0.79	1.46	0.51	M5	0.16	2	±0.012	0.006	1.0	39,830	0.101
	M							1.61					±0.020	0.008	1.5	26,996	0.108
20	S		132	0.188	1.000	1.57	1.06	1.65	0.59	M5	0.20	2	±0.016	0.006	1.0	84,970	0.168
	M							1.93					±0.024	0.008	1.5	58,417	0.181

1) Design S = 4 section bellows 2) Design M = 6 section bellows 3) For selection, please see page 160 4) Quantity each hub, from size 9: 2x120° offset

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

Maximum peripheral speed V_{max}= 984 in/s (20 m/s)

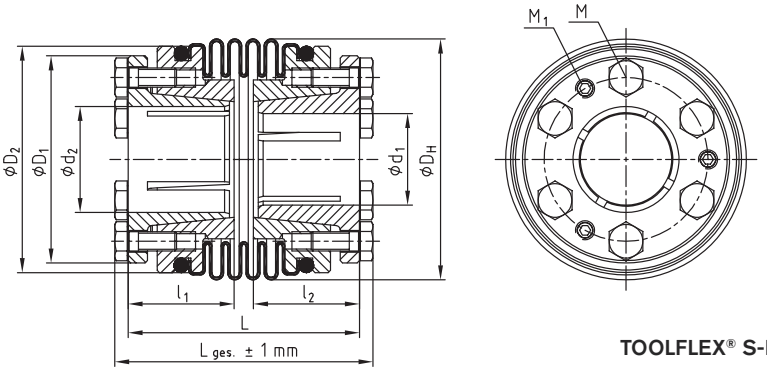
Hub design 1.1 = hub without keyway with set screw. Hub design 1.0 = hub with keyway with set screw

Order form:

TOOLFLEX® 7 M	2.5 - [4	2.5 - [6
Coupling size	Hub design / Bore	Hub design / Bore

Design KN

- Zero-backlash, reduced maintenance, torsionally stiff
- Machined hubs mechanical bellow connection – Low inertia, good dynamic properties
- Keyless concentric locking clamp design increases frictional torques
- Suitable for high temperatures up to +392 °F (200 °C)
- Peripheral speeds up to 1,572 in/s (40 m/s)
- All metallic construction, stainless bellows helps resist corrosion
- Installation instructions available at www.ktr.com



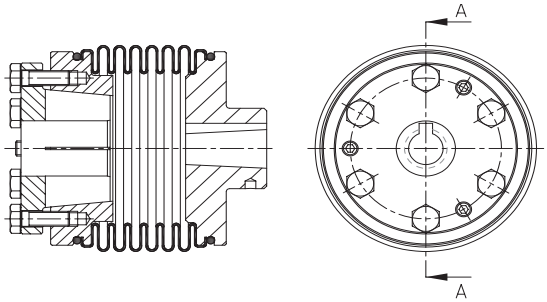
TOOLFLEX® S-KN

TOOLFLEX® Design KN																		
Size	Bellow Torque T_{KN} [1)] [lb-in]	Dimensions [in]																
		Bore		L		$L_{ges.}$						Clamping Screw			Pull-off threads			
		min. d	max. d	4 [2)]	6 [3)]	4 [2)]	6 [3)]	l_1; l_2	D_H	D_1	D_2	M	T_A [lb-in]	Number z	M_1	Number z	T_{A1} [5)] [lb-in]	
30	309	0.438	0.875	1.89	2.24	2.13	2.48	0.87	1.97	1.69	1.85	M4	26	12	M4	6	11	
38	575	0.438	1.125	2.20	2.68	2.48	2.95	1.02	2.38	2.05	2.20	M5	53	12	M5	6	12	
42	840	0.563	1.375	2.52	2.95	2.80	3.23	1.14	2.60	2.36	2.48	M5	53	12	M5	6	12	
45	1,327	0.563	1.563	2.93	3.58	3.25	3.90	1.34	3.23	2.68	3.03	M6	124	12	M6	6	27	
55 [1)]	3,009	0.563	2.188	3.76	4.29	4.17	4.72	1.57	3.82	3.74	3.74	M8	310	12	M8	6	53	

Inch equivalent bore ranged and the corresponding transmittable torques TR of frictional engagement of the clamping hub [lb-in]																		
Size	0.551	0.591	0.630	0.748	0.787	0.945	0.984	1.102	1.181	1.260	1.378	1.496	1.575	1.654	1.772	1.890	1.969	2.165
30	443	513	584	628	699													
38		717	814	1,151	912	1,319	1,425	1,788										
42				929	1,036	1,487	1,159	1,452	1,673	1,903	2,275							
45					2,036	2,939	2,036	2,549	2,930	3,328	3,992	4,700	5,213					
55 [1)]							4,275	5,364	6,160	7,010	5,178	6,107	6,762	7,461	8,559	9,745	10,568	12,790

[1)] Selection please see page 141 [2)] Design S = 4 section bellows [3)] Design M = 6 section bellows [4)] Hubs from steel welded with bellow
[5)] After assembly of the clamping screws (M) tighten the pull-off thread (M1) to the torque TA1 indicated.

Other designs: TOOLFLEX® KN for FANUC motors

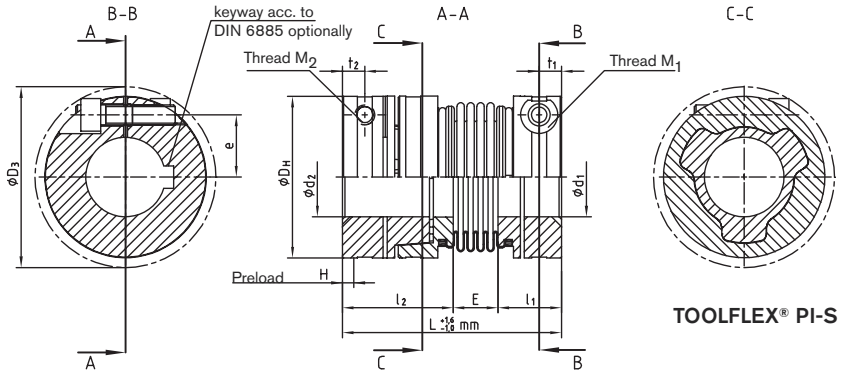


Order form:

TOOLFLEX® 38 S-KN	⌈15	⌈22
Coupling size	Bore	Bore

Design PI

- Zero-backlash, reduced maintenance, torsionally stiff
- Machined hubs mechanical bellow connection – Low inertia, good dynamic properties
- Axial plug-in design eases assembly, available in both designs M and S.
- Clamping hubs as standard
- Suitable for high temperatures
- Peripheral speeds up to 1,572 in/s (40 m/s)
- All metallic construction, stainless bellows helps resist corrosion
- Installation instructions available at www.ktr.com



TOOLFLEX® PI-S

Plug in metal bellow-type coupling Design PI

Size	Type	Dimensions [in]													
		General									Fasteners				
		$d_1;d_{2\,min.}$	$d_{1\,max.}$	$d_{2\,max.}$	L [1]	l_1	l_2	E	D_H	H	$M_1;M_2$	D_3	e	$t_1;t_2$	T_A [lb-in]
20	S	0.313	0.813	0.813	2.64	0.85	1.32	0.47	1.57	0.02 - 0.04	M5	1.71	0.57	0.24	53
	M				2.91			0.75							
30	S	0.375	1.188	1.125	2.89	0.91	1.32	0.67	2.17	0.02 - 0.04	M6	2.28	0.75	0.28	89
	M				3.25			1.02							
38	S	0.563	1.500	1.250	3.44	1.00	1.73	0.71	2.56	0.02 - 0.06	M8	2.86	0.98	0.35	221
	M				3.92			1.18							
42	S	0.563	1.750	1.625	3.66	1.18	1.54	0.94	2.76	0.02 - 0.06	M8	3.00	0.98	0.35	221
	M				4.09			1.38							
45	S	0.563	1.750	1.625	3.78	1.26	1.63	0.89	3.27	0.02 - 0.06	M10	3.50	1.18	0.43	434
	S				4.43			1.54							

Technical data

Size	Type	Torque T_{KN} [lb-in]	Speed [1] n [rpm]	Moment of inertia [2] [x10-6 lb-in-sec²]	Torsional stiffness C_T [lb-in/rad]	Axial spring stiffness [lbf/in]	Radial spring stiffness [lbf/in]	Allowable misalignments		Mass [2] [lb]
								Parallel [in]	Angular [degrees]	
20	S	132	11,950	3.27E -04	84,970	360	1,079	0.006	1.0	0.33
	M			3.36E -04	58,417	240	720	0.008	1.5	0.34
30	S	309	8,700	1.24E-03	157,548	554	1,331	0.008	1.5	0.65
	M			1.28E-03	130,995	371	885	0.010	2.0	0.69
38	S	575	7,350	2.91E-03	331,027	617	1,816	0.008	1.5	1.09
	M			3.06E-03	220,390	411	1,211	0.010	2.0	1.15
42	S	840	6,820	3.50E-03	484,150	685	2,850	0.008	1.5	1.07
	M			3.78E-03	323,062	457	1,902	0.010	2.0	1.15
45	S	1,327	5,750	9.13E-03	847,926	754	4,215	0.010	1.5	2.05
	M			9.98E-03	566,464	503	2,810	0.012	2.0	2.21

Transmittable friction torque of clamping hubs d_1 / d_2 [lb-in]

Size	0.313	0.375	0.438	0.500	0.625	0.688	0.750	0.813	0.875	0.938	1.000	1.125	1.188	1.250	1.313	1.375	1.500	1.563
20	155	162	169	175	189	195	202											
30		284	293	303	322	331	341	350	360	369	379	398						
38				687	721	739	756	774	791	808	826	861	878	895	913	930	965	
42				730	765	783	800	817	835	852	870	904	922	939	957	974	1,009	1,026
45				1,781	1,858	1,897	1,936	1,975	2,014	2,053	2,092	2,169	2,208	2,247	2,286	2,325	2,403	2,442

[1] When fully assembled

[2] Calculated as complete coupling with maximum bores

Order form:

TOOLFLEX® 30 PI-S	d_1 - ⍰22	d_2 - ⍰18
Coupling size	Bore Component 1	Bore Component 2