COUPLING SELECTION ACC. TO DIN 740 PART II WITH SPECIFIC FACTORS

Coupling types

Backlash-free servo couplings

ROTEX® GS

Backlash-free, flexible jaw coupling (see page 116)

- Backlash-free and flexible
- Maintenance-free
- Fail-safe
- Compact dimensions, high power density
- Single-cardanic or double-cardanic
- Axial plug-in
- High speeds

TOOLFLEX®

Backlash-free, torsionally rigid metal bellow-type coupling (see page 116)

- Backlash-free and torsionally rigid
- Maintenance-free
- Shear type
- Compact dimensions
- Double-cardanic
- Axial plug-in (as an option)
- All-steel

RADEX®-NC

Backlash-free, torsionally rigid servo lamina coupling (see page 116)

- Backlash-free and torsionally rigid
- Maintenance-free
- Compact dimensions
- Single-cardanic or double-cardanic
- All-steel

COUNTEX®

Backlash-free, torsionally rigid shaft encoder coupling (see page 116)

- Backlash-free and torsionally rigid
- Maintenance-free
- Compact dimensions
- Double-cardanic
- Axial plug-in

Terminology of coupling selection

Description	Symbol	Definition or explanation
Rated torque of coupling [Nm]	T_{KN}	Torque which can be transmitted continuously over the entire permissible speed range, taking into account the factors.
Maximum torque of coupling [Nm]	$T_{K\ max.}$	Torque which can be transmitted over the entire service life of the coupling as dynamic load ≥ 10^5 or as alternating load $5 \cdot 10^4$ taking into account the factors.
Rated torque of machine [Nm]	T_N	Stationary rated torque on the coupling
Rated torque of driving side [Nm]	T_{AN}	Constantly occuring driving torque as per the data indicated by the motor manufacturer
Peak torque [Nm]	T_S	Peak torque on the coupling
Peak torque of driving side [Nm]	T_{AS}	Peak torque with torque shock on driving side, e. g. starting torque of the servo motor as per the data indicated by the motor manufacturer.
Peak torque of load side [Nm]	T_{LS}	Peak torque with torque shock on load side, e. g. braking
Screw tightening torque [Nm]	T_A	Screw tightening torque
Friction torque [Nm]	T_R	Torque that can be transmitted through the frictionally engaged shaft-hub-connection

Description	Symbol	Definition or explanation
Rotational inertia coefficient of driving side	M_A	Factor taking into account the mass distribution with shocks and vibrations produced on the driving or load side.
Rotational inertia coefficient of load side	M_L	
Mass moment of inertia of driving side[kgm²]	J_A	Total of moments of inertia existing on the driving or load side referring to the coupling speed.
Mass moment of inertia of load side [kgm²]	J_L	
Mass moment of inertia of coupling [kgm²]	J_{KA}	Mass mom. of inertia of the coupl. half on the drive side
	J_{KL}	Mass mom. of inertia of the coupl. half on the load side
Mass moment of inertia [kgm²]	$J_{Mot}/J_{Sp}/J_{HS}$	Mass moment of inertia of the motor/mass moment of inertia of the spindle/mass moment of inertia of the main spindle
Shock factor on driving side	S_A	Factor taking into account the shocks arising depending on the application (e. g. starting shocks) With positioning drives the additional load is considered by the starting frequency per hour.
Shock factor on load side	S_L	
Temperature factor	S_t	Temperature factor - Factor considering the lower loading capacity or larger deformation of an elastomer part under load particularly with increased temperatures.
Operating factor	S_B	Factor considering the different demands on the coupling dependent on the application.

COUPLING SELECTION ACC. TO DIN 740 PART II WITH SPECIFIC FACTORS

Factors

Temperature factor S_t														
	-50 °C	-40 °C	-30 °C	-20 °C/ +30 °C	≤ +40 °C	≤ +50 °C	≤ +60 °C	≤ +70 °C	≤ +80 °C	≤ +90 °C	≤ +100 °C	≤ +110 °C	≤ +120 °C	≤ +200 °C
ROTEX® GS														
Polyurethan 80 Sh-A-GS	1,0	1,0	1,0	1,0	1,2	1,3	1,4	1,55	1,8	–	–	–	–	–
Polyurethan 92 Sh-A-GS	–	1,0	1,0	1,0	1,2	1,3	1,4	1,55	1,8	2,2	–	–	–	–
Polyurethan 98 Sh-A-GS	–	–	1,0	1,0	1,2	1,3	1,4	1,55	1,8	2,2	–	–	–	–
Polyurethan 64 Sh-D-GS	–	–	–	1,0	1,2	1,3	1,4	1,55	1,8	2,2	3,0	–	–	–
Polyurethan 72 Sh-D-GS	–	–	–	1,0	1,2	1,3	1,4	1,55	1,8	2,2	3,0	–	–	–
Hytrel 64 Sh-D-H-GS	1,0	1,0	1,0	1,0	1,2	1,3	1,4	1,5	1,6	1,8	2,0	2,3	2,8	–
Hytrel 72 Sh-D-H-GS	1,0	1,0	1,0	1,0	1,2	1,3	1,4	1,5	1,6	1,8	2,0	2,3	2,8	–
TOOLFLEX®														
Size 5 to 12	–	–	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	–	–	–
Size 16 to 65	–	–	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,1
RADEX-NC®														
EK and DK	–	–	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,1

Operating factor S_B		
ROTEX® GS*		
Backlash-free drives		
Main spindle drive of machine tool		2,0 – 5,0
Positioning drives		
Ball screw drive/toothed belt drive		3,0 – 5,0
Gearbox	i 3 – ≤ 5	8,0
	i >5 – ≤ 7	5,0
	i >7	3,0
Servohydraulic drives		
With pulsating load [1]		1,0 – 1,2
With alternating load [2]		1,3 – 1,5
TOOLFLEX®, RADEX®-NC		
Uniform motion		1,5
Nonuniform motion		2,0
Shocking motion		2,5 – 4,0
Für Antriebe an Werkzeugmaschinen (Servomotoren) sind Werte von 1,5 – 2,0 einzusetzen		

Shock factor S_A/S_L	
Main spindle drive	
Moderate shocks	1,0
Average shocks	1,4
Heavy shocks	1,8
Positioning drive [3]	
< 60	1,0
≥60 – <300	1,4
≥300	1,8

*When using the spider 64 Sh-D-GS or 72 Sh-D-GS a factor of at least 4 or steel hubs have to be considered.
[1] With pulsating load the use of aluminium is permissible.
[2] With alternating load please make use of steel hubs.
[3] Starts per minute
Shaft encoder drives: Subject to the low torques to be transmitted the coupling size for shaft encoder drives is selected according to the shaft diameters to be connected.

Coupling selection

The coupling selection of the backlash-free servo couplings is based on DIN 740 part 2, but with specific factors. The coupling has to be dimensioned in a way that the permissible coupling load is not exceeded during any operating condition. For this purpose the actual loads have to be compared to the permissible parameters of the coupling. The shaft-hub-connection has to be investigated by the customer. The size of the coupling must be selected so that the following conditions are met.

1. Backlash-free drives

$$T_{KN} \geq T_N \bullet S_t \bullet S_B \quad \text{and} \quad T_{KN} \geq T_S \bullet S_t \bullet S_B$$

In case of a loaded torque: $T_{KN} \geq T_S \bullet S_t \bullet S_B + T_N \bullet S_t$

Taking into account the temperature factor St and the operating factor S_B, the permissible rated torque T_{KN} must be at least as big as the the rated torque T_N of the machine. Furthermore the permissible rated torque T_{KN} has to be at least as big as the maximum driving torque, even under the influence of the temperature factor S_t.
Calculation of the maximum driving torque T_S:

Shock loads on driving side $T_S = T_{AS} \bullet M_A \bullet S_A \rightarrow M_A = \frac{J_L}{(J_A + J_L)}$

Shock loads on loaded side $T_S = T_{LS} \bullet M_L \bullet S_L \rightarrow M_L = \frac{J_A}{(J_A + J_L)}$

2. Servohydraulic drives

$$T_{KN} \geq T_{AS} \bullet S_t \bullet S_B$$

Taking into account the ambient temperature and the operating factor, the permissible rated torque T_{KN} of the coupling has to correspond at least to the peak torque of the driving side T_{AS}.

Please note:
For general applications (not backlash-free applications) please follow coupling selection according to DIN 740 part 2 (page 10 et seqq.)

COUPLING SELECTION ACC. TO DIN 740 PART II WITH SPECIFIC FACTORS

Example of calculation for positioning drives

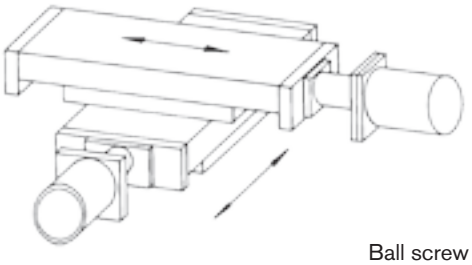
Requested: Backlash-free coupling damping vibrations → ROTEX® GS

Application: Connecting servo motor and ball screw drive for backlash-free positioning

→ Coupling selection following page 19, item 1: Backlash-free drives

Given: Details of driving side

Servo motor



Ball screw

Rated torque T_{AN}:	43 Nm	
Max. driving torque T_{AS}:	144 Nm	
Moment of inertia J_{Mot}:	0,0108 kgm²	
Diameter of motor shaft	32 k6 without feather keyway	
Ambient temperature:	40 °C	→ S_t = 1,2 **(see page 19)**
Starts per minute	60	→ S_A = 1,0 **(see page 19)**

Given: Details of machine on driving side

Ball spindle J_{SP}:	0,0038 kgm²
Spindle pitch s:	10 mm
Diameter of spindle shaft:	30 k6 without feather keyway
Mass of slide + work piece m_{SI}:	1030 kg

No load torque available

Required: hohe Drehsteifigkeit → S_B = 4 **(s. Seite 19)**

Calculation

1. Backlash-free drives

- Loading by rated torque (pre-selection)

$T_{KN} \geq T_{AN} \bullet S_t \bullet S_B$ → 43 Nm • 1,2 • 4 → $T_{KN} \geq$ 206,4 Nm

- Coupling selection (pre-selection)

ROTEX® GS 38

Spider 98 Shore-A with clamping ring hubs 6.0 light:

T_{KN} = 325 Nm

$T_{K\ max.}$ = 650 Nm

Mass moments of inertia (see page **130**)

J_{KA} = 0,000517 kgm²

J_{KL} = 0,000517 kgm²

- Load by maximum driving torque, not including load torque

$T_{KN} \geq T_S \bullet S_t \bullet S_B$

Shock on driving side $T_S = T_{AS} \bullet M_A \bullet S_A$ → = 144 Nm • 0,379 • 1,0 → T_S = 54,58 Nm

$M_A = \frac{J_L}{(J_A + J_L)}$ → = $\frac{0{,}006917\ kgm^2}{(0{,}011317\ kgm^2 + 0{,}006917\ kgm^2)}$ → M_A = 0,379

$J_A = J_{Mot} + J_{KL}$ → 0,0108 kgm² + 0,000517 kgm² → J_A = 0,011317 kgm²

$J_L = J_{Sp} + J_{SI} + J_{KL}$ → 0,0038 kgm² + 0,0026 kgm² + 0,000517 kgm² → J_L = 0,006917 kgm²

$J_{SI} = m_{SI} \bullet \left(\frac{s}{2 \bullet \pi}\right)^2$ → 1030 kg • $\left(\frac{0{,}01}{2 \bullet \pi}\right)^2$ → J_{SI} = 0,0026 kgm²

→ $T_{KN} \geq$ 54,58 Nm • 1,2 • 4 → $T_{KN} \geq$ 261,9 Nm

T_{KN} with 325 Nm ≥ 261,9 Nm

- Review of shaft-hub-connection: Friction torque for clamping ring hubs type 6.0 light

The coupling has to be dimensioned such that the permissible friction torque is not exceeded during any operating condition.

$T_R \geq T_{AS}$ values T_R see page 130

Friction torque of ROTEX® GS 38 clamping ring hub 6.0 light Ø30 H7/k6 T_R = 443 Nm > 144 Nm

Result

The coupling is sufficiently dimensioned.

COUPLING SELECTION ACC. TO DIN 740 PART II WITH SPECIFIC FACTORS

Example of calculation for main spindle drives

Requested: Backlash-free, axial plug-in coupling for high speeds → ROTEX® GS

Application: Connecting servo motor and and main spindle in a grinding machine

Coupling selection following page 19, item 1: Backlash-free drives

Given: Details of driving side

Servo motor

Rated torque with operation T_{AN}:	154 Nm	
Max. driving torque T_{AS}:	190 Nm	
Max. speed:	6000 1/min	
Moment of inertia J_{Mot}:	0,316 kgm²	
Diameter of motor shaft	30 k6 without feather keyway	
Ambient temperature:	60 °C	→ S_t = 1,4 **(see page 19)**
Shock factor S_A:	moderate shocks	→ S_A = 1,0 **(see page 19)**

Given: Details of machine on driving side

Moment of inertia of load side J_{HS}	0,1094 kgm²	
Diameter of main spindle shaft:	30 k6 without feather keyway	
No load torque available		
Required:	no high torsion stiffness	→ S_B = 2 **(see page 19)**

Calculation

1. Backlash-free drives

- Loading by rated torque (pre-selection)

$T_{KN} \geq T_{AN} \bullet S_t \bullet S_B$ → 154 Nm • 1,4 • 2 → $T_{KN} \geq$ 431,2 Nm

- Coupling selection (pre-selection)

ROTEX® GS 42

Spider 98 Shore-A with clamping ring hubs 6.0 light:

T_{KN} = 450 Nm

$T_{K\ max.}$ = 900 Nm

Mass moments of inertia of page 130

J_{KA} = 0,001117 kgm²

J_{KL} = 0,001117 kgm²

- Load by maximum driving torque, not including load torque

$T_{KN} \geq T_S \bullet S_t \bullet S_B$

Shock on driving side $T_S = T_{AS} \bullet M_A \bullet S_A$ → = 144 Nm • 0,376 • 1,0 → T_S = 54,14 Nm

$M_A = \frac{J_L}{(J_A + J_L)}$ → = $\frac{0{,}191517\ kgm^2}{(0{,}317117\ kgm^2 + 0{,}191517\ kgm^2)}$ → M_A = 0,376

$J_A = J_{Mot} + J_{KL}$ → 0,316 kgm² + 0,001117 kgm² → J_A = 0,317117 kgm²

$J_L = J_{MS} + J_{KL}$ → 0,1094 kgm² + 0,001117 kgm² → J_L = 0,191517 kgm²

$T_{KN} \geq$ 54,14 Nm • 1,4 • 2 → $T_{KN} \geq$ 151,6 Nm

T_{KN} with 450 Nm ≥ 151.6 Nm

- Review of shaft-hub-connection: Friction torque for clamping ring hubs type 6.0 light

The coupling has to be dimensioned such that the permissible friction torque is not exceeded during any operating condition.

$T_R \geq T_{AS}$ values T_R see page 130

Friction torque of ROTEX® GS 42 clamping ring hub 6.0 light Ø30 H7/k6 T_R = 507 Nm > 190 Nm

Result

The coupling is sufficiently dimensioned.