Technical Properties

Mönninghoff friction clutches can be utilised in dry and wet runnings. The torques indicated in the data sheet apply to dry operation. During dry operation the torques decrease by about 25% of the given torque. Minor impurities on the frictional surfaces caused by oil or grease lead to short-term torque loss; after several switchings under load the original values are once again reached.

The armature disk rings have no environmentally harmful friction linings. Good friction and abrasion properties are achieved through special surface handling of the frictional surfaces.

Upon initial assembly or exchange of the armature and rotor modules, Mönninghoff friction clutches begin to transmit the given torques only after pole faces warm up.

The grease-lubricated deep-groove ball bearings are prestressed axially with cup springs to prevent sliding wear and hence are maintenance-free.

The magnet element is attached to a stationary machine component to ensure against rotation over a groove on the circumference.

The friction clutches can only be operated only on 24 V direct voltage. Switching times are controllable with special protective circuits.

Mönninghoff friction clutches come in two designs as shown in Fig. 1:
Design 1.3 includes an armature, rotor and magnet element with free cable ends. The magnet housing and the rotor are mounted according to the customer-provided connection layout.
Design 4.3 also includes the mounting of the magnet housing and the hub. Power is fed through a connector socket according to DIN 43650-A.

Switching operation

The Mönninghoff friction clutches show the torque curve represented in Fig. 2 of electromagnetically activated friction clutches. The selected concepts for torques and switching times correspond to the definitions in DIN VDE 0580 and VDI Guideline 2241.

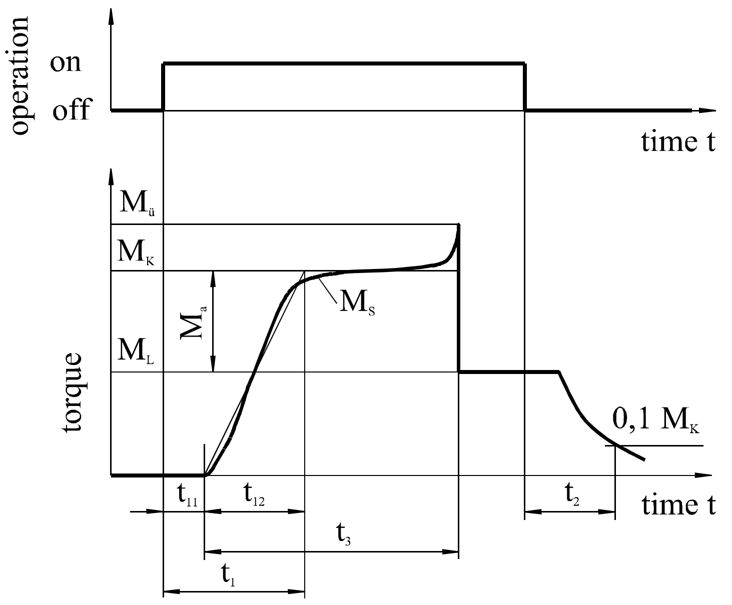

Fig. 2

When the clutch is operated, switching torque M_S builds up after response time t_{11} during rise time t_{12}. The clutch output side is accelerated with torque M_a to the synchronism of the clutch halves. At synchronisation point, the clutch torque rises for a short time to the highest transmissible torque $M_ü$ due to the resulting frictional grip and then drops to load torque M_L.

M_L = load torque; torque with which the output of the closed clutch is loaded by the working machine

M_S = switching torque; after rise time t_{12} elapses, the torque effective in the shaft assembly given a slipping clutch

M_K = characteristic torque; the characteristic value of switching torque M_S indicated in the data sheet

$M_ü$ = transmissible torque; highest torque with which the closed clutch can be loaded without slipping

M_a = accelerating torque; torque until the acceleration of the masses of the output side, difference of the characteristic torque and load torque

t_{11} = response time; time from the switching of the clutch to the beginning of the torque increase, depending on the structure of the magnetic field

t_{12} = rise time; time from the beginning of the torque increase until characteristic torque M_K is reached

t_1 = running time; sum of response time t_{11} and rise time t_{12}

t_3 = slipping time; time from the beginning of the torque increase to the synchronism of the clutch halves

t_2 = splitting time; time from the switching of the clutch until the torque drops to 10% of the characteristic torque M_K

Layout according to the torque

When selecting the clutch according to the torque to be transmitted, the following conditions must be met:

1. To accelerate the clutch output side in the prescribed time and transfer the load torque, the following must be met:

$$M_a + M_L \leq \frac{M_K + M_S(\Delta n)}{2}$$

$M_a = \frac{J_L \cdot \Delta n}{9{,}55 \cdot t_3} =$ accelerating torque in Nm

J_L = mass moment of inertia of all output shaft parts (armature and connecting parts) in kg·m²

Δn = $n_1 - n_2$ = relative speed of the clutch halves at switching start in min^{-1}

n_1 = drive speed in min^{-1}

n_2 = speed of the driven side in min^{-1}

t_3 = acceleration time (slipping time) in s

Important: to prevent thermal overloading of the friction faces
t_3 must be $\leq$ 1 s.

M_L = load torque in Nm

M_K = characteristic torque of the clutch according to data sheet in Nm

M_S = switching torque during switching start in Nm; with friction clutches switching torque M_S depends on the relative speed Δn of the clutch halves according to the
curve shown in Fig. 3.

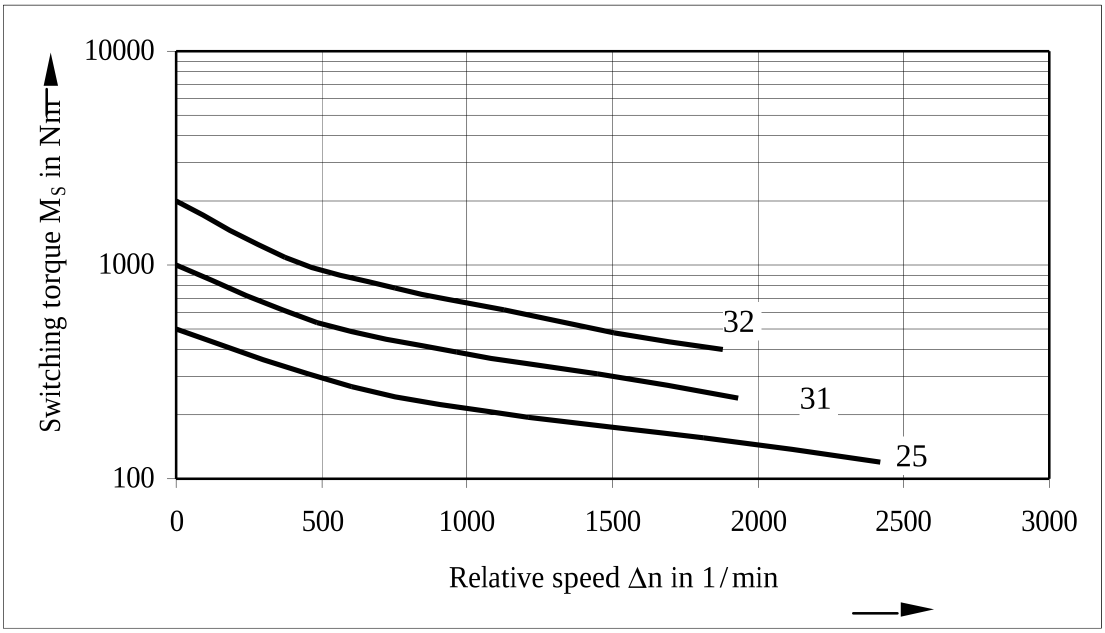

Fig. 3 Values of M_S apply to the resulting status

2. The load torque must securely be transmitted between the driven side and the output side of the clutch even at the initial relative speed.

$$M_L \leq M_S\,(\Delta n)$$

M_L = load torque in Nm
M_S = switching torque during switching start in Nm according to Fig. 3

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3. The load torque including short-term overloads (sudden torque changes) may not exceed the transmissible torque of the clutch.

$$M_L \cdot c_S \leq M_{ü}$$

M_L = load torque in Nm
$M_{ü}$ = transmissible torque of the clutch according to the data sheet in Nm
c_S = 1, 2 ... 4 = load factor depending on operating conditions

Layout according to the switched energy

During the slipping of the clutch at the beginning of the switching sequence, the switched energy produced is converted to heat. To prevent undue heating of the clutch the permissible switched energy Q_{perm} must not be exceeded with switched energy Q given an engagement frequency of S_h switchings per hour:

$$Q \leq Q_{zul}(S_h)$$

The switched energy to be adopted by the clutch per switching is

$$Q = \frac{M_K}{(M_K - M_L)} \frac{J_L \left(\Delta n \frac{p}{30} \right)^2}{2 \cdot 10^3} \quad \text{in kJ}$$

M_K = characteristic torque of the clutch according to the data sheet in Nm

M_L = load torque in Nm

J_L = mass moment of inertia of all output shaft parts (armature and connecting parts) in kg·m²

Δn = relative speed of the clutch halves during switching start in min^{-1}

The permissible switched energy Q_{perm}, depending on the clutch size, can be read from Fig. 4 or
can be calculated from the following equations.

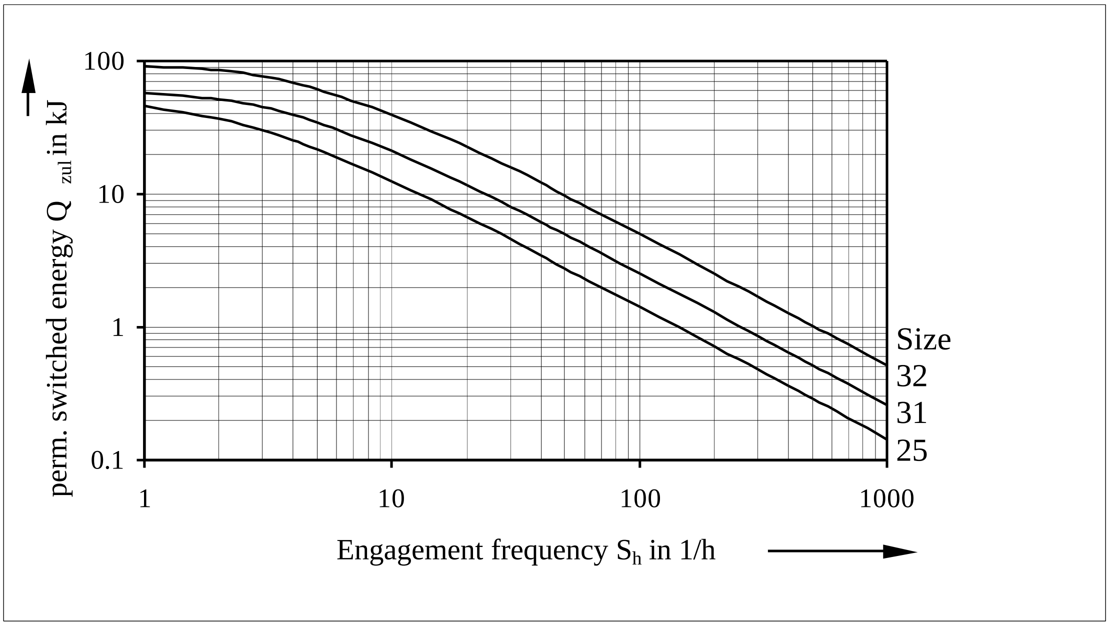

Fig. 4

Size 25: $Q_{zul} = 48(1 - e^{-3/S_h})$ in kJ

Size 31: $Q_{zul} = 58(1 - e^{-4,5/S_h})$ in kJ

Size 32: $Q_{zul} = 91(1 - e^{-5,7/S_h})$ in kJ

S_h = engagement frequency in 1/h

Example of clutch selection

Mounting situation: Clutch in the drive train of a working machine

given data:	Load torque	M_L = 380 Nm
	Acceleration time	t_3 = 0.2 s
	Load factor	c_S = 2.0
	Inertia of the working machine relating to the output side of the clutch	J_M = 0.7 kg·m²
	Drive speed	n_1 = 500 min^{-1}
	Engagement frequency	S_h = 100 h^{-1}

1. Clutch selection

   Accelerating torque $M_a = \frac{J_L \cdot \Delta n}{9{,}55 \cdot t_3} = \frac{0{,}74347 \cdot 500}{9{,}55 \cdot 0{,}2} \text{ Nm} = 195 \text{ Nm}$

   with J_L = $J_M + J_A$ = 0.7 + 0.04347 kg·m² = 0.74347 kg·m²

   J_A = mass moment of inertia of the armature according to the data sheet
   Δn = $n_1 - n_2$ = 500 min^{-1}
   n_2 = 0 = speed of the driven side at switching start

   $M_a + M_L$ = 195 + 380 Nm = 575 Nm
   ⇒ selected: clutch 450.31 with M_K = 800 Nm

   Switching torque at switching start from Fig. 3:
   $M_S (\Delta n) = M_S (500 \text{ min}^{-1})$ = 440 Nm

   Proof: $M_a + M_L = 575 \text{ Nm} \leq \frac{M_K + M_S(\Delta n)}{2} = \frac{800 + 440}{2} \text{ Nm} = 620 \text{ Nm}$

   Thermal loading of the friction faces:
   Condition t_3 = 0.2 s ≤ 1 s.

2. Transfer of the load torque at switching start
   Proof: M_L = 380 Nm ≤ $M_S (\Delta n)$ = 440 Nm

3. Transfer of the load torque after the start-up
   Proof: $M_L \cdot c_S$ = 380 · 2.0 Nm = 760 Nm ≤ $M_ü$ = 1000 Nm

3. Switched energy

   switched energy to be adopted per switching:

   $$Q = \frac{M_K}{(M_K - M_L)} \frac{J_L \cdot \Delta n^2}{182{,}4 \cdot 10^3} = \frac{800}{(800-380)} \frac{0{,}74347 \cdot 500^2}{182{,}4 \cdot 10^3} \text{ kJ} = 1{,}94 \text{ kJ}$$

   permissible switched energy:

   $$Q_{zul} = 58\,(1 - e^{-4{,}5/S_h}) = 58\,(1 - e^{-4{,}5/100}) = 2{,}55 \text{ kJ}$$

   Proof: Q = 1.94 kJ ≤ Q_{perm} = 2.55 kJ