DRUM COUPLING
ABC-V

APPLICATION

The Sibre ABC-V drum coupling of the series is especially designed for the use in rope drum drives. It is used for the transfer of medium and high torques as rope drum couplings in crane hoisting gear, conveyance, stackers, ship unloaders, container cranes as well as in heavy, rough smelting works.

Torques of up to 1025 kNm and radial loads of up to 550 kN can be transferred with a maximum coupling diameter of 1025 mm.

The design of the SIBRE drum coupling is performed on the basis of the steel-iron-guidelines (Stahl-Eisen-Betriebsblatt) SEB 666 212. The exchangeability regarding connection dimensions with series on the market is ensured.

The following drawings 1 and 2 show the typical arrangement of a rope drum drive in a crane installation.

Drawing 1 shows the direct displacement of the rope drum over a rigid hub on the drive output shaft. This un-recommended construction leads to a structurally undefined suspension.

In practice such a connection requires a difficult to achieve precision in assembly and alignment.

Misalignment during assembly or dending of the foundation with this hub causes significant additional loads in the drive shaft, which in turn leads to damage in the drive gearing or in the bearings, or to fatigue failure on the shaft.

Drawing 1: Double drum drive with quadruple supported shaft (structurally undefined case).
Drawing 2 shows the standard support of a rope drum via a drum coupling on the gearbox output shaft. The drum coupling is working as a joint, that also allows limited axial displacements. As a result, the connection is structurally defined and the side load on the drive shaft is significantly reduced.

Drawing 3 shows the use of a drum coupling in a single drum drive. The drum coupling is designed as a loose bearing with length compensation. The axial forces accrued due to the inertial forces and rope flow have to be absorbed by the oppositely lying vertical bearing of the rope drum. The vertical bearing is usually constructed with a spherical roller bearing as a "fixed bearing".

Drawing 3: Single drum drive
DESCRIPTION AND CHARACTERISTICS

Drum Coupling
ABC-V

B06 20 246 E-EN

Wear grooves
Wear cam
Bleeder hole
Lip seal
Lip seal
Drum roll
Housing
Coupling hub
Locking ring
Outer pressure ring
Lubricating pipe connection
Cover screws
Outer cover

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The drum coupling largely consists of a hub part and a housing part, fitted above each other axially. Drill holes are arranged in the parting plane throughout the diameter of both parts. The power transmission of the hub part onto the housing part occurs with positive locking. Hardened barrel rollers are fit into the drill holes, which are formed from the two circular gearings, as power transmission elements. The sealing of the coupling is achieved through double-sided covers with lip seals. This prevents escape of lubricant from the coupling, as well as intrusion of dirt from outside. The semicircular gearing of the hub over the outer diameter is crowned. Together with the arched drum roll it is possible for the hub to oscillate relative to the housing part, therefore angular and axial displacement can be compensated.

The coupling housing has an attachment flange which is fixed to the front flange of the drum. The transmission between the coupling and the drum roll occurs partially by friction torque, and partially by positive locking by the oppositely lying camming surfaces on the housing. Grade 10.9 high-tension bolts are to be used as connection bolts.

The coupling is built with visual wear and position display. Using a wear cam on the housing part and wear grooves on the hub part, the wear on the coupling gearing can be easily checked from the side of the coupling.

The wear cam also can be used for checking the axial position of the coupling housing to the coupling hub. The drum couplings of the ABC-V series, that transfers high radial loads in addition to high torques, are characterized by the following features:

- Compensation of angular displacement up to +/- 1°
- Depending on the size of the coupling axial shifting from up to +/- 4mm to up to +/- 10mm.
- The max. angular displacement and max. axial shifting must not be fully exploited simultaneously (see information in the OM).
- The standard drum coupling is not suitable for transfer of axial loads.
- Due to the adjustability of the arched drum roll the sliding within the gearing at an angular displacement is limited, which significantly reduces wear due to relative movements.
- A high overload safety is the result of the robust design.
- The power transmission between the coupling hub, the drum roll, and the coupling housing additionally leads to smoothed tooth flanks. There is a strain hardening of the material structure which improves the wear resistance.
- Due to the convex and concave fit of the drum rolls to the coupling hub and the coupling’s housing, the forces are spread across a large contact surface which leads to favourable compressive stresses (drawing 4).
The circular gearings of the drum coupling have a much more favourable tooth flow load compared to the involute gearing of a tooth coupling. Due to the wide tooth base of the drum coupling the tooth flow bending stress is much lower than a comparable tooth coupling (see drawing 5).

CALCULATORY BASES / DIMENSIONING

Required design parameters:
- max. drive torque \( T_{A,\text{max}} \) \([\text{Nm}]\)
- max. radial load \( F_{R,\text{max}} \) \([\text{N}]\)
- Dimensions of the gear box output shaft

MAX. DRIVE TORQUE \( T_{A,\text{MAX}} \)

The determined torque \( T_{A,\text{MAX}} \) intended to be transferred by the coupling due to the installed or used power must be less than the max. torque \( T_{k,\text{max}} \) of the drum coupling (according to the dimension sheet).

\[
T_{A,\text{MAX}} = \left( \frac{P_1}{n_{Tr}} \right) \cdot C_{erf} \leq T_{k,\text{max}}
\]

or

\[
T_{A,\text{MAX}} = \left( \frac{P_e}{n_{Tr}} \right) \cdot C_{erf} \leq T_{k,\text{max}}
\]

or

\[
T_{A,\text{MAX}} = \left( \frac{S_{Tr}}{2} \right) \cdot \frac{D_{Tr}}{n_{Tr}} \cdot C_{erf} \leq T_{k,\text{max}}
\]

- \( P_1 \) = max. installed drive power \([\text{kW}]\)
- \( P_e \) = max. used power \([\text{kW}]\)
- \( S_{Tr} \) = rope tensile force at the rope drum \( \) (including load of the suspension elements) \([\text{N}]\)
- \( n_{Tr} \) = rotation speed of the rope drum \([1/\text{min}]\)
- \( D_{Tr} \) = diameter to the drum roll in respect of the midpoint of the rope \([\text{m}]\)
- \( C_{erf} \) = required operating coefficient for engine groups by operating time group and load collective \([\text{-}]\)
Drum Coupling

Calculatory Bases /

The determined torque \( T \)

Required design parameters:

(3)

(1)

ABC

3.1 max. drive torque \( T \)

compared to the involute gearing of a tooth coupling. Due to the wide tooth base of the drum

\[
C = \frac{D_{irf} \cdot \pi \cdot n_{irf}}{36000}
\]

\( D_{irf} \) = diameter to the drum roll in respect of the midpoint of the rope

\( n_{irf} \) = rope speed at the drum roll in respect to the midpoint of the rope [m/min]

\( V_{irf} = D_{irf} \cdot \pi \cdot n_{irf} \)

MAX. RADIAL LOAD \( F_{R MAX} \)

The support of the rope drum occurs by the vertical bearing (fixed bearing) on one side, and by the drum coupling (floating bearing) on the other side. The radial load \( F_{R MAX} \) is the proportion of the rope tensile force that has to be absorbed by the drum coupling. The rope tensile force in turn includes the max. payload as well as the load of the suspension elements.

\[
S_{irf} = \frac{(m_1 + m_2) \cdot 9.81}{i_v \cdot \eta_{irf}}
\]

\( m_1 \) = max. payload

\( m_2 \) = dead weight of the suspension elements

\( i_v \) = ratio of reeving

\( \eta_{irf} \) = efficiency of reeving (table 2)

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To increase the lifetime of the coupling concerning the wear especially at crane systems with high lift heights and high speeds, e.g. cable cranes but also production cranes working in three shifts it is recommended to raise the operating coefficient \( C_{irf} \) seen in table 1 by 20% up to 40%.

\[
P_e = \frac{S_{irf} \cdot V_{irf}}{60000}
\]

\( V_{irf} \) = max. installed drive power

\( S_{irf} \) = max. drive torque

\( n_{irf} \) = engine group

\( D_{irf} \) = max. diameter of the rope drum

\( m_1 \) = dead weight of the suspension elements [kg]

\( m_2 \) = max. payload [kg]

\( i_v \) = number of load bearing rope lines

\( \eta_{irf} \) = efficiency of reeving (table 2)
### Calculation of radial load $F_{R_{\text{max}}}$ with multiple rope lines to the rope drum

(7)

$$281.9 \text{m} SF Tr_{\text{max}}R + S_{\text{Tr}} = \text{rope tensile force at the rope drum [N]}$$

- $S_{\text{Tr}}$: dead weight of the rope drum [kg]
- $b$: minimum distance from rope to middle of drum roll [mm]
- $l$: distance between middle of fixed bearing to middle of drum roll [mm]

Case study drawing 6:
- 4 load bearing rope lines
- 8 load bearing rope lines
- 2 rope lines arriving on the drum

### Calculation of radial load $F_{R_{\text{max}}}$ with one rope line to the rope drum

(8)

$$281.9 \text{m} l_{b1}SF Tr_{\text{max}}R + S_{\text{Tr}} = \text{rope tensile force at the rope drum [N]}$$

- $S_{\text{Tr}}$: rope tensile force at the rope drum [N]
- $m_{\text{Tr}}$: dead weight of the rope drum [kg]
- $b$: minimum distance from rope to middle of drum roll [mm]
- $l$: distance between middle of fixed bearing to middle of drum roll [mm]

### Table 2: Efficiency $\eta_F$

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**CALCULATION OF RADIAL LOAD \( F_{R\text{MAX}} \)**

**WITH MULTIPLE ROPE LINES TO THE ROPE DRUM**

(7) \[
F_{R\text{MAX}} = \frac{S_{Tr}}{2} + \frac{m_{Tr} \cdot 9.81}{2}
\]

- \( S_{Tr} \) = rope tensile force at the rope drum (including load of the suspension elements) [N]
- \( m_{Tr} \) = dead weight of the rope drum [kg]

Case study drawing 6:
- 4 load bearing rope lines
- 2 rope lines arriving on the drum

Case study drawing 7:
- 8 load bearing rope lines
- 2 rope lines arriving on the drum

**CALCULATION OF RADIAL LOAD \( F_{R\text{MAX}} \)**

**WITH ONE ROPE LINE TO THE ROPE DRUM**

(8) \[
F_{R\text{MAX}} = \left[ S_{Tr} \cdot \left( 1 - \frac{b}{l} \right) \right] + \frac{m_{Tr} \cdot 9.81}{2}
\]

- \( S_{Tr} \) = rope tensile force at the rope drum (including load of the suspension elements) [N]
- \( m_{Tr} \) = dead weight of the rope drum [kg]
- \( b \) = minimum distance from rope to middle of drum roll [mm]
- \( l \) = distance between middle of fixed bearing to middle of drum roll [mm]
The max. radial load $F_{R_{\text{max}}}$ must be less than the max. approved coupling radial load $F'_{R_{\text{max}}}$ given in the dimension sheet of the drum coupling.

(9) $F_{R_{\text{max}}} \leq F'_{R_{\text{max}}}$

**CORRECTED RADIAL LOAD $F_{KKORR}$**

A correction/increase of the max. approved radial load $F'_{R_{\text{max}}}$ can occur if the max. drive torque $T_A$ is lower than $T_{k\text{max}}$ of the selected coupling.

The unused torque can be converted to increase the max. approved radial load $F_{R_{\text{max}}}$ as follows:

(10) $F_{kkorr} = \frac{T_{k\text{max}} - T_{A_{\text{max}}}}{C_{\text{eff}}} + F'_{R_{\text{max}}}$

If not all radial load is used, a correction of the max. approved torque is not permitted!

**DIMENSIONS OF THE GEAR BOX OUTPUT SHAFT**

- Confirming that the diameter of the shaft of the gear box output shaft is less than the max. approved drilling diameter according to the dimensions sheet of the chosen drum coupling.

- Confirming that the shaft/hub connection is dimensioned sufficiently for the transmitted torque.
CALCULATION EXAMPLES

A.) Closed Winch Grab Unloader

• Installed motor power : \( P_i \) = 515 kW
• Rated motor speed : \( n_m \) = 1230 min\(^{-1}\)
• Gear ratio : \( i_0 \) = 31.5
• Radial load that acts on the drum coupling : \( F_{r_{\text{max}}} \) = 145000 N
• Engine group : FEM 1.001 = M8
• Operating coefficient : \( C_{\text{erf}} \) = 2.0

Rotation speed of the rope drum

\[
\begin{align*}
n_{\text{v}} &= \frac{n_m}{i_0} = \frac{1230 \text{ min}^{-1}}{31.5} \\
&= 39 \text{ min}^{-1}
\end{align*}
\]

Max. output torque

\[
\begin{align*}
T_{A_{\text{max}}} &= \frac{P_i \cdot 9550 \cdot C_{\text{erf}}}{n_m} = \frac{515 \cdot 9550}{39} \cdot 2 \\
&= 252200 \text{ Nm}
\end{align*}
\]

Chosen drum coupling

ABC-V-545

\[
\begin{align*}
T_{k_{\text{max}}} &= 320000 \text{ Nm} \\
F_{r_{\text{max}}} &= 260000 \text{ N}
\end{align*}
\]

\( T_{A_{\text{max}}} = 252200 \text{ Nm} \leq T_{k_{\text{max}}} = 320000 \text{ Nm} \)

\( F_{r_{\text{max}}} = 145000 \text{ N} \leq F_{r_{\text{max}}} = 260000 \text{ N} \)
**B.) Main Hoist**

- Max. payload \( m_1 = 20000 \text{ kg} \)
- Dead weight of the suspension elements \( m_2 = 7000 \text{ kg} \)
- Dead weight of the rope drum \( m_{tr} = 3000 \text{ kg} \)
- Installed motor power \( P_i = 450 \text{ kW} \)
- Rated motor speed \( n_M = 90 \text{ min}^{-1} \)
- Gear ratio \( i_G = 20 \)
- Rope drum diameter \( D_{tr} = 1.4 \text{ m} \)
- Lifting speed \( v_H = 90 \text{ m/min} \)
- Ratio of reeving \( i_r = 2 \) (see drawing 6)
- Efficiency of reeving \( \eta_r = 0.97 \)
- Engine group \( \text{FEM 1.001 = M7} \)
- Operating coefficient \( C_{erf} = 1.8 \)

**Rotation speed of the rope drum**

\[
n_{tr} = \frac{n_M}{i_G} = \frac{900 \text{ min}^{-1}}{20} = 45 \text{ min}^{-1}
\]

**Max. drive torque based on installed power**

\[
T_{A_{\text{max}}} = \frac{P_i \cdot 9550 \cdot C_{erf}}{n_{tr}} = \frac{450 \cdot 9550 \cdot 1.8}{45} = 171900 \text{ Nm}
\]

**Max. drive torque based on used power**

\[
P_e = \frac{S_{tr} \cdot V_{tr}}{60000}
\]

\[
S_{tr} = \frac{(m_1 + m_2) \cdot 9.81}{i_r \cdot \eta_r} = \frac{(20000 + 7000) \cdot 9.81}{2 \cdot 0.97} = 136500 \text{ N}
\]

\[
v_{tr} = v_H \cdot i_r = 90 \text{ m/min} \cdot 2 = 180 \text{ m/min}
\]

\[
P_e = \frac{136500 \cdot 180}{60000} = 410 \text{ kW}
\]

\[
T'_{A_{\text{max}}} = \frac{410 \cdot 9550 \cdot 1.8}{45} = 156600 \text{ Nm}
\]

**Chosen drum coupling**

- ABC-V-450
  - \( T_{k_{\text{max}}} = 180000 \text{ Nm} \)
  - \( F_{r_{\text{max}}} = 150000 \text{ N} \)

**Max. radial load**

\[
F_{r_{\text{max}}} = \frac{S_{tr}}{2} + \frac{m_{tr} \cdot 9.81}{2} = \frac{136500}{2} + \frac{3000 \cdot 9.81}{2} = 83000 \text{ N}
\]

\[
T'_{A_{\text{max}}} = 156600 \text{ Nm} \leq T_{k_{\text{max}}} = 180000 \text{ Nm}
\]

\[
T'_{A_{\text{max}}} = 156600 \text{ Nm} \leq T_{k_{\text{max}}} = 180000 \text{ Nm}
\]
The material of the drum flange should have a min. yield strength of 320 N/mm². We recommend the use of screws in accordance with DIN931, 933 with strength class 10.9 with washers in accordance with DIN125-300HV or screws in accordance with DIN6914 with high tensile washers in accordance with DIN6916 for attaching the SIBRE drum coupling to the rope drum. Screws in accordance with DIN912 with strength class 8.8 are to be used as cover screws.

Table 4

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Hole pattern size 280-420
Hole pattern size 450-530

Hole pattern size 545-730
Hole pattern size 800-860

Drawing 8
The given values are valid for drillings in accordance with DIN6885-1. In principle every feather key connection must be checked for surface pressure.

Feather keyways in accordance with BS 46, ANSI B17.1 or other standards are also possible. We request consultation for other connection methods such as involute splines in accordance with DIN5480.

### Table 5 key ways in accordance with DIN 6885 part 1

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### Table 5 key ways in accordance with DIN 6885 part 1

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SPECIAL MODELS

ABC-AZ

ABC-B

ABC-AS

Drawing 10

Drawing 11

Drawing 12
WEAR DISPLAY

The wear display serves to detect the wear at the gearing. With increasing wear the wear cam will cover the wear groove more and more caused by the torsion of the coupling hub in relation to the housing. If the wear cam is centrically covered, the max. wear is reached and the drum coupling has to be replaced.

The layout of the wear display simplifies a lateral check. The max. permitted wear is shown in Table 6. In applications with two load directions the max. permitted wear has to be halved. This must be indicated during ordering so that the appropriate wear grooves are produced.

Table 6 coupling wear

<table>
<thead>
<tr>
<th>Coupling size</th>
<th>Max. permitted wear</th>
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<tr>
<td>280-400</td>
<td>6 mm</td>
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<td>420-860</td>
<td>8 mm</td>
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