5 Guidelines for Gear Unit Selection

5.1 Additional documentation

In addition to the information in this catalog, SEW-EURODRIVE offers extensive documentation covering the entire topic of electrical drive engineering. This is primarily documentation from the “Drive Engineering - Practical Implementation” series. You can order the latest documentation from SEW-EURODRIVE. The documentation can also be downloaded in PDF from the SEW-EURODRIVE homepage (http://www.sew-eurodrive.com).

The publication "Drive Engineering - Practical Implementation – Drive Selection with SEW-EURODRIVE Gearmotors" features extensive information on characteristics, differentiating features and application areas of SEW drives. A comprehensive collection and assignment of the most important formulae for drive calculation as well as detailed examples for the most frequently used applications make this documentation an important tool for project planning and an essential addition to SEW-EURODRIVE product catalogs.
5.2 Project planning procedure

The following flow diagram illustrates the project planning procedure for a planetary gear unit.

Inquiry

Step 1
Completing the drive selection sheet

Step 2
Calculating the basic data
\( M_{K2}, n_2, P_{K2}, i, \eta \)

Step 3
Selecting the application factors
\( F_{\text{min}}, F, F_{\text{Start}} \)

Step 4
Calculating the required rated gear unit torque
\( M_{N2} \)

Step 5
Selecting the planetary stage
\( M_{N2} \)

Step 6
Selecting the motor power rating
\( P_{M} \)

Step 7
Selecting the combination with gearmotor of the “7 Series” / checking \( M_{N2,\text{ex}} \)

Step 8
Checking the peak load conditions
\( M_{K2,\text{max}} < M_{K2,\text{zul}} \)

Step 9
Checking external additional forces

Step 10
Checking the thermal rating

Step 11
Selecting the lubricant

Step 12
Selecting the accessories

Step 13
Technical information for quotation
Step 1: Drive selection data:

1.0 Machine on LSS (normally the driven machine)

Legend: [...] = fill in values
[X] = make your selections by ☑

1.1 Field of application/industry [...] 

1.2 Application [...] 

1.3 Ambient temperature [°C] [...] 

1.4 Altitude [m] [...] 

1.5 Installation [X] 

- small rooms \( (v \geq 0.5 \text{ m/s}) \)
- large rooms and halls \( (v \geq 1.4 \text{ m/s}) \)
- outdoors with protection from the sun \( (v \geq 3 \text{ m/s}) \)

1.6 Ambient conditions [X] 

- normal
- dusty
- moist
- corrosive
- dry

2.0 Load characteristics

2.1 Required speed \( n_2 \) [(1/min)] [...] 

2.2 Input power \( P_{K1} \) [kW] [...] 

2.3 Output torque \( M_{K2} \) [kNm] [...] 

2.4 Frequency of peak load \( M_{K2,\text{max}} \) or \( P_{K1,\text{max}} \) [per hour] 

2.5 Number of starts per hour [...] 

2.6 Rotation direction under load (LSS) [X] 

- clockwise (CW)
- counter-clockwise (CCW)
- both directions
- reversible

2.7 Operating period/day [X] 

- ≤ 3 hours
- 3 ... 10 hours
- > 10 hours

2.8 Backstop required in gear unit [X] 

- No
- Yes

2.9 Exact load cycle attached [X] 

- No
- Yes

3.0 Machine on HSS (normally the driving machine)

3.1 Type: [X] 

- AC motor
- AC motor/inverter
- DC motor
- Hydraulic motor
- Servomotor

3.2 Motor power \( P_m \) [kW] [...] 

3.3 Motor speed \( n_m \) [1/min] [...] 

3.4 Motor torque \( M_m \) [kNm] [...] 

3.5 Input speed \( n_1 \) [1/min] [...] 

3.6 If electric motor: [X] [...] 

- IEC
- NEMA

Motor size (IEC- or NEMA code): 

3.7 Mounting of motor [X] [...] 

- B3
- B5
- V1
- other:

4.0 Gear unit requirements

4.1 Gear Unit Type [X] 

- Inline P. RF..
- Right-Angle P.KF..
Project planning procedure

4.2 Mounting position [X]
- M1
- M2
- M3
- M4
- M5
- M6

4.3 Mounting positions for primary stage RF/KF gearmotors [X]
- 0°
- 90°
- 180°
- 270°

4.4 Position of motor terminal box and cable entry [X]
- 0° (R)
- 90° (B)
- 180° (L)
- 270° (T)
- X
- 1
- 2
- 3
4.6 Service factor requirements $F_{S_{\text{min}}}$ [X] [...] 
- On motor power $P_{M}$ / motor torque $M_{M}$
- On operating power at LSS $P_{K2}$ / operating torque at LSS $M_{K2}$

4.7 Required bearing life $L_{h_{\text{min}}}$ [...] hours

4.8 Mounting of gear unit housing [X]
- Foot
- Flange
- Torque arm

4.9 LSS connection to customer machine shaft [X] [...] 
- Elastic coupling (claw or pin type)
- Flexible coupling
- Rigid flange coupling
- Barrel coupling
- Chain sprocket
- Pinion
- Hollow shaft - torque arm
- Hollow shaft - foot-mounted
- Hollow shaft - flange-mounted
- Other

4.10 LSS gear unit design [X] [...] 
- LSS design (if solid shaft)
  - Solid shaft with key
  - Solid shaft without keyway
  - Solid shaft with spline DIN 5480
  - Other
- LSS connection (if hollow shaft)
  - Hollow shaft with keyway
  - Hollow shaft for shrink disk connection, shrink disk included
  - Hollow shaft with spline DIN 5480
  - Other

4.11 HSS connection to motor [X]
- Customer installation (foundation base frame)
- Motor adapter with elastic coupling
- Swing base/base frame
- Motor bracket with V-belt drive
- Motor scoop
- Other, see sketch

4.12 Machine shaft bearing
- 2 bearings, gear unit only transmits torque
- 1 bearing opposite to gear unit, gear unit acts as bearing support
- 1 bearing next to gear unit, gear unit acts as bearing support

4.13 Loads on LSS [X] [...] 
- Axial load $F_{A2}$ [N] normal min. max.
- Radial load $F_{R2}$ [N] normal min. max.
- Distance from shaft shoulder $X$ [mm] normal min. max.
- Application angle of radial load $\alpha$ [°] or rotating

4.14 Machine shaft [X] [...] 
- Pinion

4.15 Electrical supply [X] [...] 
- Line voltage $V_{\text{line}}$
  - 3-phase AC
  - 1-phase AC
  - DC
- Auxiliary voltage $V_{\text{aux}}$
  - 3-phase AC
  - 1-phase AC
  - DC
- Degree of protection IP
- Explosions protection required Yes
  - No

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### Step 2: Calculating the basic data - $M_{K2}$, $n_2$, $i$, $\eta$

#### Constant torque

\[
M_{K2} = \frac{PK_1 \times 9550 \times \eta}{n_2} \quad \text{[Nm]}
\]

Comment: If $PK_1$ is not known → $PK_1 = P_M$

- $M_{K2}$ = Required output torque [Nm]
- $PK_1$ = Required operating power on HSS [kW]
- $n_2$ = Output speed (LSS) rpm

#### Equivalent torque with load spectrum and constant Speed $n_2$

\[
M_{K2\text{equiv}} = \sqrt{\sum (M_{K2i})^{6.6} \times \frac{t_i}{\Sigma t_N} + (M_{K2ii})^{6.6} \times \frac{t_{ii}}{\Sigma t_N} + \ldots + (M_{K2n})^{6.6} \times \frac{t_n}{\Sigma t_N}}
\]

The following figure shows a load example:

- $M_{K2}$ = Operating torque on LSS [Nm]
- $t_i$ = Time slice of the load
- $I$, $II$, $III$, $IV$ = Types of load

\[
\frac{t_i}{\Sigma t_N} = \frac{t_i}{\Sigma t_N} = \text{Time slice of the load}
\]

#### Gear ratio

\[
i = \frac{n_1}{n_2}
\]

- $n_1$ = Input speed (HSS) rpm
- $n_2$ = Output speed (LSS) rpm

#### Efficiency $\eta$

\[
h = f(i; \text{gear unit type})
\]

The efficiency of the gear unit is mainly determined by the gearing and bearing friction as well by churning losses. For the calculation, a reference value of 98% is used.
Step 3: Select the application factors

Application-specific service factor \( F_{S \text{ min}} \)
Peak load factor \( F_F \) see page 52
Startup factor \( F_{\text{Start}} \) see page 52

The application-specific service factor \( F_s \) considers the typical load behavior with regard to the drive machine.

Recommended values with reference to:
- Field of application
- Type of driven machine
- Operating time / day

are given in the following table.

INFORMATION

These tables apply only to gear units driven by electric motors. For other types of drive motors, the following correction values apply:
- Combustion engines with four or more cylinders:
  - \( F_{S \text{ min}} \) (selection table) + 0.25

- Combustion engines with one to three cylinders:
  \( F_{S \text{ min}} \) (selection table) + 0.5

INFORMATION

In the event of deviations from the typical load behavior, please consult SEW-EURODRIVE.
### Guidelines for Gear Unit Selection

**Project planning procedure**

#### Guideline for Gear Unit Selection

<table>
<thead>
<tr>
<th>Field of application</th>
<th>Type of application (driven machine)</th>
<th>Application-specific service factor $F_{S_{\text{min}}}$ Operating period / day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt; 3 h</td>
</tr>
<tr>
<td>Waste water treatment</td>
<td>Impeller aerator</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Thickeners</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>Vacuum filters</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>Collectors</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>Screw pump</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Brush aerators</td>
<td>-</td>
</tr>
<tr>
<td>Mining</td>
<td>Crushers</td>
<td>1.55</td>
</tr>
<tr>
<td></td>
<td>Screens and shakers</td>
<td>1.55</td>
</tr>
<tr>
<td></td>
<td>Slewing drives</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Bucket wheel excavators</td>
<td>1)</td>
</tr>
<tr>
<td>Power</td>
<td>Frequency inverters</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Water wheels (low speed)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Water turbines</td>
<td>-</td>
</tr>
<tr>
<td>Conveyors</td>
<td>Bucket elevators</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Vertical conveyors other</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Belt conveyors ≤ 100 kW</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>Belt conveyors &gt; 100 kW</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>Apron feeders</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Screw feeders</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>Shakers, screens</td>
<td>1.55</td>
</tr>
<tr>
<td></td>
<td>Escalators</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>Passenger elevators</td>
<td>1)</td>
</tr>
<tr>
<td>Rubber and plastic industry</td>
<td>Extruders (plastic)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Extruders (rubber)</td>
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</tr>
<tr>
<td></td>
<td>Rubber rollers (2 in a row)</td>
<td>1.55</td>
</tr>
<tr>
<td></td>
<td>Rubber rollers (3 in a row)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Heated rollers</td>
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</tr>
<tr>
<td></td>
<td>Calender</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Mills</td>
<td>1.55</td>
</tr>
<tr>
<td></td>
<td>Mixing rollers</td>
<td>1)</td>
</tr>
<tr>
<td></td>
<td>Slab rollers</td>
<td>1.55</td>
</tr>
<tr>
<td></td>
<td>Refiners</td>
<td>1.55</td>
</tr>
<tr>
<td></td>
<td>Tire machines</td>
<td>1)</td>
</tr>
<tr>
<td>Timber industry</td>
<td>Timber industry</td>
<td>1)</td>
</tr>
<tr>
<td>Cranes</td>
<td>Cranes and hoists</td>
<td>2)</td>
</tr>
<tr>
<td>Food industry</td>
<td>Crushers and mills</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Beet slicers</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Drying drums</td>
<td>-</td>
</tr>
<tr>
<td>Metal production and processing</td>
<td>Winders</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Cutting rollers</td>
<td>1.55</td>
</tr>
<tr>
<td></td>
<td>Table conveyors, individual drives</td>
<td>1)</td>
</tr>
<tr>
<td></td>
<td>Table conveyors, group drives</td>
<td>1)</td>
</tr>
<tr>
<td></td>
<td>Table conveyors, reciprocating</td>
<td>1)</td>
</tr>
<tr>
<td></td>
<td>Wire drawing machines</td>
<td>1.35</td>
</tr>
<tr>
<td></td>
<td>Rollers</td>
<td>1)</td>
</tr>
<tr>
<td>Field of application</td>
<td>Type of application (driven machine)</td>
<td>Application-specific service factor $F_s$ min Operating period / day</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt; 3 h</td>
</tr>
<tr>
<td>Mills and drums</td>
<td>Cooling and drying drums</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Rotary kilns</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Ball mills</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Coal mills</td>
<td>-</td>
</tr>
<tr>
<td>Pulp and paper industry</td>
<td>Debarking drums and machines</td>
<td>1.55</td>
</tr>
<tr>
<td></td>
<td>Rollers (pick-up, wire drive, wire suction)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Drying cylinders (anti-friction bearings)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Calenders (anti-friction bearings)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Filters (pressure and vacuum)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Beaters and chippers</td>
<td>1.55</td>
</tr>
<tr>
<td></td>
<td>Jordan mills</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Presses (bark, felt, glue, suction)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Reels</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Pulpers</td>
<td>1)</td>
</tr>
<tr>
<td></td>
<td>Washer filters</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Yankee cylinders (dryers)</td>
<td>1)</td>
</tr>
<tr>
<td>Pumps</td>
<td>Centrifugal pumps</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>Reciprocating pumps (single-cylinder)</td>
<td>1.35</td>
</tr>
<tr>
<td></td>
<td>Reciprocating pumps (multi-cylinder)</td>
<td>1.20</td>
</tr>
<tr>
<td></td>
<td>Screw pumps</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Rotary pumps (gear type, vane)</td>
<td>-</td>
</tr>
<tr>
<td>Agitators and mixers</td>
<td>Agitators for liquids</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>Agitators for liquids (variable density)</td>
<td>1.20</td>
</tr>
<tr>
<td></td>
<td>Agitators for solids (non-uniform material)</td>
<td>1.40</td>
</tr>
<tr>
<td></td>
<td>Agitators for solids (uniform material)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Concrete mixers</td>
<td>-</td>
</tr>
<tr>
<td>Cable cars</td>
<td>Material ropeways</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Aerial tramways</td>
<td>1)</td>
</tr>
<tr>
<td></td>
<td>Surfane lifts</td>
<td>1)</td>
</tr>
<tr>
<td></td>
<td>Continuous aerial tramways</td>
<td>1)</td>
</tr>
<tr>
<td></td>
<td>Funicular railways</td>
<td>1)</td>
</tr>
<tr>
<td>Fans</td>
<td>Heat exchangers</td>
<td>1.50</td>
</tr>
<tr>
<td></td>
<td>Dry cooling towers</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Wet cooling towers</td>
<td>2.00</td>
</tr>
<tr>
<td></td>
<td>Blowers (axial and radial)</td>
<td>1.50</td>
</tr>
<tr>
<td>Compressors</td>
<td>Reciprocating compressors</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Radial compressors</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Screw-type compressors</td>
<td>-</td>
</tr>
</tbody>
</table>

1) Consult SEW-EURODRIVE
2) Please contact SEW-EURODRIVE; dimensioning according to FEM1001
**Peak factor \( F_F \)**

The peak load factor \( F_F \) takes account of the overload capacity of the gearing and the rotating parts.

<table>
<thead>
<tr>
<th>Type / size of planetary gear unit</th>
<th>Peak factor - ( F_F )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency of peak load per hour</td>
</tr>
<tr>
<td></td>
<td>1...5</td>
</tr>
<tr>
<td>Output shaft as solid shaft P.002...P.102</td>
<td>1</td>
</tr>
<tr>
<td>Hollow shaft with shrink disk connection P.002</td>
<td>1.25</td>
</tr>
<tr>
<td>Hollow shaft with shrink disk connection P.012...P.102</td>
<td>1.1</td>
</tr>
</tbody>
</table>

**Start factor - \( F_{Start} \)**

The start factor \( F_{Start} \) takes account of the overload caused by startup.

<table>
<thead>
<tr>
<th>Start mode</th>
<th>Start factor - ( F_{Start} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct</td>
<td>3.0</td>
</tr>
<tr>
<td>Soft start</td>
<td>1.8</td>
</tr>
<tr>
<td>Frequency inverter</td>
<td>1.5...2.0(^1)</td>
</tr>
<tr>
<td>Star/delta</td>
<td>1.3</td>
</tr>
<tr>
<td>Hydraulic coupling without delay chamber</td>
<td>2.0</td>
</tr>
<tr>
<td>Hydraulic coupling with delay chamber</td>
<td>1.6</td>
</tr>
</tbody>
</table>

1) Dependent on setting

**Step 4: Calculating the required nominal gear unit torque \( M_{N2} \)**

Constant load direction – constant torque:

\[
M_{N2} \geq M_{K2} \times F_{S\ min} \ [Nm]
\]

- \( M_{N2} \) = Nominal gear unit torque [Nm]
- \( M_{K2} \) = Operating torque at LSS [Nm]
- \( F_{S\ min} \) = Application-specific service factor

Reversing direction of load – constant torque:

\[
M_{N2} \geq M_{K2} \times F_{S\ min} \times 1.43 \ [Nm]
\]

- \( M_{N2} \) = Nominal gear unit torque [Nm]
- \( M_{K2} \) = Operating torque at LSS [Nm]
- \( F_{S\ min} \) = Application-specific service factor
**Step 5: Selecting the planetary gear unit - $M_{N2}$**

The selection is based on $M_{N2}$ according to the table.

<table>
<thead>
<tr>
<th>Size</th>
<th>$M_{N2}$ [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.002</td>
<td>24 830</td>
</tr>
<tr>
<td>P.012</td>
<td>36 810</td>
</tr>
<tr>
<td>P.022</td>
<td>51 190</td>
</tr>
<tr>
<td>P.032</td>
<td>69 620</td>
</tr>
<tr>
<td>P.042</td>
<td>100 170</td>
</tr>
<tr>
<td>P.052</td>
<td>124 060</td>
</tr>
<tr>
<td>P.062</td>
<td>185 660</td>
</tr>
<tr>
<td>P.072</td>
<td>245 660</td>
</tr>
<tr>
<td>P.082</td>
<td>359 400</td>
</tr>
<tr>
<td>P.092</td>
<td>423 000</td>
</tr>
<tr>
<td>P.102</td>
<td>500 000</td>
</tr>
</tbody>
</table>

**Step 6: Selecting the nominal motor power $P_M$**

$$P_M \geq P_{K1} = \frac{P_{K2}}{\eta} [kW]$$

- $P_M$ = Nominal motor power [kW]
- $P_{K1}$ = Operating power on HSS [kW]
- $P_{K2}$ = Operating power on LSS [kW]
- $\eta$ = Efficiency

**Step 7: Selecting the combination with gearmotor**

**Exact gear unit reduction ratio $i_{ex}$**

**Check $M_a$**

<table>
<thead>
<tr>
<th>$P_M$ [kW]</th>
<th>$n_{e}$ [min⁻¹]</th>
<th>$M_a$ [Nm]</th>
<th>$i_{ex}$</th>
<th>$F_{R3}$ [N]</th>
<th>$M_{N2}$ [Nm]</th>
<th>$m$ [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.75</td>
<td>0.44</td>
<td>16200</td>
<td>3197</td>
<td>124000</td>
<td>24830</td>
<td>285</td>
</tr>
<tr>
<td>0.46</td>
<td>15300</td>
<td>3018</td>
<td>24830</td>
<td>0.54</td>
<td>13000</td>
<td>285</td>
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<tr>
<td>0.54</td>
<td>13000</td>
<td>2570</td>
<td>124000</td>
<td>0.62</td>
<td>11400</td>
<td>285</td>
</tr>
<tr>
<td>0.62</td>
<td>11400</td>
<td>2254</td>
<td>124000</td>
<td>0.69</td>
<td>10300</td>
<td>285</td>
</tr>
<tr>
<td>0.69</td>
<td>10300</td>
<td>2035</td>
<td>124000</td>
<td>0.78</td>
<td>9070</td>
<td>285</td>
</tr>
<tr>
<td>0.78</td>
<td>9070</td>
<td>1790</td>
<td>124000</td>
<td>0.83</td>
<td>8560</td>
<td>285</td>
</tr>
<tr>
<td>0.83</td>
<td>8560</td>
<td>1691</td>
<td>124000</td>
<td>0.97</td>
<td>7290</td>
<td>285</td>
</tr>
</tbody>
</table>

[1] see $P_M$ and planetary stage

[2] see selection of the gearmotor / $n_2$ / gear ratio $i_{ex}$

[3] see $M_a > M_{K2}$
Guidelines for Gear Unit Selection
Project planning procedure

Step 8: Checking the peak load conditions - $M_{K2 \text{ zul}}; M_{K2 \text{ max}}$

Permitted peak output torque $M_{K2 \text{ zul}}$:

$$M_{K2 \text{ zul}} = \frac{2 \times M_{N2}}{F_F} \text{ [kNm]}$$

- $M_{K2 \text{ zul}}$ = Permitted peak output torque [Nm]
- $M_{N2}$ = Nominal gear unit torque [Nm]
- $F_F$ = Peak load factor

Calculate the peak load $M_{K2 \text{ max}}$:

$$M_{K2 \text{ max}} = M_a \times F_{\text{Start}} \text{ [Nm]}$$

- $M_{K2 \text{ max}}$ = Peak output torque [Nm]
- $M_a$ = Output torque in relation to motor power [Nm]
- $F_{\text{Start}}$ = Startup factor

* If $F_{\text{Start}}$ is not specified, take account of the start factors according to the table page 52.

Check the gear unit selection:

$$M_{K2 \text{ max}} \leq M_{K2 \text{ zul}}$$

Step 9: Check the external additional forces

Influences and dependencies:

- The permitted additional forces depend on the following factors:
  - Existing service factor of the gear unit with respect to the selection data
  - Required bearing life
  - Direction of the axial load (from or towards gear unit)
  - Application angle of the radial force (rotating or at a specific position)
  - Point of force application
  - Ratio between radial and axial force
  - Gear unit mounting
**Determining the overhung load**

An important factor for determining the resulting overhung load is the type of transmission element mounted to the shaft end. The following transmission element factors $f_Z$ must be considered for various transmission elements.

<table>
<thead>
<tr>
<th>Transmission element</th>
<th>Transmission element factor $f_Z$</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gears</td>
<td>1.15</td>
<td>&lt; 17 teeth</td>
</tr>
<tr>
<td>Chain sprockets</td>
<td>1.40</td>
<td>&lt; 13 teeth</td>
</tr>
<tr>
<td>Chain sprockets</td>
<td>1.25</td>
<td>&lt; 20 teeth</td>
</tr>
<tr>
<td>Narrow V-belt pulleys</td>
<td>1.75</td>
<td>Influence of the pre-tensioning</td>
</tr>
<tr>
<td>Flat-belt pulleys</td>
<td>2.50</td>
<td>Influence of the pre-tensioning</td>
</tr>
<tr>
<td>Toothed belt pulleys</td>
<td>1.50</td>
<td>Influence of the pre-tensioning</td>
</tr>
</tbody>
</table>

The overhung load exerted on the motor or gear shaft is calculated as follows:

$$ F_R = \frac{M_d \times 2000}{d_0} \times f_z \ [N] $$

- $F_R$ = Overhung load [N]
- $M_d$ = Torque [Nm]
- $d_0$ = Mean diameter of the installed transmission element [mm]
- $f_z$ = Transmission element factor

**Permitted overhung load**

The basis for determining the permitted overhung loads in the roller bearing calculation is the nominal bearing service life $L_{H10}$ (according to ISO 281).

For special operating conditions, the permitted overhung loads can be determined with regard to the modified service life $L_{na}$ on request.

**Permitted overhung loads on the output**

The permitted overhung loads $F_{ZR \text{zul}}$ for solid shaft gear units can be calculated exactly. The force values relate to the force application in the middle of the shaft end for solid shafts and to the gear unit flange contact point for hollow shafts. In planetary gear units, the force application angle and direction of rotation do not influence the permitted values as there are no inner forces from the gear unit acting on the output bearing.

**Permitted overhung loads and axial loads on the input**

All the possibilities and restrictions specified in the SEW "Gearmotors" catalog apply.
Guidelines for Gear Unit Selection
Project planning procedure

Checking the permitted overhung load on the output

The permitted overhung load $F_R$ on the center of the shaft end is checked according to the following table. The load is permitted if $F_{R\text{ zul}} \geq F_R$.

Permitted overhung loads for solid shafts:

The values apply to force application to the middle of the shaft end and an output speed of $n = 10$ rpm.

<table>
<thead>
<tr>
<th>Size P</th>
<th>002</th>
<th>012</th>
<th>022</th>
<th>032</th>
<th>042</th>
<th>052</th>
<th>062</th>
<th>072</th>
<th>082</th>
<th>092</th>
<th>102</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_{R\text{ zul}}$ [kN]</td>
<td>96</td>
<td>134</td>
<td>183</td>
<td>194</td>
<td>249</td>
<td>280</td>
<td>364</td>
<td>403</td>
<td>526</td>
<td>580</td>
<td>680</td>
</tr>
</tbody>
</table>

Calculating $F_{R\text{ zul}}$ [N] for different output speeds $n^*$ (rpm)

$$ F_{R\text{ zul}}^* = F_{R\text{ zul}} \times \left( \frac{10}{n^*} \right) \left( \frac{1}{3.33} \right) \leq F_{R\text{ max}}$$

- $F_{R\text{ zul}}^*$ = Permitted overhung load [N] for different output speed
- $F_{R\text{ zul}}$ = Permitted overhung load [N]
- $F_{R\text{ max}}$ = Maximum overhung load [N] (see following table)
- $n^*$ = differing output speed [rpm]

<table>
<thead>
<tr>
<th>Size P</th>
<th>002</th>
<th>012</th>
<th>022</th>
<th>032</th>
<th>042</th>
<th>052</th>
<th>062</th>
<th>072</th>
<th>082</th>
<th>092</th>
<th>102</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_{R\text{ max}}$ [kN]</td>
<td>124</td>
<td>156</td>
<td>197</td>
<td>252</td>
<td>323</td>
<td>364</td>
<td>473</td>
<td>523</td>
<td>683</td>
<td>720</td>
<td>850</td>
</tr>
</tbody>
</table>

Note

$F_R \leq F_{R\text{ zul}}^* \leq F_{R\text{ max}}$

However, if $F_{R\text{ zul}}^* > F_{R\text{ max}}$, you have to check: $F_R \leq F_{R\text{ max}}$
Conversion of permitted overhung load on the output for force application away from the middle of the shaft end

Calculating the off-center force application:

\[
F_{R_{zul}}(x) = F_{R_{zul}} \times \frac{(a + b)}{(a + b^*)} \leq F_{R_{max}} [N]
\]

\[
b^* = (b - l/2) + x [\text{mm}]
\]

\[
F_{R_{zul}}(x) = \text{Permitted overhung load [N] of the off-centre force application}
\]

\[
F_{R_{zul}} = \text{Permitted overhung load [N]}
\]

\[
F_{R_{max}} = \text{Maximum overhung load [N]}
\]

**Note**

\[
F_{R} \leq F_{R_{zul}}(x) \leq F_{R_{max}}
\]

However, if \( F_{R_{zul}}(x) > F_{R_{max}} \), you will have to check: \( F_{R} \leq F_{R_{max}} \)

**Permitted axial force**

The permitted axial force is 20% of the effective radial force.

**INFORMATION**

- Please consult SEW-EURODRIVE if you use the PH.. variant subject to overhung loads, or the PHF.. variant with flange mounting.
- Please contact SEW-EURODRIVE if a purely axial force is applied.
Step 10: Checking the thermal rating / heating

**INFORMATION**

For the following operating conditions:
- High ambient temperatures (above 45 °C)
- Vertical mounting position and/or motor speed over 1800 rpm

please contact SEW-EURODRIVE.

Step 11: Selecting the lubricant

Lubricants can be chosen according to the lubricant table (see page 65).

Output speeds $n_2 < 1.0$ rpm:
We recommend using MOBIL SHC XMP 460 synthetic lubricant in conjunction with Viton oil seals to ensure lubricating properties at low output speeds.

Step 12: Technical specifications

```
P H F 042 /... KF107DRE160M4
```

- Primary gearmotor
- Planetary gear unit accessories:
  - $T =$ Torque arm on one side
- Size of planetary gear unit:
  - 002 ... 102
- Planetary gear unit installation:
  - $F =$ Flange-mounted
- Output shaft type [LSS]
  - $H =$ Hollow shaft with shrink disk
- Planetary gear unit
5.3 Selection example

Step 1: Drive selection data

- Application: Apron feeders
- Bevel-helical planetary gear unit
- Hollow shaft with shrink disk and torque arm
- Required output speed $n_2 = 1.5$ rpm
- Required output power at LSS $P_{K2} = 10$ kW
- Motor 4-pole/50 Hz in star/delta connection
- Operating period: 24 hours a day
- Cyclic duration factor: 100 % cdf, 10 starts per hour
- Outdoors, dusty environment
- Ambient temperature = 0 °C...40 °C
- Installation altitude $H = 10$ m
- No axial or radial forces acting on the output shaft
Guidelines for Gear Unit Selection

Selection example

**Step 2: Calculating the basic data** $M_{K2}$, $i$, $\eta$

Output torque on LSS:

$$M_{K2} = \frac{P_{K2} \times 9550}{n_2} \quad [Nm]$$

- $M_{K2}$ = Operating torque at LSS [Nm]
- $P_{K2}$ = Operating power on LSS [kW]
- $n_2$ = Output speed (LSS) [rpm]

$$M_{K2} = \frac{10 \times 9550}{1.5} = 63667 \text{ Nm}$$

Required reduction ratio:

$$i = \frac{n_1}{n_2} = \frac{1440}{1.5} = 960$$

- $n_1$ = Input speed (HSS) [rpm]
- $n_2$ = Output speed (LSS) [rpm]

Efficiency:

$$\eta = 0.98 \text{ (page 48)}$$

**Step 3: Selecting the application factors** $F_{S \text{ min}}$, $F_P$, $F_{\text{Start}}$

- **Application-specific service factor** $F_{S \text{ min}}$
  Application: Apron feeder $t > 10$ h $\rightarrow F_{S \text{ min}} = 1.5$ (page 49)

- **Peak load factor** $F_P$
  Hollow shaft with shrink disk
  Load per hour = 1...5 $\rightarrow F_P = 1.2$ (page 52)

- **Start factor** $F_{\text{Start}}$
  Motor in star/delta $\rightarrow F_{\text{Start}} = 1.3$ (page 52)

**Step 4: Calculating the required nominal output torque** $M_{N2}$

Constant direction of the load - constant torque:

$$M_{N2} \geq M_{K2} \times F_{S \text{ min}} = 63667 \times 1.5 = 95500 \text{ Nm}$$

- $M_{N2}$ = Nominal torque [Nm]
- $M_{K2}$ = Operating torque at LSS [Nm]
- $F_{S \text{ min}}$ = Application-specific service factor
Guidelines for Gear Unit Selection
Selection example

Step 5: Selecting the planetary gear unit size $M_{N2}$

PHF 042 $\rightarrow M_{N2} = 100170$ [Nm]

<table>
<thead>
<tr>
<th>Size</th>
<th>$M_{N2}$ [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.002</td>
<td>24 830</td>
</tr>
<tr>
<td>P.012</td>
<td>36 810</td>
</tr>
<tr>
<td>P.022</td>
<td>51 190</td>
</tr>
<tr>
<td>P.032</td>
<td>69 620</td>
</tr>
<tr>
<td>P.042</td>
<td>100 170</td>
</tr>
<tr>
<td>P.052</td>
<td>124 060</td>
</tr>
<tr>
<td>P.062</td>
<td>185 660</td>
</tr>
<tr>
<td>P.072</td>
<td>245 660</td>
</tr>
<tr>
<td>P.082</td>
<td>359 400</td>
</tr>
<tr>
<td>P.092</td>
<td>423 000</td>
</tr>
<tr>
<td>P.102</td>
<td>500 000</td>
</tr>
</tbody>
</table>

Step 6: Selecting the motor power $P_M$

$$P_M \geq P_{K2} = \frac{P_{K2}}{\eta} = \frac{10}{0.98} = 10.2 \text{ [kW]}$$

$P_M$ = Nominal motor power [kW]
$P_{K2}$ = Operating power on LSS [kW]

Motor selection $\rightarrow P_M = 11$ [kW]

Step 7: Selecting the combination with gearmotor

<table>
<thead>
<tr>
<th>$P_M$ [kW]</th>
<th>$n_2$ [min$^{-1}$]</th>
<th>$M_a$ [Nm]</th>
<th>$i_{ex}$</th>
<th>$F_{Ra}$ [N]</th>
<th>$M_{N2}$ [Nm]</th>
<th>$m$ [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.0</td>
<td>1.2</td>
<td>86100</td>
<td>1209</td>
<td>308900</td>
<td>100170</td>
<td>[P]</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>69100</td>
<td>971</td>
<td>322500</td>
<td>100170</td>
<td>[PF]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>[PH]</td>
</tr>
</tbody>
</table>

[1] PHF042 KF97 042KF97 DRS 160M4 1050
[2] PHF042 KF97 042KF97 DRS 160M4 860
[3] PHF042 KF97 042KF97 DRS 160M4 1060

[1+2] Combination selection: PHF042 KF97 DRS 160M4
[3] Checking the output torque: $M_a = 69100$ Nm $> M_{K2} = 56026$ Nm $\rightarrow$ ok
[4] Exact gear ratio: $i_{ex} = 971$ (required $\geq 960 \rightarrow$ ok)
Step 8: Checking the peak load conditions $M_{K2\, \text{max}} < M_{K2\, \text{zul}}$

Permitted peak output torque $M_{K2\, \text{zul}}$:

$$M_{K2\, \text{zul}} = \frac{2 \times M_{N2}}{F_F} = \frac{2 \times 100.170}{1.2} = 166950 \, \text{Nm}$$

$M_{K2\, \text{zul}}$ = Permitted peak output torque [Nm]
$M_{N2}$ = Nominal gear unit torque [Nm]
$F_F$ = Peak load factor

Calculate the peak load $M_{K2\, \text{max}}$:

$$M_{K2\, \text{max}} = M_a \times F_{\text{Start}} = 69100 \times 1.3 \, \text{[Nm]} = 89830 \, \text{[Nm]}$$

$M_{K2\, \text{max}}$ = Peak output torque [Nm]
$M_a$ = Output torque in relation to the motor power [Nm]
$F_{\text{Start}}$ = Startup factor

$M_{K2\, \text{max}} < M_{K2\, \text{zul}} \rightarrow \text{OK}$

$M_{K2\, \text{max}}$ = Peak output torque
$M_{K2\, \text{zul}}$ = Permitted peak output torque

Step 9: Check the external additional forces

There are no overhung loads or axial forces in this case $\rightarrow \text{OK}$

Step 10: Checking the thermal rating / heating

The ambient temperature is below 45 °C
Horizontal mounting position
$\rightarrow$ Thermal limit rating OK

Step 11: Selecting the lubricant:

As $n_2 = 1.5 \, \text{rpm}$ ($n_2 > 1.0 \, \text{rpm}$), you can choose the lubricants according to the lubricant table (see chapter 6.2).
Step 12: Technical specification:

P H F 042 / T KF97DRS160M4

Primary gearmotor

Planetary gear unit accessories:
T = Torque arm

Size of planetary gear unit:
042

Planetary gear unit installation:
F = Flange-mounted

Output shaft type [LSS]
H = Hollow shaft with shrink disk

With labyrinth seal on the output shaft