1. Temperature

1.1 Cooling system

The ambient air is used as the coolant (indirect ventilation). Its temperature must be under 40°C and the installation location of the drive must not be over 1000 m without using a special design.

1.2 Excess temperature of the winding

Heat occurs in the motor mainly in the winding. In addition to the maximal permitted output temperature of 40°C listed under 1.1, a so-called excess temperature is normally permitted for the winding. The excess temperature is calculated from the measured resistance change of the winding wire. (EN 60034-1, main section 7)

1.3 Insulation

The insulation material used to insulate the winding is divided into temperature classes according to EN 60034.

Table 9.10 Heating (ΔT) and maximum temperatures on the hottest point of the winding (Tmax) according to the temperature classes of Norm IEC 34-1

<table>
<thead>
<tr>
<th>Insulation mat.</th>
<th>ΔT According to the resistance method</th>
<th>Tmax With a cooling temperature of 40°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class B</td>
<td>80 °K</td>
<td>125 °C</td>
</tr>
<tr>
<td>Class F</td>
<td>105 °K</td>
<td>155 °C</td>
</tr>
<tr>
<td>Class H</td>
<td>125 °K</td>
<td>180 °C</td>
</tr>
</tbody>
</table>

As a rule, Gefeg-Neckar motors are designed with an insulation from the temperature class B; some of the series are optionally available with the temperature classes F and H. Information can be found in the individual data sheets.

2. Operating modes

An exact definition of the operating mode is necessary to guarantee that the temperature limits listed under point 1 are not exceeded. For this reason, the thermal steady conditions and final condition are defined so that the excess temperature Δϑ during an operating hour can change a maximum of 2°C.

The following operating modes are differentiated:

2.1 Continuous operation S 1

An operation with constant load, whose duration is sufficient to reach the thermal steady conditions.

Our motors are principally designed for continuous operation S1. This is also the nominal operation.

2.2 Short time operation S 2

An operation with constant load, whose duration is not sufficient to reach the thermal steady condition, with a following pause with a duration, where the lowered machine temperature deviates less than 2°C from the temperature of the coolant.

2.3 Intermittent operation S 3

An operation made up of a series of periodic duties, each of which consisting of a time with constant load and a pause. The starting current does not noticeably effect the temperature rise.

2.4 Intermittent operation with influence on the starting operation S 4

An operation made up of a series of similar cycles, each of which consisting of a noticeable starting time, a time with constant load and a pause. (EN 60034-1, main section 4)

3. Power supply

AC motors are designed for practical sinusoidal and symmetrical currents. Because of the over-lapping alternating currents, DC motors, which are fed using an electronic power converter, require a smoothing reactor to reduce the loss and improve the commutation. (see thyristor regulator).

3.1 Voltage fluctuations

The tolerance is set at + 6%–10% for 230/400 V alternating currents.

When operating with the tolerance values, the motors may exceed the middle limit temperature up to 10°C.

3.2 High-voltage test

The high-voltage test for voltage resistance is already carried out during the production flow. The last high-voltage test takes place during the final test just before shipping. The corresponding values are documented. If an additional high-voltage test is requested by the customer, it will be carried out with only 80% voltage.

4. EMC-Regulations

To harmonize the regulations within the EU, the EMC test (electro-magnetic compatibility) was standardized as of 1.1.96. Accordingly, electric devices which do not conform to the named regulations may not be operated.

The K, D, Es, Eg, M and Dg series small motors do not generally require an interference suppressor.

If needed, the G, Pg and PM series commutator motors can be delivered with an interference suppression, whose extent is to be agreed upon.

We recommend that you check the device in its entirety according to the individual regulations.
5. Noise level
(measuring surfaces, sound level)

Measuring with a microphone distance of 1 m is problematic with small motors and small gear motors and imprecise because of the low noise level. The factory test takes place by appointment in a sound absorbing housing with a microphone distance of 30 cm vertical to the motor shaft. The results at a distance of 1 m can be calculated from these results. The measurement is taken following a weighting curve dB (A). The noise performance of a motor is dependent on diverse influences, such as:
– Bearing, lubrication, fit,
– Mechanical and electro-magnetic imbalance,
– Precision of the individual parts,
– Care in installation,
– Capacitor, especially the rotational direction reversal,
– Relation to the environment (structure-borne noise radiation),
– Resonance creation, etc.
In gear motors, an additional hobbing noise from the gear meshing can be heard.
Reference points as average values for our motors and gear motors are listed in the following table. Other factors come into play during operating condition. A check in the device is always required. The overview at hand should only act as a reference when evaluating a drive system.
These values can be reduced with a special agreement.
(See EN 60034 part 1, chapter 54)

6. Protection classes

Protection classes for the housing of rotating electr. machines are defined in section 5 of EN 60034. (The protection type is not meant for sealing the shaft!) The protection type is defined by the code letters IP in addition to two code numbers. (see table)

<table>
<thead>
<tr>
<th>First letter</th>
<th>Protection against electric shock and foreign matter</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No protection</td>
</tr>
<tr>
<td>1</td>
<td>Protection against large foreign matter (Ø larger than 50 mm)</td>
</tr>
<tr>
<td>2</td>
<td>Protection against average foreign matter (Ø larger than 12 mm)</td>
</tr>
<tr>
<td>3</td>
<td>Protection against small foreign matter (Ø larger than 2.5 mm)</td>
</tr>
<tr>
<td>4</td>
<td>Protection against grain sized foreign matter (Ø larger than 1 mm)</td>
</tr>
<tr>
<td>5</td>
<td>Protection against large damaging dust deposits</td>
</tr>
<tr>
<td>6</td>
<td>Protection against dust penetration</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Second number</th>
<th>Water protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No protection</td>
</tr>
<tr>
<td>1</td>
<td>Protection against vertically dripping water (from vertical to 15°)</td>
</tr>
<tr>
<td>2</td>
<td>Protection against diagonally dripping water (from vertical to 60°)</td>
</tr>
<tr>
<td>3</td>
<td>Protection against jetting water (from all directions)</td>
</tr>
<tr>
<td>4</td>
<td>Protection against flooding</td>
</tr>
<tr>
<td>5</td>
<td>Protection against the results of immersion</td>
</tr>
<tr>
<td>6</td>
<td>Protection against the results of submersion</td>
</tr>
</tbody>
</table>

Example IP 54

Code letter  
First number  
Second number  
Motor is protected from dust and spray water.


Drive design

Depending on the operational degree of difficulty, the correct drive design can require more or less effort (consultation, prototype, measurements, etc.).

In complex cases, you can simplify the consultation phase by first answering the following questions:

1. **What type of power supply(s) are available?**
The motor design with its specific pros and cons can be generally determined by the power supply. We differentiate the following designs with the corresponding power supplies:

   1.1 **Capacitor motors**
      - 1-phase power supply with an operating capacitor
      - 1-phase power supply with a frequency converter

   1.2 **AC motors**
      - 3-phase power supply
      - 1-phase power supply with a frequency converter (3-phase output, here a different winding)

   1.3 **DC motors**
      - 1-phase power supply with a transformer and rectifier bridge
      - 1-phase power supply and power pack
      - 1-phase power supply and control/regulator

   1.4 **Brushless DC motors and servo-motors**
      - 1-phase power supply with a transformer and regulator
      - Direct current voltage

   1.5 **AC/DC motors**
      - 1-phase power supply

   1.6 **Repulsion motors**
      - 1-phase power supply

2. **Can you give the power requirements of your machine as the speed function?**
The more precise your power profile, the more exact the dimensions of the corresponding drive can be given.

Possible problems could be:
- Starting behavior
- Acceleration power
- Precision in maintaining the speed
- Peak powers (can be up to 5 times the nominal power)

3. **What operating modes are available?**
The operating mode is determined by the power output during the timed sequence of the motor (definition see page T-04). It has a crucial influence on the service life and installation size of the drive. What is important here is knowing the average cyclic duration factor during short-time operation and the number of rotational direction reversals during continuous operation. The general rule applies: the more precise the timed dependency of the speed and torque are known, the more exact the dimensions of the corresponding drive can be given.

4. **What kind of service life do you expect from the drive system?**
Brushless DC motors and asynchronous motors have a higher service life and in this way are superior to the commutator DC motors. As a rough estimate, between 20,000 and 40,000 operating hours can be reached. Commutator DC drives reach more than 5,000 operating hours, depending on the type of operation. Operating and environmental conditions, however, can cause a drastic reduction in the service life.

5. **In what type of environment will the drive be used?**

   5.1. Of primary importance are the cooling conditions. What type of coolant (generally air), environmental temperature, inhibited or aided convection (blower), free or inhibited heat radiation, thermal conduction, contact with hot spots (flange), hot surfaces. These points are of great importance when determining the maximum motor output.

   5.2. The necessary protection against dust and water is given according to the environmental conditions, as shown in the table on page T-02. It is important that the outlet shaft is not impeded by the protection. The terminal boxes and connectors often have a much higher protection.

5.3. In some cases, it is important to know the installation position, as well as the location of the connecting cables and connectors.

6. **Is a thermal protection necessary?**
When the drive is operated close to the permitted limit temperature, the use of thermal protection is recommended. In this case, two measures can be considered:

   6.1. **Use of a PTC resistor (Tk)**
   This must be placed inside insulated in the winding. The temperature dependent PTC resistance must be calculated by an external electronic circuit, therefore it offers no inherent protection.

   6.2. **Installation of a thermocouple (Th)**
The thermocouple is also placed insulated in the winding. This thermocouple is designed as either an on or an off switch. When not prescribed, the installation is carried out as an off switch with a switching power of:

   - 250 V, 2.5 A at cos ϕ = 1
   - 1.6 A at cos ϕ = 0.6

   In a single-phase AC voltage, the switching occurs directly in the main phase. When the prescribed temperature is reached, the thermocouple turns the motor off.

   There are two variations available:
   - Re-starting when cooled down
   - Re-starting only after separation from the power supply.

7. **Noise emission**
Is there higher demands on the noise emission? Measures for noise reduction are primarily by reducing the motor speed (use of 8-pole or 4-pole instead of 2-pole AC motors). In the gears, fabric-base laminate can also be applied in the first stage. The resonance amplitude can also be reduced by specially balancing the rotor. If not, a consultation at the parent company is necessary.
Drive design

8. Do you need a brake?
A built-in brake can be necessary in the motor to:
  – shorten the coasting after turning off the motor (after-run brake)
  – fix the motor in a specific position after a power failure (holding or fail-safe brake)

9. Do you need an automatic speed control?
When the speed needs to be precisely maintained independent from other parameters, the use of a control system is recommended. This is made up from a sensor (rotary encoder, tacho, resolver, etc.) for measuring the speed and an electronic control circuit. You can find support for this in our company.

10. Do you need a gear?
Gears are used to:
  – reduce the speed of the drive motor
  – raise the torque at the same time
If it is just to reduce the speed, there are enough possibilities to regulate this electronically (regulator, frequency converter). If the available input torque needs to be significantly raised at the same time, this can only be done using a gear unit.

\[ M \text{[gear]} = M \text{[motor]} \times i \times \eta \]

At the same time, the torque is raised by the factor, where \( \eta \) is the gear efficiency.

The transmission ratio and initial torque must be determined when engineering a gear. The conversion of the power and torque can be calculated with the following approximation formula.

\[ P \text{[W]} = \frac{T \text{[Ncm]} \times n \text{[min]}}{955} \]

11. Which gear design is best?
The following types are available:
- **Spur gears** have a high efficiency even with large transmission ratios and offer an excellent price-performance ratio.
- **Worm gears** are characterized by a continual power transmission, 90° power deviation and an optional second shaft end. The self-locking and poor efficiency with large transformation ratios should be kept in mind.
- **Planetary gears** offer triple meshing and the highest torque at any given volume. They are further characterized by a centrical output shaft and a high efficiency.

Duty factors \( f_b \)

<table>
<thead>
<tr>
<th>Operating modes</th>
<th>Load type</th>
<th>3 h up to 10 reversals / h</th>
<th>8 h more than 10 reversals / h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>even</td>
<td>8 h</td>
<td>24 h</td>
</tr>
<tr>
<td></td>
<td>pulsating</td>
<td>3 h</td>
<td>8 h</td>
</tr>
<tr>
<td></td>
<td>impulsive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No reversal</td>
<td>○</td>
<td>1</td>
<td>0.83</td>
</tr>
<tr>
<td>Reversal</td>
<td>○</td>
<td>1.10</td>
<td>0.83</td>
</tr>
<tr>
<td>No reversal</td>
<td>○</td>
<td>0.9</td>
<td>0.77</td>
</tr>
<tr>
<td>Reversal</td>
<td>○</td>
<td>0.71</td>
<td>0.58</td>
</tr>
<tr>
<td>No reversal</td>
<td>○</td>
<td>0.83</td>
<td>0.66</td>
</tr>
<tr>
<td>Reversal</td>
<td>○</td>
<td>0.63</td>
<td>0.45</td>
</tr>
</tbody>
</table>

12. What operating factors are available?

**Reduction of the torque at the gear output**

To achieve a consistent service-life, the torques must be reduced at the gear output during various types of running (see table below). The torque \( T \) available under the duty/load types is factored by multiplying the maximal nominal torque \( T_{\text{max}} \) with the duty factor \( f_b \) listed in the table.

\[ T = T_{\text{max}} \times f_b \]

For example: during the operation/load type “rotational direction reversal, swelling” up to 10 reversals, 24 h operating time/ day, the resulting torque \( T = 0.5 \times T_{\text{max}} \).

“Running against stop” is generally not permissible because it can destroy the gears. When dimensioning the gear, all the duty factors in the table must be observed. In any case, a calculation of the motor-gear combination torque is necessary.

All catalog specifications correlate to a duty factor of \( f_b = 1 \).