1. Temperature

1.1 Cooling

The surrounding air is the coolant (indirect air cooling). The temperature of the ambient air must be under 40°C and the place of installation of the drive must not be above 1000 m; otherwise a special design required.

1.2 Excess temperature of the winding

Heat in the motor is mainly produced in the winding. For the maximum permitted starting temperature of 40°C in 1.1 the Norm allows a so-called excess temperature for the winding. The excess temperature is calculated from the measured resistance change in the winding wires. (see VDE 0530, Part 1, Section 15)

2. Types of operation

An exact definition of the types of operation is necessary in order to ensure that limit temperatures listed in 1 are not exceeded. For this the steady-state temperature and the final state temperature is defined in such a way that the excess temperature $\Delta \vartheta$ during one hour of operation may change by a max. of 2°C.

The following types of operation are to be differentiated:

2.1 Continuous duty S 1

An operation with constant load with a duration long enough to reach the thermal steady-state condition to be reached.

2.2 Short-time duty S 2

An operation with constant load, with a duration not long enough to reach the thermal steady-state condition and a subsequent pause of such duration that the machine temperature, which has dropped again, is only less than 2°C different from that of the coolant.

2.3 Intermittent duty S 3

An operation comprised of a series of similar duty cycles each consisting of a period of constant load and then a pause, whereby the starting current does not noticeably affect warming.

2.4 Intermittent duty with an effect by the starting process S 4

An operation comprised of similar duty cycles, each consisting of a noticeable starting time, a period of constant load and then a pause. (see VDE 0530, Part 1, Section 4)

3. Power supply

Alternating and 3-phase current motors are designed according to DIN 57530, VDE 0530 for practically sinusoidal and symmetrical voltages.

Direct current motors, powered through a rectifier, require a smoothing choke due to superimposed alternating currents to lower the losses and improve commutation (see thyristor control).

3.1 voltage fluctuations

IEC 38 sets tolerances of +6% –10% for alternating voltages 230/400 V.

For operation with these tolerances the motors can exceed the mean limit temperature by 10°C. (Table 1, VDE 0530, Part 1).

3.2 Winding test

The winding test for electric strength has already been carried out during production. The last high voltage test is carried out during the final test just before shipment. The corresponding values are documented. If an additional high voltage test is required by the customer, this is carried out at 80% of the voltage.

4. EMV (Electromagnetic compatibility)-Regulations

Within the framework of the harmonisation process within the EU the EMV test will also be standardised as of 1.1.96. In the future electrical devices may not be operated if they do not conform to the above regulation.

The miniature motors series R, K, D, SM, M do not require a suppresser in normal operation.

The collector motors series G can be delivered with basic suppression if required, with a scope which has to be agreed.

We recommend the device as an entity.

Extract from the DIN 57530, VDE 0530 Regulations, Part 1

If not expressly agreed otherwise, all motors and geared motors are made and tested according to VDE 0530. The user should therefore take careful note of DIN 57530/ VDE when designing a drive. Neckar-Motoren has made this job easier for you and put together the most important points below.

2.2 Short-time duty S 2

An operation with constant load, with a duration not long enough to reach the thermal steady-state condition and a subsequent pause of such duration that the machine temperature, which has dropped again, is only less than 2°C different from that of the coolant.

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The collector motors series G can be delivered with basic suppression if required, with a scope which has to be agreed.

We recommend the device as an entity.
5. Noise intensity (Measurement areas, sound pressure level)

Measurement with a microphone separation of 1 m with miniature motors and miniature geared motors is problematic and too inaccurate because of the low noise level. The factory test, after agreement, is carried out in a sound proofed housing with a microphone separation of 30 cm vertically from the motor shaft. The results can be converted for 1 m separation. The measurement is carried out according to the evaluation graph dB (A). The noise behaviour of a motor is dependent on various effects such as:
- type of bearing, lubrication, fit,
- mechanical and electromagnetic unbalance,
- precision of the individual parts,
- care during assembly,
- commutator, especially rotation reversal,
- connection to the surroundings (structure-bound sound emission),
- resonance formation, among others.

For geared motors there is also the additional rolling sound of the toothed wheels. The following table shows reference points as average values for our motors and geared motors. During operation other factors come into play. A check is always necessary on the equipment. The following summary should only give reference points for the appraisal of a drive. These values can be reduced by special agreement. (see VDE 0530, Part 1, Section 54)

6. Protection type according to DIN VDE 0530, EN 60034, Part 5

Part 5 of DIN VDE 0530 defines the protection types of housings for enclosed electrical machines. (The protection type does not cover the shaft seal!)

The type of protection is defined by the identification letters IP and the identification numbers.

<table>
<thead>
<tr>
<th>First identification No.</th>
<th>Protection against contact and foreign bodies</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No protection</td>
</tr>
<tr>
<td>1</td>
<td>Protection against large foreign bodies (Ø larger than 50 mm)</td>
</tr>
<tr>
<td>2</td>
<td>Protection against medium foreign bodies (Ø larger than 12 mm)</td>
</tr>
<tr>
<td>3</td>
<td>Protection against small foreign bodies (Ø larger than 2.5 mm)</td>
</tr>
<tr>
<td>4</td>
<td>Protection against granular foreign bodies (Ø larger than 1 mm)</td>
</tr>
<tr>
<td>5</td>
<td>Protection against damaging dust deposits</td>
</tr>
<tr>
<td>6</td>
<td>Protection against dust penetration</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Second identification No.</th>
<th>Protection against water</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No protection</td>
</tr>
<tr>
<td>1</td>
<td>Protection against vertically falling water droplets</td>
</tr>
<tr>
<td>2</td>
<td>Protection against water droplets falling at an angle (up to 15° to the vertical)</td>
</tr>
<tr>
<td>3</td>
<td>Protection against water spray (up to 60° to the vertical)</td>
</tr>
<tr>
<td>4</td>
<td>Protection against water spray (from all directions)</td>
</tr>
<tr>
<td>5</td>
<td>Protection against water jets (from all directions)</td>
</tr>
<tr>
<td>6</td>
<td>Protection against flooding</td>
</tr>
<tr>
<td>7</td>
<td>Protection against dipping</td>
</tr>
<tr>
<td>8</td>
<td>Protection against submerging</td>
</tr>
</tbody>
</table>

Example IP 54
Identification letters [5 4]
First identification number 5
Second identification number 4
Motor is protected against dust and splashed water
The correct design of a drive can require a larger or smaller expenditure (advice, sampling, tests etc.) corresponding to the degree of difficulty of the application.

You can simplify the advice stage of complicated cases by previously clearing the following questions:

1. Which voltage supply or supplies is (are) available?
   The voltage supply also normally determines the type of motor with its advantages and disadvantages. We differentiate between the following types with the corresponding voltage supplies.

1.1 Capacitor motors
   - Single phase supply with operating capacitor
   - Single-phase supply with frequency inverter

1.2 Three-phase current motors
   - 3-phase supply
   - Single-phase supply with frequency converter (3-phase output, other winding in this case)

1.3 Direct current motors
   - Single-phase supply with transformer and bridge rectifier
   - Single-phase supply and mains unit
   - Single-phase supply and control/regulation

1.4 Electronically commutated direct current motors and servomotors
   Single-phase supply with transformer and controller

1.5 Stepping motors and servomotors
   Single-phase supply with mains unit and control

1.6 Synchronous motors
   - Single phase supply with operating capacitor
   - Single-phase supply with frequency converter

2. Can you give the power demand for your machine as a function of the speed?
   Accurate knowledge of the power profile enables the corresponding drive to be dimensioned more precisely.

Possible problems could be:
- Starting behaviour
- Acceleration ability
- Accuracy in maintaining speed
- Power peaks (can be as high as 5x the rated power)

3. What type of operation is required?
   The type of operation is determined by the variation in time of the power output of the motor (for definitions see Page 7). Thus has a decisive effect on service life and size of the drive.

It is important to know the average on-period for short-time duty; for continuous duty the number of rotation changes is still of importance. Here also, it is a fact that: Accurate knowledge of the variation in time of the speed and torque enables the suitable drive to be dimensioned more precisely.

4. What is the service life that you expect from the drive?
   In terms of service life brushless drives and capacitor-3-phase-synchronous and electronically commutated motors are clearly better than direct current motors with brushes.

As a rough approximate value, 20,000 to 40,000 operating hours can be attained for these. Depending on the application, conventional direct current motors can reach over 5,000 operating hours. However, operating and surrounding conditions can drastically reduce the service life.

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5.1. Cooling conditions are the most important. Which coolants (generally air), ambient temperature, convection hinder or improve heat emission (fans), or hinder heat conduction, contact with hot areas (flanges), hot surfaces?

These points are very important for determining the maximum power of the motor.

5.2. The surrounding conditions also determine the necessary type of protection against dust and water, according to the table on Page 8. It is important to note that the output shaft is not covered by the type of protection.

On the other hand, the terminal boxes and plugs often have a higher type of protection (see Pages 14/15).

5.3. In some cases it is also important to know the installation position and the position of the connection cable and plug.

6. Is thermal protection required?
   Thermal protection is recommended if the drive is operated close to the permitted limit temperature. Two measures come into consideration for this:

6.1. Use of a PTC (Positive temperature coefficient) resistor (Tk)

This must be insulated and inserted into the winding. The temperature dependent resistance of the PTC resistor must be evaluated by external electronics; this therefore, does not offer inherent protection.

6.2. Thermocouple installation (Th)

The thermocouple is also insulated and inserted into the winding. The design of this thermocouple is as an ON or Off switch. If not otherwise requested the installation is made as an Off switch with a switching capacity of:

- 250 V  2,5 A at cos ϕ = 1
- 1,6 A at cos ϕ = 0,6

For single-phase alternating current the installation is carried out directly into the main phase. The motor is switched off when the set temperature is reached.

Two variations are available:
- Switching on again after cooling
- Switching on again only after disconnection from the supply.

7. Noise development
   Are there any increased demands on noise development? Noise reduction is first of all possible by reducing the speed (use of 8 pole or 4 pole motors instead of 2 pole AC motors).

For the gears it is also possible to use laminated plastic in the first stage. The resonance amplitude can also be reduced by specially balancing the rotor.

Other than that it is imperative to get advice on site.
8. Do you need a brake?
A motor equipped with a brake can be necessary to
– shorten the slowing-down time after
switching the motor off (Slowing-down
brake)
– hold the motor in a determined position
after power failure (Holding or Safety
brake)

9. Do you need speed control?
The use of a control system is recommend-
ed if the speed must be held exactly inde-
pendent of other parameters. This consists
of a sensor which measures the speed
(shaft decoder, tachometer, resolver etc.)
and control electronics. Our sales depart-
ment will give you support for this.

10. Do you need gears?
Gears are needed to
– reduce the speed of the drive motor and
– at the same time increase the torque
If it is just a case of lowering the speed,
there are enough possibilities today to do
this electronically (controller, frequency
converter). If however the torque must be
substantially increased at the same time,
this can only be done using a gear.
If \( i = \) the transmission then
\[
\text{n [gear]} = \frac{\text{n [Motor]}}{i}
\]

At the same time the torque is increased
by the factor
\[
M_{\text{[gear]}} = M_{\text{[Motor]}} \times i \times \eta
\]
whereby \( \eta \) is the efficiency of the gear.
When dimensioning a gear the transmis-
sion and output torque must be deter-
mined. The conversion of power and
torque can be found from the approxima-
tion:
\[
P [W] = \frac{M_{\text{[Nm]}} \times n [\text{min}^{-1}]}{955}
\]

11. Which type of gear is advantageous?
We supply the following types:
• Spur gears also have high efficiency
  with large transmissions and offer an ex-
  cellent price/performance relationship.
• Worm gears are characterised by con-
  tinuous power transmission, power de-
  flection through 90° and the option to
  have a second shaft end.
  The fact that they can self-lock and that
  efficiency is lower at high transmissions
  should be taken into consideration.
• Planetary gears offer triple meshing and
  the highest torque for a given volume.
  They are further characterised by a cen-
  tric output shaft and high efficiency.

12. Which operational factors are present?
Reduction of the torque on the gear output
In order to get a uniform service life, the
torque on the gear output of the various
types of gear must be reduced (see the
table below). The torque \( M \) available from
the type of operation/load is found by
multiplying the maximum rated torque
\( M_{\text{max}} \) by the application factor \( f_s \) given in
the table.
\[
M = M_{\text{max}} \times f_s
\]
For example the torque is \( M = 0.5 \times M_{\text{max}} \)
for the operation/load “rotation change,
pulsating” for up to 10 changes, 24 h
duty/day.
Generally “Running against a block” is not
permitted as the gear can be destroyed.
When designing a gear the application
factors in the table must be observed. A
calculation of the torque of the motor-gear
combination must be made in every case.

Application factors \( f_s \)

<table>
<thead>
<tr>
<th>Operation type</th>
<th>Load type</th>
<th>Operation period in h/day</th>
<th>Uniform</th>
<th>Pulsating</th>
<th>Surging</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 h</td>
<td>8 h up to 10 changes/h</td>
<td>24 h</td>
<td>3 h</td>
<td>8 h over 10 changes/h</td>
</tr>
<tr>
<td>One rotation direction</td>
<td>1</td>
<td>1</td>
<td>0.83</td>
<td>1</td>
<td>0.83</td>
</tr>
<tr>
<td>Rotation change</td>
<td></td>
<td>1</td>
<td>0.77</td>
<td>0.63</td>
<td>0.83</td>
</tr>
<tr>
<td>One rotation direction</td>
<td>0.9</td>
<td>0.77</td>
<td>0.63</td>
<td>0.77</td>
<td>0.66</td>
</tr>
<tr>
<td>Rotation change</td>
<td></td>
<td>0.71</td>
<td>0.58</td>
<td>0.5</td>
<td>0.63</td>
</tr>
<tr>
<td>One rotation direction</td>
<td>0.83</td>
<td>0.66</td>
<td>0.55</td>
<td>0.66</td>
<td>0.55</td>
</tr>
<tr>
<td>Rotation change</td>
<td></td>
<td>0.63</td>
<td>0.5</td>
<td>0.43</td>
<td>0.5</td>
</tr>
</tbody>
</table>

All details in the catalogue refer to an application factor \( f_s = 1 \).
**Circuit Diagrams**

**Single-phase capacitance motors series K, KV**

- **Synchronous motors series R**
  - sw = black white
  - rt = red
  - bl = blue
  - gn = green
  - gn/ge = green-yellow

  Circuit diagram. Loose stranded wire
  Connection for motor types K ..8 correspond to K ..4

**3-phase current motors series D**

  Circuit diagram. Loose stranded wire
  Connection for motor types D ..8 correspond to D ..4

**Mechanically commutated direct current motors series G**

  Circuit diagram. Loose stranded wire
  rt bl = input direction brushes

**Electronically commutated direct current motors series M**

- **Size 3: Loose stranded, 200 mm**
  - Blue: Phase A
  - Red: Phase B
  - Green: Phase C
  - Violet: +12 V
  - Black: 0 Volt
  - Orange: Sensor 1
  - Yellow: Sensor 2
  - White: Sensor 3

- **Size 5, 6, 8 Standard design**
  - 1 Phase A
  - 2 Phase B
  - 3 Phase C
  - 4 RLG +12 V
  - 5 0 V
  - 6 Sensor 1
  - 7 Sensor 2
  - 8 Sensor 3
Circuit Diagrams, Plug Positions

**Alternating/3-phase current motors series KD**

KD-design with 6 pole terminal box and the option for slowing-down brake B as well as PTC resistor thermal protection

KD-design with 9 pole terminal box and the option for slowing-down brake B as well as bimetal thermal protection

All rotation direction details are with reference to the motor drive side

**Plug Positions**

Standard plug position (9 o’clock).

Intermediate positions possible, with the exception of series G motors.

Standard plug position left (9 o’clock) for motors with gears series Z and M.

Standard plug position left (9 o’clock) for motors with worm gears series S 345, S 567, S 668 and S 769.
## Types of Connection

### Alternating/3-phase current motors series KD

- **K 2 / K 5**
- **K 2**
- **K 4**
- **K 6**
- **K 9**

### Optional connections

- **K 2 AW**
- **K 5 AW**
- **K 22 AW**
## Types of Connection

<table>
<thead>
<tr>
<th>Type</th>
<th>Voltage</th>
<th>S</th>
<th>Continuous current in A</th>
<th>No. of contacts</th>
<th>PG screw connections</th>
<th>Protection type DIN 40050</th>
<th>Insulation VDE 0110</th>
<th>L</th>
<th>H</th>
<th>W</th>
<th>Connectable</th>
</tr>
</thead>
<tbody>
<tr>
<td>K 2</td>
<td>250V</td>
<td>16</td>
<td>3 + PE</td>
<td>PG 11</td>
<td>IP 65</td>
<td>C</td>
<td>48</td>
<td>55</td>
<td>27.5</td>
<td>4 x 90°</td>
<td></td>
</tr>
<tr>
<td>K 22</td>
<td>400V</td>
<td>16</td>
<td>3 + PE</td>
<td>PG 11</td>
<td>IP 65</td>
<td>C</td>
<td>51</td>
<td>70</td>
<td>34</td>
<td>4 x 90°</td>
<td></td>
</tr>
<tr>
<td>K 4</td>
<td>500V</td>
<td>16</td>
<td>6 + PE</td>
<td>2 x PG 11</td>
<td>IP 54</td>
<td>C</td>
<td>32</td>
<td>80</td>
<td>71</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K 5</td>
<td>250V</td>
<td>16</td>
<td>2 + PE</td>
<td>PG 9</td>
<td>IP 65</td>
<td>C</td>
<td>48</td>
<td>51</td>
<td>21</td>
<td>2 x 180°</td>
<td></td>
</tr>
<tr>
<td>K 6</td>
<td>500V</td>
<td>16</td>
<td>6 + PE</td>
<td>PG 11</td>
<td>IP 65</td>
<td>C</td>
<td>40</td>
<td>83</td>
<td>66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K 9</td>
<td>400V</td>
<td>16</td>
<td>3 + PE</td>
<td>PG 9</td>
<td>IP 55</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K 11</td>
<td>250V</td>
<td>5</td>
<td>3...7</td>
<td>PG 9</td>
<td>IP 65</td>
<td>A</td>
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<td></td>
</tr>
<tr>
<td>K 11</td>
<td>60V</td>
<td>3</td>
<td>12 u. 14</td>
<td></td>
<td>IP 65</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K 12</td>
<td>250V</td>
<td>5</td>
<td>5 + PE</td>
<td>PG 9</td>
<td>IP 65</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K 12</td>
<td>60V</td>
<td>3</td>
<td>3...7</td>
<td>PG 9</td>
<td>IP 65</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K 14</td>
<td>400V</td>
<td>16</td>
<td>5 + PE</td>
<td>PG 11 + PG 13,5</td>
<td>IP 65</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K 14</td>
<td>60V</td>
<td>5</td>
<td>14 + PE</td>
<td>PG 11 + PG 13,5</td>
<td>IP 65</td>
<td>C</td>
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Combination of motors with two or more plug and socket connectors

1) for brake, tachometer, thermal protection

See page 13 for plug positions
Thank you for viewing product information on TEA’s range of engineering components.

Now please contact us at the nearest office to you for any further information, prices and availability:

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