

# Technical Manual

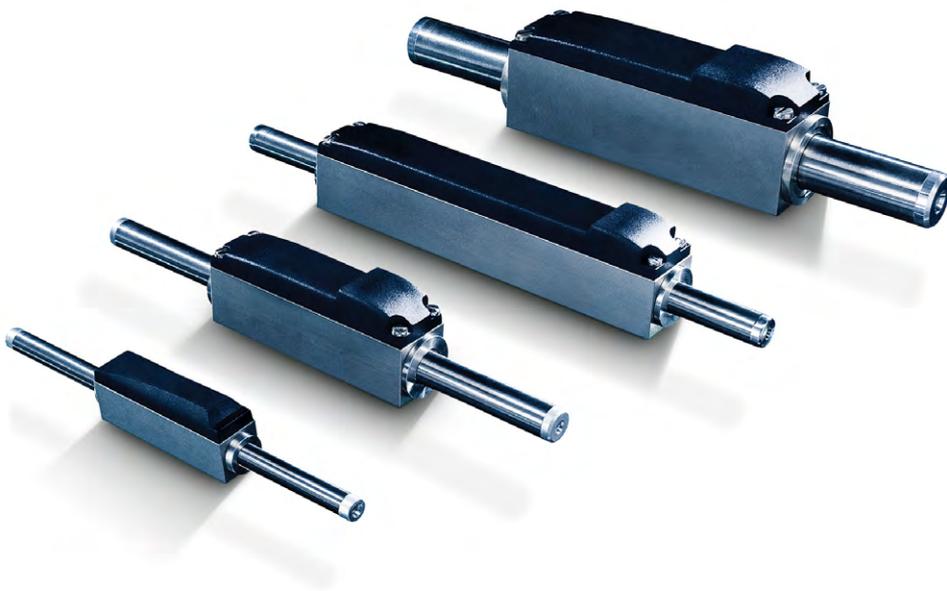
Linear DC-Servomotors

Series LM 0830

Series LM 1247

Series LM 1483

Series LM 2070



# Imprint

---

Version:

7th edition, 14.11.2023

Copyright

by Dr. Fritz Faulhaber GmbH & Co. KG  
Faulhaberstraße 1 · 71101 Schönaich

All rights reserved, including those to the translation.  
No part of this description may be duplicated, reproduced,  
stored in an information system or processed or  
transferred in any other form without prior express written  
permission of Dr. Fritz Faulhaber GmbH & Co. KG.

This document has been prepared with care.  
Dr. Fritz Faulhaber GmbH & Co. KG cannot accept any  
liability for any errors in this document or for the  
consequences of such errors. Equally, no liability can be  
accepted for direct or consequential damages resulting  
from improper use of the equipment.

The relevant regulations regarding safety engineering  
and interference suppression as well as the requirements  
specified in this document are to be noted and followed  
when using the software.

Subject to change without notice.

The respective current version of this technical manual is  
available on FAULHABER's internet site:  
[www.faulhaber.com](http://www.faulhaber.com)

# Table of Contents

<b>1 Safety requirements</b>	<b>4</b>
1.1 Important Information	4
1.2 Operation	4
1.3 Installation	4
1.4 Dispatch	4
<b>2 Motor characteristics</b>	<b>5</b>
2.1 Linear DC-Servomotor Tecnology	5
2.2 Tecnichal information	5
2.2.1 Lifetime	6
2.2.2 Environment	6
2.2.3 Resolution Repeatability Accuracy	6
2.2.3.1 Resolution	6
2.2.3.2 Repeatability	6
2.2.3.3 Accuracy	6
2.2.3.4 Representation	6
2.2.3.5 Observations	6
<b>3 Mechanics</b>	<b>7</b>
3.1 Fixing	7
3.1.1 Fixing the stator	7
3.1.2 Fixing the rod	8
3.2 Linear guide / fixed rod	8
3.3 Distance between motors	8
3.4 Locking in position	8
<b>4 Electrics</b>	<b>9</b>
4.1 Characteristics	9
4.2 Connection	9
4.3 Magnetic field	9
4.4 Fault finding	10
<b>5 Choice of motor</b>	<b>11</b>
5.1 Scheme	11
<b>6 EC Product Safety Directives</b>	<b>12</b>
<b>7 Warranty</b>	<b>13</b>

# 1 Safety requirements

## 1.1 Important Information

Read first the following information before proceeding with unpackaging and using the product.

**WARNING!**

Static-sensitive device. Handle only at static safe work stations.



**WARNING!**

Presence of strong magnetic fields.



**WARNING!**

Presence of magnetic fields potentially dangerous for medical device users such as pacemakers and metal prostheses. Keep at a safe distance



- Ensure the working area is completely clear of all metallic and/or magnetic items before proceeding with unpackaging and using the product.
- Remove all residues of metallic parts and/or powders from working area.
- Credit cards, computer disks, watches and precision instruments can be damaged by magnetic fields.
- Attention! never damage the thrust rod, this could cause the projection of metal parts.
- Attention! never use the motor if any parts are damaged.
- Attention ! electric connections must be exclusively made by qualified personnel. Wrong system configuration could cause undesired rod movements.
- Attention! Before connecting the linear DC-Servomotor to the power supply be sure that the thrust rod is in home position. Never insert or remove the rod with motor powered.

## 1.2 Operation

**WARNING!**

While the motor is operating, the housing can get extremely hot.



## 1.3 Installation



In the application where the motor is installed, give warning of the presence of strong magnetic fields by fixing a sign near the motor with the symbol for "presence of magnetic fields".

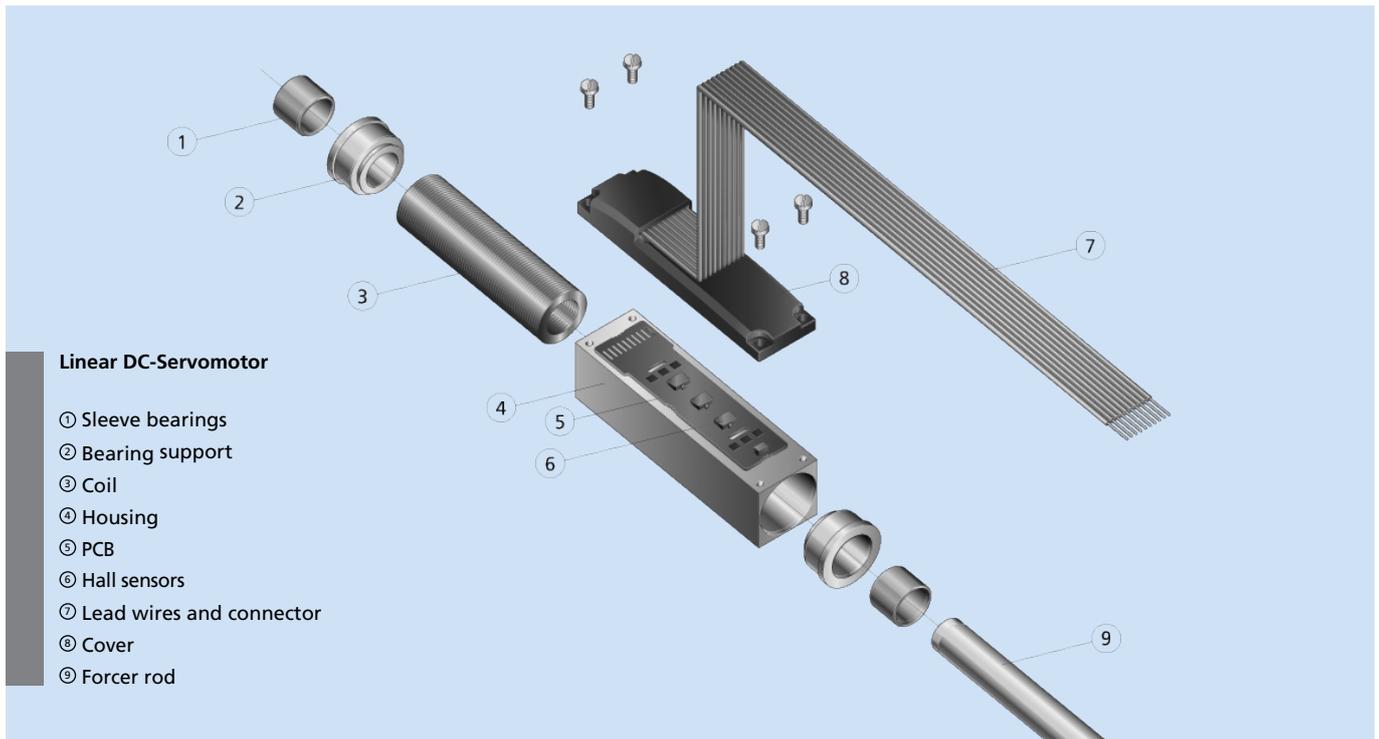
## 1.4 Dispatch

If dispatching the motor, use the original packaging, include the information sheet and attach these three warning symbols to the outside of the packaging.



## 2 Motor characteristics

### 2.1 Linear DC-Servomotor Technology



#### Features

The Linear DC-Servomotor combines the speed and robustness of a pneumatic system with the flexibility and reliability features of an electro-mechanical linear motor.

The innovative design with a 3-phase self-supporting coil and non-magnetic metal housing offers outstanding performance.

The absence of residual static force and the excellent relationship between the linear force and current make these motors ideal for use in micro-positioning applications. Position control of the Linear DC-Servomotor is made possible by the built-in Hall sensors.

Performance lifetime of the Linear DC-Servomotors is mainly influenced by the wear of the sleeve bearings, which depends on operating speed and applied load of the cylinder rod.

#### Benefits

- High dynamics
- Excellent force to volume ratio
- No residual force present
- Non-magnetic metal housing
- Compact and robust construction
- No lubrication required
- Simple installation and configuration

#### Product Code



LM	Linear Motor
12	Motor width □ [mm]
47	Motor length [mm]
020	Stroke length [mm]
11	Sensors type: linear

LM1247-020-11

## 2 Motor characteristics

### 2.2 Technical information

#### 2.2.1 Lifetime

The lifetime of the linear DC-Servomotor depends principally on the life of the sleeve bearings. The wear on these bearings is strongly affected by the following factors:

- Ambient conditions:  
Temperature, humidity, shocks, vibration.
- Point of operation:  
Speed, acceleration, pressure (force of the rod on the sleeve bearing), cycle.

#### 2.2.2 Environment

All the parameters in the data sheet are specified at room temperature (22°C). Pay attention to the motor's working environment. Suitable cooling can improve the performance of the motor.

#### 2.2.3 Resolution Repeatability Accuracy

##### 2.2.3.1 Resolution

The resolution depends directly on the motor's control board. The resolution corresponds to the motor's minimum step. This value depends on the measurement system (Hall sensors, encoder etc.) and the control electronics. This should not be confused with the actual step, which in reality depends on repeatability, accuracy and application.

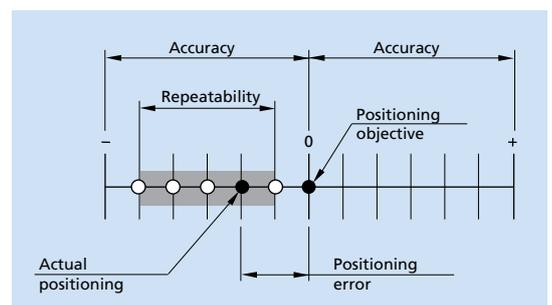
$$\text{Resolution} = \frac{\text{Magnetic pitch}}{\text{Resolution Drive Electronics}}$$

##### 2.2.3.2 Repeatability

It is the difference in positioning measured at the motor when the same movement is repeated several times in the same conditions.

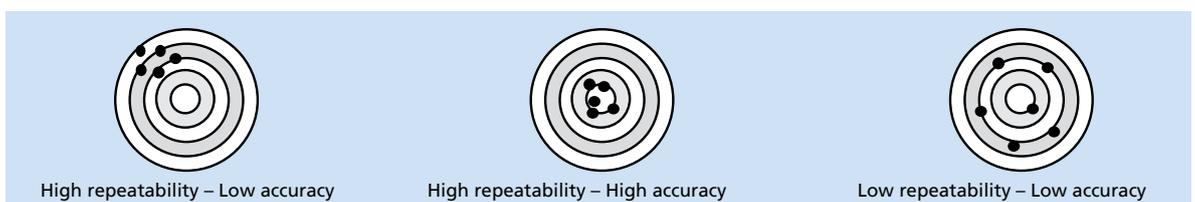
##### 2.2.3.3 Accuracy

It is the positioning error of the motor. This value corresponds to the difference between the set position and the exact measured position of the system.



##### 2.2.3.4 Representation

We can represent accuracy and repeatability as follows:



##### 2.2.3.5 Observations

To increase positioning performance, it is essential to use an encoder.

## 3 Mechanics

### 3.1 Fixing

In order for the linear motor to operate properly, it is important to consider the fixing of the various components.

The linear motor is a source of magnetic fields, and is therefore sensitive to the materials used for fixing.

Avoid materials with high electrical conductivity (e.g. aluminum) and use non-magnetic materials.

The motor heats up in operation.

For optimum use, it is advisable to facilitate heat exchange between the motor and the environment.

This can be achieved by ensuring good circulation of air around the motor, and/or using thermally conductive materials for the fixings.



- Use non-magnetic materials in the vicinity of the motor.
- For high performance (high speed and dynamics) avoid having highly electrically conductive metal parts moving in relation to the rod, so as to avoid induced parasitic currents which would reduce efficiency.
- Take care when inserting the rod into the motor. A mistake in handling could cause damage to the coil and/or the sleeve bearings.
- Re-zero the position each time the rod is replaced or inverted in the motor.

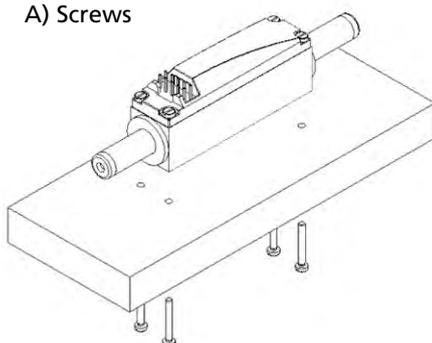
#### 3.1.1 Fixing the stator

Some examples of fixing the stator:

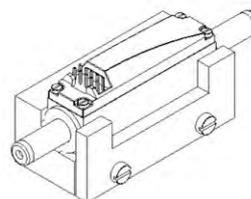
- A. With screws (using the threads on the housing).
- B. Pressing the housing onto a support.

The front flanges can be used as a reference or for grip.

A) Screws



B) Pressure



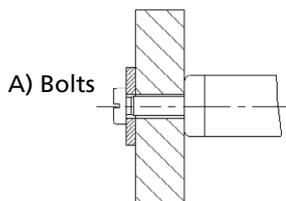
Non-magnetic screws recommended.

## 3 Mechanics

### 3.1.2 Fixing the rod

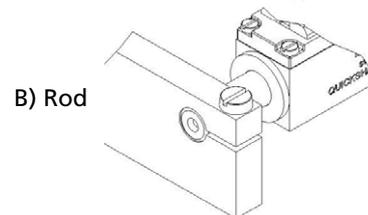
Some examples of fixing the rod:

A. Using the threads in the rod.



Non-magnetic screws recommended.

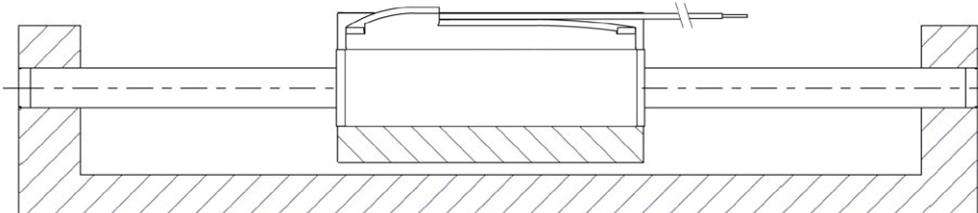
B. With mechanical fixing at the end of the rod.



Pressure must be applied on the extreme end of the rod (aluminum plug), and never on the rod itself.

### 3.2 Linear guide / fixed rod

For large strokes without an external guide, it is preferable to have the stator moving.



Provide a cable grip, in order to avoid the connector becoming detached and/or to avoid an increase in the external forces due to the mechanical resistance of the cable.

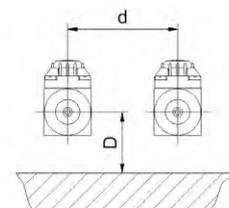
### 3.3 Distance between motors

To avoid magnetic interactions between two motors positioned with moving rods parallel to each other, comply with the minimum distance indicated in the table.

At distances lower than those indicated, there is mutual attraction between the rods and their movements can influence each other.

Similarly, it is inadvisable to use the linear motor without respecting the minimum distances from ferromagnetic metal surfaces. Below the recommended distances, the attraction generated between the rod and a metal surface of this kind causes an increase in friction and consequently in power consumption, thus reducing the efficiency of the motor.

Motor	Minimum distance d	Minimum distance D
LM0830	18 mm	8 mm
LM1247	27 mm	15 mm
LM1483	27 mm	15 mm
LM2070	40 mm	22 mm



### 3.4 Locking in position

Sometimes it is necessary to lock the system in position with the aid of external mechanical stops. In fact to maintain its position in particular conditions (inclined plane, vertical position, against an external force etc.), the motor requires energy.

Examples of solutions:

- Direct locking of the rod
- Locking the external guide system

## 4 Electrics

### 4.1 Characteristics

Linear motors must be supplied and driven by a specific motion controller (see data sheet or the website [www.faulhaber.com](http://www.faulhaber.com)).

### 4.2 Connection

Connecting the Hall sensors and the phases to the motor is performed by means of a cable or a flex-print. In working environments subject to sources of electromagnetic disturbance, and for cables over 300 mm in length, it may be necessary to use a screened supply cable.

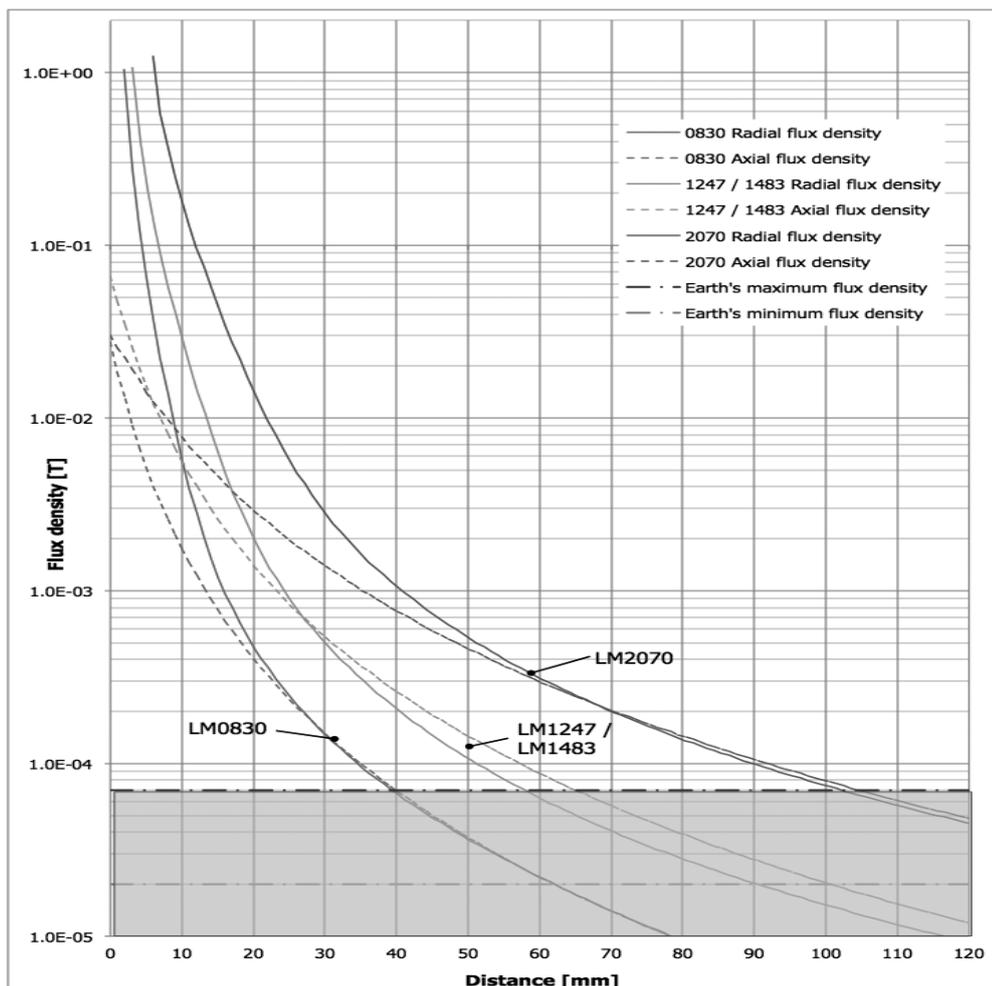
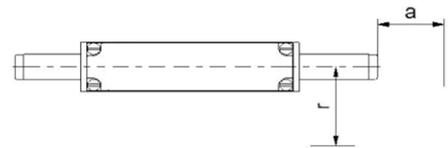


- Incorrect connection can cause irreparable damage to the motor. Before powering up the motor, check that the connections are correct.
- Linear motors are sensitive to electrostatic discharges.

### 4.3 Magnetic field

The rod of a linear motor contains magnets with high specific energy. The surrounding space is therefore the site of a permanent magnetic field.

The graph below gives an idea of the intensity of magnetic induction in relation to axial distance ( $a$ ) and radial distance ( $r$ ) from the rod (theoretical values, not binding).



## 4 Electrics

### 4.4 Fault finding

The table below gives some examples of faults and the corresponding corrective action.

Problem	Cause	Action
Incorrect positioning / problem of motor control	Bad contact to Hall sensors or motor phases	Check the connections
	Incorrect PID parameters	Modify the PID parameters
	Faulty Hall sensor	Replace the motor
Mechanical jamming of the rod	Misalignment between rod and housing	Reset the alignment between rod and housing

The following operations cause damage to the Hall sensors (which are not replaceable):

- Supplying power to the sensors with reversed polarity
- Supplying power to the sensors with voltage greater than 6V
- Connecting a motor phase to a signal from a Hall sensor
- Connecting the positive pole of the supply voltage of the sensors to the output of a sensor
- Connecting a signal from a Hall sensor to another device with different GND reference
- Exposing the motor connector to electrostatic discharges.

## 5 Choice of motor

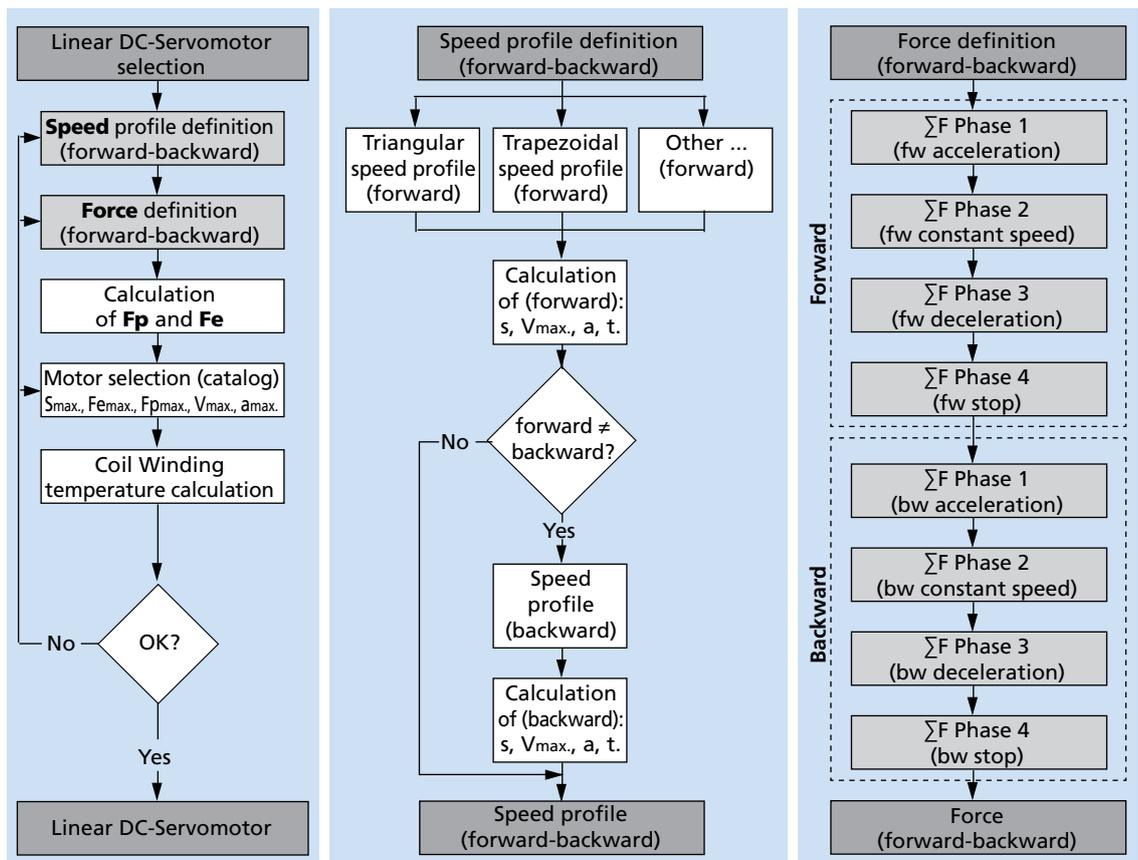
The choice of motor must be made taking into consideration the active and passive forces which act on the movable part of the motor and the working cycle.  
The choice of motor must be made in such a way that the temperature of the windings never exceeds the maximum temperature indicated in the data-sheet.

The selection process can be summarized as follows:

- 1) Define the speed profile, define the stroke.
- 2) Calculate the peak forces and continue with the calculation proposed below.
- 3) With this data (peak force, continuous force and stroke), consult the catalogue for the choice of motor.
- 4) Calculate the temperature of the windings as a check.
- 5) If the temperature of the windings exceeds the permissible level, consider using a more powerful motor and/or modify the speed profile and/or reduce the applied forces.

In calculating the temperature of the windings, thermal resistances play a very important role. The lower they are, the lower is the temperature of the windings for equal load conditions. To reduce thermal resistance, the motor must be fixed to a thermally conductive support which will act as a heat dissipater. Even a forced-air blower can reduce the temperature of the windings.

### 5.1 Scheme



All parameters are defined at room temperature of 22°C and with  $R_{th2}$  reduced by 55%.

## 7 EC Product Safety Directives

---

### **REGULATION!**



The following EC Product Safety Directives are important for users of the described products:

#### **Machinery Directive (2006/42/EC):**

Due to their small size, small standard electrical drives cannot cause any noteworthy risk of injuries to people.

Therefore, the Machinery Directive does not apply to our products.

The products described here are not “part machines” or “incomplete machines”.

Therefore, Faulhaber does not provide a standard Declaration of Incorporation.

#### **Low-Voltage Directive (2014/35/EU):**

It applies to all electrical equipment with a nominal voltage from 75 to 1 500 V DC, or from 50 to 1 000 V AC. The products described in this instruction manual do not fall within the scope of this Directive as they are designed for smaller voltages.

#### **EMC Directive (2014/30/EU):**

The Electromagnetic Compatibility (EMC) Directive applies to all electronic and electrical equipment, plant and systems sold to end users (consumers). In addition, CE marking can be undertaken for built-in components according to the EMC Directive. Compliance is documented by the Declaration of Conformity.

#### **WEEE Directive (2012/19/EU)**

The directive on the disposal of electrical and electronic devices prescribes the separate collection of old electrical and electronic devices. The products described in this technical manual fall within the scope of this directive.

## 8 Warranty

---

**Note:**

All sales and deliveries made exclusively on the basis of our general Terms and Conditions of Business.

These are available to view and download on the FAULHABER homepage at

[www.faulhaber.com/agb](http://www.faulhaber.com/agb).

