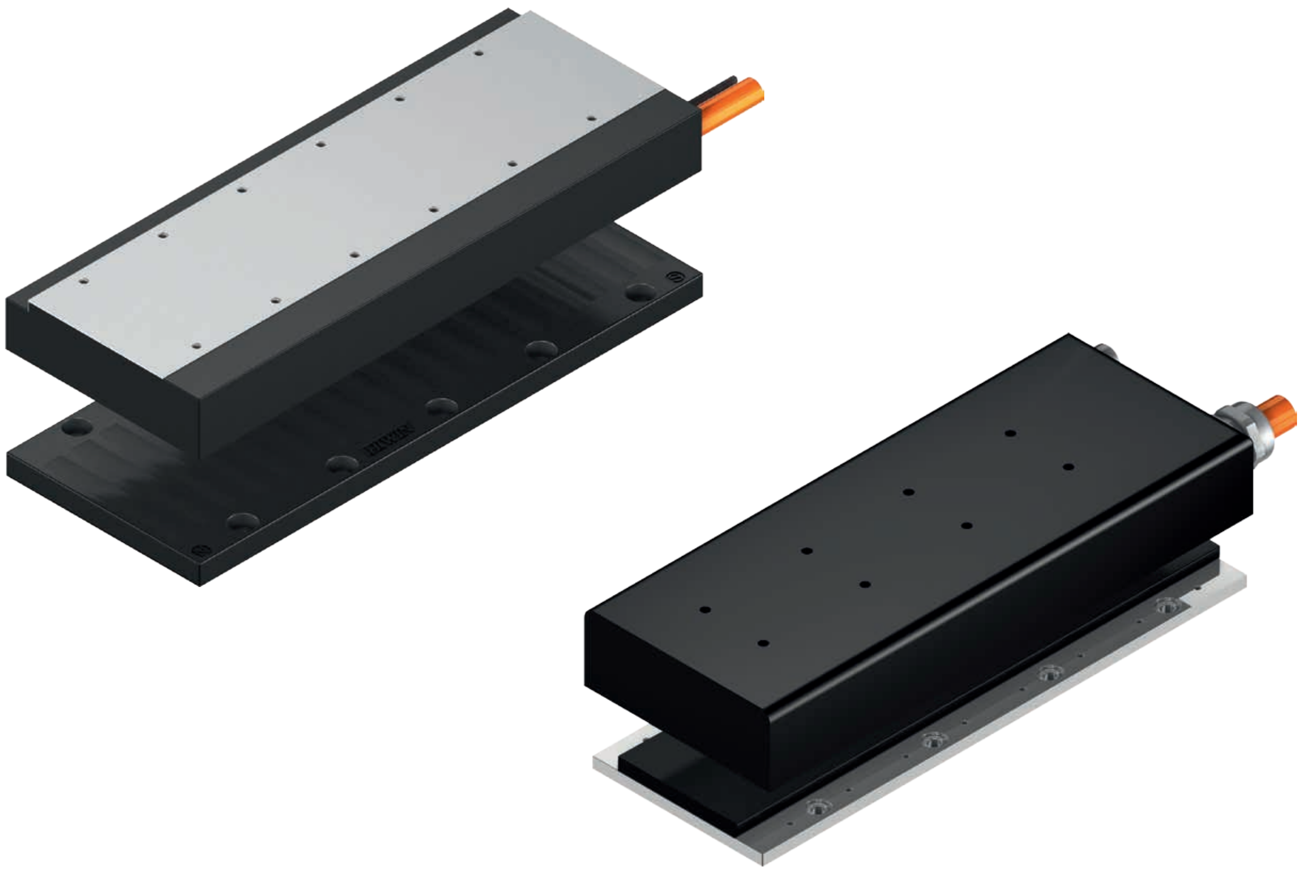
HIWIN®

Motion Control & Systems



Assembly Instructions

Linear Motors

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Contents

1. General information

1.1 About these assembly instructions

1.1.1 Version management

Table 1.1 **Version management**

Version	Date	Comment
01-3	March 2017	General update
01-2	October 2016	Update of "Declaration of Conformity"
01-1	July 2016	Various corrections, section 5.4 completely revised
01-0	January 2016	Initial creation of common assembly instructions for linear motors

1.1.2 Requirements

We assume that

- operating staff are trained in the safe operation practices for linear motors and have read and understood these assembly instructions in full;
- maintenance staff maintain and repair the linear motors in such a way that they pose no danger to people, property or the environment.

1.1.3 Availability

These assembly instructions must remain constantly available to all persons who work with or on the linear motors.

1.2 Depictions used in these assembly instructions

1.2.1 Instructions

Instructions are indicated by triangular bullet points in the order in which they are to be carried out.
Results of the actions carried out are indicated by ticks.

Example:

▶ Position the linear motor on the mounting holes.
▶ Place the mounting bolts into the mounting holes and tighten in a spiral pattern to a torque of 10 Nm.

✓ Linear motor is mounted.

1.2.2 Lists

Lists are indicated by bullet points.

Example:
The linear motors must not be operated:

- Outdoors
- In potentially explosive atmospheres
- ...

1.2.3 Depiction of safety notices

Safety notices are always indicated using a signal word and sometimes also a symbol for the specific risk (see section 1.2.4 „Symbols used").
The following signal words and risk levels are used:

⚠ DANGER!
Imminent danger! Non-compliance with the safety notices will result in serious injury or death!

⚠ WARNING!
Potentially dangerous situation! Non-compliance with the safety notices runs the risk of serious injury or death!

⚠ CAUTION!
Potentially dangerous situation! Non-compliance with the safety notices runs the risk of slight to moderate injury!

ATTENTION!
Potentially dangerous situation! Non-compliance with the safety notices runs the risk of damage to property or environmental pollution!

1.2.4 Symbols used

The following symbols are used in these assembly instructions and on the linear motor components:

Table 1.2 **Warning signs**

	Warning of dangerous electrical voltage!		Warning of hot surfaces!
	Warning of magnetic fields!		Warning! Danger of crushing!
	Substance hazardous to the environ-ment!		

Table 1.3 **Mandatory signs**

	Wear protective gloves!
	Isolate before work!

1.2.5 Information

NOTE	Describes general information and recommendations.

1.3 Warranty and liability

The manufacturer's "General conditions of sale and delivery" apply.

1.4 Manufacturer's details

Table 1.4 **Manufacturer's details**

Address	HIWIN GmbH Brücklesbünd 2 77654 Offenburg Germany
Tel.	+49 (0) 781 / 9 32 78 - 0
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E-mail	info@hiwin.de
Website	www.hiwin.de

1.5 Copyright

These assembly instructions are protected by copyright. Any reproduction, publication in whole or in part, modification or abridgement requires the written approval of HIWIN GmbH.

1.6 Product monitoring

Please inform HIWIN, the manufacturer of the linear motors, of:

- Accidents
- Potential sources of danger in the linear motors
- Anything in these assembly instructions which is difficult to understand

2. Basic safety notices

⚠ WARNING!

Danger from strong magnetic fields!
Strong magnetic fields around linear motor components pose a health risk to persons with implants (e.g. cardiac pacemakers) that are affected by magnetic fields.

- Persons with implants that are affected by magnetic fields should maintain a safe distance of at least 1 m from linear motor components.

ATTENTION!

Risk of physical damage to watches and magnetic storage media.
Strong magnetic forces may destroy watches and magnetisable data storage media near to the linear motor components!

- Do not bring watches or magnetisable data storage media into the vicinity (<300 mm) of the linear motors!

2.1 Intended use

The linear motor components are designed exclusively for installation in commercial and industrial machines. Linear motor components are parts of a linear drive system for the precise positioning in terms of time and location of fixed mounted loads, e.g. system components, within an automated system. Linear motors are designed for installation and operation in any position. The loads being moved must be firmly attached. Linear motor components may only be used for the intended purpose as described. Linear motors must be operated within their specified performance limits (see Section 11). Proper use of the linear motors includes observing the assembly instructions and following the maintenance and repair specifications. Use of the motor components for any other purpose shall be considered improper use. Only original spare parts from HIWIN GmbH may be used.

2.2 Reasonably foreseeable misuse

Linear motors must not be operated:

- Outdoors
- In potentially explosive atmospheres

2.3 Conversions and modifications

Conversions or modifications of the linear motors are not permitted!

2.4 Residual risks

Normal operation of the linear motors constitutes no residual risks.
Warnings about risks that may arise during maintenance and repair work are provided in the relevant sections.

2.5 Personnel requirements

Only authorised persons may carry out work on the linear motors! They must be familiar with the safety equipment and regulations before starting work (see Table 2.1).

Table 2.1 **Personnel requirements**

Activity	Qualification
Normal operation	Trained personnel
Cleaning	Trained personnel
Maintenance	Trained specialist personnel of the operator or manufacturer
Repairs	Trained specialist personnel of the operator or manufacturer

2.6 Protective equipment

Table 2.2 **Personal protective equipment**

Operating phase	Personal protective equipment
Normal operation	When in the vicinity of the linear motors, the following personal protective equipment is required: ○ Safety shoes
Cleaning	When cleaning the linear motors, the following personal protective equipment is required: ○ Safety shoes
Maintenance and repairs	When carrying out maintenance and repairs, the following personal protective equipment is required: ○ Safety shoes

2.7 Labels on linear motor components

2.7.1 Warning symbols

Table 2.3 **Warning symbols**

Pictogram	Type and source of danger	Protective measures
	Danger from strong magnetic fields!	Persons whose health may be endangered by strong magnetic fields must keep a safe distance (1 m) from the linear motors!
 	Danger of electric shock!	Disconnect the power supply of the linear motors before maintenance or repairs!
	Danger from hot surfaces!	Let hot surfaces cool down before touching them!
	Danger from movements!	Keep out of the machine's area of movements! Prevent unauthorised access to the danger area! Secure vertical linear motor axes against lowering or falling after switching OFF the motor!

2.7.2 Type plate

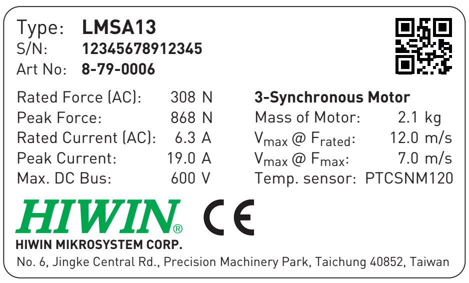


Fig. 2.1 **Type plate (Example only)**

3. Description of the linear motors

3.1 Field of application

A linear motor consists of two components, the forcer (primary part) with coils and the stator (secondary part) with permanent magnets. The coils carrying alternating current generate a magnetic field that changes over time and interacts with the steady magnetic field of the stator. The resulting force is used to generate linear motion.

The linear motor components are supplied as separate parts.

3.2 Design of the linear motor components

Stator:

The stators consist of a nickel plated carrier plate with glued-on permanent magnets. Depending on the series, there are a number of stator lengths to choose from. Each of the stators are connected in series, forming a linear motor axis of variable length.

Forcer:

Depending on the series, the forcers are designed as iron-core or ironless motors. The motor windings are cast in epoxy resin. Each motor is fitted with temperature sensors protecting it against thermal overload.

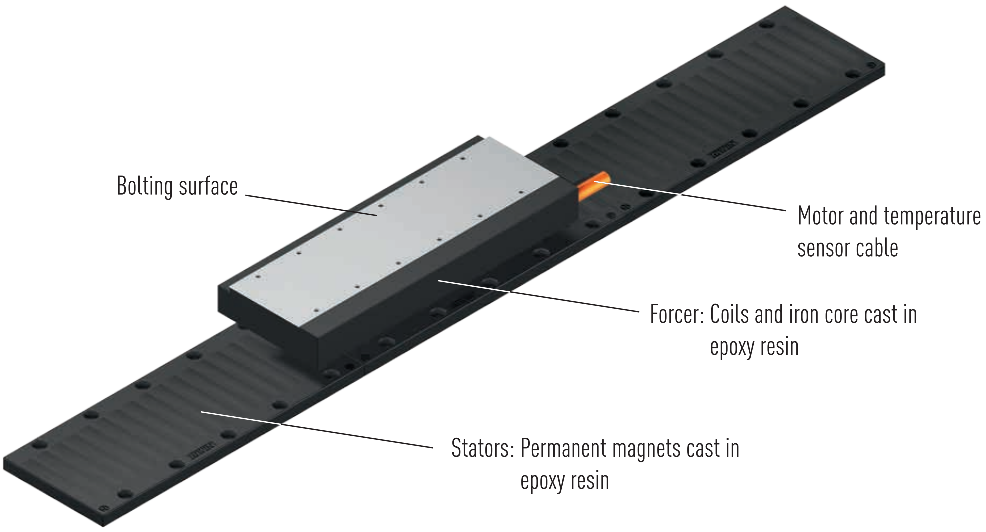


Fig. 3.1 **Design of a LMSA linear motor**

3.3 Protection classes

The forcers meet the requirements of the protection class according to EN 60529 and EN 60034-5 (see Table 3.1).

Table 3.1 **Protection classes of the linear motors**

Linear motor	Protection class
LMS	IP54
LMSA	IP54
LMFA	IP65
LMC	IP54

The stators are largely protected against corrosion by their mechanical design. However, suitable constructive measures have to be taken to prevent that ferromagnetic particles (for example, iron chips) accumulate on the stators.
Contact with liquids and general contact with corrosive media must be avoided by suitable protective measures (encapsulation, bellows, protective lacquer).

3.4 Linear motor types

3.4.1 LMCxx – the dynamic sprinter

- Three-phase, ironless synchronous linear motor
- Lightweight and extremely dynamic
- Extremely high synchronism
- Sandwich arrangement of permanent magnets suppresses magnetic forces of attraction in the guiding system
- Intermediate circuit voltage up to 340 VDC
- Suitable for drives with up to 240 VAC

3.4.2 LMSxx – the solid all-rounder

- Three-phase, iron-core synchronous linear motor
- High power density
- Low cogging torque
- Intermediate circuit voltage up to 600 VDC
- Suitable for drives with up to 3 × 420 VAC

3.4.3 LMSAxx – the compact power pack

- Three-phase, iron-core synchronous linear motor
- Very high power density
- Very flat design
- Intermediate circuit voltage up to 600 VDC
- Suitable for drives with up to 3 × 420 VAC
- UL certified

3.4.4 LMSCxx

- Three-phase, iron-core synchronous linear motor
- The forcer arranged between two stators suppresses magnetic forces of attraction
- This reduces the load on the guiding rail and generates a high power density on a relatively short carriage
- Intermediate circuit voltage up to 600 VDC
- Suitable for drives with up to 3 × 420 VAC

3.4.5 LMFxx/LMFAxx – the cooled heavy-duty drive

- Three-phase, iron-core synchronous linear motor
- Efficient liquid cooling system
- High power density
- Minimal cogging torque
- Intermediate circuit voltage up to 800 VDC
- Suitable for drives with up to 3 × 560 VAC
- UL certified

4. Transport and installation

4.1 Delivery

4.1.1 Packaging

As supplied, the linear motor components are wrapped in film inside padded cardboard packaging.

- Do not remove the film wrapping until just before installation.

4.1.2 Scope of delivery

Included in forcer delivery (primary part):

- Forcer with motor and temperature sensor cable or motor plug
- Type plate

Included in stator delivery (secondary part):

- Stator
- Type designation
- Adhesive safety labels

For the full scope of delivery, please see the contractual documentation. The forcer and stators may also be delivered separately.

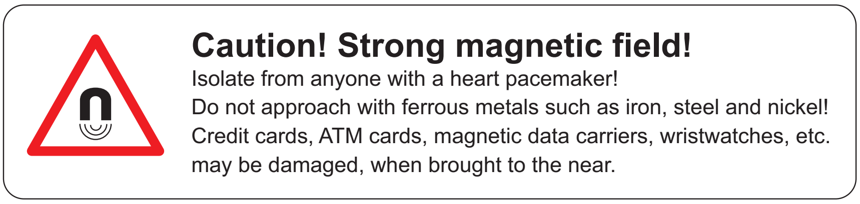


Fig. 4.1 **Adhesive safety labels on stator**

Examine on delivery that the supplied components corresponding to the descriptions in the contractual documentation. If you discover damage on the components or their packaging, report this immediately to the transport company. **Damaged components may not be put into operation!**

4.2 Transport to the installation site

⚠ WARNING!

Danger from strong magnetic fields!
Strong magnetic fields around linear motor components pose a health risk to persons with implants (e.g. cardiac pacemakers) that are affected by magnetic fields.

- Persons with implants that are affected by magnetic fields should maintain a safe distance of at least 1 m from linear motor components.

⚠ WARNING!

Risk of crushing from strong forces of attraction!
Danger of injury from crushing and damage to the rotor or stator caused by very strong forces of attraction from unpackaged stators.

- Do not remove stators from their packaging until directly before their installation!

ATTENTION!

Risk of physical damage to watches and magnetic storage media.
Strong magnetic forces may destroy watches and magnetisable data storage media near to the linear motor components!

- Do not bring watches or magnetisable data storage media into the vicinity (<300 mm) of the linear motors!

ATTENTION!

Damage of the linear motor components!
The linear motor components may be damaged by mechanical loading.

- During transport, do not transport any additional loads on the linear motor components!
- Secure the linear motor components against tilting!
- Do not raise or move the forcer by its cable strand!

Depending on the size and weight of each linear motor component, it may no longer be possible to transport these by hand. In these cases, suitable lifting equipment should be provided.

⚠ CAUTION!

Risk of injury and/or damage when stators are handled!

- The stators fitted with permanent magnets are not provided with magnetic shielding. Use antimagnetic fasteners when transporting the stators in lifting slings. These fasteners prevent the lifting slings from slipping during transport.

ATTENTION!

Magnetic fields may cause interference in an aircraft's onboard electronics!

- Observe the packaging and transport instructions (IATA 953)

4.3 Requirements at the installation site

4.3.1 Ambient conditions

Ambient temperature	+5 °C to +40 °C
Installation site	flat, dry, vibration-free
Atmosphere	not corrosive, not explosive

4.3.2 Safety equipment to be provided by the operator

Possible safety equipment/measures:

- Personal protective equipment in accordance with UVV (German accident prevention regulations)
- Zero-contact protective equipment
- Mechanical protective equipment

4.4 Storage

⚠ WARNING!

Danger from strong magnetic fields!
Strong magnetic fields around linear motor components pose a health risk to persons with implants (e.g. cardiac pacemakers) that are affected by magnetic fields.

- ▶ Persons with implants that are affected by magnetic fields should maintain a safe distance of at least 1 m from linear motor components.

- ▶ Store the linear motor components in its transport packaging.
- ▶ Do not store the linear motor components in explosive atmospheres or in environments exposed to chemicals.
- ▶ Only store the linear motor components in dry, frost-free areas with a corrosion-free atmosphere.
- ▶ Make sure that the motors are not subjected to vibrations or impacts while in storage.
- ▶ Clean and protect used linear motor components before storage.
- ▶ The ambient temperature for storing the motors should be between –10 and +50 °C.
- ▶ When storing the components, attach signs warning of magnetic fields.

4.5 Unpacking

⚠ WARNING!

Risk of crushing from strong forces of attraction!
There is a risk of crushing from the strong forces of attraction emitted by the stators, as they are assembled with opposing polarity!
- Assemble the stators carefully!
- Do not place fingers or objects between the stators!

⚠ WARNING!

Risk of crushing from strong forces of attraction!
Danger of injury from crushing and damage to the forcer or stator caused by very strong forces of attraction from unpackaged stators.
- Do not remove stators from their packaging until directly before their installation.

ATTENTION!

Damage of the linear motor components!
The linear motor components may be damaged by mechanical loading.
- During transport, do not transport any additional loads on the linear motor components!
- Secure the linear motor components against tilting!

NOTE

The linear motors may only be installed and operated indoors.

Do not remove stators from their packaging until directly before their installation.
- Remove the motor or stator from its packaging
- Remove protective film.
- Dispose of packaging in an environmentally friendly way.

5. Assembly and connection

⚠ DANGER!

Danger from electrical voltage!
Before and during assembly, disassembly and repair work, dangerous currents may flow.
- Work may only be carried out by a qualified electrician and with the power supply disconnected!
- Before carrying out work on the torque motor, disconnect the power supply and protect it from being switched back on!

⚠ WARNING!

Risk of crushing from strong forces of attraction!
There is a risk of crushing from the strong forces of attraction emitted by the stators, as they are assembled with opposing polarity!
- Assemble the stators carefully!
- Do not place fingers or objects between the stators!

⚠ WARNING!

Risk of crushing from the forcer!
Danger of injury from crushing and damage to the forcer through uncontrolled movements during assembly.
- Ensure that the forcer is locked in place during assembly using a lateral transportation safety device!

⚠ WARNING!

Risk of crushing from strong forces of attraction!
Danger of injury from crushing and damage to the forcer or stator caused by very strong forces of attraction.
- Prevent any loose metal or magnetic objects from coming too close to the stator!

⚠ CAUTION!

Danger from heavy loads!
Lifting heavy loads may damage your health.
- Use a hoist of an appropriate size when positioning heavy loads!
- Observe applicable occupational health and safety regulations when handling suspended loads!

The linear motor axis may only be assembled by specialist personnel. NOTE

The assembly instructions describe the basic procedure for installing the linear motor components. NOTE

They do not describe installation situations for specific machines. NOTE

5.1 Assemble the stators

⚠ WARNING!

Danger from strong magnetic fields!
Strong magnetic fields around linear motor components pose a health risk to persons with implants (e.g. cardiac pacemakers) that are affected by magnetic fields.
- Persons with implants that are affected by magnetic fields should maintain a safe distance of at least 1 m from linear motor components.

⚠ WARNING!

Risk of crushing from strong forces of attraction!
There is a risk of crushing from the strong forces of attraction emitted by the stators, as they are assembled with opposing polarity!
- Assemble the stators carefully!
- Do not place fingers or objects between the stators!

⚠ WARNING!

Risk of crushing from the forcer!
Danger of injury from crushing and damage to the forcer through uncontrolled movements during assembly.
- Ensure that the forcer is locked in place during assembly using a lateral transportation safety device!

- (1) Clean mounting surface
- (2) Take a stator out of the packaging
- (3) Position the stator on the mounting surface
- (4) Secure the stator with mounting bolts
- (5) Take the next stator out of the packaging
- (6) Position the stator on the mounting surface. Note the alignment of the magnetic poles.
- (7) Secure the stator with mounting bolts
- (8) Repeat from (5) until all stators have been installed

✓ The stators are assembled.

NOTE

Secure the bolts with suitable screw retention. The screw union must be suitable for the surrounding structure.

Table 5.1 **Recommended mounting bolts and tightening torques for the stators**

Stator	Mounting bolt (DIN EN ISO 4762)			
	Thread	**Length [mm]**	**Strength class**	**Recommended tightening torque [Nm]**
LMSA1Sx	M4	10	8.8	3.0
LMSA2Sx	M5	12	8.8	5.9
LMSA3Sx	M5	12	8.8	5.9
LMF0Sx	M4	12	8.8	3.0
LMF1Sx	M5	14	8.8	5.9
LMF2Sx	M5	14	8.8	5.9
LMF3Sx	M8	18	8.8	24.6
LMF4Sx	M8	20	8.8	24.6
LMF5Sx	M8	16	8.8	24.6
LMF6Sx	M8	18	8.8	24.6
LMCASx, LMCBSx	M5	35	8.8	5.9
LMCCSx	M6	40	8.8	10.1
LMCDSx, LMCESx	M6	40	8.8	10.1
LMCFSx	M6	45	8.8	10.1

5.1.1 Segmented stator

⚠ WARNING!

Risk of damage or injury from a malfunction and/or uncontrolled movement by the motor!
- Connect the stator segments correctly in sequence!

When using multiple stator segments over the whole travel distance, pay the greatest attention to the pole sequence and the flush alignment (see Fig. 5.1).

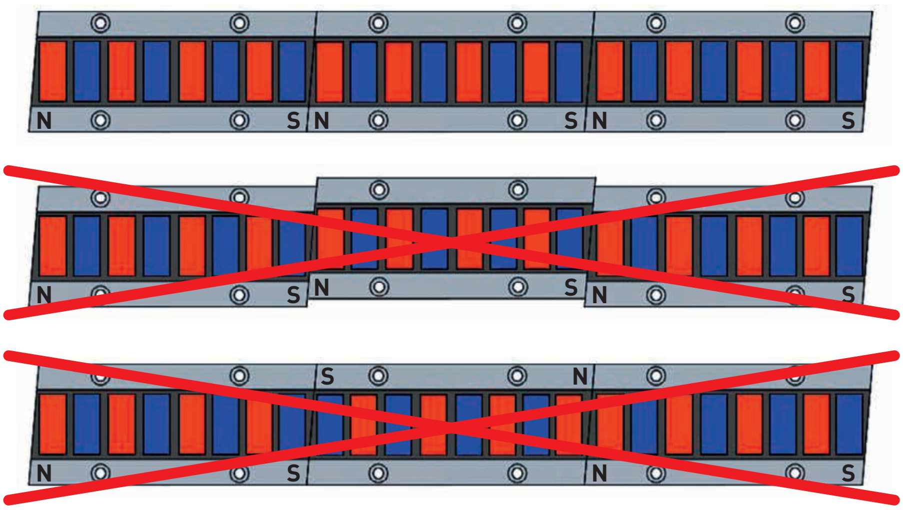


Fig. 5.1 **Connecting multiple stator segments in series**

⚠ WARNING!

The forces of attraction and repulsion between the stator segments may cause injury or damage when they are being connected in series!
- Secure against uncontrolled movement
- Do not remove the packaging until directly before installation in the machine

Depending on the size of the secondary part segments, the forces of attraction and repulsion between them may range from 50 N to about 350 N when they are being connected in series.

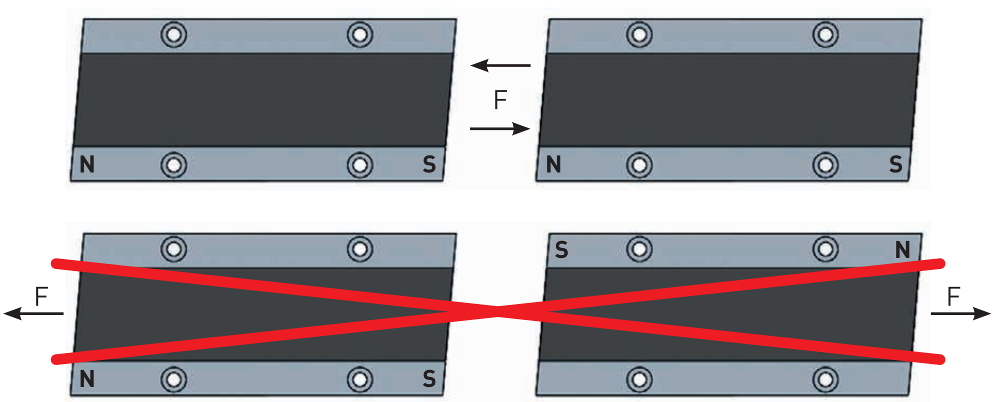


Fig. 5.2 **Forces of attraction and repulsion between stator segments when they are being connected in series**

5.2 Assemble block and forcer

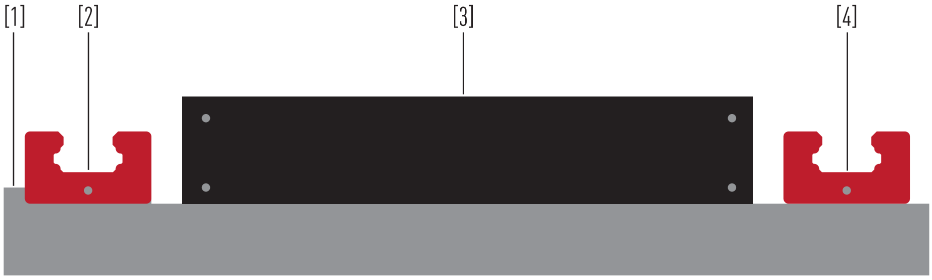


Fig. 5.3 **Configuration of the block and forcer on the carriage**

Table 5.2 **Components of the block with forcer**

Position	Components
1	Stop edge of the reference block
2	Reference block
3	Forcer
4	Following block

NOTE

The forcer must lie over its whole surface on the carriage for the optimal heat transfer between these two components.

NOTE

- Using suitable mounting bolts, screw the forcer [3] to the carriage, from the inside to the outside (see Fig. 5.4). See Table 5.3 and Table 5.4 for the tightening torques.
- Secure the screws with retaining rings to prevent them from accidentally coming loose!

✓ The forcer is assembled.

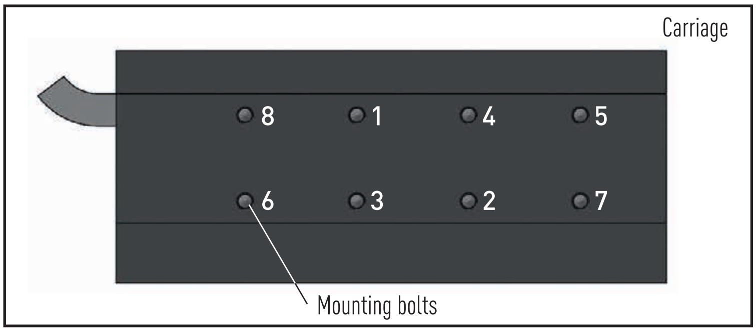


Fig. 5.4 **Tightening pattern on the forcer's mounting bolts**

Table 5.3 **Recommended mounting bolts and tightening torques for the forcers – fasteners at top**

Forcer	Mounting bolt (DIN EN ISO 4762)			
	Thread	**Thread reach [mm]**	**Strength class**	**Recommended tightening torque [Nm]**
LMS	M6	9	8.8	10.1
LMSA	M4	4	8.8	3.0
LMFA0, LMFA1, LMFA2	M5	10	8.8	5.9
LMFA3, LMFA4, LMFA5, LMFA6	M8	11	8.8	24.6
LMCA, LMCB, LMCC	M3	4.5	8.8	1.3
LMCD	M5	6	8.8	5.9
LMCF	M5	6	8.8	5.9

Table 5.4 **Recommended mounting bolts and tightening torques for the forcers – fasteners on side**

Forcer	Mounting bolt (DIN EN ISO 4762)			
	Thread	Thread reach [mm]	Strength class	Recommended tightening torque [Nm]
LMCA, LMCB, LMCC	M4	5	8.8	3.0
LMCD	M4	8	8.8	3.0
LMCF	M5	9	8.8	5.9

5.2.1 Assemble carriage with forcer

⚠ WARNING!

Risk of crushing from strong forces of attraction!

Danger of injury from crushing and damage to the forcer or stator caused by very strong forces of attraction.

▶ Ensure that the forcer only comes close to the stator when the linear guideway can absorb the forces!

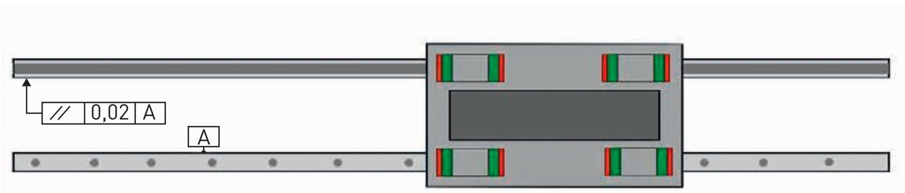
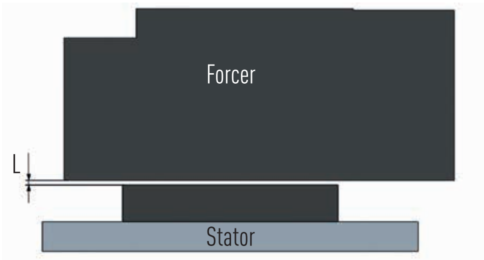


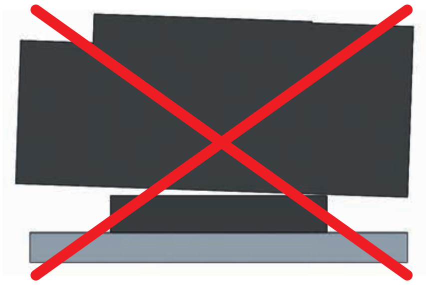
Fig. 5.5 **Assemble carriage with forcer**

5.2.2 Mounting tolerances

5.2.2.1 Air gap between forcer and stator

After installation, the air gap L between the stator and forcer must be measured. Too small an air gap can cause damage to the motor and the guiding system. Too large an air gap causes a loss of motor force. The air gap is measured with a nonmagnetic (brass) feeler gauge. The size of the air gap depends on the series. See the motor data sheets in Section 11.





L = Air gap

Fig. 5.6 **Alignment of the linear motor components**

ATTENTION!
An inadequate air gap between the forcer and stator will damage the motor! ▶ After installing the linear motor components, verify the minimum air gap needed between the forcer and stator.

5.2.2.2 Evenness of the mounting surface

The evenness of the forcer's mounting surface must be at least 0.02 mm, and the stators' at least 0.05 mm per 500 mm of stator length.

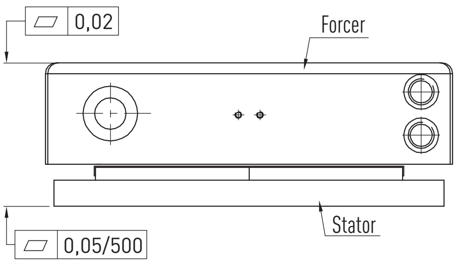


Fig. 5.7 **Evenness of the mounting surface**

5.3 Electrical connection

DANGER!

Danger from electrical voltage!
If linear motors are incorrectly earthed, there is a danger of electric shock.
- Before connecting the electrical power supply, ensure that the linear motor is correctly earthed!

DANGER!

Danger from electrical voltage!
Electrical currents may flow even if the motor is not moving.
- Ensure that the linear motor is disconnected from the power supply before the electrical connections are detached from the motors.
- After disconnecting the drive amplifier from the power supply, wait at least 5 minutes before touching live parts or breaking connections.
- For safety reasons, measure the voltage in the intermediate circuit and wait until it has fallen below 40 V.

Observe the separate assembly instructions of the drive amplifier! NOTE

5.3.1 Motor cables

The motor and temperature sensor cables delivered as standard are listed in Table 5.5.

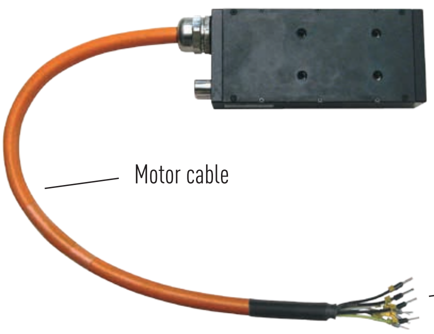


Fig. 5.8 **Motor cable with open cable ends**

Table 5.5 **Motor cables delivered as standard**

Motor type	Cable length [mm]	Cable ends	Cable diameter [mm]	
			Motor	Temperature sensor
LMS	500	Open cable ends	10	2.8
LMSA	1,000	Open cable ends	9.2	2.8
LMFA	1,000	Open cable ends		
LMC	500	Open cable ends	7.5	7.5

Optionally, the motor cables can be delivered with assembled plugs matching the HIWIN extension cables. Also, you can choose from motor plugs mounted directly on the LMF and LMFA linear motors.

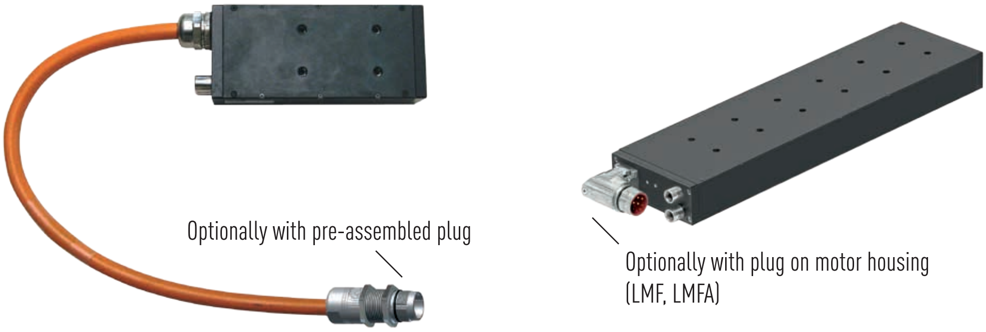


Fig. 5.9 **Connecting the motor plug**

NOTE

Maximum length of the supply cable 10 m, for intermediate circuit voltage 560 V.
For longer cables, suitable filters must be fitted to prevent voltage peaks!

5.3.2 Recommended motor plugs for iron-core motors

The temperature sensor system cable is routed as standard through the motor's extension cable. Both cables are therefore connected to the motor plug. For continuous currents up to 30 A, we recommend the M23 couplings and plugs; for continuous currents over 30 A, the M40 couplings and plugs.

Table 5.6 **Recommended motor plugs up to 30 A continuous current for LMS, LMSA, LMSC and LMFA motors**

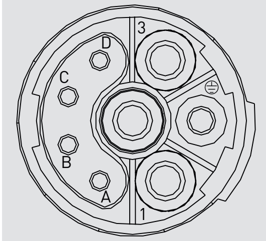
Coupling M23/M40, 8-pin	Plug M23/M40, 8-pin	Pole configuration
		 Plug-side view of coupling

Table 5.7 **Pin assignment in motor plug M23/M40, 8-pin**

Motor cable	Pin no.	Signal	Function	Extension cable
Black-1	1	U	Motor phase	Black-1
Black-2	4	V	Motor phase	Black-2
Black-3	3	W	Motor phase	Black-3
LMF, LMFA				
Red	A	T+ [1)]	Thermal protection	Red
Yellow	B	T– [1)]	Thermal protection	Yellow
Black	C	T+ [2)]	Thermal protection	Black
White	D	T– [2)]	Thermal protection	White
LMS, LMSA, LMSC				
Brown	A	T+ [1)]	Thermal protection	Red
Blue	B	T– [1)]	Thermal protection	Yellow
–	C	–	–	Black
–	D	–	–	White
Green/yellow	Protective earth/ground		GND	Green/yellow

[1)] PTC temperature sensor
[2)] PT1000/KTY84 temperature sensor (LMF, LMFA only)

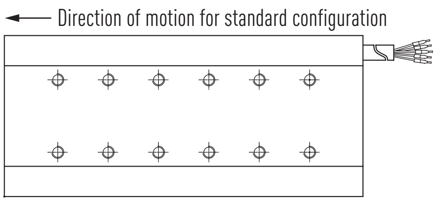


Fig. 5.10 **Direction of movement for connection according to Table 5.7**

5.3.3 Recommended motor plugs for ironless motors

The temperature sensor system cable is routed as standard through the motor's extension cable. Both cables are therefore connected to the motor plug.

Table 5.8 **Recommended motor plugs suitable for LMC motors**

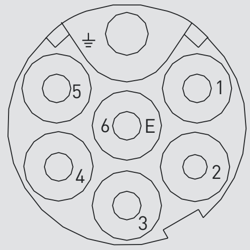
Coupling M17, 7-pin	Plug M17, 7-pin	Pole configuration
		
		Plug-side view of coupling

Table 5.9 **Pin assignment in motor plug M17, 7-pin**

Motor cable	Pin no.	Signal	Function	Extension cable
Brown	1	U	Motor phase	Black-1
White	4	V	Motor phase	Black-2
Grey	3	W	Motor phase	Black-3
Yellow	5	T+ [1]	Thermal protection	Black-5
Green	6	T– [1]	Thermal protection	Black-6
	2		Not assigned	
Green/yellow	Protective earth/ground		GND	Green/yellow

[1] PTC temperature sensor

Direction of motion for standard configuration →

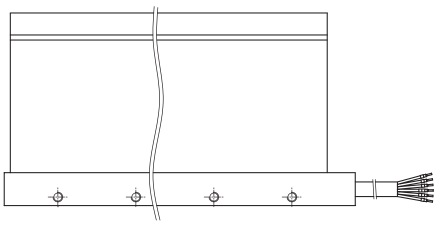


Fig. 5.11 **Direction of movement for connection according to Table 5.9**

5.3.4 Temperature sensor function and connection

5.3.4.1 Temperature monitoring

To protect the motor windings against thermal damage, every motor is equipped with a triple positive temperature coefficient (PTC) sensor, type SMN100 (LMC linear motor) or SNM120 (LMS, LMSA, LMSC, LMF, and LMFA linear motors) in accordance with DIN 44082-M180. Since the degree of heating of the individual motor phases can be very different in direct drives, a PTC sensor is fitted in each phase winding (U, V and W). Each PTC element has a "quasi-switching" characteristic, i.e. the resistance suddenly increases close to the rated temperature (switching threshold, see Fig. 5.12). As a result of the low thermal capacity and good thermal contact with the motor winding, the PTC sensor responds very quickly to a temperature increase, thus ensuring reliable motor protection. The PTC elements located in every phase winding in HIWIN motors are wired in series; they connect via two wires.

NOTE

These PTC elements do not have a linear characteristic curve and therefore are not suitable for determining the current motor temperature.
It is a mandatory requirement that the PTC elements are connected to protect the motor.

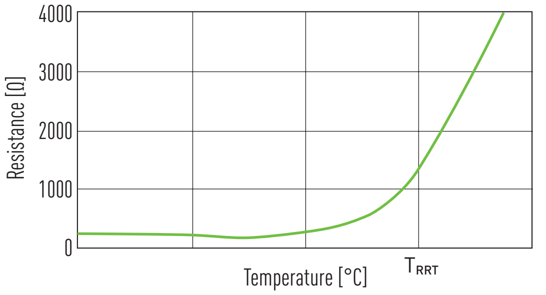


Fig. 5.12 **PTC sensors characteristic curve (T_{RRT} = rated response temperature)**

5.3.4.2 Temperature measurement

Some frequency converters have the capability of adjusting the temperature-dependent motor parameters according to the measured motor temperature. To determine the current motor temperature, it is usual to integrate a PTC thermistor into the motor.
The PTC thermistor has a nearly linear characteristic curve (see Fig. 5.13 and Fig. 5.14) and is therefore well suited to temperature measurement.
The PTC thermistor is placed between two phase windings in the motor. If an excessive temperature occurs in a phase winding that is not monitored, this cannot be displayed or evaluated immediately. Furthermore, the PTC thermistor has slow response characteristics compared to the "quasi-switching" PTC element, which are insufficient for rapid shutdown.

NOTE

It is not acceptable to evaluate the PTC thermistor for motor protection purposes.

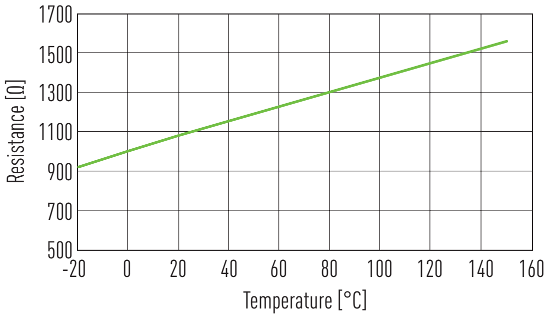


Fig. 5.13 **PT1000 sensors characteristic curve (standard)**

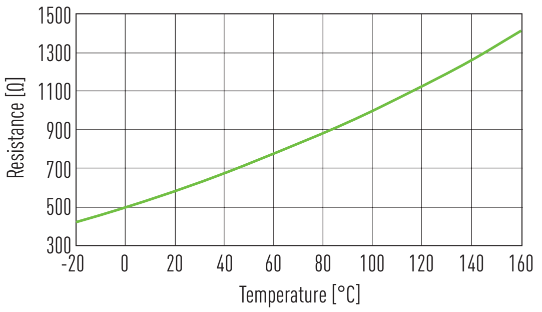


Fig. 5.14 **KTY sensors characteristic curve (option)**

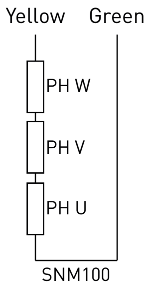


Fig. 5.15 **Temperature sensor: LMC**

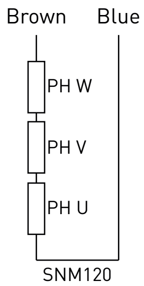


Fig. 5.16 **Temperature sensor: LMS, LMSA, LMSC**

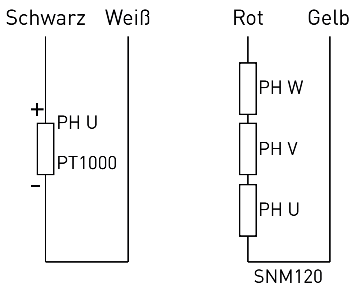


Fig. 5.18 **Temperature sensor: LMFA (standard)**

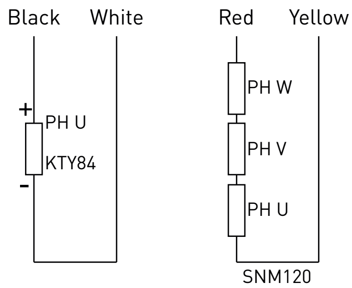


Fig. 5.17 **Temperature sensor: LMFA (option)**

Connection to the drive amplifier

The temperature monitoring circuits can normally be connected directly to the drive control. If the protective separation requirements in accordance with EN 61800-5-1 are to be fulfilled, the sensors must be connected to the decoupling modules provided by the drive manufacturers.

5.3.5 Extension cables

NOTE

If cables other than those listed are used, this may lead to damage and malfunctioning. The manufacturer shall not be liable for damages arising from use of unapproved cables.

NOTE

Maximum length of the supply cable 10 m, for intermediate circuit voltage 560 V. For longer cables, suitable filters must be fitted to prevent voltage peaks.

Fig. 5.19 **Extension cable for linear motors (iron-core)**

Table 5.10 **Extension cables for LMS, LMSA, LMSC and LMFA motors (iron-core)**

Article number	Designation	Cross section	Plug	Length [m]
8-10-0069	Chainflex CF27.15.05.04.D	4 × 1,5 mm²; 4 × 0,5 mm²	M23, 8-pin	3
8-10-0070				5
8-10-0071				8
8-10-0072				10
8-10-0074				15
8-10-0593	Chainflex CF27.25.05.04.D	4 × 2,5 mm²; 4 × 0,5 mm²	M23, 8-pin	3
8-10-0594				5
8-10-0595				8
8-10-0596				10
8-10-0598				15
8-10-0946	Chainflex CF27.40.05.04.D	4 × 4,0 mm²; 4 × 0,5 mm²	M23, 8-pin	3
8-10-0971				5
8-10-0972				8
8-10-0973				10
8-10-0947				15
8-10-0879	Chainflex CF27.40.05.04.D	4 × 4,0 mm²; 4 × 0,5 mm²	M40, 8-pin	3
8-10-0880				5
8-10-0881				8
8-10-0882				10
8-10-0974				15

Fig. 5.20 **Extension cable for linear motors (ironless)**

Table 5.11 **Extension cables for LMC motors (ironless)**

Article number	Designation	Cross section	Length [m]
8-10-0258	Chainflex CF10.07.07	7 × 0,75 mm²	3
8-10-0259			5
8-10-0260			8
8-10-0261			10
8-10-0263			15

We recommend for LMCF motors the extension cables of 1.5 mm² cross section listed in Table 5.10

5.3.6 Hall sensors (optional)

⚠ **CAUTION!**

An incorrectly installed or connected Hall sensor may cause uncontrolled motor movements and damage the machine.

Hall sensors with analogue and digital output signal are available for each linear motor. The analogue Hall sensors have a sin/cos output signal of 1 V_{SS} (see Fig. 5.21). The digital Hall sensors have three square signals offset through 120° (see Fig. 5.22).

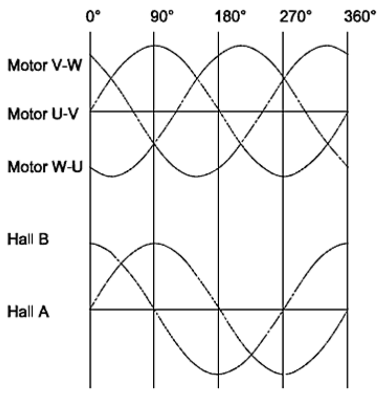


Fig. 5.21 **Output signal from analogue Hall sensor with differential output**

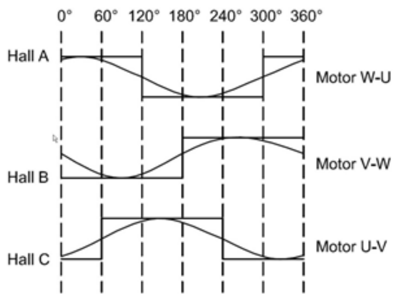


Fig. 5.22 **Output signal from digital Hall sensor with single ended output**

- Sensor signal either 0 or 1
- A combined analysis of the motor voltage supply and Hall sensor determines reliably the motor's sense of direction
- Analysis based on the rotor displacement angle between 0° and 90° (ideally 0° and 45°)

5.3.6.1 Assembling the Hall sensor

Use two M3 screws to secure the Hall sensor to the mounting holes provided for the forcer. If the Hall sensor is not secured directly to the forcer, but e.g. on the carriage, then the distance between the forcer and Hall sensor must always be an integral multiple of the Pole pair pitch 2τ (see technical data for the affected series). On this assembly variant, the supplied spacers can be used for precise adjustments to the distance. The Hall sensor must be mounted flush to the bottom side of the forcer.

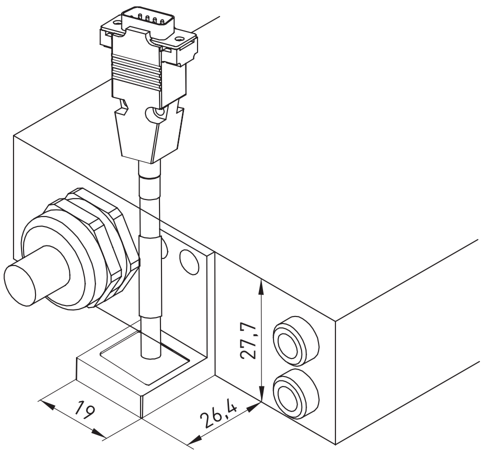


Fig. 5.23 **Example mounting of a Hall sensor to an LMFA linear motor**

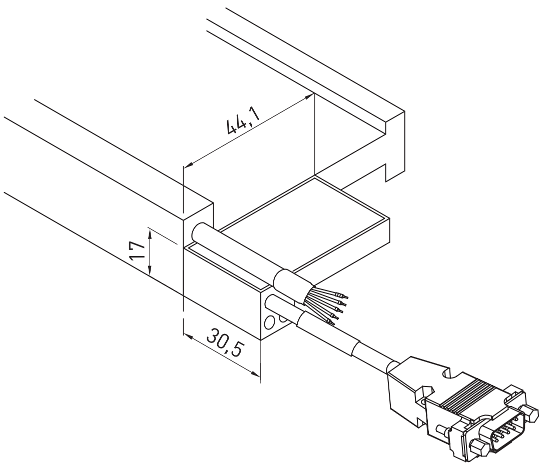


Fig. 5.24 **Example mounting of a Hall sensor to an LMC linear motor**

5.3.6.2 Connecting the Hall sensor

The Hall sensors are delivered with open cable ends, M17 round connectors, or 9-pin sub-D connectors.

Connecting the analogue Hall sensor

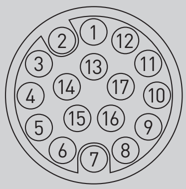
Pin assignment of open cable ends (cable length 500 mm):

Table 5.12 **Pin assignment of Hall sensor with open cable ends**

Colour of Hall sensor cable	Signal
Blue	Hall A+
Green	Hall A–
Yellow	Hall B+
Grey	Hall B–
White	5 V
Brown	0 V
Shielding	Shielding

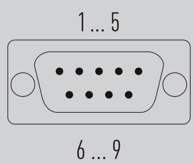
Pin assignment of round connector (coupling) M17, 17-pin (cable length 500 mm):

Table 5.13 **Pin assignment of Hall sensor round connector**

Colour of Hall sensor cable	Coupling M17 – pin no.	Signal	Drawing
Blue	9	Hall A+	
Green	1	Hall A–	
Yellow	10	Hall B+	
Grey	2	Hall B–	
White	4	5 V	
Brown	12	0 V	
Housing	Housing	Shielding	

Assignment of 9-pin Sub-D connector (cable length 500 mm):

Table 5.14 **Pin assignment of Hall sensor Sub-D connector**

Colour of Hall sensor cable	Coupling M17 – pin no.	Signal	Drawing
Blue	2	Hall A+	
Green	3	Hall A–	
Yellow	4	Hall B+	
Grey	5	Hall B–	
White	1	5 V	
Brown	6	0 V	
Housing	Housing	Shielding	

Connecting the digital Hall sensor

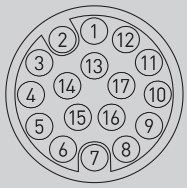
Pin assignment of open cable ends (cable length 500 mm):

Table 5.15 **Pin assignment of Hall sensor with open cable ends**

Colour of Hall sensor cable	Signal
White	Hall A
Grey	Hall B
Yellow	Hall C
Brown	5 V
Green	0 V
Shielding	Shielding

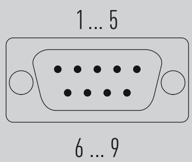
Pin assignment of round connector (coupling) M17, 17-pin (cable length 500 mm):

Table 5.16 **Pin assignment of Hall sensor round connector**

Colour of Hall sensor cable	Coupling M17 – pin no.	Signal	Drawing
White	14	Hall A	
Grey	16	Hall B	
Yellow	17	Hall C	
Brown	5	5 V	
Green	13	0 V	
–	Housing	Shielding	

Assignment of 9-pin Sub-D connector (cable length 500 mm):

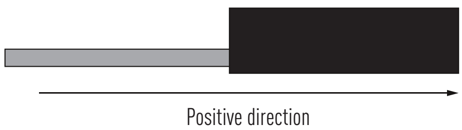
Table 5.17 **Pin assignment of Hall sensor Sub-D connector**

Colour of Hall sensor cable	Coupling M17 – pin no.	Signal	Drawing
White	2	Hall A	
Grey	3	Hall B	
Yellow	4	Hall C	
Brown	1	5 V	
Green	5	0 V	
–	Housing	Shielding	

Analogue Hall sensor signals are analysed via a second encoder input.
Tracks A and B must be modified to the counting direction and the motor's mounted position.

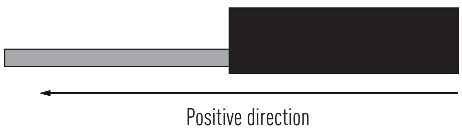
Hall sensor counts in the direction of the positioning measurement system.
Positive travel direction away from the motor cable.

Positioning measurement system:	Track sin	Track cos
Hall sensor:	Track A	Track B



Hall sensor counts in the opposite direction of the positioning measurement system.
Positive travel direction towards the motor cable.

Positioning measurement system:	Track sin	Track cos
Hall sensor:	Track B	Track A



5.4 Connecting liquid cooling (LMFA linear motors)

The LMFA series can be connected to a liquid cooling system. The linear motor's continuous force can therefore be increased without the additional input of process heat.

5.4.1 Setting up/connecting the liquid cooling system

All cooler connectors for the LMFA motor series are designed as Rc1/8" pipe threads. Corresponding adaptors must be used for tubes/pipes.

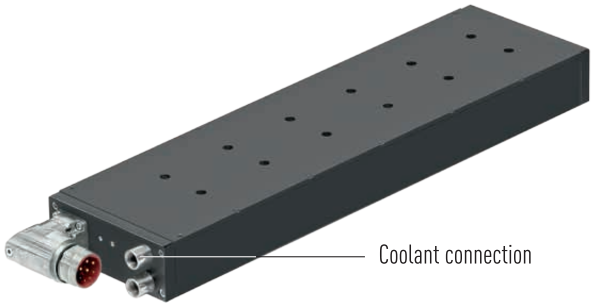


Fig. 5.25 **Cooling connections on forcer LMFA**

The materials of the couplings and seals must be tested for their compatibility with the coolant and its constituents. Suitable connectors for a coolant circle are for example adaptors from the company Serto GmbH.
The recommended cooling conduit is a Jacoflon tube in a PTFE pipe with single-ply wire mesh. This can also be purchased from the company Serto GmbH.
Owing to their diffusion properties, we do not recommend the use of plastic hosing.

NOTE

These recommendations are for outside products whose basic suitability is known to us.
Of course, equivalent products from other manufacturers may also be used. Our recommendations are intended to be an aid, not a stipulation. We never grant any warranties on the quality of outside products.

Contact details:
SERTO GmbH
www.serto.de

5.4.2 Determination and meaning of inlet temperature

There are essentially two quantities that are important in the determination of the cooler's inlet temperature: The power density of the motor and condensation.

Power density:
The lower the cooler's inlet temperature, the larger the heat rate that can be drawn out of the motor. This raises the motor's power density.

Condensation:
The motor itself is impervious to condensation, but the latter can cause damage to the surrounding machinery, e.g. corrosion. The inlet temperature should therefore be no lower than 3 K below the ambient temperature.

NOTE

The basic rule of thumb for determining the inlet temperature is as follows.

- **As low as possible for high power densities**
- **As high as needed to prevent condensation**

5.4.3 Coolant: Type and requirements

ATTENTION!

Chemical reactions can cause damage to linear motors and machine components!
- Mixtures of monoethylene glycol and water without inhibitors must not be used.
- Examine combined materials for their compatibility.

The coolant is provided by the customer. Only water with an anticorrosive may be used as the coolant. This is important because untreated water can cause serious damage or disruption as a consequence of mineral scale, mould and algae formation, and corrosion, e.g.
- Reduced cooling efficiency
- Greater pressure losses in the cooling circuit
- Wear on elements in the cooling circuit (e.g. valves, gates, jets)

The cooling water must therefore contain an anticorrosive that reliably counteracts deposits and corrosion even under extreme conditions.
Owing to the risk of dirt and deposits, it is not recommended to use the machine's coolant/lubricant circuit. The coolant must be precleaned or filtered. Contaminated or unfiltered contaminant can clog the cooling circuit.

NOTE

Maximum particle size in the coolant used: < 100 µm

The water must fulfil the following requirements:
- Chloride concentration: c < 100 mg/l
- Sulphate concentration: c < 100 mg/l
- 6.5 ≤ ph value ≤ 9.5

The anticorrosive must fulfil the following requirements:
- (Mono)ethylene glycol basis
- The water and anticorrosive may not separate
- The anticorrosive used must be compatible with the cooler's adapters, hosing, and materials.

Check these requirements, specifically for material compatibility, with the manufacturer of the cooler or coolant!

Corrosion inhibitors include:
- Antifrogen N (made by Hoechst)

We recommend the following contact for dimensioning, design and operation of cooling systems:
BKW K-W-V GmbH
www.bkw-kuema.de

The following materials inside the motor come into contact with the coolant:
- Connections: Nickel plated brass or steel
- Inner tube: Copper

5.4.4 Dimensioning the cooler

The cooler's dimensions depend on the pressure drop and the motor power loss drawn into the cooling circuit. The calculations below take as their example an LMFA34 motor with water cooling.

The motor power loss can be calculated with the following formula.

$$P = \left(\frac{F}{K_m}\right)^2$$

P	Motor power loss [W]
F	Motor continuous force [N]
K_m	Motor constant [N/√W]

The motor constant can be taken from the motor's data sheet. The continuous force is the mean continuous force in the actual application.

Figures from the data sheet:

Motor constant:	K_m	96.9 N/√W
Motor pressure drop:	Δp_m	1.28 bar

The example calculation uses the motor's continuous force F_c = 1,519 Nm

Coolant (water) properties:

Density	ρ	0.998 kg/dm³
Specific heat capacity	c	4.1813 kJ/kg K
Dyn. Viscosity at 20 °C	η	1.00 mPa s

$$P = \left(\frac{1{,}519\,N}{96.9\,N} \times \sqrt{W}\right)^2 = 245.74\,W$$

The resulting motor power loss is 245.74 W, which must be drawn off in the coolant.

Calculating the pressure drop first involves determining the volumetric flow rate used for cooling. This analyses the coolant's temperature changes at various volumetric flow rates.

$$\Delta\vartheta = \frac{P \times 60}{Q \times \rho \times c}$$

$\Delta\vartheta$	Change in coolant temperature [K]
P	Motor power loss [kW]
Q	Volumetric flow rate [l/min]
ρ	Coolant density [kg/dm³]
c	Specific heat capacity [kJ/kg K]

Table 5.18 **Change in coolant temperature as a function of volumetric flow rate**

Volumetric flow rate Q [l/min]	0.5	1	2	3	4	5	6	7	8	9	10
Change in coolant temperature $\Delta\vartheta$ [K]	7.07	3.53	1.77	1.18	0.88	0.71	0.59	0.50	0.44	0.39	0.35

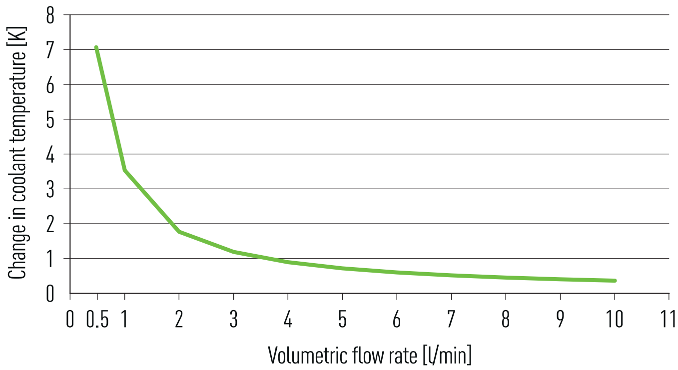


Fig. 5.26 **Change in coolant temperature (water) in kelvins under continuous current during LMF34 motor downtime**

The graph shows that at low volumetric flow rates there are large temperature changes between the supply and return. Make sure that the temperature change is no greater than 2 K, otherwise disruptive temperature differences may occur on the motor's surface. A flow of 2 l/min would be adequate in the example shown.

Now the pressure drop can be calculated in the connecting cable. The decisive criteria here are the cable length and its internal diameter.

$$\Delta p_L = \frac{128 \times \eta \times L \times Q}{6{,}000{,}000 \times \pi \times d^4}$$

Δp_L Pressure drop [bar]
η Dyn. viscosity [mPa s]
L Cable length [mm]
Q Volumetric flow rate [ml/min]
d Internal cable diameter [mm]

NOTE

The maximum pressure for all motors is 10 bar

The following table lists the calculated pressure drops for a volumetric flow rate of 2 l/min (water) through various cable lengths and diameters.

Table 5.19 **Pressure drop in the cooling conduit as a function of diameter and cable length**

Cable length [mm]	Pressure drop 1/8" [bar]	Pressure drop 1/4" [bar]	Pressure drop 1/2" [bar]
1,000	0.13	0.01	0.001
2,000	0.27	0.02	0.001
3,000	0.40	0.03	0.002
4,000	0.53	0.03	0.002
5,000	0.67	0.04	0.003
6,000	0.80	0.05	0.003
7,000	0.94	0.06	0.004
8,000	1.07	0.07	0.004
9,000	1.20	0.08	0.005
10,000	1.34	0.08	0.005
12,000	1.60	0.10	0.006
14,000	1.87	0.12	0.007
16,000	2.14	0.13	0.008
18,000	2.41	0.15	0.009
20,000	2.67	0.17	0.010

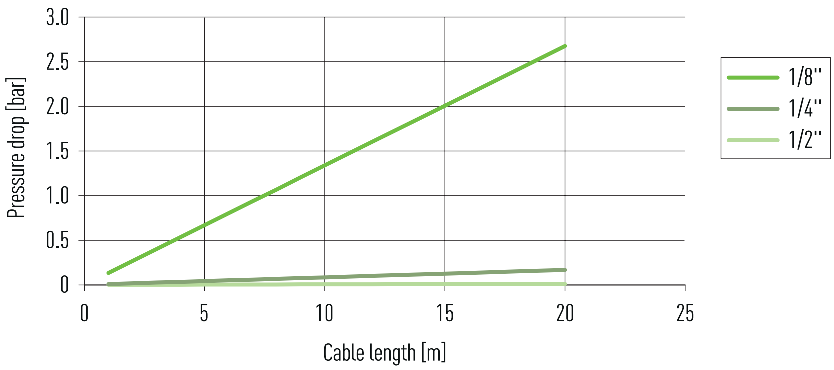


Fig. 5.27 **Pressure drop in the cooling conduit as a function of diameter and cable length**

The pressure drop increases sharply in a 1/8'' hose. A hose of at least 1/4'' is therefore recommended. The pressure loss over the whole system is obtained when the separate pressure drops are now added.

$$\Delta p = \Delta p_m + \Delta p_L$$

Δp Total pressure drop [bar]
Δp_L Pressure drop over the cable [bar]
Δp_m Pressure drop across the motor [bar]

$$\Delta p = 1.28\,\text{bar} + 0.03\,\text{bar} = 1.31\,\text{bar}$$

This motor requires a water cooler delivering about 250 W and 2 l/min under about 1.5 bar through a 3 m long 1/4'' hose.

6. Commissioning

6.1 Switch on the linear motor

⚠ **CAUTION!**

Risk of burns!
The motor heats up during operation and thus touching the motor can lead to burns!
- Provide protective devices and warning notices at the motor!

ATTENTION!

Danger of material damage!
Danger of material damage through uncontrolled movements of the forcer in the case of a power cut!
- Make sure that suitable end stops are fitted at the end positions or that clamping or braking elements are engaged!

NOTE

The operator should provide a controller pursuant to DIN EN ISO 12100 that prevents the machine from being started up unintentionally after power is restored, troubleshooting or the machine is stopped.

- Switch off the controller
- Pull out the motor cable
- If applicable connect positioning measurement system cable
- Switch on the controller
- If applicable check the positioning measurement system (see separate assembly instructions for the drive amplifier and positioning measurement system)
- Switch off the controller
- Connect the motor cable (see section 5.3)
- Switch on the controller
- Perform test run at slow speed
- Perform test under usage conditions

✓ The linear motor is ready for operation.

6.2 Programming

NOTE

The programming of the linear motor depends on the controller and drive amplifier used. Observe the assembly instructions for the controller and drive amplifier!

7. Maintenance and cleaning

7.1 Maintenance

⚠ **WARNING!**

Unauthorised repairs on the system
Unauthorised work on the system creates the risk of injuries and may invalidate the warranty.
- The system must only be serviced by specialist personnel!

Use only suitable, non-hazardous agents. Please observe the manufacturer's safety data sheets. **NOTE**

During maintenance:
- Secure the linear motor against being switched on without authorisation
- Disconnect the power supply of the linear motor
- Secure the linear motor against being switched back on without authorisation

Ensure that permissible ambient conditions, voltage and current loads are observed! **NOTE**

- Direct drive components are maintenance-free because they work on a non-contact basis.

7.2 Cleaning

⚠ **CAUTION!**

Aggressive media
Using aggressive media for cleaning creates the risk of injury and of damaging the torque motor components.
- Use only suitable, non-hazardous agents.
- Check the safety data sheets!

Dirt can settle and accumulate over time on the linear motor components. The linear motor components must therefore be regularly checked for dirt and cleaned if necessary, e.g. using a 70 % alcohol solution.

8. Faults

8.1 Faults with the motor

Table 8.1 **Fault table**

Fault	Possible cause	Remedy
Forcer does not start	Supply lines disconnected	Check connections, plug contacts may be compressed, repair if necessary. The connectors have seals, which means that a certain screw connection resistance must be overcome.
	Fuse has tripped via motor protection	Check motor protection for the right settings, remedy defects if necessary
Motor turns in the wrong direction	Encoder setting wrong	Check settings
	Input phase fault	Change over two phases on the motor
Smell of burning	Controller setup parameters are incorrect	1. Check controller settings 2. Check cooling system
	Cooling system not working properly	
	Controller setting does not match the motor parameters	
Communication fault	Motor phase connected incorrectly	Check drive amplifier, check nominal value
Forcer hums and has a high current consumption	Forcer is jammed	Check forcer
	Brake jammed	Check air pressure and power supply
	Fault in encoder cable	Check encoder cable
	Problem with motor insulation	Check resistance values > 50 MΩ (phase/earth and phase/sensor)
Forcer heats up too much (measure temperature)	Controller setting incorrect	Check controller settings
	Overload	Carry out power measurement, if necessary use a larger forcer or reduce load
	Cooling insufficient	Rectify cooling air supply or open cooling air passages, retrofit external fan if necessary
	Ambient temperature too high	Observe permissible temperature range
	Rated duty cycle exceeded, e.g. duty cycle too long	Adjust forcer's rated duty cycle to the necessary operating conditions
	Damaged bearings	Check bearings
Abnormal friction noise or friction torque too high	Dirt in air gap	Remove dirt

8.2 Faults during operation with drive amplifier

The faults described in chapter 8.1 „Faults with the motor" can also occur while operating the linear motor with a drive amplifier. For interpretation of faults and information on how to remedy them, see the drive amplifier manufacturer's installation instructions.

9. Disposal

ATTENTION!

Danger caused by environmentally hazardous substances!

The danger to the environment depends on the type of substance used.

- Clean contaminated parts thoroughly before disposal!
- Clarify the requirements for safe disposal with disposal companies and, where appropriate, with the competent authorities!

Table 9.1 **Disposal**

Fluids	
Lubricants	Dispose of as hazardous waste in an environmentally friendly way
Soiled cleaning cloths	Dispose of as hazardous waste in an environmentally friendly way
Linear motor	
Cabling, electrical components	Dispose of as electrical waste
Polypropylene (PP) components	Dispose of separately
Aluminium components (housing)	Dispose of separately
Iron components	Dispose of separately
Copper components	Dispose of separately
Brass, nickel-plated components (plug connector materials)	Dispose of separately
Nitrile butadiene rubber (NBR) components (seals)	Dispose of separately
Stainless steel components (bolts)	Dispose of separately

10. Appendix 1: Type plate and order codes

10.1 Type plate

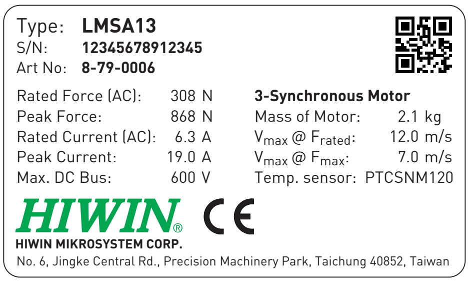
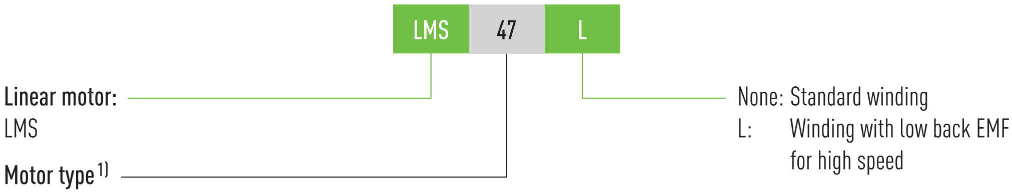


Fig. 10.1 **Type plate (example only)**

10.2 Order codes

10.2.1 Order code for LMS linear motors



1) See technical data in section 11.1

Fig. 10.2 **Order coder of LMS primary part (forcer)**

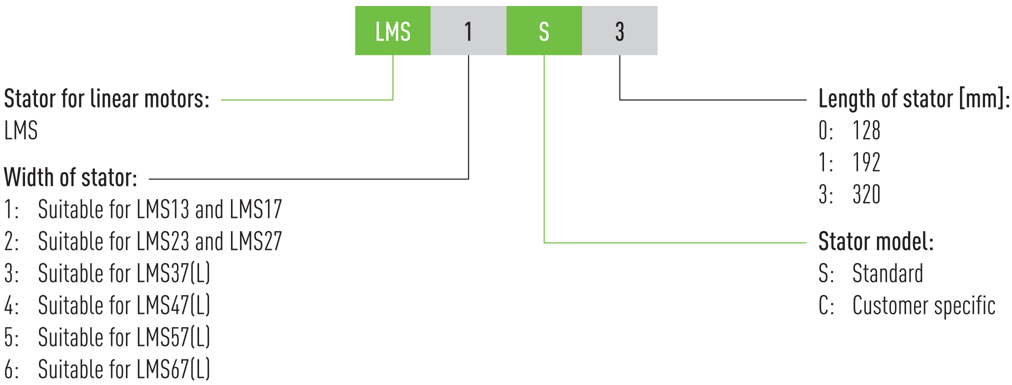
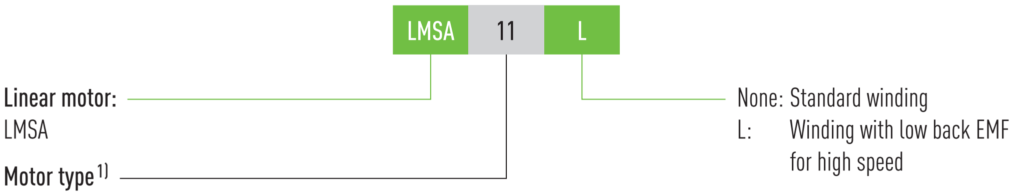


Fig. 10.3 **Order code of LMS magnet track (stator)**

10.2.2 Order code for LMSA linear motors



[1)] See technical data in section 11.2

Fig. 10.4 **Order coder of LMSA primary part (forcer)**

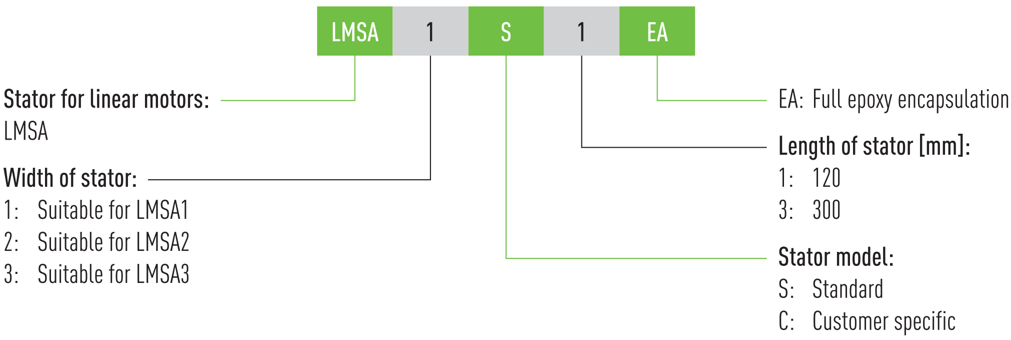


Fig. 10.5 **Order code of LMSA magnet track (stator)**

10.2.3 Order code for LMC linear motors

LMC	A2

Linear motor: LMC

Motor type [1]

[1] See technical data in section 11.3

Fig. 10.6 **Order coder of LMC primary part (forcer)**

LMC	A	S	1

Stator for linear motors:
LMC

Height of stator:
A: Suitable for LMCA
B: Suitable for LMCB
C: Suitable for LMCC
D: Suitable for LMCD
E: Suitable for LMCE
F: Suitable for LMCF

Length of stator [mm]:
LMCA, LMCB, LMCC: 0: 128
3: 320
LMCD, LMCE, LMCF: 1: 120
2: 300

Stator model:
S: Standard
C: Customer specific

Fig. 10.7 **Order code of LMC magnet track (stator)**

10.2.4 Order code for LMFA linear motors

LMFA	01	L	C

Linear motor:
LMFA

Motor type [1)]

None: Cable output
C: Connector output

None: Standard winding
L: Winding with low back EMF for high speed

[1)] See technical data in section 11.4

Fig. 10.8 **Order coder of LMFA primary part (forcer)**

LMF	1	S	2	E

Stator for linear motors:
LMFA

Width of stator:
0: Suitable for LMFA01–LMFA03
1: Suitable for LMFA11–LMFA14
2: Suitable for LMFA21–LMFA24
3: Suitable for LMFA31–LMFA34
4: Suitable for LMFA41–LMFA44
5: Suitable for LMFA52–LMFA54
6: Suitable for LMFA62–LMFA64

E: Permanent magnets cast in epoxy resin

Length of stator [mm]:
1: 120 for LMFA01–LMFA24
3: 300 for LMFA01–LMFA24
1: 184 for LMFA31–LMFA64
3: 460 for LMFA31–LMFA54

Stator model:
S: Standard
C: Customer specific

Fig. 10.9 **Order code of LMFA magnet track (stator)**

11. Appendix 2: Technical data

11.1 LMS linear motor specifications

11.1.1 LMS1, LMS2 specifications

Force-velocity curves (DC bus voltage: 600 VDC)

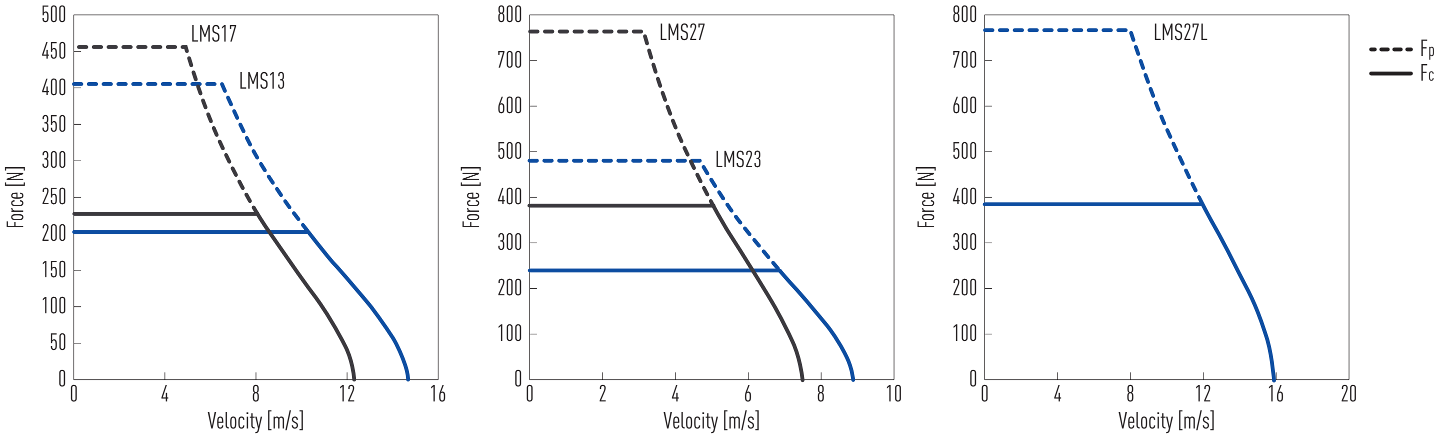


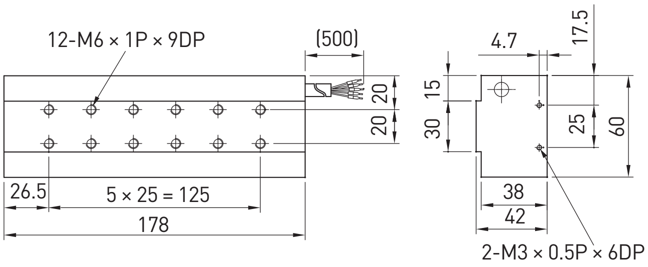
Table 11.1 **Technical data**

	Symbol	Unit	LMS13	LMS17	LMS23	LMS27	LMS27L
Forces and electrical parameters forcer							
Continuous force (at T_{max})	F_c	N	203	228	240	382	382
Continuous current (at T_{max})	I_c	A_{eff}	4.6	3.9	3.9	3.9	7.9
Peak force (for 1 s)	F_p	N	406	456	480	764	764
Peak current (for 1 s)	I_p	A_{eff}	13.8	11.8	11.8	11.8	23.7
Force constant	K_f	N/A_{eff}	44	58	61	97	46
Attraction force	F_a	N	805	1,221	1,350	2,036	2,036
Electrical time constant	K_e	ms	10.4	10.6	10.5	11.3	8.9
Resistance [1]	R_{25}	Ω	3.1	4.8	4.6	6.8	1.6
Inductance [1]	L	mH	32.2	50.8	48.4	76.8	14
Back EMF constant	K_u	$V_{eff}/(m/s)$	26	31	43	51	24
Motor constant	K_m	$N/\sqrt{W}$	20.4	21.6	23.2	30.4	31.4
Thermal resistance	R_{th}	°C/W	0.7	0.6	0.7	0.5	0.5
Thermal switch			3 PTC SNM 120 in series				
Max. DC bus voltage		V	600				
Mechanical parameters forcer + stator							
Max. bending radius of motor cable	R_{bend}	mm	69				
Pole pair pitch	2τ	mm	32				
Max. winding temperature	T_{max}	°C	120				
Weight of forcer	M_F	kg	1.8	2.7	2.7	4.1	4.1
Unit mass of stator	M_S	kg/m	4.2	4.2	6.2	6.2	6.2
Width of stator	W_S	mm	60	60	80	80	80
Stator mounting distance	A_S	mm	45	45	65	65	65
Length of stator/Dimension N	L_S	mm	128 mm/N = 2; 192 mm/N = 3; 320 mm/N = 5				
Total height (forcer + stator)	H	mm	55.2	57.4	55.2	57.4	57.4

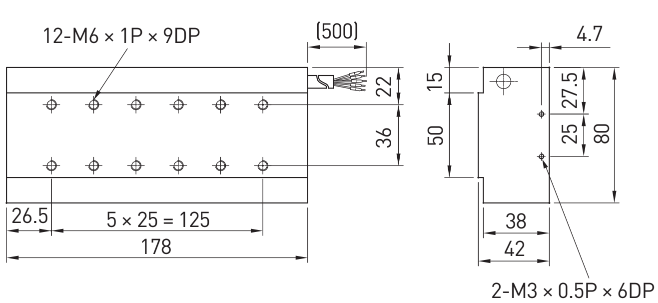
All the specifications in the table (except dimensions) are in ± 10 % of tolerance at 25 °C ambient temperature

[1] Line to line

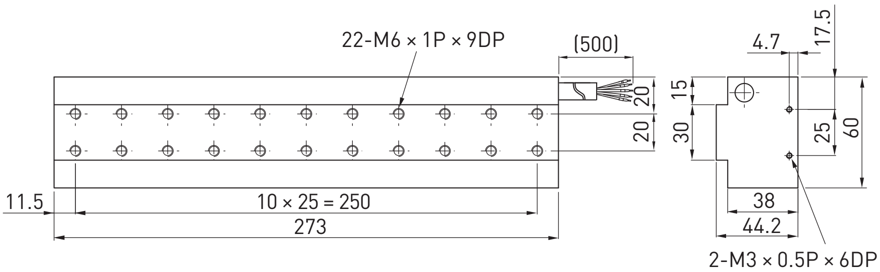
Dimensions of LMS13 forcer



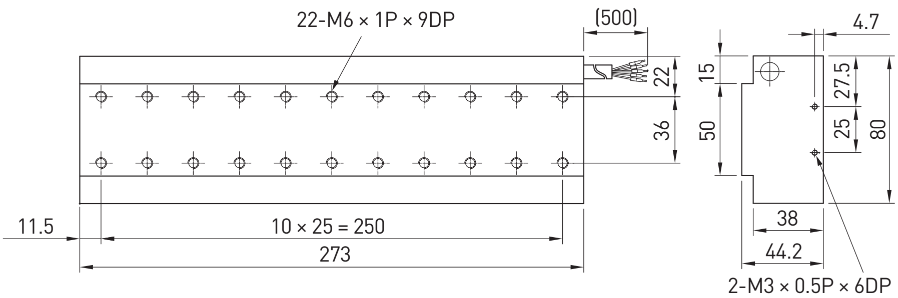
Dimensions of LMS23 forcer



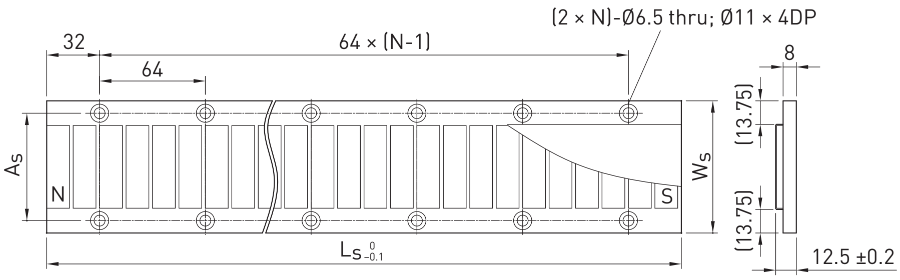
Dimensions of LMS17 forcer



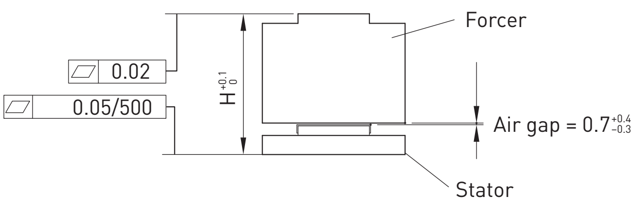
Dimensions of LMS27(L) forcer



Dimensions of stator



Mounting tolerances



11.1.2 LMS3, LMS4 specifications

Force-velocity curves (DC bus voltage: 600 VDC)

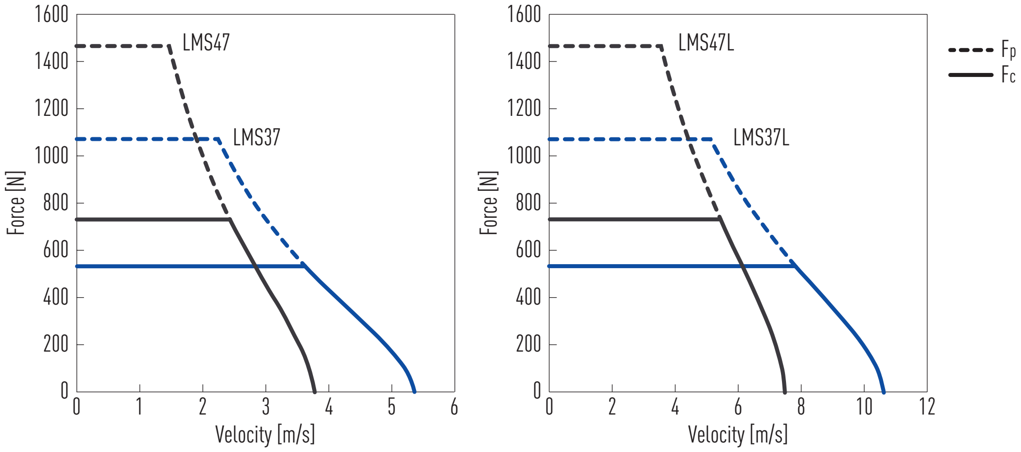


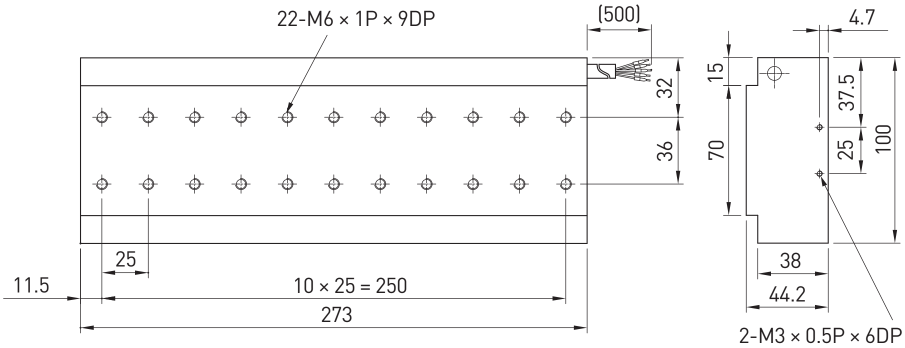
Table 11.2 **Technical data**

	Symbol	Unit	LMS37	LMS37L	LMS47	LMS47L
Forces and electrical parameters forcer						
Continuous force (at T_{max})	F_c	N	535		733	
Continuous current (at T_{max})	I_c	A_{eff}	3.9	7.9	3.9	7.9
Peak force (for 1 s)	F_p	N	1,070		1,466	
Peak current (for 1 s)	I_p	A_{eff}	11.8	23.7	11.8	23.7
Force constant	K_f	N/A_{eff}	136	68	186	93
Attraction force	F_a	N	2,850		4,071	
Electrical time constant	K_e	ms	11.6	11.0	13.0	12.2
Resistance [1)]	R_{25}	Ω	8.9	2.1	11.9	2.7
Inductance [1)]	L	mH	103.4	23.1	154.4	33
Back EMF constant	K_u	$V_{eff}/(m/s)$	71	36	101	51
Motor constant	K_m	$N/\sqrt{W}$	37.2	38.3	44.0	46.2
Thermal resistance	R_{th}	°C/W	0.3	0.4	0.3	0.3
Thermal switch			3 PTC SNM 120 in series			
Max. DC bus voltage		V	600			
Mechanical parameters forcer + stator						
Max. bending radius of motor cable	R_{bend}	mm	69			
Pole pair pitch	2τ	mm	32			
Max. winding temperature	T_{max}	°C	120			
Weight of forcer	M_F	kg	5.9		8	
Unit mass of stator	M_S	kg/m	8.2		11.5	
Width of stator	W_S	mm	100		130	
Stator mounting distance	A_S	mm	85		115	
Length of stator/Dimension N	L_S	mm	128 mm/N = 2; 192 mm/N = 3; 320 mm/N = 5			
Total height (forcer + stator)	H	mm	57.4			

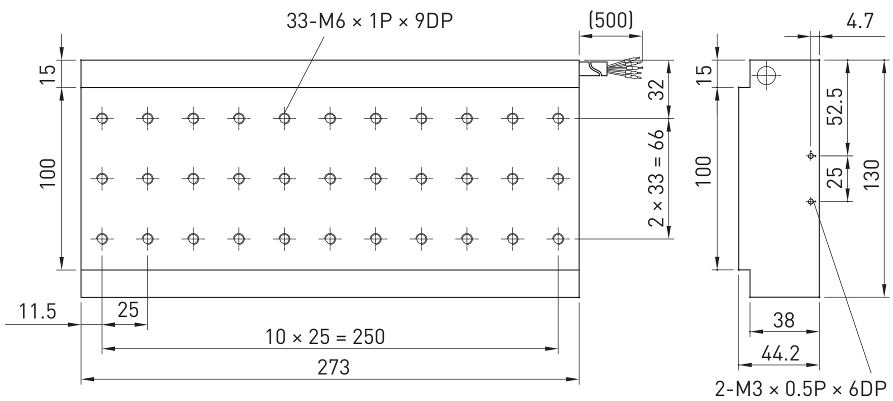
All the specifications in the table (except dimensions) are in ± 10 % of tolerance at 25 °C ambient temperature

1) Line to line

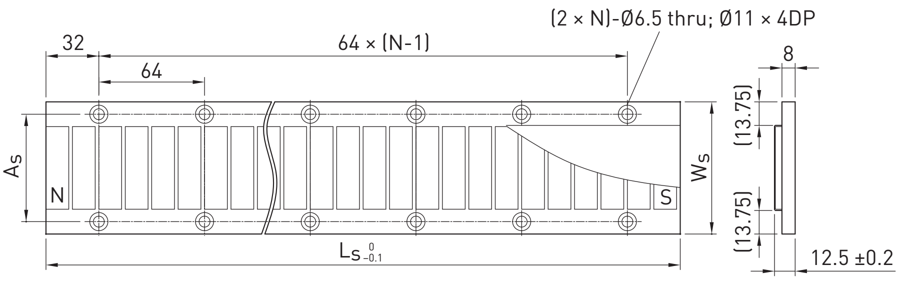
Dimensions of LMS37(L) forcer



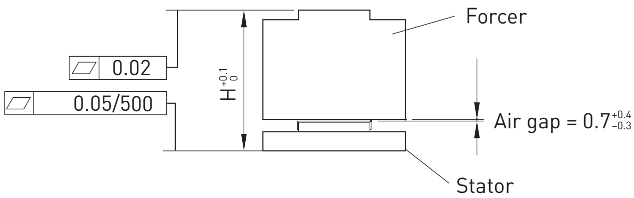
Dimensions of LMS47(L) forcer



Dimensions of stator



Mounting tolerances



11.1.3 LMS5, LMS6 specifications

Force-velocity curves (DC bus voltage: 600 VDC)

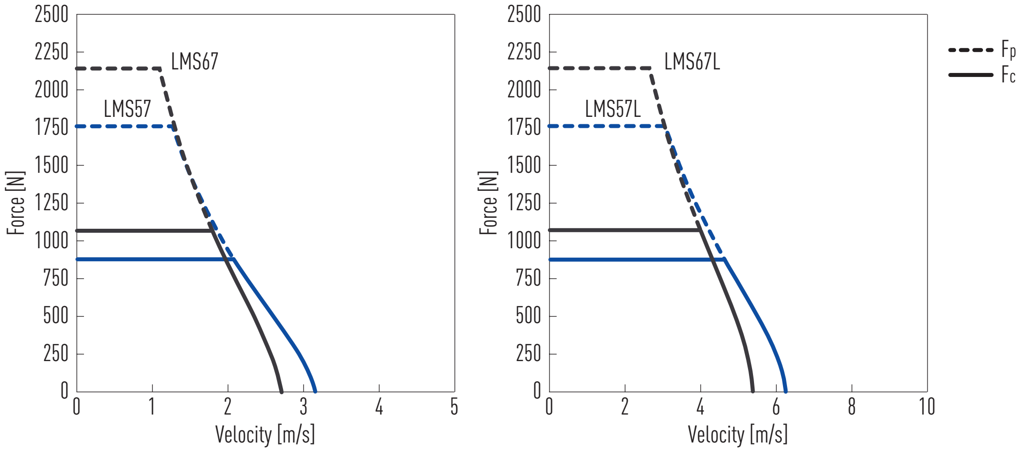


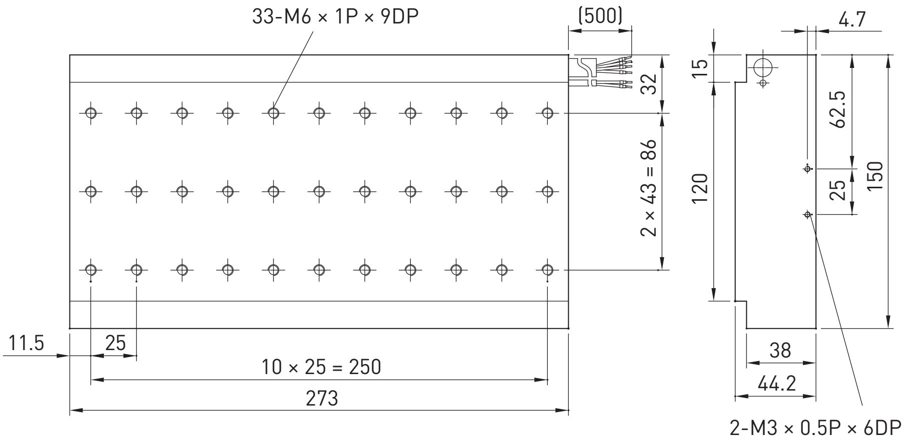
Table 11.3 **Technical data**

	Symbol	Unit	LMS57	LMS57L	LMS67	LMS67L
Forces and electrical parameters forcer						
Continuous force (at T_{max})	F_c	N	879		1069	
Continuous current (at T_{max})	I_c	A_{eff}	3.9	7.9	3.9	7.9
Peak force (for 1 s)	F_p	N	1,758		2,138	
Peak current (for 1 s)	I_p	A_{eff}	11.8	23.7	11.8	23.7
Force constant	K_f	N/A_{eff}	223	112	271	136
Attraction force	F_a	N	4,885		5,700	
Electrical time constant	K_e	ms	12.4	12.0	12.4	12.6
Resistance 1)	R_{25}	Ω	13.8	3.1	15.4	3.4
Inductance 1)	L	mH	170.8	37.3	190.7	43
Back EMF constant	K_u	$V_{eff}/(m/s)$	121	61	141	71
Motor constant	K_m	$N/\sqrt{W}$	49.0	51.6	56.4	60.2
Thermal resistance	R_{th}	°C/W	0.2	0.2	0.2	0.2
Thermal switch			3 PTC SNM 120 in series			
Max. DC bus voltage		V	600			
Mechanical parameters forcer + stator						
Max. bending radius of motor cable	R_{bend}	mm	69			
Pole pair pitch	2τ	mm	32			
Max. winding temperature	T_{max}	°C	120			
Weight of forcer	M_F	kg	9.4		10.8	
Unit mass of stator	M_S	kg/m	13.7		15.9	
Width of stator	W_S	mm	150		170	
Stator mounting distance	A_S	mm	135		155	
Length of stator/Dimension N	L_S	mm	128 mm/N = 2; 192 mm/N = 3; 320 mm/N = 5			
Total height (forcer + stator)	H	mm	57.4			

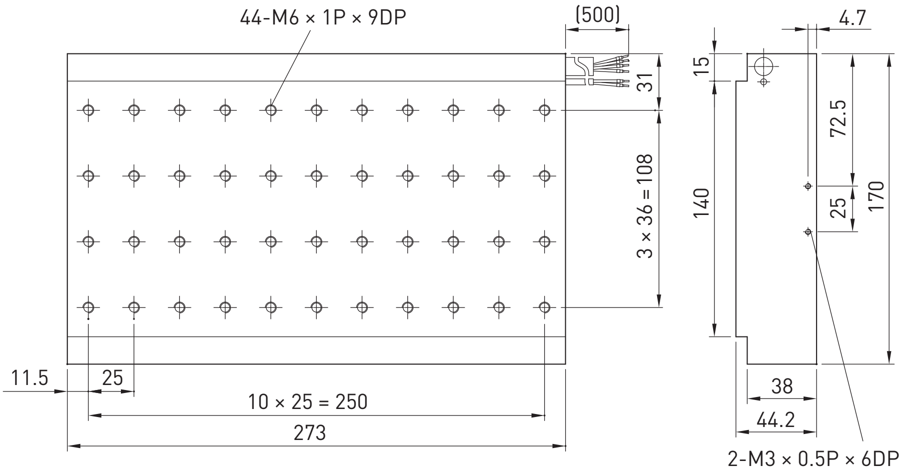
All the specifications in the table (except dimensions) are in ± 10 % of tolerance at 25 °C ambient temperature

1) Line to line

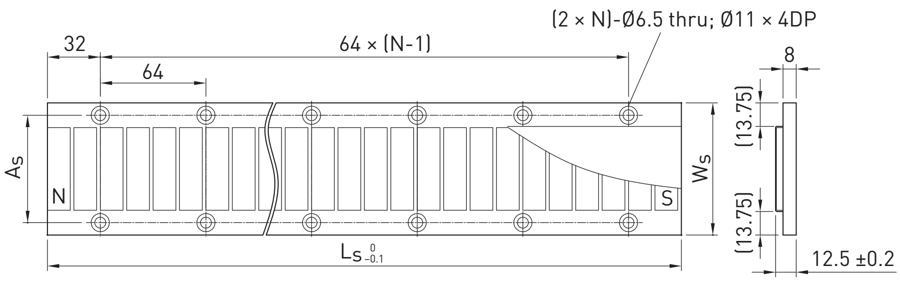
Dimensions of LMS57(L) forcer



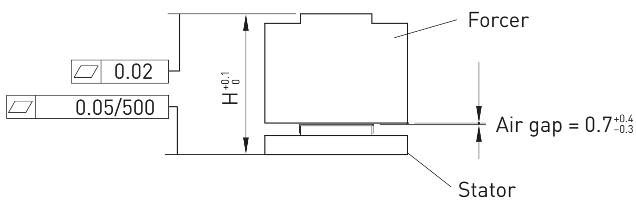
Dimensions of LMS67(L) forcer



Dimensions of stator



Mounting tolerances



11.2 LMSA linear motor specifications

11.2.1 LMSA1 specifications

Force-velocity curves (DC bus voltage: 600 VDC)

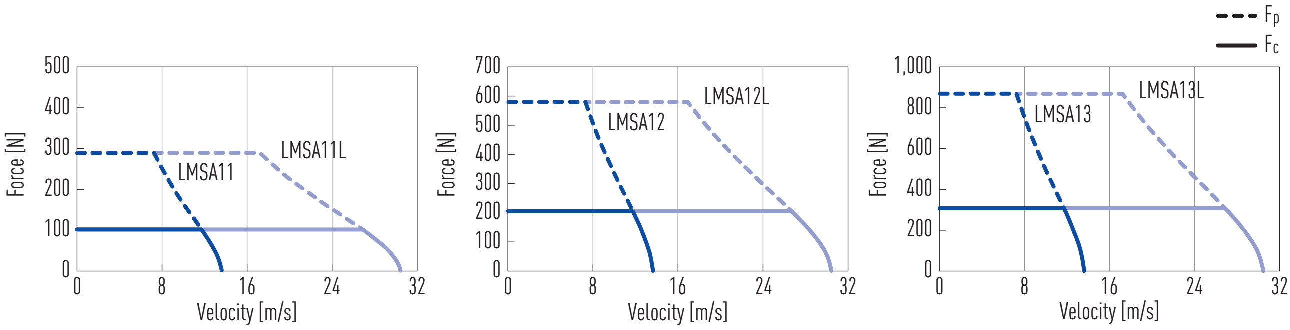


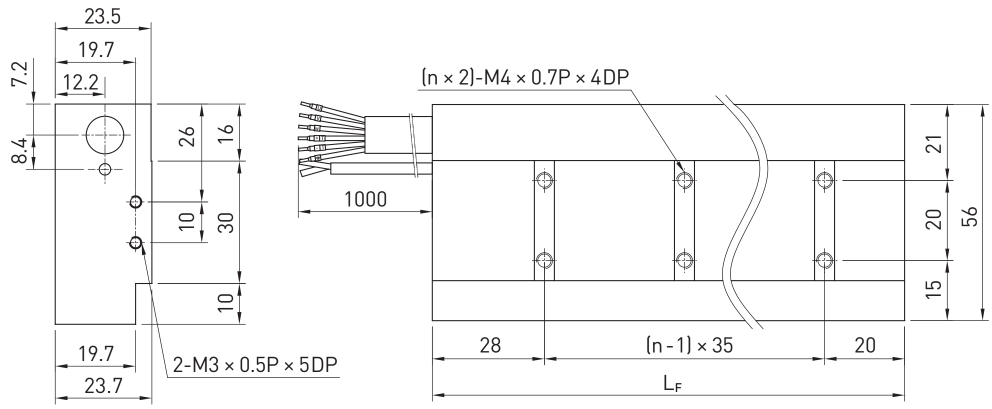
Table 11.4 **Technical data**

	Symbol	Unit	LMSA11	LMSA11L	LMSA12	LMSA12L	LMSA13	LMSA13L
Forces and electrical parameters forcer								
Continuous force (at T_{max})	F_c	N	103		205		308	
Continuous current (at T_{max})	I_c	A_{eff}	2.1	4.7	4.2	9.4	6.3	14.1
Peak force (for 1 s)	F_p	N	289		579		868	
Peak current (for 1 s)	I_p	A_{eff}	6.3	14.1	12.7	28.3	19.0	42.4
Ultimate force (for 0.5 s)	F_u	N	379		759		1,138	
Ultimate current (for 0.5 s)	I_u	A_{eff}	10.6	23.6	21.1	47.1	31.7	70.7
Force constant	K_f	N/A_{eff}	48.6	21.7	48.6	21.7	48.6	21.7
Attraction force	F_a	N	481		963		1,444	
Electrical time constant	K_e	ms	4.4	4.3	4.5	4.1	4.4	4.0
Resistance [1]	R_{25}	Ω	8.4	1.7	4.1	0.9	2.8	0.6
Inductance [1]	L	mH	37.1	7.3	18.5	3.7	12.4	2.4
Back EMF constant	K_u	V_{eff}/(m/s)	28.1	12.6	28.1	12.6	28.1	12.6
Motor constant	K_m	N/√W	13.7	13.6	19.6	18.7	23.7	22.9
Thermal resistance	R_{th}	°C/W	1.23		0.63		0.41	
Thermal time constant	T_{th}	s	1,830		2,720		4,210	
Thermal switch			3 PTC SNM 120 in series					
Max. DC bus voltage		V	600					
Mechanical parameters forcer + stator								
Max. bending radius of motor cable	R_{bend}	mm	69					
Pole pair pitch	2τ	mm	30					
Max. winding temperature	T_{max}	°C	120					
Mounting holes (forcer)	n		3		6		9	
Weight of forcer	M_F	kg	0.7		1.4		2.1	
Length of forcer	L_F	mm	118		223		328	
Unit mass of stator	M_S	kg/m	2.7					
Length of stator/Dimension N	L_S	mm	120 mm/N = 2; 300 mm/N = 5					
Total height (forcer + stator)	H	mm	34					

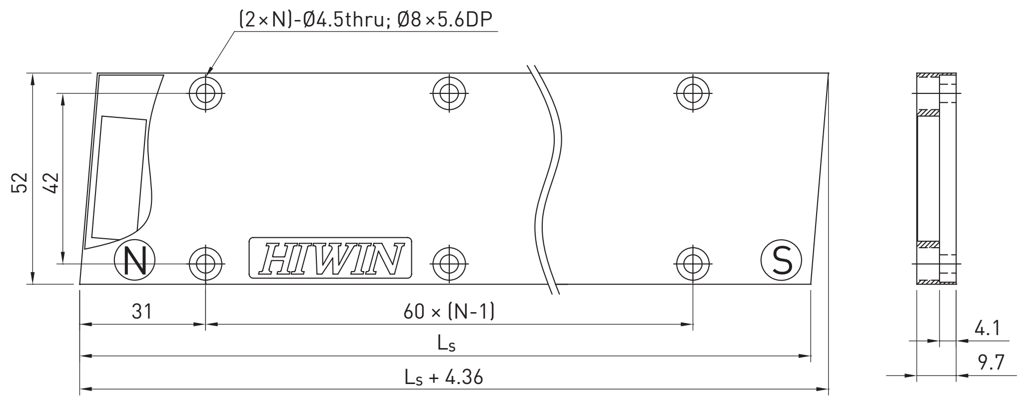
All the specifications in the table (except dimensions) are in ± 10 % of tolerance at 25 °C ambient temperature

[1] Line to line

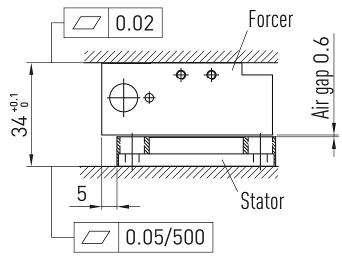
Dimensions of forcer



Dimensions of stator



Mounting tolerances



11.2.2 LMSA2 specifications

Force-velocity curves (DC bus voltage: 600 VDC)

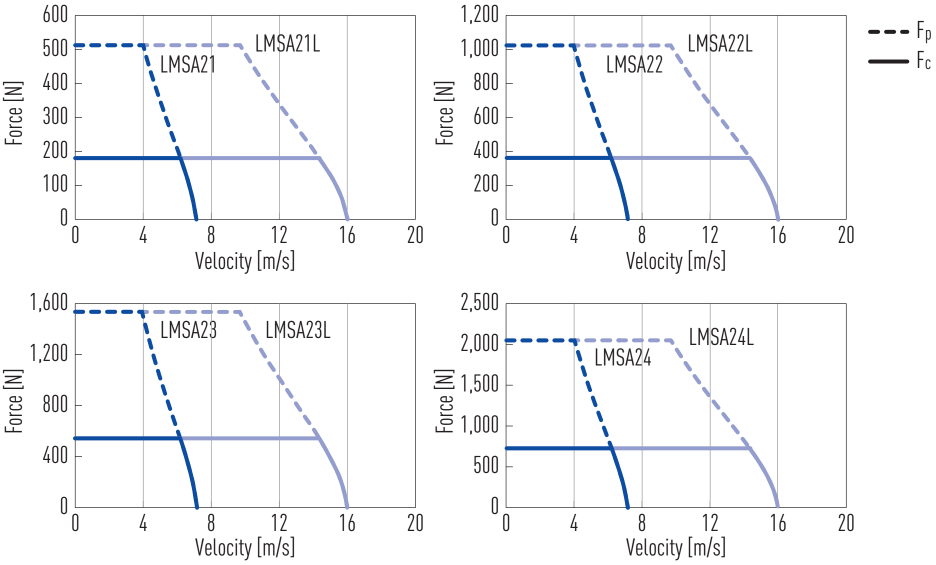


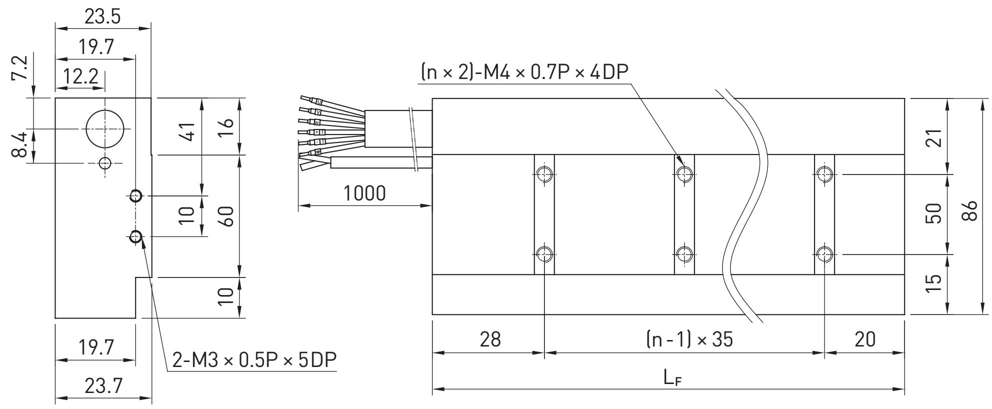
Table 11.5 **Technical data**

	Symbol	Unit	LMSA21	LMSA21L	LMSA22	LMSA22L	LMSA23	LMSA23L	LMSA24	LMSA24L
Forces and electrical parameters forcer										
Continuous force (at T_{max})	F_c	N	181		362		544		725	
Continuous current (at T_{max})	I_c	A_{eff}	2.0	4.4	3.9	8.8	5.9	13.1	7.8	17.5
Peak force (for 1 s)	F_p	N	512		1,023		1,535		2,048	
Peak current (for 1 s)	I_p	A_{eff}	5.9	13.1	11.8	26.3	17.6	39.4	23.5	52.5
Ultimate force (for 0.5 s)	F_u	N	670		1,341		2,011		2,682	
Ultimate current (for 0.5 s)	I_u	A_{eff}	9.8	21.9	19.6	43.8	29.4	65.7	39.2	87,6
Force constant	K_f	N/A_{eff}	92.5	41.4	92.5	41.4	92.5	41.4	92.5	41.4
Attraction force	F_a	N	963		1,926		2,888		3,851	
Electrical time constant	K_e	ms	4.6	4.6	4.9	4.6	4.9	4.8	4.6	4.7
Resistance [1]	R_{25}	Ω	13.8	2.8	6.8	1.4	4.6	0.9	3.5	0.7
Inductance [1]	L	mH	64.0	12.8	33.0	6.4	22.4	4.3	16.0	3.2
Back EMF constant	K_u	$V_{eff}/(m/s)$	53.4	23.9	53.4	23.9	53.4	23.9	53.4	23.9
Motor constant	K_m	$N/\sqrt{W}$	20.3	20.2	28.9	28.6	35.2	35.6	40.6	40.8
Thermal resistance	R_{th}	°C/W	0.87		0.44		0.29		0.22	
Thermal time constant	T_{th}	s	2,830		4,060		5,080			
Thermal switch			3 PTC SNM 120 in series							
Max. DC bus voltage		V	600							
Mechanical parameters forcer + stator										
Max. bending radius of motor cable	R_{bend}	mm	69							
Pole pair pitch	2τ	mm	30							
Max. winding temperature	T_{max}	°C	120							
Mounting holes (forcer)	n		3		6		9		12	
Weight of forcer	M_F	kg	1.1		2.2		3.3		4.4	
Length of forcer	L_F	mm	118		223		328		433	
Unit mass of stator	M_S	kg/m	4.8							
Length of stator/Dimension N	L_S	mm	120 mm/N = 2. 300 mm/N = 5							
Total height (forcer + stator)	H	mm	34							

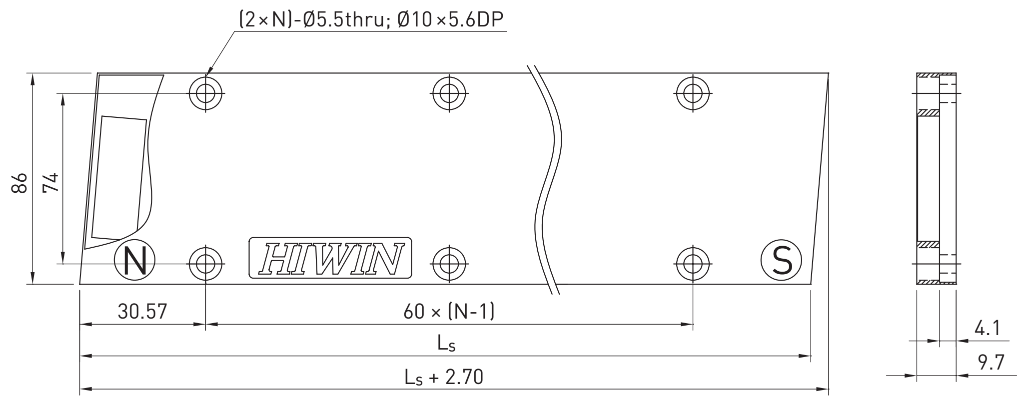
All the specifications in the table (except dimensions) are in ± 10 % of tolerance at 25 °C ambient temperature

[1] Line to line

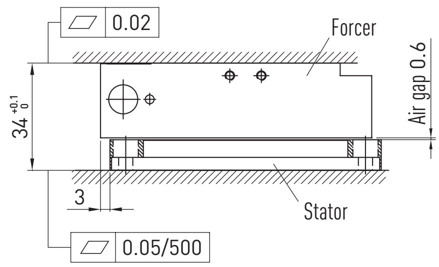
Dimensions of forcer



Dimensions of stator



Mounting tolerances



11.2.3 LMSA3 specifications

Force-velocity curves (DC bus voltage: 600 VDC)

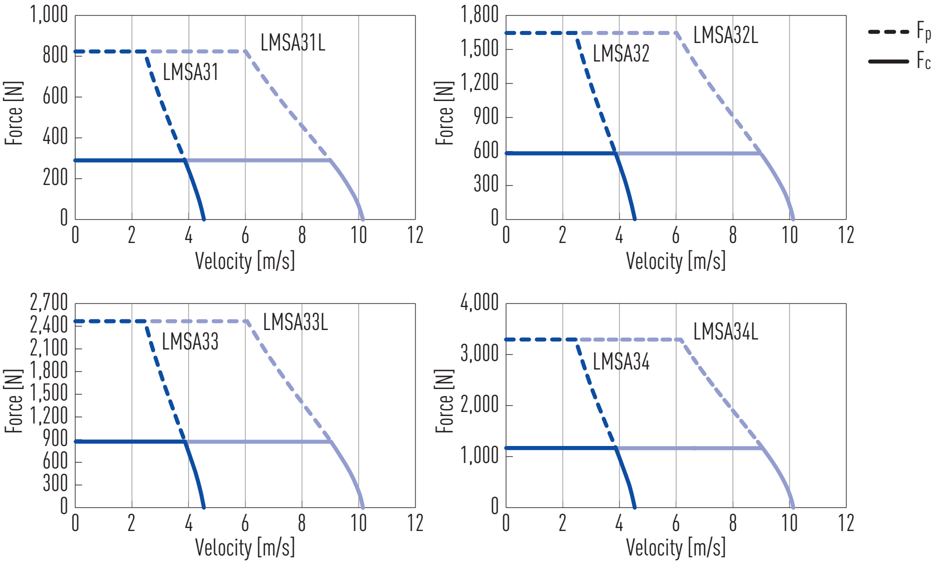


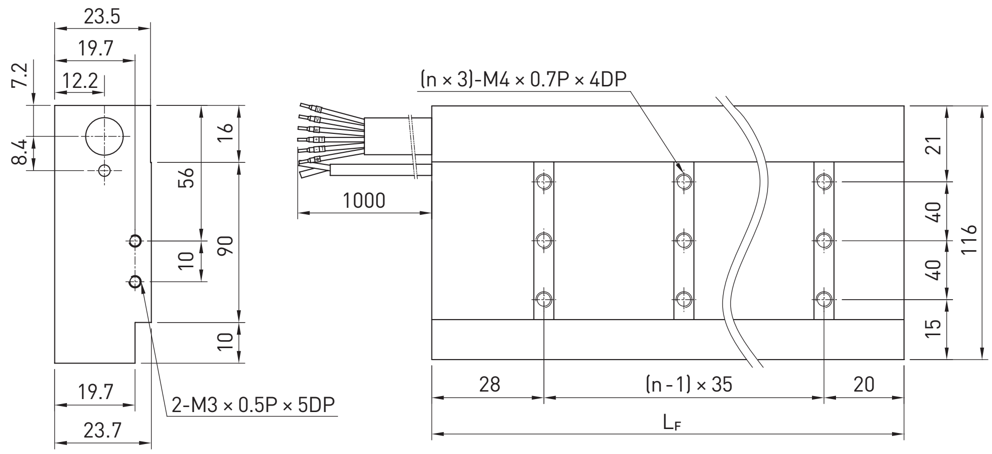
Table 11.6 **Technical data**

	Symbol	Unit	LMSA31	LMSA31L	LMSA32	LMSA32L	LMSA33	LMSA33L	LMSA34	LMSA34L
Forces and electrical parameters forcer										
Continuous force (at T_{max})	F_c	N	292		583		875		1.166	
Continuous current (at T_{max})	I_c	A_{eff}	2.0	4.5	4.0	8.9	6.0	13.4	8.0	17.9
Peak force (for 1 s)	F_p	N	823		1,646		2,469		3,292	
Peak current (for 1 s)	I_p	A_{eff}	6.0	13.4	12.0	26.8	18.0	40.2	24.0	53.6
Ultimate force (for 0.5 s)	F_u	N	1,079		2,157		3,236		4,314	
Ultimate current (for 0.5 s)	I_u	A_{eff}	10.0	22.3	20.0	44.7	30.0	67.0	40.0	89.4
Force constant	K_f	N/A_{eff}	145.8	65.2	145.8	65.2	145.8	65.2	145.8	65.2
Attraction force	F_a	N	1,444		2,888		4,333		5,777	
Electrical time constant	K_e	ms	4.9	4.9	4.9	4.9	4.9	5.0	4.9	4.9
Resistance [1]	R_{25}	Ω	19.2	4.0	9.6	2.0	6.4	1.3	4.8	1.0
Inductance [1]	L	mH	94.1	19.6	47.1	9.8	31.3	6.5	23.5	4.7
Back EMF constant	K_u	$V_{eff}/(m/s)$	84.2	37.7	84.2	37.7	84.2	37.7	84.2	37.7
Motor constant	K_m	$N/\sqrt{W}$	27.2	26.6	38.4	37.7	47.0	46.7	54.3	54.5
Thermal resistance	R_{th}	°C/W	0.60		0.30		0.20		0.15	
Thermal time constant	T_{th}	s	4,540		5,740		5,580			
Thermal switch			3 PTC SNM 120 in series							
Max. DC bus voltage		V	600							
Mechanical parameters forcer + stator										
Max. bending radius of motor cable	R_{bend}	mm	69							
Pole pair pitch	2τ	mm	30							
Max. winding temperature	T_{max}	°C	120							
Mounting holes (forcer)	n		3		6		9		12	
Weight of forcer	M_F	kg	1.9		3.8		5.7		7.6	
Length of forcer	L_F	mm	118		223		328		433	
Unit mass of stator	M_S	kg/m	8.5							
Length of stator/Dimension N	L_S	mm	120 mm/N = 2. 300 mm/N = 5							
Total height (forcer + stator)	H	mm	36							

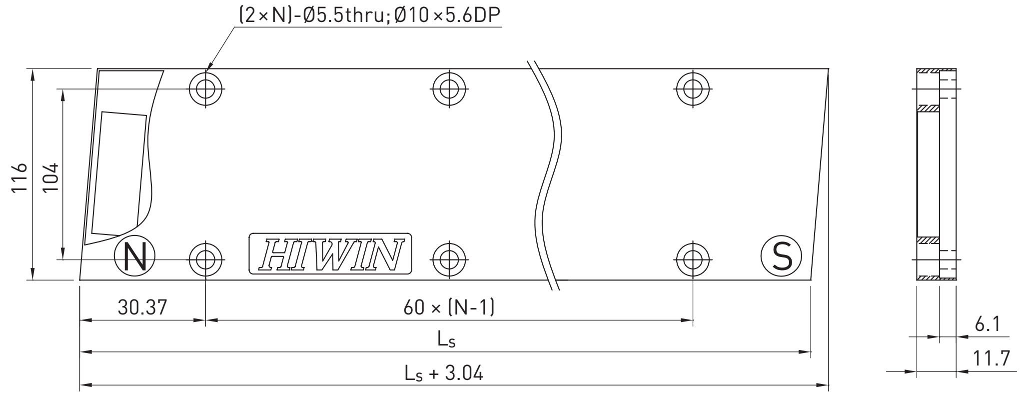
All the specifications in the table (except dimensions) are in ± 10 % of tolerance at 25 °C ambient temperature

[1] Line to line

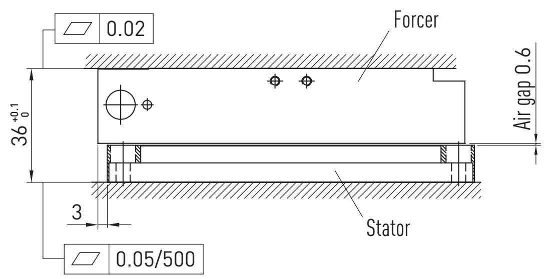
Dimensions of forcer



Dimensions of stator



Mounting tolerances



11.3 LMC linear motor specifications

11.3.1 LMCA, LMCB, LMCC specifications

Force-velocity curves (DC bus voltage: 330 VDC)

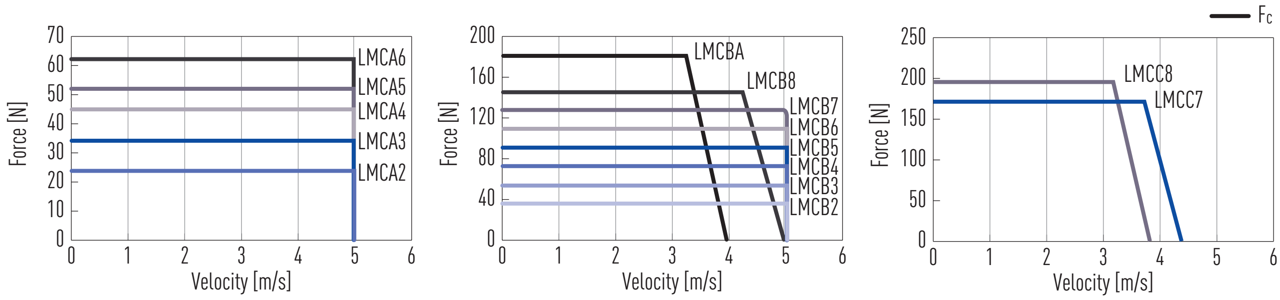


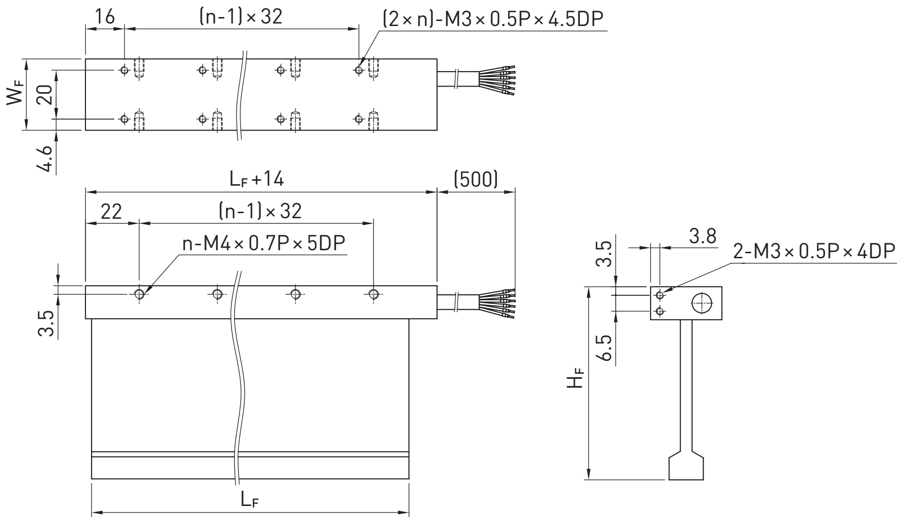
Table 11.7 **Technical data**

	Symbol	Unit	LMCA2	LMCA3	LMCA4	LMCA5	LMCA6	LMCB2	LMCB3	LMCB4	LMCB5	LMCB6	LMCB7	LMCB8	LMCBA	LMCC7	LMCC8
Forces and electrical parameters																	
Continuous force (at T_{max})	F_c	N	24	34	45	52	62	36	54	73	91	109	128	145	181	171	195
Continuous current (at T_{max})	I_c	A_{eff}	2.3	2.1	2.1	1.8	1.8	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Peak force (for 1 s)	F_p	N	96	136	180	208	248	144	216	292	364	436	512	580	724	684	780
Peak current (for 1 s)	I_p	A_{eff}	9.2	8.4	8.4	7.2	7.2	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Force constant	K_f	N/A_{eff}	10.6	15.8	21.2	28.2	33.8	18.1	27.2	36.3	45.4	54.5	63.5	72.5	90.6	85.4	97.5
Electrical time constant	K_e	ms	0.4	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3
Resistance [1)]	R_{25}	Ω	2.7	4.1	5.4	6.7	8.2	3.6	5.4	7.1	9.0	10.7	12.6	14.6	17.9	15.8	18.2
Inductance [1)]	L	mH	1.0	1.4	1.9	2.3	2.8	1.4	1.9	2.6	3.2	3.8	4.4	5.0	6.2	5.5	6.3
Back EMF constant	K_u	$V_{eff}/(m/s)$	5.9	8.8	11.9	14.5	17.4	10.1	15.2	20.0	24.8	29.3	34.7	40.0	50.0	45.4	51.9
Motor constant	K_m	$N/\sqrt{W}$	5.2	6.5	7.5	9.1	9.8	7.7	9.5	11.2	12.4	13.6	14.7	15.5	17.5	17.6	18.7
Thermal resistance	R_{th}	°C/W	2.80	2.21	1.68	1.84	1.50	2.77	1.85	1.41	1.11	0.93	0.79	0.68	0.56	0.63	0.55
Thermal switch			3 PTC SNM 100 in series														
Max. DC bus voltage		V	330														
Mechanical parameters																	
Max. bending radius of motor cable	R_{bend}	mm	37.5														
Pole pair pitch	2τ	mm	32														
Max. winding temperature	T_{max}	°C	100														
Mounting holes (forcer)	n		2	3	4	5	6	2	3	4	5	6	7	8	10	7	8
Weight of forcer	M_F	kg	0.15	0.23	0.31	0.38	0.45	0.2	0.29	0.38	0.48	0.58	0.68	0.72	0.88	0.74	0.76
Width of forcer	W_F	mm	29.2													29.2	
Length of forcer	L_F	mm	66	98	130	162	194	66	98	130	162	194	226	258	322	226	258
Height of forcer	H_F	mm	59					79								99	
Unit mass of stator	M_S	kg/m	7					12								21	
Width of stator	W_S	mm	31.2													35.2	
Length of stator/Dimension N	L_S	mm	128 mm/N = 2; 320 mm/N = 5														
Height of stator	H_S	mm	60					80								103	
Total height (forcer + stator)	H	mm	74.5					94.5								117.5	

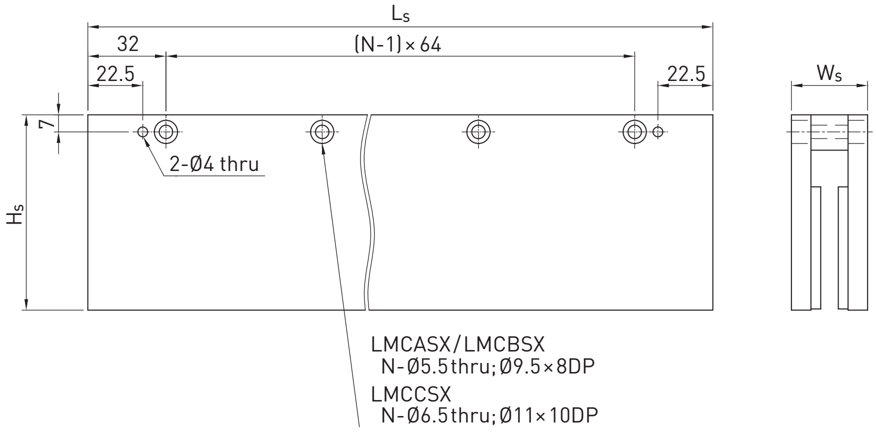
All the specifications in the table (except dimensions) are in ± 10 % of tolerance at 25 °C ambient temperature

[1)] Line to line

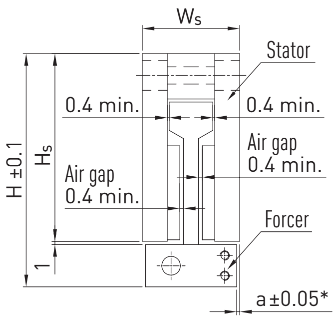
Dimensions of forcer



Dimensions of stator



Mounting tolerances



*LMCA, LMCB: a = 1
*LMCC: a = 3

11.3.2 LMCD, LMCE specifications

Force-velocity curves (DC bus voltage: 330 VDC)

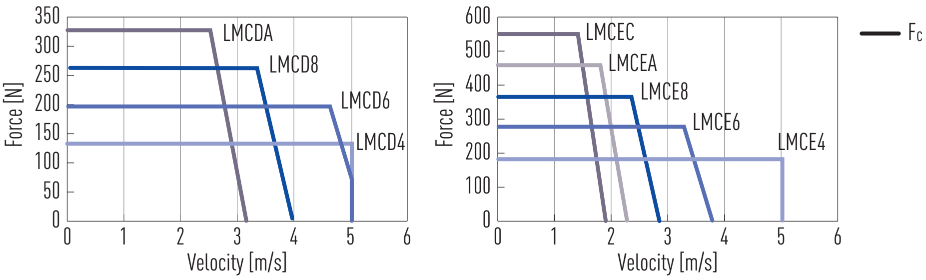


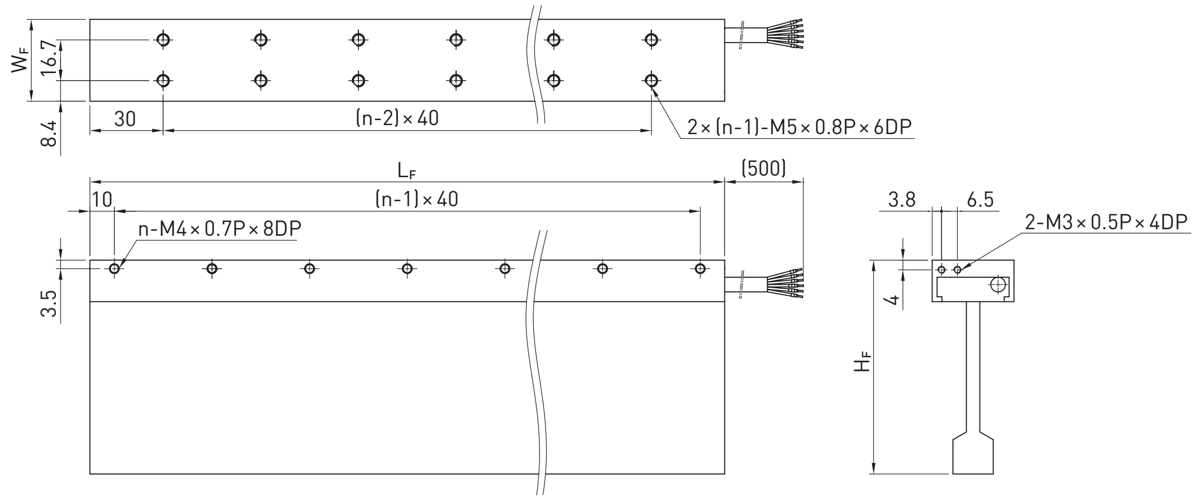
Table 11.8 **Technical data**

	Symbol	Unit	LMCD4	LMCD6	LMCD8	LMCDA	LMCE4	LMCE6	LMCE8	LMCEA	LMCEC
Forces and electrical parameters											
Continuous force (at T_{max})	F_c	N	131	197	262	328	184	276	368	460	552
Continuous current (at T_{max})	I_c	A_{eff}	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25
Peak force (for 1 s)	F_p	N	524	788	1,048	1,312	736	1,104	1,472	1,840	2,208
Peak current (for 1 s)	I_p	A_{eff}	13	13	13	13	13	13	13	13	13
Force constant	K_f	N/A_{eff}	40.3	60.6	80.6	100.9	56.6	84.9	113.2	141.5	169.8
Electrical time constant	K_e	ms	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Resistance [1]	R_{25}	Ω	4.6	7.1	9.0	11.6	5.6	8.4	11.0	13.8	16.7
Inductance [1]	L	mH	2.3	3.5	4.7	5.8	2.9	4.4	5.9	7.3	8.8
Back EMF constant	K_u	$V_{eff}/(m/s)$	25	38	50	63	35	53	70	88	106
Motor constant	K_m	$N/\sqrt{W}$	14.6	17.8	20.0	22.2	19.1	23.4	27.0	30.2	33.2
Thermal resistance	R_{th}	°C/W	0.82	0.53	0.42	0.33	0.68	0.45	0.34	0.27	0.23
Thermal switch			3 PTC SNM 100 in series								
Max. DC bus voltage		V	330								
Mechanical parameters											
Max. bending radius of motor cable	R_{bend}	mm	37.5								
Pole pair pitch	2τ	mm	60								
Max. winding temperature	T_{max}	°C	100								
Mounting holes (forcer)	n		7	10	13	16	7	10	13	16	19
Weight of forcer	M_F	kg	0.88	1.32	1.76	2.20	1.23	1.84	2.46	3.08	3.70
Width of forcer	W_F	mm	33.5								
Length of forcer	L_F	mm	260	380	500	620	260	380	500	620	740
Height of forcer	H_F	mm	87.5				107.5				
Unit mass of stator	M_S	kg/m	16				20				
Width of stator	W_S	mm	35.5								
Length of stator/Dimension N	L_S	mm	120 mm/N = 2; 300 mm/N = 5								
Height of stator	H_S	mm	86.8				106.8				
Total height (forcer + stator)	H	mm	105				125				

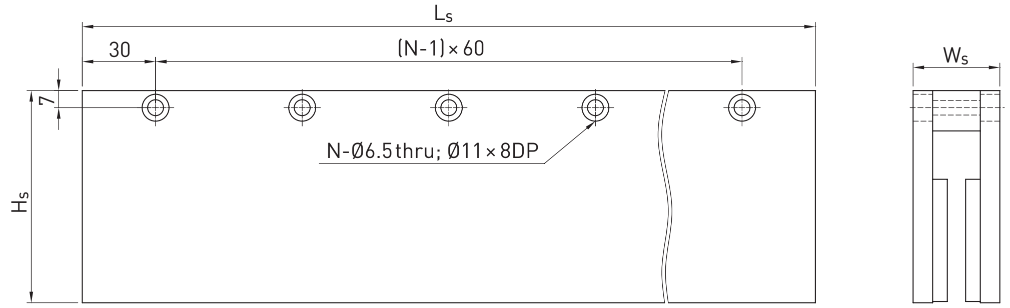
All the specifications in the table (except dimensions) are in ± 10 % of tolerance at 25 °C ambient temperature

[1] Line to line

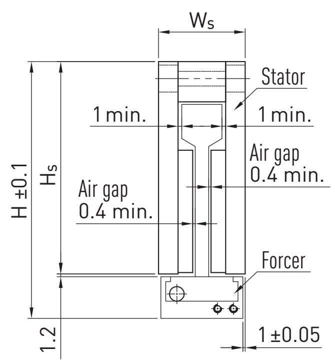
Dimensions of forcer



Dimensions of stator



Mounting tolerances



11.3.3 LMCF specifications

Force-velocity curve (DC bus voltage: 330 VDC)

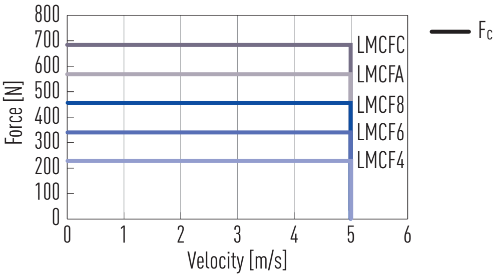
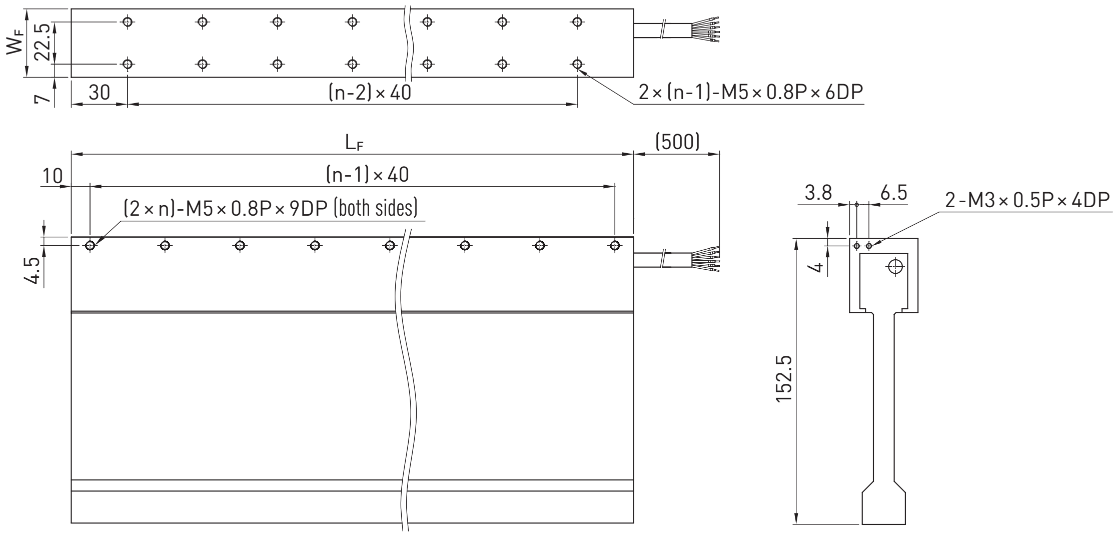


Table 11.9 **Technical data**

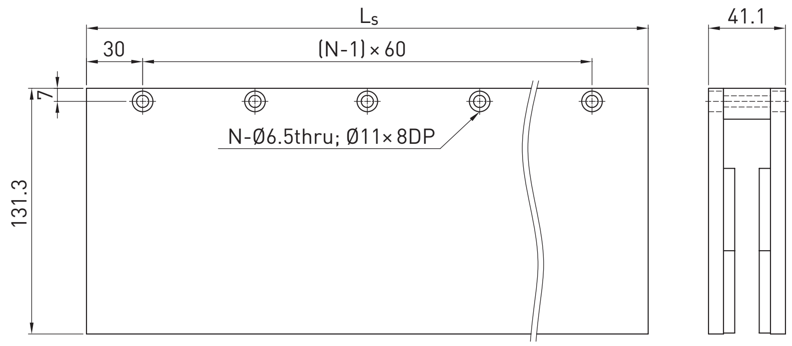
	Symbol	Unit	LMCF4	LMCF6	LMCF8	LMCFA	LMCFC
Forces and electrical parameters							
Continuous force (at T_{max})	F_c	N	228	342	456	570	684
Continuous current (at T_{max})	I_c	A_{eff}	3.8	5.7	7.6	9.5	11.4
Peak force (for 1 s)	F_p	N	912	1,368	1,824	2,280	2,736
Peak current (for 1 s)	I_p	A_{eff}	15.2	22.8	30.4	38.0	45.6
Force constant	K_f	N/A_{eff}	60	60	60	60	60
Electrical time constant	K_e	ms	1	1	1	1	1
Resistance [1]	R_{25}	Ω	3.3	2.2	1.7	1.3	1.1
Inductance [1]	L	mH	3.3	2.2	1.7	1.3	1.1
Back EMF constant	K_u	$V_{eff}/(m/s)$	34.4	34.4	34.4	34.4	34.4
Motor constant	K_m	$N/\sqrt{W}$	27.0	33.0	37.7	43.0	46.2
Thermal resistance	R_{th}	°C/W	0.84	0.56	0.41	0.34	0.27
Thermal switch			3 PTC SNM 100 in series				
Max. DC bus voltage		V	330				
Mechanical parameters							
Max. bending radius of motor cable	R_{bend}	mm	57.5				
Pole pair pitch	2τ	mm	60				
Max. winding temperature	T_{max}	°C	100				
Mounting holes (forcer)	n		7	10	13	16	19
Weight of forcer	M_F	kg	2.5	3.75	5	6.25	7.5
Width of forcer	W_F	mm	36.5				
Length of forcer	L_F	mm	260	380	500	620	740
Height of forcer	H_F	mm	152.5				
Unit mass of stator	M_S	kg/m	25.6				
Width of stator	W_S	mm	41.1				
Length of stator/Dimension N	L_S	mm	120 mm/N = 2; 300 mm/N = 5				
Height of stator	H_S	mm	131.3				
Total height (forcer + stator)	H	mm	172				

All the specifications in the table (except dimensions) are in ± 10 % of tolerance at 25 °C ambient temperature
[1] Line to line

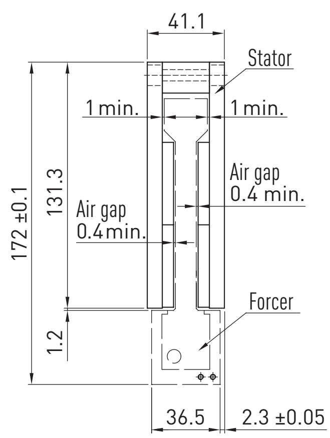
Dimensions of forcer



Dimensions of stator



Mounting tolerances



11.4 LMF linear motor specifications

11.4.1 LMFA0 specifications

Force-velocity curves (DC bus voltage: 750 VDC)

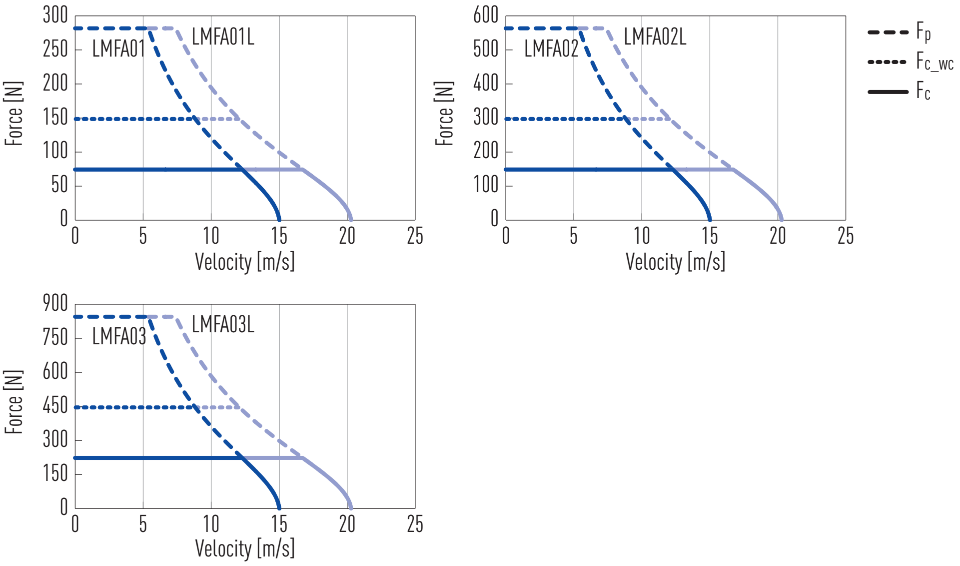


Table 11.10 **Technical data**

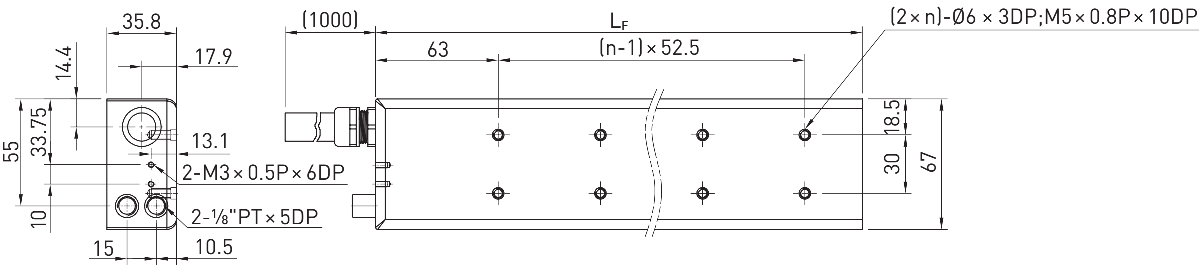
	Symbol	Unit	LMFA01	LMFA01L	LMFA02	LMFA02L	LMFA03	LMFA03L
Forces and electrical parameters								
Continuous force at T_{max}	F_c	N	74		149		223	
Peak force at T_{max} (WC)	F_{c_WC}	N	149		297		446	
Continuous current at T_{max}	I_c	A_{eff}	1.4	1.8	2.7	3.6	4.1	5.5
Continuous current at T_{max} (WC)	I_{c_WC}	A_{eff}	2.7	3.6	5.4	7.3	8.1	10.9
Peak force (for 1 s)	F_p	N	282		564		845	
Peak current (for 1 s)	I_p	A_{eff}	8.4	11.3	16.7	22.6	25.1	33.9
Force constant	K_f	N/A_{eff}	55.1	40.8	55.1	40.8	55.1	40.8
Attraction force	F_a	N	457		914		1,372	
Resistance [1)]	R_{25}	Ω	11.7	6.0	5.9	3.0	3.9	2.0
Inductance [1)]	L	mH	84.2	46.2	42.1	23.1	28.1	15.4
Back EMF constant	K_u	$V_{eff}/(m/s)$	31.8	23.5	31.8	23.5	31.8	23.5
Motor constant	K_m	$N/\sqrt{W}$	13.1	13.6	18.6	19.2	22.8	23.5
Thermal resistance	R_{th}	°C/W	2.25	2.40	1.13	1.20	0.75	0.80
Thermal resistance (WC)	R_{th_WC}	°C/W	0.56	0.60	0.28	0.30	0.19	0.20
Thermal switch			1 × PT1000 + 1 × (3 PTC SNM 120 in series)					
Max. DC bus voltage		V	750					
Mechanical parameters								
Pole pair pitch	2τ	mm	30					
Max. winding temperature	T_{max}	°C	120					
Mounting holes (forcer)	n		2		4		6	
Weight of forcer	M_F	kg	1.5		2.3		3.1	
Length of forcer	L_F	mm	145		250		355	
Unit mass of stator	M_S	kg/m	3.7					
Length of stator/Dimension N	L_S	mm	120 mm/N = 2; 300 mm/N = 5					

WC: with water cooling

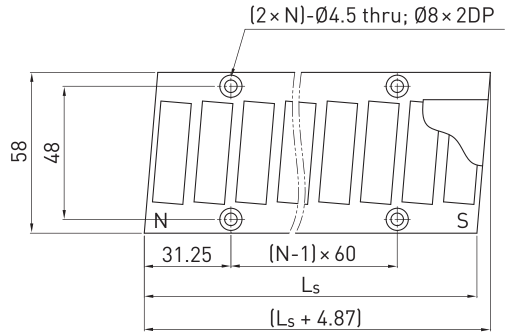
All the specifications in the table (except dimensions) are in ± 10 % of tolerance at 25 °C ambient temperature

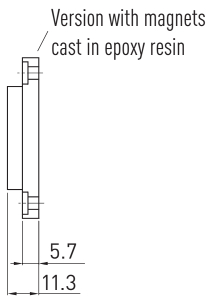
1) Line to line

Dimensions of forcer

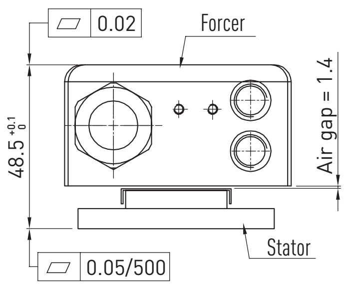


Dimensions of stator

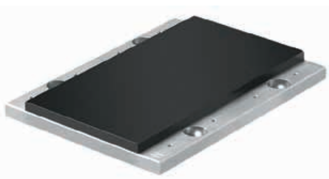




Mounting tolerances



Stator versions available



Epoxy:
Magnets cast in epoxy resin.

Stainless steel cover plate (upon request):
Additional, one-piece stainless steel cover plate for magnet tracks consisting of stators with magnets cast in epoxy resin.

11.4.2 LMFA1 specifications

Force-velocity curves (DC bus voltage: 750 VDC)

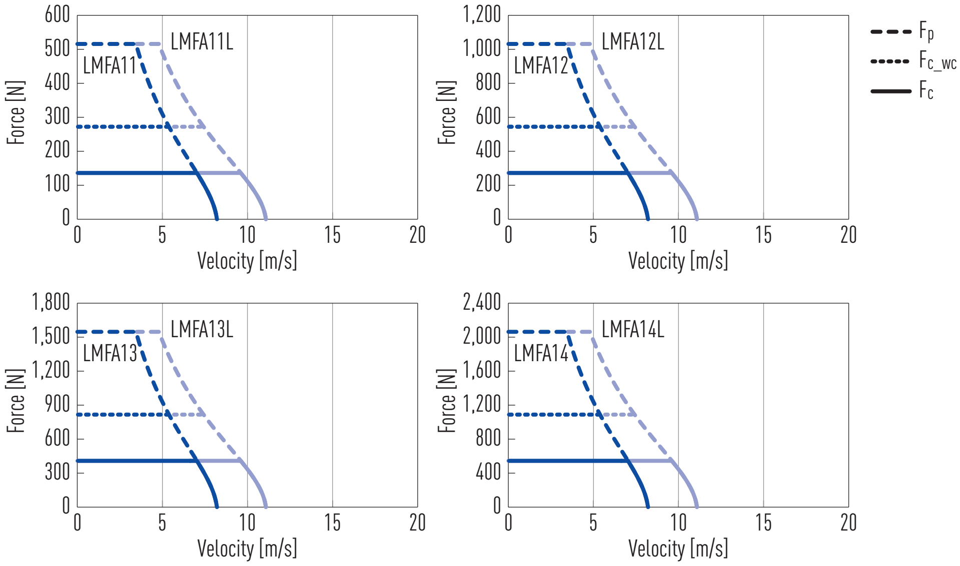


Table 11.11 **Technical data**

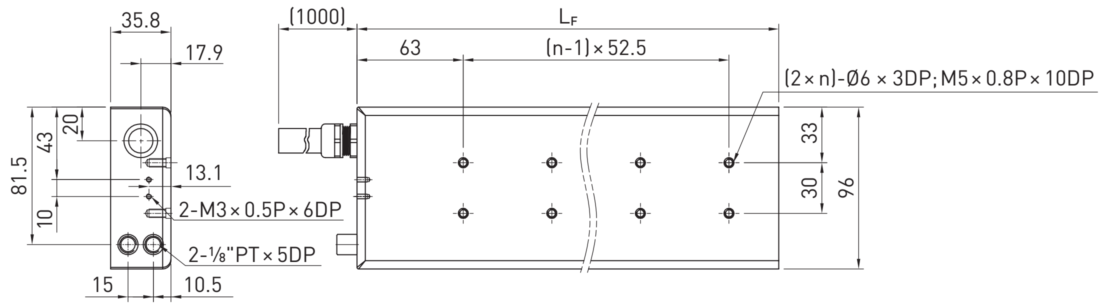
	Symbol	Unit	LMFA11	LMFA11L	LMFA12	LMFA12L	LMFA13	LMFA13L	LMFA14	LMFA14L
Forces and electrical parameters										
Continuous force at T_{max}	F_c	N	136		272		408		544	
Continuous force at T_{max} (WC)	F_{c_WC}	N	272		544		816		1,089	
Continuous current at T_{max}	I_c	A_{eff}	1.4	1.8	2.7	3.6	4.0	5.5	5.4	7.3
Continuous current at T_{max} (WC)	I_{c_WC}	A_{eff}	2.7	3.6	5.4	7.3	8.1	10.9	10.8	14.6
Peak force (for 1 s)	F_p	N	516		1,032		1,548		2,063	
Peak current (for 1 s)	I_p	A_{eff}	8.4	11.3	16.7	22.3	25.1	33.9	33.5	45.2
Force constant	K_f	N/A_{eff}	100.8	74.4	100.8	74.6	100.8	74.6	100.8	74.6
Attraction force	F_a	N	837		1,674		2,511		3,348	
Resistance [1]	R_{25}	Ω	16.9	8.7	8.4	4.3	5.6	2.9	4.2	2.2
Inductance [1]	L	mH	121.9	66.8	60.9	33.4	40.6	22.3	30.5	16.7
Back EMF constant	K_u	$V_{eff}/(m/s)$	58.2	43.1	58.2	43.1	58.2	43.1	58.2	43.1
Motor constant	K_m	$N/\sqrt{W}$	20.0	20.7	28.3	29.2	34.7	35.8	40.1	41.4
Thermal resistance	R_{th}	°C/W	1.56	1.66	0.78	0.83	0.52	0.55	0.39	0.42
Thermal resistance (WC)	R_{th_WC}	°C/W	0.39	0.42	0.20	0.21	0.13	0.14	0.10	0.10
Thermal switch			1 × PT1000 × (3 PTC SNM 120 in series)							
Max. DC bus voltage		V	750							
Mechanical parameters										
Pole pair pitch	2τ	mm	30							
Max. winding temperature	T_{max}	°C	120							
Mounting holes (forcer)	n		2		4		6		8	
Weight of forcer	M_F	kg	2.4		4		5.6		7.6	
Length of forcer	L_F	mm	145		250		355		460	
Unit mass of stator	M_S	kg/m	5.8							
Length of stator/Dimension N	L_S	mm	120 mm/N = 2; 300 mm/N = 5							

WC: with water cooling

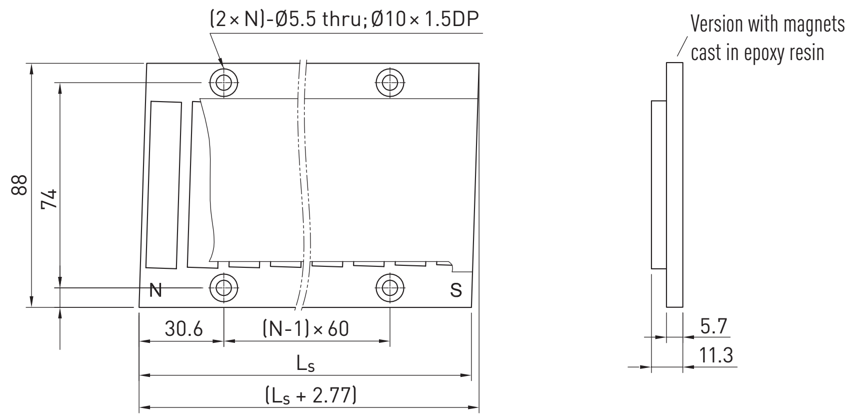
All the specifications in the table (except dimensions) are in ± 10 % of tolerance at 25 °C ambient temperature

[1] Line to line

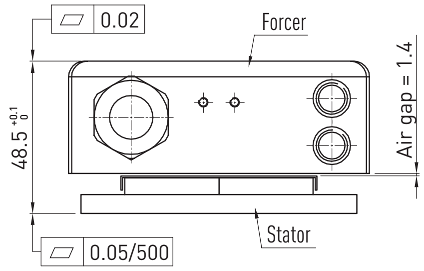
Dimensions of forcer



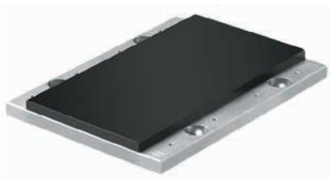
Dimensions of stator

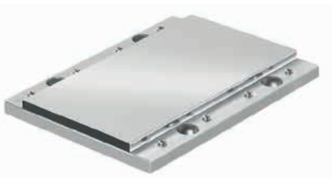


Mounting tolerances



Stator versions available





Epoxy:
Magnets cast in epoxy resin.

Stainless steel cover plate (upon request):
Additional, one-piece stainless steel cover plate for magnet tracks consisting of stators with magnets cast in epoxy resin.

11.4.3 LMFA2 specifications

Force-velocity curves (DC bus voltage: 750 VDC)

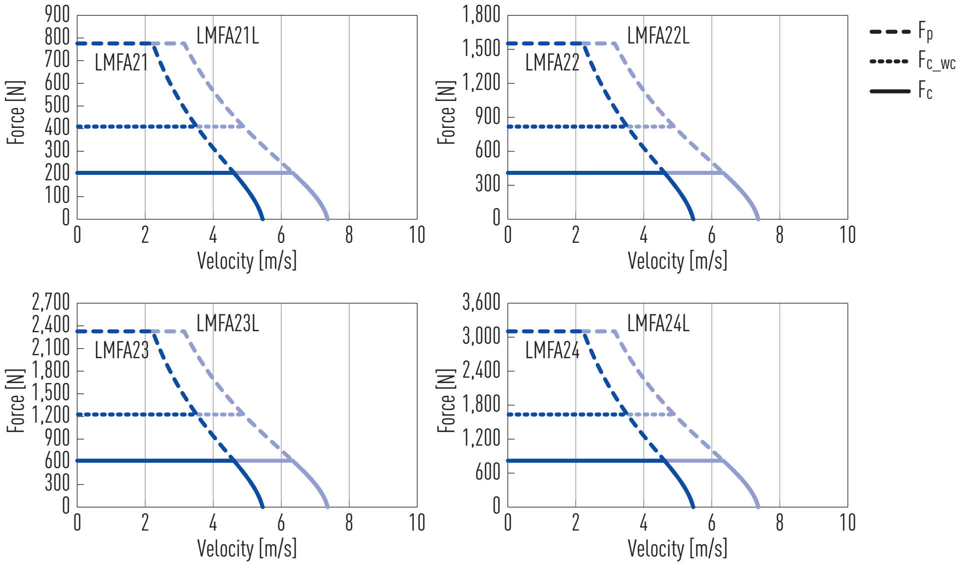


Table 11.12 **Technical data**

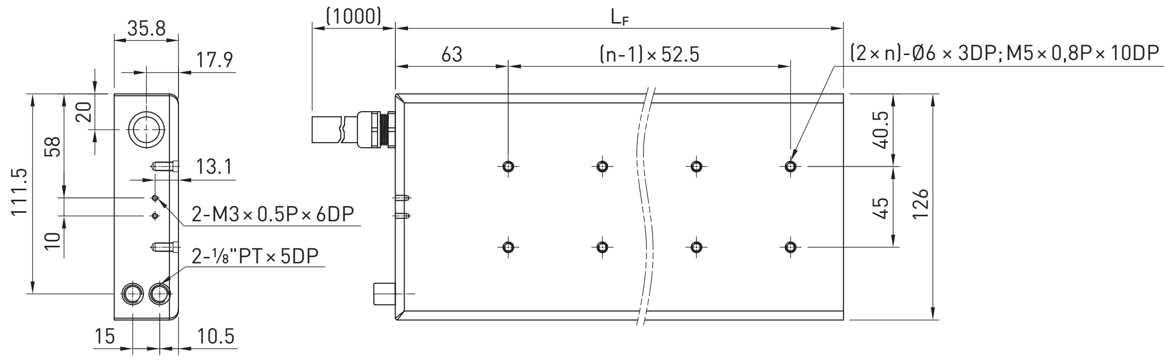
	Symbol	Unit	LMFA21	LMFA21L	LMFA22	LMFA22L	LMFA23	LMFA23L	LMFA24	LMFA24L
Forces and electrical parameters										
Continuous force at T_{max}	F_c	N	205		409		614		819	
Continuous force at T_{max} (WC)	F_{c_WC}	N	409		819		1,228		1,638	
Continuous current at T_{max}	I_c	A_{eff}	1.4	1.8	2.7	3.6	4.1	5.5	5.4	7.3
Continuous current at T_{max} (WC)	I_{c_WC}	A_{eff}	2.7	3.6	5.4	7.3	8.1	10.9	10.8	14.6
Peak force (for 1 s)	F_p	N	776		1,552		2,328		3.104	
Peak current (for 1 s)	I_p	A_{eff}	8.4	11.3	16.7	22.6	25.1	33.9	33.5	45.2
Force constant	K_f	N/A_{eff}	151.6	112.2	151.6	112.2	151.6	112.2	151.6	112.2
Attraction force	F_a	N	1,259		2,518		3,777		5,036	
Resistance [1]	R_{25}	Ω	24.8	12.7	12.4	6.4	8.3	4.2	6.2	3.2
Inductance [1]	L	mH	178.6	97.8	89.3	48.9	59.5	32.6	44.6	24.5
Back EMF constant	K_u	$V_{eff}/(m/s)$	87.5	64.8	87.5	64.8	87.5	64.8	87.5	64.8
Motor constant	K_m	N/√W	24.9	25.7	35.2	36.3	43.1	44.5	49.7	51.3
Thermal resistance	R_{th}	°C/W	1.06	1.13	0.53	0.57	0.35	0.38	0.27	0.28
Thermal resistance (WC)	R_{th_WC}	°C/W	0.27	0.28	0.13	0.14	0.09	0.09	0.07	0.07
Thermal switch			1 × PT1000 + 1 × (3 PTC SNM 120 in series)							
Max. DC bus voltage		V	750							
Mechanical parameters										
Pole pair pitch	2τ	mm	30							
Max. winding temperature	T_{max}	°C	120							
Mounting holes (forcer)	n		2		4		6		8	
Weight of forcer	M_F	kg	3.2		5.5		8.0		10.4	
Length of forcer	L_F	mm	145		250		355		460	
Unit mass of stator	M_S	kg/m	9.8							
Length of stator/Dimension N	L_S	mm	120 mm/N = 2; 300 mm/N = 5							

WC: with water cooling

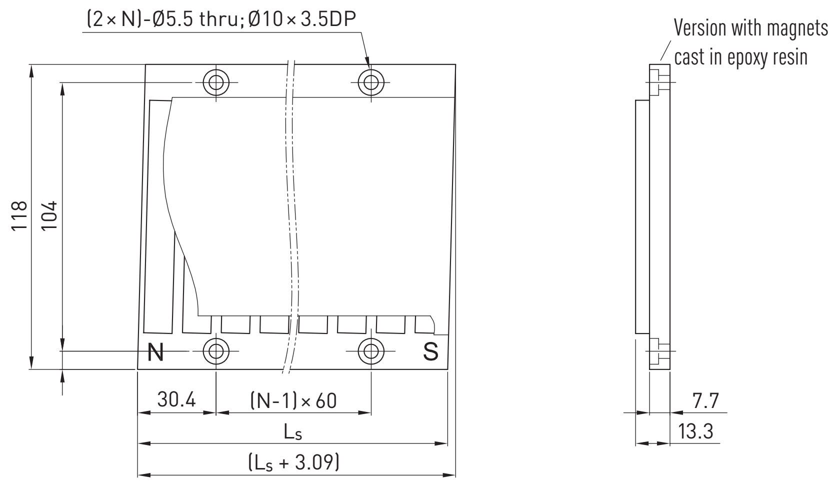
All the specifications in the table (except dimensions) are in ± 10 % of tolerance at 25 °C ambient temperature

[1] Line to line

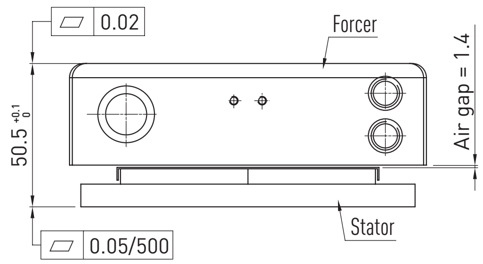
Dimensions of forcer



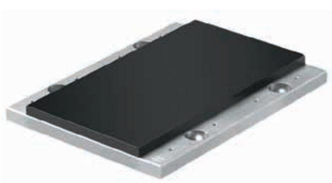
Dimensions of stator



Mounting tolerances



Stator versions available



Epoxy:
Magnets cast in epoxy resin.

Stainless steel cover plate (upon request):
Additional, one-piece stainless steel cover plate for magnet tracks consisting of stators with magnets cast in epoxy resin.

11.4.4 LMFA3 specifications

Force-velocity curves (DC bus voltage: 750 VDC)

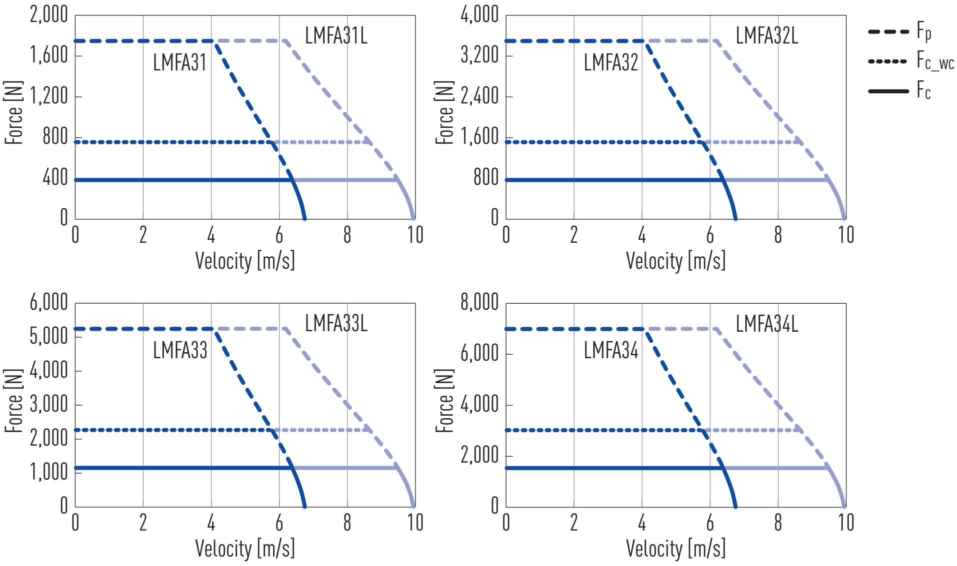
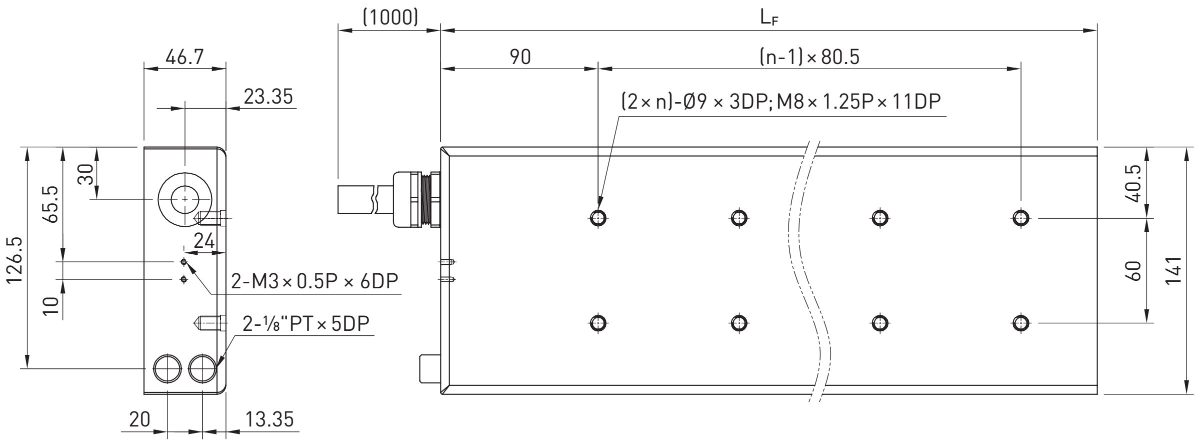


Table 11.13 **Technical data**

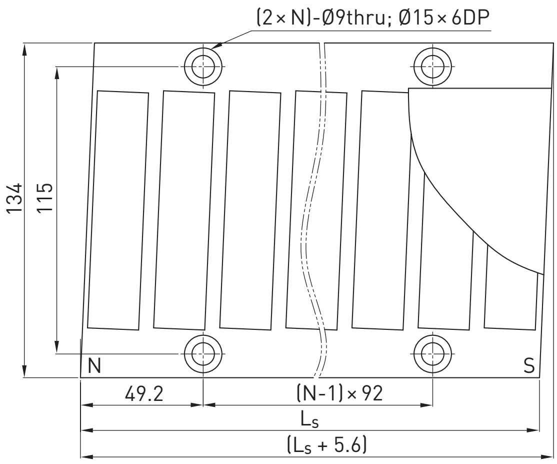
	Symbol	Unit	LMFA31	LMFA31L	LMFA32	LMFA32L	LMFA33	LMFA33L	LMFA34	LMFA34L
Forces and electrical parameters										
Continuous force at T_{max}	F_c	N	380		759		1139		1519	
Continuous force at T_{max} (WC)	F_{c_WC}	N	759		1,519		2,278		3,037	
Continuous current at T_{max}	I_c	A_{eff}	3.1	4.6	6.2	9.1	9.3	13.7	12.4	18.3
Continuous current at T_{max} (WC)	I_{c_WC}	A_{eff}	6.2	9.1	12.4	18.3	18.6	27.4	24.7	36.5
Peak force (for 1 s)	F_p	N	1,750		3,500		5,250		7,000	
Peak current (for 1 s)	I_p	A_{eff}	19.2	28.3	38.4	56.6	57.5	84.9	76.7	113.3
Force constant	K_f	N/A_{eff}	122.7	83.1	122.7	83.1	122.7	83.1	122.7	83.1
Attraction force	F_a	N	3,430		6,860		10,290		13,720	
Electrical time constant	K_e	ms	11.3	11.4	11.3	11.4	11.3	11.4	11.3	11.4
Resistance [1]	R_{25}	Ω	4.3	1.9	2.1	1.0	1.4	0.6	1.1	0.5
Inductance [1]	L	mH	48.3	22.2	24.2	11.1	16.1	7.4	12.1	5.5
Back EMF constant	K_u	$V_{eff}/(m/s)$	70.9	48.0	70.9	48.0	70.9	48.0	70.9	48.0
Motor constant	K_m	$N/\sqrt{W}$	48.4	48.7	68.5	68.9	83.9	84.4	96.9	97.4
Thermal resistance	R_{th}	°C/W	1.17	1.19	0.59	0.59	0.39	0.40	0.29	0.30
Thermal resistance (WC)	R_{th_WC}	°C/W	0.29	0.30	0.15	0.15	0.10	0.10	0.07	0.07
Thermal switch			1 × PT1000 + 1 × (3 PTC SNM 120 in series)							
Max. DC bus voltage		V	750							
Mechanical parameters										
Pole pair pitch	2τ	mm	46							
Max. winding temperature	T_{max}	°C	120							
Mounting holes (forcer)	n		2		4		6		8	
Weight of forcer	M_F	kg	6.4		11.7		17.3		22.5	
Length of forcer	L_F	mm	214		375		536		697	
Unit mass of stator	M_S	kg/m	16.2							
Length of stator/Dimension N	L_S	mm	184 mm/N = 2; 460 mm/N = 5							

WC: with water cooling
All the specifications in the table (except dimensions) are in ± 10 % of tolerance at 25 °C ambient temperature
[1] Line to line

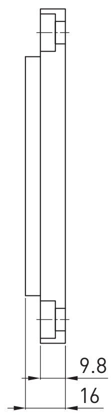
Dimensions of forcer



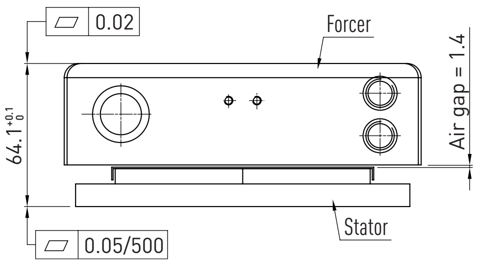
Dimensions of stator



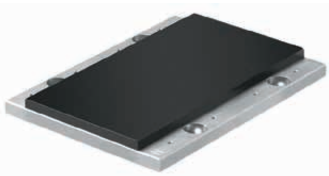
Version with magnets cast in epoxy resin

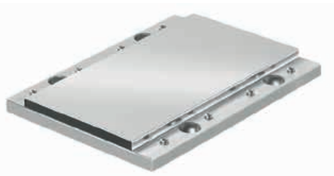


Mounting tolerances



Stator versions available





Epoxy:
Magnets cast in epoxy resin.

Stainless steel cover plate (upon request):
Additional, one-piece stainless steel cover plate for magnet tracks consisting of stators with magnets cast in epoxy resin.

11.4.5 LMFA4 specifications

Force-velocity curves (DC bus voltage: 750 VDC)

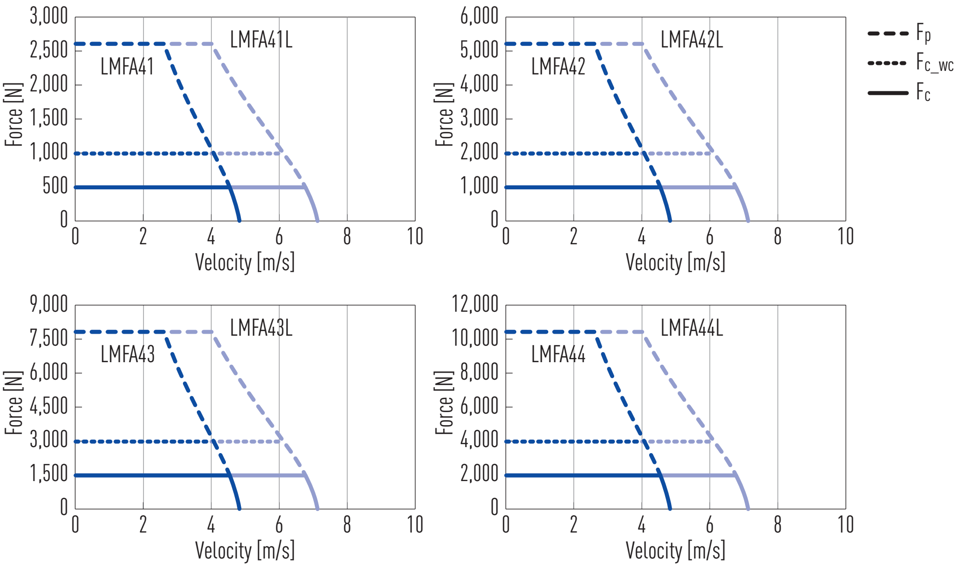


Table 11.14 **Technical data**

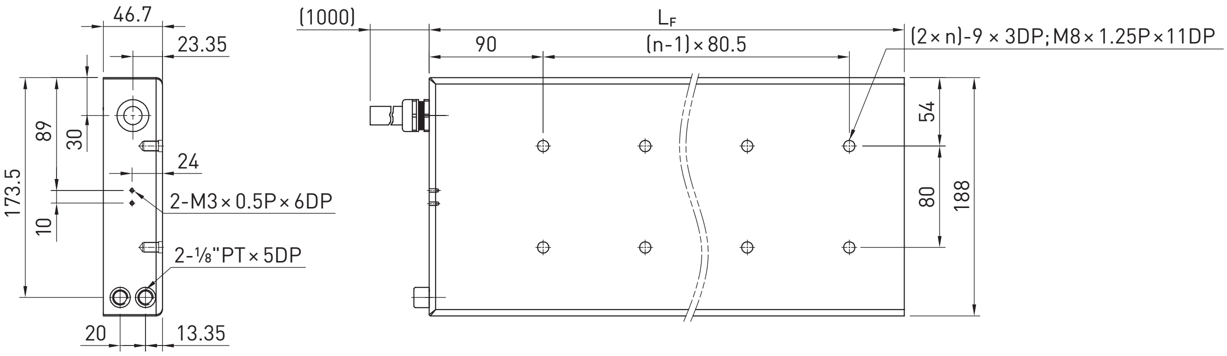
	Symbol	Unit	LMFA41	LMFA41L	LMFA42	LMFA42L	LMFA43	LMFA43L	LMFA44	LMFA44L
Forces and electrical parameters										
Continuous force at T_{max}	F_c	N	495		990		1,484		1,979	
Continuous force at T_{max} (WC)	F_{c_WC}	N	990		1,979		2,969		3,958	
Continuous current at T_{max}	I_c	A_{eff}	2.9	4.3	5.8	8.5	8.7	12.8	11.5	17.0
Continuous current at T_{max} (WC)	I_{c_WC}	A_{eff}	5.8	8.5	11.5	17.0	17.3	25.6	23.1	34.1
Peak force (for 1 s)	F_p	N	2,603		5,207		7,810		10,413	
Peak current (for 1 s)	I_p	A_{eff}	17.9	26.4	35.8	52.9	53.5	79.3	71.6	105.7
Force constant	K_f	N/A_{eff}	171.4	116.1	171.4	116.1	171.4	116.1	171.4	116.1
Attraction force	F_a	N	5,145		10,290		15,435		20,580	
Electrical time constant	K_e	ms	12.0	12.1	12.0	12.1	12.0	12.1	12.0	12.1
Resistance [1]	R_{25}	Ω	6.0	2.7	3.0	1.4	2.0	0.9	1.5	0.7
Inductance [1]	L	mH	72.0	33.0	36.0	16.5	24.0	11.0	18.0	8.3
Back EMF constant	K_u	V_{eff}/(m/s)	98.9	67.0	98.9	67.0	98.9	67.0	98.9	67.0
Motor constant	K_m	$N/\sqrt{W}$	57.1	57.5	80.8	81.3	98.9	99.5	114.2	114.9
Thermal resistance	R_{th}	°C/W	0.96	0.97	0.48	0.49	0.32	0.32	0.24	0.24
Thermal resistance (WC)	R_{th_WC}	°C/W	0.24	0.24	0.12	0.12	0.08	0.08	0.06	0.06
Thermal switch			1 × PT1000 + 1 × (3 PTC SNM 120 in series)							
Max. DC bus voltage		V	750							
Mechanical parameters										
Pole pair pitch	2τ	mm	46							
Max. winding temperature	T_{max}	°C	120							
Mounting holes (forcer)	n		2		4		6		8	
Weight of forcer	M_F	kg	9.5		16.2		23		29	
Length of forcer	L_F	mm	214		375		536		697	
Unit mass of stator	M_S	kg/m	22.3							
Length of stator/Dimension N	L_S	mm	184 mm/N = 2; 460 mm/N = 5							

WC: with water cooling

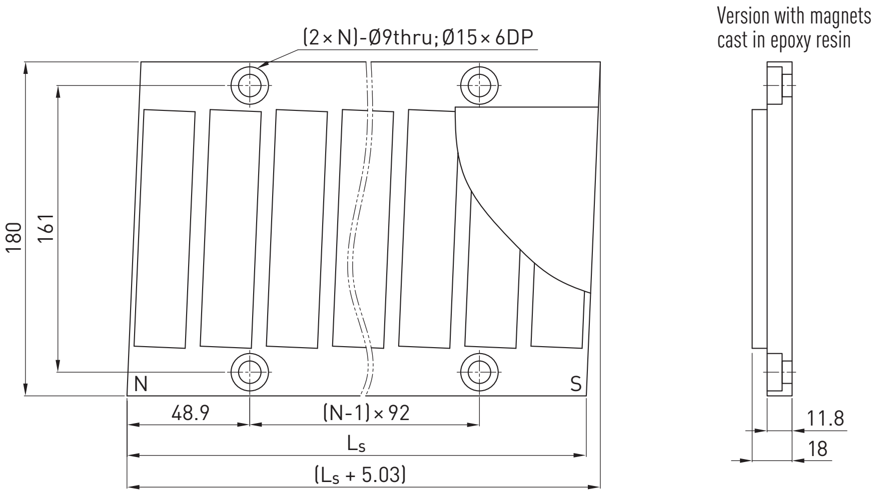
All the specifications in the table (except dimensions) are in ± 10 % of tolerance at 25 °C ambient temperature

[1] Line to line

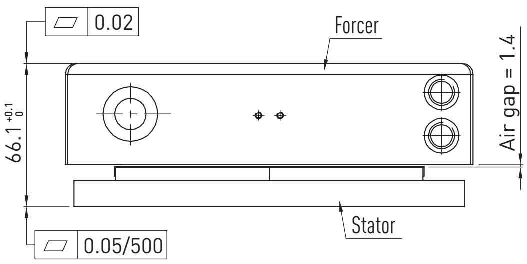
Dimensions of forcer



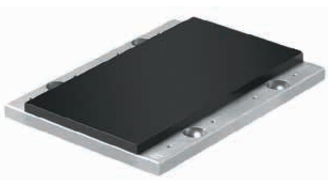
Dimensions of stator



Mounting tolerances



Stator versions available



Epoxy:
Magnets cast in epoxy resin.

Stainless steel cover plate (upon request): Additional, one-piece stainless steel cover plate for magnet tracks consisting of stators with magnets cast in epoxy resin.

11.4.6 LMFA5 specifications

Force-velocity curves (DC bus voltage: 750 VDC)

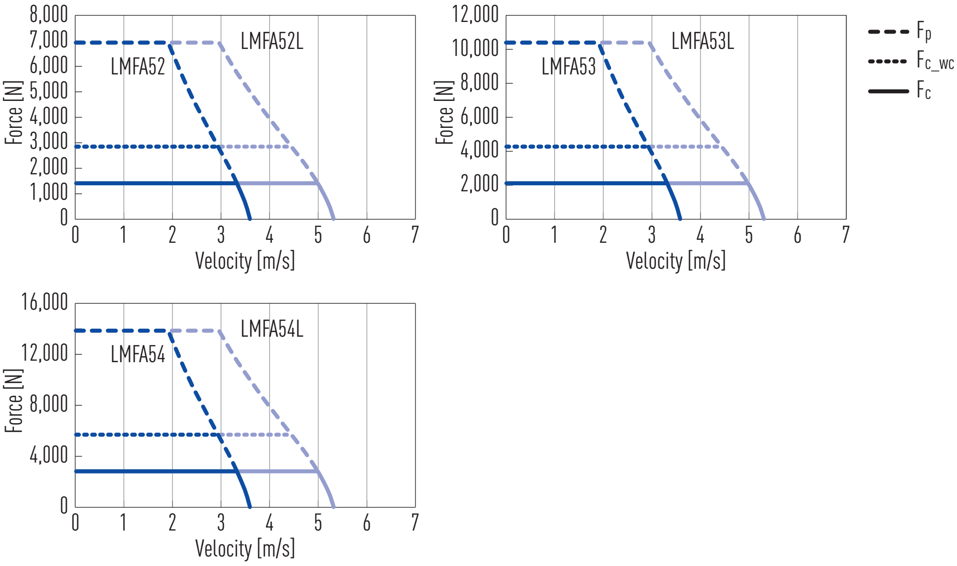


Table 11.15 **Technical data**

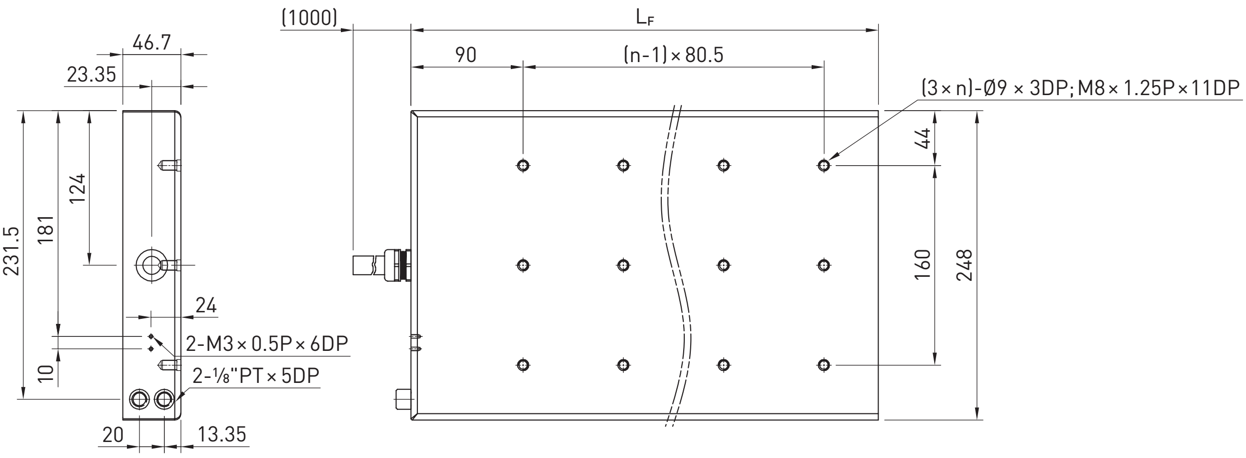
	Symbol	Unit	LMFA52	LMFA52L	LMFA53	LMFA53L	LMFA54	LMFA54L
Forces and electrical parameters								
Continuous force at T_{max}	F_c	N	1,422		2,133		2,844	
Continuous force at T_{max} (WC)	F_{c_WC}	N	2,844		4,266		5,688	
Continuous current at T_{max}	I_c	A_{eff}	6.2	9.1	9.3	13.7	12.4	18.3
Continuous current at T_{max} (WC)	I_{c_WC}	A_{eff}	12.4	18.3	18.6	27.4	24.7	36.5
Peak force (for 1 s)	F_p	N	6,925		10,388		13,850	
Peak current (for 1 s)	I_p	A_{eff}	38.4	56.6	57.5	84.9	76.7	113.2
Force constant	K_f	N/A_{eff}	229.9	155.7	229.9	155.7	229.9	155.7
Attraction force	F_a	N	13,700		20,550		27,400	
Electrical time constant	K_e	ms	12.2	12.4	12.2	12.4	12.2	12.4
Resistance [1)]	R_{25}	Ω	3.9	1.8	2.6	1.2	2.0	0.9
Inductance [1)]	L	mH	47.7	21.9	31.8	14.6	23.9	10.9
Back EMF constant	K_u	$V_{eff}/(m/s)$	132.7	89.9	132.7	89.9	132.7	89.9
Motor constant	K_m	$N/\sqrt{W}$	95.0	95.6	116.4	117.1	134.4	135.2
Thermal resistance	R_{th}	°C/W	0.32	0.33	0.21	0.22	0.16	0.16
Thermal resistance (WC)	R_{th_WC}	°C/W	0.08	0.08	0.05	0.05	0.04	0.04
Thermal switch			1 × PT1000 + 1 × (3 PTC SNM 120 in series)					
Max. DC bus voltage		V	750					
Mechanical parameters								
Pole pair pitch	2τ	mm	46					
Max. winding temperature	T_{max}	°C	120					
Mounting holes (forcer)	n		4		6		8	
Weight of forcer	M_F	kg	23.8		32.3		40.8	
Length of forcer	L_F	mm	375		536		697	
Unit mass of stator	M_S	kg/m	25					
Length of stator/Dimension N	L_S	mm	184 mm/N = 2; 460 mm/N = 5					

WC: with water cooling

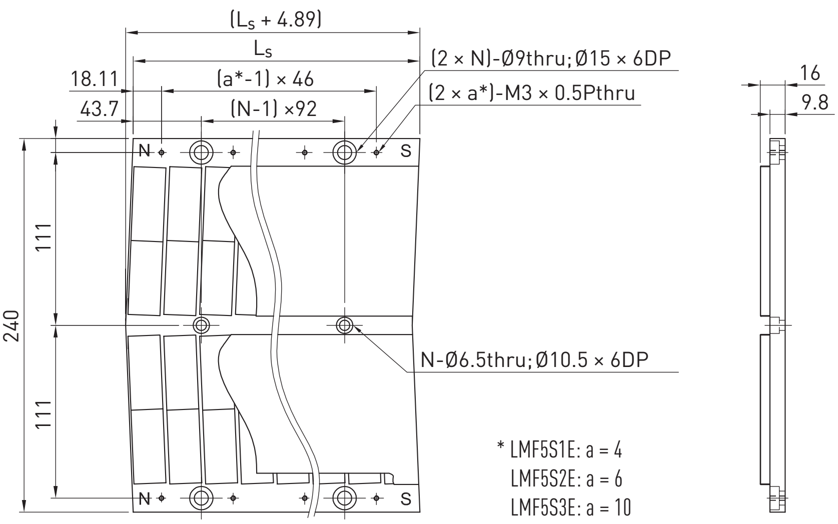
All the specifications in the table (except dimensions) are in ± 10 % of tolerance at 25 °C ambient temperature

[1)] Line to line

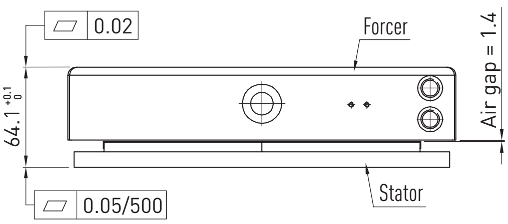
Dimensions of forcer



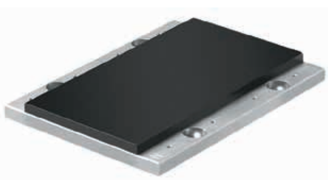
Dimensions of stator



Mounting tolerances



Stator versions available



Epoxy:
Magnets cast in epoxy resin.

Stainless steel cover plate (upon request):
Additional, one-piece stainless steel cover plate for magnet tracks consisting of stators with magnets cast in epoxy resin.

11.4.7 LMFA6 specifications

Force-velocity curves (DC bus voltage: 750 VDC)

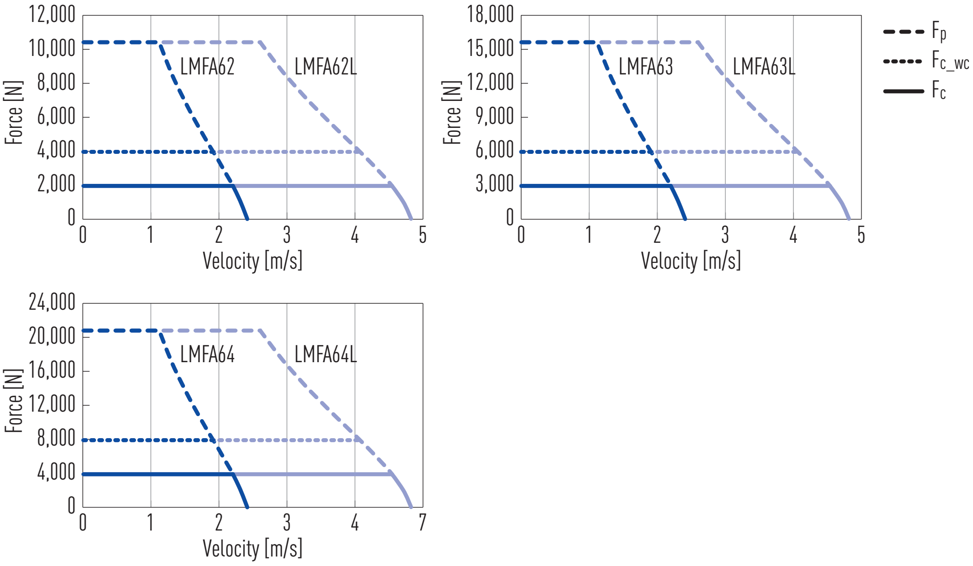


Table 11.16 **Technical data**

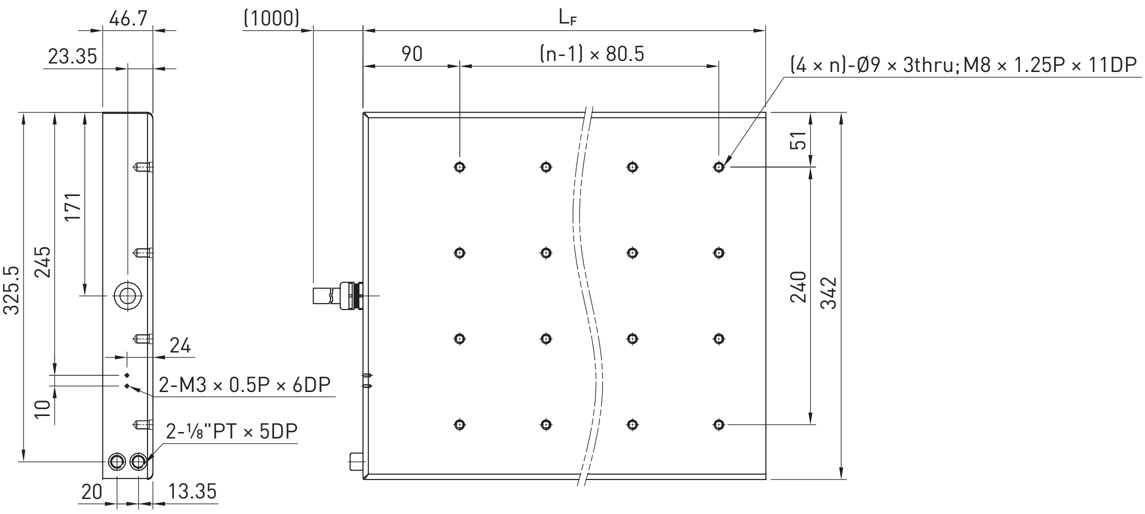
	Symbol	Unit	LMFA62	LMFA62L	LMFA63	LMFA63L	LMFA64	LMFA64L
Forces and electrical parameters								
Continuous force at T_{max}	F_c	N	1,979		2,969		3,958	
Continuous force at T_{max} (WC)	F_{c_WC}	N	3,958		5,938		7,917	
Continuous current at T_{max}	I_c	A_{eff}	5.8	11.5	8.7	17.3	11.5	23.1
Continuous current at T_{max} (WC)	I_{c_WC}	A_{eff}	11.5	23.1	17.3	34.6	23.1	46.2
Peak force (for 1 s)	F_p	N	10,413		15,620		20,827	
Peak current (for 1 s)	I_p	A_{eff}	35.8	71.6	53.7	107.4	71.3	142.6
Force constant	K_f	N/A_{eff}	342.7	171.4	342.7	171.4	342.7	171.4
Attraction force	F_a	N	20,580		30,870		41,160	
Electrical time constant	K_e	ms	12.0					
Resistance [1]	R_{25}	Ω	6.0	1.5	4.0	1.0	3.0	0.8
Inductance [1]	L	mH	72.0	18.0	48.0	12.0	36.0	9.0
Back EMF constant	K_u	$V_{eff}/(m/s)$	197.9	98.9	197.9	98.9	197.9	98.9
Motor constant	K_m	$N/\sqrt{W}$	114.2		139.9		161.6	
Thermal resistance	R_{th}	°C/W	0.24		0.16		0.12	
Thermal resistance (WC)	R_{th_WC}	°C/W	0.06		0.04		0.03	
Thermal switch			1 × PT1000 + 1 × (3 PTC SNM 120 in series)					
Max. DC bus voltage		V	750					
Mechanical parameters								
Pole pair pitch	2τ	mm	46					
Max. winding temperature	T_{max}	°C	120					
Mounting holes (forcer)	n		4		6		8	
Weight of forcer	M_F	kg	32.2		44.2		56.2	
Length of forcer	L_F	mm	375		536		697	
Unit mass of stator	M_S	kg/m	40.1					
Length of stator/Dimension N	L_S	mm	184 mm/N = 2					

WC: with water cooling

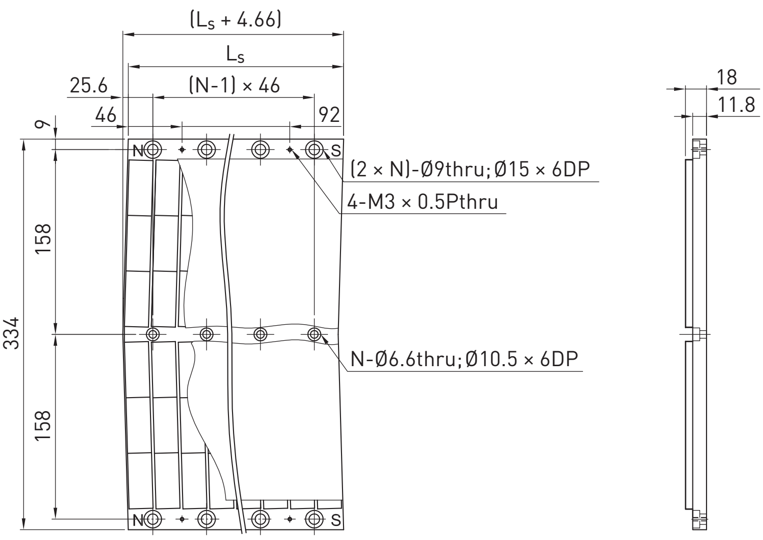
All the specifications in the table (except dimensions) are in ± 10 % of tolerance at 25 °C ambient temperature

[1] Line to line

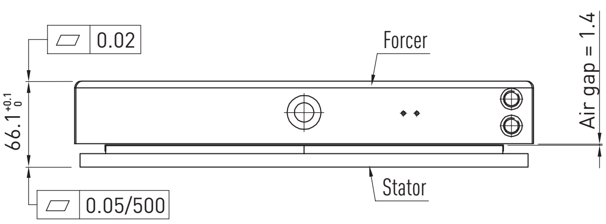
Dimensions of forcer



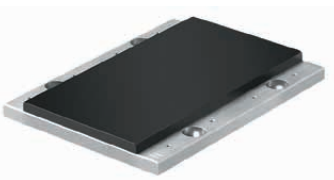
Dimensions of stator



Mounting tolerances



Stator versions available



Epoxy:
Magnets cast in epoxy resin.

Stainless steel cover plate (upon request):
Additional, one-piece stainless steel cover plate for magnet tracks consisting of stators with magnets cast in epoxy resin.

12. EC Declaration of Conformity

According to EC Directive 2014/35/EU – Low Voltage Directive

Manufacturer
HIWIN MIKROSYSTEM CORP., Ltd
No. 6, Jingke Central Rd
2 Taichung Precision Machinery Park
Taichung City 40852, Taiwan

This declaration relates exclusively to the following product in the state in which it was placed on the market, and excludes components which are added and/or operations carried out subsequently by the final user. The declaration is no more valid, if the product is modified without agreement.

Product denomination::	Linear motors
Model/type:	LMS, LMSA, LMF, LMFA, LMC
Year of manufacture:	from 2016

The manufacturer hereby declares that the product is complying with all essential requirements of the Directive 2014/35/EU (Low Voltage Directive) relating to electrical equipment.

In Addition the product is in accordance with the EC Directives:
- EC RoHS Directive on the restriction of hazardous substances (2011/65/EU)

Harmonised standards applied:
- IEC 60034-1:2010, modified: Rotating electrical machines
  Part 1: Rating and performance
- IEC 60034-5:2000 + Corrigendum 2001 + A1:2006: Rotating electrical machines
  Part 5: Degrees of protection provided by integral design of rotating electrical machines

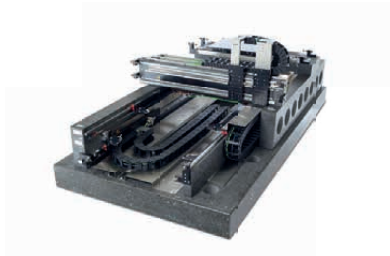
The person authorised to compile the relevant technical documentation:

Offenburg, 20.04.2016

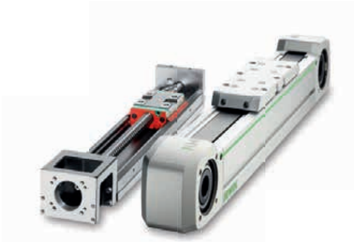
Werner Mäurer
Managing Director

Linear Guideways

Ballscrews



Linear Motor Systems



Linear Axes

Linear Actuators

Robots

Linear Motor Components

Rotary Tables

Drives & Servo Motors

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