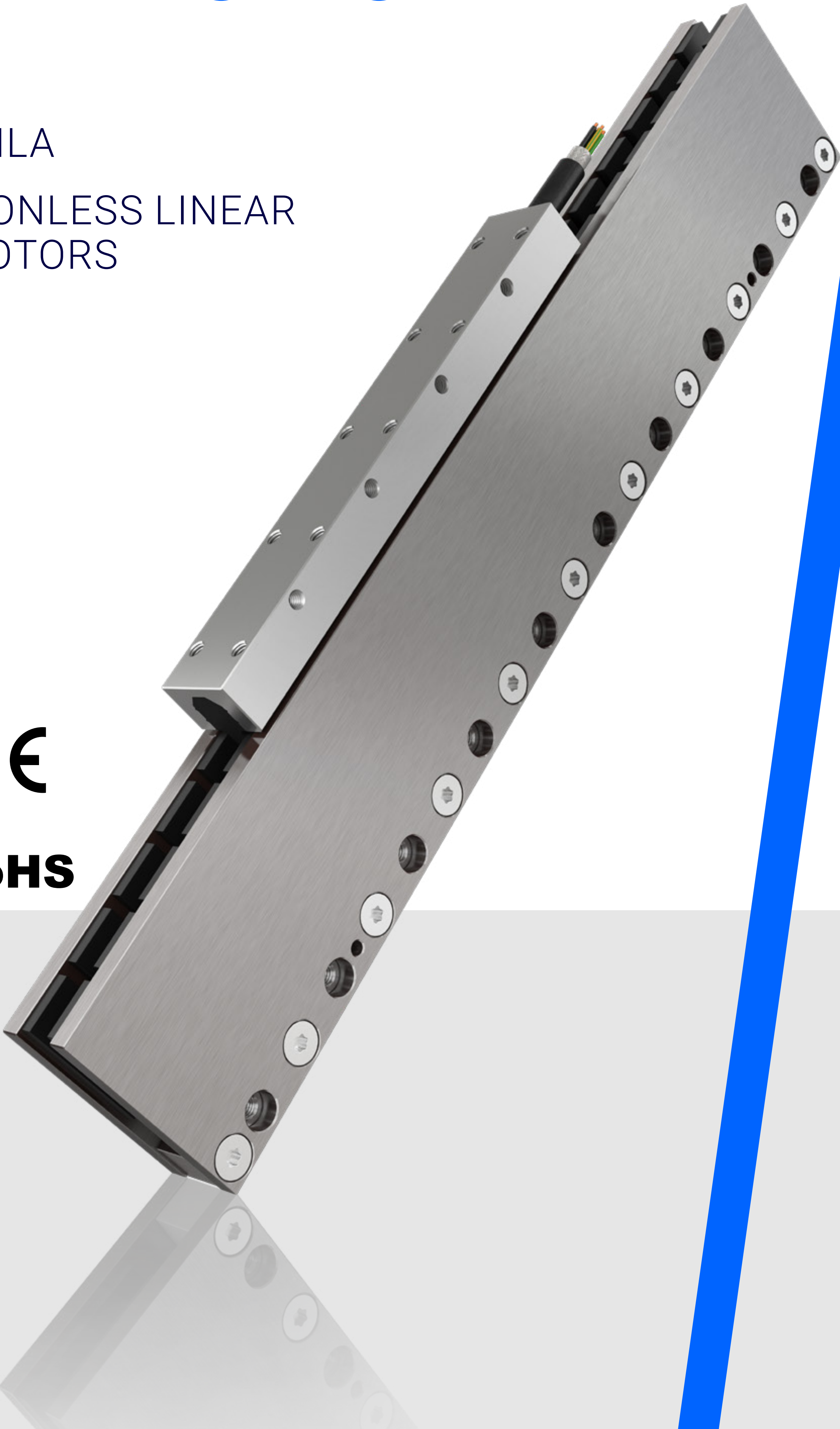
UNIMOTION

LMLA

IRONLESS LINEAR MOTORS



CE

RoHS

About Us

UNIMOTION is a leading company in the industrial automation field, at a global level. Combining innovative engineering solutions – Unimotion helps companies of all sizes across a wide range of industrial segments. Unimotion develops Industry 4.0-enabled products and systems with leading quality, performance and value. Engineering, Production, Construction, Warehouse, Research & Development department; all this can be found under one roof. Thanks to years of experience and a consistent focus on automation technology, we are continually improving our products and implementing innovations that provide customers with many technical advantages. Our core values are precision, innovation, passion, and integrity. At Unimotion, our main goal is the satisfaction of every single customer with a commitment to deliver the impossible.

Unimotion sales team, technicians and experts are at your disposal to provide customized expertise and support. We look forward to meeting you and work on your special project.

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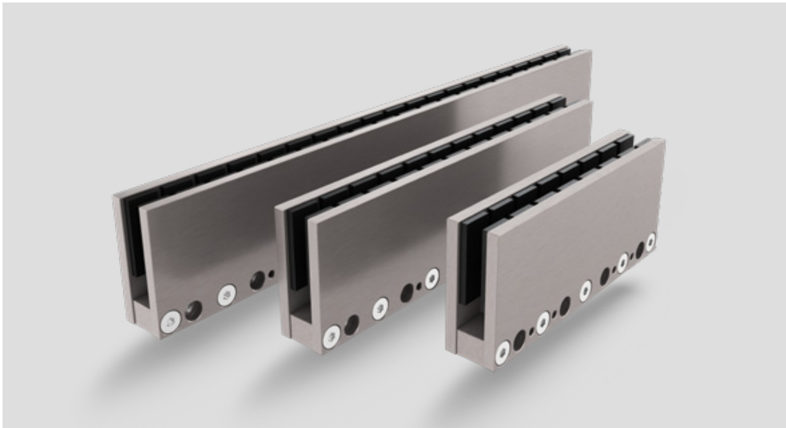
Product overview

PRODUCT OVERVIEW

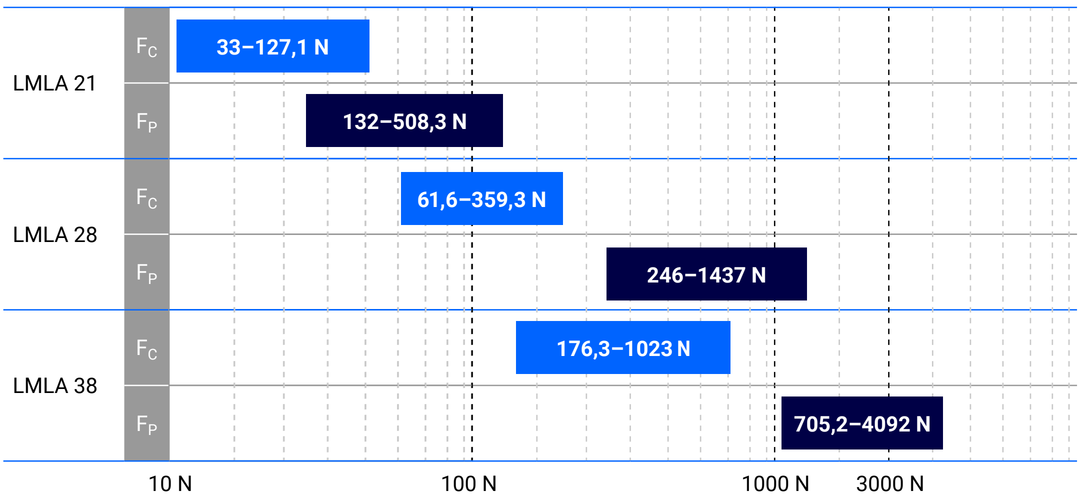
Welcome to the future of motion control with UNIMOTION cutting-edge Ironless linear motors. Designed to convert electrical energy directly into precise linear motion, these motors offer unrivaled speed, efficiency, and reliability across various industries and applications. Explore our catalog and revolutionize your projects with the seamless precision of UNIMOTION linear motor solutions.

Forcers



Magnet plates

POWER RANGE



F_C = Continuous Force

F_P = Peak Force

Basic description

Linear motors, like UNIMOTION Ironless Linear Motors, are an ideal substitute for pneumatic, hydraulic, belt, ball screw, or other types of drives. Linear motor drive systems do not require conversion from rotational to linear movement, because the movement is generated directly from the linear electromagnetic force. The linear motor driven systems, in comparison with the traditional linear units, are more compact, accurate, repeatable, faster, robust, reliable, generate less noise and, after all, require no maintenance. Linear motors are also known as "direct-drive" motors because the load is directly coupled onto them.

In contrast to iron core motors, UNIMOTION Ironless motors feature an ironless coil unit, eliminating attraction forces and cogging free between the motor and the magnet plate. This design offers numerous benefits, such as a lightweight framework, exceptional precision, dynamic responsiveness, high velocity, and swift acceleration and deceleration. These features collectively deliver unparalleled performance across diverse applications.

- UNIMOTION linear motors are ideal for a variety of applications, ie.: actuators, robots, XYZ tables, positioning, assembly, tool machines, P&P machines, fiber optic machines, and many others. The main advantage of UNIMOTION linear motors is force density, which is 5–30 % higher compared to other competitors on the market. Thanks to our innovative design and state-of-the-art materials, we can offer our customers the industry-leading linear motor on the market for a competitive price.

Besides different motor sizes and versions, we offer magnet plates that cover all variants and types of all motor sizes.

Magnetic plates designed to accommodate various plate sizes, ensuring optimal length and stroke coverage.

Additionally, for each motor size, we are offering two speed variants:

- A low-speed variant, and
- A high-speed variant, which has a lower BEMF constant and is suitable for applications, requiring higher speed or lower supply voltage (110Vac).

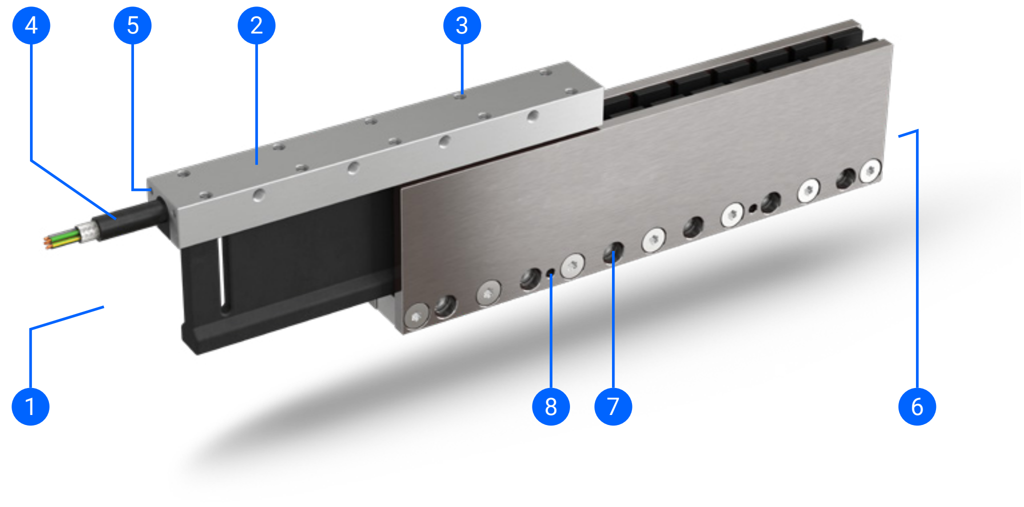
Both solutions are air-cooled and with an extremely high force density, which offers a small and very compact design of the linear motion systems and units.

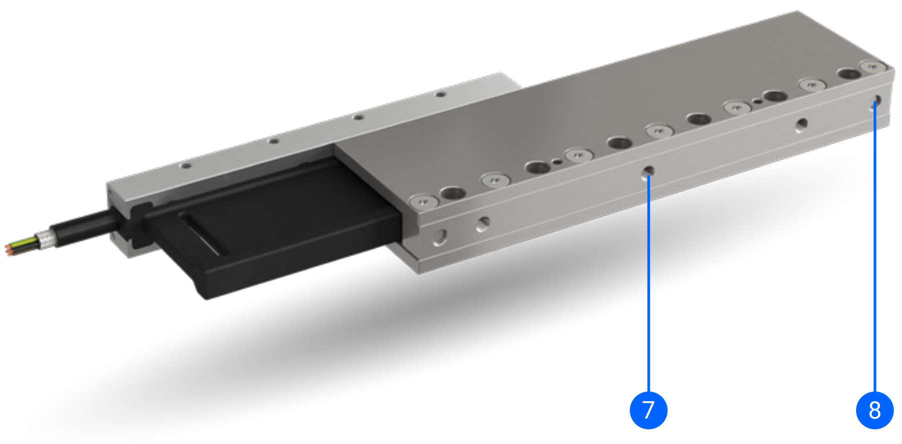
In order to allow an easy drive integration, we designed our own Hall sensor.

For more information regarding the Hall sensor, please refer to page 26–28.

All UNIMOTION LMLA linear motors are CE and RoHS compliant.

STRUCTURAL DESIGN





1 – Forcer

2 – Forcer body

3 – Forcer mounting holes

4 – Hybrid power and signal cable

5 – Hall sensor mounting holes

6 – Magnet plate

7 – Magnet plate mounting holes

8 – Magnet plate holes for centering ring or pin

For more information regarding the Hall sensor, please refer to page 26–28.

TERMS EXPLANATION

Supply voltage VDC:
A maximum allowed supply voltage, that can be applied to the motor windings.

Continuous force F_C:
Force produced by the continuous current (IC) at next conditions:
– ambient temperature 20 °C
– attached to the mounting surface at 20 °C
– motor in continuous movement.

Peak force F_P:
Force produced by the peak current (IP) for a duration of 1 second. The force is used for acceleration or deceleration.

Force constant K_F:
Defines how much force is produced per unit of current. It is the ratio of the force to the motor phase current.

Motor constant K_M:
The ratio of the motor force and square root of the power loss at 20 °C. The constant determines the motor’s efficiency.

Back EMF phase-phase constant K_{BEMF}:
Defines the phase-to-phase voltage generated when the motor is moving at 1 m/s at the magnet temperature of 20 °C.

Continuous current I_C:
It corresponds to the continuous force (FC) and can be continuously applied to the motor at next conditions:
– ambient temperature 20 °C
– attached to the mounting surface at 20 °C
– motor in continuous movement.

Peak current I_P:
Corresponds to the peak force (FP) and can be applied to the motor for 1 second.

Resistance phase-phase R_{20}:
Motor windings resistance measured phase to phase (line to line) at 20 °C.

Resistance phase-phase R_{125}:
Motor windings resistance measured phase to phase (line to line) at 125 °C.

Induction phase-phase L_P:
Motor windings inductance measured phase-to-phase (line-to-line).

Electrical time constant t_C:
The electrical time constant is the amount of time it takes for the current in the motor windings to reach 63 % of its rated value. The time constant is found by dividing inductance by resistance.

Max. winding temperature T_{max}:
Defined as a maximum permissible temperature of the motor windings. During the normal operation, it is recommended that windings temperature does not exceed 80 % of T_{max}.

Thermal resistance R_{th}:
Defines the heat transfer resistance from the motor windings to the environment at the defined plate (heatsink) and air dissipation.

Thermal resistance to heatsink R_{th-HS}:
Defines the heat transfer resistance from the motor windings to the heatsink attached surface.

Magnet pitch τ:
Magnet pitch or pole pair length is the distance between two same polar magnets on the magnet plate.

Thermal time constant τ_{th}:
Defined as a time required for the winding to reach 63 % of the max. temperature at continuous current. This value is only applicable when the mounting surface is at the constant temperature.

How to order

HOW TO ORDER

Forcer order code

LMLA - 21 - 04 - L

Series:
LMLA

Size:
– 14 (Available soon)
– 21
– 28
– 38

Version:
– 02
– 04
– 06
– 08
– 09
– 10
– 12

Type:
– L: Low speed
– H: High speed

Possible versions:
– LMLA 21: 02, 04, 06, 08
– LMLA 28: 02, 04, 06, 08, 12
– LMLA 38: 02, 04, 06, 09, 12[1]

[1]Version LMLA 38 12 will be available soon.

Magnet plate order code

LPA - 21 - 180 - C

Series:
LPA

Size:
– 14 (Available soon)
– 21
– 28
– 38

Length:
– 120
– 180
– 300

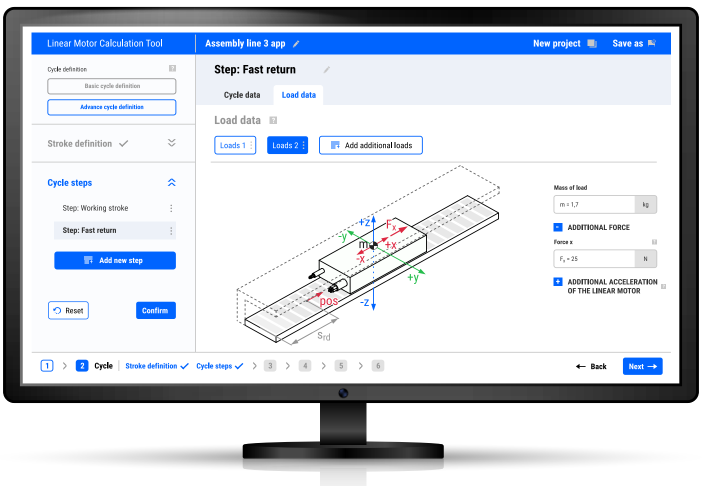
Type:
– C: Classic

UNIMOTION

CALCULATE AND CONFIGURE YOUR OWN SOLUTION

The LINEAR MOTOR CALCULATION TOOL is an online application that enables quick and easy selection of a suitable product, with the possibility of achieving the optimal ratio between the given capacity and the price and the creation of the 3D models.

For more information please contact us or visit our website.



Characteristics

LMLA 21

General technical data

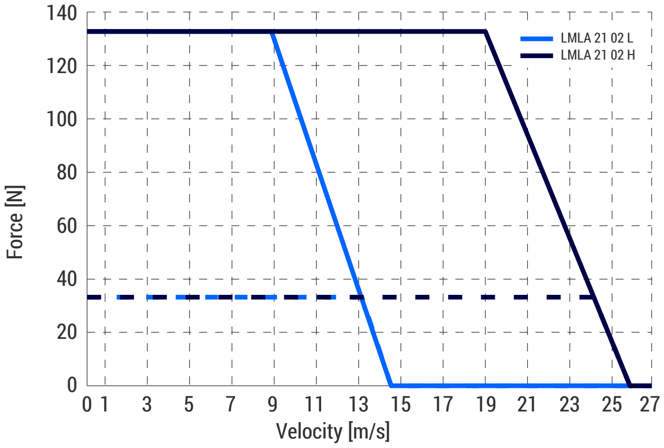
				LMLA 21							
				Version 02		Version 04		Version 06		Version 08	
	PARAMETER	SYM	UNIT	Low speed	High speed	Low speed	High speed	Low speed	High speed	Low speed	High speed
PERFORMANCE	Max. supply voltage	V_{DC}	V (DC)	340							
PERFORMANCE	Continuous force[1]	F_C	N	33		63,5		95,4		127,1	
PERFORMANCE	Peak force (1 s)[1]	F_P	N	132		254,2		381,4		508,3	
PERFORMANCE	Force constant	K_F	$\frac{N}{A_{RMS}}$	24,5	13,8	27,5	12,2	36,7	20,6	27,5	12,2
PERFORMANCE	Motor constant	K_M	$\frac{N}{\sqrt{W}}$	4,9	4,9	6,8	6,9	8,4	8,4	9,7	9,7
PERFORMANCE	Back EMF phase-phase constant	K_{BEMF}	$\frac{V_{RMS}}{(m/s)}$	14,1	7,9	15,9	7,1	21,2	11,9	15,9	7,1
ELECTRICAL	Continuous current	I_C	A_{RMS}	1,4	2,4	2,3	5,2	2,6	4,6	4,6	10,4
ELECTRICAL	Peak current	I_P	A_{RMS}	5,4	9,6	9,2	20,8	10,5	18,5	18,5	41,6
ELECTRICAL	Resistance at 20 °C phase-phase	R_{20}	Ω	16,9	5,3	10,8	2,1	12,7	4,0	5,4	1,1
ELECTRICAL	Resistance at 125 °C phase-phase	R_{125}	Ω	23,8	7,5	15,3	3,0	17,9	5,7	7,6	1,5
ELECTRICAL	Induction phase-phase	L_P	mH	3,4	1,1	2,1	0,4	2,6	0,8	1,1	0,2
ELECTRICAL	Electrical time constant[2]	t_C	ms	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2
THERMAL	Max. winding temperature	T_{max}	°C	125							
THERMAL	Max. allowed magnet plate temperature	T_{magnet}	°C	70							
THERMAL	Thermal time constant	τ_{th}	s	65							
THERMAL	Thermal resistance	R_{th}	$\frac{K}{W}$	1,61		0,86		0,58		0,43	
THERMAL	Thermal resistance to heatsink	R_{th_HS}	$\frac{K}{W}$	1,120		0,596		0,397		0,298	
MECHANICAL	Forcer overall length	M_L	mm	80		140		200		260	
MECHANICAL	Forcer overall width	M_W	mm	20							
MECHANICAL	Forcer overall height	M_H	mm	53							
MECHANICAL	Forcer mass	m_m	kg	0,22		0,32		0,42		0,62	
MECHANICAL	Magnet plate weight	m_S	$\frac{kg}{m}$	4,8							
MECHANICAL	Forcer wires cross-section	S_C	mm^2	0,5						0,75	
MECHANICAL	Sensor wires cross-section	S_{SC}	mm^2	0,14							
MECHANICAL	Hybrid cable	L_M	mm	1000							
MECHANICAL	Magnet pitch	τ	mm	30							

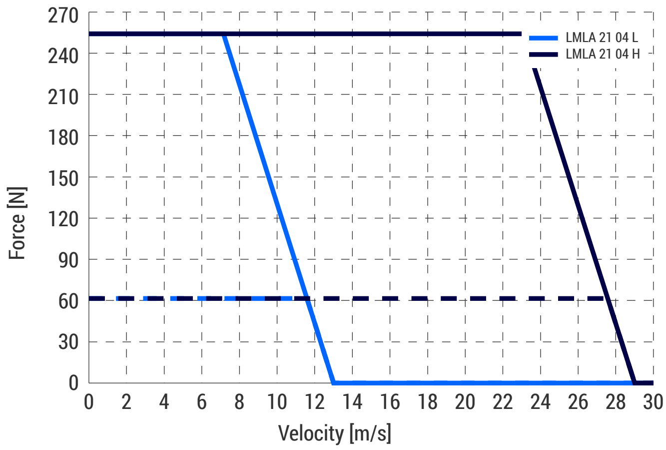
[1] Magnets at 20 °C.
[2] Windings at 20 °C.

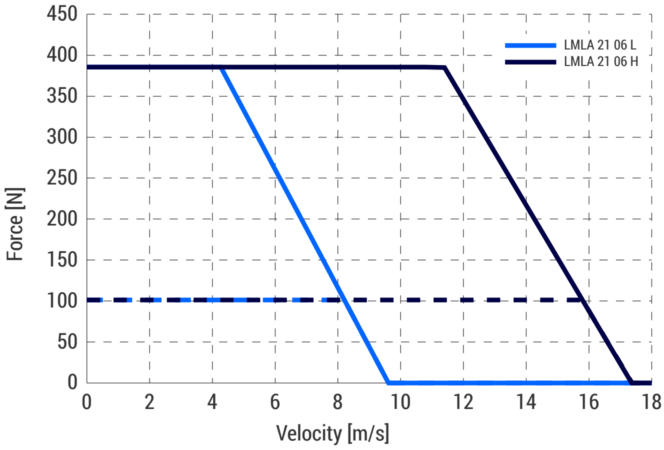
The specifications were measured without forced cooling. For performance and electrical and thermal specifications tolerance is ± 10 %.

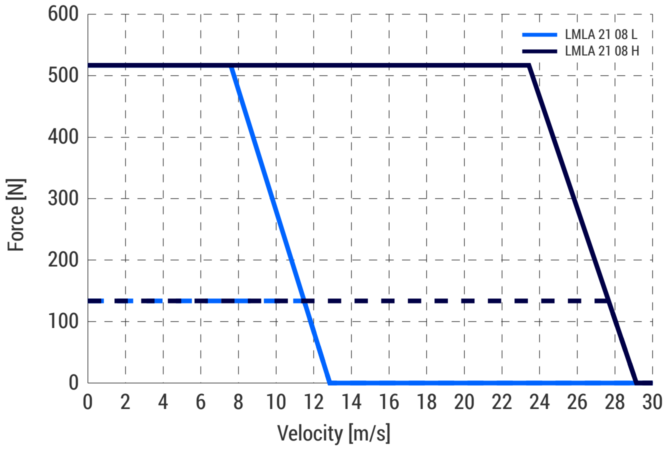
Force as a function of velocity diagrams

Bus voltage = 325 V DC

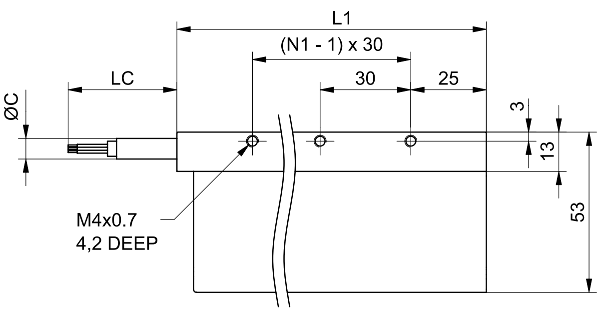


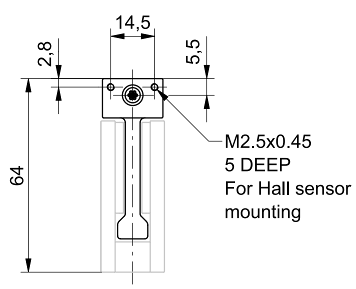


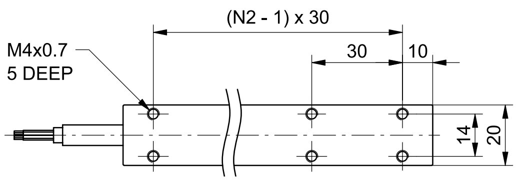




Forcer dimensions








Positive motor direction

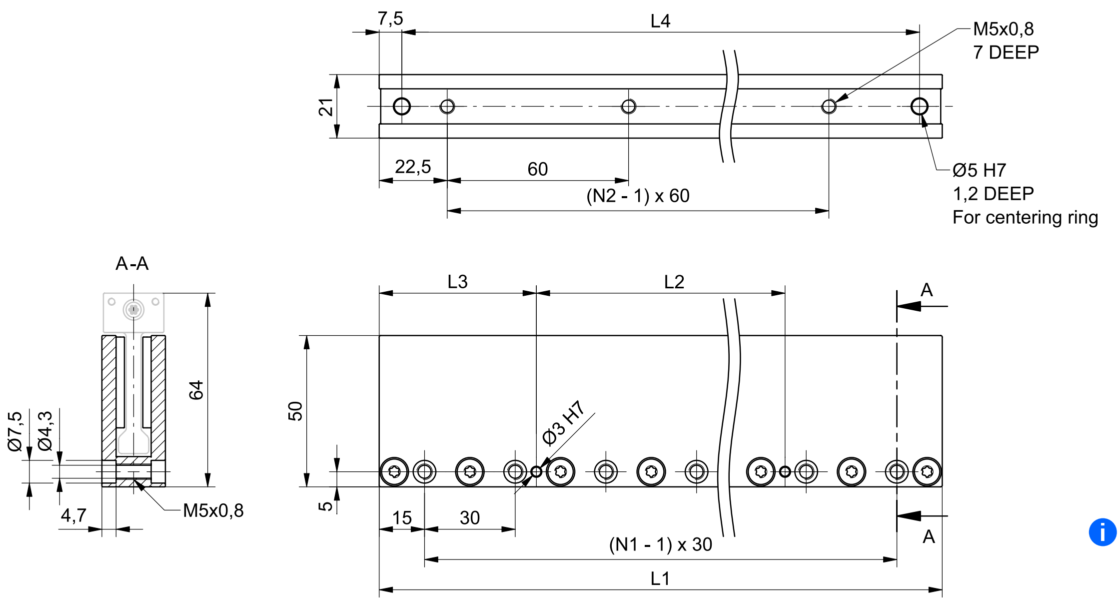
All dimensions are in mm.
The scale of the drawings may not be equal.

LMLA			L1	LC	ØC	N1	N2
Size	Version	Type	[mm]				
21	02	H	80	1000[1]	7,1	2	3
		L					
	04	H	140			4	5
		L					
	06	H	200			6	7
		L					
	08	H	260		7,5	8	9
		L					

[1] Standard cable length.

'N1' and 'N2' are the number of mounting holes along the motor direction.

Magnet plate dimensions



All dimensions are in mm. The scale of the drawings may not be equal.

LPA			L1	L2 (±0,02)	L3	L4 (±0,02)	N1	N2
Size	Length	Type	[mm]					
21	120	C	120	60	37,5	105	4	2
	180		180	76	52	165	6	3
	300		300	196	52	285	10	5

'N1' and 'N2' are the number of mounting holes along the motor direction.

LMLA 28

General technical data

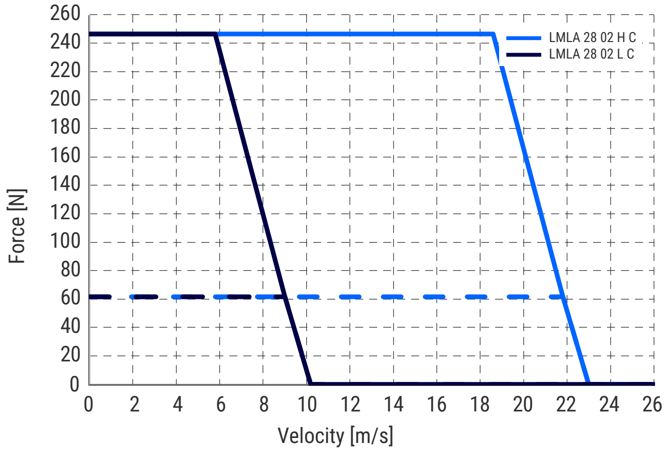
				LMLA 28									
				Version 02		Version 04		Version 06		Version 08		Version 12	
	PARAMETER	SYM	UNIT	Low speed	High speed	Low speed	High speed	Low speed	High speed	Low speed	High speed	Low speed	High speed
PERFORMANCE	Max. supply voltage	V_{DC}	V (DC)	340									
PERFORMANCE	Continuous force[1]	F_C	N	61,6		119,7		179,6		239,5		359,3	
PERFORMANCE	Peak force (1 s)[1]	F_P	N	246		479		718		958		1437	
PERFORMANCE	Force constant	K_F	$\frac{N}{A_{RMS}}$	35,2	15,7	35,2	15,7	52,8	23,5	62,6	31,3	70,4	31,3
PERFORMANCE	Motor constant	K_M	$\frac{N}{\sqrt{W}}$	7,7	7,7	10,9	10,9	13,4	13,4	15,4	15,4	18,9	18,9
PERFORMANCE	Back EMF phase-phase constant	K_{BEMF}	$\frac{V_{RMS}}{(m/s)}$	20,3	9,0	20,3	9,0	30,5	13,6	36,2	18,1	40,7	18,1
ELECTRICAL	Continuous current	I_C	A_{RMS}	1,8	3,9	3,4	7,7	3,4	7,7	3,8	7,7	5,1	11,5
ELECTRICAL	Peak current	I_P	A_{RMS}	7,0	15,7	13,6	30,6	13,6	30,6	15,3	30,6	20,4	45,9
ELECTRICAL	Resistance at 20 °C phase-phase	R_{20}	Ω	13,9	2,7	6,9	1,4	10,4	2,1	11,0	2,7	9,3	1,8
ELECTRICAL	Resistance at 125 °C phase-phase	R_{125}	Ω	19,6	3,9	9,8	1,9	14,7	2,9	15,5	3,9	13,1	2,6
ELECTRICAL	Induction phase-phase	L_P	mH	4,3	0,9	2,2	0,4	3,2	0,6	3,4	0,9	2,9	0,6
ELECTRICAL	Electrical time constant[3]	t_C	ms	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3
THERMAL	Max. winding temperature	T_{max}	°C	125									
THERMAL	Max. allowed magnet plate temperature	T_{magnet}	°C	70									
THERMAL	Thermal time constant	τ_{th}	s	77									
THERMAL	Thermal resistance	R_{th}	$\frac{K}{W}$	1,110		0,590		0,390		0,290		0,200	
THERMAL	Thermal resistance to heatsink	R_{th_HS}	$\frac{K}{W}$	0,788		0,417		0,278		0,208		0,138	
MECHANICAL	Forcer overall length	M_L	mm	80		140		200		260		380	
MECHANICAL	Forcer overall width	M_W	mm	27									
MECHANICAL	Forcer overall height	M_H	mm	81,8									
MECHANICAL	Forcer mass	m_m	kg	0,3		0,6		0,74		0,96		1,39	
MECHANICAL	Magnet plate weight	m_S	$\frac{kg}{m}$	9,9									
MECHANICAL	Forcer wires cross-section	S_C	mm^2	0,5				0,75					
MECHANICAL	Sensor wires cross-section	S_{SC}	mm^2	0,14									
MECHANICAL	Hybride cable	L_M	mm	1000									
MECHANICAL	Magnet Pitch	τ	mm	30									

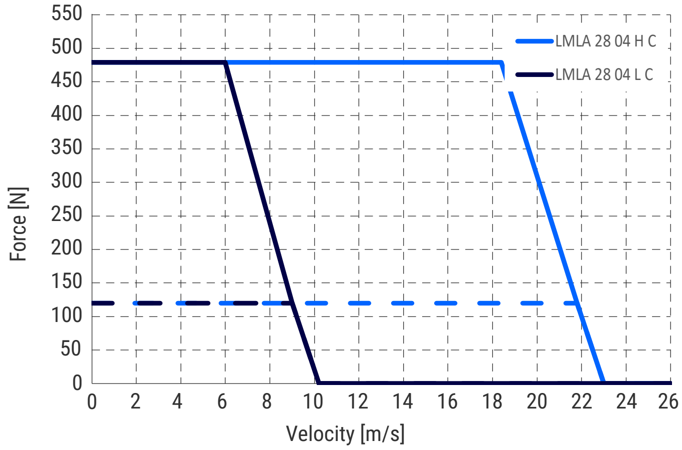
[1] Magnets at 20 °C.
[2] RMS at 0 A
[3] Windings at 20 °C.

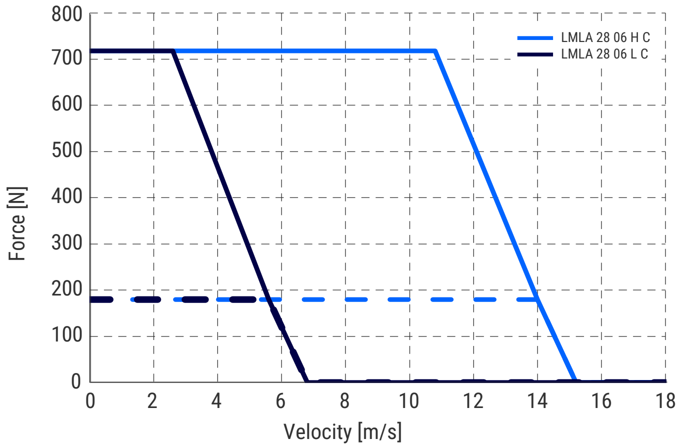
ℹ The specifications were measured without forced cooling. For performance and electrical and thermal specifications tolerance is ± 10 %.

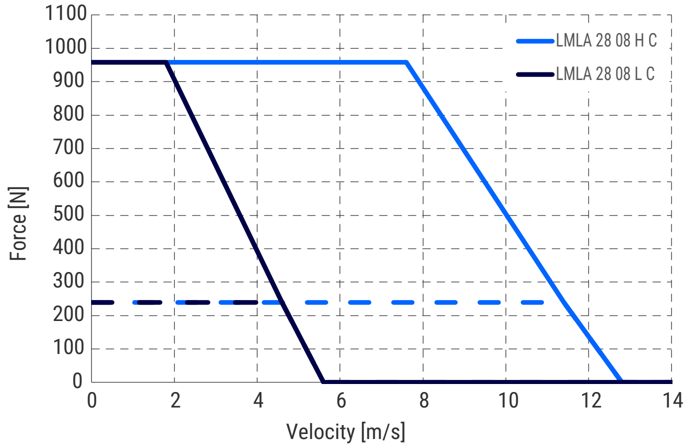
Force as a function of velocity diagrams

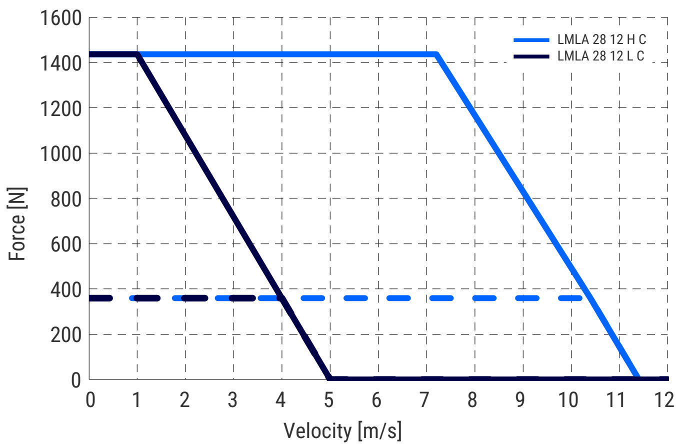
Bus voltage = 325 V DC



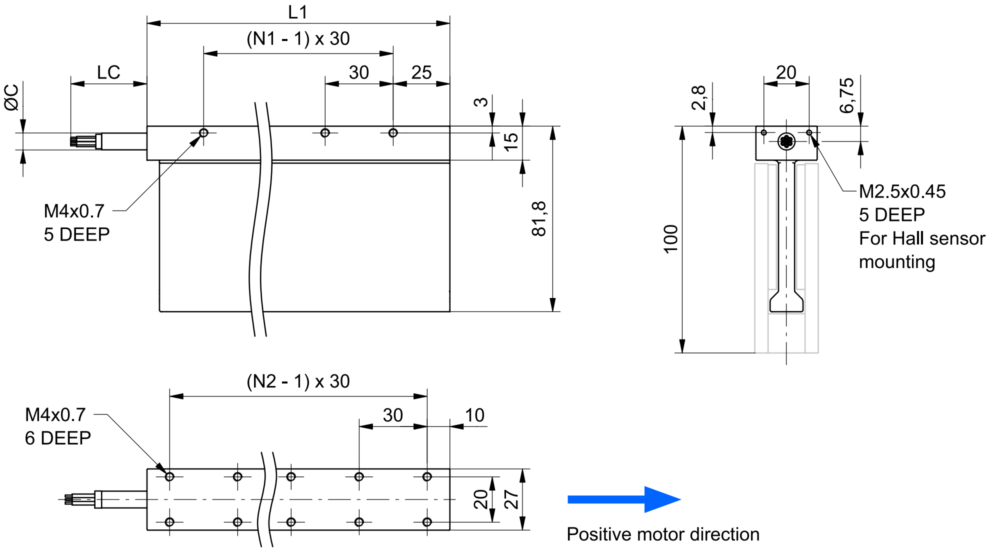








Forcer dimensions



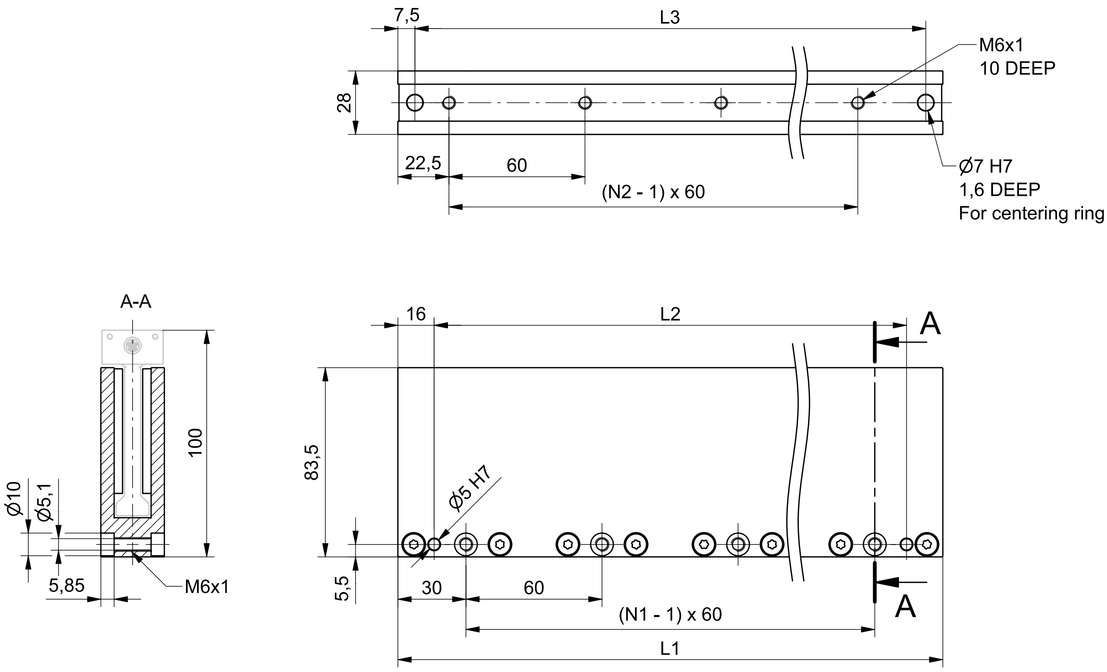
All dimensions are in mm. The scale of the drawings may not be equal.

LMLA			L1	LC	ØC	N1	N2
Size	Version	Type	[mm]				
28	02	H	80	1000[1]	7,1	2	3
		L					
	04	H	140			4	5
		L					
	06	H	200		7,5	6	7
		L					
	08	H	260			8	9
		L					
	12	H	380			12	13
		L					

[1] Standard cable length.

'N1' and 'N2' are the number of mounting holes along the motor direction.

Magnet plate dimensions



LPA			L1	L2 (±0,02)	L3 (±0,02)	N1	N2
Size	Length	Type	[mm]				
28	120	C	120	88	105	2	2
	180		180	148	165	3	3
	300		300	268	285	5	5

'N1' and 'N2' are the number of mounting holes along the motor direction.

LMLA 38

General technical data

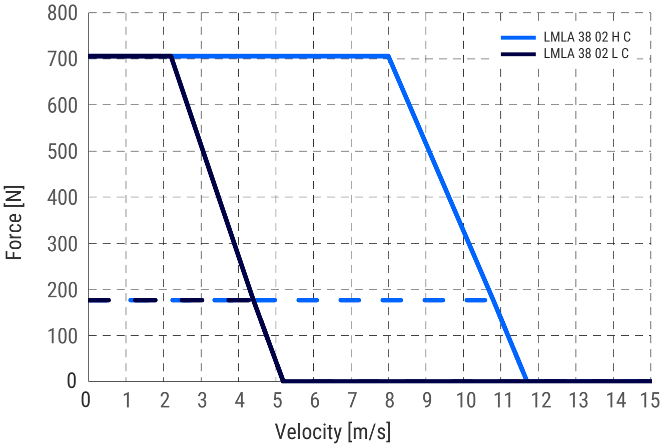
	PARAMETER	SYM	UNIT	LMLA 38 Version 02 Low speed	Version 02 High speed	Version 04 Low speed	Version 04 High speed	Version 06 Low speed	Version 06 High speed	Version 09 Low speed	Version 09 High speed	Version 12 Low speed	Version 12 High speed
PERFORMANCE	Max. supply voltage	V_{DC}	V (DC)	340									
	Continuous force[1]	F_C	N	176,3		341		511,5		767,3		1023	
	Peak force (1 s)[1]	F_P	N	705,2		1364		2046		3069		4092	
	Force constant	K_F	$\frac{N}{A_{RMS}}$	68,2	30,7	68,2	30,7	92,0	46,0	102,3	46,0	92,0	46,0
	Motor constant	K_M	$\frac{N}{\sqrt{W}}$	16,0	16,0	22,7	22,7	27,8	27,8	34,0	34,0	39,3	39,3
	Back EMF phase-phase constant	K_{BEMF}	$\frac{V_{RMS}}{(m/s)}$	39,4	17,7	39,4	17,7	53,1	26,6	59,1	26,6	53,1	26,6
ELECTRICAL	Continuous current	I_C	A_{RMS}	2,6	5,8	5,0	11,1	5,6	11,1	7,5	16,7	11,1	22,2
	Peak current	I_P	A_{RMS}	10,3	23,0	20,0	44,5	22,2	44,5	30,0	66,7	44,5	89,0
	Resistance at 20 °C phase-phase	R_{20}	Ω	12,0	2,4	6,0	1,2	7,3	1,8	6,0	1,2	3,7	0,9
	Resistance at 125 °C phase-phase	R_{125}	Ω	17,0	3,4	8,5	1,7	10,3	2,6	8,5	11,7	5,2	1,3
	Induction phase-phase	L_P	mH	10,9	2,2	5,5	1,1	6,6	1,7	5,5	1,1	3,3	0,8
	Electrical time constant[3]	t_C	ms	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9
THERMAL	Max. winding temperature	T_{max}	°C	125									
	Max. allowed magnet plate temperature	T_{magnet}	°C	70									
	Thermal time constant	τ_{th}	s	117									
	Thermal resistance	R_{th}	$\frac{K}{W}$	0,590		0,310		0,210		0,140		0,100	
	Thermal resistance to heatsink	R_{th_HS}	$\frac{K}{W}$	0,415		0,223		0,149		0,099		0,074	
MECHANICAL	Forcer overall length	M_L	mm	150		270		390		570		750	
	Forcer overall width	M_W	mm	37									
	Forcer overall height	M_H	mm	104,9									
	Forcer mass	m_m	kg	1		1,8		2,6		3,7		4,9	
	Magnet plate weight	m_S	$\frac{kg}{m}$	14,2									
	Forcer wires cross-section	S_C	mm^2	0,5				0,75					
	Sensor wires cross-section	S_{SC}	mm^2	0,14									
	Hybride cable	L_M	mm	1000									
	Magnet Pitch	τ	mm	60									

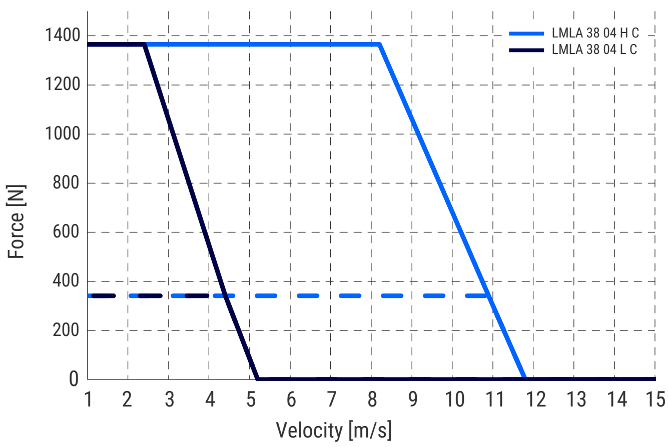
[1] Magnets at 20 °C.
[2] RMS at 0 A.
[3] Windings at 20 °C.

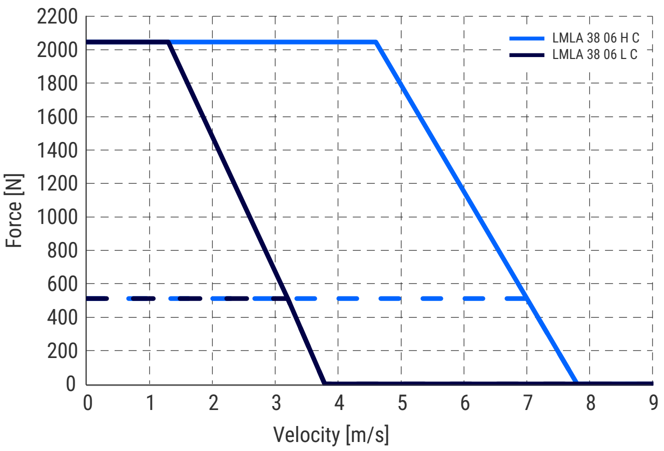
The specifications were measured without forced cooling. Electrical specifications tolerance is ± 10 %.

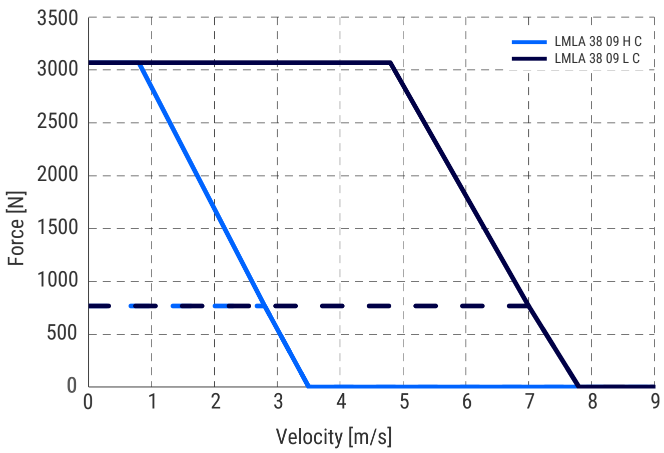
Force as a function of velocity diagrams

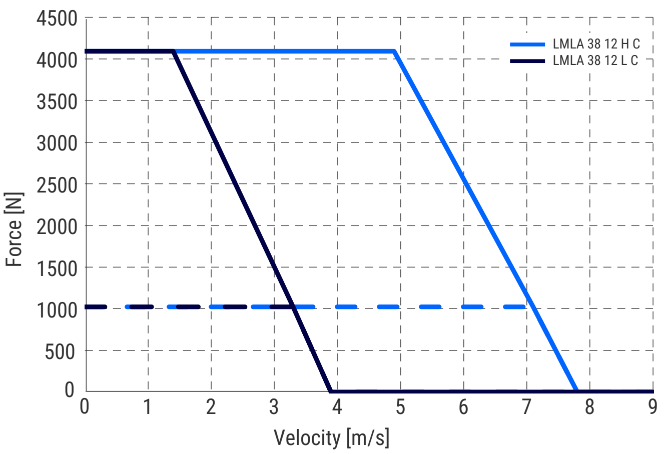
Bus voltage = 325 V DC



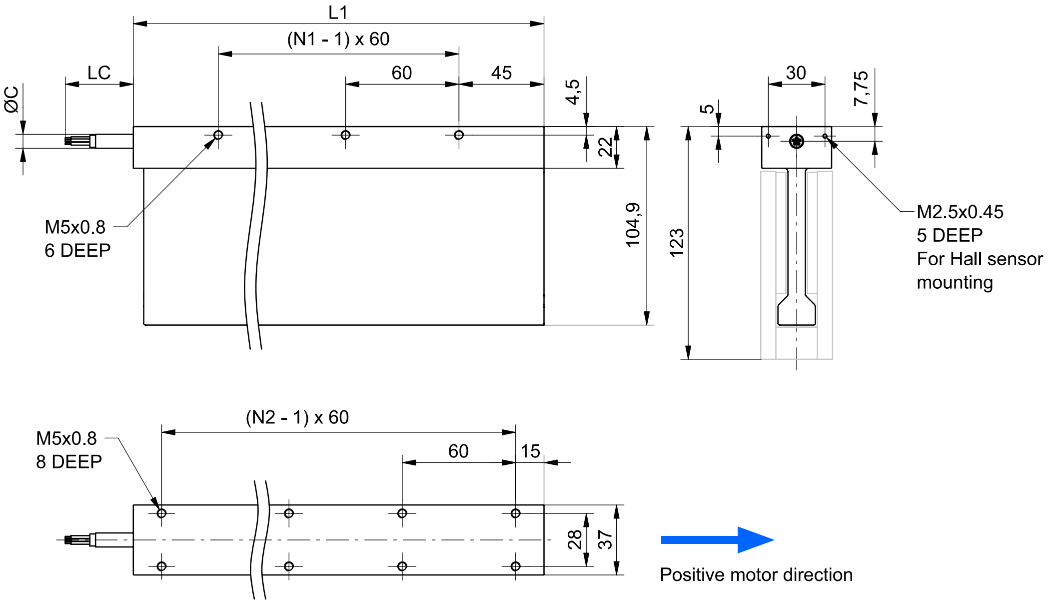








Forcer dimensions



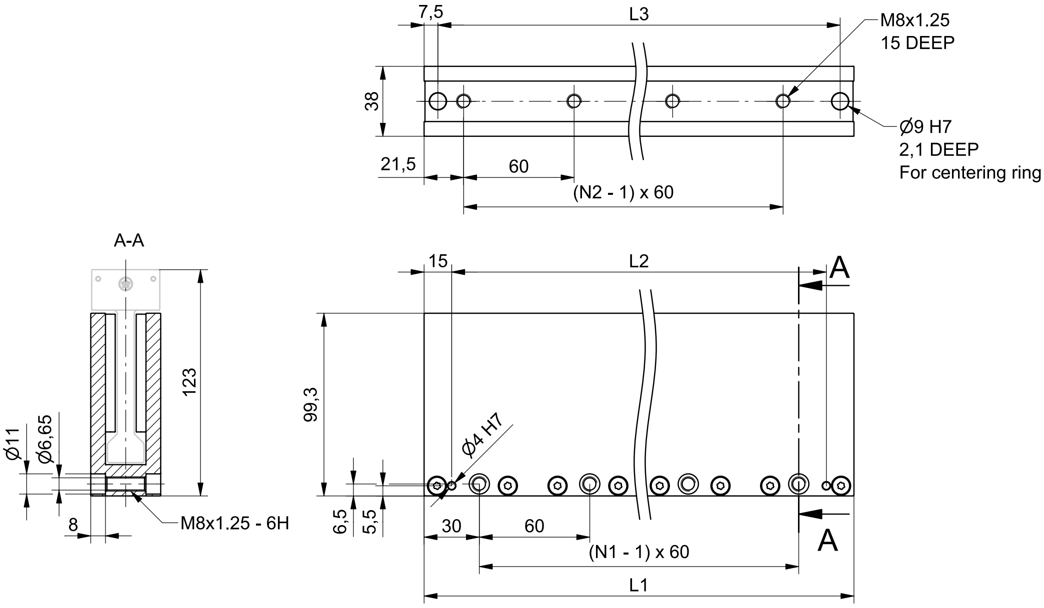
All dimensions are in mm. The scale of the drawings may not be equal.

LMLA			L1	LC	ØC	N1	N2
Size	Version	Type	[mm]				
38	02	H	150	1000[1]	7,1	2	3
		L					
	04	H	270			4	5
		L					
	06	H	390		7,5	6	7
		L					
	09	H	570			9	10
		L					
	12	H	750			12	13
		L					

[1] Standard cable length.

'N1' and 'N2' are the number of mounting holes along the motor direction.

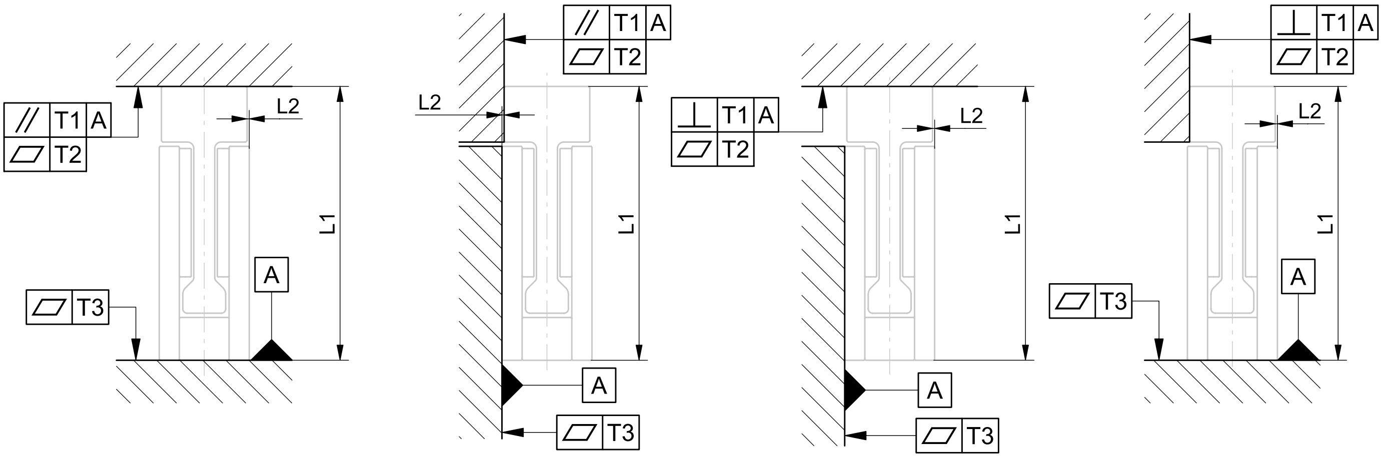
Magnet plate dimensions



LPA			L1	L2 (±0,02)	L3 (±0,02)	N1	N2
Size	Length	Type	[mm]				
38	120	C	120	90	105	2	2
	180		180	150	165	3	3
	300		300	270	285	5	5

'N1' and 'N2' are the number of mounting holes along the motor direction.

MOUNTING TOLERANCES



We recommend using a thermally conductive paste between the forcer and heatsink to ensure a better heat transfer.

LMLA	L1 (±0,1)	L2	T1	T2	T3
21	64	0,5 ± 0,05	0,05	0,05	0,05/500 mm
28	100	0,5 ± 0,10	0,10	0,10	0,05/500 mm
38	123	0,5 ± 0,10	0,10	0,10	0,05/500 mm

ELECTRICAL DATA

Temperature sensor

LMLA linear motors are equipped with a temperature sensor which is generally used for overheating protection. The sensor type is STS1 1000 3 which is thermally coupled with the U winding.

The STS1 1000 3 sensor is commonly used for monitoring motor temperature and can be use for limitation of maximum operational temperature.

For continuous operation, it is recommended that the motor temperature does not exceed 80 % of the maximum allowed motor temperature (125 °C).

STS1 1000 3 Thermistor

The linear motor is equiped with a STS1 1000 3 thermistor. This sensor features a positive temperature coefficient, and its characteristic curve exhibits near-linearity across the entire operating range. With a thermal time constant of approximately 6 seconds.

The temperature of the windings can be calculated from the current resistance of the STS1 1000 3 sensor with the use of the following equation.

$$\boldsymbol{T} = 100 + \frac{\sqrt{\alpha^2 - 4 \cdot \beta + 4 \cdot \beta \cdot \frac{R_T}{R_{25}}} - \alpha}{2 \cdot \beta}$$

R_T	Current sensor reading	[Ω]
α	$6{,}7 \cdot 10^{-3}$	[K^{-1}]
β	$1{,}5 \cdot 10^{-5}$	[K^{-1}]
R_{25}	1000	[Ω]

In the table below, resistance values of STS1 1000 3 at specific temperatures are presented.

T [°C]	20	30	40	50	60	70	80	90	100	110	120	125	130
R [Ω]	561	603	647	695	747	804	866	931	1000	1071	1142	1177	1213

Resistance of STS1 at ambient temperature (25 °C)	582 Ω
Normal operating STS1s resistance (25 °C–120 °C)	< 1142 Ω
Cut-off resistance of STS1	> 1177 Ω

Pin layout

In the following table the pin layout of the forcer is presented.

Parameter	Symbol	Wire colour
Motor phase U	U	black
Motor phase V	V	gray
Motor phase W	W	brown
Grounding	GND	yellow/green
Temperature sensor	$T_{temp +}$	yellow
Temperature sensor	$T_{temp -}$	green
Cable shield	Earth	Shield

LMLA Hall sensor

Description

UNIMOTION offers a Hall sensor which was specifically developed for the LMCA linear motors. The sensor utilizes existing magnet feedback which allows an unmatched accuracy to price ratio. Its main advantage is integration of the analog[1] and digital sensors into one housing.

Our Hall sensor can be used for a cost-effective solution when the position accuracy demands are not very high. Repeatable accuracy is in the range of +/–30 µm whilst absolute accuracy is in the range of +/–250 µm. With the integration of both sensors, analog[1] is used for exact position control, where digital is used for commutation. A combination of both offers the customer a free "wake & shake" operation feature.

The sensor is equipped with 10 highly flexible shielded wires, which are suitable for use in the energy chains. The digital sensor generates the U, V, and W signal outputs with a 120° phase shift while the analog[1] sensor generates sine and cosine signals with an amplitude of 1 VPP. For the best resistance against the EMC, the signals are differential, ie.: sine: A+, A– and cosine: B+, B–.

Our Hall sensor enables easy and precise mounting which results in an ideal alignment of the sensors and motor windings.

[1] Version with analog signals: Available soon

Specifications

Absolute maximum ratings:

Parameter	Unit	Min	Max
Power supply voltage V_{CC}	V_{DC}	–0,3	6
Output pin current U, V, W, A+, A–, B+, B–	mA	0	100
Operating junction temperature, T_J	°C	–15	60
Storage temperature, T_{stg}	°C	–25	85

Recommended operating conditions:

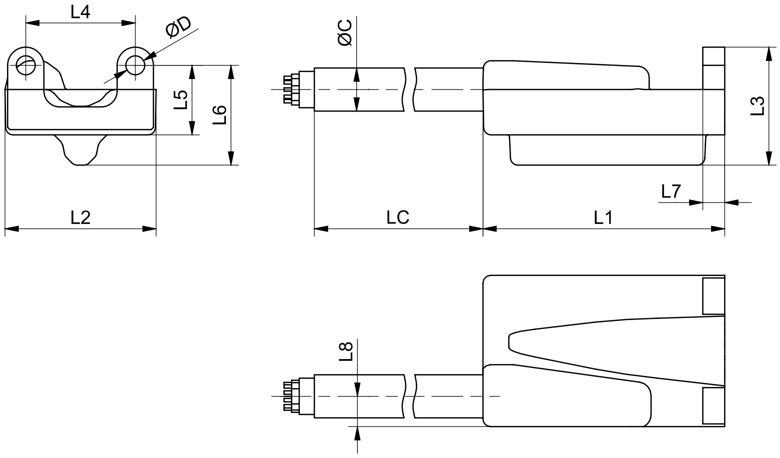
Parameter	Unit	Min	Max
Power supply voltage V_{CC}	V_{DC}	4,9	5,5
Power supply current	mA	30	50
Output current	mA	–	20
Output voltage A+ to A– and B+ to B–	V_{pp}	0,8	1,2
Operating junction temperature, T_J	°C	–15	60
Storage temperature, T_{stg}	°C	–25	85

Technical specifications:

Parameter	Unit	Value
Sensor accuracy[1]	µm	±250
Repeatability	µm	±30
Hysteresis	µm	±10
Signal period	mm	30
Cable (high flex)	/	10 x 0,14 mm^2
Cable bending radius (fixed installation)	mm	26,8
Cable bending radius (flexible installation)	mm	50,25

[1] In case of drive compensation, the accuracy can be improved.

Dimensions



All dimensions are in mm.
The scale of the drawings may not be equal.

LMLA HALL	L1	L2	L3	L4	L5	L6	L7	L8	ØD	LC	ØC
Size	[mm]										
21[2]	32	20	15,6	14,5	9,2	13,2	2,9	4	2,5	1000[1]	5,7

[1] Standard cable length. For different lengths, please refer to the "Hall sensor – How to order" section.
[2] Sizes 14, 28 and 38 will be available soon.

Pin layout

Parameter	Symbol	Wire colour
Analog hall output A+	A+	Yellow
Analog hall output A–	A–	Green
Analog hall output B+	B+	Violet
Analog hall output B–	B–	White
Digital hall output U	U	Gray
Digital hall output V	V	Black
Digital hall output W	W	Pink
Power supply +5 V_{DC}	+5 V_{DC}	Red
Power supply GND	GND	Blue
NC	Service	Brown
Cable shield	Earth	Shield

How to order

LMLA HALL - **21** - **1**

Sensor:
LMLA Hall

For motor size:
– 21
– 28 (available soon)
– 38 (available soon)

Cable length [m]:
– 1
– 5

Motor selection example

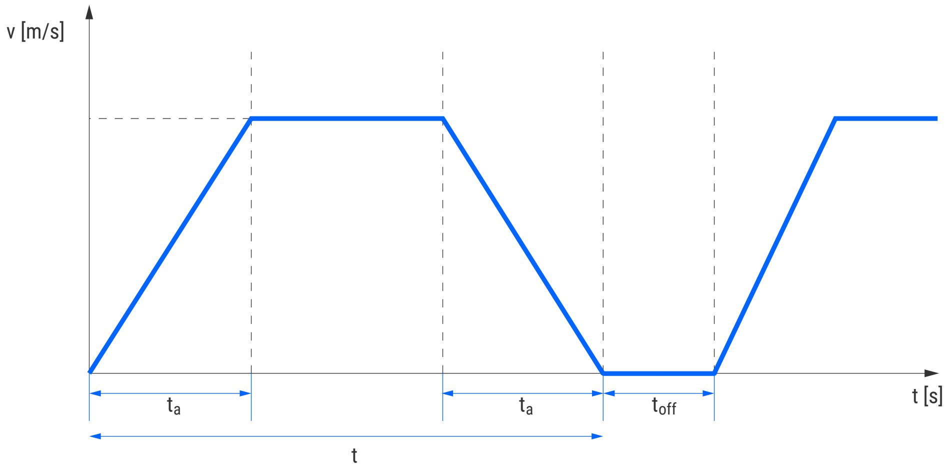
Motor selection guide:
The proper motor selection is done in three steps:

I. Definition of the motion profile
II. Calculation of continuous and peak forces
III. Motor selection

I. Definition of the motion profile

There is a wide range of different motion profiles which can be expressed by basic kinematic equations. The most commonly used motion profiles are trapezoidal and triangular.

Trapezoidal profile:



Moving input data:

L	Moving distance (stroke)	[m]
t	Moving time	[s]
t_a	Acceleration time	[s]
t_{off}	Pause	[s]

Average velocity:

$$v = \frac{L}{t}$$

Maximum velocity:

$$v_{max} = \frac{L}{t - t_a}$$

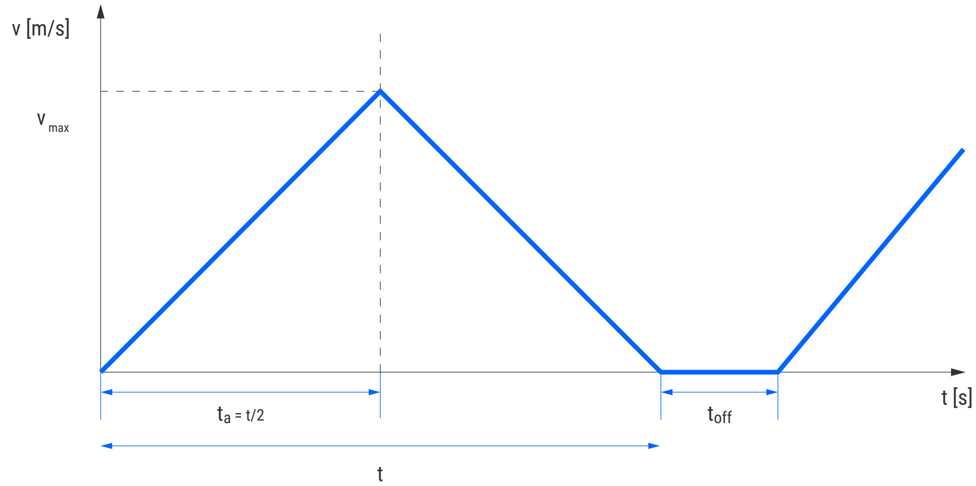
Acceleration/deceleration:

$$a = \frac{v_{max}}{t_a}$$

Variables used in equations:

v	Average velocity	[m/s]
v_{max}	Maximum velocity	[m/s]
L	Moving distance	[m]
t	Moving time	[s]
t_a	Acceleration time	[s]
a	Acceleration/deceleration	[m/s²]

Triangular profile:



Moving input data:

L	Moving distance (stroke)	[m]
t	Moving time	[s]
t_a	Acceleration time	[s]
t_{off}	Pause	[s]

Average velocity:

$$v = \frac{L}{t}$$

Maximum velocity:

$$v_{max} = \frac{a}{t_a}$$

Acceleration/deceleration:

$$a = \frac{4 \cdot L}{t^2}$$

Variables used in equations:

v	Average velocity	[m/s]
v_{max}	Maximum velocity	[m/s]
L	Moving distance	[m]
t	Moving time	[s]
t_a	Acceleration time	[s]
a	Acceleration/deceleration	[m/s^2]

II. Calculation of continuous and peak forces

When velocity and acceleration are defined, we can proceed to the calculation of continuous and peak forces which the motor has to overcome.

Input parameters:

m_{load}	Mass of load	[kg]
k_f	Friction coefficient	
α	Inclination angle	[°]

Peak force can be calculated by using the following equation:

$$F_p = F_{mass} + F_{fri} + F_{incl}$$

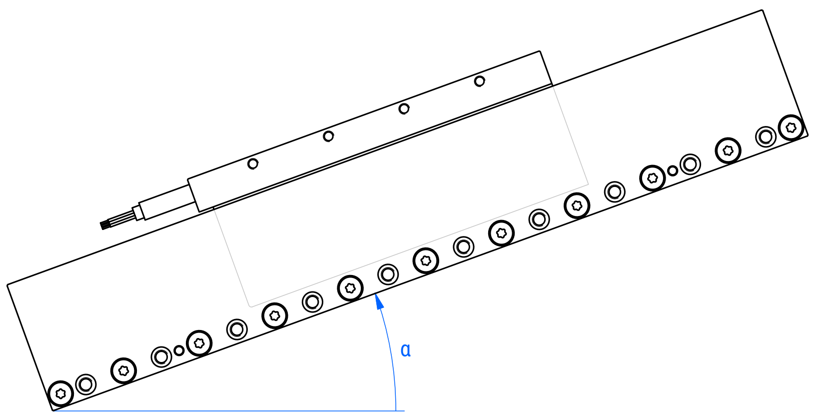
$$F_{mass} = a \cdot m_{load}$$

$$F_{fri} = k_f(g \cdot m_{load} \cdot cos\alpha)$$

$$F_{incl} = m_{load} \cdot g \cdot sin\alpha$$

Variables used in equations:

F_P	Peak force	[N]
a	Acceleration	[m/s²]
m_{load}	Mass of load	[kg]
k_f	Friction coefficient	
g	Gravitational constant (9,81)	[m/s²]
α	Inclination angle	[°]
F_{incl}	Inclination force (if the motor is placed horizontally (α = 0°) the F_{incl} is 0)	[N]



Continuous force can be calculated by following equation:

$$F_C = \sqrt{\frac{F_p^2 \cdot t_a + (F_{fri} + F_{incl})^2 \cdot (t - 2t_a) + (F_{mass} + F_{incl} - F_{fri})^2 \cdot t_a}{t + t_{off}}}$$

III. Motor selection

Defining the motors RMS and MAX current:

$I_{MAX} = \frac{F_P}{K_F}$ < I_P from the motor specification.

$I_{RMS} = \frac{F_C}{K_F}$ < I_C from the motor specification.

We recommend a safety factor where I_P and I_C are 30 % higher than I_{MAX} and I_{RMS}.

Variables used in equations:

F_P	Peak force	[N]
F_C	Continuous force	[N]
K_F	Force constant (you can find it in the motor specifications)	[N/A_{RMS}]

Motor voltage calculation:

For the proper motor selection, the correct voltage must be calculated with the below equation:

$$V_{mot} = \sqrt{\left(\sqrt{2}\,\frac{v_{max} \cdot K_{BEMF}}{\sqrt{3}} + \frac{F_P}{K_F} \cdot R_{20} \cdot \frac{\sqrt{2}}{2}\right)^2 + \left(\sqrt{2} \cdot 2\pi \cdot \frac{F_P \cdot L_P}{K_F \cdot 2 \cdot \tau}\right)^2}$$

Variables used in equations:

v_{max}	Maximum velocity	[m/s]
K_{BEMF}	Motor induction voltage phase-phase RMS (listed in the motor specifications)	[V/m/s]
K_F	Force constant (listed in the motor specifications)	[N/A_{RMS}]
F_P	Peak force	[N]
R_{20}	Phase-phase resistance (listed in the motor specifications)	[Ω]
L_P	Phase-phase inductance	[H]
τ	Magnet pitch (listed in the motor specifications)	[m]

Available drive voltage can be calculated with the following equations:

$V_{drive\_SVM} \frac{\sqrt{2}\, V_{supply}[VAC]}{\sqrt{3}}$; In the case of AC power supply

$V_{drive\_SVM} \frac{V_{supply}[VDC]}{\sqrt{3}}$; In the case of DC power supply

Variables used in equations:

V_{supply}	Drive supply voltage (for example 230 V AC or 325 V DC)	[V_{RMS}]
V_{drive_SVM}	The available voltage that can be applied to the linear motor	[V]

Motor selection condition:

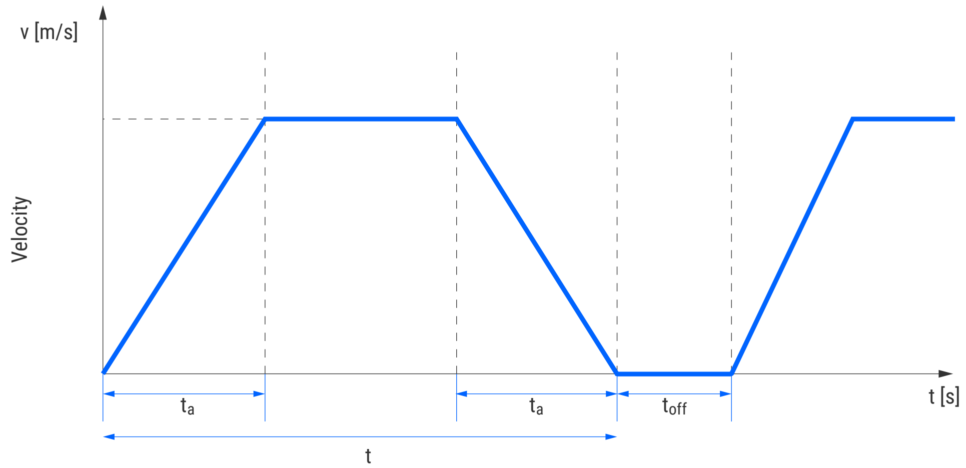
Drive voltage must be higher than the maximum voltage of the motor.

$\mathbf{V_{mot} < V_{drive\_SVM}}$

A safety factor where V_{drive_SVM} is 30 % higher than V_{mot} is recommended.

Selection example

I. Definition of the motion profile



- Moving distance L = 2 m
- Moving time t = 1 s
- Acceleration time t_a = 0,25 s
- Pause t_{off} = 0,5 s
- Mass of load m_{load} = 5 kg
- Friction coefficient k_f = 0,01
- α = 0°

Average velocity:

$$v = \frac{L}{t} = \frac{2}{1} = \mathbf{2\ m/s}$$

Maximum velocity:

$$v_{max} = \frac{L}{t - t_a} = \frac{2}{1 - 0{,}25} = \mathbf{2{,}67\ m/s}$$

Acceleration/deceleration:

$$a = \frac{v_{max}}{t_a} = \frac{2{,}67}{0{,}25} = \mathbf{10{,}67\ m/s^2}$$

II. Continuous and peak force calculation

Peak force:

$F_{mass} = a \cdot m_{load} = 10{,}67 \cdot 5 = \mathbf{53{,}3\ N}$

$F_f = k_f(g \cdot m_{load} \cdot cos\alpha) = 0{,}01 \cdot (9{,}81 \cdot 5 \cdot cos0) = \mathbf{0{,}5\ N}$

$F_{incl} = m_{load} \cdot g \cdot sin\alpha = \mathbf{0\ N}$

$F_p = F_{mass} + F_f + F_{incl} = 53{,}3 + 0{,}5 + 0 = \mathbf{53{,}8\ N}$

Continuous force:

$$F_C = \sqrt{\frac{F_p{}^2 \cdot t_a + (F_{fri} + F_{incl})^2 \cdot (t - 2t_a) + (F_{mass} + F_{incl} - F_{fri})^2 \cdot t_a}{t + t_{off}}}$$

$$= \sqrt{\frac{53{,}89^2 + 0{,}25 + (0{,}5 + 0)^2 \cdot (1 - 2 \cdot 0{,}25) + (53{,}3 + 0 - 0{,}5)^2 \cdot 0{,}25}{1 + 0{,}5}} = \mathbf{30{,}8\ N}$$

III. Motor selection

Maximum motor current:

$$I_{MAX} = \frac{F_P}{K_F} = \frac{53{,}8}{27{,}51} = \mathbf{1{,}96\ A_{RMS} < 9{,}2\ A_{RMS}}$$

Continuous motor current:

$$I_{RMS} = \frac{F_C}{K_F} = \frac{30{,}8}{27{,}51} = \mathbf{1{,}12\ A_{RMS} < 2{,}3\ A_{RMS}}$$

Motor related parameters can be found in the motor specifications (example see LMLA21_4L):

- K_F = 27,5 N/A_{RMS}
- I_C = 2,3 A_{RMS}
- I_P = 9,2 A_{RMS}

Motor voltage calculation:

For a proper motor selection, voltage is also important, which must be applied by the servo drive. Maximum voltage is calculated by:

$$V_{mot} = \sqrt{\left(\sqrt{2}\,\frac{v_{max} \cdot K_{BEMF}}{\sqrt{3}} + \frac{F_P}{K_F} \cdot R_{20} \cdot \frac{\sqrt{2}}{2}\right)^2 + \left(\sqrt{2} \cdot 2\pi \cdot \frac{F_P \cdot L_P}{K_F \cdot 2 \cdot \tau}\right)^2}$$

$$= \sqrt{\left(\sqrt{2}\,\frac{2{,}67 \cdot 15{,}9}{\sqrt{3}} + \frac{53{,}8}{27{,}51} \cdot 10{,}8 \cdot \frac{\sqrt{2}}{2}\right)^2 + \left(\sqrt{2} \cdot 2\pi \cdot \frac{53{,}8 \cdot 0{,}00215}{27{,}51 \cdot 2 \cdot 30}\right)^2} = \mathbf{49{,}6\ V}$$

Motor related parameters can be found in the motor specification:

- K_F = 27,5 N/A_{RMS}
- K_{BEMF} = 15,9 V/m/s
- R_{20} = 10,8 Ω
- L_P = 2,1 mH
- τ = 30 mm

Available drive voltage:

V_{supply} = 230 V_{AC}

$$V_{drive\_SVM} = \frac{\sqrt{2}\,V_{supply}}{\sqrt{3}} = \frac{\sqrt{2} \cdot 230}{\sqrt{3}} = \mathbf{187{,}8\ V > 49{,}6\ V}$$

UNIMOTION

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Unimotion: May 2024