DG MOTION

iLMA

LINEAR MOTORS

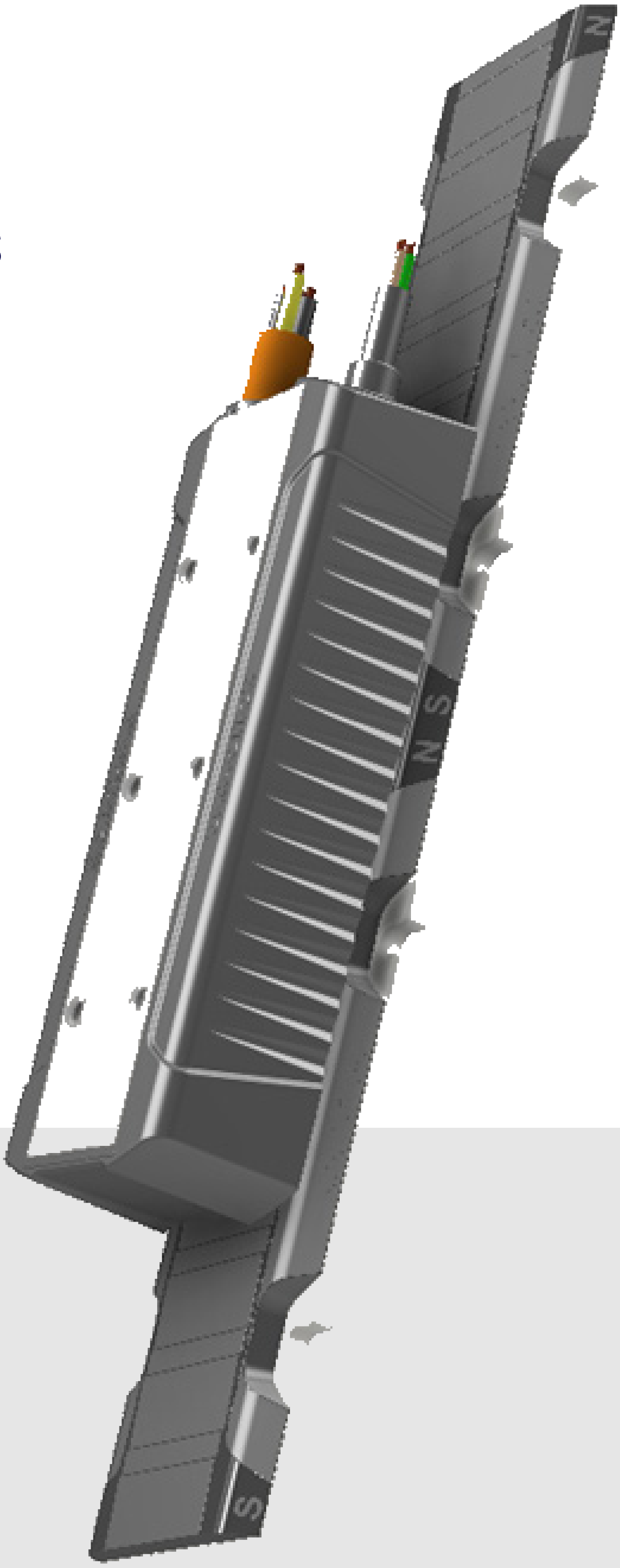
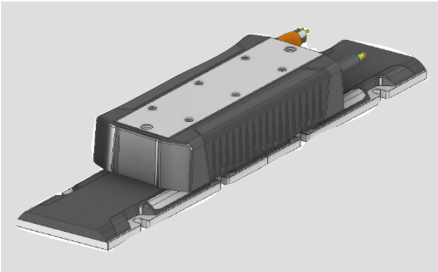
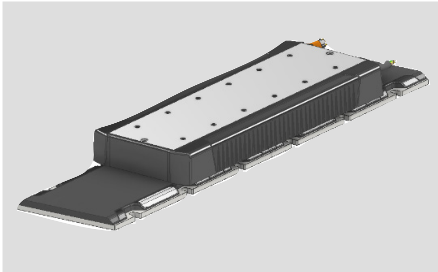


Table of Contents

Product overview





iLMA 30 is our smallest design in the iLMA family. In the picture above, iLMA 30 S is presented and it should be noted that it also comes in M and L versions.

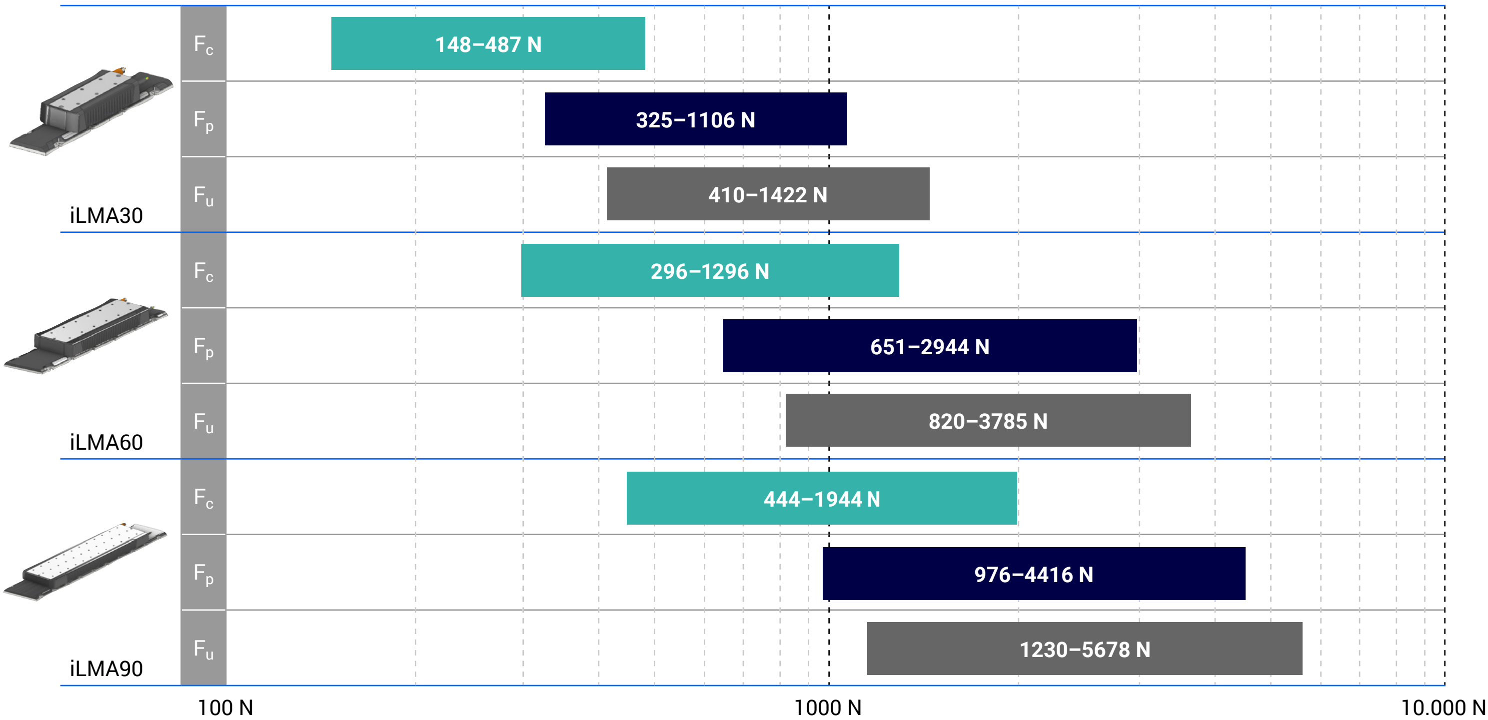
They offer a superb ratio between maximum velocity and the mass of the forcer, therefore they are suitable for applications with light payloads, where high speeds and accelerations are required.

iLMA 60 represents the middle section of the iLMA family. In the picture above, iLMA 60 M is presented and it should be noted that it also comes in S, L and XL versions.

Because of their mid-range design, they offer a lot of dynamics and a great speedto-force ratio.

iLMA 90 is our strongest design in the iLMA family. In the picture above, iLMA 90 XL is presented and it should be noted that it also comes in S, M and L versions.

Because of their size, they are primarily used where force demands are the highest. It can withstand even the largest payloads.



F_c = Continuous Force

F_p = Peak Force

F_u = Ultimate Force

Linear motors basic description

Linear motors are an ideal substitute for the linear systems/units driven by pneumatic, hydraulic, belt, ball screw, and other types of drives. Linear motor drive systems/units do not require conversion from the rotational to linear movement, because the movement is generated directly from the linear electromagnetic force. The linear motors 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.

- DGMOTION linear motors are ideal for a variety of things, ie.: Actuators, robots, XYZ tables, positioning, assembly, tool machines, P&P machines, fiber optic machines, and many others. The main advantage of DGMOTION linear motors is force density, which is 30–50 % higher compared to other competitors on the market, while still retaining a very low cogging force. Thanks to our innovative design and state of the art materials, we can offer our customers the best industry-leading linear motor on the market for a competitive price.

Beside different motor sizes (30, 60, 90) and types (S, M, L and XL), we can offer two types of magnet plates which are compatible with all the motors:

– A classic magnet plate, that reaches continuous forces from 148 N to 1744 N (peak from 325 N ti 3853 N), and
– Our innovative high-performance magnet plate design, which results in much higher force density and also boosts the continuous (from 165 N to 1944 N) and peak forces (from 374 N to 4416 N), which is nearly 11 % higher in comparison with the classic magnet plate.

Secondly, for each motor size, we are offering two speed version:

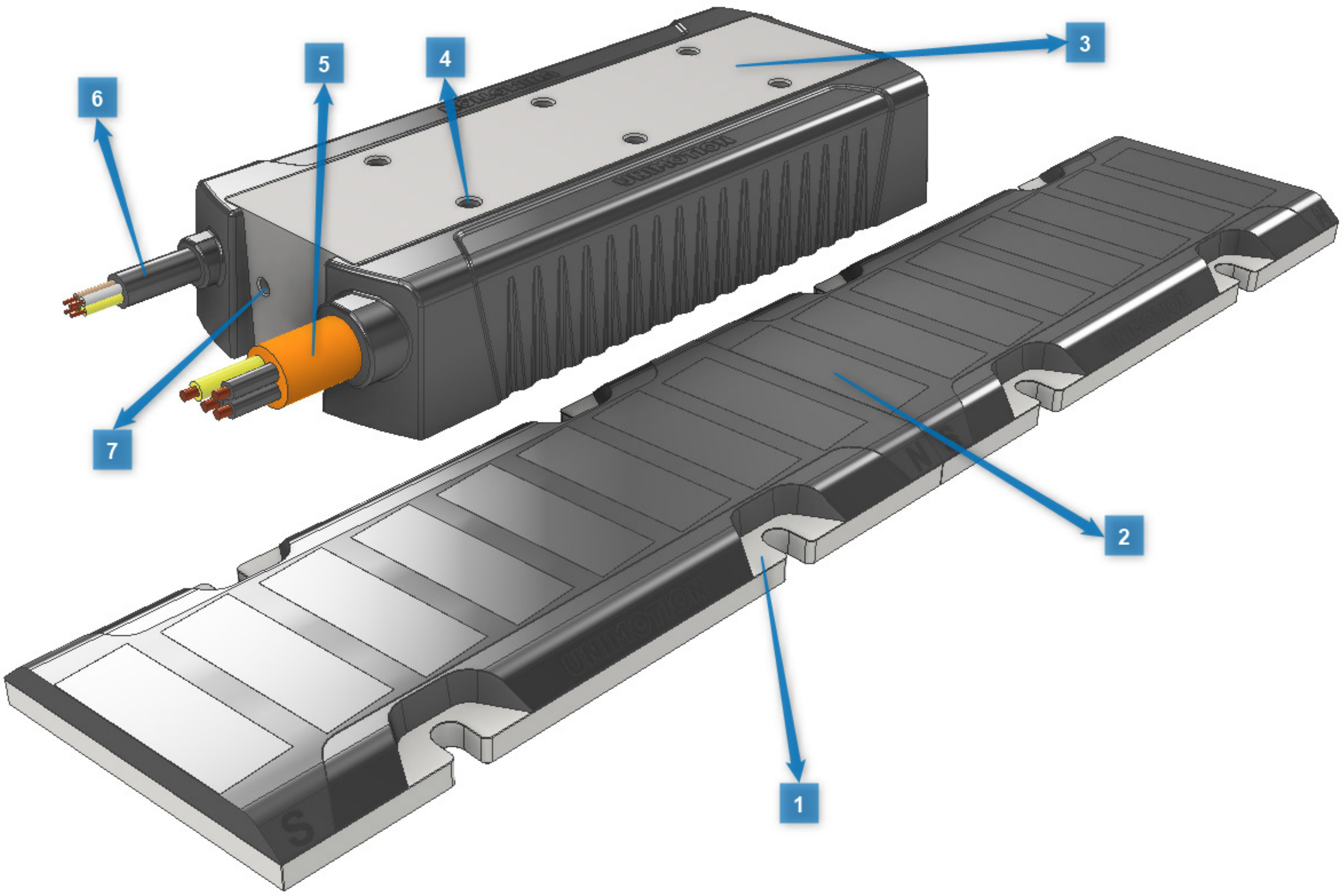
– A low-speed variant, and
– A high-speed variant, which has a lower BEMF constant and is suitable for applications, requiring higher speed or low supply voltage

Both solutions are air-cooled 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 for an easy drive integration, we designed our own Hall sensor which features analog as well as a digital Hall sensor in only ONE housing.

For more information regarding the Hall sensor, please refer to page 29–30.

STRUCTURAL DESIGN



1. Magnet plate
2. Magnets
3. Forcer body
4. Mounting holes
5. Power cable
6. Sensor cable
7. Hall sensor mounting

ⓘ For more information regarding the Hall sensor, please refer to page xx.

TERMS EXPLANATION

Supply voltage V_{DC}:
Defined as 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 an ambient temperature of 20 °C and continuous movement of the motor. The windings temperature depends on the attached plate (heatsink) dissipation and airflow around the motor.

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.

Ultimate Force F_U:
Force produced by the ultimate current (Iu) for a duration of 0,5 seconds. The force is used for acceleration or deceleration.

Attraction force of magnets F_A:
Attraction force between the forcer and the magnet plate at the defined air gap.

Cogging (Detent) force F_G:
Force generated due to the interaction between the permanent magnets of the magnet plate and the mover slots. The cogging force is permanently present and is position-dependent.

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:
Defined as the motor force ratio to the square root of power consumption at 20 °C. The constant determines motor 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.

Maximum Continuous Current I_C:
It corresponds to the continuous force (Fc) and can be continuously applied to the motor at the ambient temperature of 20 °C and continuous movement of the motor. The windings temperature depends on the attached plate (heatsink) heat dissipation and airflow around the motor windings.

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

Ultimate Current I_u:
Corresponds to the ultimate force (Fu) and can be applied to the motor for 0,5 seconds.

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

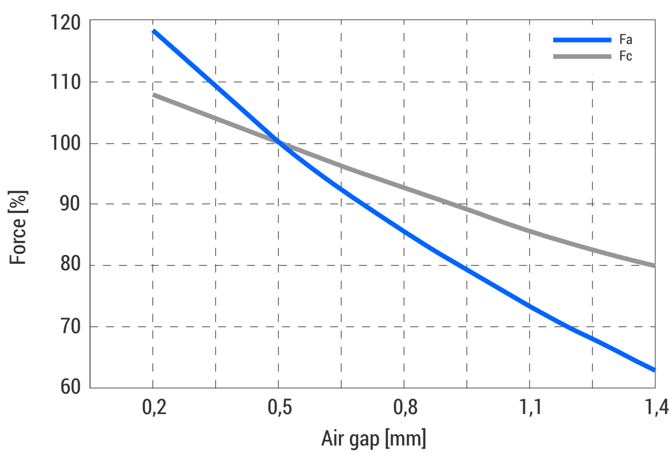
Thermal Resistance R_{th}:
Defines the heat transfer resistance from the motor windings to the environment at the defined plate (heatsink) and air dissipation.

Thermal Resistance to heatsink $R_{th\text{-}HS}$:
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.

Described parameters were measured with an air gap of 0,5 mm. Increasing the air gap will result in a lower attraction force, cogging and useful force.

Continuous and attraction force as a function of an air gap



How to order

HOW TO ORDER

Forcer order code:

iLMA - 60 - M - LS

Series:
iLMA

Size:
- 30
- 60
- 90

Version:
- S
- M
- L
- XL

ⓘ XL version is only available for sizes 60 and 90.

Type:
LS: Low speed
HS: High speed

Magnet plate order code:

MPA - 60 - 180 - H

Series:
MPA

Size:
- 30
- 60
- 90

Length:
- 120
- 180
- 300

Type:
C: Classic
H: High performance

Linear motor characteristics

iLMA30

General technical data

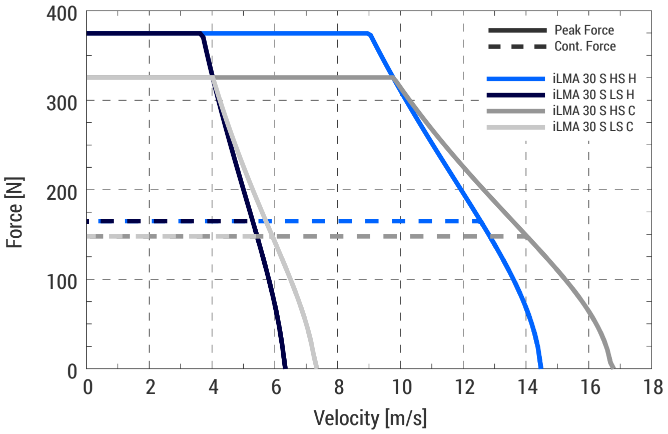
				iLMA 30											
				Version S				Version M				Version L			
				Classic Plate		High Performance		Classic Plate		High Performance		Classic Plate		High Performance	
	PARAMETER	SYM	UNIT	Low Speed	High Speed	Low Speed	High Speed	Low Speed	High Speed	Low Speed	High Speed	Low Speed	High Speed	Low Speed	High Speed
PERFORMANCE	Supply voltage	V_{DC}	V (DC)	600											
PERFORMANCE	Continuous Force*	F_C	N	148		165		292		326		436		487	
PERFORMANCE	Peak Force (1s)*	F_P	N	325		374		643		740		961		1106	
PERFORMANCE	Ultimate Force (0,5s)*	F_U	N	410		482		810		952		1210		1422	
PERFORMANCE	Attraction force of magnets**	F_A	N	678		958		1245		1759		1812		2560	
PERFORMANCE	Cogging (Detent) force	F_G	N	5		6		0		0		0		0	
PERFORMANCE	Force constant	K_F	$\frac{N}{A_{RMS}}$	49,3	21,5	55,0	24,0	48,7	21,3	54,3	23,8	48,4	21,2	54,1	23,6
PERFORMANCE	Motor constant	K_M	$\frac{N}{\sqrt{W}}$	17,6	17,6	19,7	19,6	24,6	24,6	27,5	27,5	30,0	30,1	33,5	33,6
PERFORMANCE	Back EMF Phase-Phase Constant	K_{BEMF}	$\frac{V}{(m/s)}$	28,4	12,4	32,9	14,4	28,1	12,3	32,5	14,2	28,0	12,2	32,3	14,1
ELECTRICAL	Maximum Continuous Current	I_C	A_{RMS}	3,0	6,9	3,0	6,9	6,0	13,7	6,0	13,7	9,0	20,6	9,0	20,6
ELECTRICAL	Peak Current	I_P	A_{RMS}	9,0	20,6	9,0	20,6	18,0	41,2	18,0	41,2	27,0	61,8	27,0	61,8
ELECTRICAL	Ultimate Current	I_U	A_{RMS}	15,0	34,3	15,0	34,3	30,0	68,7	30,0	68,7	45,0	103,0	45,0	103,0
ELECTRICAL	Resistance at 20 °C Phase - Phase	R_{25}	Ω	5,2	1,0	5,2	1,0	2,6	0,5	2,6	0,5	1,7	0,3	1,7	0,3
ELECTRICAL	Resistance at 125 °C Phase - Phase	R_{120}		7,4	1,4	7,4	1,4	3,7	0,7	3,7	0,7	2,5	0,5	2,5	0,5
ELECTRICAL	Induction Phase - Phase	L_P	mH	31,0	5,9	31,0	5,9	15,5	2,9	15,5	2,9	10,3	2,0	10,3	2,0
ELECTRICAL	Electrical time constant***	t_C	mS	5,9	5,9	5,9	5,9	5,9	5,8	5,9	5,8	5,9	6,0	5,9	6,0
ELECTRICAL	Max. Winding temperature****	T_{max}	°C	125											
THERMAL	Thermal Resistance	R_{th}	$\frac{K}{W}$	1,055				0,527				0,352			
THERMAL	Thermal Resistance to heatsink	Rth_HS	$\frac{K}{W}$	0,250				0,125				0,063			
MECHANICAL	Motor overall length	ML	mm	128				233				338			
MECHANICAL	Motor overall width	MW	mm	56											
MECHANICAL	Motor overall height	MH	mm	23,5											
MECHANICAL	Motor mass	mm	kg	0,8				1,4				2,4			
MECHANICAL	Motor wires cross-section	SC	mm^2	1,5											
MECHANICAL	Sensor wires cross-section	SSC	mm^2	0,25											
MECHANICAL	Motor cable length	LM	mm	400											
MECHANICAL	Sensor cable length	LS	mm	400											
MECHANICAL	Magnet Pitch	τ	mm	30											

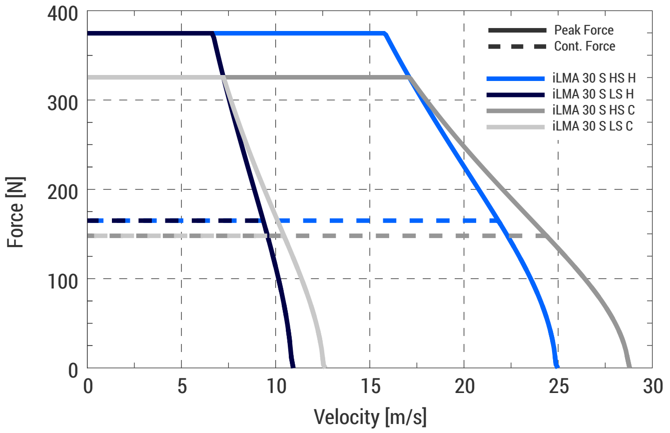
* Magnets at 20 °C
** RMS at 0 A and air gap of 0,6 mm
*** Windings at 20 °C
**** Maximum allowed magnet plate temperature is 90 °C

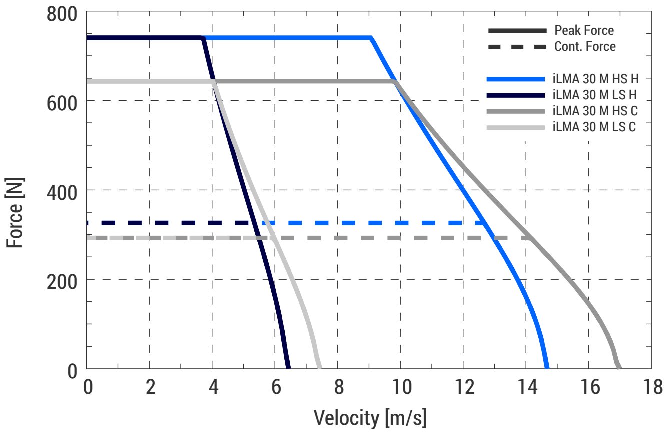
Force as a function of velocity diagrams

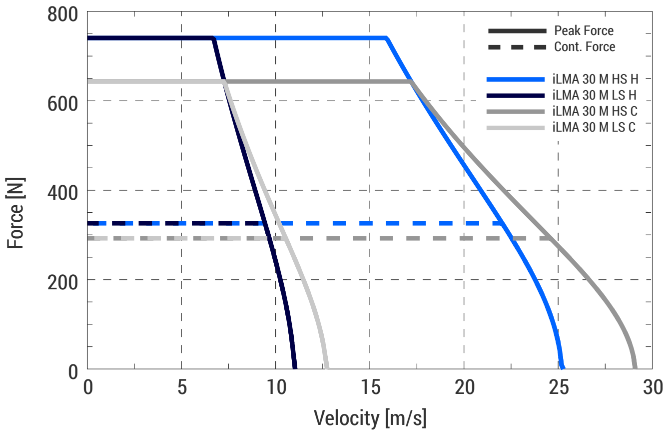
Bus voltage = 325 V DC

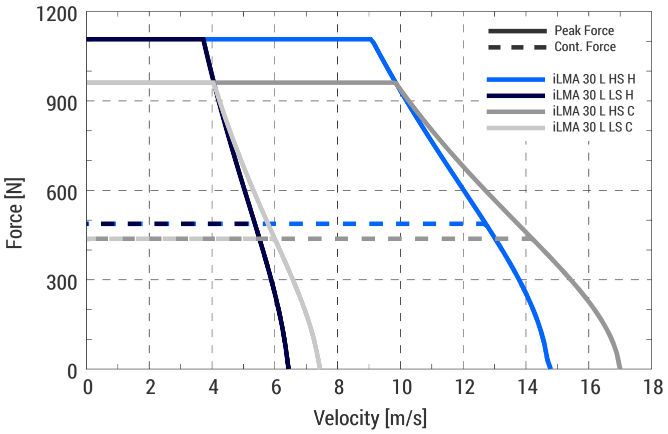
Bus voltage = 560 V DC

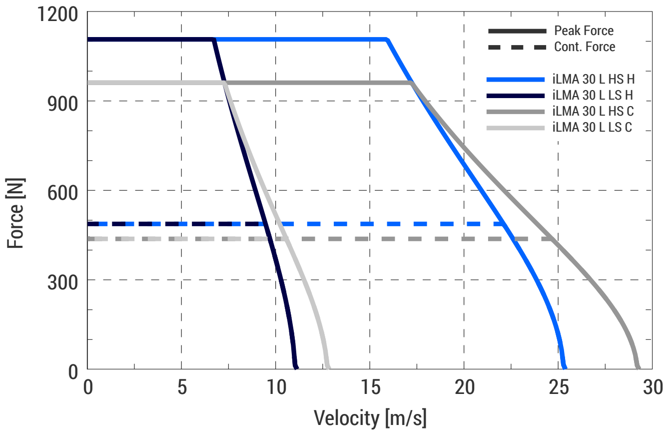




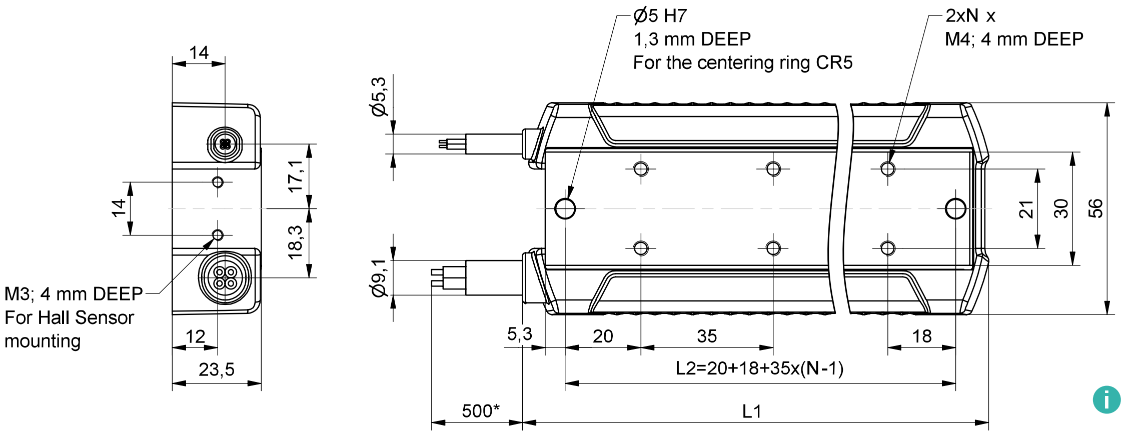








Forcer dimensions

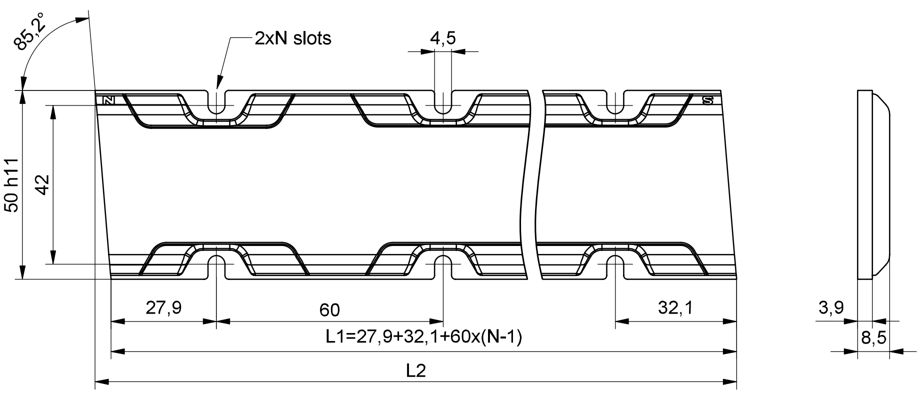


* This is a standard cable length.

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

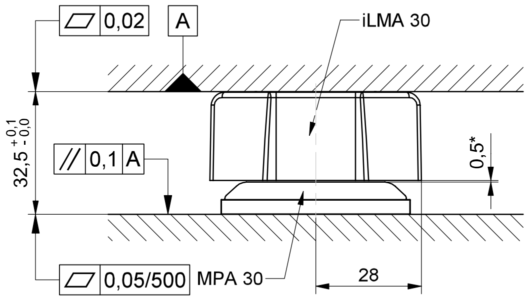
iLMA30	L1	L2	N
iLMA 30 S HS/LS	128	108	3
iLMA 30 M HS/LS	233	213	6
iLMA 30 L HS/LS	338	318	9

Magnet plate dimensions



MPA30	L1	L2	N
MPA 30 120 C/H	120	124,2	2
MPA 30 180 C/H	180	184,2	3
MPA 30 300 C/H	300	304,2	5

Mounting tolerances



*This the recommended air gap between the forcer and the magnet plate.

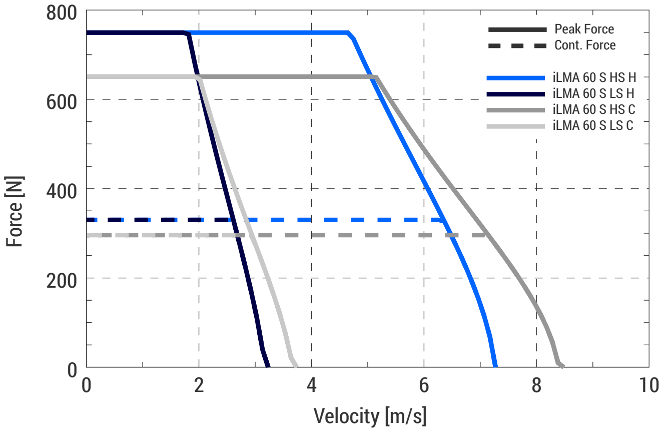
iLMA60

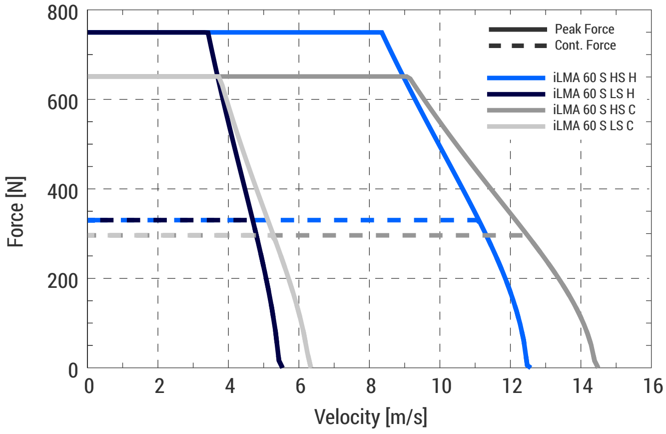
General technical data

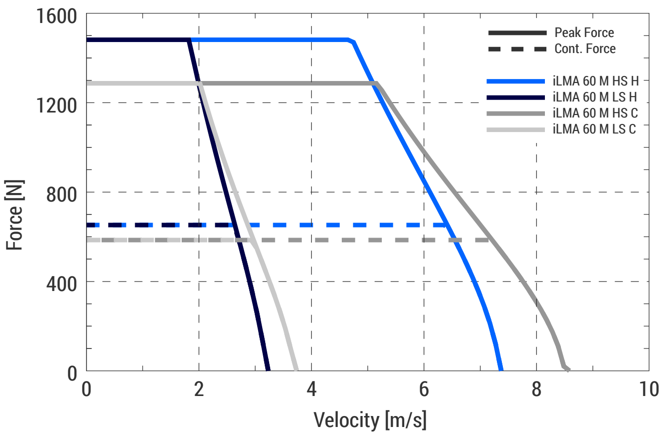
				iLMA 60															
				Version S				Version M				Version L				Version XL			
				Classic Plate		High Performance		Classic Plate		High Performance		Classic Plate		High Performance		Classic Plate		High Performance	
	PARAMETER	SYM	UNIT	Low Speed	High Speed	Low Speed	High Speed	Low Speed	High Speed	Low Speed	High Speed	Low Speed	High Speed	Low Speed	High Speed	Low Speed	High Speed	Low Speed	High Speed
PERFORMANCE	Supply voltage	V_{DC}	V (DC)	600															
	Continuous Force*	F_C	N	296		330		585		652		874		974		1162		1296	
	Peak Force (1s)*	F_P	N	651		749		1286		1481		1921		2212		2557		2944	
	Ultimate Force (0,5s)*	F_U	N	820		964		1620		1904		2420		2845		3221		3785	
	Attraction force of magnets**	F_A	N	1356		1916		2490		3518		3624		5120		4758		6722	
	Cogging (Detent) force	F_G	N	10		12		0		0		0		0		0		0	
	Force constant	K_F	$\frac{N}{A_{RMS}}$	98,7	43,1	110,0	48,0	97,5	42,6	108,7	47,5	97,1	42,4	108,2	47,3	96,8	42,3	108,0	47,1
	Motor constant	K_M	$\frac{N}{\sqrt{W}}$	27,6	27,6	30,8	30,8	38,6	38,6	43,0	43,0	47,1	47,1	52,5	52,5	54,3	53,9	60,6	60,1
	Back EMF Phase-Phase Constant	K_{BEMF}	$\frac{V}{(m/s)}$	57,0	24,9	65,8	28,7	56,3	24,6	65,0	28,4	56,0	24,5	64,7	28,3	55,9	24,4	64,6	28,2
ELECTRICAL	Maximum Continuous Current	I_C	A_{RMS}	3,0	6,9	3,0	6,9	6,0	13,7	6,0	13,7	9,0	20,6	9,0	20,6	12,0	27,5	12,0	27,5
	Peak Current	I_P	A_{RMS}	9,0	20,6	9,0	20,6	18,0	41,2	18,0	41,2	27,0	61,8	27,0	61,8	36,0	82,4	36,0	82,4
	Ultimate Current	I_U	A_{RMS}	15,0	34,3	15,0	34,3	30,0	68,7	30,0	68,7	45,0	103,0	45,0	103,0	60,0	137,4	60,0	137,4
	Resistance at 20°C Phase - Phase	R_{25}	Ω	8,5	1,6	8,5	1,6	4,3	0,8	4,3	0,8	2,8	0,5	2,8	0,5	2,1	0,4	2,1	0,4
	Resistance at 125°C Phase - Phase	R_{120}		12,0	2,3	12,0	2,3	6,0	1,1	6,0	1,1	4,0	0,8	4,0	0,8	3,0	0,6	3,0	0,6
	Induction Phase - Phase	L_P	mH	54,0	10,4	54,3	10,4	27,0	5,2	27,2	5,2	18,1	3,4	18,1	3,4	13,6	2,6	13,6	2,6
	Electrical time constant***	t_C	mS	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,3	6,4	6,3	6,4	6,3	6,4	6,3
	Max. Winding temperature****	T_{max}	°C	125															
THERMAL	Thermal Resistance	R_{th}	$\frac{K}{W}$	0,648				0,324				0,216				0,162			
	Thermal Resistance to heatsink	Rth_HS	$\frac{K}{W}$	0,180				0,090				0,060				0,045			
MECHANICAL	Motor overall length	ML	mm	128,4				233,4				338,4				443,4			
	Motor overall width	MW	mm	90															
	Motor overall height	MH	mm	23,5															
	Motor mass	mm	kg	0				2,48				0				0			
	Motor wires cross-section	SC	mm²	1,5								2,5							
	Sensor wires cross-section	SSC	mm²	0,25															
	Motor cable length	LM	mm	400															
	Sensor cable length	LS	mm	400															
	Magnet Pitch	τ	mm	30															

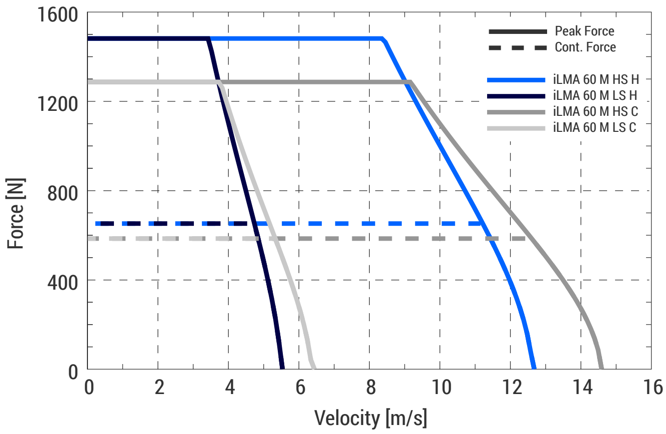
* Magnets at 20 °C
** RMS at 0 A and air gap of 0,6 mm
*** Windings at 20 °C
**** Maximum allowed magnet plate temperature is 90 °C

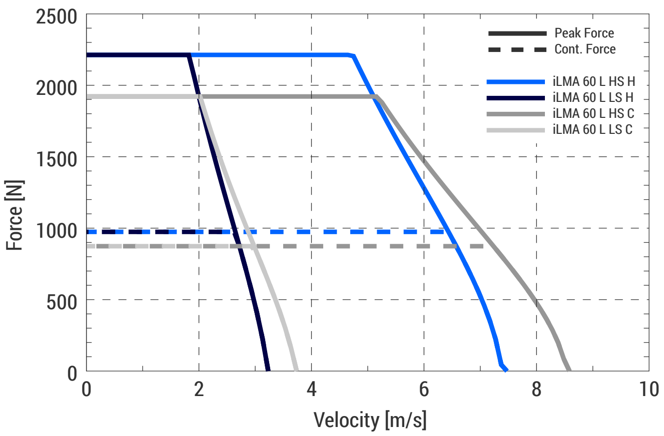
Force as a function of velocity diagrams

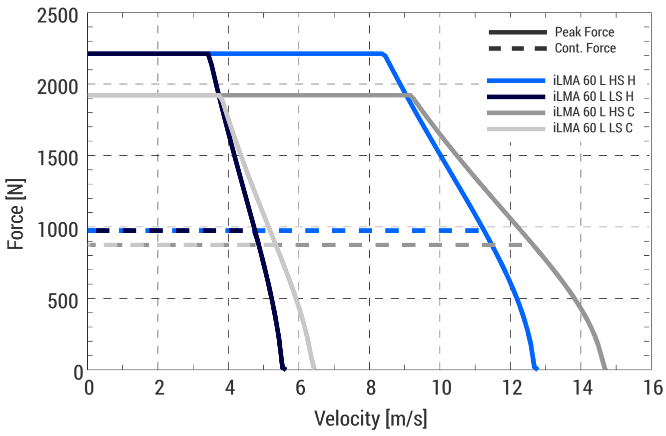


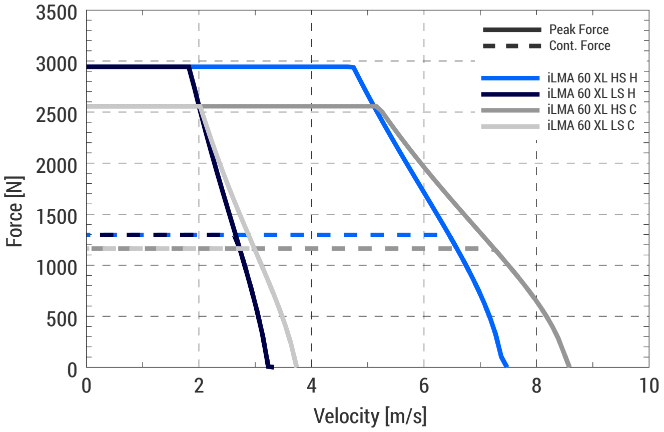


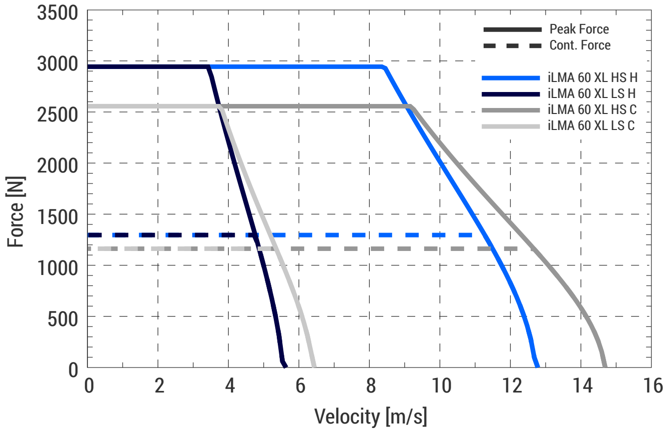




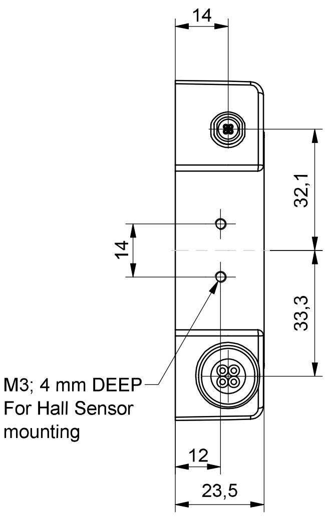


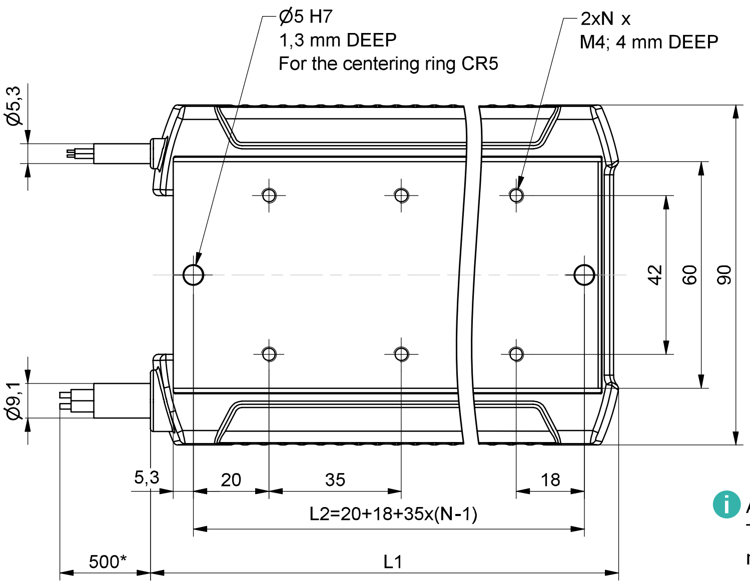






Forcer dimensions



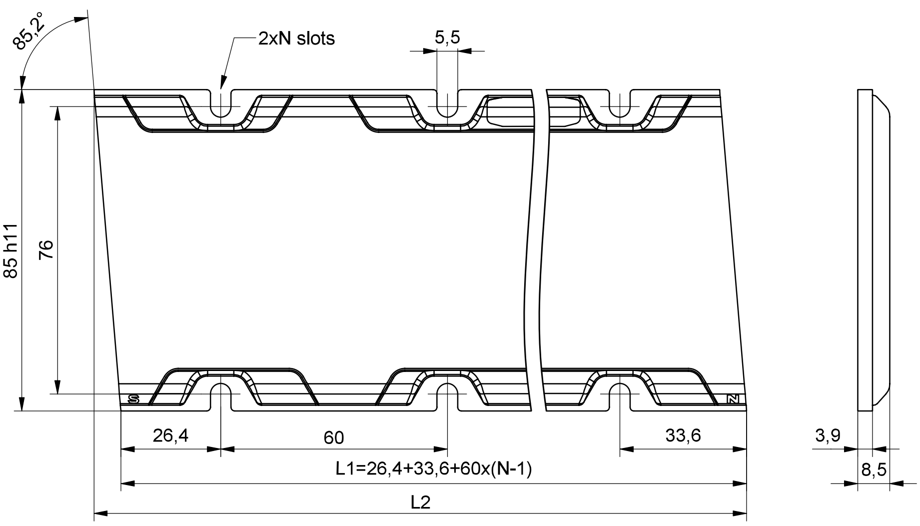


All dimensions are in mm. The scale of the drawings may not be equal.

* This is a standard cable length.

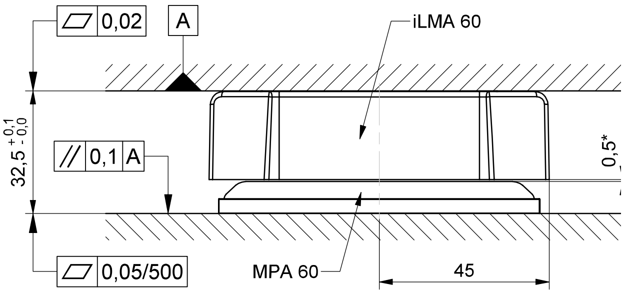
iLMA60	L1	L2	N
iLMA 60 S HS/LS	128	108	3
iLMA 60 M HS/LS	233	213	6
iLMA 60 L HS/LS	338	318	9
iLMA 60 XL HS/LS	443	423	12

Magnet plate dimensions



MPA60	L1	L2	N
MPA 60 120 C/H	120	127,1	2
MPA 60 180 C/H	180	187,1	3
MPA 60 300 C/H	300	307,1	5

Mounting tolerances



*This the recommended air gap between the forcer and the magnet plate.

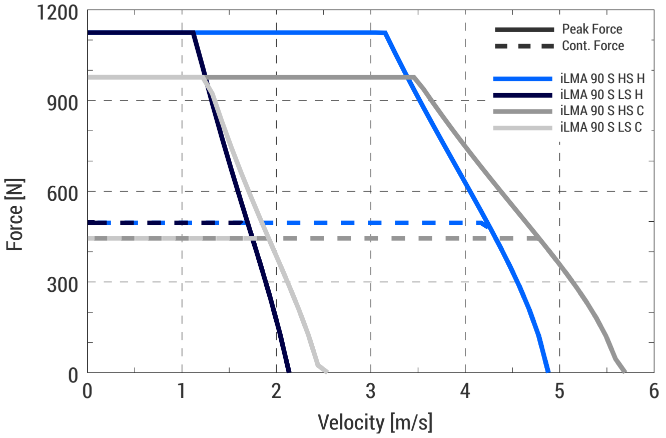
iLMA90

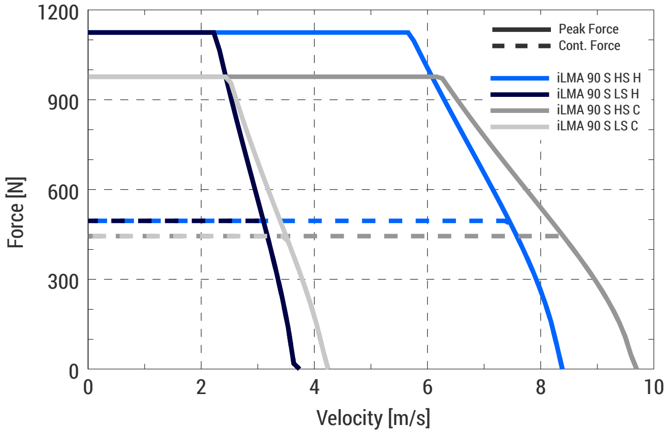
General technical data

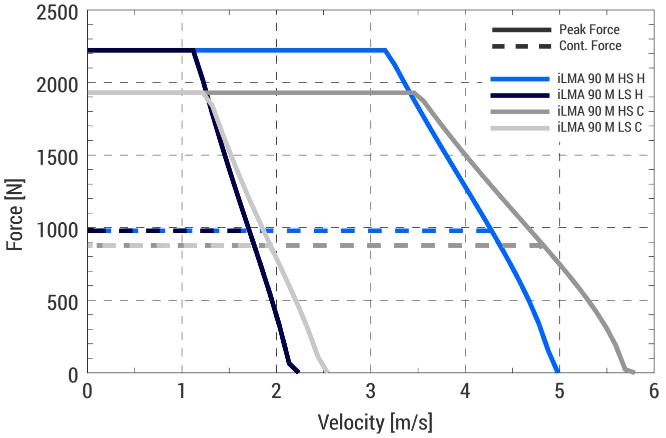
				iLMA 90															
				Version S				**Version M**				**Version L**				**Version XL**			
				Classic Plate		**High Performance**		**Classic Plate**		**High Performance**		**Classic Plate**		**High Performance**		**Classic Plate**		**High Performance**	
	PARAMETER	SYM	UNIT	Low Speed	High Speed	Low Speed	High Speed	Low Speed	High Speed	Low Speed	High Speed	Low Speed	High Speed	Low Speed	High Speed	Low Speed	High Speed	Low Speed	High Speed
PERFORMANCE	Supply voltage	V_{DC}	V (DC)	600															
	Continuous Force*	F_C	N	444		495		877		978		1311		1461		1744		1944	
	Peak Force (1s)*	F_P	N	976		1124		1929		2221		2882		3318		3835		4416	
	Ultimate Force (0,5s)*	F_U	N	1230		1445		2430		2856		3631		4267		4831		5678	
	Attraction force of magnets**	F_A	N	2034		2874		3735		5277		5436		7680		8838		12486	
	Cogging (Detent) force	F_G	N	15,0		18,0		0,0		0,0		0,0		0,0		0,0		0,0	
	Force constant	K_F	$\frac{N}{A_{RMS}}$	148,0	64,6	165,0	72,1	146,2	63,8	163,0	71,2	145,7	63,6	162,3	70,9	145,3	63,4	162,0	70,7
	Motor constant	K_M	$\frac{N}{\sqrt{W}}$	35,3	35,2	39,4	39,2	49,2	49,2	54,8	54,9	60,1	60,0	66,9	66,9	69,2	69,2	77,1	77,1
	Back EMF Phase-Phase Constant	K_{BEMF}	$\frac{V}{(m/s)}$	85,4	37,3	98,7	43,1	84,4	36,9	97,5	42,6	84,1	36,7	97,1	42,4	83,9	36,6	96,9	42,3
ELECTRICAL	Maximum Continuous Current	I_C	A_{RMS}	3,0	6,9	3,0	6,9	6,0	13,7	6,0	13,7	9,0	20,6	9,0	20,6	12,0	27,5	12,0	27,5
	Peak Current	I_P	A_{RMS}	6,0	20,6	6,0	20,6	18,0	41,2	18,0	41,2	27,0	61,8	27,0	61,8	36,0	82,4	36,0	82,4
	Ultimate Current	I_U	A_{RMS}	15,0	34,3	15,0	34,3	30,0	68,7	30,0	68,7	45,0	103,0	45,0	103,0	60,0	137,4	60,0	137,4
	Resistance at 20°C Phase - Phase	R_{25}	Ω	11,7	2,3	11,7	2,3	5,9	1,1	5,9	1,1	3,9	0,8	3,9	0,8	2,9	0,6	2,9	0,6
	Resistance at 125°C Phase - Phase	R_{120}		16,5	3,2	16,5	3,2	8,3	1,6	8,3	1,6	5,5	1,1	5,5	1,1	4,2	0,8	4,2	0,8
	Induction Phase - Phase	L_P	mH	75,5	14,4	75,5	14,4	37,7	7,2	37,7	7,2	25,1	4,8	25,1	4,8	18,9	3,6	18,9	3,6
	Electrical time constant***	t_C	mS	6,5	6,4	6,5	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4	6,4
	Max. Winding temperature****	T_{max}	°C	20															
THERMAL	Thermal Resistance	R_{th}	$\frac{K}{W}$	0,471				0,234				0,156				0,117			
	Thermal Resistance to heatsink	Rth_ HS	$\frac{K}{W}$	0,125				0,063				0,042				0,031			
MECHANICAL	Motor overall length	ML	mm	128,4				233,4				338,4				443,4			
	Motor overall width	MW	mm	120															
	Motor overall height	MH	mm	23,5															
	Motor mass	mm	kg																
	Motor wires cross-section	SC	mm²	1,5								2,5							
	Sensor wires cross-section	SSC	mm²	0,25															
	Motor cable length	LM	mm	400															
	Sensor cable length	LS	mm	400															
	Magnet Pitch	τ	mm	30															

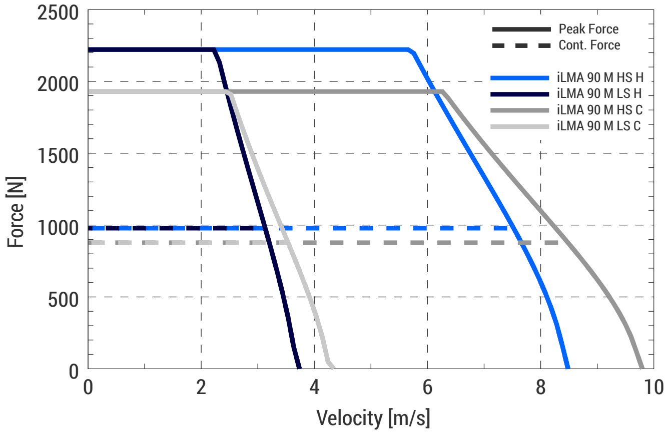
* Magnets at 20 °C
** RMS at 0 A and air gap of 0,6 mm
*** Windings at 20 °C
**** Maximum allowed magnet plate temperature is 90 °C

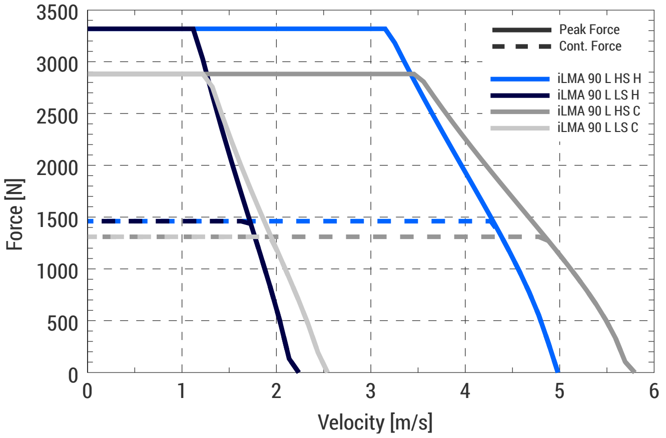
Force as a function of velocity diagrams

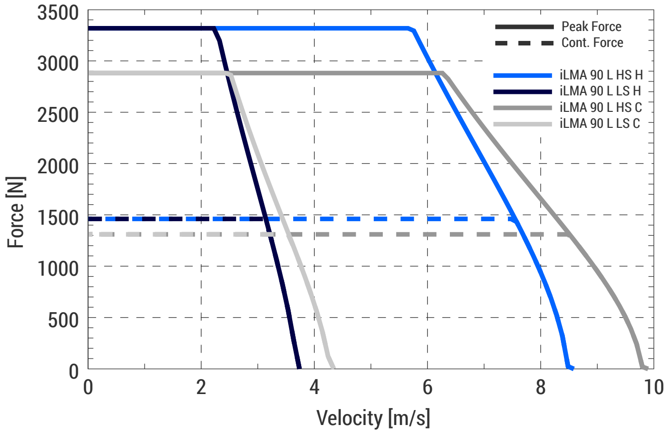


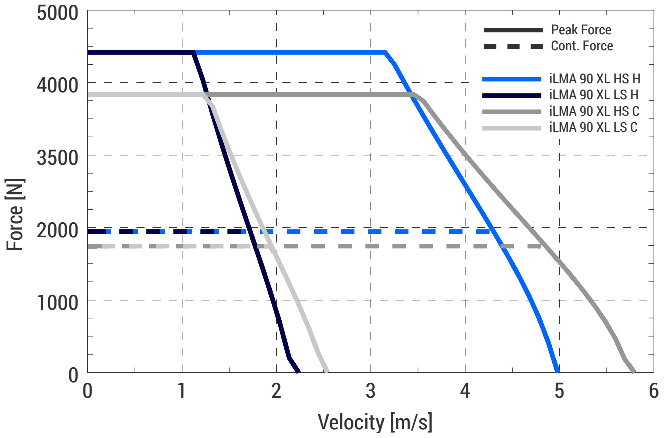


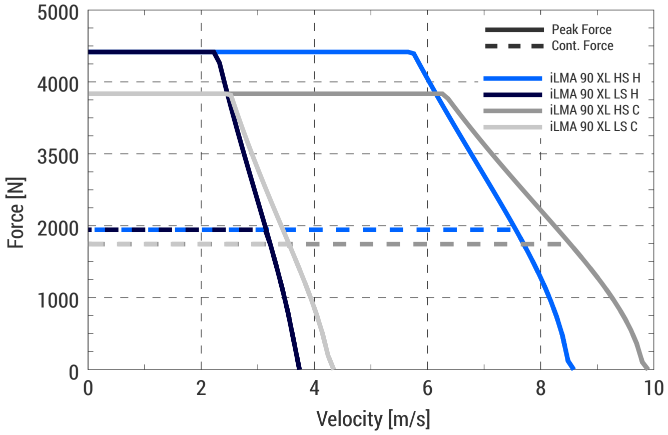




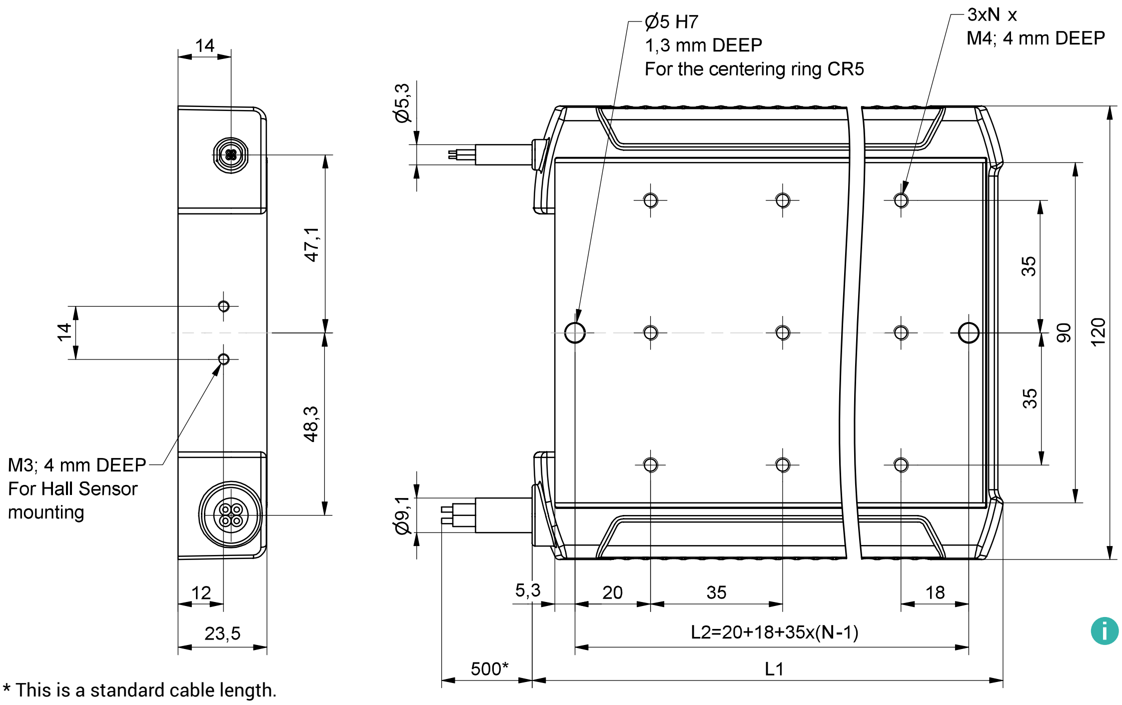








Forcer dimensions

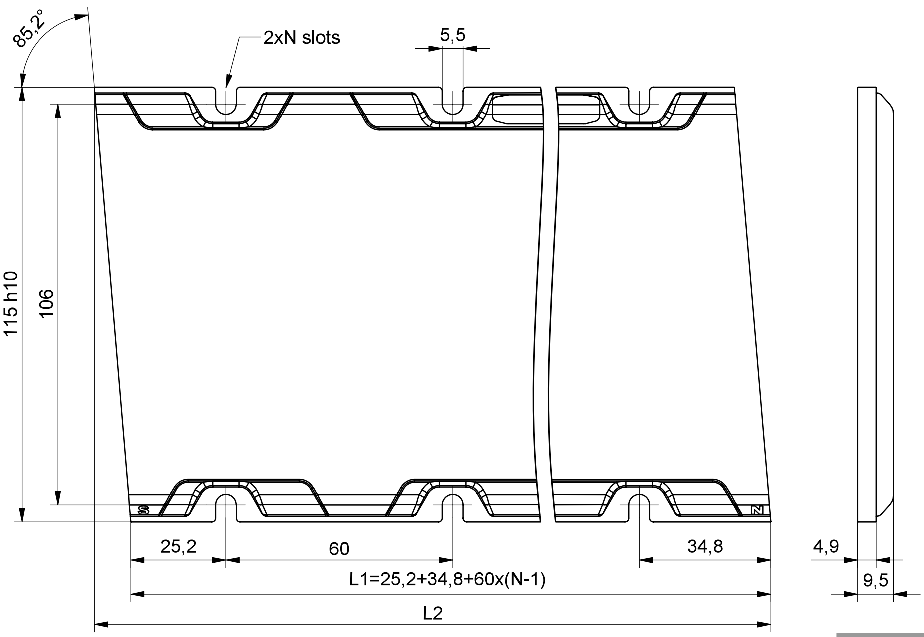


* This is a standard cable length.

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

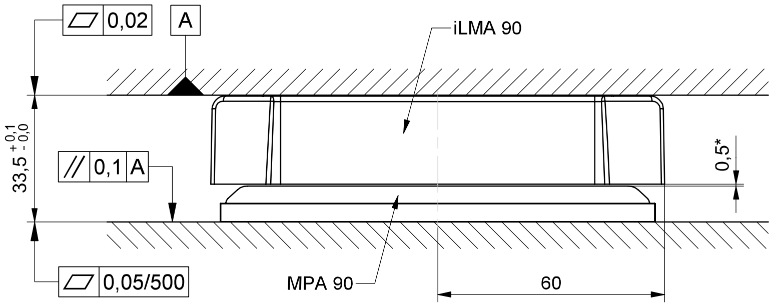
iLMA90	L1	L2	N
iLMA 90 S HS/LS	128	108	3
iLMA 90 M HS/LS	233	213	6
iLMA 90 L HS/LS	338	318	9
iLMA 90 XL HS/LS	443	423	12

Magnet plate dimensions



MPA90	L1	L2	N
MPA 90 120 C/H	120	129,6	2
MPA 90 180 C/H	180	189,6	3
MPA 90 300 C/H	300	309,6	5

Mounting tolerances



*This the recommended air gap between the forcer and the magnet plate.

ELECTRICAL DATA

Temperature sensors description (NTC / PTC)

iLMA linear motors are equipped with two types of temperature sensors which are normally used for overheating protection. The first type is 10k Ω NTC which is thermally coupled with the U winding. The second one is 1,4k Ω PTC, which consists of three 470 Ω PTCs connected in series. The PTC sensors are thermally coupled with U, V, and W windings.

The NTC sensor is commonly used for monitoring motor temperature. While the PTC sensor is used for cut-off protection when the motor temperature exceeds the maximum allowed temperature.

For continuous operation, it is recommended that the motor temperature does not exceed 80 % (100 °C) of the maximum allowed motor temperature (125 °C).

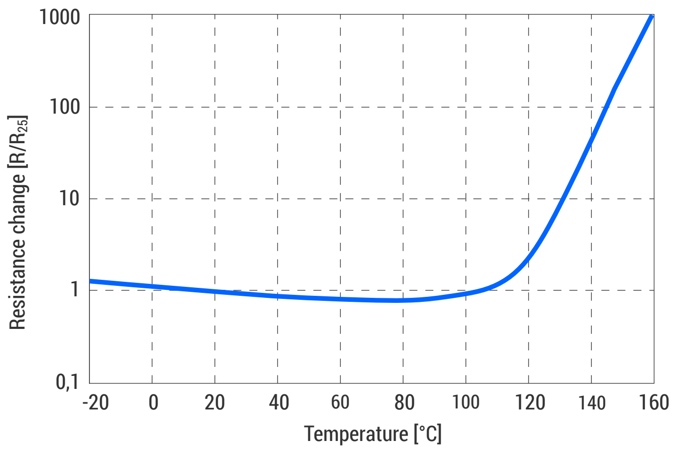
PTC Thermistor

As mentioned in the above description, windings are equipped with three series-connected 470 Ω PTC thermistors. This sensor's characteristic curve has a very exponential rise when the windings are closing in on their maximum temperature of 125 °C. That's why we can use it as an indicator of signaling critical temperatures which eliminates the need for sensing electronics. With this particular sensor, it is not possible to receive the exact temperature.

In the table below, you can see the resistances, during, near, or at specific operational temperatures.

Resistance of PTCs at ambient temperature (25 °C)	1410 Ω
Normal operating PTCs resistance (25 °C–120 °C)	< 10k Ω
Warning resistance level of PTCs (120 °C)	10k Ω
Cut-off resistance of PTCs	14.1k Ω

The resistance is the sum of all the PTCs.



NTC Thermistor

As mentioned in the above description, the forcer is equipped with one 10k Ω NTC thermistor. This sensor's characteristic curve is somehow linear throughout the whole operating range. The thermal time constant of this sensor is ~10 seconds.

With the below equation, you can calculate the temperature of the windings from the current resistance of this NTC sensor.

$$T = \frac{B}{ln\left(\frac{R_{th}}{R_0 \times e\frac{-B}{T_0}}\right)}$$

Values of specific elements are:

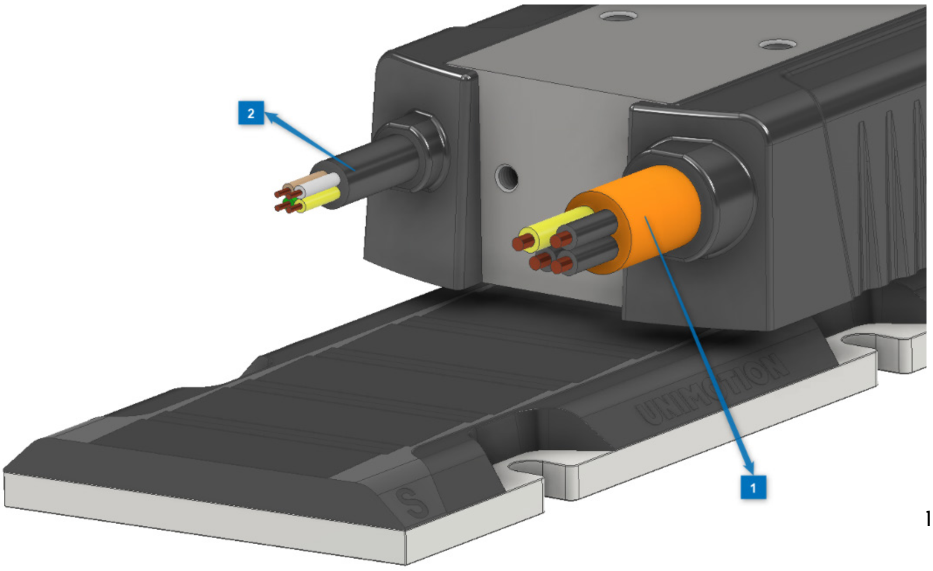
Parameter	Value	Unit
Rth	*Current sensor reading*	Ω
B	3940	/
$R_0 = R_{25}$	10000	Ω
$T_0 = T_{25}$ (273 K + 25 °C)	298	K

In the table below, you can see the NTC 10k Ohm resistance values at specific temperatures.

T [°C]	25	30	40	50	60	70	80	90	100	110	120	125	130
R [Ω]	10k	8040	5307	3594	2492	1765	1275	937	701	532	409	361	319

Resistance of NTCs at ambient temperature (25 °C)	10k Ω
Normal operating NTCs resistance (25 °C–120 °C)	> 405 Ω
Warning resistance level of NTCs (120 °C)	405 Ω
Cut-off resistance of NTCs	360 Ω

NTC Thermistor

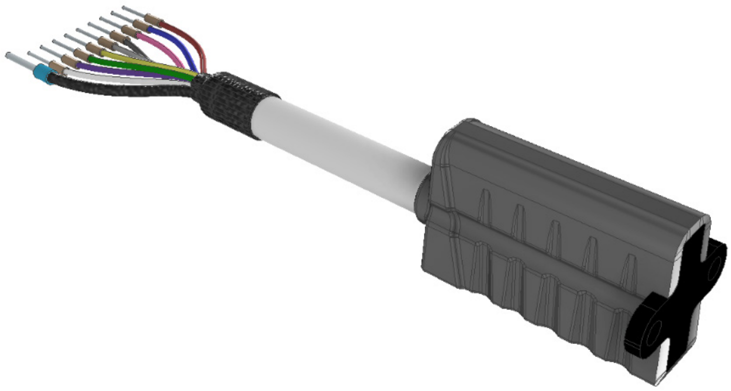


1. Motor power cable
   - Black: Phase Cables (L1, L2, L3)
   - Yellow: Neutral (N) + Ground (Protective Earth, PE)
2. Motor temperature sensor
   - Yellow & Green: PTC Thermistors
   - White & Brown: NTC Thermistor

iLMA Hall effect sensor

Description

DGMOTION offers a Hall sensor which was specially developed for the iLMA linear motors. The sensor utilizes existing magnet feedback which allows for an unmatched accuracy to price ratio. Its main advantage is that the analog and the digital sensors are integrated 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 um whilst absolute accuracy is in the range of 100 um. With the integration of both sensors, analog 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 between them while the analog sensor generates sine and cosine signals with an amplitude of 1 Vpp. For the best EMC resistance, the signals are differential, ie.: sine: A+, A– and cosine: B+, B–.

Our Hall sensor is compatible with the iLMA motors, which helps the customers with an easy and precise mounting that allows for an ideal alignment between the sensors and the motor windings.

Specifications table

Absolute Maximum Ratings:

Parameter	MIN	MAX	UNIT
Power supply voltage V_{cc}	–0.3	6	V_{DC}
Output pin current U, V, W, A+, A–, B+, B–	0	–100	mA
Operating junction temperature, TJ	–15	85	°C
Storage temperature, T_{stg}	–25	90	°C

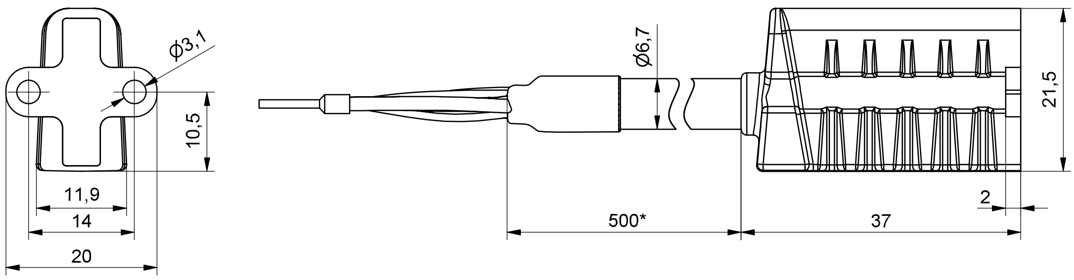
Recommended Operating Conditions:

Parameter	MIN	MAX	UNIT
Power supply voltage V_{cc}	4.9	5.5	V_{DC}
Powe supply current	30	50	mA
Output current	–	5	mA
Output voltage A+ to A– and B+ to B–	0.8	1.2	V_{pp}
Operating junction temperature, TJ	–15	85	°C
Storage temperature, T_{stg}	–25	90	°C

Technical specifications:

Parameter	VALUE	UNIT
Sensor accuracy	+/– 100	µm
Repeatability	+/– 30	µm
Hysteresis	+/– 10	µm
Signal period	30	mm
Cable	LAPP UNITRONIC FD CP plus 10x0.14	/
Cable bending radius (Fixed installation)	26.8	mm
Cable bending radius (Flexible installation)	50.25	mm

Description



* This is a standard cable length.
For different lengths, please refer to the "Hall sensor – How to order" section.

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

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 +5V_{DC}	+5V_{DC}	Red
Power supply GND	GND	Blue
Cable screen	EARTH	Screen

How to order

HALL - **0,5**

Sensor:
– iLMA Hall

Cable length [m]:
– 0,5
– 2
– 5

Motor selection example

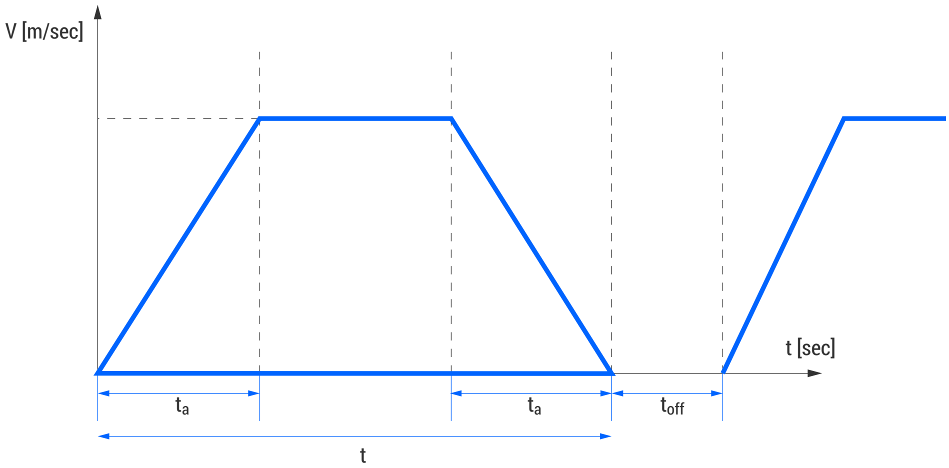
Motor selection guide:
The proper motor selection is done in three steps:

I. Definition of motion profile
II. Continuous and peak forces calculation
III. Motor selection

I. Definition of motion profile

There is a wide range of different motion profiles which can be expressed by basic kinematics equations. The most useful is trapezoid point to point moving profile and triangular profile.

Trapezoid profile:



Moving input data:

L	moving distance (stroke)	[m]
t	moving time	[s]
t_a	acceleration time	[s]
t_{off}	pause	[s]

Average velocity is expressed by:

$$v = \frac{L}{t}\ [m/s]$$

Max speed is defined as:

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

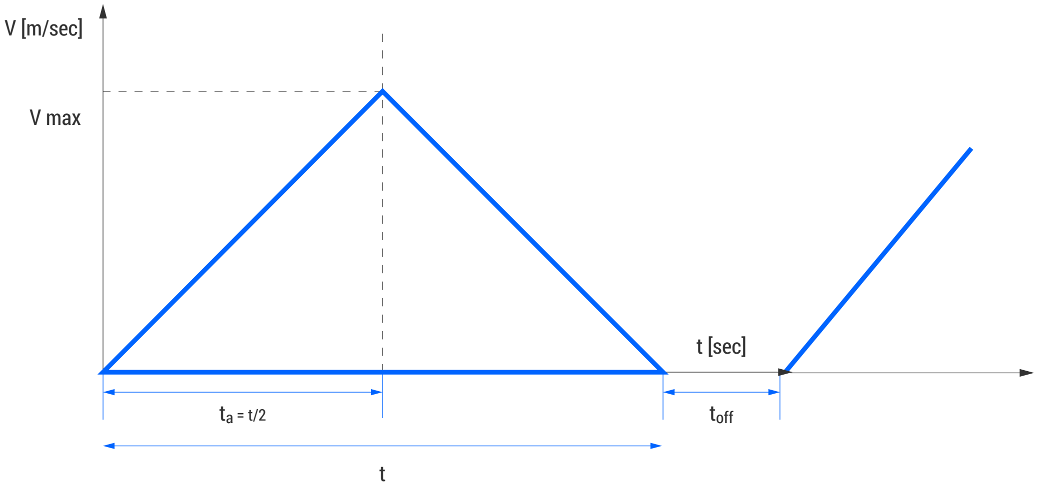
Acceleration/deceleration is defined by:

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

Where is:

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]

Triangle profile:



Moving input data:

L	moving distance (stroke)	[m]
t	moving time	[s]
t_a	acceleration time	[s]
t_{off}	pause	[s]

Average velocity is expressed by:

$$v = \frac{L}{t}\ [m/s]$$

Acceleration/deceleration are defined by:

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

Max speed is defined as:

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

Where is:

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]

II. Continuous and peak force calculation

There is a wide range of different motion profiles which can be expressed by basic kinematics equations. The most useful is trapezoid point to point moving profile and triangular profile.

Input parameters:

m_{load}	load mass	[kg]
K_{fri}	friction coefficient (usually 0,01)	
F_A	attraction force (you can find it in motor specification)	[N]
α	inclination angle	[°]

The peak forces can be calculated by the following equation:

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

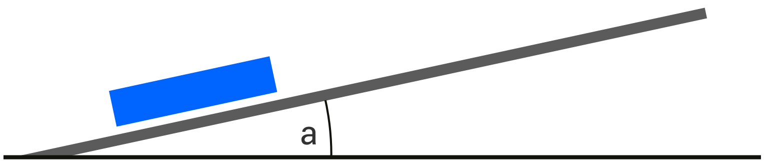
$$F_{mass} = a * m_{load}$$

$$F_{fri} = K_{fri}(g * m_{load} * cos\alpha + F_A)$$

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

Where is:

F_p	peak force	[N]
a	acceleration	[m/s²]
m_{load}	load mass	[kg]
K_{fri}	friction coefficient (usually 0,01)	
g	gravity constant (9,78)	[m/s²]
F_A	attraction force	[N]
α	inclination angle	[°]
F_{incl}	inclination force (in case if motor is placed horizontal (α = 0°) the F_{incl} is 0)	[N]



The continuous forces can be calculated by following equation:

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

III. Motor selection

Define motor RMS and MAX current:

$I_{MAX} = \frac{F_p}{K_F}$ < I_p from motor specification.

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

Where is:

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

Motor voltage calculation:

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

$$V_{mot} = \sqrt{\left(\frac{v_{max} * K_{BEMF}}{\sqrt{3}} + \frac{F_p}{K_F} * R_{25} * \frac{\sqrt{2}}{2}\right)^2 + \left(\sqrt{2}\ \frac{F_P * L_p}{K_F * 2 * \tau}\right)^2}$$

Where is:

v_{max}	maximum velocity	[m/s]
K_{BMF}	motor induction voltage Phase to Phase peak (you can find it in motor specification)	[V/m/s]
K_F	Force constant (you can find it in motor parameters)	[N/A_{RMS}]
F_p	peak force	[N]
R25	Phase to phase resistance (you can find it in motor specification)	[Ω]
L_P	Phase to phase inductance	[H]
τ	Magnet pitch (you can find it in motor specification)	[m]

Driver available voltage can be calculated by

$$V_{driver} = \frac{\sqrt{2}\ V_{supply}}{\sqrt{3}} * 0{,}8$$

Where is:

Vsupply	driver supply voltage (for example 230 V AC or 400 V AC)	[V_{RMS}]

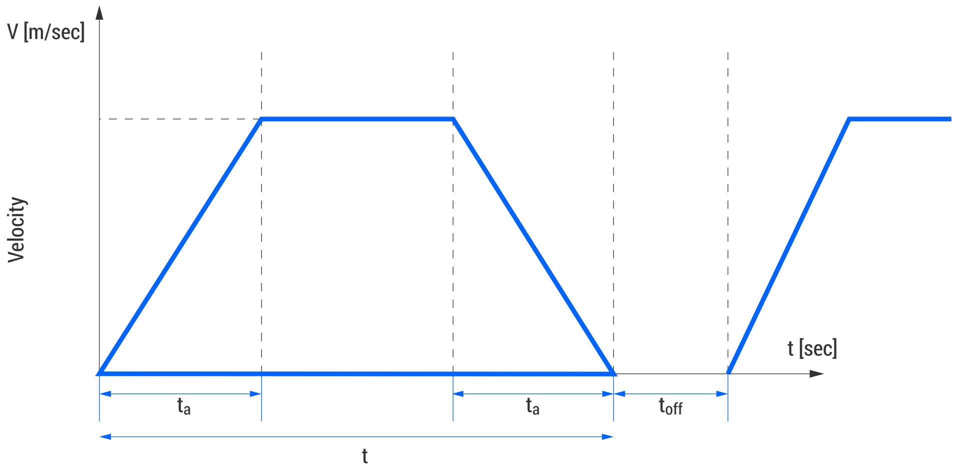
Motor selection condition:

Driver voltage must be higher as max motor voltage.

$\mathbf{V_{driver} > V_{mot}}$

Selection example

I. Definition of motion profile



- Motion distance L = 2 m
- Moving time t = 2 s
- Acceleration time t_a = 0,5 s
- Pause t_{off} = 1 s
- Moving mass m_{load} = 50 kg
- Friction coefficient K_{fri} = 0,01
- α = 0°

Average velocity:

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

Max speed is defined as:

$$V_{max} = \frac{L}{t - t_a} = \frac{2}{2 - 0{,}5} = \mathbf{1,33\ m/s}$$

Acceleration/deceleration are defined by:

$$a = \frac{V_{max}}{t_a} = \frac{1{,}33}{0{,}5} = \mathbf{2,66\ m/s^2}$$

II. Continuous and peak force calculation

Peak force:

$$F_{mass} = a * m_{load} = 2{,}66 * 50 = \mathbf{133,3\ N}$$

$$F_{fri} = K_{fri}(g * m_{load} * cos\alpha + F_A) = 0{,}01(9{,}72 * 50 * cos0 + 985) = \mathbf{14,47\ N}$$

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

$$F_p = F_{mass} + F_{fri} + F_{incl} = 133{,}3 + 14{,}47 = \mathbf{147,8\ N}$$

Motor related parameters, can be found in motor specification:

- Attraction force $F_{A\,=}$ 958 N

RMS force:

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

$$= \sqrt{\frac{147{,}8^2 * 0{,}5 + 14{,}47^2 * (2 - 2 * 0{,}5) + (133{,}3 + 0 - 14{,}47)^2 * 0{,}5}{2 + 1}} = \mathbf{77{,}88\ N}$$

Motor related parameters, can be found in motor specification:

- Attraction force $F_{A\,=}$ 958 N

III. Motor selection

Motor max current:

$I_{MAX} = \frac{F_p}{K_F} = \frac{147{,}8}{55{,}5} = \mathbf{2{,}66\ Arms}$ **< 9,72 Arms**

Motor continuous current:

$I_{RMS} = \frac{F_c}{K_F} = \frac{77{,}88}{55{,}5} = \mathbf{1{,}4\ Arms}$ **< 3,24 Arms**

Motor related parameters, can be found in motor specification:

- Attraction force F_A = 958 N
- K_F = 55,5 N/A_{rms}
- I_C = 3,24 Arms
- I_P = 9,72 Arms

Motor voltage calculation:

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

$$V_{max} = \sqrt{\left(\frac{v_{max} * K_{BEMF}}{\sqrt{3}} + \frac{F_p}{K_F} * R_{25} * \frac{\sqrt{2}}{2}\right)^2 + \left(\sqrt{2}\,\frac{F_P * L_p}{K_F * 2 * \tau}\right)^2}$$

$$= \sqrt{\left(\frac{1{,}33 * 35}{\sqrt{3}} + \frac{147{,}8}{55{,}5} * 4{,}75 * \frac{\sqrt{2}}{2}\right)^2 + \left(\sqrt{2}\,\frac{147{,}8 * 0{,}022}{55{,}5 * 2 * 0{,}03}\right)^2} = \mathbf{35{,}9\ V}$$

Motor related parameters, can be found in motor specification:

- Attraction force $F_{A\,=}$ 958 N
- K_M = 55,5 N/A_{RMS}
- K_{BMF} = 35 V/m/s
- R_{25} = 4,75 Ω
- L_p = 22 mH
- τ = 30 mm

Driver available voltage:

V_{supply} = 230 Vac

$V_{driver} = \frac{\sqrt{2}\,V_{supply}}{\sqrt{3}} * 0{,}8 = \frac{\sqrt{2} * 230}{\sqrt{3}} * 0{,}8 = \mathbf{150{,}23\ V > 36{,}2\ V}$