GIMATIC

ELECTRIC LINEAR ACTUATORS

LV SERIES

USER GUIDE

Version 1.4

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1. SAFETY

WARNING: Embedded tubular motor shafts contain powerful permanent magnets. People with pacemakers, AICD or similar medical devices should maintain a minimum distance of 30 cm from the shaft.

WARNING: The shaft emits a very strong magnetic field. Always use caution when handling. To avoid injury, keep fingers and other body parts clear.

DANGER HIGH VOLTAGE: Ensure the power has been completely disconnected before touching any electrical connections. Electrical shock can cause serious or fatal injury.

DANGER HIGH VOLTAGE: The system must be properly grounded before applying power. Ensure the system has been grounded according to *Section 6.3.1 Motor power and temperature feedback*. National and local electrical codes must be followed. Electrical shock can cause serious or fatal injury.

WARNING: When embedded temperature sensor (PTC) is employed a temperature value of 100 °C must be set as maximum temperature allowed for the stator during driver's programming. This is equivalent to the PTC value less or equal to 1342 Ω (*Section 4.5 Sensors*). Whenever PTC connection is not possible a proper I2T parameter has to be set by the user during driver's programming in order to preserve ML stator from permanent damaging.

This manual and the warnings attached to the LV linear slides only highlight hazards that can be predicted by Gimatic. Be aware they do not cover all possible hazards.
Gimatic shall not be responsible for any accidents caused by the misuse or abuse of the device by the operator.
Safe operation of these devices is your own responsibility. By taking note of the safety precautions, tips and warnings in this manual, you can help to ensure your own safety and the safety of those around you.

1.1 General safety

The following points must be understood and adhered to at all times:

- Equipment operators must read the User Guide carefully and make sure of the correct procedure before operating the LV linear actuators.
- Memorize the locations of the power and drive isolator switches so that you can activate them immediately at any time if required.
- If two or more people are working together, establish signals so that they can communicate to confirm safety before proceeding to another step.
- Be aware of the closest First Aid station.
- Always make sure there are no obstacles or people near the devices during installation and or operation. Be aware of your environment and your surroundings.
- Keep the area around LV actuators clean and tidy.
- Take precautions to ensure that your clothing, hair or personal effects (such as jewelry) cannot become entangled in the equipment.
- Do not turn on any of the equipment without all safety features in place and known to be functioning correctly. Never remove any covers or guards unless instructed by the procedures described in this manual.
- Never touch any exposed wiring, connections or fittings while the equipment is in operation.
- Visually check all switches on the operator panel before operating them.
- Do not apply any mechanical force to the LV actuators, which may cause malfunction or failure.
- Never attempt cleaning or inspection when the machine is operating.
- Clean or inspect the equipment only after isolating all power sources.
- Only suitably qualified personnel should install, operate, repair and/or replace this equipment.
- Ensure all external wiring is clearly labeled. This will assist you and your colleagues in identifying possible electrical safety hazards.
- Use cables with the minimum cross sectional area as specified in the Electrical Connection specification section of this guide.
- Install cables according to local legislation and regulations as applicable.
- Ensure there are not moving parts of the actuator while in contact with the motor’s electrical connections. Movement can induce a voltage that could cause an electrical shock.

2 INTRODUCTION

2.1 About this user guide

This user guide provides the required information for planning to install, installation and servicing of the LV linear slides. It has been written specifically to meet the needs of qualified engineers, tradespersons, technicians and operators.

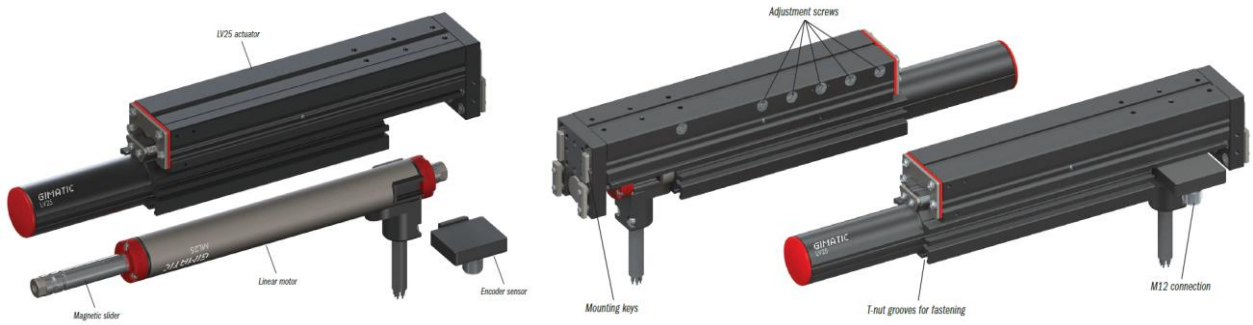
2.2 Terms and abbreviations

GND	Ground
rms	Root mean square
g	Gravity m/s^2
V / mV	Volt / millivolt
A / mA	Ampere / milliampere
Ω	ohms
AC / DC	Alternating Current / Direct Current
Hz	Hertz
ms	millisecond
AICD	Automatic Implantable Cardioverter-Defibrillator
EMC	Electromagnetic Compatibility

3 PRODUCT OVERVIEW

3.1 About Gimatic's LV actuators

The Gimatic LV actuator is a recirculating ball bearing slide equipped with a 3-phase, brushless, DC, permanent-magnet motor designed for direct-drive, high-precision and high-dynamics applications. High efficiency and performance of Gimatic's ML linear motors meet a lightweight aluminium slide which provides a prismatic guide for the motion of the slider (anti-rotation), a heat dissipation functionality and high stiffness in several directions. Adjustable preloading screws and long life bearings assure low installation and maintenance costs.



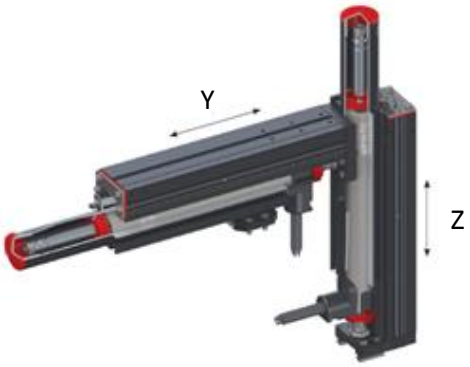
3.2 Features

- High continuative force/current.
- Zero backlash – No ball screw or gearbox eliminates backlash.
- High acceleration forces – More than 400 [N] depending on model.
- Low installation and maintenance costs – Simple construction, T-nut grooves for fastening.
- Fully sealed – IP67 rating standard.
- Zero net attractive forces improve efficiency with no down force and extended machine life.
- Durable – Stator materials' high insulation class results in long motor life. 10 million cycles maintenance-free.
- Efficient – The extremely strong magnetic flux, cylindrical design and small moving mass provide for very efficient linear motion.

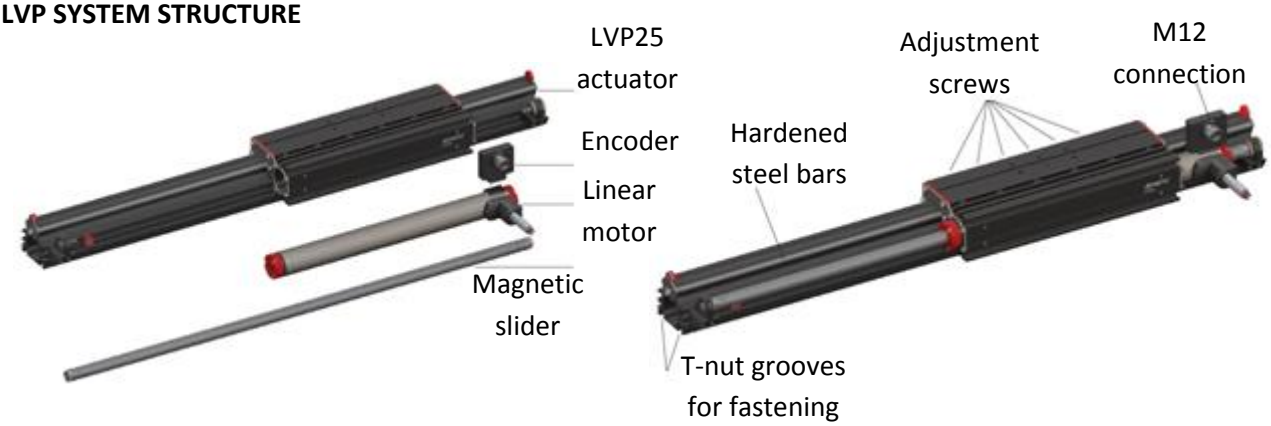
3.3 LV and LVP systems

LV actuators can be combined in order to create multiple axis systems. Furthermore for all those applications requiring longer strokes and/or higher stiffness along the entire stroke, Gimatic linear actuators are also available as linear guides (LVP25 and LVP40). These guides can be combined with LV actuators to create more complex structures (i.e. cartesian manipulators).

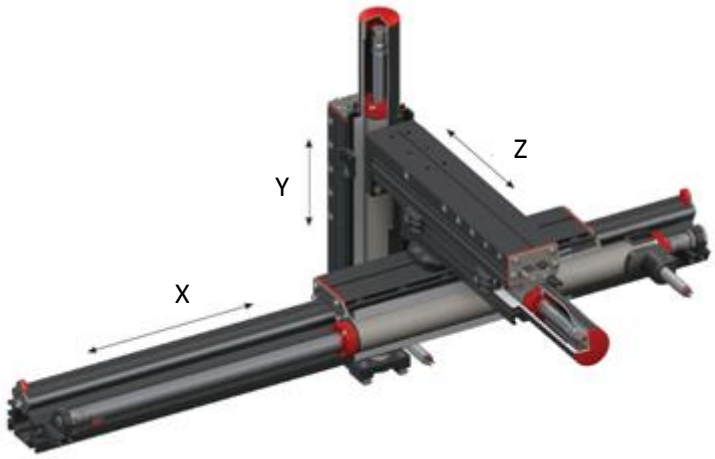
LV EXAMPLE APPLICATION: 2 AXIS PICK&PLACE SYSTEM



LVP SYSTEM STRUCTURE



LVP+LV EXAMPLE APPLICATION: 3 AXIS PICK&PLACE SYSTEM

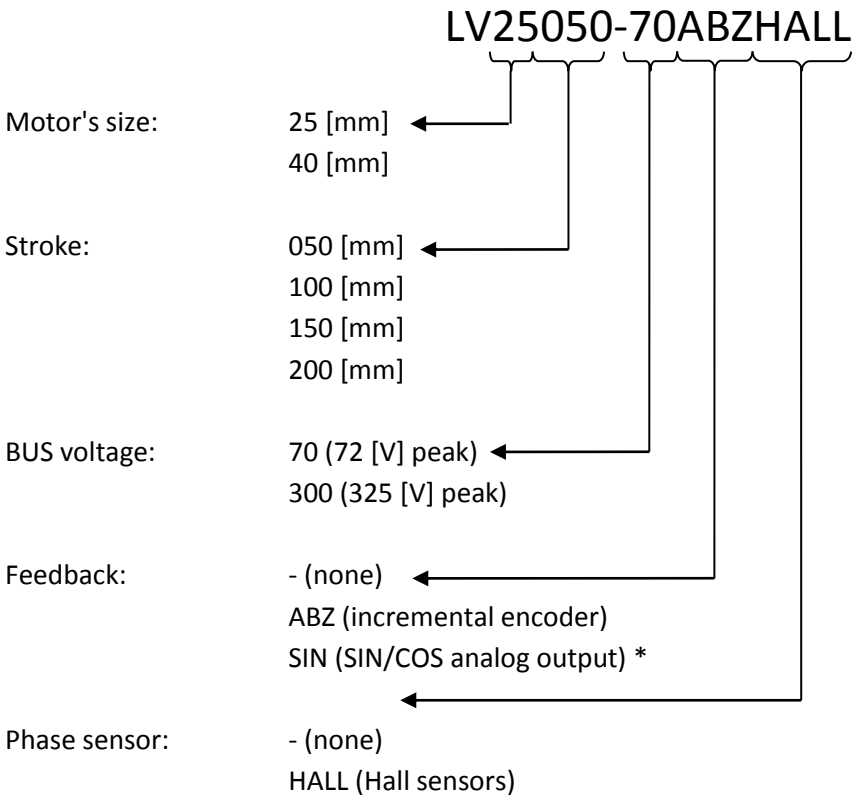


3.4 LV product range

																
	LV25050		**LV25100**		**LV25150**		**LV25200**		**LV40050**		**LV40100**		**LV40150**		**LV40200**	
Stroke [mm]	50		100		150		200		50		100		150		200	
Total mass [g]	1170		1380		1825		2185		2730		3590		4430		4865	
Mass of parts fixed to the slider [g]	560		670		850		1050		1350		1840		2150		2420	
BUS voltage [Vdc] (peak)	72	325	72	325	72	325	72	325	72	325	72	325	72	325	72	325
Peak current [A]	7.7	3.1	7.7	3.1	5.2	2.1	5.2	2.1	19	8.8	19	8.8	14.2	5.8	14.2	5.8
Continuative current [A]	2.0	0.6	2.0	0.6	2.1	0.6	2.1	0.6	4.3	1.2	4.3	1.2	4.0	1.0	4.0	1.0
Peak force [N]	98	117	98	117	105	132	105	132	258	421	258	421	294	412	294	412
Continuative force [N]	25	20	25	20	42	37	42	37	58	57	58	57	83	71	83	71

3.5 Catalogue number interpretation

Electric linear slide: ordering code example



(*) Under development.

4 SYSTEM DESIGN

4.1 System components

The design of the LV linear slide allows for simple installation in any custom application, however to achieve the best performance the final system must be optimized. This chapter describes the main components to consider when designing such a system.
The primary components of LV systems based are:
1. Cable carrier
2. Servo drive
3. Linear position transducer (encoder)

Additionally the following secondary components may be required depending on the application:
4. Home and End-stop sensors
5. Mechanical over stroke limitation
6. Weight counter balance device (for vertical applications)
7. Brake

4.2 Electric linear slides

4.2.1 Application

A LV linear actuator is based on a tubular linear motor that provides relative motion between the slider and the stator. In a single axis system the LV part hosting the motor's stator is typically fixed to an external frame while the slide hosting the motor's slider interacts with the load (directly or by means of gripper or some other tools). In multiple axis systems, several LV actuators can be connected in series to create cartesian robotic arms or more complex architectures. The LV slide can be mounted horizontally, vertically or any angle in between.

4.2.2 Slider

DANGER: LV slide integrates a magnetic shaft that must be grounded to prevent the possibility of electric shock during actuator operation.

WARNING: The shaft emits a very strong magnetic field. Always use caution when handling. To avoid injury, keep fingers and other body parts clear.

WARNING: Interaction around the shaft must be carefully considered. Ensure appropriate warnings and/or guards are installed to prevent damage to the machine or operator.

The strong magnetic nature of the embedded slider must be considered in the final machine design. Care should be taken with its proximity to magnetic materials and sensitive parts. It is recommended that non-magnetic material be used in the system wherever possible. If magnetic material is required, ensure it is at sufficient distance from the slider so that it is unaffected. The slider's performance can be reduced if subjected to temperatures above 100 °C. Therefore, consideration must be given to the slider's operating environment and the continuous operating current of the application for the expected ambient temperature.

4.2.3 Stator

LV model selection is primary dependent upon the peak force, continuous force and peak velocity. These specifications depend on the embedded motor's stator and they need to be identified before ordering a LV system.

- Peak Force – Identify the peak force required for the application. An electric actuator will only be able to produce its peak force for a short period of time; the duty cycle also needs to be considered.

- Continuous Force – Identify the RMS force usage of the application. An electric actuator is able to exceed its continuous force rating by an amount depending on the duty cycle. Exceeding this can result in exceeding the motor temperature ratings and damage to the motor. Refer to the **Application continuous force calculation example** for more information on how to calculate an application's continuous force requirement.

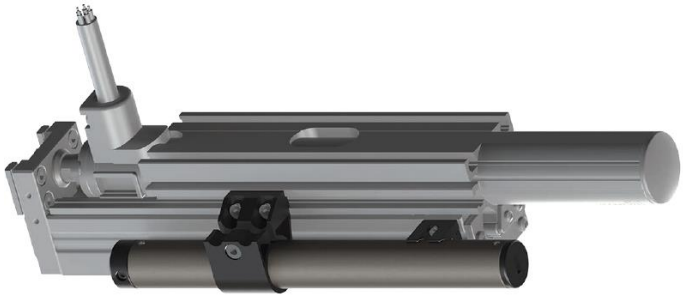
- Peak Velocity – Identify the peak velocity required for the application. Available peak force may be reliant on velocity depending on the DC Bus voltage of the servo drive and the LV model chosen. Refer to **Operative fields** section of this guide which summarizes performances of motors themselves. Despite motors can reach very high speed (several m/s), 10 milion cycles maintenance-free operations of LV actuators are guaranteed for movement speed of up to 2 m/s.

WARNING: Cooling of the stator must be considered for applications with a high continuous operating current.

DANGER: The stator must be grounded via the proper cable to prevent the possibility of electric shock during motor operation.

4.2.4 Weight counter balance

In vertical applications where a counter-balance is not used, the actuator must constantly produce a force directly opposing gravity. This adds to the application continuous force requirements and, therefore, influences the motor model selection. A counter balance device should be considered in order to compensate the load statically. Gimatic manufactures a spring compensator that can be mounted laterally on LV devices. A brake is recommended for most applications but must be used to prevent damage in applications where the load drops immediately after power is removed.



	LV25-KIT-50	LV25-KIT-100	LV25-KIT-150	LV25-KIT-200
Linear actuator	LV25050	LV25100	LV25150	LV25200
Length [mm]	187	227	284	339
Total mass [g]	105	136	165	191
Stroke [mm]	50	100	150	200
Stiffness [N/m]	100			

(in preparation)	**LV40-KIT-100**	**LV40-KIT-150**	**LV40-KIT-200**
Linear actuator	LV40100	LV40150	LV40200
Length [mm]	270	320	370
Total mass [g]	250	290	330
Stroke [mm]	100	150	200
Stiffness [N/m]	1225		

4.2.5 Brake

An external brake should be considered for all applications to prevent damage to systems or users in the event of a failure or fault. A brake is recommended for vertical applications regardless of whether a counter balance is used or not. In applications that are deemed to require brakes, it is recommended that they be applied to the bearing or aligning rod systems used with the linear motor. A braking system should not be directly applied to the motor's slider as this could result in damaging the slider. The brake must be chosen so that it provides enough force to resist gravity, inertia and machine operation. The kinetic energy of the moving load will be converted into heat due to friction when the brake is applied. The amount of kinetic energy must be taken into account to prevent damage to the brake due to overheating.

4.2.6 Cable carrier

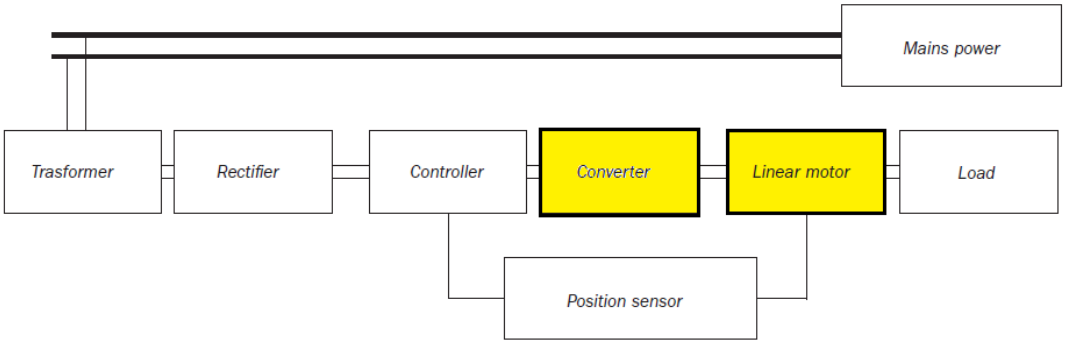
When the LV motor's stator is the component moving relative to the servo drive, it is recommended that a cable carrier be used to guide and protect cables connected to the stator. Where the machine has a very short stroke, a cable carrier may not be required. In all cases, strain relief is recommended. Refer to the cable supplier's information to ensure the cable bends and flexes within specification.

4.3 Servo drive

Gimatic does not manufacture servo drives since the LV actuators are compatible with most 3-phase, AC, brushless servo drives available on the market. The following is a list of some of the commercial drives tested over time.

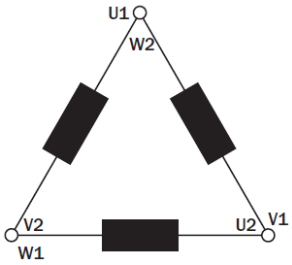
BRAND	**CODE**
Linmot	B1100; E1100
Copley	Accelnet
Hitachi	Servo AD
Advanced Motion Control	DPRALTE-020B080
Technosoft	IDM680
Janaer	Ecovario 114
BR Automation	Apocos
Elmo	Harmonica Drive
Servotronix	LVD drive
Maxon Motor	Epos Drive 70/10
LeadShine	ACS806
Aerotech	Ensemble HPE10
ABB	MicroFlex 150
Galil	CDS-3310
Infranor	XtraPlusPac
HDT	Digifox/Tomcat
Stober	SD6A02TNX
Selema	Micro ECO

Appropriate servo drive model selection for the application and selected stator model is important for optimum performance. Considerations include maximum current rating, continuous current rating and DC bus voltage. These factors, in turn, influence the peak force, force duty cycle and maximum velocity of the motor.



Please, refer to the following schema and to the specific servo-drive user manual for all the recommendations and installation notes on connecting the motor to the driver.

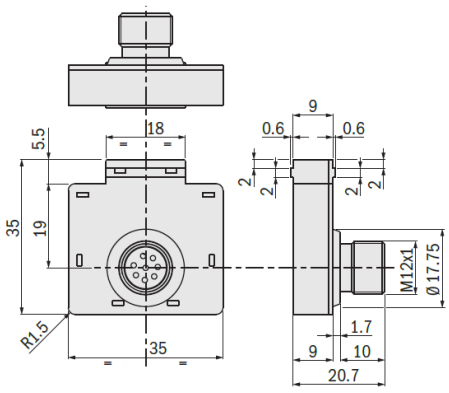
Connection	Color
U-PHASE	Grey
V-PHASE	Yellow
W-PHASE	Brown
PTC	White
PTC	Pink
GROUND	Green



WARNING: During functional tests and electromagnetic compatibility tests of Gimatic's LV products, shield conductors have been left unconnected from motors and drivers.

4.4 Linear encoder

The linear encoder is used to provide position feedback to the servo drive to allow for accurate control of the LV actuators. Gimatic manufactures an incremental ABZ encoder with RS-422 output signal for two different resolutions: 25 µm (SE9ABZ1) and 10 µm (SE9ABZ1-HR). The choice of what encoder best fits the application also depends on the maximum speed expected: the higher the resolution, the lower the maximum speed. A sine/cosine analog output version of the linear transducer is under development.

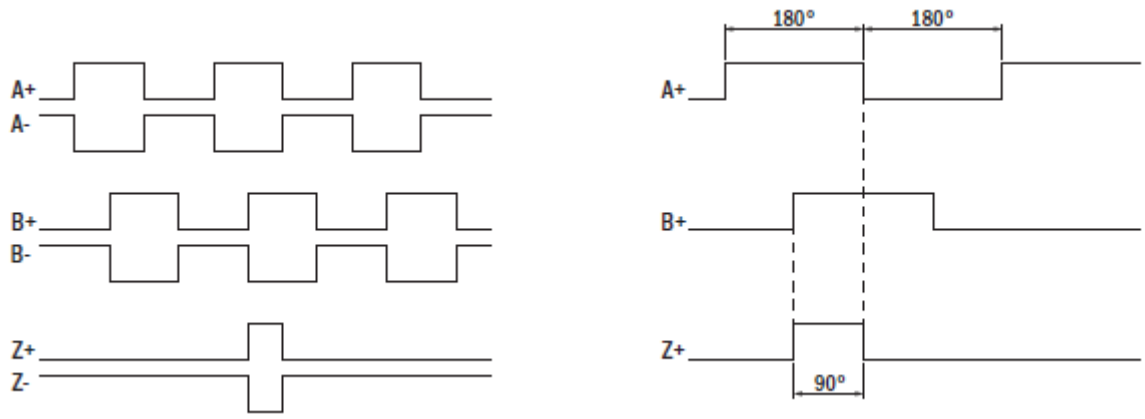


	SE9ABZ1	SE9ABZ1-HR	SE9SIN1(*)
Circuit output	ABZ		SIN/COS
Output signal	RS-422		1 Vss
Power supply	5 Vdc		
Current consumption	50 mA		25 mA
Working speed	6 m/s	2 m/s	4 m/s
Operating temperature	-40 ÷ +85 °C		
Resolution	25 µm	10 µm	-
Pole pitch	35.4 mm		
Cycles per rev. (CPR)	354	885	1
Pulses per rev (PPR)	1416	3540	1 sinusoid
Weight	20 g		
Connection	M12, 8 poles		
Pin 1 (White)	Z-		
Pin 2 (Brown)	+5 Vdc		
Pin 3 (Green)	B-	B-	COS -
Pin 4 (Yellow)	B+	B+	COS +
Pin 5 (Grey)	A-	A-	SIN -
Pin 6 (Pink)	A+	A+	SIN +
Pin 7 (Blue)	GND		
Pin 8 (Red)	Z+		

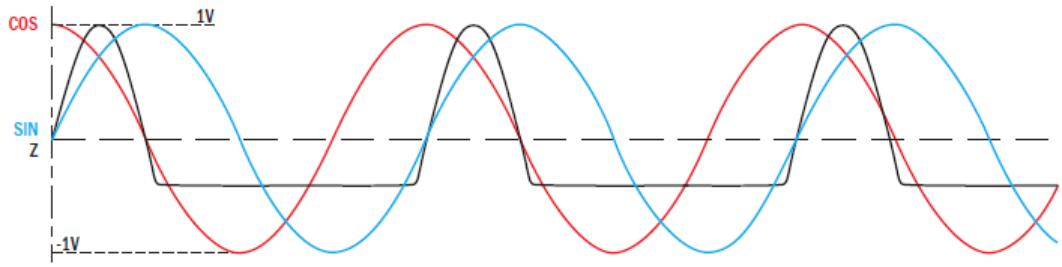
(*) Under development

Feedback signals

SE9ABZ1/SE9ABZ1-HR

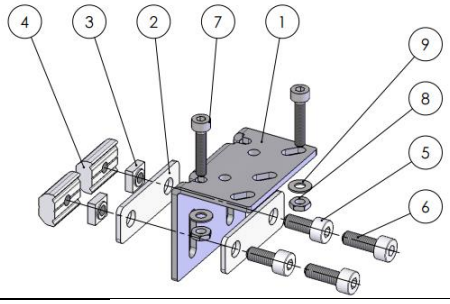
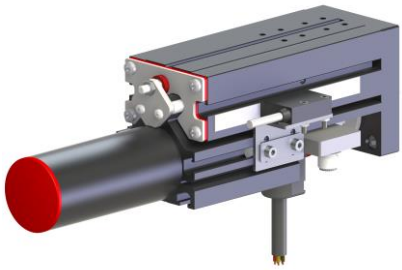


SE9SIN1



NOTE: Despite all linear encoders can be mechanically installed in any of the two motor's grooves, the positive direction of the position measurement is opposite from one installation side to the other.

However, the user can install third party, external, position transducers whose type depends greatly on the application. Factors such as the required precision, operating environment and servo drive signaling requirements need to be taken into account. As the LV embedded motor does not have any backlash, it is recommended that the position feedback system chosen does not contain backlash either. The most commonly used encoders consist of an encoded surface, either solid rail or adhesive strip, mounted parallel to the slider and a sensor read head mounted to the stator. LV linear actuators have been designed to be compatible with several major brands of external transducers (i.e. Givi Misure®, Siko® and Renishaw®) by means of specific fixing accessories (i.e. LV25-KIT-05 refer also to the "Accessories" section).

LV25-KIT-05		
 LV25		 LV40

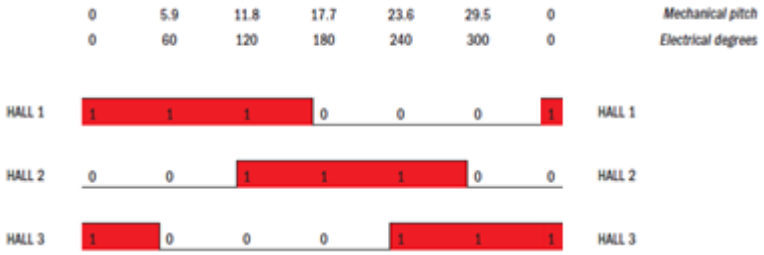
WARNING: Due to the highly magnetic nature of the slider, care must be taken when installing a magnetic encoder. It is possible that the slider will affect the strip or read head resulting in inaccuracies or damage. Therefore, it is necessary to ensure the encoder components are a sufficient distance away from the slider.

4.5 Sensors

Hall sensors

In the same package of the incremental encoder transducer, Gimatic manufactures a sensor with simulated HALL sensors output. This accessory is especially suited for vertical applications where initial movement usually required for the wake and shake procedure is not allowed.

	SE9HALL1
Circuit output	3 HALL
Output signal	Open Collector
Power supply	5 Vdc
Current consumption	25 mA
Working speed	4 m/s
Operating temperature	-40 ÷ +85 °C
Resolution	60°
Pole pitch	35.4 mm
Weight	20 g
Connection	M12, 8 poles
Pin 1 (White)	N/C
Pin 2 (Brown)	+5 Vdc
Pin 3 (Green)	N/C
Pin 4 (Yellow)	HALL 2
Pin 5 (Grey)	N/C
Pin 6 (Pink)	HALL 1
Pin 7 (Blue)	GND
Pin 8 (Red)	HALL 3



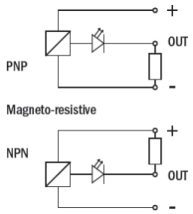
End stop Sensors

End stop sensors, also known as limit switches, are used to prevent motor travel in the case of incorrect behavior. In the event that the motor passes a defined maximum physical position, the end stop sensors will be triggered which can stop and/or disable the motor, minimizing potential damage. In addition to end stop sensors, it is recommended to incorporate end stop bumpers to absorb and stop the movement in the case of over travel. Gimatic can provide both end stop sensors and bumpers, please contact your local area Gimatic's distributor.

Home Sensor

When an incremental encoder is used, the servo drive will not know the absolute position of the motor relative to the machine. To establish the absolute position, it is necessary to move the motor to a known ‘home’ location, often referred to as ‘homing’. The servo drive can be informed that it has reached the ‘home’ location in many ways, the most common being via a proximity switch at one end of travel and/or an index (marker) pulse. Frequently a home sensor is of the same type of end stop sensor. Please contact your local area Gimatic's distributor.

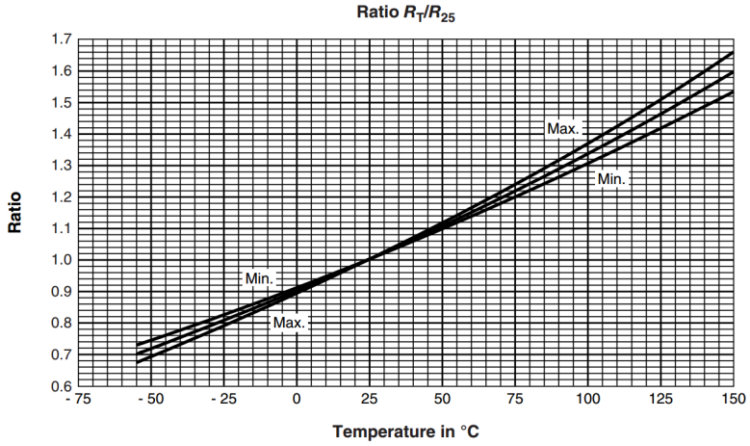
LV linear actuators are provided with special brackets allowing the usage of magnetic proximity switches as end stop and home sensors. Since sliders of LV40 actuators show a much stronger magnetic field respect to LV25 models, inductive proximity switches can also be used for LV40 actuators only that can be mounted using optional brackets. Please refer to the accessories section for models and ordering codes.



Temperature Sensor

The LV embedded motor contains a PTC temperature sensor. At an ambient temperature of 25 °C, the embedded PTC sensor shows a resistance value of 1 kΩ and the sensor increases in resistance as the motor winding temperature increases. When this temperature sensor is employed, the trip temperature should be set no higher than 120 °C. The maximum rated power of the PTC at 70 °C (P70) is 100 mW. Within the temperature range from 20°C to 130 °C, the following equation applies:

T winding [°C] = (Phase resistance [Ω] × 0.216) -190



WARNING: When embedded temperature sensor (PTC) is employed a temperature value of 100 °C must be set as maximum temperature allowed for the stator during driver's programming. This is equivalent to the PTC value less or equal to 1342 Ω (see T winding equation). Whenever PTC connection is not possible a proper I2T parameter has to be set by the user during driver's programming in order to preserve ML stator from permanent damaging.

Operating Environment

The temperature of the operating environment is critical when determining the appropriate actuator model to use. When the motor is producing force, it will produce a temperature rise above ambient. The higher the temperature of the motor operating environment, the hotter the motor will become under the same duty cycle. The motor will also be subject to a temperature related reduction in the force produced.
Therefore, it is important that the motor cooling method be carefully considered. If air-cooling is used, ensure that the motor is well ventilated to limit localized heating. If the motor is liquid cooled, ensure that the coolant and flow rates are sufficient to maintain the motor temperature within operating limits.
It is recommended that the inbuilt temperature sensor (PTC) be monitored to prevent the motor exceeding absolute temperature limits.

5 SPECIFICATIONS

5.1 Electrical

	LV25050-70	LV25100-70	LV25150-70	LV25200-70
Stroke [mm]	50	100	150	200
Mass of parts fixed to the slider [g]	560	670	850	1050
Total mass [g]	1170	1380	1825	2185
BUS peak voltage [Vdc]	72			
Max Continuous Force [N]	25		42	
Max Continuous Current [A]	2.0		2.1	
Peak Force [N]	97.8		105.6	
Peak Current [A]	7.7		5.2	
Force constant [N/Arms]	12.7		20.3	
Back EMF constant [Vs/m]	11.6		18.2	
Resistance [Ω] @25 [°C]	4.8		7.1	
Inductance [mH]	1.2		1.9	
Thermal resistance [°C/W]	2.2		1.2	

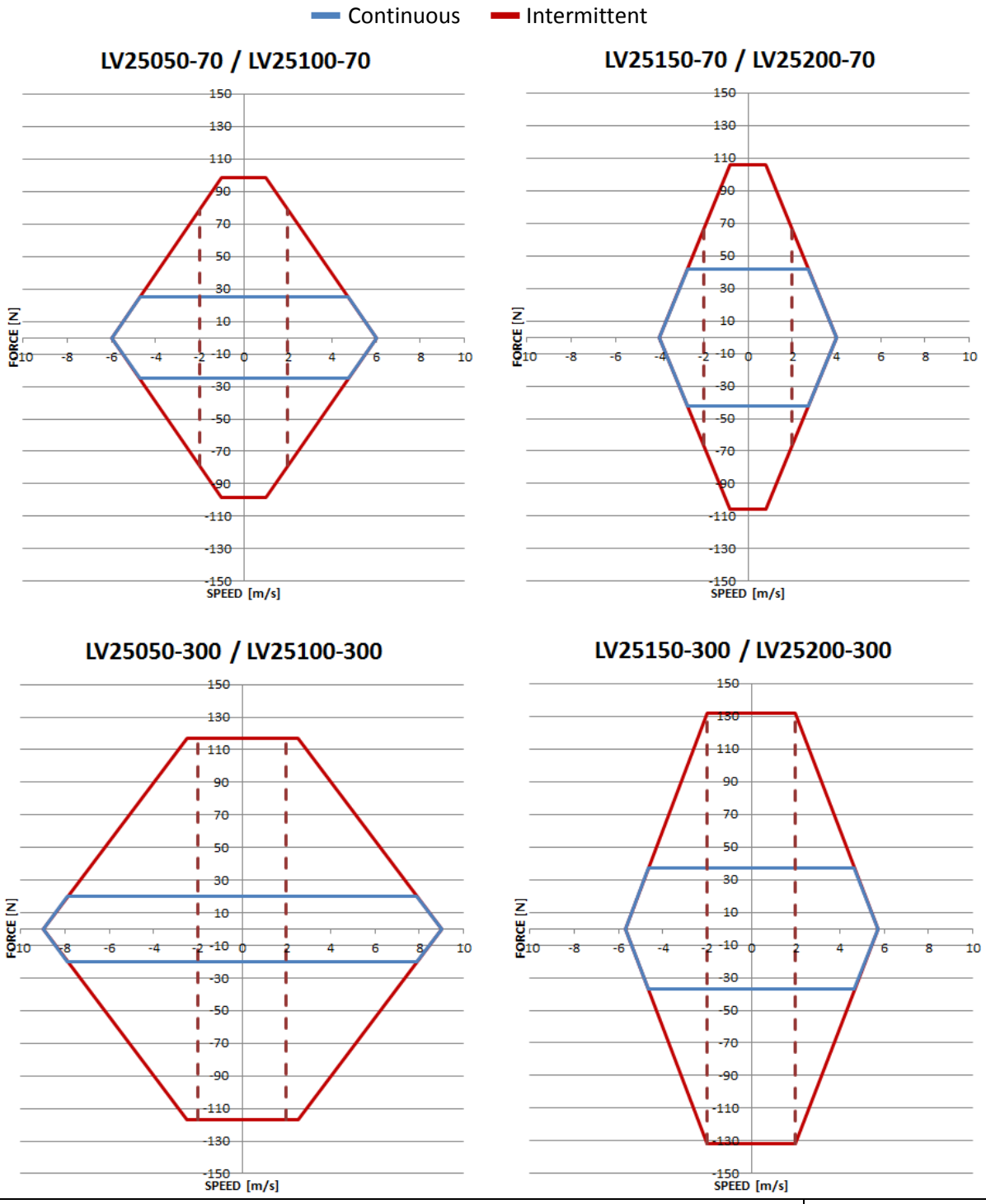
	LV25050-300	LV25100-300	LV25150-300	LV25200-300
Stroke [mm]	50	100	150	200
Mass of parts fixed to the slider [g]	560	670	850	1050
Total mass [g]	1170	1380	1825	2185
BUS peak voltage [Vdc]	325			
Max Continuous Force [N]	20		37	
Max Continuous Current [A]	0.6		0.6	
Peak Force [N]	106.7		131.7	
Peak Current [A]	3.1		2.1	
Force constant [N/Arms]	34.4		62.7	
Back EMF constant [Vs/m]	36.3		57.7	
Resistance [Ω] @25 [°C]	48.6		77.5	
Inductance [mH]	11.2		20.5	
Thermal resistance [°C/W]	2.5		1.5	

	LV40050-70	LV40100-70	LV40150-70	LV40200-70
Stroke [mm]	50	100	150	200
Mass of parts fixed to the slider [g]	1350	1840	2150	2420
Total mass [g]	2730	3590	4430	4865
BUS peak voltage [Vdc]	72			
Max Continuous Force [N]	58		83	
Max Continuous Current [A]	4.3		4.0	
Peak Force [N]	258		294	
Peak Current [A]	19		14.2	
Force constant [N/Arms]	13.6		20.7	
Back EMF constant [Vs/m]	12		17.5	
Resistance [Ω] @25 [°C]	1.8		2.6	
Inductance [mH]	0.7		1.1	
Thermal resistance [°C/W]	1.3		1.0	

	LV40050-300	LV40100-300	LV40150-300	LV40200-300
Stroke [mm]	50	100	150	200
Mass of parts fixed to the slider [g]	1350	1840	2150	2420
Total mass [g]	2730	3590	4430	4865
BUS peak voltage [Vdc]	325			
Max Continuous Force [N]	57		71	
Max Continuous Current [A]	1.2		1.0	
Peak Force [N]	421		412	
Peak Current [A]	8.8		5.8	
Force constant [N/Arms]	47.8		71.1	
Back EMF constant [Vs/m]	41		62	
Resistance [Ω] @25 [°C]	19.1		28.9	
Inductance [mH]	9.08		13.25	
Thermal resistance [°C/W]	1.6		1.4	

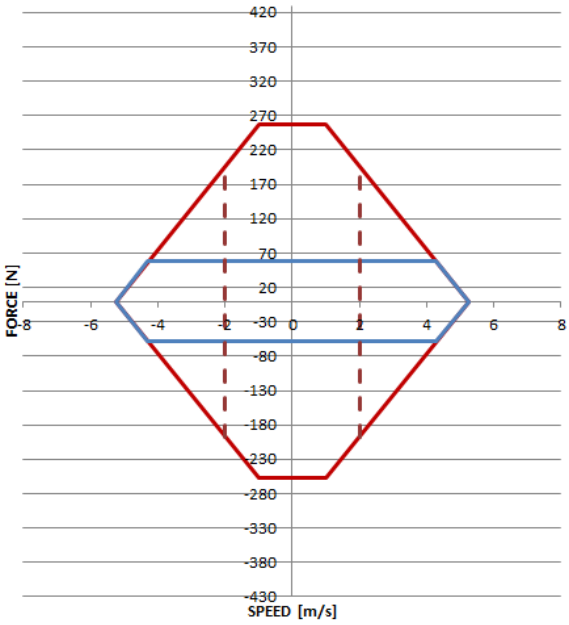
5.2 Operative fields

The following graphs show the operative field of LV linear actuators, that is all the possible operation points of the actuator only. The internal portion defines the motor's continuous operation area and shows the conditions that enable the actuator to operate for an indefinite period of time. The remaining portion shows the conditions that enable the actuator to operate for short periods of time only. According to the general sizing criteria, the load's characteristic curve should be entirely included in the intermittent area and the operation point (rms point) should be inside the continuous area. For 10 milion cycles maintenance-free operations the maximum speed value of 2 m/s should not be exceeded.

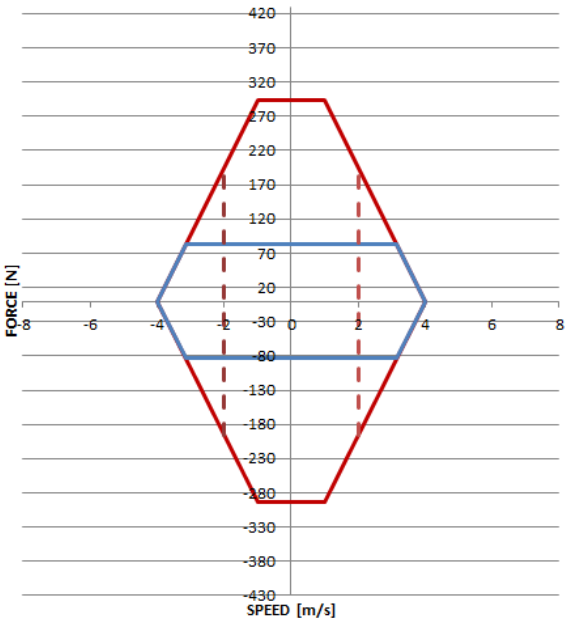


Continuous Intermittent

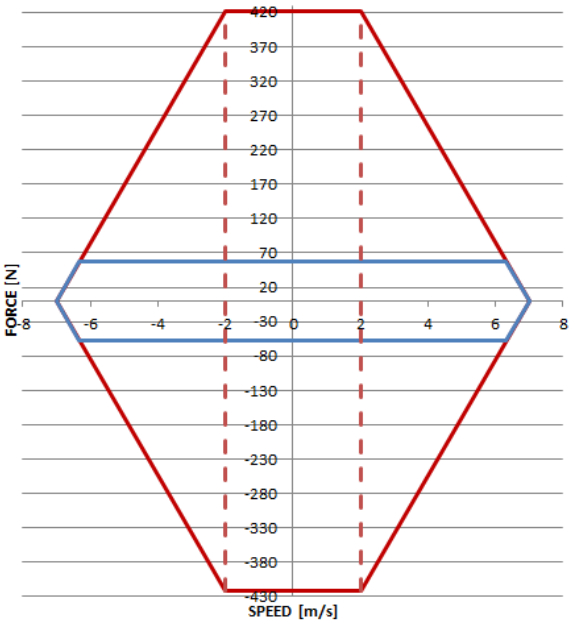
LV40050-70 / LV40100-70



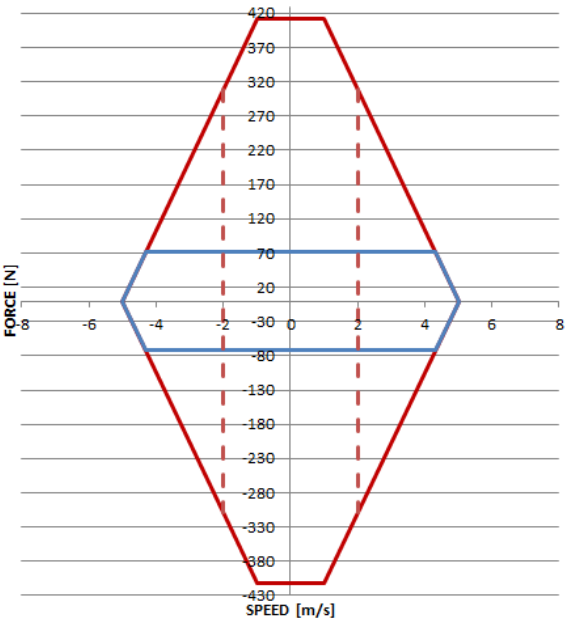
LV40150-70 / LV40200-70



LV40050-300 / LV40100-300

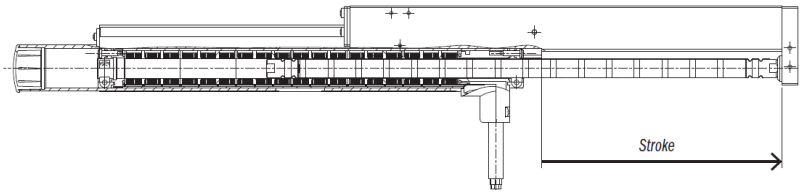


LV40150-300 / LV40200-300



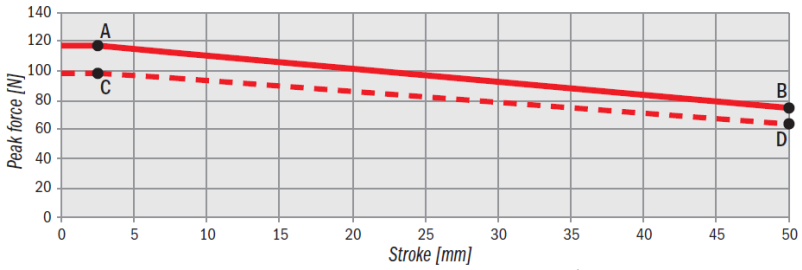
5.3 Static thrusts

The maximum thrust the linear actuator can exert depends on the slider portion inserted in the motor. The following graphs show the variation of the maximum force that can be exerted by the motor under static conditions.



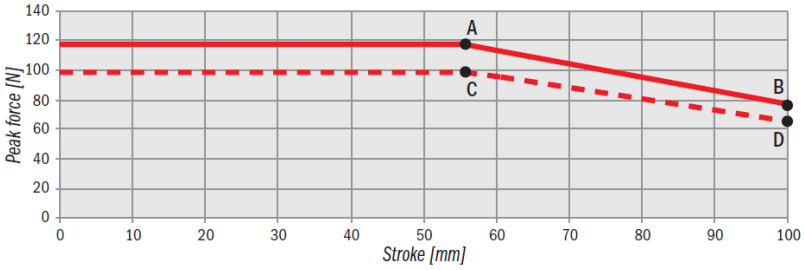
LV25050-300
LV25050-70

	Force	Stroke
A	117 N	2.5 mm
B	74.3 N	50 mm
C	98.1 N	2.5 mm
D	63.1 N	50 mm



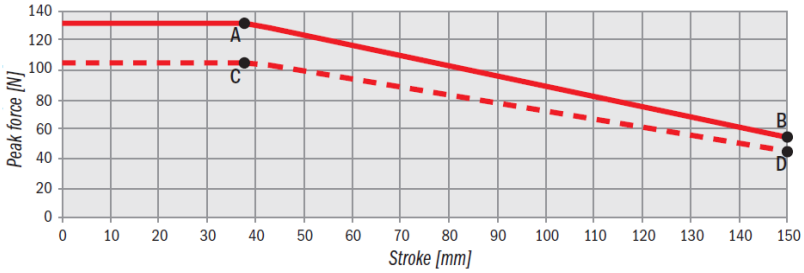
LV25100-300
LV25100-70

	Force	Stroke
A	117 N	55.5 mm
B	77 N	100 mm
C	98.1 N	55.5 mm
D	65.3 N	100 mm



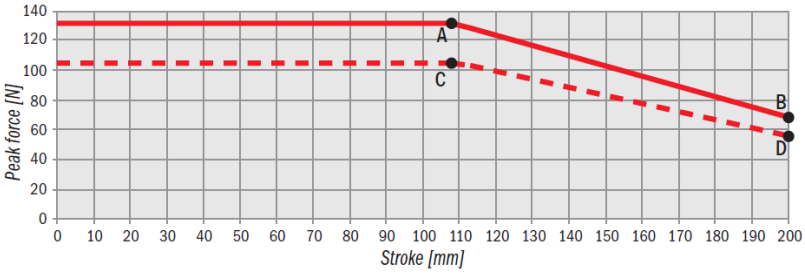
LV25150-300
LV25150-70

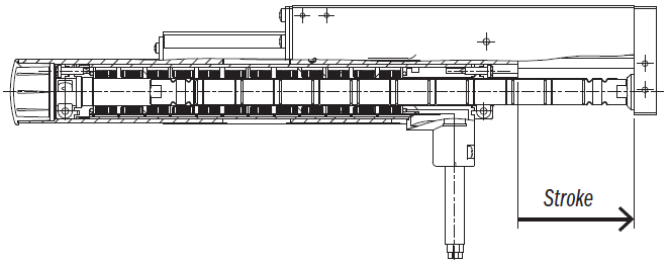
	Force	Stroke
A	131.6 N	37.7 mm
B	54.4 N	150 mm
C	105.4 N	37.7 mm
D	45 N	150 mm



LV25200-300
LV25200-70

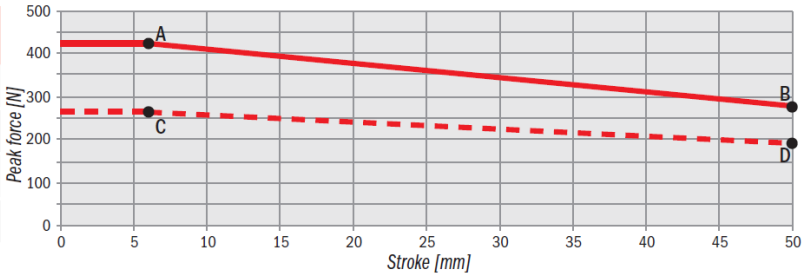
	Force	Stroke
A	131.6 N	107.7 mm
B	68.1 N	200 mm
C	105.4 N	107.7 mm
D	55.7 N	200 mm





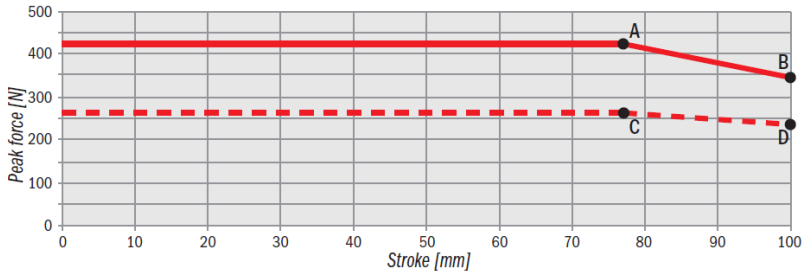
LV40050-300
LV40050-70

	Force	Stroke
A	421 N	6 mm
B	277 N	50 mm
C	258 N	6 mm
D	189 N	50 mm



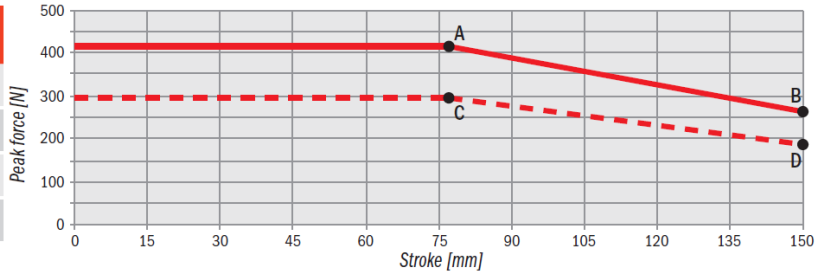
LV40100-300
LV40100-70

	Force	Stroke
A	421 N	77 mm
B	346 N	100 mm
C	258 N	77 mm
D	236 N	100 mm



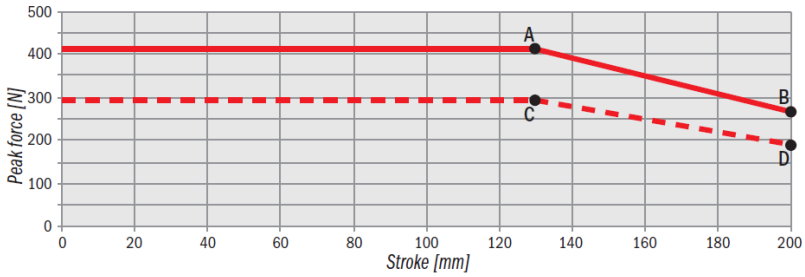
LV40150-300
LV40150-70

	Force	Stroke
A	412 N	77 mm
B	260 N	150 mm
C	294 N	77 mm
D	185 N	150 mm

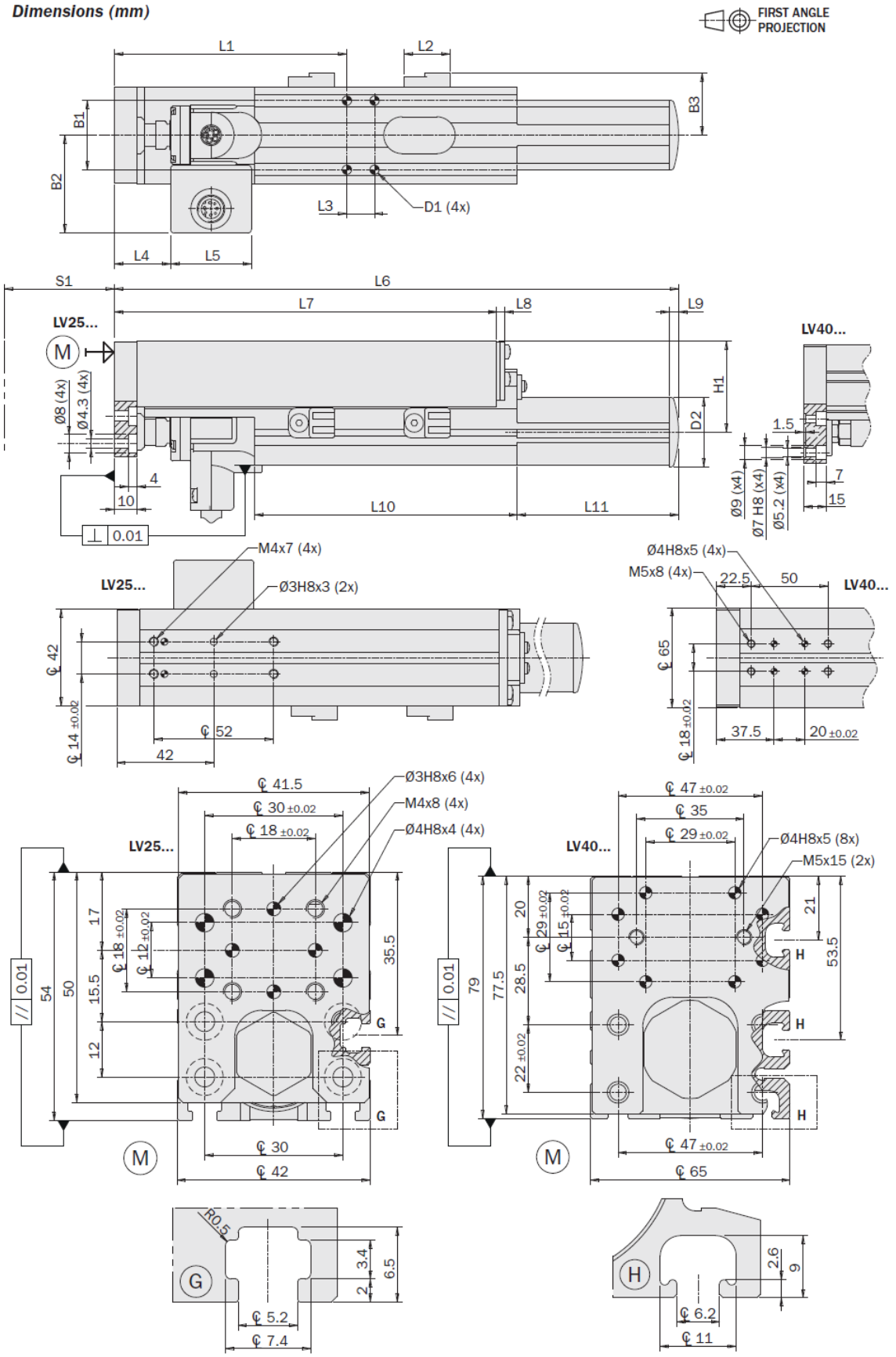


LV40200-300
LV40200-70

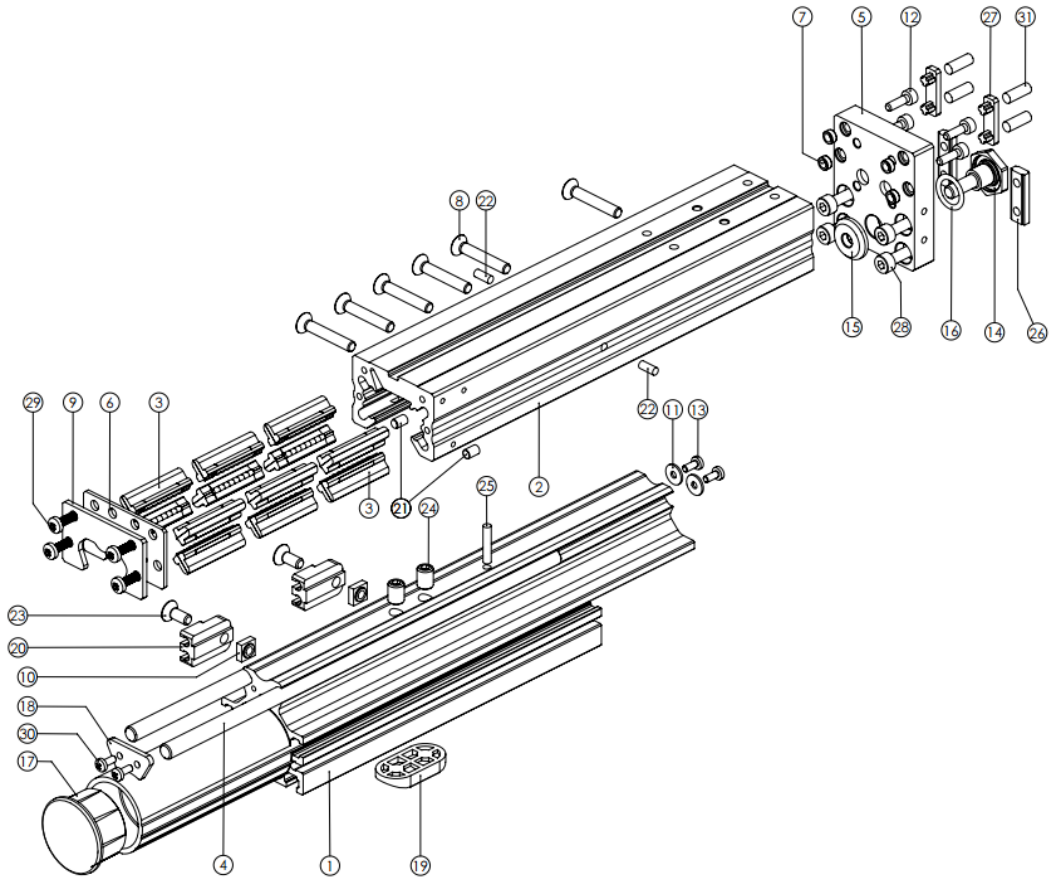
	Force	Stroke
A	412 N	130 mm
B	266 N	200 mm
C	294 N	130 mm
D	190 N	200 mm



5.4 Mechanical



		LV25050-...	LV25100-...	LV25150-...	LV25200-...	LV40050-...	LV40100-...	LV40150-...	LV40200-...
B1	±0.02	30	30	30	30	29	29	29	29
B2		42.5	42.5	42.5	42.5	48.5	48.5	48.5	48.5
B3		27	27	27	27	38.5	38.5	38.5	38.5
L1		101	101	101	101	95	95	95	95
L2		20	20	20	20	15	15	15	15
L3	±0.02	12	12	12	12	29	29	29	29
L4		24.5	24.5	24.5	24.5	47.5	47.5	47.5	47.5
L5		35	35	35	35	35	35	35	35
L6		245	296	349	419	275	335	406	460
L7		166	206	285	364	159	251	301	351
L8		3.5	3.5	3.5	3.5	4	4	4	4
L9		4	4	4	4	5	5	5	5
L10		114	154	233	312	87	179	229	279
L11		70	81	55	46	105	73	94	98
H1		39.5	39.5	39.5	39.5	66.5	66.5	66.5	66.5
D1		Ø4 H8	Ø4 H8	Ø4 H8	Ø4 H8	Ø4 H8	Ø4 H8	Ø4 H8	Ø4 H8
D2		Ø30	Ø30	Ø30	Ø30	Ø45	Ø45	Ø45	Ø45
S1		50	100	150	200	50	100	150	200

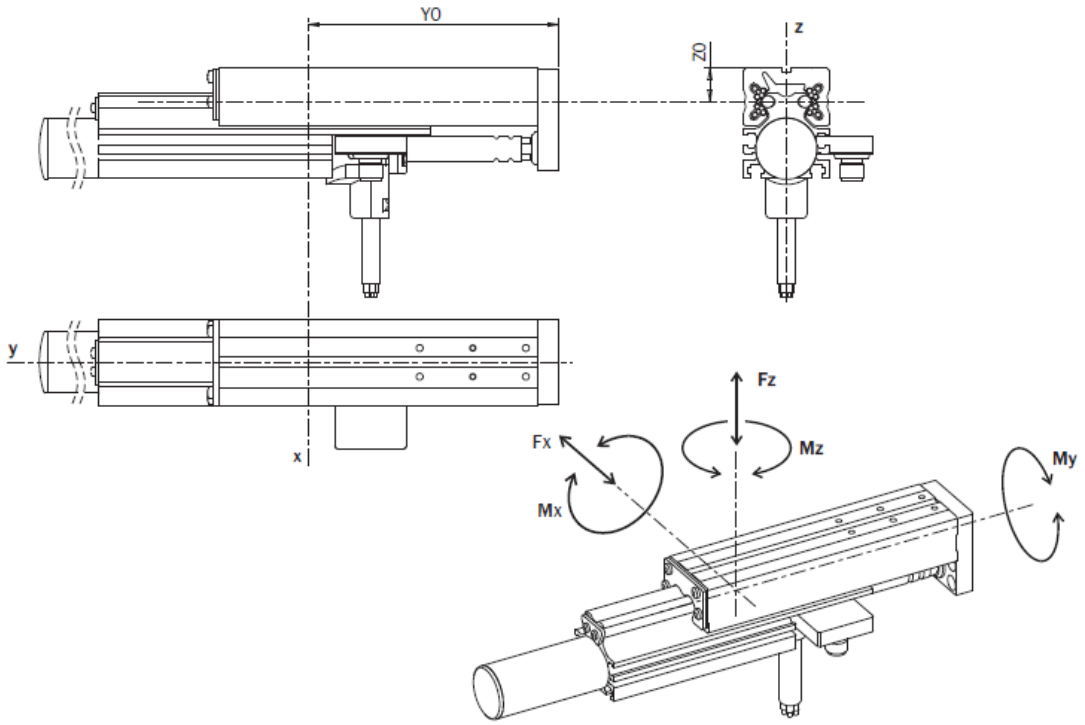


5.5 Safety loads

Excessive loads can damage the linear unit and cause functioning troubles. The dimensions Y0 and Z0 identify the centre of the linear bearing (dimensions measured under conditions of maximum opening).

Fx s, Fz s, Mx s, My s, Mz s are maximum permitted static loads.
Fx d, Fz d, Mx d, My d, Mz d are maximum permitted dynamic loads.

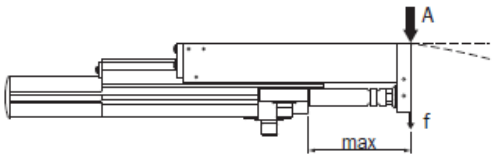
The static loads can be applied when the carrier is motionless, the dynamic loads when the carrier is running. The dynamic load represents the limit load at which actuators are tested with 1 million full opening and closing cycles.

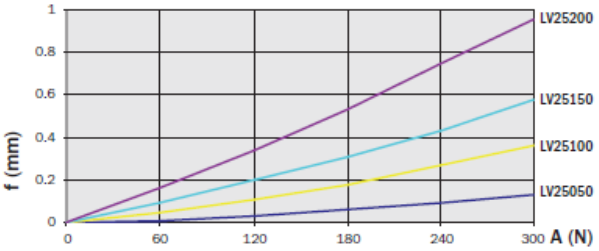


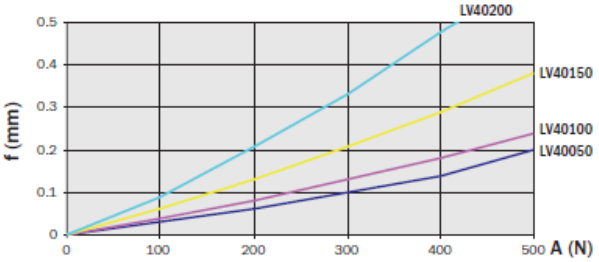
	LV25050	LV25100	LV25150	LV25200	LV40050	LV40100	LV40150	LV40200
Zo	16.5 mm	16.5 mm	16.5 mm	16.5 mm	21 mm	21 mm	21 mm	21 mm
Yo	122.5 mm	162.5 mm	227 mm	291.5 mm	107 mm	178 mm	228 mm	278 mm
Fx s	120 N	120 N	160 N	200 N	160 N	250 N	250 N	250 N
Fz s	120 N	120 N	160 N	200 N	160 N	250 N	250 N	250 N
Mx s	19 Nm	19 Nm	28 Nm	36 Nm	24 Nm	56 Nm	56 Nm	56 Nm
My s	11 Nm	11 Nm	14 Nm	18 Nm	20 Nm	30 Nm	30 Nm	30 Nm
Mz s	19 Nm	19 Nm	28 Nm	36 Nm	24 Nm	56 Nm	56 Nm	56 Nm
Fx d	60 N	60 N	80 N	100 N	80 N	120 N	120 N	120 N
Fz d	60 N	60 N	80 N	100 N	80 N	120 N	120 N	120 N
Mx d	3.8 Nm	3.8 Nm	5.6 Nm	7.2 Nm	6 Nm	14 Nm	14 Nm	14 Nm
My d	2.2 Nm	2.2 Nm	2.8 Nm	3.6 Nm	5 Nm	8 Nm	8 Nm	8 Nm
Mz d	3.8 Nm	3.8 Nm	5.6 Nm	7.2 Nm	6 Nm	14 Nm	14 Nm	14 Nm

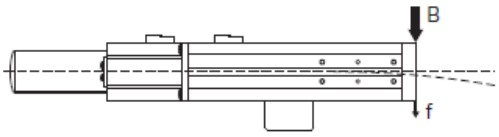
5.6 Deflection

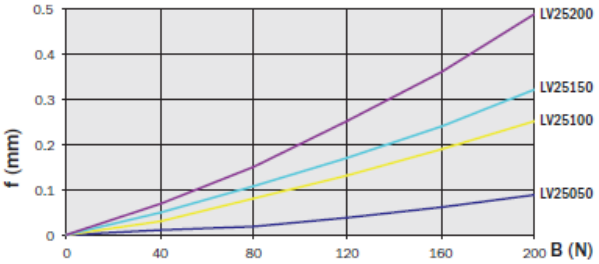
The graphs show the deflection f (mm) in the three directions shown, as a function of forces A, B or C and the stroke of the slide.

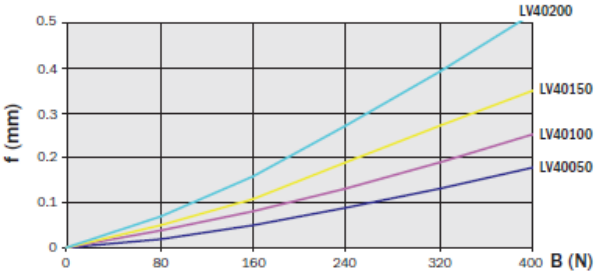


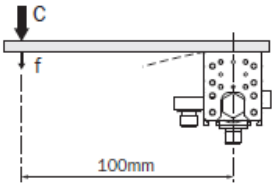


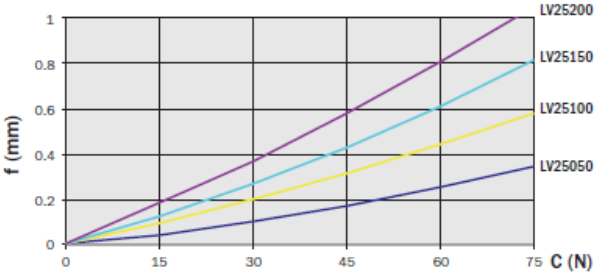


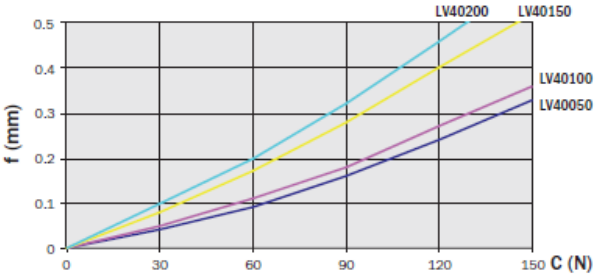












6 INSTALLATION

6.1 Unpacking

WARNING: Tubular motor shafts contain powerful permanent magnets. People with a pacemaker, AICD or similar medical devices should maintain a minimum distance of 30 cm from the shaft

WARNING: The shaft emits a very strong magnetic field. Always use caution when handling. To avoid injury, keep fingers and other body parts clear.

Before unpacking commences, wait for the actuator to reach room temperature to prevent condensation. Once at room temperature, remove protective packaging from the device. Due to the magnetic nature of the slider, it is recommended that protective material around the slider be left on as long as possible during installation. During installation, ensure that the actuator is kept on a clean surface away from any other magnetic and ferrous materials.
If the slider is to be left unattended, precautions should be taken to prevent accidents or damage due to its strong magnetic field. All personnel involved in transporting, storing, installing and/or maintenance of the actuator must be made aware of the potential hazards involved.

6.2 Mechanical

WARNING: Surface temperatures of up to 80°C can be present during operation of the LV system. Allow the actuator to cool before touching the LV.

WARNING: Always isolate the motor from the electrical supply. The motor could move unexpectedly and present a crushing hazard.

WARNING: The shaft emits a very strong magnetic field. Always use caution when handling. To avoid injury, keep fingers and other parts clear.

Due to the strong magnetic nature of the slider, proximity to magnetic parts and items sensitive to magnetic fields must be considered at all times. It is recommended that nonmagnetic packing material be used when adjusting the actuator to prevent the slider being attracted to any magnetic parts e.g. ferromagnetic brackets.

6.2.1 Linear encoder

Third party encoders should be installed according to the encoder manufacturer's instructions. Care should be taken with the sensitive electronics of the encoder near the strong magnetic field of the slider. Particular care should be taken with magnetic encoders as close proximity to the slider could cause inaccuracies or damage. Installing the encoder at a minimum distance of 150 mm from the slider is recommended.
The positive and negative directions of the linear encoder need to be correctly aligned to the direction of motor movement.
The direction of the encoder can be adjusted in multiple ways:
1. mechanical orientation of the encoder;

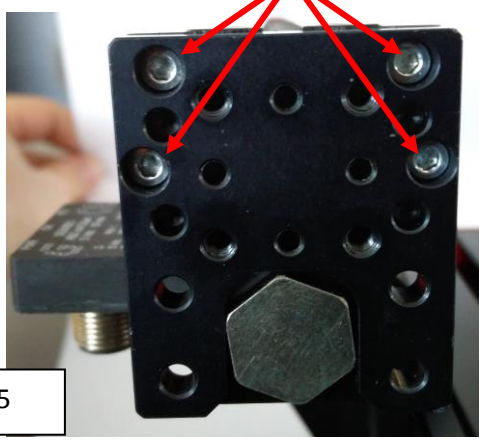
2. electrical wiring between the encoder and servo drive (on an incremental encoder, inversion of one of the quadrature signals is sufficient);

3. software configuration on the servo drive.

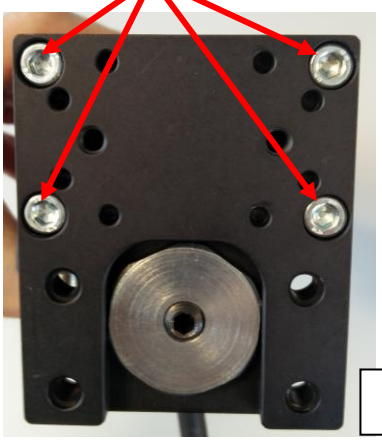
In case of first installation or replacement of Gimatic's position transducers and/or sensors (SE9 series), please refer to the following steps:

- disconnect the power supply of both the motor and the transducer to replace (if present);
- indentify the cover at the cable output side of the motor (step 1 of the following schema);
- remove the 4 frontal screws and extract the slider from the carriage of LV (see following images);
- remove the fixing screws of the cover (step 2 of the following schema);
- eventually remove defective transducer (step 2 of the following schema);
- check the model of the new transducer (i.e. read the text printed on the transducer itself);
- insert the new transducer in the motor's groove (step 3 of the following schema);
- re-mount the cover and all the 3 fixing screws (step 4 of the following schema);
- re-insert the slider into the carriage of LV and fix it with the 4 frontal screws;
- reconnect and power on the transducer only;
- check the presence of the power supply (i.e. green fixed light);
- in the case a red fixed light is present two different situations may occur:
    - the installed transducer is defective (in this case replace the transducer with another one or contact your local area support);
    - the transducer is not in front of the slider (be sure the slider is installed).
- move the moving part of the motor back and forth several times along the whole stroke (this operation is necessary in order to let the transducer identify the strength of the slider's magnetic field).

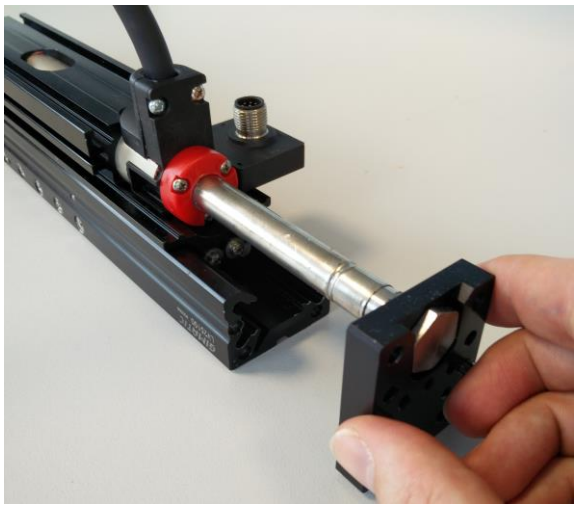
Remove these screw to extract the slider from the carriage

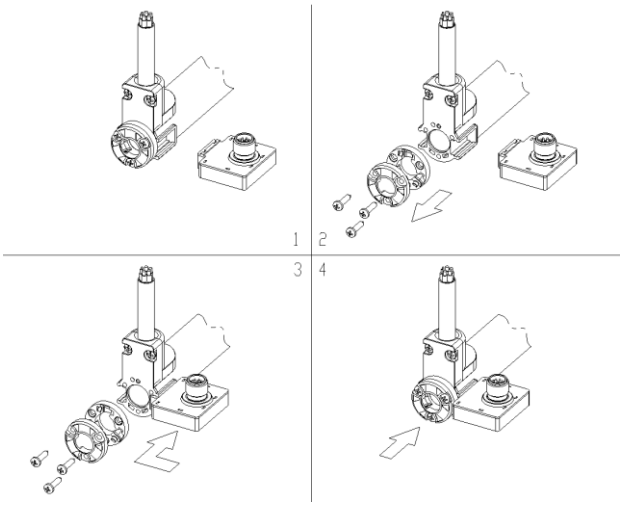


LV25



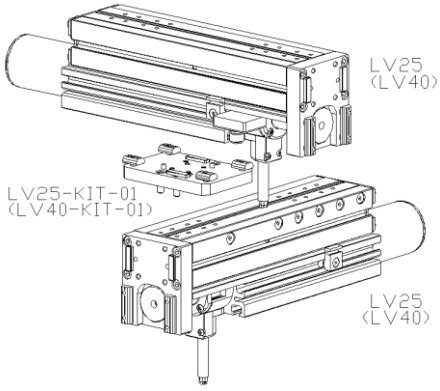
LV40

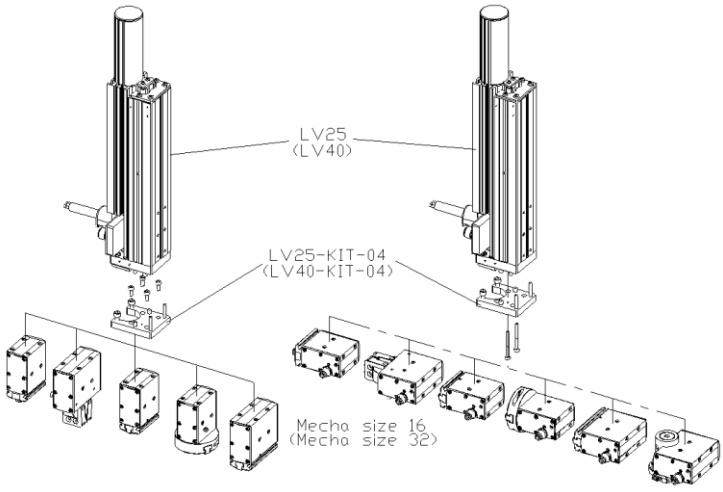


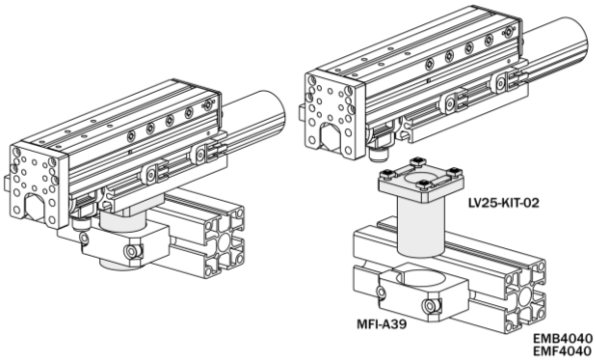


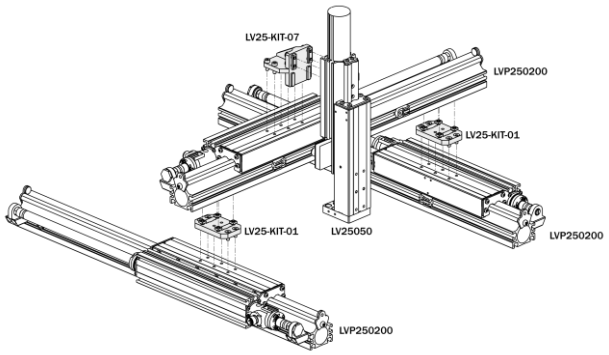
6.2.2 Mounting examples

Several mounting interfaces are available to connect LV actuators with other LV units, LVP guides, gripping and rotating devices of Gimatic's Mechatronics series. An overview on some mounting solutions is summarized here in the following pictures but many others are possible. Please refer to the accessories section for a complete list of available interfaces and ordering codes.





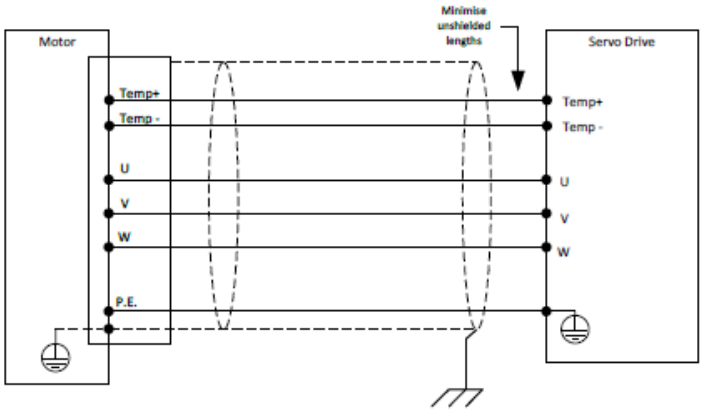




6.3 Electrical

DANGER HIGH VOLTAGE: Ensure power has been completely disconnected before touching electrical connections. Electrical shock can cause serious or fatal injury.

6.3.1 Motor power and temperature feedback



DANGER: The actuator must be grounded to prevent the possibility of electric shock during motor operation.

Any Gimatic's ML motor is provided with a 30 mm log flying cable output. The power supply and temperature signal cable can be directly connected to a servo drive by means of an extension cable and either EN175000 7-pole circular connectors (for 70 V BUS voltage) or M23 6 pole circular connectors (for 325 V BUS voltage). Male connector should be used for the motor side while female connector should be used for the extension cable side. The 30 mm cable must be fixed respect to the stator in order to avoid fatal stress to the cable output while the extension cable can be used in dynamic conditions eventually in combination with cable carriers. Please refer also to the "Accessories" section and to the servo drive documentation for further information on how to wire in the motor power supply and temperature sensor.

6.3.2 Sensors

Connect the sensors, such as home switches and dead stops, to be used to the servo drive as specified in the sensor and servo drive documentation.

6.3.3 Electromagnetic Compatibility (EMC)

While the ultimate responsibility for a system's EMC compliance lies with the system builder, the LV design provides good EMC performance as a system component.
The following are general recommendations when using the LV actuator to minimize Electromagnetic Interference (EMI) in the system.

- Keep all cable routing as short and direct as possible;
- Separate low voltage signal cables from power cables and noisy components.
- Ensure cable shielding is terminated correctly.
- Other sources of EMI in the system, such as servo drives, must also be considered for EMC, refer to component documentation for further information.

6.4 Servo Drive Configuration

In general, servo drives will need the following configuration to control the ML motor. Servo drives that do not specifically support linear motors can be configured as a 2-pole rotary motor. Configuration requirements will depend on the specific servo drive and linear encoder used; refer to product documentation for specific information.

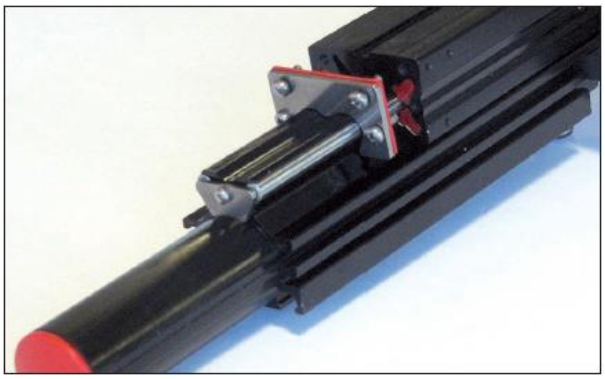
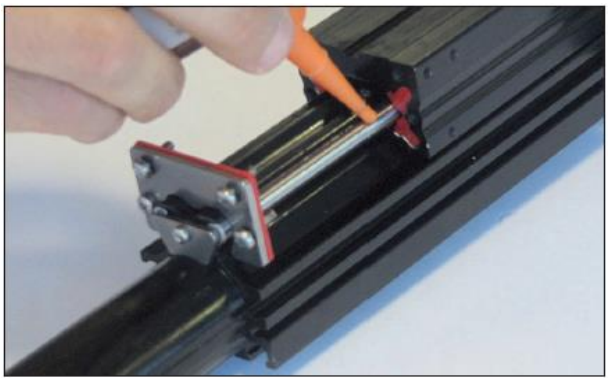
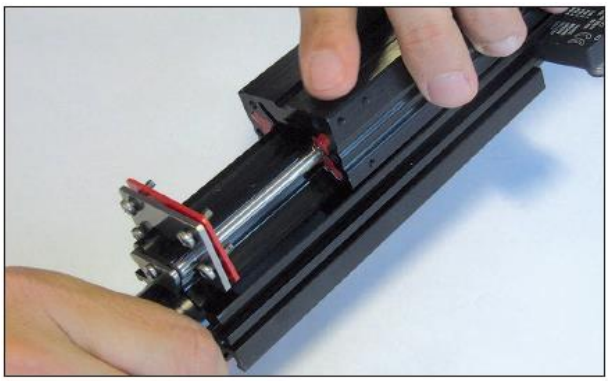
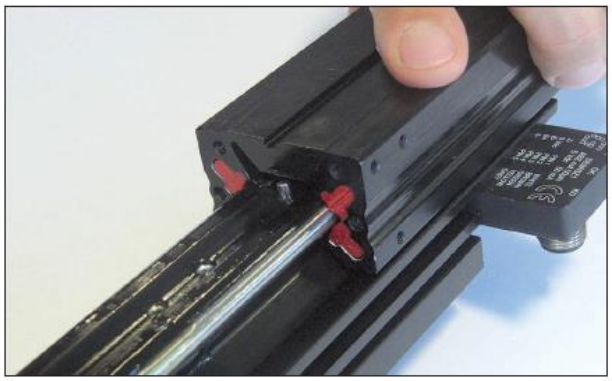
Parameter	Units	Linear Motor	Linear as Rotary Motor
Motor Type	-	Linear	Rotary
Distance between magnet poles	Distance or encoder counts	As per motor specification	As per motor specification
Number of Motor Poles	Integer	-	2
Rotary encoder pulses per revolution	Encoder counts/lines	-	$\frac{\text{Magnet Pitch}}{\text{Linear Encoder Pitch}}$
Linear encoder pitch	Distance	As per encoder specification	-
Peak Current	Amps	As per motor specification	As per motor specification
Continuous Current	Amps	As per motor specification	As per motor specification

7. MAINTENANCE

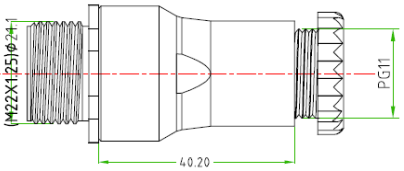
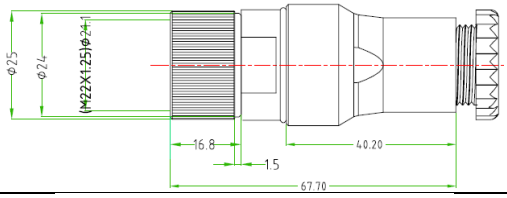
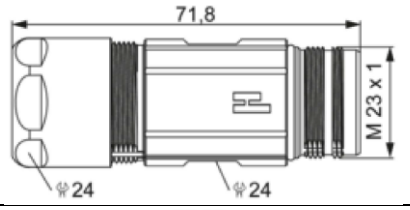
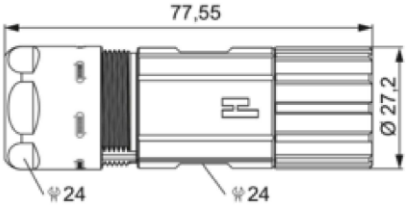
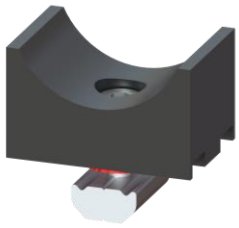
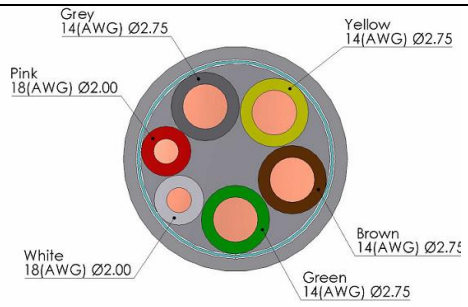
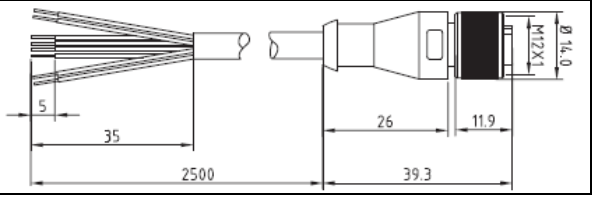
LV linear actuator requires very little maintenance. However, the following activities are recommended for periodic maintenance.

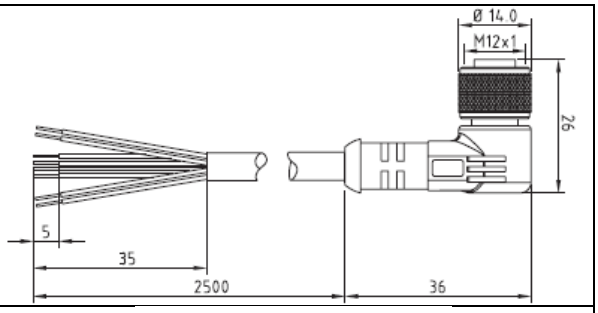
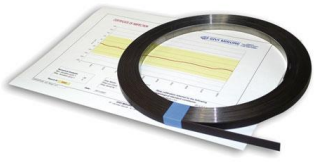
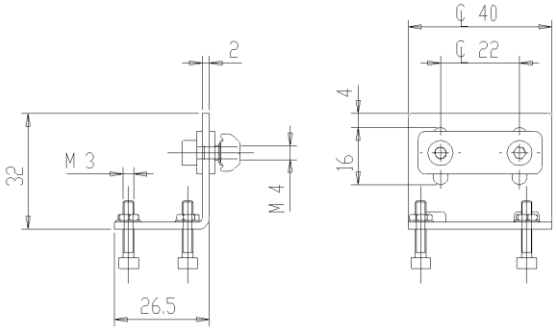
- Ensure the stator can move freely over the entire stroke.
- Clean any accumulated debris from the slider.
- Check the slider deflection is within specification.
- Ensure all parts are secured.
- Check cables for signs of wear or damage.

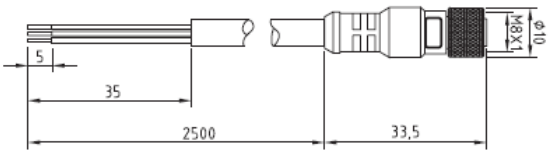
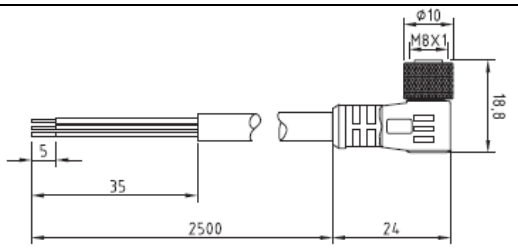
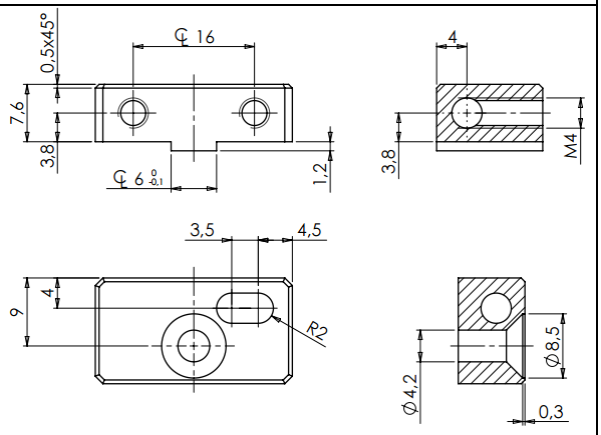
A smooth motion of LV actuators relies not only on linear motor but on recirculating ball bearings as well. Periodically check the steel bars and lubricate when dry. Eventually adjust ball bearing preload acting on dedicated adjustment screws. Please refer to the following procedure for lubrication operation.

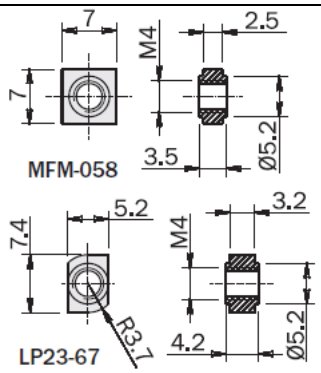
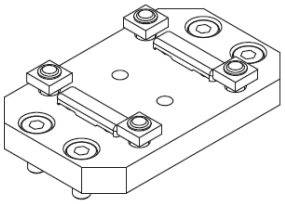
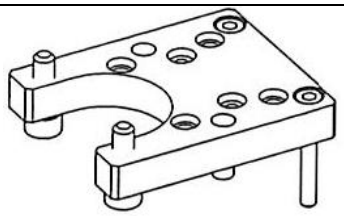
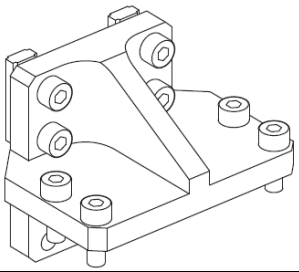
	Remove the protection metal plate.
	Lubricate the steel bars.
	Move the carrier to distribute the lubricant in the ball bearings.
	Pay attention not to drive the carrier out of the guide.

8. ACCESSORIES

Part Number	Description	Image
CMGM2200700	Cabling connector EN175000, 7 poles, male version (motor side) for 72 Vdc BUS voltage. Weight 55 g.	
CFGM2200700	Cabling connector EN175000, 7 poles, female version (extension cable side) for 72 Vdc BUS voltage. Weight 55 g.	
CMGM2300600	Cabling connector M23, 6 poles, male version (motor side) for 325 Vdc BUS voltage. Weight 85 g.	
CFGM2300600	Cabling connector M23, 6 poles, female version (extension cable side) for 325 Vdc BUS voltage. Weight 105 g.	
LV25-KIT-16	Bracket for fixing EN175000 and M23 connectors to LV frame.	
SPZ-6P-090T-02500 SPZ-6P-090T-05000 SPZ-6P-090T-10000	Cable 4x 14(AWG)+2x18(AWG) + Drain Wire (19x0.15) UL STYLE 20234 for ML and dynamic applications. Specific weight 127 g/m.	
CFGM1200825P	Cabling connector M12, 8 poles straight for connection of SE series transducers, with 2.5 m pig tailed cable output.	

CFGM1290825P	Cabling connector M12, 8 poles 90 degrees for connection of SE series transducers, with 2.5 m pig tailed cable output.	
MPS24-8.4 MPS24-13	Power supply unit series SP with universal AC input and 24 Vdc output (available with 8.4 A and 13 A as nominal current) by MeanWell®.	
DRV300IN040IP080	Driver TomCat TMC240 4/8 (for ML25300 and ML40300).	
DRV070IN100IP200	Driver DGFox 60-10-20 (for ML2570 and ML4070).	
SEXT20SIN020	External linear position transducer series MTV M2KC 528VS M02/N SC by Givi Misure®.	
SEXT20BAND015	External magnetic strip 1.5 m long for linear position transducer series MP200 + stainless steel cover CV103 by Givi Misure®.	
LV25-KIT-05	LV25 and LV40 mounting interface for external transducers.	

SN4N225-G SN4M225-G SS4N225-G SS4M225-G	Magnetic proximity switches (N for PNP and M for NPN output) with 2.5 m pig tailed cable output.	
SN3N203-G SN3M203-G SS3N203-G SS3M203-G	Magnetic proximity switches (N for PNP and M for NPN output) with 0.3 m cable output length and M8 connector.	
CFGM800325P	Cabling connector M8, 3 poles straight for connection of magnetic proximity switches, with 2.5 m pig tailed cable output.	
CFGM890325P	Cabling connector M8, 3 poles 90 degrees for connection of magnetic proximity switches, with 2.5 m pig tailed cable output.	
SI4N225-G SI4M225-G	Inductive proximity switches Ø4 mm (N for PNP and M for NPN output) with 2.5 m pig tailed cable output.	
LV40-KIT-16	Mounting bracket for inductive proximity switches SI series (only for LV40).	
LV25-KIT-50 LV25-KIT-100 LV25-KIT-150 LV25-KIT-200	Spring compensator for weight counterbalance on LV25 actuators.	
LV40-KIT-100 LV40-KIT-150 LV40-KIT-200	Spring compensator for weight counterbalance on LV40 actuators.	

MFM-058 LP23-67	T-nuts for LV slots.	
LV25-KIT-01 LV40-KIT-01*	LV over LV/LVP mounting interface plate.	
LV25-KIT-04 LV40-KIT-04*	LV head interface.	
LV25-KIT-07 LV40-KIT-07*	LV over LV/LVP angular mounting interface plate.	

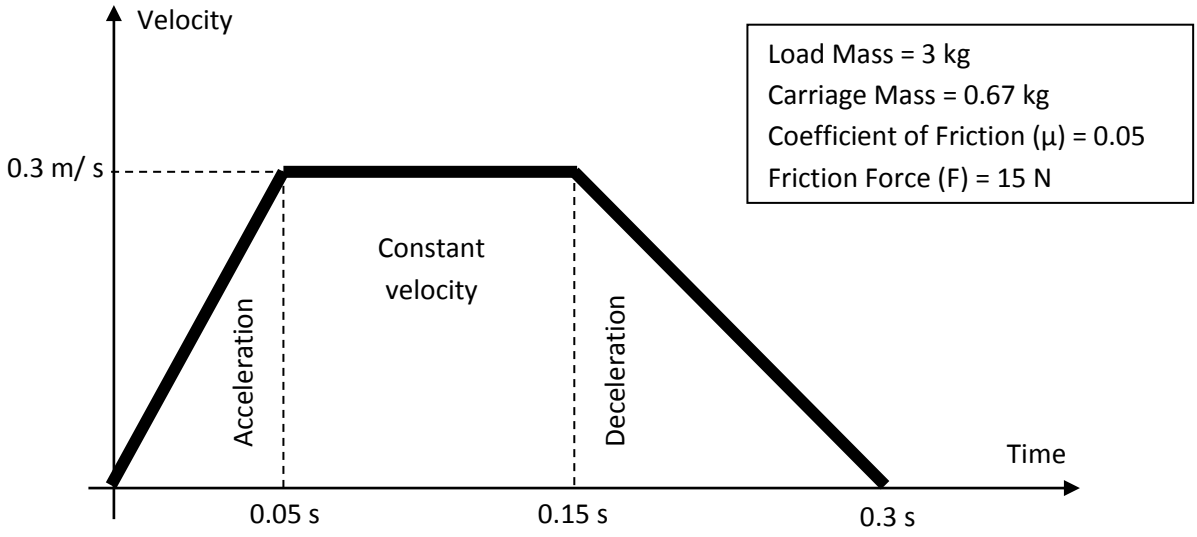
(*) Under development.

For a complete and up to date list of accessories, please refer to Gimatic's website *www.gimatic.com*

9. APPENDIX

9.1 Application continuous force calculation example

The following example demonstrates calculation of a LV25100-70 duty cycle for a simple horizontal positioning movement with a trapezoidal velocity profile. The profile is broken up into sections i.e. acceleration, constant velocity and deceleration in order to determine the RMS force and duty cycle.



Positioning example velocity profile

In this example, friction is taken as a combination of the Coefficient of Friction (μ) and a constant force.

$$Friction = \mu \times Mass \times g + F = 0.05 \times (3\ kg + 0.67\ kg) \times 9.81\frac{m}{s^2} + 15 \cong 16.8\ \text{N}$$

Referring to the previous picture, the positioning move can be broken down into the following segments:

Acceleration

$$Force = Mass \times Acceleration + Friction$$

$$= (3\ kg + 0.67\ kg) \times \frac{0.3\ m/s}{0.05\ s} + 16.8\ N$$

$$\cong 38.8\ N$$

Constant Velocity

$$Force = Friction = 16.8\ N$$

Deceleration

$$Force = Mass \times Acceleration - Friction$$

$$= (3\ kg + 0.67\ kg) \times \frac{0.3\ m/s}{0.15\ s} - 16.8\ N$$

$$\cong -9.5\ N$$

Other application forces must also be taken into consideration such viscous and external forces; however, for the sake of simplicity, they will be ignored in this example.

Force RMS

$$Force = \sqrt{\frac{F1^2 \times T1 + F2^2 \times T2 + F3^2 \times T3}{T1 + T2 + T3}}$$

$$= \sqrt{\frac{38.8^2 \times 0.05 + 16.8^2 \times 0.1 + (-9.5)^2 \times 0.15}{0.3}} \cong 19.8\ N$$

This motion can be cyclically actuated by Gimatic's LV25100-70 motor because the value of the calculated force RMS is lower than the maximum continuous (19.8 N << 25 N), that the maximum force required is lower than the motor's peak force (38.8 N << 98.1 N) and the maximum speed is lower than the maximum speed suggested for the 10 milion cycles maintenance-free operation (0.3 m/s << 2 m/s).

9.2 Duty cycle calculation

The duty cycle of a linear motor is defined in terms of power usage and can be used to determine whether the application RMS current (i_{rms}) is too high for the chosen stator. A total duty cycle less than 100% is required to keep the linear motor within its specifications. Exceeding 100% duty cycle could result in damage to the motor.

$$Duty\ Cycle\ (\%) = \left(\frac{i_{rms}}{i_{continuous}}\right)^2 \times 100\%$$

10. SERVICE ENQUIRIES

10.1 Main application data

In order to properly size an actuator for a specific application, the following information should firstly be collected:

- Required stroke
- Duration of the motion cycles
- Orientation of the motion (horizontal or vertical)
- Movement condition (continuous or intermittent)
- Mass of the load
- External axial force profile as a function of the working cycle
- External transversal forces
- Environment temperature
- Type of the Fixation of the stator (i.e. flange)
- Required positioning resolution
- Nominal supply voltage
- Required environmental degree of protection

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