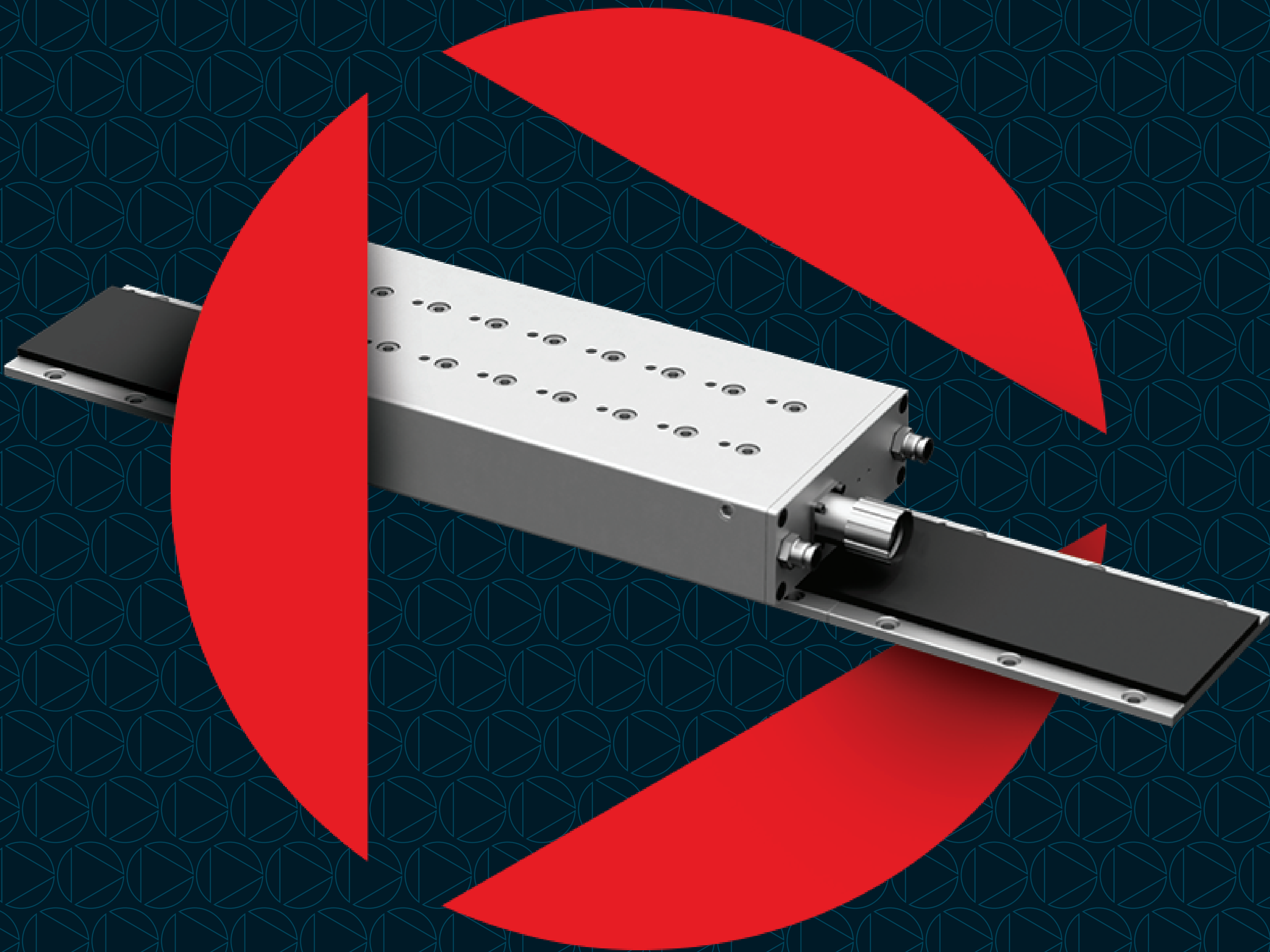


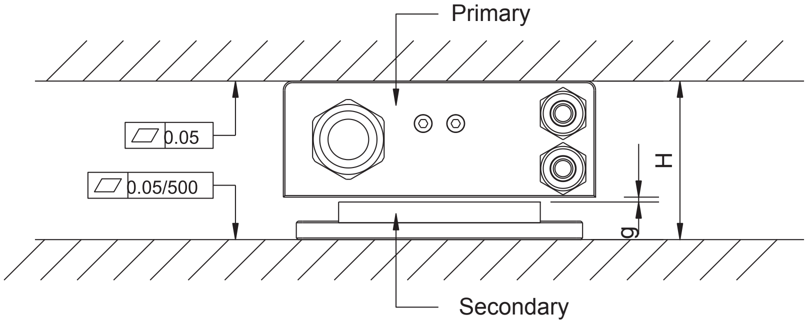
LINEAR MOTORS

PRODUCT INFORMATION

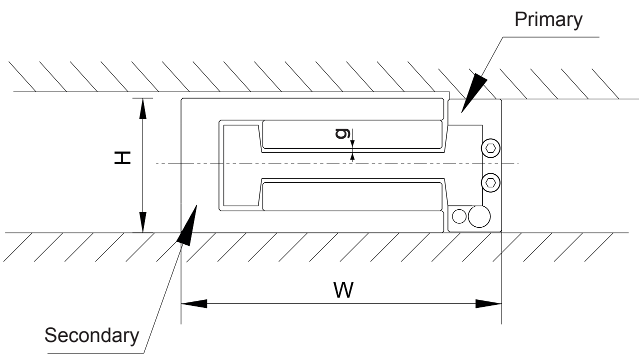
INFRANOR
MOTION EXCELLENCE

LINEAR MOTORS

HEIGHT DIMENSIONS FOR LINEAR MOTOR ASSEMBLY MOUNTING



Flat plate with iron core	Series	H (+0.1/-0.1) mm	gmm	mm Polar distance
Plate water-cooled	DLMF-01W	48.5	1±0.1	30
	DLMF-01CW	43.2	0.8±0.1	48
	DLMF-01DW	43.2	0.8±0.1	24
	DLMF-03W	78	0.6±0.1	48
	DLMF-03BW	64.1	1±0.2	46
	DLMF-04W	66.1	1±0.2	46
	DLMF-04CW	60.6	1±0.1	32
	DLMF-04DW	60.6	1±0.1	32
	DLMF-05W	81	1.5±0.2	48
	DLMF-06W	43.2	0.6±0.1	26.4
	DLMF-08W	64.1	0.8±0.2	32
	DLMF-09W	64.1	0.8±0.2	32
	DLMF-10W	64.1	1±0.2	46
	DLMF-11W	66.1	1±0.2	46
	DLMF50-W	61.1	0.8±0.2	32
	DLMF100-W	61.1	0.8±0.2	32
	DLMF200-W	84.1	0.8±0.2	32
Plate natural-cooled	DLMF-01	34	0.6±0.1	30
	DLMF-02	34	0.6±0.1	30
	DLMF-03	36	0.6±0.1	30
	DLMF-**G01	42	0.6±0.1	36
	DLMF-**G02	42	0.8±0.1	36
	DLMF-**G03	34.3	0.8±0.1	32
	DLMF-**G04	34.3	0.8±0.1	32
	DLMF-**G05	61.1	1±0.1	42
	DLMF-**G06	61.1	1±0.1	42



	Series	H (±0.1) mm	w (±0.1) mm	g (±0.1) mm	mm Pole Width
DLMU-Series	DLMU-01	14.8	51.2	1.1	16.5
	DLMU-02	35.5	68.5	1.15	60
	DLMU-03	39	93	1	60
	DLMU-04	50	122	1.1	84

START SELECTING MOTOR

The following sections describe how to select the appropriate motor based on the requirements of speed, acceleration, stroke, load, and so on. The basic process for the selection work is as follows:

/01 Determine motion planning and set motion parameters

/02 Maximum thrust and continuous thrust calculations

/03 Select the appropriate motor

Use Symbols	
	X：Stroke(mm)
	T：Move Time(sec)
	a：Acceleration(mm/s^2)
	V：Speed(mm/s)
	Ml：Load(kg)
	g： Acceleration of gravity(mm/s^2)
	F_p：Transient thrust(N)
	F_c：Continuous thrust(N)
	F_a：(LMS，LMF）(N) Primary/Secondary inter-stage attraction (for LMS, LMF series)
	F_i：Inertial thrust(N)
	Kf：Thrust constant(N/Arms)
	I_p：Transient curren(Arms)
	I_e：Equivalent current(Arms)
	I_c：Continuous current(Arms)
	V0：Start Speed(mm/s)

STEP/01

Determines motion planning and motion parameters

In order to determine correctly which motor is suitable for the user's needs, it is necessary to understand the calculation of the following motion formula before selecting it.

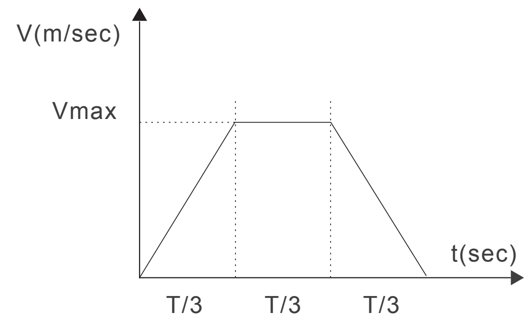
MOTION FORMULA Common basic kinematic equations are described below: $V=V_0+aT$ $X=V_0 T+1/2\ aT^2$

It's V is speed, a is acceleration, T is move time, X is move distance.
Users can select any two of the four variables (V,a,T and X) as design values, the remaining two variables can be calculated from the above formula.

SPEED PLANNING

1) 1/3-1/3-1/3 (Trapezoid profile)

If the stroke (X) and move time (T) are given first, the most common and effective speed planning method, i.e., 1/3-1/3- 1/3 trapezoidal profile point-to-point motion planning method, can be adopted, because it can provide an optimal motion mode with minimum power. The planning mode is to divide the acceleration section, constant velocity section and deceleration section into three equal phases, and the velocity curves are as follows:



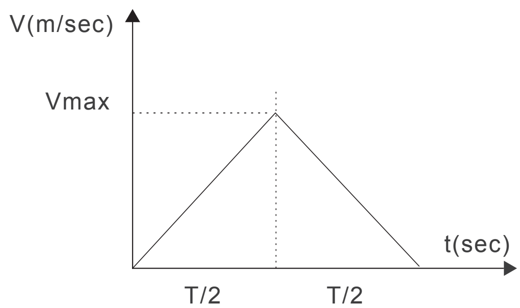
$V_{max}=1.5\times X/T$(Because$X=$
$V/2\times T/3+V\times T/3+V/2\times T/3$)

$a_{max}=V_{max}/(T/3)=4.5X/T^2$

The parameter definitions used herein are identical to those described in the motion formula.

2) 1/2-1/2 (Triangle profile)

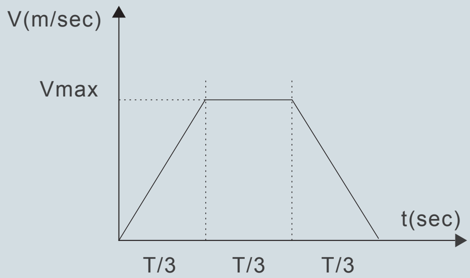
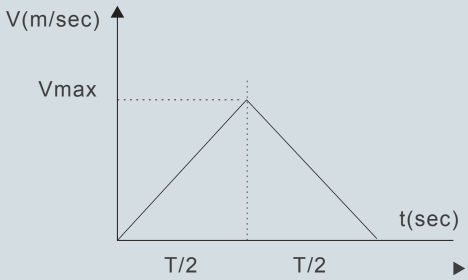
If X and T is given first, another commonly used motion planning method is 1/2-1/2 Triangle Profile. The planning mode is divided into two parts: acceleration and deceleration. The velocity curves are as follows:



$V_{max}=2\times X/T$ $a_{max}=4X/T_2$

The acceleration calculated by the first motion planning Trapezoid profile is greater than that calculated by the second motion planning Triangle profile, so the first motion planning typically requires a larger thrust motor. The second plan results in a smaller motor, but because its maximum speed V_max will be relatively large, it needs to be confirmed that the DC bus is large enough.

COMMON FORMULA

	1/3-1/3-1/3 (Trapezoid profile)	1/2-1/2 (Triangle profile)
		
V	$1.5\times X/T$	$2\times X/T$,or $\sqrt{(a\times X)}$
a	$4.5X/T^2$	$4X/T^2$

STEP/02

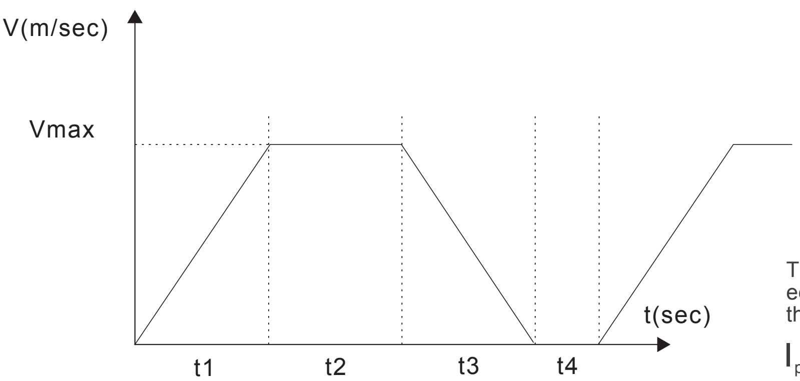
Calculation of instantaneous thrust and equivalent thrust

The calculation of the instantaneous thrust can be carried out by the following formula:

$$F_p = M_L \times a_{max} + (M_L \times g + F_a) \times \mu = F_i + F_f$$

Where Fi it is the inertial thrust and Ff friction thrust, and μ is the coefficient of friction. In most use cases, the motion is usually periodic point-to-point motion. Assuming a periodic motion, where t4 is the residence time after the motion is complete, the equivalent thrust of the periodic motion is calculated as follows:

$$Fe = \sqrt{(F_i+F_f)^2 t_1 + F_f^2\, t_2 + (F_i-F_f)^2\, t_3)/(t_1+t_2+t_3+t_4)}$$



The corresponding instantaneous current I_p and equivalent current I_e can be calculated by substituting the motor thrust constant into the following formula.

$$I_p = F_p/K_f \quad I_e = F_e/K_f$$

STEP/03

Selects the motor from the instantaneous thrust demand and confirms the drive current

The motor specifications in the Dake sample allow the user to select the appropriate motor based on the instantaneous thrust requirements, after which the user can calculate to confirm whether the required supply current is within the specification limits after the motion planning.

$I_p=F_p/K_f<I_p$ $I_p=F_p/K_f<I_p$ (Motor specifications for check and selection)

Users should consider the ratio of the equivalent current to the continuous current(Ie/Ic), which is usually set to be safer within 0.7.

Examples of motor selection

For example, assuming that a total load is 580 kg, a friction coefficient is μ of 0.01, a stroke is 800 mm, a move time is 0.9 S, and a residence time is 0.1 S. First, we can calculate these four variables (V_{max}、 a_{max}、 F_p and F_e), and in this case, we can choose the first motion plan, so it is calculated as follows:

* V_{max} (Maximum speed V_{max} is)：

  $V_{max}=1.5\times\ X/T=1.5\times0.8/0.9=1.333(m/sec)$

* a_{max}(Maximum acceleration a_{max} is)：

  $a_{max}=4.5\ X/T^2=(4.5\times0.8)/(0.9)^2=4.444(m/sec^2)$

* F_p (Instantaneous thrust F_p is)：

$$F_p=(M_L+Mg)\times a_{max}+(M_L\times g+F_a)\times\mu$$
$$=(580+25.5)\times4.444+(580\times9.8+11700)\times0.01$$
$$=2690.842+173.84=2864.682(N)$$

* (Equivalent thrust F_e is)：

$$F_e=\sqrt{\frac{(F_i+F_f)^2t_1+F_f{}^2t_2+(F_i-F_f)^2t_3}{t_1+t_2+t_3+t_4}}$$

$$=\sqrt{\frac{[(2690.842+173.84)^2+173.84^2+(2690.842-173.84)^2]\times0.3}{0.9+0.1}}$$

$$=2090.832(N)$$

* I_p(Instantaneous current I_p is)：

$$I_p=\mathrm{F_p}/\mathrm{K_f}=2864.682/171.5=16.704(A)$$

* I_e(Equivalent current I_e is)：

$$I_e=\frac{F_e}{K_f}=\frac{2090.832}{171.5}=12.191(A)$$

* The ratio of the equivalent current to the continuous current is:

$$\mathrm{I_e}/\mathrm{I_c}=12.191/17.5=0.697<0.7$$

Therefore, the linear motor model DLMFP-0403W is selected to meet the motion demand.

Why we use linear motors and what are the advantages compared with ball screws?

Linear motors driven directly can reduce the number of parts of positioning system, reduce the mechanical complexity and improve the reliability.

The speed of linear motors is faster than traditional axis drives, and the longer the stroke, the more advantageous the linear motor is. Because the stator of the linear motor is designed in the mode of modules, it can be infinitely connected with the module, so the stroke is basically unlimited. When ball screw stroke is long, it may have the problem of sagging.

Linear motors have no backlash problem because they are driven directly.

What's the fastest speed? What's the slowest speed?

The acceleration and deceleration caused by load and motor thrust are the key to high-speed motion besides the effect of stroke. In fact, it can run up to 4M/s, which is not a problem in terms of tested experience. But we must consider the slideway, wiring groove and other periphery matches.

There are essentially no special limits to low-speed motion, and there is basically no problem running several micron per second as long as the drive control device supports it.

How much acceleration can it reach?

At present, the acceleration thrust of large linear motors can reach 3~5g, and the thrust of small linear motors can reach10g.

Motor heating problem

When the motor is running, there will be heat generation, which has been optimized in the design stage. If the motor runs at the design current value or increases or decreases its running speed, the heat generation of the motor can meet the design requirements, and there will be no serious heating problems.

If there is a short-term large current demand in the process of maximum thrust or acceleration/deceleration, the heating problem of the motor must be considered at this time, and only instantaneous operation or short-term operation is allowed, then the time of pause motion must be added; otherwise the motor will have the problem of excessive heating.

How much load can it reach?

The motor provides the thrust source in the positioning system, and the load weight mainly depends on the acceleration demand. According to F=am, when the thrust is constant, the higher the acceleration required, the smaller the load mass must be, and vice versa. In practice, the greater the mass of the sliding rail or air bearing, the greater the load on them, which will increase the friction between the sliding rail and the block, so there is no unified answer as to this question, engineers can be consulted for specific applications.

What stroke can it reach?

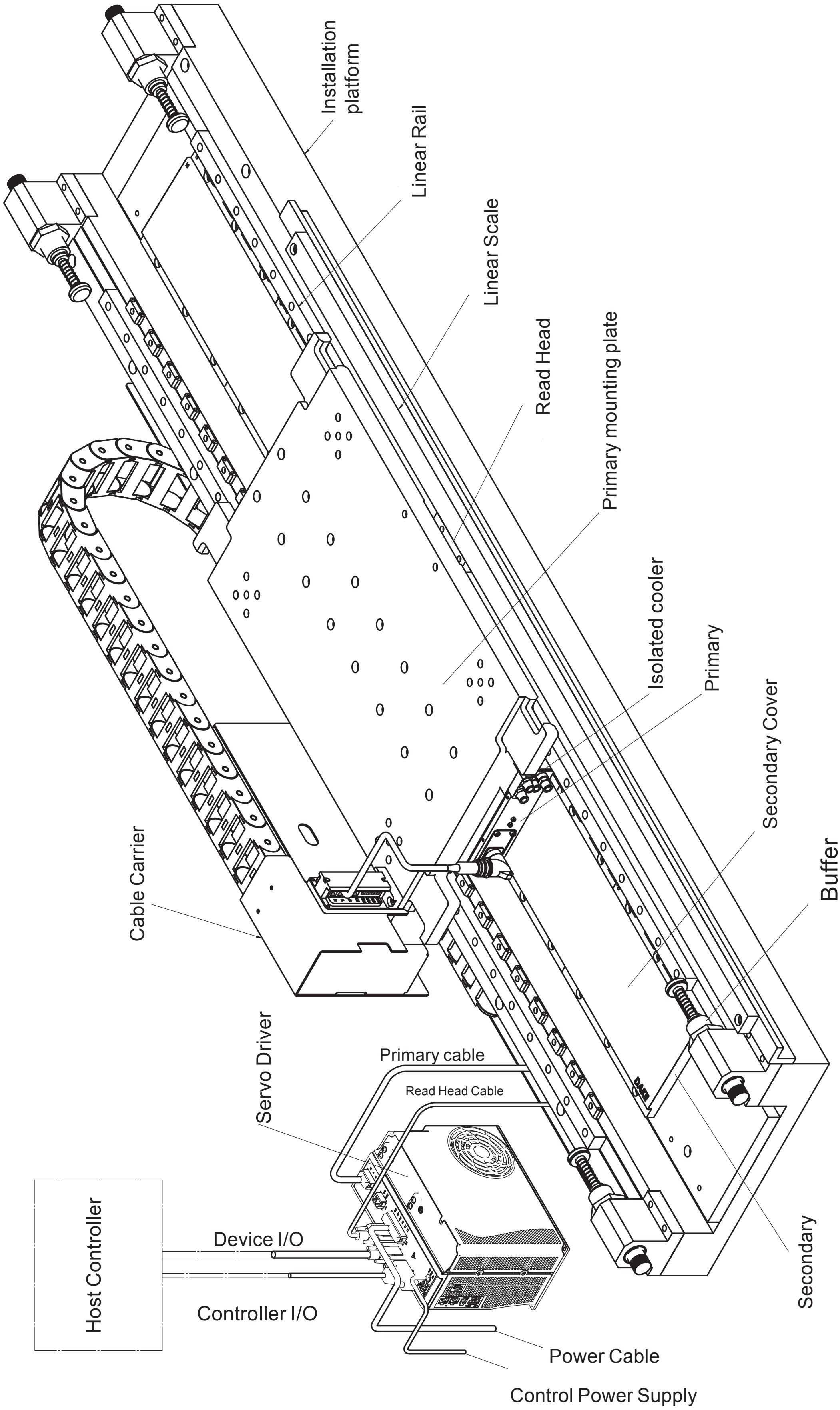
Theoretically, the stroke is not limited, and the stator can be infinitely prolonged by means of modular splicing. But the practical application is limited by other factors such as cable, signal feedback device and so on.

What determines the accuracy and repetition accuracy?

Resolution of position feedback devices. 1MICRON digital optical ruler is the most commonly used, and 0.1MICRON digital optical ruler can also be selected. The higher the resolution, the higher the positioning accuracy. Generally, the positioning accuracy is within + /-0.05 mm, and the repetitive positioning accuracy is within + / -0.02 mm.

COMPOSITION DIAGRAM

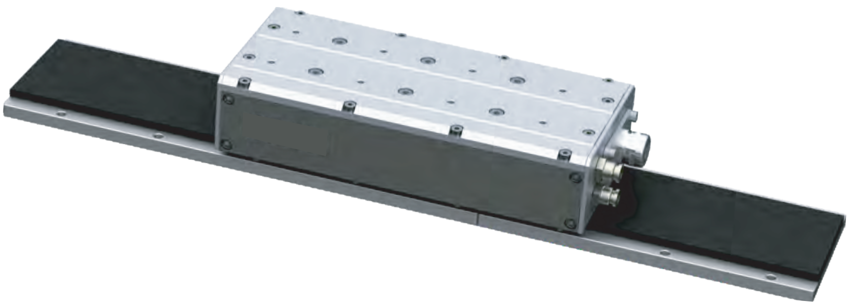
Direct drive motion servo system composition diagram



LINEAR MOTORS

The rise of the linear motor to the new standard in high- and ultra-precision technology

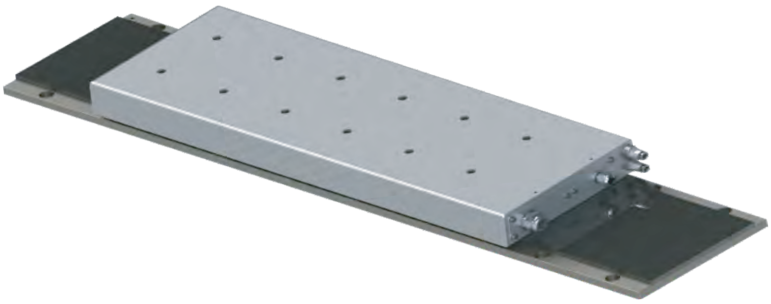
NC machine tools are developing towards high precision, high speed and high intelligence. The requirements of precision and high speed machining put forward higher requirements for the traditional transmission and its control system. For example: In the PCB industry, as the array of PCB substrates becomes more and more complex and huge, there are stringent performance requirements for PCB drilling rigs, mainly embodied in the following: The hole spacing decreases, the hole diameter decreases, the hole density increases, and the drilling efficiency improves.
In order to achieve higher dynamic characteristics and control accuracy, higher feed speed and acceleration, lower vibration, noise and less wear. By eliminating the intermediate links between the motor and the working parts, the concept of "zero drive", which drives the final working part directly by the motor, is gradually being promoted in the market.
With the development of linear motors in recent years, permanent magnet linear synchronous motors (PMLSM), which is nearly the ideal feed transmission mode, has gradually replaced the traditional rotating motors, and has got rapid development. It breaks the traditional transmission mode of "rotating motor + ball screw" and realizes "zero transmission".
Compared with the traditional screw drive, the DLMF-Series linear motor has the characteristics of high speed and high precision. Its stroke is prolonged with the secondary array, but the precision and servo performance will not be degraded at all. At the same time, as there are no mechanical parts for primary and secondary motor, the motor is easy to realize “maintenance-free”. Acceleration is large and noise is small.



DLMF-Series permanent magnet linear motors belong to plate linear motors with iron core. Its continuous thrust covers 0.2-4KN, and its peak thrust range covers 1-12KN. It is widely used in precision numerical control machining centers, gantry systems, laser machining equipment, PCB equipment and other industrial application fields.

An Application Example of PCB Drilling Machine

The PCB Drilling Machine is a device for the drilling and milling of printed circuit boards. Now 6-axis and 4-axis drilling machines are the most popular. The key performance indicators of the PCB drilling machine are drilling speed, positioning accuracy and repeat positioning accuracy, which means hole location accuracy CPK that is reflected in the drilling quality. As PCB drilling machine equipment supplier, upgraded its existing 6-axis drilling machine to improve its equipment competitiveness.
At the request of the customer: "The X-axis load of the equipment is about 500KG, and the Y-axis load is about 650KG. It is hoped that the fast-moving speed of both axes can reach 60m/min and the acceleration can reach 1G to improve the efficiency; meanwhile, the repeated positioning accuracy reaches 0.003mm to improve the hole location accuracy CPK." Our linear motor and drive is adopted to achieve high-speed and high-precision positioning. DLMF-0403W permanent magnet linear motor is selected for X-axis, while the DLMF-0404W permanent magnet linear motor is selected for Y-axis.



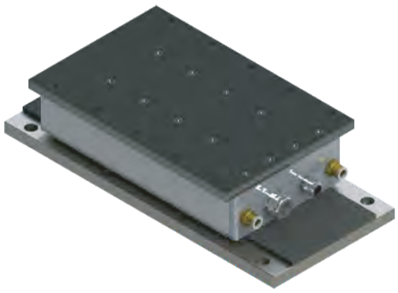
DLMF-0403W

Achieved effects

Stroke	The X-axis 100mm,The Y-axis 650mm
Thrust	The X-axis has a continuous thrust of 3000N, with a peak thrust of 8000N The X-axis has a continuous thrust of 4000N, with a peak thrust of 11400N
Speed	Both X axis and Y axis can reach 80m/min
Acceleration	The acceleration of both X axis and Y axis can reach 1G
Position feedback	0.1μm resolution grating
Repeated positioning accuracy	2μm
Positioning precision	4μm

An Application Case of Graphite milling

Graphite milling is applied in the making of graphite electrodes for mold making. To meet the ever-increasing user experience of ITC product users, the requirements for the molds are increasingly high. The key performance indicators of graphite milling machines are efficiency, precision and protection. The request of the customer: "The fast speed to be increased to over 48m/min from the current 15m/min, the repeated positioning accuracy to reach 0.002mm, and the finished surface to be smooth and shiny is required to achieve good effects." Infranor uses a linear motor as the feed drive, of which the fast-moving speed reaches 60m/min. The DLMF-0301W permanent magnet linear motor is used for both X axis and Y axis, while the DLMF-0203W permanent magnet linear motor is used for the Z axis.



DLMF-0301W

DLMF-0203W

Achieved effects

Stroke	The X-axis 100mm,The Y-axis 650mm,The Z-axis 220mm
Thrust	The X/Y-axis has a continuous thrust of 1000N, with a peak thrust of 1700N The Z-axis has a continuous thrust of 720N, with a peak thrust of 2000N
Speed	Both X axis and Y axis can reach 60m/min
Acceleration	The acceleration of both X axis and Y axis can reach 1G, Z-axis can reach1.2G
Position feedback	0.1um resolution absolute grating
Repeated positioning accuracy	2μm
Positioning precision	3μm

LINEAR MOTORS

RECOMMENDED DRIVER

Founded in 1941 in Geneva, Infranor is a famous manufacturer of high-quality industrial drive and control products in Europe. It has established cooperation relationship with enterprises, including Siemens, BOSCH, ABB, Coca Cola, Rolex and Citroen, to offer efficient and accurate drive products and system solutions. Infranor's products are widely applied in the manufacturing processes and detection equipment of emerging industries, such as ITC industry, laser, panel display, semiconductor and new energy, as well as traditional industries and defence.
Infranor has already started R&D and production of servo drives since 1973, which contributes to its present mature technologies. Infranor has launched its new generation XtrapulsPac HPa series servo drives, which apply to domestic direct-drive markets (linear and direct driven motors).

XtrapulsPac HPa HIGH-PERFORMANCE SERVO DRIVE

230V

400V

Advantage:

All-digital AC servo drive
- Control mode

-Bus control (CANopen®or EtherCAT®)
-Pulse (including A/B pulse of electronic handwheel) and analog control
- Support multiple feedback interfaces of encoders,

-TTL encoder + H ES
-SinCos encoder + HES
-Absolute single-turn SinCos encoder
-Hiperface® with SinCos channels
-EnDat®2.2 (without SinCos channels)
-Hiperface DSL ® (one single motor cable)
-BiSS-C
- Multiple self-tuning functions:

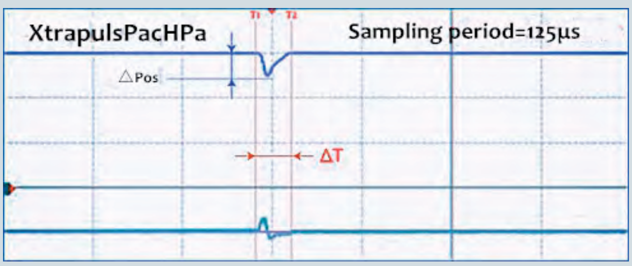
-Auto-phasing
-Auto-tuning
-Cogging Torque Compensation
- RS232 external function/USB communication diagnosis interface
- STO (safe torque off) function

Xtrapuls Pac HPa

With reasonable drive structure, convenient use, advanced control algorithm and excellent performance, Xtrapuls Pac HPa series servo drive is always the first choice for high-accuracy and high-benefit equipment.

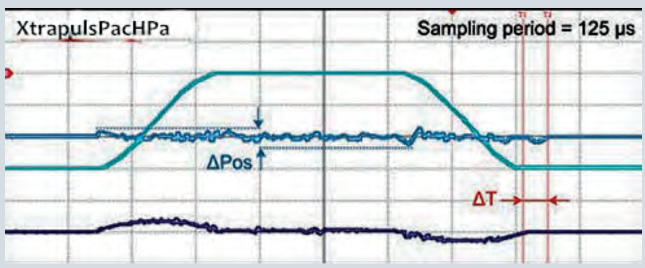
In comparison to the last version XtrapulsPac™, its servo dynamic performance its positioning accuracy and its response time have improved by 300%.

The position deviation and rigidity test of stair torque disturbance is applied on the motor spindle.



(Figure 1)

Position following error test of S-shape acceleration/deceleration track at position mode



(Figure 2)

LINEAR MOTORS

DYNAMIC PERFORMANCE OF SERVO DRIVE

CONTROL LOOP

Sampling period of current loop:
31.25μs (PWM 16kHz)
62.5μs (PWM 8kHz)

Sampling period of speed and position loop:
125μs, 250μs, 500μs (Optional)

Max. speed 25000rpm

Torque compensation of tooth socket

I/O LNTERFACE

Analog input ±10V/16-bit

Analog output 0-5V/12-bit

AOK" relay output

Motor brake control

Settable figure 1/0 of user
Input x5 output x3 (Prog rammable, applies to Sequences running mode)

RUNNING MODE

EtherCAT®or
CANopen®Bus control
Cyclic synchronization position mode
Cyclic synchronization speed mode
Cyclic synchronization torque mode
Position interpolation mode
Outline position mode
Outline speed mode
Outline torque mode
Homing mode

-Analog speed
-Stepper emulation
-Sequences
-Master-slave camming
-Electronic gearing

Multi-spindle toolbox

Configuration tools
- Configuration of motor and drive
- Configuration of application program
- Interface configuration
- Self-tuning, self-phasing
- Sequencer programming
- Motorwarehouse
- Multi-language software

Diagnosist ools
- Multi-spindle oscilloscope
- Equipment control
- Equipment monitoring
- Object dialog window

Authentication

Product series	Control mode	Feedback sensor
PacHPa-ed	EtherCAT® Stepper emulation Analog speed RS232	TTL encoder + HES SinCos encoder + HES Absolute single-turn SinCos encoder Hiperface® with SinCos channels EnDat® 2.2 (withou SinCos channels) Hiperface DSL® (one single motor cable) BiSS-C
PacHPa-kd	CANopen® Stepper emulation Analog speed RS232	

Applies to linear motor, DD motor and servo motor



Order selection: Power specification and dimensions

		Supply voltage (V_{ac})	Rated current (A_{rms})	Peak current (A_{rms}3S)	Wide (mm)	Heigh (mm)	Deep (mm)
Pac HPa-ed-230/17	Single phase	230	8.5	17	75.45	177.80	149.10
Pac HPa-ed-400/20	Three phase	400	10	20	75.45	235	192.10
Pac HPa-ed-400/45	Three phase	400	22.5	45	75.45	235	192.10
Pac HPa-ed-400/100	Three phase	400	35	100	80	235	214
Pac HPa-kd-230/17	Single phase	230	8.5	17	75.45	177.80	149.10
Pac HPa-kd-400/20	Three phase	400	10	20	75.45	235	192.10
Pac HPa-kd-400/45	Three phase	400	22.5	45	75.45	235	192.10
Pac HPa-kd-400/100	Three phase	400	35	100	80	235	214

Relevant technical indexes

Peak current overload time	Phase finding function	Parameter gain self-tuning,No running is required basically in tuning process, completed within 1/4s as the shortest period	Velocity fluctuation	Tuning time
3	One-key phase finding, compieteci automatically within several seconds.	Tuning parameters can satisfy most application scenarios.	The optimum choice in industry	The optimum choice in industry

Product introduction:

1. Featured by simple shape and easy installation, the DMR-HSI magnetic grating ruler applies to linear measurement in different environments.
2. The resolution of linear encoders is defined as the measurable min. step pitch, which depends on the pale pitch of scale and subdivision ratio of reading head.
3. System accuracy means the average error at all position data points is within the specified 1m stroke.

Product characteristics:

1. Applicable to linear position measurement.
2. The max. comprehensive accuracy: below ±10μm.
3. No-contact measurement, no-wear use, high speed and long service life.
4. Resistant to dust, oil stain, vibration and moisture.
5. The min. resolution: 0.25μm.
6. It is mounted with LED signal indicator to facilitate installation.

Composition and installation requirements of magnetic grating ruler

1. Applicable to linear position measurement.
2. The max. comprehensive accuracy: below ±10μm.
3. No-contact measurement, no-wear use, high speed and long service life.
4. Resistant to dust, oil stain, vibration and moisture.
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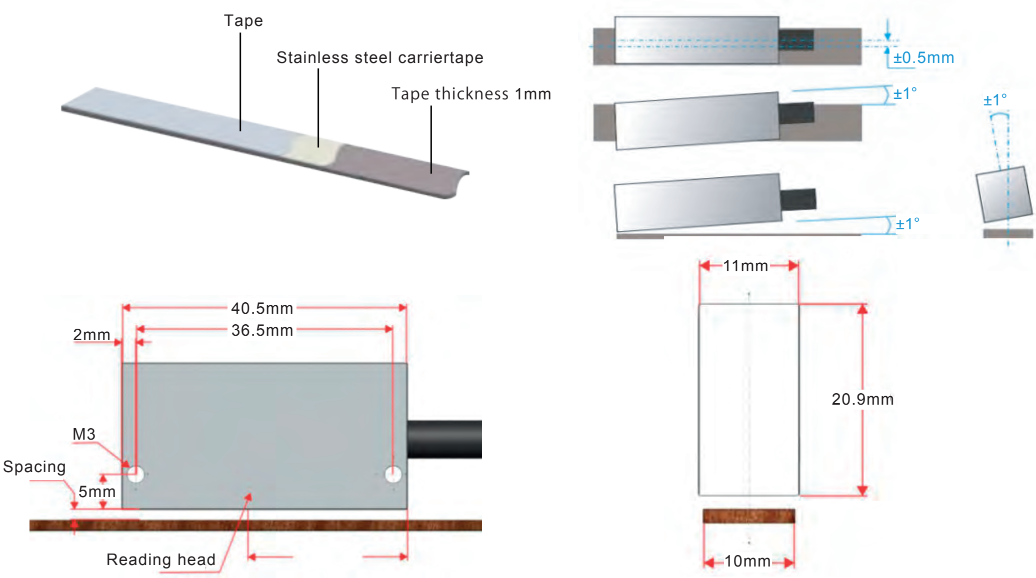


Pole pitch	1mm	2mm
Reading head and air gap of magnet,c tape	0.1-0.3mm	0.1-0.8mm

Technical specification of magnetic tape

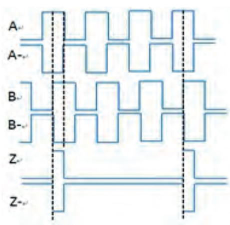
Accuracy grade	±3μm, ±10μm, ±20μm, ±40μm	
Measurement mode	Incremental	
Material	Stainless-steel baseband, magnetic tape that is filled with ferrite	
Min. bending radius	65mm	
Width	10mm±0.2mm	
Thickness	1.43mm±0.13mm	
Grid distance	1mm±2mm	
Zero and single volume length	1mm Pole pitch	2mm Pole pitch
	50m coil package (external zero position) 2.3m coil package (with reference point)	50m coil package (external zero position)
Operating temperature	0-80°C	0-80°C

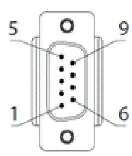
Technical specification of magnetic tape

Power supply	5V±5% typical current 60mA
Resolution	0.25μm , 0.5μm , 1μm , 5μm , 10μm Related to pole pitch
Maximum velocity	2m / s (1μm)
Repetition accuracy	± 10μm
Measurement accuracy	Resolution
Output signal	Rs422
LED Display	Green: Normal working
Protection class	Ip67

Definition of contact and output signal

Db9 Pin	1	2	3	4	5	6	7	8	9
Rs422	A-	OA	B-	/	Z-	A	5V	B	Z
Cable color	Yellow	White	Pink	/	Red	Green	Brown	Ash	Blue





Compatible with multiple drives