HIWIN®
Motion Control and System Technology

IRON-CORE Linear Motor

Installation Manual

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CONTENTS

*** Phase Out Notification:**

LMF and LMS series will be phased out from April 2016. LMS series will be replaced by LMSA series. LMF series will be replaced by LMFA series.

1. INSTALLATION AND SAFETY GUIDE

	CAUTION	**Before using this product, be sure to read and understand the user manual. Strictly adhere to the statements given in the manual. HIWIN is not responsible for any damage, accident or injury caused by incorrect handling.**

- **Precautions and Warning**

1. Before installing and operating this product, perform an ocular inspection. If there are any signs of damage, please contact HIWIN customer service or its local agent.
2. The product designs are based on structural calculations, computer simulations and experimental testing. Do not disassemble or modify product without permission from HIWIN.
3. Keep product out of reach of children.
4. Anyone with a pacemaker or A.I.C.D is prohibited from using this product.
5. The product should be operated only by personnel with experience and technical knowledge.

- **User Guide Criteria**

1. Stator assembly has a strong magnet field, handle with care otherwise personnel may get injuried and the stator will be damaged.
2. Keep magnetic storage media or precision instruments away from the product to avoid damage-caused fields. (*i.e.* magnetic scale, watch, credit card and magnetic response device).
3. Precautions should be taken for ESD (Electrostatic Discharge), like wearing gloves, shoes, etc.
4. The product should be installed and operated by specialized personnel.
5. During assembly, avoid using magnetic tools and screws.
6. During assembly of stator to system structure, keep any magnetic material at a distance to prevent the risk of injury to hands.
7. Before fixing the stator, please adhere the label of strong magnetic field to the position where it can easily be seen to prevent personnel from injury.
8. Do not drag the cables while moving or placing the forcer and stator units.
9. Whenever disassembling the stator, do not handle the stator with the edge of the cover directly, otherwise personnel may get injuried and the stator will be damaged.
10. Do not damage or bend the cables to avoid electric shock.
11. Do not run the continuous current of the forcer higher than specified in the datasheet.
12. Be sure to confirm that there is no interference with other components in the operations. Confirm that the cable bending radius is large enough to prevent reducing the lifetime of the cables.
13. Do not touch the forcer and stator during operations.
14. Operate within specified temperature range.
15. Allow forcer to cool down sufficiently (in a 25℃ room temperature) before working around the product, to avoid burns.

16. When an abnormal smell, noise, smokes and vibration are detected, please turn off power immediately.
17. The product can only be repaired by HIWIN engineers. Please send the product back to HIWIN if there are any unusual occurrences.
18. Do not change or disassemble the components by yourself. HIWIN will not take responsibility for any accidents or damages to the forcer and stator caused by this.
19. Clean stator surface by using disposable cotton rags and cleaning liquid such as isopropanol alcohol (95% Vol.). It is suggested to clean surface once every three months or once every two weeks in high fume formation rate facilities with machines such as PCB machines or drilling machines.
20. The products with Epoxy have some spot on the surface, that is the natural phenomenon.
21. A one year guarantee is provided from the date of delivery. HIWIN will not be held responsibility for replacing or maintaining product which has been incorrectly handled (please refer to the notes and instructions in the user manual) or damaged from natural disasters.
22. Safety Regulations

REGULATIONS	MEANING
	Danger of High Voltage
	Danger of High Magnetic Field
	Danger of High Temperature
	Hazardous to Environments

♦

♦ **Circuit Precautions**

1. Before using the product, please do confirm the information regarding the configuration of the power supply marked on the specifications and labels thereof, as well as if the power supply in usage meets the product requirements.
2. Please check if the circuit layout of the motor is correct or not. Incorrect circuit connection may cause the abnormal operation of the motor, leading it to malfunction or to be damaged.
3. Whenever using an extension cord, please choose the one equipped with shielding, where the shielding must be grounded.
4. Please do avoid sharing the same extension cord for the power cable and temperature control cable.
5. Shielding is equipped with a power cable as well as temperature control cable, where the shielding must be grounded.

- **Maintenance and Storage Precautions**

OPERATING (AMBIENT)	Temperature	0~40 ℃
	Humidity	5~85 %
STORAGE & TRANSPORTATION	Temperature	-5℃~40 ℃
	Humidity	5~85 %
ATMOSPHERE	Under 1000M	
TEMPERATURE VARIATION SPEED	MAX 0.5K/min	
CONDENSATION	not allowed	
FROZEN	not allowed	

*Disposal method of the broken product: Follow the local laws and regulations to recycle.

2. MOUNTING INTERFACE ACCURACY

2.1 INSTALLATION PRECISION REQUIREMENT OF LMSA/LMSS/LMFA SERIES INTERFACE

Observe dimension of the gap between forcer and stator after assembly. It will impact linear motor performance and reliability. A well designed positioning stage and proper tolerance value will improve the stability of products. The sectional view of typical linear motor stage base and the suggested tolerance value are below. The flatness of installation interface with stator should be 0.02mm per 300mm (Refer to Fig. 1)

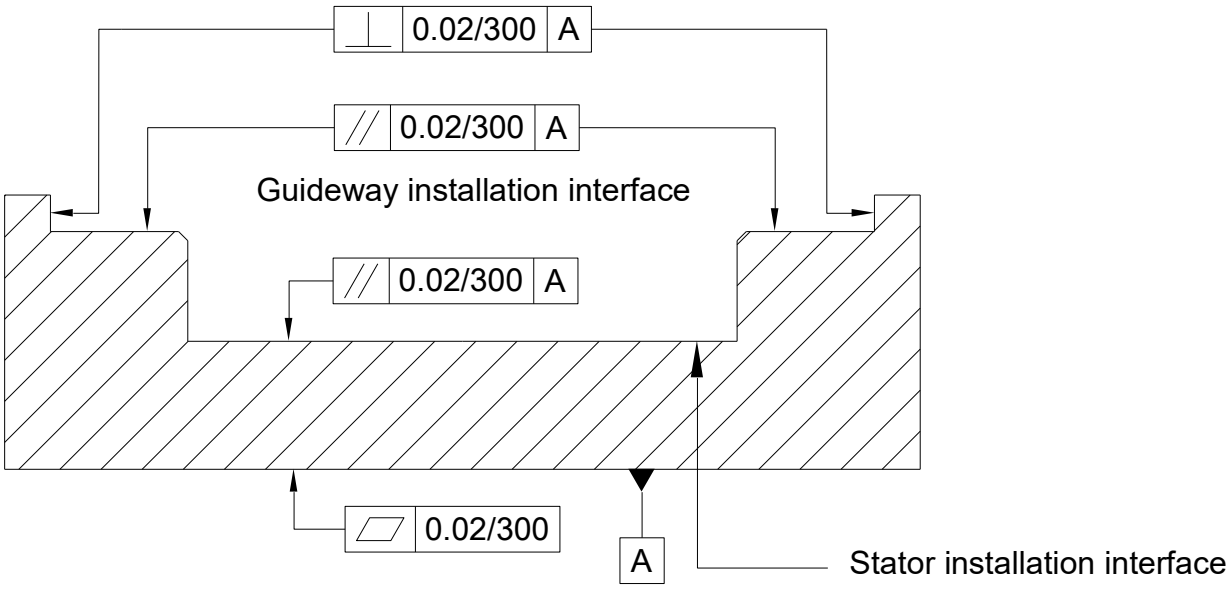


Fig. 1 The sectional view of base design

2.2 INSTALLATION DIMENSIONS FOR MOTOR

Observe the assembly total height H and the air gap dimensions between the forcer and stator G after assembly, they will impact the linear motor performance and reliability. Please refer to the following tables (Table 1&Table 2). There are two types of stators: stainless cover version and epoxy version.

Forcer and stator of an iron-core linear motor have an immense magnetic attraction with each other (please refer to linear motor catalogue F_a of each series for the attraction value). Hence, when designing the installation interfaces of both forcer and stator, we must consider and compute the deformation due to the attraction to ensure the height of the total composition H and air gap between forcer and stator G can be maintained. Should there be any circumstance of a bad air gap G caused by structural deformation, or interferential damage of forcer and stator, our company shall not be responsible to repair nor adjust for free.

2.2.1 LMSA IRON-CORE LINEAR MOTOR

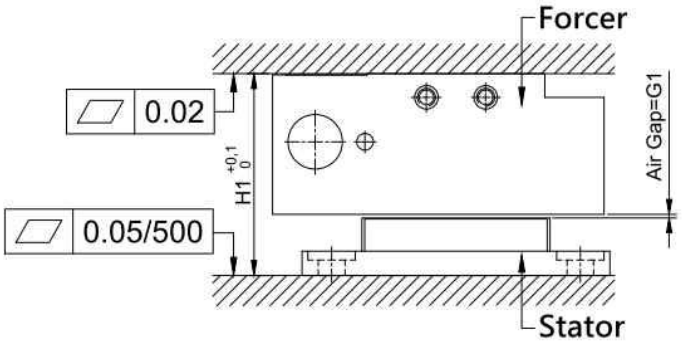


Fig. 2 LMSA linear motor assembly

Table 1. LMSA assembly dimensions

TYPE	DIMENSIONS (mm)		
	H1	G1	
		Stainless Cover	Epoxy
LMSA1□	34	0.6 +0.35/-0.25	0.6 ±0.25
LMSA2□			
LMSA3□	36		
LMSAC□			

2.2.2 LMFA LINEAR MOTOR WITH WATER-COOLING

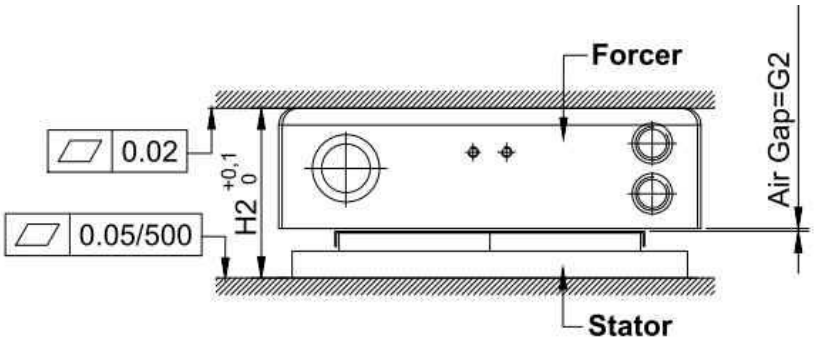


Fig. 3 LMFA linear motor assembly

Table 2. LMFA assembly dimensions

TYPE	DIMENSIONS (mm)		
	H2	G2	
		Stainless Cover	Epoxy
LMFA0□	48.5	0.9 ±0.2	1.4 ±0.2
LMFA1□	48.5		
LMFA2□	50.5		
LMFA3□	64.1		
LMFA4□	66.1		
LMFA5□	64.1		
LMFA6□	66.1		

2.2.3 LMFA PRECISION COOLING DEVICE LINEAR MOTOR

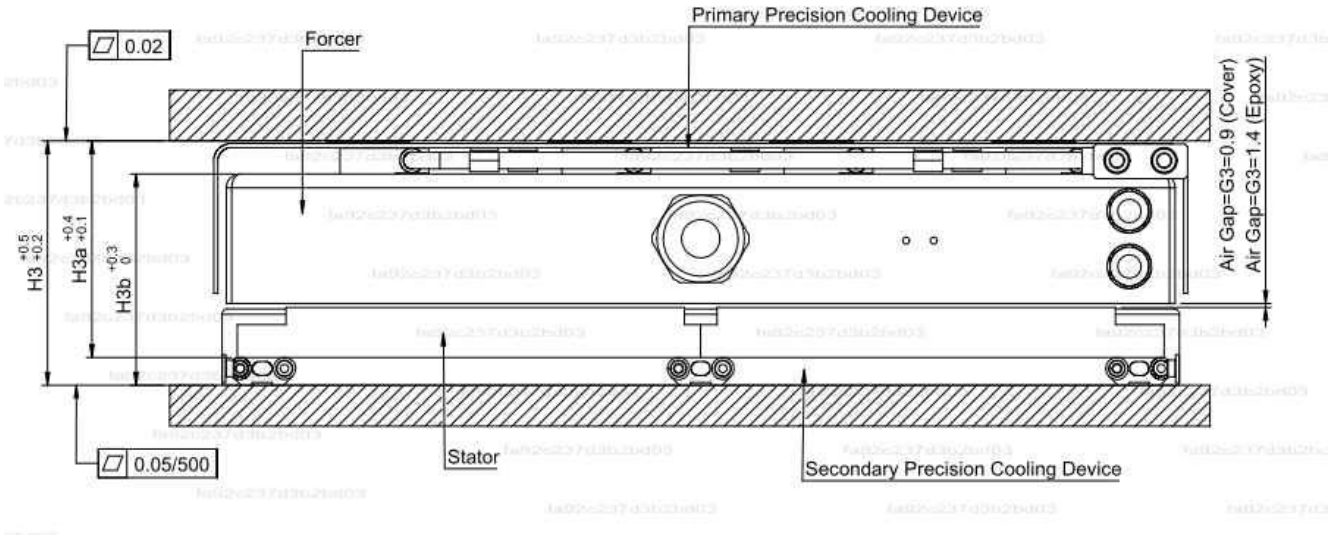


Fig .4 LMFA precision cooling device linear motor assembly

Table 3. LMFA precision cooling device assembly dimensions

TYPE	DIMENSIONS (mm)				
	H3	H3a	H3b	G3	
				Stainless Cover	Epoxy
LMFA0□					
LMFA1□					
LMFA2□					
LMFA3□	79.0	69	67.1	0.9 +0.7/-0.5	1.4 +0.7/-0.5
LMFA4□	81.0	78	69.1		
LMFA5□	86.0	76	74.1		
LMFA6□	88.0	78	76.1		

Note:

H3: Additional Cooler Forcer, Forcer, Stator and Stator Cooler.

H3a: Additional Cooler Forcer, Forcer and Stator.

H3b: Additional Cooler Stator, Forcer and Stator.

2.2.4 LMSC DOUBLE THRUST LINEAR MOTOR

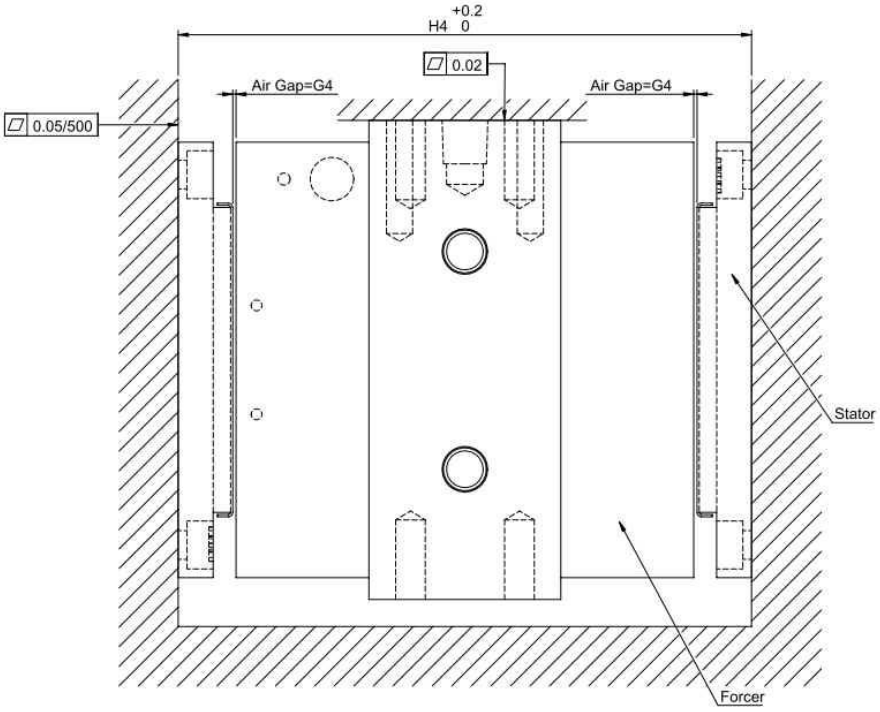


Fig.5 LMSC double thrust linear motor assembly

Table 4. LMSC double thrust assembly dimensions

TYPE	DIMENSIONS (mm)	
	H4	G4
LMSC7	131.5	0.75 +0.35/-0.2

2.2.5 LMSS IRON-CORE LINEAR MOTOR

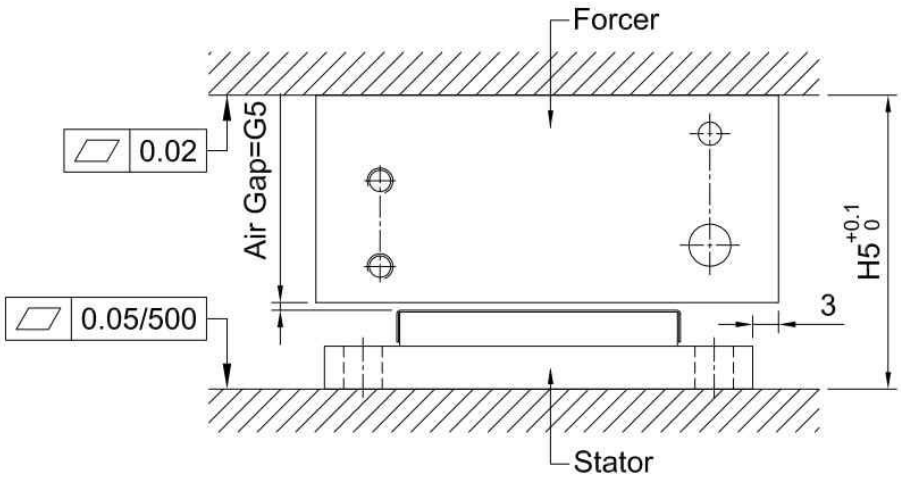


Fig.6 LMSS linear motor assembly

Table 5. LMSS assembly dimensions

Type	DIMENSIONS (mm)	
	H5	G5
LMSS11	34.3	0.9 +0.3/-0.35

3. INSTALLATION PRECAUTIONS OF STATORS

Please correctly take the stator to prevent personnel from injury or the stator from being damaged (refer to Fig. 7 and Fig. 8).

No matter by what method you take a stator, please be aware of not directly using the edge of the cover to handle a stator (refer to Fig. 9 and Fig. 10), otherwise personnel may get injured and the stator will be damaged.

CORRECT	WRONG

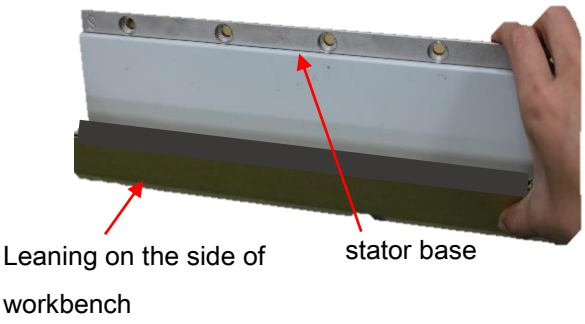


Fig. 7 Leaning the stator on one side of the workbench, taking the stator by handling the base.

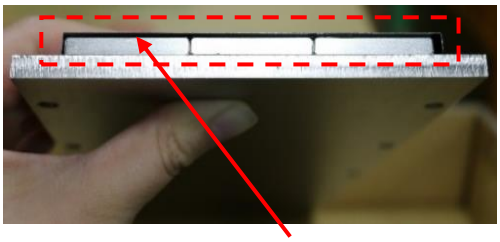


Fig. 9 Do not take the stator by handling the edge of the cover.

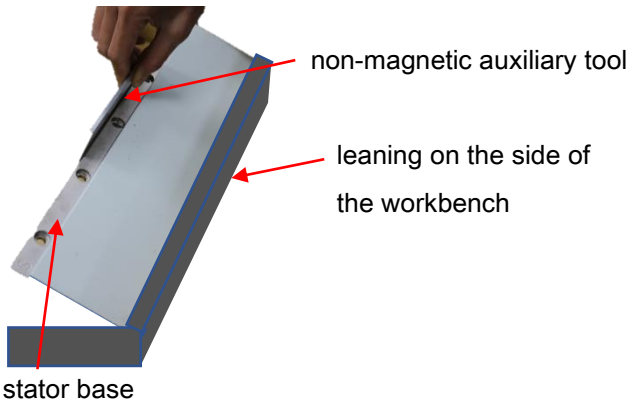


Fig. 8 Stator leans on one side with the non-magnetic auxiliary tool, handling the stator by its base.

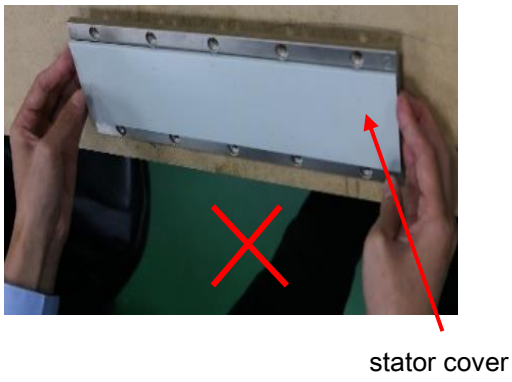
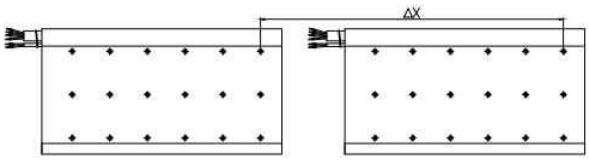


Fig. 10 In order to prevent personnel from injury or the stator from being damaged, contact with the edge of the cover is strictly prohibited.

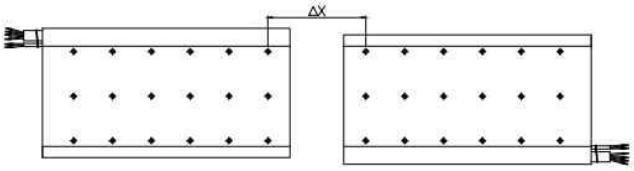
4. INSTALLATION PRECAUTIONS OF FORCER

Whenever the multiple forcers are assembled in parallel, the model, cable outlet direction and span of parallel installation of the linear motor must be confirmed in advance, as well as its phase.

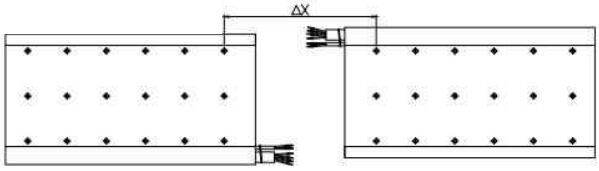
4.1 LMSA

<table>
<tr><th>Motor type</th><th>LMSA1□ / LMSA2□ / LMSA3□ / LMSAC□</th></tr>
<tr><td>Same cable outlet direction</td><td> 

<table>
<tr><td></td><td colspan="3">Phase</td></tr>
<tr><td>Motor1</td><td>U</td><td>V</td><td>W</td></tr>
<tr><td>Motor2</td><td>U</td><td>V</td><td>W</td></tr>
</table>
ΔX=n*2P
2P=30 mm
n is an integer,sufficiently large.</td></tr>
<tr><td>Opposing cable outlet direction

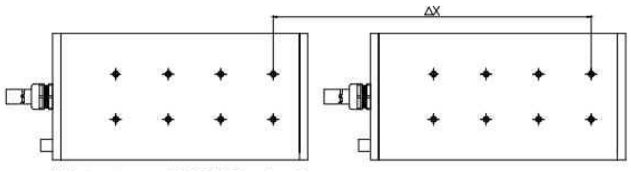
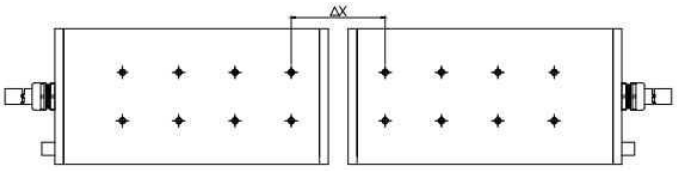
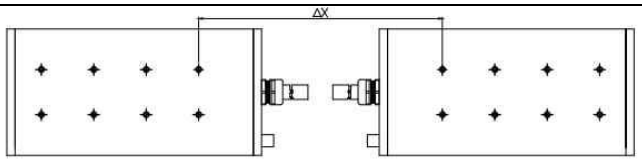
(facing outside)</td><td> 

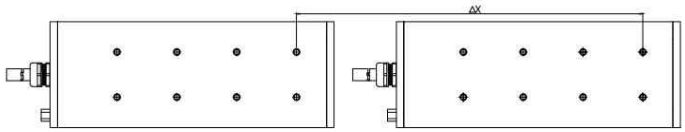
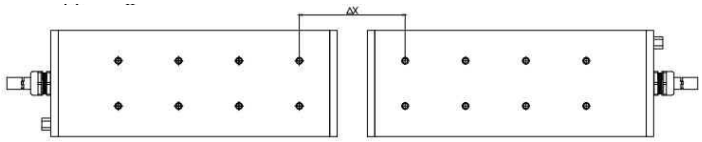
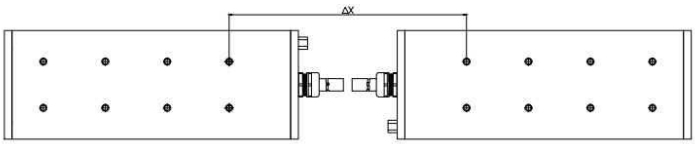
<table>
<tr><td></td><td colspan="3">Phase</td></tr>
<tr><td>Motor1</td><td>U</td><td>V</td><td>W</td></tr>
<tr><td>Motor2</td><td>W</td><td>V</td><td>U</td></tr>
</table>
ΔX=65+n*2P (n=0.1.2...etc)
2P=30 mm</td></tr>
<tr><td>Opposing cable outlet direction

(facing inside)</td><td> 

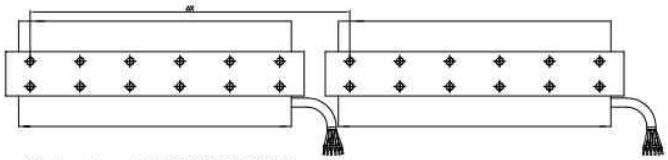
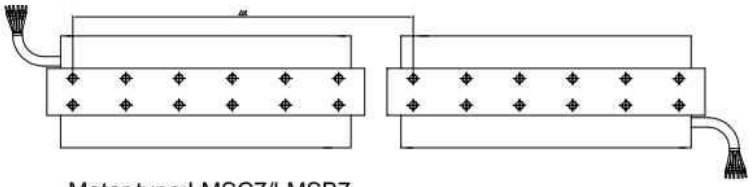
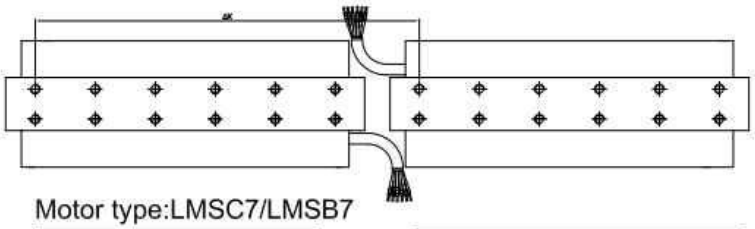
<table>
<tr><td></td><td colspan="3">Phase</td></tr>
<tr><td>Motor1</td><td>U</td><td>V</td><td>W</td></tr>
<tr><td>Motor2</td><td>W</td><td>V</td><td>U</td></tr>
</table>
ΔX=155+n*2P (n=0.1.2...etc)
2P=30 mm</td></tr>
</table>

4.2 LMFA

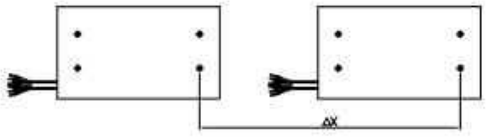
Motor type	LMFA0□ / LMFA1□ / LMFA2□
Same cable outlet direction	 Phase: Motor1 U V W; Motor2 U V W ΔX=n*2P 2P=30 mm n is an integer,sufficiently large.
Opposing cable outlet direction (facing outside)	 Phase: Motor1 U V W; Motor2 W V U ΔX=82.5+n*2P (n=0.1.2...etc) 2P=30 mm
Opposing cable outlet direction (facing inside)	 Phase: Motor1 U V W; Motor2 W V U ΔX=322.5+n*2P (n=0.1.2...etc) 2P=30 mm

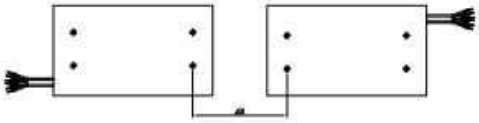
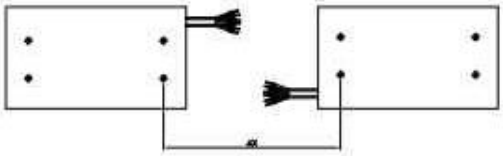
Motor type	LMFA3□ / LMFA4□ / LMFA5□ / LMFA6□
Same cable outlet direction	 Phase: Motor1 U V W; Motor2 U V W ΔX=n*2P 2P=46 mm n is an integer,sufficiently large.
Opposing cable outlet direction (facing outside)	 Phase: Motor1 U V W; Motor2 W V U ΔX=127+n*2P (n=0.1.2...etc) 2P=46 mm
Opposing cable outlet direction (facing inside)	 Phase: Motor1 U V W; Motor2 W V U ΔX=402+n*2P (n=0.1.2...etc) 2P=46 mm

4.3 LMSC

Motor type	LMSC7
Same cable outlet direction	 Motor type:LMSC7/LMSB7 Phase: Motor1 U V W; Motor2 U V W ΔX=320+n • 2P (n=1.2.3...etc) 2P=32 mm
Opposing cable outlet direction (facing outside)	 Motor type:LMSC7/LMSB7 Phase: Motor1 U V W; Motor2 W V U ΔX=320+n • 2P (n=1.2.3...etc) 2P=32 mm
Opposing cable outlet direction (facing inside)	 Motor type:LMSC7/LMSB7 Phase: Motor1 U V W; Motor2 W V U ΔX=320+n • 2P (n=1.2.3...etc) 2P=32 mm

4.4 LMSS

<table>
<tr><th>Motor type</th><th>LMSS11</th></tr>
<tr><td>Same cable outlet direction</td><td> 

Motor type:LMSA11
<table>
<tr><td></td><td colspan="3">Phase</td></tr>
<tr><td>Motor1</td><td>U</td><td>V</td><td>W</td></tr>
<tr><td>Motor2</td><td>U</td><td>V</td><td>W</td></tr>
</table>
ΔX=n*2P
2P=20 mm
n is an integer,sufficiently large.</td></tr>
<tr><td>Opposing cable outlet direction
(facing outside)</td><td> 
Motor type:LMSA11
<table>
<tr><td></td><td colspan="3">Phase</td></tr>
<tr><td>Motor1</td><td>U</td><td>V</td><td>W</td></tr>
<tr><td>Motor2</td><td>W</td><td>V</td><td>U</td></tr>
</table>
ΔX=35+n*2P (n=0.1.2...etc)
2P=20 mm</td></tr>
<tr><td>Opposing cable outlet direction
(facing inside)</td><td> 
Motor type:LMSA11
<table>
<tr><td></td><td colspan="3">Phase</td></tr>
<tr><td>Motor1</td><td>U</td><td>V</td><td>W</td></tr>
<tr><td>Motor2</td><td>W</td><td>V</td><td>U</td></tr>
</table>
ΔX=81+n*2P (n=0.1.2...etc)
2P=20 mm</td></tr>
</table>

5. INSTALLATION PROCEDURES- LMSA/LMFA IRON-CORE LINEAR MOTOR

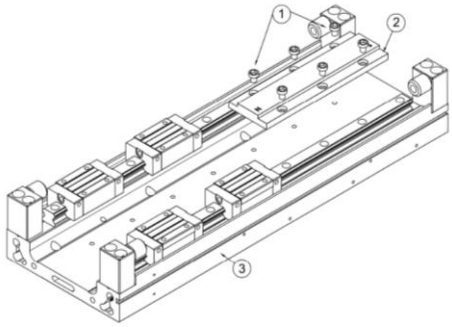
Note：There is a strong magnetic field between the forcer and stator (hundreds of kilograms). Technician should follow the following instructions to handle with care.

5.1 INSTALLATION OF THE STATOR

Install one side of stator. Please note the flatness of the guideway and stator. Install stator ② on stage ③ by using screw ① .

Note:

1. Warning label of stator is required to be placed on top surface of stator.
2. The max. thread depth of stator screw should be in accordance with the screw holes of the stage. For min. thread depth of stator screws, please refer to Appendix A.
3. Please do handle the stator with the correct method, otherwise personnel may get injured and the stator will be damaged.



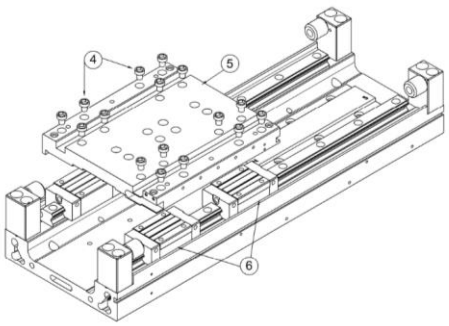
5.2 INSTALLATION OF THE FORCER PLATE AND FORCER

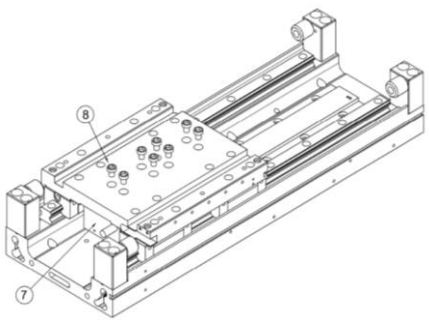
Install forcer plate ⑤ on a block ⑥ by using screw ④ .

Install forcer ⑦ on forcer plate by using screw ⑧ .

Note:

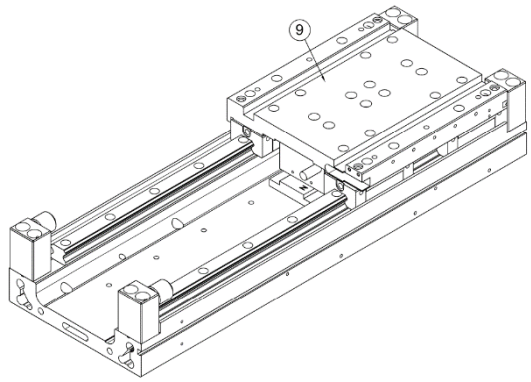
1. Observe the air gap between forcer and stator after assembly, they will impact the cogging force and thrust of motor. Please refer to (2.2.1-2.2.2).
2. Refer to Appendix B for the max. thread depth of the forcer. Refer to Appendix C for thread depth of forcer screws.
3. Whenever the multiple forcers are assembled in parallel, the span specifications as well as the phase of the motor must be noticed to ensure an efficient thrust.





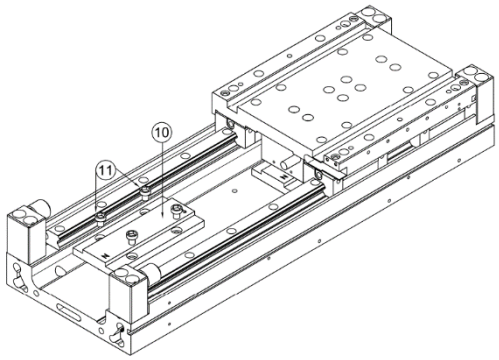
5.3 MOVE THE FORCER PLATE AND FORCER

Move the forcer plate ⑨ to the other side to ease installation of stators.



5.4 INSTALLTION OF STATOR

Install stator ⑩ on stage by using screw ⑪. Check that the forcer can move freely over the entire stroke after assembly is finished.



Note:

1. The max. thread depth of the stator screw should be in accordance with the screw holes of stage; For min. thread depth of stator screws, please refer to Appendix A.
2. Refer to Appendix D for screw torques table to assemble stator and forcer.

3. Strong magnetic attraction between two stators must be paid attention to, in between where the handle should not be placed (refer to Fig. 11) otherwise personnel may get injured (magnetic objects or watches should also be kept at a distance from the stators).

4. Whenever the multiple stators are installed, the hole offset may occur due to the accumulated tolerance by the length of stators, which is a normal situation. As a result, a 0.1~0.2mm plastic spacer can be placed in between the two supporting stators to adjust the positioning of the screws (refer to Fig. 12). Screws are to be fixed after the positioning, and the plastic spacer can be removed after the screws are fixed.

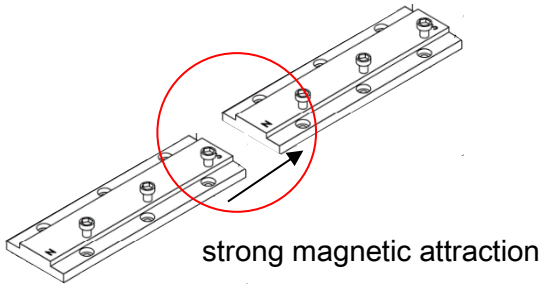


Fig. 11 Strong magnetic attraction dominates between each stator, personnel must pay attention to avoid one`s hand from having a pinch injury.

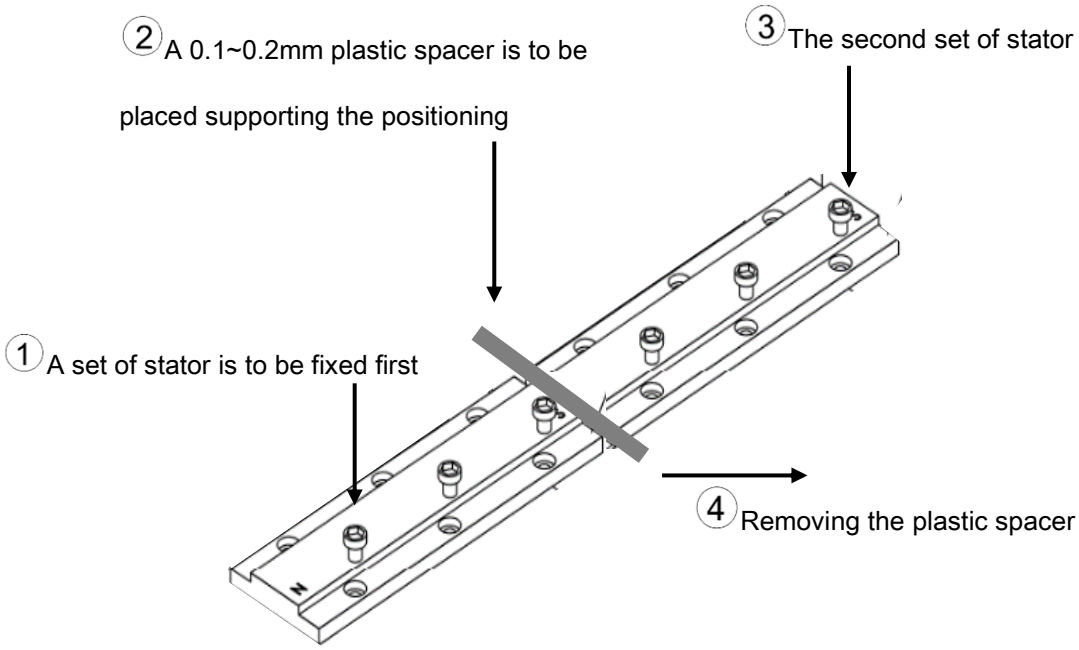
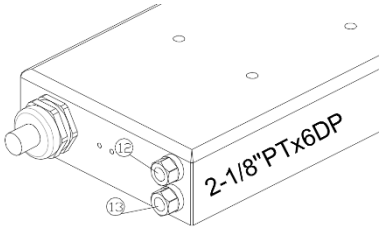


Fig. 12 Using a plastic spacer to support the positioning while assembling the multiple stators is advised.

5.5 INSTALLATION OF QUICK CONNECTOR (FOR LMFA)

Water-cooling connector 12 is the inlet hole.
Water-cooling connector 13 is the outlet hole.

Note:
1. Use a torque wrench (maximum torque should not be over 100 kgf-cm) to install (1/8 Pipe Thread) water-cooling connector. Bind quick connector (1/8 Pipe Thread) with white thread seal tape to avoid leaking. Improper installation may cause the water-cooling connector damaged or broken.
2. Max. pressure of water-cooling circuit: 10 bar.

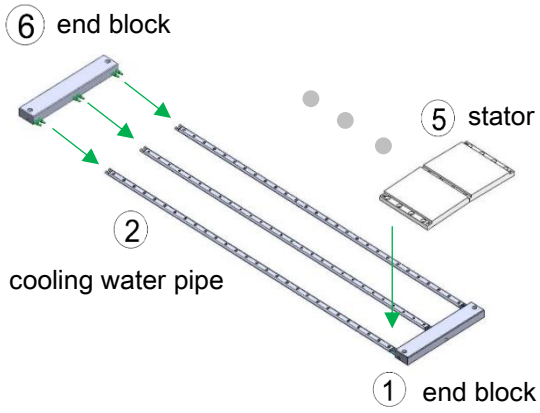


5.6 INSTALLATION OF PRECISION COOLING DEVICE SYSTEM (FOR LMFA)

PRECISION COOLING DEVICE SYSTEM FOR STATOR

For example, the stator (model : LMF6S1E) collocates with the stator presicion cooling device system (model : LMFC6S) :

1. Fix the end block ① to the working position of the workbench.
2. Fix the cooling water pipe ② to the end block ①.
3. Place the stator ⑤ at the corresponding position to the cooling water pipe ②.
4. Simultaneously fix the cooling water pipe ② and the stator ⑤ to the workbench.
5. If the stator is longer in length, the cooling water pipe and stators can be connected via spliced.
6. Please refer to Section 5.3 and 5.4 of this chapter for the installation descriptions of multiple stators.
7. Fix the end block ⑥ to the cooling water pipe which on the other side, after fix all the cooling water pipe and stator.
8. The connector used for precision cooling device is G1/8.

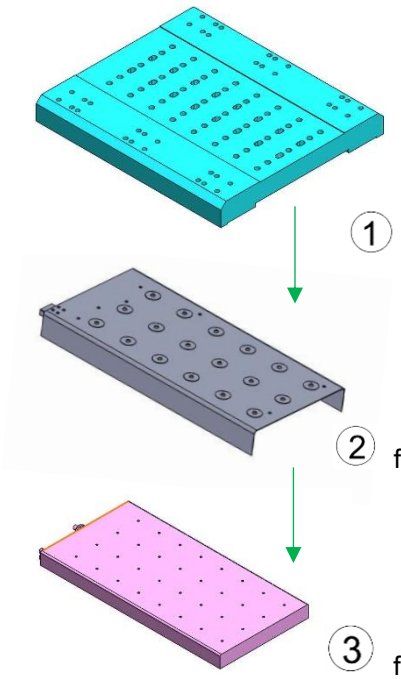


Completion Image of Assembly

PRECISION COOLING DEVICE SYSTEM FOR FORCER

For example, the motor (model : LMFA64)　collocates with the forcer presicion cooling device system (model : LMFC64) :

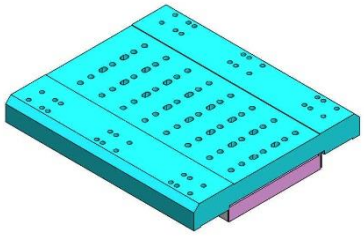
1. Place the forcer precision cooling device system ② above the forcer ③.
2. Install the forcer plate ①, forcer precision cooling device system ② and the forcer ③.
3. After the assembly is completed, it can be installed on the block on the workbench. Please refer Section 5.2 for the related information.
4. The connector used for precision cooling device is G1/8.



① forcer plate

② forcer precision cooling device system

③ forcer



Completion Image of Assembly

5.7 FLOW RATE OF WATER-COOLING SYSTEM (FOR LMFA)

The flow rates of LMFA linear motor with water-cooling system are in the following table. The internal diameter of water tube of LMFA 0~2 series is 4mm and LMFA 3~6 series is 6mm.

Type	Flow rate(L/min)	Internal diameter(mm)
LMFA01	3.3	4
LMFA02	3.3	
LMFA03	3.3	
LMFA11	3.3	
LMFA12	3.7	
LMFA13	3.7	
LMFA14	3.7	
LMFA21	4.0	
LMFA22	4.0	
LMFA23	4.0	
LMFA24	4.0	
LMFA31	4.0	6
LMFA32	5.2	
LMFA33	5.7	
LMFA34	6.2	
LMFA41	5.2	
LMFA42	5.2	
LMFA43	5.7	
LMFA44	6.2	
LMFA52	6.3	
LMFA53	6.8	
LMFA54	7.3	
LMFA62	6.8	
LMFA63	7.3	
LMFA64	7.8	

6. INSTALLATION PROCEDURES OF FORCER/STATOR– LMSC DOUBLE THRUST LINEAR MOTOR

6.1 INSTALLATION OF STATOR

1.First, clean up all the contact surfaces of interface.

2.Adhere the blue glue to the screws of the stators (refer to Fig. 13).

3.Use the non-magnetic material for isolation above the stators.

4.Put in the stators.

5.Use a non-magnetic tool (refer to Fig. 14) to install the stators on one side of half of the stroke.

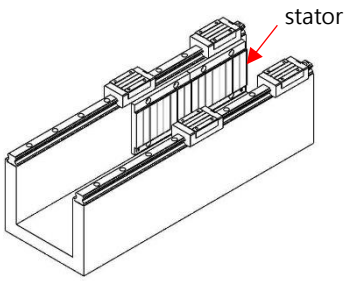


Fig. 13

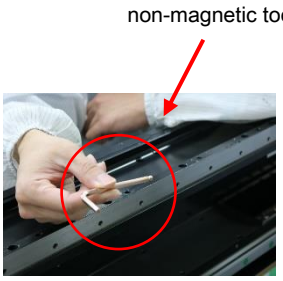
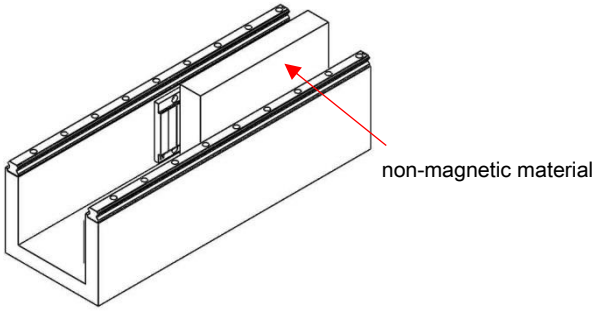
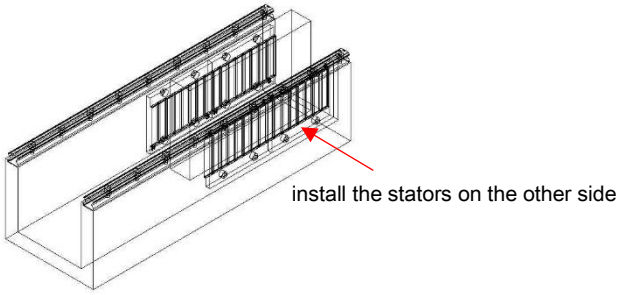


Fig. 14

6.Place the non-magnetic material between the interface of the stators on two sides.

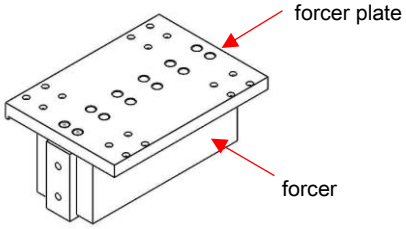


7. Use a non-magnetic tool to install the stators on the other side of half of the stroke.

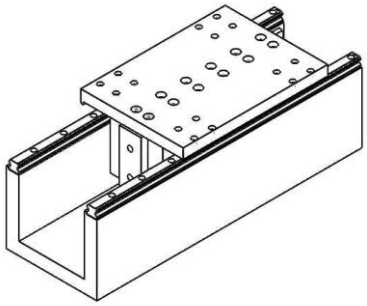


6.2 INSTALLATION OF FORCER PLATE AND FORCER

1.First, install the forcers on the forcer plate.



2.Install the forcer plate on the block.



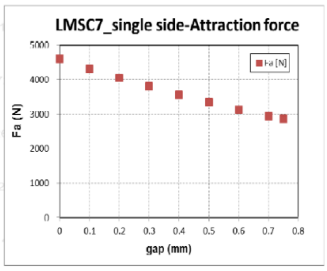
3.Use a thickness gauge to adjust the air gap (refer to Fig. 15) to $\mathbf{0.75^{+0.25}_{-0.15}}$.

Note：

1. A strong magnetic attraction force dominates in between the forcer and stator, of which the attraction force on single side is at least 2850N.

2. Installation structural strength of the stators on two sides must be taken into consideration, avoiding the strong magnetic attraction force from causing deformation of the whole structure.

air gap	Fa [N]
0	4601
0.1	4313
0.2	4042
0.3	3796
0.4	3556
0.5	3338
0.6	3134
0.7	2942
0.75	2850



Dependency of the attraction force on the air gap for LMSC7 with single side.

3. When the distance between the forcer and stator is over 4.5mm, the attraction force thereof will be approximately zero.

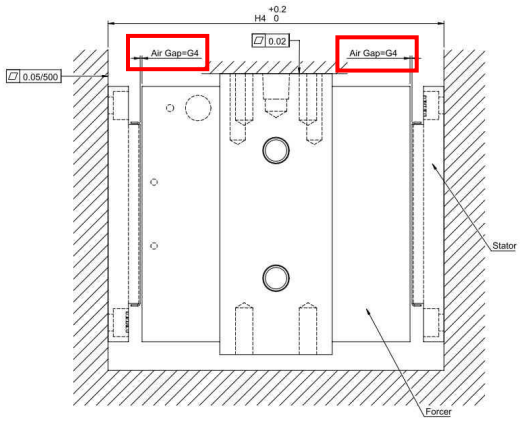
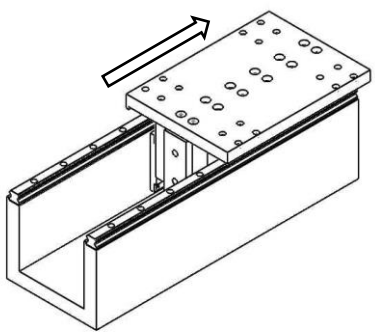


Fig. 15

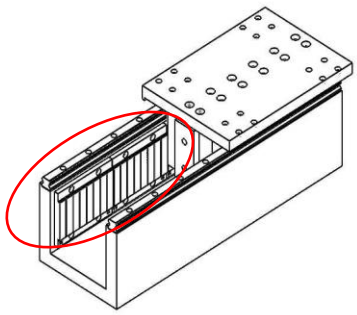
6.3 MOVE FORCER PLATE AND FORCER

1.Move the forcer plate in order to install other stators.

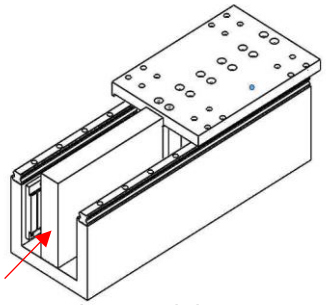


6.4 INSTALLATION OF STATOR

1. Use a non-magnetic tool to install the stators on one side of half of the stroke.

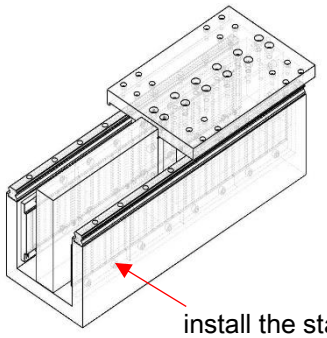


2. Place the non-magnetic material in between the interface of the stators on two sides.



non-magnetic material

3. Use a non-magnetic tool to install the stators on the other side of half of the stroke.

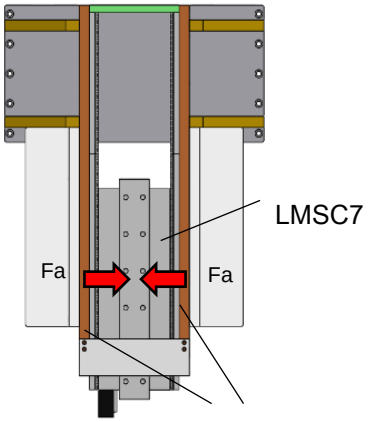


install the stators on the other side

Note :

1. Magnetic poles of the stators on both sides must be oppositely marked.

2. Air gap in a LMSC double thrust linear motor will influence the attraction force between forcer and stator.



installation of stator base

LMSC7-Attraction Force		
gap1	gap2	Fa [N]
0	1.5	2838
0.05	1.45	2633
0.15	1.35	2230
0.25	1.25	1840
0.35	1.15	1461
0.45	1.05	1090
0.55	0.95	724
0.65	0.85	361
0.75	0.75	0

7. THE SELECTION OF WATER-COOLING MACHINE

7.1 THE INSTALLATION OF MOTOR WATER-COOLING CIRCUIT

When using multiple linear motors, the motor cooling circuit must be mounted in parallel, diagram as shown in Fig.16. Each inlet holes as well as outlet holes must be connected together. The flow directions are shown in Fig. 17 when the precision cooling-water system is adopted.

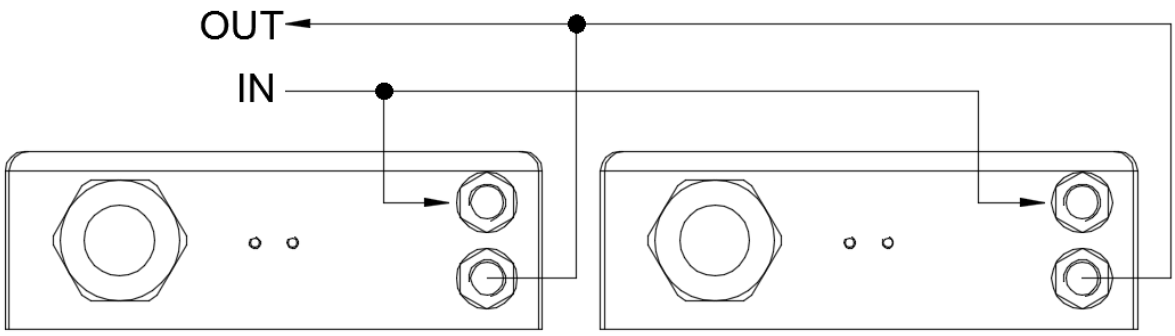


Fig.16 The diagram of motor cooling circuit installation

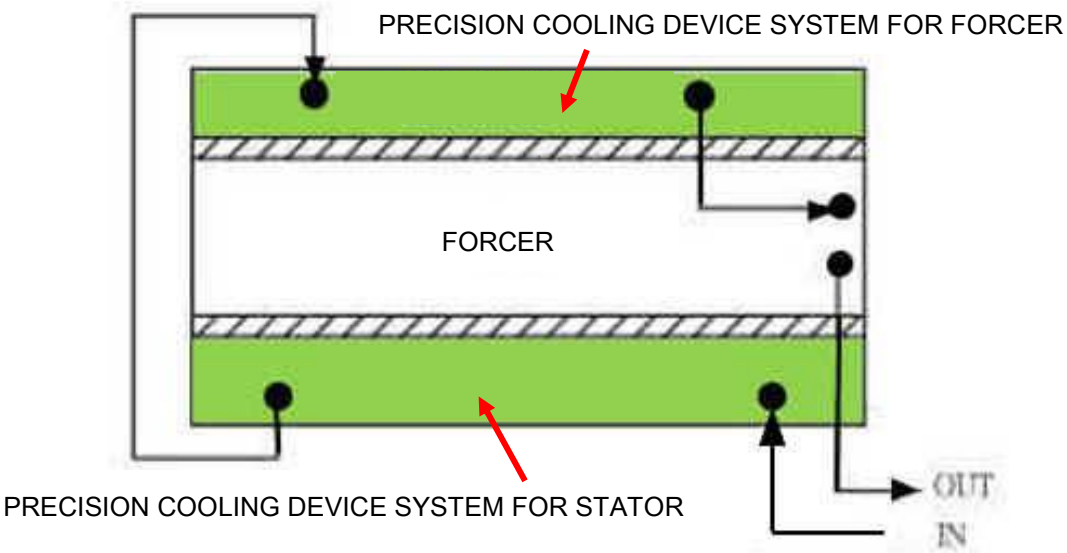


Fig. 17 The diagram of runner of precision cooling device

7.2 THE COOLING CAPACITY OF WATER-COOLING MACHINE

After selecting the frequency of the water-cooling machine (50/60Hz), the cooling capacity of the water-cooling machine must be greater than the sum of the maximum dissipated heat output from the motors.

Example: Use two linear motors LMFA31 in parallel, which the maximum dissipated heat output is 324(W), so that the sum of the maximum dissipated heat output from the motors is 648(W). Taking the cooler shown in the figure below for example, the「cooling capacity」is 980W at 50Hz, which is actually more than the maximum dissipated heat output at 648W of the motor.

LMFA31 L

Electrical Specifications

	Symbol	Unit	LMFA31
Continuous force	F_c	N	380
Continuous current	I_c	A(rms)	3.1
Continuous force(WC)	$F_{c(wc)}$	N	759
Continuous current(WC)	$I_{c(wc)}$	A(rms)	6.2
Peak force(for 1 sec.)	F_p	N	1750
Peak current(for 1 sec.)	I_p	A(rms)	19.2
Force constant	K_f	N/A(rms)	122.7
Attraction force	F_a	N	3430
Max. winding temp.	T_{max}	℃	120
Electrical time constant	K_e	ms	11.3
Resistance(line to line at 25℃)	R_{25}	Ω	4.3
Resistance(line to line at 120℃)	R_{120}	Ω	5.6
Inductance(line to line)	L	mH	48.3
Pole pair pitch	2τ	mm	46
Back emf constant(line to line)	K_v	Vrms/(m/s)	70.9
Motor constant(at 25℃)	K_m	N/√W	48.4
Thermal resistance	R_{th}	℃/W	1.17
Thermal resistance(WC)	$R_{th(wc)}$	℃/W	0.29
Minimun flow rate	-	L/min	4.0
Temperature of cooling water	-	℃	20
Thermal switch	-		+ 1 x (3 PTC SNM120 In Series)
Maximum velocity at maximum force	V_{MAX},F_{MAX}	m/s	4.08
Maximum electric power input	$P_{EL,MAX}$	W	10255
Maximum dissipated heat output	$Q_{P,H,MAX}$	W	324

Specification Water Cooler - Ve

Item / Model		HWK-50PTS	HWK-250PTS	HWK-400PTS
Cooling capacity	KCAL/H 50/60Hz	450/500	840/1000	1400/1500
	W 50/60Hz	525/580	980/1170	1630/1750
	BTU/H 50/60Hz	1800/2000	3360/4000	5600/6000
Temperature controller	A			
	B		Differential temperat	

7.3 THE PUMP FLOW RATE OF WATER-COOLING MACHINE

After selecting the frequency of water-cooling machine(50/60Hz), the pump flow rate of the water-cooling machine must be greater than the sum of the minimum flow rate from the motors. Also, the pressure of the pump flow rate should be greater than the sum of the pressure drop of motor internal cooling circuit. If the motor internal cooling circuit is longer for large equipment, you should consider pressure drop caused by resistance of water tube circuit.

Example: Use two linear motors LMFA31 in parallel, where the minimum flow rate is 4.0(L/min), so that the sum of the minimum flow rate from the motors is 8.0(L/min). Taking the cooler shown in the figure below for example, the “pump flow rate” is 40L/min at 50Hz, which is actually more than the minimum flow rate at 8.0L/min of the motor.

LMFA31 L

Electrical Specifications

	Symbol	Unit	LMFA31
Continuous force	F_c	N	380
Continuous current	I_c	A(rms)	3.1
Continuous force(WC)	$F_{c(wc)}$	N	759
Continuous current(WC)	$I_{c(wc)}$	A(rms)	6.2
Peak force(for 1 sec.)	F_p	N	1750
Peak current(for 1 sec.)	I_p	A(rms)	19.2
Force constant	K_f	N/A(rms)	122.7
Attraction force	F_a	N	3430
Max. winding temp.	T_{max}	℃	120
Electrical time constant	K_e	ms	11.3
Resistance(line to line at 25℃)	R_{25}	Ω	4.3
Resistance(line to line at 120℃)	R_{120}	Ω	5.6
Inductance(line to line)	L	mH	48.3
Pole pair pitch	2τ	mm	46
Back emf constant(line to line)	K_v	Vrms/(m/s)	70.9
Motor constant(at 25℃)	K_m	N/√W	48.4
Thermal resistance	R_{th}	℃/W	1.17
Thermal resistance(WC)	$R_{th(wc)}$	℃/W	0.29
Minimun flow rate	-	L/min	4.0
Temperature of cooling water	-	℃	20

Specification — Water Cooler - Vertical With Tank

Item / Model		HWK-50PTS	HWK-250PTS	HWK-400PTS	HWK-600PTS	HWK-750PTS	HWK-900PTS
Cooling capacity	KCAL/H 50/60Hz	450/500	840/1000	1400/1500	1700/2100	2600/3000	3200/3800
	W 50/60Hz	525/580	980/1170	1630/1750	1980/2450	2900/3500	3700/4400
	BTU/H 50/60Hz	1800/2000	3360/4000	5600/6000	6800/8400	10000/12000	12800/1520
Temperature controller	A	Fixed temperature control type					
	B	Differential temperature control type (tracing ambient/mac					
Use range	Ambient temperature℃	10~40℃ (Sta					
	Liquid temperature℃	10~30℃					
Power source		3Ø 200~230V					
Motor	Compressor	460			740	1136	1450
	Fan	56	50	95		180	
	Pump	120	750				
Pump flow rate (L/min)	50Hz	2	40				
	60Hz	3.5	50				

The instruction of selection of water-cooling machine above is only for reference. Please kindly consult with water-cooling machine supplier for further information.

8. SELECTION OF MOTOR POWER CABLE

8.1 STANDARD SPECIFICATION OF POWER CABLE

The lengths of the power cable as well as temperature control cable for the LMSA/LMSC motor are 500±50mm, and 1000±50mm for a LMFA motor (refer to Fig. 18), where open ends are the standard spec. The lengths of all the other cables are defined as 1m as for a basic section. Please contact HIWIN or its dealers for further support.

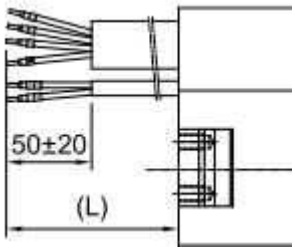


Fig. 18 Outlet Specifications for a Power Cable

8.2 RECOMMENDATION FOR CONSTRUCTION GROUNDING PROTECTION

1. shielding must be equipped to the power cable or temperature control cable. Also, the shielding must be grounded (refer to Fig. 19).

2. After the shielding is removed, the whole shielding can be cut to an appropriate length for more convenient operations. Part cutting of the shielding is not advised otherwise the shielding will be easier to break, influencing the grounding efficiency.

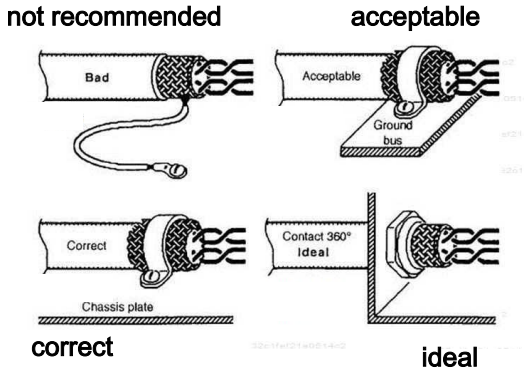


Fig. 19 Recommendation for Grounding Method

9. TROUBLESHOOTING

This chapter only provides a quick access of troubleshooting and is for reference only.

MALFUNCTION STATUS	ROOT CAUSE	SOLUTION
The motor cannot run under any circumstances	Wrong wiring of power cable	Check the connection status of the power cable to the controller
Wrong operating direction of the motor	Wrong encoder configuration	Check encoding configuration
	Wrong wiring of power cable	Swapping the two phases of power cable connected to the controller
Abnormal burning smell	Abnormal operation of the cooler machine	Check water-cooling system
	Controller configuration error	Check controller configuration
	Motor parameter configuration error	Check motor parameter configuration
Abnormal motor temperature	Abnormal operation of the cooler machine	Check cooling-water system
	Controller configuration error	Check controller configuration
	Abnormal operation	Check assembly method
	Abnormal temperature control display	Check assembly method and grounding
Unstable operation (vibration)	Invalid shielding	Check the earthing resistance of the power cable, which should be more than 10MΩ
	Encoder installation error	Check the installation rigidity of encoder
	Encoder signal error	Check the grounding terminal and connection terminal of encoder
	Encoder signal noise	Check the grounding of shielding
	Controller configuration error	Check controller configuration
Unsmooth operation of motor or abnormal noise generated by friction	Abnormal forcer assembly	Check assembly method
	Foreign object in air gap	Remove foreign object in air gap
	Abnormal air gap	Check assembly tolerance and structural rigidity

APPENDIX A. MINIMUM THREAD DEPTH OF STATOR SCREW

(Refer to DIN912, bolt strength class 10.9)

Materials	FC250	FC300	FCD600	Aluminum	SS400	SS490
Hole depth	1.4 • d	1.3 • d	0.7 • d	2.8 • d	1.8 • d	1.3 • d

APPENDIX B. SPECIFICATIONS OF THREAD HOLE FOR FORCER AND STATOR

Forcer of LMSA series	
LMSA□□(L)	M4x0.7Px4DP
Stator of LMSA series	
LMSA1S□(E)	Φ4.5THRU;Φ8x1.5DP
LMSA2S□(E)	Φ5.5THRU;Φ10x1.5DP
LMSA3S□(E)	Φ5.5THRU;Φ10x3.5DP
LMSACS□(E)	Φ5.5THRU;Φ10x3.5DP

Forcer of LMSS	
LMSS11	M3x0.5Px5DP
Stator of LMSS	
LMSS1S□	Φ4.5THRU

Forcer of LMFA series	
LMFA0□(L)~ LMFA2□(L)	Φ6x3DP;M5x0.8Px10DP
LMFA3□(L)~ LMFA6□(L)	Φ9x3DP;M8x1.25Px11DP
Stator of LMFA series	
LMF0S□(E)	Φ4.5THRU;Φ8x2DP
LMF1S□(E)	Φ5.5THRU;Φ10x1.5DP
LMF2S□(E)	Φ5.5THRU;Φ10x3.5DP
LMF3S□(E) LMF4S□(E)	Φ9THRU;Φ15x6DP
LMF5S□(E)	Φ9THRU;Φ15x6DP
LMF6S□(E)	Φ6.5THRU;Φ10.5x6DP

APPENDIX C. MINIMUMTHREAD DEPTH OF FORCER SCREW

Series	Borehole depth
LMSS	1.4 • d
LMSA	0.9 • d
LMFA	1.2 • d

APPENDIX D. SCREW TORQUES FOR ASSEMBLY OF FORCER AND STATOR

(Refer to DIN912, bolt strength class 10.9)

Screw size	Torque (kgf-cm)
M3x0.5P	15
M4x0.7P	34
M5x0.8P	69
M6x1.0P	118
M8x1.25P	286