LKR Series: Linear Module

Main Introduction

Caution

This series of products belong to electromechanical equipment, in order to maintain the safety of users, before selecting the model and the actual operation of this product, please be sure to read the relevant information and the following precautions and use in accordance with the instructions, if not in accordance with the precautions to use this product and cause abnormal function, damage or other accidents, the company will not be responsible.

Life Safety

O This product is intended for industrial use and should not be used on security components directly related to human life or personal safety.

O When operating this product, personnel should remain outside the range of mechanical action to avoid entrapment or other safety accidents.

O When this product is connected to a motor and energized, the person installing the cardiac pacemaker should remain one meter away to avoid interference.

O This product should not be installed near fire sources, flammable materials, or combustible gases to prevent fire.

Storage and Installation

O Avoid dropping or collision when handling.

O When storing this product, it is recommended to store it flat and pack it properly to avoid exposure to high temperature, low temperature and humidity.

O Do not disassemble or modify the product by yourself to avoid foreign objects entering or damaging the product, causing abnormal function or safety accidents.

O The product should be locked during installation to avoid loosening due to vibration.

O When installing the coupling and motor, use the appropriate fittings and pay attention to the centerline of the shaft and then lock the screws, do not force the installation.

Operation Use

O Operation shall be in accordance with the rated conditions of the data, such as maximum speed and load, to avoid functional damage or safety accidents.

O Foreign objects such as dust and chips should be avoided to enter the ball circulation system, which may cause damage, shortened life or abnormal function.

O The operating environment temperature should be below 80°C. If the product needs to be applied in high temperature place, please consult us.

O If the environment is special, such as strong vibration, vacuum chamber, clean room, corrosive chemicals, organic solvents or chemicals, extremely high or low temperature, wet splash, oil drops and oil mist, high salt, heavy load, vertical or cantilever installation, etc., please consult us first to confirm the conditions of application of the products.

O If the load is in danger of falling when installed vertically, it is recommended to install appropriate brakes and confirm that the brakes function properly before use.

Maintenance

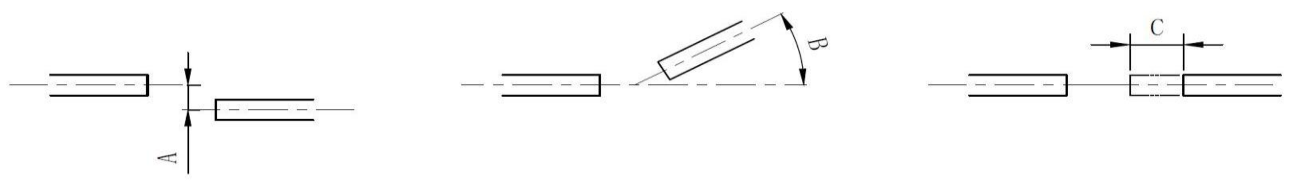
O The grease should be replenished before the first use, please pay attention to the type of greases, different ones should not be mixed.

O Under normal use, it is recommended to check the running condition once every 100km, remove the dirt, and replenish the grease, the guide way and ball screw should be greased.

Installation instructions for motor flange, motor and coupling

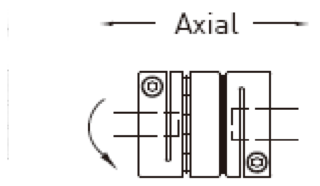
O Three types of misalignments may exist while installing the ball screw with motor axis, which are shown as below.

1.Parallel misalignment[A] 2. Angular misalignment [B]: 3. Axial misalignment [C]:

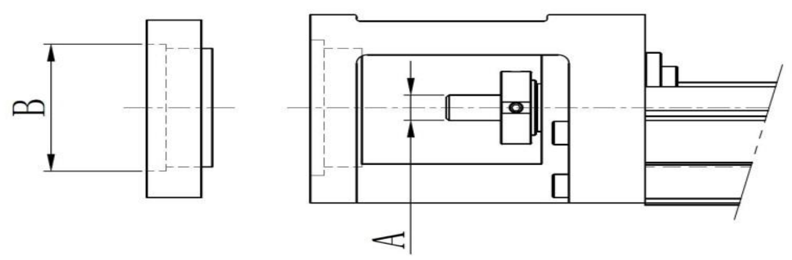


O Confirmation of axial alignment: When the balls crew shaft and motor are connected by a coupling, rotate the coupling gently to assure its rotating without restrictions. This will ensure the concentricity of both axes.

The figure is shown as below.



O The use of a motor mounting fixture might be necessary to make sure the ball screw spindle end (A) and the positioning hole of the motor flange (B) are concentric. The illustration is shown below.



O Precaution:

1. During motor flange mounting, the misalignments between ball screw spindle end and the positioning hole of the motor flange should be under controlled which is within the accepted misalignment range of the relative coupling.

2. The balls crew spindle end or the coupling may be broken if the coupling is mounted incorrectly or the misalignments are out of the range limit.

3. Make sure the accepted misalignments of the coupling is sufficient for your application, flexible couplings are recommended, disc type are preferred. Please consult us for coupling installation or selection.

Selection Steps

When choosing a module based on different conditions and restrictions, below selection steps may be helpful:

1. User requirements

- O Effective stroke
- O Location restrictions (width, height, length)
- O Installation type (horizontal, vertical, side mount)
- O Position of gravity, center of loading
- O Operating conditions (lead, speed, acceleration and deceleration, duty cycle)
- O Environment (high temperature, vibration, oil, water, corrosion)

2. Demand for precision

- O Position accuracy
- O Repeatability
- O Running parallelism

3. Configuration

- O Single axis
- O Double axis
- O Multi axis
- O Special combination

4. Motor selection

- O AC servo motor
- O Stepper motor
- O With or without brake (included, plug-in)

5. Motor load calculation

- O Maximum speed
- O Motor resolution
- O Motor torque calculation

6. Operation analysis

- O Acceleration
- O Actual operation mode (V-T diagram)

7. Other accessories

- O The use of related accessories (limit switches, adapter plate, retractable sheath, the slip ring protection tube)

8. Final confirmation

- O Conditions of use should be confirmed
- O Price, deadline
- O Alteration
- O Special requirements

Precision

1. Positioning accuracy

The maximum difference (absolute value) between the actual arrival distance and the reaching distance based on the original setting.

2. Repeatability of round-trip position (precision)

The maximum difference in the entire cycle. The difference in the positioning value measured from a setting position during the round trip movement of the module's slider.

3. Running parallelism

(1) The parallelism between module platform plane and module installation plane. Position the scale at the center of the slider, and then put the pointer on the installation plane. Finally, take the maximum deviation value measured in the full stroke as the result.

(2) The parallelism between module platform and the installation datum. Position the scale at the center of the slider, and put the pointer on the installation datum. Finally, take the maximum deviation value measured in the full stroke as the result.

Speed

1. Maximum linear velocity

The module's maximum linear velocity (V) is calculated from the ball screw speed (S) multiplied by the lead (L).

V(mm/sec)=S(rpm)÷60×L(mm)

2. Maximum rotational speed

The maximum allowable rotational speed of the ball screw is decided by it's critical rotational speed. If the ball screw speed exceeds it's critical speed it may result in resonance. Hence, the critical speed is related to the ball screw length, the critical speed can help to determine the ball screws effective stroke and total length.

The maximum allowable rotational speed of the ball screw is calculated as follows:

$$N_P = 0.8 \times 2.71 \times 10^8 \times \frac{M_f \ d_r}{L_t^2}$$

N_p= the maximum allowable rotation speed (rpm)

M_f= breakdown of the assembly mounting type

d_r= screw root diameter (mm)

L_t= screw span between bearings (mm)

3. Acceleration/Deceleration

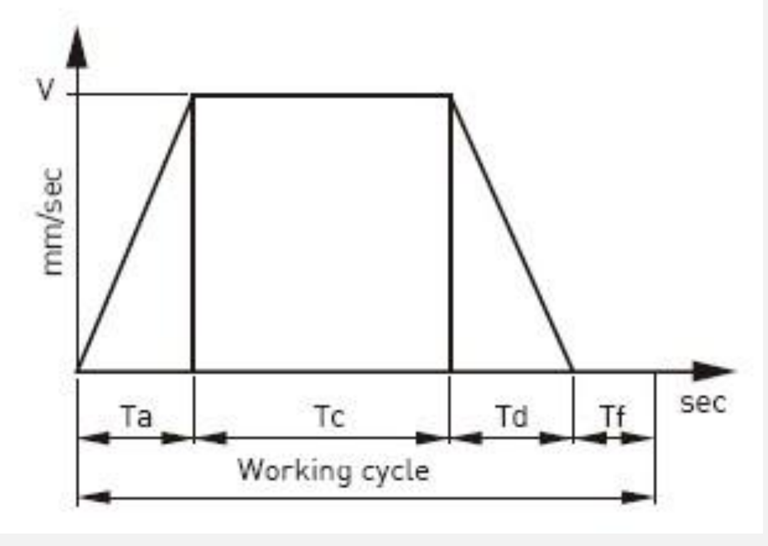
Speed is specified as the working speed of the sliding table. The sliding table must accelerate to the designated speed as it moves to it's target position, in opposite, it must decelerate before it comes to a stop.

Acceleration/deceleration is programmed by the operator according to the needed conditions. The acceleration is set at 0.3G calculated for lead = 5. 1G = 9.8m/s^2, therefore 0.3G = 2940mm/s^2. The maximum load shown in the catalog is based on this acceleration/deceleration.

Attention: Acceleration/deceleration will generate an inertia force on the load. For higher acceleration/deceleration, load will increase accordingly. In addition, higher acceleration/deceleration could generate a possible impact and should be noted.

4. Working cycle

The working cycle is determined by the operator. Below figure illustrates how the working cycleis generally calculated. The variables include acceleration time T_a, constant speed time T_c, deceleration time T_d, and idling time T_f.



Accelerating Speed=V/T_a

Decelerating Speed=V/T_d

Working cycle (sec) = T_a+T_c+ T_d+ T_f

Working time=working cycle × frequency

Operating ratio=working time / (working time+off time)

Operating ratio is closely related to the load of the motor. Normally, the operating ratio is not recommended to exceed 0.5 for long, continuous work.

Motor Loading Calculation

1. Confirm the moving conditions required by the loading mechanism, including acceleration, deceleration, the weight of the mechanism and it's movement.

2. Momentum loading calculation:

Momentum calculation for loads moving along a straight line

$$J_L = W \times \left(\frac{V}{2 \times \pi \times N \times 10}\right)^2 = W \times \left(\frac{\triangle S}{20 \times \pi}\right)^2$$

J_L : Momentum of load, calculated to the motors axial output ($kg.cm^2$)
V : Velocity of load along a straight line(mm/min)
ΔS : Displacement of load per motor rotation(mm)
W : Weight of load (kg)
N : Rotational speed of motor[r/min]

3. Select suitable specification of motor with the proportional principle per the momentums between load and motor.

4. Calculate the acceleration and deceleration torques per the momentum of the selected motor combined with the momentum of the load.

Acceleration torque:

$$T_a = \frac{(J_L + J_M) \times N}{9.55 \times 10^4 \times T_{psa}}$$

Deceleration torque:

$$T_d = \frac{(J_L + J_M) \times N}{9.55 \times 10^4 \times T_{psd}}$$

J_L : Momentum of load, calculated to the motors axial output ($kg.cm^2$)
J_M : Momentum of motor ($kg.cm^2$)
N : Rotational speed of motor (r/min)
T_{psa} : Acceleration/deceleration time(s)
T_{psd} : time (s)

5. Per the loads, installation methods, friction coefficients, and motor efficiency, calculate the torque at uniform motion.

$$T_L = \frac{F \times V}{2 \times 10^3 \times \pi \times \eta \times N} = \frac{F \times \Delta S}{2 \times 10^3 \times \pi \times \eta}$$

F : Axial force moving along a straight line
$F = F_C + \mu x (Wxg + F_0)$

T_L : Load torque (N.m)

F_C : External force exerted in the axial direction (N)

F_0 : External positive pressure exerted by the load onto the module (N)

W : Load (including sliding platform) (kg)
μ : Friction coefficient
η : Mechanical efficiency
V : Velocity of load in a straight line (mm/min)
N : Rotational speed of motor (r/min)
g : Gravity ($9.8 m/s^2$)
ΔS : Displacement of load per motor rotation

6. The maximum output torque of the selected motor should be larger than the sum of the acceleration torque and load torque; if this condition is not met, the model number needs to be changed and calculated until the requirement is satisfied.

7. Obtain the continuous effective torque per the load torque, acceleration torque, deceleration torque, and continuous torque.

$$T_{RMS} = \sqrt{\frac{T_a^2 \times T_{psa} + T_L^2 \times t_c + T_d^2 \times T_{psd} + T_{LH}^2 \times t_h}{T_f}}$$

T_{psa} : Acceleration time
T_{psd} : Deceleration time
T_f : Cycle time
T_L : Load torque
t_c : Constant speed time
t_h : Stop time
T_a : Acceleration torque
T_d : Deceleration torque
T_{LH} : Continuous torque (horizontal movement, $T_{LH}=0$)

8. The rated output torque of the selected motor should be larger than the continuous effective torque; otherwise, the model number needs to be changed and calculated until the requirement is compliant.

Installation

If the ball screw is used in the vertical direction (Z axis), the load should be within the maximum value indicated for vertical loading. Vertical installation using timing belts is forbidden.

Service life

For horizontal, side or slope (less than 30 degrees) orientation, the service life depends on the life of guide way, but for vertical or slope (more than 30 degrees) orientation, the service life depends on the life of ball screw or fixed bearing (on the which is shorter).

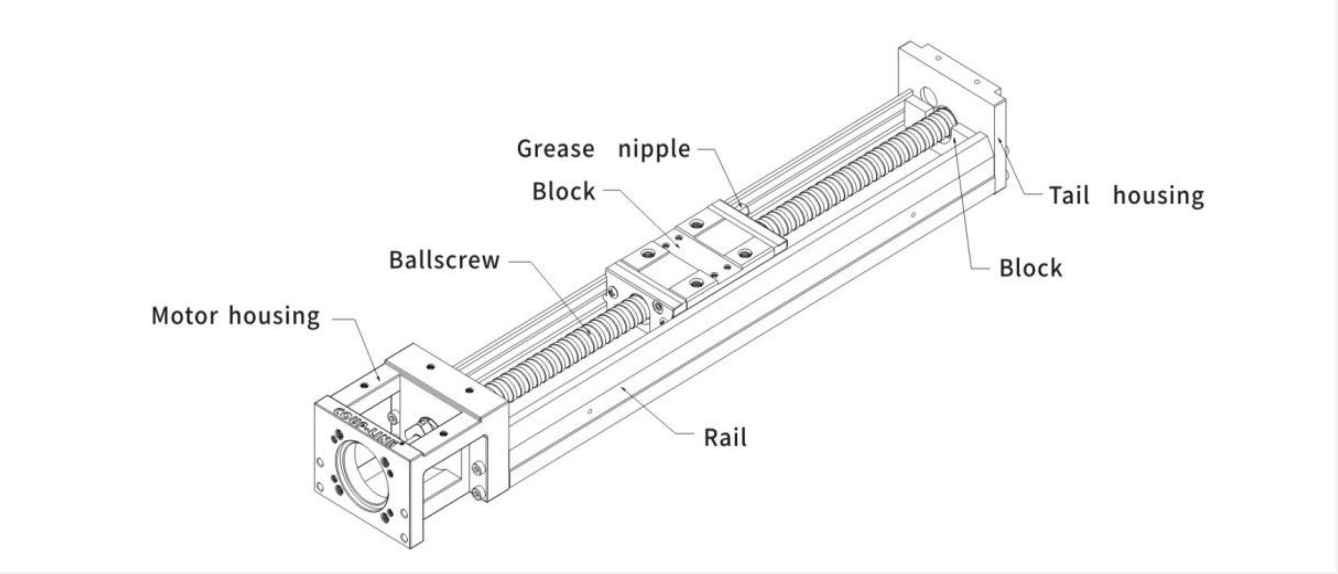
The listed dynamic load (Fy, Fz, Mx, My, Mz) is based on a service life of 10,000km of travel. If the load is less than the loading condition (Fy/Fyd + Fz/Fzd + Mx/Mxd + My/Myd + Mz/Mzd)≦1), the service life could be extended. If the load is over, the service life will be less than 10,000km. To ensure long term use, it is recommended that the loading must be within the listed range.

Maintenance

All the related accessories, ball screw and guide way need to be maintained. After every 3 months or 100km travel distance, it is recommended to add grease to the ball screw and guide way. Clean any dust or debris from the system. Replace the grease if there is any color change. If you have any further questions, please consult us.

LKR Series

The LKR Series linear module integrating a ballscrew and guideway forms a modularized product. The modularized design can help customers save time, cost and system inspection. It is driven by a ballscrew when a guideway slides on an optimized U-rail to achieve higher accuracy and greater stiffness.



Features

- High accuracy
- High stiffness
- Compact
- Easy intallation and convenient

Application

- High-precision industry
- Photovoltaic industry
- Automation equipment
- Lithium battery equipment

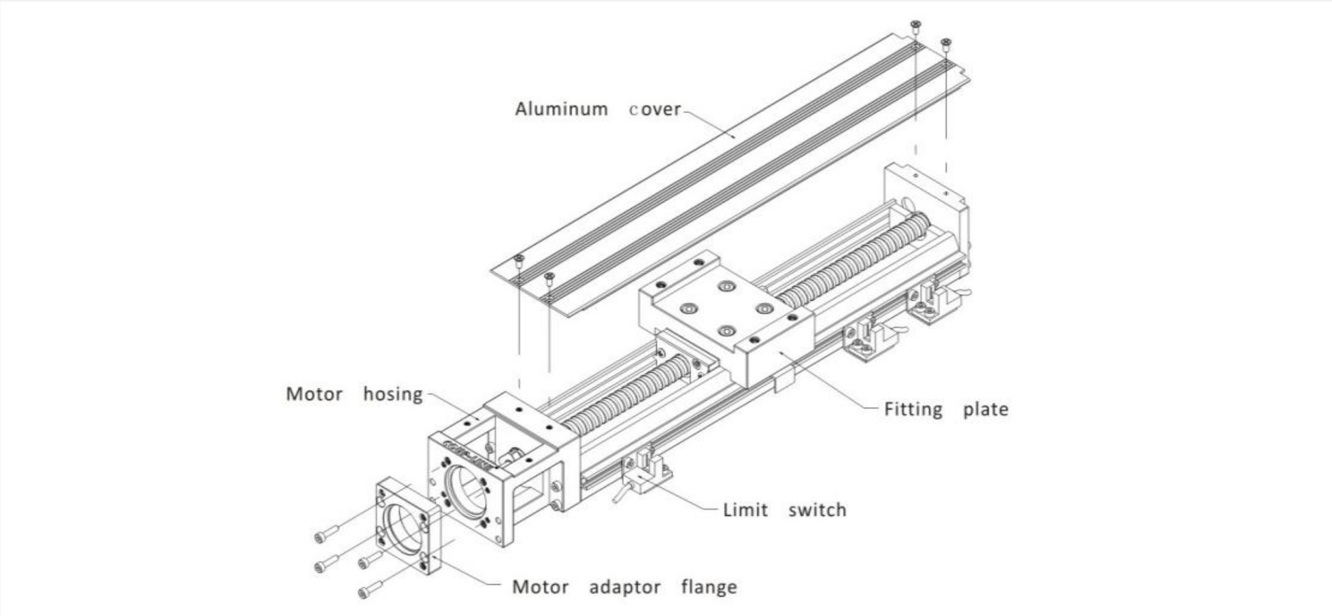
Various Specifications

The following linear modules have been developed to meet various needs, and are available for customers to choose according to usage requirements, space, and load.

Accessories Option

Aluminum cover, motor adaptor flange and limit switchs are available for option to meet specific demands.

- O Aluminum cover: contamination prection
- O Motor adaptor flange: connection for different types of motors
- O Limit switchs: starting point, positioning and other saftety matters

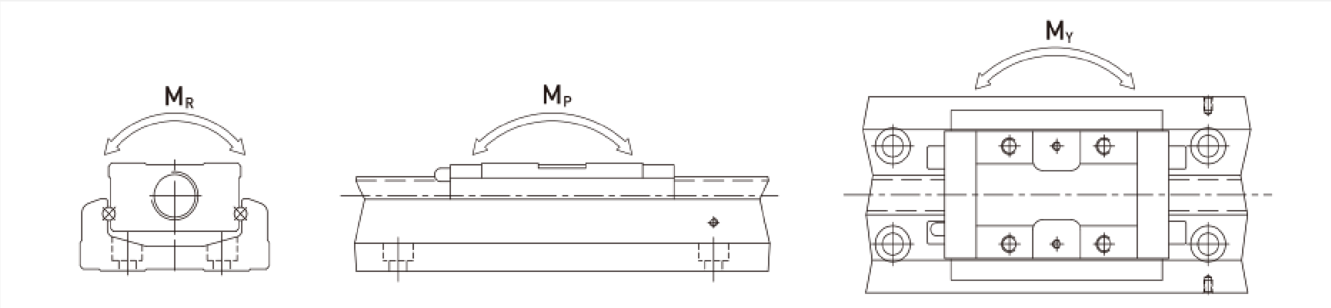


Ordering Information

LKR 60 10 P E — 400 E A 1 E — F0 C S0 M

- LKR Series
- Size: 50, 60, 86, 100
- Ballscrew Lead: LKR50: 2; LKR60: 5, 10; LKR86: 10, 20
- Accuracy Grade: P: Precision, C: Normal
- E: Ballscrew Special Order; Blank: Standard
- Rail Length (mm)
  - LKR50: 150, 200, 250, 300
  - LKR60: 150, 200, 250, 300, 400, 500, 600
  - LKR86: 340, 440, 540, 640, 740, 940
- E: Rail Special Order; Blank: Standard
- Block Type: A: Standard; S: Light Load
- Number of Blocks: 1
- E: Block Special Order; Blank: Standard
- Motor Adaptor Flange:
  - F0: Direct Fixed
  - F1: ref. Flange Spec
  - F2: ref. Flange Spec
- C: Aluminum Cover; Blank: W/O Cover
- Limit Switch:
  - S0: Switch Rail Only
  - S1: SX671
  - S2: SX674
  - Blank: No Switch Rail
- M: Motor; Blank: Without Motor

Load Specifications



Model No.		Ballscrew				Guideway				
		Nominal Diameter (mm)	Lead (mm)	Basic Dynamic Load (N)	Basic Static Load (N)	Basic Dynamic Load Rating (N)	Basic Static Load Rating (N)	Static Rated Moment		
								Allowable Static Moment M_p (N.m)	Allowable Static Moment M_Y (N.m)	Allowable Static Moment M_R(N.m)
						Block A	Block A	Block A1	Block A1	Block A1
LKR5002	Precision	8	2	2136	3489	8007	12916	116	116	222
	Normal			1813	2910					
LKR6005	Precision	12	5	3744	6243	13230	21462	152	152	419
	Normal			3377	5625					
LKR6010	Precision	12	10	2410	3743	13230	21462	152	152	419
	Normal			2107	3234					
LKR8610	Precision	15	10	7144	12642	31458	50764	622	622	1507
	Normal			6429	11387					
LKR8620	Precision	15	20	4645	7655	31458	50764	622	622	1507
	Normal			4175	6889					

Accuracy Grade

Model	Rail Length	Repeatability		Accuracy		Running Parallelism		Starting Torque (N.cm)	
		Precision	Normal	Precision	Normal	Precision	Normal	Precision	Normal
LKR50	150	± 0.003	± 0.005	0.02	-	0.01	-	4	2
	200								
	250								
	300								
LKR60	150	± 0.003	± 0.005	0.02	-	0.01	-	15	7
	200								
	300								
	400								
	500	± 0.003	± 0.005	0.025	-	0.015	-	15	7
	600								
LKR86	340	± 0.003	± 0.005	0.025	-	0.015	-	15	10
	440								
	540								
	640								
	740	± 0.003	± 0.005	0.03	-	0.02	-	17	10
	940	± 0.003	± 0.005	0.04	-	0.03	-	25	10

Maximun Speed Limit

Model	Ballscrew Lead (mm)	Rail Length (mm)	Speed (mm/sec)	
			Precision	Normal
LKR50	02	150	270	270
		200	270	270
		250	270	270
		300	270	270
LKR60	05	150	550	390
		200	500	390
		300	550	390
		400	550	390
		500	550	390
		600	340	340
LKR86	10	150	1100	790
		200	1100	790
		300	1100	790
		400	1100	790
		500	1100	790
		600	670	670
LKR86	10	340	740	790
		440	740	520
		540	740	520
		640	740	520
		740	740	520
		940	610	430
LKR86	20	340	1480	1050
		440	1480	1050
		540	1480	1050
		640	1480	1050
		740	1480	1050
		940	1220	1050

Life Calculations

1. Service Life

Under repeated stress between the raceway and the rolling elements, pitting and flaking will occur as it reaches fatigue failure. The service life of the LKR linear module is defined as the distanced traveled before any failure of the raceway or rolling elements appear.

2. Nominal Life

The service life varies greatly even when the LKR units are manufactured in the same way or operated under the same conditions. For this reason, nominal life is used as the criteria for predicting the service life of a LKR unit.

3. Nominal Life Calculation

The calculating formulas are divided into two parts, guideway and ballscrew. The smaller value of the two would be the recommended nominal life of the LKR unit.

Nominal life formulas for both the guideway and ballscrew depend on several parameters and are shown below.

O Guideway

$$L = \left(\frac{f_t}{f_w} \cdot \frac{C}{P_n}\right)^3 \times 50 \text{ km}$$

L : Life Rating (km)

f_t : Contact Coefficient (ref. Table1)

f_w : Loading Coefficient (ref. Table2)

C : Basic Dynamic Load Rating (N)

P_n : Calculated Loading (N)

Table 1

Block Type	Contact Coefficient f_t
A1	1.0

Table 2

Operating Condition		Loading Coefficient f_w
Thrust and Vibration	Velocity	
No Thrust	V<15m/min	1.0~1.5
Normal Vibration	15m/min≤V≤60m/min	1.5~2.0
High Vibration	V>60m/min	2.0~3.5

O Ballscrew and Bearing

$$L = \left(\frac{1}{f_w} \cdot \frac{C_a}{P_{a,n}}\right)^3 \times 10^6 \text{ rev}$$

L : Life Rating (rev.)

f_w : Loading Coefficient (ref. Table2)

C_a : Basic Dynamic Load Rating (N)

$P_{a,n}$: Axial Loading (N)

Lubrication

Insufficient lubrication of the guideway would lead to a reduction of the service life.

The lubricant provides the following functions:

- Reducing rolling friction and avoiding abrasion
- Providing a lubricating film and extending the service life
- Anti-rusting

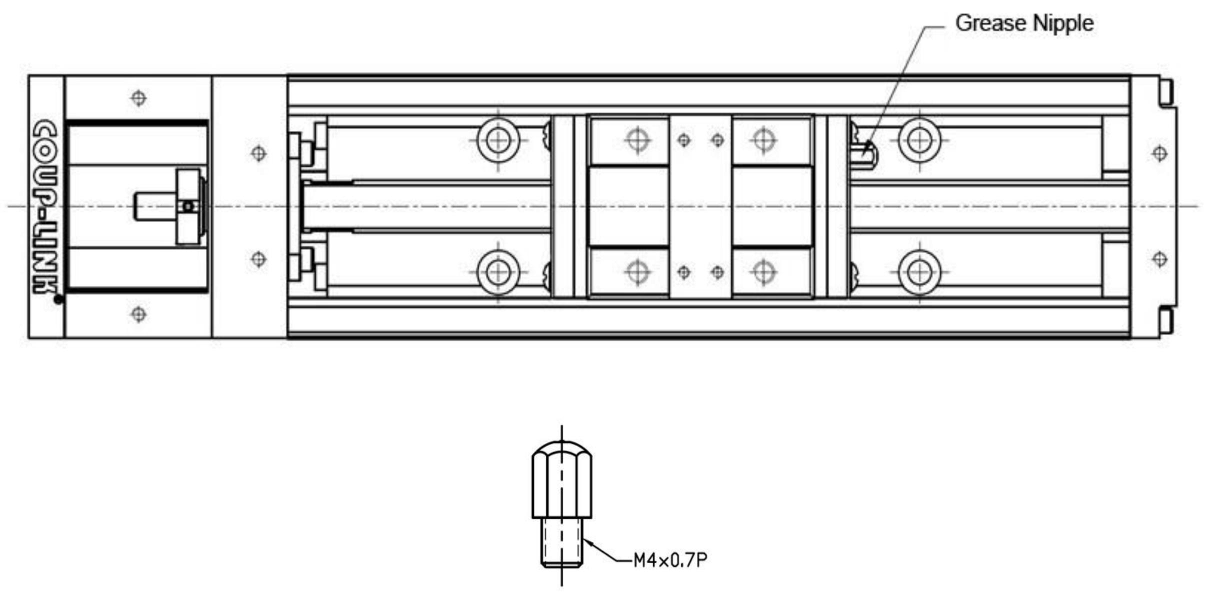
Lubricating Grease

Re-lubricating the robot every 100km is recommened. Generally, grease is applied for speeds under 60 m/min, a grease with a higher viscosity should be used.

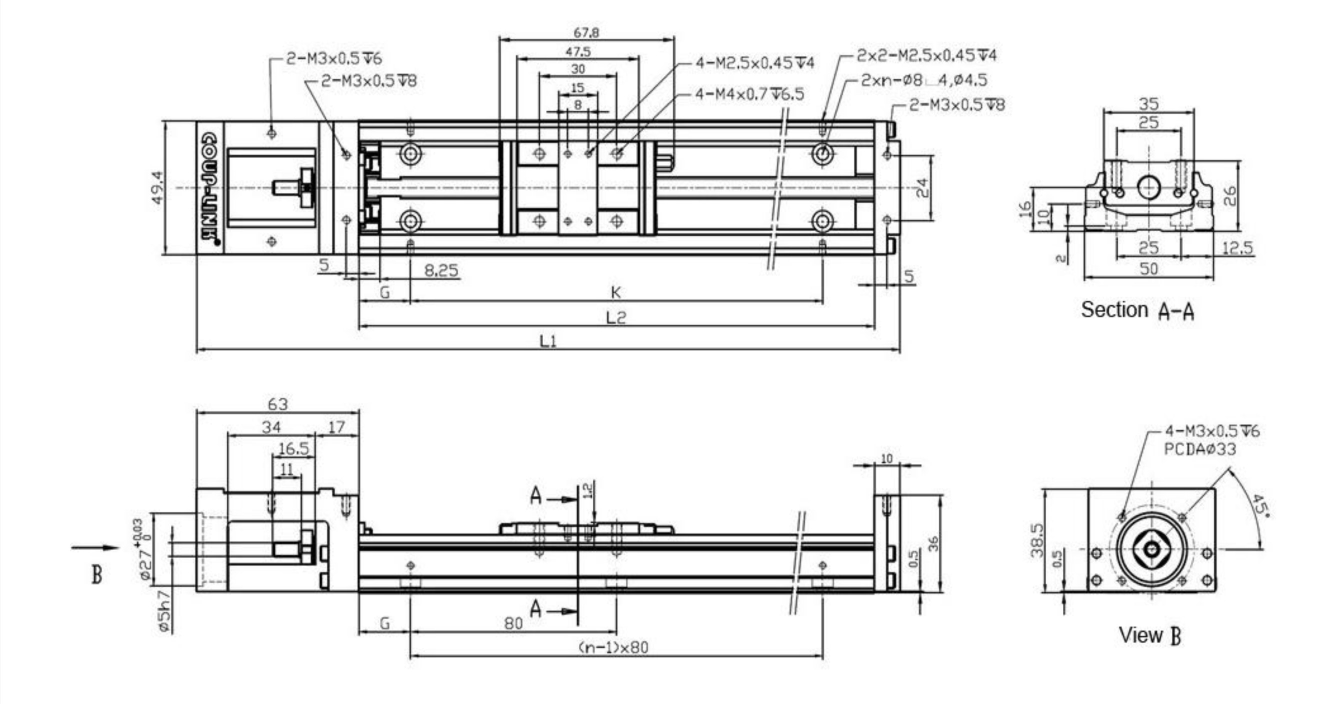
$$T = \frac{100 \times 1000}{V_e \times 60}$$

T : Lubricating frequency (hrs)
V_e : Speed (m/min)

Grease Nipple Location

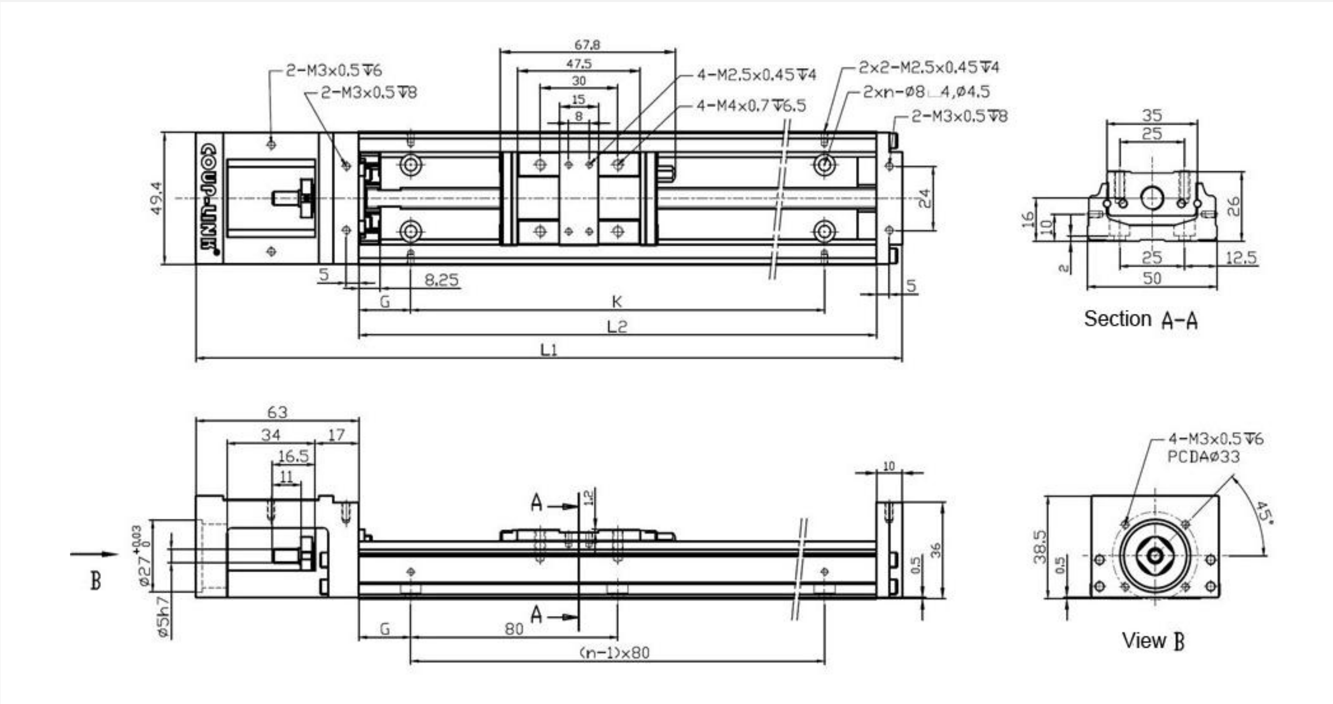


LKR 50 Without cover



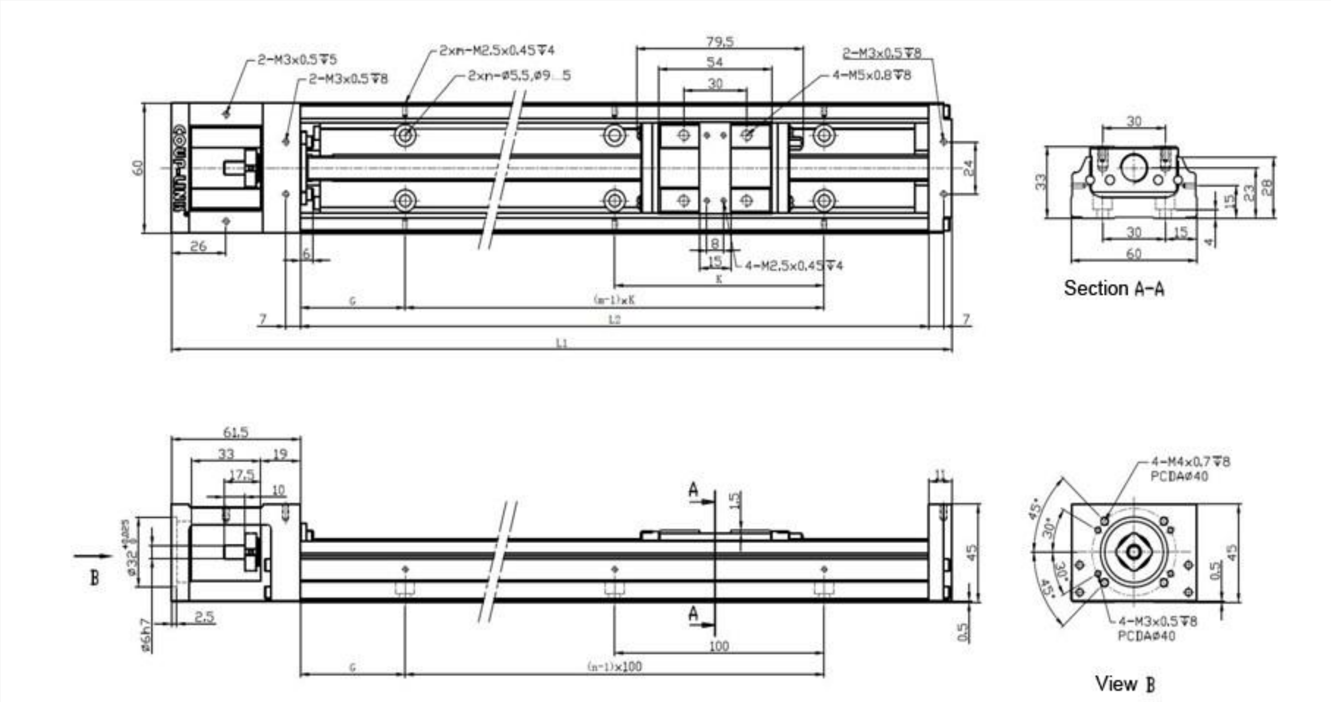
Rail Length L2 (mm)	Total Length L1 (mm)	Maximum Stroke (mm)	G (mm)	K (mm)	n	N.W./ea (kg)
150	223	70	35	80	2	0.97
200	273	120	20	160	3	1.17
250	323	170	45	160	3	1.36
300	373	220	30	240	4	1.56

LKR 50 With cover



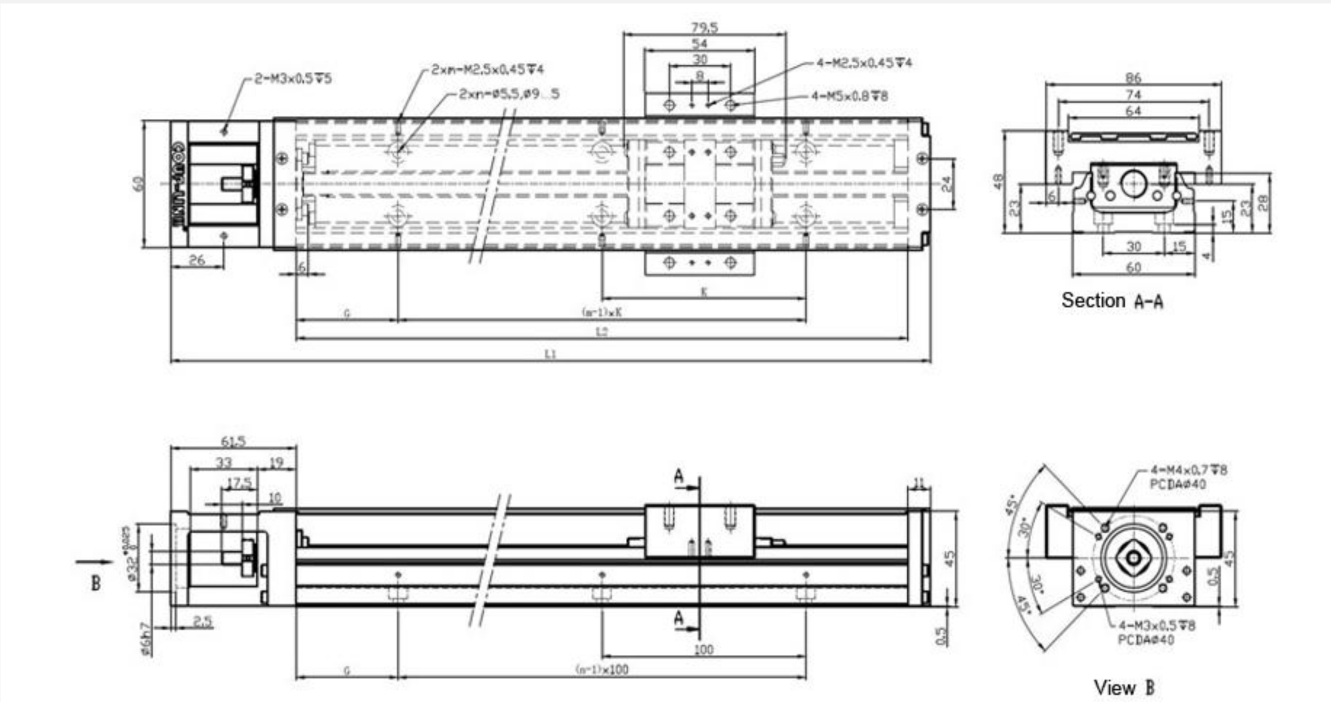
Rail Length L2 (mm)	Total Length L1 (mm)	Maximum Stroke (mm)	G (mm)	K (mm)	n	N.W./ea (kg)
150	223	70	35	80	2	1.10
200	273	120	20	160	3	1.31
250	323	170	45	160	3	1.52
300	373	220	30	240	4	1.73

LKR 60 Without cover



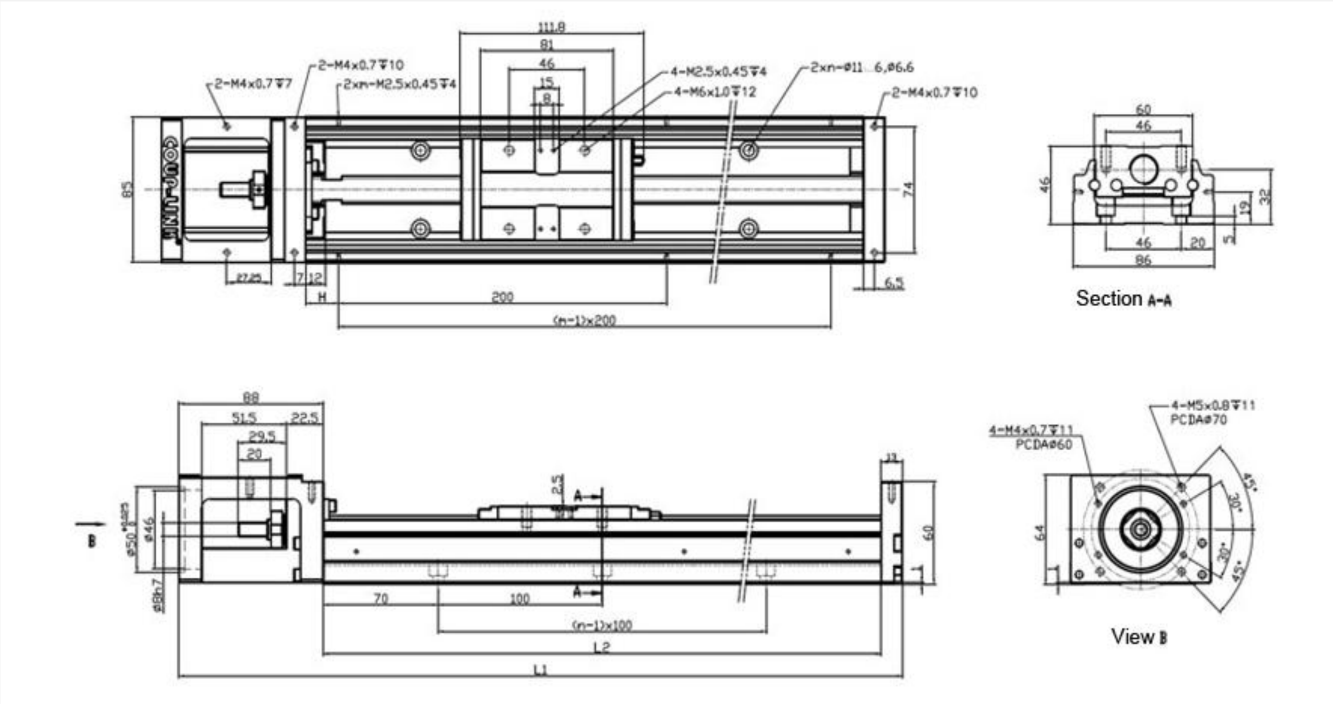
Rail Length L2 (mm)	Total Length	Maximum Stroke (mm)	G (mm)	K (mm)	n	m	N.W./ea (kg)
150	222.5	60	25	100	2	2	1.69
200	272.5	110	50	100	2	2	2.03
300	372.5	210	50	200	3	2	2.70
400	472.5	310	50	100	4	4	3.38
500	572.5	410	50	200	5	3	4.05
600	672.5	510	50	100	6	6	4.73

LKR 60 With cover



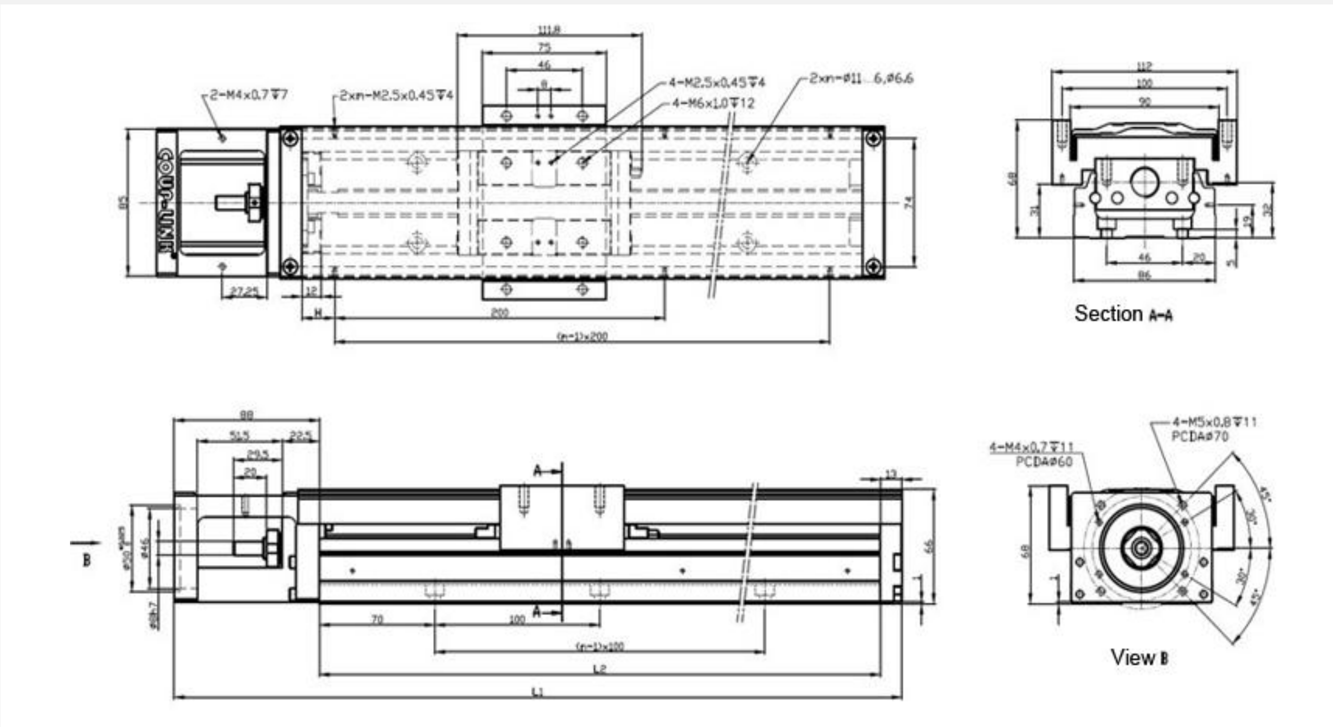
Rail Length L2 (mm)	Total Length	Maximum Stroke (mm)	G (mm)	K (mm)	n	m	N.W./ea (kg)
150	222.5	60	25	100	2	2	1.98
200	272.5	110	50	100	2	2	2.32
300	372.5	210	50	200	3	2	2.99
400	472.5	310	50	100	4	4	3.67
500	572.5	410	50	200	5	3	4.34
600	672.5	510	50	100	6	6	5.02

LKR 86 Without cover



Rail Length L2 (mm)	Total Length	Maximum Stroke (mm)	H (mm)	n	m	N.W./ea (kg)
340	441	216.5	70	3	2	5.87
440	541	316.5	20	4	3	7.10
540	641	416.5	70	5	3	8.33
640	741	516.5	20	6	4	9.56
740	841	616.5	70	7	4	10.79
940	1041	816.5	70	9	5	13.25

LKR 86 With cover

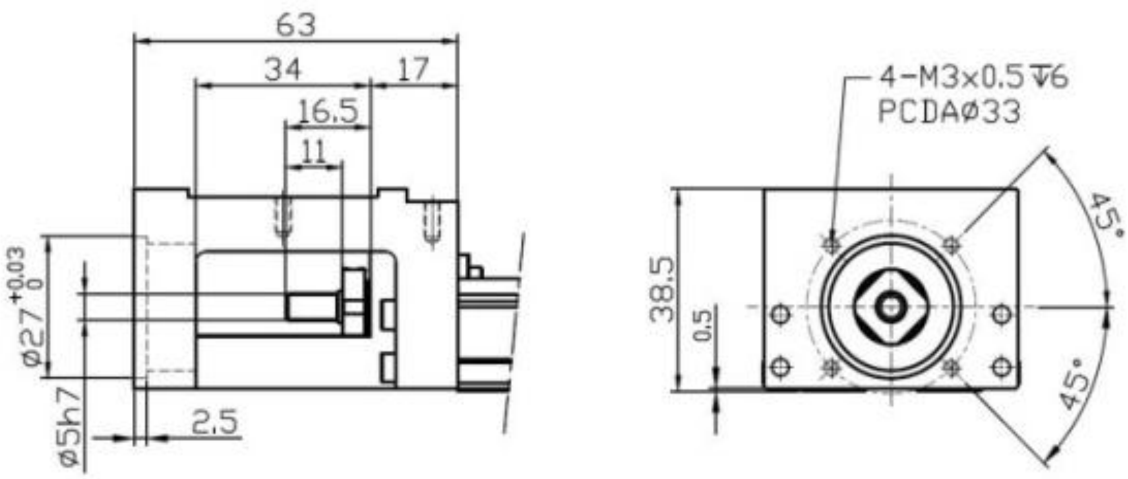


Rail Length L2 (mm)	Total Length	Maximum Stroke (mm)	H (mm)	n	m	N.W./ea (kg)
340	441	216.5	70	3	2	6.75
440	541	316.5	20	4	3	8.07
540	641	416.5	70	5	3	9.39
640	741	516.5	20	6	4	10.71
740	841	616.5	70	7	4	12.03
940	1041	816.5	70	9	5	14.66

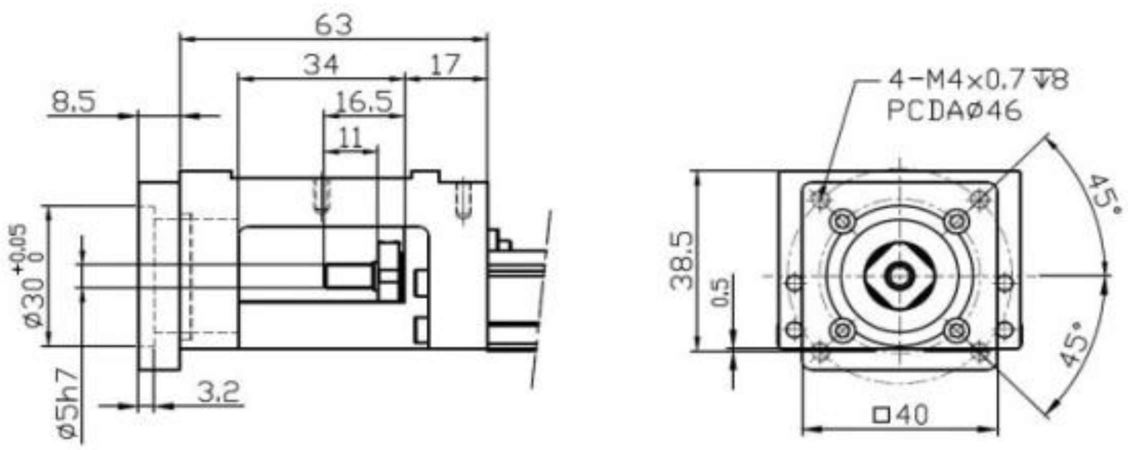
Motor Housing and Motor Adaptor Flange

LKR50

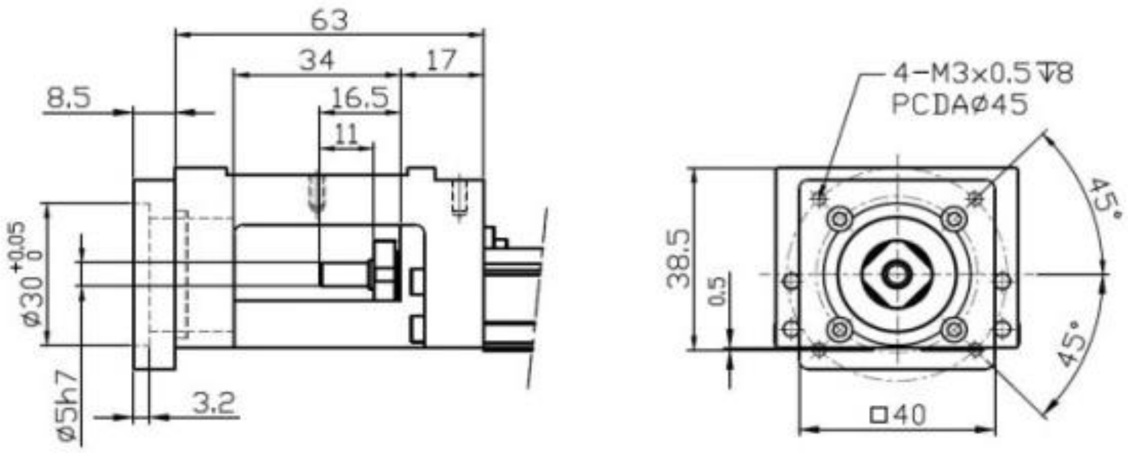
Motor Housing F0



Motor Adaptor Flange F1

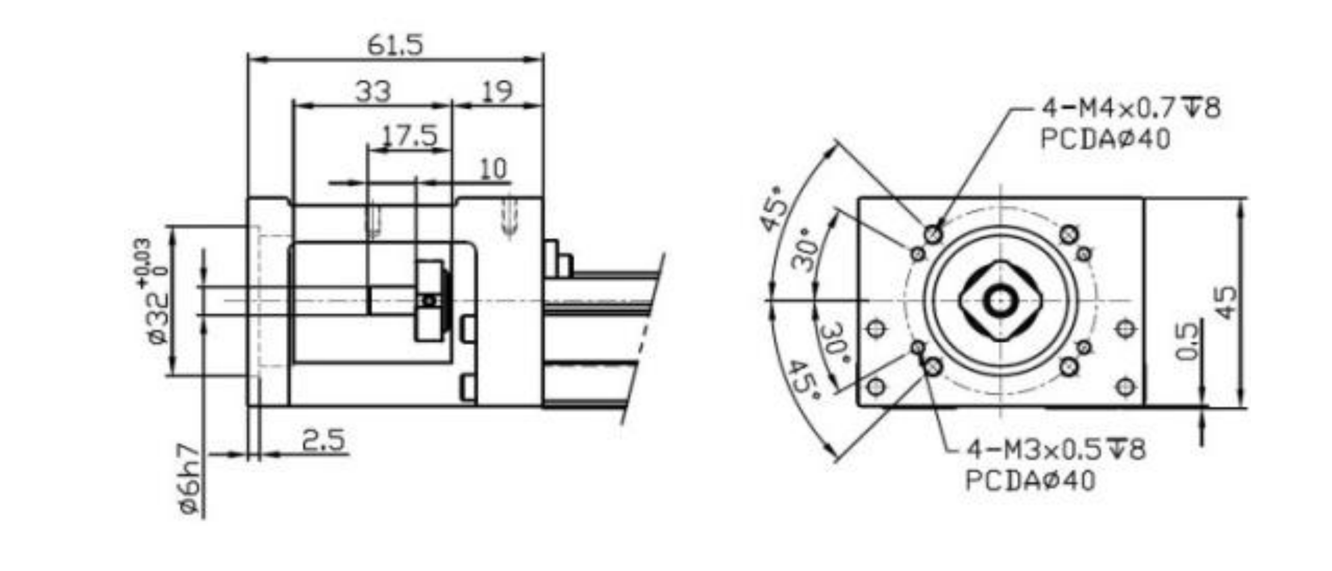


Motor Adaptor Flange F2

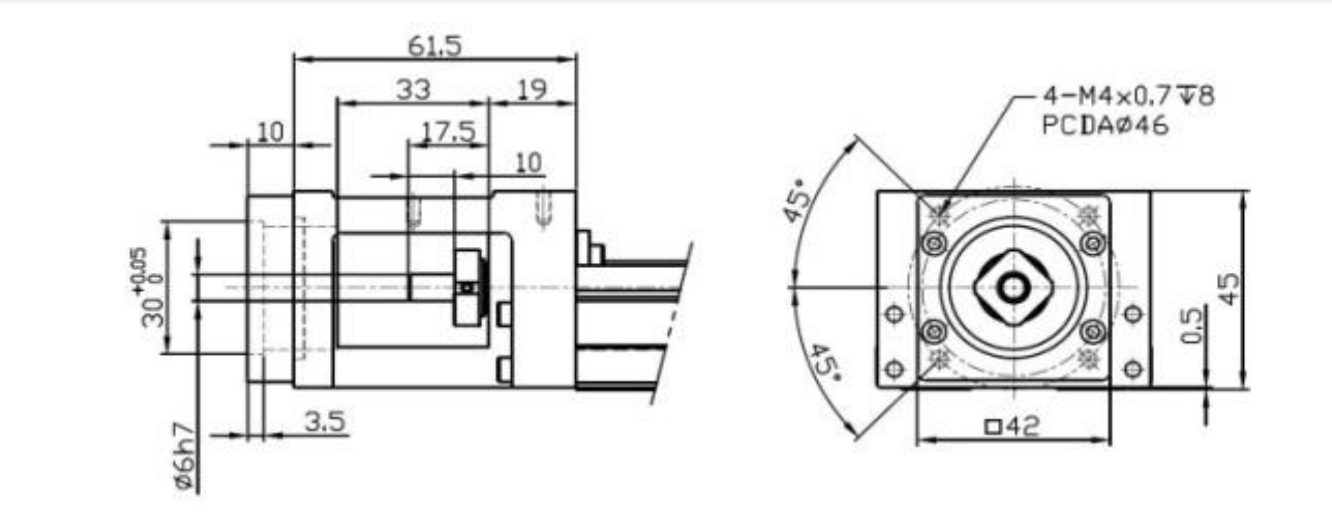


LKR60

Motor Housing F0



Motor Adaptor Flange F1



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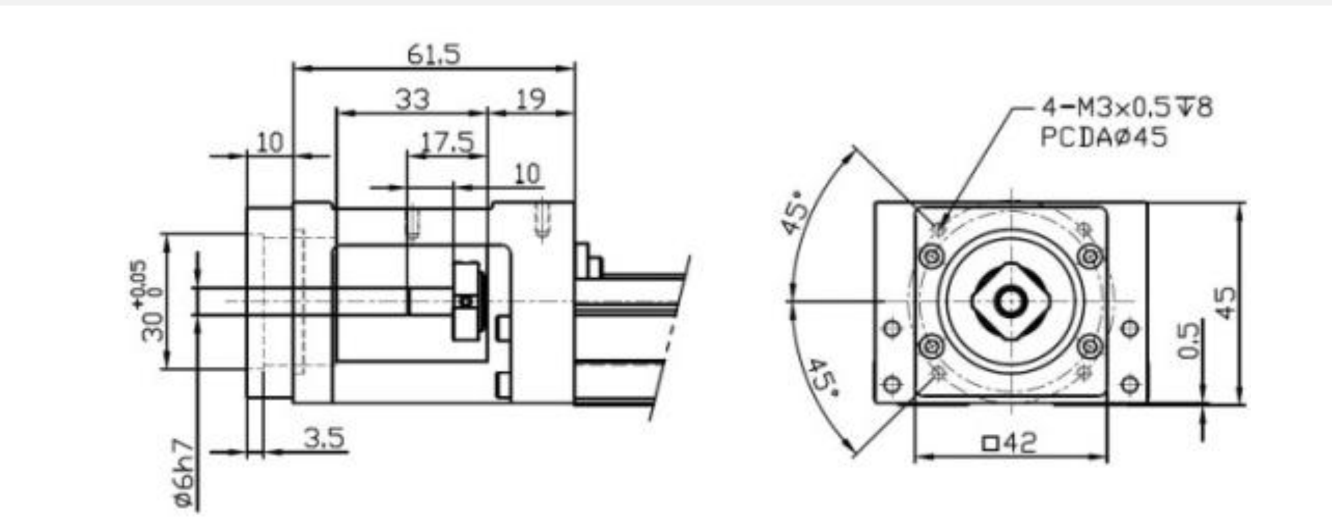
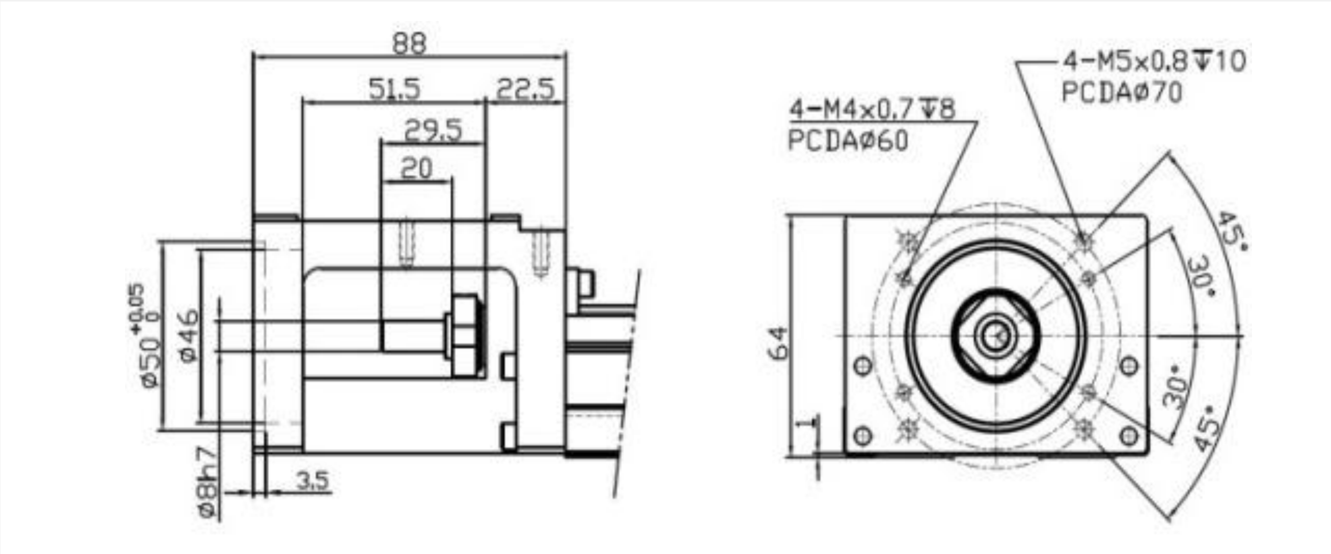
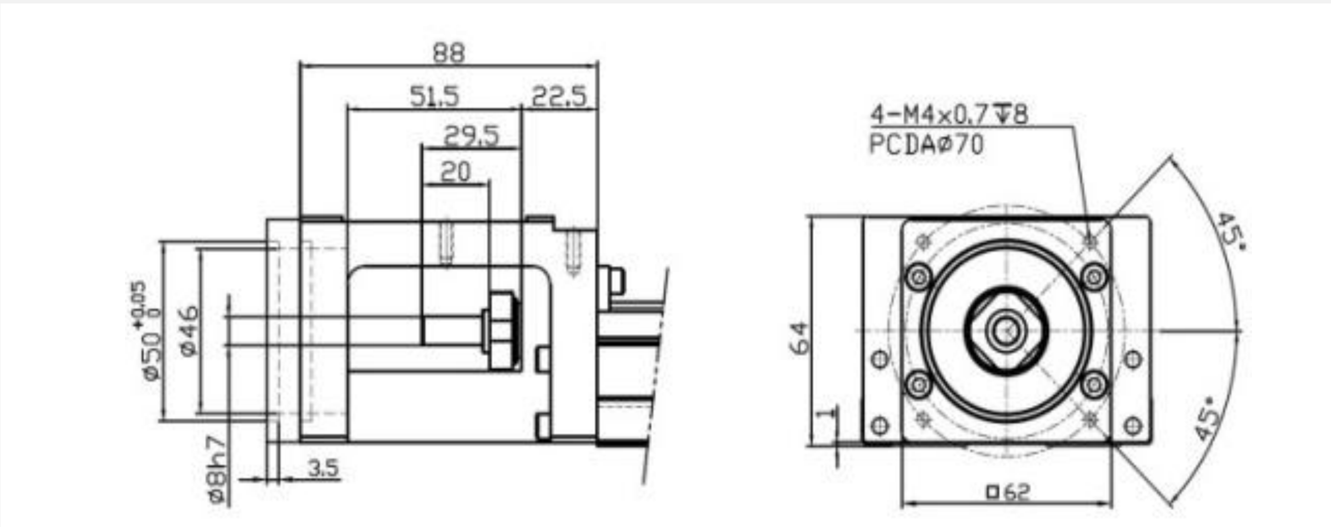


LKR86

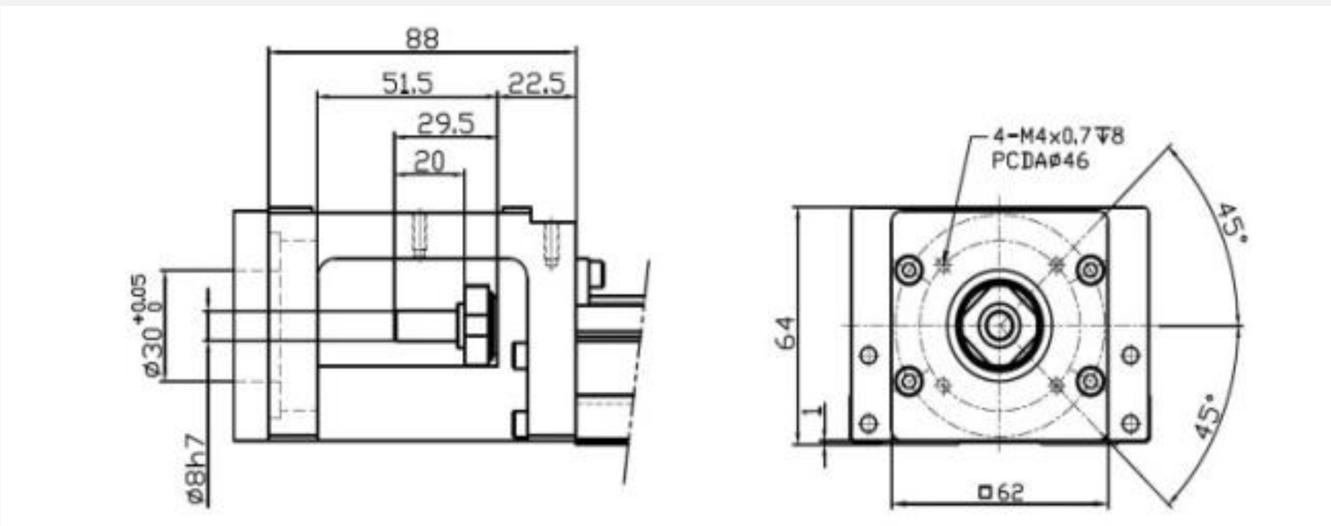
Motor Housing F0



Motor Adaptor Flange F1

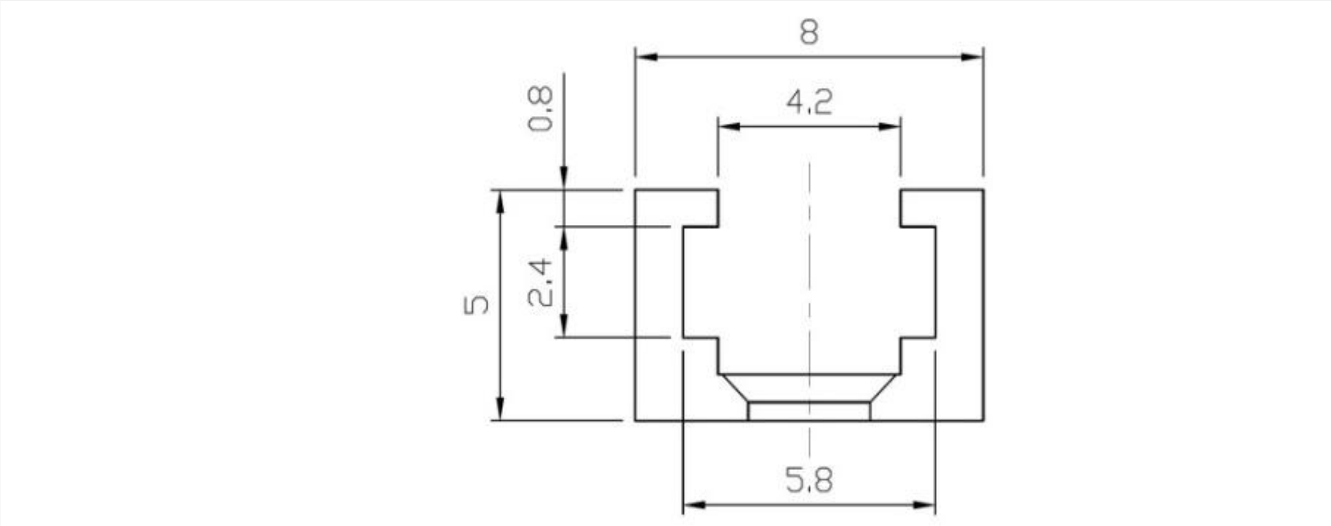


Motor Adaptor Flange F2

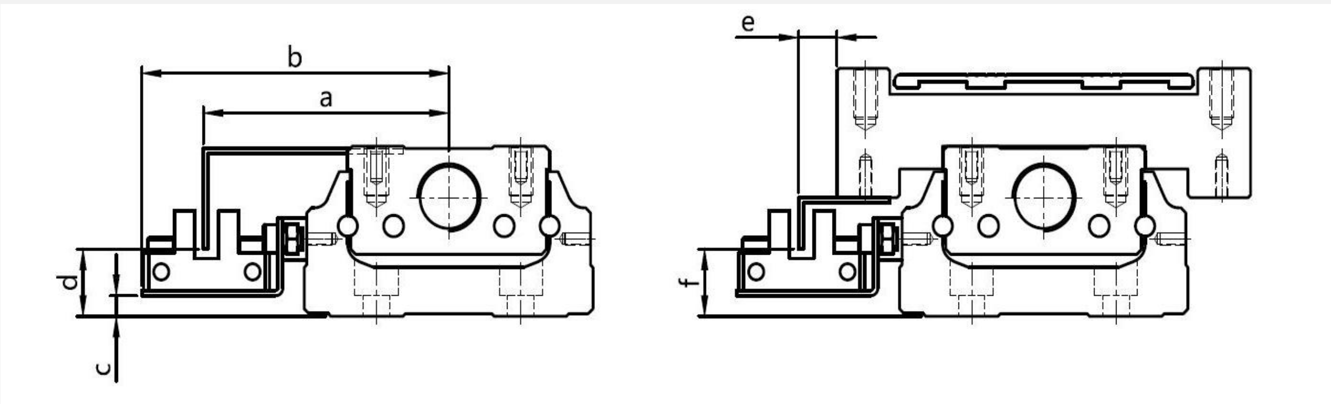


Switch

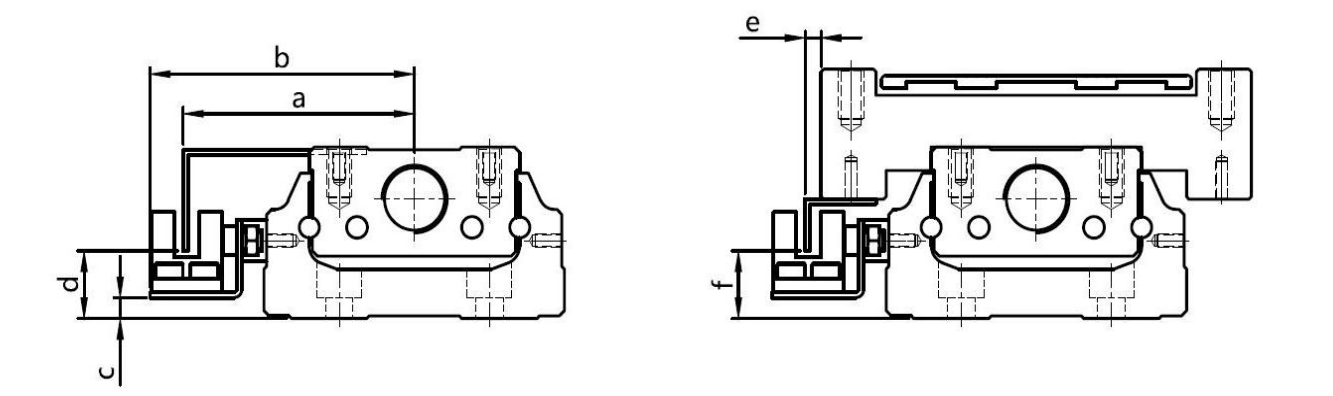
Switch Rail



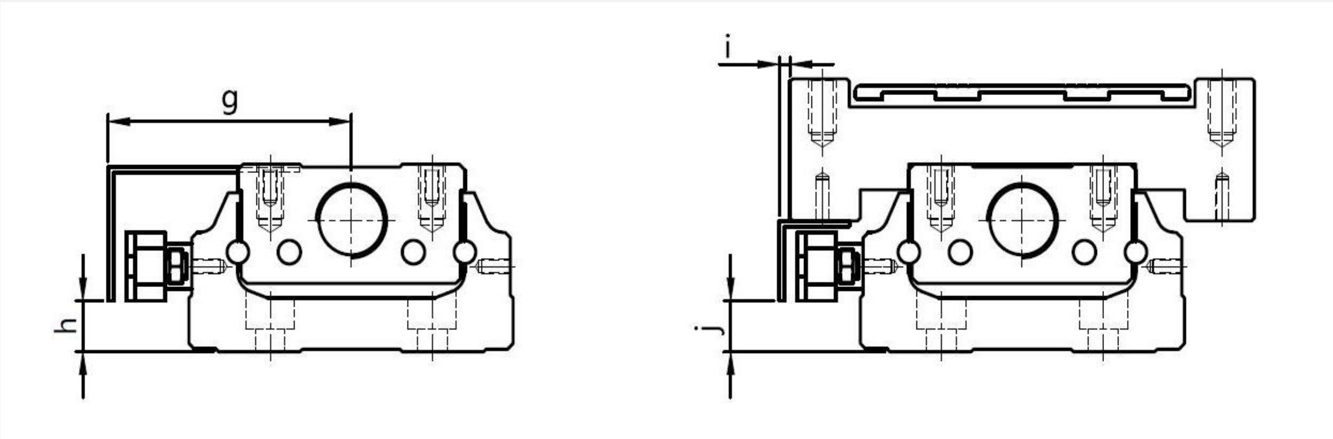
Switch



Size	a	b	c	d	e	f
LKR50	45.5	59	1	10	15	11
LKR60	51	63.8	4	14.5	8	13
LKR86	63.5	76.7	8	18	8	18
LKR100	71	84	10	20	9	20



Size	a	b	c	d	e	f
LKR50	41.3	48	1	10.5	10.2	11
LKR60	46.2	52.8	4	14	3.2	13
LKR86	59	65.7	8	18	3	18
LKR100	66	73	10	20	4.2	20



Size	g	h	i	j
LKR50	39.5	5.7	7	19.5
LKR60	44.5	9	2	9
LKR86	57	13	1	13
LKR100	64.5	15	2.5	15