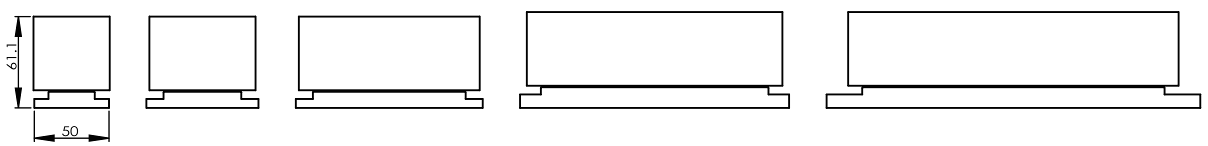
AKM

Specifications

AKM30



Model		AKM30-B1	AKM30-B2	AKM30-B4
		Natural Cooling	Natural Cooling	Natural Cooling
Performance Parameters	Unit	Series	Series	parallel
Continuous Force @100°C	N	108.4	216.8	433.6
Peak Force	N	241.6	483.2	966.3
Force Constant	N/Arms	23.0	45.9	45.9
Back EMF Constant	Vpeak/(m/s)	18.7	37.5	37.5
Motor Constant	N/Sqrt(W)	17.7	25.0	35.4
Resistance (Terminal to Terminal)	Ω	1.1	2.2	1.1
Inductance (Terminal to Terminal)	mH	21.0	42.0	21.0
Electrical Time Constant	ms	18.8	18.8	18.8
Continuous Current @100°C	Arms	4.8	4.8	9.6
Peak Current	Arms	14.4	14.4	28.8
Continuous Power Dissipation @100°C	W	38.7	77.4	154.8
Max. Coil Temperature	°C	100.0	100.0	100.0
Thermal Dissipation Constant	W/ °C	0.5	1.0	2.1
Max. Bus Voltage	Vdc	600.0	600.0	600.0
Magnetic Period	mm	42.0	42.0	42.0
Cogging Force (pk to pk)	N	2.3	4.0	5.7
Attraction Force	kN	0.4	0.8	1.6

Note: All parameters vary in the range of ± 10% except dimensions.
Pure or distilled water is recommended for circulating water.

Motor Coil

Size	Length(mm)	Mass(Kg)
B1	112	1.5
B2	196	2.7
B4	364	5.3

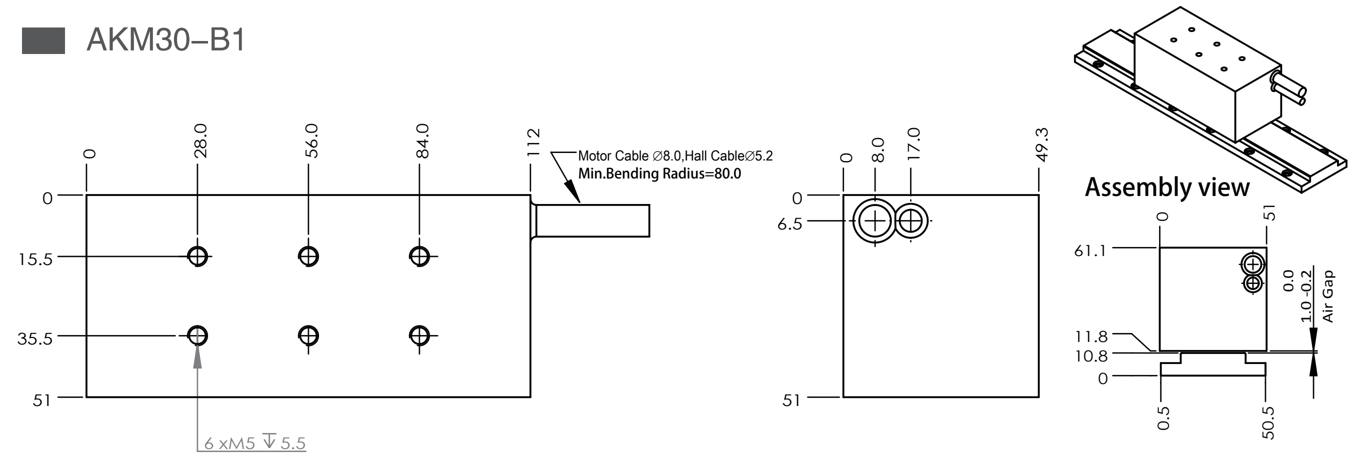
Motor Track

Size	Length(mm)	Mass(Kg)
TL168	168	0.4
TL252	252	0.6
TL420	420	1.1

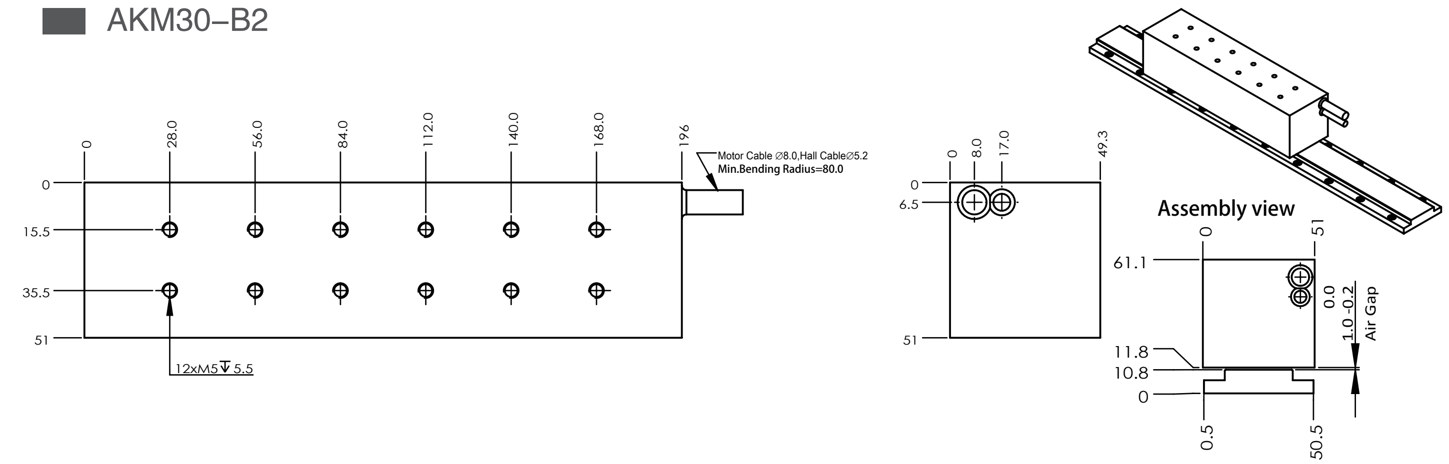
AKM

Dimensions

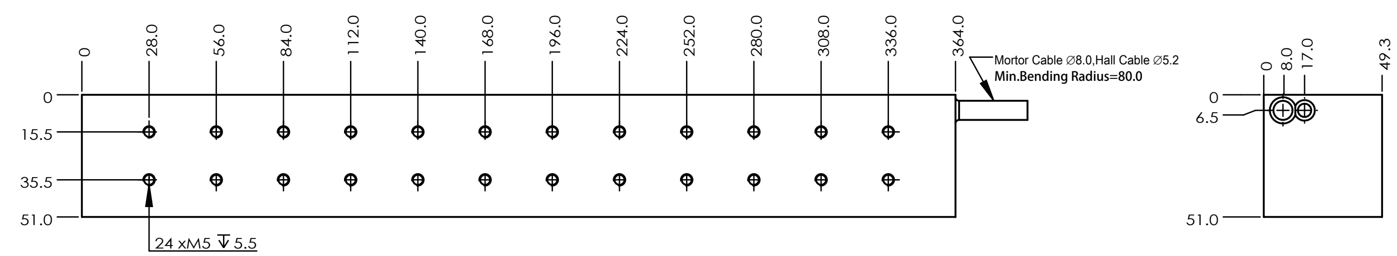
AKM30–B1



AKM30–B2



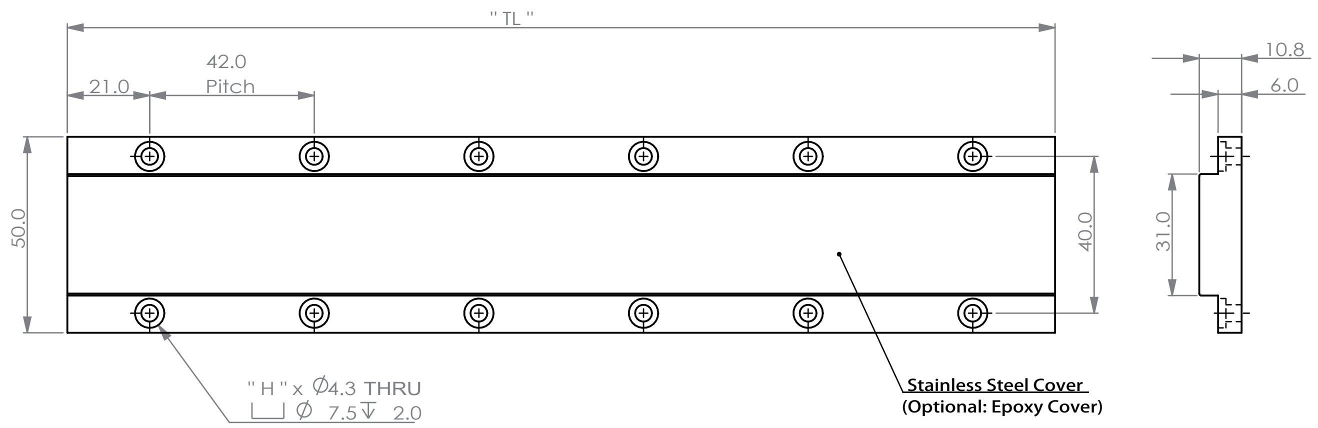
AKM30–B4



AKM

Track

AKM30



Magnet Track P / N:	Track Length "TL"	No.of Holes "H"
AKM30-TL168	168.0	8
AKM30-TL252	252.0	12
AKM30-TL420	420.0	20

For epoxy cover option, add "E" to P/N.(e.g. AKM30–TL168E)

AKM

Part Numbering

Coil

AKM30–B1–J–H9D–3.0–FB

- **Model**: AKM30
- **Segment**: B1/B2/B4
- **Thermal Sensor**: J = Thermostat (standard), K = PT100 (RTD); K4 = PTC Thermistor, KTY81/121; K5 = RTD, PT1000 Sensor
- **Hall Options**: Blank[1], H9D[2], NH[3]
- **Cable Length (m)**: 3.0
- **Ferrite Bead Options**: Blank[4], FB[5]

Track

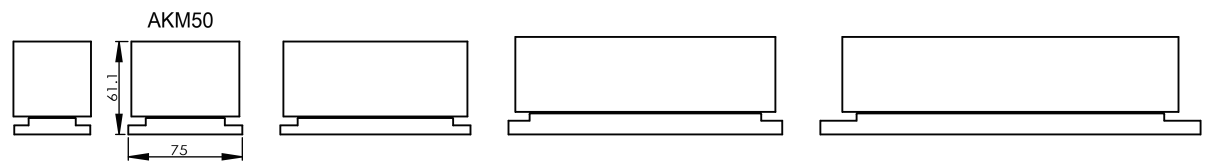
AKM30–TL420–E

- **Model**: AKM30
- **Track Length**: TL168/ TL252/ TL420
- **Cover Type**: Blank[6], E[7]

1. Blank = comes with built–in hall sensor & hall cable terminated in flying leads. (standard)
2. H9D = comes with built–in hall sensor & hall cable terminated with 9–Pins D–Sub connector.
3. NH = comes without built–in hall sensor
4. Blank = motor cable terminated in flying leads. (standard)
5. FB = motor cable terminated with ferrite bead.
6. Blank = Stainless steel cover
7. E = Epoxy cover

AKM

Specifications



Model		AKM50-B1	AKM50-B2	AKM50-W-B2	AKM50-B4	AKM50-W-B4
		Natural Cooling	Natural Cooling	Water Cooling	Natural Cooling	Water Cooling
Performance Parameters	Unit	Series	Series	Series	parallel	parallel
Continuous Force @100°C	N	180.7	361.3	579.6	722.6	1159.3
Peak Force	N	402.6	805.3	805.3	1610.5	1610.5
Force Constant	N/Arms	38.3	76.5	76.5	76.5	76.5
Back EMF Constant	Vpeak/(m/s)	31.2	62.5	62.5	62.5	62.5
Motor Constant	N/Sqrt(W)	26.3	37.2	37.2	52.6	52.6
Resistance (Terminal to Terminal)	Ω	1.4	2.8	2.8	1.4	1.4
Inductance (Terminal to Terminal)	mH	31.8	63.7	63.7	31.8	31.8
Electrical Time Constant	ms	22.6	22.6	22.6	22.6	22.6
Continuous Current @100°C	Arms	4.8	4.8	8.2	9.6	16.4
Peak Current	Arms	14.4	14.4	14.4	28.8	28.8
Continuous Power Dissipation @100°C	W	48.7	97.3	284.1	194.7	568.1
Max. Coil Temperature	°C	100.0	100.0	100.0	100.0	100.0
Thermal Dissipation Constant	W/ °C	0.6	1.3	3.8	2.6	7.6
Max. Bus Voltage	Vdc	600.0	600.0	600.0	600.0	600.0
Magnetic Period	mm	42.0	42.0	42.0	42.0	42.0
Cogging Force (pk to pk)	N	3.8	6.7	6.7	9.6	9.6
Attraction Force	kN	0.7	1.3	1.3	2.7	2.7

Note: All parameters vary in the range of ±10% except dimensions.
Pure or distilled water is recommended for circulating water.

Motor Coil

Size	Length(mm)	Mass(Kg)
B1	112	2.2
B2	196	4.1
B4	364	7.8

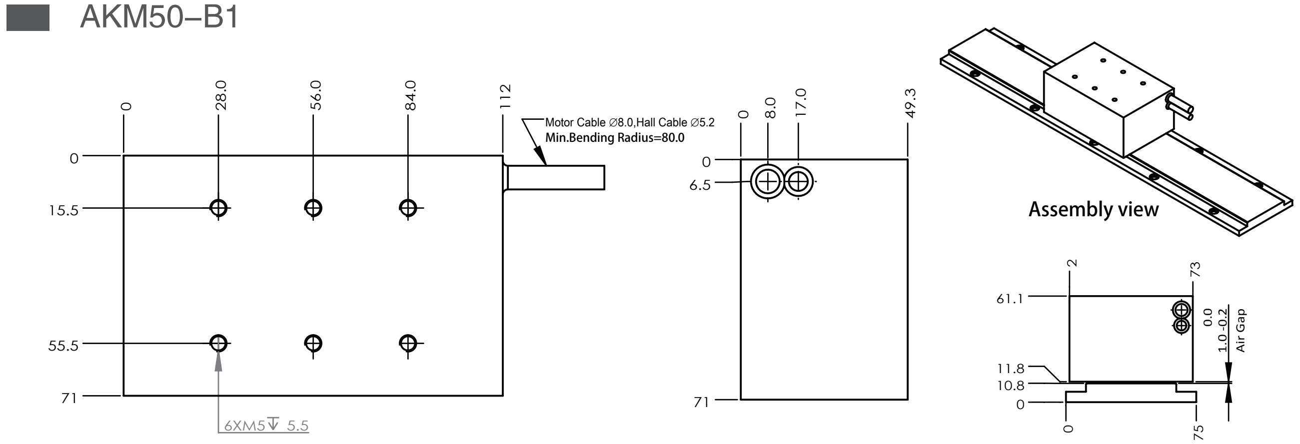
Motor Track

Size	Length(mm)	Mass(Kg)
TL168	168	0.8
TL252	252	1.2
TL420	420	2.0

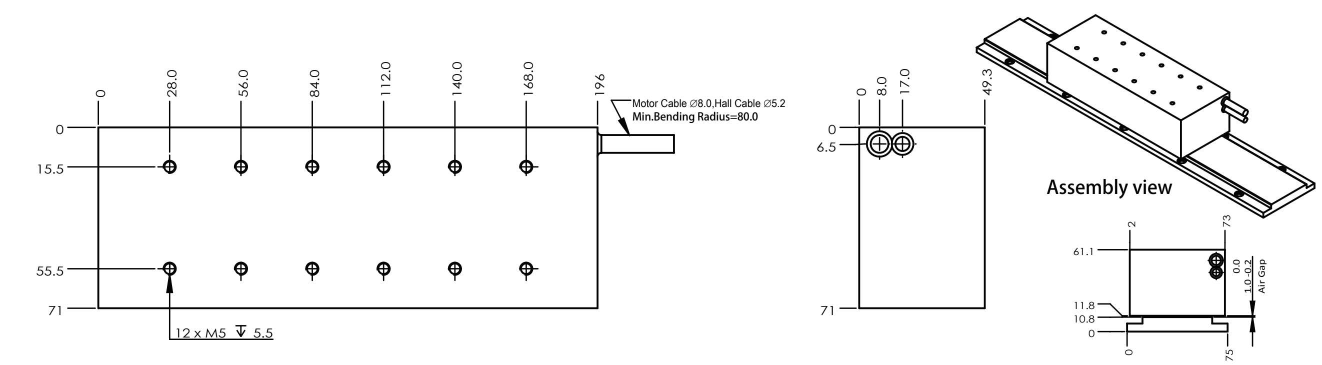
AKM

Dimensions

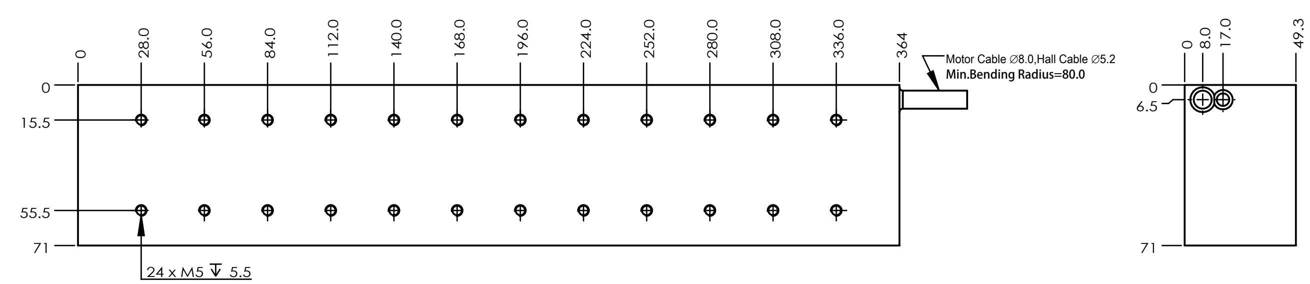
AKM50–B1



AKM50–B2



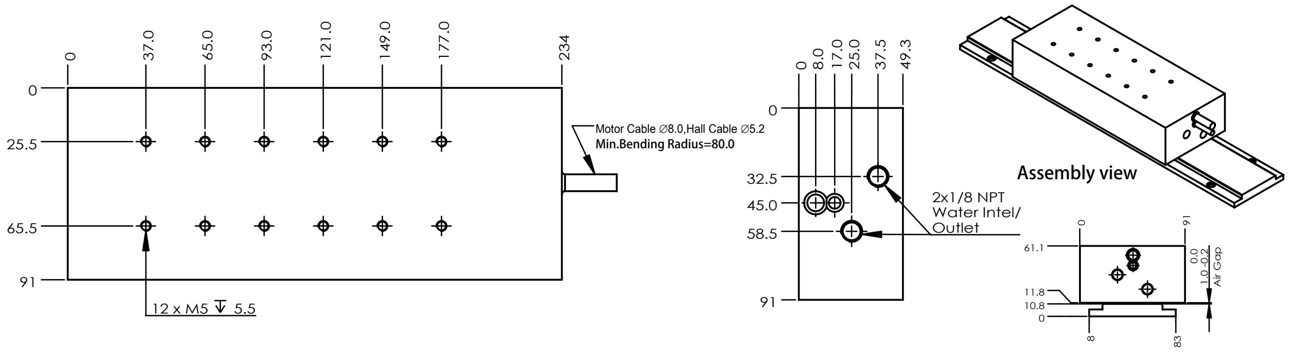
AKM50–B4



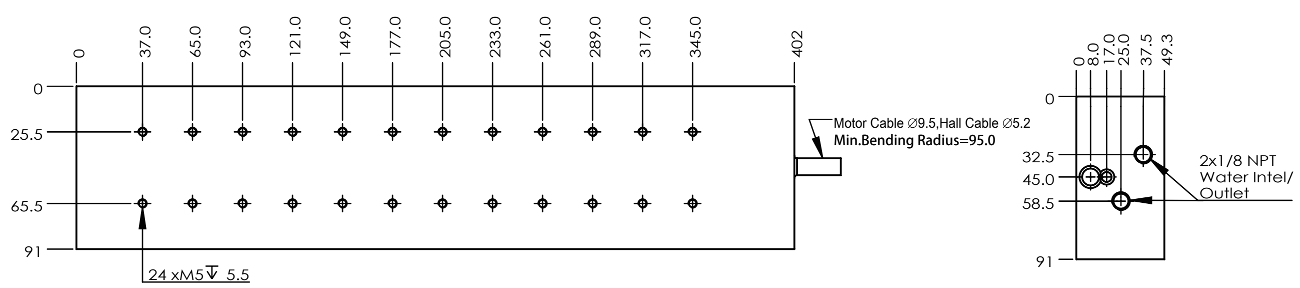
AKM

Dimensions

AKM50–W–B2



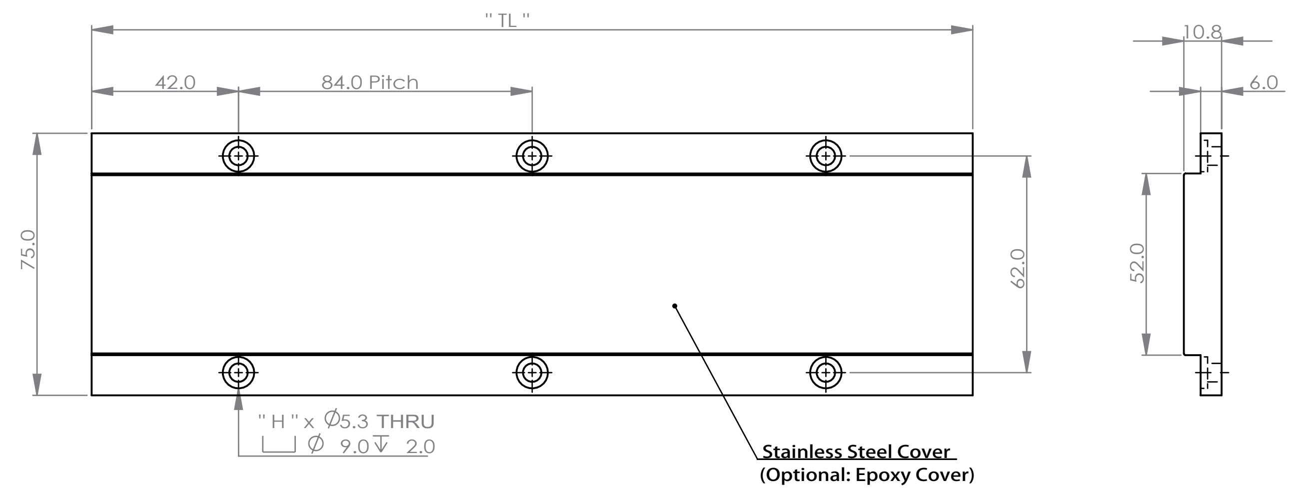
AKM50–W–B4



AKM

Track

AKM50



Magnet Track P / N:	Track Length “TL”	No.of Holes “H”
AKM50-TL168	168.0	4
AKM50-TL252	252.0	6
AKM50-TL420	420.0	10

For epoxy cover option, add “E” to P/N.(e.g. AKM50–TL168E)

AKM

Part Numbering

Coil

AKM50–W–B2–J–H9D–3.0–FB

Model
AKM50

Cooling Options
Blank = Natural Convection
W = Water Cooled

Segment
B1/B2/B4

Thermal Sensor
J = Thermostat (standard), K = PT100 (RTD)
K4 = PTC Thermistor, KTY81/121
K5 = RTD, PT1000 Sensor

Ferrite Bead Options
Blank[4], FB[5]

Cable Length (m)
3.0

Hall Options
Blank[1], H9D[2], NH[3]

Track

AKM50–TL420–E

Model
AKM50

Cover Type
Blank[6], E[7]

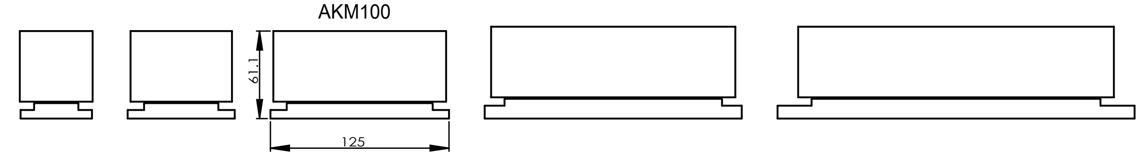
Track Length
TL168/ TL252/ TL420

1. Blank = comes with built–in hall sensor & hall cable terminated in flying leads. (standard)
2. H9D = comes with built–in hall sensor & hall cable terminated with 9–Pins D–Sub connector.
3. NH = comes without built–in hall sensor
4. Blank = motor cable terminated in flying leads. (standard)
5. FB = motor cable terminated with ferrite bead.
6. Blank = Stainless steel cover
7. E = Epoxy cover

AKM

Specifications

AKM100



Model		AKM100-B1	AKM100-B2	AKM100-W-B2	AKM100-B4	AKM100-W-B4
		Natural Cooling	Natural Cooling	Water Cooling	Natural Cooling	Water Cooling
Performance Parameters	Unit	Series	Series	Series	parallel	parallel
Continuous Force @100°C	N	361.3	722.6	1159.3	1445.3	2318.5
Peak Force	N	805.3	1610.5	1610.5	3221.1	3221.1
Force Constant	N/Arms	76.5	153.0	153.0	153.0	153.0
Back EMF Constant	Vpeak/(m/s)	62.5	124.9	124.9	124.9	124.9
Motor Constant	N/Sqrt(W)	41.2	58.2	58.2	82.4	82.4
Resistance (Terminal to Terminal)	Ω	2.3	4.6	4.6	2.3	2.3
Inductance (Terminal to Terminal)	mH	58.0	116.0	116.0	58.0	58.0
Electrical Time Constant	ms	25.2	25.2	25.2	25.2	25.2
Continuous Current @100°C	Arms	4.8	4.8	8.2	9.6	16.4
Peak Current	Arms	14.4	14.4	14.4	28.8	28.8
Continuous Power Dissipation @100°C	W	79.5	159.0	464.0	318.0	927.9
Max. Coil Temperature	°C	100.0	100.0	100.0	100.0	100.0
Thermal Dissipation Constant	W/ °C	1.1	2.1	6.2	4.2	12.4
Max. Bus Voltage	Vdc	600.0	600.0	600.0	600.0	600.0
Magnetic Period	mm	42.0	42.0	42.0	42.0	42.0
Cogging Force (pk to pk)	N	7.7	13.3	13.3	19.1	19.1
Attraction Force	kN	1.34	2.68	2.68	5.36	5.36

Note: All parameters vary in the range of ±10% except dimensions.
Pure or distilled water is recommended for circulating water.

Motor Coil

Size	Length(mm)	Mass(Kg)
B1	112	4.0
B2	196	7.4
B4	364	14.1

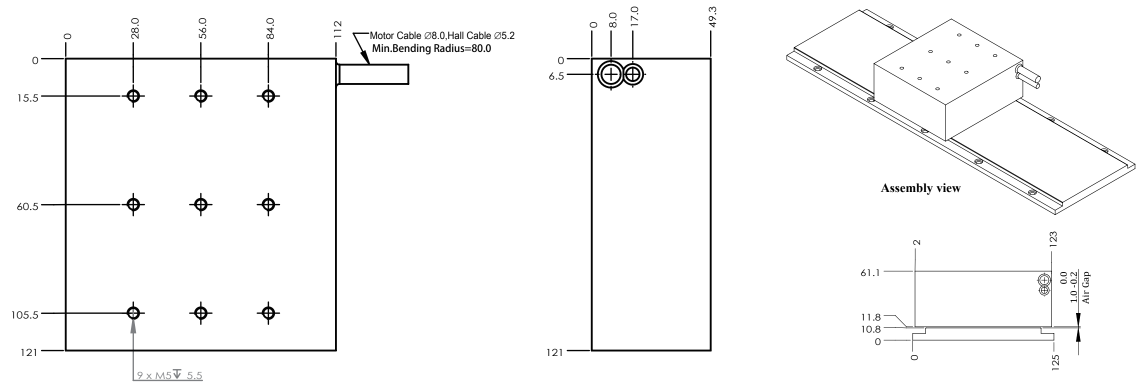
Motor Track

Size	Length(mm)	Mass(Kg)
TL168	168	1.4
TL252	252	2.2
TL420	420	3.6

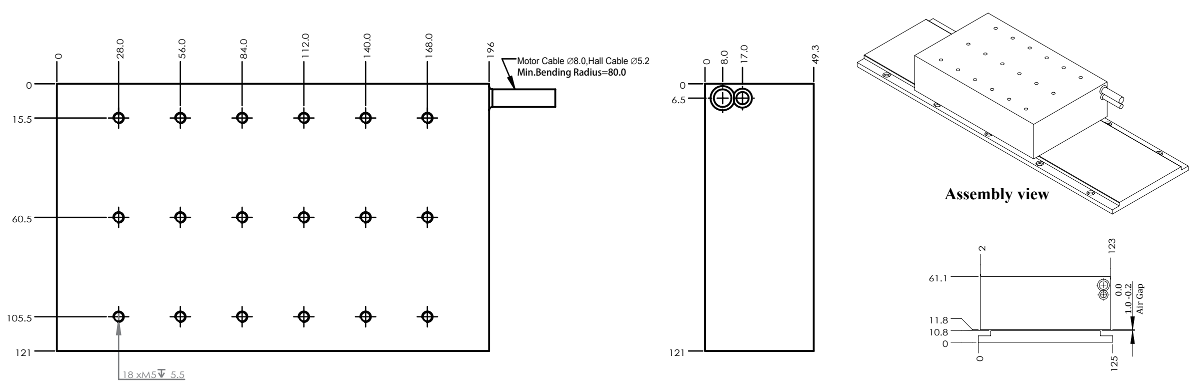
AKM

Dimensions

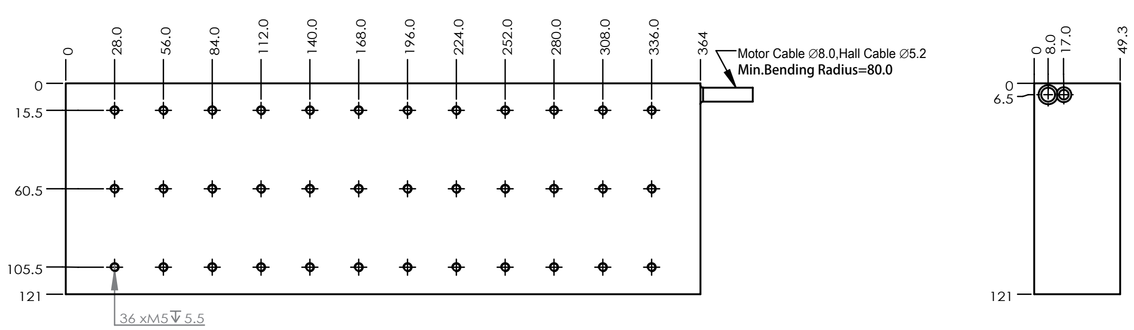
AKM100–B1



AKM100–B2



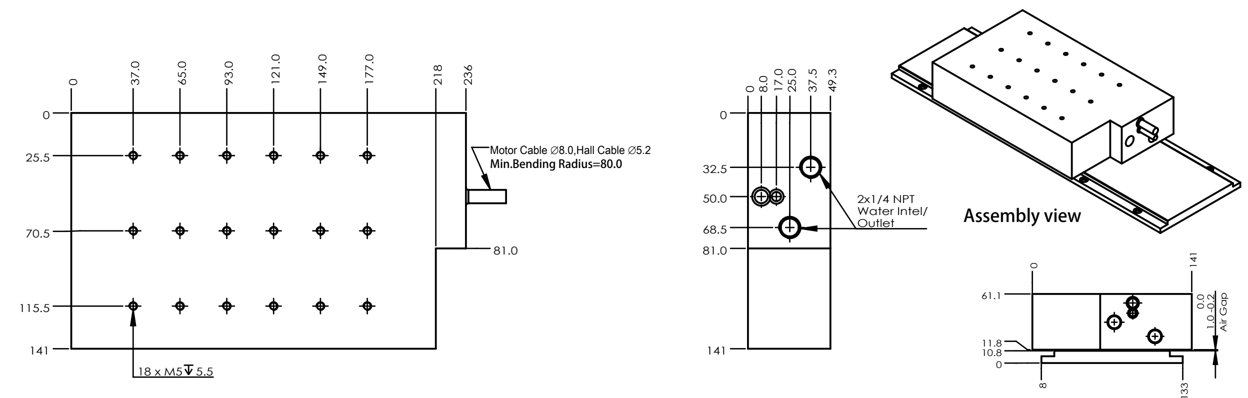
AKM100–B4



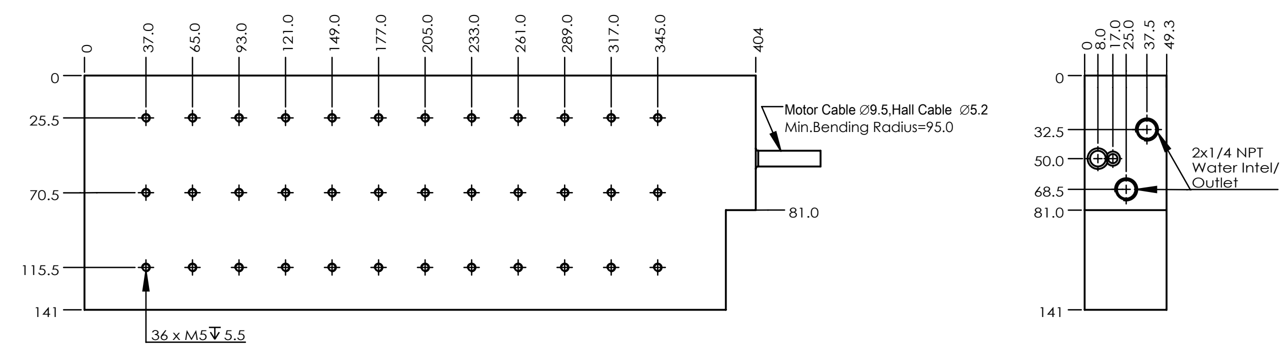
AKM

Dimensions

AKM100–W–B2



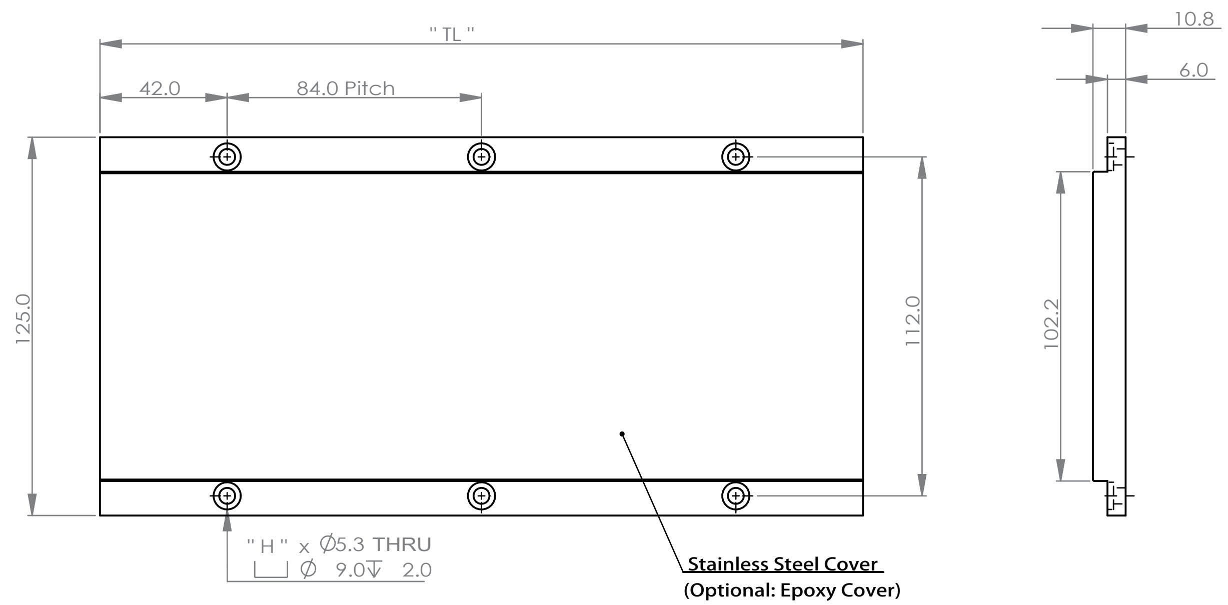
AKM100–W–B4



AKM

Track

AKM100



Magnet Track P / N:	Track Length "TL"	No.of Holes "H"
AKM100-TL168	168.0	4
AKM100-TL252	252.0	6
AKM100-TL420	420.0	10

For epoxy cover option, add "E" to P/N.(e.g. AKM100–TL168E)

AKM

Part Numbering

Coil

AKM100–W–B2–J–H9D–3.0–FB

Model
AKM100

Cooling Options
Blank = Natural Convection
W = Water Cooled

Segment
B1/B2/B4

Thermal Sensor
J = Thermostat (standard), K = PT100 (RTD)
K4 = PTC Thermistor, KTY81/121
K5 = RTD, PT1000 Sensor

Hall Options
Blank[1], H9D[2], NH[3]

Cable Length (m)
3.0

Ferrite Bead Options
Blank[4], FB[5]

Track

AKM100–TL420–E

Model
AKM100

Track Length
TL168/ TL252/ TL420

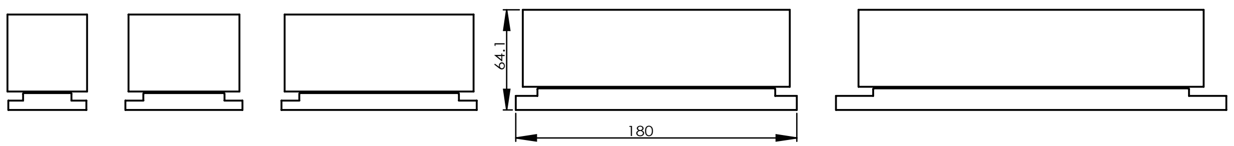
Cover Type
Blank[6], E[7]

1. Blank = comes with built–in hall sensor & hall cable terminated in flying leads. (standard)
2. H9D = comes with built–in hall sensor & hall cable terminated with 9–Pins D–Sub connector.
3. NH = comes without built–in hall sensor
4. Blank = motor cable terminated in flying leads. (standard)
5. FB = motor cable terminated with ferrite bead.
6. Blank = Stainless steel cover
7. E = Epoxy cover

AKM

Specifications

AKM150



Model		AKM150-B4	AKM150-W-B4	AKM150-B8	AKM150-W-B8
		Natural Cooling	Water Cooling	Natural Cooling	Water Cooling
Performance Parameters	Unit	parallel	parallel	parallel	parallel
Continuous Force @100°C	N	2167.9	3477.8	4335.9	6955.5
Peak Force	N	4831.6	4831.6	9663.2	9663.2
Force Constant	N/Arms	229.5	229.5	229.5	229.5
Back EMF Constant	Vpeak/(m/s)	187.4	187.4	187.4	187.4
Motor Constant	N/Sqrt(W)	104.8	104.8	148.1	148.1
Resistance (Terminal to Terminal)	Ω	3.2	3.2	1.6	1.6
Inductance (Terminal to Terminal)	mH	80.5	80.5	40.3	40.3
Electrical Time Constant	ms	25.2	25.2	25.2	25.2
Continuous Current @100 °C	Arms	9.6	16.4	19.2	32.8
Peak Current	Arms	28.8	28.8	57.6	57.6
Continuous Power Dissipation @100 °C	W	442.4	1291.0	884.7	2582.0
Max. Coil Temperature	°C	100.0	100.0	100.0	100.0
Thermal Dissipation Constant	W/ °C	5.9	17.2	11.8	34.4
Max. Bus Voltage	Vdc	600.0	600.0	600.0	600.0
Magnetic Period	mm	42.0	42.0	42.0	42.0
Cogging Force (pk to pk)	N	28.7	28.7	75.0	75.0
Attraction Force	kN	8.0	8.0	16.1	16.1

Note: All parameters vary in the range of ±10% except dimensions.
Pure or distilled water is recommended for circulating water.

Motor Coil

Size	Length(mm)	Mass(Kg)
B4	364	20.2
B8	700	39.4

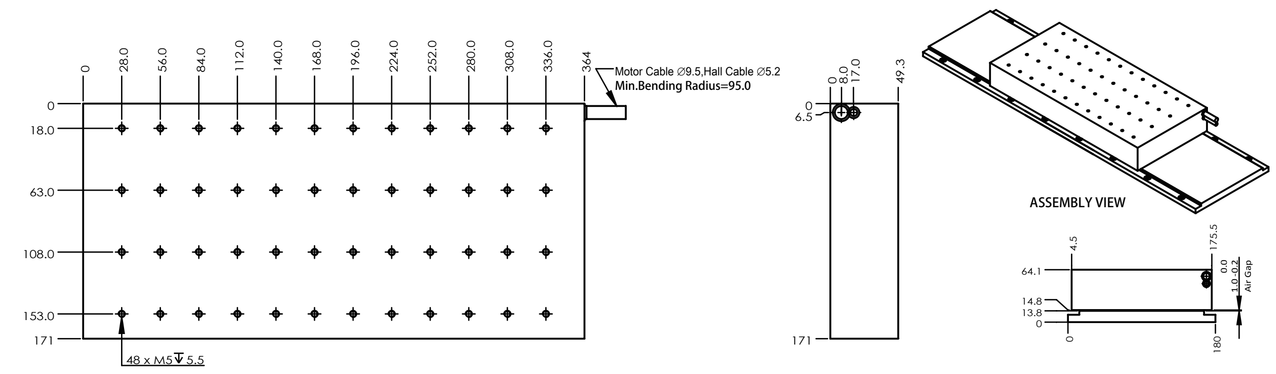
Motor Track

Size	Length(mm)	Mass(Kg)
TL168	168	2.6
TL252	252	3.8
TL420	420	6.4

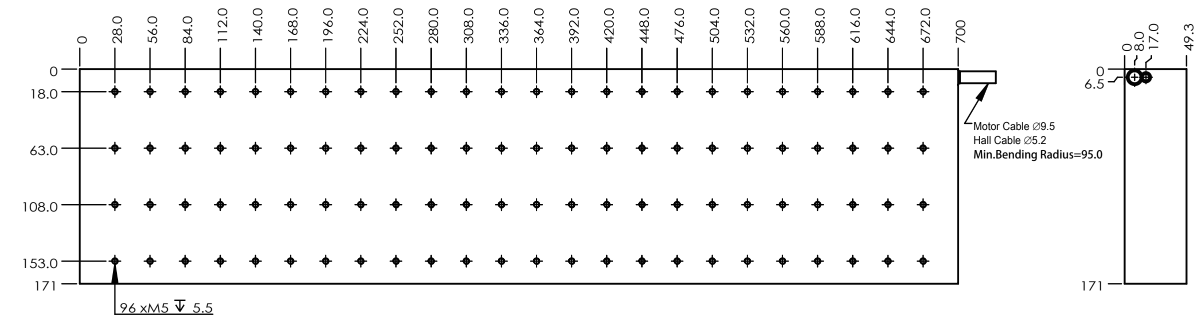
AKM

Dimensions

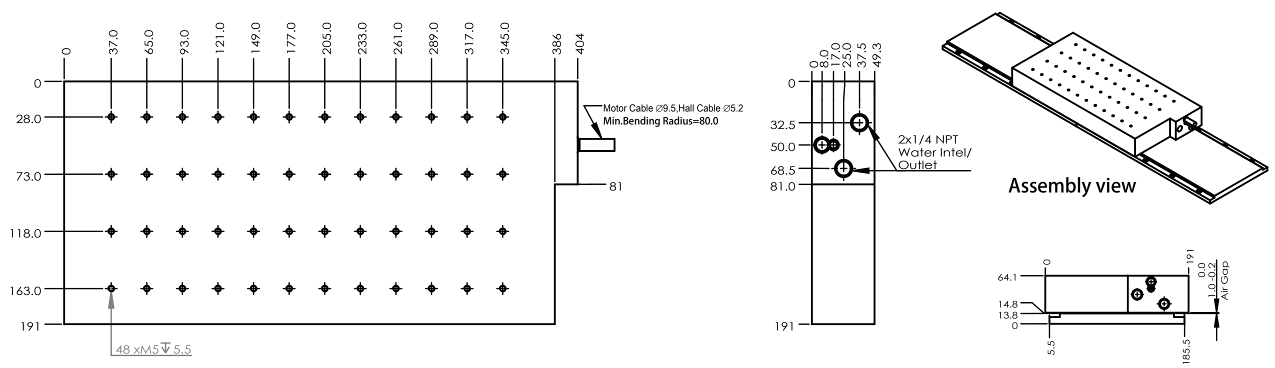
AKM150–B4



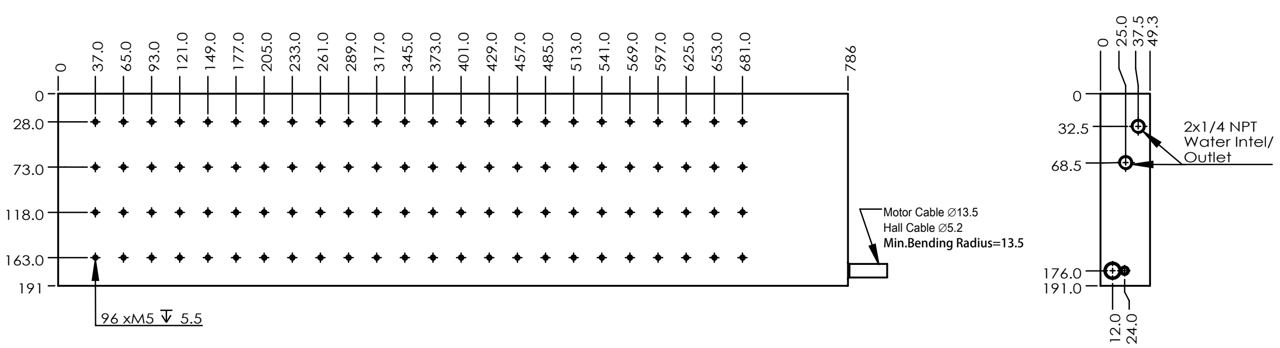
AKM150–B8



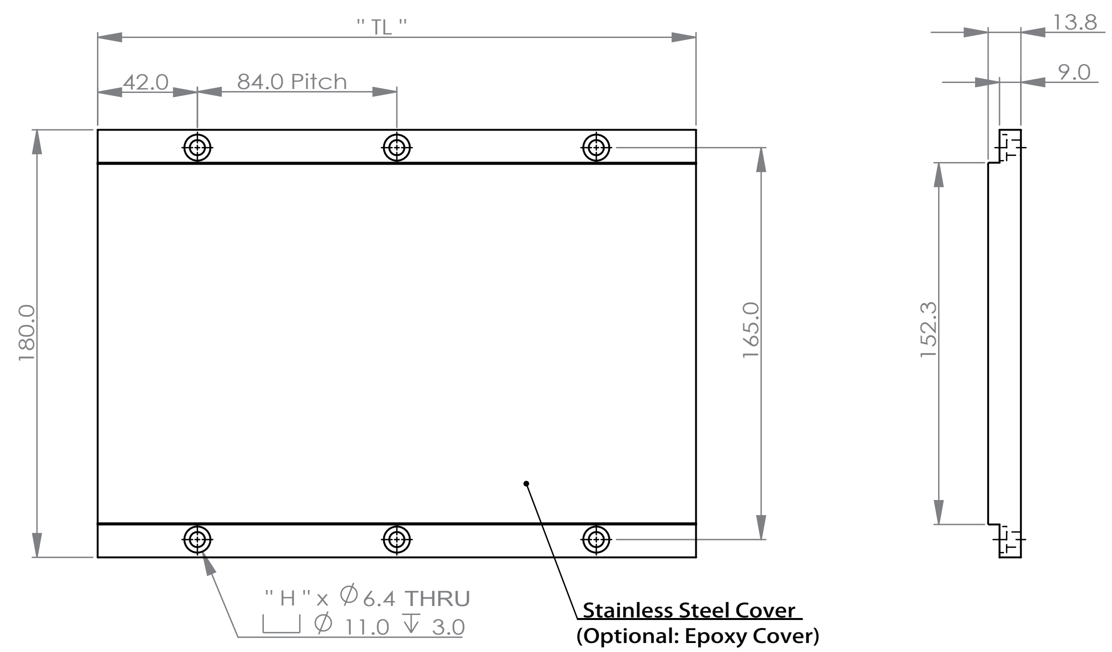
AKM150–W–B4



AKM150–W–B8



AKM150



Magnet Track P / N:	Track Length "TL"	No.of Holes "H"
AKM150-TL168	168.0	4
AKM150-TL252	252.0	6
AKM150-TL420	420.0	10

For epoxy cover option, add "E" to P/N.(e.g. AKM150–TL168E)

AKM

Part Numbering

Coil

AKM150–W–B4–J–H9D–3.0–FB

- **Model**
  AKM150
- **Cooling Options**
  Blank = Natural Convection
  W = Water Cooled
- **Segment**
  B4/B8
- **Thermal Sensor**
  J = Thermostat (standard), K = PT100 (RTD)
  K4 = PTC Thermistor, KTY81/121
  K5 = RTD, PT1000 Sensor
- **Hall Options**
  Blank[1], H9D[2], NH[3]
- **Cable Length (m)**
  3.0
- **Ferrite Bead Options**
  Blank[4], FB[5]

Track

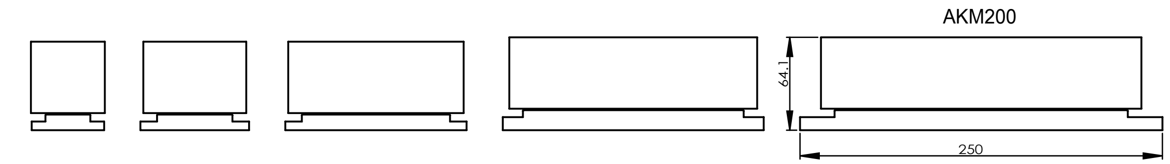
AKM150–TL420–E

- **Model**
  AKM150
- **Track Length**
  TL168/ TL252/ TL420
- **Cover Type**
  Blank[6], E[7]

1. Blank = comes with built–in hall sensor & hall cable terminated in flying leads. (standard)
2. H9D = comes with built–in hall sensor & hall cable terminated with 9–Pins D–Sub connector.
3. NH = comes without built–in hall sensor
4. Blank = motor cable terminated in flying leads. (standard)
5. FB = motor cable terminated with ferrite bead.
6. Blank = Stainless steel cover
7. E = Epoxy cover

AKM

Specifications



Model		AKM200-B4	AKM200-W-B4	AKM200-B8	AKM200-W-B8
		Natural Cooling	Water Cooling	Natural Cooling	Water Cooling
Performance Parameters	Unit	parallel	parallel	parallel	parallel
Continuous Force @100°C	N	2890.6	4637.0	5781.2	9274.0
Peak Force	N	6442.2	6442.2	12884.3	12884.3
Force Constant	N/Arms	306.0	306.0	306.0	306.0
Back EMF Constant	Vpeak/(m/s)	249.8	249.8	249.8	249.8
Motor Constant	N/Sqrt(W)	124.5	124.5	176.0	176.0
Resistance (Terminal to Terminal)	Ω	4.0	4.0	2.0	2.0
Inductance (Terminal to Terminal)	mH	103.0	103.0	51.5	51.5
Electrical Time Constant	ms	25.6	25.6	25.6	25.6
Continuous Current @100 °C	Arms	9.6	16.4	19.2	32.8
Peak Current	Arms	28.8	28.8	57.6	57.6
Continuous Power Dissipation @100 °C	W	557.1	1625.9	1114.2	3251.7
Max. Coil Temperature	°C	100.0	100.0	100.0	100.0
Thermal Dissipation Constant	W/ °C	7.4	21.7	14.9	43.4
Max. Bus Voltage	Vdc	600.0	600.0	600.0	600.0
Magnetic Period	mm	42.0	42.0	42.0	42.0
Cogging Force (pk to pk)	N	38.2	38.2	101.0	101.0
Attraction Force	kN	10.7	10.7	21.4	21.4

Note: All parameters vary in the range of ± 10% except dimensions.
Pure or distilled water is recommended for circulating water.

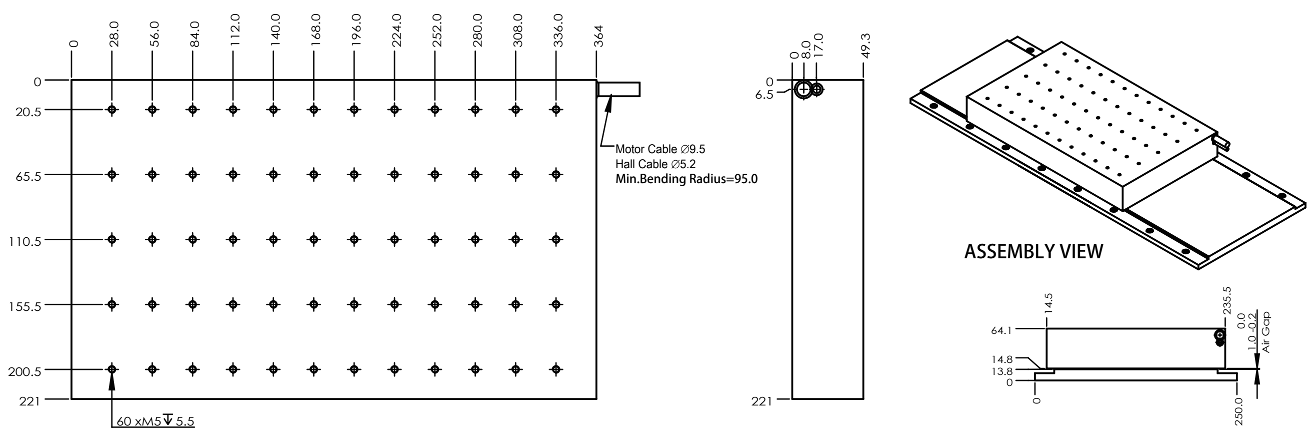
Motor Coil

Size	Length(mm)	Mass(Kg)
B4	364	26.5
B8	700	51.6

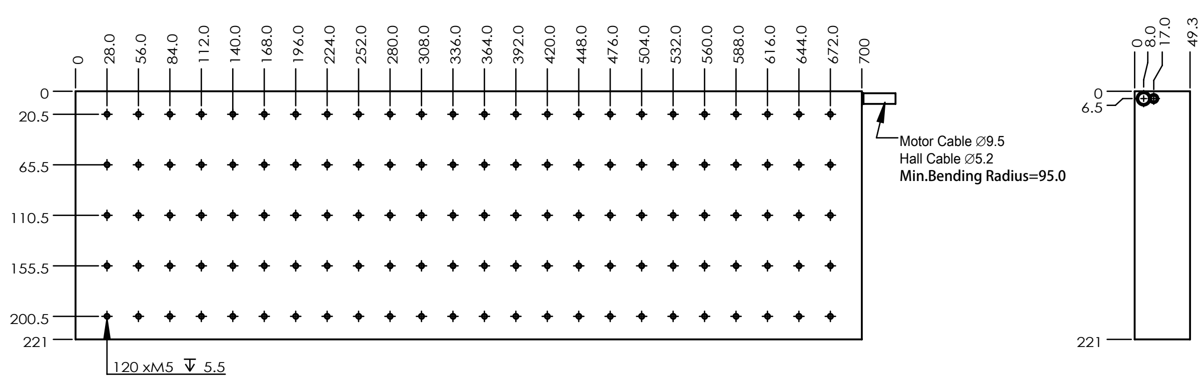
Motor Track

Size	Length(mm)	Mass(Kg)
TL168	168	3.8
TL252	252	5.7
TL420	420	9.4

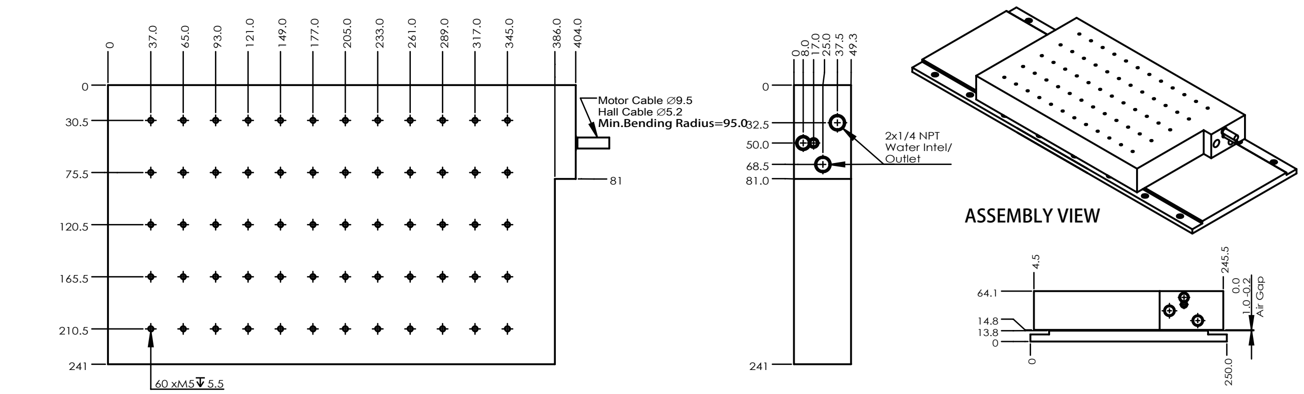
AKM200–B4



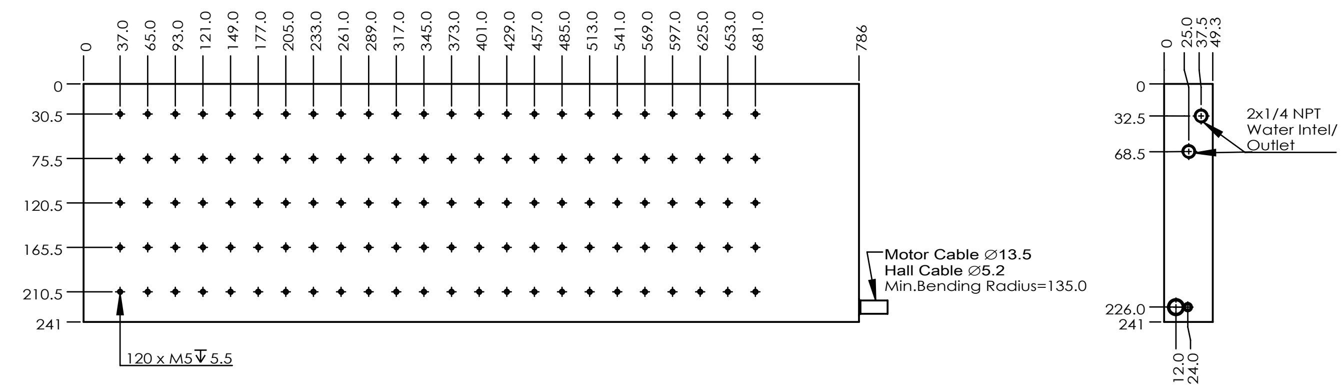
AKM200–B8



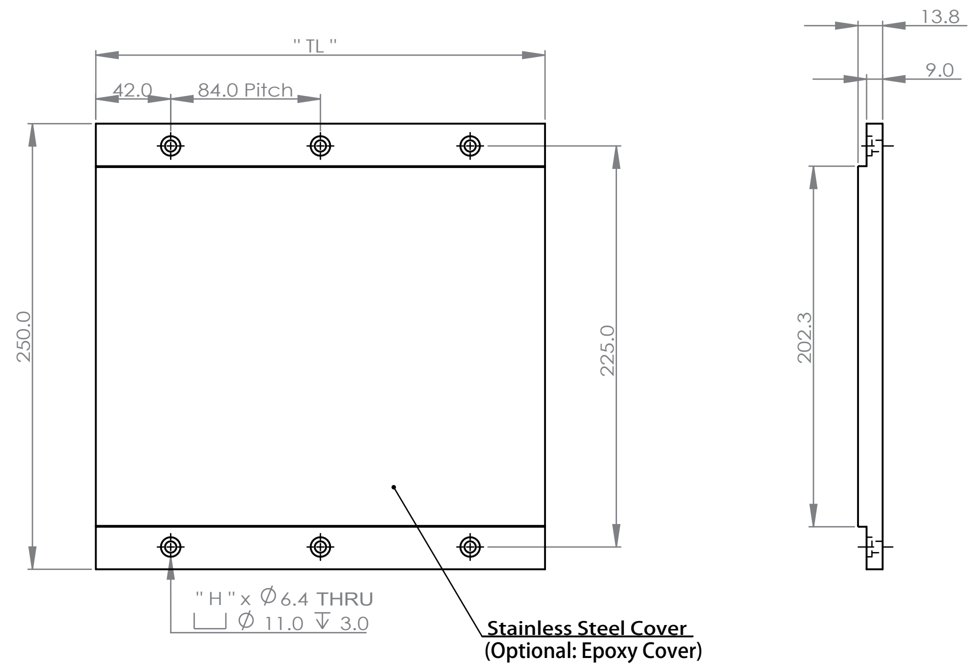
AKM200–W–B4



AKM200–W–B8



AKM200



Magnet Track P / N:	Track Length "TL"	No.of Holes "H"
AKM200-TL168	168.0	4
AKM200-TL252	252.0	6
AKM200-TL420	420.0	10

For epoxy cover option, add "E" to P/N.(e.g. AKM200–TL168E)

Coil

AKM200–W–B4–J–H9D–3.0–FB

Model
AKM200

Cooling Options
Blank = Natural Convection
W = Water Cooled

Segment
B4/B8

Thermal Sensor
J = Thermostat (standard), K = PT100 (RTD)
K4 = PTC Thermistor, KTY81/121
K5 = RTD, PT1000 Sensor

Ferrite Bead Options
Blank[4], FB[5]

Cable Length (m)
3.0

Hall Options
Blank[1], H9D[2], NH[3]

Track

AKM200–TL420–E

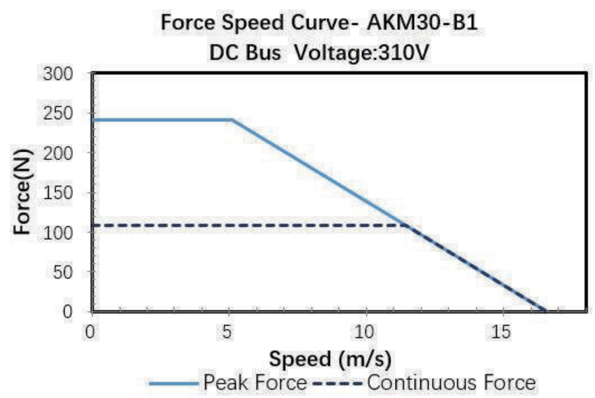
Cover Type
Blank[6], E[7]

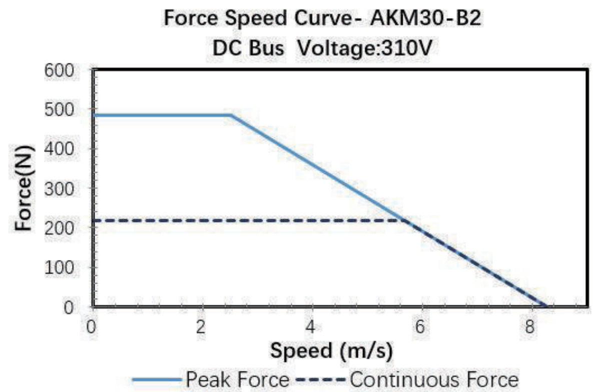
Model
AKM150

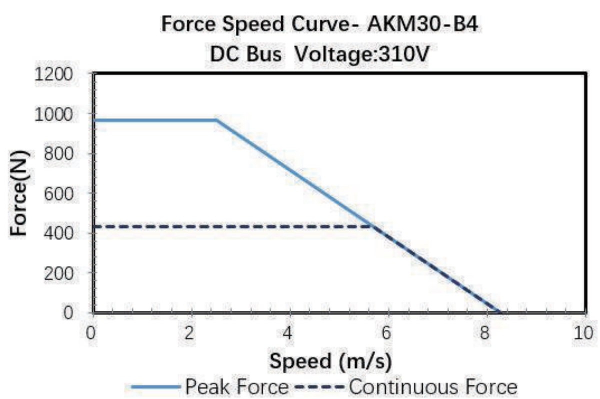
Track Length
TL168/ TL252/ TL420

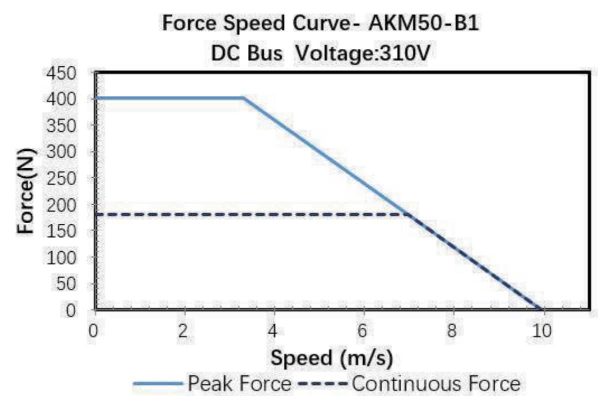
1. Blank = comes with built–in hall sensor & hall cable terminated in flying leads. (standard)
2. H9D = comes with built–in hall sensor & hall cable terminated with 9–Pins D–Sub connector.
3. NH = comes without built–in hall sensor
4. Blank = motor cable terminated in flying leads. (standard)
5. FB = motor cable terminated with ferrite bead.
6. Blank = Stainless steel cover
7. E = Epoxy cover

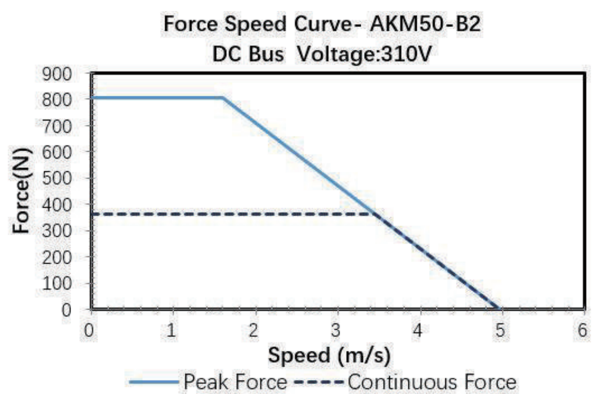
DC Bus Voltage = 310 Vdc

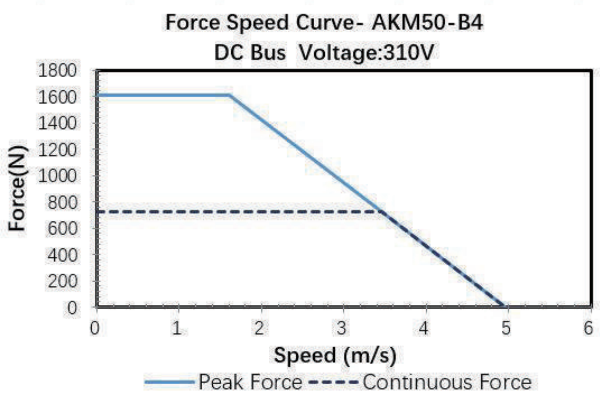


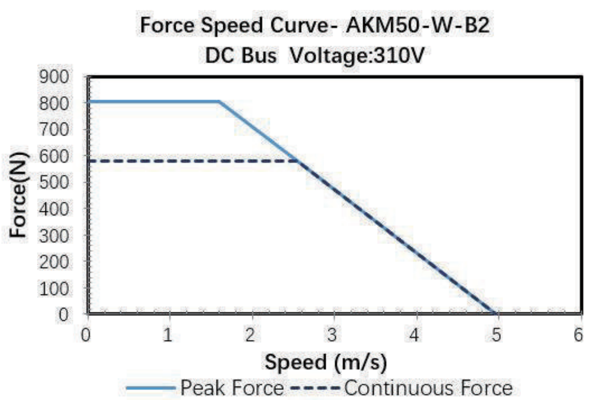


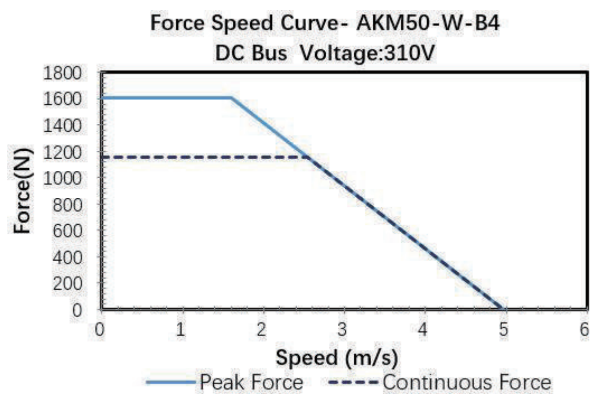


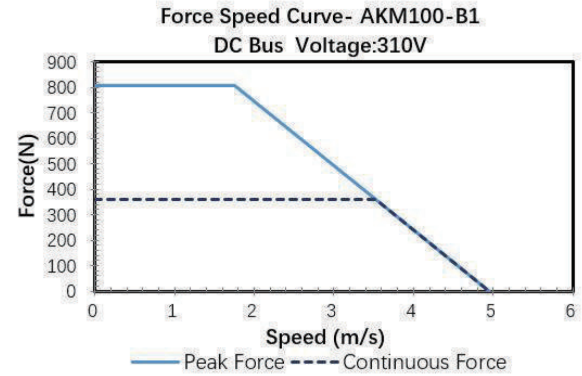


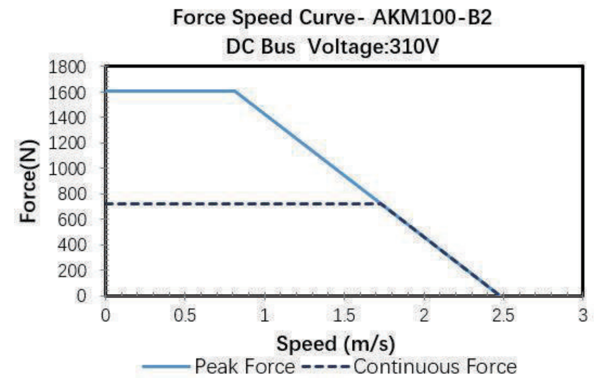


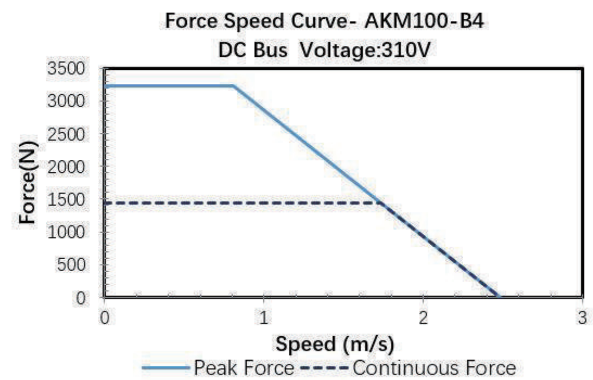


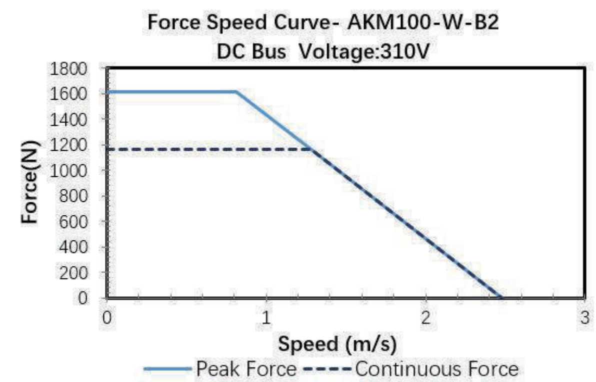


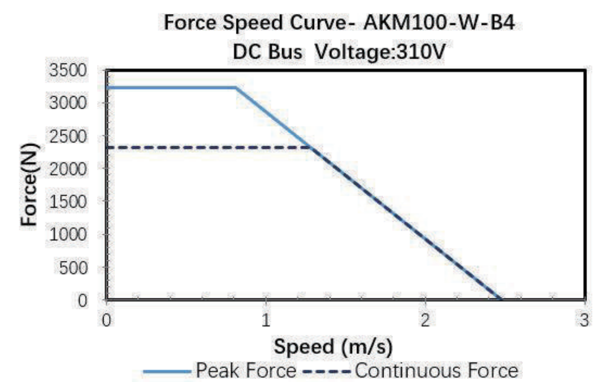


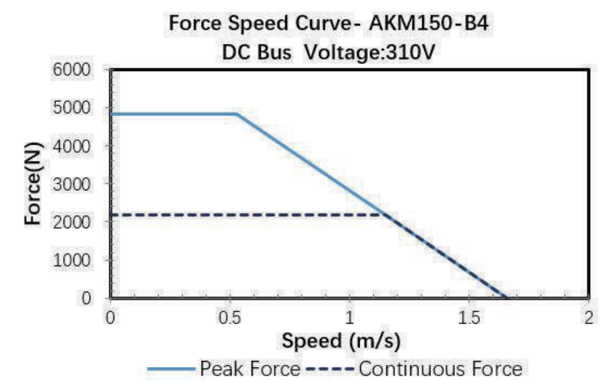


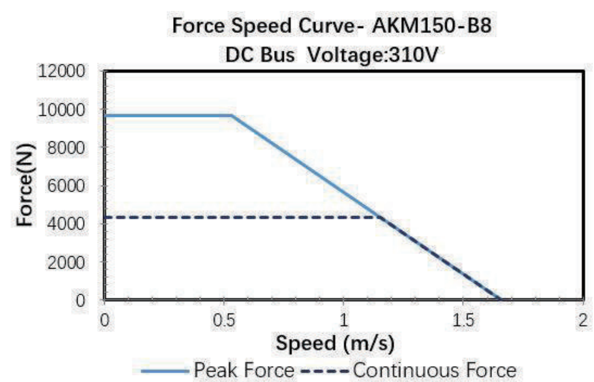


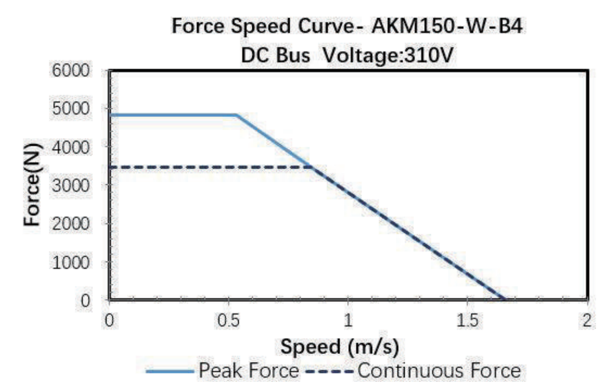




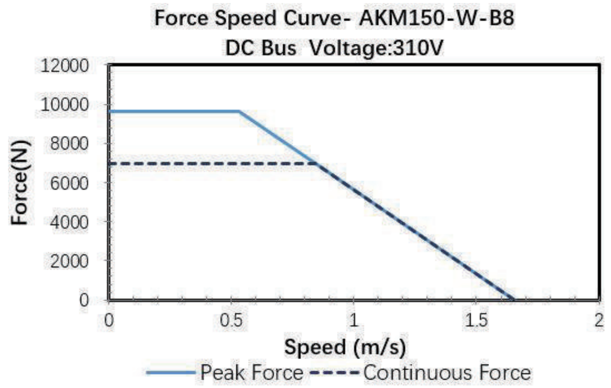


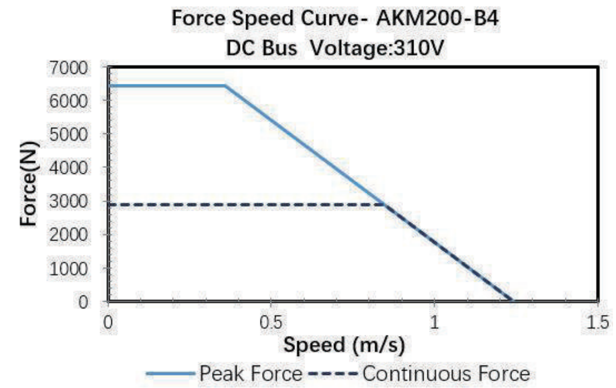


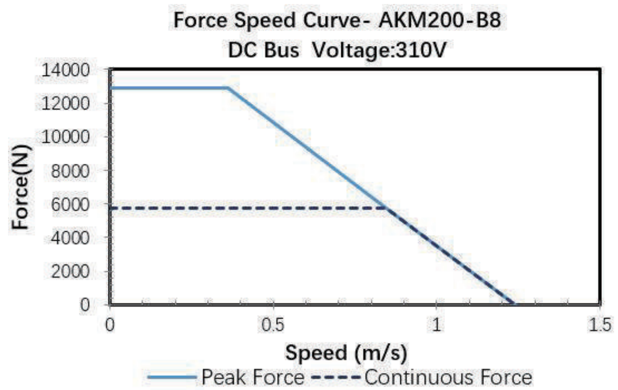


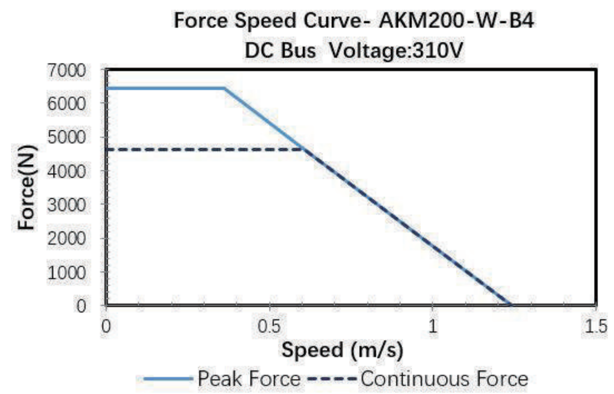


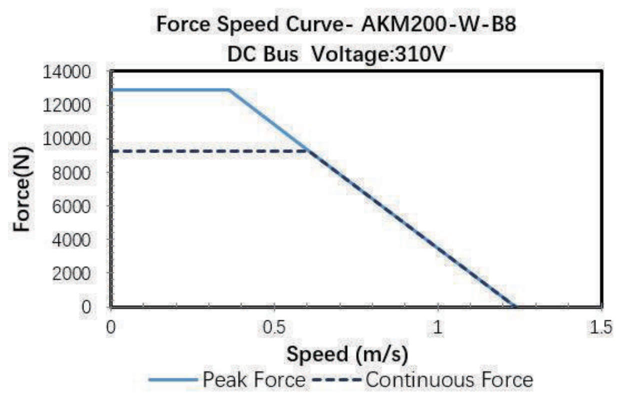
DC Bus Voltage = 600 Vdc

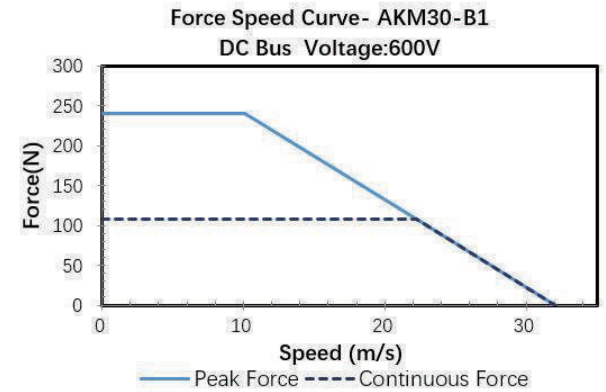


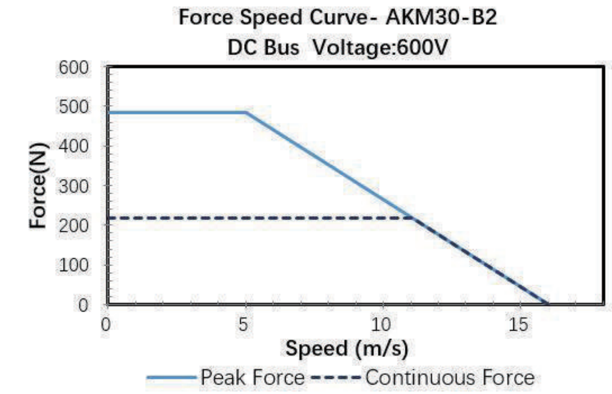


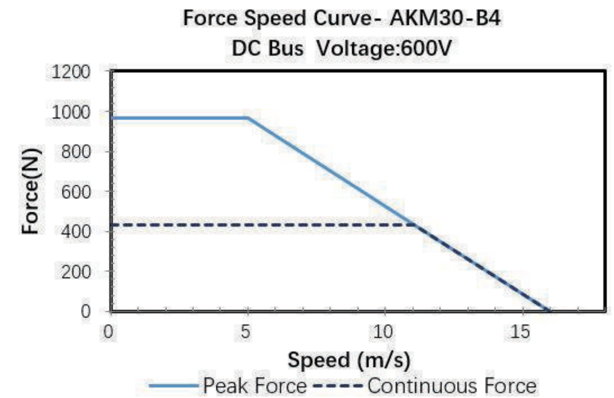


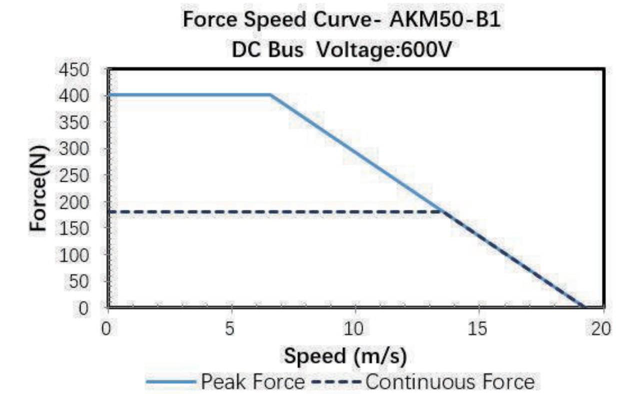


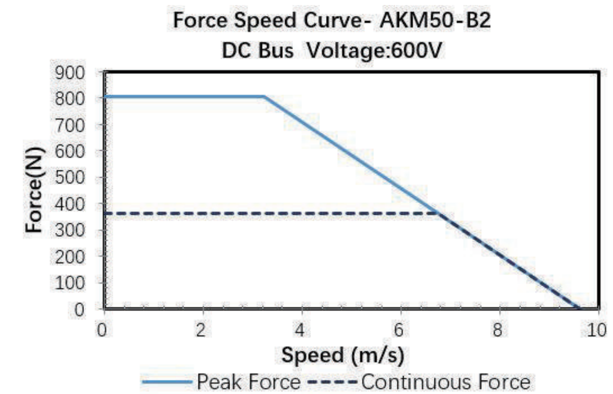


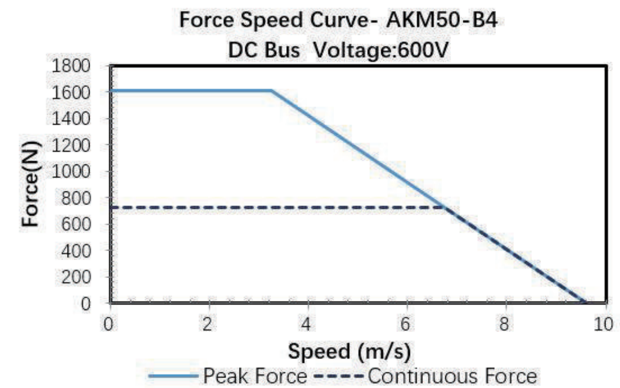


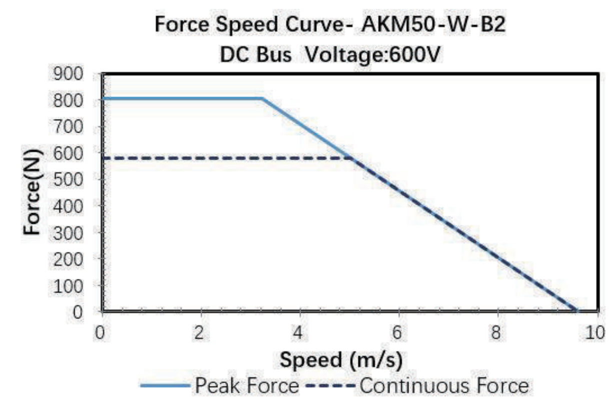


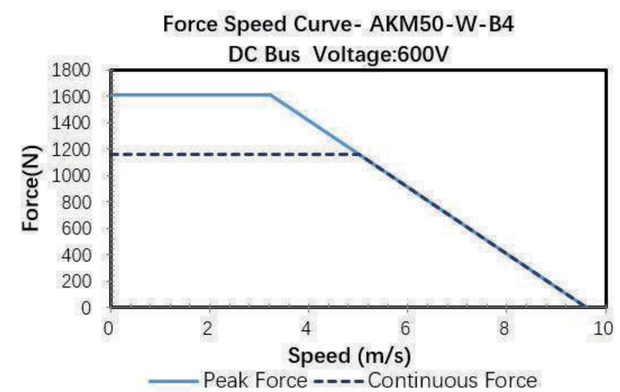




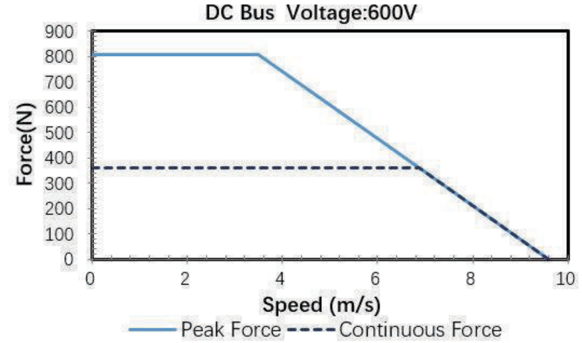




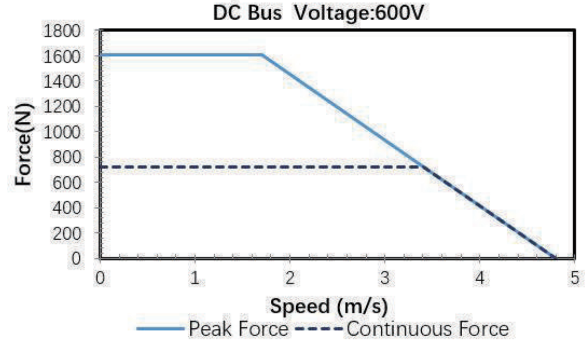




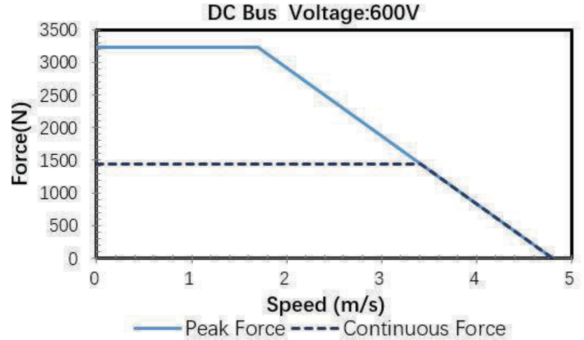
Force Speed Curve- AKM100-B1
DC Bus Voltage:600V



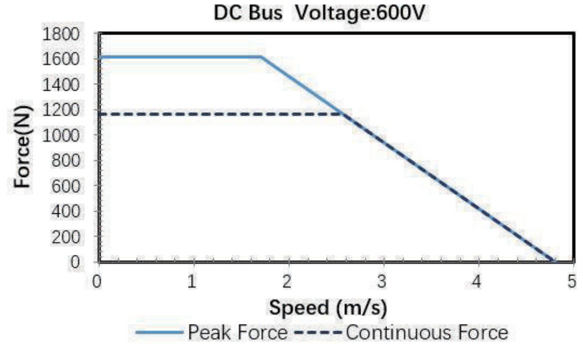
Force Speed Curve- AKM100-B2
DC Bus Voltage:600V



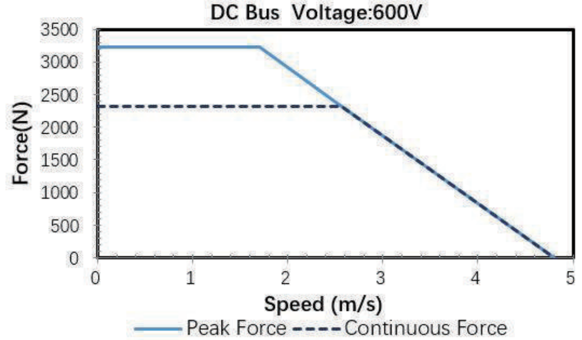
Force Speed Curve- AKM100-B4
DC Bus Voltage:600V



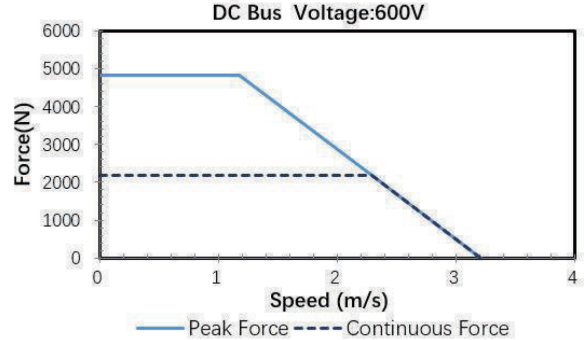
Force Speed Curve- AKM100-W-B2
DC Bus Voltage:600V



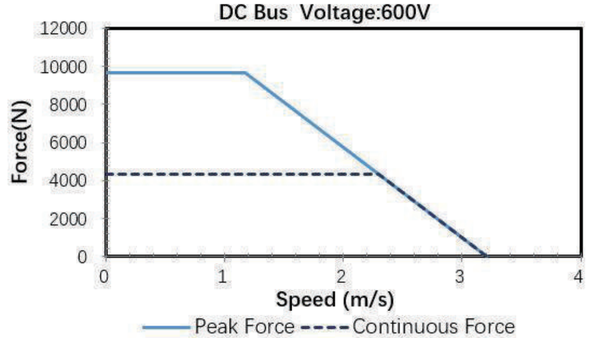
Force Speed Curve- AKM100-W-B4
DC Bus Voltage:600V



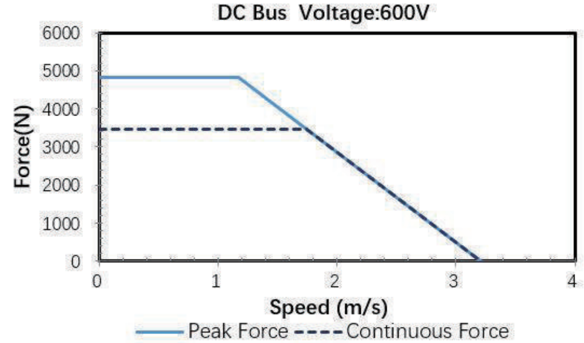
Force Speed Curve- AKM150-B4
DC Bus Voltage:600V



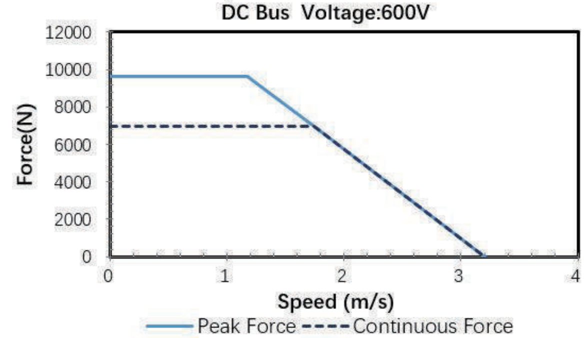
Force Speed Curve- AKM150-B8
DC Bus Voltage:600V



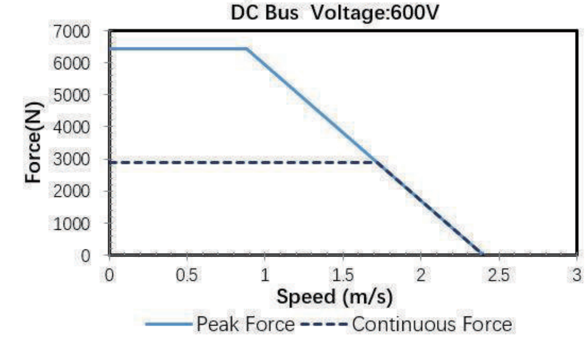
Force Speed Curve- AKM150-W-B4
DC Bus Voltage:600V



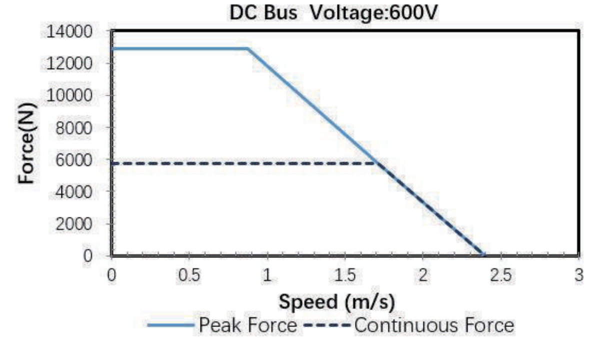
Force Speed Curve- AKM150-W-B8
DC Bus Voltage:600V



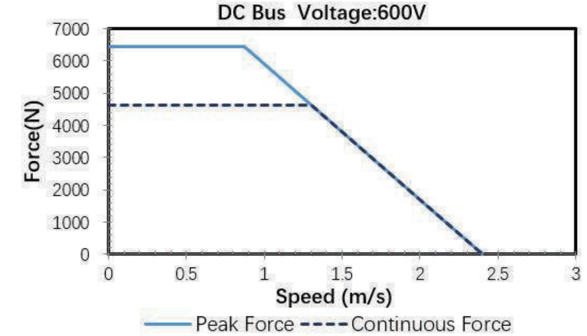
Force Speed Curve- AKM200-B4
DC Bus Voltage:600V



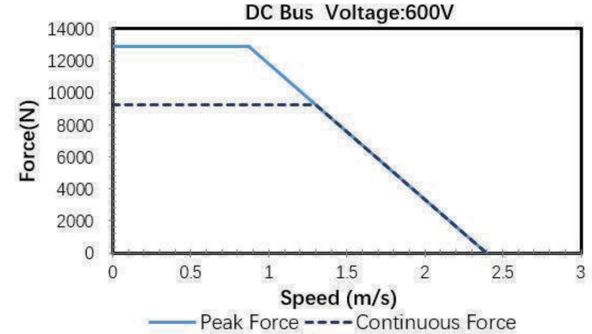
Force Speed Curve- AKM200-B8
DC Bus Voltage:600V



Force Speed Curve- AKM200-W-B4
DC Bus Voltage:600V



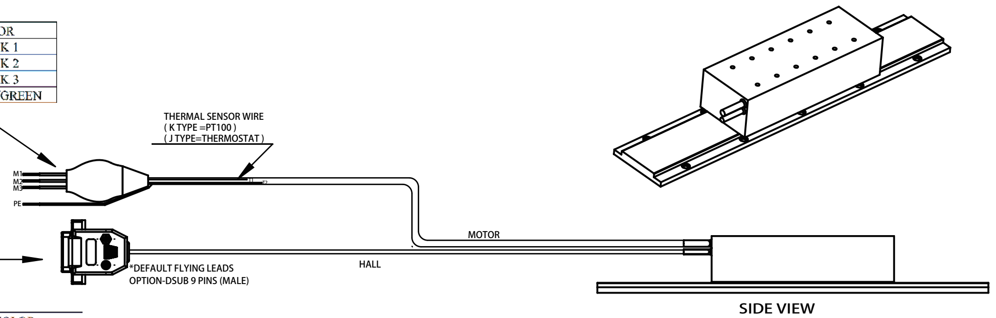
Force Speed Curve- AKM200-W-B8
DC Bus Voltage:600V



AKM

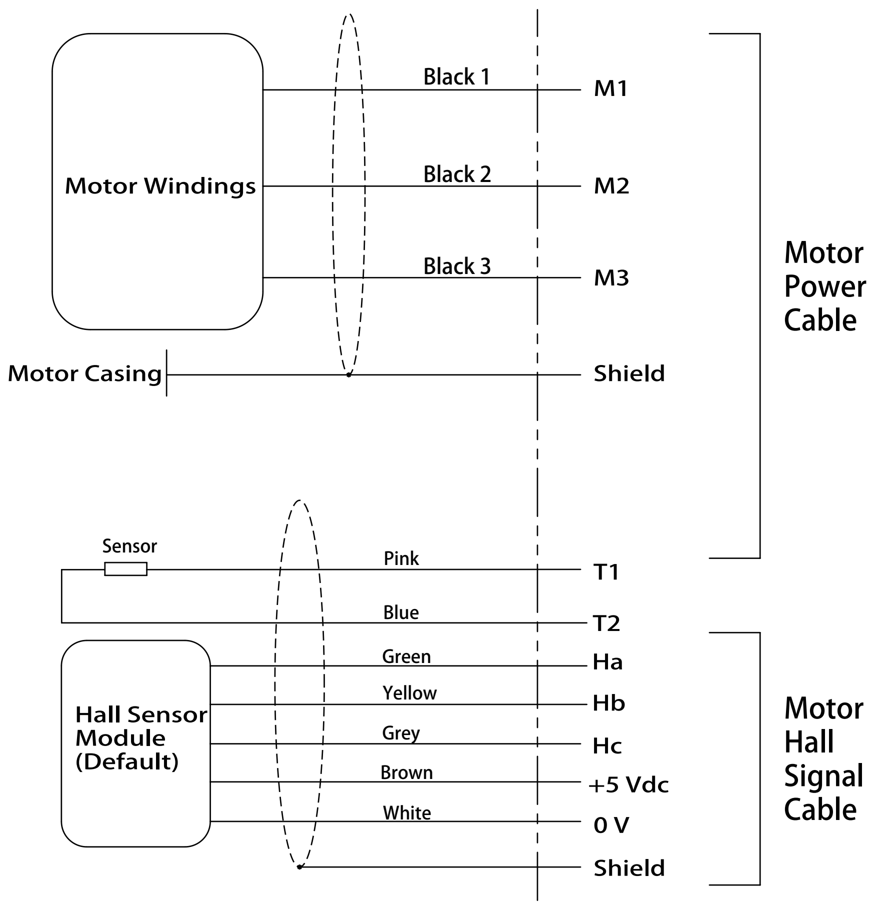
MOTOR CABLE

PIN	DESCRIPTION	COLOR
-	M1	BLACK 1
-	M2	BLACK 2
-	M3	BLACK 3
-	PE	YELLOW/GREEN



HALL CABLE

PIN	DESCRIPTION	COLOR
1	HA	GREEN
2	HB	YELLOW
3	HC	GREY
4	5VDC	BROWN
5	0VDC	WHITE
6	T1	PINK
7	T2	BLUE



Sizing Guide

Linear Motor Sizing Guide

1. Sizing of a linear motor includes calculating the peak force and Root-Mean-Square (RMS) force requirement.

2. Peak force is determined by the moving mass and maximum acceleration required.

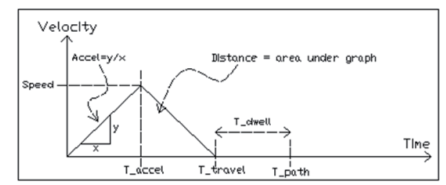
Force = mass*Acceleration+ Friction Force + External Opposing Force

For example, if moving mass is 2.5 kg (including coil assembly), and required acceleration is 30m/s^2, the motor will have to exert a force of 75N. This is assuming Friction and Opposing Forces are negligible.

3. Very often, we do not know the actual required acceleration, but we have the motion time requirement. We can calculate the required acceleration if we know the travel distance and the travel time. Usually for short travel distances, a Triangle-Shape Velocity Profile is used whereas for long travel distances, it is more efficient to use Trapezoidal-Shape Velocity Profile. In a Triangle profile, the motor does not cruise at any velocity.

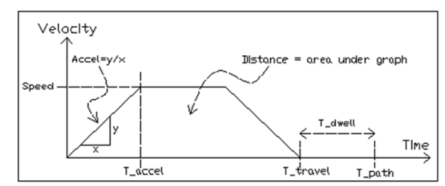
4.For Triangle Profile：

Acceleration = 4 * Distance / Travel_Time^2



5. For Trapezoidal Profile, a desired cruising speed will help to determine the required acceleration.

Acceleration = Cruise Speed / (Travel Time – Distance / Cruise Speed)



6. Similarly, compute the deceleration force required. Most likely, this is the same as acceleration force unless there is an unbalanced force (e.g. gravitational force) acting on the motor.

7. Force required by the motor during cruising (against friction and opposing forces) and dwelling (against opposing force) may also be calculated.

8 . Compute the RMS force using the formula below.

$$RMSForce=\sqrt{\frac{Fa^2*Ta+Fc^2*Tc+Fd^2*Td+Fw^2*Tw}{Ta+Tc+Td+Tw}}$$

where,

Fa = Acceleration Force	Ta = Acceleration Time
Fc = Cruise Force	Tc = Cruise Time
Fd = Deceleration Force	Td = Deceleration Time
Fw = Dwell Force	Tw = Dwell Time

9 . Select a motor according to the computed peak force and RMS force requirement. User should factor in a safety factor of at least 20-30% especially if friction and external opposing forces are assumed to be zero.

10. For example, an application requires the motor to move a 4kg load for 0.3m in 0.2s using Triangle Profile. The motor will dwell 0.15s before moving the same cycle again. Assume friction is negligible and no presence of any unbalanced force.

Acceleration = Deceleration = 4 * 0.3 / $(0.2)^2$= $30m/s^2$

Peak Force = Fa = Fd = mass * acceleration = 4 * 30 = 120N

$$RMSForce=\sqrt{\frac{(120)^2*(0.1)+(120)^2*(0.1)}{0.1+0.1+0.15}}=90.7N$$

Giving an additional 30% safety factor, a suitable motor will be AKM50-B1.

11 . Motor selection software is available to automate the calculation process.
Please contact cust-service@akribis-sys.com for a copy of the software.

1. Accuracy, Repeatability and Resolution

There are many ways to define the three confusing terms for accuracy, repeatability and resolution. Professor Slocum of Massachusetts Institute of Technology in his book "Precision Machine Design" [1], defines them in a very interesting manner namely,
"Accuracy is the ability to tell the truth"
"Repeatability is the ability to tell the same story over and over again"
"Resolution is how detailed your story is"
[1] A.H. Slocum. Precision Machine Design. Prentice Hall, Englewood Cliffs, New Jersey, 1992.

Typically, a servo positioning system usually consists of the mechanics which includes the structural elements and the bearing guidance; the prime mover such as the motor and its electronics; a feedback device and the controller.
In a nut-shell
Accuracy has a dual meaning for a positioning system, namely

accuracy of the motion is contributed mainly by the bearings and it is the lateral deviation from the ideal motion path or the straight-line accuracy or running parallelism.

ability to be served to a desired position, which is the largest error between any two points in a positioning system's coverage.

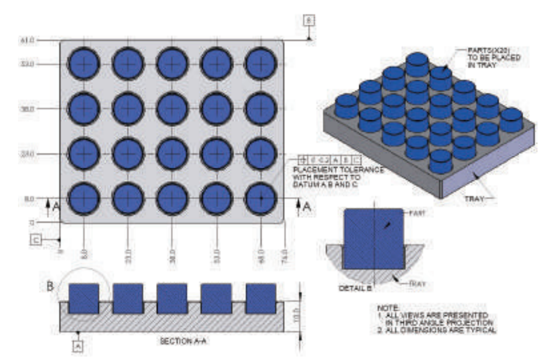
Like accuracy, repeatability has a dual meaning for a positioning system, namely

repeatability of the motion is the ability of the bearing to repeat its motion. For linear motion bearings, this is often referred to as the straight-line repeatability or running
parallelism repeatability.

ability to be servoed to the same position, which is the error between a number of successive attempts to move a workpiece or tool to the same position within the positioning system's coverage.

Resolution in a position system currently is determined by the ability of the bearing to allow for a small increment of motion. It is the smallest mechanical step that the positioning system is capable of making during point to point motion. In other words, it will be meaningless to put an encoder with nanometer encoder resolution on a positioning system with contact type bearing and hoping to achieve nanometer level mechanical resolution. For contact type of bearings, 0.1 micron is by far the best achievable results.

The three terms are best illustrated with a pick and place example below. The objective is to place the cylinder into a tray as shown in figure 1 below.
The specifications indicate that we have to place the cylinder such that the centre of the cylinder is accurate to within a diameter of 0.2 millimetre, with respect to the three datums marked A, B and C.



In order to satisfy the specification, it is important that we select a position system with adequate resolution to achieve the require repeatability. The Table below shows a typical example on deciding the positioning resolution.

Description	Value
Tolerance (+/- 3 sigma)	= 0.2 mm
Required repeatability	= 0.2 mm/6 = 0.033 mm
Required resolution	= 0.033 mm/10 = 0.003 mm

Therefore, we should use an encoder with at least 3 microns resolution.

Now, if we successive move the cylinder to the same position, we can note down the actual position of the cylinder's centre via an independent measurement system. The centre of the cylinder can be plotted as in figure 2 below.

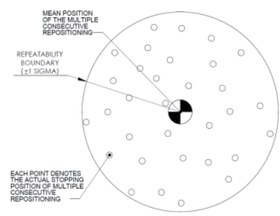


Figure 2: Actual stopping position of cylinder centre

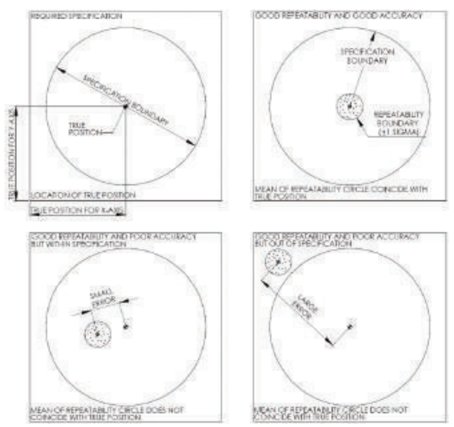


Figure 3: Specifications, Accuracy and Repeatability

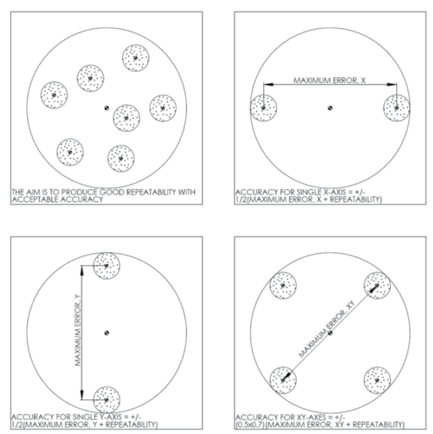


Figure 4: The aim is to produce good repeatability with acceptable accuracy

The mean position of the consecutive repositioning is marked by the centre of a circle which enclose all the points. The boundary of the big circle is the repeatability of the positioning system. Now if we superimpose the repeatability circle onto the given specifications as shown in figure 3.0, in positioning system, it is much easier to achieve good repeatability than good accuracy. In many cases, the positioning need not have to be very accurate, but only reasonably accurate, as reasonably accurate but repeatable positioning systems are capable to positioning within the required specifications given the proper positioning resolution as shown in Figure 4. It is economical to build a system which is repeatable and correct the accuracy using calibration and error compensation in the controller.

2. The relationship between force and speed.

To relate the terms force and speed, let's take a look at the 7 common terms in physics when dealing with position systems, namely

Description	Units	Symbol
Force	N	F
Load or mass	kg	m
Time	s	t
Acceleration	m/s^2	a
Velocity	m/s	v
Displacement	m	s
work	Nm	W
Power	Nm/s, Watt	P

This equation is known as the equation of motion and it gives the instantaneous value of the acceleration corresponding to the instantaneous values of the forces that are acting.

If an object starts moving from rest, that is, its initial velocity is zero, then, the relationship between velocity and acceleration is given by the equation,$v = at$

Likewise, the relationship between displacement, velocity and acceleration is given by equation, ∶ $s = ½at^2$

When a force is applied to an object or load and displaced (moved) it over a distance, the work done by the force during the displacement is related by the equation,$W = Fs$

When time comes into the equation, we have power which is the rate of doing work and it is related to velocity by the equation, ∶ $P = Fv$

Now, let's relate all these terms back to positioning systems. The objective of a positioning system is to position a tool (which is the load) with respect to a workpiece. We are always concerned over how fast (which is related to time) we can perform this task of moving (which is displacement) the tool to the workpiece (which is the work to be done). To do this work, we may use a motor which is available in many sizes.

The capacity of a motor is measured by the rate in which it can do work or deliver energy. The total work done or energy output is not a measure of this capacity. A motor no matter how big or small can deliver a large amount of energy if given sufficient time. On the other hand, a large and powerful motor can deliver a large amount of energy in a short period of time. In other words, if we want to travel from one point to another, we can reach that place travelling either in a small car or a big car. The only different is how long to reach the place when the same route is used. In the same light, a sport car can reach a speed of 100km/h in 5 seconds and within a very short distance. A family car can also reach 100km/h, but maybe in 12 seconds and need a longer distance. The different is in the capacity of the engine which can produce more power to accelerate the mass of the car in a very short time, thus over a very short distance.

Given the same load and travel distance, a bigger motor will be able to accelerate its load in a shorter time and at a higher velocity when compared to a smaller motor.