GHC

HITACHI
Inspire the Next

SHAFTMOTOR DRIVE SYSTEM

Shaft motor drive system

The door to the high performance linear servo system has opened !
Shaftmotor and ADA3 series servo drive
give you a simple but excellent solution.

GHC SHAFTMOTOR

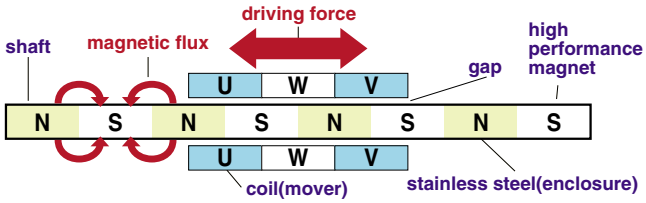
Hitachi AD series
linear servo driver
standarized for SHAFTMOTOR

SHAFTMOTOR

Shaftmotor, with its "Simple is the best" concept, realized a high-efficiency linear motor system. Shaftmotor made a breakthrough to the common sense of so-called "difficult to handle" linear motor technology and made it to a "easy to handle" component.

1 Simple mechanism! Stainless-steel shaft filled with magnet and coil unit without any iron core give a complete set of the hardware of shaftmotor.

→ No cogging force derived from the core-less coil.
→ No attraction force is working between the shaft and the coil
→ Wide gap between the shaft and the coil. Uniform force is obtained even under deviated center of the gap.

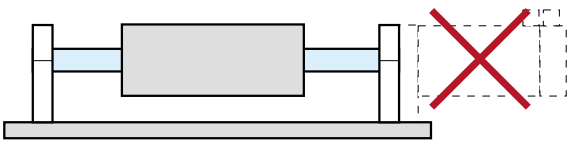


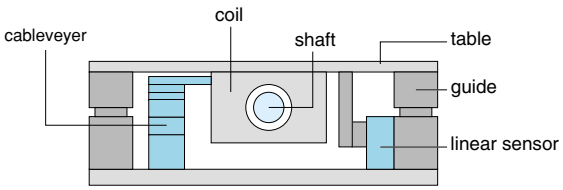
Complete utilization of magnetic flux from high performance magnet. Whole magnetic flux has efficient interaction in every direction with the current of the coil.

→ High efficiency, less heating up.
→ Enough power is obtained even from small-size shaft.

2 Similar mechanism to the linear drive by ball screw. No need of big change in mechanism structure.

→ Easy to re-design.
Total length along the moving axis will get shorter.

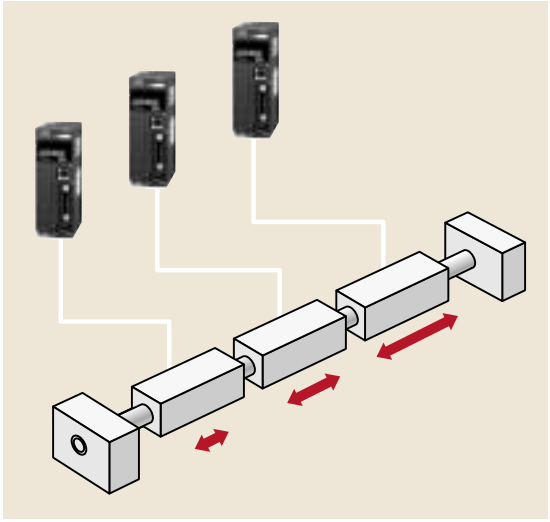


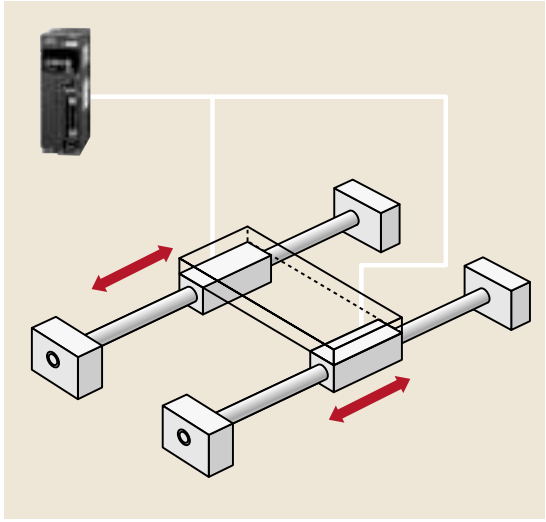


3 Flexibility of combination of coils and shaft and driver is allowed.

Multi-carrier drive system
Multiple coil units can be mounted on the same shaft. (Each coil is driven independently by each driver.)

Parallel drive system
Parallel connection to plural coils on spacially aparted shafts from one driver is achievable. (All coils must be rigidly combined and the magnetic phase must be aligned)





AD SERIES LINEAR DRIVE

AD Series servo driver is standarized for shaftmotor drive.
Advantages of shaftmotor are fully emerged by AD series,
and linear servo system with high cost performance is obtained.

4 Two types of interface are available which are suitable for linear servo system.

→Besides "pulse train command" and "analog voltage level command", driver with "built-in PLC function" can be chosen.

→Stand alone operation by "built-in PLC function" will strongly support the setup procedure and realize a simple but powerful control system!.

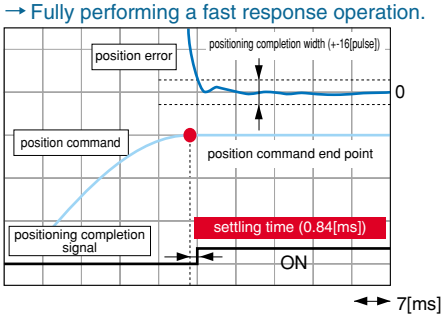
5 Easy to construct a linear drive system without hall sensors!

(P.12)

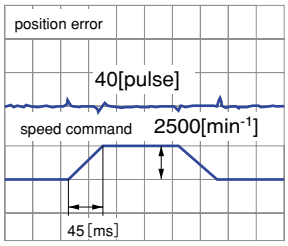
Automatic detection of magnetic pole becomes much more powerful!
Hall-sensorless technology makes the linear system simple and reliable.

6 "Fast positioning mode" realizes a positioning with settling time less than 1 milisecond.

→Fully performing a fast response operation.



7 "Minimum error mode" realizes an operation with drastically reducing position error during moving.



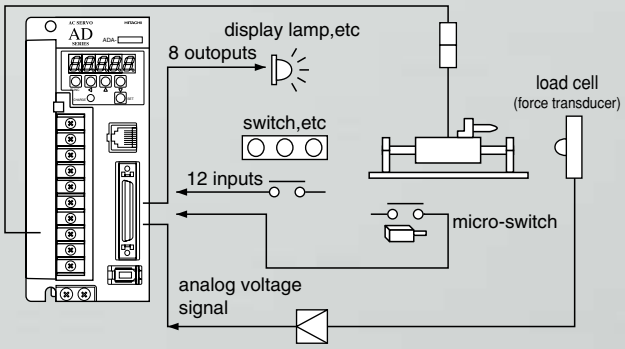
8 Anti- vibration function

→ Notch filter (2 filters)
→ Disturbance observer (optional)

Driver with built-in PLC Function

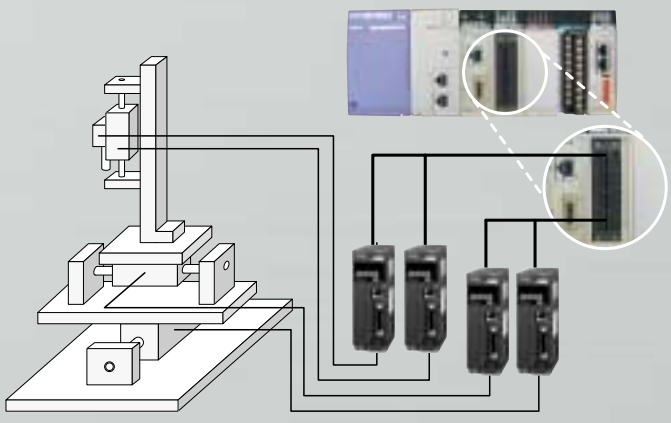
(ADAX3-***L2)

Automatic cyclic operation prescribed by user program is realized by this driver with built-in PLC function.
Input/Output control of 12 DI signal and 8 DO signal, and 2 port of analog voltage signal can be processed.



PLC positioning system

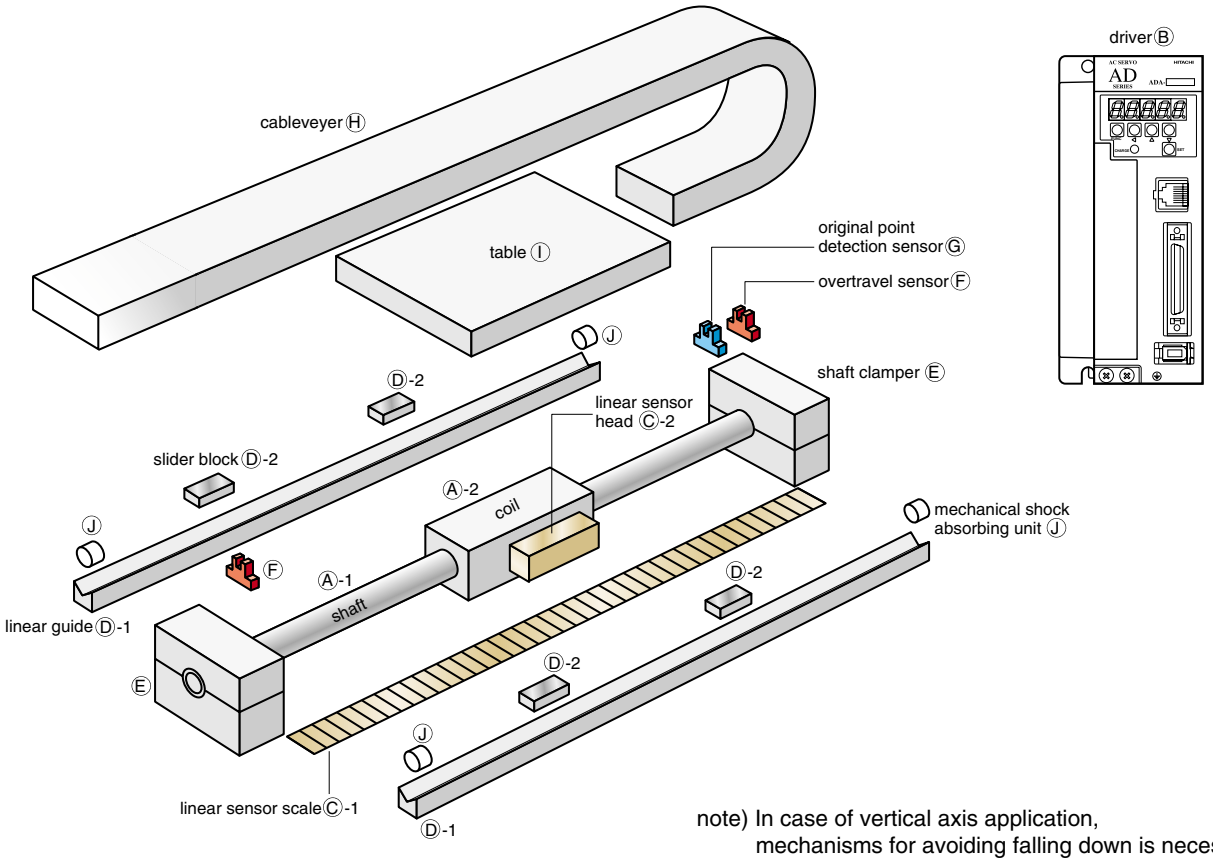
PLC:EH-150 series,EH-POS4 positioning module
Interpolation of 4 axes can be done by this system.



SYSTEM OUTLINE WITH SHAFTMOTOR APPLICATION

System with shaftmotor is built up from the components listed below
(1)Shaftmotor (Shaft and coil)Ⓐ
(2)Driver for shaftmotorⒷ
(3)Linear sensorⒸ
(4)Mechanism and equipments for safetyⒹ-Ⓙ
(Shaft clamper, Linear guide, mechanical shock absorbing unit, original point detection sensor, overtravel sensor, cableveyer,etc)

Especially items in (4) will have many variations according to the application, required performance,and environmental conditions. Consider about the general outline of the mechanism before starting the selection procedure of the model of the shaftmotor.
(In case of multi-carrier drive and parallel-drive, please consult to your nearest representative.)



note) In case of vertical axis application,
mechanisms for avoiding falling down is necessary.

CONDITIONS FOR SELECTING LINEAR SENSORS

Select the linear sensor which output type is line-driver signal, square-wave two-phase differential pulse.
Please be careful to confirm the current necessary for the sensor is not exceeding the capacity of the power supply from the driver(DC5V, Maximum 280mA).
In case above condition fails, supply from any additional power supply unit.

Resolution of the sensor should be smaller than 5 micrometer, especially in case the stability of velocity under slow moving is required.
The highest frequency of the square-wave pulse train signal which come into the driver should be less than 1MHz.
Please keep above condition by restricting the relationship of the resolution and the maximum speed.

f x a <= 4000,000 [Hz]
a=>1.2(this margin should be determined by the overshoot of speed regulation)

f = V x1000/r
r : resolution after multiplication by 4 [μm]
V : maximum value of operating velocity [mm/s]

ABOUT HALL SENSOR INSTALLATION

Installation of hall sensor is optional specification. Please consult to your nearest representative.
Hall sensor is very sensitive to electro-magnetic noise. Be careful to avoid from noise influence when user plans to use hall sensors.

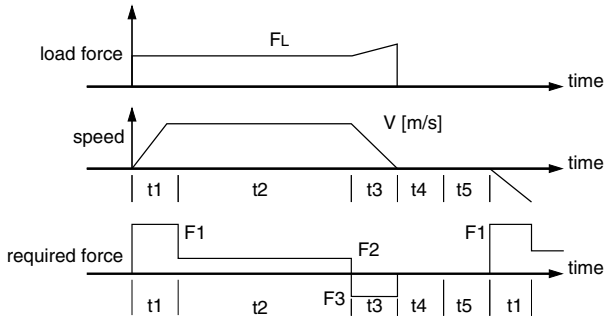
OUTLINE OF SELECTION OF SHAFTMOTOR

This sheet shows a general procedure for selection of appropriate model of shaftmotor.
User may check the validity of each selection by this sheet.

Actual temperature may vary much by the condition of refrigeration. Please confirm on the shaftmotor in practical to verify the actual temperature is below the expected level.
In case of using pre-pressure in the linear guide for high accuracy, mechanical friction loss may be so big that the validity of the selection would be influenced.
User should understand the actual condition from the documents of manufacturer of the linear guide.
Fill in the form to confirm whether any lack of the specification and condition is remaining or not.

1.terms of operation

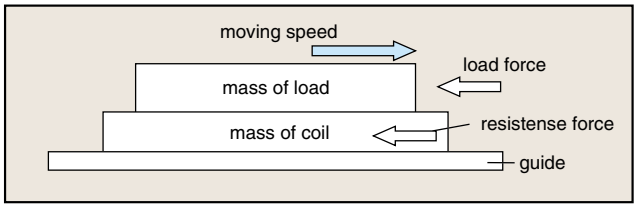
item	symbol	specification	unit	remark
stroke	St		mm	
maximum amount of loading	M_L		kg	
load force	F_L		N	external force that would disrturb the movement
maximum speed	Vm		m/s	
Typical time chart of driving and load force 1. With the biggest acceleration 2. With the biggest average force both of the case should be considered.				
moving speed	V		m/s	
acceleration time	t1		s	
constant speed feeding time	t2		s	
deceleration time	t3		s	
settling time	t4		s	
time for aimed process	t5		s	



2.Flow chart for selection

(1) Calculate the condition of load force

Estimate the external applying force by referring to the illustration.
Friction force of linear guide and resistence by deformation of cableveyer are taken into account as an external force Fc.
The mass of the coil(mover) Mc is assumed to be 1/10 of the mass of load M_L as initial value.



(2) Calculation of driving force

Calculate the necessary force for each interval among the operation.
Here, μ means friction coefficient of linear guide.
G denotes gravitational acceleration.

F1	force during acceleration	F1 = Fa+F_L+Fr	sum of Fa and load force
F2	force during constant speed	F2 = F_L+Fr	load force
F3	force during deceleration	F3 = Fd+F_L+Fr	sum of Fd and load force
Fa	acceleration force	Fa = (M_L+MC)×V/t1	
Fd	deceleration force	Fd = - (M_L+Mc)×V/t3	
Fr	resistence force during moving	Fr = μ(M_L+Mc) G+Fc	

(3) selection of tentative shaftmotor model

Select tentatively a shaftmotor model, maximum force of which is larger than the maximum force among the calculated necessary force. Keep 20-50% of margin.

(4) In the case of larger mass of coil Mc than the tentative value assumed in the step(1), go back to step(1)

(5) Confirmation on effective force

Calculate the effective force Feff from the necessary force in each timing by the formula.
Check whether the rated force of the shaftmotor Frated is larger than the effective force even with a consideration of some margin(safety ratio SF around 1.3 to 1.5).

$$F_{eff} = \sqrt{\frac{\{F1^2 \times t1 + F2^2 \times t2 + F3^2 \times t3\}}{(t1+t2+t3+t4+t5)}} < \frac{F_{rated}}{SF}$$

(6) In the case of larger Feff than rated force of the coil, go gack to (3)

Shaftmotor/Driver Specification

■Model code : Shaftmotor

S 080 D – 1000ST △△△

- S: Shaftmotor
- 080: Diameter of Shaft
- D: Coil size
- 1000ST: Stroke
- △△△: option

■Model code : Driver for Shaftmotor

ADA-3 – □□ *L2

- ADA-3: Standard Driver for Shaftmotor
- □□: Capacity
- *L2: Voltage

ADAX-3 –□□ *L2

- ADAX-3: Driver for Shaftmotor with built-in PLC Function
- □□: Capacity
- *L2: Voltage M:100V L:100V

Model name of Shaftmotor		S040D	S040T	S040Q	S080D	S080T	S080Q	S120D	S120T	S120Q	S160D	S160T	S160Q
Model name of Driver	100V	ADA*3-R5ML2(*3)			ADA*3-R5ML2			ADA*3-R5ML2			ADA*3-R5ML2		
	200V	ADA*3-R5LL2(*3)			ADA*3-01LL2			ADA*3-R5LL2			ADA*3-01LL2		
Rated Force(*1)	N	0.29	0.45	0.58	1.8	2.7	3.5	4.5	6.6	8.9	10	15	20
Rated Current(*1)	A	0.32	0.32	0.32	0.81	0.81	0.81	0.40	0.40	0.40	0.62	0.62	0.62
Maximum Force	N	1.2	1.8	2.3	5.9	9	12	18	26	36(31)	39	58	78(75)
Maximum Current	A	1.3	1.3	1.3	2.7	2.7	2.7	1.6	1.6	1.6(1.4)	2.4	2.4	2.4(2.3)
Force constant	N/A	0.9	1.4	1.8	2.2	3.3	4.3	11	17	22	16	24	33
Back emf constant	V/m/s	0.4	0.6	0.7	0.7	1.1	1.4	3.7	5.5	7.4	5.4	8.1	11
Coil resistance(*2)	ohm	11	17	22	4.7	6.8	9.0	37	54	73	21	33	43
Coil Inductance(*2)	mH	0.5	0.7	1.0	0.7	1.0	1.3	12	18	24	8.2	12	16
Heat resistance	deg/W	50	33	25	35	24	18	19	13	9.4	13	8.7	6.6
Mass of Mover	kg	0.009	0.011	0.014	0.05	0.06	0.08	0.09	0.12	0.16	0.15	0.20	0.30
pole pitch(N to N)	mm	18	18	18	30	30	30	48	48	48	60	60	60
Stroke	mm	20,30,40			25,50,100,150,200			50-1050(every 50 pitch)			100-1050(every 50 pitch)		

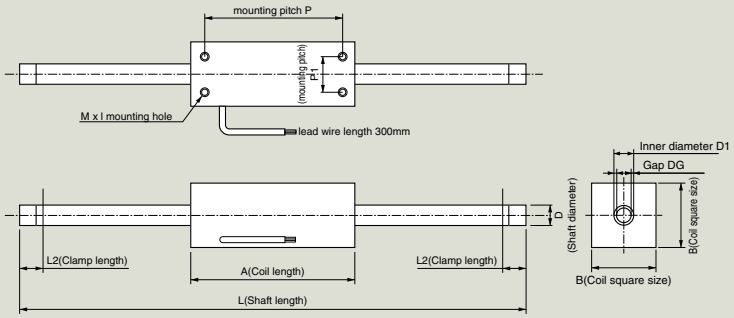
Model name of Shaftmotor		S200D	S200T	S200Q	S250D	S250T	S250Q	S250X	S320D	S320T	S320Q	S320X
Model name of Driver	100V	ADA*3-R5ML2			ADA*3-01ML2			ADA*3-02ML2	ADA*3-01ML2			ADA*3-02ML2
	200V	ADA*3-01LL2			ADA*3-02LL2			ADA*3-04LL2	ADA*3-02LL2			ADA*3-04LL2
Rated Force(*1)	N	18	28	38	38	57	75	139	56	85	113	226
Rated Current(*1)	A	0.59	0.59	0.59	1.3	1.3	1.3	2.4	1.2	1.2	1.2	2.5
Maximum Force	N	72	111	151(115)	148(157)	224(238)	296(313)	505(557)	217	326	435	788
Maximum Current	A	2.36	2.36	2.36(1.8)	5.1(5.4)	5.1(5.4)	5.1(5.4)	8.7(9.6)	4.8	4.8	4.8	8.7
Force constant	N/A	31	47	64	29	44	58	58	45	68	91	91
Back emf constant	V/m/s	10	16	21	10	15	19	19	15	23	30	30
Coil resistance(*2)	ohm	28.7	43	56	7.8	12	15	7.6	11	17	23	11
Coil Inductance(*2)	mH	19.3	29	39	10	15	19	10	17	26	34	17
Heat resistance	deg/W	11.0	7.3	5.6	8.3	5.4	1.4	2.5	6.3	4.2	3.1	1.6
Mass of Mover	kg	0.30	0.50	0.70	0.80	1.1	1.5	2.9	1.2	1.7	2.2	4.2
pole pitch(N to N)	mm	72	72	72	90	90	90	90	120	120	120	120
Stroke	mm	100-1550(every 50 pitch)							100-2000(every 50 pitch)			

Model name of Shaftmotor		S350D	S350T	S350Q	S427D	S427T	S427Q	S435D	S435T	S435Q	S500D	S500T	S500Q
Model name of Driver	100V	ADA*3-01ML2		ADA*3-02ML2	ADA*3-04ML2			ADA*3-04ML2			-	-	-
	200V	ADA*3-02LL2		ADA*3-08LL2	ADA*3-08LL2			ADA*3-08LL2			ADA*3-10LL2	ADA*3-15LL2	ADA*3-20LL2
Rated Force(*1)	N	104	148	190	100	150	200	120	180	230	289	440	585
Rated Current(*1)	A	1.5	1.5	2.7	3.0	3.0	3.0	3.0	3.0	3.0	3.8	5.8	7.7
Maximum Force	N	352(373)	505(535)	760(742)	396	595	794	463	697	926	1156	1760	2340
Maximum Current	A	5.1(5.4)	5.1(5.4)	10.8 (10.6)	11.8	11.8	11.8	11.8	11.8	11.8	15.2	23.2	30.8
Force constant	N/A	69	99	70	34	50	67	39	59	79	73	73	73
Back emf constant	V/m/s	23	33	23	11	17	22	13	20	26	24	24	24
Coil resistance(*2)	ohm	13.8	20.2	6.9	2.7	3.9	5.2	2.7	3.9	5.2	4.5	3	2.3
Coil Inductance(*2)	mH	21.8	33.0	10.9	7.3	11	15	7.3	11	15	27	18	13.5
Heat resistance	deg/W	3.5	2.4	2.2	4.6	3.2	2.4	4.6	3.2	2.4	2.2	1.5	1.1
Mass of Mover	kg	1.3	1.9	2.4	3.0	4.2	5.4	3.0	4.2	5.4	11	13	15
pole pitch(N to N)	mm	120	120	120	180	180	180	180	180	180	180	180	180
Stroke	mm	100-2000(every 50 pitch)			100-3000(every 50 pitch)			100-2000(every 50 pitch)			100-2000(every 50 pitch)		

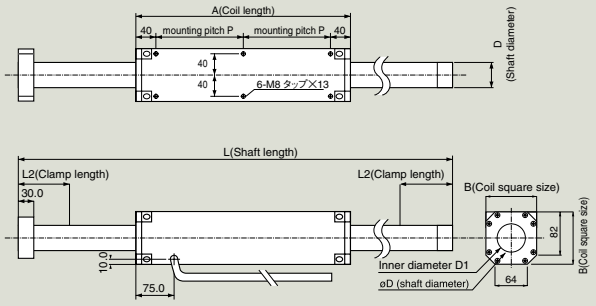
(*1) At temperature rise of 110K on the surface of the internal wire within coil unit.
(*2) Average value of U-V,V-W,W-U.This specification is based on the atomosphere temperature of 23degree centigrate.
(*3) With S040, additional tuning from the parameter which is already set to the driver may be necessary to obtain an accurate dynamic characteristics.
Values in ( ) is for the Driver for AC100V supply voltage type.
Please consult if longer stroke is necessary.

Shaftmotor Dimensions

●S040~S435



●S500



Additive length for setting limit sensors and other parts to keep mechanical system safe should be considered into the stroke S.
Calculate the shaft length by next formula. L =Stroke S + Coil length A + 2*L2(clamp length)

Model name of Shaftmotor		S040D	S040T	S040Q	S080D	S080T	S080Q	S120D	S120T	S120Q	S160D	S160T	S160Q
shaft diameter D	mm	4±0.1			8±0.1			12±0.2			16±0.1		
Coil length A	mm	25	34	43	40	55	70	64	88	112	80	110	140
Coil square size B	mm	10			20			25			30		
Mass of Mover	kg/f	0.009	0.011	0.014	0.05	0.06	0.08	0.09	0.12	0.16	0.15	0.20	0.30
Mounting pitch P	mm	21.5	30.5	39.5	34	49	64	56	80	104	70	100	130
Mounting pitch P1	mm	4±0.3			10±0.3			12±0.3			16±0.3		
Mounting screw M	mm	4-M2 x 2			4-M3 x 5			4-M3 x 5			4-M3 x 5		
Inner diameter D1	mm	4.6			9			13			17		
Gap DG	mm	0.3			0.5			0.5			0.5		

Model name of Shaftmotor		S200D	S200T	S200Q	S250D	S250T	S250Q	S250X	S320D	S320T	S320Q	S320X
shaft diameter D	mm	20±0.2			25±0.2				32±0.2			
Coil length A	mm	94	130	166	120	165	210	390	160	220	280	520
Coil square size B	mm	40			50				60			
Mass of Mover	kg/f	0.3	0.5	0.7	0.8	1.1	1.5	2.9	1.2	1.7	2.2	4.2
Mounting pitch P	mm	84	120	156	105	150	195	375	140	200	260	500
Mounting pitch P1	mm	20±0.3			25±0.3				30±0.3			
Mounting screw M	mm	4-M4 x 6			4-M6 x 9				4-M8 x 12			
Inner diameter D1	mm	21.5			26.5				34			
Gap DG	mm	0.75			0.75				1.00			

Model name of Shaftmotor		S350D	S350T	S350Q	S427D	S427T	S427Q	S435D	S435T	S435Q	S500D	S500T	S500Q
shaft diameter D	mm	35±0.2			42.7±0.2			43.5±0.2			50±0.3		
Coil length A	mm	160	220	280	220	310	400	220	310	400	240	330	420
Coil square size B	mm	60			80			80			100		
Mass of Mover	kg/f	1.3	1.9	2.4	3.0	4.2	5.4	3.0	4.2	5.4	11	13	15
Mounting pitch P	mm	140	200	260	200	290	380	200	290	380	80	125	170
Mounting pitch P1	mm	30±0.3			50±0.3			50±0.3			80±0.3		
Mounting screw M	mm	4-M8 x 12			4-M8 x 12			4-M8 x 12			6-M8 x 12		
Inner diameter D1	mm	37			46			46			53.5		
Gap DG	mm	1.00			1.65			1.25			1.75		

■The clamping length of shaftmotor is different by the stroke, even for the same shaft diameter.

Model name of Shaftmotor		S040D/T/Q	S080D/T/Q	S120D/T/Q	S160D/T/Q
Stroke S	mm	-40	-200	-350	351-800	801-
Clamping length L2	mm	5	10	25	40	60

Model name of Shaftmotor		S200D/T/Q			S250D/T/Q			S250X			S320D/T/Q			S320X		
Stroke S	mm	-300	-700	701-	-700	-1500	1501-	-500	-1300	1301-	-750	-1500	1501-	-500	-1250	1251-
Clamping length L2	mm	25	40	60	50	70	100	50	70	100	50	70	100	50	70	100

Model name of Shaftmotor		S350D/T/Q		S427D/T/Q		S435D/T/Q		S500D/T/Q	
Stroke S	mm	-750	751-1500	1501-	-550	551-1000	1001-	-750	-2000
Clamping length L2	mm	50	70	100	60	80	100	80	100

SPECIFICATION OF DRIVER

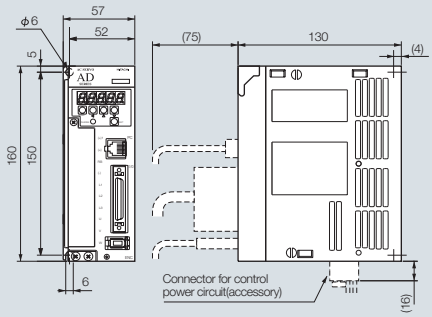
ADA3-,ADAX3-		R5ML2	01ML2	02ML2	04ML2	R5LL2	01LL2	02LL2	04LL2	08LL2	10LL2	15LL2	20LL2	30LL2	50LL2
Basic specifications	Applicable motor capacity (kW)	0.05	0.1	0.2	0.4	0.05	0.1	0.2	0.4	0.75	1	1.5	2	3	5
	Maximum rated current (Arms)	0.9	1.8	2.9	5.1	0.9	0.9	1.7	2.9	4.8	6.2	9.5	13	23.5	35
	Minimum rated current (Arms)	0.7	1.4	2.2	3.8	0.7	0.7	1.3	2.2	3.6	4.7	7.1	9.8	17.6	26
	Instantaneous maximum current (Arms)	2.7	5.4	10.6	16.8	2.7	2.7	5.1	8.7	14.4	19.8	28.5	39	60.1	105
	Power supply equipment capacity (KVA)	0.3	0.4	0.5	1	0.3	0.3	0.5	0.9	1.3	1.8	2.5	3.5	4.8	7.5
	Input power supply (main circuit) (Note1)	Single-phase 100 to 115 V +10%,-15%				Three-phase 200 to 230 V +10%, -15% 50/60Hz±5%									
	Input power supply(control circuit)	50/60H±5%				Single-phase 200 to 230 V +10%,-15% 50/60Hz±5%									
	Maximum speed (mm/s) (Note 2)	4000													
	Speed control range (Note 2)	1:4000													
	Maximum Force (Ratio to the rated force)	more than 300%(depends on the applied motor model)													
	Protective structure (Note 3)	Open type IP00													
	Control system	Sine- wave pulse width modulation PWM system													
	Control mode	Position control/speed control/torque control													
	Applicable linear sensor (Note 4)	Incremental type, square-wave two-phase differencial pulse (A-phase and B-phase), line-driver output (AM26LS31 compatible) ; power supply : 5V±10%, 280mA or less													
	Maximum frequency of pulse signal from linear sensor	4MHz(after multiplication by 4) [original phase differencial pulse: 1MHz]													
Input/ output-related functions	Speed command/limitation input	Analog input: 0 to +10/-10 V/Maximum speed (gain adjustable)													
	Force command/limitation input	Analog input: 0 to +10/-10 V/Maximum Force (gain adjustable)													
	Forward force limit/ Reverse force limit	Two analog inputs: each 0 to +10/-10 V/Maximum Force in forward/reverse direction (separated ports)													
	Position command input (Note 4)	Line driver signal (2M pulses/s or less) Three patterns can be adopted. 1-Forward pulse/reverse pulse :2-Direction signal+clock pulse: 3-Two Phase differencial pulse input													
	Input signal	DC 12/24V Contact signal(internal DC24V power supply available). Usable as both of Sink type/Source type. 1)Servo ON, 2)Alarm reset, 3)Control mode switch, 4)Force limit, 5)Forward overtravel, 6)Reverse overtravel, 7)Multistage speed 1 /Exchange electronic gear, 8)Multistage speed 2, 9)Speed loop proportional control /Gain change, 10)Zero speed clamp /External trip(Abnormal temperature signal)(Note5), 11)Homing limit switch, 12)Homing, 13)Pulse train input enable /Forward command, 14)Position error clear /Reverse Command													
	Output signal	Open collector signal output, usable only as Sink type 1)Servo ready, 2)Alarm(normally ON), 3)Positioning complete, 4)Up to speed /Alarm code1, 5)Zero speed detection, 6)Brake release, 7)Force limiting /Alarm code2, 8)Overload notice /Alarm code3													
	Encoder monitor signal output	Two-phase differencial pulse (A-phase and B-phase) : Line driver signal output (output resolution selectable) Phase Z signal output : Line driver signal output port and open collector signal output port (separated ports)													
	Monitor output	2 ch, 0 to 3 V analog voltage output. User selectable from Speed detection value, Force command, etc.													
Internal functions	Built-in operator	5-digit number display unit, key input x 5													
	External operator	Windows®95/98/Me/XP, Windows NT® ,Windows 2000®PC connectable (using RS-232C port)													
	Regenerative braking circuit	Built-in (without a braking resistor)		Built-in		Built-in (without a braking resistor)			Built-in						
	Dynamic brake (Note 6)	Actuated at Servo OFF, Trip, or Power OFF (operating condition settable)													
	DB resistor: resistance [Ω]	not provided			2	not provided				2	8.2	8.2	0.7	0.7	1.2
	DB resistor: Joule energy [J]				58					58	105	105	711	711	2155
	DB resistor: minimum operation interval [s]				10					30	30	30	60	60	60
	DB circuit: peak current (0-P) [A]	2.7	7.4	10.4	13.6	2.9	2.9	6.9	10.9	6.5	12.0	6.5	42.6	86	91.0
	DB circuit: connection	two phase short				two phase short							star-connection		
	Protective functions	Overcurrent, overload, braking resistor overload, main power overvoltage, memory error, main power undervoltage, CT error, CPU error, ground fault, power failure , control power undervoltage, External trip(Abnormal temperature of motor (Note 5)), power module error, encoder error, position error, speed error, overspeed error, driving range error, position monitoring timeout error, Overtravel error, Abnormal temperature error, motor power unmach, Magnetic detection not completed													
Operating environment	Ambient temperature/ Storage temperature (Note 7)	0 to +55°C/ -10 to +70°C													
	Humidity	20 to 90%RH or less (without condensation)													
	Vibration (Note 8)	5.9 m/s²(0.6G), 10 to 55 Hz													
	Installation location	1000m or less above the sea, indoor place (free from corrosive gas and dust)													
	Estimated mass (kg)	0.8	0.8	1	1.4	0.8	0.8	0.8	1	1.4	1.9	1.9	4.6	4.6	7.7

Note 1: This is only for normal operation of the driver, not for guaranteeing the speed-force characteristic curve of the shaftmotor.
Note 2: This is only for setting of parameters within the driver, not for guaranteeing the actual attainable speed of the shaftmotor. Maximum speed is restricted by the back emf force voltage of the shaftmotor (should be less than the maximum DC voltage within the driver), as well as the response limit of the linear sensor.
Note 3: The protective system conforms to JEM1030.
Note 4: As for linear sensor signal and position command pulse signal (high frequency pulse train signal), user needs to suppress noise well and confirm the operation before actual run.
Note 5: In case of connecting thermal detector to "EOH" terminal.
Note 6: Use the dynamic brake as an emergency stopping method.
Note 7: The storage temperature is the short-term temperature during transport.
Note 8: The testing method of JIS C0040 is applied.

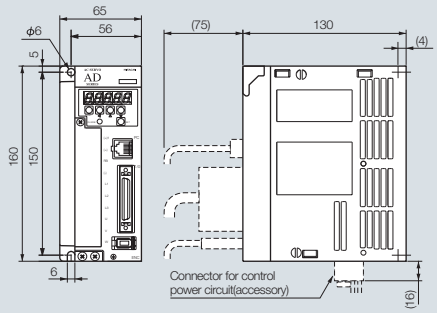
SPECIFICATION OF DRIVER

unit : mm

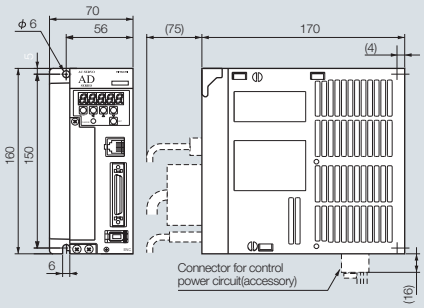
● **ADA3-R5,01,02LL2, -R5,01ML2**
ADAX3-R5,01,02LL2, -R5,01ML2



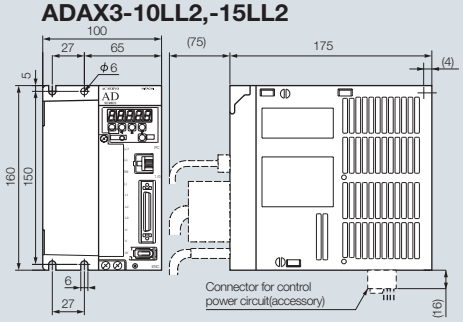
● **ADA3-04LL2,-02ML2**
ADAX3-04LL2,-02ML2



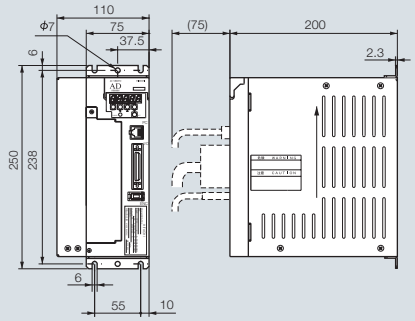
● **ADA3-08LL2, -04ML2**
ADAX3-08LL2, -04ML2



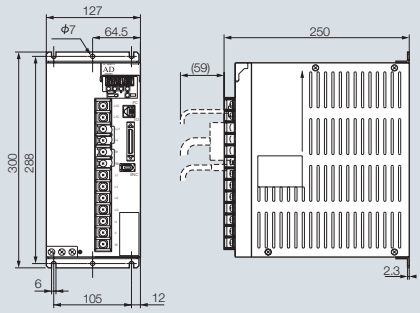
● **ADA3-10LL2,-15LL2**
ADAX3-10LL2,-15LL2



● **ADA3-20LL2,-30LL2**
ADAX3-20LL2,-30LL2



● **ADA3-50LL2**
ADAX3-50LL2



Recommended wire size and Wiring quipment

voltage class	type code of driver ADA*3-	Main circuit power cable L1,L2,L (+)1,(+),RB,(-)	Motor cable (U,V,W) Grounding cable	Control power cable (L1C,L2C)	Motor cable (U,V,W) Grounding cable(ELB)(*1)	Electro-magnetic contactor (MG)(*1)
three-phase 200V	R5LL2 01LL2 02LL2 04LL2	1.25mm² or more (*2)	1.25mm² or more (*2)	0.5mm² or more	EX3(05A)	H10C
	08LL2 10LL2				EX30(10A)	
	15LL2	2mm²or more	2mm²or more	0.5mm²or more	EX30(15A)	
	20LL2	2mm²or more	3.5mm²or more	1.25mm²or more	EX30(20A)	H20
	30LL2	3.5mm²or more	5.5mm²or more	1.25mm²or more	EX30(30A)	
	50LL2	5.5mm²or more	8mm²or more	1.25mm²or more	EX50(50A)	H25
single-phase 100V	R5ML2 01ML2 02ML2 04ML2	1.25mm² or more (*2)	1.25mm² or more (*2)	0.5mm² or more	EX50B(5A) EX50(5A) EX50B(10A) EX50B(15A)	H10C

(*1)These models are manufactured by Hitachi Industrial Equipment Systems Co.,Ltd.
(*2)For the driver from R5LL2 to 10LL2 and from R5ML2 to 04ML2, since the width of the terminal in main circuit terminal closed-loop terminal can be connected.
For the driver 15LL2,use a closed-loop terminal of the diameter of 8.1mm or less sized for 2mm² cable.

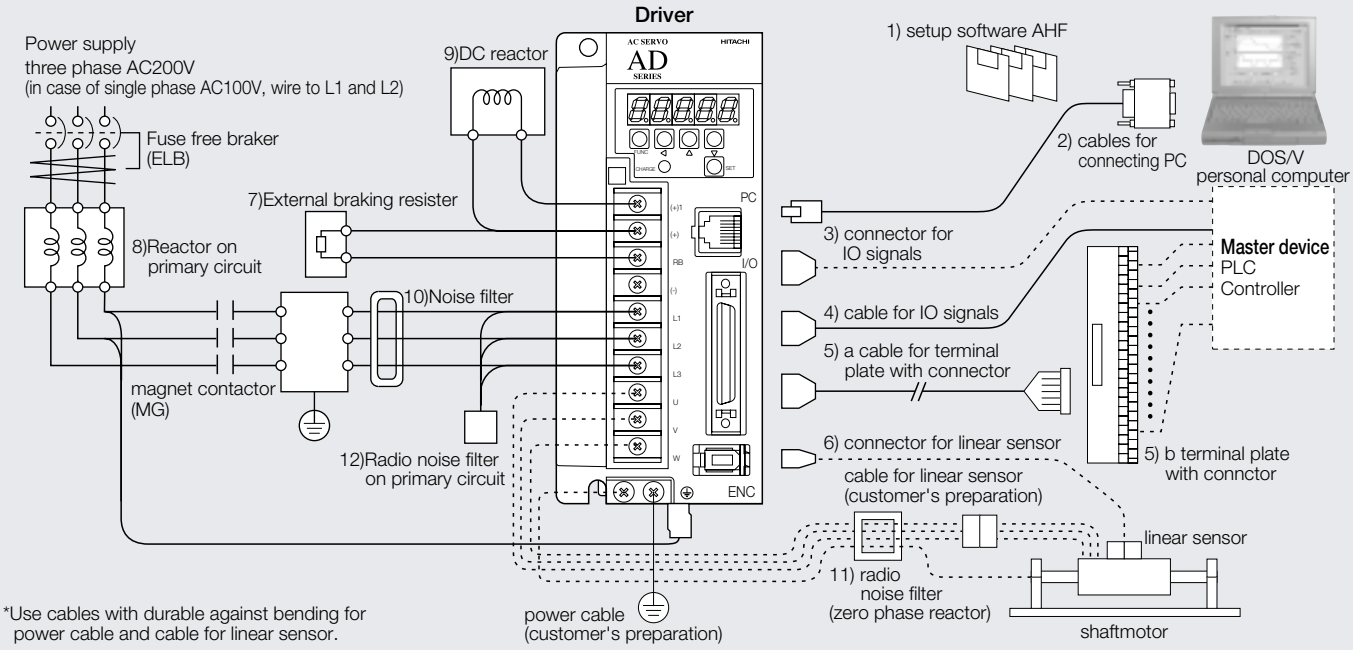
SPECIFICATION

To enhance the braking capacity, connect the optional externalbraking resistor exceeding the resistance value RBRmin shown inthe following table.Never to install a resistor not exceeding the resistance value shown in the table.Otherwise, damage to the regenerative braking circuit may occur.

voltage class	type code of driver ADA*3-	voltageclass	voltageclass
three-phase 200V	R5LL2 01LL2 02LL2	Not provided	100Ω
	04LL2	30W,75Ω(10W, 0.5%)(*3)	50Ω
	08LL2	50W,50Ω(15W, 0.5%)(*3)	40Ω
	10LL2 15LL2	70W,25Ω(27W, 0.5%)(*3)	25Ω
	20LL2 30LL2	120W,10Ω(70W, 0.5%) (*3)	10Ω
	50LL2	180W,6Ω(120W, 0.5%) (*3)	6Ω
single phase 200V	R5ML2 01ML2	Not provided	35Ω
	02ML2	30W,40Ω(9W, 1.0%) (*3)	25Ω
	04ML2	50W,20 Ω(17W, 1.0%) (*3)	17Ω

(*3) The values are the nominal power and the resistance value of the built-in braking resistor.The available average power and the allowable operation ratio are written in the parenthes.

SYSTEM CONFIGURATION



OPTIONAL PARTS, PERIPHERAL APPLIANCES

■Setup support tool

A software which contains functions for perfoming

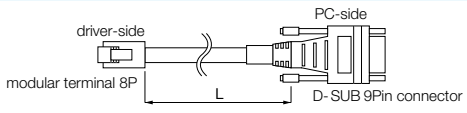
	item	model code	function
1	setup software	AHF-P01	Software to setup or change the parameters in the driver, to display the monitoring status of the shaftmotor in operation, to get and display an waveform of servo-data in specific period.
		AHF-P02	Be used for drivers with built-in PLC function.Editer function for programming of built-in PLC function is added to AHF-P01.
2	cables for connecting PC	ADCH-AT2	Cable to connect to DOS/V personal computer

Operational environment

item	Environmental condition
PC	DOS/V PC memory:more than 32MB harddisk workspace: more than 30MB Resolution of monitor display: more than 800x600
OS	Windows®95/98/Me/XP, Windows NT®,Windows2000®

*Windows® is a trademark of Microsoft corporation in United states and other countries.

■Cables for connecting PC

type code	lenghth L	Figure
ADCH-AT2	2m	

■Connector and cables

	item	model code	function
3	connector for IO signals	ADCC-CON	Connector to apply command signal to I/O port
4	cable for IO signals	ADCC-03	Cable to apply command signal to I/O port
5a	cable for terminal plate with connector	ADCC-T01 ADCC-T02	Cable to connect terminal plate to IO connector
5b	terminal plate with connector	ADCC-TM	for relaying command signal. Use with cable of 5a as a set.
6	connector for linear sensor	ADCC-EA2	Connector to apply feedback pulse from linear sensor to driver

note1) select one among 3,4 and 5a+5b . Note2) when using 4, wire to the connector for the controller to be used.
note3) 5a and 5b should be used together. Note4) when using 6, wire to the recommended cable of linear sensor manufacturer.

■Peripheral device

	item	model code	function
7	Braking resistor	JRB,SRB,RB	for increasing the regenerative braking capacity.
8	Primary circuit reactor	ALI-	for supression of harmonics and improvement of power factor.
9	Direct current reactor	DCL-	for supression of harmonics emitted from the driver.
10	Noise Filter	NF-	for reduction of noise transported by wire from the driver.
11	Radio frequency noise filter (zero phase reactor)	ZCL-B40,B75, ZCL-A	for reduction of noise, especially in case of disturbances to such as a radio reciever located nearby.
12	Primary circuit radio noisefilter	CFI-L	for reduction of radiational noise from the wiring of primary circuit.

OPTIONAL PARTS,PERIPHERAL APPLIANCES

Pin assignment of Connector for IO signals

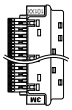
PIN NO	terminal symbol	signal name
1	P24	Interface power
2	PLC	Intelligent input common
3	X(00) / MOD	Control mode switch
4	X(01) / TL	Torque limit
5	X(04) / SS1 / EGR2	Multistage speed 1 / Electronic gear change
6	X(05) / SS2 / ECLR	Multistage speed 2 / Encoder counter clear
7	X(07) / SRZ / EOH	Zero speed clamp / External trip
8	X(08) /ORL	Home limit switch
9	X(11) / CER / REV	Position error clear / Reverse movement

PIN NO	terminal symbol	signal name
10	CM1	Interface power common
11	Y(01) /ALM	Alarm
12	Y(02) / INP	Positioning complete
13	Y(05) /BRK	Brake release
14	Y(06) / TLM / AL2	Torque limiting /Alarm code 2
15	PLSP	Position command pulse (Pulse signal) (P)
16	PLSN	Position command pulse (Pulse signal) (N)
17	L	Analog input/output common
18	AI3	Analog input 3
19	XA(0) / AI1	Analog input 1
20	L	Analog output common
21	OAP	Encoder Monitor output signal Phase A (P)
22	OAN	Encoder Monitor output signal Phase A (N)
23	OZP	Encoder Monitor output signal Phase Z (P)
24	OZN	Encoder Monitor output signal Phase Z (N)
25	AO1	Analog monitor 1

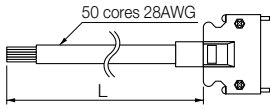
PIN NO	terminal symbol	signal name
26	SON	Servo ON
27	RS	Alarm reset
28	X(02)/FOT]	Forward overtravel
29	X(03)/ROT	Reverse overtravel
30	CM1	Interface power common
31	X(06)/ PPI/ GCH	Proportional control / Gain change
32	X(09)/ORG	Homing
33	X(10)/ PEN/ FWD	Pulse train input enable / Forward movement
34	CM2	Output common

PIN NO	terminal symbol	signal name
35	Y(00)/SRD	Servo ready
36	Y(03)/ SA/ AL1	Up to speed / Alarm code 1
37	Y(04)/SZD	Zero speed detection
38	Y(07)/ OL1/ AL3	Overload notice / Alarm code 3
39	CM2	Output common
40	SIGP	Position command pulse (Code signal) (P)
41	SIGN	Position command pulse (Code signal) (N)
42	-	-
43	AI4	Analog input 4
44	XA(1)/AI2	Analog input 2
45	L	Analog input/output common
46	OBP	Encoder Monitor output signal Phase B (P)
47	OBN	Encoder Monitor output signal Phase B (N)
48	OZ	Phase Z detection
49	L	Phase Z detection common
50	AO2	Analog monitor 2

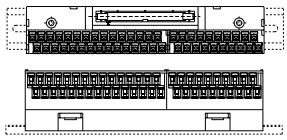
Connector for IO signals

model code	contents
ADCC-CON	 Plug for soldering 10150-3000VE manufactured by Sumitomo 3M Co.,Ltd.  Non-shield shell kit 10350-52A0-008 manufactured by Sumitomo 3M Co.,Ltd.

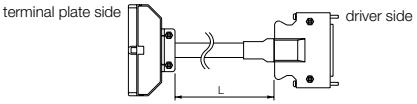
Cable for IO signals

model code	length L	contents
ADCC-03	3m	 50P connector connector: 10150-6000EL connector cover: 10350-52A0-008 manufactured by Sumitomo 3M Co.,Ltd.

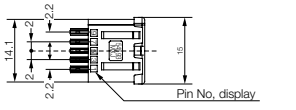
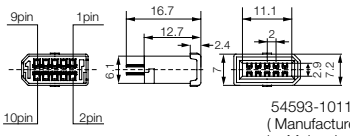
Terminal plate with connector

model code	contents
ADCC-TM	

Cable for terminal plate with connector

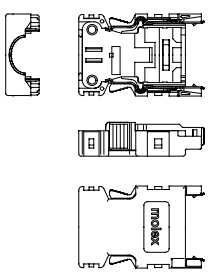
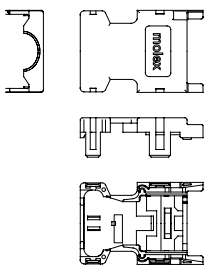
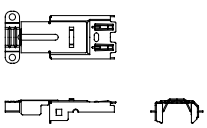
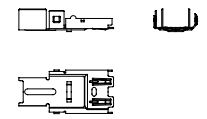
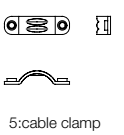
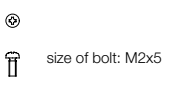
model code	length L	contents
ADCC-T01 ADCC-T02	1m 2m	

Connector for linear sensor

model code	contents
ADCC-EA2	  terminal side for soldering 54593-1011 (Manufactured by Molex Japan Co.,Ltd.)

Pin assignment and Symbols of Connector for linear sensor

PIN NO	terminal symbol	signal name
1	EP	power supply to sensor (+)
2	EG	power supply to sensor (-)
3	-	-
4	-	-
5	B+	Phase B signal (P)
6	B-	Phase B signal (N)
7	A+	Phase A signal (P)
8	A-	Phase A signal (N)
9	Z+	Phase Z signal (P)
10	Z-	Phase Z signal (N)

model code	contents / connector cover(consist of parts No.1-No.6) 54599-1005 (Manufactured by Molex Japan Co.,Ltd.)			
ADCC-EA2	 1:cover A	 2:cover B	 3:shell cover  4:shell body	 5:cable clamp  6:screw bolt with crossline groove

INITIAL SETTING PROCEDURE OF THE DRIVER(For systems without hall sensors)

With the initial setting after shipping, driver may display 'E39-1' alarm at the first time it is turned on.
(In case of a system with hall sensor, this alarm doesn't occur.) This setting is for fail-safe purpose.
Before actual operation, user need to set appropriate values into parameters shown below.
* As for motor parameter (for the shaftmotor to be driven), set up by the set up software AHF is necessary.
In case the manufacturer set the motor parameter when shipping(charged), step7 is not necessary.
* General settings of other parameters than shown below should be also necessary. Consult to the manuals.

START Control power turn on

E39-1 displayed on the front panel

① FA-90(Hall sensor connecting) CnCt (yes) --> oFF (no)

② FA-80(sensor type selection) confirm inC

③ FA-81(sensor selection) confirm inCE

④ FA-85(linear sensor resolution) value in micrometer

⑤ FA-82 (pole pitch devided by sensor resolution) calculated value by formula

⑥ FA-87(direction of sensor count up) b or A

⑦ load appropriate "motor parameter"

⑧ Fd-00(Mass of moving part) mass of moving portion in kg devided by 10

Control power turn OFF and again turn ON

END

① by this setting, E39 alarm may be resolved by the next control power turn on.
* In case of using hall sensors, leave FA-90 CnCt ,but it is necessary to set other parameters appropriately according to the manual.

②③ confirm the setting(default setting is OK)

④ set the length for 1 pulse from sensor (after multiplication by 4)
If the resolution after multiplication by 4 is 0.5 micrometer, set 0.5 .
If the resolution after multiplication by 4 is 5 micrometer, set 5 .

⑤ set the pulse count from the linear sensor(original pulse) for the length of pole pitch of magnet(N to N)

$$\frac{A}{B \times 4/1000} = \frac{A \times 250}{B} = \square$$

shaftmotor type code	S040	S080	S120	S160	S200	S250	S320/S350	S427/S435/ S500
A :pole pitch of magnet	18	30	48	60	72	90	120	180

B :linear sensor resolution set in step 4

⑥ Initial setting after shipping is b .
Confirm the setting as described in P12, by moving the coil manually and verify the monitored position d-08 is increasing or not.

⑦ For this step, set up software (AHF) and motor parameter file is necessary.
Please purchase the set up software and ask for motor parameter file.

⑧ Initial value is the mass of the coil devided by 10.
Add the weight of the moving portion of the load.

$$\frac{M + L}{10} = \square$$

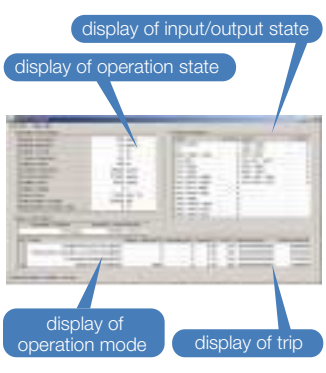
M :Mass of the coil of shaftmotor(mover)
L :Mass of the moving portion of the load

SETUP SOFTWARE AHF

By AHF, user can work easily for below functions.

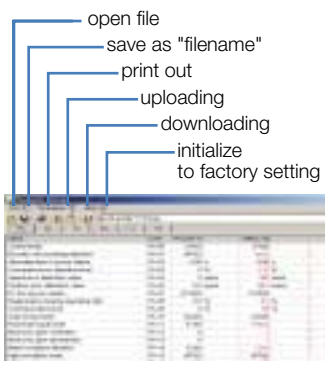
Monitoring

Realtime monitoring of operation state and output state



Setting parameters

Setting, change, print out, store to memory is able.



Trace operation data

graphically displays the dynamic data such as velocity,current,etc.

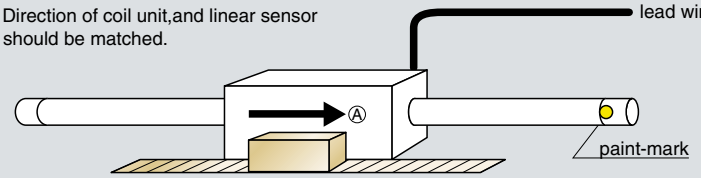
Trial run and adjustment

Jog operation, original point search, off-line auto tuning, online auto tuning are supported.

PRECAUTIONS ABOUT INITIAL SET UP

1. Set up of shaftmotor.

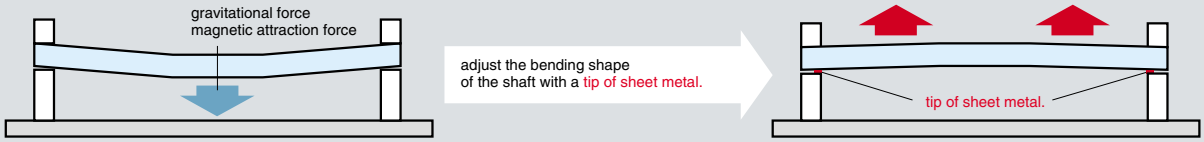
Direction Direction of coil unit,and linear sensor should be matched.



to move the coil manually in Ⓐdirection, and check d-08 monitor

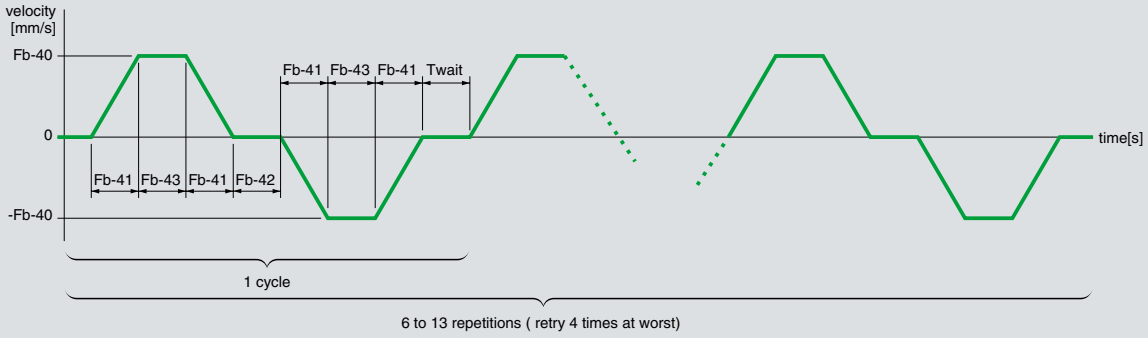
1) The paint-mark on the shaft is no relation to the direction of the coil unit.
2) While moving the coil manually in Ⓐ direction, check d-08 monitor whether the value increases or not.
If it increases, the direction of the linear sensor is OK.
If it decreases, parameter FA-87 should be reversed.
(b↔A)

Set up Set the shaft and the mover(coil unit) so that the coil doesn't touch with the shaft on the whole stroke.
*In case of very long stroke, the shaft may bend due to gravitational force or magnetic attractive force.
Adjust the fixed angle of the shaft by a tip of sheet metal inserting to the fixed points of the shaft.



2. Automatic estimation function of magnetic pole detection

The driver can detect the position of the magnetic pole without hall sensor. For this function, searching procedure is necessary everytime the driver is turned on, and is triggered by turning on the SON signal while RS signal has been turned on beforehand.While searching, the shaftmotor moves as back and forth.
User must assure that no interferrence would happen during this movement.
Relationship of the movement and the parameter set in the driver is shown as below.



By initial setting of the driver, each parameter is as below and the moving distance is about 1.6mm.

Speed	Fb-40=80[mm/sec]
Acceleration time	Fb-41=10[msec]
Constant speed time	Fb-43=10[msec]
Halting time	Fb-42=100[msec]

In some load condition, the detection fails with the initial parameter, and the driver displays E95 alarm.
Also, in case that smaller distance or smooth movement is necessary, change the parameter and try as below.
(1) In case of too small friction load, such as with air slide guide
①Speed Fb-40 set up to larger value like "100" than initial setting "80"
*The distance becomes larger after commit ①
(2) In case of too large friction load, or smaller distance and smooth movement is required.
①Speed Fb-40 be set up to smaller value like "50" than initial setting "80".
②Acceleration time Fb-41 set up to larger value like "20" than initial setting "10"
③Halting time Fb-43 set up to larger value like "300" than initial setting "100"
*The distance becomes larger after commit ②
*Testing is necessary for ① and ② because these changes make the estimation harder.
(3) In case of inaccurate setting of Fd-00(Mass of moving part) also leads to failure of this detection. Correct the setting in such case. ---See Page 11.

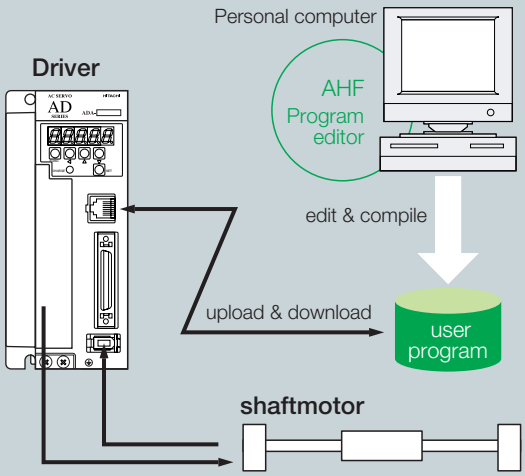
note)Consult to use in vertical movement
note)Consult if the operation does not work out or it is over permissible range.

SERVO DRIVER WITH BUILT-IN PLC FUNCTION (ADAX3-***L2)

Driver which can produce positioning command signal itself, and also equipped with built-in Programmable Logic Controller Function

(The size of the driver is the same as a standard driver.)

- **Commands are similar to the commands of BASIC language.**
  By coding with the program control commands similar to BASIC language and set of commands like positioning command and velocity commands,automatic execution of patterned cyclic operation of PTP(Point to Point) motion is easily realized.
- **A plenty of resisters for memorizing reference value**
  position command resisters: 100 points
  velocity command registers: 16 points
  Position command can be set easily by teaching function
- **A plenty of input / output control**
  12 ports inputs, 8 ports outputs, 2 ports of analog voltage inputs can be controlled.
  In some commands, pulse train signal can be used as a position command input.
- **Easy-to-use program editor**
  Program coding is easy with an editor on the setup software AHF-P02, which can be operated on Windows® 95/98/Me/XP, and Windows NT®, Windows 2000® Operating system.

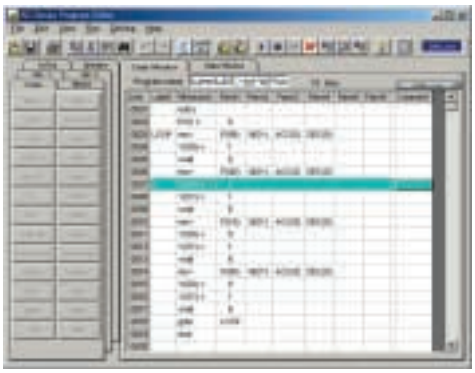


■ Specification

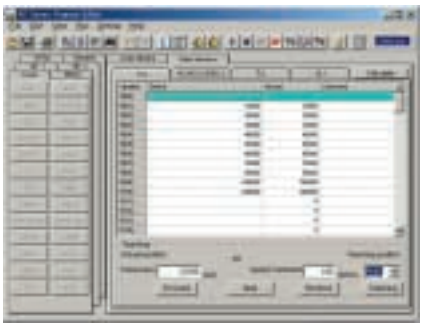
	Item	Specifications
Language Specificaions	Language type	Language similar to BASIC with additional commands for motion control.
	Input device	Personal computers (Windows® 95/98/Me/XP,WindowsNT4.0®,Windows2000®)
	Program size capacity	512steps(The drive can store up to 512 steps or 6KB.)
	Programming support function	Text input Display on terminal Program syntax check on terminal Program loading and all clear (PC<-->servo drive) Single step execution Breakpoints (up to 4 points)
	Execution method	Interpreter method, 1.12ms/command (subroutine calls available ,up to 8 nesting levels)
input/ output functions	Digital input	Contacts signal/open-collector signal input (24V-DC internal power supply provided).Servo On, alarm reset, and general-purpose input(12points,referred as X(0) to X(11))
	Digital output	8 points (Y(0) to Y(7))
	Analogue input	2 points (XA(0) to XA(1))
Reserved words	Variables	Position reference :P(00) to P(99)(100points) Speed reference : N(00)toN(15)(16points) Force reference : T(00)to T(15)(16points) Acceleration time : ACC(0).AC(1)(2points) Deceleration time : DEC(0),DEC(1)(2points) Control mode : MOD Control gain : KSP,KSI,KP,etc Monitoring:IFB.IRF,NFB,NRF,POS,PRF,etc User-defined variable : U(00) to (15) (16variables)
	Commands	Program control command(ex. if ~then ~else) Motion control command(ex. mov, speed, trq) Arithmetic operation(ex. +, -, *, /) Logic operation(ex. and, or)

(*) Windows® is a trademark of Microsoft corporation in United States and other countries.

■ Programming and Debugging window



■ Position command setting window



FOR CORRECT OPERATION ⚠

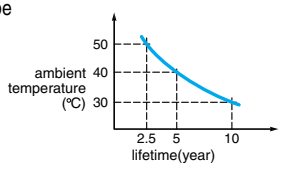
1 Notes on the safety about shaftmotor

(1) On the surface of the shaft of shaftmotors, the magnetic flux density is 0.5~0.7[T](5000~7000[G]).
Attractive force may work onto magnetic substances like iron.
Do not put any tool with magnetic substances near the shaft.
Do not assemble the shaftmotor without any protective materials covering the shaft.
Do not disassemble the shaft nor the coil unit of shaftmotor.
Damages will be caused if watches, products with precise mechanism, or floppy disks are put near the shaft.
(2) Do not transport, mount, connect, or inspect while an electrical power is applied to the shaftmotor.
Transportation, mounting, connection, or inspection must be performed by only specified trained personnel.
(3) Apply power after the shaft and the coil are correctly fixed to the mounting base.
(4) In case of disconnecting the feedback signal(linear sensor signal) during the operation, the shaftmotor will be out of control.
Be sure to make a perfect protection of wiring, add fail-safe mechanisms, and careful handling.
(5) Do not touch the moving part during operation.
(6) In heavy duty operation, the temperature of the surface of the coil may rise more than 70[℃].
Do not touch the coil during operation, nor touch the coil while in rest but still before cooling.
(7) Use bolts with non-magnetized materials for fixing the shaft, coil, and mechanical parts near the shaft.
(8) Use tools with non-magnetized materials for fixing the shaft, coil, and mechanical parts near the shaft.
(9) When stocking the shaftmotor for a long time, cover the shaft with non-magnetized materials, thickness of more than 25mm, and store in the dry place with moderate temperature(-5℃~40℃).
(10) Avoid from operation which exceeds the motor performance. Overheat, fire, damage, or degradation of performance may occur.

2 Notes on the safety about driver

(1) Before use, be sure to read through the Instruction manual to insure proper use of the driver.
(2) Note that the driver requires electrical wiring; a specialist should carry out the wiring.
(3) The driver in this catalog is designed for general industrial applications. For special applications in fields such as aircraft, outer space, nuclear power, electrical power, transport vehicles, clinics, and submarine relay equipment,please consult with us in advance.
(4) For application in a faclity where human life is involved or serious losses may occur, make sure to provide safty devices to avoid a serious accident.

*) The driver and the shaftmotor are intended to use with correct combination. If they are used with wrong combination, there may be a chance of fire and damage.

Installation location and operating environment	Avoid installation in areas of high temperature, excessive humidity, or where moisture can easily collect, as well as areas that are dusty, subject to corrosive gasses, mist of liquid for grinding, or salt. Install the driver away from direct sunlight in a well-ventilated room that is free of vibration. The driver can be operated in the ambient temperature range from 0 to 55˚C.The shaftmotorr can be operated in the ambient temperature range from 0 to 40˚C.
Wiring connections	(1) Be sure to connect main power wires with L1, L2, and L3 terminals (input) and motor wires to U, V, and W terminals (output).(Incorrect connection will cause a breakdown.) (2) Be sure to provide a grounding connection with the ground terminal (⏚).
Run/Stop	Run or stop of the motor must be done with IO signals through a control circuit terminal. Do not operate by installing a electromagnetic contactor (Mg) in the main circuit.
Speciality	Be sure to confirm the load speciality before choosing the type of shaftmotor.
Installing a circuit breaker	Install a circuit breaker on the main power input side to protect driver wiring and ensure personal safety. Choose an inverter-compatible circuit breaker. The conventional type may malfunction due to harmonics from the driver. For more information, consult the circuit breaker manufacturer.
Phase advance capacitor	Do not use a capacitor for power factor improvement between the driver and the motor. High-frequency components of inverter output may overheat or damage the capacitor.
High-Frequency Noise and Leakage Current	(1) High-frequency components are included in the input/output of the driver main circuit, and they may cause interference in a transmitter, radio, or sensor if used near the driver. The interference can be minimized by attaching noise filters (option) in the driver circuitry. (2) The switching action of an driver causes an increase in leakage current. Be sure to ground the driver and the motor.
Installation of an AC reactors on the input side	In the cases below involving a driver , a large peak current flows on the main power supply side,and is able to destroy the converter module. Where such situations are foreseen or the connected equipment must be highly reliable,install an AC reactor between the power supply and the driver. Also, where influence of indirect lightning strike is possible,install a lightning conductor. (A) The unbalance factor of the power supply is 3% or higher. (Note) (B) The power supply capacity is 10 times greater than the driver capacity (the power supply capacity is 500 kVA or more). (C) Abrupt power supply changes are expected. Examples: (1) Several drivers are interconnected with a short bus. (2) A thyristor converter and an driver are interconnected with a short bus. (3) An installed phase advance capacitor opens and closes. In cases (A), (B) and (C), it is recommended to install an AC reactor on the main power supply side. Note: Example calculation with V_{L1L2} = 205V, V_{L2L3} = 201V, V_{L3L1}= 200V $\text{Unbalance factor of voltage} = \frac{\text{Max. line voltage (min.) - Mean line voltage}}{\text{Mean line voltage}} \times 100$ $= \frac{V_{L1L2}-(V_{L1L2}+V_{L2L3}+V_{L3L1})/3}{(V_{L1L2}+V_{L2L3}+V_{L3L1})/3} \times 100 = \frac{205-202}{202} \times 100 = 1.5(\%)$
Lifetime of Primary Parts	Because a smoothing capacitor deteriorates as it undergoes internal chemical reaction, it should normally be replaced every five years. Be aware, however, that its life expectancy is considerably shoter when the driver is subjected to such adverse factors as high temperatures or heavy loads exceeding the reted current of the driver.The approximate lifetime of the capacitor is as shown in the figure at the right when it is used 12 hours daily.Also, such consumable parts as a cooling fan should be replaced. (Maintenance inspection and parts replacement must be performed by only specified trained personnel.) 

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