

SANMOTION

SERVO SYSTEMS

R **ADVANCED
MODEL**

48 VDC 2.4 W-200 W



SANYO DENKI

Ver. 4

SANMOTION R

SERVO SYSTEMS

ADVANCED MODEL

Input voltage 48 VDC

Servo Amplifiers

Pulse input single-axis

EtherCAT single-axis

EtherCAT multi-axis



Amplifier capacity 25 A, 40 A

Servo Motors



Flange size 14 mm sq., 20 mm sq., 40 mm sq., 60 mm sq.



Rated output 2.4 to 200 W

Cylinder linear servo motors **Motor width** 12 mm, 20 mm



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High-Performance Servo Systems

SANMOTION R

SERVO SYSTEMS



These are compact, lightweight, and low-voltage servo systems.

Lineup

			Servo amplifiers		
			Pulse input single-axis	EtherCAT single-axis	EtherCAT multi-axis
Servo motors	Rated output [W]	Flange size	<p>The amplifier has been much downsized from our conventional AC servo amplifier,* having a volume about 0.30 times and a weight about 0.31 times that of it.</p>	<p>This type has an EtherCAT interface for high-speed communication. The communication cycle is as fast as 0.125 ms, realizing smoother servo motion.</p>	<p>Capable of controlling four axes with one unit, this product helps you build a compact system, saving space. The generated regenerative energy can be used to power other motors, achieving energy savings.</p>
	2.4	14 mm sq.			
	20 to 30	20 mm sq.			
	30 to 80	40 mm sq.			
100 to 200	60 mm sq.				
Cylinder linear servo motors	Rated thrust [N]	Motor width	<p>* SANMOTION R AC servo amplifier (model no.: RS2A01A)</p>		
	3.0 to 5.1	12 mm			
	15	20 mm			

Note: SANMOTION multi-axis integrated linear servo motor unit that integrates multiple cylinder linear servo motors into a single unit is also available.

Ultra compact and lightweight

As a result of downsizing and weight reduction, the pulse input type has a volume about 0.30 times and a weight about 0.31 times that of our conventional AC servo amplifier.* The EtherCAT multi-axis type can drive 4 motor axes with a single unit, saving space.

We offer small servo motors with 14 and 20 mm sq. flanges and compact cylindrical linear servo motors with 12 and 20 mm widths for use in chip mounters and other equipment with limited installation space.

* SANMOTION R AC servo amplifier (model no.: RS2A01A)

EtherCAT communication

EtherCAT is a 100 Mbps high-speed fieldbus system. It contributes to shortening machine cycle time. This highly versatile EtherCAT is compatible with Ethernet, which makes it possible to build a system where various machines co-exist. The EtherCAT single-axis type amplifier can update the firmware of the servo amplifier via an EtherCAT network. Also, the EtherCAT conformance test certificate from a trusted third party has been acquired.

Simple start-up and servo tuning

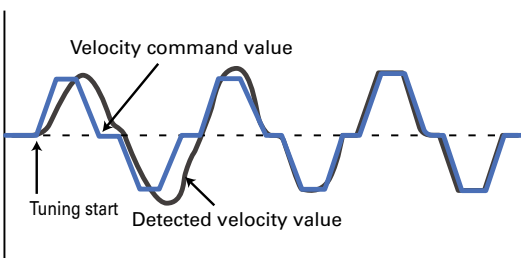
SANMOTION MOTOR SETUP SOFTWARE displays the parameters required for operation in an easy-to-understand manner for quick and easy equipment startup.

Servo amplifiers have a jog function for checking motor-amplifier connections. Test runs can be performed without connecting to a host controller.

In coordination with the setup software, the amplifiers also offer a variety of servo tuning support functions according to given mechanical and load conditions. This greatly shortens servo tuning time.

Auto-tuning

The servo amplifier automatically makes real-time adjustments of servo gain and filter frequency to optimum while in operation.



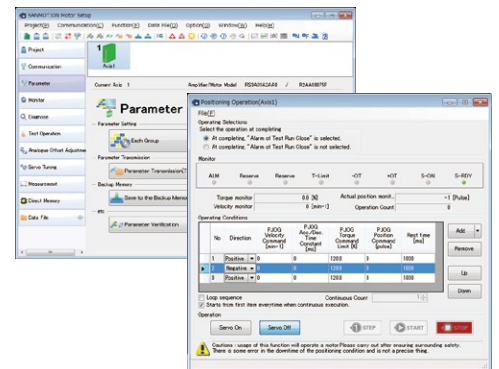
Low-voltage systems

The servo amplifiers have a low power supply voltage with a low risk of electrical shock. This means they can be used in equipment that complies with Low Voltage Directive.

They are suitable for applications including semiconductor manufacturing equipment, small robots, chip mounters, axes in machine tools, and medical equipment that are powered by low voltage.

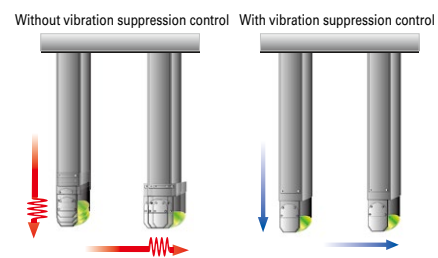


EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.



Feed-forward vibration suppression control

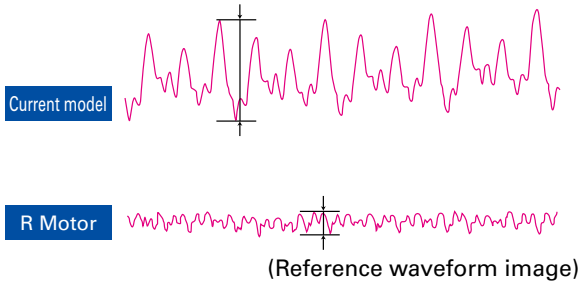
With feed-forward vibration suppression control, vibrations of the end effector and the base of machines can be suppressed through simple tuning. Also, the vibration control frequency can be selected.



Low cogging torque

Cogging torque of 40 and 60 mm sq. motors has been reduced compared to our conventional product, achieving smoother machine operation.

Comparison of cogging torque waveforms



Water and dust protection

40 and 60 mm sq. servo motors are highly resistant to water and dust ingress with IP65 protection, ensuring normal operation even in severe environments. Models with IP67 protection are available as options. Except for shaft through-hole and cable ends.



High-Precision Battery-Less Absolute Encoder

40 and 60 mm sq. servo motors come with a high-precision battery-less absolute encoder as standard. Has a wide operating temperature range of -20 to +105°C. Withstands environmental vibration of up to 147 m/s² (15 G). (When mounted on a servo motor, the operating temperature and environmental vibration of the motor prevail.)

They can be used in harsher environments than our conventional products.

For even higher precision, custom options such as single-turn resolution of 1048576 (20-bit) and absolute angular accuracy of approximately 0.0167° (1 arcmin) are available. We offer a variety of encoders available for use in various equipment. See the table below.

Name	Compatible motor size	Standard				Custom options
		Single-turn resolution	Multi-turn resolution	Baud rate	Absolute angular accuracy	
Single-turn absolute encoder This is an optical single-turn encoder.	14 mm sq.	131072 (17-bit)	–	2.5 Mbps	Approx. 0.167°	
Single-turn absolute encoder (Model No. MA018) This is a magnetic single-turn encoder. It has high environmental durability against water, oil, and dust.	20 mm sq.	8192 (13-bit)	–	2.5 Mbps	Approx. 0.167°	
Battery-less absolute encoder (Model No. GAER) This is a high-precision battery-less optical multi-turn encoder. It reduces maintenance because it doesn't need batteries, which require maintenance.	40 mm sq. 60 mm sq.	131072 (17-bit)	65536 (16-bit)	2.5 Mbps	Approx. 0.167°	<ul style="list-style-type: none"> • Single-turn resolution: 1048576 (20-bit) • Baud rate: 4.0 Mbps • Absolute angular accuracy: Under 0.0167°
Single-turn absolute encoder (Model No. PA035S) This is a thin profile, optical single-turn encoder. It helps save wiring and downsize systems particularly for systems where incremental encoders are currently used.	40 mm sq. 60 mm sq.	131072 (17-bit)	–	2.5 Mbps	Approx. 0.167°	<ul style="list-style-type: none"> • Single-turn resolution: 1048576 (20-bit) • Baud rate: 4.0 Mbps
Options Battery-backup absolute encoder (Model No. PA035C) This is a thin profile, battery-backed optical multi-turn encoder. Because the length of the motor can be shortened, it is ideal for devices with limited motor installation space. It requires an optional battery.	40 mm sq. 60 mm sq.	131072 (17-bit)	65536 (16-bit)	2.5 Mbps	Approx. 0.167°	<ul style="list-style-type: none"> • Single-turn resolution: 1048576 (20-bit) • Baud rate: 4.0 Mbps

Note: Battery-less absolute resolver encoders with high environmental durability are also available.

Servo Amplifier and Servo Motor Combination Table

Standard servo motor spec... Output shaft: straight, oil seal: none, connection: cable

Servo motor				Page		Servo amplifier model no.				
Classification	Rated output [W]	Flange size	Model no.	Specifi-cations	Dimen-sions	Pulse input single-axis	EtherCAT single-axis	EtherCAT multi-axis (max. 4)		
R2 servo motor, medium inertia	2.4	14 mm sq.	R2GAD102RMXH50	20	23	RF2G11A0A00	RS2K02A2HA5	RF2J14A0HL5	-	
	20	20 mm sq.	R2GA02D20FXC00	20	23			RF2J24A0HL5 (Up to a total of 120 W)	-	RF2K24A0HL5 (Up to a total of 300 W)
	30	20 mm sq.	R2GA02D30FXC00	20	23					
	30	40 mm sq.	R2GA04003F□□	20	24					
	50	40 mm sq.	R2GA04005F□□	21	24					
	80	40 mm sq.	R2GA04008D□□	21	24					
	100	60 mm sq.	R2GA06010D□□	21	24					
	200	60 mm sq.	R2GA06020D□□	21	24					
R1 servo motor, low inertia	50	40 mm sq.	R1GA04005F□□	22	24	RF2G21A0A00	RS2K04A2HL5/ RS2K04A2HA5	-	-	
	100	40 mm sq.	R1GA04010F□□	22	24					
	200	60 mm sq.	R1GA06020D□□	22	24					

Classification	Rated thrust [N]	Motor width	Model no.	Specifi-cations	Dimen-sions	Pulse input single-axis	EtherCAT single-axis	EtherCAT multi-axis (max. 4)	
Cylinder linear servo motor	3.0	12 mm	DE0AC0A1A03CX00	34	35	RF2G21L8A10	RS2K04AAHA5	RF2J24A8HL5	
	5.1	12 mm	DE0AC001A03CX00	34	35				
	15	20 mm	DE0BC005A05CX00	34	35				

Features

Servo Amplifier and Motor Combination Table

Standard Model Number List

ADVANCED MODEL Servo Amplifiers Pulse input single-axis

ADVANCED MODEL Servo Amplifiers EtherCAT single-axis

ADVANCED MODEL Servo Amplifiers EtherCAT multi-axis

Servo Motors

Options

Linear Servo Motors

Selection Guide

Servo Amplifiers

Type	No. of controllable axes	Main circuit power supply	Control circuit power supply	Encoder type	General-purpose output	Built-in regenerative resistor	STO function	Amplifier capacity	Model no.	Page	
										Specifications	Dimensions
Pulse input type	1	48 VDC	5 VDC	Absolute encoder	Sinking	-	-	25 A	RF2G11A0A00	10	10
								40 A	RF2G21A0A00	10	10
EtherCAT interface type	1	48 VDC	24 VDC	Absolute encoder	Photo relay	-	✓ (with delay circuit)	40 A	RS2K04A2HL5	16	17
								25 A	RS2K02A2HA5	16	17
								40 A	RS2K04A2HA5	16	17
								40 A (Up to a total of 120 W)	RF2J24A0HL5	16	17
	4	48 VDC	24 VDC	Absolute encoder	Photo relay	-	✓ (with delay circuit)	40 A (Up to a total of 300 W)	RF2K24A0HL5	16	17
								40 A (Up to a total of 300 W)	RF2K24A0HL5	16	17

Note 1: All servo amplifier models conform to international standards (UL, cUL, and EN standards and KC mark) as standard.

Note 2: Contact us if a 24 VDC main circuit power supply is needed.

R2 Servo Motors Compact, small capacity, medium inertia

Standard... Output shaft: straight, oil seal: none, connection: cable (no connector)

Motor flange size	Rated output	Protection rating	Holding brake (24 VDC)	CE-UKCA-UL	Model no.	Page	
					Single-turn absolute encoder	Specifications	Dimensions
14 mm sq.	2.4 W	IP40	-	-	R2GAD102RMXH50	20	23
20 mm sq.	20 W	IP40	-	-	R2GA02D20FXC00	20	23
	30 W				R2GA02D30FXC00	20	23

R2 Servo Motors Small capacity, medium inertia

Standard... Output shaft: straight, oil seal: none, connection: cable (no connector)

Motor flange size	Rated output	Protection rating	Holding brake (24 VDC)	CE-UKCA-UL	Model no.		Page	
					Battery-less absolute encoder	Single-turn absolute encoder	Specifications	Dimensions
40 mm sq.	30 W	IP65	-	✓	R2GA04003FXR03M	R2GA04003FXH03M	20	24
			✓	✓	R2GA04003FCR03M	R2GA04003FCH03M	20	24
	50 W	IP65	-	✓	R2GA04005FXR03M	R2GA04005FXH03M	21	24
			✓	✓	R2GA04005FCR03M	R2GA04005FCH03M	21	24
	80 W	IP65	-	✓	R2GA04008DXR03M	R2GA04008DXH03M	21	24
			✓	✓	R2GA04008DCR03M	R2GA04008DCH03M	21	24
60 mm sq.	100 W	IP65	-	✓	R2GA06010DXR03M	R2GA06010DXH03M	21	24
			✓	✓	R2GA06010DCR03M	R2GA06010DCH03M	21	24
	200 W	IP65	-	✓	R2GA06020DXR03M	R2GA06020DXH03M	21	24
			✓	✓	R2GA06020DCR03M	R2GA06020DCH03M	21	24

R1 Servo Motors Small capacity, low inertia

Standard... Output shaft: straight, oil seal: none, connection: cable (no connector)

Motor flange size	Rated output	Protection rating	Holding brake (24 VDC)	CE-UKCA-UL	Model no.		Page	
					Battery-less absolute encoder	Single-turn absolute encoder	Specifications	Dimensions
40 mm sq.	50 W	IP65	-	✓	R1GA04005FXR03M	R1GA04005FXH03M	22	24
			✓	✓	R1GA04005FCR03M	R1GA04005FCH03M	22	24
	100 W	IP65	-	✓	R1GA04010FXR03M	R1GA04010FXH03M	22	24
			✓	✓	R1GA04010FCR03M	R1GA04010FCH03M	22	24
60 mm sq.	200 W	IP65	-	✓	R1GA06020DXR03M	R1GA06020DXH03M	22	24
			✓	✓	R1GA06020DCR03M	R1GA06020DCH03M	22	24

Note: Contact us for models with IP67 protection.

Servo Amplifiers

Pulse input single-axis

How to Read Model Numbers

Note that not all possible parameter combinations are valid. Also note that some of the parameters below are for options. Refer to the Standard Model Number List section for standard models with valid model numbers.

RF2 G 21 A 0 A 00

Code	Specifications
00	Standard
10	Cylinder linear servo motor

Code	Specifications
A	Analog/pulse, sinking type (NPN) general-purpose output

Code	Specifications
0	Absolute encoder
8	Incremental encoder

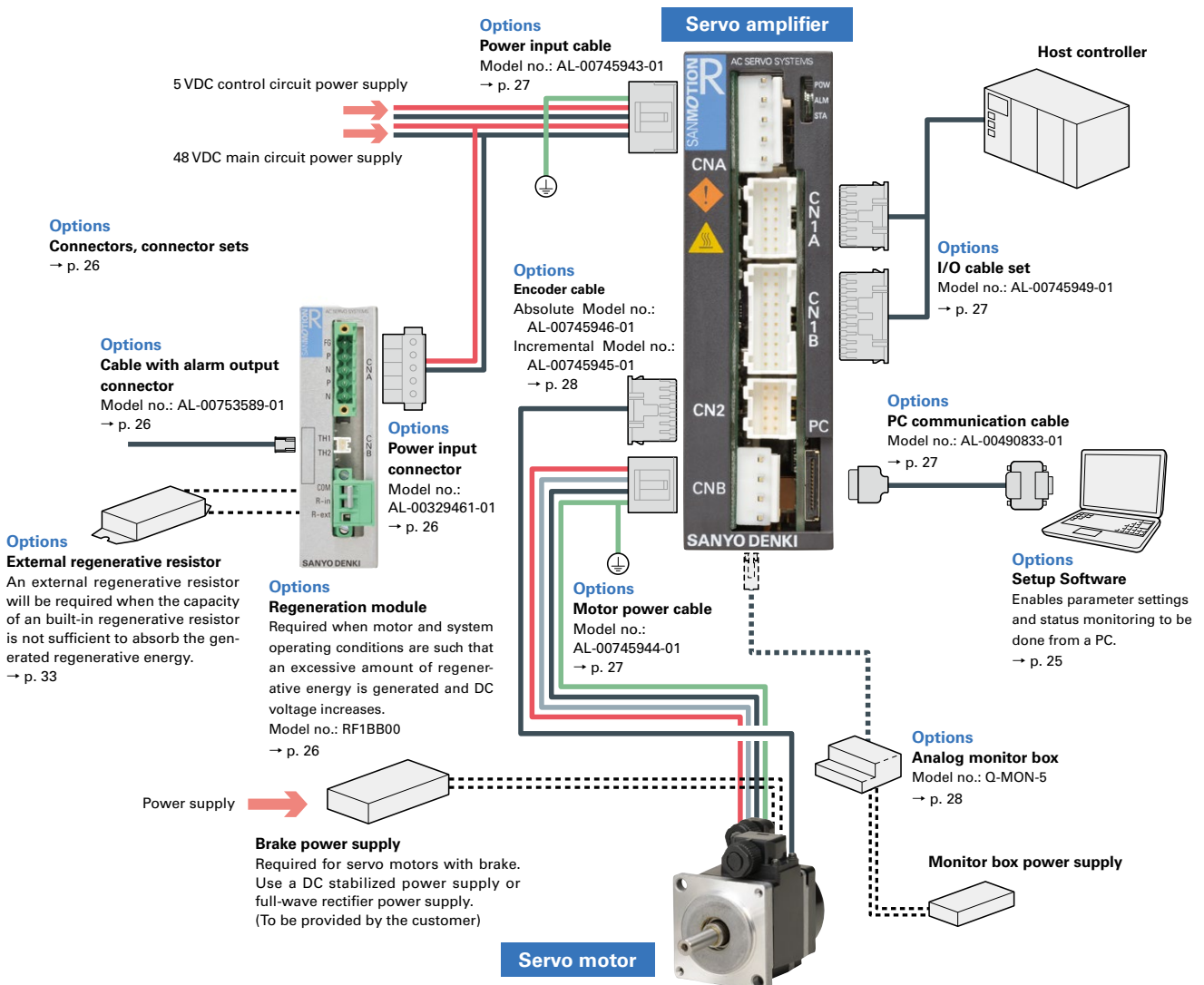
Code	Specifications
11	25 A (Dedicated for motor R2GAD102R)
21	40 A

Code	Specifications
G	48 VDC

Note: Contact us if a 24 VDC power supply is needed.

ADVANCED MODEL series

System Configuration



Control functions	Position control	
Control system	Power MOSFET-based sinusoidal PWM control	
Main circuit power supply	48 VDC $\pm 10\%$ ⁽¹⁾	
Control circuit power supply	5 VDC $\pm 5\%$ ⁽²⁾	
Environment	Operating temperature	0 to 40°C ⁽³⁾
	Storage temperature	-20 to +65°C
	Operating and storage humidity	Below 90% RH (non-condensing)
	Altitude	1000 m or below
	Vibration resistance	4.9 m/s ² At frequency of 10 to 55 Hz in each X, Y, and Z direction for 2 hours
Shock resistance		19.6 m/s ²
	Structure	Tray type, external DC power supply required
Speed control range	1:5000 (Internal speed command)	
Frequency characteristics	1200 Hz (at high-speed sampling mode)	
Protection functions	Overcurrent, current meter error, overload, main circuit power supply overvoltage, main circuit power supply undervoltage, control circuit power supply undervoltage, encoder error, overspeed, speed control error, speed feedback error, CPU error, memory error, parameter error, excessive position deviation, positioning command pulse error, amplifier overheating, external error	
LED indicator	Alarm indicator (red), status indicator (green), control power ON (green)	
Dynamic braking	Built-in	
Regenerative resistor	Option: External	
Analog monitor	Option	

(1) Ensure that the main circuit power supply voltage is within the specified range.

(2) The control circuit power supply is used to power encoders. Note that a long encoder wiring, even if the input voltage is within the range, may drop the voltage and prevent the encoder from operating normally.

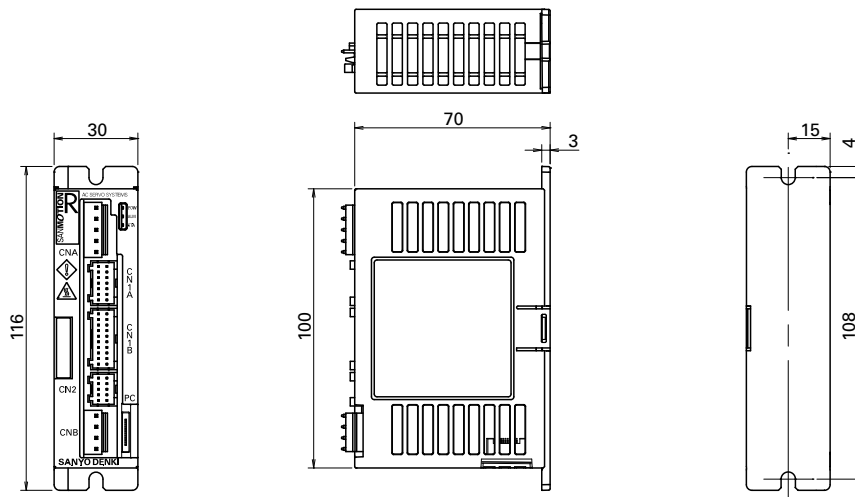
(3) Use the product within the specified temperature and humidity ranges.

Safety Standards

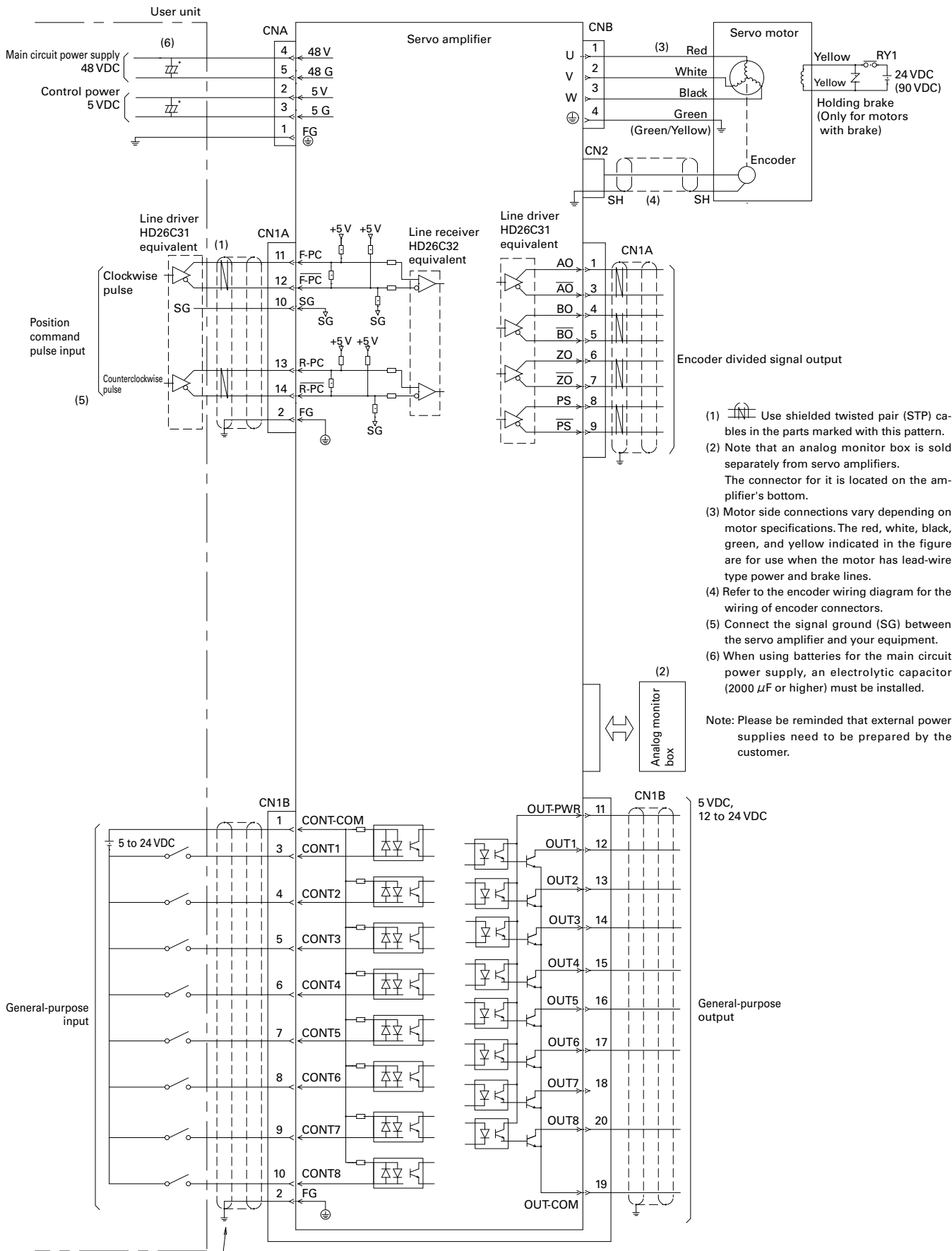


Servo amplifier type	Safety standards		
All pulse input single-axis models	North American standards (UL, cUL)	UL 508C	
	EU Directive (CE) Great Britain (UKCA)	Low Voltage Directive	EN 61800-5-1
		EMC Directive	EN 61000-6-2 EN 61800-3
	KC (Korea Certification) Mark	KN 61000-6-2, KN 61000-6-4	

Servo Amplifier Dimensions [Unit: mm]



Mass: 0.25 kg



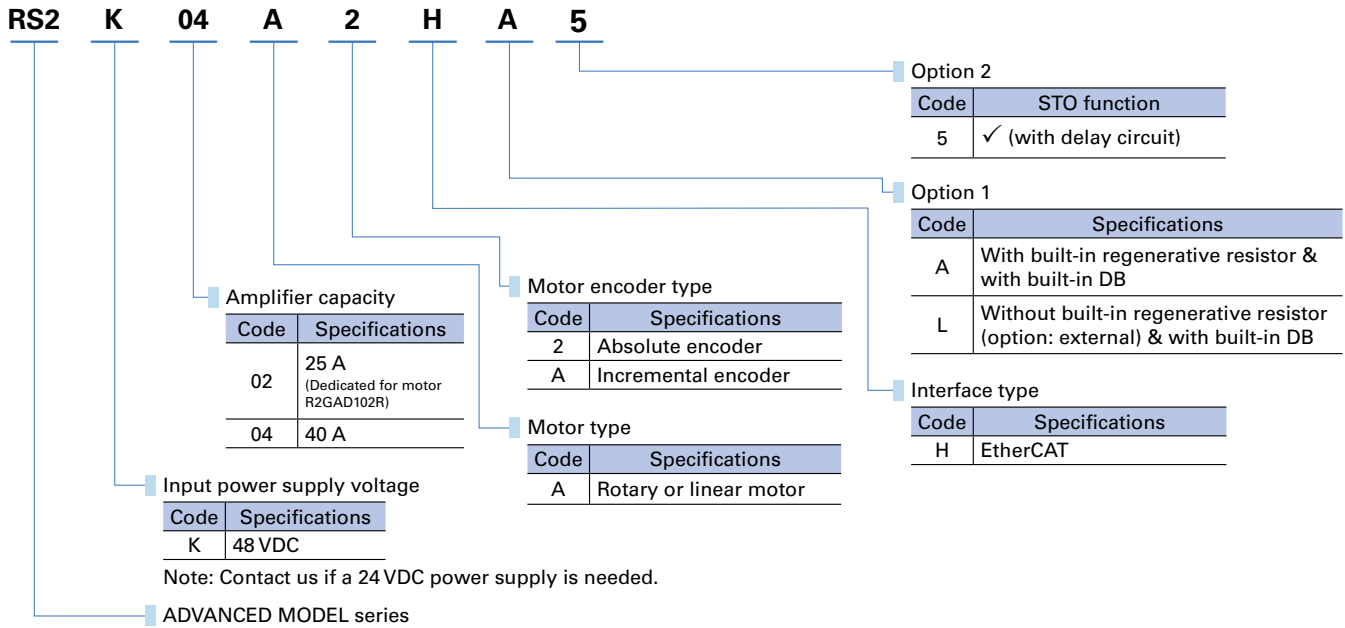
Connector no.	Name	Housing, plug, shell	
		Housing	Contact
CNA	Main/control power supply connector	VHR-5N	BVH-21T-P1.1
CNB	Servo motor power connector	VHR-4N	BVH-21T-P1.1
CN1A	Controller line receiver/driver connector	PADP-14V-1-S	SPH-002GW-P0.5S
CN1B	Controller GPIO connector	PADP-20V-1-S	SPH-002GW-P0.5S
CN2	Encoder connector	PADP-10V-1-S	SPH-002GW-P0.5S

Servo Amplifiers

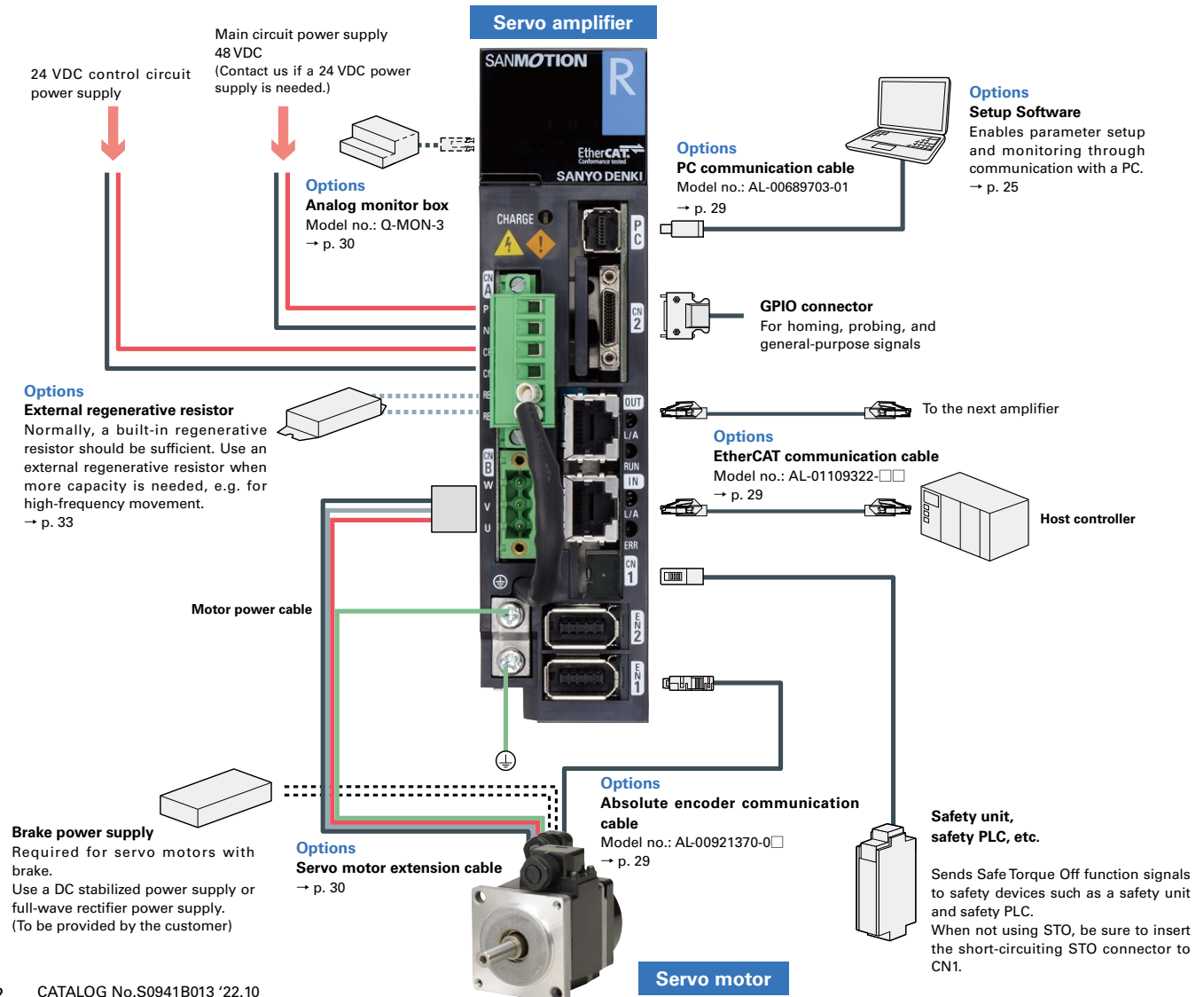
EtherCAT single-axis

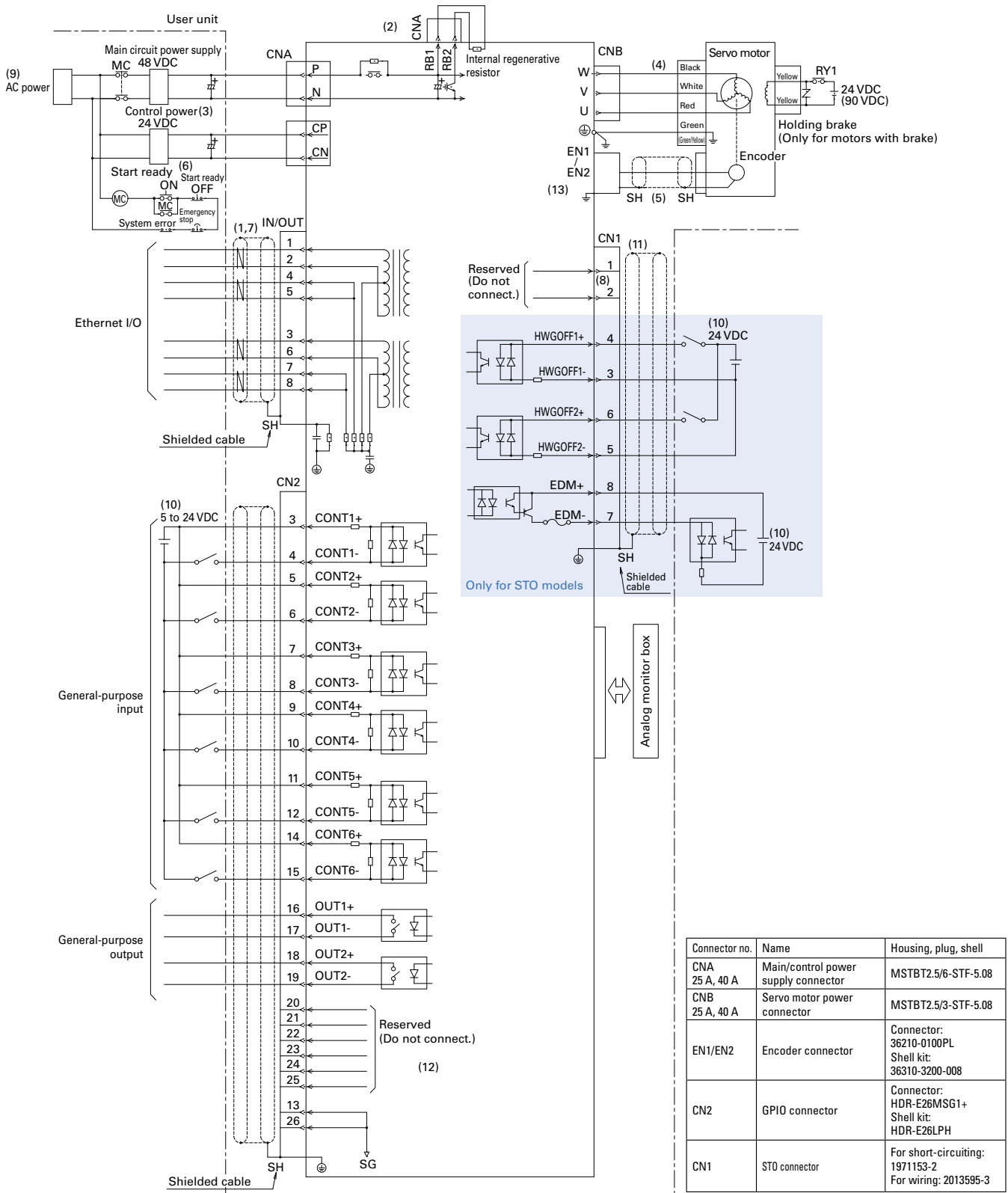
How to Read Model Numbers

Note that not all possible parameter combinations are valid. Also note that some of the parameters below are for options. Refer to the Standard Model Number List section for standard models with valid model numbers.



System Configuration





- (1) Use shielded twisted pair (STP) cables in the parts marked with this pattern.
- (2) Ensure that the regenerative resistor is connected between the RB1 and RB2 terminals.
When using an external regenerative resistor, remove the built-in regenerative resistor connected to the RB1 and RB2 terminals, and then connect the external regenerative resistor between RB1 and RB2 terminals.
- (3) Electrolytic capacitors are required to be installed in P-to-N and CP-to-CN on the amplifier side if the wiring between the DC power supply and servo amplifier is too long.
 - When using batteries in the DC power supplies between P and N or between CP and CN, electrolytic capacitors must be installed. (2000 μF or higher recommended)
 - Contact us if a 24 VDC power supply is needed.
- (4) Motor side connections vary depending on motor specifications.
The red, white, black, green, and yellow indicated in the figure are for use when the motor has lead-wire type power and brake lines.
- (5) Refer to the encoder connection diagram for the wiring of encoder connectors.
- (6) For the protection of the servo amplifier, when designing an emergency shutdown system, ensure that it shuts down the input of DC power supplies.
- (7) Use a category 5e (TIA standards) or better shielded twisted pair cable (STP).
- (8) Do not connect anything to the CN1-1 or CN1-2 pins.
- (9) Use of a UL or IEC/EN compliant leakage circuit breaker is recommended.
- (10) An external power supply is to be prepared by the customer.
- (11) CN1 is a connector for the Safe Torque Off function. Turning Servo ON (motor in operation) requires to connect a safety device and get STO enabled. When not using STO, be sure to insert the short-circuiting STO connector to CN1.
- (12) Do not connect anything to the CN2-20 to CN2-25 pins.
- (13) When using a pulse encoder to configure a semi-closed system, connect it to EN2.

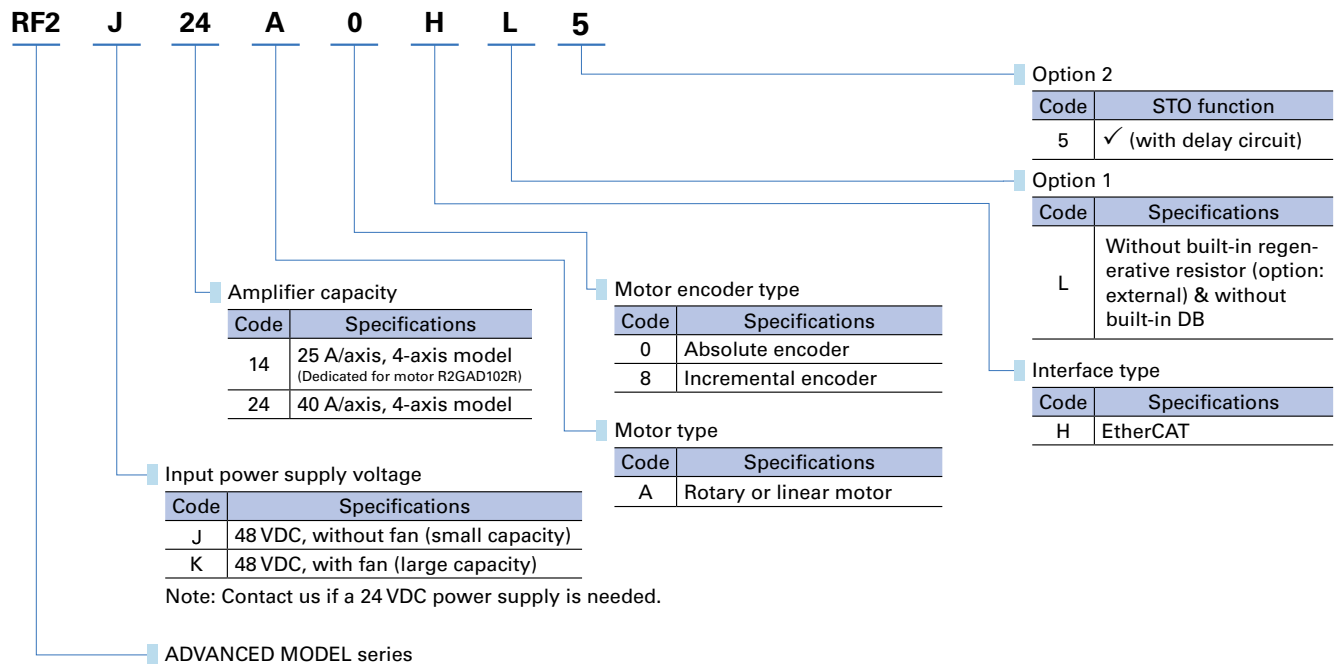
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Servo Amplifiers

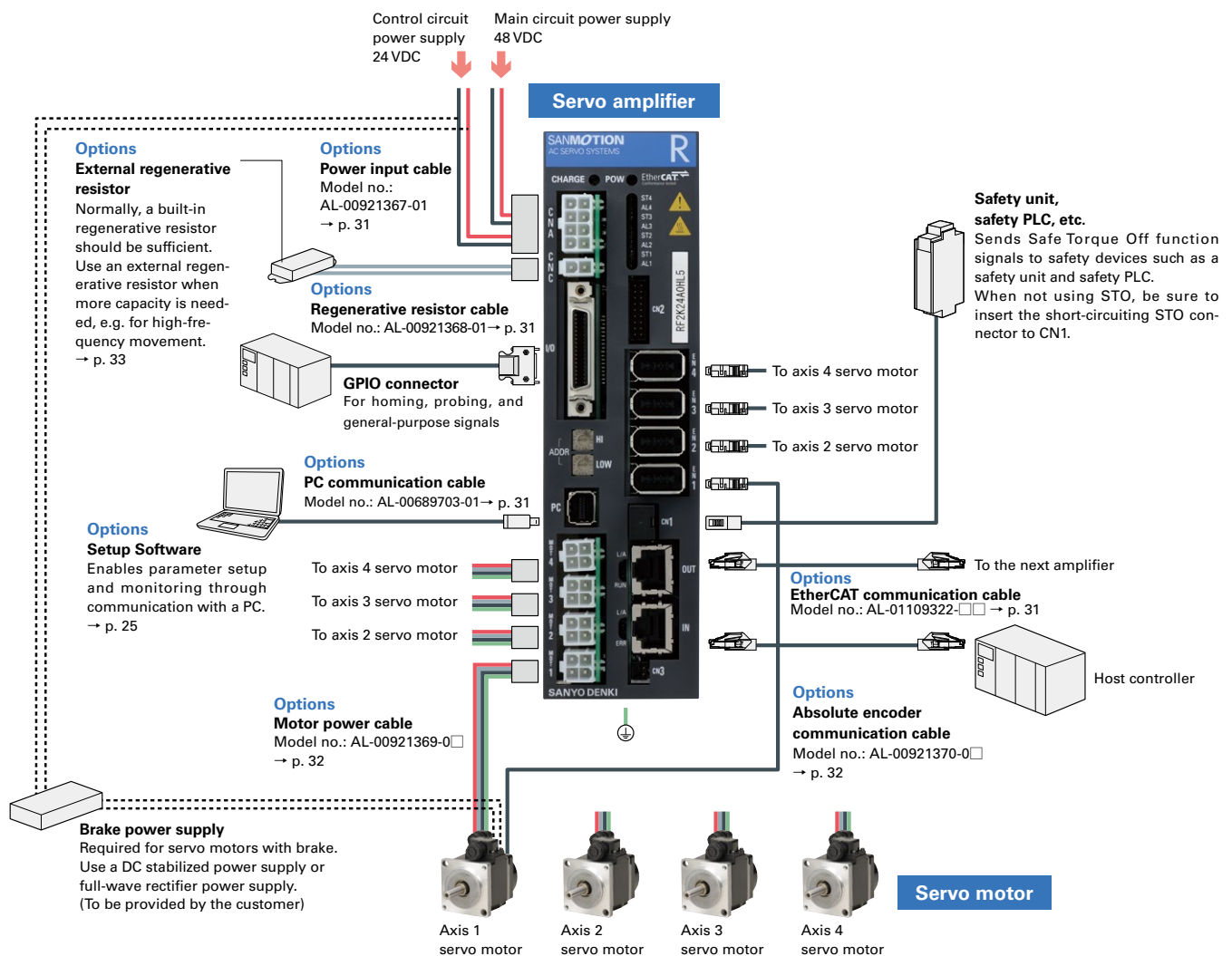
EtherCAT multi-axis

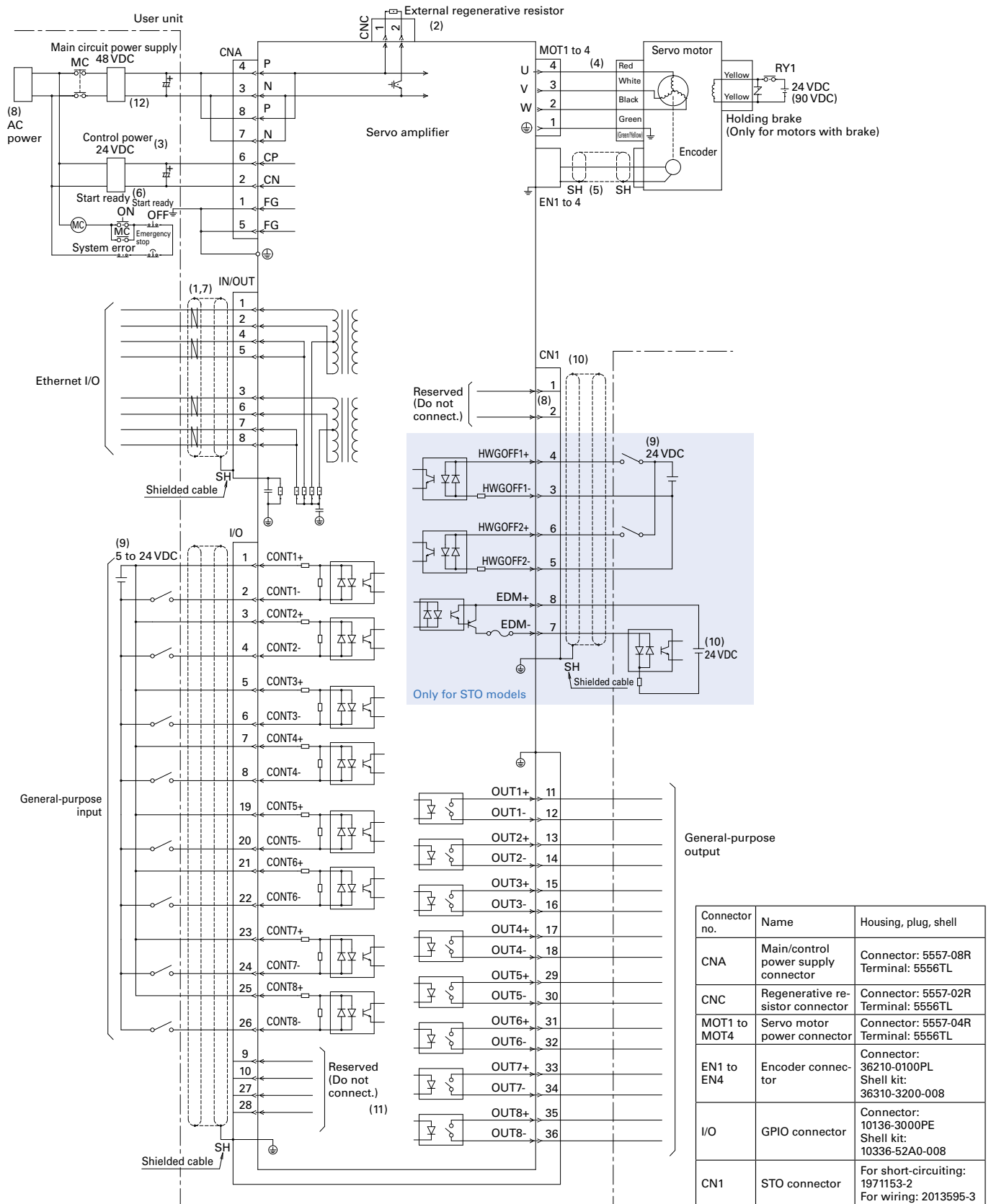
How to Read Model Numbers

Note that not all possible parameter combinations are valid. Also note that some of the parameters below are for options. Refer to the Standard Model Number List section for standard models with valid model numbers.



System Configuration





- Use shielded twisted pair (STP) cables in the parts marked with this pattern.
- Servo amplifiers come with a built-in regeneration processing circuit. Connect a regenerative resistor when motor and system conditions are such that an excessive amount of regenerative energy is generated and DC voltage increases.
- Electrolytic capacitors are required to be installed in P-to-N and CP-to-CN on the amplifier side if the wiring between the DC power supply and servo amplifier is too long.
 - When using batteries in the DC power supplies between P and N or between CP and CN, electrolytic capacitors must be installed. (2000 μ F or higher recommended)
- Motor side connections vary depending on motor specifications. The red, white, black, green, and yellow indicated in the figure are for use when the motor has lead-wire type power and brake lines.
- Refer to the encoder wiring diagram for the wiring of encoder connectors.
- For the protection of the servo amplifier, when designing an emergency shut-down system, ensure that it shuts down the input of DC power supplies.
- Use a category 5e (TIA standards) or better shielded twisted pair cable (STP).
- Use of a UL or IEC/EN compliant leakage circuit breaker is recommended.
- An external power supply is to be prepared by the customer.
- CN1 is a connector for the Safe Torque Off function. Turning Servo ON (motor in operation) requires to connect a safety device and get STO enabled. When not using STO, be sure to insert the short-circuiting STO connector to CN1.
- Do not connect anything to I/O-9, -10, -27, or -28 pins.
- Contact us if a 24 VDC main circuit power supply is needed.

Servo amplifier type		EtherCAT single-axis	EtherCAT multi-axis
Control functions		Position, speed, torque control (switched with parameters)	
Control system		Power MOSFET-based sinusoidal PWM control	
Main circuit power supply		48 VDC ±10%*	
Control circuit power supply		24 VDC ±10%*	
Environment	Operating temperature	0 to 55°C	
	Storage temperature	-20 to +65°C	
	Operating and storage humidity	90% RH or below (non-condensing)	
	Altitude	1000 m or below	
	Vibration resistance	4.9 m/s ² At frequency of 10 to 55 Hz in each X, Y, and Z direction for 2 hours	
Shock resistance		19.6 m/s ²	
Structure		Tray type, external DC power supply required	
Frequency characteristics		800 Hz	
Speed control range		1:5000	
Protection functions		Overcurrent, current detection error, overload, regenerative error, overheating error, external error, overvoltage, undervoltage, encoder error, excessive velocity, velocity control error, velocity feedback error, excessive position deviation, position command pulse error, internal memory error, parameter error	
LED indicator		Status indicator, monitoring indicator, alarm indicator, parameter settings, test run, adjustment modes	Alarm indicator (red), status indicator (green), control circuit power established (green), main circuit power charging (red), communication link (green) x 2, communication running (green), communication error (red)
Dynamic braking		Built-in	None
Regenerative resistor		Model no. RS2K0□A2HA5: Built-in Model no. RS2K04A2HL5: None (option: external)	None (Option: external; to be connected to CNC connector)
Analog monitor		Options	None

* Make sure that the main circuit power supply voltage is within the specified range.

Servo Amplifier Conformance to Safety Standards

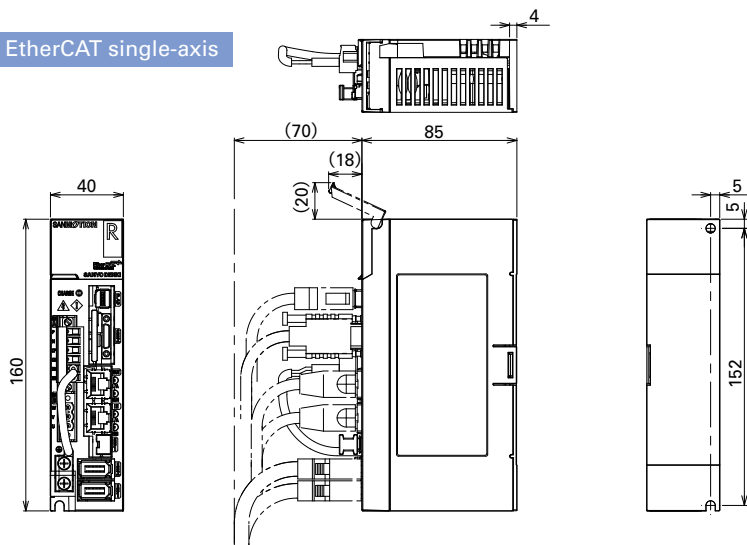


Servo amplifier type	Safety standards		
All models	North American safety standards (UL, c-UL)		UL508C
	EU Directive (CE) Great Britain (UKCA)	Low-voltage directive	EN 61800-5-1
		EMC directive	EN 61000-6-2, EN 61800-3, EN 61326-3-1 (EtherCAT only)
	KC Mark (Korea Certification Mark)		KN 61000-6-2, KN 61000-6-4
Models with safety features	Functional safety		EtherCAT single-axis IEC61508: SIL2, ISO 13894-1 Cat3: PL=d, IEC62061: SILCL2
			EtherCAT multi-axis IEC61508: SIL3, ISO 13894-1 Cat3: PL=e, IEC62061: SILCL3

Physical layer	IEC 61158-2 IEEE802.3u 100BASE-TX
Data link layer	IEC 61158-3, -4 Type 12
Application layer	IEC 61158-5, -6 Type 12
Device profile	IEC 61800-7 Profile Type 1 (CiA402) · CoE (CANopen over EtherCAT) · FoE (File access over EtherCAT)
Communication port	RJ-45 connector (2 ports)
Bit rate	100 Mbps (Full duplex)
Maximum number of nodes	65535 nodes
Transmission distance / Topology	Max. 100 m (between nodes) / Daisy chain
Communication cable	Twisted pair CAT5e (straight-through or crossover)
Communication object	SDO (Service Data Object) PDO (Process Data Object)
Synchronization type	SYNC0 event synchronization, SYNC1 event synchronization, asynchronous
Operation modes	Profile Position mode, Profile Velocity mode, Profile Torque mode, Homing mode, Cyclic Synchronous Position mode, Cyclic Synchronous Velocity mode, Cyclic Synchronous Torque mode
LED indicator	Port 0/1 link indicator, RUN indicator, ERROR indicator
General-purpose I/O	EtherCAT single-axis: Input x 6, output x 2 (8 in total) EtherCAT multi-axis: Input x 8 (in total), output x 2 per axis (8 in total)

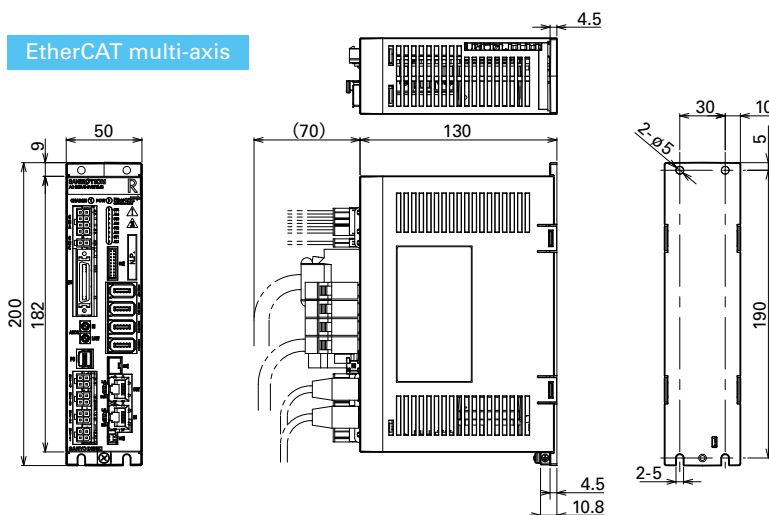
Servo Amplifier Dimensions [Unit: mm]

EtherCAT single-axis



Mass:
 RS2K04A2HL5: 0.5 kg
 (Without regenerative resistor)
 RS2K0□A2HA5: 0.55 kg
 (With built-in regenerative resistor)

EtherCAT multi-axis



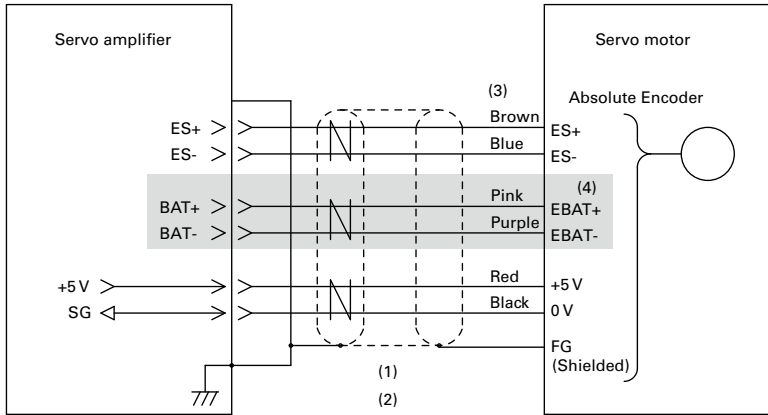
Mass:
 RF2J□4A0HL5: 0.75 kg (Without fan)
 RF2K24A0HL5: 0.8 kg (With fan)

Absolute encoders

Single-turn absolute encoder

Battery-less absolute encoder

Option: Battery-backup absolute encoder



- (1) Use shielded twisted pair (STP) cables.
- (2) Max. permissible cable length of power supply wiring (5 V to SG) by conductor size:

Conductor size		Conductor resistance (Ω /km) *20°C	Length (m)
AWG	SQ (mm ²)		
26	0.15	150 or less	4
24	0.2	100 or less	6
22	0.3	60 or less	10
20	0.5	40 or less	15
18	0.75	25 or less	25

The conductor resistance varies depending on the conductor specifications.

- (3) The colors indicated are wire colors.
- (4) Batteries (EBAT+, EBAT-) need wiring only if using a battery-backup absolute encoder.

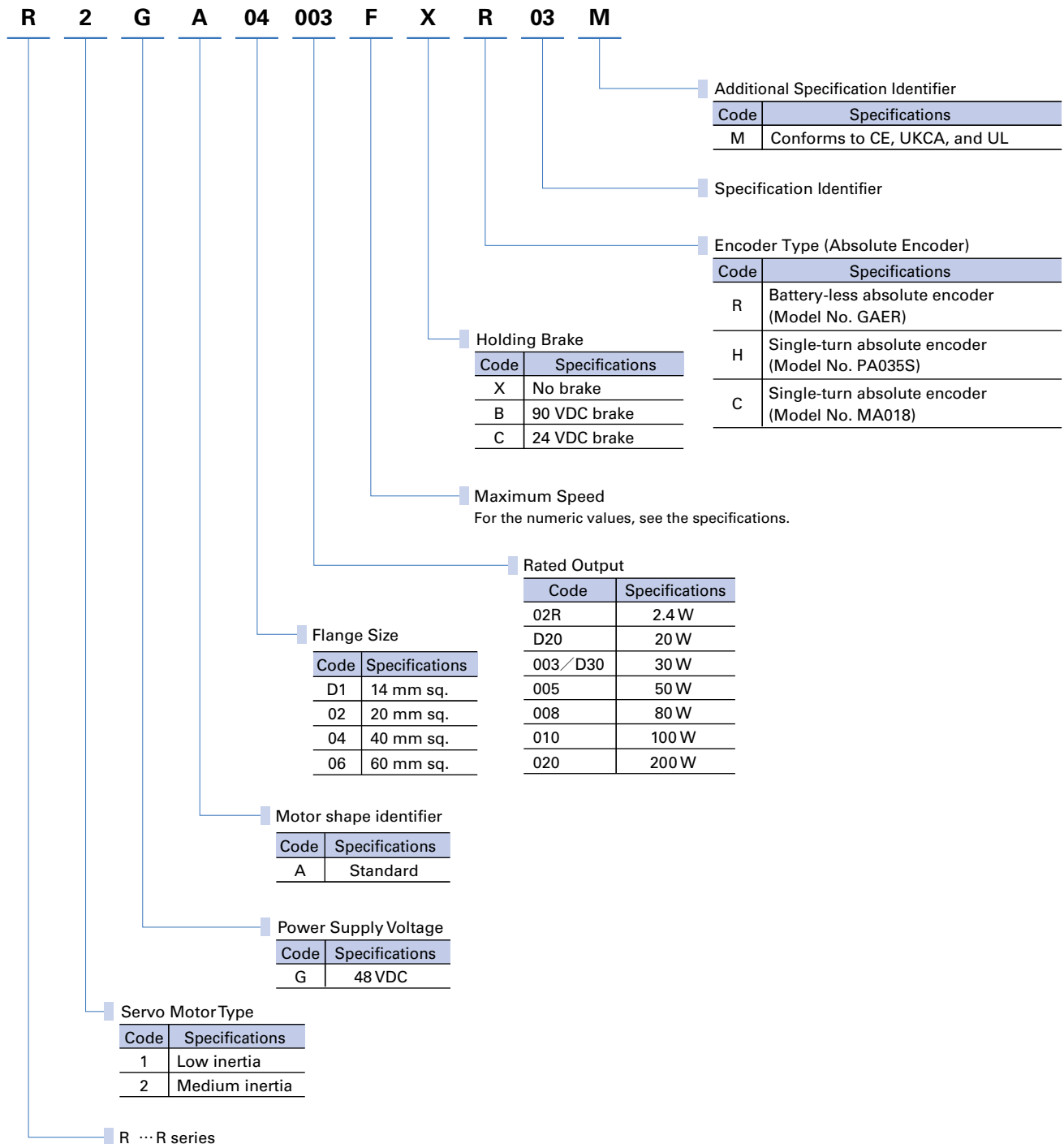
Specifications of servo amplifier connectors

Servo amplifier	Connector no.	Connector/contact model no.	Servo amplifier connector model no.			
			ES+	ES-	+5 V	SG
Pulse input single-axis	CN2	Housing: PADP-10V-1-S Contact: SPH-002GW-P0.5S	3	4	1	2
EtherCAT single-axis	EN1, EN2	Connector: 36210-0100PL Shell kit: 36310-3200-008	7	8	1	2
EtherCAT multi-axis	EN1 to EN4					

Servo Motors

How to Read Model Numbers

Note that not all possible parameter combinations are valid. Also note that some of the parameters below are for options. Refer to the Standard Model Number List section for standard models with valid model numbers.



General Specifications



Servo Amplifier +



R2 Servo Motor

Medium inertia,
high efficiency, low ripple

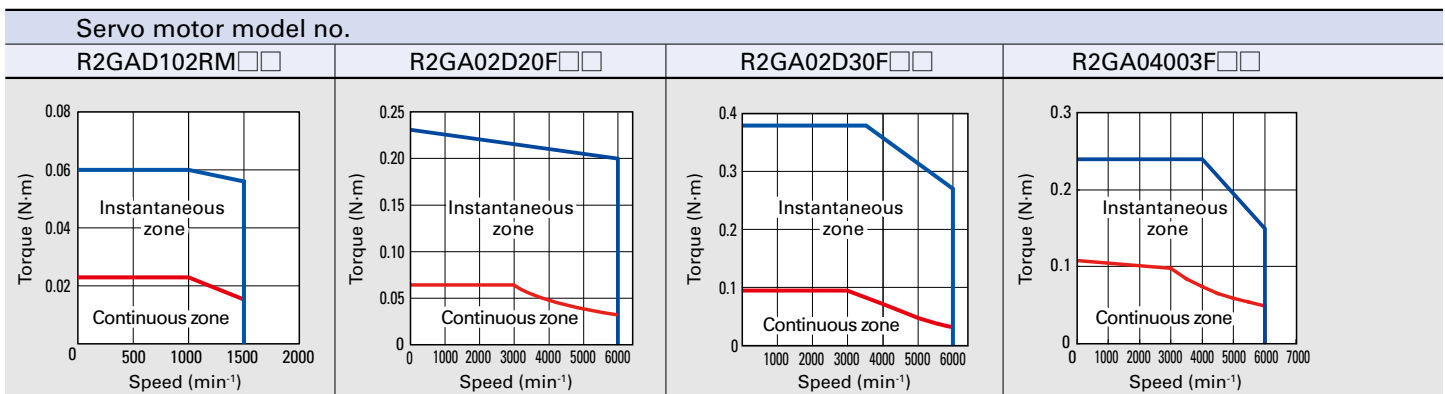


Compatible servo amplifier model no.	Pulse input single-axis			RF2G11A0A00 《25 A》	RF2G21A0A00 《40 A》		
	EtherCAT single-axis			RS2K02A2HA5 《25 A》	RS2K04A2HL5 / RS2K04A2HA5 《40 A》		
	EtherCAT multi-axis			RF2J14A0HL5 《25 A》	RF2J24A0HL5 (Up to 120 W in total of 4 axes) RF2K24A0HL5 (Up to 300 W in total of 4 axes) 《40 A》		
Servo motor model no.	In 《》 are motor flange sizes			R2GAD102RM□□ 《14 mm sq.》	R2GA02D20F□□ 《20 mm sq.》	R2GA02D30F□□ 《20 mm sq.》	R2GA04003F□□ 《40 mm sq.》
	Notes	Symbol	Unit				
Rated output	★	P _R	W	2.4	20	30	30
Rated speed	★	N _R	min ⁻¹	1000	3000	3000	3000
Maximum speed	★	N _{max}	min ⁻¹	1500	6000	6000	6000
Rated torque	★	T _R	N·m	0.023	0.064	0.095	0.098
Continuous torque at stall	★	T _S	N·m	0.023	0.064	0.095	0.108
Peak torque at stall	★	T _P	N·m	0.06	0.23	0.38	0.24
Rated armature current	★	I _R	Arms	0.67	1.8	2.6	1.9
Continuous armature current at stall	★	I _S	Arms	0.64	1.8	2.6	2.0
Peak armature current at stall	★	I _P	Arms	1.7	6.0	9.6	4.8
Torque constant	☆	K _T	N·m/Arms	0.042	0.0458	0.0487	0.0582
Phase resistance	☆	R _φ	Ω	7.2	1.06	0.76	1
Rated power rate	★	Q _R	kW/s	2.2	12.4	20	3.9
Rotor inertia		J _M	×10 ⁻⁴ kg·m ² (GD ² /4)	0.0023	0.0033	0.0046	0.0247
Absolute encoder inertia*		J _S	×10 ⁻⁴ kg·m ² (GD ² /4)	0.00002	0.00021	0.00021	0.0042
Motor mass*		W _e	kg	0.15	0.14	0.18	0.37 (0.64)
Brake static friction torque		T _b	N·m	–	–	–	0.32 or greater
Brake rated voltage		V _b	V	–	–	–	90/24 DC ±10%
Brake current consumption		I _b	A	–	–	–	0.07/0.27
Brake inertia		J _b	×10 ⁻⁴ kg·m ² (GD ² /4)	–	–	–	0.0078
CE, UKCA, and UL certified motor				–	–	–	✓
Motor protection rating				IP40	IP40	IP40	IP65 (Option: IP67)
Size of heat dissipation aluminum plate				150 × 150 × 3 mm	150 × 150 × 6 mm	250 × 250 × 6 mm	250 × 250 × 6 mm
Page of dimensional drawing					p. 23		p. 24

★ Values are for a combination with a standard servo amplifier after thermal equilibrium is established.
☆ Values are typical values when the winding temperature is 20°C.

* The encoder inertia and servo motor mass values are when equipped with:
14 mm sq.: Single-turn absolute encoder
20 mm sq.: Single-turn absolute encoder [Model No. MA018]
40 and 60 mm sq.: Battery-less absolute encoder [Model No. GAER]
Inside () are the values with brake.

Speed-Torque Characteristics



Note 1: The characteristics curves above are for when a 48 VDC main circuit power supply is used and the length of the wiring between the servo amplifier and servo motor is 2 m.
Note 2: With low-voltage servo systems, the motor torque tends to drop more notably than that of 200 VAC servo systems when the input voltage is low or the cable between the servo amplifier and servo motor is long or its diameter is small. When selecting a motor, select one that has sufficient margin of safety in acceleration torque, deceleration torque, and effective torque.

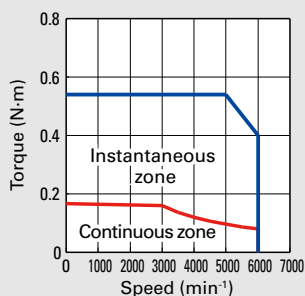
RF2G21A0A00 《40 A》				Pulse input single-axis	Compatible servo amplifier model no.		
RS2K04A2HL5 / RS2K04A2HA5 《40 A》				EtherCAT single-axis			
RF2K24A0HL5 (Up to 300 W in total of 4 axes) 《40 A》				EtherCAT multi-axis			
R2GA04005F□□ 《40 mm sq.》	R2GA04008D□□ 《40 mm sq.》	R2GA06010D□□ 《60 mm sq.》	R2GA06020D□□ 《60 mm sq.》	Servo motor model no. In 《》 are motor flange sizes			
				Unit	Symbol	Notes	
50	80	100	200	W	P _R	★	Rated output
3000	3000	3000	3000	min ⁻¹	N _R	★	Rated speed
6000	5000	5000	4500	min ⁻¹	N _{max}	★	Maximum speed
0.159	0.255	0.318	0.637	N·m	T _R	★	Rated torque
0.167	0.255	0.353	0.637	N·m	T _S	★	Continuous torque at stall
0.54	0.86	0.84	1.5	N·m	T _P	★	Peak torque at stall
3.8	4.1	5.1	6	Arms	I _R	★	Rated armature current
3.9	4.1	5.5	6	Arms	I _S	★	Continuous armature current at stall
13.7	14.1	14.1	14.1	Arms	I _P	★	Peak armature current at stall
0.047	0.0693	0.0673	0.117	N·m/Arms	K _T	☆	Torque constant
0.33	0.32	0.19	0.19	Ω	R _φ	☆	Phase resistance
6.7	10	8.6	19	kW/s	Q _R	★	Rated power rate
0.0376	0.0627	0.117	0.219	×10 ⁻⁴ kg·m ² (GD ² /4)	J _M		Rotor inertia
0.0042	0.0042	0.0042	0.0042	×10 ⁻⁴ kg·m ² (GD ² /4)	J _S		Absolute encoder inertia ⁽¹⁾
0.41 (0.68)	0.53 (0.8)	0.74 (1.1)	0.99 (1.4)	kg	W _e		Motor mass ⁽¹⁾
0.32 or greater	0.32 or greater	0.36 or greater	1.37 or greater	N·m	T _b		Brake static friction torque
90/24 DC ±10%				V	V _b		Brake rated voltage
0.07/0.27	0.07/0.27	0.07/0.27	0.11/0.32	A	I _b		Brake current consumption
0.0078	0.0078	0.06	0.06	×10 ⁻⁴ kg·m ² (GD ² /4)	J _b		Brake inertia
✓							CE, UKCA, and UL certified motor
IP65 (Option: IP67)							Motor protection rating
250 × 250 × 6 mm							Size of heat dissipation aluminum plate
p. 24							Page of dimensional drawing

Servo motor operating environment

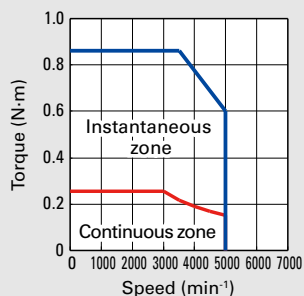
Operating temperature & humidity	Temperature: 0 to 40°C, humidity: 20 to 90% or less (non-condensing)
Vibration resistance	24.5 m/s ²
Shock resistance	98 m/s ² , 2 times
Altitude	1000 m or below sea level
Installation locations	Indoors (a location not exposed to direct sunlight). A location free of corrosive gases, flammable gases, powder dust, and other substances that are detrimental to the used devices and motors.

Servo motor model no.

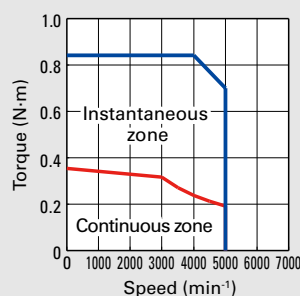
R2GA04005F□□



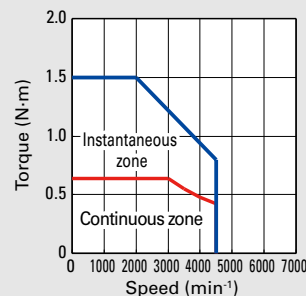
R2GA04008D□□



R2GA06010D□□



R2GA06020D□□





Servo Amplifier +



R1 Servo Motor

Low inertia, high power rate

RoHS

Compatible servo amplifier model no.	Pulse input single-axis			RF2G21A0A00 《40 A》		
	EtherCAT single-axis			RS2K04A2HL5 / RS2K04A2HA5 《40 A》		
	EtherCAT multi-axis			RF2K24A0HL5 (Up to 300 W in total of 4 axes) 《40 A》		
Servo motor model no. In 《》 are motor flange sizes				R1GA04005F□□ 《40 mm sq.》	R1GA04010F□□ 《40 mm sq.》	R1GA06020D□□ 《60 mm sq.》
	Notes	Symbol	Unit			
Rated output	★	P _R	W	50	100	200
Rated speed	★	N _R	min ⁻¹	3000	3000	3000
Maximum speed	★	N _{max}	min ⁻¹	6000	6000	5000
Rated torque	★	T _R	N·m	0.159	0.318	0.637
Continuous torque at stall	★	T _S	N·m	0.167	0.318	0.686
Peak torque at stall	★	T _P	N·m	0.56	1.11	1.4
Rated armature current	★	I _R	Arms	3.5	3.6	6.0
Continuous armature current at stall	★	I _S	Arms	3.7	3.8	6.0
Peak armature current at stall	★	I _P	Arms	12.5	13.3	14.1
Torque constant	☆	K _T	N·m/Arms	0.052	0.101	0.117
Phase resistance	☆	R _φ	Ω	0.36	0.59	0.23
Rated power rate	★	Q _R	kW/s	17	42	33
Rotor inertia		J _M	×10 ⁻⁴ kg·m ² (GD ² /4)	0.0146	0.0242	0.122
Absolute encoder inertia*		J _S	×10 ⁻⁴ kg·m ² (GD ² /4)	0.0042	0.0042	0.0042
Motor mass*		W _e	kg	0.46 (0.7)	0.61 (0.85)	1.1 (1.5)
Brake static friction torque		T _b	N·m	0.32 or greater	0.32 or greater	1.37 or greater
Brake rated voltage		V _b	V	24 DC	24 DC	24 DC
Brake current consumption		I _b	A	0.27	0.27	0.32
Brake inertia		J _b	×10 ⁻⁴ kg·m ² (GD ² /4)	0.0078	0.0078	0.06
CE, UKCA, and UL certified motor				✓		
Motor protection rating				IP65		
Size of heat dissipation aluminum plate				250 × 250 × 6 mm		
Page of dimensional drawing				p. 24		

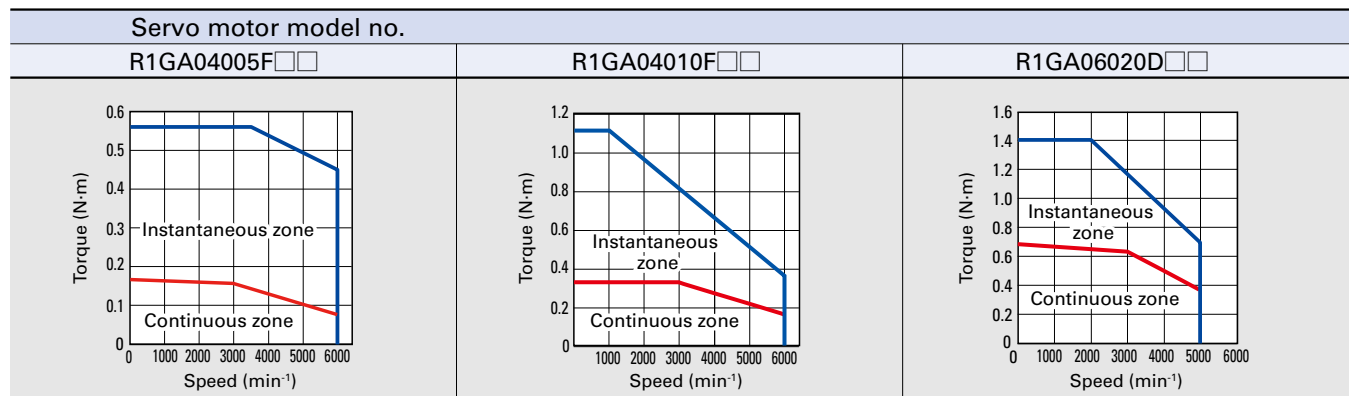
★ Values are for a combination with a standard servo amplifier after thermal equilibrium is established.
 ☆ Values are typical values when the winding temperature is 20°C.

* The encoder inertia and servo motor mass values are when equipped with: Battery-less absolute encoder [Model No. GAER]
 Inside () are the values with brake.

Servo motor operating environment

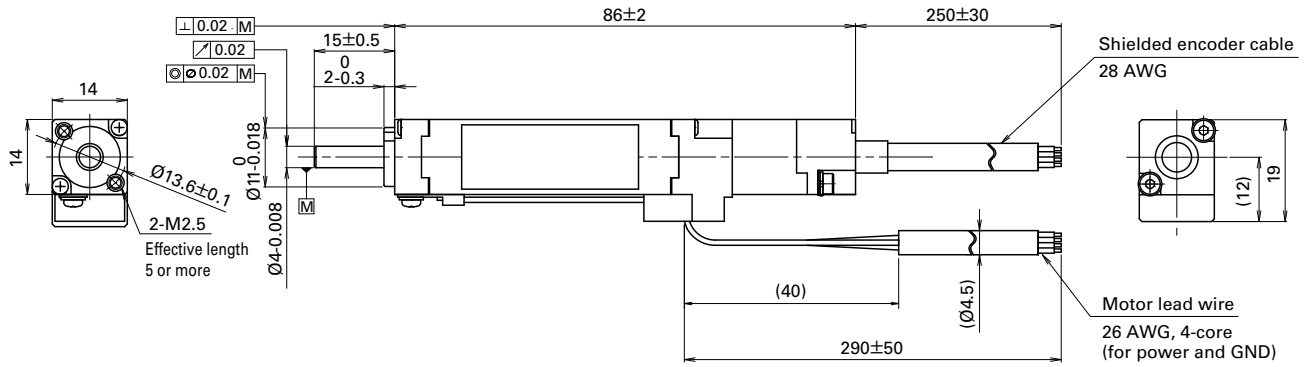
Operating temperature & humidity	Temperature: 0 to 40°C, humidity: 20 to 90% or less (non-condensing)
Vibration resistance	24.5 m/s ²
Shock resistance	98 m/s ² , 2 times
Altitude	1000 m or below sea level
Installation locations	Indoors (a location not exposed to direct sunlight). A location free of corrosive gases, flammable gases, powder dust, and other substances that are detrimental to the used devices and motors.

Speed-Torque Characteristics

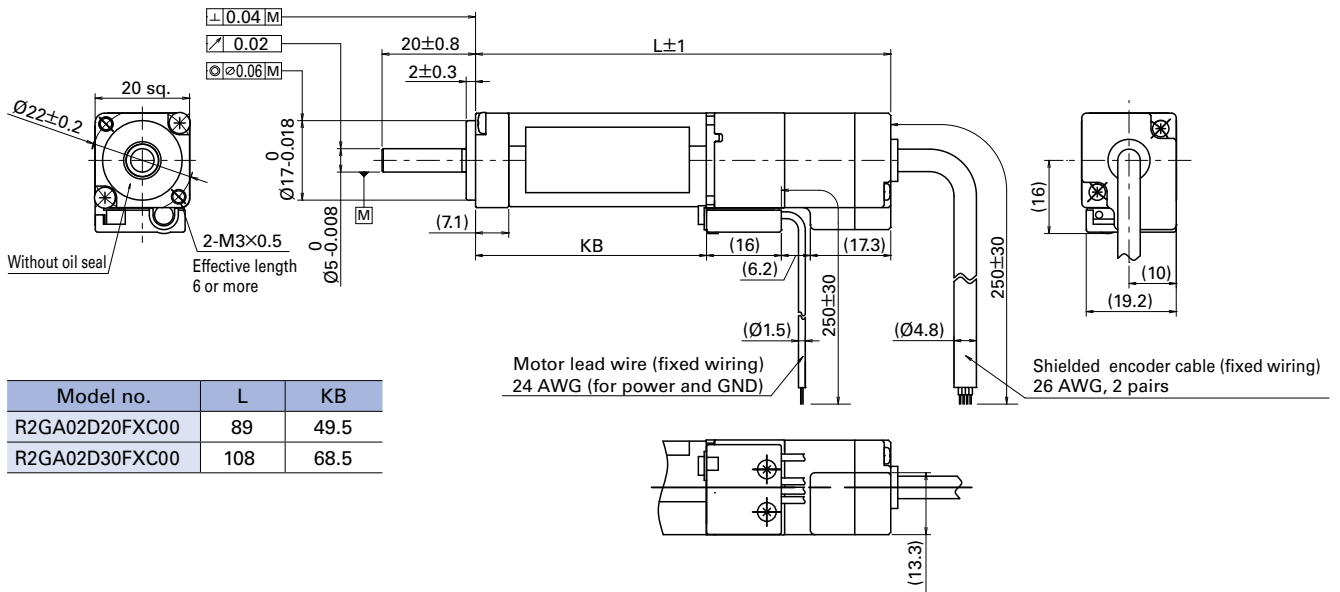


Note 1: The characteristics curves above are for when a 48VDC main circuit power supply is used and the length of the wiring between the servo amplifier and servo motor is 2 m.
 Note 2: With low-voltage servo systems, the motor torque tends to drop more notably than that of 200VAC servo systems when the input voltage is low or the cable between the servo amplifier and servo motor is long or its diameter is small. When selecting a motor, select one that has sufficient margin of safety in acceleration torque, deceleration torque, and effective torque.

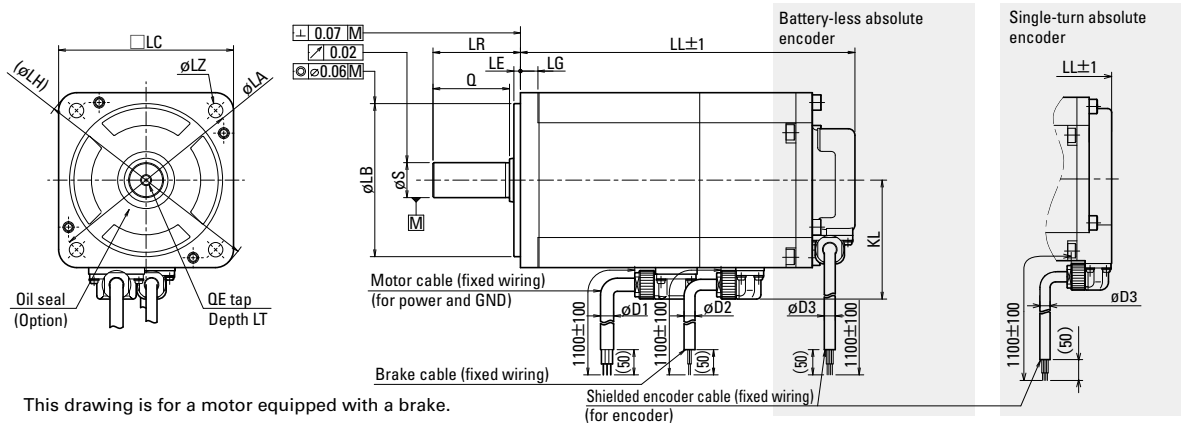
14 mm sq. R2 servo motor



20 mm sq. R2 servo motor



40 mm sq., 60 mm sq. R2 Servo Motor

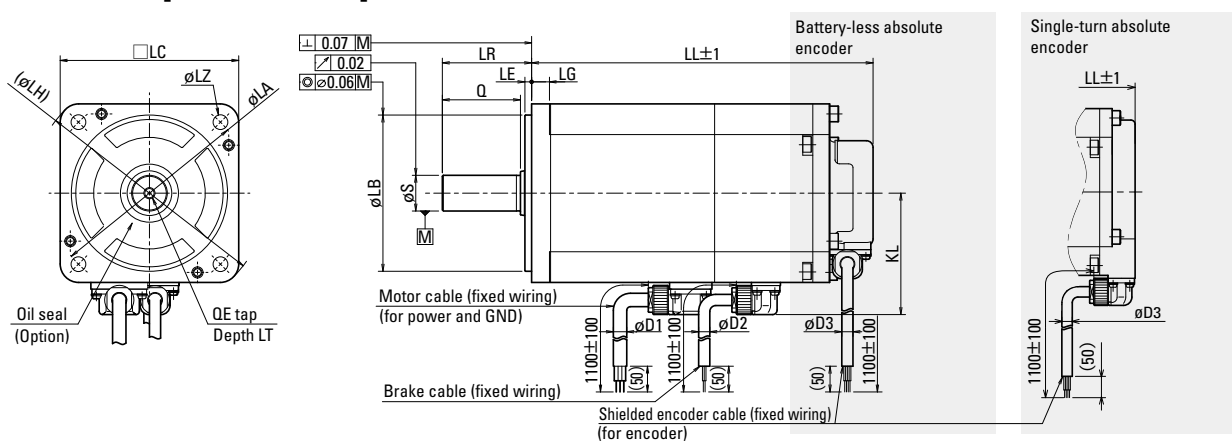


This drawing is for a motor equipped with a brake.

Model no.	Battery-less absolute encoder				Single-turn absolute encoder			
	Without oil seal		With oil seal		Without oil seal		With oil seal	
	Without brake	With brake	Without brake	With brake	Without brake	With brake	Without brake	With brake
R2GA04003	62.5	98.5	67.5	103.5	51.5	87.5	56.5	92.5
R2GA04005	67.5	103.5	72.5	108.5	56.5	92.5	61.5	97.5
R2GA04008	83.0	119.0	88.0	124.0	72	108	77	113
R2GA06010	68.5	92.5	75.5	99.5	58.5	82.5	65.5	89.5
R2GA06020	79.5	107.5	86.5	114.5	69.5	97.5	76.5	104.5

Model no.	LG	KL	LA	LB	LE	LH	LC	LZ	LR	S	Q	QE	LT	D1	D2	D3
R2GA04003	5	35.4	46	0	2.5	56	40	2-φ4.5	25	0	20	-	-	6	5	5
6 -0.008				0				8 -0.009								
8 -0.009																
R2GA06010	6	44.6	70	0	3	82	60	4-φ5.5	25	0	25	M5	12			
50 -0.025				8 -0.009				14 -0.011								
R2GA06020									30	0						

40 mm sq., 60 mm sq. R1 Servo Motor



This drawing is for a motor equipped with a brake.

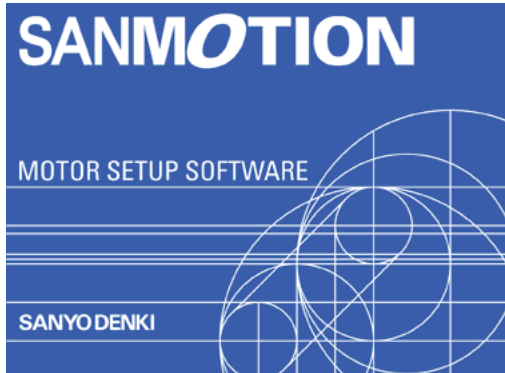
Model no.	Battery-less absolute encoder				Single-turn absolute encoder			
	Without oil seal		With oil seal		Without oil seal		With oil seal	
	Without brake	With brake	Without brake	With brake	Without brake	With brake	Without brake	With brake
R1GA04005	84	115	89	120	73	104	78	109
R1GA04010	103	134	108	139	92	123	97	128
R1GA06020	96.5	126.5	103.5	133.5	86.5	116.5	93.5	123.5

Model no.	LG	KL	LA	LB	LE	LH	LC	LZ	LR	S	Q	QE	LT	D1	D2	D3
R1GA04005	5	35.3	46	0	2.5	56	40	4-φ4.5	25	0	20	-	-	6	5	5
R1GA04010				30-0.021				8 -0.009								
R1GA06020	6	44.4	70	0	3	82	60	4-φ5.5	30	0	25	M5	12			
				50-0.025						14 -0.011						

Setup Software (Option)

This software allows you to set servo system parameters from a PC. It also allows you to easily start up and run tests for the servo system. The software can be downloaded from Product Information on our website. <https://www.sanyodenki.com/>

Start-up screen



■ Setup software name:

SANMOTION MOTOR SETUP SOFTWARE

■ Main functions

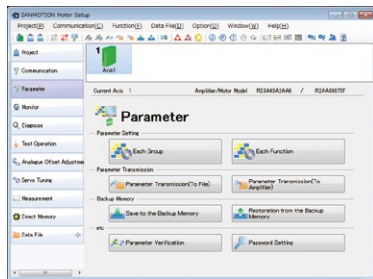
- Parameter settings (by group, by function)
- Diagnosis (alarm indicator, warning indicator, alarm cancellation)
- Test run execution (speed jog, position jog, motor home position search, absolute encoder clear)
- Servo tuning (notch filter tuning, FF vibration control frequency tuning)
- Various measurement functions (operating waveform display, machinery frequency response measurement)

■ Supported operating systems

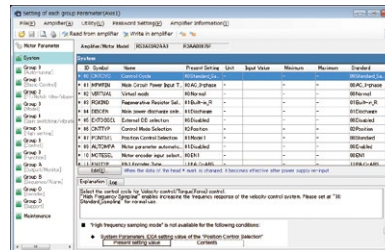
Windows 7/8/10

See our website for details on supported OS versions.

Main screen

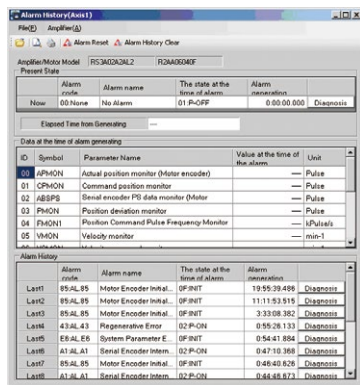


Parameter settings screen by group



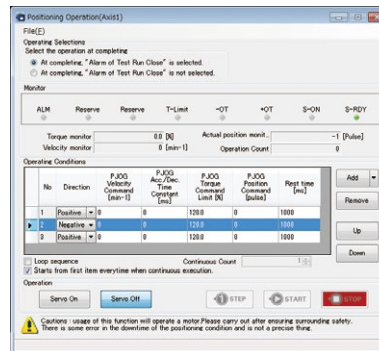
Parameters can be set, saved, and more.

Diagnosis screen



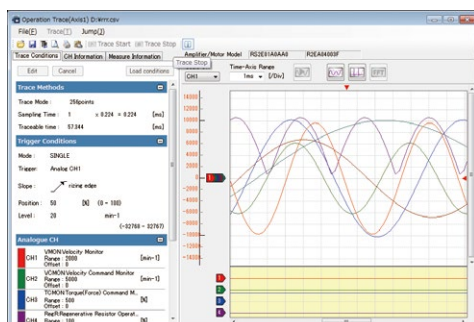
The current and last 7 alarm events can be checked.

Test run



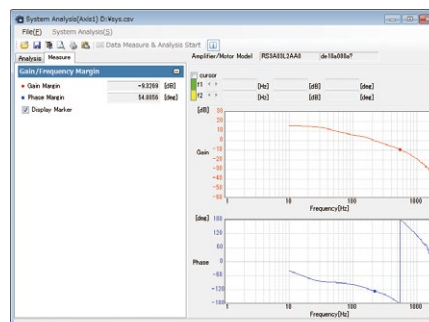
Servo motor test runs can be performed easily by issuing velocity commands and position commands from a PC. (A position jog screen is shown)

Measurement



Operation tracing

Graphically displays the servo motor's speed, torque, and internal status.



System analysis

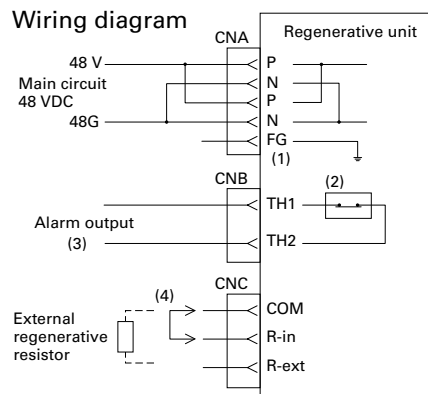
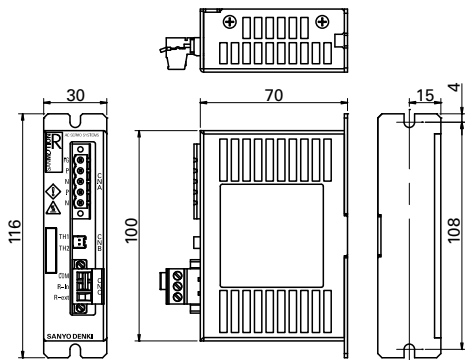
Analyzes servo system frequency characteristics.

■ Regeneration module

For some high-performance applications, a regeneration module is needed to prevent the generated regenerative energy from increasing the power supply voltage.

Model no.	RF1BB00	
Power supply	To be powered by the 48 VDC main circuit power supply	
Regeneration	Regeneration starting voltage	55 ± 1.5 V
	Hysteresis range	2 ± 0.5 V
	Resistance of built-in regenerative resistor	15 Ω ±5%
	Power capacity of built-in regenerative resistor	7 W
Environment	Operating temperature	0 to 40°C
	Storage temperature	-20 to +65°C
	Operating and storage humidity	90% RH or below (non-condensing)
	Altitude	1000 m or below
	Vibration resistance	4.9 m/s ² At frequency of 10 to 55 Hz in each X, Y, and Z direction for 2 hours
	Shock resistance	19.6 m/s ²
Structure	Tray type	
Mass	0.2 kg	
Protection functions	Built-in thermostat-based resistor overheat detection (Normally closed contact signal output)*	

* Users are required to design a system to monitor the detection signal output from the thermostat and stop the servo motor operation.



- (1) CNA has two of each N and P terminal.
- (2) This is a thermal guard for overheat detection.

Specifications	
Contact type	Normally closed (break) contact
Max. switching voltage	30 VDC
Max. switching current	0.1 ADC
Max. switching power	1 W
Min. switching current	0.1 mA, 1 VDC

- (3) Ensure to design a system to monitor the overheat detection alarm signal output and stop the servo motor operation by shutting down the main circuit power input.
- (4) An external regenerative resistor will be required when the capacity of an built-in regenerative resistor is not sufficient to absorb the generated regenerative energy. In that case, remove the shorting bar connected to COM and R-in, and then connect an external regenerative resistor between COM and R-ext.

Connectors and cables

Connector no.	Description	Model no.	Manufacturer	Mfr. part no.	Housing	Contact
CNA	Power input connector	AL-00329461-01	Phoenix Contact	MSTB2.5/5-STF-5.08	-	-
CNB	Cable with alarm output connector	AL-00753589-01	J.S.T.	-	PAP-02V-S	SPHD-001G-P0.5

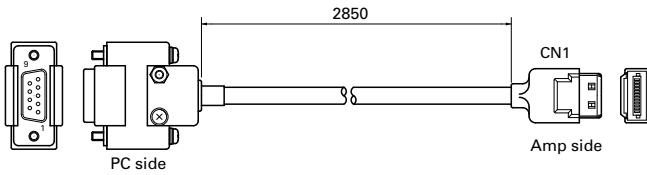
Note: The regenerative module comes with a CNC connector.

■ Servo amplifier connectors

Connector sets

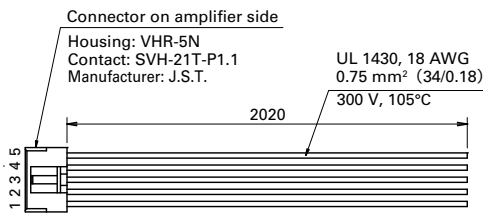
Connector set no.		AL-00763831	AL-00763832
Connectors included in the set	CNA: Main circuit power supply connection	✓	-
	CNB: Servo motor connection	✓	-
	CN1A: Controller connection	-	✓
	CN1B: Controller connection	-	✓
	CN2: Encoder connection	-	✓
Items in the set		CNA housing: VHR-5N × 1 CNB housing: VHR-4N × 1 CNA/CNB contact: BVH-21T-P1.1 × 10	CN1A housing: PADP-14V-1-S × 1 CN1B housing: PADP-20V-1-S × 1 CN2 housing: PADP-10V-1-S × 1 CN1A/CN1B/CN2 contact: SPH-002GW-P0.5S × 45
Manufacturer		J.S.T.	J.S.T.

■ **PC communication cable** Model no.: AL-00490833-01



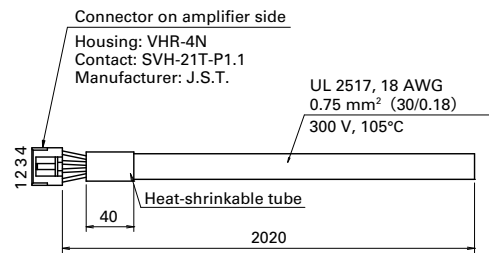
Connect to a PC with an RS-232C serial cable

■ **Power input cable** Model no.: AL-00745943-01



Connector no.	Pin no.	Name	Description	Wire color
CNA	1	FG	Frame ground	Green
	2	5V	5 V control circuit power supply	Yellow
	3	SG	Control circuit power supply ground	Gray
	4	P	48 VDC main circuit power supply	Red
	5	N	Main circuit power supply ground	Blue

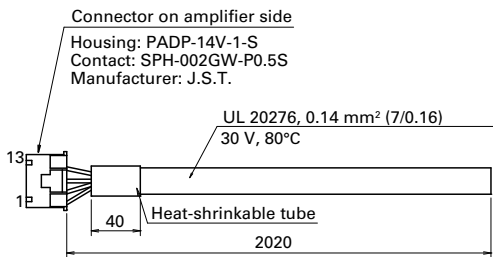
■ **Motor power cable** Model no.: AL-00745944-01



Connector no.	Pin no.	Name	Description	Wire color
CNB	1	U	U phase	Red
	2	V	V phase	White
	3	W	W phase	Black
	4	FG	Frame ground	Yellow (Green)

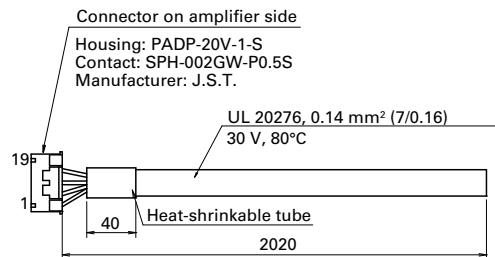
■ **I/O cable set** A set of cables for CN1A (14-pin) and CN1B (20-pin). Model no.: AL-00745949-01

For CN1A



Connector no.	Pin no.	Name	Wire color	Remarks
CN1A	1	AO	Blue	Twisted pair
	3	A0	White	
	4	BO	Green	Twisted pair
	5	B0	White	
	6	ZO	Yellow	Twisted pair
	7	Z0	White	
	8	PS	Red	Twisted pair
	9	P5	White	
	11	F-PC	Blue	Twisted pair
	12	F-PC	Brown	
	13	R-PC	Yellow	Twisted pair
	14	R-PC	Brown	
	10	SG	Purple	
	2	FG	Drain	

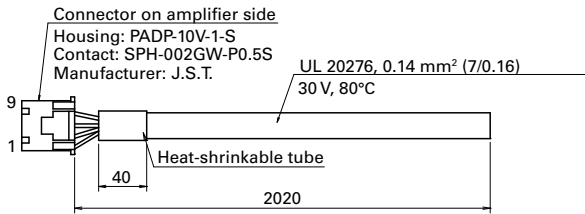
For CN1B



Connector no.	Pin no.	Name	Wire color	Remarks
CN1B	1	IN-COM	Blue	Twisted pair
	3	CONT1	Yellow	
	4	CONT2	White	Twisted pair
	5	CONT3	Green	
	6	CONT4	White	Twisted pair
	7	CONT5	Red	
	8	CONT6	White	Twisted pair
	9	CONT7	Purple	
	10	CONT8	White	Twisted pair
	11	OUT-PWR	Blue	
	19	OUT-COM	Brown	Twisted pair
	12	OUT1	Yellow	
	13	OUT2	Brown	Twisted pair
	14	OUT3	Green	
	15	OUT4	Brown	Twisted pair
	16	OUT5	Red	
	17	OUT6	Brown	Twisted pair
	18	OUT7	Purple	
	20	OUT8	Brown	Twisted pair
	2	FG	Drain	

■ Absolute encoder cable

Model no.: AL-00745946-01

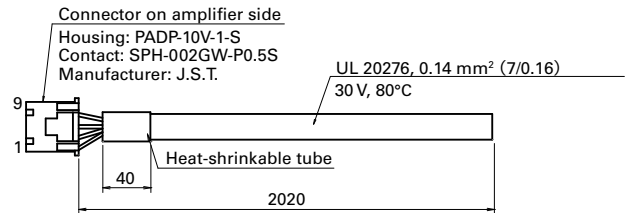


Connector no.	Pin no.	Name	Wire color	Remarks
CN2	1	+5 V	Red	Twisted pair
	2	SG	White	
	3	ES+	Blue	Twisted pair
	4	ES-	White	
	5	BAT+	Yellow	Twisted pair
	6	BAT-	White	
	7			
	8			
	9			
	10	FG	Drain	Shield

Note: Pins 5 and 6 are used only for battery-backup absolute encoders.

■ Incremental encoder cable

Model no.: AL-00745945-01



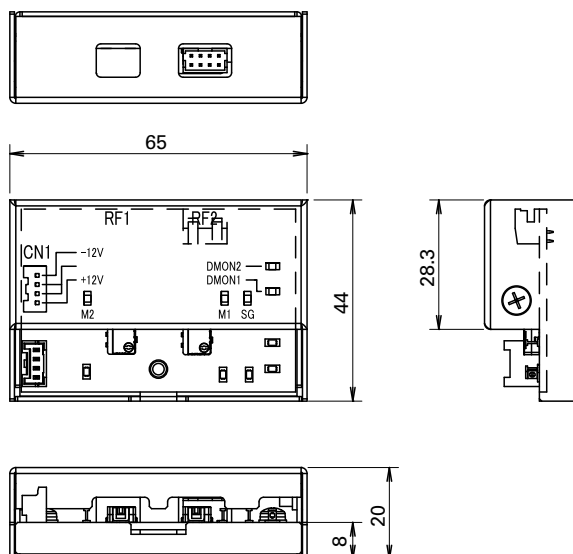
Connector no.	Pin no.	Name	Wire color	Remarks
CN2	1	+5 V	Red	Twisted pair
	2	5G	White	
	3	A	Blue	Twisted pair
	4	Ā	White	
	5	B	Green	Twisted pair
	6	B̄	White	
	7	Z	Yellow	Twisted pair
	8	Z̄	White	
	9			
	10	FG	Drain	Shield

■ Analog monitor box

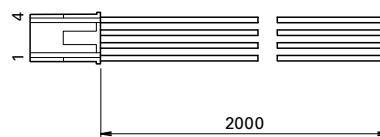
Used to monitor the operating status of the servo amplifier and servo motor.

Model no.	Q-MON-5
Power supply	±12 V ±5%, externally powered (To be prepared by user)
Monitoring channels	Analog × 2, digital × 2, signal settings can be done using the setup software
Output voltage range; error	Within ±8 Vmax DC; within ±20%
Offset voltage	Within ±100 mV
Output resistance	1 kΩ
Load	2 mA or less

A servo amplifier-analog monitor box cable (2 m) and a power input cable will be included.



Power supply cable



Connector no.	Pin no.	Color	Definition
CN1	1	Red	+12 V
	2	Black	SG
	3	Black	SG
	4	Blue	-12 V

■ Servo amplifier connectors

Individual connectors

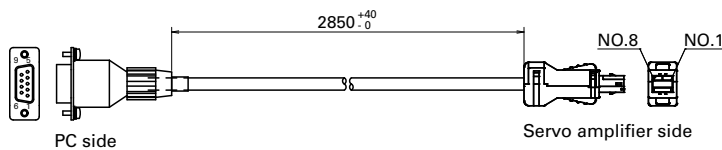
Connector no.	Description	Model no.	Mfr. part no.	Manufacturer
CNA	Input power supply and regenerative resistor connections	AL-Y0010913-01	MSTBT2.5/6-STF-5.08	Phoenix Contact K.K.
CNB	Servo motor connection	AL-Y0004079-01	MSTBT2.5/3-STF-5.08	
CN1 ⁽¹⁾	Safety device connection (for short-circuiting)	AL-00849548-02	1971153-2	Tyco Electronics Japan G.K.
CN1	Safety device connection (for wiring)	AL-00718252-01	2013595-3	
CN2	GPIO connections	AL-00842383	A set of HDR-E26MSG1+ and HDR-E26LPH	HONDA TSUSHIN KOGYO CO., LTD.
EN1	Encoder connection	AL-00632607	36210-0100PL and 36310-3200-008	3M Japan Limited
EN2	Encoder connection	AL-00632607	36210-0100PL and 36310-3200-008	

(1) A safety device connector (for short-circuiting) for CN1 is included with a servo amplifier.

Connector sets

Connector set no.		AL-00887322	AL-00887326	AL-00887323	AL-00887327
Connectors included in the set	CNA: Input power supply and regenerative resistor connections	–	–	✓	✓
	CNB: Servo motor connection	✓	✓	✓	✓
	CN1: Safety device connection (for short-circuiting)	–	–	–	–
	CN1: Safety device connection (for wiring)	✓	✓	✓	✓
	CN2: GPIO connections	✓	✓	✓	✓
	EN1: Encoder connection	✓	✓	✓	✓
	EN2: Encoder connection	–	✓	–	✓

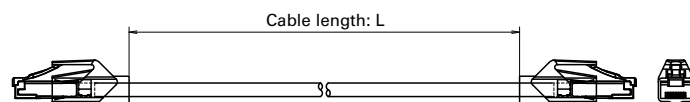
■ PC communication cable Model no.: AL-00689703-01 (The same cable as the one for EtherCAT multi-axis type)



■ EtherCAT communication cables

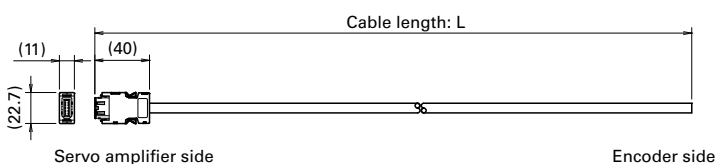
Controller-amplifier and amplifier-amplifier EtherCAT communication cables
(The same cables as the ones for EtherCAT multi-axis type)

Model no.	Cable length (L)
AL-01109322-R50	0.5 m
AL-01109322-01	1 m
AL-01109322-03	3 m
AL-01109322-05	5 m
AL-01109322-10	10 m



■ Absolute encoder communication cables (The same cables as the ones for EtherCAT multi-axis type)

Model no.	Cable length (L)
AL-00921370-01	3 m
AL-00921370-02	5 m
AL-00921370-03	10 m

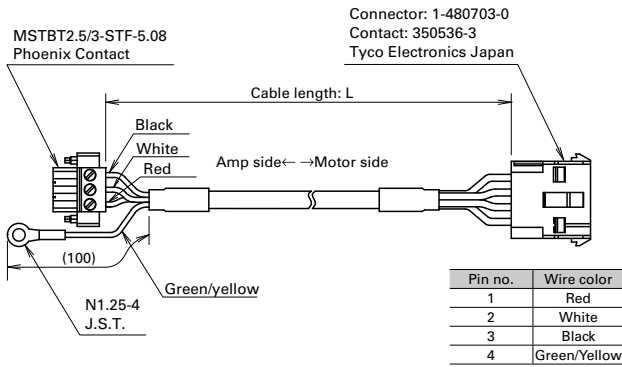


Connector no.	Pin no.	Name	Wire color	Remarks
EN1	1	+5 V	Red	
	2	SG	Black	
	7	ES+	Brown	
	8	ES-	Blue	
	9	BAT+	Green	
	10	BAT-	Purple	
	Shell	Ground		Shield

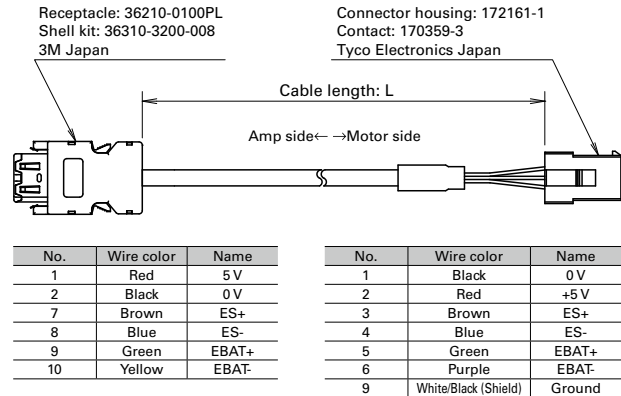
Note: Pins 9 and 10 are used only for battery-backup absolute encoders.

Servo motor extension cables

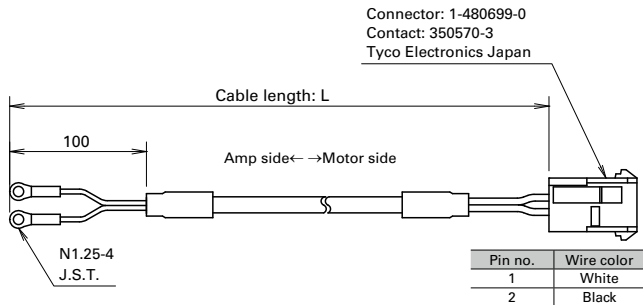
Power cable



Encoder cable



Brake cable



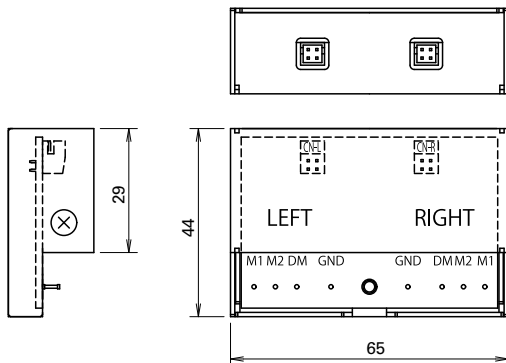
Model no.			Cable length: L [m]
Power cable	Brake cable	Encoder cable	
RS-CM4-01-R	RS-CB3-01-R	RS-CA4-01-R	1
RS-CM4-02-R	RS-CB3-02-R	RS-CA4-02-R	2
RS-CM4-03-R	RS-CB3-03-R	RS-CA4-03-R	3
RS-CM4-05-R	RS-CB3-05-R	RS-CA4-05-R	5
RS-CM4-10-R	RS-CB3-10-R	RS-CA4-10-R	10

Analog monitor box

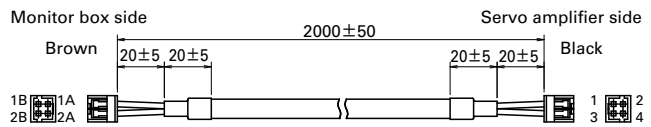
Used to monitor the operating status of the servo amplifier and servo motor.

Name	Description	Model no.
1) Analog monitor box	Monitor box unit Dedicated cable × 2	Q-MON-3
2) Dedicated cable	Dedicated cable × 1	AL-00690525-01

1) Monitor box (model no.: Q-MON-3)



2) Dedicated cable (model no.: AL-00690525-01)



Note 1: The monitor box (model no.: Q-MON-3) includes two dedicated cables (model no.: AL-00690525-01) in 2).

Note 2: To be powered by the servo amplifier.

Servo amplifier connectors

Individual connectors

Connector no.	Description	Model no.	Mfr. part no.	Manufacturer
CNA	Input power supply connection	AL-00922656	5557-08R and 5556TL	Molex Japan Co., Ltd.
CNC	Regenerative resistor connection	AL-00922658	5557-02R and 5556TL	
CN1 ⁽¹⁾	Safety device connection (for short-circuiting)	AL-00849548-02	1971153-2	Tyco Electronics Japan G.K.
CN1	Safety device connection (for wiring)	AL-00718252-01	2013595-3	
I/O	GPIO connections	AL-00922662	10136-3000PE and 10336-52A0-008	3M Japan Limited
EN1, EN2, EN3, EN4 ⁽²⁾	Encoder connection	AL-00632607	36210-0100PL and 36310-3200-008	
MOT1, MOT2, MOT3, MOT4 ⁽²⁾	Servo motor connection	AL-00922660	5557-04R and 5556TL	Molex Japan Co., Ltd.

(1) CN1, a safety device connector (for short-circuiting), is included with a servo amplifier.

(2) For EN1 to EN4 and MOT1 to MOT4, order the quantity you need for the number of motor axes used.

Note that these are not a set of four connectors, but a single connector.

Connector sets

Connector set no.		AL-00922664	AL-00922666
Connectors included in the set	CNA: Input power supply and regenerative resistor connections	✓	–
	CNC: Regenerative resistor connection	✓	–
	CN1: Safety device connection (for short-circuiting)	–	–
	CN1: Safety device connection (for wiring)	–	✓
	I/O: GPIO connections	–	✓
	EN1 to EN4: Encoder connection	–	✓ (Set of 4 pcs)
	MOT1 to MOT4: Servo motor connection	✓ (Set of 4 pcs)	–

PC communication cable Model no.: AL-00689703-01 (The same cable as the one for EtherCAT single-axis type)

Dimensional drawing → p. 29

EtherCAT communication cables

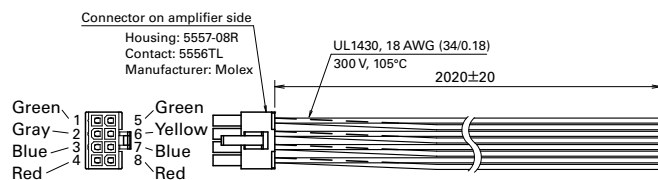
Controller-amplifier and amplifier-amplifier EtherCAT communication cables

(The same cables as the ones for EtherCAT single-axis type)

Dimensional drawing → p. 29

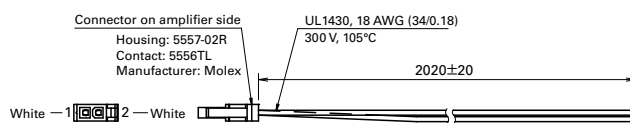
Model no.	Cable length (L)
AL-01109322-R50	0.5 m
AL-01109322-01	1 m
AL-01109322-03	3 m
AL-01109322-05	5 m
AL-01109322-10	10 m

Power input cable Model no.: AL-00921367-01



Connector no.	Pin no.	Name	Wire color
CNA	1	FG	Green
	2	CN	Gray
	3	N	Blue
	4	P	Red
	5	FG	Green
	6	CP	Yellow
	7	N	Blue
	8	P	Red

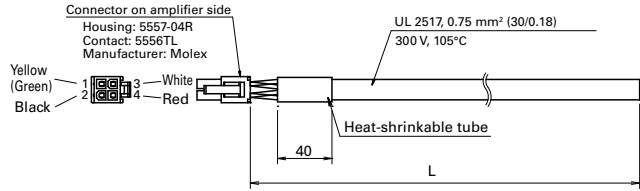
Regenerative resistor cable Model no.: AL-00921368-01



Connector no.	Pin no.	Name	Wire color
CNC	1	RB1	White
	2	RB2	White

Motor power cable

Model no.	Cable length (L)
AL-00921369-01	3 m
AL-00921369-02	5 m
AL-00921369-03	10 m



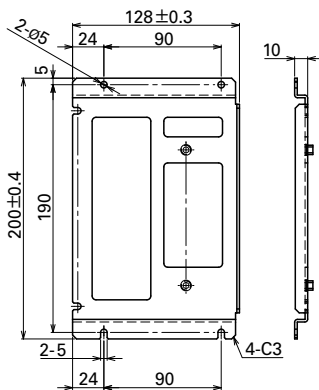
Connector no.	Pin no.	Name	Wire color
MOT1 to MOT4	1	FG	Yellow (Green)
	2	W	Black
	3	V	White
	4	U	Red

Absolute encoder communication cables (The same cables as the ones for EtherCAT single-axis type)

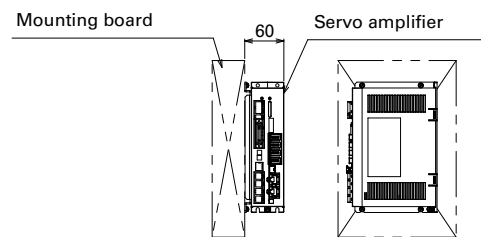
Dimensional drawing → p.29

Model no.	Cable length (L)
AL-00921370-01	3 m
AL-00921370-02	5 m
AL-00921370-03	10 m

Side mounting brackets Model no.: AL-00921371-01



Mounting example



Items included: Bracket mounting screws (M4, 4 pcs)

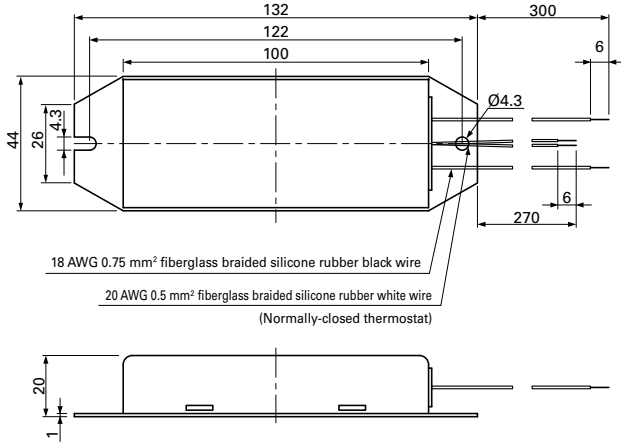
Mass: 0.3 kg

External regenerative resistor

An external regenerative resistor is required when the capacity of an built-in regenerative resistor is not sufficient to absorb the generated regenerative energy.

Model no.: REGIST-080W100B EtherCAT single-axis

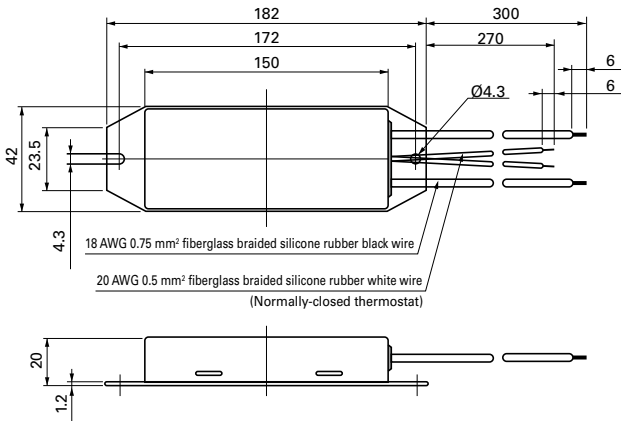
REGIST-080W50B Pulse input single-axis EtherCAT single-axis EtherCAT multi-axis



Mass: 0.19 kg

Model no.: REGIST-120W100B EtherCAT single-axis

REGIST-120W50B Pulse input single-axis EtherCAT single-axis EtherCAT multi-axis

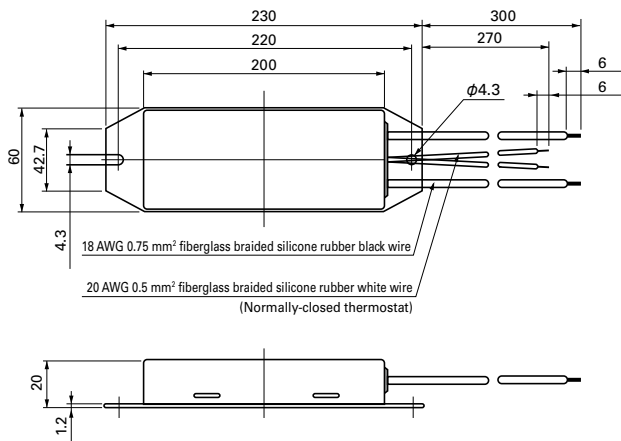


Mass: 0.24 kg

Model no.: REGIST-220W100B EtherCAT single-axis

REGIST-220W50B Pulse input single-axis EtherCAT single-axis

REGIST-220W20B EtherCAT multi-axis



Mass: 0.44 kg

Cylinder Linear Servo Motors Motor width 12 mm, 20 mm



■ Features

- This linear servo motor provides high thrust with a compact size, and is ideal for chip mounter heads.
- A new model with a shorter motor length for further downsizing has been added to the 12 mm width lineup. (Model no.: DE0AC0A1A03CX00)
- High-frequency operation with high acceleration/deceleration can speed up your applications.
- The built-in linear encoder and linear guide simplify system designs.
- Multiple axes can be placed side-by-side, contributing to downsizing of multi-axis heads.

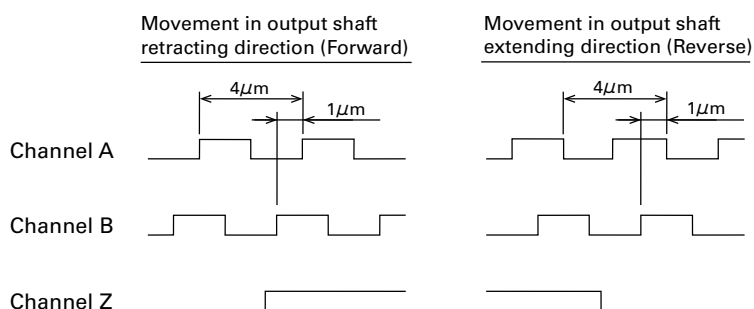
■ Applications

Chip mounters, semiconductor manufacturing equipment, inspection equipment, assembly equipment, lens mounters, and in the Z-axis of flexible printed circuit board (FPC) bonders

■ Specifications

Model no. In ◊ are motor widths			DE0AC0A1A03CX00 ◊12 mm	DE0AC001A03CX00 ◊12 mm	DE0BC005A05CX00 ◊20 mm
	Symbol	Unit			
Drive method			Sinusoidal		
Excitation			Permanent magnet		
Rated			Continuous		
Rated thrust	FR	N	3.0	5.1	15
Continuous thrust at stall	FS	N	3.0	5.1	15
Maximum thrust	FP	N	8.5	16.5	50
Rated current	IR	Arms	0.7	0.6	1.0
Continuous current at stall	IS	Arms	0.7	0.6	1.0
Maximum current	IP	Arms	2.0	2.0	3.2
Rated speed	VR	m/s	0.9	1.0	0.7
Maximum speed	V _{max}	m/s	1.8	2.0	1.4
Mover mass	MC	g	33	45	120
Motor mass	W	g	152	192	450
Linear encoder			Incremental encoder		
Linear encoder resolution (× 4 multiplier)		μm	1		
Thrust-Speed Characteristics (48 VDC power supply)					
			Speed (m/s)	Speed (m/s)	Speed (m/s)
			Thrust (N)	Thrust (N)	Thrust (N)

■ Linear encoder signal output

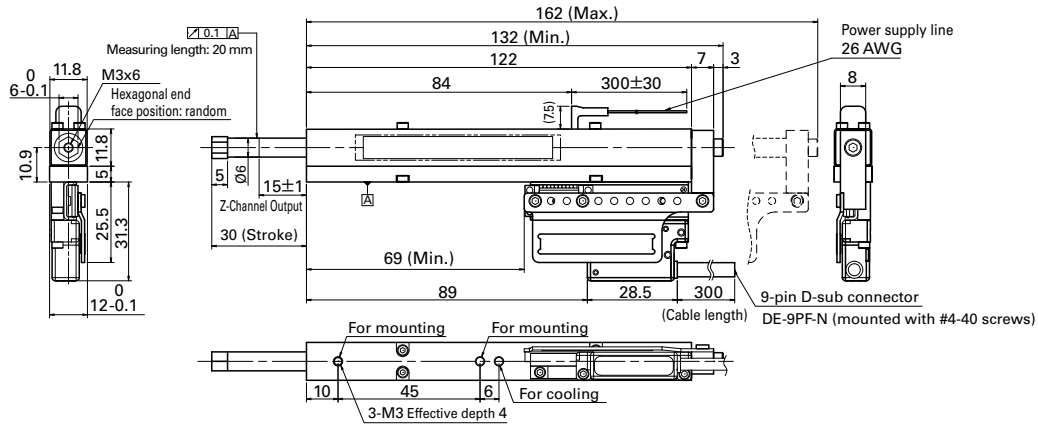


Linear encoder
Minimum resolution: 1.0 μm
9-pin D-sub connector

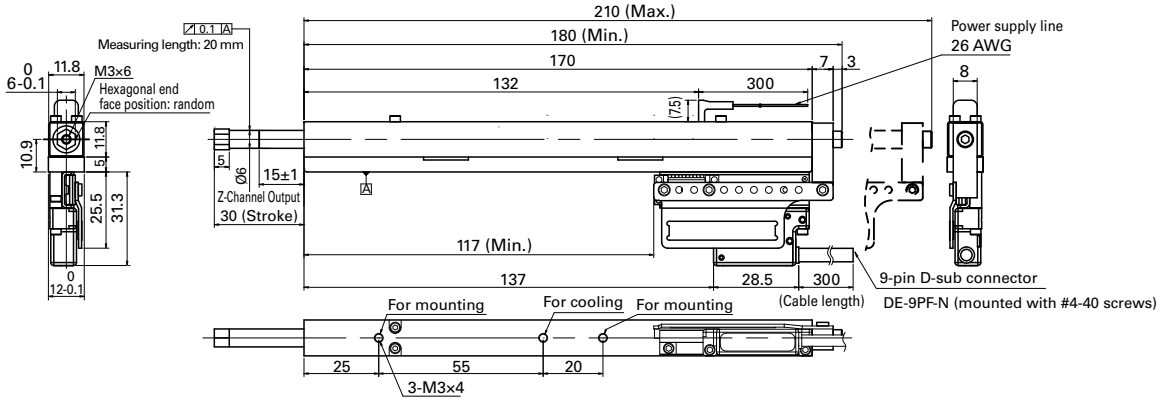
Pin no.	Description
1	Free (unused)
2	Channel Z
3	Channel B
4	Channel A
5	+5 VDC
6	Channel Z̄
7	Channel B̄
8	Channel Ā
9	GND

Dimensions [Unit: mm] Note: Contact us or your point of sale for the installation, and design your system taking it into account.

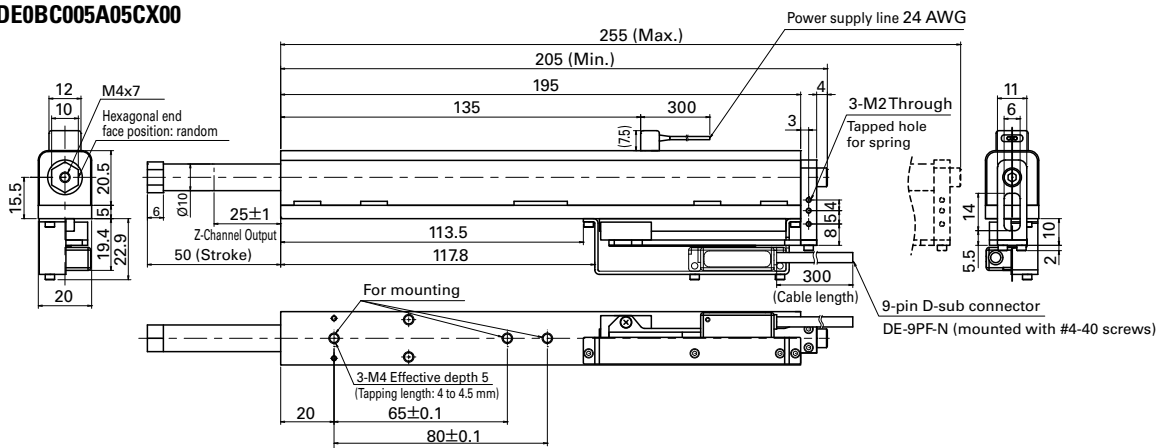
12 mm DE0AC0A1A03CX00



12 mm DE0AC001A03CX00



20 mm DE0BC005A05CX00



Compatible servo amplifiers

Servo amplifier model no.	RF2G21L8A10	RS2K04AAHA5	RF2J24A8HL5
Amplifier capacity	40 A		
Power supply voltage (main/control)	48/5 VDC	48/24 VDC	
Interface	Pulse input	EtherCAT	
Dimensions [mm]	30 × 116 × 70	40 × 160 × 85	50 × 200 × 130
No. of controllable axes	1		4

Multi-Axis Integrated Linear Servo Motor Unit



■ Features

- The individual cylinder linear servo motors in the unit achieved a maximum thrust of 11 N despite their compact 16 mm size. It contributes to reducing size and weight and increasing the speed of the equipment.
- Multiple cylinder linear servo motors can be integrated into a single unit, with the number and size customizable to your needs. Individual motors are not separated but come preassembled as a single unit, saving assembly time.
- With a 4-axis unit as standard, customization with up to 8 axes can be made.

■ Applications

This pre-assembled unit can be installed to equipment easily in applications that require multiple linear servo motors, such as PCB surface mounter heads. It is also suitable for semiconductor manufacturing and inspection equipment.

■ Linear servo motor specifications

Model no.			DM04GG011A37CX00
	Symbol	Unit	4-axis integrated unit
Drive method			Sinusoidal
Excitation			Permanent magnet
Rated			Continuous
Rated thrust	F_R	N	3.5
Continuous thrust at stall	F_S	N	3.5
Maximum thrust	F_P	N	11
Rated speed	V_R	m/s	1.0
Maximum speed	V_{max}	m/s	1.0
Distance between axes	P_A	mm	24
Mover mass	M_C	g	37
Motor mass	W	g	1300
Linear encoder			Incremental encoder
Linear encoder resolution ($\times 4$ multiplier)		μm	1.0
Thrust-Speed Characteristics (48 VDC power supply)			

■ Linear encoder signal output

- Same as the linear encoder signal output on p. 34.

■ Compatible servo amplifiers

Servo amplifier model no.	RF2G21L8A10	RS2K04AAHA5	RF2J24A8HL5
Amplifier capacity	40 A		
Power supply voltage (main/control)	48/5 VDC	48/24 VDC	
Interface	Pulse input	EtherCAT	
Dimensions [mm]	30 × 116 × 70	40 × 160 × 85	50 × 200 × 130
No. of controllable axes	1		4

Selection of Servo Motor Output (Rotary Motors)

This is a calculation method for deriving required servo motor output based on specifications of machines. In this instance an introduction on the procedure for the selection is provided primarily for instances where ball screw (horizontal) mechanism is involved.

Selection Steps

1. Determine the motion profile

Determine the mechanism to use and the motion profile.

2. Calculate the axial load moment of inertia, J_L

Calculate the load moment of inertia about the motor axis based on the mechanism.

3. Calculate the axial load torque, T_L

Calculate the load torque for the mechanism to use.

4. Provisional selection of servo motor output

Provisionally select a motor that meets the following conditions: the load moment of inertia (J_L) is 10 times or below the motor's rotor moment of inertia (J_M), and the load torque (T_L) is 80% or below ($T_R \times 0.8$) the motor's rated torque (T_R).

$$J_L \leq J_M \times 10$$

$$T_L \leq T_R \times 0.8$$

5. Calculate the acceleration/deceleration torque

Calculate the total torque required to accelerate/decelerate the system (motor and load) based on the motion profile.

6. Calculate actual torque

Calculate the required actual torque using a formula and the results of the previous steps.

7. Check the calculation results

Check if the calculated acceleration and deceleration torques (T_a and T_b) are 80% or below the selected motor's peak torque at stall ($\leq T_p \times 0.8$) and the calculated actual torque (T_{rms}) is 80% or below the motor's rated torque ($\leq T_R \times 0.8$).

$$T_a \leq T_p \times 0.8$$

$$T_b \leq T_p \times 0.8$$

$$T_{rms} \leq T_R \times 0.8$$

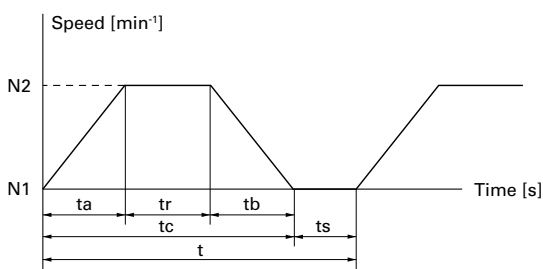
If the selected motor does not meet the conditions above, then change the servo motor output and try one with a larger output.

8. Calculate the regenerative power

Calculate the regenerative power and select an external regenerative resistor if needed.

1. Determine the motion profile

First, determine the machine mechanism and required parameters such as the dimensions of components, positioning resolution, positioning time, and gear ratio. Make a motion profile for the determined drive in a graph with speed and time axes.



N1: Servo motor rotational speed before acceleration [min^{-1}]

N2: Servo motor rotational speed after acceleration [min^{-1}]

t_a = Time spent accelerating the load [s]

t_b = Time spent decelerating the load [s]

t_r = Time spent while motor is turning at constant speed [s]

t_s = Time spent while motor is at rest [s]

t = 1 cycle [s]

2. Calculate J_L , the load moment of inertia referred to the motor shaft

Load moment of inertia is the quantity that expresses an object's resistance to change its state of rotational motion. The following formula is for calculating it in the case of a (horizontal) ball screw mechanism.

■ Moment of inertia of ball screw

$$J_{L1} = \left(\frac{1}{G}\right)^2 \times \frac{\pi \times \rho \times D^4 \times L}{32} \quad [\text{kg}\cdot\text{m}^2]$$

G: Gear ratio

ρ : Ball screw density [kg/m^3] (Iron: 7.8×10^3)

D: Ball screw diameter [m]

L: Ball screw length [m]

■ Moments of inertia of workpiece and table

$$J_{L2} = \left(\frac{1}{G}\right)^2 \times W \times \left(\frac{P}{2\pi}\right)^2 \quad [\text{kg}\cdot\text{m}^2]$$

G: Gear ratio

W: Workpiece mass + table mass [kg]

P: Ball screw pitch [m]

■ Load moment of inertia referred to the motor shaft

$$J_L = J_{L1} + J_{L2}$$

Note: The moments of inertia of the reduction gear and coupling are assumed to be small enough to be negligible

3. Calculate T_L , the load torque referred to the motor shaft

The formula for load torque converts forces exerted on the load due to friction and gravity into the rotational equivalent as reflected to the motor shaft by the lead screw. This is the torque against which a motor works against to drive the load.

The following formula is for calculating it in the case of a (horizontal) ball screw mechanism.

$$T_L = \frac{F + \mu W \times 9.8}{\eta} \times \frac{P}{2\pi} \times \frac{1}{G} \quad [\text{N}\cdot\text{m}]$$

F: External force [N]

η : Mechanical efficiency

μ : Friction coefficient

W: Workpiece mass + table mass [kg]

P: Ball screw lead [m]

G: Gear ratio

4. Provisional selection of servo motor output

Provisionally, select motors that satisfy the following 2 conditions.

- The load moment of inertia (J_L) calculated in step 2 is 10 times or below the motor's rotor moment of inertia ($J_M \times 10$)

$$J_L \leq J_M \times 10$$

- The load torque (T_L) calculated in step 3 is 80% or below the rated torque ($T_R \times 0.8$) of the motor

$$T_L \leq T_R \times 0.8$$

5. Calculate the acceleration/deceleration torque

The acceleration/deceleration torque is the torque required to accelerate or decelerate the motor and load.

- How to calculate acceleration torque (T_a)

$$T_a = \frac{2\pi(N_2 - N_1) \times (J_L + J_M)}{60 \times t_a} + T_L \text{ [N}\cdot\text{m]}$$

N_2 : Servo motor rotating speed after acceleration [min^{-1}]

N_1 : Servo motor rotating speed before acceleration [min^{-1}]

J_L : Load moment of inertia about the motor axis [$\text{kg} \cdot \text{m}^2$]

J_M : Servo motor rotor moment of inertia [$\text{kg} \cdot \text{m}^2$]

T_L : Axial load torque [$\text{N}\cdot\text{m}$]

t_a = Acceleration time [s]

- Deriving deceleration torque (T_b)

$$T_b = \frac{2\pi(N_2 - N_1) \times (J_L + J_M)}{60 \times t_b} - T_L \text{ [N}\cdot\text{m]}$$

N_2 : Servo motor rotating speed before acceleration [min^{-1}]

N_1 : Servo motor rotating speed after acceleration [min^{-1}]

J_L : Load moment of inertia about the motor axis [$\text{kg} \cdot \text{m}^2$]

J_M : Servo motor rotor moment of inertia [$\text{kg} \cdot \text{m}^2$]

T_L : Axial load torque [$\text{N}\cdot\text{m}$]

t_b = Deceleration time [s]

6. Calculate actual torque

The actual torque is a root mean square of the load torque, acceleration torque, and deceleration torque.

$$T_{rms} = \sqrt{\frac{(T_a^2 \times t_a) + (T_L^2 \times t_r) + (T_b^2 \times t_b)}{t}} \text{ [N}\cdot\text{m]}$$

7. Assessment

We use the following conditions for assessment.

- Load torque: $T_L \leq T_R \times 0.8$
(Load torque $\leq 80\%$ of the rated torque)
- Acceleration torque: $T_a \leq T_p \times 0.8$
(Acceleration torque $\leq 80\%$ of the peak torque at stall)
 T_p : Peak torque at stall
- Deceleration torque: $T_b \leq T_p \times 0.8$
(Deceleration torque $\leq 80\%$ of the peak torque at stall)
 T_p : Peak torque at stall

- Actual torque: $T_{rms} \leq T_R \times 0.8$
(Actual torque $\leq 80\%$ of the rated torque)

- Inertia moment ratio $J_L \leq J_M \times 10$
(Load moment of inertia ≥ 10 times or below the motor rotor moment of inertia)

Furthermore, the rising temperature of the motor can be inhibited by securing a large margin for torque load ratios. The moment of inertia ratio can be more than 10 times, for example, for mechanisms that slowly rotate a table. Testing with an actual machine is recommended.

8. Calculate the regenerative power

Calculate the regenerative power (P_M) to determine the type of suitable regenerative resistor. The result of this calculation determines if a built-in regenerative resistor can be used or an external one is required.

- How to calculate the regenerative power (P_M) of horizontal shaft drive

First, calculate the regenerative energy.

$$E_M = E_{hb} = \frac{1}{2} \times N \times 3 \times K_{e\phi} \times \frac{T_b}{KT} \times t_b - \left(\frac{T_b}{KT}\right)^2 \times 3 \times R_\phi \times t_b$$

E_M : Regenerative energy during horizontal driving [J]

E_{hb} : Regenerative energy during deceleration [J]

$K_{e\phi}$: Phase voltage constant [$\text{V}_{rms}/\text{min}^{-1}$] (motor constant)

K_T : Torque constant [$\text{N}\cdot\text{m}/\text{A}_{rms}$] (motor constant)

N : Motor speed [min^{-1}]

R_ϕ : Phase resistance [Ω] (motor constant)

t_b : Deceleration time [s]

T_b : Torque from deceleration [$\text{N}\cdot\text{m}$]

Calculate the regenerative power from regenerative energy.

$$P_M = \frac{E_M}{t}$$

P_M : Regenerative power [W]

E_M : Regenerative energy [J]

t : Cycle time [s]

- Selection of regenerative resistor

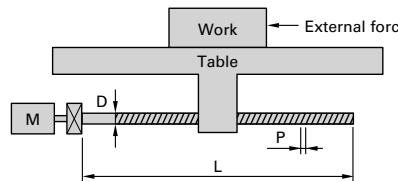
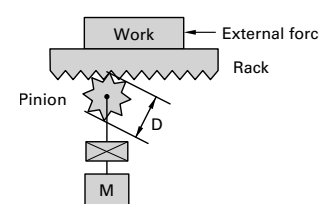
Select a regenerative resistor that satisfies the following conditions.

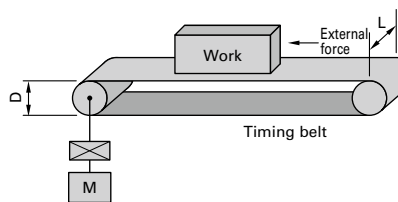
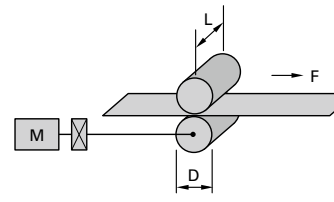
- Servo amplifier's built-in regenerative resistor
Required regenerative power [P_M] < Maximum regenerative power that can be handled by a built-in regenerative resistor [P_R]
- External regenerative resistor
Required regenerative power [P_M] < Maximum regenerative power that can be handled by an external regenerative resistor [P_{Ro}]

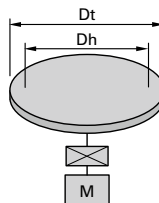
Note and be careful when making selections, since model numbers for servo amplifiers include those that have built-in regenerative resistor for absorbing regenerative power and those that do not.

Selection materials by mechanism

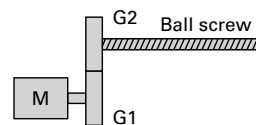
Typical mechanism examples and required selection criteria are shown below. Provide us with these information when consulting us for selection.

Ball Screw		Rack & Pinion	
			
External force	F	<input type="text"/>	N
Workpiece mass + table mass	W	<input type="text"/>	kg
Ball screw diameter	D	<input type="text"/>	m
Ball screw length	L	<input type="text"/>	m
Ball screw pitch	P	<input type="text"/>	m
Ball screw material density	ρ	<input type="text"/>	kg/m ³
Friction coefficient	μ	<input type="text"/>	
Gear ratio*	G	<input type="text"/>	
Mechanical efficiency	η	<input type="text"/>	

Belt drive		Roll feed	
			
External force	F	<input type="text"/>	N
Workpiece mass + belt mass	W	<input type="text"/>	kg
Pulley diameter	D	<input type="text"/>	m
Pulley width	L	<input type="text"/>	m
Pulley material density	ρ	<input type="text"/>	kg/m ³
Gear ratio*	G	<input type="text"/>	
Mechanical efficiency	η	<input type="text"/>	
Sheet tension	F	<input type="text"/>	N
Roll diameter	D	<input type="text"/>	m
Roll width	L	<input type="text"/>	m
Roll material density	ρ	<input type="text"/>	kg/m ³
Gear ratio*	G	<input type="text"/>	
Mechanical efficiency	η	<input type="text"/>	

Rotary indexing table			
			
Table mass	W	<input type="text"/>	kg
Table diameter	Dt	<input type="text"/>	m
Table support diameter	Dh	<input type="text"/>	m
Friction coefficient of table support	μ	<input type="text"/>	
Gear ratio*	G	<input type="text"/>	
Mechanical efficiency	η	<input type="text"/>	

* Calculation of gear ratio (G)

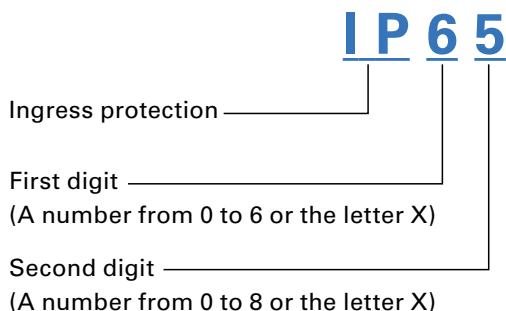


$$G = \frac{\text{Ball screw gear teeth (G2)}}{\text{Motor gear teeth (G1)}}$$

Motor Protection Rating (IP code)

The protection ratings of our servo motors comply with IEC standard (IEC 60034-5).

The standard states that the liquid used for testing should be fresh (pure) water, and liquids other than water such as oil are not included in the test conditions.



The protection rating (IP code), is defined by IEC (International Electrotechnical Commission) 60529 "DEGREES OF PROTECTION PROVIDED BY ENCLOSURES (IP Code)."
 Note: IEC 60529

First digit	Description	Definition
0	No protection	—
1	Protection against solid objects > 50 mm	A spherical 50 mm diameter solid probe shall not completely penetrate
2	Protection against solid objects > 12.5 mm	A spherical 12.5 mm diameter solid probe shall not completely penetrate
3	Protection against solid objects > 2.5 mm	A spherical 2.5 mm diameter solid probe shall not penetrate at all
4	Protection against solid objects > 1 mm	A spherical 1 mm diameter solid probe shall not penetrate at all
5	Protection against a level of dust that could hinder operation or impair safety	Although it is impossible to completely prevent the penetration of dust, there should be no intrusion of an amount of dust that could impede the prescribed operation and safety of the electrical equipment
6	Complete protection against dust	Completely protected against dust

Second digit	Description	Definition
0	No protection	—
1	Protected against vertically falling drops of water	Vertically dripping water shall have no harmful effect.
2	Protected against vertically falling drops of water even if inclined up to 15°	Vertically dripping water shall have no harmful effect when the enclosure is tilted at an angle up to 15° from its normal position.
3	Protected against spraying water	Water falling as a spray at any angle up to 60° from the vertical shall have no harmful effect.
4	Protected against splashing water	Water splashing against the enclosure from any direction shall have no harmful effect.
5	Protected against water jets	Water projected by a nozzle against enclosure from any direction shall have no harmful effects.
6	Protected against powerful water jets	Water projected in powerful jets against the enclosure from any direction shall have no harmful effects.
7	Protected against temporary immersion in water	Ingress of water in harmful quantity shall not be possible when the enclosure is immersed in water under defined conditions of pressure and time.
8	Protected against submersion in water	The equipment is suitable for continuous immersion in water under conditions which negotiated with stakeholders. The test conditions are expected to be greater than the requirements for IPx7, and other environmental effects may be added.

Note 1: According to the standard, "the liquid used for the test is to be fresh water," and liquids other than water such as oil are not included in the test conditions.

Separate evaluation is necessary when used in environments where machine tool cutting oil is present.

Our servo motors have a proven track record for machine tool applications, and we can respond with options, so please contact us as necessary.

Note 2: For the second digit, values of 6 and under indicate compliance with all lower conditions, however when the second digit is 7 it does not indicate protection against jets (indicated by a second digit of 5 or 6)

Select a protection rating suitable for your environment.

Safety Precautions

The products featured in this catalog are designed for use with general industrial machinery. Pay sufficient attention to the following.

- Read the included Instruction Manual carefully before installing, assembling, and using the product for proper use. The Instruction Manual is available for download from our website.
- Refrain from modifying or processing the product in any way.
- Contact your point of sale or a properly licensed technician for installation or maintenance service of the product.
- Consult us when using the product for the following uses, as these require special considerations for operations, maintenance, and management such as redundancy and emergency power generators.
 - ① Use in medical equipment or other devices that may directly affect people's lives or cause bodily injury
 - ② Use in transportation systems or transport-related equipment such as trains or elevators, that may affect people's lives or cause bodily injury
 - ③ Use in computer systems that have a major impact on society or on the public
 - ④ Use in other devices that have a significant impact on human safety or on maintaining public operations

Consult us when using the product in an environment where vibrations occur, such as in a moving vehicle or during transportation. Use the product only after becoming thoroughly proficient with relevant product knowledge, safety information, and precautions.

Warning Labels on Products

Products bear the following Warning Labels to indicate the situations as below, depending on the model.



This label is attached in the vicinity of high-voltage portions such as charging or cover-protected parts, to indicate locations with risk of electric shock.



This label is attached in the vicinity of grounding terminals to indicate that grounding is required.

Safety Alert Symbols

The following safety symbols are used in the manual to indicate different hazardous situations and prohibited or required actions.




DANGER Indicates immediate hazards that will cause severe bodily injury or death as a result of failure to follow the instructions.



WARNING Indicates hazards that could cause severe bodily injury or death as a result of failure to follow the instructions.



CAUTION Indicates possible hazards that could cause moderate bodily injury or only property damage as a result of failure to follow the instructions.

Note that even items with a  CAUTION symbol could potentially lead to serious outcomes, depending on the situation. They all indicate important situations, so be sure to observe them.



PROHIBITED Indicates actions that must not be taken.



MANDATORY Indicates actions that must be taken.

WARNING

Precautions on Use

1. Do not use the product in explosive environments. Failure to follow this may cause injury or fire.
2. Do not work on wiring, maintenance servicing, or inspection with the power on. After turning off the power, wait at least 15 minutes and confirm extinction of CHARGE-LED for the main circuit power supply, and then start working. Failure to follow this may cause electric shock or product damage.
3. Make sure to ground protective grounding terminals of servo amplifiers to equipment or control board. The grounding terminals of servo motors must be connected to protective grounding terminals of servo amplifiers. Failure to follow this may cause electrical shock.
4. Never touch inside of servo amplifiers with hands. Electrical shock may result.
5. Do not damage, apply excessive stresses, put heavy things on, or tuck down cables. Failure to follow this may cause electrical shock.
6. Never touch the rotating part of servo motors during operation. Failure to follow this may cause injury.

CAUTION

Precautions on Use

1. Use servo amplifiers and servo motors in specified combinations. Failure to follow this may cause fire or product malfunctions.
2. Only technically qualified personnel should transport, install, wire, operate, or perform maintenance and inspection on the product. Failure to follow this may cause electric shock, injury, or fire.
3. Never install products in a location exposed to water, in a corrosive or flammable gas atmosphere, or in the vicinity of flammable materials. Failure to follow this may cause fire or product malfunctions.
4. Be careful of the high temperatures generated by the servo amplifier/motor and peripherals. Failure to follow this may cause burns.
5. Never touch regenerative resistors, servo motors, and the servo amplifier's radiation fins as such parts become hot in operation and remain hot for a while after power is turned off. Failure to follow this may cause burns.
6. Designing a safety system that uses the Safe Torque Off function must be done by individuals who have safety standard expertise and have sufficiently understood the descriptions of the Instruction Manual. Failure to follow this may cause injury or product failures.
7. Prior to installation, operation, maintenance servicing or inspection, be sure to read the Instruction Manual and follow the instructions. Failure to follow this may cause electric shock, injury, or fire.
8. Do not use servo amplifiers and servo motors outside their specified operating ranges. Failure to follow this may cause electric shock, injury, or product damage.
9. Consult us for use in high-inertia or high-speed applications that generate high peak regenerative power because these may exceed the capacity of regenerative resistor wires.

Transportation

10. When transporting products, do not hold cables, servo motor shafts, or detector parts. Failure to follow this may cause product damage or injury.
11. Handle products with care during transportation to prevent them from dropping or falling. Failure to do so may cause injury.

Installation

12. Do not stand on products or place heavy objects on top of them. Failure to do so may cause injury.
13. Make sure that the mounting orientation is correct. Failure to follow this may cause fire or product malfunctions.
14. Do not drop products or subject them to excessive shock of any kind. Failure to follow this may cause product failures.
15. Do not obstruct the air intake and exhaust vents. Failure to follow this may cause fire.
16. Follow the Instruction Manual and give sufficient clearance for the wiring of the servo amplifier control board. Failure to follow this may cause fire or product failures.
17. Unpack product packages right side up. Failure to do so may cause injury.
18. Verify if the product you receive is the product you ordered. Failure to follow this may cause injury or product damage.
19. During installation, be careful that the product does not fall or tip over, as this can be dangerous. Use eyebolts, if included, for transporting servo motors. Failure to do so may cause injury.
20. Install the product to incombustible materials such as metals. Failure to follow this may cause fire.
21. For anti-collision devices, use ones that can sufficiently withstand the maximum output of the system. Failure to do so may cause injury.

Wiring

22. Perform wiring correctly and securely. Failure to do so may cause injury.
23. Perform wiring work according to the wiring diagrams or the Instruction Manual. Failure to follow this may cause electric shock or fire.
24. Perform wiring work according to local standards of electrical installations. Failure to follow this may cause motor burnout or fire.
25. Do not connect commercial power supply to the U, V and W terminals of servo motors. Failure to follow this may cause fire or product malfunctions.
26. Install safety devices such as circuit breakers in case of short-circuiting of external wiring. Failure to follow this may cause fire.
27. Do not bind or band the power cable, input/output signal cable and/or encoder cable together or pass through the same duct or conduit. Failure to follow this may cause faulty operation.
28. When connecting an inductive load such as a relay to the control output signal of the servo amplifier, be sure to connect a surge absorber diode. Be aware that reverse-connecting the diode polarity may cause servo amplifier malfunctions.
29. Do not connect an AC or 90 VDC power supply to the servo motor's 24 VDC brakes. Also, do not connect a 400 VAC power supply to the servo motor's 200 VAC cooling fans. Failure to follow this may cause motor burnout or fire.
30. The surge absorber for the servo motor's holding brake relay prolongs the brake delay time. Therefore, program a sequence taking the delay time into account. Failure to follow this may result in falls or injury.
31. Do not use half-wave rectifier circuits in power supplies of 24 VDC or 90 VDC brakes. Failure to follow this may cause excessive heating or product failures.

Control and Operations

32. Do not perform drastic setting changes as such changes may cause unstable operation. Failure to do so may cause injury.
33. Test-run a servo motor with the motor position fixed and isolated from machine systems. Install the motor to the machine system only after the test is done. Failure to do so may cause injury.
34. The holding brake cannot be used as a dynamic braking, which stops machines for safety. For that purpose, install stop devices. Failure to do so may cause injury.
35. In the case of an alarm, make sure to eliminate the cause and ensure safety before resuming operations. Failure to do so may cause injury.
36. Verify that the input power supply voltage is within the specified range. Failure to follow this may cause product failures.
37. After a power interruption is restored, avoid getting close to stopped machines as it may restart suddenly. (Design a safety system to prepare for such an event.) Failure to do so may cause injury.
38. Do not use servo amplifiers or servo motors that have failed, damaged, or burnt out. Failure to follow this may cause injury or fire.
39. Immediately stop operation in case of anomaly. Failure to follow this may cause electric shock, injury, or fire.
40. When using servo motors in vertical axes, install safety devices to prevent a workpiece from falling even in the event of an alarm. Failure to follow this may cause injury or product damage.

Maintenance and Inspection

41. Parts and components used in servo amplifiers (such as electrolytic capacitors, cooling fans, lithium batteries for encoders, fuses, relays) deteriorate by aging. Considering the standard replacement period, replace these parts and components with new ones for preventive maintenance. Failure to follow this may cause product failures. Contact us when replacing such parts and components.
42. Never touch terminals and connectors while electricity is supplied. Failure to follow this may cause electrical shock.
43. Since the frame of servo amplifiers becomes high in temperature, be careful when conducting maintenance and inspection work. Failure to follow this may cause burns.
44. Contact us for repairs. Disassembling the product by yourself may result in product failures and render it inoperable.

PROHIBITED

Storage

1. Avoid storing products in locations exposed to rain or water drops, or in an environment with hazardous gas or liquid. Failure to follow this may cause malfunctions.

Control and Operations

2. Brakes used in servo motors are holding brakes and must not be used for dynamic braking. Doing so may damage or break the holding brake.
3. Do not apply static electricity or excessively high voltage to servo motor encoder cables. Failure to follow this may cause failures.
4. Never rotate standard servo motors continuously by external force when the amplifier is at Servo OFF state because doing so will heat up the

- motor's dynamic braking resistor and may result in accidents. Failure to follow this may cause fire or burns.
- Never use products with voltages exceeding their specified input voltage range. Failure to follow this may cause component failures or product damage. Failure to follow this may cause product damage or injury.
 - Do not turn power on and off frequently. Turning power on and off more than 30 times a day or 5 times in an hour may cause premature failures of internal components.

Maintenance and Inspection

- Do not disassemble or repair products by yourself. Failure to follow this may cause fire or electric shock.
- Do not perform measurements of insulation resistance or dielectric voltage. Failure to follow this may cause product damage.
- Never plug or unplug connectors while power is on (hot swapping) as the resulting surge voltage may cause electronic component malfunctions. Failure to follow this may cause electric shock or product damage.
- Do not remove the product name plate.

MANDATORY

Storage

- Store products where they are not exposed to direct sunlight, within the specified temperature and humidity ranges of -20 to +65°C, below 90% RH (non-condensing). Failure to follow this may cause malfunctions.
- When you use servo amplifiers after a long-term storage (3 years or longer), contact us. The capacitance of electrolytic capacitors can decrease through long-term storage, which may cause malfunctions.
- When you use servo motors after a long-term storage (3 years or longer), contact us. Checking on bearings and brakes will be needed.

Transportation

- Follow the instructions written on the package box and avoid excessively stacking boxes. Failure to do so may cause injury.
- Use the included eyebolts for transporting servo motors. Do not use them for transporting machines in which servo motors are used. Failure to follow this may cause injury or product failures.

Wiring

- Install an external emergency stop circuit that can stop machinery and cut off power instantly. Also, prepare an external protective circuit to the amplifier to cut off the main circuit power in the event of an alarm. Failure to follow this may cause injury, fire, motor runaway, motor burnout, or secondary damage.

Control and Operations

- Protection devices are not supplied with servo motors. Prepare an over-voltage protection device, earth leakage breaker, overheat protection device, and emergency stop device to ensure safe operation. Failure to follow this may cause injury or fire.
- Use products within the specified temperature and humidity ranges. For servo amplifiers... Temperature: 0 to 55°C; humidity: 90% RH or less (non-condensing) For servo motors... Temperature: 0 to 40°C; humidity: 90% RH or less (non-condensing) Failure to follow this may cause burnout or malfunction.

Disposal

- Dispose of servo amplifiers and servo motors as industrial waste.

Harmonic Suppression Measures Guidelines

Harmonic current generated by equipment such as servo amplifiers can potentially have adversely impact on other power consumers, if it flows out. For that reason, the "How to Calculate Harmonic Current of Servo Amplifiers for Specific Users" was stipulated by the Japan Ministry of International Trade and Industry (current Ministry of Economy, Trade and Industry).

Servo amplifiers used by specific power consumers fall in the category of "harmonic wave generating devices" that are subject to these guidelines. Those power consumers who are subject to these guidelines must determine whether or not any measures for harmonics suppression are required and if so, the measures must be implemented to ensure that the harmonic current emissions are within the limit values stipulated by the contract demand. Implementation of harmonic suppression measures are recommended to prevent impediments arising from harmonics, even for users not subject to the guidelines.

Refer to the document described below for calculation method of harmonic currents.

- "How to Calculate Harmonic Current of Servo Amplifiers for Specific Power Consumers" (JEM-TR225), Japan Electrical Manufacturers' Association

Determine whether or not any harmonics suppression measures are required on the converter (AC-DC converter) side if the servo amplifier has a DC input power supply of DC type.

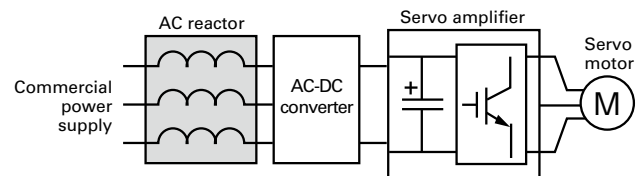


Table 1

Power supply	Circuit classification	Circuit type	Conversion factor Ki	
3-Phase	3	3-Phase bridge (Condenser smooth)	3-1 6-pulse converter without reactor	K31 = 3.4
			3-2 6-pulse converter with reactor (AC side)	K32 = 1.8
Single-phase	4	Single-phase bridge (Condenser smooth, full-wave rectification)	4-3 Without reactor	K43 = 2.9
			4-4 With reactor (AC side)	K44 = 1.3

References
<ul style="list-style-type: none"> "Guidelines of Harmonics Reduction for Consumers of High or Ultra-High Voltage Power" (September 1994) Japan Ministry of International Trade and Industry (current Japan Ministry of Economy, Trade and Industry) "Technical Guidelines for Suppressing Harmonics" (JEAG 9702-2018), The Japan Electric Association "Measures for Suppressing Servo Amplifier and General-purpose Inverter Harmonics" (April 2022), Japan Electrical Manufacturers' Association "How to Calculate Harmonic Current of Servo Amplifiers for Specific Power Consumers" (JEM-TR225), Japan Electrical Manufacturers' Association "Guidelines for Suppressing Servo Amplifier (input current of 20 A or less) Harmonics" (JEM-TR227), Japan Electrical Manufacturers' Association



■ ECO PRODUCTS

ECO PRODUCTS are designed to reduce the environmental impacts throughout the product's life cycle. Ranging from design to manufacturing stages, the environmental impact of a product and its packaging materials is assessed against the eco-design requirements. Those products that satisfy the requirements are accredited as ECO PRODUCTS.

Notes before Purchase

The products in this catalog are designed to be used with general industrial devices.

Always follow the following precautions.

- Read the accompanying Instruction Manual carefully prior to using the product.
- If applying to medical devices and other equipment affecting people's lives, please contact us beforehand and take appropriate safety measures.
- If applying to equipment that can have significant effects on society and the general public, please contact us beforehand.

· Do not use this product in an environment where vibration is present, such as in a moving vehicle or shipping vessel.

· Do not perform any retrofitting, re-engineering, or modification to this equipment.

· The products presented in this catalog are meant to be used for general industrial applications. If using for special applications related to aviation and space, nuclear power, electric power, submarine repeaters, and the like, please contact us beforehand.