SANM**O**TION

SERVO SYSTEMS

R
ADVANCED MODEL

48 VDC   20 W-200 W

Ver.**2**

SANYO DENKI

SANM○TION R
SERVO SYSTEMS

ADVANCED MODEL

Input voltage 48 VDC

Servo amplifier
Pulse input Single-axis   EtherCAT Single-axis   EtherCAT Multi-axis

Amp. capacity   40 A

Servo motor

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

Rated output   20 W to 200 W

Contents

SANMOTION R
SERVO SYSTEMS

ADVANCED MODEL

This low voltage, compact servo system achieves the same high performance as an AC input servo amplifier.

In addition to our pulse input type, our lineup also includes servo amplifiers equipped with high-speed fieldbus EtherCAT interface and an ultracompact servo motor with a 20 mm flange size.

Lineup

Servo Motor		Servo Amplifier		
Rated Output [W]	Flange size	Pulse input Single-axis	EtherCAT Single-axis	EtherCAT Multi-axis
20 to 30	**20mm** sq. This high output, compact motor features 17% improved peak torque and 8.5% reduced mass compared with our conventional product.*1	This product has been downsized by about 30% in volume and 31% in mass from our AC input servo amplifier.*2	This model is equipped with high-speed fieldbus EtherCAT interface. The high-speed communication cycle of 0.125 ms allows smooth device operation.	This 4-axis integrated model is compact and space-saving. Regenerative power can be used to drive other motors, contributing to making devices energy-efficient.
30 to 80	**40mm** sq.			
100 to 200	**60mm** sq.		EtherCAT Conformance tested	EtherCAT Conformance tested
		Applicable motor capacity: 20 W to 200 W	Applicable motor capacity: 20 W to 200 W	Applicable motor capacity: 120 W in total for 4 axes or up to 300 W

Compact and lightweight

In our pursuit of making compact and lightweight products, we have reduced the volume of the pulse input type by about 30% and in mass by about 31%, while still maintaining the same high performance as an AC input servo amplifier.*2

Servo motors with 20 mm sq. flanges are also available, allowing for mounting within chip mounters or other equipment with limited installation space.

*1: Servo motor P series Model no. P50B02002DXS00
*2: AC servo amplifier "SANMOTION R" Model no. RS2A01A

Low voltage specification

The main circuit power supply is 48 VDC, a highly safe, low voltage specificiation with low risk of electrical shock. This product can be used in equipment in conformity with the EU Low Voltage Directive.

It is ideal for low voltage applications such as semiconductor manufacturing equipment, small robots, chip mounters, option axes of machine tools, and conveying machines.
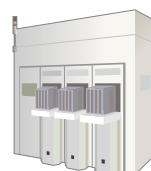
Semiconductor equipment   Chip mounter
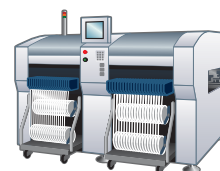
With High-Speed Fieldbus EtherCAT Interface

With a 100 Mbps high-speed fieldbus system, EtherCAT contributes to shortening takt times.
In addition, with the high-speed EtherCAT 0.125 ms communication cycle, positioning commands can be subdivided for smooth device operation.

Additional functions of EtherCAT single-axis and multi-axis types

- The models include the EtherCAT high-precision command synchronization function, and a position feedback synchronization function with independent communication via a dedicated line. These functions contribute to enhanced controllability of gantry systems.

- In addition to the trapezoidal trajectory profile generated during positioning, the new models also include a jerk profile function*, for modifying acceleration/deceleration speed. This function helps reduce vibration during acceleration, deceleration, and settling.

  * A function that generates an S-shaped movement profile by modifying acceleration/deceleration speed

- Equipped with a Safe Torque Off function.
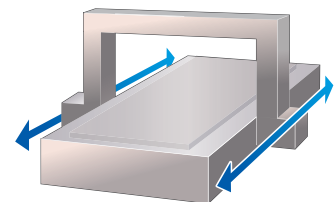
Gantry system

Easy startup and servo tuning

"SANMOTION MOTOR SETUP SOFTWARE" displays the parameters required for operation in an easy-to-understand manner in order to enable fast and easy equipment startup.
This model has a jog function for testing the servo motor and amplifier connection, without the need to connect to a host device.
By connecting with the setup software this model offers a variety of servo tuning support functions depending on mechanical and load conditions. This dramatically shortens time required for servo tuning.
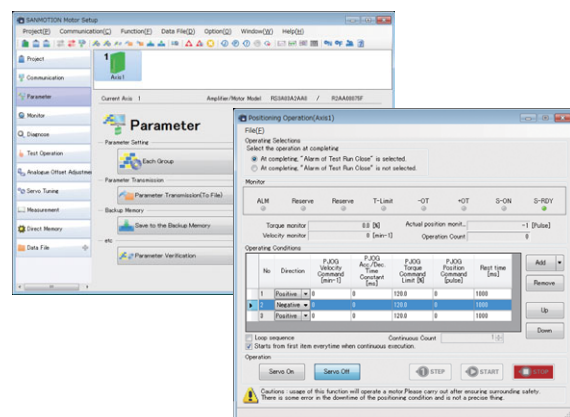
Auto-tuning

The servo amplifier automatically optimizes servo gain and filter frequency in real time.

Velocity command value

Tuning start

Detected velocity value
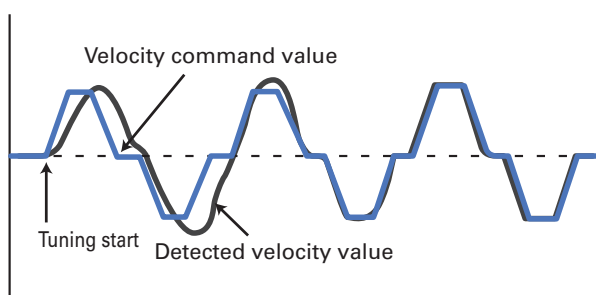
Feed-forward vibration suppression control

With feed-forward vibration suppression control, vibrations at the end effector and base of a machine can be suppressed through simple tuning procedures. Vibration control frequencies are selectable.

With vibration suppression control   Without vibration suppression control

Features

Setup software

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Low cogging torque

Cogging torque has been reduced in 40 mm sq. to 60 mm sq. servo motors compared to our conventional products, achieving smoother movement at low speeds.

Comparison of cogging torque waveform

Current model

R Motor

(Representative example)
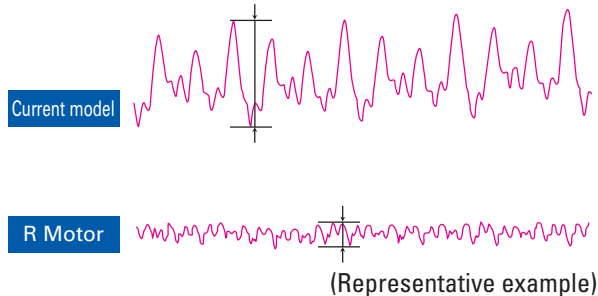
Waterproof and dustproof

Our 40 mm sq. to 60 mm sq. servo motors have IP65-rated high waterproof and dustproof characteristics, allowing them to work in severe environments. Servo motors can be modified to IP67 as an option.
* Excluding shaft feedthrough and cable end.

Water

Dust

High-precision battery-less optical absolute encoder

The high-precision battery-less optical absolute encoder HA035 comes standard on 40 mm sq. and 60 mm sq. servo motors.
It features a wide -20 to +105°C operating temperature range, and a maximum of 147 m/s^2 (15G)* of environmental vibration.
The encoder can be used in severe environments.
* When the encoder is mounted on a servo motor, the operating temperature and the environmental vibration vary depending on the servo motor specification.

As an optional specification, high-precision specifications with a maximum resolution of 1048576 (20 bits) during single rotation and an absolute angle accuracy of approximately 0.0167 deg within a rotation (1 min.) can be selected.

In addition, selecting an encoder that is optimal to the device is also available as an option. Refer to the following table.

Serial encoder

| Encoder type	Applicable servo motor	Resolution during single rotation	Total number of rotations during multiple rotations	Encoder model no.	Optional specifications
Single-turn absolute encoder This is a magnetic detection type single-turn encoder. Its outstanding ruggedness makes it highly resistant against moisture, oil, and dust.	20 mm sq.	8192 (13 bits)	–	MA018	- Resolution during single rotation: 32768 (15 bits)
Battery-less optical absolute encoder This is a high-precision battery-less optical multi-turn encoder. It does not use batteries, which need to be replaced; therefore, the encoder does not require maintenance. This encoder can be broadly used for general industrial equipment including machine tools and robots.	40 mm sq. 60 mm sq.	131072 (17 bits)	65536 (16 bits)	HA035	- Resolution during single rotation: 1048576 (20 bits) - Absolute angular accuracy within one rotation: Approx. 0.0167 deg (one minute) or lower (standard is approx. 0.1667 deg (ten minutes) or lower.) - Baud rate: 4.0 Mbps (standard is 2.5 Mbps)
Optical absolute encoder for incremental systems This is a slim and single-turn optical encoder. Enables wire-saving and size-reduction for applications that use pulse encoders.	40 mm sq. 60 mm sq.	131072 (17 bits)	–	PA035S	- Resolution during single rotation: 1048576 (20 bits) -Baud rate: 4.0 Mbps (standard is 2.5 Mbps)
Option **Resolver method battery-less absolute encoder** This is a resolver method battery-less multi-turn encoder. Being a resolver method encoder with outstanding ruggedness, it is ideal for equipment used in harsh environments such as injection molding machines and robots.	40 mm sq. 60 mm sq.	131072 (17 bits)	65536 (16 bits)	RA035C	-Baud rate: 4.0 Mbps (standard is 2.5 Mbps)

Setup Software (Option)

This software allows you to set servo system parameters from a PC.
It also allows you to easily start up or test run the servo system.
The software can be downloaded from Product Information on our website.
URL : http://www.sanyodenki.com

Start-up screen
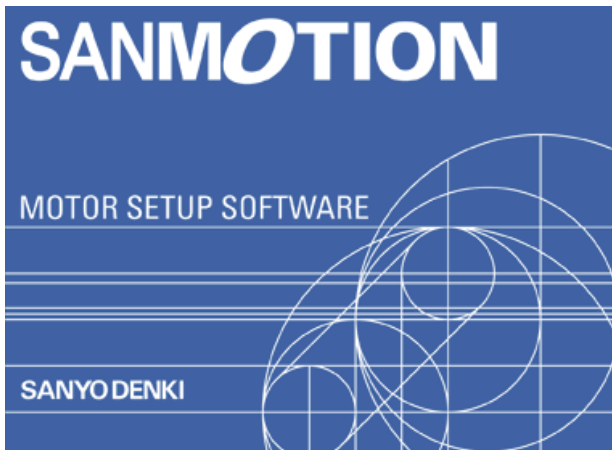
Main screen
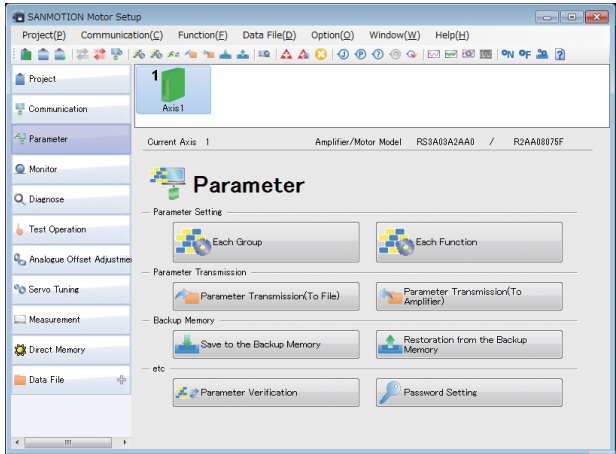
■ Setup software title:

SANMOTION MOTOR SETUP SOFTWARE

■ Main Functions

Parameter settings (settings by group, settings by function)

Diagnosis (alarm display, warning display, alarm cancellation)

Test run execution (speed JOG, position JOG, motor starting point search, serial encoder clearance)

Servo tuning (notch filter tuning, FF vibration control frequency tuning)

Various measurement functions (operating waveform display, machinery frequency response measurement)

■ Supported OS

Windows XP (SP3 or higher) / Vista / 7 / 8

* See our website for details on supported versions.

Setting of each group Parameter
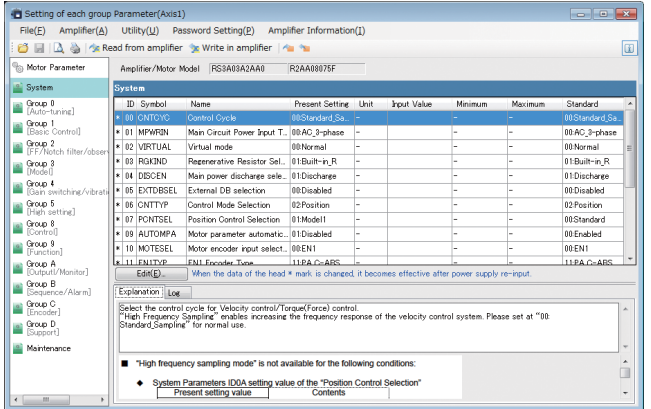
Parameters can be set, saved, and read from a PC.

Features

Setup software

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Setup Software (Option)

Diagnosis screen
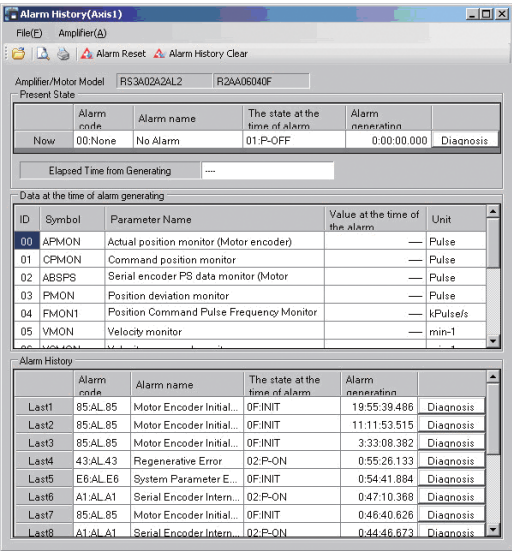
The current and previous 7 alarm occurrences can be checked.

Test run
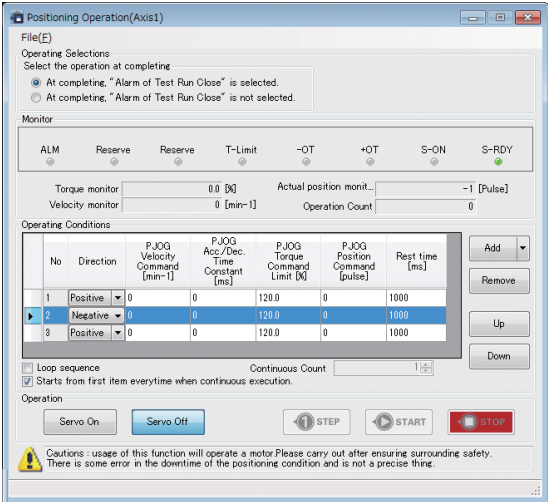
Simple test run of servo motor by issuing velocity commands and position commands from a PC. (Position JOG in operation shown in screen)

Measurement
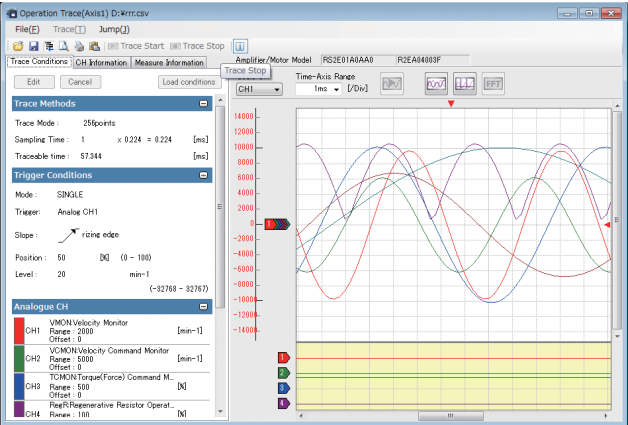
Operation Trace
Graphically displays servo motor's speed, torque and internal status.
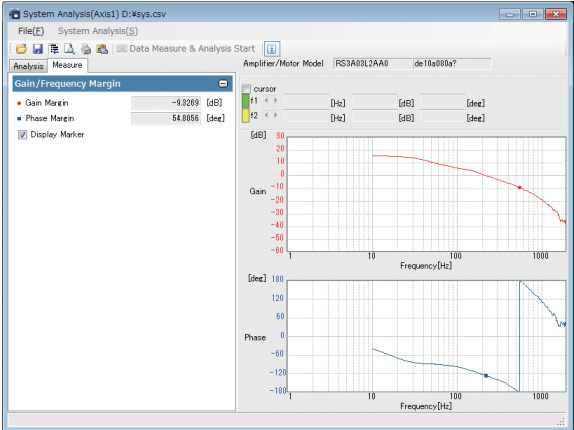
System Analysis
Analyzes servo system frequency characteristics.

List of Combinations of Servo Amplifiers and Servo Motors

Servo motor standard specifications···Output shaft: straight, oil seal: none, connecting method: cable

Servo motor			Page		Servo amplifier model name			
Rated output [W]	Flange size	Model name	Specifications	Exterior drawing	Pulse input Single-axis	EtherCAT Single-axis	EtherCAT Multi-axis (Up to 4 axes)	
20	20mm sq.	R2GA02D20F	p. 22	p. 24	RF2G21A0A00	RS2K04A2HL5／RS2K04A2HA5	RF2J24A0HL5 (Up to 120W in total)	RF2K24A0HL5 (Up to 300W in total)
30	20mm sq.	R2GA02D30F	p. 22	p. 24				
30	40mm sq.	R2GA04003F	p. 22	p. 24				
50	40mm sq.	R2GA04005F	p. 23	p. 24				
80	40mm sq.	R2GA04008D	p. 23	p. 24			-	
100	60mm sq.	R2GA06010D	p. 23	p. 24				
200	60mm sq.	R2GA06020D	p. 23	p. 24				

Option

Servo amplifier type	Pulse input Single-axis		EtherCAT Single-axis		EtherCAT Multi-axis	
Regenerative unit	RF1BB00	→ p. 25	-		-	
Power input connector for regenerative unit	AL-00329461-01	→ p. 25	-		-	
Cable with connector for regenerative unit	AL-00753589-01	→ p. 25	-		-	
PC cable	AL-00490833-01	→ p. 26	AL-00689703-01	→ p. 28	AL-00689703-01	→ p. 29
Power cable	AL-00745943-01	→ p. 26	-		AL-00921367-01	→ p. 29
Regenerative resistor cable	-		-		AL-00921368-01	→ p. 29
Motor power cable	AL-00745944-01	→ p. 26	-		AL-00921369-01 AL-00921369-02 AL-00921369-03	→ p. 29
I/O cable set	AL-00745949-01	→ p. 26	-		-	
Serial encoder cable	AL-00745946-01	→ p. 27	AL-00921370-01 AL-00921370-02 AL-00921370-03	→ p. 28	AL-00921370-01 AL-00921370-02 AL-00921370-03	→ p. 29
Analog monitor box	Q-MON-5	→ p. 27	Q-MON-3	→ p. 28	-	
Side mounting bracket	-		-		AL-00921371-01	→ p. 29
External regenerative resistor	REGIST-080W50B, REGIST-120W50B					→ p. 30
	REGIST-220W50B			→ p. 30	REGIST-220W20B	→ p. 30

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How to Read Model Numbers

Not all combinations shown below are valid. Option specifications are also provided.
For available models of standard products, refer to "Standard Model Number List".

■ Servo Amplifier

Pulse input Single-axis
RF2 G 21 A 0 A 00

EtherCAT Single-axis	EtherCAT Multi-axis
RS2 K 04 A 2 H A 5	

RF2 G 21 A 0 A 00

Specification Identification
00...Standard

Interface Type
A...Pulse train,
NPN (sink) output

Motor Encoder Type
0...Serial encoder

Servo Motor Type
A...Rotary motor

Servo Amplifier Capacity
21...40 A

Input Voltage
G...48 VDC
(Contact us for the request of 24 VDC specification.)

R ADVANCED MODEL Series
RF2

RS2 K 04 A 2 H A 5

Option 2
5...With Safe Torque Off function
(With delay circuit)
* If you do not use the Safe Torque
Off function, mount the mask
connector provided.

Option 1
Single-axis: A...Equipped with internal
regenerative resistor/With DB,
L...Not equipped with internal
regenerative resistor/With DB
Multi-axis: L...Not equipped with internal
regenerative resistor/Without DB

Interface Type
H...EtherCAT interface (high speed
communication)

Motor Encoder Type
Single-axis: 2...Serial encoder
Multi-axis : 0...Serial encoder

Servo Motor Type
A...Rotary motor

Servo Amplifier Capacity
Single-axis : 04...40 A
Multi-axis : 24...40 A/axis, 4-axis specification

Input Voltage
Single-axis: K...48 VDC
Multi-axis: J...48 VDC (fanless), K...48 VDC (with fan)
(Contact us for 24 VDC specifications)

R ADVANCED MODEL Series
Single-axis: RS2
Multi-axis: RF2

■ Servo Motor

R 2 GA 04 003 F X R 03 M

Additional Specification Identification
M...Conforms to CE and UL

Specification Identification
03...Protection code IP65
00...Protection code IP67

Encoder Type
Serial Encoder
R...Battery-less optical absolute encoder (HA035)
H...Optical absolute encoder for incremental systems (PA035S)
C...Single-turn absolute encoder (MA018)

Holding Brake
X...No brake
B...90 VDC brake
C...24 VDC brake

Maximum Rotation Speed
For the numeric values, see the specifications on p. 22-23.

Rated Output
D20...20 W
003/D30...30 W
005...50 W
008...80 W
010...100 W
020...200 W

Flange Size
02...20 mm sq.
04...40 mm sq.
06...60 mm sq.

Power Supply Voltage
GA...48 VDC

Servo Motor Type
2...Medium inertia

R Series

Standard Model Number List For specifications on other models, contact us for details.

Servo Amplifier

Type	No. of control axes	Main circuit power supply	Control power	Encoder type	General output	Internal regenerative resistor	Safe torque off function	Amplifier capacity	Model no.	Page	
										Specifications	Dimensions
Pulse input type	1	48 VDC	5 VDC	Serial encoder	Sink	No	No	40 A	RF2G21A0A00	p. 12, 18	p. 20
EtherCAT interface type	1	48 VDC	24 VDC	Serial encoder	Photo relay	No	Yes (With delay circuit)	40 A	RS2K04A2HL5	p. 14, 18	p. 20
						Yes		40 A	RS2K04A2HA5	p. 14, 18	p. 20
	4	48 VDC	24 VDC	Serial encoder	Photo relay	No	Yes (With delay circuit)	40 A	RF2J24A0HL5	p. 16, 18	p. 20
								40 A	RF2K24A0HL5	p. 16, 18	p. 20

* Our standard servo amplifier achieves the KC Mark of safety and conforms to the international UL, c-UL, EN standards.
Contact us for the request of main circuit power supply 24 VDC.

R2 Servo Motor   Small Size, Small Capacity, Medium Inertia

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

Rated output	Motor flange size	Protection code	Holding brake	CE and UL approved	Model no. Single-turn absolute encoder (MA018)	Page	
						Specifications	Dimensions
20 W	20 mm sq.	IP40	No	-	R2GA02D20FXC00	p. 22	p. 24
30 W					R2GA02D30FXC00	p. 22	p. 24

R2 Servo Motor   Small Capacity, Medium Inertia

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

Rated output	Motor flange size	Protection code	Holding brake	CE and UL approved	Model no. Battery-less optical absolute encoder (HA035)	Optical absolute encoder for incremental systems PA035S	Page	
							Specifications	Dimensions
30 W	40 mm sq.	IP65	No	-	R2GA04003FXR03	R2GA04003FXH03	p. 22	p. 24
				Yes	R2GA04003FXR03M	R2GA04003FXH03M	p. 22	p. 24
			Yes (24 VDC)	-	R2GA04003FCR03	R2GA04003FCH03	p. 22	p. 24
				Yes	R2GA04003FCR03M	R2GA04003FCH03M	p. 22	p. 24
50 W	40 mm sq.	IP65	No	-	R2GA04005FXR03	R2GA04005FXH03	p. 23	p. 24
				Yes	R2GA04005FXR03M	R2GA04005FXH03M	p. 23	p. 24
			Yes (24 VDC)	-	R2GA04005FCR03	R2GA04005FCH03	p. 23	p. 24
				Yes	R2GA04005FCR03M	R2GA04005FCH03M	p. 23	p. 24
80 W	40 mm sq.	IP65	No	-	R2GA04008DXR03	R2GA04008DXH03	p. 23	p. 24
				Yes	R2GA04008DXR03M	R2GA04008DXH03M	p. 23	p. 24
			Yes (24 VDC)	-	R2GA04008DCR03	R2GA04008DCH03	p. 23	p. 24
				Yes	R2GA04008DCR03M	R2GA04008DCH03M	p. 23	p. 24
100 W	60 mm sq.	IP65	No	-	R2GA06010DXR03	R2GA06010DXH03	p. 23	p. 24
				Yes	R2GA06010DXR03M	R2GA06010DXH03M	p. 23	p. 24
			Yes (24 VDC)	-	R2GA06010DCR03	R2GA06010DCH03	p. 23	p. 24
				Yes	R2GA06010DCR03M	R2GA06010DCH03M	p. 23	p. 24
200 W	60 mm sq.	IP65	No	-	R2GA06020DXR03	R2GA06020DXH03	p. 23	p. 24
				Yes	R2GA06020DXR03M	R2GA06020DXH03M	p. 23	p. 24
			Yes (24 VDC)	-	R2GA06020DCR03	R2GA06020DCH03	p. 23	p. 24
				Yes	R2GA06020DCR03M	R2GA06020DCH03M	p. 23	p. 24

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Encoder Wiring Diagram
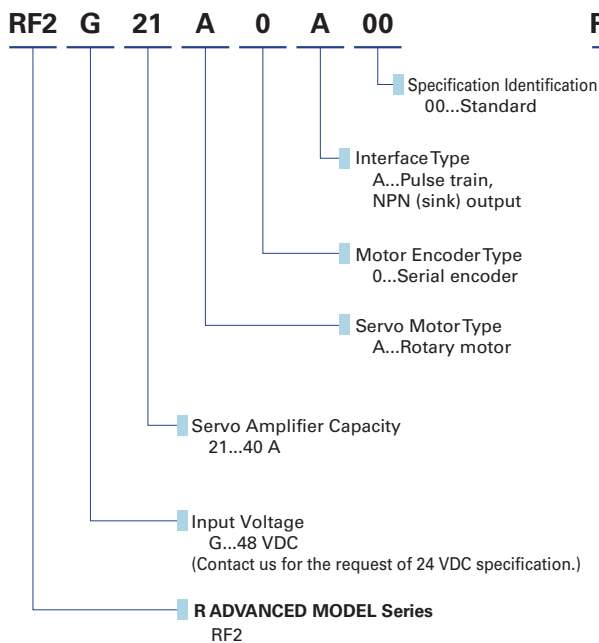
Servo Motor Specifications

Options

Selection Guide

Servo amplifier

Host devices

Control Power 5 VDC

Main circuit power supply 48 VDC

Option
Power cable
Model No.: AL-00745943-01
→p. 26

Option
I/O cable set
Model No.: AL-00745949-01
→p. 26

Option
Serial encoder cable
Model No.:
AL-00745946-01
→p. 27

Option
Alarm output cable with connector
Model No.: AL-00753589-01
→p. 25

Option
Power input connector
Model No.:
AL-00329461-01
→p. 25

Option
External regenerative resistor
Use when regenerative power cannot be absorbed by the internal regenerative resistor of the regenerative unit.
→p. 30

Option
Regenerative unit
Depending on the drive motor and operating conditions, regenerative power may occur when the motor is stopped. Install this regenerative unit if the DC voltage increases.
Model No.: RF1BB00
→p. 25

Option
Motor power cable
Model No.:
AL-00745944-01
→p. 26

Option
PC cable
Model No.: AL-00490833-01
→p. 26

Option
Setup software
Parameter setting and monitoring are possible via communication with a PC.
→p. 7

Brake power

Power input

Use when the servo motor is equipped with the brake.
Use stabilized DC power supply or power supply with a full-wave rectifier.
(To be arranged by the customer)

Option
Analog monitor box
Model No.: Q-MON-5
→p. 27

Power supply for monitor

Servo motor

External Wiring Diagram

User unit

Main circuit power supply 48 VDC
Control power 5 VDC

CNA — Servo amplifier
4 48 V
5 48G
2 5V
3 5G
1 FG

CNB
1 *3) Red — U
2 White — V
3 Black — W
4 Green (Green/Yellow)

Servo motor
Orange (Yellow) RY1
Orange (Yellow) 90 V (24 V)
Holding brake (Install only devices with brakes)

CN2 — SH *4) SH — Encoder

Line driver Equivalent to HD26C31

CN1A *1)
Clockwise pulse
11 F-PC
12 F-PC
10 SG
+5 V +5 V
Line receiver Equivalent to HD26C32

Position command pulse input

Counterclockwise pulse
13 R-PC
14 R-PC
2 FG
*5)

Line driver Equivalent to HD26C31

CN1A
AO 1
AO 3
BO 4
BO 5
ZO 6
ZO 7
PS 8
PS 9

Encoder divided signal output

*1 Use a twisted pair shielded cable.
*2 The analog monitor box is sold seperately from the servo amplifier. The connector is on the bottom of the amplifier.
*3 Motor connection differs by the motor specifications. The indications of red, white, black, green and orange apply when the motor power and brake lines are the lead type.
*4 Refer to the encoder connection figure for the wiring of the connector for the encoder connection.
*5 Connect the SG (signal ground) between the servo amplifier and the device.
*6 When using a battery for the main circuit power supply, always install an electrolytic capacitor (2000 μF or more).

Analog monitor box *2)

CN1B
1 CONT-COM
5 V to 24 VDC
3 CONT1
4 CONT2
5 CONT3
6 CONT4
7 CONT5
8 CONT6
9 CONT7
10 CONT8
2 FG

General input

CN1B
OUT-PWR 11   5 VDC, 12 VDC to 24 V
OUT1 12
OUT2 13
OUT3 14   General output
OUT4 15
OUT5 16
OUT6 17
OUT7 18
OUT8 20
19
OUT-COM

Shield processing

The external power supply is to be arranged by the customer.

Connector No.	Name	Housing, Plug, Shell		Manufacturer
		Housing	Contact	
CNA	Main power supply, Control power input connector	VHR-5N	SVH-41T-P1.1	J.S.T. Mfg. Co.,Ltd.
CNB	Servo motor power line connector	VHR-4N	SVH-41T-P1.1	
CN1A	Connector for host device line receiver and driver signals	PADP-14V-1-S	SPH-002GW-P0.5S	
CN1B	Connector for host device general-purpose I/O signals	PADP-20V-1-S	SPH-002GW-P0.5S	
CN2	Connector for encoder signal	PADP-10V-1-S	SPH-002GW-P0.5S	

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System Configuration

Servo amplifier

Control power 24 VDC

Main circuit power supply 48 VDC

(Contact us for the request of main circuit power supply 24 VDC.)

Option
Analog monitor box
Model No.: Q-MON-3
→p. 28

Option
Setup software

Parameter setting and monitoring are possible via communication with a PC.
→p. 7

Option
PC cable
Model No.: AL-00689703-01
→p. 28, 29

General I/O connector to connect homing, probing and general signals.

External regenerative resistor

For normal operations, the internal regenerative resistor in the servo amplifier can be used, but for special operations, such as high cycle applications that require greater power dissipation than that provided by the servo amplifier's internal regenerative resistor, use an external regenerative resistor.
→p. 30

To the next amplifier

Host devices

Option
Serial encoder cable
Model No.: AL-00921370-01
→p. 28, 29

Motor power line

Brake power

Use when the servo motor is equipped with the brake. Use stabilized DC power supply or power supply with a full-wave rectifier. (To be arranged by the customer)

Safety unit, safety PLC, etc.

The I/O signals of the Safe Torque Off function are connected to safety devices such as the safety unit and safety PLC.

Servo motor

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External Wiring Diagram

Safe Torque Off function

Connector No.	Name	Housing, Plug, Shell
CNA 25A,40A	Main power supply, Control power input connector	MSTBT2.5/6-STF-5.08L
CNB 25A,40A	Servo motor power line connector	MSTBT2.5/3-STF-5.08
EN1/EN2	Connector for encoder signal	Connector: 36210-0100PL Shell kit: 36310-3200-008
CN2	Connector for general-purpose I/O signals for battery supply	Connector: HDR-E26MSG1+ Shell kit: HDR-E26LPH
CN1	Safe Torque Off function connector	2013595-3

*1   ⊟ Use a twisted pair shielded cable.

*2   Connect a regenerative resistor between the RB1-RB2 terminals.
     When using an external regenerative resistor, remove the wiring of the internal regenerative resistor connected between the RB1 and RB2 terminals and then connect the external regenerative resistor between the RB1 and RB2 terminals.

*3   · When the wiring from the DC power supply to the servo amplifier is long, install an electrolytic capacitor on the amplifier side between P-N and CP-CN if necessary.
     · When using a battery for the DC power supply between P-N and CP-CN, always install an electrolytic capacitor (2000 μF or more).
     · Contact us for the request of main circuit power supply 24 VDC.

*4   Motor connection differs by the motor specifications.
     The indications of red, white, black, green and orange apply when the motor power and brake lines are the lead type.

*5   Refer to the encoder connection figure for the wiring of the connector for the encoder connection.

*6   Turn the power off as a way to shut off the main circuit power for the protection of the servo amplifier during emergency stops.

*7   Use a shielded twisted pair cable (STP) with Category 5e (TIA standards) or higher.

*8   Do not connect anything to CN1 pin 1 and 2.

*9   An earth leakage circuit breaker conforming to UL and either IEC or EN standards is recommended.

*10 The external power supply is to be arranged by the customer.

*11 CN1 is a connector for the Safe Torque Off function. Connect the connector to the safety function to make the Safe Torque Off function active. Otherwise, the servo can not be turned on (no power to the motor).

*12 Do not connect anything to CN2-20 to 25.

*13 When using a pulse encoder in a semi-closed system, connect it to EN2.

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Control power
24 VDC

Main circuit power supply
48 VDC

(Contact us for the
request of main circuit
power supply 24 VDC.)

For side mounting the servo
amplifier.
Option
Side mounting bracket
Model No.: AL-00921371-01
→p. 29

Servo amplifier

Option
Power cable
Model No.: AL-00921367-01
→p. 29

External regenerative resistor
The servo amplifier contains an
internal regenerative process
circuit. If DC voltage
increases due to the
regenerative power
occuring when the motor
is stopped, connect a
regenerative resistor.
→p. 30

Option
**Regenerative resistor
connection cable**
Model No.: AL-00921368-01
→p. 29

General I/O connector
Connect homing,
probing, and general
signals.

Option
Setup software
Parameter setting and monitoring are
possible via communication with a PC.
→p. 7

Option
PC cable
Model No.: AL-00689703-01
→p. 28, 29

Safety unit,
safety PLC, etc.
The I/O signals of the Safe Torque Off
function are connected to safety
devices such as the safety unit and
safety PLC.

SANMOTION
AC SERVO SYSTEMS
R

CHARGE • POW •
EtherCAT

ST4
AL4
ST3
AL3
ST2
AL2
ST1
AL1

CN2

RF2K24A0HL5

I/O

EN4
EN3
EN2
EN1

ADDR HI LOW

PC

CN1

L/A OUT
RUN
L/A IN
ERR

CN3

MOT4
MOT3
MOT2
MOT1

SANYO DENKI

To 4-axis servo motor

To 3-axis servo motor

To 2-axis servo motor

To the next amplifier

Host devices

To 4-axis servo motor

To 3-axis servo motor

To 2-axis servo motor

Option
Motor power cable
Model No.: AL-00921369-0☐
→p. 29

Option
Serial encoder cable
Model No.: AL-00921370-01
→p. 28, 29

Brake power
Use when the servo motor is
equipped with the brake.
Use stabilized DC power
supply or power supply with
a full-wave rectifier.
(To be arranged by the
customer)

1-axis servo motor

2-axis servo motor

3-axis servo motor

4-axis servo motor

Servo motor

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Connector No.	Name	Housing, Plug, Shell
CNA	Main power supply, Control power input connector	Connector: 5557-08R Terminal: 5556PBT3
CNC	Regenerative resistor connector	Connector: 5557-02R Terminal: 5556PBT3
MOT1 to 4	Servo motor power line connector	Connector: 5557-04R Terminal: 5556PBT3
EN1 to 4	Connector for encoder signal	Connector: 36210-0100PL Shell kit: 36310-3200-008
I/O	Connector for general-purpose I/O signals	Connector: 10136-3000PE Shell kit: 10336-52A0-008
CN1	Safe Torque Off function connector	For short-circuiting: 2040978-1 For wiring: 2013595-3

*1   Use a twisted pair shielded cable.

*2   The servo amplifier contains an internal regenerative process circuit. If DC voltage increases due to the regenerative power occuring when the motor is stopped, connect a regenerative resistor.

*3   · When the wiring from the DC power supply to the servo amplifier is long, install an electrolytic capacitor on the amplifier side between P-N and CP-CN if necessary.
  · When using a battery for the DC power supply between P-N and CP-CN, always install an electrolytic capacitor (2000 μF or more).

*4   Motor connection differs by the motor specifications. The indications of red, white, black, green and orange apply when the motor power and brake lines are the lead type.

*5   Refer to the encoder connection figure for the wiring of the connector for the encoder connection.

*6   Turn the power off as a way to shut off the main circuit power for the protection of the servo amplifier during emergency stops.

*7   Use a shielded twisted pair cable (STP) with Category 5e (TIA standards) or higher.

*8   An earth leakage circuit breaker conforming to UL and either IEC or EN standards is recommended.

*9   The external power supply is to be arranged by the customer.

*10   CN1 is a connector for the Safe Torque Off function. Connect the connector to the safety function to make the Safe Torque Off function active. Otherwise, the servo will not be turned on (no power to the motor).

*11   Do not connect anything to I/O-9, 10, 27 and 28.

*12   Contact us for main circuit power supply 24 VDC.

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Servo Amplifier Common Specifications `Pulse input Single-axis` `EtherCAT Single-axis` `EtherCAT Multi-axis`

Pulse input Single-axis

Control function	Position control
Control system	POWER-MOS-FET : PWM control sinusoidal drive
Main Circuit Power Supply	48 VDC±10%[*1]
Control power	5 VDC±5%[*2]
Environment — Ambient temperature	0 to 40℃ [*3]
Environment — Storage temperature	−20 to +65℃
Environment — Operation/Storage humidity	Below 90%RH (no condensation)
Environment — Elevation	1000 m or lower
Environment — Vibration	4.9 m/s^2 freq. range 10 to 55 Hz in X, Y, and Z direction each, within 2 hours
Environment — Shock	19.6 m/s^2
Structure	External tray type DC power supply
Mass	0.25 kg
Frequency characteristics	1200 Hz (In high frequency sampling mode)
Speed control range	1:5000 (Internal speed command)
Protection functions	Over current, Current detector error, Overload, Main circuit overvoltage, Main circuit power low voltage, Control circuit undervoltage, Encoder error, Over speed, Speed control error, Speed feedback error, CPU error, Memory error, Parameter error, Unreasonable position deviation, Position command pulse error, Amplifier overheating, External disorder
Display	Alarm display (red), status display (green), control power ON (green)
Dynamic brake	Built-in
Regenerative resistor	Option
Analog monitor	Option

*1: Always use input voltage within the specificiation range for the main circuit power supply.

*2: The control power can be directly used as power source for the encoder. If the wiring to the encoder is long, the voltage may be reduced in the wiring, causing the encoder to not work properly even when the voltage is within the specified range.

*3: Use within the operating ambient temperature range.

EtherCAT Single-axis EtherCAT Multi-axis

Servo amplifier type	EtherCAT Single-axis	EtherCAT Multi-axis
Control function	Position control/Speed control/Torque control (Parameter switching)	
Control system	POWER-MOS-FET : PWM control sinusoidal drive	
Main Circuit Power Supply	48 VDC±10%[*1]	
Control power	24 VDC±10%[*1]	
Environment — Ambient temperature	0 to 55℃	
Environment — Storage temperature	−20 to +65℃	
Environment — Operation/Storage humidity	Below 90%RH (no condensation)	
Environment — Elevation	1000 m or lower	
Environment — Vibration	4.9 m/s^2 freq. range 10 to 55 Hz in X, Y, and Z direction each, within 2 hours	
Environment — Shock	19.6 m/s^2	
Structure	External tray type DC power supply	
Mass	0.5 kg (Without regenerative resistor) 0.55 kg (With regenerative resistor)	RF2J24A0HL5: 0.75 kg RF2K24A0HL5: 0.8 kg
Frequency characteristics	800 Hz	
Speed control range	1:5000	
Protection functions	Over current, Current detection error, Overload, Regeneration error, Overheating, External disorder, Over voltage, Main circuit power low voltage, Encoder error, Over speed, Speed control error, Speed feedback error, Unreasonable position deviation, Position command pulse error, Built-in memory error, Parameter error	
Display	Status display, Monitor display, Alarm display, Parameter setting, Test run, Adjustment mode	Alarm display (red), status display (green), control power establishment (green), main circuit charge (red), communication link (green) × 2, communication RUN (green), communication Error (red)
Dynamic brake	Built-in	No
Regenerative resistor	Built-in	external type (Connect to the CNC connector if a regenerative resistor is required.)
Analog monitor	Option	No

*1: Always use input voltage within the specificiation range for the main circuit power supply.

Servo Amplifier Safety Standards

CE cURus TÜV KC RoHS

Servo amplifier type	Safety standards		
All models	North American safety standards (UL ratings)	UL508C	
	European directive	Low-voltage directive	・EN61800-5-1
		EMC directive	・EN61000-6-2 ・EN61800-3 ・EN61326-3-1 （EtherCAT only）
	KC Mark (Korea Certification Mark)	KN61000-6-2, KN61000-6-4	
Models with safety features	Safety feature standards	EtherCAT Single-axis ・IEC61508, SIL2　・ISO13894-1, Cat3, PL＝d　・IEC62061, SILCL2	
		EtherCAT Multi-axis ・IEC61508, SIL3　・ISO13894-1, Cat3, PL＝e　・IEC62061, SILCL3	

EtherCAT interface specifications

Physical layer	IEC61158-2 IEEE802.3u 100BASE-TX
Data link layer	IEC61158-3, -4 Type12
Application layer	IEC61158-5, -6 Type12
Device profile	IEC61800-7 Profile type1 (CiA402) ・CoE (CANopen over EtherCAT) ・FoE (File access over EtherCAT)
Communication port	RJ45 connector (2 ports)
Bit rate	100 Mbps (Full duplex)
Max. no. of nodes	65535 nodes
Transmission distance/Topology	100 m max. (between nodes)/Daisy-chain
Communication cable	Twisted-pair CAT5e (Straight or cross)
Communication objects	SDO (Service Data Object) PDO (Process Data Object)
Synchronization types	SYNC0, SYNC1 event synchronization mode, asynchronous mode
Operation modes	Profile position mode, profile velocity mode, profile torque mode, homing mode, cycle sync position mode, cycle sync velocity mode, cycle sync torque mode
LED indicators	Port 0/1 link display, RUN display, error display
General purpose I/O	Single-axis EtherCAT: Input × 6 points, output × 2 points (8 points in total) Multi-axis EtherCAT: Input × 8 points (total), output × 2 points/axis (8 points in total)

Servo Amplifier Dimensions [Unit : mm]   Pulse input Single-axis   EtherCAT Single-axis   EtherCAT Multi-axis

Pulse input Single-axis
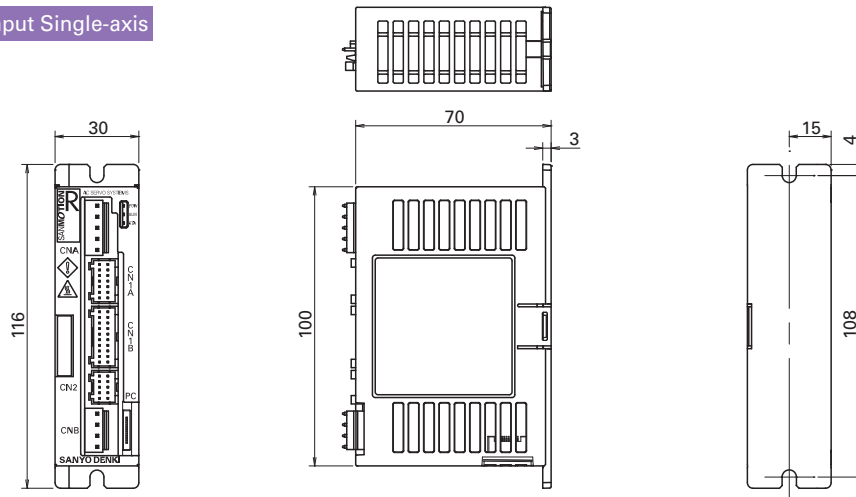
Mass: 0.25 kg

EtherCAT Single-axis
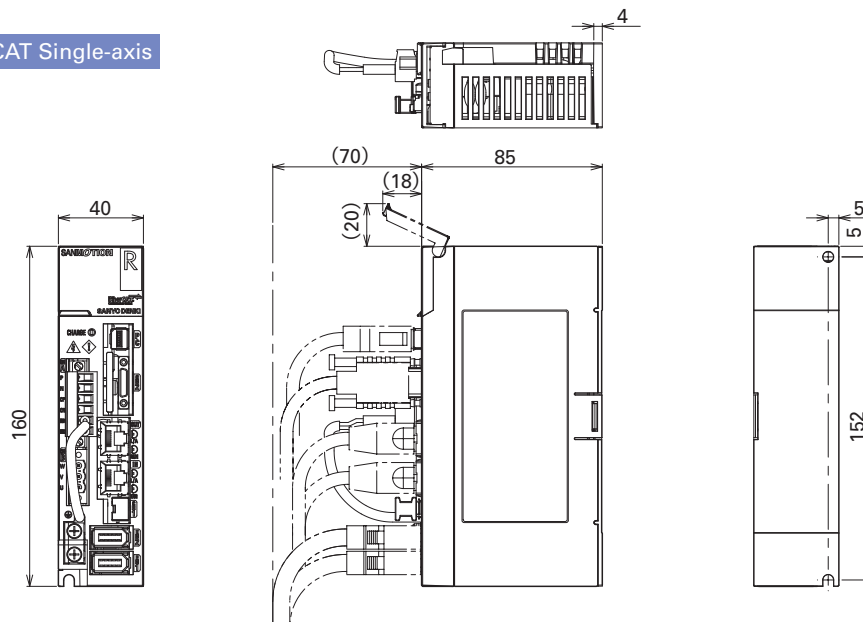
Mass
0.5 kg (Without regenerative resistor)
0.55 kg (With regenerative resistor)

EtherCAT Multi-axis
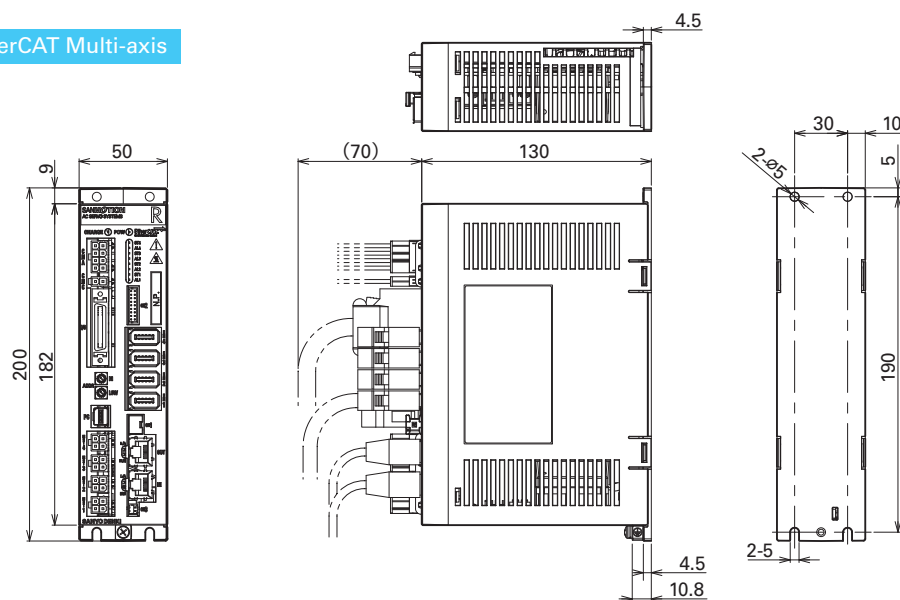
Mass
RF2J24A0HL5: 0.75 kg (Fanless)
RF2J24A0HL5: 0.8 kg (With fan)

Encoder Wiring Diagram

■ Serial Encoder

Single-turn absolute encoder (MA018)
Battery-less optical absolute encoder (HA035)
Optical absolute encoder for incremental systems (PA035S)
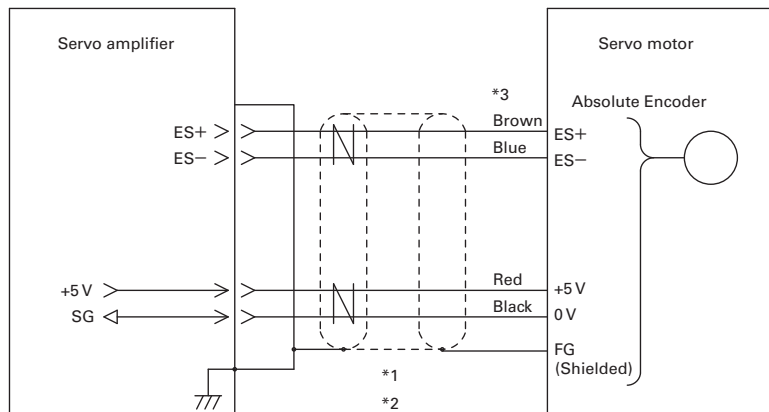
*1 Use a twisted pair shielded cable.
*2 Maximum cable lengths by conductor size of the power supply cable (5 V, SG)

Conductor size		Conductor resistance	Length
AWG	SQ (mm²)	(Ω/km) *20℃	(m)
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

Conductor resistance differs according to conductor specifications.

*3 Indicates the lead wire color.

Servo amplifier connector

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

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General Specifications

Servo Amplifier + R2 Servo motor High efficiency and low ripple (medium inertia) [RoHS]

Servo amplifier model no.	Pulse input Single-axis			RF2G21A0A00 《40A》		
	EtherCAT Single-axis			RS2K04A2HL5/RS2K04A2HA5 《40A》		
	EtherCAT Multi-axis			RF2J24A0HL5 (Up to 120 W in total for 4 axes)/RF2K24A0HL5 (Up to 300 W in total for 4 axes) 《40A》		
Servo motor model no. 《 》 indicates flange size				R2GA02D20F 《20 mm sq.》	R2GA02D30F 《20 mm sq.》	R2GA04003F 《40 mm sq.》
	Status	Symbol	Unit			
Rated output	★	P_R	W	20	30	30
Rated speed	★	N_R	min^{-1}	3000	3000	3000
Maximum speed	★	Nmax	min^{-1}	6000	6000	6000
Rated torque	★	T_R	N·m	0.064	0.095	0.098
Continuous stall torque	★	T_S	N·m	0.064	0.095	0.108
Peak stall torque	★	T_P	N·m	0.23	0.38	0.24
Rated armature current	★	I_R	Arms	1.8	2.6	1.9
Armature stall current	★	I_S	Arms	1.8	2.6	2.0
Peak armature stall current	★	I_P	Arms	6.0	9.6	4.8
Torque constant	☆	K_T	N·m/Arms	0.0458	0.0487	0.0582
Voltage constant for each phase	☆	$K_{E\phi}$	mV/min^{-1}	1.60	1.70	2.03
Phase resistance	☆	R_ϕ	Ω	1.06	0.76	1
Rated power rate	★	Q_R	kW/s	12.4	20	3.9
Electrical time constant	☆	te	ms	0.56	0.55	0.55
Mechanical time constant (not including encoder)	☆	tm	ms	0.50	0.44	2.2
Rotor inertia		J_M	×10^{-4}kg·m^2 (GD^2/4)	0.0033	0.0046	0.0247
Absolute encoder inertia[*1]		J_S	×10^{-4}kg·m^2 (GD^2/4)	0.00021	0.00021	0.0042
Servo motor mass[*1]		We	kg	0.14	0.18	0.37
Brake static friction torque		Tb	N·m	-	-	0.32 min.
Brake rated voltage		Vb	V	-	-	90 VDC/24 VDC ± 10%
Brake rated current		Ib	A	-	-	0.07/0.27
Rotor moment of inertia (brake)		Jb	×10^{-4}kg·m^2 (GD^2/4)	-	-	0.0078
Brake mass		W	kg	-	-	0.23
CE and UL approved servo motors[*4]				No	No	Yes
Servo motor protection code				IP40	IP40	IP65
Size of aluminum plates for heat radiation during measurement				150 × 150 × 6 mm	250 × 250 × 6 mm	250 × 250 × 6 mm
Servo motor dimensions				p. 24		

*1 These values are for 20 mm sq. servo motor with absolute encoder [MA018], and 40 mm sq./60 mm sq. servo motor with battery-less absolute encoder [HA035].
For the servo amplifier mass, refer to p. 20.

*2 Items with ★ and speed - torque characteristics indicate values after temperature rise saturation when used with a standard servo amplifier. The values are the typical values.

*3 ☆ : Indicates a typical value when the winding temperature is 20°C. The values are the typical values.

*4 Our standard servo amplifiers are CE and UL approved.

■ Speed-Torque Characteristics

Servo motor model no.		
R2GA02D20F	R2GA02D30F	R2GA04003F
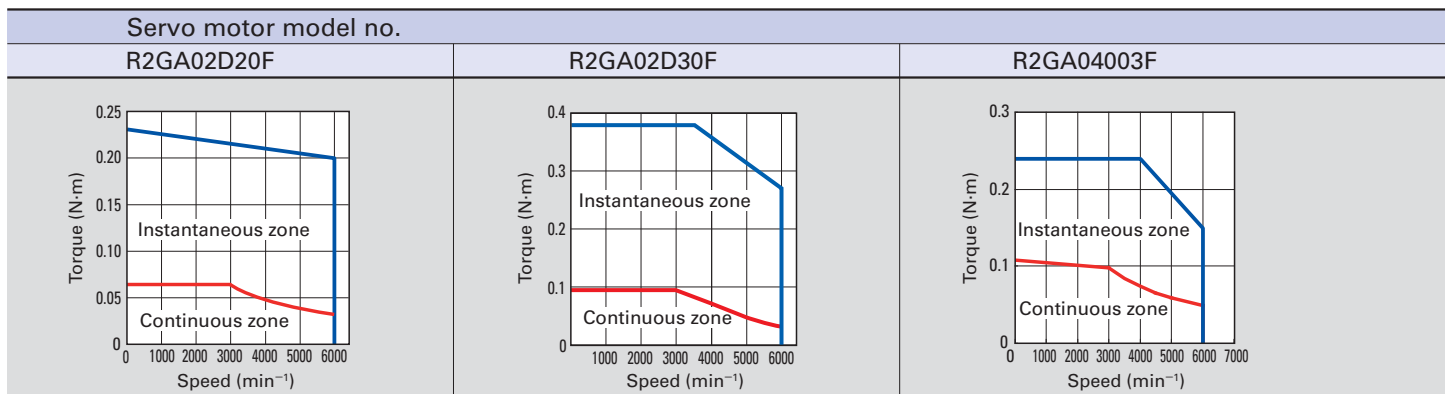
· These characteristics are for when the input voltage of the main power supply is 48 VDC and the distance between the servo amplifier and the servo motor is 2 m.
· In low voltage servo systems, the tendency for motor torque to decrease is more obvious than in 200 VAC servo systems due to narrow wiring diameter or long wiring distance between the servo amplifier and servo motor. Select a motor with higher acceleration, deceleration, and effective torque.

Pulse input Single-axis | EtherCAT Single-axis | EtherCAT Multi-axis

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RF2G21A0A00 《40A》				Pulse input Single-axis			Servo amplifier model no.
RS2K04A2HL5/RS2K04A2HA5 《40A》				EtherCAT Single-axis			
RF2K24A0HL5(Up to 300 W in total for 4 axes) 《40A》				EtherCAT Multi-axis			
R2GA04005F 《40 mm sq.》	R2GA04008D 《40 mm sq.》	R2GA06010D 《60 mm sq.》	R2GA06020D 《60 mm sq.》	Servo motor model no. 《 》 indicates flange size			
				Unit	Symbol	Status	
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}	Nmax	★	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 stall torque
0.54	0.86	0.84	1.5	N·m	T_P	★	Peak stall torque
3.8	4.1	5.1	6	Arms	I_R	★	Rated armature current
3.9	4.1	5.5	6	Arms	I_S	★	Armature stall current
13.7	14.1	14.1	14.1	Arms	I_P	★	Peak armature stall current
0.047	0.0693	0.0673	0.117	N·m/Arms	K_T	☆	Torque constant
1.64	2.42	2.35	4.07	mV/min^{-1}	$K_{E\phi}$	☆	Voltage constant for each phase
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
0.58	0.72	1.7	2.1	ms	te	☆	Electrical time constant
1.7	1.3	1.5	0.92	ms	tm	☆	Mechanical time constant (not including encoder)
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	0.53	0.74	0.99	kg	We		Servo motor mass[*1]
0.32 min.	0.32 min.	0.36 min.	1.37 min.	N·m	Tb		Brake static friction torque
90 VDC/24 VDC ± 10%				V	Vb		Brake rated voltage
0.07/0.27	0.07/0.27	0.07/0.27	0.11/0.32	A	Ib		Brake rated current
0.0078	0.0078	0.06	0.06	×10^{-4}kg·m^2 (GD^2/4)	Jb		Rotor moment of inertia (brake)
0.23	0.23	0.3	0.35	kg	W		Brake mass
Yes							CE and UL approved servo motors[*4]
IP65							Servo motor protection code
250 × 250 × 6 mm							Size of aluminum plates for heat radiation during measurement
p. 24							Servo motor dimensions

Servo Motor Operating Ambient Conditions

Operating temperature and humidity	Temp.: 0 to 40°C. Humidity: 90% max. (No condensation)
Vibration resistance	24.5 m/s^2
Shock resistance	98 m/s^2, twice
Elevation	1000 m or lower above sea level
Installation location	Indoor (without direct sunlight) Location where no substance that gives adverse effects on the device and motor, such as corrosive gas, flammable gas, or dust exists

Servo motor model no.			
R2GA04005F	R2GA04008D	R2GA06010D	R2GA06020D
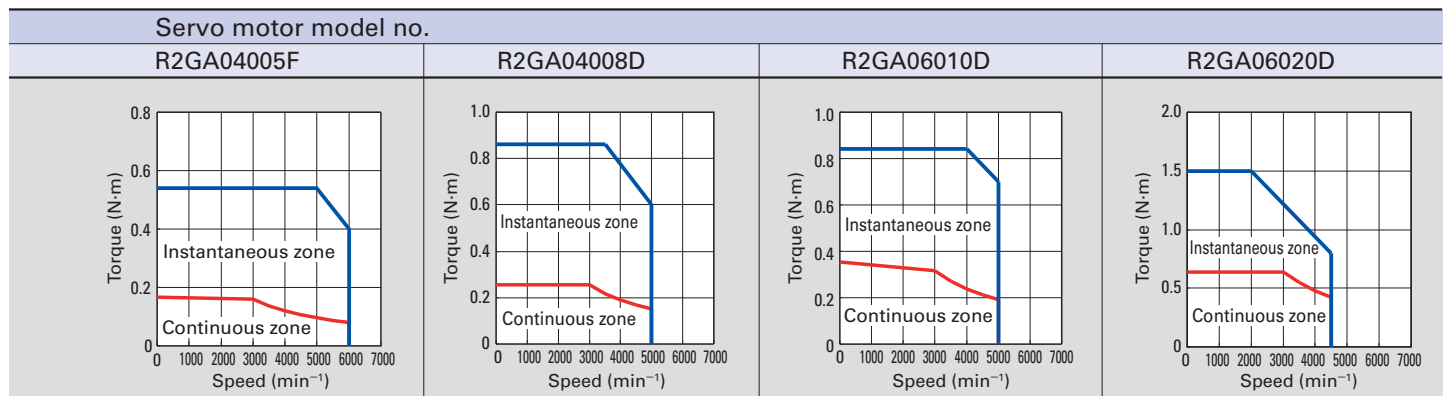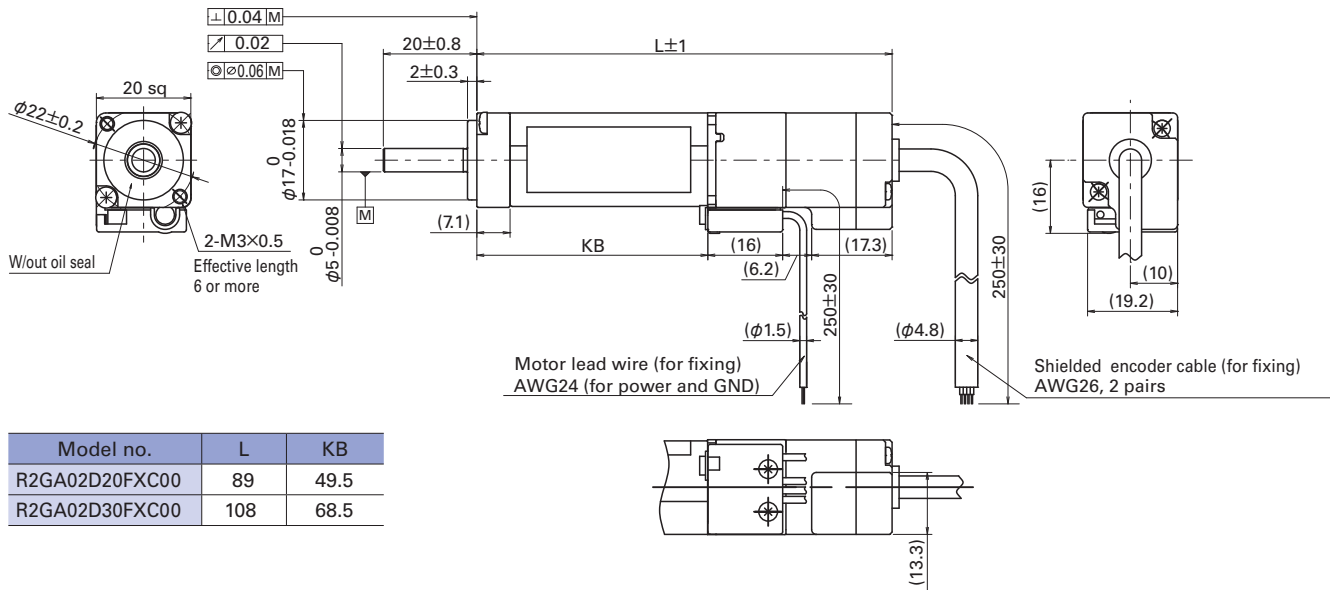
20 mm sq.

Model no.	L	KB
R2GA02D20FXC00	89	49.5
R2GA02D30FXC00	108	68.5

40 mm sq. to 60 mm sq.
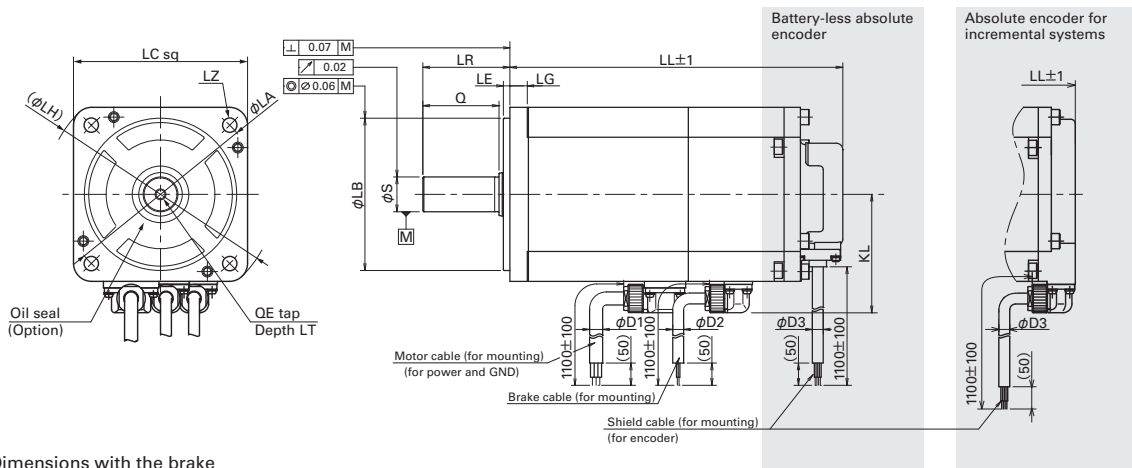
Dimensions with the brake

	Battery-less absolute encoder				Absolute encoder for incremental systems			
	W/out oil seal		With oil seal		W/out oil seal		With oil seal	
	W/out brake	With brake	W/out brake	With brake	W/out brake	With brake	W/out brake	With brake
Model no.	LL	LL	LL	LL	LL	LL	LL	LL
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	$30_{-0.021}^{0}$	2.5	56	40	2-ϕ4.5	25	$6_{-0.008}^{0}$	20	—	—	6	5	5
R2GA04005										$8_{-0.009}^{0}$						
R2GA04008																
R2GA06010	6	44.6	70	$50_{-0.025}^{0}$	3	82	60	4-ϕ5.5	25	$8_{-0.009}^{0}$		—	—			
R2GA06020									30	$14_{-0.011}^{0}$	25	M5	12			

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■Regenerative unit

Depending on the operating conditions of a servo system, a regenerative unit may be necessary to absorb voltage increases.

Model no.		RF1BB00
Power supply		Operated by main circuit power supply (48 VDC)
Regenerative operation	Regenerative starting voltage	55 V±1.5 V
	Hysteresis width	2 V±0.5 V
	Internal regenerative resistance value	15Ω±5%
	Allowable absorbed power of internal regenerative resistance	7 W
Environment	Ambient temperature	0 to 40℃
	Storage temperature	−20 to +65℃
	Operation/Storage humidity	Below 90%RH (no condensation)
	Elevation	1000 m or lower
	Vibration	4.9 m/s² freq. range 10 to 55 Hz in X, Y, and Z direction each, within 2 hours
	Shock	19.6 m/s²
Structure		Tray-type
Mass		0.2 kg
Protection functions		Resistive overheating detection (break contact signal output) with a built-in thermostat[1]

*1 The customer is responsible for monitoring the signal and shutting off the servo motor upon alarm.

Dimentions
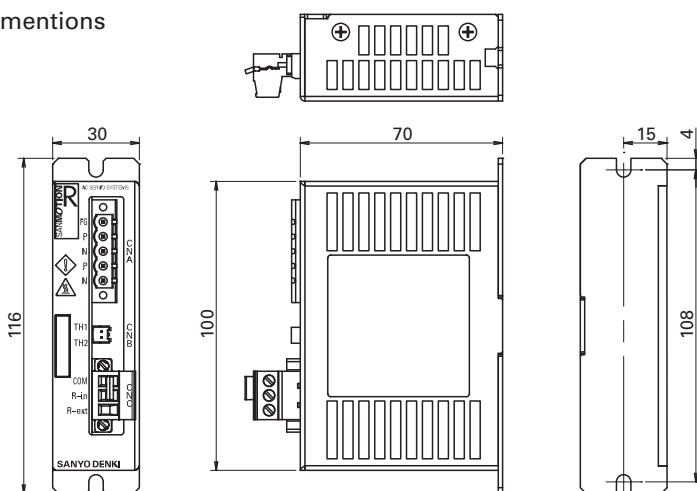
Wiring diagram
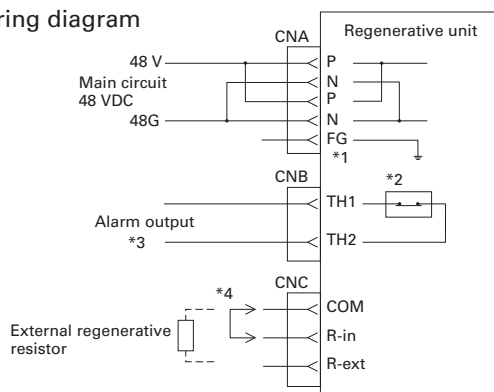
*1: There are two P terminals and two N terminals for CNA.
*2: This is a thermal guard for overheat detection.

Specifications	
Contact format	Normally closed (break)
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: The customer is responsible for handling the alarm output signal. If overheat is detected, stop the operation of servo motor and shut off the power supply to the main circuit.
*4: If regenerative power cannot be absorbed by the internal regenerative resistor, use an external regenerative resistor. In this case, remove the short bar between COM-R-in and install a resistor between COM-R-ext.

Connector and cable

			Model no.	Manufacturer	Manufacturer model no.	Housing	Contact
CNA	Power input	Connector	AL-00329461-01	Phoenix Contact.K.K	MSTBT2.5/5-STF-5.08	-	-
CNB	Alarm output	Cable with a connector	AL-00753589-01	J.S.T. Mfg. Co.,Ltd.	-	PAP-02V-S	SPHD-001G-P0.5

· The regenerative unit comes with a connector for CNC.
· Alarm output cable (with connector)

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

Dimentions (Unit : mm)

2850

CN1

PC side

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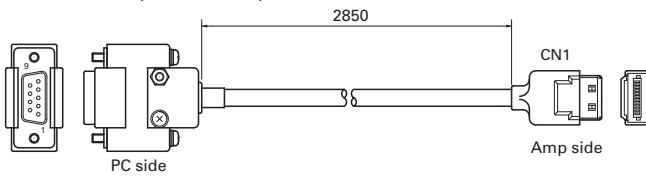
* Connect to a PC with an RS-232C serial cable

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

Dimentions (Unit : mm)

Connector on amplifier side
Housing: VHR-5N
Contact: SVH-21T-P1.1
Manufacturer: J.S.T. Mfg. Co.,Ltd.

UL1430 AWG18
0.75 mm² (34/0.18)
300 V, 105℃

2020
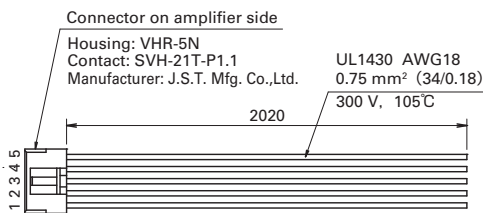
Connector No.	Pin No.	Symbol	Name	Wire color
CNA	1	FG	Frame ground	Green
	2	5 V	Control power 5 V	Yellow
	3	SG	Control power ground	Gray
	4	P	Main power supply 48 VDC	Red
	5	N	Main power supply ground	Blue

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

Dimentions (Unit : mm)

Connector on amplifier side
Housing: VHR-4N
Contact: SVH-21T-P1.1
Manufacturer: J.S.T. Mfg. Co.,Ltd.

UL STYLE 2517 AWG18
0.75 mm² (30/0.18)
300 V, 105℃

40   Heat-shrinkable tube

2020
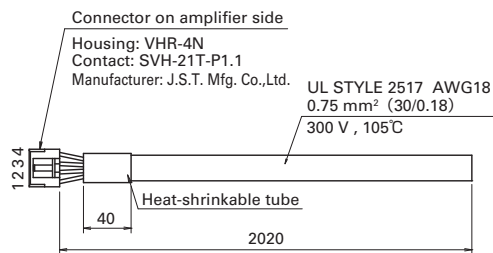
Connector No.	Pin No.	Symbol	Name	Wire color
CNB	1	U	U phase	Red
	2	V	V phase	White
	3	W	W phase	Black
	4	FG	Frame ground	Yellow (Green)

■ I/O cable set   For CN1A (14 pin) and CN1B (20 pin).   Model no.: AL-00745949-01

Dimentions (Unit : mm)

For CN1A

Connector on amplifier side
Housing: PADP-14V-1-S
Contact: SPH-002GW-P0.5S
Manufacturer: J.S.T. Mfg. Co.,Ltd.

UL STYLE 20276 0.14 mm² (7/0.16)
30 V, 80℃

13
1
40   Heat-shrinkable tube
2020
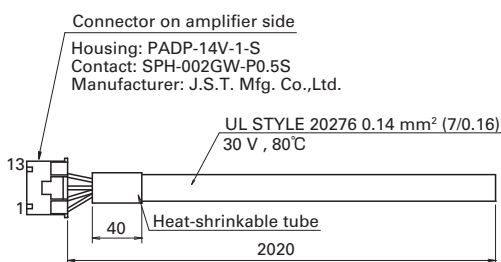
Connector No.	Pin No.	Symbol	Wire color	Remarks
CN1A	1	AO	Blue	Twisted pair
	3	A̅O̅	White	
	4	BO	Green	Twisted pair
	5	B̅O̅	White	
	6	ZO	Yellow	Twisted pair
	7	Z̅O̅	White	
	8	PS	Red	Twisted pair
	9	P̅S̅	White	
	11	F-PC	Blue	Twisted pair
	12	F̅-̅P̅C̅	Brown	
	13	R-PC	Yellow	Twisted pair
	14	R̅-̅P̅C̅	Brown	
	10	SG	Purple	
	2	FG	Drain wire	

For CN1B

Connector on amplifier side
Housing: PADP-20V-1-S
Contact: SPH-002GW-P0.5S
Manufacturer: J.S.T. Mfg. Co.,Ltd.

UL STYLE 20276 0.14 mm² (7/0.16)
30 V, 80℃

19
1
40   Heat-shrinkable tube
2020
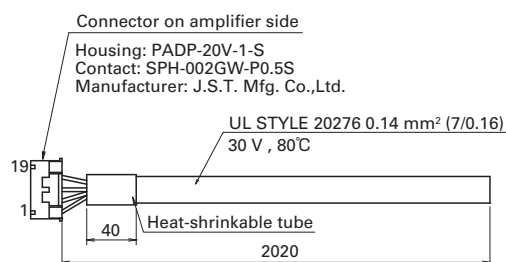
Connector No.	Pin No.	Symbol	Wire color	Remarks
CN1B	1	IN-COM	Blue	Twisted pair
	3	CONT1	Yellow	
	4	CONT2	White	Twisted pair
	5	CONT3	Green	
	6	CONT4	White	Twisted pair
	7	CONT5	Red	
	8	CONT6	White	Twisted pair
	9	CONT7	Purple	
	10	CONT8	White	Twisted pair
	11	OUT-PWR	Blue	
	19	OUT-COM	Brown	Twisted 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 wire	

Options

Pulse input Single-axis

■ Serial encoder cable

Model no.: AL-00745946-01

Dimentions (Unit : mm)

Connector on amplifier side
Housing: PADP-10V-1-S
Contact: SPH-002GW-P0.5S
Manufacturer: J.S.T. Mfg. Co.,Ltd.

UL STYLE 20276 0.14 mm² (7/0.16)
30 V , 80℃

Heat-shrinkable tube

40
2020
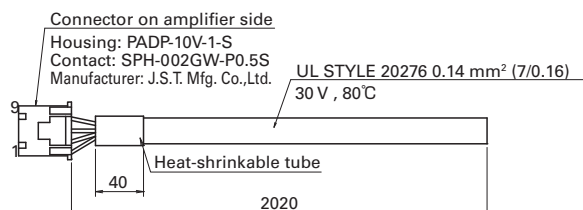
Connector No.	Pin No.	Symbol	Wire color	Remarks
CN2	1	+5 V	Red	Twisted pair
	2	SG	White	
	3	ES+	Blue	Twisted pair
	4	ES-	White	
	5	BAT+	Yellow	Twisted pair
	6	BAT-	White	
	7			
	8			
	9			
	10	FG	Drain wire	Shielded

Pins 5 and 6 are not used with encoders in this catalog.

■ Analog monitor box

This is used to monitor operation waveforms of servo amplifier with a measuring equipment.

Model no.	Q-MON-5
Power supply	±12 V±5% , external supply (Power source should be arranged by the customer.)
Monitor channel	Analog × 2 CH, digital × 2 CH, signal is to be selected according to setup software.
Output voltage range, output error	±8 VDC max, within ±20%
Offset voltage	within ±100 mV
Output resistance	1 kΩ
Load	within 2 mA

A cable for connecting the servo amplifier and analog monitor box (2 m) and a power cable are supplied.

Dimentions (Unit : mm)

Power cable

2000
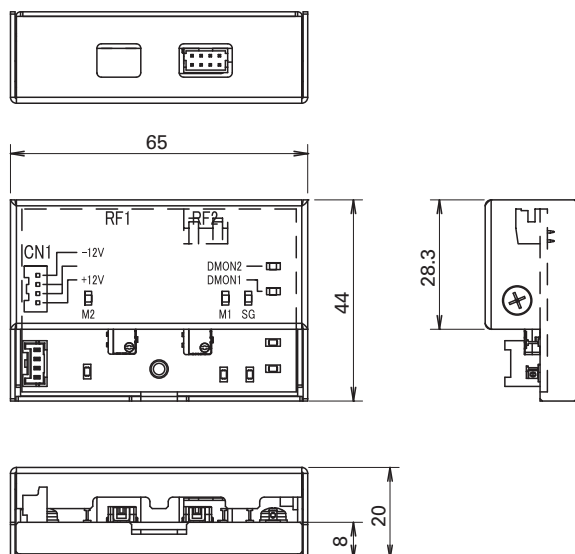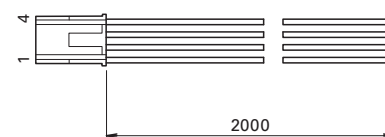
Connector No.	Pin No.	Color	Definition
CN1	1	Red	+12 V
	2	Black	SG
	3	Black	SG
	4	Blue	-12 V

■ PC cable Model no.: AL-00689703-01 (same cable as for EtherCAT multi-axis)

Dimentions (Unit : mm)

2850^{+40}_{-0}

NO.8   NO.1

PC side

Amplifier side
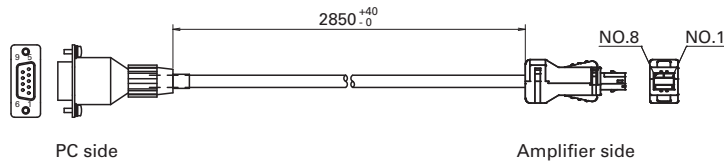
■ Serial encoder cable (same cable as for EtherCAT multi-axis)

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

Dimentions (Unit : mm)

Cable length: L

(11) (40)

(22.7)

Servo amplifier side

Encoder side
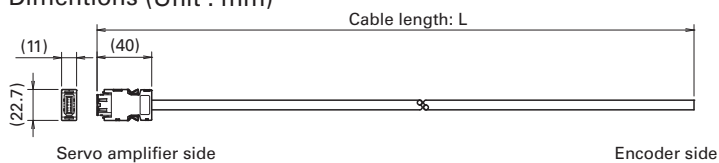
Connector No.	Pin No.	Symbol	Wire color	Remarks
EN1	1	+5 V	Red	
	2	SG	Black	
	7	ES+	Brown	
	8	ES-	Blue	
	9	BAT+	Green	
	10	BAT-	Purple	
	Shell	Ground		Shielded

The pin No. 9 and 10 are not used for the encoder in this catalog.

■ Analog monitor box

Monitors operating waveform of a servo amplifier using measuring equipment.

Model no.	Q-MON-3

Two dedicated cables for connecting the servo amplifier and analog monitor box (model no: AL-00690525-01) are supplied.

Dimentions (Unit : mm)

1) Monitor box (model no. : Q-MON-3)
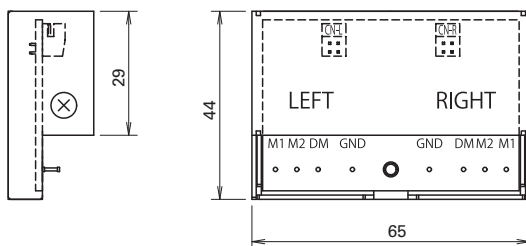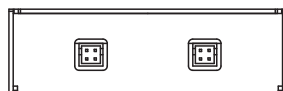
2) Dedicated cable (model no. : AL-00690525-01)
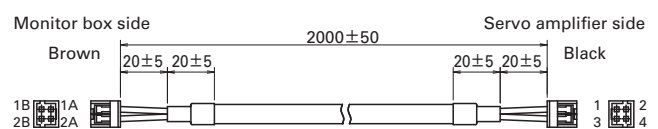
Monitor box side

Servo amplifier side

Brown

2000 ± 50

Black

20 ± 5 20 ± 5

20 ± 5 20 ± 5

1B 1A
2B 2A

1 2
3 4

29

44

LEFT   RIGHT

M1 M2 DM GND   GND DM M2 M1

65

Options

■ PC cable   Model no.: AL-00689703-01 (same cable as for EtherCAT single-axis.)

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

Dimentions (Unit : mm)

Connector on amplifier side
Housing: 5557-08R
Contact: 5556TL
Manufacturer: molex

UL1430 AWG18(34/0.18)
300 V , 105℃
2020±20

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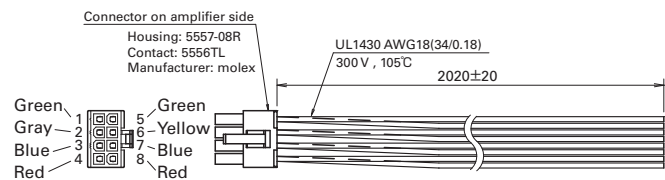
Connector No.	Pin No.	Symbol	Wire color
CNA	1	FG	Green
	2	CN	Gray
	3	N	Blue
	4	P	Red
	5	FG	Green
	6	CP	Yellow
	7	N	Blue
	8	P	Red

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

Dimentions (Unit : mm)

Connector on amplifier side
Housing: 5557-02R
Contact: 5556TL
Manufacturer: molex

UL1430 AWG18(34/0.18)
300 V , 105℃
2020±20

White 1 2 White
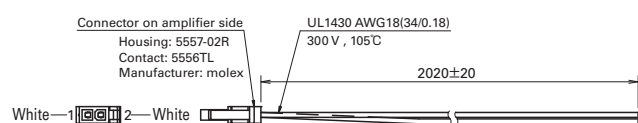
Connector No.	Pin No.	Symbol	Wire color
CNC	1	RB1	White
	2	RB2	White

■ Motor power cable

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

Dimentions (Unit : mm)

Connector on amplifier side
Housing: 5557-04R
Contact: 5556TL
Manufacturer: molex

UL STYLE 2517 0.75 mm² (30/0.18)
300 V , 105℃

Yellwo (Green) 1 3 White
Black 2 4 Red

Heat-shrinkable tube
40
L(m)
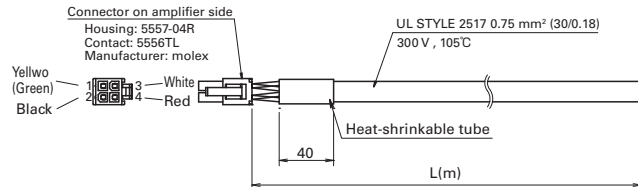
Connector No.	Pin No.	Symbol	Wire color
MOT1 to MOT4	1	FG	Yellow (Green)
	2	W	Black
	3	V	White
	4	U	Red

■ Serial encoder cable (same cable as for EtherCAT single-axis.)

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

■ Side mounting bracket   Model no. : AL-00921371-01

2-Ø5
128±0.3
24   90
10
5
200±0.4
190
2-5
24   90
4-C3

Mounting example
Mounting panel
60
Servo amplifier

Accessories: Screws for mounting brackets (M4, 4 pcs)

Mass: 0.3 kg

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■ External regenerative resistor

Use this external regenerative resistor if regenerative power cannot be absorbed with the internal regenerative resistor.

Model no. : REGIST-080W50B

Pulse input Single-axis | EtherCAT Single-axis | EtherCAT Multi-axis
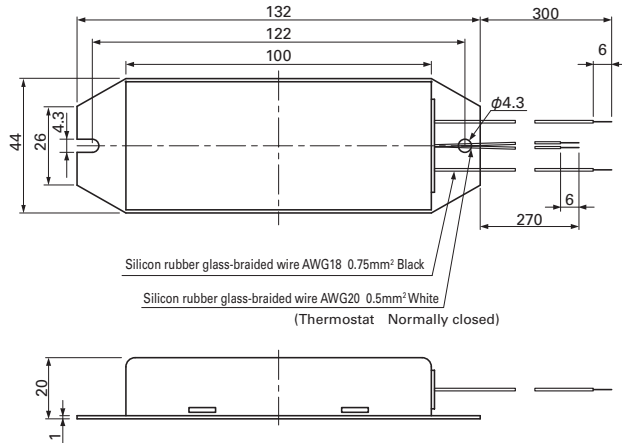
Dimentions (Unit : mm)

Mass: 0.19 kg

Model no. : REGIST-120W50B

Pulse input Single-axis | EtherCAT Single-axis | EtherCAT Multi-axis
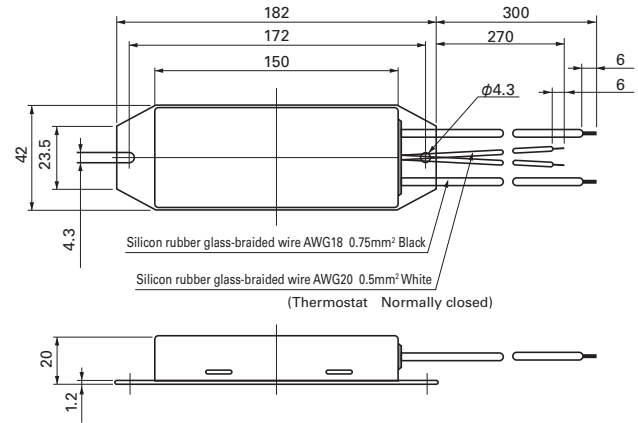
Dimentions (Unit : mm)

Mass: 0.24 kg

Model no. : REGIST-220W50B — Pulse input Single-axis | EtherCAT Single-axis

REGIST-220W20B — EtherCAT Multi-axis

Dimentions (Unit : mm)

Mass: 0.44 kg

30
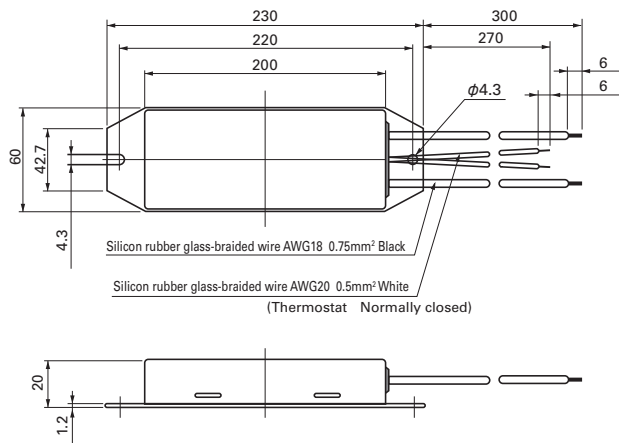
■ Servo motor capacity selection

This is a method of calculating the required capacity of servo motors from the mechanical specifications.
Here we have introduced the basic selection procedure focusing on a ball screw (flat) mechanism.

Selection procedure

1. Creation of operation patterns

Create the operation patterns.

2. Calculation of conversion of motor shaft moment of load inertia J_L

Calculate the moment of load inertia from the machine configuration.

3. Calculation of load torque T_L for motor shaft conversion

Calculate the load torque from the machine configuration.

4. Provisional selection of servo motor capacity

Provisionally select a motor in which the load moment of inertia (J_L) is 10 times or less than the rotor moment of inertia (J_M) of servo motor, while the load torque (T_L) is 80% or less (T_R x 0.8) of rated torque of motor (T_R).
$$J_L \leqq J_M \times 10$$
$$T_L \leqq T_R \times 0.8$$

5. Calculation of acceleration/deceleration torque

Calculate the required acceleration/deceleration torque from the operation patterns.

6. Calculation of effective torque

Calculate the effective torque from the torque patterns.

7. Judgment

Determine whether the acceleration/deceleration torque (T_a, T_b) is 80% or less (T_p x 0.8) of peak stall torque (T_p) of servo motor, and the effective torque (T_{rms}) is 80% or less (T_R x 0.8) of rating torque (T_R) of servo motor.
$$T_a \leqq T_p \times 0.8$$
$$T_b \leqq T_p \times 0.8$$
$$T_{rms} \leqq T_R \times 0.8$$
If the judgment results cannot be applied in the aforementioned equation, reconsider the servo motor capacity, for example increasing the capacity.

8. Calculation of regenerative power

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

1. Creation of operation patterns

First, determine the equipment mechanism, dimensions of all parts, positioning amount, positioning time, gear ratio, etc. An operation pattern is the determined driving force plotted on the speed/time axis.
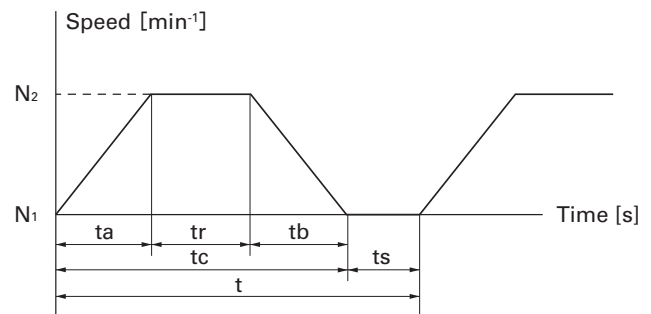
ta = Acceleration time[s]
tb = Deceleration time[s]
tr = Constant speed-time[s]
ts = Downtime[s]
t = 1 cycle[s]

2. Calculation of conversion of motor shaft moment of load inertia J_L

Load moment of inertia is the quantity showing inertia of a rotating object.
Given below is the calculation method used in case of ball screw (flat) mechanism.

■ Ball screw moment of inertia

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

G: Gear ratio
ρ : Ball screw specific gravity [kg/m³] [Iron: 7.8×10^3]
D: Ball screw diameter [m]
L: Ball screw length [m]

■ Work + table moment of inertia

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

G: Gear ratio
W: Work + table mass [kg]
P: Ball screw pitch [m]

■ Conversion of motor shaft moment of load inertia.
$$J_L = J_{L1} + J_{L2}$$

* Moments of inertia of reducer and coupling are assumed to be negligible and have therefore been omitted.

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3. Calculation of load torque T_L for motor shaft conversion

Load torque is the power generated from the friction of the driving part or from the gravity that is converted on the motor shaft. When activated, this torque always acts as the load. Given below is the calculation method used in the case of a ball screw (flat) mechanism.

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

F: External force [kg]
η : Machine efficiency
μ : Coefficient of friction
W: Work + table mass [kg]
P: Ball screw pitch [m]
G: Gear ratio

4. Provisional selection of servo motor capacity

Provisionally select the motors that apply to the following 2 conditions.
· Load moment of inertia (J_L) calculated in step 2 is 10 times or less than the rotor moment of inertia (J_M) of servo motor
$\quad J_L \leqq J_M \times 10$
· Load torque (T_L) calculated in step 3 is 80% or less ($T_R \times 0.8$) of rated torque (T_R) of servo motor
$\quad T_L \leqq T_R \times 0.8$

5. Calculation of acceleration/deceleration torque

Acceleration/deceleration torque is necessary for accelerating and decelerating the motor and load.

■ Method of obtaining acceleration torque (T_a)

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

N_2: Servo motor rotary speed after acceleration [min^{-1}]
N_1: Servo motor rotary speed before acceleration [min^{-1}]
J_L: Conversion of motor shaft moment of load inertia [kg $\cdot$ m^2]
J_M: Conversion of servo motor moment of rotor inertia [kg $\cdot$ m^2]
T_L: Calculation of load torque for motor shaft conversion [N $\cdot$ m]
ta: Acceleration time [s]

■ Method of obtaining deceleration torque (T_b)

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

N_2: Servo motor rotary speed before deceleration [min^{-1}]
N_1: Servo motor rotary speed after deceleration [min^{-1}]
J_L: Conversion of motor shaft moment of load inertia [kg $\cdot$ m^2]
J_M: Conversion of servo motor moment of rotor inertia [kg $\cdot$ m^2]
T_L: Calculation of load torque for motor shaft conversion [N $\cdot$ m]
tb: Deceleration time [s]

6. Calculation of effective torque

Effective torque is the value per unit time obtained from root mean square of load torque / acceleration torque / deceleration torque .

$$Trms = \sqrt{\frac{(T_a{}^2 \times ta) + (T_L{}^2 \times tr) + (T_b{}^2 \times tb)}{t}} \quad [\text{N} \cdot \text{m}]$$

7. Judgment

Our company's judgment criteria are as follows.
· Load torque load factor $T_L \leqq T_R \times 0.8$
 (Load torque is 80% or less of rated torque)

· Acceleration torque load factor $T_a \leqq T_P \times 0.8$
 (Acceleration torque is 80% or less of peak stall torque)
 T_P: Peak stall torque

· Deceleration torque load factor $T_b \leqq T_P \times 0.8$
 (Deceleration torque is 80% or less of peak torque at stall)
 T_P: Peak stall torque

· Effective torque load factor $Trms \leqq T_R \times 0.8$
 (Effective torque is 80% less than rated torque)

· Moment of inertia ratio $J_L \leqq J_M \times 10$
 (Load moment of inertia is 10 times or less than the rotor moment of inertia of motor)

Rise in motor temperature can be suppressed by keeping a large margin in torque load factor. The moment of inertia ratio can be controlled at 10 times or more, for example, by slowly rotating the table mechanism. Testing with an actual machine is recommended.

8. Calculation of regenerative power

Calculate the regenerative efficient power (PM) to determine the regenerative resistor to be used. From the calculation results, determine whether an internal regenerative resistor can be used.

■ Method of obtaining regenerative efficient power (PM) of horizontal drive shaft
Derive the regenerative energy.

$$EM = Ehb = \frac{1}{2} \times N \times 3 \times Ke\phi \times \frac{T_b}{KT} \times tb - \left(\frac{T_b}{KT}\right)^2 \times 3 \times R\phi \times tb$$

EM: Regenerative energy in case of horizontal drive shaft [J]
Ehb: Regenerative energy during deceleration [J]
Keϕ : Induced voltage constant [Vrms/min^{-1}] (motor constant)
KT: Torque constant [N $\cdot$ m/Arms] (motor constant)
N: Motor rotary speed [min^{-1}]
Rϕ : Armature resistance [Ω] (motor constant)
tb: Deceleration time [s]
T_b: Deceleration torque [N $\cdot$ m]

Derive the regenerative efficient power from regenerative energy.
$$PM = \frac{EM}{t}$$

PM: Regenerative efficient power [W]
EM: Regenerative energy [J]
t: Cycle time [s]

■ Selection of regenerative resistor
Select a regenerative resistor that meets the following conditions.
· In case of servo amplifiers with an internal regenerative resistor:
 Permissible regenerative power [PR] that is less than efficient regenerative power [PM] and can be used with internal regenerative resistors
· In case of external regenerative resistor:
 Permissible regenerative power [PRO] that is less than efficient regenerative power [PM] and can be used with external regenerative resistors
Note that we have servo amplifier models both with and without internal regenerative resistors for absorbing regenerative power. Select the model accordingly.
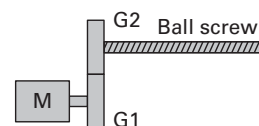
■ Selection data for each mechanism

Typical examples of mechanisms and items that require selection are shown below. Provide this information when placing an order.

Ball screw

External force	F	N
Work + table mass	W	kg
Ball screw diameter	D	m
Ball screw length	L	m
Ball screw lead	P	m
Ball screw material specific gravity	ρ	kg/m^3
Coefficient of friction	μ	
Gear ratio *	G	
Machine efficiency	η	

Rack & pinion

External force	F	N
Work + rack mass	W	kg
Pinion diameter	D	m
Pinion thickness	L	m
Pinion material specific gravit	ρ	kg/m^3
Coefficient of friction	μ	
Gear ratio *	G	
Machine efficiency	η	

Belt drive

External force	F	N
Work + belt mass	W	kg
Pulley diameter	D	m
Pulley width	L	m
Pulley material specific gravity	ρ	kg/m^3
Pulley moment of inertia	J	kg · m^2
Gear ratio *	G	
Machine efficiency	η	

Roll feed

Sheet tension	F	N
Roll diameter	D	m
Roll width	L	m
Roll material specific gravity	ρ	kg/m^3
Roll moment of inertia	J	kg · m^2
Gear ratio *	G	
Machine efficiency	η	

Rotary table

Table mass	W	kg
Table diameter	Dt	m
Table support diameter	Dh	m
Table moment of inertia	J	kg · m^2
Support part coefficient of friction	μ	
Gear ratio *	G	
Machine efficiency	η	

* Derivation of gear ratio (G)

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

Features

Setup software

List of Combinations of Servo Amplifiers and Servo Motors

How to Read Model Numbers

Standard Model Number List

System Configuration External Wiring Diagram

Servo Amplifier Specifications

Encoder Wiring Diagram

Servo Motor Specifications

Options

Selection Guide

http://www.sanyodenki.com

SANYO DENKI CO., LTD.
3-33-1, Minami-Otsuka, Toshima-ku, Tokyo, 170-8451, Japan
TEL: +81 3 5927 1020

SANYO DENKI *EUROPE SA.*
P.A. Paris Nord Ⅱ, 48 Allée des Erables-VILLEPINTE, BP.57286, F-95958 ROISSY CDG Cedex, France
TEL: +33 1 48 63 26 61

SANYO DENKI *AMERICA,INC.*
468 Amapola Avenue Torrance, CA 90501, U.S.A.
TEL: +1 310 783 5400

SANYO DENKI *SHANGHAI CO.,LTD.*
Room 2106-2109, Bldg A, Far East International Plaza, No.319, Xianxia Road, Shanghai, 200051, China
TEL: +86 21 6235 1107

Beijing Branch
Room1222, Tower B, Beijing COFCO Plaza, No.8 Jianguomennei Dajie, Dong Cheng District, Beijing 100005 China
TEL: +86 10 6522 2160

SANYO DENKI *(H.K.)CO., LIMITED*
Room 2305, 23/F, South Tower, Concordia Plaza, 1 Science Museum Road, TST East, Kowloon, Hong Kong
TEL: +852 2312 6250

Tianjin Representative Office
Room AB 16th Floor TEDA Building, No. 256 Jie Fang Nan Road, Hexi District, Tianjin 300042 China
TEL: +86 22 2320 1186

Chengdu Representative Office
Room2105B, Block A, Times Plaza, 2 Zongfu Road, Jinjiang District, Chengdu, 610016 China
TEL: +86 28 8661 6901

SANYO DENKI *TAIWAN CO., LTD.*
N-711, 7F, Chia Hsin 2nd Bldg., No.96, Sec.2, Zhongshan N. Rd., Taipei 10449, Taiwan (R.O.C.)
TEL: +886 2 2511 3938

SANYO DENKI *SINGAPORE PTE. LTD.*
988 Toa Payoh North, #04-05/06/07/08, Singapore 319002
TEL: +65 6223 1071

Indonesia Representative Office
Summitmas II 4th Floor, Jl. Jend. Sudirman Kav.61-62, Jakarta 12190, Indonesia
TEL: + 62 21 252 3202

SANYO DENKI *GERMANY GmbH*
Frankfurter Strasse 92, 65760 Eschborn, Germany
TEL: +49 6196 76113 0

SANYO DENKI *KOREA CO., LTD.*
9F, Sunhwa B/D 89, Seosomun-ro, Jung-gu, seoul, 100-731, Korea
TEL: +82 2 773 5623

Busan Branch
8F, CJ Korea Express Bldg., 119, Daegyo-ro, Jung-gu, Busan, 600-016, Korea
TEL: +82 51 796 5151

SANYO DENKI *(Shenzhen)CO., LTD.*
2F 02-11, Shenzhen International Chamber of Commerce Tower, No.168 Fuhua 3 Road, Futian District, Shenzhen, 518048 China
TEL: +86 755 3337 3868

SANYO DENKI *(THAILAND)CO.,LTD.*
388 Exchange Tower, 25th Floor, Unit 2501-1, Sukhumvit Road, Klongtoey, Klongtoey, Bangkok 10110 Thailand
TEL: +66 2261 8670

SANYO DENKI *INDIA PRIVATE LIMITED*
#14 (Old No.6/3), Avenue Road, Nungambakkam, Chennai - 600034, Tamil Nadu, India
TEL: +91 44 420 384 72

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