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SV680-INT Series Servo Drive

Hardware Guide

Industrial Automation | Intelligent Elevator | New Energy Vehicle | Industrial Robot | Rail Transit

Data code PS00015494A03

Preface

Introduction

The SV680-INT series servo drive is a high-end servo drive designed based on global-leading standards and high-end application needs. It is featured with high speed, high precision, high performance, and tuning-free function. Compliant with CE, UL, KC, EAC, UKCA and TUV certification requirements and top international quality standards, it is specially suitable for high-end applications.

Its power ranges from 0.05 kW to 7.5 kW. It supports Modbus, CANopen and EtherCAT communication protocols and carries necessary communication interfaces to work with the host controller for implementing a networked operation of multiple servo drives. The servo drive supports adaptive stiffness level setting, inertia auto-tuning, and vibration suppression for easy use. The drive, together with an MS1 series high-response servo motor (with ultra-low, low or medium inertia) equipped with a 23- or 26-bit single-turn/multi-turn absolute encoder, any third party servo motor, linear motor or DDR motor, serves to deliver a quiet and stable operation and accurate process control through features like fully closed-loop, internal process segment and gantry synchronization.

The drive also comes with features like safe torque off, dynamic braking, and brake output (external relay not needed) as standard and supports extension of seven kinds of functional safety and bus functional safety FSoE (the PINT version further offers 24V backup power) for continuous safe production. The drive aims to achieve quick and accurate position control, speed control, and torque control through high-performance solutions for automation equipment in such industries as electronic manufacturing, lithium batteries, manipulators, packaging, and machine tools.

This guide describes the technical data, installation, terminals, certification and standard compliance requirements, and suggestions for solving common EMC problems.

Note

The speed of a servo motor and DDR motor is in rpm and DDL motor is in mm/s. rpm is used throughout the manual. Unless otherwise specified, an rpm value is equivalent to the mm/s one.

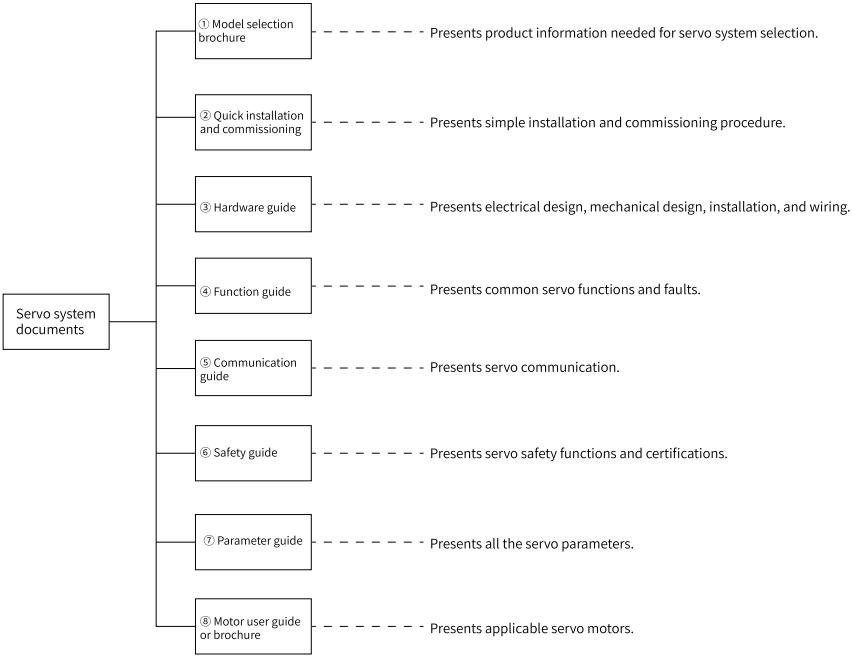
Product Name Abbreviation

The following abbreviations will be used herein to refer to the corresponding servo drives.

Abbreviation	Servo drive
[P]	SV680P*****-*INT
[N]	SV680N*****-*INT

More documents

The documents related to the drive are shown in the following figure and table.



No.	Name	Data Code	Description
①	SV680-INT series flagship servo drive	19120347	Provides instructions on product selection, including the list of supporting components, technical data on the drive, and the selection guide of cables.
②	SV680-INT Series Servo Drive Quick Installation and Commissioning	PS00015536	Describes the model number, installation, terminals and quick commissioning and operation of the drive.
③	SV680-INT Series Servo Drive Hardware Guide	PS00015494	Describes technical data, installation, terminals, required certificates and standards and solutions to common EMC problems of the drive.
④	SV680-INT Series Servo Drive Function Guide	PS00015554	Introduces the functions and faults of the drive, including function overview, adjustment, basic servo functions and fault handling.
⑤	SV680-INT Series Servo Drive Communication Guide	PS00015535	Introduces the communication of the drive, including configuration of Modbus, CANopen, and EtherCAT communication.

No.	Name	Data Code	Description
⑥	SV680P-INT Series Servo Drive Safety Guide	PS00009740	Describes the safety function and related certifications and standards, wiring, commissioning process, troubleshooting and parameters of the drive.
	SV680N-INT Series Servo Drive Safety Guide	PS00009768	
⑦	SV680-INT Series Servo Drive Parameter Guide	PS00015555	Introduces the parameters of the drive, including a parameter list and description of parameters.
⑧	MS1-R Series Servo Motor Selection Guide	PS00004605	Introduces the product information, general specifications, motor selection, cable selection, and required certificates and standards of the servo motor.
	MS1-R Series Servo Motor Installation Guide	PS00005407	Describes installation of the motor, including an installation flowchart, unpacking and transportation, mechanical installation, and electrical installation.
	Direct drive motor module platform and drive	19120011	Introduces the product information, general specifications, motor selection, cable selection, and required standards of the motor.

Revision History

Date	Version	Description
2024-08	A03	Made minor corrections. Updated content on parameters. Added parameters of surge current.
2024-05	A02	Modified specifications of recommended main circuit cables. Added information on the maximum number of brake outputs. Modified the weight of the product with a backup power supply.
2024-03	A01	Minor corrections.
2023-08	A00	First release.

Access to the Guide

This guide is not delivered with the product. You can obtain the PDF version in the following way:

- Visit *www.inovance.com*, go to Support > Download, search by keyword, and then download the PDF file.
- Scan the QR code on the product with your mobile phone.
- Scan the QR code below to install the app, where you can search for and download manuals.

Warranty

Inovance provides warranty service within the warranty period (as specified in your order) for any fault or damage that is not caused by improper operation of the user. You will be charged for any repair work after the warranty period expires.

Within the warranty period,maintenance fee will be charged for the following damage:

- Damage caused by operations not following the instructions in the user guide
- Damage caused by fire, flood, or abnormal voltage
- Damage caused by unintended use of the product
- Damage caused by use beyond the specified scope of application of the product
- Damage or secondary damage caused by force majeure (natural disaster, earthquake, and lightning strike)

The maintenance fee is charged according to the latest Price List of Inovance. If otherwise agreed upon, the terms and conditions in the agreement shall prevail.

For details, see the Product Warranty Card.

Table of Contents

Fundamental Safety Instructions

Safety disclaimer

- This chapter provides essential safety instructions for proper use of the equipment. Before operating the equipment, read through the guide and comprehend all the safety instructions. Failure to observe the safety instructions may result in death, personal injury, or equipment damage.
- "Danger", "Warning", and "Caution" items in this guide do not indicate all safety precautions that need to be followed; instead, they just supplement the safety precautions.
- Use this product according to the designated environment requirements. Damage caused by improper use is not covered by warranty.
- Inovance shall take no responsibility for any personal injuries or property damage caused by improper usage.

Safety Levels and Definitions

	Indicates that failure to comply with the notice can result in death or severe personal injuries.
	Indicates that failure to comply with the notice may result in severe personal injury or even death.
	Indicates that failure to comply with the notice may result in minor or moderate personal injuries or equipment damage.

Safety Precautions

- Drawings in the guide are sometimes shown without covers or protective guards. Remember to install the covers or protective guards as specified first, and then perform operations in accordance with the instructions.
- The drawings in the guide are shown for illustration only and may be different from the product you purchased.
- Operators must take mechanical precautions to protect personal safety and wear protective equipment, such as anti-smashing shoes, safety clothing, safety glasses, protective gloves, and protective sleeves.

Unpacking

- Do not install the equipment if you find damage, rust, or signs of use on the equipment or accessories upon unpacking.
- Do not install the equipment if you find water seepage or missing or damaged components upon unpacking.
- Do not install the equipment if you find the packing list does not conform to the equipment you received.

- Check whether the packing is intact and whether there is damage, water seepage, dampness, and deformation before unpacking.
- Unpack the package by following the unpacking sequence. Do not strike the package violently.
- Check whether there is damage, rust, or signs of bumping on the surface of the equipment and equipment accessories before unpacking.
- Check whether the package contents are consistent with the packing list before unpacking.

Storage and Transportation

- Large-scale or heavy equipment must be transported by qualified professionals using specialized hoisting equipment. Failure to comply may result in personal injuries or equipment damage.
- Before hoisting the equipment, ensure the components such as the front cover and terminal blocks are secured firmly with screws. Loosely-connected components may fall off and result in personal injury or equipment damage.
- Never stand or stay below the equipment when the equipment is being hoisted by the hoisting equipment.
- When hoisting the equipment with a steel rope, ensure the equipment is hoisted at a constant speed without suffering from vibration or shock. Do not turn the equipment over or let the equipment stay hanging in the air. Failure to comply may result in personal injuries or equipment damage.

- Handle the equipment with care during transportation and mind your steps to prevent personal injuries or equipment damage.
- When carrying the equipment with bare hands, hold the equipment casing firmly with care to prevent parts from falling. Failure to comply may result in personal injuries.
- Store and transport the equipment based on the storage and transportation requirements. Failure to comply will result in equipment damage.
- Do not store or transport the drive in environments with water splash, rain, direct sunlight, strong electric field, strong magnetic field, and strong vibration.
- Avoid storing the product for more than 3 months. When the product needs to be stored for an extended period, take more strict protection and necessary inspection.
- Pack the equipment strictly before transportation. Use a sealed box for long-distance transportation.
- Never transport the equipment with other equipment or materials that may harm or have negative impacts on this equipment.

Installation

- The equipment can only be operated by professionals with electrical knowledge. Non-professionals are not allowed to operate on the equipment.

- Read through the guide and safety instructions before installation.
- Do not install this equipment in places with strong electric or magnetic fields.
- Before installation, check that the mechanical strength of the installation site can bear the weight of the equipment. Failure to comply will result in mechanical hazards.
- Do not wear loose clothes or accessories during installation. Failure to comply may result in an electric shock.
- When installing the equipment in a closed environment (such as a cabinet or casing), use a cooling device (such as a fan or air conditioner) to cool the environment down to the required temperature. Failure to comply may result in equipment over-temperature or a fire.
- Do not retrofit the equipment.
- Do not fiddle with the bolts used to fix equipment components or the bolts marked in red.
- When the equipment is installed in a cabinet or final assembly, a fireproof enclosure providing both electrical and mechanical protections must be provided. The IP rating must meet IEC standards and local laws and regulations.
- Before installing devices with strong electromagnetic interference, such as a transformer, install a shielding device for the equipment to prevent malfunction.
- Install the product on an incombustible object such as metal and do not touch or attach the product to combustibles. Failure to comply can result in fire accident.

- Cover the top of the equipment with a piece of cloth or paper during installation. This is to prevent unwanted objects such as metal chippings, oil, and water from falling into the equipment and causing faults. After installation, remove the cloth or paper on top of the equipment to prevent over-temperature caused by poor ventilation due to blocked ventilation holes.
- Resonance may occur when the equipment operating at a constant speed executes variable speed operations. In this case, install the vibration-proof rubber under the motor frame or use the vibration suppression function to reduce resonance.

Wiring

- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals.
- Before wiring, disconnect all the power supplies of the equipment, and wait for at least the time designated on the equipment warning label before further operations because residual voltage still exists after power-off. Measure the DC voltage of the main circuit and ensure that the voltage is within the safety range. Failure to comply can result in an electric shock.
- Do not perform wiring, remove the equipment cover, or touch the circuit board with power ON. Failure to comply will result in an electric shock.
- Check that the equipment is grounded properly. Failure to comply can result in an electric shock.

- Do not connect the input power supply to the output end of the equipment. Failure to comply can result in equipment damage or even a fire.
- When connecting a drive to the motor, check that the phase sequences of the drive and motor terminals are consistent to prevent reverse motor rotation.
- Cables used for wiring must meet cross sectional area and shielding requirements. The shield of the cable must be reliably grounded at one end.
- Fix the terminal screws with the tightening torque specified in the user guide. Improper tightening torque may overheat or damage the connecting part, resulting in a fire.
- After wiring is done, check that all cables are connected properly and no screws, washers or exposed cables are left inside the equipment. Failure to comply may result in electric shock or equipment damage.

- Follow the proper electrostatic discharge (ESD) procedure and wear an anti-static wrist strap to perform wiring. Failure to comply may result in damage to the equipment or to the internal circuit of the product.
- Use shielded twisted pairs for the control circuit. Connect the shield to the grounding terminal of the equipment for grounding purpose. Failure to comply can result in equipment malfunction.

Power-on

- Before power-on, check that the equipment is installed properly with reliable wiring and the motor can be restarted.
- Check that the power supply meets equipment requirements before power-on to prevent equipment damage or fire accident.
- Do not open the cabinet door or protective cover of the product, touch any wiring terminal of the product, or remove any part of the product with power on. Failure to comply can result in an electric shock.

- Perform a trial run after wiring and parameter setting to ensure the equipment operates safely. Failure to comply may result in personal injuries or equipment damage.
- Before power-on, check that the rated voltage of the equipment is consistent with that of the power supply. Failure to comply may result in a fire accident.
- Before power-on, check that no one is near the equipment, motor, or machine. Failure to comply may result in death or personal injury.

Operation state

- The equipment must be operated only by professionals. Failure to comply can result in death or personal injury.
- Do not touch any connecting terminals or disassemble any unit or component of the equipment during operation. Failure to comply can result in an electric shock.

- Do not touch the equipment casing, fan, or resistor with bare hands to feel the temperature. Failure to comply may result in personal injuries.
- Prevent metal or other objects from falling into the equipment during operation. Failure to comply may result in a fire or equipment damage.

Maintenance

- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals.
- Do not maintain the equipment with power ON. Failure to comply will result in an electric shock.
- Before maintenance, disconnect all the power supplies of the equipment and wait for at least the time designated on the equipment warning label.
- When a permanent magnet motor is used, do not touch the motor terminals immediately after power-off because the motor terminals can generate induced voltage during rotation even after the equipment power supply is off. Failure to comply can result in an electric shock.

- Perform routine and periodic inspection and maintenance on the equipment according to maintenance requirements and keep a maintenance record.

Repair

- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals.
- Do not repair the equipment with power ON. Failure to comply can result in an electric shock.
- Before inspection and repair, cut off all the power supplies of the equipment and wait for at least the time designated on the equipment warning label.

- Submit the repair request according to the warranty agreement.
- When the fuse is blown or the circuit breaker or earth leakage current breaker (ELCB) trips, wait for at least the time designated on the equipment warning label before power-on or further operations. Failure to comply may result in death, personal injury or equipment damage.
- When the equipment is faulty or damaged, the troubleshooting and repair work must be performed by professionals that follow the repair instructions, with repair records kept properly.
- Replace quick-wear parts of the equipment according to the replacement instructions.
- Do not operate on damaged equipment. Failure to comply may result in death, personal injury, or severe equipment damage.
- After the equipment is replaced, check the wiring and set parameters again.

Disposal

- Dispose of retired equipment in accordance with local regulations and standards. Failure to comply may result in property damage, personal injuries, or even death.
- Recycle retired equipment by observing industry waste disposal standards to avoid environmental pollution.

Cautions for the dynamic brake

- Dynamic braking can only be used for emergency stop in case of failure and sudden power failure. Do not trigger failure or power failure frequently.
- Ensure that the dynamic braking function has an operation interval of more than 5 minutes at high speed, otherwise the internal dynamic braking circuit may be damaged.
- Dynamic braking is common in rotating mechanical structures. For example, when a motor has stopped running, it keeps rotating due to the inertia of its load. In this

case, this motor is in the generating state and short circuit current passes through the dynamic brake. If this situation continues, the drive, and even the motor, may be burned.

Safety Labels

For safe operation and maintenance, comply with the safety labels on the equipment. Do not damage or remove the safety labels. See the following table for descriptions of the safety labels.

Safety Label	Description
	• Never fail to connect Protective Earth (PE) terminal. Read the manual and follow the safety instructions before use. • Do not touch terminals within 15 minutes after disconnecting the power supply to prevent the risk of electric shock. • Do not touch the heatsink with power ON to prevent the risk of burn.

1 SV680-INT series

1.1 Product Information

1.1.1 Model Number and Nameplate

Model description

①**Product series** SV680: SV680 general-purpose servo drive	④**Rated output current**		⑤**Model configuration** I: Standard type S: Functional safety type
②**Product type** N: EtherCAT communication type P: Pulse type + CANopen communication type	S: 200 V	1R6: 1.6 A 2R8: 2.8 A 5R5: 5.5 A 7R6: 7.6 A 012: 12.0 A 018: 18.0 A 022: 22.0 A 027: 27.0 A	⑥**Model configuration** GINT: General (global version) PINT: Backup power supply type (global version)
③**Voltage class** S: 200 V T: 400 V	T: 400 V	3R5: 3.5 A 5R4: 5.4 A 8R4: 8.4 A 012: 12.0 A 017: 17.0 A 021: 21.0 A 026: 26.0 A	

Nameplate

Figure 1-1 Nameplate

Encryption of the production serial number

① **Internal code** Product material code	③ **Year** 9: 2009 A: 2010 ... S: 2024 ... Note: I/L/O/Q is not used.	⑤ **Lot number** 00001: 1st in current month 00002: 2nd in current month 00003: 3rd in current month ... Range: 00001 to 99999
② **Manufacturer code** 4: Suzhou Inovance	④ **Month** 1: January 2: February ... A: October B: November C: December	

Example: The S/N 010502024S700001 indicates the drive is manufactured in July, 2024.

1.1.2 Components [P]

Figure 1-2 Servo drive components

Table 1–1 Description of servo drive components

No.	Name	Description
①	CHARGE (bus voltage indicator)	Indicates the electric charge is present in the bus capacitor. When the indicator turns on, charges possibly still exist in the internal capacitor of the servo unit, even if the power supply of the main circuit is OFF. To prevent electric shock, do not touch the power terminals when this indicator lights up.
②	Main circuit terminal	For detailed description of main circuit terminals, see *"5.1.1 Terminal Arrangement" on page 49*.
③	CN8 (brake and PTC input terminal)	Connected to brake and PTC.
④	Servo drive grounding terminal	Connected to the grounding terminal of the power supply for grounding purpose.
⑤	CN6 (STO safety function terminal)	Connected to external functional safety signal for functional safety purpose.
⑥	CN3, CN4 (communication terminals)	Connected to Modbus and CANopen host controllers in parallel.

No.	Name	Description
⑦	CN11 (24 V standby power input terminal)	When the main circuit is not energized, it supplies power to the control circuit to maintain functions like programming, parameter configuration in the software tool, and communication.
⑧	LED display	The 5-digit 8-segment LED display is used to show servo system's running state and parameter setting.
⑨	Keys	M: Used to switch parameters in sequence. ▲: Increases the value of the blinking digit. ▼: Decreases the value of the blinking digit. ◀◀ : Used to shift the blinking position leftwards (long press to turn to the next page when the displayed number exceeds five digits). S: Saves modifications and enters the next menu.
⑩	CN5 communication terminal	Supports online upgrade and background commissioning when the drive is powered on. In USB mode, the terminal only supports download and upload of parameters, and driver firmware update; The terminal uses USB power supply. If there is a fault that cannot be completely reset, disconnect the USB power supply and drive control power, and then power on again.
⑪	CN1 (control terminal)	Used by reference input signals and other I/O signals.
12	CN7 (encoder feedback terminal)	Supports communication encoder and pulse encoder. Supports gantry synchronization.
13	CN2 (encoder feedback terminal)	Supports communication-type encoders. Supports gantry synchronization.

1.1.3 Components [N]

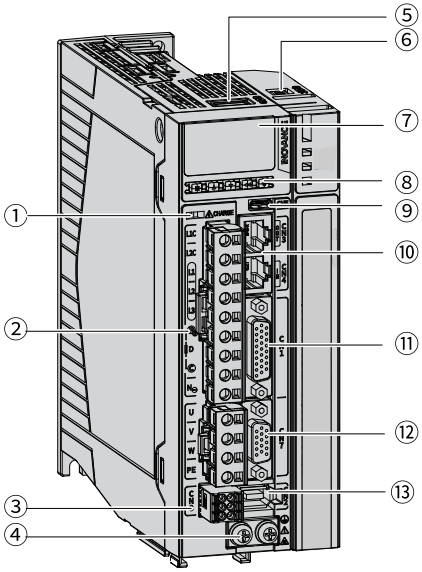


Figure 1-3 Servo drive components

Table 1–2 Description of servo drive components

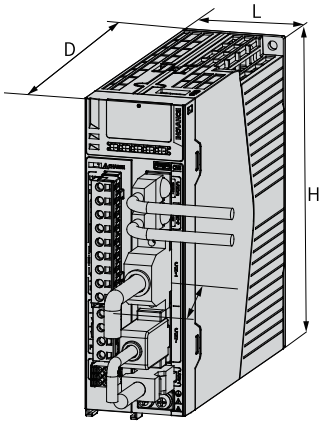
No.	Name	Description
①	CHARGE (bus voltage indicator)	Indicates the electric charge is present in the bus capacitor. When the indicator turns on, charges possibly still exist in the internal capacitor of the servo unit, even if the power supply of the main circuit is OFF. To prevent electric shock, do not touch the power terminals when this indicator lights up.
②	Main circuit terminal	For detailed description of main circuit terminals, see *"5.1.1 Terminal Arrangement" on page 49*.
③	CN8 (brake and PTC input terminal)	Connected to brake and PTC.
④	Servo drive grounding terminal	Connected to the grounding terminal of the power supply for grounding purpose.
⑤	CN6 (STO safety function terminal)	Connected to external functional safety signal for functional safety purpose.
⑥	CN11 (24 V standby power input terminal)	When the main circuit is not energized, it supplies power to the control circuit to maintain functions like programming, parameter configuration in the software tool, and communication.

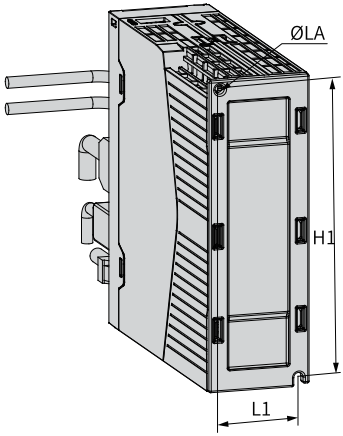
No.	Name	Description
⑦	LED display	The 5-digit 8-segment LED display is used to show servo system's running state and parameter setting.
⑧	Keys	M: Used to switch parameters in sequence. ▲: Increases the value of the blinking digit. ▼: Decreases the value of the blinking digit. ◀◀: Used to shift the blinking position leftwards (long press to turn to the next page when the displayed number exceeds five digits). S: Saves modifications and enters the next menu.
⑨	CN5 (communication terminals)	Supports online upgrade and background commissioning when the drive is powered on.
⑩	CN3, CN4 (EtherCAT communication terminals)	CN4 (IN): Connected to the master or the last slave device CN3 (OUT): Connected to the next slave device
⑪	CN1 (control terminal)	Used by reference input signals and other I/O signals.
12	CN7 (encoder feedback terminal)	Supports communication encoder and pulse encoder. Supports gantry synchronization.
13	CN2 (encoder feedback terminal)	Supports communication-type encoders. Supports gantry synchronization.

Note

CN11 24 V backup power input terminal: It is only available in functional safety and backup power-enabled products.

1.1.4 Product Dimensions





Size	L	H	D	L1	H1	D1	ϕLA	Tightening Torque	Weight
	Unit: mm (in.)							Unit: (N·m)	Unit: (kg)
A	45.5 (1.79)	170 (6.69)	150 (5.91)	33 (1.30)	161 (6.34)	75 (2.95)	2×M4	1.2	0.96
C	55±1 (2.17±0.04)	170 (6.69)	173±1 (6.81±0.04)	44 (1.73)	160 (6.30)	75 (2.95)	2×M4	1.2	1.3
D	80±1 (3.15±0.04)	170 (6.69)	183 (7.20)	71 (2.80)	160 (6.30)	75 (2.95)	3×M4	1.2	1.8
E	90 (3.54)	250 (9.84)	230 (9.06)	78 (3.07)	240.5 (9.47)	75 (2.95)	4×M4	1.2	3.6

1.2 Product Specifications

1.2.1 Electrical Specifications

- Single-phase 200 V drive

Item	Size A		Size C		Size D
Servo Drive Model	S1R6	S2R8	S5R5	S7R6	S012
Drive Power (kW)	0.2	0.4	0.75	1.0	1.5
Max. applicable motor capacity (kW)	0.2	0.4	0.75	1.0	1.5
Power supply equipment capacity (kVA)	1.4	2.8	4.6	6.0	8.0
Continuous output current (Arms)	1.6	2.8	5.5	7.6	12.0

Item		Size A		Size C		Size D
Max. output current (Arms)		5.8	10.1	16.9	23.0	32.0
Main circuit[*]	Continuous input current (Arms)	2.3	4.0	7.9	9.6	12.8
	Main circuit power supply	Single-phase 200 VAC–240 VAC, -10% to +10%, 50 Hz/60 Hz				
	Heat (W)[1]	12	23.8	38.2	47.32	69.84
Control circuit	Control circuit power supply	Single-phase 200 VAC–240 VAC, -10% to +10%, 50 Hz/60 Hz				
	Heat (W)[2]	16				
Control circuit backup power circuit[3]	Power input range	Voltage: 24 V DC±15% (must be SELV/PELV power supply)				
	Power of the external power supply	⩾ 50 W				
Braking Resistor	Resistance (Ω)	Optional	Optional	50	25	25
	Resistor power (W)	Optional	Optional	50	80	80
	Min resistance of external resistor (Ω)	40	40	40	20	15
	Max. braking energy absorbed by capacitor (J)	9.3	18.59	32.42	32.42	47.68
	Braking resistor	All models in the series support built-in and external braking resistors. But Size A does not come with a built-in braking resistor as standard				
Cooling mode		Self-cooling		Air cooling		
Overvoltage class		III				
Max. Input Surge Current at Start-up (A)		18.65	18.65	9.325	9.325	12.43333
3τ(ms) (3 x RC time constant)		23.4	46.8	163.2	163.2	180

- Three-phase 200 V drive

Item	Size A		Size C		Size D	Size E		
Servo Drive Model	S1R6	S2R8	S5R5	S7R6	S012	S018	S022	S027
Drive Power (kW)	0.2	0.4	0.75	1.0	1.5	2.0	3.0	5.0
Max. applicable motor capacity (kW)	0.2	0.4	0.75	1.0	1.5	2.0	3.0	5.0
Power supply equipment capacity (kVA)	1.21	2.42	3.84	5.05	6.68	8.33	10.42	20.08
Continuous output current (Arms)	1.6	2.8	5.5	7.6	12.0	18.0	22.0	27.0
Max. output current (Arms)	5.8	10.1	16.9	23.0	32.0	45	55	67.5

Item		Size A		Size C		Size D	Size E		
Main circuit	Continuous input current (Arms)	1.1	2.3	4.4	5.1	8.0	8.7	11.0	23.8
	Main circuit power supply	3-phase 200 VAC–240 VAC, -10% to +10%, 50 Hz/60 Hz							
	Heat (W)[1]	12	23.8	38.2	47.32	69.84	120	125	200
Control circuit	Control circuit power supply	Single-phase 200 VAC–240 VAC, -10% to +10%, 50 Hz/60 Hz							
	Heat (W)[2]	16							
Control circuit backup power circuit[3]	Power input range	Voltage: 24 V DC±15% (must be SELV/PELV power supply)							
	Power of the external power supply	⩾ 50 W							
Braking Resistor	Resistance (Ω)	Optional	Optional	50	25	25	20	20	20
	Resistor power (W)	Optional	Optional	50	80	80	100	100	100
	Min resistance of external resistor (Ω)	40	40	40	20	15	20	20	20
	Max. braking energy absorbed by capacitor (J)	9.3	18.59	32.42	32.42	47.68	78.19	114.43	114.43
	Braking resistor	All models in the series support built-in and external braking resistors. But Size A does not come with a built-in braking resistor as standard					Built-in and external resistor is supported		
Cooling mode		Self-cooling		Air cooling					
Overvoltage class		III							
Max. Input Surge Current (A)		18.65	18.65	9.325	9.325	12.43333	12.43333	12.43333	12.43333
3τ(ms) (3 x RC time constant)		23.4	46.8	163.2	163.2	180	295.2	432	432

- Three-phase 400 V drive

Item	Size C		Size D		Size E		
Servo Drive Model	T3R5	T5R4	T8R4	T012	T017	T021	T026
Drive Power (kW)	1.0	1.5	2.0	3.0	5.0	6.0	7.5
Max. applicable motor capacity (kW)	1.0	1.5	2.0	3.0	5.0	6.0	7.5
Power supply equipment capacity (kVA)	6.05	9.08	10.23	15.15	22.25	25.0	31.25
Continuous output current (Arms)	3.5	5.4	8.4	12.0	17.0	21.0	26.0
Max. output current (Arms)	11.0	14.0	20.0	30.0	42.5	52.5	65.0

Item		Size C		Size D		Size E		
Main circuit	Continuous input current (Arms)	2.4	3.6	5.6	8.0	12.0	16.0	21.0
	Main circuit power supply	3-phase 380 VAC–480 VAC, -10% to +10%, 50 Hz/60 Hz						
	Heat (W)[1]	39.5	63.25	94.82	135.47	187.62	228.28	258.63
Control circuit	Control circuit power supply	Single-phase 380 VAC–480 VAC, -10% to +10%, 50 Hz/60 Hz						
	Heat (W)[2]	16						
Control circuit backup power circuit[3]	Power input range	Voltage: 24 V DC±15% (must be SELV/PELV power supply)						
	Power of the external power supply	⩾ 50 W						
Braking Resistor	Resistance (Ω)	100	100	50	50	35	35	35
	Resistor power (W)	80	80	80	80	100	100	100
	Min resistance of external resistor (Ω)	80	60	45	40	35	25	25
	Max. braking energy absorbed by capacitor (J)	36.06	43.79	64.40	64.40	105.62	154.56	154.56
	Braking resistor	Built-in braking resistor						
Cooling mode		Air cooling						
Overvoltage class		III						
Max. Input Surge Current (A)		18.65	18.65	24.86667	24.86667	24.86667	24.86667	24.86667
3τ(ms) (3 x RC time constant)		33.6	40.8	45	45	73.8	108	108

1.2.2 Technical Specifications [P]

Item			Description
General Specifications	Control mode		IGBT SVPWM control, sine wave current drive mode
			200 V, 400 V: Single-phase/Three-phase full bridge rectification
	Encoder feedback		The drive supports Inovance 23-bit/26-bit multi-turn absolute encoders and functional safety encoders (the drive must be of the functional safety type). For other supported encoder types, see section "Commissioning Items" in the quick installation and commissioning guide. You can use the Inovance multi-turn absolute encoder as an incremental encoder if you remove the battery.
	Conditions for use	Operating/Storage temperature [1]	0°C to 55°C (average load ratio not exceeding 80% in ambient temperatures between 45°C to 55°C) (non freezing)/ -40°C to 70°C
		Operating/Storage humidity	Below 90% RH (no condensation)
		Vibration resistance	Operation: ● 5 Hz–8.4 Hz: 3.5 mm displacement ● 8.4 Hz–200 Hz: 1g
			Product package: ● 5 Hz–100 Hz：$0.01g^2$/Hz ● 200 Hz: $0.001g^2$/Hz ● Grms = 1.14 g
		Impact resistance	19.6 m/s^2
		IP rating	IP20
			Note: excluding terminals (IP00)
		Pollution degree	PD2
		Protection class	Class I
		Altitude	The maximum altitude is 2000 m. ● For altitudes not higher than 1000 m, derating is not required ● Derating is required for altitudes above 1000 m (derate 1% for every additional 100 m) ● For altitudes above 2000 m, contact Inovance.
Speed/ torque control mode	Performance	Load change ratio	Below 0.5% at 0–100% load (under rated speed)
		Voltage change ratio	0.5% at rated voltage±10% (under rated speed)
		Speed control range	1–10000 (The lower limit of the speed control range is that the load can be rotated under rated motor torque)
		Torque control accuracy	±1%
		Soft startup time setting	0s to 65s (Acceleration and deceleration can be set separately.)
	Input signal	Speed Reference Input	Analog input signal; digital input signal; DI signal combination is used to achieve selection of speed 0 to 15
		CANopen communication mode	PV mode
		Torque Reference	Analog input signal; digital input signal
		CANopen communication mode	PT mode

Item				Description
Position Control Mode	Performance	Feedforward compensation		0% to 100.0% (resolution: 0.1%)
		Timing window		1–65535 encoder unit
	Input signal	Pulse reference	Input pulse form	Four forms: direction+pulse, positive logic; direction+pulse, negative logic; phase A + phase B quadrature pulse; CW/ CCW pulse
			Input form	Differential input; open collector
			Input pulse frequency	Differential input: single: 4 Mpps, quadrature: 16 Mpps, pulse width ⩾ 0.125 μs Open collector: max. single pulse frequency: 200 kpps, pulse width must not be less than 2.5 μs
		Power supply for built-in open collector [2]		24 V (built-in 2.4 kΩ resistor)
		Multi-position reference selection		Position 0 to position 15 selectable through DI signal combination. You can assign this function to any other terminal.
		CANopen communication mode		PP mode/HM mode/IP mode
	Position output	Output mode		Phase A, phase B: differential output
				Phase Z: differential output or open collector output
		Frequency division ratio		Any frequency division
Input/ Output signal	DI signal	DI signal function assignment		8 DIs DI1–DI6: normal DI (rising edge (24 V input low to high) input delay: 50 μs, falling edge (24 V input high to low) input delay: 200 μs, voltage range: 20 V–30 V) DI7–DI8: fast DI (rising edge (24 V input low to high) input delay: 10 μs, falling edge (24 V input high to low) input delay: 50 μs, voltage range: 20 V–30 V)
				The DI functions are as follows: Servo enable, alarm reset, gain switching, reference switching, mode switching, zero clamp enable, position reference inhibit, pulse reference inhibit, forward overtravel, reverse overtravel, speed limit, torque limit, forward and reverse jog, step enable, hand wheel switching, electronic gear selection, reference direction setting, home switch, homing enable, current position as home, emergency stop, multi-position, interrupt positioning, position deviation clearing, positioning and command completion signal clearing
	Digital output signal	Output signal function selection		5 DOs. With-load capacity: 50 mA; Voltage range: 5 V to 30 V
				The DO function is as follows: Servo ready, motor rotation signal, zero speed signal, speed consistent, speed attained, torque attained, positioning completed, positioning proximity, torque limit, speed limit, braking, warning output, fault output, warning or fault output, interrupt positioning completed, homing completed, electrical homing completed, enable completed, comparison output, communication forced output, and EDM output
	Analog input signal			AI1 voltage input: 16-bit, -10 V to +10 V; max. allowable voltage: ±12 V
				AI2 voltage input: 12-bit, -10 V to +10 V; max. allowable voltage: ±12 V
	Analog output signal			AO1 voltage output range: -10 V to +10 V

Item			Description
Built-in functions	Overtravel (OT) prevention		The servo drive stops immediately when P-OT or N-OT is active
	Electronic gear ratio		0.001 ⩽ B/A ⩽ 26843545.6
	Protective functions		Including protections against overcurrent, overvoltage, undervoltage, overload, main circuit detection error, heatsink overheat, power phase loss, overspeed, encoder error, CPU error, and parameter error
	Safety Function	Type	STO (standard)/SS1/SBC/SOS/SS2/SLS/SDI/SSM[3]
		Applicable standard	IEC61800-5-2:2016
	LED display		Main circuit CHARGE indicator, 5-digit LED display
	Vibration suppression		5 notches (including two adaptive notches) available, 50 Hz to 8000 Hz
	Usability functions		One-key parameter tuning, adaptive parameter tuning, intelligent parameter tuning, speed observer, and model tracking
	Communication function	Software commissioning	Type_C
		Multi-station communication	Modbus (RS485 interface), CANopen
		Number of multi-station communication axes	Up to 32 For Modbus, and up to 127 for CANopen
		Axis address setting	No physical knob, set through the software
		Function	Including status display, user parameter setting, monitored value display, fault tracing display, JOG and auto-tuning, and communication and motion control command setting
	Others		Gain tuning, alarm log, JOG

1.2.3 Technical Specifications [N]

Item				Description
General Specifications	Control mode			IGBT SVPWM control, sine wave current drive mode
				200 V, 400 V: Single-phase/Three-phase full bridge rectification
	Encoder feedback			The drive supports Inovance 23-bit/26-bit multi-turn absolute encoders and functional safety encoders (the drive must be of the functional safety type). For other supported encoder types, see section "Commissioning Items" in the quick installation and commissioning guide. You can use the Inovance multi-turn absolute encoder as an incremental encoder if you remove the battery.
	Conditions for use	Operating/Storage temperature [1]		0°C to 55°C (average load ratio not exceeding 80% in ambient temperatures between 45°C to 55°C) (non freezing)/ -40°C to 70°C
		Operating/Storage humidity		Below 90% RH (no condensation)
		Vibration resistance		Operation: ● 5 Hz–8.4 Hz: 3.5 mm displacement ● 8.4 Hz–200 Hz: 1g Product package: ● 5 Hz–100 Hz: $0.01g^2$/Hz ● 200 Hz: $0.001g^2$/Hz ● Grms = 1.14 g
		Impact resistance		19.6 m/s^2
		IP rating		IP20 Note: excluding terminals (IP00)
		Pollution degree		PD2
		Protection class		Class I
		Altitude		The maximum altitude is 2000 m. ● For altitudes not higher than 1000 m, derating is not required ● Derating is required for altitudes above 1000 m (derate 1% for every additional 100 m) ● For altitudes above 2000 m, contact Inovance.
Speed/torque control mode	Performance	Load change ratio		Below 0.5% at 0–100% load (under rated speed)
		Voltage change ratio		0.5% at rated voltage±10% (under rated speed)
		Speed control range		1–10000 (The lower limit of the speed control range is that the load can be rotated under rated motor torque)
		Torque control accuracy		±2%
	Input signal	Speed Reference Input	EtherCAT communication mode	CSV/PV mode
			Analog setting; digital setting (H06.03)	
		Torque Reference	EtherCAT communication mode	CST/PT mode
			Analog setting; digital setting (H07.03)	

Item			Description
Position Control Mode	Performance	Feedforward compensation	0% to 100.0% (resolution: 0.1%)
		Timing window	1–65535 encoder unit
	Input signal	EtherCAT communication mode	CSP mode/PP mode/HM mode
	Output mode		Phase A, phase B: differential output
			Phase Z: differential output or open collector output
	Position output	Frequency division ratio	Any frequency division
Input/Output signal	DI signal	DI signal function assignment	5 DIs DI1–DI3: normal DI (rising edge (24 V input low to high) input delay: 50 μs, falling edge (24 V input high to low) input delay: 200 μs, voltage range: 20 V–30 V) DI4–DI5: fast DI (rising edge (24 V input low to high) input delay: 10 μs, falling edge (24 V input high to low) input delay: 50 μs, voltage range: 20 V–30 V)
			The DI functions are as follows: servo enable, alarm reset, forward overtravel, reverse overtravel, electronic gear selection, home switch, emergency stop, probe
	Digital output signal	Output signal function selection	2 DOs With-load capacity: 50 mA Voltage range: 5 V to 30 V
			The DO functions are as follows: servo ready, motor rotation output, comparison output, brake output, forced communication output, EDM output, fault, and warning
	Analog input signal		AI1 voltage input: 16-bit, -10 V to +10 V; max. allowable voltage: ±12 V
			AI2 voltage input: 12-bit, -10 V to +10 V; max. allowable voltage: ±12 V
	Analog output signal		AO1 voltage output range: -10 V to +10 V

Item			Description
Built-in functions	Overtravel (OT) prevention		The servo drive stops immediately when P-OT or N-OT is active
	Electronic gear ratio		0.001 ⩽ B/A ⩽ 26843545.6
	Protective functions		Including protections against overcurrent, overvoltage, undervoltage, overload, main circuit detection error, heatsink overheat, power phase loss, overspeed, encoder error, CPU error, and parameter error
	Safety Function	Type	STO (standard)/SS1/SBC/SOS/SS2/SLS/SDI/SSM[2]
		Applicable standard	IEC61800-5-2:2016
	LED display		Main circuit CHARGE indicator, 5-digit LED display
	Vibration suppression		5 notches (including two adaptive notches) available, 50 Hz to 8000 Hz
	Usability functions		One-key parameter tuning, adaptive parameter tuning, intelligent parameter tuning, speed observer, and model tracking
	Communication function	Software commissioning	Type-C
		Multi-station communication	EtherCAT, FSoE[2]
		Number of multi-station communication axes	Maximum number of slaves: 65535
		Axis address setting	No physical knob, set to 0 to 65535 through the software
		Function	Including status display, user parameter setting, monitored value display, fault tracing display, JOG and auto-tuning, and communication and motion control command setting
	Others		Gain tuning, alarm log, JOG

1.2.4 Communication Technical Data

Modbus [P]

Item		Specification
Modbus Basic performance of slave	Link layer protocol	RS485
	Application layer protocol	Modbus-RTU, GBT 19582.2-2008, custom command areas
	Baud rate	2400kbps, 4800kbps, 9600kbps, 19200kbps, 38400kbps, 57600kbps, 115200kbps
	Duplex mode	Half-duplex
	Data format	8-N-1 (8 data bits, no parity, 1 stop bit)

CANopen [P]

Item		Specification
Item	Name	Description
Parameter setting	Node address switching	The node address can only be set manually. The maximum value is 127.
	Baud rate switching	The baud rate can only be set manually.
Description of state machine	State description/display of communication layer	Initializing, Pre-Operational, Operational, Stopped
	Description/display of emergency error codes	Time-Out, State-Switch-Err, PDO-Lenth-Err, Manu-Err
Error frame recording	Reception error frames can be recorded.	Count of NMT frames with incorrect length
		Count of NMT frames with incorrect command
		Count of heartbeat/node protection frames with incorrect length
Sync deviation detection	Multi-quantile sync deviation detection	1/4-period deviation
		1/2-period deviation
		3/4-period deviation
		1-period deviation
		2-period deviation
Baud rate	20 k–1 M	20kbps, 50kbps, 100kbps, 125kbps, 250kbps, 500kbps, 1Mbps
SYNC	SYNC Producer	Synchronous frame production
	SYNC Consumer	Synchronous signal consumption with deviation detection (in IP mode)
SDO	Start domain upload/ download	Transmit data ⩽ 4 bytes
	SDO abort error	Report an SDO error code contextually
	Name	Segmented upload/download
	Description	Transmit data larger than 4 bytes
PDO	Synchronous TPDO	The sync number is 1–240. The default number of TPDOs/RPDOs is 4, which can be configured.
	Asynchronous TPDO	Time-triggered by time. The default number of TPDOs/RPDOs is 4, which can be configured.
EMCY	**Emergency message**	Heartbeat timeout, PDO length error, node state switching error, application layer error
NMT	Bootup Service	Support for node online message transmit
NMTErrCtl	Life Guard	Optional node protection (cannot be used with heartbeat production)
	Heartbeat Consumer	Node heartbeat consumption
	Heartbeat Producer	Node heartbeat production
Expert mode	PDO communication parameters and their mapping are set through parameters.	PDO communication parameters and their mapping are set manually.

EtherCAT [N]

Item		Specification
Basic performance of slave	Communication protocol	EtherCAT protocol
	Service supported	CoE (PDO, SDO)
	Synchronization mode	DC - Distributed clock FreeRun
	Physical layer	100Base-TX
	Baud rate	100 Mbit/s (100Base-TX)
	Duplex mode	Full duplex
	Topology	Ring, linear, star
	Transmission medium	Shielded cables of Cat 5e or higher
	Transmission distance	Less than 100 m between two nodes (with proper environment and cables)
	Number of slaves	Up to 65535 by protocol, not exceeding 100 in actual use
	EtherCAT frame length	44 bytes to 1498 bytes
	Process Data	A maximum of 1486 bytes per Ethernet frame
	Synchronous jitter of two slaves	< 1 μs
	Min. sync period	250μs
	Update time	1000 digital input/output: 30 μs About 100 μs for 100 servo axes Define different update time for different interfaces.
	Bit error rate	10^{-10} Ethernet standard
Configuration unit	Number of FMMU units	8
	Number of storage synchronization management units	8
	Process data RAM	8 KB
	Distributed clock	64-bit
	EEPROM capacity	32 kbit

1.2.5 Dynamic Brake Characteristics

According to the motor model, initial speed and load inertia, the dynamic braking distance can be estimated. The approximate value of the dynamic braking distance can be calculated by the following formula. For the accurate value, please use the dynamic braking calculation function provided by our software.

Maximum braking distance s (turn) is:

The coefficient is as follows:

- V_0 : Maximum feedback speed
- t_e : Dynamic brake program and relay delay
- J_L: Load moment of inertia
- J_M : Motor moment of inertia

- P_n: Number of motor pole pairs
- R_s: Stator resistance (Ω)
- L_q, L_d: q-axis inductance (mH), d-axis inductance (mH).

1.2.6 Load Moment of Inertia

The load moment of inertia represents the inertia of the load. The larger the load moment of inertia is, the weaker the responsiveness is. An excessively high inertia may result in unstable motion. The allowable load moment of inertia () of the motor is restricted. This value is provided strictly as a guideline and results depend on the motor driving conditions.

An overvoltage warning may occur during deceleration if the load moment of inertia exceeds the allowable value. For servo drives with a built-in braking resistor, an overload alarm my be present. In case of such warnings, take one of the following measures:

- Reduce the torque limit values.
- Reduce the deceleration rate.
- Reduce the maximum speed.
- Install an external braking resistor if the warning cannot be cleared using the above measures.

Table 1–3 Allowable Load Moment of Inertia

<table>
<tr><td rowspan="2">*Motor speed*</td><td colspan="2">Size A</td><td colspan="4">Size C</td><td colspan="3">Size D</td><td colspan="6">Size E</td></tr>
<tr><td>S1
R6</td><td>S2
R8</td><td>S5
R5</td><td>S7
R6</td><td>T3
R5</td><td>T5
R4</td><td>S0
12</td><td>T8
R4</td><td>T0
12</td><td>S0
18</td><td>S0
22</td><td>S0
27</td><td>T0
17</td><td>T0
21</td><td>T0
26</td></tr>
<tr><td>1500rpm</td><td colspan="15">x 20</td></tr>
<tr><td>3,000 rpm</td><td colspan="9">x 20</td><td colspan="6">x 10</td></tr>
<tr><td>4500rpm</td><td colspan="9">x 20</td><td colspan="6">x 5</td></tr>
<tr><td>6000 rpm</td><td colspan="9">x 20</td><td colspan="5">x 5</td><td>Not supported</td></tr>
<tr><td>7000rpm</td><td colspan="3">x 20</td><td colspan="12">Not supported</td></tr>
<tr><td colspan="16">Note: *Motor speed* refers to the maximum speed supported by the motor driven by the drive. For example, MS1H1/H4 can reach 7000 rpm, MS1H2 can reach 6000 rpm, and MS1H3 can reach 4500 rpm. The AC drive may raise an alarm if you set a short acceleration/deceleration time when the running speed exceeds 10 times of the maximum speed.</td></tr>
</table>

2 Installation

2.1 Precautions

- Observe the installation direction described in this manual. Failure to comply may result in equipment fault or damage.
- Do not install or operate damaged or defective equipment. Failure to comply will result in personal injury.
- Do not install the equipment in environments exposed to water splashes or corrosive gases. Failure to comply will result in equipment fault.
- Do not install the equipment near inflammable gases or combustible objects. Failure to comply will result in a fire or electric shock.
- Install the equipment inside a fire-proof cabinet that provides electrical protection. Failure to comply may result in a fire.
- Ensure the specified clearance is reserved among the drive, the interior surface of the control cabinet, and other machines. Failure to comply will result in a fire or equipment fault.
- Do not put heavy objects on the equipment. Failure to comply may result in personal injury or equipment damage.
- Do not impose large impact on the equipment. Failure to comply may result in equipment damage.
- Do not block the air inlet/outlet of the equipment or allow unwanted objects to fall into the equipment. Failure to comply may result in a fire or equipment fault.

Table 2–1 Installation Precautions

Item	Description
Installation Method	• Install the servo drive vertically and upward to facilitate heat dissipation. For installation of multiple servo drives inside the cabinet, install them side by side. For dual-row installation, install an air guide plate. • Make sure the servo drive is installed vertically to the wall. Cool the servo drive down with natural convection or a cooling fan. Secure the servo drive to the mounting surface through two to four mounting holes (the number of mounting holes depends on the capacity of the servo drive). • Install the servo drive vertically to the wall, with its front (actual mounting face) facing the operator. • The mounting bracket (if needed) must be made of incombustible materials.
Cooling	As shown in *"2.3.2 Installation Clearance" on page 38*, reserve sufficient space around the servo drive to ensure a good heat dissipation through the cooling fan or natural convection. Take the heat dissipated by other devices inside the cabinet into consideration. Install a cooling fan to the upper part of the servo drive to avoid excessive temperature rise in a certain area, keeping an even temperature inside the control cabinet.
Grounding	Ground the grounding terminal properly. Failure to comply may result in electric shock or malfunction due to interference.
Wiring requirements	As shown in the figure below, route the servo drive cables downwards to prevent liquid from flowing into the servo drive along the cables.
Dust-proof cover (included in the standard configuration)	Insert the dust-proof cover into the communication port (CN3/CN4) not in use. This is to prevent unwanted objects, such as solids or liquids, from falling into the servo drive and resulting in faults. Each servo drive is delivered with two dust-proof covers inserted into the communication ports by default. You can place an order for more dust-proof covers as needed (model: NEX-02-N2B; manufacturer: PINGOOD). **Note:** • Dust-proof cover: Prevents unwanted objects, such as solids or liquids, from falling into the servo drive and resulting in faults. • Dust-proof covers are delivered along with the servo drive. Keep the dust-proof covers in a proper place.

2.2 Installation Flowchart

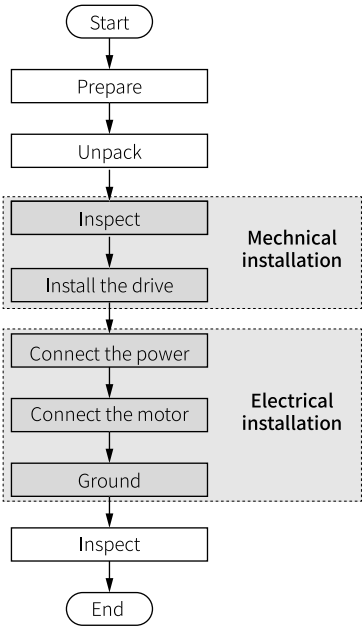


Figure 2-1 Installation Flowchart

Note

The illustration presents the recommended installation procedure. You can adjust the procedure as appropriate.

2.3 Installation of the Servo Drive

2.3.1 Installation Environment Requirements

Table 2–2 Environment requirements

Item	Requirement
Installation location	Indoor
Grid overvoltage	Overvoltage category (OVC) III

Item	Requirement
Altitude	The maximum altitude is 2000 m. • 1000 m and below: Derating is not required. • For altitudes above 1000 m, derate 1% for every additional 100 m. • For altitudes above 2000 m, contact Inovance
Temperature	• Installation/Ambient temperature: –5°C to +55°C. When the temperature ranges from 0°C to +45°C, no derating is required. For temperature above 45°C, derate 2% for every additional 1°C. • Storage/Transportation temperature: -40°C to +70°C. • To improve the reliability of the machine, use the drive in environments without dramatic temperature change. • When installing the drive into an enclosed environment such as a control cabinet, use a cooling fan or air conditioner to keep the temperature of the inlet air below 45°C. Failure to comply will result in over-temperature or a fire. • Install the drive on a flame-retardant surface, with sufficient clearance reserved for heat dissipation. • Take measures to prevent the drive from being frozen.
Ambient humidity	< 90% RH, without condensation
Storage humidity	< 90% RH, without condensation
Vibration resistance	Operation: • 5 Hz to 8.4 Hz: 3.5 mm displacement • 8.4 Hz to 200 Hz: 1 g Product package: • 5 Hz to 100 Hz: 0.01 g^2/Hz • 200 Hz: 0.001 g^2/Hz • Grms = 1.14 g
Impact resistance	Below 19.6 m/s^2
Degree of protection	IP20 Note: Terminals are excluded, which have an IP rating of IP00.
Item	Pollution degree 2 and below Install the drive in a location that meets the following requirements: • Free from direct sunlight, dust, radioactive substance, combustibles, corrosive gas, inflammable or explosive gas, oil mist, water vapor, drip, or salty elements • Insusceptible to vibration (away from equipment that may generate strong vibration, such as a punch press) • Free from unwanted objects such as metallic dust, oil, and water that may enter the drive • Away from combustible materials such as wood • Do not use the drive in vacuum environments.

Figure 2-2 Environment requirements

2.3.2 Installation Clearance

Clearance for side-by-side installation

Drives in different specifications require different installation clearances. It is recommended to reserve a horizontal clearance of at least 10 mm (0.39 in.) on both sides among drives, a horizontal clearance of at least 20 mm (0.79 in.) on both sides among drives and control cabinets, and a vertical clearance of at least 80 mm (3.15 in.) on the top and bottom among drives and control cabinets.

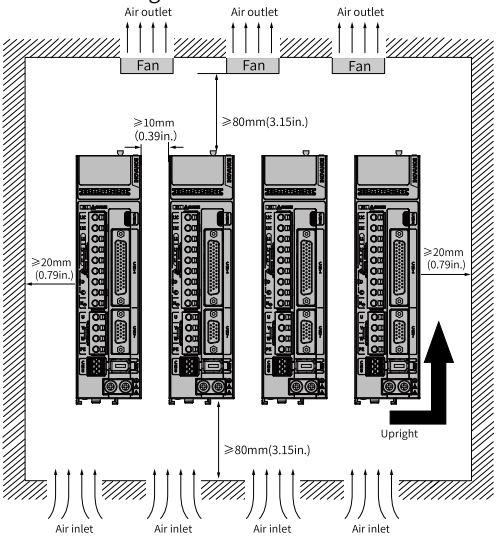


Figure 2-3 Clearance for side-by-side installation

Compact installation

Drives in size A support compact installation, in which a clearance of at least 1 mm (0.04 in.) must be reserved between every two drives. When adopting compact installation, derate the load to 75% of the rated load.

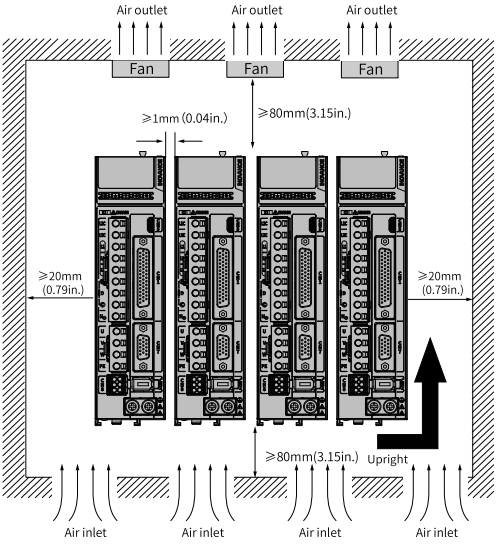


Figure 2-4 Clearance for compact installation

Close installation

Drives in sizes C and D support close installation without derating.

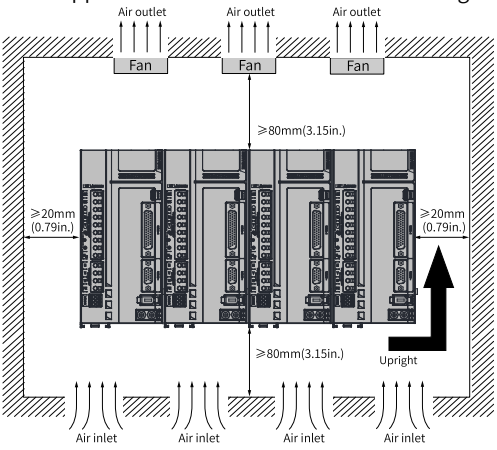


Figure 2-5 Close installation

2.3.3 Installation Dimensions [P]

Servo drives in size A (rated power: 0.2 kW to 0.4 kW)

Figure 2-6 Dimensions

Fixing screw: 2 × M4; recommended tightening torque: 1.2 N·m

Weigh: 0.96 kg

Servo drives in size C (rated power: 0.75 kW to 1.5 kW)

Figure 2-7 Dimensions

Fixing screw: 2 × M4; recommended tightening torque: 1.2 N·m

Weigh: 1.3 kg

Servo drives in size D (rated power: 1.5 kW to 3.0 kW)

Figure 2-8 Dimensions

Fixing screw: 3 × M4; recommended tightening torque: 1.2 N·m

Weigh: 1.8 kg

Servo drives in size E (rated power: 2.0 kW to 7.5 kW)

Figure 2-9 Dimensions

Fixing screw: 4 × M4; recommended tightening torque: 1.2 N·m

Weigh: 3.6 kg

2.3.4 Installation Dimensions [N]

Servo drives in size A (rated power: 0.2 kW to 0.4 kW)

Figure 2-10 Dimensions

Fixing screw: 2 × M4; recommended tightening torque: 1.2 N·m

Weigh: 0.96 kg

Servo drives in size C (rated power: 0.75 kW to 1.5 kW)

Figure 2-11 Dimensions

Fixing screw: 2 × M4; recommended tightening torque: 1.2 N·m

Weigh: 1.3 kg

Servo drives in size D (rated power: 1.5 kW to 3.0 kW)

Figure 2-12 Dimensions

Fixing screw: 3 × M4; recommended tightening torque: 1.2 N·m

Weigh: 1.8 kg

Servo drives in size E (rated power: 2.0 kW to 7.5 kW)

Figure 2-13 Dimensions

Fixing screw: 4 × M4; recommended tightening torque: 1.2 N·m

Weigh: 3.6 kg

2.3.5 Backup power type - Installation Dimensions [P]

Servo drives in size A (rated power: 0.2 kW to 0.4 kW)

Figure 2-14 Dimensions

Fixing screw: 2 × M4; recommended tightening torque: 1.2 N·m

Weigh: 1.11 kg

Servo drives in size C (rated power: 0.75 kW to 1.5 kW)

Figure 2-15 Dimensions

Fixing screw: 2 × M4; recommended tightening torque: 1.2 N·m

Weigh: 1.45 kg

Servo drives in size D (rated power: 1.5 kW to 3.0 kW)

Figure 2-16 Dimensions

Fixing screw: 3 × M4; recommended tightening torque: 1.2 N·m

Weigh: 1.95 kg

Servo drives in size E (rated power: 2.0 kW to 7.5 kW)

Figure 2-17 Dimensions

Fixing screw: 4 × M4; recommended tightening torque: 1.2 N·m

Weigh: 3.75 kg

2.3.6 Backup power type - Installation Dimensions [N]

Servo drives in size A (rated power: 0.2 kW to 0.4 kW)

Figure 2-18 Dimensions

Fixing screw: 2 × M4; recommended tightening torque: 1.2 N·m

Weigh: 1.11 kg

Servo drives in size C (rated power: 0.75 kW to 1.5 kW)

Figure 2-19 Dimensions

Fixing screw: 2 × M4; recommended tightening torque: 1.2 N·m

Weigh: 1.45 kg

Servo drives in size D (rated power: 1.5 kW to 3.0 kW)

Figure 2-20 Dimensions

Fixing screw: 3 × M4; recommended tightening torque: 1.2 N·m

Weigh: 1.95 kg

Servo drives in size E (rated power: 2.0 kW to 7.5 kW)

Figure 2-21 Dimensions

Fixing screw: 4 × M4; recommended tightening torque: 1.2 N·m

Weigh: 3.75 kg

2.3.7 Pre-installation Check

Table 2–3 Pre-inspection checklist

No.	Item	Checked
1	The delivered product is consistent with your order.	☐
2	No deformation or cracks are present on the casing.	☐
3	All screws are in position and tightened.	☐
4	The signal terminal is free from fracture, foreign objects and bent pins.	☐

2.3.8 Installing the Drive

The drive supports backplate mounting only.

Figure 2-22 Backplate mounting

2.4 Installation of Optional Parts

2.4.1 Instructions for Installing the Magnetic Ring and Ferrite Clamp

The drive generates very strong interference during operation. The drive may interfere with or be interfered with by other devices due to improper routing or grounding. Wind the drive output U/V/W cable onto a magnetic ring for two to four turns. Wind the signal cable onto a ferrite clamp or magnetic ring for one to two turns.

- An amorphous magnetic ring has a high magnetic conductivity when the frequency is within 1 MHz and can efficiently suppress interference of the servo drive, but is expensive.
- A ferrite clamp has a high magnetic conductivity when the frequency is above 1 MHz and can efficiently suppress interference of various signal cables and low-power servo drives at a low cost.

The following figure shows the connection of the magnetic ring and ferrite clamp.

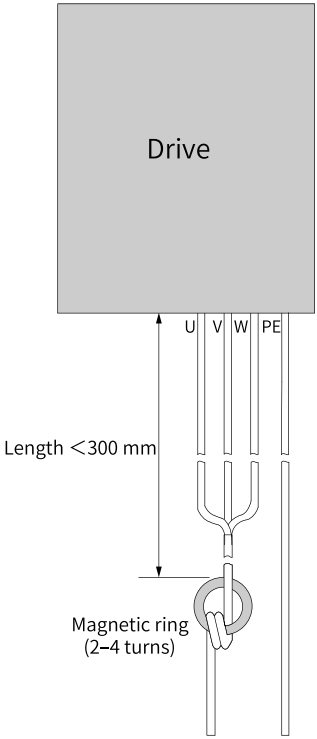


Figure 2-23 Installing the magnetic ring

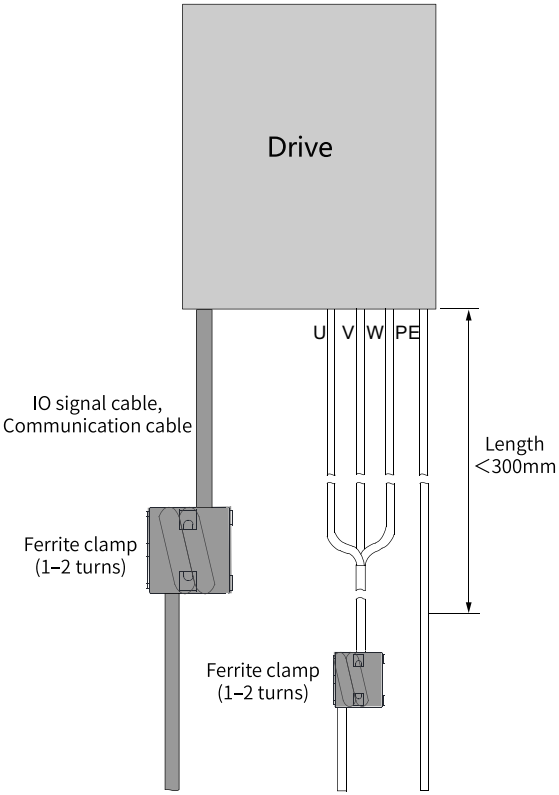


Figure 2-24 Installation of the ferrite clamp

3 System Connection

3.1 System Composition

- The servo drive is directly connected to an industrial power supply, with no isolation such as a transformer. A fuse or circuit breaker therefore must be connected to the input power supply to prevent electric shock in the servo system. For the sake of safety, install a residual current device (RCD) to provide protections against overload and short circuit or a specialized RCD to protect the grounding cable.
- Do not start or stop the motor by using the electromagnetic contactor. As a high-inductance device, the motor may generate transient high voltage that may break down the contactor.
- When connecting an external power supply to the control circuit or a 24 VDC power supply, pay attention to the power capacity as insufficient power capacity will lead to insufficient supply current, resulting in failure of the servo drive or the brake. This is especially true when the power supply is used to power up multiple servo drives or brakes. The brake must be powered up by a 24 VDC power supply that matches the motor model and meets the brake power requirements.

3.2 System Wiring Diagram [P]

Figure 3-1 System wiring example

3.3 System Wiring Diagram [N]

Figure 3-2 System wiring example

4 Electrical Connection

4.1 Electrical Wiring Diagram [P]

Figure 4-1 Electrical Wiring Diagram

Note

- indicates shielded twisted pairs.
- [1] The range of the internal +24 V power supply is 20 V to 30 V, with maximum operating current being 150 mA.
- [2] DI7 and DI8 are high-speed DIs that must be used according to their functions assigned. DI allows external power supplies. See *" DI circuit" on page 66* for details.
- [3] Use the shielded twisted pairs for pulse terminals, with both ends of the shield connected to PE. Connect GND and signal GND of the host controller properly. Pins 41, 43, 37 and 39 or 38, 36, 42, and 40 can be used for both low-speed and high-speed pulses.
- [4] Use shielded twisted pairs as frequency-division output cables and full closed-loop input cables, with both ends of the cable shield connected to PE. Connect GND to the signal ground of the host controller properly.
- [5] The DO power supply (voltage range: 5 V to 24 V) needs to be prepared by users. The DO terminals support 30 VDC voltage and 50 mA current to the maximum. You can enable optocoupler input on the affiliated device through an additional current limiting resistor. For details, see *" DO circuit" on page 66*.

4.2 Electrical Wiring Diagram [N]

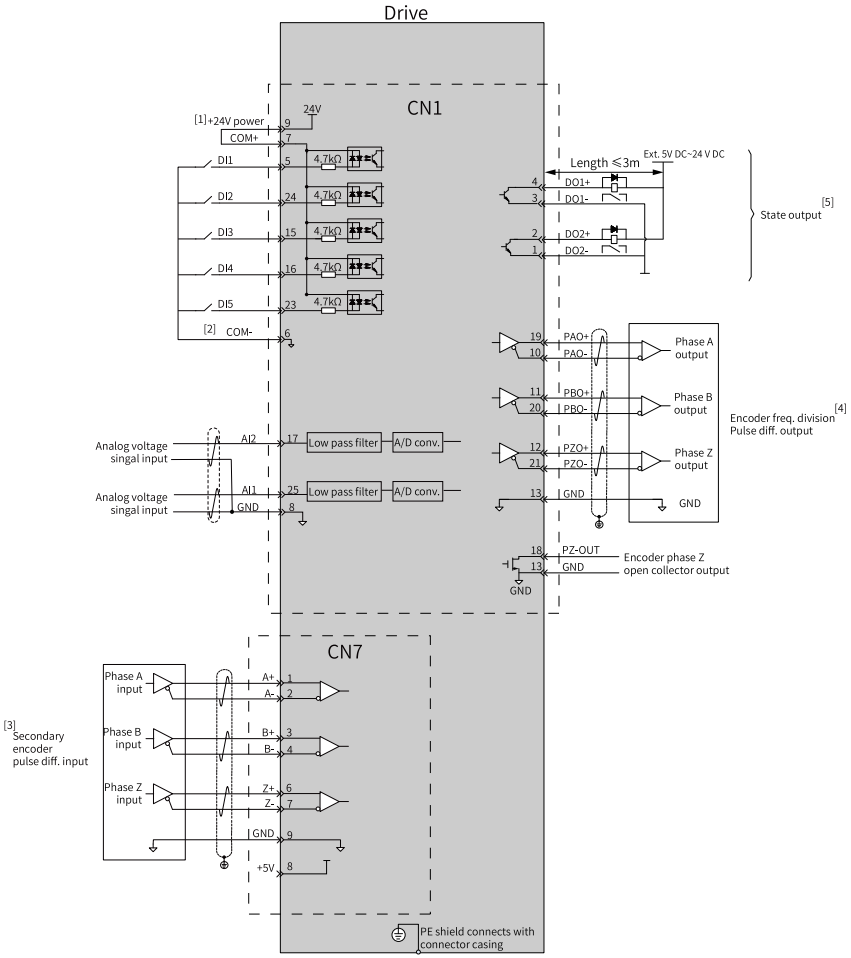


Figure 4-2 Electrical Wiring Diagram

Note

- indicates shielded twisted pairs.
- [1] The range of the internal +24 V power supply is 20 V to 30 V, with maximum operating current being 150 mA.
- [2] DI4 and DI5 are high-speed DIs that must be used according to their functions assigned. DI allows external power supplies. See *" DI circuit" on page 66* for details.
- [3] Use shielded twisted pairs as frequency-division output cables and full closed-loop input cables, with both ends of the cable shield connected to PE. Connect GND to the signal ground of the host controller properly.
- [4] The DO power supply (voltage range: 5 V to 24 V) needs to be prepared by users. The DO terminals support 30 VDC voltage and 50 mA current to the maximum. You can enable optocoupler input on the affiliated device through an additional current limiting resistor. For details, see *" DO circuit" on page 66*.

5 Wiring Terminals

5.1 Introduction to Main Circuit Terminals

5.1.1 Terminal Arrangement

Servo drives in sizes A, C and D (rated power: 0.2 kW to 3.0 kW)

Figure 5-1 Main circuit terminals

Table 5–1 Description of main circuit terminals

Name	Description
L1C, L2C (control circuit power input terminals)	See the nameplate for the rated voltage class.
L1, L2, L3 (main circuit power input terminals)[1]	Power input terminals of the servo drive. See the nameplate for the rated voltage class.
P ⊕ , D, and C (terminals for connecting an external braking resistor)[2]	Remove the jumper bar between terminals P⊕ and C before connecting an external braking resistor between terminals P ⊕ and D.
P ⊕ , N ⊖ (servo bus terminals)	Used by the common DC bus for multiple servo drives.
U, V, W (terminals for connecting the servo motor)	Connected to U, V, and W phases of the servo motor.
PE (grounding) terminal	Connected to the grounding terminal of the motor for grounding purpose.

Servo drives in size E (rated power: 2.0 kW to 7.5 kW)

Figure 5-2 Main circuit terminals

Table 5–2 Description of main circuit terminals

Name	Description
L1C, L2C (control circuit power input terminals)	See the nameplate for the rated voltage class.
R, S, and T (main circuit power input terminals)[1]	Power input terminals of the servo drive. See the nameplate for the rated voltage class.

Name	Description
P ⊕ , D, C (terminals for connecting external braking resistor)	Remove the jumper bar between terminals P⊕ and C before connecting an external braking resistor between terminals P ⊕ and D.
N2, N1 (terminals for connecting external reactor)	Terminals N1 and N2 are jumpered by default. To suppress harmonics in the power supply, remove the jumper between terminals N1 and N2 first and connect an external DC reactor between terminals N1 and N2.
U, V, W (terminals for connecting the servo motor)	Connected to U, V, and W phases of the servo motor.

5.1.2 Wiring Precautions and Requirements

- Do not connect the output terminals U, V, and W of the drive to a three-phase power supply. Failure to comply may result in physical injury or a fire.
- Do not connect the motor terminals U, V, and W to a mains power supply. Failure to comply may result in physical injury or a fire.
- The main circuit cable must be away from the motor so that its insulation will not be damaged by high temperature of the motor surface.
- Connect the servo drive to the motor directly. Do not use an electromagnetic contactor during wiring. Failure to comply may result in equipment fault.

- Do not use the power from IT system for the drive. Use the power from TN/TT system for the drive. Failure to comply may result in an electric shock.
- Connect a electromagnetic contactor between the input power supply and the main circuit power supply of the servo drive (R, S and T) to form a structure which allows independent power cutoff on the servo drive power side. This is to prevent fire accident caused by continuous high current generated upon fault.
- Check that the input power supply of the drive is within the specified voltage range. Failure to comply may result in faults.
- The main circuit cable must be away from the motor so that its insulation will not be damaged by high temperature of the motor surface.
- Use the ALM (fault) signal to cut off the main circuit power supply. A faulty braking transistor may overheat the regenerative resistor and lead to a fire.
- Connect the PE terminal of the drive to the PE terminal of the control cabinet. Failure to comply may result in an electric shock.
- Ground the entire system properly. Failure to comply may result in equipment malfunction.
- After the power supply is cut off, residual voltage is still present in the internal capacitor of the drive, wait for at least 15 min before further operations. Failure to comply may result in an electric shock.
- The specifications and installation method of external cables must comply with the applicable local regulations.
- Observe the following requirements when the servo drive is used on a vertical axis.
  - Set the safety device properly to prevent the workpiece from falling upon warning or overtravel.
  - Ensure the positive/negative polarity of the 24 V power supply is correct. Otherwise, the axis may fall and cause personal injury or equipment damage.
- It is recommended to use Teflon cables featuring a higher temperature limit when the temperature inside the cabinet exceeds the temperature limit of regular cables. As the surface of regular cables may be easily hardened and cracked under low temperature, take thermal insulation measures for cables laid in environments with low temperature.
- The servo drive must be grounded properly. Failure to comply may result in device malfunction or damage.

- Observe the following requirements during wiring of the power supply and main circuit:
  - When the main circuit terminal is a connector, remove the connector from the servo drive before wiring.
  - Insert one cable into one cable terminal of the connector. Do not insert multiple cables into one cable terminal.
  - When inserting cables, take enough care to prevent the cable conductor burrs from being short circuited to the neighboring cable.
  - Insulate the connecting part of the power supply terminals to prevent electric shock.
  - Do not connect a 220 V servo drive to a 380 V power supply directly.
  - Install safety devices such as a circuit breaker to prevent short circuit in external circuits. Failure to comply may result in a fire.
  - Cut off the main circuit power supply and switch off the S-ON signal after an alarm signal is detected.
  - After all cables are connected, it is recommended to tie them at the point 10cm–20cm away from the connector end.
- Do not put heavy objects onto cables or pull cables with excessive force. Failure to comply may result in cable damage, leading to an electric shock.
- Use a power supply filter to reduce the electromagnetic interference on electronic devices surrounding the servo drive.

- The DDR motor has been matched with the encoder adapter before it is shipped. Do not replace it yourself, otherwise there is a danger of runaway. Inovance is not liable for any personal injury and property damage incurred.
- During wiring, strictly follow the phase sequence of the DDR motor. Otherwise, there is a danger of runaway. Inovance is not liable for any personal injury and property damage incurred.

Caution

- Ensure that the DDR motor grounding cable and shield cable are securely connected to the drive grounding terminal. Ensure that the cables are properly and securely installed. Failure to comply will result in motor malfunction or damage.
- Fasten the screws on the power side and motor output side. Failure to comply will result in a fire. Use the motor within the rated voltage range. Failure to comply will result in a fire.
- Reduce the routing length and cable length as possible. For cable diameters, see the instructions in this manual about the precautions for wiring the signal cable. Keep the power cable away from the signal cable at least 100 mm. Interference on the signal cables will cause vibration or malfunction.
- Cables of the standard specifications are recommended. If cables of other specifications need to be used, select the cables properly based on the rated current of the equipment and the running environment. The cables of other specifications must be twisted-pair or multi-core twisted pair.
- Do not connect the commercial-use power directly to the motor. Risk of fire or malfunction.

5.1.3 Wiring Example

5.1.3.1 Power Supply Wiring Example

Single-phase 200 V models

Figure 5-3 Main circuit wiring of single-phase 200 V models

Three-phase 200 V models

Figure 5-4 Main circuit wiring of three-phase 200 V models

Three-phase 400 V models

Figure 5-5 Main circuit wiring of three-phase 400 V models

5.1.3.2 Wiring of the Grounding Cable

Observe the following requirements to ensure a proper grounding of the servo drive.

Grounding requirements

Observe the following requirements to ensure a proper grounding of the drive.

- The protective grounding conductor must be a yellow/green cable comprised of copper conductors. Do not connect the protective grounding conductor to a switching device (such as a circuit breaker) in serial.
- Ground the grounding terminal properly. Improper grounding will lead to device malfunction or damage.
- Do not connect the grounding terminal to the N terminal of the neutral wire of the power supply.
- It is recommended to install the drive on a conductive metal surface. Ensure the whole conductive bottom of the drive is connected properly to the mounting face.
- Tighten the grounding screw with specified tightening torque to prevent the protective grounding conductor from being secured improperly.

Multi-drive grounding

Side-by-side installation of multiple drives:

Table 5–3 Description for grounding of multiple drives installed in parallel

No.	Wiring
①	Connect the main circuit input PE terminal of the drive to the grounding copper busbar of the control cabinet through a protective grounding conductor.
②	Connect the PE cable on the input power supply side to the grounding copper busbar of the control cabinet.
③	Connect the grounding copper busbar of the control cabinet to the metal enclosure of the control cabinet through the protective grounding conductor.
④	Connect the motor output cable shield to the output PE terminal of the servo drive.

Grounding the control cabinet system

The most cost-effective method of suppressing interference in a control cabinet is to isolate the interference source from devices that may be interfered with. Divide the control cabinet into multiple EMC compartments or use multiple control cabinets based on the intensity of interference sources, and install each device in accordance with the following wiring principles.

Table 5–4 Wiring requirements

No.	Wiring requirements
1	Place the control unit and the drive unit in two separate control cabinets.
2	If multiple control cabinets are used, connect the control cabinets by using a PE cable with a cross-sectional area of at least 16 mm^2 for equipotentiality between the control cabinets.

No.	Wiring requirements
3	If only one control cabinet is used, place different devices in different compartments of the control cabinet based on signal intensity.
4	Apply equipotential bonding to devices in different compartments inside the control cabinet.
5	Shield all communication (such as RS485) and signal cables drawn from the control cabinet.
6	Place the power input filter in a position near the input interface of the control cabinet.
7	Apply spray coating to each grounding point in the control cabinet.

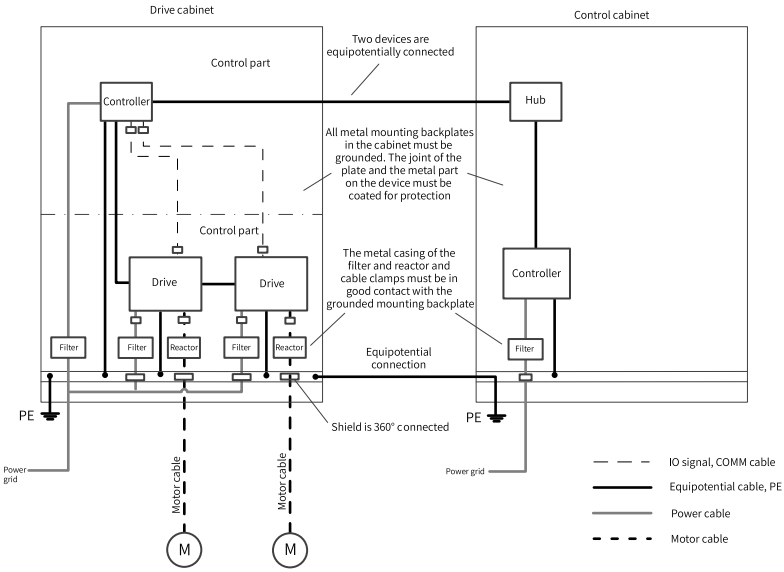


Figure 5-6 Recommended wiring for the control cabinet system

5.1.4 Cable Requirements

Cable Requirements

- The bending radius of a cable must be above 10 times its outer diameter to prevent the internal conductor from breaking due to long-time bending.
- Use cables with a rated voltage above 600 VAC and rated temperature above 75°C. Under an ambient temperature of 30°C and normal cooling conditions, the permissible current density of the cable cannot exceed 8 A/mm2 when the total current is below 50 A, or 5 A/mm2 when the total current is above 50 A. The permissible current density (A/mm^2) can be adjusted based on the following formula in case of high ambient temperature or bundled cables.

Allowable current density = 8 x Reduction coefficient of current-carrying density of the conductor x Current correction coefficient

Table 5–5 Reduction coefficient of conductor current-carrying density

Number of Cables in a Duct	Current Reduction Coefficient
< 3	0.7
4	0.63
5–6	0.56
7–15	0.49

- Do not bundle power cables and signal cables together or route them through the same duct. Power cables and signal cables must be separated by at least 30 cm to prevent interference.
- Use a grounding cable with the same cross-sectional area as the main circuit cable. If the cross-sectional area of the main circuit cable is less than 1.6 mm2, use a grounding cable with a cross-sectional area of 2.0 mm2.

To comply with the EMC standards, use shielded cables. Shielded cables are divided into three-conductor shielded cables and four-conductor shielded cables, as shown in *"Figure 5–7 " on page 56* .

If the conductivity of the three-conductor cable shield is insufficient, add an extra PE cable. Or use a four-core shielded cable, with one core being the PE wire. The shield of the shielded cable is comprised of coaxial cooper braids to suppress radio frequency interference. To enhance the shielding performance and conductivity, the braided density of the shield must be greater than 90%.

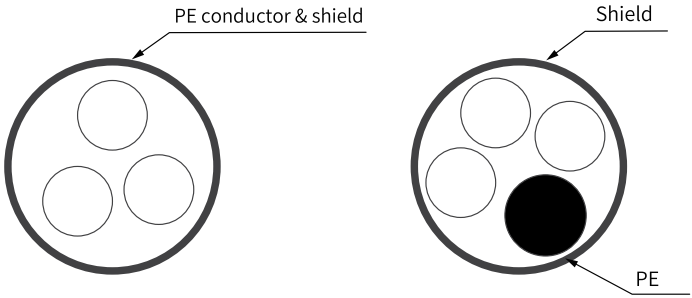


Figure 5-7 Recommended power cable

Cable shield requirements

Take proper shielding measures in the following locations to prevent equipment damage:

- Locations with interference caused by static electricity
- Locations with strong electric field or magnetic field
- Locations with radioactive rays

It is recommended to use the shielded cable as the motor output cable. Perform a 360° connection on the shield structure by using the shield grounding bracket, and crimp the drain wire of the shield to the PE terminal. Connect the shielded cable with shielded iron plate at the grounding end of the equipment for 360°, and avoid connecting the shielding layer to the casing in the form of "pig tail", otherwise, it will become high impedance for high frequency noise. If the shielding must be disconnected to install the motor contactor, the shielding must be kept continuous and its high frequency impedance as low as possible.

See *"Figure 5–8 Connection of the shielding layer" on page 57* for the correct connection of the shielding layer. Connect the shielding wire to the drive for 360° and avoid pig tail connection as possible. In the figure, the red line is the power line shielding layer, and the yellow line and blue line are the IO signal line shielding layer.

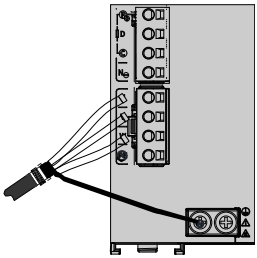


Figure 5-8 Connection of the shielding layer

Grounding bracket of the power cable shield.

Keep the lead wire of the motor cable shield as short as possible, with its width (b in the following figure) not shorter than 1/5 of its length (a in the following figure).

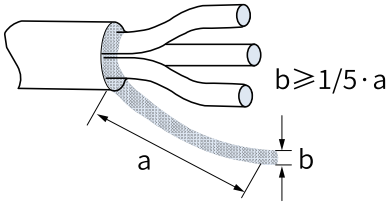


Figure 5-9 Lead-out of the motor cable shield

5.1.5 Cable Length

Table 5–6 Input/Output current specifications of the servo drive

Servo Drive Model		Rated input current (A)	Rated output current (A)	Maximum Output Current (A)
Single-phase 200 V				
Size A	S1R6	2.3	1.6	5.8
	S2R8	4.0	2.8	10.1
Size C	S5R5	7.9	5.5	16.9
	S7R6	9.6	7.6	23.0
Size D	S012	12.8	12.0	32.0
Three-phase 200 V				
Size A	S1R6	1.1	1.6	5.8
	S2R8	2.3	2.8	10.1
Size C	S5R5	4.4	5.5	16.9
	S7R6	5.1	7.6	23.0
Size D	S012	8.0	12.0	32.0
Size E	S018	8.7	18.0	45.0
	S022	11.0	22.0	55.0
	S027	23.8	27.0	67.5
Three-phase 400 V				
Size C	T3R5	2.4	3.5	11.0
	T5R4	3.6	5.4	14.0
Size D	T8R4	5.6	8.4	20.0
	T012	8.0	12.0	30.0
Size E	T017	12.0	17.0	42.5
	T021	16.0	21.0	52.5
	T026	21.0	26.0	65.0

Table 5–7 Recommended main circuit cables

Servo Drive Model			L1C, L2C		L1, L2, L3/R, S, T		P ⊕ , D, C, N ⊖ , N2, N1		U, V, W, PE		Grounding terminal	
Size	Model	Rated input current (A)	(mm^2)	AWG	(mm^2)	AWG	(mm^2)	AWG	(mm^2)	AWG	(mm^2)	AWG
Single-phase 200 V												
A	S1R6	2.3	2×0.52	20	3×0.52	20	2×0.52	20	4×0.52	20	0.52	20
	S2R8	4	2×0.52	20	3×0.52	20	2×0.52	20	4×0.52	20	0.52	20
C	S5R5	7.9	2×0.52	20	3×0.52	20	2×0.52	20	4×0.52	20	0.52	20
	S7R6	9.6	2×0.82	18	3×0.82	18	2×0.82	18	4×0.81	18	0.52	20
D	S012	12.8	2×1.31	16	3×1.31	16	2×1.31	16	4×1.31	16	0.81	18
Three-phase 200 V												

Servo Drive Model			L1C, L2C		L1, L2, L3/R, S, T		P ⊕ , D, C, N ⊖ , N2, N1		U, V, W, PE		Grounding terminal	
Size	Model	Rated input current (A)	(mm^2)	AWG	(mm^2)	AWG	(mm^2)	AWG	(mm^2)	AWG	(mm^2)	AWG
A	S1R6	1.1	2×0.52	20	3×0.52	20	2×0.52	20	4×0.52	20	0.52	20
	S2R8	2.3	2×0.52	20	3×0.52	20	2×0.52	20	4×0.52	20	0.52	20
C	S5R5	4.4	2×0.52	20	3×0.52	20	2×0.52	20	4×0.52	20	0.52	20
	S7R6	5.1	2×0.52	20	3×0.52	20	2×0.52	20	4×0.81	18	0.52	20
D	S012	8	2×1.31	16	3×1.31	16	2×1.31	16	4×1.31	16	0.81	18
E	S018	8.7	2×2.08	14	3×2.08	14	2×2.08	14	4×2.08	14	1.31	16
	S022	11	2×2.08	14	3×2.08	14	2×2.08	14	4×2.08	14	1.31	16
	S027	23.8	2×3.33	12	3×3.33	12	2×3.33	12	4×3.33	12	2.08	14
Three-phase 400 V												
C	T3R5	2.4	2×0.52	20	3×0.52	20	2×0.52	20	4×0.52	20	0.52	20
	T5R4	3.6	2×0.52	20	3×0.52	20	2×0.52	20	4×0.52	20	0.52	20
D	T8R4	5.6	2×0.52	20	3×0.52	20	2×0.52	20	4×0.81	18	0.52	20
	T012	8	2×1.31	16	3×1.31	16	2×1.31	16	4×1.31	16	0.81	18
E	T017	12	2×2.08	14	3×2.08	14	2×2.08	14	4×2.08	14	1.31	16
	T021	16	2×2.08	14	3×2.08	14	2×2.08	14	4×2.08	14	1.31	16
	T026	21	2×3.33	12	3×3.33	12	2×3.33	12	4×3.33	12	2.08	14

Table 5–8 Recommended Cable Specifications and Models

Cable Type	Cable Size	OD (mm)
Power cable	4×12AWG	12.2±0.4
	4×14AWG	10.5±0.3
	4×16AWG	9.5±0.4
	4×18AWG	7.8±0.2
	4×20AWG	6.5±0.2
Power cable shield	4×12AWG	12.9±0.4
	4×14AWG	11.2±0.4
	4×16AWG	10.1±0.4
	4×18AWG	8.3±0.2
	4×20AWG	6.5±0.2
Power cable + brake cable	4 × 20AWG + 2 × 24AWG	6.5±0.2
Brake cable	2×18AWG	5.8±0.2
	2×20AWG	5.0±0.2

Table 5–9 Main circuit cable lug model and tightening torque

Servo Drive Model			Recommended PVC Cable Model (at 40°C)			
Size	Model	Rated Input Current (A)	U, V, W, PE	Recommended Model of Brake Cable Lug	Recommended Model of Grounding Cable Lug	Tightening Torque (N·m)
Single-phase 200 V						
A	S1R6	2.3	GTVE10008	GTVE05008	TVR2–4	-
	S2R8	4				-
C	S5R5	7.9				-
	S7R6	9.6	GTVE15008	GTVE10008		-
D	S012	12.8				-
Three-phase 200 V						
A	S1R6	1.1	GTVE10008	GTVE05008	TVR2–4	-
	S2R8	2.3				-
C	S5R5	4.4				-
	S7R6	5.1				-
D	S012	8.0				-
E	S018	8.7				-
	S022	11.0	GTVE15008	GTVE10008		-
	S027	23.8	GTVE25010	GTVE15008		-
Three-phase 400 V						
C	T3R5	2.4	GTVE10008	GTVE05008	TVR2–4	-
	T5R4	3.6				-
D	T8R4	5.6				-
	T012	8.0				-
E	T017	12.0	TVS1.25–4	GTVE10008	TVR1.25–4	1.36
	T021	16.0	TVS2–4	GTVE10008	TNR2–4	1.36
	T026	21.0	TVS3.5–4	GTVE10008	TNR3.5–4	1.36

The following table lists the data for recommended cable lugs (manufacturer: Suzhou Yuanli Metal Enterprise Co., Ltd) for your reference.

Table 5–10 TVR2-4 cable lug

Lug Model		D (mm)	d2 (mm)	B (mm)	Dimension Drawing
TVR	2-4	4.5	4.3	8.5	

Table 5–11 Specifications of motor output cables

MS1H1/H4 05B–10C (applicable to 0.05 kW–1 kW)			
Cable type	Regular cable	Flexible cable	Oil-resistant shielded flexible cable
Cable model	S6-L-M/B***-X.X	S6-L-M/B***-X.X-T	S6-L-M/B***-X.X-TS

MS1H1/H4 05B–10C (applicable to 0.05 kW–1 kW)			
Cable specifications	UL2517 (rated temperature: 105°C) 4E x 20AWG + 2C x 24AWG	UL2517 (rated temperature: 105°C) 4E x 20AWG + 2C x 24AWG	UL2517 (rated temperature: 105°C) 4E x 20AWG + 2C x 24AWG
	Power cable: 20AWG (0.52 mm^2); OD of insulation: 1.7 mm	Power cable: 20AWG (0.52 mm^2); OD of insulation: 1.7 mm	Power cable: 20AWG (0.52 mm^2); OD of insulation: 1.7 mm
	Brake cable: 24AWG (0.205 mm^2); OD of insulation: 1.1 mm	Brake cable: 24AWG (0.205 mm^2); OD of insulation: 1.1 mm	Brake cable: 24AWG (0.205 mm^2); OD of insulation: 1.1 mm
Sheath diameter	6.5±0.2 mm		
Internal structure and conductor colors			
Fill in "X.X" in the model number with cable length.			

Table 5–12 Specifications of motor output cables

MS1H2 10C–50C (Applicable to 1 kW–5 kW)/MS1H3 85B–18C (Applicable to 850 W–1.8 kW)			
Cable type	Regular cable	Flexible cable	Oil-resistant shielded flexible cable
Cable model	S6-L-M/B***-X.X	S6-L-M/B***-X.X-T	S6-L-M/B***-X.X-TS
Cable specifications	UL2586 (rated temperature: 105°C) 4E x 16AWG, 2C x 18AWG	UL2586 (rated temperature: 105°C) 4E x 16AWG, 2C x 18AWG	UL2586 (rated temperature: 105°C) 4E x 16AWG, 2C x 18AWG
	Power cable: 16AWG (1.31 mm^2) OD of insulation: 3.1 mm	Power cable: 16AWG (1.31 mm^2) OD of insulation: 3.25 mm	Power cable: 16AWG (1.31 mm^2) OD of insulation: 3.25 mm
	Brake cable: 18AWG (0.823 mm^2) OD of insulation: 2.0 mm	Brake cable: 18AWG (0.823 mm^2) OD of insulation: 2.15 mm	Brake cable: 18AWG (0.823 mm^2) OD of insulation: 2.15 mm
Sheath diameter	9.5±0.3 mm (main circuit)	10.0±0.3 mm (main circuit)	10.5±0.3 mm (main circuit)
Internal structure and conductor colors			
Fill in "X.X" in the model number with cable length.			

Table 5–13 Specifications of motor output cables

MS1H3 29C–75C (Applicable to 2.9 kW–7.5 kW)			
Cable type	Regular cable	Flexible cable	Oil-resistant shielded flexible cable
Cable model	S6-L-M/B***-X.X	S6-L-M/B***-X.X-T	S6-L-M/B***-X.X-TS

MS1H3 29C–75C (Applicable to 2.9 kW–7.5 kW)			
Cable specifications	UL2586 (rated temperature: 105°C) 4E x 12AWG, 2C x 18AWG	UL2586 (rated temperature: 105°C) 4E x 12AWG, 2C x 18AWG	UL2586 (rated temperature: 105°C) 4E x 12AWG, 2C x 18AWG
	Power cable: 12AWG (3.31 mm^2) OD of insulation: 4.1 mm	Power cable: 12AWG (3.31 mm^2) OD of insulation: 4.2 mm	Power cable: 12AWG (3.31 mm^2) OD of insulation: 4.2 mm
	Brake cable: 18AWG (0.823 mm^2) OD of insulation: 2.0 mm	Brake cable: 18AWG (0.823 mm^2) OD of insulation: 2.15 mm	Brake cable: 18AWG (0.823 mm^2) OD of insulation: 2.15 mm
Sheath diameter	12.2±0.4 mm (main circuit)	12.5±0.4 mm (main circuit)	13.2±0.4 mm (main circuit)
Internal structure and conductor colors			
Fill in "X.X" in the model number with cable length.			

5.2 Description of Control Terminal (CN1)

5.2.1 Terminals [P]

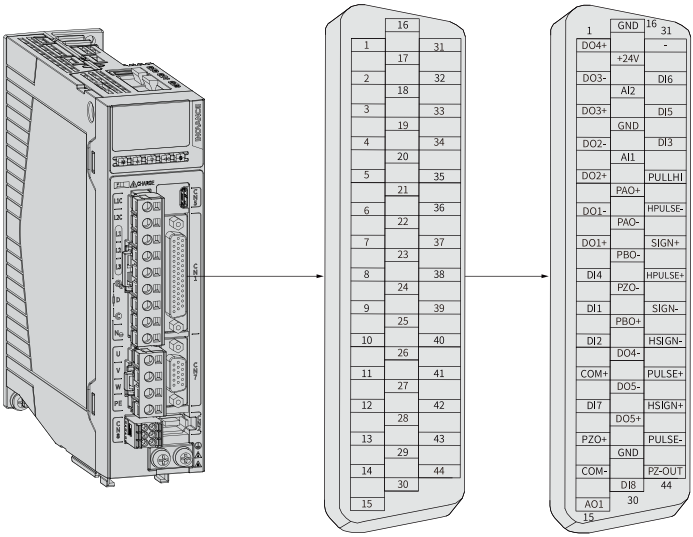


Figure 5-10 Control terminal pin layout of the servo drive

Table 5–14 Position Reference Input Signals

Signal Name		Pin No.	Function
Position reference	PULSE+	41	Low-speed pulse reference input mode: • Differential drive input • Open-collector Pulse input form: • Direction+Pulse • Quadrature pulse of phases A and B • CW/CCW pulse
	PULSE–	43	
	SIGN+	37	
	SIGN–	39	
	PULLHI	35	
	HPULSE+	38	High-speed pulse input reference
	HPULSE–	36	
	HSIGN+	42	High-speed position reference symbols
	HSIGN–	40	

Table 5–15 Description of DI/DO signals

Signal Name		Default Function	Pin No.	Function
General	DI1	P-OT	9	Positive limit switch
	DI2	N-OT	10	Negative limit switch
	DI3	INHIBIT	34	Position reference inhibited
	DI4	ALM-RST	8	Alarm reset (edge-triggered)
	DI5	S-ON	33	Servo ON
	DI6	-	32	-
	DI7	XintStart	12	Interrupt positioning selection
	DI8	HomeSwitch	30	Home switch
	+24 V		17	Internal 24 V power supply; voltage range: 20 V to 30 V; maximum output current: 150 mA
	COM–		14	
	COM+		11	Common terminal of DI terminals
	DO1+	S-RDY+	7	Ready to switch on
	DO1-	S-RDY-	6	
	DO2+	COIN+	5	Positioning completed
	DO2-	COIN–	4	
	DO3+	-	3	-
	DO3-	-	2	
	DO4+	ALM+	1	Fault output
	DO4-	ALM-	26	
	DO5+	HomeAttain+	28	Homing is completed.
	DO5-	HomeAttain–	27	

Table 5–16 Encoder frequency-division output signals

Signal Name		Pin No.	Function	
General	PAO+	21	Phase A frequency-division output signal	Quadrature frequency-division pulse output signals of phases A and B
	PAO–	22		
	PBO+	25	Phase B frequency-division output signal	
	PBO–	23		
	PZO+	13	Phase Z frequency-division output signal	Home pulse output signal
	PZO–	24		
	PZ-OUT	44	Phase Z frequency-division output signal	Home pulse open-collector output signal
	GND	29	Home pulse open-collector output signal ground	
	PE	Housing	-	

Table 5–17 Specifications of AI/AO signals

Signal Name		Pin No.	Function
General	AO1	15	Analog Output
	GND	19	Common terminal of AI/AO
	AI1	20	Voltage-type AI 1 Voltage range: –10 V to +10 V
	AI2	18	Voltage-type AI 2 Voltage range: –10 V to +10 V
	GND	16	Power ground
	PE	Housing	-

5.2.2 Terminals [N]

Figure 5-11 Control terminal pin layout (CN1)

Table 5–18 Description of DI/DO signals

Signal Name		Default Function	Pin No.	Function
General	DI1	P-OT	5	Positive limit switch
	DI2	N-OT	24	Negative limit switch
	DI3	HomeSwitch	15	Home switch
	DI4	Emergence Stop	16	Emergency stop
	DI5	TouchProbe1	23	Touch probe 1
	+24 V		9	Internal 24 V power supply; voltage range: 20V to 30V; maximum output current: 150 mA.
	COM–		6	
	COM+		7	Common terminal of DI terminals
	DO1+	S-RDY+	4	Ready to switch on
	DO1-	S-RDY-	3	
	DO2+	ALM+	2	Fault
	DO2-	ALM+	1	

Table 5–19 Encoder frequency-division output signals

Signal Name		Pin No.	Function	
General	PAO+	19	Phase A frequency-division output signal	Quadrature frequency-division pulse output signals of phases A and B
	PAO–	10		
	PBO+	11	Phase B frequency-division output signal	
	PBO–	20		
	PZO+	12	Phase Z frequency-division output signal	Home pulse output signal
	PZO–	21		
	PZ-OUT	18	Home pulse open-collector output signal	
	GND	13	Home pulse open-collector output signal ground	
	PE	Housing	-	

Table 5–20 Specifications of AI/AO signals

Signal Name		Pin No.	Function
General	AO1	26	Analog Output
	GND	8	Common terminal of AI/AO
	AI1	25	Voltage-type analog input 1, 16-bit resolution Voltage range: –10 V to +10 V
	AI2	17	Voltage-type analog input 2, 12-bit resolution Voltage range: –10 V to +10 V
	PE	Housing	-

5.2.3 Wiring Precautions and Requirements

I/O signals include DI/DO signals and relay output signals.

Observe the following requirement during control circuit wiring:

5.2.4 Wiring Example

5.2.4.1 DI/DO Signals

DI circuit

This section takes DI1 of SV680N-INT as an example.

For pin assignment of the DI terminal of SV680P-INT, see *"Table 5–15 Description of DI/DO signals" on page 63*. For pin assignment of the DI terminal of SV680N-INT, see *"Table 5–18 Description of DI/DO signals" on page 65*.

- The host controller provides relay output:
  - When you use the internal 24 V power supply:
  - When you use an external power supply:
- The host controller provides open-collector output.
  - When you use the internal 24 V power supply:
  - When you use an external power supply:

Note

PNP and NPN input cannot be used together in the same circuit.

DO circuit

This section takes DO1 of SV680N-INT as an example.

For pin assignment of the DO terminal of SV680P-INT, see *"Table 5–15 Description of DI/DO signals" on page 63*. For pin assignment of the DO terminal of SV680N-INT, see *"Table 5–18 Description of DI/DO signals" on page 65*.

- The host controller provides relay input.

Note

When the host controller provides relay input, a flywheel diode must be installed. Otherwise, the DO terminals may be damaged.

- The host controller provides optocoupler input:

Note

The maximum permissible voltage and current capacity of the optocoupler output circuit inside the servo drive are as follows:

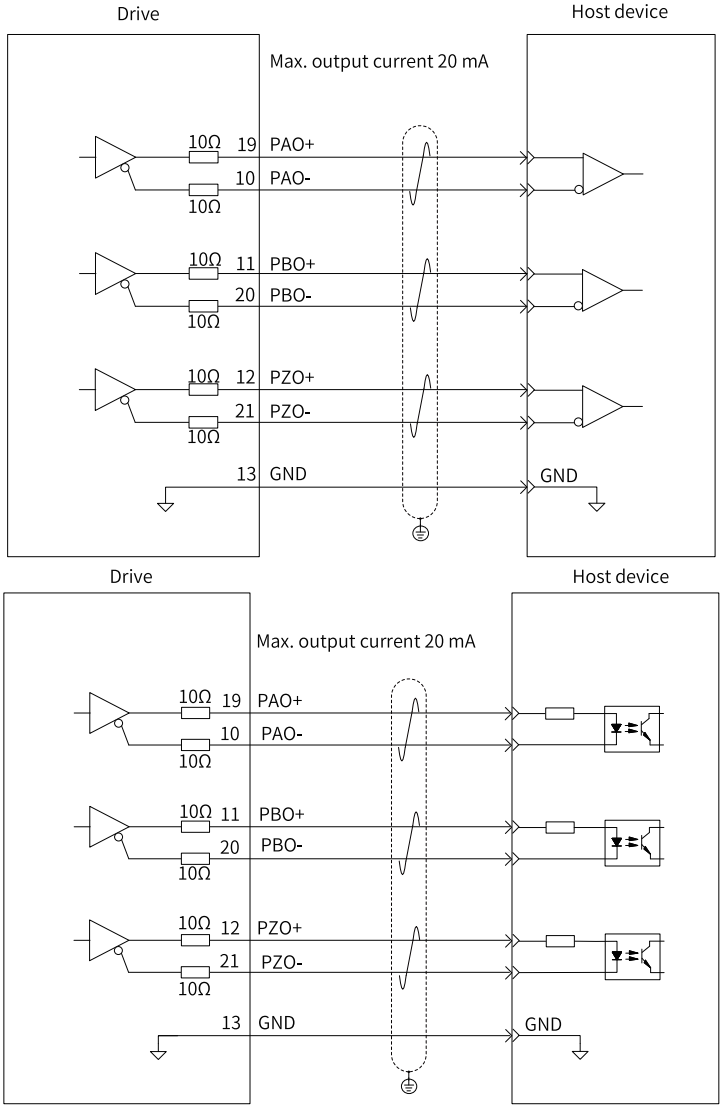
- Max. voltage: 30 VDC
- Max. current: DC 50 mA

5.2.4.2 Encoder Frequency-Division Output Signals

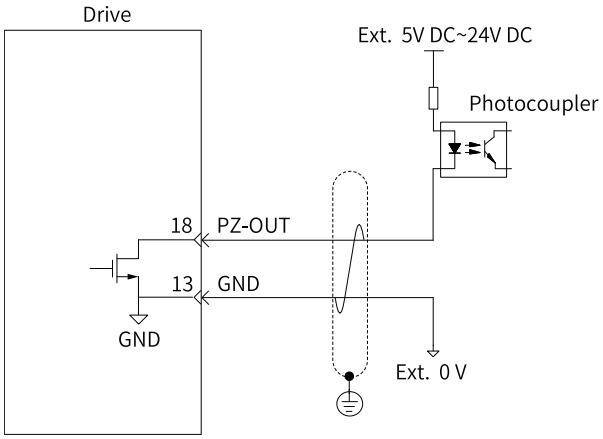
Encoder frequency-division output circuit outputs differential signals via the differential drive. Typically, this circuit provides feedback signals to the host controller in a position control system. Use a differential or optocoupler receiving circuit on the host controller side to receive feedback signals. The maximum output current is 20 mA.

This section takes the encoder frequency-division output signal of SV680N-INT as an example.

For pin assignment of the encoder frequency-division output signal terminal of SV680P-INT, see *"Table 5–16 Encoder frequency-division output signals" on page 64*. For pin assignment of the encoder frequency-division output signal terminal of SV680N-INT, see *"Table 5–19 Encoder frequency-division output signals" on page 65*.



Encoder phase Z output circuit outputs OC signals. Typically, this circuit provides feedback signals to the host controller in a position control system. An optocoupler circuit, relay circuit, or bus receiver circuit shall be used in the host controller to receive feedback signals.



5.2.4.3 AI/AO Signals

This section takes the analog signal of SV680N-INT as an example.

For pin assignment of the analog signal terminal of SV680P-INT, see *"Table 5–17 Specifications of AI/AO signals" on page 64*. For pin assignment of the analog signal terminal of SV680N-INT, see *"Table 5–20 Specifications of AI/AO signals" on page 66*.

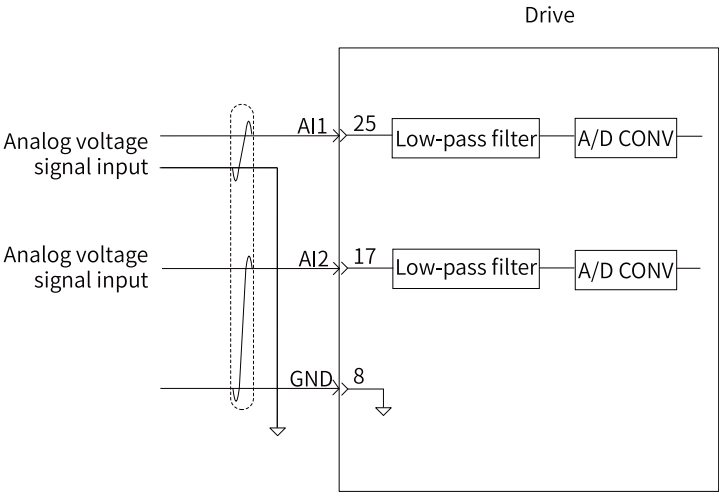
Analog input signal

The input terminal for analog speed and torque signals is AI1 and AI2.

AI1 is a voltage-type analog input terminal with a resolution of 16 bits. The voltage value is set in group H03.

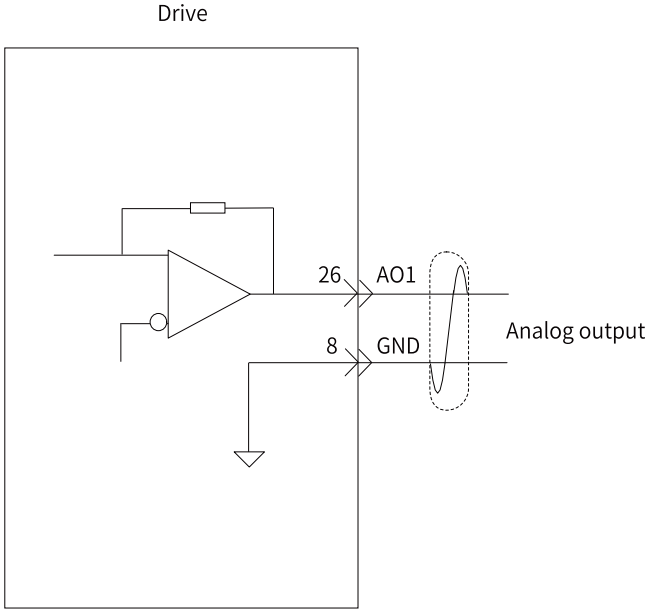
AI2 is a voltage-type analog input terminal with a resolution of 12 bits. The voltage value is set in group H03.

- Voltage-type input specification: –10 V to +10 V; maximum permissible voltage: ±12 V
- Input impedance: approx. 74 kΩ.



Analog output signal

The output terminal for analog speed and torque signals is AO1, supporting a voltage range of –10 V to +10 V. The voltage value is set in group H04.



5.2.4.4 Position Reference Input Signal [P]

For assignment of the position reference input signal terminal pins of SV680P-INT, see *"Table 5–14 Position Reference Input Signals" on page 63*.

The reference pulses and signs on the host controller side can be outputted through the differential drive or open-collector. The following table lists the maximum input frequency and minimum pulse width.

Table 5–21 Correspondence between pulse input frequency and pulse width

Pulse Mode		Max. Pulse Frequency (pps)	Min. Pulse Width (μs)	Voltage (V)
Low speed	Differential	200k	1	＞3.0
	Open-collector	200k	2.5	24
High-speed differential		4M	0.125	＞3.0

Note

- 高速脉冲和低速脉冲不可以同时使用，两者只可使用其中一个功能。
- 上位装置输出脉冲宽度若小于最小脉宽值，会导致驱动器接收脉冲错误。
- 本文中的符号  表示屏蔽双绞线。

Low-speed pulse reference input

- Differential mode
- Open-collector mode

① For use of the internal 24 V power supply of the servo drive:

Figure 5-12 Correct: The internal 24 V power supply of the servo drive is used.

Figure 5-13 Incorrect: Pin 14 (COM–) is not connected, leading to failure in forming a closed-loop circuit.

When the external power supply is used:

- Scheme 1: Using the built-in resistor (recommended)
- Scheme 2: Using the external resistor
  Select resistor R1 based on the following formula.

Table 5–22 Recommended resistance of R1

V_{CC} Voltage (V)	Resistance of R1 (kΩ)	Power of R1 (W)
24	2.4	0.5
12	1.5	0.5

- The following figures show examples of improper wiring.
- 1: The current limiting resistor is not connected, resulting in terminal burnout.

Figure 5-14 Incorrect wiring example 1: The current limiting resistor is not connected, resulting in terminal burnout.

Note

- A detection feature is added on SIGN+ and SIGN- to detect if SIGN+ is connected to 24 V, SIGN- is connected to external 0 V, but no current limit resistor is connected. When this case is detected, the drive issues an E991.1 warning.
- In this case, check the wiring and then test the drive. Otherwise, the port may be damaged.
- This feature cannot detect polarity reversal.

- 2: Multiple terminals share the same current limiting resistor, resulting in pulse receiving error.

Figure 5-15 Incorrect wiring example 2: Multiple terminals share the same current limiting resistor, resulting in pulse receiving error.

- Incorrect wiring 3: The SIGN port is not connected, preventing these two ports from receiving pulses.

Figure 5-16 Incorrect wiring example 3: The SIGN port is not connected, preventing these two ports from receiving pulses.

- Wrong wiring 4: Terminals are connected incorrectly, resulting in terminal burnout.

Figure 5-17 Incorrect wiring example 4: Terminals are connected incorrectly, resulting in terminal burnout.

- Wrong wiring 5: Multiple terminals share the same current limiting resistor, resulting in pulse receiving error.

Figure 5-18 Incorrect wiring example 5: Multiple terminals share one current limiting resistor, resulting in a pulse receiving error.

High-speed pulse reference input

High-speed reference pulses and signs on the host controller side can be outputted to the servo drive through the differential drive only.

Note

- This is a 5 V system. Do not input 24 V power.
- A detection feature is added on HSIGN+ and HSIGN- to detect if HSIGN+ is connected to 24 V, HSIGN- is connected to external 0 V, but no current limit resistor is connected. When this case is detected, the drive issues an E991.1 warning.
- In this case, check the wiring and then test the drive. Otherwise, the port may be damaged.
- This feature cannot detect polarity reversal.

5.2.5 Cable Requirements

Observe the requirements in standard EN 60204-1 during connecting control circuit cables.

I/O signal cable selection

It is recommended to use shielded signal cables to prevent I/O signal circuit from being disturbed by external noise. Use separate shielded cables for different analog signals. It is recommended to use shielded twisted pairs for digital signals.

Figure 5-19 Diagram of shielded twisted pairs

Control Cable Specifications

Table 5–23 Recommended Control Cable Specifications

Control terminal	Drive Model	Connector Kit/Material No.	Recommended Lug Size (AWG)
CN1	SV680P-INT series servo drive	DB44	24–30
	SV680N-INT series servo drive	DB26	16–26

5.3 CN2 Encoder Terminal

5.3.1 Terminal Arrangement

Note

- Primary encoder: The main encoder.
- Secondary encoder: The slave encoder when the fully closed loop feature is used.

Terminal Arrangement

Figure 5-20 Terminal pin arrangement

Table 5–24 Pin assignment

Pin No.	Name	Description
1	5 V	5 V power supply
2	GND	5V power ground
3	PS4+/CLK+	1. PS± signal of the second encoder; 2. CLK± signal of the communication-type encoder
4	PS4-/CLK-	
5	PS3+/DATA+	1. PS± signal of the first encoder; 2. DATA± signal of the communication-type encoder; 3. Gantry synchronization signal
6	PS3-/DATA-	
Enclosure	PE	Shield

Note

It is recommended to use shielded twisted pair cables. Connect the shield layer to the CN2 terminal housing to reduce noise interference.

5.3.2 Wiring Precautions and Requirements

- Ground the shielded layers on both the servo drive side and the motor side. Otherwise, the servo drive will report a false alarm.
- Do not connect cables to the "reserved" terminals.
- Given the voltage drop caused by cable resistance and signal attenuation caused by distributed capacitance, it is recommended to use twisted-pair cables of

26AWG or above (as per UL2464 standard) with length no longer than 10 m as the encoder cable.

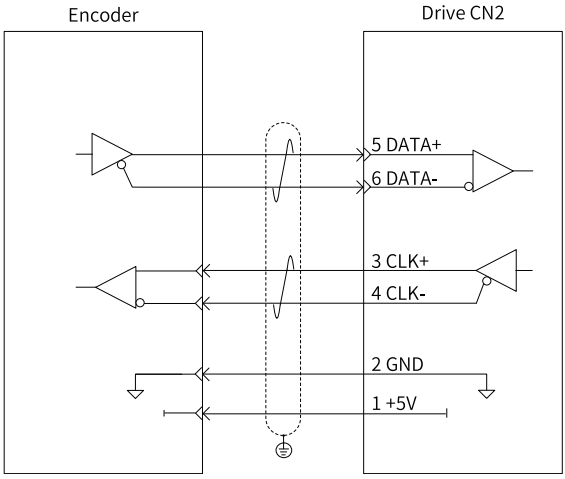
5.3.3 Wiring Example

5.3.3.1 Communication with the First Encoder

Set H32.01 to 0 for an Inovance rotary motor, and 1 for a direct drive motor or third-party motor.

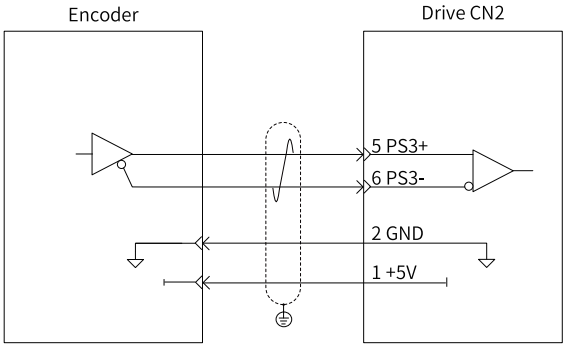
Wiring of Endat2.2/SSI/BISS-C master encoder

The drive sends a clock signal to the master encoder, which exchanges data with the servo drive through a DATA signal.



Wiring of Inovance/TAMAGAWA/Nikon master encoder

The master encoder interacts with the servo drive through PS3+ and PS3-.



Suppose the current consumed by the motor encoder is 200 mA, you can select the cable based on the following recommendations.

Table 5–25 Recommended cable between the servo drive and linear motor encoder

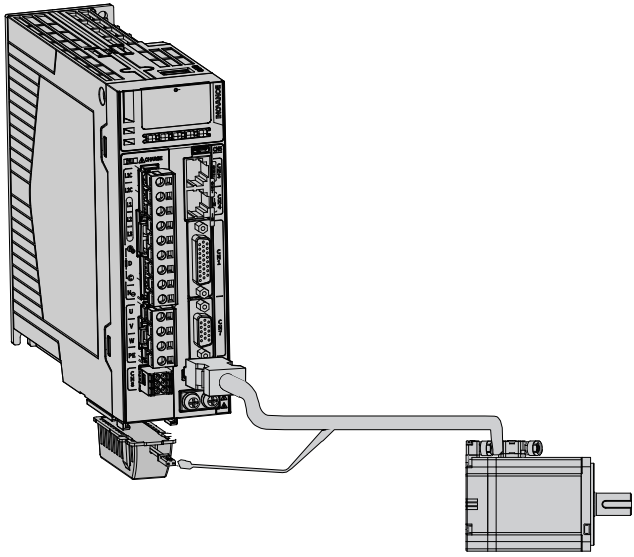
Cable Size	Line Resistance	Allowable Length
26AWG (0.13 mm^2)	143 Ω/km	8.0 m
25AWG (0.15 mm^2)	89.4 Ω/km	14.0 m
24AWG (0.21 mm^2)	79.6 Ω/km	15.0 m
23AWG (0.26 mm^2)	68.5 Ω/km	18.0 m
22AWG (0.32 mm^2)	54.3 Ω/km	23.0 m
21AWG (0.41 mm^2)	42.7 Ω/km	29.0 m

Suppose the current consumed by the motor encoder is higher than 200 mA,

you can select the cable based on the following formula.

△U is 0.5 V, $I_{encoder}$ represents the current consumed by the encoder (see the encoder user guide for details), and R_{unit} represents the unit resistance (Ω/km) of the cable. L2 is the allowable cable length (in m).

Wiring of Inovance rotary motor



5.3.3.2 Communication with the Second Encoder

Set H0F.06 = 0, and change the port for the second encoder to CN2. It is connected to CN7 by default (H0F.06 = 1).

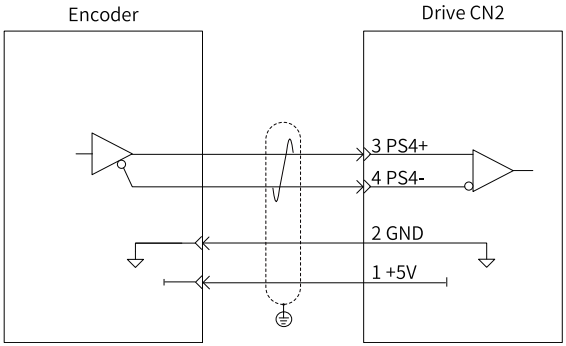
Wiring of Endat2.2/SSI/BISS-C second encoder

The drive communicates with the first encoder normally, that is, the first encoder exists all the time. In the case of the Endat2.2/SSI/BISS-C second encoder, the drive sends clock signals to the encoder and the encoder exchanges data with the drive through DATA signals.

For details, see *" Wiring of Endat2.2/SSI/BISS-C master encoder" on page 75*.

Wiring of Inovance/TAMAGAWA/Nikon second encoder

The drive communicates with the first encoder normally, that is, the first encoder exists all the time. In the case of the Inovance/TAMAGAWA/Nikon second encoder, the encoder exchanges data with the drive through PS4+ and PS4- signals.



Suppose the current consumed by the motor encoder is 200 mA, you can select the cable based on the following recommendations.

Table 5–26 Recommended cable between the servo drive and linear motor encoder

Cable Size	Line Resistance	Allowable Length
26AWG (0.13 mm^2)	143 Ω/km	8.0 m
25AWG (0.15 mm^2)	89.4 Ω/km	14.0 m
24AWG (0.21 mm^2)	79.6 Ω/km	15.0 m
23AWG (0.26 mm^2)	68.5 Ω/km	18.0 m
22AWG (0.32 mm^2)	54.3 Ω/km	23.0 m
21AWG (0.41 mm^2)	42.7 Ω/km	29.0 m

Suppose the current consumed by the motor encoder is higher than 200 mA,

You can calculate the allowable cable length L2 according to the following formula.

△U is 0.5 V, $I_{encoder}$ represents the current consumed by the encoder (see the encoder user guide for details), and R_{unit} represents the unit resistance (Ω/km) of the cable. L2 is the allowable cable length (in m).

5.3.4 Cable Requirements

Table 5–27 Recommended cables

Cable Size	Cable Size (mm^2)	Line Resistance (Ω/km)	Allowable Length (m)	OD (mm)
3P×26AWG	0.13	143	10.0	6.0±0.2
3P×25AWG	0.16	89.4	16.0	6.2±0.2
3P×24AWG	0.2	79.6	18.0	6.5±0.2
3P×23AWG	0.26	68.5	20.9	6.8±0.2
3P×22AWG	0.32	54.3	26.4	7.0±0.2
3P×21AWG	0.41	42.7	33.5	7.3±0.2
3P×20AWG	0.52	33.9	42.2	7.6±0.3
3P×19AWG	0.57	26.9	53.2	8.5±0.3
3P×18AWG	0.81	21.4	66.8	8.8±0.3
3P×17AWG	1.03	16.3	87.7	9.7±0.3
3P×16AWG	1.31	13.5	105.0	11.4±0.3

5.4 Communication Terminals CN3 and CN4 [P]

5.4.1 Terminal Arrangement

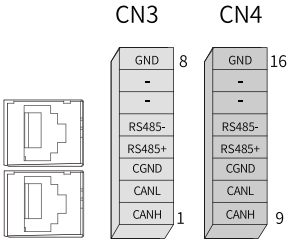


Figure 5-21 Communication Terminal pin layout of the servo drive

Table 5–28 Description of communication terminal pins

Pin No.	Description	Description
1 and 9	CANH	CAN communication port
2 and 10	CANL	
3 and 11	CGND	CAN communication GND
4 and 12	RS485+	Modbus communication interface
5 and 13	RS485-	
6 and 14	-	-

Pin No.	Description	Description
7 and 15	-	-
8 and 16	GND	Signal reference ground
Enclosure	PE	Shield

5.4.2 Wiring Precautions and Requirements

Rules

When using CAN communication, connect the CGND terminal of the host controller device to the CGND terminal of the servo driver, as shown in the following figure.

Figure 5-22 Correct CAN connection way

Figure 5-23 Incorrect CAN connection way

CAN communication bus and multi-node connection

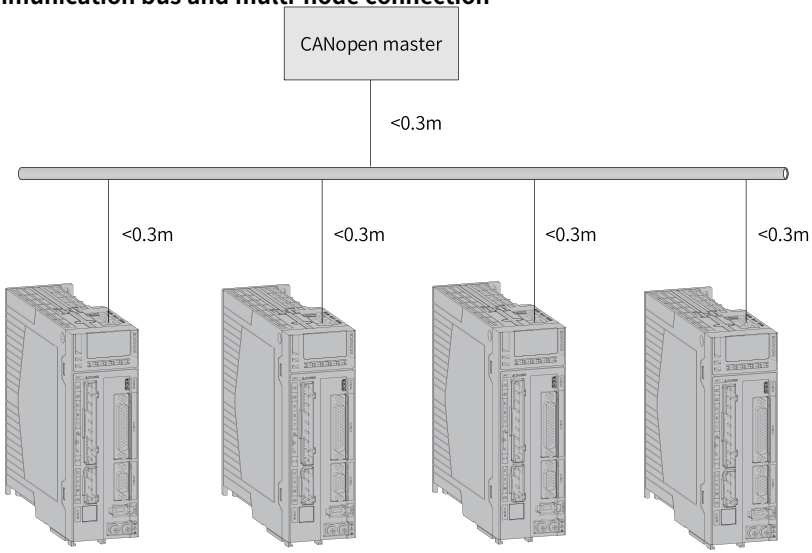


Figure 5-24 CAN communication network topology

Connect the CAN communication network in the bus topology, as shown in *"Figure 5–24 " on page 79* .

Connect each CAN transceiving device to the bus by using a branch cable shorter than 0.3 m. Otherwise, reflection may occur and cause communication problems.

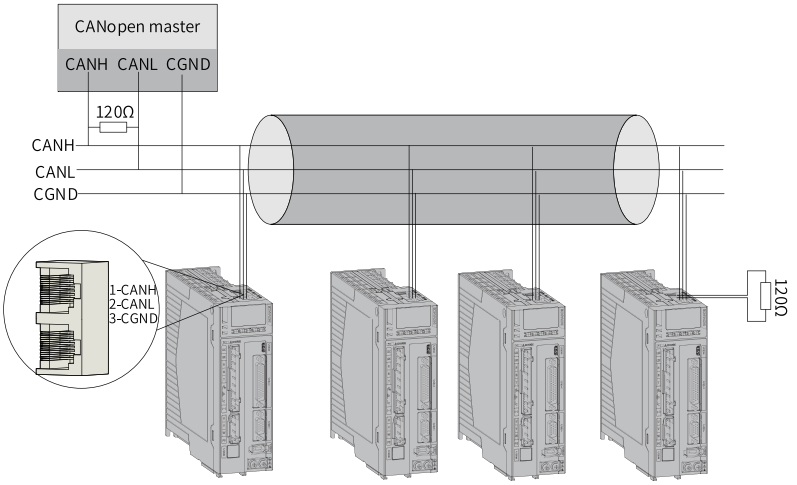


Figure 5-25 CANopen wiring diagram

It is recommended to use shielded twisted pairs. Connect two 120 Ω termination resistors at each end of the bus to prevent signal reflection. Typically, ground the shield in the single-point grounding mode. Using a multimeter to measure the resistance between CANH and CANL helps to confirm whether the junction resistance on the field is correct. The normal resistance value is about 60 Ω (with two resistors in parallel connection). Up to 64 devices can be connected.

When CAN devices communicate over a long distance, CGND of different CAN circuits must be mutually connected to ensure the reference potential of different communication devices is the same.

Recommended Connection Modes of Different Cables

Figure 5-26 Recommended connection mode 1

Figure 5-27 Recommended connection mode 2

Figure 5-28 Recommended connection mode 3

Figure 5-29 Recommended connection mode 4

Figure 5-30 Recommended connection mode 5

Wiring for other devices without external CGND ports

- **The device is a non-isolated CAN device and shares the GND or COM port with other signals.**

Connect the GND or COM port of the device with the CGND port of the drive, as shown in the following figure.

Figure 5-31 Connection mode for sharing the ground with other circuits

- **The CAN terminal of the device has no common ground with other ports.** Do not connect the CGND port to any cable. Use a cable of at least 12AWG to connect the PE of each device. Separate the cable from the CAN communication cable by a distance greater than 5 cm, as shown in the following figure.

Figure 5-32 The CAN terminals of other devices have no external ground ports.

Recommended CAN communication cable layout

CAN communication is susceptible to interference. Route the CAN communication cables away from interference sources to prevent interference.

Figure 5-33 Recommended routing modes

Route the CAN cable and any interfering cable perpendicularly to each other. For parallel routing, keep a distance D1 greater than 20 cm between the CAN cable and an R/S/T cable, or keep a distance D2 greater than 50 cm between the CAN cable and a U/V/W cable. If interference cables are routed closely along the backplate of the cabinet, the distance between the CAN communication cable and the cabinet backplate must be longer than 1 cm.

The R/S/T power cable, U/V/W power cable, and CAN communication cables, after passing through the cabinet, are routed in three cable troughs respectively. The distance L3 among the cable troughs must be longer than 20 cm. The preceding principle also applies when interference cables and CAN communication cables are routed in the same cable trough.

5.4.3 Wiring Example

5.4.3.1 CAN Communication Connection Example

CAN communication with PLC

The following figure shows the cable used for the communication between the servo drive and PLC in CAN communication networking.

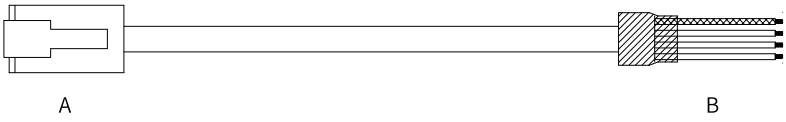


Figure 5-34 Outline drawing of cable used for CAN communication between the servo drive and PLC

Use a three-conductor shielded cable to connect the CAN bus, with the three conductors connected to CANH, CANL, and CGND (CGND represents isolated RS485 circuit signal reference ground) respectively. Connect CANH and CANL with twisted pairs. Connect CGND to the CAN reference ground. Connect the shield to the device ground. Connect a 120Ω termination resistor on each end of the bus to prevent CAN signal reflection.

Table 5–29 Pin connection relation of the cable used for CAN communication between the servo drive and PLC

RJ45 on the Drive Side (A)			PLC Side (B)		
Communication Type	Pin No.	Description	Communication Type	Pin No.	Description
CAN	1	CANH	CAN	1	CANH
	2	CANL		2	CANL
	3	CGND		3	CGND
-	Enclosure	PE (shield layer)	-	Enclosure	PE (shield layer)

CAN communication connection for multi-CAN applications

The following figure shows the cable used for parallel connection of multiple servo drives during CAN communication.

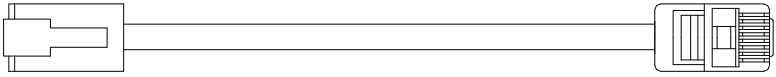


Figure 5-35 Outline drawing of multi-drive communication cable

Table 5–30 Pin connection relation of multi-drive communication cable (pins in CAN group used only)

RJ45 on the Drive Side (A)			RJ45 on Servo Drive Side (Side B)		
Communication Type	Pin No.	Description	Communication Type	Pin No.	Description
CAN	1	CANH	CAN	1	CANH
	2	CANL		2	CANL
	3	CGND		3	CGND
-	Enclosure	PE (shield layer)	-	Enclosure	PE (shield layer)

Use the daisy chain mode for CAN bus, as shown in the following figure.

- Shielded twisted pair cables are recommended for connecting the CAN bus. Twisted pairs are recommended for connecting CANH and CANL.

- Connect a 120Ω termination resistor on each end of the bus to prevent signal reflection.
- Connect the reference grounds of CAN signals of all the nodes together.
- Up to 127 nodes can be connected.

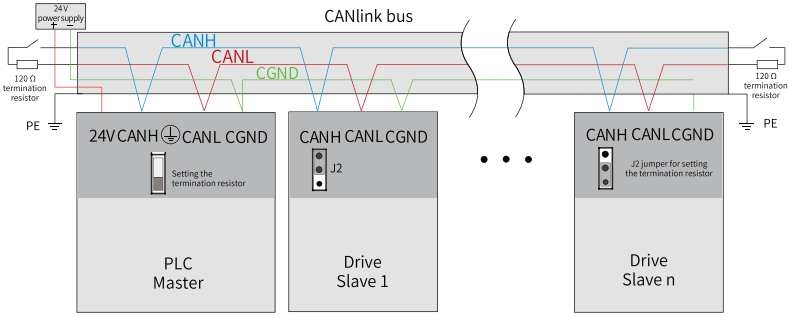


Figure 5-36 CAN bus topology

Caution

Do not connect the CGND terminal of the host controller to the GND terminal of the servo drive. Otherwise, the servo drive may be damaged.

5.4.3.2 RS485 Communication Connection Example

RS485 communication connection with PLC

The following figure shows the cable used for 485 communication between the servo drive and PLC.

Figure 5-37 Outline drawing of cable used for CAN communication between the servo drive and PLC

Use a three-conductor shielded cable to connect the RS485 bus, with three conductors connected to 485+, 485-, and GND (GND represents non-isolated RS485 signal reference ground) respectively. Connect RS485+ and RS485- with two conductors twisted together and connect the remaining conductor to the RS485 reference ground (GND). Connect the shield to the device ground (PE). Connect a 120Ω termination resistor on each end of the bus to prevent RS485 signal reflection.

Table 5–31 Pin connection relation of the cable used for CAN communication between the servo drive and PLC

RJ45 on the Drive Side (A)			PLC Side (B)		
Communication Type	Pin No.	Description	Communication Type	Pin No.	Description
RS485	4	485+	RS485	4	485+
	5	485-		5	485-
	8	GND		8	GND
-	Enclosure	PE (shield layer)	-	Enclosure	PE (shield layer)

RS485 communication connection for multi-CAN applications

The following figure shows the cable used for parallel connection of multiple servo drives during RS485 communication.

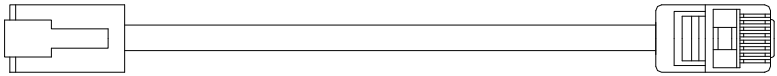


Figure 5-38 Outline drawing of multi-drive communication cable

Table 5–32 Pin connection relation of multi-drive communication cable (pins in RS485 group used only)

RJ45 on the Drive Side (A)			RJ45 on Servo Drive Side (Side B)		
Communication Type	Pin No.	Description	Communication Type	Pin No.	Description
RS485	4	485+	RS485	4	485+
	5	485-		5	485-
	8	GND		8	GND
-	Enclosure	PE (shield layer)	-	Enclosure	PE (shield layer)

In case of a large number of nodes, use the daisy chain mode for RS485 communication. Connect the reference grounds of RS485 signals of all the nodes (up to 128 nodes) together.

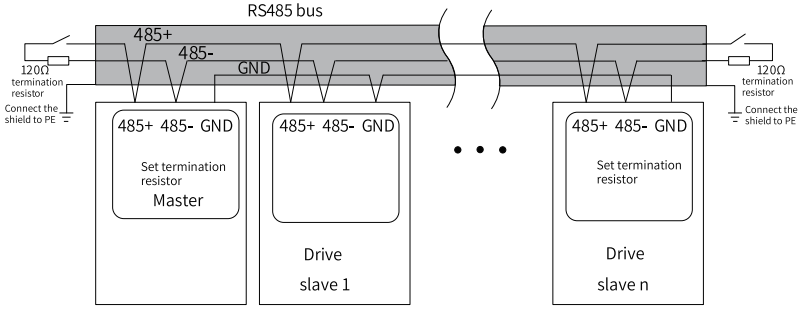


Figure 5-39 RS485 bus topology

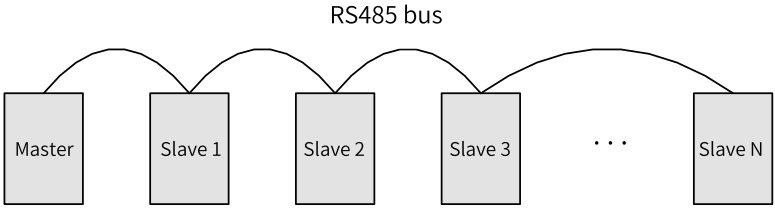


Figure 5-40 Daisy chain mode

The maximum number of nodes and transmission distance of standard RS485 circuit vary with the baud rate, as listed in the following figure:

Table 5–33 Transmission distance and number of nodes

No.	Transmission Rate (kbps)	Transmission Distance (m)	Number of Nodes	Cable Size (AWG)
1	115.2	100	128	26
2	19.2	1000	128	26

5.4.4 Cable Requirements

Communication cable types

Twisted pairs are recommended for CAN communication. Twisted pairs can resist high-frequency magnetic field noise and reduce radiation escaped from the cables to the outside, as shown in the following figure.

Figure 5-41 Twisted pairs

- The torque D of a twisted pair must be smaller than 2 cm. Smaller torque indicates better anti-interference effect.

- During short-distance, low-speed communication, a shielded twisted pair can be used to enhance the anti-interference capacity. Connect both ends of the shield to PE.
- During long-distance high-speed communication, shielded cables are not recommended. This is because large distributed capacitance exists between the shield and the signal cable, which may cause signal transmission delay.

Communication cable specifications

The transmission distance of the CAN bus is directly related to the baud rate and communication cables. The following table describes the relationship between the maximum bus length and the baud rate.

No.	Speed (bps)	Transmission Distance (m)	Number of Nodes	Cross-sectional Area (mm^2)
1	1M	25	64	0.205
2	500 k	95	64	0.34
3	100k	560	64	0.5
4	50k	1100	64	0.75

5.5 Communication Terminals CN3 and CN4 [N]

5.5.1 Terminal Arrangement

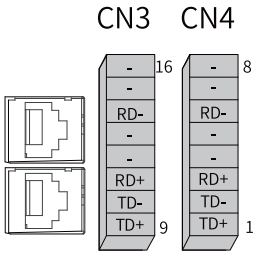


Figure 5-42 Communication Terminal pin layout of the servo drive

Table 5–34 EtherCAT communication terminal pins

Pin No.	Name	Description
1	TD+	Data transmit positive
2	TD-	Data transmit negative
3	RD+	Data reception+
4 and 5	-	-
6	RD-	Data reception–
7 and 8	-	-

Pin No.	Name	Description
9	TD+	Data transmit positive
10	TD-	Data transmit negative
11	RD+	Data reception+
12 and 13	-	-
14	RD-	Data reception–
15 and 16	-	-

5.5.2 EtherCAT Communication Connection Example

CN3 and CN4 are EtherCAT connectors. Connect CN4 (IN) to the communication port of the master and CN3 (OUT) to the next slave. For assignment of CN3/CN4 terminal pins, see *"Table 5–34 EtherCAT communication terminal pins" on page 86*.

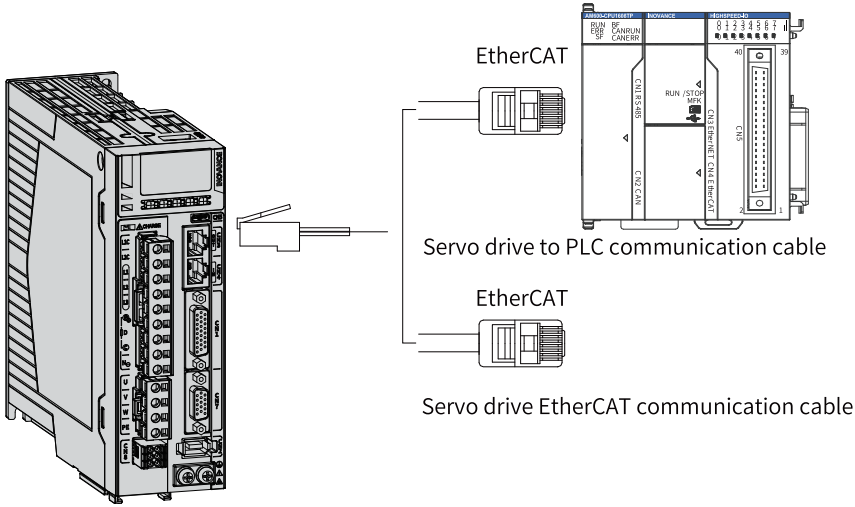


Figure 5-43 Wiring of communication cables

Topology

The communication topology of EtherCAT is flexible without any limit, as shown in *"Figure 5–44 Communication network topology" on page 88*. The drive carries IN and OUT ports.

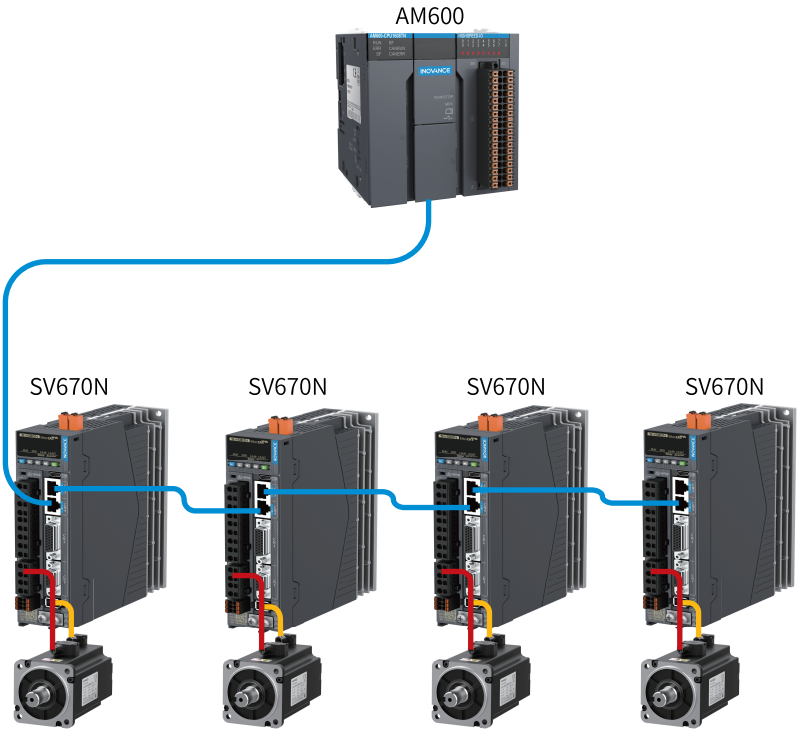
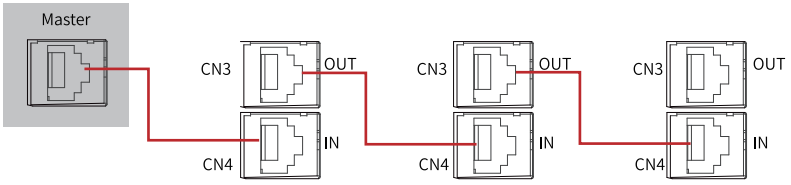
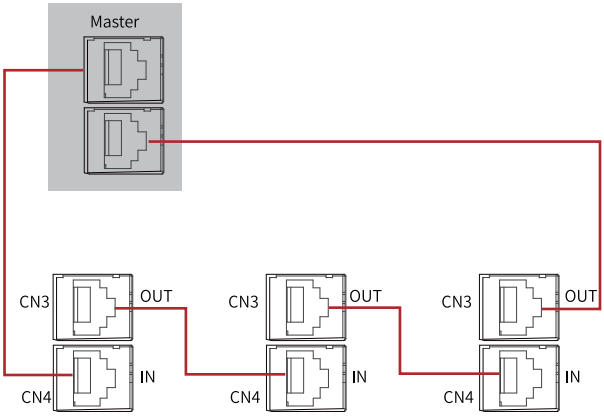


Figure 5-44 Communication network topology

Linear topology



Redundant ring topology



Note

When using the redundant ring, set H0E.36 (EtherCAT AL enhanced link) to 1 (Enable). Power on the drive so that the setting become effective.

5.5.3 Cable Requirements

Rules

EtherCAT cables are connected to the network ports (IN and OUT) equipped with the metal shield. The electric characters are compliant with IEEE 802.3 and ISO 8877 standards.

Communication cable types

Table 5–35 Cable data

Material Code	Cable Model	Cable Length (m)
15040261	S6-L-T04-0.3	0.3
15040262	S6-L-T04-3.0	3.0
15041960	S6-L-T04-0.2	0.2
15041961	S6-L-T04-0.5	0.5
15041962	S6-L-T04-1.0	1.0
15041963	S6-L-T04-2.0	2.0
15041964	S6-L-T04-5.0	5.0
15041965	S6-L-T04-10.0	10.0
1504QV45	S6-L-T07-0.3	0.3
1504QV46	S6-L-T07-1.0	1.0

Material Code	Cable Model	Cable Length (m)
1504QV47	S6-L-T07-3.0	3.0
1504QV49	S6-L-T08-0.3	0.3
1504QV50	S6-L-T08-1.0	1.0
1504QV51	S6-L-T08-3.0	3.0

Communication cable specifications

Table 5–36 Specifications

Item	Description
UL	Compliant with UL certification
CAT.5E cable	CAT.5E cable
CAT6A cable	CAT6A cable
CAT7 cable	CAT7 cable
Double shield	Braided shield (coverage: 85%), aluminum foil shield (coverage: 100%)
Ambient temperature	-40°C to +60°C.

Cable shield

The EtherCAT communication cable must be Ethernet Category 5 (100BASE-TX) network cable or high-strength shielded network cable. The cable for the servo drive must be the shielded network cable with the length no longer than 100 m. The shielded network cable enhances the anti-interference capacity of the system.

5.6 Description of Communication Terminal (CN5)

Terminal Arrangement

Table 5–37 Pin assignment of communication terminal (CN5)

Pin No.	Description	Description
A1 B1	GND	Signal reference ground
A4 B4	VBUS	USB power supply
A5 B5	-	-
A6 B6	DP	Differential data transmission
A7 B7	DN	Differential data transmission
A8 B8	-	-

Pin No.	Description	Description
A9 B9	VBUS	USB power supply
A12 B12	GND	Signal reference ground

Description

This terminal is a commissioning port connected with the PC. The communication cable must be of fast-charging Type-C with a magnetic ring. It must be equipped with a grounding wire, aluminum foil and metal shielding layer. Its length can be up to 3 m.

Figure 5-45 Recommended cables

5.7 CN6 STO Safety Terminal

Terminal Arrangement

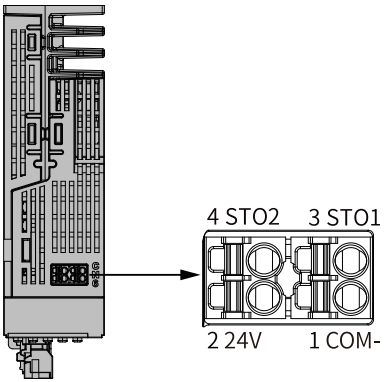


Table 5–38 Pin assignment

Pin No.	Description	Description
1	COM–	STO reference ground
2	24 V	Internal 24V power supply
3	STO1	Control input for STO1
4	STO2	Control input for STO2

Two isolated inputs are configured to dual-channel inputs of the STO function: STO1/ STO2.

To facilitate commissioning, additional pin with supply voltage (+24V) is integrated. The bridging of the 24 V terminal to STO1/STO2 is needed in case the safety circuit is installed but no STO function is needed.

Description

- **Electrical specifications and connection of the input circuit**
  This section describes the characteristics of the input signals assigned to the CN6 connectors.
  - Specifications
    The servo drive operates normally only when the input states of STO1 and STO2 are both "High" ("1" or "H").

    The servo drive does not operate when the input states of STO1 or STO2 are different or are both "Low" ("0" or "L").
  - Electrical characteristics of Safety Request Input Signal are as follows:

Item	Characteristics	Description
Voltage range	24 VDC (±15%)	-
Input current	3.6 mA (Typ.)	The input current of STO1 and STO2.
Standards of logic levels	“0” < 5 V, “1” > 15 V	-
Digital input impedance	6.6 kΩ	-

  - Connection example of external 24 V
  - Connection example of internal 24 V
- **EMC requirements**
  - To avoid short circuit between two adjacent conductors, either use cable with shield connected to the protective bonding circuit on each separate conductor, or use flat cables with one earthed conductor between each signal conductor.
  - Double-shielded or single-shielded twisted multi-pair cable is strongly recommended.
  - Fix and ground the cable shield using a piece of conductive metal.
    Example of cable clamp:
  - The maximum allowable cable length between the drive and the activation switch is 30 m.
- **Other requirements**
  - All wiring must be well protected, routed and clamped where practicable.
  - It must be assured that there is no pulling or pinching on the cable when installing.
  - For cabling the DI inputs of the STO, to avoid common cause failure in the cables, the two channels must be routed through two well-apart routes, or the cable must be protected with double-shielded methods.

Cables	Description
Category	Low voltage, double-shielded or single-shielded twisted multi-pair cable
Maximum size	0.8 mm^2 (18AWG)
Minimum size	0.3 mm^2 (28AWG)
Maximum length	The max. distance between STO input and the operating contact is 30 m

Applicable servo drives

STO applies to the following servo drives:

Size	Power Range (kW)	Structure	W×H×D (mm^3)
A	0.2–0.4	Split-type structure	45.5 x 170 x 150
C	0.75–1.5	Split-type structure	55 x 170 x 173
D	1.5–3	Split-type structure	80 x 170 x 183
E	2–7.5	Split-type structure	90 x 250 x 230

5.8 Encoder Terminal (CN7)

5.8.1 Terminal Arrangement

Terminal Arrangement

Pin No.	Terminal Definition	Description	Pin No.	Terminal Definition	Description
1	A+	Encoder pulse phase A±	9	GND	Power supply reference ground
2	A–		10	PS1-/DATA-	• PS- signal of the first encoder • DATA- signal of the communication encoder • Gantry synchronization signal
3	B+	Encoder pulse phase B±	11	HALL_U+	Hall signal U
4	B–		12	HALL_V+	Hall signal V
5	PS1+/DATA+	• PS+ signal of the first encoder • DATA+ signal of the communication encoder • Gantry synchronization signal	13	HALL_W+	Hall signal W
6	Z+	Encoder pulse phase Z±	14	PS2+/CLK+	• PS+ signal of the second encoder • CLK+ signal of the communication encoder
7	Z-		15	PS2-/CLK-	
8	+5 V	Encoder 5 V power supply (load current lower than 200 mA)	Enclosure	PE	Shield

5.8.2 Wiring Example

5.8.2.1 Communication with the First Encoder

Set H32.01 to 1 for an Inovance rotary motor, and 0 for a direct drive motor or third-party motor.

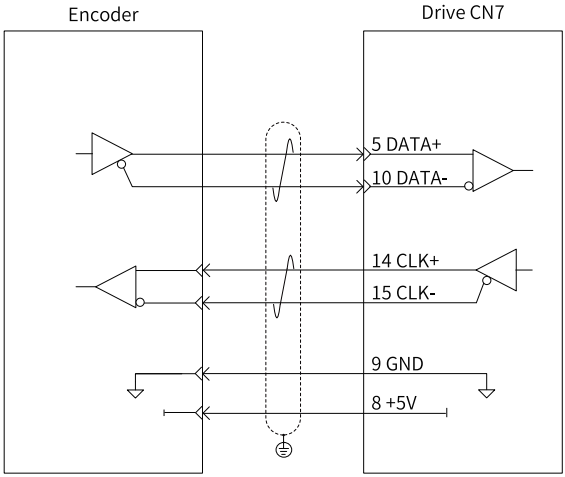
Wiring of a pulse encoder

Use shielded twisted pairs to match the high input frequency.

- To reduce noise interference, connect the reference ground of the external encoder to the GND of the drive. Use shielded cables and connect the shield to the CN7 terminal enclosure.
- The input mode of the external encoder is differential input.
- The maximum pulse frequency supported by a phase A/B linear encoder is 4 Mbps.
- The pulse input terminal of a phase A/B encoder supports open circuit detection.

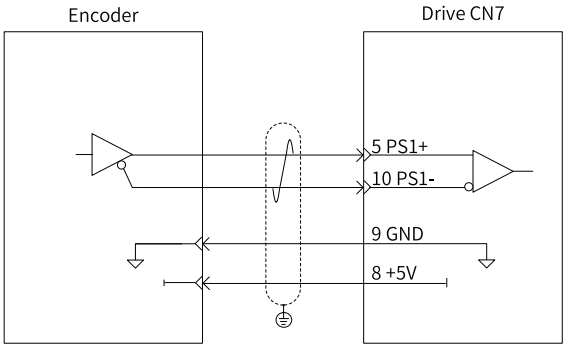
Wiring of Endat2.2/SSI/BiSS-C master encoder

The drive sends a clock signal to the master encoder, which exchanges data with the servo drive through a DATA signal.



Wiring of Inovance/TAMAGAWA/Nikon master encoder

The master encoder interacts with the servo drive through PS1+ and PS1-.



Suppose the current consumed by the motor encoder is 200 mA, you can select the cable based on the following recommendations.

Table 5–39 Recommended cable between the servo drive and linear motor encoder

Cable Size	Line Resistance	Allowable Length
26AWG (0.13 mm^2)	143 Ω/km	8.0 m
25AWG (0.15 mm^2)	89.4 Ω/km	14.0 m
24AWG (0.21 mm^2)	79.6 Ω/km	15.0 m
23AWG (0.26 mm^2)	68.5 Ω/km	18.0 m

Cable Size	Line Resistance	Allowable Length
22AWG (0.32 mm^2)	54.3 Ω/km	23.0 m
21AWG (0.41 mm^2)	42.7 Ω/km	29.0 m

If the consumption current of the motor encoder is higher than 200 mA, you can calculate the allowable cable length according to the following formula.

△U is 0.5 V, $I_{encoder}$ represents the current consumed by the encoder (see the encoder user guide for details), and R_{unit} represents the unit resistance (Ω/km) of the cable. L2 is the allowable cable length (in m).

5.8.2.2 Communication with the Second Encoder

The second encoder is connected to the CN7 port (H0F.06 = 1) by default.

Wiring of a pulse encoder

For details, see *" Wiring of a pulse encoder" on page 94*.

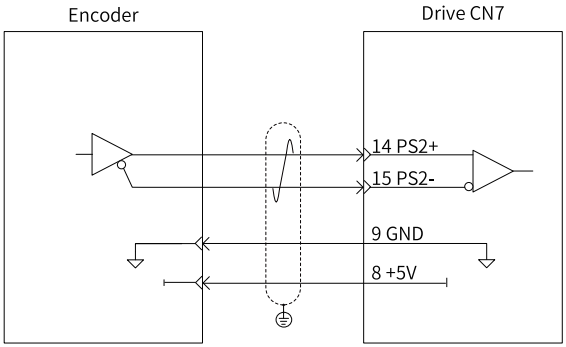
Wiring of Endat2.2/SSI/BiSS-C second encoder

The drive communicates with the first encoder normally, that is, the first encoder exists all the time. In the case of the Endat2.2/SSI/BiSS-C second encoder, the drive sends clock signals to the encoder and the encoder exchanges data with the drive through DATA signals.

For details, see *" Wiring of Endat2.2/SSI/BiSS-C master encoder" on page 95*.

Wiring of Inovance/TAMAGAWA/Nikon second encoder

The drive communicates with the first encoder normally, that is, the first encoder exists all the time. In the case of the Inovance/TAMAGAWA/Nikon second encoder, the encoder exchanges data with the drive through PS2+ and PS2- signals.



Suppose the current consumed by the motor encoder is 200 mA, you can select the cable based on the following recommendations.

Table 5–40 Recommended cable between the servo drive and linear motor encoder

Cable Size	Line Resistance	Allowable Length
26AWG (0.13 mm^2)	143 Ω/km	8.0 m
25AWG (0.15 mm^2)	89.4 Ω/km	14.0 m
24AWG (0.21 mm^2)	79.6 Ω/km	15.0 m
23AWG (0.26 mm^2)	68.5 Ω/km	18.0 m
22AWG (0.32 mm^2)	54.3 Ω/km	23.0 m
21AWG (0.41 mm^2)	42.7 Ω/km	29.0 m

If the consumption current of the motor encoder is higher than 200 mA, you can calculate the allowable cable length according to the following formula.

△U is 0.5 V, $I_{encoder}$ represents the current consumed by the encoder (see the encoder user guide for details), and R_{unit} represents the unit resistance (Ω/km) of the cable. L2 is the allowable cable length (in m).

5.9 Brake and PTC Input Terminal (CN8)

5.9.1 Terminal Arrangement

Pin No.	Description	Description	Pin No.	Description	Description
1	PTC	Motor temperature feedback input	2	COM–	Onboard 24V, COM
3	BK+	Brake+	4	BK-	Brake–
5	24V_BK	External power supply for the brake	6	COM_BK	Brake 24V, COM

5.9.2 Wiring Example

5.9.2.1 PTC Wiring Example

Figure 5-46 PTC wiring diagram

5.9.2.2 Brake Wiring Examples

The brake is used to prevent the motor shaft from moving and lock the position of the motor and the motion part when the drive is in the non-operational status.

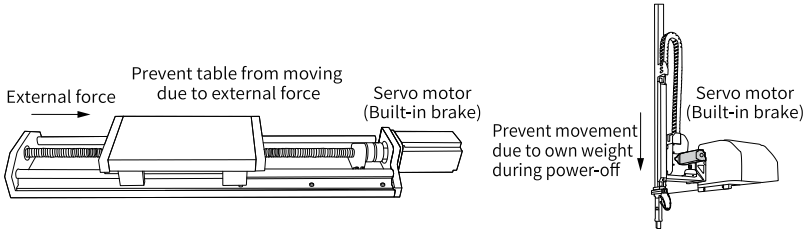
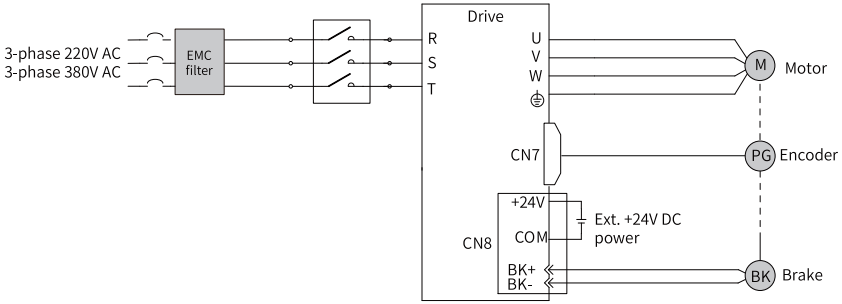


Figure 5-47 Application of the brake

Caution

- Use the built-in brake for position-lock purpose only. Do not use this brake for any other purposes (such as braking) other than position-lock in the stop state.
- The brake coil has no polarity.
- Switch off the S-ON signal after the motor stops.
- When the motor with brake runs, the brake may generate a click sound, which does not affect its function.
- When brake coils are energized (the brake is released), flux leakage may occur on the shaft end. Pay special attention when using magnetic sensors around the motor.

The connection of brake input signals is polarity-insensitive. Users need to prepare a 24 V power supply. The following figure shows the standard wiring of the brake signals (BK) and the brake power supply.



Pay attention to the following precautions during wiring:

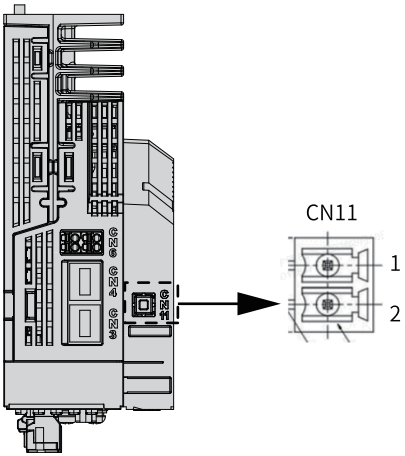
When determining the length of the motor brake cable, take full account the voltage drop caused by cable resistance. The input voltage must be at least 21.6 V to enable the brake to work properly.

Note

- In the standard environment, the number of brake outputs at the drive side can reach at least 5 million. For details on the standard environment, see *" " on page* .
- The brake must not share the power supply with other electrical devices. This is to prevent a malfunction of the brake due to a drop in the voltage or current when other electrical devices work in tandem.
- Use cables with a cross-sectional area above 0.5 mm^2.

5.10 CN11 24V Terminal

Terminal Arrangement



Pin No.	Descrip tion	Description	Pin No.	Descrip tion	Description
1	GND_BP	0 V input of the backup power supply	2	24V_BP	24 V input of the backup power supply

Description

Models with backup power can have separate power supply to the control circuit. When the main circuit is not energized, 24V BP supplies power to the control circuit to maintain functions like programming, parameter configuration in the software tool, and communication. The operating panel of the drive shows "nrd.1" under this circumstance.

Table 5–41 Power input specifications

Item	Specification
Power input range	Voltage: 24 V DC±15% (must be SELV/PELV power supply)
Power of the external power supply	⩾ 50 W

Wiring

As shown in the following figure.

5.11 Wiring and Setting of the Braking Resistor

When the capacitance of the bus is insufficient, the extra energy can be consumed by connecting an external braking resistor to the P ⊕ -C terminal.

When the motor torque direction is opposite to the direction of rotation, the energy is fed back to the servo drive from the motor side, leading to bus voltage rise. Once the bus voltage rises to the braking threshold, the excessive energy must be consumed by a braking resistor. Otherwise, the servo drive will be damaged. The braking resistor can be a built-in or an external one. The internal and built-in braking resistors must not be used together.

Figure 5-48 Wiring of external braking resistor

For cables used for terminals P ⊕ and C, see *"Table 5–7 Recommended main circuit cables" on page 58*.

6 常见EMC问题解决建议

6.1 Residual Current Device Malfunction

If a residual current device (RCD) is needed, select the RCD according to the following requirements:

- Use a B-type RCD because the drive may generate DC leakage current in the protective conductor.
- For each drive, use an RCD whose tripping current is not lower than 100 mA to prevent RCD malfunction due to high-frequency leakage current generated by the drive.
- When multiple drives are connected in parallel and share one RCD, select an RCD whose tripping current is not lower than 300 mA.
- It is recommended to use Chint or Schneider RCDs.

When malfunction occurs on the RCD, take the following measures.

Table 6–1 Measures against leakage current

Symptom	Possible Cause	Solution
The RCD trips at the moment of power-on.	The anti-interference performance of the RCD is weak.	• It is recommended to use Siemens or Schneider RCDs. • Use a RCD with a higher tripping current. • Move the unbalanced load to the front end of the RCD.
	The tripping current of the RCD is too low.	
	An unbalanced load is connected to the rear end of the RCD.	
	The capacitance of the front end of the servo drive is too high.	
The RCD trips during operation.	The anti-interference performance of the RCD is weak.	• It is recommended to use Siemens or Schneider RCDs. • Use a RCD with a higher tripping current. • Install a simple filter on the input side of the drive and wind the magnetic ring on the LN and RST cables near the RCD, as shown in *"Figure 6–1 Magnetic ring on the input side" on page 101*. • Reduce the carrier frequency without compromising the performance. • Reduce the length of motor cables.
	The tripping current of the RCD is too low.	
	An unbalanced load is connected to the rear end of the RCD.	
	For motor cables and the motor, the distributed capacitance to ground is too high.	

Figure 6-1 Magnetic ring on the input side

6.2 Harmonic Suppression

To suppress harmonics and improve the power factor to allow the drive to fulfill the standards, install an AC input reactor on the input side of the drive. For details about reactor models, see *"7.1.4 AC Input Reactor" on page 109*. For details about the installation method, see *" " on page* .

6.3 Control Circuit Interference

6.3.1 High-speed Pulse Interference [P]

Take the measures listed in the following table to suppress interference.

No.	Step
1	Used shielded twisted pair cables with both ends of the cable grounded (see *" I/O signal cable selection" on page 73*).
2	Connect the motor enclosure to the PE terminal of the drive.
3	Connect the PE terminal of the drive to the PE terminal of the mains power supply.
4	Add an equipotential bonding grounding cable between the host controller and drive (see *" Grounding the control cabinet system" on page 54*).
5	Separate signal cables from power cables with a distance of at least 30 cm.
6	Wind the signal cable onto a ferrite clamp or magnetic ring for one to two turns (see *"2.4.1 Instructions for Installing the Magnetic Ring and Ferrite Clamp" on page 42*).
7	At the drive output side, wind the output U/V/W cable onto a magnetic ring for two to four turns. For details, see *"2.4.1 Instructions for Installing the Magnetic Ring and Ferrite Clamp" on page 42*.
8	Use shielded power cables and ground the shield properly.

6.3.2 Interference with control circuit wiring

For analog/frequency-division input/fully closed-loop wiring, see *"6.3.1 High-speed Pulse Interference [P]" on page 102* for details.

6.3.3 Common I/O Signal Interference

The drive generates strong interference during operation. Although EMC measures are taken, interference may still exist due to improper wiring or grounding during use. When the drive disturbs or is disturbed by other devices, adopt the following measures.

No.	Step
1	Use shielded cables as the I/O signal cables and connect the shield to the PE terminal. For details, see *" I/O signal cable selection" on page 73*.
2	Reliably connect the PE terminal of the motor to the PE terminal of the servo drive, and connect the PE terminal of the servo drive to the PE terminal of the grid.
3	Add an equipotential bonding grounding wire between the host controller and the servo drive.
4	At the drive output side, wind the output U/V/W cable onto a magnetic ring for two to four turns. For details, see *"2.4.1 Instructions for Installing the Magnetic Ring and Ferrite Clamp" on page 42*.
5	Increase the filter capacitance for low-speed DIs. A capacitance up to 0.1 μF is recommended, as shown in *"Figure 6–2 I/O signal cables with capacitance increased" on page 103*.
6	Increase the filter capacitance between AI and GND. A capacitance up to 0.22 μF is recommended.
7	Wind the signal cable onto a ferrite clamp or magnetic ring for one to two turns (see *"2.4.1 Instructions for Installing the Magnetic Ring and Ferrite Clamp" on page 42*).
8	Use shielded power cables and ground the shield properly.

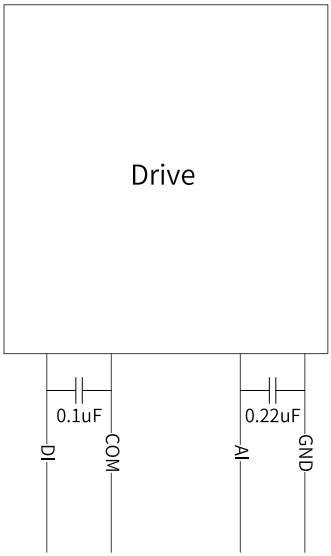


Figure 6-2 I/O signal cables with capacitance increased

6.4 通信干扰

6.4.1 RS485&CAN Communication Interference [P]

Take the measures listed in the following table to suppress interference.

Step	Solution
1	Install a 120 Ω termination resistor on each end of the bus.
2	Replace with multi-conductor shielded twisted pair cables and ground both ends of the shield.
3	Separate communication cables from power cables with a distance of at least 30 cm.
4	Adopt daisy chain mode for multi-node communication layout.
5	Add an equipotential bonding grounding cable between nodes during multi-node communication (see *" Grounding the control cabinet system" on page 54*).
6	Install ferrite clamps on both sides of the communication cable or wind the magnetic ring by one or two turns (see *"2.4.1 Instructions for Installing the Magnetic Ring and Ferrite Clamp" on page 42*).
7	At the drive output side, wind the output U/V/W cable onto a magnetic ring for two to four turns. For details, see *"2.4.1 Instructions for Installing the Magnetic Ring and Ferrite Clamp" on page 42*.
8	Use shielded power cables and ground the shield properly.

6.4.2 EtherCAT Communication Interference [N]

Take the measures listed in the following table to suppress interference.

No.	Step
1	The communication cable complies with the specifications of Cat 5e cables
2	The communication port is tight and secure without the risk of poor contact.
3	Separate communication cables from power cables with a distance of at least 30 cm.
4	Add an equipotential bonding grounding cable between nodes during multi-node communication (see *" Grounding the control cabinet system" on page 54*).
5	Ensure the length of the cable between two nodes does not exceed 100 m.
6	Install ferrite clamps on both sides of the communication cable and wind the cable for one or two turns (see *"2.4.1 Instructions for Installing the Magnetic Ring and Ferrite Clamp" on page 42*).

No.	Step
7	At the drive output side, wind the output U/V/W cable onto a magnetic ring for two to four turns. For details, see *"2.4.1 Instructions for Installing the Magnetic Ring and Ferrite Clamp" on page 42*.
8	Use shielded power cables and ground the shield properly.

7 Optional Parts

7.1 Peripheral Electrical Component

7.1.1 Fuse

To prevent accidents caused by short circuit, install a fuse on the input side of the drive.

Table 7–1 List of recommended fuses

Servo drive SV680-INT series			Recommended Fuse		
Size	Model	Rated Input Current (A)	Manufacturer	Rated Current (A)	Model
Single-phase 200 V					
A	S1R6	2.3	Bussmann	5	FWP-5B
	S2R8	4.0		10	FWP-10B
C	S5R5	7.9		20	FWP-20B
	S7R6	9.6		20	FWP-20B
D	S012	12.8		20	FWP-20B
Three-phase 200 V					
A	S1R6	1.1	Bussmann	5	FWP-5B
	S2R8	2.3		5	FWP-5B
C	S5R5	4.4		15	FWP-15B
	S7R6	5.1		15	FWP-15B
D	S012	8.0		20	FWP-20B
E	S018	8.7		20	FWP-20B
	S022	11.0		35	FWP-35B
	S027	23.8		40	FWP-40B
Three-phase 400 V					
C	T3R5	2.4	Bussmann	5	FWP-5B
	T5R4	3.6		10	FWP-10B
D	T8R4	5.6		15	FWP-15B
	T012	8.0		20	FWP-20B
E	T017	12.0		35	FWP-35B
	T021	16.0		35	FWP-35B
	T026	21.0		40	FWP-40B

7.1.2 Electromagnetic Contactor

Table 7–2 Recommended electromagnetic contactor models

Servo drive SV680-INT series			Recommended Contactor		
Size	Model	Rated Input Current (A)	Manufacturer	Current (A)	Model
Single-phase 200 V					
A	S1R6	2.3	Schneider	9	LC1 D09
	S2R8	4.0		9	LC1 D09
C	S5R5	7.9		9	LC1 D09
	S7R6	9.6		12	LC1 D12
D	S012	12.8		18	LC1 D18
Three-phase 200 V					
A	S1R6	1.1	Schneider	9	LC1 D09
	S2R8	2.3			
C	S5R5	4.4			
	S7R6	5.1			
D	S012	8.0		9	LC1 D09
E	S018	8.7		12	LC1 D12
	S022	11.0			
	S027	23.8		25	LC1 D25
Three-phase 400 V					
C	T3R5	2.4	Schneider	9	LC1 D09
	T5R4	3.6		9	LC1 D09
D	T8R4	5.6		9	LC1 D09
	T012	8.0		9	LC1 D09
E	T017	12.0		18	LC1 D18
	T021	16.0		18	LC1 D18
	T026	21.0		25	LC1 D25

7.1.3 Breaker

Table 7–3 Recommended circuit breaker models

Servo drive SV680-INT series			Recommended Circuit Breaker		
Size	Model	Rated Input Current (A)	Manufacturer	Current (A)	Model
Single-phase 200 V					
A	S1R6	2.3	Schneider	4	OSMC32N2D4
	S2R8	4.0		6	OSMC32N2D6
C	S5R5	7.9		16	OSMC32N2D16
	S7R6	9.6		16	OSMC32N2D16
D	S012	12.8		20	OSMC32N2D20
Three-phase 200 V					
A	S1R6	1.1	Schneider	4	OSMC32N3D4
	S2R8	2.3		6	OSMC32N3D6
C	S5R5	4.4		16	OSMC32N3D16
	S7R6	5.1		16	OSMC32N3D16
D	S012	8.0		16	OSMC32N3D16
E	S018	8.7		20	OSMC32N3D20
	S022	11.0		25	OSMC32N3D25
	S027	23.8		32	OSMC32N3D32
Three-phase 400 V					
C	T3R5	2.4	Schneider	4	OSMC32N3D4
	T5R4	3.6		6	OSMC32N3D6
D	T8R4	5.6		10	OSMC32N3D10
	T012	8.0		16	OSMC32N3D16
E	T017	12.0		20	OSMC32N3D20
	T021	16.0		25	OSMC32N3D25
	T026	21.0		32	OSMC32N3D32

If a residual current device (RCD) is needed, select the RCD according to the following requirements:

- Use a B-type RCD because the drive may generate DC leakage current in the protective conductor.
- For each drive, use an RCD whose tripping current is not lower than 100 mA to prevent RCD malfunction due to high-frequency leakage current generated by the drive.
- When multiple drives are connected in parallel and share one RCD, select an RCD whose tripping current is not lower than 300 mA.
- It is recommended to use Chint or Schneider RCDs.

7.1.4 AC Input Reactor

Selection

An AC input reactor is optional and mainly used to reduce harmonics in the input current. Install an external reactor as needed in actual applications. The following table lists the recommended manufacturers and models of input reactors.

Table 7–4 AC input reactor model selection

Servo drive SV680-INT series			Applicable Reactor	Inductance (mH)
Size	Model	Rated Input Current (A)		
Three-phase 200 V				
A	S1R6	1.1	MD-ACL-10-5-4T	5
	S2R8	2.3	MD-ACL-10-5-4T	5
C	S5R5	4.4	MD-ACL-10-5-4T	5
	S7R6	5.1	MD-ACL-10-5-4T	5
D	S012	8.0	MD-ACL-10-5-4T	5
E	S018	8.7	MD-ACL-15-3-4T	3
	S022	11.0	MD-ACL-15-3-4T	3
	S027	23.8	MD-ACL-40-1.45-4T	1.45
Three-phase 400 V				
C	T3R5	2.4	MD-ACL-10-5-4T	5
	T5R4	3.6	MD-ACL-10-5-4T	5
D	T8R4	5.6	MD-ACL-10-5-4T	5
	T012	8.0	MD-ACL-10-5-4T	5
E	T017	12.0	MD-ACL-15-3-4T	3
	T021	16.0	MD-ACL-40-1.45-4T	1.45
	T026	21.0	MD-ACL-40-1.45-4T	1.45

Dimensions

- Inovance input reactors

Figure 7-1 Dimensions of 10–15 A AC input reactors

Figure 7-2 Dimensions of 40 A (1.45 mH) AC input reactors

Table 7–5 Dimensions of Inovance AC input reactors (unit: mm)

Model	A	B	C	D	E	F	G	H	I	J
MD-ACL-10-5-4T	150±2	155	8	160	80	10	85±2	100±2	125±1	Ø7 x 10
MD-ACL-15-3-4T	150±2	155	8	160	80	10	85±2	100±2	125±1	Ø7 x 10
MD-ACL-40-1.45-4T	180±2	185	16	200	105	10	95±2	117±2	150±1	Ø7 x 10

7.1.5 EMC filter

Selection

To comply with the radiated and conducted emission requirements of EN IEC 61800-3, install the EMC filter listed in the following table. EMC filter options are FN2090 and FN3287 series EMC filters manufactured by Schaffner. Select the EMC filter according to the rated input current of the servo drive, as shown in the following table.

Table 7–6 Standard EMC filter model and appearance

Filter Model		Appearance
Schaffner	FN2090 series	
	FN3287 series	

Table 7–7 Filter model selection (Schaffner)

Servo drive SV680-INT series			Applicable Filter
Size	Model	Rated Input Current (A)	
Single-phase 200 V			
A	S1R6	2.3	FN 2090-3-06
	S2R8	4.0	FN 2090-4-06
C	S5R5	7.9	FN 2090-8-06
	S7R6	9.6	FN 2090-10-06
D	S012	12.8	FN 2090-16-06
Three-phase 200 V			
A	S1R6	1.1	FN 3287-10-44-C28-R65
	S2R8	2.3	FN 3287-10-44-C28-R65
C	S5R5	4.4	FN 3287-10-44-C28-R65
	S7R6	5.1	FN 3287-10-44-C28-R65
D	S012	8.0	FN 3287-10-44-C28-R65
E	S018	8.7	FN 3287-10-44-C28-R65
	S022	11.0	FN 3287-16-44-C33-R65
	S027	23.8	FN 3287-25-33-C33-R65

Servo drive SV680-INT series			Applicable Filter
Size	Model	Rated Input Current (A)	
Three-phase 400 V			
C	T3R5	2.4	FN 3287-10-44-C28-R65
	T5R4	3.6	FN 3287-10-44-C28-R65
D	T8R4	5.6	FN 3287-10-44-C28-R65
	T012	8.0	FN 3287-10-44-C28-R65
E	T017	12.0	FN 3287-16-44-C33-R65
	T021	16.0	FN 3287-16-44-C33-R65
	T026	21.0	FN 3287-25-33-C33-R65

Dimensions

- Dimensions of Schaffner FN 2090 series filters

Figure 7-3 Dimensions of FN 2090 series filters (unit: mm)

Table 7–8 Dimensions of FN 2090 series filters (unit: mm)

Rated Current (A)	A	B	C	D	E	F	G	H	I	J	K	L	M	N
3	85	54	30.3	64.8	49.8	75	27	12.3	20.8	19.9	5.3	6.3	0.7	6.3×0.8
4														
6														
8	113.5±1	57.5±1	45.4±1	94±1	56	103	25	12.4	32.4	15.5	4.4	6	1	6.3×0.8

- Dimensions of Schaffner FN 3287 series filters

Figure 7-4 Dimension drawing of FN 3287 series filters (unit: mm)

Table 7–9 Dimensions of FN 3287 series filters (unit: mm)

Rated Current (A)	A	B	C	D	E	F	G	H	J±2	K	L±1	M
10	180	40	112	153	0.8	170	20	4.5	94	11	68	M5
16	200	45	112	170	0.8	185	25	5.4	102	11	76	M5
25	205	45	132	173	0.8	190	25	5.4	113	13	83	M5

7.1.6 Magnetic Ring and Ferrite Clamp

The magnetic ring is intended to be installed on the input or output side of the drive. Install the magnetic ring as close to the drive as possible. Installing the magnetic ring on the input side can suppress the noise in the input power supply system of the drive. When it is installed on the output side, it can reduce the interference generated by the drive to external devices and the bearing current.

In applications with leakage current and signal cable interference, install a magnetic ring or a ferrite clamp.

Selection

- Amorphous magnetic ring: featuring a high permeability within 1 MHz and excellent anti-interference performance, but not as low-cost as the ferrite clamp. See *" Dimensions" on page 112* for details..
- Ferrite clamp: featuring a good interference suppression performance within a frequency band above 1MHz, applicable to low-power servo drives and signal cables, low-cost and easy to install

Magnetic Ring and Ferrite Clamp		Appearance
Magnetic ring	DY644020H	
	DY805020H	
Ferrite clamp	DYR-130-B	

Dimensions

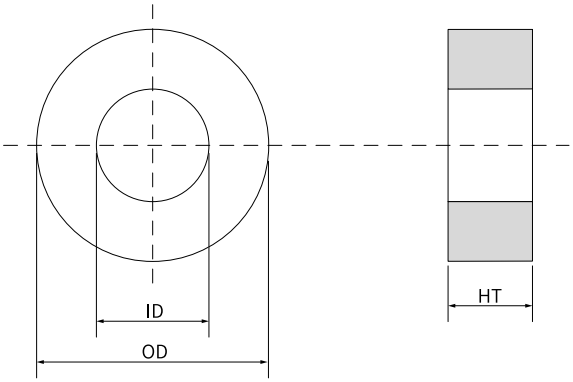


Figure 7-5 Dimensions of the magnetic ring

Table 7–10 Dimensions of the magnetic ring

Model	Dimension (OD x ID x HT) (mm)
DY644020H	64 x 40 x 20
DY805020H	80 x 50 x 20

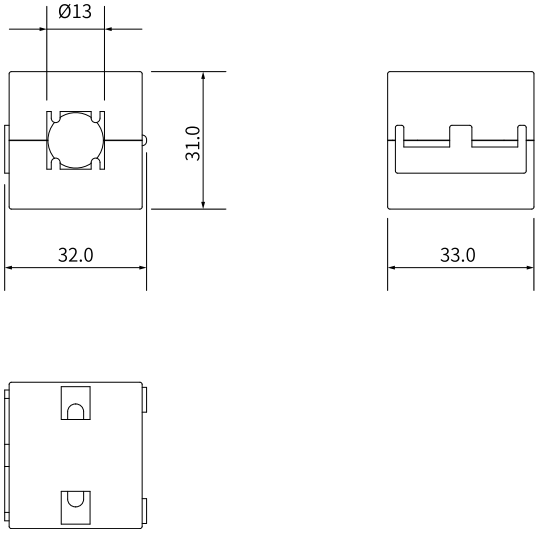


Figure 7-6 Dimensions of the ferrite clamp

Table 7–11 Dimensions of the ferrite clamp

Model	Size (Length × OD × ID) (mm)
DYR-130-B	32.0 x 31 x 13

7.2 Shield Bracket

To reduce electromagnetic interference, an EMC bracket and clamp are used with the drive cables.

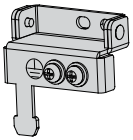


Figure 7-7 Shield Bracket

7.3 Absolute Encoder Batteries

Selection

Select an appropriate battery according to the following table.

Table 7–12 Description of the absolute encoder battery

Specification	Item	Rating			Condition
		Min.	Typical Value	Max.	
Output: 3.6 V, 2500 mAh	External battery voltage (V)	3.2	3.6	5	In standby state[1]
	Circuit fault voltage (V)	-	2.6	-	In standby state
	Battery alarm voltage (V)	2.85	3	3.15	-
	Current consumed by the circuit (uA)	-	2	-	In normal operation[2]
		-	10	-	In standby state, shaft at standstill
		-	80	-	In standby state, shaft rotating
	Ambient temperature (°C)	0	-	40	Same as the motor.
	Storage temperature (°C)	-20	-	60	

The preceding values are obtained under an ambient temperature of 20°C.

7.4 Braking Resistor

When the motor torque direction is opposite to the direction of rotation, the energy is fed back to the servo drive from the motor side, leading to bus voltage rise. Once the bus voltage rises to the braking threshold, the excessive energy must be consumed by a braking resistor. Otherwise, the servo drive will be damaged. The braking resistor can be a built-in or an external one. The internal and built-in braking resistors must not be used together. Specifications of the braking resistor are as follows.

Table 7–13 Specifications of the braking resistor

Servo Drive Model	Specifications of Built-in Braking Resistor			Min. Permissible Resistance of External Braking Resistor (Ω) (H02.21)
	Resistance (Ω)	Power (Pr) (W)	Processing Power (Pa) (W)	
SV680 x S1R6I-INT	-	-	-	40
SV680 x S2R8I-INT	-	-	-	
SV680 x S5R5I-INT	50	50	40	
SV680 x S7R6I-INT	25	80	64	20
SV680 x S012I-INT				15

Servo Drive Model	Specifications of Built-in Braking Resistor			Min. Permissible Resistance of External Braking Resistor (Ω) (H02.21)
	Resistance (Ω)	Power (Pr) (W)	Processing Power (Pa) (W)	
SV680 x S018I-INT	20	100	80	20
SV680 x S022I-INT				
SV680 x S027I-INT				
SV680 x T3R5I-INT	100	80	64	80
SV680 x T5R4I-INT	100			60
SV680 x T8R4I-INT	50			45
SV680 x T012I-INT				40
SV680 x T017I-INT	35	100	80	35
SV680 x T021I-INT				25
SV680 x T026I-INT				

The kinetic energy generated upon braking of a reciprocating motor is converted into electric energy that fed back to the bus capacitor. When the bus voltage rises above the braking voltage threshold, the braking resistor starts consuming the excessive energy fed back by the motor. The motor speed curve is as shown in *"Figure 7–8 " on page 115*.

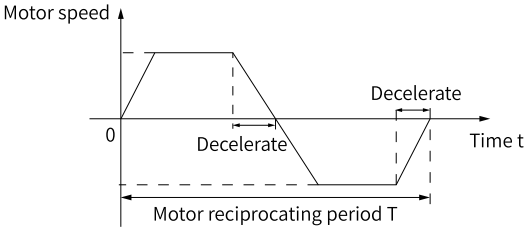


Figure 7-8 Motor speed curve

Energy calculation

The built-in braking resistor is not available in SV680*S1R6I-INT and SV680*S2R8I-INT models. Capacitors are used to store energy. An external braking resistor is needed when the rotational energy of the motor and the load exceeds the values listed in the following table.

Drive Model	Regenerative Energy Can Be Absorbed (W)	Remarks
SV680 x S1R6I-INT	13.15	The input voltage of the main circuit power supply is 220 VAC.
SV680 x S2R8I-INT	26.29	

- The following table shows the energy generated by a 200 V motor in decelerating from the rated speed to a standstill during no-load operation.

Table 7–14 200 V motor energy data

Capacity (kW)	Servo Motor Model MS1H*-*******-*****	Rotor Inertia J (kgm^2)	EO Generated During Decelerating from Rated Speed to a Standstill (J)	Max. Braking Energy Absorbed by the Capacitor E_C (J)
0.05	MS1H1-05B30CB-**30Z-INT MS1H1-05B30CB-**32Z-INT	0.026×10^4 (0.028×10^4)	0.13 (0.14)	9.3
0.1	MS1H1-10B30CB-**30Z-INT MS1H1-10B30CB-**32Z-INT	0.041×10^4 (0.043×10^4)	0.20 (0.21)	
0.2	MS1H1-20B30CB-**30R-INT MS1H1-20B30CB-**32R-INT	0.0938×10^4 (0.106×10^4)	0.46 (0.52)	
0.4	MS1H1-40B30CB-**30R-INT MS1H1-40B30CB-**32R-INT	0.145×10^4 (0.157×10^4)	0.72 (0.78)	18.59
0.55	MS1H1-55B30CB-**30R-INT	0.55×10^4	2.72	32.42
0.75	MS1H1-75B30CB-**30R-INT MS1H1-75B30CB-**32R-INT	0.68×10^4 (0.71×10^4)	3.36 (3.51)	32.42
1	MS1H1-10C30CB-**30R-INT MS1H1-10C30CB-**32R-INT	0.82×10^4 (0.87×10^4)	4.05 (4.30)	32.42
1	MS1H2-10C30CB-**31R-INT MS1H2-10C30CB-**34R-INT	1.78×10^4 (2.6×10^4)	8.80 (12.86)	32.42
1.5	MS1H2-15C30CB-**31R-INT MS1H2-15C30CB-**34R-INT	2.35×10^4 (3.17×10^4)	11.6 (15.68)	47.68
2.0	MS1H2-20C30CB-**31R-INT MS1H2-20C30CB-**34R-INT	2.92×10^4 (3.74×10^4)	14.44 (18.49)	78.19
2.5	MS1H2-25C30CB-**31R-INT MS1H2-25C30CB-**34R-INT	3.49×10^4 (4.3×10^4)	17.26 (21.26)	114.43
3.0	MS1H2-30C30CB-**31R-INT MS1H2-30C30CB-**34R-INT	6.4×10^4 (9.38×10^4)	31.65 (46.38)	114.43
4.0	MS1H2-40C30CB-**31R-INT MS1H2-40C30CB-**34R-INT	9×10^4 (11.98×10^4)	44.51 (59.24)	114.43
5.0	MS1H2-50C30CB-**31R-INT MS1H2-50C30CB-**34R-INT	11.6×10^4 (14.58×10^4)	57.36 (72.10)	114.43
0.85	MS1H3-85B15CB-**31R-INT MS1H3-85B15CB-**34R-INT	13.56×10^4 (15.8×10^4)	16.45 (17.3)	32.42
1.3	MS1H3-13C15CB-**31R-INT MS1H3-13C15CB-**34R-INT	19.25×10^4 (21.5×10^4)	22 (22.86)	47.68
1.8	MS1H3-18C15CB-**31R-INT MS1H3-18C15CB-**34R-INT	24.9×10^4 (27.2×10^4)	30.78 (33.63)	78.19
2.9	MS1H3-29C15CB-**31R-INT MS1H3-29C15CB-**34R-INT	44.7×10^4 (52.35×10^4)	55.26 (64.72)	114.43
4.4	MS1H3-44C15CB-**31R-INT MS1H3-44C15CB-**34R-INT	64.9×10^4 (72.55×10^4)	80.23 (89.69)	114.43
0.1	MS1H4-10B30CB-**30Z-INT MS1H4-10B30CB-**32Z-INT	0.102×10^4 (0.104×10^4)	0.50 (0.51)	9.3
0.2	MS1H4-20B30CB-**31R-INT MS1H4-20B30CB-**34R-INT	0.22×10^4 (0.23×10^4)	1.09 (1.14)	9.3

Capacity (kW)	Servo Motor Model MS1H*-*******-*****	Rotor Inertia J (kgm^2)	EO Generated During Decelerating from Rated Speed to a Standstill (J)	Max. Braking Energy Absorbed by the Capacitor E_C (J)
0.4	MS1H4-40B30CB-**31R-INT MS1H4-40B30CB-**34R-INT	0.43×10^4 (0.44×10^4)	2.13 (2.18)	18.59
0.55	MS1H4-55B30CB-**31R-INT	1.12×10^4	5.54	32.42
0.75	MS1H4-75B30CB-**31R-INT MS1H4-75B30CB-**34R-INT	1.46×10^4 (1.51×10^4)	7.22 (7.47)	32.42
1.0	MS1H4-10C30CB**31R-INT MS1H4-10C30CB**34R-INT	1.87×10^4 (1.97×10^4)	9.25 (9.74)	32.42

- The following table shows the energy generated by a 400 V motor in decelerating from the rated speed to a standstill during no-load operation.

Table 7–15 400 V motor energy data

Capacity (kW)	Servo Motor Model MS1H*-*******-*****	Rotor Inertia J (kgm^2)	Braking Energy E_O (J) Generated During Operation	Max. Braking Energy Absorbed by the Capacitor E_C (J)
1.0	MS1H2-10C30CD-**31R-INT MS1H2-10C30CD-**34R-INT	1.78×10^4 (2.6×10^4)	8.8 12.86	36.06
1.5	MS1H2-15C30CD-**31R-INT MS1H2-15C30CD-**34R-INT	2.35×10^4 (3.17×10^4)	11.62 (15.68)	43.79
2.0	MS1H2-20C30CD-**31R-INT MS1H2-20C30CD-**34R-INT	2.92×10^4 (3.74×10^4)	14.44 (18.49)	64.40
2.5	MS1H2-25C30CD-**31R-INT MS1H2-25C30CD-**34R-INT	3.49×10^4 (4.3×10^4)	17.26 (21.26)	64.40
3.0	MS1H2-30C30CD-**31R-INT MS1H2-30C30CD-**34R-INT	6.4×10^4 (9.38×10^4)	31.65 (46.38)	64.40
4.0	MS1H2-40C30CD-**31R-INT MS1H2-40C30CD-**34R-INT	9×10^4 (11.98×10^4)	44.51 (59.24)	105.62
5.0	MS1H2-50C30CD-**31R-INT MS1H2-50C30CD-**34R-INT	11.6×10^4 (14.58×10^4)	57.36 (72.10)	154.56
0.85	MS1H3-85B15CD-**31R-INT MS1H3-85B15CD-**34R-INT	13.56×10^4 (15.8×10^4)	16.76 (19.53)	36.06
1.3	MS1H3-13C15CD-**31R-INT MS1H3-13C15CD-**34R-INT	19.25×10^4 (21.5×10^4)	23.8 (26.58)	43.79
1.8	MS1H3-18C15CD-**31R-INT MS1H3-18C15CD-**34R-INT	24.9×10^4 (27.2×10^4)	30.78 (33.63)	64.40
2.9	MS1H3-29C15CD-**31R-INT MS1H3-29C15CD-**34R-INT	44.7×10^4 (52.35×10^4)	55.26 (64.72)	64.40
4.4	MS1H3-44C15CD-**31R-INT MS1H3-44C15CD-**34R-INT	64.9×10^4 (72.55×10^4)	80.23 (89.69)	105.62
5.5	MS1H3-55C15CD-**31R-INT MS1H3-55C15CD-**34R-INT	86.9×10^4 (94.55×10^4)	107.43 (116.89)	154.56
7.5	MS1H3-75C15CD-**31R-INT MS1H3-75C15CD-**34R-INT	127.5×10^4 (135.15×10^4)	157.62 (167.08)	154.56

If the total braking time T is known, you can determine whether an external braking resistor is needed and the power required using the following flowchart and formula.

Selection of the braking resistor for a servo rotary motor

- **Without external load torque**

Figure 7-9 Flowchart for selecting the braking resistor

Take the H1 series 750 W model as an example. Assume that the reciprocating cycle (T) is 2s, the maximum speed is 3000 RPM, and the load inertia is (4 x Motor inertia), then the required power of the braking resistor is as follows:

$$P_b = \frac{2 \times [(N+1) \times E_O - E_C]}{T} = \frac{2 \times [(4+1) \times 6.824 - 32.422]}{2} = 1.698W$$

The calculated result is smaller than the processing capacity (Pa = 40 W) of the built-in braking resistor, so a built-in braking resistor is enough.

If the inertia ratio in the preceding example is changed to 10 x motor inertia, and other conditions remain the same, the power of the braking resistor required will be as follows:

$$P_b = \frac{2 \times [(N+1) \times E_O - E_C]}{T} = \frac{2 \times [(10+1) \times 6.824 - 32.422]}{2} = 42.642W$$

The calculated result is larger than the processing capacity (Pa = 40 W) of the built-in braking resistor, so an external braking resistor is needed. so an external braking resistor is required. The recommended power of the external braking resistor is Pb/(1 – 70%) = 142.14W.

☆ Related parameters:

Parameter	Hex	Name	Value	Default	Unit	Change Mode
H02.21	2002-16h	Permissible minimum resistance of braking resistor	1Ω to 1000Ω	40	Ω	Unchangeable
H02.24	2002-19h	Resistor heat dissipation coefficient	10% to 100%	30	%	Real-time
H02.25	2002-1Ah	Braking resistor type	0: Built-in 1: External, natural cooling 2: External, forced air cooling 3: No resistor needed	3	-	Real-time

Parameter	Hex	Name	Value	Default	Unit	Change Mode
H02.26	2002-1Bh	Power of external braking resistor	1 W–65535W	40	W	Real-time
H02.27	2002-1Ch	Resistance of external braking resistor	15Ω to 1000Ω	50	Ω	Real-time

- Braking resistor not needed
  When $E_1 < E_C$, the braking resistor is not needed because the braking energy can be absorbed by the bus capacitor. In this case, set H02.25 to 3.
- Using the built-in braking resistor
  When $P_b < P_a$ and $E_1 > E_C$, use the built-in braking resistor. In this case, set H02.25 to 0.

  When using the built-in braking resistor, connect terminals $P_\oplus$ and D with a jumper bar.
- Using an external braking resistor
  When P_b is greater than P_a, use an external braking resistor. Set H02.25 to 1 or 2 based on the cooling mode of the braking resistor.

  Use the external braking resistor with 70% derated, that is, $P_r = P_b/(1 – 70\%)$, and ensure the resistance of the braking resistor is higher than the minimum permissible resistance allowed by the servo drive. Remove the jumper bar between terminals $P_\oplus$ and D, and connect the external braking resistor between terminals $P_\oplus$ and C.

  For the wiring diagram and lead wire specifications of the external braking resistor, see *"Table 5–7 Recommended main circuit cables" on page 58*. Set H02.25 to 1 or 2 based on the cooling mode of the braking resistor. Check and set the following parameters.

  ☆ Related parameters:

Parameter	Hex	Name	Value	Default	Unit	Change Mode
H02.21	2002-16h	Permissible minimum resistance of braking resistor	1Ω to 1000Ω	40	Ω	Unchangeable
H02.25	2002-1Ah	Braking resistor type	0: Built-in 1: External, natural cooling 2: External, forced air cooling 3: No resistor needed	3	-	Real-time

Parameter	Hex	Name	Value	Default	Unit	Change Mode
H02.26	2002-1Bh	Power of external braking resistor	1 W–65535W	40	W	Real-time
H02.27	2002-1Ch	Resistance of external braking resistor	15Ω to 1000Ω	50	Ω	Real-time

Set the heat dissipation coefficient based on the heat dissipation condition of the external braking resistor.

☆ Related parameters:

Parameter	Hex	Name	Value	Default	Unit	Change Mode
H02.24	2002-19h	Resistor heat dissipation coefficient	10% to 100%	30	%	Real-time

- **External load torque applied, motor in generating state**

When the motor direction of rotation is the same with the shaft direction of rotation, the motor outputs energy to the outside. In some applications where the motor direction of rotation is opposite to the shaft direction of rotation, the motor is in the generating state and feeds the electric energy back to the servo drive.

When the load is in the generating state continuously, it is recommended to adopt the common DC bus mode.

Figure 7-10 Example of the curve with external load torque

Take the H1 series 750 W model (rated torque 2.39 N·m) as an example. When the external load torque is 60% of the rated torque and the motor speed is 1500 RPM, the power pumped back to the drive is: (60% x 2.39) x (1500 x 2π/60) = 225 W. As the braking resistor is derated by 70%, and therefore, the power of the external braking resistor is: 225/(1 – 70%) = 750 W, with resistance 50 Ω

Selection of the braking resistor for a direct drive motor

- **Without external load torque**

Figure 7-11 Flowchart for selecting the braking resistor

- **Calculate the feedback energy at each deceleration**

$$E_S = \frac{1}{2} \times (M_M + M_L) \times (V_1^2 - V_2^2)$$

E_S: Feedback energy during deceleration (J)

M_M: Motor rotor mass (kg)

M_L: Load mass (kg)

V_1: Speed before deceleration (m/s)

V_2: Speed after deceleration (m/s)

- **Determine the energy consumed by the motor**

$$E_M=3\times I_M^2\times (R_M\div 2)\times t_d$$

E_M: Energy consumed by the motor winding (J)

I_M: Current at deceleration (A)

R_M: Motor phase resistance (Ω)

t_d: Deceleration time (s)

- **Determine the energy consumed by friction (the friction consumption of a direct drive motor is not great, and can be ignored if the working conditions permit)**

$$E_F=\frac{1}{2}\times T_f\times (V_1-V_2)\times t_d$$

E_f: Energy consumed by friction (J)

T_f: Friction resistance (N)

V_1: Speed before deceleration (m/s)

V_2: Speed after deceleration (m/s)

t_d: Deceleration time (s)

- **Determine the energy consumed by the drive**

$$E_1=E_F-E_M-E_F$$

E_1: Energy consumed by the drive (J)

- **Determine the energy consumed by the braking resistor**
  - $E_1>E_C$: The braking resistor is required.
  - $E_1<E_C$: The braking resistor is not required.
- **Calculate the power of the braking resistor**

$$P_b=2\times (E_1-E_C)\div T$$
$$P_r=P_b\div 0.3$$

P_b: Power to be handled by the braking resistor (W)

P_r: Recommended braking resistor power (W)

T: Motor cyclic operation period (s)

0.3: Resistor heat dissipation coefficient (setpoint of H02.24)

- Take the S5R5 model as an example:
  Assume that the reciprocating period T=2s, the maximum operating speed is 8 m/s, deceleration ends at 0m/s in 0.05 s, load mass is three times of motor mass, and friction torque is 2.5 N·m. When motor mass is 0.6 kg, phase resistance is 1.53 Ω and force constant is 23.5 N/A, then:

  The deceleration current can be obtained by monitoring H0b.24 (RMS of phase current) at deceleration:

  I_M = 15 (A)

  Energy calculation:

$$E_S = \frac{1}{2} \times (1+3) \times 0.6 \times 8^2 = 76.8\,(J)$$
$$E_M = 3 \div 15^2 \div \frac{1.53}{2} \times 0.05 = 25.82\,(J)$$
$$E_F = \frac{1}{2} \times 2.5 \times 8 \times 0.05 = 0.5\,(J)$$
$$E_1 = E_S - E_M - E_F = 50.48\,(J)$$

  Because $E_1 > E_C$, you need to use a braking resistor. The power of the braking resistor:

$$P_b = 2 \times (50.48 - 32.42) \div 2 = 18.06\,(W)$$

  Because $P_b < P_a$ (the power that can be handled by a built-in braking resistor) resistor, you can use a built-in braking resistor

- **External load torque applied, motor in generating state**
  When the motor direction of rotation is the same with the shaft direction of rotation, the motor outputs energy to the outside. In some applications where the motor direction of rotation is opposite to the shaft direction of rotation, the motor is in the generating state and feeds the electric energy back to the servo drive.

  When the load is in the generating state continuously, it is recommended to adopt the common DC bus mode.

Figure 7-12 Example of the curve with external load torque

8 Requirements of Certifications and Standards

CE Certification

Directive	Standard	
EMC Directive 2014/30/EU	Servo drive	EN 61800-3 EN 61800-6-2 EN 61800-6-4 EN 55011
	Servo motor	
Low Voltage Directive 2014/35/EU	Servo drive	EN 61800-5-1
	Servo motor	EN 60034-1 EN 60034-5
RoHS Directive 2011/65/EU	Servo drive	EN 50581
	Servo motor	

UL/cUL Certification

Certification	Standard	
UL/cUL Certification	Servo drive	UL61800-5-1 C22.2 No.274-17
	Servo motor	UL 1004-1 UL 1004-6 CSA C22.2 No. 100-14

KC Certification

Note

SV680XXXXXX-PINT is not KC-certified.

Certification	Standard	
KC Certification	Servo drive	KN 61800-3 (Ver 2014.06) (IEC 61800-3 Ver 2012.03)

Others

The SV680-INT series servo drive meets the requirements of EAC, UKCA and functional safety certification.

8.1 CE Certification

Figure 8-1 CE Marking

- The CE mark indicates compliance with the Low Voltage Directive LVD), Electromagnetic Compatibility (EMC), and Restriction of Hazardous Substances (RoHS) directives.
- The CE mark is required for engaging in commercial business (production, importation, and distribution) in Europe.
- The drive complies with LVD, EMC, and RoHS directives and carries the CE mark.
- Machines and devices integrated with this drive must also comply with CE requirements for distribution in Europe.
- The integrator who integrates this drive into other products and attaches CE mark to the final assembly has the responsibility of ensuring compliance with CE certification.

8.1.1 Requirements for Compliance with EMC

The drive is applicable to the first environment and second environment and complies with EMC directive 2014/30/EU and standard EN 61800-3.

As required by EMC Directive 2014/30/EU and standard EN IEC 61800-3, install an EMC filter on the input side of the drive and use shielded cables on the output side. Ensure the filter is grounded properly and the shield of the output cable is grounded 360 degrees.

Introduction to EMC standards

Electromagnetic compatibility (EMC) describes the ability of electrical and electronic devices or systems to work properly in the electromagnetic environment without introducing electromagnetic interferences that disturb the operation of other local devices or systems. In other words, EMC includes two aspects: 1) The electromagnetic interference generated by a device during normal operation cannot exceed a certain limit. 2) The device must have sufficient immunity to the electromagnetic interference in the environment.

EN 61800-3 defines the following two types of environments.

- First environment: Environment that includes domestic premises, and establishments directly connected without intermediate transformers to a low-voltage power supply network which supplies buildings used for domestic purposes

- Second environment: Environment that includes all establishments other than those directly connected to a low-voltage power supply network which supplies buildings used for domestic purposes

Devices are divided into the following four categories based on the intended application environment.

- Category C1: a Power drive system (PDS) with the rated voltage less than 1000 V, intended for use in the first environment.
- Category C2 equipment: PDS with rated voltage less than 1000 V, which is neither a plug-in device nor a movable device and, when used in the first environment, is intended to be installed and commissioned only by professionals.
- Category C3 equipment: PDS with rated voltage less than 1000 V, intended for use in the second environment and not intended for use in the first environment.
- Category C4 equipment: PDS with rated voltage equal to or above 1000 V, or rated current equal to or above 400 A, or intended for use in complex systems in the second environment.

8.1.2 Requirements for Compliance with LVD

The drive has been tested in accordance with EN61800-5-1 to determine compliance with LVD. Observe the following requirements to enable machines and devices integrated with this drive to comply with LVD.

Installation location

Install the drive in a place with overvoltage category III and pollution degree 1 or 2 as specified by EN61800-5-1.

Installation Environment

For requirements of the installation environment, see SV680–INT Series Servo Drive Hardware Guide.

Protection

The drive must be installed in a fireproof cabinet with doors that provide effective electrical and mechanical protection. The installation must conform to local and regional laws and regulations and relevant IEC standards.

IP20-rated drives intended to be installed inside the cabinet must be installed in a structure that prevents intrusion of unwanted objects from the top and the front.

Main Circuit Cable Requirements

For wiring requirements of main circuit terminals, see SV680–INT Series Servo Drive Hardware Guide.

Requirements of protective devices

To comply with EN 61800-5-1, install a fuse/circuit breaker on the input side of the drive to prevent accidents caused by short circuit in the internal circuit.

See SV680–INT Series Servo Drive Hardware Guide for recommended fuse models and breaker models.

8.2 UL/cUL Certification

Figure 8-2 UL/cUL mark

The UL/cUL mark commonly applies to products sold in the United States and Canada. Products with UL/cUL mark have been inspected and assessed by the UL organization. To pass UL/cUL certification, main built-in components of electrical products must also be UL certified.

The drive has been tested in accordance with UL 61800–5–1 and CSA C22.2 No. 274-17 to determine compliance with UL/cUL standards. Observe the following requirements to enable machines and devices integrated with this drive to comply with UL/cUL standards.

Installation location

Install the drive in a place with overvoltage category III and pollution degree 1 or 2 as specified by UL61800–5–1.

Ambient temperature

According to the protection level, the ambient temperature must be maintained within the following range:

Ambient temperature for open-type drives: 0°C to 50°C

Installation requirements

Installation requirements for open-type drives:

SV680 series servo drives are open-type drives that must be installed in a fireproof cabinet with the enclosure that provides effective electrical and mechanical protection. The installation must conform to local laws and regulations and related NEC requirements.

Main circuit wiring requirements

- Terminals P⊕, C, and NΘ are used to connect optional parts. Do not connect these terminals to an AC power supply.
- To protect the main circuit, separate and cover the surface that may come into contact with the main circuit.
- The control circuit is the internal safety extra-low voltage (SELV) circuit that must be strictly insulated and isolated from other circuits. Make sure that the control circuit is connected to the external SELV circuit.
- Prevent foreign matters from entering the wiring part of the terminal block.
- Do not solder the twisted conductors.
- The tightening torque may vary with terminals. Tighten terminal screws with the specified tightening torque. You can use the torque screwdriver, ratchet, or wrench.
- When using an electric screwdriver to tighten terminal screws, set a low speed to prevent damage to the terminal screws.
- Tighten the terminal screws at an angle lower than 5 degrees. Failure to comply may result in screw damage.

Control circuit wiring requirements

Observe the requirements in UL508 during wiring.

Cable requirements

Cable dimensions must be compliant with requirements in NEC (National Electric Code) and CEC (Canadian Electrical Code) Part I and local regulations.

- Use cables with copper conductors.
- The recommended cables for the main circuit are 600 V class 2 heat-resistant indoor PVC cables that can work under temperature of 75°C continuously. The following conditions are premises for use of the cables.
  - Ambient temperature: < 40°C
  - Normal operating ratings

If the recommended cable specifications for peripheral devices or optional parts exceed the applicable cable specification range, contact Inovance.

Terminal cable selection

To comply with UL61800-5-1 and CSA C22.2 No. 274-17, power cables used for SV680 series servo drives must meet the following requirements:

- Compliant with NEC, Table 310-16 of NFPA70, and NFPA79.
- Comprised of copper conductors with a rated temperature not lower than 75°C (167°F)
- Compliant with 14AWG or higher.
- With a rated voltage not lower than the rated voltage of the servo drive

- It is recommended to use cables compliant with UL758 Style 2517 and Style 2586 as motor main circuit cables.

Requirements for protective devices

To comply with UL61800-5-1, install a fuse/circuit breaker on the input side of the drive to prevent accidents caused by short circuit in the internal circuit.

Install sufficient protective devices against short circuit in branch circuits according to applicable regulations and this guide. The drive is applicable to circuits with a rated breaking capacity lower than 5kA and 65 kA and a maximum voltage of 480 VAC (class 400 V).

For the SV680 drive applied in North America, the recommended protective devices are as follows:

Table 8–1 Recommended protective device for the drive

Servo drive model		Circuit breaker (A)	Class J fuse (A)	Recommended inverse time lag breaker[1] (A)
Single-phase 200 V				
Size A	S1R6	15	6	40
	S2R8	15	10	40
Size C	S5R5	15	20	40
	S7R6	15	20	100
Size D	S012	20	20	100
Three-phase 200 V				
Size A	S1R6	15	6	40
	S2R8	15	6	40
Size C	S5R5	15	15	40
	S7R6	15	15	100
Size D	S012	20	20	100
Size E	S018	40	20	100
	S022	40	35	100
	S027	40	40	100
Three-phase 400 V				
Size C	3R5	15	6	100
	5R4	15	10	100
Size D	T8R4	20	15	100
	T012	20	20	100
Size E	T017	40	35	100
	T021	40	35	100
	T026	40	40	100

8.3 KC Certification

Figure 8-3 KC Certification Mark

The KC mark indicates compliance with ROK standards related to safety (KC) and EMC (KCC).

- The KC mark is required for engaging in commercial business (production, importation, and distribution) in the ROK.
- Machines and devices integrated with this drive must also comply with KC requirements for distribution in the ROK.
- The integrator who integrates this drive into other products and attaches KC mark to the final assembly has the responsibility of ensuring compliance with KC certification.
- Observe the following requirements to enable machines and devices integrated with this drive to comply with KC standards.

Appllicant Suzhou Inovance Technology Co., Ltd.
AC Servo Drive
Model SV680 series
Made In China
Manufacturer
Suzhou Inovance Technology Co.,Ltd.

A급기기 (업무용 방송통신기자재)
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8.4 UKCA Certification

Products exported to Great Britain must carry a UKCA mark. However, the products with the CE mark can still be exported to the United Kingdom.

8.5 Functional Safety Certification

EC directives and standards

Low Voltage Directive 2014/35/EU Standard EN 61800-5-1

EMC Directive 2014/30/EU Standard EN 61800-3: 2018

Machinery Directive 2006/42/EC (Safety Functions) Standard IEC 61800-5-2

9 Maintenance

9.1 Routine Maintenance

The required operating conditions are as follows: Average ambient temperature: 30°C Average load rate: Below 80% Daily operating time: Below 20 hours

9.1.1 Routine Inspection

Check the following items during routine inspection.

Table 9–1 Routine checklist

No.	Routine Inspection	Yes
1	The ambient temperature and humidity are normal. There is no dust or unwanted objects in the servo drive.	☐
2	There is no abnormal vibration or noise.	☐
3	The voltage of the power supply is normal.	☐
4	There is no strange smell.	☐
5	There are no fibers adhered to the air inlet.	☐
6	There is no intrusion of unwanted object on the load end.	☐

9.1.2 Routine Cleaning

Check the following items during routine cleaning.

Table 9–2 Routine cleaning list

No.	Routine Cleaning	Yes
1	Clean the dust on the equipment surface, especially the metallic dust.	☐
2	Keep the front end of the servo drive and the connectors clean.	☐

Note

- Cut off the power supply before cleaning. Clean the equipment with an air gun or a piece of dry cloth.
- Do not use the gasoline, diluent, alcohol, acidic or alkaline detergent during cleaning to prevent enclosure discoloration or damage.

9.2 Regular Checklist

9.2.1 Periodic Inspection Items

Table 9–3 Periodic checklist

No.	Item	Yes
1	The screws used to fix the couplings between devices are in place.	☐
2	There is no sign of overheating.	☐
3	Terminal blocks are in good condition without any sign of damage.	☐
4	The clamping units of terminal blocks are in place.	☐

9.2.2 Periodic Maintenance

The electrical and electronic parts inside the servo drive may be mechanically worn out and degraded. To keep the servo drive in good condition, perform parts replacement based on the replacement cycles listed in the following table. Contact Inovance or your Inovance agent to check whether the parts need to be replaced.

Object	Type	Standard Replacement Interval	Remarks
Servo drive	Power bus capacitor	About 8 years (ambient temperature: 30°C; load rate: 80%; uptime per day: 20 hours; standard environment[1])	The standard replacement interval is for reference only. If any device/component works improperly before the replacement interval expires, replace it immediately.
	Fan	5 years (ambient temperature: 30°C; load rate: 80%; uptime per day: 20 hours; standard environment[1])	
	Control circuit aluminum electrolytic capacitor	About 10 years (ambient temperature: 30°C; load rate: 80%; uptime per day: 20 hours; standard environment[1])	
	Pre-charge relay	100000 operations (depending on the operating conditions)	
	Pre-charge resistor	20000 operations (depending on the operating conditions)	
	Dynamic brake relay	About 1000 times (rated motor speed; interval: 5 min; inertia: 20 times)	
	Dynamic brake resistor		

Note

[1]: For details on the standard environment, see *"2.3.1 Installation Environment Requirements" on page 36*.

10 Service and Support

Downloads

More product manuals, leaflets, brochures, certificates, 2D/3D drawings and other information can be downloaded in the following way:

Visit *https://www.inovance.com* and do keyword search in Service and Support > Downloads.

Contact us

We are honored to have you as our client. You can submit basic information to us in the following way, so that we can reach you as soon as possible. We are committed to your privacy. We will never share your information with any third party.

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