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SV660ND Series Servo Drive

Safety Guide

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

Data code 19011888 A00

Preface

Introduction

Thank you for purchasing the SV660ND series servo drive.

The SV660ND series standard multi-drive servo products are high-performance AC servo drives developed by Inovance. They provide a power range from 0.4 kW to 0.75 kW and supports EtherCAT bus communication. The SV660ND supports STO (SIL3), one-key tuning, and self-adaptive notch, making the servo drive ease-of-use. It allows a quiet and stable operation through working with an MS1 series high-response servo motor with a 23-bit-turn absolute encoder.

SV660ND provides effective solutions to meet requirements of high integration, bus topology, small footprint, simple commissioning, and environmental resistance in the mobile phone manufacturing, robot, machine tool, lithium battery, silicon semiconductor, touchscreen, and LED industries.

This guide presents the safety function and related certifications and standards, wiring, commissioning process, commissioning steps, troubleshooting, and functions.

More Documents

Document Name	Data Code	Description
SV660ND Series Servo Drive Selection Guide	19011910	Presents product model selection, including the list of matching models, drive product information, motor product information, and cable selection.
SV660ND Series Servo Drive Installation Guide	19011911	Presents installation of the servo drive, including installation procedures, mechanical installation, and electrical installation.
SV660ND Series Servo Drive Hardware Guide	19011912	Presents the electrical design, wiring terminals, certification standards and requirements, and common solutions to EMC problems of the product.
SV660ND Series Servo Drive Commissioning Guide	19011913	Presents servo commissioning, parameter descriptions, troubleshooting, including the operating panel, commissioning software, commissioning process and procedure, and parameter list.
SV660ND Series Servo Drive Function Guide	19011914	Presents functions and parameters, including function overview, basic servo functions, adjustment, and parameter list.

Document Name	Data Code	Description
SV660ND Series Servo Drive Communication Guide	19011915	Presents functions and parameters of the servo drive, including EtherCAT communication configuration, parameter description, and communication application cases.
SV660ND Series Servo Drive Troubleshooting Guide	19011916	Presents faults and fault levels, the troubleshooting process, warning codes, and fault codes.
SV660ND Series Servo Drive Maintenance Guide	19011917	Provides instructions on maintenance and repair, routine maintenance, and part replacement of the equipment.
SV660ND Series Servo Drive Safety Guide	19011918	Presents the safety function and related certifications and standards, wiring, commissioning process, troubleshooting, and functions.
SV660ND Series Servo Drive Manual Package	PS00005852	Provides information on selection, installation, commissioning, function, troubleshooting, and parameters of the servo drive.

Revision History

Date of Revision	Version	Description
May 2022	A00	First release

Document Acquisition

This manual is not delivered with the product. You can obtain the PDF version by visiting:

- *www.inovance.com*
- Scan the QR code on the equipment to acquire more.

Table of Contents

Preface 1
Fundamental Safety Instructions 5
1 General 12
1.1 Terms and Abbreviations 12
1.2 Safety Standards 12
1.3 Precautions for Use 15
2 Product Information 20
2.1 Model Number and Nameplate 20
2.2 Components 21
2.3 Electrical Specifications 23
2.4 Basic Specifications 25
2.5 EtherCAT Communication Specifications 27
2.6 Product Dimensions 28
3 Installation 29
3.1 Unpacking Inspection 29
3.2 Installation Environment 31
3.3 Installation Clearance 32
3.4 Installation Dimensions 35
3.5 Mounting the Drive 36
4 Wiring 37
4.1 Precautions 37
4.2 Cable Layout 38
4.2.1 Specifications 38
4.2.2 Routing Recommendations 39
4.2.3 Grounding 40
4.3 CN7 (STO Safety Terminal) 45
5 Keypad 48
5.1 Components 48
5.2 Panel Display 50
5.3 Parameter Settings 56
6 STO 66
6.1 Overview 66
6.2 Function Use and Monitoring 67
6.3 Fault Reset 68

6.4 Safety Function Response Time. 70
7 Commissioning and Operation 71
7.1 Commissioning Flowchart. 71
7.2 Commissioning Steps. 72
7.3 Acceptance 72
8 Maintenance. 75
8.1 Routine Maintenance 75
8.1.1 Routine Checklist 75
8.1.2 Routine Cleaning List 75
8.2 Periodic Checklist 76
8.2.1 Periodic Checklist 76
8.2.2 Periodic Maintenance Checklist 76
9 Certification and Standard Compliance. 78
9.1 Compliance List 78
9.2 CE Certification 78
9.2.1 Requirements for Compliance with EMC 79
9.2.2 Requirements for Compliance with LVD 80
9.3 UL and cUL Certification 81
10 Troubleshooting 84
11 List of Parameters. 85

Fundamental Safety Instructions

Safety Precautions

- This chapter presents essential safety instructions for a proper use of the equipment. Before operating the equipment, read through the guide and comprehend all the safety instructions. Failure to comply with the safety instructions may result in death, severe personal injuries, or equipment damage.
- "CAUTION", "WARNING", and "DANGER" items in the guide only indicate some of the precautions that need to be followed; they just supplement the safety precautions.
- Use this equipment 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 use.

Safety Levels and Definitions

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

General Safety Instructions

- 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.

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 injuries 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 equipment components such as the front cover and terminal blocks are secured firmly with screws. Loosely-connected components may fall off and result in personal injuries 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.
- Avoid storing or transporting the equipment in environments with water splash, rain, direct sunlight, strong electric field, strong magnetic field, and strong vibration.
- Avoid storing the equipment for more than three months. Long-term storage requires stricter protection and necessary inspections.
- 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 must be operated only by professionals with electrical knowledge.



- 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 equipment onto an incombustible object such as a metal. Keep the equipment away from combustible objects. Failure to comply will result in a fire.



- 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 the 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, cut off 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. After waiting for the designated time, measure the DC voltage in the main circuit to ensure the DC voltage is within the safe voltage range. Failure to comply will 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 will result in an electric shock.



- Do not connect the input power supply to the output end of the equipment. Failure to comply will 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 an electric shock or equipment damage.



- During wiring, follow the proper electrostatic discharge (ESD) procedure, and wear an antistatic wrist strap. Failure to comply will damage the equipment or the internal circuits of the equipment.
- Use shielded twisted pairs for the control circuit. Connect the shield to the grounding terminal of the equipment for grounding purpose. Failure to comply will 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 a fire.
- After power-on, do not open the cabinet door or protective cover of the equipment, touch any terminal, or disassemble any unit or component of the equipment. Failure to comply will 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.
- Before power-on, check that no one is near the equipment, motor, or machine. Failure to comply may result in death or personal injuries.

Operation



- The equipment must be operated only by professionals. Failure to comply will result in death or personal injuries.
- Do not touch any connecting terminals or disassemble any unit or component of the equipment during operation. Failure to comply will 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, cut off all the power supplies of the equipment and wait for at least the time designated on the equipment warning label.
- In case of a permanent magnet motor, do not touch the motor terminals immediately after power-off because the motor terminals will generate induced voltage during rotation even after the equipment power supply is off. Failure to comply will 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 will 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.



- 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 injuries 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 use damaged equipment. Failure to comply may result in death, personal injuries, 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.

Other Precautions

Dynamic brake

- The dynamic brake can only be used for emergency stop upon fault or power failure. Do not trigger faults or power failure frequently.
- The action interval of the dynamic brake function must be above 5 min during high-speed operation. Failure to comply may damage the internal dynamic braking circuit.
- A motor being driven by the load axis is in the generating state, which is common in rotary mechanical structures during dynamic braking stop. Under such state, a short circuit current will pass through the dynamic brake. If the motor keeps being driven by the load axis, smoke or flame may be generated from the drive, resulting in motor damage.

Safety Labels

For safe equipment 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 through the guide 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 heatsink with power ON to prevent the risk of burn.

1 General

1.1 Terms and Abbreviations

Terms and Abbreviations	Description
Cat.	Safety category It includes B, 1, 2, 3, and 4.
CCF	Common cause failure
DCavg	Average diagnostic coverage (%)
DTI	Diagnostic test interval time
SFF	Safe failure fraction
HFT	Hardware fault tolerance
PFH_D	Probability of a dangerous Failure per Hour
PL	Performance Level
SC	Systematic capability
SIL	Safety integrity level
T_1	Test interval
DI	Digital input
DO	Digital output
PCB	Printed circuit board
MCU	Micro computer unit
FPGA	Field programmable gate array
MTTFd	Mean time to dangerous failure
STO	The safe torque off (STO) function brings the machine safely into a no-torque state and prevents it from unexpected start. If the motor is running when STO function is activated, it coasts to 0 RPM.
Safe state	Disabling the PWM gating signal of the drive
System reset	Resetting the servo system through resetting the power supply or executing software reset
Proof test	Tests used to detect the failure of safety-related systems
Mission time	Specified cumulative operating time of the safety-related parts of the servo drive during its overall lifetime

1.2 Safety Standards

Standards compliance

- North American standards (UL)
  UL 61800-5-1

  CSA C22.2 No. 274

- EC directives and standards
  Low Voltage Directive 2014/35/EU Standard EN 61800-5-1

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

  Machinery Directive 2006/42/EC (functional safety) Standard IEC 61800-5-2

- Safety standard

Safety Standard	Reference
Functional safety	IEC 61508: 2010 ISO 13849-1: 2015 ISO 13849-2: 2012 IEC 62061: 2021 IEC 61800-3: 2017 EN 61508: 2010 EN ISO 13849-1: 2015 EN ISO 13849-2: 2012 EN IEC 62061: 2021 EN IEC 61800-3: 2018 IEC60204-1:2016 (in extracts) EN60204-1:2018 (in extracts)
EMC	IEC 61000-6-7:2014 IEC 61326-3-1:2017 IEC 61800-5-2: 2016 IEC 61800-3:2017 EN 61000-6-7:2015 EN 61326-3-1:2017 EN 61800-5-2: 2017 EN IEC 61800-3:2018
LVD	IEC 61800-5-1:2007/AMD1:2016 EN 61800-5-1:2007/A1:2017

- Safety Data

Item	Safety Data
Safety Integrity Level (SIL)	SIL3, IEC61508 Maximum SIL3, EN IEC62061
Probability of Failure on Demand per Hour (PFH_D)	$PFH_D \leqslant 0.16 \times 10^{-7}$[1/h] (16% of SIL3)
Category	Category 3, EN ISO 13849-1
Performance Level (PL)	e, EN ISO 13849-1
Mean Time to Dangerous Failure (MTTFd)	441.3 years (high)
Diagnostic Coverage (DCavg)	⩾ 90% (medium)
T_1	10 years
Hardware Fault Tolerance (HFT)	1
Stop Category (SC)	SC3

Item	Safety Data
Application mode	High demand or continuous mode
λ_S	1.49 x 10^{-7}/h
λ_{DD}	1.32 x 10^{-8}/h
λ_{DU}	4.93 x 10^{-10}/h
MTTR	0 hour
MRT	0 hour

- λ_S means the failure rate of safe failure which brings the system into safe state.
- λ_{DD} means the failure rate of dangerous failure but can be diagnosed by the diagnosis subsystem.
- λ_{DU} means the failure rate of dangerous failure and can't be diagnosed by the diagnosis subsystem.

- Failure mode of each component is from ISO13849-2:2012.
- Failure mode distribution of each component is divided equally.
- Failure rate of each component calculated is from SN29500.

Specifications

- Electrical safety according to IEC 61800-5-1:2016, overvoltage category II
- Environment test requirement according to IEC 61800-5-1:2016
- Operating conditions are shown as follows:

Item	Description
Ambient/Storage temperature	0°C to +55°C/–20°C to +70°C
Ambient/Storage humidity	20% to 95% RH (non-condensing)
Vibration	<table><tr><th>Item</th><th>Test Condition</th></tr><tr><td>Test reference</td><td>See IEC 60068-2-6 4.6.</td></tr><tr><td>Condition</td><td>EUT powered on, operating normally</td></tr><tr><td>Motion mode</td><td>Sinusoidal</td></tr><tr><td>Vibration amplitude/ Acceleration</td><td>-</td></tr><tr><td>10 Hz ⩽ f ⩽ 57 Hz</td><td>0.075 mm amplitude</td></tr><tr><td>57 Hz < f ⩽ 150 Hz</td><td>1 g</td></tr><tr><td>Duration of vibration</td><td>10 sweep cycles per axis on each of the three mutually perpendicular axes</td></tr><tr><td>Axes</td><td>X, Y, Z</td></tr><tr><td>Detail of mounting</td><td>According to manufacturer's specification</td></tr></table>

<table>
<tr><th>Item</th><th>Description</th></tr>
<tr><td>Impact resistance</td><td>
<table>
<tr><th>Item</th><th>Test Condition</th></tr>
<tr><td>Test reference</td><td>See IEC 60068-2-27: 2008 Table 17.</td></tr>
<tr><td>Condition</td><td>EUT powered on, operating normally</td></tr>
<tr><td>Motion mode</td><td>Half-sine pulse</td></tr>
<tr><td>Impact amplitude/ Duration</td><td>50 m/s^2 (5 g) 30 ms</td></tr>
<tr><td>Times of impact</td><td>3 per axis on each of the three mutually perpendicular axes</td></tr>
<tr><td>Axes</td><td>±X, ±Y, ±Z</td></tr>
<tr><td>Detail of mounting</td><td>According to manufacturer's specification</td></tr>
</table>
</td></tr>
<tr><td>IP rating</td><td>IP20</td></tr>
<tr><td>Pollution degree (PD)</td><td>PD2: free of corrosive or explosive gases; free of exposure to water, oil or chemicals; free of dust, salts or iron dust</td></tr>
<tr><td>Altitude</td><td>2000 m or below</td></tr>
<tr><td>Cooling method</td><td>Clean air (natural convection)</td></tr>
<tr><td>Others</td><td>Free of static electricity, strong electromagnetic fields, magnetic fields, or exposure to radioactivity</td></tr>
</table>

- The drive complies with EMC standards EN/IEC 61800-3:2017, IEC 61326-3-1, and IEC 61800-5-2.
- Others

Item	Description
Applicable servo drives	SV6***S2R8I-FS SV6***S5R5I-FS
Position	Integrated on the control board of the drive
Safety function - Inputs	Two channels: STO1/STO2

The STO subsystem elements must always be able to operate within the range of temperature, humidity, corrosion, dust, and vibration and other requirements specified above.

1.3 Precautions for Use

General Safety Instructions

The chapter contains the warning symbols used in this manual and the safety instructions which you must obey when you install or connect an option module to a drive or inverter. If you ignore the safety instructions, injury, death or damage can occur. Read this chapter before you start the installation.

Any illustrations, photographs, or examples used in this manual are provided as examples only and may not apply to all products to which this manual is applicable.

The products and specifications described in this manual or the content and presentation of the manual may be changed without notice to improve the product and/or the manual.

Table 1–1 Warnings, Cautions and Notes

Pictogram	Signal word	Meaning	Consequences in case of disregard
Example:  DANGER  Hazardous voltage e.g. electric shock	DANGER	DANGER	Indicates that failure to comply with the notice will result in death or severe personal injuries
	WARNINGS	Warning	Indicates that failure to comply with the notice may result in death or severe personal injuries
	CAUTION	Note	Indicates that failure to comply with the notice may result in minor or moderate personal injuries or equipment damage
	STOP	Prohibit	Indicates that failure to comply with the notice will result in equipment or environmental damage



- High attention is required for electrical installation and at the system design to avoid hazards either in normal operation or in the event of equipment malfunction.
- System design, installation, commissioning and maintenance must be carried out by personnel who have the necessary training and experience. They must read the operating instruction and this safety information.

It is the responsibility of the machine builder/OEM/system integrator to make sure that the essential health and safety function requirements specified in the Machinery Directive are met. Risk analysis and risk assessment is needed before using a product. Make sure that adequate measures are taken to eliminate/reduce the relating risks and components chosen must meet the safety requirements.

This section describes the information that needs to be noted before starting operation. Read the following safety precautions, risk assessment information, and limitations before starting operation.

Safety function: Use the safety function after properly understanding all of these information. Incorrect use of safety functions or use of safety functions that are not sufficient to meet the safety requirements of the site may result in personal injury.

Safety Precautions

Carefully read the following important precautions and observe them when using the safety function.

- STO function is not intended as a replacement for the emergency stop function (E-stop). If only the STO function is triggered, with no extra measures taken, the power supply cannot be cut off in emergencies and high-current parts of the motor and drive are still energized, incurring the risk of electric shock or other risks result in electric energy. Therefore maintenance work on electrical parts of the drive or motor can only be carried out after isolating the drive system from the main supply.
- Depending on the standards and requirements for a particular application, it may be possible to use STO as an integral part of an E-stop system. However, its main purpose is for use in a dedicated safety control arrangement whose purpose is to prevent any hazard from occurring, without the use of an E-stop.
- An E-stop is often provided in a machine to allow for unexpected situations where an operator sees a hazard and can take action to prevent an accident.
- The design requirement for an E-stop differs from that of a safety interlock. Generally, the E-stop is required to be independent from any complex or "intelligent" control. It may use purely electromechanical devices to either disconnect the power or initiate a controlled rapid stop using other means such as dynamic or regenerative braking.

Note

- The design of safety-related systems requires specialist knowledge. To ensure that a complete control system is safe, it is necessary for the whole system to be designed according to recognized safety principles. The use of individual sub-systems such as drives with STO function, which are intended for safety-related applications, does not in itself ensure that the complete system is safe.
- The STO function can be used to stop the drive in emergency stop situations.
- In processes without personnel protection, it is recommended not to stop the drive by using the STO function. If a drive running is stopped by using STO, the drive performs a coast-to-stop. If this is not acceptable, the system should be stopped using the correct mode instead of the STO function.
- This publication is a guide to the application of Inovance SV660 series safety functions, and also on the design of safety-related systems for machinery control.
- It is the responsibility of the designer of the end product or application to ensure that it is safe and in compliance with the relevant regulations.

Risk Assessment

- When using the safety functions, perform risk assessment on the servo system in advance. Make sure that the safety integrity level of the standards is met.
- The following residual risks can be present even when the safety functions operate. Therefore, safety must always be given consideration during risk assessment.
- If external forces (such as gravitational force with a vertical axis) are applied when the safety functions are operating, the motor will rotate due to the action of these external forces. Therefore, you must use a separate mechanical brake to secure the motor.

Note

- In the case of failure of multiple IGBTs, regardless of whether the STO function is enabled, the servo drive can generate an alignment torque. This torque can cause the motor shaft to rotate within a range of up to 180÷p (for a synchronous reluctance motor, the range is 180÷2p).
- p: Number of motor pole pairs.

To ensure safety, users should decide all the risk assessments and residual risks in the entire machine equipment. A company and individual who constructed the safety related system must take full responsibility for installation and commissioning of the system. Additionally, when complying with a European machinery directive, the system must acquire safety standards certification as a whole.

Perform all risk assessments and safe level certification to the machine or the system as a whole. It is recommended that a Certification Body final safety certification of the system be used.

The following shows residual risks concerning the safety function of this product.

Common residual risks

- At the shipment to end-users, check the settings of safety related components with programming tools and monitored/displayed contents on display and record and save the setting data concerning the safety observation function and the programming tools you used. Perform them using a check sheet, etc.
- The safety will not be ensured such as in assembling machine until installing, wiring, and adjustment are completed properly. Install, wire, and adjust your system referring to installation guide for each unit.
- Only qualified personnel are authorized to install, start-up, repair or adjust the machines in which these components are installed. Only trained engineers should install and operate the equipment.
- Separate the wiring for safety observation function from other signal wiring.
- Protect the cables with appropriate ways (routing them in a cabinet, using a cable guard, etc.).
- We recommend using a switch, relay, sensor, etc. which comply with safety standards. When using a switch, relay, sensor, etc. which do not comply with safety standards, perform a safety confirmation.
- Keep the required clearance/creepage distance depending on voltage you use.
- The time to a safety observation error depends on parameter settings.

Safe torque off (STO)

This function only cuts off the torque of the motor, and does not cut off the power supply of the servo/inverter. Before servicing the servo/inverter, cut off the power supply and ensure that the servo/inverter are not energized.

2 Product Information

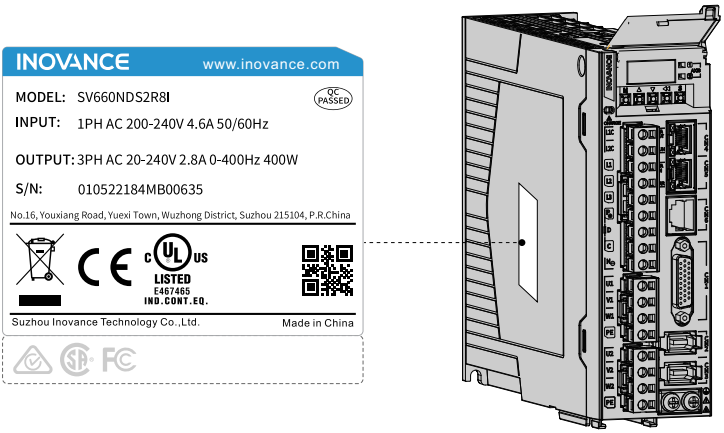
2.1 Model Number and Nameplate

Model number

SV660 N D S 2R8 I - *
① ② ③ ④ ⑤ ⑥ ⑦

① **Product series** SV660: SV660 series servo drive	④ **Voltage class** S: 220 V	⑥ **Installation mode** I: Baseplate-mounted
② **Product type** N: Network type	⑤ **Rated output current** 2R8: 2.8 A 5R5: 5.5 A	⑦ **Customized function** Blank: Standard FS: STO FH: High protection
③ **Number of axes** D: Dual-axis (two-in-one)		

Nameplate



Encryption of the production serial number

01050202 4 P 7 00001
① ② ③ ④ ⑤

① **Internal code** Part number	③ **Year** A: 2010 ... N: 2021 P: 2022 ... Note: I/L/O/Q is not used.	⑤ **Lot number** 00001: 1st in the month of manufacturing 00002: 2nd in the month of manufacturing 00003: 3rd in the month of manufacturing ... 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 010502024H700001 indicates that the drive is manufactured in July, 2017.

2.2 Components

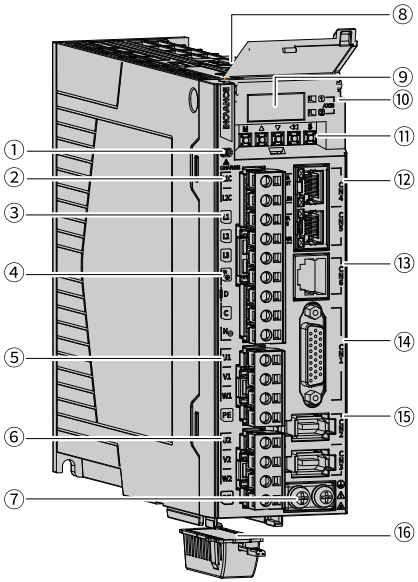


Figure 2-1 Components of servo drives

Table 2–1 Components of the servo drive

No.	Name	Description
①	CHARGE (bus voltage indicator)	Indicates that the bus capacitor carries electric charge. When this indicator is 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 avoid electric shock, do not touch the power terminals when this indicator is on.
②	L1C, L2C (control circuit power input terminals)	See the nameplate for the rated voltage class.
③	L1, L2, L3 (main circuit power input terminals)	Used as the power input terminals for a three-phase 220 V servo drive. See the nameplate for the rated voltage class.
④	P⊕, D, C (terminals for connecting an external braking resistor)[1]	To connect an external braking resistor, remove the jumper between terminals P⊕ and D and connect the resistor between terminals P⊕ and C.
	P⊕, N⊖ (servo bus terminals)	Used when multiple servo drives share one DC bus
⑤	U1, V1, W1, PE (terminals for connecting the servo motor)	Connected to U, V, and W phases and grounding terminal of the servo motor 1
⑥	U2, V2, W2, PE (terminals for connecting the servo motor)	Connected to U, V, and W phases and grounding terminal of the servo motor 2
⑦	Servo drive grounding terminal	Connected to the grounding terminal of the power supply for grounding purpose
⑧	CN7 (STO safety function terminal)[3]	Connected to external functional safety signal for functional safety purpose
⑨	LED display	A 5-digit 8-segment LED display used to show the servo drive's operating status and parameter settings
⑩	Axle status indicator	Blinking: The axis is faulty. Steady on: Someone is operating the panel. Steady off: No one is operating the panel.
⑪	Keys	M: Press this key to switch parameters in sequence. Press and hold this key to switch axes in cycle. ▲: Used to increase the value of the blinking bit ▼: Used to decrease the value of the blinking bit ◀◀ : Used to shift the blinking bit leftwards (Hold down: Turning to the next page when the displayed number exceeds five digits) S: Used to save modifications and enter the next menu

No.	Name	Description
⑫	CN4, CN5 (EtherCAT communication terminals)	CN5 (IN): Connected to the master or the preceding slave device CN4 (OUT): Connected to the next slave device
⑬	CN6 (communication terminal)	Connected to an RS232 communication instruction device
⑭	CN1 (control terminal)	Used for reference input signals and other I/O signals
⑮	CN2, CN3 (terminals for connecting the encoder)	CN2 is connected to the encoder terminal of motor 1. CN3 is connected to the encoder terminal of motor 2.
⑯	Battery location	Used to hold the battery box of the absolute encoder

Note

The built-in braking resistor and jumper bar are not available in model S2R8. If an external braking resistor is needed for this model, connect it between terminals P⊕ and C.

2.3 Electrical Specifications

Single-phase 220 V drive

Item		Size A	Size B
Servo drive model SV660ND***I		S2R8	S5R5
Drive power (kW)		0.4	0.75
Maximum applicable motor capacity (kW)		0.4	0.75
Power capacity (kVA)		6.0	8.0
Continuous output current (Arms)		2.8	5.5
Maximum output current (Arms)		10.1	16.9
Main circuit	Continuous input current (Arms)	7.2	13.6
	Main circuit power supply	Single phase 200 VAC to 240 VAC, –10% to +10%, 50 Hz/60 Hz	
Control circuit	Control circuit power supply	Single phase 200 VAC to 240 VAC, –10% to +10%, 50 Hz/60 Hz	

Item		Size A	Size B
Braking resistor	Resistance (Ω)	-	25
	Resistor power (W)	-	80
	Minimum resistance of external resistor (Ω)	20	20
	Maximum braking energy absorbed by capacitor (J)	54.6	80.3
	Braking resistor	Built-in resistor not supported	Built-in braking resistor and external braking resistor supported
Cooling mode		Air cooling	
Overvoltage level		III	

Three-phase 220 V drive

Item		Size A	Size B
Servo drive model SV660ND***I		S2R8	S5R5
Drive power (kW)		0.4	0.75
Maximum applicable motor capacity (kW)		0.4	0.75
Power capacity (kVA)		6.0	8.0
Continuous output current (Arms)		2.8	5.5
Maximum output current (Arms)		10.1	16.9
Main circuit	Continuous input current (Arms)	4.2	7.5
	Main circuit power supply	Three phase 200 VAC to 240 VAC, –10% to +10%, 50 Hz/60 Hz	
Control circuit	Control circuit power supply	Single phase 200 VAC to 240 VAC, –10% to +10%, 50 Hz/60 Hz	
Braking resistor	Resistance (Ω)	-	25
	Resistor power (W)	-	80
	Minimum resistance of external resistor (Ω)	20	20
	Maximum braking energy absorbed by capacitor (J)	54.6	80.3
	Braking resistor	Built-in resistor not supported	Built-in braking resistor and external braking resistor supported
Cooling mode		Air cooling	
Overvoltage level		III	

2.4 Basic Specifications

Item			Description
Basic specifications	Control mode		IGBT PWM control, sine wave current drive mode 220 V, 380 V: single-phase/three-phase full wave bridge rectification
	Encoder feedback		23-bit multi-turn absolute encoder, which can be used as an incremental encoder in absence of the battery
	Use conditions	Operating/Storage temperature[1]	0°C to +55°C (over 45°C: derate 10% for every additional 5°C)/–40°C to +70°C
		Operating/Storage humidity	Below 90%RH (non-condensing)
		Vibration resistance	Operation: ● 5 Hz to 8.4 Hz: displacement of 3.5 mm ● 8.4 Hz to 200 Hz: 1 g Product packaging: ● 5 Hz to 100 Hz: 0.01 g^2/Hz ● 200 Hz: 0.001g^2/Hz ● Grms = 1.14 g
		Impact resistance	19.6 m/s^2
		IP rating	IP20 Note: The IP rating of terminals is IP00.
		Pollution degree	PD2
		Altitude	Up to 2000 m ● 1000 m and below: no derating ● Above 1000 m: Derate 1% for every additional 100 m. ● Above 2000 m: Contact Inovance.
Speed/Torque control mode	Performance	Speed control range	1:6000 (The lower limit is the threshold within which the servo drive keeps running with the rated torque load.)
		Speed loop bandwidth	3 kHz
		Torque control accuracy (repeatability)	±2%
		Soft startup time setting	0s to 65s (This parameter can be set for acceleration and deceleration separately.)
	Input signal	Speed reference input	Source of network-based references: EtherCAT communication Local mode and local multi-speed supported
		Torque reference input	
Position control mode	Performance	Positioning time	1 ms to 10 ms
	Input signal	Position reference	Source of network-based references: EtherCAT communication Local mode supported

Item			Description
Position control mode	Digital input (DI) signal	Input signal function selection	8 DIs DI1 to DI8: High-speed DIs (input delay for rising edge (24 V input from high to low): 30 us; input delay for falling edge (24 V input from low to high): 5 us; voltage range: 12 V to 24 V)
			P-OT (Positive limit switch) N-OT (Negative limit switch) HomeSwitch (Home switch) TouchProbe1 (Touch probe 1) TouchProbe2 (Touch probe 2)
	Digital output (DO) signal	Output signal function selection	4 DOs DO load capacity: 50 mA, voltage range: 5 V to 30 V
			S-RDY: Servo ready Brake output
Built-in functions	Overtravel (OT) prevention		The servo drive stops immediately when P-OT or N-OT becomes active.
	Protection functions		Protections against overcurrent, overvoltage, undervoltage, overload, main circuit detection error, heatsink overheat, overspeed, encoder error, CPU error, and parameter error
	LED display		Main circuit CHARGE indicator, 5-digit LED display
	Vibration suppression		Four notches (including two adaptive notches), 50 Hz to 5000 Hz
	Communication function	Background commissioning	RS232
		Communication protocol	EtherCAT
		Multi-station communication	Up to 255 slave stations
		Axis address setting	No physical knob, setting to 0 to 255 through the software
		Function	Status display, user parameter setting, monitored value display, fault tracing display, jog and auto-tuning, and speed/torque reference signal observation
	Others		Gain tuning, alarm record, and jog

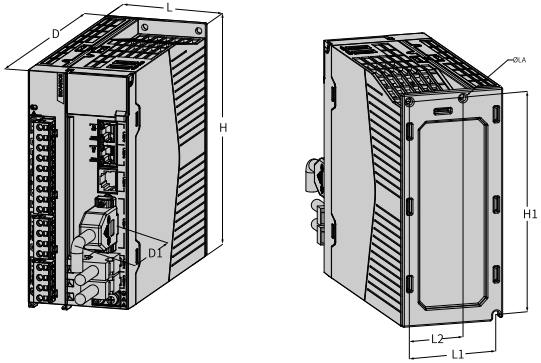
Note

[1] The temperature of the environment where the servo drive is installed must be within the range specified in the preceding table. When the servo drive is installed into a control cabinet, the temperature inside the cabinet must also be within this range.

2.5 EtherCAT Communication Specifications

Item		Specifications
Basic performance of slaves	Communication protocol	EtherCAT
	Available services	CoE (PDO, SDO)
	Synchronization mode	DC - Distributed clock
	Physical layer	100BASE-TX
	Baud rate	100 Mbit/s (100Base-TX)
	Duplex mode	Full duplex
	Topology	Ring and linear
	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 in 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 us
	Refresh time	About 30 us for 1000 DI/DOs About 100 us for 100 servo axes Define different refresh time for different interfaces.
	Communication code 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

2.6 Product Dimensions



Size	L	H	D	L1	L2	H1	D1	ØLA	Recommended Tightening Torque	Weight
	Unit: mm (in.)								Unit: N·m	Unit: kg
A	55 (2.17)	170 (6.69)	183 (7.20)	45 (1.77)	-	160 (6.30)	75 (2.95)	2-M4	1.2	
B	75 (2.95)	170 (6.69)	183 (7.20)	65 (2.56)	40 (1.57)	160 (6.30)	75 (2.95)	3-M4	1.2	

3 Installation

- Observe the installation direction described in this guide. 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 physical 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.
- Reserve specified clearance between the servo drive and its adjacent machines and the interior surface of the control cabinet. 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 physical 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.

3.1 Unpacking Inspection

Check the following items upon unpacking.

Item	Description
Check whether the delivered product is consistent with your order.	Check whether the servo drive model and specifications comply with your order. See the dimensions of the packing box in *"Table 3–1 " on page 29*. The deliverables include the product, cushion, carton box, and screw bag, as shown in *"Figure 3–1 " on page 30* .
Check whether the product is intact.	Check whether the product delivered is in good condition. If there is any missing or damage, contact Inovance or your supplier immediately.

Table 3–1 Dimensions of the outer packing box

Size	Model SV660ND****I	Outer Width (mm)	Outer Height (mm)	Outer Depth (mm)	Weight (kg)
Size A	S2R8	250.0	90.0	195.0	
Size B	S5R5	225.0	90.0	205.0	

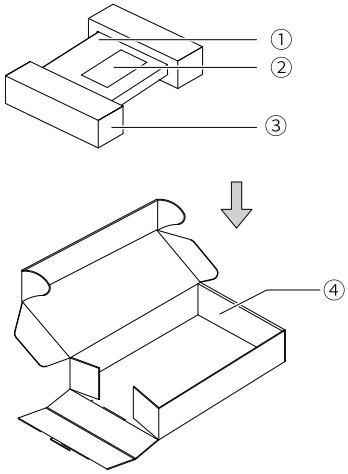


Figure 3-1 Contents in the packing box

No.	Name
①	Product
②	Terminal accessory package
③	Cushion
④	Carton box

Table 3–2 Contents in the terminal accessory package

Part Number	Name	Quantity
15210577	Plug-in terminal block–plug–spring clamp wiring–9P–black–with safety lock	1
15210648	Plug-in terminal block–plug–spring clamp wiring–2*2P–green–printing on both sides	1
15210695	Plug-in terminal block–plug–spring clamp wiring–4P–black	2
1504CK54	Cable set–servo drive S6–C74–DB26 connector kit (RoHS)	1
15220274	Jumper bar–16A–pluggable bridge	1
19021377	Labels–labels for servo drive terminals	1
2120021	Plastic parts–plug wiring key–for use with servo drive power plug	2
80240140	Complete accessories–S6–C103–SV660ND terminal accessory package	1

If you need to purchase the terminal accessory package separately, please contact Inovance.

3.2 Installation Environment

Table 3–3 Environment requirement

Item	Requirement
Installation location	Indoors
Grid overvoltage	Overvoltage Class III (OVC III).
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.
Temperature	• Mounting/Operating temperature: 0°C to +55°C For temperatures between 0°C to 45°C, derating is not required. For temperatures 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 servo drive in environments without dramatic temperature change. • When installing the servo 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 overheat or fire. • Install the servo drive on the surface of an incombustible object and leave sufficient surrounding space for heat dissipation. • Take measures to prevent the servo drive from being frozen.
Ambient humidity	Below 90% RH (no condensation)
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=1.14g
Impact resistance	Below $19.6m/s^2$

Item	Requirement
IP rating	IP20.
Environment	Pollution Degree 2 and below Install the servo drive in a place that meets the following requirements: • Free from direct sunlight, dust, corrosive gas, explosive and inflammable gas, oil mist, vapor, water drop, and salty element • Insusceptible to vibration (away from equipment that may generate strong vibration, such as a punch press) • Free from unwanted objects such as metal powder, oil, and water inside the servo drive • Free from radioactive substances, combustible materials, harmful gases and liquids, and salt corrosion • Away from combustible materials such as wood • Do not use the equipment in vacuum.

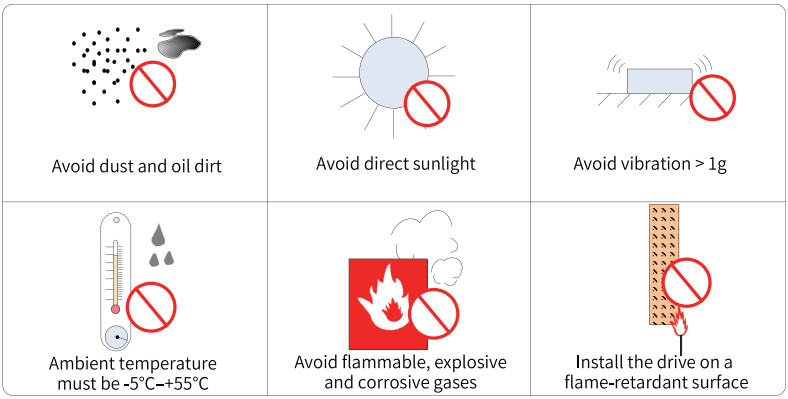


Figure 3-2 Environment requirements

3.3 Installation Clearance

Servo drives with different power ratings require different installation clearances. When installing multiple servo drives side by side, reserve a clearance of at least 10 mm (0.39 in.) between adjacent servo drives and a clearance of at least 50 mm (1.97 in.) above and below each servo drive for heat dissipation.

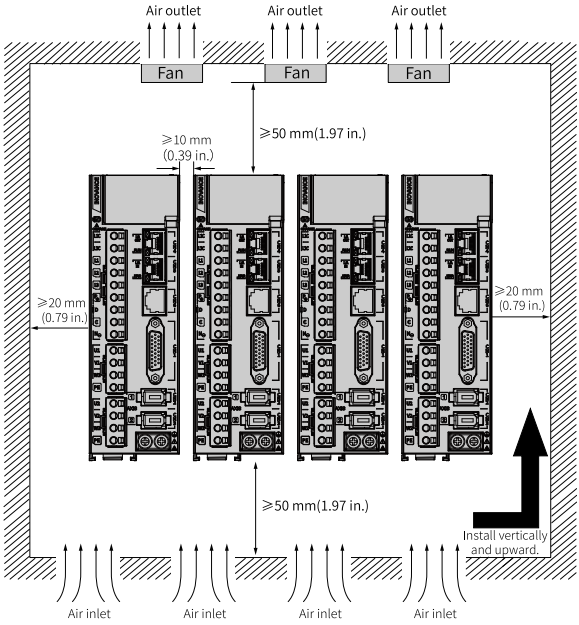


Figure 3-3 Clearance for side-by-side installation

Servo drives rated at 0.2 kW to 0.4 kW support compact installation, in which a clearance of at least 1 mm (0.04 in.) must be reserved between two servo drives. When adopting compact installation, derate the load rate to 75%.

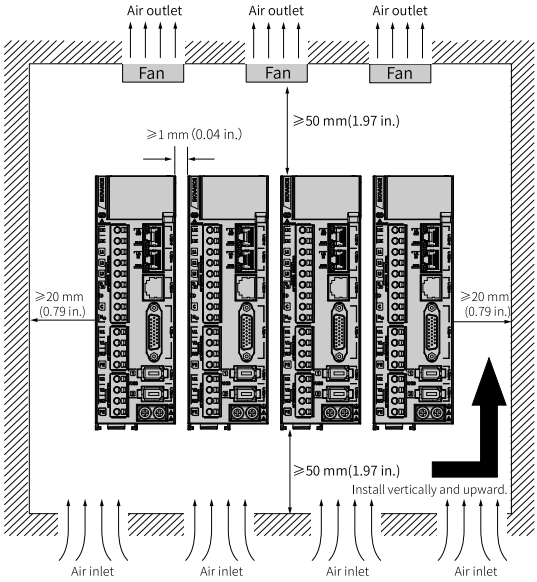


Figure 3-4 Clearance for compact installation

Servo drives rated at 0.75 kW to 7.5 kW support zero-clearance installation, without the need for derating.

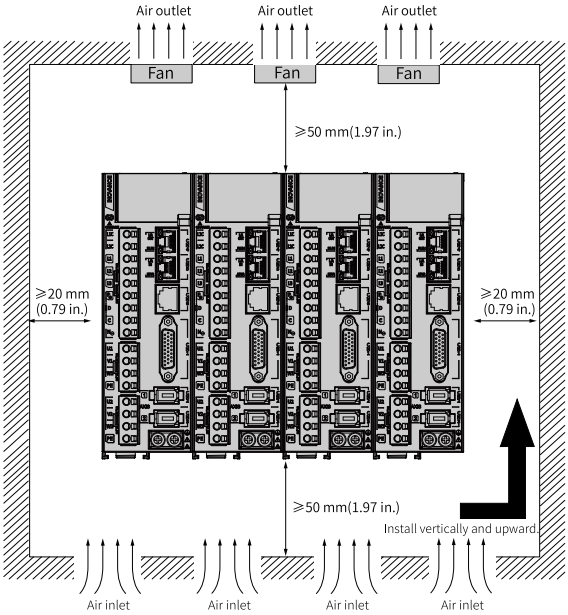


Figure 3-5 Zero-clearance installation

3.4 Installation Dimensions

Servo drives in size A (rated power: 0.4 kW): SV660NDS2R8I

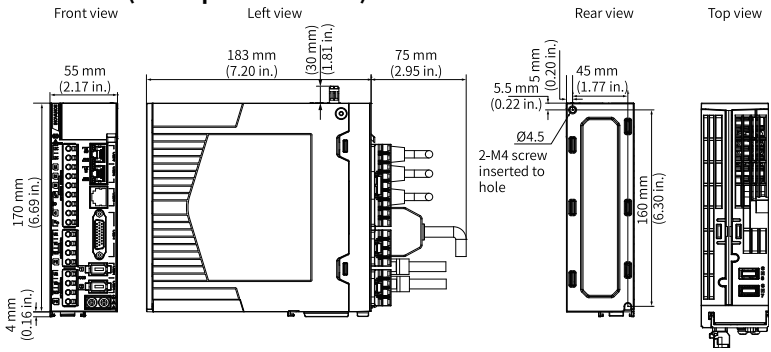


Figure 3-6 Outline dimensions of servo drives in size A

Fixing screws: 2-M4; recommended tightening torque: 1.2 N·m

Weight: kg

Servo drives in size B (rated power: 0.75 kW) SV660NDS5R5I

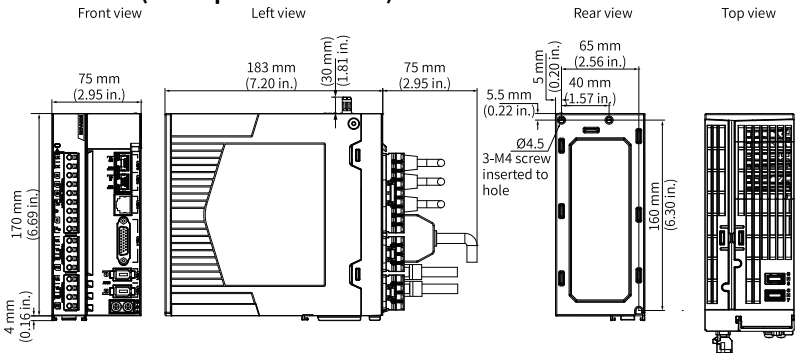


Figure 3-7 Outline dimensions of servo drives in size B

Fixing screws: 3-M4; recommended tightening torque: 1.2 N·m

Weight: kg

3.5 Mounting the Drive

The servo drive supports backplate mounting only.

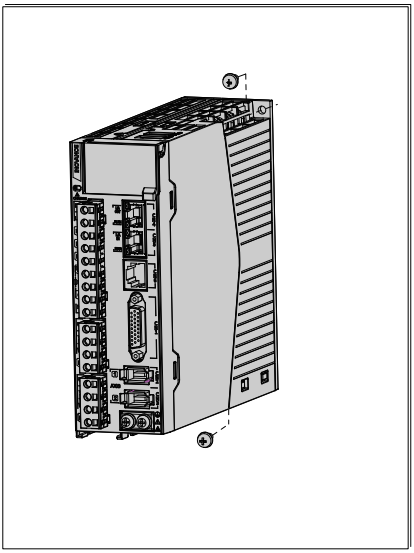


Figure 3-8 Backplate mounting for servo drives in size A

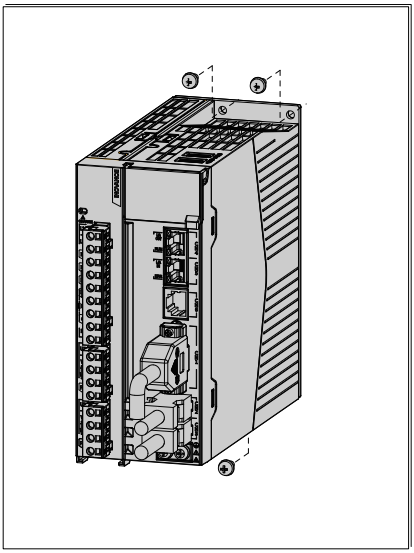


Figure 3-9 Backplate mounting for servo drives in size B

4 Wiring

4.1 Precautions



Read the section Rules carefully. Failure to comply may result in serious consequences.

- 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 specification and installation of external cables must comply with 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.

Caution

- 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.
- 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.

4.2 Cable Layout

4.2.1 Specifications

- Do not connect the input power cables to the output terminals U, V, and W. Failure to comply will damage the servo drive.
- When cables are bundled in a duct, the cooling effect will be deteriorated. In this case, take the permissible current reduction ratio into account.
- High voltage may be still present in the servo drive after the power supply is switched off. Do not touch the power terminals within 5 minutes after power-off.
- Do not switch on/off the power supply frequently. If the power supply is switched on or off frequently within 1s, E740.0/E136.0/E430.0 may occur (see Chapter "Fault Code" in SV660ND Series Servo Troubleshooting Guide). In this case, wait for the specified ON/OFF interval before powering on the servo drive again. If frequent ON/OFF control is needed, keep an ON/OFF interval of at least 1 minute.
  As the servo drive contains a capacitor in the power supply, a large charging current flows through for 0.2 seconds when the power supply is turned on. Turning

on/off the power supply frequently degrades the performance of main circuit components inside the servo drive.

- Do not power on the servo drive when any screw of the terminal block or any cable becomes loose. Failure to comply may cause a fire.

Observe national or regional regulations when selecting cable dimensions. IEC cables must meet the following requirements:

- EN 60204-1 and IEC 60364-5-52 standards
- PVC cable with copper conductors
- Withstanding 40°C ambient temperature and 70°C cable surface temperature (When the ambient temperature exceeds 40°C, contact Inovance.)

Requirements for UL cable selection are described in *" Cable requirements" on page 82*.

Note

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

4.2.2 Routing Recommendations

Servo drive power input cables and motor cables may generate strong electromagnetic interference. To prevent electromagnetic interference generated by long-distance parallel routing and coupling between strong-interference cables and control circuits, keep a clearance of more than 30 cm between them. Common main circuit cables include input R/S/T cables, output U/V/W cables, DC buses, and braking cables. Signal cables include I/O signal cables, communication cables, and encoder cables.

Cable ducts must be securely connected and well grounded. Use aluminum cable ducts to ensure equipotentiality of the servo drive. Connect the filter, servo drive, and motor to the system (machines or devices) properly. Protect all connections with spray coating and ensure good contact of conductive metal.

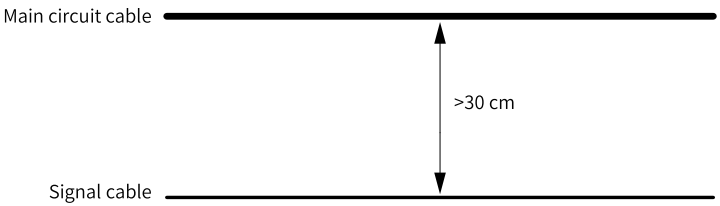


Figure 4-1 Cable layout

Wiring requirements

- Terminals (P⊕, C, and NΘ) are used to connect optional parts. Avoid connecting these terminals to an AC power supply.
- To protect the main circuit, separate it from all surfaces that may come into contact with it and provide covers as required.
- Prevent foreign objects from entering the wiring part of the terminal block.
- Avoid welding when using stranded wires.
- Tightening torque required by terminals may vary. Tighten the screws in accordance with applicable requirements. Use screwdrivers, ratchets, or wrenches as appropriate.
- When using an electric tool to tighten the terminal screws, set the tool to a low speed to avoid damage to the terminal screws.
- Tighten the terminal screws at an angle within 5 degrees. Failure to comply may result in terminal screw damage.

4.2.3 Grounding

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



- To prevent electric shock, ground the grounding terminal properly. Observe related national or regional regulations during grounding.
- To prevent electric shock, ensure the protective grounding conductor complies with technical specifications and local safety standards. Keep the grounding cable as short as possible. As the leakage current of the drive may exceed 3.5 mA, use a copper protective grounding conductor with a cross-sectional area of at least 10 mm^2, or use two protective grounding conductors with the same specification.
- The dimensions of the grounding cable must comply with the technical standards for electrical devices. Keep the grounding cable as short as possible. Failure to comply can lead to unstable potential in the grounding terminals that are routed away from the grounding point, resulting in electric shock.



- For use of multiple drives, observe all the grounding instructions for the drive. Improper grounding of the device can lead to malfunction of the drive and the device.
- Do not share the same grounding cable with other devices (such as welding machines or high-current electrical devices). Improper grounding of the device can lead to drive or device faults caused by electrical interference.
- For drives equipped with selective grounding screws for VDR and insulation resistor, remove the selective grounding screw for VDR before voltage resistance test. Failure to comply may cause the drive to fail the test.

Grounding requirements

Observe the following requirements to ensure 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 for the neutral wire of the power supply.
- It is recommended to install the drive on a conductive metal mounting surface. Ensure that the whole conductive bottom of the drive is attached properly to the mounting surface.
- Tighten the ground screw with specified tightening torque to avoid loose or excessively-tight connection.

Single-drive grounding

Installation of an individual drive:

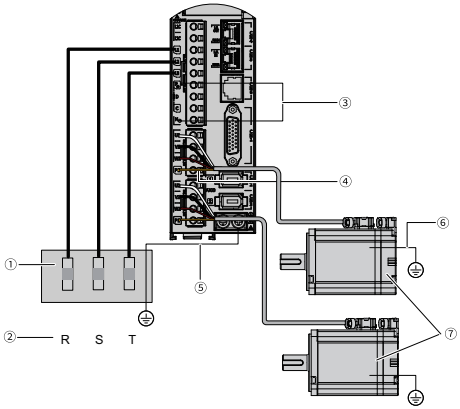


Table 4–1 Single-drive grounding

No.	Description
①	Input protection (fuse or circuit breaker) Connect the lower end of the fuse to the filter.
②	Input power supply
③	Do not ground the DC bus terminal or the braking resistor terminal.
④	Connect the output PE terminal of the servo drive to the motor output cable shield.
⑤	Connect the PE cable on the input power supply end to the input PE terminal of the servo drive.
⑥	Ground the motor enclosure.
⑦	Three-phase motor
Note: The main circuit terminal layout varies with models and is subject to the physical product.	

Multiple AC Drives

Side-by-side installation of multiple drives:

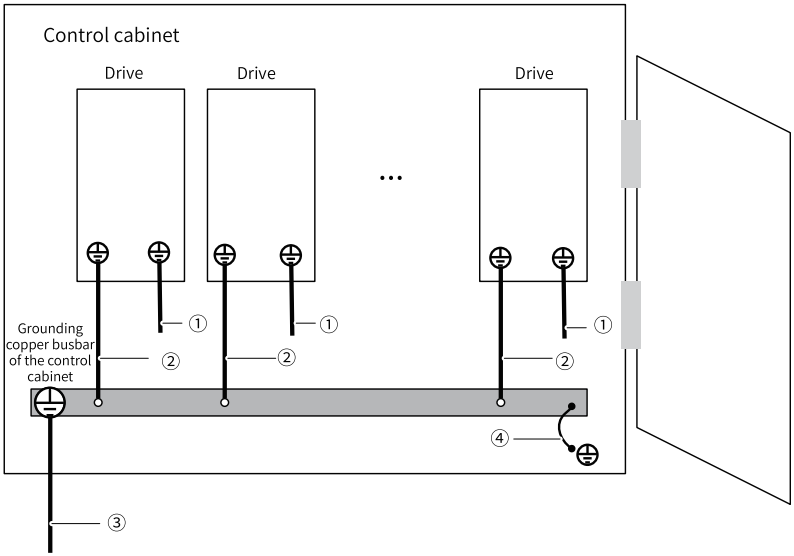


Table 4–2 Description for grounding of multiple drives installed side by side

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

Grounding of the control cabinet system

The most effective measure to suppress interference inside the cabinet is to isolate the interference source from the affected devices during installation. Divide the control cabinet into several EMC areas or use multiple cabinets based on the intensity of the interference source, and install devices into corresponding areas based on the requirements listed in the following table.

Table 4–3 Wiring requirements

No.	Wiring Requirement
1	Install the control devices and drive devices into two separate control cabinets.
2	For installation involving multiple control cabinets, use the ground cable with a cross-sectional area of at least 16 mm^2 to connect the cabinets. This is to ensure equipotentiality between the cabinets.
3	For installation involving only one control cabinet, install different devices into different areas inside the cabinet according to the signal intensity.
4	Apply equipotential bonding to devices in different areas inside the control cabinet.
5	Shield all the communication and cables and signal cables routed out from the control cabinet.
6	Install the power input filter inside the cabinet to a place near the input interface of the control cabinet.
7	Apply spray coating to each grounding point in the control cabinet.

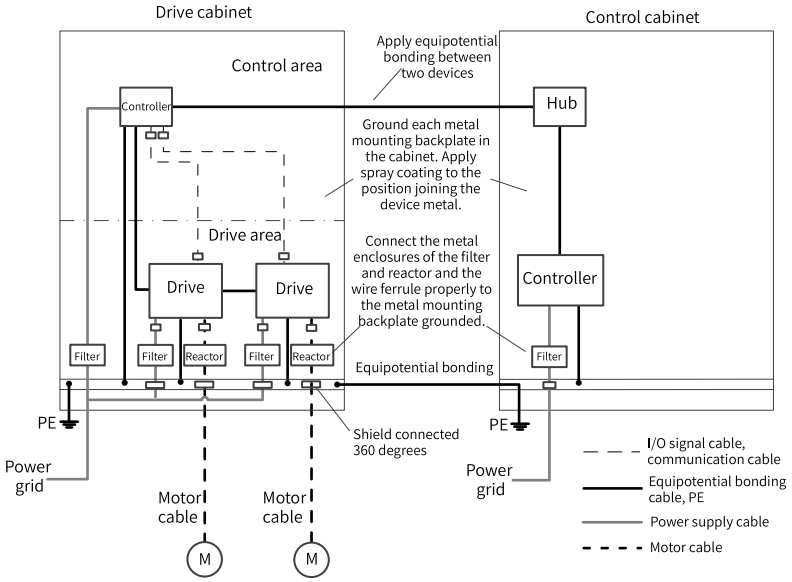


Figure 4-2 Recommended wiring of the control cabinet system

4.3 CN7 (STO Safety Terminal)

Terminal arrangement

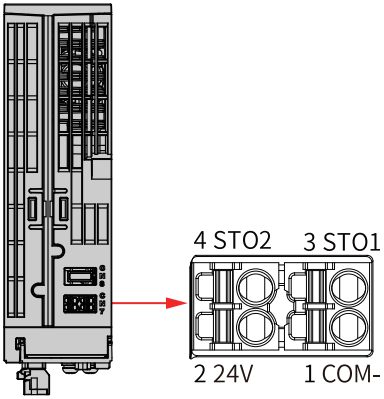


Table 4–4 STO safety terminal pins of servo drives

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

Two independent inputs are configured as dual-channel inputs for the STO function: STO1/STO2.

To facilitate commissioning, an additional pin for supply voltage (+24 V) is integrated. If the safety circuit is installed but no STO function is needed, bridge STO1/STO2 to the 24 V terminal.

Terminal description

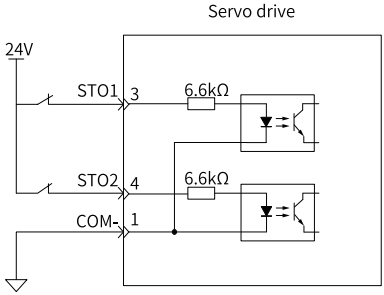
- **Electrical specifications and connections of input circuit**
  This section describes the characteristics of the input signals of the CN7 connectors.
  - Specifications
    The servo drive operates normally only when the input states of STO1 and STO2 are both "High" ("1" or "H").

    The servo drive does not operate when the input states of STO1 and STO2 are different or are both "Low" ("0" or "L").

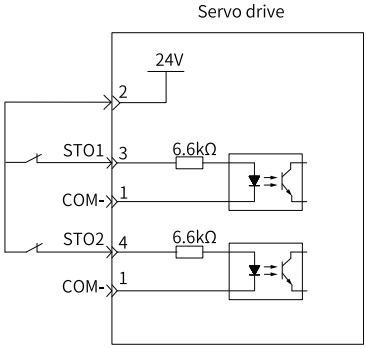
- The following table describes the electrical characteristics of the safety request input signal.

Item	Characteristics	Description
Voltage range	24 VDC (±15%)	-
Input current	3.6 mA (Typ.)	This is the per-channel value.
Standards of logic levels	"0" < 5 V, "1" > 15 V	-
Digital input impedance	6.6 kΩ	-

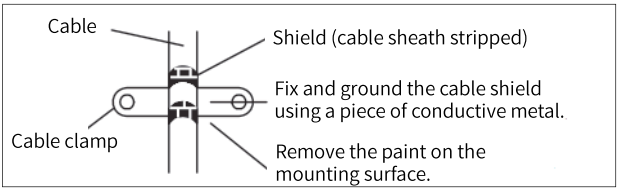
- Example connection of external 24 V



- Example connection of internal 24 V



- **EMC requirements**
  - To avoid short circuit between adjacent conductors, use shielded cables and connect the shield to the protective bonding circuit. Alternatively, use flat cables and connect a grounding wire between adjacent signal conductors.
  - 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.

- **Additional requirements**
  - All wiring must be well protected, routed and clamped where practicable.
  - Avoid pulling or pinching on the cable during installation.
  - When routing DI cables for STO, route the two cables along two separated paths or protect the cables with double shields, to avoid common failures.

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

Applicable servo drives

STO applies to FS servo drives in the following table.

Size	Power Range	Structure	W x H x D (mm^3)
A	0.4 kW	Split-type structure	40 x 170 x 150
B	0.75 kW	Split-type structure	55 x 170 x 173

5 Keypad

5.1 Components

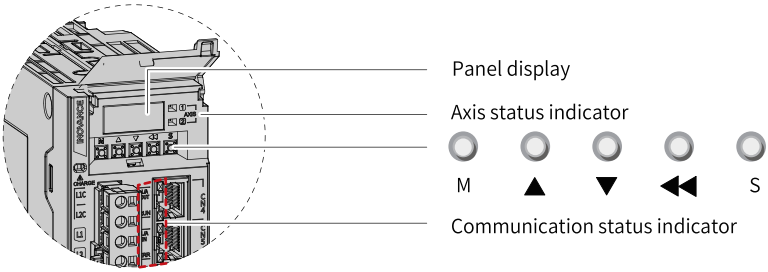


Figure 5-1 Magnified view of the operating panel

The operating panel of the SV660ND series servo drive consists of an LED display (5-digit, 8-segment) and five keys. The operating panel is used for value display, parameter setting, user password setting, and general function execution. The following table takes parameter setting as an example to describe the general functions of the keys.

Keys

Table 5–1 General functions of keys

Name	Diagram	Description
MODE	MODE	Press this key to switch parameters in sequence. Press and hold this key to switch axes in cycle. Used to return to the previous menu
UP	▲	Used to increase the value of the blinking digit
DOWN	▼	Used to decrease the value of the blinking digit
SHIFT	◀◀	Used to shift the blinking bit leftwards (Hold down: Turning to the next page when the displayed number exceeds five digits)

Name	Diagram	Description
SET	 SET	Used to save modifications and enter the next menu Executes commands such as saving parameter settings.
Axle status indicator		Blinking: The axis is faulty. Steady on: Someone is operating the panel. Steady off: No one is operating the panel.

Communication status indicators

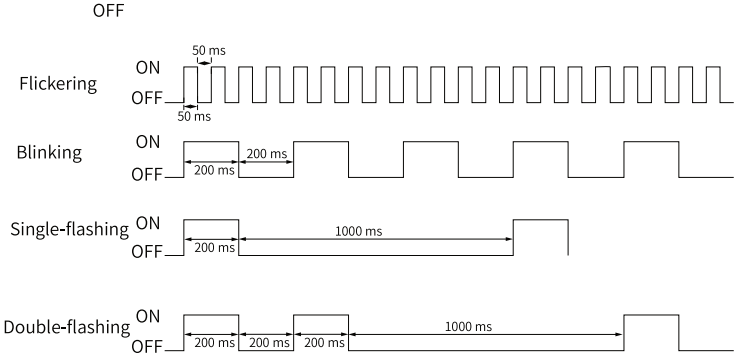


Figure 5-2 Status of communication status indicators

Table 5–2 Indicator status

Indicator	Status	Status Indication
RUN indicator	OFF	The servo drive is in the INIT state.
	Blinking (on: 200 ms/ off: 200 ms)	The servo drive is in the Pre-Operational state.
	Single flash (on: 200 ms/off: 1000 ms)	The servo drive is in the Safe-Operational state.
	ON	The servo drive is in the Operational state.
ERR indicator	OFF	No network fault occurs.
	Blinking (on: 200 ms/ off: 200 ms)	The communication setting is incorrect.
	Single flash (on: 200 ms/off: 1000 ms)	The synchronization event is abnormal.
	Double flash (on: 200 ms, off: 200 ms, on: 200 ms, off: 1000 ms)	The application watchdog times out.

Indicator	Status	Status Indication
L/A IN indicator[1] L/A OUT indicator	OFF	The link is not established.
	Flickering (on: 50 ms/ off: 50 ms)	The link is established, and data sending and receiving signals are available.
	ON	The link is established, but data sending and receiving signals are unavailable.

Note

- [1]: L/A IN and L/A OUT indicate the LINK state and action state of the physical layer of each port.
- The ERR indicator lights up red and the other three indicators light up green.

5.2 Panel Display

The operating panel can be used to display the servo drive status, parameters, faults, and monitored values.

- Status display: Displays current servo drive status, such as servo ready or servo running.
- Parameter display: Displays parameters and their setpoints.
- Fault display: Displays faults and warnings that occurred on the servo drive.
- Monitored value display: Displays values of monitoring parameters.

Mapping relation between operating panel display and object dictionary

The mapping relation between the parameter displayed on the operating panel (in decimal) and the object dictionary operated by the host controller (in hexadecimal, "Index" and "Sub-index") is as follows.

Object dictionary index = 0x2000 + Parameter group number

Object dictionary sub-index = Hexadecimal offset within the parameter group + 1 For example:

Panel Display	Object Dictionary Operated by the Host Controller
H02.15	2002.10h

Note

The following section only describes the display and parameter settings on the keypad side (in decimal), which are different from those displayed in the software tool (in hexadecimal). Make necessary value conversions during use.

Display mode switchover

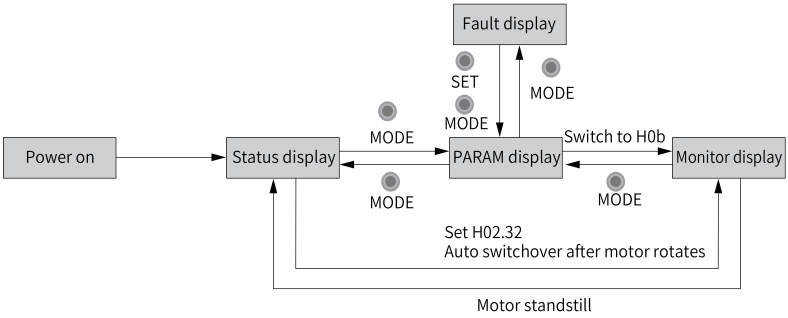
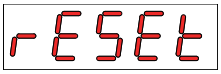


Figure 5-3 Switchover among different display modes

- The operating panel enters status display immediately upon power-on.
- Press MODE to switch among different display modes based on the conditions shown in *"Figure 5–3 " on page 51* .
- In status display, set H02.32 to select the parameter to be monitored. When the motor rotates, the operating panel automatically switches to monitored value display. After the motor stops, the operating panel automatically returns to status display.
- In the parameter display mode, after you select the parameter to be monitored in group H0b, the operating panel switches to monitored value display.
- Once a fault occurs, the operating panel switches to fault display immediately, with all the five LEDs blinking. Press SET to stop the LEDs from blinking, and then press MODE to switch to parameter display.

Status display

Display	Name	Applicable Occasion	Meaning
	reset Servo initializing	At the moment upon power-on	The servo drive is in the initialization or reset status. After initialization or reset is done, the servo drive automatically switches to other status.
	nr Servo not ready	Initialization done, but servo drive not ready	The servo drive is not ready to run because the main circuit is not powered on. For details, see Chapter "Troubleshooting".
	ry Servo ready	Servo drive ready	The servo drive is ready to run and is waiting for the S-ON signal.

Display	Name	Applicable Occasion	Meaning
	rn Servo running	Servo ON (S-ON) signal activated (S-ON signal switched on)	The servo drive is running.
	1 to A: Control modes	-	Displays present operation mode of the servo drive in hexadecimal digits. 1: Profile position control 3: Profile velocity mode 4: Profile torque mode 6: Homing mode 8: Cyclic synchronous position mode 9: Cyclic synchronous velocity mode A: Cyclic synchronous torque mode
	1 to 8: Communication status	-	Displays the status of the slave EtherCAT state machine in characters. 1: Initialization 2: Pre-operational 4: Safe-operational 8: Operational
	- CN4 connection indication	CN4 indicates the EtherCAT output connection status.	OFF: No communication connection is detected in the physical layer. ON: A communication connection is detected in the physical layer.
	- CN5 connection indication	CN5 indicates the EtherCAT input connection status.	

Parameter display

Parameters are divided into 14 groups based on their functions. A parameter can be located quickly based on the parameter group it belongs to.

- Display of parameter groups

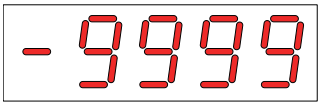
Display	Name	Description
HXX.YY	Parameter group	XX: Parameter group number (hexadecimal) YY: Offset within the parameter group (decimal)

For example, "H02.00" is displayed as follows.

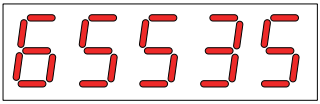
Display	Name	Description
	H02.00	02: Parameter group number 00: Offset within the parameter group

- Display of negative numbers and numbers with different lengths
  - Signed number with 4 digits or below and unsigned number with 5 digits or below
    Such numbers are displayed in a single page (five digits). For signed numbers, the highest bit "–" represents the negative sign.

    For example, "–9999" is displayed as follows.

    For example, "65535" is displayed as follows.

  - Signed number with more than 4 digits and unsigned number with more than 5 digits
    Such numbers are displayed from low to high bits in several pages (5 digits per page) in the format of "current page + values on current page", as shown in the following figure. Hold down SHIFT for more than 2s to switch to the next page.

    For example, "–1073741824" is displayed as follows.

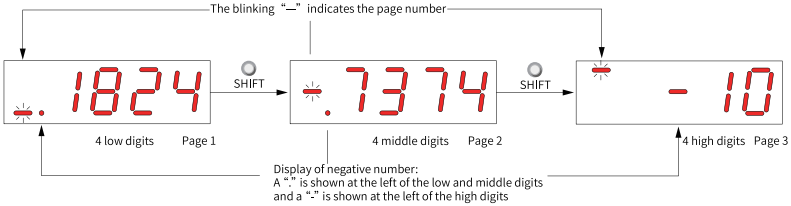
    

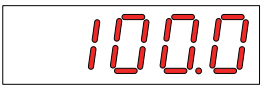
    Figure 5-4 Display of "–1073741824"

    For example, "1073741824" is displayed as follows.

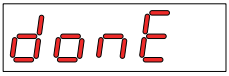


Figure 5-5 Display of "1073741824"

- Display of the decimal point
  The segment "." of the ones indicates the decimal point, which does not blink.

Display	Name	Description
	Decimal point	100.0

- Display of parameter setting status

Display	Name	Applicable Occasion	Meaning
	Done (parame ter setting done)	The parameter is set successfully.	The parameter is set and saved to the servo drive (Done). The servo drive can execute other operations.
	F.InIt (restored to default)	Parameter initialization is in progress (H02.31 = 1).	The servo drive is in the process of parameter initialization. Switch on the control circuit again after initialization is done.
	Error (wrong password)	The user password (H02.30) is enabled and the password entered is wrong.	A wrong password is entered. You need to enter the password again.
	TunE	Auto-tuning with one-key enabled	The function of auto-tuning with one-key is in progress.
	FAIL	Auto-tuning with one-key enabled	The function of auto-tuning with one-key fails.

Fault display

- The operating panel can be used to display present or previous fault and warning codes. For analysis and solutions to the faults and warnings, see Chapter "Troubleshooting".
- When a fault or warning occurs, the operating panel displays the corresponding fault or warning code immediately. When multiple faults or warnings occur, the operating panel displays the fault code of the highest fault level.
- You can select the previous fault/warning to be viewed through H0b.33 and view the code of the selected fault/warning in H0b.34.
- You can clear the latest 10 faults or warnings saved in the servo drive by setting H02.31 to 2.

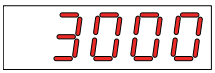
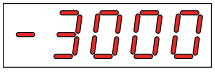
For example, "E941.0" is displayed as follows.

Display	Name	Description
	E941.0 Warning code	E: A fault or warning occurs on the servo drive. 941.0: Warning code

Monitored value display

- Group H0b: Displays parameters used to monitor the operating state of the servo drive.
- Set H02.32 (Default operating panel display) properly. After the motor operates normally, the operating panel switches from status display to parameter display. The parameter group number is H0b and the offset within the group is the setpoint of H02.32.
- For example, if H02.32 is set to 00 and the motor speed is not 0 RPM, the operating panel displays the value of H0b.00.

The following table describes the monitoring parameters in H0b.00.

Param. No.	Name	Unit	Meaning	Example
H0b.00	Actual motor speed	RPM	Displays the actual value of the motor speed after round-off, which can be accurate to 1 RPM.	Display of 3000 RPM:  Display of –3000 RPM: 

5.3 Parameter Settings

Example of parameter settings

You can set parameters through the operating panel. For details on parameters, see Chapter "Parameters". The following figure shows how to switch from position control mode to speed control mode using the operating panel after power-on.

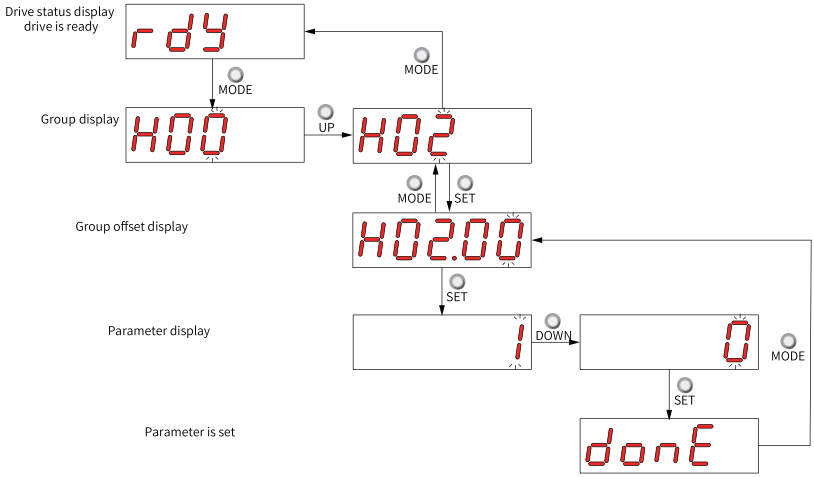


Figure 5-6 Example of parameter settings

- MODE: Used to switch the operating panel display mode and return to the previous screen
- UP/DOWN: Used to increase or decrease the value of the blinking digit
- SHIFT: Used to shift the blinking digit
- SET: Used to save the present setpoint or switch to the next screen

After parameter setting is done, that is, "donE" is displayed on the operating panel, press MODE to return to parameter display (the "H02.00" screen).

Forced DI/DO signals

Terminal CN1 of SV660ND supports 8 DI signals and 4 DO signals.

You can assign different functions and logic to DIs/DOs by setting parameters in groups H03 and H04 through the operating panel (or host controller communication), so that the host controller can control corresponding servo functions through DI signals or use DO signals output by the servo drive.

The servo drive also provides forced DI/DO functions. The forced DIs can be used to test the DI functions of the servo drive, and the forced DOs can be used to check the DO signal connection between the host controller and the servo drive.

- **Forced DI function**

After this function is enabled, all DI signal levels are controlled by the forced DI setting (H0d.18), independent of external DI signal status.

1. Operating procedure:

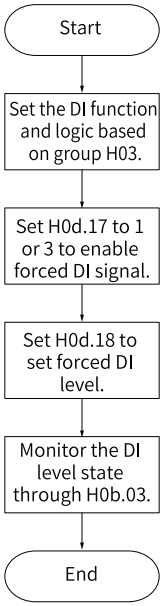


Figure 5-7 Procedure for setting forced DI function

Related parameters:

Param. No.		Name	Value Range	Function	Setting Condition	Effective Time	Default
Panel Side	Software Tool Side						
H0d.17	200d.12h	Forced DI/ DO selection	0: No operation 1: Forced DI enabled, forced DO disabled 2: Forced DO enabled, forced DI disabled 3: Forced DI and DO enabled 4: EtherCAT forced DO enabled	Forced DI/DO selection	During operation	Immediately	0

H0d.18 is used to set the forced DI level. The operating panel displays the value in hexadecimal. After the hexadecimal value is converted to a binary value, the value "1" indicates high level and "0" indicates low level.

The DI logic is defined by parameters in group H03. H0b.03 is used to monitor the DI level status. The operating panel displays the level, and the value of H0b.03 read in the software tool is hexadecimal.

2. Example:

To activate the function assigned to DI1 and deactivate functions assigned to DI2 to DI8 (all the eight DIs are active at low level), set as follows:

As the value "1" indicates high level and the value "0" indicates low level, the corresponding binary value and hexadecimal value are "11111110" and "FE" respectively. Therefore, set H0d.18 to "FE" through the operating panel.

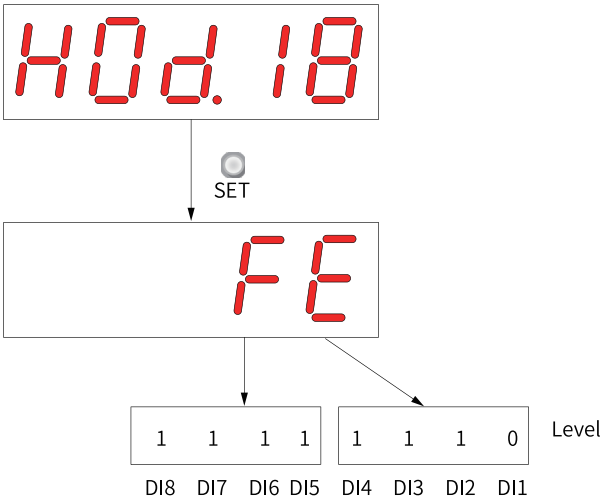


Figure 5-8 Setpoints of H0d.18

Monitor the DI level status through H0b.03:

If the DI function is normal, the display value of H0b.03 is always the same as that of H0d.18.

In this case, DI1 is displayed as low level and DI2 to DI8 are displayed as high level on the operating panel, and the value of H0b.03 read by the software is FE (hexadecimal).

The operating panel displays as follows:

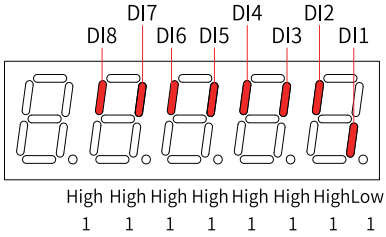


Figure 5-9 DI level status corresponding to H0b.03

3. Exit

   The forced DI signal function is not retentive upon power-off. Normal DIs apply after restart, or you can set H0d.17 to 0 to return to the normal DI mode.

- Forced DO function
  After this function is enabled, all DO signal levels are controlled by H0d.19, regardless of the internal DO status of the servo drive.

Caution

If the motor is used in vertical motion, when the brake output signal is set to Enabled, the brake will open and the load may fall. Take protective measures on the machine to prevent the risk of falling.

- Operating procedure

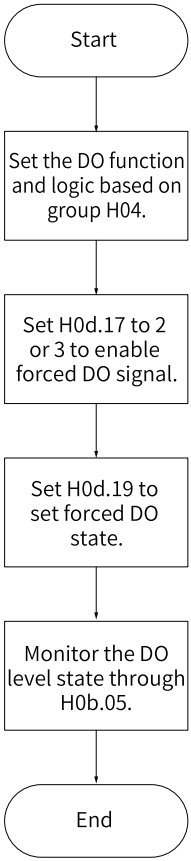


Figure 5-10 Procedure for setting forced DO function

H0d.19 is used to set whether the DO function is active. The operating panel displays the value in hexadecimal. After the hexadecimal value is converted to a binary value, the value 1 indicates that the DO function is active and 0 indicates that the DO function is inactive.

The DO logic is defined by parameters in group H04. H0b.05 is used to monitor the DO level status. The operating panel displays the level, and the value of H0b.05 read in the software tool is hexadecimal.

- Example:
  To deactivate the function assigned to DO1 and activate the functions assigned to DO2 and DO4, set as follows:

  As the value "1" indicates that the DO function is active and "0" indicates that the DO function is inactive, the binary value is "1110", which corresponds to the

hexadecimal value "E". Therefore, set H0d.19 to "E" through the operating panel.

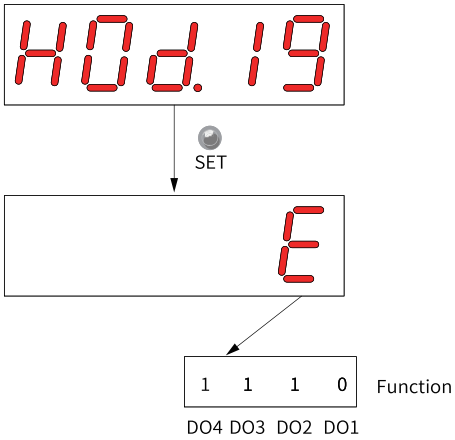


Figure 5-11 Setpoints of H0d.19

Monitor the DO level status through H0b.05:

If the logic of all the four DO terminals are "active low", DO1 is high level and DO2 to DO4 are low level. In this case, the corresponding binary number is "0001" and the value of H0b.05 read by the software tool is 1 (decimal). The operating panel displays as follows:

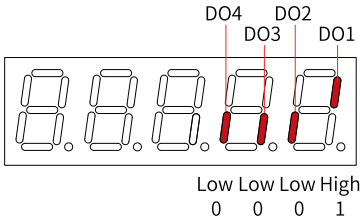


Figure 5-12 Display of H0b.05 when all DOs are "active low"

If the logic of all the four DO terminals are "active high", DO1 is low level and DO2 to DO4 are high level. In this case, the corresponding binary number is "1110" and the value of H0b.05 read by the software tool is "E" (hexadecimal). The operating panel displays as follows:

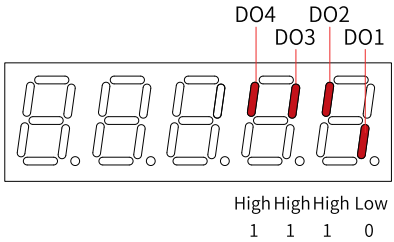


Figure 5-13 Display of H0b.05 when all DOs are "active high"

- Exit
  The forced DO signal function is not retentive upon power-off. Normal DOs apply after restart, or you can set H0d.17 to 0 to return to the normal DO mode.

- Bus control forced DO function
  After this function is enabled, all DO signal levels are controlled by 60FE.01h (Physical output) and are unrelated to the internal DO signal status.

  If the motor is used for vertical motion, when the brake output signal is set to Active (DO assigned with function 9: BK), the brake will open and the load may fall. Take protective measures on the machine to prevent the risk of falling.

  - Operating procedure

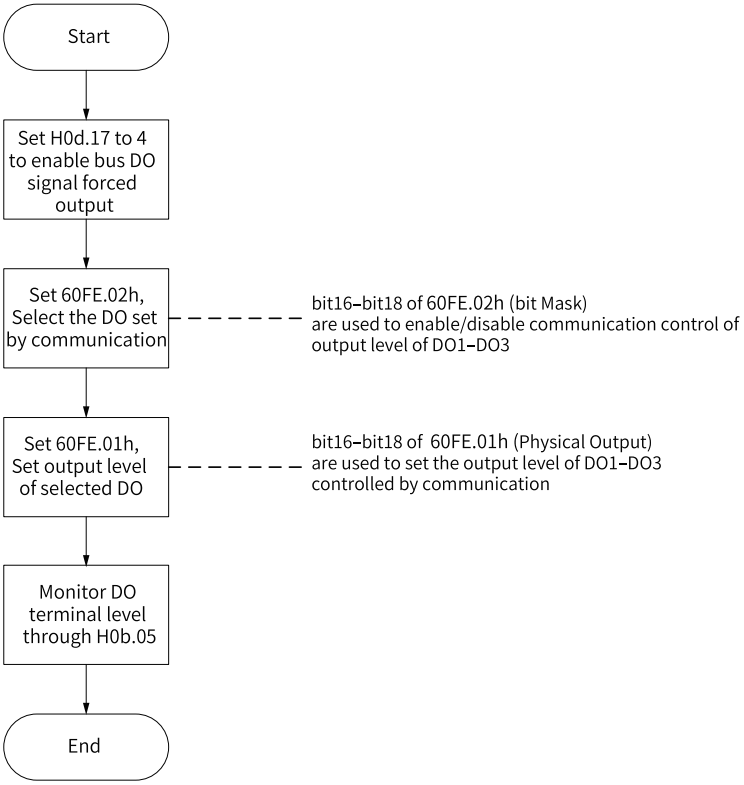


Figure 5-14 Procedure for setting bus control forced DO function

When 200D.12h is set to 4, 60FE (Digital output) can be used to forcibly set the DO terminal level through the bus, regardless of the internal DO status of the drive.

Bit	Related DO	Output Mask: 60FE.02h	Physical Output: 60FE.01h
16	DO1	1: DO1 forced output enabled	DO1 forced output (0: OFF, 1: ON)
17	DO2	1: DO2 forced output enabled	DO2 forced output (0: OFF, 1: ON)
18	DO3	1: DO3 forced output enabled	DO3 forced output (0: OFF, 1: ON)
19	DO4	1: DO4 forced output enabled	DO4 forced output (0: OFF, 1: ON)

When 200D.12h is set to 4 and any bit among bit 16 to bit 19 of 60FE.02h is set to 1, the corresponding forced DO is OFF.

H0b.05 is used to monitor the DO level status. The operating panel displays the level, and the value of H0b.05 read in the software tool is hexadecimal.

Example: To make the output levels of DO1 to DO4 be forcibly set through the bus, in which DO1 outputs low level and DO2 to DO4 output high level, set as follows:

Set 200d.12h to 4, 60FE.02h to 0x00070000, and 60FE.01h to 0x000E0000. Monitor the DO level status through H0b.05. The operating panel displays as follows.

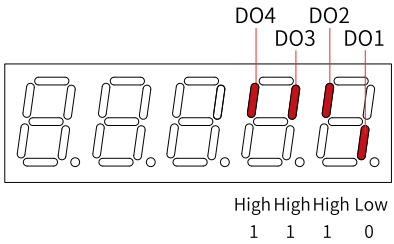


Figure 5-15 Display of H0b.05 when DO signals are controlled through the bus

- Exit
  The forced DO signal function controlled by the bus is not retentive upon power-off. Normal DOs apply after restart, or you can set H0d.17 (200d.12h) to 0 (No operation) to return to the normal DO mode.

User password

After the user password (H02.30) is enabled, only authorized operators can set parameters.

Set bit 5 of H0A.71 to 1. After setting the user password, you can't view and change the parameters in H02 group through the panel and Inovance servo commissioning platform.

- Setting the user password
  The following figure shows how to set the user password to "00001".

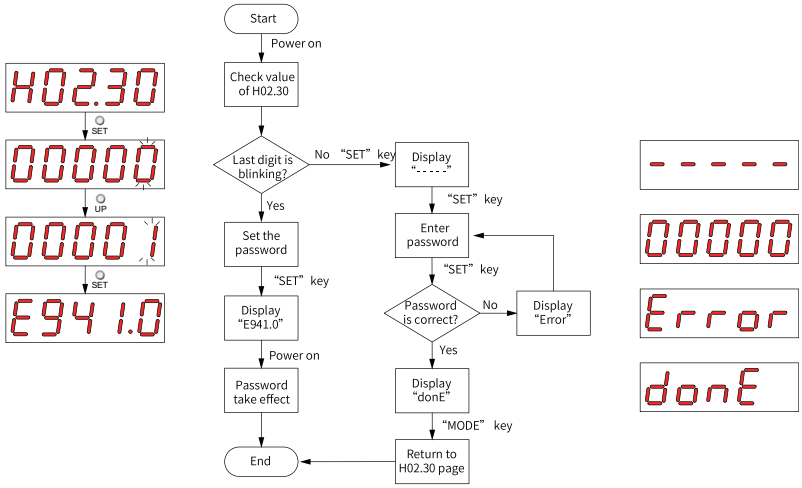


Figure 5-16 Procedure for setting the user password

To change the user password, enter the current password first to authorize the access to parameter setting. Next, enter H02.30 again to set a new password based on the procedure shown in the preceding figure.

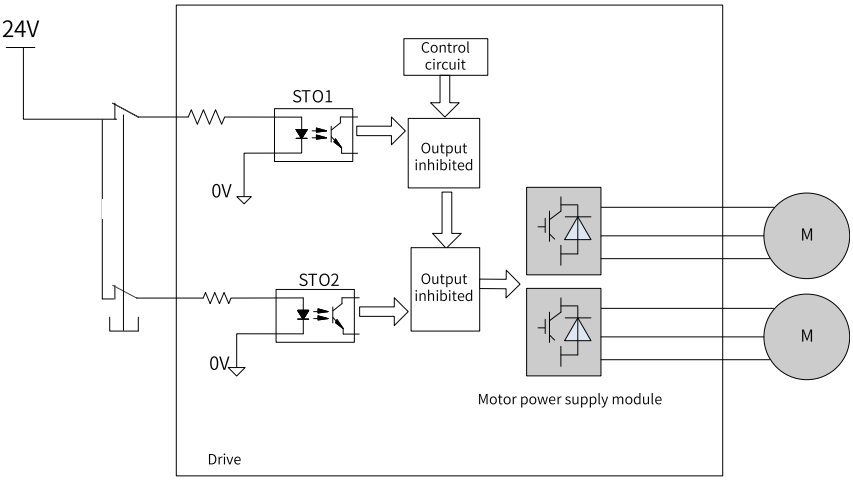
Note

If the last bit does not blink, the access to parameters is password protected. If the last bit blinks, password is not needed or the password entered is correct.

- Canceling the user password
  Enter the set user password, and set H02.30 to "00000" to cancel the user password.

6 STO

6.1 Overview



Switch off the motor power supply module to cut off the motor current and motor torque.

Figure 6-1 Schematics of the STO function

Safe Torque Off (STO) is a safety function that complies with IEC 61800-5-2:2016. It is built into Inovance SV660 series servo drives.

The STO function prohibits the control signal of the power semiconductors of the drive output stage, thus preventing the driver from generating torque at the motor shaft end.

The STO function prevents movement of the motor by two redundant external hardware signals (STO1 and STO2) that block the PWM signals from being transmitted to the power layer of the servo drive. STO1 and STO2 input signals must be both active ("H") to allow the servo drive to operate normally.

The following table describes the STO function.

STO1 Input	STO2 Input	PWM Signal
H	H	Normal
L	H	Disabled
H	L	Inhibited
L	L	Disabled

STO (Safe Torque Off)	
Definition	Cuts off the power of the motor.
Description	The STO function brings the machine safely into a no-torque state and prevents it from unexpected start. If the motor is running when STO function is enabled, it coasts to stop.
Safe state	Disables the PWM gating signal of the drive.
Operating mode	High demand mode or continuous mode

6.2 Function Use and Monitoring

Function Use

The keypad displays the STO function state and error information.

See the following table to identify the cause of a fault and the action to be taken. Contact Inovance technical support if the fault persists after corrective actions listed in the following table are taken.

Fault codes related to the STO function are listed in the following table:

Fault Code	State	Description	Cause	Corrective Action
E150.1	Status of STO1 and STO2 inconsistent	Only one of STO1 and STO2 is in "Low" state, status of STO1 and STO2 are inconsistent.	The input states of STO1 and STO2 are inconsistent.	1. Ensure the requests for disconnecting the voltage of STO1 and STO2 are triggered simultaneously. 2. The input circuit is abnormal and a certain STO input signal is still in the"H" state after the 24 V signal is disconnected. Contact Inovance for technical support.
E150.2	STO activated	OV/UV of the 5V power supply is detected.	OV/UV of the 5V power supply.	Restore the 5 V power supply to normal state. Contact Inovance for technical support.
E150.3	STO activated	The input circuit of STO works improperly.	The input circuit of STO works improperly.	Fix the input circuit fault. Contact Inovance for technical support.
E150.4	STO activated	The buffer circuit of STO works improperly.	The buffer circuit of STO works improperly.	Fix the buffer circuit fault. Contact Inovance for technical support.

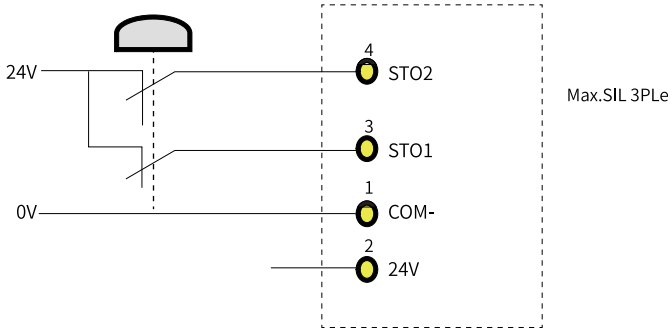
Note

- For a motor with brake, if either STO1 or STO2 closes, the drive will be disabled within 30 ms (STO response time).
- For a motor without brake, if either STO1 or STO2 closes, the drive will be disabled within 5 ms (STO response time).
- In the preceding two cases, if the 24V disconnection time difference between STO1 and STO2 is higher than 10 ms, the drive reports E150.1.

Application Example of Safety Function

Example 1:

Emergency button（dual-contact）Class 3 ISO13849



6.3 Fault Reset

The exceptional operation refers to the durations of power-on and initialization, and how to return from the STO state.

- The PWM buffer is disabled as the enable terminal is pulled up during power-on, so the PWM signal is inhibited.
- The PWM buffer is disabled as the enable terminal is pulled up during initialization of the MCU, so the PWM signal is inhibited. Such condition is cleared and servo drive works normally after initialization is done.
- When all of the following conditions are met, the servo system that enters the safe state through the STO function can be back to normal with the safe state cleared after auto-reset of the drive.
  - The input state of the STO request must be "high".
  - The servo ON or servo RUN command must be inactive.
  - No dangerous faults exist.

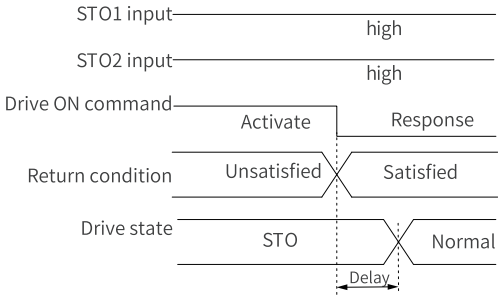


Figure 6-2 Return condition of servo ON/RUN command

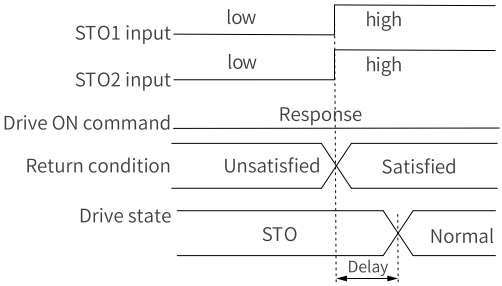


Figure 6-3 Return condition of external STO request state

- When STO_IN (STO1 or STO2 input) is restored to 24 V, the EDM and servo ready signals are immediately reset to 0. After 400 milliseconds, the servo operation signal is activated (when STO_IN keeps at 24 V). Servo operation is PWM drive signal output.

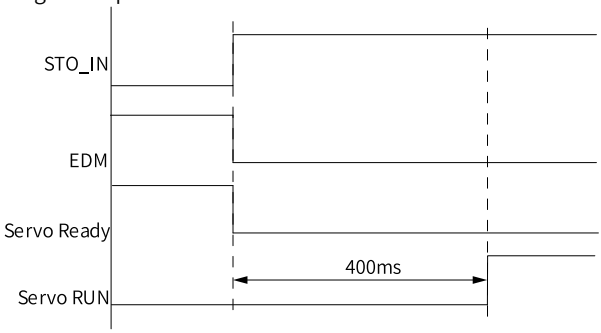
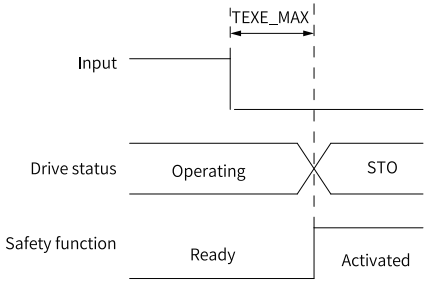


Figure 6-4 Servo drive reset timing diagram

6.4 Safety Function Response Time

The STO function prevents movement of the motor by two redundant external hardware signals (STO1 and STO2) that block the PWM signals from being outputted to the power layer of the servo drive. STO1 and STO2 input signals must be both active to allow the servo drive to operate normally.

If either one or both signals are set to "Low" level, the PWM signals will be blocked within 30 ms.



7 Commissioning and Operation

7.1 Commissioning Flowchart

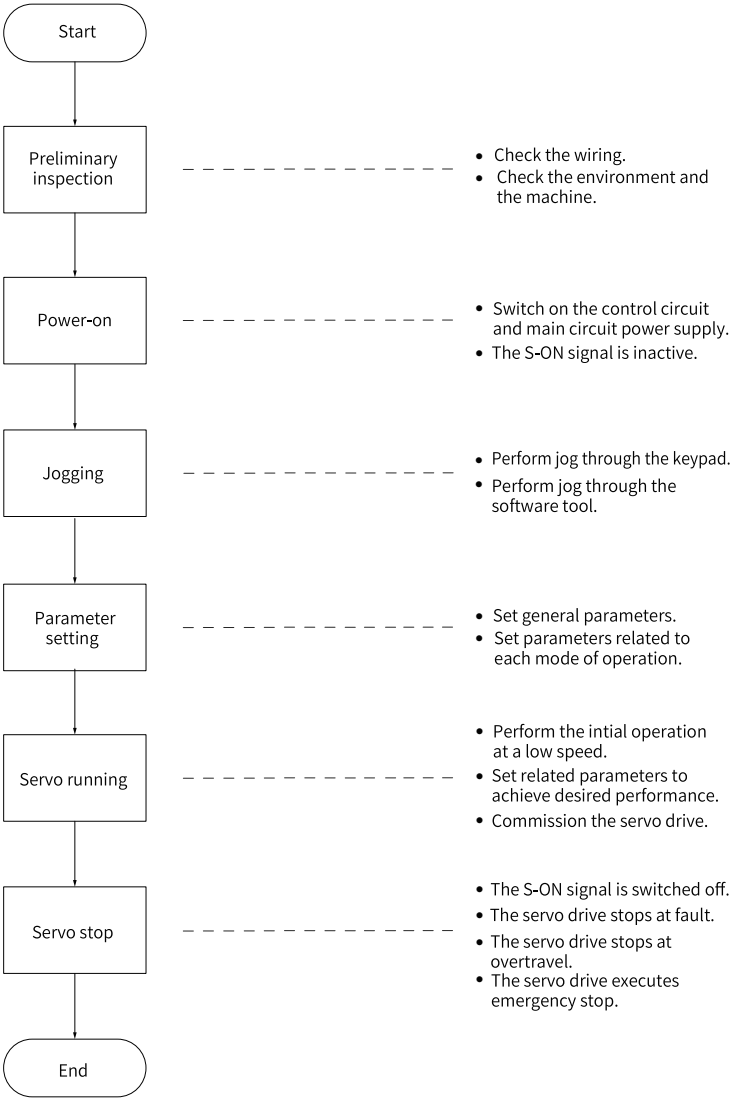


Figure 7-1 Commissioning flowchart of the drive

7.2 Commissioning Steps

See SV660ND Series Servo Drive Commissioning Guide.

7.3 Acceptance

Basic requirements

- Technical staff must be trained to understand the requirements and principles of designing and operating safety-related systems.
- Person performing the maintenance must be trained to understand the requirements and principles of designing and operating safety-related systems.
- Operators must be trained to understand the requirements and principles of designing and operating safety-related systems.
- The safety-related circuit on the control board that fails to operate must be replaced with a new one as it is not repairable.

Commissioning Checklist

- Start-up test and validation
  IEC 61508, EN/IEC 62061 and EN ISO 13849 require the final assembler of the equipment to verify the operation of the safety function through acceptance testing. This acceptance test is described in the drive manual. The testing of optional safety features is described in the corresponding manuals.

  The acceptance test must be performed:

  - at initial start-up of the safety function
  - after any changes related to the safety function (wiring, components, settings and so on).
  - after any maintenance work related to the safety function.

  The acceptance test of the safety function must be carried out by an authorized person with expertise and knowledge of the safety function. The test must be documented and signed by the test staff.

  Signed acceptance test reports must be stored in the logbook of the machine. The report shall include documentation of start-up activities and test results, references to failure reports and resolution of failures. Any new acceptance tests performed due to changes or maintenance need to be logged into the logbook.

- Checklist

Step	Action	Result
1	Ensure that the drive runs and stops freely during commissioning.	
2	Stop the drive (if running), switch the input power supply off and isolate the drive from the power line by a disconnector.	

Step	Action	Result
3	Check the STO circuit connections based on the circuit diagram.	
4	Check that the shield of the STO input cable is grounded to the drive frame.	
5	Close the disconnector and switch the power supply on.	
5.1	Test the STO signal #1 when the motor stops: Set STO1 and STO2 to "H". Send a stop command to the drive (if running) and wait until the motor shaft is at standstill. Awake the STO function by de-energizing (low state or open-circuit) the STO input signal #1 and send a start command to the drive. Ensure that the motor stays at a standstill and the keypad of the drive displays "E150.1".	
5.2	Set STO1 to "H" and disable the ON/RUN command of the drive. Then, reset the drive automatically and enable ON/RUN command of the drive. Finally, check whether the motor runs normally.	
5.3	Test the STO signal #2 when the motor stops: Set STO1 and STO2 to "H". Send a stop command to the drive (if running) and wait until the motor shaft is at standstill. Awake the STO function by de-energizing (low state or open-circuit) the STO input signal 2 and send a start command to the drive. Ensure that the motor stays at a standstill and the keypad of the drive displays "E150.1".	
5.4	Set STO2 to "H" and disable the ON/RUN command of the drive. Then, reset the drive automatically and enable ON/RUN command of the drive. Finally, check whether the motor runs normally.	
6.1	Test the STO channel 1 when the motor is running: Set STO1 and STO2 to "H". Start the drive and ensure the motor is running. Awake the STO function by de-energizing (low state or open-circuit) the STO input signal 1. Ensure that the motor stops and the drive trips. Reset the fault and try to start the drive. Ensure that the motor stays at a standstill and the keypad of the drive displays "E150.1".	
6.2	Set STO1 to "H" and disable the ON/RUN command of the drive. Then, reset the drive automatically and enable ON/RUN command of the drive. Finally, check whether the motor runs normally.	

Step	Action	Result
6.3	Test the STO channel 2 when the motor is running: Set STO1 and STO2 to "H". Start the drive and ensure the motor is running. Awake the STO function by de-energizing (low state or open-circuit) the STO input signal 2. Ensure that the motor stops and the drive trips. Reset the fault and try to start the drive. Ensure that the motor stays at a standstill and the keypad of the drive displays "E150.1".	
6.4	Set STO2 to "H" and disable the ON/RUN command of the drive. Then, reset the drive automatically and enable ON/RUN command of the drive. Finally, check whether the motor runs normally.	
7	Document and sign the acceptance test report which verifies that the safety function is safe and acceptable for operation.	

Special requirements

You must conduct STO diagnosis every three month by powering off and powering on the drive once, or running the STO function once.

Note

There are two ways to perform STO diagnosis:

- Power off and restart;
- Trigger and then cancel STO.

You can use either of them.

8 Maintenance

8.1 Routine Maintenance

Standard operating conditions:

Average annual ambient temperature: 30°C Average load rate: ＜ 80% Daily operating time: ＜ 20 h

8.1.1 Routine Checklist

Check the following items during routine inspection.

Table 8–1 Routine checklist

No.	Routine Checklist	Checked
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.	☐

8.1.2 Routine Cleaning List

Check the following items during routine cleaning.

Table 8–2 Routine cleaning list

No.	Routine Cleaning List	Checked
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.

8.2 Periodic Checklist

8.2.1 Periodic Checklist

Table 8–3 Periodic checklist

No.	Item	Checked
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.	☐

8.2.2 Periodic Maintenance Checklist

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

Object	Category	Standard Replacement Interval	Remarks
Drive	Power bus capacitor	About 10 years (ambient temperature: 30°C, load rate: 80%, duty type: 20H, 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.
	Cooling fan	5 years (ambient temperature: 30°C, load rate: 80%, duty type: 20H, standard environment[1])	
	Aluminum electrolytic capacitor on the PCB	About 10 years (ambient temperature: 30°C, load rate: 80%, duty type: 20H, standard environment[1])	
	Pre-charge relay	100,000 operations (depending on the operating conditions)	
	Pre-charge resistor	20,000 operations (depending on the operating conditions)	
	Dynamic brake relay	1,000 operations (rated motor speed, interval of 5 minutes, 20 times the inertia)	
Motor	Bearing	3 to 5 years (20,000 h to 30,000 h)	
	Oil seal	5,000 h	
	Encoder	3 to 5 years (20,000 h to 30,000 h)	
	Absolute encoder battery	Depends on the operating conditions. See the operation instructions for the encoder battery for details.	

Note

For standard environment, see section Requirements on Installation Environment in the relevant installation guide.

9 Certification and Standard Compliance

9.1 Compliance List

Table 9–1 Compliance list

Certification	Directive Name		Standard
CE certification	EMC directive	2014/30/EU	EN IEC 61800-3
	LVD directive	2014/35/EU	EN 61800-5-1 EN 60034
	RoHS directive	2011/65/EU	EN 50581
UL/cUL certification	-		UL61800-5-1 C22.2 No.274-17 UL 1004-6 CSA C22.2 No. 100-14

Note

The drive complies with the latest version of directives and standards for CE and UL/cUL certifications.

9.2 CE Certification

Figure 9-1 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.

9.2.1 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.



- When applied in the first environment, the drive may generate radio interference. In addition to the CE compliance requirements described in this chapter, take additional measures, if necessary, to prevent the radio interference generated by the drive.

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

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

- Category C1 equipment: Power drive system (PDS) with 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.

9.2.2 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 Chapter "Installation Environment" in SV660ND Series Servo Drive Installation Guide.

Protective requirements of installation

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.

Drives (IP20) 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 wiring requirements

For wiring requirements of main circuit terminals, see Chapter "Power Cable Selection".

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.

For recommended fuse/circuit breaker models, see "Fuses" and "Circuit Breakers" in Chapter "Optional Parts" of SV660ND Series Servo Drive Selection Guide.

9.3 UL and cUL Certification



Figure 9-2 UL/cUL mark

The UL/cUL mark is commonly applied to products sold in the United States and Canada. It indicates that UL has performed product tests and evaluation, and determined that their stringent standards have been met. For a product to receive UL/cUL certification, the main components inside the product 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

Keep the ambient temperature within the following range based on the IP rating:

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

Installation requirements

Installation requirements for open-type drives:

SV660ND series servo drives are open-type drives that must be installed in a fireproof cabinet with the housing that provides effective electrical and mechanical protection. The installation must conform to local laws and regulations and related NEC requirements.

Main circuit wiring requirements

Warning

On-site installation of output terminals (such as P⊕, C, and NΘ) is not allowed.

- 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 an 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 an external SELV circuit.
- Prevent foreign objects from entering the wiring area 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 a torque screwdriver, torque ratchet, or torque wrench to tighten terminal screws.
- When using an electric screwdriver to tighten terminal screws, set the electric screwdriver to low speed to prevent damage to the terminal screws.
- Avoid tightening the terminal screws at an angle greater than 5°. Failure to comply may damage the terminal screws.

Control circuit wiring requirements

Observe the requirements in UL508 during wiring.

Cable requirements

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

- Use cables with copper conductors.
- The cable recommended for the main circuit is a 600 V class 2 indoor heat-resistant PVC cable that can continuously tolerate a temperature up to 75°C. The following conditions are used as premises:
  - 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.

Cable selection

To comply with UL61800-5-1 and CSA C22.2 No. 274-17, power cables used for SV660ND series servo drives must meet the following requirements:

- Compliant with NEC and Table 310-16 of NFPA70
- Comprised of copper conductors designed to tolerate a temperature not lower than 75°C (167°F)
- Cable size must be 14 AWG 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 of protective devices

To comply with UL 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.

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 5,000 A or 65,000 A and a maximum voltage of 480 VAC (class 400 V).

Note

All breaker protective devices must be UL-certified.

For SV660ND series servo drives applied in North America, the following protective devices are recommended:

Servo Drive Model SV660ND****I		Circuit Breaker (A)	Class J Fuse (A)	Recommended Inverse Time Lag Circuit Breaker[1] (A)
Single-phase 220 V				
Size A	S2R8	15	6	40
Size B	S5R5	15	10	40
Three-phase 220 V				
Size A	S2R8	15	6	40
Size B	S5R5	15	10	40

Note

[1]: It is recommended to use the inverse time circuit breaker for multiple servo drives connected in parallel.

10 Troubleshooting

See SV660ND Series Servo Drive Troubleshooting Guide.

11 List of Parameters

See SV660ND Series Servo Drive Commissioning Guide.

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