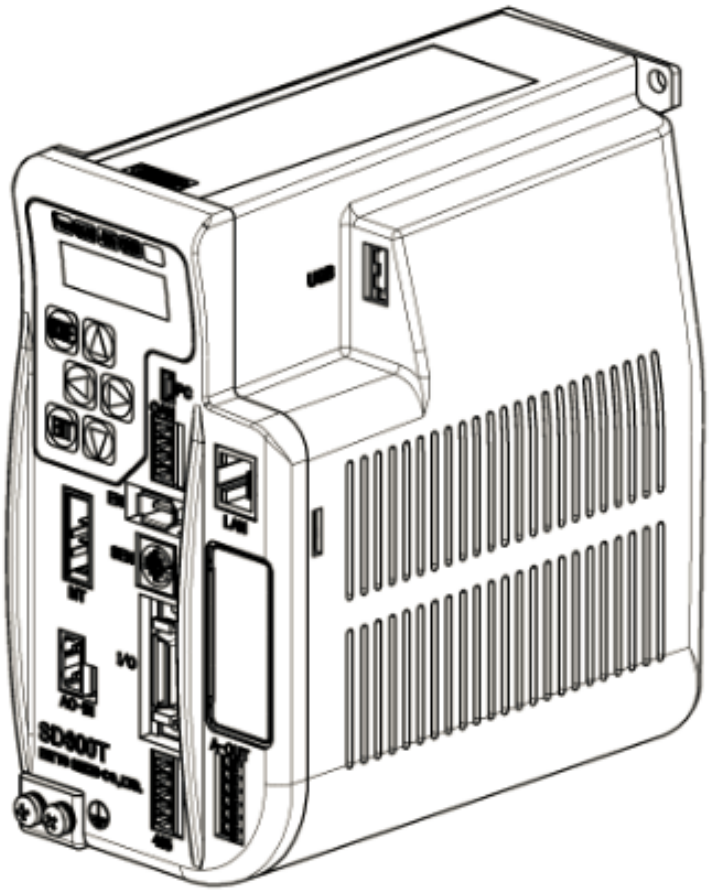
Fastening solution. <Toward a new future of manufacturing technology> NITTO SEIKO

NX T3 series

Driver controller

SD600T

Instruction manual Ver. 1.00



NITTO SEIKO CO.,LTD.

Update: Jul. 7, 2017

Introduction

Thank you for purchasing our driver controller, “SD600T” (hereafter referred to simply as the “controller”).
The SD600T is a high-performance controller for drivers that use AC servomotors to fasten screws and other parts. This controller allows the user to handle various fastening operations flexibly by creating programs for each operation. For general screw fastening, the controller uses its standard tightening program so that the user may simply perform screw fastening of high accuracy only by entering the values of tightening conditions.
Be sure to read this instruction manual before using the controller in a proper manner to ensure effective use of this product for a long time.
After reading the instruction manual, carefully store it together with the “Results of NX Driver Torque Sensor Inspection”.

Please observe the following:

- The copyright of the instruction manual is ascribed to Nitto Seiko Co., Ltd. No part of this document may be reproduced without prior written permission of Nitto Seiko Co., Ltd.
- If this instruction manual is provided as electronic media, the user is assumed to agree with the contents of readme.txt contained in the media.
- The contents of this manual may be changed without prior notice due to product specification changes or for some other reason.
- Product names and other specific names in this document are registered trademarks or trademarks of their respective companies.
- In the figures of this manual, the products may be shown without the covers and safety shielding materials for the ease of explanation on detailed parts. When you operate a product, make sure specified covers and shielding materials on and follow this instruction manual.
- Typical examples are shown in this manual and may differ from the system delivered to the customer.
- Please contact our agent or our closest branch if an additional copy of this instruction manual is needed.
- Any modifications to this product by the customer shall be beyond the scope of our warranty. Nitto Seiko shall not take any responsibility for any damage resulting from its products modified by customers.

The instructions for use:

- The final fastening torque might change depending on the rotational speed of the driver output shaft or the inertia of the joint mounted on the output shaft, or for some other reason. Set the torque value and rotational speed of the tool unit output shaft to appropriate values according to the instruction manual.
- Each tool unit model uses different parameters (motor characteristic values). When connecting a tool unit and the SD600T controller, always specify appropriate parameter values according to the instruction manual.
- Avoid using the controller in such a manner as to restrain (or stall) the output shaft of tool unit as much as possible. Doing this may damage the tool unit or the controller or shortens the life of the product.

Contents

For safe usage

When using this product (for installation, operation, maintenance, and inspection), be sure to understand the meaning of the following precautions and handle it correctly with much care for safety.
It is difficult to state clearly all items regarding safety in this manual. Therefore, be aware that accurate judgment about safety by persons handling this product is very important to avoid a risk.

DANGER	Indicates that incorrect handling may lead to an imminent injury accident (death or serious injury).
WARNING	Indicates that incorrect handling may lead to an injury accident (death or serious injury).
CAUTION	Indicates that incorrect handling may lead to an injury, physical damage, or machine operation failure.

Even the following items covered by “CAUTION” may lead to a serious accident depending on circumstances. All the items are important. Be sure to follow the precautions:

Meanings of signs

(Example of sign)

INDICATES WHAT SHOULD BE TAKEN CARE OF.

INDICATES WHAT MUST NOT BE DONE.

INDICATES WHAT MUST BE DONE.

DANGER

- **Be sure to establish a ground.**

  Be sure to connect a ground terminal to the ground pole (Class D ground). Otherwise, an electric shock or fire may occur.

WARNING

- **Don't touch rotating part.**

  During operation, don't touch rotating part of a driver.
  Otherwise, you may be injured.

- **Turn off power when an abnormal symptom is exhibited.**

  When an abnormal symptom is exhibited, such as smoke emission or bad smell, turn off the power and contact our agent or sales office to ask for repair.
  If the product is used without repair, a fire or electric shock accident may occur.

⚠ WARNING

- **Don't use a voltage other than specified.**

  Don't use the driver with a voltage other than specified. Otherwise, a fire, electric shock, or failure may occur.

- **Don't touch a part inside the controller.**

  Don't touch a part inside the controller. Otherwise, an electric shock or failure may occur.

- **Don't use the product in a place with much humidity, greasy fumes, or dust.**

  Don't use the product in a place where water is splashed, in a corrosive atmosphere, in a flammable gas atmosphere, and near a flammable substance. Otherwise, a fire, electric shock, or failure may occur.

- **Don't damage a cable.**

  Don't place a heavy object on, pull forcefully, or twist a cable.
  Otherwise, a cable may be broken, causing a fire, electric shock, accident, or failure.

- **Don't disassemble or modify the product.**

  Otherwise, a fire, electric shock, accident, or failure may occur.

⚠ CAUTION

- **Use a tool with a specified setting.**

  Since a parameter setting of a controller may vary depending on a tool unit, use the controller after configuring settings as specified. Otherwise, a fire or failure may occur.

- **Don't obstruct the ventilation hole of the controller.**

  Otherwise, heat is kept inside, and a fire or failure may occur.

- **Don't change wiring while power is turned on.**

  Otherwise, an electric shock or failure may occur.

- **Fix each unit securely.**

  Fix a tool unit and controller securely before using.
  Otherwise, injury or failure may occur.

1. Functions and configuration

1-1 Startup procedure

Use the following procedure to turn the SD600T controller on:

[1] Check that the model of the controller matches that of the tool unit to be used. (Refer to 1-5.)

[2] Check that each type of cable is connected correctly. (Refer to 1-7-1.)
- Power supply circuit wiring
- Motor cable
- Encoder cable
- Sensor cable
- External I/O wiring
- Other cables (such as RS-485)

[3] Turn on the power switch of the user equipment to turn the primary power supply on.
The power lamp will light up and “ 0.00” (monitor mode: -155 (torque judgment value)) will appear on the display.
* What appears on the display differs depending on the tool unit.

[4] Specify settings for the channel to be operated according to the memory sheet. (Refer to Chapter 3.)

[5] Send signals from the higher-level control device to the controller according to external I/O. (Refer to 1-8.)

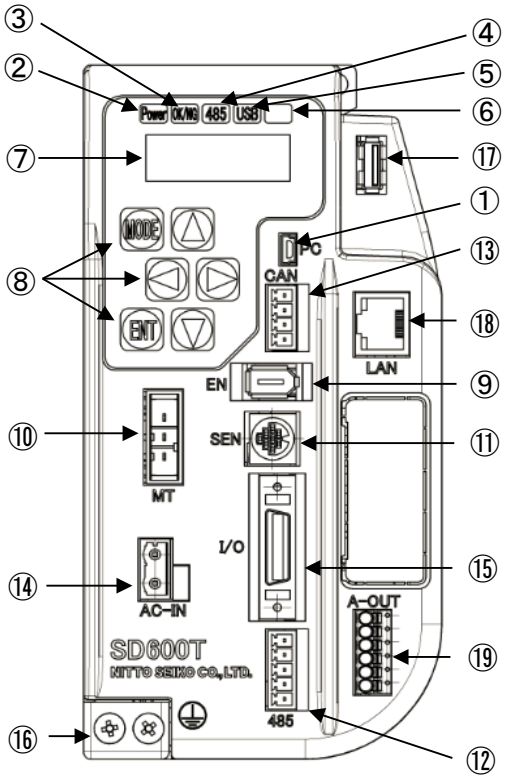
[6] Start and then complete operations. (Refer to 1-8-3.)

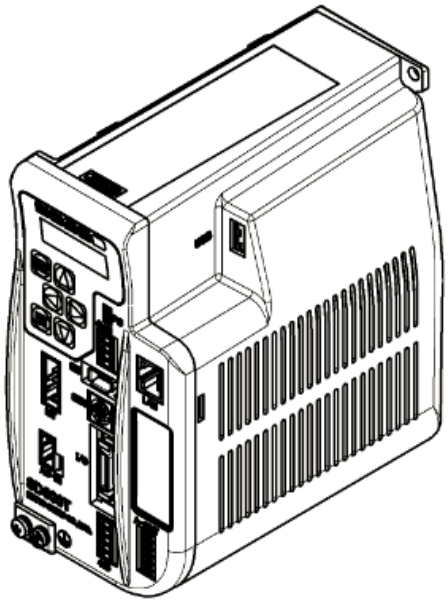
[7] Signals are sent from the controller to the higher-level control device according to external I/O. (Refer to 1-8-3.)

*** Notes on turning the power off**

When the power is turned off, alarm “A.002” is displayed until an electric discharge from the inside of the controller finishes, but this does not indicate a system error or controller fault. To turn the power on again after the power has been turned off, wait at least five seconds after the display on the screen disappears.
Also, do not repeat turning the controller on and off continuously in a short time. Doing so significantly shortens the service life of the product and may also result in failure.

1-2 Part names





[1] Communication connector (mini USB)
Allows the user to communicate with a PC when dedicated software is used.

[2] Power lamp
Lights up while power is turned on.
When the power is turned off, it remains lit until the internal capacitor is discharged.

[3] OK/NG lamp
Lights up green when fastening is completed, and red when an interrupt or timeout occurs.

[4] Communication lamp 1 (RS-485 communication)
Lights up for 0.5 seconds when data is sent via RS-485 communications.

[5] Communication lamp 2 (USB memory)
Lights up when the USB memory is connected to the system.

[6] Communication lamp 3
Unsupported

[7] Display
Indicates a controller status and setting values.

[8] Operation key
Enters setting values.

[9] Encoder connector (EN)
Connects to an encoder cable.

[10] Motor power connector (MT)
Connects to a motor cable.

[11] Sensor connector (SEN)
Connects to a sensor cable.

[12] Network connector (485)[Note 1]
Allows the user to output data via RS-485 serial communications.

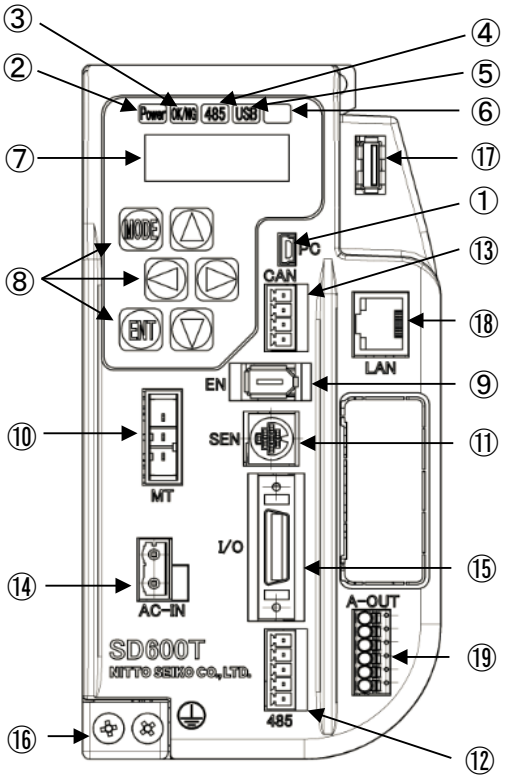
[13] CAN communication connector (CAN)[Note 2]
Allows the user to communicate with a PC when the data collection software for the SD500T (α series) is used.

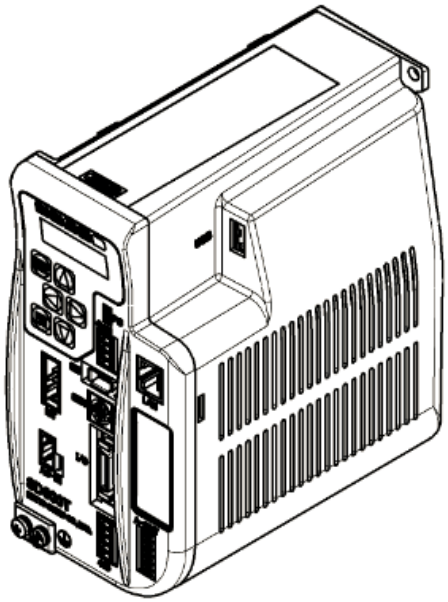
[14] Power connector (ACIN)[Note 2]
Connects to an AC input power cable.

[15] External I/O connector (I/O)[Note 2]
Connects to an external I/O cable for I/O signal connector to an external control device.

[16] Ground terminal
Connects a ground wire.

[Note 1] Only the connector is attached.
[Note 2] The cable is optional. Only the connector is attached.





[17] USB memory connector

Unsupported

* This connector cannot be used for recharging.

[18] Ethernet connector

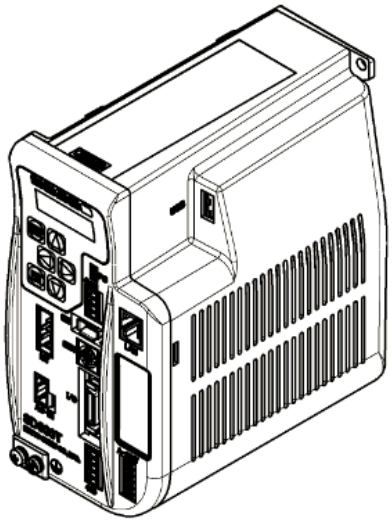
Allows the user to communicate with a PC when dedicated software is used.

[19] Connector (A-OUT)

Unsupported

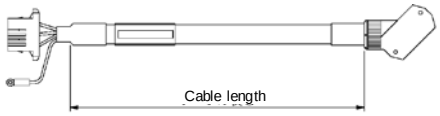
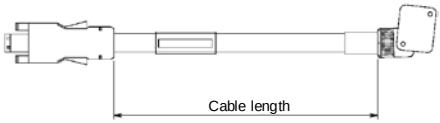
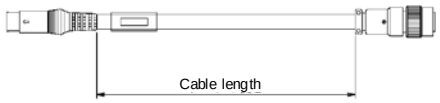
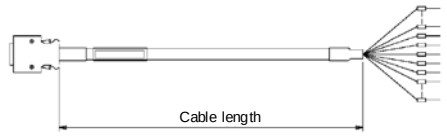
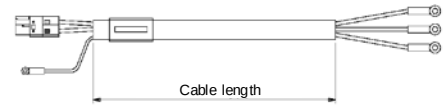
1-3 Controller models

This section explains the models of the controller.

Appearance of controller	Model
	SD600T 03 - 2020 - * Control number Output voltage 20: 200 VAC Input voltage 20: 200 VAC Applicable tool unit type 03: NX020T3 : NX050T3 05: NX100T3 Series name

1-4 Models of connection cable

Connect the following dedicated cables to the controller. Refer to Chapter 9 for communication-related cables such as network cables.

Cable name	Model
[1] Motor cable A cable connecting a tool unit to the controller 	SD-MC11- 050 - FJ Control number* Tool unit type FJ: NX020T3 NX050T3 NX100T3 Cable length 020: 2 m 050: 5 m 075: 7.5 m
[2] Encoder cable A cable connecting a tool unit to the controller 	SD-EC7- 050 - CG Control number* Cable length 020: 2 m 050: 5 m 075: 7.5 m
[3] Sensor cable A cable connecting a tool unit to the controller 	SD-SC1- 050 - CC Control number* Cable length 020: 2 m 050: 5 m 075: 7.5 m
[4] External I/O cable A cable connecting an external device to the controller 	SD-IC7- 040 - E Control number* Cable length 040: 4 m 070: 7 m Note: Do not use this cable with cable carriers or robot arms, or in environments where the cable is slid or continuously bent.
[5] AC input power cable A cable connecting a primary power supply to the controller 	SD-AC5- 040 - D Control number* Cable length 020: 2 m 040: 4 m 070: 7 m Note: Do not use this cable with cable carriers or robot arms, or in environments where the cable is slid or continuously bent.

* Even if the control number is different from the one shown above, the cable can be used. Control numbers are unrelated to cable compatibility.

- Cable outer diameter and minimum bend radius

Cable name	Cable outer diameter	Minimum bend radius
Motor cable	6.7 mm	55 mm
Encoder cable	5.1 mm	50 mm
Sensor cable	5.5 mm	50 mm
External I/O cable	9.7 mm	
AC input power cable	7.8 mm	

Do not place heavy objects on dedicated cables (motor cables, encoder cables, sensor cables, external I/O cables, and AC input power cable), pull them forcibly, twist them, or handle them inappropriately. Doing so may break the cables.

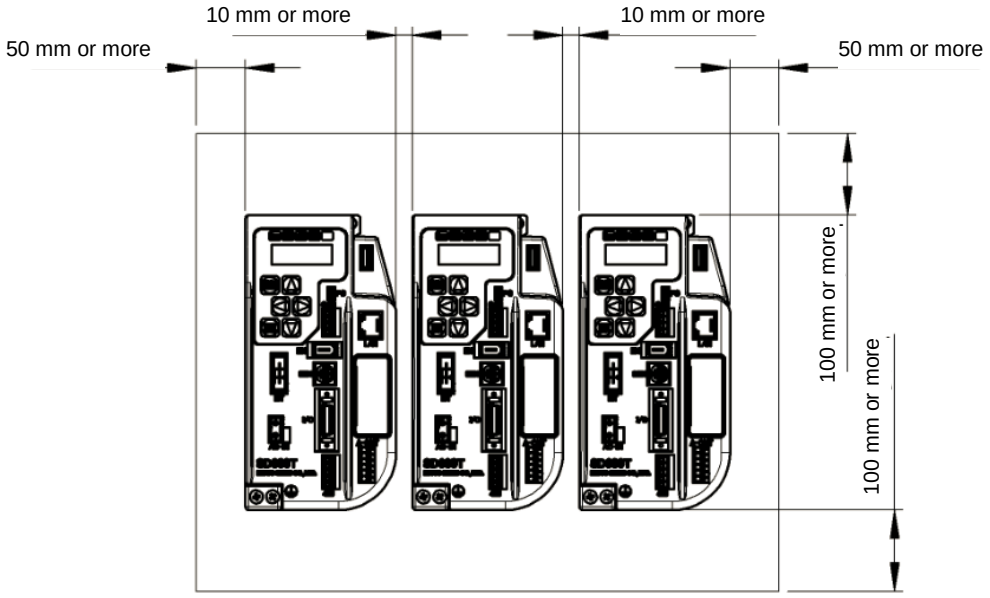
1-5 Standard specifications

<table>
<tr><td colspan="3">Controller model</td><td>SD600T 03</td><td>SD600T 05</td></tr>
<tr><td rowspan="2">Primary power supply input</td><td colspan="2">Voltage</td><td colspan="2">Single-phase 200 to 230 VAC ±10%, 50/60 Hz</td></tr>
<tr><td colspan="2">Maximum power supply capacity</td><td>450 VA (when the NX020T3 is connected)
600 VA (when the NX050T3 is connected)</td><td>750 VA</td></tr>
<tr><td rowspan="2">External I/O power supply input</td><td colspan="2">Input specifications</td><td colspan="2">10 mA, 24 VDC</td></tr>
<tr><td colspan="2">Output specifications</td><td colspan="2">Maximum output current 50 mA, 24 VDC (resistive load)</td></tr>
<tr><td colspan="3">Fastening method</td><td colspan="2">Torque control method, angle control method</td></tr>
<tr><td colspan="3">Maximum number of channels</td><td colspan="2">32 pairs (0 to 31)</td></tr>
<tr><td colspan="2" rowspan="2">Number of external I/O points</td><td>Input</td><td colspan="2">12 points</td></tr>
<tr><td>Output</td><td colspan="2">10 points</td></tr>
<tr><td colspan="3">External interface</td><td colspan="2">USB, Ethernet, CAN, and RS-485</td></tr>
<tr><td colspan="3">Memory device</td><td colspan="2">EEPROM</td></tr>
<tr><td colspan="3">Self-diagnosis function</td><td colspan="2">Error number display and external signal output at system error occurrence</td></tr>
<tr><td colspan="3">Other functions</td><td colspan="2">Torque waveform processing function, data collection function, and serial communication (fastening result output)</td></tr>
<tr><td rowspan="5">Environmental conditions</td><td colspan="2">Cooling system</td><td colspan="2">Self-cooling</td></tr>
<tr><td colspan="2">Operating ambient temperature</td><td colspan="2">0 to 40ºC (no freezing)</td></tr>
<tr><td colspan="2">Operating ambient humidity</td><td colspan="2">90%RH or less (no condensation)</td></tr>
<tr><td rowspan="3">Installation</td><td>Inside the control panel</td><td colspan="2">Cooling design is required to ensure that the ambient temperature of the controller does not exceed 40°C.</td></tr>
<tr><td>Vibration</td><td colspan="2">The controller must be installed through vibration isolators.</td></tr>
<tr><td>Other</td><td colspan="2">The ambient environment must be free from corrosive gases, explosive gases, dust, iron powder, and soot.</td></tr>
<tr><td colspan="3">Mass of controller</td><td colspan="2">1.4 kg</td></tr>
<tr><td colspan="3">Applicable tool unit models</td><td>NX020T3
NX050T3</td><td>NX100T3</td></tr>
</table>

1-6 Notes on installation

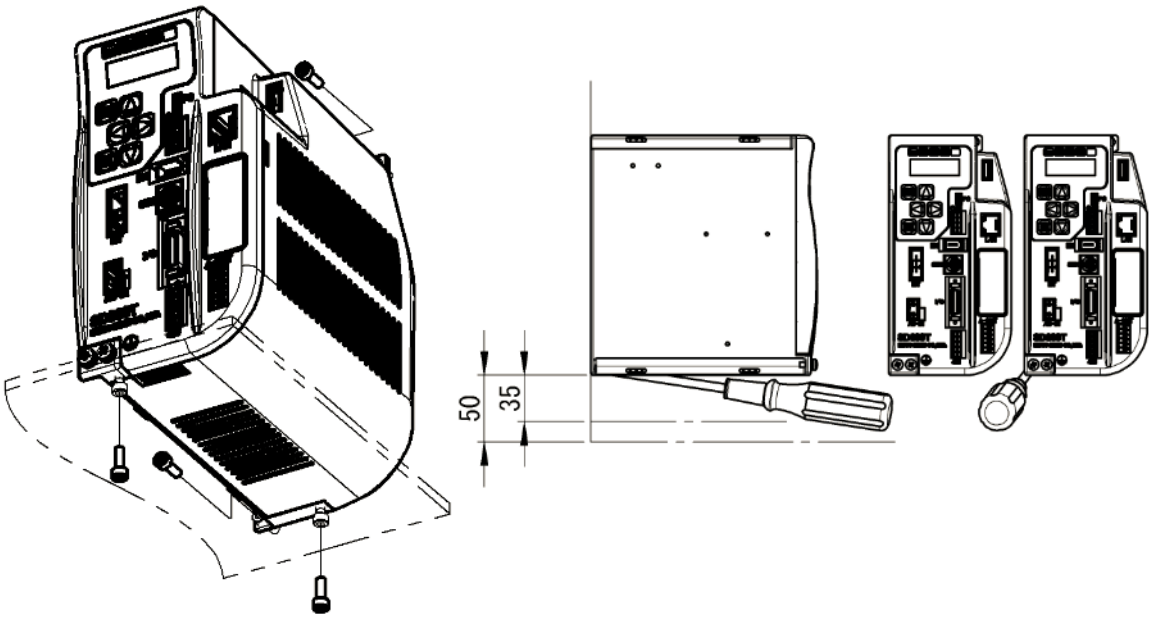
1-6-1 Installation location (inside control panel)

Design the size, layout, and cooling method of the control panel so that the ambient temperature of the controller does not exceed 40ºC and the environmental conditions specified in 1-5 “Standard specifications” are met. Failure to meet the environmental conditions may result in failures. Reference values are shown in the following figure. Design the control panel according to the environment where the controller is to be used.



1-6-2 Installation method

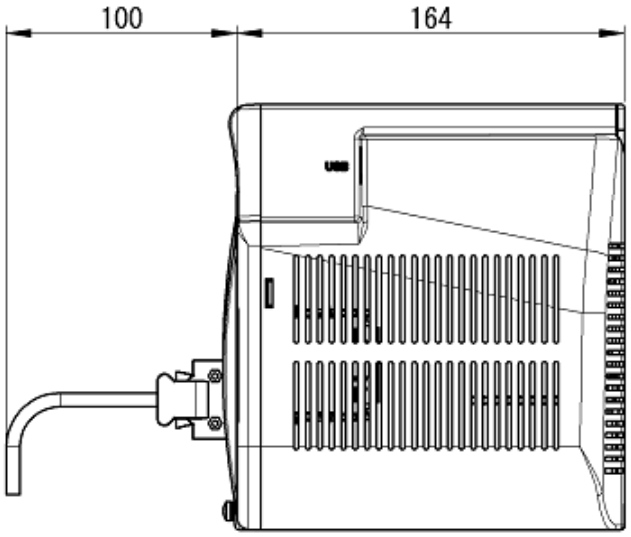
Pay attention to the notes below.



* Use either the back or bottom installation method to secure the controller properly with two M4 screws.
* For the bottom installation method, the length of thread engagement in the controller must be 6 mm or less.

1-6-3 Range required for wiring

Pay attention to the following range required for wiring.



1-6-4 Mechanical stress on cables

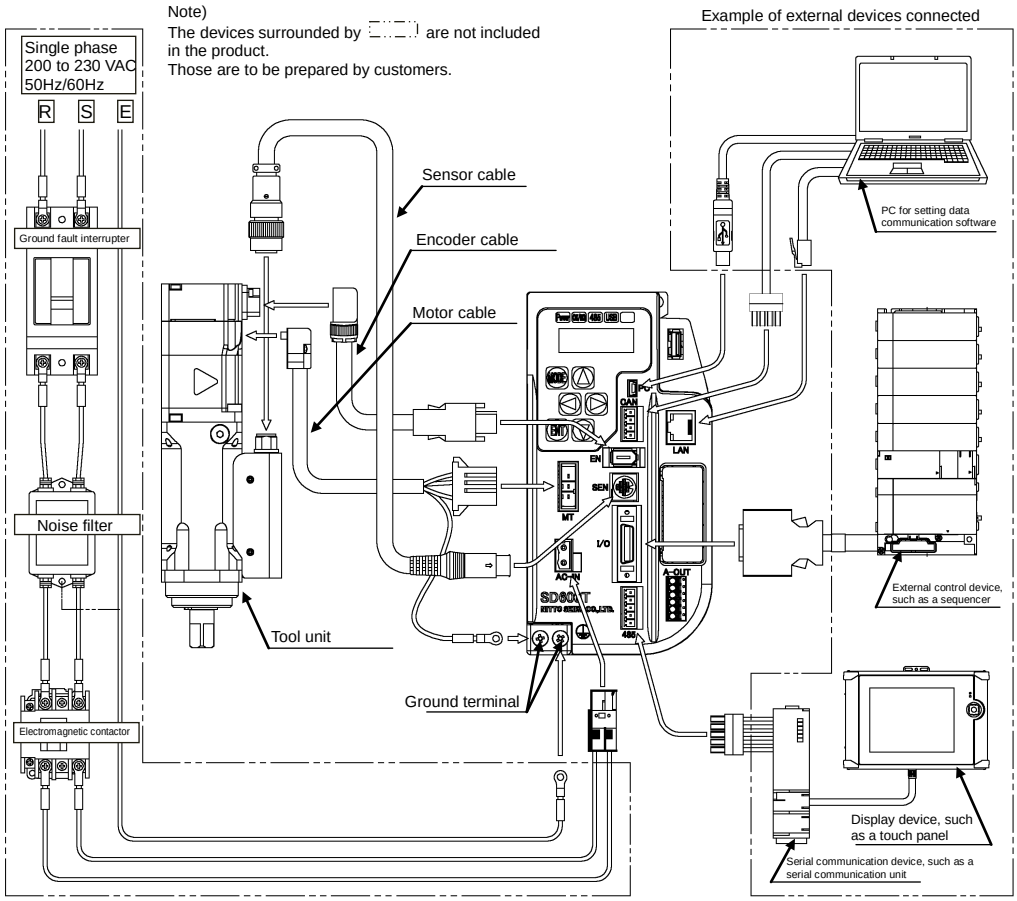
Do not place heavy objects on dedicated cables (motor cables, encoder cables, sensor cables, external I/O cables, and AC input power cable), pull them forcibly, twist them, or handle them inappropriately. Doing so may break the cables.

1-7 Overall configuration including peripheral devices

Connect various cables as shown in the figure below. Then, check that each connector is inserted and locked properly. Be sure to connect the ground wire of the motor cable to a ground terminal. To connect the ground wire, always use the screws provided. (For connection on the tool unit side, refer to the NX-T3 Series (SD600T) NX Driver Tool Unit Instruction Manual, provided separately.)

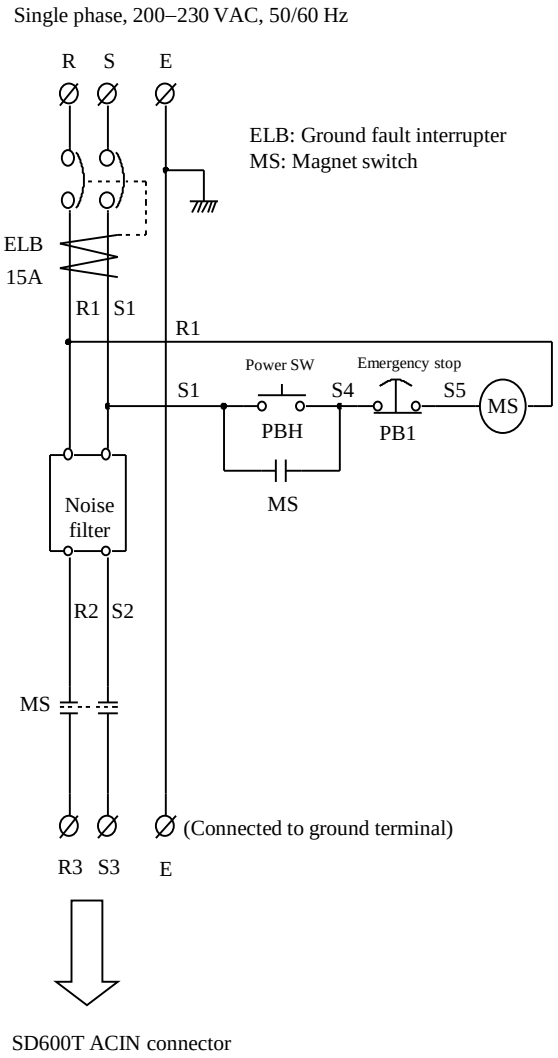
*** Before connecting each cable, make sure that the controller is turned off. Failure to do so may result in electric shock or failure.**

1-7-1 General connection diagram



1-7-2 Wiring example of primary power supply circuit

A typical example of circuit diagrams is shown below.

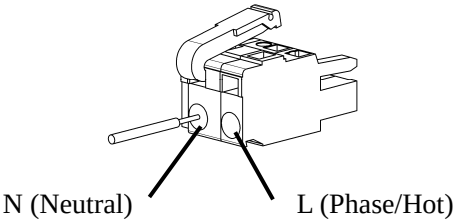


Devices listed for reference

	Manufacturer	Model
Ground fault interrupter	Mitsubishi Electric Corporation	NV30-FAU (2P, 15A)
Electromagnetic contactor	Fuji Electric FA Components & System Co., Ltd.	SC-4-0
Noise filter	TDK Lambda Corporation	RSHN-2016

1-7-3 Connecting the power connector

Connect the power connector to a power source (single-phase, 200 to 230 VAC ±10%, 50/60Hz). The following connector is provided, so wire and connect it according to the specifications described below.

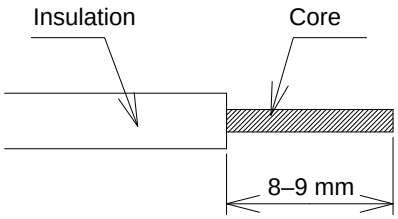


- Power connector

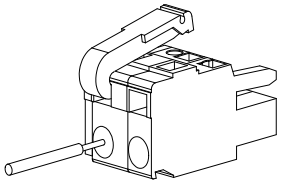
Manufacturer	Model
Wago Company of Japan, Ltd.	231-202/026-000

- Wire size
  AWG16 to AWG12 (1.25 to 3.5 sq.)
  Maximum outer diameter of wire insulation: 4.1 mm

- Treatment of wires to be used



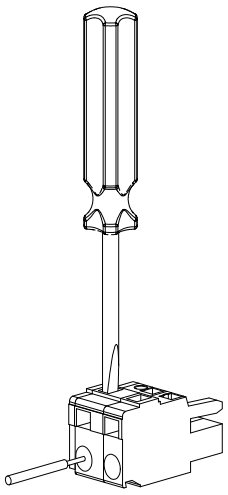
- Wire insertion method
  Wire holes can be opened on the connector by using the following two ways:
  (1) Opening a wire hole by hooking the operation lever (231-131) on the connector



Opening method (1)

Manufacturer	Model
Wago Company of Japan, Ltd.	231-131

  (2) Opening a wire hole with a slotted screwdriver
  Insert a slotted screwdriver with a blade width of 3.5 mm or less (210-120J or equivalent) into the operation slot to open the spring.



Opening method (2)

Manufacturer	Model
Wago Company of Japan, Ltd.	210-120J

1-8 Wiring for external I/O

Connect the signal lines from the higher-level control device to the external I/O connector. The following connector is provided, so wire and connect it according to the specifications described below.

* Wire size: AWG24 to AWG30 (0.2 to 0.05sq.)

Manufacturer	Model (connector plug)	Model (shell)
Sumitomo 3M Limited	10126-3000PE	10326-52F0-008

1-8-1 List of external I/O pins

Pin number	Signal name	Type	Signal description
1	COMIN	Input	Common terminal for input signals
2	COMIN	Input	Common terminal for input signals
3	COMOUT	Input	Common terminal for output signals
4	COMOUT	Input	Common terminal for output signals
5	IN 0	Input	Start (continuous signal)
6	IN 1	Input	Channel number selection 1
7	IN 2	Input	Channel number selection 2
8	IN 3	Input	Channel number selection 4
9	IN 4	Input	Channel number selection 8
10	IN 5	Input	Channel number selection 16
11	IN 6	Input	Sync fastening start/Continuation start
12	IN 7	Input	External sensor signal
13	IN 8	Input	Not used
14	IN 9	Input	Not used
15	IN 10	Input	Not used
16	IN 11	Input	Not used
17	OUT 0	Output	Ready to receive start
18	OUT 1	Output	OK completion (torque judgment OK)
19	OUT 2	Output	NG completion (torque judgment NG, discontinuation, timeout)
20	OUT 3	Output	System alarm
21	OUT 4	Output	Screw height judgment OK
22	OUT 5	Output	Ready to receive sync fastening start, channel operation completed
23	OUT 6	Output	Final fastening angle judgment OK
24	OUT 7	Output	Torque waveform processing result OK
25	OUT 8	Output	Torque waveform processing finished
26	OUT 9	Output	Not used

1-8-2 Explanation of external I/O pins

Pin number	Signal name	Type	Signal description
1, 2	COMIN	Input	Common terminal for input signals: Connect 24 VDC signal lines when using I/O devices with SINK (NPN) specifications. Connect 0 VDC signal lines when using I/O devices with SOURCE (PNP) specifications.
3, 4	COMOUT	Input	Common terminal for output signals: Connect 0 VDC signal lines when using I/O devices with SINK (NPN) specifications. Connect 24 VDC signal lines when using I/O devices with SOURCE (PNP) specifications.
5	IN 0	Input	Start (continuous signal): This signal starts a fastening operation. The operation continues while the signal is on. Continue inputting the signal until the operation is completed (OUT1or OUT2 turns on).

<table>
<tr><th>Pin number</th><th>Signal name</th><th>Type</th><th>Signal description</th></tr>
<tr><td>6, 7, 8,
9, 10</td><td>IN1 to IN5</td><td>Input</td><td>Channel number selection 1, 2, 4, 8, 16:
Each signal is used to select one of all the 32 channels (0 to 31) that can be registered for the controller.

○:ON ×:OFF
<table>
<tr><th></th><th>Selection 1 (IN1)</th><th>Selection 2 (IN2)</th><th>Selection 4 (IN3)</th><th>Selection 8 (IN4)</th><th>Selection 16 (IN5)</th></tr>
<tr><td>CH0</td><td>×</td><td>×</td><td>×</td><td>×</td><td>×</td></tr>
<tr><td>CH1</td><td>○</td><td>×</td><td>×</td><td>×</td><td>×</td></tr>
<tr><td>CH2</td><td>×</td><td>○</td><td>×</td><td>×</td><td>×</td></tr>
<tr><td>CH3</td><td>○</td><td>○</td><td>×</td><td>×</td><td>×</td></tr>
<tr><td>CH4</td><td>×</td><td>×</td><td>○</td><td>×</td><td>×</td></tr>
<tr><td>CH5</td><td>○</td><td>×</td><td>○</td><td>×</td><td>×</td></tr>
<tr><td>CH6</td><td>×</td><td>○</td><td>○</td><td>×</td><td>×</td></tr>
<tr><td>CH7</td><td>○</td><td>○</td><td>○</td><td>×</td><td>×</td></tr>
<tr><td>CH8</td><td>×</td><td>×</td><td>×</td><td>○</td><td>×</td></tr>
<tr><td>CH9</td><td>○</td><td>×</td><td>×</td><td>○</td><td>×</td></tr>
<tr><td>CH10</td><td>×</td><td>○</td><td>×</td><td>○</td><td>×</td></tr>
<tr><td>CH11</td><td>○</td><td>○</td><td>×</td><td>○</td><td>×</td></tr>
<tr><td>CH12</td><td>×</td><td>×</td><td>○</td><td>○</td><td>×</td></tr>
<tr><td>CH13</td><td>○</td><td>×</td><td>○</td><td>○</td><td>×</td></tr>
<tr><td>CH14</td><td>×</td><td>○</td><td>○</td><td>○</td><td>×</td></tr>
<tr><td>CH15</td><td>○</td><td>○</td><td>○</td><td>○</td><td>×</td></tr>
<tr><td>CH16</td><td>×</td><td>×</td><td>×</td><td>×</td><td>○</td></tr>
<tr><td>CH17</td><td>○</td><td>×</td><td>×</td><td>×</td><td>○</td></tr>
<tr><td>CH18</td><td>×</td><td>○</td><td>×</td><td>×</td><td>○</td></tr>
<tr><td>CH19</td><td>○</td><td>○</td><td>×</td><td>×</td><td>○</td></tr>
<tr><td>CH20</td><td>×</td><td>×</td><td>○</td><td>×</td><td>○</td></tr>
<tr><td>CH21</td><td>○</td><td>×</td><td>○</td><td>×</td><td>○</td></tr>
<tr><td>CH22</td><td>×</td><td>○</td><td>○</td><td>×</td><td>○</td></tr>
<tr><td>CH23</td><td>○</td><td>○</td><td>○</td><td>×</td><td>○</td></tr>
<tr><td>CH24</td><td>×</td><td>×</td><td>×</td><td>○</td><td>○</td></tr>
<tr><td>CH25</td><td>○</td><td>×</td><td>×</td><td>○</td><td>○</td></tr>
<tr><td>CH26</td><td>×</td><td>○</td><td>×</td><td>○</td><td>○</td></tr>
<tr><td>CH27</td><td>○</td><td>○</td><td>×</td><td>○</td><td>○</td></tr>
<tr><td>CH28</td><td>×</td><td>×</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>CH29</td><td>○</td><td>×</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>CH30</td><td>×</td><td>○</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>CH31</td><td>○</td><td>○</td><td>○</td><td>○</td><td>○</td></tr>
</table>
</td></tr>
</table>

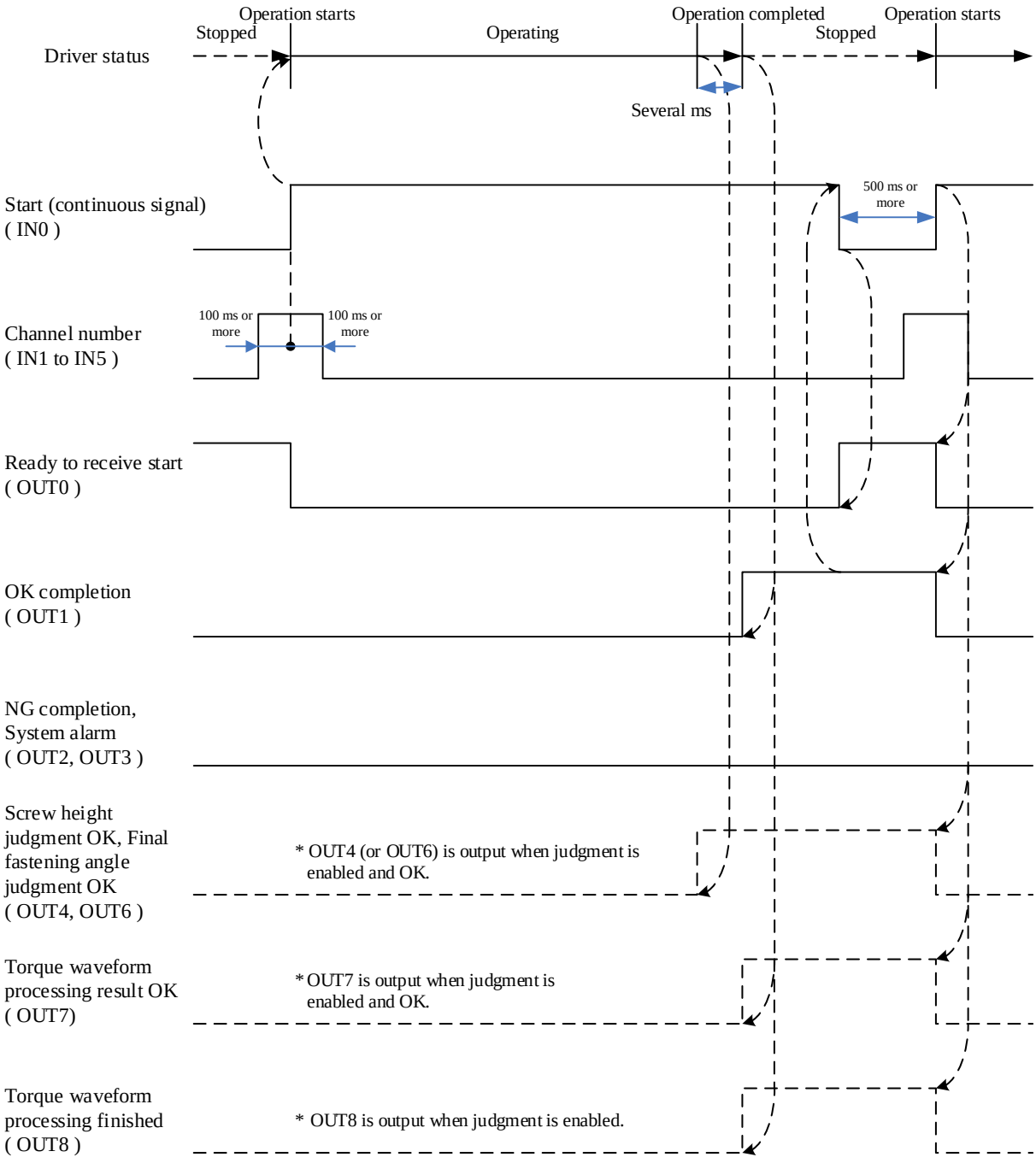
Pin number	Signal name	Type	Signal description
11	IN 6	Input	Sync fastening start/Continuation start This signal is used when “Synchronous fastening operation”[Note] or “Channel connection”[Note] is enabled. The signal triggers starting each operation. [Note]: Refer to 3-2-2, 3-2-3, and 4-1.
12	IN 7	Input	External sensor signal: This signal is used as an operation switching trigger for “Tapping process”[Note]. This signal is used as a start trigger of rotational angle detection for “Screw height judgment”[Note]. [Note]: Refer to 3-2-2, 3-2-3, and 4-1.
13, 14, 15, 16	IN8 to IN11	Input	Not used
17	OUT0	Output	Ready to receive start: This signal is output when the conditions for starting fastening operations are met. After this signal is output, input IN0 (Start (continuous signal)). Note: This signal is continuously output until next IN0 (Start (continuous signal)) is input.
18	OUT1	Output	OK completion (torque judgment OK): This signal is output when a series of fastening operation processes is completed normally. However, because only torque judgment is monitored, this signal is output even if screw height judgment or final fastening angle judgment is NG. Note: This signal is continuously output until next IN0 (Start (continuous signal)) is input.
19	OUT2	Output	NG completion (torque judgment NG, discontinuation, timeout): This signal is output when a series of fastening operation processes is not completed normally (such as when torque judgment is NG, IN0 (Start (continuous signal)) turns off before operation is completed, operation is not completed within the preset cycle time, or the settings are faulty). However, this signal is output even if the screw height judgment, final fastening angle judgment, or torque waveform processing result is OK. Note: This signal is continuously output until next IN0 (Start (continuous signal)) is input.

Pin number	Signal name	Type	Signal description
20	OUT3	Output	System alarm: This signal is output when a controller system error[Note] occurs, and output continues until the power is turned off. After the power is turned off, make sure that the display on the screen disappears before the power is turned on again. [Note]: Refer to 6-2.
21	OUT 4	Output	Screw height judgment OK: This signal is output if the screw height judgment result is within the acceptable judgment range when a series of fastening operation processes is completed. However, this signal is output only if criteria are set in memory sheets. Note: This signal is continuously output until next IN0 (Start (continuous signal)) is input.
22	OUT 5	Output	Ready to receive sync fastening start, channel operation completed: This signal is output when "Synchronous fastening operation",[Note] or "Channel connection"[Note] is enabled. [Note]: Refer to 3-2-2, 3-2-3, and 4-1.
23	OUT 6	Output	Final fastening angle judgment OK: This signal is output if the final fastening angle result is within the acceptable judgment range when a series of fastening operation processes is completed. However, this signal is output only if criteria are set in memory sheets. Note: This signal is continuously output until next IN0 (Start (continuous signal)) is input.
24	OUT 7	Output	Torque waveform processing result OK: This signal is output if the waveform processing function is enabled and the waveform judgment result is normal when a series of fastening operation processes is completed. If OUT7 is off, it indicates that the waveform processing result is NG only when OUT8 ("Torque waveform processing finished") is on. If OUT8 ("Torque waveform processing finished") is off, the waveform processing result is judged NG due to discontinuation or timeout. Note: This signal is continuously output until next IN0 (Start (continuous signal)) is input.
25	OUT 8	Output	Torque waveform processing finished: This signal is output when the waveform processing function is enabled and the waveform processing function determines judgment results. Note: This signal is continuously output until next IN0 (Start (continuous signal)) is input.
26	OUT 9	Output	Not used

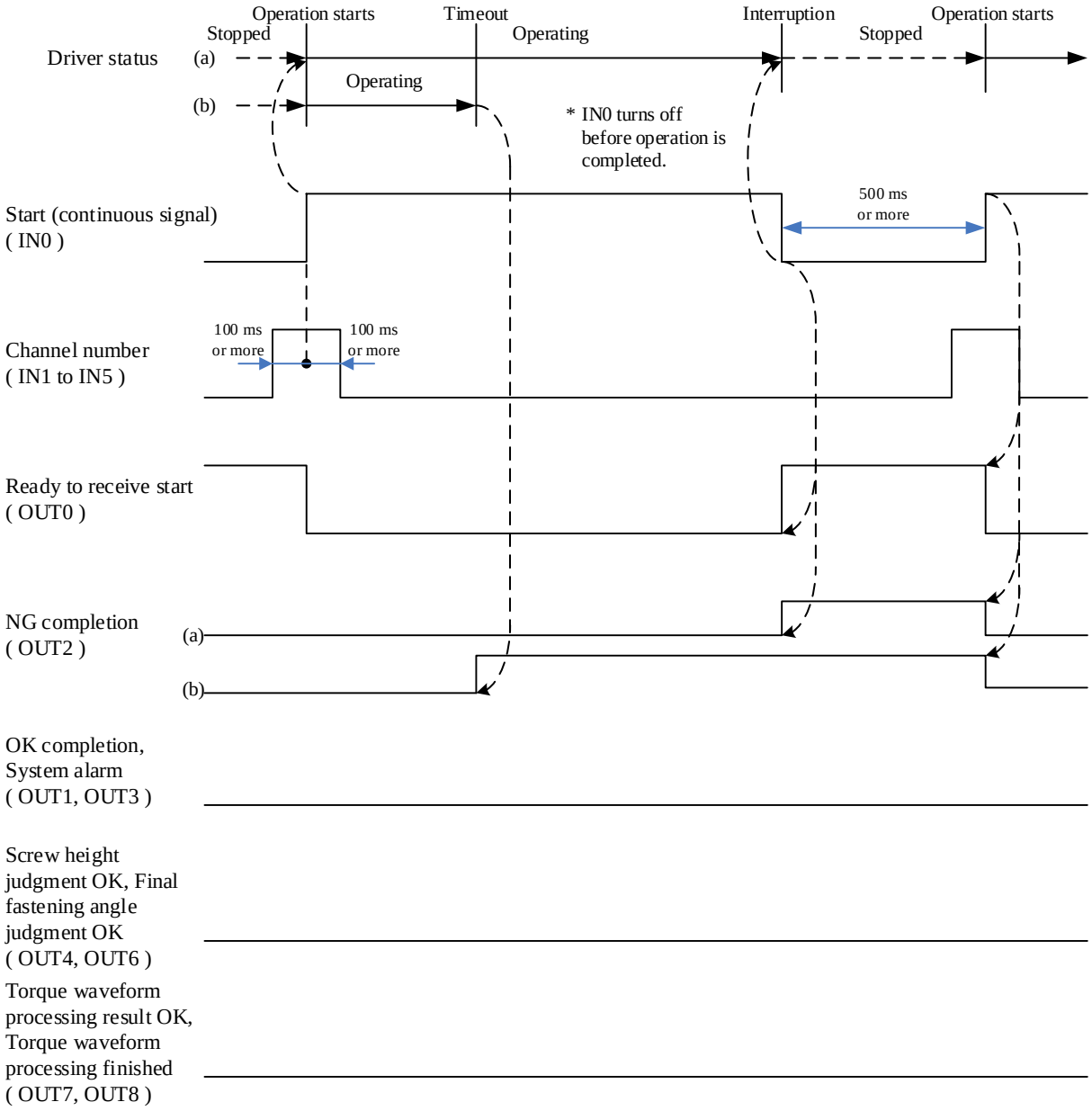
1-8-3 Timing charts for external I/O

The timing charts for external I/O are as shown in Figures (1) to (5) below.

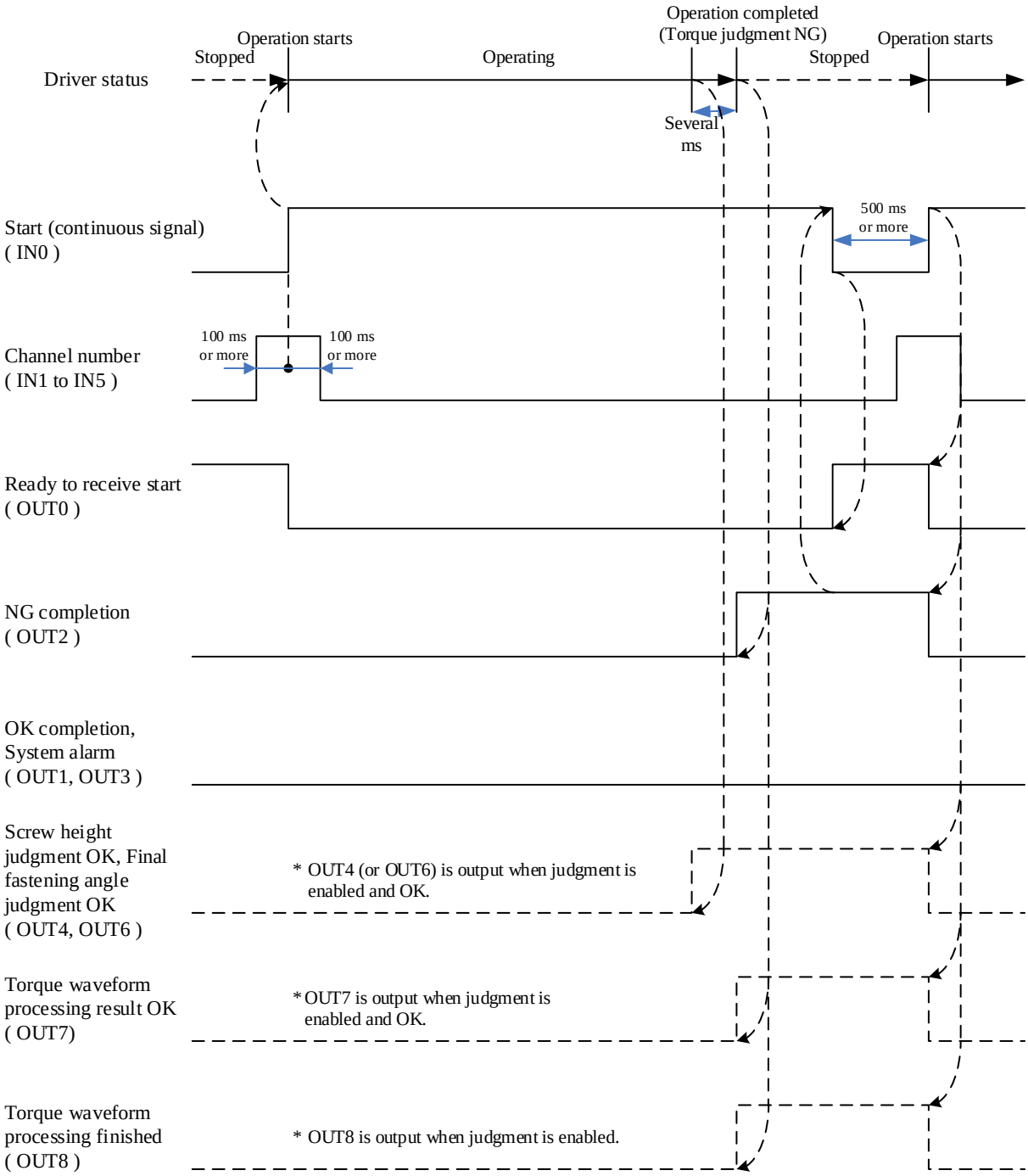
(1) When fastening is completed normally



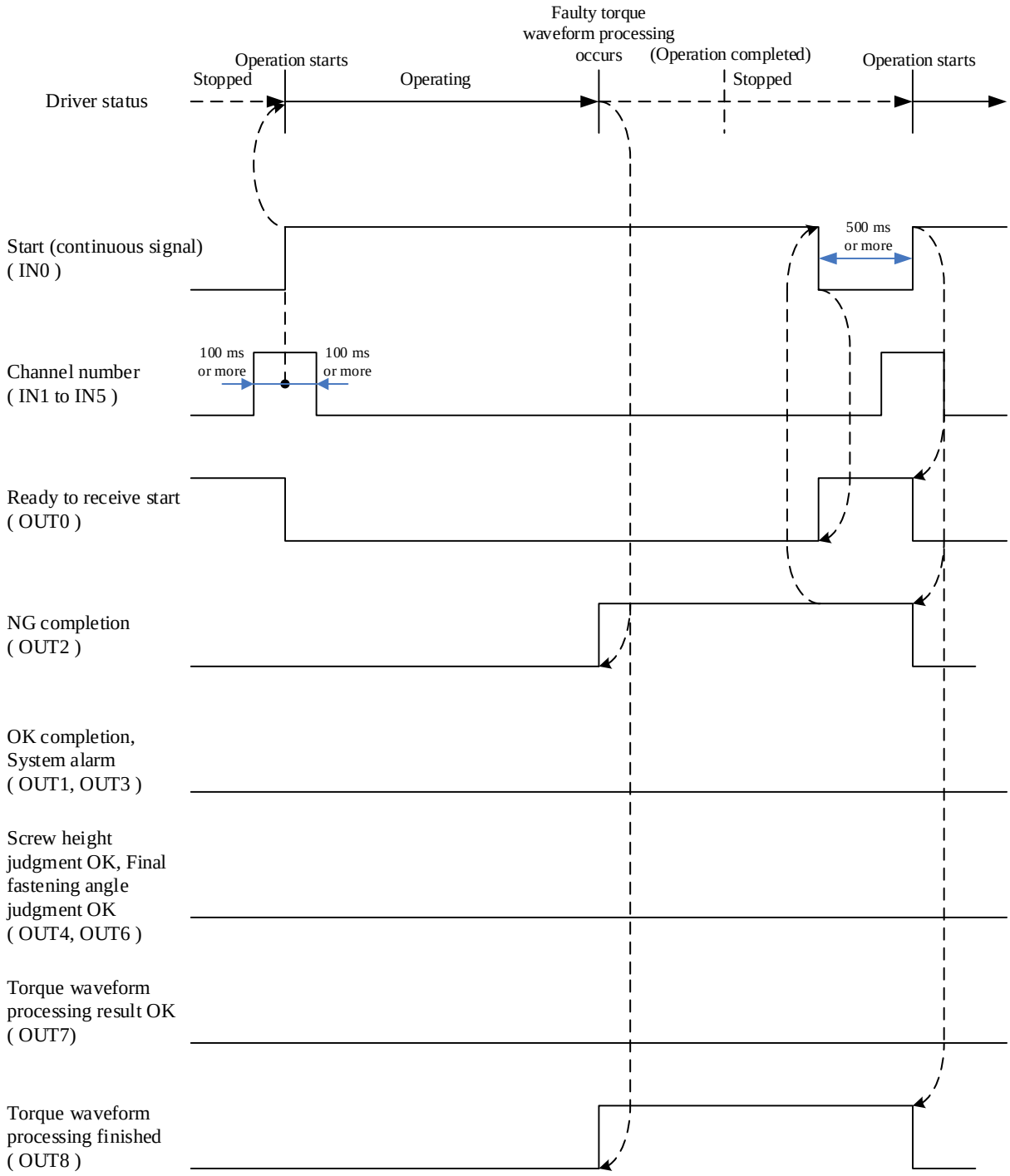
(2) When operation is stopped due to interruption or timeout



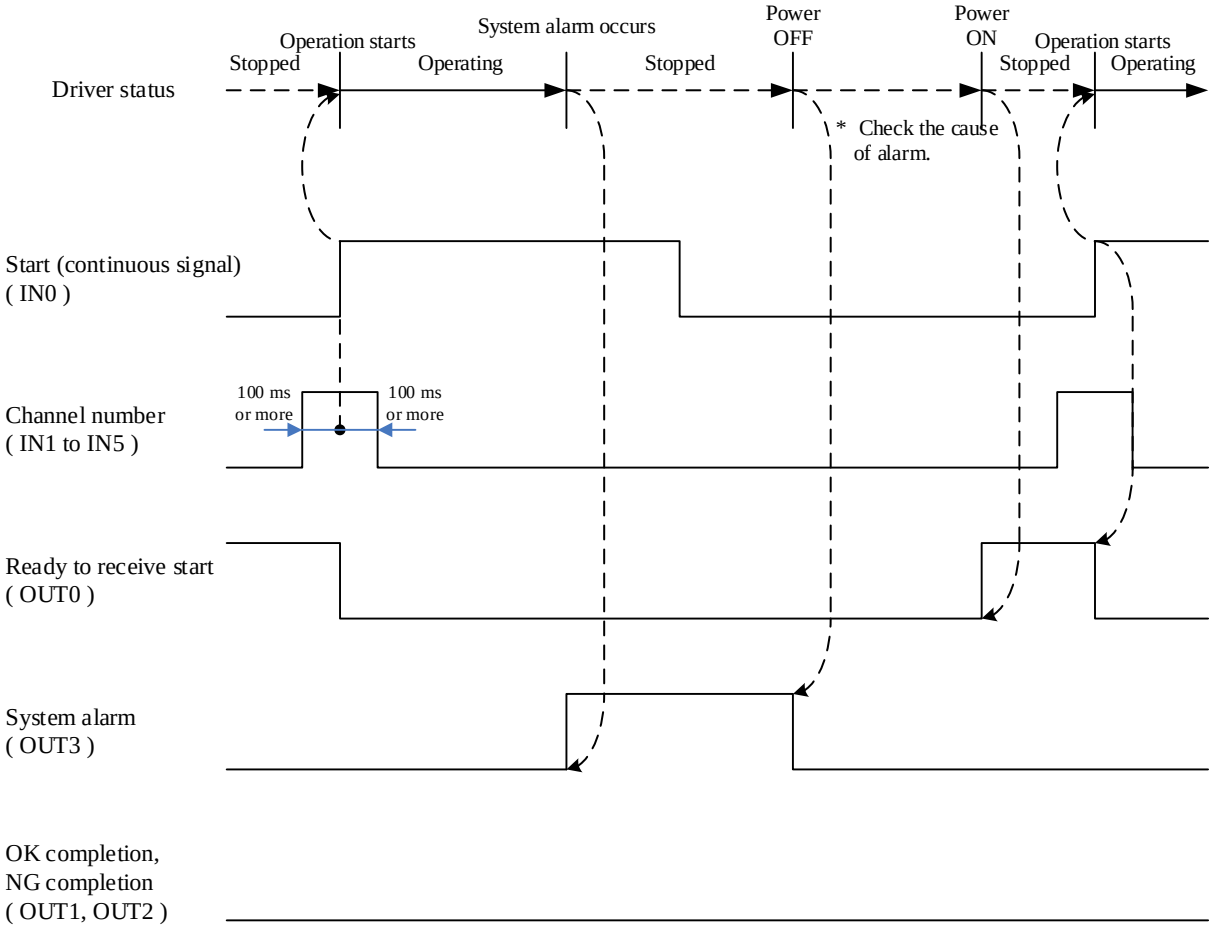
(3) When torque judgment is NG upon completion of fastening



(4) When torque waveform processing result is NG



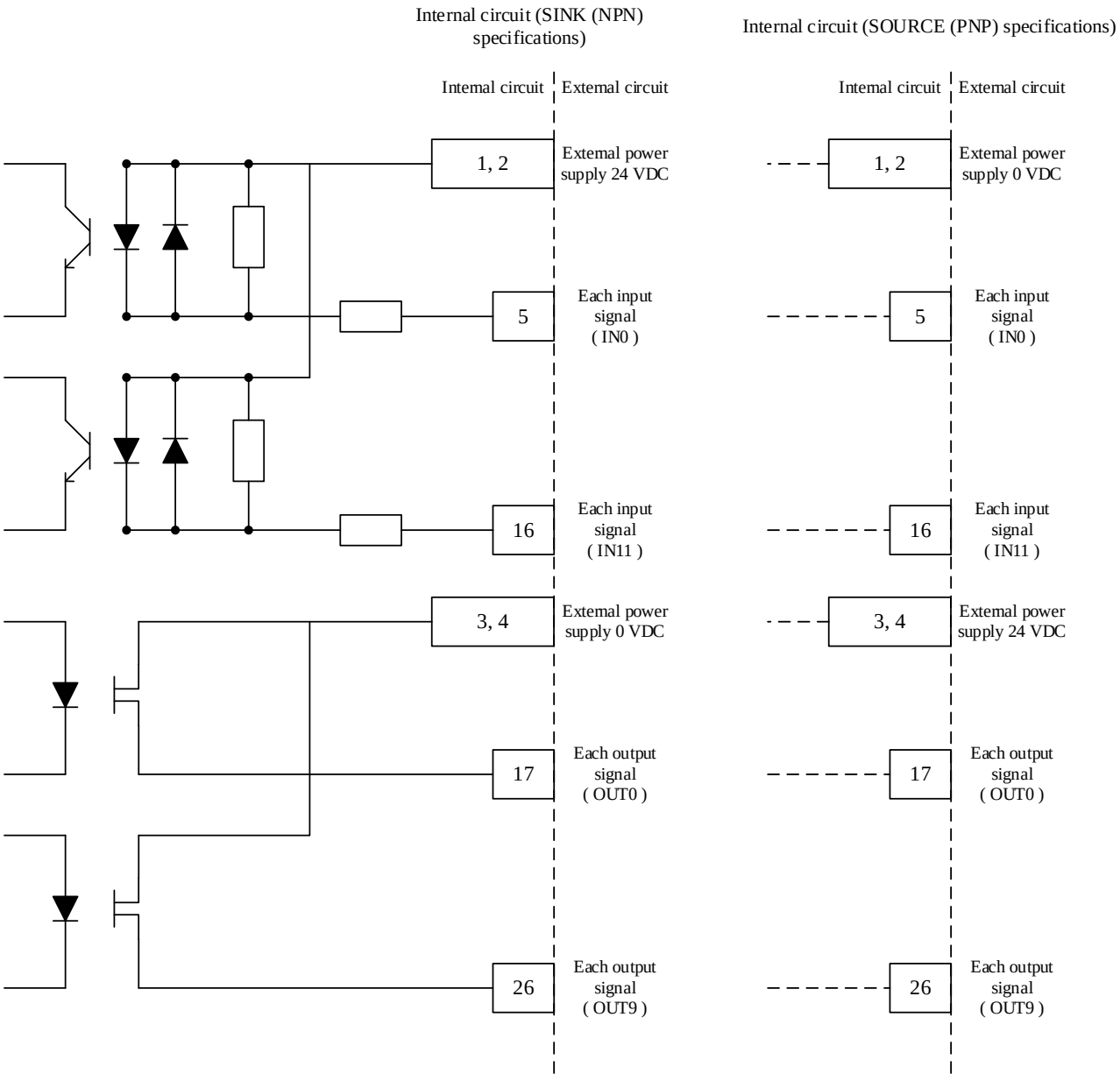
(5) When system alarm occurs



1-8-4 Electrical specifications of external I/O

(1) Input: Photocoupler insulation
Input current 10 mA, 24 VDC

(2) Output: PhotoMOS output
Maximum output current 50 mA, 24 VDC (resistive load)



1-8-5 Display monitor for external I/O

In monitor mode (refer to 2-2), I/O signal states of I/O ports appear on the 7-segment display. When multiple input (or output) signals turn on simultaneously, they are displayed as combinations of displays corresponding to each signal.

Monitor value for checking input status: "-0595"
Monitor value for checking output status: "-0596"

Input (-0595)	**Output (-0596)**	**Display**
(All input signals OFF)	(All output signals OFF)	00000
IN0	OUT0	00000.
IN1	OUT1	0000.0
IN2	OUT2	000.00
IN3	OUT3	00.000
IN4	OUT4	0.0000
IN5	OUT5	00001
IN6	OUT6	00010
IN7	OUT7	00100
IN8	OUT8	01000
IN9	OUT9	10000
IN10		00002
When both IN5 and IN10 are on		00003
IN11		00020
When both IN6 and IN11 are on		00030
	(All output signals ON)	1.1.1.1.1.
(All input signals ON)		1.1.133.

2. Displays and operation keys

2-1 Operation key function

The following table shows the function of each key.

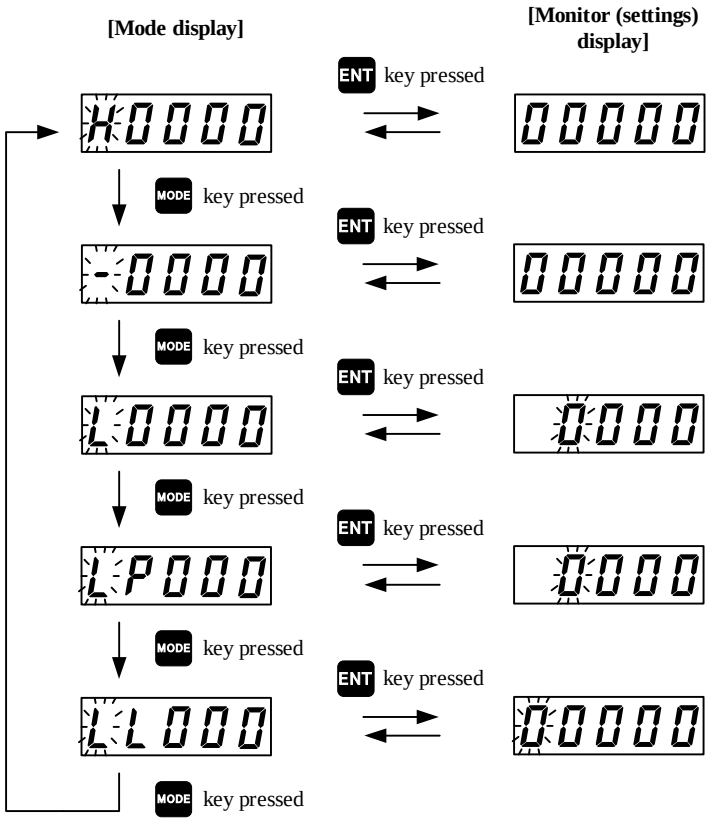
Key	Name	Function
	Left arrow key	・Moves the blinking digit to the left
	Right arrow key	・Moves the blinking digit to the right
	Up arrow key	・Changes the numeric value at the blinking digit as below (0 → 1 → 2 → … → 9 → 0)
	Down arrow key	・Changes the numeric value at the blinking digit as below (0 → 9 → 8 → … → 1 → 0)
	Mode key	・Switches the mode display
	Enter key	・Switches between mode display and monitor (or settings) display

2-2 Various displays

2-2-1 List of displays

Display	Description
	Trace mode: This mode is used to display the channel number and process number that are currently being executed. (Refer to 2-2-2 and 6-1.)
	Monitor mode: This mode displays various monitored values for the controller. (Refer to 2-2-3.)
	Memory mode: This mode is used to change memory sheet settings. (Refer to 2-2-4 and 3-3.)
	Parameter mode: This mode is used to change parameter settings. (Refer to 2-2-5 and 3-8.)
	Reset mode: This mode is used to reset the operating status. (Refer to 2-2-6 and 5-2.)
	Alarm: This indicates that a system error has occurred on the controller. (Refer to 6.-2.)

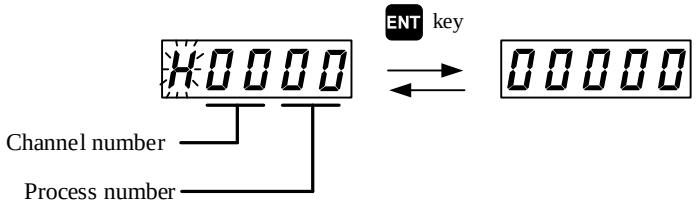
- Switching the mode display



2-2-2 Trace mode

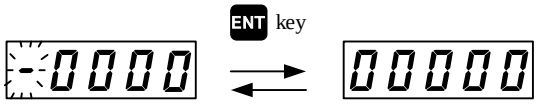
In trace mode, a channel number is displayed in the third and fourth digits from the right, and a fastening operation process number is displayed in the first and second digits from the right.
This mode can be used to check in which process the operation stopped when fastening was judged NG for some reason. For process details, refer to 4-1 and 6-1.
Moreover, pressing the Enter key enables the user to check the program code of the last operation (controller internal processing).

* Program codes are not disclosed to customers, but we may ask them to check the program code when they send us an inquiry.



2-2-3 Monitor mode

In monitor mode, various controller statuses can be checked. Use the up arrow key or down arrow key to enter the monitor number for the data to be monitored. Moreover, pressing the Enter key enables the user to check various monitor values.

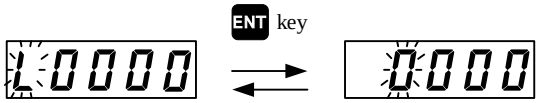


Monitor number	Description
-0054	Last four digits of the number of fastening times (in one time increments)
-0055	First four digits of the number of fastening times (in increments of 10,000 times)
-0155	Torque judgment value Note: The units differ depending on the tool unit.
-0158	Final fastening angle judgment value (in units of 1 degree)
-0159	Screw height judgment value (in units of 10 degrees)
-0220	Current sensor 1 value
-0221	Current sensor 2-value

Monitor number	Description
-0222	Torque sensor value
-0230	Motor encoder value
-0240	Motor overload rate (current)
-0241	Motor overload rate (voltage)
-0595	Input signal status
-0596	Output signal status
-0910	NG factor of waveform processing function

2-2-4 Memory mode

Memory mode is used to change the settings for fastening operations. Different address numbers (L****) are assigned to each cell in the memory sheet. Check the desired address number and use the up arrow key or down arrow key to enter the address number of the cell to be changed. Pressing the Enter key enables the user to check the settings of the address number. Refer to 3-3 for details on how to change values. Note that fastening operation cannot be started while in memory mode.

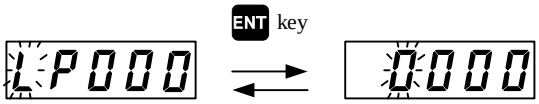


2-2-5 Parameter mode

* Parameters are factory-adjusted, and changing parameter values by mistake affects operations.

The user may need to check parameter values during maintenance. Use the up arrow key or down arrow key to enter the parameter number to be checked. Pressing the Enter key enables the user to check the parameter value. Refer to 3-8 for details on how to change values.

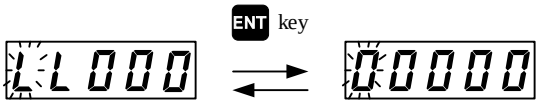
Note that fastening operation cannot be started while in parameter mode.



2-2-6 Reset mode

Reset mode is used to reset the operating status (the number of fastening times). Refer to 5-2 for details on how to reset the operating status.

Note that fastening operation cannot be started while in reset mode.



3. Memory sheet parameters

3-1 Memory sheet structure

The memory sheet is an area that stores the settings for each operation process. Multiple models can be set up by storing different settings for 32 channels (channels 0 to 31). Different address numbers (L****) are assigned to each setting item for each channel, so that settings can be changed by accessing these address numbers.
Memory sheets are divided into memory sheet (0) to memory sheet (4). Memory sheet (0) contains common settings for all channels, while memory sheets (1) to (4) contain rotational speed, output torque, and other operation settings for each channel.

3-1-1 Structure of memory sheet (0) (containing common settings for all channels)

Memory sheet (0)

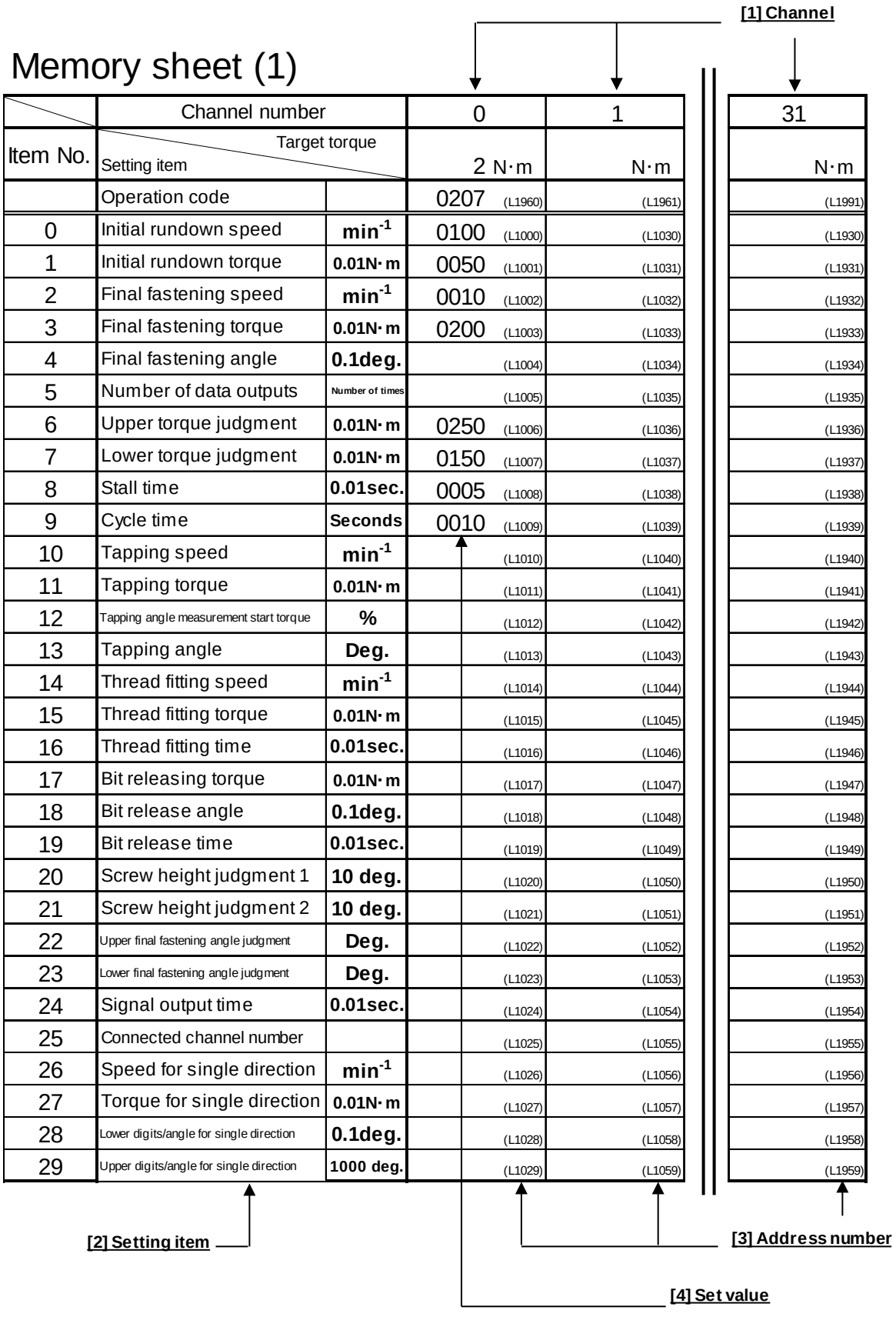
Item No.	Setting item		
0	Channel number to specify operation		(L0960)
1	Rotational speed for checking initial revolution	**min^{-1}**	0100 (L0961)
2	Torque value for checking initial revolution	**0.01N·m**	0050 (L0962)
3			(L0963)
4			(L0964)
5			(L0965)
6			(L0966)
7			(L0967)
8			(L0968)
9			(L0969)

[2] Setting item

[4] Set value

[3] Address number

3-1-2 Structure of memory sheets (1) to (4)



Memory sheet (1)

Item No.	Channel number / Setting item		0	1	31
	Target torque		2 N·m	N·m	N·m
	Operation code		0207 (L1960)	(L1961)	(L1991)
0	Initial rundown speed	min^{-1}	0100 (L1000)	(L1030)	(L1930)
1	Initial rundown torque	0.01N·m	0050 (L1001)	(L1031)	(L1931)
2	Final fastening speed	min^{-1}	0010 (L1002)	(L1032)	(L1932)
3	Final fastening torque	0.01N·m	0200 (L1003)	(L1033)	(L1933)
4	Final fastening angle	0.1deg.	(L1004)	(L1034)	(L1934)
5	Number of data outputs	Number of times	(L1005)	(L1035)	(L1935)
6	Upper torque judgment	0.01N·m	0250 (L1006)	(L1036)	(L1936)
7	Lower torque judgment	0.01N·m	0150 (L1007)	(L1037)	(L1937)
8	Stall time	0.01sec.	0005 (L1008)	(L1038)	(L1938)
9	Cycle time	Seconds	0010 (L1009)	(L1039)	(L1939)
10	Tapping speed	min^{-1}	(L1010)	(L1040)	(L1940)
11	Tapping torque	0.01N·m	(L1011)	(L1041)	(L1941)
12	Tapping angle measurement start torque	%	(L1012)	(L1042)	(L1942)
13	Tapping angle	Deg.	(L1013)	(L1043)	(L1943)
14	Thread fitting speed	min^{-1}	(L1014)	(L1044)	(L1944)
15	Thread fitting torque	0.01N·m	(L1015)	(L1045)	(L1945)
16	Thread fitting time	0.01sec.	(L1016)	(L1046)	(L1946)
17	Bit releasing torque	0.01N·m	(L1017)	(L1047)	(L1947)
18	Bit release angle	0.1deg.	(L1018)	(L1048)	(L1948)
19	Bit release time	0.01sec.	(L1019)	(L1049)	(L1949)
20	Screw height judgment 1	10 deg.	(L1020)	(L1050)	(L1950)
21	Screw height judgment 2	10 deg.	(L1021)	(L1051)	(L1951)
22	Upper final fastening angle judgment	Deg.	(L1022)	(L1052)	(L1952)
23	Lower final fastening angle judgment	Deg.	(L1023)	(L1053)	(L1953)
24	Signal output time	0.01sec.	(L1024)	(L1054)	(L1954)
25	Connected channel number		(L1025)	(L1055)	(L1955)
26	Speed for single direction	min^{-1}	(L1026)	(L1056)	(L1956)
27	Torque for single direction	0.01N·m	(L1027)	(L1057)	(L1957)
28	Lower digits/angle for single direction	0.1deg.	(L1028)	(L1058)	(L1958)
29	Upper digits/angle for single direction	1000 deg.	(L1029)	(L1059)	(L1959)

3. Memory sheet parameters

[1] Channel: A desired channel can be selected from among 32 channels (channels 0 to 31) by using signals IN1 to IN5 for external I/O.
[2] Setting item: Rotational speed, torque value, angle, time, and other items for each operation process.
[3] Address number: Different address numbers are assigned to each setting item for each channel.
[4] Set value: The value specified for each setting item.

	Address number	
	Operation code	**Item Nos. 0 to 29**
0ch	L1960	L1000 to L1029
1ch	L1961	L1030 to L1059
2ch	L1962	L1060 to L1089
3ch	L1963	L1090 to L1119
4ch	L1964	L1120 to L1149
5ch	L1965	L1150 to L1179
6ch	L1966	L1180 to L1209
7ch	L1967	L1210 to L1239
8ch	L1968	L1240 to L1269
9ch	L1969	L1270 to L1299
10ch	L1970	L1300 to L1329
11ch	L1971	L1330 to L1359
12ch	L1972	L1360 to L1389
13ch	L1973	L1390 to L1419
14ch	L1974	L1420 to L1449
15ch	L1975	L1450 to L1479
16ch	L1976	L1480 to L1509
17ch	L1977	L1510 to L1539
18ch	L1978	L1540 to L1569
19ch	L1979	L1570 to L1599
20ch	L1980	L1600 to L1629
21ch	L1981	L1630 to L1659
22ch	L1982	L1660 to L1689
23ch	L1983	L1690 to L1719
24ch	L1984	L1720 to L1749
25ch	L1985	L1750 to L1779
26ch	L1986	L1780 to L1809
27ch	L1987	L1810 to L1839
28ch	L1988	L1840 to L1869
29ch	L1989	L1870 to L1899
30ch	L1990	L1900 to L1929
31ch	L1991	L1930 to L1959

3-2 Explanation of memory sheet setting items

3-2-1 Setting items for memory sheet (0)

	Address No.
Channel number to specify operation	L0960
Rotational speed for checking initial revolution	L0961
Torque value for checking initial revolution	L0962

(1) Channel number to specify operation (Address No: L0960)
This setting item is used to check operations for all channels (1 to 31) regardless of channel signals for external I/O. If a value from “0001” to “0031” is specified, the specified channel operation is performed when the start signal is turned “ON”. Normally, set this item to “0000”.

(2) Rotational speed for checking initial revolution (address number: L0961)
This item specifies the rotational speed of the tool unit output shaft during the initial revolution check process (or immediately after the Start signal turns on) in order to check whether the tool unit output shaft revolves (or check the tool unit for damage). Note that the initial revolution check function can be disabled by specifying a particular operation code.
Normally, set this item to a value that is not greater than the value of “Initial rundown speed”.

(3) Torque value for checking initial revolution (address number: L0962)
This item specifies the output torque value of the tool unit output shaft during the initial revolution check process (or immediately after the Start signal turns on) in order to check whether the tool unit output shaft revolves (or check the tool unit for damage). Note that the initial revolution check function can be disabled by specifying a particular operation code.
Normally, set this item to a value that is not greater than the value of “Initial rundown torque”.

3-2-2 Operation code

(1) Operation code (address number: L1960 to L1991)
This code is a four-digit number that specifies tool unit operations. The controller reads the setting items corresponding to the specified operation code to control tool unit operations.
The following page shows the numbers that can be set in each digit, as well as the meaning of each number. (For the setting items corresponding to each operation code, refer to “List of setting items by operation code” in Chapter 8.)

• Final fastening operation/User program number

When the value specified for “Fastening method 1” is 0, 1, 2, 3, or 4
0: Torque control method (Without controlled fastening and channel connection operation)
1: Angle control method (Without connection operation)
2: Torque control method (With controlled fastening and channel connection operation)
3: Not used
4: Angle control method (With channel connection operation)
5: Torque/angle control method (Without channel connection operation)
6: Torque/angle control method (With channel connection operation)
7: Torque control method (Without measured fastening and channel connection operation)
8: Torque control method (With measured fastening and channel connection operation)

When the value specified for “Fastening method 1” is 5
0-9: Executable program number

• Additional operation

0: No additional operation
1: Synchronous fastening operation
2: Sensor input operation
3: Sensor input operation + Synchronous fastening operation
4: Torque waveform processing
5: Torque waveform processing + Synchronous fastening operation
6: Torque waveform processing + Sensor input operation
7: Torque waveform processing + Sensor input operation + Synchronous fastening operation

* The values that can be specified for “Additional operation” differ according to the value specified for “Fastening method 1”.

• Fastening method 2

0: Initial revolution check process + Two-step fastening
1: Initial revolution check process + Tapping process + Two-step fastening
2: Two-step fastening
3: Not used
4: Not used
5: Not used
6: Tapping process + Two-step fastening

* “Fastening method 2” is valid when the value specified for “Fastening method 1” is 0, 1, or 2.

• Fastening method 1

0: Two-step fastening
1: Bit fitting process + Two-step fastening + Bit release process
2: Two-step fastening + Bit release process
3: Free revolution operation in forward direction
4: Free revolution operation in reverse direction
5: User program

- Fastening method 1 (the fourth digit from the right)

Specified number	Description	Main applicable screws
0	Two-step fastening is performed.	Machine screws
1	After a bit fitting process, two-step fastening is performed and then followed by bit release process.	Nuts
2	Two-step fastening is performed and then followed by bit release process.	Bolts
3	Only forward rotation operation is performed.	
4	Only reverse rotation operation is performed.	
5	User program operation is performed.	

* “Two-step fastening” is an operation that performs both the initial rundown process and the final fastening process.

- Fastening method 2 (the third digit from the right)

Specified number	Description	Main applicable screw fastening
0	Before two-step fastening, an initial revolution check process is performed.	Normal fastening of screws
1	After the initial revolution check process, a tapping process is performed and then followed by two-step fastening.	Fastening of self-tapping screws, etc.
2	Before two-step fastening, the initial revolution check process is not performed.	Re-fastening of screws, etc.
3	Not used	
4	Not used	
5	Not used	
6	The tapping process is performed and then followed by two-step fastening.	Fastening of self-tapping screws, etc.

* The tapping process is effective only when a screw penetrates through the workpiece.

- Additional operation (the second digit from the right)

Specified number	Name	Description
0	No additional operation	The following additional operations are not performed.
1	Synchronous fastening operation	After the initial rundown process is finished, the controller temporarily stops operation, waits for signal input (IN6), and proceeds to the final fastening process.
2	Sensor input operation	Signal input (IN7) terminates the tapping process and free revolution in the forward direction (or the reverse direction).
3	Sensor input operation + Synchronous fastening operation	When the tapping process is performed, both “Synchronous fastening operation” and “Sensor input operation” are enabled.
4	Torque waveform processing	Torque waveform processing is performed.
5	Torque waveform processing + Synchronous fastening operation	Both “Torque waveform processing” and “Synchronous fastening operation” are enabled.
6	Torque waveform processing + Sensor input operation	Both “Torque waveform processing” and “Sensor input operation” are enabled.
7	Torque waveform processing + Sensor input operation + Synchronous fastening operation	When the tapping process is performed, “Torque waveform processing”, “Sensor input operation”, and “Synchronous fastening operation” are enabled.

- Final fastening operation/User program number (the first digit from the right)

Specified number	Name	Description
0	Torque control method[Note 1] (Without controlled fastening and channel connection operation)	Operation stops if the torque value reaches a preset value.
1	Angle control method (Without channel connection operation)	If the rotation angle with reference to that at the completion of initial rundown process reaches a preset value, operation stops.
2	Torque control method[Note 1] (With controlled fastening and channel connection operation)	If the torque value reaches a preset value, operation temporarily stops and the operation shown in Fig.- A (refer to 4-1-1) is performed.
3	Not used	
4	Angle control method (With channel connection operation)	If the rotation angle with reference to that at the completion of the initial rundown process reaches a preset value, operation stops temporarily and the operation shown in Fig.- A (refer to 4-1-1) is performed.
5	Torque/angle control method (Without channel connection operation)	If the torque value or the rotation speed with reference to that at the completion of initial rundown reaches a preset value, operation stops.
6	Torque/angle control method (With channel connection operation)	If the torque value or rotation angle with reference to that at the completion of the initial rundown process reaches a preset value, operation stops temporarily and the operation shown in Fig.- A (refer to 4-1-1) is performed.
7	Torque control method[Note 2] (Without measured fastening and channel connection operation)	Operation stops if the torque value reaches a preset value.
8	Torque control method[Note 2] (With measured fastening and channel connection operation)	If the torque value reaches a preset value, operation temporarily stops and the operation shown in Fig.- A (refer to 4-1-1) is performed.

If “Fastening method 1” is set to 5, the last digit of the operation code indicates the number of the user program to be executed and operations are performed according to the program number.

[Note 1] Controlled fastening: A fastening method that uses torque control based on torque feedback. Torque is controlled, and fastening is performed until the target torque is maintained for the time specified for item No. 8 (“Stall time”).

[Note 2] Measured fastening: A fastening method that does not use torque feedback. Fastening torque is measured, and fastening is performed until the target torque is reached. If item No. 8 (“Stall time”) is specified, constant torque will be maintained for the specified time after the target torque is reached.

3-2-3 Setting items for memory sheets (1) to (4)

* [Note 1]: The unit of each torque value below differs depending on the tool unit used.

No.	Description	Example of corresponding operation code
0	**Initial rundown speed: Units: [min^{-1}]** This item specifies the rotational speed of the tool unit output shaft in the initial rundown process. Normally, this item specifies the rotational speed that is used until a screw is seated (or while it is being screwed in). (Specify a value that considers an impact torque such as the one imposed when a screw is seated.)	0*** 1*** 2***
1	**Initial rundown torque: Units: [0.001N・m], [0.01N・m], [0.1N・m]** ***[Note 1]** This item specifies the torque value to be used during the initial rundown process. After the specified torque is measured, the controller proceeds to the next process. Normally, this item is set to a torque value at which a screw is judged as being seated. (Specify a value that considers an impact torque such as the one imposed when a screw is seated.)	0*** 1*** 2***
2	**Final fastening speed: Units: [min^{-1}]** This item specifies the rotational speed of the tool unit output shaft in the final fastening process. Normally, this item specifies the rotational speed to be used from when a screw is seated until fastening is completed. (We recommend that this item be set to 10 to 50 min^{-1} because low-speed revolutions enable stable torque fastening.)	0*** 1*** 2***
3	**Final fastening torque: Units: [0.001N・m], [0.01N・m], [0.1N・m]** ***[Note 1]** This item specifies the torque value to be used during the final fastening process. If the final fastening operation for the operation code is based on the torque control method, the controller proceeds to the next process after fastening is performed at the specified torque value. Normally, this item is set as the target torque for fastening.	0*** 1*** 2***
4	**Final fastening angle: Units: [0.1 degrees]** This item specifies the rotational angle of the tool unit output shaft in the final fastening process. If the final fastening operation for the operation code is based on the angle control method, the controller proceeds to the next process after the output shaft revolves through the specified angle. Normally, this item specifies the rotational angle to be used from when a screw is seated until fastening is completed.	0**1 0**5 1**1 1**5 2**1 2**5
5	**Number of data outputs: Units: [Number of times]** This item is set when data such as torque data is sent from a serial port to an external device. It specifies the number of data transmissions to be output at one time. The maximum number of data transmissions that can be set is 5. If "1 0 * *" is specified by adding 1 to the highest-order digit of the set value, the string is sent when screw fastening starts. Refer to 9.-1.	All
6	**Upper torque judgment: Units: [0.001N・m], [0.01N・m], [0.1N・m]** ***[Note 1]** This item specifies the upper limit value for torque judgment. If the torque upon completion of fastening is greater than this upper limit value, OUT2 of external I/O is output and the fastening is judged NG.	All
7	**Lower torque judgment: Units: [0.001N・m], [0.01N・m], [0.1N・m]** ***[Note 1]** This item specifies the lower limit value for torque judgment. If the torque upon completion of fastening is smaller than this lower limit value, OUT2 of external I/O is output and the fastening is judged NG.	All

3. Memory sheet parameters

No.	Description	Example of corresponding operation code
8	**Stall time: Units: [0.01 seconds]** This item specifies the time during which the output shaft torque for the tool unit should be maintained after the torque has reached the target torque (final fastening torque value) during the final fastening process. Note that "Stall time" is invalid if "Angle control method" is specified for the final fastening operation for the operation code and "Free revolution operation in forward direction" or "Free revolution operation in reverse direction" is specified for "Fastening method 1" in the operation code. (Specifying a too large value may damage the tool unit or controller or shorten their service life. We recommend that this item be set to 0.00 to 0.30 seconds.)	0**0 0**7 1**0 1**7 2**0 2**7
9	**Cycle time: Units: [Seconds]** This item specifies the cycle time for each process of screw fastening. If the specified value is exceeded, OUT2 of external I/O is output as timeout and fastening is judged NG.	All
10	**Tapping speed: Units: [min^{-1}]** This item specifies the rotational speed of the tool unit output shaft in the tapping process. Normally, this item specifies the rotational speed that is used when a screw such as a self-tapping screw taps its own hole.	01** 11** 21**
11	**Tapping torque Units: [0.001N・m], [0.01N・m], [0.1N・m]** ***[Note 1]** This item specifies the torque value to be used during the tapping process. Normally, this item specifies the torque value that is used when a screw such as a self-tapping screw taps its own hole. If this item is set to a torque value that is smaller than the torque required for tapping, the tool unit output shaft may fail to revolve, causing a timeout to occur, resulting in the fastening being judged NG.	01** 11** 21**
12	**Tapping angle measurement start torque: Units: [%]** After measuring a torque value that matches the percentage specified in this item to the tapping torque value specified in item No. 11 that is assumed as 100%, the controller begins to measure the angle specified in item No. 13 ("Tapping angle"). ([1] Start tapping operation → [2] Measure the torque value specified in "Tapping angle measurement start torque" [%] → [3] Rotate the output shaft by the angle specified in "Tapping angle") → Finish tapping operation and proceed to the next process)	010* 110* 210*
13	**Tapping angle Units: [Degrees]** This item specifies the angle through which the tool unit output shaft revolves after the torque value specified in item No. 12 ("Tapping angle measurement start torque") is measured. After the output shaft revolves through the specified angle, the controller proceeds to the next process. ---------- [If "Sensor input operation" is specified for "Additional operation" in the operation code] This item specifies the angle through which the tool unit output shaft revolves after IN7 of external I/O turns on. After the output shaft revolves through the specified angle, the controller proceeds to the next process.	010* 110* 210* ---------- 012* 112* 212*
14	**Thread fitting speed: Units: [min^{-1}]** This item specifies the rotational speed of the tool unit output shaft during the bit fitting process. Normally, this item is set to the rotational speed that is used when the bit is fitted onto a nut, etc. Note that the tool unit output shaft revolves in the reverse direction.	1***
15	**Thread fitting torque: Units: [0.001N・m], [0.01N・m], [0.1N・m]** ***[Note 1]** This item specifies the torque value to be used during the bit fitting process. Normally, this item is set to the torque value that is used when the bit is fitted onto a nut, etc.	1***

No.	Description	Example of corresponding operation code
16	**Thread fitting time: Units: [0.01 seconds]** This item specifies the time during which the tool unit output shaft revolves during the bit fitting process. After the specified time elapses, the controller proceeds to the next process.	1***
17	**Bit releasing torgue: Units: [0.001N・m], [0.01N・m], [0.1N・m]** ***[Note 1]** This item specifies the torque value to be used during the bit release process. After the fastening of a screw (or another object) is completed, the output shaft is reversed to release the bit seized by the screw (or another object). After the specified torque is measured, the controller proceeds to the next process. Note: To prevent the nut (or another object) from being loosened by specifying a too large torque value, this item is controlled so that the upper limit of torque is half the final fastening torque value.	1*** 2***
18	**Bit release angle: Units: [0.1 degrees]** This item specifies the rotational angle of the tool unit output shaft in the bit release process. After the fastening of a screw (or another object) is completed, the output shaft is reversed to release the bit seized by the screw (or another object). After the output shaft revolves through the specified angle, the controller proceeds to the next process.	1*** 2***
19	**Bit release time: Units: [0.01 seconds]** This item specifies the time during which the tool unit output shaft revolves during the bit release process. After the fastening of a screw (or another object) is completed, the output shaft is reversed to release the bit seized by the screw (or another object). After the specified time elapses, the controller proceeds to the next process.	1*** 2***
20	**Screw height judgment 1: Units: [10 degrees]** This item is set when sensors or other devices of external equipment are used to determine whether a screw is seated properly when fastening is completed. Connect a sensor or another device of external equipment to IN7 of external I/O. After operation starts, angle measurement starts when IN7 turns on. This item specifies the lower limit value that is judged as the rotational angle of the tool unit output shaft. Therefore, note that setting this item to 0000 causes the rotational angle to be judged OK even if the sensor signal does not turn on. Specifying monitor number "-0159" enables the screw height judgment value to be monitored in units of 10 degrees.	0*** 1*** 2***
21	**Screw height judgment 2: Units: [10 degrees]** This item is set when sensors or other devices of external equipment are used to determine whether a screw is seated properly when fastening is completed. Connect a sensor or another device of external equipment to IN7 of external I/O. After operation starts, angle measurement starts when IN7 turns on. This item specifies the upper limit value that is judged as the rotational angle of the tool unit output shaft. Therefore, note that setting this item to 0000 disables the judgment. Specifying monitor number "-0159" enables the screw height judgment value to be monitored in units of 10 degrees.	0*** 1*** 2***
22	**Upper final fastening angle judgment: Units: [Degrees]** This item specifies the upper limit value that is judged as the rotational angle of the tool unit output shaft during the final fastening process. Setting this item to 0000 disables the judgment. Specifying monitor number "-0158" enables the final fastening angle judgment value to be monitored in units of one degree.	0*** 1*** 2***
23	**Lower final fastening angle judgment: Units: [Degrees]** This item specifies the lower limit value that is judged as the rotational angle of the tool unit output shaft during the final fastening process. Specifying monitor number "-0158" enables the final fastening angle judgment value to be monitored in units of one degree.	0*** 1*** 2***

No.	Description	Example of corresponding operation code
24	**Signal output time: Units: [0.01 seconds]** This item is set when channel connection operations (for operating more than one channel in succession) are performed. It specifies the time during which a channel operation completion signal (OUT5) is output to external devices after one channel finishes operation. Refer to 4.-1.	***2 ***4 ***6 ***8
25	**Connected channel number: Units: [ ]** This item is set when channel connection operations (for operating more than one channel in succession) are performed. Specifying any value between 1000 (channel 0) and 1031 (channel 31) operates the channel corresponding to the specified number in succession. Refer to 4.-1.	***2 ***4 ***6 ***8
26	**Speed for single direction: Units: [min^{-1}]** This item specifies the rotational speed of the tool unit output shaft for free revolution operations in the forward or reverse direction. Normally, this item is set when free revolution operations are performed in only the forward or reverse direction. This item is valid only when "Free revolution operation in forward direction" or "Free revolution operation in reverse direction" is specified for "Fastening method 1" in the operation code.	3*** 4***
27	**Torque for single direction: Units: [0.001N・m], [0.01N・m], [0.1N・m]** ***[Note 1]** This item specifies the torque value to be used for free revolution operations in the forward or reverse direction. Normally, this item is set when free revolution operations are performed in only the forward or reverse direction. This item is valid only when "Free revolution operation in forward direction" or "Free revolution operation in reverse direction" is specified for "Fastening method 1" in the operation code. If the final fastening operation for the operation code is based on the torque control method, the controller proceeds to the next process after the specified torque value is measured.	3*** 4***
28	**Lower digits/angle for single direction: Units: [0.1 degrees]** This item specifies the rotational angle for free revolution operations in the forward or reverse direction. Normally, this item is set when free revolution operations are performed in only the forward or reverse direction. This item is valid only when "Free revolution operation in forward direction" or "Free revolution operation in reverse direction" is specified for "Fastening method 1" in the operation code. If the final fastening operation for the operation code is based on the angle control method, the controller proceeds to the next process after the output shaft revolves through the specified angle. The rotational angle is specified in combination with "Upper digits/angle for single direction" below.	3**1 4**1
29	**Upper digits/angle for single direction: Units: [1000 degrees]** This item specifies the rotational angle for free revolution operations in the forward or reverse direction. Normally, this item is set when free revolution operations are performed in only the forward or reverse direction. This item is valid only when "Free revolution operation in forward direction" or "Free revolution operation in reverse direction" is specified for "Fastening method 1" in the operation code. If the final fastening operation for the operation code is based on the angle control method, the controller proceeds to the next process after the output shaft revolves through the specified angle. The rotational angle is specified in combination with ""lower digits/angle for single direction"" above. Example: If 1234 is specified for item No. 29 and 5678 is specified for item number 28, the rotational angle is 1234567.8°.	3**1 4**1

3-3 Editing the memory sheet

The following procedure allows the user to edit the memory sheet by operating the keys on the controller.

*** Before starting the procedure, make sure that the operation is stopped.**

(Display on the controller)

[1] Press the ENT key once to switch the monitor (or settings) display to the mode display.

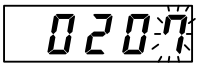
[2] Press the MODE key several times to switch to “L0000” (memory mode).

[3] Press the → key to move the blinking digit to the digit to be set, and then press the ↑ key or ↓ key to change to the address number of the cell where the set value is to be changed.

Change these four digits

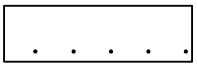
[4] Pressing the ENT key displays the set value of the current address number.

[5] Press the → key to move the blinking digit to the digit to be set, and then press the ↑ key or ↓ key to change to a desired value.

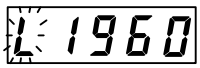


[6] When the value has been changed, press the ENT key once to switch to the mode display. Check that the blinking digit is located at the highest-order digit “L”.

[7] Save the changed value to the controller.
Keep pressing the ← key until all the digits change to dots (.).
(Releasing the key returns the display to the original state.)



[8] This completes the procedure for editing one cell. To edit another cell, repeat steps [1] through to [7].



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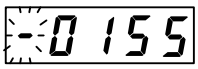
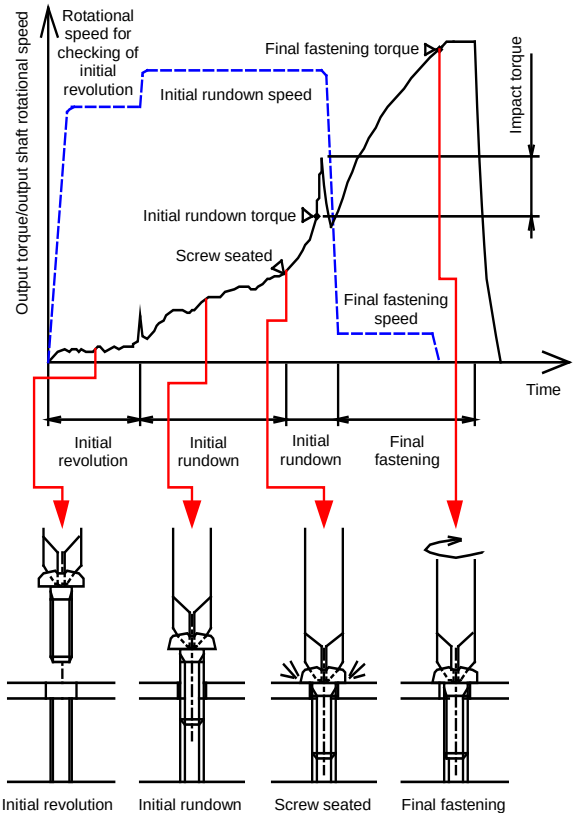
[9] When you have finished editing cells, press the MODE key several times to switch to trace mode (“H”) or monitor mode (“-”).
While in memory mode (“L”), fastening operations cannot be performed.
The example on the right side shows that the mode has been switched to monitor mode and the monitor number has been changed to “-0155” (the monitor number of torque judgment value).



[10] Then, press the ENT key to display the monitor value.

3-4 Example of editing the memory sheet

This section describes how to set channel 0 to two-step fastening operations to be performed with a target torque value of 2.5 N-m (fastening torque range: 2 to 3 N-m) by using an NX050T3 tool unit.
“Two-step fastening” means a screw fastening method consisting of two processes of “initialrundown” and “final fastening”, which is a basic method of screw fastening conducted by SD600T.
The values of fastening torque in this screw fastening method are plotted against the time, and the resulting temporal response graph is shown in the diagram below.



The impact torque increases as the rotational speed and torque of the output shaft increase. This means that selecting an unnecessarily high rotational speed causes the torque during the initial rundown process to exceed the final fastening torque due to impact torque, preventing fastening operations from being performed correctly. To ensure that impact (initial rundown) torque is smaller than final fastening torque, determine the values for “Initial rundown speed” and “Initial rundown torque” by referring to the graphs of the relationship between the rotational speed of the output shaft and impact torque in the NX-T3 Series (SD600T) NX Driver Tool Unit Instruction Manual, provided separately.

As a procedure, first, determine the value of “Final fastening torque” according to the fastening torque range for the target value, and then determine the values for “Initial rundown torque” and “Initial rundown speed” by referring to the graphs mentioned above.

Specifically, use the following procedure to enter values (when setting to channel 0).

(1) Set the cell of address number “L1960” to “0007” (value of operation code).
(2) Set the cell of address number “L0961” to “0300” (value of “Rotational speed for checking initial revolution”).
(3) Set the cell of address number “L0962” to “0500” (value of “Torque value for checking initial revolution”).
(4) Set the cell of address number “L1000” to “0300” (value of “Initial rundown speed”).
(Determine the value for “Initial rundown speed” by referring to the graphs of the relationship between the rotational speed of the output shaft and impact torque in the NX-T3 Series (SD600T) NX Driver Tool Unit Instruction Manual, provided separately.)
(5) Set the cell of address number “L1001” to “1000” (value of “Initial rundown torque”).
(The value should be set to the necessary lowest one in order to suppress the impact torque.)
(6) Set the cell of address number “L1002” to “0010” (value of “Final fastening speed”).
(For “Final fastening speed”, set a value between 5 and 10 [min^{-1}] for torque-measured fastening and set a value between 30 and 50 [min^{-1}] for torque-controlled fastening.)
(7) Set the cell of address number “L1003” to “2500” (value of “Final fastening torque”).
(Set the value of final fastening torque to the target fastening torque.)
(8) Set the cell of address number “L1006” to “3000” (value of “Upper torque judgement”).
(Decide the upper torque judgement from the target fastening torque range.)
(9) Set the cell of address number “L1007” to “2000” (value of “Lower torque judgement “).
(Decide the lower torque judgement from the target fastening torque range.)
(10) Set the cell of address number “L1008” to “0005” (value of “Stall time”).
(Please set up default configuration of stall time value for Torque- measured fastening as 50[ms] and for Torque- controlled fastening as 300[ms].)
(11) Set the cell of address number “L1009” to “0010” (value of “Cycle time”).
(Setting 0000 for “Cycle time” disables the detection of operations exceeding the cycle time.)

3-5 Explanation of parameters

Parameters specify settings that indicate the entire system configuration (such as tool unit characteristics) of the controller. Settings differ among individual units or system configurations. Each parameter is factory-set to appropriate values, but they may need to be changed during tool unit replacement, servicing, or maintenance.
If the settings of parameters for system administration or parameters with fixed specific values are changed unintentionally, malfunctions could result or the accuracy of various operations could degrade. To avoid such problems, handle parameters with due care.
* There is no function for initializing parameters to their factory settings.

3-6 List of parameters

* The initial values of parameters may be changed without notice for performance improvement, and the values presented in this document may differ from the values stored in the controller before shipping.

• Pa000–Pa039

Parameter number	Description	Initial value	
Pa000	* For system administration	0	
Pa001	* For system administration	1155	
Pa002	* For system administration	5	
Pa003	* For system administration	10	
Pa004	* For system administration	0	
Pa005	* For system administration	1	
Pa006	* For system administration	5	
Pa007	* For system administration	10	
Pa008	* For system administration	60	
Pa009	* For system administration	200	
Pa010	* For system administration	500	
Pa011	* For system administration	500	
Pa012	* For system administration	500	
Pa013	* For system administration	500	
Pa014	* For system administration	1000	
Pa015	* For system administration	33	
Pa016	* For system administration	300	
Pa017	* For system administration	8000	
Pa018	* For system administration	Specific value	* Different for each tool unit type
Pa019	* For system administration	Specific value	* Different for each tool unit type
Pa020	* For system administration	20	
Pa021	* For system administration	10	
Pa022	* For system administration	595	
Pa023	* For system administration	110	
Pa024	* For system administration	1	
Pa025	* For system administration	64	
Pa026	* For system administration	30	
Pa027	* For system administration	0	
Pa028	* For system administration	0	
Pa029	* For system administration	0	
Pa030	Speed proportional gain 1	Specific value	* Different for each tool unit type
Pa031	Speed integral gain 1	Specific value	* Different for each tool unit type
Pa032	* For system administration	0	
Pa033	* For system administration	0	
Pa034	* For system administration	0	
Pa035	Torque proportional gain 1	Specific value	* Different for each tool unit type
Pa036	Torque integral gain 1	Specific value	* Different for each tool unit type
Pa037	* For system administration	0	
Pa038	* For system administration	0	
Pa039	* For system administration	0	

• Pa040–Pa079

Parameter number	Description	Initial value	
Pa040	Current proportional gain 1	Specific value	* Different for each tool unit type
Pa041	Current integral gain 1	Specific value	* Different for each tool unit type
Pa042	* For system administration	0	
Pa043	* For system administration	0	
Pa044	* For system administration	0	
Pa045	* For system administration	Specific value	* Different for each tool unit type
Pa046	* For system administration	Specific value	* Different for each tool unit type
Pa047	* For system administration	0	
Pa048	* For system administration	0	
Pa049	* For system administration	0	
Pa050	* For system administration	Specific value	* Different for each tool unit type
Pa051	* For system administration	Specific value	* Different for each tool unit type
Pa052	* For system administration	0	
Pa053	* For system administration	0	
Pa054	* For system administration	0	
Pa055	* For system administration	Specific value	* Different for each tool unit type
Pa056	* For system administration	Specific value	* Different for each tool unit type
Pa057	* For system administration	0	
Pa058	* For system administration	0	
Pa059	* For system administration	0	
Pa060	* For system administration	Specific value	* Different for each tool unit type
Pa061	* For system administration	Specific value	* Different for each tool unit type
Pa062	* For system administration	1	
Pa063	* For system administration	3600	
Pa064	* For system administration	0	
Pa065	* For system administration	0	
Pa066	* For system administration	0	
Pa067	Torque rate value	Specific value	* Different for each tool unit type
Pa068	Current rate value	Specific value	* Different for each tool unit type
Pa069	* For system administration	100	
Pa070	Serial port communication settings	8	
Pa071	* For system administration	1	
Pa072	* For system administration	0	
Pa073	* For system administration	0	
Pa074	* For system administration	0	
Pa075	* For system administration	0	
Pa076	* For system administration	0	
Pa077	* For system administration	0	
Pa078	* For system administration	0	
Pa079	* For system administration	0	

• Pa080–Pa119

Parameter number	Description	Initial value	
Pa080	Communication ID	0	
Pa081	Serial port communication settings	3	
Pa082	Termination code	13	
Pa083	Serial port timeout	0	
Pa084	* For system administration	3	
Pa085	* For system administration	0	
Pa086	* For system administration	0	
Pa087	* For system administration	0	
Pa088	* For system administration	0	
Pa089	* For system administration	0	
Pa090	Buzzer setting 1 (for OK)	0	
Pa091	Buzzer setting 2 (for OK)	0	
Pa092	Buzzer setting 1 (for NG)	0	
Pa093	Buzzer setting 2 (for NG)	0	
Pa094	* For system administration	0	
Pa095	* For system administration	2000	
Pa096	* For system administration	0	
Pa097	* For system administration	2	
Pa098	* For system administration	0	
Pa099	Key serial settings change lock	0	
Pa100	* For system administration	2	
Pa101	* For system administration	0	
Pa102	* For system administration	0	
Pa103	* For system administration	0	
Pa104	* For system administration	1	
Pa105	* For system administration	0	
Pa106	* For system administration	Specific value	* Different for each tool unit type
Pa107	* For system administration	0	
Pa108	* For system administration	0	
Pa109	* For system administration	0	
Pa110	Calibrated value for current sensor 1	Specific value	* Value calibrated for each controller
Pa111	* For system administration	40	
Pa112	Calibrated value for current sensor 2	Specific value	* Value calibrated for each controller
Pa113	* For system administration	40	
Pa114	* For system administration	Specific value	* Different for each tool unit type
Pa115	* For system administration	0	
Pa116	* For system administration	3600	
Pa117	Direction of motor rotation	0	
Pa118	* For system administration	1	
Pa119	* For system administration	1003	

• Pa120–Pa159

Parameter number	Description	Initial value	
Pa120	* For system administration	Specific value	* Different for each tool unit type
Pa121	* For system administration	Specific value	* Different for each tool unit type
Pa122	* For system administration	Specific value	* Different for each tool unit type
Pa123	* For system administration	Specific value	* Different for each tool unit type
Pa124	* For system administration	Specific value	* Different for each tool unit type
Pa125	* For system administration	Specific value	* Different for each tool unit type
Pa126	* For system administration	2000	
Pa127	* For system administration	8000	
Pa128	* For system administration	0	
Pa129	* For system administration	0	
Pa130	* For system administration	10	
Pa131	* For system administration	0	
Pa132	* For system administration	2	
Pa133	* For system administration	0	
Pa134	* For system administration	Specific value	* Different for each tool unit type
Pa135	Torque sensor sensitivity	Specific value	* Value calibrated for each controller
Pa136	Torque sensor calibrated value	Specific value	* Value calibrated for each controller
Pa137	* For system administration	80	
Pa138	* For system administration	1024	
Pa139	* For system administration	0	
Pa140	* For system administration	1024	
Pa141	* For system administration	0	
Pa142	* For system administration	0	
Pa143	* For system administration	0	
Pa144	* For system administration	0	
Pa145	* For system administration	0	
Pa146	* For system administration	10	
Pa147	* For system administration	0	
Pa148	* For system administration	21	
Pa149	* For system administration	22	
Pa150	* For system administration	32	
Pa151	* For system administration	2	
Pa152	* For system administration	0	
Pa153	* For system administration	0	
Pa154	* For system administration	0	
Pa155	* For system administration	0	
Pa156	* For system administration	0	
Pa157	* For system administration	0	
Pa158	* For system administration	0	
Pa159	* For system administration	0	

• Pa160–Pa199

Parameter number	Description	Initial value
Pa160	* For system administration	0
Pa161	* For system administration	0
Pa162	* For system administration	0
Pa163	* For system administration	0
Pa164	* For system administration	0
Pa165	* For system administration	0
Pa166	* For system administration	0
Pa167	* For system administration	0
Pa168	* For system administration	0
Pa169	* For system administration	0
Pa170	CAN ID	0
Pa171	CAN error detection settings	2007
Pa172	CAN communication settings	0
Pa173	* For system administration	660
Pa174	* For system administration	120
Pa175	* For system administration	20
Pa176	* For system administration	55
Pa177	* For system administration	0
Pa178	* For system administration	0
Pa179	* For system administration	0
Pa180	* For system administration	0
Pa181	* For system administration	0
Pa182	* For system administration	0
Pa183	* For system administration	0
Pa184	* For system administration	0
Pa185	* For system administration	0
Pa186	* For system administration	0
Pa187	* For system administration	0
Pa188	* For system administration	0
Pa189	* For system administration	0
Pa190	Data collection operation settings	0
Pa191	* For system administration	0
Pa192	* For system administration	0
Pa193	* For system administration	0
Pa194	* For system administration	0
Pa195	* For system administration	0
Pa196	* For system administration	0
Pa197	* For system administration	0
Pa198	* For system administration	0
Pa199	* For system administration	0

3-7 Different parameters for each tool unit type

The same controller models are used for the NX020T3 and NX050T3 tool units, so both tool units can be used by changing the parameter values. However, the controller models for use with the NX100T3 tool unit differ from the above controller models and so cannot be combined with the above tool units. Connecting incompatible models by mistake could damage the tool unit or controller, so take care not to make mistakes when replacing the tool unit.

	Tool unit type		
	NX020T3	**NX050T3**	**NX100T3**
Pa18	220	300	330
Pa19	2400	6000	1080
Pa30	500	1000	1000
Pa31	500	1000	1000
Pa35	800	1500	1500
Pa36	800	1500	1500
Pa40	700	400	300
Pa41	700	400	300
Pa45	500	1000	1000
Pa46	500	1000	1000
Pa50	800	1500	1500
Pa51	800	1500	1500
Pa55	700	400	300
Pa56	700	400	300
Pa60	78	78	78
Pa61	11	11	11
Pa67	6100	6100	7100
Pa68	100	100	100
Pa106	0	0	0
Pa114	3	3	5
Pa120	9	9	9
Pa121	5	5	5
Pa122	465	375	186
Pa123	124	157	136
Pa124	383	598	605
Pa125	843	1794	1997
Pa134	0	0	0

3-8 Editing the parameters

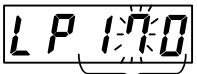
The following procedure allows the user to edit parameters by operating the keys on the controller. **Before editing a parameter, carefully check that the parameter number is correct. Before starting the procedure, make sure that the operation is stopped.**

(Display on the controller)

[1] Press the ENT key once to switch the monitor (or settings) display to the mode display.

[2] Press the MODE key several times to switch to “LP000” (parameter mode).

[3] Press the → key to move the blinking digit to the digit to be set, and then press the ↑ key or ↓ key to change to the parameter number to be edited.

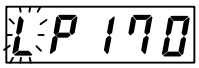


Change these three digits

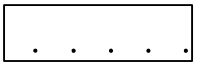
[4] Pressing the ENT key displays the value of the parameter.

[5] Press the → key to move the blinking digit to the digit to be set, and then press the ↑ key or ↓ key to change to a desired value.

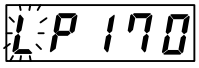
[6] When the value has been changed, press the ENT key once to switch to the mode display. Check that the blinking digit is located at the highest-order digit “L”.



[7] Save the changed value to the controller.
Keep pressing the ← key until all the digits change to dots (.).
(Releasing the key returns the display to the original state.)



[8] This completes the procedure for editing one parameter. To edit another parameter, repeat steps [1] through to [7].
When all changes have been completed, turn the power off temporarily, make sure that the display on the screen has disappeared, and then turn the power on again.

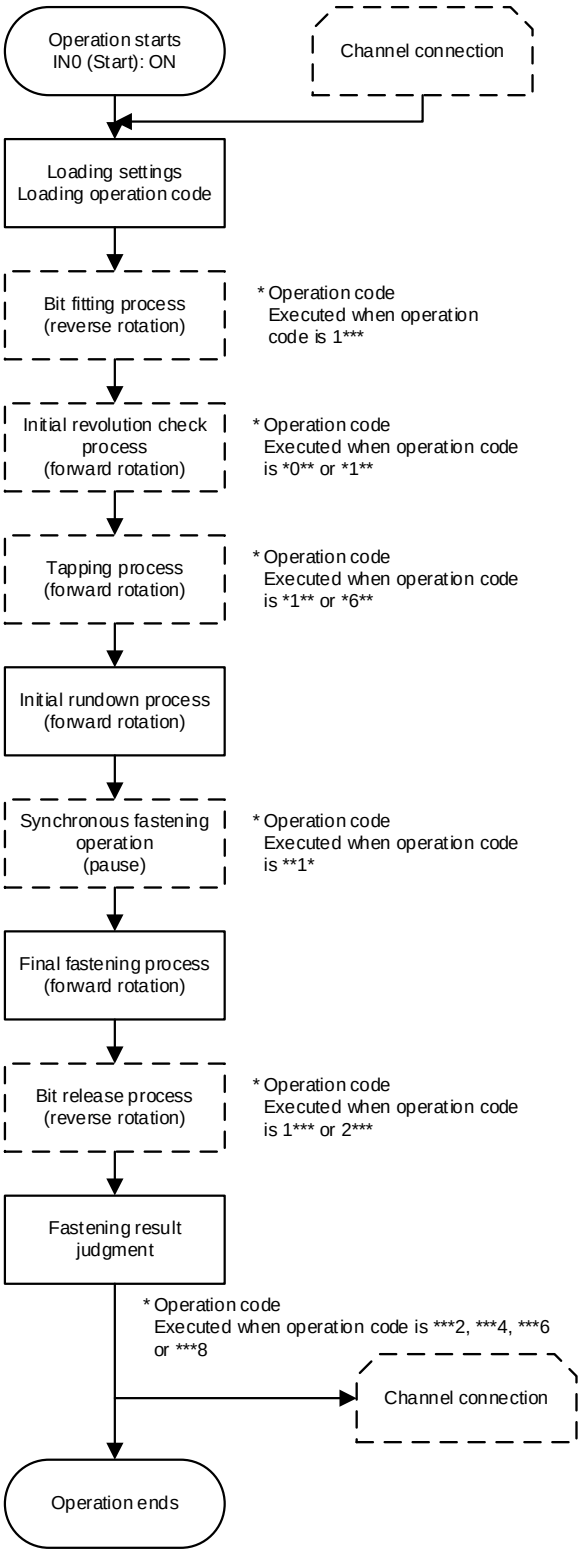


4. Fastening operation flow

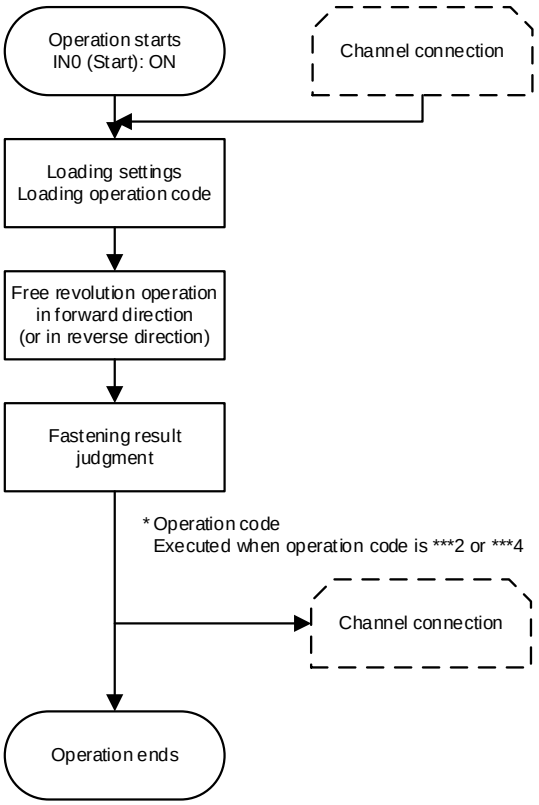
4-1 Operation flow based on operation code

The following figure shows the flow of fastening operations based on the standard specifications. Each process is operated according to the operation code.

• When the operation code is 0***, 1*** or 2***



• When the operation code is 3*** or 4***



4-1-1 Explanation of each process

* When the display is in trace mode (“H****”), the process number appears in the last two digits of the display.

- **Loading settings and operation codes (process number 0)**

This process loads the memory sheet settings and operation codes of the channel numbers specified by IN1 to IN5 for external I/O (“Channel number selection”). Then, if no value or an invalid value has been specified for any of the item numbers corresponding to the operation code, fastening will be judged NG (OUT2: ON) and the operation will stop.

- **Initial revolution check process (process number 1)**

This process is performed according to the values specified for “Rotational speed for checking initial revolution” and “Torque value for checking initial revolution” in memory sheet (0). When the rotational speed reaches the value specified for “Rotational speed for checking initial revolution”, the controller terminates this process and proceeds to the next process. Normally, this process is used to check whether the rotary shaft can revolve smoothly under no load condition (or check the tool unit for any damage), so you must disable this process when performing re-fastening or when starting fastening with the bit engaged with the screw. Examples of operation codes for which this process must be disabled: *2**, *6**

- **Initial rundown process (process number 2)**

This process is performed according to the values specified for “Initial rundown speed” and “Initial rundown torque” in memory sheets (1) to (4). When the torque specified for “Initial rundown torque” is measured, the controller terminates this process and proceeds to the next process. If the measured torque value exceeds the value specified for item No. 6 “Upper limit value for torque judgment”, the controller will assume that an impact torque has been imposed, judge the fastening operation as NG (OUT2: ON), and stop the operation. In this case, the monitor value of monitor number “-0155” becomes 9999.

- **Final fastening process (process number 3)**

This process is performed according to the values specified for “Final fastening speed”, “Final fastening torque”, “Final fastening angle”, and “Stall time” in memory sheets (1) to (4). If the final fastening operation for the operation code is based on the torque control method, the controller terminates this process and proceeds to the next process after a screw is fastened to the torque specified for “Final fastening torque”. Note that the fastening method differs between torque-controlled fastening and torque-measured fastening. (Refer to 3-2-2.)
If the final fastening operation for the operation code is based on the angle control method, the controller terminates this process and proceeds to the next process after the output shaft revolves through the angle specified for “Final fastening angle”.

- **Bit fitting process (process number 5)**

This process is performed according to the values specified for “Thread fitting speed”, “Thread fitting torque”, and “Thread fitting time” in memory sheets (1) to (4). When the time specified for “Thread fitting time” has elapsed, the controller terminates this process and proceeds to the next process.

- **Bit release process (process number 6)**

This process is performed according to the values specified for “Bit releasing torque”, “Bit release angle”, and “Bit release time” in memory sheets (1) to (4). When any of the values specified for “Bit releasing torque”, “Bit release angle”, and “Bit release time” is measured, the controller terminates this process and proceeds to the next process.

- **Tapping process (process number 9)**

This process is performed according to the values specified for “Tapping speed”, “Tapping torque”, “Tapping angle measurement start torque”, and “Tapping angle” in memory sheets (1) to (4). After the torque value specified for “Tapping angle measurement start torque” is measured, the controller proceeds to the next process when the output shaft revolves through the angle specified for “Tapping angle”. If “Sensor input operation” is specified for “Additional operation” in the operation code, the controller proceeds to the next process when the output shaft revolves through the angle specified for “Tapping angle ” after IN7 (External sensor signal) for external I/O has turned on.

- **Channel connection (process number 10)**

This process performs two channel operations successively according to the values specified for “Signal output time” and “Connected channel number” in memory sheets (1) to (4).

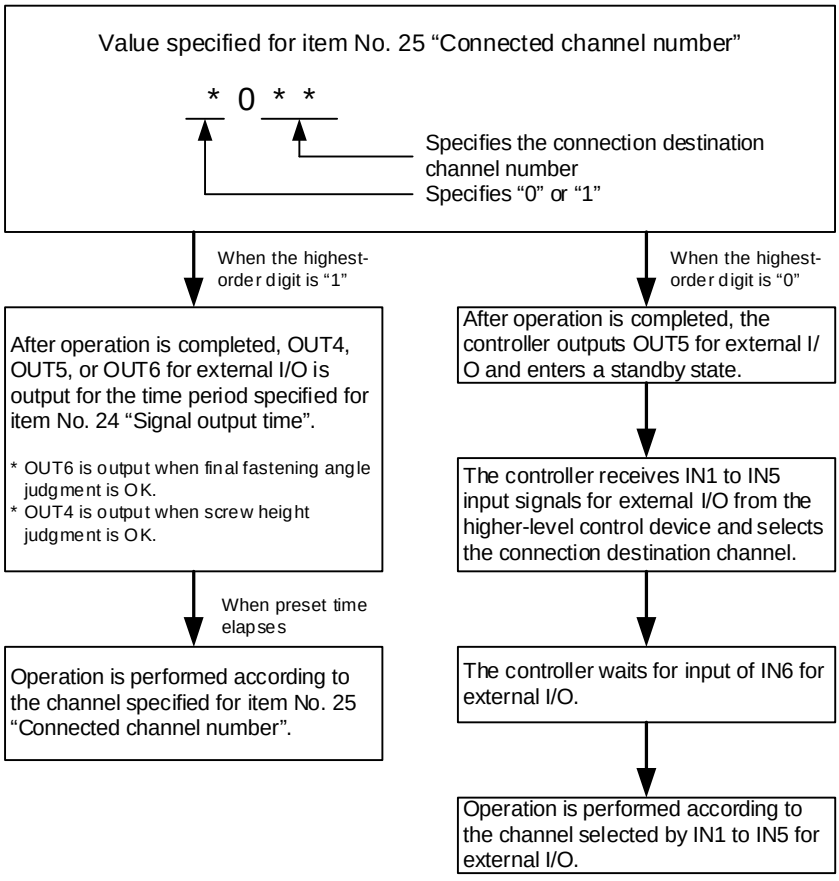


Fig. A

Channel connection operations differ according to the values specified for item No. 24 “Signal output time” and item No. 25 “Connected channel number”. If a fastening fault occurs with the channel before connection, the controller will judge the channel as a fastening fault (OUT2: ON) without connecting the other channel and then stop the operation.

- **Synchronous fastening operation (process number 11)**

After the initial rundown process is finished, the driver temporarily stops, waits for IN6 (Sync fastening start/Continuation start) for external I/O, and proceeds to the final fastening process. This operation is effective when startup timing for the final fastening processes for multiple drivers is adjusted.

- **Free revolution operation in forward or reverse direction (process number 13)**

This process is performed according to the values specified for “Speed for single direction”, “Torque for single direction”, “Lower digits/angle for single direction”, and “Upper digits/angle for single direction” in memory sheets (1) to (4). If the final fastening operation for the operation code is based on the torque control method, the controller proceeds to the next process after the specified torque value is measured. If the final fastening operation for the operation code is based on the angle control method, the controller proceeds to the next process after the output shaft revolves through the specified angle.
Also, if “Sensor input operation” is specified for “Additional operation” in the operation code, this process can be terminated by turning on IN7 (External sensor signal) for external I/O (examples of operation code: 3020, 4020) or by rotating the output shaft through the specified angle after IN7 (External sensor signal) turns on (examples of operation code: 3021, 4021).

- **Fastening result judgment (process numbers 18 and 19)**

Fastening results such as torque judgment, final fastening angle judgment, and screw height judgment are judged, and output signals are output according to the judgment result.
When the process number is 18, the torque judgment result is NG completion. When the process number is 19, the torque judgment result is OK completion.

- **Other (process numbers 88, 98, and 99)**

When the process number is 88, it is assumed that the screw could have been fastened until it was seated during the tapping process, fastening is judged NG (OUT2: ON), and the driver stops.
When the process number is 98, abnormal torque (significantly exceeding the upper torque judgment) such as impact torque is detected during the final fastening process, fastening is judged NG (OUT2: ON), and the driver stops.
When the process number is 99, abnormal torque (exceeding the upper torque judgment) such as impact torque is detected during the initial rundown process, fastening is judged NG (OUT2: ON), and the driver stops.

5. Other operations

5-1 Scaling function

By scaling function you can correct actual torque output against indicated value and setting value. Note, however, that using this function disables the tool unit calibrations performed by Nitto Seiko, **making it impossible to prove traceability. We also do not guarantee the results of using this function.**

[How to set up]
Increasing the value of the “100” segment of the parameter value (*100) decreases the output torque, while decreasing this value increases the output torque.

Example: If the value indicated by the controller is 10 N-m and the torque that is measured when the screw is actually fastened into the workpiece is 0.9 N-m, which is lower than the value indicated by the controller, the value that should be specified for the parameter can be calculated as below.
0.9/1.0 = 0.9 = 90%
Thus, “*090” should be specified for this parameter.

Refer to 3-8 for details on how to change parameter values.

5-2 Operation Condition Alarm Function

This function flashes the OK/NG lamp in orange as a warning indicator when the number of fastening operations exceeds one million times. (This warning appears when the power is turned on or at least 30 seconds after fastening is completed.) Use this warning as a guide for regular tool unit inspections. When replacing or overhauling a tool unit, reset the operating status of the tool unit.

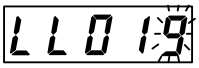
Monitor number for the number of fastening times:
–0054: Last four digits of the number of fastening times (in one time increments)
–0055: First four digits of the number of fastening times (in increments of 10,000 times)

How to reset the operating status

[1] Press the ENT key once to switch the monitor (or settings) display to the mode display.

[2] Press the MODE key several times to switch to “LL000” (reset mode).

[3] Press the → key to move the blinking digit to the digit to be set, and then press the ↑ key or ↓ key to change the value to “LL019”.

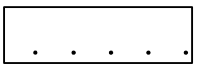


[4] Pressing the ENT key displays “00000”.

[5] Press the → key to move the blinking digit to the digit to be set, and then press the ↑ key or ↓ key to change the value to “09101”.

[6] When the value has been changed, press the ENT key once to switch to the mode display. Check that the blinking digit is located at the highest-order digit “L”.

[7] Keep pressing the ← key until all the digits change to dots (.).
(Releasing the key returns the display to the original state.)



[8] This completes the procedure for resetting the operating status.
Turn the power off temporarily, make sure that the display on the screen has disappeared, and then turn the power on again.

5-3 Torque waveform processing function

The waveform processing function determines whether fastening is acceptable or unacceptable according to the fastening waveform. It determines whether fastening waveforms fall within the allowable range (that has been specified for the controller beforehand) during fastening. If fastening is completed without deviating from the range, it is judged OK. If fastening waveforms deviate from the allowable range halfway during fastening, the operation will be stopped and judged NG. This function could detect the following kinds of error.

- Application examples
  - Galling in the early stage of screw fastening: Monitoring for abnormal waveforms when the driver begins to drive a screw into a female thread
  - Obliquely oriented and seized screw: Monitoring for abnormal waveforms until the screw is fastened completely
  - Caught foreign objects: Detecting abnormal waveforms when a foreign object is caught between the screw and the workpiece

[Caution]
For effective use of the torque waveform processing function, waveform data must be measured sufficiently beforehand. If there is no clear difference between acceptable and unacceptable fastening waveforms, this function will not be effective.

- **Controller setup**

To use the torque waveform processing function, the following setup operations must be performed on the controller. Note that dedicated software “SD600T Communication Software” is required to configure and write settings for torque waveform processing.

[1] Use the dedicated software to write settings for torque waveform processing to the controller.
  * For details, refer to the instruction manual for the dedicated software.

[2] Change the value of “Additional operation” (the second digit from the right) in the operation code to a number including torque waveform processing. For details, refer to 3-2-2.
  Example: Changing the operation code from “0007” to “0047”

- **How to determine whether torque waveform processing result is NG**

The judgment result of torque waveform processing is valid only when OUT8 (“Waveform processing finished”) is ON. When OUT8 is OFF, it indicates that torque waveform processing has not finished and the output of OUT7 (“Waveform processing result OK”) is invalid.

Table: Relationship between judgment results of torque waveform processing and I/O output signals

Judgment result of torque waveform processing	OUT8	OUT7
Invalid (fastening NG due to another cause)	OFF	–
OK	ON	ON
NG	ON	OFF

- **Causes of failures (NG) judged by torque waveform processing function**

Causes of failures (NG) judged by the torque waveform processing function can be checked with monitor number "-0910".

Monitor display	Cause	Action method
0000	Fastening operations other than torque waveform processing are faulty.	Check the action methods for common fastening faults.
0001	Torque waveform processing is faulty.	Check the workpiece status to find out any abnormal factors.
0012 0013 0014	Fastening was started during communication with the software (such as while waveform data was being sent).	Wait until communications with the software are completed, and then perform fastening.
0020	Settings for torque waveform processing have not been written.	Write the settings for torque waveform processing to the channel to be operated.
0021	Settings for torque waveform processing are incorrect.	Check if the settings for torque waveform processing are correct, and write them again.
0022	Trigger conditions are invalid.	Reset the trigger conditions for torque waveform processing.
0051	The torque for triggering torque waveform processing has not been reached.	• Correct any torque waveform processing problems. • Adjust the trigger point specified for torque waveform processing. • Take measures against common fastening faults.
0052	Sensor input for triggering torque waveform processing has not been received.	• Correct any torque waveform processing problems. • Check the status of sensor input (IN7). • Take measures against common fastening faults.
0053	The torque for triggering torque waveform processing has not been reached.	• Correct any torque waveform processing problems. • Adjust the trigger point specified for waveform processing. • Take measures against common fastening faults.
0054	Screw fastening was suspended during torque waveform processing (due to cycle time exceeded or for some other reason).	• Take measures against common fastening faults.

5-4 Data collection function (via Ethernet communication)

5-4-1 Overview of the data collection function using Ethernet communication

Installing the dedicated software “SD600T Communication Software” on a PC allows the user to use the data collection function.

Main functions provided by using the SD600T Communication Software
* For details on the functions, refer to 9-2 “Dedicated PC software “SD600T Communication Software”.

- **Collecting, displaying, and saving fastening result data**

This software can collect fastening result data that is sent from the controller as necessary when a screw is fastened, and display the data in list format. The software can also save the collected fastening result data to a file, allowing the user to view the data as many times as possible, by loading the data from the file.

[Examples of fastening results: Controller ID, date, torque value, final fastening angle, unseated screw, etc.]

- **Collecting and saving waveform data**

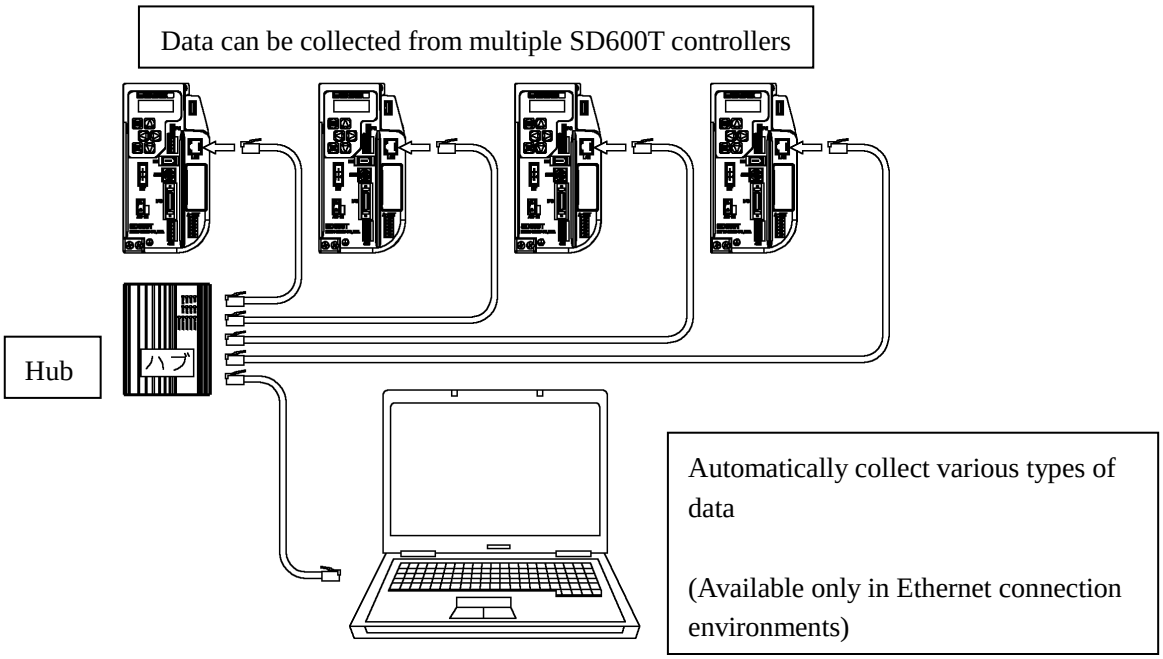
This software can collect waveform data that is sent from the controller as necessary when a screw is fastened, and save the data to a file.

5-4-2 Connection method

Use a commercially available Ethernet cable (LAN cable) to connect the controller and PC.
The total length of the cable between the PC and the controller must be no more than 20 m.

[LAN cable]
Category 5 or higher cables are recommended. Use straight cables.

[Number of controllers connected]
Up to four controllers can be connected.
* If only fastening operation results are collected without saving waveform data, up to eight controllers can be connected.



5-4-3 Preparation for controller setup

To allow the dedicated software (SD600T Communication Software) and the controller to communicate with each other via Ethernet, configure the following settings for the controller.

[1] Set the Pa190 parameter (“Data collection operation settings”) to 1. After changing the settings, always turn the controller off and then on to restart it.
* If settings are configured when there is no need to collect data, system alarm A.301 will occur when fastening operation starts.

[2] Set item No. 05 (“Number of data outputs”) for the selected channel in the memory sheet to a value other than 0.
* If this value is 0, Ethernet communication will be disabled.

5-5 Data collection function (via CAN communication)

5-5-1 Overview of the data collection function using CAN communication

Customers who use the SD500 series controllers (equipped with the network function) can use the data collection function only if they upgrade the SD500 series to the SD600T. Take due care as there are differences in connector wiring and some functions between the network function and the data collection function. When this function is used, only PC can be used as the receiving device. The dedicated software ("Data Collection Software") must be installed on the PC.

Main functions provided by using "Data Collection Software"

*For details on the functions of the Data Collection Software, refer to the KX/NX Driver Data Collection Software Instruction Manual.

- **Collecting, displaying, and saving fastening result data**

This software can collect fastening result data that is sent from the controller as necessary when a screw is fastened, and display the data in list format. The software can also save the collected fastening result data to a file (.csv), allowing the user to view the data as many times as possible, by loading the data from the file.

[Examples of fastening result: Controller ID, date, time, fastening time, torque value, final fastening angle, unseated screw, etc.]

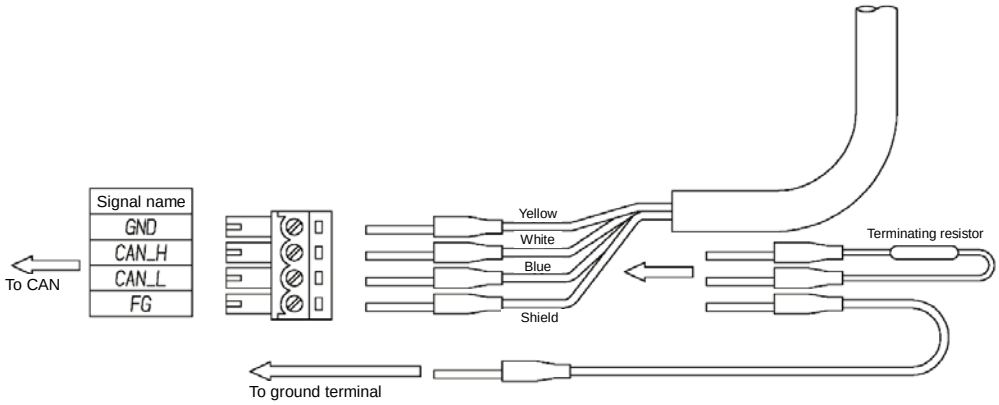
- **Collecting and saving waveform data**

This software can collect waveform data that is sent from the controller as necessary when a screw is fastened, and save the data to a file (.csv).

5-5-2 Differences with the SD500 series

- Controller-PC connection cable

The number of connector pins has been changed from six to four. For customers who use the PC connection cable with 9-pin D-sub connectors (SD-NCC-050B) or the PC connection cable with 25-pin D-sub connectors (SD-NCC-050A), these connectors must be replaced with the connectors provided with the SD600T. Take care to perform wiring correctly.



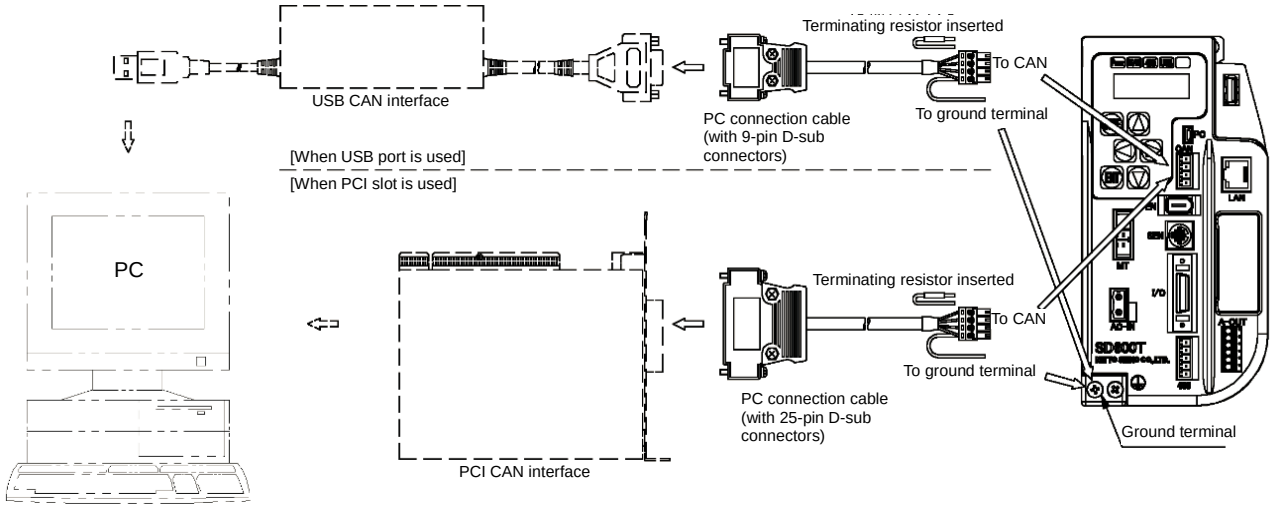
- Editing setup data is not supported

The SD500 series controllers allow setup data (memory sheets, parameters, and programs) to be edited using "Data Collection Software". However, setting items have been added and changed for the SD600T controller, but "Data Collection Software" does not support these setting items that have been added and changed. To avoid the possibility of unexpected data handling, do not use the following **setup data editing functions** of "Data Collection Software": **loading settings, loading all settings simultaneously, writing settings, and writing all**

settings simultaneously.

5-5-3 Connection method

- PC connection cable (with 9-pin D-sub connectors): SD-NCC-050B (manufactured by Nitto Seiko)
- PC connection cable (with 25-pin D-sub connectors): SD-NCC-050A (manufactured by Nitto Seiko)
- USB CAN interface: KVASER LEAF LIGHT V2 (manufactured by Kvaser)
- PCI CAN interface: LPC-485220 (manufactured by Interface Corporation)



[1] Connect a PC connection cable (with 9-pin or 25-pin D-sub connectors) to the CAN communication connector on the front panel of the controller. Connect the PC connection cable to the XW4B-04B1-H1 connector (manufactured by OMRON Corporation) provided with the controller.
[2] Insert a 120-ohm terminating resistor between CAN_H and CAN_L of the CAN communication connector.
[3] Connect the shield frame ground on the controller side from the connector to the ground terminal of the controller.
[4] Connect the PC connection cable and the USB CAN interface (or PCI CAN interface).

[Caution]
When using the LPC-485220, do not connect the ground terminal on the PC side (such as the ground terminal on the AC power cable) to an earth ground (such as the ground terminal of an AC power outlet). Doing so may not only prevent normal communications but may also cause the controller to malfunction, because the ground terminal of PC may be internally grounded.

5-5-4 Preparation for controller setup

To allow the dedicated software (Data Collection Software) and the controller to communicate with each other via CAN, configure the following settings for the controller.

[1] For the Pa170 parameter, specify the ID No. (1 to 30) of the controller as the node ID of CAN.
  * If this value is 0, CAN communication will be disabled. If settings are configured when there is no need to perform CAN communications, a system alarm (A.150 to A.159) will occur when fastening operation starts.

[2] Set item No. 05 (“Number of data outputs”) for the selected channel in the memory sheet to a value other than 0.
  * If this value is 0, CAN communication will be disabled.

6. Troubleshooting

6-1 Action taken when fastening is judged NG

This section explains the causes and action methods for fastening failures (NG) that occur when screw fastening operations are performed according to the standard specifications. Fastening failures can occur when the status of the machinery or workpiece does not match the driver operation (memory sheet settings).
This section presents a method that discovers the causes of fastening failures according to the operating status of the controller.

Switching to trace mode according to the following procedure allows the user to identify the process of the operation that stopped during fastening. See also the following pages to check the causes and action methods for operation stoppages during each process.

[1] Press the ENT key once to switch the monitor (or settings) display to the mode display.

[2] Press the MODE key several times to switch to “H0000” (trace mode).

[3] Pressing the ENT key once displays the program code. This will allow the user to identify the detailed cause of the operation stoppage.

For example, if trace mode indicates “H**00” as the process number that stopped and the program code is “00023”, check the operation code and set values for any setting errors.

Trace mode display	Program code / Cause	Action method
H**00 (Loading settings)	[1] [00023] Invalid operation code is set. [2] [00023] Necessary settings have not been entered. [3] [00023] Operation was started by specifying a channel for which settings have not been entered.	[1] Check the operation code. [2] Check for any omissions in the necessary setting items corresponding to the operation code. [3] Check output signals for PLC or other equipment and wiring for external I/O.

Trace mode display	Cause	Action method
Common to all displays	[1] The value specified for “Cycle time” is smaller than the time required for fastening. [2] IN0 (Start (continuous signal)) turned off.	[1] Adjust the value specified for “Cycle time”. [2] Check the cycle time for the machinery and input IN0 (Start (continuous signal)) until the completion signal (OUT1 or OUT2) turns on. Also, check the external I/O for broken wiring. Using monitor number “-0595” or “-0596” for external I/O is also an effective method.
H**00 (Loading settings)	[1] [00023] Invalid operation code is set. [2] [00023] Necessary settings have not been entered. [3] [00023] Operation was started by specifying a channel for which settings have not been entered.	[1] Check the operation code. [2] Check for any omissions in the necessary setting items corresponding to the operation code. [3] Check output signals for PLC or other equipment and wiring for external I/O.
H**01 (Initial revolution check process)	[1] [03590] The value specified for “Torque value for checking initial revolution” is too small. [2] [03590] The rotational speed does not rise because load is imposed when the driver rotates with the bit engaged with the screw (due to re-fastening or for some other reason). [3] [03590] The rotational speed does not rise because the rotary shaft cannot revolve smoothly.	[1] As a guide, set the same value as for “Initial rundown torque”. [2] Disable the initial revolution check process. [3] Maintain the rotary shaft. If the shaft cannot revolve smoothly under no load condition, disable the initial revolution check process as necessary.
H**02 (Initial rundown process)	[1] [03990] The torque does not rise because the bit does not engage with the screw. [2] [03990] The torque does not rise because the teaching position is out of alignment. [3] [03990] The torque does not rise because the pilot hole on the workpiece has been crushed. [4] [03990] The torque does not rise because an appropriate torque value is not specified for the workpiece.	[1] Check the teaching position, tool unit elevation stroke, and fastening thrust (pressing force). [2] Check the teaching position. [3] Because the values specified for “Initial rundown speed” and “Initial rundown torque” are too large, impact torque could be imposed. Fastening thrust (pressing force) could also be too large. [4] Adjust the value specified for “Initial rundown torque”.

Trace mode display	Cause	Action method
H**03 (Final fastening process)	[1] [03108], [33803] The torque does not rise because the bit does not engage with the screw.	[1] Check the teaching position, tool unit elevation stroke, and fastening thrust (pressing force).
	[2] [03108], [33803] The torque does not rise because the pilot hole on the workpiece has been crushed.	[2] Because the values specified for “Initial rundown speed” and “Initial rundown torque” are too large, impact torque could be imposed. Fastening thrust (pressing force) could also be too large.
	[3] [03108], [33803] The torque does not rise because an appropriate torque value is not specified for the workpiece.	[3] Adjust the value specified for “Final fastening torque”.
	[4] [03108], [33803], [03102], [03104] Because foreign objects get caught or the screw is fastened obliquely, the initial rundown process terminates before the screw is seated, thereby causing the cycle time to be exceeded.	[4] Check the statuses of the workpiece and machinery.
	[5] [03108], [33803], [03102], [03104] Because the value specified for “Initial rundown torque” is too small, the initial rundown process terminates before the screw is seated, thereby causing the cycle time to be exceeded.	[5] Adjust the value specified for “Initial rundown torque”.
	[6] [03108], [33803] The final fastening process does not terminate because torque is unstable.	[6] Lowering the value specified for “Final fastening speed” makes it easier to stabilize torque. Lowering the value specified for “Stall time” makes it easier to raise torque, but doing so reduces the torque transmitted to the workpiece, so make adjustments such as increasing the value specified for “Final fastening torque”.
	[7] [03102] Because the value specified for “Final fastening angle” is greater than the rotatable angle when the final fastening process is based on the angle control method, the output shaft cannot revolve through more than the rotatable angle, resulting in the cycle time being exceeded.	[7] Adjust the value specified for “Final fastening angle”.
	[8] [03102] Because the value specified for “Final fastening torque” is smaller than the torque required for revolutions when the final fastening process is based on the angle control method, the output shaft cannot revolve, resulting in the cycle time being exceeded.	[8] Adjust the value specified for “Final fastening torque”.

Trace mode display	Cause	Action method
H**05 (Bit fitting process)	IN0 (Start (continuous signal)) turned off.	Check the value specified for “Thread fitting time” and the cycle time of the machinery.
H**06 (Bit release process)	IN0 (Start (continuous signal)) turned off.	Check the values specified for “Bit releasing torque”, “Bit release angle”, and “Bit release time”, and the cycle time of the machinery.
H**09 (Tapping process)	[1] [32802] The tapping process does not terminate because the torque value specified for “Tapping angle measurement start torque” cannot be measured. [2] [03102] Because the value specified for “Tapping angle ” is greater than the rotatable angle, the output shaft cannot revolve through more than the rotatable angle, resulting in the cycle time being exceeded. [3] [03102], [32107] Because the value specified for “Tapping torque” is smaller than the torque required for revolutions, the output shaft cannot revolve, resulting in the cycle time being exceeded. [4] [32107] If “Sensor input operation” is specified for “Additional operation” in the operation code, IN7 of external I/O does not turn on.	[1] Adjust the values specified for “Tapping torque” and “Tapping angle measurement start torque”. [2] Adjust the value specified for “Tapping angle”. [3] Adjust the value specified for “Tapping torque”. [4] Check output signals for PLC or other equipment and wiring for external I/O.
H**10 (Channel connection)	[1] [00023] The channel fastening result was NG before channel connection. [2] [33001] Because the value specified for “Signal output time” before channel connection is too large, it is not possible to switch to the channel connection destination. [3] [32106] If 0*** is specified for “Connected channel number”, IN6 of external I/O does not turn on after OUT5 of external I/O turns on.	[1] Check the statuses of the workpiece and machinery, and check the values specified for “Final fastening torque”, “Upper torque judgment”, “Lower torque judgment”, and other items before channel connection. [2] Adjust the value specified for “Signal output time”. [3] Check output signals for PLC or other equipment and wiring for external I/O.

Trace mode display	Cause	Action method
H**11 (Synchronous fastening operation)	IN6 of external I/O does not turn on after OUT5 of external I/O turns on.	Check output signals for PLC or other equipment and wiring for external I/O.
H**13 (Free revolution operation in forward or reverse direction)	[1] [03102], [03103] If the value specified for “Angle for single direction” is greater than the rotatable angle when revolution operations in the forward or reverse direction are based on the angle control method, the output shaft cannot revolve through more than the rotatable angle, resulting in the cycle time being exceeded. [2] [03102], [03103] If the value specified for “Torque for single direction” is smaller than the torque required for revolutions when revolution operations in the forward or reverse direction are based on the angle control method, the output shaft cannot revolve, resulting in the cycle time being exceeded. [3] [03990] The torque does not rise because the bit does not engage with the screw. [4] [03990] The torque does not rise because an appropriate torque value is not specified for the workpiece. [5] [32107] If “Sensor input operation” is specified for “Additional operation” in the operation code, IN7 of external I/O does not turn on.	[1] Adjust the value specified for “Angle for single direction”. [2] Adjust the value specified for “Torque for single direction”. [3] Check the teaching position, tool unit elevation stroke, and fastening thrust (pressing force). [4] Adjust the value specified for “ Torque for single direction”. [5] Check output signals for PLC or other equipment and wiring for external I/O.
H**18 (Torque judgment NG completion)	The fastening torque is outside the range between the upper and lower limit values for torque judgment.	Check the statuses of the workpiece and machinery, and adjust the values specified for “Final fastening speed”, “Final fastening torque”, “Stall time”, “Speed for single direction”, and “Torque for single direction”. Check if the values specified for “Upper torque judgment” and “Lower torque judgment” are appropriate.
H**19 (Torque judgment OK completion)	The screw has been fastened normally. Note: The results of final fastening angle judgment, screw height judgment, and waveform judgment are not included. Check the states of OUT4, OUT6, and OUT7 of external I/O.	

Trace mode display	Cause	Action method
H**88	The screw could have been fastened until it was seated during the tapping process.	Adjust the values specified for “Tapping speed”, “Tapping angle measurement start torque”, and “Tapping angle” so that the tapping process can terminate before the screw is seated. If “Sensor input operation” is specified for “Additional operation” in the operation code, adjust the height position at which IN7 of external I/O turns on so that the tapping process can terminate before the screw is seated. If the initial rundown process terminates because torque rises instantaneously, the screw is judged as having been seated even before the screw is seated. In such a case, increase the value specified for “Initial rundown torque”.
H**98	Abnormal torque (significantly exceeding the upper l torque judgment) such as impact torque was detected during the final fastening process.	Check the statuses of the workpiece and machinery, and check whether the values specified for “Final fastening torque” and “Upper torque judgment” are appropriate. The smaller the value specified for “Final fastening speed”, the more stable the fastening torque. Adjust the settings between 10 and 50 [min^{-1}].
H**99	Abnormal torque (exceeding the upper torque judgment) such as impact torque was detected during the initial rundown process.	Adjust the values specified for “Initial rundown speed” and “Initial rundown torque”.

* “H**88”: Normally, the tapping process rotates the output shaft at high speed and with high torque in order to form a tapped hole.
If a screw is fastened until it is seated, it will be fastened with an impact torque, resulting in the risk of damaging the pilot hole on the workpiece. To prevent this problem, the operation is stopped as a fastening failure (NG).

6-2 System alarm

If a system error occurs on the controller, an alarm number will appear on the display and the operation will be stopped. In this case, check the alarm number that is displayed and eliminate the cause of the error by taking action as described below. **Temporary system alarms can be reset by turning the power off. [Note 1] While a system alarm is occurring, fastening operations cannot be started, and key operations on the display, communications, and other operations are restricted.**

*** For encoder communication errors and other similar errors, it is difficult to identify the cause of the error (tool unit, controller, or cables) by appearances. Therefore, if you have spares, replace each device or part one by one to identify the cause of the error.**

Number	Name	Cause	Remedial method
A.0001	Watchdog timer	Occurrence of system error	Replace the controller.
A.0002	Power-down	Power supply shutdown	Review primary power.
A.0003	NMI	[1] Influence by equipment environment [2] Occurrence of system error	[1] Review noise filter and controller ground connection. [2] Replace the controller.
A.0004	Incorrect exception handling	Occurrence of system error	Replace the controller.
A.0005	EEPROM write error	Occurrence of system error	Replace the controller.
A.0006	Memory error 1	Occurrence of system error	Replace the controller.
A.0007	Tool communication error	[1] Encoder cable is not connected properly [2] Encoder cable is broken. [3] Tool unit is damaged.	[1] Connect each connector again. [2] Replace the encoder cable. [3] Replace the tool unit.
A.0008	Data error of tool unit	The versions of controller and tool unit do not match	Replace the tool unit or the controller.
A.0009	EEPROM read error	Occurrence of system error	Replace the controller.
A.0010	Motor overload (Current) [Note 2]	Load imposed by the tool unit is too high for the workpiece	• Lengthen the downtime interval between fastening points Downtime interval that provides monitor value 0000 for monitor number “-0240” or “-0241” • Replace the tool unit with the one whose torque range is one rank above the current range.
A.0011	Motor overload (Voltage) [Note 2]		
A.0012	Memory error 2	Occurrence of system error	Replace the controller.
A.0014	Machine type faulty	Unsupported tool unit is connected to the controller	Replace the tool unit or the controller.
A.0015	IPM Fo	[1] Motor cable is shorted. [2] Tool unit is damaged. [3] Controller is damaged.	[1] Replace the motor cable. [2] Replace the tool unit. [3] Replace the controller.
A.0027	Position error	Tool unit is damaged.	Replace the tool unit.
A.0028	Encoder error		
A.0029	Encoder communication error	[1] Encoder cable is not connected properly [2] Influence by equipment environment [3] Encoder cable is broken. [4] Tool unit is damaged.	[1] Connect each connector again. [2] Review noise filter and controller ground connection. [3] Replace the encoder cable. [4] Replace the tool unit.

Number	Name	Cause	Remedial method
A.0030	U-phase current sensor zero error [Note 3]	[1] Parameter setting error [2] Current sensor failure	[1] Check the parameter settings. [2] Replace the controller.
A.0031	V-phase current sensor zero error [Note 3]		
A.0032	Torque sensor zero error [Note 4]	[1] Parameter setting error [2] Sensor cable is not connected properly [3] Sensor cable is broken [4] Tool unit is damaged [5] Controller is damaged	[1] Check the parameter settings. [2] Re-connect connectors. [3] Replace the sensor cable. [4] Replace the tool unit. [5] Replace the controller.
A.0033	Torque sensor amp error.	[1] Sensor cable is not connected properly [2] Sensor cable is broken [3] Tool unit is damaged	[1] Re-connect connectors. [2] Replace the sensor cable. [3] Replace the tool unit.
A.0050	IPM temperature warning	Controller is overheating	• Check that the ambient temperature is between 0 and 40ºC. • Stop operating the controller for approximately one hour and check if the problem recurs • Replace the controller.
A.0150	CAN bus-off	[1] CAN communication cable is not connected properly [2] CAN communication cable is broken [3] PC software is not ready to communicate with the controller [4] Settings are unintentionally configured to perform CAN communication [5] CAN communication cable is too long [6] The CAN ID (parameter Pa170) of the controller overlaps that of another controller [7] No terminating resistor is connected to CAN communication cable [8] CAN is in poor communication status	[1] Review the wiring. [2] Replace the CAN communication cable. [3] Check the communication status of PC software. [4] If CAN communication is not performed, change the value of parameter Pa170 to 0000. [5] Reduce the total length of the CAN communication cable to 20 m or less. [6] Change the value of parameter Pa170. [7] Insert a 120-ohm terminating resistor into pins 2 and 3 of the CAN connector. [8] Review the CAN communication cable. Review the controller ground connection.
A.0151	CAN error passive		
A.0152	CAN send/receive warning		
A.0153	CAN error counter		
A.0154	CAN reception overrun		
A.0155	CAN reception buffer full		
A.0156	CAN transmission buffer full		
A.0159	Other CAN module errors		
A.0204	Illegal exception processing (OP)	Occurrence of system error	Replace the controller.
A.0205	System error (OP)	Occurrence of system error	Replace the controller.
A.0206	Memory error (OP)	Occurrence of system error	Replace the controller.
A.0301	Abnormal stoppage of data collection	Ethernet cable is broken	• Reconnect the cable. • Replace the Ethernet cable. • Check the operations of repeaters (such as hubs). • Check if repeaters (such as hubs) are mixed with other local networks.
A.0302	Abnormal stoppage of data collection	Ethernet communication error	• Check the IP address of the PC. • Replace the Ethernet cable. • Close the communication software once. • Check the operations of repeaters (such as hubs). • Check if repeaters (such as hubs) are mixed with other local networks.
A.0303	Abnormal stoppage of data collection	Ethernet communication buffer error	

[Note 1] Before turning the power on again, wait at least five seconds after the display on the screen disappears. Also, do not repeat turning the controller on and off continuously in a short time. Doing so significantly shortens the service life of the product and may also result in failure.

[Note 2] Motor overload occurs when the load factor of the driver motor reaches 100%. For A.0010, the load factor can be checked with monitor number "-0240". For A.0011, the load factor can be checked with monitor number "-0241". This alarm occurs when it takes time to increase torque or when the fastening cycle is too short. While monitoring the load factor, extend the fastening cycle so that the monitor value becomes "0000" from when fastening is completed until the next fastening starts.

[Note 3] A current sensor error occurs when an incorrect value is specified for any of the Pa110 to Pa113 parameters or when the zero-point position of the current sensor significantly changes. The following procedure can be used to reset the zero-point of the current sensor to the parameter value. However, if the monitor value deviates from the factory-set parameter value by ±50 or more or if this alarm occurs frequently in a short period of time even after the zero-point of the current sensor is reset, the current sensor could be faulty. In this case, replace the controller.

[1] Turn off the power once to reset the alarm.
[2] Check if the values of the Pa110 to Pa113 parameters are the same as the factory settings. (Refer to the memory sheets and parameter sheets enclosed during shipping.)
→ If any values are different, reset the parameters to the factory settings.
[3] Check that the driver is stopped.
[4] If the alarm number is "A.0030":
Read the monitor value of monitor number "-0220" and set the Pa110 parameter to the value that you read.
[5] If the alarm number is "A.0031":
Read the monitor value of monitor number "-0221" and set the Pa112 parameter to the value that you read.

(Because the monitor value that is displayed fluctuates within a certain range, read an intermediate value and specify it for the parameter.)

[Note 4] A torque sensor error occurs when an incorrect value is specified for any of the Pa135 to Pa141 parameters or when signals from the torque sensor are abnormal. The following procedure can be used to check the parameters:

[1] Turn off the power once to reset the alarm.
[2] Check if the values of the Pa135 to Pa141 parameters are the same as the factory settings. (Refer to the memory sheets and parameter sheets enclosed during shipping.)
→ If any values are different, reset the parameters to the factory settings.
[3] Check that the driver is stopped.
[4] Check that no load is imposed on the rotary shaft of the driver (for example, there is no load imposed by the shaft that is twisted).
[5] Check the monitor value of monitor number "-0222" and the value of the Pa136 parameter.
If the monitor value of monitor number "-0222" differs from the value of the Pa136 parameter by ±80 or more, the torque sensor could be faulty. In this case, replace the tool unit.

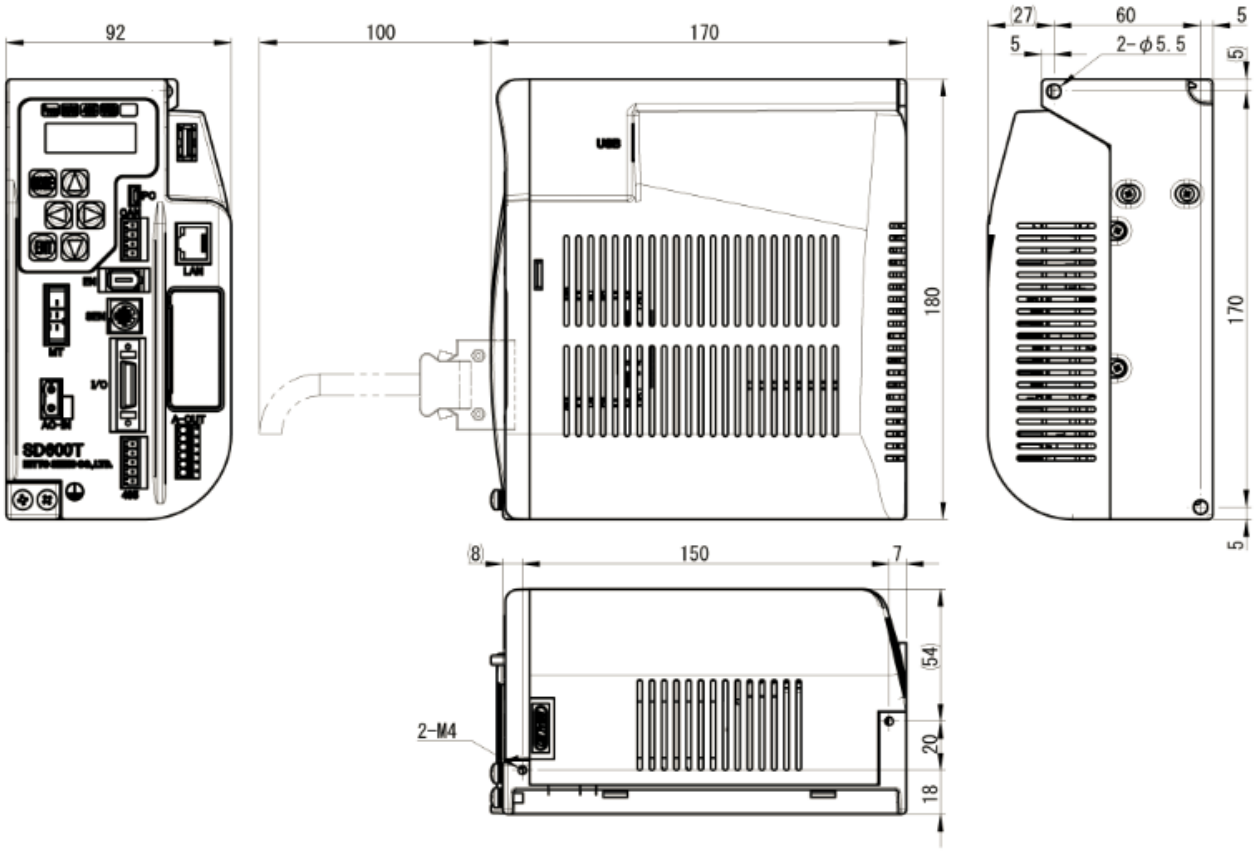
(Because the monitor value that is displayed fluctuates within a certain range, read the minimum and maximum values.)

6-3 Other problems

Problem	Controller state	Check points	Action method
Driver does not rotate (Unstable revolutions)	OK/NG lamp: Unlit	[1] Primary power supply	[1] Check if the controller power lamp is lit.
		[2] Fastening operation status	[2] Display trace mode “H****” and take action according to the process number.
		[3] Output signals of PLC, etc. Wiring of external I/O	[3] Check if IN0 (Start (continuous signal)) of external I/O is sent. Check PLC (or other equipment) for sequence errors and external I/O for incorrect wiring. Using monitor number “-595” or “-596” for external I/O is also an effective method.
		[4] Motor cable breakage, damage to tool unit	[4] Replace the tool unit or motor cable.
	OK/NG lamp: Lit in red	[1] Fastening operation status	[1] Display trace mode “H****” and take action according to the process number.
		[2] Fastening time settings	[2] Adjust the value specified for “Cycle time”. Check the cycle time for the machinery and input IN0 (Start (continuous signal)) until the completion signal (OUT1 or OUT2) of external I/O turns on.
		[3] Output signals of PLC, etc. Wiring of external I/O	[3] Check PLC (or other equipment) for sequence errors and external I/O for incorrect wiring. Using monitor number “-595” or “-596” for external I/O is also an effective method.
		[4] Motor cable breakage, damage to tool unit	[4] Replace the tool unit or motor cable.
The power does not turn on (The power lamp and display do not light up)		Primary power supply	Check the main power supply and AC input power cables of the machinery for broken wiring. If there is no problem with these cables, the controller could be faulty.

Problem	Controller state	Check points	Action method
When the power is turned on, “LP***” appears on the display.	OK/NG lamp: Flashing in red	Parameters	“LP***” indicates parameter mode. If “LP***” appears when the power is turned on, the settings of the parameter corresponding to the number indicated by “***” are incorrect. Make corrections by referring to the memory sheets and parameter sheets enclosed during shipping.
When the power is turned on, “000E.*” appears on the display. (*: 0, 1, or 2)		0: Tool unit 1: Parameter 2: Tool unit	0: A new tool unit has been connected. 1: Parameter information of the tool unit does not match that of the controller. 2: Information of the tool unit does not match that of the controller. Pressing the Enter key overwrites the information of the controller with the information of the tool unit Before pressing the Enter key, reconfirm that the information of the tool unit can be applied to the controller.
“9998” appears on the display of the controller.	Abnormal torque (significantly exceeding the upper torque judgment) such as impact torque was detected during the final fastening process.	Memory sheet	Check the statuses of the workpiece and machinery, and check whether the values specified for “Final fastening torque” and “Upper torque judgment” are appropriate. The smaller the value specified for “Final fastening speed”, the more stable the fastening torque. Adjust the settings between 10 and 50 [min^{-1}].
“9999” appears on the display of the controller.	Abnormal torque (exceeding the upper torque judgment) such as impact torque was detected during the initial rundown process.	Memory sheet	Adjust the values specified for “Initial rundown speed” and “Initial rundown torque”.
“8888” appears on the display of the controller.	The screw could have been fastened until it was seated during the tapping process.	Memory sheet	Adjust the values specified for “Tapping speed”, “Tapping angle measurement start torque”, and “Tapping angle” so that the tapping process can terminate before the screw is seated. If “Sensor input operation” is specified for “Additional operation” in the operation code, adjust the height position at which IN7 of external I/O turns on so that the tapping process can terminate before the screw is seated. If the initial rundown process terminates because torque rises instantaneously, the screw is judged as having been seated even before the screw is seated. In such a case, increase the value specified for “Initial rundown torque”.

7. External dimensions



8. Tables of correspondences between operation codes and memory sheet setting items

The following tables summarize the item numbers of the setting items that must be specified for each operation code. Refer to Chapter 3 for details on setting items and setting details.

For example, the following setting items are required when the operation code is "0007":

Memory sheet (0): Item Nos. 01 and 02
Memory sheets (1) to (4): Item Nos. 00, 01, 02, 03, 06, 07, 08, and 09

If a value between 4 and 7 (torque waveform processing enabled) is specified for "Additional operation" (the second digit from the right) in the operation code, the setting items of this operation code are the same as those of an operation code that is determined by subtracting 40 from that operation code.

For example, if the operation code is "0047":

0047 – 40 = 0007, which means that you are supposed to refer to the row of "0007" in the following table.

List of setting items by operation code

User setting value must be input for the item No. marked with ○.
△… Operation varies depending on whether each setting item is specified.

Operation code	Memory sheet (0) Item No.			Memory sheet (1)–(4) Item No.																													Remarks
	00	01	02	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
0000		○	○	○	○	○	○		△	○	○	○	○											△	△	△	△						
0001		○	○	○	○	○	○	○	△	○	○		○											△	△	△	△						
0002		○	○	○	○	○	○		△	○	○	○	○											△	△	△	△	△	△				
0004		○	○	○	○	○	○	○	△	○	○		○											△	△	△	△	△	△				
0005		○	○	○	○	○	○	○	△	○	○		○											△	△	△	△						
0006		○	○	○	○	○	○	○	△	○	○		○											△	△	△	△	△	△				
0007		○	○	○	○	○	○		△	○	○	△	○											△	△	△	△						
0008		○	○	○	○	○	○		△	○	○	△	○											△	△	△	△	△	△				
0010		○	○	○	○	○	○		△	○	○	○	○											△	△	△	△						
0011		○	○	○	○	○	○	○	△	○	○		○											△	△	△	△						
0012		○	○	○	○	○	○		△	○	○	○	○											△	△	△	△	△	△				
0014		○	○	○	○	○	○	○	△	○	○		○											△	△	△	△	△	△				
0015		○	○	○	○	○	○	○	△	○	○		○											△	△	△	△						
0016		○	○	○	○	○	○	○	△	○	○		○											△	△	△	△	△	△				
0017		○	○	○	○	○	○		△	○	○	△	○											△	△	△	△						
0018		○	○	○	○	○	○		△	○	○	△	○											△	△	△	△	△	△				

Operation code	Memory sheet (0) Item No.			Memory sheet (1)–(4) Item No.																													Remarks
	00	01	02	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
0100		○	○	○	○	○	○		△	○	○	○	○	○	○	○	○							△	△	△	△						
0101		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○							△	△	△	△						
0102		○	○	○	○	○	○		△	○	○	○	○	○	○	○	○							△	△	△	△	△	△				
0104		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○							△	△	△	△	△	△				
0105		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○							△	△	△	△						
0106		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○							△	△	△	△	△	△				
0107		○	○	○	○	○	○		△	○	○	△	○	○	○	○	○							△	△	△	△						
0108		○	○	○	○	○	○		△	○	○	△	○	○	○	○	○							△	△	△	△	△	△				
0110		○	○	○	○	○	○		△	○	○	○	○	○	○	○	○							△	△	△	△						
0111		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○							△	△	△	△						
0112		○	○	○	○	○	○		△	○	○	○	○	○	○	○	○							△	△	△	△	△	△				
0114		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○							△	△	△	△	△	△				
0115		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○							△	△	△	△						
0116		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○							△	△	△	△	△	△				
0117		○	○	○	○	○	○		△	○	○	△	○	○	○	○	○							△	△	△	△						
0118		○	○	○	○	○	○		△	○	○	△	○	○	○	○	○							△	△	△	△	△	△				
0120		○	○	○	○	○	○		△	○	○	○	○	○	○		△							△	△	△	△						
0121		○	○	○	○	○	○	○	△	○	○		○	○	○		△							△	△	△	△						
0122		○	○	○	○	○	○		△	○	○	○	○	○	○		△							△	△	△	△	△	△				
0124		○	○	○	○	○	○	○	△	○	○		○	○	○		△							△	△	△	△	△	△				
0125		○	○	○	○	○	○	○	△	○	○		○	○	○		△							△	△	△	△						
0126		○	○	○	○	○	○	○	△	○	○		○	○	○		△							△	△	△	△	△	△				
0127		○	○	○	○	○	○		△	○	○	△	○	○	○		△							△	△	△	△						
0128		○	○	○	○	○	○		△	○	○	△	○	○	○		△							△	△	△	△	△	△				
0130		○	○	○	○	○	○		△	○	○	○	○	○	○		△							△	△	△	△						
0131		○	○	○	○	○	○	○	△	○	○		○	○	○		△							△	△	△	△						
0132		○	○	○	○	○	○		△	○	○	○	○	○	○		△							△	△	△	△	△	△				
0134		○	○	○	○	○	○	○	△	○	○		○	○	○		△							△	△	△	△	△	△				
0135		○	○	○	○	○	○	○	△	○	○		○	○	○		△							△	△	△	△						
0136		○	○	○	○	○	○	○	△	○	○		○	○	○		△							△	△	△	△	△	△				
0137		○	○	○	○	○	○		△	○	○	△	○	○	○		△							△	△	△	△						
0138		○	○	○	○	○	○		△	○	○	△	○	○	○		△							△	△	△	△	△	△				

8. Tables of correspondences between operation codes and memory sheet setting items

List of setting items by operation code

User setting value must be input for the item No. marked with ○.
△… Operation varies depending on whether each setting item is specified.

Operation code	Memory sheet (0) Item No.			Memory sheet (1)–(4) Item No.																												Remarks
	00	01	02	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
0200				○	○	○	○		△	○	○	○	○											△	△	△	△							
0201				○	○	○	○	○	△	○	○		○											△	△	△	△							
0202				○	○	○	○		△	○	○	○	○											△	△	△	△	△	△					
0204				○	○	○	○	○	△	○	○		○											△	△	△	△	△	△					
0205				○	○	○	○	○	△	○	○		○											△	△	△	△							
0206				○	○	○	○	○	△	○	○		○											△	△	△	△	△	△					
0207				○	○	○	○		△	○	○	△	○											△	△	△	△							
0208				○	○	○	○		△	○	○	△	○											△	△	△	△	△	△					
0210				○	○	○	○		△	○	○	○	○											△	△	△	△							
0211				○	○	○	○	○	△	○	○		○											△	△	△	△							
0212				○	○	○	○		△	○	○	○	○											△	△	△	△	△	△					
0214				○	○	○	○	○	△	○	○		○											△	△	△	△	△	△					
0215				○	○	○	○	○	△	○	○		○											△	△	△	△							
0216				○	○	○	○	○	△	○	○		○											△	△	△	△	△	△					
0217				○	○	○	○		△	○	○	△	○											△	△	△	△							
0218				○	○	○	○		△	○	○	△	○											△	△	△	△	△	△					

Operation code	Memory sheet (0) Item No.			Memory sheet (1)–(4) Item No.																												Remarks
	00	01	02	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
0600				○	○	○	○		△	○	○	○	○	○	○	○	○							△	△	△	△							
0601				○	○	○	○	○	△	○	○		○	○	○	○	○							△	△	△	△							
0602				○	○	○	○		△	○	○	○	○	○	○	○	○							△	△	△	△	△	△					
0604				○	○	○	○	○	△	○	○		○	○	○	○	○							△	△	△	△	△	△					
0605				○	○	○	○	○	△	○	○		○	○	○	○	○							△	△	△	△							
0606				○	○	○	○	○	△	○	○		○	○	○	○	○							△	△	△	△	△	△					
0607				○	○	○	○		△	○	○	△	○	○	○	○	○							△	△	△	△							
0608				○	○	○	○		△	○	○	△	○	○	○	○	○							△	△	△	△	△	△					
0610				○	○	○	○		△	○	○	○	○	○	○	○	○							△	△	△	△							
0611				○	○	○	○	○	△	○	○		○	○	○	○	○							△	△	△	△							
0612				○	○	○	○		△	○	○	○	○	○	○	○	○							△	△	△	△	△	△					
0614				○	○	○	○	○	△	○	○		○	○	○	○	○							△	△	△	△	△	△					
0615				○	○	○	○	○	△	○	○		○	○	○	○	○							△	△	△	△							
0616				○	○	○	○	○	△	○	○		○	○	○	○	○							△	△	△	△	△	△					
0617				○	○	○	○		△	○	○	△	○	○	○	○	○							△	△	△	△							
0618				○	○	○	○		△	○	○	△	○	○	○	○	○							△	△	△	△	△	△					
0620				○	○	○	○		△	○	○	○	○	○	○		△							△	△	△	△							
0621				○	○	○	○	○	△	○	○		○	○	○		△							△	△	△	△							
0622				○	○	○	○		△	○	○	○	○	○	○		△							△	△	△	△	△	△					
0624				○	○	○	○	○	△	○	○		○	○	○		△							△	△	△	△	△	△					
0625				○	○	○	○	○	△	○	○		○	○	○		△							△	△	△	△							
0626				○	○	○	○	○	△	○	○		○	○	○		△							△	△	△	△	△	△					
0627				○	○	○	○		△	○	○	△	○	○	○		△							△	△	△	△							
0628				○	○	○	○		△	○	○	△	○	○	○		△							△	△	△	△	△	△					
0630				○	○	○	○		△	○	○	○	○	○	○		△							△	△	△	△							
0631				○	○	○	○	○	△	○	○		○	○	○		△							△	△	△	△							
0632				○	○	○	○		△	○	○	○	○	○	○		△							△	△	△	△	△	△					
0634				○	○	○	○	○	△	○	○		○	○	○		△							△	△	△	△	△	△					
0635				○	○	○	○	○	△	○	○		○	○	○		△							△	△	△	△							
0636				○	○	○	○	○	△	○	○		○	○	○		△							△	△	△	△	△	△					
0637				○	○	○	○		△	○	○	△	○	○	○		△							△	△	△	△							
0638				○	○	○	○		△	○	○	△	○	○	○		△							△	△	△	△	△	△					

8. Tables of correspondences between operation codes and memory sheet setting items

List of setting items by operation code

User setting value must be input for the item No. marked with ○.
△… Operation varies depending on whether each setting item is specified.

Operation code	Memory sheet (0) Item No.			Memory sheet (1)–(4) Item No.																												Remarks
	00	01	02	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
1000		○	○	○	○	○	○		△	○	○	○	○					○	○	○	○	○	○	△	△	△	△							
1001		○	○	○	○	○	○	○	△	○	○		○					○	○	○	○	○	○	△	△	△	△							
1002		○	○	○	○	○	○		△	○	○	○	○					○	○	○	○	○	○	△	△	△	△	△	△					
1004		○	○	○	○	○	○	○	△	○	○		○					○	○	○	○	○	○	△	△	△	△	△	△					
1005		○	○	○	○	○	○	○	△	○	○		○					○	○	○	○	○	○	△	△	△	△							
1006		○	○	○	○	○	○	○	△	○	○		○					○	○	○	○	○	○	△	△	△	△	△	△					
1007		○	○	○	○	○	○		△	○	○	△	○					○	○	○	○	○	○	△	△	△	△							
1008		○	○	○	○	○	○		△	○	○	△	○					○	○	○	○	○	○	△	△	△	△	△	△					
1010		○	○	○	○	○	○		△	○	○	○	○					○	○	○	○	○	○	△	△	△	△							
1011		○	○	○	○	○	○	○	△	○	○		○					○	○	○	○	○	○	△	△	△	△							
1012		○	○	○	○	○	○		△	○	○	○	○					○	○	○	○	○	○	△	△	△	△	△	△					
1014		○	○	○	○	○	○	○	△	○	○		○					○	○	○	○	○	○	△	△	△	△	△	△					
1015		○	○	○	○	○	○	○	△	○	○		○					○	○	○	○	○	○	△	△	△	△							
1016		○	○	○	○	○	○	○	△	○	○		○					○	○	○	○	○	○	△	△	△	△	△	△					
1017		○	○	○	○	○	○		△	○	○	△	○					○	○	○	○	○	○	△	△	△	△							
1018		○	○	○	○	○	○		△	○	○	△	○					○	○	○	○	○	○	△	△	△	△	△	△					

Operation code	Memory sheet (0) Item No.			Memory sheet (1)–(4) Item No.																												Remarks
	00	01	02	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
1100		○	○	○	○	○	○		△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△							
1101		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○	○	○	○	○	○	○	△	△	△	△							
1102		○	○	○	○	○	○		△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△					
1104		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△					
1105		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○	○	○	○	○	○	○	△	△	△	△							
1106		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△					
1107		○	○	○	○	○	○		△	○	○	△	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△							
1108		○	○	○	○	○	○		△	○	○	△	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△					
1110		○	○	○	○	○	○		△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△							
1111		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○	○	○	○	○	○	○	△	△	△	△							
1112		○	○	○	○	○	○		△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△					
1114		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△					
1115		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○	○	○	○	○	○	○	△	△	△	△							
1116		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△					
1117		○	○	○	○	○	○		△	○	○	△	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△							
1118		○	○	○	○	○	○		△	○	○	△	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△					
1120		○	○	○	○	○	○		△	○	○	○	○	○	○		△	○	○	○	○	○	○	△	△	△	△							
1121		○	○	○	○	○	○	○	△	○	○		○	○	○		△	○	○	○	○	○	○	△	△	△	△							
1122		○	○	○	○	○	○		△	○	○	○	○	○	○		△	○	○	○	○	○	○	△	△	△	△	△	△					
1124		○	○	○	○	○	○	○	△	○	○		○	○	○		△	○	○	○	○	○	○	△	△	△	△	△	△					
1125		○	○	○	○	○	○	○	△	○	○		○	○	○		△	○	○	○	○	○	○	△	△	△	△							
1126		○	○	○	○	○	○	○	△	○	○		○	○	○		△	○	○	○	○	○	○	△	△	△	△	△	△					
1127		○	○	○	○	○	○		△	○	○	△	○	○	○		△	○	○	○	○	○	○	△	△	△	△							
1128		○	○	○	○	○	○		△	○	○	△	○	○	○		△	○	○	○	○	○	○	△	△	△	△	△	△					
1130		○	○	○	○	○	○		△	○	○	○	○	○	○		△	○	○	○	○	○	○	△	△	△	△							
1131		○	○	○	○	○	○	○	△	○	○		○	○	○		△	○	○	○	○	○	○	△	△	△	△							
1132		○	○	○	○	○	○		△	○	○	○	○	○	○		△	○	○	○	○	○	○	△	△	△	△	△	△					
1134		○	○	○	○	○	○	○	△	○	○		○	○	○		△	○	○	○	○	○	○	△	△	△	△	△	△					
1135		○	○	○	○	○	○	○	△	○	○		○	○	○		△	○	○	○	○	○	○	△	△	△	△							
1136		○	○	○	○	○	○	○	△	○	○		○	○	○		△	○	○	○	○	○	○	△	△	△	△	△	△					
1137		○	○	○	○	○	○		△	○	○	△	○	○	○		△	○	○	○	○	○	○	△	△	△	△							
1138		○	○	○	○	○	○		△	○	○	△	○	○	○		△	○	○	○	○	○	○	△	△	△	△	△	△					

8. Tables of correspondences between operation codes and memory sheet setting items

List of setting items by operation code

User setting value must be input for the item No. marked with ○.
△… Operation varies depending on whether each setting item is specified.

Operation code	Memory sheet (0) Item No.			Memory sheet (1)–(4) Item No.																												Remarks
	00	01	02	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
1200				○	○	○	○		△	○	○	○	○					○	○	○	○	○	○	△	△	△	△							
1201				○	○	○	○	○	△	○	○		○					○	○	○	○	○	○	△	△	△	△							
1202				○	○	○	○		△	○	○	○	○					○	○	○	○	○	○	△	△	△	△	△	△					
1204				○	○	○	○	○	△	○	○		○					○	○	○	○	○	○	△	△	△	△	△	△					
1205				○	○	○	○	○	△	○	○		○					○	○	○	○	○	○	△	△	△	△							
1206				○	○	○	○	○	△	○	○		○					○	○	○	○	○	○	△	△	△	△	△	△					
1207				○	○	○	○		△	○	○	△	○					○	○	○	○	○	○	△	△	△	△							
1208				○	○	○	○		△	○	○	△	○					○	○	○	○	○	○	△	△	△	△	△	△					
1210				○	○	○	○		△	○	○	○	○					○	○	○	○	○	○	△	△	△	△							
1211				○	○	○	○	○	△	○	○		○					○	○	○	○	○	○	△	△	△	△							
1212				○	○	○	○		△	○	○	○	○					○	○	○	○	○	○	△	△	△	△	△	△					
1214				○	○	○	○	○	△	○	○		○					○	○	○	○	○	○	△	△	△	△	△	△					
1215				○	○	○	○	○	△	○	○		○					○	○	○	○	○	○	△	△	△	△							
1216				○	○	○	○	○	△	○	○		○					○	○	○	○	○	○	△	△	△	△	△	△					
1217				○	○	○	○		△	○	○	△	○					○	○	○	○	○	○	△	△	△	△							
1218				○	○	○	○		△	○	○	△	○					○	○	○	○	○	○	△	△	△	△	△	△					

Operation code	Memory sheet (0) Item No.			Memory sheet (1)–(4) Item No.																												Remarks
	00	01	02	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
1600				○	○	○	○		△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△							
1601				○	○	○	○	○	△	○	○		○	○	○	○	○	○	○	○	○	○	○	△	△	△	△							
1602				○	○	○	○		△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△					
1604				○	○	○	○	○	△	○	○		○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△					
1605				○	○	○	○	○	△	○	○		○	○	○	○	○	○	○	○	○	○	○	△	△	△	△							
1606				○	○	○	○	○	△	○	○		○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△					
1607				○	○	○	○		△	○	○	△	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△							
1608				○	○	○	○		△	○	○	△	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△					
1610				○	○	○	○		△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△							
1611				○	○	○	○	○	△	○	○		○	○	○	○	○	○	○	○	○	○	○	△	△	△	△							
1612				○	○	○	○		△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△					
1614				○	○	○	○	○	△	○	○		○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△					
1615				○	○	○	○	○	△	○	○		○	○	○	○	○	○	○	○	○	○	○	△	△	△	△							
1616				○	○	○	○	○	△	○	○		○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△					
1617				○	○	○	○		△	○	○	△	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△							
1618				○	○	○	○		△	○	○	△	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△					
1620				○	○	○	○		△	○	○	○	○	○	○		△	○	○	○	○	○	○	△	△	△	△							
1621				○	○	○	○	○	△	○	○		○	○	○		△	○	○	○	○	○	○	△	△	△	△							
1622				○	○	○	○		△	○	○	○	○	○	○		△	○	○	○	○	○	○	△	△	△	△	△	△					
1624				○	○	○	○	○	△	○	○		○	○	○		△	○	○	○	○	○	○	△	△	△	△	△	△					
1625				○	○	○	○	○	△	○	○		○	○	○		△	○	○	○	○	○	○	△	△	△	△							
1626				○	○	○	○	○	△	○	○		○	○	○		△	○	○	○	○	○	○	△	△	△	△	△	△					
1627				○	○	○	○		△	○	○	△	○	○	○		△	○	○	○	○	○	○	△	△	△	△							
1628				○	○	○	○		△	○	○	△	○	○	○		△	○	○	○	○	○	○	△	△	△	△	△	△					
1630				○	○	○	○		△	○	○	○	○	○	○		△	○	○	○	○	○	○	△	△	△	△							
1631				○	○	○	○	○	△	○	○		○	○	○		△	○	○	○	○	○	○	△	△	△	△							
1632				○	○	○	○		△	○	○	○	○	○	○		△	○	○	○	○	○	○	△	△	△	△	△	△					
1634				○	○	○	○	○	△	○	○		○	○	○		△	○	○	○	○	○	○	△	△	△	△	△	△					
1635				○	○	○	○	○	△	○	○		○	○	○		△	○	○	○	○	○	○	△	△	△	△							
1636				○	○	○	○	○	△	○	○		○	○	○		△	○	○	○	○	○	○	△	△	△	△	△	△					
1637				○	○	○	○		△	○	○	△	○	○	○		△	○	○	○	○	○	○	△	△	△	△							
1638				○	○	○	○		△	○	○	△	○	○	○		△	○	○	○	○	○	○	△	△	△	△	△	△					

8. Tables of correspondences between operation codes and memory sheet setting items

List of setting items by operation code

User setting value must be input for the item No. marked with ○.
△… Operation varies depending on whether each setting item is specified.

Operation code	Memory sheet (0) Item No.			Memory sheet (1)–(4) Item No.																													Remarks
	00	01	02	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
2000		○	○	○	○	○	○		△	○	○	○	○								○	○	○	△	△	△	△							
2001		○	○	○	○	○	○	○	△	○	○		○								○	○	○	△	△	△	△							
2002		○	○	○	○	○	○		△	○	○	○	○								○	○	○	△	△	△	△	△	△					
2004		○	○	○	○	○	○	○	△	○	○		○								○	○	○	△	△	△	△	△	△					
2005		○	○	○	○	○	○	○	△	○	○		○								○	○	○	△	△	△	△							
2006		○	○	○	○	○	○	○	△	○	○		○								○	○	○	△	△	△	△	△	△					
2007		○	○	○	○	○	○		△	○	○	△	○								○	○	○	△	△	△	△							
2008		○	○	○	○	○	○		△	○	○	△	○								○	○	○	△	△	△	△	△	△					
2010		○	○	○	○	○	○		△	○	○	○	○								○	○	○	△	△	△	△							
2011		○	○	○	○	○	○	○	△	○	○		○								○	○	○	△	△	△	△							
2012		○	○	○	○	○	○		△	○	○	○	○								○	○	○	△	△	△	△	△	△					
2014		○	○	○	○	○	○	○	△	○	○		○								○	○	○	△	△	△	△	△	△					
2015		○	○	○	○	○	○	○	△	○	○		○								○	○	○	△	△	△	△							
2016		○	○	○	○	○	○	○	△	○	○		○								○	○	○	△	△	△	△	△	△					
2017		○	○	○	○	○	○		△	○	○	△	○								○	○	○	△	△	△	△							
2018		○	○	○	○	○	○		△	○	○	△	○								○	○	○	△	△	△	△	△	△					

Operation code	Memory sheet (0) Item No.			Memory sheet (1)–(4) Item No.																													Remarks
	00	01	02	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
2100		○	○	○	○	○	○		△	○	○	○	○	○	○	○	○				○	○	○	△	△	△	△							
2101		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○				○	○	○	△	△	△	△							
2102		○	○	○	○	○	○		△	○	○	○	○	○	○	○	○				○	○	○	△	△	△	△	△	△					
2104		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○				○	○	○	△	△	△	△	△	△					
2105		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○				○	○	○	△	△	△	△							
2106		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○				○	○	○	△	△	△	△	△	△					
2107		○	○	○	○	○	○		△	○	○	△	○	○	○	○	○				○	○	○	△	△	△	△							
2108		○	○	○	○	○	○		△	○	○	△	○	○	○	○	○				○	○	○	△	△	△	△	△	△					
2110		○	○	○	○	○	○		△	○	○	○	○	○	○	○	○				○	○	○	△	△	△	△							
2111		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○				○	○	○	△	△	△	△							
2112		○	○	○	○	○	○		△	○	○	○	○	○	○	○	○				○	○	○	△	△	△	△	△	△					
2114		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○				○	○	○	△	△	△	△	△	△					
2115		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○				○	○	○	△	△	△	△							
2116		○	○	○	○	○	○	○	△	○	○		○	○	○	○	○				○	○	○	△	△	△	△	△	△					
2117		○	○	○	○	○	○		△	○	○	△	○	○	○	○	○				○	○	○	△	△	△	△							
2118		○	○	○	○	○	○		△	○	○	△	○	○	○	○	○				○	○	○	△	△	△	△	△	△					
2120		○	○	○	○	○	○		△	○	○	○	○	○	○		△				○	○	○	△	△	△	△							
2121		○	○	○	○	○	○	○	△	○	○		○	○	○		△				○	○	○	△	△	△	△							
2122		○	○	○	○	○	○		△	○	○	○	○	○	○		△				○	○	○	△	△	△	△	△	△					
2124		○	○	○	○	○	○	○	△	○	○		○	○	○		△				○	○	○	△	△	△	△	△	△					
2125		○	○	○	○	○	○	○	△	○	○		○	○	○		△				○	○	○	△	△	△	△							
2126		○	○	○	○	○	○	○	△	○	○		○	○	○		△				○	○	○	△	△	△	△	△	△					
2127		○	○	○	○	○	○		△	○	○	△	○	○	○		△				○	○	○	△	△	△	△							
2128		○	○	○	○	○	○		△	○	○	△	○	○	○		△				○	○	○	△	△	△	△	△	△					
2130		○	○	○	○	○	○		△	○	○	○	○	○	○		△				○	○	○	△	△	△	△							
2131		○	○	○	○	○	○	○	△	○	○		○	○	○		△				○	○	○	△	△	△	△							
2132		○	○	○	○	○	○		△	○	○	○	○	○	○		△				○	○	○	△	△	△	△	△	△					
2134		○	○	○	○	○	○	○	△	○	○		○	○	○		△				○	○	○	△	△	△	△	△	△					
2135		○	○	○	○	○	○	○	△	○	○		○	○	○		△				○	○	○	△	△	△	△							
2136		○	○	○	○	○	○	○	△	○	○		○	○	○		△				○	○	○	△	△	△	△	△	△					
2137		○	○	○	○	○	○		△	○	○	△	○	○	○		△				○	○	○	△	△	△	△							
2138		○	○	○	○	○	○		△	○	○	△	○	○	○		△				○	○	○	△	△	△	△	△	△					

8. Tables of correspondences between operation codes and memory sheet setting items

List of setting items by operation code

User setting value must be input for the item No. marked with ○.
△… Operation varies depending on whether each setting item is specified.

Operation code	Memory sheet (0) Item No.			Memory sheet (1)–(4) Item No.																												Remarks
	00	01	02	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
2200				○	○	○	○		△	○	○	○	○								○	○	○	△	△	△	△							
2201				○	○	○	○	○	△	○	○		○								○	○	○	△	△	△	△							
2202				○	○	○	○		△	○	○	○	○								○	○	○	△	△	△	△	△	△					
2204				○	○	○	○	○	△	○	○		○								○	○	○	△	△	△	△	△	△					
2205				○	○	○	○	○	△	○	○		○								○	○	○	△	△	△	△							
2206				○	○	○	○	○	△	○	○		○								○	○	○	△	△	△	△	△	△					
2207				○	○	○	○		△	○	○	△	○								○	○	○	△	△	△	△							
2208				○	○	○	○		△	○	○	△	○								○	○	○	△	△	△	△	△	△					
2210				○	○	○	○		△	○	○	○	○								○	○	○	△	△	△	△							
2211				○	○	○	○	○	△	○	○		○								○	○	○	△	△	△	△							
2212				○	○	○	○		△	○	○	○	○								○	○	○	△	△	△	△	△	△					
2214				○	○	○	○	○	△	○	○		○								○	○	○	△	△	△	△	△	△					
2215				○	○	○	○	○	△	○	○		○								○	○	○	△	△	△	△							
2216				○	○	○	○	○	△	○	○		○								○	○	○	△	△	△	△	△	△					
2217				○	○	○	○		△	○	○	△	○								○	○	○	△	△	△	△							
2218				○	○	○	○		△	○	○	△	○								○	○	○	△	△	△	△	△	△					

Operation code	Memory sheet (0) Item No.			Memory sheet (1)–(4) Item No.																												Remarks
	00	01	02	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
2600				○	○	○	○		△	○	○	○	○	○	○	○	○				○	○	○	△	△	△	△							
2601				○	○	○	○	○	△	○	○		○	○	○	○	○				○	○	○	△	△	△	△							
2602				○	○	○	○		△	○	○	○	○	○	○	○	○				○	○	○	△	△	△	△	△	△					
2604				○	○	○	○	○	△	○	○		○	○	○	○	○				○	○	○	△	△	△	△	△	△					
2605				○	○	○	○	○	△	○	○		○	○	○	○	○				○	○	○	△	△	△	△							
2606				○	○	○	○	○	△	○	○		○	○	○	○	○				○	○	○	△	△	△	△	△	△					
2607				○	○	○	○		△	○	○	△	○	○	○	○	○				○	○	○	△	△	△	△							
2608				○	○	○	○		△	○	○	△	○	○	○	○	○				○	○	○	△	△	△	△	△	△					
2610				○	○	○	○		△	○	○	○	○	○	○	○	○				○	○	○	△	△	△	△							
2611				○	○	○	○	○	△	○	○		○	○	○	○	○				○	○	○	△	△	△	△							
2612				○	○	○	○		△	○	○	○	○	○	○	○	○				○	○	○	△	△	△	△	△	△					
2614				○	○	○	○	○	△	○	○		○	○	○	○	○				○	○	○	△	△	△	△	△	△					
2615				○	○	○	○	○	△	○	○		○	○	○	○	○				○	○	○	△	△	△	△							
2616				○	○	○	○	○	△	○	○		○	○	○	○	○				○	○	○	△	△	△	△	△	△					
2617				○	○	○	○		△	○	○	△	○	○	○	○	○				○	○	○	△	△	△	△							
2618				○	○	○	○		△	○	○	△	○	○	○	○	○				○	○	○	△	△	△	△	△	△					
2620				○	○	○	○		△	○	○	○	○	○	○		△				○	○	○	△	△	△	△							
2621				○	○	○	○	○	△	○	○		○	○	○		△				○	○	○	△	△	△	△							
2622				○	○	○	○		△	○	○	○	○	○	○		△				○	○	○	△	△	△	△	△	△					
2624				○	○	○	○	○	△	○	○		○	○	○		△				○	○	○	△	△	△	△	△	△					
2625				○	○	○	○	○	△	○	○		○	○	○		△				○	○	○	△	△	△	△							
2626				○	○	○	○	○	△	○	○		○	○	○		△				○	○	○	△	△	△	△	△	△					
2627				○	○	○	○		△	○	○	△	○	○	○		△				○	○	○	△	△	△	△							
2628				○	○	○	○		△	○	○	△	○	○	○		△				○	○	○	△	△	△	△	△	△					
2630				○	○	○	○		△	○	○	○	○	○	○		△				○	○	○	△	△	△	△							
2631				○	○	○	○	○	△	○	○		○	○	○		△				○	○	○	△	△	△	△							
2632				○	○	○	○		△	○	○	○	○	○	○		△				○	○	○	△	△	△	△	△	△					
2634				○	○	○	○	○	△	○	○		○	○	○		△				○	○	○	△	△	△	△	△	△					
2635				○	○	○	○	○	△	○	○		○	○	○		△				○	○	○	△	△	△	△							
2636				○	○	○	○	○	△	○	○		○	○	○		△				○	○	○	△	△	△	△	△	△					
2637				○	○	○	○		△	○	○	△	○	○	○		△				○	○	○	△	△	△	△							
2638				○	○	○	○		△	○	○	△	○	○	○		△				○	○	○	△	△	△	△	△	△					

8. Tables of correspondences between operation codes and memory sheet setting items

△… Operation varies depending on whether each setting item is specified.

Operation code	Memory sheet (0) Item No.			Memory sheet (1)–(4) Item No.																												Remarks
	00	01	02	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
3000									△	○	○		○																	○	○			
3001									△	○	○		○																	○	○	○	○	
3002									△	○	○		○															△	△	○	○			
3004									△	○	○		○															△	△	○	○	○	○	
3020									△	○	○		○																	○	○			
3021									△	○	○		○																	○	○	△	△	
3022									△	○	○		○															△	△	○	○			
3024									△	○	○		○															△	△	○	○	△	△	

Operation code	Memory sheet (0) Item No.			Memory sheet (1)–(4) Item No.																												Remarks
	00	01	02	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
4000									△	○	○		○																	○	○			
4001									△	○	○		○																	○	○	○	○	
4002									△	○	○		○															△	△	○	○			
4004									△	○	○		○															△	△	○	○	○	○	
4020									△	○	○		○																	○	○			
4021									△	○	○		○																	○	○	△	△	
4022									△	○	○		○															△	△	○	○			
4024									△	○	○		○															△	△	○	○	△	△	

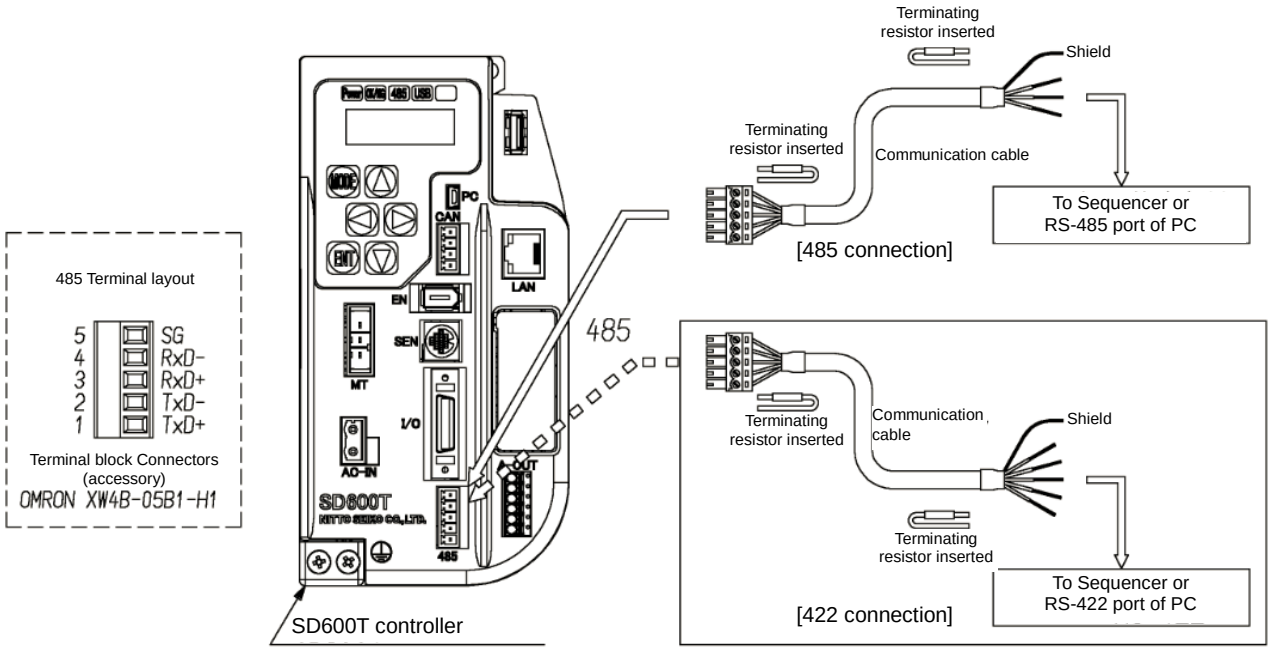
9. Communication function

9-1 Serial communication (automatic transmission of fastening results)

After fastening is completed, fastening results (such as torque data, final fastening angle data, and unseated screw data) can be automatically sent as serial data to external control devices (such as PLC).

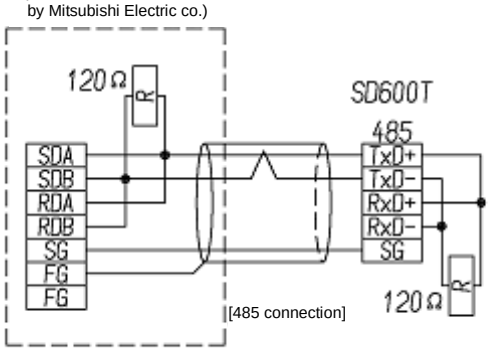
9-1-1 Connection method

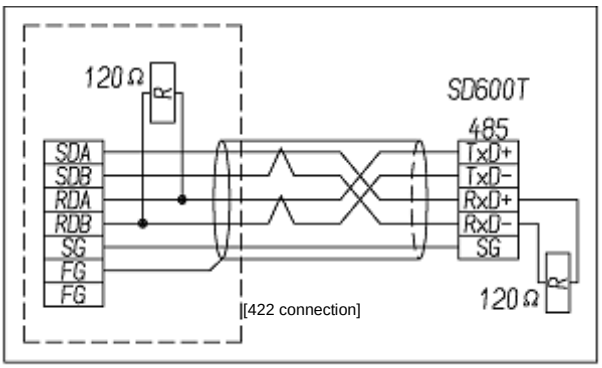
In the case of connection by RS485 (or RS422), please connect controller and external control devices (such as a PLC) with 1 to 1. (Refer to 9-1-2 for the structure of output data.)



In case of QJ71C24 (Serial communication unit by Mitsubishi Electric co.)

* The shield at only one end of each communication cable must be connected to a ground terminal or floor ground. (Both ground terminals of the controller must not be connected with a shield.)





[Communication port settings: 9600 bps, 8 bits, 1 stop bit, no parity]
[Terminating resistance value: 110 to 130 Ω]
[Cables listed for reference: U-TKVV BSAWG22 × 2P manufactured by Tachii Electric Wire Co., Ltd.
FKEV-SB 03 sq × 2P (AWG22, shielded twisted pair cable with two pairs of wires) manufactured by Fuji Electric Wire Industries Co., Ltd.
[Connector provided: XW4B-05B1-H1 manufactured by OMRON Corporation]

[Caution]

- The shield at only one end of each communication cable must be connected to a ground terminal or floor ground.
  (Both ground terminals of the controller must not be connected with a shield.)
- The number of connector pins differs between the SD550 series (6 pins) and the SD600T (5 pins). When replacing an SD550 series controller with an SD600T controller, take care to perform wiring correctly.

9-1-2 Checking the data structure as preparation for controller setup

Transmission data is classified into data that is sent as fastening results after fastening is completed and data that is sent as string “START” before fastening is started. The data structure of fastening results is divided into three types according to the memory sheet settings. See “Table: Relationship between set values and data structure” and “Data configuration (1)” to “Data configuration (4)” below.

* Changing the following memory sheet settings changes the data structure. After changing any settings, always check if the data structure is the same as the intended data structure.

- Item No. 5 (“Number of data outputs”)
  This item specifies how many times data can be sent in a single operation. It can also specify whether to send string “START”.

- Item No. 20 (“Screw height judgment 1”), item No. 21 (“Screw height judgment 2”)
  If item No. 21 (“Screw height judgment 2”) is set to “0000”, judgment will be disabled and screw height judgment data will not be sent.

- Item No. 22 (“Upper final fastening angle judgment”), item No. 23 (“Lower final fastening angle judgment”)
  If item No. 22 (“Upper final fastening angle judgment”) is set to “0000”, judgment will be disabled and final fastening angle judgment data will not be sent.

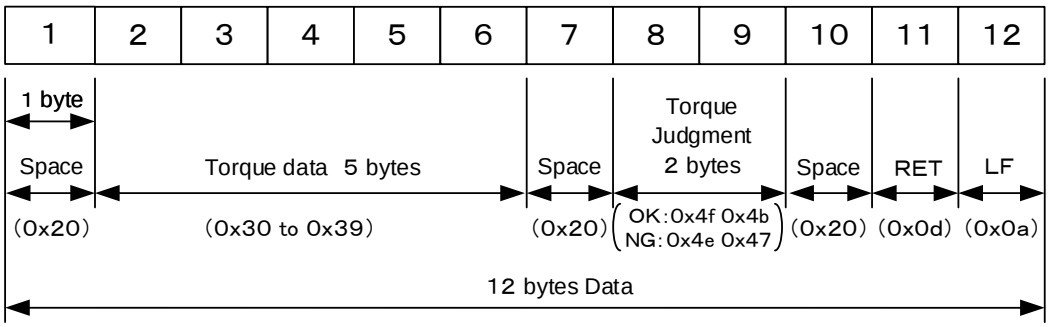
Table: Relationship between set values and data structure

Memory sheet setting item	Setting value[Note1]					
Number of data outputs (Item No. 5)	*001–*005				0000	1***
Screw height judgment (Item Nos. 20, 21)	×	○	×	○	—	—
Final fastening angle judgement (Item Nos. 22, 23)	×	×	○	○	—	—
Figure number corresponding to the data structure of transmission data	(1)	(2)		(3)	[note2]	(4)

[Note 1]: “*” means an arbitrary numerical value.
“o” means a certain value having been set, and “×” means the value not having been set.
[Note 2]: The data are not transmitted.

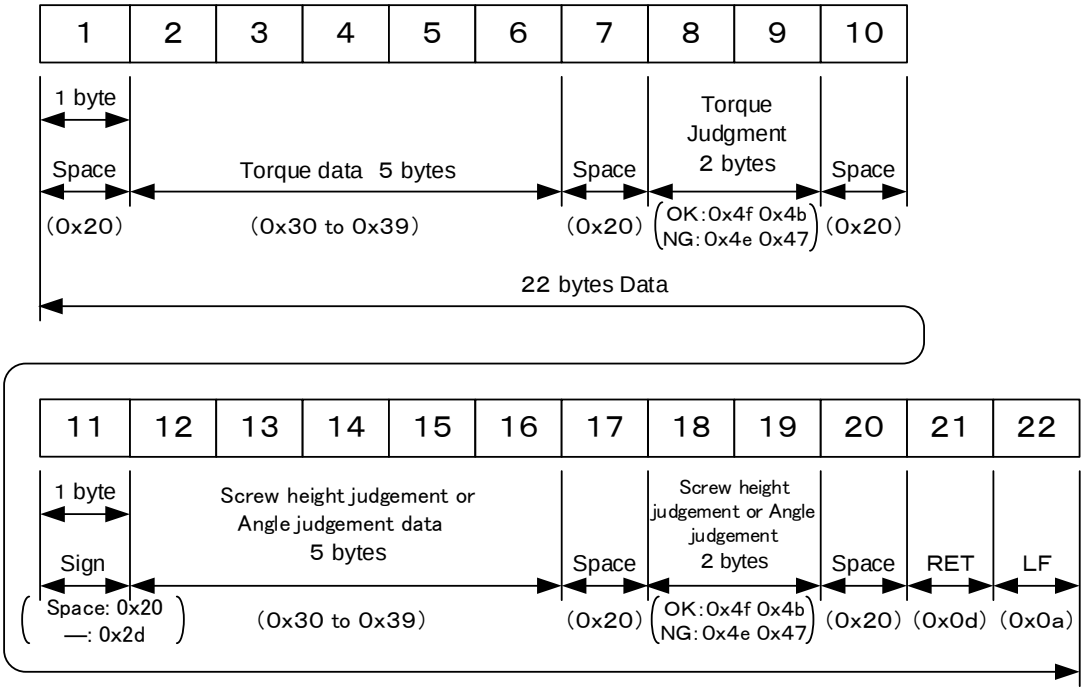
Data configuration

(1)When fastening operation only



- Data transmission example : __00100__OK__

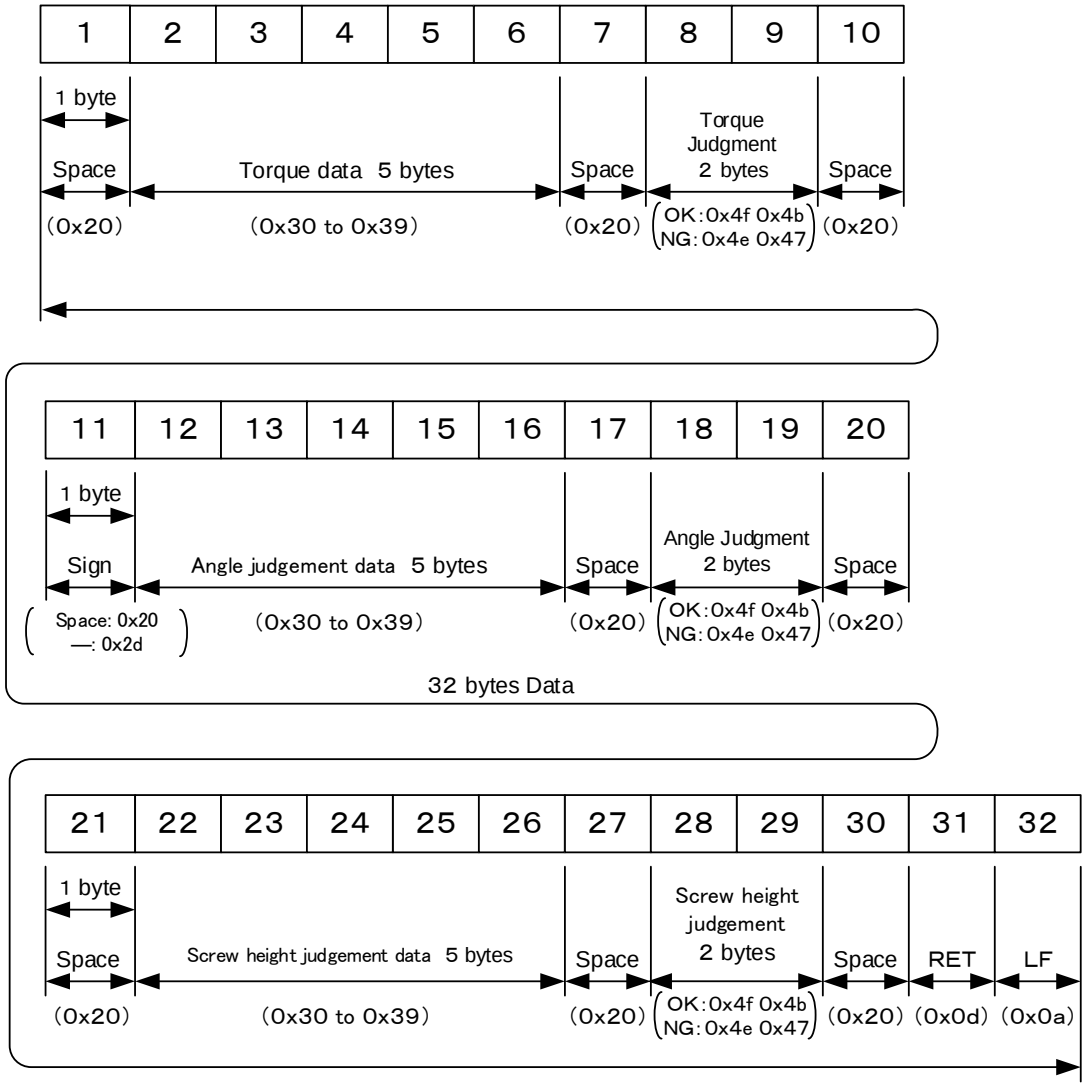
(2)When fastening operation with screw height judgement or final fastening angle judgement



- Data transmission example : __00100__OK____00150__OK__

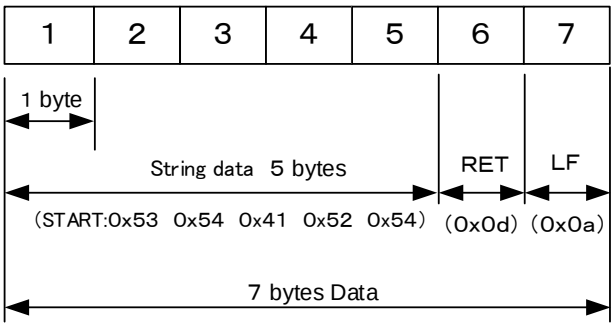
Data configuration

(3) When fastening operation with final fastening angle judgement and screw height judgement



- Data transmission example : _00100_OK___00150_OK___00300_OK_

(4) String sent when screw fastening starts

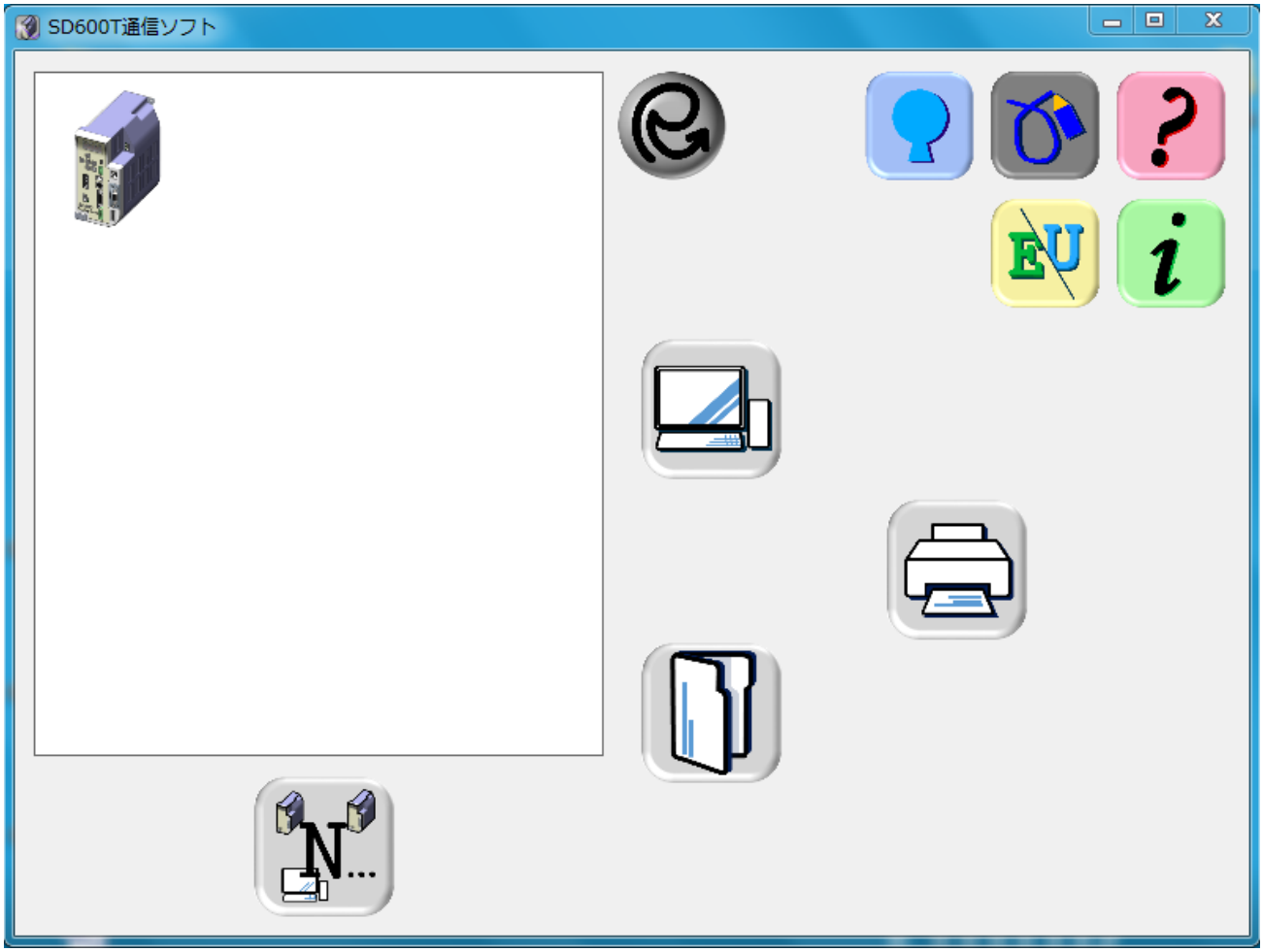


- Data transmission example : START

* Whether to send the string depends on the value specified for "Number of data outputs".

9-2 Dedicated PC software “SD600T Communication Software”

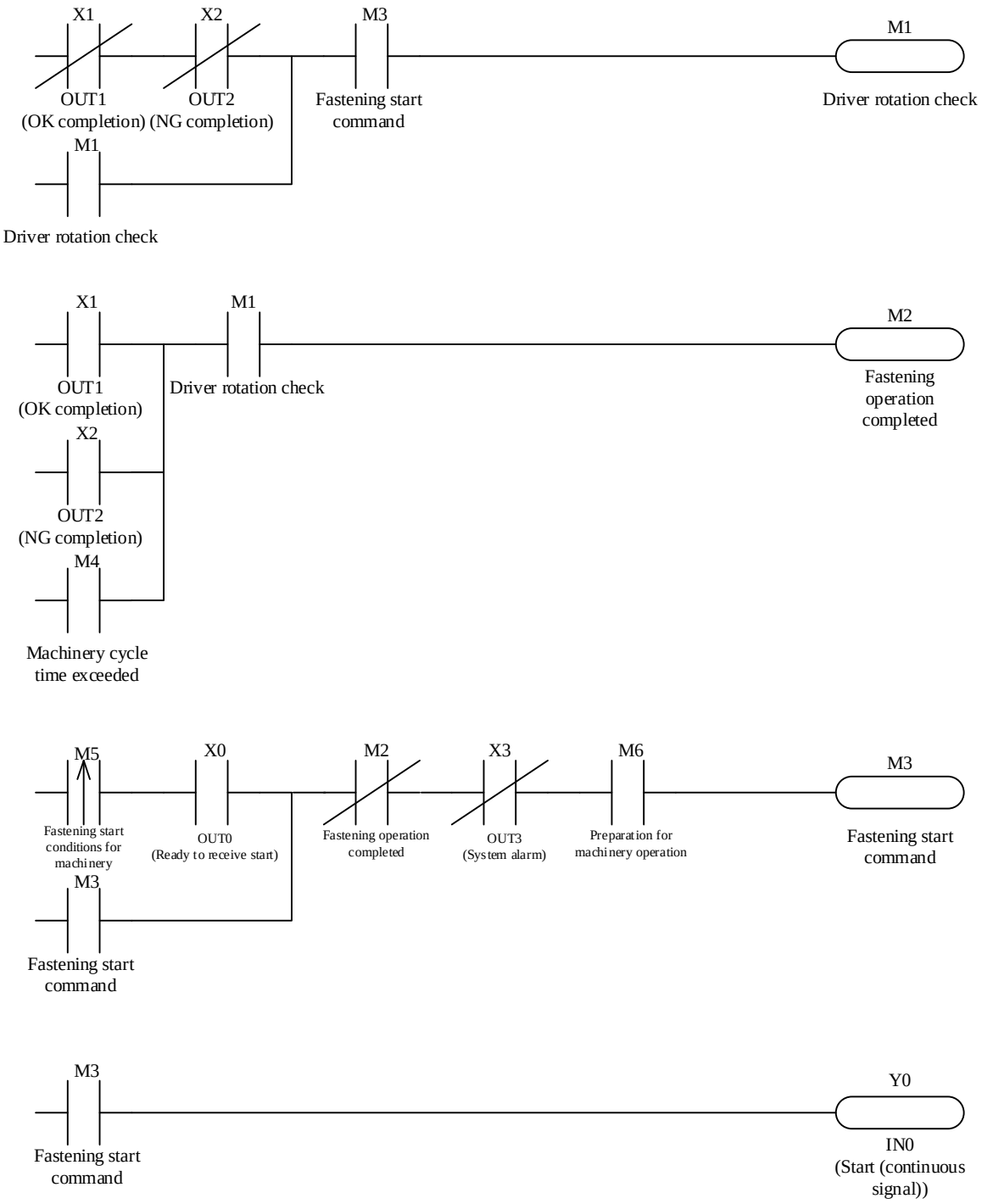
Dedicated PC software “SD600T Communication Software” can communicate with the controller via serial communications (using the Mini USB connector) or Ethernet communications (using the Ethernet connector). This software allows the user to change memory sheet settings, write the settings for the torque waveform processing function, and perform data collection (such as collecting and saving fastening results, and collecting and saving waveform data). For details, refer to the instruction manual for “SD600T Communication Software”.



10. Appendix

- **Example of sequence creation**

This chapter shows an example of a sequence that holds IN0 (Start signal) from the beginning to the completion of operation. However, this does not guarantee operations based on all specifications, so create a sequence according to the specifications that you use.



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