

# HITACHI INVERTER

WJ200 SERIES

**WJ-FS** (Functional Safety Option)

## Instruction Manual

Thank you for purchase of "HITACHI INVERTER SERIES." This manual outlines the handling of "WJ-FS (Functional Safety Option)" Refer to this manual and the instruction manual of the inverter for installation, maintenance, and inspection.

After reading this manual, keep it handy for future reference.  
Be sure to deliver this manual to the end user.

**After reading this manual, keep it handy for future reference.**

**HITACHI**

NT340DX



**- Request -**

Thank you for purchase of “WJ-FS (Functional Safety option)”.

This manual outlines the handling and maintenance of “WJ-FS”. Before using the product, carefully read this manual with the instruction manual of inverter, and keeps it handy for quick reference of operator and maintenance inspector. Read this manual carefully and follow the instructions exactly, before installing, operating, maintenance and inspection.

Always keep various kinds of specifications mentioned in this manual and use exactly. Be sure to prevent trouble by correct inspection and maintenance. Make sure to deliver this manual to the end user.

**- Treatment of this manual-**

- (1) Please understand that mentioned items in this manual may be changed without permission.
- (2) Keep this manual carefully not to lose because it cannot be reissued.
- (3) All right reserved.
- (4) Please understand that the functions that are not listed in this manual shall mean that "they are not supported".
- (5) If you find any incorrect description, missing description or have a question or inquiry concerning the contents of this manual, please contact your nearest Hitachi distributor.
- (6) Please understand that we hold no responsibility for any resulting effects, in spite of the above mentioned content.

**Revision History Table**

No.	Manual No. (Revision)	Date of Issue	Revised content
1	NT340AX	2016/03/22	First Edition
2	NT340BX	2016/04/06	Correction of typographical error
3	NT340CX	2016/05/06	Modification of section 7.3 Requirement for Wiring on WJ-FS
4	NT340DX	2016/07/12	Update of standards

**-Troubleshooting –**

Please refer to chapter 12 in this manual.

**-Original instruction-**

This English manual is the original instruction manual for the functional safety option WJ-FS.

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## SAFETY PRECAUTIONS

### SAFETY PRECAUTIONS

Carefully read this manual and all of the warning labels attached to WJ-FS and the inverter before installing, operating, maintaining, inspecting. Safety precautions are classified into “Warning” and “Caution” in this manual.

 **WARNING** : Indicates a potentially hazardous situation which, if not avoided, can result in serious injury or death.

 **CAUTION** : Indicates a potentially hazardous situation which, if not avoided, can result in minor to moderate injury, or serious damage to the product

The situation described in  **CAUTION** may, if not avoided, lead to serious results. Important safety measures are described in CAUTION (as well as WARNING) so be sure observe them.

Notes are described in this manual in “(Note).” Carefully read the contents and follow them exactly.



### CAUTION

In all the illustrations in the manual of inverter and this manual, covers and safety device are occasionally removed to describe the details. When the inverter is operated, make sure that the covers and safety devices are placed as they were specified originally and operate it according to the instruction manual of inverter and this product.



## WARNING

Wiring:

Wiring work shall be carried out by electrical experts.

**Otherwise, there is a danger of electric shock, fire and/or damage of product.**

Implement wiring after checking that the power supply is off.

**Otherwise, there is a danger of electric shock and/or fire.**

Be sure not to operate electrical equipment with wet hands.

**Otherwise, there is a danger of electric shock and/or injury.**

Concerning the cables, please do not injure, cause stress or pinch

**Otherwise, there is a danger of electric shock.**

Operating:

Please do not open the inverter's and WJ-FS's case or optional case during power supply is on, and, please do not carry out the following operation during power supply is on.

- (1) Please do not open the inverter's case or optional case.
- (2) Please do not touch the inside (e.g. terminal parts).
- (3) Please do not check the internal signal.
- (4) Please do not put on or take off the internal wiring and connector.

**Otherwise, there is a danger of electric shock and/or fire.**

Do not touch the conductive parts such as the internal PCB, terminals or connector while the power is being supplied.

**Otherwise, there is a danger of electric shock.**

Be sure not to remove this product while inverter is powered ON.

**Otherwise, there is a danger of electric shock and/or fire.**

Maintenance, Inspection and Part Replacement:

Wait at least 10 minutes after turning off the input power supply before performing maintenance and inspection.

(Confirm the charge lamp on the inverter is off, checks direct current voltage between P-N terminals and confirm it is less than 45V)

**Otherwise, there is a danger of electric shock.**

Make sure that only qualified persons will perform maintenance, inspection, and part replacement

Before starting the work, remove metallic objects from your person (wristwatch, bracelet, etc.).

Be sure to use tools protected with insulation.

**Otherwise, there is a danger of electric shock and/or injury.**

Please do not carry out insulation resistance (megger) and voltage proof test

**Otherwise, there is a danger of electric shock and/or a possibility that the product will get damaged.**

Note:

Never disassemble / repair / modify the unit.

**Otherwise, there is a danger of electric shock and/or injury.**

**Additionally safety-related certification and CE self-declaration of this product are no longer valid.**

- **This is a safety-related product. It is a responsibility of user to conduct risk analysis of whole safety-related system where this product is used.**
- **Configuration of safety-related system using this unit must be conducted only by qualified persons.**
- **Be sure to conduct commissioning test to verify the STO function of WJ-FS and inverter before starting the actual operation of the system.**

### CAUTION

#### Installation:

Be sure not to let the foreign matter such as wire clippings, spatter from welding, metal shaving, dust etc enter the unit.

**Otherwise, there is a danger of fire.**

Be sure to install this product in a cabinet with a protection of IP54 or higher.

**Otherwise, the conformity to the safety norms is not valid.**

Be sure to fix this product to the inverter using an attached fixed screw.

**Otherwise, there is a danger of connecting error.**

Be sure to fasten the screws connecting signal wire in side of this product and check for any loosening of screws, and make sure that the all switches have been set properly.

**Otherwise, there is a danger of connecting error or malfunction.**

Be sure that all cable connector screws are tightened with the torque specified in the relevant manual.

**Otherwise, improper tightening torque may result in malfunction.**

In order to prevent damage on the product caused by static electricity, please remove the static electricity of the body by touching the metal nearby before touching this product.

**Otherwise, there is a possibility that the product will get damaged.**

Please do not carry out insulation resistance (megger) and voltage proof test

**Otherwise, there is a danger of electric shock and/or a possibility that the product will get damaged.**

Be careful of the followings

- When removing WJ-FS, do not pull the wiring cables.
- When mounting WJ-FS, be sure that the wirings are not pinched.
- When mounting WJ-FS. Be careful of burrs of the break-outs on the inverter.

**Otherwise, there is a possibility that the product will get damaged.**

#### Wiring:

Be sure to fasten the screws so they will not come loose.

**Otherwise, there is a danger of a connection error.**

Be sure that all cable connector screws are tightened to the torque specified in the relevant manuals.

**Otherwise, improper tightening torque may result in malfunction.**

#### Operation:

Check rotary direction, abnormal motor noise and vibrations during operating.

**Otherwise, there is a danger of injury to personnel and/or machine breakage.**

Check the inverter's EzSQ program and its interaction with the safety function and system before actually running it on the inverter.

**Otherwise, there is a danger of injury to personnel and/or machine breakage.**

If an unexpected phenomenon happens, please do not touch the product, the inverter and cables.

**Otherwise, there is a danger of injury to personnel.**

#### Maintenance and inspection:

**Daily inspection** and periodical test must be performed only by the engineer who has enough knowledge of the functional safety.

**Otherwise, there is a danger of injury to personnel and/or machine breakage.**

## 1.1 Check at the time of the purchase

Make sure to treat the product carefully not to give shock and vibration while unpacking. Check that the product is the one you have ordered, no defect, and that there is no damage during transportation.

Contents of packing:

- (1) WJ-FS (Functional Safety option): 1 piece



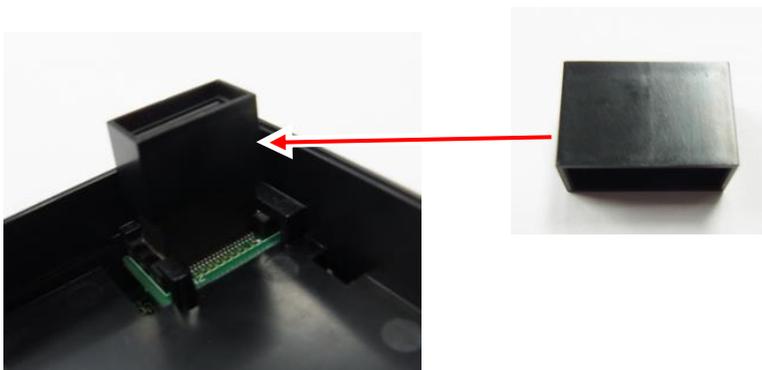
- (2) Instruction manual: 1 copy (this manual)

- (3) Adhesive tape (Black color / round shape): 4 pcs (2 pcs are for spare)

If you find any problems, contact your sales agent immediately.

Please keep the original packing box/material and return all of them for the factory investigation.

Note: Please be careful not to lose the connector cover attached on the connector of WJ-FS.



## 1.2 Inquiry of the product and warranty for the product

### 1.2.1 Requirements while inquiring

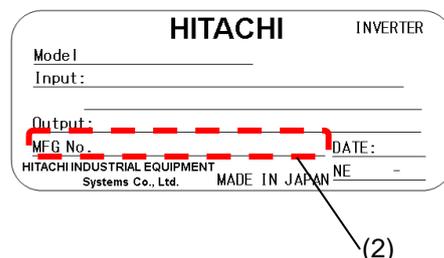
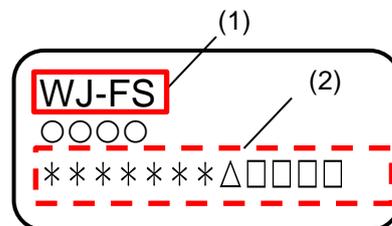
If inquiry of breakage, question, damage etc. is needed, please relay the following information about WJ200 and WJ-FS to the supplier from which you ordered or the nearest Hitachi Distributor.

- (1) Type of product: WJ-FS
- (2) Manufacturing number (code)

The manufacturing number of WJ-FS is written in a specification label attached on the side of this product. See the part enclosed by the dot line in the figure on the right. (Refer to section 13.2)

For the specification label of WJ200, please refer to the instruction manual of WJ200

- (3) Date of purchase
- (4) Contents of inquiry
  - Damage parts and its condition etc.
  - Question parts and their contents etc.



In order to shorten downtime of system, utilizing a replacement unit is recommended.

### 1.2.2 Warranty of the product

The warranty period under normal installation and handling conditions shall be 2 (two) years from the date of manufacture, or 1 (one) year from the date of installation, whichever occurs first. The warranty shall cover the repair or replacement, at Hitachi's sole discretion, of ONLY the product that was installed.

- 1. Service in the following cases, even within the warranty period, shall be charged to the purchaser:
  - (1) Malfunction or damage caused by miss-operation, modification or improper repair.
  - (2) Malfunction or damage caused by a drop after purchase and transportation
  - (3) Malfunction or damage caused by fire, earthquake, flood, lightning, abnormal input voltage, contamination, or other natural disasters.
  - (4) Malfunction or damage caused by use in range out of specification.
- 2. When service is required for the product at your work site, all expenses associated with field repair shall be charged to the purchaser.

Warranty mentioned here means warranty for shipped product itself. Damage caused by trouble of shipped product is not guaranteed.

[Replacement]

Any inspection and replacement after the expiration of warranty period (one-year) shall be charged to the purchaser. If you require the replacement, please contact your sales representative.

## 1.3 Modification of product

Modifying the product is strictly prohibited. Any modification of product will lose its conformity to functional safety standards and other standards immediately.

## 1.4 Compatibility (Applicable inverter model, series name)

WJ-FS realizes STO function only when mounted on the inverter series listed below and having STO certification.

No	Series	Remark
1	WJ200 series inverter	Only models have safety (STO) function certification (see below)

WJ-FS must be used in combination with the inverter models listed below. No conformities to any functional safety norm, thus Machinery Directive, are valid with the inverter models which are not listed below or with any additional suffix at the end of the models code from the ones listed below.

Model WJ200, followed by -001SF, -002SF, -004SF, -007SF, -015SF, -022SF.

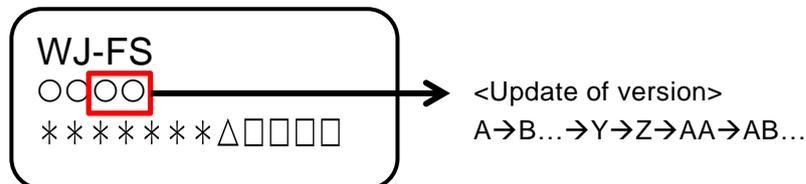
Model WJ200, followed by -001LF, -002LF, -004LF, -007LF, -015LF, -022LF, -037LF, -055LF, -075LF, -110LF, -150LF.

Model WJ200, followed by -004HF, -007HF, -015HF, -022HF, -030HF, -037HF, -040HF, -055HF, -075HF, -110HF, -150HF.

## 1.5 Version of Product

For a version of the product, please refer to the codes in the specification label marked in the figure below. (The third and fourth letter in the second line of the specification label)

The version code starts from a single letter of "A" and then is updated to "B".



## 2.1 Outline of the product

WJ-FS is a functional safety option which is always used in combination with the inverter listed in the section 1.4 to realize Safe Torque Off (STO) function. Please note that STO functionality is only achieved in combination with the inverter and WJ-FS alone does not realize STO functionality.

WJ-FS provides the following functions:

- Transferring safety-related signal (STO signal) to the inverter
- Diagnosis of safety-related paths in the inverter using feedback signal (EDM signal) from inverter
- Diagnosis of safety-related paths in WJ-FS
- Manual reset (optional) (In factory default setting, it is set to the automatic reset mode. See the section 3.5 for detail)

Note: When WJ-FS is not used, STO functionality of the inverter listed in the section 1.4 is achieved only in combination with an external safety unit. For the detailed information, please refer to the instruction manual of the inverter.

## 2.2 Standard and safety-related parameters

The safety-related function with safety-related parameters becomes effective when WJ-FS is installed and operated as instructed in this manual and that for inverter.

The supported safety-related function by WJ-FS and its safety-related parameters are described in the table below.

### Safety function

Function to shut off motor torque

Function	Standard
STO (Safe Torque Off)	IEC61800-5-2:2016
Stop category 0	EN 60204-1: 2006+AC:2010

### Safety related parameter for WJ-FS (without inverter)

Safety Parameter	Value	Standard
PL	d	EN ISO 13849-1:2015
CAT.	3	
MTTFd	100 years	
DCavg	99%	
SIL	2	IEC61508: 2010
HFT	1	IEC61800-5-2:2016
SFF	98.9%	EN 62061:2005+A1:2012+A2:2015
PFH	$1.11 \times 10^{-8}$	

## 2.3 Exclusion of liability

The information and examples given in this manual are for general use only. They do not describe all necessary details for developing a safety-related system. The manufacturer of machinery is always ultimately responsible for the product safety and compliance with applicable norms and laws.

Hitachi does not accept any liability for direct or indirect injury or damage caused by misuse of product not following the instructions provided in this manual. Hitachi hereby disclaims all liabilities that may result from misuse of product.

## **2.4 Supported safety function (STO)**

This manual provides instructions for creating Safe Torque Off function for the inverter on which WJ-FS is installed.

## **2.5 Target audience**

The manual is intended for qualified persons who design the safety-related application, plan the installation as well as install and commission the safety-related application. Before working on the safety-related application, read this manual and the manual for the inverter. The reader is expected to have the fundamental knowledge of functional safety and electrical technologies.

## **2.6 Requirement for user**

(1) Risk analysis and system configuration

It is the responsibility of manufacturer of machinery to conduct risk analysis of the total system and build a system in consideration of the result of the risk analysis.

(2) This is a safety-related product. A user shall understand the safety-related standards, handling, inspection and functions of this product.

### **3.1 Safe torque off (STO) function of WJ-FS and Inverter**

WJ-FS supports input redundancy. The redundant safety-related inputs given from terminal ST1 and ST2 of WJ-FS are transferred to the inverter. When safety-related inputs are given from WJ-FS to inverter, it disables the drive output, i.e. the power supply to the motor is cut by stopping the switching of the output transistors in a safe way.

The STO function is activated by removing current flow on terminal ST1 and ST2. Always use both inputs to disable the output of the inverter.

### **3.2 Reaction time**

The reaction time after current flows removed from the terminal ST1 and ST2 of WJ-FS until STO outputs to inverter are activated is less than 10ms. The reaction time of inverter is also less 10ms, and therefore the total reaction time of STO function (combination of WJ-FS and inverter) is less than 20ms.

### **3.3 Supported diagnostic function**

WJ-FS supports following diagnostic functions:

- Diagnosis of the safety-related paths of WJ-FS
- Diagnosis of the safety-related paths of inverter by using EDM signal given from inverter.

When a failure is detected in safety-related paths of WJ-FS and/or inverter, WJ-FS activates STO command to inverter and it is kept until powered down.

Note: WJ-FS does not diagnose any failure of external device. It is required to ensure that two independent safety-related inputs are given simultaneously to ST1 and ST2 terminals of WJ-FS.

### **3.4 Start-up test (Self- diagnosis)**

WJ-FS activates STO function for approx. 200ms after power-up to diagnose the safety-related paths of WJ-FS and inverter. During this start-up test, output to motor is disabled.

### **3.5 Reset function**

Once the STO inputs (ST1, ST2) to WJ-FS are activated, STO outputs to inverter are activated as well and the inverter goes into STO status. This status is kept until the release condition of the selected reset mode is established. There are two options of reset mode to release STO status:

#### **1. Automatic reset (default setting)**

STO outputs to the inverter are automatically released when both STO inputs of WJ-FS are released. Please note that, in this reset mode, if the both STO inputs (ST1/ST2) are released while the RUN command to the inverter is being given, the inverter automatically starts operation of the motor. In order to prevent unintentional restart according to EN 60204-1, section 9.2.5.4.1, either of the measures below must be taken by a system:

- (1) When STO inputs are given to WJ-FS, RUN command to the inverter must be set to OFF. The RUN command must be kept OFF until intentional start command is given by a person after STO inputs to WJ-FS have been released.
- (2) Configure a system, by using for example a safety relay, so that STO inputs to WJ-FS are not released until an intentional start command is given by a person after releasing stop command of a system.

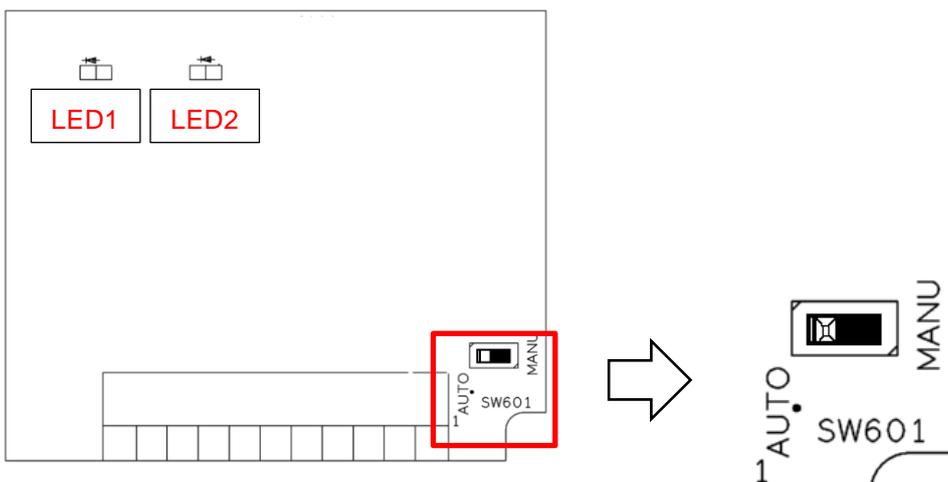
## 2. Manual reset

In case that manual reset is selected, STO outputs to the inverter are not released even both STO inputs (ST1 / ST2) are released.

In order to release STO status, a reset signal needs to be given from the dedicated reset input terminal (RST) while both STO inputs (ST1 and ST2) are inactive.

Automatic and manual reset mode can be selected by setting physical switch on WJ-FS.

**Note: The selection of the reset mode shall be made by the qualified person of the safety-related system. The person shall understand the difference of the release behavior of those reset mode. An appropriate reset mode to achieve the requirements of the safety-related system must be selected.**



Note: The manual reset function of WJ-FS meets the requirements in the section 5.2.2 of ISO 13849-1:2006.

## 3.6 Indicator LEDs

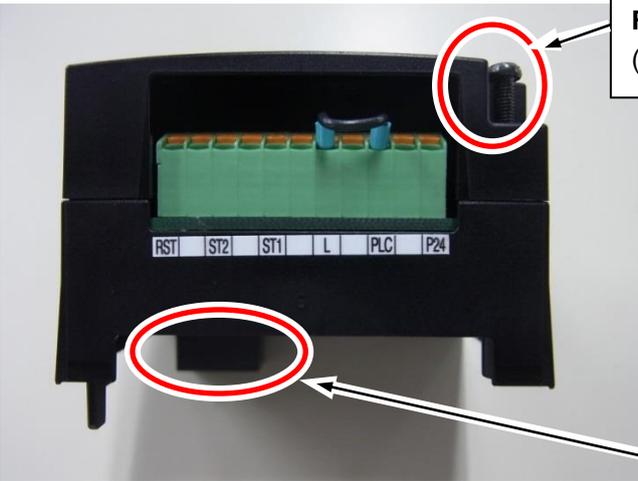
WJ-FS has two status indicator LEDs. The status indicated by the LEDs is described in the table below.

Status	LED1	LED2	Status
#1	ON	ON	Powered up (No failure detected)
#2	OFF	ON	Internal failure in WJ-FS is detected
#3	ON	OFF	Internal failure in inverter is detected or/and Internal failure(s) in WJ-FS is(are) detected
#4	OFF	OFF	When power is not supplied: Powered down
			When power is supplied: Internal failure of WJ-FS

# 4.1 Appearance and each part name

WJ-FS external description is the following. For more information about the LEDs and the connector, please refer to each page mentioned.

**Status LED:**  
 The LEDs indicates failure detection status in the safety-related paths.  
 LED 1  
 LED 2  
 See chapter 3.6 for detailed information

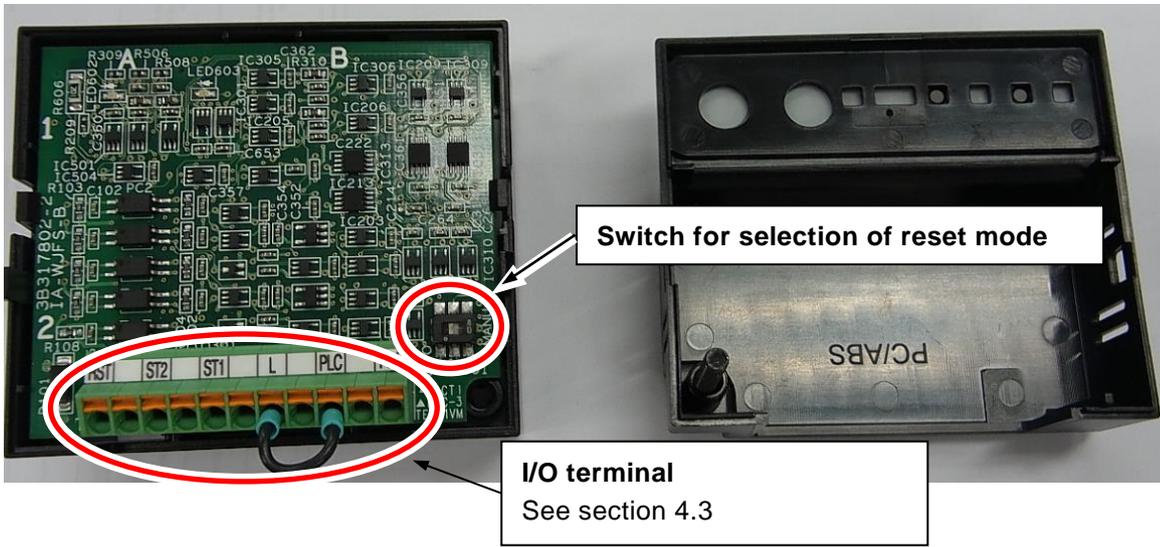


**Fixing screw**  
 (For attachment to inverter)

**Installation connector (connection to inverter)**  
 (See Section 5.2)



**Cover removed**



**Switch for selection of reset mode**

**I/O terminal**  
 See section 4.3

## 4.2 Summary of all parts

The descriptions and specifications of the LEDs, the switch and the I/O terminal are described below.

### (1) LEDs

The two LEDs indicate status of failure detection in safety-related paths by WJ-FS. (During powered up)

Name	Color	Description
LED1	Red	Turns off when a failure is detected in the safety-related paths of WJ-FS
LED2	Red	Turns off when a failure in the safety-related paths of inverter or/and failure(s) in the safety-related paths of WJ-FS is (are) detected.

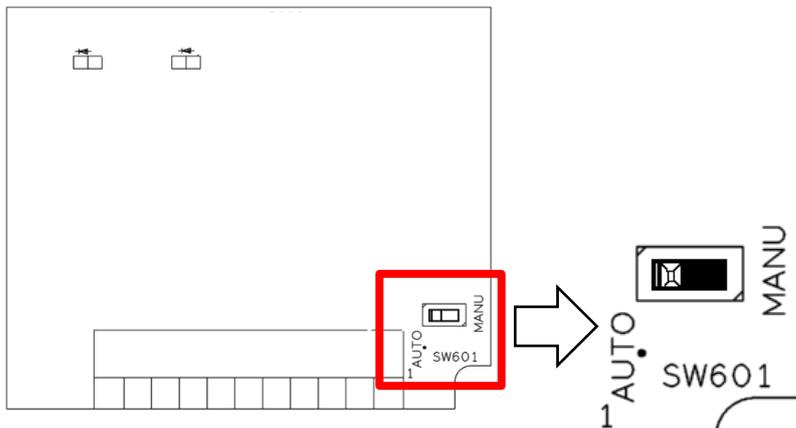
**NOTE:** This LED indication may differ from the actual failure status.

### (2) Reset mode selection switch

The switch on WJ-FS is used to select reset mode of STO function.

The factory default setting of the switch is automatic reset mode.

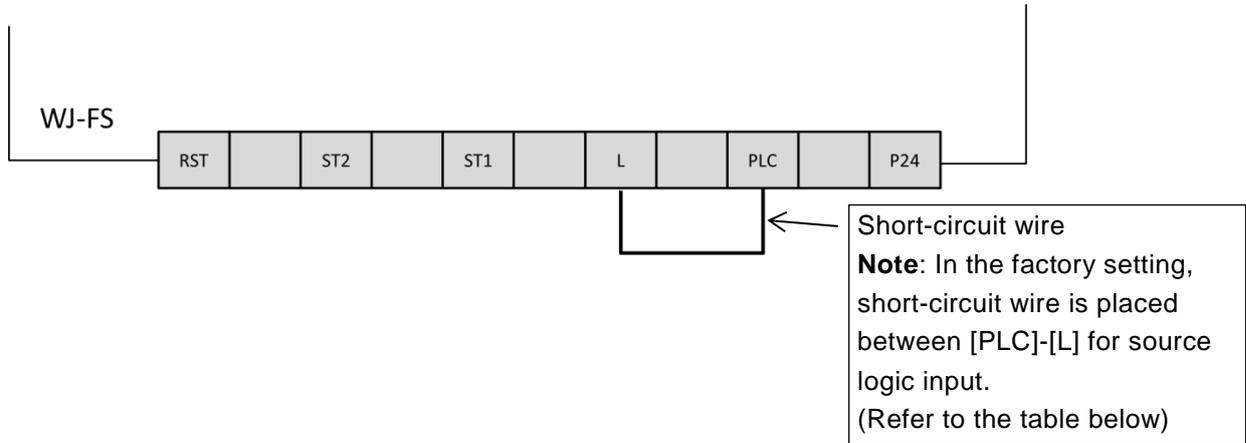
Item	Reset mode	Description
AUTO (Left) (Default)	Automatic reset	STO is released when both STO inputs (ST1, ST2) are released (both STO inputs are ON)
MANU (Right)	Manual reset	STO is released when reset input is given to RST terminal of WJ-FS while both STO inputs are released (both STO inputs are ON)



(3) I/O terminal

The terminal arrangement, names and specification of the I/O terminal are described below.

**Terminal arrangement**



**Name and specification**

Terminal	Name	Description	Rating
P24	DC24V power supply	DC24V Internal power supply for interface circuits. Common with [P24] terminal of inverter	Max.100mA *1
PLC	ST1, ST2, RST inputs common	(1)For selection of sink and source logic by changing position of short-circuit wire - Source: Between [PLC]-[L] (Default) - Sink : Between [PLC]-[P24] (2)For selection of use of internal and external power supply (See section 7.3 and 7.5)	
L	Ground for DC24V power supply	Ground for DC24 power supply. Common with [L] terminal of inverter	
ST1	STO1 input	Input terminal for STO1 input	<[ST1]/[ST2]/[RST]-[PLC]>
ST2	STO1 input	Input terminal for STO2 input	Minimum ON threshold: 18V Maximum OFF threshold: 3V
RST	Reset input terminal	Input terminal for manual reset of STO status.	Load current: 5mA at 24VDC input -Maximum DC27V

Note 1: P24 terminal is common with P24 of the control terminal of inverter.

The indicated maximum allowable current is total current of P24. (WJ-FS + inverter total)

## 5.1 Before attaching WJ-FS

Ensure that the inverter has been powered down before mounting WJ-FS.

## 5.2 Attachment procedure

- ① Loosen the screw of the optional board cover on inverter.



- ② Detach the terminal cover



- ③ Complete wiring on the control terminal and main terminal of inverter.  
 \*Wiring cannot be done when WJ-FS is installed.  
 \*For wiring, please refer to the instruction manual of inverter.  
 \***No wiring shall be made on control terminal 3 and 4 of inverter.**

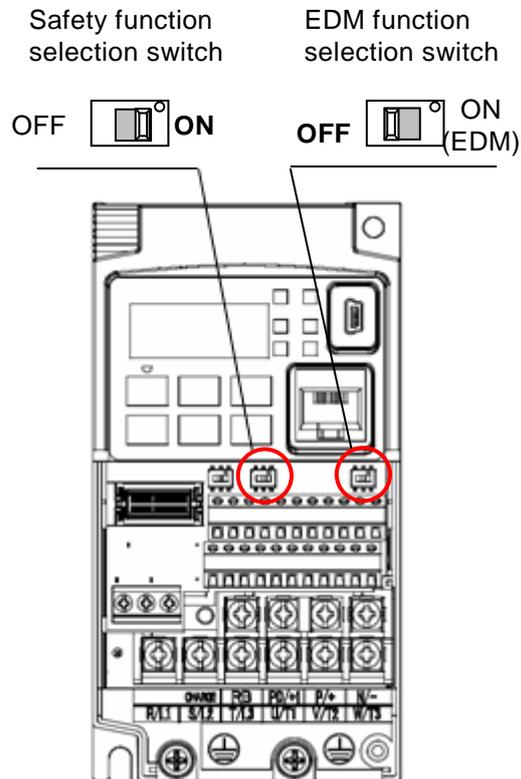


## Chapter 5

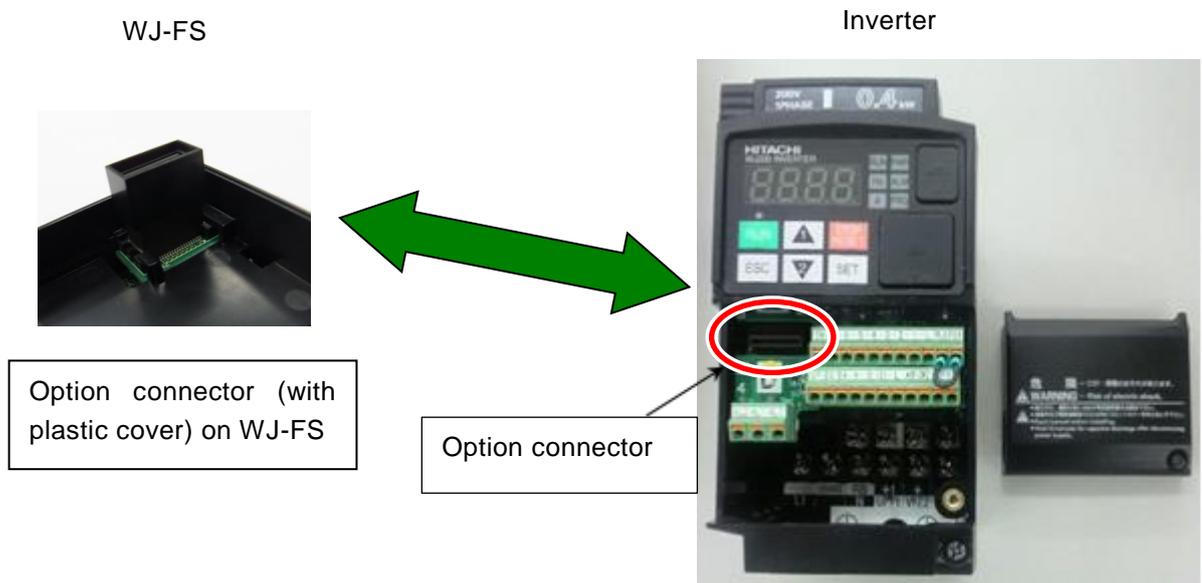
- ④ Set the selection switches on inverter

**“Safety function selection switch” to ON, and “EDM function selection switch” to OFF.**

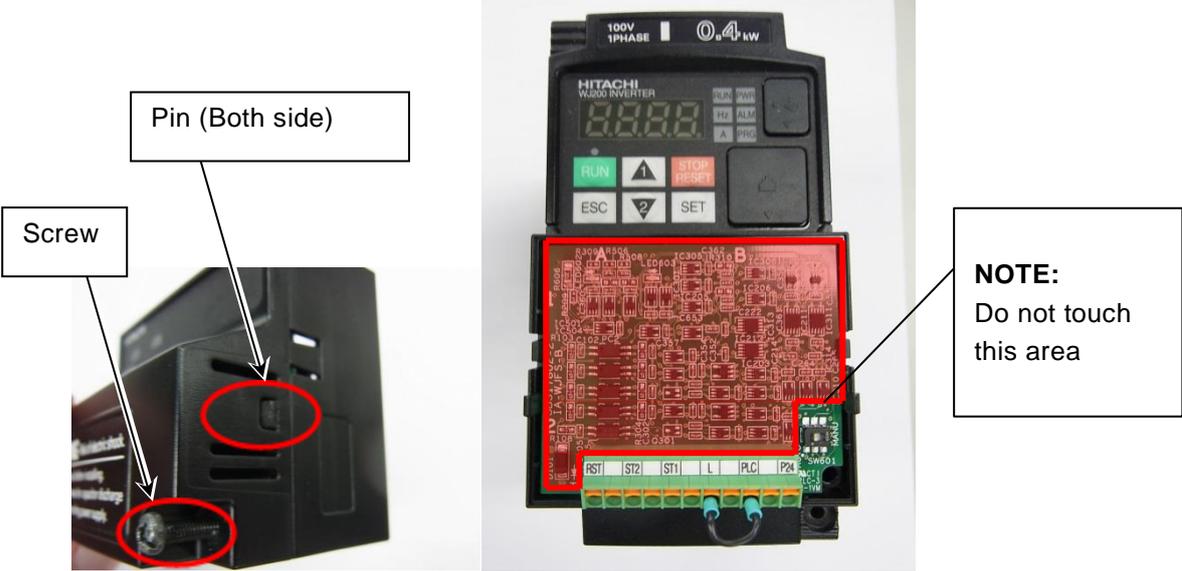
\* Please ensure to set these switches as instructed above. Otherwise, safety function does not function properly.



- ⑤ As positioning the connector of WJ-FS and option connector of inverter, install WJ-FS onto inverter carefully and slowly. Be careful to match the connectors straight and not to break the hooks.



- ⑥ Loosen the screw of WJ-FS and remove the cover as softly pushing fixing pins on the sides using a tool such as a screw driver. Please be careful not to break pins.



- ⑦ Set the reset mode selection switch if necessary and perform wiring on the I/O terminal of WJ-FS.
- ⑧ Attached the cover of WJ-FS and tighten the screw attached to WJ-FS.



Please check the connection between WJ-FS and the inverter via the connector.

## 5.3 Attachment of Adhesive tape

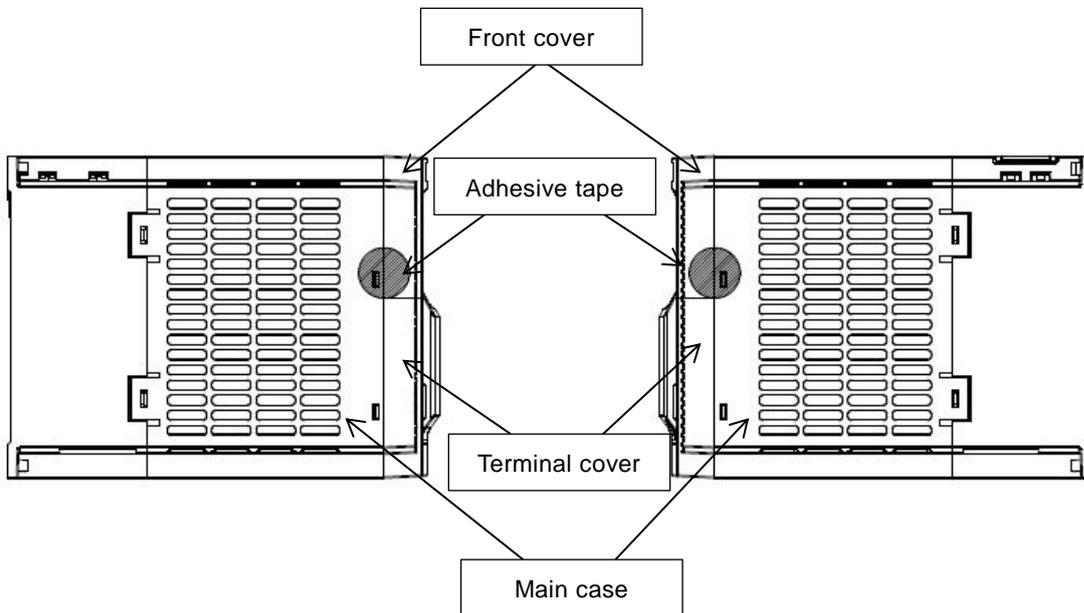
After attaching WJ-FS to WJ200, the two enclosed adhesive tapes (refer to section 1.1) must be attached on the both side of the WJ200 inverter.

For the pasting positions for each frame size, please refer to the figures below.

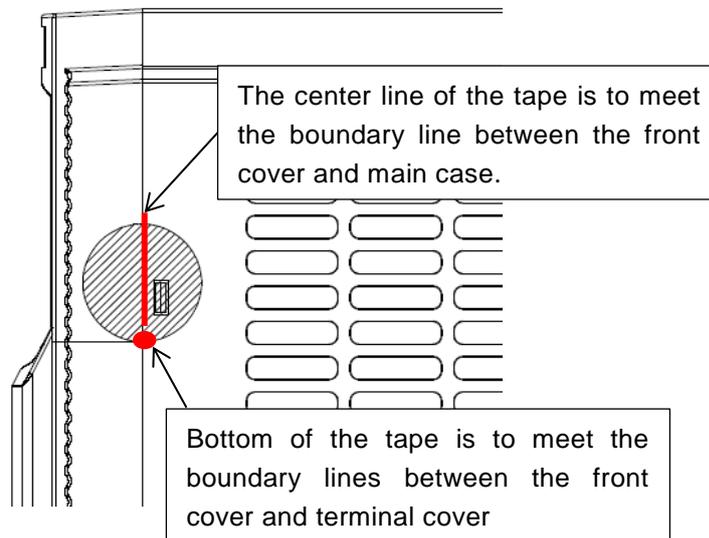
Power supply	Model name	Frame size
1-ph 200V	WJ200-001SF	A
	WJ200-002SF	
	WJ200-004SF	
3-ph 200V	WJ200-001LF	
	WJ200-002LF	
	WJ200-004LF	
	WJ200-007LF	
1-ph 200V	WJ200-007SF	B
1-ph 200V	WJ200-015SF	
	WJ200-022SF	
3-ph 200V	WJ200-015LF	
	WJ200-022LF	
3-ph 400V	WJ200-004HF	
	WJ200-007HF	
3-ph 400V	WJ200-015HF	
	WJ200-022HF	
	WJ200-030HF	
3-ph 200V	WJ200-037LF	C
3-ph 400V	WJ200-040HF	
3-ph 200V	WJ200-055LF	D
	WJ200-075LF	
3-ph 400V	WJ200-055HF	
	WJ200-075HF	
3-ph 200V	WJ200-110LF	E
3-ph 400V	WJ200-110HF	
	WJ200-150HF	
3-ph 200V	WJ200-150LF	F

① For frame size A B C, and F

Please paste the adhesive tapes on the position indicated in the figure below.

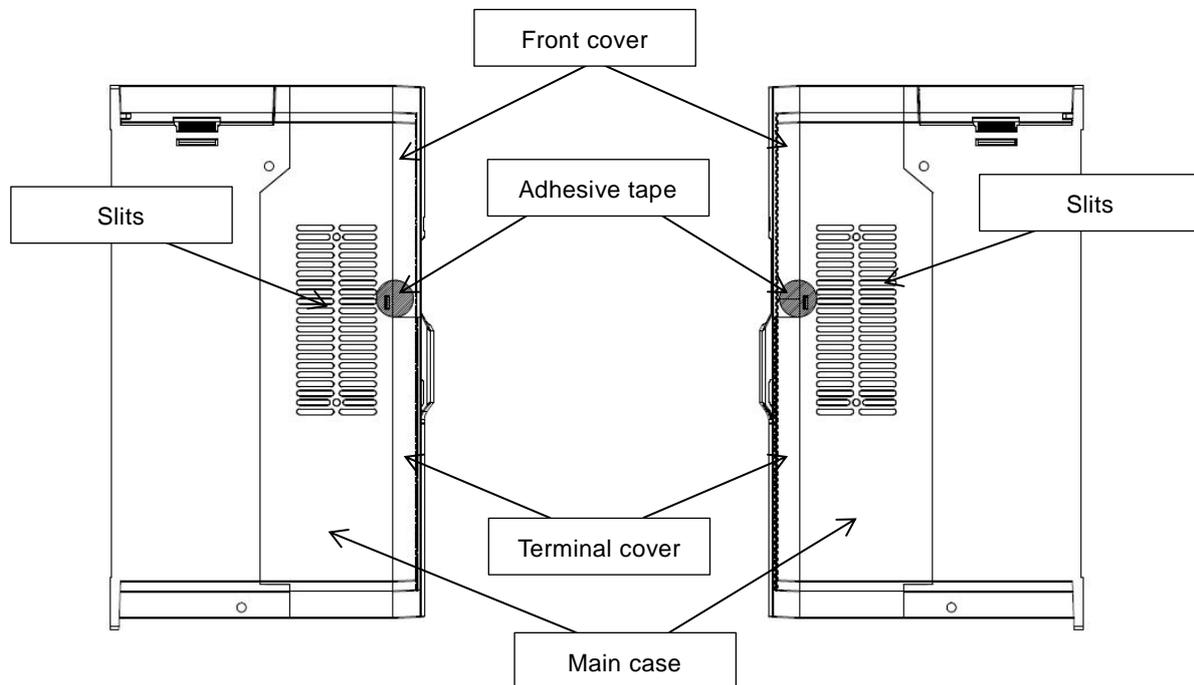


**Enlarged view of pasting position**

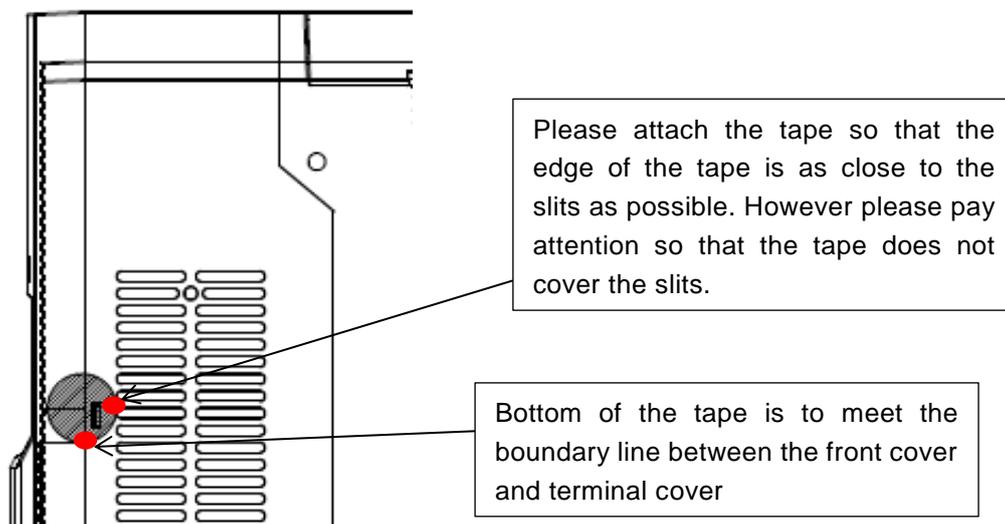


② For frame size D and E

Please paste the adhesive tapes on the position indicated in the figure below



### Enlarged view of pasting position



### Note for all models:

- When attaching the tapes, never touch the bonding plane of the tape.
- After attaching the tapes on the both side of WJ200, please make sure that the tapes are pasted firmly onto both the front cover and the main case.
- Please do not remove the tapes once it has been attached.
- The attachment of the tapes on the inverter is one of the conditions to conform to the safety norms. Please ensure to attach these tapes on the inverter.
- In case that the inverter is replaced due to some reasons such as breakdown and no spare tapes are available on your hands, please contact your nearest sales agent.

## **6.1 Requirement for Installation**

For installation of the inverter with WJ-FS, please refer to the instruction manual of the inverter.

Additionally, when WJ-FS is mounted, the inverter must be installed in a cabinet having protection of IP54 or higher to conform to the safety standards.

## **7.1 Requirement for Wiring on inverter**

For wiring on the main and control terminals of the inverter, please refer to the instruction manual of the inverter.

Additionally, when WJ-FS is used with the inverter, please pay attention to the limitations and requirements below.

### ① **Main wiring**

Please make sure that lengths of cables are less than the lengths specified in the table below.

No	Item	Maximum cable length	Remark
1	Cable between the inverter (P,RB / P,N) and dynamic braking unit or dynamic braking resistor	5m	Twisted pair
2	Cable for DC reactor	5m	Twisted pair

### ② **Wiring on control terminal and cable on RJ45 port**

All wirings on control terminal and cable on RJ45 port except cables for Modbus-RTU (SP / SN terminals) must be less than 25m.

### ③ **Wiring on SP/SN terminal (Modbus-RTU)**

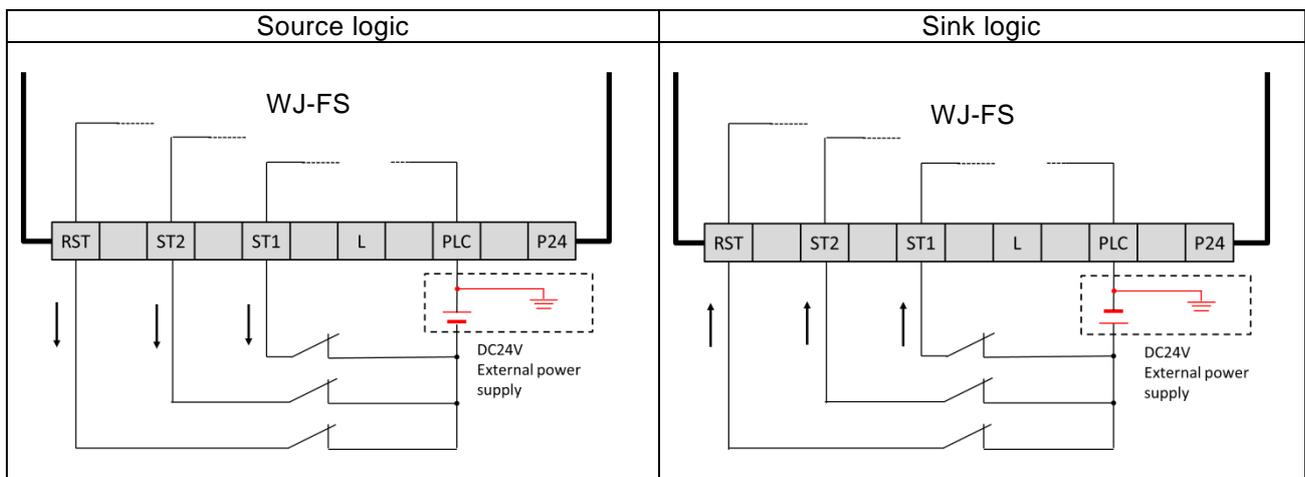
When the cable length exceeds 25m, shielded cable must be used.

### ④ **Wiring on control terminal 3, 4**

No wiring must be performed on control terminal 3, 4.

## 7.2 Requirement for Wiring on WJ-FS

- Length of cables connected to the I/O terminal of WJ-FS must be less than 25m.
- Sufficient measures must be taken to ensure the wirings on ST1/ST2/RST are physically separated and independent from each other.
- At least one of the measures 1 to 3 described below must be taken to input wiring on WJ-FS:
  1. Grounding power line (PLC)
    - ✧ For use of **internal power supply**
      - Grounding PLC
    - ✧ For use of **external power supply**
      - Use a power supply (PELV) which is grounded on PLC side (see the figure below)

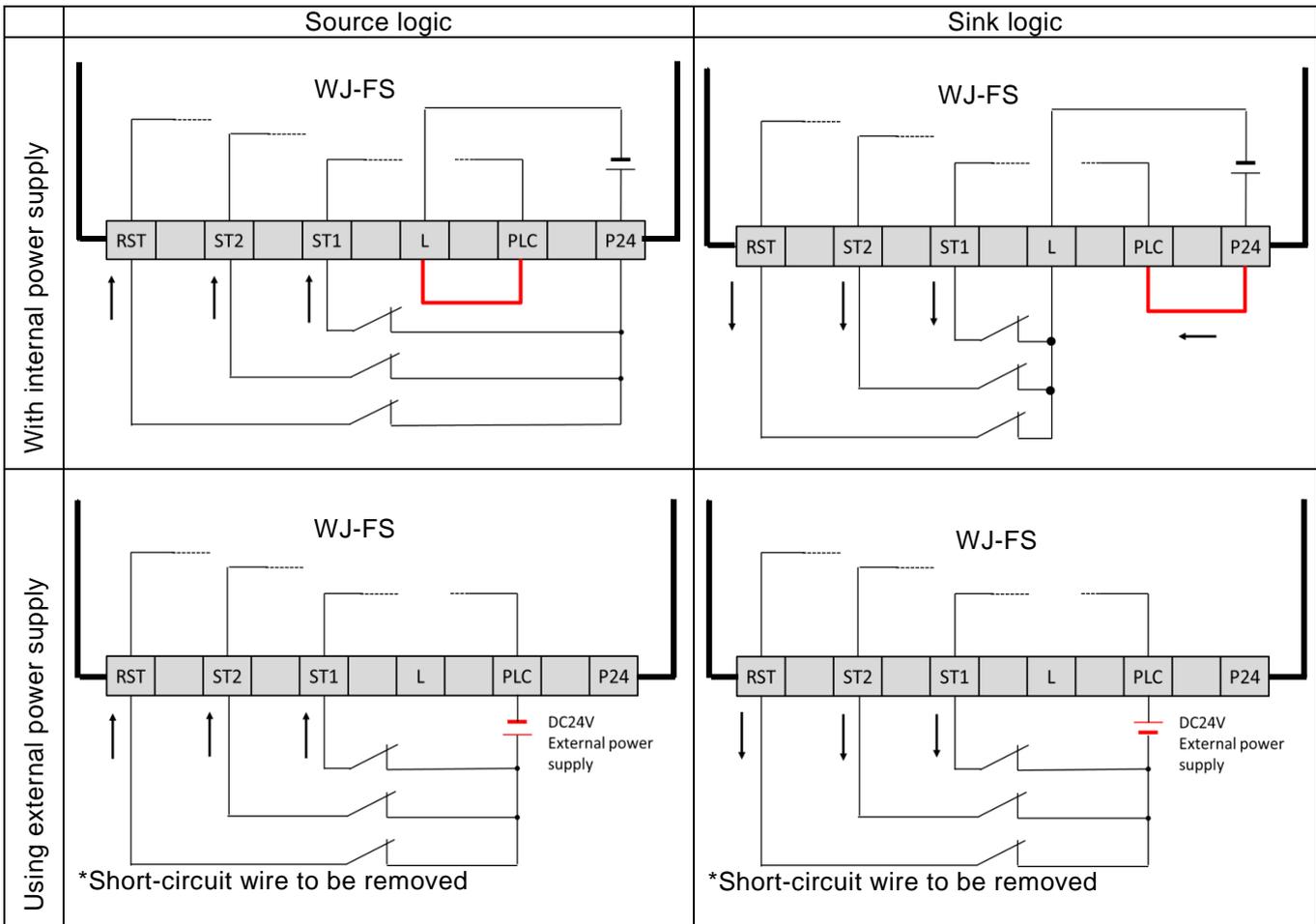


2. A fail-safe cable routing (The requirement of ISO13849-2 table D.4 to be met. One of following measures needs to be adopted)
  - ✧ Permanently connected (fixed) and protected against external damage, e.g. by cable ducting or
  - ✧ Use of separate multicore cables or
  - ✧ Within an electrical enclosure, with both conductor and enclosure meeting the requirement of IEC 60204-1 or
  - ✧ Individually shielded with earth connection
3. Using an external device for grounding fault detection

### 7.3 Input logic – sink / source logic

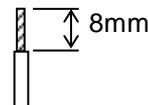
Input logic of sink or source is selectable by changing position of the short-circuit wiring on the I/O terminal. Additionally power for inputting signal can be supplied using internal power supply (P24) or externally prepared DC24V power supply. Please refer to the wiring examples below for each case. Please note the position of short-circuit wire for each configuration.

External DC24V power supply must comply with PELV.



## 7.4 Wire size and recommended ferrule

Use wires within the specifications listed below. For safe wiring and reliability, it is recommended to use ferrules, but if solid or stranded wire is used, stripping length should be 8mm.



	Solid mm <sup>2</sup> (AWG)	Stranded mm <sup>2</sup> (AWG)	Ferrule mm <sup>2</sup> (AWG)
I/O terminal	0.2 to 1.5 (AWG 24 to 16)	0.2 to 1.0 (AWG 24 to 17)	0.25 to 0.75 (AWG 24 to 18)

### Recommended ferrule

For safe wiring and reliability, it is recommended to use following ferrules.

#### Rod terminal with sleeve

Wire size mm <sup>2</sup> (AWG)	Model name of ferrule*	L1 [mm]	L2 [mm]	Φd [mm]	ΦD [mm]	
0.25 (24)	AI 0.25-8YE	8	12.5	0.8	2.0	
0.34 (22)	AI 0.34-8TQ	8	12.5	0.8	2.0	
0.5 (20)	AI 0.5-8WH	8	14	1.1	2.5	
0.75 (18)	AI 0.75-8GY	8	14	1.3	2.8	

#### Rod terminal without sleeve

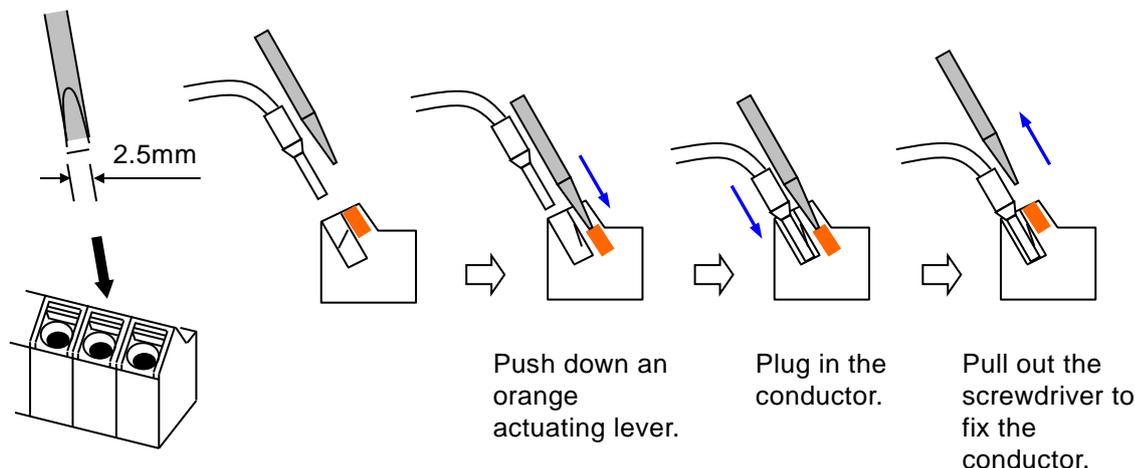
Wire size mm <sup>2</sup> (AWG)	Model name of ferrule*	L1 [mm]	L2 [mm]	Φd [mm]	ΦD [mm]	
0.5 (20)	A 0,5-8	7.3	8	1.0	2.1	
0.75 (18)	A 0,75-8	7.3	8	1.2	2.3	

\* Supplier: Phoenix contact

Crimping pliers: CRIMPFOX UD 6-4 or CRIMPFOX ZA 3

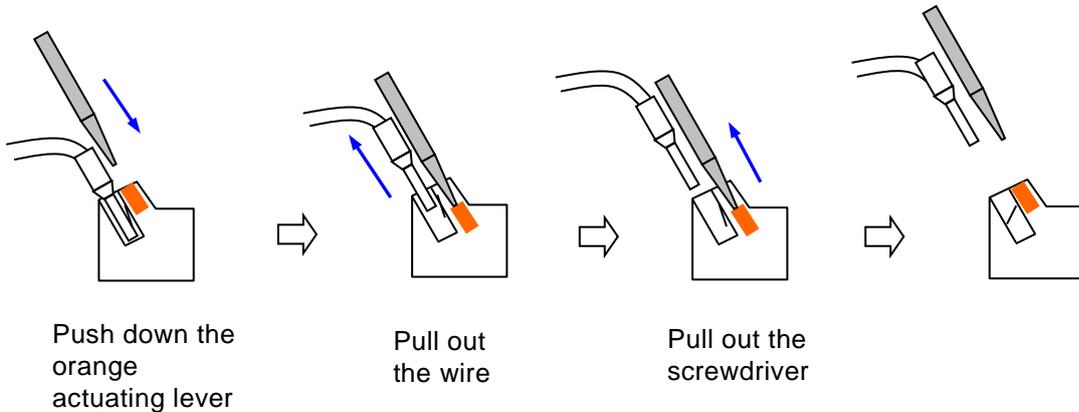
### How to connect?

- (1) Push down an orange actuating lever by a slotted screwdriver (width 2.5mm max.).
- (2) Plug in the conductor.
- (3) Pull out the screwdriver then the conductor is fixed.

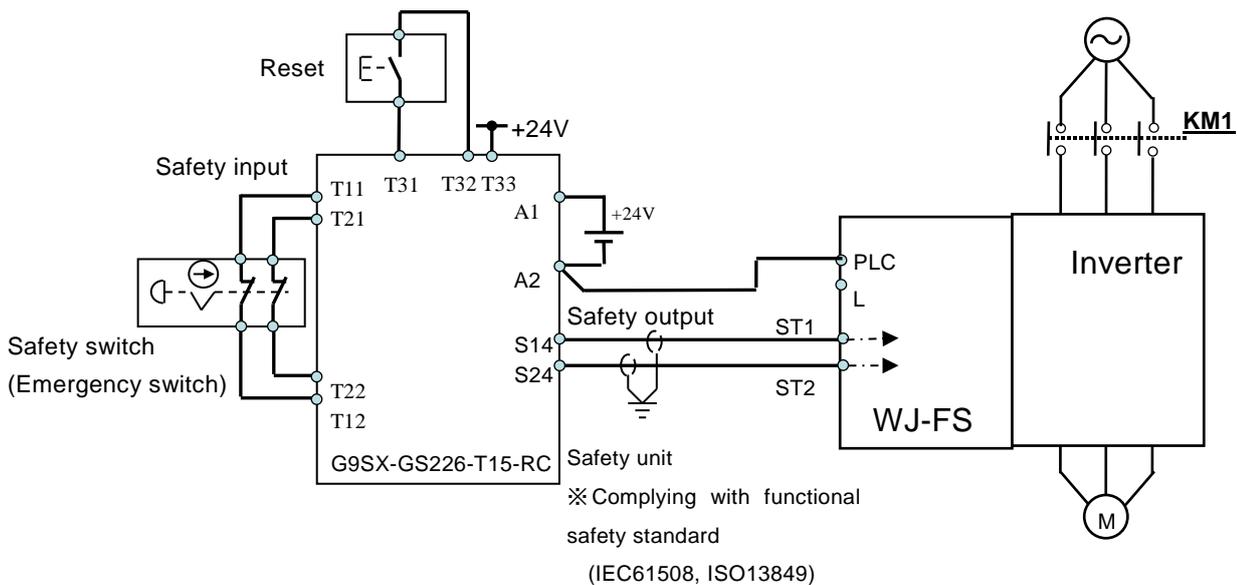


**How to disconnect**

- (1) Push down the orange actuating lever by a slotted screw driver ((width 2.5mm max.) to release the wire.
- (2) Pull out the wire.
- (3) Pull out the screwdriver.

**7.5 Wiring example**

The below figure shows a wiring example of source input logic when automatic reset is selected. (ISO13849-1, PL=d)



By pushing emergency switch depicted on the right in the figure above, current flows on ST1 and ST2 are interrupted and sequentially output of the inverter to motor is shut off. Output of inverter is permitted after pushing reset switch, and current flows on ST1 and ST2 are resumed. (In case that automatic reset is selected)

Note 1: For wiring in case that sink logic is selected, refer to section 7.3

Note 2: Cables between safety relay and ST1/ST2 terminal must be selected in order to satisfy the requirement described in section 7.2

Note 3: When an external DC24V power supply is used, it must comply with PELV.

Note 4: Please fix the wirings of WJ-FS

## **7.6 Component to be combined**

Followings are examples of the safety devices to be combined.

### **Safety relay**

Series	Model	Norms to comply
PNOZsigma	PNOZ s3 24VDC 2n/o	ISO13849-1 cat4, PL e IEC 61511 SIL 3 EN IEC62061 SIL CL 3
3TK28	3TK2823-2CB30	ISO13849-1 cat4, PL e IEC 61508 SIL 3
PSR-SCP	PSR-SCP-24DC/ESD/4X1/30 -2981800	ISO13849-1 cat3/4, PL d/e IEC61508 SIL 3 IEC62061 SIL CL 3
GS9A	301	ISO13849-1 cat4, SIL3
G9SX	GS226-T15-RC	IEC61508 SIL1-3
NE1A	SCPU01-V1	IEC61508 SIL3

In combination with the safety device complying with the class complying PL=d, PL=d of the inverter is to be achieved.

### **External power supply**

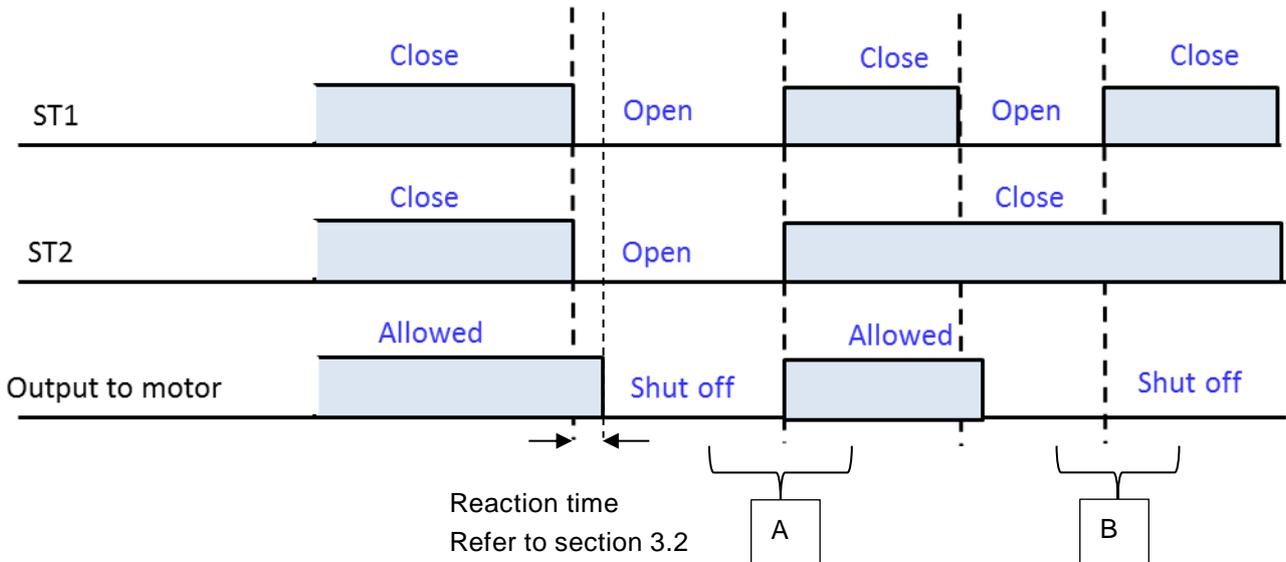
External power supply must be PELV 24V. The voltage is 24Vdc (-15%, +10%).

## 7.7 Timing chart

The below figures are timing charts for input signals (ST1/ST2/RST) and shut off timing of inverter output.

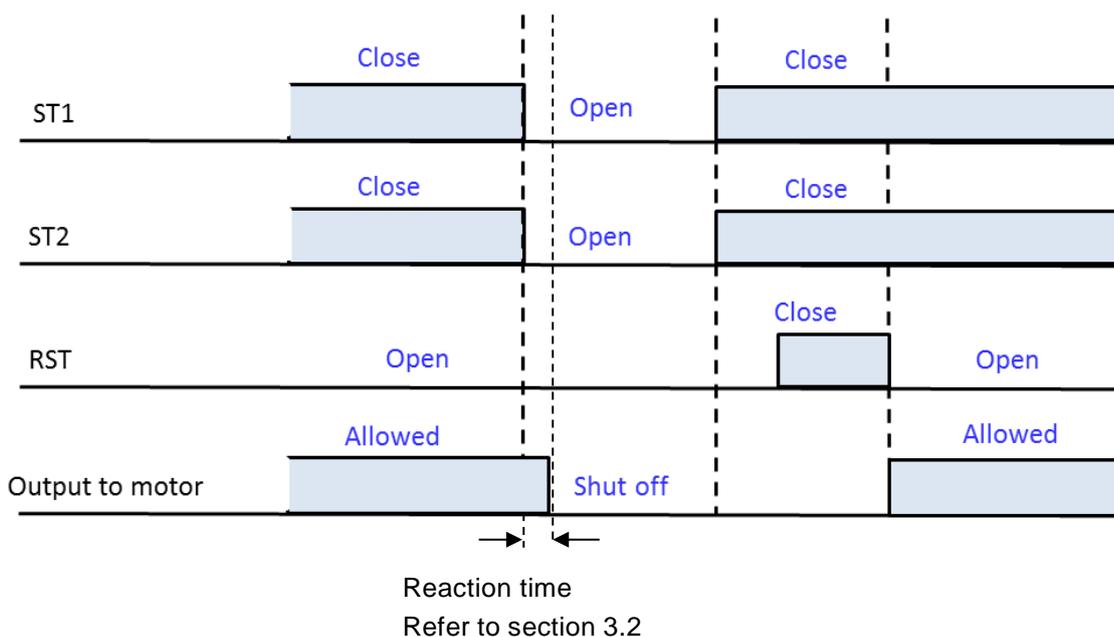
### ① Automatic reset mode

- Once the input ST1 and ST2 are opened and STO is activated, STO status is released at the timing when the both ST1 and ST2 are closed. (See "A" in the time chart below)
- If only either ST1 or ST2 but not both is opened and once STO is activated, STO status is not released even after the opened input signal is closed. (See "B" in the time chart below)



### ② Manual reset mode

- Once the input ST1 and ST2 are opened and STO is activated, STO is released when -
  - Both inputs ST1 and ST2 are closed
  - Reset input RST is closed and then opened



## 8.1 Commissioning and verification of safety system

After installation of WJ-FS in the system, verification of safety system must be performed before starting operation of the system.

Please conduct the following procedure of the functional test to verify correct installation and function of system.

### ① Automatic reset

No	Operation	Check list
1	Power up inverter	Check if LED1 and LED2 are lighting
2	Close the contacts connected to ST1 and ST2 terminal. Start operation of inverter	Check if motor operation is started normally
3	Open only the contact connected to ST1 while the contact connected to ST2 is closed and motor is being operated	Check if output of INVERTER to motor is shut off Check if LED1 and LED2 are lighting
4	Close the contacts connected to ST1 and ST2 terminal. Start operation of inverter	Check if motor operation is started normally
5	Open only the contact connected to ST2 while the contact connected to ST1 is closed and motor is being operated	Check if output of inverter to motor is shut off Check if LED1 and LED2 are lighting
6	Close the contacts connected to ST1 and ST2 terminal. Start operation of inverter	Check if motor operation is started normally
7	Open both contacts connected to ST1 and ST2 while motor is being operated	Check if output of inverter to motor is shut off Check if LED1 and LED2 are lighting

### ② Manual reset

No	Operation	Check list
1	Power up inverter	Check if LED1 and LED2 are lighting
2	Close the contacts connected to ST1 and ST2 terminal. Give RST (reset) input. Start operation of inverter	Check if motor operation is started normally
3	Open only the contact connected to ST1 while the contact connected to ST2 is closed and motor is being operated	Check if output of inverter to motor is shut off Check if LED1 and LED2 lighting
4	Close the contacts connected to ST1 and ST2 terminal. Give RST (reset) input. Start operation of inverter	Check that motor operation is started normally
5	Open only the contact connected to ST2 while the contact connected to ST1 is closed and motor is being operated	Check if output of inverter to motor is shut off Check if LED1 and LED2 lighting
6	Close the contacts connected to ST1 and ST2 terminal. Give RST (reset) input. Start operation of inverter	Check if motor operation is started normally
7	Open both contacts connected to ST1 and ST2 while motor is being operated	Check if output of inverter to motor is shut off Check if LED1 and LED2 lighting

## **9.1 Checklist**

Before starting using the unit, please check the following items and ensure that all requirements are satisfied.

No	Check Item	
1	The ambient operating conditions are within the allowable range (See 6.1 / 13.1 and instruction manual of WJ200 inverter)	<input type="checkbox"/>
2	Make sure that WJ-FS has been installed properly onto the WJ200 inverter (see section 5.2)	<input type="checkbox"/>
3	The safety function selection switch and EDM function selection switch on WJ200 inverter have been set properly (See section 5.2)	<input type="checkbox"/>
4	Enclosed adhesive tape have been properly attached on the WJ200 inverter (See section 5.3)	<input type="checkbox"/>
5	The installation and wiring have been performed in accordance with the instruction in this manual and the manual of the WJ200 inverter	<input type="checkbox"/>
6	Intended behavior has been verified by commissioning test (see section 8.1)	<input type="checkbox"/>

## **10.1 Daily inspection**

In addition to the daily inspection items provided in the instruction manual of WJ200 inverter, please check the following items related to WJ-FS daily.

No	Check Item	Criteria
1	Two LED (LED1 and LED2).on WJ-FS	Both of the LEDs are lighting →If either of the LEDs is turned off, please check the unit by following the information in section 13.1.
2	Adhesive tapes attached on WJ200	The adhesive tapes are in place and fastened to the plastic cover properly. →If it is found that the adhesive tape are loose or not in place properly, replace it with a spare tape enclosed with WJ-FS. (See section 1.1)
3	Wiring and installation	No abnormality in wiring and installation. →Correct abnormal item(s)

## **11.1 Periodical test**

A periodical test must be performed to verify the correct functionality of WJ-FS and check there is no abnormalities in hardware (damage on case, wiring and installation condition) once a year. Please follow the functional test procedure below. Please check the hardware inspection items below.

### ① **Functional test**

Follow the functional test procedure described in section 8.1 to verify the proper functionality of the individual safety paths.

### ② **Hardware inspection**

The items to be verified during the periodical test are listed in the table below.

No	Inspection Item	Criteria
1	Two LED (LED1 and LED2).on WJ-FS	Both of the LEDs are lighting →If either of the LEDs is turned off, please check the unit by following the information in section 13.1.
2	Adhesive tapes attached on WJ200	The adhesive tapes are in place and fastened properly. →If it is found that the adhesive tape are loose or not in place properly, replace it with a spare tape enclosed with WJ-FS. (See section 1.1)
3	Wiring	Wirings are fastened securely. No looseness and damage →If any looseness is found, correct wirings.
4	Connection to WJ200 inverter	The fixing screw is tightened properly. No looseness of connection between WJ-FS and WJ200 →If any looseness is found, tighten the fixing screw or fasten the connection between WJ-FS and WJ200

If any failure in WJ-FS or WJ200 is found during a periodical test, please replace WJ-FS or/and WJ200 with a fault.

## 12.1 Error and Troubleshooting

The error detection of WJ-FS is indicated by LED1 and LED2 on the front. (See section 3.6 and 4.1)  
Lighting conditions of LEDs and indicated status are summarized in the table below.

Status	LED1	LED2	Status
#1	ON	ON	Powered up (No failure detected)
#2	OFF	ON	Internal failure in WJ-FS is detected
#3	ON	OFF	Internal failure in inverter or/and Failure(s) in WJ-FS is/are detected
#4	OFF	OFF	When power is not supplied: Powered down
			When power is supplied: Internal failure of WJ-FS or Bad connection

In the status #2 and #3 (and part of #4) where an internal failure has been detected, WJ-FS maintains STO status regardless of the status of input signals until power-down.

In case that LED1 or/and LED2 is/are turned off, there is a fault in the safety paths detected. STOP using the unit immediately and inspect the WJ-FS and connected WJ200 completely. DO NOT use the unit unless the all factors of the fault are eliminated.

The both LEDs may light up by cycling power even after either of LEDs has turned off. However continuous use of the unit without inspection may lead to dangerous situation since the factor of the fault may have not been eliminated and in that case the safety function does not work properly.

LED status	Possible factor	Inspection and trouble shooting
Status #2 / #3 /#4 is not released even after cycling power	Failure in the safety path of WJ-FS	<ol style="list-style-type: none"> <li>① Perform the procedure shown in section 8.1</li> <li>② Check if the output of WJ200 is shut off by each safety input and path independently</li> <li>③ If any abnormality is found during the procedure ②, please check the safety paths of WJ200 by following the procedure provided in the next section.</li> <li>④ If there is no abnormality in WJ200, WJ-FS has internal fault. Please replace WJ-FS with new unit.</li> </ol>
	Failure in the safety path of WJ200	<ol style="list-style-type: none"> <li>① Power down WJ200 and remove WJ-FS</li> <li>② Check if there is any abnormality in WJ200 by following procedure provided by the instruction manual of WJ200.</li> <li>③ If any fault or abnormality is found in WJ200, please replace WJ200 with new unit.</li> </ol>
	EDM function selection switch (see section 5.2) has not been set properly	Check if EDM function selection switch on WJ200 is set to "OFF".
	Bad connection of WJ-FS	Check if WJ-FS is connected to WJ200 properly
Status #2/#3/#4 is released after cycling power	In case any noise source is located near to the unit	Separate the noise source
	In case error indication of LEDs is released after cycling power, please use the unit only after checking the safety path of WJ-FS and WJ200 and then verifying proper behavior of safety function by commissioning (see section 8.1).	

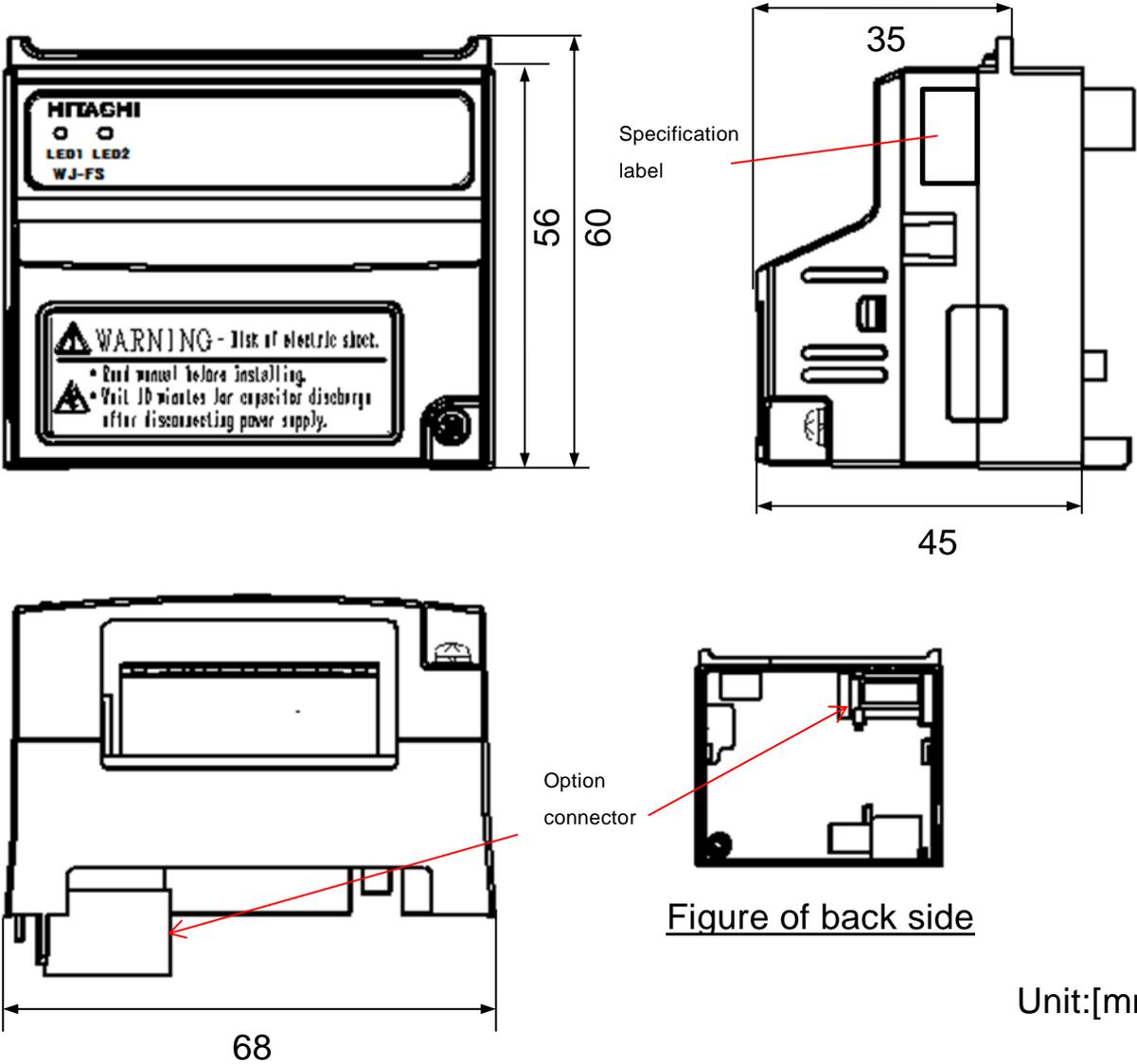
If STO is not able to be released even the two LEDs turns ON (status #1), there may be a failure in WJ-FS or WJ200. Please check wiring and connection between WJ-FS and WJ200. Please conduct the commissioning test (see section 8.1) and check WJ200 by following the procedure provided in the instruction manual of WJ200. If WJ-FS or WJ200 does not function properly, please replace the unit.

## 13.1 WJ-FS Specifications

	Item	Specification
Installation	Unit type	Safety option module (built-in type)
	Model	WJ-FS
	Dimensions (W x H x D)	68 x 60 x 45 mm
	Weight	120g (typical)
Environment	Ambient operating temperature	-10 to 50°C (no icing or condensation)
	Ambient operating humidity	20 to 90%RH
	Ambient storage temperature	-20 to 65°C (no icing or condensation)
	Vibration resistance	5.9m/s <sup>2</sup> (0.6G) at 10...55Hz
	Conformance to safety standards	See section 2.2
	Enclosure rating	IP 20
	Protection rating of cabinet <sup>*1</sup>	IP 54 or higher
Interface	Internal power supply	P24 / PLC
	Signal common	L
	Safety input	ST1 / ST2
	Reset input	RST

\*1: Required protection rating of the cabinet in which WJ-FS is installed

### 13.2 WJ-FS Dimensions



#### Difference of depth

When WJ-FS is mounted, the depth becomes greater by 26.3mm as shown in the figure below.

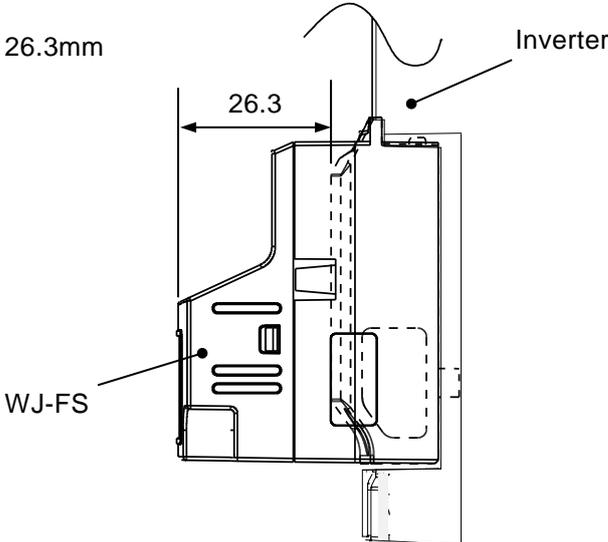


Figure of installation (right side view)

## **Annex – EC-Declaration of Conformity according to 2006/42/EC**

\* This section is only for providing required information about EC-Declaration.  
The original EC-Declaration is available separately.

### **Business name and full address of the manufacture**

Hitachi Industrial Equipment Systems Co., Ltd.  
1-1 Higashinarashino 7-chome, Narashino-shi, Chiba 275-8611, Japan

We declare, under our solo responsibility, that the following products conform to all the relevant provisions.

### **Product name:**

WJ-FS, Functional safety option for WJ200  
Version A and later (see section 1.4)

### **Authorized Representative:**

Hitachi Europe GmbH  
Am Seestern18, D-40547 Dusseldorf, Germany

### **Council Directives:**

MD: 2006/42/EC (MD: Machinery Directive)  
EMC: 2004/108/EC (until April 19<sup>th</sup> 2016)  
EMC: 2014/30/EU (from April 20<sup>th</sup> 2016)

### **Harmonized Standards:**

MD: EN ISO 13849-1:2015  
IEC61800-5-2:2016  
EN 60204-1:2006+AC:2010  
EMC: EN61800-3:2004 + A1:2012

### **Relevant Standards:**

EN 61508 Parts 1-7: 2010

### **Notified Body:**

IFA - Institute for Occupational Safety and Health of the German Social Accident Assurance  
Alte Heerstr. 111, D-53757 Sankt Augustin, Germany

### **Authorized person / Person empower to draw up the declaration:**

Department Manager, Quality Assurance Group  
Hitachi Industrial Equipment Systems Co., Ltd.