VF66B

TOYO INTELLIGENT INVERTER

Overseas Standard Support

Operation Manual
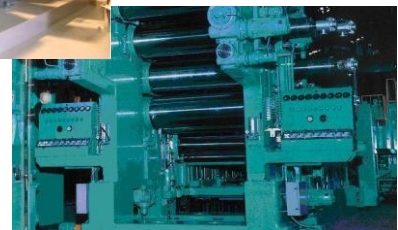
TOYODENKI

Table of Contents

Preface

Thank you very much for choosing our inverter.

This "operating manual" explains the conditions for fitting an inverter to an overseas standard.

When using it, fitting an inverter to an overseas standard, this description is drawn up so that it may install correctly and the wiring method etc. may be understood.

The "VF66B operating manual (TIM003)" explains handling of the main part of an inverter.

You may combine with this operating manual, read and please deal with it.

When delivering any of your products with our inverter built in, consider that this manual can be distributed to end users. Also, when changing our factory default initialized data (hereinafter referred to as Initialized data) for setting parameters of the inverter, make sure that end users can be informed about the changed contents of the Initialized data.

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Be Sure To Read This Before Use

Safety Notice

To use the inverter correctly, be sure to completely read this manual and all other attached documents before installation, operation, maintenance, and inspection.

You need to have a good knowledge of equipment, safety information, and all notices before using the inverter.

In this manual, safety notices are ranked as "DANGER," "WARNING," and "CAUTION."

⚠ DANGER
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⚠️CAUTION Installation

● Do not use what is damaging and changing at the time of unpacking.
It may result in a risk of failure, or malfunction.
● Install the inverter on non-inflammables such as metal.
Otherwise, a fire may occur.
● Do not put inflammables near the inverter.
Otherwise, a fire may occur.
● Do not hold the front cover when transporting the inverter.
It may fall, which may result in injury.
● A model over 22 kW is considered as a heavy material. Don't lift it by yourself. Otherwise, you may be injured.
● Install the inverter in a place which can support its weight.
It may fall, which may result in injury.
● Do not install and operate the inverter which is damaged or does not have any parts.
Otherwise, you may be injured.
● Do not install the inverter in an atmosphere which contains plasticizer such as halogen and DOP (phthalate ester).
Otherwise, it may be damaged.

⚡DANGER Wiring

● Check that the input power is turned off before wiring.
Otherwise, electric shock or a fire may occur.

⚡WARNING Wiring

● Be sure to connect a ground wire.
Otherwise, electric shock or a fire may occur.
● Electrical engineering technicians should connect wires.
Otherwise, electric shock or a fire may occur.
● Be sure to install the inverter before wiring.
Otherwise, electric shock or a fire may occur.
● For ground fault protection, connect a leakage protection relay or leakage circuit breaker to inverter input terminals [R/L1, S/L2, and T/L3].
Otherwise, electric shock or a fire may occur.

⚠️WARNING Wiring

● Do not connect the alternating-current power supply to inverter output terminals [U/T1, V/T2, and W/T3].
Otherwise, injury or a fire may occur.
● Check that inverter power rating matches alternating-current power supply voltage.
Otherwise, injury or a fire may occur.
● Do not directly connect a resistor between direct-current terminals [+1]/[+2] and [-] or [+1] and [+2].
Otherwise, a fire may occur.
● Surely install, and lock the cable and the connector.
It may result in a risk of failure, or malfunction.

⚠️CAUTION Wiring

● If the 400V class inverter is used as the as the correspondence of Europe standard, connect to the power supply with which the natural point is grounded.

⚡WARNING Operation

● Be sure to install the front cover before turning on the input power. Do not remove the front cover during energization.
Otherwise, it may result in a risk of electric shock.
● Do not use operation keys by wet hands.
Otherwise, it may result in a risk of electric shock.
● Do not touch terminals such as main circuit terminals and a protective earth terminal during energization.
Otherwise, it may result in a risk of electric shock.

⚠WARNING Operation

● The stop button ([STOP/RESET] key) is available only when functions have been set. Provide an emergency stop button separately.
Otherwise, you may be injured.
● When alarm reset is performed with operation signals input, the inverter suddenly restarts. Check that signals are turned off, and then perform alarm reset.
Otherwise, you may be injured.

⚠CAUTION Operation

● Do not touch the heat sink and the discharge resistor because they reach high temperatures.
Otherwise, you may get burned.
● You can set speed of the inverter from low to high. Before operation, check the permitted range of the motor and machinery sufficiently.
Otherwise, you may be injured.
● Provide a holding brake separately if necessary.
Otherwise, you may be injured.

⚡CAUTION Maintenance and inspection, and replacement of parts

● Before inspection, turn off the input power after checking that the motor is stopped, and then wait for over ten minutes. Also, check that direct-current voltage between the direct-current terminals [+1] and [-] or [+2] and [-] is less than or equal to 30 V.
Otherwise, electric shock, injury, or a fire may occur.
● Check that inverter power rating matches alternating-current power supply voltage.
Otherwise, injury and electric shock may occur, or parts may be damaged.
● Do not perform maintenance and inspection or replace parts except qualified persons. Use a tool for insulation for maintenance and inspection.
Otherwise, electric shock or injury may occur.

⚡WARNING Others

● Never modify the inverter.
Otherwise, electric shock or injury may occur.
All when remodeling it is not guaranteed.

⚠CAUTION General precautions

● To provide detailed explanation, all figures described in this manual are sometimes drawn with the cover or a safety shield removed.
To operate the inverter, be sure to set the specified cover or shield to its original position and to follow the procedure described in this manual.
● When the inverter is packed with fumigated wooden materials, its electronic components may be fatally damaged.
Be sure to use ways other than fumigation for sterilization and insect removal. Also, process them before packing.
● These safety notices and specifications in this manual are subject to change without notice.

Chapter 1 Supporting Overseas Standards

This operating manual has indicated conditions for an inverter to suit each directive and UL standards of Europe, and required external options.

This inverter has been tested in accordance with European Low Voltage Directive, EMC (Electro Magnetic Compatibility) Directive, Machinery Directive, and the North American standard UL508C. The test results demonstrate that the inverter conforms to each directive and standard listed in the table below. However, only incorporating our inverter and a supported option into a device does not mean that the entire device conforms to Low Voltage Directive, EMC Directive, Machinery Directive, and the UL standard. The customer who assembles a final product is liable for conformity with each directive and standard of the entire device. The customer should check the conformity with each directive and standard of the final product.

Please note that the inverter for Europe can only drive ED motors.

In addition, the inverter conforming to each instruction and standard is stuck the conformity label shown in the following figure on the right side of the inverter. Please keep in mind that inverters with no label does not conform to the direcrives and standard.

The conformity label

CE	It is stuck on the inverter which conforms to Low Voltage Directive (2014/35/EU), EMC Directive (2014/30/EU) and RoHS Directive (2011/65/EU, (EU) 2015/863).
TÜV SÜD	It is stuck on the inverter which conforms to Machinery Directive (2006/42/EC).
TÜV SÜD US	It is stuck on the inverter which conforms to UL508C. (Note) At the request of updating a mark from the United States Occupational Safety and Health Administration (OSHA), the mark has been updated to a mark on the left since production in August 2016.

Compatible standards

LowVoltage Directive 2014/35/EU		EN 61800-5-1:2007/A1:2017
EMC Directive 2014/30/EU	Emission	EN IEC 61800-3:2018 Environment II category C3 EN 55011:2016/A1:2017 Group1 ClassA
	Immunity	EN IEC 61800-3:2018 Environment II category C3 EN 61326-3-1:2017 SIL2[*1]
Machinery Directive 2006/42/EC[*1]		EN 61800-5-2:2017 STO EN ISO 13849-1:2015 Category3 PL d EN 61508:2010 SIL2 EN 62061:2005/A2:2015 SIL2 EN 60204-1:2018 Stop Category 0
RoHS Directive (2011/65/EU, (EU) 2015/863)		EN IEC 63000:2018 Product Category 9
UL Standard[*2]		UL508C

*1: Only the inverter which conforms to Machinery Directive corresponds.

*2: Parallel models are not compliant with UL508C.

Chapter 2 Conformity to a North America Standard

2.1. Correspondence of UL standards (UL508C)

Satisfy the following conditions, in order to conform an inverter to UL508C.

■Installation Environment

Install the inverter in the environment below the overvoltage category III and the pollution degree 2 defined by the IEC60664-1.

Overvoltage category

Overvoltagecategory	Equipment	Equipment overview
I	Secondary circuit	Equipment connecting to a circuit where any measures are taken to limit transient overvoltage to a lower level. It includes a protected electronic circuit.
II	Home electrical appliance and office machine	Equipment consuming energy supplied from a fixed wiring facility.
III	**Electrical facility**	**Equipment in the fixed wiring facility which especially requires reliability and effectiveness.**
IV	Power receiving	Equipment used for a service entrance.

Pollution degree

Pollution degree	Overview	Specific example
1	There is no pollution, or only dry and non-conductive pollution occurs. This type of pollution has no effect.	Clean room and others
2	**Typically, only non-conductive pollution occurs. However, when a PDS (Power Drive System) is not running, temporary conductivity can be expected due to condensation.**	**Electrical equipment in an office and the control panel, and others**
3	Conductive pollution, or dry and non-conductive pollution resulting in conductivity due to expected condensation occurs.	In a general factory and others
4	Pollution causes continuous conductivity due to conductive dust, rain, and snow.	Outdoor and others

■How to Install Inverter

①Requirements of install location of the inverter

Installation conditions of the inverter greatly affect its life and reliability. Avoid the location listed as follows to install. Use it under the environmental conditions described in Chapter 3 of the "VF66B Operating Manual (TIM003)".

(1) In a humid and dusty area or a place where water or oil drips, the insulation of circuits is deteriorated, which may reduce the life of parts.

(2) Too high ambient temperature will cause the life of the main circuit capacitors or the cooling fan to be reduced.

(3) In a place containing corrosive gas, connectors may have a loose connection, electrical wires may be disconnected, and parts may be damaged.

(4) In a place having many vibrations, connectors may have a loose connection, electrical wires may be disconnected, and parts may be damaged.

(5) When using the inverter in a place where ambient temperature is below 0 $^{\circ}$C, use a heater, etc. to ensure that it becomes 0 $^{\circ}$C or higher at the start of the inverter. After it starts, when the temperature becomes 0 $^{\circ}$C or higher due to its heat generation, there is no problem.

②Inverter installation requirements and heat radiation

To use the inverter, incorporate it into the control panel, etc. to meet the environmental conditions for installation.

⚡WARNING How to install inverter

● Install it correctly.
Incorrect installation results in a risk of electric shock or a fire.

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(1) Installation orientation and intake/exhaust direction

Install the inverter vertically with a logo mark "VF66B" facing up. When it is installed sideways, ventilation is prevented, which may increase temperature. It is required to consider sufficiently a path of intake and exhaust.

The cooling fans built in the inverter intake air from the bottom and exhausts it to the top. To prevent a wiring duct, etc. from blocking up the vent, keep enough space.

(2) Exhaust amount required for inverter loss and heat radiation

Inverter loss is represented as a ratio to the motor load capacity as follows:

2.2 to 37 kW: 5.0 %, 45 to 55 kW: 4.0 %, 75 to 90 kW: 3.0 %, 110 to 315 kW: 2.5 %

For example, when the motor load is 3.7 kW, the loss is 3.7 kW x 5.0 % = 185 W.

When heat generated from the inverter is forcibly exhausted outward by an exhaust fan installed on the control panel, necessary exhaust amount can be calculated in the following formula:

$$Q = q/\{\rho \cdot C \cdot (To - Ta)\}$$

Q : Exhaust flow (m³/s)

q : Amount of heat generated from the inverter (kW)

ρ : Density (1.057 to 1.251 kg/ m³)

C : Specific heat (1.0 kJ/kg $\cdot$ $^{\circ}$C)

To : Exhaust fan exit temperature ($^{\circ}$C)

Ta : Control panel inlet temperature ($^{\circ}$C)

When ambient temperature on the control panel is 40 $^{\circ}$C, to ensure that exhaust temperature is below 50 $^{\circ}$C, a difference between intake and exhaust should be 10 $^{\circ}$C.

To exhaust a loss of 1 kW, an exhaust ability of about 0.1 m³/s is required.

(3)Keeping cooling space

To install the inverter, the direct-current reactor (DCL)*1 and the paralleling reactor*2, keep cooling spaces. In the case that there are heating devices around the inverter, install them not to affect cooling the inverter.
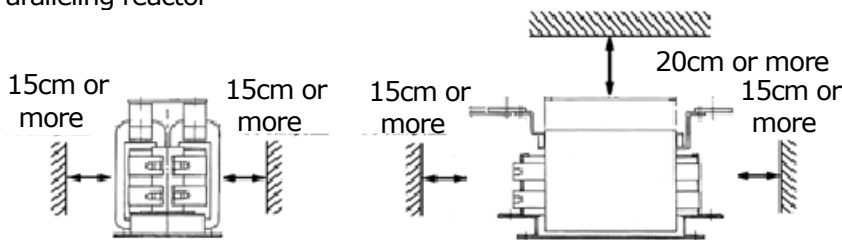
The operating temperatures of the inverter are 0 to 50 $^{\circ}$C. To install in a control panel, ventilate to ensure that the temperature in the panel is below 50 $^{\circ}$C. High ambient temperature decreases the reliability.

*1: For 55 kW or less model, direct-current reactor (DCL) is optional.

*2: The paralleling reactor is for parallel models.
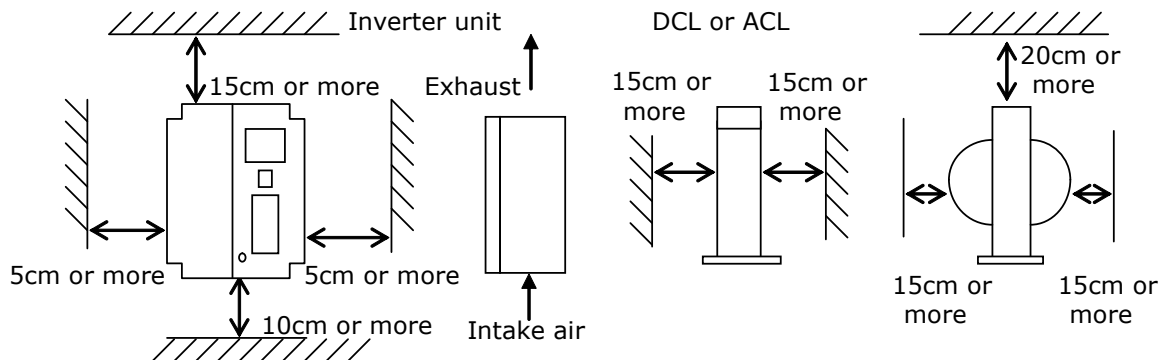
(4) NOTES

Since a direct-current reactor gets hot, please provide a space enough with other apparatus.

(100 $^{\circ}$C may be exceeded)

Since the paralleling reactor used at the time of inverter parallel connection gets hot, please provide a space enough with other apparatus.

When you operate by a parallel model, please give me wiring from the output of each inverter to each paralleking reactor as the same length. Moreover, please also give me wiring from each reactor for parallel to a motor as the same length.

Please discharge certainly generation of heat of an inverter, a direct-current reactor, and the paralleling reactor besides a board. Moreover, please keep the exhaust gas of an inverter from circulating through the inside of a board.

When you use a dynamic-braking unit, please install a braking resistor out of a board as much as possible.

Please do not carry out use in a bad environmental remarkable place.

■Electrical Wire Size of Main CircuitWires

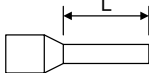Refer to another manual of the "VF66B operating manual (TIM003)".

■Electrical Wire Size of Control Board and PG Input Board and STO Board

Circuit board	Terminal block	Terminal name	Wire gauge [mm^2][*1] (AWG)	Terminal size
Control board <VFC66-Z>	[TB1]	[52MA-GND]	0.12-0.32 (26-22)	M3 screw
PG input board <PG66-Z>	[TB2]	[+12-PGOUT]	0.12-0.32 (26-22)	M3 screw
STO board <STO66-Z>	[TB24-1]	[+24-1,0-1]	0.32 (22)	M3 screw
	[TB24-2]	[+24-1,0-1]		
	[TB-ANS-A]	[ANS-1a,ANS-2a]		
	[TB-ANS-B]	[ANS-1b,ANS-2b]		
Master side Parallel control board[*3] <PRIM66-Z-P52>	[TB-ANSP]	[+24-P,0-P]	0.25-0.32 (24-22)	Sleeve size L=6mm[*2]
	[TB-ANS-A]	[ANS-P1a,ANS-0, ANS-P2a,ANS-0]		
Slave side parllel control board[*3] <PRIS66-Z-P52>	[TB-ANSP]	[+24-P,0-P]	0.25-0.32 (24-22)	Sleeve size L=6mm[*2]
	[TB-ANS-A]	[ANS-P1a,ANS-0, ANS-P2a,ANS-0]		

*1: Please use the electric wire which acquires the standard of UL10369.

*2: The following sleeves(ferrule) are recommended.

List of recommended sleeve(ferrule) for each wire gauge

Manufacturer	Wire gauge[mm^2]	AWG	Type	Sleeve(ferrule) size
PHOENIX CONTACT	0.25	24	AI 0,25-6 BU	
	0.3, 0.32	22	AI 0,34-6 TQ	

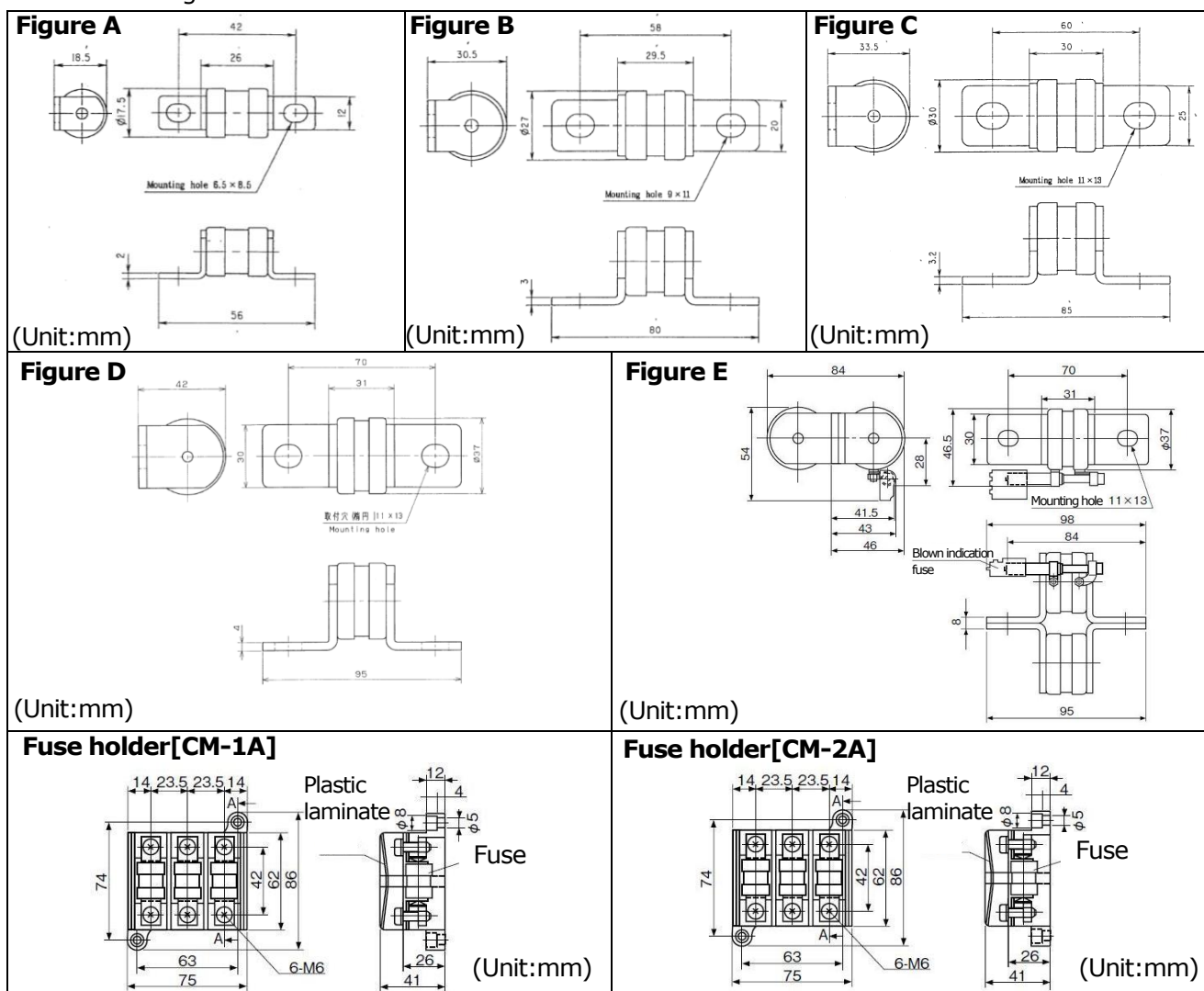(Crimp tool for reference : PHOENIX CONTACT products CRIMPFOX6 etc.)

*3: Use only the board name ends "-P52" as the parallel control board for both master and slave side.

■Mounting protective device

As a protective device when a short-circuit causes an accident, be sure to connect a fuse shown in the following table on the input side of the inverter.

■Selection of a fuse (200V class)

Outline drawing

Figure A	Figure B	Figure C

(Unit:mm) (Unit:mm) (Unit:mm)

Figure D	Figure E

(Unit:mm) (Unit:mm)

Fuse holder[CM-1A]	Fuse holder[CM-2A]

(Unit:mm) (Unit:mm)

Fuse form list

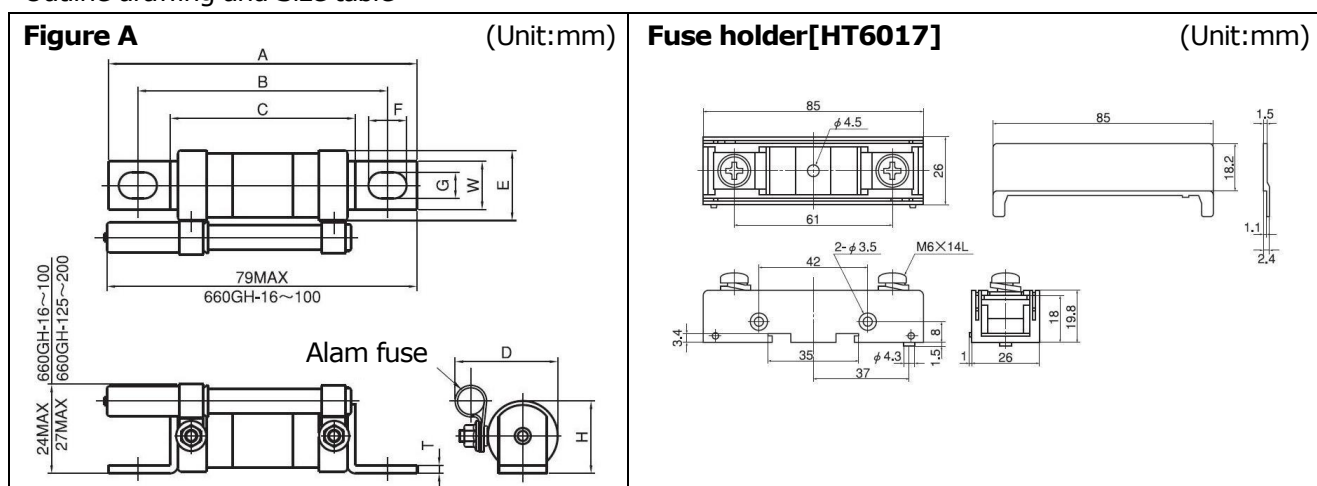| Inverter model	Fuse type*1	Figure	Weight (Unit:g)	All the number	Fuse holder type*1
2R222	CR2LS-20/UL	A	28	3	CM-1A
3R722	CR2LS-30/UL	A	28	3	CM-1A
5R522	CR2LS-50/UL	A	28	3	CM-1A
7R522	CR2LS-75/UL	A	28	3	CM-1A
1122	CR2LS-100/UL	A	28	3	CM-1A
1522	CR2L-150/UL	B	100	3	CM-2A
2222	CR2L-150/UL	B	100	3	CM-2A
3022	CR2L-260/UL	C	130	3	—*2
3722	CR2L-300/UL	C	130	3	—*2
4522	CR2L-325/UL	C	130	3	—*2
5522	CR2L-400/UL	D	220	3	—*2
7522*3	CR2L-450/UL	D	220	3	—*2
9022*3	CR2L-500/UL	E	450	3	—*2

*1: Fuji Electric Co., Ltd. Production
*2: It is not a maker recommendation article. Please constitute in your product to be attached.
*3: In the case of a parallel model, the product of all the number in the table and the number of parallel connection of the inverter is required.

■Selection of a fuse (400V class)

Outline drawing and Size table

Figure A	(Unit:mm)	Fuse holder[HT6017]	(Unit:mm)

Fuse form list

Inverter model	Fuse type*4	Size (Unit:mm)									Fig ure	Weight (Unit:g)	All the number	Fuse holder type*4
		A	B	C	D	E	F	G	H	T	W				
2R244	660GH-16UL	76	61±3	46	27max	17.5	9.5	6.5	19	2	12	A	37	3	HT6017
3R744	660GH-16UL	76	61±3	46	27max	17.5	9.5	6.5	19	2	12	A	37	3	HT6017
5R544	660GH-25UL	76	61±3	46	27max	17.5	9.5	6.5	19	2	12	A	37	3	HT6017
7R544	660GH-32UL	76	61±3	46	27max	17.5	9.5	6.5	19	2	12	A	37	3	HT6017
1144	660GH-40UL	76	61±3	46	27max	17.5	9.5	6.5	19	2	12	A	37	3	HT6017
1544	660GH-63UL	76	61±3	46	27max	17.5	9.5	6.5	19	2	12	A	37	3	HT6017
2244	660GH-80UL	76	61±3	46	27max	17.5	9.5	6.5	19	2	12	A	37	3	HT6017
3044	660GH-125UL	98	77±4	50	30max	23	14	9	26	3	20	A	100	3	—*5
3744	660GH-160UL	98	77±4	50	30max	23	14	9	26	3	20	A	100	3	—*5
4544	660GH-200UL	98	77±4	50	30max	23	14	9	26	3	20	A	100	3	—*5
5544	660GH-200UL	98	77±4	50	30max	23	14	9	26	3	20	A	100	3	—*5
7544	660GH-250UL	108	82±4	51	51max	31	16	10.5	34	3	25	A	180	3	—*5
11044	660GH-315UL	108	82±4	51	51max	31	16	10.5	34	3	25	A	180	3	—*5
16044	660GH-250UL	108	82±4	51	51max	31	16	10.5	34	3	25	A	180	6*6	—*5
20044*7	660GH-315UL	108	82±4	51	51max	31	16	10.5	34	3	25	A	180	6*6	—*5
25044*7	660GH-200UL	98	77±4	50	30max	23	14	9	26	3	20	A	100	12*6	—*5
31544	660GH-250UL	108	82±4	51	51max	31	16	10.5	34	3	25	A	180	12*6	—*5

*4: HINODE ELECTRIC CO., LTD. Production
*5: It is not a maker recommendation article. Please constitute in your product to be attached.
*6: Connect athird of all the number of fuses in parallel to each phase.
    Example: For 25044 model, Connect 4 Fuses (12 / 3 = 4) in parallel to each phase.
*7: In the case of a parallel model, the product of all the number in the table and the number of parallel connection of the inverter is required.

■Short-circuit capacity

An inverter attaches a fuse to the input side of an inverter, and suits UL508C on condition of the following

Condition

Inverter model	Input voltage	Short-circuit current
2R222 to 3722	less than 242V	less than 5,000A
4522 to 9022	less than 242V	less than 10,000A
2R244 to 3744	less than 506V	less than 5,000A
4544 to 11044	less than 506V	less than 10,000A
16044 to 25044	less than 506V	less than 18,000A
31544	less than 506V	less than 30,000A

■Action after short-circuit

Dispose a short-circuited inverter in any circumstances without using it.

Chapter 3 Compatibility Conditions for European Standards

3.1. Compatible Conditions for Low Voltage Directive

Satisfy the following conditions, in order to conform an inverter to Low Voltage Directive.

■Installation Environment and How to Install Inverter

Refer to the chapter 2(p.10) "Conformity to a North America Standard" of this operating manual.

■Mounting protective device

Be sure to connect the fuse shown in the chapter 2(p.10) "Conformity to a North America Standard" to the input side as a protection instrument at the time of an accident (Short-circuit etc.).

■Grounding of 400V Class inverter

Connect with the power supply by which neutral grounding (TN system) was carried out.

■Action after short-circuit

Dispose a short-circuited inverter in any circumstances without using it.

3.2. Compatible Conditions for EMC Directive

Satisfy the following conditions, in order to fit the inverter to EMC Directive.

■How to Install Inverter

1. Put the output line which comes out of the main circuit electric wire drawn in an operator control panel, or an operator control panel into a metal tube etc., wire and carry out both-ends grounding.

2. Only the inverter which suited Machinery Directive should connect serge absorber to the input side of the inverter.

3. Connect a noise filter to the inverter input side. (Attach one made by Schaffner or Soshin Electric. Refer to each data sheets etc. of the manufacturers for the characteristic of the noise filter.)

4. Only the inverter of 160 kW or more should be connected a grounding capacitor to the input side of the noise filter.

5. Install a zero phase reactor at the input and output of the noise fileter, put the all three phase electric wires of main circuit through the reactor. Refer to the item of each option for the required number and the number of turns.

6. The inverter of 11 kW or more should be connected a direct current reactor (DCL). The wiring between the inverter and the DCL should be shielded, and both ends should be grounded.

7. Install a zero phase reactor at the output side of the inverter, put the all three phase electric wires of main circuit through the reactor.

8. Only for parallel model, connect the outputs of the inverters through the paralleling reactor.

＊Installation example for parallel model
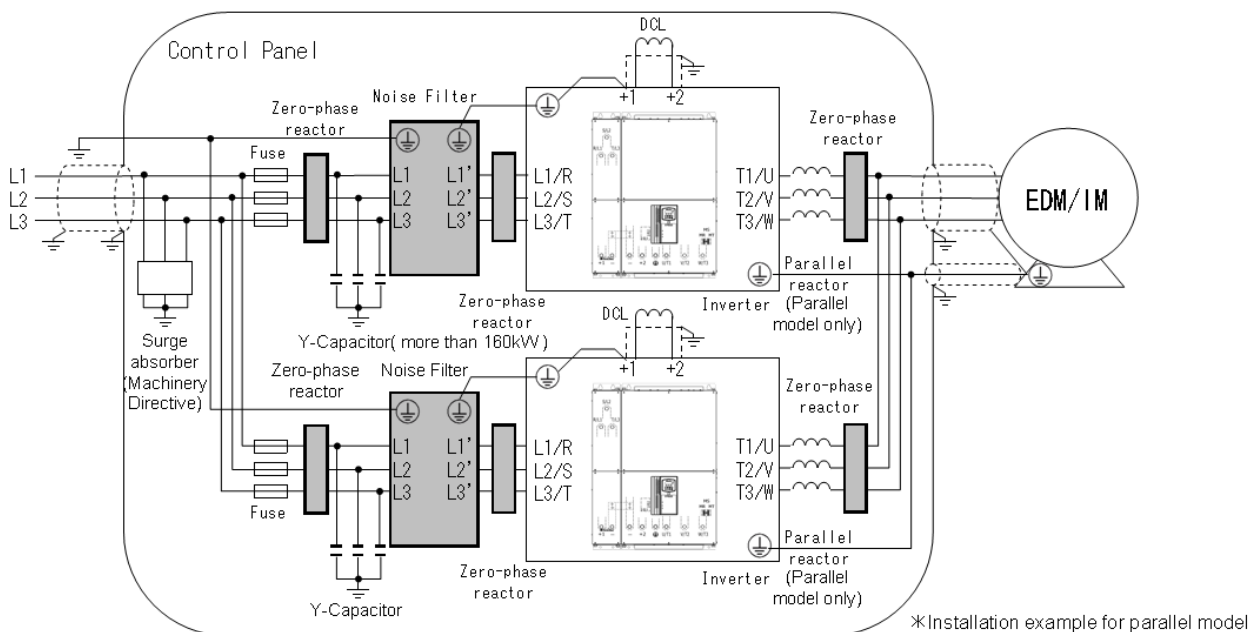
About the inverter and the clamp face of each option, remove the paint of the control panel and ground within the same panel as the inverter.

■The wiring method between the inverters of a parallel model

In the case of a parallel model, connect each inverter according to the example of the following figure.
In addition, although the middle is omitted in the example of the following figure, up to four-inverter parallel connection is possible.


Master Unit side (W52M model)   Slave Unit side (W52S model)
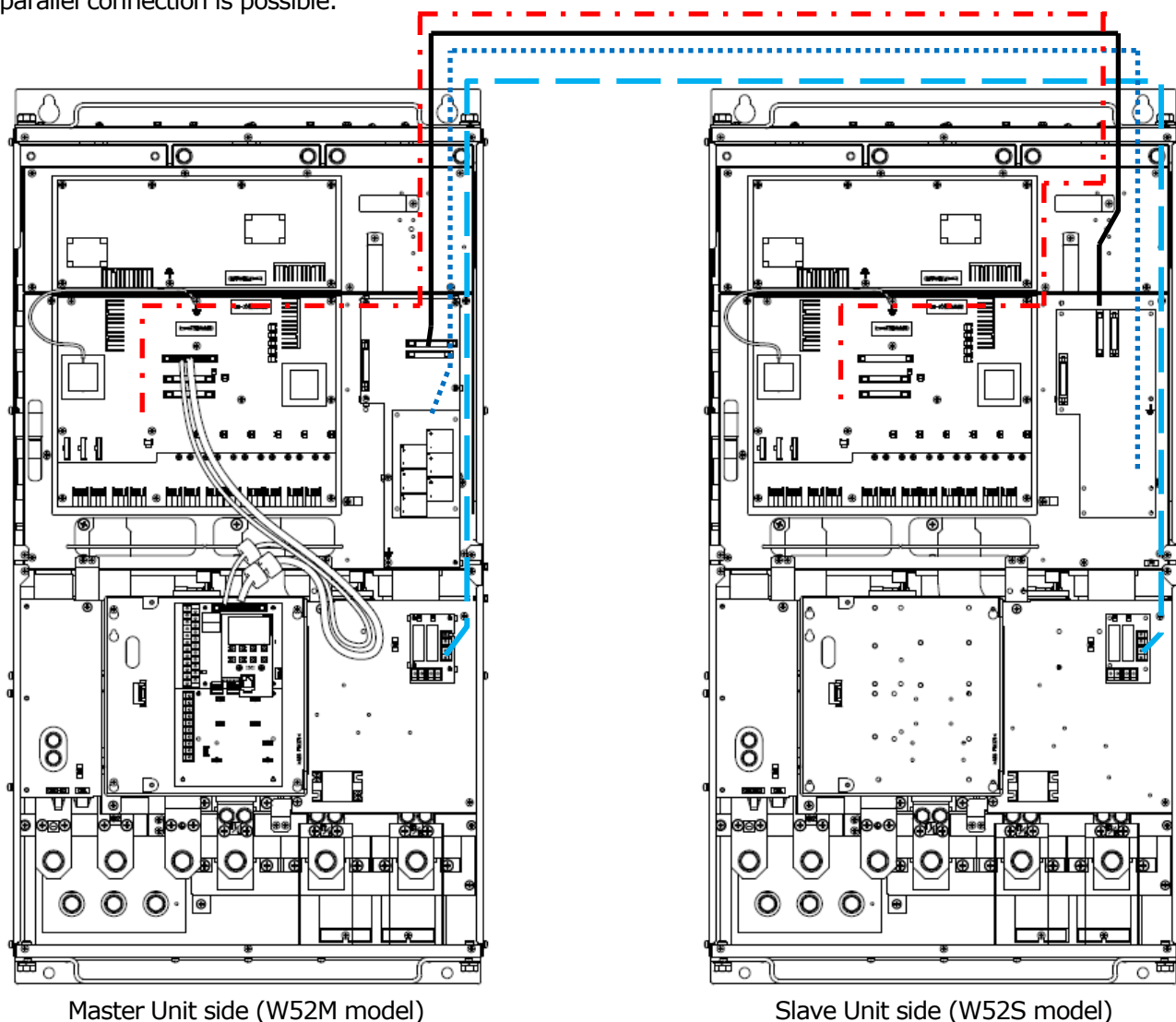
Wiring	Connection point
———	PRIM66-Z-P52 [CN17] - PRIS66-Z-P52 [CN15] (Connection between W52M and W52S model) PRIS66-Z-P52 [CN11] - PRIS66-Z-P52 [CN15] (Connection between W52S models)
··············	DCCT66-Z-P1 [CN1] - PRIS66-Z-P52 [CN7] (Connection between W52M and W52S model) PRIS66-Z-P52 [CN8] - PRIS66-Z-P52 [CN7] (Connection between W52S models)
—·—·—·—	GAC66-9022 or 31544-Z-P51 [CN-CM2] -GAC66-9022 or 31544-Z-P51 [CN-CM1] (Connection between W52M and W52S models or Connection between W52S models)
— — —	STO66-Z [TB-ANS-B(ANS-2b)] (W52M or W52S model) - STO66-Z [TB-ANS-B(ANS-2b)](W52S model)

NOTE: The cable which connects between each printed circuit board currently used when carrying out parallel connection of the inverter is an exclusive cable. In addition, since the exclusive cable serves as length below 3 m, arrange between each inverter to be able to be wired. Moreover, don't use other cables. When you lose the cable, make a reference to our company.

■The wiring method of a speed sensor (PG) cable

In the case using speed sensor (PG) cable, wire as following methods.

(1) PG cable should be the cable recommended by 3.3.2 clause of the "VF66B operating manual (TIM003)."

(2) Dissociate the PG cable from input and output electric wire. When it is difficult to dissociate the cable, let the PG cable across input and output electric wire.

(3) Wind the speed sensor (PG) cable two times around the four EMI cores <ESD-R-47B> .

(4) Put the PG cable between the control panel and the motor into a metal tube, a conduit pipe, etc. and only the control panel side should be grounded.
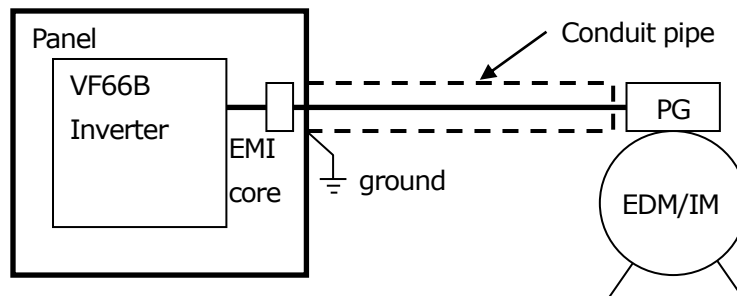
■The wiring method of the terminal box of a control board <VFC66-Z>

When you use the operation point-of-contact terminal [52MA], the protection point-of-contact terminal [86A], the multifunctional input/output terminal, analog input/output terminal, and normal rotation operation terminal [ST-F] in a control board <VFC66-Z>, wire by the following methods so that wiring length does not exceed 5 m.

(1) The electric wire shoule be twisted electric wire.

(2) Dissociate the PG cable from input and output electric wire, and shield the cable. When it is difficult to dissociate the cable, let the PG cable across input and output electric wire.

(3) Wind the electric wires four times around the EMI core <ESD-R-47B>.

(4) Put the electric wires between the control panel and the connected apparatus into a metal tube, a counduit pipe, etc., and both ends should be grounded.
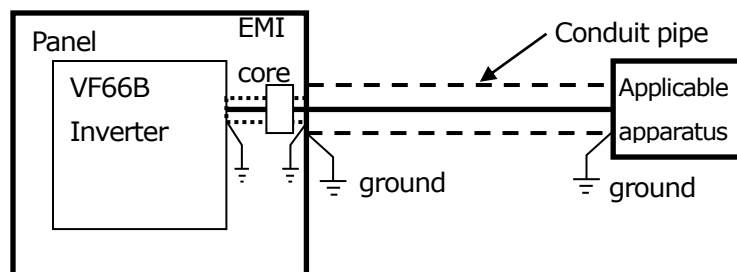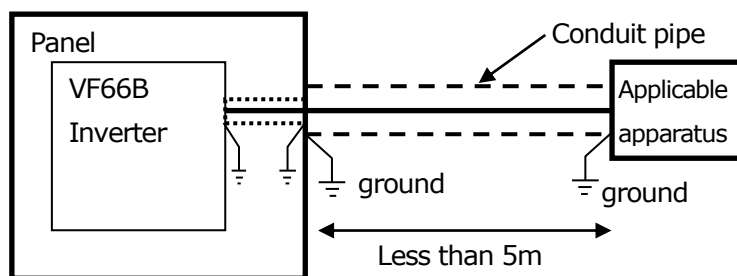
■The wiring method of the terminal box of a functional safe board <STO66-Z>
Only the inverter with which this explanation suited Machinery Directive is applicable.
When you use the DC24V signal input terminal stand 1 of the terminal box of a substrate [TB24-1], 2[TB24-2], an answerback a-contact terminal box[TB-ANS-A], and an answerback b-contact terminal box[TB-ANS-B], wire by the following methods so that wiring length does not exceed 5 m.
(1) The electric wire shoule be twisted electric wire.
(2) Dissociate the PG cable from input and output electric wire, and shield the cable. When it is difficult to dissociate the cable, let the PG cable across input and output electric wire.
(3) When there is no apparatus to connect into the same operator control panel, before the apparatus connected from an operator control panel should put an electric wire into a metal tube, a conduit pipe, etc., and it should carry out both-ends grounding.

■The wiring method of the terminal box of the functional safe board <STO66-Z>   in a parallel model

Only the inverter with which this explanation suited Machinery Directive by the parallel model is applicable.
When you carry out parallel connection of the inverter, the terminal box of <STO66-Z> , <PRIM66-Z-P52> and <PRIS66-Z-P52> should wire as the following example. In addition, the number of the maximum parallel connection of <STO66-Z> is four sets. Moreover, refer to the below for the fundamental wiring method.
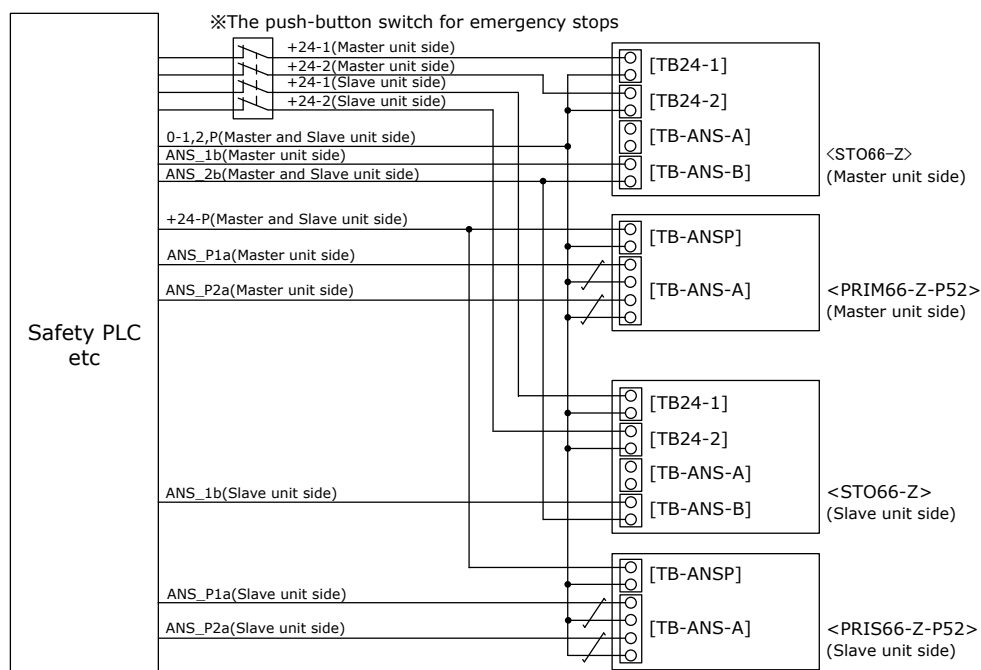
*Substitute the safety PLC etc., when there is no push-button switch for emergency stops corresponding to SIL or PL to demand.

■Selection of serge absorber

In order to satisfy the requirements of immunity demanded by Machinery Directive, use the following serge absorber.

Outline drawing

Figure A

Action indication window

φ4.5

Ground cable

Vinyl electric wire

39

(Unit: mm)
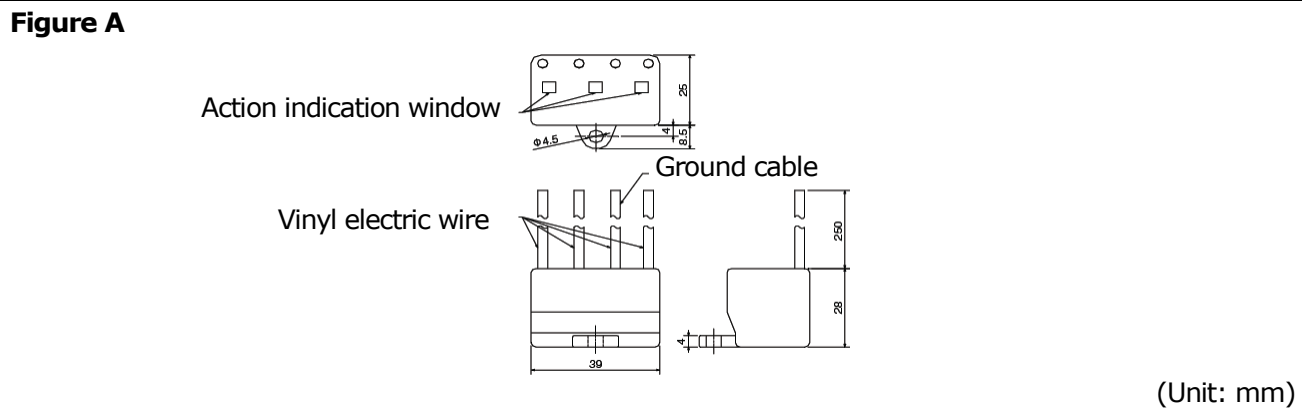
Serge absorber model list

Inverter model	serge absorber type	Figure	number
Apply to all the inverters.	LT-C35G102WS	A	1

*1: Soshin Electric Co., LTD. Production

■Selection of noise Filter (Schaffner)

Outline drawing and Size table
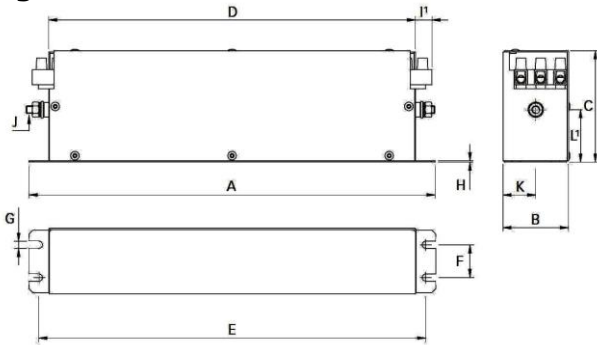
Figure A
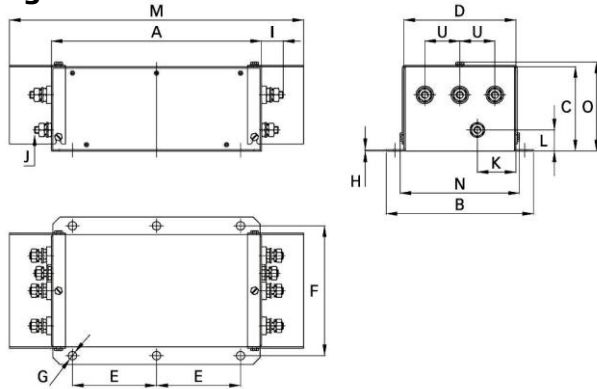
Figure B

Figure C

Figure D

Bus bar connection
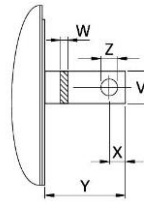
Bus bar size

mark	FN3359-320-99 FN3359-400-99	FN3359-600-99	FN3359-1000-99
V	25mm	25mm	40mm
W	6mm	8mm	8mm
X	15mm	15mm	20mm
Y	40mm	40mm	50mm
Z	Φ10.5mm	Φ10.5mm	Φ14mm

Noise filter model list (200V class)

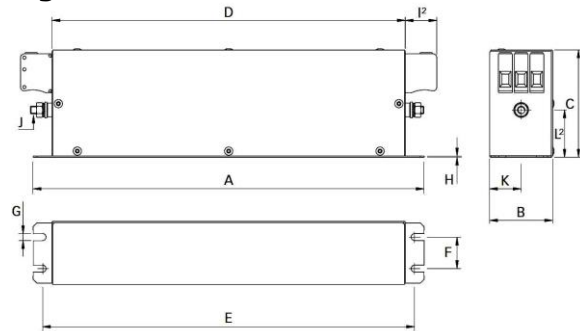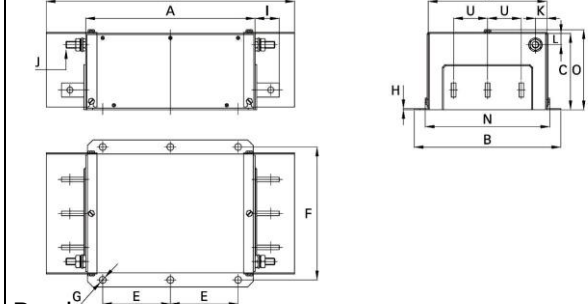| Inverter model	Noise filter type	Size (unit:mm)														figure	weight (unit :kg)	number
		A	B	C	D	E	F	G	H	I1	I2	J	K	L1	L2			
2R222	FN3258-16-XX[*2]	250	45	70	220	235	25	5.4	1	10.6	-	M5	22.5	31	-	A	0.8	1
3R722	FN3258-30-XX[*2]	270	50	85	240	255	30	5.4	1	12.6	-	M5	25	40	-	A	1.2	1
5R522	FN3258-30-XX[*2]	270	50	85	240	255	30	5.4	1	12.6	-	M5	25	40	-	A	1.2	1
7R522	FN3258-55-XX[*2]	250	85	90	220	235	60	5.4	1	19	-	M6	42.5	45	-	A	2.0	1
1122	FN3258-75-XX[*2]	270	80	135	240	255	60	6.5	1.5	19	-	M6	40	60	-	A	2.7	1
1522	FN3258-75-XX[*2]	270	80	135	240	255	60	6.5	1.5	19	-	M6	40	60	-	A	2.7	1
2222	FN3258-100-35	270	90	150	240	255	65	6.5	1.5	-	45	M10	45	-	64	B	4.3	1
3022	FN3258-130-35	270	90	150	240	255	65	6.5	1.5	-	45	M10	45	-	64	B	4.5	1
3722	FN3258-180-40	380	120	170	350	365	102	6.5	1.5	-	49.5	M10	60	-	47	B	6.0	1

Inverter model	Noise filter type	Size (unit:mm)																figure	weight (unit :kg)	number
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	U			
4522	FN3359-250-28	300	230	125	180	120	205	Φ12	2	32	M10	62.5	35	420	191	132	55	C	7.0	1
5522	FN3359-250-28	300	230	125	180	120	205	Φ12	2	32	M10	62.5	35	420	191	132	55	C	7.0	1
7522[*1]	FN3359-400-99	300	260	115	210	120	235	Φ12	2	43	M12	20	20	440	221	122	60	D	10.5	1
9022[*1]	FN3359-400-99	300	260	115	210	120	235	Φ12	2	43	M12	20	20	440	221	122	60	D	10.5	1

*1: In the case of a parallel model, the product of number in the table and the number of parallel connection of the inverter is required.
*2: Terminal code. Please check the manufacture's (SCHAFFNER) catalog.

Noise filter model list (400V class)

Inverter model	Noise filter type	Size (unit:mm)														figure	weight (unit:kg)	number
		A	B	C	D	E	F	G	H	I1	I2	J	K	L1	L2			
2R244	FN3258-7-XX*2	190	40	70	160	180	20	4.5	1	10.6	-	M5	20	31	-	A	0.5	1
3R744	FN3258-16-XX*2	250	45	70	220	235	25	5.4	1	10.6	-	M5	22.5	31	-	A	0.8	1
5R544	FN3258-30-XX*2	270	50	85	240	255	30	5.4	1	12.6	-	M5	25	40	-	A	1.2	1
7R544	FN3258-30-XX*2	270	50	85	240	255	30	5.4	1	12.6	-	M5	25	40	-	A	1.2	1
1144	FN3258-30-XX*2	270	50	85	240	255	30	5.4	1	12.6	-	M5	25	40	-	A	1.2	1
1544	FN3258-42-XX*2	310	50	85	280	295	30	5.4	1	12.6	-	M6	25	40	-	A	1.4	1
2244	FN3258-55-XX*2	250	85	90	220	235	60	5.4	1	19	-	M6	42.5	45	-	A	2.0	1
3044	FN3258-75-XX*2	270	80	135	240	255	60	6.5	1.5	19	-	M6	40	60	-	A	2.7	1
3744	FN3258-100-35	270	90	150	240	255	65	6.5	1.5	-	45	M10	45	-	64	B	4.3	1
4544	FN3258-100-35	270	90	150	240	255	65	6.5	1.5	-	45	M10	45	-	64	B	4.3	1
5544	FN3258-130-35	270	90	150	240	255	65	6.5	1.5	-	45	M10	45	-	64	B	4.5	1
7544	FN3258-180-40	380	120	170	350	365	102	6.5	1.5	-	49.5	M10	60	-	47	B	6.0	1

Inverter model	Noise filter type	Size (unit:mm)																figure	weight (unit:kg)	number
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	U			
11044	FN3359-320-99	300	260	115	210	120	235	Φ12	2	43	M12	20	20	440	221	122	60	D	10.5	1
16044	FN3359-400-99	300	260	115	210	120	235	Φ12	2	43	M12	20	20	440	221	122	60	D	10.5	1
20044*1	FN3359-600-99	300	260	135	210	120	235	Φ12	2	43	M12	20	20	440	221	142	60	D	11.0	1
25044*1	FN3359-600-99	300	260	135	210	120	235	Φ12	2	43	M12	20	20	440	221	142	60	D	11.0	1
31544	FN3359-1000-99	350	280	170	230	145	255	Φ12	3	53	M12	25	25	510	241	177	60	D	18.0	1

*1: In the case of a parallel model, the product of number in the table and the number of parallel connection of the inverter is required.

*2: Terminal code. Please check the manufacture's (SCHAFFNER) catalog.

■Selection of noise Filter (Soshin Electric)

Outline drawing and Size table
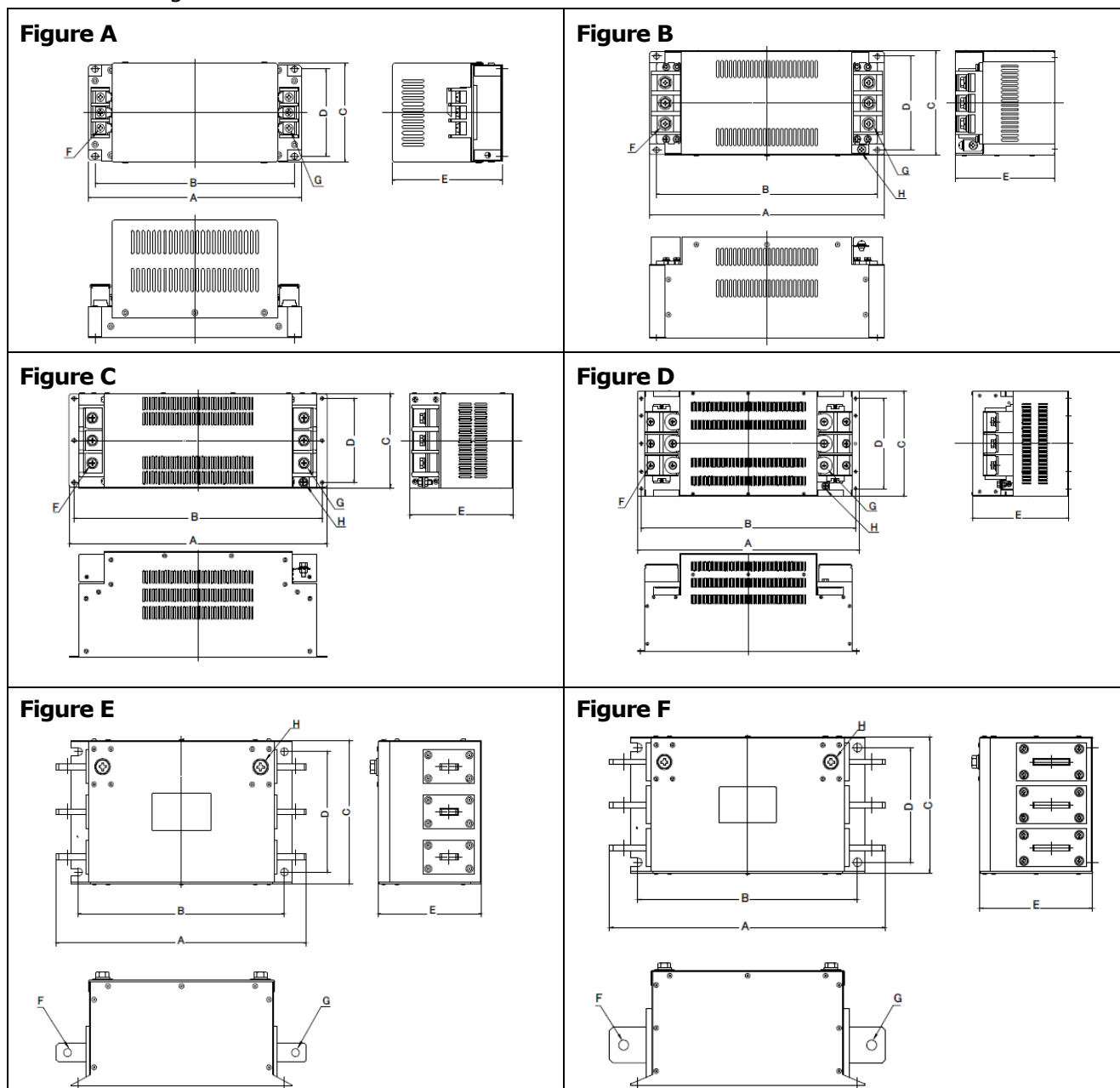
Figure A	**Figure B**

Figure C	**Figure D**

Figure E	**Figure F**

Noise filter model list (200V class)

| Inverter model	Noise filter type	Size (unit:mm)								figure	weight (unit:kg)	number
		A	B	C	D	E	F	G	H			
2R222	HF3020C-UQA	236	221	105	90	122	M5	M5	-	A	2.8	1
3R722	HF3030C-UQA	236	221	105	90	122	M5	M5	-	A	3.3	1
5R522	HF3030C-UQA	236	221	105	90	122	M5	M5	-	A	3.3	1
7R522	HF3050C-UQA	256	241	115	100	127	M5	M5	-	A	4	1
1122	HF3060C-UQA	256	241	115	100	127	M5	M5	-	A	4.5	1
1522	HF3080C-UQA	330	310	145	130	140	M8	M8	M6	B	9	1
2222	HF3100C-UQA	330	310	145	130	140	M8	M8	M6	B	11	1
3022	HF3150C-UQA	400	380	165	145	160	M8	M8	M6	B	14	1
3722	HF3200C-UQA	500	480	180	160	200	M10	M10	M8	C	20	1
4522	HF3200C-UQA	500	480	180	160	200	M10	M10	M8	C	20	1
5522	HF3250C-UQA	500	480	180	160	200	M10	M10	M8	C	21	1
7522[*1]	HF3400C-UQA	600	580	280	240	260	M12	M12	M10	D	33	1
9022[*1]	HF3400C-UQA	600	580	280	240	260	M12	M12	M10	D	33	1

*1: In the case of a parallel model, the product of number in the table and the number of parallel connection of the inverter is required.

Noise filter model list (400V class)

Inverter model	Noise filter type	Size (unit:mm)								figure	weight (unit:kg)	number
		A	B	C	D	E	F	G	H			
2R244	HF3010C-UQA	186	171	98	84	95	M4	M4	-	A	2.2	1
3R744	HF3020C-UQA	236	221	105	90	122	M5	M5	-	A	2.8	1
5R544	HF3020C-UQA	236	221	105	90	122	M5	M5	-	A	2.8	1
7R544	HF3030C-UQA	236	221	105	90	122	M5	M5	-	A	3.3	1
1144	HF3030C-UQA	236	221	105	90	122	M5	M5	-	A	3.3	1
1544	HF3040C-UQA	256	241	115	100	127	M5	M5	-	A	4	1
2244	HF3050C-UQA	256	241	115	100	127	M5	M5	-	A	4	1
3044	HF3080C-UQA	330	310	145	130	140	M8	M8	M6	B	9	1
3744	HF3100C-UQA	330	310	145	130	140	M8	M8	M6	B	11	1
4544	HF3100C-UQA	330	310	145	130	140	M8	M8	M6	B	11	1
5544	HF3150C-UQA	400	380	165	145	160	M8	M8	M6	B	14	1
7544	HF3200C-UQA	500	480	180	160	200	M10	M10	M8	C	20	1
11044	HF3250C-UQA	500	480	180	160	200	M10	M10	M8	C	21	1
16044	HF3400C-UQA	600	580	280	240	260	M12	M12	M10	D	33	1
20044	-	-	-	-	-	-	-	-	-	-	-	-
25044	-	-	-	-	-	-	-	-	-	-	-	-
31544	-	-	-	-	-	-	-	-	-	-	-	-

■Selection of Y-Capacitor

Outline drawing

Figure A

(Unit : mm)
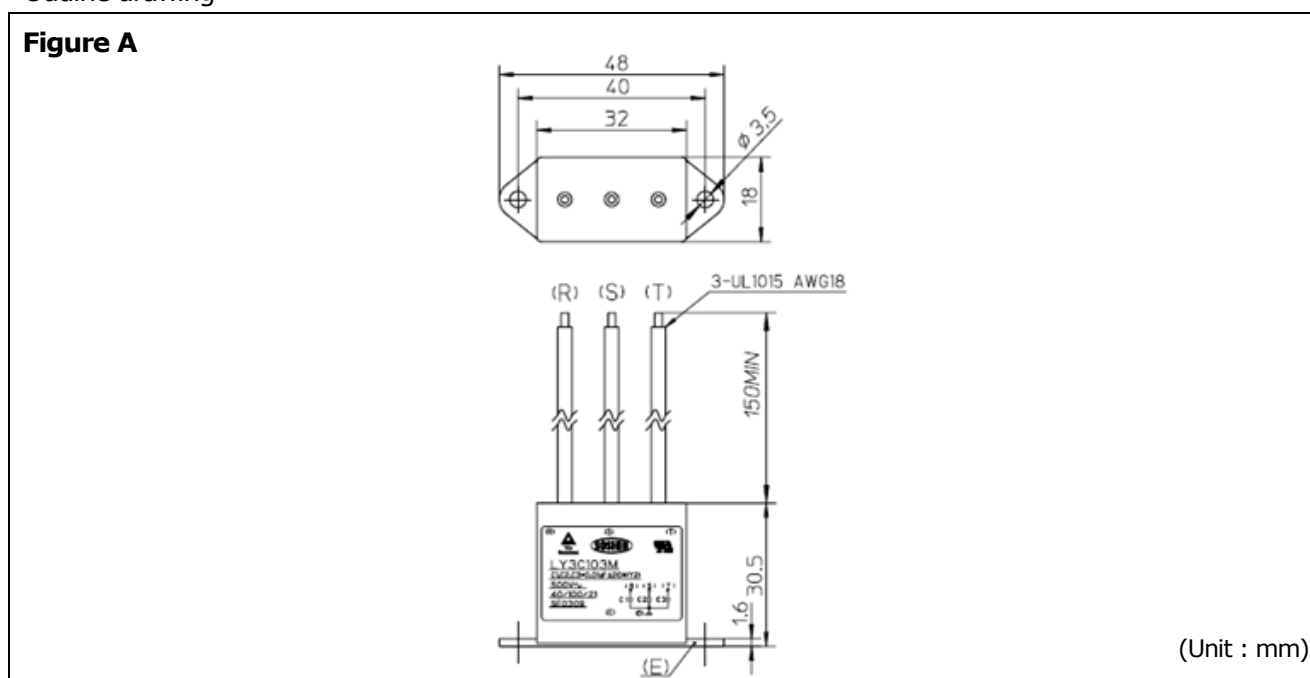
Y-Capacitor model list

Inverter model	Y-Capacitor type*1	Figure	number
VF66B-16044	LY3C333ML	A	1
VF66B-20044*2	LY3C333ML	A	1
VF66B-25044*2	LY3C333ML	A	1
VF66B-31544	LY3C333ML	A	1

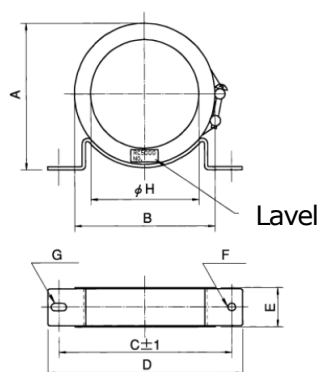NOTE: The grounding capacitor is unnecessary except the above-mentioned inverter model.

*1: Soshin Electric Co., LTD. Production

*2: In the case of a parallel model, the product of number in the table and the number of parallel connection of the inverter is required.

■Selection of Zero-phase Reactor

Outline drawing and Size table

Figure A

Lavel

Zero-phase Reactor model list

Inverter model	Zero-phase Reactor type*4	Size (unit:mm)								figure	number(P)×turn(T)		
		A	B	C	D	E	F	G	H		input side 1*1	input side 2*2	output side
2R222	RC5060	67	45	95	115	19	Φ7	7x14	38	A	1P×3T	1P×3T	1P×3T
3R722	RC5060	67	45	95	115	19	Φ7	7x14	38	A	1P×3T	1P×3T	1P×3T
5R522	RC5060	67	45	95	115	19	Φ7	7x14	38	A	1P×3T	1P×3T	1P×3T
7R522	RC5060	67	45	95	115	19	Φ7	7x14	38	A	1P×3T	1P×3T	1P×3T
1122	RC5060	67	45	95	115	19	Φ7	7x14	38	A	2P×3T	2P×3T	2P×3T
1522	RC5060	67	45	95	115	19	Φ7	7x14	38	A	2P×3T	2P×3T	2P×3T
2222	F6045GB*3	78	-	80	95	26	M5	-	39	A	1P×1T	1P×1T	1P×1T
3022	F140100*3	162	-	160	181	42	M6	-	95	A	1P×2T	1P×2T	1P×2T
3722	F140100*3	162	-	160	181	42	M6	-	95	A	1P×2T	1P×2T	1P×2T
4522	F140100*3	162	-	160	181	42	M6	-	95	A	1P×2T	1P×2T	1P×2T
5522	F140100*3	162	-	160	181	42	M6	-	95	A	1P×2T	1P×2T	1P×2T
7522*5	F140100*3	162	-	160	181	42	M6	-	95	A	2P×1T	2P×1T	2P×1T
9022*5	F140100*3	162	-	160	181	42	M6	-	95	A	2P×1T	2P×1T	2P×1T
2R244	RC5060	67	45	95	115	19	Φ7	7x14	38	A	1P×3T	1P×3T	1P×3T
3R744	RC5060	67	45	95	115	19	Φ7	7x14	38	A	1P×3T	1P×3T	1P×3T
5R544	RC5060	67	45	95	115	19	Φ7	7x14	38	A	1P×3T	1P×3T	1P×3T
7R544	RC5060	67	45	95	115	19	Φ7	7x14	38	A	1P×3T	1P×3T	1P×3T
1144	RC5060	67	45	95	115	19	Φ7	7x14	38	A	2P×3T	2P×3T	2P×3T
1544	RC5060	67	45	95	115	19	Φ7	7x14	38	A	2P×3T	2P×3T	2P×3T
2244	F6045GB*3	78	-	80	95	26	M5	-	39	A	1P×1T	1P×1T	1P×1T
3044	F140100*3	162	-	160	181	42	M6	-	95	A	1P×2T	1P×2T	1P×2T
3744	F140100*3	162	-	160	181	42	M6	-	95	A	1P×2T	1P×2T	1P×2T
4544	F140100*3	162	-	160	181	42	M6	-	95	A	1P×2T	1P×2T	1P×2T
5544	F140100*3	162	-	160	181	42	M6	-	95	A	1P×2T	1P×2T	1P×2T
7544	F140100*3	162	-	160	181	42	M6	-	95	A	2P×1T	2P×1T	2P×1T
11044	F140100*3	162	-	160	181	42	M6	-	95	A	2P×1T	2P×1T	2P×1T
16044	F140100*3	162	-	160	181	42	M6	-	95	A	2P×1T	2P×1T	2P×1T
20044*5	F140100*3	162	-	160	181	42	M6	-	95	A	3P×1T	3P×1T	3P×1T
25044*5	F140100*3	162	-	160	181	42	M6	-	95	A	5P×1T	3P×1T	5P×1T
31544	F140100*3	162	-	160	181	42	M6	-	95	A	7P×1T	3P×1T	5P×1T

*1: The number and the number of turns which are attached to a primary noise filter side.

*2: The number and the number of turns which are attached to a secondary noise filter side
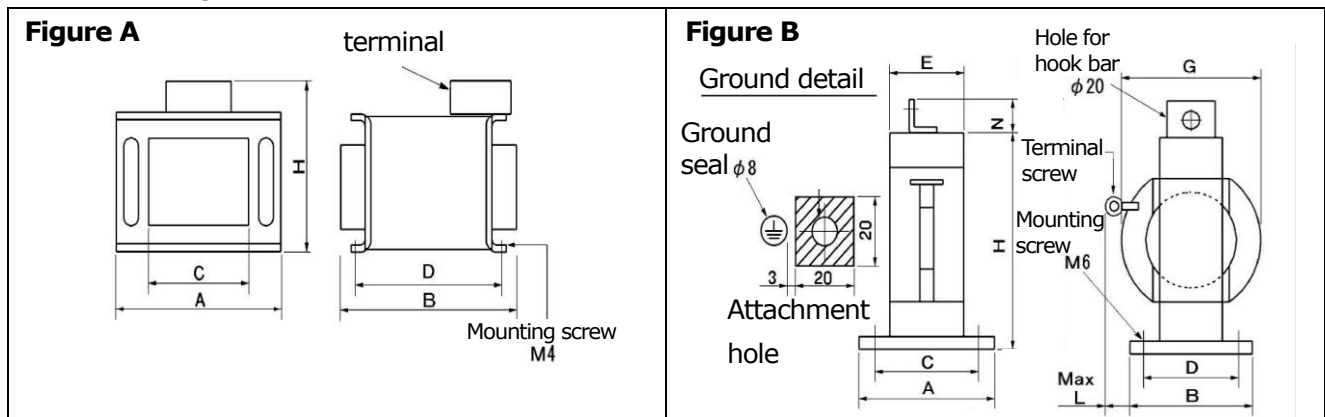
*3: The quality of the material of a core should use either FT-1KM, FT-3KM or FT-3KL.

*4: RC5060 : Soshin Electric Co., LTD. Production, F6045GB, F140100 : Hitachi Metals LTDProduction

*5: In the case of a parallel model, the product of number in the table and the number of parallel connection of the inverter is required.

■Direct-Current Reactor(DCL)

Outline drawing and Size table

Figure A — terminal, Mounting screw M4

Figure B — Ground detail, Ground seal φ8, Attachment hole, Hole for hook bar φ20, Terminal screw, Mounting screw M6

Inverter model	Direct-Current Reactor type	Size (unit:mm)									terminal	figure	weight (unit:kg)	number
		A	B	C	D	E	G	H	N	L				
1122	DCL1122	60	110	40	90	48	162	205	-	90	M6	B	4.0	1
1522	DCL1522	60	110	40	90	48	169	212	-	90	M8	B	5.0	1
2222	DCL2222	60	110	40	90	50	182	226	-	90	M10	B	6.0	1
3022	DCL3022	90	120	70	100	75	181	224	-	90	M10	B	10	1
3722	DCL3722	90	120	70	100	77	182	226	-	90	M10	B	10	1
4522	DCL4522	110	125	90	105	81	170	214	-	90	M12	B	11	1
5522	DCL5522	120	145	100	125	107	182	236	-	90	M12	B	15	1
7522[*1]	DCL7522	110	125	90	105	92	205	259	-	100	M12	B	16	1
9022[*1]	DCL9022	135	135	115	115	111	215	279	40	100	M12	B	20	1
1144	DCL1544	106	100	80	75	-	-	150	-	-	M6	A	4.0	1
1544	DCL1544	106	100	80	75	-	-	150	-	-	M6	A	4.0	1
2244	DCL2244	60	120	40	100	48	192	235	-	90	M6	B	6.0	1
3044	DCL3044	60	120	40	100	48	192	235	-	90	M8	B	6.5	1
3744	DCL3744	90	120	70	100	75	195	238	-	90	M8	B	10	1
4544	DCL4544	90	120	70	100	75	186	230	-	90	M10	B	10	1
5544	DCL5544	110	125	90	105	90	194	248	-	90	M10	B	14	1
7544	DCL7544	110	125	90	105	92	209	263	-	100	M10	B	16	1
11044	DCL11044	135	135	115	115	117	219	283	40	100	M12	B	24	1
16044	DCL16044	145	145	125	125	124	251	325	40	110	M12	B	28	1
20044[*1]	DCL20044	145	145	125	125	130	256	330	40	110	M12	B	35	1
25044[*1]	DCL25044	155	155	135	135	141	283	367	40	120	M16	B	40	1
31544	DCL31544	155	155	135	135	142	310	389	40	210	M16	B	45	1

*1: In the case of a parallel model, the product of number in the table and the number of parallel connection of the inverter is required.

⚠CAUTION Notes of attachment

● A direct-current reactor gets hot. Since it may exceed 100 $^{\circ}$C, provide a space enough with other apparatus.
● Discharge generation of heat of an inverter and a direct-current reactor out of an operator control panel certainly. Keep generation of heat of an inverter and a direct-current reactor from circulating through the inside of a board.

15cm or more   15cm or more
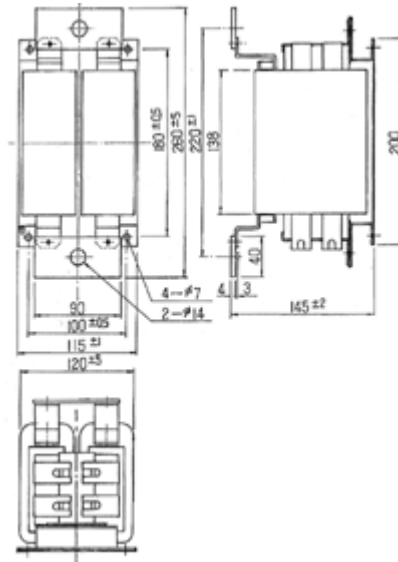
15cm or more   20cm or more   15cm or more
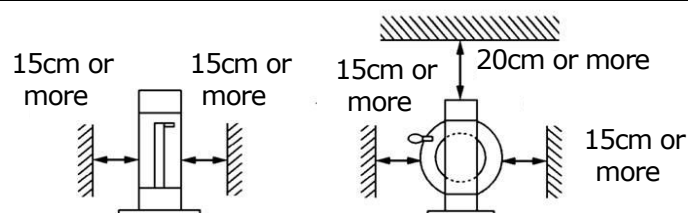
■Paralleling Reactor

Do not fail to connect paralleling reactors at using paralleling model that is for cross current control and output current balance of inverter. Paralleling reactors choices also see the following table.

Outline drawing

Figure A

(Unit:mm)

Paralleling Reactor model list

200V class

Inverter model	Paralleling Reactor type	figure	weight (unit:kg)	num ber
7522	QS23929-2R (ALF7522)	A	9.8	3
9022	QS23929-1R (ALF9022)	A	11.0	3

400V class

Inverter model	Paralleling Reactor type	figure	weight (unit:kg)	num ber
20044	QS23928-2R (ALF20044)	A	9.8	3
25044	QS23928-1R (ALF25044)	A	10.5	3

NOTE: The number is the number for one set.In the case of use, the product of the number in the table and the number of parallel connection of the inverter is required.

⚠ CAUTION Notes of attachment

● Since a paralleling reactor gets hot, don't arrange the affected apparatus close. Moreover, keep generation of heat of a paralleling reactor from circulating through the inside of a board.
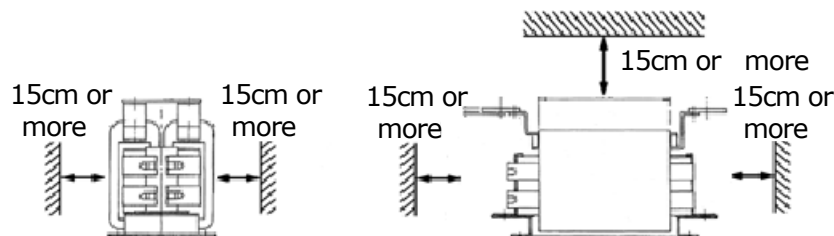
3.3. Compatible Conditions for Machinery Directive

Satisfy the following conditions, in order to fit an inverter to Machinery Directive.

■The compatibility condition of an inverter
1. The conditions of Chapter 3.1(p.14) and Chapter 3.2(p.15) are satisfied.
2. The conditions of Chapter 4(p.29) are satisfied.

When the conditions of Machinery Directive are satisfied, the combination of an inverter and an option serves as a configuration example as shown in the following figure.

■The configuration example at the time of single opportunity model connection
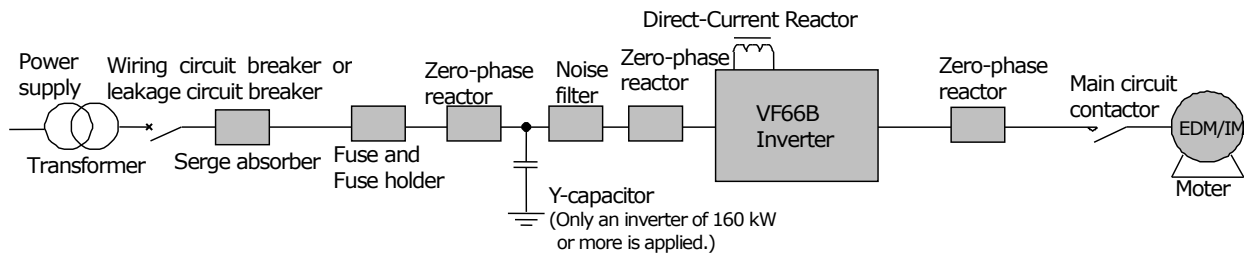
■The configuration example at the time of paralleling model connection
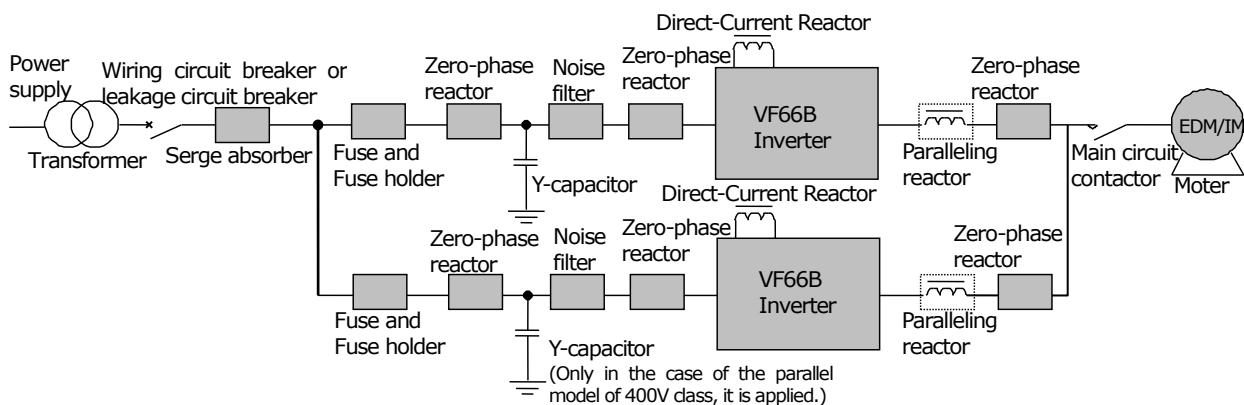
Chapter 4 The directions for a functional safe board

4.1. The directions for a STO(Safe Torque Off) function

■NOTES at the time of using a STO function

This inverter gate blocks by an internal relay on STO66-Z, and the STO (Safe Torque Off: prescript by IEC 61800-5-2) function is equipped to cutoff the energy supply of the output. The STO function is the emergency stop function, because it is the stop function of stop category 0 (stop by power quick shutdown to the machine) prescript by IEC 60204-1. Therefore, the STO function is used to defend the worker when operation with a dangerous moving part of the machine is done.

The STO function leads to the death and the serious illness when handling is mistaken. Observe strictly the following notes, and use it correctly when you use the STO function.

⚠DANGER For use

● The entire system doesn't fill the safety requirement with the application of the STO function. Confirm the risk assessment of the entire system is done, and it fills the safety requirement.
● The signal of the safety function input terminal must use the SELV (Safety Extra Low Voltage) signal of less than hazardous voltage (DC60V).
● The input signal to a safety function input terminal and a safety function monitor terminal should separate from other signals at any cost.
● Push the operating signal stop button ([STOP/RESET]key) of the inverter after behavior the STO function.
● Do not put the operating signal in the inverter until the motor stops after behavior the STO function.
● Do the strategy that cannot be immediately turned on again after behavior the STO function.
● After behavior the STO function, the motor stops by the free run.Do not approach until a mechanical brake or the motor that fills the safety requirement of the entire system stops.
● The STO function is the emergency stop function. Do not use, if normally rest is possible.
● Do not deactivate the STO function, if the RUM signal is input to the inverter.

Observe strictly it so that all items may cause the injury, the breakdown, and the malfunction.

⚠DANGER Daily check

● Execute the check before it uses it without fail when use the STO function.
It may result in a risk of injury, failure, or malfunction.

⚡ WARNING Wiring

● Be sure to turn off the inverter before wiring.
It may result in a risk of electric shock, fire.


⚡ WARNING Connector installation/detaching

● Be sure to turn off the inverter before removal and attachment of a connector.
It may result in a risk of injury, failure, or malfunction.
● After connector removal, when you attach again, don't mistake the insertion place of a connector.
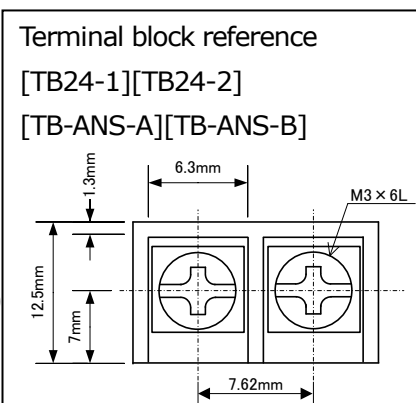It may result in a risk of injury, failure, or malfunction.

⚠WARNING Removal of a board

● Contact us, when you perform removal and exchange of <STO66-Z>.
Otherwise, it may be damaged.

■The name of each part of <STO66-Z>


<STO66-Z>
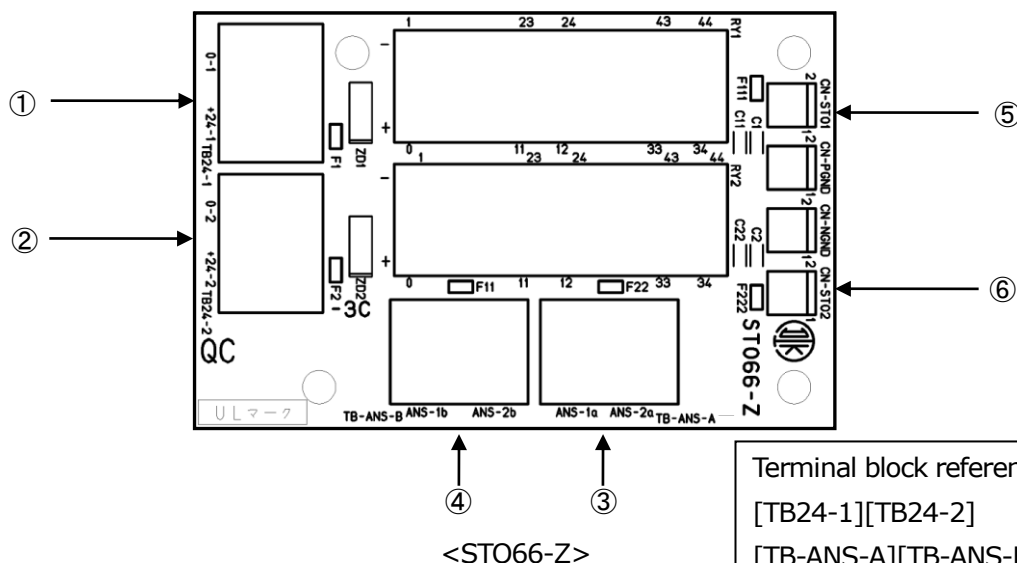
① DC24V signal input terminal 1 ([TB24-1] : M3 screw x2)
② DC24V signal input terminal 2 ([TB24-2] : M3 screw x2)
③ Answer back "a" contact terminal ([TB-ANS-A] : M3 screw x2)
④ Answer back "b" contact terminal ([TB-ANS-B] : M3 screw x2)
⑤ P-Gate block signal connect [CN-STO1]
⑥ N-Gate block signal connect [CN-STO2]

Terminal block reference
[TB24-1][TB24-2]
[TB-ANS-A][TB-ANS-B]

■Terminal specifications of <STO66-Z>

	Part No.	Terminal Name	Discription		
STO66-Z terminal block	TB24-1	+24-1	Safety input terminal	DC24V signal input terminal 1	Input DC 24V signal via a different contact from the one used in terminal [+24-2]. Signal should be from SELV circuit in the following range. Input range: DC24V±10%, 15 to 50mA
		0-1		GND terminal 1	Ground terminal for the terminals [+24-1] and [+24-2]. Use in common with GND terminal 2.
	TB24-2	+24-2		DC24V signal input terminal 2	Input DC 24V signal via a different contact from the one used in terminal [+24-1]. Signal should be from SELV circuit in the following range. Input range: DC24V±10%, 15 to 50mA
		0-2		GND terminal 2	Ground terminal for the terminals [+24-1] and [+24-2]. Use in common with GND terminal 1.
	TB-ANS-A	ANS_1a	Safety function monitor terminal	Answer back "a" contact	(NOTE: For single modes only. Not used in parallel models.) An "a" contact to be connected to exterior. In the case the signal is input to terminal [+24-1] or [+24-2], the contact is closed and current flows. Use for monitoring the relay for STO function. Refer to p.40 (Operation of Safety function monitor) for the detail. Signal should be from SELV circuit in the following rating range. Rating: DC 5 to 30V, 1 to 100mA
		ANS_2a		Answer back "a" contact	
	TB-ANS-B	ANS_1b		Answer back "b" contact	A "b" contact to be connected to exterior. In the case the signal is not input to terminal [+24-1] or [+24-2], the contact is closed and current flows. Use with [TB-ANS-A] for failure detection of <STO66-Z>. Refer to p.40 (Operation of Safety function monitor) for the detail. Signal should be from SELV circuit in the following rating range. Rating: DC 5 to 30V, 1 to 100mA
		ANS_2b		Answer back "b" contact	

■ The name of the safety input part and safety function monitor part on <PRIM66-Z-P52> /
<PRIS66-Z-P52>(For parallel models only)
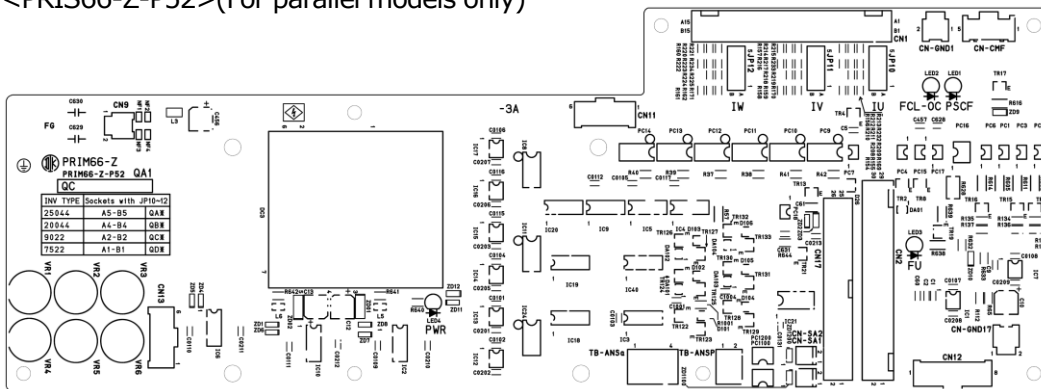
② ①

<PRIM66-Z-P52>
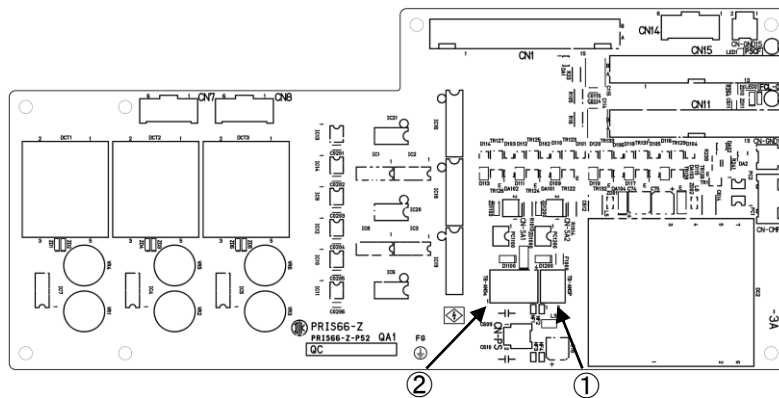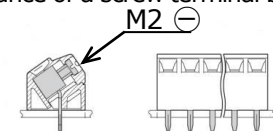

② ①

<PRIS66-Z-P52>

<PRIM66-Z-P52>/<PRIS66-Z-P52>
in common
① DC24V signal input terminal
[TB-ANSP] : Screw terminal block* 2 pole
② Answer back a signal terminal
[TB-ANS-A]: Screw terminal block* 4 pole
*Appearance of a screw terminal block
M2 ⊖

PHOENIX CONTACT SMKDS1 series

■Terminal specification of <PRIM66-Z-P52>/<PRIS66-Z-P52>(For parellel models)

	Part No.	Terminal No.	Terminal Name	Discription		
PRIM66-Z-P52 /PRIS66-Z-P52 Terminal block	TB-ANS P	1	+24-P	Safety input terminal	DC24V signal input terminal	Input for DC24V signal. Signal should be from SELV circuit in the following voltage range. Input range: DC24V±10%, 8mA
		2	0-P		GND terminal	Ground terminal for terminal [+24-P].
	TB-ANS-A	1	ANS_P1a	Safety function monitor terminal	Answer back a1	(For parallel models) Transistor output terminal to be connected to external circuit. In the case the signal is input to the terminal [+24-1] on <STO66-Z>, ANS_P1a outputs "L", and the other case, outputs "H". Use for monitoring the relay for STO function. Refer to p.40 (Operation of Safety function monitor) for the detail. Maximum rating output:DC24V±10%, 4mA
		2	ANS_0		GND terminal	Common ground terminal with terminal [0-P]. Connected to [0-P] internally.
		3	ANS_P2a		Answer back a2	Transistor output terminal to be connected to external circuit. In the case the signal is input to the terminal [+24-2] on <STO66-Z>, ANS_P2a outputs "L", and the other case, outputs "H". Use for monitoring the relay for STO function. Refer to p.40 (Operation of Safety function monitor) for the detail. Maximum rating output:DC24V±10%, 4mA
		4	ANS_0		GND terminal	Common ground terminal with terminal [0-P]. Connected to [0-P] internally.

NOTE: The characters in the above shows the following state. H : 24V signal is applied, L : No signal is applied .
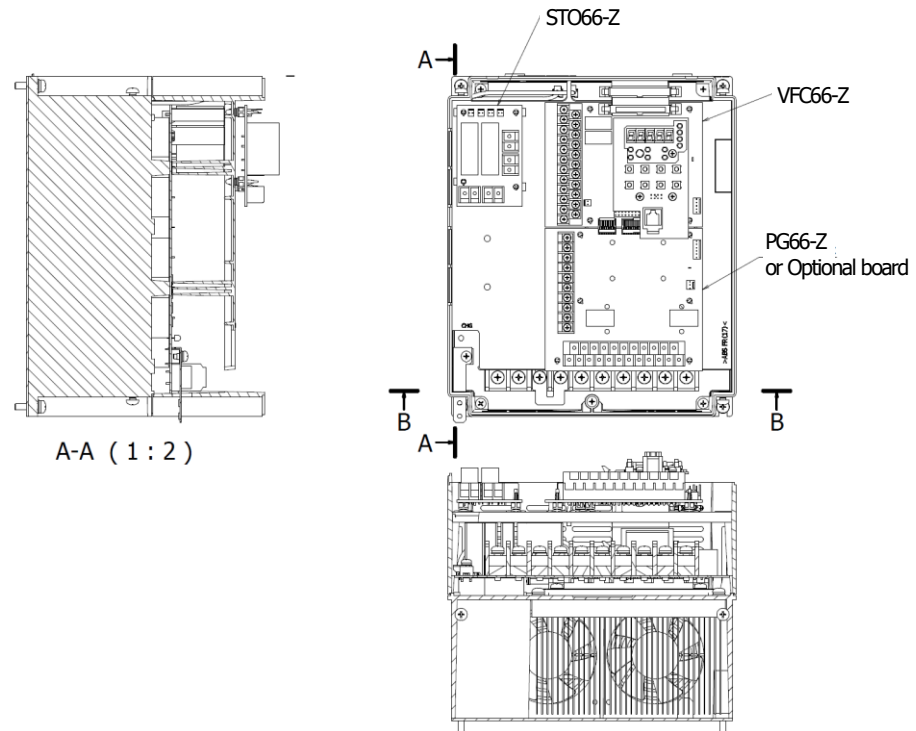
■Installation position of STO66-Z

(1)Model of 3.7kW or less that uses case and cover made of resin

MRMT66-Z

STO66-Z

A

A (1 : 2.5)

For SUBPS*2
terminal

For function safety
STO66-Z terminal

2-Ø6
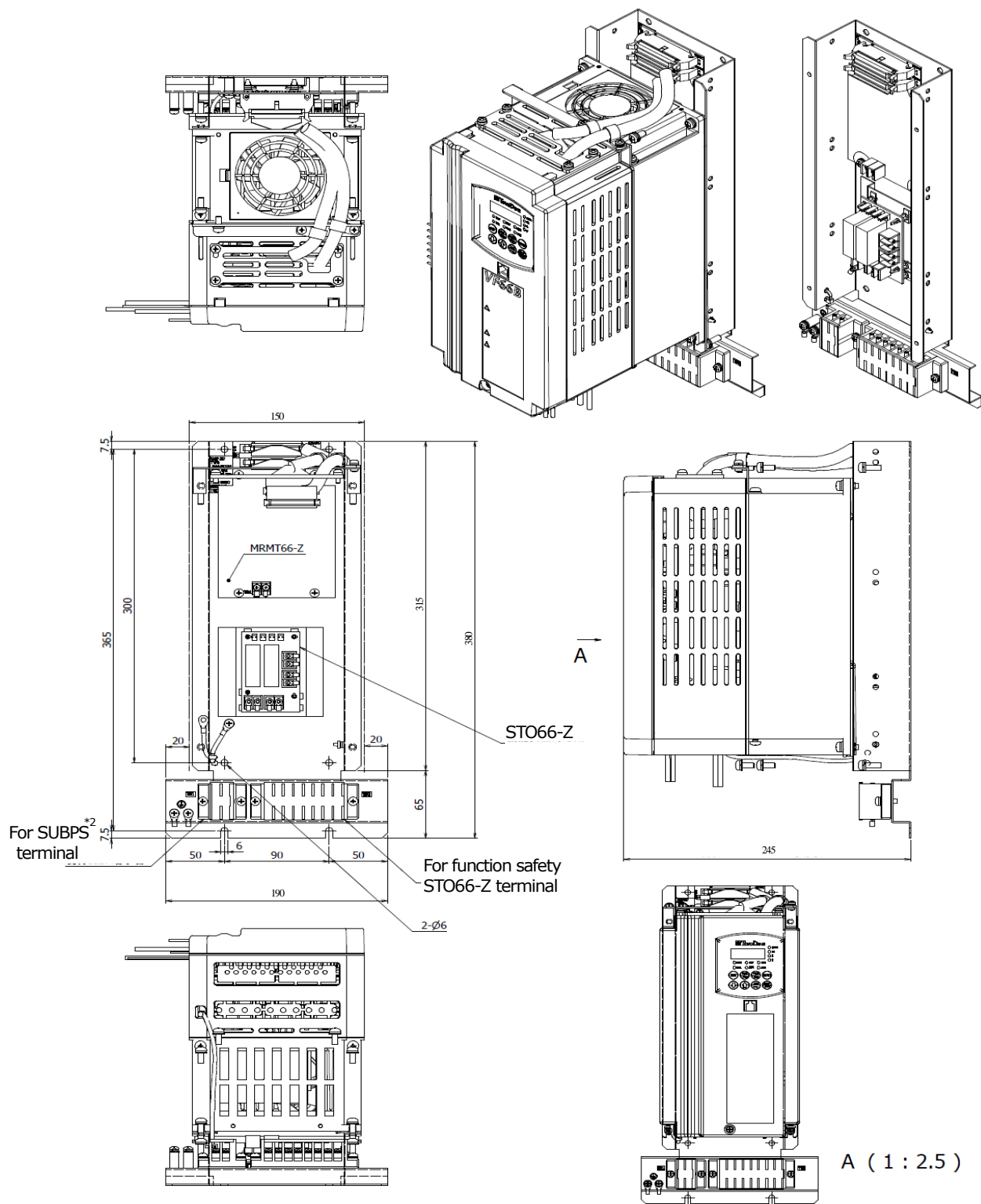
*1 : MRMT66-Z is optional board.

*2 : When MRMT66-Z installed, it is attached.

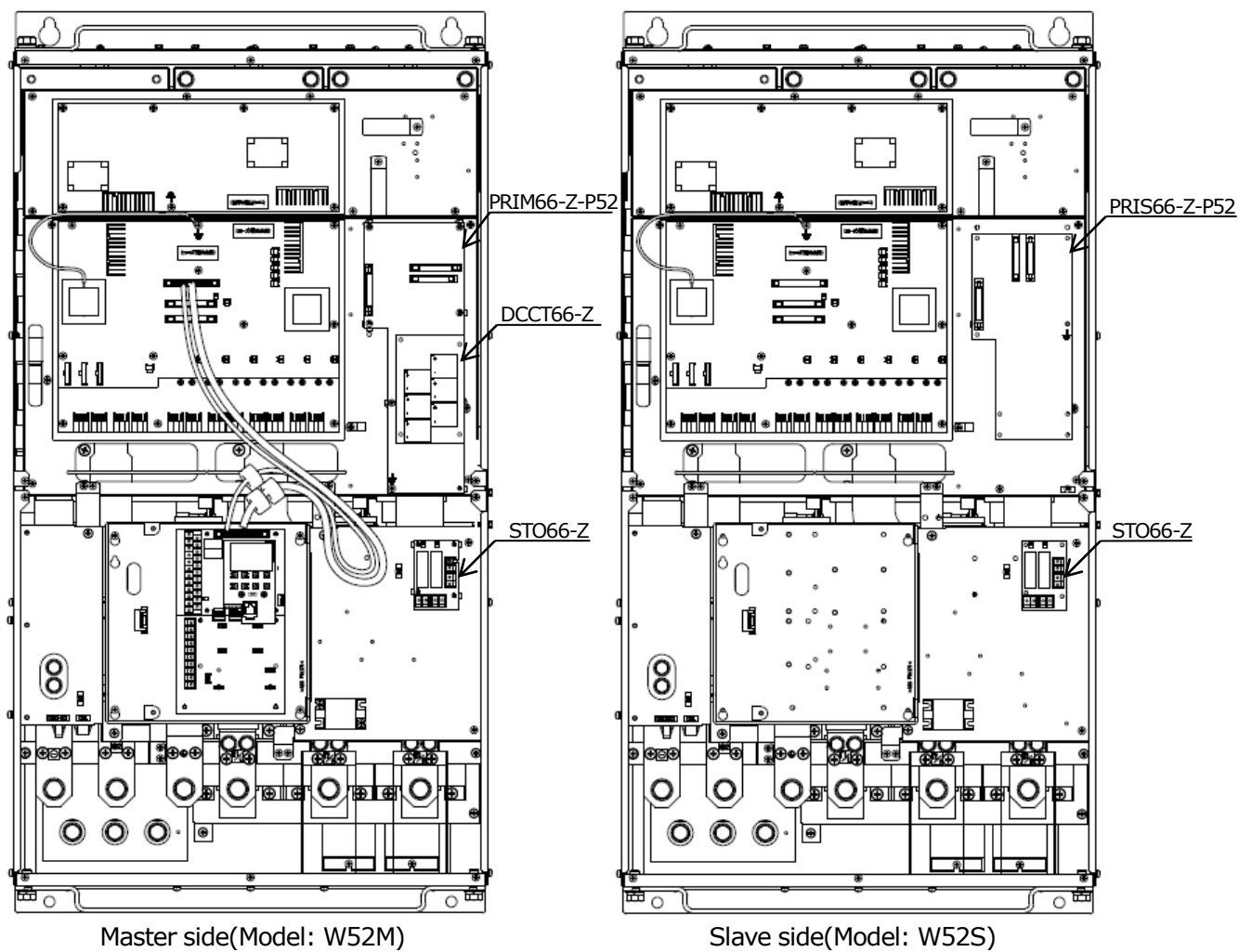(2)5.5kW and 7.5kW model that uses case and cover made of resin

STO66-Z

VFC66-Z

PG66-Z
or Optional board

A-A（1:2）

(3) Model of 11kW or more that uses case and cover made of metal

VFC66-Z

PG66-Z
or Optional board

STO66-Z
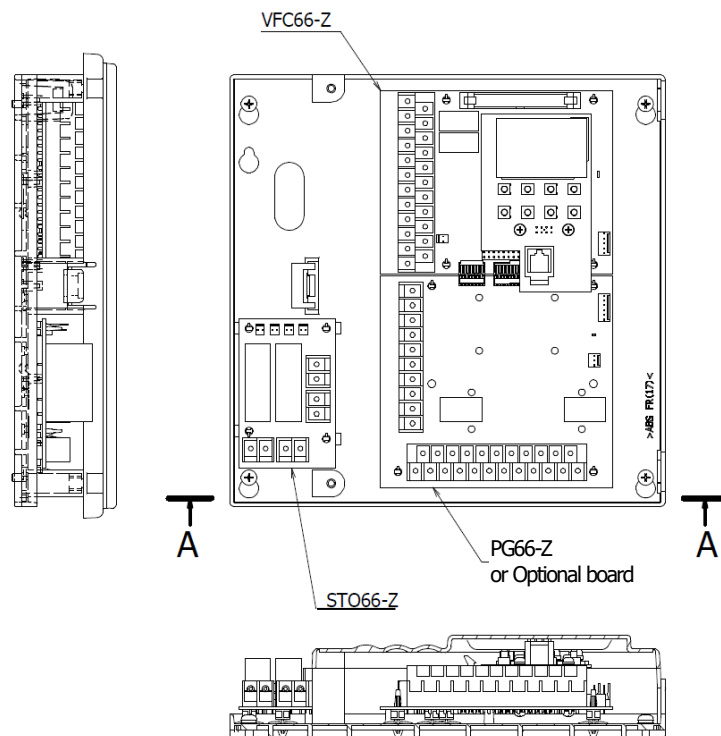
■Mounting position of <PRIM66-Z-P52>/<PRIS66-Z-P52> circuit board

(1)Parallel Models

Master side(Model: W52M)

Slave side(Model: W52S)

■ SIL(Safety Integrity Level) and PL(Performance Level) of STO function

The STO function of this inverter achieves SIL2 of EN 61800-5-2 and PL d of EN ISO 13849-1. However, do the safety function monitor (EDM) use to achieve PL. When using safety function monitor with the parallel model, wiring as shown in wiring methods in chapter 3(p.18). And, SIL and PL in the entire system are not achieved by only the inverter. SIL and PL of the final system are check by the customer built the final system.

■ Failure rate(PFD, PFH) of STO function

The failure rate (PFD, PFH) of the STO function confirms it is low enough from the failure rate requirement by SIL2.
The failure rate (PFD, PFH) was calculated according to EN 61508 and EN 62061. The calculation condition was assumed to be MTTR (mean time to repair) 72hour at diagnosis test interval and proof test intervals one year/times.

<STO66-Z>: Single connection

Failure rate when failure diagnosis function is used

SIL2 requirement failure rate[1]	Failure rate	%Failure rate[2]	Note
PFD < 0.5×10^{-2}	2.64×10^{-7}	0.01%	Probability of a dangerous failure on demand
PFH < 0.5×10^{-6}	8.38×10^{-11}	0.02%	Probability of a dangerous random hardware failure per hour

Failure rate when the failure diagnosis function unused

SIL2 requirement failure rate[1]	Failure rate	%Failure rate[2]	Note
PFD < 0.5×10^{-2}	9.84×10^{-6}	0.20%	Probability of a dangerous failure on demand
PFH < 0.5×10^{-6}	4.48×10^{-9}	0.90%	Probability of a dangerous random hardware failure per hour

<STO66-Z>: Parallel connection

Failure rate when failure diagnosis function is used

SIL2 requirement failure rate[1]	Failure rate	%Failure rate[2]	Note
PFD < 0.5×10^{-2}	7.08×10^{-7}	0.01%	Probability of a dangerous failure on demand
PFH < 0.5×10^{-6}	1.77×10^{-10}	0.04%	Probability of a dangerous random hardware failure per hour

Failure rate when the failure diagnosis function unused

SIL2 requirement failure rate[1]	Failure rate[3]	%Failure rate[2]	Note
PFD < 0.5×10^{-2}	3.96×10^{-5}	0.79%	Probability of a dangerous failure on demand
PFH < 0.5×10^{-6}	1.80×10^{-8}	3.60%	Probability of a dangerous random hardware failure per hour

*1: Refer to IEC61511

*2: (Failure rate/SIL2 requirement failure rate)×100%

*3: Failure rate when connected in parallel with four inverters.

■Explanation of STO function

The STO function of this inverter gate block with hardware in stopping the external input signal connected with the safety input terminal, and becomes a function to stop the inverter output.

As for the connection destination of the safety input terminal ([TB24-1], [TB24-2]), the circuit is independent. And, the gate is intercepted with each circuit. Connect the connection to the safety input terminal by composing "1 input 2 contact" as shown in figure 5-1-1. Moreover, [TB-ANS-A] and [TB-ANS-B] are connected to the safety related equipment such as Safety PLC concerned, and monitoring the STO operation.

STO66-Z is able to connect in parallel with the maximum four inverters. When connect in parallel of wiring method, please refer to the wiring methods in chapter 3(p.18).
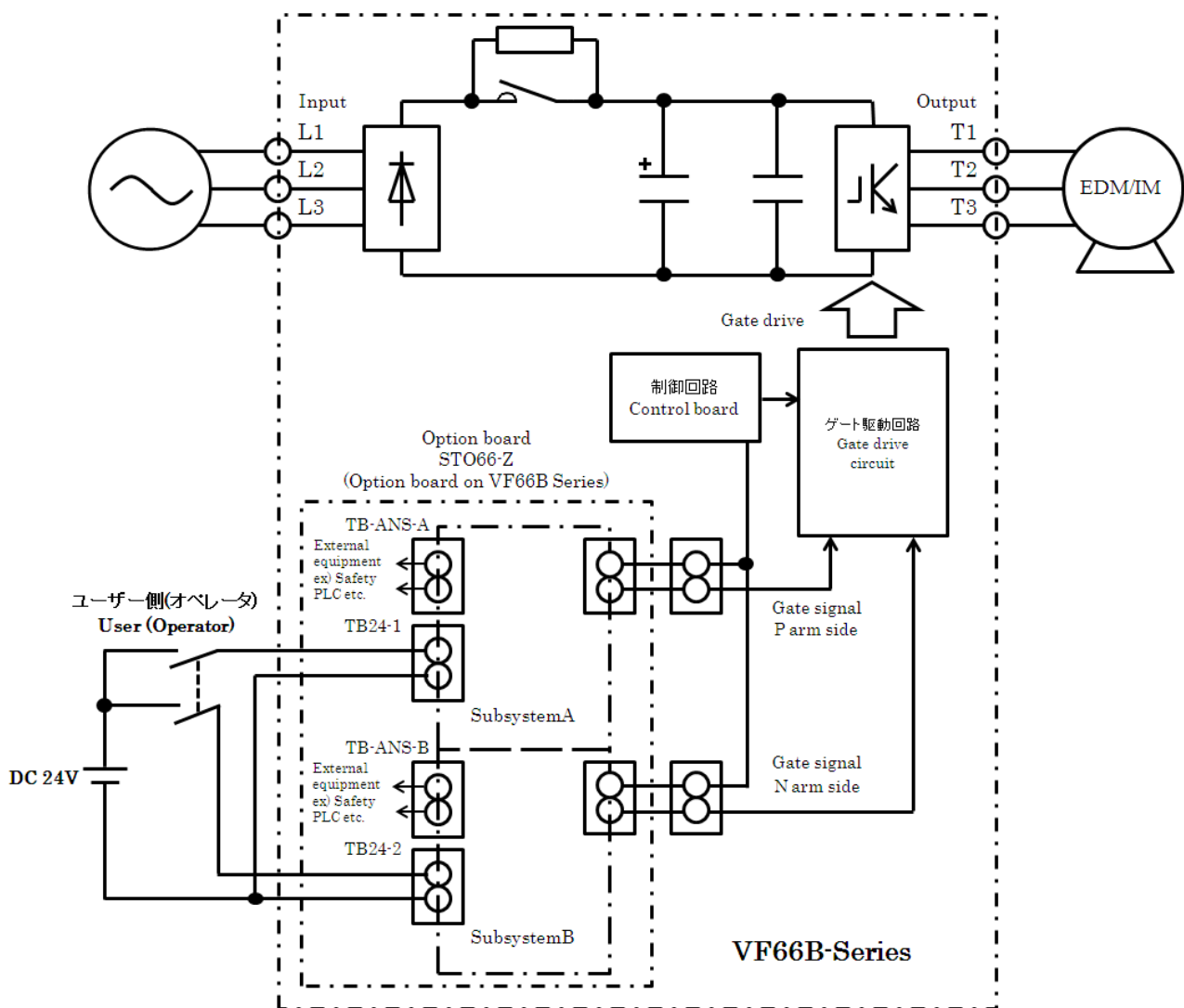
Connection to STO66-Z

■Operation of STO function

At the time of STO functional operation, the inverter operates, as shown in the following figure (a).
Moreover, in the case of the inverter of a parallel model, as shown in the following figure (b), it operates.
STO The function requires the response time of 20ms or less. Therefore, the STO function may not
operation when reclosing a signal into safety input terminal ([TB24-1], [TB24-2]) again within 20ms.
The inverter operating instruction doesn't stop even when the STO function operates. Therefore, push
the STOP button of an inverter manually at the time of STO functional operation, and suspend operation
instructions. Or be sure to perform the operation instruction stop measure shown in the example of the
following page, and to perform correspondence which suspends operation instructions of an inverter.

When correspondence which suspends operation instructions of an inverter is omitted, it is recognized
as the output line being disconnected and the "Cut" error (open phase) is displayed.
Refer to Chapter 6 of the "VF66B operating manual (TIM003)" for the details of the "Cut" error.
Moreover, since a motor serves as a free-run stop and rotates by inertia, perform measures, such as
preparing a load brake, on safety.
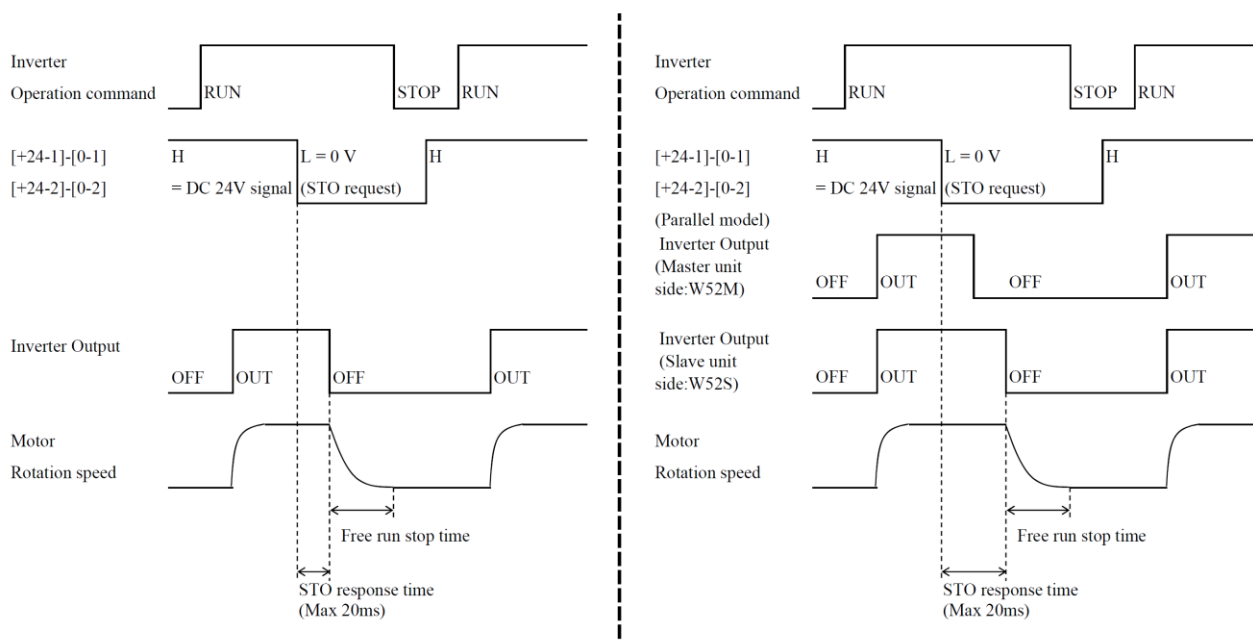
(a) <STO66-Z> single-connection   (b)<STO66-Z> parallel-connection
Timing chart when STO operates

■The example of the operation command stop during STO function operation
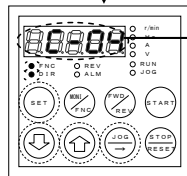
1. Power on the inverter. (NOTE: Don't supply DC24V signal to the safe input terminal of <STO66-Z>.)

2. Set the parameter "C-04" to "32" as the following procedure, then power off. In addition, at the factory default, the parameter is already set to "32".
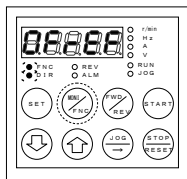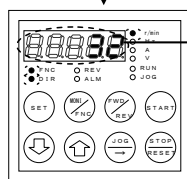

When the [FNC] LED on the console turns off, press the [MONI/FNC] key.
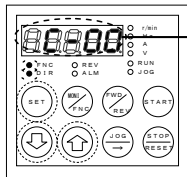
Press the keys [↑] and [↓] to display "C-00."

Press the [JOG/→] key to blink required digits, and then press the keys [↑] and [↓] to specify numbers to become "C-04".
Press the [SET] key.

The data set up now is displayed.
Press the [JOG/→] key to blink required digits, and then press the keys [↑] and [↓] to specify numbers to become "32." Press the [SET] key.
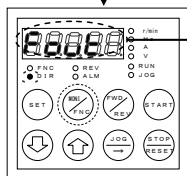- - - → When data cannot be written in

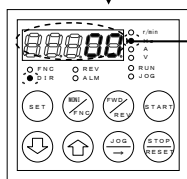| Beyond a setting range maximum | Below a setting range minimum | It sets up by "b-00" "it is write-protected." |

Press the [MINI/FNC] key.
The [FNC] LED turns off, a monitor item is displayed for about one second.

After about 1 second

After about 1 second, it changes to the data display of the monitor item set up. (In the case of the left figure, it is shown that output frequency is 0.0 Hz.)

3. After 10 minutes or more passed since the power off, connect <VFC66-Z> and <STO66-Z> with a twisted-pair cable, as shown in the following figure.
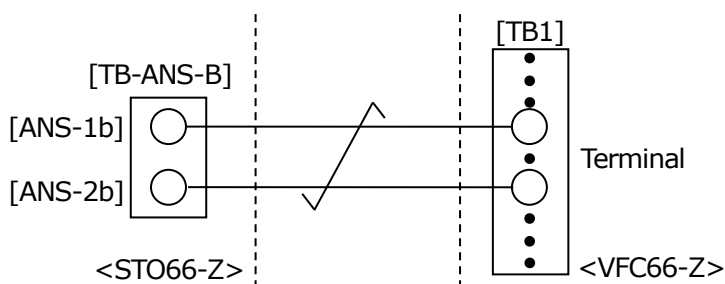
4. Power on the inverter again.
5. When connected correctly, it is displayed on a monitor as 88888. Moreover, check that the display of [Fout]key does not change from "0.0", and the motor does not rotate, even if [RUN] button on the console is pushed. Then power off the inverter.
6. Supply DC24V signal is to the safe input terminal of <STO66-Z> and power on the inverter.
7. Check that the inverter operates normally and the motor drives by pushing the [RUN] button of the console.
8. Push the [STOP/RESET] button of the console. After the motor stops, power off the inverter and STO66-Z.

By the above procedure, it is enabled to stop operation command during STO function operation.

■Operation of safety function monitor

As the safety function monitor, the function is equipped to supervise operation and failure of the relay for gate interception. Use for the feedback to the safety PLC etc.
Operation principle is shown as the following figure.
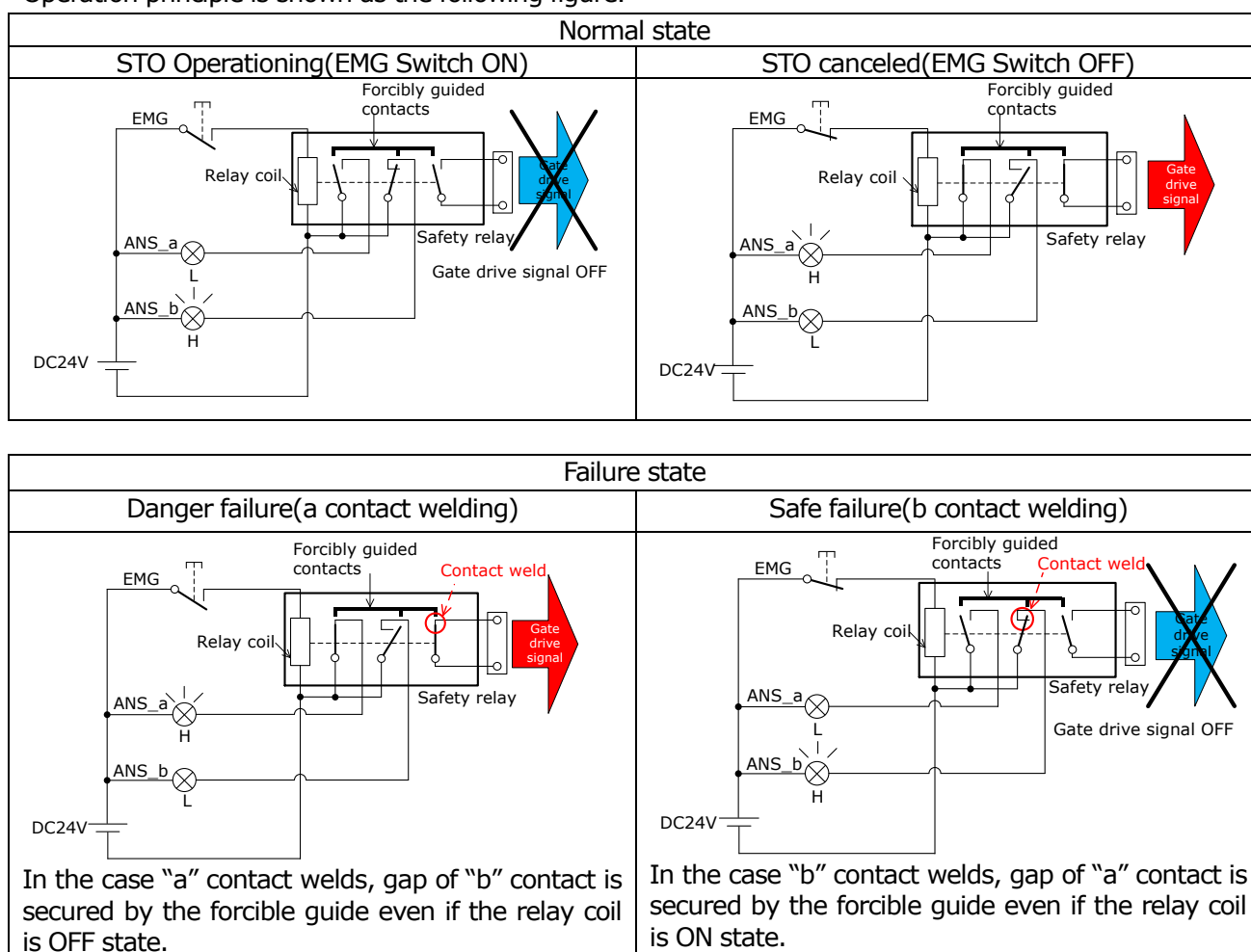
<STO66-Z> equips a safety relay. Safety relay has a forcibly guided contacts, each contact is interlocked mechanically by the link structure of the forcible guide.
In the case either "a" contact or "b" contact is in welding failure, the other contact not welding is locked by the forcible guide.

It is possible to detect the operation and failure of the relay by monitoring each signal state.

The state of a safe input terminal and a safety function monitor is shown as follows, refer at daily and periodic check. In addition, be sure to power off the inverter at check.

Moreover, the state of the safety function monitor at the danger failure (contact welding of a relay) and safe failure (fuse blowout) is shown as follows.

In the case of a danger failure, the contact between [ANS-1b] and [ANS-2b] is OFF, regardless of the input signal. In the case of a safe failure, the contact between [ANS-1a] and [ANS-2a] is OFF for single models, [ANS-P1a] or [ANS-P2a] is 'H' level for parallel models, regardless of the input signal.

The state of safety input and safety function monitor(Single models)

Circuit board	Terminal Name	Normal state			
STO board <STO66-Z>	[+24-1] – [0-1]	H	H	L	L
	[+24-2] – [0-2]	H	L	H	L
	[ANS_1a] – [ANS_2a]	ON	OFF	OFF	OFF
	[ANS_1b] – [ANS_2b]	OFF	OFF	OFF	ON
Inverter state		Run	SS	SS	SS

The state of safety input and safety function monitor (Parallel models)

Circuit board	Terminal Name	Normal state			
STO board <STO66-Z>	[+24-1] – [0-1]	H	H	L	L
	[+24-2] – [0-2]	H	L	H	L
Parallel control board <PRIM66-Z-P52> <PRIS66-Z-P52>	[ANS_P1a]	L	L	H	H
	[ANS_P2a]	L	H	L	H
STO board <STO66-Z>	[ANS_1b] – [ANS_2b]	OFF	OFF	OFF	ON
Inverter state		Run	SS	SS	SS

NOTE: The characters in the above shows the following state. H : 24V signal is applied, L : No signal is applied, ON : The contact is closed, OFF : The contact is open, Run : The inverter is running, and SS(Safety Stop) : The inverter is safety stopped.

The state of safety input and safety function monitor at failure(Single models)

Circuit board	Terminal Name	Danger failure					Safe failure				
		[+24-1] failure		[+24-2] failure		[+24-1,2] failure	[+24-1] failure		[+24-2] failure		[+24-1,2] failure
STO board <STO66-Z>	[+24-1] – [0-1]	H/L	H/L	H	L	H/L	H/L	H/L	H	L	H/L
	[+24-2] – [0-2]	H	L	H/L	H/L	H/L	H	L	H/L	H/L	H/L
	[ANS_1a] – [ANS_2a]	ON	OFF	ON	OFF	ON	**OFF**	**OFF**	**OFF**	**OFF**	**OFF**
	[ANS_1b] – [ANS_2b]	**OFF**	**OFF**	**OFF**	**OFF**	**OFF**	OFF	ON	OFF	ON	OFF
Inverter state		Run	SS	Run	SS	Run	SS	SS	SS	SS	SS

The state of safety input and safety function monitor at failure (Parallel models)

Circuit board	Terminal Name	Danger failure					Safe failure				
		[+24-1] failure		[+24-2] failure		[+24-1,2] failure	[+24-1] failure		[+24-2] failure		[+24-1,2] failure
STO board <STO66-Z>	[+24-1] – [0-1]	H/L	H/L	H	L	H/L	H/L	H/L	H	L	H/L
	[+24-2] – [0-2]	H	L	H/L	H/L	H/L	H	L	H/L	H/L	H/L
Parallel control board <PRIM66-Z-P52> <PRIS66-Z-P52>	[ANS_P1a]	L	L	L	H	L	**L**	**H**	**L**	**H**	**H**
	[ANS_P2a]	L	H	L	L	L	**H**	**L**	**H**	**L**	**H**
STO board <STO66-Z>	[ANS_1b] – [ANS_2b]	**OFF**	**OFF**	**OFF**	**OFF**	**OFF**	OFF	ON	OFF	ON	OFF
Inverter state		Run	SS	Run	SS	Run	SS	SS	SS	SS	SS

NOTE: The characters in the above shows the following state. H : 24V signal is applied, L : No signal is applied, ON : The contact is closed, OFF : The contact is open, Run : The inverter is running, and SS(Safety Stop) : The inverter is safety stopped.

⚠️**DANGER** Use of a safety function monitor terminal

● Don't use the safety function monitor terminal other than operation of a relay, and the function of fault monitoring.
● Since the function of a safety function monitor terminal loses, don't use the voltage and current more than the maximum rating.
● Since there is a possibility that all the items may lead to an injury, failure, and malfunction, be sure to protect.

TOYODENKI SEIZO K.K.

In addition, the contents of this the "operation manual" may be changed without a preliminary announcement by specification change of a product etc. Please understand that it may differ from the contents of the "operation manual" enclosed by the model of purchase, and the contents of the "operation manual" posted on our homepage.
Please have a look from our homepage about the newest "operation manual".

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