



MITSUBISHI IGBT GENERAL-PURPOSE INVERTER  
FREQROL-A500L SERIES

## **PANEL BUILDING GUIDELINE**

## 1. Panel design

When designing and manufacturing the inverter panel, sufficient consideration must be given to the heat generated by the built-in devices, and the working environment, etc. The panel structure, dimensions and device layout must be decided with these in mind. Many semiconductor elements are used in the inverter. To enhance the reliability and to ensure long use, use the inverter in an ambient environment that satisfies the device specifications.

### 1.1 Inverter installation environment

The standard specifications for the inverter's installation environment are shown in Table 1. Using the inverter in a place that exceeds this conditions will not only lead to a drop in performance and life, but will also cause faults. Refer to the following points and take proper measures.

**T a b l e 1 [Standard specifications of inverter panel environment resistance]**

Ambient temperature	: 10°C to +40°C (with no freezing)
Ambient humidity	: 90%RH or less (with no dew condensation)
Atmosphere	: No corrosive or explosive gases, and no dust.
Altitude	: 1000m or less
Vibration	: 5.9m/S <sup>2</sup> { 0.6G } or less (JIS C0911 compliant)

### 1.2 Temperature

The tolerable ambient temperature of the inverter is -10 to +50°C, so always use within this temperature range. Use over this range will markedly shorten the life of the semiconductor, parts and capacitor, etc. Take the following types of measures so that the inverter's ambient temperature is within the specified values.

If the temperature rise in the inverter panel is 10°C, then the inverter panels' ambient temperature must be 40°C or less.

#### (1) High temperature measures

- (a) Always install a forced exhaust fan in the panel to discharge accumulated heat.
- (b) Install the panel in an air-conditioned electricity room.
- (c) Avoid installation where the inverter will be subject to directly sunlight.
- (d) Install a partition, etc., so that the heat radiated from the heat source and hot wind does not affect the inverter.

#### (2) Low temperature measures

- (a) Install a space heater in the panel. (Turn ON while operation is stopped.)
- (b) Do not turn OFF the inverter power. (Turn the inverter start signal OFF.)

### **1.3 Humidity**

The working ambient humidity of the inverter is between 45 and 90%. If the humidity is too high, problems such as a drop in insulation and corrosion of the metal parts will occur. Conversely, if the humidity is too low, the space insulation may be damaged.

#### (1) High humidity measures

- (a) Install the panel in an air-conditioned electricity room.
- (b) Do not install the panel in place with high humidity levels.
- (c) Install a space heater in the panel.

#### (2) Low humidity measures

Install the inverter in place that is not too dry. Before mounting or inspecting the unit in this state, discharge the static electricity in the worker's body, and make sure not to touch the parts or patterns.

#### (3) Dew condensation measures

Dew could condense if the temperature in the panel changes suddenly due to frequent stopping of operation, or if the outdoor temperature changes suddenly.

Dew can cause the insulation to drop and rust to form, etc.

- (a) Take the high temperature measures given in (1).
- (b) Do not turn OFF the inverter power. (Turn the inverter start signal OFF.)

### **1.4 Dust and oil mist**

Dust can cause a contact defect at the contact sections, a drop in the insulation when built-up dust absorbs moisture, and a drop in cooling effect when the filter clogs leading to an increase in the panel's inner temperature.

In an environment where conductive particles are suspended, faults such as a deterioration in the insulation and short circuits, etc., could occur. The same state will occur when oil mist is suspended, so take sufficient measures.

- (a) Install the unit in an electricity room with good environment.
- (b) Blow clean air into the panel from outside. (The air amount must be sufficient.)

### **1.5 Corrosive gases and salt damage**

If the unit is installed in an environment containing corrosive gases, or where the unit could be damaged by salt, such as near the sea coast, the PCB patterns or parts could corrode, and contact defects could occur in the relays and switches.

Take the measures given in section 1.4 (a) and (b) in these types of places.

## **1.6 High altitudes**

Use the inverter at an altitude of 1000m or less. If used at a higher place, the cooling effect could drop due to the thin air, and the dielectric strength could deteriorate due to the drop in atmospheric pressure.

## **1.7 Vibration and impacts**

The mechanism's screws and bolts could loosen, and the connector's contact could fail due to vibration and impacts.

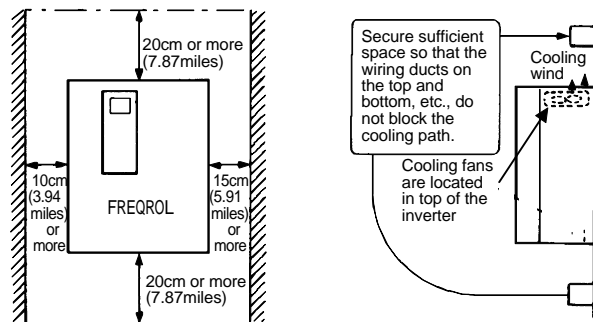
If vibration is repeatedly applied, the part installation legs could break, etc. Caution must be taken by separating the panel from the vibration source, etc.

## 2. Precautions for designing inverter panel

### 2.1 Precautions for structure

- (1) Securely install the inverter unit with bolts or screws so that it is not loose. Install the unit vertically.
- (2) The inverter unit and DC reactors will become hot. Always install the unit on non-combustible materials such as metal.
- (3) Always secure a space with the dimensions or more shown in Fig. 1 to prevent the inverter unit's cooling performance from dropping.  
(Note that space for replacing the cooling fan is required at the top of the inverter unit. Thus, the design must also consider the serviceability.)

**Fig.1 : Ambient space**



- (4) When arranging the inverter unit and DC reactor in the panel, place the DC reactor at the top so that the inverter can be cooled with the air taken in from the bottom of the panel. (Establish inverter unit intake port temperature < panel intake port temperature. Make sure that the heat generated from the DC reactor does not affect the inverter.)
- (5) Always mount an air filter on the intake port to prevent contact defects and short circuit accidents caused by dust at the contact sections.
- (6) The heat in the inverter will rise from the bottom to the top by the cooling fan built into the unit. Thus, when placing devices at the top, only place items that will not be obstructed even if affected by heat.
- (7) Modify the part layout and external terminal layout so that the main circuit and control circuit wiring can be separated.
- (8) The main circuit wire size is large. Consider the wire bending radius, and the wiring route between the device and between the devices and external terminals so that excessive force will not be applied on the inverter's main circuit terminal section.
- (9) For minute signals such as the analog signal or pulse signal, separate these and wire with shielded wires so that they will not be affected by induction from other sources.
- (10) It is important to ground the inverter panel. Provide a grounding bus to which  $38\text{mm}^2$  or more can be connected. (The grounding wire size will differ according to the load capacity. Refer to the VVVF System Grounding Standards for details.)

## 2.2 Precautions for circuit structure

- (1) Use of a shunt trip device (SHT) for the no-fuse breaker on the input side of the inverter is recommended. Cut off the no-fuse breaker for safety purposes when the inverter is stopped by a protection function. When providing a magnetic contactor on the inverter's input side, turn the magnetic contactor in the same manner as above.
- (2) A magnetic contactor does not necessarily need to be installed on the inverter's input side. However, when providing a magnetic contactor so that voltage is not applied on the main circuit while stopped, the timing when operation is stopped must be as shown below for safety purposes.
  - (a) After turning ON the input contactor (88L1), provide a one-second time lag, and turn ON the inverter run command. (Provide a timing to oscillate the inverter after the inverter's main circuit DC voltage is established.)
  - (b) Provide a timing so that when stopping, the input contactor (88L1) turns OFF 0.5 seconds after the inverter stops. (If the input side contactor is turned OFF before the inverter stops, the IPF/UVT may be incorrectly detected, and could malfunction.)
- (3) When providing a backup circuit using commercial power, the 88L1, 88L2 and 88H contactors are required. (Refer to 5. Panel building example)
  - (a) Provide a mechanical and electrical interlock so that the commercial contactor (88H) and inverter output side contactor (88L2) do not turn ON simultaneously.  
If the commercial power is applied on the inverter output terminal from 88H via 88L2, the inverter will be damaged.
  - (b) When changing from commercial operation to inverter operation, first turn 88H OFF, and turn 88L1 ON. After the inverter input power has been applied and the DC voltage has been established (there is an approx. 1 sec. time-lag), turn the inverter output side contactor 88L2 ON. This is to prevent a rush current from flowing from the motor to the inverter due to the motor's residual voltage.
  - (c) When changing from inverter operation to commercial operation, turn the inverter OFF and then the inverter output side contactor (88L2) OFF. Then, wait (approx. 3 sec.) for the motor's residual voltage to attenuate, and then turn the commercial contactor (88H) ON.  
In this case, pay attention to the power voltage drop and thermal relay malfunction (when load  $GD^2$  of fan, etc., is large) caused by the starting current.
- (4) Do not carry out resetting operations from a remote location when the protection function activates. If the reset operation is carried out remotely, faults could occur. Depending on the fault, the extent of the trouble could increase.
- (5) Provide an exhaust fan circuit. Refer to the selection of the peripheral devices for the ratings and specifications of the exhaust fan.
- (6) It is recommended to structure a power circuit that does not turn OFF the control power even when the main circuit power is released. If the control power turns OFF simultaneously with the main circuit

power when the protection function activates, the cause of the protection function's activation will be unclear, or it may not be possible to confirm the operation of the control circuit when voltage is applied only on the control circuit.

- (7) If a contact must be inserted in the frequency setting signal circuit, use a minute signal contact to prevent contact defects as the current is minute.
- (8) When providing a ground fault relay, install it on the inverter power side. Select a high harmonics and surge compatible ground fault relay according to the inverter.
- (9) If a thyristor converter is provided in the same power supply, or when the power voltage unbalance is 3% or more, install an AC reactor (option).
- (10) When installing a fluorescent lamp in the inverter panel, structure the circuit so that the fluorescent lamp does not light while the inverter is operating.  
If the fluorescent lamp must be lit while the inverter is operating, install a spark killer on the fluorescent lamp's terminal section.

### 3. Heat losses of inverter chassis unit and DC reactor

Watt losses of inverter chassis unit and DC reactor are as follows:

- Note: 1. No consideration of other losses except for above both equipments is included.  
 2. When designing the panel enclosure, other losses must be considered.

#### 3.1 In case of installing both inverter chassis unit and DC reactor in the panel enclosure.

Inverter Model	Applicable motor(kW)		Inverter loss(W)	DC reactor loss(W)	Total loss(W)
	CT	VT			
FR-A540L-75K	CT	75	2250	65	2315
	VT	110	3300	166	3466
FR-A540L-90K	CT	90	2700	75	2775
	VT	132	3960	192	4152
FR-A540L-110K	CT	110	3300	90	3390
	VT	160	4800	198	4998
FR-A540L-132K	CT	132	3960	95	4055
	VT	185	5550	214	5764
FR-A540L-160K	CT	160	4800	120	4920
	VT	220	6600	253	6853
FR-A540L-220K	CT	220	6600	130	6730
	VT	280	8400	276	8676
FR-A540L-280K	CT	280	8400	160	8560
	VT	375	11250	372	11622

#### 3.2 In case of installing the cooling fin of heat sink of inverter chassis unit at outside of the panel enclosure.

A part of losses of inverter chassis unit is dissipated through the fin of it's heat sink to the outside. Heat losses inside the panel enclosure shall be as shown below:

Inverter Model	Applicable motor(kW)		Loss inside panel(W)	Loss outside panel(W)
	CT	VT		
FR-A540L-75K	CT	75	740	1510
	VT	110	1089	2211
FR-A540L-90K	CT	90	891	1809
	VT	132	1307	2653
FR-A540L-110K	CT	110	1089	2211
	VT	160	1584	3216
FR-A540L-132K	CT	132	1307	2653
	VT	185	1830	3720
FR-A540L-160K	CT	160	1584	3216
	VT	220	2178	4422
FR-A540L-220K	CT	220	2178	4422
	VT	280	2772	5628
FR-A540L-280K	CT	280	2772	5628
	VT	375	3710	7540



## 4. Selecting peripherals

### 4.1 Selection guide

Name (Model)	Functions & Applications, etc.	Installation location
Power supply capacitance	Choose a power supply with a kVA at least as high as the one shown in the "Power facility capacity" column in the standard specification	
Main circuit power line at input side	Make a selection using the table on the next page. You may need a larger cable than indicated depending on the length of the cable from the power supply transformer.	
Circuit breaker	Select proper input circuit breaker using the table on the next page.	
Cooling fan	Install a cooling fan to exhaust heat produced by the inverter and DC reactor for improving the power factor from the panel. Make a selection using the table on the next page.	
Electromagnetic contactor	Make a selection using the table on the next page.	
AC reactor for coordinating power	Install a reactor to prevent inverter malfunctions when thyristor converters, vacuum contactors, or the like in the same supply system (low voltage side) cause a surge voltage in the power line. Install a reactor when the imbalance in the supply voltage is 3% or greater.	
Radio noise filter (FR-BIF)	This filter reduces noise in the AM radio band, which is part of the electromagnetic noise produced by the inverter. It is dedicated for the input side.	
DC reactor for improving power factor	Always install a reactor dedicated for the FR-A500L.	
Reactor connection power line	Make a selection using the table on the next page.	
MT-BU5 brake unit and brake resistor	This is a brake unit used to increase the inverter's braking power. It can be used over a wide range of capacitances to provide strong braking force. Use it in combination with a brake resistor.	
Sine wave filter	This filter reduces motor noise. See page 34.	
Main circuit power line at output side	Make a selection using the table on the next page. You may need a larger cable than indicated depending on the length of the external cable and the way it is wired.	

## 4.2 Selection of peripheral devices

Check the capacity of the motor to be used with the inverter you purchased. Appropriate peripheral devices must be selected according to the capacity.

Refer to the following list and prepare appropriate peripheral devices:

### 400V class

Inverter Type	Motor Output (kW)	Power Supply Capacity (kVA)	No-Fuse Breaker or Earth Leakage Circuit Breaker (Note2)	Magnetic Contactor (Note3)	Cooling fan (Remarks) (Note 4)
FR-A540L-75K	75	110	Type NF225, NV225 225A (NF225, NV225 225A)	S-K100 (S-K150)	MITSUBISHI EF-25ASB 1 100/110V 50/60Hz 19m <sup>3</sup> /min
FR-A540L-90K	90	135	Type NF225, NV225 225A (NF400, NV400 300A)	S-K150 (S-K180)	
FR-A540L-110K	110	165	Type NF225, NV225 225A (NF400, NV400 350A)	S-K180 (S-K220)	
FR-A540L-132K	132	198	Type NF400, NV400 400A (NF400, NV400 400A)	S-K300 (S-K300)	
FR-A540L-160K	150	220	Type NF400, NV400 400A (NF400, NV400 400A)	S-K300 (S-K300)	MITSUBISHI EF-30BSB 1 100/110V 50/60Hz 28m <sup>3</sup> /min
FR-A540L-160K	160	244	Type NF400, NV400 400A (NF600, NV600 500A)	S-K300 (S-K400)	
FR-A540L-220K	185	277	Type NF400, NV400 400A (NF600, NV600 500A)	S-K300 (S-K400)	
FR-A540L-220K	200	300	Type NF400, NV400 400A (NF600, NV600 600A)	S-K400 (S-K400)	
FR-A540L-220K	220	330	Type NF600, NV600 500A (NF600, NV600 600A)	S-K400 (S-K600)	
FR-A540L-280K	250	375	Type NF600, NV600 600A (NF600, NV600 600A)	S-K600 (S-K600)	
FR-A540L-280K	280	420	Type NF600, NV600 600A (NF800, NV800 800A)	S-K600 (S-K600)	

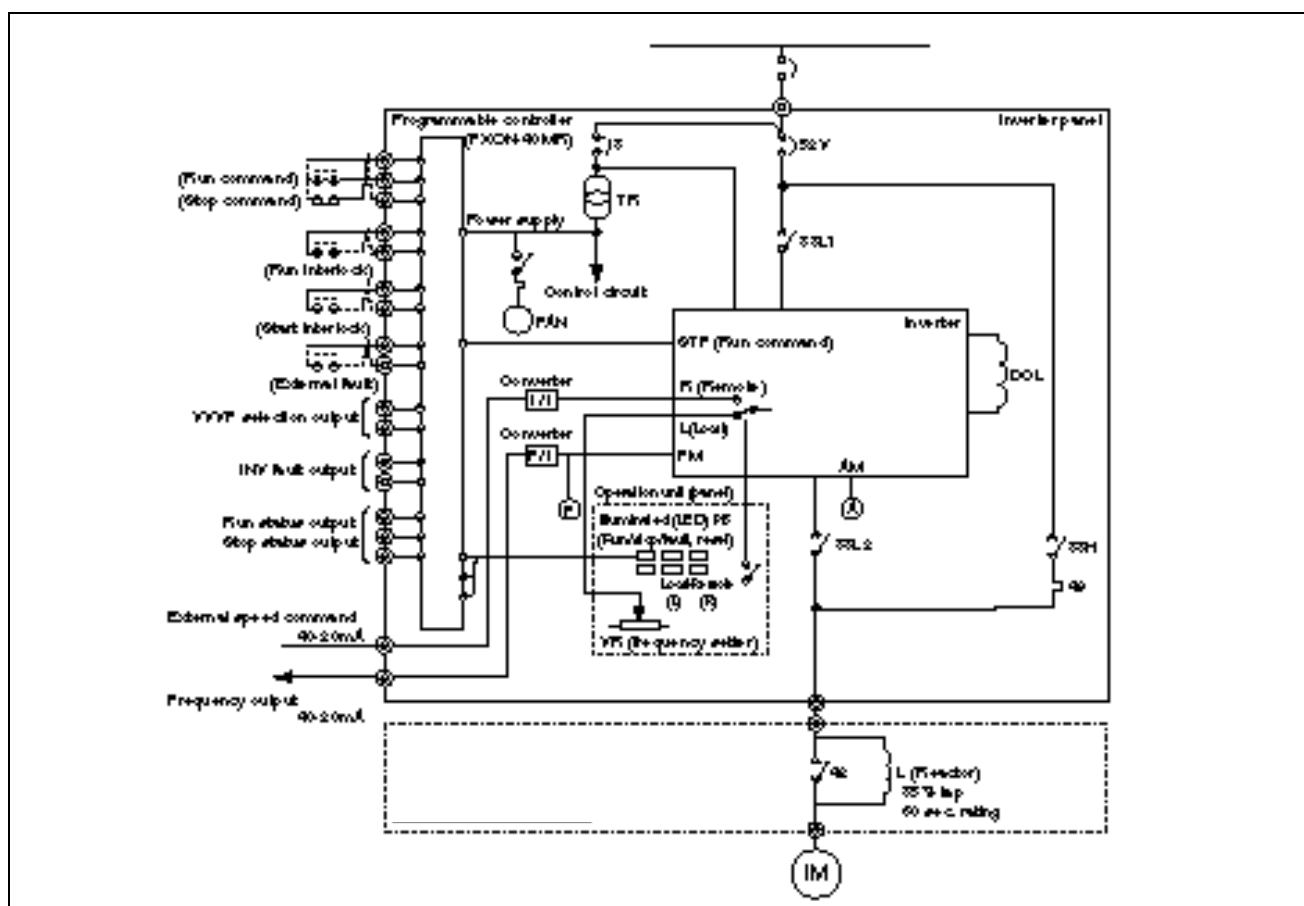
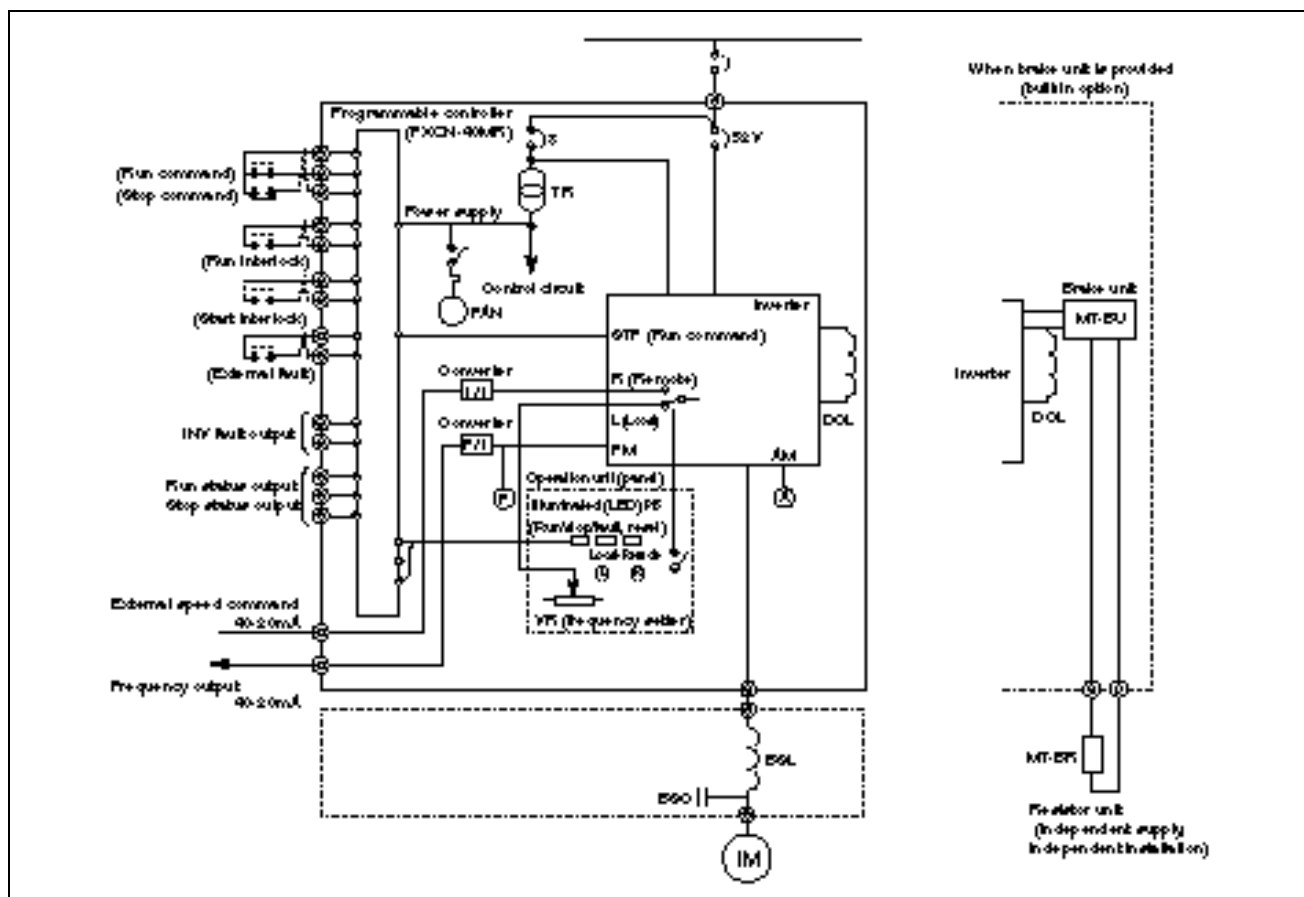
Note : 1. Basically the 75kW and above motor is order-made, and the No. of poles, protection, type, etc., will differ according to the maker. Check the motor to be used again.

2. The types shown in parentheses apply for commercial operation. Select the breaking capacity that matches the short circuit capacity. When using an earth leakage breaker, use a high harmonics and surge compatible type, with a sensitivity current of 100 to 500mA.

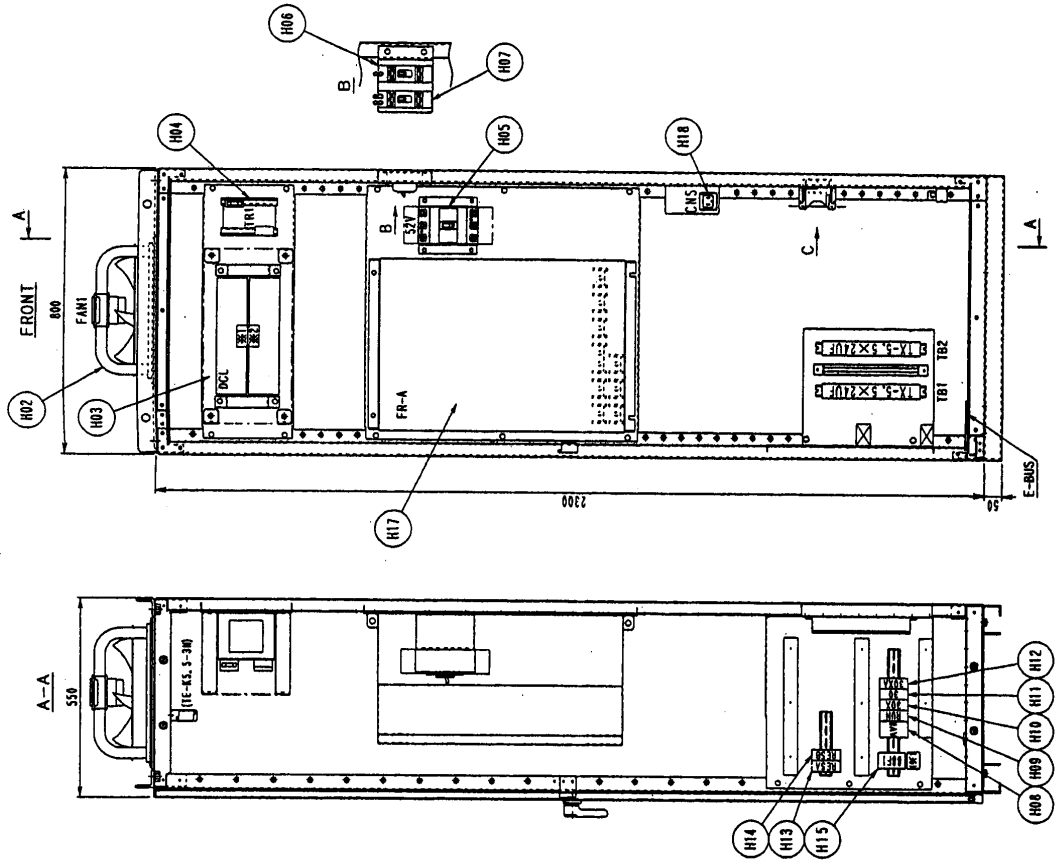
3. The types shown in parentheses indicate the magnetic contactor on the motor side for commercial operation.

4. An exhaust fan is required to expel the heat generated in the panel. Consider the pressure loss caused by the intake port filter, and select a fan that provides sufficient exhaust wind.

## 5. Panel building example

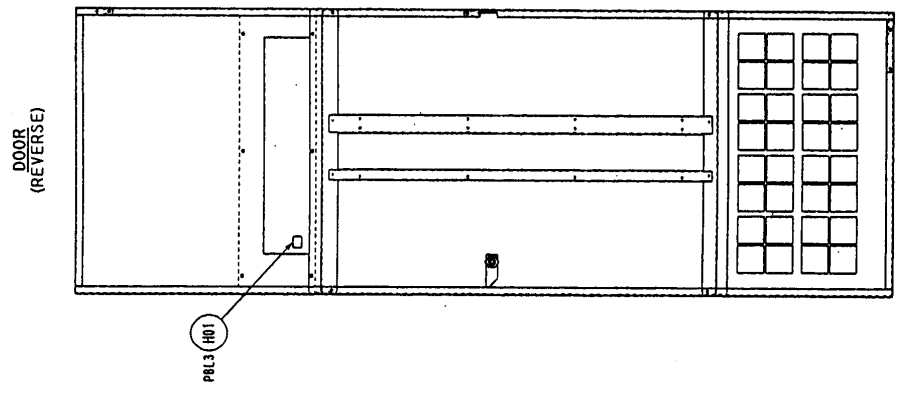
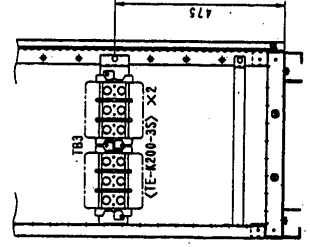


No.	SYMBOL	TYPE	SPECIFICATION	REMARK
H01	PBL3	LS33-TAKA1-24A	DC24V (OL)	FAULT RESET
H02	FAM1	EF-30BSB	AC100V 50/60HZ	(G-30EB)
H03	DCL	UZDA-B	351A 0.199MH	
H04	TR1	CB0-300YA	AC440-420-400V/100V	
H05	52V	HF225-SP	3P 225A SHI AX AL TC-L	MAIN POWER
H06	8	HF30-CS	2P 5A TC-L	CONTROL POWER
H07	88	HF30-CS	2P 20A TC-L	SAFETY POWER
H08	AYR	S82K-01524	AC100V/DC24V	
H09	RUN	MY4N-D2	DC24V	
H10	30X			
H11	30			
H12	30XA			
H13	RESA	MY4N-CR	AC100V	
H14	RESB			
H15	88F1/49F1	MS0-N10	AC100V L-9 0.9A	(UN-5A23)
H16	CMS	WK-3001	125V 15A	
H17	FR-A	FR-AS40L-110K		
H18				
H19				
H20				

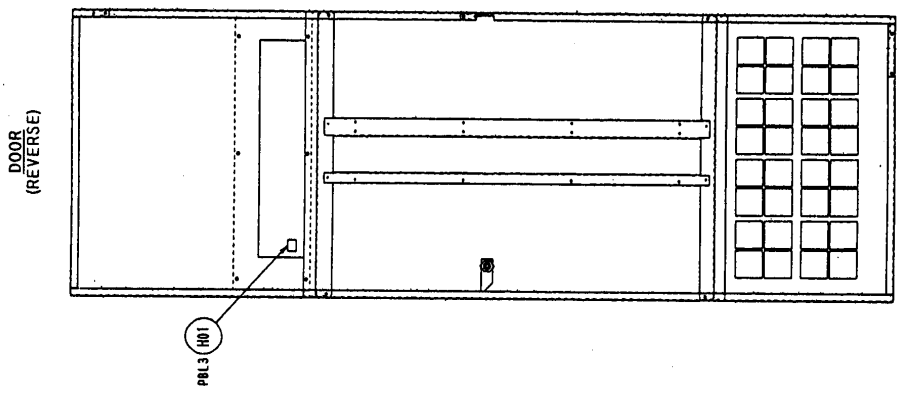
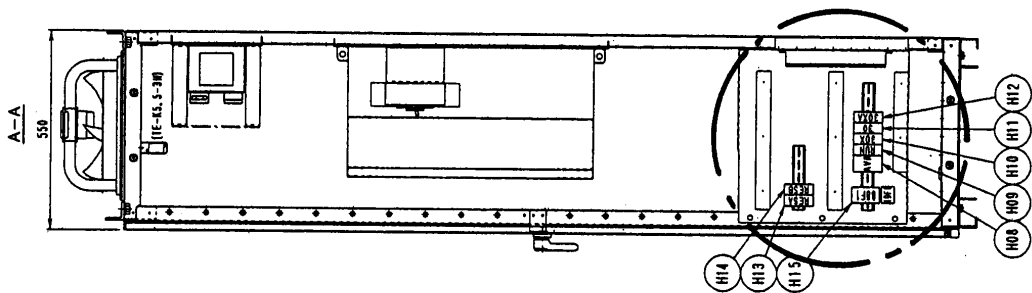
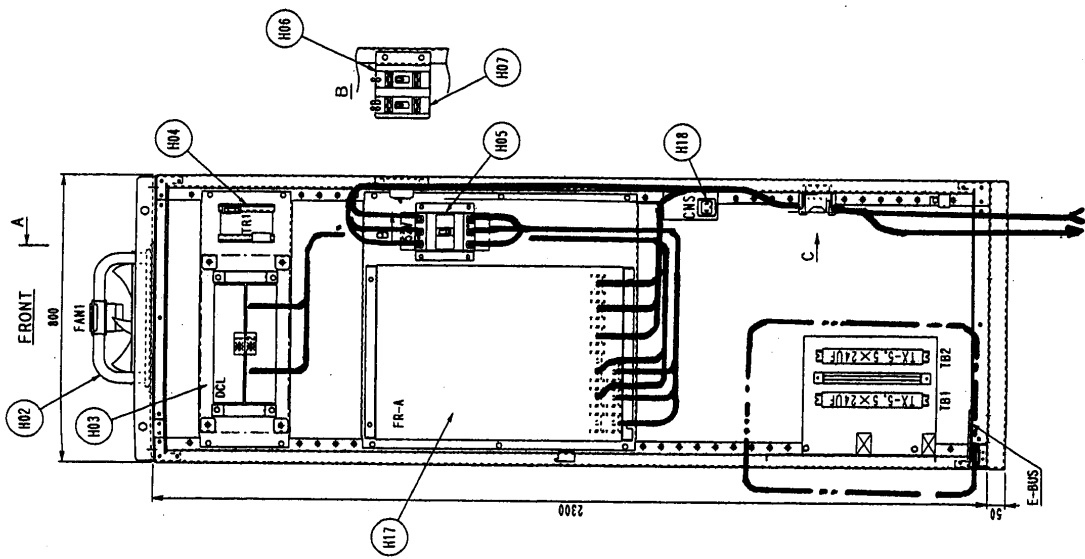


※1 CAUTION SEAL (There is electric shock!)

※2 CAUTION SEAL (There is tear of obstacle!)



No.	SYMBOL	TYPE	SPECIFICATION	REMARK
H01	PBL3	1A4A1-24A	DC24V (UL)	FACT (RESET)
H02	FAN1	EF-30BSB	AC100V 50/60HZ	(G-30EB)
H03	DCL	UZDA-B	351A 0.199MH	
H04	TR1	C80-500VA	AC440-420-400V/100V	
H05	S2V	NF225-SP	3P 225A SHI AX AL TC-L	SHOCK PROTECT
H06	B	NF30-CS	2P 5A TC-L	SHOCK PROTECT
H07	BB	NF30-CS	2P 20A TC-L	SHOCK PROTECT
H08	AVR	S82K-01524	AC100V/DC24V	
H09	RUN	MY4N-02	DC24V	
H10	30X			
H11	30			
H12	30XA			
H13	RESA	MY4N-CR	AC100V	
H14	RESB			
H15	88F/49F1	MS0-M10	AC100V E-9 0.9A	(MF-SR23)
H16	CNS	WK-3001	125V 15A	
H17	FR-A	FR-AS40L-110K		
H18				
H19				
H20				



\*1 CAUTION SEAL (There is electric shock!)

\*2 CAUTION SEAL (There is tear of obstacle!)

矢張り白

