6 Protective Operation

6-1 List of Protective Functions

In the event of an abnormality in the inverter, the protective function will activate immediately to trip the inverter, display the alarm name on the LED monitor, and the motor coasts-to-a stop. For alarm contents, see Table 6.1.1.

Alarm Name	Keypad panel display		Contents of operation	
	LED	LCD		
Over current	OC1	OC DURING ACC	During acceleration	If the inverter output current momentarily exceeds the overcurrent detection level due to an overcurrent in the motor, or a short-circuit or a ground fault in the output circuit, the protective function is activated.
	OC2	OC DURING DEC	During deceleration	
	OC3	OC AT SET SPD	Running at constant speed	
Ground fault	EF	GROUND FAULT	If a ground fault in the inverter output circuit is detected, the protective function is activated (for 30 kW or more only). If a ground fault occurs in an inverter rated at 25 kW or less, the inverter is protected by the overcurrent protection. If protection against personal injury or property damage is required, install a ground-fault protective relay or earth-leakage circuit breaker separately.	
Overvoltage	OU1	OV DURING ACC	During acceleration	If the DC link circuit voltage of the main circuit exceeds the overvoltage detection level (400 V series: 800 V DC) due to an increase in the regenerating current from the motor, the output is shut down. However, protection against inadvertent overvoltage apply (e.g., high-voltage line) may not be provided.
	OU2	OV DURING DEC	During deceleration	
	OU3	OV AT SET SPD	Running at constant speed	
Undervoltage	LU	UNDER-VOLTAGE	If the DC link circuit voltage of the main circuit falls below the undervoltage detection level (400 V series: 400 V DC) due to a lowered power supply, the output is shut down. If function code F14 (Restart after momentary power failure) is selected, an alarm is not displayed. In addition, if the supply voltage falls to a level unable to maintain control power, an alarm may not be displayed.	
Input open-phase	Lin	PHASE LOSS	If the inverter is driven with any one of the three phases connected to L1/R, L2/S and L3/T of the main circuit power supply "open," or if there is a significant disparity between the phases, the rectifying diodes or smoothing capacitors may be damaged, at such time an alarm is issued and the inverter is tripped.	
Overheating of heat sink	OH1	FIN OVERHEAT	If the temperature of the heat sink rises due to a cooling fan failure, etc., the protective function is activated.	

Alarm Name	Keypad panel display		Contents of operation
	LED	LCD	
External alarm	OH2	EXT ALARM	If the external alarm contacts of the braking unit, braking resistor or external thermal O/L relay are connected to the control circuit terminals (THR), this alarm will be actuated according to contact off signal. When the PTC thermal protection is activated, the drive also stops indicating this alarm.
Inverter internal overheating	OH3	HIGH AMB TEMP	If the temperature inside the inverter rises due to poor ventilation, etc., the protective function is activated.
Overheating of braking resistor	dbH	DBR OVERHEAT	If electronic thermal O/L relay (for braking resistor) function code F13 is selected, the protective function is activated to prevent the resistor from burning due to overheating following frequent use of the braking resistor.
Motor 1 overload	OL1	MOTOR1 OL	The protective function is activated if the motor current exceeds the preset level, provided that electronic thermal O/L relay 1 function code F10 has been selected.
Motor 2 overload	OL2	MOTOR2 OL	If the second motor current exceeds the preset level when the operation is switched to drive the second motor, the protective function is activated, provided that electronic thermal O/L relay 2 of function code A04 is selected.
Inverter overload	OLU	INVERTER OL	If the output current exceeds the rated overload current, the protective function is activated to provide thermal protection against semiconductor element overheating in the inverter main circuit.
Blown fuse	FUS	DC FUSE OPEN	If the fuse in the inverter is blown out following a short-circuit or damage to the internal circuit, the protective function is activated (for 30 kW or more only).
Memory error	Er1	MEMORY ERROR	If a memory error occurs, such as missing or invalid data, the protective function is activated.
Keypad panel communication error	Er2	KEYPD COM ERR	If a communication error or interrupt between the keypad panel and control circuit is detected, the protective function is activated.
CPU error	Er3	CPU ERROR	If an CPU error occurs due to noise, etc., the protective function is activated.
Option error	Er4	OPTN COM ERR	Error when using an optional unit
	Er5	OPTION ERROR	
Forced stop	Er6	OPR PROCD ERR	Error when using the forced stop command
Output wiring error	Er7	TUNING ERROR	If there is an open circuit or a connection error in the inverter output wiring during performing auto-tuning, the protective function is activated.
RS485 communication error	Er8	RS485 COM ERR	If an error occurs when using RS485, the protective function is activated.

Table 6-1-1 List of alarm displays and protective functions

6-2 Alarm Reset

To release the trip status, enter the reset command by pressing the RESET key on the keypad panel or inputting signal from the terminal (RST) of the control terminals after removing the cause of the trip.
Since the reset command is an edge operation, input a command such as "OFF-ON-OFF" as shown in Fig. 6-2-1.

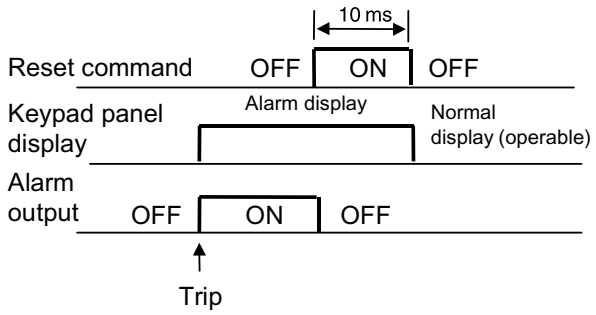


Figure 6-2-1

When releasing the trip status, set the operation command to OFF. If the operation command is set to ON, inverter will start operation after resetting.

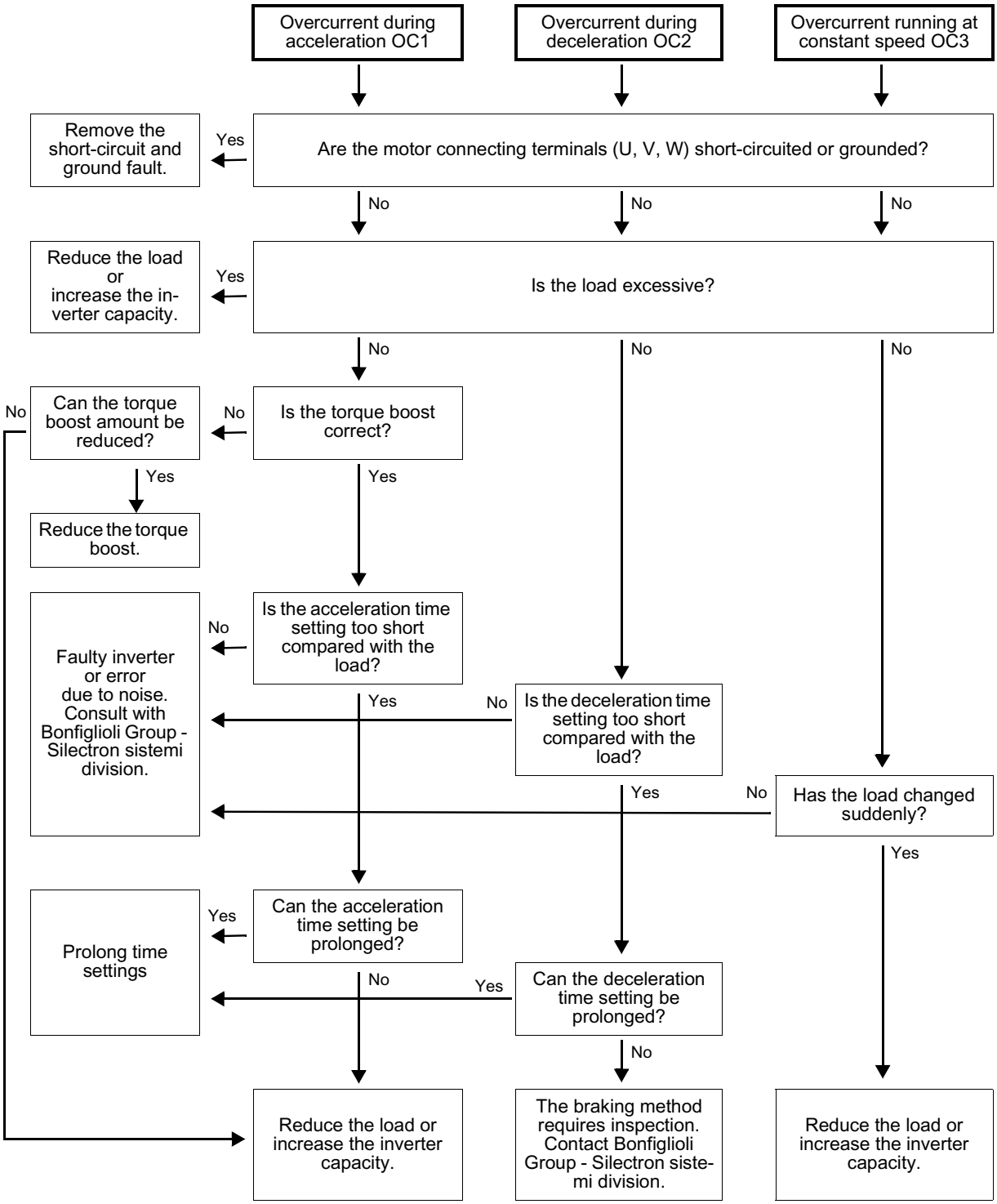
WARNING

If the alarm reset is activated with the operation signal ON, the inverter will restart suddenly, which may be dangerous. To ensure safety, disable the operating signal when releasing the trip status, **as accident may result.**

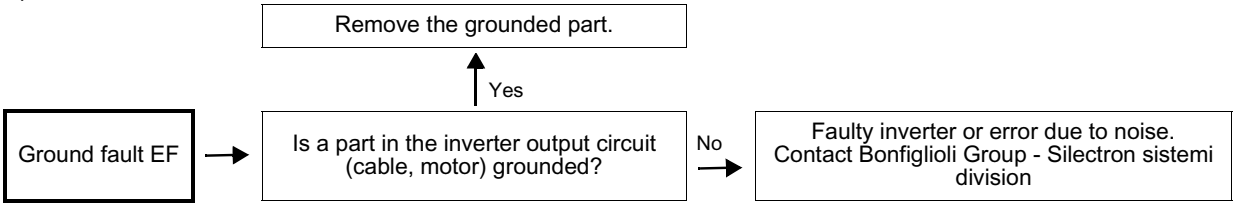
7 Troubleshooting

7-1 Protective function activation

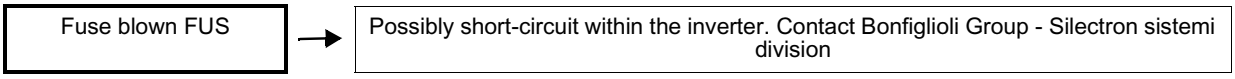
1) Overcurrent



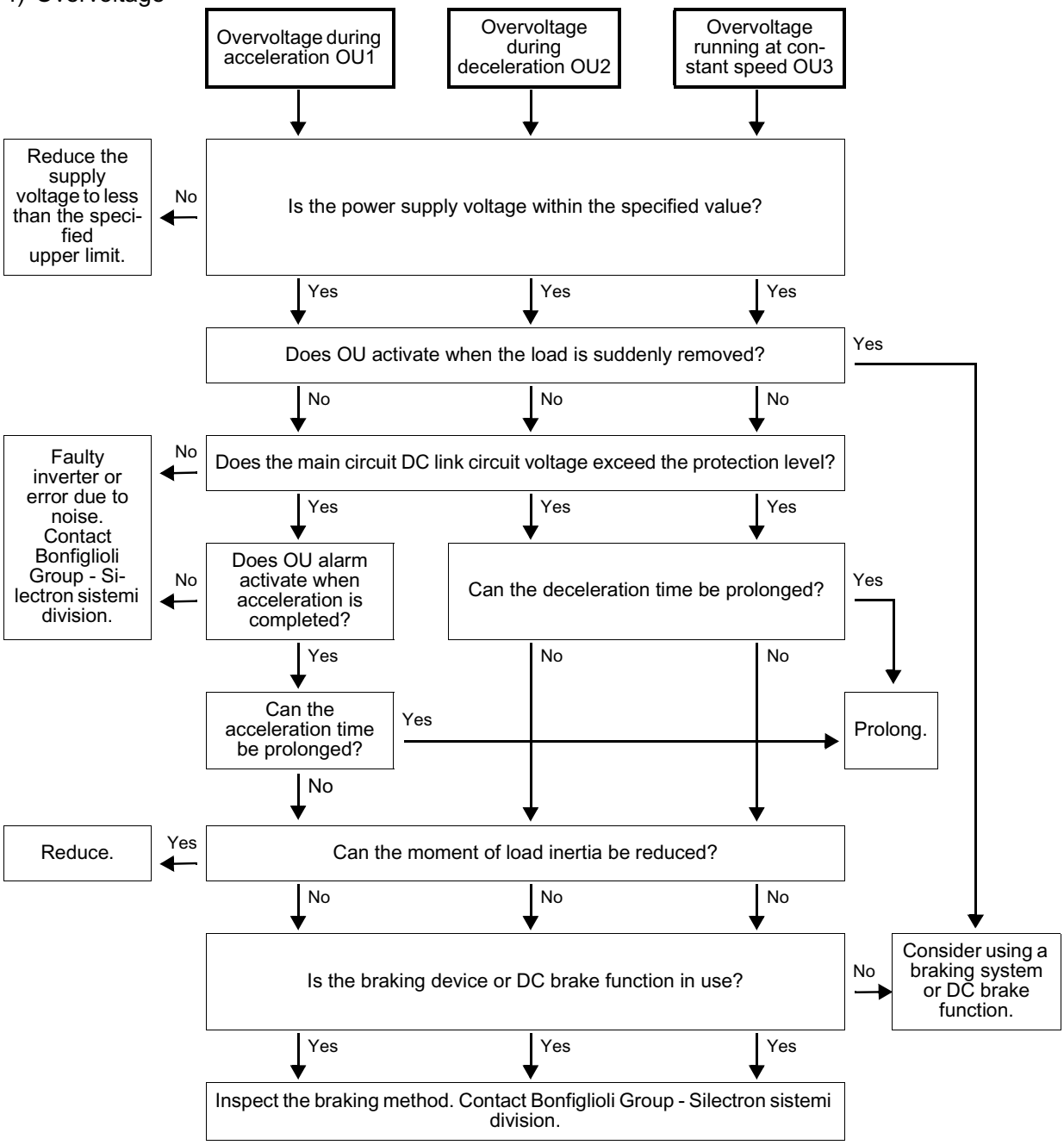
2) Ground fault



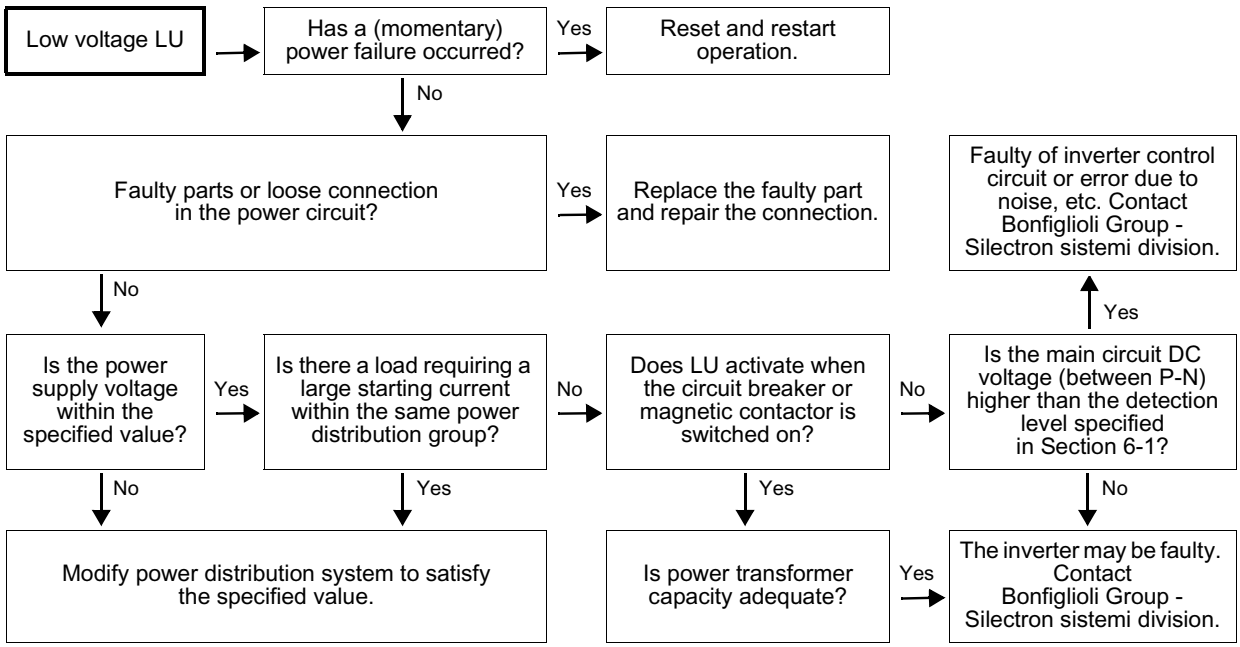
3) Fuse blown



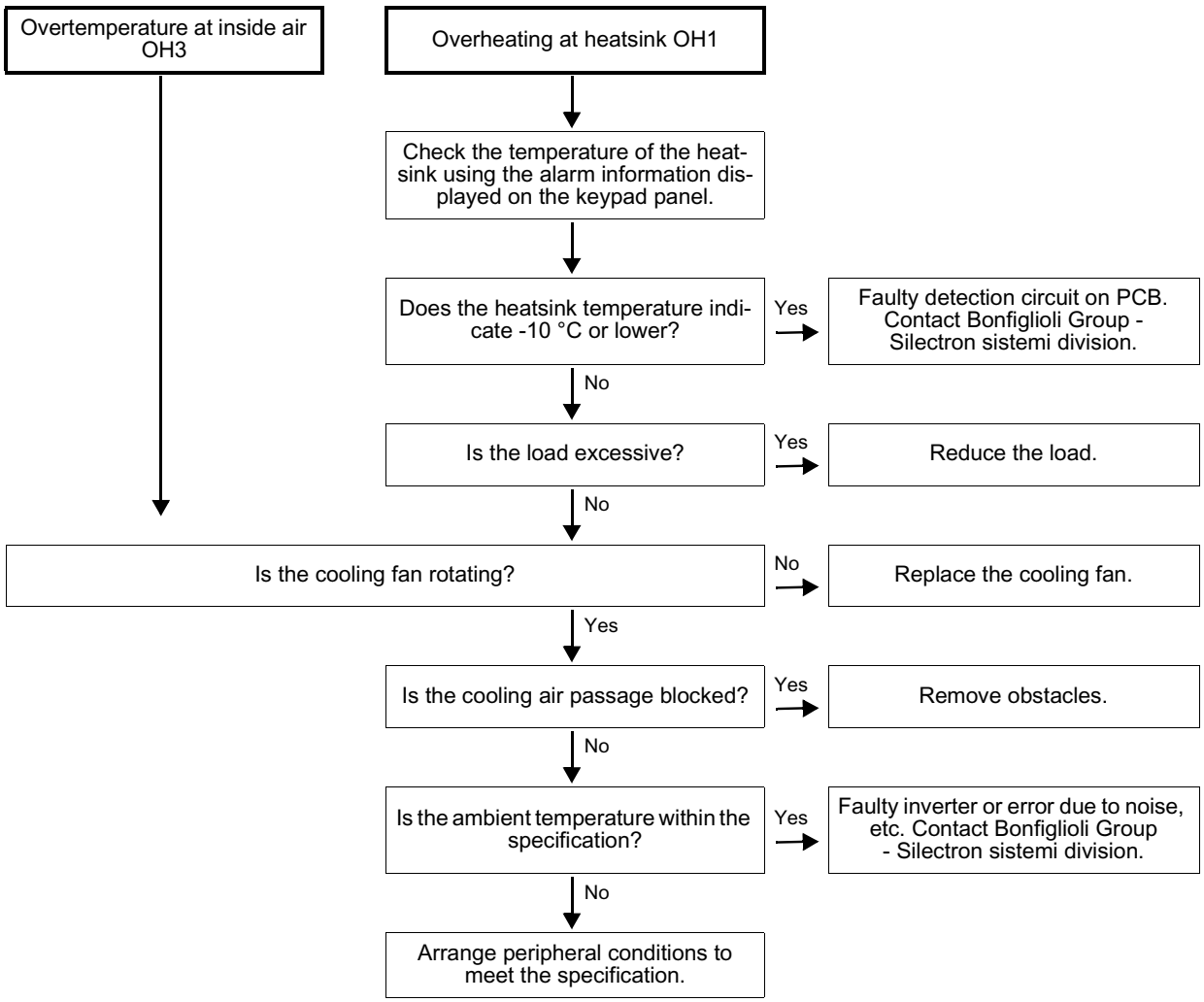
4) Overvoltage



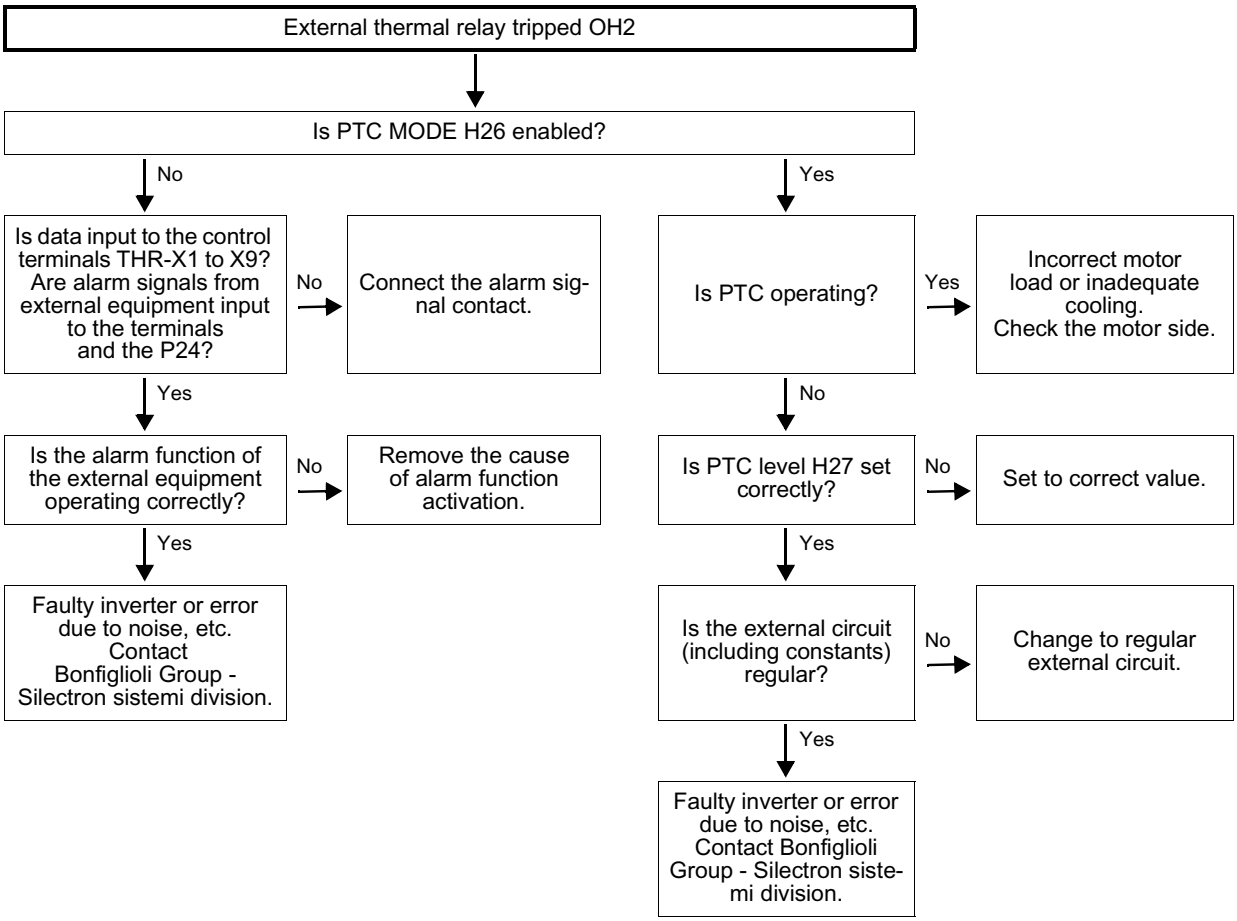
5) Low voltage



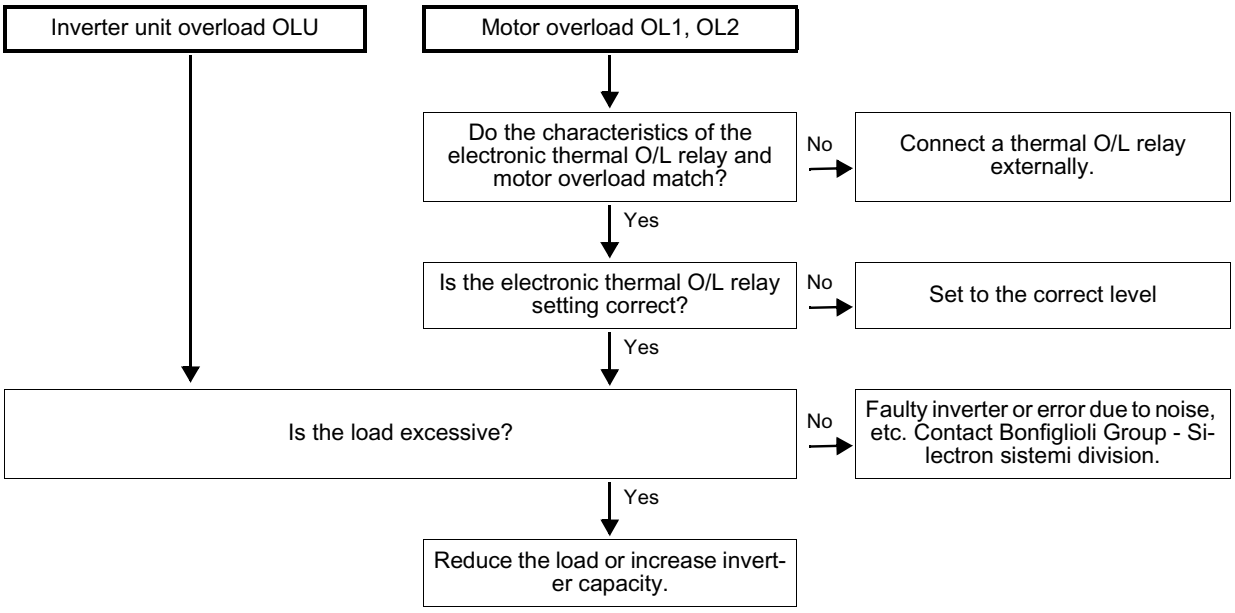
6) Overtemperature at inside air and overheating at heatsink.



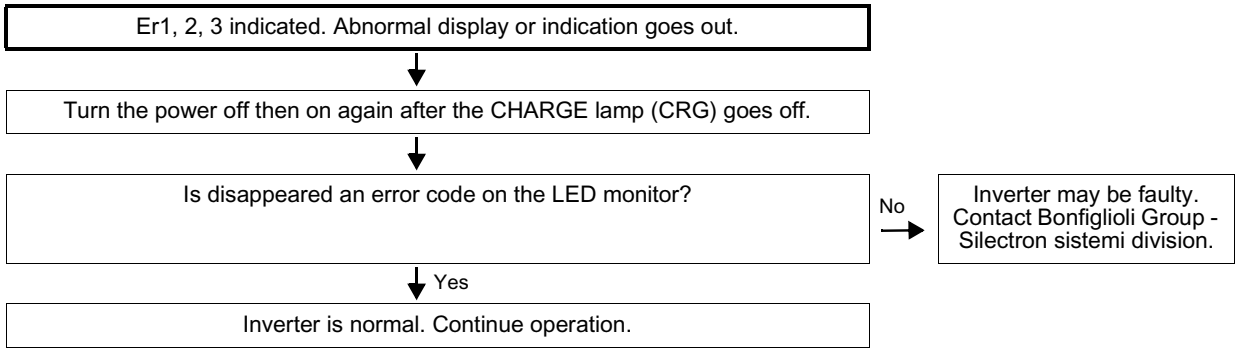
7) External thermal relay tripped



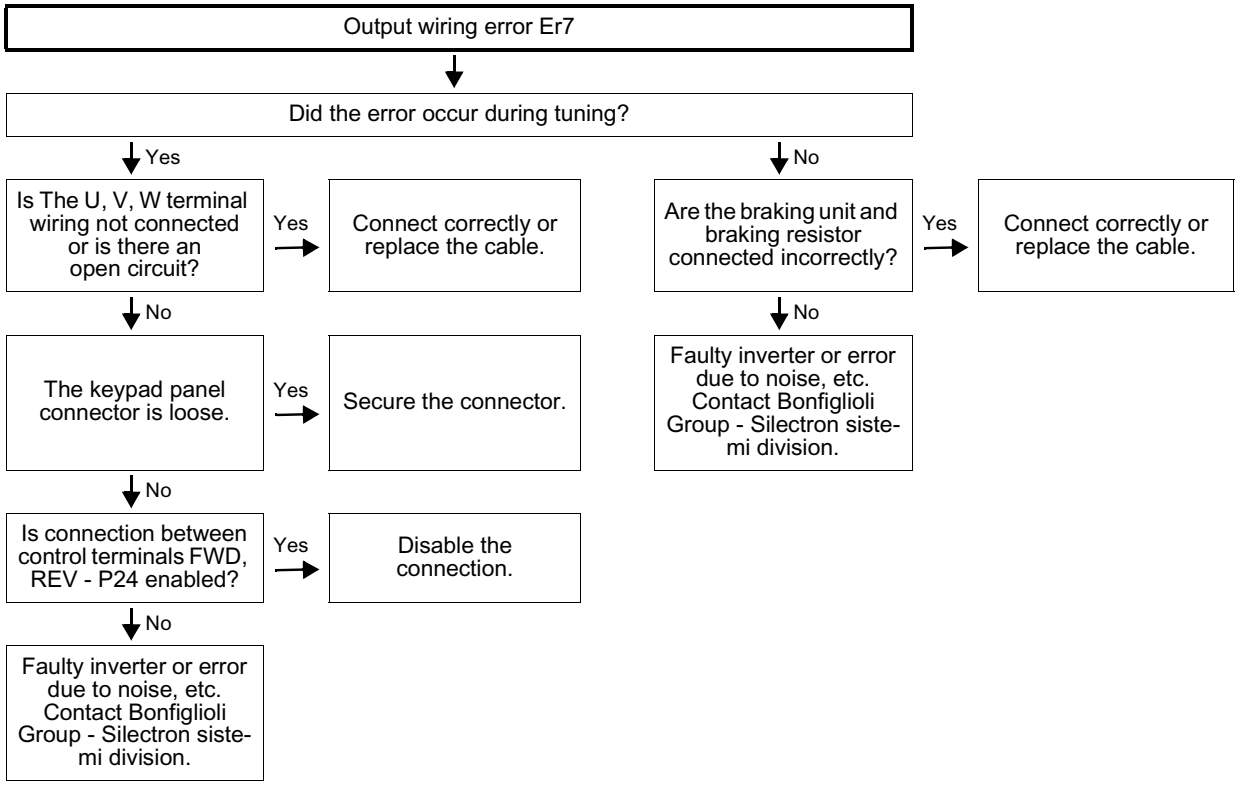
8) Inverter unit overload and motor overload



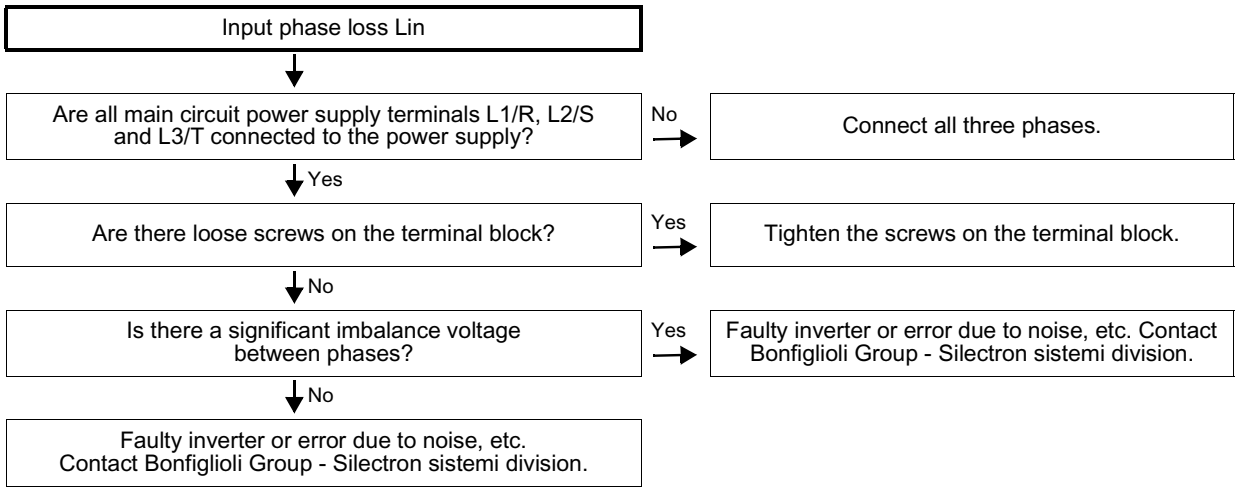
9) Memory error Er1, Keypad panel communication error Er2, CPU error Er3



10) Output wiring error

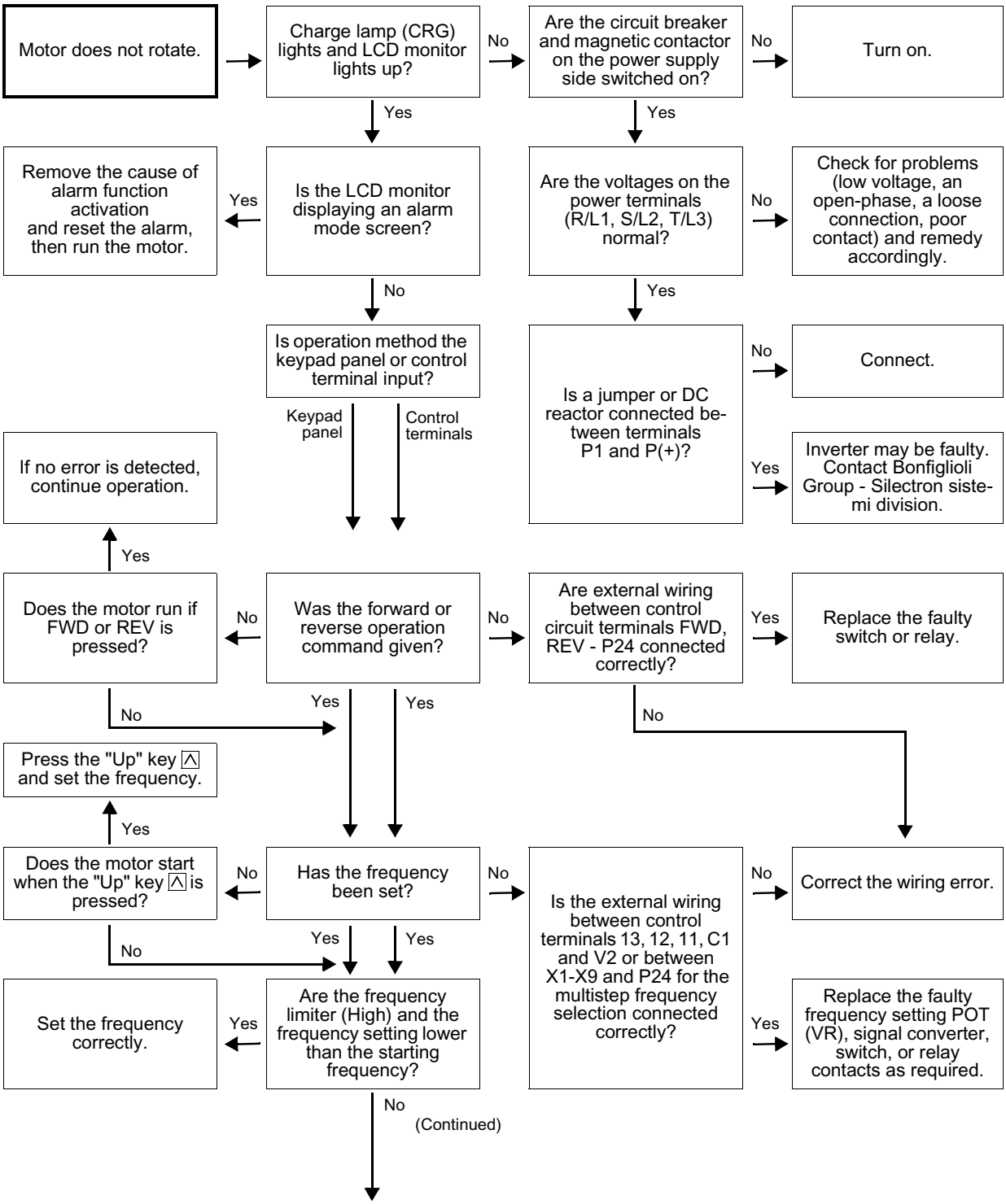


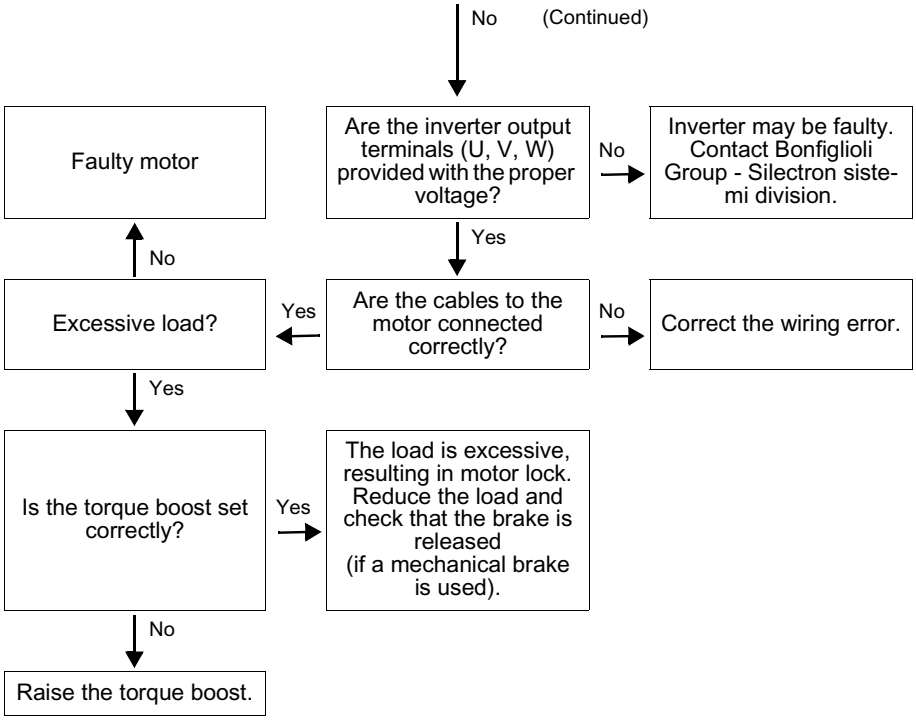
11) Input phase loss



7-2 Abnormal motor rotation

1) If motor does not rotate



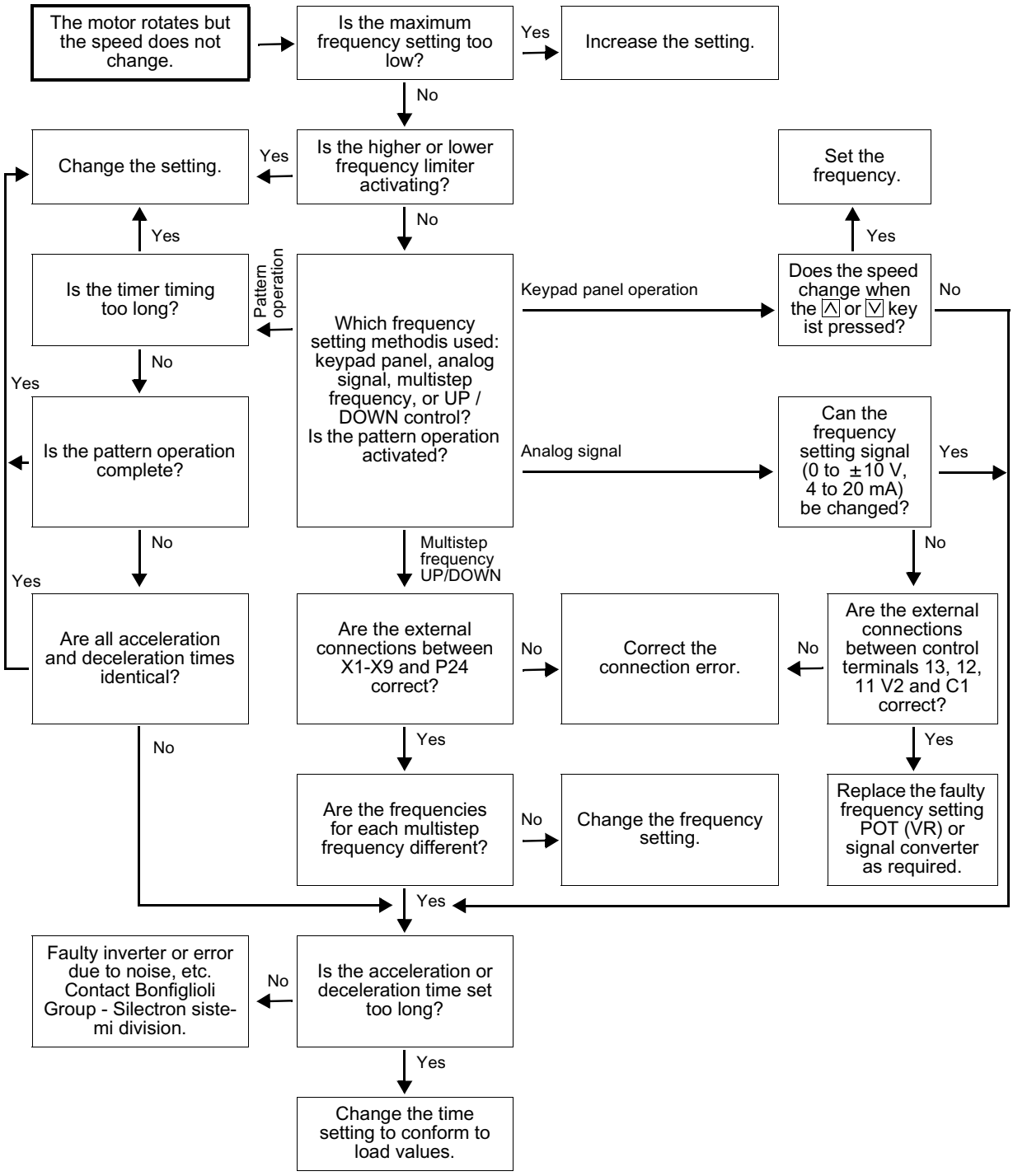


Note: Monitor the operation command or frequency setting values, etc., on the LED or LCD monitor after selecting the respective functions.

The motor does not rotate if the following commands are issued:

- An operation command is issued while the coast-to-stop or DC braking command is output.
- A reverse operation command is issued with the "H08 Rev. phase sequence lock" value set to 1.

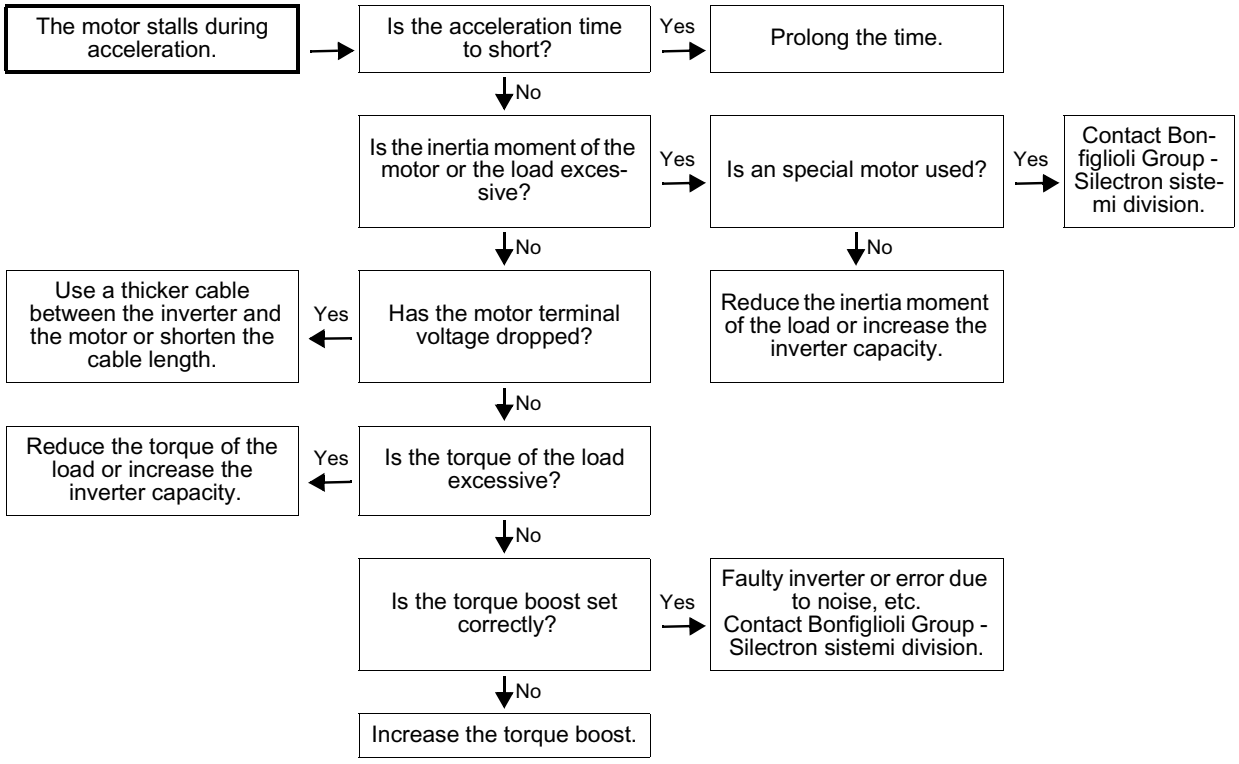
2) If the motor rotates but the speed does not change



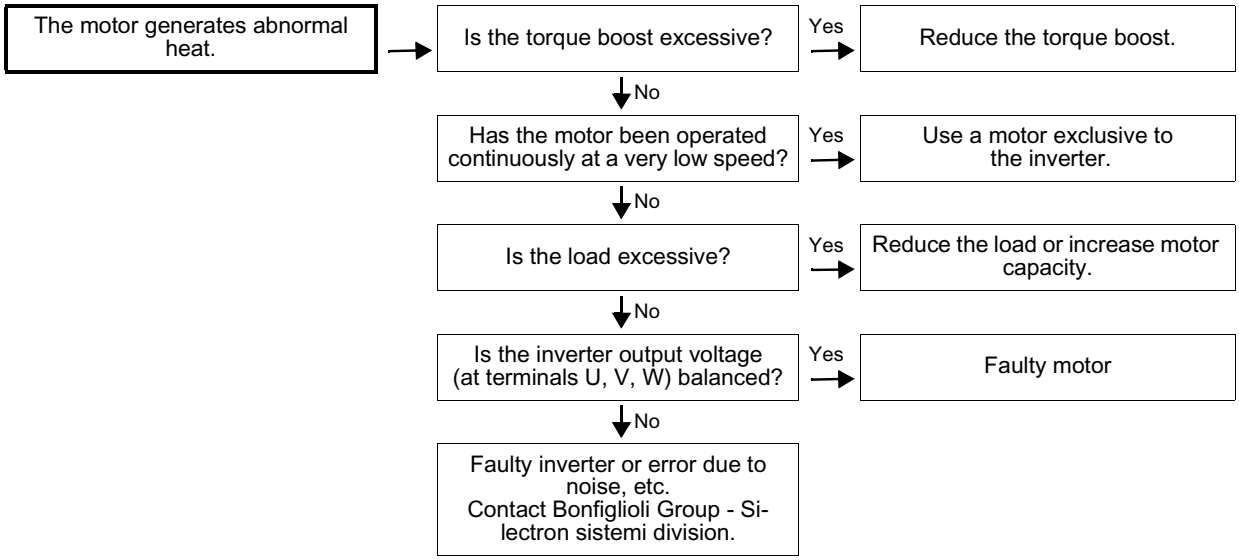
In the following cases, changing the motor speed is also restricted:

- Signals are input from control terminals both 12 and C1 when "F01 Frequency command 1" and "C30 Frequency command 2" are set to 3, and there is no significant change in the added value.
- The load is excessive, and the torque limiting and current limiting functions are activated.

3) If the motor stalls during acceleration



4) If the motor generates abnormal heat



Note: Motor overheating following higher frequency setting is likely the result of current waveform.
Contact Bonfiglioli Group - Silectron sistemi division.

8 Maintenance and Inspection

Proceed with daily inspection and periodic inspection to prevent malfunction and ensure long-term reliability.
Note the following:

8-1 Daily Inspection

During operation, a visual inspection for abnormal operation is completed externally without removing the covers

The inspections usually cover the following:

1) The performance (satisfying the standard specification) is as expected.
2) The environment satisfies standard specifications.
3) The keypad panel display is normal.
4) There are no abnormal sounds, vibrations, or odors.
5) There are no indications of overheating or no discoloration.

8-2 Periodical Inspection

Periodic inspections must be completed after stopping operations, cutting off the power source, and removing the surface cover.
Note that after turning off the power, the smoothing capacitors in the DC section in the main circuit take time to discharge. To prevent electric shock, confirm using a multimeter that the voltage has dropped below the safety value (25 V DC or below) after the charge lamp (CRG) goes off.

WARNING

1. Start the inspection at least five minutes after turning off the power supply for inverter rated at 25 kW or less, and ten minutes for inverter rated at 30 kW or more. (Check that the charge lamp (CRG) goes off, and that the voltage is 25 V DC or less between terminals P(+) and N(-). **Electric shock may result.**
2. Only authorized personnel should perform maintenance and component replacement operations (remove metal jewelry such as watches and rings and use insulated tools).
3. Never modify the inverter.
   Electric shock or injury may result.

Check parts		Check items	How to inspect	Evaluation Criteria
Environment		1) Check the ambient temperature, humidity, vibration, atmosphere (dust, gas, oil mist, water drops). 2) Is the area surrounding the equipment clear of foreign objects.	1) Conduct visual inspection and use the meter. 2) Visual inspection	1) The specified standard value must be satisfied. 2) The area is clear.
Keypad panel		1) Is the display hard to read? 2) Are the characters complete?	1), 2) Visual inspection	1), 2) The display can be read and is not abnormal.
Structure such as a frame or cover		1) Is there abnormal sound or vibration? 2) Are nuts or bolts loose? 3) Is there deformation or damage? 4 Is there discoloration as a result of overheating? 5) Are there stains or dust?	1) Visual and aural inspection 2) Tighten. 3), 4), 5) Visual inspection	1), 2), 3), 4), 5) Not abnormal
Main circuit	Common	1) Are there loose or missing nuts or bolts? 2) Are there deformation, cracks, damage, and discoloration due to overheating or deterioration in the equipment and insulation? 3) Are there stains and dust?	1) Tighten. 2), 3) Visual inspection	1), 2), 3) Not abnormal **Note:** Discoloration of the bus bar does not indicate a problem.
	Conductor and wire	1) Is there discoloration or distortion of a conductor due to overheating? 2) Are there cracks, crazing or discoloration of the cable sheath?	1), 2) Visual inspection	1), 2) Not abnormal
	Terminal block	Is there damage?	Visual inspection	Not abnormal
	Smoothing capacitor	1) Is there electrolyte leakage, discoloration, crazing, or swelling of the case? 2) Is the safety valve not protruding or are valves protruding too far? 3) Measure the capacitance if necessary.	1), 2) Visual inspection 3) * Estimate life expectancy from maintenance information and from measurements using capacitance measuring equipment.	1), 2) Not abnormal 3) Capacitance ≥ initial value x 0.85
	Resistor	1) Is there unusual odor or damage to the insulation by overheating? 2) Is there an open circuit?	1) Visual and olfactory inspection 2) Conduct a visual Inspection or use a multimeter by removing the connection on one side.	1) Not abnormal 2) Less than about ±10 % of the indicated resistance value
	Transformer and reactor	Is there abnormal buzzing or an unpleasant smell?	Aural, olfactory, and visual inspection	Not abnormal

Check parts		Check items	How to inspect	Evaluation Criteria
Main circuit	Magnetic conductor and relay	1) Is there rattling during operation? 2) Are the contacts rough?	1) Aural inspection 2) Visual inspection	1), 2) Not abnormal
Control circuit	Control PC board and connector	1) Are there any loose screws or connectors? 2) Is there an unusual odor or discoloration? 3) Are there cracks, damage, deformation, or excessive rust? 4) Is there electrolyte leakage or damage to the capacitor?	1) Tighten. 2) Visual and olfactory inspection 3) Visual inspection 4) * Estimate life expectancy by visual inspection and maintenance information	1), 2), 3), 4) Not abnormal
Cooling system	Cooling fan	1) Is there abnormal sound or vibration? 2) Are nuts or bolts loose? 3) Is there discoloration due to overheating?	1) Aural and visual inspection. Turn manually (confirm the power is off). 2) Tighten. 3) Visual inspection 4) * Estimate life expectancy by maintenance information	1) The fan must rotate smoothly. 2), 3) Not abnormal
	Ventilation	Is there foreign matter on the heat sink or intake and exhaust ports?	Visual inspection	Not abnormal

Table 8-2-1 Periodical inspection list

* Estimation of life expectancy based on maintenance information
The maintenance information is stored in the inverter keypad panel and indicates the electrostatic capacitance of the main circuit capacitors and the life expectancy of the electrolytic capacitors on the control PC board and of the cooling fans. Use this data as the basis to estimate the life expectancy of parts.

Note: If equipment is stained, wipe with a clean cloth.
Vacuum the dust.

1) Determination of the capacitance of the main circuit capacitors
This inverter is equipped with a function to automatically indicate the capacitance of the capacitors installed in the main circuit when powering up the inverter again after disconnecting the power according to the prescribed conditions.
The initial capacitance values are set in the inverter when shipped from the factory, and the decrease ratio [%] to those values can be displayed.
Use this function as follows:

1. Remove any optional cards from the inverter. Also disconnect the DC bus connections to the main circuit P(+) and N(-) terminals from the braking unit or other inverters if connected. The existing power-factor correcting reactor (DC reactor) need not be disconnected.
A power supply introduced to the auxiliary input terminals (R0, T0) that provides control power should be isolated.
2. Disable all the digital inputs (FWD, REV, X1-X9) on the control terminals. Also disconnect RS485 communication if used.
Turn on the main power supply. Confirm that the cooling fan is rotating and that the inverter is not operating. (There is no problem if the "OH2 External thermal relay tripped" trip function is activated due to the digital input terminal setting off).
3. Turn the main power off.
4. Turn on the main power again after verifying that the charge lamp is completely off.
5. Open the maintenance information on the keypad panel and confirm the capacitance values of the built-in capacitors.

2) Life expectancy of the control PC board
The actual capacitance of a capacitor is not measured in this case. However, the integrated operating hours of the control power supply multiplied by the life expectancy coefficient defined by the temperature inside the inverter will be displayed. Hence, the hours displayed may not agree with the actual operating hours depending on the operational environment.
Since the integrated hours are counted by unit hours, power input for less than one hour will be disregarded.

3) Life expectancy of cooling fan
The integrated operating hours of the cooling fan are displayed. Since the integrated hours are counted by unit hours, power input for less than one hour will be disregarded.
The displayed value should be considered as a rough estimate because the actual life of a cooling fan is influenced significantly by the temperature.

Parts	Level of judgment
Capacitor in main circuit	85 % or less of the initial value
Electrolytic capacitor on control PC board	61,000 hours
Cooling fan	40,000 hours (4.0 kW or less), 25,000 hours (Over 5.5 kW) [1)]

Table 8-2-2 Rough estimate of life expectancy using maintenance information

1) Estimated life expectancy of a ventilation-fan at inverter ambient temperature of 40 °C.

8-3 Measurement of Main Circuit Electrical Quantity

The indicated values depend on the type of meter because the harmonic component is included in the voltage and current of the main circuit power (input) and the output (motor) side of the inverter. When measuring with a meter for commercial power frequency use, use the meters shown in Table 8-3-1.

The power-factor cannot be measured using power-factor meters currently available on the market, which measure the phase difference between voltage and current. When power-factors must be measured, measure the power, voltage, and current on the input side and output side, then calculate the power-factor using the following formula:

$$\text{Power - factor} = \frac{\text{Power [W]}}{\sqrt{3} \times \text{Voltage [V]} \times \text{Current [A]}} \times 100\ [\%]$$

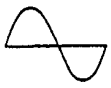
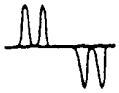
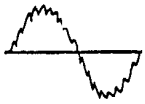
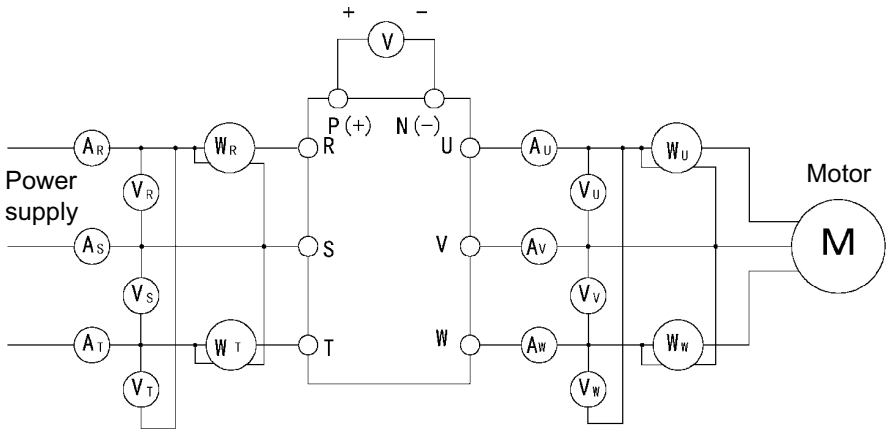
Item	Input (power supply) side			Output (motor) side			DC link circuit voltage (P(+) - N(-))
	Voltage  Current 			Voltage  Current 			
Meter name	Ammeter **A**R, S, T	Voltmeter **V**R, S, T	Powermeter **W**R, S, T	Ammeter **A**U, V, W	Voltmeter **V**U, V, W	Powermeter **W**U, V, W	DC voltmeter **V**
Meter type	Moving-iron type	Rectifier or moving-iron type	Digital power meter	Moving-iron type	Rectifier type	Digital power meter	Moving-coil type
Symbol							

Table 8-3-1 Meters for measuring main circuit

Note: When measuring the output voltage using a rectifier type meter, an error may occur.
Use a digital AC power meter to ensure accuracy.



8-4 Insulation Test

Avoid testing an inverter with a megger because an insulation test is completed at the factory. If a megger test must be completed, proceed as described below. Use of an incorrect testing method may result in product damage.
If the specifications for the dielectric strength test are not followed, the inverter may be damaged. If a dielectric strength test must be completed, contact Bonfiglioli Riduttori - Silectron sistemi division.

1) Megger test for the main circuit

1. Use a 500 V DC type megger and isolate the main power before commencing measurement.
2. If the test voltage is connected to the control circuit, remove all connection cables to the control circuit.
3. Connect the main circuit terminals using common cables as shown in Fig. 8-4-1.
4. Execute the megger test only between the common cables connected to the main circuit and the ground (terminal ⏚G).
5. A megger indicating 5 MΩ or more is normal. (This is the value measured with an inverter only).

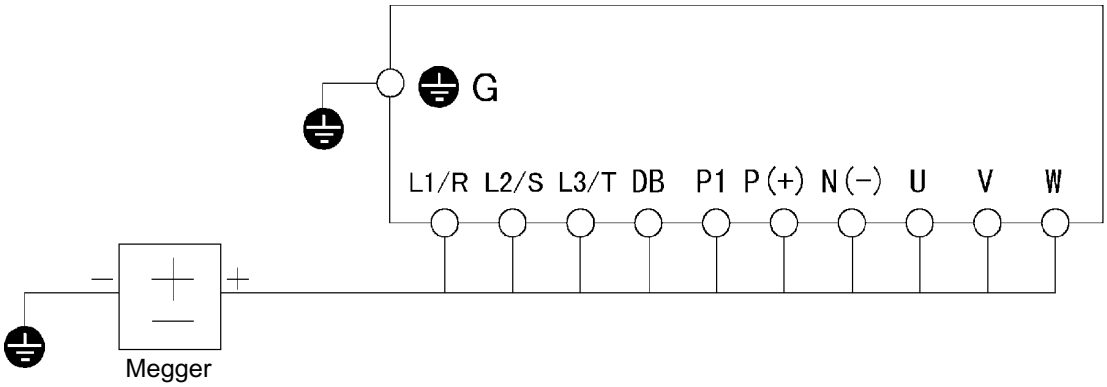


Figure 8-4-1 Megger test

2) Insulation test in the control circuit
A megger test and a dielectric strength test must not be performed in the control circuit. Prepare a high resistance range multimeter for the control circuit.

1. Remove all external cables from the control circuit terminals.
2. Conduct a continuity test between grounds. A result of 1M or more is normal.

3) Exterior main circuit and sequence control circuit
Remove all cables from inverter terminals to ensure the test voltage is not applied to the inverter.

8-5 Parts Replacement

The life expectancy of a part depends on the type of part, the environment, and usage conditions. Parts should be replaced as shown in Table 8-5-1. Check the actual state of fans and capacitors as described on page 8-4.

Part name	Standard period for replacement	Comments
Cooling fan	3 years	Exchange for a new part.
Smoothing capacitor	5 years	Exchange for a new part (determine after checking).
Electrolytic capacitor on the PC board	7 years	Exchange for a new PC board (determine after checking).
Fuse	10 years	Exchange for a new part.
Other parts	-	Determine after checking.

Table 8-5-1 Part replacement

8-6 Inquiries about Products and Product Guarantee

1) Inquiries
If there is damage, a fault in the product, or questions concerning the product, contact your local distributor or nearest Bonfiglioli Riduttori - Silectron sistemi division:

a) Inverter type
b) Serial No. (equipment serial number)
c) Purchase date
d) Inquiry details (e.g., damaged part, extent of damage, questions, status of fault)

2) Product guarantee
The product guarantee is 12 months from delivering.
However, the guarantee will not apply in the following cases, even if the guarantee term has not expired:

1. Damage was caused by incorrect use or inappropriate repair and modification.
2. The product was used outside the standard specified range.
3. Damage was caused by dropping the product after purchasing or damage during transportation.
4. Damage was caused by an earthquake, fire, flooding, lightning, abnormal voltage or other natural calamities and secondary disasters.