Instruction Manual

Supplementary for conformity with standards

Designed for Elevating Machinery

FRENIC-Lift

MESI
ELEVATOR

⚠CAUTION

Thank you for purchasing our FRENIC-Lift series of inverters.

- This product is designed to drive a three-phase induction motor and synchronous motor. Read through this instruction manual and be familiar with the handling procedure for correct use.
- Improper handling might result in incorrect operation, a short life, or even a failure of this product as well as the motor.
- Deliver this manual to the end user of this product. Keep this manual in a safe place until this product is discarded.
- For how to use an option card, refer to the installation and instruction manuals for that option card.

Fuji Electric Co., Ltd. **INR-SI47-1148c-E**

Preface

Thank you for purchasing our FRENIC-Lift series of inverters.

FRENIC-Lift is an inverter designed to drive a three-phase induction motor (hereafter called an induction motor) and a three-phase permanent magnet synchronous motor (hereafter called a synchronous motor) for exclusively controlling elevating machinery.

Improper handling might result in incorrect operation, a short life, or even a failure of this product as well as the motor.

This book is a record of the standard correspondence of the FRENIC-Lift series.

Listed below are the other materials related to the use of the FRENIC-Lift. Read them in conjunction with FRENIC-Lift Instruction Manual (INR-SI47-1038-E) and this manual as necessary.

The materials are subject to change without notice. Be sure to obtain the latest editions for use.

■ Safety precautions

Read FRENIC-Lift Instruction Manual (INR-SI47-1038-E) and this manual thoroughly before proceeding with installation, connections (wiring), operation, or maintenance and inspection. Ensure you have sound knowledge of the device and familiarize yourself with all safety information and precautions before proceeding to operate the inverter.

Safety precautions are classified into the following two categories in this manual.

⚠WARNING	Failure to heed the information indicated by this symbol may lead to dangerous conditions, possibly resulting in death or serious bodily injuries.
⚠CAUTION	Failure to heed the information indicated by this symbol may lead to dangerous conditions, possibly resulting in minor or light bodily injuries and/or substantial property damage.

Failure to heed the information contained under the CAUTION title can also result in serious consequences. These safety precautions are of utmost importance and must be observed at all times.

Conformity with Low Voltage Directive in the EU

If installed according to the guidelines given below, inverters marked with CE can be considered to be compliant with the Low Voltage Directive 2006/95/EC.

Compliance with European Standards

Adjustable speed electrical power drive systems (PDS).
Part 5-1: Safety requirements. Electrical, thermal and energy. EN61800-5-1: 2003

⚠CAUTION

1. Be sure to earth the grounding terminal ⏚G. Use an earth wire sized more than that of the power wires used in the power dispatch system. Do not use a residual-current-operated protective device (RCD)* or an earth leakage circuit breaker (ELCB)* as a sole mechanism of electric shock protection.
   *With over current protection.
2. Use an MCCB, RCD/ELCB or MC in conformity with EN or IEC standards.
3. When an RCD/ELCB is used for protection of electric shock caused by a direct or indirect contact to the live parts, insert **a type B RCD/ELCB** in input lines (primary) of the inverter for the single-phase 200 V or 3-phase 200 V or 400 V power source.
4. Use inverters in an environment that does not exceed pollution degree 2. If inverters are to be used in an environment with pollution degree 3 or 4, place them in an enclosure of IP54 or above.
5. To protect human body from an electric shock caused by a contact to live parts, install inverters and input /output filter in the enclosure of IP2X. In the case where human body easily contacts to live parts, a top panel of the enclosure should be IP4X or higher.
6. Do not directly connect a copper wire to the grounding terminal. Use a crimp terminal with tin or equivalent plating to connect the earth wire.
7. When using inverters at an altitude of more than 2000 m, note that the basic insulation applies to the insulation degree of the control circuitry. At an altitude of more than 3000 m, inverters cannot be used.

Conformity with Low Voltage Directive in the EU (continued)

⚠CAUTION

8. To prevent the risk of hazardous accidents that could be caused by damage of the inverter, install the specified fuses in the supply side (primary side) according to the following tables.

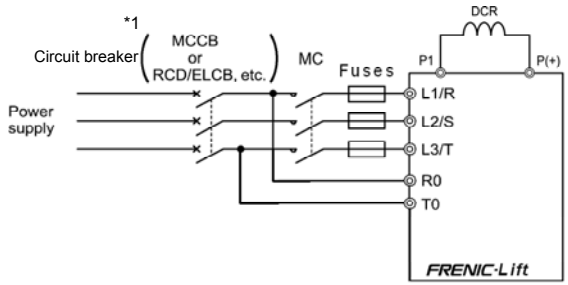
   - Breaking capacity: Min. 10 kA
   - Rated voltage: Min. 500 V

Power supply voltage	Nominal applied motor (kW)	Inverter type	Fuse rating (A) *2		Recommended fuse type*2
Single -phase 200V	2.2	FRN2.2LM1S-7__	20	(IEC60269-2)	A4J20
Three-phase 200V	5.5	FRN5.5LM1S-2_	40	(IEC60269-2)	A4J40
	7.5	FRN7.5LM1S-2_	60	(IEC60269-2)	A4J60
	11	FRN11LM1S-2_	70	(IEC60269-2)	A4J70
	15	FRN15LM1S-2_	90	(IEC60269-2)	A4J90
	18.5	FRN18.5LM1S-2	100	(IEC60269-2)	A4J100
	22	FRN22LM1S-2_	125	(IEC60269-2)	A4J125
Three-phase 400V	4.0	FRN4.0LM1S-4_	15	(IEC60269-2)	A4J15
	5.5	FRN5.5LM1S-4_	20	(IEC60269-2)	A4J20
	7.5	FRN7.5LM1S-4_	30	(IEC60269-2)	A4J30
	11	FRN11LM1S-4_	40	(IEC60269-2)	A4J40
	15	FRN15LM1S-4_	60	(IEC60269-2)	A4J60
	18.5	FRN18.5LM1S-4_	60	(IEC60269-2)	A4J60
	22	FRN22LM1S-4_	60	(IEC60269-2)	A4J60
	30	FRN30LM1S-4_	90	(IEC60269-2)	A4J90
	37	FRN37LM1S-4_	100	(IEC60269-2)	A4J100
	45	FRN45LM1S-4_	125	(IEC60269-2)	A4J125

Note: An underscore (_) in the above table replaces A, C, E or J depending on the shipping destination.

*1 The frame size and model of the MCCB or RCD/ELCB (with over current protection) will vary, depending on the power transformer capacity. Refer to the related technical documentation for details.

*2 The recommended fuse type is applicable to the inverter equipped with a DC reactor. Be sure to use a DC reactor. (For details about DC reactor types, refer to Table 1.1.)



Conformity with Low Voltage Directive in the EU (continued)

⚠CAUTION

9. Use the wires listed in EN60204 Appendix C.

Power supply voltage	Nominal applied motor (kW)	Inverter type	MCCB or RCD/ELCB *1 Rated current (A)		Recommended wire size (mm^2)						
					Main power input *2 [L1/R, L2/S, L3/T] Inverter's grounding [⏚G]		Inverter outputs *2 [U, V, W]	Braking resistor [DB]	DC reactor [P1, P(+)]	Control circuit	Aux. control power supply [R0, T0]
			W/ DCR	W/o DCR	W/ DCR	W/o DCR					
Single-phase 200V	2.2	FRN2.2LM1S-7_	30	40	4	6	2.5	2.5	4	1	2.5
Three-phase 200V	5.5	FRN5.5LM1S-2_	30	50	4	6	4	2.5	4	1	2.5
	7.5	FRN7.5LM1S-2_	40	75	6	10	10		6		
	11	FRN11LM1S-2_	50	100	10	16			16		
	15	FRN15LM1S-2_	75	125	16	25	16	4	25		
	18.5	FRN18.5LM1S-2_	100	150	25	35	25	6	35		
	22	FRN22LM1S-2_		175	35	50	35	10			
Three-phase 400 V	4.0	FRN4.0LM1S-4_	10	20	2.5	2.5	2.5	2.5	1	1	2.5
	5.5	FRN5.5LM1S-4_	15	30					1.5		
	7.5	FRN7.5LM1S-4_	20	40		4			2.5		
	11	FRN11LM1S-4_	30	50	4	6	4		4		
	15	FRN15LM1S-4_	40	60	6	10	6		6		
	18.5	FRN18.5LM1S-4_		75		16	10		10		
	22	FRN22LM1S-4_	50	100	10				16		
	30	FRN30LM1S-4_	75	125	16	25	16	4	25		
	37	FRN37LM1S-4_	100		25	35	25	6			
	45	FRN45LM1S-4_		150		50	35		35		

Note: An underscore (_) in the above table replaces A, C, E or J depending on the shipping destination.

*1 The frame size and model of the MCCB or RCD/ELCB (with over current protection) will vary, depending on the power transformer capacity. Refer to the related technical documentation for details.

*2 The recommended wire size for main circuits is for the 70°C 600V PVC wires used at an ambient temperature of 40°C.

10. The inverter has been tested with IEC61800-5-1 2007 5.2.3.6.3 Short-circuit Current Test under the following conditions.

    Short-circuit current in the supply: 10 kA

    Maximum 240 V for 200 V class series with 22 kW or below
    Maximum 230 V for 200 V class series with 30 kW or above
    Maximum 480 V for 400 V class series

Chapter 1 CONFORMITY WITH STANDARDS

1.1 Conformity with EU Directives

The CE marking on Fuji products indicates that they comply with the essential requirements of the Electromagnetic Compatibility (EMC) Directive 2004/108/EC, Low Voltage Directive 2006/95/EC and Machinery Directive 2006/42/EC which are issued by the Council of the European Communities

Inverters can be in conformity with EMC Directives if an optional EMC-compliant filter is mounted to them.

Inverters that bear a CE Marking are compliant with the Low Voltage Directive.

■The FRENIC-Lift series of inverters is in conformity with the following standards:

EMC Directive	Electromagnetic Compatibility		EN61800-3: 2004 *1 Immunity : *2 Emission : Category C3
Low Voltage Directive	Electrical Safety		EN61800-5-1: 2003
Machinery Directive	Functional Safety *3		EN61800-5-2:2007 SIL 2, EN ISO 13849-1:2008
		Stop function	Safe torque off (STO: acc.EN61800-5-2:2007)
		Response time	50 ms or less (delay time to "Safe torque off" from turning off either terminal [EN1] or [EN2])
		Safety integrity level	SIL 2
		PFH	5.9×10^{-10} (Probability of a dangerous random hardware failure per hour)
		Category	3 (EN ISO 13849-1:2008)
		Performance level	d (EN ISO 13849-1:2008)

*1 Inverters can be in conformity with EMC Directives if an optional EMC-compliant filter is mounted to them. See the section 1.4.2..

*2 The FRENIC-Lift inverters FRN2.2LM1S-7_, FRN4.0LM1S-4_ to FRN22LM1S-4_, FRN5.5LM1S-2_ to FRN7.5LM1S-2_, FRN15LM1S-2_ to FRN22LM1S-2_ are categorized as category C2 according to the EN61800-3:2004. When you use these products in a domestic environment, you may need to take appropriate countermeasures to reduce or eliminate any noise emitted from these products.

The FRENIC-Lift inverters FRN30LM1S-4_ to FRN45LM1S-4_, FRN11LM1S-2_ are categorized as category C3 according to the EN61800-3:2004. It is not designed for use in a domestic environment. It may interfere with the operations of home appliances or office equipment due to noise emitted from it.

*3 30kW or less

Note: To bring the inverter into compliance with Functional Safety Standard, it is necessary to achieve compliance with European Standards EN61800-5-1 and EN61800-3.

1.2 Conformity with Low Voltage Directive in the EU

1.2.1 General

General-purpose inverters are subject to the regulations set forth by the Low Voltage Directive in the EU. Fuji Electric declares the inverters bearing a CE marking are compliant with the Low Voltage Directive.

1.2.2 Considerations when using FRENIC-Lift as a product in conformity with Low Voltage Directive

If you wish to use the FRENIC-Lift series of inverters as a product in conformity with the Low Voltage Directive, refer to the related guidelines described on pages ii and iii.

1.3 Harmonic Component Regulation in the EU

1.3.1 General

Any electrical and electronic equipment connected to low voltage systems (interfacing with the public supply at the low voltage level) must fulfil the requirements of EN IEC 61000-3-12 in terms of the limitation of harmonic currents injected into the public supply system

The scope of this standard is electrical or electronic equipment with an input current exceeding 16 A and up to and including 75 A per phase intended to be connected to public low-voltage AC distribution systems of the following types:

- Nominal voltage up to 240 V, single-phase, two or three wires
- Nominal voltage up to 690 V, three-phase, three or four wires
- Nominal frequency 50 Hz or 60 Hz.

1.3.2 Compliance with the harmonic component regulation

FRENIC Lift inverter capacities under the scope of EN IEC 61000-3-12 fulfil the requirements of this standard when an optional DC reactor is connected. Table 1.1 describes the correct DC reactor type for each inverter capacity to fulfil EN IEC 61000-3-12.

The installation personnel or the user is required to satisfy this standard, based on the condition that the short-circuit ratio Rsce is equal to or higher than 120 at the point of connection of the inverter to the public network.

*The FRN2.2LM1S-7 is not compliant with the EN IEC 61000-3-12.

Table 1.1 Combination of Inverter and DC Reactor, Compliant with EN IEC 61000-3-12

Power supply voltage	Inverter type	DC reactor type	Compliant with/Exempt from EN IEC 61000-3-12
3-phase 200V	FRN5.5LM1S-2_	DCRE2-5,5-F	Compliant
	FRN7.5LM1S-2_	DCRE2-7,5-F	
	FRN11LM1S-2_	DCRE2-11-F	
	FRN15LM1S-2_	DCRE2-15-F	
	FRN18.5LM1S-2_	DCRE2-18,5-F	
	FRN22LM1S-2_	DCRE2-22-F	Exempt
3-phase 400V	*1 FRN4.0LM1S-4_	DCRE4-4,0-F	Exempt
	*1 FRN5.5LM1S-4_	DCRE4-5,5-F	
	*1 FRN7.5LM1S-4_	DCRE4-7,5-F	
	FRN11LM1S-4_	DCRE4-11-F	Compliant
	FRN15LM1S-4_	DCRE4-15-F	
	FRN18.5LM1S-4_	DCRE4-18.5-F	
	FRN22LM1S-4_	DCRE4-22-F	
	FRN30LM1S-4_	DCRE4-30-F	
	FRN37LM1S-4_	DCRE4-37-F	
	FRN45LM1S-4_	DCRE4-45-F	Exempt
Single-phase 200V	FRN2.2LM1S-7_	DCRE2-4.0-F	Not compliant

*1 When two or more inverters are connected, these combinations are objects of the regulation.

1.4 Conformity with the EMC Directive in the EU

1.4.1 General

The CE Marking on inverters does not ensure that the entire equipment including CE-marked products is compliant with the EMC Directive. Therefore, it is the responsibility of the equipment manufacturer to ensure that the equipment including the product (inverter) or connected with it actually complies with the standard and to put a CE Marking as the equipment.

In general, the user's equipment comprises a variety of products supplied from a number of manufacturers in addition to Fuji inverters. Therefore, the manufacturer of the final equipment needs to take responsibility for conformity.

In addition, to satisfy the requirements noted above, it is necessary to use a Fuji inverter in connection with an EMC-compliant filter (option) and install it in accordance with the instructions contained in this manual. Install the Fuji inverter in a metal enclosure.

1.4.2 EMC-compliant filter (Option)

There are two installation styles of an optional EMC-compliant filter: footmount and split styles. As listed on the next page, the footmount style applies to inverters from FRN4.0LM1S-4_ to FRN22LM1S-4_, and the split style, to FRN30LM1S-4_ to FRN45LM1S-4_ and FRN5.5LM1S-2_ to FRN22LM1S-2_ FRN2.2LM1S-7_.

For how to install the EMC-compliant filter, see Section 1.4.3 "Recommended installation of EMC-compliant filter."

Note The use of an EMC-compliant filter increases leakage current as shown in table 1.2.

Table 1.2 EMC-compliant Filters and Leakage Current

Power supply voltage	Inverter type	EMC-compliant filter model	Leakage current (mA) *1 *2		Installation style
			Normal condition	Worst condition	
Single-phase 200V	FRN2.2LM1S-7_	FS20159-25-07	4.8	9.6	Split style See Figure 1.2 (B).
3-phase 200V	FRN5.5LM1S-2_	FS23293-57-52	28.6	44.6	Split style See Figure 1.2 (B).
	FRN7.5LM1S-2_				
	FRN11LM1S-2_	FN3258T-75-34	57.6	88.4	
	FRN15LM1S-2_	FN3258T-100-35	57.6	88.3	
	FRN18.5LM1S-2_				
	FRN22LM1S-2_	FN3258T-130-35	57.6	88.3	
3-phase 400 V	FRN4.0LM1S-4_	FS21312-18-07	22.4	147.8	Footmount style See Figure 1.2 (A).
	FRN5.5LM1S-4_	EFL-7.5G11-4 (FS5536-35-07)	22.2	160.2	
	FRN7.5LM1S-4_				
	FRN11LM1S-4_ *3	FS21312-44-07	22.4	159.7	
		EFL-15G11-4 (FS5536-50-07)	33.3	230.2	
	FRN15LM1S-4_				
	FRN18.5LM1S-4_	EFL-22G11-4 (FS5536-72-07)	22.2	160.2	
	FRN22LM1S-4_				
	FRN30LM1S-4_	FS21312-78-07	22.4	170.3	Split style See Figure 1.2 (B).
	FRN37LM1S-4_	FN3258T-100-35	14.9	102.2	
	FRN45LM1S-4_	FN3258T-130-35	14.9	102.2	

Note: An underscore (_) in the above table replaces A, C, E, or J depending on the shipping destination.

*1 Calculated based on these measuring conditions:
200V class series: 220V, 50 Hz, grounding of a single wire in delta connection, interphase voltage unbalance ratio 2%.
400V class series: 440 V, 50 Hz, neutral grounding in Y-connection, interphase voltage unbalance ratio 2%.

*2 The worst condition includes a phase loss in the supply line.

1.4.3 Recommended installation of EMC-compliant filter

This section shows how to install an EMC-compliant filter. In the footmount style, mount the inverter on the EMC-compliant filter. In the split style, mount the filter beside or under the inverter.

Note For the footmount style, FRN11LM1S-4_ inverter requires a panel-mount adapter (option) as listed below only when using FS5536-50-07 EMC filter.

Table 1.3 EMC-compliant Filter and Panel-mount Adapter (option)

3-phase 400 V	Inverter type	EMC filter model [Bundled screws to fix the filter onto panel-mount adapter]	Panel-mount adapter model [Bundled screws to fix the adapter onto inverter]
11 kW	FRN11LM1S-4_	EFL-15G11-4(FS5536-50-07) [Four M8 x 20 screws]	MA-F1-15 [Four M8 x 25 screws]

Note: An underscore (_) in the above table replaces A, C, E, or J depending on the shipping destination.

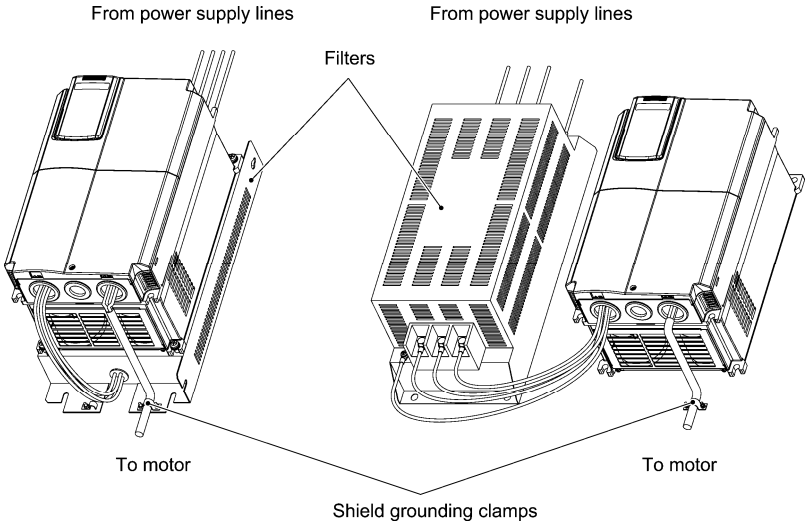


Figure 1.2 Installing Inverter and EMC-compliant Filter

The EMC-compliant filter and the inverter should be connected with each other according to the procedure given below. The wiring on the inverter and motor should be performed by an authorized electrical engineer. In order to ensure compliance with the EMC Directive, this procedure should be followed as closely as possible.

■ **Basic connection procedure**

1) Install the inverter and the EMC-compliant filter on a grounded metal plate. Use a shielded cable also for connection to the motor and make it as short as possible. Connect the shield layer of the cable firmly to the metal plate. Also, at the motor side, connect the shield layer electrically to the grounding terminal of the motor.
2) Use a shielded cable for connection of control circuit lines of the inverter and also for connection of the signal cable of an RS485 communications card. As with the motor, clamp the shield layer of the cable firmly to a grounded plate.
3) If noise radiated from the inverter exceeds the level prescribed in the EMC Directive, enclose the inverter and its peripherals (EMC-compliant filter) inside a metal enclosure as shown in Figure 1.3.

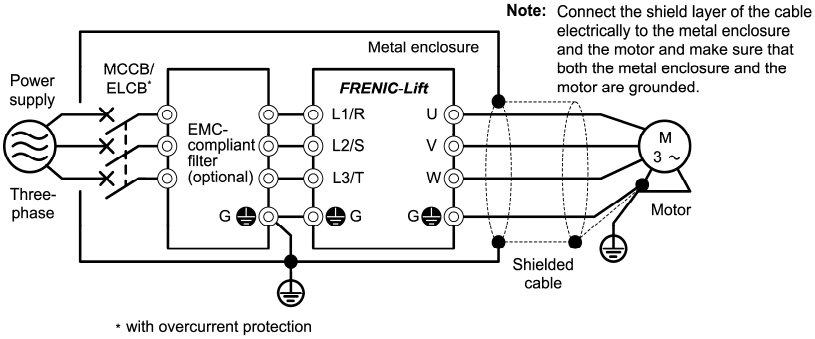


Figure 1.3 Installation of EMC-Compliant Filter (Option)

1.4.4 EMC-compliant environment and class

The table below lists the capacity and power supply voltage of the FRENIC-Lift and the EMC-compliant environment.

Table 1.4 EMC-compliant environment and class

Requirement	Inverter capacity				
	Single-phase 200V	3-phase 200V		3-phase 400V	
	2.2 kW	5.5 to 7.5 kW 15 to 22 kW	11 kW	4.0 to 22 kW	30 to 45 kW
Immunity	EN61800-3:2004 Second environment (Industrial environment)				
Emission	EN61800-3:2004 Category C2 (Group 1 Class A)	EN61800-3:2004 Category C2 (Group 1 Class A)	EN61800-3:2004 Category C3 (Group 2 Class A)	EN61800-3:2004 Category C2 (Group 1 Class A)	EN61800-3:2004 Category C3 (Group 2 Class A)

⚠WARNING⚠

Before changing any internal wiring, turn OFF the power and wait for at **least five minutes for models of 22 kW or below, or for at least ten minutes for models of 30 kW or above**. Make sure that the LED monitor and charging lamp are turned OFF. Further, make sure, using a multimeter or a similar instrument, that the DC link bus voltage between the terminals P (+) and N (-) has dropped below the safe voltage (+25 VDC).

Otherwise electric shock could occur.

1.5 Compliance with Functional Safety Standard

1.5.1 General

In FRENIC-LIFT series of inverters, opening the hardware circuit between terminals [EN1]-[PLC] or between terminals [EN2]-[PLC] stops the output transistor, coasting the motor to a stop. (EN1: Enable input 1, EN2: Enable input 2) This is the Safe Torque Off (STO) function prescribed in EN60204-1, Category 0 (Uncontrolled stop) and compliant with Functional Safety Standard.

Using the Safe Torque Off (STO) function eliminates the need of external safety circuit breakers while conventional inverters need those breakers to configure the Functional Safety Standard compliant safety system.

⚠WARNING⚠

- The output shutdown function of this inverter uses the Safe Torque Off (STO) function prescribed in IEC61800-5-2 so that it does not completely shut off the power supply to the motor electrically. Depending upon applications, therefore, additional measures are necessary for safety of end-users, e.g., brake function that locks the machinery and motor terminal protection that prevents possible electrical hazard(s).
- The output shutdown function does not completely shut off the power supply to the motor electrically. Before starting wiring or maintenance jobs, therefore, be sure to disconnect the input power to the inverter and wait at least five minutes for inverters of 22 kW or below, or at least ten minutes for inverters of 30 kW or above.

Enable terminals and peripheral circuit, and internal circuit configuration

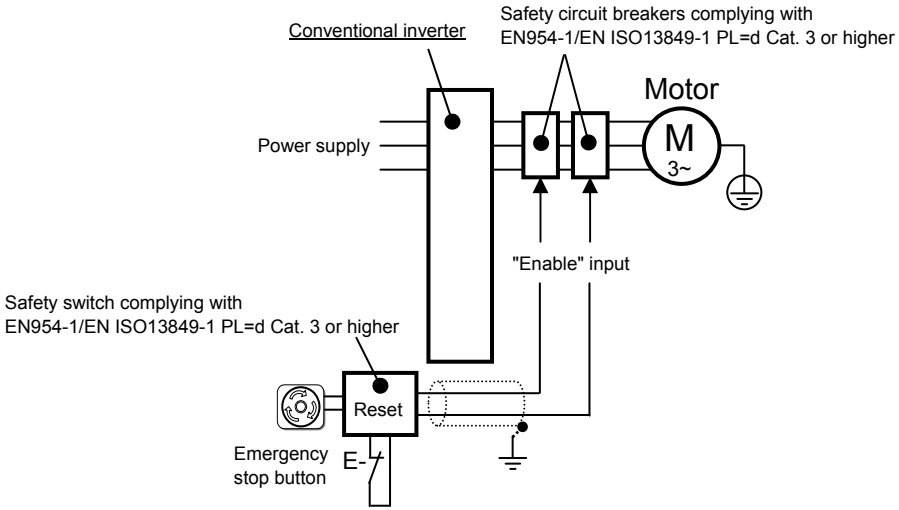
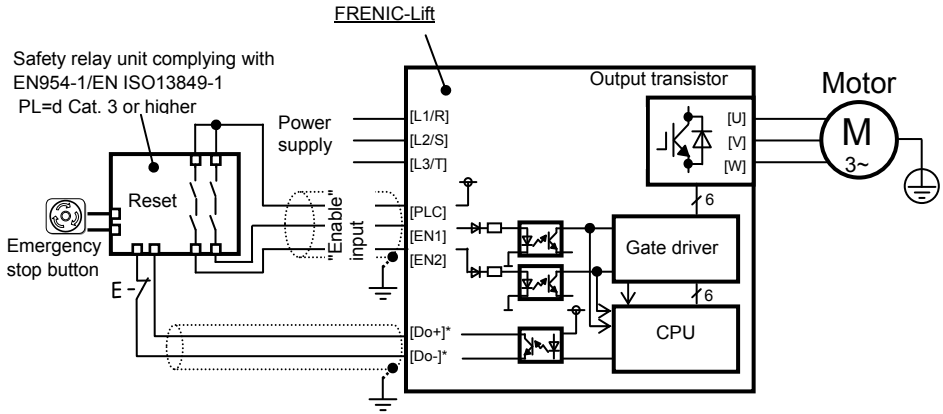


Figure 1.4 Conventional Inverter



*Transistor output terminals (e.g., [Y1]-[CMY], ***DECF***
(Function code data=1101), Refer to Section 1.5.6)

Figure 1.5 FRENIC-Lift

1.5.2 Notes for compliance to Functional Safety Standard

(1) Wiring for terminals [EN1] (Enable input 1) and [EN2] (Enable input 2)

- [EN1]/[EN2] and [PLC] are terminals prepared for connection of safety related wires; therefore, careful wiring should be performed to ensure that no short-circuit(s) can occur to these terminals.
- For opening and closing the hardware circuit between terminals [EN1]/[EN2] and [PLC], use safety approved components such as safety relays that comply with EN954-1/EN ISO13849-1 PL=d Cat. 3 or higher to ensure a complete shutoff.
- It is the responsibility of the machinery manufacturer to guarantee that a short-circuiting or other fault does not occur in wiring of external safety components between terminals [EN1]/[EN2] and [PLC].

  Fault examples:
  - Terminals [EN1]/[EN2] and [PLC] are short-circuited due to the wiring being caught in the door of the control panel so that a current continues to flow in terminal [EN1]/[EN2] although the safety component is OFF and therefore the safety function may NOT operate
  - The wiring is in contact with any other wire so that a current continues to flow in terminal [EN1]/[EN2] and therefore the safety function may NOT operate

(2) Note for Safe Torque Off (STO)

- When configuring the product safety system with this Safe Torque Off (STO) function, make a risk assessment of not only the external equipment and wiring connected to terminals [EN1] and [EN2] (Enable input 1 and Enable input 2) but also the whole system including other equipment, devices and wiring against the product safety system required by the machinery manufacturer under the manufacturer's responsibility in order to confirm that the whole system conforms to the product safety system required by the machinery manufacturer.

  In addition, as preventive maintenance, the machinery manufacturer must perform periodical inspections to check that the product safety system properly functions.
- To bring the inverter into compliance with Functional Safety Standard, it is necessary to install the inverter on a control panel with the enclosure rating of IP54 or above.
- To bring the inverter into compliance with Functional Safety Standard, it is necessary to bring it into compliance with European Standards EN61800-5-1 and EN61800-3.
- This Safe Torque Off (STO) function coasts the motor to a stop. When a mechanical brake is used to stop or hold the motor for the sake of the product of whole system safety, do not use the inverter's control signals such as output from terminal [Y]. Using control signals does not satisfy the safety standards because of software intervention. Use safety relay units complying with EN954-1/EN ISO13849-1 PL=d Cat. 3 or higher to activate mechanical brakes.
- The safety shutdown circuit between terminal [EN1] and [EN2] input sections and inverter's output shutdown section is dual-configured (redundant circuit) so that an occurrence of a single fault does not detract the Safe Torque Off (STO).

  If a single fault is detected in the safety shutdown circuit, the inverter coasts the motor to a stop even with the [EN1]-[PLC] and [EN2]-[PLC] states being ON, as well as outputting an alarm to external equipment. (Note that the alarm output function is not compliant with EN954-1/EN ISO13849-1 PL=d Cat. 3).
- The Safe Torque Off (STO) function does not completely shut off the power supply to the motor electrically. Before starting wiring or maintenance jobs, be sure to disconnect the input power to the inverter and wait at least 5 minutes.

(3) A test of Safe Torque Off (STO)

- In application where no regular activation of the Safe Torque Off (STO) function is guaranteed, check at least once a year that the Safe Torque Off (STO) function works correctly.

1.5.3 EN ISO 13849-1 PL=d

European Standard EN ISO13849-1 PL=d (Safety of machinery–Safety related parts of control systems) prescribes the basic safety requirements for machinery categorized according to the requirement level. Category 3 represents the requirements that the machinery shall be designed with redundancy so that a single fault does not lead to the loss of the safety function. Table 9.3 shows an outline of the category levels and their safety requirements. For detailed requirements, refer to EN ISO13849-1 PL=d.

Table 1.5

Category	Summary of requirements	System behavior
B	SRP/CS and/or their protective equipment, as well as their components, shall be designed, constructed, selected, assembled and combined in accordance with relevant standards so that they can withstand the expected influence. Basic safety principles shall be used.	The occurrence of a fault can lead to the loss of the safety function.
1	Requirements of Category B shall apply. Well-tried components and well-tried safety principles shall be used.	The occurrence of a fault can lead to the loss of the safety function but the probability of occurrence is lower than for Category B.
2	Requirements of Category B and the use of well-tried safety principles shall apply. Safety function shall be checked at suitable intervals by the machine control system.	The occurrence of a fault can lead to the loss of the safety function between the checks. The loss of safety function is detected by the check.
3	Requirements of Category B and the use of well-tried safety principles shall apply. Safety-related parts shall be designed, so that - a single fault in any of these parts does not lead to the loss of the safety function, and - whenever reasonably practicable, the single fault is detected.	When a single fault occurs, the safety function is always performed. Some, but not all, faults will be detected. Accumulation of undetected faults can lead to the loss of the safety function.
4	Requirements of Category B and the use of well-tried safety principles shall apply. Safety-related parts shall be designed, so that - a single fault in any of these parts does not lead to a loss of the safety function, and - the single fault is detected at or before the next demand upon the safety function, but that if this detection is not possible, an accumulation of undetected faults shall not lead to the loss of the safety function.	When a single fault occurs, the safety function is always performed. Detection of accumulated faults reduces the probability of the loss of the safety function (high DC). The faults will be detected in time to prevent the loss of the safety function.

1.5.4 Inverter output state when Safe Torque Off (STO) is activated

Turning the emergency stop button ON turns EN1 and EN2 OFF, bringing the inverter into the Safe Torque Off (STO) state.

Figure 1.6 shows the timing scheme to apply when the emergency stop button is turned OFF with the inverter being stopped. Input to the EN1 and EN2 comes ON, making the inverter ready to run.

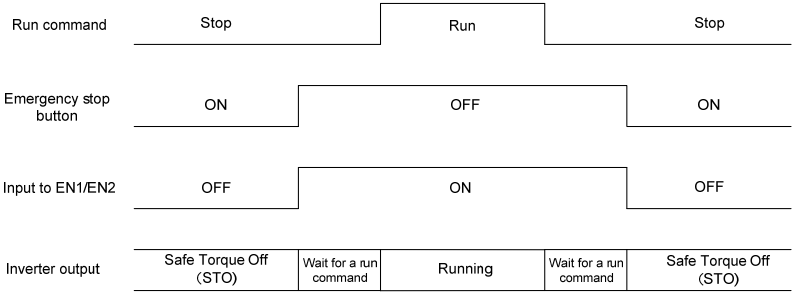


Figure 1.6 Inverter Output State when the Emergency Stop Button is Turned OFF with the Inverter being Stopped

Figure 1.7 shows the timing scheme to apply when the emergency stop button is turned ON with the inverter running. Input to the EN1 and EN2 goes OFF, bringing the inverter into the Safe Torque Off (STO) state and coasting the motor to a stop.

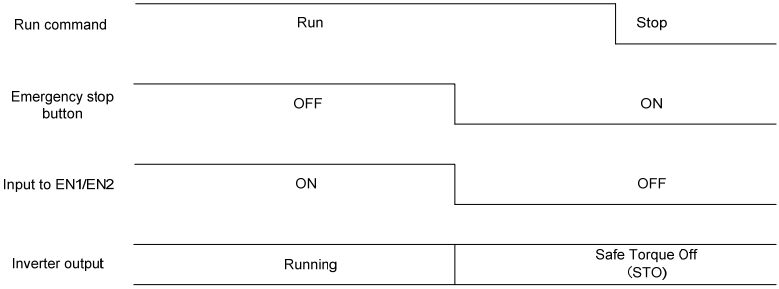


Figure 1.7 Inverter Output State when the Emergency Stop Button is Turned ON with the Inverter Running

1.5.5 ECF alarm (caused by logic discrepancy) and inverter output state

Figure 1.8 shows the timing scheme to apply when EN1 and EN2 inputs are not aligned so that an alarm ECF occurs.

Turning the emergency stop button ON turns EN1 and EN2 inputs OFF, which usually brings the inverter into the Safe Torque Off (STO) state. If the misalignment of the EN1 and EN2 inputs is within 50 ms, no alarm occurs; if it is more than 50 ms, the inverter interprets it as a logic discrepancy, outputting an alarm ECF. The alarm can be cleared by restarting the inverter.

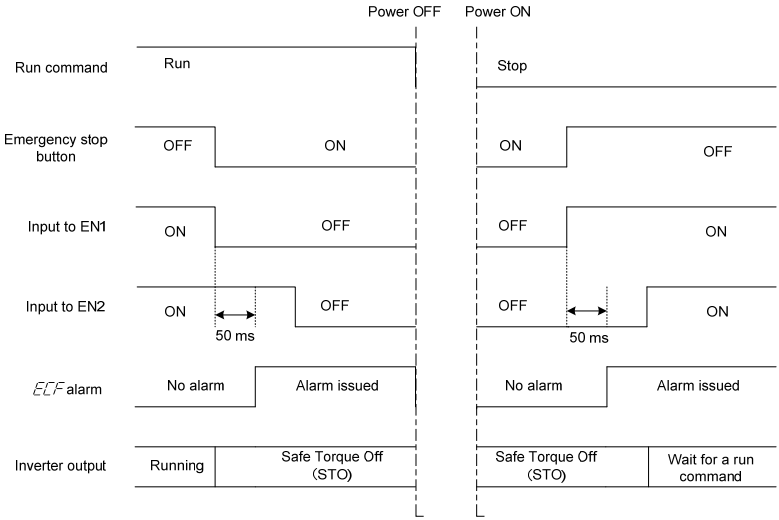


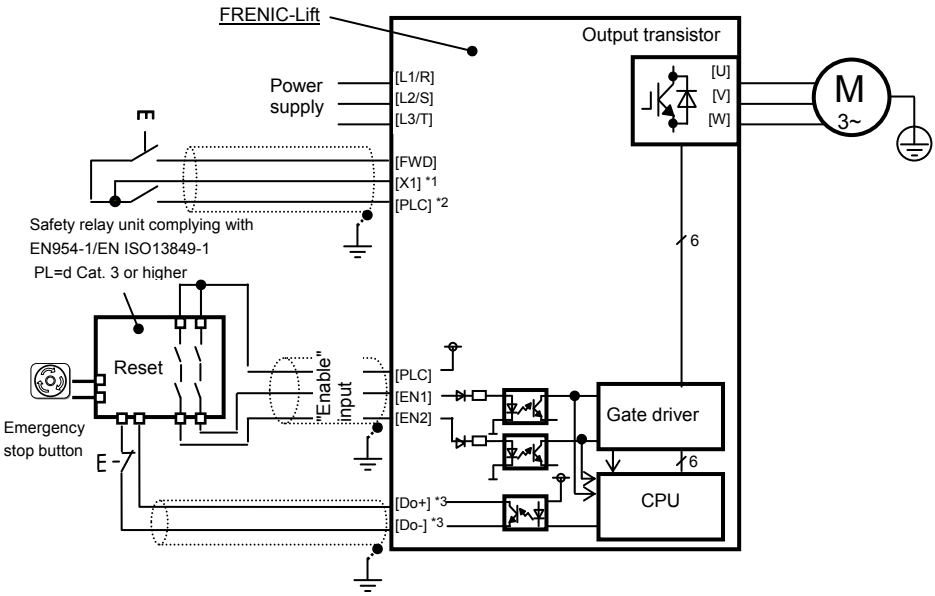
Figure 1.8 ECF Alarm (Caused by Logic Discrepancy) and Inverter Output State

1.5.6 Prevention of restarting

To prevent the inverter from restarting just by turning the emergency stop button OFF, configure the Enable input circuit as shown below. Figure 1.10 shows the timing scheme for prevention of restarting.

Assigning the ***HLD*** ("Enable 3-wire operation") to any digital input terminal and setting the E01 data to "6" sets up the ***HLD*** function at the [X1] terminal.

After the ***FWD*** comes ON with the ***HLD*** being ON, even turning the ***FWD*** OFF keeps the inverter running due to the ***HLD***. Turning the emergency stop button ON under the condition causes the motor to coast to a stop. After that, turning the emergency stop button OFF no longer starts the inverter to run. To run the inverter, turn the ***FWD*** ON again.



*1 Digital input terminal (e.g., [X1])

*2 If SW1 is in the SINK mode, [CM] applies; if in the SOURCE mode, [PLC] applies.

*3 Transistor output terminals (e.g., [Y1]-[CMY], ***DECF***(Function code data=1101))

Figure 1.9 Connection Diagram and Internal Circuit Configuration

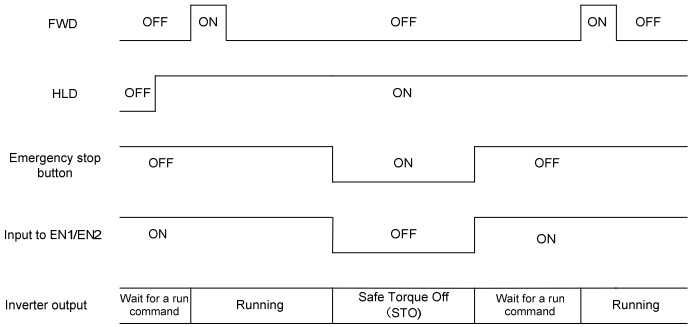


Figure 1.10 Prevention of Restarting

Designed for Elevating Machinery

FRENIC-Lift

Instruction Manual

First Edition, April 2008

Fourth Edition, January 2012

Fuji Electric Co., Ltd.

The purpose of this instruction manual is to provide accurate information in handling, setting up and operating of the FRENIC-Lift series of inverters. Please feel free to send your comments regarding any errors or omissions you may have found, or any suggestions you may have for generally improving the manual.