OPC-LM1-PS1

Option Card for Permanent Magnet Synchronous Motor Drive

⚠ CAUTION

- ■ Deliver this instruction manual without fail to those who actually operate the equipment.

- ■ Read this instruction manual and understand the description before installing, connecting (wiring), operating or performing maintenance and inspection of the option.

- ■ Keep this instruction manual in a safe place until the option is discarded.

- ■ The product is subject to change without prior notice.

Preface

Thank you for purchasing our OPC-LM1-PS1 inverter option card. Before using the option card, read this manual carefully to understand how to use the option card correctly. Improper handling blocks correct operation or causes a short life or breakdown. This manual does not describe how to use the inverter. Refer to the FRENIC-Lift Instruction Manual for details about the inverter. Keep this manual on hand for reference when using the option card.

Safety Precautions

Note the following items when using the option card. Improper use may result in unexpected failure, electric shock, or possible injury.

(1) Application

WARNING
• This product must not be used for any life support system or other purpose directly related to human safety. • Although this product is manufactured under strict quality control, be sure to install appropriate safety devices for applications where drive failure could result in serious accident or material loss.   **An accident could occur.**

(2) Installation and Wiring

WARNING

• Wait at least five minutes after turning off the power before installing or wiring the option card.
  Use a circuit tester or similar instrument to check the voltage before performing installation or wiring.
  (Check whether the charge lamp goes off.) **Otherwise, electric shock may occur.**
• Discharge statistic electricity from your body before handling the option card. Never touch the option card with wet hands; **otherwise, accident or electric shock may occur.**
• No foreign matter such as screws, metal patches, lint, chips, and dust in the option card.
  There is risk of fire or accident.
• Do not damage or stress the wiring; **otherwise, accident or electric shock may occur.**
• Do not connect the reducer between the motor and the encoder.
  There is a risk of accident.

CAUTION
• Do not install or operate a damaged option card or one that is lacking parts; **otherwise, an injury may occur.** • Since noise is generated by the inverter, motor, and wiring, carefully monitor surrounding sensors and devices for abnormal operation. **There is a risk of accident.**

(3) Operation

WARNING
• Check and adjust parameters before operation. Improper parameters may cause an unexpected action for some machines. **There is a risk of accident.**

CAUTION
• High-speed operation can be set easily for the inverter. Fully check motor or device performance before changing the setup; **otherwise, accident may occur.**

(4) Maintenance and Inspection, and Parts Replacement

WARNING
• Wait at least five minutes after turning off the power before inspecting the option card. (Check whether the charge lamp goes off.) **There is a risk of electric shock.** • Only authorized personnel are allowed to maintain and inspect the option card and replace parts; **otherwise, electric shock or injury may occur.** • Never modify the option card; **otherwise, electric shock or injury may occur.**

CAUTION
• Do not execute a megger test (insulation resistance measurement).

(5) Discard

CAUTION
• Since the option card uses soldering lead, treat it as an industrial waste when discarding it.

Contents

If anything is unclear about the option card or there is something doubtful about its condition, contact your distributor or your nearest branch office.

1 General Information

1.1 Introduction to OPC-LM1-PS1

This product is an encoder interface card to be installed in the Fuji inverter FRENIC-Lift. It enables vector control according to feedback signals from the HEIDENHAIN rotary encoder (ECN1313 Endat2.1).

1.2 Applicable Inverter ROM Versions

This option is applicable to the inverters having any of the ROM versions listed below. Before mounting this option, check the ROM version of your inverter using any of the following procedures.

- Via the RS-485 communications link, check the monitor data with function code M25. (For details, refer to the RS-485 Communication User's Manual (MHT276).)
- Use the multi-function keypad (option) and check Menu #5 "Maintenance Information." (For details, refer to the Multi-function Keypad Instruction Manual (INR-SI47-1092-E).)
- Use the FRENIC Loader (option) for the FRENIC-Lift and click the System monitor tab on the Operation Status Monitor window. (For details, refer to the FRENIC Loader Instruction Manual (INR-SI47-1096-E).)

Inverter ROM Version
Versions 0804, 0808, 1100 or later

1.3 Before Using the Option Card

Check the following items when you receive this product. Also check whether this product has been damaged during transport. If anything is amiss, contact your distributor or your nearest branch office.

(1) The option card is contained in the package.
(2) The option card is not damaged during transportation--no defective electronic devices, dents or warps.
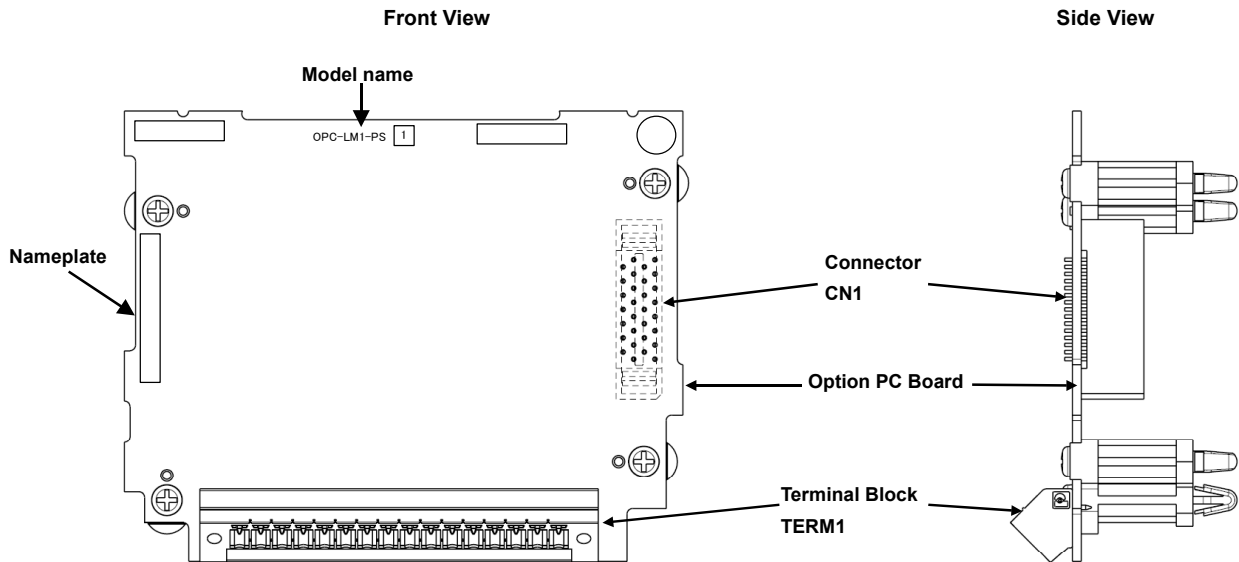(3) The model name "OPC-LM1-PS1" is printed on the option card. (See Figure 1.1.)
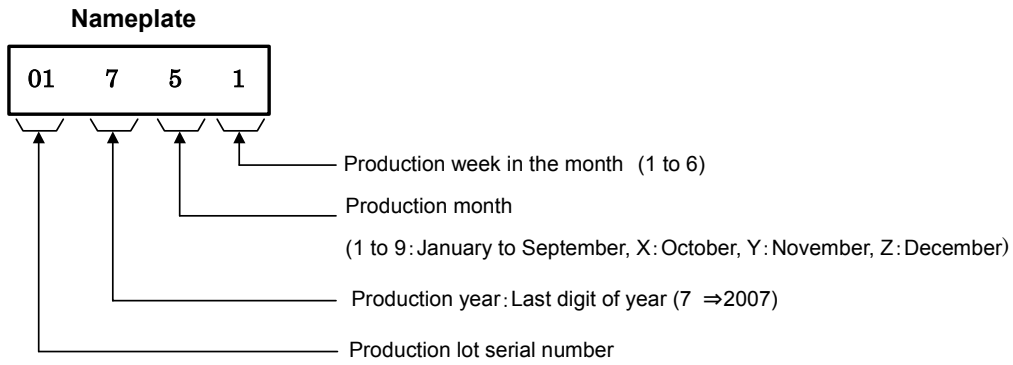

Figure 1.1   Product Appearance

Nameplate

01	7	5	1

Production week in the month (1 to 6)

Production month

(1 to 9：January to September, X：October, Y：November, Z：December)

Production year：Last digit of year (7 ⇒2007)

Production lot serial number

Figure 1.2   Nameplate

1.4 Accessories

Confirm that the following accessories are included in the package:

1. Instruction Manual		·········· 1
2. Accessories	1) Plug for TERM1	·········· 1

1.5 Installation Procedure

WARNING
• Turn off the power and wait for at least five minutes before starting installation. Further, check that the LED monitor is unlit and check that the DC link bus voltage between the P (+) and N (-) terminals is lower than 25 VDC. **Otherwise, electric shock could occur.**

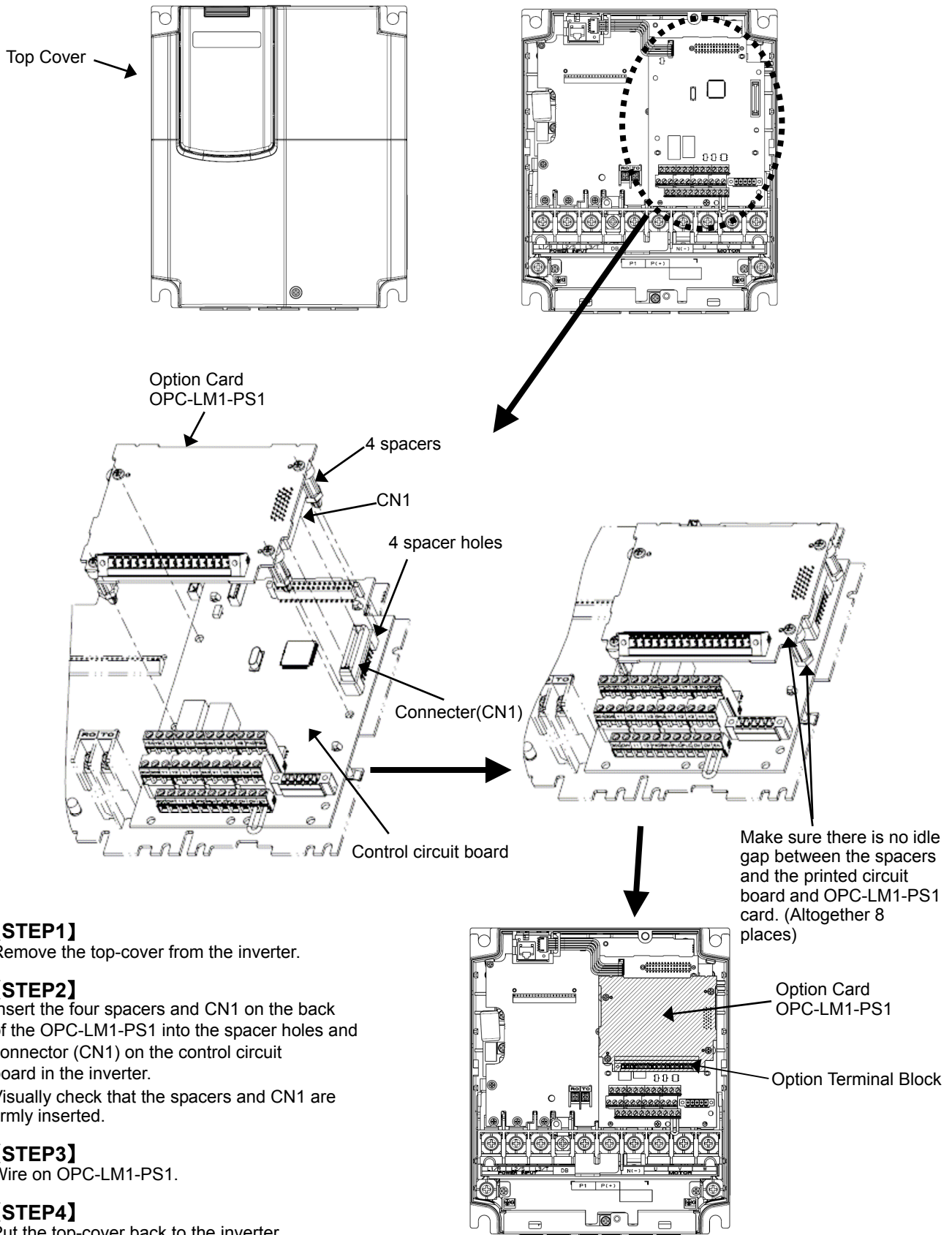| CAUTION |
|---|
| • Do not touch any metallic part of the connector for the main unit (CN1) or any electronic component. Otherwise, electronic components may be damaged by static electricity charged in your body. Also, the stain or adhesion of sweat or dust may adversely affect the contact reliability of the connector in the long run.
An accident could occur. |

Top Cover

Option Card
OPC-LM1-PS1

4 spacers

CN1

4 spacer holes

Connecter(CN1)

Control circuit board

Make sure there is no idle gap between the spacers and the printed circuit board and OPC-LM1-PS1 card. (Altogether 8 places)

Option Card
OPC-LM1-PS1

Option Terminal Block

【STEP1】
Remove the top-cover from the inverter.

【STEP2】
Insert the four spacers and CN1 on the back of the OPC-LM1-PS1 into the spacer holes and connector (CN1) on the control circuit board in the inverter.
Visually check that the spacers and CN1 are firmly inserted.

【STEP3】
Wire on OPC-LM1-PS1.

【STEP4】
Put the top-cover back to the inverter.

Figure 1.3   Installation Drawing

1.6 Product Guarantee

The product guarantee term is one year after installation or two years after manufacturing on the nameplate, whichever expires first.
However, the guarantee will not apply in the following cases, even if the guarantee term has not expired.

(1) The cause includes incorrect usage or inappropriate repair or modification.
(2) The product is used outside the standard specified range.
(3) The failure is caused by dropping, damage or breakage during transportation after the purchase.
(4) The cause is earthquake, fire, storm or flood, lightening, excessive voltage, or other types of disaster or secondary disasters.

2 Specifications

2.1 Storage Environment

2.1.1 Temporary Storage

Store the option card in an environment that satisfies the requirements listed in Table 2.1.

Table 2.1   Environmental Requirements for Storage and Transportation

Item	Requirements	
Storage Temperature [*1]	-25 to 70°C	Location where the option card is not subject to abrupt changes in temperature that would result in the formation of condensation or ice.
Relative humidity	5 to 95% [*2]	
Atmosphere	The inverter must not be exposed to dust, direct sunlight, corrosive or flammable gases, oil mist, vapor, water drops or vibration. The atmosphere must contain only a low level of salt. (0.01 mg/cm^2 or less per year)	
Atmospheric pressure	86 to 106 kPa (in storage)	
	70 to 106 kPa (during transportation)	

[*1] Assuming a comparatively short storage period (e.g., during transportation or the like)
[*2] Even if the humidity is within the specified requirements, avoid such places where the option card will be subjected to sudden changes in temperature that will cause condensation to form.

Precautions for temporary storage

(1) Do not leave the inverter directly on the floor.
(2) If the environment does not satisfy the specified requirements, wrap the option card in an airtight vinyl sheet or the like for storage.
(3) If the option card is to be stored in an environment with a high level of humidity, put a drying agent (such as silica gel) in the airtight package described in item (2).

2.1.2 Long-term Storage

The long-term storage methods for the inverter vary largely according to the environment of the storage site. General storage methods are described below.
(1) The storage site must satisfy the requirements specified for temporary storage.
(2) The inverter must be stored in a package that is airtight to protect it from moisture. Include a drying agent inside the package to maintain the relative humidity inside the package to within 70%.
(3) If the option card has been installed in the equipment or control board at a construction site where it may be subjected to humidity, dust or dirt, then remove the option card and store it in a suitable environment specified in Table 2.1.

2.2 Operating Environment

Install the inverter in an environment that satisfies the requirements listed in Table 2.2.

Table 2.2   Environment Requirements

Item	Specifications
Location	Indoors
Ambient temperature	-10 to 45°C
Relative humidity	5 to 95% (No condensation)
Atmosphere	The option card must not be exposed to dust, direct sunlight, corrosive gases, flammable gas, oil mist, vapor or water drops. The atmosphere must contain only a low level of salt. (0.01 mg/cm^2 or less per year) The inverter must not be subjected to sudden changes in temperature that will cause condensation to form.
Altitude	1,000 m max. (Note)
Vibration	3 mm (Max. amplitude)：2 to 9 Hz, 9.8 m/s^2：9 to 20 Hz, 2 m/s^2：20 to 55 Hz 1 m/s^2：55 to 200 Hz

(Note) If you use the inverter in an altitude above 1000 m, you should apply an output current derating factor as listed in Table 2.3.

Table 2.3   Output Current Derating Factor in Relation to Altitude

Altitude	Output current derating factor
1000 m or lower	1.00
1000 to 1500 m	0.97
1500 to 2000 m	0.95
2000 to 2500 m	0.91
2500 to 3000 m	0.88

2.3 Terminal Arrangement
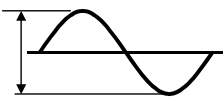
PO	PO	CM	CM	CM	PA+	PA-	PB+	PB-	CK+	CK-	DT+	DT-	FPA	FPB	CM

TERM1

Figure 2.1   Terminal Arrangement

2.4 Terminal Function and Specifications

Table 2.4   Terminal Function and Electrical Specifications of OPC-LM1-PS1

Abbreviation	Terminal name	Terminal function	Electric specifications
PO	Power supply for encoder	Terminal which supplies power for encoder	・5 VDC±5%, Max. 300 mA ・5 VDC±5% Allowable wiring length.
CM	Common terminal of power supply		0 to 10 m：One wire each for PO and CM line 0 to 20 m：Two wire each for PO and CM line
PA+	The A phase input terminal (non-inverting)	The A phase input the amplitude and the frequency change depending on the speed of the motor.	・Input frequency Max. 50 kHz ・Differential input signal： PA(+) - PA(-), PB(+) - PB(-)
PA-	The A phase input terminal (inverting)		
PB+	The B phase input terminal (non-inverting)	The B phase input the amplitude and the frequency change depending on the speed of the motor.	0.6V to 1.2V
PB-	The B phase input terminal (inverting)		
CK+	Communication clock (non-inverting)	Clock transmission	RS-485 conforming
CK-	Communication clock (inverting)		
DT+	Communication data (non-inverting)	Data sending and receiving	
DT-	Communication data (inverting)		
FPA	The A phase pulse output	The pulses with same frequency as the A phase input are output.	・Transistor output (Open collector) ・Operation voltage of OFF level : Max. 27 V ・Operation voltage of ON level : Max. 2.0 V ・Load current at ON : Max. 50 mA ・Leakage current at OFF : Max. 200μA
FPB	The B phase pulse output	The pulses with same frequency as the B phase input are output	

(Note) It is recommended that terminals FPA and FPB are pulled up with lowest value of resistor with the sink current not exceeding 50 mA when terminals FPA and FPB are used.

2.5 Control Specifications

Table 2.5   Control Specifications

Item	Control Specifications	Remarks
Motor control method	Vector control	-
Speed control range	0 r/min to 1500 r/min	-

3 Applicable Encoder

CAUTION
• Check the encoder specification again before operating the inverter. Improper encoder specification may cause unexpected inverter operation or device operation. **There is a risk of accident or injury.**

3.1 Specifications of Applicable Encoder

Table 3.1 Specifications of Applicable Encoder

Item		Specifications
Application encoder	Incremental signals	2 sinusoidal signals A and B as sine and cosine with 2048 periods per revolution
	Rotor Position Detection	2 sinusoidal signals C and D as sine and cosine with one period per revolution
	Encoder power supply	+5 VDC (5 VDC ±5%/300 mA)
	Encoder model	HEIDENHAIN ECN1313 or its equivalent

3.2 Encoder Installation and Signal

The encoder shall rotate in the direction shown in Figure 3.1 when terminal FWD is ON.
Encoder output pulse is shown in Figure 3.2. Connect the encoder directly to the motor using a coupling.
If the encoder rotation is different from that shown in Figure 3.1, interchange V with W of inverter output.
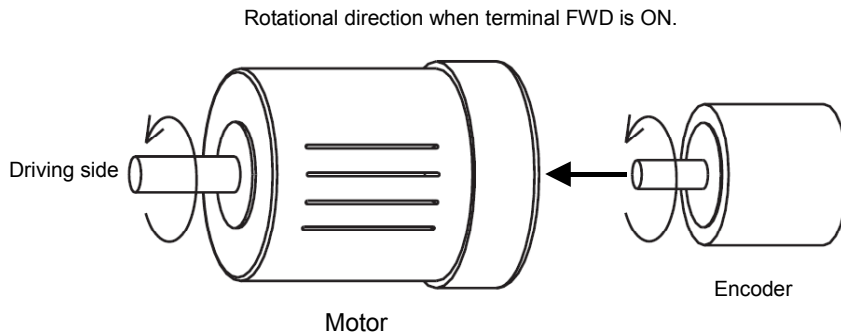The rotational direction of IEC standard motors is opposite to that shown in Figure 3.1.

Rotational direction when terminal FWD is ON.

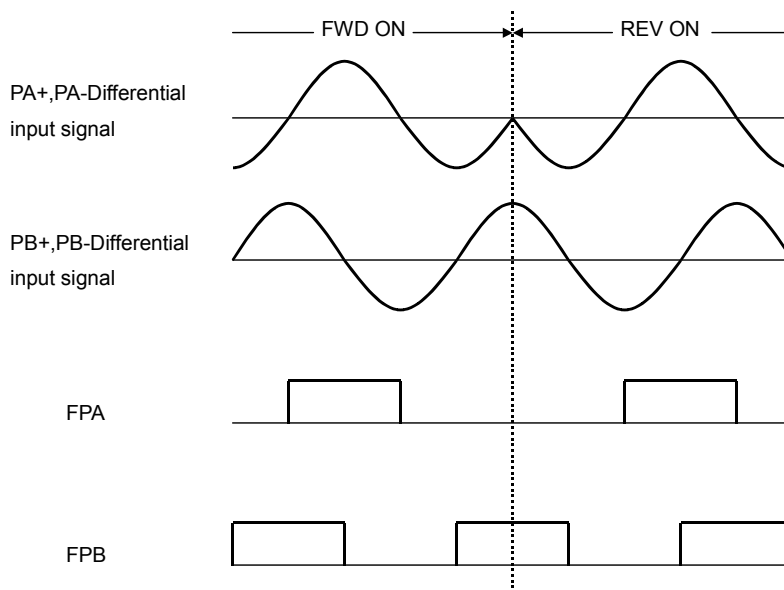Figure 3.1 Motor and Encoder Rotational Direction when Terminal FWD is ON

Figure 3.2 Definition of Terminal FWD ON/REV ON

9

4 Wiring

CAUTION
• Check the wiring again before operating the inverter. Improper wiring may cause unexpected inverter operation or device operation. **There is a risk of accident or injury.**

4.1 Wiring Length and Cable Size

Table 4.1   Maximum Wiring Length

Item	Specifications
Maximum wiring length between option card and encoder	20 m
Maximum wiring length between option card (terminals FPA and FPB) and user controller	5 m

Wiring for the encoder option card and encoder
The encoder connection cable must use cable made by HEIDENHAIN 17 pin (4 x 0.14) +4(2 x 0.14) + (4 x 0.5) mm^2.
Connect 0.5 mm^2 with PO and terminal CM of the option card.

Table 4.2   Terminal Wiring of OPC-LM1-PS1

Terminal name	Wiring color	Encoder side symbol	Note
PO	blown / green	5V Up	
	blue	5V sensor	Connect when the wiring length is 10 m or more.
CM	white / green	0V Un	
	white	0V sensor	Connect when the wiring length is 10 m or more.
PA+	green / black	A+	
PA-	yellow / black	A-	
PB+	blue / black	B+	
PB-	red / black	B-	
CK+	purple	CLOCK	
CK-	yellow	$\overline{\text{CLOCK}}$	
DT+	gray	DATA	
DT-	pink	$\overline{\text{DATA}}$	

Wiring of the option card and the encoder
• The wiring of the option card and encoder must use the shield wire. Moreover, the cable length is 20 m or less.
• Connect shield of the wire to terminal CM of this option card.
• Separate the wiring of the option card and the wiring of other power lines to prevent the malfunction by the noise. Never put them in the same duct.

4.2 Plug

Applicable terminal plugs
The terminal block for encoder connection is removable type.
The plug (electric wire connection side) is provided as an accessory of the option card.

Table 4.3   Applicable Plug Model

Terminal Block	Terminal Plugs Type	Manufacturer
TERM1	MC1.5/16-STF-3.81	Phoenix Contact

Plug specifications

Table 4.4   Plug Specifications

Item	Specifications
Tightening torque	0.22 to 0.25 N·m
Screw size	M2
Bared wire length	7 mm
Maximum wire size	AWG16

(Note) Insert the wire into the upper side of the metal bracket on the terminal block, and tighten the screw.

7(mm)

M2
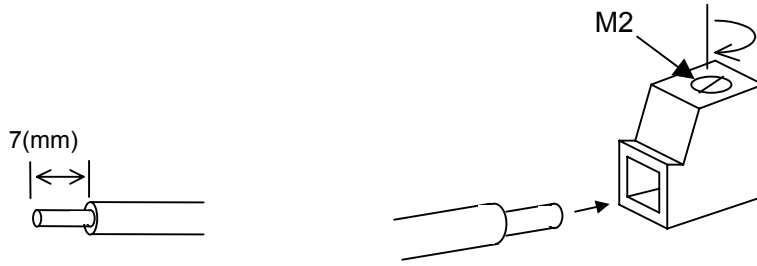
Connection of Wiring on Option

Terminal Side.

4.3 Basic Wiring Diagram

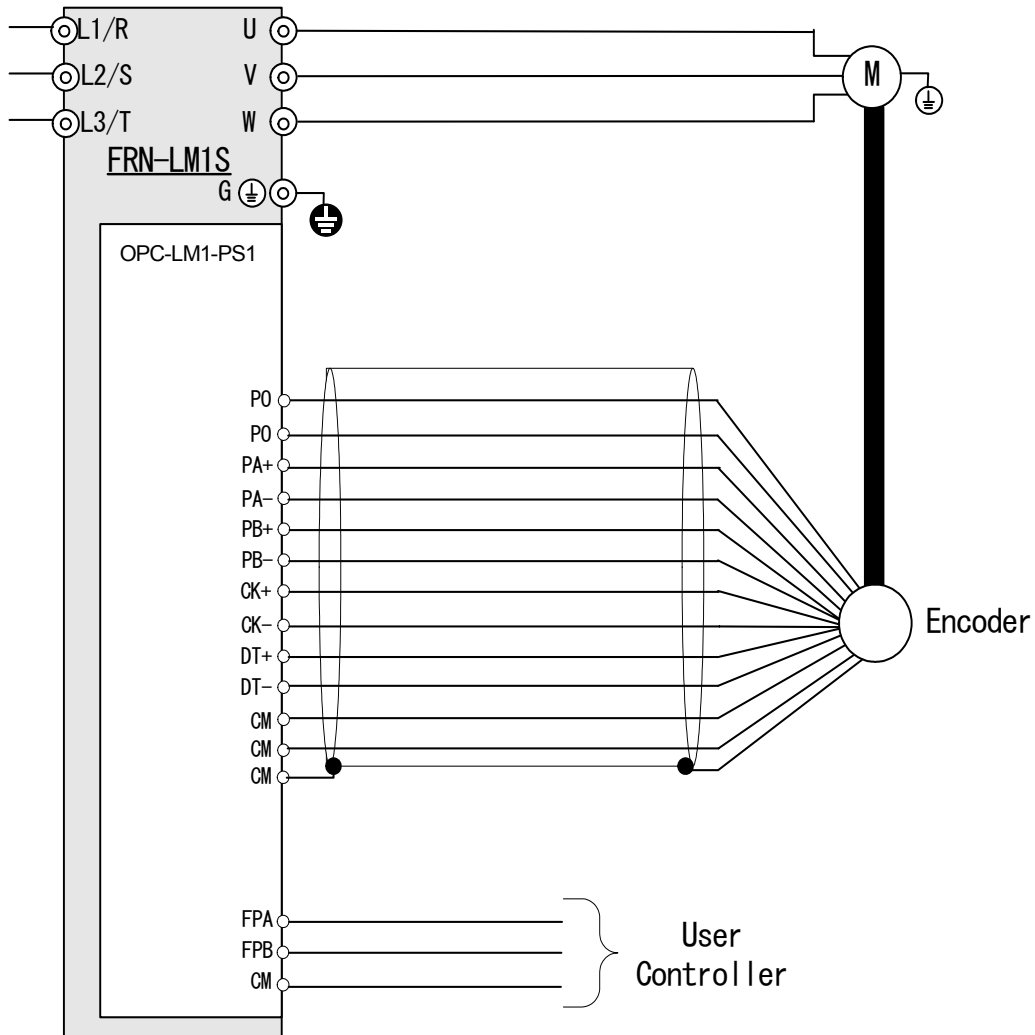| CAUTION |
| --- |
| • Keep the power supply voltage of encoder in the specification voltage of encoder.
There is a risk of failure. |

Figure 4.1　Basic Wiring Diagram

5 Function

5.1 Function Code Setting

CAUTION

• Set the function code in the following order at first.
    (1) C21   (2) P01   (3) F03   (4) L31   (5)P02
  Because when you change them, some other function codes synchronize and change.
There is a risk of accident or injury.

Set the function code as follows before beginning magnetic pole position offset tuning.

Code	Name	Data Setting
C21	Unit for Speed Command	Your easy-to-use setting
P01	Motor - Number of poles	Depends on the motor
F03	Maximum Speed	Depends on the motor
L31	Elevator Parameter - Speed	Depends on the elevator
P02	Motor - Rated capacity	Depends on the motor

Code	Name	Data Setting
F04	Rated Speed	Depends on the motor
F05	Rated Voltage at Rated Speed	Depends on the motor
F42	Control Mode	1 (PM motor - Vector control with encoder)
P03	Motor - Rated current	Depends on the motor
P07	Motor - %R1	5.0 (%)
P08	Motor - %X	10.0 (%)
L01	Pulse encoder - System	4
L02	Pulse encoder - Resolution	Depends on the encoder
L36	ASR - P - Constant at high speed	2.0 (It is necessary to adjust)
L38	ASR - P - Constant at low speed	2.0 (It is necessary to adjust)

5.2 Procedure of Magnetic Pole Position Offset Tuning

You have to execute the tuning as follows before driving motor.
Please inquire of the maker if tuning is impossible normally.

1. Tuning Mode (Function code L03)
Tuning mode is selected by function code L03 as follows. Usually, it is selected according to the tuning procedure.
    1 : Tuning operation
    2 : Tuning operation with wrong wiring detection (Er7 occurs if wrong wiring is detected.)
    3 : Tuning operation with checking accuracy (Er7 occurs if tuning accuracy is not good.)
    4 : Reserved for particular manufactures (Do not access this function code.)
    5 : Reserved for particular manufactures (Do not access this function code.)

2. Tuning Condition
The recommended condition is following.

    (1) The rotor is fixed.
        If it is impossible to fix the rotor, it is acceptable even if the rotor is free. (In this case, if the torque bias has been set, cancel it.)

    (2) Encoder abnormality detection is effective. (It is effective in the initial condition as follows. L90=1, L91=10%, L92=0.5)

3. Tuning procedure

(1) Apply the brakes and fix the rotor. It is acceptable without the brake in the case of the tuning at the motor unit.
(2) Confirm the motor is connected with the inverter.
(3) If you use Multi Function Key Pad (MFKP), we recommend local mode. Keep pushing the "REM/LOC" key of MFKP until the indicator "REM" change into "LOC".

(4) Execute the tuning with the function code L03=2 (**Note 1**). This work is used to detect the wrong wiring.
    However, in the case of Surface Permanent Magnet motor (SPM motor), this work cannot detect the wrong wiring. In this case, skip to procedure 3-(5).

In the case of finishing tuning normally, Skip to procedure 3-(5).

If tuning error (Er7) occurs, it might be wrong wiring. Reset the error display and execute the procedure as follows.
    After turning off the power supply, replace V and W of the wiring for inverter drive, and execute the tuning again afterwards.
(In the case of the rotor free, if tuning error (Er7) occurs similarly even if V and W are replaced, it might be disconnection or wrong wiring of the encoder. Try to wire correctly, and execute again from the beginning.)

(5) Execute the tuning with the function code L03=3. (**Note 1**)

The tuning procedure is completed.

(**Note 1**) Tuning procedure after reactivates
- In the case of local mode
Select "1 DATA SET" in the program mode of MFKP, change the function code L03, and set with the "FUNC/DATA" key. Pressing the "FWD" key starts tuning. The "EXECUTING" is displayed on the monitor of the MFKP during the tuning.
The "EXECUTING" disappears, indicating that it is the end of tuning. The L03 data automatically returns to "0". The tuning result is stored in the function code L04. Check the result and make the note of the value.
- In the case of remote mode
Set the function code L03. When the drive instruction is set, the tuning is begun.
In the tuning mode (L03=1 or 3), tuning takes 4 seconds. In the tuning mode (L03=2), tuning takes 24 seconds.
Release the drive instruction after the regulated time has elapsed. The L03 data returns to "0." The tuning result is stored in the function code L04. Check the result and make the note of the value.

4. Checking that tuning is completed normally

In the normal mode, run the motor.
The recommended checking procedure is given below.
Make the motor rotate more than one rotation at the low frequency about 1 Hz.
In the MFKP local mode, do the following:
1) Push the "FWD" key and set the reference speed at about 1 Hz.
2) Make the motor rotate more than one rotation.
3) Push the "STOP" key. When the motor stops, the reference speed returns to 0.

If the motor does not rotate normally, do the following:
1) Check that the function codes are properly configured.
2) Check the wiring between the encoder and option card.
3) Match the rotational direction of the motor with that of the encoder.

If any problem is found in steps 1) to 3) above, correct it (them) and perform tuning again.
If no problem is found, change the motor-inverter wiring between V and W and then perform tuning again.

5.3 Procedure of Adjusting the Unbalanced Load Compensation

1. Procedure of control parameter setting

Set the function code as follows.

Code	Name	Data setting
L05	ACR P Constant	1.5 to 4.0 *1
L06	ACR I Constant	0.80 ms
L65	Unbalanced Load Compensation (Operation)	1 (Enable)
L68	Unbalanced Load Compensation (ASR P constant)	4.00 *2
L69	Unbalanced Load Compensation (ASR I constant)	0.010s *2
L73	Unbalanced Load Compensation (APR Gain)	3.00 *2

*1 Calculate the setting value of L05 as follows.

$$L05 = 2.5 \times \frac{\sqrt{3} \times I_n \times L}{V_n}$$

  L: Motor Inductance [mH]   the value of small one among Ld and Lq.
  Vn: Motor Rated Voltage [V] (F05)
  In: Motor Rated Current [A] (P03)

*2 Adjust the following parameters to eliminate vibration, and the rollback becomes small.

The following table shows the tendency to the phenomenon by setting of the parameter.

| Function Code		Rollback	Vibration generation probability	Condition
Code	Setting value			
L69 ASR I	Too small	Small	High	1
	Too big	Big	Low	2
L73 APR Gain	Too small	Big	Low	3
	Too big	Small	High	4

Set L68 to the same value as L38.

2. Procedure of timing adjustment

Unbalanced load compensation requires keeping the reference speed (pre-ramp) at 0.00 r/min and releasing the brake during unbalanced load compensation is activated (that is, during the activation timer setting specified by L66).
If the reference speed (pre-ramp) other than 0.00 r/min is entered before the time length specified by L66 elapses, unbalanced load compensation immediately finishes.
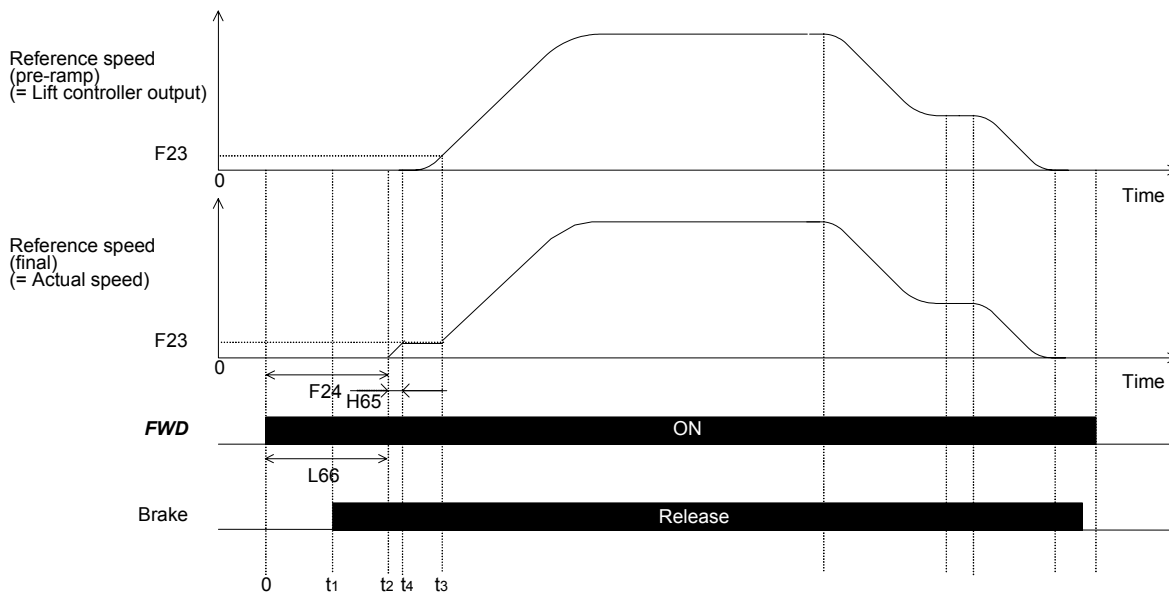
i) Using multistep speed command
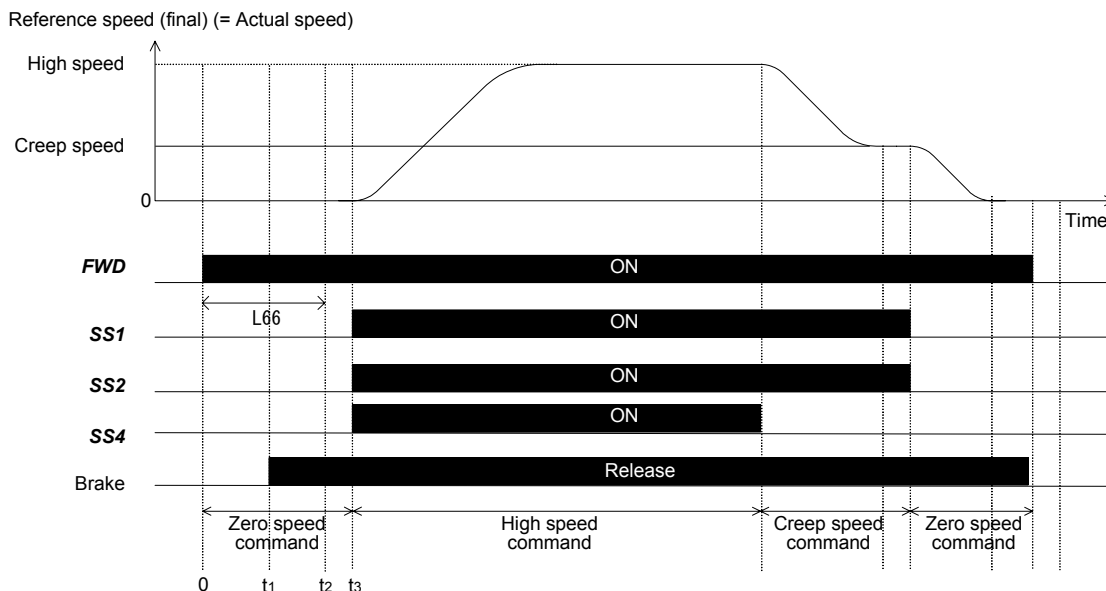
Reference speed (final) (= Actual speed)

t_1 : The time when real brake open.

t_2 : The time when unbalanced load compensation control is finished.

t_3 : The time when speed command switch "High speed command" from "Zero speed command".

- Please adjust "Brake open timing", "Speed command timing" and L66 to become $t_1 < t_2 < t_3$.

  If shock is generated at L65 = 0 and it is not generated at L65 = 1 at the time of started inverter, unbalanced load compensation works correctly.

ii) Using analog speed command

t_1 : The time when real brake open.

t_2 : The time when unbalanced load compensation control is finished.

t_3 : The time when reference speed (pre-ramp) arrives at F23.

t_4 : The time when reference speed (final) arrives at F23.

- Please adjust "Brake open timing", "Speed command timing" and F24 to become $t_1 < t_2 < t_3$.

- Please set a value of L66 bigger than value of F24.

- Please adjust "Speed command timing" and H65 to become $t_4 < t_3$.

  If shock is generated at L65=0 and it is not generated at L65=1 at the time of started inverter, unbalanced load compensation works correctly.