Fuji Electric

Innovating Energy Technology

FRENIC-Lift

Starting guide

Dedicated
Inverter for Lift
Applications

3 ph 400 VAC 2.2 – 45 kW
1 ph 200 VAC 2.2 – 4.0 kW

SG_LM2A_EN_1.2.0

Version	Changes applied	Date	Written	Checked	Approved
0.0.1	Draft	30.09.2015	J. Alonso		
1.0.0	First release	30.11.2015	J. Alonso	M. Fuchs	J. Català
1.1.0	Directives updated. RM/IM version modified. Some text modified in Chapter 1. Specifications table 3.1 changed. Notes on table 5.1 modified. Terminal [NTC] is corrected in page 12. Figure 5.7 updated. Table 6.1 updated. FUNC/DATA key changed to SET key. French branch name is corrected.	14.06.2016	J. Alonso	M. Fuchs	J. Català
1.2.0	Firmware version updated. European standards updated. Specifications. Output ratings. Frequency removed. Table 7.2 updated. Table 7.10 added. Table 8.5 updated. Text added or modified. Spain branch address updated.	10.03.2017	J. Alonso	M. Fuchs	J. Català

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0. About this manual

Thank you very much for choosing FRENIC-Lift (LM2) inverter series.

FRENIC-Lift (LM2) inverter series is specially designed for operation of induction and permanent magnet synchronous motors used in lift applications. Also induction motors without encoder (open loop) can be controlled obtaining good performance and high positioning accuracy at stop.

This starting guide includes the basic information and explanations about the connection and commissioning of FRENIC-Lift (LM2).

Note This starting guide is based on firmware version 0900 or later. For other software versions, please contact with Fuji Electric technical department.
Firmware version (ROM version) can be monitored on TP-A1-LM2 PRG > 3 > 4

For extended information about the product and its use, refer to below mentioned documents:

- FRENIC-Lift Reference Manual INR-SI47-1909_-E (RM).
- FRENIC-Lift Instruction Manual INR-SI47-1894_-E (IM).

1. Safety information

Read this manual thoroughly before proceeding with installation, connections (wiring), operation, or maintenance and inspection. Ensure you have enough 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 importance and must be observed at all times.

Application

⚠WARNING

- FRENIC-Lift is designed to drive a three-phase motor. Do not use it for single-phase motors or for other purposes.
  Fire or an accident could occur.
- FRENIC-Lift may not be used for a life-support system or other purposes directly related to the human safety.
- Though FRENIC-Lift is manufactured under strict quality control, install safety devices for applications where serious accidents or material losses are foreseen in relation to the failure of it.
  An accident could occur.

Installation

⚠WARNING

- Install the inverter on a non-flammable material such as metal.
  Otherwise fire could occur.
- Do not place flammable object nearby.
  Doing so could cause fire.

⚠CAUTION

- Do not carry the inverter by its terminal block cover during transportation.
  Doing so could cause a drop of the inverter and injuries.
- Prevent lint, paper fibres, sawdust, dust, metallic chips, or other foreign materials from getting into the inverter or from accumulating on the heat sink.
  Otherwise, a fire or an accident might result.
- Do not install or operate an inverter that is damaged or lacking parts.
  Doing so could cause fire, an accident or injuries.
- Do not stand on a shipping box.
- Do not stack shipping boxes higher than the indicated information printed on those boxes.
  Doing so could cause injuries.

Wiring

⚠WARNING

- When wiring the inverter to the power supply, insert an appropriate mains disconnecting device (e.g. switch, contactor, breaker etc.) Use the devices within the recommended current range.
- Use wires size recommended in Instruction Manual.
- When wiring the inverter to the power supply that is 500 kVA or more, be sure to connect an optional DC reactor (DCR).

  Otherwise, fire could occur.
- Do not connect a surge killer to the inverter's output (secondary) circuit.

  Doing so could cause fire.
- Ground the inverter in compliance with the national or local electric standards.

  Otherwise, electric shock could occur.
- Qualified electricians should carry out wiring.
- Disconnect power before wiring.

  Otherwise, electric shock could occur.
- Install inverter before wiring.

  Otherwise, electric shock or injuries could occur.
- Ensure that the number of input phases and the rated voltage of the product match the number of phases and the voltage of the AC power supply to which the product is to be connected.

  Otherwise fire or an accident could occur.
- Do not connect the power supply wires to output terminals (U, V, and W).
- Connect the braking resistor only to the terminals DB and P(+).

  Otherwise, fire could occur.
- Generally, control signal wires are not reinforced insulation. If they accidentally touch any of live parts in the main circuit, their insulation coat may break for any reasons. In such a case, ensure the signal control wire is protected from making contact with any high voltage cables.

  Doing so could cause an accident or electric shock.

⚠CAUTION

- Connect the three-phase motor to terminals U, V, and W of the inverter.

  Otherwise injuries could occur.
- The inverter, motor and wiring generate electric noise. Ensure preventative measures are taken to protect sensors and sensitive devices from RF noise.

  Otherwise an accident could occur.

Operation

⚠WARNING

- Be sure to install the terminal cover before turning the power ON. Do not remove the covers while power is applied.

  Otherwise electric shock could occur.
- Do not operate switches with wet hands.

  Doing so could cause electric shock.
- If the auto-reset function has been selected, the inverter may automatically restart and drive the motor depending on the cause of tripping.
  (Design the machinery or equipment so that human safety is ensured after restarting.)
- If an alarm reset is made with the Run command signal turned ON, the inverter may start immediately. Ensure that the Run command signal is turned OFF in advance.

  Otherwise an accident could occur.
- Ensure you have read and understood the manual before programming the inverter, incorrect parameter settings may cause damage to the motor or machinery.

  An accident or injuries could occur.
- Do not touch the inverter terminals while the power is applied to the inverter even if the inverter is in stop mode.

  Doing so could cause electric shock.

⚠CAUTION

- Do not turn the main circuit power (circuit breaker) ON or OFF in order to start or stop inverter operation.
  Doing so could cause failure.
- Do not touch the heat sink and braking resistor because they become very hot.
  Doing so could cause burns.
- Before setting the speeds (frequency) of the inverter, check the specifications of the machinery.
- The brake function of the inverter does not provide mechanical holding means.
  Injuries could occur.

Maintenance and inspection, and parts replacement

⚠WARNING

- Turn the power OFF and wait for at least five minutes before starting inspection. Further, check that the LED monitor is unlit and that the DC link bus voltage between the P (+) and N (-) terminals is lower than 25 VDC.
  Otherwise, electric shock could occur.
- Maintenance, inspection, and parts replacement should be made only by qualified persons.
- Take off the watch, rings and other metallic objects before starting work.
- Use insulated tools.
  Otherwise, electric shock or injuries could occur.

Disposal

⚠CAUTION

- Treat the inverter as an industrial waste when disposing of it.
  Otherwise injuries could occur.

Others

⚠WARNING

- Never attempt to modify the inverter.
  Doing so could cause electric shock or injuries.

2. Conformity to European standards

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

Inverters with built-in EMC filter that bear a CE marking are in conformity with EMC directives. Inverters having no built-in EMC filter can be in conformity with EMC directives if an optional EMC compliant filter is connected to them. 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.

FRENIC-Lift (LM2) inverter series are in accordance with the regulations of following council directives and their amendments:

- Electromagnetic Compatibility Directive: 2014/30/EU
- Low Voltage Directive: 2014/35/EU
- Machine Directive: 2006/42/EC

For assessment of conformity the following relevant standards have been taken into consideration:

- EMC: EN61800-3:2004+A1:2012, EN12015:2014, EN12016:2013.
- Electrical Safety: EN61800-5-1:2007
- Functional Safety: EN61800-5-2:2007 SIL3, EN ISO13849-1:2008 PL=e, Cat.3 Safe Torque Off

⚠CAUTION

The FRENIC-Lift (LM2) inverter series are categorized as category C2 or C3 according to EN61800-3:2004+A1:2012. When you use these products in the domestic environment, you may need to take appropriate countermeasures to reduce or eliminate any noise emitted from these products.

3. Technical data

3.1 Specifications

Table 3.1. FRENIC-Lift LM2A General specifications

Item				3-phase 400 V											1-phase 200 V	
Type FRN___LM2A-□E □:4/7				0006	0010	0015	0019	0025	0032	0039	0045	0060	0075	0091	0011	0018
Nominal applied motor [kW]				2.2	4.0	5.5	7.5	11	15	18.5	22	30	37	45	2.2	4.0
Output ratings	Rated capacity[1] [kVA]			4.6	7.6	11	14	18	24	29	34	45	57	69	4.1	6.8
	Rated voltage[2] [V]			3-phase 480 to 480 VAC											3-ph 200 to 240 VAC	
	Rated current[3] [A]			6.1	10.0	15.0	18.5	24.5	32.0	39.0	45.0	60.0	75.0	91.0	11.0	18.0
	Overload capacity [A] (Permissible overload time)			11.0 (3)	18.0 (3)	27.0 (3)	37.0 (3)	49.0 (3)	64.0 (3)	78.0 (3)	90.0 (3)	120 (3)	150 (3)	182 (3)	22.0 (3)	36.0 (3)
Input ratings	Main power supply	Normal	Phases, voltage, frequency	3-ph 380 to 480 VAC, 50/60 Hz											1-ph 200 to 240 VAC, 50/60 Hz	
				Variations: Voltage: +10 to -15% (Voltage unbalance: 2% or less[4]), Frequency: +5 to -5%												
			Rated current[3] [A] With DCR	4.5	7.5	10.6	14.4	21.1	28.8	35.5	42.2	57.0	68.5	83.2	17.5	33.0
			Rated current[3] [A] Without DCR	8.2	13.0	17.3	23.2	33.0	43.8	52.3	60.6	77.9	94.3	114	24.0	41.0
			Required power supply capacity (with DCR) [kVA]	3.2	5.2	7.4	10.0	15.0	20.0	25.0	30.0	40.0	48.0	58.0	3.5	6.1
		UPS	Input power for driving phases, voltage, frequency	1-ph 220 to 480 VAC, 50/60 Hz											1-ph 200 to 240 VAC, 50/60 Hz	
				Variations: Voltage: +10 to -10%, Frequency: +5 to -5%												
			Operation time [s]	180												
		Battery	Input power for driving voltage	48 VDC											36 VDC	
			Operation time [s]	180												
	Aux. control power voltage			24 VDC (22 to 32 VDC), max. 40 W						1-ph 220 to 480 VAC, 50/60 Hz[8]					24 VDC (22 to 32VDC), max. 40 W	
Braking	Braking time[7] [s]			60												
	Braking duty-cycle (%ED)[7] [%]			50												
	Rated regenerative power[7] [kW]			1.8	3.2	4.4	6.0	8.8	12.0	14.8	17.6	24.0	29.6	36.0	1.8	3.2
	Minimum resistance[6] [Ω]			160	96	47	47	24	24	16	16	10	8.5	8	33	20
Conformity standard				- Lift Directive (95/16/EC) - Replacement of two motor contactors: interrupting the current to the motor (to stop the machine), as required by EN 81-1:1998+A3:2009 12.7.3 a), EN 81-2:1998+A3:2009 12.4.1 a) and EN 81-20:2014 5.9.2.5.4 d), 5.9.3.4.1 d). - Brake monitoring for UCM:EN 81-1:1998+A3:2009 9.11.3 and EN 81-20:2014 5.6.7.3 - Travel direction change counter for lifts with belt or coated ropes - Machinery Directive - EN ISO13849-1: PL-e - EN60204-1: stop category 0 - EN61800-5-2: STO SIL3 - EN62061: SIL3 - Low Voltage Directive - EN61800-5-1: Over voltage category 3 - EMC Directive - EN12015, EN12016, EN 61800-3 +A1, EN 61326-3-1 (Emission) Built-in EMC filter type: Category 2 (0025 (11kW) or lower) / Category 3 (0032 (15kW) or higher) (Immunity) 2nd Env. - Canadian and U.S. standards - Can/CSA C22.2 No.14-13: Industrial Control Equipment - CSA C22.2 No.274-13: Adjustable speed drives - UL 508 C (3rd Edition): Power Conversion Equipment - According to CSA B44.1-11/ASME A17.5-2014: Elevator and escalator electrical equipment													
Enclosure (IEC60529)	Main body			IP20								IP00			IP20	
	Heat sink			IP54						IP20		IP00			IP54	
Cooling method				Fan cooling												

*1) Rated capacity is calculated by regarding the output rated voltage as 440 VAC.
*2) Output voltage cannot exceed the power supply voltage.
*3) These values correspond to the following conditions: carrier frequency is 10 kHz (2 phase modulation) and ambient temperature is 45°C. Select the inverter capacity such that the square average current during operation is not higher than the 80% of the rated current of the inverter.
*4) Voltage unbalance [%] = (Max.voltage [V] - Min.voltage [V])/ Three-phase average voltage [V] x 6 (IEC61800-3). Just for 3ph 400 VAC input supply case.
*5) The power supply capacity is 500kVA (ten times the inverter capacity when the inverter capacity exceeds 50kVA), and the value of the power supply impedance is %X=5%.
*6) The admissible error of minimum resistance is ±5%.
*7) Braking time and duty cycle (%ED) are defined by cycle operation at the rated regenerative power.
*8) Variations (Voltage: +10 to -10%, Frequency: +5 to -5%)

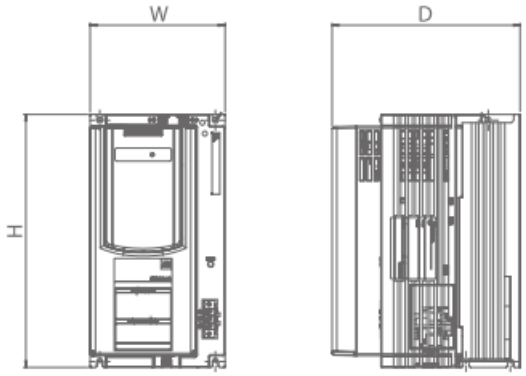
3.2 External dimensions

Table 3.2. External dimensions and frame definition

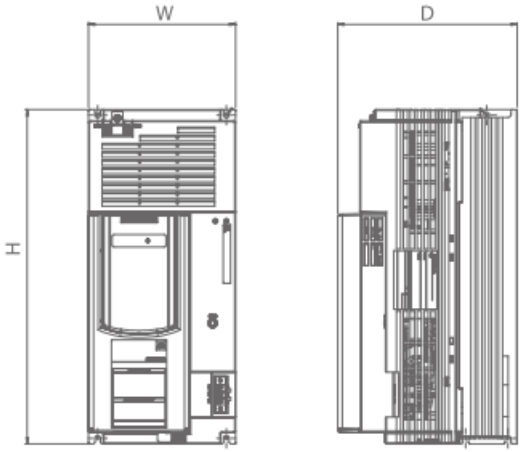
Power Supply voltage	Type	Frame	W (mm)	H (mm)	D (mm)
3-ph 400 VAC	FRN0006LM2A-4E	1	140,0	260,0	195,0
	FRN0010LM2A-4E				
	FRN0015LM2A-4E				
	FRN0019LM2A-4E				
	FRN0025LM2A-4E	2	160,0	360,0	195,0
	FRN0032LM2A-4E				
	FRN0039LM2A-4E	3	250,0	400,0	195,0
	FRN0045LM2A-4E				
	FRN0060LM2A-4E	4	326,2	550,0	261,3
	FRN0075LM2A-4E				
	FRN0091LM2A-4E	5	361,2	615,0	276,3
1-ph 200 VAC	FRN0011LM2A-7E	1	140,0	260,0	195,0
	FRN0018LM2A-7E				

Frame 1 and frame 2 can be called as well from now on Book type.

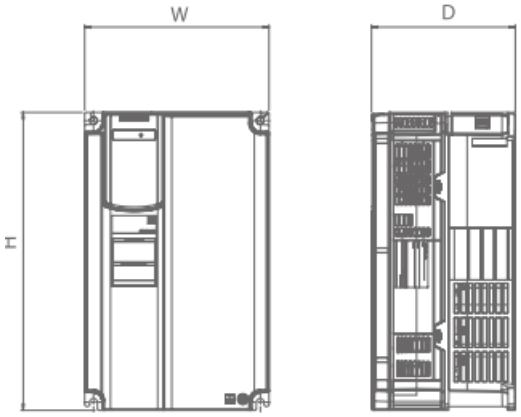
FRN0006LM2A-□E to FRN0019LM2A-□E
□: 4 / 7



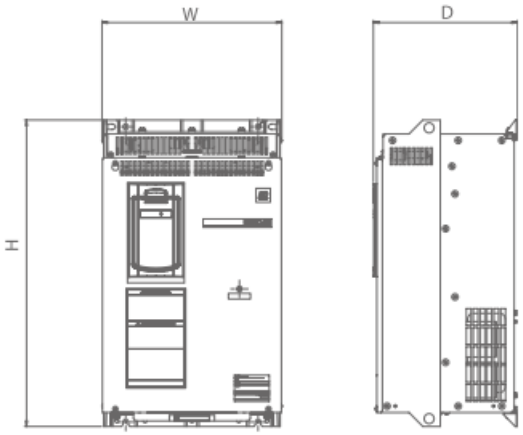
FRN0025LM2A-4E to FRN0032LM2A-4E



FRN0039LM2A-4E to FRN0045LM2A-4E



FRN0060LM2A-4E to FRN0091LM2A-4E



4. Removal and attachment of front cover

In order to remove properly front cover in each frame, please follow the procedure below shown in each figure. In the following description, it is assumed that the inverter has already been installed.

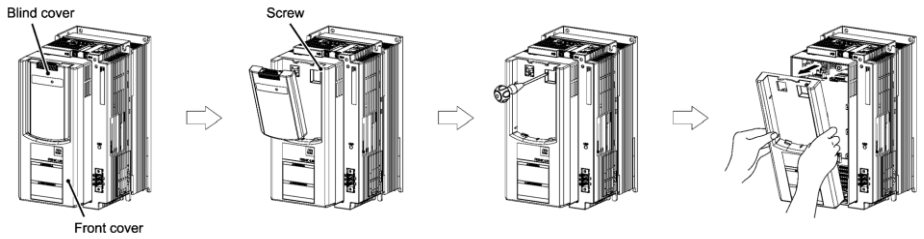


Figure 4.1: Removing front cover step by step (Frame 1 & 2 – Book type)

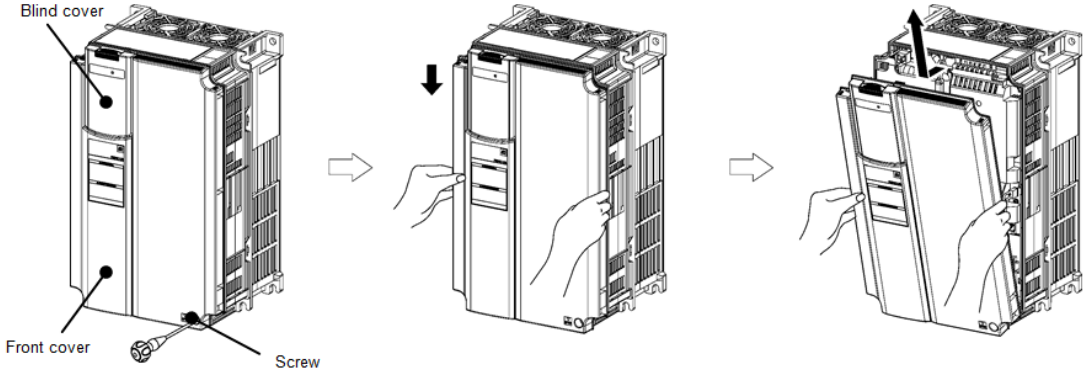


Figure 4.2: Removing front cover step by step (Frame 3)

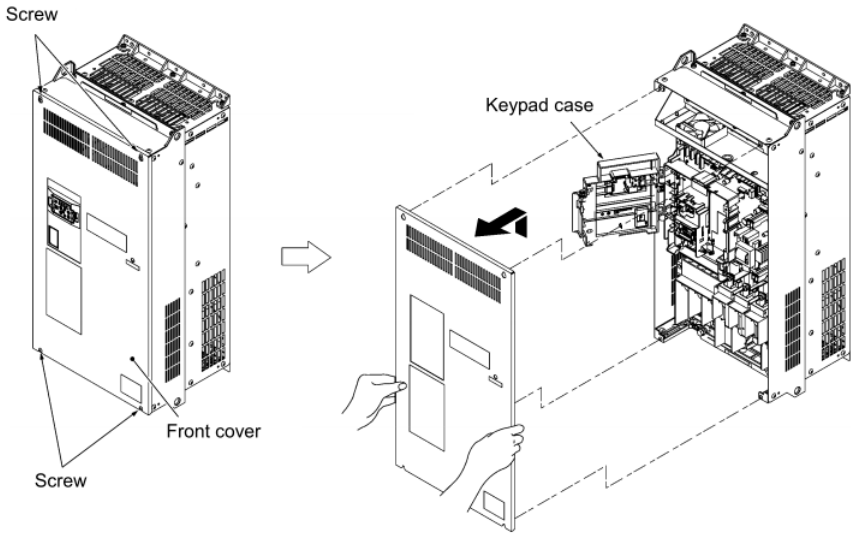


Figure 4.3: Removing front cover step by step (Frame 4 & 5)

5. Connections

5.1 Control signals connection

In LM2A two frames typologies can be identified. One is book type frame, the one which includes frame 1 and 2. The other one is standard frame and includes frame from 3 to 5. The different connection types are shown in figure 5.1 and 5.2.

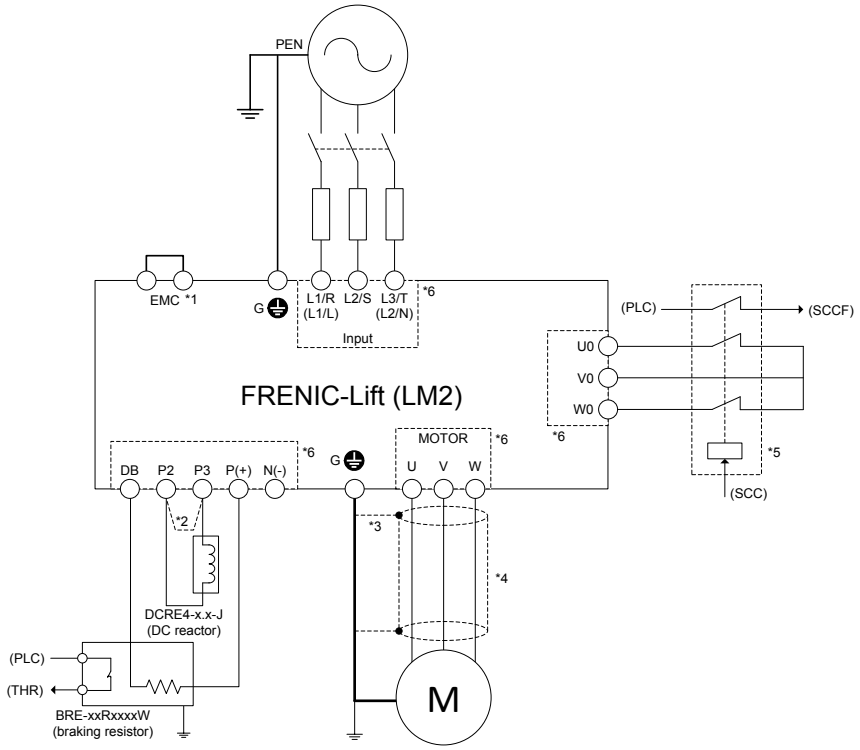


Figure 5.1. Power terminals connection in book type frames (frame 1-2).

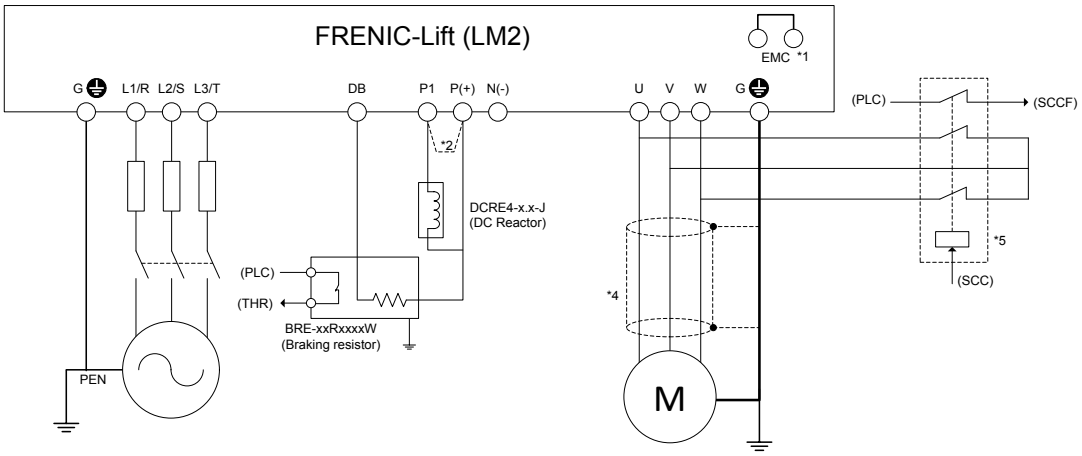


Figure 5.2. Power terminals connection in frames 3~5.

Note *1: Jumper to connect/disconnect internal EMC filter. In case of book type it is a metal plate placed on the EMC terminal. In case of other frames it is a wire jumper placed inside (front cover has to be removed).

Note *2: DC Reactor terminals:

- Frames 1 and 2: In case of NOT installing DC Reactor wire a jumper between terminals P2 and P3.
- Frames 3-5: In case of installing DC Reactor remove metal plate jumper between P1 and P(+).

Note *3: Use the metal plates placed on removable terminals to connect the shield by means of metal cable ties for example.

Note *4: In case of not installing the two MC between motor and inverter, please follow the procedure explained in "AN-Lift2-0001" document.

Note *5: External MC for PMS motor phases short-circuit is an optional function.

Note *6: Removable terminals.

All the power terminals, independently of frame, even don't appear on figure 5.1 and 5.2 are listed in table 5.1.

Table 5.1. Power terminals description

Terminal label		Description of the power terminals
L1/R, L2/S, L3/T (L1/L, L2/N)		3-phase supply input from mains supply. (1-phase supply input from mains supply).
U, V, W		3-phase motor connection for induction or permanent magnet synchronous motors.
U0, V0, W0		PMS motor short circuit phases terminals (Book type frames only).
DC Reactor	P2, P3	DC Reactor connection (book type frames only).
	P1, P(+)	DC Reactor connection (frames 3-5 only).
24V+, 24V-		Input power terminals for 24 VDC. These terminals have to be used in case of rescue operation by means of batteries to supply control circuit.(Book type frame only).
R0, T0		Input power terminals for 220 VAC. These terminals have to be used in case of rescue operation by means of batteries to supply control circuit. (Frames 3-5 only).
DB , P(+)		Connection of external braking resistor.
EMC		Jumper to connect/disconnect internal EMC filter.
⏚ G		Terminals for the connection of the inverter enclosure with the protecting earth. Book type frames: 3 terminals available. Frames 3~5: 2 terminals available.

Please connect the screen in both motor and inverter sides. Ensure that the screen is continued also through the main contactors (if used).

It is recommended to use braking resistors with thermal switch in order to protect the system from failures. Additionally, inverter has a software function to electronically protect the system (For additional information please check parameters F50 to F52).

5.2 Control signals connection

In figure 5.3 all control terminals included in the electronic boards are shown. Electronic boards are divided in control board (fixed) and I/O terminals board (removable). I/O terminals board can be easily removed from control board. EN circuit terminals have their own connector which can be removed as well. For additional information about wiring and terminals function refer to below sub chapters.

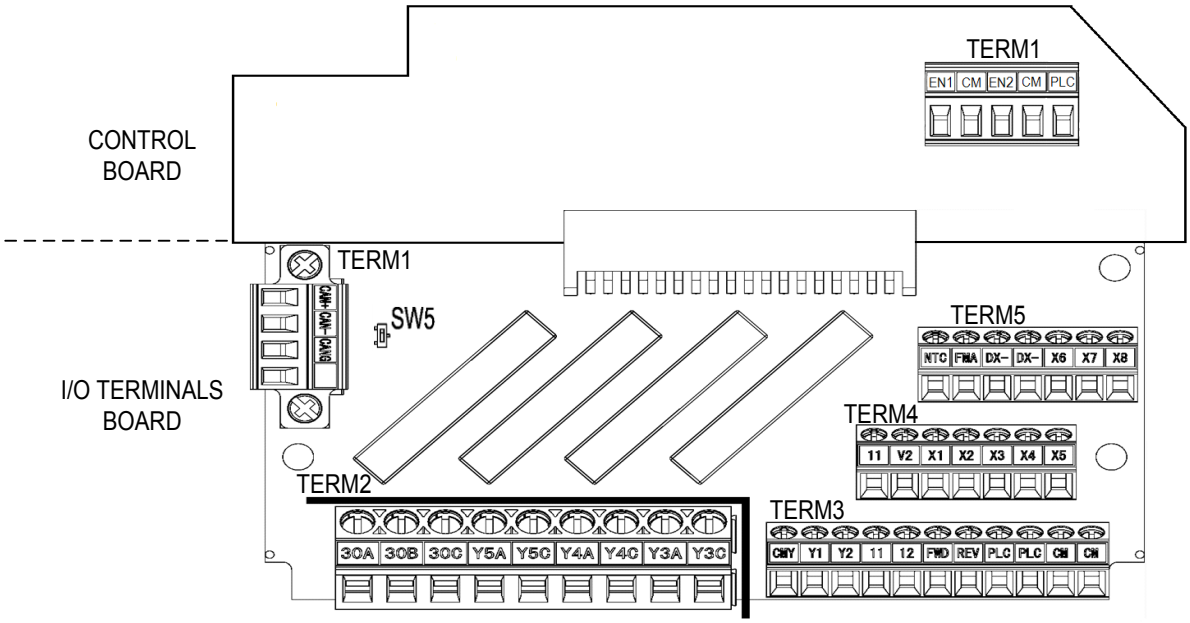


Figure 5.3. Control board and I/O terminals board terminals

All the examples below are based on FRENIC-Lift (LM2A) default setting. For other functions please refer to FRENIC-Lift RM document.

5.3 Use of input terminals for speed set point selection

Table 5.2: binary combination for speed selection

X3 (SS4)	X2 (SS2)	X1 (SS1)	Binary speed coding function	Value	Selected Speed	Speed set point function
0	0	0	L11	0 (000)	Zero speed	C04
0	0	1	L12	1 (001)	Intermediate speed 1	C05
0	1	0	L13	2 (010)	Inspection speed	C06
0	1	1	L14	3 (011)	Creep speed	C07
1	0	0	L15	4 (100)	Intermediate speed 2	C08
1	0	1	L16	5 (101)	Intermediate speed 3	C09
1	1	0	L17	6 (110)	Intermediate speed 4	C10
1	1	1	L18	7 (111)	High speed 1	C11

In case that lift controller signals doesn't match with selected speed described in table 5.2, signals can be adapted by modifying the setting on parameters L11 to L18. In the example below (table 5.3), lift controller uses X2 and X1 as a High speed and X1 as a Creep speed.

Table 5.3: Example of binary combination for speed selection modification

SS4 (X3)	SS2 (X2)	SS1 (X1)	Binary speed coding function	Value	Selected Speed	Speed set point function
0	0	0	L11	0 (000)	Zero speed	C04
1	1	1	L12	7 (111)	Intermediate speed 1	C05
0	1	0	L13	2 (010)	Inspection speed	C06
0	0	1	L14	1 (001)	Creep speed	C07
1	0	0	L15	4 (100)	Intermediate speed 2	C08
1	0	1	L16	5 (101)	Intermediate speed 3	C09
1	1	0	L17	6 (110)	Intermediate speed 4	C10
0	1	1	L18	3 (011)	High speed 1	C11

5.4 Control terminals description

Control terminals can be classified between digital signals (input and output), analog signals (input and output) and communication ports. Below each type of terminal is described. All inputs and outputs can be freely programmed with any available function. For an easy set up all examples on this guide are referred to default configuration.

5.4.1 Analog inputs

Using analog inputs the motor speed and the torque bias can be set without steps (stageless). Analog command signals can be either voltage or current on terminal [V2]; selection is done by means of slide switch SW4. Terminal [NTC] can be to connect a PTC/NTC thermistor for motor overheat protection. Function is disabled in factory setting, for additional information refer to description of parameter H26 in Reference Manual.

5.4.2 Digital inputs

Digital inputs can operate either in NPN or PNP logic. The selection of the logic is set on slide switch SW1 located on the control board. Factory setting is PNP (Source) Logic. Description of each input terminal function can be found on table 5.4.

Table 5.4: Description of digital inputs (optocoupled inputs)

Terminal	Function description of the digital inputs
FWD	Clockwise rotation of the motor seen from the shaft side. Depending on the mechanical set up this can be UP or DOWN direction of the car.
REV	Anticlockwise rotation of the motor seen from the shaft side. Depending on the mechanical set up this can be DOWN or UP direction of the car.
CM	Common 0 VDC.
X1 to X3	Digital inputs for speed selection. From binary combination 7 different speeds can be selected.
X4 to X7	The default setting function of these terminals is not explained on this guide. For additional information refer to RM.
X8	Configured from factory as "BATRY" for Battery or UPS operation (Rescue operation).
EN1 & EN2	Inverters enable terminals (IGBT drives habilitation). These terminals complies with the STO SIL 3 function described in the standard 61800-5-2, therefore if properly used, these terminals can be used to substitute the two contactors between the inverter and the motor (as described on EN81-20:2014 5.9.2.5.4 d). For additional information regarding STO function refer to "AN-Lift2-0001" document. Even STO function is not used, the correct usage of these terminals is recommended. An incorrect usage of these terminals can deal to inverter trips (OCx trip) or even to the destruction of it. For additional information refer to figure 5.6. The logic of these terminals is fixed to SOURCE. It doesn't depend on SW1 configuration.

On below figures, different input configuration examples are shown. On below images different connection examples using PNP Logic are shown:

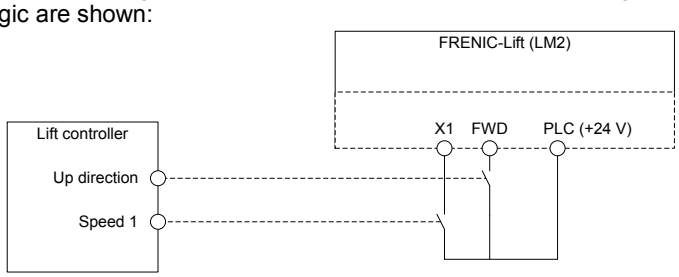


Figure 5.4: Connection using free potential contacts of lift controller.

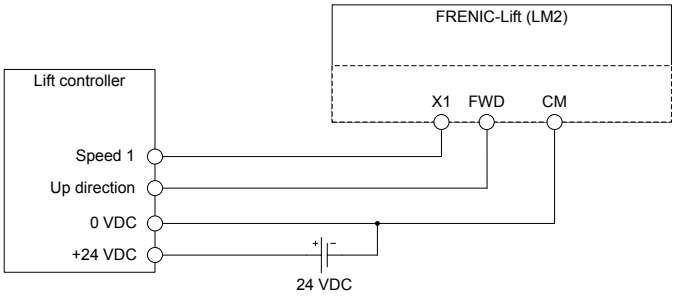


Figure 5.5: Connection using external power supply.

As explained in table 5.4, even STO function is not used, a proper usage of EN terminals is recommended. In figure 5.6 an example of wiring is shown.

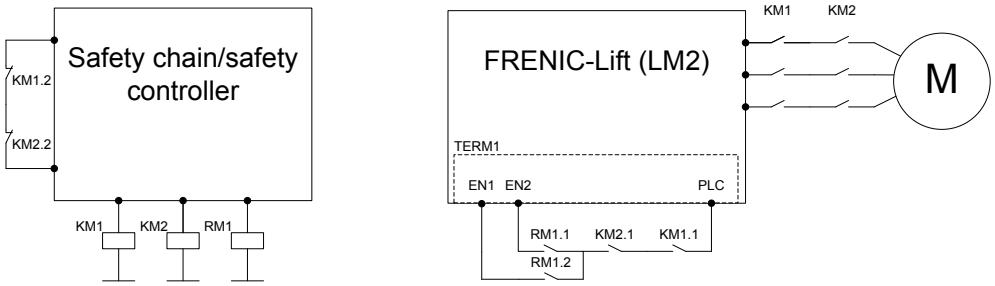


Figure 5.6: Recommended wiring of EN circuit terminals.

Electrical specifications of digital inputs using PNP (Source) Logic is shown in table 5.5.

Table 5.5: Digital inputs electrical specifications.

Item	Status	Range
Voltage	ON	22 to 27 V
	OFF	0 to 2 V
Current	ON	Min. 2.5 mA Max. 5.0 mA

5.4.3 Relay output

Terminals Y3(A/C), Y4(A/C), Y5(A/C) and 30(A/B/C) are configured from factory with the functions described in the table 5.6. Other functions can be set using functions from E22 to E30.

Table 5.6: Default setting and specifications of relay outputs.

Terminals	Function description of the relay outputs
30A; 30B and 30C	Inverter in alarm status (ALM). In case of fault, the motor stops and the contact 30C-30A (NO) switches (closes). Contact rating: 250 VAC; 0.5 A / 30 VDC; 0.5A.
Y5A-Y5C	Motor brake control function (BRKS). Contact rating: 250 VAC; 0.5 A / 30 VDC; 0.5A.
Y4A-Y4C	Main MC control function (SW52-2). Contact rating: 250 VAC; 0.5 A / 30 VDC; 0.5A.
Y3A-Y3C	Speed detected function (FDT). Contact rating: 250 VAC; 0.5 A / 30 VDC; 0.5A.

5.4.4 Transistor output

Terminals Y1 and Y2 are configured from factory with the functions described in the table 5.7. Other functions can be set using functions E20 and E21.

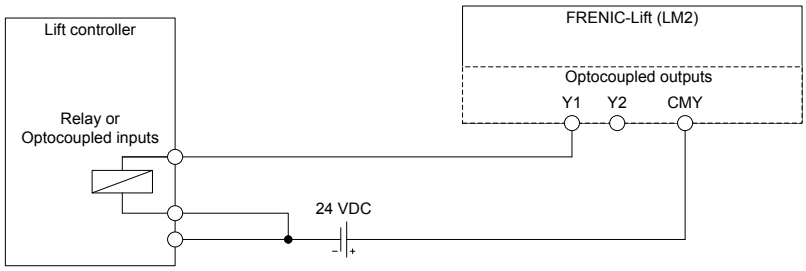


Figure 5.7: Connection using PNP (Source) Logic

Table 5.7: Default setting and specifications of transistor outputs.

Terminal	Function description of the transistor outputs
Y1	Main MC control function (SW52-2).
Y2	Anticipated door opening control (DOPEN).
CMY	Common for transistor outputs

Electrical specification of transistor outputs is shown in table 5.8.

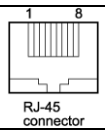
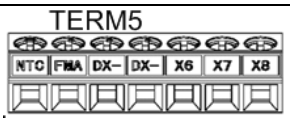
Table 5.8: Output transistors electrical specifications.

Item	Status	Range (Max.)
Voltage	ON	3 V
	OFF	48 V
Operation current	ON	50 mA
Leakage current	OFF	0.1 mA

In case of Figure 5.7 example, the voltage OFF is 24 VDC (Power supply connected to CMY).
Inductive loads should not be connected directly (they should be connected through a relay or optocoupler).

5.4.5 Communication ports

FRENIC-Lift (LM2) has up to three communication ports built-in. CAN bus is accessible by removable terminal TERM1 in I/O terminals board. RS-485 port 1 is accessible by RJ-45. RS-485 port 2 is accessible by I/O terminals board terminals DX+ and DX-.

		
Port 1 (Keypad, Modbus RTU, Loader software, DCP)	Port 2 (Modbus RTU, Loader software, DCP)	Port 3 (CAN bus)

For additional information about communication protocols refer to specific manual.

6. Hardware configuration

Up to 5 slide switches can be found in the control and I/O terminals boards. With these switches different configurations can be set. Function of each switch and it possible configurations are shown in table 6.1.

Table 6.1: Configuration of the slide switches

Switch	Slide switches factory setting
SW1	Digital inputs operation mode selection between PNP and NPN (SINK/SOUCE).
SW2	Terminating resistor of RS-485 communications port 1. Port 1 is in RJ-45 connector. (When keypad or converter for FRENIC Loader is used, set SW2 to OFF position). (When DCP or Modbus communication is used, set SW2 to ON position if needed).
SW3	Terminating resistor of RS-485 communications port 2. Port 2 is in I/O terminals board. (When converter for FRENIC Loader is used, set SW2 to OFF position). (When DCP or Modbus communication is used, set SW3 to ON position if needed).
SW4	[V2] terminal function selection between V2 (0 to ±10 VDC) and C1 (4 to 20 mADC).
SW5	Terminating resistor of CAN communications port. (When CANopen communication is used, set SW5 to ON position if needed).

By using the PTC input, the cut-off (stopping) function of the inverter does not fulfil EN81-1 or EN81-20/50.

Figure 6.1 shows the position of the slide switches in the control and I/O terminals board. It shows as well the default position (factory default) of each switch.

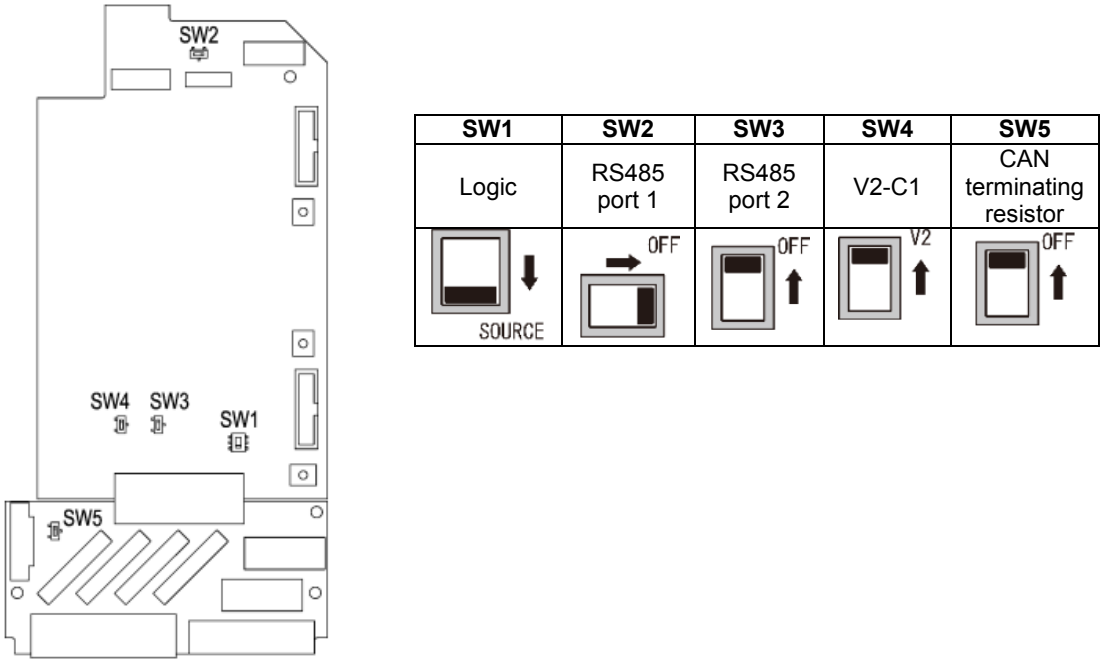


Figure 6.1 Slide switches position and meaning

7. Encoder option boards

Encoder boards mentioned in this can be only connected to port C as is shown in figure 7.1. Option board is selected as well by software on parameter L01.

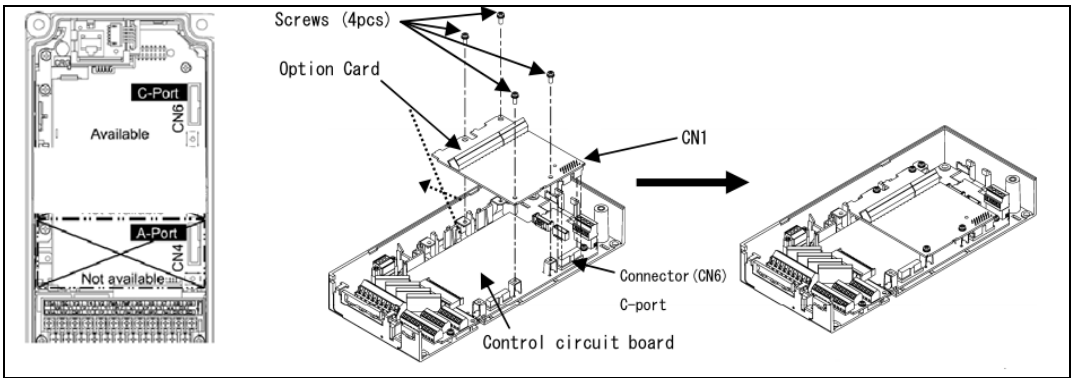


Figure 7.1. Available port and option board installation.

The setting on L01 will depend on the option board installed, and each option board can be used for different configurations. Table 7.1 shows the different settings of L01 and its option boards available.

Table 7.2: L01 setting and encoder option board related.

L01	Encoder specifications		Option	Motor
	Incremental signals	Absolute signals		
0	Push-pull/Open collector	-	OPC-PG3	IM
	Line driver		OPC-PMPG	
	Sinusoidal differential (1 Vpp)		OPC-PS/PSH OPC-PR	
1*1	Push-pull/Open collector	Z phase	OPC-PG3	PMSM
	Line driver		OPC-PMPG	
	Sinusoidal differential (1 Vpp)	R phase	OPC-PR	
4	Sinusoidal differential (1 Vpp)	EnDat2.1 (i.e.ECN413)	OPC-PS/PSH	PMSM
5	Sinusoidal differential (1 Vpp)	Sinusoidal differential 1 Vpp (i.e.ERN1387)	OPC-PR	PMSM
6	Sinusoidal differential (1 Vpp)	BISS-C (i.e. Sendix 5873)	OPC-PS/PSH	PMSM
7	Sinusoidal differential (1 Vpp)	SSI (i.e.ECN413)	OPC-PS/PSH	PMSM
8	Sinusoidal differential (1 Vpp)	Hiperface (i.e.SRS 50)	OPC-PSH	PMSM

*1) In such case, motor has to be validated by Fuji Electric.

7.1 OPC-PG3

Option board OPC-PG3 is the specific board for HTL standard encoders (standard power supply voltage range between 10~30 VDC). The encoder connected must fulfil the technical requirements specified in table 7.2.

Table 7.2: Encoder technical requirements.

Property	Specification	
Supply voltage	12,15 or 24 VDC±10%	
Output signal connection	Open Collector	Push pull
Maximum input frequency	25 kHz	100 kHz
Maximum cable length	20 m	100 m
Minimum detection time for Z Phase	5 µs	
Encoder pulses resolution	360 to 60000 pulses/rev (recommended 1024 pulses/rev)	

To wire this encoder type to OPC-PG3, see table 7.3 and figure 7.2 below.

Table 7.3: Required signals and their meaning.

Signal	OPC-PG3 terminal	Meaning
+UB	PO	Power supply 12, 15 or 24 VDC (SW2) (120 mA for 12 and 15 VDC) (90 mA for 24 VDC)
0 V	CM	Common 0 VDC
A	PA	Pulses phase A
B	PB	Pulses phase B 90° shifted
Z	PZ	Marker*1
-	FA+	・Line Driver output ・Ratio of dividing frequency setting (SW1) 1/1, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64 ・Output voltage : Max. 5.25 V
	FA-	
	FB+	
	FB-	
	FZ+	
	FZ-	

*1 Only needed for PMS motors control

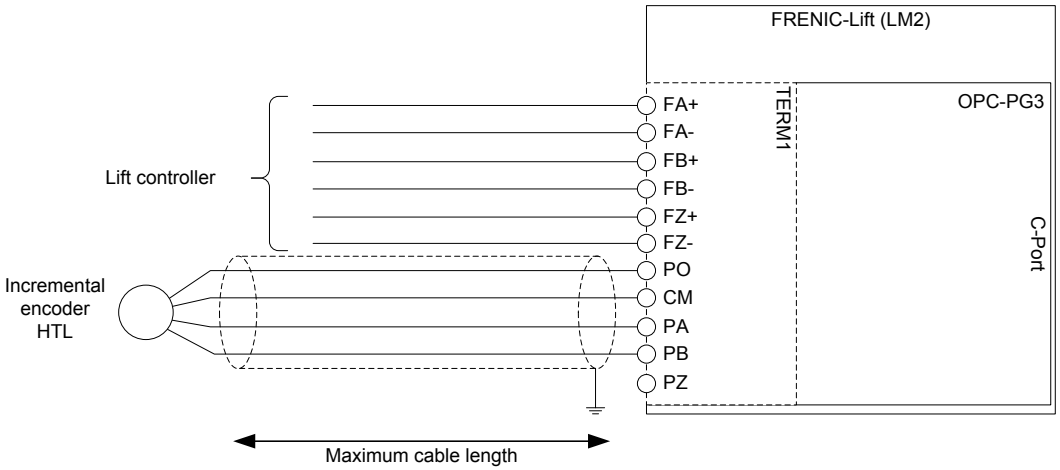


Figure 7.2: Connection using HTL encoder interface

- *The encoder cable must be always shielded. The shield must be connected in the inverter side and the encoder side using the ground terminal or the dedicated shield glands.*
- *The signal names may be different depending on the encoder manufacturer.*

7.2 OPC-PMPG

Option board OPC-PMPG is the specific board for line driver standard encoders (differential signals of 5 VDC). The encoder connected must fulfil the technical requirements specified in table 7.4.

Table 7.4: Encoder technical requirements

Property	Specification
Supply voltage	5 VDC±10%, 300 mA
Output signal connection	Line driver
Maximum input frequency	100 kHz
Maximum cable length	100 m
Encoder pulses resolution	360 to 60000 pulses/rev (recommended 1024 pulses/rev)

To wire this encoder type to OPC-PMPG, see table 7.5 and figure 7.3 below.

Table 7.5: Required signals and their meaning

Signal	OPC-PMPG terminal	Meaning
+UB	PO	Power supply 5 VDC
0 V	CM	Common 0 VDC
A	PA+	Pulses phase A
/A	PA-	Pulses phase A inverted
B	PB+	Pulses phase B 90° shifted
/B	PB-	Pulses phase B 90° shifted inverted
-	FA+	・Line Driver output ・Ratio of dividing frequency setting (SW1) 1/1, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64 ・Output voltage : Max. 5.25 V
	FA-	
	FB+	
	FB-	
	FZ+	
	FZ-	

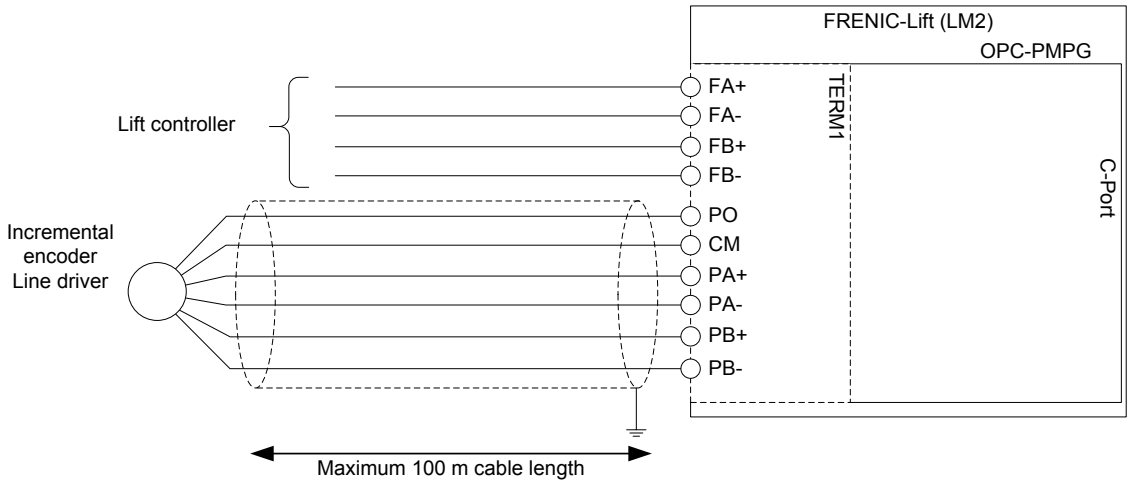


Figure 7.3: Connection using line driver encoder interface

- *The encoder cable must be always shielded. The shield must be connected in the inverter side and the encoder side using the ground terminal or the dedicated shield glands.*
- *The signal names may be different depending on the encoder manufacturer.*
- *Make sure to disable F0,F1,F2 and F3 wire brake detection (PG error) by setting all switches to ON (SW2).*

7.3 OPC-PR

Option board OPC-PR is the specific board for sin/cos sin/cos encoders (sinusoidal wave for incremental and absolute signals). The encoder connected must fulfil the technical requirements specified in table 7.6.

Table 7.6: Encoder technical requirements.

Property	Specification
Supply voltage	5 VDC±5%, 200 mA
Incremental output signals	Two sinusoidal signals A and B as sine and cosine ・Signal level: 0.6 to 1.2 Vpp ・Phase angle: 90 degree ± 10 degree
Rotor position detection (absolute signals)	Two sinusoidal signals (C,D) as sine and cosine with one period per revolution: ・Signal level: 0.6 to 1.2 Vpp ・Phase angle: 90 degree ± 10 degree
Maximum cable length	20 m
Encoder sinus resolution	360 to 60000 sin/rev (recommended 2048 sin/rev)

To wire this encoder type to OPC-PR, see table 7.7 and figure 7.4 below.

Table 7.7: Required signals and their meaning.

Signal	Color	OPC-PR terminal	Meaning
Up	Brown/Green	PO	Power supply 5 VDC
Up Sensor	Blue	PO	Power supply 5 VDC - Sensor
0 V	White/Green	CM	Common 0 VDC
0 V Sensor	White	CM	Common 0 VDC - Sensor
A+	Green/Black	PA+	Sinus wave (incremental)
A-	Yellow/Black	PA-	Sinus wave inverted (incremental)
B+	Blue/Black	PB+	Cosine wave (incremental)
B-	Red/Black	PB-	Cosine wave inverted (incremental)
C+	Grey	PC+	Sinus wave (absolute)
C-	Pink	PC-	Sinus wave inverted (absolute)
D+	Yellow	PD+	Cosine wave (absolute)
D-	Violet	PD-	Cosine wave inverted (absolute)
-	-	FA+	・Line Driver output ・Ratio of dividing frequency setting (SW1) 1/1, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64 ・Output voltage : Max. 5.25 V
		FA-	
		FB+	
		FB-	
		FZ+	
		FZ-	

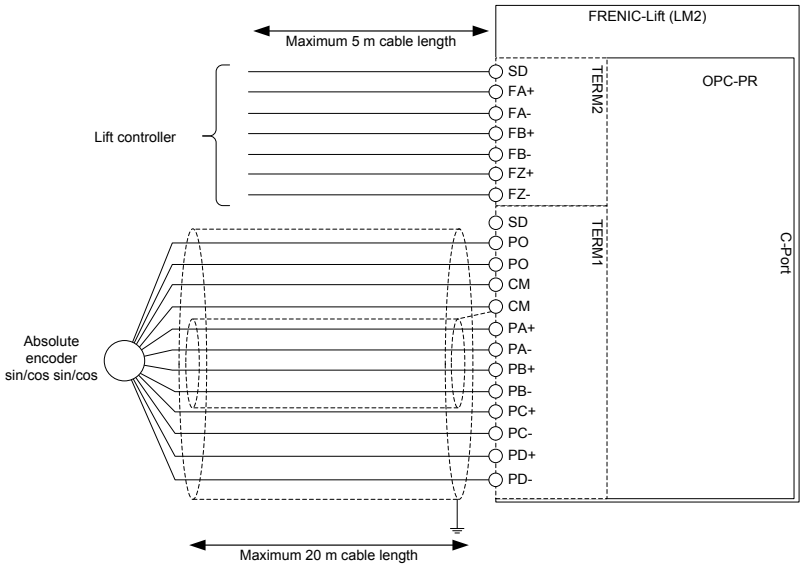


Figure 7.4: Connection using sin/cos sin/cos encoder interface

- *The encoder cable must be always shielded. The shield must be connected in the inverter side and the encoder side using the ground terminal or the dedicated shield glands.*
- *The signal names and colours may be different depending on the encoder/cable manufacturer. Encoder cable colours based on ERN487.*
- *Sensor signals have to be connected only in case that encoder cable is 10 m or more.*

7.4 OPC-PSH

Option board OPC-PSH is the specific board for serial absolute encoders (sinusoidal wave for incremental signals and serial communications for absolute signals). The encoder connected must fulfil the technical requirements specified in table 7.8.

Table 7.8: Encoder technical requirements.

Property	Specification			
Supply voltage	5 VDC±5% 200 mA			8 VDC±5% 200 mA[*1]
Incremental output signals	Two sinusoidal signals A and B as sine and cosine ・Signal level: 0.6 to 1.2 Vpp ・Phase angle: 90 degree ± 10 degree			
Data interface	EnDat2.1	SSI	Biss-C	Hiperface
Code signals	Differential line driver/receiver			
Encoder sinus resolution	360 to 60000 sinus/rev (recommended 2048 sinus/rev)			

[*1]) OPC-PSH power supply is by default 5 VDC, in case that 8 VDC are needed use SW1.

To wire this encoder type to OPC-PSH, see table 7.8 and figure 7.5 below.

Table 7.9: Required signals and their meaning.

OPC-PSH terminal	EnDat 2.1 and SSI		Biss-C		Hiperface	
	Color	Signals	Color	Signals	Color	Signals
PO	Brown/Green	Up	Brown	+V	Red	U
PO	Blue	Up Sensor	-	-	-	-
CM	White/Green	0 V	White	0 V	Blue	GND
CM	White	0 V Sensor	-	-	-	-
PA+	Green/Black	A+	Black	A	Pink	+COS
PA-	Yellow/Black	A-	Purple	/A	Black	+RECOS
PB+	Blue/Black	B+	Grey/Pink	B	White	+SIN
PB-	Red/Black	B-	Red/Blue	/B	Brown	+RESIN
CK+	Violet	Clock	Green	C+	-	-
CK-	Yellow	/Clock	Yellow	C-	-	-
DT+	Grey	Data	Grey	D+	Grey or Yellow	Data+
DT-	Pink	/Data	Pink	D-	Green or violet	Data-

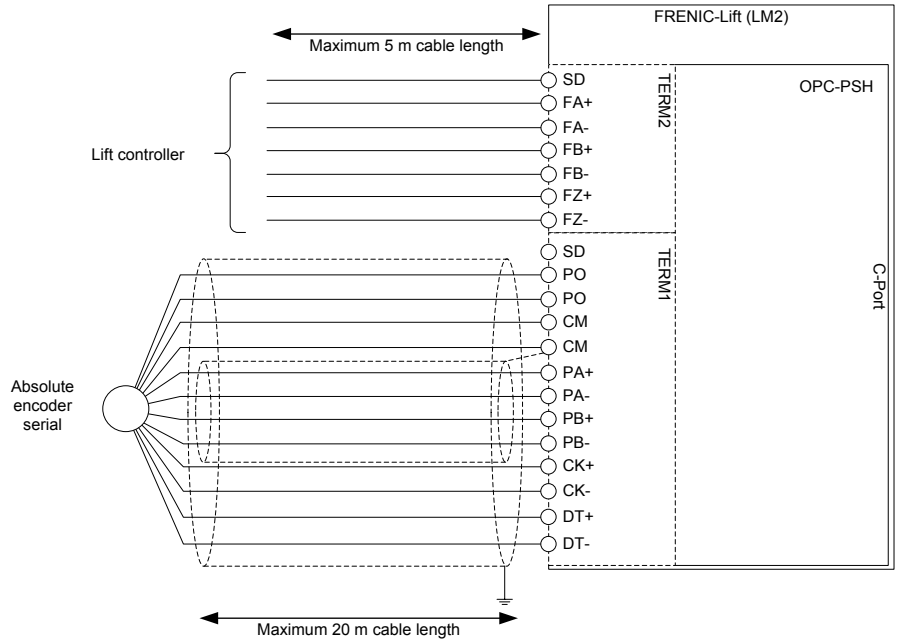


Figure 7.5: Connection using serial communications encoder interface

- *The encoder cable must be always shielded. The shield must be connected in the inverter side and the encoder side using the ground terminal or the dedicated shield glands.*
- *The signal names and colours may be different depending on the encoder/cable manufacturer. Encoder cable colours based on ECN413 (EnDat, SSI), Sendix 5873 (BiSS-C) and SRS50 (hiperface).*
- *Sensor signals have to be connected only in case that encoder cable is 10 m or more (EnDat and SSI).*
- *Another available option is OPC-PS. This option board has same characteristics than OPC-PSH without hiperface protocol and + 8 VDC power supply.*

In case of SSI, BiSS-C and hiperface encoders, some additional setting may be needed. This additional setting depends on communications frame structure. In table 7.9. related parameters are shown. No additional parameters need to be modified for EnDat.

Table 7.10: Specific setting for BiSS, SSI and hiperface encoders.

Parameter	Description	Biss*1	SSI*2	Hiperface*3
L209	Encoder Serial communication (number of ST bits)	13 bits	13 bits	15 bits
L212	Alarm/warning bit enable and position (SSI)	0x00h	0x00h	-
L213	Number of AL1 bits	0	0	-
L214	Number of AL2 bits	2	0	-
L215	Number of CRC bits	6	0	-
L216	CRC polynomial	0x43h	0x00h	-

Values validated/tested on:

*1: SMRS64 (Hohner)
Sendix 5873 (Kübler)
WDGF 58M (Wachendorf)
*2: 5873 ThyssenKrupp specification (Kübler)
SMRS64 (Hohner)
*3: SRM50 (Sick)
SRS50 (Sick)

8. Keypad operation

8.1 Keypad keys

Keypad “TP-A1-LM2” allows the user to run and stop the motor locally, monitor the running status, set the function code data, and monitor I/O signal states, maintenance information, and alarm information. Figure 8.1 shows an overview of TP-A1-LM2. Table 8.1 explains the three main areas of the keypad.

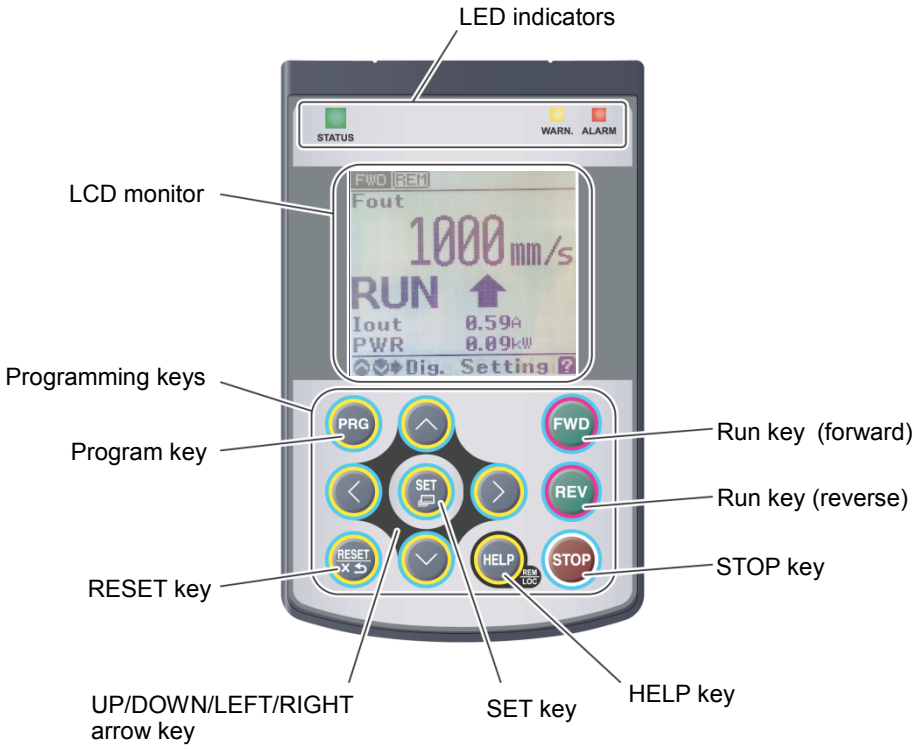


Figure 8.1: Names and Functions of Keypad Components

Table 8.1: Keypad overview.

Keypad item	Specification	Additional information
LED indicators	These indicators show the current running status of the inverter.	Refer to Table 8.2.
LCD monitor	This monitor shows the following various information about the inverter according to the operation modes.	
Keys	These keys are used to perform various inverter operations.	Refer to Table 8.3.

Table 8.2: Indication of LED Indicators.

LED Indicators	Indication	
STATUS (Green)	Shows the inverter running state.	
	Flashing	No run command input (Inverter stopped)
	ON	Run command input
WARN. (Yellow)	Shows the warning state (light alarm).	
	OFF	No light alarm has occurred.
	Flashing /ON	A light alarm has occurred. But inverter can continue running.
ALARM (Red)	Shows the alarm state (heavy alarm).	
	OFF	No heavy alarm has occurred.
	Flashing	A heavy alarm has occurred. Inverter shuts off its output.

Table 8.3: Overview of Keypad Functions.

Keys	Functions
	This key switches the operation modes between Running mode/Alarm mode and Programming mode.
	Reset key which works as follows according to the operation modes. ■ In Running mode: This key cancels the screen transition. ■ In Programming mode: This key discards the settings being configured and cancels the screen transition. ■ In Alarm mode: This key resets the alarm states and switches to Programming mode.
	UP/DOWN key which works as follows according to the operation modes. ■ In Running mode: These keys switch to the digital reference speed (when local mode). ■ In Programming mode: These keys select menu items, change data, and scroll the screen. ■ In Alarm mode: These keys display multiple alarms and alarm history.
	These keys move the cursor to the digit of data to be modified, shift the setting item, and switch the screen.
	Set key which works as follows according to the operation modes. ■ In Running mode: Pressing this key switch to the selection screen of the LCD monitor content. ■ In Programming mode: Pressing this key establishes the selected items and data being changed. ■ In Alarm mode: Pressing this key switch to the alarm detailed information screen.
	Pressing this key call up the HELP screen according to the current display state. Holding it down for 2 seconds toggles between the remote and local modes.
	Pressing this key starts running the motor in the forward rotation (when local mode).
	Pressing this key starts running the motor in the reverse rotation (when local mode).
	Pressing this key stops the motor (when local mode).

8.2 Keypad menus

Table 8.4: Keypad menus organization and its function.

Main Menu	Sub-Menu		Hierarchy indicator	Principal Functions
0. Quick Setup: Shows only frequently used function codes.				
	—	—	PRG>0	
1. Start-up: Sets functions for initial settings.				
	1	Language	PRG>1>1	Sets language to be displayed on LCD monitor.
	2	Select application	PRG>1>2	Allows individual initialization of function codes that are grouped by application.
	3	Display settings	PRG>1>3	Selects content to be displayed on LCD screen.
2. Function Code: Setting screens related to function codes, such as setting/copying function code data.				
	1	Set data	PRG>2>1	Allows function code data to be displayed/changed.
	2	Confirm data	PRG>2>2	Allows confirmation of function code settings.
	3	Confirm revised data	PRG>2>3	Allows confirmation of function code changes from factory-default settings.
	4	Copy data	PRG>2>4	Reads, writes and verifies function code data between the inverter and the keypad.
	5	Initialize data	PRG>2>5	Restores function code data values to factory-default settings.
3. INV Information: Allows monitoring of inverter operational status.				
	1	Operation monitor	PRG>3>1	Displays operational information.
	2	I/O checking	PRG>3>2	Displays external interface information.
	3	Maintenance information	PRG>3>3	Displays cumulative run time and other information used during maintenance.
	4	Unit information	PRG>3>4	Allows confirmation of inverter type, serial number and ROM version.
	5	Travel direction counter	PRG>3>5	Allows confirmation and setting of travel direction counter. This function provides the information for replacing wire/rope.
4. Alarm Information: Displays alarm information.				
	1	Alarm history	PRG>4>1	Lists alarm history (newest + 3 previous). Also this allows you to view the detail information on the running status at the time when alarm occurred.
5. User Configure: Allows any settings to be made.				
	1	Quick setup selection	PRG>5>1	Allows function codes to be added to or deleted from the "Quick Setup".
6. Tools: Various functions				
	1	Customizable logic monitor	PRG>6>1	Previews status of each step in customizable logic.
	2	Load Factor Measurement	PRG>6>2	Allows measurement of the operational status of the maximum output current and average output current.
	3	Communication Debugging	PRG>6>3	Allows monitoring and setting of function codes for communication (S, M, W, X, Z, and etc.)

8.3 Example of function setting

PRG > 2 > 1

This section explains how to set function code data. The example below shows how to change “F03: Rated speed” from 1450 r/min to 1800 r/min.

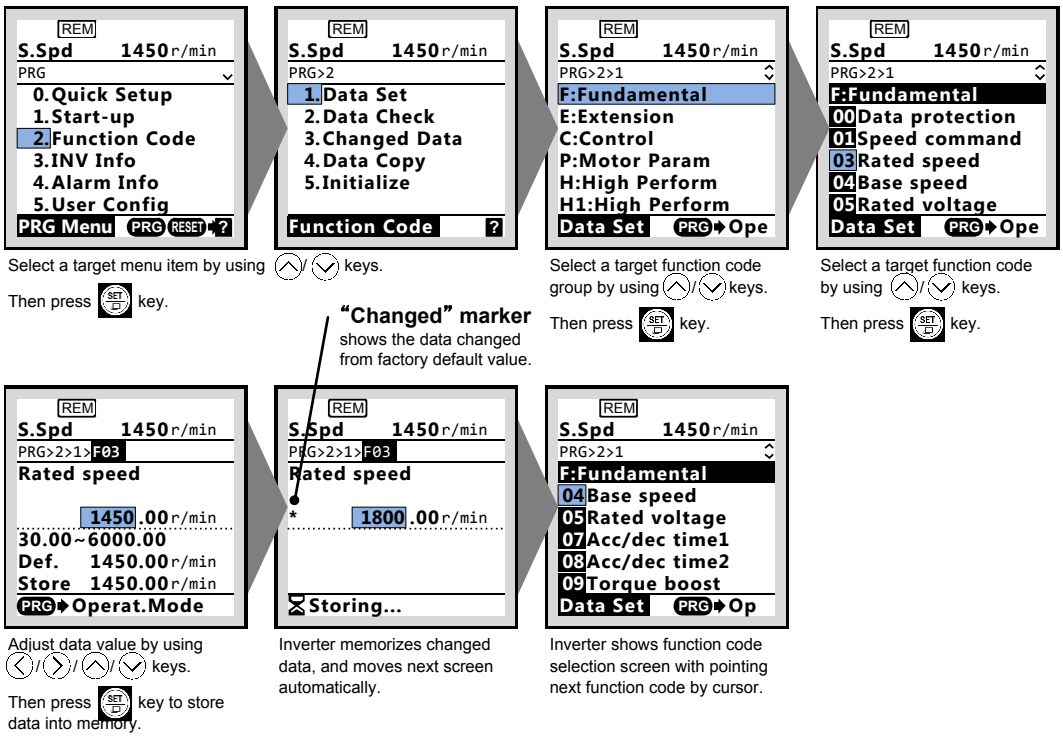


Figure 8.2: Screen transition example for setting a function code.

8.4 Display language setting

PRG > 1 > 1

Display language can be selected on sub menu Language of the Menu 1. Start-up. To access the Program menu press PRG key, select the desired menu by using up and down arrow and validate with SET key. Another way is by changing the setting on parameter K01. Table 8.5 shows all available languages and its associated number.

Table 8.5: Available languages

Language selection	Language
1	English
3	German
4	French
5	Spanish
6	Italian
7	Greek
8	Russian
9	Turkish
10	Czech
11	Polish
13	Swedish
14	Portuguese
15	Dutch
100	User-customized language

9. Driving the motor

9.1 Inverter initialization

PRG > 2 > 5

Inverter can be programed with different pre-settings depending on the application type. Changing the data requires double-key operation (the STOP key and the ∧ key or the STOP key and the ∨ key). The types of initialization shown in Table 9.1 are available.

Table 9.1: Initialization types

Initialization type		Function
0	Manually set values	Does not initialize.
1	Vector control for IM (closed loop)	Initialize all function code data to settings suited for vector control for IM.
2	Vector control for PMSM	Initialize all function code data to settings suited for vector control for PMSM.
3	Vector control for IM (open loop)	Initialize all function code data to settings suited for open loop control for IM.

Pre-setting for Vector control for PMSM is based on a motor with EnDat encoder (OPC-PS/PSH and L01=4). If any other encoder is used, or any other option board is used, please set the correct value on L01 and L02.

9.2 Specific setting for induction motors

Motor parameters, in other words motor name plate, have to be set manually. Table 9.2 shows the basic setting that needs to be set. Parameters has to be set in the same order shown in the table below, otherwise a malfunction may occur.

Table 9.2. Basic setting for induction motors (IM)

Function	Meaning	Factory setting	Comments
P01	Motor poles.	4	Depends on the motor.
F03	Motor's rated speed. Normally F03 is motor speed at nominal lift speed.	1450 rpm	
F04	Motor's synchronous speed. For 4-pole motors (50Hz) is 1500 r/min, for 6-poles motors (50Hz) is 1000 r/min.	1500 rpm	Depends on the motor.
F05	Motor rated voltage.	V	Depends on the motor.
F11	Overload detection level.	A	Set manually same value than P03.
P02	Motor rated power (kW).	kW	Depends on the motor.
P03	Motor rated current.	A	Depends on the motor.

9.3 Auto tuning procedure (for IM)

After inverter initialization and motor parameters setting an auto tuning has to be performed. Auto tuning will get special data from the motor like no-load current (P06), stator resistance (P07), stator inductance (P08) and slip frequency (P12).

In order to perform an auto tuning follows below step by step procedure:

1. **Please set the functions described in the table 9.1 and 9.2.**
2. Set function P04 to 3 and press SET.
3. Give RUN command to the inverter from the lift controller (normally INSPECTION mode). Keep the RUN command until inverter indicates that the procedure has been finished. At this point, the main contactors will be closed and current will flow through the motor producing some acoustic noise. This procedure will take some seconds. After this auto tuning procedure is finished.

If during the procedure inverter trips Er7 make sure that setting specified in table 9.1 and 9.2 is correctly set. Make sure as well of the connection recommended on chapter 5. Connections. If too high no-load current is recognized, especially in case of IM in closed loop (motor with encoder), try auto tuning mode 2 (P04=2).

After that, please give RUN command from the lift controller (for example in INSPECTION), and check that motor is turning without any problem. Check that the output current has reasonable value. By a reasonable value it is understood below rated current (empty car going down for example).

In case of closed loop control (motor with encoder):

If inverter trips OC, OS or Ere after giving RUN command please set H190=0. This setting is equivalent to swap two motor phases.

PRG > 3 > 2 [6/6]

Check that the inverter receives the encoder pulses as following; if the motor is not moving, the display should show **0 kP/s** after P2. Open (release) the brake and turn a little bit the motor. In this moment the display should show a number different than 0 (positive or negative depending on the rotation direction). If the display shows **----p/s** (or **0 kP/s** meanwhile the motor is turning) means that no signal is coming from the encoder. In this case please check the encoder cable and the connection of the signals.

9.4 Specific setting for PMS motors

Motor parameters, in other words motor name plate, have to be set manually. Table 9.3 shows the basic setting that needs to be set. Parameters has to be set in the same order shown in the table below, otherwise a malfunction may occur.

Table 9.3: Basic setting for synchronous motor (PMSM)

Function	Meaning	Factory setting	Comments
P01	Motor poles.	20	Depends on the motor.
F03	Motor's maximum speed. F03 is motor speed at nominal lift speed.	60 rpm	
F04	Motor's rated speed.	60 rpm	Depends on the motor.
F05	Motor rated voltage.	V	Depends on the motor.
F11	Overload detection level.	A	Set manually same value than P03.
P02	Motor rated power (kW).	kW	Depends on the motor.
P03	Motor rated current.	A	Depends on the motor.
P07	Motor stator resistance R1 in %	%	Set this parameter always to 5%

9.5 Pole tuning procedure (for PMS motors)

After inverter initialization and motor parameters setting a pole tuning has to be performed. Pole tuning procedure will get the encoder offset and will set the obtained value on the parameter L04.

In order to perform a pole tuning follows below step by step procedure:

1. **Please set the functions described in the table 9.1 and 9.2.**
2. Set function L03 to 4 and press SET.
3. Give RUN command to the inverter from the lift controller (normally INSPECTION mode). Keep the RUN command until inverter indicates that the procedure has been finished. At this point, the main contactors will be closed and current will flow through the motor producing some acoustic noise. This procedure will take some seconds. After this auto tuning procedure is finished.
4. After the procedure is finished correctly the offset value is saved and shown in function **L04**. Write down the displayed value.
5. If possible, open the brake and let the cabin move some centimetres.
6. Perform step 3 and 4 again. The result in function **L04** between different measurements must not differ more than ± 15°.

If the result between two measurements, in two motor positions, is more than ± 15°please set H190=0. If inverter trips OC, OS or Ere after giving RUN command please set H190=0 as well. This setting is equivalent to swap two motor phases. If during the procedure inverter trips Er7 make sure that setting specified in table 9.1 and 9.2 is correctly set. Make sure as well of the connection recommended on chapter 5. Connections.

After that, please give RUN command from the lift controller (for example in INSPECTION), and check that motor is turning without any problem. Check that the output current has reasonable value. By a reasonable value it is understood below rated current (empty car going down for example).

PRG > 3 > 2 [6/6]

Check that the inverter receives the encoder pulses as following; if the motor is not moving, the display should show **0 kP/s** after P2. Open (release) the brake and turn a little bit the motor. In this moment the display should show a number different than 0 (positive or negative depending on the rotation direction). If the display shows **----p/s** (or **0 kP/s** meanwhile the motor is turning) means that no signal is coming from the encoder. In this case please check the encoder cable and the connection of the signals.

10.Setting the speed profile

The setting of the speed profile includes:

- Travelling speed
- Acceleration and deceleration times (s)
- S curves (%)

For the rated speed, each intermediate speed and creep speed the acceleration, deceleration times and S curves can be set independently. Acceleration and deceleration times are referred to maximum speed (F03), in other words, the value set on the acceleration/deceleration ramp is the time to accelerate/decelerate from 0.00 rpm to F03 (and other way around). The setting of the S curve means the speed change in terms of percentage of the maximum speed (F03) used for the acceleration change.

Table 10.1 shows all acceleration/deceleration times and S curves available. Each box shows the acceleration/deceleration ramp used to accelerate/decelerate from the speed shown in the first column to the speed shown in the first raw. Ramp will accelerate when the speed set on the column function code is lower than the speed set on the raw function code. STOP is the status after or before removing RUN command (FWD or REV).

Table 10.1: Correspondence of acceleration and deceleration ramps and S-curves.

ACCELERATION & DECELERATION RAMPS (S-CURVES)									
AFTER CHANGE / BEFORE CHANGE	**STOP**	**C04**	**C05**	**C06**	**C07**	**C08**	**C09**	**C10**	**C11**
STOP	-/F08 (- / -)	F07 (H57 / H58)	F07 (H57 / H58)	F07 (- / -)	F07 (H57 / H58)	F07 (H57 / H58)	F07 (H57 / H58)	F07 (H57 / H58)	F07 (H57 / H58)
C04	E16 (H59 / H60)	F07 / F08 (- / -)	E10 (L19 / L22)	F07 (- / -)	F07/ F08 (H57 / H58)	F07 (L19 / L20)	F07 (L19 / L20)	E10 (L19 / L22)	E12 (L19 / L24)
C05	E16 (H59 / H60)	E11 (L23 / L28)	F07 / F08 (- / -)	F07 / F08 (- / -)	E11 (L23 / L26)	F07 / F08 (H59 / H60)	F07 / F08 (H59 / H60)	F07 / F08 (H57 / H58)	F07/ F08 (H57 / H58)
C06	E16 (- / -)	F08 (- / -)	F07 / F08 (- / -)	F07 / F08 (- / -)	F07 / F08 (- / -)	F07 / F08 (- / -)	F07 / F08 (- / -)	F07 / F08 (- / -)	F07 / F08 (- / -)
C07	E15 (L27)	E14 (L28)	F07 / F08 (H57 / H58)	F07 / F08 (- / -)	F07 / F08 (- / -)	F07 / F08 (H57 / H58)	F07 / F08 (H57 / H58)	F07 / F08 (H57 / H58)	F07 / F08 (H57 / H58)
C08	E16 (H59 / H60)	F08 (L21 / L28)	F07 / F08 (H57 / H58)	F07 / F08 (- / -)	F08 (L21 / L26)	F07 / F08 (- / -)	F07 / F08 (H57 / H58)	F07 / F08 (H57 / H58)	F07 / F08 (H57 / H58)
C09	E16 (H59 / H60)	F08 (L21 / L28)	F07 / F08 (H57 / H58)	F07 / F08 (- / -)	F08 (L21 / L26)	F07/ F08 (H59 / H60)	F07 / F08 (- / -)	F07 / F08 (H57 / H58)	F07 / F08 (H57 / H58)
C10	E16 (H59 / H60)	E11 (L23 / L28)	F07 / F08 (H59 / H60)	F07 / F08 (- / -)	E11 (L23 / L26)	F07 / F08 (H59 / H60)	E11 (L23 / L26)	F07 / F08 (- / -)	F07 / F08 (H57 / H58)
C11	E16 (H59 / H60)	E13 (L25 / L28)	F07 / F08 (H59 / H60)	F07 / F08 (- / -)	E13 (L25 / L26)	F07 / F08 (H59 / H60)	E13 (L25 / L26)	F07 / F08 (H59 / H60)	F07 / F08 (- / -)

In order to know which ramps and S-curves are used we have to enter in Table 10.1 from the left hand column in the row of the speed that is settled before the change (ex. C08) and look up in the column pointing at the target speed after the change (ex. C09). In the intersection of the row and the column we can find the ramps (ex. F07 / F08) and the S-curves (in brackets, ex. H57/H58) used during the change. In the example the change uses F07 as acceleration ramp or F08 in case of deceleration; for the S-curves H57 is used at the beginning of the speed change (close to C08) and H58 is used at the end of the change (when the speed has reached C09).

On table 10.2 shows different deceleration distances taking in consideration specific settings on speed, ramps and S curves parameters.

Table 10.2: Guideline of acceleration, deceleration times and deceleration distances for different travelling speeds

Rated speed **Function C11**	Creep speed **Function C07**	Acc./Dec. Times settings **Function E13**	S curve settings **Functions L24,L25,L26**	Acc./Dec. Times settings **Function E14**	Deceleration distance
0.6 m/s	0.05 m/s	1.6 s	25%	1.6 s	**892 mm**
0.8 m/s	0.10 m/s	1.7 s	25%	1.7 s	**1193 mm**
1.0 m/s	0.10 m/s	1.8 s	25%	1.0 s	**1508 mm**
1.2 m/s	0.10 m/s	2.0 s	25%	1.0 s	**1962 mm**
1.6 m/s	0.10 m/s	2.2 s	30%	1.0 s	**2995 mm**
2.0 m/s	0.15 m/s	2.4 s	30%	0.8 s	**4109 mm**
2.5 m/s	0.20 m/s	2.6 s	30%	0.7 s	**5649 mm**

The deceleration distance and therefore the starting point of the deceleration phase depends on the function settings. The deceleration distance shown in the above table is the distance from the start of the deceleration to the final floor landing position. The time during creep speed has been estimated for 1 s. This time depends on the real application.

Acceleration/Deceleration distances can be monitor as well on TP-A1-LM2 PRG > 3 > 1 [7/8] and [8/8]

Factory setting of the speed units is rpm (defined by function C21). To set up all functions correctly the rated speed of the motor must be known. If this speed is NOT known it can be calculated from the formula below:

$$n_{rated} = \frac{19{,}1 \times v \times r}{D \times i}$$

Where
v: rated speed in m/s
r: Cabin suspension (1 for 1:1, 2 for 2:1, 4 for 4:1,…)
D: Pulley diameter in m
I : Gear ratio

11.Signals time diagram for close loop control (IM and PMSM)

Figure 11.1 shows a complete time diagram and signals sequence in case of closed loop application. It shows a standard travel with a lift controlled by digital inputs with high and creep speed. In this case, induction motor and PMS motor are equivalent.

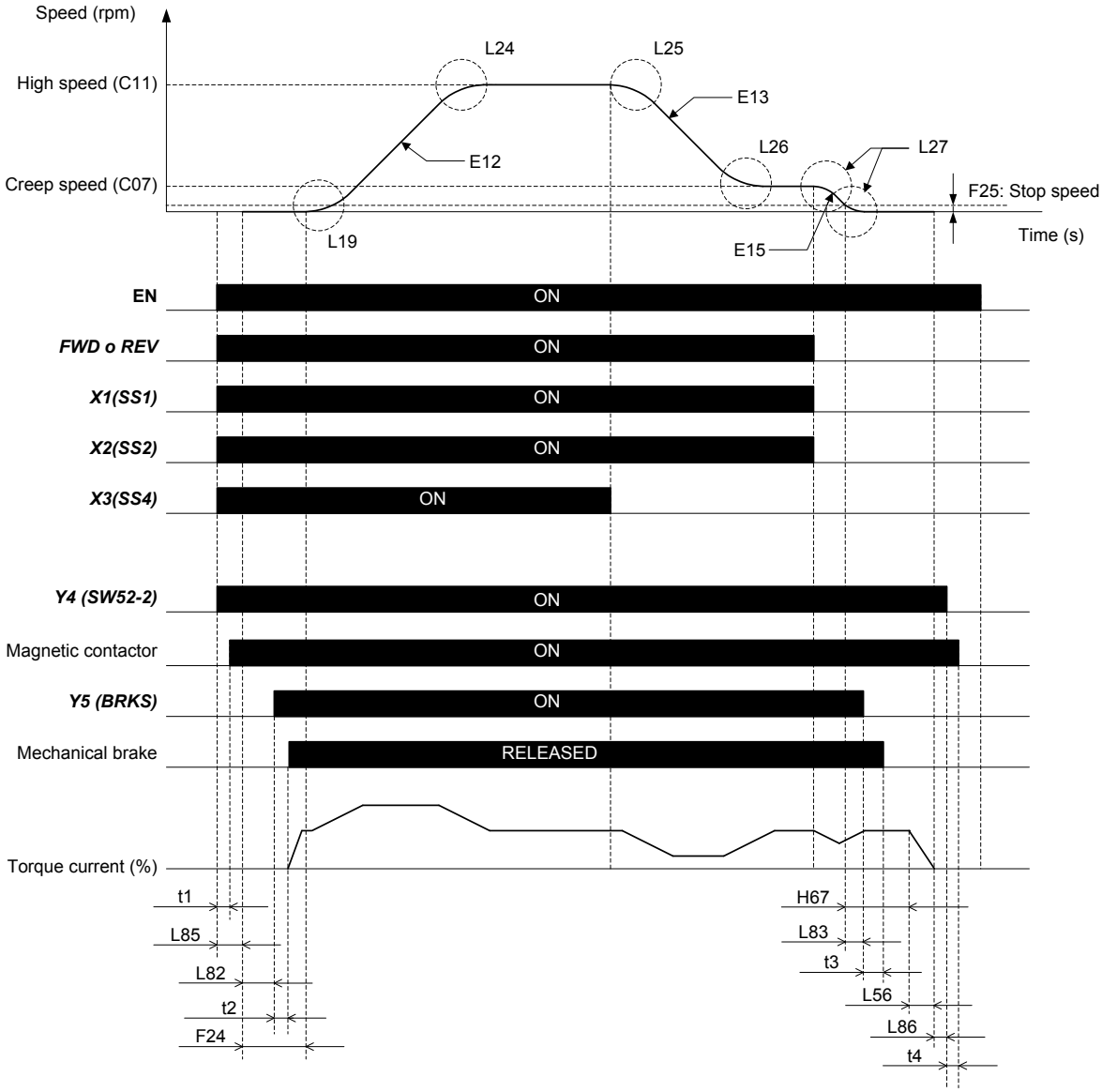


Figure 11.1: Closed loop application time and signals sequence diagram.

Sequence description:

Start:

By activating FWD (UP) or REV (DOWN) terminal and EN1 and EN2 (enable) terminals, t1 and L85 times start to count. At same time high speed is selected by X1, X2 and X3. When timer L85 is elapsed inverter will activate IGBT's gates (voltage at the output ON).

After the completion of time L82 the output of brake control will be activated and the mechanical brake opens (releases) after t2 time elapses (delay time to the reaction of contactors, coil…). After completion of time F24, the speed set point will be used and the lift will start to move accelerating to reach high speed (normal case).

Stop:

To decelerate to creep speed, the terminal X3 will be deactivated by the lift controller (from the internal settings of the controller).

After reaching the floor level, also creep speed will be deactivated (FWD/REV, X1 and X2 deactivated).

After the deceleration the motor will reach zero speed. In this moment timer H67 begins to count. After time L83, the brake output is deactivated (and brake will be applied after t3).

EN signal cannot be removed until no current is flowing from the inverter to the motor. This is when L56 timer is elapsed.

- Figure 11.1 is a travel example where brake and main contactor signals are controlled by the inverter. If these signals are controlled by the lift controller, timing might differ.
- Speeds, acceleration/deceleration ramps and S curves are based in a specific signals sequence (EN, FWD/REV, X1,X2 and X3). If the signals sequence is different, speed, acceleration/deceleration ramps and S curves might be different.

12.Signal time diagram for open loop (IM)

Figure 12.1 shows a complete time diagram and signals sequence in case of open loop application. It shows a standard travel with a lift controlled by digital inputs with high and creep speed. Only induction motors can be controlled in open loop in a standard lift travel.

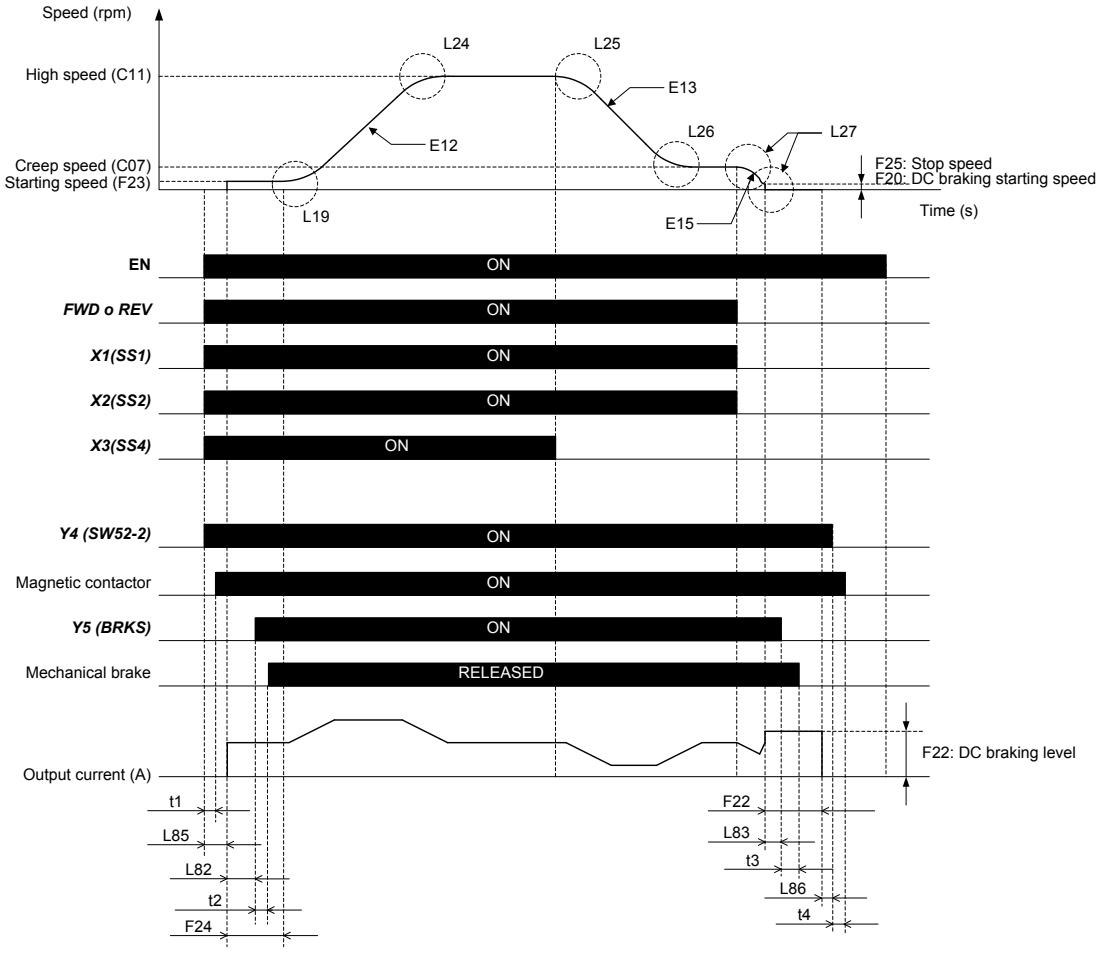


Figure 12.1: Open loop application time and signals sequence diagram.

Sequence description:

Start:
By activating FWD (UP) or REV (DOWN) terminal and EN1 and EN2 (enable) terminals, t1 and L85 times start to count. At same time high speed is selected by X1, X2 and X3. When timer L85 is elapsed inverter will activate IGBT's gates (voltage at the output ON).
After the completion of time L82 the output of brake control will be activated and the mechanical brake opens (releases) after t2 time elapses (delay time to the reaction of contactors, coil…). After completion of time F24, the speed set point will be used and the lift will start to move accelerating to reach high speed (normal case).

Stop:
To decelerate to creep speed, the terminal X3 will be deactivated by the lift controller (from the internal settings of the controller).
After reaching the floor level, also creep speed will be deactivated (FWD/REV, X1 and X2 deactivated).
After the deceleration the motor will reach zero speed (F25). At this moment, due to F20 setting, inverter starts to apply DC current (DC braking function). After time L83, the brake output is deactivated (and brake will be applied after t3).
EN signal cannot be removed until no current is flowing from the inverter to the motor. This is when F22 timer is elapsed.

- Figure 12.1 is a travel example where brake and main contactor signals are controlled by the inverter. If these signals are controlled by the lift controller, timing might differ.
- Speeds, acceleration/deceleration ramps and S curves are based in a specific signals sequence (EN, FWD/REV, X1,X2 and X3). If the signals sequence is different, speed, acceleration/deceleration ramps and S curves might be different.

13.Travel optimization in closed loop

Inverter default setting explained in chapter 9.1 Inverter initialization normally will be good for most of the lifts. In some cases, due to mechanical construction, frictions or motor behaviour it will be needed to adjust some parameters to get a better performance (lift comfort). These parameters are divided in different control loops; these loops are called ASR (Automatic Speed Regulator), APR (Automatic Position Regulator) and ACR (Automatic Current Regulator). Figure 13.1 shows the different phases of standard lift travel and which control loop is active.

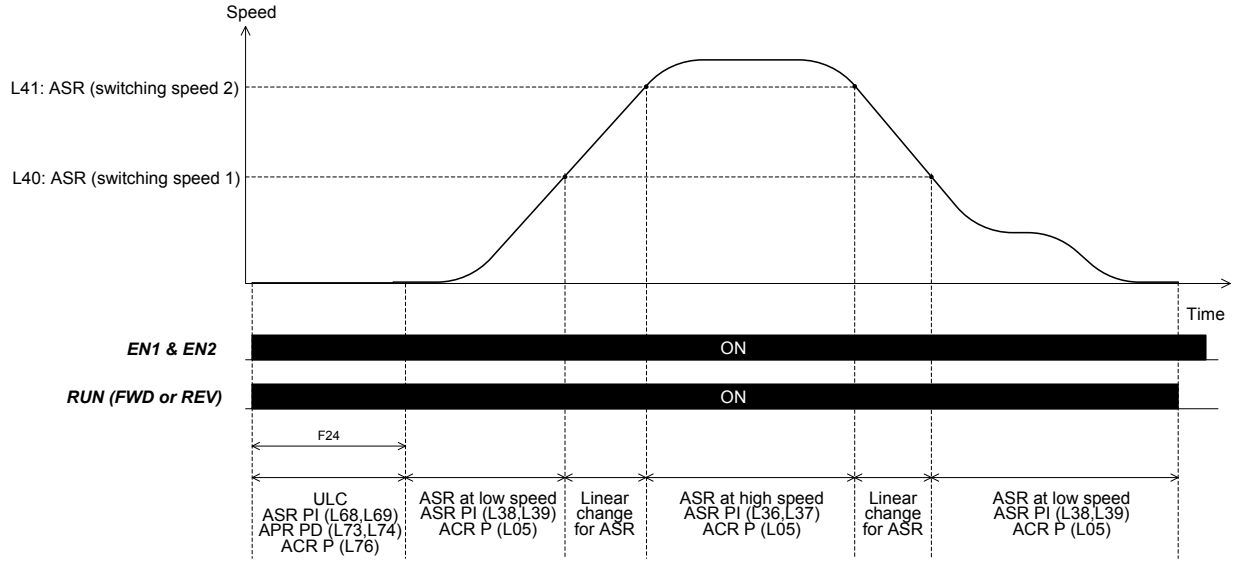


Figure 13.1. Lift standard travel divided by phases (control loops).

- *When L76=0, L05 is the gain effective on the ACR loop for ULC.*
- *If soft start function is used (H64, H65) ULC will be active during H64 time. During F24 time ASR at low speed will be active. For additional details about soft start function please check RM.*
- *L05 can be obtained by Auto tuning (P04=4). For additional details refer to chapter 9.3 Auto tuning procedure (for IM)*

14.Lift fine tuning (troubleshooting)

The typical problems have been divided in three different zones: starting, travel and stopping. Figure 14.1 shows a standard lift travel divided in the three areas.

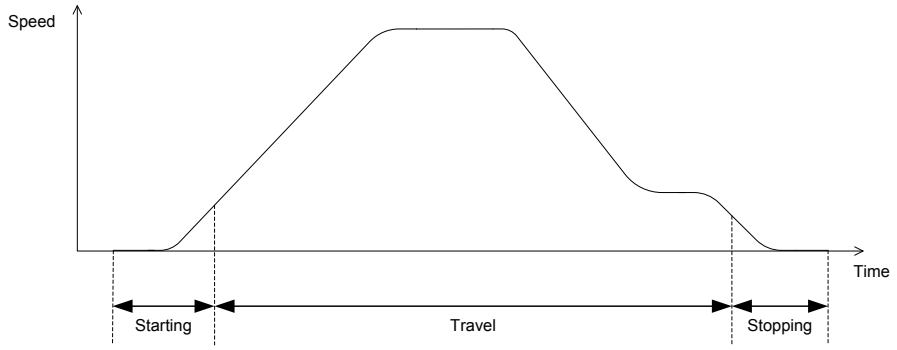


Figure 14.1. Standard lift travel divided in three zones

14.1. Open loop control (IM)

TROUBLESHOOTING (Starting)		
ROLLBACK	**CAUSE**	**ACTION**
	Insufficient starting frequency	Increase **F23** *Max. F23=1.0 Hz*
	Early brake opening	Increase **L82** *Max. L82=F24 – Brake reaction time*
	Insufficient torque	Increase **P06** *P06=30~70% of P03*
		Increase **F09** *Max. F09=5.0%*
HIT AT STARTING	**CAUSE**	**ACTION**
	Too high starting frequency	Reduce **F23** *Min. F23=0.1 Hz*
	Late brake opening	Reduce **L82** *Min. L82=0.20 s*
		Increase **F24** *Max. F24=1.5 s*
	Too high torque	Reduce **P06** *P06=30~70% of P03*
	Not related to inverters setting	Check brake operation Check guides (oil, alignment, etc.) Check car fixation (shoes)

TROUBLESHOOTING (Travel)		
VIBRATION AT CONSTANT SPEED	**CAUSE**	**ACTION**
	Too high torque	Decrease **P06** *P06=30~70% of P03*
	HIGH speed too fast	Reduce HIGH speed **(i.e. C11)** *Set motors rated speed instead of motor synchronous speed*
	Not related to inverters setting	Check guides (oil, alignment, etc.) Check car fixation (shoes) Check motor connection (Δ or 人) Check motor gearbox
UNDERSHOOT FROM HIGH SPEED TO CREEP SPEED	**CAUSE**	**ACTION**
	Slip frequency too high	Reduce **P12** *Min. P12=0.1 Hz*
	Deceleration too fast *(NOTE: Control that creep speed is kept)*	Increase deceleration ramp **(i.e. E13)** *Max. **E10-E16, F07-F08**=2.00 s*
		Increase 2nd S-curve at deceleration **(i.e. L25)** *Max. **L19-L28, H57-H60**=50 %*
	Insufficient torque	Increase **P06** *P06=30~70% of P03*
		Increase **F09** *Max. F09=5.0%*

TROUBLESHOOTING (Stopping)		
HIT AT STOPPING	**CAUSE**	**ACTION**
	Early brake closing	Increase **L83** *Max. L83=F22 - Brake reaction time*
	DC brake reaction too strong	Reduce **F21** *Min. F21=50%*
	Deceleration ramp too fast	Increase deceleration ramp **(i.e. E15)** *The maximum value depends on the lift magnets*
	Not related to inverters setting	Check security chain Check brake operation
ROLLBACK	**CAUSE**	**ACTION**
	Late brake closing	Reduce **L83**
	DC brake reaction too soft	Increase **F21** *Max. F21=90%* Check F22≠0.00s
	Insufficient torque	Increase **P06** *P06= 30~70% of P03*
		Increase **F09** *Max. F09=5.0 %*
	Not related to inverters setting	Check security chain operation (EN signal) Check brake operation
LANDING ACCURACY (STOPPING DEPENDING ON THE LOAD)	**CAUSE**	**ACTION**
	Incorrect slip frequency	Perform Auto tuning (**P04**=2)
		Calculate slip frequency manually $P12 = \frac{(Synchronous\_speed(rpm) - Rated\_speed(rpm)) \times Nom\_Frequency}{Synchronous\_speed(rpm)}$
	Insufficient torque	Increase **P06** *P06=30~70% of P03*
	Different landing accuracy (braking, driving)	Stopping too early (driving mode): Increase P09 Stopping too late (driving mode): Decrease P09

14.2 Closed loop control (PMSM and IM)

TROUBLESHOOTING (Starting)		
ROLLBACK	**CAUSE**	**ACTION**
	ULC gains and times (ASR, APR)	Make sure ULC control is active **L65** = 1
		ASR Not strong enough L68= Add 1.0 to current value (PMSM) L68= Add 10.0 to current value (IM) L69= Subtract 0.001 to current value (PMSM&IM) *Be careful that a value too high on L68 (P) or a value too low on L69 (I) may cause vibrations*
		APR Not strong enough L73= Add 1.0 to current value (PMSM) L74= Add 1.0 to current value (PMSM) *Be careful that a value too high on L73 and L74 may cause vibrations*
	Brake opening too early	Increase **L82** *Min. L82=0.2s* *Max. L82=F24 – Brake reaction time*
HIT AT STARTING	**CAUSE**	**ACTION**
	Late brake opening	reduce **L82** *Min. L82=0.2 s*
	Due to too early start	Increase **F24** *Reference value F24 = 1.0 s*
	ULC gains and times (ASR, APR)	ASR Too strong L68= Subtract 1.0 to current value (PMSM) L68= Subtract 10.0 to current value (IM) L69= Add 0.001 to current value (PMSM&IM) *Be careful that a value too low on L68 (P) or a value too high on L69 (I) may cause rollback*
		APR Too strong L73= Subtract 1.0 to current value (PMSM) L74= Subtract 1.0 to current value (PMSM)
	Not related to inverters setting	Check brake operation Check guides (oil, alignment, etc.) Check car fixation (shoes)

TROUBLESHOOTING (Travel)		
VIBRATIONS AT CONSTANT SPEED	**CAUSE**	**ACTION**
	ASR gain and time at HIGH speed	ASR Too strong L36= Subtract 1.0 to current value (PMSM) L36= Subtract 10.0 to current value (IM) L37= Add 0.050 to current value (PMSM&IM)
	ASR gain and time at CREEP speed	ASR Too strong L38= Subtract 1.0 to current value (PMSM) L38= Subtract 10.0 to current value (IM) L39= Add 0.050 to current value (PMSM&IM)
	Due to too fast speed	Reduce **C11** *Use the rated speed instead of the Synchronous speed of the Motor*
	Not due to inverters parameterization	Check guides Check cabin fixation Check motor connection (Δ or 人) Check motor gear
OSILATIONS AT CONSTANT SPEED	**CAUSE**	**ACTION**
	ASR gain and time at HIGH speed	ASR Too soft L36= Add 1.0 to current value (PMSM) L36= Add 10.0 to current value (IM) L37= Subtract 0.050 to current value (PMSM&IM)
	ASR gain and time at CREEP speed	ASR Too soft L38= Add 1.0 to current value (PMSM) L38= Add 10.0 to current value (IM) L39= Subtract 0.050 to current value (PMSM&IM)
VIBRATION DURING SPEED CHANGE	**CAUSE**	**ACTION**
	Due to ramp	Increase acceleration/deceleration ramps (**i.e. E12**,**E13**,**E15**)
	Switching speed setting	Increase the distance between switching speed limits (**L40**,**L41**)
UNDERSHOOT FROM HIGH SPEED TO CREEP SPEED	**CAUSE**	**ACTION**
	ASR gain and time at CREEP speed	ASR Too soft L38= Add 1.0 to current value (PMSM) L38= Add 10.0 to current value (IM) L39= Subtract 0.050 to current value (PMSM&IM)
	Deceleration too fast *(NOTE: Control that creep speed is kept)*	Increase deceleration ramp **(i.e. E13)** *Max. **E10-E16, F07-F08**=2.00 s*
		Increase 2nd S-curve at deceleration **(i.e. L25)** *Max. **L19-L28, H57-H60**=50 %*
	Feed forward not set	Increase **L42** setting (Add 0.100 to current value)
OVERSHOOT AT HIGH SPEED	**CAUSE**	**ACTION**
	ASR gain and time at HIGH speed	ASR Too soft L36= Add 1.0 to current value (PMSM) L36= Add 10.0 to current value (IM) L37= Subtract 0.050 to current value (PMSM&IM)
	Feed forward not set	Increase **L42** setting (Add 0.100 to current value)

TROUBLESHOOTING (Stopping)		
HIT AT STOPPING	**CAUSE**	**ACTION**
	Early brake closing	Increase **L83** *Max. L83=F22 - Brake reaction time*
	Deceleration ramp too fast	Increase deceleration ramp **(i.e. E15)** *The maximum value depends on the lift magnets*
	Not related to inverters setting	Check security chain Check brake operation
ROLLBACK	**CAUSE**	**ACTION**
	Late brake closing	Reduce **L83**
	Motor current is removed too early	Check that **EN** signal remains active until brake is closed
		Increase **H67**
	ASR gain and time at CREEP speed	ASR Too soft L38= Add 1.0 to current value (PMSM) L38= Add 10.0 to current value (IM) L39= Subtract 0.050 to current value (PMSM&IM)

15.Alarm messages

Alarm message Displayed	Description	Possible causes
OC1 OC2 OC3	Instantaneous overcurrent OC1= Overload during acceleration OC2= Overload during deceleration OC3= Overload during constant speed	Check if the motor used in the application has been selected properly. Check if the inverter used in the application. has been selected properly. Check if brake opens. Has the pole tuning procedure been completed successfully?
OV1 OV2 OV3	Overvoltage in inverter DC link: OV1= Overvoltage during acceleration OV2= Overvoltage during deceleration OV3= Overvoltage during constant speed	Braking resistor not connected or defective. Counterweight not counterbalanced. Deceleration time too short. Check connection. Check mains connection.
LV	Undervoltage in inverter DC link	Supply voltage too low. Mains supply failure. Acceleration too fast. Load too high. Check connection of the input signal.
Lin*	Input phase loss	Check inverters input protections. Check input connections.
OPL*	Output phase loss	Misconnection on inverters side. Misconnection on motors side. Misconnection on main contactors.
OH1	Heat sink overheat	Inverter fan defective. Ambient temperature too high.
OH2	External Alarm	Digital input programmed with value 9 (**THR**) is not active.
OH3	Inverter internal overheat	Check temperature inside electrical cabinet.
OH4	Motor protection (PTC/NTC thermistor)	Motor fan too small. Ambient temperature too high. Check setting of H26, H27.
OH6	Charging resistor overheat	The temperature of the charging resistor inside the inverter has exceeded the allowed limit. Reduce number of Power ON/OFF.
DBH	Braking resistor overheat (Electronic protection)	The temperature of the braking resistor has exceeded the allowable value (power too small). Check setting on F50, F51, F52.
OL1	Overload of motor 1	Check brake. Motor, car or counterweight blocked. Inverter at current limit, possibly too small. Check functions F10~F12.
OLU	Inverter overload	Over temperature in IGBT. Failure in the cooling system. Switching frequency (function F26) too high Car load too high.
Er1	Memory error	An error has occurred when writing data to the inverter memory.
Er2	Keypad communication error	A communication error has occurred between the keypad and the inverter.
Er3	CPU error	Failure in the inverter CPU.
Er4	Option card communication error	A communication error occurred between the option card and the inverter. Check option card installation. Check cables and shield connection.
Er5	Encoder error (option error)	A communication error occurred between the option board and the encoder. Check encoder cable. Check encoder. Check shield connection.

* These alarms can change enable/disable by a function code.

Alarm message Displayed	Description	Possible causes
Er6	Operation error	Check function L11-L18. Repeated value. Check brake signal status (BRKE). Check MC signal status (CS-MC). Check function L84. Check function L80, L82, L83. Pole tuning not done (L04=0.00). Error on brake monitoring (EN81-1+A3).
Er7	Error during Auto Tuning / Pole tuning	RUN command removed before finishing the process. Enable input interrupted.
Er8 ErP	RS 485 Communications error (Er8: RS-485 port 1, ErP: port 2)	Cable is interrupted. High noise level.
ErF	Data saving error during undervoltage	undervoltage is detected (LV) while inverter was saving data.
ErH	Option card hardware error	Option card not correctly installed. Inverter software version not compatible with option card.
OS	Motor speed greater than $\frac{L32xF03}{100}$ (rpm)	Check encoder resolution setting in function L02. Check value of function F03. Check value of function P01. Check value of function L32.
ErE	Speed error (disagreement)	Check brake. Motor, car or counterweight blocked. Check functions L90~L92. Current limiter active. Encoder pulses correctly set? Has been completed successfully the pole tuning procedure?
Ert	CAN bus communication error	CAN bus disconnected from the inverter. Electrical noise, connect cable shield. Terminating resistor not connected.
PG	Broken wiring in the encoder cable	Inverter detects a problem on the wiring connection of the encoder.
Ot	Over torque current	Reference torque current is excessive. Check setting of E34, E35 and E37.
bbE	Brake status monitoring according to EN81-1+A3	Brake state differs from expected. For additional information, please contact Fuji Electric.
tCA	Reaching maximum number of trip counter	The number of trip direction changes has reached the pre-set level. Remove lift ropes/belt and install new ones.
SCA	Short-circuit control	The inverter detects mismatch between the short-circuit control signal and short-circuit detection (feedback) signal.
LCO	Load-cell overload	Load-cell function has detected overload situation by means of pre-set value.
rbA	Rescue by brake alarm	No movement detected during rescue operation by brake control.
nrb	NTC wire break error	Detected a wire break in the NTC thermistor detection circuit.
ECL	Customizable logic error	A customizable logic configuration error has caused an alarm.
Eo	EN1, EN2 terminals chattering	Detected collision between ENOFF output and EN1/EN2 input terminals.
ECF	EN1 and EN2 terminals circuit error	The inverter detects an error on the enable terminals circuit, and stops itself. Check if the error can be reset by switching OFF and ON. If yes, make sure EN1 and EN2 signals come at same time.

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