



## Starting guide *FRENIC* Lift

Specific guide to set up  
asynchronous motor in  
open loop control mode

3 ph 400 V 4.0 kW – 30 kW  
3 ph 200 V 5.5 kW – 22 kW



| <b>Version</b> | <b>Changes applied</b>  | <b>Date</b> | <b>Written</b> | <b>Checked</b> | <b>Approved</b> |
|----------------|---|-------------|----------------|----------------|-----------------|
| 0.0.1          | Draft   | 02.02.2009  | J.Alonso       | J. Català      | D. Bedford      |
| 0.0.2          | Draft 2.<br>Chapter 4 is added.<br>Chapter 5 is added.<br>Figures 3.2, 3.3 and 6.1 are modified.<br>Figure 3.4 is added.<br>Some small text corrections<br>Inverters software version is added in chapter 0 | 12.03.2009  | J.Alonso       | J. Català      |                 |
| 0.1.0          | Text corrections.<br>Units of P09 and P10 corrected.<br>Keypad reference corrected.   | 03.04.2009  | J.Alonso       | J. Català      | D.Bedford       |
| 0.2.0          | Product range updated<br>Auto tuning 3 is included<br>Formula to calculate slip is added<br>UK, Italy and France are added as a branches<br>Small text corrections  | 05.11.2009  | J.Alonso       |                |                 |
| 0.3.0          | Method 1 description is changed<br>Small text corrections   | 11.11.2009  | J.Alonso       | D.Bedford      | D.Bedford       |
| 0.3.1          | Chapter 6 is updated  | 15.03.2010  | J.Alonso       | D.Bedford      | D. Bedford      |



## Contents

| Chapters  | Page |
|---|------|
| 0. About this manual                              | 4    |
| 1. Motor parameters                               | 4    |
| 2. Auto tuning procedure                          | 5    |
| 3. Slip compensation gains set up                 | 5    |
| 3.1 Method 1                                      | 7    |
| 3.2 Method 2                                      | 8    |
| 3.3 Additional settings                           | 8    |
| 4. How to check if the lift is correctly balanced | 9    |
| 5. Recommended inverters setting                  | 9    |
| 6. Quick guide to solve problems                  | 10   |
| 6.1 Problems at starting                          | 11   |
| 6.2 Problems during travelling                    | 11   |
| 6.3 Problems at stopping                          | 12   |




## 0. About this manual

This manual tries to explain clearly how to adjust a lift driven by an open loop induction motor. Most important parameters and functions are described.

For additional information, or general information of FRENIC-Lift, please refer to the following documents:

- FRENIC-Lift Starting guide
- FRENIC-Lift Reference Manual
- FRENIC-Lift Instruction Manual

 **Note** This starting guide is based on 1300 and 1301 firmware version. For other software versions, please contact with Fuji Electric technical department.

## 1. Motor parameters

In this chapter most important motor data are described. This motor data must be set on the inverter properly in order to perform a correct torque vector control and auto tuning. With the correct torque vector control and auto tuning we will be able to get the best performance from the motor in terms of comfort and landing accuracy (stop position not dependant on the load).

The minimum information that we need from motor plate is the following:

| PARAMETER | NAME                  | REMARKS  |
|-----------|-----------------------|--|
| P01       | Number of motor poles |  |
| P02       | Motor capacity        | In kW  |
| P03       | Motor rated current   | In A   |
| F03       | Maximum speed         | Rated speed of the motor (in rpm)                        |
| F04       | Rated speed           | Base speed/frequency of the motor (units depends on C21) |
| F05       | Rated voltage         | Rated voltage of the motor (in V)                        |

### CAUTION

Parameters must be set in this order. Otherwise some values could change automatically.

In some motors this information is not given directly, here you have some helpful information:

- **F03 (Maximum speed of the motor)**

The unit of this parameter is always rpm. This information is always given in the motor name plate.

- **F04 (Base speed of the motor)**

The units of this parameter depends on the value of parameter C21 (0: rpm, 1: m/min, 2: Hz). You can get base speed of the motor from the followings formulas depending on the case.

When C21=0

$$F04 = \frac{120 \cdot F_{base}}{P}$$

When C21=1

$$F04 = \frac{L31}{F03} \cdot \frac{120 \cdot F_{base}}{P}$$

When C21=2

$$F04 = F_{base}$$



Where:

$F_{base}$  = Base frequency of the motor (from nameplate) in Hz

$P$  = Number of motor poles

$L31$  = Lift rated speed in m/min

- **P02 (Motor capacity)**

This parameter must be set in kW. If motor plate does not have this information in kW you can use the following formulas in order to obtain the correct value for the inverter:

$$kW = 0,745 \cdot HP$$

$$kW = 0,735 \cdot CV$$




## 2. Auto tuning procedure

It is recommended to perform auto tuning procedure before driving the motor. With this procedure we can get important information from the motor. There are two different methods of auto tuning and, depending on which one we choose, we can get different motor information:

| PARAMETER | NAME                      | AUTO TUNING mode 1<br>P04=1 | AUTO TUNING mode 3<br>P04=3 |
|-----------|---------------------------|-----------------------------|-----------------------------|
| P06       | Motor no-load current (A) |                             | X (calculated)              |
| P07       | Motor %R1                 | X                           | X                           |
| P08       | Motor %X                  | X                           | X                           |
| P12       | Motor rated slip (Hz)     |                             | X                           |

The goal of both auto tuning methods is that both are static. This means that the motor will not turn during auto tuning; therefore there is no need to remove the load from the motor (the motor brake remains closed). It is highly recommended to perform auto tuning mode 3 (P04=3), because with this method we can get more information about the motor.

In order to perform an auto tuning please follow this procedure:

- Set motor parameters (refer to chapter 1).
- Enable inverter (activate EN control input).
- Set P04=3.
- Push button  on the inverter keypad (TP-G1-ELS).
- Give run command to the inverter.  
If the inverter is in LOCAL mode by means of buttons  . If the inverter is in REMOTE mode by means of controller signals (In case of REMOTE mode, controller must keep the signals FWD or REV until the auto tuning has finished).

After that, the inverter will close the main contactors (in case that the inverter has the control) and some noise coming from the motor could be heard. If auto tuning 1 is performed the tuning procedure will take around 15 seconds (we can hear 3 times a noise coming from the motor); if auto tuning 3 is performed the tuning procedure will take around 20 seconds (we can hear 4 times a noise coming from the motor). After that, auto tuning is finished.

In case that inverter trips with error *Er7* please check motor parameters and auto tuning procedure, if error persists (in case of auto tuning 3), change from auto tuning 3 to 1.

## 3. Setting up of slip compensation gains

The rated slip function (P12, in Hz) defines the value of the slip frequency of the motor. It is the key function for good slip compensation by the inverter. This means that this function is very important in open loop control of induction motors especially for a good landing accuracy; it will ensure that the rotating frequency of the motor is the same regardless of the load condition of the motor.

The value of slip measured by the inverter during auto tuning 3 is correct.



In some installations, due the behavior of the motor or the mechanical installation, is possible that we have to adjust the value of slip in braking mode (motor braking the load) or in driving mode (motor driving the load). It is easy to see because the cabin (the lift) stopping position (in the same floor) is different depending on the load conditions of the lift. For this purpose the inverter has the following parameters:

- P09: Slip compensation driving gain (%)
- P10: Slip compensation braking gain (%)

The best way to know when the inverter is working in driving or braking mode is to check torque generated by the inverter. This is possible to check in the menu 3.OPERATION MONITOR in the 2<sup>nd</sup> screen, as is shown in figure 3.1.

When TRQ (percentage) applied is positive, the inverter is driving the motor load, when TRQ applied is negative the inverter is braking the motor load.

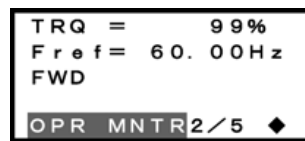


Figure 3.1 Reference torque in inverters keypad (TP-G1-ELS)

Theoretically the torque generated by the motor should be as is shown in the diagram of figure 3.2. The torque is generated depending on the motor load and the direction of the cabin.

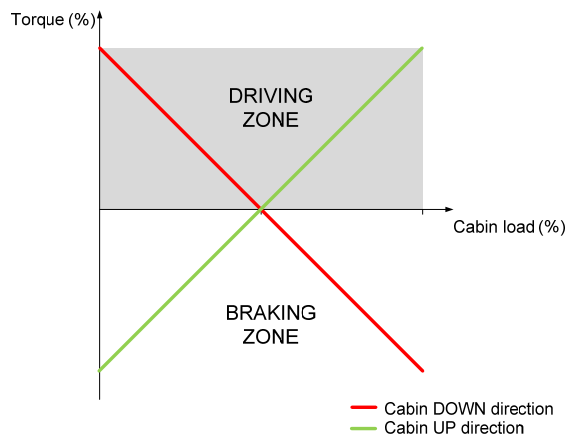


Figure 3.2 Theoretical torque generated by the motor.

Because a lot of times the lift is not perfectly balanced, and/or the mechanical system or the motor (due to gearbox and shaft efficiency) has some losses the real diagram is the one shown in figure 3.3.

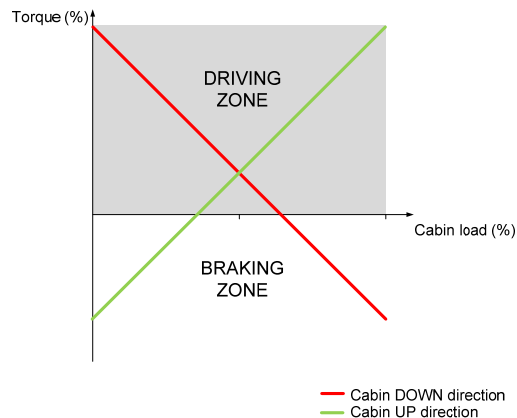


Figure 3.3 Torque generated by the motor in a real lift

In the case that the torque never achieves big negative values (not less than 10%) there is no need to set up the braking gain (P10), because there is no real braking condition. In this case it is only important to set driving gain (P09).

Frequency applied by the inverter is dependant of the slip and the torque. Where  $F_{out1}$  is Reference speed (final). The formula that relates these values is following:

$$F_{out2} = F_{out1} + P12 \cdot TRQ$$

We propose 2 methods in order to set up slip compensation gains. In both cases, please check before balance condition (refer to Chapter 4) and the mechanical efficiency of the lift (if there is braking condition).

### 3.1 Method 1

The aim of this test is to achieve the same stopping position in both cases, cabin with half load (no slip influences) and empty (maximum slip influences). If we can achieve repeatability of stopping, no dependant of the cabin load, we only have to reduce (or increase) inverter ramps or move lift magnets (or flags, etc.) in order to stop at floor level.

In this method we will compare the landing position when the cabin is half loaded and when the cabin is empty. Therefore, for this method half load of the cabin is needed. When we have half load inside the cabin we should have a balanced condition; in this case the slip influences should be almost zero. Choose one floor and wait out of the cabin. Put **half load** in the cabin. First call the lift to come to the floor where you are measuring in **down** direction (coming from an upper floor) and measure (note) the distance where the lift has stopped (from the floor level).

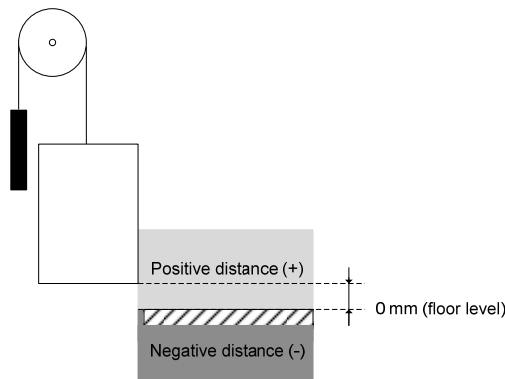


Figure 3.4 Cabin positioning at floor level

If the cabin is above the floor level, the distance is positive (Ex. +4mm); if the cabin is below the floor level, the distance is negative (Ex. -13mm). Repeat the test (still with **half load**) calling the lift to come to the floor where you are waiting in **up** direction (coming from a lower floor) and measure (note) the distance where the lift has stopped (from the floor level).

Remove now the cabin load (**empty cabin**) and measure the stopping position when the cabin is going **down** (coming from upper floor). Doing so, we are checking the slip in driving condition. Compare the position with the one measured with **half load**:

- If the cabin landing position is higher without load than with half load it means that the slip is not enough. We need to give more slip when the cabin is empty (with more slip the lift will go faster than without load in driving condition); in this case increase P09 (slip compensation driving gain) by 10% and measure again.
- If the cabin landing position is higher with half load than without load it means that the slip is too much. We need to give less slip when the cabin is empty (with less slip the lift will go slower without load in driving condition); in this case decrease P09 (slip compensation driving gain) by 10% and measure again.



- If the cabin landing position is the same with half load and without load, there is no need to change slip compensation driving gains. Slip frequency is correctly adjusted in driving condition.

Measure the stopping position when the cabin is going **up** (coming from a lower floor). Doing so, we are checking the slip in braking condition. Compare the position with the one measured with **half load**:

- If the cabin landing position is higher without load than with half load it means that the slip is not enough. We need to give more slip when the cabin is empty (with more slip the lift will go slower without load in braking condition); in this case increase P10 (slip compensation braking gain) by 10% and measure again.
- If the cabin landing position is higher with half load than without load it means that the slip is too much. We need to give less slip when the cabin is empty (with less slip the lift will go faster without load in braking condition); in this case decrease P10 (slip compensation braking gain) by 10% and measure again.
- If the stop distance is the same with half load and without load, there is no need to change slip compensation braking gains. Slip frequency is correctly adjusted in braking condition.

### 3.2 Method 2

The aim of this test is to reduce the differences between theoretical speed (low speed, for example 120 rpm) and measured speed. After that we can check the stopping position with different loads. If we achieve repeatability of stopping, no dependant of the cabin load, we only have to reduce (or increase) inverter ramps or move lift magnets (or flags, etc.) in order to stop at floor level.

For this method a tachometer is needed. At low speed the slip compensation is more critical in torque vector control. For that reason we recommend to measure the speed of the motor at very low speed, because we can observe better the effect of the slip compensation. For this test we can move the lift in inspection mode at very low speed (lower than the speed used normally in inspection mode).

We have to move the lift in maintenance mode with empty cabin in UP direction and in DOWN direction. For a 4 Hz of maintenance speed, speed measured in the motor shaft by means of a tachometer, has to be 120 rpm. If the measured speed is not the expected we should proceed as is explained below:

- If speed measured in DOWN direction is smaller than 120 rpm, slip is not enough; in that case increase P09 (slip compensation driving gain) by 10% and measure again.
- If speed measured in DOWN direction is higher than 120 rpm, slip is too much; in that case decrease P09 (slip compensation driving gain) by 10% and measure again.
- If speed measured in UP direction is smaller than 120 rpm, slip is too much; in that case decrease P10 (slip compensation braking gain) by 10% and measure again.
- If speed measured in UP direction is higher than 120 rpm, slip is not enough; in that case increase P10 (slip compensation braking gain) by 10% and measure again.

### 3.3 Additional settings

In case that due to motor's behavior auto tuning 3 cannot be finalized (inverter trips error *Er7*) is recommended to perform auto tuning mode 1. In that case no-load current and slip has to be adjusted manually.

The motor no-load current (parameter P06) defines the value of the current of the motor when no load is applied to the motor (magnetizing current). No-load current range normally is from 30 % up to 70 % of motor rated current (P03). To calculate it, following formula can be used:

$$P06 = \sqrt{(P03)^2 - \left(\frac{P02 \cdot 1000}{1.47 \cdot F05}\right)^2}$$



Too low values of P06 will make that the motor does not have enough torque. Too high values will make that the motor vibrates (the vibration in the motor may be transmitted to the cabin).

To set function P12 manually it can be calculated by following formula:

$$P12 = \frac{(\text{Synchronous\_speed}(rpm) - \text{Rated\_speed}(rpm)) \times \text{No\_Poles}}{120}$$

#### 4. How to check if the lift is correctly balanced

To achieve a good performance a correctly balanced lift is needed. The formula that gives us the load of the counterweight is the following (for a lift balanced with half load):

$$\text{Counterweight}(kg) = \text{Cabin}_{\text{weight}}(kg) + \frac{\text{Cabin}_{\text{load}}(kg)}{2}$$

Normally we don't have a mechanical data, so an empiric way to check if the lift is balanced is:

- To put half load inside the cabin
- To move the lift around the half of the shaft
- To check  $I_{out}$  in inverters keypad (Menu 3. DRIVE MONITORING in the 1<sup>st</sup> screen) going up and down, for example moving the lift in maintenance speed.

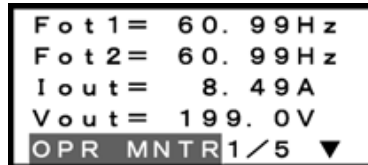


Figure 4.1 Inverter output current shown in the keypad (TP-G1-ELS)

If the lift is correctly balanced (correct counterweight for lift weight) current must be approximately same moving cabin in up and down direction. The motor needs same current to move the load in up and down directions. If the current is not the same we can have two situations:

- $I_{out}$  UP DIRECTION <  $I_{out}$  DOWN DIRECTION

Motor needs more current to move the counterweight than the cabin. It means that the counterweight is too heavy. Remove some weight from the counterweight and test again.

- $I_{out}$  UP DIRECTION >  $I_{out}$  DOWN DIRECTION

Motor needs more current to move the cabin than the counterweight. It means that the cabin is too heavy. Add some weight to the counterweight and test again.

#### 5. Recommended inverters setting

It is not easy to recommend a complete inverter setting because a lot of parameters depend on the installation, motor and lift controller. In the following table we try to summarize minimum parameters which have to be set on the inverter in order to obtain quickly a good behavior.

| PARAMETER | NAME                         | VALUE  |
|-----------|------------------------------|--|
| C21       | Speed command units          | 2: Hz  |
| P01       | Number of motor poles        | Motor name plate (poles)                         |
| P02       | Motor capacity               | Motor name plate (kW)                            |
| P03       | Motor rated current          | Motor name plate (A)                             |
| P06       | Motor no-load current        | Calculated by Auto tuning mode 3                 |
| P07       | Motor %R1                    | Measured by Auto tuning modes 1 and 3            |
| P08       | Motor %X                     | Measured by Auto tuning modes 1 and 3            |
| P12       | Rated slip                   | Measured by Auto tuning mode 3                   |
| F03       | Maximum speed                | Motor name plate (rpm)                           |
| F04       | Rated speed                  | Motor name plate (Hz)                            |
| F05       | Rated voltage                | Motor name plate (V)                             |
| F20       | DC braking starting speed    | 0.20 Hz  |
| F21       | DC braking level             | 50 %   |
| F22       | DC braking time              | 1.00 s   |
| F23       | Starting speed               | 0.50 Hz  |
| F24       | Starting speed holding time  | 0.50 s   |
| F25       | Stop speed                   | 0.20 Hz  |
| F42       | Control mode                 | 2: Torque vector control for induction motors    |
| L83       | Brake control OFF delay time | 0.00 s (in case that inverter control the brake) |

For speed, ramps and S-curves parameters please refer to FRENIC-Lift starting guide; the parameters values depend on the controller signals and the lift installation. Normally the inverter default setting for ramps and S-curve are correct values. To achieve a stopping non dependant on the load a short ramp from creep speed to stop is advisable.

## 6. Quick guide to solve problems

This chapter is made in order to give some clues to solve typical problems when setting up an Open Loop induction motor lift with FRENIC-Lift inverter.

The typical problems have been divided in three different zones: starting, travel and stopping.

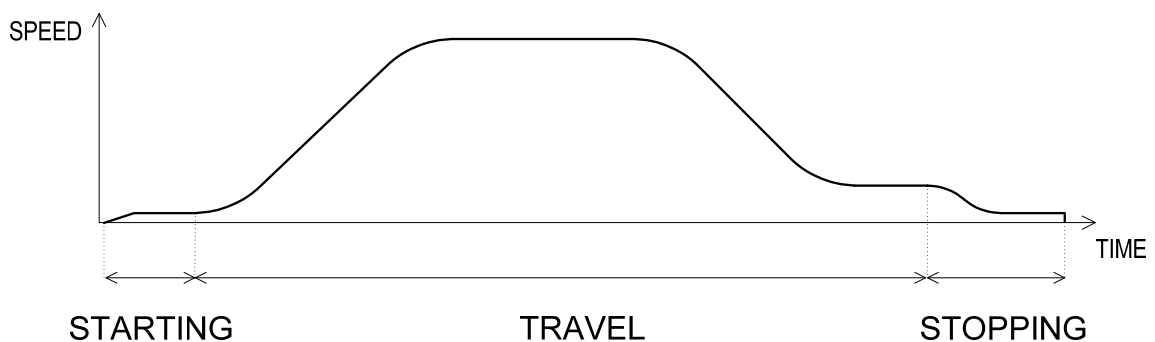


Figure 6.1 Lift typical profile



### 6.1 Problems at starting

|                        | Cause                                   | Action  |
|------------------------|---|---|
| <b>Rollback</b>        | Due to insufficient starting frequency  | Increase <b>F23</b><br><i>Max. F23=1.0 Hz</i>                 |
|                        | Due to early brake opening              | Increase <b>L82</b><br><i>Max. L82=F24-0.2 s</i>              |
|                        | Due to insufficient torque              | Increase <b>P06</b><br><i>P06=30~70% of P03</i>               |
| <b>Hit at starting</b> | Due to high value of starting frequency | Reduce <b>F23</b><br><i>Min. F23=0.1 Hz</i>                   |
|                        | Due to late brake opening               | Reduce <b>L82</b><br><i>Min. F23=0.20 s</i>                   |
|                        | Due to late brake opening               | Increase <b>F24</b><br><i>Max. F24=1.5 s</i>                  |
|                        | Due to high torque                      | Reduce <b>P06</b><br><i>P06=30~70% of P03</i>                 |
|                        | Not due to inverters parameterization   | Check brake operation<br>Check guides<br>Check cabin fixation |

### 6.2 Problems during travel

|  | Cause  | Action   |
|--|--|--|
| <b>Vibrations</b>                                | Due to high torque                                 | Decrease <b>P06</b><br><i>P06=30~70% of P03</i>  |
|  | Due to motor high speed                            | Reduce High speed<br><i>Use motor rated speed instead of motor synchronous speed</i>   |
|  | Not due to inverters parameterization              | Check guides<br>Check cabin fixation<br>Check motor connection ( $\Delta$ or $\lambda$ )<br>Check motor gear   |
| <b>Undershoot from high speed to creep speed</b> | Due to slip frequency too high                     | Reduce <b>P12</b><br><i>Min. P12=0.5 Hz</i>  |
|  | Due to fast deceleration                           | Increase deceleration ramp from High speed to creep speed<br><i>Max. E10-E16, F07-F08=2.00 s</i><br>Increase 2nd S-curve at deceleration<br><i>Max. L19-L28, H57-H60=50 %</i><br><i>(NOTE: Control that you always keep creep speed)</i> |
|  | Due to insufficient torque                         | Increase <b>P06</b><br><i>P06=30~70% of P03</i>  |
|  | Due to creep speed and slip frequency disagreement | Check if the following formula is fulfilled:<br>$\text{Creep speed} \geq \text{P12} + 2 \text{ Hz}$<br>In negative case increase Creep speed   |



### 6.3 Problems at stopping

|  | Cause   | Action  |
|--|---|---|
| <b>Hit at stopping</b>                                       | Due to early brake closing                          | Increase <b>L83</b><br>Max. $L83 = F22 - 0.2$ s<br>Check <b>F25</b> = 0.2Hz                                     |
|  | Due to heavy DC current injection                   | Reduce <b>F21</b><br>Min. $F21 = 50\%$  |
|  | Due to fast deceleration                            | Increase deceleration ramp between creep speed and stop<br><i>The maximum value depends on the lift magnets</i> |
|  | Not due to inverters parameterization               | Check security chain<br>Check brake operation   |
| <b>Rollback</b>  | Due to late brake closing                           | Reduce <b>L83</b><br>Min. $L83 = 0.1$ s<br>Check <b>F25</b> = 0.2 Hz  |
|  | Due to soft DC current injection                    | Increase <b>F21</b><br>Max. $F21 = 90\%$<br>Check $F22 \neq 0.00$ s   |
|  | Due to insufficient torque                          | Increase <b>P06</b><br>$P06 = 30 \sim 70\%$ of $P03$  |
|  | Not due to inverters parameterization               | Check security chain<br>Check brake operation   |
| <b>Leveling accuracy (positioning dependent on the load)</b> | Due to insufficient torque                          | Refer to chapter "3.3 Additional setting"   |
|  | Due to incorrect slip compensation gains adjustment | Refer to chapter "3.Slip compensation gains adjustment"   |



## CONTACT INFORMATION

### Headquarters Europe

#### Electric Europe GmbH

Goethering 58  
63067 Offenbach/Main  
Germany  
Tel.: +49 (0)69 669029 0  
Fax: +49 (0)69 669029 58  
info\_inverter@fujielectric.de  
www.fujielectric.de

#### Germany

Fuji Electric Europe GmbH  
Sales Area South  
Drosselweg 3  
72666 Neckartailfingen  
Tel.: +49 (0)7127 9228 00  
Fax: +49 (0)7127 9228 01  
hgneiting@fujielectric.de

#### Switzerland

Fuji Electric Schweiz  
ParkAltenrhein  
9423 Altenrhein  
Tel.: +41 71 85829 49  
Fax.: +41 71 85829 40  
info@fujielectric.ch  
www.fujielectric.ch

#### Italy

Fuji Electric Europe GmbH  
Filiale Italiana  
Via Rizzotto 46  
41126 Modena (MO)  
Tel. +390594734266  
Fax +390594734294  
adegani@fujielectric.de

#### United Kingdom

Fuji Electric Europe GmbH  
UK Branch  
Te.: +44 (0)7 989 090 783  
mkitchen@fujielectric.de

### Headquarters Japan

#### Fuji Electric Systems Co., Ltd

Gate City Ohsaki East Tower,  
11-2 Osaki 1-chome, Shinagawa-ku, Chuo-ku  
Tokyo 141-0032  
Japan  
Tel.: +81 3 5435 7280  
Fax: +81 3 5435 7425  
www.fesys.co.jp

Fuji Electric Europe GmbH  
Sales Area North  
Friedrich-Ebert-Str. 19  
35325 Mücke  
Tel.: +49 (0)6400 9518 14  
Fax: +49 (0)6400 9518 22  
mrost@fujielectric.de

#### Spain

Fuji Electric España  
Ronda Can Fatjó 5, Edifici D, Local B  
Parc Tecnològic del Vallès  
08290 Cerdanyola (Barcelona)  
Tel.: +34 93 582 43 33  
Fax: +34 93 582 43 44  
infospain@fujielectric.de

#### France

Drive & Automation (inverters, servos, HMI)  
Fuji Electric Europe GmbH  
French Branch  
265 Rue Denis Papin  
F - 38090 Villefontaine  
Tel.: +33 (0)4 74 90 91 24  
Fax: +33 (0)4 74 90 91 75  
svalenti@fujielectric.de

Subject to change without prior notice



FUJI INVERTERS

Elevator Inverter *FRENIC-Lift*