Fuji Electric
Innovating Energy Technology

APPLICATION NOTE	AN-Lift2-0004v100EN
Travel direction changes counter for coated ropes/belt lifts (Lift directive)	

Inverter type	FRENIC-Lift (LM2A)
Software version	Software version L2S1_03011150 or later
Required options	TP-A1-LM2 (Multifunctional keypad)
Software version	Software version A1K6_80010350 or later
Related documentation	DESIGN REQUEST DR-LIFT2_0011v131EN
Author	Jaume Alonso
Use	Public, web
Date	26/02/2015
Version	1.0.0
Languages	English

1. Introduction

According to EN81-1 suspension means must be evaluated according to a safety factor. If this safety factor is not reached suspension means might not be used. One way to use certain type of suspension means not reaching safety factor is by means of a type examination certificate. This type examination certificate defines under which circumstances product (in this case suspension ropes) can be used. Normally one of the conditions is the number of travels (direction changes) allowed. After number of travels is expired, ropes must be changed.

In the other hand, some elevators use coated ropes or belt as a suspension element. These types of suspension elements cannot be easily checked. Because of cover (belt or coat), metal part cannot be seen, making impossible a visual maintenance. One way to use these types of suspension elements is by means of type examination certificate. This type examination certificate defines under which circumstances product (in this case coated ropes or belt) can be used. Normally one of the conditions is the number of travels (direction changes) allowed. After number of travels is expired, coated ropes or belt must be changed.

Additionally, a lift with these types of suspension means, has to be equipped with a device which is monitoring and controlling number of travels (direction changes). This device must be able to lock any lift movement when lifetime of suspension means is finished.

2. How to recognize inverters which Travel direction counter (TDC) function

Basically, all standard family of FRENIC-Lift inverter (LM2A type), with the software number mentioned on the description of the document (or later versions), will have this function available. There are two name plates on the

inverter where inverter type is written. Both name plates, and the position in capacities from 0006 to 0032, are shown in figure 1.

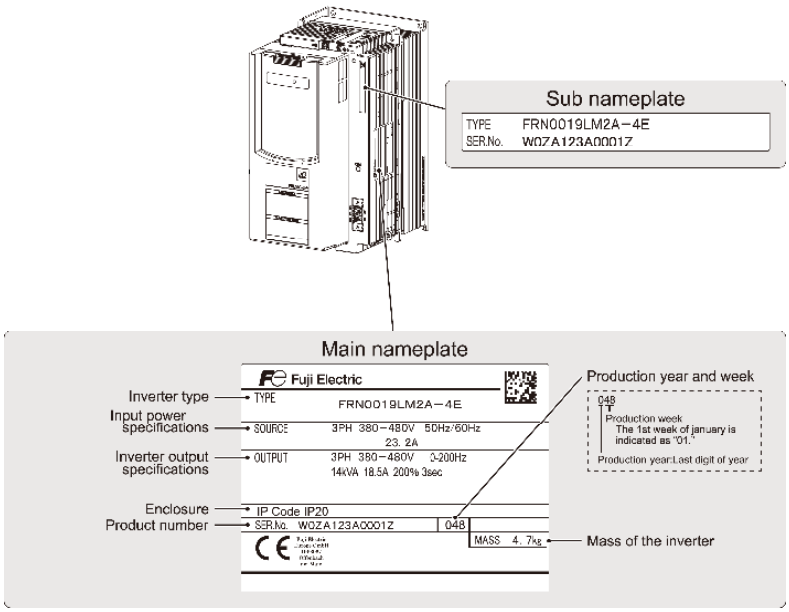


Figure 1. Inverter name plates and position in capacities from 0006 to 0032.

Name plates in other capacities is shown in figures 2 and 3.

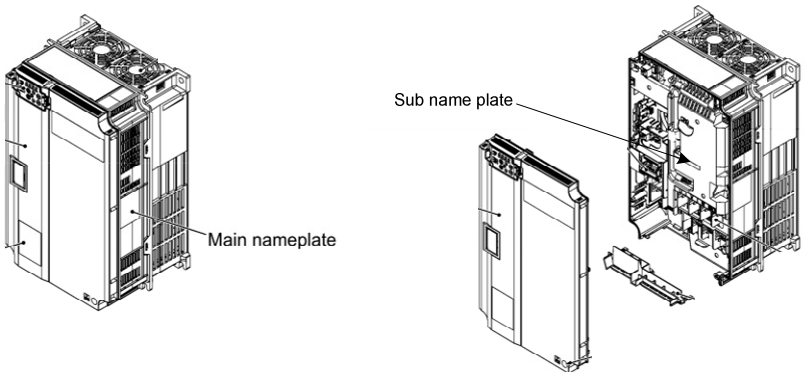


Figure 2. Name plate position in capacities from 0039 to 0045.

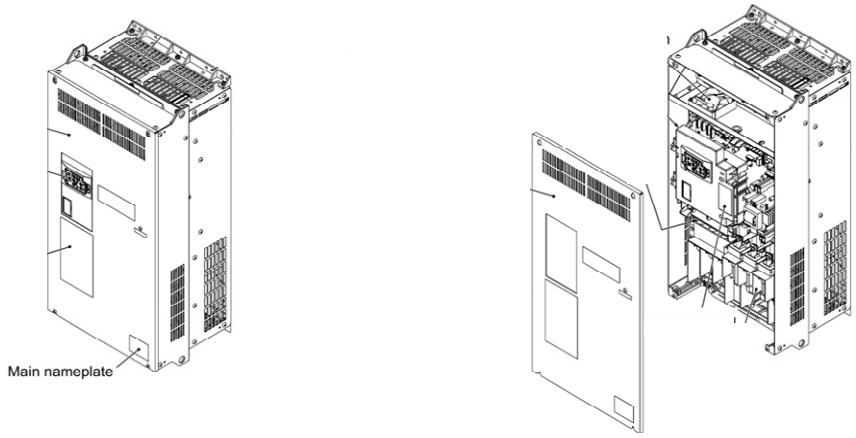
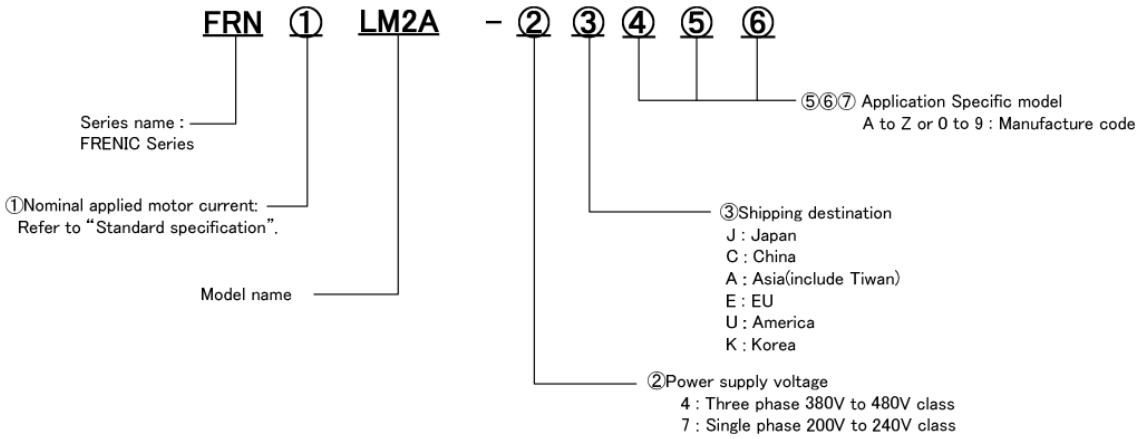


Figure 3. Name plate position in capacities from 0060 to 0091.

FRENIC-Lift (LM2A) types which include this function can be recognized by the below type code. This code is shown as inverter type in each name plate.



Inverter and keypad software version (ROM number) can be checked on Menu PRG>3>3 (PRG/INV Info/Maintenance) on page [8/9] as it is shown on figure 4.

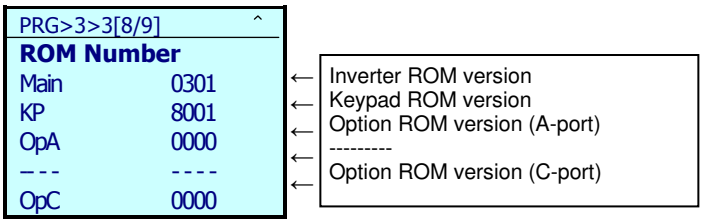


Figure 4. Page 8/9 of Menu PRG>3>3 on TP-A1-LM2.

As mentioned before, software can be updated, so this number might be different. In this case, software version will be always higher.

3. FRENIC-Lift basic diagram

On figure 5 a basic diagram of the inverter is shown.

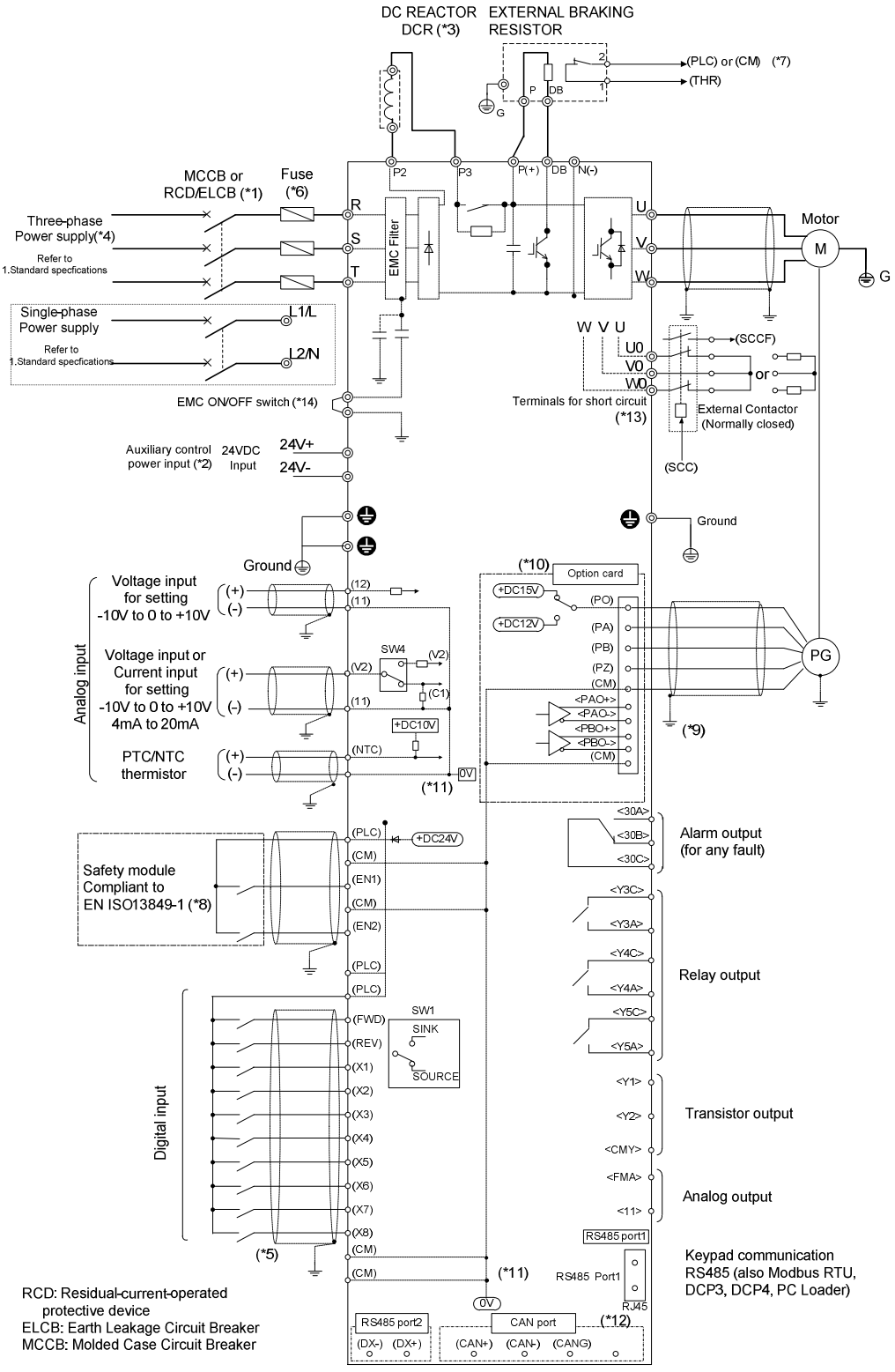


Figure 5. Basic inverter's diagram.

4. Description of functions and parameters

The parameters and functions related to TDC function are shown in table 1:

Table 1. Parameters and functions related to TDC function.

Function codes	Name	Setting range	Symbol	Unit	Default setting
E01 to E08, E98 and E99	Command assignment on [FWD] and [REV]	98(1098): Run forward	***FWD***	-	-
		99(1099): Run reverse	***REV***	-	-
E20 to E24 and E27	Command Assignment [Y1] to [Y5] and [30]	121(1121): Travel Direction Changes lifetime early warning	***TDCl***	-	-
		122(1122): Travel Direction Changes pulse	***TDCp***	-	-
L109	TDC Password setting	0000h: No password. Function disabled 0001h~FFFFh: Password setting	-	-	0000h
L110	TDC Password unlock	0000h: No password. Function disabled 0001h~FFFFh: Password unlock	-	-	0000h
L111	TDC Direction change limit	OFF: Disabled 0.01~10.00 Millions	-	-	OFF
L112	TDC Direction change early warning level	0: Disabled 1~90%: Percentage of L111	-	%	80
L113	TDC Partial number of direction change	Parameter range from 0.00 to 10.00 Millions	-	-	0.00
L114	TDC Total number of direction change	READ ONLY Parameter range from 0.00 to 10.00 Millions	-	-	0.00
L115	TDC Total number of resets	READ ONLY Parameter range from 0 to 65535	-	-	0
L197	Light alarm selection 1	Bit0: 0: - 1: *tCW*	-	-	0000 0000

This function is not active in factory default settings. It means that this function has to be activated. The parameter used to activate this function are explained below.

- Run forward ***FWD*** and Run Reverse ***REV***
  (Function code data 98 and 99)

  A part of the existing function of ***FWD*** and ***REV*** which is run the motor in forward and reverse direction, these two functions are used to detect direction change.

A direction change is understood as the movement when going from up to down, or down to up.

So each direction change (from ***FWD*** to ***REV*** or from ***REV*** to ***FWD***) will be counted and reflected in parameter **L113** (partial counter) and **L114** (global counter).

If ***EN1*** and ***EN2*** terminals are not activated while changing from ***FWD*** to ***REV*** or from ***REV*** to ***FWD***, internal counter will not be increased, as this cannot be counted as a travel.

- Travel Direction Changes lifetime early warning ***TDCl***
  (Function code data 120)

  This output function will go from OFF to ON when **L112** (TDC Direction change early warning level) is reached. **L112** is a percentage of **L111** (TDC Direction change limit). This level is reached when **L113** reaches the percentage of **L111** set in **L112**.

  When output function is in ON status, and **L113** becomes different than **L112** percentage of **L111**, output will go to OFF condition.

  L112 set to 0% is understood as disabled. So in this case inverter will not show any warning, and output will not go from OFF to ON even 120 (or 1120) is set.

  Early warning function is linked to a light alarm called *tCW*. For additional information, please check **L197** parameter information.

- Travel Direction Changes pulse ***TDCp***
  (Function code data 121)

  This output function generates a pulse each time that **L113** is increased. In other words, output generates a pulse each time changing from ***FWD*** to ***REV*** or from ***REV*** to ***FWD.***

  This pulse can have a duration of 0.5 s.

- TDC Password setting
  (Parameter **L109**)

  In this parameter, password for TDC can be defined. In other words, until password is not assigned in **L109**, TDC function remains disabled.

  Setting range is described below:

  - 0000h: No password. Function disabled.
  - 0001h~FFFFh: Password setting.

As soon as password is defined, **L109** returns to default setting value (0000h).

After assigning a password, TDC function has to be locked. To do so, please turn the power supply of the inverter OFF, wait until keypad is not lighted, and switch ON again.

- TDC Password unlock
(Parameter **L110**)

  In this parameter, password can be set in order to unlock menu 2. Setting, 4. Set PW and 5. TDC Copy. Setting range is described below:

  - 0000h: No password. Function remains locked.
  - 0001h~FFFFh: Password setting

  As soon as password is introduced, **L110** returns to default setting value (0000h).

  After modify TDC function parameters, make sure function is locked again. To do so, please turn the power supply of the inverter OFF, wait until keypad is not lighted, and switch ON again.

- TDC Direction change limit
(Parameter **L111**)

  Maximum travel direction changes allowed are set in this parameter. When parameter **L113** reaches this level, inverter is blocked with the alarm *tCA*.

  Setting range is described below:

  - OFF: Disabled.
  - 0.01~10.00 Millions: Maximum number of travel direction changes allowed. Where 0.01 are 10.000 changes and 10.00 are 10.000.000 changes.

- TDC Direction change early warning level
(Parameter **L112**)

  The early warning level (***TDCl***) is set on this parameter. Setting range is 1%~90%. Level is a percentage of parameter **L111**. Additionally, keypad will issue a light alarm as soon as **L111** reaches percentage set on this parameter.

Setting range is described below:

- 0%: Disabled.
- 1%~90% Tripping level of early warning. Related to **L111**.
-

- TDC Partial number of direction change
  (Parameter **L113**)

  In this parameter the accumulated number of direction changes is shown. In other words, when running direction is changed from ***FWD*** to ***REV***, or from ***REV*** to ***FWD*** counter is incremented.
  This parameter can be modified and set back to 0.00. When this parameter is manipulated (changed the value) is understood that belts or coated ropes are changed, and then **L115** counter is increased by one.

  By definition **L113** counter cannot be bigger than **L111** limit, in other words, inverter will trip *tCA* when **L113**=**L111**.

  After modifying this parameter (reset), TDC function has to be locked. To do so, please turn the power supply of the inverter OFF, wait until keypad is not lighted, and switch ON again.

- TDC Total number of direction change
  (Parameter **L114**)

  This is ONLY READ parameter. It shows total number of direction changes. In other words, when running direction is changed from ***FWD*** to ***REV***, or from ***REV*** to ***FWD*** this counter is incremented. This parameter cannot be reset in order to detect if function is used properly. In other words, if total number of direction change, direction change limit and total number of resets doesn't match, it means that somebody is manipulating intentionally the inverter in order to avoid changing belts (or coated ropes). So sabotage can be detected.

  On the other hand, lifts which uses belt (or coated ropes) are designed for a very low duty cycle, so 10 million cycles (direction changes maximum setting) should be more than enough.

  Monitoring range is described below:

  - 0.00~10.00 Millions: Maximum number of travel direction changes allowed. Where 0.01 are 10.000 changes and 10.00 are 10.000.000 changes.

- TDC Total number of resets
  (Parameter **L115**)

  This is ONLY READ parameter. It shows total number of reset operations. It increments to one each time that parameter **L113** is modified.

- Light alarm selection 1
  (Parameter **L197**)

  Bit 0 of parameter **L197** defines the state of light alarm related to early warning setting (**L112**). Meaning of bit setting is described below:

  - Bit0=0: Light alarm disabled (default setting)
  - Bit0=1: Light alarm enabled (*tCW*)

  When **L113** counter reaches value of the percentage set on **L112** of **L111** limit light alarm is shown on inverter's keypad. As well WARN. Led will blink in orange. Light alarm doesn't lock the inverter functionality. The purpose of a light alarm is just to prevent user that life time of coated ropes (or belt) is going to be expired soon.

5. Function behaviour

In figure 6, a basic time chart is shown. As it can be observed, several travels in forward (up) and reverse (down) direction are shown. When direction is changed from up to down, or from down to up, **L113** counter increases one unit. At same time, an output programed with the function ***TCDp*** outputs a pulse. On the other hand, even starting a new travel direction is not changed, nothing changes on outputs or counter. In this example **L112** is set to 60%. When **L113** counter reaches the value 2, which corresponds to the 66.66% of travel limit, an output programed with the function **TCDI** changes from OFF to ON. At same time, light alarm for pre warning is shown in the keypad (*tCW*). When **L113** counter reaches the value 3, inverter is blocked by the alarm *tCA*. Even forward or reverse are activated, inverter will not allow any other travel until suspension means are changed and **L113** counter is reset. For additional information about alarm code check chapter 9. Extra travels, pre warning and alarm reset.

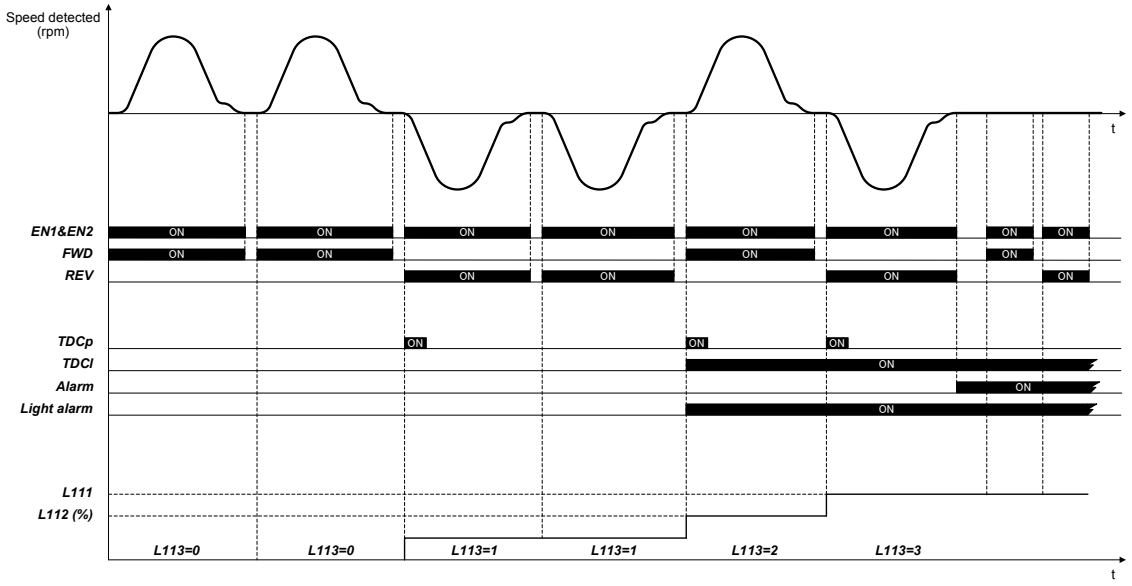


Figure 6. Basic function time chart of TDC function

6. Example of wiring and setting

This function is not active in factory default settings. It means that this function has to be activated. This chapter shows an example of inverter wiring and setting.

Figure 7 shows an example of connection. On this example, there is an inverter connected to a lift controller by means digital inputs and outputs. It is understood as inputs the signals going from the controller to the inverter, on the other hand, it is understood as outputs signals going from the inverter to the controller. From the controller side there are four signals, two to give up (**FWD**) or down (**REV**) direction and two to enable the inverter (**EN1** and **EN2**). From the inverter side there are three signals; one to inform about alarm status (**ALM**), another to inform about pre warning (**TDCI**) and last one to give information about direction changes (**TDCp**). Signals for pre warning and direction changes are optional.

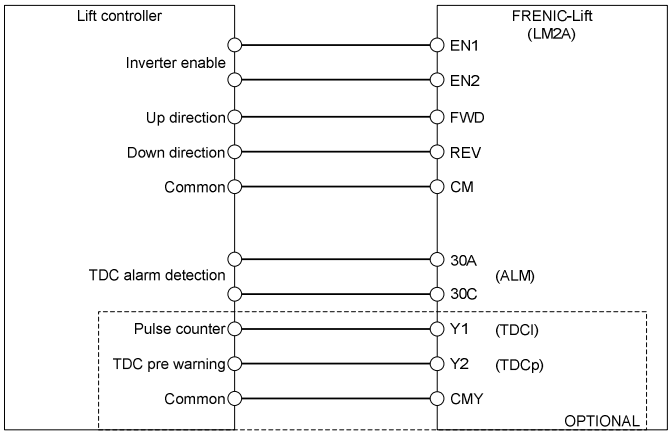


Figure 7. Wiring example for TDC function

According to figure 7, related parameters have to be set as described in table 2.

Table 2. Parameters setting according to figure 7 example.

Parameter	Name	Setting
E98	Input terminal [FWD]	98
E99	Input terminal [REV]	99
E20	Output terminal [Y1]	121
E21	Output terminal [Y2]	122
E27	Output terminal [30/A/B/C]	99
L109	TDC Password setting	Different in each case. For additional information please refer to chapter 7.
L111	TDC Direction change limit	7.00
L112	TDC Direction change early warning	80%
L197	Light alarm selection 1	0000 0001 (1h)

7. Set a password and enable TDC function

In order to enable TDC function a password has to be set. This can be done in specific menu of keypad for TDC function. To do so please go to menu 4.Set PW in Travel Direction Counter specific menu as is shown in figure 8 (PRG>3>5>4).

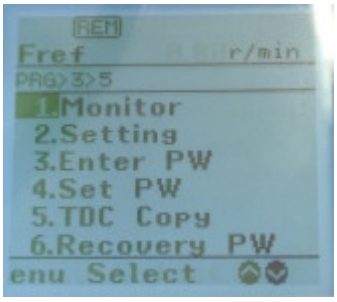


Figure 8. Set password menu to enable TDC function

To set a password a combination of buttons has to be used, in other words, to set a digit of the passwords, use ▲ or ▼ and STOP at same time. To scroll digits, use ◄ to go to left direction or ► to go to right direction. As soon as password is set, valudate it by pressing SET.

Note After setting the password, turn the power supply of the inverter OFF and ON in order to enable the function. Otherwise it will remain disabled.

After enabling the function, some menus will be locked as shown in figure 9.

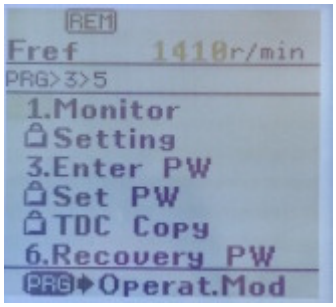


Figure 9. Locked menus after setting the password

8. Unlock the function and modify setting

In order to set TDC function a password has to be entered. This can be done in specific menu of keypad for TDC function. To do so please go to menu 3.Enter PW in Travel Direction Counter specific menu as is shown in figure 9 (PRG>3>5>3).

To enter a password a combination of buttons has to be used, in other words, to set a digit of the passwords, use  or  and  at same time. To scroll a digit, use  to go to left direction or  to go to right direction. As soon as password is set, valudate it by pressing  . As soon as password is entered, locked menus are unlocked.

Menu 2.Setting (PRG>3>5>2) is the specific menu for TDC function setting. On Menu 2.Travel Limit (PRG>3>5>2>2) the maximum number of direction changes allowed can be set. On Menu 3.Warning level (PRG>3>5>2>3) the level for pre warning of direction changes allowed can be set.

Note Check with coated ropes (or belt) manufacturer the maximum number of direction changes allowed. This number might be different for each manufacturer and each type of coated ropes (or belt).

Note To set the pre warning level, check the average number of travels expected per day. After this, calculate the percentage of pre warning level. Set the pre warning level in order that, light alarm is tripping minimum half a year before reaching maximum level of travels allowed.

Note After setting the password, turn the power supply of the inverter OFF and ON in order to enable the function. Otherwise it will remain disabled. Make sure that before turning power supply ON keypad is completely OFF.

9. Extra travels, pre warning and alarm reset

As soon as maximum number of direction changes allowed is reached, inverter will be blocked by *tCA* alarm. Even so, extra movements (travels) can be done. As soon as power supply is switched OFF and ON (make sure keypad is completely OFF) alarm *tCA* will be reset. After this a single travel is allowed, as

soon as a single travel is finished (RUN command is removed), inverter will be blocked by *tCA* alarm again.

In order to reset the alarm, coated ropes (or belt) has to be changed by a new ones. After that, direction changes counter can be reset. Menu 2.Setting (PRG>3>5>2) is the specific menu for TDC function setting. On Menu 1. Reset counter (PRG>3>5>2>1) a reset of the counter can be performed. Modify the value of the counter and validate it pressing the button SET.

After that, direction change counter will be set back to 0 and number of resets will be increased by 1. Alarm can be reset by RESET button. Pre warning will disapear alone.

Note Make sure to reset the counter in the right moment, in other words, when live time of coated ropes (or belt) is expired, otherwise it will be understood that inverter has been manipulated (sabotage).

10. TDC monitoring information

TDC keypad menu has a specific sub menu to monitor all related variables. To do so go to menu 1. Monitor of TDC function specific menu (PRG>3>5>1). Table 3 contains information shown in this menu.

Table 3. Information related to TCD in Monitor menu

Name	Description
Current number of direction changes	Current value of internal counter. Minimum unit change is 1. Maximum number shown is 10000000.
Direction changes limit	It corresponds to the value on parameter **L111**
Total number of direction changes	It corresponds to the value on parameter **L114**
Total number of direction changes counter resets	It corresponds to the value on parameter **L115**
Warning level (%)	It corresponds to the value on parameter **L112**

11. Copy and paste TDC related parameters

In case that an inverter is broken and has to be replaced, keypad can Copy and Paste (Read and Write) counters and levels from one inverter to another one.

TDC keypad menu has a specific sub menu to copy/paste all related variables. To do so go to menu 5. TDC Copy of TDC function specific menu (PRG>3>5>5). Table 4 shows different options of TDC copy menu, to validate the action press always SET button.

Table 4. Copy and paste function

Name	Description
INV→ KP Read	L109, L111, L112, L113, L114 and L115 parameters are copied (read) from inverter to the keypad.
KP→ INV Write	L109, L111, L112, L113, L114 and L115 parameters are pasted (write) from keypad to the inverter.

Note For safety, and in order to be able to recover counters and limits data in case of CPU error, keypad is making an automatic copy every 5 minutes. Make sure to have always TP-A1-LM2 installed when using this function.

12. Lost password

It can happen that end users create a password in order to use TDC function and it loses it. If password is lost there is no way to reset internal counter, so as soon as maximum travels are reached, inverter will be locked forever.

In order to avoid that, each time that password is introduced, inverter generates a code which is shown in TDC function specific menu. To do so go to menu 6. Recovery PW of TDC function specific menu (PRG>3>5>6). In figure 10 an example of code is shown.

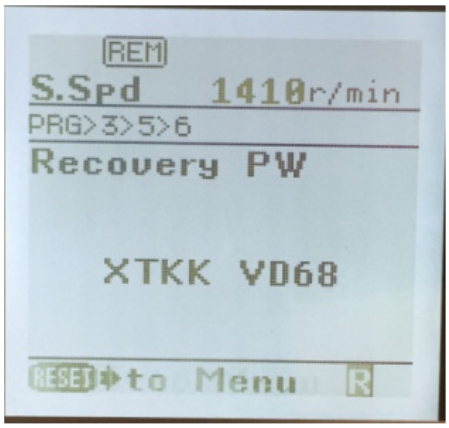


Figure 10. Generated password example

Note By means of generated code, FEE technical department staff can recover the set password.

13. Conclusion

This Application Note explains how to set, use and give a configuration example of TDC function.

By means of TDC function, FRENIC-Lift is able to safely handle elevators with reduced diameter ropes, coated ropes or belt:

- FRENIC-Lift counts number of travels (direction change) allowed for each ropes/belt type.

- FRENIC-Lift informs in advance when counter is going to be finished. This signal can be programed by end user (optional). Additionally a light alarm is be shown in the keypad.

- FRENIC-Lift blocks the elevator when lifetime of ropes/belt is expired. Under certain conditions a travel will be allowed. Normal use will not be possible until ropes are changed (counter is re initialized).

14. Document history

Version	Changes applied	Date	Written	Checked	Approved
1.0.0	First version	26/02/2015	J. Alonso	J. Català	W. Visser