Fuji Electric

Innovating Energy Technology

FRENIC-Lift

Starting guide for CAN CiA 417

Dedicated
Inverter for Lift
Applications

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

SG_LM2A_CAN417_EN_0.0.3

Version	Changes applied	Date	Written	Checked	Approved
0.0.1	Draft	30.07.2018	J. Alonso	M. Fuchs	
0.0.2	CAUTION message is included for DCP compatibility. Figure 1.4 and 1.5 modified. Some text modified or added.	27.09.2018	J. Alonso	M. Fuchs	
0.0.3	Table 3.4 text modified. Figures 8.1, 8.2 and 8.3 added. Chapter 6 and 7 slightly modified (text and figures).	26.11.2018	J. Alonso	M. Fuchs	J. Català

CONTENTS

0. Introduction

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

This starting guide includes the basic information to operate FRENIC-Lift (LM2A) via CANopen CiA 417. To do so a lift controller based on CANopen CiA 417 is necessary. This starting guide is written from end users point of view (not developers).

FRENIC-Lift (LM2A) supports Velocity mode (open and closed loop) and Profile position mode.

Note This starting guide is based on firmware version 1200 or later. For other software versions, please contact with Fuji Electric technical department.
Firmware version (ROM) can be monitored on TP-E1U in 5_14 and on TP-A1-LM2 in 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).
- FRENIC-Lift Starting guide SG_LM2A_EN_x.x.x (SG).

⚠CAUTION

CANopen 417 is not compatible with DCP communications (3 or 4). Therefore Virtual Console of CANopen 417 cannot be used at same time than DCP monitor function.

1. Connections

1.1 CAN bus terminal

CAN bus terminal is placed in Terminals-PCB and it is called TERM1. Terminal is shown in figure 1.1; the meaning of each terminal is described in table 1.1.

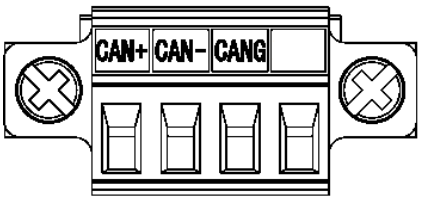


Figure 1.1. CAN bus terminal

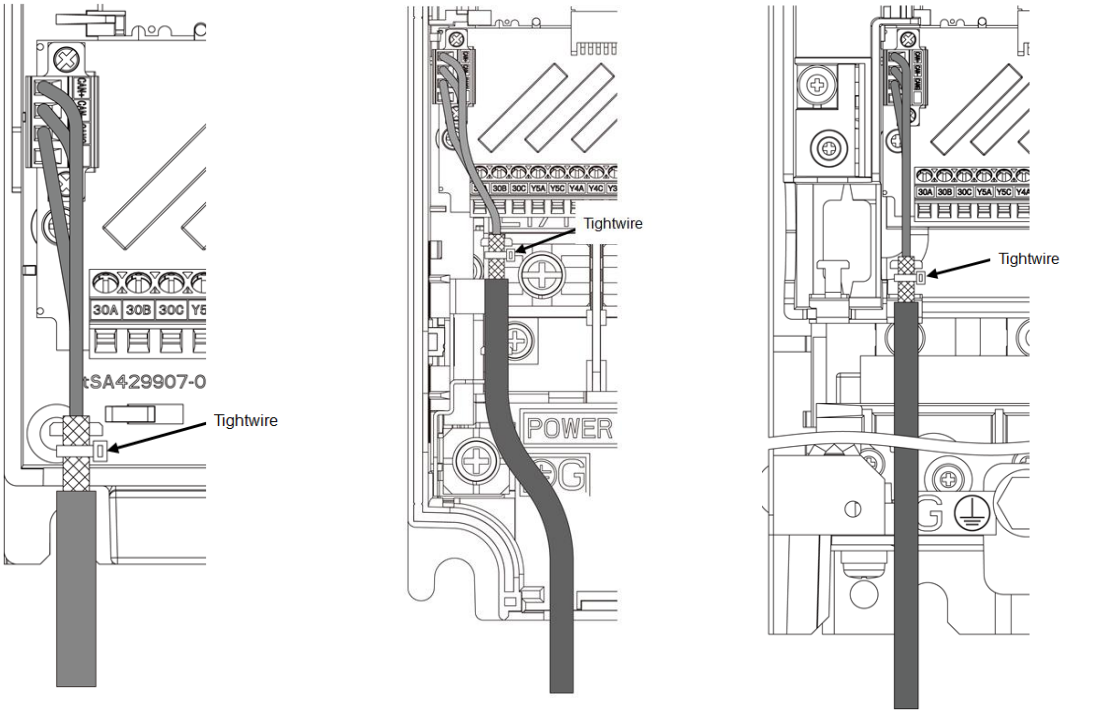
Table 1.1. CAN bus terminal symbols description

Symbol	Description	Comments
CAN+	CAN H	
CAN-	CAN L	
CANG	CAN ground	Terminal not mandatory. It depends on each CAN bus topology. If there is no ground cable in CAN bus, don't connect anything on this terminal.
Blank	Not used	

Note To prevent malfunction against the noise and ensure reliability please use twisted and shielded cables for CAN bus.

1.2 Shield connection

As explained before, it is recommended to use shielded cables. FRENIC-Lift has specific metal plates to connect the shield of CAN bus wires. The position of the metal plate depends on the inverter capacity. Each plate position is shown in figure 1.2.



(FRN0011LM2A-7□/ FRN0018LM2A-7□) (FRN0006LM2A-4□to FRN0032LM2A-4□)

(FRN0039LM2A-4□/ FRN0045LM2A-4□)

(FRN0060LM2A-4☐to FRN0091LM2A-4☐)

Figure 1.2. Metal plate for shield connection position

1.3 Terminal resistor

FRENIC-Lift CAN bus is provided with a terminal resistor. Terminal resistor is placed next to the CAN bus terminal as shown in figure 1.3.

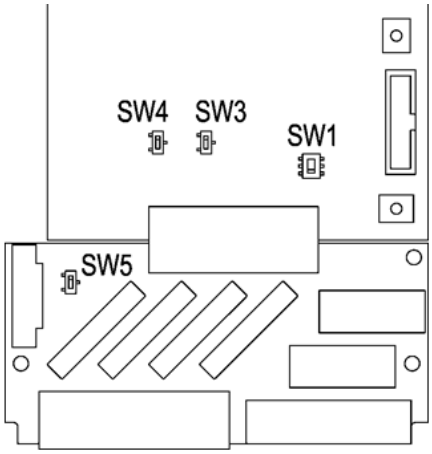


Figure 1.3. SW5 position in Terminals-PCB.

By default the terminal resistor is disabled (OFF position). If the inverter is one of the end components in CAN bus, please enable terminal resistor by placing SW5 in ON position.

Figure 1.4 shows a bus configuration where FRENIC-Lift is not at the end of bus, therefore SW5 has to be set to OFF.

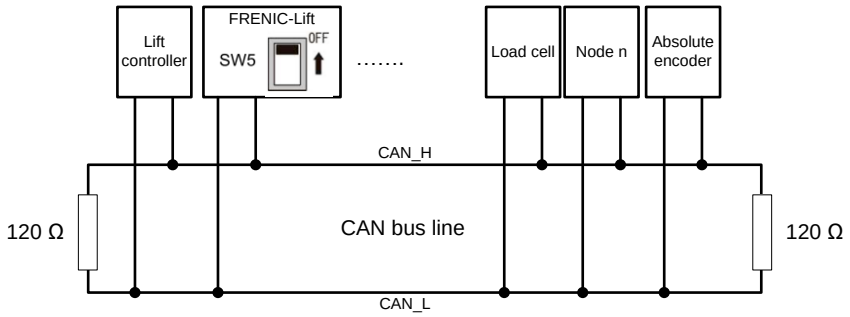


Figure 1.4. CAN bus configuration where FRENIC-Lift is not at the end

Figure 1.5 shows a bus configuration where FRENIC-Lift is at the end of bus, therefore SW5 has to be set to ON.

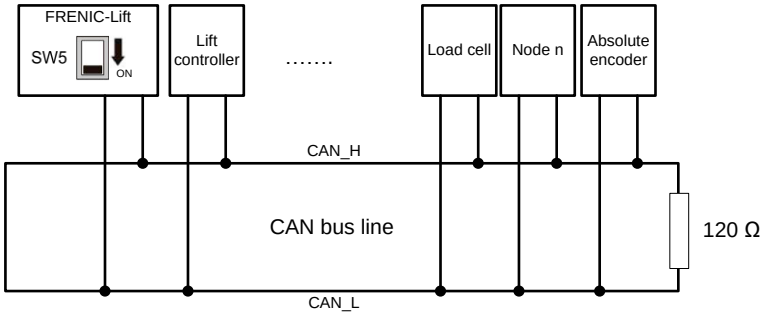


Figure 1.5. CAN bus configuration where FRENIC-Lift is at the end

2. Virtual console

FRENIC-Lift has implemented the Virtual console function; therefore it can be operated by means of lift controller keypad. Data can be monitored by lift controller screen as well. The way to access virtual console and the buttons functionality differs from each lift controller manufacturer. For additional information how to access virtual console, please check with each lift control manufacturer.

2.1 Virtual console keys

In table 2.1, the main function for each key on the controller keypad is described. The sign shown in the key column might differ from the controller's keypad.

Table 2.1. Virtual console keys description

Key	Role / behavior
S	Move to the next group which is defined in current page. If the next group is not defined, nothing happens. In case of "Function setting group" or "F-code + Monitor", move to corresponding function setting. Request writing the value to the function code, then move to "waiting" page. Decide to execute or not.
↑	Move to previous page in current group. In case of the first page, move to the last page. Increment setting value toward maximum value. Move cursor to "yes".
↓	Move to next page in current group. In case of the last page, move to the first page. Decrement setting value toward minimum value. Move cursor to "no".
→ or +	Move cursor to the right. In case the cursor is located at most right, move cursor to most left.
← or −	Move to the previous group which is defined in current page. If the previous page is not defined, nothing happens. Back to the original page without storing the function code data.

Figure 2.1 shows a flow diagram to move across Virtual console and its menus.

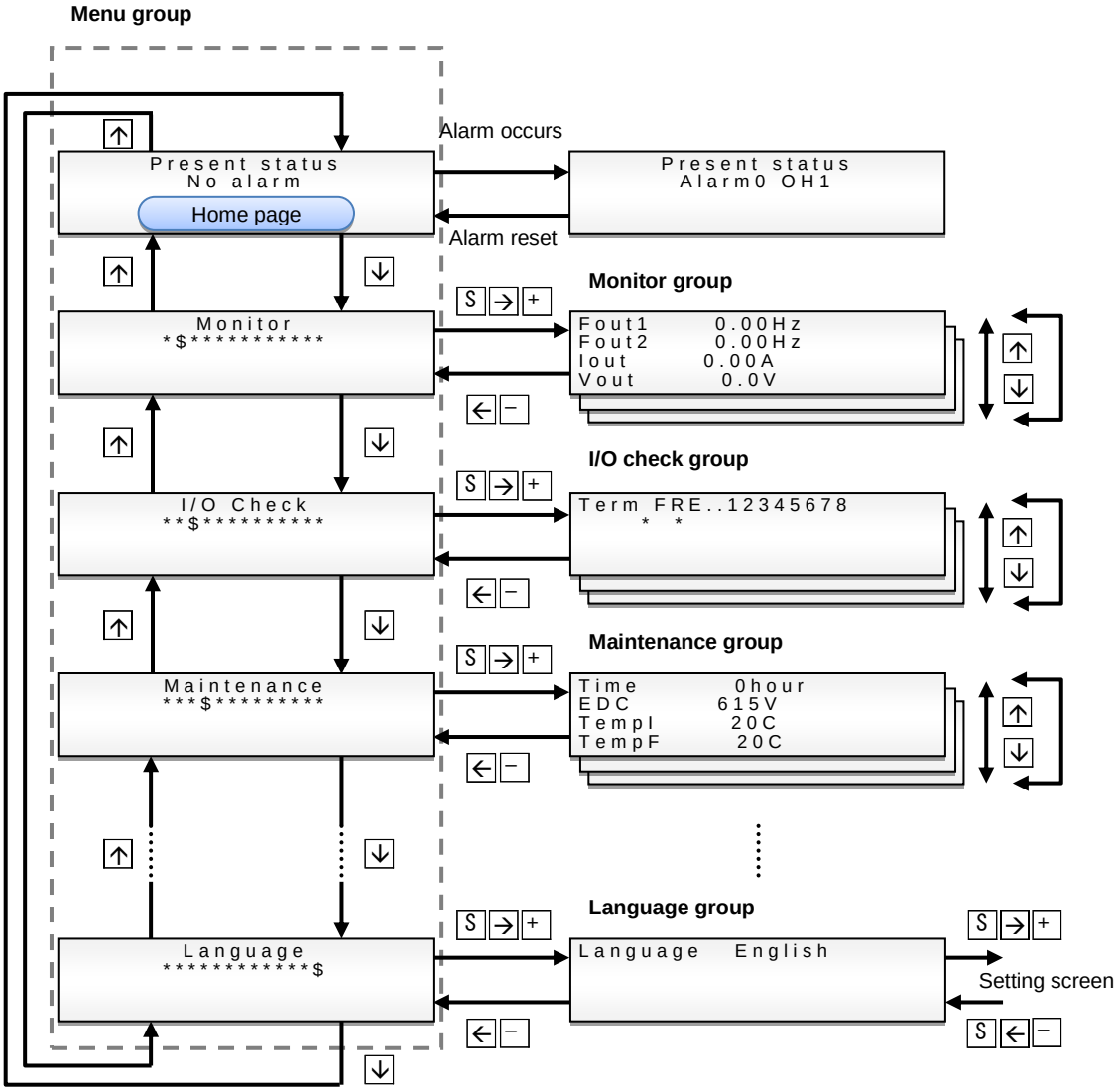
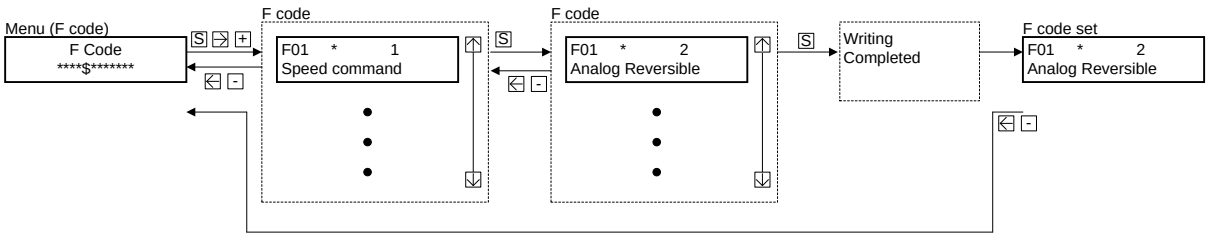


Figure 2.2 shows how to modify the setting of parameter F01 using Virtual keypad keys. The setting of parameter F01 is modified from 1 (default setting) to 2. Parameter is modified as soon as the screen showing the message “Writing completed” appears.

Figure 2.1 Inverter parameter modification example



2.2 Virtual console menus

Virtual console is organized by different menus; in each menu different information can be monitored or modified. The name of the menus is listened below:

- Monitor
- I/O check
- Maintenance
- Alarm
- Function codes
- Language setting

Function codes are grouped by families. Families are F, E, C, P, H, L, L1, L2 and L3.

Two types of languages can be selected: English and German.

Tables below show which information can be monitored or modified in each menu.

Table 2.2 Monitor menu

Page No.	Page content
0	Reference speed
	Primary speed
	Output current
	Output voltage
1	Reference speed (pre-ramp)
	Detected speed (r/min)
	Detected speed (m/min)
	Elevator speed (mm/s)
2	Operation status
3	Torque calculation value
	Reference torque bias
	Reference torque current
	Reference torque
4	Estimated value for OL1
	Motor temperature by NTC
	-BLANK-
	-BLANK-

Table 2.3 I/O check menu

Page No.	Page content
0	Terminal input
1	Terminal input (link)
2	Terminal output
3	Analog input 12
	Analog input C1
	Analog input V2
	PTC input (pending)
4	Electric angle (final)
	Electric angle
	Mechanical angle
	Detected magnetic pole position
5	Pulse frequency (A/B)
	Pulse frequency (Z)
	-BLANK-
	-BLANK-

Table 2.4 Maintenance menu

Page No.	Page content
0	Cumulative operation time
	DC link circuit voltage
	Internal maximum temperature
	Heat sink maximum temperature
1	Maximum effective current
	Capacitance of DC link capacitor
	-BLANK-
	-BLANK-
2	Cumulative operation time of motor
	Cumulative energization time of capacitors on PCB
	Cumulative run time of cooling fan
	-BLANK-
3	Number of startups
	Integral power consumption
	Number of RS-485 error
	Content of RS-485 error
4	ROM version of inverter
	Inverter capacity and voltage
	ROM version of Option (Port-C)
	Option name (Port-C)
5	Fixed string “Type”
	<Inverter type name>
	Fixed string “Serial No.”
	<Inverter serial number>

Table 2.5 Alarm menu

Page No.	Page content
0	Reference speed
	Torque calculation value
	Output current
	Output voltage
1	Reference speed (pre-ramp)
	Detected speed
	magnetic pole position offset
	-BLANK-
2	Reference torque current
	Reference Torque
	-BLANK-
	-BLANK-
3	Operation status
4	Cumulative operation time
	DC link circuit voltage
	Number of startups
	-BLANK-
5	Internal maximum temperature
	Heat sink maximum temperature
	-BLANK-
	-BLANK-
6	Terminal input
7	Terminal input (link)
8	Terminal output

3. Basic setting

To enable the internal CAN interface it is necessary to setup some basic Function codes. Basic function codes are shown in table 3.1.

Table 3.1. Basic setting to enable CANopen CiA 417 control

Function code	Description	Setting	Comments
H30	Communications Link Operation	0033 h	
y33	CAN (Operation)	2: Enable (CiA 417)	
F03	Rated speed (maximum speed)	30.0 to 6.000 rpm	Motor maximum speed to reach lift maximum speed (L31).
L31	Elevator parameter (speed)	1 to 4.000 mm/s	Lift speed at maximum motor speed (F03).

Example 1: 0,6 m/s lift with an Induction motor of 1450 rpm -> F03=1450 rpm, L31=600 mm/s
Example 2: 2,5 m/s lift with a Permanent magnet synchronous motor of 60 rpm -> F03=60 rpm, L31=2500 mm/s

By setting y33=2 the inverter automatically sets the Node ID = 2 and the baud rate to 250 kbps as recommended in CiA DS 417 standard. If your controller works with different settings, please refer to table 3.2.

Table 3.2. Additional setting to enable CANopen CiA 417 control

Function code	Description	Setting range
y21	CAN communication (Node-ID)	1 to 127
y24	CAN communication (Baud rate)	0: 10 kbps 1: 20 kbps 2: 50 kbps 3: 125 kbps 4: 250 kbps 5: 500 kbps 6: 800 kbps 7: 1 Mbps

To enable all settings related to basic CANopen communication it is necessary to reboot the inverter; it is recommended to reboot also the Lift Controller. Power down until keypad and charging LED are OFF, then power ON again. After rebooting, the controller will transmit the specific CANopen objects for the application to the inverter.

When boot up sequence is finished, make sure lift controller does not display any error related to inverter (drive unit). In affirmative case, please check with lift controller manufacturer.

Additionally make sure there is a value different from 0000h in the parameters shown in table 3.3. If the value is different from 0000h means that lift controller has set them properly.

Table 3.3. Lift shaft characteristics parameters

Function code	Description	Setting range
L311	Number of position units (High)	0000_H to $FFFF_H$
L312	Number of position units (Low)	0000_H to $FFFF_H$
L313	Total length in millimetres (High)	0000_H to $FFFF_H$
L314	Total length in millimetres (Low)	0000_H to $FFFF_H$
L317	Min position range limit (High)	8000_H to $7FFF_H$
L318	Min position range limit (Low)	0000_H to $FFFF_H$
L319	Max position range limit (High)	8000_H to $7FFF_H$
L320	Max position range limit (Low)	0000_H to $FFFF_H$
L321	Min position limit (High)	8000_H to $7FFF_H$
L322	Min position limit (Low)	0000_H to $FFFF_H$
L323	Max position limit (High)	8000_H to $7FFF_H$
L324	Max position limit (Low)	0000_H to $FFFF_H$

If all above parameters remain to 0000h and lift controller does not use them, it is recommended to set the maximum value on Max parameters and minimum value on Min parameters as shown in table 3.4.

Table 3.4. Lift shaft characteristics parameters recommended setting

Function code	Description	Recommended setting
L317	Min position range limit (High)	8000_H
L318	Min position range limit (Low)	0000_H
L319	Max position range limit (High)	$7FFF_H$
L320	Max position range limit (Low)	$FFFF_H$
L321	Min position limit (High)	8000_H
L322	Min position limit (Low)	0000_H
L323	Max position limit (High)	$7FFF_H$
L324	Max position limit (Low)	$FFFF_H$

4. Start-up

It is recommended to follow the start-up procedures described on FRENIC-Lift LM2A Starting guide. The start-up procedure is different depending on the motor type (Induction Motor open or closed loop and Permanent Magnets Synchronous Motor). Start-up procedure can be done either with FRENIC-Lift keypads (TP-A1-LM2 or TP-E1U) or with Virtual console (described on Chapter 2 of this manual).

In case that your lift controller controls the opening of the brake, make sure that it is disabled during Pole tuning (for PMS motors) and Auto tuning (for Induction motors). If brake opens, the result of the tuning might be not correct, additionally the lift car might move without control.

Make sure as well that the travel cancellation due to no movement function is disabled. If your lift controller has this function activated, due to the non-movement of the lift car during the tuning, it will stop the tuning process. In such case inverter will trip Er7 (SUB=7 or 24).

As described on the Starting guide, first movement should be carried out in inspection (auxiliary control mode). Check if the driving direction matches with the commanded direction. If it does not match change the bits 6 and 7 in function code L310 as shown in table 4.1. This function code is equivalent to CANopen CiA Object 641Eh.

Table 4.1. Function code L310 desciption

Function code	Description	Setting range
L310	Polarity	0 to 255d 64d: Invert velocity polarity 128d: Invert position polarity 192d: Invert velocity and polarity

At this point, it is important to make sure that the speed monitored in inverter keypad and real lift speed (Speed shown by shaft encoder or controller) is the same. If this is not the case, check the setting on the function codes F03 (maximum speed) and L31 (Elevator speed). For additional information check Chapter 3 on this guide.

5. Lift speed profile settings

The lift speed profile, in other words, lift comfort, can be adjusted either by CANopen objects or by inverter parameters. This chapter explains how to adjust speed profile by inverter parameters. In case of CANopen objects please refer to lift controller. The cross-reference between inverter parameters and CANopen objects is shown in table 5.1.

Table 5.1. Inverter parameters and CANopen objects cross-reference (Lift speed profile)

Function code	Description	CANopen object	Default setting
L302	Profile acceleration in mm/s	640Bh Sub01h	500 mm/s
L303	Profile deceleration in mm/s	640Bh Sub02h	500 mm/s
L304	Profile jerk 1 in mm/s²	640Dh Sub01h	500 mm/s²
L305	Profile jerk 2 in mm/s²	640Dh Sub02h	500 mm/s²
L306	Profile jerk 3 in mm/s²	640Dh Sub03h	500 mm/s²
L307	Profile jerk 4 in mm/s²	640Dh Sub04h	500 mm/s²
L308	Profile jerk 5 in mm/s²	640Dh Sub05h	500 mm/s²
L309	Profile jerk 6 in mm/s²	640Dh Sub06h	500 mm/s²
L333	Motion profile type	6405h	+3
L334	Profile jerk use	640Ch	4

As mentioned before, inverter can work in a CANopen Speed mode or a Profile position mode. This is selected by lift controller. The difference between Profile position mode and speed mode is that the first one, thanks to a better accuracy, creep speed is not needed, in other words the deceleration is direct to floor.

Different speed profiles are available depending on the setting of L333 and L334 parameters. On below sub chapters the different speed profiles available are shown. First speed profile shown corresponds to inverter default setting.

5.1 Velocity mode

L333= +3 : Jerk-limited ramp (Deffault setting)

L334= 04h

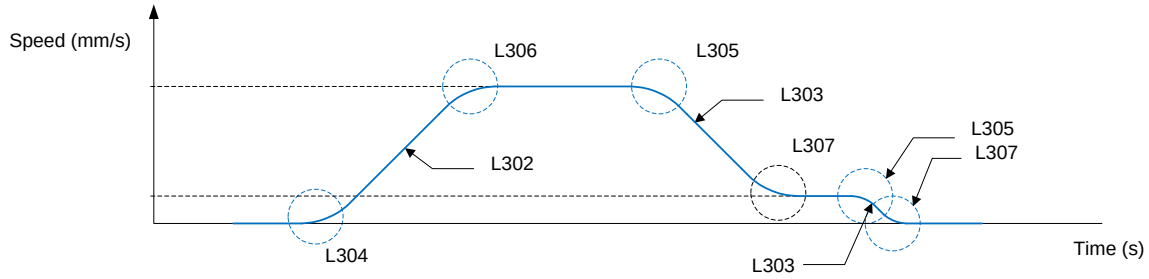


Figure 5.1. Velocity mode speed profile 1

L333= -1 : Manufacturer specific

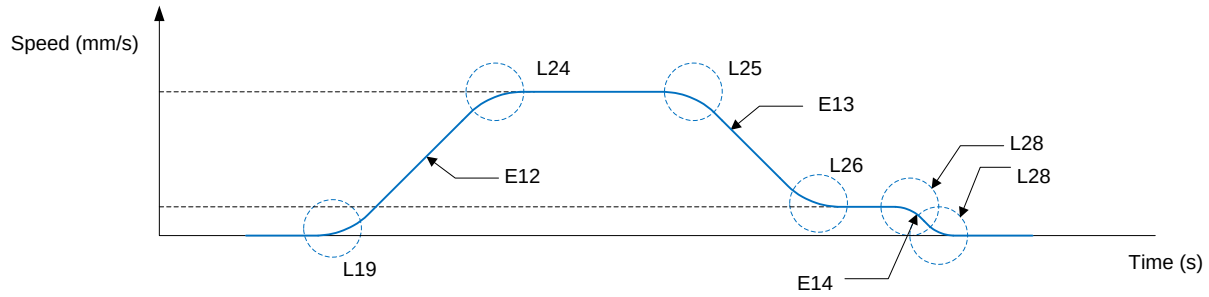


Figure 5.2. Velocity mode speed profile 2

L333= 0 : Linear ramps

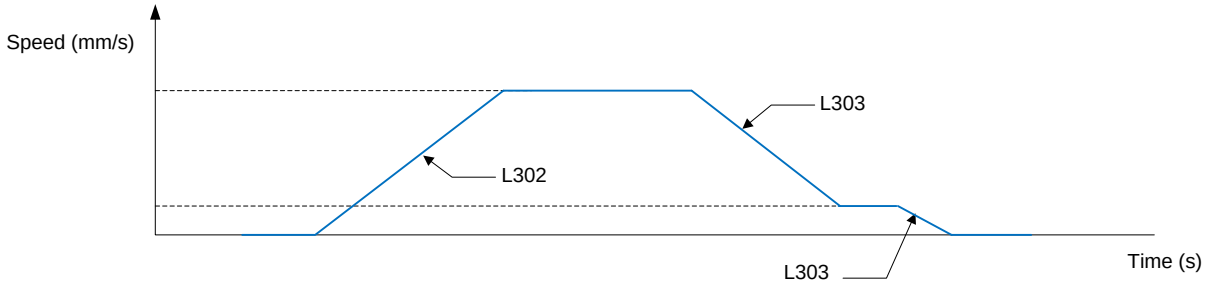


Figure 5.3. Velocity mode speed profile 3

L333= +3 : Jerk-limited ramp

L334= 01h

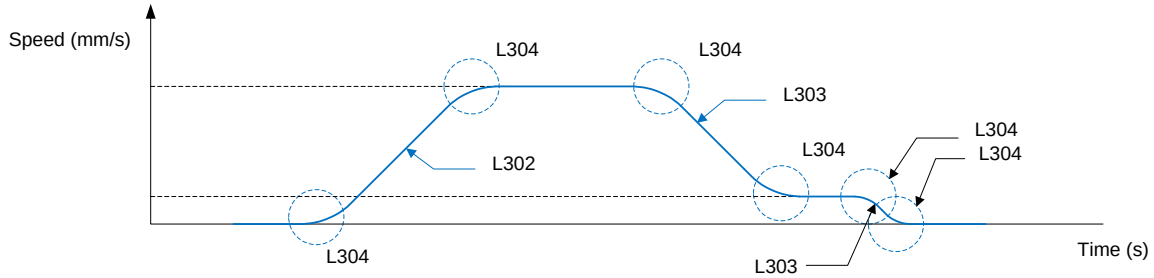


Figure 5.4. Velocity mode speed profile 4

L334= 02h

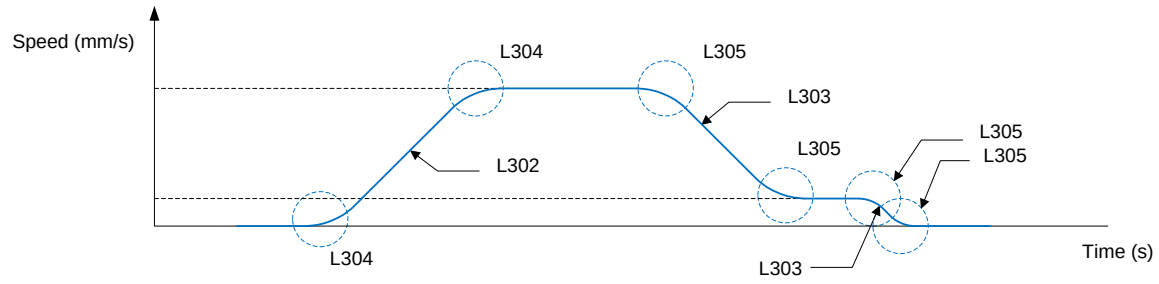


Figure 5.5. Velocity mode speed profile 5

5.2 Profile position mode

L333= +3 : Jerk-limited ramp (Deffault setting)

L334= 04h

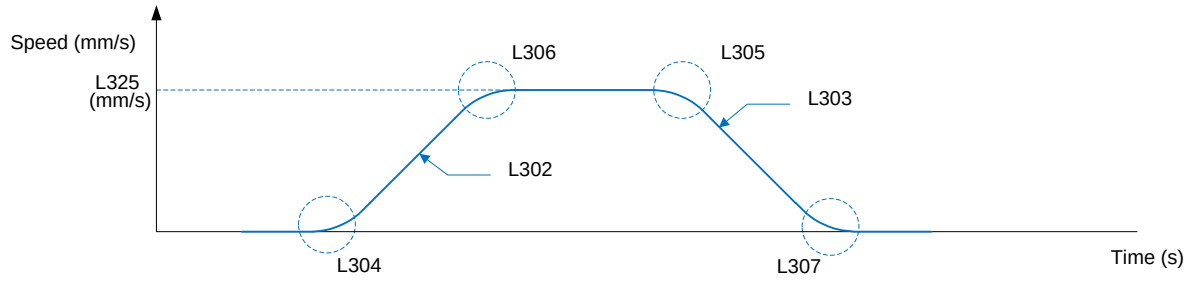


Figure 5.6. Profile position mode speed profile 1

L333= -1 : Manufacturer specific

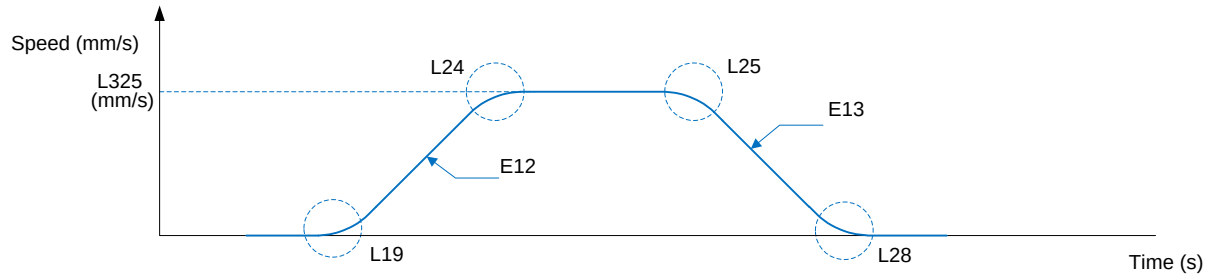


Figure 5.7. Profile position mode speed profile 2

L333= 0 : Linear ramps

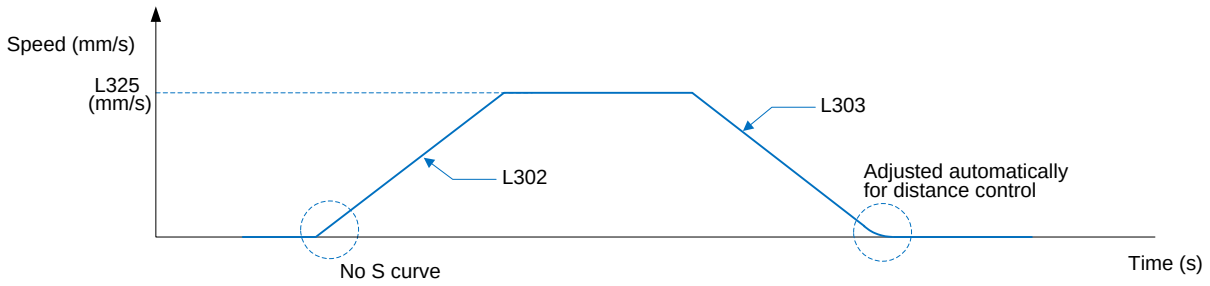


Figure 5.8. Profile position mode speed profile 3

L333= +3 : Jerk-limited ramp

L334= 01h

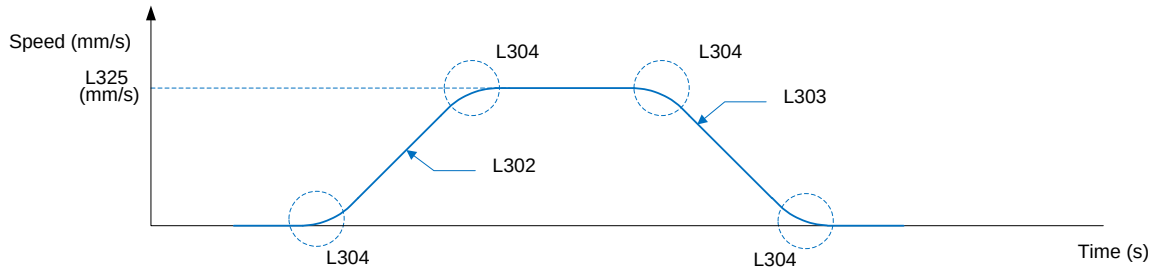


Figure 5.9. Profile position mode speed profile 4

L334= 02h

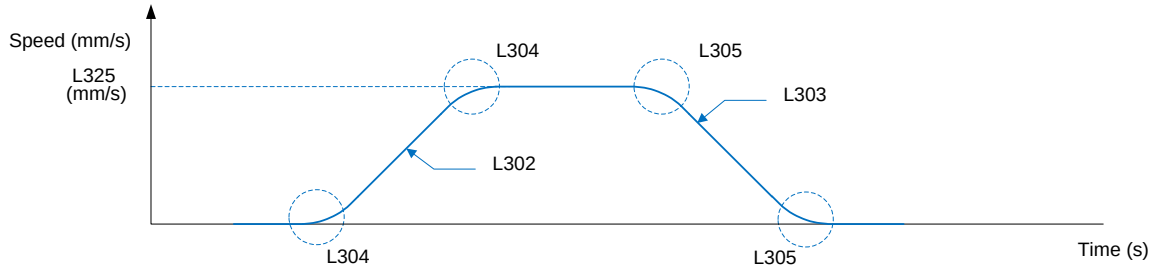


Figure 5.10. Profile position mode speed profile 5

L334 (640Ch)= 06h

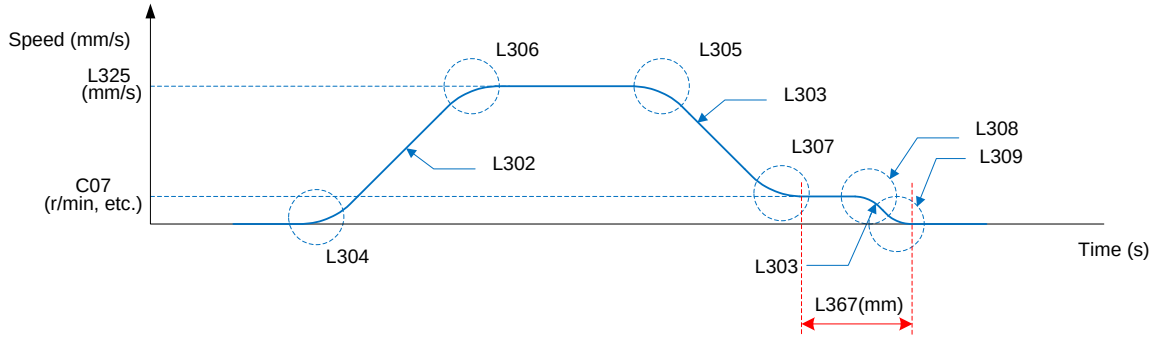


Figure 5.11. Profile position mode speed profile 6

6. Signals timing diagram for close loop control (IM and PMSM)

Figure 6.1 shows a complete timing diagram and signals sequence in case of closed loop application. From inverter point of view, closed loop means that the motor has an encoder (incremental or absolute). Under such circumstance induction motor and PMS motor are equivalent.

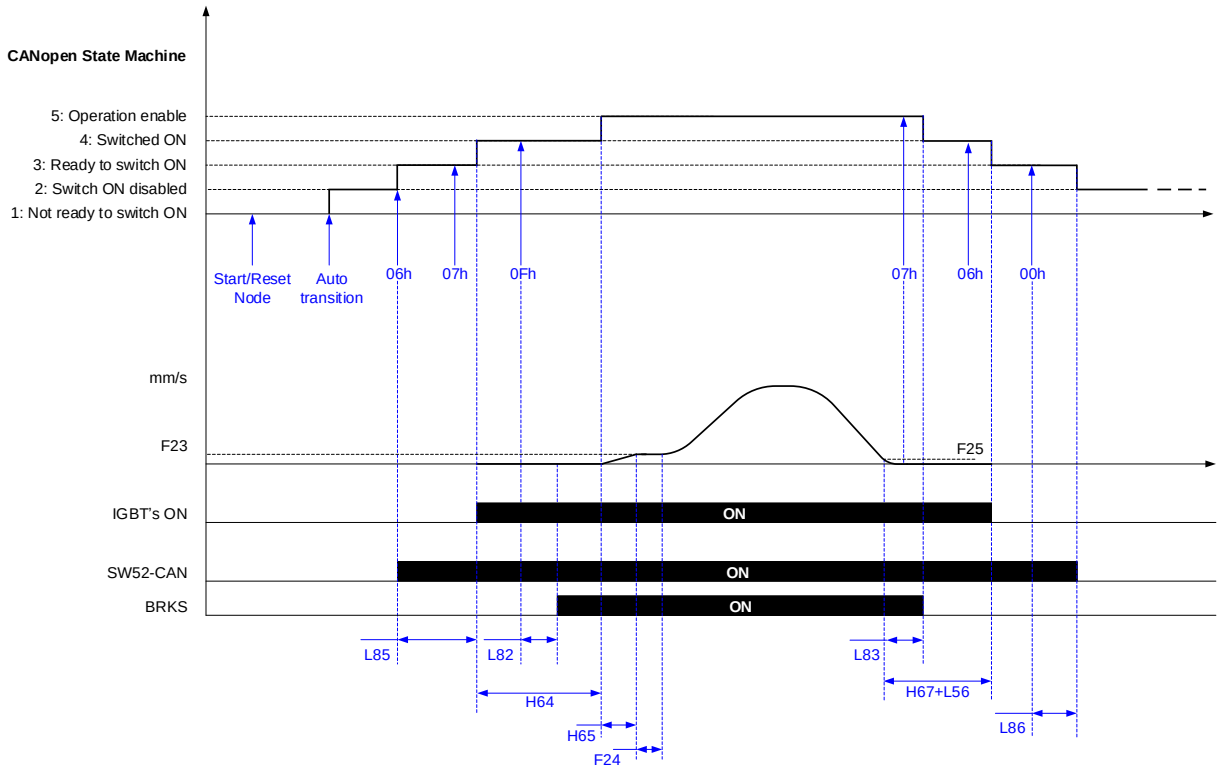


Figure 6.1: Closed loop application time and signals sequence diagram.

Sequence description:

Start:
As soon as State machine moves to “3: Ready to switch ON” state inverter activates the output function SW52-CAN. This function can be used to control the main contactors (between inverter and motor). Not all lift controllers control the main contactors with this signal.
Until L85 timer doesn’t elapse, inverter will not move to “4: Switched ON” state after command “07h” is sent by the controller.
When L85 timer elapses, inverter starts to apply voltage on the output (IGBT’s ON).
As soon as the controller sends “0Fh” command, the inverter starts the timer L82 to open the brake. Not all lift controllers control brake with this signal.
Until H64 timer does not elapse, inverter will not move to “5: Operation enable” state after command “0Fh” is sent by the controller.
Soft start function (H65, F23 and F24) is not mandatory. If this function is not needed, these parameters can be set to 0. In such case inverter will start to accelerate the motor to target speed as soon as “5: Operation enable” state is reached.

Stop:
The diagram shows a Profile position mode movement without creep speed. In case of Speed mode, the speed diagram will be the same but with creep speed.
When lift reaches floor level the lift controller sends the command “07h”. Even command is set by the controller, inverter will not switch state machine to “4: Switched ON” until the timer L83 elapses.
When speed level F25 is reached the timers L83 and H67 start.
Until L56 timer doesn’t elapse, inverter will not move to “3: Ready to switch ON” state after command “06h” is sent by the controller. When L56 timer elapses, the inverter stops voltage on the output (IGBT’s OFF).
Until L86 timer doesn’t elapse, inverter will not move to “2: Switched ON disabled” state after command “00h” is sent by the controller.

7. Signal time diagram for open loop (IM)

Figure 7.1 shows a complete timing diagram and signals sequence in case of open loop application. From inverter point of view, open loop means that the motor has no encoder. In this case we speak always about Induction motor. As the speed accuracy in open loop control is not as perfect as in closed loop, only Speed mode is available.

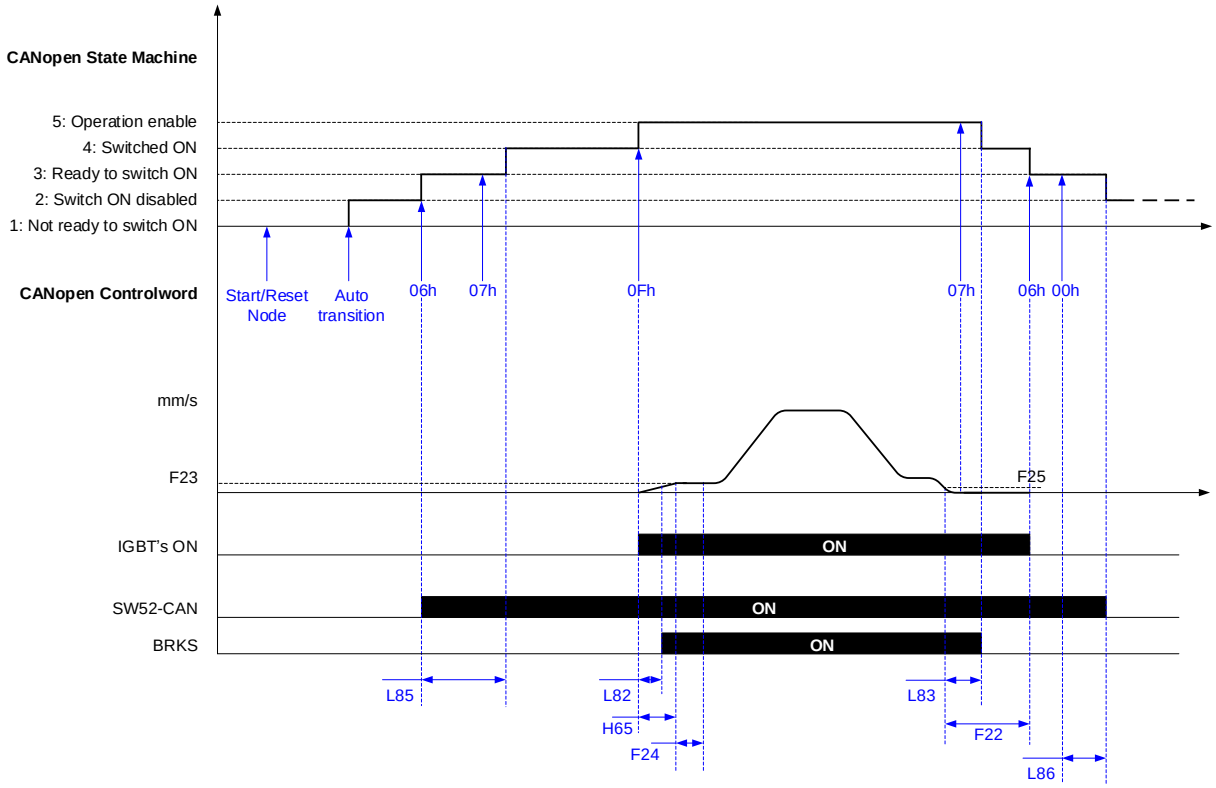


Figure 7.1: Open loop application time and signals sequence diagram.

Sequence description:

Start:
As soon as State machine moves to “3:Ready to switch ON” state inverter activates the output function SW52-CAN. This function can be used to control the main contactors (between inverter and motor). Not all lift controllers control the main contactors with this signal.
Until L85 timer doesn’t elapse, inverter will not move to “4:Switched ON” state after command “07h” is sent by the controller.
As soon as the controller sends “0Fh” command, the inverter starts the timer L82 to open the brake. Not all lift controllers control brake with this signal. At same time inverter starts to apply voltage on the output (IGBT’s ON). The transition to “5:Operation enable” state is direct.
Soft start function (H65,F23 and F24) is not mandatory. If this function is not needed, set H65=0. F23 and F24 needs to be set with a certain value as in open loop a minimum frequency is needed (in other words, the inverter doesn’t keep the motor at zero speed).

Stop:
When lift reaches floor level the lift controller sends the command “07h”. Even command is set by the controller, inverter will not switch state machine to “4:Switched ON” until the timer L83 elapses.
When speed level F25 is reached the timers L83 and F22 start (F21 should be set like F25).
Inverter will move to “3:Ready to switch ON” state after command “06h” is sent by the controller. This will happen independently of the time set on F22.
Until L86 timer doesn’t elapse, inverter will not move to “2:Switched ON disabled” state after command “00h” is sent by the controller.

8. Travel optimization in position mode

There are different parameters to optimize the travel in position mode; these parameters are implemented to get the best stopping accuracy.

The parameters are listed in table 8.1.

Table 8.1. Parameters related to stop accuracy in position mode

Function code	Description	Default setting
L352	Early deceleration distance	45 mm
L353	Early deceleration minimum speed	0.0 %
L354	Target offset	0.0
L366	CAN arrival level	10 mm
L377	CAN TR-bit Timer	0.000 s
L199	Operation setting switch 2 - Bit0: Activate TR-bit condition by L366/L377	0x00h

L352 and L353 are parameters implemented in order to compensate the communications delay, which may deal with a wrong stopping. Figure 8.1 shows the effect of L352 and L353 due to early deceleration distance.

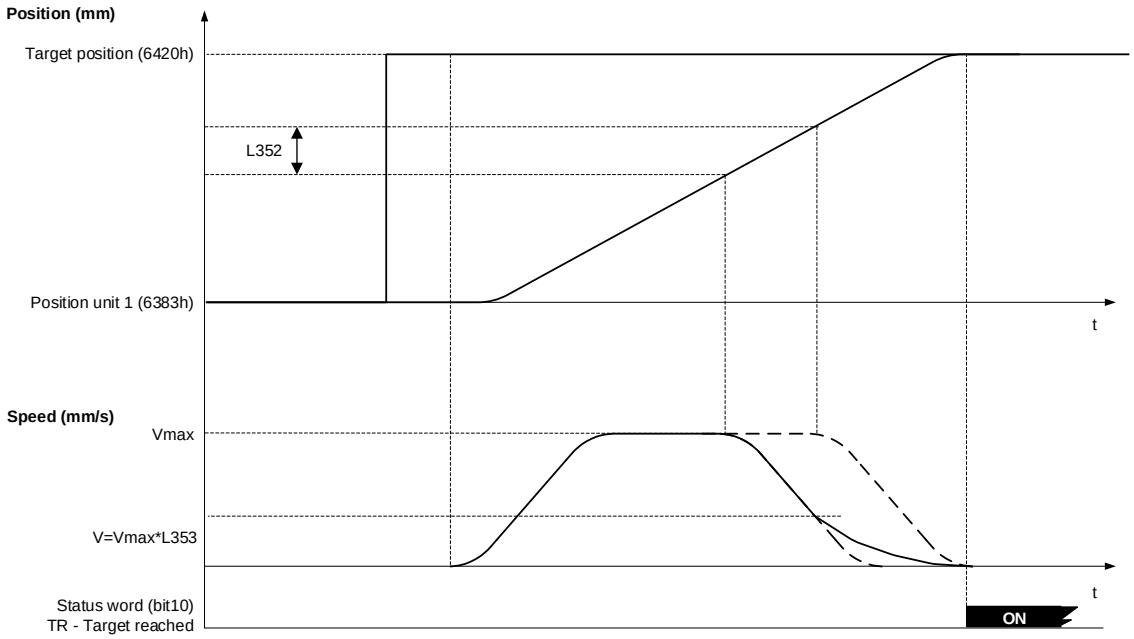


Figure 8.1: Early deceleration distance to compensate communications delay.

With L354, an offset to target position sent by the controller can be added. If L354 has a negative value, the lift will stop earlier than target position sent by the controller. Figure 8.2 shows the effect of L354 on real position.

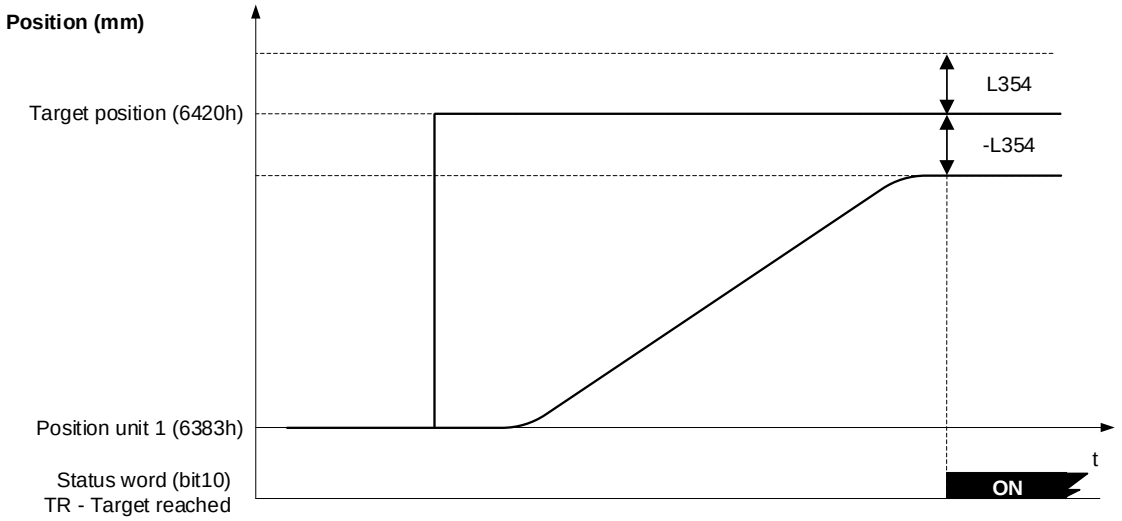


Figure 8.2: L354 effect on real position.

The target position detection signal can be as well triggered by Position level (deviation) and time. In order to activate this detection method, bit0 of L199 has to be set to 1. After this, Target position detection signal is triggered by the parameters L366 and L377. The behaviour of Target reached bit (Status word bit10) according to 366 and L377 is shown in Figure 8.3.

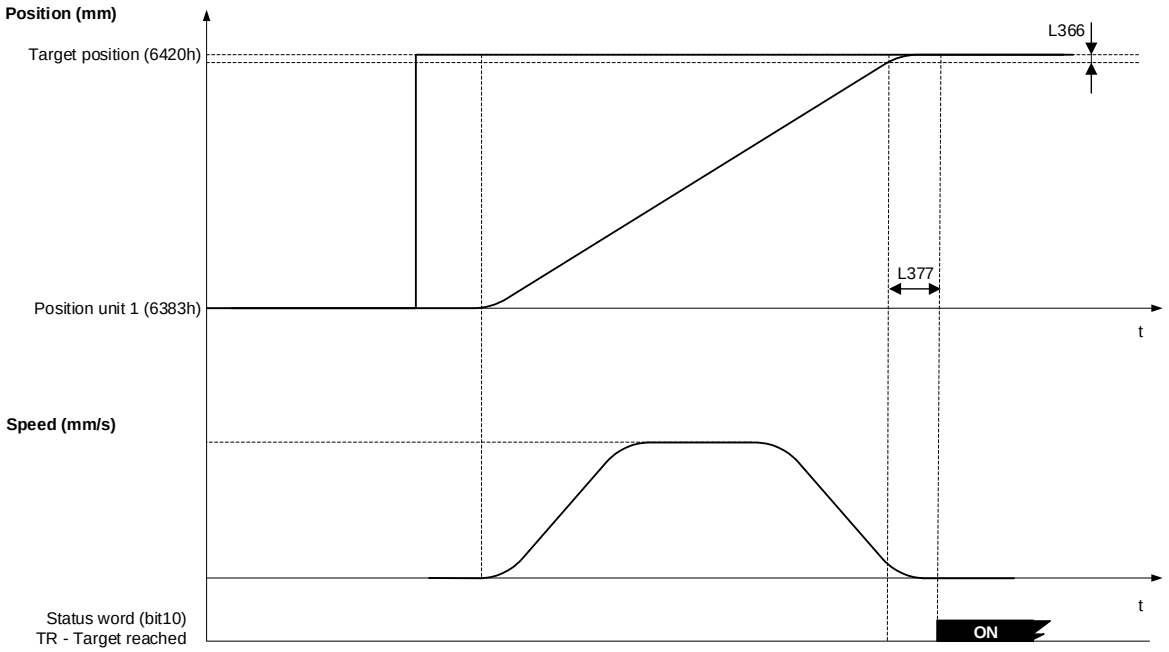


Figure 8.3: Target reached bit (bit 10 of status word) when L199(bit0)=0x01h

9. Alarm messages

Every time inverter trips an alarm it generates a code. This code is specific for FRENIC-Lift and it is shown in Virtual console. In parallel FRENIC-Lift generates an EMCY message. If the lift controller doesn't support Virtual console EMCY message can be monitored in controller's keypad. In such case, a cross-reference between FRENIC-Lift alarm messages and EMCY codes is shown in table 9.1.

Table 9.1. EMCY codes cross reference with FRENIC-Lift alarm codes

Alarm code (EMCY)	Content	Display	Alarm code (EMCY)	Content	Display
0000	No alarm	---	7510	Option communications error	*er4*
2310	Over current (accelerating)	*OC1*	8100	Option error	*er5*
2310	Over current (decelerating)	*OC2*	F004	Operation error	*er6*
2310	Over current (constant rate)	*OC3*	7200	Tuning error	*er7*
2330	Ground fault	*ef*	7510	RS-485 communications error (COM port 1)	*er8*
3210	Over voltage (accelerating)	*0v1*	3300	Output phase-failure detection	*0pl*
3210	Over voltage (decelerating)	*0v2*	8400	Speed inconsistency/ excessive speed deviation	*ere*
3210	Over voltage (constant speed or stopping)	*0v3*	3221	Data saving error during undervoltage	*erf*
3220	Under voltage	*lv*	7510	RS-485 communications error (COM port 2)	*erp*
3130	Input phase loss	*Lin*	5220	Hardware error	*erh*
4210	Heat sink overheat	*0h1*	0000	CANopen communication error	*ert*
9000	External alarm	*0h2*	5430	EN circuit failure	*ecf*
4210	Inverter internal overheat	*0h3*	8311	Over torque	*Ot*
4310	Motor protection (PTC/NTC thermistor)	*0h4*	7110	Braking transistor broken	*dba*
4210	Braking resistor overheat	*dbh*	FF02	EN1/EN2 terminals chattering	*Eo*
4310	Motor overload	*OL1*	6320	Customizable logic failure	*ecl*
4110	Inverter overload	*OLU*	5220	Hardware error	*erh*
7310	Overspeed protection	*0s*	4210	Charging resistor overheat	*Oh6*
7301	PG wire break	*pg*	FF03	Rescue by brake alarm	*RBA*
7300	NTC wire break error	*nrb*	FF04	Reaching maximum number of trip counter	*TCA*
5500	Memory error	*er1*	5440	Short-circuit control error	*SCA*
7520	Keypad communications error	*er2*	FF05	Load cell function	*LOC*
5220	Terminal block PCB error	*er3*	FF06	Mock alarm	*err*

For additional information about the meaning of each alarm code, please refer to other manuals.

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