Lift
Application

USER'S MANUAL

Lift Application

Par. 0.1 = 0

INDEX

Application Smc126

1   Lift Application

With the lift application, the Vacon frequency converter can be integrated smoothly to the modern lift system. In the application, there are functions included which are required to achieve a smooth ride in a lift car. The I/O interface table includes the most commonly needed signals in lift applications.

1.1   Linear speed

In the application, constant speeds are presentend in [m/s], acceleration and deceleration in [m/s^2] and jerks are presented in [ms].

1.2   Mechanical brake

To achieve smooth departures and landings from and to floor level, a mechanical brake control designed specifically for lifting is included. The brake can be set to open and close in various ways to meet the different requirements of lift motors and lift control logics.

1.3   Autotuning

Different motor parameters can be tuned by the frequency converter. For example, motor magnetizing current, speed controller parameters can be identified by the frequency converter. For the best result, identification should be done with unloaded motor.

2   Scope of this document

This document describes the functions, parameters and control logics of the Lift Application. For wiring, installation and commissioning please refer to the manual for Vacon CX family.

3   System requirements

The hardware can be any Vacon CX/CXL/CXS frequency converter with or without the option board CX107OPT installed. For installation of the option board please refer to the "Vacon CX107OPT option board manual (ud00371a)" .

For the Lift application the following software modules must be installed in the frequency converter:
System software: Sm00100_.bin or compatible.
Application: Smc126__.hex or compatible.
If closed loop control is used, the CX107OPT option board is needed.
Option board software: Smpb003_.bin or compatible.
For installation of software components, refer to the built-in help for the loading tool FCLoad.

4 Control I/O

Terminal		Signal	Description
1	$+10V_{ref}$	Reference output	Voltage for potentiometer, etc.
2	$U_{in}+$	Analogue input, voltage range 0—10V DC	Active speed reference if Par1.6 = 4.
3	GND	I/O Ground	Ground for reference and controls
4	$I_{in}+$	Analogue input, current	Active speed reference if Par1.6 = 3.
5	$I_{in}-$	range 0—20mA	
6	+24V	Control voltage output	Voltage for switches, etc. max 0.1 A
7	GND	I/O ground	Ground for reference and controls
8	DIA1	Start forward (programmable)	Contact closed = start forward
9	DIA2	Start reverse (programmable)	Contact closed = start reverse
10	DIA3	External fault reset (programmable)	Reset active fault.
11	CMA	Common for DIA 1—DIA 3	Connect to GND or +24V
12	+24V	Control voltage output	Voltage for switches (see #6)
13	GND	I/O ground	Ground for reference and controls
14	DIB4	Speed Reference Selection	Speed reference set according to P1.6.
15	DIB5		
16	DIB6		
17	CMB	Common for DIB4—DIB6	Connect to GND or +24V
18	$I_{out}+$	Motor speed	Programmable (par. 3.1)
19	$I_{out}-$	Analogue output	Range 0—20 mA/R_l, max. 500Ω
20	DO1	Digital output FAULT	Programmable, par. 3.7 Open collector, I≤50mA, U≤48 VDC
21	RO1	Relay output 1 RUN	Programmable, par. 3.10
22	RO1		
23	RO1		
24	RO2	Relay output 2 Mechanical brake	Programmable, par. 3.14
25	RO2		
26	RO2		

Table 1. Default I/O configuration and connection in Lift Application
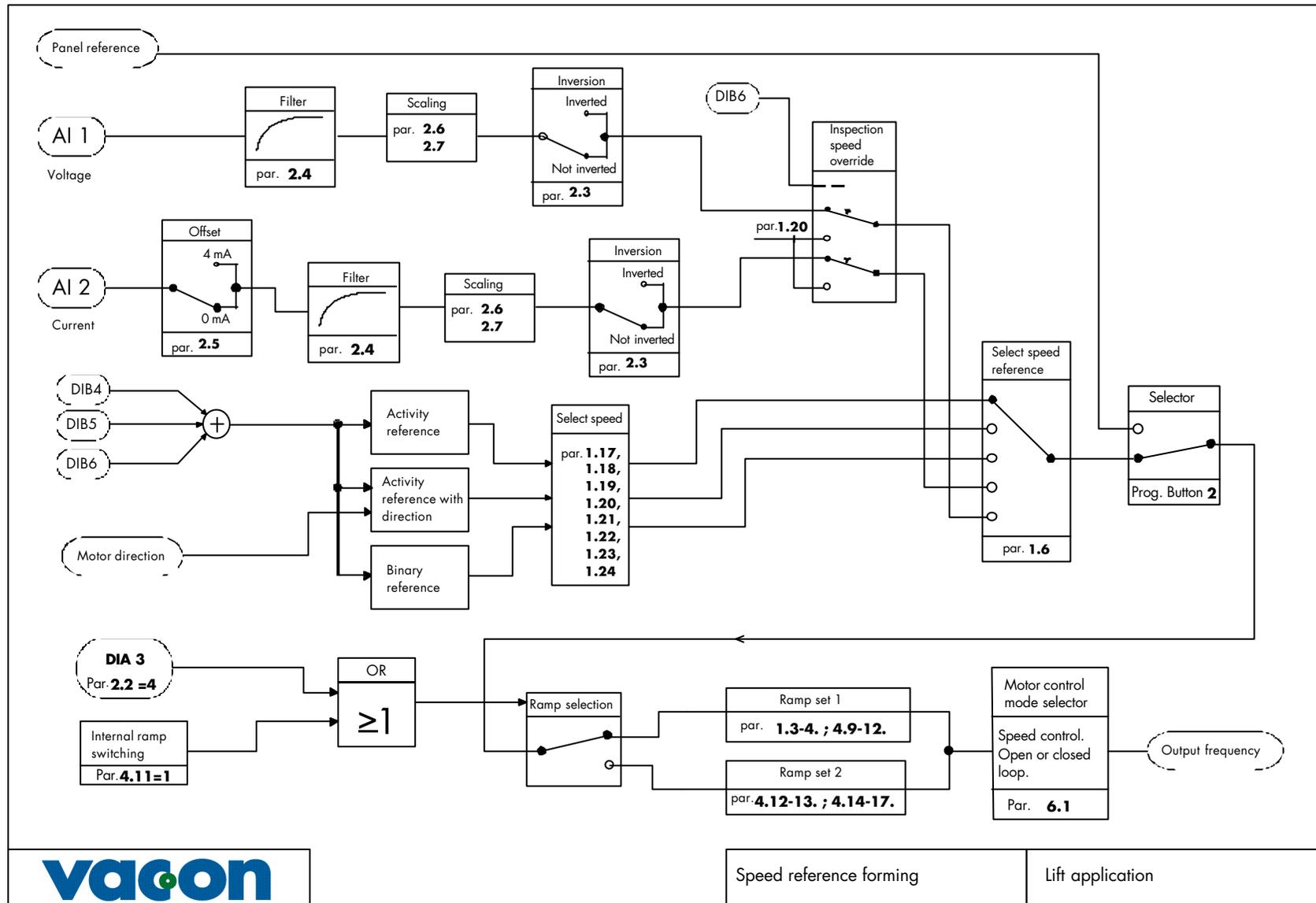
5 Control logic
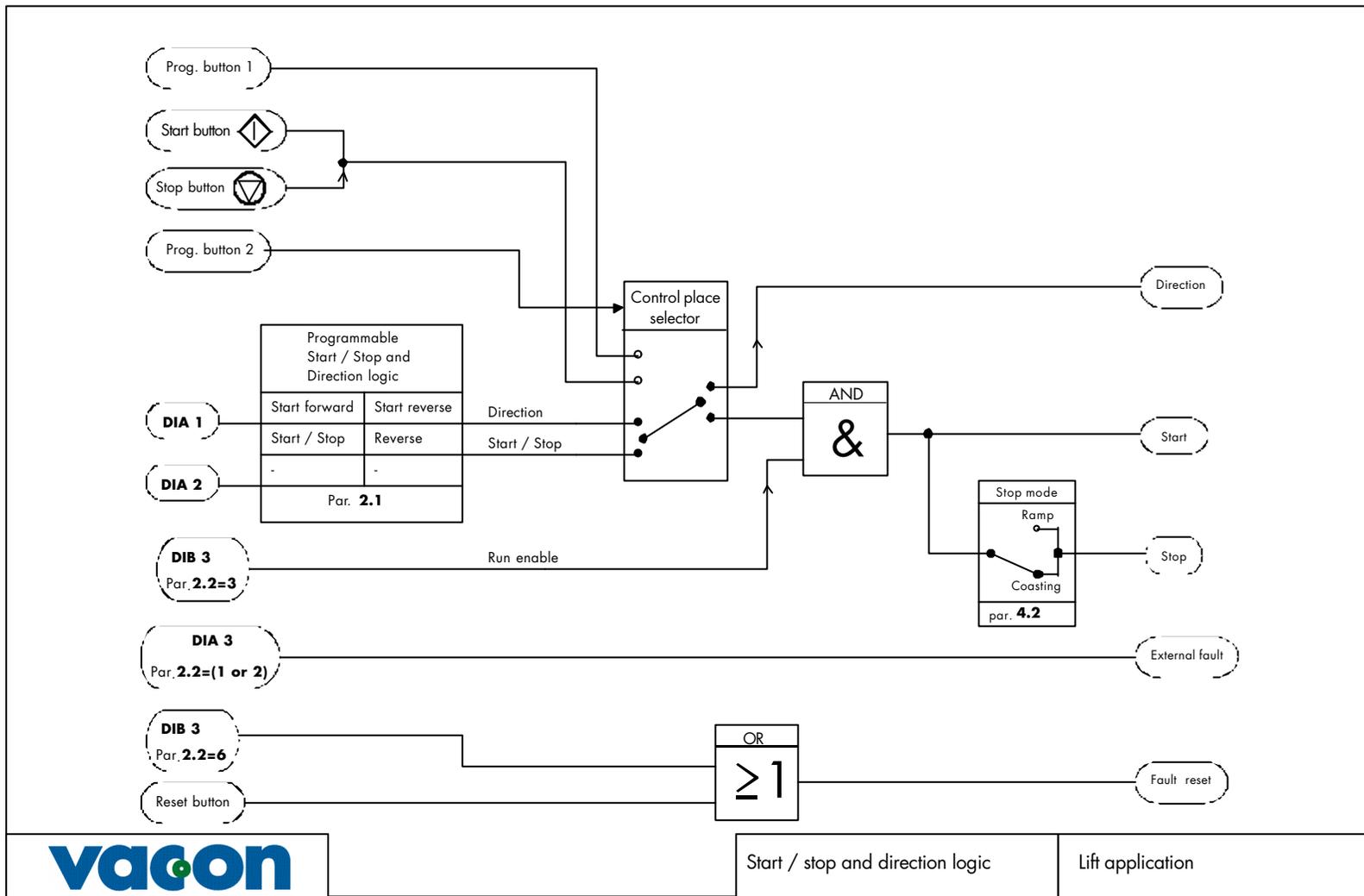

Figure 1. Speed reference generation chain

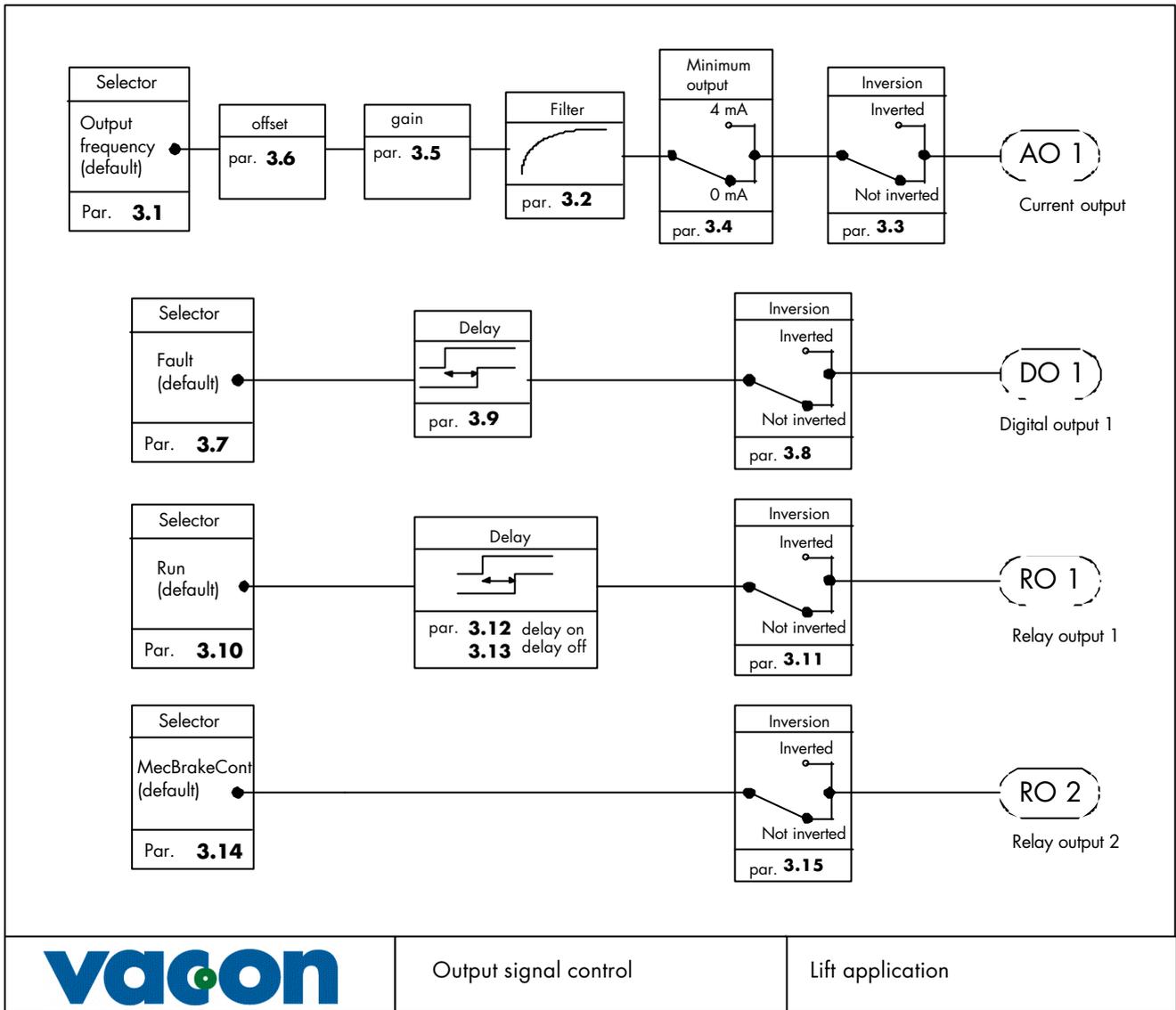Figure 2. Start/Stop logic and external fault generation and reset.

Figure 3. Output signal control.

6 Parameter Tables

Group 1, Basic Parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
1.1	Minimum speed	$0-v_{min}$ m/s	0.01 m/s	0.00 m/s			
1.2	Maximum speed	$v_{min}-v_{max}$ m/s	0.01 m/s	1.00 m/s		V_{max} corresponds to 120 Hz	
1.3	Acceleration 1	$0.20-2.00$ m/s^2	0.01 m/s^2	0.70 m/s^2			
1.4	Deceleration 1	$0.20-2.00$ m/s^2	0.01 m/s^2	0.70 m/s^2			
1.5	Nominal Linear Speed STOP	$0.20-5.00$ m/s	0.01 m/s	1.00 m/s		Speed at motor nominal frequency	
1.6	Speed Reference	$0-4$				0 = Activity reference 1 = Activity reference with direction 2 = Binary reference 3 = Current reference 4 = Voltage reference	
1.7	Current limit	$0.1-2.0 \times I_{nCX}$	0.1 A	$1.5 \times I_{nCX}$		Output current limit [A] of the unit	
1.8	U/f ratio selection STOP	$0-2$	1	0		0 = Linear 1 = Not in use 2 = Programmable U/f curve	
1.9	U/f optimisation STOP	$0-1$	1	0		0 = None 1 = Automatic torque boost	
1.10	Nominal voltage of the motor STOP	$180-690$	1 V	230 V 400 V 500 V 690 V		Vacon range CX/CXL2 Vacon range CX/CXL/CXS4 Vacon range CX/CXL/CXS5 Vacon range CX6	
1.11	Nominal frequency of the motor STOP	$25-120$ Hz	1 Hz	50 Hz		f_n on the rating plate of the motor	
1.12	Nominal speed of the motor STOP	$200-7200$ rpm	1 rpm	1440 rpm		n_n on the rating plate of the motor	
1.13	Nominal current of the motor STOP	$2.5 \times I_{nCX}$	0.1 A	I_{nCX}		I_n on the rating plate of the motor	
1.14	Supply voltage STOP	$208-240$ $380-440$ $380-500$ $525-690$		230 V 400 V 500 V 690 V		Vacon range CX/CXL2 Vacon range CX/CXL/CXS4 Vacon range CX/CXL/CXS5 Vacon range CX6	
1.15	Parameter conceal	$0-1$	1	1		Visibility of parameters: 0 = All parameter groups visible 1 = Only group 1 visible	
1.16	Parameter value lock	$0-1$	1	0		Disables parameter changes: 0 = Changes enabled 1 = Changes disabled	
1.17	V0 A000 - B000	$v_{min}-v_{max}$ (1.1) (1.2)	0.01 m/s	0.10 m/s		See Table 3, Table 4 and Table 5 for description of speed reference selection.	
1.18	V1 A100 - B100	$v_{min}-v_{max}$ (1.1) (1.2)	0.01 m/s	1.00 m/s		A stands for activity reference and B for binary reference	
1.19	V2 A010 - B010	$v_{min}-v_{max}$ (1.1) (1.2)	0.01 m/s	0.25 m/s			
1.20	V3 A001 - B110	$v_{min}-v_{max}$ (1.1) (1.2)	0.01 m/s	0.50 m/s			
1.21	V4 A000 - B001	$v_{min}-v_{max}$ (1.1) (1.2)	0.01 m/s	0.10 m/s			

1.22	V5 A100 - B101	$v_{min} - v_{max}$ (1.1) (1.2)	0.01 m/s	1.00 m/s			
1.23	V6 A010 - B011	$v_{min} - v_{max}$ (1.1) (1.2)	0.01 m/s	0.25 m/s			
1.24	V7 A001 - B111	$v_{min} - v_{max}$ (1.1) (1.2)	0.01 m/s	0.50 m/s			
1.25	Start of reference hold	0.00 — 1.00s	0.01 s	0.10 s		Time from start command the speed reference is set to hold.	
1.26	Stop of reference hold	0.00 — 3.00s	0.01 s	0.50 s		Time from start command the speed reference is released from hold.	

Note! 🛑 **=** Parameter value can be changed only when the frequency converter is stopped.

*) If 1.2 > motor synchronizing speed, check suitability for motor and drive system.

Group 2, Input Signal Parameters

Code	Parameter	Range	Step	Default	Custom	Description		Page
2.1	Start/Stop logic selection 🛑	0 — 2	1	0		DIA1	DIA2	
						0 = Start forward	Start reverse	
						1 = Start/Stop	Reverse	
2.2	DIA3 function (terminal 10) 🛑	0 — 9	1	4		0 = Not used 1 = External fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Accel./decel. Time selection 5 = Stop by coast, opening contact 6 = Fault reset 7 = DC-braking command 8 = External brake control 9 = Stop by coast, closing contact		
2.3	Uin / Iin invert.	0 — 1	1	0		0 = No inversion 1 = Inversion		
2.4	U_{in} / I_{in} filt.	0.00 — 1.00 s	0.01 s	0.10 s		0 = No filtering		
2.5	I_{in} signal range	0 — 1	1	0		0 = 0 — 20 mA 1 = 4 — 20 mA		
2.6	Reference scaling minimum value	0.0 — P 2.7	0.1 %	0.0 %		The minumum speed is increased with defined value. If 0.0 % the minimum speed equals with P1.1		
2.7	Reference scaling maximum value	P 2.6 — 100.0 %	0.1 %	100.0 %		The maximum speed is decreased with defined value. If 100.0 % the maximum speed equals with P1.2		

Note! 🛑 **=** Parameter value can be changed only when the frequency converter is stopped.

Group 3, Output and Supervision Parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
3.1	Analogue output function	0—7	1	2		0 = Not used	
						1 = Motor Freq. $(0-f_{max})$	
						2 = Motor speed (0—max. speed)	
						3 = Motor current $(0-2.0 \times I_{nCx})$	
						4 = Motor torque $(-2 \times T_{nCx} - 2 \times T_{nCx})$	
						5 = Motor power $(-2 \times P_{nCx} - 2 \times P_{nCx})$	
						6 = Motor voltage $(0-100\% \times U_{nM})$	
						7 = DC-link volt. (0—1000 V)	
3.2	Analogue output filter time	0.01—10.00s	0.01s	1.00s			
3.3	Analogue output inversion	0—1	1	0		0 = Not inverted 1 = Inverted	
3.4	Analogue output minimum	0—1	1	0		0 = 0 mA 1 = 4 mA	
3.5	Analogue output gain	10—1000%	1%	100%			
3.6	Analogue output offset	-100.0 — 100.0%	0.1%	0.0 %			
3.7	DO1 content	0—9	1	4		0 = Not used 1 = Allways on 2 = Ready 3 = Run 4 = Fault 5 = Warning 6 = Speed below limit 7 = Torque above limit 8 = Mechanical brake control 9 = Open enable control	
3.8	DO1 invert	0—1	1	0		0 = No inversion 1 = Inverted	
3.9	DO1 delay	0.00 — 10.00s	0.1s	0.00s		Delay contents of DO1. 0.00= delay not in use	
3.10	RO1 content	0 — 9	1	3		As parameter 3.7	
3.11	RO1 invert	0 — 1	1	0		0 = No inversion 1 = Inverted	
3.12	RO1 on delay	0.00 — 10.00s	0.01s	0.00s		Delay rising edge of RO1 signal. 0.00= delay not in use	
3.13	RO1 off delay	0.00 — 10.00s	0.01s	0.00s		Delay falling edge of RO1 signal. 0.00= delay not in use	
3.14	RO2 content	0 — 9	1	8		As parameter 3.7	
3.15	RO2 invert	0 — 1	1	0		0 = No inversion 1 = Inverted	
3.16	Speed supervision limit	$v_{min} - v_{max}$	0.01 m/s	0.10 m/s			
3.17	Motoring torque supervision	0.0 — 200.0% x T_{nCx}	0.1 %	150.0%			
3.18	Generating torque supervision	-200.0% — 0.0 x T_{nCx}	0.1 %	0.0 %		If set to 0.0% P3.17 defines the limit for motoring and generating mode.	
3.19	rpm source selection	0 — 1	1	0		0 = calculated rpm 1= rpm from encoder	

Group 4, Drive Control Parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
4.1	Brake Chopper	0 — 2	1	1		0 = No 1 = Yes 2 = Yes External	
4.2	Stop Function	0 — 1	1	1		0 = Coasting 1 = Ramping	
4.3	DC-Brake Current	0.15 — 1.5xI_{nCX} (A)	0.1 A	0.5xI_{nCX}			
4.4	Start DC-Brake t	0.00 — 5.00s	0.01s	1.00 s		0 = DC-brake at start not used	
4.5	Stop DC-Brake f	0.00 — 10.00Hz	0.1Hz	1.5 Hz			
4.6	Stop DC-Brake t 🛑	0.00 — 5.00s	0.10s	1.00 s		0 = DC-brake at stop not used	
4.7	Acc Inc Jerk 1	0.01 —1.00s	0.01s	0.50s		See Figure 14.	
4.8	Acc Dec Jerk 1	0.01 —1.00s	0.01s	0.25s		As parameter 4.7	
4.9	Dec Inc Jerk 1	0.01 —1.00s	0.01s	0.25s		As parameter 4.8	
4.10	Dec Dec Jerk 1	0.01 —1.00s	0.01s	0.50s		As parameter 4.9	
4.11	Internal ramp switching	0 — 1	1	0		0 = No change 1 = Activate ramp set 2 at levelling speed	
4.12	Acceleration 2	0.20 — 2.00 m/s^2	0.01 m/s^2	0.20 m/s^2		Second ramp time set is activated according to P2.2 and P4.11.	
4.13	Deceleration 2	0.20 — 2.00 m/s^2	0.01 m/s^2	0.20m/s^2		As parameter 4.12	
4.14	Acc Inc Jerk 2	0.01 —1.00s	0.01s	0.10s		Second ramp time set is activated according to P2.2 and P4.11. See Figure 14.	
4.15	Acc Dec Jerk 2	0.01 —1.00s	0.01s	0.10s		As parameter 4.14	
4.16	Dec Inc Jerk 2	0.01 —1.00s	0.01s	0.10s		As parameter 4.14	
4.17	Dec Dec Jerk 2	0.01 —1.00s	0.01s	0.10s		As parameter 4.14	
4.18	Enable jerks	0 — 1	1	1		0 = Disabled 1 = Enabled	

Note! 🛑 = Parameter value can be changed only when the frequency converter is stopped.

Group 5, Mechanical Brake Control Parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
5.1	Current limit forward	0 — 1.5 x I_{nCX}	0.1 A	0.2 x I_{nCX}			
5.2	Current limit reverse	0 — 1.5 x I_{nCX}	0.1 A	0.2 x I_{nCX}			
5.3	Torque limit forward	0 — 100 %	1 %	0 %			
5.4	Torque limit reverse	0 — 100 %	1 %	0 %			
5.5	Frequency limit open forward	0.00 — 10.00 Hz	0.01 Hz	1.00 Hz			
5.6	Frequency limit open reverse	0.00 — 10.00 Hz	0.01 Hz	1.00 Hz			
5.7	Signal for external brake control	0 — 1	1	0		0 = Inactive 1 = Active	
5.8	Brake releasing delay	0.00 — 1.00s	0.01s	0.00s			
5.9	Dual brake control	0 — 1	1	0		0 = Inactive 1 = Active	
5.10	Frequency limit close forward	0.00 — 20.00 Hz	0.01 Hz	1.20 Hz			
5.11	Frequency limit close reverse	0.00 — 20.00 Hz	0.01 Hz	1.20 Hz			
5.12	Close from frequency	0 — 1	1	0		0 = Not delayed 1 = Delayed	
5.13	Run request closing	0 — 1	1	0		0 = Excluded 1 = Included	
5.14	Closing delay forward	0.00 — 5.00s	0.01 s	0.00 s			
5.15	Closing delay reverse	0.00 — 5.00s	0.01 s	0.00 s			
5.16	External brake feedback supervision	0 — 1	1	0		0 = Inactive 1 = Active	

5.17	Brake feedback supervision time	0.00 — 10.00 s	0.01s	0.00s		Time within feedback supervision signal have to be inactive. If set fault	
5.18	Maximum frequency brake closed	0.00 — 10.00 Hz	0.01 Hz	2.50 Hz			
5.19	Brake release supervision	0.00 — 4.00s	0.01 s	1.30 s			
5.20	Mechanical brake reaction time	0.00 — 1.00s	0.01 s	0.05 s			
5.21	Direction change mode	0 — 2	1	0		0 = Inac tive 1 = Brake Closed 2 = Stop State	
5.22	Smooth start time	0.00 — 1.00s	0.01 s	0,00s		Use only when in closed loop control mode.	
5.23	Smooth start frequency	0.00 — 5.00 Hz	0.01 Hz	0.10 Hz		As P5.22	
5.24	0Hz time start	0.00 — 2.00s	0.01s	0.50 s		Active only in closed loop control mode.	
5.25	0Hz time stop	0.00 — 2.00s	0.01s	0.60 s		As P5.24	

Group 6, Motor Control Parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
6.1	Control mode STOP	0 — 3	1	1		0 = Frequency control open loop 1 = Speed control open loop 2 = Not used 3 = Speed control closed loop	
6.2	Switching frequency STOP	1.0—16.0 kHz	0.1 kHz	10 kHz		Depending on kW	
6.3	Field weakening point STOP	25—120 Hz	1 Hz	50 Hz			
6.4	Voltage at field weakening point STOP	15—200% x U_{nmot}	1%	100%			
6.5	U/F-curve mid point frequency STOP	$0.0 - f_{max}$	0.1 Hz	5.0 Hz			
6.6	U/F-curve mid point voltage STOP	0.00—100.00% x U_{nmot}	0.01%	10.00%			
6.7	Output voltage at zero frequency STOP	0.00—100.00% x U_{nmot}	0.01%	1.0%			
6.8	Undervoltage controller	0—1	1	1		0 = controller is OFF 1 = controller is ON	

Note! STOP = Parameter value can be changed only when the frequency converter is stopped.

Group 7, Protections Parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
7.1	4 mA fault	0 — 2	1	0		0 = No action 1 = Warning 2 = Fault	
7.2	External fault	0 — 2	1	2		0 = No action 1 = Warning 2 = Fault	
7.3	Mechanical brake control fault	0 — 2	1	2		0 = No action 1 = Warning 2 = Fault	
7.4	Shaft speed fault	0 — 2	1	0		0 = No action 1 = Warning 2 = Fault	
7.5	Shaft speed supervision limit	0.0 — 1.0 m/s	0.1 m/s	0.3 m/s		According to P7.5 and P7.6 is the sfaft speed fault generated	
7.6	Shaft speed supervision time	0.00—1.00 s	0.01 s	0.40 s			
7.7	Phase supervision of the motor	0 — 2	1	2		0 = No action 1 = Warning 2 = Fault	
7.8	Input line phase supervision	0 — 2	2	2		0 = No action 2 = Fault	
7.9	Earth fault	0 — 2	1	2		0 = No action 1 = Warning 2 = Fault	
7.10	Over torque protection	0 — 2	1	0		0 = No action 1 = Warning 2 = Fault	
7.11	Motor thermal protection	0 — 2	1	2		0 = No action 1 = Warning 2 = Fault	
7.12	Motor thermal protection break point current	50.0—150.0 % x I_{nMotor}	1.0%	100%			
7.13	Motor thermal protection zero frequency current	10.0—150.0 % x I_{nMotor}	1.0%	45.0 %			
7.14	Motor thermal protection time constant	0.5—300.0 min	0.5 min			Default value is set according to motor nominal current	
7.15	Motor thermal protection break point frequency	10—500 Hz	1 Hz	35 Hz			
7.16	Stall protection	0—2	1	2		0 = No action 1 = Warning 2 = Fault	
7.17	Stall current	10.0—200.0 % x I_{MOTOR}	1.0%	130.0%			
7.18	Stall time	2.0—120.0 s	1.0s	15.0s			
7.19	Maximum stall frequency	0 Hz—f_{max}	1 Hz	25 Hz			
7.20	Torque supervision time	0.00—1.00 s	0.01 s	0.10 s			
7.21	Minimum current supervision limit	0 — 0.2 x I_{nCX}	0.1 A	0.05 x I_{nCX}			
7.22	Response to control conflict	0 — 2	1	0		0 = No action 1 = Warning 2 = Fault	

Group 8, Autorestart parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
8.1	Automatic restart: number of trials	0 — 10	1	0		0 = not in use	
8.2	Automatic restart: trial	1 — 6000 s	1 s	60 s			

	time						
8.3	Rst if undervolt	0 — 1	1	0		0 = No 1 = Yes	
8.4	Rst if overvolt	0 — 1	1	0		0 = No 1 = Yes	
8.5	Rst if overcurrent	0 — 1	1	0		0 = No 1 = Yes	
8.6	Rst if temp fault	0 — 1	1	0		0 = No 1 = Yes	

Group 9, Special Open Loop Parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
9.1	Motor boost gain	0—200.0%	0.1%	75.0%		This is used when torque boost is actived. P1.9 = 1 Default value is set according to motor nominal size.	
9.2	Generator boost gain	-200.0 — 100.0 %	0.1%	40.0%		As P9.1	
9.3	Minimum field frequency	0.00 — 2.00 Hz	0.01 Hz	0.75 Hz			
9.4	Minimum field	0 — 2	1	0		0 = Default 1 = Ramp 2 = Step	
9.5	Stator impedance					Default value is set according to motor nominal size.	
9.6	Voltage stabilator gain	0—100.0%	0.1%	10.0%			
9.7	Voltage stabilator damp	0—100.0%	0.1%	60.0%			
9.8	Torque stabilator gain	0—100.0%	0.1%	10.0%			
9.9	Torque stabilator damp	0—100.0%	0.1%	80.0%			

Group 10, Closed Loop Parameters

10.1	Encoder P/R	256 — 5000	1	1024 P/R			
10.2	Encoder direction	0 — 1	1	0		0 = Forward 1 = Reverse	
10.3	Encoder filt time	0 — 20 ms	1 ms	3 ms		0 = Automatic	
10.4	Identification	0 — 1	1	0		0 = Inactive 1 = Identify	
10.5	Motor magnetising current	0.0A — In	0.1 A	0.0 A			
10.6	Slip adjust	0 — 1000 %	1%	100%			
10.7	Speed controller P gain	0 — 500	1	30			
10.8	Speed controller I time	0 — 1000	1ms	10 ms			
10.9	Current controller gain	0 — 500	1	150			

Table 2.Parameters tables of groups 1–10.

7 Description of parameters

1.1   *Minimum speed*
1.2   *Maximum speed*
Defines the minimum and maximum speed of the lift. The minimum speed should be set to 0 m/s to achieve a smooth start from and stop at floor level.
The maximum settable value correcponds to speed of 120 Hz output frequency.

1.3   *Acceleration 1*
1.4   *Deceleration 1*
Acceleration and deceleration of lift car.
Acceleration and deceleration curves are affected as well by the jerk time settings presented in group 4.

1.5   *Nominal Linear Speed*
This speed shall correspond to the lift speed at nominal frequency of the motor.

Speed parameters 1.17-1.24 are entered in linear magnitudes insted of Hz. The internal scaling of linear speeds to frequencies is done with a scaling factor calculated from v_{nom} (par. 1.5) and $f_{nomMotor}$ (par. 1.11) as $k_{scaling}$ = (par 1.11) / (par 1.5). A linear speed is converted to frequency as $f = v_{NomLin} \times k_{scaling}$.

1.6   *Speed Reference Selection*
Speed reference can be generated from digital inputs DIB4, DIB5, DIB6 or from analog input i.e. current or voltage.

Speed reference can be generated in three diffrent ways from digital inputs. Activity coding, activity coding with direction and binary coding. In activity coding method 4 different constant speeds can be selected. In activity coding with direction method the constant speeds are selected according to state of digital inputs and motor direction. 4 different speed per direction is available and so this makes 8 different speeds totally. In binary coding method one of the 8 different constant speeds is selected according to binary word made through digital inputs. DIB6 is the most significant bit (MSB) when creating the binary word in binary coding method.
In current and voltage reference method the speed reference is created according to current or voltage input.

In the tables below the first column contains the state of digital inputs, the second the speed reference and the third priority. If speed reference is different when running different direction the direction is defined in the fourth column. In the fifth column the stop mode is dedicated to speed. The priority column defines which speed is activated in a case where more than one digital input are active in the activity reference and in activity reference with direction method.
With parameter 1.6 (Speed Reference) the speed reference selection method is selected.

Following tables 3, 4 and 5 describe how the speed reference is created.

DIB[4;5;6]	SpeedRef	Priority	Direction	Stop mode
[0;0;0]	*P1.17* v0 (v;levelling)	0 low	irrelevant	ramp
[**1**;0;0]	*P1.18* v1 (v;nominal)	1 medium	irrelevant	coast (P4.2)
[0;**1**;0]	*P1.19* v2 (v;limited speed)	2 high	irrelevant	coast (P4.2)
[0;0;**1**]	*P1.20* v3 (v;inspection)	3 highest	irrelevant	coast (P4.2)

Table 3. Activity reference. Parameter 1.6 = 0.

DIB[4;5;6]	SpeedRef	Priority	Direction	Stop mode
[0;0;0]	*P1.17* v0 (v;levelling)	0 low	forward	ramp
[**1**;0;0]	*P1.18* v1 (v;nominal)	1 medium	forward	coast (P4.2)
[0;**1**;0]	*P1.19* v2 (v;limited speed)	2 high	forward	coast (P4.2)
[0;0;**1**]	*P1.20* v3 (v;inspection)	3 highest	forward	coast (P4.2)
[0;0;0]	*P1.21* v4 (v;levelling)	0 low	reverse	ramp
[**1**;0;0]	*P1.22* v5 (v;nominal)	1 medium	reverse	coast (P4.2)
[0;**1**;0]	*P1.23* v6 (v;limited speed)	2 high	reverse	coast (P4.2)
[0;0;**1**]	*P1.24* v7 (v;inspection)	3 highest	reverse	coast (P4.2)

Table 4. Activity reference with direction. Parameter 1.6 = 1. As activity reference method except there is dedicated speed per motor direction.

DIB[4;5;6]	SpeedRef	Priority	Direction	Stop mode
[0;0;0]	*P1.17* v0 (v;levelling)	-	irrelevant	ramp
[**1**;0;0]	*P1.18* v1 (v;nominal)	-	irrelevant	coast (P4.2)
[0;**1**;0]	*P1.19* v2 (v;limited speed)	-	irrelevant	coast (P4.2)
[**1**;**1**;0]	*P1.20* v3 (v;inspection)	-	irrelevant	coast (P4.2)
[0;0;**1**]	*P1.21* v4	-	irrelevant	coast (P4.2)
[**1**;0;**1**]	*P1.22* v5	-	irrelevant	coast (P4.2)
[0;**1**;**1**]	*P1.23* v6	-	irrelevant	coast (P4.2)
[**1**;**1**;**1**]	*P1.24* v7	-	irrelevant	coast (P4.2)

Table 5. Binary reference. Parameter 1.6 = 2.

In a case where speed reference is generated from the analog input the inspection speed is (P1.20 ; v3) generated by activating digital input 6, DIB6.
If the states of digital inputs DIB4, DIB5, DIB6 are false, the stop mode is Stop by ramp. In all other cases the Stop by coast is performed. If the stop mode P4.2 is set to "1 =Ramping" the stop by ramp is performed also in those cases where the Stop by coast was defined.

1.7 *Current limit*
This parameter determines the maximum motor current from the freqeuency converter. To avoid motor overload, set this parameter according to the rated current of the motor.

1.8   *U/f ratio selection*

Linear:

0   The voltage of the motor changes linearly with the frequency in the constant flux area from 0 Hz to the field weakening point (par. 6. 3) where the nominal voltage is also supplied to the motor. Linear U/f ratio should be used in constant torque applications. This default setting should be used if there is no special need for another setting.

Not used:

1

Programmable
U/f curve

2   The U/f curve can be programmed with three different points.
         The parameters for programming are in group 6.
         Programmable U/f curve can be used if the other settings do not satisfy the needs of the application. See Figure 4.
         Programmable U/f curve can be used if the other settings do not satisfy the needs of the application.
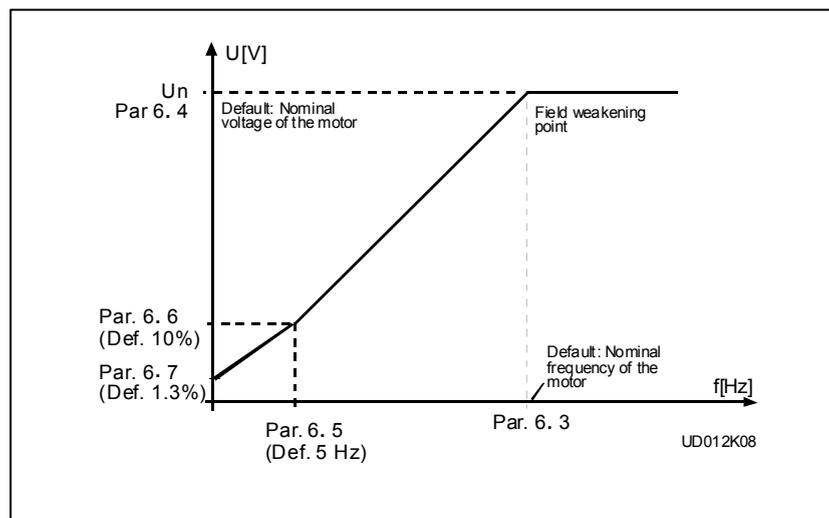
Figure 4.Programmable U/f curve.

1.9   *U/f optimisation*

Automatic   The voltage to the motor changes automatically which makes the motor
torque   produce sufficient torque to start and run at low frequencies. The voltage
boost   increase depends on the motor type and power.
         Automatic torque boost can be used in applications where starting torque due to starting friction is high.

NOTE!   *In high torque - low speed applications - it is likely the motor will overheat.*

> ⚠ *If the motor has to run a prolonged time under these conditions, special attention must be paid to cooling the motor. Use external cooling for the motor if the temperature tends to rise too high.*

1.10 *Nominal voltage of the motor*
Find this value U_n on the rating plate of the motor. This parameter sets the voltage at the field weakening point, parameter 6. 4, to 100% x U_{nmotor}.

1.11 *Nominal frequency of the motor*
Find this value f_n on the rating plate of the motor. This parameter sets the field weakening point, parameter 6. 3, to the same value.

1.12 *Nominal speed of the motor*
Find this value n_n on the rating plate of the motor.

1.13 *Nominal current of the motor*
Find this value I_n on the rating plate of the motor.

1.14 *Supply voltage*
Set parameter value according to the nominal voltage of the supply.
Values are predefined for CX/CXL2, CX/CXL/CXS4, CX/CXL/CXS5 and CX6 ranges.

1.15 *Parameter conceal*
Defines which parameter groups are available:
         0 = all parameter groups are visible
         1 = only group 1 is visible

1.16 *Parameter value lock*
Determines the access to parameter value changes:

         0 = parameter value changes enabled
         1 = parameter value changes disabled

1.17   *v0 A000 – B000* See the description for parameter 1.6.
1.18   *v1 A100 – B100* See the description for parameter 1.6.
1.19   *v2 A010 – B010* See the description for parameter 1.6.
1.20   *v3 A001 – B110* See the description for parameter 1.6.
1.21   *v4 A000 – B001* See the description for parameter 1.6.
1.22   *v5 A100 – B101* See the description for parameter 1.6.
1.23   *v6 A010 – B011* See the description for parameter 1.6.
1.24   *v7 A001 – B111* See the description for parameter 1.6.
1.25   *Start of reference hold*
1.26   *Stop of reference hold*
These parameters define a time window after the start command is given during which the speed reference is not read. This function can be used to delay deceleration when the distance between two floors is shorter than normal. The

function is also called "½ floor ride". The start and stop inputs are not affected by this function. Example: 1.25 = 0.1 s and 1.26 = 0.5 define a window between 0.1 and 0.5 s after start during the speed reference cannot be changed.

2.1   Start/Stop logic selection

0 DIA1: closed contact = start forward
DIA2: closed contact = start reverse

Figure 5. Start forward/Start reverse

①   The first selected direction has the highest priority

②   When DIA1 contact opens, the direction of rotation starts to change

③   If Start forward (DIA1) and Start reverse (DIA2) signals are active simultaneously, the Start forward signal (DIA1) has priority.

1   DIA1: closed contact = start   open contact = stop
DIA2: closed contact = reverse   open contact = forward
See Figure 5.

2.2   DIA 3 function

If "External brake control" activated to mechanical brake control value of this parameter is automatically set to "8 External brake control".

0 Not used
1 External fault, closing contact =   Fault is shown and motor is stopped when the input is active.
2 External fault, opening contact =   Fault is shown and motor is stopped when the input is not active.
3 Run enable   contact open =   Motor start disabled
contact closed =   Motor start enabled

4 Acc./Dec   contact open =   Acceleration/deceleration time 1 selected
   time select.   contact closed =   Acceleration/deceleration time 2 selected
5 Stop by coast, opening contact
              Stop by coast is performed when DIA3 is opened.

6 Fault reset   contact closed =   Resets all faults
7 DC.braking command
              contact closed =   In stop mode, the DC-braking operates until
                                    the contact is opened. DC-brake current is
                                    set with parameter 4.3.
8 External brake control
              External brake control input in mechanical brake control is
              connected to DIA3 is selected. See Figure 15 and parameters
              descriptions for P5.7, P5.9, P5.16.
9 Stop by coast, closing contact
              Stop by coast is performed when DIA3 is closed.

2.3 U_{in} / I_{in} Inversion

If voltage or current reference is selected with P1.6. the reference can be inverted.
Parameter 2. 3 = 1, inversion of analog U_{in} or I_{in} signal.
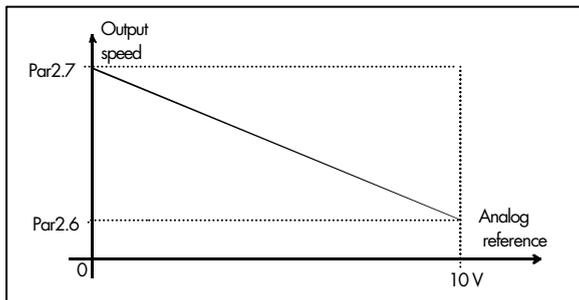
Figure 6. U_{in} signal inversion.

2.4 U_{in} / I_{in} Filter Time

Filters out disturbances from
the incoming analogue U_{in} / I_{in}
signal.
Long filtering time makes
regulation response slower.
See Figure 7.
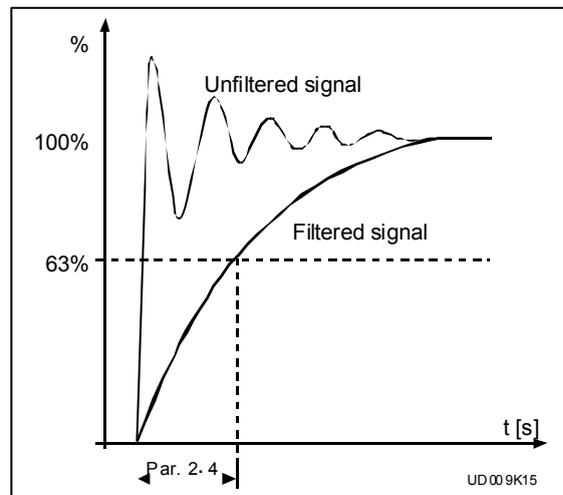
Figure 7. U_{in} signal filtering.

2.5 *Iin signal range*
0 = 0 - 20 mA
1 = 4-20 mA
Offset 4 mA ("living zero"), provides supervision of zero level signal. The response to reference fault can be programmed with the parameter 7.1.

2.6 *Reference scaling minimum value*
2.7 *Reference scaling maximum value*
Makes the scaling of the basic reference.
Setting limits: par2.5<par2.6
If par2.5 = 0.0 % and par2.6 =100.0 % scaling is set off. See Figure 8.
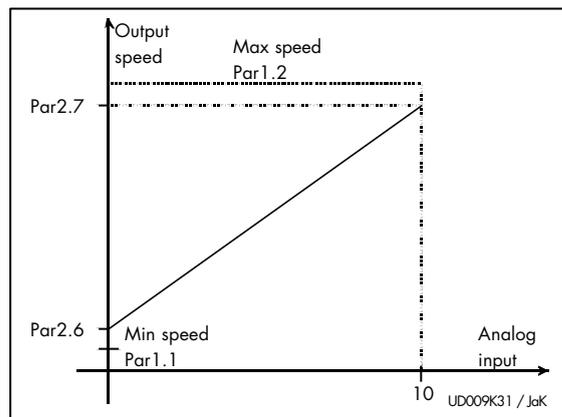
Figure 8. Reference scaling.

3.1 *Analogue output function*

Signal	Max. value of the signal
0 = Not used	
1 = Motor Freq.	$(0-f_{max})$
2 = Motor speed	$(0-$ max. speed$)$
3 = Motor current	$(0-2.0 \times I_{nCX})$
4 = Motor torque	$(-2 \times T_{nCX} - 2 \times T_{nCX})$
5 = Motor power	$(-2 \times P_{nCX} - 2 \times P_{nCX})$
6 = Motor voltage	$(0-100\% \times U_{nM})$
7 = DC-link volt.	$(0-1000$ V$)$

3.2 Analogue output filter time

Filters the analogue output signal.
See Figure 9.
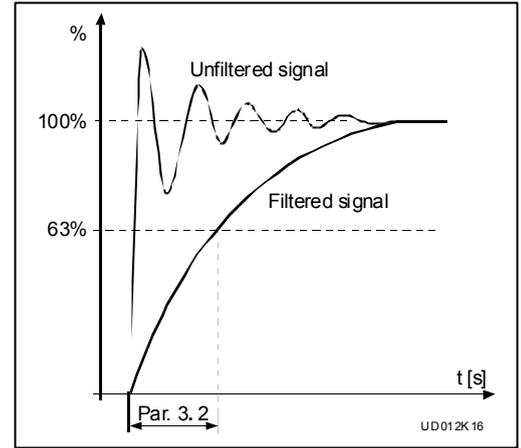
Figure 9. Analogue output filtering.

3.3 Analogue output invert

Inverts analogue output signal:
max. output signal = minimum set value
min. output signal = maximum set value
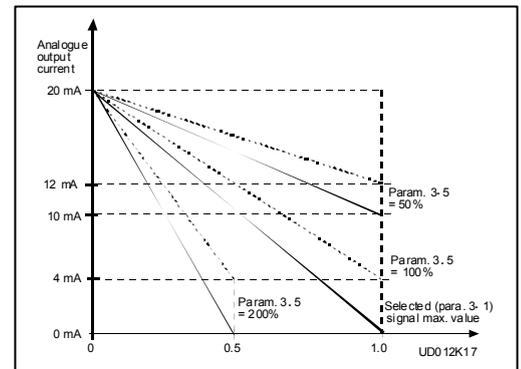
Figure 10. Analogue output invert.

3.4 Analogue output minimum

Defines the signal minimum to
either 0 mA or 4 mA (living
zero). See Figure 11.
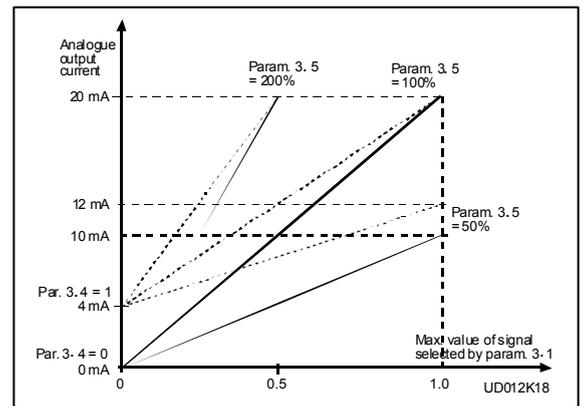
Figure 11. Analogue output scale.

3.5 Analogue output gain

Scaling factor for analogue output. See Figure 11.

3.6 *Analogue output offset*

With this parameter the offset of control board analog output signal is set.
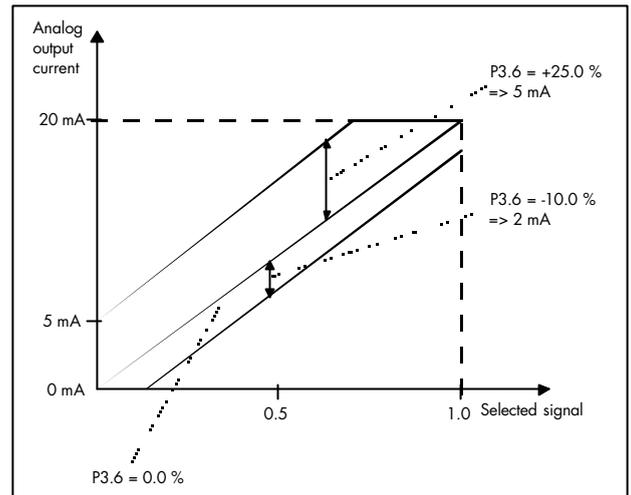
Figure 12. Analogue output scale.

3.7 *DO1 content*

Setting value	Signal content
0 = Not used	
1 = Allways on	Active all the time
2 = Ready	The frequency converter is ready to operate
3 = Run	The frequency converter operates (motor is running)
4 = Fault	A fault trip has occurred
5 = Warning	Always if a warning exists
6 = Speed below limit	Speed below limit set in P3.16
7 = Torque above limit	Torque above set limit in P3.17, P3.18
8 = Mechanical brake control	Mechanical brake control signal. See fig. 31-1 for functional description
9 = Open enable control	Vacon is ready to open the mechanical brake. See Figure 15 for functional description

Table 6.Output signals via DO1 and output relays RO1 and RO2.

3.8 *DO1 invert*
0 = Not inverted
1 = Inverted

3.9 *DO1 delay*
State transition of digital output is delayed with defined time. The delay is the same on rising and falling edge of the signal.

3.10 *RO1 content*
As parameter 3.7

3.11 *RO1 invert*
0 = Not inverted
1 = Inverted

3.12 *RO1 on delay*
Delay the rising edge of RO1 signal

3.13   RO1 of delay
Delay the falling edge of RO1 signal

3.14   RO2 content
As parameter 3.7

3.15   RO2 invert
0 = Not inverted
1 = Inverted

3.16   Speed supervision limit
The speed value to be supervised. This value is compared with calculated speed and
when this exceeds P3.16 the signal "Speed below limit" is false. When the speed
remains below the P3.16 the signal "Speed below limit" is true. See Table 6 for
"Speed below limit" signal.

3.17   Motoring torque supervision

Torque limit when operating in motoring mode. If P3.18 generating limit set to 0.0 %
torque is monitored without a sign. If P3.18 is 0.0 % this parameter defines both
motoring and genereting mode torque limit. According to P3.17 and P3.18 the
torque protetection fault F56 or warning F57 is activated according to P7.9.

3.18   Generating torque supervision

Torque limit when operating in generating mode. If set to 0.0 % this parameter is
ignored and the limit is defined by P3.17.

3.19   rpm source selection
0 = calculated rpm
1= rpm from encoder
If value 0 is selected the speed on monitoring page and the speed on the analog
output are updated according to the output frequency from the motor control. If value
1 is selected the contents of speed display and analog output are updated according
to the speed of the encoder.

4.1   *Brake chopper*

0 = No brake chopper
1 = Brake chopper and brake resistor installed
2 = External brake chopper

When the frequency converter is operating in generating mode , the inertia of the motor and the load are fed into the external brake resistor. This enables the frequency converter to decelerate the load with the torque equal to that of acceleration, if the brake resistor is selected correctly. If parameter set to 2 "External brake chopper" the brake chopper supervision is disabled. Otherwise the operation is the same as with parameter value 1.

4.2   *Stop function*

Coasting:

0: The motor coasts to a halt without any control from the frequency converter, after the Stop command.

Additionally to parameter value if all digital inputs DIB4–6 are inactive the stop mode is stop by ramp. I.e. inactive digital inputs are overriding this parameter. The function is the same regardless of selected frequency refererence source.

Ramp:

1: After the Stop command, the speed of the motor is decelerated according to the set deceleration parameters.

4.3   *DC-braking current (in closed loop, this parameter has no effect)*
Defines the current injected into the motor during DC-braking.

4.4   *DC-brake time at start*

0: DC-brake is not used.

>0: DC-brake is active at the start moment and this parameter defines the time before the brake is released. After brake is released output frequency increases according to the set reference and acceleration parametres (1.3, 4.14, 4.15). See Figure 13.

4.5   *Execute frequency of DC-brake at ramp Stop*
See Figure 13.

4.6   ***DC-braking time at stop (in closed loop, this parameter has no effect)***
Determines if braking is ON or OFF and the braking time of the DC-brake when the motor is stopping. The DC-brake is activated only when the stop is performed be ramp. When the stop by coast is performed the DC-brake is not activated.
0: DC-brake is not used
>0: DC-brake is in use and it's function depends on the Stop function, (param. 4. 2), and the time depends on the value of parameter 4. 6.

Stop-function = 0 (coasting):

DC-brake is not activated att all.

Stop-function = 1 (ramp):

After the Stop command, the speed of the motor is reduced according to the set deceleration parameters, to a speed defined with parameter 4. 5, where the DC-braking starts.

The braking time is defined with parameter 4. 6.

If high inertia exists, it is recommended to use an external braking resistor for faster deceleration. See Figure 13.
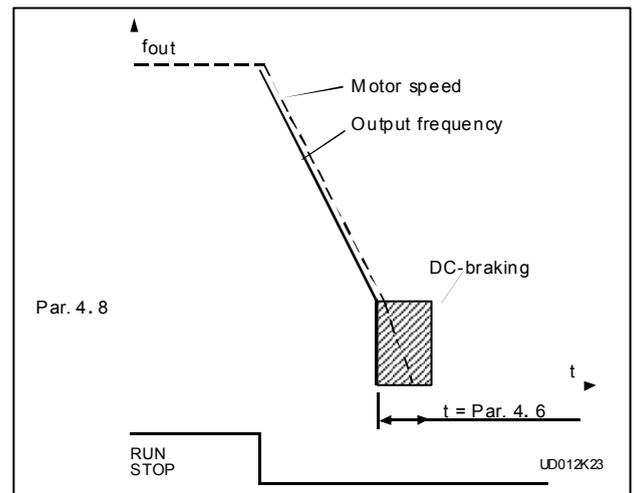
Figure 13. DC-braking time when stop function = ramp

4.7	*Acc Inc Jerk 1*
4.8	*Acc Dec Jerk 1*
4.9	*Dec Inc Jerk 1*
4.10	*Dec Dec Jerk 1*
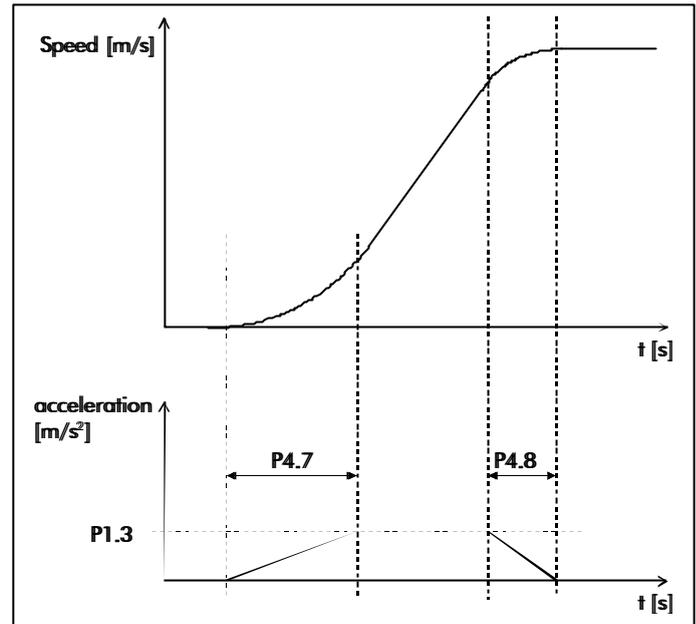
Figure 14. Jerks releted to speed and acceleration.

Deceleration increment P 4.11 and deceleration decrease (P 4.12) are used when decreasing the speed. The second ramp time set can be activated with digital input DIA3 or by activating P4.11 for internal ramp switching.

4.11 *Internal ramp switching*
The ramp set 2 can be activated internally. The update is done when the speed is decelerated to speed v0 defined in P1.17. Ramp set 1 is changed back when frequency converter enters the stop stage.
To the ramp set 2 is included parameters 4.12-4.17.

4.12 *Acceleration time 2*

4.13 *Deceleration time 2*
If ramp set 2 activated these values replase values defined in P1.3 and P1.4.

4.14	*Acc Inc Jerk 2*	See Figure 14
4.15	*Acc Dec Jerk 2*	See Figure 14
4.16	*Dec Inc Jerk 2*	See Figure 14
4.17	*Dec Dec Jerk 2*	See Figure 14

4.18 *Enable jerks*
0 = Disabled
1 = Enabled
Acceleration and deceleration rounding with jerks can be disabled by setting this parameter to 0. If set to 0 (Disabled) values set in P4.7 - P4.10 and P4.14 - P4.17 have no effect.

Mechanical brake control parameters

Mechanical brake control parameters are parameters affecting the mechanical brake control, the smooth start and stop functions and the safety functions.

Mechanical brake can be set to release on current, on torque, on frequency or on external input. The closing can be performed by frequency, external input or run request signals. In case of fault the closing is done directly without delay.

On the next page in Figure 15, the mechanical brake control logic is described. The area in the upper part in the picture describes the brake opening logics and the lower part the brake closing logics.
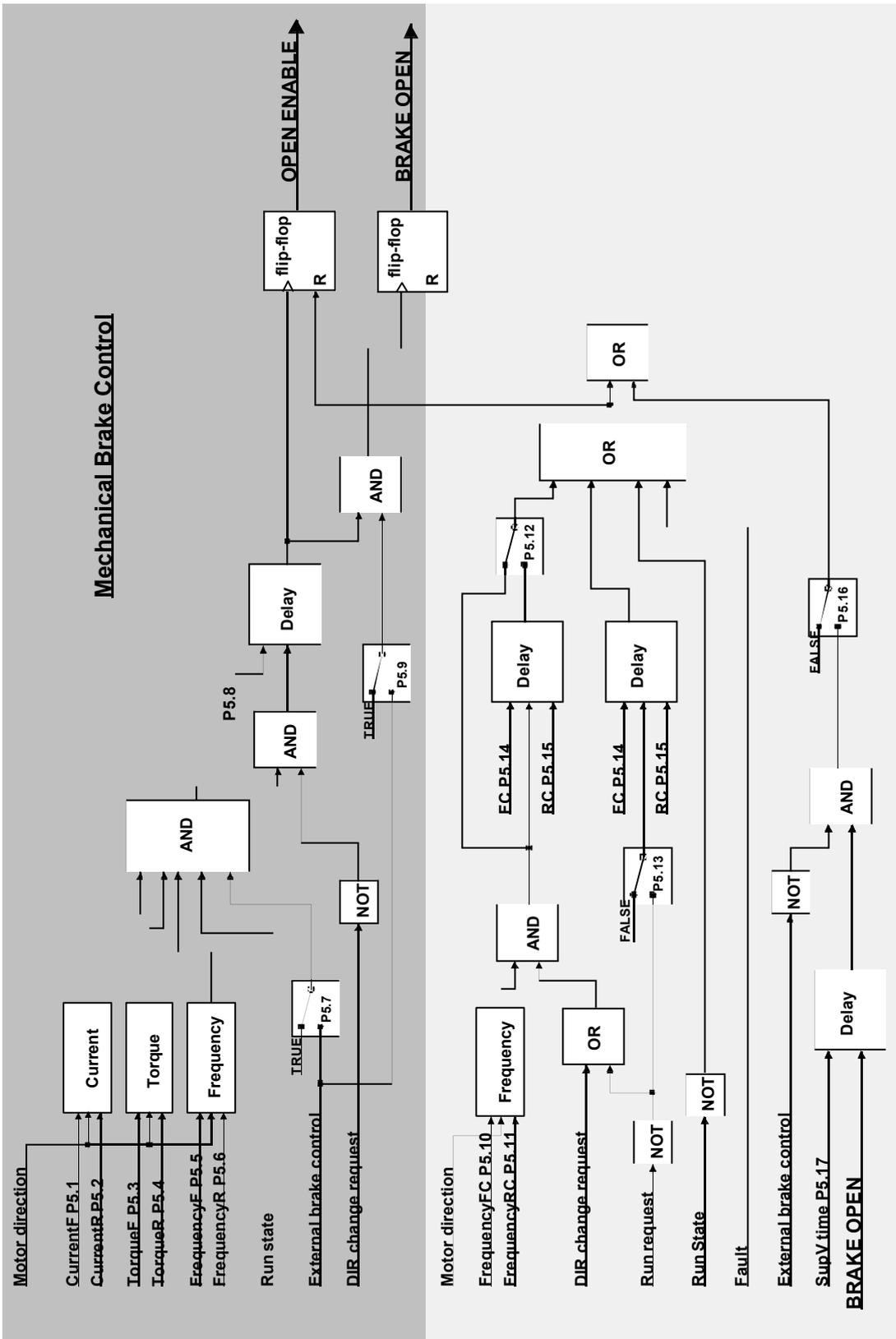
Figure 15. Mechanical brake control logic

In Figure 15, the "BRAKE OPEN" is the mechanical brake control signal and it can be selected to digital or to relay output to control the external mechanical brake.

In the mechanical brake control some of the blocks have *"Motor direction"* as input. In these blocks the actual parameter is selected according to motor direction. For example, in the upper left corner you find the *Current* block which compares the actual current fed to motor with parameter 5.1 or parameter 5.2 according to motor direction. The actual current is compared with P5.1 if motor is running forward and with P5.2 if motor is running reverse.

If two drives are used when running one lift the brakes and ramps need to be synchronized for smooth operation.
The mechanical brakes and ramps can be synchronized by connecting the "OPEN ENABLE" signal to another drive's "External brake control" input. The parameter P5.7 has to be set to "Inactive" so the "External brake control" signal does not affect the brake opening through delay. "External brake control" signal is transferred to brake opening condition by activating P5.9, i.e. the drive can not release the brake before the "External brake control" signal is active.
The brake closing synchronization is done by activating P5.16 and setting the P5.17 delay to zero. So if another drive is closing the brake the another one is following after the "OPEN ENABLE" signal becomes inactive.
The "OPEN ENABLE" signal can be selected to digital or relay output.

The "External brake control" signal is connected to brake control logic via digital input (DIA3). When activating a function using "External brake control" signal parameter 2.2 is set to "8 ExtBrakeControl" automatically.

Flip-flop blocks used in the diagram are set on the rising clock signal and reset with high reset [R] signal. The reset signal has priority if both conditions are true at the same time.

The term "closed mechanical brake" used further on in the text corresponds to a situation where the motor shaft rotation is prevented mechanically.
The term "released mechanical brake" corresponds to a situation where the motor shaft can rotate freely without mechanical prevention.

Parameters from 5.1 to 5.9 affect the mechanical brake release

5.1   *Current limit forward (Motor shaft running forward)*
5.2   *Current limit reverse (Motor shaft running reverse)*
          The actual current fed to motor have to exceed the limit to allow brake release. If set
          to zero this condition is excluded.

5.3   *Torque limit forward*
5.4   *Torque limit reverse*
          These paramters define the actual torque limit that has to be exceeded for a brake
          release. If set to zero this condition is excluded.
          100 % correcponds to the calculated nominal torque of the motor.

5.5   *Frequency limit forward*
5.6   *Frequency limit reverse*
          These parameters define the actual frequency limit that has to be exceeded for brake
          release. If set to zero this condition is excluded.

5.7   *External brake control*
          DIA3 can be connected to brake releasing logic by activating this parameter. Set
          P2.2 to 8 connect the DIA3 to External brake control signal.

5.8   *Opening delay*
          Time with which the brake release is delayed.

5.9   *Dual brake control*
          If running the lift with two Vacon drives this function is to gain synchronized brake
          and ramp control. The OPEN ENABLE signal is connected to digital input DIA3 and
          in the another drive connected vice versa. For dual drive control, P5.17 has to be set
          to zero and parameters 5.16, 5.9 activated. Parameter 5.7 has to be set to inactive.

Parameters from 5.10 to 5.17 affect the mechanical brake closing.

5.10   *Frequency limit closing forward*
5.11   *Frequency limit closing reverse*
          The output frequency limit which closes the brake. The run request signal needs to be
          disabled to allow the signal to affect.

5.12   *Close from frequency*
          If the brake closing from frequency limit is to be delayed.

5.13   *Run request closing*
          If the run request signal is included in the brake closing logic.

5.14   *Closing delay forward*
5.15   *Closing delay reverse*
          The brake closing is delayed with the defined time. If set to zero there is no delay
          between the brake closing condition and the actual brake closing.

5.16   *External brake feedback supervision*
After the mechanical brake is released, DIA3 can be used to verify the brake open state. A time window within which DIA3 has to be activated from the brake release is defined in P5.17. If DIA3 is deactivated outside this time window, external brake fault is generated. The response to external brake fault is set with parameter 7.3.

5.17   *Brake feedback supervision time*
A time window within the DIA3 input have to be activated after the brake is released. Is the time withing the digital input DIA3 have to activated from brake releasing.
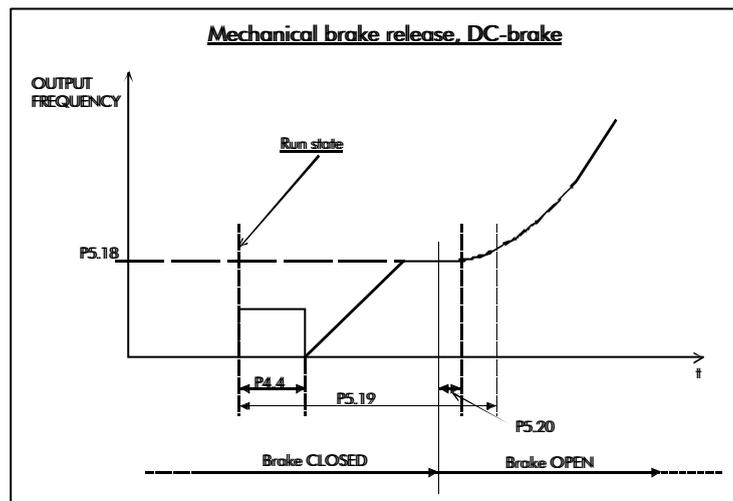
Figure 16.Mechanical brake release, DC-brake.

5.18   *Maximum frequency brake closed*
Output frequency does not exceed this value when mechanical brake is closed. When modifying this parameter make sure that the brake release from frequency "P5.5 and P5.6" is possible with new value.

5.19   *Brake release supervision*
Time within the brake have to be released from entering the "run state". If the time is exceeded mechanical brake control fault or warning is activated. The response to external brake fault is set with parameter 7.3.

5.20   *Mechanical brake reaction time*

After brake is released the speed reference is in hold for a defined time. This hold time should be set to correspond mechanical brakes reaction time.

5.21   *Direction change mode*

If direction change situation has to be handled with external brake control the function is set with this parameter.

If set to 0 (Inactive) the change of direction does not cause mechanical brake closing.

If set to 1 (Brake Closed) the signal *DIR change request* is activated in a case of direction change request. The mechanical brake is closed and released by the limits (frequency, torque, etc.) set by parameters.

If set to 2 (StopState) the drive is forced to stop state in case of direction change request. After the external brake is closed and the drive has entered the stop state the overriding "stop request" signal is released and the ramp up sequence is started as in a normal start case.

5.22   *Smooth start time*

The smooth start is a function that is used is closed loop control mode. It cannot be used in open loop. After the start command has been given the drive is rotating the motor shaft with a very low frequency (P5.23) to overcome the static friction. After the shaft has been rotating time defined is the reference increased normally.

5.23   *Smooth start frequency*

The reference frequency that is used during the smooth start operation.

5.24   *Zero speed time start*
5.25   *Zero speed time stop*

Closed loop start and stop zero speed times. The mechanical brake should be set to release during zero speed time at start and the brake should be set to close during zero speed time stop.

6.1   *Motor control mode*

0 = Frequency control: The I/O terminal and panel references are frequency references and the frequency converter controls the output frequency.

1 = Speed control: The I/O terminal and panel references are speed references and the frequency converter controls the motor speed (regulation accuracy ± 1%).

2 = Not used

3 = Speed control closed loop:

When running the motor in closed loop motor control mode the closed loop parameters in group 10 need to be set to correspond to the motor and encoder type.

6.2   *Switching frequency*

Motor noise can be minimized using a high switching frequency. Increasing the switching frequency reduces the capacity of the Vacon CX unit.

Before changing the frequency from the factory default 10 kHz (3.6 kHz from 30 kW upwards) check the allowed capacity on the curve in Figure 5.2-3 in Chapter 5.2 of the User's Manual.

6.3   *Field weakening point*
6.4   *Voltage at field weakening point*

The field weakening point is the output frequency at which the output voltage reaches the set maximum value (par. 6.4). Above that frequency the output voltage remains at the set maximum value.

Below that frequency the output voltage depends on the setting of the U/f curve parameters 1.8, 1.9, 6.5, 6.6 and 6.7. See Figure 17.

When the parameters 1.10 and 1.11, nominal voltage and nominal frequency of the motor, are set, parameters 6.3 and 6.4 are also set automatically to the corresponding values. If different values for the field weakening point and the maximum output voltage are required, change these parameters <u>after</u> setting the parameters 1.10 and 1.11.

6.5   *U/f curve, middle point frequency*

If the programmable U/f curve has been selected with the parameter 1.8 this parameter defines the middle point frequency of the curve.

6.6   *U/f curve, middle point voltage*

If the programmable U/f curve has been selected with the parameter 1.8 this parameter defines the middle point voltage of the curve.

6.7   *Output voltage at zero frequency*

If the programmable U/f curve has been selected with the parameter 1.8 this parameter defines the zero frequency voltage of the curve.
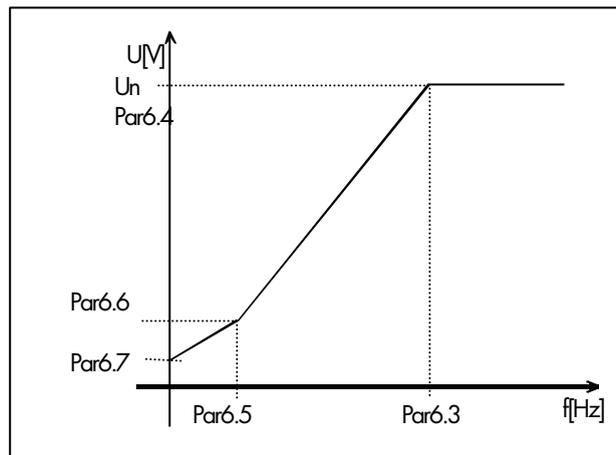
Figure 17. Programmable U/f curve.

6.8   *Undervoltage controller*

This parameter allows the undervoltage controller to be switched out of operation. This may be useful, for example, if the mains supply voltage varies more than –15% and the application will not tolerate this undervoltage, the regulator controls output frequency according to the supply fluctuations.

Undervoltage trips may occur when controllers are switched out of operation.

Safety functions

The safety function provided by the Vacon frequency converter equipped with lift application (smc126) does not fulfil any standards or regulations for lifts.
The lift manufacturer is responsible for making the motor and drive installation according to the safety regulations for construction and installation of lifts.

7.1   *4 mA fault*

0 = No response
1 = Warning
2 = Fault

A warning or fault action and message is generated if 4—20 mA reference signal is used and the signal falls below 4 mA.

7.2   *External fault*

0 = No response
1 = Warning
2 = Fault
A warning or fault action and message is generated through the external fault signal in the digital input DIA3.

7.3 *Mechanical brake control fault*

0 = No response
1 = Warning
2 = Fault

Mechanical brake supervision fault ensures that the brake is released within the defined time and external brake supervision does not trigger the fault. With this parameter this function can be turned off.

7.4 *Shaft speed fault*

0 = No response
1 = Warning
2 = Fault

Actual shaft speed according to encoder and calculated shaft speed from motor control are compared and in case the speed diffrence is more than set limit P7.5 for a defined time in P7.6, the set action is taken.

This fault is generated only when the mechanical brake is open. i.e. if running against mechanical brake this fault is not generated.

In open loop motor control mode this fault is not generated. See Figure 18.
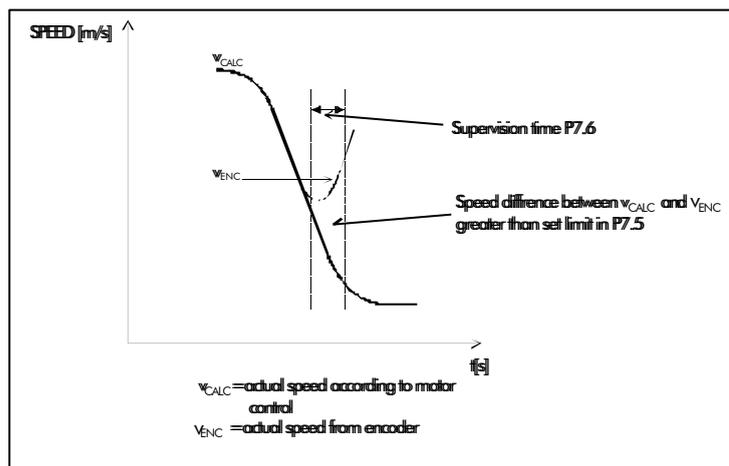
Figure 18. Shaft speed supervision

7.5 *Shaft speed supervision limit*

The speed difference between the actual and the calculated lift speed which will cause tripping. See Figure 18.

7.6 *Shaft speed supervision time*

If the speed difference in shaft speed supervision is greater than set limit P7.5 for a defined supervision time the shaft speed warning or fault is generated. See Figure 18.

7.7 *Phase supervision of the motor*

0 = No action
1 = Warning
2 = Fault

Phase supervision of the motor ensures that the motor phases have an approximately equal current. With this parameter this function can be turned off.

7.8 *Input line phase supervision*

0 = No action
2 = Fault

By setting the parameter to zero, the phase supervision of the supply voltage will not cause tripping.

7.9 *Earth fault protection*

0 = No action
2 = Fault

Earth fault protection ensures that the sum of the motor phase currents is zero. The overcurrent protection is always working and protects the Vacon CX against earth faults with high currents.

7.10 *Overtorque protection*

0 = No response
1 = Warning
2 = Fault
The actual torque is compared to torque limits set with P3.17 and P3.18. If exceeded the defined action is taken.

Parameters 7.11−7.15 Motor thermal protection

General

Motor thermal protection is to protect the motor from overheating. Vacon CX/CXL/CXS drive is capable of supplying higher than nominal current to the motor. If the load requires this high current there is a risk that the motor will be thermally overloaded. This is true especially at low frequencies. At low frequencies the cooling effect of the motor is reduced as well as the capacity of the motor. If the motor is equipped with an external fan the load reduction at low speeds is small.

Motor thermal protection is based on a calculated model and it uses the output current of the drive to determine the load on the motor. When the power of the drive is turned on, the calculated model uses the heatsink temperature to determine the initial thermal stage for the motor. The calculated model assumes that the ambient temperature of the motor is 40°C.

Motor thermal protection can be adjusted by setting the parameters. The thermal current I_T specifies the load current above which the motor is overloaded. This current limit is a function of the output frequency. The curve for I_T is set with parameters 7.12, 7. 13 and 7. 15, See Figure 19. The parameters have their default values taken from the motor name plate data.
With the output current at I_T the thermal stage will reach the nominal value (100%). The thermal stage changes by the square of the current.

With output current at 75% of I_T the thermal stage will reach a 56% value and with output current at 120% of I_T the thermal stage would reach a 144% value. The function will trip the device (refer par. 7. 11) if the thermal stage will reach a value of 105%. The speed of change in thermal stage is determined with the time constant parameter 7. 14. The bigger the motor the longer it takes to reach the final temperature.

The thermal stage of the motor can be monitored through the display. Refer to the table for monitoring items. (User's Manual, table 7.3-1).

⚠ CAUTION! *The calculated model does not protect the motor if the airflow to the motor is reduced by blocked air intake grill*

7.11 Motor thermal protection

Operation:
      0 = Not in use
      1 = Warning
      2 = Trip function

Tripping and warning will display the same message code. If tripping is selected the drive will stop and activate the fault stage.

Deactivating the protection, setting parameter to 0, will reset the thermal stage of the motor to 0%.

7.12   *Motor thermal protection, break point current*

The current can be set between 50.0—150.0% x I_{nMotor}.

This parameter sets the value for thermal current at frequencies above the breakpoint on the thermal current curve. See Figure 19.

The value is set in percentage which refers to the name plate data of the motor, parameter 1. 13, nominal current of the motor, not the drive's nominal output current. The motor's nominal current is the current which the motor can withstand in direct on-line use without being overheated.

If parameter 1. 13 is adjusted, this parameter is automatically restored to the default value.

Setting this parameter (or parameter 1. 13) does not affect the maximum output current of the drive. Parameter 1. 7 alone determines the maximum output current of the drive.
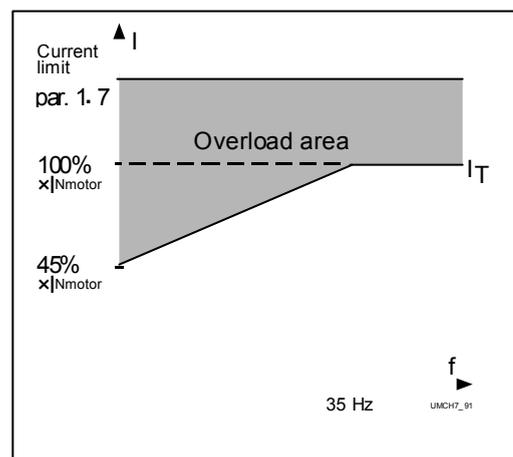
Figure 19. Motor thermal current I_T curve

7.13   *Motor thermal protection, zero frequency current*

The current can be set between 10.0% and 150.0% x I_{nMotor}. This parameter sets the value for thermal current at zero frequency. Refer to Figure 19.

The default value is set assuming that there is no external fan cooling the motor. If an external fan is used this parameter can be set to 90% (or even higher).

The value is set as a percentage of the motor name plate data, parameter 1.13, motor's nominal current, not the drive's nominal output current. Motor's nominal current is the current which the motor can stand in direct on-line use without being overheated.

If you change the parameter 1.13 this parameter is automatically restored to the default value.

Setting this parameter (or parameter 1. 13) does not affect to the maximum output current of the drive. Parameter 1. 7 alone determines the maximum output current of the drive.

7.14 *Motor thermal protection, time constant*

This time can be set to 0.5—300 minutes.
This is the thermal time constant of the motor. The bigger the motor the bigger the time constant. The time constant is the time within which the calculated thermal stage has reached 63% of its final value.

The motor thermal time is specific for the motor design and it varies between different motor manufacturers.

The default value for the time constant is calculated basing on the motor name plate data given with parameters 1. 12 and 1. 13. If either of these parameters is set, this parameter is set to default value.

If the motor's t_6-time is known (given by the motor manufacturer) the time constant parameter could be set basing on t_6-time. As a rule of thumb, the motor thermal time constant in minutes equals to $2 \times t_6$ (t_6 in seconds is the time a motor can safely operate at six times the rated current). If the drive is in stop stage the time constant is internally increased to three times the set parameter value. The cooling in the stop stage is based on convection and the time constant is increased.

7.15 *Motor thermal protection, breakpoint frequency*

The frequency can be set between 10—500 Hz.
This is the breakpoint of thermal current curve. With frequencies above this point the thermal capacity of the motor is assumed to be constant. See Figure 19.

The default value is based on the motor's name plate data, parameter 1. 11. It is 35 Hz for a 50 Hz motor and 42 Hz for a 60 Hz motor. More generally, it is 70% of the frequency at field weakening point (parameter 6. 3). Changing either parameter 1. 11 or 6. 3 will restore this parameter to its default value.
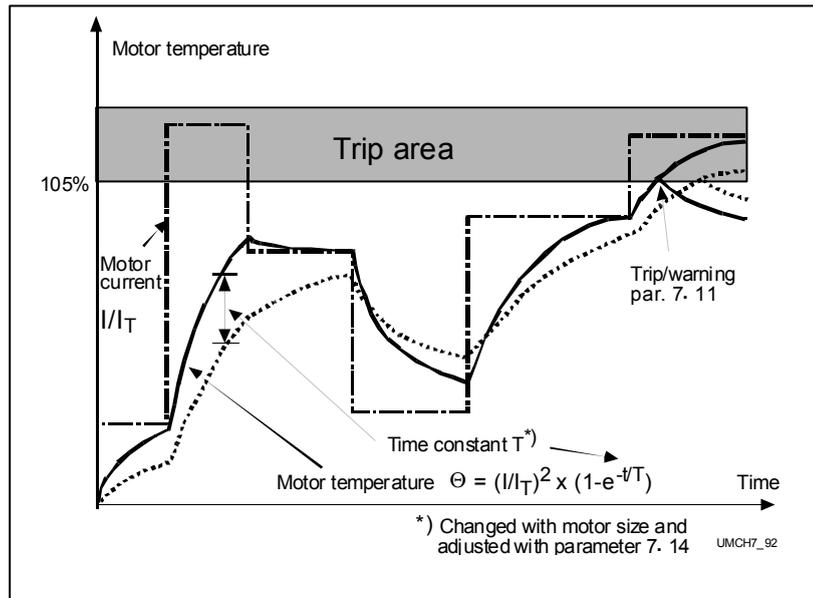
Figure 20. Motor temperature calculation

Parameters 7.16—7.19, Stall protection
General

Motor stall protection protects the motor from short time overload situations like a stalled shaft. The reaction time of stall protection can be set shorter than with motor thermal protection. The stall state is defined with two parameters, 7.17. Stall Current and 7.19. Stall Frequency. If the current is higher than the set limit and output frequency is lower than the set limit, the stall state is true. There is actually no real indication of the shaft rotation. Stall protection is a type of overcurrent protection.

7.16   *Stall protection*

Operation:

        0 = Not in use
        1 = Warning
        2 = Trip function

Tripping and warning will display the same message code. If tripping is set on, the drive will stop and activate the fault stage.

Setting the parameter to 0 will deactivate the protection and will reset the stall time counter to zero.

7.17 Stall current limit

The current can be set to 0.0—200% x I_{nMotor}.
In a stall stage the current has to be above this limit. See Figure 21. The value is set as a percentage of the motor's name plate data, parameter 1.13, motor's nominal current. If parameter 1.13 is adjusted, this parameter is automatically restored to the default value.
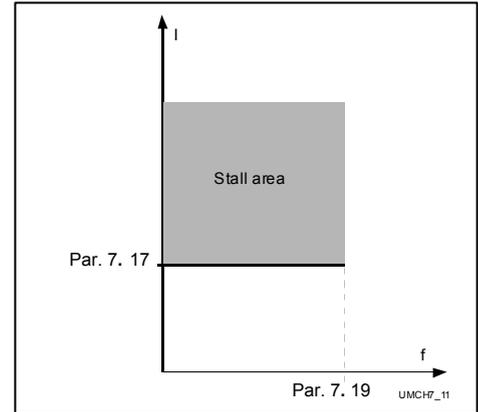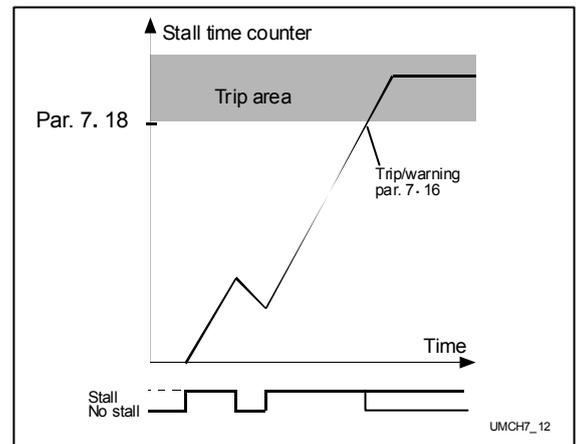

Figure 21. Setting the stall characteristics

7.18 Stall time

The time can be set between 2.0—120s.
This is the maximum allowed time for a stall stage. There is an internal up/down counter to count the stall time. See Figure 22. If the stall time counter value goes above this limit the protection will cause a trip (see parameter 7.16).

Figure 22. Stall time counting.

7.19 Maximum stall frequency

The frequency can be set between $1—f_{max}$. In a stall state, the output frequency has to be smaller than this limit. See Figure 21.

7.20 Torque overshoot time

When torque exceeds limits set in P3.17 and P3.18 is the over torque protection fault activated after the overshoot situation have been present the defined time. If set to zero the fault is activated at once the actual torque exceeds the supervision limits. Torque protection fault set in P7.10

7.21 Minimum current supervision limit

If current fed to motor is below set limit fault "F58 Current limit fault" generated. This fault can be activated only when the mechanical brake is open. 100.0 % corresponds to frequency converters nominal current.

7.22   *Response to control conflict*

0 = No response
1 = Warning
2 = Fault
With this parameter the application can be set to monitor the states of the DIA1 and DIA2. In a case these are active at the same time the defined action is taken. In a case of warning, a warning "59 Direction request warning" is activated and in a case of fault, a fault "51 Direction request fault" is given.

8.1   *Automatic restart: number of tries*
8.2   *Automatic restart: trial time*
The Automatic restart function restarts the frequency converter after the faults selected with parameters 8. 3—8. 6.
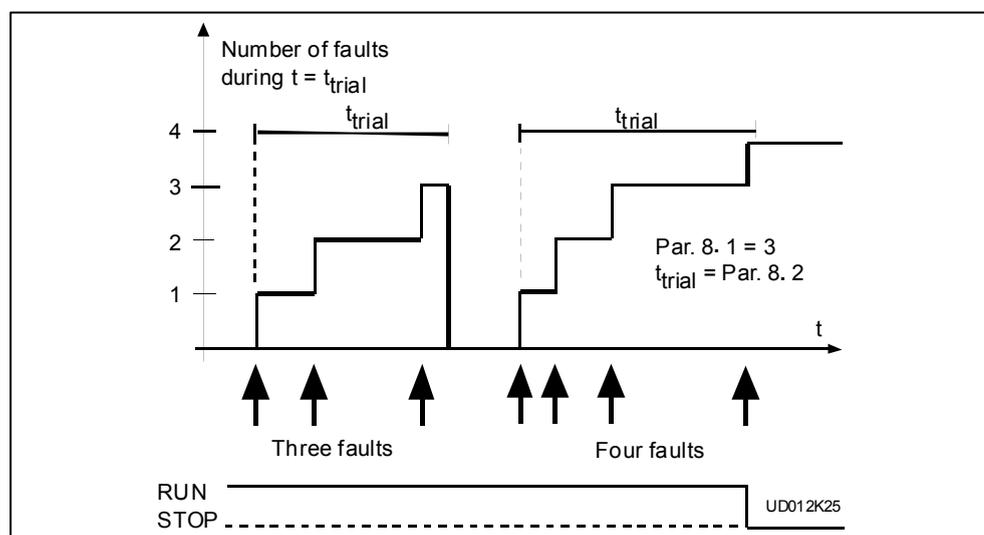

Figure 23. Automatic restart.

Parameter 8. 1 determines how many automatic restarts can be made during the trial time set by parameter 8. 2.

The time count starts from the first autorestart. If the number of restarts does not exceed the value of parameter 8. 1 during the trial time, the count is cleared after the time is elapsed and the next fault starts the counting again.

8.3   *Automatic restart after undervoltage trip*
0 = No automatic restart after undervoltage fault
1 = Automatic restart after undervoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)
8.4   *Automatic restart after overvoltage trip*
0 = No automatic restart after overvoltage fault
1 = Automatic restart after overvoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)
8.5   *Automatic restart after overcurrent trip*
0 = No automatic restart after overcurrent fault
1 = Automatic restart after overcurrent faults
8.6   *Automatic restart after over-/undertemperature fault trip*

0 = No automatic restart after temperature fault
1 = Automatic restart after heatsink temperature has returned to its normal level between -10°C—+75°C.

Parameters in group 9 have effect only on open loop motor control (P6.1=1).

9.1   **Mot Boost gain**
9.2   **Generator boost gain**
Sets the level of boost for the Torque Boost Function (par 1.9 =1) for motor and generator loading.

9.3   **Minimum field frequency**
Minimum field frequency is compensating the slip of the motor. Used only in open loop speed control mode (P6.1=1). Unless necessary it is not recommended to change parameter from it's default values.

9.4   **Minimum field**
0=Default
1=Ramp
2=Step
With this parameter the speed controller is set for smooth ramps. Unless necessary it is not recommended to change the parameter's default values.

9.5   **Stator Impedance**
Defines the resistance in the stator of the motor as seen between two phases to the frequency converter. The value is essential to speed control in open loop control. The value is identified automatically during autotuning or when the DC brake time at start is longer than 300 ms.

9.6   **Voltage Stab Gain**
9.7   **Voltage Stab Damp**
9.8   **Torque Stab Gain**
9.9   **Torque Stab Damp**
Normally, there is no need to set these except for special motors. Contact the factory before doing adjustments to these.

10.1   **Encoder pulse number**
Encoder pulse number is very essential in closed loop. Wrong pulse number leads to high torque estimate even at no-load. Please check the encoder P/R on the encoder nameplate.

10.2   **Encoder direction**
0=Forward
1=Reverse

10.3   **Encoder filter time**
This parameter can be used to eliminate noise due to high frequency encoder feedback. If the value is 0=Automatic, the filtering time is automatically calculated from speed control gain. Too high a filter time value reduces speed control stability. Preferred range 0 to 5 ms.

10.4   *Identification*

Identification run is started by setting the value 1 to this parameter in stop state and giving a run command within 10 seconds. Motor must be disconnected from the load during identification run.

The following closed loop control parameters are automatically set by the identification control program:

P10.2 Encoder direction, P10.5 Motor magnetising current, P10.7 speed control gain, P10.8 speed control integration time.

Open loop control parameters automatically set by the identification:

P6.5 U/f curve middle point frequency, P6.6 U/f curve middle point voltage, P6.7 Output voltage at zero frequency.

The above mentioned parameters can be further adjusted after the identification run.

10.5   *Motor magnetising current*

Magnetising current is the no-load current of the motor. It can be measured in open loop at two thirds of the nominal frequency. Normally, the value is about one third of the nominal current. Magnetising current determines the no-load voltage of the motor.

10.6   *Slip Adjust*

Parameter for tuning the nominal slip of the motor. Before tuning the nominal rpm P1.12 needs to be set according to motor nameplate value.

10.7   *Speed control P gain*
10.8   *Speed control I time*

Speed controller parameters. If the inertia is large, the P-gain can be increased. Increasing the I-time increases stability but decreases speed performance if too large.

10.9   *Current control P gain*

This parameter can be used to improve current control stability with special motors.

8 Commissioning of Closed Loop Control

Setting up the closed loop control without using autotuning

Autotuning requires that the motor is not loaded. If it is not possible to disconnect the load or run with light load, parameters P10.5, P10.7, P10.8 and P10.2 must set manually.

1) Check very carefully the encoder connections and encoder supply voltages. Check the brake resistor connection.

2) Do all normal commissioning phases 1 to 10 in open loop, see VACON CX/CXL/CXS manual, Chapter 8.2.

3) Set the displayed rpm to "ENCODER RPM" (P3.19=1). Run the motor in open loop at different frequencies. Check that the displayed RPM equals to the assumed RPM. Negative number to forward direction indicates wrong encoder direction. This can be corrected by setting P10.2=1. Zero rpm indicates problems with encoder. Check.

4) Run the motor at about 2/3 of the nominal frequency with low load. The motor current should be the magnetising current, which is usually about one third of the nominal current. Check the displayed torque to insure that the load is low. If friction exists, the measured current can be higher than the magnetising current.

5) Activate the brake chopper and set the closed loop control mode (P6.1=3), set first speed control gain to low value (20) and integral time to at least 30. Set motor magnetising current to one third of the motor nominal current or to the measured no-load current.

6) Put a zero speed reference and start. If fault F32 appears, reverse the encoder direction (P10.2). Fault F31 indicates problems with encoder. Run at about 2/3 of the nominal frequency with low load. Adjust the motor magnetising current to achieve about 2/3 of the motor nominal voltage.

7) Increase the load. If the motor voltage changes a lot, adjust the motor nominal speed (P1.12).

8) Increase the speed control gain and decrease the integral time for tighter control.

It must be noted that the speed controllers have to be stable also in torque control mode. This is because the maximum speed is limited with speed controllers.

Setting up the closed loop control using autotuning

Autotuning can be used to measure the magnetising current, change the encoder direction and set the speed control parameters automatically. The motor load should be low. The control program controls the frequency, so the motor should be disconnected from the process. The gear and possible additional inertia should be present for proper speed control gain setting.

1) Activate autotuning by setting P10.4=1 and by starting the motor within 10 seconds.

Identification run should last a few seconds and the motor will stop. Identification corrects the encoder direction, measures the magnetising current and determines suitable speed control parameter values. These can be further adjusted for improved performance. Refer the previous chapter.

Note ! The autotuning function also sets the open loop U/f curve parameters.

9 Open loop motor control parameters

9.1 Tuning motor control parameters

Tuning is needed to get good torque properties out of the motor on the low speeds. This is very essential when the levelling speed of the lift is low (2…3 Hz) or even below. Although the levelling speed would be higher (5Hz) the low speed is used on start and stop.

The purpose of the tuning is:

1) To avoid "free falling" on start and stop.

2) To avoid too high current on now load situation and on the situation when the motor is generating.

3) To achieve a smooth enough start and stop both on full load and no load situation.

On tuning we affect the drive operations at low speed. The low speed area in this text means the area below 5…6Hz (2…3*nominal slip of the motor).

The points 1) and 2) are done by tuning the U/f curve (IR compensation) and in difficult situations also tuning the gain of the torque boost function.

The point 3) is affected by the U/f curve settings, but also by the mechanical brake control.

9.2 Three different methods for tuning motor control parameters

The parameters used for tuning are mainly the U/f curve setting parameters 6.6. and 6.7. The higher values (higher voltage) you give, the stronger the motor will be. However, if you set the values too high the operation might come rough, "bumpy" and the current on the generating situation will get all too high.

If you set the values too low (lower voltage) the motor gets weak. It takes more current on motoring situation than on generating situation and it might even "drop" the load.

1) Autotuning

Autotuning requires that the motor is not loaded. If it is not possible to disconnect the load or run with light load, parameters 6.5, 6.6 and P6.7 must be set manually. For tuning open loop motor parameters the same identification run as for closed loop motor control parameters can be used. To start the identification run, parameter 10.4 is set to "1=Identify" and then the run command has to be given within 10 seconds. During the identification a set of tests is performed and parameters 6.5, 6.6, 6.7 are set. If needed these can be further adjusted after identification run.

2) Motor identification procedure for open loop vector control. No load on the motor

If for some reason the identification run fails to measure the motor characteristics, the tunning can be done manually. In chapter 9.3 "Motor identification procedure for open loop vector control. No load on the motor" the identification method for unloaded motor is presented.

The result of the motor parameter tuning described in 1) and 2) is usually accurate enough and no further tuning is required or the fine tuning is done with the torque boost gain parameters 9.1 and 9.2.

3) Motor identification procedure for open loop vector control. Loaded motor

In many cases the tuning of motor parameters is done with the lift i.e. the motor is attached to the gearbox. In this case, the tuning is done by modifying the U/f curve setting parameters 6.5, 6.6 and 6.7. The U/f curve tuning is done by monitoring output current and corresponding torque with different load conditions in the lift car. This identification method is presented in Chapter 9.4.

9.3 Motor identification procedure for open loop vector control. No load on the motor

To be able to get high torque from the motor at low frequencies (0..4Hz) we need to do some adjustment with parameters.

The magnetization of the motor has to be right also at low frequencies (IR compensation). This can be achieved either by setting the U/f curve of the motor with parameters of group 6 or by activating the automatic torque boost operation by setting parameter 1.9 to 1.

The output frequency has to be high enough (bigger than the slip of the motor). If there is a requirement of high torque with reference frequencies near or even below the nominal slip of the motor then the speed control operation is used. Parameter 6.1 is set to "1 Speed control open loop", which is the default in the lift application. When this parameter is activated the Vacon CX compensates the slip in the motor.

It is important to have the motor name plate values set in the correct way. There are internal parameters which are initialized basing on the given motor name plate values.

Normally we can get satisfactory operation just by setting the motor name plate values. If this is the case the motor identification procedure is not needed. However, using this setup procedure will help to get the most out of the drive properties.

The speed control and torque boost operations utilize the motor model in the internal calculations. There are internal parameters in this motor model. The initial values for all internal parameters fit the most standard motors. However, if Vacon CX is not running the nominal size motor then this set up procedure might be needed. Also, if the operation at low speeds and reversing operations are very important and critical for the application this setup procedure is recommended.

Start the identification with the default values

- Set the parameters to the default values (by re-selecting the Application).

- Set the motor name plate values to parameters 1.10-1.13.

- Set the parameter 6.1 Control mode to "0=Frequency control open loop".

- Set the parameter 1.9 U/f optimisation to "0=None".

Set the motor magnetizing curve

- Set the parameter 1.8. to 2 Programmable U/f curve.

- Record the motor magnetization (Im) current by running the motor with free shaft at 40Hz (= 0.8 * field weakening point). Check the motor current in monitoring item V3 and write it down. This is the magnetization current of the motor (Im). It should be about 0.5 * In of the motor. If the current is clearly higher or lower than 0.5 * In of the motor, double check the motor name plate values and check that there is no load on the shaft.

- Set the U/f mid point frequency with parameter 6.5 around 3...5 Hz. This frequency should be about 3*nominal slip of the motor. Run the motor at this frequency. Adjust the U/f curve mid point voltage with parameter 6.6. in the way that motor current is the same as running with 40 Hz (Im). With standard motors the value should be 1...2% above the "linear curve" value (P6.6 = 11 ... 12% if 6.5 was set to 5 Hz).

- Run at a frequency of 1 Hz and adjust the motor voltage with parameter 6.7 in the way that the motor current is again the same as if running at 40 Hz (Im). With standard motors the value should be between 1 and 2.5%.

- Now when you are running the motor at whatever frequency between 0 Hz and field weakening point the motor current should stay constant (Im) and the torque display V4 should be around 0%. (Naturally, only when the drive is not decelerating or accelerating.)

Stator resistance (Rs) measurement

The motor model in vector calculation needs the stator resistance value to be able to make accurate calculations. The initial value of stator resistance is based on given motor nominal current value. However, this value changes between different motor designs and also the temperature of the motor has an effect on the stator resistance value.

The drive makes a stator resistance measurement every time a DC braking operation is activated at the start. The recommended value for the DC-braking current should be set between 0.5...0.8 * In of the motor. The motor shaft should be at stand still during this DC-braking operation, keeping the mechanical brake closed. When time for DC-braking is set equal or longer than 1 s the stator resistance is measured and stored into the EEPROM. When the start DC-brake time is between 0.2 s – 1 s the stator resistance is measured, but not stored into the EEPROM. i.e. at every start a new value for stator resistance is evaluated.

When commissioning the lift, the DC-brake time should be set longer than 1s and for permanent setting it is recommended to set the "measure only operation" i.e. 0.2s< DC-brake time <1s.

Set parameters 4.3 DC-Brake current and 4.4 Start DC-Brake time accordingly.

Activate the actual operation

Activate the automatic magnetization optimization by setting parameter 1.9 to 1. This operation utilizes the internal vector calculation to keep the motor magnetization constant with different load levels.

Activate the speed control operation by setting the parameter 6.1 to "1 Speed control open loop". This operation will adjust the output frequency according to the slip of the motor.

With this operation on, we can get high torque even if the set frequency reference is smaller than the slip of the motor.

9.4 Motor identification procedure for open loop vector control. Loaded motor

1. Preceding operations.

Start with the default values for programmable curve or with the values tuned by method described in "Motor identification procedure for open loop vector control. No load on the motor". You can also refer to your previous experience. The smaller the power size of the motor the higher the voltage setting has to be.

Examples presented in this chapter refer to a lift with no counterweight.

2. First step

No load in the cabinet.

Parameter on starting values 1.9=1, 6.1=1, motor name plate values set except 1.12 is set to synchronous speed of the motor e.g. 1500 rmp, 6.5, 6.6 and 6.7 at some reasonable values.

Note! When setting the motor name plate values use the values which are for the 100% ED for that motor.

Set the reference to 10...12 Hz and make a run and record the values of output current (V3) and output torque (V4). Run up and down.

Set the reference to 5...5,2 Hz (assuming you have parameter 6.5 at 5 Hz) and compare the current and torque values. Adjust the parameter 6.6 so that you can get about the same readings you had when running at 10Hz. The values running up (motoring) do not change much with the parameter but the values when running down (generating) are affected by the parameter change.

On generating (T<0):

If current is higher and torque smaller (less negative) you should decrease the parameter 6.6 value.

On motoring (T>0):

If current is higher and torque smaller you should increase the parameter 6.6 value.

Set the reference to 1.8...2 Hz and compare the current and torque values. Adjust the parameter 6.7 so that you can get about the same readings you had when running at 10Hz. The values running up (motoring) do not change much with the parameter but the values when running down (generating) are affected by the parameter change.

The same basic rules for changing as above.

3. Second step

Full load in the cabinet.

Do the same test as above and the same basic tuning.

You can also test the operation at 1Hz. It might happen that the cabinet does not move upwards due to the high load. The main thing is that the cabinet does not "drop".

Note! On the start situation you need have the reference frequency above the brake release frequency but after start you can decrease the reference frequency below the brake release frequency.

If it is hard to make the values match, you can also tune the automatic torque boost gain factors.

On generating (T<0): Parameter 9.2.

If current is high and torque small (less negative) on display then you can improve the situation by giving negative values to the gain. In practice, reasonable values are between (+300) 0 and -600. (Bigger negative value decreases the voltage)

On motoring (T>0): Parameter 9.1

If current is high and torque small, by increasing the gain you can improve the behaviour. In practice the reasonable values are between +300 and +1000. (Higher positive value increases the voltage)

4. Third Step

Set the right value from the name plate to parameter 1.12 and check the operation at the same speed points around 10, 5 and 2 Hz. If you do not succeed follow the instructions above to tune the parameter values.

5. Some special things

When using for example the alphanumeric panel or FCDrive for monitoring current torque etc. the display is filtered making it slow. To check things on start and stop you can use the analog output of the drive and record it with the scope. Also if you have a device available to measure one of the output phases, you will receive additional information.

The operation of the motor gives also indications for the tuning. If the sound of the motor is "strong" and if there is a strong "zip zip zip...." sound on the motor it might be an indication of too high a voltage.

If there is a "pumping" operation on the motor (half round at the time) it is a sign of too low a voltage.

6. The accuracy on the tuning.

Example of a tuning case:

The values in the table correspond to a 7.5 kW motor

U/f curve 5Hz, 10.5%; 0Hz, 3% ; P9.1 TM=750 ;P9.2 TG=0

I [A] up	T [%] up	I [A] down	T [%] down	
12	80	11,9	-39	9 Hz
12	86	11,9	-39	5,5 Hz
12,2	73	**15,5**	**-28**	2 Hz

Table 7.

The motoring side looks fairly good. The current is about the same and the torque values do not vary remarkably. At 5 Hz the torque is high and therefore we should increase the voltage, but on the other hand, the generator side looks quite good. No changes.

At 2 Hz the torque is low => we should decrease the voltage and the reading on generator side strongly supports this.

2. 5Hz, 10.5%; 0Hz, 2,4% ; P9.1 TM=750 ;P9.2 TG=0

I [A] up	T [%] up	I [A] down	T [%] down	
11,6	77	14,2	-29	2 Hz
-	-	12,7	-22	1 Hz

Table 8.

3. The current is still a little high so 0Hz voltage is set to 2.2%

When running at 2Hz, different torque boost gain values are monitored.

I [A] up	T [%] up		P9.1 TM
11.8	88	does not move	559
11.5	81	moves very slowly	730
11.7	78	moves even at 1 Hz	900

Table 9.

In fact, the default value 750 seems to give the best value.

Running down

I [A] down	T [%] down	P9.2 TG
12,9	-30	-270
11,8	-32	-760
11	-39	-970

Table 10.

We can achieve very nice looking behaviour, but with parameter value –970, the lift car dropped a bit at the start every now and then.

4. After some testing with full load the parameter values were set as follows.

U/f curve 5Hz, 10.5%; 0Hz, 2,4% ; P9.1 TM=750 ;P9.2 TG=-200

I [A] up	T [%] up	I [A] down	T [%] down	
15	103	12,9	-58	10 Hz
15	106	15,1	-51	5 Hz
14,8	105	13,2	-44	2 Hz

Table 11.

At 5 Hz downwards the current is still a little high but close enough. The current is close to nominal with full load so can be considered acceptable.

The intent of the example was to give an idea of the tuning procedure. The "accuracy" of the tuning (current and torque values) was almost too good in this example, but anyhow, the example was to give an impression of how the parameters work and how to avoid the high current situation when load is generating. If the lift is running near to the current limit of the drive the tuning has to be performed well because the current limiting situation will result in a rough ride in the cabinet. Also the "dropping" might happen if the current limiting situation should take place.

Activate the speed control operation by setting the parameter 6.1 to "1 Speed control open loop". This operation will adjust the output frequency according to the slip of the motor. With this operation on we can get a high torque even if the set frequency reference is smaller than the slip of the motor.
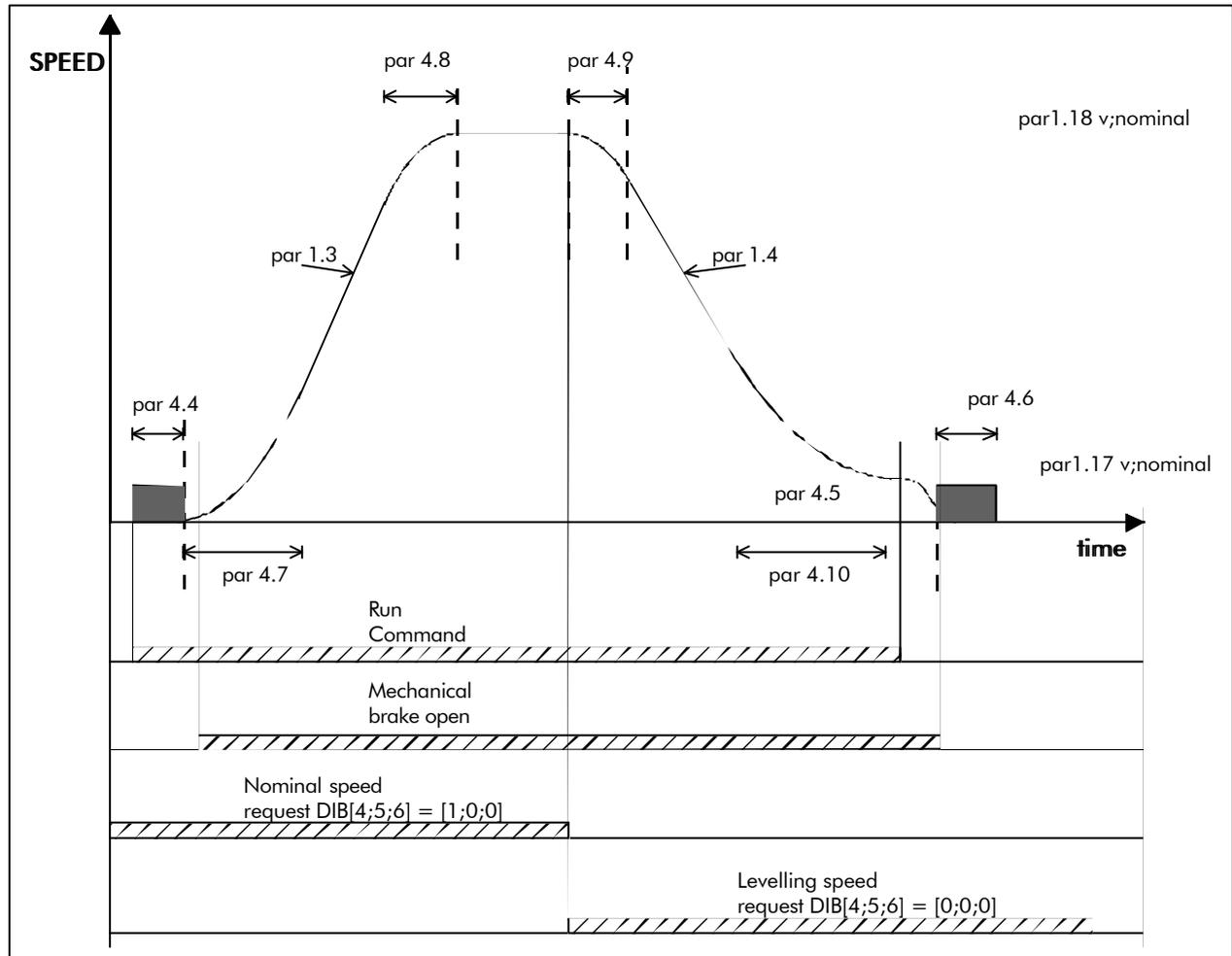
10 Motion profile

Figure 24. Speed curve done between floors.

The parameters related to speed curve in Figure 24 can be chosen as desired. *Run command* in the picture equals the DIA1 or DIA2. *Mechanical brake open* is the control command from relay output. Mechanical brake operations are set with parameters of Group 5. If automatic ramp change is set with parameter 4.11 the ramps are changed when the speed is decelerated down to levelling speed. This requires the ramp set 2 to be used when the run command is deactivated. The sequence presented is done when running the motor in open loop control mode. When the closed loop control is used the mechanical brake is usually set to release and close from zero speed. DC-brake times are also replaced with zero speed hold times P5.24 and P5.25.

11 Parameter group 0

Number	Parameter	Range	Step	Default	Customer	Description
0.1	Application selection	0—7	1	0		0 = (loaded special application) 1 = Basic Application 2 = Standard Application 3 = Local/Remote Control Application 4 = Multi-step Speed Application 5 = PI-control Application 6 = Multi-purpose Control Application 7 = Pump and Fan Control Application
0.2	Parameter loading	0—5	1	0		0 = Loading ready / Select loading 1 = Load default setting 2 = Read up parameters to user's set 3 = Download user's set parameters 4 = Upload parameters to the panel (possible with alpha-numerical and graphical panel) 5 = Download parameters from the panel (possible only with alpha-numerical or graphical panel)
0.3	Language selection			0		0 = English

Table 12.Parameter group 0.

0.1 Application selection

With this parameter the active application can be selected. If the device has been ordered from the factory equipped with loaded special application this has been loaded to the unit as application 0.
This lift application is a loaded application.
Check that the value of parameter 0.1 is zero when you want to use the loaded application.
If the application should be loaded to the device later it has to be set active always after loading by setting the value of parameter 0.1 to zero.

0.2 Parameter loading

With this parameter it is possible to do different kinds of parameter loading operations. After the operation is completed the parameter value changes automatically to 0 (loading ready).

0 Loading ready / select loading
Loading operation has been completed and frequency converter is ready to operate.

1 Load default settings

By setting the value of parameter 0.2 to 1 and then pressing Enter-button the parameter default values are set. The default values correspond to those of the application selected with parameter 0.1.

2 Read up parameters to the User's set

By setting the value of parameter 0.2 to 2 and then pressing the Enter-button the parameter values are read up to the User's parameter value set. The parameter values can be later loaded by setting parameter 0.2 to 3 and pressing the Enter-button.

3   Load down user's set parameters

By setting the value of parameter 0.2 to 3 and then pressing the Enter-button the parameter values are set according to the User's parameter set.

4   Read parameters up to the panel (possible only with the graphical panel).

5   Load down parameters from the panel (possible only with the graphical panel).

0.3   Language

With this parameter, the language of the graphical or alphanumeric panel can be selected.

12 Programmable Push Buttons (BTNS)

Button number	Button name	Function	Feedback information		
			0	1	Note
b 1	Reverse	Changes the direction of rotation of the motor. Active only if the panel is the active control place.	Direction command forward	Direction command backward	Feedback information flashes as long as direction is different from the command
b 2	Active control place	Selects the active control place between the panel and I/O terminals	Control via I/O terminals	Control from the Control Panel	
b 3	Reset operating hour trip counter	Resets the operating hour trip counter when pressed	No reset	Reset accepted	
b 4	Reset MWh trip counter	Resets the MWh trip counter when pressed	No reset	Reset accepted	

Table 13. Programmable push-buttons.

13 Faults and warnings

Faults

Code	**Fault**	Possible cause	Checking
F 1	Overcurrent	Vacon frequency converter has measured too high a current ($>4*I_{In}$) in the motor output: - sudden heavy load changes - short circuit in the motor cables - unsuitable motor	Check loading Check motor size Check cables
F 2	Overvoltage	The voltage of the internal DC-link of the Vacon frequency converter has exceeded 135% of the nominal voltage – decleration time is not suitable – high overvoltage spikes at mains	Adjust the deceleration time

F 3	Earth fault	Current measurement has detected that the sum of the motor phase current is not zero. - insulation failure in the motor cables	Check the motor cables
F 4	Inverter fault	Vacon frequency converter has detected a faulty operation in the gate drivers or IGBT bridge - interference fault - component failure	Reset the fault and restart. If the fault occurs again contact nearest Vacon distributor.
F 5	Charging switch	Charging switch open when START command active - interference fault - component failure	Reset the fault and restart. If the fault occurs again contact nearest Vacon distributor.
F 9	Undervoltage	DC-bus voltage has gone below 65% of the nominal voltage - most common reason is failure of the mains supply - internal failure of the Vacon frequency converter can also cause an undervoltage trip	In case of temporary supply voltage break, reset the fault and start again. Check mains input, if mains supply is correct, an internal failure has occurred. Contact nearest Vacon distributor.
F 10	Input line supervision	Input phase is missing	Check the mains connection
F 11	Output phase supervision	Current measurement has detected there is no current in one motor phase	Check motor cables
F 12	Brake chopper supervision	- brake resistor not installed - brake resistor broken - brake chopper broken	Check brake resistor - If resistor is OK then the chopper is broken. Contact nearest Vacon distributor.
F 13	Vacon undertemperature	Temperature of heatsink below –10 °C	
F 14	Vacon overtemperature	Temperature of heatsink over +75°C	Check cooling air flow Check that sink is not dirty Check ambient temperature Check that switching frequency is not too high compared with ambient temperature and motor load
F 15	Motor stalled	The motor stall protection has tripped	Check the motor
F 16	Motor overtemperature	The Vacon frequency converter motor temperature model has detected motor overheat - motor is overloaded	Decrease motor load. Check the temperature model parameters if the motor was not overheated
F 17	Motor underload	The motor underload protection has tripped	
F 18	Analogue input polarity fault	Wrong analogue input polarity	Check polarity of the analogue input
	Analogue input hardware fault	Component failure on control board	Contact nearest Vacon distributor
F 19	Option board identification	Reading the option board has failed	Check installation, if installation is correct contact nearest Vacon distributor.

F 20	10 V supply reference	+ 10 V reference shorted on control board or option board	Check the cabling from +10V reference voltage
F 21	24 V supply	+ 24 V reference shorted on control board or option board	Check the cabling from +24V reference voltage
F 22 F 23	EEPROM Checksum fault	Parameter restoring error - interference fault - component failure	When fault is reset the Vacon frequency converter will automatically load parameter default settings. Check all parameter settings after reset. If fault occurs again contact nearest Vacon distributor.
F 25	Microprocessor watchdog	- interference fault - component failure	Reset the fault and restart. If fault occurs again contact nearest Vacon distributor.
F 26	Panel communication error	The connection between panel and the Vacon frequency converter is not working	Check the panel cable
F 29	Thermistor protection	Thermistor input of the I/O-expander board has detected increase of the motor temperature	Check motor cooling and loading Check thermistor connection (if thermistor input of the expander board is not in use, it has to be short cicuited)
F31	Encoder pulse missing	Malfunction in encoder Noisy encoder signal Motor running against mechanical brake	Check the encoder connections
F32	Wrong encoder direction	Encoder differential inputs connected in contrary directions compared to mains cables	Change the encoder direction with parameter 10.2
F 36	Analogue input $I_{in}+ < 4mA$ (signal range 4-20mA selected)	The current in the analogue input I_{in} is below 4 mA - signal source has failed - control cable is broken	Check the current loop circuitry
F 41	External fault	Fault is detected in external fault digital input	Check the external fault circuit or device
F 52	Mechanical brake control fault	Fault is activated by mechanical brake control logic.	Check parameter definitions for mechanical brake control logic.
F 55	Shaft speed fault	Fault is activated if calculated speed differs from actual speed.	If fault has been activated an overload situation has occured.
F 56	Overtorque protection	Actual torque above torque limits set in parameter group 3	Check the cause for motor shaft blocking.
F 58	Current limit fault	Current fed to motor below set limit.	Check the motor cables.
F 51	Direction request fault	DIA1 and DIA2 active at the same time.	Check the control of the DIA1 and DIA2

Table 14. Fault codes

Warnings

A 15	Motor Stalled (Motor stall protection)	Check motor
A 16	Motor overtemperature (Motor thermal protection)	Decrease motor loading
A 17	Motor underload (Warning can be activated in application)	Check motor loading
A 24	The values in the fault history, MWh-counters or operating day/hour counters might have been changed in the previous mains interrupt	No action required. Take a critical attitude toward these values
A 28	The change of application has failed	Choose the application again and Push the Enter-button
A 30	On-balance current fault, the load of the segments is not equal	Contact nearest Vacon distributor
A 45	Vacon overtemperature warning, temperature >+70 °C	Check cooling air flow and ambient temperature
A 46	Reference warning, analogue input I_{in} + < 4mA	Check the current loop circuitry
A 47	External warning	Check the external fault circuit or device
A 53	Mechanical brake control warning	Same actions as with fault F 52
A 54	Shaft speed warning	Same actions as with fault F 55
A 57	Overtorque protection	Same actions as with fault F 56
A 59	Direction request warning	Check the control of the DIA1 and DIA2

Table 15. Warning codes

14 Monitoring values (MON)

Nr	Data name	Unit	Description
V1	Output frequency	Hz	Frequency to the motor
V2	Motor speed	rpm	Calculated motor speed
V3	Motor current	A	Measured motor current
V4	Motor torque	%	Calculated actual torque/nominal torque of the unit
V5	Motor power	%	Calculated actual power/nominal power of the unit
V6	Motor voltage	V	Calculated motor voltage
V7	DC-link voltage	V	Measured DC –link voltage
V8	Temperature	°C	Temperature of the heat sink
V9	Operating day counter	DD.dd	Operating days [1], not resettable
V10	Operating hours, "trip counter"	HH.hh	Operating hours [2], can be reset with programmable button #3
V11	MWh-counter	MWh	Total MWh, not resettable
V12	MWh-counter, "trip counter"	MWh	MWH, can be reset with programmable push button #4
V13	Voltage /analogue input	V	Voltage of the terminal U_{in}+ (term. #2)
V14	Current /analogue input	mA	Current of terminals I_{in}+ and I_{in}- (term. #4, #5)
V15	Digital input status, gr. A		Binary status word DIA1 DIA2 DIA3, 0=open, 1=closed
V16	Digital input status, gr. B		Binary status word DIB4 DIB5 DIB6, 0=open, 1=closed
V17	Digital and relay output status		Binary status word DIO RO1 RO2, 0=open, 1=closed
V18	Control program		Version number of the control software
V19	Unit nominal power	kW	Shows the power size of the unit
V20	Motor temperature rise	%	100% = temperature of the motor has risen to nominal value
V21	Lift Speed	m/s	Speed of lift
V22	Ramp down distance	cm	The distance carried when the speed is decelerated from nominal speed(P1.18) to levelling speed (P1.17). The actual value can vary due to rope slip, stretch, etc. The calculated value is to visualize the effect of different parameters to motion profile.

Table 16. Monitored signals

[1] DD = full days, dd = decimal part of day

[2] HH = full hours, hh = decimal part of hour

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