SV9000 AF DRIVES

Fast Closed Loop Control Application

Cutler-Hammer

EATON

Fast Closed Loop Application

Contents

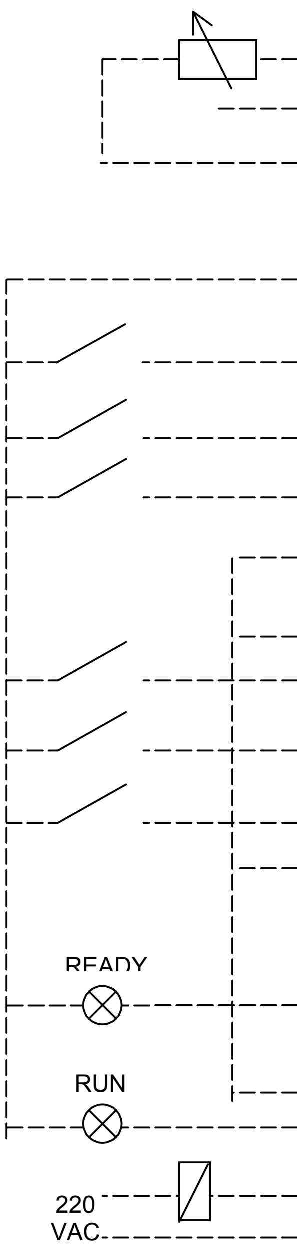
1 General

The Fast Closed Loop Application provides parameters for torque control and fieldbus communication, with both open loop control and closed loop control algorithms.

Closed loop control modes can be used to improve performance near zero speed and improve static and dynamic speed and torque accuracy at higher speeds. Closed loop control modes are based on full vector control. With this control principle, the phase currents are divided into a torque producing current component and a magnetizing current component, which allows the three-phase induction motor to be controlled like a traditional DC-motor.

Fast Closed Loop Control includes:
* 10ms resolution ramp times
* fast analog input with 1 ms update interval
* encoder input

1.1 Control I/O



Terminal		Signal	Description
1	$+10V_{ref}$	Reference output	Voltage for potentiometer, etc.
2	$V_{in}+$	Analog input, voltage (programmable)	Frequency reference range 0—10 VDC
3	GND	I/O Ground	Ground for reference and controls
4	$I_{in}+$	Analog input current (programmable)	Default setting: not used, range 0—20 mA
5	$I_{in}-$		
6	+24V	Control voltage output	Voltage for switches, etc. max 0.1 A
7	GND	I/O ground	Ground for reference and controls
8	DIA 1	Start forward (programmable)	Contact closed = start forward
9	DIA 2	Start reverse (programmable)	Contact closed = start reverse
10	DIA 3	Fault reset (programmable)	Contact open = no action Contact closed = fault reset
11	CMA	Common for DIA 1—DIA 3	Connect ot 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	Jogging speed select (programmable)	Contact open = no action Contact closed = jogging speed
15	DIB5	External fault (programmable)	Contact open = no fault Contact closed = fault
16	DIB6	Acceleration/deceleration time select (programmable)	Contact open = par. 1.3, 1.4 in use Contact closed = par. 4.3, 4.4 in use
17	CMB	Common for DIB4—DIB6	Connect to GND or +24V
18	$I_{out}+$	Ouput frequency Analog output	Programmable (par. 3.1) Range 0—20 mA/R_L, max. 500Ω
19	$I_{out}-$		
20	DO1	Digital output READY	Programmable, par. 3.6 Open collector, I≤50mA, U≤48 VDC
21	RO1	Relay output 1 RUN	Programmable, par. 3.7
22	RO1		
23	RO1		
24	RO2	Relay output 2 FAULT	Programmable, par. 3.8
25	RO2		
26	RO2		

Figure 1-1: Default I/O Configuration and Connection; Closed Loop Application Example

1.2 Control Signal Logic

Figure 1-2 presents the logic of the I/O-control signals and push button signals from the panel.

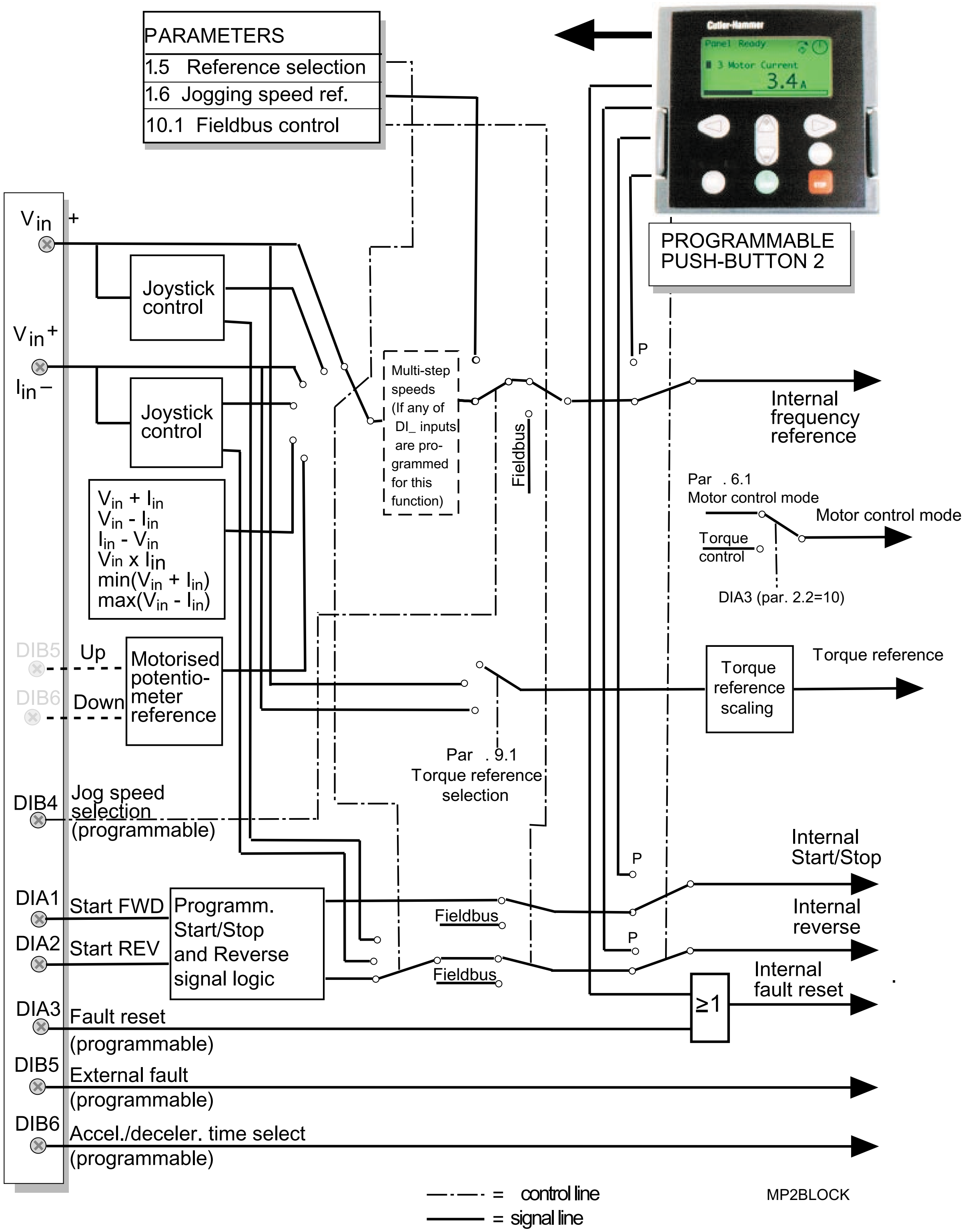


Figure 1-2: Closed Loop Application Control Signal Logic.
Switch positions correspond to factory settings.

1.3 Parameter Group 0

Number	Parameter	Range	Step	Default	Customer	Description
0.1	Application selection	0—7	1	1		0 = Fast Closed Loop (loaded special application) 1 = “FB Closed Loop” 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 1-1. Parameter Group 0.

1.3.1 Application selection

With system software sm00099j or later the Closed Loop Application has been integrated to the unit as application 1. The closed loop application is loaded separately from the system software, and will appear on the menu as application 0 - “ CL.”

1.3.2 Parameter loading

See User's Manual, Chapter 11.

1.3.3 Language

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

2 Closed Loop Commissioning

2.1 Sequence of actions

Auto-tuning requires that the motor is not loaded. If it is not possible to disconnect the load or run with a light load, parameters P10.2, 10.3, 10.4 and 10.5 must be set manually.

1. Check very carefully the encoder connections and encoder supply voltages. Check the brake resistor connection.
2. Do all normal commissioning phases 1-10 in openloop, see Cutler-Hammer SV9000 User manual chapter 8.2.
3. Set the displayed rpm to “ENCODER RPM” (P3.26=1). Run the motor in openloop with 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 with about 2/3 of the nominal frequency with low load. The motor current should be the magnetising current, which is usually about one thrid of the nominal current. Check the displayed torque to insure that load is low. If there is friction, 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 with 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 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.

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

2.2 Auto-tuning

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 auto-tuning by setting P10.8=1 and by starting the motor within 10 seconds

Identification run should last 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.

Autotuning can also be used to improve the open loop performance.

3 Group 1, Basic parameters

3.1 Group 1 Parameter Table

Code	Parameter	Range	Step	Default	Custom	Description	Page
1.1	Minimum frequency	0—120/500 Hz	1 Hz	0 Hz			18
1.2	Maximum frequency[1]	0—120/500 Hz	1 Hz	60 Hz			18
1.3	Acceleration time 1	0.1—3000 s	0.1 s	3 s		Time from f_{min} (1.1) to f_{max} (1.2)	18
1.4	Deceleration time 1	0.1—3000 s	0.1 s	3 s		Time from f_{max} (1.2) to f_{min} (1.1)	18
1.5	Reference selection STOP	0—15	1	0		0 = V_{in} 1 = I_{in} 2 = V_{in} + I_{in} 3 = V_{in} – I_{in} 4 = I_{in} – V_{in} 5 = V_{in} * I_{in} 6 = V_{in} joystick control 7 = I_{in} joystick control 8 = Signal from internal motor pot. 9 = Signal from internal motor pot. reset if unit is stopped 10 = Signal from internal motor potentiometer is stored in memory if power is removed 11= Min (V_{in}, I_{in}) 12 = Max (V_{in}, I_{in}) 13 = Panel reference r1 14 = Max Frequency 15 = V_{in} / I_{in} Reference Selection	18
1.6	Jogging speed reference	f_{min} – f_{max} (1.1) (1.2)	0.1 Hz	5 Hz			20
1.7	Current limit	0.1—2.5 x I_{nSV9}	0.1 A	1.5 x I_{cSV9}		Output current limit [A] of the unit	20
1.8	V/Hz ratio selection STOP	0—2	1	0		0 = Linear 1 = Squared 2 = Programmable V/f ratio	20
1.9	V/Hz optimisation STOP	0—1	1	0		0 = None 1 = Automatic torque boost	21
1.10	Nominal voltage of the motor STOP	180—690	1 V	230 V 400 V 500 V 690 V		Voltage code 8 Voltage code 11 Voltage code 16 Voltage code19 (V_n on the rating plate of the motor)	21
1.11	Nominal frequency of the motor STOP	30—500 Hz	1 Hz	60 Hz		f_n on the rating plate of the motor	21
1.12	Nominal speed of the motor STOP	300—20000 rpm	1 rpm	1765 rpm		n_n on the rating plate of the motor	21
1.13	Nominal current of the motor STOP	2.5 x I_{nSV9}	0.1 A	I_{nSV9}		I_n on the rating plate of the motor	21
1.14	Supply voltage STOP	180—250 380—440 380—500 525—690		230 V 380 V 480 V 575 V		Voltage code 8 Voltage code 11 Voltage code 16 Voltage code19 (V_n on the rating plate of the motor)	21
1.15	Parameter conceal	0—1	1	0		Visibility of parameters: 0 = All parameter groups visible 1 = Only group 1 visible	21
1.16	Parameter value lock	0—1	1	0		Disables parameter changes: 0 = Changes enabled 1 = Changes disabled	21

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

[1] If 1.2 > motor synchronising speed, check suitability for motor and drive system.

4 Groups 2—12, Special parameters

4.1 Groups 2—12 Parameter Tables

Group 2, Input Signal Parameters

Code	Parameter	Range	Step	Default	Custom	Description		Page
						DIA1	DIA2	
2.1	Start/Stop logic selection	0—5	1	0		0 = Start forward 1 = Start/Stop 2 = Start/Stop 3 = Start pulse 4 = Start/stop pulse 5 = Forw/Motpotup	Start reverse Reverse Run enable Stop pulse Run enable	22
2.2	DIA3 function (terminal 10)	0—10	1	7		0 = Not used 1 = External fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Accel./decel. time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Accel./decel. operation prohibit 9 = DC-braking command 10 = Torque control		24
2.3	DIB4 function (terminal 14)	0—10	1	6		0 = Not used 1 = External fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Accel./decel. time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Accel./decel. operation prohibit 9 = DC-braking command 10 = Multi-step speed select 1		25
2.4	DIB5 function (terminal 15)	0—11	1	1		0 = Not used 1 = External fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Accel./decel. time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Accel./decel. operation prohibit 9 = DC-braking command 10 = Multi-step speed select 2 11 = Motorised pot. speed up		25
2.5	DIB6 function (terminal 16)	0—11	1	4		0 = Not used 1 = External fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Accel./decel. time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Accel./decel. operation prohibit 9 = DC-braking command 10 = Multi-step speed select 3 11 = Motorised pot. speed down		25
2.6	V_{in} signal range	0—2	1	0		0 = 0—10 V 1 = Custom setting range 2 = -10—+10 V (can only be used with joystick control)		25
2.7	V_{in} custom setting min.	0—100%	0.01%	0.00%				25
2.8	V_{in} custom setting max.	0—100%	0.01%	100.00%				25

Code	Parameter	Range	Step	Default	Custom	Description	Page
2.9	V_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	26
2.10	V_{in} signal filter time	0—10 s	0.01 s	0.1 s		0 = No filtering	26
2.11	I_{in} signal range	0—2	1	0		0 = 0—20 mA 1 = 4—20 mA 2 = Custom setting range	26
2.12	I_{in} custom setting min.	0—100%	0.01%	0.00%			26
2.13	I_{in} custom setting max.	0—100%	0.01%	100.0%			26
2.14	I_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	26
2.15	I_{in} signal filter time	0—10 s	0.01 s	0.1 s		0 = No filtering	27
2.16	V_{in} minimum scaling	-320.00%– +320.00%	0.01%	0%		0% = no minimum scaling	27
2.17	V_{in} maximum scaling	-320.00%– +320.00%	0.01%	100%		100% = no maximum scaling	27
2.18	I_{in} minimum scaling	-320.00%– +320.00%	0.01%	0%		0% = no minimum scaling	27
2.19	I_{in} maximum scaling	-320.00%– +320.00%	0.01%	100%		100% = no maximum scaling	27
2.20	Free analog input, signal selection	0—5	1	0		0 = Not used 1 = V_{in} (analog voltage input) 2 = I_{in} (analog current input) 3 = $A_{in}1$ (option board) 4 = $A_{in}2$ (option board) 5 = FB Signal	28
2.21	Free analog input, function	0—4	1	0		0 = No function 1 = Reduces current limit (par. 1.7) 2 = Reduces DC-braking current 3 = Reduces acc. and dec. times 4 = Reduces torque superv. limit	29
2.22	Motorised potentiometer ramp time	0.1— 2000.0 Hz/s	0.1 Hz/s	10.0 Hz/s			30

Note! STOP = 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	Analog output function	0—7	1	1		0 = Not used Scale 100% 1 = O/P frequency (0—f_{max}) 2 = Motor speed (0—max. speed 3 = O/P current (0—2.0 x I_{nSV}) 4 = Motor torque (0—2 x T_{nSV}) 5 = Motor power (0—2 x P_{nSV}) 6 = Motor voltage (0—100%xV_{nM}) 7 = DC-link volt. (0—1000 V)	30
3.2	Analog output filter time	0.01—10 s	0.01	1.00			30
3.3	Analog output inversion	0—1	1	0		0 = No Inversion 1 = Inverted	30
3.4	Analog output minimum	0—1	1	0		0 = 0 mA 1 = 4 mA	30
3.5	Analog output scale	10—1000%	1%	100%			31
3.6	Digital output function	0—21	1	1		0 = Not used 1 = Ready 2 = Run 3 = Fault 4 = Fault inverted 5 = Overheat warning 6 = External fault or warning 7 = Reference fault or warning 8 = Warning 9 = Reversed 10 = Jogging speed selected 11 = At speed 12 = Motor regulator activated 13 = Output frequency limit superv. 1 14 = Output frequency limit superv. 2 15 = Torque limit supervision 16 = Reference limit supervision 17 = External brake control 18 = Control from I/O terminals 19 = Frequency converter temperature limit supervision 20 = Unrequested rotation direction 21 = External brake control inverted	32
3.7	Relay output 1 function	0—21	1	2		As parameter 3.6	31
3.8	Relay output 2 function	0—21	1	3		As parameter 3.6	32
3.9	Output frequency limit 1 supervision function	0—2	1	0		0 = Not Used 1 = Low limit 2 = High limit	33
3.10	Output frequency limit 1 supervision value	0—f_{max} (par. 1.2)	0.1 Hz	0 Hz			33
3.11	Output frequency limit 2 supervision function	0—2	1	0		0 = Not Used 1 = Low limit 2 = High limit	33
3.12	Output frequency limit 2 supervision value	0—f_{max} (par. 1.2)	0.1 Hz	0 Hz			33
3.13	Torque limit supervision function	0—2	1	0		0 = Not Used 1 = Low limit 2 = High limit	33
3.14	Torque limit supervision value	0 — 200% x T_{nSV}	1%	100%			33
3.15	Reference limit supervision function	0—2	1	0		0 = Not Used 1 = Low limit 2 = High limit	33
3.16	Reference limit supervision value	0—f_{max}	0.1 Hz	0 Hz			33

Code	Parameter	Range	Step	Default	Custom	Description	Page
3.17	External brake closing delay	0—100.0 s	0.1 s	0.5 s			34
3.18	External brake opening delay	0—100.0 s	0.1 s	1.5 s			34
3.19	Frequency converter temperature limit supervision function	0—2	1	0		0 = Not Used 1 = Low limit 2 = High limit	34
3.20	Frequency converter temperature limit value	-10—+75°C	1°C	+40°C			34
3.21	I/O-expander board (opt.) analog output content	0—9	1	3		See parameter 3.1	34
3.22	I/O-expander board (opt.) analog output filter time	0.01—10 s	0.01	1.00			34
3.23	I/O-expander board (opt.) analog output inversion	0—1	1	0		See parameter 3.3	34
3.24	I/O-expander board (opt.) analog output minimum	0—1	1	0		See parameter 3.4	34
3.25	I/O-expander board (opt.) analog output scale	10—1000%	1	100%		See parameter 3.5	34
3.26	Displayed Speed	0-1	1	0		0 = Calculated RPM 1 = Encoder RPM	34

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

Group 4, Drive control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
4.1	Acceleration/deceleration ramp 1 shape	0—10 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acceleration/deceleration time	35
4.2	Acceleration/deceleration ramp 2 shape	0—10 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acceleration/deceleration time	35
4.3	Acceleration time 2	0.1—3000 s	0.1 s	10.0 s			35
4.4	Deceleration time 2	0.1—3000 s	0.1 s	10.0 s			35
4.5	Brake chopper	0—2	1	0		0 = No (brake chopper not in use) 1 = Yes (brake chopper in use) 2 = Yes External (external brake chopper)	35
4.6	Start function	0—1	1	0		0 = Ramping 1 = Flying Start	35
4.7	Stop function	0—1	1	0		0 = Coasting 1 = Ramping	36
4.8	DC-braking current	0.15—1.5 x I_{nSV} (A)	0.1 A	0.5 x I_{nSV}			36
4.9	DC-braking time at Stop	0—250.0 s	0.1 s	0 s		0 = DC-brake is off at Stop	36
4.10	Execute frequency of DC-brake during ramp stop	0.1—10 Hz	0.1 Hz	1.5 Hz			37
4.11	DC-brake time at Start	0.0—25.0 s	0.1 s	0.0 s		0 = DC-brake is off at Start	37
4.12	Multi-step speed reference 1	f_{min}–f_{max} (1.1) (1.2)	0.1 Hz	10.0 Hz			38
4.13	Multi-step speed reference 2	f_{min}–f_{max} (1.1) (1.2)	0.1 Hz	15.0 Hz			38
4.14	Multi-step speed reference 3	f_{min}–f_{max} (1.1) (1.2)	0.1 Hz	20.0 Hz			38
4.15	Multi-step speed reference 4	f_{min}–f_{max} (1.1) (1.2)	0.1 Hz	25.0 Hz			38
4.16	Multi-step speed reference 5	f_{min}–f_{max} (1.1) (1.2)	0.1 Hz	30.0 Hz			38
4.17	Multi-step speed reference 6	f_{min}–f_{max} (1.1) (1.2)	0.1 Hz	40.0 Hz			38
4.18	Multi-step speed reference 7	f_{min}–f_{max} (1.1) (1.2)	0.1 Hz	50.0 Hz			38

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

Group 5, Prohibit frequency parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
5.1	Prohibit frequency range 1 low limit	0—f_{max} (1.2)	0.1 Hz	0 Hz			39
5.2	Prohibit frequency range 1 high limit	0—f_{max} (1.2)	0.1 Hz	0 Hz		0 = Prohibit range 1 is off	39
5.3	Prohibit frequency range 2 low limit	0—f_{max} (1.2)	0.1 Hz	0 Hz			39
5.4	Prohibit frequency range 2 high limit	0—f_{max} (1.2)	0.1 Hz	0 Hz		0 = Prohibit range 2 is off	39
5.5	Prohibit frequency range 3 low limit	0—f_{max} (1.2)	0.1 Hz	0 Hz			39
5.6	Prohibit frequency range 3 high limit	0—f_{max} (1.2)	0.1 Hz	0 Hz		0 = Prohibit range 3 is off	39

Group 6, Motor control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
6.1	Motor control mode STOP	0—4	1	0		0 = Frequency control 1 = Speed control (open loop) 2 = Torque control (open loop) 3 = Speed control (closed loop) 4 = Torque control (closed loop)	40
6.2	Switching frequency STOP	1—16 kHz	0.1 kHz	10/3.6 kHz		Depending on kW	40
6.3	Field weakening point STOP	30—500 Hz	1 Hz	Par. 1.11			40
6.4	Voltage at field weakening point STOP	15—200% x V_{nmot}	1%	100%			40
6.5	V/Hz-curve mid-point frequency STOP	0—500 Hz	1 Hz	0 Hz		No effect in Closed Loop motor control mode.	41
6.6	V/Hz-curve mid-point voltage STOP	0—123.20%	0.01%	0.00%		No effect in Closed Loop motor control mode.	41
6.7	Output voltage at zero frequency STOP	0—40%	0.01%	0.00%		No effect in Closed Loop motor control mode.	41
6.8	Overvoltage controller STOP	0—2	1	1		0 = Off 1 = On 2 =Mode 2 No effect in Closed Loop motor control mode.	41
6.9	Undervoltage controller	0—1	1	1		0 = Off 1 = On No effect in Closed Loop motor control mode.	41

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

Group 7, Protections

Code	Parameter	Range	Step	Default	Custom	Description	Page
7.1	Response to reference fault	0—3	1	0		0 = No Action 1 = Warning 2 = Fault (stop according to par. 4.7) 3 = Fault, Coast (stop by coasting)	42
7.2	Response to external fault	0—3	1	2		0 = No Action 1 = Warning 2 = Fault (stop according to par. 4.7) 3 = Fault, Coast (stop by coasting)	42
7.3	Phase supervision of motor	0—2	2	2		0 = No Action 1 = Warning 2 = Fault	42
7.4	Earth fault protection	0—2	2	2		0 = No Action 1 = Warning 2 = Fault	42
7.5	Motor thermal protection	0—2	1	2		0 = No action 1 = Warning 2 = Fault	43
7.6	Motor thermal protection break point current	50.0—150% x I_{nMOTOR}	1.0%	100.0%			44
7.7	Motor thermal protection zero frequency current	5.0—150% x I_{nMOTOR}	1.0%	45.0%			44
7.8	Motor thermal protection time constant	0.5—300.0 minutes	0.5 min			Default value is set according to motor nominal current	44
7.9	Motor thermal protection breakpoint frequency	10—500 Hz	1 Hz	35 Hz			45
7.10	Stall protection	0—2	1	1		0 = No Action 1 = Warning 2 = Fault	46
7.11	Stall current limit	10.0—200% x I_{nMOTOR}	0.1%	130.0%			46
7.12	Stall time	2.0—120 s	1.0 s	15.0 s			46
7.13	Maximum stall frequency	1—f_{max}	1 Hz	25 Hz			46
7.14	Underload protection	0—2	1	0		0 = No Action 1 = Warning 2 = Fault	47
7.15	Underload protection, field weakening area load	10.0—150% x T_{nMOTOR}	1.0%	50.0%			47
7.16	Underload protection, zero frequency load	5.0—150.0% x T_{nMOTOR}	1.0%	10.0%			47
7.17	Underload time	2.0—600.0 s	1.0 s	20.0 s			47

Group 8, Autorestart parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
8.1	Automatic restart: number of tries	0—10	1	0		0 = Not in use	48
8.2	Automatic restart: trial time	1—6000 s	1 s	30 s			48
8.3	Automatic restart: start function	0—1	1	0		0 = Ramp 1 = Flying start	48
8.4	Automatic restart after undervoltage trip	0—1	1	0		0 = No 1 = Yes	48
8.5	Automatic restart after overvoltage trip	0—1	1	0		0 = No 1 = Yes	48
8.6	Automatic restart after overcurrent trip	0—1	1	0		0 = No 1 = Yes	48
8.7	Automatic restart after reference fault	0—1	1	0		0 = No 1 = Yes	48
8.8	Automatic restart after over-/under-temperature fault	0—1	1	0		0 = No 1 = Yes	48

Group 9, Fast Analog input

Code	Parameter	Range	Step	Default	Custom	Description	Page
9.1	Source	0—5	1	0		0 = Off 4 = Opt V_{in} 5 = Opt Joystick	49
9.2	Gain	-300 - 300%	1%	100%		0 = Not in use	49
9.3	Bias	-300 - 300%	1%	100%		100% = No scaling	49
9.4	Offset	-10000 - 10000	1mV	0 mV			49

Group 10, Fieldbus parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
10.1	Opt Joystick	300-5000	1	1024 P/R			50
10.2	Encoder direction	0—1	1	0		0=Forward 1=Reverse	50
10.3	Motor magnetising current	0-2000A	0.1 A	0 A			50
10.4	Speed control P	0-500	1	30			50
10.5	Speed control I	0-1000	1	10		0 = None 1 = Even 2 = Odd	50
10.6	0Hz time start	0-2,00 s	0,01 s	0,30 s			50
10.7	0Hz time stop	0-2,00 s	0,01 s	1,00 s			50
10.8	Identification	0—1	1	0		0=Not Used 1=Identify	50
10.9	Curr Cntrl Gain	0-500	1	150			51
10.10	Enc filt time	0-1000ms	1ms	0		0 = Automatic	51
10.11	Ref filt time	0-1000ms	1 ms	5 ms			51

5 Parameter Descriptions, Group 1

1.1 Minimum frequency
[“Min Frequency”; Range: 0—120/500 Hz; Default: 0 Hz]

1.2 Maximum frequency
[“Max Frequency”; Range: 0—120/500 Hz; Default: 60 Hz]

Defines the upper and lower frequency limits for the frequency converter.

Parameters 1.1 and 1.2 have two frequency ranges:
- 0—120 Hz (with 0.01 Hz resolution) or
- 0—500Hz (with 0.1 Hz resolution).

The initial frequency range for parameters 1.1 and 1.2 is 0—120 Hz, with a resolution of 0.01 Hz. To use the second frequency range (0—500 Hz), set parameter 1.2 = 120 Hz when the device is stopped (RUN indicator not lit). This also changes the resolution to 0.1 Hz. To return to the initial frequency range, set parameter 1.2 =119 Hz when the device is stopped (RUN indicator not lit).

1.3 Acceleration time 1
[“Accel Time 1”; Range: 0.1—3000 s; Default: 3 s]

1.4 Deceleration time 1
[“Decel Time 1”; Range: 0.1—3000 s; Default: 3 s]

These limits correspond to the time required for the output frequency to accelerate from the set minimum frequency (f_{min}, parameter 1.1) to the set maximum frequency (f_{max}, parameter 1.2).

1.5 Reference selection
[“Ref Selection 1”; Range: 0—15; Default: 0]

0 Analog voltage reference from terminals 2 - 3, e.g. potentiometer

1 Analog current reference from terminals 4 - 5, e.g. transducer

2 Reference is obtained by adding the voltage input (V_{in} – terminal 2) value to the current input (I_{in} – terminal 4) value

3 Reference is obtained by subtracting the voltage input (V_{in} – terminal 2) value from the current input (I_{in} – terminal 4) value.

4 Reference is obtained by subtracting the current input (I_{in} – terminal 4) value from the voltage input (V_{in} – terminal 2) value

5 Reference is obtained by multiplying the voltage input (V_{in} – terminal 2) value and the current input (I_{in} – terminal 4) value

6 Joystick control from the voltage input (V_{in})

Signal range	Max reverse speed	Direction change	Max. forward speed
0—10 V	0 V	5 V	+10 V
Custom	Par. 2.7 x 10 V	In the middle of custom range	Par. 2.8 x 10 V
-10 V—+10 V	-10 V	0 V	+10 V

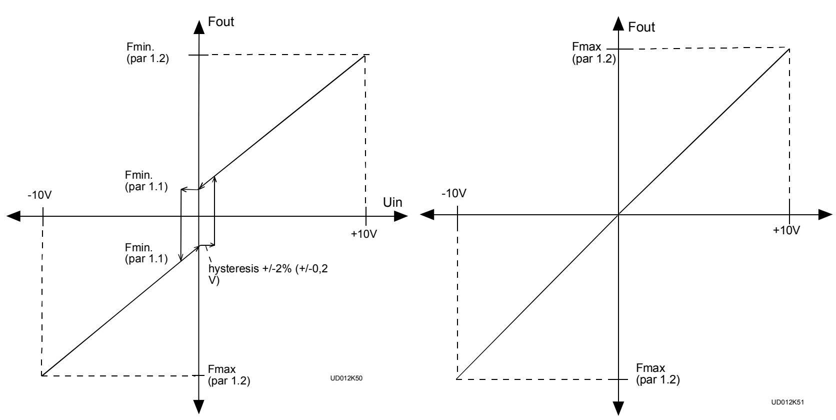
Warning! Use the -10 to +10 V signal range only. If a custom or 0-10 V signal range is used and the reference signal is lost, the drive starts to run at the maximum reverse speed.

7 Joystick control from the current input (I_{in}).

Signal range	Max reverse speed	Direction change	Max. forward speed
0—20 mA	0 mA	10 mA	20 mA
Custom	Par. 2.13 x 20 mA	In the middle of custom range	Par. 2.14 x 20 mA
4—20 mA	4 mA	12 mA	20 mA

Warning! Use the 4 - 20 mA signal range only. If the reference fault (parameter 7. 2) is active when the 4 - 20 mA range is used and the reference signal is lost, the drive will stop and generate a reference fault.
If a custom or 0 - 20 mA signal range is used, and the control signal is lost, the drive will run at the maximum reverse speed.

Note! When joystick control is used, the direction of control is generated from the joystick reference signal. See Figure 5.1.
The analog input scaling parameters (2.16—2.19), are not used when joystick control is used.



If the minimum frequency (parameter 1.1) > 0, then hysteresis is ± 2% at reversing point

Figure 5-1: Joystick Control V_{in} Signal –10 V—+10 V or I_{in} Signal—0—20 mA.

8 Reference value is changed with digital input signals DIA4 and DIA5.
- DIA3 closed = frequency reference increases
- DIA4 closed = frequency reference decreases

The speed of the reference change can be set with the parameter 2.20.

9 Same as setting 8 (above), but the reference value is set to the minimum frequency (parameter 1.1) each time the frequency converter is stopped.

10 Same as setting 8 (above), but the reference value is stored in memory when power is removed.

Note! When the value of parameter 1.5 is set to 8, 9, or 10, the values of parameters 2.4 (DIB5) and 2.5 (DIB6) are automatically set to 11 (motorized potentiometer speed up/down).

11 Reference value is the smaller of signals V_{in} and I_{in}

12 Reference value is the larger of signals V_{in} and I_{in}

13 Panel reference r1 is the frequency reference.

14 Reference value is the maximum frequency

15 Reference value is V_{in} or I_{in} based on parameter 2.3.

1.6 Jog speed reference
[“Jog Speed Ref”; Range: f_{min} – f_{max} ; Default: 5 Hz]

Parameter value defines the jog speed selected with the digital input.

1.7 Current limit
[“Current Limit”; Range: 0.1—2.5 x I_{nSV9}; Default: 1.5 x I_{cSV9}]

This parameter determines the maximum motor current from the frequency converter. To avoid motor overload, set this parameter according to the rated current of the motor.

1.8 V/Hz ratio selection
[“V/Hz Ratio”; Range: 0—2; Default: 0]

0 “**Linear V/Hz ratio”** — The voltage of the motor changes linearly with the frequency in the constant flux area from 0 Hz to the field weakening point (parameter 6.3), where the nominal voltage is also supplied to the motor. See figure 5-2. A linear V/Hz ratio should be used in constant torque applications. **This default setting should be used if there is no special need for another setting.**

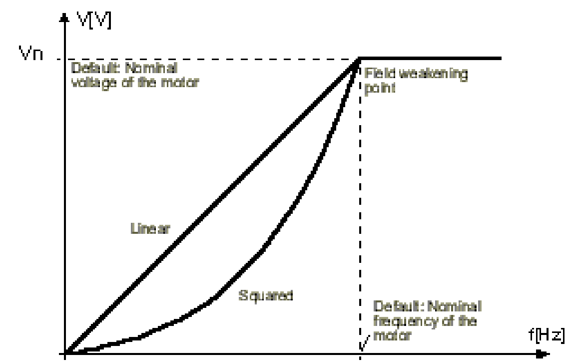


Figure 5-2: Linear and Squared V/Hz Curves.

1 “**Squared V/Hz ratio:** — The voltage of the motor changes following a squared curve, with the frequency in the area from 0 Hz to the field weakening point (parameter 6.3), where nominal voltage is also supplied to the motor. See Figure 5-2.

The motor runs under-magnetized below the field weakening point and produces less torque and electromechanical noise. Squared V/Hz ratio can be used in applications where the torque demand of the load is proportional to the square of the speed, e.g. in centrifugal fans and pumps.

2 “**Programmable V/Hz curve”** — The V/Hz curve is programmed by defining three points— Parameters 6.3 – 6.6.

The programmable V/Hz curve is used when the other settings do not satisfy the needs of the application. See Figure 5.3.

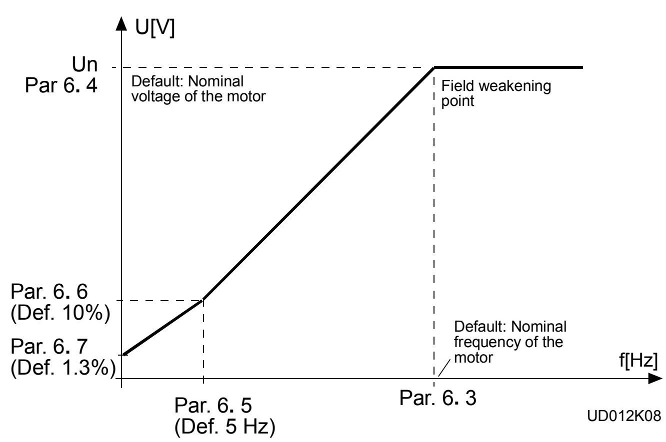


Figure 5-3: Programmable V/Hz Curve.

1.9 *V/Hz optimization*
[“V/Hz Optimize”; Range: 0—1; Default: 0]

0 **“None”** — V/Hz optimization disabled

1 “**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 is high, due to starting friction, e.g. in conveyors.

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

Warning! 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*
[“Motor Nom Voltg”; Range: 180—690; Default: 230 V, 400 V, 500 V, or 690 V]

Find this value (V_n) on the rating plate of the motor. This parameter sets the voltage at the field weakening point, parameter 6.4, to 100% x V_{nmotor}.

1.11 *Nominal frequency of the motor*
[“Motor Nom Freq”; Range: 30—500 Hz; Default: 60 Hz]

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*
[“Motor Nom Speed”; Range: 300—20000 rpm; Default: 1765 rpm]

Find this value n_n on the rating plate of the motor.

1.13 *Nominal current of the motor*
[“Motor Nom Currnt”; Range: 2.5 x I_{nSV9}; Default: I_{nSV9}]

Find this value I_n on the rating plate of the motor.

1.14 *Supply voltage*
[“Supply Voltage”; Range: 180—250V, 380—440V, 380—500V, or 525—690V; Default: 230, 380, 480, or 575 V]

Set the parameter value according to the nominal voltage of the supply. Values are predefined for voltage codes 8, 11, 16, and 19.

1.15 *Parameter conceal*
[“Param Conceal”; Range: 0—1; Default: 0]

Defines which parameter groups are visible:

0: “**All Visible”** — all parameter groups are visible

1: “**Group1Visibl”** — only group 1 is visible

1.16 *Parameter value lock*
[“Parameter Lock”; Range: 0—1; Default: 0]

Determines the access to parameter value changes:

0: “**ChangeEnable”** — parameter value changes enabled

1: **“ChangeDisabl”** — parameter value changes disabled

6 Parameter Descriptions, Groups 2—12

2.1 Start/Stop logic selection
[“Start/Stop Logic”; Range: 0—5; Default: 0]

0: “Fwd – Rev” —
DIA1: closed contact = start forward
DIA2: closed contact = start reverse
See Figure 6-1.

(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.

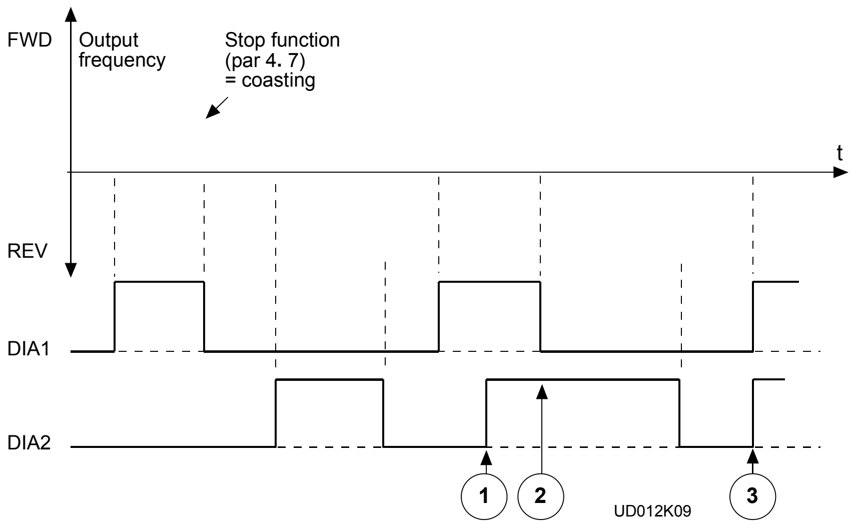


Figure 6-1: Start Forward/Start Reverse

1: “Start – Rev” —
DIA1: closed contact = start; open contact = stop
DIA2: closed contact = reverse; open contact = forward
See Figure 6-2.

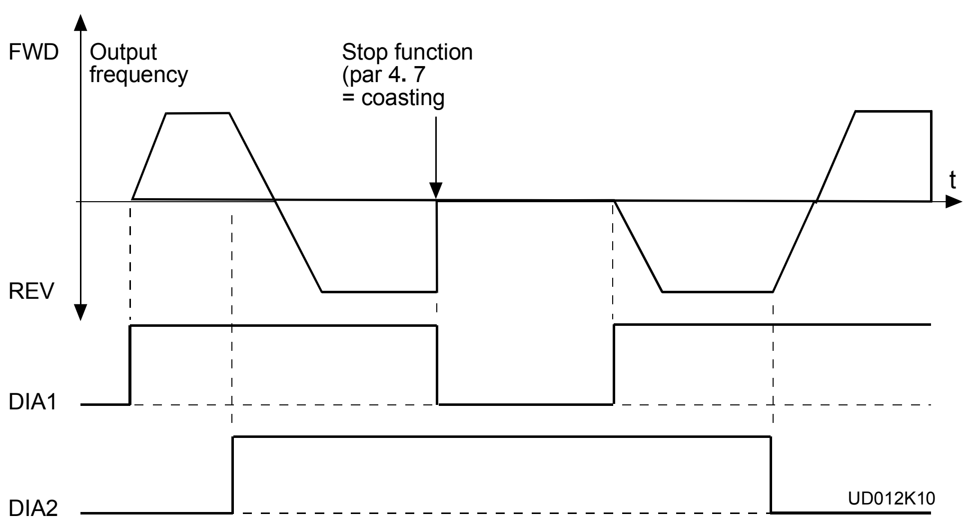


Figure 6-2: Start, Stop, Reverse

2: "Start – Enable" —
DIA1: closed contact = start; open contact = stop
DIA2: closed contact = start enabled; open contact = start disabled

3: "StartP – StopP" — 3-wire connection (pulse control)
DIA1: closed contact = start pulse
DIA2: closed contact = stop pulse
(DIA3 can be programmed for reverse command) See Figure 6-3.

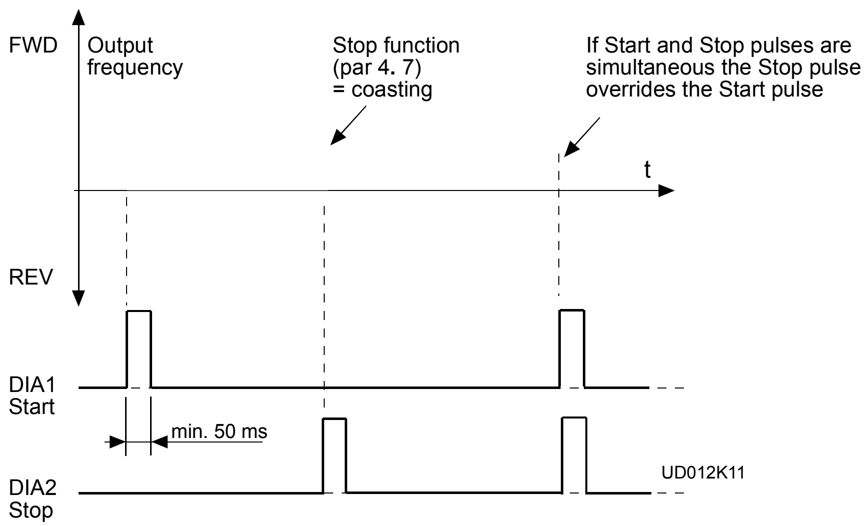


Figure 6.3: Start Pulse/Stop Pulse

4: "Pulse R/S-Enable" —
DIA1: closed contact = start/stop pulse
DIA2: closed contact = start enabled

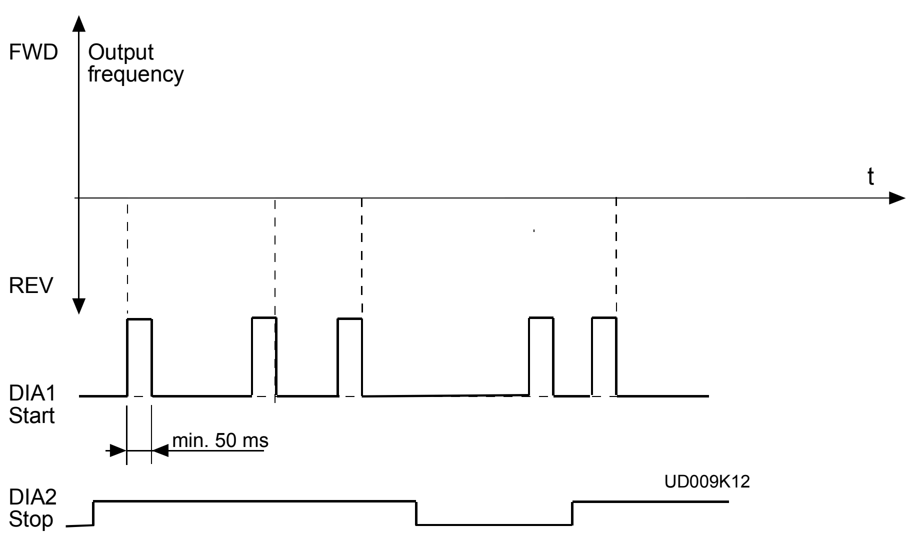


Figure 6-4: Start/Stop Pulse, Run Enable

5: "Forw – Mot-up" —
DIA1: closed contact = start forward
DIA2: closed contact = references increases

2.2 *DIA3 function*

[“DIA3 Function”; Range: 0—10; Default: 7]

0: “Not Used”

1: “ExtFaulClose” — External fault, closing contact = fault is shown and motor is stopped when the input is active.

2: “ExtFaulOpen” — 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/DecTimSe” — contact open = Acceleration/deceleration time 1 selected
contact closed = Acceleration/deceleration time 2 selected

5: “Reverse” — contact open = forward Can be used for reversing if contact closed = reverse (parameter 2.1 has value 3)

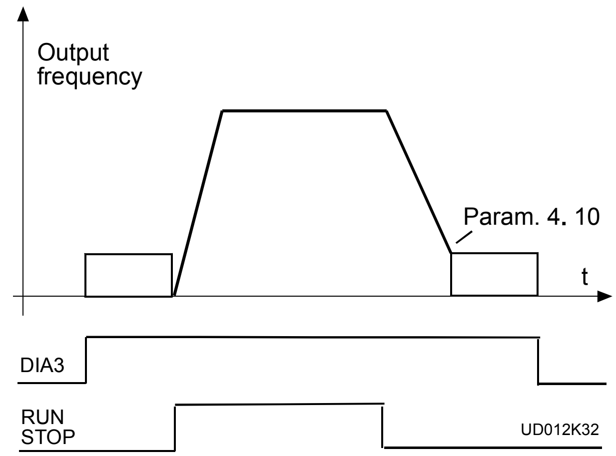
6: “JogSpeedSel” — contact closed = jog speed selected for frequency reference

7: “FaultReset” —
contact closed = resets all faults

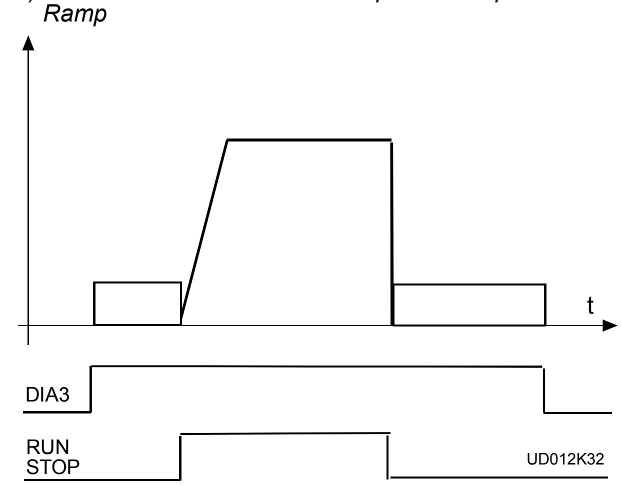
8: “Acc/DecProhi” —
operation prohibited,
contact closed =stops acceleration or deceleration until the contact is opened

9: “DC-brakeComm” — DC-braking command,
contact closed = In Stop mode, the DC-braking operates until the contact is opened, see Figure 6.5. DC-brake current is set with parameter 4.8.

10: “Fast Ref Off” —
Turns off fast analog input and reverts to jog mode (parameter 1.6)



a) DIA3 as DC-brake command input and stop-mode = Ramp



b) DIA3 as DC-brake command input and stop-mode = Coasting

Figure 6-5: DIA3 as DC-brake Command Input:
a) Stop Mode = Ramp,
b) Stop Mode = Coasting

2.3 *DIB4 function*
[“DIB4 Function”; Range: 0—10; Default: 6]

Selections are the same as parameter 2.2 selections, except:

10: “Multi-Step Sel 1” — contact closed = active speed select 1.

2.4 *DIB5 function*
[“DIB5 Function”; Range: 0—11; Default: 1]

Selections are the same as parameter 2.2 selections, except:

10: “Multi-Step Sel 2” — contact closed = active speed select 2

11: “Mot Pot UP” — contact closed = reference decreases until contact is UP opened

2.5 *DIB6 function*
[“DIB6 Function”; Range: 0—11; Default: 4]

Selections are the same as parameter 2.2 selections, except:

10: “Multi-Step Sel 3” — contact closed = active speed select 3

11: “Mot Pot DOWN” — contact closed = reference decreases until contact is opened

2.6 *V_{in} signal range*
[“V_{in} Signal Range”; Range: 0—2; Default: 0]

0 **“0-10 V”** — Signal range from 0 to +10 V

1 **“Custom Range”** — Custom setting range from custom minimum (parameter 2.7) to custom maximum (parameter 2.8)

2 **“-10-+10 V”** — Signal range from -10 to +10 V, can be used only with Joystick control

2.7 *V_{in} custom minimum setting*
[“V_{in} Custom Min”; Range: 0—100%; Default: 0.00%]

2.8 *V_{in} custom maximum setting*
[“*V_{in} Custom Max*”; Range: 0—100%; Default: 100%]

With these parameters, V_{in} can be set for any input signal span within 0—10 V.

Minimum setting: Set the V_{in} signal to its minimum level, select parameter 2.7, press the Enter button

Maximum setting: Set the V_{in} signal to its maximum level, select parameter 2.8, press the Enter button

Note! These parameters can only be set with this procedure
(not with the Browser buttons)

2.9 V_{in} signal inversion
[“V_{in} Invert”; Range: 0—1; Default: 0]

0 **“No Inversion”** — no inversion of analog V_{in} signal.

1 **“Inverted”** — inversion of analog V_{in} signal

2.10 V_{in} signal filter time
[“V_{in} Filter Time”; Range: 0—10 s; Default: 0.1 s]

Filters out disturbances from the incoming analog V_{in} signal.

Long filtering time makes regulation response slower. See Figure 6-6.

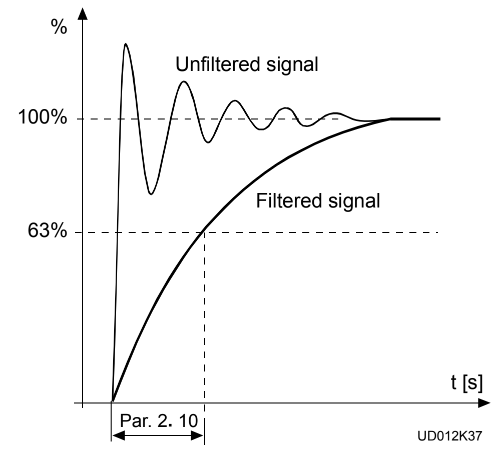


Figure 6-6: V_{in} Signal Filtering.

2.11 Analog input I_{in} signal range
[“I_{in} Signal Range”; Range: 0—2; Default: 0]

0 **“0-20 mA”** — Input signal range of 0 to 20 mA

1 **“4-20 mA”** — Input signal range of 4 to 20 mA

2 **“Custom Range”** — Custom input signal span (defined by parameters 2.13 and 2.13)

2.12 Analog input I_{in} custom setting minimum
[“I_{in} Custom Min”; Range: 0—100%; Default: 0.00%]

2.13 Analog input I_{in} custom setting maximum
[“I_{in} Custom Max”; Range: 0—100%; Default: 100%]

With these parameters, the scaling of the input current signal (I_{in}) range can be set between
0 – 20 mA.

Minimum setting: Select parameter 2.12, set the I_{in} signal to its minimum level, then press the Enter button.

Maximum setting: Select parameter 2.13, set the I_{in} signal to its maximum level, then press the Enter button.

Note! These parameters can only be set with this procedure (not with the *Browser buttons*)

2.14 Analog input I_{in} inversion
[“I_{in} Invert”; Range: 0—1; Default: 0]

0 **“No Inversion”** — no inversion of I_{in} input

1 **“Inverted”** — inversion of I_{in} input

2.15 *Analog input I_{in} filter time*
[“I_{in} Filter Time”; Range: 0—10 s; Default: 0.1 s]

Filters out disturbances from the incoming analog I_{in} signal.

Long filtering time makes regulation response slower. See Figure 6-7.

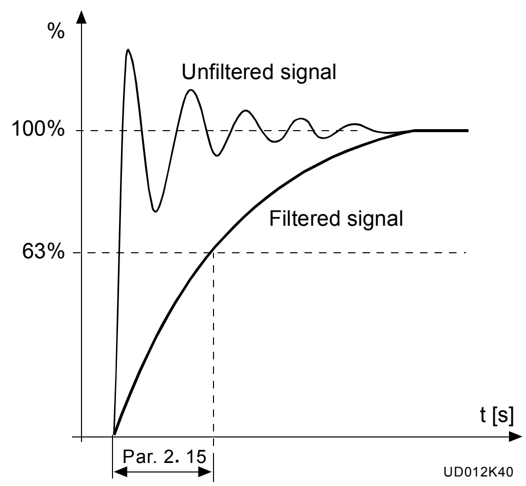


Figure 6-7: Analog Input I_{in} Filter Time

2.16 *V_{in} signal minimum scaling*
[“V_{in} Scale Min”; Range: -320.00% – +320.00%; Default: 0.01%]

Sets the minimum scaling point for V_{in} signal. See Figure 6-8.

2.17 *V_{in} signal maximum scaling*
[“V_{in} Scale Max”; Range: -320.00% – +320.00%; Default: 0.01%]

Sets the maximum scaling point for V_{in} signal. See Figure 6-8.

2.18 *I_{in} signal minimum scaling*
[“I_{in} Scale Min”; Range: -320.00% – +320.00%; Default: 0.01%]

Sets the minimum scaling point for I_{in} signal. See Figure 6-8.

2.19 *I_{in} signal maximum scaling*
[“I_{in} Scale Max”; Range: -320.00% – +320.00%; Default: 0.01%]

Sets the maximum scaling point for I_{in} signal. See Figure 6-8.

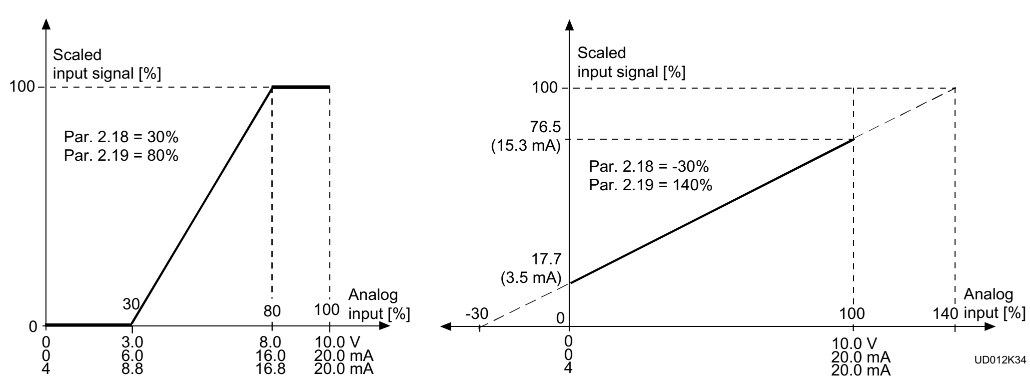


Figure 6-8: Examples of the Scaling of V_{in} and I_{in} Inputs

2.20 *Free analog input signal*
[“Free Analog Sign”; Range: 0—4; Default: 0]

Selection of input signal for free analog input (an input not used for reference signal):

0 **“Not Used”**

1 **“Voltage Input”** — Voltage signal V_{in}

2 **“Current Input”** — Current signal I_{in}

3 **“AIN1 I/O-expand”** — Voltage signal A_{in1} from terminals 202-203 of I/O Expander

4 **“AIN2 I/O-expand”** — Analog signal A_{in2} from terminal 204-205 of I/O Expander
- current signal SV9IOC100
- voltage signal SV9IOC102

5 **“FB signal”** – the signal comes through the fieldbus board and depends on the option board used.

2.21 *Free analog input signal function* **[“Free Analog Func”; Range: 0—4; Default: 0]**

This parameter sets the function of the free analog input:

0 **“Not Used”** — Function is not used

1 **“I lim Scaling”** — Reducing motor current limit. This signal will adjust the maximum motor current between 0 and parameter maximum limit set with parameter 1.7. See Figure 6-9.

2 **“DC-curr Scaling”** — Reducing DC brake current. The DC braking current can be reduced with the free analog input signal, between 0.15 x I_{nSV} and current set with parameter 4.8. See Figure 6-10.

3 **“Acc/Dec Ramp Rdy”** — Reducing acceleration and deceleration times. The acceleration and deceleration times can be reduced with the free analog input signal, according to the following formula:

Reduced time = set acc./dec. time (parameter 1.3, 1.4; 4.3, 4.4) divided by factor R from figure 6-11.

4 **“Torque Suprv Scl”** — Reducing torque supervision limit. The set torque supervision limit can be reduced with the free analog input signal between 0 and set supervision limit (parameter 3.14), see Figure 6-12.

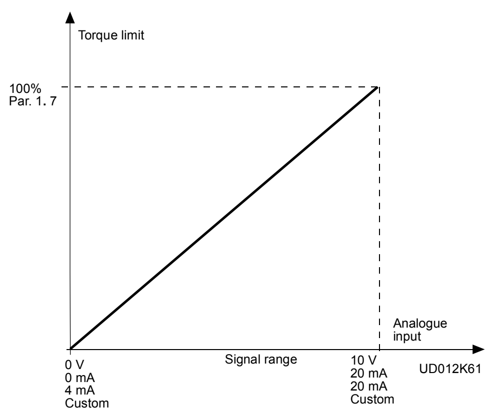


Figure 6-9: Reducing Maximum Motor Current

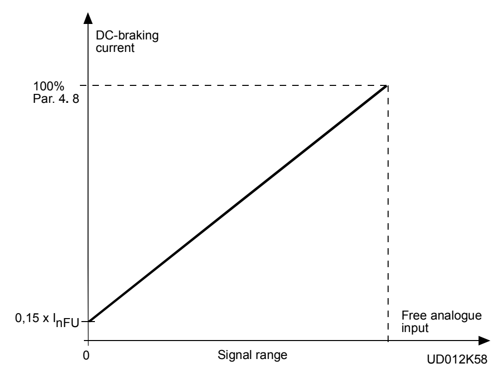


Figure 6-10: Reducing DC Brake Current

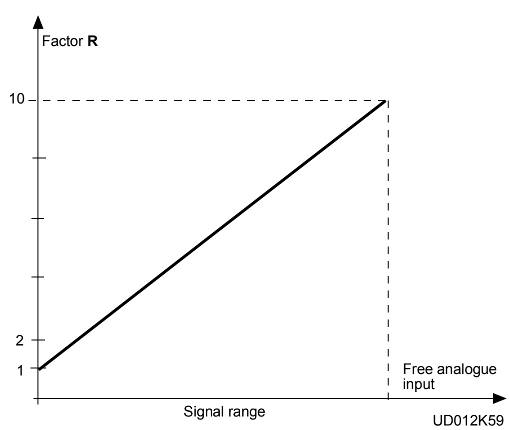


Figure 6-11: Reducing Acceleration and Deceleration Times

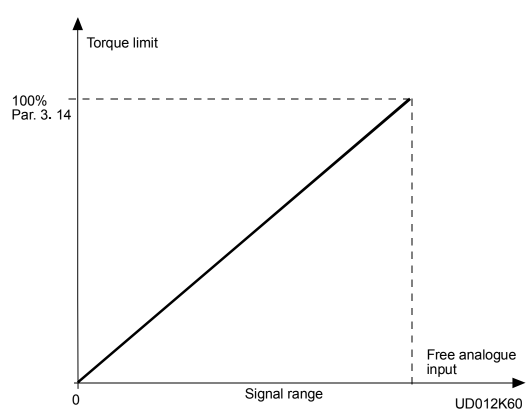


Figure 6-12: Reducing Torque Supervision Limit

2.22 Motor potentiometer ramp time
[" Mot Pot Ramp Tim"; Range: 0.1—2000.0 Hz/s; Default: 10.0 Hz/s]

Defines how fast the electronic motor potentiometer value changes.

3.1 Analog output function
["I_{out} content"; Range: 0—7; Default: 1]

0 **"Not Used"** — Scale 100%

1 **"Motor Freq."** — 0 to f_{max}

2 **"Motor Speed"** — 0 to maximum speed

3 **"Motor Current"** — 0 to 2.0 x I_{nSV}

4 **"Motor Torque"** — 0 to 2 x T_{nSV}

5 **"Motor Power"** — 0 to 2 x P_{nSV}

6 **"Motor Voltage"** — 0 to 100% x V_{nM}

7 **"DC-Bus Voltage"** — 0 to1000 V

3.2 Analog output filter time
["I_{out} Filter Time"; Range: 0.01—10 s; Default: 1.00]

Filters the analog output signal.
See Figure 6-13.

3.3 Analog output invertsion
["I_{out} Invert"; Range: 0—1; Default: 0]

Inverts analog the analog output signal:
maximum output signal = minimum set value
minimum output signal = maximum set value

3.4 Analog output minimum
["I_{out} Minimum"; Range: 0—1; Default: 0]

Defines the signal minimum to either 0 mA or 4 mA (living zero). See Figure 6-15.

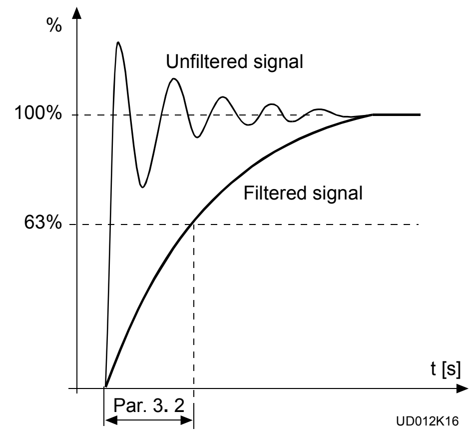


Figure 6-13: Analog Output Filtering

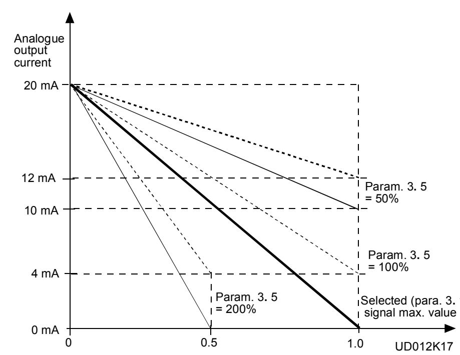


Figure 6-14: Analog Output Invert

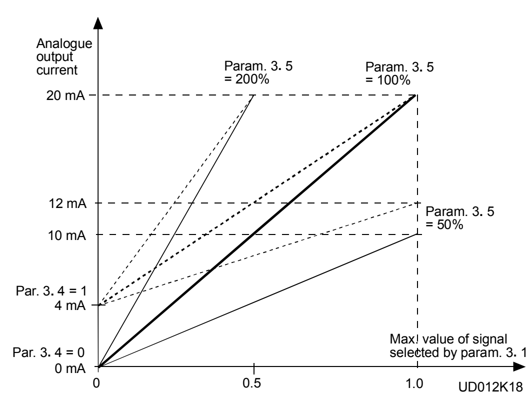


Figure 6-15: Analog Output Scale

3.5 Analog output scale
[“I_{out} Scale ”; Range: 10—1000%; Default: 100%]

Scaling factor for analog output.
See Figure 6-15.

Signal	Max. value of the signal
Output frequency	Max frequency (par. 1.2)
Motor speed	Max speed ($n_n x f_{max}/f_n$)
Output current	2 x I_{nSV}
Motor torque	2 x T_{nSV}
Motor power	2 x P_{nSV}
Motor voltage	100% x U_{nmotor}
DC-link voltage	1000 V
V_{in} signal	Max U_{in}
I_{in} signal	Max I_{in}

3.6 Digital output function
[“DO1 Content”; Range: 0—22; Default: 1]

3.7 Relay output 1 function
[“RO1 Content”; Range: 0—22; Default: 2]

3.8 Relay output 2 function
[“RO2 Content ”; Range: 0—22; Default: 3]

Setting value	Signal content
0 = Not used	Out of operation
Setting value	**Digital output DO1 sinks the current, and programmable relay (RO1, RO2) is activated when:**
1 = Ready	The frequency converter is ready to operate
2 = Run	The frequency converter operates (motor is running)
3 = Fault	A fault trip has occurred
4 = Fault inverted	A fault trip has not occurred
5 = Drive overheat warning	The heat-sink temperature exceeds +70°C (158°F)
6 = External fault or warning	Fault or warning depending on parameter 7.2
7 = Reference fault or warning	Fault or warning depending on parameter 7.1 - if analog reference is 4—20 mA and signal is <4mA
8 = Warning	Always if a warning exists
9 = Reversed	The reverse command has been selected
10 = Jogging speed	Jogging speed has been selected with digital output
11 = At speed	The output frequency has reached the set reference
12 = Motor regulator activated	Overvoltage or overcurrent regulator was activated
13 = Output frequency supervision 1	The output frequency goes outside the set supervision Low limit/High limit (parameters 3.9. and 3.10)
14 = Output frequency supervision 2	The output frequency goes outside the set supervision Low limit/High limit (parameters 3.11 and 3.12)
15 = Torque limit supervision	The motor torque goes outside the set supervision Low limit/High limit (parameters 3.13 and 3.14)
16 = Reference limit supervision	The reference goes outside the set supervision Low limit/High limit (parameters 3.15 and 3.16)
17 = External brake control	External brake ON/OFF control with programmable delay (parameters 3.17 and 3.18)
18 = Control from I/O terminals	External control mode selected with programmable push-button #2
19 = Frequency converter temperature limit supervision	Temperature on frequency converter goes outside the set supervision limits (parameters 3.19 and 3.20)
20 = Unrequested rotation direction	Rotation direction of the motor shaft is different from the requested one
21 = External brake control inverted	External brake ON/OFF control (parameters 3.17 and 3.18) output active when brake control is OFF

Table 6-2: Output Signals via DO1 and Output Relays RO1 and RO2.

3.9 *Output frequency limit 1, supervision function*
[“Freq Supv Lim 1”; Range: 0—2; Default: 0]

3.11 *Output frequency limit 2, supervision function*
[“Freq Supv Lim 2”; Range: 0—2; Default: 0]

0 **“Not Used”** — No supervision

1 **“Low Limit”** — Low limit supervision

2 **“High Limit”** — High limit supervision

If the output frequency goes under/over the set limit (parameters 3.10 and 3.12), this function generates a warning message via the digital output DO1 and via the relay output RO1 or RO2 depending on the settings of parameters 3.6 to 3.8.

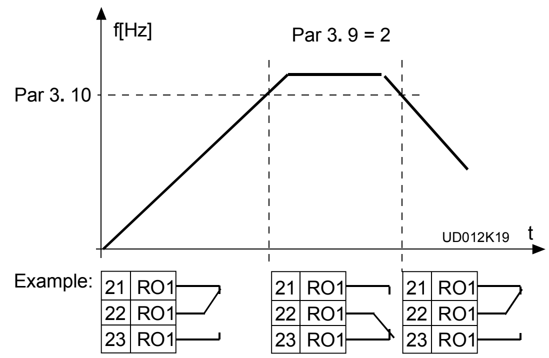


Figure 6-16: Output Frequency Supervision

3.10 *Output frequency limit 1, supervision value*
[“Freq Supv Val 1”; Range: ; Default: *0—f_{max} (par. 1.2)*]

3.12 *Output frequency limit 2, supervision value*
[“Freq Supv Val 2”; Range: ; Default: *0—f_{max} (par. 1.2)*]

The frequency value supervised by parameters 3.9 and 3.11. See Figure 6-16.

3.13 *Torque limit, supervision function*
[“Torque Supv Lim”; Range:; Default:]

0 **“Not Used”** — No supervision

1 **“Low Limit”** — Low limit supervision

2 **“High Limit”** — High limit supervision

If the calculated torque value goes under/over the set limit (parameter 3.14), this function generates a warning message via the digital output DO1and/or via the relay outputs RO1 or RO2, depending on parameter 3.6 – 3.8 settings.

3.14 *Torque limit, supervision value*
[“Torque Supv Val”; Range: 0—200% x T_{nSV}; Default: 100%]

The calculated torque value supervised by parameter 3.13.

3.15 *Reference limit, supervision function*
[“Ref Superv Lim”; Range: 0—2; Default: 0]

0 **“Not Used”** — No supervision

1 **“Low Limit”** — Low limit supervision

2 **“High Limit”** — High limit supervision

If the reference value goes under/over the set limit (parameter 3.16), this function generates a warning message via the digital output DO1 and/or via the relay outputs RO1 or RO2, depending on parameter 3.6 – 3.8 settings. The supervised reference is the currently active reference. It can be source A or B reference depending on DIB6 input or the panel reference if panel is the active control source.

3.16 *Reference limit, supervision value*
[“Ref Superv Value”; Range: *0—f_{max}*; Default: 0 Hz]

The frequency value supervised by parameter 3.15.

3.17 *External brake closing delay*
[“Ext Brake OffDel”; Range: *0—100.0 s*; Default: *0.5 s*]

3.18 *External brake opening delay*
[“Ext Brake OnDel”; Range: *0—100.0 s*; Default: 1*.5 s*]

These parameters are used only with brake control. The brake control signal can be programmed via the digital output DO1 and/or via the relay outputs RO1 or RO2, depending on parameter 3.6 – 3.8 settings. With these parameters, timing of the external brake can be linked to the Start and Stop control signals, see Figure 6-17.

Refer also to parameters 3.35 – 3.39.

If parameter 3.7 and 3.8 (Relay output functions) setting values are 17 or 21, parameter 3.17 and 3.18 are in use.

3.19 *Frequency converter temperature limit supervision function*
[“Temp Limit Supv”; Range: 0—2; Default: 0]

0 **“Not Used”** — No supervision

1 **“Low Limit”** — Low limit supervision

2 **“High Limit”** — High limit supervision

If the temperature of the frequency converter goes under/over the set limit (parameter 3.20), this function generates a warning message via the digital output DO1 and/or via the relay outputs RO1 or RO2, depending on parameter 3.6 – 3.8 settings.

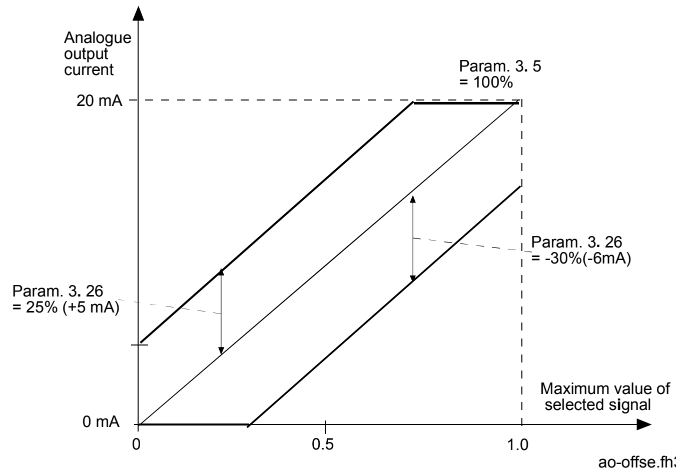


Figure 6-17: Analog Output Offset

3.20 *Frequency converter temperature limit value*
[“Temp Supv Value”; Range: *-10—+75°C*; Default: *+40°C*]

The temperature value to be supervised by parameter 3.19.

3.21 *I/O-expander board (opt.) analog output content*
[“Opt A_{out} Content”; Range: *0—9*; Default: 3]

Refer to Parameter 3.8 for option definintions.

3.22 *I/O-expander board (opt.) analog output filter time*
[“Opt A_{out} Filter T”; Range: *0.01—10 s*; Default: 1.00]

3.23 *I/O-expander board (opt.) analog output inversion*
[“Opt A_{out} Invert”; Range: *0—1*; Default: 0]

3.24 *I/O-expander board (opt.) analog output minimum*
[“Opt A_{out} Minimum”; Range: *0—1*; Default: 0]

3.25 *I/O-expander board (opt.) analog output scale*
[“Opt A_{out} Scale”; Range: *10—1000%*; Default: *100%*]

3.26 *Display Speed* Range: *0-1;* Default: *0*]

0 = Calculated
1 = Encoder

4.1 Acceleration/Deceleration ramp 1 shape
["Ramp 1 Shape"; Range: 0—10 s; Default: 0.0]

4.2 Acceleration/Deceleration ramp 2 shape
["Ramp 2 Shape"; Range: 0—10 s; Default: 0.0]

The start and end of acceleration and deceleration ramps can be smoothed with these parameters. Setting value 0 gives a linear ramp shape, which causes acceleration and deceleration to act on changes in the reference signal with the time constant set by parameters 1.3 and 1.4 or parameters 4.3 and 4.4.

Setting a value 0.1 to 10 seconds for 4.1 (4.2) causes linear acceleration/deceleration to adopt an S-shape. Parameter 1.3 and 1.4 (4.3 and 4.4) determines the time constant of acceleration/ deceleration in the middle of the curve. See Figure 6-20.

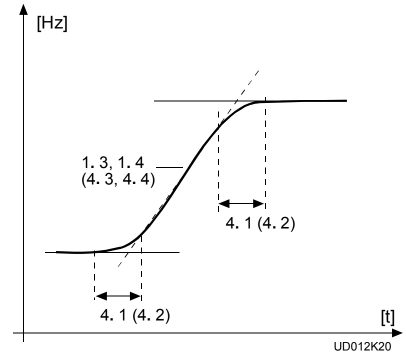


Figure 6-20: S-Shaped Acceleration/Deceleration

4.3 Acceleration time 2
["Accel Time 2"; Range: 0.1—3000 s; Default: 10.0 s]

4.4 Deceleration time 2
["Decel Time 2"; Range: 0.1—3000 s; Default: 10.0 s]

These values correspond to the time required for the output frequency to accelerate from the set minimum frequency (parameter 1.1) to the set maximum frequency (parameter 1.2). These times give the possibility to set two different acceleration/deceleration time sets for one application. The active set can be selected with the programmable signal DIA3 of this application, see parameter 2.2. Acceleration/deceleration times can be reduced with an external free analog input signal. See parameters 2.20 and 2.21.

4.5 Brake chopper
["Brake Chopper"; Range: 0—2; Default: 0]

0 **"No"** — No brake chopper

1 **"Yes"** — Brake chopper and brake resistor installed

2 **"Yes External"** — External brake chopper

When the frequency converter is decelerating the motor, 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. See separate brake resistor installation manual.

4.6 Start function
["Start Function"; Range: 0—1; Default: 0]

0 **"Ramping"** — The frequency converter starts from 0 Hz and accelerates to the set reference frequency within the set acceleration time. (Load inertia or starting friction may cause prolonged acceleration times).

1 **"Flying Start"** — The frequency converter is able to start into running motor by applying a small torque to motor and searching for a frequency corresponding to the speed the motor is running at. Searching starts from the maximum frequency towards the actual frequency until the correct value is detected. Thereafter the output frequency will be accelerated/decelerated to the set reference value according to the set acceleration/deceleration parameters.

Use the flying start function if the motor is coasting when the start command is given. With the flying start it is possible to ride through short power interruptions.

4.7 *Stop function*
[“0—1”; Range: 0—1; Default: 0]

0 **“Coasting”** — The motor coasts to a halt without any control from the frequency converter after the Stop command.

1 **“Ramping”** — After the Stop command, the speed of the motor is decelerated according to the set deceleration parameters. If the regenerated energy is high, it may be necessary to use an external braking resistor for faster deceleration.

4.8 *DC-braking current*
[“DC Brake Current”; Range: 0.15—1.5 x I_{nSV} (A); Default: 0.5 x I_{nSV}]

Defines the current injected into the motor during DC-braking.

In closed loop, this parameter defines the magnetizing current injected into the motor at a start. This is of importance if the value of parameter 4.8 is higher than the motor magnetizing current (parameter 11.3).

4.9 *DC-braking time at stop (in closed loop, this parameter has no effect)*
[“Stop DC-Brake t”; Range: 0—250.0 s; Default: 0 s]

Note: Unless parameter 6.1 “Motor Control Mode” is set to 0, 1, or 2, this parameter will have no effect on braking time. If parameter 6.1 is set to either 3 or 4, the motor control mode is a closed loop control type, and this parameter will be ignored.

Determines if braking is ON or OFF and the braking time of the DC-brake when the motor is stopping. The function of the DC-brake depends on the stop function, parameter 4.7. See Figure 6-21.

0 DC-brake is not used

>0 DC-brake is in use and its function depends on the Stop function, (parameter 4.7), and the time depends on the value of parameter 4.9.

Stop-function = 0 (coasting):

After the stop command, the motor coasts to a stop without control of the frequency converter.

With DC-injection, the motor can be electrically stopped in the shortest possible time, without using an optional external brake resistor.

The braking time is scaled according to the frequency when the DC-braking starts. If the frequency is ≥ the nominal frequency of the motor (parameter 1.11), the value of parameter 4.9 determines the braking time. When the frequency is ≤10% of the nominal, the braking time is 10% of the value of parameter 4.9.

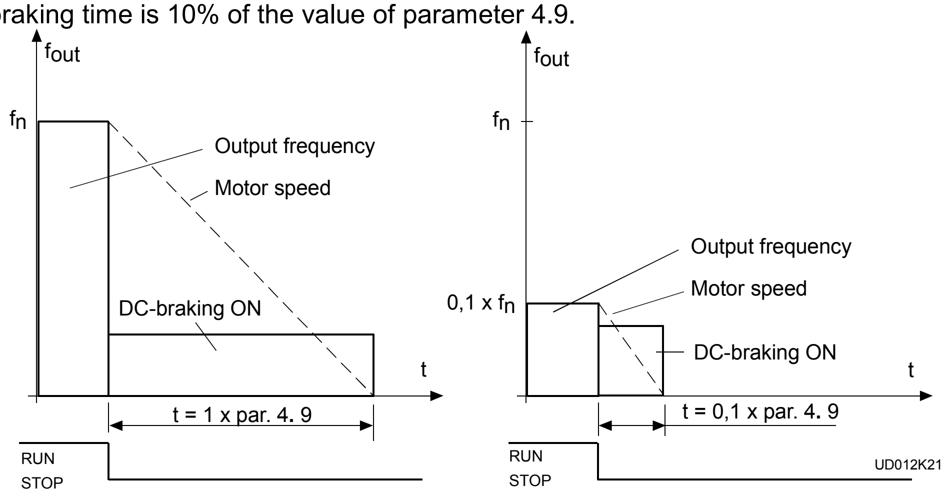


Figure 6-21: DC-Braking Time when Stop = Coasting

Stop-function = 1 (ramp):

After the Stop command, the speed of the motor is reduced according to the deceleration parameters, as fast as possible, to a speed defined with parameter 4.10, where the DC-braking starts.

The braking time is defined with parameter 4.9.

If high inertia exists, an external braking resistor is recommended for faster deceleration. See Figure 6-22.

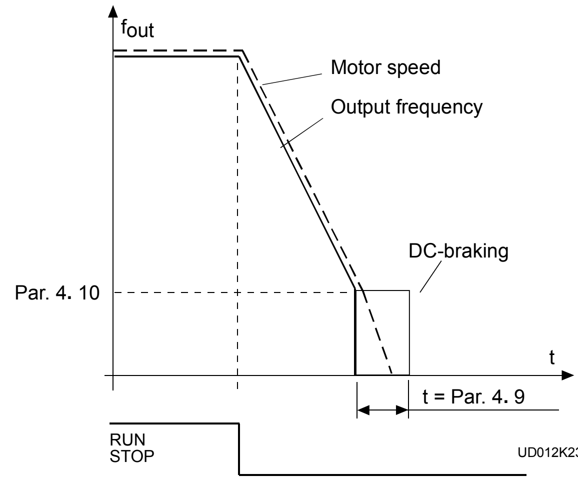


Figure 6-22: DC-Braking Time when Stop Function = Ramp

4.10 Execute frequency of DC-brake during ramp stop (in closed loop, this parameter has no effect)
[“Stop DC-Brake f”; Range: 0.1—10 Hz; Default: 1.5 Hz]

Note: Unless parameter 6.1 “Motor Control Mode” is set to 0, 1, or 2, this parameter will have no effect on braking time. If parameter 6.1 is set to either 3 or 4, the motor control mode is a closed loop control type, and this parameter will be ignored.

See Figure 6-22.

4.11 DC-brake time at start (in closed loop, this parameter has no effect)
[“Start DC-Brake f”; Range: 0.0—25.0 s; Default: 0.0 s]

Note: Unless parameter 6.1 “Motor Control Mode” is set to 0, 1, or 2, this parameter will have no effect on braking time. If parameter 6.1 is set to either 3 or 4, the motor control mode is a closed loop control type, and this parameter will be ignored.

0 DC-brake is not used

>0 DC-brake is activated when the start command is given and this parameter defines the time before the brake is released. After the brake is released, the output frequency increases according to the set start function parameter 4.6 and acceleration parameters (1.3, 4.1 or 4.2, 4.3), see Figure 6-23.

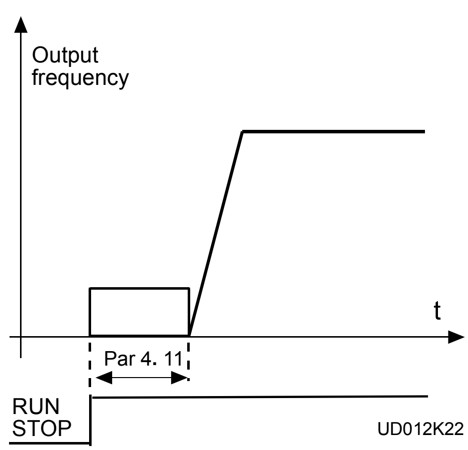


Figure 6-23: DC-Braking at Start

4.12 Multi-step speed reference 1
[“Multi Step 1”; Range: f_{min}–f_{max} (par. 1.1 – par. 1.2); Default: 10.0 Hz]

4.13 Multi-step speed reference 2
[“Multi Step 2”; Range: f_{min}–f_{max} (par. 1.1 – par. 1.2); Default: 15.0 Hz]

4.14 Multi-step speed reference 3
[“Multi Step 3”; Range: f_{min}–f_{max} (par. 1.1 – par. 1.2); Default: 20.0 Hz]

4.15 Multi-step speed reference 4
[“Multi Step 4”; Range: f_{min}–f_{max} (par. 1.1 – par. 1.2); Default: 25.0 Hz]

4.16 Multi-step speed reference 5
[“Multi Step 5”; Range: f_{min}–f_{max} (par. 1.1 – par. 1.2); Default: 30.0 Hz]

4.17 Multi-step speed reference 6
[“Multi Step 6”; Range: f_{min}–f_{max} (par. 1.1 – par. 1.2); Default: 40.0 Hz]

4.18 Multi-step speed reference 7
[“Multi Step 7”; Range: f_{min}–f_{max} (par. 1.1 – par. 1.2); Default: 50.0 Hz]

Parameter value defines the Multi-Step speeds selected with the digital inputs.

5.1 Prohibit frequency range 1 low limit
[“Range 1 Low Lim”; Range: 0—f_{max} (par. 1.2); Default: 0 Hz]

5.2 Prohibit frequency range 1 high limit
[“Range 1 High Lim”; Range: 0—f_{max} (par. 1.2); Default: 0 Hz]

5.3 Prohibit frequency range 2 low limit
[“Range 2 Low Lim”; Range: 0—f_{max} (par. 1.2); Default: 0 Hz]

5.4 Prohibit frequency range 2 high limit
[“Range 2 High Lim”; Range: 0—f_{max} (par. 1.2); Default: 0 Hz]

5.5 Prohibit frequency range 3 low limit
[“Range 3 Low Lim”; Range: 0—f_{max} (par. 1.2); Default: 0 Hz]

5.6 Prohibit frequency range 3 high limit
[“Range 3 High Lim”; Range: 0—f_{max} (par. 1.2); Default: 0 Hz]

In some systems it may be necessary to avoid certain frequencies because of mechanical resonance problems. With these parameters it is possible to set limits for three "skip frequency" regions.

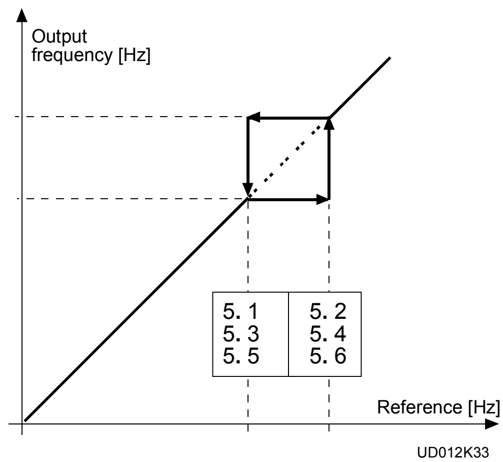


Figure 6-24: Example of Prohibit Frequency Area Setting

6.1 *Motor control mode*
["Control Mode"; Range: 0—4; Default: 0]

0 **"Freq Control"** — The I/O terminal and panel references are frequency references and the frequency converter controls the output frequency (output frequency resolution = 0.01 Hz)

1 **"Speed control"** — The I/O terminal and panel references are speed references and the frequency converter controls the motor speed (regulation accuracy ± 0.5%).

2 **"Torque control"** — The I/O terminal and panel references are torque references and the frequency converter controls the motor torque (regulation accuracy ± 3 % ; proper tuning required: motor nameplate values, V/Hz -setting).

3 = *Speed control*: The I/O terminal and panel references are speed references (closed loop), and the drive controls the motor speed (regulation accuracy ± 0.01%).

4 = *Torque control*: The I/O terminal and panel references are torque references (closed loop) and the drive controls the motor torque (regulation accuracy ±1.5%; proper tuning required: motor nameplate values)

6.2 *Switching frequency*
["Switching freq"; Range: 1—16 kHz; Default: 10/3.6 kHz]

Motor noise can be minimized using a high switching frequency. Increasing the switching frequency reduces the capacity of the frequency converter 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*
["Field weakn pnt"; Range: 30—500 Hz; Default: Par. 1.11]

6.4 *Voltage at field weakening point*
["Voltage at FWP"; Range: 15—200% x U_{nmot}; Default: 100%]

The field weakening point is the output frequency at which the output voltage reaches the set maximum value (parameter 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 V/Hz curve parameters 1.8, 1.9, 6.5, 6.6 and 6.7. See Figure 6-25.

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 after setting parameters 1.10 and 1.11.

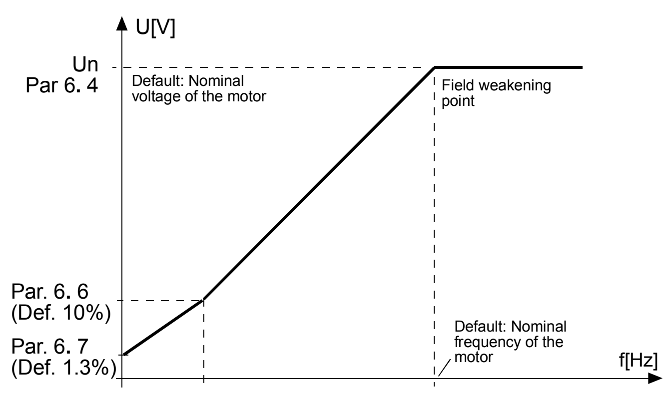


Figure 6-25: Programmable V/Hz Curve.

IMPORTANT!: The following parameters have no effect in closed loop fieldbus control. Unless parameter 6.1 “Motor Control Mode” is set to 0, 1, or 2, parameters 6.5—6.9 will have no effect. If parameter 6.1 is set to either 3 or 4, the motor control mode is a closed loop control type, and these parameters will be ignored.

6.5 V/Hz-curve mid-point frequency
[“V/Hz Mid Freq”; Range: 0—500 Hz; Default: 0 Hz]

If the programmable V/Hz curve has been selected with parameter 1.8 this parameter defines the middle point frequency of the curve. See figure 6-25.

6.6 V/Hz-curve mid-point voltage
[“V/Hz Mid Voltg”; Range: 0—123.20%; Default: 0.00%]

If the programmable V/Hz curve has been selected with parameter 1.8 this parameter defines the middle point voltage of the curve. See figure 6-25.

6.7 Output voltage at zero frequency
[“Zero Freq Voltg”; Range: 0—40%; Default: 0.00%]

If the programmable V/Hz curve has been selected with the parameter 1.8 this parameter defines the zero frequency voltage (% of motor nominal voltage) of the curve.
See figure 6-25.

6.8 Overvoltage controller
[“Overvolt Contr”; Range: 0—2; Default: 1]

6.9 Undervoltage controller
[“Undervolt Contr”; Range: 0—1; Default: 1]

These parameters allow the over/undervoltage controllers to be switched ON or OFF. This may be useful in cases where the utility supply voltage varies more than -15%—+10% and the application requires a constant speed. If the controllers are on they will change the motor speed in over/undervoltage cases. Overvoltage = faster, undervoltage = slower.

Over/undervoltage trips may occur when controllers are switched OFF.

7.1 Response to the reference fault
[“Reference Fault”; Range: 0—3; Default: 0]

0 “No Action” — No response

1 “Warning” —Warning

2 “Fault” — Stop mode after fault according to parameter 4.7

3 “Fault, Coast” — Stop mode after fault always by coasting

A warning or a fault action and message is generated if 4—20 mA reference signal is used and the signal falls below 4 mA. The information can also be programmed via digital output DO1 and via relay outputs RO1 and RO2.

7.2 Response to external fault
[“External Fault”; Range: 0—3; Default: 2]

0 “No Action” — No response

1 “Warning” —Warning

2 “Fault” — Stop mode after fault according to parameter 4.7

3 “Fault, Coast” — Stop mode after fault always by coasting

A warning or a fault action and message is generated from the external fault signal in the digital input DIA3. The information can also be programmed into digital output DO1 and relay outputs RO1 and RO2.

7.3 Phase supervision of the motor
[“Phase Supervisn”; Range: 0—2; Default: 2]

0 “No Action” — No response

2 “Fault” — Fault

Phase supervision of the motor ensures that the motor phases have an approximately equal current.

7.4 Earth fault protection
[“Ground Fault”; Range: 0—2; Default: 2]

0 “No Action” — No response

2 “Fault” — Fault

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

Parameters 7.5—7.9 Motor thermal protection

General

Motor thermal protection is used to help protect the motor from overheating. The drive is capable of supplying higher than nominal current to the motor. If the load requires 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 is the capacity of the motor. If the motor is equipped with an external fan, the load reduction on low speeds is small.

Motor thermal protection is based on a calculated model, and uses the output current of the drive to determine the load on the motor. When power to 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 (104°F).

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 7.6, 7.7 and 7.9. See Figure 6-26. Parameters default values are 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 56% value and with output current at 120% of I_T the thermal stage would reach 144% value. The function will trip the device (parameter 7.5) if the thermal stage reaches a value of 105%. The speed of change in thermal stage is determined with the time constant (parameter 7.8). 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 a blocked air intake grill reduces airflow to the motor.

7.5 Motor thermal protection
[“Motor Therm Prot”; Range: 0—2; Default: 2]

0 “No Action” — No response

1 “Warning” —Warning

2 “Fault” — Fault

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

Deactivating the protection (setting this parameter to 0) will reset the thermal stage of the motor to 0%.

7.6 *Motor thermal protection, break point current*
["MTP fnom Current"; Range: 50.0—150% x I_{nMOTOR}; Default: 100.0%]

This parameter sets the value for thermal current at frequencies above the breakpoint on the thermal current curve. See Figure 6-26.

The value is set in a percentage that is relative to the name plate data of the motor, (parameter 1.13 - nominal current of the motor), not to the drive's nominal output current.

The motor's nominal current is the current that the motor can withstand in direct on-line use without being overheated.

If parameter 1.13 is adjusted, parameter 7.6 is automatically restored to the default value.

Setting this parameter (7.6) 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.

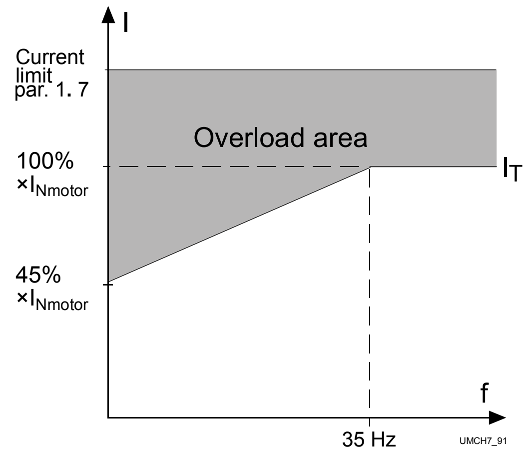


Figure 6-26: Example of Prohibit Frequency Area Setting

7.7 *Motor thermal protection, zero frequency current*
["MTP f0 Current"; Range: 5.0—150% x I_{nMOTOR}; Default: 45.0%]

This parameter sets the value for thermal current at zero frequency. Refer to figure 6-26.

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 nominal current), not the drive's nominal output current. Motor nominal current is the current that the motor can stand in direct on-line use without being overheated.

If parameter 1.13 is changed, parameter 7.7 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.

7.8 *Motor thermal protection, time constant*
["MTP Motor T"; Range: 0.5—300.0 min.; Default: relative to motor nominal current]

This is the thermal time constant of the motor. The larger the motor, the longer the time constant will be. 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 based on the motor nameplate data given in parameters 1.12 and 1.13. If either parameter is changed, parameter 7.8 is automatically restored to the default value.

If the motor's t_6 -time is known (given by the motor manufacturer), the time constant parameter could be set based on t_6 -time. As a rule of thumb, the motor thermal time constant in minutes should equal 2 x t_6 (where t_6, in seconds, is the time a motor can safely operate at six times the rated current). If the drive is at the stop stage, the time constant is internally increased to three times parameter 7.8's value. The cooling calculation for the stop stage is based on convection and the time constant is increased.

7.9 *Motor thermal protection, breakpoint frequency* [“MTP fnom”; Range: *10—500 Hz*; Default: *35 Hz*]

This is the breakpoint of thermal current curve. When the motor frequency is above this point, the thermal capacity of the motor is assumed to be constant. See Figure 6-27.

The default value is based on the motor's nameplate data (parameter 1.11). For a 50 Hz motor, the default breakpoint frequency is 35 Hz, and for a 60 Hz motor the default breakpoint frequency is 42 Hz. In general, the breakpoint frequency typically is 70% of the frequency at field weakening point (parameter 6.3). Changing either parameter 1.11 or 6.3 will automatically restore parameter 7.9 to its default value.

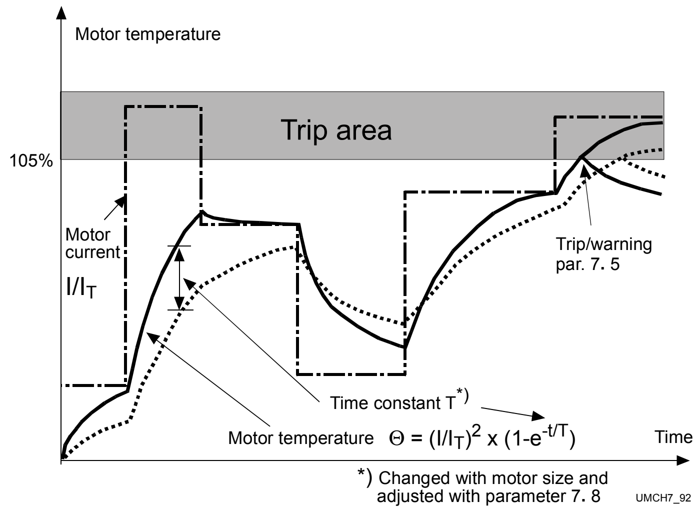


Figure 6-27: Calculating Motor Temperature

Parameters 7.10—7.13, Stall Protection

General

Motor stall protection protects the motor from short duration overload situations such as 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: parameter 7.11 - stall current limit, and parameter 7.13. stall frequency limit. If the stall current is higher than the limit, and output frequency is lower than the limit, the stall state is true. The stall state is not based on real indication of the shaft rotation. Stall protection is a type of overcurrent protection.

7.10 Stall protection
[“Stall Protection”; Range: 0—2; Default: 1]

0 “No Action” — No response

1 “Warning” —Warning

2 “Fault” — Fault

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

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

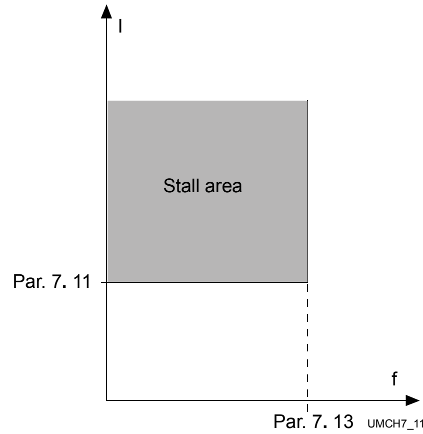


Figure 6-28: Setting the Stall Characteristics

7.11 Stall current limit
[“Stall Current”; Range: 10.0—200% x I_{nMOTOR}; Default: 130.0%]

In a stall stage, the current must be above this limit. See Figure 6-28. The value is set as a percentage of the motor nameplate data (parameter 1.13 - motor nominal current). If parameter 1.13 is adjusted, parameter 7.11 is automatically restored to the default value.

7.12 Stall time
[“Stall Time Lim”; Range: 2.0—120 s; Default: 15.0 s]

This is the maximum allowed time for a stall stage. There is an internal counter to count the stall time. See Figure 6-29. If the stall time counter value goes above the stall time limit, stall protection will cause a trip (see parameter 7.10).

7.13 Maximum stall frequency
[“Stall Freq Lim”; Range: 1—f_{max}; Default: 25 Hz]

In a stall state, the output frequency must be smaller than this limit. See Figure 6-28.

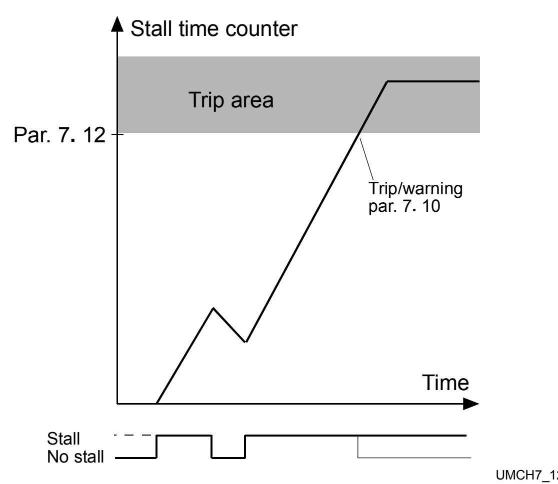


Figure 6-29: Stall Time Counting.

Parameters 7.14—7.17, Underload protection

General

The purpose of motor underload protection is to ensure that there is a load on the motor when the drive is running. If the motor loses its load, there may be a problem in the process, e.g. a broken belt or a dry pump.

Motor underload protection can be adjusted by setting the underload curve with parameters 7.15 and 7.16. The underload curve is a squared curve set between zero frequency and the field weakening point. Underload protection is not active below 5Hz (the underload counter value is stopped). See Figure 6-30.

The torque values for setting the underload curve are set in a percentage relative to the nominal torque of the motor. The motor name plate data, parameter 1.13, the motor nominal current and the drive nominal current I_{CT}, are used to find the scaling ratio for the internal torque value. If the value entered in parameter 1.3 is different than the motor's nominal current, the accuracy of the torque calculation decreases.

7.14 Underload protection
["Underload Protec"; Range: 0—2; Default: 0]

0 **"No Action"** — No response

1 **"Warning"** —Warning

2 **"Fault"** — Fault

Fault and warning will display the same message code. If fault is set active, the drive will stop and activate the fault stage.

Deactivating the protection by setting the parameter to 0 will reset the underload time counter to zero.

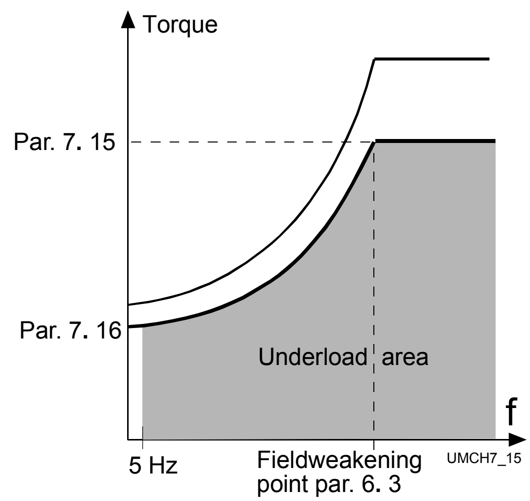


Figure 6-30: Minimum Load Setting

7.15 Underload protection, field weakening area load **["UP fnom Torque"; Range: 10.0—150% x T_{nMOTOR}; Default: 50.0%]**

This parameter gives the value for the minimum torque allowed when the output frequency is above the field weakening point. Refer to figure 6-30. If parameter 1.13 is adjusted, parameter 7.15 is automatically restored to the default value.

7.16 Underload protection, zero frequency load
["UP f0 Torque"; Range: 5.0—150.0% x T_{nMOTOR}; Default: 10.0%]

This parameter sets the minimum torque allowed with zero frequency. Refer to figure 6-30. If parameter 1.13 is adjusted, parameter 7.16 is automatically restored to the default value.

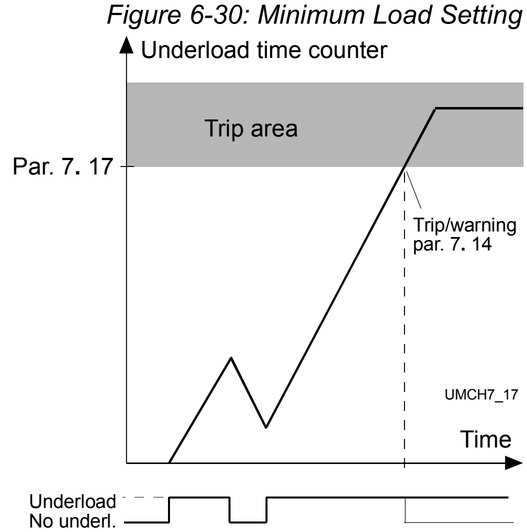


Figure 6-31: Underload Time Counting

7.17 Underload time limit
["UP Time Limit"; Range: 2.0—600.0 s; Default: 20.0 s]

This is the maximum allowed time for an underload state. There is an internal counter to accumulate the underload time. See Figure 6-31. If the underload counter value goes above the underload time limit, the underload protection will cause a trip (see parameter 7.14). If the drive is stopped, the underload counter is reset to zero.

8.1 Automatic restart: number of tries
["Number of Tries"; Range: 0—10; Default: 0]

8.2 Automatic restart: trial time
["Trial Time"; Range: 1—6000 s; Default: 30 s]

The automatic restart function restarts the frequency converter after the faults selected with parameters 8.4—8.8. The start function for automatic restart is selected with parameter 8.3.

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 auto-restart. If the number of restart attempts does not exceed the value of parameter 8.1 during the trial time, the count is cleared after the time has elapsed. The next fault restarts counting the number of restart attempts.

8.3 Automatic restart: start function
["Start Function"; Range: 0—1; Default: 0]

The parameter defines the start mode:

0 **"Ramping"** — Start with ramp

1 **"Flying Start"** — Flying start, see parameter 4.6

8.4 Automatic restart after undervoltage trip
["Undervolt Reset"; Range: 0—1; Default: 0]

0 **"No"** — No automatic restart after undervoltage fault trip

1 **"Yes"** — Automatic restart after undervoltage fault condition returns to normal condition (DC-link voltage returns to the normal level)

8.5 Automatic restart after overvoltage trip
["Overvolt Reset"; Range: 0—1; Default: 0]

0 **"No"** — No automatic restart after overvoltage fault trip

1 **"Yes"** — Automatic restart after overvoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)

8.6 Automatic restart after overcurrent trip
["Overcurrent Rst"; Range: 0—1; Default: 0]

0 **"No"** — No automatic restart after overcurrent fault trip

1 **"Yes"** — Automatic restart after overcurrent faults

8.7 Automatic restart after reference fault
["Ref Fault Reset"; Range: 0—1; Default: 0]

0 **"No"** — No automatic restart after reference fault trip

1 **"Yes"** — Automatic restart after analog current reference signal (4—20 mA) returns to the normal level (≥4 mA)

8.8 Automatic restart after over-/undertemperature fault
["Temp Fault Reset"; Range: 0—1; Default: 0]

0 **"No"** — No automatic restart after temperature fault trip

1 **"Yes"** — Automatic restart after heatsink temperature has returned to its normal level between -10°C—+75°C (14°F—167°F).

Group 9, Fast Analog input

9.1 Source

0 = Off
4 = Opt V_{in}
5 = Opt Joystick

9.2 Gain

Fast analog input reference gain

9.3 Bias

Fast analog input reference bias

9.4 Offset

Fast analog input offset in mV is used to adjust zero speed with zero voltage reference.

Parameter group 10, Closed loop parameters

Closed Loop Parameters

The Closed Loop speed control mode (parameter 6.1 = 3) can be used to improve the performance near zero speed and to improve the static speed accuracy with higher speeds. Closed loop control modes are based on "rotor flux oriented current vector control". With this controlling principle, the phase currents are divided into a torque producing current portion and a magnetizing current portion. Thus, the squirrel cage induction machine can be controlled in a fashion of a separately excited DC-motor. The closed loop operation needs a special option card with encoder inputs. Brake resistor is usually also needed.

10.1 Encoder P/R
[“Encoder P/R”; Range: 300—5000; Default: 1024]

The encoder pulse number is essential in the closed loop concept. A wrong pulse number leads to a high torque estimate even with no load. Check the encoder P/R on the encoder nameplate.

10.2 Encoder direction
[“Encoder dir”; Range: 0—1; Default: 0]

0 = “Forward”

0 = “Reverse”

10.3 Motor magnetizing current
[“Motor magn curr”; Range: 0—2000 A; Default: 0 A]

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

10.4 Speed control P-gain
[“Speed control P”; Range: 0—500; Default: 30]

10.5 Speed control I-time
[“Speed control I”; Range: 0—1000; Default: 10]

If the inertia is great, the P-gain can be increased. Increasing the I-time increases stability but decreases speed performance if set too high.

10.6 0 Hz time start
[“0Hz time start”; Range: 0—2.00 s; Default: 0.30 s]

10.7 0 Hz time stop
[“0Hz time stop”; Range: 0—2.00 s; Default: 1.00 s]

Closed loop start and stop zero-speed times.

10.8 Auto-tuning
[“Auto Tuning”; Range: 0—1; Default: 0]

An automatic identification run is started by setting this parameter to 1 while the drive is stopped, then sending a run command to the drive within 10 seconds.

Note! The motor must be disconnected from the load during the identification run.

The identification control program automatically sets the following parameters:

- Parameter 11.2 Encoder direction
- Parameter 11.3 Motor magnetizing current
- Parameter 11.4 Speed control gain
- Parameter 11.5 Speed control integration time

These parameters can be further adjusted after the identification run.

10.9 Current control P gain

These parameter can be use to improve current control stability with special motors.

10.10 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 filter time value reduces speed control stability. Preferred range 0-5ms.

10.11 Ref filt time

Default 5 ms. Filtering the internal reference reduces speed noise***.***

7 Fault codes

The Closed Loop fieldbus application has four special error codes:

Fault Number	Fault	Possible cause	Checking
F12	Brake chopper supervision	- brake resistor not installed - brake resistor broken - brake chopper broken	Check brake resistor - If resistor is OK, the chopper might be broken
F19	Option board identification	Reading of the option board has failed	Check the installation -if installation is correct, contact your distributor
F31	Encoder pulse missing	Encoder broken/missing. Cable broken Defective board	Check encoder, cable and board
F32	Wrong encoder direction	Encoder channels set wrongly	Switch the channels. See parameter 11.2

Table 9-1: Closed Loop Fieldbus Faults.

8 Monitoring data

Code	Signal 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	ºC	Heat sink temperature
V9	Operating day counter	DD.dd	Operating days[1]- can not be reset
V10	Operating hours, “trip counter”	HH.hh	Operating hours[1] can be reset with programmable button #3
V11	MW hours counter	MWh	Total MWh- can not be reset
V12	MW hours, “trip counter”	MWh	Can be reset with programmable button #4
V13	Voltage/analog input	V	Voltage of terminal V_{in} (term. #2)
V14	Current/analog input	mA	Current of terminals I_{in}+ and I_{in}- and (term. #2)
V15	Digital input “A” status		See Page 1
V16	Digital input “B” status		See Page 1
V17	Digital and relay output status		See Page 1
V18	Control program		Version number of the control software
V19	Unit nominal power	kW	Unit power size of the unit
V20	Motor temperature rise	%	100% = nominal motor temperature has been reached

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

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

Table 10–1: Monitoring Items

Notes

Notes

Notes

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