ADJUSTABLE
FREQUENCY DRIVES

SV9000 AF DRIVES

Fieldbus Control Application

- **User Manual**

Cutler-Hammer

EATON

Fieldbus Control Application

(par. 0.1 = 0)

CONTENTS

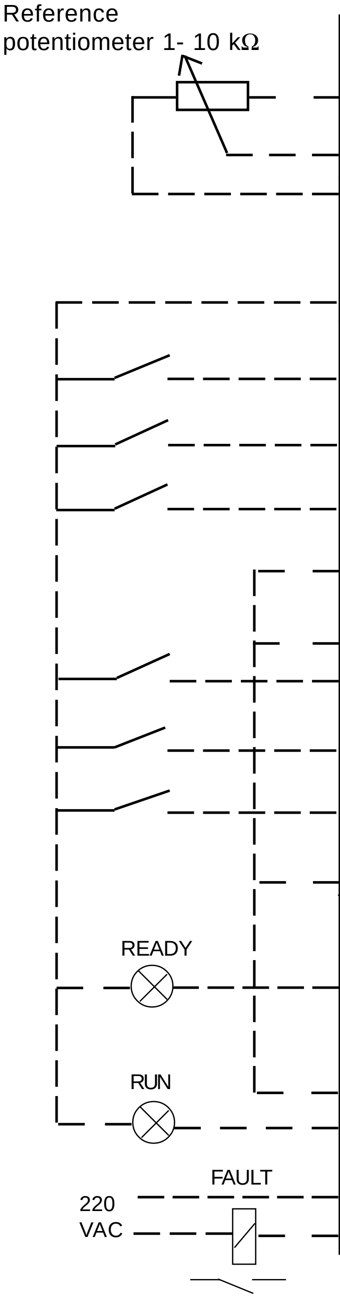
1 General

The Fieldbus Application is an extended version of the normal Multipurpose application. It has parameters for torque control and for fieldbus communication. The following fieldbuses are supported: Interbus, Modbus, Profibus, LonWorks, DeviceNet, and N2.

The frequency reference, the analog and digital outputs have extra alternatives in their control parameters. The source of the free analog input can now be selected from the I/O Expander. These inputs also have parameters for signal area etc. programming.

2 Control I/O

NOTE! Remember to connect the CMA and CMB inputs!!



Terminal		Signal	Description
1	+10V_{ref}	Reference output	Voltage for a potentiometer, etc.
2	V_{in}+	Analog input, voltage (programmable)	Frequency reference range 0—10 V DC
3	GND	I/O ground	Ground for reference and controls
4	I_{in}+	Analog input,	Default setting: not used
5	I_{in}-	current (programmable)	range 0—20 mA
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	Fault reset (programmable)	Contact open = no action Contact closed = fault reset
11	CMA	Common for DIA1—DIA3	Connect to GND or +24V
12	+24V	Control voltage output	Voltage for switches, (same as #6)
13	GND	I/O ground	Ground for reference and controls
14	DIB4	Jog 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	Accel./deceler. 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}+	Output frequency	Programmable (par. 3. 1)
19	I_{out}-	Analog output	Range 0—20 mA/R_L max. 500 Ω
20	DO1	Digital output READY	Programmable (par. 3. 6) Open collector, I≤50 mA, V≤48 VDC
21	RO1	Relay output 1	Programmable (par. 3. 7)
22	RO1	RUN	
23	RO1		
24	RO2	Relay output 2	Programmable (par. 3. 8)
25	RO2	FAULT	
26	RO2		

Figure 2-1 Default I/O configuration and connection example of the Fieldbus Control Application.

3 Control signal logic

In figure 3-1 the logic of I/O-control signals and push button signals from the panel are shown.

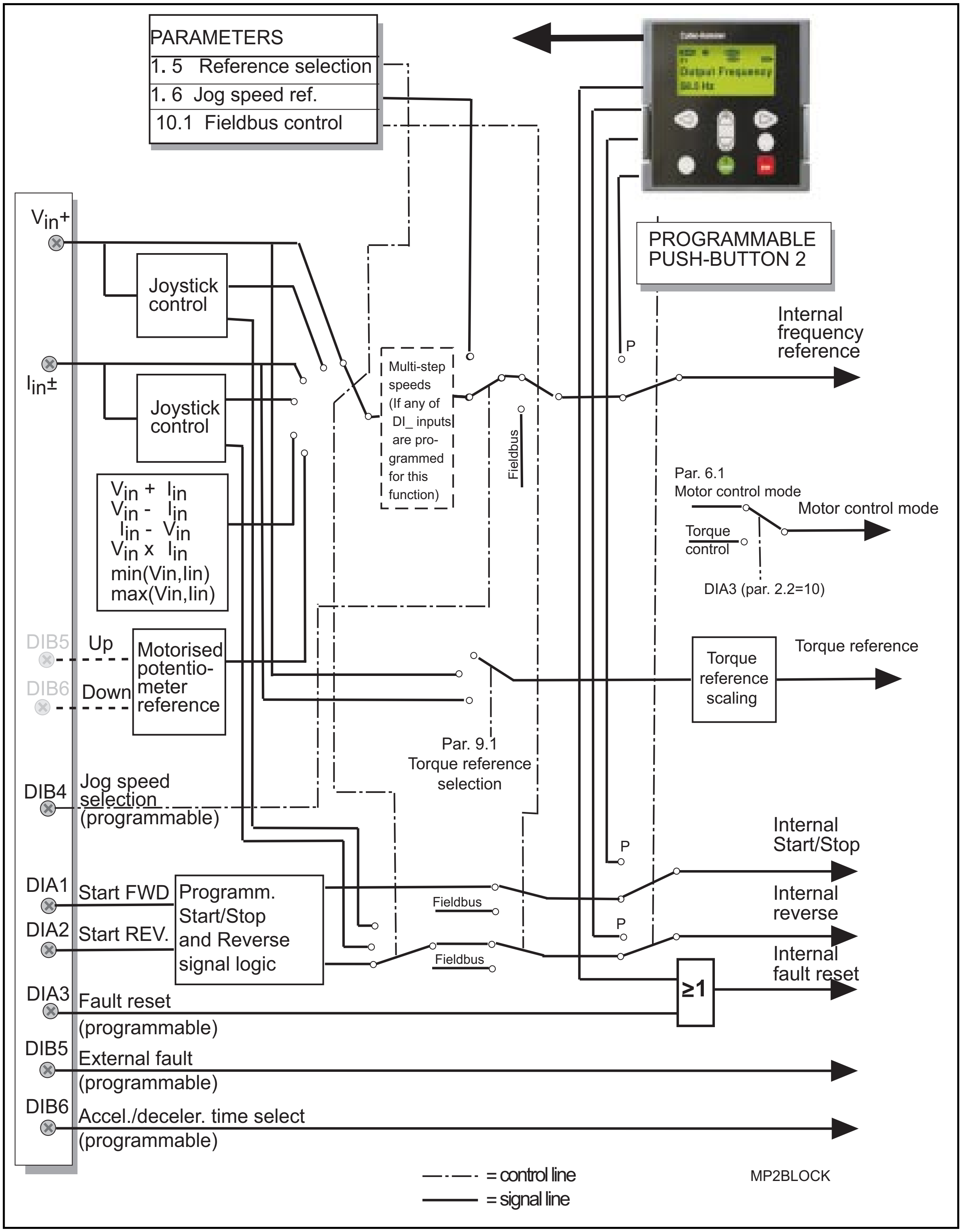


Figure 3-1 Control signal logic of the Fieldbus Application. Switch positions correspond to factory settings.

4 Parameter group 0

Number	Parameter	Range	Step	Default	Customer	Description
0.1	Application selection	0-7	1	0		0 = Fieldbus Ctr (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 = Store parameters as user's set 3 = Reload user's set parameters 4 = Store parameters in the panel (possible only with the graphical panel) 5 = Load parameters from the panel (possible only with the graphical panel)
0.3	Language selection			0		0 = English

Table 4-1 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 the fieldbus application, this has been loaded in the unit as application 0. The application has also been set active at the factory. However, check that the value of the parameter 0.1 is zero when you want to use the Fieldbus Application.

If the application is loaded later it has to be activated after loading by setting the value of parameter 0.1 to zero.

0.2 Parameter loading

See User's Manual chapter 11.

0.3 Language

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

5 Basic parameters, Group 1

5.1 Parameter table

Code	Parameter	Range	Step	Default	Custom	Description	Page
1. 1	Minimum frequency	0—120/500 Hz	1 Hz	0 Hz			6
1. 2	Maximum frequency	0—120/500 Hz	1 Hz	50 Hz	*		6
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)	6
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)	6
1. 5	Reference selection STOP	0—13	1	0		0 = V_{in} 3 = V_{in} - I_{in} 1 = I_{in} 4 = I_{in} - V_{in} 2 = V_{in} + I_{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 SV9000 unit is stopped 10 = Signal from internal motor pot. (stored in memory over utility break) 11 = Min (Vin, Iin) 12 = Max (Vin, Iin) 13 = Panel reference r1	6
1. 6	Jog speed reference	f_{min} —f_{max} (1. 1) (1. 2)	0.1 Hz	5 Hz			7
1. 7	Current limit	0.1—2.5 x I_{nSV9}	0.1 A	1.5 x I_{nSV9}		Output current limit [A] of the unit	7
1. 8	V/Hz ratio selection STOP	0—2	1	0		0 = Linear 1 = Squared 2 = Programmable V/Hz ratio	7
1. 9	V/Hz optimisation STOP	0—1	1	0		0 = None 1 = Automatic torque boost	9
1. 10	Nominal voltage of the motor STOP	180—690	1 V	230 V 380 V 480 V 575 V		Voltage code 2 Voltage code 4 Voltage code 5 Voltage code 6	9
1. 11	Nominal frequency of the motor STOP	30—500 Hz	1 Hz	60 Hz		f_n on the rating plate of the motor	9
1. 12	Nominal speed of the motor STOP	1—20000 rpm	1 rpm	1710 rpm		n_n on the rating plate of the motor	9
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	9
1. 14	Supply voltage STOP	180—250 380—440 380—500 525—690		230 V 380 V 480 V 575 V		Voltage code 2 Voltage code 4 Voltage code 5 Voltage code 6	9
1. 15	Parameter conceal	0—1	1	0		Visibility of the parameters: 0 = All parametergroups visible 1 = Only group 1 is visible	9
1. 16	Parameter value lock	0—1	1	0		Disables parameter changes: 0 = Changes enabled 1 = Changes disabled	9

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

Table 5-1 Group 1 basic parameters. * If 1. 2 >motor synchr. speed, check suitability for motor and drive system.

5.2 Description of Group 1 parameters

1. 1, 1. 2 Minimum / maximum frequency

Defines the frequency limits of the drive.
The default maximum value for parameters 1**.** 1 and 1**.** 2 is 120 Hz. By setting 1**.** 2 = 120 Hz when the drive is stopped (RUN indicator not lit) the maximum value of parameters 1**.** 1 and 1**.** 2 is changed to 500 Hz. At the same time the panel reference resolution is changed from 0.01 Hz to 0.1 Hz.
Changing the max. value from 500 Hz to 120 Hz is done by setting parameter 1**.** 2 = 119 Hz when the drive is stopped.

1. 3, 1. 4 Acceleration time 1, deceleration time 1:

These limits correspond to the time required for the output frequency to accelerate from the set minimum frequency (par. 1**.** 1) to the set maximum frequency (par. 1**.** 2).

1. 5 Reference selection

0 Analog voltage reference from terminals 2—3, e.g. a potentiometer
1 Analog current reference trom terminals 4—5, e.g. a transducer.
2 Reference is formed by adding the values of the analog inputs
3 Reference is formed by subtracting the voltage input (V_{in}) value from the current input (I_{in}) value.
4 Reference is formed by subtracting the current input (I_{in}) value from the voltage input (V_{in}) value.
5 Reference is the formed by multiplying the values of the analog inputs
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

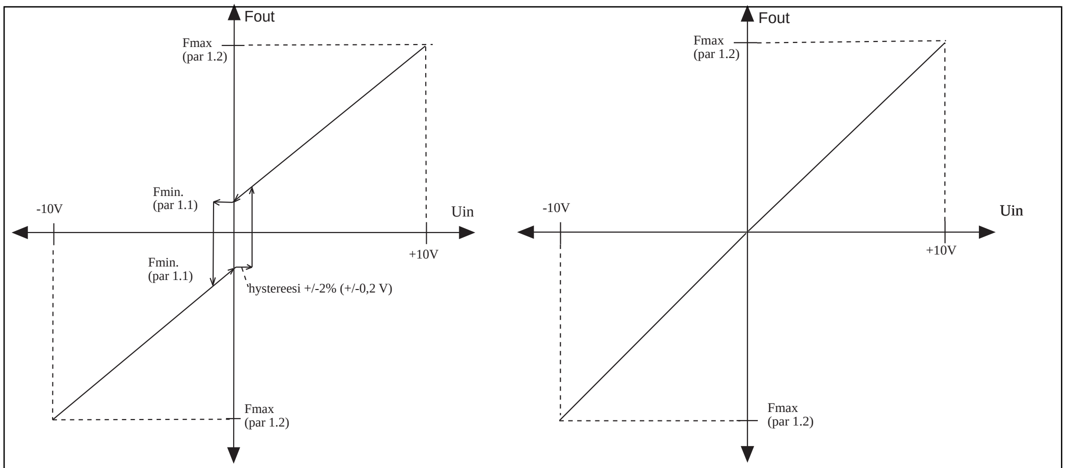
Warning! Use only the -10V—+10 V signal range. If a custom or 0—10 V signal range is used, the drive starts to run at the max. reverse speed if the reference signal is lost.

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 only the 4—20 mA signal range. If a custom or 0—20 mA signal range is used, the drive runs at max. reverse speed if the control signal is lost. Set the reference fault (par. 7**.** 2) active when the 4—20 mA range is used, then the drive will stop with a reference fault if the reference signal is lost.

Note! When joystick control is used, the direction control is generated from the joystick reference signal. See figure 5.4-1.
Analog input scaling, parameters 2**.** 16—2**.** 19, is not used when joystick control is used.



If minimum frequency (par 1**.** 1) >0, hysteresis is ± 2% at reversing point.

If minimum frequency (par 1**.** 1) = 0, there is no hysteresis at reversing point.

Fig. 5-1 Joystick control Vin signal -10 V—+10 V.

8 Reference value is changed with digital input signals DIA4 and DIA5.
- switch in DIA3 closed = frequency reference increases
- switch in DIA4 closed = frequency reference decreases
Speed of reference change can be set with parameter 2**.** 20.

9 Same as setting 8 but the reference value is set to the minimum frequency (par. 1**.** 1) each time the drive is stopped.

10 Same as setting 8 but the reference is stored in memory over a utility break. When the value of parameter 1**.** 5 is set to 8, 9 or 10, the value of the parameters 2**.** 4 and 2**.** 5 is automatically set to 11.

11 The smaller of signals Vin and Iin is the frequency reference

12 The greater of signals Vin and Iin is the frequency reference

13 Panel reference r1 is the frequency reference

1. 6 Jog speed reference

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

1. 7 Current limit

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

1. 8 V/Hz 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. See figure 5-2. 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.

Squared: **1** The voltage of the motor changes following a squared curve form with the frequency in the area from 0 Hz to the field weakening point (par. 6. 3) where the nominal voltage is also supplied to the motor. See figure 5-2.
The motor runs undermagnetised below the field weakening point and produces less torque and electromechanical noise. Squared V/Hz ratio can be used in applications where torque demand of the load is proportional to the square of the speed, e.g. in centrifugal fans and pumps.

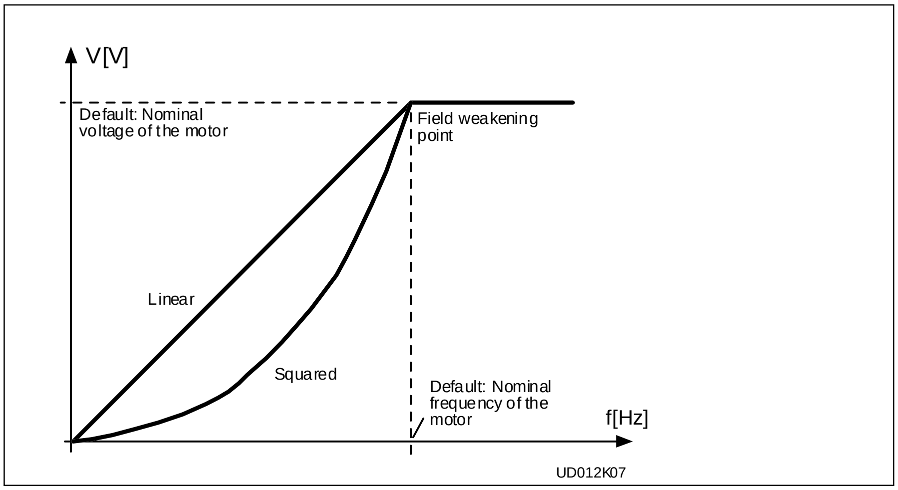


Figure 5-2 Linear and squared V/Hz curves.

Programm. V/Hz curve **2** The V/Hz curve can be programmed with three different points. The parameters for programming are explained in the chapter 5.5.2. Programmable V/Hz curve can be used if the other settings do not satisfy the needs of the application. See figure 5 -3.

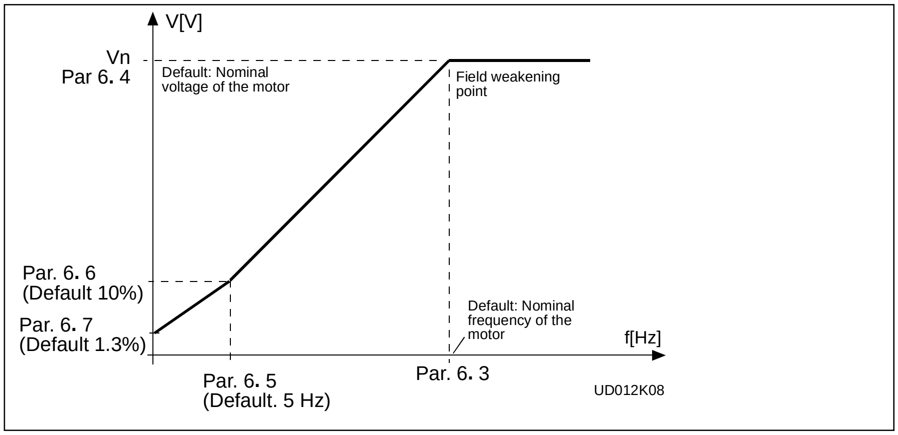


Figure 5-3 Programmable V/Hz curve.

1.9 V/Hz optimisation

Automatic torque — The voltage to the motor changes automatically which makes the motor produce sufficient torque to start and run at low frequencies. The boost voltage 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, e.g. in conveyors.

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 the 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}.

Note! If the nominal motor voltage is lower than the supply voltage, check that the insulation level of the motor is adequate.

1. 11 Nominal frequency of the motor

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

1. 13 Nominal current of the motor

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

1. 14 Supply voltage

Set the parameter value according to the nominal voltage of the supply.
Values are predefined for voltage codes 2, 4, 5 and 6. See table 5-1.

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

Allows parameter value changes:

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

6 Special parameters, Groups 2—10

6.1 Parameter tables

Group 2, Input signal parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
2.1	Start/Stop logic selection	0—3	1	0		DIA1 / DIA2 0 = Start forward / Start reverse 1 = Start/Stop / Reverse 2 = Start/Stop / Run enable 3 = Start pulse / Stop pulse 4 = Start/stop pulse / Run enable	19
2.2	DIA3 function (terminal 10)	0—9	1	7		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acc./dec. time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc./dec. operation prohibit 9 = DC-braking command 10 = Torque control	20
2.3	DIB4 function (terminal 14)	0—10	1	6		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acc./dec. time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc./dec. operation prohibit 9 = DC-braking command 10 = Multi-Step speed select 1	22
2.4	DIB5 function (terminal 15)	0—11	1	1		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acc./dec. time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc./dec. operation prohibit 9 = DC-braking command 10 = Multi-Step speed select 2 11 = Motorised pot. speed up	22
2.5	DIB6 function (terminal 16)	0—11	1	4		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acc./dec. time selection 5 = Reverse 6 = Jog speed 7 = Fault reset 8 = Acc./dec. operation prohibit 9 = DC-braking command 10 = Multi-Step speed select 3 11 = Motorised pot. speed down 12 = Auto	22
2.6	V_{in} signal range	0—2	1	0		0 = 0—10 V 1 = Custom setting range 2 = -10—+10 V (can be used only with Joystick control)	22

(Continues)

Code	Parameter	Range	Step	Default	Custom	Description	Page
2.7	V_{in} custom setting min.	0—100%	0.01%	0.00%			22
2.8	V_{in} custom setting max.	0—100%	0.01%	100.00%			22
2.9	V_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	22
2.10	V_{in} signal filter time	0—10s	0.01s	0.1s		0 = No filtering	22
2.11	I_{in} signal range	0—2	1	0		0 = 0—20 mA 1 = 4—20 mA 2 = Custom setting range	23
2.12	I_{in} custom setting minim.	0—100%	0.01%	0.00%			23
2.13	I_{in} custom setting maxim.	0—100%	0.01%	100.00%			23
2.14	I_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	23
2.15	I_{in} signal filter time	0—10s	0.01s	0.1s		0 = No filtering	23
2.16	V_{in} minimum scaling	-320,00%— +320,00 %	0%	0,01		0% = no minimum scaling	23
2.17	V_{in} maximum scaling	-320,00%— +320,00 %	100%	0,01		100% = no maximum scaling	23
2.18	I_{in} minimum scaling	-320,00%— +320,00 %	0%	0,01		0% = no minimum scaling	23
2.19	I_{in} maximum scaling	-320,00%— +320,00 %	100%	0,01		100% = no maximum scaling	23
2.20	Free analog input, signal selection	0—4	1	0		0 = Not use 1 = V_{in} (analog voltage input) 2 = I_{in} (analog current input) 3 = Ain1 (option board) 4 = Ain2 (option board)	24
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 decel. times 4 = Reduces torque supervis. limit	24
2.22	Motorised potentiometer ramp time	0.1—2000.0 Hz/s	0.1 Hz/s	10.0 Hz/s			25
2.23	Option board Ain1 signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	25
2.24	Option board Ain1 signal filter time	0—10s	0.01s	0.1s		0 = No filtering	25
2.25	Option board Ain2 signal signal range	0—2	1	0		0 = 0—20 mA 1 = 4—20 mA 2 = 0—10 V	25
2.26	Option board Ain2 signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	25
2.27	Option board Ain2 signal filter time	0 —10s	0.01s	0.1s		0 = No filtering	25

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

(Continues)

Group 3, Output and supervision parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
3.1	Analog output function	0—11	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_{nSV9}) 4 = Motor torque (0—2 x T_{nSV9}) 5 = Motor power (0—2 x P_{nSV9}) 6 = Motor voltage (0—100% x U_{nM}) 7 = DC-link volt. (0—1000 V) 8 = Input signal Vin 9 = Input signal Iin 10 = Reference frequency 11 = Reference torque	26
3.2	Analog outp. filter time	0.01—10 s	0.01	1.00			26
3.3	Analog outp. inversion	0—1	1	0		0 = Not inverted 1 = Inverted	26
3.4	Analog output minimum	0—1	1	0		0 = 0 mA 1 = 4 mA	26
3.5	Analog output scale	10—1000%	1%	100%			26
3.6	Digital output function	0—22	1	1		0 = Not used 1 = Ready 2 = Run 3 = Fault 4 = Fault inverted 5 = HV9000 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 freq. limit superv. 1 14 = Output freq. limit superv. 2 15 = Torque limit supervision 16 = Reference limit supervision 17 = External brake control 18 = Control from I/O terminals 19 = Drive temperature limit supervision 20 = Unrequested rotation direction 21 = External brake control inverted 22 = Termistor fault or warning	27
3.7	Relay output 1 function	0—21	1	2		As parameter 3.6	27
3.8	Relay output 2 function	0—21	1	3		As parameter 3.6	27
3.9	Output freq. limit 1 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	27
3.10	Output freq. limit 1 supervision value	0—f_{max} (par. 1.2)	0.1 Hz	0 Hz			27
3.11	Output freq. limit 2 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	27
3.12	Output freq. limit 2 supervision value	0—f_{max} (par. 1.2)	0.1 Hz	0 Hz			27

Code	Parameter	Range	Step	Default	Custom	Description	Page
3. 13	Torque limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	28
3. 14	Torque limit supervision value	0—200% xT_{nSV9}	1%	100%			28
3. 15	Reference limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	28
3. 16	Reference limit supervision value	0—f_{max} (par. 1. 2)	0.1 Hz	0 Hz			28
3. 17	Extern. brake Off-delay	0—100.0 s	0.1 s	0.5 s			28
3. 18	Extern. brake On-delay	0—100.0 s	0.1 s	1.5 s			28
3. 19	Drive temperature limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	28
3. 20	Drive temperature limit value	-10—+75°C	1°C	+40°C			28
3. 21	I/O-expander board (opt.) analog output content	0—9	1	3		See parameter 3. 1	26
3. 22	I/O-expander board (opt.) analog output filter time	0.01—10 s	0.01	1.00		See parameter 3. 2	26
3. 23	I/O-expander board (opt.) analog output inversion	0—1	1	0		See parameter 3. 3	26
3. 24	I/O-expander board (opt.) analog output minimum	0—1	1	0		See parameter 3. 4	26
3. 25	I/O-expander board (opt.) analog output scale	10—1000%	1	100%		See parameter 3. 5	26
3. 26	Analog output offset (basic control board)	-100—100,0%	1	100%			29
3. 27	I/O-expander board (opt.) analog output offset	-100—+100,0%	1	100%			29
3. 28	Digital output DO1 on delay	0—320,00s	0,01	0,00		0,00 = delay not in use	29
3. 29	Digital output DO1 off delay	0—320,00s	0,01	0,00		0,00 = delay not in use	29
3. 30	Relay output RO1 on delay	0—320,00s	0,01	0,00		0,00 = delay not in use	29
3. 31	Relay output RO1 off delay	0—320,00s	0,01	0,00		0,00 = delay not in use	29
3. 32	Relay output RO1 on delay	0—320,00s	0,01	0,00		0,00 = delay not in use	29
3.33	Relay output RO2 off delay	0—320,00s	0,01	0,00		0,00 = delay not in use	29

Group 4, Drive control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
4. 1	Acc./Dec. ramp 1 shape	0—10 s	0.1 s	0		0 = Linear >0 = S-curve acc./dec. time	30
4. 2	Acc./Dec. ramp 2 shape	0—10 s	0.1 s	0		0 = Linear >0 = S-curve acc./dec. time	30
4. 3	Acceleration time 2	0.1—3000 s	0.1 s	10 s			31
4. 4	Deceleration time 2	0.1—3000 s	0.1 s	10 s			31
4. 5	Brake chopper (STOP)	0—1	1	0		0 = Brake chopper not in use 1 = Brake chopper in use 2 = External brake chopper	31
4. 6	Start function	0—1	1	0		0 = Ramp 1 = Flying start	31
4. 7	Stop function	0—1	1	0		0 = Coasting 1 = Ramp	31
4. 8	DC-braking current	0.15—1.5 x I_{nSV9} (A)	0.1 A	0.5 x I_{nSV9}			31
4. 9	DC-braking time at Stop	0—250.0 s	0.1 s	0 s		0 = DC-brake is off at Stop	32
4. 10	Execute freq. of DC-brake during ramp Stop	0.1—10 Hz	0.1 Hz	1.5 Hz			33
4. 11	DC-brake time at Start	0.0—25.0 s	0.1 s	0 s		0 = DC-brake is off at Start	33
4. 12	Multi-step speed reference 1	f_{min} —f_{max} (1. 1) (1. 2)	0.1 Hz	10 Hz			33
4. 13	Multi-step speed reference 2	f_{min} —f_{max} (1. 1) (1. 2)	0.1 Hz	15 Hz			33
4. 14	Multi-step speed reference 3	f_{min} —f_{max} (1. 1) (1. 2)	0.1 Hz	20 Hz			33
4. 15	Multi-step speed reference 4	f_{min} —f_{max} (1. 1) (1. 2)	0.1 Hz	25 Hz			33
4. 16	Multi-step speed reference 5	f_{min} —f_{max} (1. 1) (1. 2)	0.1 Hz	30 Hz			33
4. 17	Multi-step speed reference 6	f_{min} —f_{max} (1. 1) (1. 2)	0.1 Hz	40 Hz			33
4. 18	Multi-step speed reference 7	f_{min} —f_{max} (1. 1) (1. 2)	0.1 Hz	50 Hz			33

Note! (STOP) = Parameter value can be changed only when the drive 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			33
5. 2	Prohibit frequency range 1 high limit	0—f_{max} (1. 2)	0.1 Hz	0 Hz		0 = Prohibit range 1 is off	33
5. 3	Prohibit frequency range 2 low limit	0—f_{max} (1. 2)	0.1 Hz	0 Hz			33
5. 4	Prohibit frequency range 2 high limit	0—f_{max} (1. 2)	0.1 Hz	0 Hz		0 = Prohibit range 2 is off	33
5. 5	Prohibit frequency range 3 low limit	0—f_{max} (1. 2)	0.1 Hz	0 Hz			33
5. 6	Prohibit frequency range 3 high limit	0—f_{max} (1. 2)	0.1 Hz	0 Hz		0 = Prohibit range 3 is off	33

Group 6, Motor control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
6. 1	Motor control mode STOP	0—2	1	0		0 = Frequency control 1 = Speed control (open loop) 2 = Torque control (open loop)	33
6. 2	Switching frequency	1—16 kHz	0.1 kHz	10/3.6 kHz		Depending on HP	34
6. 3	Field weakening point STOP	30—500 Hz	1 Hz	Param. 1. 11			34
6. 4	Voltage at field weakening point STOP	15 —200% x U_{nmot}	1%	100%			34
6. 5	V/HZ-curve mid point frequency STOP	0—500 Hz	0,1 Hz	0 Hz			34
6. 6	V/HZ-curve mid point voltage STOP	0—100% x U_{nmot}	0.01%	0 %			34
6. 7	Output voltage at zero frequency STOP	0—100% x U_{nmot}	0.01%	0 %			34
6. 8	Overvoltage controller STOP	0—1	1	1		0 = Controller is not operating 1 = Controller is operating	35
6. 9	Undervoltage controller	0—1	1	1		0 = Controller is not operating 1 = Controller is operating	35

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

Group 7, Protections

Code	Parameter	Range	Step	Default	Custom	Description	Page
7.1	Response to reference fault	0—2	1	0		0 = No action 1 = Warning 2 = Fault, stop according to par 4.7 3 = Fault, stop always by coasting	35
7.2	Response to external fault	0—2	1	2		0 = No action 1 = Warning 2 = Fault, stop according to par 4.7 3 = Fault, stop always by coasting	35
7.3	Phase supervision of the motor	0—2	2	2		0 = No action 2 = Fault	35
7.4	Earth fault protection	0—2	2	2		0 = No action 2 = Fault	35
7.5	Motor thermal protection	0—2	1	2		0 = No action 1 = Warning 2 = Fault	36
7.6	Motor thermal protection break point current	50.0—150 % x I_{nMOTOR}	1.0 %	100.0%			36
7.7	Motor thermal protection zero frequency current	10.0—150% x I_{nMOTOR}	1.0 %	45.0%			37
7.8	Motor thermal protection time constant	0.5—300.0 minutes	0,5 min.			Default value is set according to motor nominal current	37
7.9	Motor thermal protection break point frequency	10—500 Hz	1 Hz	35 Hz			38
7.10	Stall protection	0—2	1	1		0 = No action 1 = Warning 2 = Fault	38
7.11	Stall current limit	10.0—200% x I_{nMOTOR}	1.0%	130.0%			39
7.12	Stall time	2.0—120 s	1.0 s	15.0 s			39
7.13	Maximum stall frequency	1—f_{max}	1 Hz	25 Hz			39
7.14	Underload protection	0—2	1	0		0 = No action 1 = Warning 2 = Fault	40
7.15	Underload prot., field weakening area load	20.0—150 % x T_{nMOTOR}	1.0%	50.0%			40
7.16	Underload protection, zero frequency load	10.0—150.0% x T_{nMOTOR}	1.0%	10.0%			40
7.17	Underload time	2.0—600.0 s	1.0 s	20.0s			40
7.18	Phase supervision of the supply voltage	0—2	2	2		0 = No action 2 = Fault	41
7.19	Termistor input of I/O-Expander	0—2	1	2		0 = No action 1 = Warning 2 = Fault	41
7.20	Response to fieldbus fault	0 - 2	1	0		0 = Not used 1 = Warning 2 = Fault	41

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	41
8.2	Automatic restart: trial time	1—6000 s	1 s	30 s			41
8.3	Automatic restart: start function	0—1	1	0		0 = Ramp 1 = Flying start	42
8.4	Automatic restart of undervoltage	0—1	1	0		0 = No 1 = Yes	42
8.5	Automatic restart of overvoltage	0—1	1	0		0 = No 1 = Yes	42
8.6	Automatic restart of overcurrent	0—1	1	0		0 = No 1 = Yes	42
8.7	Automatic restart of reference fault	0—1	1	0		0 = No 1 = Yes	42
8.8	Automatic restart after over/undertemperature fault	0—1	1	0		0 = No 1 = Yes	42

Group 9, Torque Control

Code	Parameter	Range	Step	Default	Custom	Description	Page
9.1	Torque reference selection	0—2	1	0		0 = None 1 = V_{in} 2 = I_{in}	43
9.2	Torque reference scaling bias	-100%—+100%	1	0		0 = not in use	43
9.3	Torque reference scaling gain	-320%—+320%	1	100		100 = no scaling	43
9.4	TC time constant	1—1000 ms	1 ms	128 ms			43
9.5	TC min. control limit	0—10.00 Hz	0.01 Hz	3.00 Hz			43

Group 10, Fieldbus parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
10. 1	Fieldbus control select	0—1	1	0		0 = Control via I/O terminals 1 = Control via Fieldbus board	44
10. 2	DIC1 function (term. 301, fieldbus board)	0—1	0	1		0 = Fieldbus control 1 = External fault	44
10. 3	MODBUS Slave address	1—247	1	1		Modbus/N2 slave address	44
10. 4	Baud rate	1—7	1	6		1 = 300 baud 2 = 600 baud 3 = 1200 baud 4 = 2400 baud 5 = 4800 baud 6 = 9600 baud 7 = 19200 baud	44
10. 5	MB Parity type	0—2	1	0		0 = None 1 = Even 2 = Odd	44
10. 6	Modbus time-out *	0—3600 s	1 s	0 s		0 = No time-out	44
10.7	Profibus slave address *	2—126	1	2			44
10.8	Profibus baud rate *	1—10	1	10		1 = 9.6 kbaud 2 = 19.2 kbaud 3 = 93.75 kbaud 4 = 187.5 kbaud 5 = 500 kbaud 6 = 1.5 Mbaud 7 = 3 Mbaud 8 = 6 Mbaud 9 = 12 Mbaud 10 = AUTO	45
10.9	Profibus PPO Type *	1—4	1	1		1 = PPO 1 2 = PPO 2 3 = PPO 3 4 = PPO 4	45
10.10	Profibus Process Data 1*	0—99	1	1			45
10.11.	Profibus Process Data 2 *	0—99	1	2			45
10.12	Profibus Process Data 3 *	0—99	1	3			45
10.13	Profibus Process Data 4 *	0—99	1	99			45
10.14	LonWorks Service Button*	0—1	1	0			45

*Note: These parameters are not used in N2 fieldbus applications

Table 6-1 Special parameters, Groups 2-10

6.2 Description of Groups 2—10 parameters

2. 1 Start/Stop logic selection

0: DIA1: closed contact = start forward
DIA2: closed contact = start reverse,
See figure 6-1.

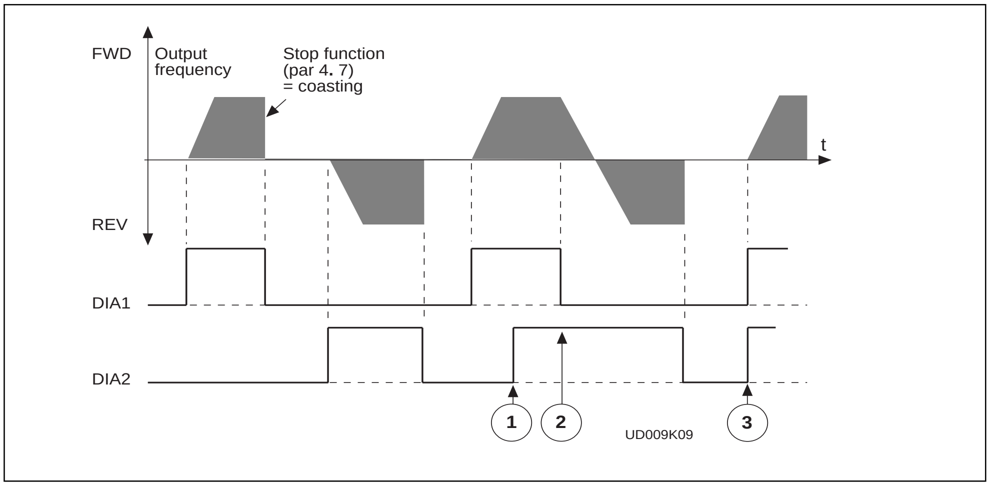


Figure 6-1 Start forward/Start reverse.

1. The first selected direction has the highest priority
2. When DIA1 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 6-2.

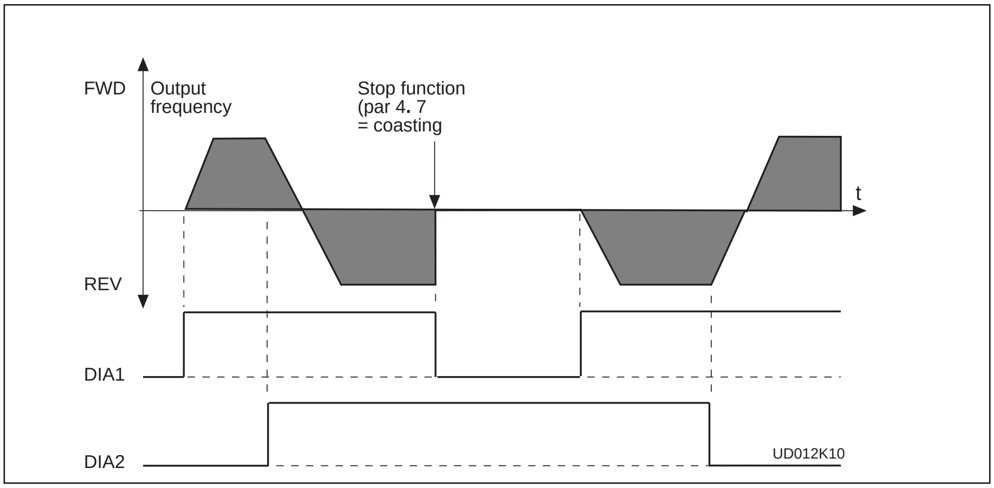


Figure 6-2 Start, Stop,reverse.

2: DIA1: closed contact = start open contact = stop
DIA2: closed contact = start enabled open contact = start disabled

3: 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

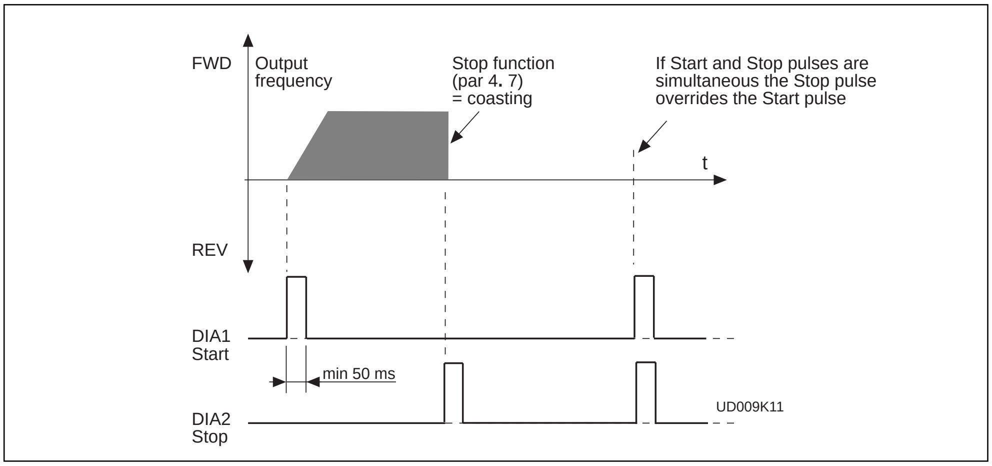


Figure 6.3 Start pulse / Stop pulse

4: DIA1: closed contact = start/stop pulse
DIA2: closed contact = start enabled

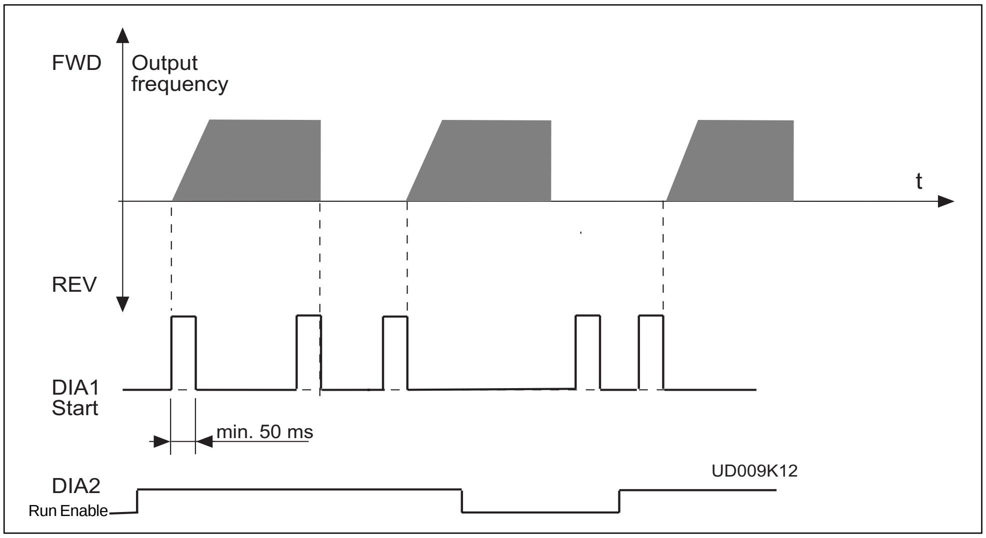


Figure 6-4. Start / Stop pulse, Run enable.

2.2 DIA3 function

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: Reverse contact open = Forward || Can be used for reversing if
contact closed = Reverse || parameter 2.1 has value 3
6: Jog. speed contact closed = Jogging speed selected for freq. reference
7: Fault reset contact closed = Resets all faults
8: Acc./Dec. operation prohibited
contact closed = Stops acceleration or deceleration until the contact is opened
9: DC-braking command
contact closed = In Stop mode, the DC-braking operates until the contact is opened, see figure 5.6-4. DC-brake current is set with parameter 4.8.
10: Torque control
contact closed = Forces the motor control mode to torque control, see par. 6.1

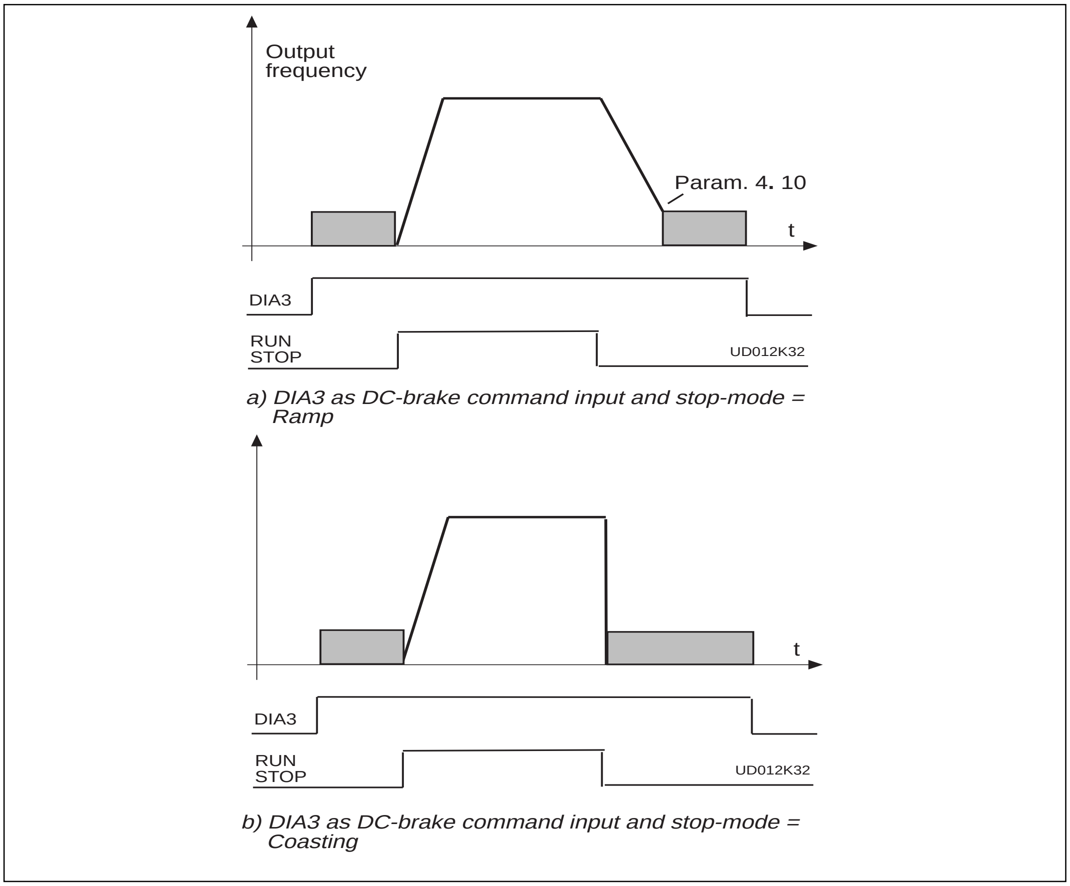


Figure 6-5 DIA3 as DC-brake command input: a) Stop-mode = Ramp, b) Stop-mode = Coasting.

2.3 DIB4 function

Selections are same as in 2. 2 except :

10: Multi-Step speed select 1 — contact closed = Selection 1 active

2.4 DIB5 function

Selections are same as in 2. 2 except :

10: Multi-Step speed select 2 — contact closed = Selection 2 active

11: Motor pot. UP — contact closed = Reference decreases until the contact is opened

2.5 DIB6 function

Selections are same as in 2. 2 except :

10: Multi-Step speed select 3 — contact closed = Selection 3 active

11: Motor pot. DOWN — contact closed = Reference decreases until the contact is opened

2. 6 V_{in} signal range

0 = Signal range 0—+10 V
1 = Custom setting range from custom minimum (par. 2. 4) to custom maximum (par. 2. 5)
2 = Signal range -10—+10 V , can be used only with Joystick control

2. 7-2. 8 V_{in} custom setting minimum/maximum

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. 4, press the Enter button

Maximum setting: Set the V_{in} signal to its maximum level, select parameter 2. 5, press the Enter button

Note! These parameters can only be set with this procedure (not with the arrow up/ arrow down buttons)

2. 9 V_{in} signal inversion

Parameter 2. 9 = 0, no inversion of the analog V_{in} signal.

Parameter 2. 9 = 1, inversion of the analog V_{in} signal.

2. 10 V_{in} signal filter time

Filters out disturbances from the incoming analog V_{in} signal. Long filtering time makes regulation response slower. See figure 6-6.

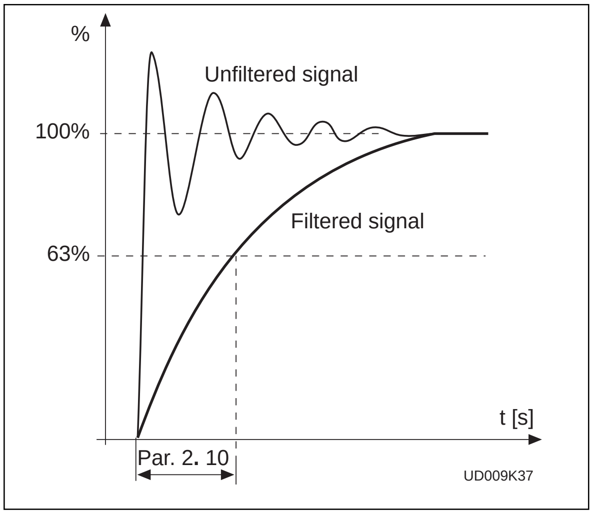


Figure 6-6 V_{in} signal filtering.

2. 11 Analog input I_{in} signal range

0 = 0—20 mA
1 = 4—20 mA
2 = Custom signal span

2. 12 Analog input I_{in} custom
2. 13 setting minimum/maximum

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

Minimum setting:
Set the I_{in} signal to its minimum level, select parameter 2. 12, press the Enter button.

Maximum setting:
Set the I_{in} signal to its maximum level, select parameter 2. 13, press the Enter button.

Note! These parameters can only be set with this procedure (not with the arrow up/ arrow down buttons)

2. 14 Analog input I_{in} inversion

Parameter 2. 14 = 0, no inversion of the I_{in} input
Parameter 2. 14 = 1, inversion of the I_{in} input.

2. 15 Analog input I_{in} filter time

Filters out disturbances from the incoming analog I_{in} signal.
Long filtering time makes control response slower. See figure 6-7.

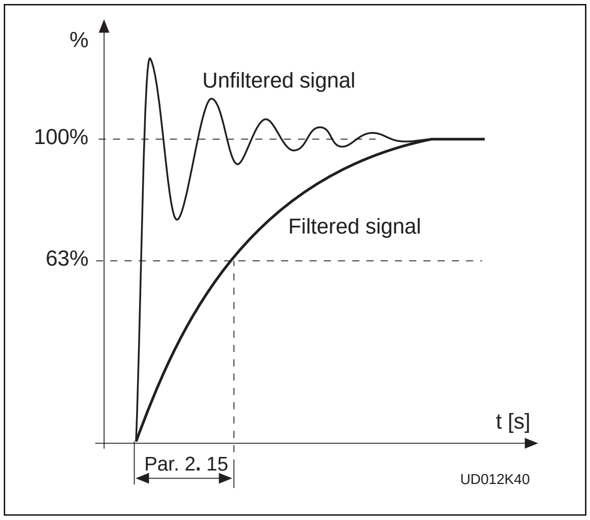


Figure 6-7 Analog input I_{in} filter time

2. 16 V_{in} signal minimum scaling

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

2. 17 V_{in} signal maximum scaling

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

2. 18 I_{in} signal minimum scaling

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

2. 19 I_{in} signal maximum scaling

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

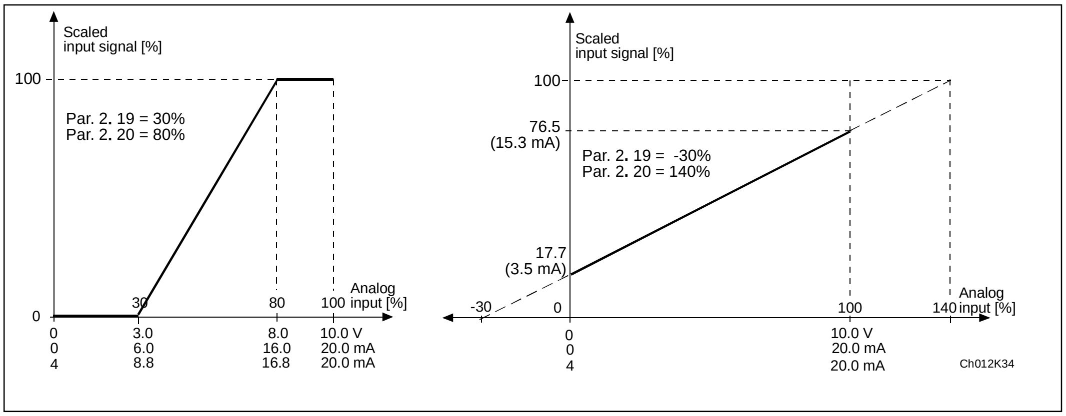


Figure 6-8 Examples of the scaling of V_{in} and I_{in} inputs .

2. 20 Free analog input signal

Selection of input signal of the free analog input (an input not used as a reference signal):

0 = Not in use
1 = Voltage signal V_{in}
2 = Current signal I_{in}
3 = Voltage signal Ain1 from terminals 202-203 of I/O Expander
4 = Analog signal Ain2 from terminals 204-205 of I/O Expander
- current signal SV9IOC100CN
- voltage signal SV9IOC102CN

2. 21 Free analog input signal function

This parameter sets the function of the free analog input:

0 = Function is not used

1 = Reducing motor current limit (par. 1. 7). This signal will adjust the maximum motor current between 0 and parameter max. limit set with parameter 1.7. See figure 6-9.

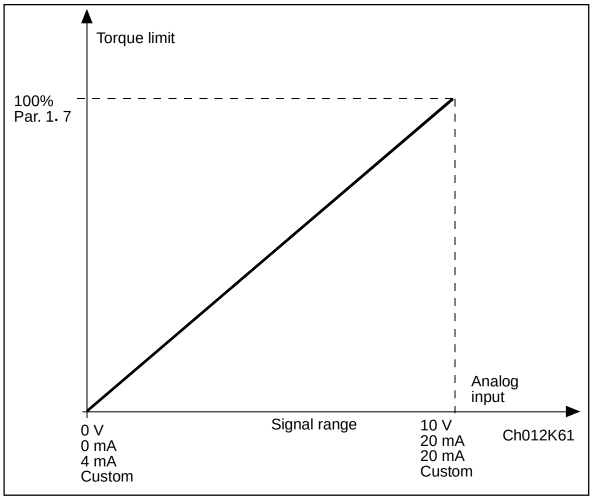


Figure 6-9 Reducing max. motor current.

2 = Reducing DC brake current.

The DC braking current can be reduced with the free analog input signal, between $0.15xI_{nSV9}$ and current set with parameter 4. 8. See figure 6-10.

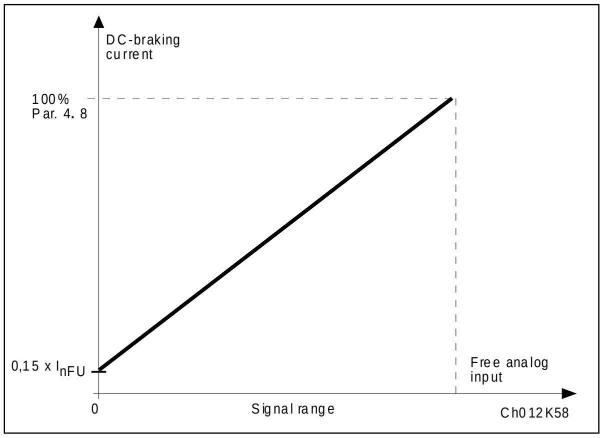


Figure 6-10 Reducing DC brake current.

3 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./deceler. time (par. 1. 3, 1. 4; 4. 3, 4. 4) divided by the factor R from figure 6-11.

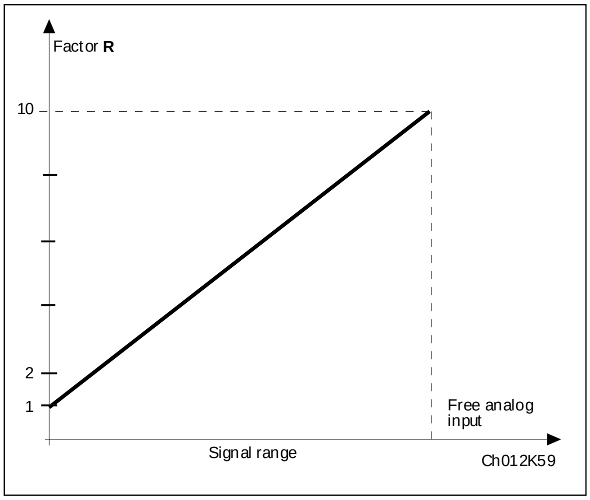


Figure 6-11 Reducing acceleration and deceleration times.

4 Reducing torque supervision limit.

The set torque supervision limit can be reduced with the free analog input signal between 0 and set supervision limit (par. 3. 14), see figure 6-12.

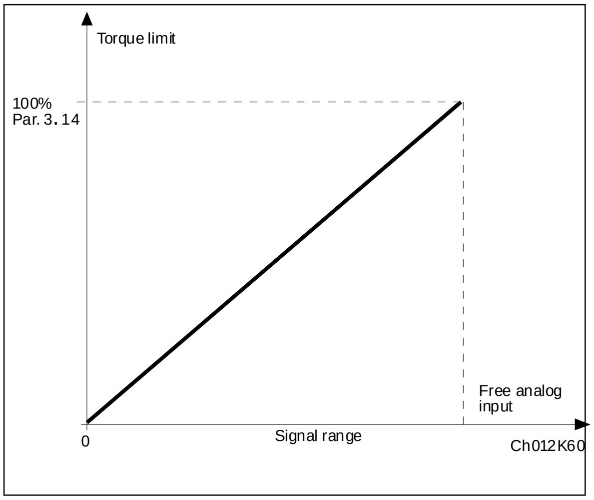


Figure 6-12 Reducing torque supervision limit

2. 22 Motor potentiometer ramp time

Defines how fast the electronic motor potentiometer value changes.

2.23 Ain1 signal inversion (I/O-Expander)

Parameter 2.30 = 0, no inversion

2.24 Ain1 signal filter time

Filters out disturbances from the incoming analog Ain1 signal.
Long filtering time makes control response slower.

2.25 Ain2 input (I/O-Expander) signal range

0 = 0—20 mA
1 = 4—20 mA
2 = 0—10 V (must be used with SV9IOC102CN)

2.26 Ain2 signal inversion (I/O-Expander)

Parameter 2.26 = 0, no inversion

2.27 Ain2 signal filter time (I/O-Expander)

Filters out disturbances from the incoming analog Ain2 signal.
Long filtering time makes control response slower.

3. 1 Analog output function

See table on page 12.

3. 2 Analog output filter time

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

3.3 Analog output invert

Inverts the analog output signal:

max. output signal = minimum set value

min. output signal = maximum set value

3. 4 Analog output minimum

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

3. 5 Analog output scale

Scaling factor for the analog output. See figure 6-15.

Signal	Max. value of the signal
Output fre-quency	Max. frequency (p. 1. 2)
Motor speed	Max. speed ($n_n x f_{max}/f_n$)
Output current	2 x I_{nSV9}
Motor torque	2 x T_{nSV9}
Motor power	2 x P_{nSV9}
Motor voltage	100% x V_{nmotor}
DC-link volt.	1000 V
Vin signal	Max Vin
Iin signal	Max Iin

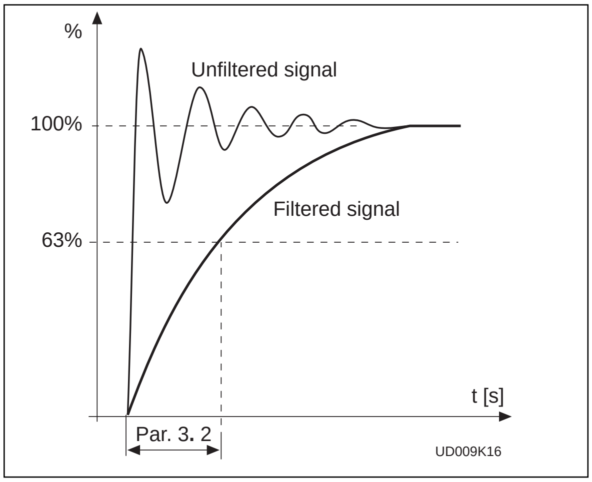


Figure 6-13 Analog output filtering.

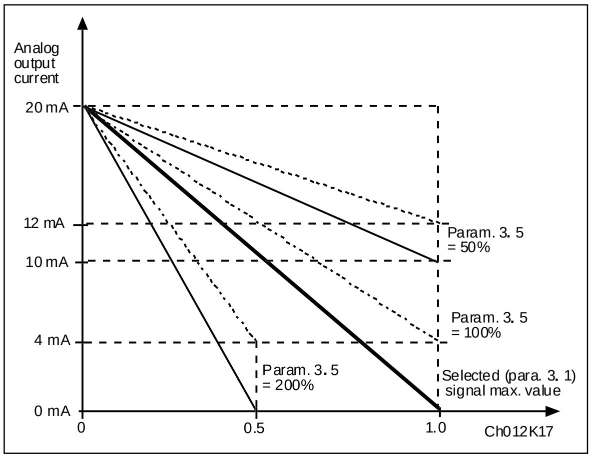


Figure 6-14 Analog output invert.

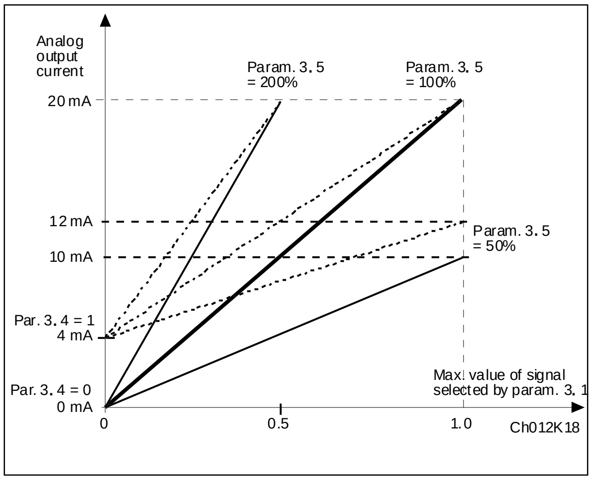


Figure 6-15 Analog output scale.

3. 6 Digital output function
3. 7 Relay output 1 function
3. 8 Relay output 2 function

Setting value	Signal content
0 = Not used	Out of operation
	Digital output DO1 sinks the current and programmable relay (RO1, RO2) is activated when:
1 = Ready	The drive is ready to operate
2 = Run	The drive operates (motor is running)
3 = Fault	A fault trip has occurred
4 = Fault inverted	A fault trip has not occurred
5 = SV9000 overheat warning	The heat-sink temperature exceeds +70°C
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 < 4 mA
8 = Warning	Always if a warning exists
9 = Reversed	The reverse command has been selected
10 = Jog speed	Jog speed has been selected with digital input
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 of the set supervision. Low limit/ High limit (par. 3. 9 and 3. 10)
14 = Output frequency supervision 2	The output frequency goes outside of the set supervision. Low limit/ High limit (par. 3. 11 and 3. 12)
15 = Torque limit supervision	The motor torque goes outside of the set supervision. Low limit/ High limit (par. 3. 13 and 3. 14)
16 = Reference limit supervision	Reference goes outside of the set supervision. Low limit/ High limit (par. 3. 15 and 3. 16)
17 = External brake control	External brake ON/OFF control with programmable delay (par 3. 17 and 3. 18)
18 = Control from I/O terminals	External control mode selected with progr. push-button #2
19 = Drive temperature limit supervision	Temperature on drive goes outside the set supervision limits (par. 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 (par. 3.17 and 3.18), output active when brake control is OFF
22 = Thermistor fault or warning	The thermistor input of option board indicates overtemperature. Fault or warning depending on parameter 7.19

Table 6-2 Output signals via DO1 and output relays RO1 and RO2.

3. 9 Output frequency limit 1, supervision function
3. 11 Output frequency limit 2, supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision
If the output frequency goes under/over the set limit (3. 10, 3. 12) this function generates a warning message via the digital output DO1 and via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8.

3. 10 Output frequency limit 1, supervision value
3. 12 Output frequency limit 2, supervision value

The frequency value to be supervised by the parameter 3. 9 (3. 11).
See figure 6-16.

3. 13 Torque limit , supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the calculated torque value goes under/over the set limit (3. 14) this function generates a warning message via the digital output DO1, via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8.

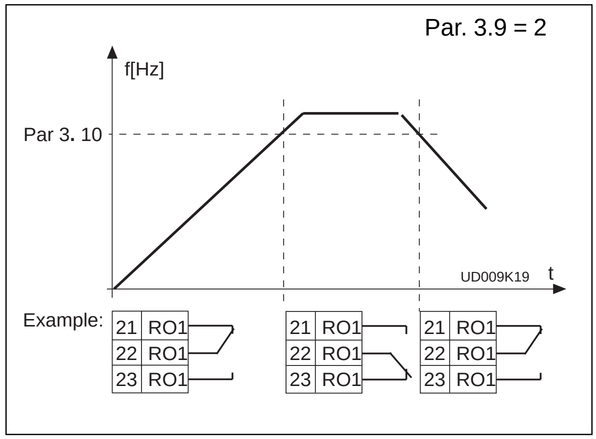


Figure 6-16 Output frequency supervision.

3. 14 Torque limit , supervision value

The calculated torque value to be supervised by the parameter 3. 13.

3. 15 Reference limit , supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the reference value goes under/over the set limit (3. 16) this function generates a warning message via the digital output DO1 or via a relay output RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8. The supervised reference is the currently active reference. It can be source A or B reference, depending on the DIB6 input, or the panel reference if the panel is the active control source.

3. 16 Reference limit , supervision value

The frequency value to be supervised by the parameter 3. 15.

3. 17 External brake-off delay
3. 18 External brake-on delay

With these parameters the timing of external brake can be linked to the Start and Stop control signals, see figure 6-17. The brake control signal can be programmed via the digital output DO1 or via one of relay outputs RO1 and RO2, see parameters 3. 6—3. 8.

3. 19 Drive temperature limit supervision function

0 = No supervision
1 = Low limit supervision
2 = High limit supervision

If the temperature of the drive goes under/over the set limit (3. 20) this function generates a warning message via the digital output DO1 or via the relay outputs RO1 or RO2 depending on the settings of the parameters 3. 6—3. 8.

3. 20 Drive temperature limit value

The temperature value to be supervised by the parameter 3. 19.3.26 Analog output offset

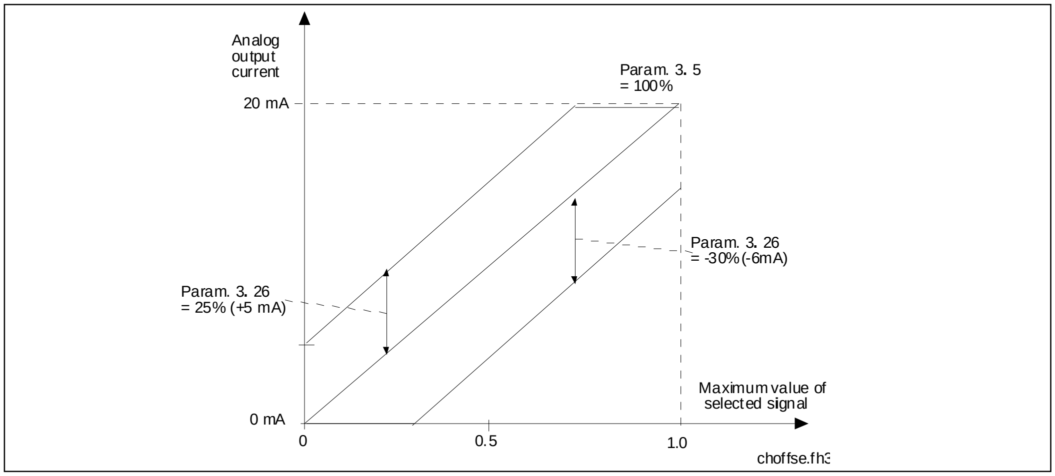


Figure 6-17. Analog output offset

3.27 I/O-Expander analog output offset

With these parameters the offsets of the basic control board and I/O-Expander analog outputs can be set. See figure 6-17.

3.28 Digital output DO1 on-delay
3.29 Digital output DO1 off-delay
3.30 Relay output RO1 on-delay
3.31 Relay output RO1 off-delay
3.32 Relay output RO2 on-delay
3.33 Relay output RO2 off-delay

With these parameters it is possible to set on- and off-delays for the digital and relay outputs. See figure 6-18.

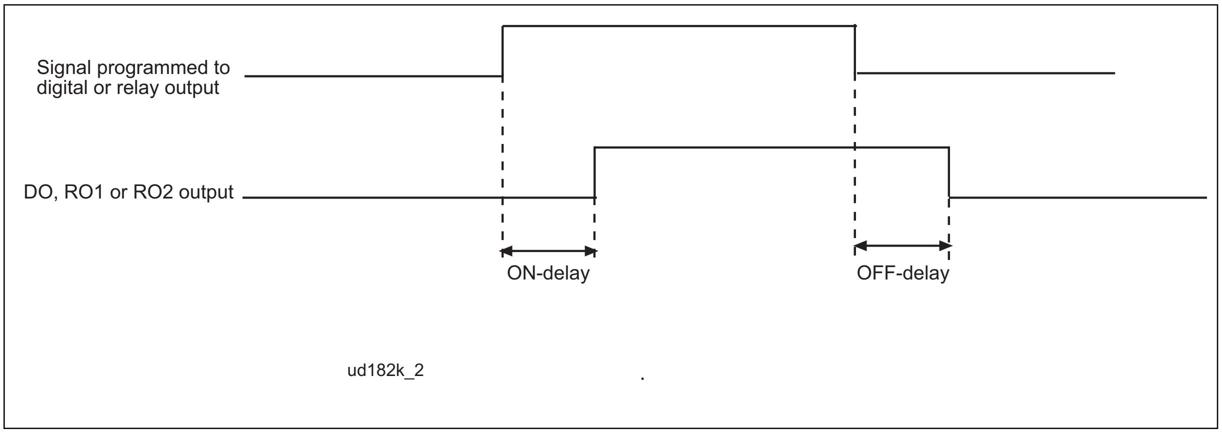


Figure 6-18. Digital and relay outputs. On- and off-delays

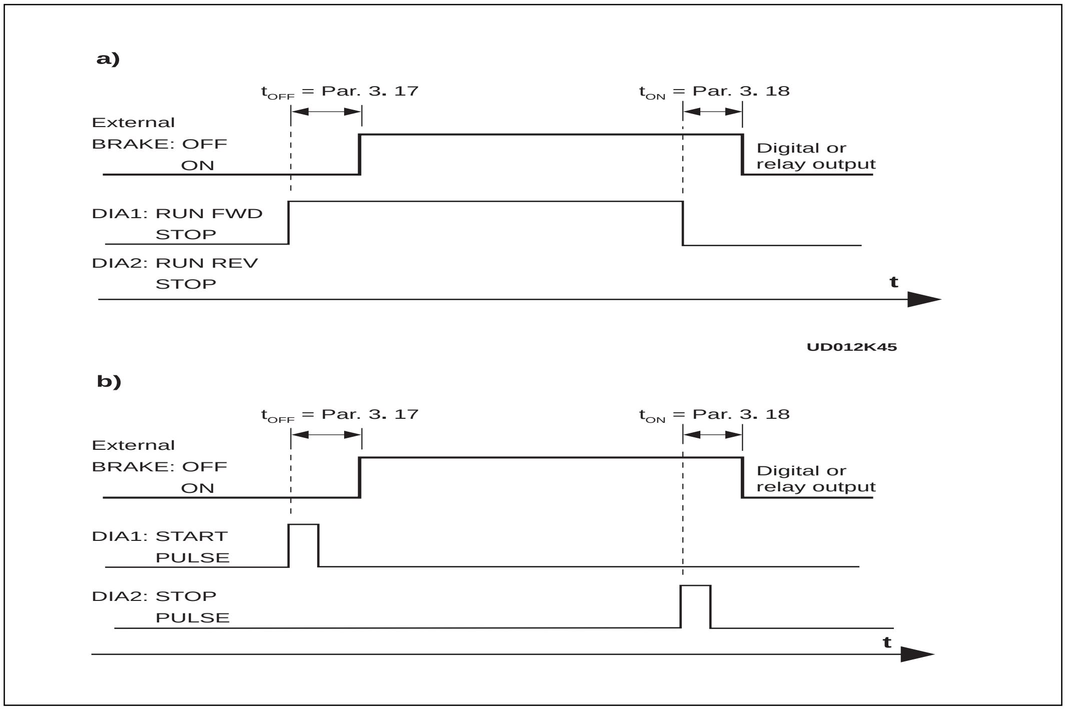


Figure 6-19 External brake control: a) Start/Stop logic selection par. 2. 1 = 0, 1 or 2 ; b)Start/Stop logic selection par. 2. 1 = 3.

4. 1 Acc/Dec ramp 1 shape
4. 2 Acc/Dec ramp 2 shape

The start and end of the acceleration and deceleration ramps can be smoothed with these parameters. Setting the value = 0 gives you a linear ramp shape. The output frequency immediately follows the input with a ramp time set by parameters 1**.** 3 and 1**.** 4 (4**.** 3 and 4**.** 4).

Setting 0.1—10 seconds for 4**.** 1 (4**.** 2) causes an S-shaped ramp. The speed changes are smooth. Parameters 1**.** 3 and 1**.** 4 (4**.** 3 and 4**.** 4) determines the ramp time of the acceleration/deceleration in the middle of the curve. See figure 6-20.

4. 3 Acceleration time 2
4. 4 Deceleration time 2

These values correspond to the time required for the output frequency to accelerate from the set minimum frequency (par. 1**.** 1) to the set maximum frequency (par. 1**.** 2). With these parameters it is possible 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**.** 18 and 2**.** 19.

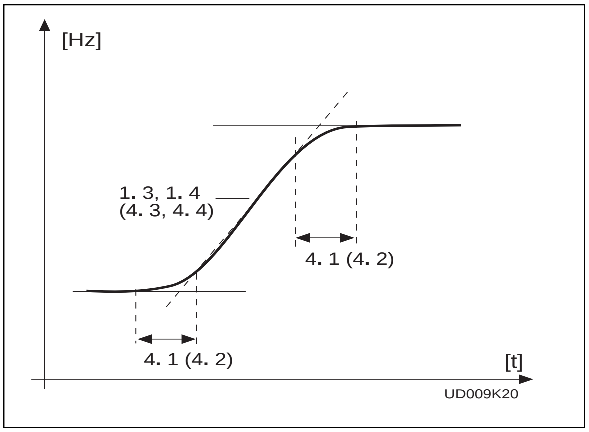


Figure 6-20 S-shaped acceleration/deceleration.

4. 5 Brake chopper

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

When the drive is decelerating the motor, the energy stored in the inertia of the motor and the load are fed into the external brake resistor. If the brake resistor is selected correctly the drive is able to brake the load with a torque equal to the e acceleration torque. See the separate Brake resistor installation manual.

4. 6 Start function

Ramp:

0 The drive starts from 0 Hz and accelerates to the set reference frequency with the set acceleration time. (Load inertia or starting friction may cause prolonged acceleration times).

Flying start:

1 The drive is able to start into a running motor by first finding the speed the motor is running at. Searching starts from the maximum frequency down until the actual frequency is reached. The output frequency then accelerates/decelerates to the set reference value at a rate set by the acceleration/deceleration ramp parameters.

Use this mode if the motor is coasting when the start command is given. With the flying start it is possible to ride through short utility voltage interruptions.

4. 7 Stop function

Coasting:

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

Ramp:

1 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

Defines the current injected into the motor during DC braking.

The DC raking current can be reduced from the setpoint with an external free analog signal, see parameters 2.20 and 2.21

4. 9 DC braking time at stop

Determines whether braking is ON or OFF. It also determines the braking duration 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, (param. 4. 7), and the time depends on the value of parameter 4. 9:

Stop-function = 0 (coasting):

After the stop command, the motor will coast to a stop with the SV9000 off.

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

The braking time is scaled according to the frequency when the DC-braking starts. If the frequency is ≥nominal frequency of the motor (par. 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 set value of parameter 4.9.

Stop-function = 1 (ramp):

After the Stop command, the speed of the motor is reduced based on deceleration parameters. If no regeneration occurs due to load inertia DC-braking starts at a speed define the parameter 4. 10.

The braking time is defined with parameter 4. 9.

If a high inertia exists, it is recommended to use an external braking resistor for faster deceleration. See figure 6-22.

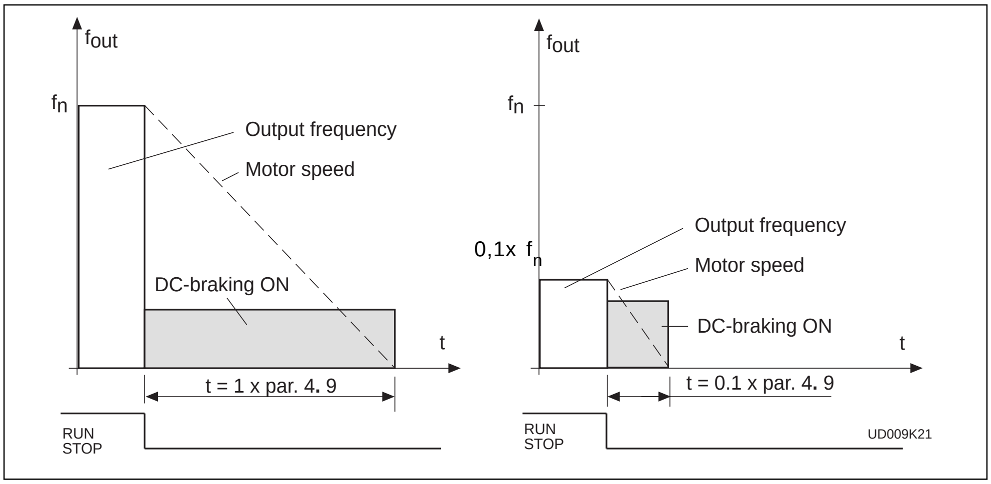


Figure 6-21 DC-braking time when stop = coasting.

4. 10 Execute frequency of DC-brake during ramp Stop

See figure 6-22.

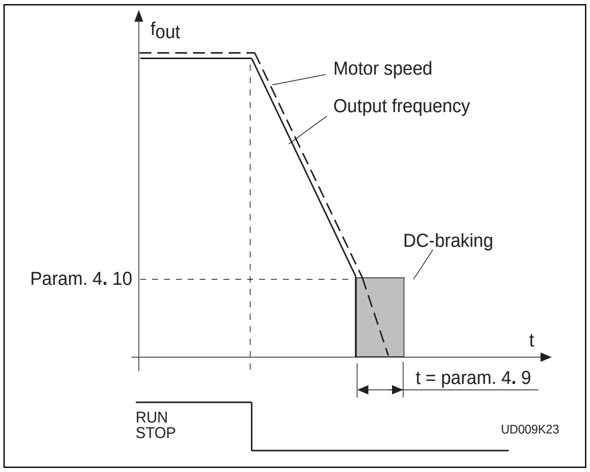


Figure 6-22 DC-braking time when stop function = ramp.

4. 11 DC-brake time at start

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.

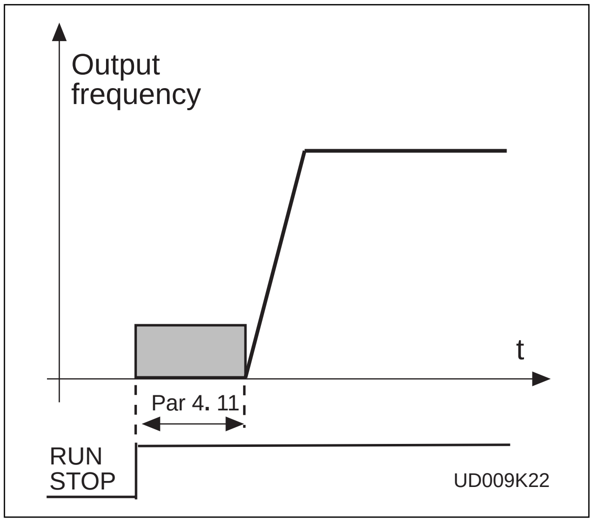


Figure 6-23 DC-braking at start

4. 12 - 4. 18 Multi-Step speeds 1-7

The parameter values define the Multi-Step speeds selected with the digital inputs.

5. 1 - 5.6 Prohibit frequency area Low limit/High limit

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.

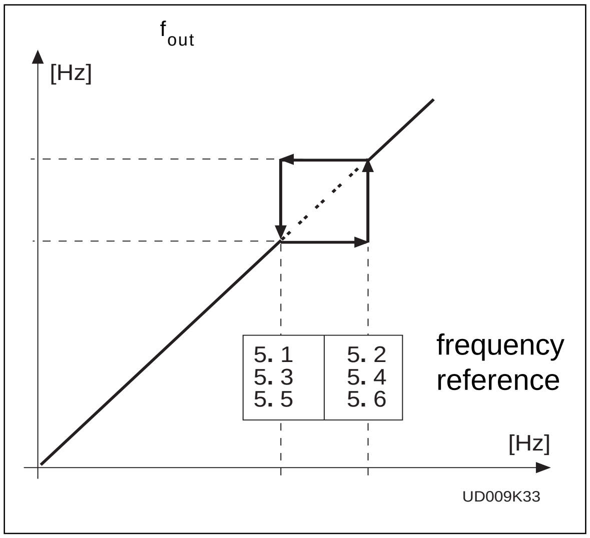


Figure 6-24 Example of prohibit frequency area setting.

6. 1 Motor control mode

0 = Frequency control: (V/Hz)	The I/O terminal and panel references are frequency references and the drive controls the output frequency (output frequency resolution = 0.01 Hz)
1 = Speed control: (Sensorless vector)	The I/O terminal and panel references are speed references and the drive controls the motor speed (control accuracy ± 0,5%).
2 = Torque control	The I/O terminal and panel references re torque references and the drive controls the motor torque (control accuracy ± 3%; proper tuning required: motor nameplate values, V/Hz setting).

6. 2 Switching frequency

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

Before changing the frequency from the factory default 10 kHz (3.6 kHz> 40 Hp), check the drive derating from the curves shown in figure 5.2-2 and 5.2-3 in chapter 5.2 of the User's Manual.

6. 3 Field weakening point
6. 4 Voltage at the field weakening point

The field weakening point is the output frequency where 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 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 same values. If you need different values for the field weakening point and the maximum output voltage, change these parameters after setting parameters 1**.** 10 and 1**.** 11.

6. 5 V/Hz curve, middle point frequency

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, middle point voltage

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.

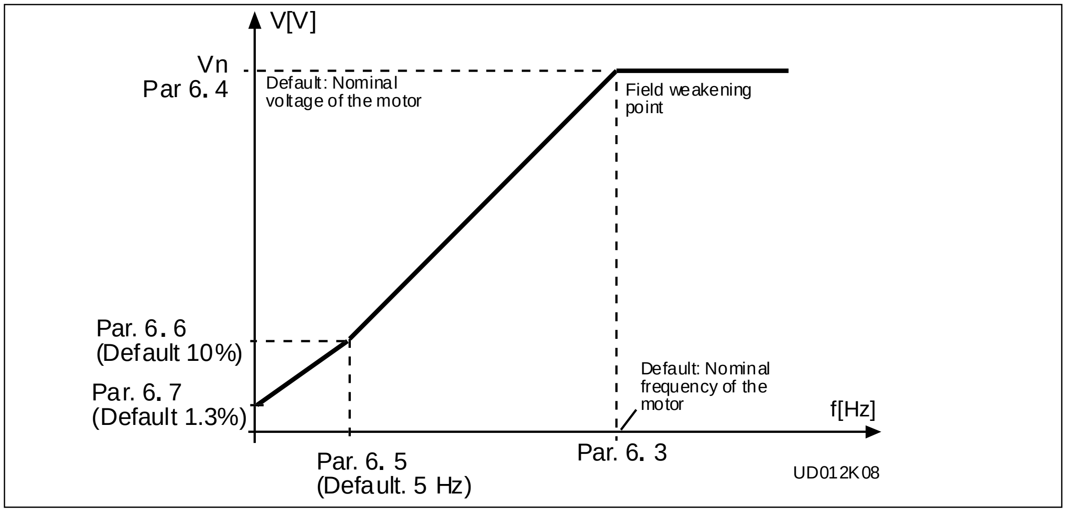


Figure 6-25 Programmable V/Hz curve

6. 7 Output voltage at zero frequency

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
6. 9 Undervoltage controller

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 reference fault

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4.7
3 = Fault, stop mode after fault always by coasting

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

7. 2 Response to external fault

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 4.7
3 = Fault, stop mode after fault always by coasting

A warning or a fault action and message is generated by the external fault signal on digital input DIA3. The information can also be transmitted via digital output DO1 or via relay outputs RO1 and RO2.

7. 3 Phase supervision of the motor

0 = No action
2 = Fault

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

7. 4 Ground fault protection

0 = No action
2 = Fault

Ground fault protection ensures that the sum of the motor phase currents is zero. The protection is always active and protects the drive from ground faults with high current levels.

Parameters 7. 5—7. 9 Motor thermal protection

General

Motor thermal protection protects the motor from overheating. The SV9000 drive is capable of supplying higher than nominal current to the motor. If the load requires this high current there is a risk that motor will be thermally overloaded. This is true especially at low frequencies. At low frequencies the cooling effect of the motor is reduced, reducing the capacity of the motor. If the motor is equipped with an external fan the capacity reduction at low speeds is small.

The 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 model uses the heatsink temperature to determine the initial thermal state of the motor. The calculated model assumes that the ambient temperature of the motor is 40°C.

The motor thermal protection can be adjusted by setting several parameters. The thermal current I_T specifies the load current above which the motor is overloaded. This current level 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. The parameter default values are taken from the motor nameplate data.

With the output current at I_T the thermal state will reach the nominal value (100%). The thermal state changes proportionally to the square of the current. With output current at 75% of I_T the thermal state will reach 56% and with output current at 120% of I_T the thermal state would reach 144% . The function will trip the drive (see par. 7**.** 5) if the thermal state reaches a value of 105%. The response time of the thermal state is determined by the time constant parameter 7**.** 8. The larger the motor the longer it takes to reach the final temperature.

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

! CAUTION!	*The calculated model does not protect the motor if the cooling of the motor is reduced either by blocking the airflow or due to dust and dirt*

7. 5 Motor thermal protection

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

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

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

7. 6 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 6-26.

The value is set as a percentage of the motor's nominal nameplate current, parameter 1.13, 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 you change parameter 1. 13, 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.

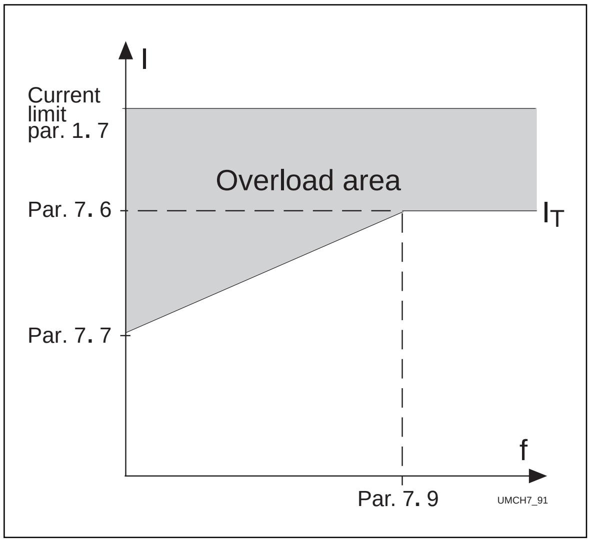


Figure 6-26 Motor thermal current I_T curve.

7. 7 Motor thermal protection, zero frequency current

The current can be set between 10.0—150.0% x I_{nMotor}. This parameter sets the value for thermal current at zero frequency. See 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 current, parameter 1. 13, not the drive's nominal output current. The 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 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

This time can be set between 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 to a motor design and it varies between different motor manufacturers.

The default value for the time constant is calculated based 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 its 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 2xt_6 (t_6 in seconds is the time a motor can safely operate at six times the rated current). If the drive is stopped the time constant is internally in-

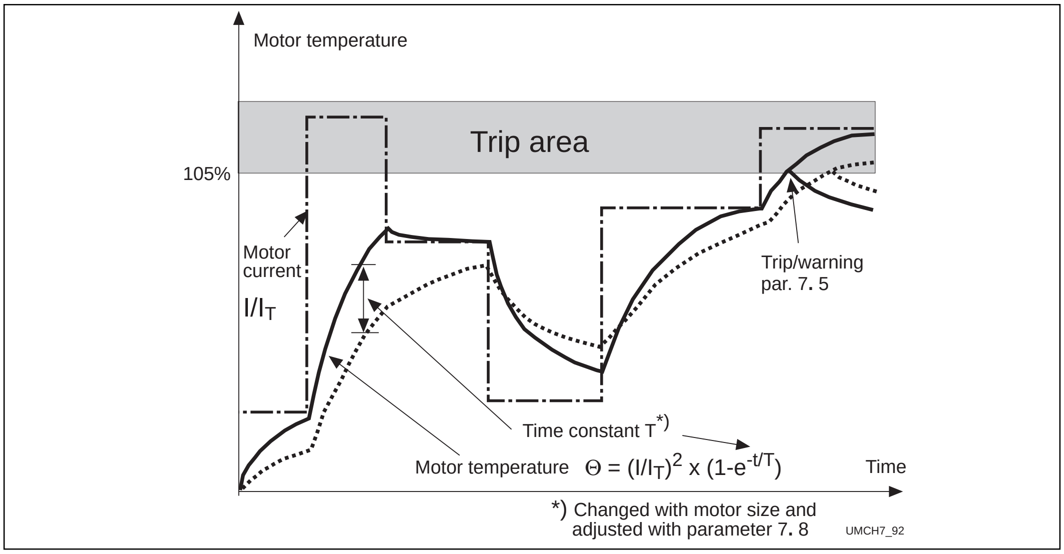


Figure 6-27 Calculating motor temperature.

creased to three times the set parameter value. Cooling during stop is based on convection with an increased time constant.

7. 9 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 6-26.

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 the field weakening point (parameter 6. 3). Changing either parameter 1. 11 or 6. 3 will restore this parameter to its default value.

Parameters 7. 10— 7. 13, Stall protection
General

Motor stall protection protects the motor from short time overload situations like a stalled shaft. The reaction time of the stall protection can be set shorter than the motor thermal protection's. The stall state is defined with two parameters, 7.11. Stall Current and 7.13. 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 no true detection of shaft rotation. Stall protection is a type of overcurrent protection.

7. 10 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 generate a fault. Deactivating the stall stage by setting the parameter to 0 will reset the stall time counter to zero.

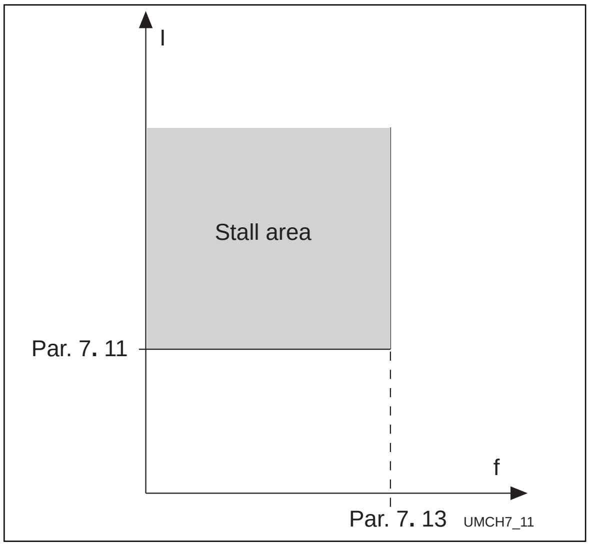


Figure 6-28 Setting the stall characteristics.

7. 11 Stall current limit

The current can be set to 0.0—200% x I_{nMotor}.

In a stall the current has to be above this limit. See figure 6-28. The value is set as a percentage of the motor's name plate data, parameter 1. 13. If parameter 1.13 is adjusted, this parameter is automatically restored to it's default value.

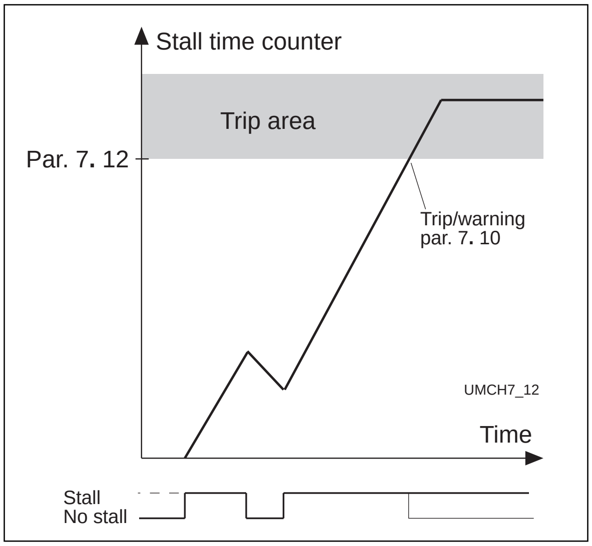


Figure 6-29 Counting the stall time.

7. 12 Stall time

The time can be set between 2.0—120 s.
This is the maximum allowed time for a stall. There is an internal up/down counter to count the stall time. See figure 6-29. If the stall time counter value goes above this limit the protection will cause a trip (see parameter 7. 10).

7. 13 Maximum stall frequency

The frequency can be set between 1—f_{max} (par. 1. 2).

In a stall the output frequency has to be smaller than this limit. See figure 6-28.

Parameters 7. 14— 7. 17, Underload protection
General

The purpose of motor underload protection is to ensure that there is load on the motor when the drive is running. If the motor loses it's load there might be a problem in the process, e.g. a broken belt or 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. The protection is not active below 5 Hz (the underload counter value is stopped). See figure 6-30.

The torque values for setting the underload curve are set in percent of the nominal torque of the motor. The motor's name plate data, parameter 1. 13 and the drive's nominal current I_{CT} are used to find the scaling ratio for the internal torque value. If other than the nominal motor is used with the drive, the accuracy of the torque calculation decreases.

7. 14 Underload protection

Operation:
0 = Not in use
1 = Warning
2 = Fault

Tripping and warning will display the same message. If tripping 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.

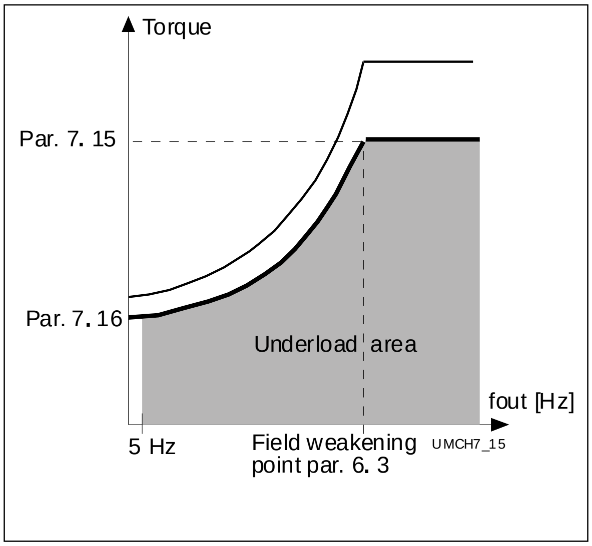


Figure 6-30 Setting of minimum load.

7. 15 Underload protection, field weakening area load

The torque limit can be set between 20.0—150 % x T_{nMotor}.

This parameter is the value for the minimum allowed torque when the output frequency is above the field weakening point. See figure 6-30. If parameter 1**.** 13 is adjusted, this parameter is automatically restored to it's default value.

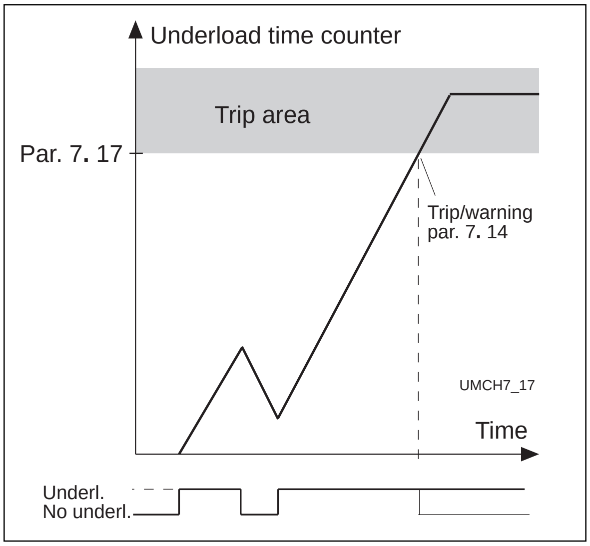


Figure 6-31 Counting the underload time.

7. 16 Underload protection, zero frequency load

The torque limit can be set between 10.0—150 % x T_{nMotor}.

This parameter is the value for the minimum allowed torque at zero frequency. See figure 6-30. If parameter 1. 13 is adjusted this parameter is automatically restored to it's default value.

7. 17 Underload time

This time can be set between 2.0—600.0 s.

This is the maximum allowed time for an underload state. There is an internal up/down counter to accumulate the underload time. See figure 6-31. If the underload counter value goes above this limit the protection will cause a trip (see parameter 7. 14). If the drive is stopped the underload counter is reset to zero.

7. 18 Phase supervision of the supply voltage

0 = No action
2 = Fault

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

7. 19 Thermistor input of IO-Expander

0 = No action
1 = Warning
2 = Fault

The thermistor connected to the thermistor input of the I/O-expander board supervises the temperature of the motor. With parameter 7.19 the response of the drive can be programmed when the thermistor indicates overtemperature.

7. 20 Response to fieldbus fault

0 = No action
1 = Warning
2 = Fault

A warning or a fault with the appropriate message on the display is generated by the fieldbus card if an error occurs in the physical layer of the fieldbus system.

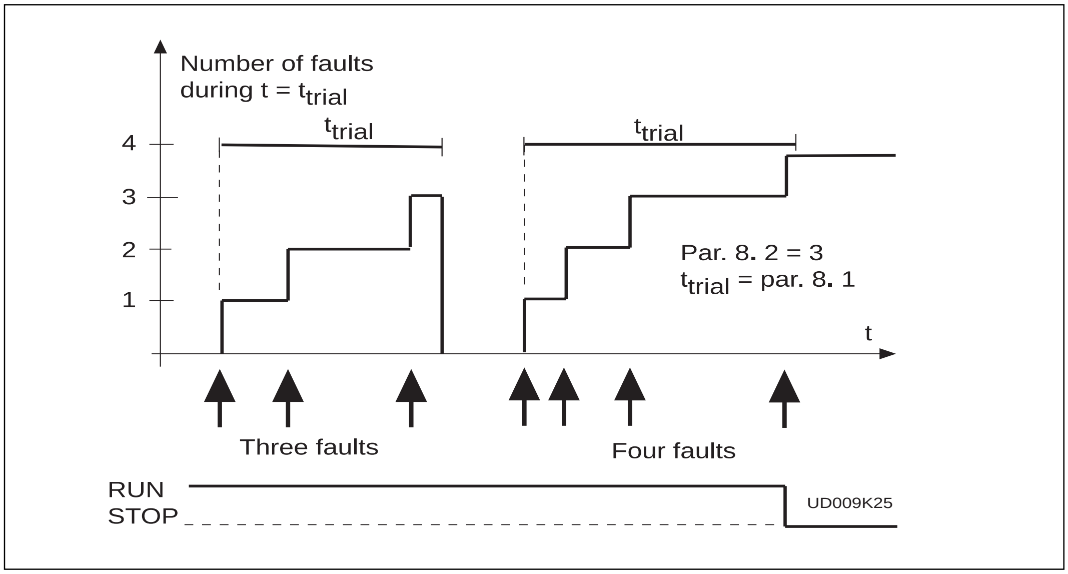


Figure 6-32 Automatic restart

8. 1 Automatic restart: number of tries
8. 2 Automatic restart: trial time

The Automatic restart function restarts the drive 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 the parameter 8. 2.

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

8. 3 Automatic restart, start function

The parameter defines the start mode:
0 = Start with ramp
1 = Flying start, see parameter 4. 6.

8. 4 Automatic restart after undervoltage trip

0 = No automatic restart after undervoltage fault trip
1 = 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

0 = No automatic restart after overvoltage fault trip
1 = 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

0 = No automatic restart after overcurrent fault trip
1 = Automatic restart after overcurrent faults

8. 7 Automatic restart after reference fault trip

0 = No automatic restart after reference fault trip
1 = 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 trip

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

Torque control

Torque control can be activated either by setting parameter 6.1 to torque control or with digital input DIA3 (parameter 2.2=10). The torque reference source is selected with parameter 9.1 and reference scaling with parameters 9.2 and 9.3.

9.1 Torque reference selection

Defines the source for torque reference value:

0 = None
1 = V_{in}
2 = I_{in}

9.2 Torque reference scaling bias
9.3 Torque reference scaling gain

The additional scaling function can be used for scaling the torque reference. The torque reference is always fed to the torque controller even if it is not activated.

$T_{ref.\ out} = gain \times T_{ref.\ in} + bias$

9.4 TC time constant

Defines the time constant for the torque controller. A short time constant means fast response.

9.5 TC min. control limit

Defines frequency limit below which the drive operates normally in frequency control mode.

The internal torque calculation is inaccurate at low speeds (< nominal slip of the motor). It is recommended to operate in frequency control operation mode at low speeds.

The reference value in frequency controlled operation mode is selected with parameter 1. 5.

Fieldbus control

Fieldbus control can be activated with parameter 10.1. Then both the frequency or speed reference and the Start/Stop and Reverse control comes from the fieldbus.

The first two parameters in group 10 concern all fieldbuses. Parameters 10.3 - 10.4 are for Modbus and N2, 10.5-10.6 for Modbus only, 10.7-10.13 for Profibus only, and 10.14 for LonWorks only.

10. 1 Fieldbus control

Defines the active control source:

0: control via I/O terminals
1: control via Fieldbus board

10.2 DIC1 function

0:	Fieldbus control, contact open =	Active control source I/O terminals
	contact closed =	Active control source the Fieldbus board
1:	External Fault, closing contact =	Fault is shown and motor is stopped when the input is active

Parameters 10.3 - 10.6 for Modbus/N2 protocol only

10.3 Slave address

Defines slave device address. Maximum value for this parameter is 247 and minimum is 1.

10.4 Baud Rate

1: 300 baud
2: 600 baud
3: 1200 baud
4: 2400 baud
5: 4800 baud
6: 9600 baud
7: 19200 baud

10.5 Parity type

0: None
1: Even
2: Odd

10.6 Modbus time-out

The Modbus time-out defines how long the Fieldbus board waits for a message from a master device and is specified in seconds.

Time can be set between 0 - 3600 s. Time 0 s = No time-out

Parameters 10.7 to 10.13 for Profibus DP protocol only

10.7 Profibus slave address

Defines slave device address. Maximum value for this parameter is 126 and minimum 2.

10.8 Profibus baud rate

1: 9.6 kbaud
2: 19.2 kbaud
3: 93.75 kbaud
4: 187.5 kbaud
5: 500 kbaud
6: 1.5 Mbaud
7: 3 Mbaud
8: 6 Mbaud
9: 12 Mbaud
10: AUTO (Automatic baud rate select)

10.9 Profibus PPO Type

Selection of Profibus PPO type.

1: PPO 1 (Parameter data 8 bytes, Control data 4 bytes)
2: PPO 2 (Parameter data 8 bytes, Control data 4 bytes)
3: PPO 3 (Control data 4 bytes)
4: PPO 4 (Control data 12 bytes)

10.10 Profibus process Data 1
10.11 Profibus process Data 2
10.12 Profibus process Data 3
10.13 Profibus process Data 4

Selection of Profibus process data source.

Value	1...22	Number of actual value (= n1 ... n22 in monitor page)
	99	Active fault code

Parameter 10.14 for LonWorks protocol only

10.14 LonWorks service button

Changing the value of this parameter from 0 to 1 or vice versa and pressing the Enter button causes the unique LonWorks ID number to be sent to the network.

7 Fault code

The Fieldbus Application has an extra fault code:

Fault number	Fault	Possible cause	Checking
27	Fieldbus communication error	Fieldbus board has detected the reset or error of the Bus system (physical layer)	Reset the fault and restart again. If the fault comes again: - check the host system - check the cables

8 MONITORING DATA

The Fieldbus Application has extra items for monitoring (n21 - n22). See table 8-1

DataData number	Unit name		Description
n 1	Output frequency	Hz	Frequency to the motor
n 2	Motor speed	rpm	Calculated motor speed
n 3	Motor current	A	Measured motor current
n 4	Motor torque	%	Calculated actual torque/nominal torque of the unit
n 5	Motor power	%	Calculated actual power/nominal power of the unit
n 6	Motor voltage	V	Calculated motor voltage
n 7	DC-link voltage	V	Measured DC-link voltage
n 8	Temperature	°C	Temperature of the heat sink
n 9	Operating day counter	DD.dd	Operating days 1), not resettable
n 10	Operating hours, "trip counter"	HH.hh	Operating hours 2), can be reset with programmable button #3
n 11	MW-hours	MWh	Total MW-hours, not resettable
n 12	MW-hours, "trip counter"	MWh	MW-hours, can be reset with programmable button #4
n 13	Voltage/analog input	V	Voltage of the terminal V_{in}+ (term. #2)
n 14	Current/analog input	mA	Current of terminals I_{in}+ and I_{in}- (term. #4, #5)
n 15	Digital input status, gr. A		
n 16	Digital input status, gr. B		
n 17	Digital and relay output status		
n 18	Control program		Version number of the control software
n 19	Unit nominal power	kW	Shows the power size of the unit
n 20	Motor temperature rise	%	100%= temperature of motor has risen to nominal
n 21	Reference frequency	Hz	Frequency reference
n 22	Torque reference	%	Torque reference when torque control in use

1) DD = full days, dd = decimal part of a day
2) HH = full hours, hh = decimal part of an hour

Table 8-1 Monitoring items