SV9000 AF DRIVES
SVReady™ User Manual

Pump and Fan Control Application

Cutler-Hammer

EATON

A General

This manual provides you with the information needed to apply these applications.

Each application is described in its own chapter. Section B tells how to select the application.

B Application selection

If the Basic Application is in use, first open the application package lock (parameter 1.15 = 0) Group 0 appears. By changing the value of parameter 0.1 a different application can be selected. See table B-1.

To change from one application to another, simply change the value of parameter 0.1 to that of the application desired: see table B-1.

Number	Parameter	Range	Description
0. 1	Application	1 —7	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

Table B-1 Application selection parameters.

Besides the parameter group 1, the applications also have parameter groups 2 — 8 available (see figure B-1).

Parameters of the groups sequentially follow each other and changing from the last parameter of one group to the first parameter of the next group or vice versa is done simply by pushing the arrow up/arrow down buttons.

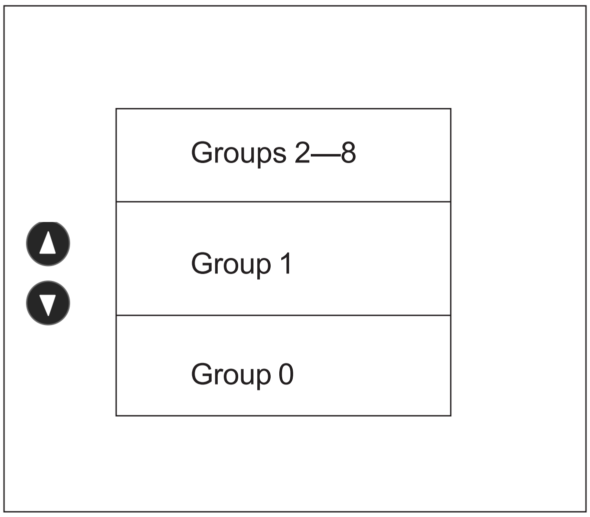


Figure B-1 Parameter Groups.

C Restoring default values of application parameters

Default values of the parameters of the applications 1 to 7 can be restored by selecting the same application again with parameter 0.1 or by setting the value of parameter 0.2 to 1. See User's manual chapter 12.

If parameter group 0 is not visible, make it visible as follows:

1. If parameter lock is set on, open the lock, parameter 1. 16, by setting the value of the parameter to 0.
2. If parameter conceal is set on, open the conceal parameter 1. 15, by setting the value of the parameter to 0.
   Group 0 becomes visible.

D Language selection

The language of the text shown on the operator's panel can be chosen with parameter 0. 3. See SV9000 User's Manual, chapter 11.

PUMP AND FAN CONTROL APPLICATION
(par. 0.1 = 7)

CONTENTS

6.1 General

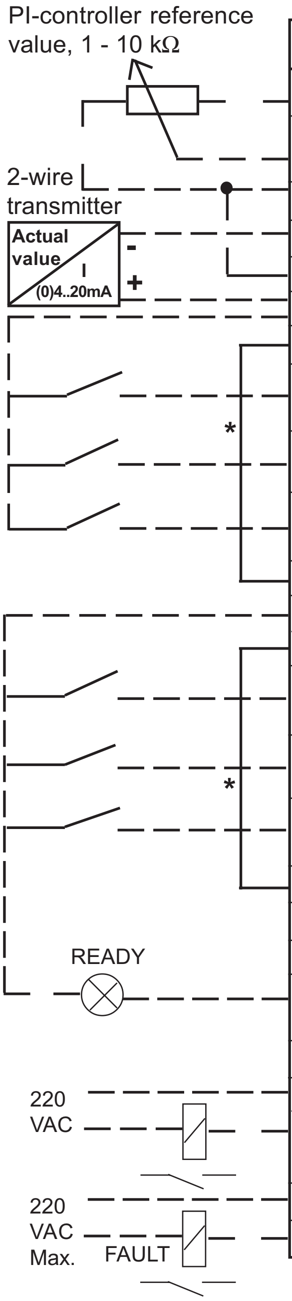
The pump and fan control appliation can be selected by setting the value of parameter 0.1 to 7.

The application can be used to control one variable speed drive and 0-3 auxiliary drives. The PI-controller of the SV9000 controls the drive speed and provides control signals to Start and Stop one to three auxiliary drives to control the total flow.

The application has two control sources on the I/O terminals. Source A is Pump and fan control and source B is direct frequency reference. The control source is selected with DIB6 input.

6.2 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)	PI-controller reference value range 0—10 V DC
3	GND	I/O ground	Ground for reference and controls
4	$I_{in}+$	Analog input,	PI-controller actual value
5	$I_{in}-$	current (programmable)	range 0—20 mA
6	+24V	Control voltage output	Voltage for switches, etc. max. 0.1 A
7	GND	Control voltage ground	Ground for reference and controls
8	DIA1	Start/Stop Source A (PI-controller)	Contact open = stop Contact closed = start
9	DIA2	External fault (programmable)	Contact open = no fault Contact closed = fault
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	Start/Stop Source B (Direct freq. ref.)	Contact open = stop Contact closed = start
15	DIB5	Jog speed select (programmable)	Contact open = no action Contact closed = jog speed
16	DIB6	Source A/B selection	Contact open = source A is active Contact closed = source B is active
17	CMB	Common for DIB4—DIB6	Connect to GND or + 24V
18	$I_{out}+$	Analog output	Programmable (par. 3. 1)
19	$I_{out}-$	Output frequency	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	Auxil. motor 1	
23	RO1	control	
24	RO2	Relay output 2	Programmable (par. 3. 8)
25	RO2	FAULT	
26	RO2		

Figure 6.2-1 Default I/O configuration and connection example of the Pump and Fan Control Application with 2-wire transmitter.

6.3 Control signal logic

The logic flow of the I/O-control signals and pushbutton signals from the panel is shown in figure 6.3-1.

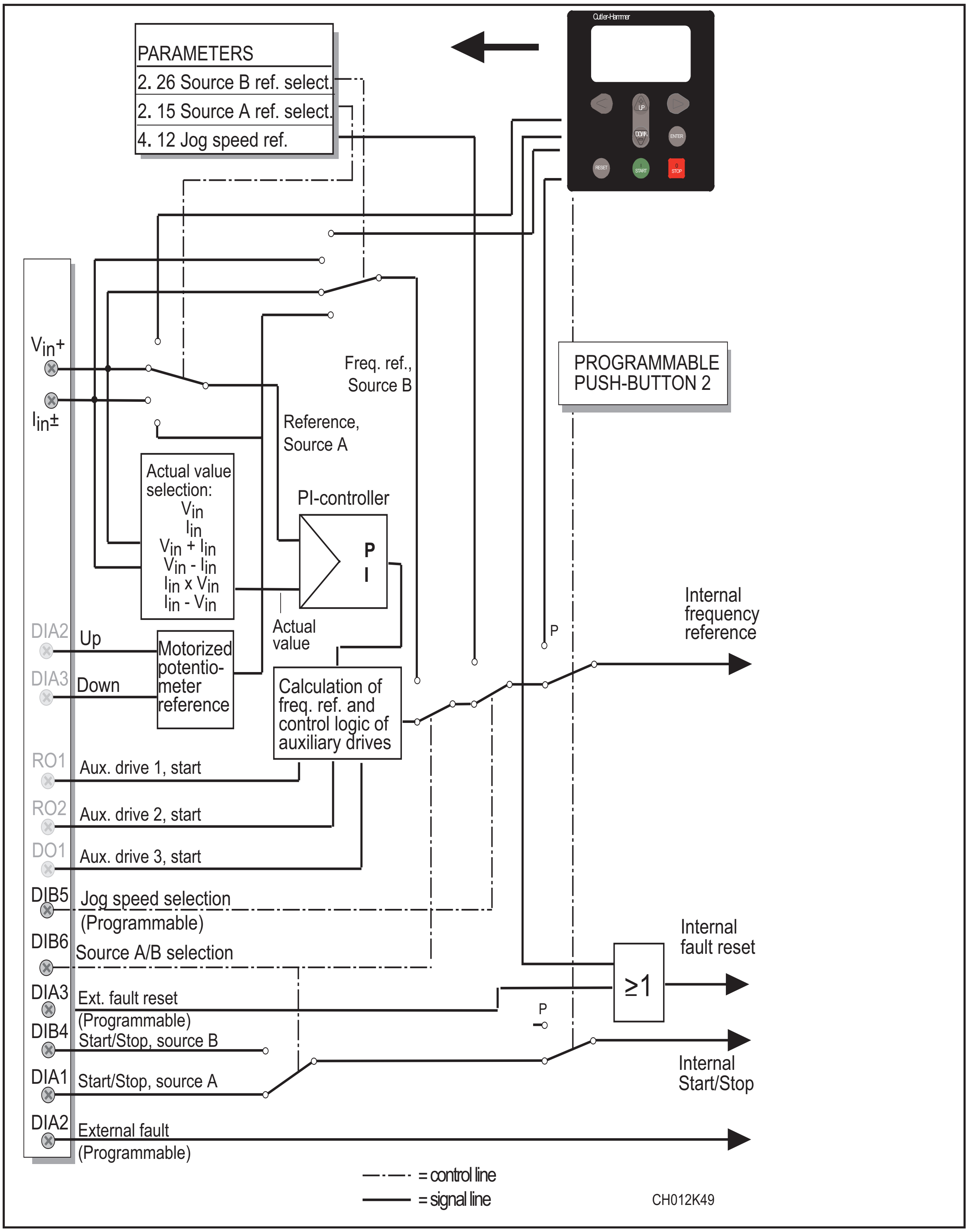


Figure 6.3-1 Control signal logic of the Pump and Fan control Application. Switch positions shown are based on the factory settings.

6.4 Basic parameters, Group 1

6.4.1 Parameter table, Group 1

Code	Parameter	Range	Step	Default	Custom	Description	Page
1. 1	Minimum frequency	0—f_{max}	1 Hz	0 Hz			6-5
1. 2	Maximum frequency	f_{min}-120/500 Hz	1 Hz	60 Hz		*	6-5
1. 3	Acceleration time 1	0.1—3000.0 s	0.1 s	1.0 s		Time from f_{min} (1. 1) to f_{max} (1. 2)	6-5
1. 4	Deceleration time 1	0.1—3000.0 s	0.1 s	1.0 s		Time from f_{max} (1. 2) to f_{min} (1. 1)	6-5
1. 5	PI-controllergain	1—1000%	1 %	100%			6-5
1. 6	PI-controller I-time	0.00—320.00 s	0.01s	10.00s		0= No Integral timein use	6-5
1. 7	Current limit	0.1—2.5 x I_{nSV9}	0.1 A	1.5 x $I_{n\ SV9}$		Output current limit [A] of the unit	6-5
1. 8	V/Hz ratio selection	0—2	1	0		0 = Linear 1 = Squared 2 = Programmable V/Hz ratio	6-5
1. 9	V/hz optimization	0—1	1	0		0 = None 1 = Automatic torque boost	6-6
1. 10	Nominal voltage of the motor	180—690 V	1 V	230 V 380 V 480 V 575 V		Voltage code 2 Voltage code 4 Voltage code 5 Voltage code 6	6-7
1. 11	Nominal frequency of the motor	30—500 Hz	1 Hz	60 Hz		f_n from the rating plate of the motor	6-7
1. 12	Nominal speed of the motor	1—20000 rpm	1 rpm	1720 rpm **		n_n from the rating plate of the motor	6-7
1. 13	Nominal current of the motor($I_{n\ Mot}$)	2.5 x $I_{n\ SV9}$	0.1 A	I_{nSV9}		I_n from the rating plate of the motor	6-7
1. 14	Supply voltage	208—240		230 V		Voltage code 2	6-7
		380—440		380 V		Voltage code 4	
		380—500		480 V		Voltage code 5	
		525—690		575 V		Voltage code 6	
1. 15	Parameter conceal	0—1	1	0		Visibility of the parameters: 0 = All parametergroups visible 1 = Only group 1 is visible	6-7
1. 16	Parameter value lock	0—1	1	0		Disables parameter changes: 0 = Changes enabled 1 = Changes disabled	6-7

Table 6.4-1 Group 1 basic parameters.

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

* If 1. 2 > motor synchr. speed, check suitability for motor and drive system
Selecting 120 Hz/500 Hz range see page 6-5.

** Default value for a four pole motor and a nominal size SV9000.

6.4.2 Description of Group 1 parameters

1. 1, 1. 2 Minimum / maximum frequency

Defines frequency limits of the SV9000.

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) parameters 1. 1 and 1. 2 are changed to 500 Hz. At the same time the resolution of the panel reference 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 PI-controller gain

This parameter defines the gain of the PI-controller.

If this parameter is set to 100%, a 10% change in error value causes the controller output to change by 1.0 Hz.

If the parameter value is set to 0 the PI-controller operates as I-controller.

1. 6 PI-controller I-time

Defines the integration time of the PI-controller.

1. 7 Current limit

This parameter determines the maximum motor current what the SV9000 will supply short term.

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 a constant voltage (nominal value) is supplied to the motor. See figure 6.4-1.

Linear V/Hz ratio should be used in constant torque applications.

This default setting should be used if there is no special requirement 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 6.4-1.

The motor runs undermagnetized below the field weakening point and produces less torque and electromechanical noise. A 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.

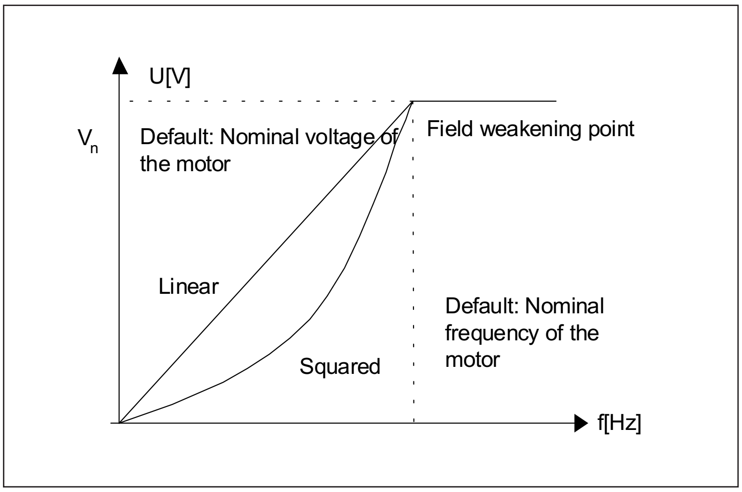


Figure 6.4-1 Linear and squared V/Hz curves.

Programm. V/Hz curve **2**

The V/Hz curve can be programmed with three different points. The parameters for programming are explained in chapter 6.5.2. A programmable V/Hz curve can be used if the standard settings do not satisfy the needs of the application. See figure 6.4-2.

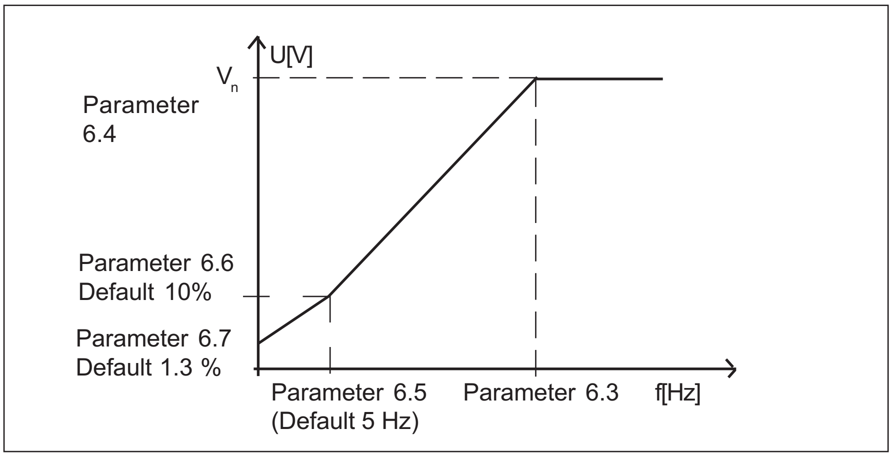


Figure 6.4-2 Programmable V/Hz curve.

1. 9 V/Hz optimization

Automatic torque boost

The voltage to the motor changes automatically which makes the motor to produce torque enough to start and run at low frequencies. The voltage increase depends on the motor type and horsepower.

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

1. 10 Nominal voltage of the motor

Find this value V_n from the nameplate of the motor.
This parameter sets the voltage at the field weakening point, parameter 6. 4, to 100% x $V_{n_{motor}}$.

1. 11 Nominal frequency of the motor

Find the nominal frequency f_n from the nameplate of the motor.
This parameter sets the frequency at the field weakening point, parameter 6. 3, to the same value.

1. 12 Nominal speed of the motor

Find this value n_n from the nameplate of the motor.

1. 13 Nominal current of the motor

Find the value I_n from the nameplate of the motor. The internal motor protection function uses this value as a reference value.

1. 14 Supply voltage

Set parameter value according to the nominal voltage of the supply.
Values are pre-defined for voltage codes 2, 4, 5 and 6. See table 6.4-1.

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

Defines access to the changes of the parameter values:

0 = Parameter value changes enabled
1 = Parameter value changes disabled

6.5 Special parameters, Groups 2—9

6.5.1 Parameter tables

Group 2, Input signal parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
2. 1	DIA2 function (terminal 9) STOP	0—10	1	1		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acceler./deceler. time selection 5 = Reverse 6 = Jog frequency 7 = Fault reset 8 = Acc./dec. operation prohibit 9 = DC-braking command 10 = Motor (digital) potent. UP	6-16
2. 2	DIA3 function (terminal 10) STOP	0—10	1	7		0 = Not used 1 = Ext. fault, closing contact 2 = External fault, opening contact 3 = Run enable 4 = Acceler./deceler. time selection 5 = Reverse 6 = Jog frequency 7 = Fault reset 8 = Acc./dec. operation prohibit 9 = DC-braking command 10 = Motor (digital) potent. DOWN	6-17
2. 3	V_{in} signal range	0—1	1	0		0 = 0—10 V 1 = Custom setting range	6-17
2. 4	V_{in} custom setting min.	0.00-100.00%	0.01%	0.00%			6-17
2. 5	V_{in} custom setting max.	0.00-100.00%	0.01%	100.00%			6-17
2. 6	V_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	6-17
2. 7	V_{in} signal filter time	0.00—10.00 s	0.01s	1.00s		0 = No filtering	6-17
2. 8	I_{in} signal range	0—2	1	0		0 = 0—20 mA 1 = 4—20 mA 2 = Custom setting range	6-17
2. 9	I_{in} custom setting minim.	0.00-100.00%	0.01%	0.00%			6-18
2. 10	I_{in} custom setting maxim.	0.00-100.00%	0.01%	100.00%			6-18
2. 11	I_{in} signal inversion	0—1	1	0		0 = Not inverted 1 = Inverted	6-18
2. 12	I_{in} signal filter time	0.01—10.00s	0.01s	1.00 s		0 = No filtering	6-18
2. 13	DIB5 function (terminal 15) STOP	0—9	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	6-18

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

Code	Parameter	Range	Step	Default	Custom	Description	Page
2. 14	Motor(digital) potentiometer ramp time	0.1—2000.0 Hz/s	0.1 Hz/s	10.0 Hz/s			6-19
2. 15	PI-controller reference signal (source A) STOP	0—4	1	0		0 = Analog voltage input (term. 2) 1 = Analog current input (term. 4) 2 = Set reference from the panel (reference r2) 3 = Signal from internal motor pot. 4 = Signal from internal motor pot. reset if SV9000 unit is stopped	619
2. 16	PI-controller actual value selection STOP	0—3	1	0		0 = Actual value1 1 = Actual 1 + Actual 2 2 = Actual 1 - Actual 2 3 = Actual 1 * Actual 2	6-19
2. 17	Actual value 1 input STOP	0—2	1	2		0 = No 1 = Voltage input 2 = Current input	6-19
2. 18	Actual value 2 input STOP	0—2	1	0		0 = No 1 = Voltage input 2 = Current input	6-19
2. 19	Actual value 1 min scale	-320.00%—+320.00%	0.01%	0.00%		0% = no minimum scaling	6-19
2. 20	Actual value 1 max scale	-320.00%—+320.00%	0.01%	100.00%		100% = no maximum scaling	6-19
2. 21	Actual value 2 min scale	-320.00%—+320.00%	0.01%	0.00%		0% = no minimum scaling	6-19
2. 22	Actual value 2 max scale	-320.00%—+320.00%	0.01%	100.00%		100% = no maximum scaling	6-19
2. 23	Error value inversion	0—1	1	0		0 = No 1 = Yes	6-20
2. 24	PI-controller reference value rise time	0.0—100.0 s	0.1 s	60.0 s		Time for reference value change from 0 % to 100 %	6-20
2. 25	PI-controller reference value fall time	0.0—100.0 s	0.1 s	60.0 s		Time for reference value change from 100 % to 0 %	6-20
2. 26	Direct frequency reference, source B STOP	0—4	1	0		0 = Analog voltage input (term. 2) 1 = Analog current input (term. 4) 2 = Set reference from the panel (reference r1) 3 = Signal from internal motor pot. 4 = Signal from internal motor pot. reset if SV9000 unit is stopped	6-20
2. 27	Source B reference scaling minimum value	0—par.2. 28	1 Hz	0 Hz		Selects the frequency that corres-ponds to the min. reference signal	6-20
2. 28	Source B reference scaling maximum value	0—f_{max}	1 Hz	0 Hz		Selects the frequency that corresponds to the max. reference signal 0 = Scaling off >0 = Scaled maximum value	6-20

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

Group 3, Output and supervision parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
3. 1	Analog output function	0—15	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_{nMot}) 5 = Motor power (0—2 x P_{nMot}) 6 = Motor voltage (0—100% xV_{nMot}) 7 = DC-link volt. (0—1000 V) 8—10 = Not in use 11 = PI-controller reference value 12 = PI-controller actual value 1 13 = PI-controller actual value 2 14 = PI-controller error value 15 = PI-controller output	6-21
3. 2	Analog output filter time	0.00—10.00 s	0.01s	1.00s			6-21
3. 3	Analog output inversion	0—1	1	0		0 = Not inverted 1 = Inverted	6-21
3. 4	Analog output minimum	0—1	1	0		0 = 0 mA 1 = 4 mA	6-21
3. 5	Analog output scale	10—1000%	1%	100%			6-21
3. 6	Digital output function STOP	0—30	1	1		0 = Not used 1 = Ready 2 = Run 3 = Fault 4 = Fault inverted 5 = SV9000 overheat warning 6 = External fault or warning 7 = Reference fault or warning 8 = Warning 9 = Reversed 10 = Jog 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—27 = Not in use 28 = Auxiliary drive 1 start 29 = Auxiliary drive 2 start 30 = Auxiliary drive 3 start	6-22
3. 7	Relay output 1 function STOP	0—30	1	28		As parameter 3. 6	6-22
3. 8	Relay output 2 function STOP	0—30	1	3		As parameter 3. 6	6-22
3. 9	Output freq. limit 1 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	6-22
3. 10	Output freq. limit 1 supervision value	0.0—f_{max} (par. 1. 2)	0.1 Hz	0.0 Hz			6-22

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

Code	Parameter	Range	Step	Default	Custom	Description	Page
3. 11	Output freq. limit 2 supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	6-22
3. 12	Output freq. limit 2 supervision value	0.0—f_{max} (par. 1. 2)	0.1 Hz	0.0 Hz			6-22
3. 13	Torque limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	6-23
3. 14	Torque limit supervision value	0.0—200.0% xT_{nSV9}	0.1%	100.0%			6-23
3. 15	Active reference limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	6-23
3. 16	Active reference limit supervision value	0.0—f_{max} (par. 1. 2)	0.1 Hz	0.0 Hz			6-23
3. 17	External brake off-delay	0.0—100.0 s	1	0.5 s			6-23
3. 18	External brake on-delay	0.0—100.0 s	1	1.5 s			6-23
3. 19	Drive temperature limit supervision function	0—2	1	0		0 = No 1 = Low limit 2 = High limit	6-23
3. 20	Drive temperature limit	-10—+75°C	1	+40°C			6-23
3. 21	I/O-expander board (opt.) analog output content	0—7	1	3		See parameter 3. 1	6-21
3. 22	I/O-expander board (opt.) analog output filter time	0.00—10.00 s	0.01	1.00 s		See parameter 3. 2	6-21
3. 23	I/O-expander board (opt.) analog output inversion	0—1	1	0		See parameter 3. 3	6-21
3. 24	I/O-expander board (opt.) analog output minimum	0—1	1	0		See parameter 3. 4	6-21
3. 25	I/O-expander board (opt.) analog output scale	10—1000%	1	100%		See parameter 3. 5	6-21

Group 4, Drive control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
4. 1	Acc./dec. ramp 1 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	6-24
4. 2	Acc./dec. ramp 2 shape	0.0—10.0 s	0.1 s	0.0 s		0 = Linear >0 = S-curve acc./dec. time	6-24
4. 3	Acceleration time 2	0.1—3000.0 s	0.1 s	10.0 s			6-25
4. 4	Deceleration time 2	0.1—3000.0 s	0.1 s	10.0 s			6-25
4. 5	Brake chopper STOP	0—2	1	0		0 = Brake chopper not in use 1 = Brake chopper in use 2 = External brake chopper	6-25
4. 6	Start function	0—1	1	0		0 = Ramp 1 = Flying start	6-25
4. 7	Stop function	0—1	1	0		0 = Coasting 1 = Ramp	6-25

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

Code	Parameter	Range	Step	Default	Custom	Description	Page
4.8	DC-braking current	0.15—1.5 x I_{nSV9} (A)	0.1 A	0.5 x I_{nSV9}			6-25
4.9	DC-braking time at Stop	0.00-250.00 s	0.01 s	0.00 s		0 = DC-brake is off at Stop	6-25
4.10	Turn on frequency of DC-brake during ramp Stop	0.1-10.0 Hz	0.1 Hz	1.5 Hz			6-27
4.11	DC-brake time at Start	0.00-25.00 s	0.01 s	0.00 s		0 = DC-brake is off at Start	6-27
4.12	Jog speed reference	f_{min} —f_{max} (1.1) (1.2)	0.1 Hz	10.0 Hz			6-27

Group 5, Prohibit frequency parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
5.1	Prohibit frequency range 1 low limit	f_{min}— par. 5.2	0.1 Hz	0.0 Hz			6-27
5.2	Prohibit frequency range 2 high limit	f_{min}—f_{max} (1.1) (1.2)	0.1 Hz	0.0 Hz		0 = No prohibit frequency range	6-27
5.3	Prohibit frequency range 2 low limit	f_{min}— par. 5.4	0.1 Hz	0.0 Hz			6-27
5.4	Prohibit frequency range 2 high limit	f_{min}—f_{max} (1.1) (1.2)	0.1 Hz	0.0 Hz		0 = No prohibit frequency range	6-27
5.5	Prohibit frequency range 3 low limit	f_{min}— par. 5.6	0.1 Hz	0.0 Hz			6-27
5.6	Prohibit frequency range 3 high limit	f_{min}—f_{max} (1.1) (1.2)	0.1 Hz	0.0 Hz		0 = No prohibit frequency range	6-27

Group 6, Motor control parameters

Code	Parameter	Range	Step	Default	Custom	Description	Page
6.1	Motor control mode STOP	0—1	1	0		0 = Frequency control 1 = Speed control	6-27
6.2	Switching frequency	1.0—16.0 kHz	0.1 kHz	10/3.6kHz		Depends on Hp rating	6-28
6.3	Field weakening point STOP	30—500 Hz	1 Hz	Param. 1.11			6-28
6.4	Voltage at field weakening point STOP	15—200% x V_{nmot}	1%	100%			6-28
6.5	V/Hz curve mid point frequency STOP	0.0—f_{max}	0.1 Hz	0.0 Hz			6-28
6.6	V/Hz curve mid point voltage STOP	0.00—100.00% x V_{nmot}	0.01%	0.00%			6-28
6.7	Output voltage at zero frequency STOP	0.00—100.00% x V_{nmot}	0.01%	0.00%			6-28
6.8	Overvoltage controller	0—1	1	1		0 = Controller is not operating 1 = Controller is in operation	6-29
6.9	Undervoltage controller	0—1	1	1		0 = Controller is not operating 1 = Controller is in operation	6-29

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—3	1	0		0 = No action 1 = Warning 2 = Fault, stop according to par 4.7 3 = Fault, always coasting stop	6-29
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, always coasting stop	6-29
7. 3	Phase supervision of the motor	0—2	2	2		0 = No action 2 = Fault	6-29
7. 4	Ground protection	0—2	2	2		0 = No action 2 = Fault	6-29
7. 5	Motor thermal protection	0—2	1	2		0 = No action 1 = Warning 2 = Fault	6-30
7. 6	Motor thermal protection break point current	50.0—150.0 % x I_{nMOTOR}	1.0 %	100.0%			6-30
7. 7	Motor thermal protection zero frequency current	5.0—150.0% x I_{nMOTOR}	1.0 %	45.0%			6-31
7. 8	Motor thermal protection time constant	0.5—300.0 minutes	0.5 min.	17.0 min.		Default value is set according to motor nominal current	6-31
7. 9	Motor thermal protection break point frequency	10—500 Hz	1 Hz	35 Hz			6-32
7. 10	Stall protection	0—2	1	1		0 = No action 1 = Warning 2 = Fault	6-32
7. 11	Stall current limit	5.0—200.0% x I_{nMOTOR}	1.0%	130.0%			6-33
7. 12	Stall time	2.0—120.0 s	1.0 s	15.0 s			6-33
7. 13	Maximum stall frequency	1—f_{max}	1 Hz	25 Hz			6-33
7. 14	Underload protection	0—2	1	0		0 = No action 1 = Warning 2 = Fault	6-34
7. 15	Underload prot., field weakening area load	10.0—150.0 % x T_{nMOTOR}	1.0%	50.0%			6-34
7. 16	Underload protection, zero frequency load	5.0—150.0% x T_{nMOTOR}	1.0%	10.0%			6-34
7. 17	Underload time	2.0—600.0 s	1.0 s	20.0 s			6-34

6

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	6-35
8. 2	Automatic restart:multi attempt maximum trial time	1—6000 s	1 s	30 s			6-35
8. 3	Automatic restart: start function	0—1	1	0		0 = Ramp 1 = Flying start	6-36
8. 4	Automatic restart after undervoltage trip	0—1	1	0		0 = No 1 = Yes	6-36
8. 5	Automatic restart after overvoltage trip	0—1	1	0		0 = No 1 = Yes	6-36
8. 6	Automatic restart after overcurrent trip	0—1	1	0		0 = No 1 = Yes	6-36
8. 7	Automatic restart after reference fault trip	0—1	1	0		0 = No 1 = Yes	6-36
8. 8	Automatic restart after over/undertemperature fault trip	0—1	1	0		0 = No 1 = Yes	6-36

Group 9, Pump and fan control special parameters

Code	Parameter	Range	Stepl	Default	Custom	Description	Page
9. 1	Number of aux. drives	0—3	1	1			6-37
9. 2	Start frequency of auxiliary drive 1	I_{min}—I_{max}	0.1 Hz	51.0 Hz			6-37
9. 3	Stop frequency of auxiliary drive 1	I_{min}—I_{max}	0.1 Hz	25.0 Hz			6-37
9. 4	Start frequency of auxiliary drive 2	I_{min}—I_{max}	0.1 Hz	51.0 Hz			6-37
9. 5	Stop frequency of auxiliary drive 2	I_{min}—I_{max}	0.1 Hz	25.0 Hz			6-37
9. 6	Start frequency of auxiliary drive 3	I_{min}—I_{max}	0.1 Hz	51.0 Hz			6-37
9. 7	Stop frequency of auxiliary drive 3	I_{min}—I_{max}	0.1 Hz	25.0 Hz			6-37
9. 8							
9. 9							
9. 10	Start delay of the auxiliary drives	0.0—300.0 s	0.1 s	4.0 s			6-37
9. 11	Stop delay of the auxiliary drives	0.0—300.0 s	0.1 s	2.0 s			6-37
9. 12	Reference step after start of the 1 aux. drive	0.0—100.0 %	0.1 %	0.0 %		In % of actual value	6-38
9. 13	Reference step after start of the 2 aux. drive	0.0—100.0 %	0.1 %	0.0 %		In % of actual value	6-38
9. 14	Reference step after start of the 3 aux. drive	0.0—100.0 %	0.1 %	0.0 %		In % of actual value	6-38
9. 15	(Reserved)						
9. 16	Sleep level	0.0—120/500 Hz	0.1 Hz	0.0 Hz		Frequency below which the freq. of the speed controlled motor has go before starting the sleep delay counting (0.0 = not in use)	6-38
9. 17	Sleep delay	0.0—3000.0 s	0.1 s	30.0 s		Time that freq. has to be below par. 9.16 before stopping the SV9000	6-38
9. 18	Wake up level	0.0—100.0 %	0.1 %	0.0 %		Level of the actual value for restarting the SV9000	6-38
9. 19	Wake up function	0—1	1	0		0 =Wake up when falling below the wake up level 1 = Wake up when exeeding the wake up level	6-38
9. 20	PI-regulator bypass	0—1	1	0		1 = PI-regulator bypassed	6-39

Table 6.5-1 Special parameters, Groups 2—9.

6.5.2 Description of Groups 2—9 parameters

2. 1 DIA2 function

1: External fault,	closing contact	= Fault is shown and drive responds according to parameter 7.2.	
2: External fault,	opening contact	= Fault is shown and drive responds according to parameter 7.2.	
3: Run enable	contact open contact closed	= Start of the motor disabled = Start of the motor enabled	
4: Acc. / Dec time select.	contact open contact closed	= Acceleration/Deceleration time 1 selected = Acceleration/Deceleration time 2 selected	
5: Reverse	contact open contact closed	= Forward = Reverse	If two or more inputs are programmed to reverse only one of them is required for reverse
6: Jog freq.	contact closed	= Jog frequency selected for freq. refer.	
7: Fault reset	contact closed	= Resets all faults	
8: Acc./Dec. operation prohibited	contact closed	= Stops acceleration and deceleration until the contact is opened	
9: DC-braking command	contact closed	= In the stop mode, the DC-braking operates until the contact is opened, see figure 6.5-1. DC-brake current is set with parameter 4. 8.	
10: Motor (digital) pot. UP	contact closed	= Reference increases until the contact is opened	

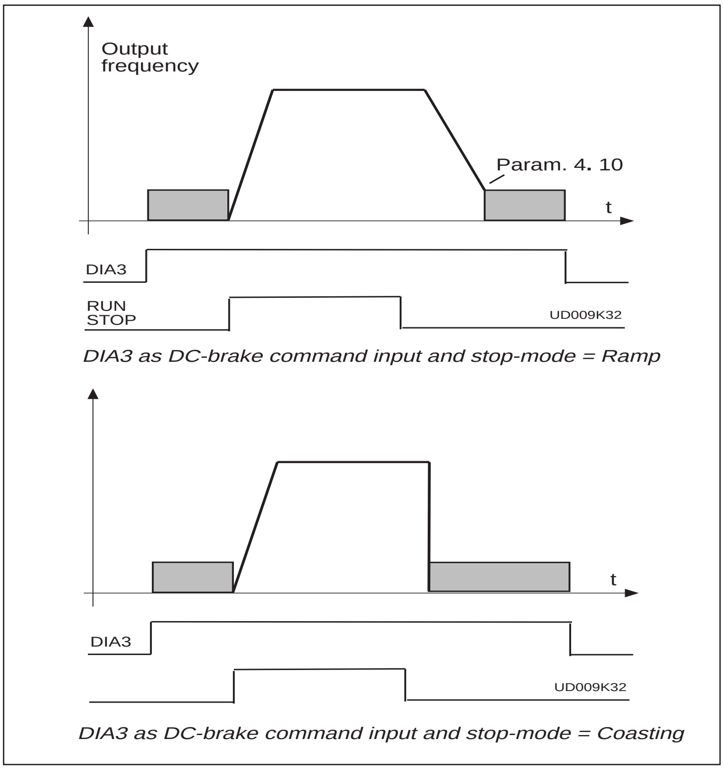


Figure 6.5-1 DIA3 as DC-brake command input:
a) Stop-mode = ramp,
b) Stop-mode = coasting

2. 2 DIA3 function

Selections are same as in 2. 1 except :

10: Motor (digital) pot. DOWN — contact closed = Reference decreases until the contact is opened

2. 3 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. 4-2. 5 V_{in} custom setting minimum/maximum

These parameters set V_{in} 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! The parameter values can only be set with this procedure (not with arrow up/arrow down buttons)

2. 6 V_{in} signal inversion

0 = no inversion of analog V_{in} signal

1 = inversion of analog V_{in} signal.

2. 7 V_{in} signal filter time

Filters out disturbances from the incoming analog V_{in} signal. A long filtering time makes the drive response slower. See figure 6.5-2.

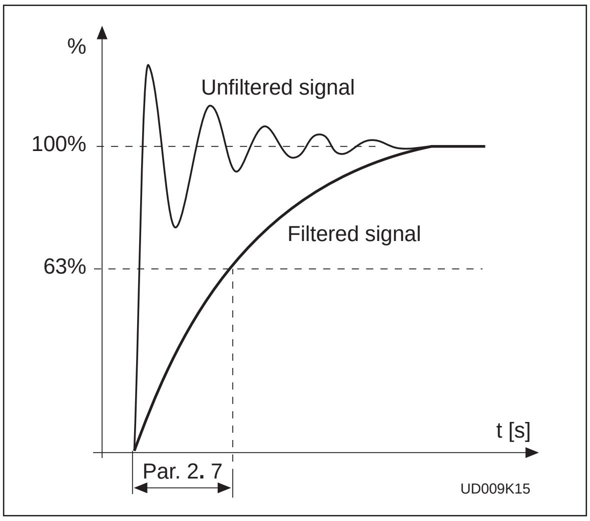


Figure 6.5-2 V_{in} signal filtering

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2. 8 **Analog input I_{in} signal range**

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

2. 9 **Analog input I_{in} custom setting**
2. 10 **minimum/maximum**

With these parameters you can scale the input current signal (I_{in}) signal range between 0—20 mA.

Minimum setting: Set the I_{in} signal to its minimum level, select parameter 2**.** 9, press the Enter button

Maximum setting: Set the I_{in} signal to its maximum level, select parameter 2**.** 10, press the Enter button

Note! The parameter values can only be set with this procedure (not with the arrow up/arrow down buttons)

2. 11 **Analog input I_{in} inversion**

0 = no inversion of I_{in} input.
1 = inversion of I_{in} input.

2. 12 **Analog input I_{in} filter time**

Filters out disturbances from the incoming analog I_{in} signal. A long filtering time makes the drive response slower. See figure 6.5-3.

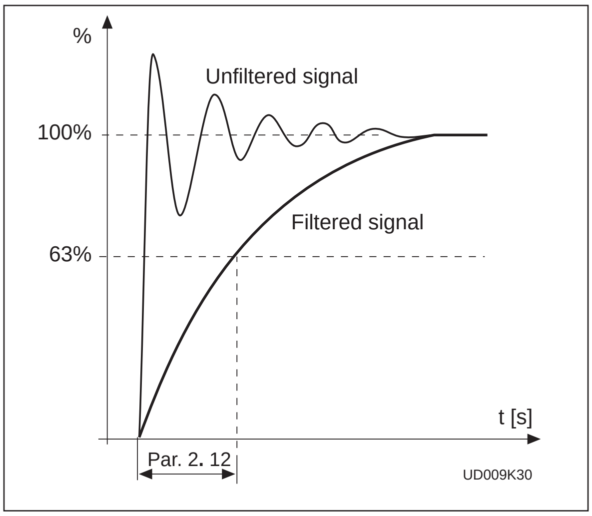

Figure 6.5-3 Analog input I_{in} filter time

2. 13 **DIA5 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 = Start of the motor disabled
contact closed = Start of the motor enabled

4: Acc. / Dec time select. contact open = Acceleration/Deceleration time 1 selected
contact closed = Acceleration/Deceleration time 2 selected

5: Reverse contact open = Forward
contact closed = Reverse

If two or more inputs are programmed to reverse only one of them is required for reverse

6: Jog freq. contact closed = Jog frequency selected for freq. refer.

7: Fault reset contact closed = Resets all faults

8: Acc./Dec. operation prohibited contact closed = Stops acceleration and deceleration until the contact is opened

9: DC-braking command contact closed = In the stop mode, the DC-braking operates until the contact is opened, see figure 6.5-1. DC-brake current is set with parameter 4**.** 8.

2. 14 Motor potentiometer ramp time

Defines how fast the electronic motor (digital) potentiometer value changes.

2. 15 PI-controller reference signal

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 Panel reference is the reference set from the Reference Page (REF). Reference r2 is the PI-controller reference, see chapter 6.
3 Reference value is changed with digital input signals DIA2 and DIA3.
- switch in DIA2 closed = frequency reference increases
- switch in DIA3 closed = frequency reference decreases
Speed of the reference change can be set with the parameter 2. 3.
4 Same as setting 3 but the reference value is set to the minimum frequency (par. 1. 1) each time the drive is stopped. When the value of parameter 1. 5 is set to 3 or 4, the value of parameter 2.1 is automatically set to 4 and the value of parameter 2. 2 is automatically set to 10.

2. 16 PI-controller actual value selection
2. 17 Actual value 1
2. 18 Actual value 2

These parameters select the PI-controller actual value.

2. 19 Actual value 1 minimum scale

Sets the minimum scaling point for Actual value 1. See figure 6.5-4.

2. 20 Actual value 1 maximum scale

Sets the maximum scaling point for Actual value 1. See figure 6.5-4.

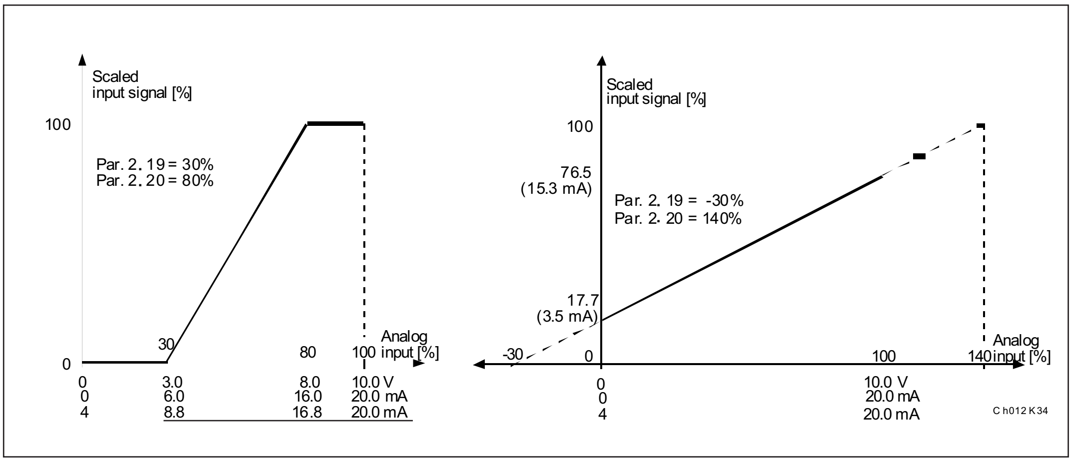

Figure 6.5-4 Examples about the scaling of actual value signal.

2. 21 Actual value 2 minimum scale

Sets the minimum scaling point for Actual value 2.

2. 22 Actual value 2 maximum scale

Sets the maximum scaling point for Actual value 2.

2. 23 Error value inversion

This parameter allows you to invert the error value of the PI-controller (and thus the the operation of the PI-controller).

2. 24 PI-controller minimum limit
2. 25 PI-controller maximum limit

These parameters set the minmum and maximum values of the PI-controller output.

Parameter value limits: par 1.1 <par. 2. 24 <par. 2. 25.

2. 26 Direct frequency reference, Place B

0 Analog voltage reference from terminals 2—3, e.g. a potentiometer
1 Analog current reference from terminals 4—5, e.g. a transducer.
2 Panel reference is the reference set from the Reference Page (REF), Reference r1 is the Place B reference, see chapter 6.
3 Reference value is changed with digital input signals DIA2 and DIA3.
- switch in DIA2 closed = frequency reference increases
- switch in DIA3 closed = frequency reference decreases
Speed of the reference change can be set with the parameter 2. 3.
4 Same as setting 3 but the reference value is set to the minimum frequency (par. 1. 1) each time the drive is stopped.
When the value of parameter 1. 5 is set to 3 or 4, the value of parameter 2.1 is automatically set to 4 and the value of parameter 2. 2 is automatically set to 10.

2. 27 2. 28 Place B reference scaling, minimum value/maximum value

Setting limits: 0 < par. 2. 27 < par. 2. 28 < par. 1. 2. If par. 2. 28 = 0 scaling is set off. See figures 6.5-5 and 6.5-6.

(In the figures below the voltage input V_{in} with signal range 0—10 V is selected for source B reference)

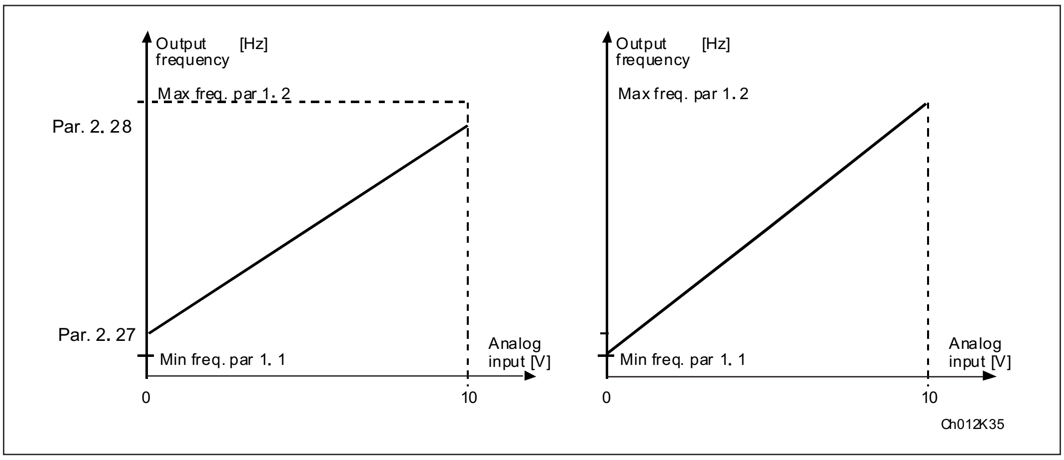

Figure 6.5-5 Reference scaling. *Figure 6.5-6 Reference scaling, par. 2. 15 = 0*

3. 1 Analog output function

See table on page 6-10.

3. 2 Analog output filter time

Filters the analog output signal. See figure 6.5-7.

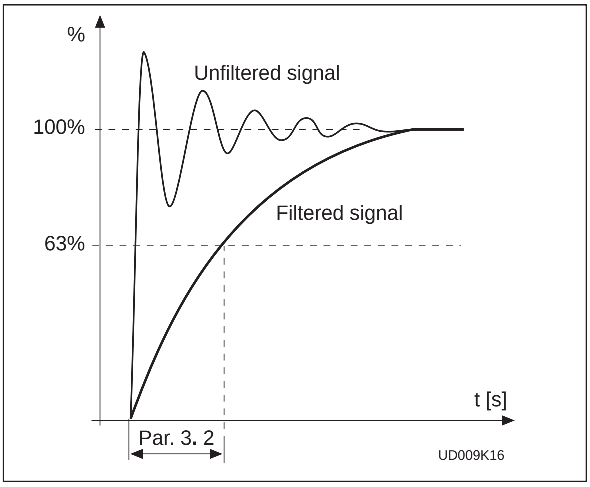

Figure 6.5-7 Analog output filtering.

3.3 Analog output invert

Inverts analog output signal:
max output signal = minimum set value
min output signal = maximum set value

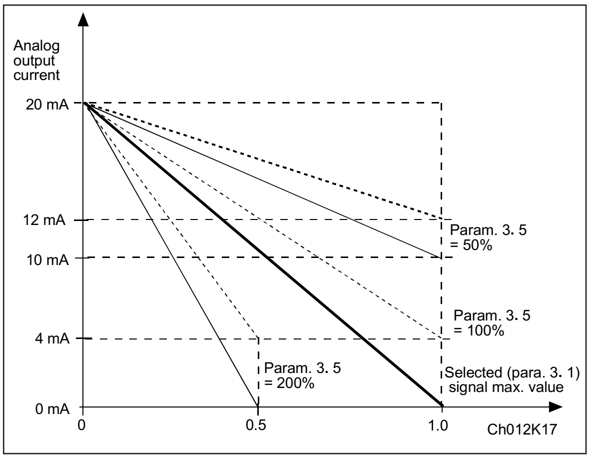

Figure 6.5-8 Analog output invert

3. 4 Analog output minimum

Defines the signal minimum to be either 0 mA or 4 mA. See figure 6.5-9.

3. 5 Analog output scale

Scaling factor for analog output. See figure 6.5-9.

Signal	Max. value of the signal
Output freq.	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_{nMot}
Motor power	2 x P_{nMot}
Motor voltage	100% x V_{nMot}
DC-link volt.	1000 V
PI-ref. value	100% x ref. value max.
PI-act. value1	100% x act. value max.
PI-act. value2	100% x act. value max.
PI-error value	100%x error value max.
PI-output	100% x output max.

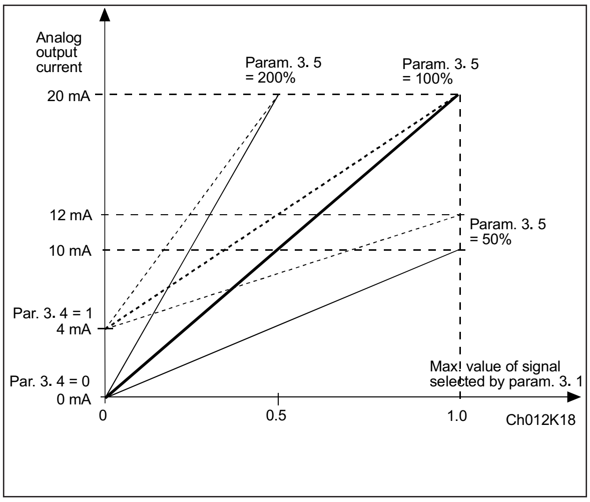

Figure 6.5-9 Analog output scale.

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 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 <4mA
8 = Warning	If a warning exists. See Table 7.10-1 in User's Manual
9 = Reversed	The reverse command has been selected
10= Multi-step or jog speed	Multi-step or jog speed has been selected by digital inp.
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 par. 3. 10)
14= Output frequency supervision 2	The output frequency goes outside of the set supervision Low limit/ High limit (par. 3. 11 and par. 3. 12)
15= Torque limit supervision	The motor torque goes outside of the set supervision Low limit/ High limit (par. 3. 13 and par. 3. 14)
16= Active reference limit supervision	Active reference goes outside of the set supervision Low limit/ High limit (par. 3. 15 and par. 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. pushbutton#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 ON
22—27 = Not in use	
28 = Auxiliary drive 1 start	Starts and stops auxiliary drive 1
29 = Auxiliary drive 2start	Starts and stops auxiliary drive 2
30 = Auxiliary drive 3 start	Starts and stops auxilary drive 3

Table 6.5-2 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 or 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 6.5-10.

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 or via a relay output RO1 or RO2 depending on the settings of parameters 3. 6—3. 8.

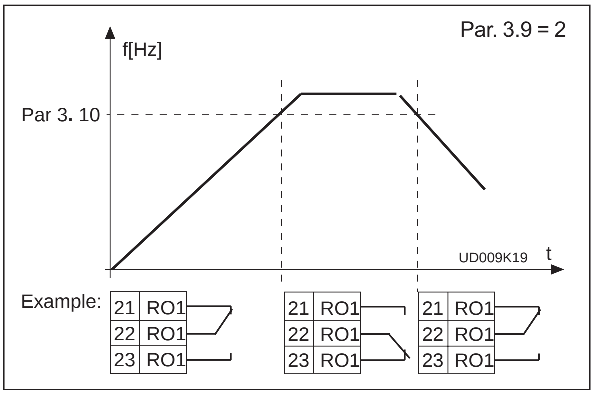

Figure 6.5-10 Output frequency supervision.

3. 14 Torque limit , supervision value

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

3. 15 Active 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 parameters 3. 6—3. 8. The supervised reference is the current active reference. It can be source A or B reference depending on DIB6 input or panel reference if the panel is the active control source.

3. 16 Active 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

The function of the external brake can be delayed from the start and stop control signals with these parameters. See figure 6.5-11.

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 a relay output RO1 or RO2 depending on the settings of parameters 3. 6—3. 8.

3. 20 Drive temperature limit value

The temperature value to be supervised by parameter 3. 19.

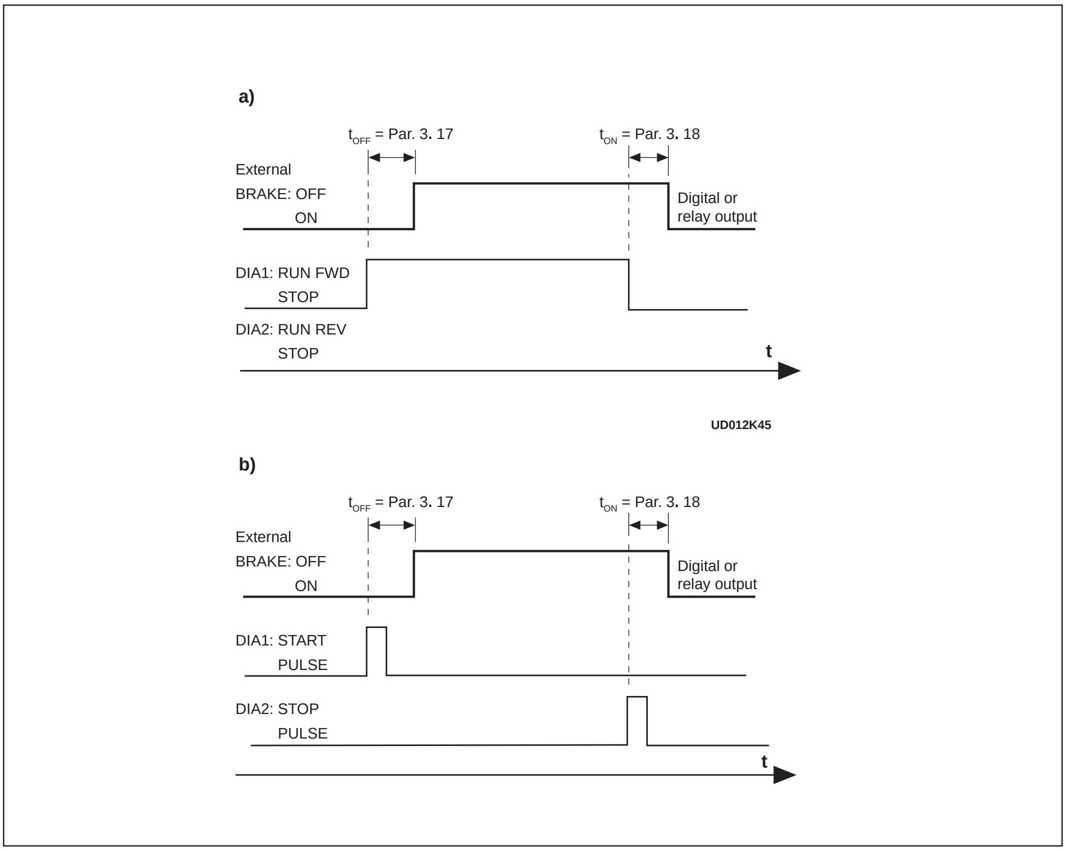

Figure 6.5-11 External brake control: a) Start/Stop logic selection par. 2. 1 = 0, 1 or 2
b)Start/Stop logic selection par. 2. 1 = 3.

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

The acceleration and deceleration ramp shape can be programmed 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, 1. 4 (4. 3, 4. 4 for Acc/Dec time 2).

Setting 0.1—10 seconds for 4. 1 (4. 2) causes an S-shaped ramp. The speed changes are smooth. Parameter 1. 3/ 1. 4 (4. 3/ 4. 4) determines the ramp time of the acceleration/deceleration in the middle of the curve. See figure 6.5-12.

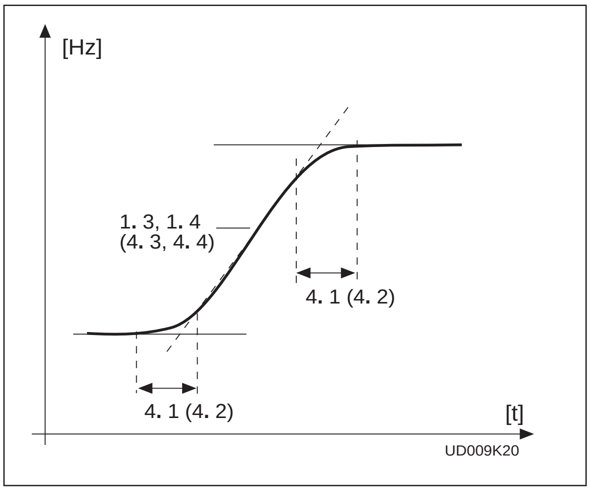

Figure 6.5-12 S-shaped acceleration/ deceleration.

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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 this parameter it is possibile to set two different acceleration/deceleration times for one application. The active set can be selected with programmable signal DIA3 of this application. See parameter 2. 2. Acceleration/deceleration times can be reduced with a external free analog input signal. See parameters 2. 18 and 2. 19.

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 is fed into the external brake resistor. If the brake resistor is selected correctly the drive is able to decelerate the load with a torque equal to that of acceleration. 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 within the set acceleration time. (Load inertia or starting friction may cause prolonged acceleration times).

Flying start:

1 The drive starts 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 reached. The output frequency then accelerates/decelerates to the set reference value at a rate determined by the acceleration/deceleration ramp parameters.

Use this mode if the motor may be 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 an uncontrolled stop with the SV9000 off, after the Stop command.

Ramp:

1 After the Stop command, the speed of the motor is decelerated according to the deceleration ramp time parameter. 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 the DC braking.

4. 9 DC braking time at stop

4. 9 DC braking time at stop

Determines whether DC 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 6.5-13.

0 DC-brake is not used

>0 DC-brake is in use depending on the setup of the stop function (param. 4**.** 7). The time is set by 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 $\geq$ nominal frequency of the motor (par. 1.11), the value of parameter 4.9 determines the braking time. When the frequency is $\leq$ 10% of the nominal, the braking time is 10% of the set value of parameter 4.9.

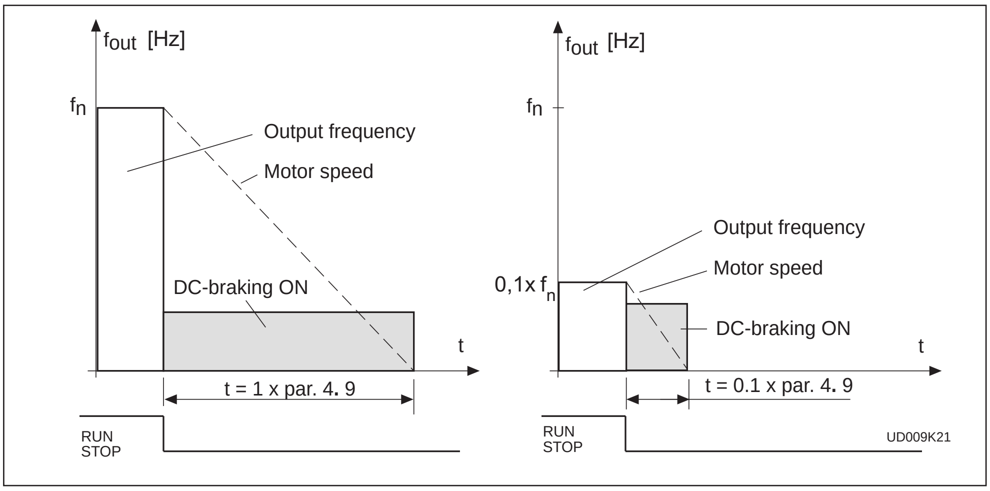

Figure 6.5-13 DC-braking time when par. 4. 7 = 0.

Stop-function = 1 (ramp):

After the Stop command, the speed of the motor is reduced baed on the deceleration ramp parameter, if no regeneration occurs due to load inertia, to a speed defined with by parameter 4**.** 10, where the DC-braking starts.

The braking time is defined with parameter 4**.** 9.

If high inertia exists, it is recommended to use an external braking resistor for faster deceleration. See figure 6.5-14.

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

See figure 6.5-14.

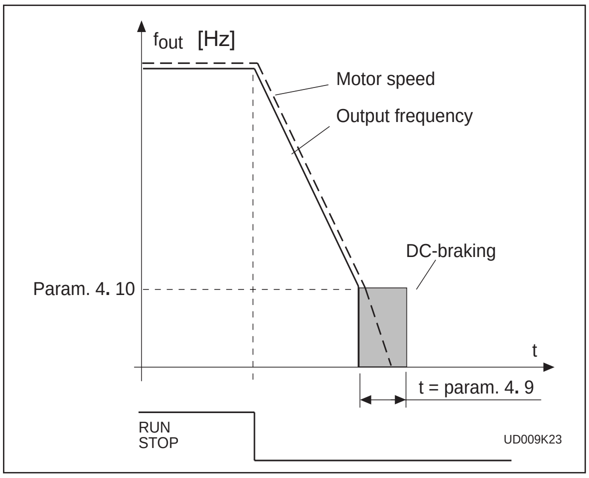

Figure 6.5-14 DC-braking time when par. 4. 7 = 1.

4. 11 DC-brake time at start

0 DC-brake is not used

>0 DC-brake is active when the start command is given. 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 6.5-15.

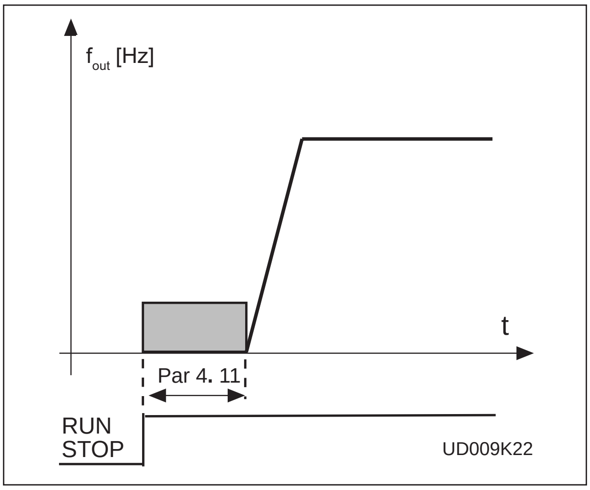

Figure 6.5-15 DC-braking time at start

4. 12 Jog speed reference

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

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. The accuracy of the setting is 0.1 Hz.

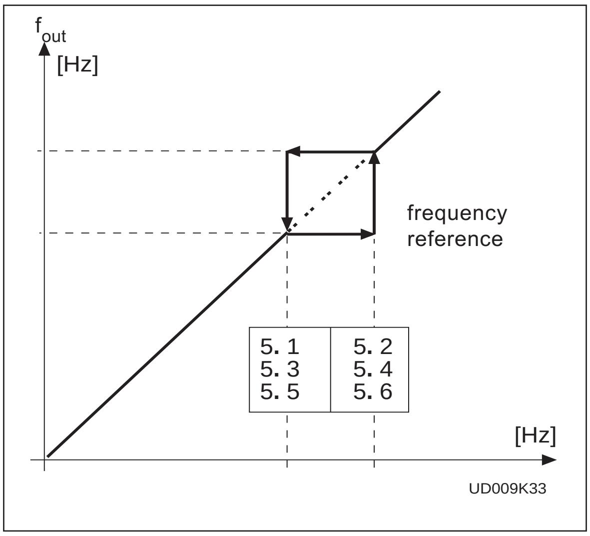

Figure 6.5-16 Example of prohibit frequency area setting.

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 freq. 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%).

6. 2 Switching frequency

Motor noise can be minimized by using a high switching frequency. Increasing the frequency reduces the capacity of the SV9000. Before changing the frequency from the factory default 10 kHz (3.6 kHz≥40Hp), check the drive derating from the curves in figure 5.2-2 and 5.2-3 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 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 6.5-17.

When 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 the parameters 1. 10 and 1. 11.

6. 5 V/Hz curve, middle point frequency

If the programmable V/Hz curve has been selected with **2. 28**parameter 1. 8 this parameter defines the middle point frequency of the curve. See figure 6.5-17.

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 motor nominal voltage) of the curve. See figure 6.5-17.

6. 7 Output voltage at zero frequency

If the programmable V/Hz curve has been selected with parameter 1. 8 this parameter defines the zero frequency voltage of the curve. See figure 6.5-17.

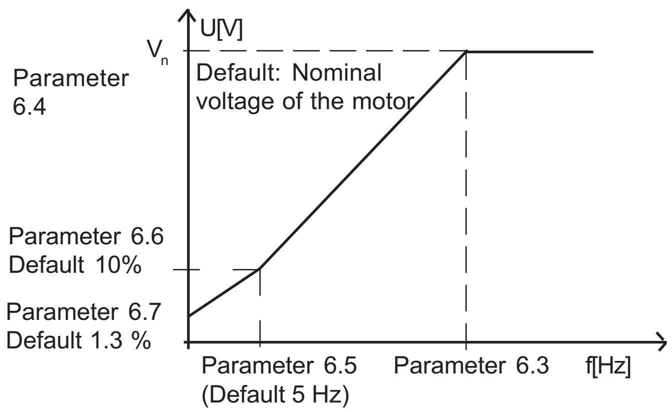

Figure 6.5-17 Programmable V/Hz curve

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 not used.

7. 1 Response to the reference fault

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

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

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

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 into 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 message

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

Parameters 7. 5—7. 9 Motor thermal protection

General

Motor thermal protection is to protect 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. With low frequencies the cooling effect of the motor fan is reduced and the capacity of the motor is reduced. If the motor is equipped with an external fan, the load reduction on low speed is small.

Motor thermal protection is based on a calculated model and it uses the output current of the drive to determine the load on the motor. When the power is turned on to the drive, the calculated 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.

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 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 6.5-18. The default values of these parameters are set 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 with 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 (refer par. 7**.** 5) if the thermal model reaches a value of 105%. The response time of the thermal model 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. Refer to the table for monitoring items. (User's Manual, table 7.3-1).

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

7. 5 Motor thermal protection

Operation:

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

Tripping and warning will give a display indication with the same message code. If tripping is selected, the drive will stop and activate the fault stage.

Deactivating the protectionby setting this 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 break point on the thermal current curve. See figure 6.5-18.

The value is set as a percentage of the motor nameplate nominal current, parameter 1**.** 13, nominal current of the motor, not the drive's nominal output current.

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

If parameter 1**.** 13 is adjusted, this parameter is automatically restored to its 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. 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 6.5-18.

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 higher).

The value is set as a percentage of the motor's nameplate nominal current, parameter 1**.** 13, not the drive's nominal output current. The motor's nominal

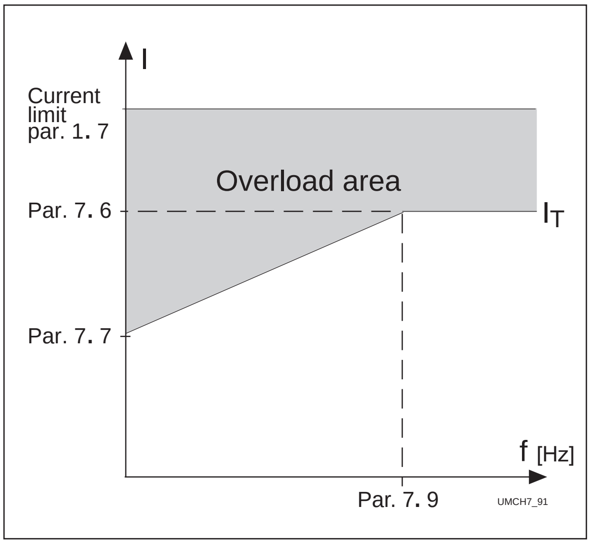

Figure 6.5-18 Motor thermal current I_T curve.

current is the current which the motor can stand 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 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

The time can be set between 0.5—300 minutes.This is the thermal time constant of the motor. The larger the motor the greater the time constant. The time constant is defined as the time it takes the calculated thermal stage to reach 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 nameplate data from parameters 1. 12 and 1. 13. If either of these parameters is reset, then 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 based 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 in stopped, the time constant is internally increased to three times the set parameter value. The cooling in the stop stage is based on convection with an increased time constant.

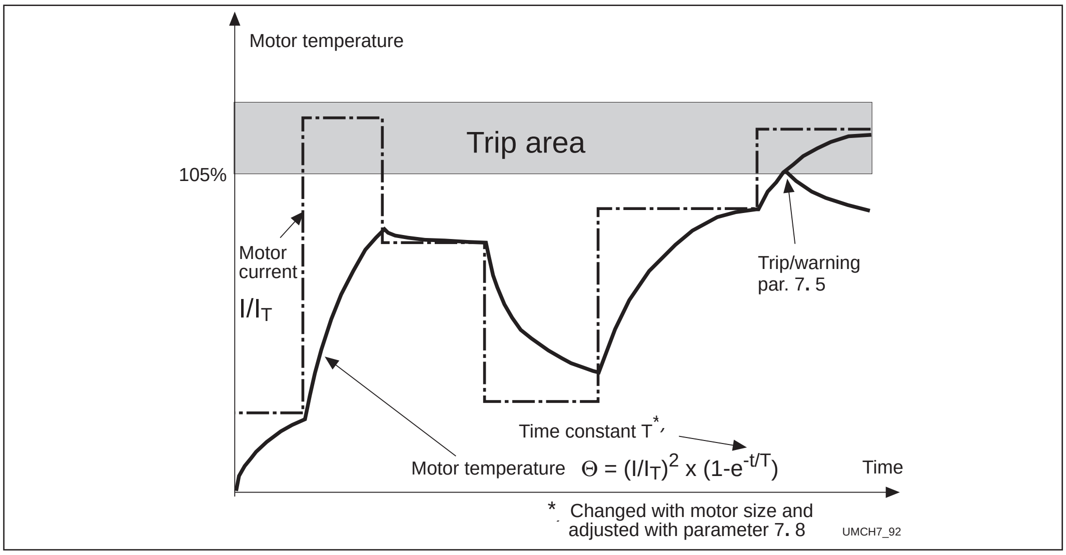

Figure 6.5-19 Calculating motor temperature

7. 9 Motor thermal protection, break point frequency

The frequency can be set between 10—500 Hz.This is the frequency break point of thermal current curve. With frequencies above this point the thermal capacity of the motor is assumed to be constant. See figure 6.5-18.

The default value is based on motor's nameplate 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 stall protection can be set shorter than with motor thermal protection. 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 actually no real indication of the 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 give a display indication with the same message code. If tripping is set on, the drive will stop and activate the fault stage.

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

7. 11 Stall current limit

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

In a stall the current has to be above this limit. See figure 6.5-20. The value is set as a percentage of the motor's name-plate nominal current, parameter 1.13. If parameter 1.13 is adjusted, this parameter is automatically restored to its default value.

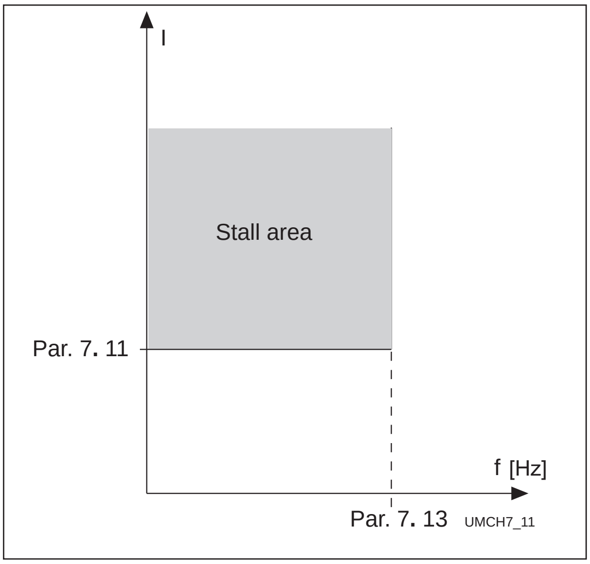

Figure 6.5-20 Setting the stall characteristics.

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 6.5-21. If the stall time counter value goes above this limit the protection will cause a trip (refer to the parameter 7. 10).

7. 13 Maximum stall frequency

The frequency can be set between 1—f_{max} (par. 1. 2).
In the stall state, the output frequency has to be smaller than this limit. See figure 6.5-20.

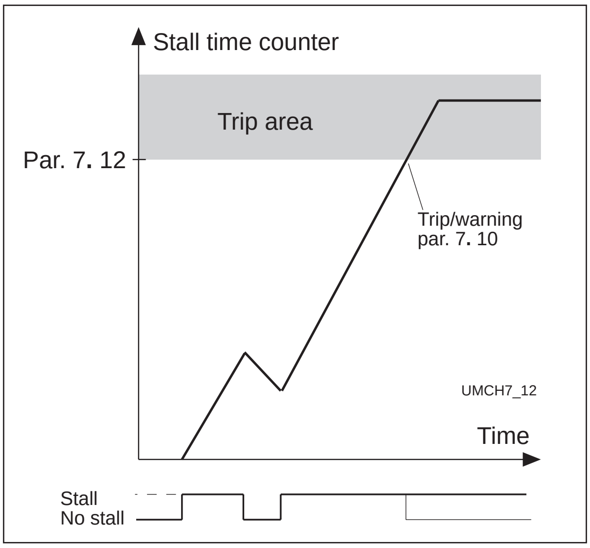

Figure 6.5-21 Counting the stall time.

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

The purpose of motor underload protection is to ensure that there is load on the motor while the drive is running. If the motor load is reduced, there might be a problem in the process, e.g. 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 5Hz (the underload counter value is stopped). See figure 6.5-22.

The torque values for setting the underload curve are set with percentage values which refer to the nominal torque of the motor. The motor's nameplate data, parameter 1. 13, the motor's nominal current and the drive's nominal current I_{CT} are used to find the scaling ratio for the internal torque value. If other than standard motor is used with the drive, the accuracy of the torque calculation is decreased.

7. 14 Underload protection

Operation:

0 = Not in use
1 = Warning
2 = Fault

Tripping and warning will give a display indication with the same message code. If tripping is set active the drive will stop and activate the fault stage.

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

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 the figure 6.5-22. If parameter 1. 13 is adjusted, this parameter is automatically restored to its default value.

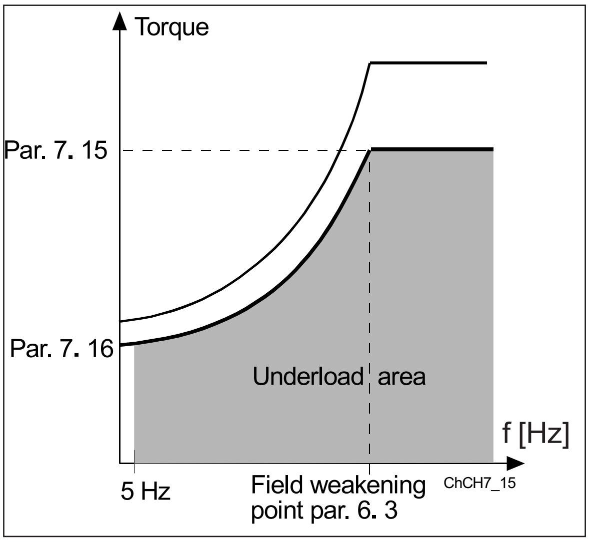

Figure 6.5-22 Setting of minimum load.

7. 16 Underload protection, zero frequency load

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

This parameter is the value for the minimum allowed torque with zero frequency. See figure 6.5-22. If parameter 1. 13 is adjusted, this parameter is automatically restored to its 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 6.5-23. If the underload counter value goes above this limit, the protection will cause a trip (refer to the parameter 7. 14). If the drive is stopped the underload counter is reset to zero.

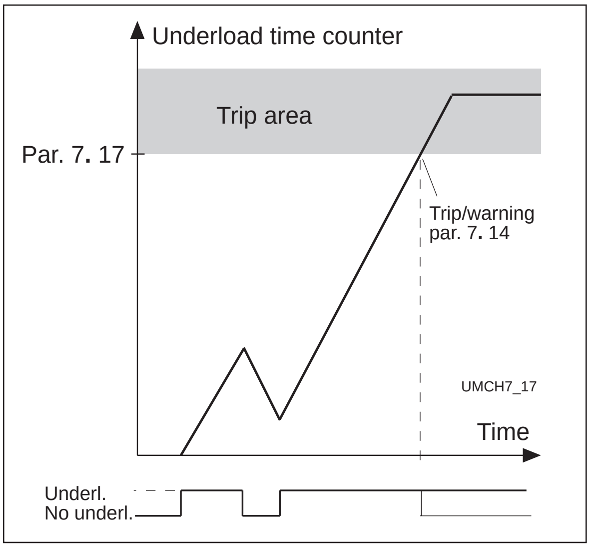

Figure 6.5-23 Counting the underload time.

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 time counting starts from the first autorestart. If the number of restarts does not exceed the value of parameter 8.1 during the trial time, the counting is cleared after the trial time has elapsed. The next fault starts the counting again. See figure 6.5-2.

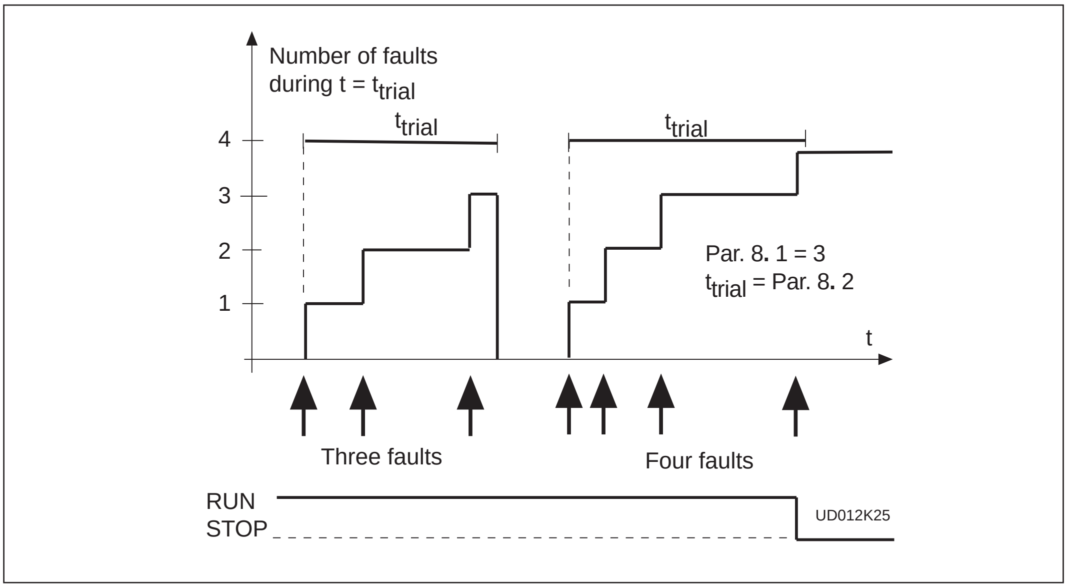

Figure 6.5-24 Automatic restart.

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 trip
1 = Automatic restart after undervoltage fault condition returns to the normal condition (DC-link voltage returns to the normal level)

8. 5 Automatic restart after overvoltage trip

0 = No automatic restart after overvoltage 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 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.

9. 1 Number of auxiliary drives

With this parameter the number of auxiliary drives in use is defined. The signals to control the auxiliary drives on and off can be programmed to the relay outputs or to the digital output with parameters 3. 6 - 3. 8. The default setting is one auxiliary drive in use, pre-programmed to relay output RO1.

9. 2 Start frequency of auxiliary drive 1
9. 4 Start frequency of auxiliary drive 2
9. 6 Start frequency of auxiliary drive 3

The frequency of the SV9000 must exceed by 1 Hz the limit defined with these parameters before the auxiliary drive is started. The 1 Hz provides hysteresis to avoid unnecessary starts and stops. See figure 6.5-25.

9. 3 Stop frequency of auxiliary drive 1
9. 5 Stop frequency of auxiliary drive 2
9. 7 Stop frequency of auxiliary drive 3

The frequency of the SV9000 must fall 1Hz below the limit defined with these parameters before the auxiliary drive is stopped. The stop frequency limit also defines the frequency the drive drops to after starting the auxiliary drive. See figure 6.5-25.

9. 10 Start delay of auxiliary drives

Starting of the auxiliary drives is delayed based on the time setting of parameter 9. 10. This prevents unnecessary starts which could be caused by a flow reference request which is momentarily above the previous reference level. See figure 6.5-25.

9. 11 Stop delay of auxiliary drives

Stopping of the auxiliary drives is delayed based on the time setting of parameter 9. 10. This prevents unnecessary stops which could be caused by a flow reference request which is momentarily below the previous reference level. See figure 6.5-25.

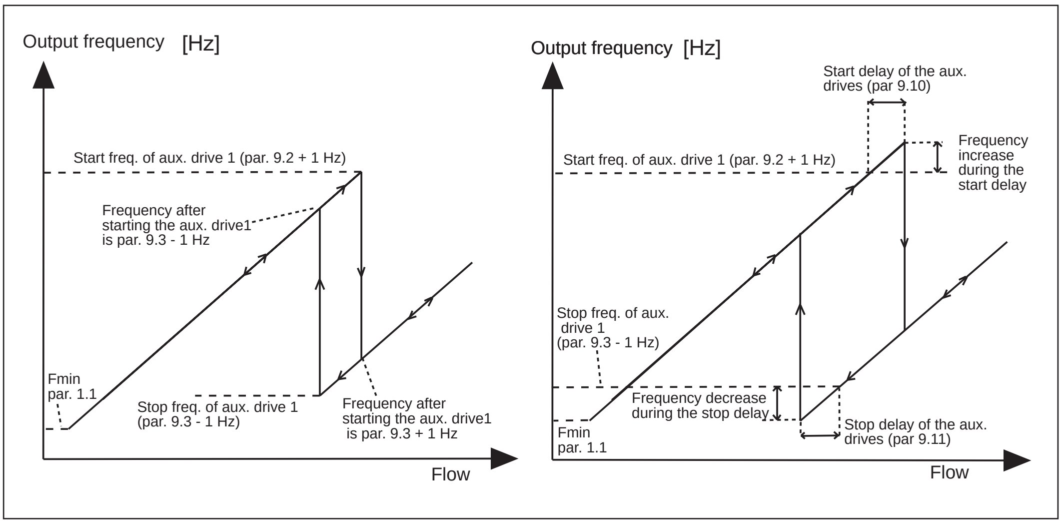

Figure 6.5-25 Example of the effect of parameters in variable speed and one auxiliary drive system.

9. 12 Reference step after start of the auxiliary drive 1
9. 13 Reference step after start of the auxiliary drive 2
9. 14 Reference step after start of the auxiliary drive 3

A reference step will automatically be added to the reference value when the corresponding auxiliary drive is started. This allows compensation for the pressure loss in the piping caused by the increased flow. See figure 6.5-26.

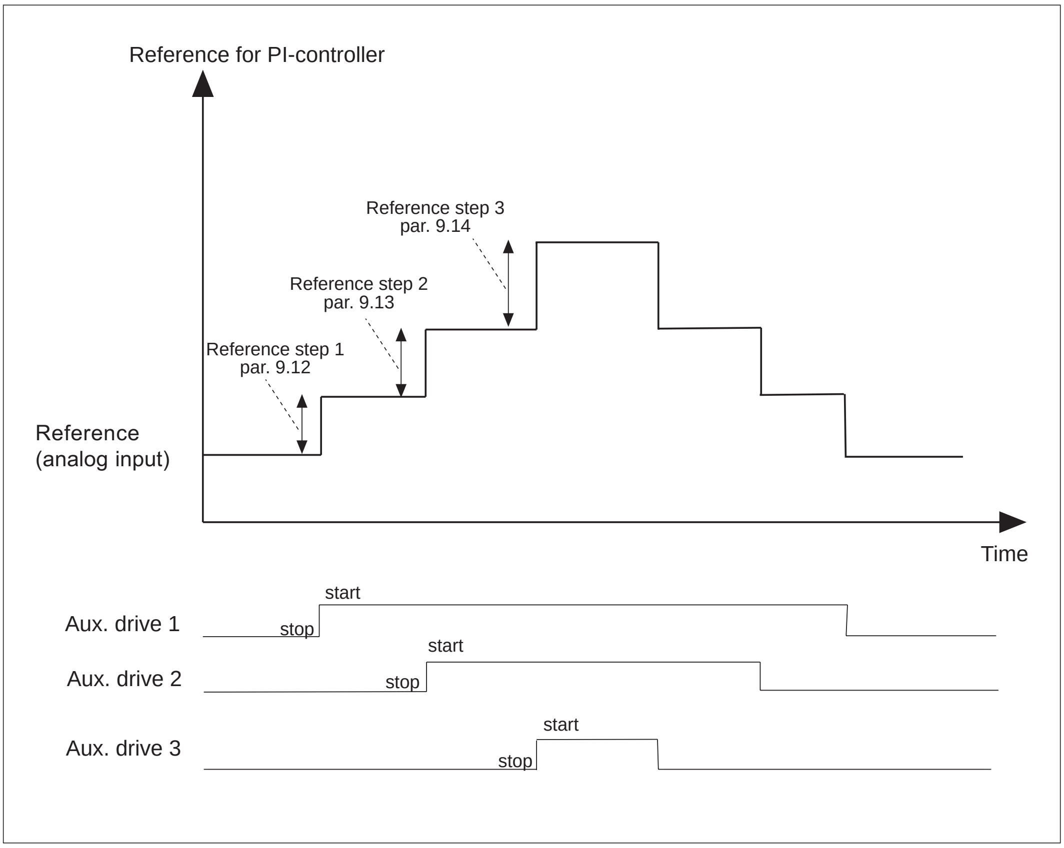

Figure 6.5-26 Reference steps after starting and stopping the auxiliary drives.

9. 16 Sleep level
9. 17 Sleep delay

Changing this parameter from a value of 0.0 Hz activates the sleep function where the drive is stopped automatically when the frequency is below the sleep level (par. 9.16) continuously over the sleep delay (9. 17) time. During the stop state the Pump and fan control logic is operating and will switch the drive to the Run state when the wake up level defined with parameters 9. 18 and 9. 19 is reached. See figure 6.5-27.

9. 18 Wake up level

The wake up level defines the percentage level below which the actual frequency must fall or which has to be exceeded before starting the drive from the sleep function. See figure 6.5-27.

9. 19 Wake up function

This parameter defines if the wake up occurs when the frequency either falls below or exceeds the wake up level (par. 9. 18).

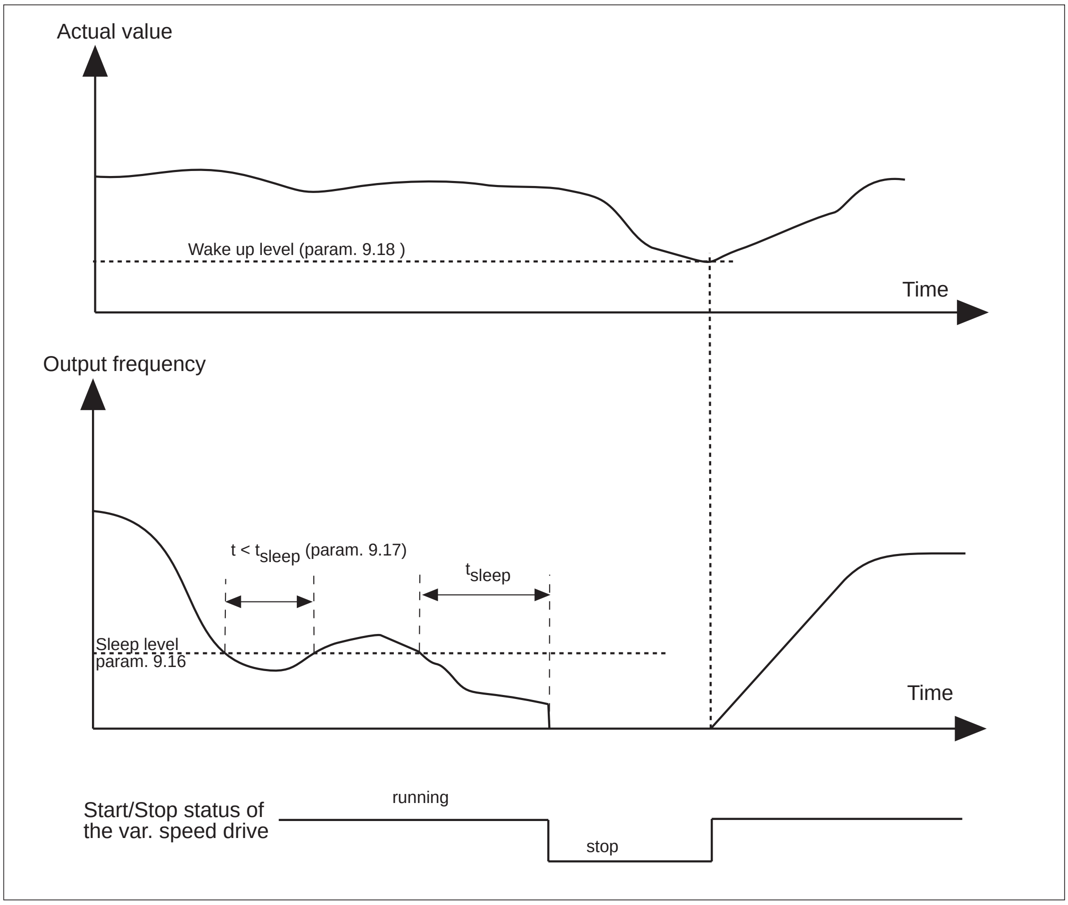

Figure 6.5-27 Example of the sleep function.

9. 20 PI-regulator bypass

With this parameter the PI-requlator can be programmed to be bypassed. Then the frequency of the drive is controlled by the frequency reference and the starting points of the auxiliary drives are also defined by this reference.

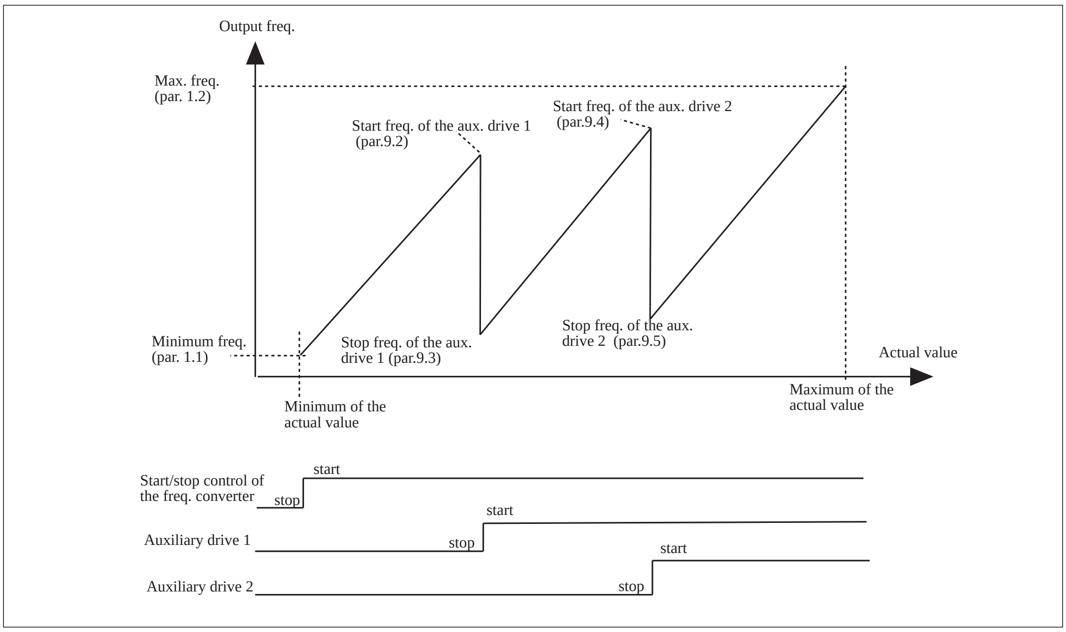

Figure 6.5-28 Example of the function of variable speed drive and two auxiliary drives when PI-requlator is bypassed with parameter 9. 20.

6.6 MONITORING DATA

The PI-control application has additional items for monitoring (n20 - n25). See table 6.6-1

Data number	Data name	Unit	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	Hp	Shows the horsepower size of the unit
n 20	PI-controller reference	%	Percent of the maximum reference
n 21	PI-controller actual value	%	Percent of the maximum actual value
n 22	PI-controller error value	%	Percent of the maximum error value
n 23	PI-controller output	Hz	
n 24	Number of running auxiliary drives		
n 25	Motor temperature rise	%	100%= temperature of motor has risen to nominal

Table 6.6-1 Monitored items.

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

6

6.7 Panel reference

The Pump and fan control application has an extra reference (r2) for PI-controller on the panel's reference page. See table 6.7-1.

Refrence number	Reference name	Range	Step	Function
r1	Frequency reference	f_{min}—f_{max}	0.01 Hz	Reference for panel control and I/O terminal Source B reference.
r2	PI-controller reference	0—100%	0.1%	Reference for PI-controller

Table 6.7-1 Panel reference.

Remarks:

Cutler-Hammer, a part of Eaton Corporation, is a worldwide leader providing customer-driven solutions. From power distribution and electrical control products to industrial automation, Cutler-Hammer utilizes advanced product development, world-class manufacturing, and offers global engineering services and support.

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