VACON® NX

AC DRIVES

LIQUID-COOLED DRIVES

HEAT EXCHANGER

APPLICATION MANUAL

VACON®

INDEX

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Heat exchanger application

1. GENERAL

This application is aimed to be used in the Vacon liquid-cooled AC drive inside the Heat exchanger unit.

The idea with the application is to maintain a constant flow of coolant through the heat exchanger and through the Vacon liquid-cooled drive.

The user sets a certain speed for the pump of the heat exchanger unit that produces a sufficient flow through the Vacon liquid-cooled drives to keep them cooled. This speed is NOT regulated but fixed by a parameter set value.

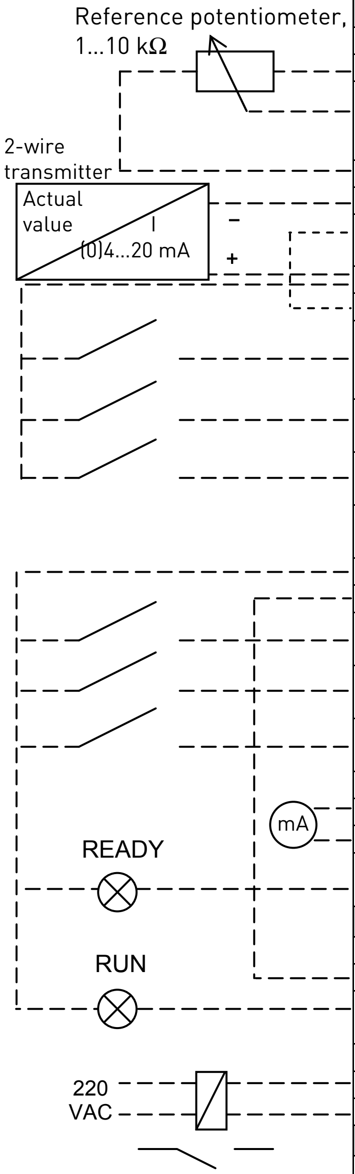
The Vacon AC drive also handles the temperature of the water in the heat exchanger unit by regulating the valve that handles the coolant intake to the heat exchanger element (from the customer's system). This regulation is based on the temperature of the water in the pipes between the outlet of the heat exchanger pump and the inlet of the cooling element of the Vacon liquid-cooled drive.

The actual value of the temperature for the regulation comes from a sensor called FSA11. This is a type of flow switch that measures both the temperature of the coolant and the flow in the pipes. If there is not enough flow in the pipe the sensor gives a signal that tells the drive to stop due to insufficient flow.

Vacon NX AC drives can be connected to the Profibus DP using a fieldbus board. The AC drive can then be controlled, monitored and programmed from the Host system. Profibus fieldbus board (OPT-C5) is normally included in the delivery of Vacon NX liquid-cooled drive Heat Exchanger Solution. The Profibus fieldbus board must be installed in slot E on the control board of the AC drive. For more information on the Profibus fieldbus board, see Vacon OPTC3/C5 Profibus Option Board User Manual.

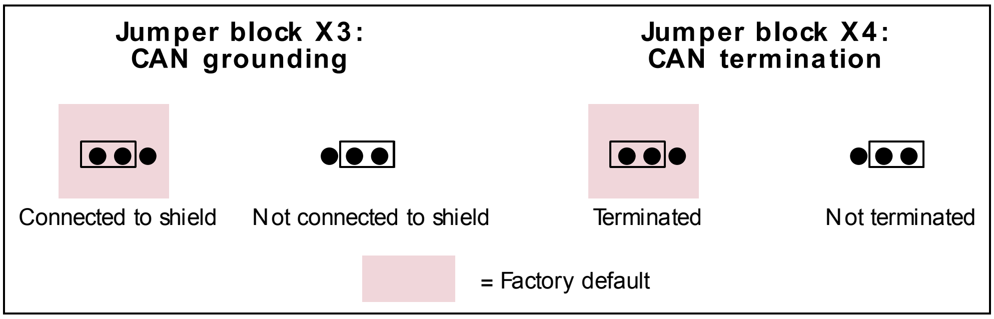
The standard delivery also includes I/O boards OPT-A1 (placed in slot A), OPT-A2 (placed in slot B) and OPT-B5 (placed in slot C or D). The application, however, offers you more signals than the standard set of I/O boards allows you to connect. If you wish to use one additional analogue input signal and/or two additional analogue output signals, we recommend you to order Vacon I/O board OPT-B4 and place it in the last free board slot (C or D).

2. CONTROL I/O



OPT-A1			
Terminal		Signal	Description
1	+10V$_{ref}$	Reference output	Voltage for potentiometer, etc.
2	AI1+	Analogue input, voltage range 0—10V DC	Pressure, outlet (pump)
3	AI1-	I/O Ground	Ground for reference and controls
4	AI2+	Analogue input, current range 0—20mA	Temperature
5	AI2-		
6	+24V	Control voltage output	Voltage for switches, etc. max 0.1 A
7	GND	I/O ground	Ground for reference and controls
8	DIN1	Start/Stop Control place A (PID controller)	Contact closed = start
9	DIN2	Flow fault	NO/NC programmable
10	DIN3	External fault (programmable)	Contact open = External fault
11	CMA	Common for DIN 1—DIN 3	Connect to GND or +24V
12	+24V	Control voltage output	Voltage for switches (see #6)
13	GND	I/O ground	Ground for reference and controls
14	DIN4	Pump 1	Forced or single run Combined with DIN1
15	DIN5	Pump 2	Forced or single run Combined with DIN1
16	DIN6	Sequence, 2-pump system	Combined with DIN1
17	CMB	Common for DIN4—DIN6	Connect to GND or +24V
18	AO1+	Output frequency	Programmable
19	AO1-	Analogue output	Range 0—20 mA/R$_L$, max. 500Ω
20	DO1	Digital output READY	Programmable Open collector, I≤50mA, U≤48 VDC
OPT-A2			
21	RO1	Relay output 1 RUN	Programmable
22	RO1		
23	RO1		
24	RO2	Relay output 2 FAULT	Programmable
25	RO2		
26	RO2		
OPT-B5			
22	RO1	Relay output 1 COOLING OK	
23	RO1		
25	RO2	Relay output 2 PUMP 1	
26	RO2		
28	RO3	Relay output 3 PUMP 2	
29	RO3		

Table 1. Heat exchanger application I/O configuration example (with 2-wire transmitter).



3. PARAMETER LISTS

On the next pages you will find the lists of parameters within the respective parameter groups. The parameter descriptions are given on pages 21 to 52.

Column explanations:
Code = Location indication on the keypad; Shows the operator the present param. number
Parameter = Name of parameter
Min = Minimum value of parameter
Max = Maximum value of parameter
Unit = Unit of parameter value; Given if available
Default = Value preset by factory
Cust = Customer's own setting
ID = ID number of the parameter
(grey) = In parameter row: Use TTF method to program these parameters.
(cyan) = On parameter code: Parameter value can only be changed after the FC has been stopped.

3.1 Monitoring values (Control keypad: menu M1)

The monitoring values are the actual values of parameters and signals as well as statuses and measurements. Monitoring values cannot be edited.
See the product's user manual for more information.

Code	Parameter	Unit	ID	Description
V1.1	Output frequency	Hz	1	Output frequency to motor
V1.2	Frequency reference	Hz	25	Frequency reference to motor control
V1.3	Motor speed	rpm	2	Motor speed in rpm
V1.4	Motor current	A	3	
V1.5	Motor torque	%	4	Calculated shaft torque
V1.6	Motor power	%	5	Motor shaft power
V1.7	Motor voltage	V	6	
V1.8	DC link voltage	V	7	
V1.9	Unit temperature	°C	8	Heatsink temperature
V1.10	Analogue input 1	V	13	AI1
V1.11	Analogue input 2	mA	14	AI2
V1.12	Analogue input 3		1543	AI3
V1.13	Analog Output1		26	
V1.14	DIN1, DIN2, DIN3		15	Digital input statuses
V1.15	DIN4, DIN5, DIN6		16	Digital input statuses
V1.16	RO1, RO2, RO3		1516	Relay output statuses
V1.17	RO4, RO5, RO6		1574	Relay output statuses
V1.18	Temp reference	°C	1500	
V1.19	Actual temperature	°C	1501	
V1.20	Temp error value	°C	1502	
V1.21	PID output	%	23	In % of the max. output value
V1.22	Inlet pressure	bar	1511	PT11

Table 2. Monitoring values

3.1.1 FB Monitor

Code	Parameter	Unit	ID	Description
V1.23.1	Motor Current	A	45	Motor current with one decimal
V1.23.2	Fault History		37	Last active fault code
V1.23.3	Status Word		43	Application status word
V1.23.4	Status Word 2		1800	Application status word 2
V1.23.5	Fault Word 1		1172	General fault word 1
V1.23.6	Fault Word 2		1173	General fault word
V1.23.7	Warning Word 1		1174	General warning word
V1.23.8	Fault Word 10		1202	Heat exchanger specific faults
V1.23.9	Warning Word 10		1269	Heat exchanger specific warnings

Table 3. Monitoring values (G1.24 FB Monitor)

3.1.1.1 Status Word, ID43

	Description	Comment
b0		
b1	Ready	
b2	Run	
b3	Fault	
b4		
b5		
b6	Run enable	
b7	Warning	
b8		
b9		
b10	RO4 status	
b11	RO5 status	
b12	Run request	
b13	Motor regulator active	
b14		
b15	Cooling OK	

Table 4. Status Word

3.1.1.2 Status Word 2, ID1800

Give this status word to Vacon personnel in case of problems with running the application.

3.1.1.3 Fault Word 1, ID1172

	Description	Comment
b0	Over current	F1
b1	Over voltage	F2
b2	Under voltage	F9
b3	Motor stalled	F15
b4		
b5	Motor underload	F17
b6	Unit over temperature	
b7	Motor over temperature	F16
b8	Input phase	F10
b9		
b10		
b11	Keypad or PC communication	F52
b12	Fieldbus communication	F53
b13		
b14	Slot communication	F54
b15	4 mA	F50

Table 5. Fault Word 1

3.1.1.4 Fault Word 2, ID1173

	Description	Comment
b0	Output phase	F11
b6	External fault	F51 (fault or warning)
b9	IGBT	F41

Table 6. Fault Word 2

3.1.1.5 Warning Word 1, ID1174

	Description	Comment
b0	Motor stalled	F15
b1	Motor over temperature	F16, F29 (fault or warn)
b2	Motor underload	F17
b3	Input phase	F10
b4	Output phase	F11
b8	Unit temperature	
b9	4 mA	F50
b15	Keypad communication	F52

Table 7. Warning Word 1

3.1.1.6 Fault Word 10, ID1202

	Description	Comment
b0		
b1		
b2		
b3		
b4		
b5	Over temperature	F85 (warning)
b6		
b7	Inlet pressure low	F88
b8	Flow	F87

Table 8. Fault Word 10

3.1.1.7 Warning Word 10, ID1269

	Description	Comment
b0		
b1		
b2		
b3	Inlet pressure low	F82
b4	Over temperature	F83
b5	Low temperature	F86
b6		

Table 9. Warning Word 10

3.2 Basic parameters (Control keypad: Menu M2 → G2.1)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.1.1	Min Frequency	0.00	Par. 2.1.2	Hz	25.00		101	
P2.1.2	Max Frequency	Par. 2.1.1	320.00	Hz	50.00		102	NOTE: If f_{max} > than the motor synchronous speed, check suitability for motor and drive system
P2.1.3	Acceleration time 1	0.1	3000.0	s	1.0		103	NOTE: If PID-controller is used, Acceleration time 2 (par. 2.4.3) is automatically applied
P2.1.4	Deceleration time 1	0.1	3000.0	s	1.0		104	NOTE: If PID-controller is used, Deceleration time 2 (par. 2.4.4) is automatically applied
P2.1.5	Current limit	0	2 x I_H	A	I_L		107	
P2.1.6	Nominal voltage of the motor	180	690	V	400V		110	
P2.1.7	Nominal frequency of the motor	30.00	320.00	Hz	50.00		111	Check the rating plate of the motor
P2.1.8	Nominal speed of the motor	300	20 000	rpm	1440		112	The default applies for a 4-pole motor and a nominal size AC drive.
P2.1.9	Nominal current of the motor	0.4 x I_H	2 x I_H	A	I_H		113	Check the rating plate of the motor.
P2.1.10	Motor cosφ	0.30	1.00		0.85		120	Check the rating plate of the motor
P2.1.11	Start function	0	1		0		505	0=Ramp 1=Flying start
P2.1.12	Stop function	0	3		0		506	0=Coasting 1=Ramp 2=Ramp+Run enable coast 3=Coast+Run enable ramp
P2.1.13	U/f optimization	0	1		0		109	0=Not used 1=Automatic torque boost
P2.1.14	I/O reference	0	1		0		117	0=Keypad reference 1=Fieldbus reference
P2.1.15	Preset speed1	0.00	Par. 2.1.2	Hz	10.00		105	
P2.1.16	Automatic restart	0	1		0		731	0=Not used 1=Automatic restart
P2.1.17	Parameter conceal	0	1		1		115	0=All parameters visible 1=Basic group (G2.1) visible

Table 10. Basic parameters G2.1

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3.3 Input signals (Control keypad: Menu M2 → G2.2)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.2.1	DIN2 input	0	1		1		1590	0=Normally open 1=Normally closed
P2.2.2	DIN3 function	0	10		3		301	0=Motor pot. UP(cc) 1=Reverse 2=External fault CC 3=External fault OC 4=Fault reset 5=Run enable 6=Preset speed 1 7=DC brake cmnd 8=PID disable 9=PID disable, go to preset speed 10=PID keypad ref 2
P2.2.3	DIN6 Function	0	1		0		1572	0=Preset Speed 1 1=Fault Reset
P2.2.4	AI1 signal range	0	3		1		379	0=Signal range 0-20mA 1=Signal range 4-20mA 2=0-10V 3=2-10V
P2.2.5	AI1 supervision	0	1		0		1544	
P2.2.6	AI1 custom minimum setting	0.00	P2.2.6	%	0.00		380	
P2.2.7	AI1 custom maximum setting	0.00	100.00	%	100.00		381	
P2.2.8	AI1 inversion	0	1		0		387	0=Not inverted 1=Inverted
P2.2.9	AI1 filter time	0.00	10.00	s	1.00		378	0=No filtering
P2.2.10	AI2 signal range	0	1		1		390	0=Signal range 0-20mA 1=Signal range 4-20mA
P2.2.11	AI2 supervision	0	1		1		1545	
P2.2.12	AI2 custom minimum setting	0.00	P2.2.6	%	0.00		391	
P2.2.13	AI2 custom maximum setting	0.00	100.00	%	100.00		392	
P2.2.14	AI2 inversion	0	1		0		398	0=Not inverted 1=Inverted
P2.2.15	AI2 filter time	0.00	10.00	s	1.00		389	0=No filtering
P2.2.16	AI3 signal selection	0	59				1558	TTF programming method
P2.2.17	AI3 signal range	0	1		1		1520	0=Signal range 0-20mA 1=Signal range 4-20mA
P2.2.18	AI3 supervision	0	1		0		1546	
P2.2.19	AI3 custom minimum setting	0.00	P2.2.18	%	0.00		1517	
P2.2.20	AI3 custom maximum setting	P2.2.17	100.00	%	100.00		1518	
P2.2.21	AI3 inversion	0	1		0		1529	0=Not inverted 1=Inverted
P2.2.22	AI3 filter time	0.00	10.00	s	1.00		1526	0=No filtering
P2.2.23	Keypad control reference	0	1		0		121	Keypad freq ref selection: 0=Reference from Keypad 1=FB reference
P2.2.24	Fieldbus control reference	0	1		1		122	Fieldbus frequency reference selection: 0=Reference from Keypad 1=FB reference

Table 11. Input signals, G2.2

*Remember to place jumpers of block X2 accordingly. See the product's user manual.

3.4 Output signals (Control keypad: Menu M2 → G2.3)

3.4.1 Analogue output 1

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.3.1.1	Analogue output 1 function	0	13		13		307	0=Not used 1=Output freq. (0—f_{max}) 2=Freq. reference (0—f_{max}) 3=Motor speed (0—Motor nominal speed) 4=Motor current (0—I_{nMotor}) 5=Motor torque (0—T_{nMotor}) 6=Motor power (0—P_{nMotor}) 7=Motor voltage (0-U_{nMotor}) 8=DC-link volt (0—1000V) 9=PI controller temp ref 10=PI contr. act. temp. 11=PI contr. temperature error value 12=PI controller output 13=Pressure from PT11, pump inlet
P2.3.1.2	Analogue output 1 filter time	0.00	10.00	s	1.00		308	0=No filtering
P2.3.1.3	Analogue output 1 inversion	0	1		0		309	0=Not inverted 1=Inverted
P2.3.1.4	Analogue output 1 minimum	0	1		1		310	0=0 mA 1=4 mA
P2.3.1.5	Analogue output 1 scale	10	1000	%	100		311	

Table 12. Analogue output 1 signals

3.4.2 Analogue output 2

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.3.2.1	Analogue output 2 function	0	13		10		1530	0=Not used 1=Output freq. (0—f_{max}) 2=Freq. reference (0—f_{max}) 3=Motor speed (0—Motor nominal speed) 4=Motor current (0—I_{nMotor}) 5=Motor torque (0—T_{nMotor}) 6=Motor power (0—P_{nMotor}) 7=Motor voltage (0-U_{nMotor}) 8=DC-link volt (0—1000V) 9=PID controller ref. value 10=PI contr. act. temp 11=PI contr. temperature error value 12=PI controller output 13=Pressure from PT11, pump inlet
P2.3.2.2	Analogue output 2 filter time	0.00	10.00	s	1.00		1531	0=No filtering
P2.3.2.3	Analogue output 2 inversion	0	1		0		1532	0=Not inverted 1=Inverted
P2.3.2.4	Analogue output 2 minimum	0	1		0		1533	0=0 mA 1=4 mA
P2.3.2.5	Analogue output 2 scale	10	1000	%	100		1534	

Table 13. Analogue output 2 signals

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3.4.3 Analogue output 3

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.3.3.1	Analogue output 3 function	0	13		4		1535	0=Not used 1=Output freq. (0—f_{max}) 2=Freq. reference (0—f_{max}) 3=Motor speed (0—Motor nominal speed) 4=Motor current (0—I_{nMotor}) 5=Motor torque (0—T_{nMotor}) 6=Motor power (0—P_{nMotor}) 7=Motor voltage (0-U_{nMotor}) 8=DC-link volt (0—1000V) 9=PID controller ref. value 10=PI contr. act. temp 11=PI contr. temperature error value 12=PID controller output 13=Pressure from PT11, pump inlet
P2.3.3.2	Analogue output 3 filter time	0.00	10.00	s	1.00		1536	0=No filtering
P2.3.3.3	Analogue output 3 inversion	0	1		0		1537	0=Not inverted 1=Inverted
P2.3.3.4	Analogue output 3 minimum	0	1		0		1538	0=0 mA 1=4 mA
P2.3.3.5	Analogue output 3 scale	10	1000	%	100		1539	

Table 14. Analogue output 3 signals

3.4.4 Relay output 1

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.3.4.1	Relay output 1 signal selection				B.1		1549	
P2.3.4.2	Relay output 1 function	0	18		2		313	0=Not used 1=Ready 2=Run 3=Fault 4=Fault inverted 5=FC overheat warning 6=Ext. fault or warning 7=Ref. fault or warning 8=Warning 9=Reversed 10=Preset speed 1 11=At speed 12=Mot. regulator active 13=OP freq. limit superv.1 14=Control place: IO 15=Thermistor fault/warn. 16=Actual value supervision 17=Cooling OK 18=Alarm latched
P2.3.4.3	Relay output 1 inversion	0	1		0		1540	0=Not inverted 1=Inverted

Table 15. Relay output 1 signals

3.4.5 Relay output 2

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.3.5.1	Relay output 2 signal selection				B.2		1550	
P2.3.5.2	Relay output 2 function	0	18		3		1513	0=Not used 1=Ready 2=Run 3=Fault 4=Fault inverted 5=FC overheat warning 6=Ext. fault or warning 7=Ref. fault or warning 8=Warning 9=Reversed 10=Preset speed 1 11=At speed 12=Mot. regulator active 13=OP freq. limit superv.1 14=Control place: IO 15=Thermistor fault/warn. 16=Actual value supervision 17=Cooling OK 18=Alarm latched
P2.3.5.3	Relay output 2 inversion	0	1		0		1541	0=Not inverted 1=Inverted

Table 16. Relay output 2 signals

3.4.6 Relay output 3

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.3.6.1	Relay output 3 signal selection				D.1		1551	
P2.3.6.2	Relay output 3 function	0	3		1		1515	0=Not used 1=Cooling OK 2=Pump 1 3=Pump 2
P2.3.6.3	Relay output 3 inversion	0	1		0		1542	0=Not inverted 1=Inverted

Table 17. Relay output 3 signals

3.4.7 Relay output 4

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.3.7.1	Relay output 4 signal selection				D.2		1552	
P2.3.7.2	Relay output 4 function	0	3		2		1553	0=Not used 1=Cooling OK 2=Pump 1 3=Pump 2
P2.3.7.3	Relay output 4 inversion	0	1		0		1554	0=Not inverted 1=Inverted

Table 18. Relay output 4 signals

3.4.8 Relay output 5

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.3.8.1	Relay output 5 signal selection				D.3		1555	
P2.3.8.2	Relay output 5 function	0	3		3		1556	0=Not used 1=Cooling OK 2=Pump 1 3=Pump 2
P2.3.8.3	Relay output 5 inversion	0	1		0		1557	0=Not inverted 1=Inverted

Table 19. Relay output 5 signals

3.4.9 Relay output 6

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.3.9.1	Relay output 6 signal selection				A.1		1573	
P2.3.9.2	Relay output 6 function	0	18		3		1567	0=Not used 1=Ready 2=Run 3=Fault 4=Fault inverted 5=FC overheat warning 6=Ext. fault or warning 7=Ref. fault or warning 8=Warning 9=Reversed 10=Preset speed 1 11=At speed 12=Mot. regulator active 13=OP freq. limit superv.1 14=Control place: IO 15=Thermistor fault/warn. 16=Actual value supervision 17=Cooling OK 18=Alarm latched
P2.3.9.3	Relay output 6 inversion	0	1		0		1568	0=Not inverted 1=Inverted

Table 20. Relay output 6 signals

3.5 Drive control parameters (Control keypad: Menu M2 → G2.4)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.4.1	Ramp 1 shape	0.0	10.0	s	0.0		500	0=Linear >0=S-curve ramp time
P2.4.2	Brake chopper	0	3		0		504	0=Disabled 1=Used when running 2=External brake chopper 3=Used when stopped/ running
P2.4.3	DC braking current	0.4 x I_H	2 x I_H	A	I_H		507	
P2.4.4	DC braking time at stop	0.00	600.00	s	0.00		508	0=DC brake is off at stop
P2.4.5	Frequency to start DC braking during ramp stop	0.10	10.00	Hz	1.50		515	
P2.4.6	DC braking time at start	0.00	600.00	s	0.00		516	0=DC brake is off at start
P2.4.7	Flux brake	0	1		0		520	0=Off 1=On
P2.4.8	Flux braking current	0.4 x I_H	2 x I_H	A	I_H		519	

Table 21. Drive control parameters, G2.4

3.6 Prohibit frequency parameters (Control keypad: Menu M2 → G2.5)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.5.1	Prohibit frequency range 1 low limit	0.00	Par. 2.5.2	Hz	0.00		509	0=Not used
P2.5.2	Prohibit frequency range 1 high limit	0.00	Par. 2.1.2	Hz	0.00		510	0=Not used
P2.5.3	Prohibit acc./dec. ramp	0.1	10.0	Times	1.0		518	
P2.5.4	Output frequency limit 1 supervision	0	2		0		315	0=No limit 1=Low limit supervision 2=High limit supervision
P2.5.5	Output frequency limit 1; Supervised value	0.00	Par. 2.1.2	Hz	0.00		316	

Table 22. Prohibit frequency parameters, G2.5

3.7 Motor control parameters (Control keypad: Menu M2 → G2.6)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.6.1	Motor control mode	0	1		0		600	0=Frequency control 1=Speed control
P2.6.2	U/f ratio selection	0	3		0		108	0=Linear 1=Squared 2=Programmable 3=Linear with flux optim.
P2.6.3	Field weakening point	8.00	320.00	Hz	50.00		602	
P2.6.4	Voltage at field weakening point	10.00	200.00	%	100.00		603	n% x U_{nmot}
P2.6.5	U/f curve midpoint frequency	0.00	par. P2.6.4	Hz	50.00		604	
P2.6.6	U/f curve midpoint voltage	0.00	100.00	%	100.00		605	n% x U_{nmot} Parameter max. value = par. 2.6.5
P2.6.7	Output voltage at zero frequency	0.00	40.00	%	Varies		606	n% x U_{nmot}
P2.6.8	Switching frequency	1.0	Varies	kHz	Varies		601	See Table 31 for exact values
P2.6.9	Overvoltage controller	0	1		1		607	0=Not used 1=Used (no ramping)
P2.6.10	Undervoltage controller	0	1		1		608	0=Not used 1=Used

Table 23. Motor control parameters, G2.6

3.8 Protections (Control keypad: Menu M2 → G2.7)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.7.1	Response to 4mA reference fault	0	3		1		700	0=No response 1=Warning 2=Fault,stop acc. to 2.1.12 3=Fault,stop by coasting
P2.7.2	Response to external fault	0	3		1		701	See par. ID700
P2.7.3	Input phase supervision	0	3		0		730	See par. ID700
P2.7.4	Response to undervoltage fault	1	3		2		727	1=Warning 2=Fault,stop acc. to 2.1.12 3=Fault,stop by coasting
P2.7.5	Output phase supervision	0	3		2		702	See par. ID700
P2.7.6	Earth fault protection	0	3		2		703	See par. ID700
P2.7.7	Thermal protection of the motor	0	3		2		704	See par. ID700
P2.7.8	Motor ambient temperature factor	–100.0	100.0	%	0.0		705	
P2.7.9	Motor cooling factor at zero speed	0.0	150.0	%	40.0		706	
P2.7.10	Motor thermal time constant	1	200	min	Varies		707	
P2.7.11	Motor duty cycle	0	100	%	100		708	
P2.7.12	Stall protection	0	3		1		709	See par. ID700
P2.7.13	Stall current	0.1	I_{nMotor} x 2	A	I_L		710	
P2.7.14	Stall time limit	1.00	120.00	s	15.00		711	
P2.7.15	Stall frequency limit	1.0	Par. 2.1.2	Hz	25.0		712	
P2.7.16	Underload protection	0	3		0		713	See par. ID700
P2.7.17	Field weakening area load	10	150	%	50		714	
P2.7.18	Zero frequency load	5.0	150.0	%	10.0		715	
P2.7.19	Underload protec-tion time limit	2	600	s	20		716	
P2.7.20	Response to thermistor fault	0	3		0		732	See par. ID700
P2.7.21	Response to fieldbus fault	0	3		2		733	See par. ID700
P2.7.22	Resp. to slot fault	0	3		2		734	See par. ID700
P2.7.23	Actual value supervision function	0	4		0		735	0=Not used 1=If below limit: Warning 2=If above limit: Warning 3=If below limit: Fault 4=If above limit: Fault
P2.7.24	Actual value supervision limit	0	100.0	%	10.0		736	
P2.7.25	Actual value supervision delay	0	3600	s	5		737	

Table 24. Protections, G2.7

3.9 Autorestart parameters (Control keypad: Menu M2 → G2.8)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.8.1	Wait time	0.10	10.00	s	0.50		717	
P2.8.2	Trial time	0.00	60.00	s	30.00		718	
P2.8.3	Start function	0	2		0		719	0=Ramp 1=Flying start 2=According to par. 2.1.11

Table 25. Autorestart parameters, G2.8

3.10 PID control parameters (Control keypad: Menu M2 → G2.9)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.9.1	PID activation	0	1		1		163	0=Not used 1=PID control activated
P2.9.2	PID reference	0	2		0		332	0=PID ref from Keypad control page, par. 3.4 1=PID ref from Keypad control page, par 3.5 2=PID ref from fieldbus (ProcessDataIN 1)
P2.9.3	Actual value 1 selection	0	2		1		334	0=AI1 signal (c-board) 1=AI2 signal (c-board) 2=Fieldbus ProcessDataIN2
P2.9.4	PID controller gain	0.0	1000.0	%	100.0		118	0=No part P used
P2.9.5	PID controller I-time	0.00	320.00	s	5.00		119	320.00=No part I used
P2.9.6	PID controller D-time	0.00	10.00	s	0.00		132	0=No part D used
P2.9.7	Actual value 1 minimum scale	–1000.0	1000.0	%	0.0		336	0=No minimum scaling
P2.9.8	Actual value 1 maximum scale	–1000.0	1000.0	%	100.0		337	100=No maximum scaling
P2.9.9	Error value inversion	0	1		0		340	0=No inversion 1=Inversion
P2.9.10	Dead band	0	10.00	°C	0.0		1575	0=Not Used
P2.9.11	Dead band delay	0	100.00	s	10.0		1576	

Table 26. PID control parameters, G2.9

3.11 Flow control parameters (Control keypad: Menu M2 → G2.10)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.10.1	Constant speed	Par. 2.1.1	Par. 2.1.1	Hz	50.00		1514	
P2.10.2	Coolant inlet pressure, minimum	0.00	Par. 2.10.3	bar	0.00		1504	
P2.10.3	Coolant inlet pressure, maximum	Par. 2.10.2	30.00	bar	10.00		1505	
P2.10.4	Coolant inlet pressure, alarm limit	0.00	100.00	bar	1.00		1570	
P2.10.5	Coolant inlet pressure, fault limit	0.00	100.00	bar	2.00		1571	
P2.10.6	Coolant inlet pressure, supervision	0	1		0		1569	**0**=Off (No sensor) **1**=On (Sensor installed)
P2.10.7	Temperature sensor, minimum value	0.00	Par. 2.10.7	°C	0.00		1509	
P2.10.8	Temperature sensor, maximum value	Par. 2.10.6	100.00	°C	100.00		1510	
P2.10.9	Coolant outlet temperature alarm, lower limit	0.00	100.00	°C	22.00		1591	
P2.10.10	Coolant outlet temperature alarm, higher limit	0.00	100.00	°C	30.00		1594	
P2.10.11	Coolant outlet temperature fault, higher limit	0.00	100.00	°C	40.00		1595	
P2.10.12	Autochange interval	0	169	h	169		1599	**0**=Test mode **169**=Single motor, no change
P2.10.13	Delayed fault	1	30	s	2		1503	

Table 27. Flow control parameters, G2.10

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3.12 Fieldbus parameters (Control Keypad: Menu M2 →G2.11)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.11.1	Fieldbus data out 1 selection	0	10000		1501		852	Choose monitoring data with parameter ID
P2.11.2	Fieldbus data out 2 selection	0	10000		2		853	Choose monitoring data with parameter ID
P2.11.3	Fieldbus data out 3 selection	0	10000		45		854	Choose monitoring data with parameter ID
P2.11.4	Fieldbus data out 4 selection	0	10000		1511		855	Choose monitoring data with parameter ID
P2.11.5	Fieldbus data out 5 selection	0	10000		1		856	Choose monitoring data with parameter ID
P2.11.6	Fieldbus data out 6 selection	0	10000		4		857	Choose monitoring data with parameter ID
P2.11.7	Fieldbus data out 7 selection	0	10000		5		858	Choose monitoring data with parameter ID
P2.11.8	Fieldbus data out 8 selection	0	10000		37		859	Choose controlled data with parameter ID

Table 28. Fieldbus parameters, G2.11

3.13 Keypad control (Control keypad: Menu M3)

The parameters for the selection of control place and direction on the keypad are listed below. See the Keypad control menu in the product's User Manual.

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P3.1	Control place	1	3		1		125	1=I/O terminal 2=Keypad 3=Fieldbus
R3.2	Keypad reference	Par. 2.1.1	Par. 2.1.2	Hz				
P3.3	Direction (on keypad)	0	1		0		123	0=Forward 1=Reverse
R3.6	Stop button	0	1		1		114	0=Limited function of Stop button 1=Stop button always enabled
R3.4	PID reference	Par. 2.10.6	Par. 2.10.7	°C	25.00			
R3.5	PID reference 2	Par. 2.10.6	Par. 2.10.7	°C	0.00			

Table 29. Keypad control parameters, M3

3.14 System menu (Control keypad: M6)

For parameters and functions related to the general use of the AC drive, such as application and language selection, customised parameter sets or information about the hardware and software, see the product's User manual.

3.15 Expander boards (Control keypad: Menu M7)

The M7 menu shows the expander and option boards attached to the control board and board-related information. For more information, see the product's User Manual.

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4. DESCRIPTION OF PARAMETERS

On the following pages you will find the parameter descriptions arranged according to the individual ID number of the parameter. A shaded parameter ID number (e.g. *418 Motor potentiometer UP*) indicates that the *TTF programming method* is applied to this parameter (see All-in-One Application Manual).
Some parameter names are followed by a number code indicating the "All in One" applications in which the parameter is included. If **no code** is shown the parameter is available in **all applications**. See below. The parameter numbers under which the parameter appears in different applications are also given.

101 Minimum frequency *(2.1.1)*
102 Maximum frequency *(2.1.2)*

Defines the frequency limits of the AC drive.
The maximum value for these parameters is 320 Hz.
The software will automatically check the values of parameters ID105, ID106 and ID728.

103 Acceleration time 1 *(2.1.3)*
104 Deceleration time 1 *(2.1.4)*

These limits correspond to the time required for the output frequency to accelerate from the zero frequency to the set maximum frequency (par. ID102).

105 Preset speed 1 *(2.1.15)*

Parameter values are automatically limited between the minimum and maximum frequencies (par. ID101, ID102).

107 Current limit *(2.1.5)*

This parameter determines the maximum motor current from the AC drive. The parameter value range differs from size to size. When this parameter is changed the stall current limit (ID710) is internally calculated to 90% of current limit.

108 U/f ratio selection *(2.6.2)*

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 where the nominal voltage is supplied to the motor. Linear U/f ration should be used in constant torque applications. **Use this default setting 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 where the nominal voltage is also supplied to the motor. The motor runs undermagnetised below the field weakening point and produces less torque and electromechanical noise. Squared U/f 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.

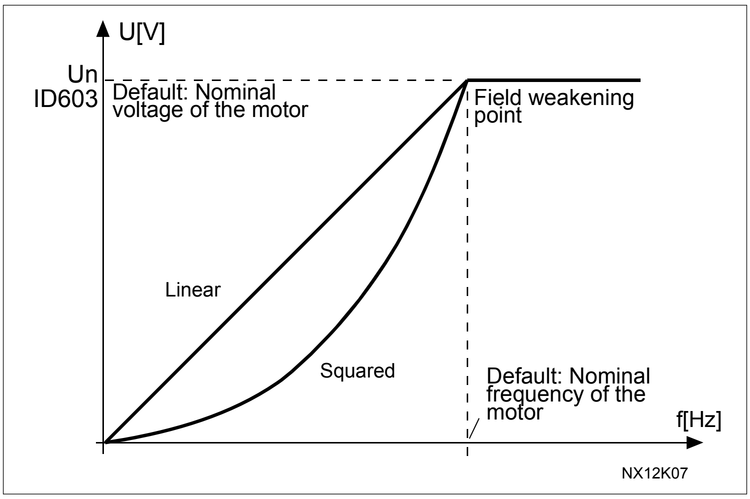


Figure 1. Linear and squared change of motor voltage

Programmable U/f curve:

2 The U/f curve can be programmed with three different points. Programmable U/f curve can be used if the other settings do not satisfy the needs of the application.

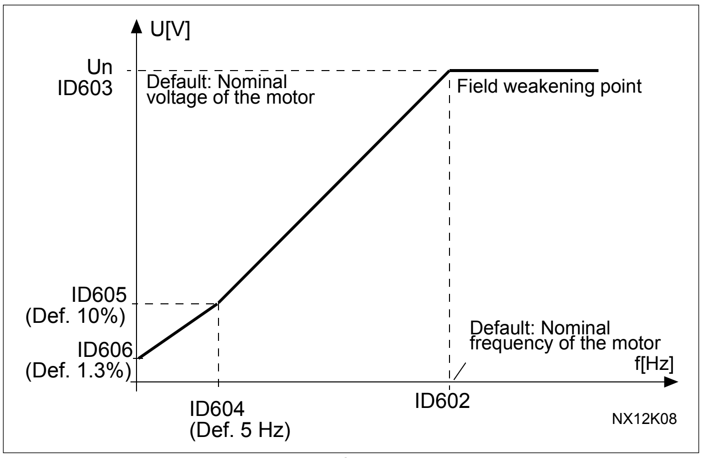


Figure 2. Programmable U/f curve

Linear with flux optimisation:

3 The AC drive starts to search for the minimum motor current in order to save energy, lower the disturbance level and the noise. This function can be used in applications with constant motor load, such as fans, pumps etc.

109 U/f optimisation [2.1.13]

Automatic torque boost: The voltage to the motor changes automatically which makes the motor produce sufficient torque to start and run at low frequencies. The 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.

EXAMPLE:

What changes are required to start with load from 0 Hz?

- First set the motor nominal values (Parameter group 2.1).

Option 1: Activate the Automatic torque boost.

Option 2: Programmable U/f curve
To get torque you need to set the zero point voltage and midpoint voltage/frequency (in parameter group 2.6) so that the motor takes enough current at low frequencies.
First set par. ID108 to *Programmable U/f curve* (value **2**). Increase zero point voltage (ID606) to get enough current at zero speed. Set then the midpoint voltage (ID605) to 1.4142*ID606 and midpoint frequency (ID604) to value ID606/100%*ID111.

NOTE! *In high torque – low speed applications – it is likely that 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.*

110 Nominal voltage of motor (2.1.6)

Find this value U_n on the rating plate of the motor. This parameter sets the voltage at the field weakening point (ID603) to 100% * U_{nMotor}. Note also used connection Delta/Star.

111 Nominal frequency of motor (2.1.7)

Find this value f_n on the rating plate of the motor. This parameter sets the field weakening point (ID602) to the same value.

112 Nominal speed of motor (2.1.8)

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

113 Nominal current of motor (2.1.9)

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

115 Parameter conceal

With this parameter you can hide all other parameter groups except the basic parameter group (P2.1).

Note! The factory default of this parameter is **1**, i.e. all parameter groups except P2.1 are hidden. The other parameter groups cannot be browsed or edited before the value of this parameter is set to **0**.

0 = Disabled (all parameter groups can be browsed with the keypad)
1 = Enabled (only the basic parameters, P2.1, can be browsed with the keypad)

117 *I/O frequency reference selection* *(2.1.14)*

Defines which frequency reference source is selected when controlled from the I/O control place.

0 = Keypad reference (Menu M3)
1 = Fieldbus reference

118 *PID controller gain* *(2.9.4)*

This parameter defines the gain of the PID controller. If the value of the parameter is set to 100% a change of 10% in the error value causes the controller output to change by 10%. If the parameter value is set to 0 the PID controller operates as ID-controller.
See examples at parameter ID132 below.

119 *PID controller I-time* *(2.9.5)*

The parameter ID119 defines the integration time of the PID controller. If this parameter is set to 1.00 second a change of 10% in the error value causes the controller output to change by 10.00%/s. If the parameter value is set to 0.00 s the PID controller will operate as PD controller.
See examples at parameter ID132 below.

120 *Motor cos phi* *(2.1.10)*

Find this value "cos phi" on the rating plate of the motor.

121 *Keypad frequency reference selection* *(2.2.22)*

Defines which frequency reference source is selected when controlled from the keypad.

0 Reference from keypad (Freq Ref)
1 Reference from fieldbus

122 *Fieldbus frequency reference selection* *(2.2.23)*

Defines which frequency reference source is selected when controlled from the fieldbus.

0 Reference from keypad (Freq Ref)
1 Reference from fieldbus

132 *PID controller D-time* *(2.9.6)*

The parameter ID132 defines the derivation time of the PID controller. If this parameter is set to 1.00 second a change of 10% in the error value during 1.00 s causes the controller output to change by 10.00%. If the parameter value is set to 0.00 s the PID controller will operate as PI controller.
See examples below.

Example 1:
In order to reduce the error value to zero, with the given values, the AC drive output behaves as follows:

<u>Given values:</u>
Par. 2.1.12, P = 0%
Par. 2.1.13, I-time = 1.00 s
Par. 2.1.14, D-time = 0.00 s   Min freq. = 0 Hz
Error value (setpoint – process value) = 10.00%   Max freq. = 50 Hz

In this example, the PID controller operates practically as I-controller only.
According to the given value of parameter 2.1.13 (I-time), the PID output increases by 5 Hz (10% of the difference between the maximum and minimum frequency) every second until the error value is 0.

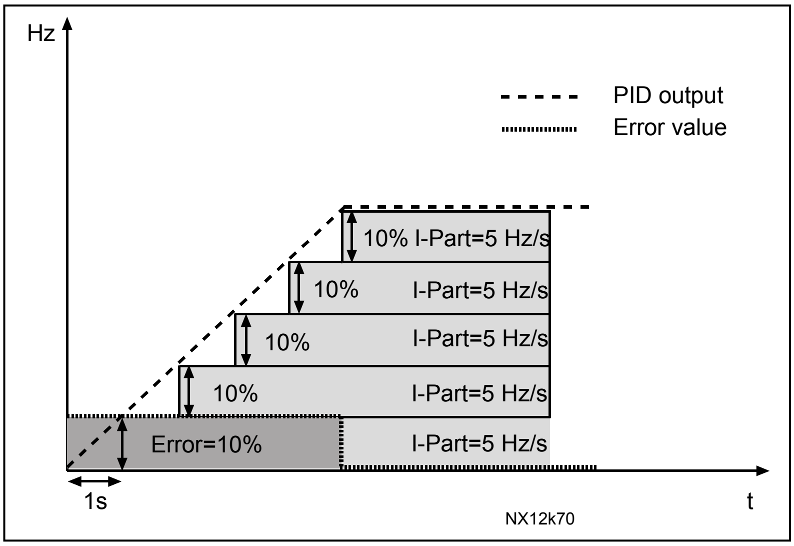


Figure 3. PID controller function as I-controller.

Example 2:
<u>Given values:</u>

Par. 2.1.12, P = 100%
Par. 2.1.13, I-time = 1.00 s
Par. 2.1.14, D-time = 1.00 s   Min freq. = 0 Hz
Error value (setpoint – process value) = ±10%   Max freq. = 50 Hz

As the power is switched on, the system detects the difference between the setpoint and the actual process value and starts to either raise or decrease (in case the error value is negative) the PID output according to the I-time. Once the difference between the set-point and the process value has been reduced to 0 the output is reduced by the amount corresponding to the value of parameter 2.1.13.
In case the error value is negative, the AC drive reacts reducing the output correspondingly. See Figure 4.

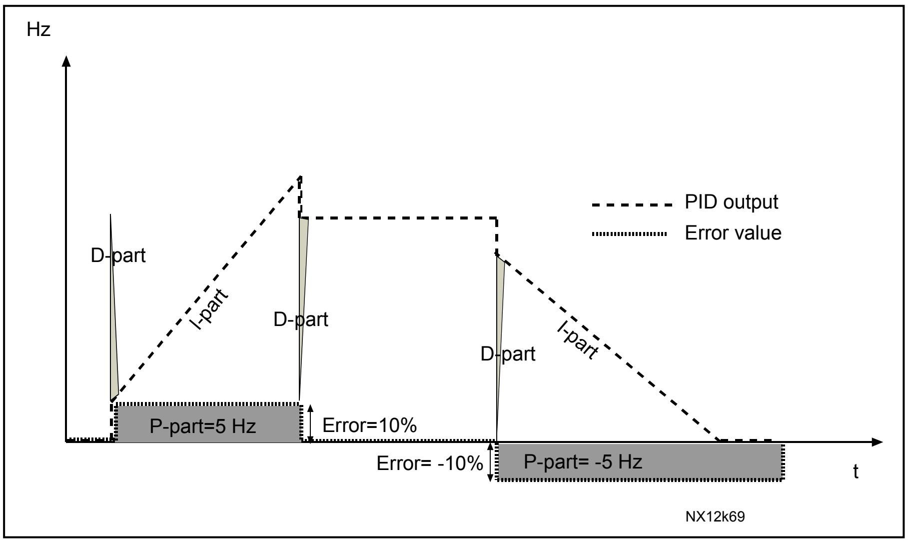


Figure 4. PID output curve with the values of Example 2.

Example 3:

Given values:

Par. 2.1.12, P = 100%
Par. 2.1.13, I-time = 0.00 s
Par. 2.1.14, D-time = 1.00 s — Min freq. = 0 Hz
Error value (setpoint – process value) = ±10%/s — Max freq. = 50 Hz

As the error value increases, also the PID output increases according to the set values (D-time = 1.00s)

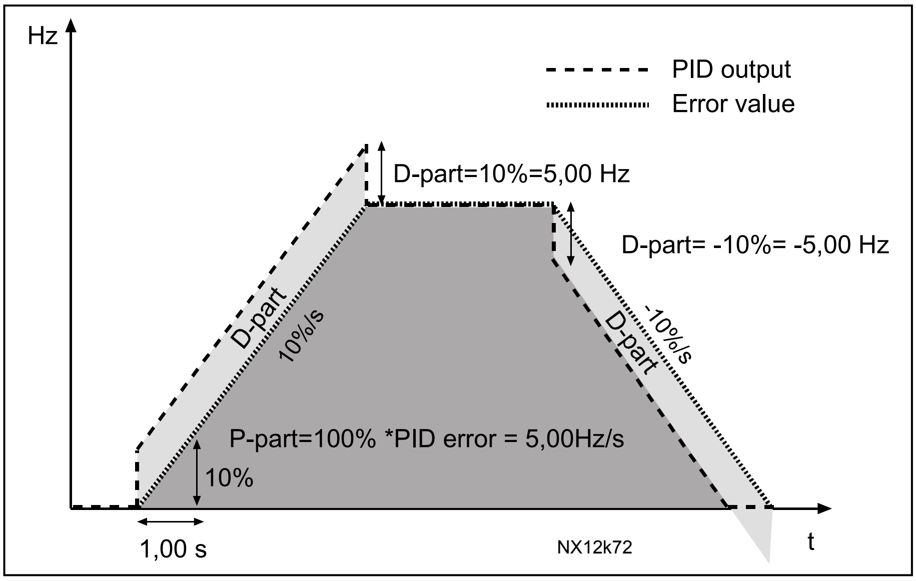


Figure 5. PID output with the values of Example 3.

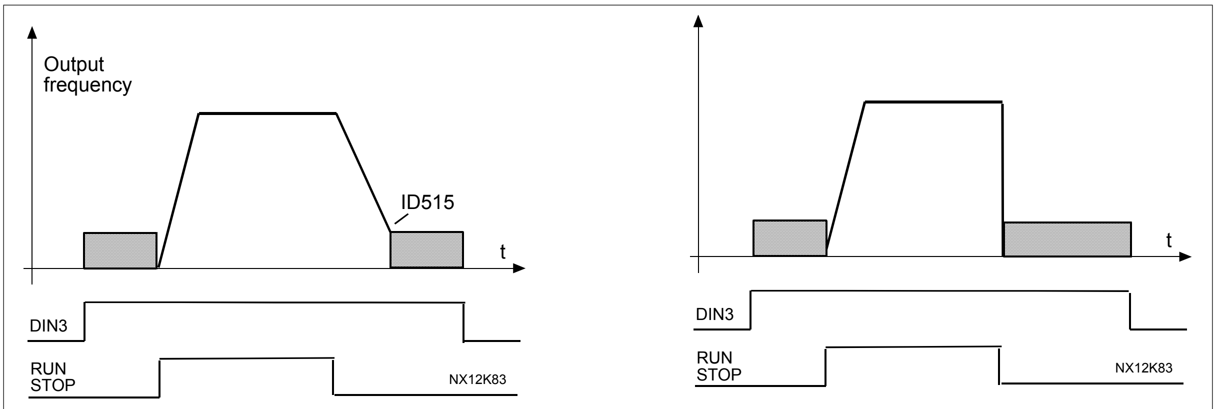
163 *PID activation* *(2.9.1)*

Activate the PID control by setting value 1 for this parameter.

301 *DIN3 function* *(2.2.2)*

This parameter has 10 selections. The default value is 3.

0 Motor potentiometer UP
Contact closed: Reference increases until the contact is opened.
1 Enable PID reference 2
Contact open: PID controller reference selected with parameter R3.4.
Contact closed: PID controller keypad reference 2 selected with parameter R3.5.
2 External fault
Contact closed: Fault is displayed and motor stopped when the input is active
3 External fault
Contact open: Fault is displayed and motor stopped when the input is not active
4 Fault reset
Contact closed: All faults reset
5 Run enable
Contact open: Start of motor disabled
Contact closed: Start of motor enabled
6 Preset speed
7 DC-braking command
Contact closed: In Stop mode, the DC braking operates until the contact is opened



a) DIN3 as DC-brake command input and stop-mode = Ramp
b) DIN3 as DC-brake command input and stop-mode = Coasting

Figure 6. DIN3 as DC-brake command input: a) Stop mode = Ramp, b) Stop mode = coasting

8 PID disable
9 PID disabled; go to Preset speed
10 PID keypad reference 2

307 *Analogue output 1 function* *(2.3.1.1)*

This parameter selects the desired function for the analogue output 1 signal.
0 Not used
1 Output frequency (0—f_{max})
2 Frequency reference (0—f_{max})
3 Motor speed (0—Motor nominal speed)
4 Motor current (0—Motor nominal current)
5 Motor torque (0—Motor nominal torque)
6 Motor power (0—Motor nominal power)
7 Motor voltage (0—Motor nominal voltage)
8 DC-link voltage (0—Motor nominal voltage)

9 PI controller temperature reference
10 PI controller actual temperature (from FSA11)
11 PI controller error value of the temperature
12 PI controller output
13 Pressure from PT11, pump inlet

308 *Analogue output 1 filter time* *(2.3.1.2)*

Defines the filtering time of the analogue output signal. Setting this parameter value 0 will deactivate filtering.

309 *Analogue output 1 inversion* *(2.3.1.3)*

Inverts the analogue output signal:

Maximum output signal = Minimum set value
Minimum output signal = Maximum set value

See parameter ID311 below.

310 *Analogue output 1 minimum* *(2.3.1.4)*

Defines the signal minimum to either 0 mA or 4 mA (living zero). Note the difference in analogue output scaling in parameter ID311 (Figure 7).

0 Set minimum value to 0 mA
1 Set minimum value to 4 mA

311 *Analogue output 1 scale* *(2.3.1.5)*

Scaling factor for analogue output.

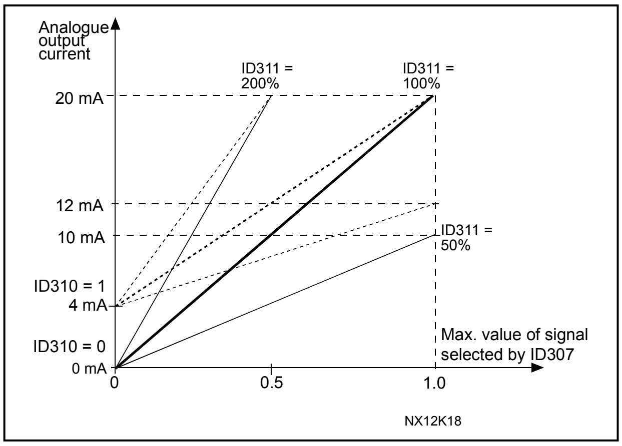


Figure 7. Analogue output scaling

313 *Relay output 1 function* *(2.3.4.2)*

Setting value	Signal content
0 = Not used	Out of operation
1 = Ready	The AC drive is ready to operate
2 = Run	The AC drive operates (motor is running)
3 = Fault	A fault trip has occurred
4 = Fault inverted	A fault trip has not occurred
5 = FC overheat warning	The heat-sink temperature exceeds +70°C
6 = External fault or warning	Fault or warning depending on par. ID701
7 = Reference fault or warning	Fault or warning depending on par. ID700 - if analogue reference is 4—20 mA and signal is <4mA
8 = Warning	Always if warning exists
9 = Reversed	The reverse command has been selected
10 = Preset speed 1	The preset 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 limit supervision	The output frequency goes outside the set supervision low limit/high limit (see parameter ID's 315 and 316 below)
14 = Control from I/O terminals	I/O control mode selected (in menu M3)
15 = Thermistor fault or warning (Appl.2)	The thermistor input of option board indicates overtemperature. Fault or warning depending on par. ID732.
16 = Actual value supervision	Actual value supervision is active
17 = Cooling OK	

Table 30. Output signals via relay outputs RO1 and RO2.

315 *Output frequency limit supervision function* *(2.5.4)*

0 No supervision
1 Low limit supervision
2 High limit supervision

If the output frequency goes under/over the set limit (ID316) this function generates a warning message via the relay output RO1 or RO2 depending on the settings of parameters ID313 and ID1513.

316 *Output frequency limit supervision value* *(2.5.5)*

Selects the frequency value supervised by parameter ID315. See Figure 8.

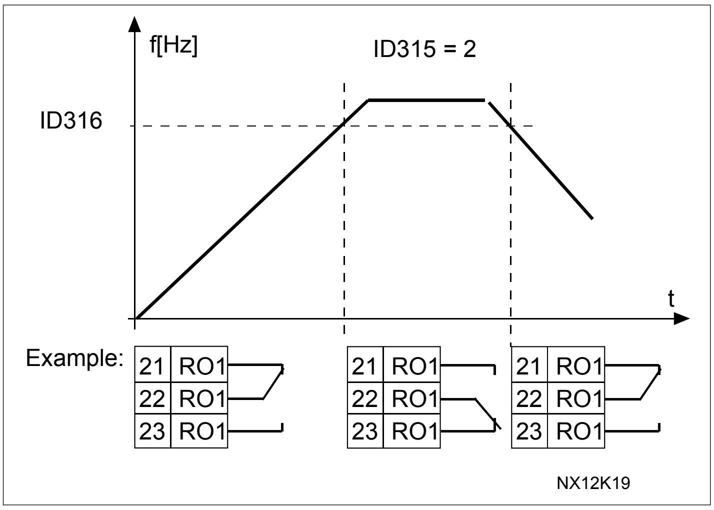


Figure 8. Output frequency supervision

332 *PID controller reference signal* *(2.9.2)*

Defines which frequency reference place is selected for the PID controller.

0 Reference from keypad (PID reference 1, Menu M3, par. R3.4)
1 Reference from keypad (PID reference 2, Menu M3, par. R3.5)
2 Fieldbus reference (FBProcessDataIN1)

334 *Actual value selection* *(2.9.3)*

0 AI1 (control board)
1 AI2 (control board)
2 Fieldbus (FBProcessDataIN2)

336 *Actual value 1 minimum scale* *(2.9.7)*

Sets the minimum scaling point for Actual value. See

Figure 9.

337 *Actual value 1 maximum scale* *(2.9.8)*

Sets the maximum scaling point for Actual value. See

Figure 9.

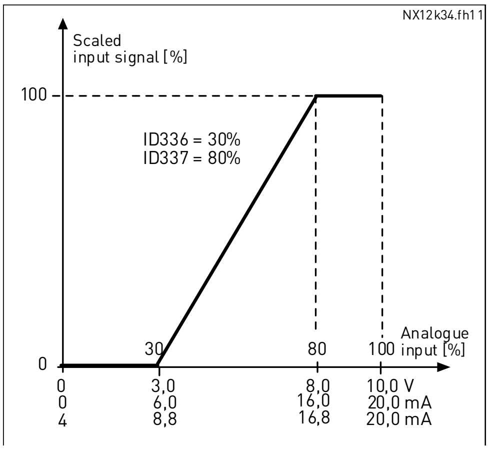


Figure 9. Example of actual value signal scaling

340 *PID error value inversion* *[2.9.9]*

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

0 No inversion
1 Inverted

378 *AI1 signal filter time* *[2.2.8]*

When this parameter is given a value greater than 0 the function that filters out disturbances from the incoming analogue signal is activated.

Long filtering time makes the regulation response slower. See Figure 10.

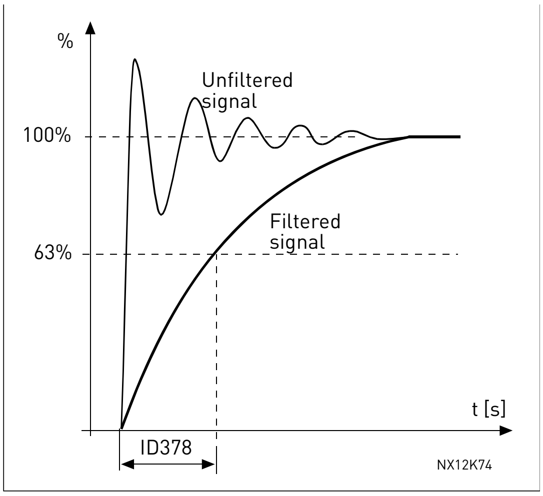


Figure 10. AI1 signal filtering

379 *AI1 signal range* *[2.2.3]*

0 Signal range 0…20 mA
1 Signal range 4…20 mA
2 Signal range 0…10 V
3 Signal range 2…10 V

380 *AI1 custom setting minimum* *[2.2.5]*
381 *AI1 custom setting maximum* *[2.2.6]*

These parameters set the analogue input signal for any input signal span between 0.00…100.00%. However, the max value of par. ID380 cannot be greater than the value set for parameter ID381, and the min value of par. ID381 cannot be smaller than the max value of par. ID380.
Note: Parameter ID379 *AI1 signal range* is inactivated if ID380 ≠ 0% or ID381 ≠ 100%. See also Figure 11.

387 *AI1 signal inversion* *(2.2.7)*

If this parameter = 0, no inversion of analogue signal takes place.

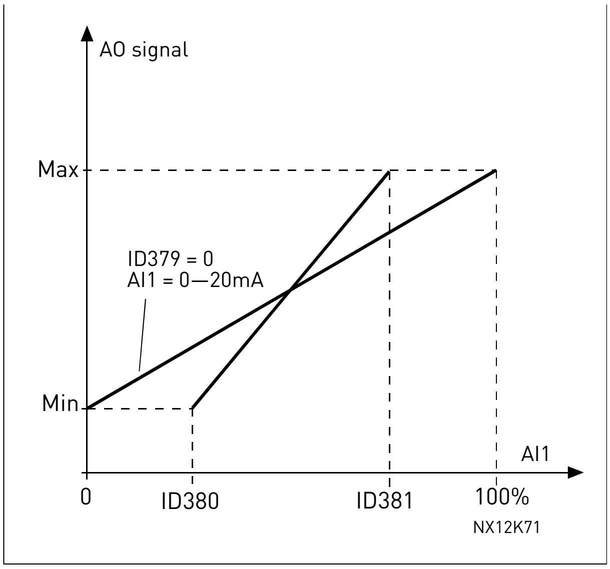


Figure 11. AI1 no signal inversion

If this parameter = 1 inversion of analogue signal takes place.

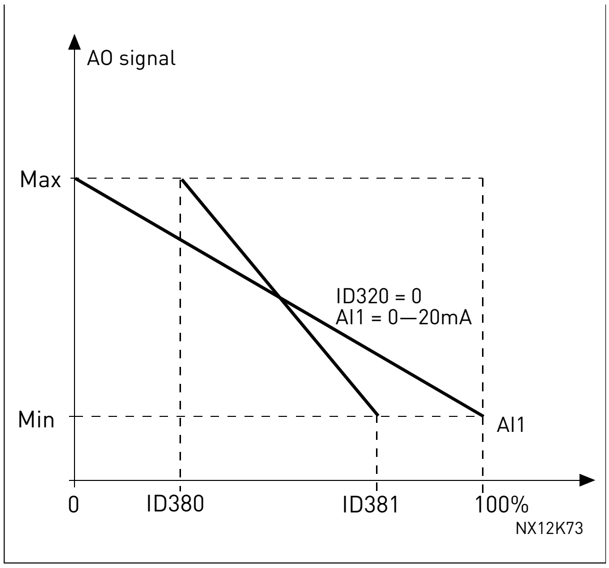


Figure 12. AI1 signal inversion

389 *AI2 signal filter time* *(2.2.14)*

See parameter ID378.

390 *AI2 signal range* *(2.2.9)*

0 Signal range 0…20 mA
1 Signal range 4…20 mA

391 AI2 custom setting minimum (2.2.11)
392 AI2 custom setting maximum (2.2.12)

See parameters ID380 and ID381.

398 AI2 signal inversion (2.2.13)

See parameter ID387.

500 Acceleration/Deceleration ramp 1 shape (2.4.1)

The start and end of acceleration and deceleration ramps can be smoothed with these parameters. Setting value 0 gives a linear ramp shape which causes acceleration and deceleration to act immediately to the changes in the reference signal.
Setting a value 0.1…10 seconds for this parameter produces an S-shaped acceleration/deceleration. The acceleration time is determined with parameters ID103/ID104.

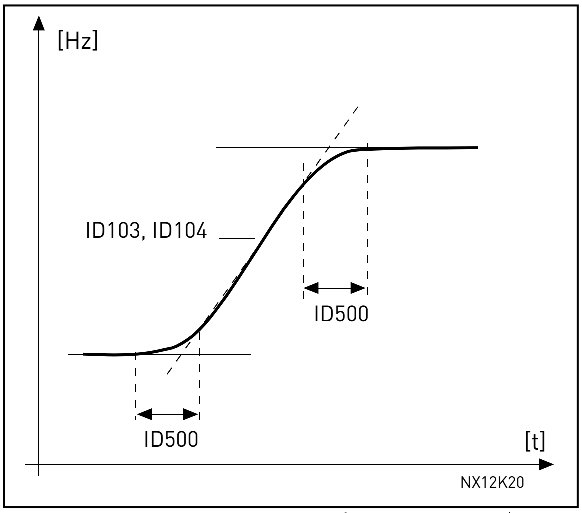


Figure 13. Acceleration/Deceleration (S-shaped)

504 Brake chopper (2.4.2)

0 = No brake chopper used
1 = Brake chopper in use and tested when running. Can be tested also in READY state
2 = External brake chopper (no testing)
3 = Used and tested in READY state and when running

When the AC drive is decelerating the motor, the inertia of the motor and the load are fed into an external brake resistor. This enables the AC drive to decelerate the load with a torque equal to that of acceleration (provided that the correct brake resistor has been selected). See separate Brake resistor installation manual.

505 *Start function* *(2.1.11)*

Ramp:

0 The AC 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 AC drive is able to start into a running motor by applying a small torque to motor and searching for the frequency corresponding to the speed the motor is running at. Searching starts from the maximum frequency towards the actual frequency until the correct value is detected. Thereafter, the output frequency will be increased/decreased to the set reference value according to the set acceleration/deceleration 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 mains voltage interruptions.

506 *Stop function* *(2.1.12)*

Coasting:

0 The motor coasts to a halt without any control from the AC 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.

Normal stop: Ramp/ Run Enable stop: coasting

2 After the Stop command, the speed of the motor is decelerated according to the set deceleration parameters. However, when Run Enable is selected, the motor coasts to a halt without any control from the AC drive.

Normal stop: Coasting/ Run Enable stop: ramping

3 The motor coasts to a halt without any control from the AC drive. However, when Run Enable signal is selected, 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.

507 *DC-braking current* *(2.4.3)*

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

508 *DC-braking time at stop* *(2.4.4)*

Determines if braking is ON or OFF and the braking time of the DC-brake when the motor is stopping. The function of the DC-brake depends on the stop function, parameter ID506.

0 DC-brake is not used
>0 DC-brake is in use and its function depends on the Stop function, (param. ID506). The DC-braking time is determined with this parameter.

Par. ID506 = 0; Stop function = Coasting:

After the stop command, the motor coasts to a stop without control of the AC drive.

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 ≥ the nominal frequency of the motor, the set value of parameter ID508 determines the braking time. When the frequency is ≤10% of the nominal, the braking time is 10% of the set value of parameter ID508.

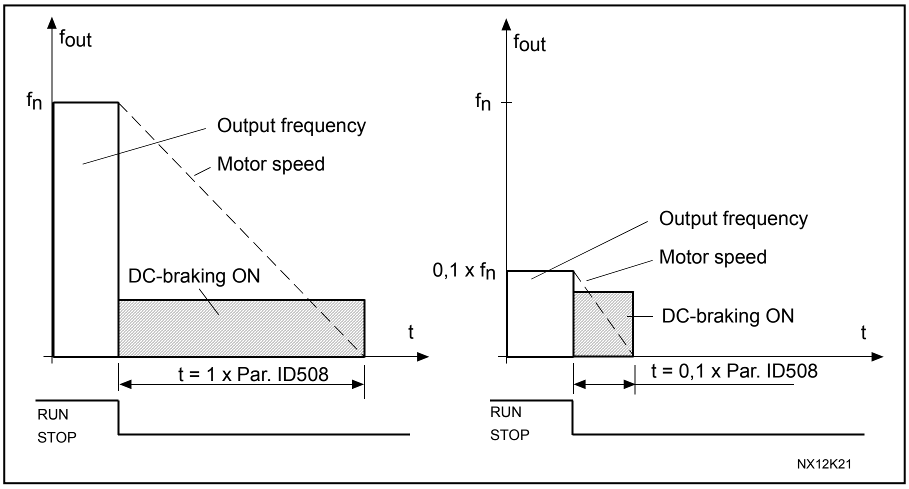


Figure 14. DC-braking time when Stop mode = Coasting.

Par. ID506 = 1; Stop function = Ramp:

After the Stop command, the speed of the motor is reduced according to the set deceleration parameters, as fast as possible, to the speed defined with parameter ID515, where the DC-braking starts.

The braking time is defined with parameter ID508. If high inertia exists, it is recommended to use an external braking resistor for faster deceleration. See Figure 15.

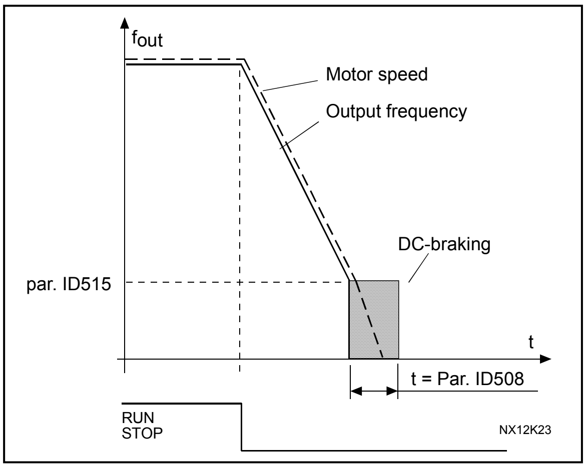


Figure 15. DC-braking time when Stop mode = Ramp

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509 Prohibit frequency area 1; Low limit (2.5.1)
510 Prohibit frequency area 1; High limit (2.5.2)

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 the "skip frequency" region. See Figure 16.

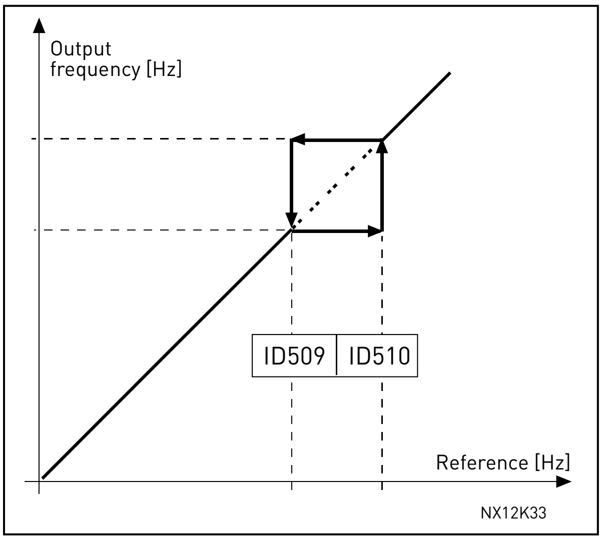

Figure 16. Example of prohibit frequency area setting.

515 DC-braking frequency at stop (2.4.5)

The output frequency at which the DC-braking is applied. See Figure 16.

516 DC-braking time at start (2.4.6)

DC-brake is activated 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 by parameter ID505.

518 Acceleration/deceleration ramp speed scaling ratio between prohibit frequency limits 23457 (2.5.3, 2.5.7)

Defines the acceleration/deceleration time when the output frequency is between the selected prohibit frequency range limits (parameters ID509 and ID510). The ramping speed (selected acceleration/ deceleration time 1 or 2) is multiplied with this factor. E.g. value 0.1 makes the acceleration time 10 times shorter than outside the prohibit frequency range limits.

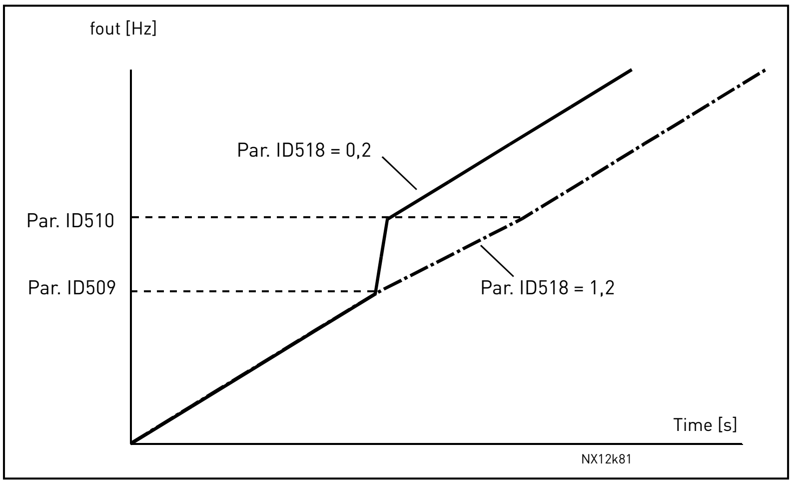

Figure 17. Ramp speed scaling between prohibit frequencies

519 ***Flux braking current*** *[2.4.8]*

Defines the flux braking current value. The value setting range depends on the used application.

520 ***Flux brake*** *[2.4.7]*

Instead of DC braking, flux braking is a useful way to raise the braking capacity in cases where additional brake resistors are not needed.
When braking is needed, the frequency is reduced and the flux in the motor is increased, which in turn increases the motor's capability to brake. Unlike DC braking, the motor speed remains controlled during braking.

The flux braking can be set ON or OFF.

0 = Flux braking OFF
1 = Flux braking ON

Note: Flux braking converts the energy into heat at the motor, and should be used intermittently to avoid motor damage.

600 ***Motor control mode*** *[2.6.1]*

0 Frequency control: The I/O terminal and keypad references are frequency references and the AC drive controls the output frequency (output frequency resolution = 0.01 Hz)

1 Speed control: The I/O terminal and keypad references are speed references and the AC drive controls the motor speed compensating the motor slip (accuracy ± 0.5%).

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601 *Switching frequency* *[2.6.8]*

Motor noise can be minimised using a high switching frequency. Increasing the switching frequency reduces the capacity of the AC drive unit.
The range of this parameter depends on the size of the AC drive:

Type	Min. [kHz]	Max. [kHz]	Default [kHz]
0016—0061 NX_5	1.0	10,0	10.0
0072—2300 NX_5	1.0	10.0	3.6
0170—1500 NX_6	1.0	6.0	1.5

Table 31. Size-dependent switching frequencies

Note! The actual switching frequency might be reduced down to 1.5kHz by thermal management functions. This has to be considered when using sine wave filters or other output filters with a low resonance frequency.

602 *Field weakening point* *[2.6.3]*

The field weakening point is the output frequency at which the output voltage reaches the set (ID603) maximum value.

603 *Voltage at field weakening point* *[2.6.4]*

Above the frequency at the field weakening point, the output voltage remains at the set maximum value. Below the frequency at the field weakening point, the output voltage depends on the setting of the U/f curve parameters. See parameters ID109, ID108, ID604 and ID605.
When the parameters ID110 and ID111 (nominal voltage and nominal frequency of the motor) are set, the parameters ID602 and ID603 are automatically given the corresponding values. If you need different values for the field weakening point and the maximum output voltage, change these parameters **after** setting the parameters ID110 and ID111.

604 *U/f curve, middle point frequency* *[2.6.5]*

If the programmable U/f curve has been selected with parameter ID108 this parameter defines the middle point frequency of the curve. See Figure 2.

605 *U/f curve, middle point voltage* *[2.6.6]*

If the programmable U/f curve has been selected with the parameter ID108 this parameter defines the middle point voltage of the curve. See Figure 2.

606 *Output voltage at zero frequency* *[2.6.7]*

If the programmable U/f curve has been selected with the parameter ID108 this parameter defines the zero frequency voltage of the curve. NOTE: If the value of parameter ID108 is changed this parameter is set to zero. See Figure 2.

607 Overvoltage controller [2.6.9]

These parameters allow the under-/overvoltage controllers to be switched out of operation. This may be useful, for example, if the mains supply voltage varies more than –15% to +10% and the application will not tolerate this over-/undervoltage. In this case, the regulator controls the output frequency taking the supply fluctuations into account.

0 Controller switched off
1 Controller switched on = Minor adjustments of OP frequency are made

608 Undervoltage controller [2.6.10]

See par. ID607.
Note: Over-/undervoltage trips may occur when controllers are switched out of operation.

0 Controller switched off
1 Controller switched on = Minor adjustments of OP frequency are made

700 Response to the 4mA reference fault [2.7.1]

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to ID506
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 3.5 mA for 5 seconds or below 0.5 mA for 0.5 seconds. The information can also be programmed into relay outputs RO1 or RO2.

701 Response to external fault [2.7.2]

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to ID506
3 = Fault, stop mode after fault always by coasting

A warning or a fault action and message is generated from the external fault signal in the programmable digital input DIN3. The information can also be programmed into relay outputs RO1 or RO2.

702 Output phase supervision [2.7.5]

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to ID506
3 = Fault, stop mode after fault always by coasting

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

703 *Earth fault protection* *(2.7.6)*

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to ID506
3 = Fault, stop mode after fault always by coasting

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

704 *Motor thermal protection* *(2.7.7)*

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to ID506
3 = Fault, stop mode after fault always by coasting

If tripping is selected the drive will stop and activate the fault stage. Deactivating the protection, i.e. setting parameter to **0**, will reset the thermal stage of the motor to 0%.

705 *Motor thermal protection: Motor ambient temp. factor* *(2.7.8)*

The factor can be set between -100.0%...100.0%.

706 *Motor thermal protection: Motor cooling factor at zero speed* *(2.7.9)*

The current can be set between 0—150.0% x I_{nMotor}. This parameter sets the value for thermal current at zero frequency. See Figure 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 even higher).

Note: The value is set as a percentage of the motor name plate data, par. ID113 (Nominal current of motor), not the drive's nominal output current. The motor's nominal current is the current that the motor can withstand in direct on-line use without being overheated.

If you change the parameter Nominal current of motor, this parameter is automatically restored to the default value.

Setting this parameter does not affect the maximum output current of the drive which is determined by parameter ID107 alone.

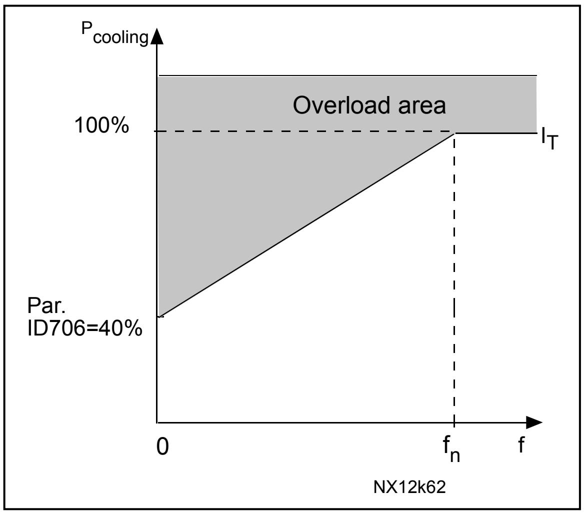


Figure 18. Motor thermal current I_T curve

707 *Motor thermal protection: Time constant* *[2.7.10]*

This time can be set between 1 and 200 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 the motor design and it varies between different motor manufacturers.

If the motor's t6–time (t6 is the time in seconds the motor can safely operate at six times the rated current) is known (given by the motor manufacturer) the time constant parameter can be set basing on it. As a rule of thumb, the motor thermal time constant in minutes equals to 2xt6. If the drive is in stop stage the time constant is internally increased to three times the set parameter value. The cooling in the stop stage is based on convection and the time constant is increased. See also Figure 19.

708 *Motor thermal protection: Motor duty cycle* *[2.7.11]*

Defines how much of the nominal motor load is applied. The value can be set to 0%...100%.

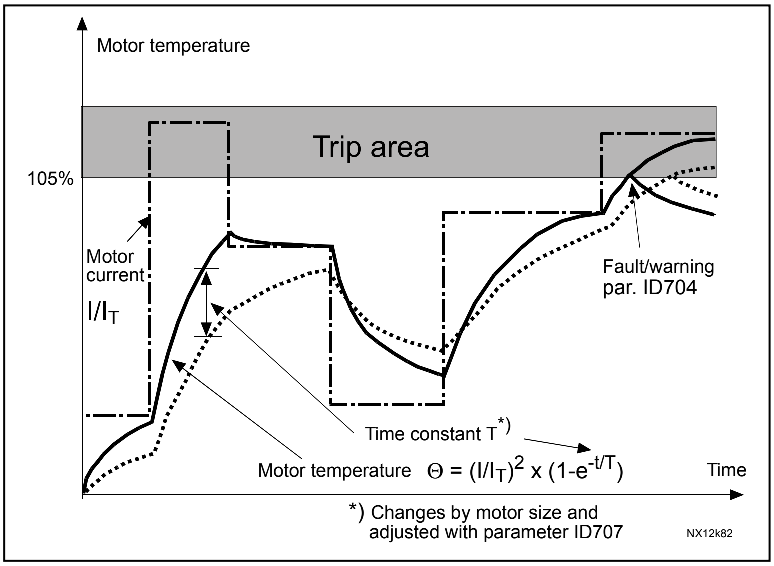


Figure 19. Motor temperature calculation

709 *Stall protection* *[2.7.12]*

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to ID506
3 = Fault, stop mode after fault always by coasting

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

710 *Stall current limit* *[2.7.13]*

The current can be set to 0.0...2*I_H. For a stall stage to occur, the current must have exceeded this limit. See Figure 20. The software does not allow entering a greater value than 2*I_H. If parameter ID107 Nominal current limit of motor is changed, this parameter is automatically calculated to 90% of the current limit.

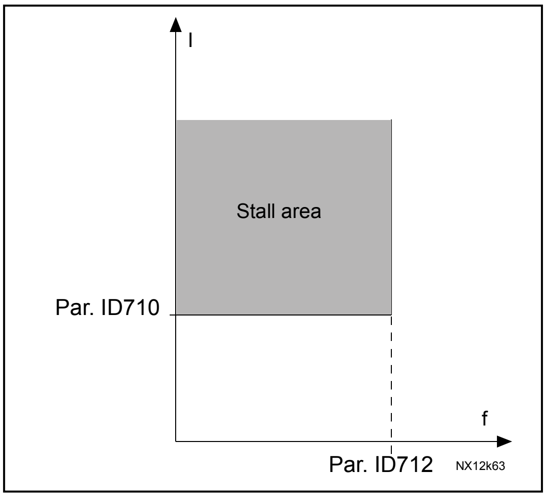


Figure 20. Stall characteristics settings

711 *Stall time* *[2.7.14]*

This time can be set between 1.0 and 120.0s.
This is the maximum time allowed for a stall stage. The stall time is counted by an internal up/down counter.
If the stall time counter value goes above this limit the protection will cause a trip (see ID709).

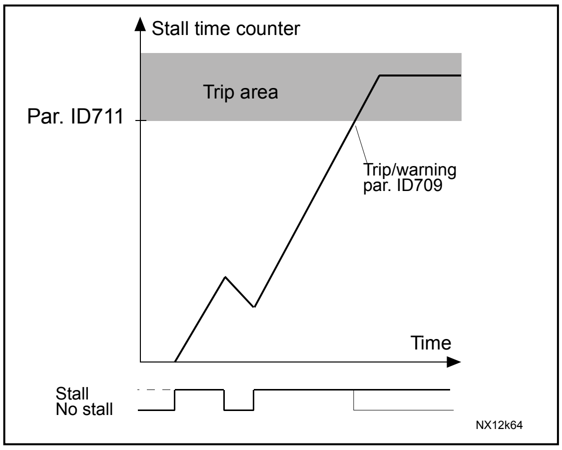


Figure 21. Stall time count

712 *Stall frequency limit* *[2.7.15]*

The frequency can be set between 1-f_{max} (ID102).
For a stall state to occur, the output frequency must have remained below this limit.

713 *Underload protection* *[2.7.16]*

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to ID506
3 = Fault, stop mode after fault always by coasting

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.

714 *Underload protection, field weakening area load* *(2.7.17)*

The torque limit can be set between 10.0—150.0 % x T_{nMotor}.
This parameter gives the value for the minimum torque allowed when the output frequency is above the field weakening point. See Figure 22.

If you change parameter ID113 (Motor nominal current) this parameter is automatically restored to the default value.

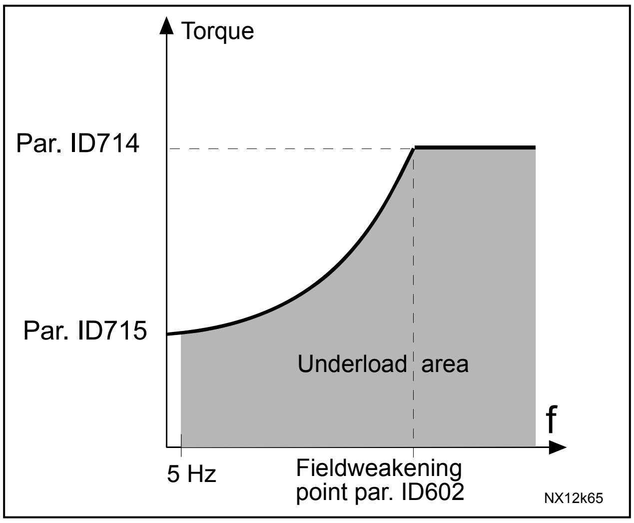


Figure 22. Setting of minimum load

715 *Underload protection, zero frequency load* *(2.7.18)*

The torque limit can be set between 5.0—150.0 % x TnMotor.
This parameter gives value for the minimum torque allowed with zero frequency. See Figure 22.

If you change the value of parameter ID113 (Motor nominal current) this parameter is automatically restored to the default value.

716 *Underload time* *(2.7.19)*

This time can be set between 2.0 and 600.0 s.
This is the maximum time allowed for an underload state to exist. An internal up/down counter counts the accumulated underload time. If the underload counter value goes above this limit the protection will cause a trip according to parameter ID713). If the drive is stopped the underload counter is reset to zero. See Figure 23.

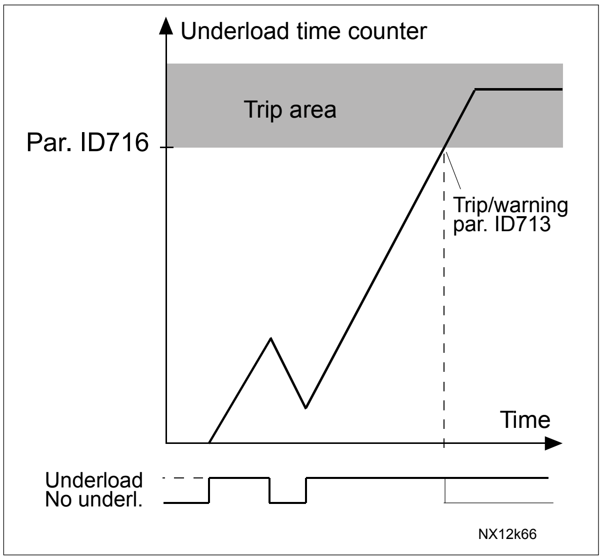


Figure 23. Underload time counter function

717 Automatic restart: Wait time *[2.8.1]*

Defines the time before the AC drive tries to automatically restart the motor after the fault state has disappeared.

718 Automatic restart: Trial time *[2.8.2]*

The Automatic restart function restarts the AC drive when the fault state has disappeared and the waiting time has elapsed.

The trial time count starts from the first autorestart. If the number of faults occurring during the trial time exceeds 3, the fault state becomes active. Otherwise the fault is cleared after the trial time has elapsed and the next fault starts the trial time count again.

If a single fault remains during the trial time, a fault state is true.

719 Automatic restart: Start function *[2.8.3]*

The Start function for Automatic restart is selected with this parameter. The parameter defines the start mode:

0 = Start with ramp
1 = Flying start
2 = Start according to ID505

727 Response to undervoltage fault *[2.7.4]*

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to ID506
3 = Fault, stop mode after fault always by coasting

For the undervoltage limits, see the product's user manual.

730 Input phase supervision *[2.7.3]*

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to ID506
3 = Fault, stop mode after fault always by coasting

The input phase supervision ensures that the input phases of the AC drive have an approximately equal current.

731 Automatic restart *[2.1.16]*

The Automatic restart is taken into use with this parameter.

0 = Disabled
1 = Enabled

The function resets the following faults (max. three times) (see the product's user manual:

- Overcurrent (F1)
- Overvoltage (F2)
- Undervoltage (F9)
- AC drive overtemperature (F14)
- Motor overtemperature (F16)
- Reference fault (F50)

732 Response to thermistor fault (2.7.20)

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to ID506
3 = Fault, stop mode after fault always by coasting

Setting the parameter to 0 will deactivate the protection.

733 Response to fieldbus fault (2.7.21)

Set here the response mode for the fieldbus fault if a fieldbus board is used. For more information, see the respective Fieldbus Board Manual.

See parameter ID732.

734 Response to slot fault (2.7.22)

Set here the response mode for a board slot fault due to missing or broken board.

See parameter ID732.

735 Actual value supervision function (2.7.22)

0 = Not used
1 = Warning, if actual value falls below the limit set with par. ID736
2 = Warning, if actual value exceeds the limit set with par. ID736
3 = Fault, if actual value falls below the limit set with par. ID736
4 = Fault, if actual value exceeds the limit set with par. ID736

736 Actual value supervision limit (2.7.24)

With this parameter you can set the limit (in percent) of actual value supervised by par. ID735.

737 Actual value supervision delay (2.7.25)

Set here the delay for the actual value supervision function (par. ID735)
If this parameter is in use, the function of par. ID735 will be active only when the actual value stays outside the defined limit for the time determined by this parameter.

852 to 859 ***Fieldbus data out selections 1 to 8*** *6* *(2.11.1 to 2.11.8)*

Using these parameters, you can monitor any monitoring or parameter value from the fieldbus. Enter the ID number of the item you wish to monitor for the value of these parameters.

Some typical values:

1	Output frequency	15	Digital inputs 1,2,3 statuses
2	Motor speed	16	Digital inputs 4,5,6 statuses
3	Motor current	17	Digital and relay output statuses
4	Motor torque	25	Frequency reference
5	Motor power	26	Analogue output current
6	Motor voltage	27	AI3
7	DC link voltage	28	AI4
8	Unit temperature	31	AO1 (expander board)
9	Motor temperature	32	AO2 (expander board)
13	AI1	37	Active fault 1
14	AI2	45	Motor current (drive independent) given with one decimal point

Table 4-32.

1503 ***Delayed fault*** *(2.10.12)*

If the sensor signals of too low a coolant flow in the system and the duration of this state exceeds the time set with this parameter, a fault is activated. Additionally, the *Cooling OK* signal is removed and the AC drive stops.

1504 ***Coolant inlet pressure, minimum*** *(2.10.2.)*
1505 ***Coolant inlet pressure, maximum*** *(2.10.3.)*

With these parameters, you can define the value for the minimum and maximum coolant inflow pressures of the pressure range in bar.

1509 ***Temperature sensor, minimum value*** *(2.10.6)*
1510 ***Temperature sensor, maximum value*** *(2.10.7)*

1513 ***Relay output 2 function*** *(2.3.5.2)*

See Table 30 at parameter ID313.

1514 ***Constant speed*** *(2.10.1)*

The constant speed reference can be set with this parameter when the PID control is enabled.

1515 ***Relay output 3 function*** *[2.3.6.2]*

Setting value	Signal content
0 = Not used	Out of operation
1 = Cooling OK	
2 = Pump 1	
3 = Pump 2	

Table 33. Output signals via relay outputs RO3 and RO4.

1517 ***AI3 custom setting minimum*** *[2.2.18]*
1518 ***AI3 custom setting maximum*** *[2.2.19]*

See parameters ID380 and ID381.

1520 ***AI3 signal range*** *[2.2.16]*

0 Signal range 0…20 mA
1 Signal range 4…20 mA

1526 ***AI3 signal filter time*** *[2.2.21]*

See parameter ID378.

1529 ***AI3 signal inversion*** *[2.2.20]*

See parameter ID387.

1530 ***Analogue output 2 function*** *[2.3.2.1]*
1531 ***Analogue output 2 filter time*** *[2.3.2.2]*
1532 ***Analogue output 2 inversion*** *[2.3.2.3]*
1533 ***Analogue output 2 minimum*** *[2.3.2.4]*
1534 ***Analogue output 2 scale*** *[2.3.2.5]*

See respective parameters 307 to 311 at *Analogue output 1*.

1535 ***Analogue output 3 function*** *[2.3.3.1]*
1536 ***Analogue output 3 filter time*** *[2.3.3.2]*
1537 ***Analogue output 3 inversion*** *[2.3.3.3]*
1538 ***Analogue output 3 minimum*** *[2.3.3.4]*
1539 ***Analogue output 3 scale*** *[2.3.3.5]*

See respective parameters 307 to 311 at *Analogue output 1*.

1540 ***Relay output 1 inversion*** *[2.3.4.3]*
1541 ***Relay output 2 inversion*** *[2.3.5.3]*
1542 ***Relay output 3 inversion*** *[2.3.6.3]*

If the values of these parameters = **0**, no inversion of the respective relay output signal takes place.

1544 ***Analogue input 1 supervision*** *[2.2.4]*
1545 ***Analogue input 2 supervision*** *[2.2.10]*
1546 ***Analogue input 3 supervision*** *[2.2.17]*

The signal level of the respective analogue input is supervised if value **1** is given to this parameter.

1549 Relay output 1, signal selection (2.3.4.1)
1550 Relay output 2, signal selection (2.3.5.1)
1551 Relay output 3, signal selection (2.3.6.1)
1552 Relay output 4, signal selection (2.3.7.1)

Connect the RO signal to the relay output of your choice with this parameter using the TTF programming method. More information on the TTF method in Vacon All in One Application manual. You will find the relay output signal contents on page 29.

1553 Relay output 4 function (2.3.7.2)

See Table 33.

1554 Relay output 4 inversion (2.3.7.3)

See par. ID1540.

1555 Relay output 5, signal selection (2.3.8.1)

See par. ID1549.

1556 Relay output 5 function (2.3.8.2)

See Table 33.

1557 Relay output 5 inversion (2.3.8.3)

See par. ID1540.

1558 AI3 signal selection (2.2.15)

Connect the AI3 signal to the analogue input of your choice with this parameter using the TTF programming method. More information on the TTF method in Vacon All in One Application manual.

1567 Relay output 6 function (2.3.9.2)

See Table 33.

1568 Relay output 6 inversion (2.3.9.3)

See par. ID1540.

1569 Coolant inlet pressure supervision (2.10.5)

If the system is equipped with a pressure sensor set value 1 for this parameter and 0 if no sensor is installed.

1570 Coolant inlet pressure alarm limit (2.10.4)

When the inlet pressure drops below the limit set with this parameter, a warning is triggered. A pressure sensor must be installed in the system.

1572 DIN6 function (2.2.3)

This parameter has 2 selections. The default value is 0.

0 Preset Speed 1
1 Fault reset
Contact closed: All faults reset

1573 *Relay output 6, signal selection* *(2.3.9.1)*

See par. ID1549.

1590 *DIN2 input* *(2.2.1)*

This parameter changes the default status of the digital input.

0 = Digital input 'normally open'
1 = Digital input 'normally closed'

1591 *Coolant outlet temperature alarm, lower limit* *(2.10.8)*
1594 *Coolant outlet temperature alarm, upper limit* *(2.10.9)*

Set here the temperature minimum and maximum limits for the coolant. If the temperature goes below or exceeds the set limits a warning is triggered.

1595 *Coolant outlet temperature fault, upper limit* *(2.10.10)*

Set here the temperature maximum limit for the coolant. If the temperature exceeds the set limits, a temperature fault is triggered.

1599 *Autochange interval* *(2.10.11)*

After the expiry of the time defined with this parameter, the autochange function takes place. The available time range for the autochange varies from 1 to 168 hours.

0	Test mode; Autochange after 30 seconds
1 to 168	Time range for autochange in hours
169	Single motor used; no autochange

- The time count is activated only if the Start/Stop request is active.
- The time count is reset after the autochange has taken place.

1575 PID output, dead band *(2.9.10)*
1576 PID output, dead band delay *(2.9.11)*

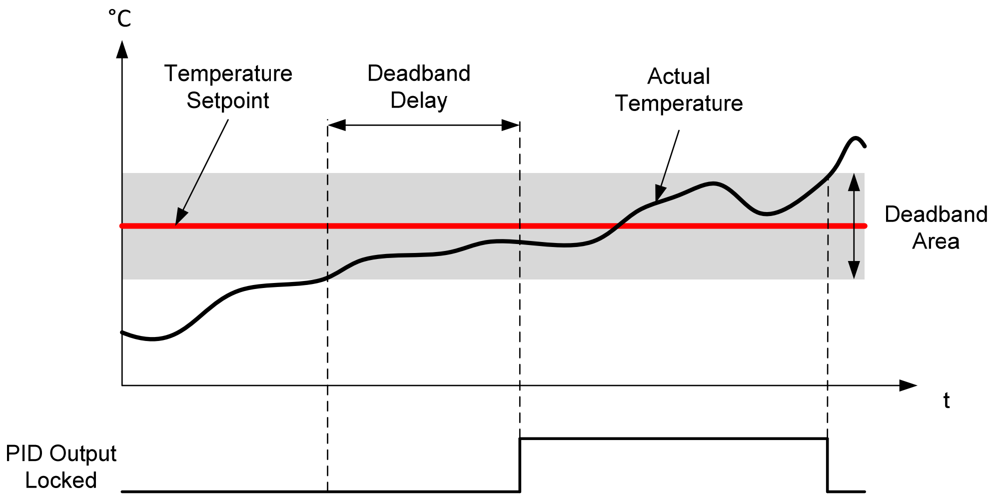
This function is designed to prevent wear and unwanted movements of the actuators, for example valves.

Use Dead band parameter to define dead band area around the PID setpoint value (temperature setpoint). The output of the PID controller will be locked, if the actual temperature (measured temperature) stays in the dead band area for the set time.

Use Dead band delay parameter to set the time that the actual temperature must stay in the dead band area, before the output of the PID controller is locked.

The output of the PID controller will be released, if the actual temperature goes outside of the dead band area.

Note! This function is disabled when Dead Band = 0.



4.1 Keypad control parameters

Unlike the parameters listed above, these parameters are located in the M3 menu of the control keypad. The reference parameters do not have an ID number.

114 *Stop button activated* *(3.4)*

If you wish to make the Stop button a "hotspot" which always stops the drive regardless of the selected control place, give this parameter the value 1.
See also parameter ID125.

125 *Control place* *(3.1)*

The active control place can be changed with this parameter. For more information, see the product's user manual.
Pushing the *Start button* for 3 seconds selects the control keypad as the active control place and copies the Run status information (Run/Stop, direction and reference).

123 *Keypad direction* *(3.3)*

0 Forward: The rotation of the motor is forward, when the keypad is the active control place.
1 Reverse: The rotation of the motor is reversed, when the keypad is the active control place.

For more information, see the product's user manual.

R3.2 *Keypad Reference* *(3.2)*

The frequency reference can be adjusted from the keypad with this parameter.
The output frequency can be copied as the keypad reference by pushing the *Stop button* for 3 seconds when you are on any of the pages of menu ***M3***. For more information, see the product's user manual.

R3.4 *PID reference 1* *(3.4)*

With this parameter, you can set the desired temperature for the coolant circulating in the system.

R3.5 *PID reference 2* *(3.5)*

With this parameter, you can set another, optional temperature for the coolant circulating in the system. The value is activated by setting the value 10 for parameter ID301. See page 27.

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