SVCH0203 SPX Advanced

Powering Business Worldwide

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Safety

Definitions and symbols

⚠ WARNING

This symbol indicates high voltage. It calls your attention to items or operations that could be dangerous to you and other persons operating this equipment. Read the message and follow the instructions carefully.

⚠

This symbol is the "Safety Alert Symbol." It occurs with either of two signal words: CAUTION or WARNING, as described below.

⚠ WARNING

Indicates a potentially hazardous situation which, if not avoided, can result in serious injury or death.

⚠ CAUTION

Indicates a potentially hazardous situation which, if not avoided, can result in minor to moderate injury, or serious damage to the product. The situation described in the CAUTION may, if not avoided, lead to serious results. Important safety measures are described in CAUTION (as well as WARNING).

Hazardous high voltage

⚠ WARNING

Motor control equipment and electronic controllers are connected to hazardous line voltages. When servicing drives and electronic controllers, there may be exposed components with housings or protrusions at or above line potential. Extreme care should be taken to protect against shock.

Stand on an insulating pad and make it a habit to use only one hand when checking components. Always work with another person in case an emergency occurs. Disconnect power before checking controllers or performing maintenance. Be sure equipment is properly grounded. Wear safety glasses whenever working on electronic controllers or rotating machinery.

Cautions and notices

Read this manual thoroughly and make sure you understand the procedures before you attempt to install, set up, or operate this 9000X AF Drives from Eaton's electrical sector.

⚠ CAUTION

Be ABSOLUTELY sure not to connect two functions to one and same output in order to avoid function overruns and to ensure flawless operation.

⚠ CAUTION

The calculated model does not protect the motor if the airflow to the motor is reduced by blocked air intake grill.

NOTICE

The *inputs*, unlike the *outputs*, cannot be changed in RUN state.

1. SPX Advanced application – introduction

Software SVCH0203, SPX Advanced application

SPX Advanced application has advanced power handling features, main focus being in different kind of propulsion systems. This application can be used also for winch control where smooth brake logic makes it possible to use a multi-motor winch system by just entering few additional parameter settings that are explained in this manual without forgetting permanent magnet motors.

1.1 Basic features

The SPX Advanced application provides a wide range of parameters for controlling induction motors and permanent magnet motors. It can be used for various kinds of different processes where wide flexibility of I/O signals is needed and only simple PI control logic.

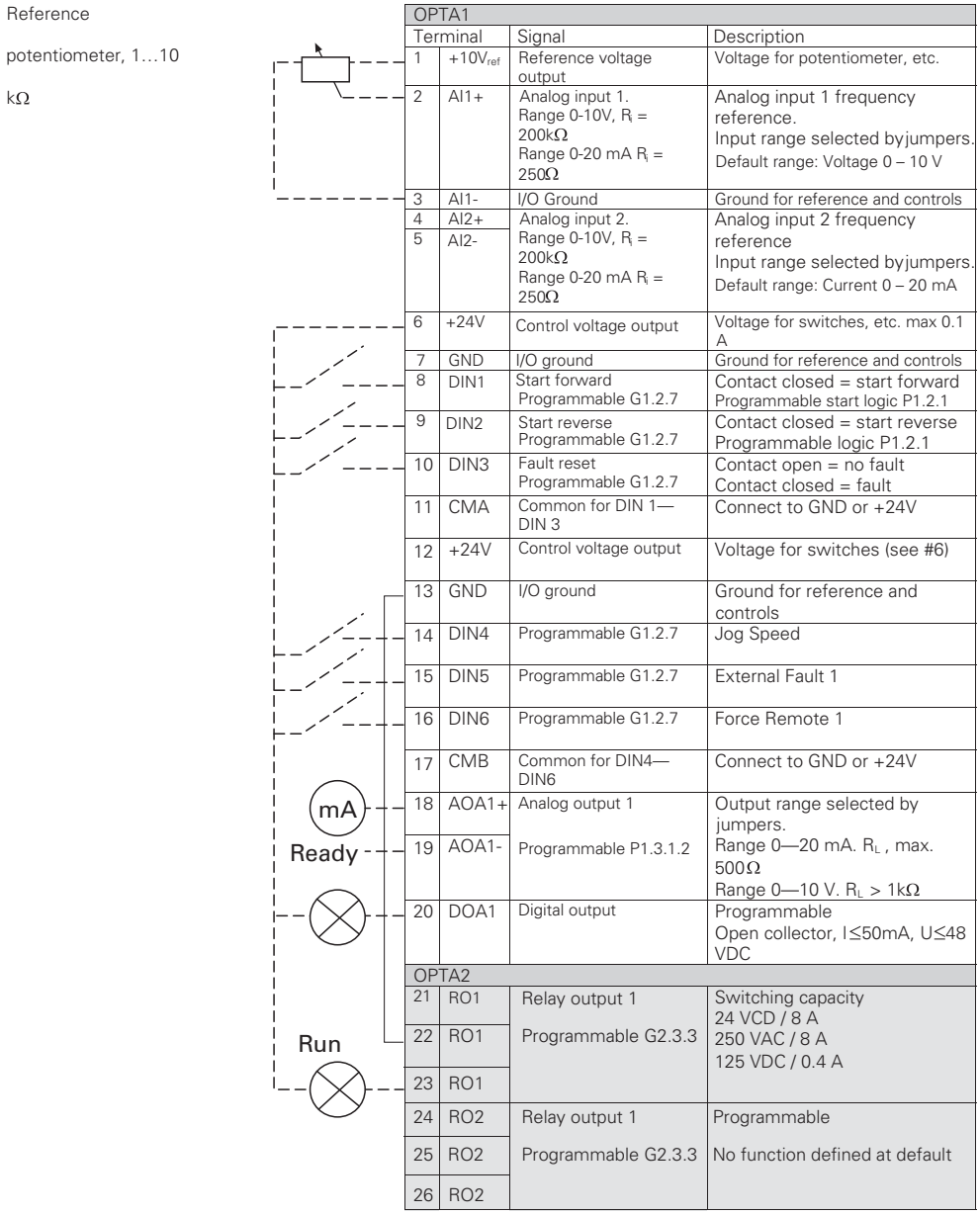
The main focus has been how power reference, power limits and torque limits behave in different situations. The application allows power and torque reference and reference ramp up rate adjustment to make the operation smooth for ship generators and mechanics.

Flexible ID control possibilities takes the application suitability to different process to a new level, allowing any input or actual value to be connected to any parameter with a scaling factor.

Additional functions:

- Joystick input dead zone
- Different power limits by DI or from Fieldbus. Motoring and generating side
- Master Follower function for steering propeller and double winding motors
- Different torque limits for motoring and generating side
- Cooling monitor input from heat exchange unit with selectable response
- Brake monitoring input and actual current monitor for immediate brake close
- Separate speed control tuning for different speeds and loads
- Inching function with two different references
- Possibility to connect FB Process data to any parameter and some monitoring values
- Analog input 3 and 4 can control any parameter by ID number
- Support for four Analog output
- Support for two PT100 board
- Power limit ramp up rate adjustment
- Torque limit ramp up rate adjustment
- Automatic power reduction from DC Voltage
- Actual power follower function, power will increase only with allowed rate

1.2 Control I/O



OPTA1			
Terminal		Signal	Description
1	+10V$_{ref}$	Reference voltage output	Voltage for potentiometer, etc.
2	AI1+	Analog input 1. Range 0-10V, R_i = 200kΩ Range 0-20 mA R_i = 250Ω	Analog input 1 frequency reference. Input range selected byjumpers. Default range: Voltage 0 – 10 V
3	AI1-	I/O Ground	Ground for reference and controls
4	AI2+	Analog input 2. Range 0-10V, R_i = 200kΩ Range 0-20 mA R_i = 250Ω	Analog input 2 frequency reference Input range selected byjumpers. Default range: Current 0 – 20 mA
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 forward Programmable G1.2.7	Contact closed = start forward Programmable start logic P1.2.1
9	DIN2	Start reverse Programmable G1.2.7	Contact closed = start reverse Programmable logic P1.2.1
10	DIN3	Fault reset Programmable G1.2.7	Contact open = no fault Contact closed = 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	Programmable G1.2.7	Jog Speed
15	DIN5	Programmable G1.2.7	External Fault 1
16	DIN6	Programmable G1.2.7	Force Remote 1
17	CMB	Common for DIN4—DIN6	Connect to GND or +24V
18	AOA1+	Analog output 1 Programmable P1.3.1.2	Output range selected by jumpers. Range 0—20 mA. R_L , max. 500Ω Range 0—10 V. R_L > 1kΩ
19	AOA1-		
20	DOA1	Digital output	Programmable Open collector, I≤50mA, U≤48 VDC
OPTA2			
21	RO1	Relay output 1 Programmable G2.3.3	Switching capacity 24 VCD / 8 A 250 VAC / 8 A 125 VDC / 0.4 A
22	RO1		
23	RO1		
24	RO2	Relay output 1 Programmable G2.3.3	Programmable No function defined at default
25	RO2		
26	RO2		

Table 1. SPX Advanced application default I/O configuration and connection example.

23	RO1		125 VDC / 0.4 A
24	RO2	Relay output 2 Programmable G2.3.3	Programmable No function defined at default
25	RO2		
26	RO2		

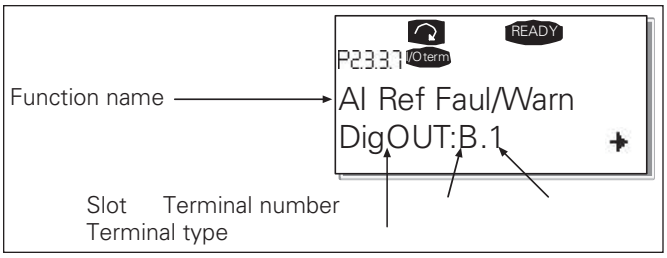
Note: See Users Manual, chapter Control Connections, for hardware specification and configuration.

2. "Terminal to Function" (TTF) programming principle

In the conventional programming method, Function to Terminal Programming Method (FTT), you have a fixed input or output that you define a certain function for. The applications mentioned above, however, use the Terminal to Function Programming method (TTF) in which the programming process is carried out the other way round: Functions appear as parameters which the operator defines a certain input/output for. See Warning on page 12.

2.1 Defining an input/output for a certain function on keypad

Connecting a certain input or output with a certain function (parameter) is done by giving the parameter an appropriate value. The value is formed of the Board slot on the 9000x control board (see 9000x User's Manual, Chapter 6.2) and the respective signal number, see below.



Example: You want to connect the digital output function Reference fault/warning (parameter 2.3.3.7) to the digital output DO1 on the basic board OPTA1 (see 9000x User's Manual, Chapter 6.2).

First find the parameter 2.3.3.7 on the keypad. Press the Menu button right once to enter the edit mode. On the value line, you will see the terminal type on the left (DigIN, DigOUT, An.IN, An.OUT) and on the right, the present input/output the function is connected to (B.3, A.2 etc.), or if not connected, a value (0.#).

When the value is blinking, hold down the Browser button up or down to find the desired board slot and signal number. The program will scroll the board slots starting from 0 and proceeding from A to E and the I/O selection from 1 to 10.

Once you have set the desired value, press the Enter button once to confirm the change.

2.2 Defining a terminal for a certain function with 9000xDrive programming tool

If you use the 9000xDrive Programming Tool for parametrizing you will have to establish the connection between the function and input/output in the same way as with the control panel. Just pick the address code from the drop-down menu in the Value column (see below Figure 1).

⚠ WARNING

Be ABSOLUTELY sure not to connect two functions to one and same output in order to avoid function overruns and to ensure flawless operation.

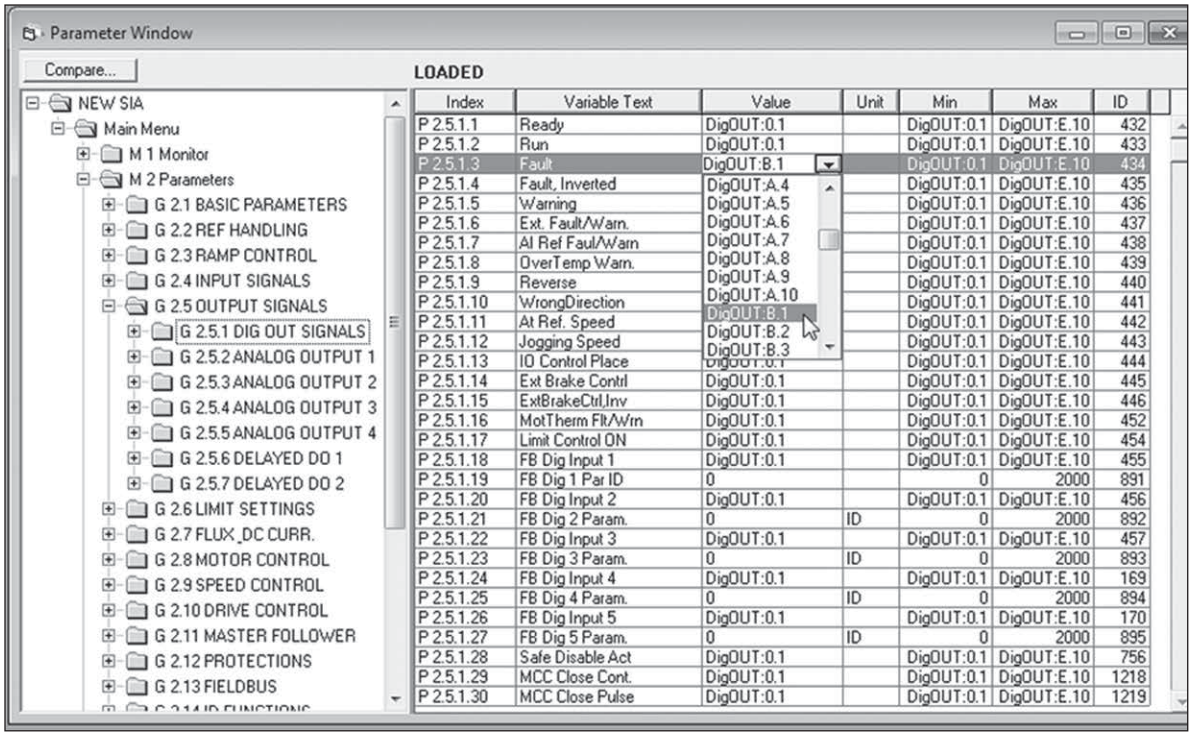
Note: The inputs, unlike the outputs, cannot be changed in RUN state.

2.3 Defining unused inputs/outputs

All unused inputs and outputs must be given the board slot value 0 and the value 1 also for the terminal number. The value 0.1 is also the default value for most of the functions. However, if you want to use the values of a digital input signal for e.g. testing purposes only, you can set the board slot value to 0 and the terminal number to any number between 2…10 to place the input to a TRUE state. In other words, the value 1 corresponds to 'open contact' and values 2 to 10 to 'closed contact'.

In case of Analog inputs, giving the value 1 for the terminal number corresponds to 0% signal level, value 2 corresponds to 20%, value 3 to 30% and so on. Giving value 10 for the terminal number corresponds to 100% signal level.

Figure 1. Screenshot of 9000xDrive programming tool; Entering the address code



Index	Variable Text	Value	Unit	Min	Max	ID
P 2.5.1.1	Ready	DigOUT:0.1		DigOUT:0.1	DigOUT:E.10	432
P 2.5.1.2	Run	DigOUT:0.1		DigOUT:0.1	DigOUT:E.10	433
P 2.5.1.3	Fault	DigOUT:B.1		DigOUT:0.1	DigOUT:E.10	434
P 2.5.1.4	Fault, Inverted			DigOUT:0.1	DigOUT:E.10	435
P 2.5.1.5	Warning			DigOUT:0.1	DigOUT:E.10	436
P 2.5.1.6	Ext. Fault/Warn.			DigOUT:0.1	DigOUT:E.10	437
P 2.5.1.7	AI Ref Faul/Warn			DigOUT:0.1	DigOUT:E.10	438
P 2.5.1.8	OverTemp Warn.			DigOUT:0.1	DigOUT:E.10	439
P 2.5.1.9	Reverse			DigOUT:0.1	DigOUT:E.10	440
P 2.5.1.10	WrongDirection			DigOUT:0.1	DigOUT:E.10	441
P 2.5.1.11	At Ref. Speed			DigOUT:0.1	DigOUT:E.10	442
P 2.5.1.12	Jogging Speed			DigOUT:0.1	DigOUT:E.10	443
P 2.5.1.13	IO Control Place			DigOUT:0.1	DigOUT:E.10	444
P 2.5.1.14	Ext Brake Contrl	DigOUT:0.1		DigOUT:0.1	DigOUT:E.10	445
P 2.5.1.15	ExtBrakeCtrl,Inv	DigOUT:0.1		DigOUT:0.1	DigOUT:E.10	446
P 2.5.1.16	MotTherm Flt/Wrn	DigOUT:0.1		DigOUT:0.1	DigOUT:E.10	452
P 2.5.1.17	Limit Control ON	DigOUT:0.1		DigOUT:0.1	DigOUT:E.10	454
P 2.5.1.18	FB Dig Input 1	DigOUT:0.1		DigOUT:0.1	DigOUT:E.10	455
P 2.5.1.19	FB Dig 1 Par ID	0		0	2000	891
P 2.5.1.20	FB Dig Input 2	DigOUT:0.1		DigOUT:0.1	DigOUT:E.10	456
P 2.5.1.21	FB Dig 2 Param.	0	ID	0	2000	892
P 2.5.1.22	FB Dig Input 3	DigOUT:0.1		DigOUT:0.1	DigOUT:E.10	457
P 2.5.1.23	FB Dig 3 Param.	0	ID	0	2000	893
P 2.5.1.24	FB Dig Input 4	DigOUT:0.1		DigOUT:0.1	DigOUT:E.10	169
P 2.5.1.25	FB Dig 4 Param.	0	ID	0	2000	894
P 2.5.1.26	FB Dig Input 5	DigOUT:0.1		DigOUT:0.1	DigOUT:E.10	170
P 2.5.1.27	FB Dig 5 Param.	0	ID	0	2000	895
P 2.5.1.28	Safe Disable Act	DigOUT:0.1		DigOUT:0.1	DigOUT:E.10	756
P 2.5.1.29	MCC Close Cont.	DigOUT:0.1		DigOUT:0.1	DigOUT:E.10	1218
P 2.5.1.30	MCC Close Pulse	DigOUT:0.1		DigOUT:0.1	DigOUT:E.10	1219

3. SPX Advanced application – monitoring values

On the next pages you will find the lists of parameters within the respective parameter groups. The parameter descriptions are given on pages 45 to 174. Parameter description includes more than is available in this application see parameter list what is available.

Column explanations:

Code = Location indication on the keypad; Shows the operator the present parameter 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

= On parameter code: Parameter value can only be changed after the FC has been stopped.

= Apply the Terminal to Function method (TTF) to these parameters (see chapter 2)

= Monitoring value is possible to control from fieldbus by ID number

The manual presents signals that are not normally visible for monitoring. i.e. is not a parameter or standard monitoring signal. These signals are presented with [Letter]. e.g. [FW] MotorRegulatorStatus

[V] Normal monitoring signal

[P] Normal parameter in application.

[FW] Firmware signal, Can be monitored with 9000xDrive when signal type is selected Firmware

[A] Application signal, can be monitored with 9000xDrive when signal type is selected Application.

[R] Reference type parameter on keypad.

[F] Function. Signal is received as a output of function.

[DI] Digital input signal.

3.1 Monitoring values

The monitoring values are the actual values of parameters and signals as well as statuses and measurements.

Note: for DriveSynch Systems:

In a DriveSynch system, only Master drive monitoring signals are reliable.

Only directly measured values are reliable in follower units. Even the Output Frequency of DriveSynch follower is not directly observed and thus may not show actual output frequency that is controlled by DriveSynch Master Drive.

Table 1. Monitoring values

Code	Parameter	Unit	Form	ID	Description
V7.1	Output frequency	Hz	#,##	1	Output frequency to motor
V7.2	Frequency reference	Hz	#,##	25	Frequency reference to motor control
V7.3	Motor speed	rpm	#	2	Motor speed in rpm
V7.4	Motor current	A	Varies	3	1 s linear filtering
V7.5	Motor torque	%	#,#	4	In % of Motor nominal torque
V7.6	Motor power	%	#,#	5	
V7.7	Motor voltage	V	#,#	6	Calculated motor voltage
V7.8	DC link voltage	V	#	7	Measured DC voltage, filtered.
V7.9	Unit temperature	°C	#	8	Heatsink temperature
V7.10	Motor temperature	%	#	9	Calculated motor temperature, trip 105 %
V7.11	Analog input 1	%	#,##	13	AI1, unfiltered.
V7.12	Analog input 2	%	#,##	14	AI2, unfiltered.
V7.13	Analog input 3	%	#,##	27	AI3, unfiltered.
V7.14	Analog input 4	%	#,##	28	AI4, unfiltered.
V7.15	Analog out 1	%	#,##	26	AO1
V7.16	Analog out 2	%	#,##	31	AO2
V7.17	Analog out 3	%	#,##	32	AO3
V7.18	Analog out 4	%	#,##	1526	
V7.19	DIN1, DIN2, DIN3			15	Digital input statuses
V7.20	DIN4, DIN5, DIN6			16	Digital input statuses
V7.21	Power reference	%	#,#	1700	Used power reference
V7.22	PT-100 Temperature	C°	#,#	42	Highest temperature of OPTB8 board. 4 s filtering.
V7.23	Motor KW	KW		1692	Motor instant KW
G7.24	Multimonitoring items				Displays three selectable monitoring values

3.1.1 Monitoring values 2

Table 2. Monitoring values 2

Code	Parameter	Unit	Form	ID	Description
V7.25.1	Current	A	Varies	1113	Unfiltered motor current
V7.25.2	Torque	%	#,#	1125	Unfiltered motor torque
V7.25.3	DC Voltage	V	#	44	Unfiltered DC link voltage
V7.25.4	Application status word			43	
V7.25.5	Shaft frequency	Hz	#,##	1124	Unfiltered
V7.25.6	Output power	kw	Varies	1508	Unfiltered electrical power
V7.25.7	Measured temperature 1	C°	#,#	50	4 s filtering.
V7.25.8	Measured temperature 2	C°	#,#	51	4 s filtering.
V7.25.9	Measured temperature 3	C°	#,#	52	4 s filtering.
V7.25.10	Measured temperature 4	C°	#,#	69	4 s filtering.
V7.25.11	Measured temperature 5	C°	#,#	70	4 s filtering.
V7.25.12	Measured temperature 6	C°	#,#	71	4 s filtering.
V7.25.13	ABS Encoder revolutions	r	#	55	
V7.25.14	ABS Encoder position		#	54	
V7.25.15	Step response	Hz	#,##	1132	
V7.25.16	Actual power factor		#,###	68	
V7.25.17	Flux current	%	#,#	72	
V7.25.18	Regulator status			77	
V7.25.19	Frequency delta	Hz/s		1847	
V7.25.20	Data logger trigger word			97	Different status bits to help diagnostic with data logger.
V7.25.21	Encoder 2 frequency	Hz		53	
V7.25.22	Operation hours	h		1856	
V7.25.23	Status word 2			89	
V7.25.24	Rotor flux	%	#,#	1158	

3.1.2 FieldBus monitoring values

Table 3. FieldBus monitoring values

Code	Parameter	Unit	Form	ID	Description
V7.26.1	FB Control word			1160	
V7.26.2	FB Speed reference			875	
V7.26.3	FB Status word			65	
V7.26.4	FB Actual speed			865	
V7.26.5	FB Torque reference	%	#,#	1140	Default control of FB PD 1
V7.26.6	FB Limit scaling	%	#,##	46	Default control of FB PD 2
V7.26.7	FB Adjust reference	%	#,##	47	Default control of FB PD 3
V7.26.8	FB Analog output	%	#,##	48	Default control of FB PD 4
V7.26.9	FB Motor current	A	#,#	45	Motor current (drive independent) given with one decimal point
V7.26.10	Fault word 1			1172	
V7.26.11	Fault word 2			1173	
V7.26.12	Warning word 1			1174	
V7.26.13	AuxStatusWord			1163	
V7.26.14	FB Power reference			1703	
V7.26.15	Last active fault			37	
V7.26.16	AuxControlWord			1161	
V7.26.17	Din status word			56	
V7.26.18	Din status word 2			57	
V7.26.19	MC Status			64	
V7.26.20	Last active warning			74	
V7.26.21	Shaft rounds			1170	

Code	Parameter	Unit	Form	ID	Description
V7.26.22	Shaft angle			1169	
V7.26.23	Fault word 10			1202	
V7.26.24	Warning word 10			1269	

3.1.3 Master/follwer monitoring values

Table 4. Master/follower monitoring values

Code	Parameter	Unit	Form	ID	Description
V7.27.1	SB SystemStatus			1601	
V7.27.2	Total current	A	#,#	80	Sum current of all drives (DS)
V7.27.3	Master CW			93	
Code	**Parameter**	**Unit**		**ID**	**Description**
V7.27.4.1	Motor current D1	A		1616	
V7.27.4.2	Motor current D2	A		1605	
V7.27.4.3	Motor current D3	A		1606	
V7.27.4.4	Motor current D4	A		1607	
Code	**Parameter**	**Unit**		**ID**	**Description**
V7.27.5.1	Status word D1			1615	
V7.27.5.2	Status word D2			1602	
V7.27.5.3	Status word D3			1603	
V7.27.5.4	Status word D4			1604	

3.1.4 PID Control monitoring values

Code	Parameter	Unit	Form	ID	Description
V7.28.1	PID Actual value			1796	Used PID Reference
V7.28.2	PID Reference			20	PID Actual value
V7.28.3	PI Error			22	PID Error

3.1.5 Frequency chain

Code	Parameter	Unit	Form	ID	Description
V7.29.1	Frequency reference 1	Hz		1126	
V7.29.2	Frequency reference 2	Hz		1127	
V7.29.3	Frequency reference 3	Hz		25	
V7.29.4	Frequency reference actual	Hz		1128	
V7.29.5	Frequency ramp out	Hz		1129	
V7.29.6	Frequency reference final	Hz		1131	
V7.29.7	Encoder frequency	Hz		1164	

3.1.6 Torque chain

Code	Parameter	Unit	Form	ID	Description
V7.30.1	Torque reference	%		18	
V7.30.2	Torque reference 3	%		1144	
V7.30.3	Torque ref final	%		1145	
V7.30.4	Speed control out	%		1134	
V7.30.5	Torque reference actual	%		1180	

3.1.7 Active limits

Code	Parameter	Unit	Form	ID	Description
V7.31.1	Motoring torque limit	%		1950	
V7.31.2	Generator torque limit	%		1951	
V7.31.3	Motoring power limit	%		1952	
V7.31.4	Generator power limit	%		1953	
V7.31.5	Current limit	A		1954	
V7.31.6	SPC Positive limit	%		1955	
V7.31.7	SPC Negative limit	%		1956	

3.2 Monitoring values description

Note: for DriveSynch Systems:

In a DriveSynch system, only Master drive monitoring signals are reliable.

Only directly measured values are reliable in follower units. Even the Output Frequency of DriveSynch follower is not directly observed and thus may not show actual output frequency that is controlled by DriveSynch Master Drive.

V7.1 ***Output frequency [#,## Hz].....ID1***
Output frequency to motor, updated at 10 ms time level.

V7.2 ***Frequency reference [#,## Hz].....ID 25***
Frequency reference to motor control, after speed share function. updates at 1 ms time level.

V7.3 ***Motor speed [# rpm] ID 2***
Motor speed in rpm

V7.4 ***Motor current [A] .....ID 3***
Open loop:
1 s linear filtering.

Closed loop:
32 ms filtering

Drive Synch Operation Master drive:
This value is the total current of the system divided by number of drives in the system (SbLastID). SbLastId cannot be changed; it needs to be set according to how many drives are linked with system bus.

Drive Synch Operation Follower drive:
This value is the current of the drive's own power unit.

Current scaling in different size of units

Note: ID45, usually in Process data OUT 3 is scaled to be with one decimal always.

Voltage	Size CT amps	Scale
208 – 240 Vac	0001 – 0011	100 – 0.01A
208 – 240 Vac	0012 – 0420	10 – 0.1A
208 – 240 Vac	0530	1 – 1A
380 – 500 Vac	0003 – 0007	100 – 0.01A
380 – 500 Vac	0009 – 0300	10 – 0.1A
380 – 500 Vac	0385 – 2643	1 – 1A
525 – 690 Vac	0004 – 0013	100 – 0.01A
525 – 690 Vac	0018 – 0261	10 – 0.1A
525 – 690 Vac	0325 – 1500	1 – 1A

V7.5 ***Motor torque % ID 4***
In % of Motor nominal torque
Open loop:
1 s linear filtering

Closed loop:
32 ms filtering

Drive Synch Operation Follower drive:
This value is the torque of the drive's own power calculated in open loop. Motor torque is valid only in Master drive.

V7.6 ***Motor power % ID 5***
Calculated motor power

V7.7 ***Motor voltage V ID 6***
Calculated motor voltage

V7.8 ***DC link voltage V ID 7***
Measured DC voltage, filtered.

V7.9 ***Unit temperature ºC ID 8***
Heatsink temperature

V7.10 ***Motor temperature % ID 9***
Calculated motor temperature
105 % is tripping limit if response is fault.

V7.11 ***Analog input 1 % ID 13***

V7.12 ***Analog input 2 % ID 14***
Unfiltered analog input level.
0 % = 0 mA/0 V, –100 % = –10 V, 100 % = 20 mA/10 V.
Monitoring scaling is determined by the option board parameter.

V7.13 ***Analog input 3 % ID 27***

V7.14 ***Analog input 4 % ID 28***
It is possible to adjust this input value from fieldbus when the input terminal selection is 0.1. This way it is possible to adjust the free analog input from fieldbus and have all analog input functions available for fieldbus process data.

V7.15 ***Analog out 1 % ID 26***

V7.16 ***Analog out 2 % ID 31***

V7.17 ***Analog out 3 % ID 32***

V7.18 ***Analog out 4 % ID 1526***
Analog Output value 0 % = 0 mA/0 V, 100 % = 20 mA/10 V

V7.19 ***DIN1, DIN2, DIN3 ID 15***

V7.20 ***DIN4, DIN5, DIN6 ID 16***

	DIN1/DIN2/DIN3 status	DIN4/DIN5/DIN6 status
b0	DIN3	DIN6
b1	DIN2	DIN5
b2	DIN1	DIN4

V7.21 ***Power reference % ID 1700***
Power reference monitoring value. If power reference is not selected in the reference group it can be directly written to this monitoring variable from fieldbus and only ramping rate function is active from power reference group.

V7.22 ***PT-100 Temperature Cº ID 42***
Highest temperature of OPTB8 board. 4 s filtering.

3.2.1 Monitoring values 2

V7.24.1 ***Current A*** ***ID 1113***
Unfiltered motor current, recommended signal for NCDrive monitoring.

Drive Synch Operation Master drive:
This value is the total current of the system divided by number of drives in the system (SbLastID). SbLastId cannot be changed; it needs to be set according to how many drives are linked with system bus.

Drive Synch Operation Follower drive:
This value is current of drive own power unit.

V7.24.2 ***Torque %*** ***ID 1125***
Unfiltered motor torque.

V7.24.3 ***DC Voltage V*** ***ID 44***
Unfiltered DC link voltage.

V7.24.4 ***Application status word "status word 1"*** ***ID 43***
Application status word combines different drive statuses to one data word.
Recommended signal for NCDrive monitoring.

Application status word 1 ID43

	False	True
b0	Flux not ready	Flux ready (>90 %)
b1	Not in ready state	Ready
b2	Not running	Running
b3	No fault	Fault
b4	Direction forward	Direction reverse
b5	Emergency stop active	Emergency stop NOT active
b6	Run disabled	Run enable
b7	No warning	Warning
b8	Power positive	Power negative or Gen torque or current limit active
b9	Parameter set 1 active (or no set used)	Parameter set 2 active
b10		Brake chopper operating
b11	No DC brake	DC brake is active
b12	No run request	Run request
b13	No limit controls active	Limit control active
b14	External brake control off	External brake control ON
b15	Not used	Not used

V7.24.5 ***Shaft frequency Hz*** ***ID1124***
Shaft Frequency used by motor control.

V7.24.6 ***Output power kw*** ***ID 1508***
Unfiltered electrical drive output power.

V7.24.7 ***Measured temperature 1 Cº*** ***ID 50***

V7.24.8 ***Measured temperature 2 Cº*** ***ID 51***

V7.24.9 ***Measured temperature 3 Cº*** ***ID 52***

V7.24.10 ***Measured temperature 4 Cº*** ***ID 69***

V7.24.11 ***Measured temperature 5 Cº*** ***ID 70***

V7.24.12 ***Measured temperature 6 Cº*** ***ID 71***
Separate measurement from two PT100 board. The signal has 4 s filtering time.

V7.24.13 ***ABS encoder revolutions*** ***ID55***
Absolute encoder revolution information.

V7.24.14 ***ABS encoder position*** ***ID54***
Absolute encoder position within one rotation. See encoder manual for scaling.

V7.24.15 ***Step response Hz*** ***ID 1132***
Frequency error. Compares ramp output to actual encoder frequency with 0,001 Hz accuracy. Can be used for speed control tuning in closed loop control.

V7.24.16 ***Actual power factor*** ***ID 68***
Estimated power factor value.

V7.24.17 ***Flux current*** ***ID 72***
Flux producing current component 100,0 % equals nominal flux current.

V7.24.18 ***Regulator status ID 77***

Regulator status ID77

b0	Motoring current regulator status	
b1	Generator current regulator status	
b2	Motoring torque regulator status	For CL monitor B0
b3	Generator torque regulator status	For CL monitor B1
b4	Over voltage regulator status	DC Voltage
b5	Under voltage regulator status	DC Voltage

V7.24.19 ***Frequency delta*** ***ID 1847***
Change of final frequency reference in Hz/s.

V7.24.20 ***Data logger trigger word*** ***ID 97***

Data logger trig word ID97

	Function	Comment
b0	Fault status	Logger is triggered when there is a fault
b1	Warning status	Logger is triggered when there is a warning
b2	Auto reset warning	Logger is triggered when there is a fault that has been defined to be automatically reset. This bit can be used to get the first fault situation.
b3	Fault status OR warning status	B0 OR B1 triggering situation has happened
b4	Fault status OR auto reset warning	B0 OR B2 triggering situation has happened

V7.24.21 ***Encoder 2 frequency***
OPT-D7 board second input encoder frequency.

V7.24.22 ***Operation hours***
Running state hours.

V7.24.23 ***Application status word 2 ID 89 "status word 2"***
Different statuses from the drive, useful for ID Control DO functions.

Application status word 2 ID89

	False	True
b0	Value control SR = FALSE	Value control SR = TRUE
b1		
b2		
b3		
b4		
b5		
b6		
b7		
b8		
b9		
b10		
b11		
b12		
b13		
b14		
b15		

V7.24.24 ***Rotor flux ID1158 "rotor flux"***
Calculated rotor flux.

3.2.2 FieldBus monitoring values

V7.25.1 ***FB Control word ID1160***
Control word used in bypass mode.
See P1.13.22 and option board ByPass.
More details in Chapter 9 status and control word in detail.

Bit	Description	
	Value = 0	**Value = 1**
b0	OFF	ON, reset after fault or b1 and b2
b1	Emergency stop by coast	ON, On normal operation: Keep TRUE
b2	Emergency stop by ramp	ON, On normal operation: Keep TRUE
b3	STOP REQUEST	RUN REQUST
b4	Force ramp to zero	Enable ramp,
b5	Freeze ramp	Enable ramp,
b6	Force ref to zero	Enable ramp,
b7	No action	FAULT RESET (0 -> 1)
b8	No action	Inching 1
b9	No action	Inching 2
b10	Disable profibus control	Enable profibus control
b11	Fieldbus DIN1=OFF	Fieldbus DIN1=ON (watchdog pulse)
b12	Fieldbus DIN2=OFF	Fieldbus DIN2=ON
b13	Fieldbus DIN3=OFF	Fieldbus DIN3=ON
b14	Fieldbus DIN4=OFF	Fieldbus DIN4=ON
b15	No action	No action

V7.25.2 ***FB Status word ID65***
ProfiDrive type status word. Not the same as used by profibus board in ProfiDrive mode. Needs to be selected with P1.14.19 GSW to be used. See detaisl in Chapter 9 status and control word in detail.

Bit	Description	
	Value = 0	**Value = 1**
b0	Not ready to switch on	Ready to switch on
b1	Not ready to operate	Ready to operate
b2	Not running	Running
b3	No Fault	Fault
b4	Coast stop active	Coast stop not active
b5	Quick stop active	Quick stop not active
b6	Switch not inhibited	Switch on inhibit
b7	No warning	Warning
b8	Speed error	Speed at reference
b9	No FB Control request	FB control active
b10	Fout < Fmax	Fout > Fmax
b11	not used	not used
b12	not used	not used
b13	not used	not used
b14	not used	not used
b15	Fieldbus DIN1=OFF	Fieldbus DIN1=ON (Watchdog pulse)

V7.25.3 ***FB Torque reference % ID 1140***
Torque reference value from fieldbus.
Default control of FB PD 1

V7.25.4 ***FB Limit scaling % ID 46***
Limit scaling input value from fieldbus.
Default control of FB PD 2.

V7.25.5 ***FB Adjust reference % ID 47***
Reference adjustment value from fieldbus.
Default control of FB PD 3.

V7.25.6 ***FB Analog output % ID 48***
Fieldbus value to control analog output.
Default control of FB PD 4.

V7.25.7 ***FB Motor current A ID 45***
Motor current (drive independent) given with one decimal point.

V7.25.8 ***Fault word 1 ID 1172***
Different faults are collected to two words that can be read from fieldbus or with NCDrive PC software.

Fault word 1 ID1172

	Fault	Comment
b0	Over current or IGBT	F1, F31, F41
b1	Over voltage	F2
b2	Under voltage	F9
b3	Motor stalled	F15
b4	Earth fault	F3
b5	Motor under load	F17
b6	Drive over temperature	F14
b7	Motor over temperature	F16, ~~F56~~, F29
b8	Input phase	F10
b9	Brake resistor over temperature	F42 (Not implemented)
b10	Device changed	F37, F38, F39, F40, F44, F45 (Not implemented)
b11	Keypad or PCControl	F52
b12	FielBus	F53
b13	SystemBus	F59

Fault word 1 ID1172

	Fault	Comment
b14	Slot	F54
b15	4 mA	F50

V7.25.9 Fault word 2 ID 1173

Fault word 2 ID1173

	Fault	Comment
b0	Output phase	F11
b1	Charge switch	F5 (Not implemented)
b2	Encoder	F43
b3	Inverter	F4, F7 (Not implemented)
b4		
b5	EEPROM	F22 (Not implemented)
b6	External	F51
b7	Brake chopper	F12 (Not implemented)
b8	Watch dog	F25 (Not implemented)
b9	IGBT	F31, F41
b10	Brake	F58
b11	Fan cooling	F32
b12	Application	F35 (Not implemented)
b13	Control fault	F33, F36, F8 (Not implemented)
b14	Main switch open	F64 (Not implemented)
b15		

V7.25.10 Warning word 1 ID 1174

Warning word 1 ID1174

	Fault	Comment
b0	Motor stalled	W15
b1	Motor over temperature	W16
b2	Motor under load	W17
b3	Input phase loss	W10
b4	Output phase loss	W11
b5	Safe disable	W30 (Not implemented)
b6	FieldBus communication fault in slot D	W53 (Not implemented)
b7	FieldBus communication fault in slot E	W67 (Not implemented)
b8	Drive over temperature	W14
b9	Analog input < 4mA	W50
b10	Not used	
b11	Emergency stop	W63 (Not implemented)
b12	Run disabled	W62 (Not implemented)
b13	Not used	
b14	Mechanical brake	W58
b15	Not used	

V7.25.11 AuxStatusWord ID 1163

Aux status word ID1163

	Fault	Comment
b0	Reserved	Reserved
b1		Window control active and speed outside of widow
b2	Reserved	Reserved
b3	Reserved	Reserved
b4	Reserved	Reserved

Aux status word ID1163

	Fault	Comment
b5	Reserved	Reserved
b6	Reserved	Reserved
b7	Reserved	Reserved
b8	Reserved	Reserved
b9	Reserved	Reserved
b10	Reserved	Drive in torque control mode
b11	Reserved	Reserved
b12	Reserved	Reserved
b13	Reserved	Reserved
b14	Reserved	Reserved
b15	Reserved	Reserved

V7.25.12 FB Power reference ID1703

Power reference from fieldbus is written to this monitoring signal.

V7.25.13 Fault history ID 37

Fault number of the last active fault.

V7.25.14 AuxControlWord ID 1161

Aux control word ID1161

	False	True
b0	Reserved	Reserved
b1	Reserved	Reserved
b2	Reserved	Reserved
b3	Reserved	Reserved
b4	Reserved	Reserved
b5	Reserved	Reserved
b6	Reserved	Reserved
b7	No Action	Ext brake is forced open
b8	Reserved	Reserved
b9	No Action	Reset encoder position
b10	Reserved	Reserved
b11	Reserved	Reserved
b12	Reserved	Reserved
b13	Reserved	Reserved
b14	Reserved	Reserved
b15	Reserved	Reserved

V7.2515 Din status word ID 56
V7.25.16 Din status word 2 ID 57

	DIN StatusWord 1	DIN StatusWord 2
b0	DIN: A.1	DIN: C.5
b1	DIN: A.2	DIN: C.6
b2	DIN: A.3	DIN: D.1
b3	DIN: A.4	DIN: D.2
b4	DIN: A.5	DIN: D.3
b5	DIN: A.6	DIN: D.4
b6	DIN: B.1	DIN: D.5
b7	DIN: B.2	DIN: D.6
b8	DIN: B.3	DIN: E.1
b9	DIN: B.4	DIN: E.2
b10	DIN: B.5	DIN: E.3

	DIN StatusWord 1	DIN StatusWord 2
b11	DIN: B.6	DIN: E.4
b12	DIN: C.1	DIN: E.5
b13	DIN: C.2	DIN: E.6
b14	DIN: C.3	
b15	DIN: C.4	

V7.25.17 MC Status ID 64

This is the value that is also send to fieldbus on those fieldbus that do not use own state machine.

Motor control status word

	False	True
b0	Not in ready state	Ready
b1	Not running	Running
b2	Direction clockwise	Counterclockwise
b3	No fault	Fault
b4	No warning	Warning
b5		At reference speed
b6		At Zero Speed
b7		Flux Ready
b8		TC Speed limiter active
b9	Encoder direction	Counterclockwise
b10		Under voltage fast stop
b11	No DC brake	DC Brake is active
b12		
b13		Restart delay active
b14		
b15		

V7.25.18 Warning ID 74

Last active warning.

V7.25.19 Shaft rounds ID 1170

Rounds information from incremental encoder. The value is reset when 24 Vdc is removed from the drive.

V7.25.20 Shaft angle ID 1169

Angle information from incremental encoder. The value is reset when 24 Vdc is removed from the drive.

V7.25.21 Fault word 10 ID 1202

Fault word 10 ID1202

	Fault	Comment
b0	Speed error	F61
b1		
b2	Over load fault active	F82
b3	No motor fault	F83
b4	PT100 Fault	F56 & F65
b5		
b6		
b7		
b8		
b9		
b10		

Fault word 10 ID1202

	Fault	Comment
b11		
b12		
b13		
b14		
b15		

V7.25.22 Warning word 10 ID 1269

Warning word 1 ID1269

	Fault	Comment
b0	Speed error	W61
b1	Earth fault warning	W3
b2	Over load warning active	W82
b3	No motor warning	W83
b4	PT100 Warning	W56 & W65
b5		
b6		
b7		
b8		
b9		
b10		
b11		
b12		
b13		
b14		
b15		

3.2.3 Master/Follower

Here are gathered relevant signals in Mater follower system.

Note: Note for DriveSynch Systems:

In a DriveSynch system, only Master drive monitoring signals are reliable.

Only directly measured values are reliable in follower units. Even the Output Frequency of DriveSynch follower is not directly observed and thus may not show actual output frequency that is controlled by DriveSynch Master Drive.

V7.26.1 SB SystemStatus ID 1601

D1: Status of all (max 4) drives status in system bus.
D2, D3 and D4: Drive own status B0-B3

System bus status word ID1601

	False	True
b0		Drive 1 in synch
b1		Drive 1 ready
b2		Drive 1 running
b3		Drive 1 fault
b4		Drive 2 in synch
b5		Drive 2 ready
b6		Drive 2 running
b7		Drive 2 fault
b8		Drive 3 in synch
b9		Drive 3 ready

System bus status word ID1601

	False	True
b10		Drive 3 running
b11		Drive 3 fault
b12		Drive 4 in synch
b13		Drive 4 ready
b14		Drive 4 running
b15		Drive 4 fault

V7.26.2 ***Total current*** ***A*** ***ID 80***
D1: This value is the current of whole drive synch system.

D2, D3 and D4:This value is the sum current of the drive's own power unit and that of the drives with smaller system bus identification number starting from master drive.

If D2 Master: This value is the current of whole drive synch system.

V7.26. 3 ***Master CW*** ***ID93***
Master Drive Control Word. Master Sending, Follower receiving.

Master control word ID93

	Master-follower	DriveSynch master-follower
b0	Ready status	
b1	Run enable	
b2	Final run request	
b3	Fault reset	Fault reset
b4	Running	Running
b5	Fault	
b6	Brake control	Brake control
b7	WD Pulse	
b8	Brake control reference release	
b9	Data logger trigger	Data logger trigger
b10	Ramp stop active	
b11	Start delay active	
b12		
b13		
b14	Disable SB diagnostic	Disable SB diagnostic
b15		

V7.26.4.1 ***Motor current D1*** ***A*** ***ID 1616***
D1, D2, D3 and D4: This value is the current of drive own power unit.

V7.26.4.2 ***Motor current D2*** ***A*** ***ID 1605***
D1: This value is the current of drive number two power unit.
D2, D3 and D4: Not updated.

V7.26.4.3 ***Motor current D3*** ***A*** ***ID 1606***
D1: This value is the current of drive number three power unit.
D2, D3 and D4: Not updated.

V7.26.4.4 ***Motor current D4*** ***A*** ***ID 1607***
D1: This value is the current of drive number four power unit.
D2, D3 and D4: Not updated.

V7.26.5.1 ***Status word D1*** ***ID 1615***
D1: Status Word for D1 without B15
D2,D3 and D4: Status Word that is send to D1.

V7.26.5.2 ***Status word D2*** ***ID 1602***
D1: D2 Status Word
D2, D3 and D4: Not updated.

V7.26.5.3 ***Status word D3*** ***ID 1603***
D1: D3 Status Word
D2, D3 and D4: Not updated.

V7.26.5.4 ***Status word D4*** ***ID 1604***
D1: D4 Status Word
D2, D3 and D4: Not updated.

Follower drive status word

	False	True
b0	Flux not ready	Flux ready (>90 %)
b1	Not in ready state	Ready
b2	Not running	Running
b3	No fault	Fault
b4	Charge switch open	Charge switch closed
b5	Brake frequency limit on	Brake frequency limit OFF
b6	Run disabled	Run enable
b7	No warning	Warning
b8		Follower
b9		Master
b10		Drive synch In synch
b11	No DC brake	DC Brake is active
b12	No run request	Run request
b13	No limit controls active	Limit control active
b14	External brake control OFF	External brake control ON
b15		Heard beat

3.2.4 PI Control monitoring

This PI control uses ID numbers for input and output signal. See detail in PI Control chapter.

V7.27.1 ***PI Reference*** ***ID20***
Used PI Reference, reference is selected by ID number.

V7.27.2 ***PI Actual value*** ***ID21***
PI Actual value. Actual input is selected by ID number.

V7.27.3 ***PI Output*** ***ID23***
PI Output before scaling. This value uses PI out high and low for limiting.

V7.27.4 ***PI Output scaled*** ***ID1807***
Scaled PI Output.
This is used for ID connection. Scaling function is used to scale value more suitable for connected signal. e.g. when output is connected to torque limit actual value need to be –1000 ...+1000 (–100,0 %..+100,0 %) But PI Out High and Low can be from –30000...+30000 to have more accurate PI control.

3.2.5 Frequency chain

V7.28.1 ***Frequency reference 1*** ***Hz*** ***1126***
Frequency reference before speed share. Speed Share is used also for reference direction control.

V7.28.2 ***Frequency reference 2*** ***Hz*** ***1126***
Frequency reference after speed share and reference adjust but before interpolator.

V7.28.3 ***Frequency reference*** ***Hz*** ***25***
Frequency reference after interpolator but before second order filtering.

V7.28.4 ***Frequency reference actual*** ***Hz*** ***1128***
Frequency reference for ramp control.

V7.28.5 ***Frequency ramp out*** ***Hz*** ***1129***
Ramp control output.

V7.28.6 ***Frequency reference final*** ***Hz*** ***1131***
Final reference to speed controller. After ramp generator and after Speed Step function, used for closed loop speed tuning when used together with Encoder 1 frequency.

V7.28.7 ***Encoder 1 frequency*** ***Hz*** ***1164***
Encoder frequency, monitored directly from encoder.

3.2.6 Torque chain

V7.29.1 ***Torque reference*** ***%*** ***ID 18***
Torque reference value before load share.

V7.29.2 ***Torque reference 3*** ***%*** ***1144***
Torque reference after load share. But before torque step.

V7.29.3 ***Torque ref final*** ***%*** ***1145***
Final torque reference in torque reference chain, before acceleration compensation and speed controller output.

V7.29.4 ***Speed control out*** ***%*** ***1134***
Closed loop speed controller output.

V7.29.5 ***Torque reference actual*** ***%*** ***1180***
Final torque reference from speed control and torque control. Also includes torque step and acceleration compensation factors.

3.2.7 Counters

Below counter values are not visible as a standard monitoring signal but are accessible with ID numbers from fieldbus.

3.2.7.1 Power on time counter

This timer is counting when control board is powered (i.e. counting when only 24 Vdc is given to control board).

ID10 ***PowerOnTimeTripCounter***
Resetable power on time counter.
UINT value. READ only access.
Use ID1050 to define format.
Use ID1051 to reset value

ID1050 ***PowerOnTripCounterUnit***
Read or select power on counter format.
USINT value. WRITE access.
1 = 1 ms
2 = 10 ms
3 = 100 ms
4 = 1 s
5 = 1 min
6 = 1 h (Default)
7 = 1 d

ID1051 ***ResetOnTimeTripCounter***
Reset Power on trip counter, rising edge will reset counter.
BOOL value. WRITE access.
Write INT value 1 to reset if Process Data is used.

3.2.7.2 Energy meter counter monitoring

ID11 ***EnergyMeter***
Read ID80 and ID81 to see used format.
UINT value. READ only access.

ID82 ***EnergyMeterFormat***
Decimal point place in the value
60 = 6 max number of digits, 0 fractional digits
61 = 6 max number of digits, 1 fractional digits
62 = 6 max number of digits, 2 fractional digits
UINT value. READ only access.

Note: Most of the standard applications use ID number ID80 for this variable.

ID81 ***EnergyMeterUnit***
Unit for the energy meter
USINT value. READ only access.
1 = kWh
2 = MWh
3 = GWh
4 = TWh

3.2.7.3 Energy trip counter monitoring

ID12 ***EnergytripCounter***
Energy trip counter, use ID1052 define format.
UINT value. READ only access.
Max. value is 65 535 and after that value is resetted to zero and counting is restarted.

ID1052 ***EnergyTripCounterUnit***
WRITE access.Unit value can be changed via fieldbus .USINT value.
1 = 0.01 kWh
2 = 0.1 kWh
3 = 1 kWh
4 = 10 kWh
5 = 100 kWh
6 = 1 MWh
7 = 10 MWh
8 = 100 MWh
9 = 1 GWh
10 = 10 GWh

ID1053 ***ResetMWhTripCounter***
Reset energy trip counter, rising edge will reset counter.
BOOL value. Write INT value 1 to reset if Process Data is used.

4. SPX Advanced application – parameter list

4.1 Basic parameters

Table 1. Basic parameters G1.1

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.1.1	Minimum frequency	0.00	P1.1.2	Hz	0.00	101	
P1.1.2	Maximum frequency	P1.1.1	320.00	Hz	60.00	102	**Note:** If f_{max} > than the motor synchronous speed, check suitability for motor and drive system
P1.1.3	Motor nominal voltage	180	690	V	2: 230V 4: 480V 5: 690V	110	Check the rating plate of the motor. Note also used connection Delta/Star
P1.1.4	Motor nominal frequency	8.00	320.00	Hz	60.00	111	Check the rating plate of the motor
P1.1.5	Motor nominal speed	5	20 000	rpm	1725	112	The default applies for a 4-pole motor and a nominal size frequency converter.
P1.1.6	Motor nominal current	0.1 x I_H	2 x I_H	A	I_H	113	Check the rating plate of the motor.
P1.1.7	Motor power factor	0.30	1.00		0.85	120	Check the rating plate of the motor
P1.1.8	Motor nominal power	0.0	3200.0	kW	0.0	116	Check the rating plate of the motor
P1.1.9	Magnetizing current	0.00	100.00	A	0.00	612	0.00 A = Drive uses estimated value from motor name plate values
P1.1.10	Identification	0	4		0	631	0=No action 1=Identification w/o run 2=Identification with run 3=Encoder ID Run 4=Ident All 5=Absolute encoder, locked rotor **Note:** Set motor control mode to freq control before identification!
P1.1.11	Motor type	0	1		0	650	0=Induction Motor 1=PMS Motor
P1.1.12	Local control source	0	3		0	172	0=Keypad 1=I/O Term 2=I/O Term B 3=Fieldbus
P1.1.13	Remote 1 control source	0	3		1	173	See P1.1.12
P1.1.14	Remote 2 control source	0	3		3	174	See P1.1.12

4.2 Reference handling

4.2.1 Basic settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.2.1	Local reference	0	17		8	121	0=AI1 1=AI2 2=AI1+AI2 3=AI1-AI2 4=AI2-AI1 5=AI1xAI2 6=AI1 Joystick 7=AI2 Joystick 8=Keypad 9=Fieldbus 10=Motor potentiometer 11=AI1, AI2 minimum 13=Max frequency 14=AI1/AI2 selection 15=Encoder 1 16=Encoder 2 17=PID Output

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.2.2	Remote 1 reference	0	17		1	117	See P1.2.1
P1.2.3	Remote 2 reference	0	17		9	122	See P1.2.1
P1.2.4	Remote 1 reference 2	0	17		2	131	See P1.2.1
P1.2.5	Speed share	–300.00	300.00	%	100.00	1241	
P1.2.6	Load share	0.0	500.0	%	100.0	1248	

4.2.2 Constant reference

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.2.7.1	Jogging speed reference	0.00	320.00	Hz	5.00	124	
P1.2.7.2	Preset speed 1	0.00	320.00	Hz	10.00	105	Multi-step speed 1
P1.2.7.3	Preset speed 2	0.00	320.00	Hz	15.00	106	Multi-step speed 2
P1.2.7.4	Preset speed 3	0.00	320.00	Hz	20.00	126	Multi-step speed 3
P1.2.7.5	Preset speed 4	0.00	320.00	Hz	25.00	127	Multi-step speed 4
P1.2.7.6	Preset speed 5	0.00	320.00	Hz	30.00	128	Multi-step speed 5
P1.2.7.7	Preset speed 6	0.00	320.00	Hz	40.00	129	Multi-step speed 6
P1.2.7.8	Preset speed 7	0.00	320.00	Hz	50.00	130	Multi-step speed 7
P1.2.7.9	Inching reference 1	–320.00	320.00	Hz	2.00	1239	
P1.2.7.10	Inching reference 2	–320.00	320.00	Hz	–2.00	1240	
P1.2.7.11	Speed step	–50.0	50.0	0.0	0.0	1252	9000xDrive speed tuning

4.2.3 Power reference

Table 2. Power reference input signal selection, G1.2.8

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.2.8.1	Power reference	0	8		0	1620	0=Not used 1=AI1 2=AI2 3=AI3 4=AI4 5=AI1 Joystick 6=AI2 Joystick 7=Keypad Ref 8=Fieldbus
P1.2.8.2	Maximum power reference	0.0	300.0	%	120.0	1621	
P1.2.8.3	Power reference Increase rate	0	10000	%/s	100	1622	

4.2.4 Torque reference

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.2.9.1	Torque reference selection	0	8		0	641	0=Not used 1=AI1 2=AI2 3=AI3 4=AI4 5=AI1 joystick (–10 – 10 V) 6=AI2 joystick (–10 – 10 V) 7=Torque reference from keypad, R3.5 8=FB Torque reference 9=Master torque 10=Power reference
P1.2.9.2	Torque reference max.	–300.0	300.0	%	100	642	
P1.2.9.3	Torque reference min.	–300.0	300.0	%	0.0	643	

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.2.9.4	Torque reference filtering time	0	32000	ms	0	1244	
P1.2.9.5	Torque reference dead zone	0.0	300.0	%	0.00	1246	
P1.2.9.6	Torque Select	0	5		2	1278	0=Speed control 1=Maximum freq limit 2=Ramp output 3=Min 4=Max 5=Window
P1.2.9.7	Window negative	0.00	50.00	Hz	2.00	1305	
P1.2.9.8	Window positive	0.00	50.00	Hz	2.00	1304	
P1.2.9.9	Window negative off	0.00	P1.10.11	Hz	0.00	1307	
P1.2.9.10	Window positive off	0.00	P1.10.12	Hz	0.00	1306	
P1.2.9.11	Torque step	–100.0	100.0	0.0	0.0	1253	

4.2.5 Torque reference OL settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.2.9.11.1	Open loop torque control minimum frequency	0.00	50.00	Hz	3.00	636	
P1.2.9.11.2	Open loop torque controller P gain	0	32000		150	639	
P1.2.9.11.3	Open loop torque controller I gain	0	32000		10	640	

4.2.6 Prohibit frequency parameters

Table 3. Prohibit frequencies G1.2.10

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.2.10.1	Prohibit frequency range 1 low limit	–1.00	320.00	Hz	0.00	509	0=Not used
P1.2.10.2	Prohibit frequency range 1 high limit	0.00	320.00	Hz	0.00	510	0=Not used
P1.2.10.3	Ramp time factor	0.1	10.0	x	1.0	518	Multiplier of the currently Selected ramp time between prohibit frequency limits.

4.2.7 Motor potentiometer

Table 4. Motor potentiometer (G1.5)

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.2.11.1	Motor potentiometer ramp rate	0.10	2000.00	Hz/s	1.00	331	Ramp rate for motor potentiometer
P1.2.11.2	Motor potentiometer frequency reference memory reset	0	2		1	367	0=No reset 1=Reset in stop state 2=Reset in powered down
P1.2.11.3	Motor potentiometer reference copy	0	2		0	366	0=No copy 1=Copy Reference 2=Copy output frequency

4.2.8 Adjust reference

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.2.12.1	Adjust input	0	5		0	493	0=Not used 1=AI1 2=AI2 3=AI3 4=AI4 5=Fieldbus
P1.2.12.1	Adjust minimum	0.0	100.0	%	0.0	494	Adjust limit to decrease ref.
P1.2.12.1	Adjust maximum	0.0	100.0	%	0.0	495	Adjust limit to increase ref.

4.3 Ramp control

4.3.1 Basic settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.3.1	Start function	0	1		0	505	0=Ramp 1=Flying start
P1.3.2	Stop function	0	1		0	506	0=Coasting 1=Ramp
P1.3.3	Acceleration time 1	0.2	3270.0	s	3.0	103	0 Hz to Max frequency
P1.3.4	Deceleration time 1	0.2	3270.0	s	3.0	104	Max frequency to 0 Hz
P1.3.5	Ramp 1 shape	0	100	%	2	500	0=Linear >0=S-curve ramp time
P1.3.6	Acceleration time 2	0.2	3270.0	s	10.0	502	
P1.3.7	Deceleration time 2	0.2	3270.0	s	10.0	503	
P1.3.8	Ramp 2 shape	0	100	%	4	501	0=Linear >0=S-curve ramp time
P1.3.9	Inching ramp	0.01	320.00	s	1.00	1257	
P1.3.10	Reducing of acc./dec. times	0	5		0	401	Scales active ramp from 100 % to 10 %. 0=Not used 1=AI1 2=AI2 3=AI3 4=AI4 5=Fieldbus

4.3.2 Quick stop

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.3.11.1	IO Quick stop mode	0	1		0	1276	0=Coasting 1=Ramp
P1.3.11.2	Quick stop ramp time	0.1	3200.0	s		1256	

4.3.3 Ramp control options

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.3.12.1	Ramp: Skip S2	0	1		0	1900	
P1.3.12.2	CL Ramp follower encoder frequency	0	1		0	1902	
P1.3.12.3	Ramp input interpolator TC	0	200	ms	10	1184	

4.4 Input signals

4.4.1 Basic settings

Table 5. Input signals: basic settings. G1.4.1

Code	Parameter	Min	Max	Unit	Default	ID	Note		
								Start signal 1 (Default: DIN1)	Start signal 2 (Default: DIN2)
							0	Start fwd	Start rvs
							1	Start/Stop	Reverse
P1.4.1.1	Start/Stop logic selection	0	7		0	300	2	Start/Stop	Run enable
							3	Start pulse	Stop pulse
							4	Start	Mot.Pot UP
							5	Start fwd*	Start rvs*
							6	Start*/Stop	Reverse
							7	Start*/Stop	Run enable

* = Rising edge required to

4.4.2 Digital inputs

Table 6. Digital input signals, G1.4.2

Code	Parameter	Min	Default	ID	Note
P1.4.2.1	Start signal 1	0.1	A.1	403	Forward, See ID300
P1.4.2.2	Start signal 2	0.1	A.2	404	Reverse. See ID300
P1.4.2.3	Run enable	0.1	0.2	407	Motor start enabled (cc)
P1.4.2.4	Reverse	0.1	0.1	412	Direction forward (oc) Direction reverse (cc)
P1.4.2.5	Preset speed 1	0.1	0.1	419	See preset speeds in basing parameter group G2.1
P1.4.2.6	Preset speed 2	0.1	0.1	420	
P1.4.2.7	Preset speed 3	0.1	0.1	421	
P1.4.2.8	Motor potentiometer reference DOWN	0.1	0.1	417	Mot.pot. reference decreases (cc)
P1.4.2.9	Motor potentiometer reference UP	0.1	0.1	418	Mot.pot. reference increases (cc)
P1.4.2.10	Fault reset	0.1	0.1	414	All faults reset (cc)
P1.4.2.11	External fault (close)	0.1	A.5	405	Ext. fault displayed (cc)
P1.4.2.12	External fault (open)	0.1	0.2	406	Ext. fault displayed (oc)
P1.4.2.13	Acc/Dec time selection	0.1	0.1	408	Acc/Dec time 1 (oc) Acc/Dec time 2 (cc)
P1.4.2.14	Acc/Dec prohibit	0.1	0.1	415	Acc/Dec prohibited (cc)
P1.4.2.15	DC braking	0.1	0.1	416	DC braking active (cc)
P1.4.2.16	Jogging speed	0.1	A.4	413	Jogging speed selected for frequency reference (cc)
P1.4.2.17	Remote 1 ref 1/2 selection	0.1	0.1	422	IO reference selection:14 ID117
P1.4.2.18	Force Local	0.1	0.1	410	Force control place to Local (cc)
P1.4.2.19	Force Remote 1	0.1	A.6	409	Force control place to Remote 1 (cc)
P1.4.2.20	Force Remote 2	0.1	0.1	411	Force control place to Remote 2 (cc)
P1.4.2.21	Parameter set 1/set 2 selection	0.1	0.1	496	Closed cont.=Set 2 is used Open cont.=Set 1 is used
P1.4.2.22	Motor control mode 1/2	0.1	0.1	164	Closed cont.=Mode 2 is used Open cont.=Mode 1 is used See par 2.6.1, 2.6.12
P1.4.2.23	External brake acknowledge	0.1	0.2	1210	Monitoring signal from mechanical brake
P1.4.2.24	Cooling monitor	0.1	0.2	750	Used when water cooled unit
P1.4.2.25	Enable inching	0.1	0.1	532	Enables inching function
P1.4.2.26	Inching 1	0.1	0.1	530	Inching reference 1 (default forward 2 Hz. See P1.4.16). This will start the drive.

Code	Parameter	Min	Default	ID	Note
P1.4.2.27	Inching 2	0.1	0.1	531	Inching reference 2 (default reverse –2 Hz. See P1.4.17). This will start the drive.
P1.4.2.28	Motoring power limit 1	0.1	0.1	1500	Activates power limit 1
P1.4.2.29	Motoring power limit 2	0.1	0.1	1501	Activates power limit 2
P1.4.2.30	2nd frequency limit	0.1	0.1	1511	Activates second freq. Limit P1.2.7.31 2nd Freq Limit
P1.4.2.31	Generator power limit 1	0.1	0.1	1506	Activates Gen. power limit 1
P1.4.2.32	Generator power limit 2	0.1	0.1	1507	Activates Gen. power limit 2
P1.4.2.33	Reset position	0.1	0.1	1090	
P1.4.2.34	MF mode 2	0.1	0.1	1092	
P1.4.2.35	Emergency stop	0.1	0.2	1213	
P1.4.2.36	Motoring torque limit 1	0.1	0.1	1624	
P1.4.2.37	Generator torque limit 1	0.1	0.1	1626	
P1.4.2.38	Store parameter set	0.1	0.1	1753	Stores active parameter set to selected parameter set
P1.4.2.39	Start signal 1B	0.1	A.1	403	Forward, See ID300
P1.4.2.40	Start signal 2B	0.1	A.2	404	Reverse. See ID300
P1.4.2.41	RunRequest enable	0.1	0.2	1896	
P1.4.2.42	Output contactor interlock	0.1	0.2	1600	Faults if contactor does not close within 250ms after run
P1.4.2.43	PID Set point 1/2	0.1	0.1	1601	

4.4.3 Analog input 1

Table 7. Analog input 1 parameters, G1.2.3

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.4.3.1	AI1 signal selection	0.1	E.10		A.1	377	Slot . Board input No.
P1.4.3.2	AI1 Reference filter TC	0.000	32.000	s	0.000	324	0=No filtering
P1.4.3.3	AI1 signal range	0	3		0	320	0=0…100%* 1=20…100%* 4 mA Fault 2= –10V…+10V* 3= Custom range*
P1.4.3.4	AI1 custom minimum setting	–160.00	160.00	%	0.00	321	Custom range: Minimum input
P1.4.3.5	AI1 custom maximum setting	–160.00	160.00	%	100.00	322	Custom range: Maximum input
P1.4.3.6	AI1 reference scaling. minimum value	0.00	320.00	Hz	0.00	303	Selects the frequency that corresponds to the min. reference signal
P1.4.3.7	AI1 reference scaling. maximum value	0.00	320.00	Hz	0.00	304	Selects the frequency that corresponds to the max. reference signal
P1.4.3.8	AI1 joystick dead zone	0.00	20.00	%	0.00	382	Dead zone for joystick input
P1.4.3.9	AI1 sleep limit	0.00	100.00	%	0.00	385	Drive goes to stop if input is below this limit for this time.
P1.4.3.10	AI1 sleep delay	0.00	320.00	s	0.00	386	Drive goes to stop if input is below this limit for this time.
P1.4.3.11	AI1 joystick offset	–100.00	100.00	%	0.00	165	Press enter for 1s to set offset
P1.4.3.12	AI1 filter time	0.000	32.000	s	0.000	1228	

4.4.4 Analog input 2

Table 8. Analog input 2 parameters, G1.2.4

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.4.4.1	AI2 signal selection	0.1	E.10		A.2	388	Slot . Board input No.
P1.4.4.2	AI2 filter time	0.000	32.000	s	0.000	329	0=No filtering
P1.4.4.3	AI2 signal range	0	3		1	325	0=0…100%* 1=20…100%* 4 mA Fault 2= –10V…+10V* 3= Custom range*
P1.4.4.4	AI2 custom minimum setting	–160.00	160.00	%	0.00	326	Custom range: Minimum input

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.4.4.5	AI2 custom maximum setting	–160.00	160.00	%	100.00	327	Custom Range: Maximum input
P1.4.4.6	AI2 reference scaling. minimum value	0.00	320.00	Hz	0.00	393	Selects the frequency that corresponds to the min. reference signal
P1.4.4.7	AI2 reference scaling, maximum value	0.00	320.00	Hz	0.00	394	Selects the frequency that corresponds to the max. reference signal
P1.4.4.8	AI2 joystick Dead Zone	0.00	20.00	%	0.00	395	Dead Zone for joystick input
P1.4.4.9	AI2 sleep limit	0.00	100.00	%	0.00	396	Drive goes to stop if input is below this limit for this time.
P1.4.4.10	AI2 sleep delay	0.00	320.00	s	0.00	397	Drive goes to stop if input is below this limit for this time.
P1.4.4.11	AI2 joystick offset	–100.00	100.00	%	0.00	166	Press enter for 1s to set offset
P1.4.4.12	AI2 Filter Time	0.00	320.00	S	.1	1232	

4.4.5 Analog input 3

Table 9. Analog input 3 parameters, G1.2.5

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.4.5.1	AI3 signal selection	0.1	E.10		0.1	141	Slot . Board input No. If 0.1 ID27 can be controlled from FB
P1.4.5.2	AI3 filter time	0.000	32.000	s	0.000	142	0=No filtering
P1.4.5.3	AI3 custom minimum setting	–160.00	160.00	%	0.00	144	Custom range always active. See ID326
P1.4.5.4	AI3 custom maximum setting	–160.00	160.00	%	100.00	145	Custom range always active. See ID327
P1.4.5.5	AI3 signal inversion	0	1		0	151	0=Not inverted 1=Inverted
P1.4.5.6	AI3 reference scaling, minimum value	–32000	32000		0	1037	Selects the value that corresponds to the min. reference signal
P1.4.5.7	AI3 reference scaling, maximum value	–32000	32000		0	1038	Selects the value that corresponds to the max. reference signal
P1.4.5.8	AI3 Controlled ID	0	10000		0	1509	Select parameter that you want to control by ID number.

4.4.6 Analog input 4

Table 10. Analog input 4 parameters, G1.2.6

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.4.6.1	AI4 signal selection	0.1	E.10		0.1	152	Slot . Board input no. If 0.1 ID28 can be controlled from FB
P1.4.6.2	AI4 filter time	0.000	32.000	s	0.000	153	0=No filtering
P1.4.6.3	AI4 custom minimum setting	–160.00	160.00	%	0.00	155	Custom range always active. See ID326
P1.4.6.4	AI4 custom maximum setting	–160.00	160.00	%	100.00	156	Custom range always active. See ID327
P1.4.6.5	AI4 signal inversion	0	1		0	162	0=Not inverted 1=Inverted
P1.4.6.6	AI3 reference scaling, minimum value	–32000	–32000		0	1039	Selects the value that corresponds to the min. reference signal
P1.4.6.7	AI3 reference scaling, maximum value	–32000	32000		0	1040	Selects the value that corresponds to the max. reference signal
P1.4.6.8	AI4 Controlled ID	0	10000		0	1510	Select parameter that you want to control by ID number.

4.4.7 Options

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.4.7.1	Input signal inversion Control	0	65532			1091	

4.4.8 Fieldbus inputs

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.4.8.1	FB Digital input 1 parameter ID	0	2000		0	891	Assign DIN parameter ID to control via FB
P1.4.8.2	FB Digital input 2 parameter ID	0	2000		0	892	Assign DIN parameter ID to control via FB
P1.4.8.3	FB Digital input 3 parameter ID	0	2000		0	893	Assign DIN parameter ID to control via FB
P1.4.8.4	FB Digital input 4 parameter ID	0	2000		0	894	Assign DIN parameter ID to control via FB
P1.4.8.5	FB Digital input 5 parameter ID	0	2000		0	895	Assign DIN parameter ID to control via FB

4.5 Output signals

4.5.1 Digital output signals

Code	Parameter	Min	Default	ID	Note
P1.5.1.1	Ready	0.1	A.1	432	Ready to run
P1.5.1.2	Run	0.1	B.1	433	Running
P1.5.1.3	Fault	0.1	B.2	434	Drive in fault state
P1.5.1.4	Inverted fault	0.1	0.1	435	Drive not in fault state
P1.5.1.5	Warning	0.1	0.1	436	Warning active
P1.5.1.6	External fault	0.1	0.1	437	External fault active
P1.5.1.7	Reference fault/warning	0.1	0.1	438	4 mA fault active
P1.5.1.8	Over temperature warning	0.1	0.1	439	Drive over temperature active
P1.5.1.9	Reverse	0.1	0.1	440	Output frequency < 0 Hz
P1.5.1.10	Unrequested direction	0.1	0.1	441	Reference <> Output frequency
P1.5.1.11	At speed	0.1	0.1	442	Reference = Output frequency
P1.5.1.12	Jogging speed	0.1	0.1	443	Jogging or preset speed command active
P1.5.1.13	Fieldbus control	0.1	0.1	445	IO control active
P1.5.1.14	Keypad control	0.1	0.1	444	Keypad control active
P1.5.1.15	I/O Control	0.1	0.1	446	I/O Control active
P1.5.1.16	External brake control	0.1	0.1	447	See explanations on chapter brake control
P1.5.1.17	External brake control, inverted	0.1	0.1	448	See explanations on chapter brake control
P1.5.1.18	Output frequency limit 1 supervision	0.1	0.1	449	See ID315
P1.5.1.19	Output frequency limit 2 supervision	0.1	0.1	450	See ID346
P1.5.1.20	Reference limit supervision	0.1	0.1	451	See ID350
P1.5.1.21	Temperature limit supervision	0.1	0.1	452	Drive temperature supervision. See ID354
P1.5.1.22	Torque limit supervision	0.1	0.1	453	See ID348
P1.5.1.23	Motor thermal protection	0.1	0.1	454	Thermistor fault or warning
P1.5.1.24	Analog input supervision limit	0.1	0.1	460	See ID356
P1.5.1.25	Motor regulator activation	0.1	0.1	459	One of limit controller is active
P1.5.1.26	Fieldbus digital input 1	0.1	0.1	455	FB CW B11
P1.5.1.27	Fieldbus digital input 2	0.1	0.1	456	FB CW B12
P1.5.1.28	Fieldbus digital input 3	0.1	0.1	457	FB CW B13
P1.5.1.29	Fieldbus digital input 4	0.1	0.1	169	FB CW B14
P1.5.1.30	Fieldbus digital input 5	0.1	0.1	170	FB CW B15
P1.5.1.31	Safe disable active	0.1	0.1	756	
P1.5.1.32	Charge switch	0.1	0.1	458	Pre-charge complete

4.5.2 Analog output 1

Table 11. Analog output 1 parameters, G1.5.2

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.5.2.1	Analog output 1 signal selection	0.1	E.10		A.1	464	TTF programming See chapter 2
P1.5.2.2	Analog output 1 function	0	20		1	307	0=Not used 1=Output freq. (0-f_{max}) 2=Freq. ref (0-f_{max}) 3=Speed (0-Motor nom 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=AI1 10=AI2 11=Output freq. (f_{min} - f_{max}) 12=–2xTorque+2xTorque 13=–2xPower+2xPower 14=PT100 temperature 15=FB Analog Output 16=–2xSpeed+2xSpeed 17=Encoder speed (0—Motor nominal speed) 18=Unit Temperature 19=Value Control Out 20=Drive Output Power
P1.5.2.3	Analog output 1 filter time	0.00	10.00	s	1.00	308	0=No filtering
P1.5.2.4	Analog output 1 inversion	0	1		0	309	0=Not inverted 1=Inverted
P1.5.2.5	Analog output 1 minimum	0	1		0	310	0=0 mA (0 %) 1=4 mA (20 %)
P1.5.2.6	Analog output 1 scale	10	1000	%	100	311	
P1.5.2.7	Analog output 1 offset	–100.00	100.00	%	0.00	375	

4.5.3 Analog output 2

Table 12. Analog output 2 parameters, G1.5.3

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.5.3.1	Analog output 2 signal selection	0.1	E.10		0.1	471	TTF programming See chapter 3.1 and 3.2
P1.5.3.2	Analog output 2 function	0	20		4	472	See P1.5.2.2
P1.5.3.3	Analog output 2 filter time	0.00	10.00	s	1.00	473	0=No filtering
P1.5.3.4	Analog output 2 inversion	0	1		0	474	0=Not inverted 1=Inverted
P1.5.3.5	Analog output 2 minimum	0	1		0	475	0=0 mA (0 %) 1=4 mA (20 %)
P1.5.3.6	Analog output 2 scale	10	1000	%	100	476	
P1.5.3.7	Analog output 2 offset	–100.00	100.00	%	0.00	477	

4.5.4 Analog output 3

Table 13. Analog output 3 parameters, G1.5.4

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.5.4.1	Analog output 3 signal selection	0.1	E.10		0.1	478	TTF programming See chapter 3.1 and 3.2
P1.5.4.2	Analog output 3 function	0	20		5	479	See P1.5.2.2
P1.5.4.3	Analog output 3 filter time	0.00	10.00	s	1.00	480	0=No filtering
P1.5.4.4	Analog output 3 inversion	0	1		0	481	0=Not inverted 1=Inverted
P1.5.4.5	Analog output 3 minimum	0	1		0	482	0=0 mA (0 %) 1=4 mA (20 %)
P1.5.4.6	Analog output 3 scale	10	1000	%	100	483	
P1.5.4.7	Analog output 3 offset	–100.00	100.00	%	0.00	484	

4.5.5 Analog output 4

Table 14. Analog output 4 parameters, G2.3.8

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.5.5.1	Analog output 4 signal selection	0.1	E.10		0.1	1527	TTF programming See chapter 3.1 and 3.2
P1.5.5.2	Analog output 4 function	0	20		5	1520	See P1.5.2.2
P1.5.5.3	Analog output 4 filter time	0.00	10.00	s	1.00	1521	0=No filtering
P1.5.5.4	Analog output 4 inversion	0	1		0	1522	0=Not inverted 1=Inverted
P1.5.5.5	Analog output 4 minimum	0	1		0	1523	0=0 mA (0 %) 1=4 mA (20 %)
P1.5.5.6	Analog output 4 scale	10	1000	%	100	1525	
P1.5.5.7	Analog output 4 offset	–100.00	100.00	%	0.00	1524	

4.5.6 Delayed digital output 1

Table 15. Delayed digital output 1 parameters, G1.5.6

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.5.6.1	Digital output 1 signal selection	0.1	E.10		0.1	486	Possibility to invert by ID1091 INV Commands
P1.5.6.2	Digital output 1 function	0	28		1	312	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=Reverse 10=Jogging spd selected 11=At speed 12=Mot. regulator active 13=Freq. limit 1 superv. 14=Freq. limit 2 superv. 15=Torque limit superv. 16=Ref. limit supervision 17=External brake control

Code	Parameter	Min	Max	Unit	Default	ID	Note
							18=I/O control place act. 19=FC temp. limit superv. 20=Reference inverted 21=Ext. brake control inverted 22=Therm. fault or warn. 23=On/Off control 24=Fieldbus input data 1 25=Fieldbus input data 2 26=Fieldbus input data 3 27=Warning Set Reset 28=ID.Bit Select
P1.5.6.3	Digital output 1 on delay	0.00	320.00	s	0.00	487	0.00 = On delay not in use
P1.5.6.4	Digital output 1 off delay	0.00	320.00	s	0.00	488	0.00 = Off delay not in use
P1.5.6.5	Invert delayed DO1	0	1		0	1587	0=Not inverted 1=Inverted
P1.5.6.6	ID.Bit Free DO	0.00	2000.15		0.00	1217	

4.5.7 Delayed digital output 2

Table 16. Delayed digital output 2 parameters, G1.5.7

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P1.5.7.1	Digital output 2 signal selection	0.1	E.10		0.1		489	Possibility to invert by ID1091 INV Commands
P1.5.7.2	Digital output 2 function	0	28		0		490	See P1.5.6.2
P1.5.7.3	Digital output 2 on delay	0.00	320.00	s	0.00		491	0.00 = On delay not in use
P1.5.7.4	Digital output 2 off delay	0.00	320.00	s	0.00		492	0.00 = Off delay not in use
P1.5.7.5	Invert delayed DO2	0	1		0		1588	0=Not inverted 1=Inverted
P1.5.7.6	ID.Bit Free DO	0.00	2000.15		0.00		1385	

4.5.8 Supervision limits

Table 17. Supervision Limit settings, G1.5.8.1

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.5.8.1	Output frequency limit 1 supervision	0	2		0	315	0=No limit 1=Low limit supervision 2=High limit supervision
P1.5.8.2	Output frequency limit 1; Supervised value	0.00	320.00	Hz	0.00	316	
P1.5.8.3	Output frequency limit 2 supervision	0	2		0	346	0=No limit 1=Low limit supervision 2=High limit supervision
P1.5.8.4	Output frequency limit 2; Supervised value	0.00	320.00	Hz	0.00	347	
P1.5.8.5	Torque limit supervision	0	4		0	348	0=Not used 1=Low limit supervision 2=High limit supervision 3= ABS(T), Low limit 4= ABS(T), High limit
P1.5.8.6	Torque limit supervision value	–300.0	300.0	%	100.0	349	
P1.5.8.7	Reducing of torque supervision limit	0	5		0	402	

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.5.8.8	Reference limit supervision	0	2		0	350	0=Not used 1=Low limit 2=High limit
P1.5.8.9	Reference limit supervision value	0.00	100.0	%	0.00	351	
P1.5.8.10	FC temperature supervision	0	2		0	354	0=Not used 1=Low limit 2=High limit
P1.5.8.11	FC temperature supervised value	–10	100	°C	40	355	
P1.5.8.12	Analog supervision signal	0	4		0	356	0=Not used 1=AI1 2=AI2 3=AI3 4=AI4
P1.5.8.13	Analog supervision low limit	0.00	100.00	%	10.00	357	Reset limit
P1.5.8.14	Analog supervision high limit	0.00	100.00	%	90.00	358	Set limit

4.6 Limit settings

4.6.1 Current handling

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.6.1.1	Current limit	0	2 x I_H	A	I_L	107	Reaching the limit will lower output frequency
P1.6.1.2	Scaling of current limit	0	5		0	399	Scaling from 0 to ID107 0=Not used 1=AI1 2=AI2 3=AI3 4=AI4 5=FB Limit Scaling ID46
P1.6.1.3	Current Limit Kp	1	32000			1451	
P1.6.1.4	Current Limit Ki	1	32000			1452	

4.6.2 Power handling

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.6.2.1	Power limit	0.0	300.0	%	300.0	1722	General power limit
P1.6.2.2	Generator power limit	0.0	300.0	%	300.0	1290	
P1.6.2.3	Motoring power limit	0.0	300.0	%	300.0	1289	
P1.6.2.4	Generator power limit 1	0.0	300.0	%	300.0	1513	Power limit activated by DI
P1.6.2.5	Generator power limit 2	0.0	300.0	%	300.0	1514	Power limit activated by DI
P1.6.2.6	Power limit 1	0	300.0	%	100.0	1503	Power limit activated by DI
P1.6.2.7	Power limit 2	0	300.0	%	50.0	1504	Power limit activated by DI
P1.6.2.8	Power limit ramp rate	0	10000	%/s	100	1502	
P1.6.2.9	Power follower	0	1		0	1705	0 = No 1 = Yes
P1.6.2.10	Power follower hysteresis	0.0	100.0	%	10.0	1529	
P1.6.2.11	Scaling motoring power limit	0	5		0	179	As parameter P1.6.2 Scaling from 0 to ID1289
P1.6.2.12	Scaling generator power limit	0	5		0	1088	As parameter P1.6.2 Scaling from 0 to ID1290
P1.6.2.13	Under voltage power DC level	0	1200	V	0	1611	
P1.6.2.14	Under voltage power limit	–300.0	300.0	%	0	1612	

4.6.3 Torque handling

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.6.3.1	Torque limit	0.0	300.0	%	300.0	609	General maximum limit
P1.6.3.2	Motoring torque limit	0.0	300.0	%	300.0	1287	Motoring side torque limit
P1.6.3.3	Generator torque limit	0.0	300.0	%	300.0	1288	Generator side torque limit
P1.6.3.4	Motoring torque limit 1	0.0	300.0	%	300.0	1625	
P1.6.3.5	Generator torque limit 1	0.0	300.0	%	300.0	1627	
P1.6.3.6	Torque follower	0	3		0	1706	0 = Not used 1 = Motoring 2 = Generator 3 = Motoring + Generator
P1.6.3.7	Torque limit increase rate	0	10000	%/s	100	1532	
P1.6.3.8	Torque limit follower hysteresis	0.0	300.0	%	10.0	1533	
P1.6.3.9	Scaling motoring torque limit	0	5		0	485	Scaling from 0 to ID1287 0=Not used 1=AI1 2=AI2 3=AI3 4=AI4 5=FB Limit scaling ID46
P1.6.3.10	Scaling generator torque limit	0	5		0	1087	Scaling from 0 to ID1288 As parameter P1.6.3.9

4.6.3.1 Torque handling OL settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.6.3.9.1	Torque limit control P-gain	0.0	32000		3000	610	
P1.6.3.9.2	Torque limit control I-gain	0.0	32000		200	611	

4.6.3.2 Torque handling CL settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.6.3.10.1	SPC Out limit	0.0	300.0	%	300.0	1382	
P1.6.3.22	SPC Pos limit	0.0	300.0	%	300.0	646	
P1.6.3.21	SPC Neg limit	0.0	300.0	%	300.0	645	

4.6.4 Frequency handling

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.6.4.1	Max Frequency 2	0.00	320.00	Hz	35.00	1512	Maximum frequency limit that is activated by digital input.
P1.6.4.2	Negative frequency limit	–320.00	320.00	Hz	–320.00	1286	Alternative limit for negative direction
P1.6.4.3	Positive frequency limit	–320.00	320.00	Hz	320.00	1285	Alternative limit for positive direction
P1.6.4.4	Zero Frequency limit	0.00	320.00	Hz	1.00	1283	

4.6.5 DC-Link handling

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.6.5.1	Overvoltage controller	0	2		1	607	0=Not used 1=Used (no ramping) 2=Used (ramping)
P1.6.5.2	Over voltage reference selector	0	2		1	1262	0=High voltage 1=Normal voltage 2=BrakeChopperLevel

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.6.5.3	Brake chopper	0	4		0	504	0=Disabled 1=Used when running 2=External brake chopper 3=Used when stopped/running 4=Used when running (no testing)
P1.6.5.4	Brake chopper level	5: 605 6: 836	5: 797 6: 1099	V		1267	
P1.6.5.5	Under voltage controller	0	2		1	608	0=Not used 1=Used (no ramping) 2=Used (ramping to zero)
P1.6.5.6	Under voltage ref selector	0	1		1	1537	0=Under Voltage Ref 1= 0.8 * Estimated DC volt.
P1.6.5.6	Under voltage reference	5: 410 6: 567	5: 540 6: 745	V	Varies	1538	

4.6.5.1 DC-link handling CL settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.6.5.8.1	Over voltage reference	94.00	130.00	%	118.00	1528	
P1.6.5.8.2	Over voltage motoring side torque limit	0.0	300.0	%	10.0	1623	Maximum motoring torque when over voltage controller is active.
P1.6.5.8.3	CL Under voltage reference	60.00	80.00	%	65.00	1567	

4.6.6 Limit settings options

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.6.6.1	Limit total current in closed loop	0	1		0	1901	0=No 1=Yes

4.6.7 Limit settings options

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.6.7.1	Current regulator response	0	1		1	757	0=No action 1=Warning
P1.6.7.2	Overvoltage regulator response	0	1		1	758	0=No action 1=Warning
P1.6.7.3	Under voltage regulator response	0	1		1	759	0=No action 1=Warning
P1.6.7.4	Torque regulator response	0	1		1	760	0=No action 1=Warning

4.7 Flux and DC current handling

4.7.1 Flux and DC current handling OL settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.7.1.1	DC braking current	0.00	I_L	A	0.00	507	
P1.7.1.2	DC braking time at start	0.00	600.00	s	0.00	516	0=DC brake is off at start
P1.7.1.3	DC braking time at stop	0.00	600.00	s	0.00	508	0=DC brake is off at stop
P1.7.1.4	Frequency to start DC braking during ramp stop	0.10	10.00	Hz	1.50	515	
P1.7.1.5	Scaling of DC-braking current	0	5		0	400	ID46Scaling from 0 to ID507 0=Not used 1=AI1 2=AI2 3=AI3 4=AI4 5=FB Limit scaling

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.7.1.6	DC-Brake current in stop	0.00	I_L	A	Varies	1080	
P1.7.1.7	Flux brake	0	1		0	520	0=Off 1=On
P1.7.1.8	Flux braking current	0.00	I_L	A	I_H	519	

4.7.2 Flux and DC current handling CL settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.7.2.1	Magnetizing current at start	0	I_L	A	0.00	627	
P1.7.2.2	Magnetizing time at start	0.0	600.0	s	0.0	628	
P1.7.2.3	Flux reference	0.0	500.0	%	100.0	1250	
P1.7.2.4	Flux off delay	–1	32000	s	0	1402	–1=forever
P1.7.2.5	Stop state flux	0.0	150.0	%	100.0	1401	
P1.7.2.6	Reduced flux level	0.0	500.0	%	100.0	1613	
P1.7.2.7	Reduced flux frequency	0.00	32.00	Hz	0.00	1614	

4.8 Motor control

4.8.1 Motor control basic settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.8.1	Motor control mode	0	4		0	600	0=Frequency control 1=Speed control 2=Speed/Torque control 3=Closed loop speed ctrl 4=Closed loop Speed/torque ctrl
P1.8.2	Motor control mode 2	0	4		2	521	See P1.8.1
P1.8.3	Torque select	0	5		2	1278	0=Speed control 1=Maximum freq limit 2=Ramp output 3=Min 4=Max 5=Window

4.8.2 U/f Settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.8.4.1	U/f optimisation	0	1		0	109	0=Not used 1=Automatic torque boost
P1.8.4.2	U/f ratio selection	0	3		0	108	0=Linear 1=Squared 2=Programmable 3=Linear with flux optim.
P1.8.4.3	Field weakening point	6.00	320.00	Hz	50.00	602	
P1.8.4.4	Voltage at field weakening point	10.00	200.00	%	100.00	603	n% x U_{nmot}
P1.8.4.5	U/f curve midpoint frequency	0.00	P1.8.3.3	Hz	50.00	604	
P1.8.4.6	U/f curve midpoint voltage	0.00	100.00	%	100.00	605	n% x U_{nmot} Parameter max. value = P1.6.5
P1.8.4.7	Output voltage at zero frequency	0.00	40.00	%	0.00	606	n% x Unmot

4.8.3 Closed loop control settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.8.5.1	Current control P gain	0.00	100.00	%	40.00	617	
P1.8.5.2	Current control I Time	0.0	3200.0	ms	1.5	657	
P1.8.5.3	Slip adjust	0	500	%	75	619	
P1.8.5.4	Acceleration compensation	0.00	300.00	s	0.00	626	
P1.8.5.5	Speed Error Filter TC	0	1000	ms	0	1311	
P1.8.5.6	Encoder filter time	0	1000	ms	0	618	
P1.8.5.7	Encoder selection	0	2		0	1595	1=Encoder Input 1 2=Encoder Input 2
P1.8.5.8	SC Torque chain select	0	65535		0	1557	Default 96 after identification.

4.8.4 PMSM control settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.8.6.1	PMSM Shaft position	0	65535		0	649	
P1.8.6.2	Start Angle identification mode	0	10		0	1691	0=Automatic 1=Forced 2=After power Up 3=Disabled
P1.8.6.3	Start angle identification DC current	0.0	150.0	%	0.0	1756	
P1.8.6.4	Polarity pulse current	–10.0	200.0	%	0.0	1566	
P1.8.6.5	Start angle ID time	0	32000	ms	0	1755	
P1.8.6.6	I/f current	0.0	150.0	%	50.0	1693	
P1.8.6.7	I/f Control limit	0.0	300.0	%	10.0	1790	
P1.8.6.8	Flux current Kp	0	32000		5000	651	
P1.8.6.9	Flux current Ti	0	1000		25	652	
P1.8.6.10	External Id reference	–150.0	150.0	%	0.0	1730	
P1.8.6.11	Enable Rs identification	0	1		1	654	0=No 1=Yes
P1.8.6.12	Lsd Voltage drop	–32000	32000		0	1757	
P1.8.6.13	Lsq Voltage drop	–32000	32000		0	1758	
P1.8.6.14	EncIDCurrent	0.0	150.0	%	90.0	1734	
P1.8.6.15	Polarity ID mode	0	1			1737	
P1.8.6.16	Polarity pulse length	0	1000	ms	200	1742	
P1.8.6.17	Polarity detection angle	0.0	360.0	Deg	1.5	1748	
P1.8.6.18	Angle identification mode	0	2			1749	
P1.8.6.19	Current control Kp d	0	32000	%		1761	
P1.8.6.20	Voltage margin	0.0	120.0	%		1759	

4.8.5 Stabilators

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.8.7.1	Torque stabilator gain	0	1000		100	1412	
P1.8.7.2	Torque stabilator damping	0	1000		800	1413	With PMSM use 980
P1.8.7.3	Torque stabilator gain in FWP	0	1000		50	1414	
P1.8.7.4	Torque stabilator limit	0	1500		150	1720	
P1.8.7.5	Flux circle stabilator gain	0	32767		10000	1550	
P1.8.7.6	Flux circle stabilator TC	0	32700		900	1551	
P1.8.7.7	Flux stabilator gain	0	32000		500	1797	
P1.8.7.8	Flux stab coeff	–30000	30000			1796	

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.8.7.9	Voltage stabilator gain	0	100.0	%	10.0	1738	
P1.8.7.10	Voltage stabilator TC	0	1000		900	1552	
P1.8.7.11	Voltage stabilator limit	0	320.00	Hz	1.50	1553	

4.8.6 Tuning parameters

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.8.8.1	Fly Start options	0	65535		0	1610	
P1.8.8.2	MC Options	0	65535		0	1740	
P1.8.8.3	Resonance damping select	0	200		0.00	1760	
P1.8.8.4	Damping frequency	0	320.0	Hz	0	1763	
P1.8.8.5	Damping gain	0	32000		0	1764	
P1.8.8.6	Damping phase	0	360		0.00	1765	
P1.8.8.7	Damping activation frequency	0	320.00	%	0	1770	
P1.8.8.8	Damping filter time constant	0	32700		105	1771	
P1.8.8.9	Over modulation limit	50	120	%	105	1515	If you have sine filter in use set this to 101 %
P1.8.8.10	Modulator index limit	0	200	%	100	655	
P1.8.8.11	DC Voltage filter	0.0	500.0		0.0	1591	
P1.8.8.12	AC Magnetizing current	0	150.0	%		1714	Current ref for flying start
P1.8.8.13	Ac scan time	0	320.0	ms		1715	
P1.8.8.14	DC Magnetizing current	0	150.0	%		1716	
P1.8.8.15	Flux build time	0	10000	s		1704	
P1.8.8.16	Flux build torque	0	300.0	%		1711	
P1.8.8.17	Motor pole pairs	0	50		0	1589	

4.8.7 Identification parameters

Table 18. Identification parameters, G1.8.9

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.8.9.1	Flux 10 %	0	2500	%	10	1355	
P1.8.9.2	Flux 20 %	0	2500	%	20	1356	
P1.8.9.3	Flux 30 %	0	2500	%	30	1357	
P1.8.9.4	Flux 40 %	0	2500	%	40	1358	
P1.8.9.5	Flux 50 %	0	2500	%	50	1359	
P1.8.9.6	Flux 60 %	0	2500	%	60	1360	
P1.8.9.7	Flux 70 %	0	2500	%	70	1361	
P1.8.9.8	Flux 80 %	0	2500	%	80	1362	
P1.8.9.9	Flux 90 %	0	2500	%	90	1363	
P1.8.9.10	Flux 100 %	0	2500	%	100	1364	
P1.8.9.11	Flux 110 %	0	2500	%	110	1365	
P1.8.9.12	Flux 120 %	0	2500	%	120	1366	
P1.8.9.13	Flux 130 %	0	2500	%	130	1367	
P1.8.9.14	Flux 140 %	0	2500	%	140	1368	
P1.8.9.15	Flux 150 %	0	2500	%	150	1369	
P1.8.9.16	Rs voltage drop	0	30000		Varies	662	Used for torque calculation in open loop
P1.8.9.17	Ir add zero point voltage	0	30000		Varies	664	
P1.8.9.18	Ir add generator scale	0	30000		Varies	665	
P1.8.9.19	Ir add motoring scale	0	30000		Varies	667	
P1.8.9.20	Ls Voltage Dropp	0	3000		0	673	
P1.8.9.21	Motor BEM Voltage	0.00	320.00	%	0	674	
P1.8.9.22	Iu Offset	–32000	32000		0	668	
P1.8.9.23	Iv Offset	–32000	32000		0	669	

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.8.9.24	Iw Offset	–32000	32000		0	670	
P1.8.9.25	Estimator Kp	0	32000			1781	
P1.8.9.26	Estimator Ki	0	32000			1782	
P1.8.9.27	Voltage Drop	0.00	20.00			671	

4.8.7.1 Fine tuning parameters

Table 19. Fine tuning parameters

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.8.10.1	DeadTimeComp.	–10	32000	ns		1751	
P1.8.10.2	DeadTieContCurL	–32000	32000			1752	
P1.8.10.3	DeadTHWCompDisab	0	1			1750	0=enabled 1=disabled
P1.8.10.4	MakeFluxTime	0	32000	Ms		660	
P1.8.10.5	CurrMeasFCompTC	0	65535			1554	700=25us
P1.8.10.6	TCDunDampGain	0	100.00	%		1576	
P1.8.10.7	TCDynDampTC	0	32000	ms		1577	
P1.8.10.8	CurrLimOptions	0	65535			1702	
P1.8.10.9	AdConvStartShift	0	65535			1701	
P1.8.10.10	VoltageCorr. Kp	0	32.000			1783	
P1.8.10.11	VoltageCorr. Ki	0	32000			1784	
P1.8.10.12	GearRatioMultipl	0	32000			1558	
P1.8.10.13	GearRatioDivider	0	32000			1559	

4.9 Speed control

4.9.1 Speed control basic settings

Table 20. Speed control basic settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.9.1	Load drooping	0.00	100.00	%	0.00	620	
P1.9.2	Load drooping time	0	32000	ms	0	656	For dynamic changes
P1.9.3	Load drooping removal	0	2		0	1534	0=Normal 1= At zero Freq Lim 2=Linear zero to Fnom

4.9.2 Speed control OL settings

Table 21. Speed control OL settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.9.4.1	Speed controller P gain (open loop)	0	32767		3000	637	
P1.9.4.2	Speed controller I gain (open loop)	0	32767		300	638	

4.9.3 Speed control CL settings

Table 22. Speed control CL settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.9.5.1	Speed control P gain	0	1000		30	613	
P1.9.5.2	Speed control I time	–32000	32000	ms	100	614	Negative value uses 0,1 ms format instead of 1 ms
P1.9.5.3	0-speed time at start	0	32000	ms	100	615	
P1.9.5.4	0-speed time at stop	0	32000	ms	100	616	

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.9.5.5	SPC f1 Point	0.00	320.00	Hz	0.00	1301	
P1.9.5.6	SPC f0 Point	0.00	320.00	Hz	0.00	1300	
P1.9.5.7	SPC Kp f0	0	1000	%	100	1299	
P1.9.5.8	SPC Kp FWP	0	1000	%	100	1298	
P1.9.5.9	SPC Torque minimum	0	400.0	%	0.0	1296	
P1.9.5.10	SPC Torque minimum Kp	0	1000	%	100	1295	
P1.9.5.11	SPC Kp TC torque	0	1000	ms	0	1297	

4.10 Drive control

Table 23. Drive control

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.10.1	Switching frequency	1.0	Varies	kHz	3.6	601	
P1.10.2	Modulator type	0	3		0	1516	
P1.10.3	Control options	0	65535		64	1084	
P1.10.4	Control options 2	0	65535		0	1798	
P1.10.5	Advanced options 1	0	65535		0	1560	
P1.10.6	Advanced options 2	0	65535		0	1561	
P1.10.7	Advanced options 4	0	65535		0	1563	
P1.10.8	Advanced options 5	0	65535		0	1564	
P1.10.9	Advanced options 6	0	65535		0	1565	
P1.10.10	Restart delay	0	65535	s	Varies	1424	
P1.10.11	Restart delay CL	0	60.000	s	Varies	672	CL and flying start
P1.10.12	High-speed mode	0	1		0	1700	0=No 1=Yes

4.11 Master follower control parameters

Table 24. Master follower control parameters, G1.11

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.11.1	Master follower mode	0	4		0	1324	0=Not Used 1=Master 2=Follower 3=Drive synch master 4=Drive synch follower
P1.11.2	Follower speed reference select	0	18		17	1081	0=AI1 1=AI2 2=AI1+AI2 3=AI1-AI2 4=AI2-AI1 5=AI1xAI2 6=AI1 Joystick 7=AI2 Joystick 8=Keypad 9=Fieldbus 10=Motor potentiometer 11=AI1, AI2 minimum 12=AI1, AI2 maximum 13=Max frequency 14=AI1/AI2 selection 15=Encoder 1 16=Encoder 2 17=Master reference 18=Master ramp out

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.11.3	Follower torque reference select	0	10		10	1083	0=Not used 1=AI1 2=AI2 3=AI3 4=AI4 5=AI1 joystick 6=AI2 joystick 7=Torque reference from keypad, R3.5 8=FB Torque Reference 9=Master Torque OL 10=Master Torque CL
P1.11.4	Follower stop function	0	2		2	1089	0=Coasting 1=Ramping 2=As Master
P1.11.5	MF Brake logic	0	2		0	1326	Not used when Ramp follower or in drive sync mode 0=Master or Own 1=Own 2=Master & Own, Master monitors also follower brake status.
P1.11.6	MF Mode 2	0	4		0	1093	P1.11.1
P1.11.7	System bus fault	0	3		1	1082	0=No response 1=Warning 2=Fault,stop acc. to 2.3.2 3=Fault,stop by coasting
P1.11.8	System bus fault delay	0.00	320.00	s	3.00	1352	
P1.11.9	Follower fault	0	3		1	1536	See P1.11.6

4.11.1.1 Drive Synch specific parameters

Table 25. Drive synch specific parameters

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.11.10.1	Drive synch follower fault	0	2			1531	
P1.11.10.2	Follower phase shift	0.0	360.0	Dec	0.0	1518	
P1.11.10.3	DC Voltage balance Gain	0	1000		100	1519	
P1.11.10.4	SB Last ID 2nd	0	64		0	1799	

4.12 Protections

4.12.1 Common settings

Table 26. Common settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.12.1.1	Input phase supervision	0	4		0	730	0=No response 1=Warning 2=Fault,stop acc. to 2.3.2 3=Fault,stop by coasting 4=Warning and Derate
P1.12.1.2	Phase lose derate %	0	100.0	%	50.0	748	When phase loss fault mode = derate the current limit will be multiplied by this value
P1.12.1.3	Phase lose derate %	0	1		0	727	0=Fault stored in history 1=Fault not stored
P1.12.1.4	Output phase supervision	0	3		2	702	0=No response 1=Warning 2=Fault,stop acc. to 2.3.2 3=Fault,stop by coasting

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.12.1.5	Response to slot fault	0	3		2	734	See P1.12.1.4
P1.12.1.6	Safe disable response	0	2		1	755	See P1.12.1.4
P1.12.1.7	O/P Contactor interlock	0	3		2	1903	See P1.12.1.4

4.12.2 Temperature sensor protections

Table 27. PT-100 protections

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.12.2.1	No. of used inputs on board 1	0	5		0	739	0=Not used (ID Write) 1 = Sensor 1 in use 2 = Sensor 1 & 2 in use 3 = Sensor 1 & 2 & 3 in use 4 = Sensor 2 & 3 in use 5 = Sensor 3 in use
P1.12.2.2	Response to temperature fault	0	3		2	740	0=No response 1=Warning 2=Fault,stop acc. to 2.3.2 3=Fault,stop by coasting
P1.12.2.3	Board 1 warning limit	–30.0	200.0	C°	120.0	741	
P1.12.2.4	Board 1 fault limit	–30.0	200.0	C°	130.0	742	
P1.12.2.5	No. of uses inputs on board 2	0	5		0	743	0=Not used (ID Write) 1 = Sensor 1 in use 2 = Sensor 1 & 2 in use 3 = Sensor 1 & 2 & 3 in use 4 = Sensor 2 & 3 in use 5 = Sensor 3 in use
P1.12.2.6	Response to temperature fault	0	3		2	766	0=No response 1=Warning 2=Fault, stop acc. to 2.3.2 3=Fault, stop by coasting
P1.12.2.7	Board 2 warning limit	–30.0	200.0	C°	120.0	745	
P1.12.2.8	Board 2 fault limit	–30.0	200.0	C°	130.0	746	
P1.12.2.9.1	Channel 1B warn	–30.0	200.0	C°	0.0	764	
P1.12.2.9.2	Channel 1B fault	–30.0	200.0	C°	0.0	765	
P1.12.2.9.3	Channel 1C warn	–30.0	200.0	C°	0.0	768	
P1.12.2.9.4	Channel 1C fault	–30.0	200.0	C°	0.0	769	
P1.12.2.9.5	Channel 2B warn	–30.0	200.0	C°	0.0	770	
P1.12.2.9.6	Channel 2B fault	–30.0	200.0	C°	0.0	771	
P1.12.2.9.7	Channel 2C warn	–30.0	200.0	C°	0.0	772	
P1.12.2.9.8	Channel 2C fault	–30.0	200.0	C°	0.0	773	

4.12.3 Stall protection

Table 28. Stall protection

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.12.3.1	Stall protection	0	3		0	709	0=No response 1=Warning 2=Fault,stop acc. to 2.3.2 3=Fault,stop by coasting
P1.12.3.2	Stall current	0.1	2 x I_H	A	I_H	710	
P1.12.3.3	Stall time limit	1.00	120.00	s	15.00	711	
P1.12.3.4	Stall frequency limit	1.0	P1.1.2	Hz	25.0	712	

4.12.4 Speed error monitoring

Table 29. Speed error monitoring

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.12.4.1	Speed error mode	0	3		0	752	0=No response 1=Warning 2=Fault,stop acc. to 2.3.2 3=Fault,stop by coasting
P1.12.4.2	Speed error limit	0.0	100.0	%	5.0	753	
P1.12.4.3	Speed fault delay	0.00	100.00	S	0.1	754	

4.12.5 Motor thermal protections

Table 30. Motor thermal protections

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.12.5.1	Thermal protection of the motor	0	3		2	704	0=No response 1=Warning 2=Fault,stop acc. to 2.3.2 3=Fault,stop by coasting
P1.12.5.2	Motor ambient temperature factor	–100.0	100.0	%	0.0	705	
P1.12.5.3	Motor cooling factor at zero speed	0.0	150.0	%	40.0	706	
P1.12.5.4	Motor thermal time constant	1	200	min	45	707	
P1.12.5.5	Motor duty cycle	0	100	%	100	708	
P1.12.5.6	Response to thermistor fault	0	3		2	732	See P1.12.5.1
P1.12.5.7	Over load response	0	2		1	1838	0=No response 1=Warning 2=Fault
P1.12.5.8	Over Load Signal	0	2		0	1837	0=Not Used 1=Current 2=Torque 3=Power
P1.12.5.9	Over load maximum input	0.0	300.0	%	150.0	1839	
P1.12.5.10	Over load maximum step	0	10000		200	1840	

4.12.6 4mA Protection

Table 31. 4mA Protection

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.12.6.1	Response to 4mA reference fault	0	5		0	700	0=No response 1=Warning 2=Warning+Previous Freq. 3=Wrng+PresetFreq 2.12.6.2 4=Fault,stop acc. to 2.3.2 5=Fault,stop by coasting
P1.12.6.2	4mA reference fault frequency	0.00	P1.1.2	Hz	0.00	728	

4.12.7 Underload protection

Table 32. Underload protection

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.12.7.1	Underload protection	0	3		0	713	0=No response 1=Warning 2=Fault,stop acc. to 2.3.2 3=Fault,stop by coasting
P1.12.7.2	Field weakening area load	10.0	150.0	%	50.0	714	
P1.12.7.3	Zero frequency load	5.0	150.0	%	10.0	715	
P1.12.7.4	Underload protection time limit	2.00	600.00	s	20.00	716	

4.12.8 Ground fault protection

Table 33. Ground fault protection

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.12.8.1	Ground fault protection	0	3		2	703	0=No response 1=Warning 2=Fault,stop acc. to 2.3.2 3=Fault,stop by coasting
P1.12.8.2	Ground fault current limit	0.0	100.0	%	50.0	1333	

4.12.9 Cooling protection

Table 34. Cooling protection

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.12.9.1	Cooling fault response	1	2		2	762	0= No Action, warning 1= Warning, warning 2= Warning, fault 3= No action, fault
P1.12.9.2	Cooling fault delay	0.00	7.00	s	2.00	751	

4.12.10 Fieldbus protection

Table 35. Fieldbus protection

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.12.10.1	Fieldbus communication response	0	5		2	733	0=No action 1=Warning 2= Fault 3= Fault,stop by coasting 4=Warning; Prev Freq 5=Quick Stop
P1.12.10.2	FB Fault delay	0.00	60.00	s	0.50	1850	Delay to fault when FB Response is 4
P1.12.10.3	FB watchdog delay	0.00	30.00	s	0.00	1354	Delay when WD pulse is missing. 0.00 s = Disabled

4.12.11 External fault

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.12.11.1	Response to external fault 1	0	3		2	701	0=No response 1=Warning 2=Fault,stop acc. to 2.3.2 3=Fault,stop by coasting
P1.12.11.2	Response to external fault 2	0	3		2	747	0=No response 1=Warning 2=Fault,stop acc. to 2.3.2 3=Fault,stop by coasting

4.12.12 Encoder fault

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.12.12.1	Encoder fast Hz limit	0.00	320.00	Hz		1801	
P1.12.12.2	Fast time limit	0.00	32.00	s		1805	
P1.12.12.3	Iq Fault limit	0	300	%		1800	

4.12.13 Cold weather

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.12.13.1	Cold weather enable	0	1		0	1490	0=Disable 1=Enable
P1.12.13.2	Cold weather voltage	0	20.00	s	2.00	1491	
P1.12.13.3	Cold weather timeout	0	10	Min	5	1492	
	Timeout						

4.12.14 Thermal derate

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.12.14.1	Derate enable	0	1		0	1680	0=Disable 1=Enable
P1.12.14.2	Derate unit temp	–10	90	C	85	1681	
P1.12.14.3	Derate %	0	100.0	%	50.0	1682	
P1.12.14.4	Derate warning	0	1		1	1683	0=Disable 1=Enable

4.13 Fieldbus parameters

Table 36. Fieldbus parameters

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.13.1	Fieldbus min scale	0.00	320.00	Hz	0.00	850	
P1.13.2	Fieldbus max scale	0.00	320.00	Hz	0.00	851	
P1.13.3	Fieldbus process data out 1 selection	0	10000		1	852	Choose monitoring data with parameter ID Def: Output frequency
P1.13.4	Fieldbus process data out 2 selection	0	10000		2	853	Def: Motor speed
P1.13.5	Fieldbus process data out 3 selection	0	10000		3	854	Def: Motor current to FB
P1.13.6	Fieldbus process data out 4 selection	0	10000		4	855	Def: Motor torque
P1.13.7	Fieldbus process data out 5 selection	0	10000		5	856	Def: Motor power
P1.13.8	Fieldbus process data out 6 selection	0	10000		6	857	Def: Motor voltage
P1.13.9	Fieldbus process data out 7 selection	0	10000		7	858	Def: DC-Link voltage
P1.13.10	Fieldbus process data out 8 selection	0	10000		37	859	Def: Last active fault
P1.13.11	Fieldbus process data in 1 selection	0	10000		1140	876	Choose controlled data with parameter ID. Def: FB Torque reference
P1.13.12	Fieldbus process data in 2 selection	0	10000		46	877	Def: FB Limit scaling
P1.13.13	Fieldbus process data in 3 selection	0	10000		47	878	Def: FB Adjust reference
P1.13.14	Fieldbus process data in 4 selection	0	10000		48	879	Def: FB Analog output.
P1.13.15	Fieldbus process data in 5 selection	0	10000		0	880	Choose controlled data with parameter ID

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.13.16	Fieldbus process data in 6 selection	0	10000		0	881	Choose controlled data with parameter ID
P1.13.17	Fieldbus process data in 7 selection	0	10000		0	882	Choose controlled data with parameter ID
P1.13.18	Fieldbus process data in 8 selection	0	10000		0	883	Choose controlled data with parameter ID
P1.13.19	General status word ID	0	10000		67	897	Choose monitoring data in General Status Word
P1.13.20	FB Actual speed mode	0	1		0	1741	0=Calculated 1=Actual
P1.13.21	Control slot selector	0	8		0	1440	0=All 4=Slot D 5=Slot E
P1.13.22	State machine	1	2		1	896	1 = Standard 2 = ProfiDrive
P1.13.23	FB Custom minimum	–32000	+32000		0	898	FB Speed reference minimum scaling
P1.13.24	FB Custom maximum	–32000	+32000		+10000	899	FB Speed rederence maximum scaling

4.14 ID Control functions

4.14.1 Value control

Table 37. Power reference input signal selection, G2.2.8

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.14.1.1	Control input signal ID	0	10000	ID	0	1580	
P1.14.1.2	Control input off limit	–32000	32000		0	1581	
P1.14.1.3	Control input on limit	–32000	32000		0	1582	
P1.14.1.4	Control output off value	–32000	32000		0	1583	
P1.14.1.5	Control output on value	–32000	32000		0	1584	
P1.14.1.6	Control output signal id	0	10000	ID	0	1585	
P1.14.1.7	Control mode	0	5		0	1586	0=SR ABS 1=Scale ABS 2=Scale INV ABS 3=SR 4=Scale 5=Scale INV
P1.14.1.8	Control output filtering rime	0.000	32.000	s	0.000	1721	

4.14.2 DIN ID control 1

Table 38. DIN ID control parameters

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.14.2.1	ID Control DIN	0.1	E.10		0.1	1570	Slot . Board input no.
P1.14.2.2	Controlled ID	0	10000	ID	0	1571	Select ID that is controlled by digital input
P1.14.2.3	False value	–32000	32000		0	1572	Value when DI is low
P1.14.2.4	True value	–32000	32000		0	1573	Value when DI is high

4.14.3 DIN ID control 2

Table 39. DIN ID control parameters

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.14.3.1	ID Control DIN	0.1	E.10		0.1	1590	Slot . Board input no.
P1.14.3.2	Controlled ID	0	10000	ID	0	1575	Select ID that is controlled by digital input
P1.14.3.3	False value	–32000	32000		0	1592	Value when DI is low
P1.14.3.4	True value	–32000	32000		0	1593	Value when DI is high

4.14.4 DIN ID control 3

Table 40. DIN ID Control parameters

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.14.4.1	ID Control DIN	0.1	E.10		0.1	1578	Slot . Board input no.
P1.14.4.2	Controlled ID	0	10000	ID	0	1579	Select ID that is controlled by digital input
P1.14.4.3	False value	–32000	32000		0	1594	Value when DI is low
P1.14.4.4	True value	–32000	32000		0	1596	Value when DI is high

4.14.5 ID Controlled digital output 1

Table 41. ID Controlled digital output parameters, G1.14.5

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.14.5.1	ID.Bit free DO	0.00	2000.15	ID.Bit	0.00	1216	
P1.14.5.2	Free DO Sel	0.1	E.10		0.1	1574	

4.14.6 ID Controlled digital output 2

Table 42. ID Controlled digital output parameters, G1.14.6

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.14.6.1	ID.Bit free DO	0.00	2000.15	ID.Bit	0.00	1386	
P1.14.6.2	Free DO Sel	0.1	E.10		0.1	1325	

4.14.7 Free DIN delay

Table 43. ID Controlled digital output parameters, G1.14.7

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.14.7.1	ID.Bit free DIN	0.00	2000.15	ID.Bit	0.00	1832	
P1.14.7.2	On delay	0.00	320.00	s	0.00	1833	
P1.14.7.3	Off delay	0.00	320.00	s	0.00	1834	
P1.14.7.4	Mono time	0.00	320.00	s	0.00	1836	
P1.14.7.5	Control out ID	0	10000		0	1835	

4.15 Brake control

Table 44. Brake control parameters, G1.15

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.15.1	BrakeMechDelay	0.00	320.00	s	0.00	1544	Time that is required to open the brake
P1.15.2	Brake OFF FreqLim open loop	0.00	320.00	Hz	1.50	1535	Opening limit and maximum reference limit when brake is closed.
P1.15.3	Brake OFF FreqLim closed loop	0.00	320.00	Hz	0.00	1555	Opening limit and maximum reference limit when brake is closed.
P1.15.4	Brake ON FreqLim +	0.00	320.00	Hz	1.00	1539	Close frequency from positive direction
P1.15.5	Brake ON FreqLim -	0.00	320.00	Hz	1.50	1540	Close frequency from negative direction
P1.15.6	Brake On/Off current limit	0.00	320.00	A	0.00	1085	Brake is closed immediately id current goes below this value.
P1.15.7	Generator torque limit increase speed level	0.00	320.00	Hz	0.00	1547	Function disabled when zero. Point where Generator torque limit stars to increase.
P1.15.8	Generator torque limit increase maximum speed limit	0.00	320.00	Hz	100.00	1548	Point where torque value of ID1549 is added to base generator torque limit.
P1.15.9	Generator torque limit increase maximum addition	0.0	300.0	%	300.0	1549	
P1.15.10	Brake fault action	1	3		1	1316	1=Warning 2=Fault,stop acc. to 2.3.2 3=Fault,stop by coasting
P1.15.11	Brake fault delay	0.00	320.00	s	0.20	1317	

4.15.1.1 Brake control start up torque for CL

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.15.12.1	Start-up torque	0	3		0	621	0=Not used 1=Torque memory 2=Torque reference 3=Start-up torque fwd/rev
P1.15.12.2	Start-up torque FWD	–300.0	300.0	s	0.0	633	
P1.15.12.3	Start-up torque REV	–300.0	300.0	s	0.0	634	
P1.15.12.4	Start Up Torque Time	–1	10000	ms	–1	1371	–1 = Automatic

4.15.1.2 Roll back control for CL

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.15.13.1	Roll back Kp					1787	
P1.15.13.2	Roll back torque					1788	
P1.15.13.3	Roll back level					1789	

4.16 Auto restart parameters

Table 45. Auto restart parameters, G1.16

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.16.1	Wait time	0.10	10.00	s	0.50	717	
P1.16.2	Trial time	0.00	60.00	s	0.10	718	
P1.16.3	Start function	0	2		2	719	0=Ramp 1=Flying start 2=According to stop function
P1.16.4	Number of tries after undervoltage trip	0	10		0	720	
P1.16.5	Number of tries after overvoltage trip	0	10		0	721	
P1.16.6	Number of tries after overcurrent trip	0	3		0	722	
P1.16.7	Number of tries after reference trip	0	10		0	723	
P1.16.8	Number of tries after motor temperature fault trip	0	10		0	726	
P1.16.9	Number of tries after external fault trip	0	10		0	725	
P1.16.10	Number of tries after underload fault trip	0	10		0	738	
P1.16.11	Number of tries after cooling fault	0	10		0	731	
P1.16.12	Number of tries after O/P contactor fault	0	10		0	735	
P1.16.13	Fault simulation	0	65535		0	1569	

4.17 PID

4.17.1 PID basic settings

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.17.1.1	PID Controller gain	0	1000.0	%	100.0	118	
P1.17.1.2	PID Controller I Time	0	320.00	s	1.00	119	
P1.17.1.3	PID Controller D Time	0	100.00	s	0.00	132	

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.17.1.4	Engineering unit	0	10		0	1795	0=% 1=degF 2=degC 3=psig 4=Bar 5=Feet 6=in water col 7=GPM 8=ft/min 9=CFM 10=PPM
P1.17.1.5	PID Min limit	–32768	P1.17.1.6		0	359	
P1.17.1.6	PID Max limit	P1.17.1.5	32767		100.00	360	
P1.17.1.7	Error inversion	0	1		0	342	0=Not Inverted 1=Inverted

4.17.2 PID Set points

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.17.2.1	PID Set point source	0	1		0	332	0=Source 1 1=Source 2
P1.17.2.2	PID Source 1 select	0	4		2	334	0=AI1 1=AI2 2=Keypad PID ref 1 3=Fieldbus PD1 4=Motor potentiometer
P1.17.2.3	PID Source 2 select	0	4		3	335	See P1.17.2.2
R1.17.2.4	Keypad PID Reference 1	P1.17.2.5	P1.17.2.6	P1.17.1.4	50.0		
P1.17.2.5	Keypad PID Set point 1 Min	P1.17.1.5	P1.17.1.6	P1.17.1.4	0	361	
P1.17.2.6	Keypad PID Set point 1 Max	P1.17.1.5	P1.17.1.6	P1.17.1.4	100.00	362	
R1.17.2.7	Keypad PID Reference 2	P1.17.2.8	P1.17.2.9	P1.17.1.4	50.0		
P1.17.2.8	Keypad PID Set point 2 Min	P1.17.1.5	P1.17.1.6	P1.17.1.4	0	363	
P1.17.2.9	Keypad PID Set point 2 Max	P1.17.1.5	P1.17.1.6	P1.17.1.4	100.00	364	
P1.17.2.10	PID Reference rise time	.1	100.0	s	.1	343	
P1.17.2.11	PID Reference fall time	.1	100.0	s	.1	344	
P1.17.2.12	PID Sum point reference	0	6		0	376	0=Direct 1=AI1 2=AI2 3=AI3 4=AI4 5=Keypad SP1 6=Fieldbus PDI3

4.17.3 PID Feedbacks

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.17.3.1	Function	0	7		0	333	0=Source 1 1=Source 1 + Source 2 2=Source 1 - Source 2 3=Source 1 * Source 2 4=Min(Source1,Source2) 5=Max(Source1,Source2) 6=Mean(Source1,Source2) 7=Sqrt(Source1+Sqrt(Source2)

Code	Parameter	Min	Max	Unit	Default	ID	Note
							0=Not Used 1=AI1 2=AI2 3=AI3 4=AI4
P1.17.3.2	Feedback source 1	0	10		2	336	5=Fieldbus 6=Motor torque 7=Motor speed 8=Motor current 9=Motor power 10=Actual speed
P1.17.3.3	Feedback source 1 min	–100.00	100.00		0	337	
P1.17.3.4	Feedback source 1 max	–100.00	100.00		100.00	338	
P1.17.3.5	Feedback source 2	0	10		2	336	See P1.17.3.2
P1.17.3.6	Feedback source 2 min	–100.00	100.00		0	337	
P1.17.3.7	Feedback source 2 max	–100.00	100.00		100.00	338	

4.17.4 PID Sleep

Code	Parameter	Min	Max	Unit	Default	ID	Note
P1.17.4.1	Sleep frequency	0	Fmax	Hz	0.0	1016	
P1.17.4.2	Sleep delay	0	360.0	s	10.0	1017	
P1.17.4.3	Wake up level	P1.17.1.5	P1.17.1.6	P1.17.1.4	50.0	1018	
P1.17.4.4	Wake up action	0	1		0	1019	0=Wake below level 1=Wake above level

4.18 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 9000x User's Manual.

Table 46. Keypad control parameters, M2

Code	Parameter	Min	Max	Unit	Default	ID	Note
P2.1	Control place	1	6		2	125	1=Keypad L/R1 2=Keypad L/R1/R2 3=Local 4=Remote 1 5=Remote 2 6=IO Select
R2.2	Keypad reference	P1.1.1	P1.1.2	Hz	0.00		
P2.3	Direction (on keypad)	0	1		0	123	0=Forward 1=Reverse
P2.4	Stop button	0	1		1	114	0=Limited function of stop button 1=Stop button always enabled
R2.5	Torque reference	0.0	100.0	%	0.0		
R2.6	Power reference	–300.0	300.0	%	0.0		
R2.7	Keypad PID Reference 1	P1.17.2.5	P1.17.2.6	P1.17.1.4	50.0		
R2.8	Keypad PID Reference 1	P1.17.2.5	P1.17.2.6	P1.17.1.4	50.0		

4.19 System menu (control keypad: menu M6)

For parameters and functions related to the general use of the frequency converter, such as application and language selection, customised parameter sets or information about the hardware and software, see the 9000x User's Manual.

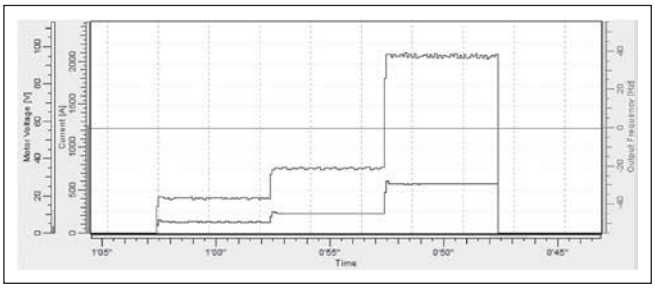
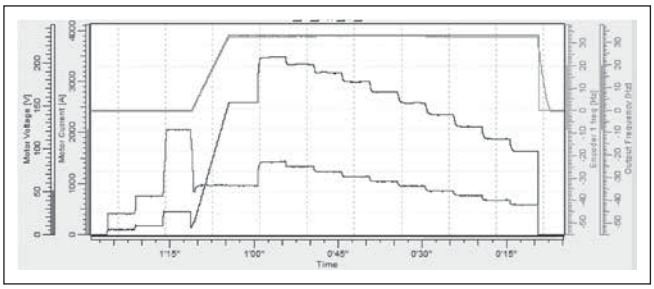
4.20 Expander boards (control keypad: menu M7)

The M7 menu shows the expander and option boards attached to the control board and board-related information. For more information, see the 9000x User's Manual.

5. SPX Advanced – description of parameters

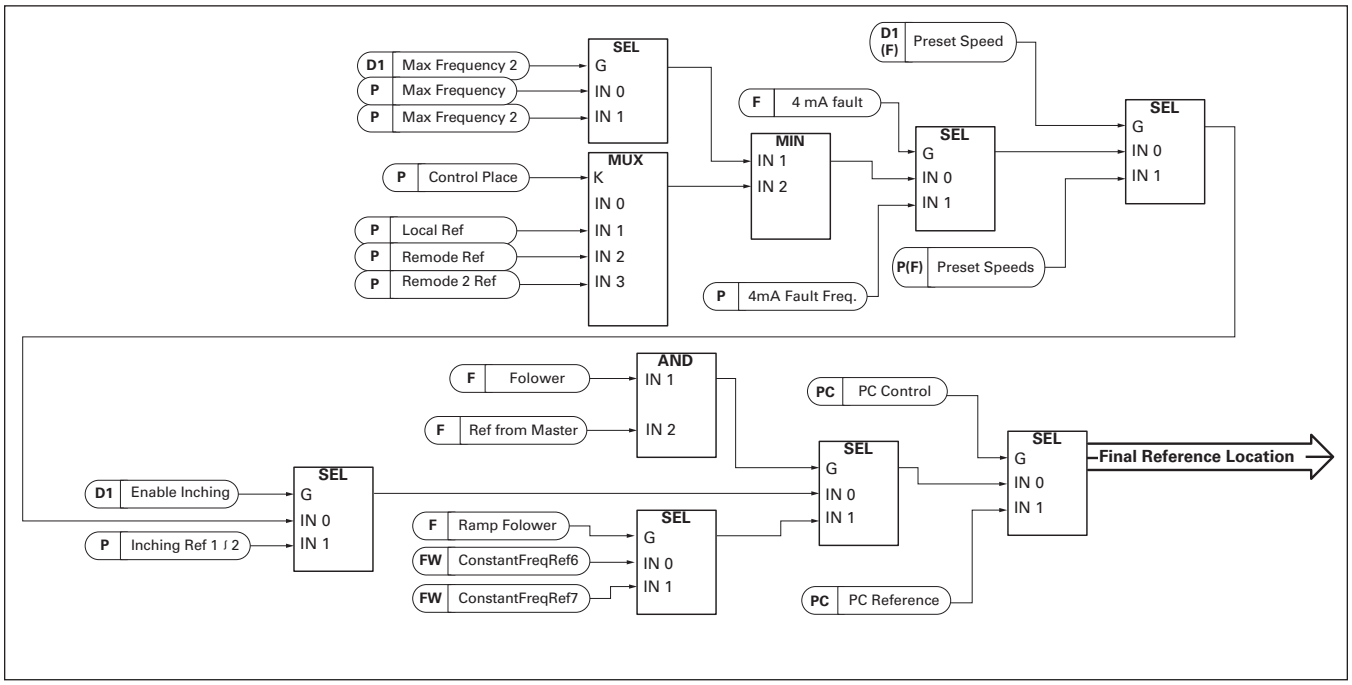
5.1 Basic parameters

Code	ID	Parameter	Notes
P1.1.1	101	**Minimum frequency** Defines minimum frequency of any adjustable reference input (i.e. reference is not a parameter). Minimum frequency is bypassed when jogging speed, preset speed or inching reference is used.	
P1.1.2	102	**Maximum frequency** Defines maximum frequency limit both negative and positive directions. Direction dependent frequency limitscan be given in "G: Limit Settings\Frequency Handling". Drive synch operation The maximum recommended frequency is 100 Hz.	Do not change this parameter to lower value that current output frequency if changed during running. The change will be executed without ramp. Max and Min frequencies are used for several scaling functions and are not mend to be adjusted dynamically. Never set maximum frequency to same or below minimum frequency. When changing maximum frequency in SPX Advanced application do not give any other command to drive for 2 seconds that change can be processed properly by software.
P1.1.3	110	**Motor nominal voltage ""Motor nom voltg"** Find this value U_n on the rating plate of the motor.	
P1.1.4	111	**Motor nominal frequency "Motor nom freq"** Find this value f_n on the rating plate of the motor. This parameter sets the field weakening point to the same value in "G: Motor Control/U/f Settings"	
P1.1.5	112	**Motor nominal speed "Motor nom speed"** Find this value n_n on the rating plate of the motor. Note also nominal frequency. Some cases motor nominal speed is shown with one decimal. In this case the practice is to give nearest integer number and adjust motor nominal frequency so that drive will calculate correct [FW]Pole Pair Number.	
P1.1.6	113	**Motor nominal current "Motor nom currnt"** Find this value I_n on the rating plate of the motor. If magnetization current is provided set also Magnetization current P1.1.9 before identification run. Drive synch operation Motor Nominal current from the motor name plate/Number of drives in parallel using Drive Synch.	
P1.1.7	120	**Power factor "Motor PF"** Find this value "cos phi" on the rating plate of the motor.	
P1.1.8	116	**Motor nominal power ""Motor nom power"** Find this value on the rating plate of the motor. Drive synch operation Motor Nominal power from the motor name plate/Number of drives in parallel using Drive Synch.	
P1.1.9	612	**Magnetizing current "Magn current"** Set here the motor magnetizing current (no-load current). Can be measured by running motor without load at 2/3 of nominal speed. When value is zero the magnetization current is calculated from motor nominal parameters Motor Magnetization Current = $\frac{5 * Sin\,\varphi - 1}{5 - Sin\,\varphi}$ *Motor Nominal Current Motor Magnetization Current = $\frac{5 * \sqrt{1-(\cos\varphi)^2} - 1}{5 - \sqrt{1-(\cos\varphi)^2}}$ *Motor Nominal Current [FW]RotorFlux = $\left(\frac{f\,(Motor\ NomFreq}{f\,(Out)}\right)^2$ (when f(Out)> f(MotorNomFreq) If given before identification run this is used as reference for U/f tuning when making identification without rotating the motor. DriveSynch Operation Motor nominal magnetization current/number of drives in parallel using Drive Synch.	

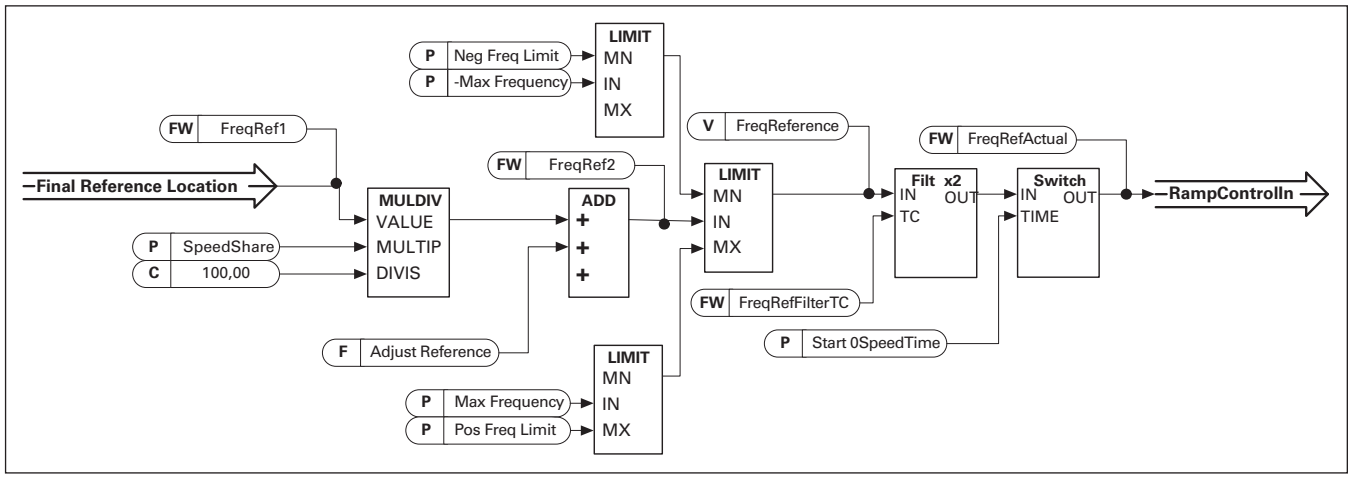
Code	Id	Descriptions	Notes
P1.1.10	**631**	**Identification "Identification"** Identification Run is a part of tuning the motor and the drive specific parameters. It is a tool for commissioning and service of the drive with the aim to find as good parameter values as possible for most drives. The automatic motor identification calculates or measures the motor parameters that are needed for optimum motor and speed control. 0 = "No Action" No action No identification requested. 1 = "ID No Run" - Identification without rotating the motor Current is applied to the motor but shaft will not be rotated. U/f settings are identified. This identification is minimum requirement if motor is only to be used in open loop control. It is however recommended to make always identification with rotating motor if need for closed loop control comes after mechanics are connected to shaft. Example of behaviour  2 = "ID With Run" - Identification with motor rotating Shaft is rotated during identification. This identification must be run without load on motor shaft. U/f settings and magnetization current are identified. This identification should be run regardless of the final operation mode (closed loop or open loop) to get the best performance from the motor. When identification with motor rotation is successfully finished the drive starts to use internal slip estimator to compensate the motor temperature changed. SCTorqueChainSelect B5 & B6. Example of behaviour  3 = "Enc. ID Run" - Encoder identification run The motor shaft is rotated during identification. IM: If performed for induction motor encoder pulse number and direction are identified. Can be used if the is no encoder information available, correct result can be achieved only when motor in unloaded. PMSM: This selection is used for PMS motor if automatic angle identification is not suitable for used motor (angle is identified automatically in every start if PMSM Shaft Position parameter is zero). This identification run will update PMSM Shaft Position parameter based on absolute position of the encoder or Z pulse position of incremental type encoder.	Set motor control mode to Frequency Control before identification! During identification drive will not open mechanical brake for safety reasons. If motor rotation requires that brake is opened this needs to be achieved externally. During identification run torque and power limits should be above 100 %. Also current limit should be above motor nominal current. During identification run acceleration time should be below 20 second. If switching frequency is changed after identification it's recommended to do identification run again. Small motor with long motor cabled may require reduction of switching frequency if identification is not successful. Identification needs to be remade if encoder position related to motor is changed e.g. due maintenance.

Code	Id	Descriptions	Notes
P1.1.10	**631**	4 = "Ident All" - Identified All Shaft is rotated during identification. All the above identification selections are made in sequence. 5 = "Enc.ABS.Lock" – Absolute encoder when locked rotor Absolute encoder zero position identification when rotor is locked while using permanent magnet motor. It's recommended to have shaft locked during this identification mode. 10 = "ID Run Fails" - Identification failed Identification failed in last attempt. The basic motor name plate data has to be set correctly before performing the identification run: • P1.1.3 – P1.1.8. Motor basic data • P1.1.9 Magnetization current can also be given if available if given before identification without rotating motor; U/f curve will be tuned according to given magnetization current • P1.1.11 Motor Type When in closed loop and with an encoder installed, also the parameter for pulses/ revolutions (in Menu M7) has to be set. The automatic identification is activated by setting this parameter to the appropriate value followed by a start command in the requested direction. The start command to the drive has to be given within 20 s. If no start command is given within 20 s the identification run is cancelled and the parameter will be reset to its default setting. The identification run can be stopped any time with normal stop command and the parameter is reset to its de-fault setting. In case identification run detects fault or other problems, the identification run is completed if possible. After the identification is finished, warning will be given is not all requested identification types has been completed successfully. During Identification Run, the brake control is disabled. DriveSynch operation: Activate identification only from the master drive:	After identification is made drive requires rising edge of start command. SPX Advanced application has all identified values stored to parameters, no need to redo identification if previous parameters are loaded back to the dive if e.g. control board is changed.
P1.1.11	**650**	**Motor type "Motor type"** Select used motor type with this parameter 0 "Induction" – Induction motor Asynchronous motor 1 "PMSM" – Permanent magnet synchronous motor • Synchronous Motor • Contact factory before using with externally magnetized motor • If Switching Frequencies above 3, 5 kHz is not needed it is recommended to change to Software Modulator 1 at this point. Read more details in Chapter 6.8.3 Permanent magnet synchronous motor setting and Chapter 8 Identification functions for permanent magnet synchronous motors See related parameter in "G2.8.6: Motor Control PMSM Control".	
P1.1.12	**172**	**Local control source "Local ctrl src"** The active control place can be set with P2.1 with P2.1 set to a keypad the keypad local remote button will change the active control place. This parameter sets the start/stop control place in Local mode to be from keypad, I/O terminal A, I/O Terminal B or Fieldbus.	
P1.1.13	**173**	**Remote 1 control source "Rem ctrl 1 src"** The active control place can be set with P2.1 with P2.1 set to a keypad the keypad local remote button will change the active control place. This parameter sets the start/stop control place in Remote 1 mode to be from keypad, I/O terminal A, I/O Terminal B or Fieldbus.	
P1.1.14	**174**	**Remote 2 control source "Rem ctrl 2 src"** The active control place can be set with P2.1 with P2.1 set to a keypad the keypad local remote button will change the active control place. This parameter sets the start/stop control place in Remote 2 mode to be from keypad, I/O terminal A, I/O Terminal B or Fieldbus.	

5. 2 Reference handling



Priority order of SPX Advanced application speed reference chain.



Speed reference chain before ramp control

5. 2.1 Basic parameters

Code	ID	Parameter	Notes
P1.2.1	121	**Local reference "local reference"** Defines which frequency reference source is used when control place is Local set in P2.1 Control Place, or forced through DIN, or selected from the keypad local remote button. 0="AI1" - Analog Input 1. Signal scaling in "G1.4.2: Input Signals\Analog Input 1" 1="AI2" - Analog Input 2. Signal scaling in "G1.4.3: Input Signals\Analog Input 2" 2="AI1+AI2" - Analog Input 1 + Analog Input 2. With alternative reference scaling in Analog Input group 100 % input values can be set to correspond 25 Hz thus when both are at 100 % final reference will be 50 Hz. 3="AI1-AI2" Analog Input 1 - Analog Input 2. 4="AI2-AI1" Analog Input 2 - Analog Input 1. 5="AI1xAI2" Analog Input 1 x Analog Input 2 6="AI1 Joystick" Analog input 1, -10 Vdc... +10 Vdc 7="AI2 Joystick" Analog input 2, -10 Vdc... +10 Vdc 8="Keypad Ref" Reference from keypad R3.2 9="Fieldbus" Reference is taken from Fieldbus, alternative scaling can be selected in "G: Fieldbus" 10="Motor Pot" - Motor potentiometer. Reference handled with two digital input "G: Input Signals\Digital Inputs" (increase and decrease). Behaviour adjusted in "G: Ref Handling\Motor Potentiometer". 11="AI1, AI2 min" The minimum of Analog Input 1 and Analog Input 2 is used as reference. 12="AI1, AI2 max" The maximum from Analog Input 1 and Analog Input 2 is used as reference. 13="Max Freq" – Maximum Frequency	
P1.1.2		**Max Frequency is used as reference.** 14="AI1/AI2 Sel" – AI1/AI2 Selection Digital Input "I/O Ref 1/2" is used to select between Analog Input 1 and Analog Input 2 reference. "I/O Ref 1/2" is sued to elect between "I/O Reference" and "I/O Reference 2" if selection is different than 14 (this one). 15="Encoder 1" Reference is read from encoder input 1. 16="Encoder 2" Reference is read from encoder input 2. This selection is usable with double encoder boards. Could be used e.g. for speed synchronization where two motor needs to run at same speed but not necessarily same angle. 17="PID Output" Reference is read from the output of the PID controller see group P1.17 for PID controller settings	
P1.2.2	117	**Remote 1 reference selection "remote 1 ref"** Defines which frequency reference source is used when control place is Remote 1 set in P2.1 Control Place, or forced through DIN, or selected from the keypad local remote button. 0="AI1" - Analog Input 1. Signal scaling in "G1.4.2: Input Signals\Analog Input 1" 1="AI2" - Analog Input 2. Signal scaling in "G1.4.3: Input Signals\Analog Input 2" 2="AI1+AI2" - Analog Input 1 + Analog Input 2. With alternative reference scaling in Analog Input group 100 % input values can be set to correspond 25 Hz thus when both are at 100 % final reference will be 50 Hz.	

Code	ID	Parameter	Notes
P1.2.2	**117**	3="AI1-AI2" Analog Input 1 - Analog Input 2. 4="AI2-AI1" Analog Input 2 - Analog Input 1. 5="AI1xAI2" Analog Input 1 x Analog Input 2 6="AI1 Joystick" Analog input 1, -10 Vdc... +10 Vdc 7="AI2 Joystick" Analog input 2, -10 Vdc... +10 Vdc 8="Keypad Ref" Reference from keypad R3.2 9="Fieldbus" Reference is taken from Fieldbus, alternative scaling can be selected in "G: Fieldbus" 10="Motor Pot" - Motor potentiometer. Reference handled with two digital input "G: Input Signals\Digital Inputs" (increase and decrease). Behaviour adjusted in "G: Ref Handling\Motor Potentiometer". 11="AI1, AI2 min" The minimum of Analog Input 1 and Analog Input 2 is used as reference. 12="AI1, AI2 max" The maximum from Analog Input 1 and Analog Input 2 is used as reference. 13="Max Freq" – Maximum Frequency P1.1.2 Max Frequency is used as reference. 14="AI1/AI2 Sel" – AI1/AI2 Selection Digital Input "I/O Ref 1/2" is used to select between Analog Input 1 and Analog Input 2 reference. "I/O Ref 1/2" is sued to elect between "I/O Reference" and "I/O Reference 2" if selection is different than 14 (this one). 15="Encoder 1" Reference is read from encoder input 1. 16="Encoder 2" Reference is read from encoder input 2. This selection is usable with double encoder boards. Could be used e.g. for speed synchronization where two motor needs to run at same speed but not necessarily same angle. 17="PID Output" Reference is read from the output of the PID controller see group P1.17 for PID controller settings	
P1.2.3	**122**	**Remote 2 reference selection "remote 2 ref"** Defines which frequency reference source is used when control place is Remote 2 set in P2.1 Control Place, or forced through DIN, or selected from the keypad local remote button. 0="AI1" - Analog Input 1. Signal scaling in "G1.4.2: Input Signals\Analog Input 1" 1="AI2" - Analog Input 2. Signal scaling in "G1.4.3: Input Signals\Analog Input 2" 2="AI1+AI2" - Analog Input 1 + Analog Input 2. With alternative reference scaling in Analog Input group 100 % input values can be set to correspond 25 Hz thus when both are at 100 % final reference will be 50 Hz. 3="AI1-AI2" Analog Input 1 - Analog Input 2. 4="AI2-AI1" Analog Input 2 - Analog Input 1. 5="AI1xAI2" Analog Input 1 x Analog Input 2 6="AI1 Joystick" Analog input 1, -10 Vdc... +10 Vdc 7="AI2 Joystick" Analog input 2, -10 Vdc... +10 Vdc 8="Keypad Ref" Reference from keypad R3.2	

Code	ID	Parameter	Notes
P1.2.3	**122**	9="Fieldbus" Reference is taken from Fieldbus, alternative scaling can be selected in "G: Fieldbus" 10="Motor Pot" - Motor potentiometer. Reference handled with two digital input "G: Input Signals\Digital Inputs" (increase and decrease). Behaviour adjusted in "G: Ref Handling\Motor Potentiometer". 11="AI1, AI2 min" The minimum of Analog Input 1 and Analog Input 2 is used as reference. 12="AI1, AI2 max" The maximum from Analog Input 1 and Analog Input 2 is used as reference. 13="Max Freq" – Maximum Frequency P1.1.2 Max Frequency is used as reference. 14="AI1/AI2 Sel" – AI1/AI2 Selection Digital Input "I/O Ref 1/2" is used to select between Analog Input 1 and Analog Input 2 reference. "I/O Ref 1/2" is sued to elect between "I/O Reference" and "I/O Reference 2" if selection is different than 14 (this one). 15="Encoder 1" Reference is read from encoder input 1. 16="Encoder 2" Reference is read from encoder input 2. This selection is usable with double encoder boards. Could be used e.g. for speed synchronization where two motor needs to run at same speed but not necessarily same angle. 17="PID Output" Reference is read from the output of the PID controller see group P1.17 for PID controller settings	
P1.2.4	**131**	**Remote 1 reference selection 2 "Remote 1 Ref 2"** Defines which frequency reference source is used when control place is Remote 1 set in P2.1 Control Place, or forced through DIN, or selected from the keypad local remote button and DIN for Remote 1 reference 2 is active. 0="AI1" - Analog Input 1. Signal scaling in "G1.4.2: Input Signals\Analog Input 1" 1="AI2" - Analog Input 2. Signal scaling in "G1.4.3: Input Signals\Analog Input 2" 2="AI1+AI2" - Analog Input 1 + Analog Input 2. With alternative reference scaling in Analog Input group 100% input values can be set to correspond 25 Hz thus when both are at 100 % final reference will be 50 Hz. 3="AI1-AI2" Analog Input 1 - Analog Input 2. 4="AI2-AI1" Analog Input 2 - Analog Input 1. 5="AI1xAI2" Analog Input 1 x Analog Input 2 6="AI1 Joystick" Analog input 1, -10 Vdc... +10 Vdc 7="AI2 Joystick" Analog input 2, -10 Vdc... +10 Vdc 8="Keypad Ref" Reference from keypad R3.2 9="Fieldbus" Reference is taken from Fieldbus, alternative scaling can be selected in "G: Fieldbus" 10="Motor Pot" - Motor potentiometer. Reference handled with two digital input "G: Input Signals\Digital Inputs" (increase and decrease). Behaviour adjusted in "G: Ref Handling\Motor Potentiometer". 11="AI1, AI2 min" The minimum of Analog Input 1 and Analog Input 2 is used as reference. 12="AI1, AI2 max" The maximum from Analog Input 1 and Analog Input 2 is used as reference. 13="Max Freq" – Maximum Frequency P1.1.2 Max Frequency is used as reference.	

Code	ID	Parameter	Notes
P1.2.4	**131**	14="AI1/AI2 Sel" – AI1/AI2 Selection Digital Input "I/O Ref 1/2" is used to select between Analog Input 1 and Analog Input 2 reference. "I/O Ref 1/2" is sued to elect between "I/O Reference" and "I/O Reference 2" if selection is different than 14 (this one). 15="Encoder 1" Reference is read from encoder input 1. 16="Encoder 2" Reference is read from encoder input 2. This selection is usable with double encoder boards. Could be used e.g. for speed synchronization where two motor needs to run at same speed but not necessarily same angle. 17="PID Output" Reference is read from the output of the PID controller see group P1.17 for PID controller settings	
P1.2.5	**1241**	**Speed share "speed share"** Defines the speed reference percentage ratio after final reference location but before ramp control. Monitoring value "FreqReference" shows the reference after speed share function. Used to adjust reference ration e.g. in line drive that PLC can give same reference to all drives while speed share compensate gear ratio affect to the line speed.	
P1.2.6	**1248**	**Load share "load share"** Defines the percentage for final torque reference after final torque reference location selection but before the torque reference step function, torque reference dead zone and reference filtering.	

5. 2.2 Constant reference

Code	ID	Parameter	Notes
P1.2.7.1	**124**	**Jogging speed reference "jog speed ref"** Defines the jogging speed reference when activated by a digital input. This reference will follow the reverse command if given. Jogging speed has a higher priority than preset speed references. Related parameters • Digital Input P1.4.2.16 Jogging Speed	
P1.2.7.2	**105**	**Preset speed 1 "preset speed 1"**	
P1.2.7.3	**106**	**Preset speed 2 "preset speed 2"**	
P1.2.7.4	**126**	**Preset speed 3 "preset speed 3"**	
P1.2.7.5	**127**	**Preset speed 4 "preset speed 4"**	
P1.2.7.6	**128**	**Preset speed 5 "preset speed 5"**	
P1.2.7.7	**129**	**Preset speed 6 "preset speed 6"**	
P1.2.7.8	**130**	**Preset speed 7 "preset speed 7"** Parameter values define the Preset speeds references activated by digital inputs. These references will follow reverse command if given. **Table 51. Preset speeds 1 to 7** Related parameters Digital inputs P1.4.2.5-7 Preset Speed 1-3	

Speed	Digital input preset speed 1	Digital input preset speed 2	Digital input preset speed 3
Basic speed	0	0	0
Preset speed 1	1	0	0
Preset speed 2	0	1	0
Preset speed 3	1	1	0
Preset speed 4	0	0	1
Preset speed 5	1	0	1
Preset speed 6	0	1	1
Preset speed 7	1	1	1

5.2.2.1 Inching function

Inching function will start the drive to reference without additional start command regardless of control place. Inching function requires enabling from digital input before command is accepted. Inching is also disabled if there is start command active from active control place.

Code	ID	Parameter	Notes
P1.2.7.9	1239	**Inching reference 1 "Inching Ref 1"**	
P1.2.7.10	1240	**Inching reference 2 "Inching Ref 2"** These parameters define the reference for the inching function. The references are bidirectional and the reverse command does not affect the direction of the inching reference. Other parameters for inching function • Digital input selection: Enable Inching • Digital input selection: Inching 1 • Digital input selection: Inching 2 • Parameter: Inching Ramp	
P1.2.7.11	1252	**Speed step "speed step"** 9000xDrive parameter to help adjusting the speed controller (see 9000xDrive Tools: Step Response). With this tool you can give step to speed reference after ramp control.	

5.2.3 Power reference

The Power reference mode allows the motor to operate at constant power while speed and torque are changing giving steady load for the generators in changing conditions.

This also gives a fast response for thrusters as torque is increased rapidly after increase of power reference thus making speed of the thrusters to speed up fast to new reference.

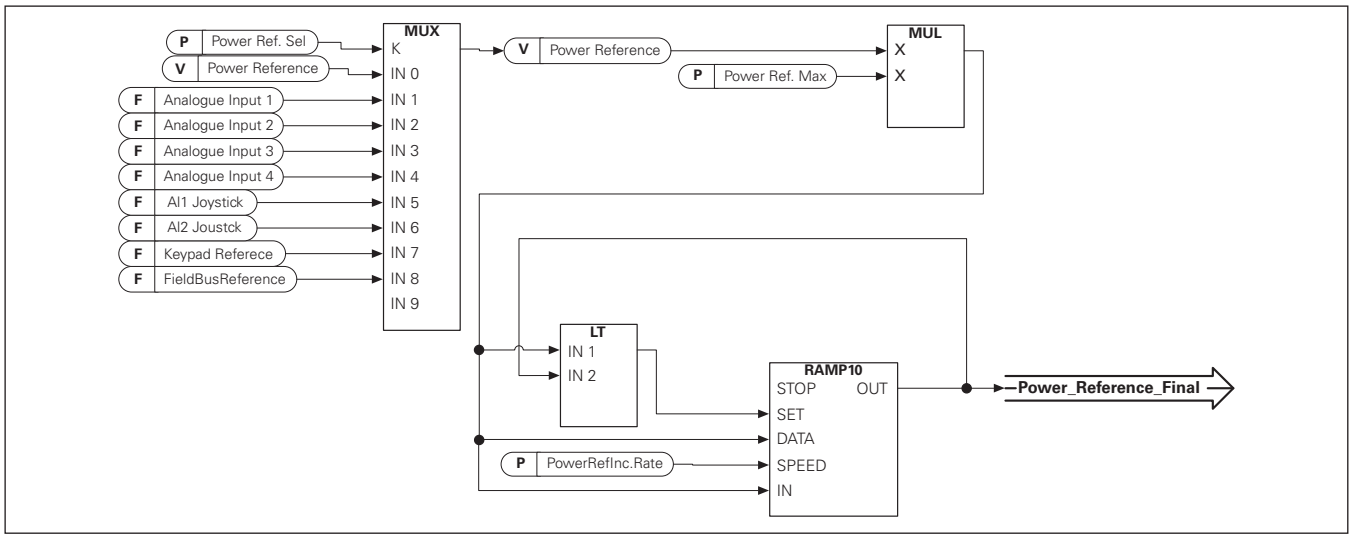
Pure speed control where ramp times are tuned slowly to limit fast power changes on higher speeds makes response slow especially when starting from zero speed where thrusters do not create thrust.

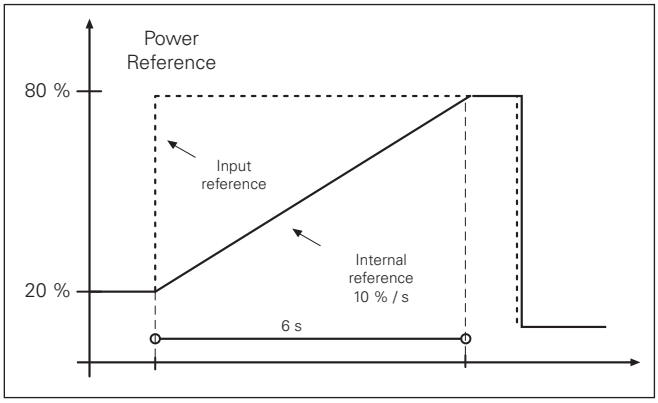
The change between power reference mode and speed controller mode is made by changing motor control modes between speed and torque control.

Note: Do not change between open loop and closed loop control modes while the drive is run state.

- P1.8.1 Motor Control Mode; Speed control modes
- P1.8.2 Motor Control Mode 2; Torque control modes
- DI Motor Control mode 1/2; Selection between speed and power control mode
- P1.2.9.1 Torque reference select "10/Power Ref"

In power reference mode the drive is operating in torque control mode. Therefore, the torque reference selector needs to be set to value 10 (Power reference) where given power reference is converted to torque reference for the motor control. "See Figure below".



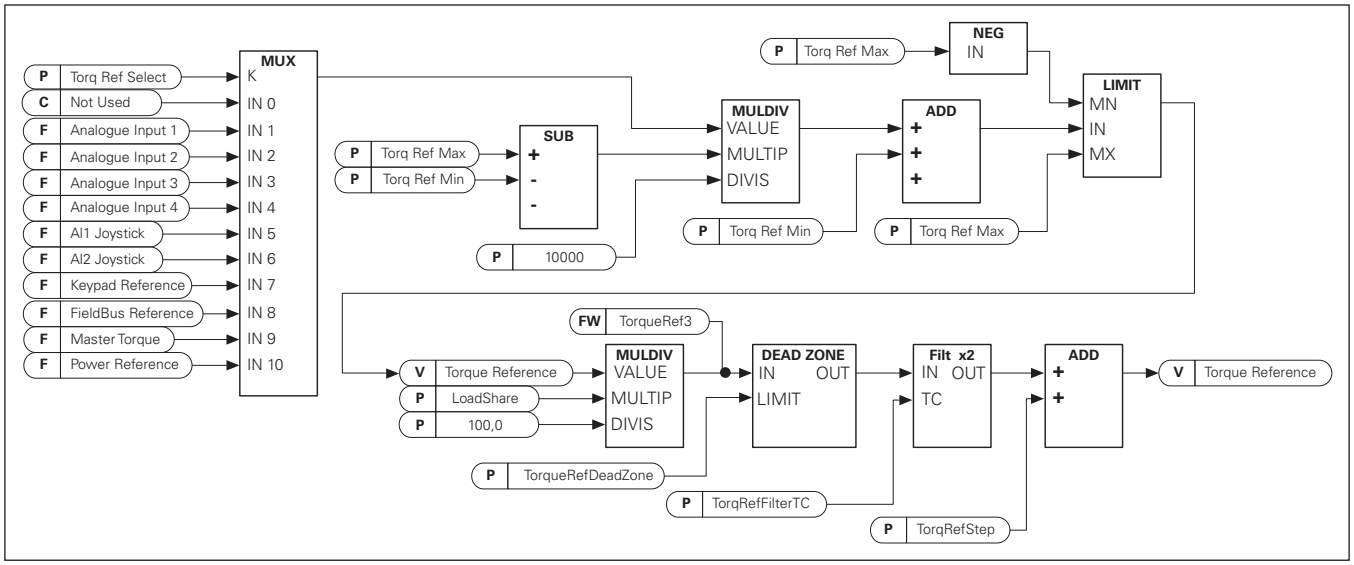
Code	ID	Parameter	Notes
P1.2.8.1	1620	**Power reference selection "power ref. sel"** With this parameter the input source for Power Reference is selected. If this value is set to zero but Torque reference selection is "10= Power Ref" power reference value can be written directly to Power Reference monitoring value from Fieldbus or with analog ID writing function. 0="Not Used" 1="AI1" - Analog Input 1. Signal scaling in "G2.4.3: Input Signals\Analog Input 1" 2="AI2" - Analog Input 2. Signal scaling in "G2.4.4: Input Signals\Analog Input 2" 3="AI3" Signal scaling in "G2.4.5: Input Signals\Analog Input 3" 4="AI4" Signal scaling in "G2.4.6: Input Signals\Analog Input 4" 5="AI1 Joystick" Analog input 1, -10 Vdc... +10 Vdc 6="AI2 Joystick" Analog input 2, -10 Vdc... +10 Vdc 7="Keypad Ref" Torque reference from keypad R3.6 8="Fieldbus" Monitoring variable FB Power Reference ID1703	
P1.2.8.2	1621	**Maximum power reference** Scaling factor for power reference input. Scaling is not used when Power reference selection is 7 or 8.	
P1.2.8.3	1621	**Power reference increase rate "PowerRefInc.Rate"** Ramp up rate for power reference. Ramping rate does not have an effect when reference is decreased. When ramp rate is set to zero ramping is bypassed.  	

5.2.4 Torque reference

Motor torque is controlled which allows the motor speed to change depending on the actual load on the motor shaft. Speed limit behaviour is controlled by P1.2.9.6 TorqSpeedLimit parameter.

For joystick inputs maximum negative reference is negated "Torq Ref Max".

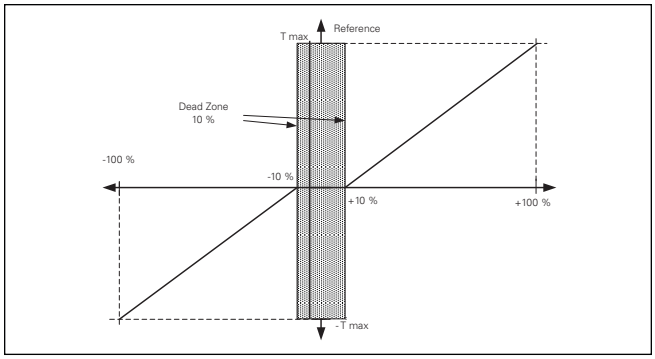
The minimum is used only for analog input selections 1 to 4. Also the maximum negative torque reference maximum is negated "Torq Ref Max".



Code	ID	Parameter	Notes
P1.2.9.1	**641**	**Torque reference selection ID641 "torq ref select"** 0="Not Used" 1="AI1" - Analog Input 1. Signal scaling in "G: Input Signals\Analog Input 1" 2. "AI2" - Analog Input Signal scaling in "G: Input Signals\Analog Input 2" 3="AI3" 4="AI4" 5="AI1 Joystick" Analog input 1, -10 Vdc... +10 Vdc. For joystick inputs the maximum negative reference is negated "Torq Ref Max". 6="AI2 Joystick" Analog input 2, -10 Vdc... +10 Vdc For joystick inputs the maximum negative reference is negated "Torq Ref Max". 7="Keypad Ref" Torque reference from keypad R3.5. 8="Fieldbus" Reference is taken from Fieldbus. Alternative scaling can be selected in "G: Fieldbus" 9="Master Torque" Reference is taken from Master drive when using Master Follower function. 10="Power Ref." Reference is taken from Power reference function. This selection converts given power reference to torque reference for motor control.	
P1.2.9.2	**642**	**Torque reference scaling, maximum value "torq ref max"** Maximum allowed torque reference for positive and negative values. This is also used for joystick input for negative maximum limit.	
P1.2.9.3	**643**	**Torque reference scaling, minimum value ID643 "torq ref min"** Minimum torque reference for analog input reference selections 1-4.	
P1.2.9.4	**1244**	**Torque reference filtering time"torqRefFilterTC"** Defines the filtering time for torque reference. Filtering is after load share function and before torque step function.	

Code	ID	Parameter	Notes
P1.2.9.5	1246	**Torque reference dead zone "TorqRefDeadZone"**	

The small values of the torque reference around zero can be ignored by setting this value greater than zero. When reference is between zero to plus/minus this parameter, the reference is forced to zero.



P1.2.9.6	1278	**Torque select "torque select"**	

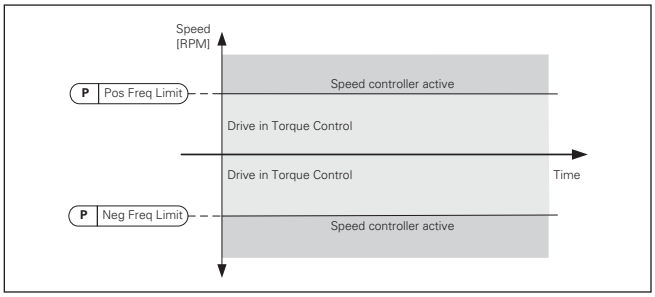
This parameter defines the speed limiting mode in torque control mode. This parameter can be used as single motor control mode selection when no change is made between open loop and closed loop controls.

0= "SpeedControl" - Speed control mode

The drive is forced to operate in speed control mode while the motor control mode parameter is set to torque control mode thus allowing selection of speed control and torque control mode with single parameter e.g. from Fieldbus.

1="MaxFreqLimit" - Positive and negative frequency limits

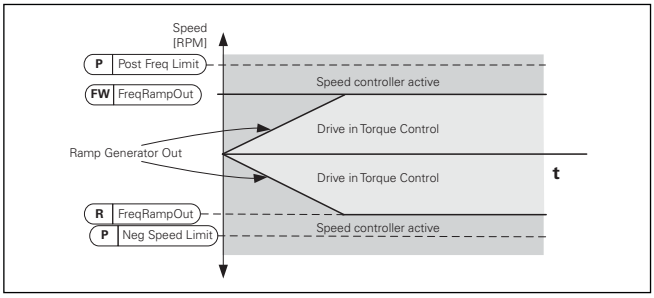
Speed is not limited by speed reference, only maximum frequency or Positive and Negative frequency limit if set lower than maximum frequency parameter.



2="RampOutput" – Ramp output for both directions

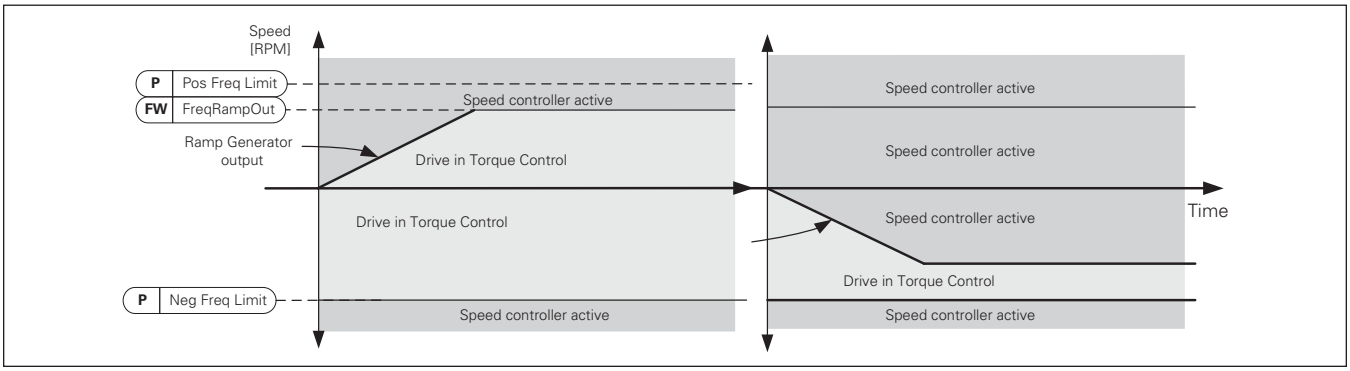
Speed is limited by reference after ramp generator, thus speed will increase with set ramp time until actual torque is equal to reference torque. If speed is below reference when load is removed from the shaft the speed will increase without ramp.

This is the default selection. For master follower system it is recommended to use selection that allows a little higher reference for torque follower that load will be balanced equally e.g. window control.



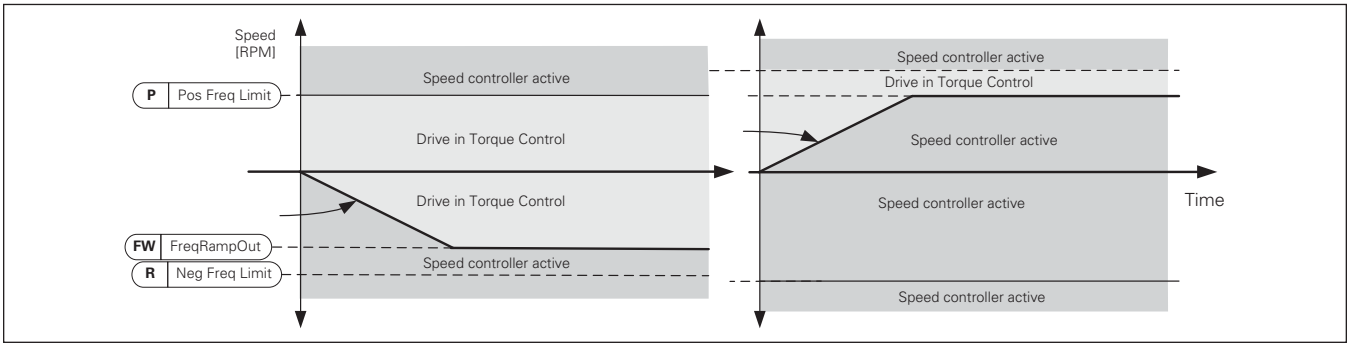
Code	ID	Parameter	Notes
P1.2.9.6	**1278**	**Torque select "torque select"**	

3="Min" – Minimum from speed reference and torque reference.
The minimum of the speed controller output and the torque reference is selected as final torque reference.



4="Max" – Maximum from speed reference and torque reference

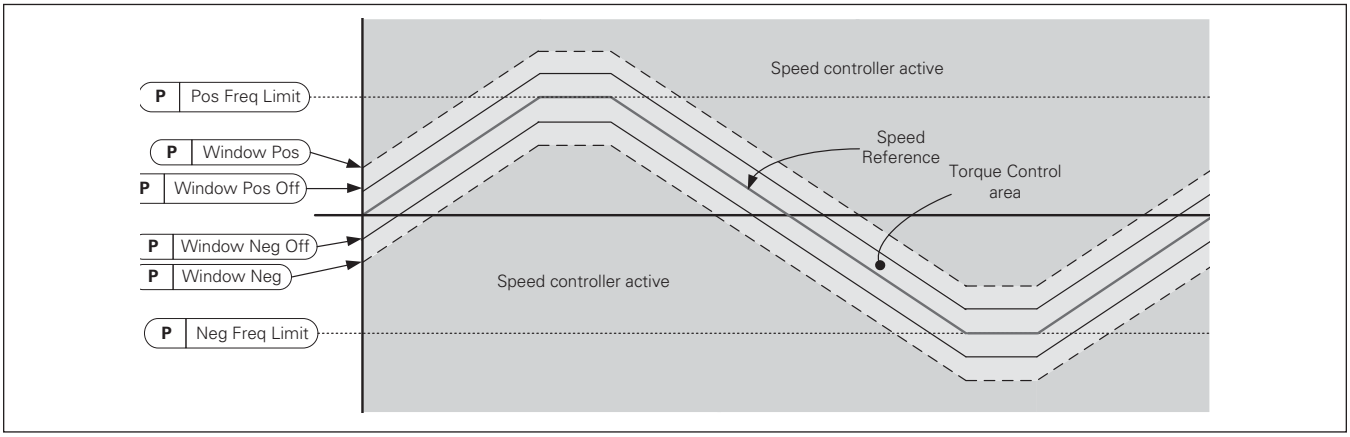
The maximum of the speed controller output and the torque reference is selected as final torque reference.



5="Window" – Window control

Speed is limited within window from speed reference.

Speed control activation limit is different from the speed limit. Speed needs, therefore, to go first to "Window Pos" or "Window Neg" limit before the speed controller activates, when speed controller is active speed will be restricted to limit defined by "Window Pos Off" and "Windows Neg Off" from the "FinalFreqRef"



Code	ID	Parameter	Notes
P1.2.9.7	1305	**Window negative "window neg"** Defines the size of window to negative direction from the final speed reference. If both windows off limits are zero this parameter is also the speed limit from the "FinalFreqRef". Otherwise this is the speed control activation limit.	
P1.2.9.8	1304	**Window positive "window pos"** Defines the size of window to positive direction from the final speed reference. If both windows off limits are zero this parameter is also the speed limit from the "FinalFreqRef". Otherwise this is the speed control activation limit.	
P1.2.9.9	1307	**Window negative off limit "window neg off"** Defines the speed controller negative off limit when the speed controller brings the speed back to window.	
P1.2.9.10	1306	**Window positive off limit "window pos off"** Defines speed controller positive off limit when speed controller brings speed back to window.	
P1.2.9.11	1253	**Torque step "torque step"** 9000xDrive parameter to help adjusting the torque controller (see 9000xDrive Tools: Step Response). With this tool you can give step to torque reference.	

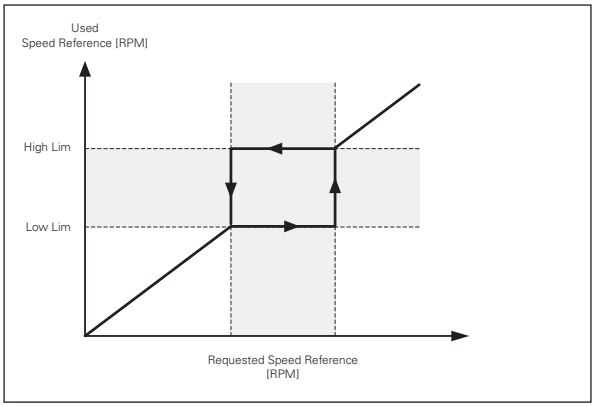
5.2.4.1 Torque reference OL settings

Code	ID	Parameter	Notes
P1.2.9.11.1	636	**Open loop torque control minimum frequency "OL TC min freq"** Defines the frequency limit below which the frequency converter operates in frequency control mode.	
P1.2.9.11.2	639	**Open loop torque controller P gain "OL TorqCtrl P"** Defines the gain for open loop torque control.	
P1.2.9.11.3	640	**Open loop torque controller I gain "OL TorqCtrl I"** Defines the integration gain for open loop torque control.	

5.2.5 Prohibited frequencies

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 prohibited frequency region and ramp rate factor to use when frequency is going above this area. When the input reference is increased the internal reference is kept at the low limit until the input reference is above the high limit.

Code	ID	Parameter	Notes
P1.2.10.1	509	**Prohibit frequency area 1; low limit "range 1 low lim"**	
P1.2.10.2	510	**Prohibit frequency area 1; high limit "range 1 high lim"** Range definition where a different ramp time defined by "RampTimeFactor" is used.	



Code	ID	Parameter	Notes
P1.2.10.3	518	**Ramp time factor for prohibited range "RampTimeFactor"** Multiplier of the currently selected ramp time between prohibit frequency limits.	

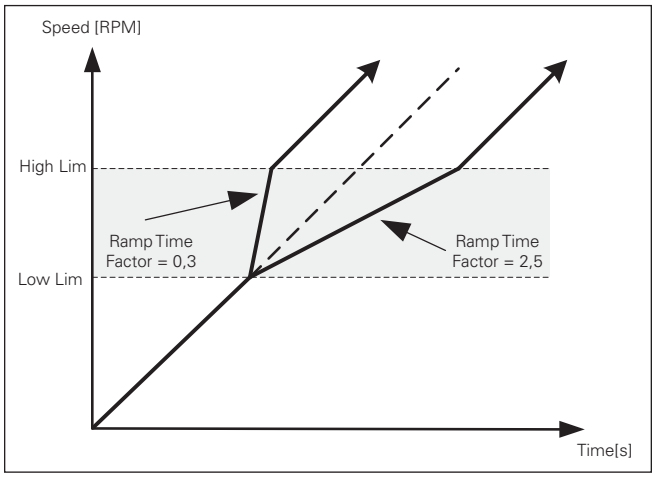
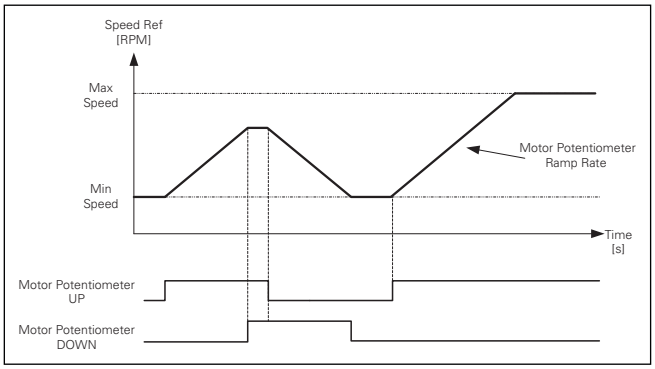


Figure 5-1. Ramp rate scaling between prohibit frequencies

5.2.6 Motor potentiometer

Motor potentiometer is used to control the reference with two digital inputs, one increasing the reference and the other decreasing the reference. The reference change rate can be set by parameter [Hz/s]. Motor potentiometer reference is available in I/O control only. It can be changed only when the drive is in running state.

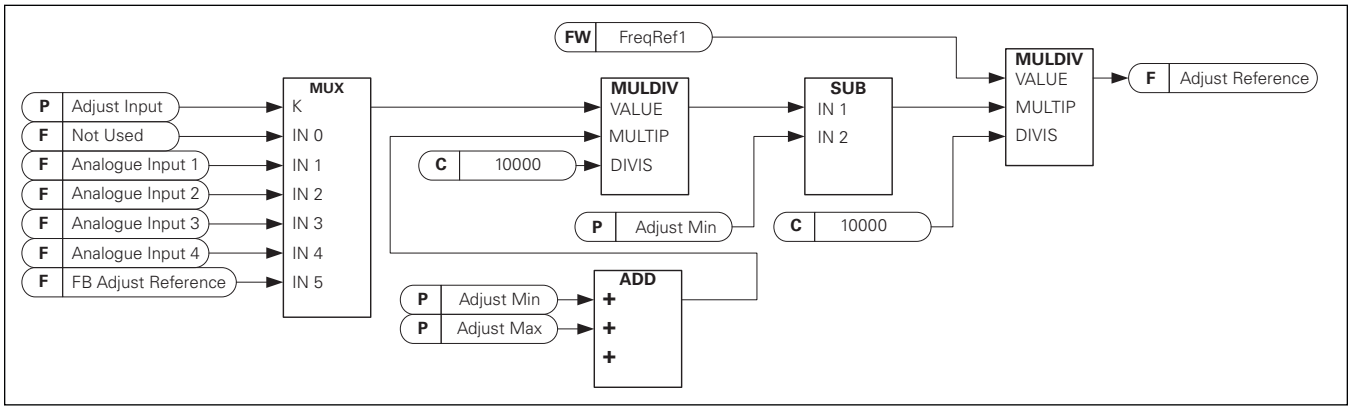


Code	ID	Parameter	Notes
P1.2.11.1	331	**Motor potentiometer ramp rate "motpot ramp rate"** Defines the rate of change of the motor potentiometer reference value in Hz/s. Normal ramp times are still active and determine how fast the actual output frequency increases.	
P1.2.11.2	367	**Motor potentiometer reference reset "MotPotRef reset"** 0 "No reset" Reference is kept past the stop state and stored to memory in case of a power down. 1 "Stop State" Reference is set to zero when the drive is in stop state. This selection includes power down situations. 2 "Power Down" Reference is reset only in a power down situation. Other parameters related to function • P1.4.2.8 Motor potentiometer DOWN ID417 "Mot Pot Ref Down" • P1.4.2.9 Motor potentiometer UP ID418 "Mot Pot Ref Up"	

Code	ID	Parameter	Notes
P1.2.11.3	366	**Motor potentiometer reference copy "MotPotRefCopy"** This parameter defines how reference is handled when reference input is changed to motor potentiometer in I/O control. 0 "No copy" Reference is not copied. Depending on "MotPot Reset" function, the drive may start from minimum frequency or from reference that was last used when the drive was run with motor potentiometer. 1 "Reference" The drive's active reference is copied. If the drive is ramping when the value of motor potentiometer is changed the drive will continue ramping after the change. This allows the reference copy in stop state unless the "MotPot Reset" function overruns it (e.g. reset in stop state is not selected). 2 "Freq. Output" Speed at the time of change is copied to reference. If the drive is ramping when the change is made the drive will stop ramping and keep the present speed.	

5.2.7 Adjust reference

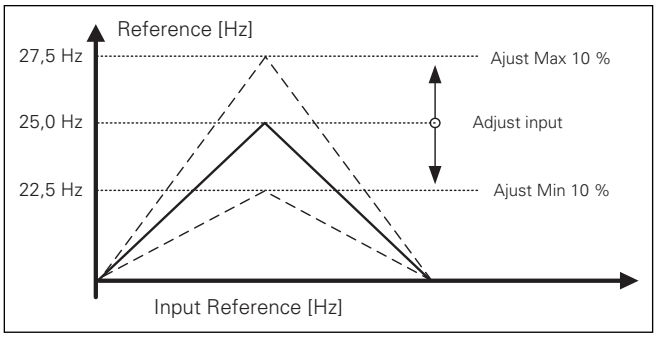
Adjust reference function is used to fine tune the main reference. Adjust reference is added to main reference after "SpeedShare" function "See Figure below"



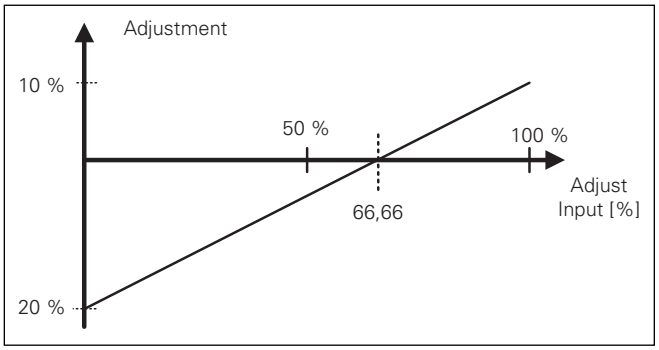
Code	ID	Parameter	Notes
P1.2.12.1	493	**Adjust input "adjust input"** With this parameter you can select the signal according to which the frequency reference to the motor is fine adjusted. 0 Not used 1 Analog input 1 2 Analog input 2 3 Analog input 3 4 Analog input 4 5 FB Adjust Reference ID47 Monitoring Signal	
P1.2.12.2	494	**Adjust minimum "adjust minimum"** Percentage that is subtracted from the main reference when adjust input is at minimum.	

Code	ID	Parameter	Notes
P1.2.12.3	**495**	**Adjust maximum "adjust maximum"**	

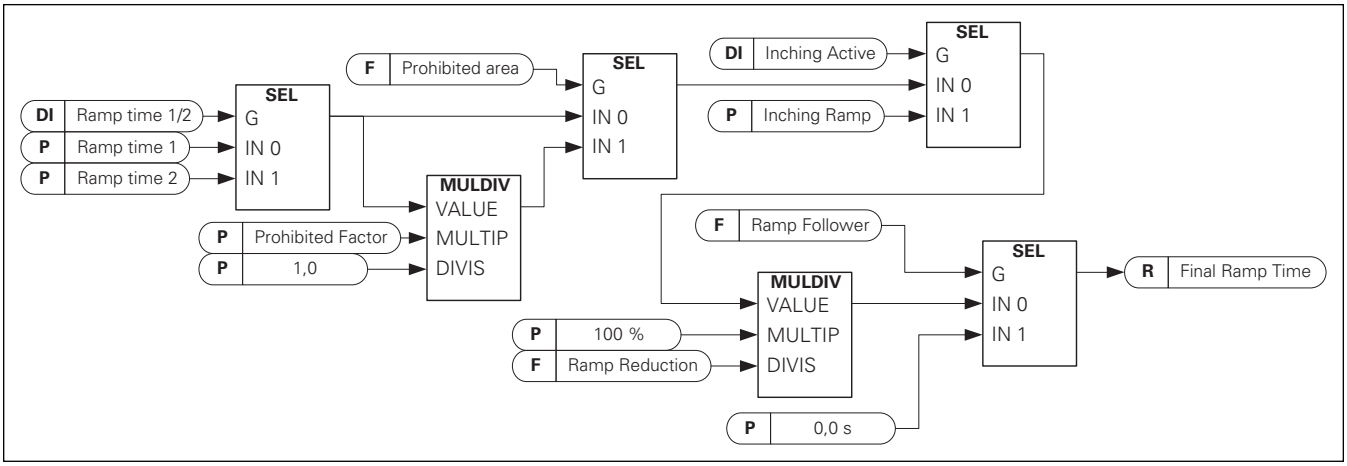
These parameters define the minimum and maximum of adjusted signals.



If minimum and maximum are not equal to zero adjustment is not at the middle point of analog input or at zero point if -10...+10 Vdc input is used. Below picture minimum is 20 % and maximum 10 %.



5.3 Ramp control



Code	ID	Parameter	Notes
P1.3.1	505	**Start function "start function"** Ramp: 0. The frequency converter starts from 0 Hz and accelerates to the set reference frequency within the set acceleration time. Flying start: 1. The frequency converter is able to start with motor running by applying current to motor and searching for the frequency corresponding to the speed the motor is running at. Searching starts from the maximum frequency towards the zero frequency until the correct value is detected. Use this mode if the motor is coasting when the start command is given. With the flying start it is possible to start motor form actual speed without forcing the speed to zero before ramping to reference. Closed loop control will always start like flying start because exact speed of the motor is known from encoder feedback.	
P1.3.2	506	**Stop function "stop function"** Coasting: 0. Drive stops controlling the motor immediately and let's motor rotate freely. Ramp: 1. After the Stop command, the speed of the motor is decelerated according to the set deceleration parameters to zero speed. DI "Run Enable" will make coasting stop regardless of selected stop function.	
P1.3.3	103	**Acceleration time 1 "accel time 1"** This parameter defines the time required for the output frequency to increase from the zero frequency to maximum frequency.	
P1.3.4	104	**Deceleration time 1 "decel time 1"** This parameter defines the time required for the output frequency to decrease from the maximum frequency to zero frequency.	
P1.3.5	500	**Acceleration/Deceleration ramp 1 shape "ramp 1 shape"** 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 value 1…100 % for this parameter produces an S-shaped acceleration/deceleration. Used to reduce mechanical erosion and current spikes when reference is changed.	

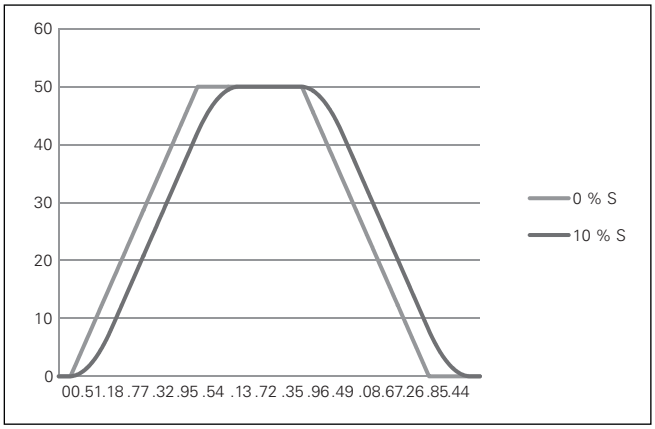
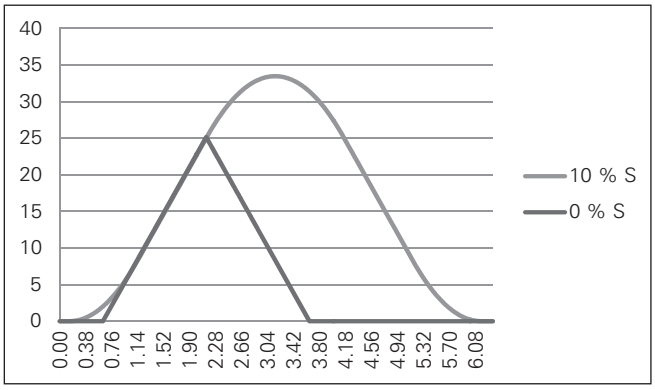
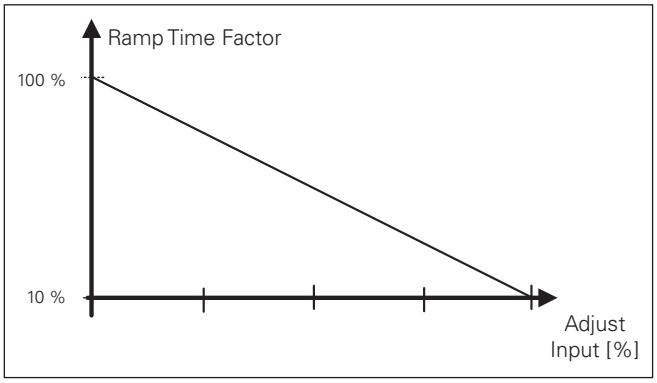


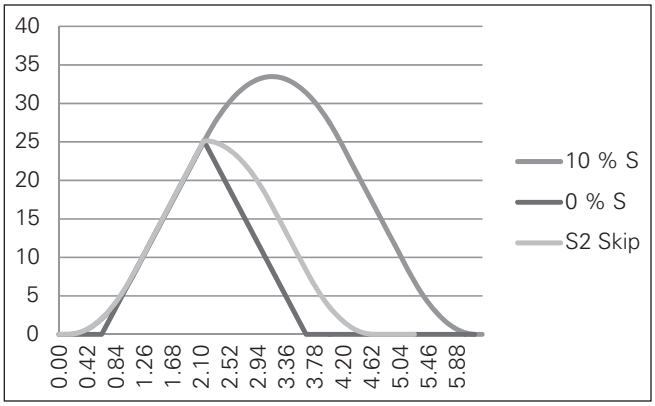
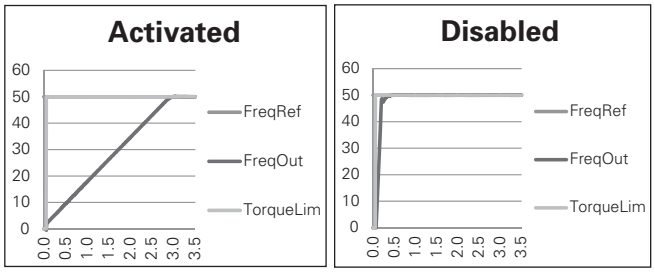
Figure 5-2. 10 % S ramp with 3 s ramp time compared to without S ramp

Code	ID	Parameter	Notes
P1.3.5	500	 **Figure 5-3. 10 % S ramp with 3 s ramp time when reference set toto zero at 25 Hz**	
P1.3.6	502	**Acceleration time 2 "accel time 2"**	
P1.3.7	503	**Deceleration time 2 "decel"**	
P1.3.8	501	**Acceleration/Deceleration ramp 2 shape "ramp 2 shape"** These ramp times and ramp shapes are used when the second ramp time is activated by digital input "Acc/Dec Time Sel"	
P1.3.9	1257	**Inching ramp "Inching Ramp"** This parameter defines acceleration and deceleration times when inching is active. Inching function will start the drive to reference without additional start command regardless of control place. Inching function requires enabling from digital input before command is accepted. Inching is also disabled if there is a start command active on the active control place. Other parameters for inching: • Parameter: Inching reference 1 • Parameter: Inching reference 2 • Digital input selection: Enableinching • Digital input selection: inching 1 • Digital input selection: inching 2	
P1.3.10	401	**Reduction of acceleration and deceleration times** Acceleration and deceleration times can be reduced with the input signal. Input signal level zero means ramp times set by parameters. Maximum level equals one tenth of the value set by parameter.  **Figure 5-4. Reducing acceleration and deceleration times**	

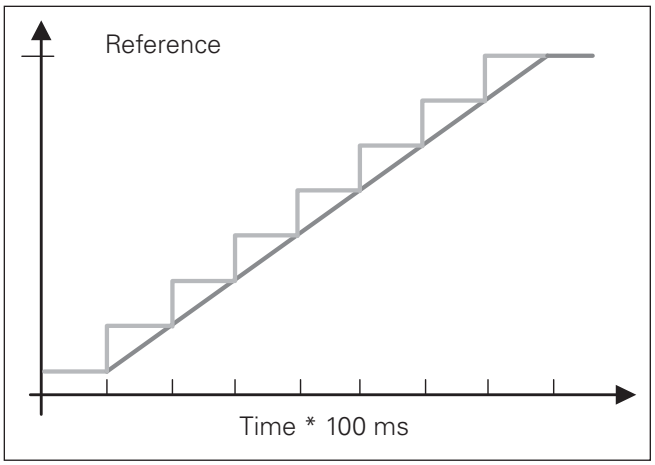
5.3.1 Qucik stop

Code	ID	Parameter	Notes
P1.3.11.1	1276	**Quick stop mode "Quick stop mode"** Selects the mode of stopping the drive when quick stop is active. • It is recommended to use same stop function in follower drives. • It is recommended to use same ramp time in both drives 0 Coast stop. 1 Ramp stop.	
P1.3.11.2	1256	**Quick stop ramp time** Decel time used in quick stop mode when P1.3.11.1 = 1	

5.3.2 Ramp options

Code	ID	Parameter	Notes
P1.3.12.1	1900	**Ramp: skip S2/S4** This function is used to bypass the second corner S ramp (i.e. to avoid the unnecessary speed increase, the blue line in Figure 5-5.) when the reference is changed before the final speed is reached. Also S4 is bypassed when reference is increased while speed is ramping down.  **Figure 5-5. Second S curve is bypassed when reference changes at 25 Hz**	
P1.3.12.2	1902	**CL Ramp generator follows encoder "CLRmpFollEncFreq"** In a normal situation, the ramp generator is not updated with the actual speed from the encoder (like in open loop control). So when the limiting situation has passed (with a step) speed is accelerated against the limit controller to the reference speed (if speed control is used). In case this parameter is active speed will increase with set ramp times. This parameter also sets the Ramp Frequency to actual frequency when change from torque control to speed control is made. 	When using undervoltage controller function 2 (Ramping to zero speed) this parameter needs to be activated to have similar operation than in open loop control.

Code	ID	Parameter	Notes
P1.3.12.3	1184	**Speed reference interpolator TC "Ramp in inter. TC"** Set here time on what interval speed reference is updated. This function ramps the reference between updated values. Function is used when PLC is updating reference e.g. 100 ms time level but drive own ramp is set much shorter to have fast response. When reference (Green) is used without interpolator also output frequency would behave same way causing torque and current spikes every time reference changes. When interpolator time is set to 100 ms output frequency behaves as blue line.	



5.4 Input signals

5.4.1 Basic settings

Code	ID	Parameter	Notes
P1.4.1.1	300	**Start/Stop logic selection "Start/Stop Logic"** This parameter defines start stop logic when using I/O control. Some of these selections do not include the 'Reverse' command. Reverse command can be activated by a separate digital input "Reverse". 0 "Forw – Rev" – Forward Start – Reverse Start Start 1: closed contact = start forward DI "Start 1" Start 2: closed contact = start reverse DI "Start 2"	

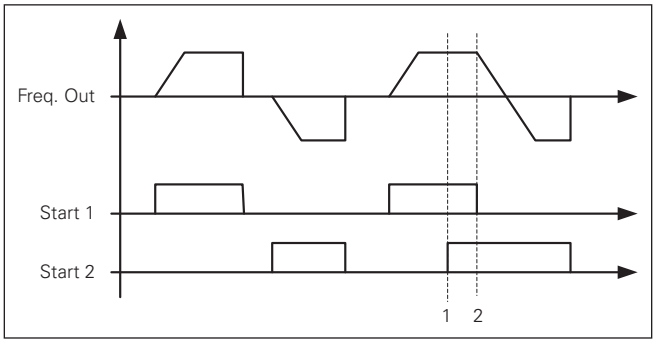


Figure 5-6. Start forward/Start reverse

① The first selected direction has the highest priority.
② When the DIN1 contact opens the direction of rotation starts the change.
1 "Start – Rev" - Start command – Direction command
Start 1: closed contact = start open contact = stop
Start 2: closed contact = reverse open contact = forward

Code	ID	Parameter	Notes
P1.4.1.1	300		

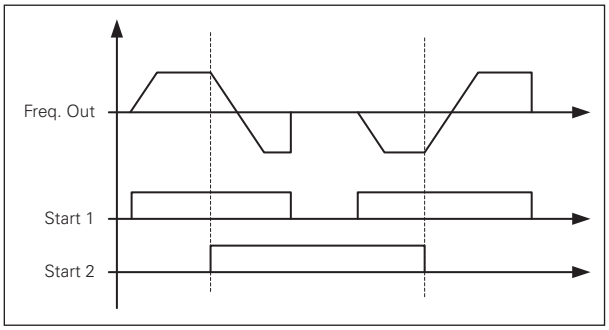


Figure 5-7. Start, stotop, reverse

2 "Start – Enable" – Start command – Run Enable

DIN1: closed contact = start open contact = stop

DIN2: closed contact = start enabled open contact = start disabled and drive stopped if running

3 "StartP-StopP" – Start Pulse – Stop Pulse

3-wire connection (pulse control):

DIN1: closed contact = start pulse

DIN2: open contact = stop pulse, falling edge.

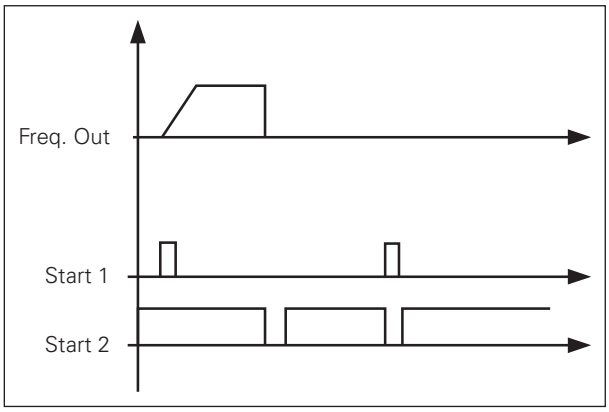


Figure 5-8. Start pulse/stotop pulse.

The selections including the text 'Rising edge required to start' shall be used to exclude the possibility of an unintentional start when, for example, power is connected, re-connected after a power failure, after a fault reset, after the drive is stopped by Run Enable (Run Enable = False) or when the control place is changed. The Start/Stop contact must be opened before the motor can be started.

4 "Strt-MotP UP" – Start – Motor potentiometer UP

DIN1: closed contact = start forward

DIN2: closed contact = Increases motor potentiometer reference, see Motor potentiometer function for more details.

5 "ForwR – RevR" – Forward start rising edge – Reverse start rising edge

DIN1: closed contact = start forward (Rising edge required to start)

DIN2: closed contact = start reverse (Rising edge required to start)

6 "StartR-Rev" - Start command rising edge – Direction command

DIN1: closed contact = start (Rising edge required to start)

Open contact = stop

DIN2: closed contact = reverse

Open contact = forward

Code	ID	Parameter	Notes
P1.4.1.1	**300**	7 "StrtR-Enable" – Start command rising edge – Run Enable DIN1: closed contact = start (Rising edge required to start) Open contact = stop DIN2: closed contact = start enabled Open contact = start disabled and drive stopped if running 8 "RPuls-RPuls" – Start rising edge – Stop rising edge DIN1: closed contact = Start (Rising edge required to start) DIN2: closed contact = Stop (Rising edge required to stop)	

5.4.2 Digital inputs

Code	ID	Parameter	Notes
P1.4.2.1	**403**	**Start signal 1 "Start signal 1"** Signal selection 1 for the start/stop logic. This is for Start Place A, selected with P1.4.1.1 Default programming A.1.Default Forward start.	
P1.4.2.2	**404**	**Start signal 2 "start signal 2"** Signal selection 2 for the start/stop logic. This is for Start Place A, selected with P1.4.1.1 Default programming A.2. Default Reverse start.	
P1.4.2.3	**407**	**Run enable "run enable"** When run enable is removed from the drive coasting stop is made always. Drive will also show warning indication when run is disabled. Contact open: Start of motor disabled Contact closed: Start of motor enabled	
P1.4.2.4	**412**	**Reverse "reverse"** This reverse command is active when Start signal 2 is not used for reverse command because setting of "Start/Stop logic selection" parameter. Contact open: Direction forward Contact closed: Direction reverse	
P1.4.2.5	**419**	**Preset speed 1 "preset speed 1"**	
P1.4.2.6	**420**	**Preset speed 2 "preset speed 2"**	
P1.4.2.7	**421**	**Preset speed 3 "preset speed 3"** Digital input selections for activating preset speeds. References are set in the "Constant Reference" parameter group. **Table 51.** **Speed** / **Digital input preset speed 1** / **Digital input preset speed 2** / **Digital input preset speed 3** Basic speed 0 0 0 Preset speed 1 1 0 0 Preset speed 2 0 1 0 Preset speed 3 1 1 0 Preset speed 4 0 0 1 Preset speed 5 1 0 1 Preset speed 6 0 1 1 Preset speed 7 1 1 1 Related parameters - G1.2.7 Constant Ref	

Code	ID	Parameter	Notes
P1.4.2.8	417	**Motor potentiometer down "Mot pot ref down"** Contact closed: Motor potentiometer reference DECREASES until the contact is opened. See details in G2.2.11 Motor Pot.	
P1.4.2.9	418	**Motor potentiometer UP "Mot pot ref up"** Contact closed: Motor potentiometer reference DECREASES until the contact is opened. See details in G2.2.11 Motor Pot.	
P1.4.2.10	414	**Fault reset "Fault reset"** Rising edge required to reset fault.	
P1.4.2.11	405	**External fault closing contact "Ext fault close"** External fault input closing contactor, response selected in protection parameter group G1.11.1 Protections/General. Gives fault "51 Ext Fault"	
P1.4.2.12	406	**External fault opening contact "Ext fault open"** External fault input opening contactor, response selected in protection parameter group. Gives fault "51 Ext Fault"	
P1.4.2.13	408	**Acceleration/Deceleration time selection "Acc/Dec time sel"** Digital input to select between ramp time 1 and 2, times are set in "Ramp Control" parameter group. Contact open: Acceleration/Deceleration time 1 selected Contact closed: Acceleration/Deceleration time 2 selected	
P1.4.2.14	415	**Acceleration/Deceleration prohibited "Acc/Dec Prohibit"** Contact closed: No acceleration or deceleration possible until the contact is opened. With P1.9.3 Control Options B13 is possible to select that deceleration direction is allowed thus speed is reduced if reference is smaller than drive speed at the time.	
P1.4.2.15	416	**DC-braking command "DC brake command"** Contact closed: In STOP mode, the DC braking operates until the contact is opened. Current level is set with P1.7.1.16 DCBrakeCurInStop parameter	
P1.4.2.16	413	**Jogging speed "Jogging speed"** Contact closed: Jogging speed selected for frequency reference Reference for jogging speed is set in G2.2.7 Constant Reference group.	
P1.4.2.16	422	**Remote 1 reference 1/2 selection "I/O Ref. 1/2"** With this parameter you can select either AI1 or AI2 signal for frequency reference if I/O reference selection is "14/AI1/AI2 Sel". If selection for P1.2.2 I/O Reference is other than "14/AI1/AI2 Sel" this digital input will change reference between P1.2.2 Remote 1 Reference and P1.2.4 Remote 1 Reference 2.	

5.4.2.1 Forced control place

Digital inputs can be used to bypass parameter P2.1 Control Place, when P2.1 is set to either keypad select or IO select.
Priority is:

1 – Force Local

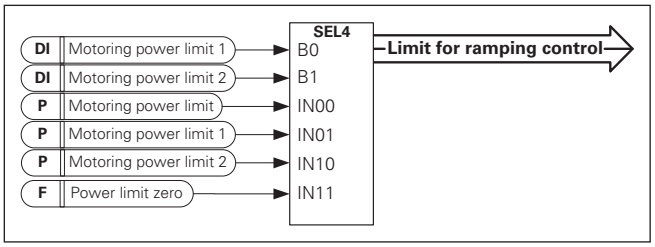
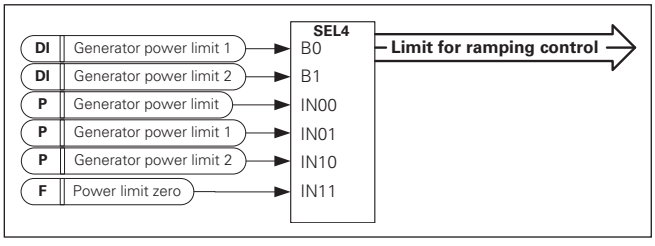
2 – Force Remote 2

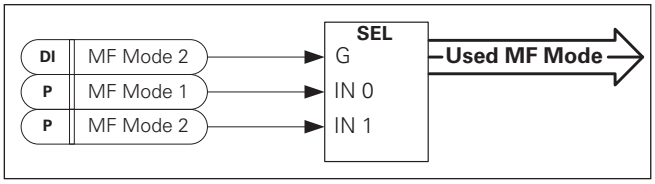
3 – Force Remote 1

Code	ID	Parameter	Notes
P1.4.2.18	**409**	**Force local "Force local"** Contact closed: Force control place to Local	
P1.4.2.19	**410**	**Force Remote 1 "Force remote 1"** Contact closed: Force control place to Remote 1	
P1.4.2.20	**411**	**Force Remote 2 "force remote 2"** Contact closed: Force control place to Remote 2	When the control place is forced to change the values of Start/ Stop, Direction and Reference valid in the respective control place are used. The value of parameter ID125 (Keypad Control Place) does not change. When the input opens the control place is selected acording to keypad control parameter P3.1 Control Place
P1.4.2.21	**496**	**Parameter Set 1/Set 2 selection "param set1/set2"** With this parameter you can select between Parameter Set 1 and Set 2. Remember to put same input for both parameter set. Parameter sets cannot be changed while drive is in run state. Digital input = FALSE: • Set 1 is loaded as the active set Digital input = TRUE: • The active set is saved to set 1 When making two parameter sets from the keypad 1. Set all parameters as needed for SET1 2. In "P6.3.1 Parameter Set" select "Store Set1" 3. Set all parameters as needed for SET 1 4. In "P6.3.1 Parameter Set" select "Store Set2" Active Set shown in Status Word B9	The parameter values are stored only when selecting parameter P6.3.1 Parameter sets Store Set 1 or Store Set 2 or from 9000xDrive: Drive > Parameter Sets.
P1.4.2.22	**164**	**Motor control mode 1/2"Mot ctrl mode1/2"** This digital input is used to change between to motor control mode selection parameters: • P1.8.1 Motor Ctrl Mode ID600 • P1.8.2 Motor Ctrl Mode2 ID521 Contact is open = Motor control mode 1 is selected Contact is closed = Motor control mode 2 is selected When changing between open loop and closed loop control modes, make this change in stop state.	
P1.4.2.23	**210**	**External brake acknowledgment. "Ext. brake ACK"** Connect this input signal to auxiliary contact of mechanical brake. If contact is not closed within given time when brake is controlled open the drive will generate a brake fault F58, response can be selected in G2.14 Brake Control parameter group.	
P1.4.2.24	**750**	**Cooling monitor "Cooling monitor"** When using a liquid-cooled drive or CPX, connect this input to the Cooling OK signal from flow control application or any input that shows state of used cooling unit. See details of operation from G2.11.9 cooling parameters group.	

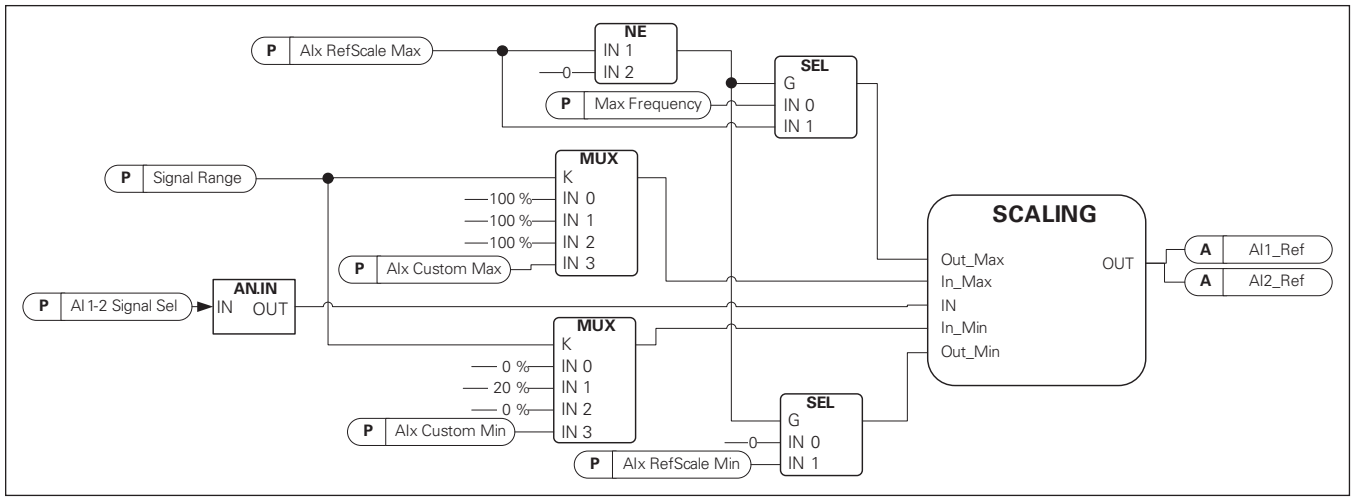
5.4.2.2 Inching function

Inching function will start the drive to reference without additional start command regardless of control place. Inching requires enabling from digital input before the command is accepted. Inching is also disabled if there is a start command active on the active control place.

Code	ID	Parameter	Notes
P1.4.2.25	532	**Enable inching "Enable Inching"** If you are using inching function the given input must be set TRUE by either digital signal or by setting the parameter value to 0.2.	
P1.4.2.26	530	**Inching reference 1 "Inching 1"**	
P1.4.2.27	531	**Inching reference 2 "Inching 2"** These inputs activate inching reference if inching is enabled. These inputs also start the drive if activated and if there is no Run Request command from anywhere else. Other parameter for inching function • P1.3.9 Inching ramp ID1257 "Inching ramp" • P1.2.7.9 Inching reference 1 ID1239 "Inching ref 1" • P1.2.7.10 Inching reference 2 ID1240 "Inching ref 2"	
P1.4.2.28	1500	**Motoring power limit digital input 1 "Mot.PowerLimit 1"**	
P1.4.2.29	1501	**Motoring power limit digital input 2 "Mot.PowerLimit 2"** With this parameter you can select the desired digital input for controlling motoring power limit. "Mot.PowerLimit 1" and "Mot.PowerLimit 2" activates respective power limits defined in parameter group G2.6.2 Power Handling. If both inputs are activated power limit is zero. 	
P1.4.2.30	1511	**Digital input 2nd frequency limit "Max frequency 2"** With this parameter you can select the digital input that will limit the maximum frequency to a lower value than what is defined by Maximum Frequency. This limit does not affect any constant references. The limit is set in G1.6.4 Freq. Limit Handling.	
P1.4.2.31	1506	**Generator power limit digital input 1 "Gen.PowerLimit 1"**	
P1.4.2.32	1507	**Generator power limit digital input 2 "Gen.PowerLimit 2"** With these parameters you can select the desired digital input for controlling the generator power limit. "Gen.PowerLimit 1" and "Gen.PowerLimit 2" activate the respective power limits defined in G2.6.2 Power Handling parameter group. If both inputs are activated power limit is zero. 	
P1.4.2.33	1090	**Reset encoder counter "Reset position"** When using encoder, the drive monitors the encoder rotations and angle (V: Shaft Rounds and V:Shaft Angle). When this input has a rising edge monitoring values V:Shaft Angle (ID1169) and Shaft Rounds (ID1170) are set to zero. Reset command is also included in V: Aux Control Word.	

Code	ID	Parameter	Notes
P1.4.2.34	**1092**	**Master Follower mode 2 "MF mode 2"** Master Follower mode can be changed with digital input between P1.10.1 MF Mode and P1.10.5: MF Mode 2 in the Master Follower parameter group. This can be used for redundancy purposes e.g. when using a Drive Synch system. 	
P1.4.2.35	**1213**	**Quick stop "Quick stop"** Digital input for Quick Stop function	
P1.4.2.36	**1624**	**Motoring torque limit 1 "Mot. torq. limit 1"** Digital input for activating motoring torque limit 1	
P1.4.2.37	**1626**	**Generator torque limit 1 "Gen. torq. limit 1"** Digital input for activation generator torque limit 1	
P1.4.2.38	**1753**	**Store parameters "Store param. Set"** Stores active set to currently selected parameters set. Selection is done by "Param. Set1/Set2" digital input that is also used to load parameter set to active set.	
P1.4.2.39	**403**	**Start signal 1B "Start signal 1B"** Signal selection 1B for the start/stop logic. This is for Start Place B, selected with P1.4.2.39 Default programming 0.1.Default Forward start, selected with P1.4.1.1	
P1.4.2.40	**404**	**Start signal 2B "Start signal 2B"** Signal selection 2B for the start/stop logic. This is for Start Place B, selected with P1.4.2.39 Default programming 0.1. Default Reverse start, selected with P1.4.1.1.	
P1.4.2.41	**1896**	**RR enable "RR enable"** Run Request Enable command.	
P1.4.2.42	**1600**	**Output contactor interlock "O/P interlock"** If contact is open 250ms after run command is given the drive will fault based on the setting of P1.12.1.7	
P1.4.2.43	**1601**	**PID set point 1/2 select "PID SP 1/2 sel"** Run Request Enable command.	

5.4.3 Analog input 1 & 2



Code	ID	Parameter	Notes
P1.4.3.1	377	**AI1 signal selection "AI1 signal sel"**	
P1.4.4.1	388	**AI2 signal selection "AI2 signal sel"** Connect the AI1/AI2 signal to the analog input of your choice with this parameter. For more information about the TTF programming method, see chapter 2.	
P1.4.3.2	324	**Analog input 1 reference filter time "AI1 filter time"**	
P1.4.4.2	329	**Analog input 2 reference filter time "AI2 filter time"** First order filtering is used for analog signals that are used to control e.g. the power limit. Second order filtering is used for frequency reference filtering.	

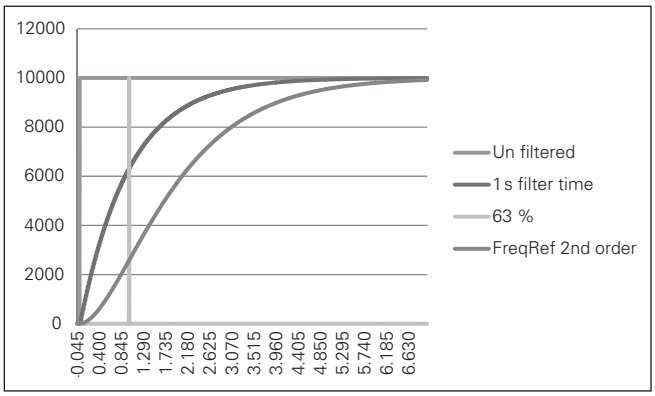
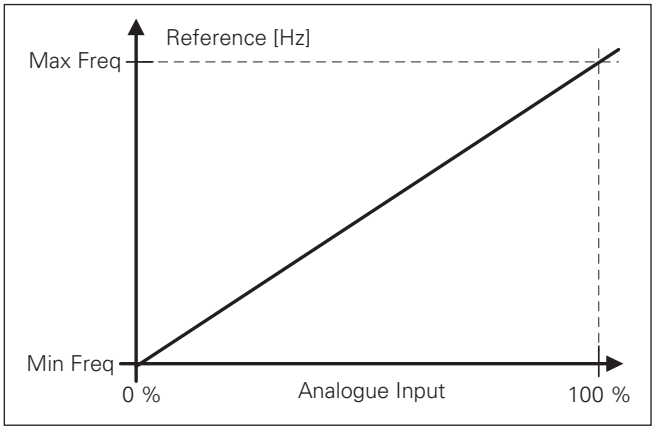
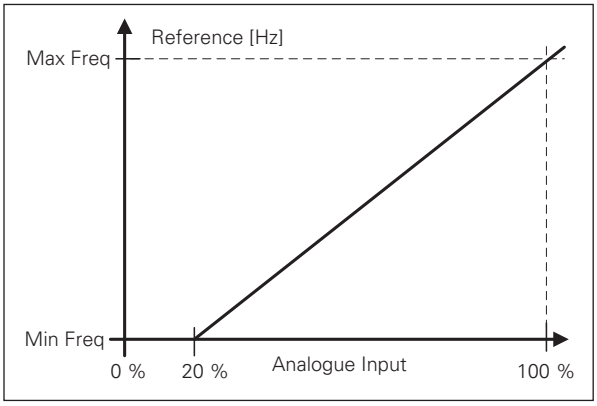


Figure 5-9. AI1 signal filtering

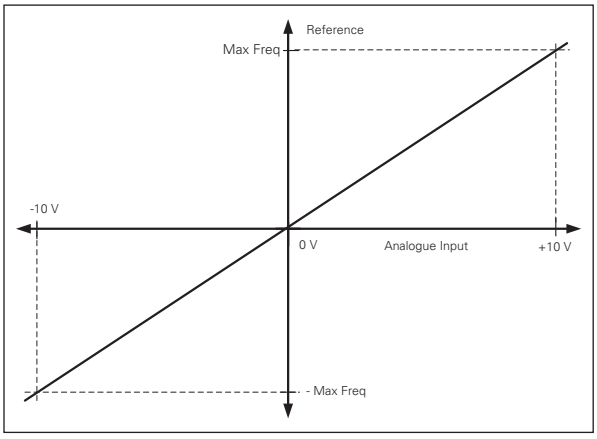
P1.4.3.3	320	**Analog input signal 1 signal range "AI1 signal range"**	
P1.4.4.3	325	**Analog input signal 2 signal range "AI2 signal range"** 0 "0-20mA/10V Signal input ranges: 0...10 V and 0...20 mA. Input signal is used from 0% to 100%.	



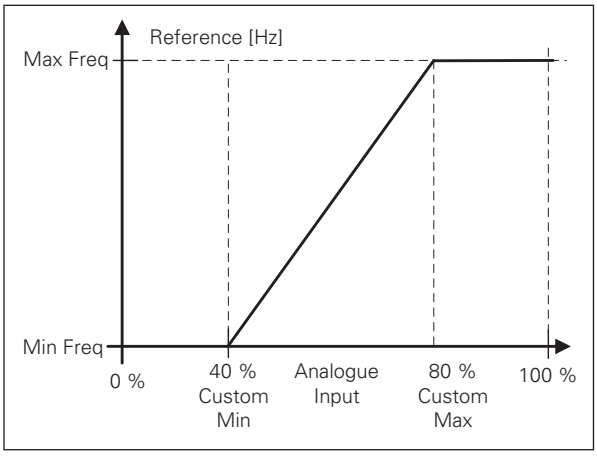
Code	ID	Parameter	Notes
P1.4.4.3	**325**	1 "4-20 mA Signal input ranges: 4 – 20 mA and 2 – 10 V Input signal is used from 20 % to 100 %	



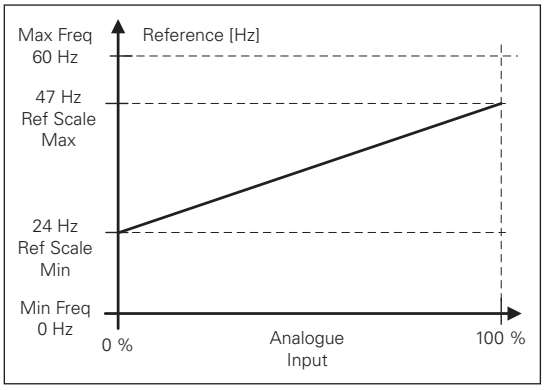
2 "–10 - + 10 V
Signal input range: -10 V - + 10 V.
Input signal is used from -100 % to +100 %.

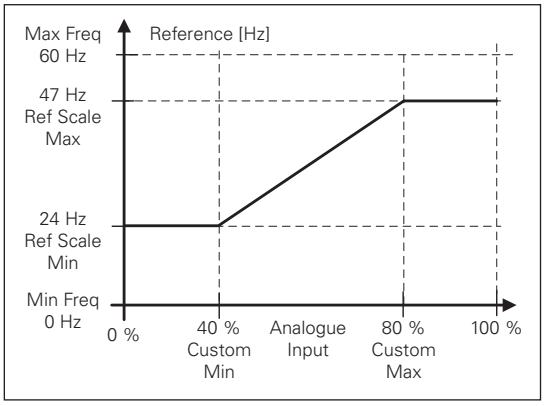


3 "Custom Range"
With custom range it is possible to freely adjust what input level corresponds to the minimum and maximum frequencies..



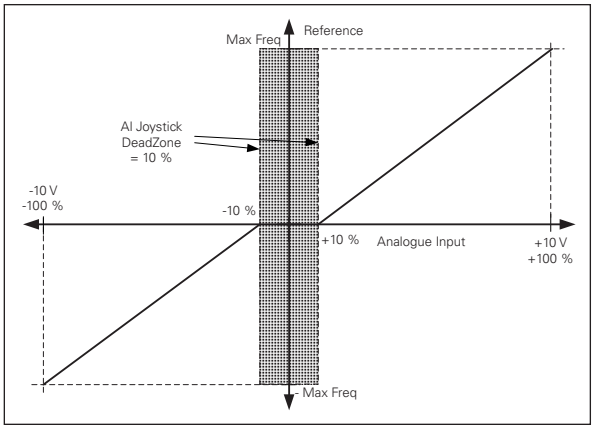
Code	ID	Parameter	Notes
P1.4.3.4	321	**AI1 custom minimum setting "AI1 custom min"**	
P1.4.3.5	322	**AI1 custom maximum setting "AI1 custom max"**	
P1.4.4.4	326	**AI2 custom minimum setting "AI2 custom min"**	
P1.4.4.5	327	**AI2 custom maximum setting "AI2 custom max"** These parameters set the analog input signal for any input signal span within -160...160%. E.g. if the signal input scaling is set to 40 %...80 % the reference can be changed from 8 mA (for Minimum Frequency) to 16 mA (for Maximum Frequency).	
P1.4.3.6	303	**AI1 Reference scaling, minimum value "AI2 RefScale min"**	
P1.4.3.7	304	**AI1 Reference scaling, maximum value "AI2 RefScale max"**	
P1.4.4.6	393	**AI2 reference scaling, minimum value "AI2 RefScale min"**	
P1.4.4.7	394	**AI2 reference scaling, maximum value "AI2 RefScale max"** Additional reference scaling. Analog input reference scaling can be set to a different value than the minimum and maximum frequency.	





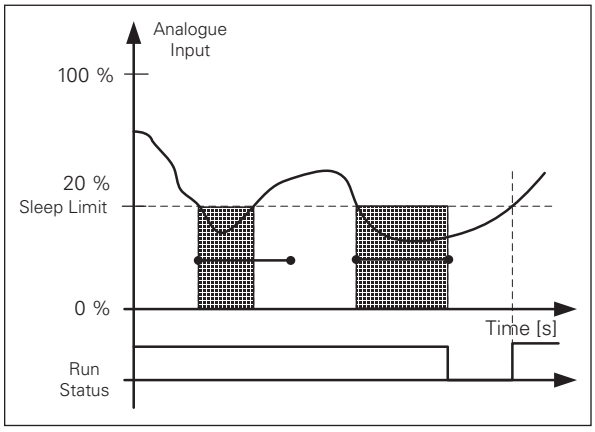
P1.4.3.8	382	**Analog Input 1 joystick input dead zone "AI1 JoysDeadZone"**	
P1.4.4.8	395	**Analog Input 2 joystick input dead zone "AI2 JoysDeadZone"** The small values of the reference around zero can be ignored by setting this value greater than zero. When the reference lays between zero and ± this parameter, it is forced to zero.	

Code	ID	Parameter	Notes
P1.4.4.8	**395**	**Analog Input 2 joystick input dead zone "AI2 JoysDeadZone"** The small values of the reference around zero can be ignored by setting this value greater than zero. When the reference lays between zero and ± this parameter, it is forced to zero.	



5.4.3.1 Sleep function

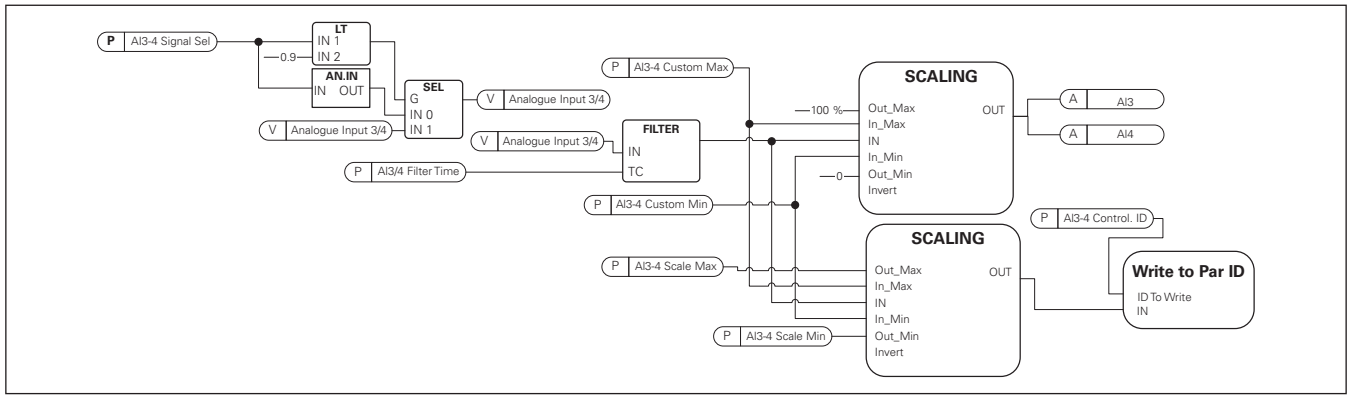
The drive can be stopped by sleep function when the analog input falls below a certain value for a certain time and speed functions become active.



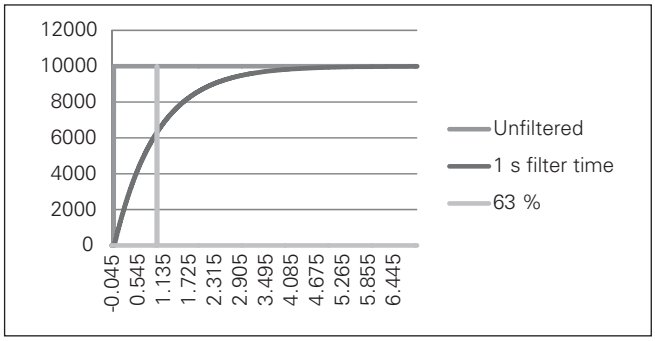
Code	ID	Parameter	Notes
P1.4.3.9	**385**	**AI1 sleep limit "AI1 sleep limit"**	
P1.4.4.9	**396**	**AI2 sleep limit "AI2 sleep limit"** The drive is stopped automatically if the AI signal level falls below the Sleep limit defined with this parameter. In joystick function, when input is between zero and ± this parameter the drive will go to sleep state.	
P1.4.3.10	**386**	**AI1 sleep delay "AI1 sleep delay"**	
P1.4.4.10	**397**	**AI2 sleep delay "AI2 sleep delay"** This parameter defines the time the analog input signal has to stay under the sleep limit in order to stop the drive.	
P1.4.3.11	**165**	**AI1 joystick offset "AI1 joyst.offset"**	
P1.4.4.11	**166**	**AI2 joystick offset "AI2 joyst.offset"** Defines the frequency zero point as follows: With this parameter on display, place the potentiometer in the assumed zero point and press enter on keypad	This will not, however, change the reference scaling. Press Reset button to change the parameter value back to 0.00%.
P1.4.3.12	**1228**	**AI1 filter time "AI1 filter time"**	
P1.4.4.12	**1232**	**AI2 filter time "AI2 filter time"**	

5.4.4 Analog input 3 & 4

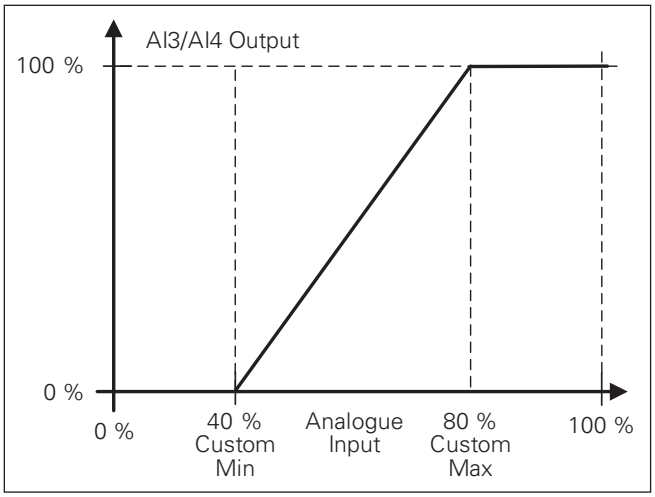
Analog Inputs 3 and 4 can be written form fieldbus. This allows signal scaling and inversion. Useful e.g. in case when PLC is not operational (value zero received) signal will be automatically at maximum. See Figure below.



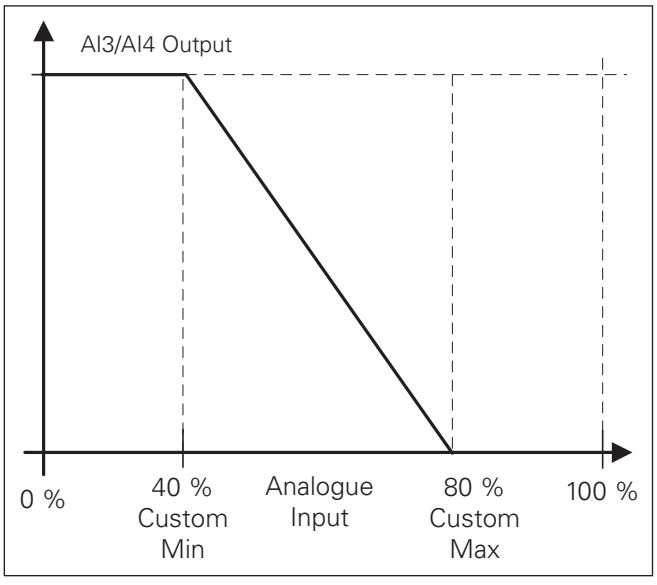
Code	ID	Parameter	Notes
P1.4.5.1	141	**AI3 signal selection "AI3 signal sel"**	
P1.4.6.1	152	**AI4 signal selection "AI4 signal sel"** Connect the AI3/AI4 signal to the analog input of your choice with this parameter. For more information, see Chapter 2 "Terminal To Function" (TTF) programming principle. When the parameter for Analog input signal selection is set to 0.1 you can control the analog input monitoring variable from Fieldbus by assigning the Process Data Input ID number to the analog input monitoring signal thus allowing the PLC input signals to be scaled with analog input scaling functions.	
P1.4.5.2	142	**Analog input 3 signal filtering time "AI3 Filter Time"**	
P1.4.6.2	153	**Analog input 4 signal filtering time "AI3 Filter Time"** First order filtering is used for analog inputs signals 3 and 4.	
P1.4.5.3	144	**AI3 custom setting minimum "AI3 custom min"**	
P1.4.5.4	145	**AI3 custom setting maximum "AI3 custom max"**	
P1.4.6.3	155	**AI4 custom setting minimum "AI4 custom min"**	



Code	ID	Parameter	Notes
P1.4.6.4	156	**AI4 custom setting maximum "AI4 custom max"** Set the custom minimum and maximum input levels for the AI3 signal within -160…160%.	



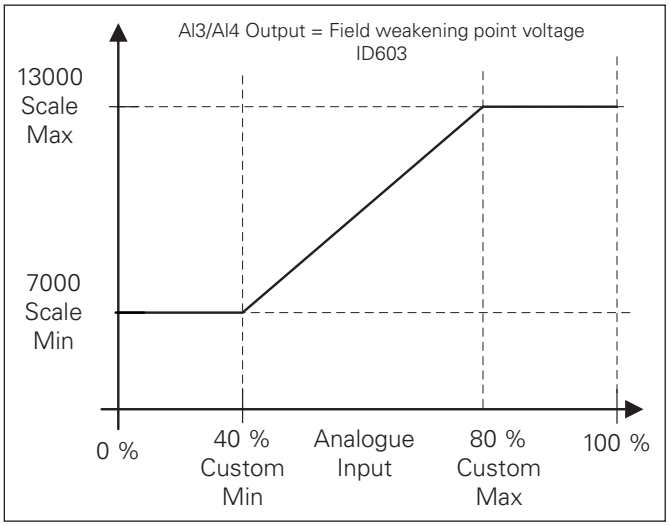
P1.4.5.5.	151	**AI3 signal inversion "AI3 signal inv"**	
P1.4.6.5	162	**AI4 signal inversion "AI3 signal inv"** The signal inversion function is useful in a situation when e.g. the PLC is sending power limit to the drive using fieldbus. If the PLC is unable to communicate with the drive the power limit from fieldbus to the drive would be zero. Using inverted signal logic zero value from PLC would mean maximum power limit. When inversion is needed for the process data signal fieldbus values need to be written to Analog input monitoring signals. See parameter P1.4.5.1 AI3 Signal selection for details. 0 = No inversion 1 = Signal inverted	



5.4.4.1 Analog input to any parameter

This function allows control of any parameter by using an analog input. The parameter selects what the range of control area and the ID number for the parameter that is controlled.

Code	ID	Parameter	Notes
P1.4.5.6	**1037**	**Analog input 3, minimum value "AI3 scale min"**	
P1.4.5.7	**1038**	**Analog input 3, maximum value "AI3 scale max"**	
P1.4.6.6	**1039**	**Analog input 4, minimum value "AI4 scale min"**	
P1.4.6.7	**1040**	**Analog input 4, maximum value "AI4 scale max"** These parameters define the range for the controlled parameters. All the values are considered to be integers i.e. when controlling the Field Weakening Point (as in example) you also need to set numbers for decimals. E.g. FWP 100.00 needs to be set as 10000.	
P1.4.5.8	**1509**	**AI3 controlled ID "AI3 control. ID"**	
P1.4.6.8	**1510**	**AI4 controlled ID "AI4 control. ID"** These parameters define the controlled parameter. Example: You want to control motor field weakening point voltage through an analog input from 70.00 % to 130.00 %. Set Scale min to 7000 = 70.00 % Set Scale max to 13000 = 130.00 % Set Controlled ID to 603 (Voltage at field weakening point)	



Now analog input 3 signal 0 V to 10 V (0 mA to 20 mA) will control the field weakening point voltage between 70.00 % - 130.00 %. When setting the value remember that decimals are handled as integers.

5.4.5 Inversion control

Code	ID	Parameter	Notes
P1.4.7.1	1091	**Inversion control "INV control"** Inversion control allows you to select which input signal operation will be inverted. B00 = +1 = Invert external fault 1 B01 = +2 = Invert external fault 2 B02 = +4 = Inverted Run Enable digital input B03 = +8 = Inverted Brake acknowledge digital input B04 = +16 = Invert Mot. Torq. Limit 1 digital input. B05 = +32 = Invert Gen Torq. Limit 1 digital input B08 = +256 = Motoring Power limit digital input inverted B09 = +512 = Generator Power limit digital input inverted	
P1.4.8.1	891	**Fieldbus digital input 1 parameter "FB dig 1 par ID"**	
P1.4.8.2	892	**Fieldbus digital input 2 parameter "FB dig 2 par ID"**	
P1.4.8.3	893	**Fieldbus digital input 3 parameter "FB dig 3 par ID"**	
P1.4.8.3	894	**Fieldbus digital input 4 parameter "FB dig 4 Par ID"**	
P1.4.8.5	895	**Fieldbus digital input 5 parameter "FB dig 5 par ID"** With these parameters you can define the parameter to be controlled by using FB Digital input. Example: All option board inputs are in use and you still want to give DI: DC Brake Command (ID416). You also have a fieldbus board in the drive. Set parameter ID891 (Fieldbus digital input 1) to 416. Now you are able to control DC Braking command from the fieldbus by Profibus control word (bit 11). It is possible to control any parameter in the same way if values 0=FALSE and 1=TRUE are significant for that parameter. For example, P1.6.5.3 Brake Chopper (ID504) can be controlled on and off using this function (Brake Chopper; 0 = Not Used, 1 = On, Run).	

5.5 Output signals

5.5.1 Digital output signals

In the SPX Advanced application, all output signals are disabled by default.

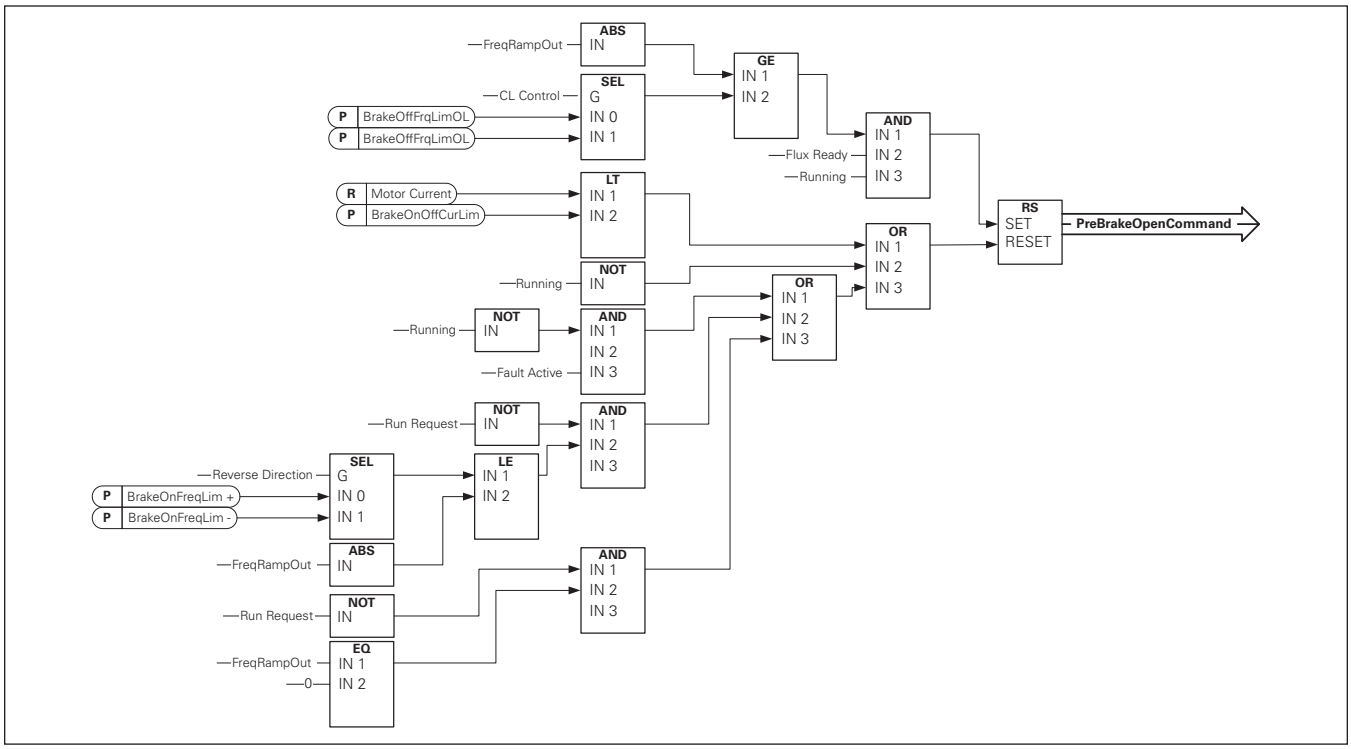
Code	ID	Parameter	Notes
P1.5.1.1	432	**Ready "Ready"** The frequency converter is ready to operate. Common reasons when ready signals are missing: • Run enable signal is low • DC Voltage is too low • DC Voltage is too high	
P1.5.1.2	433	**Run "run"** The frequency converter is modulating.	
P1.5.1.3	434	**Fault "fault"** A fault trip has occurred.	
P1.5.1.4	435	**Inverted fault "fault, inverted"** No active faults in the drive.	
P1.5.1.5	436	**Warning "warning"** General warning signal.	
P1.5.1.6	437	**External fault or warning "ext. fault/warn."** Fault or warning depending on parameter Response to external fault. P1.4.2.11 Ext Fault Close and P1.4.2.12 Ext Fault Open are used to trigger a fault. P1.12.1 External fault is used to select response.	
P1.5.1.7	438	**Reference fault or warning (4mA) "AI ref faul/warn"** Fault or warning depending on parameter Response to the 4mA reference fault. Response is selected in G2.11.6.	

Code	ID	Parameter	Notes
P1.5.1.8	439	**Drive over temperature warning "OverTemp warn"** Drive temperature has exceeded normal operation conditions. Temperature limit may wary depending on drive type on size.	
P1.5.1.9	440	**Reverse "reverse"** Drive output frequency is negative	
P1.5.1.10	441	**Wrong direction "WrongDirection"** Motor rotation direction is different from the requested one. This happens in situation when external force makes the motor rotate in different direction or when the direction change command has been given and the drive is still ramping down to change direction.	
P1.5.1.11	442	**At reference speed "at ref. Speed"** Induction motor: Speed is within nominal slip of the reference. PMS motor: Output frequency is within 1 Hz of the reference frequency.	
P1.5.1.12	436	**Jogging speed "jogging speed"** Jogging speed command has been given.	
P1.5.1.13	445	**Fieldbus control "fieldbus control"** Active control place is Fieldbus defined by the parameter for Control place (P2.1) or forced with digital input function.	
P1.5.1.14	444	**Keypad control "keypad control"** Active control place is Keypad defined by the parameter for Control place (P2.1) or forced with digital input function.	
P1.5.1.15	446	**IO Control place "IO control place"** Active control place is I/O terminal defined by the parameter for Control place (P2.1) or forced with digital input function.	

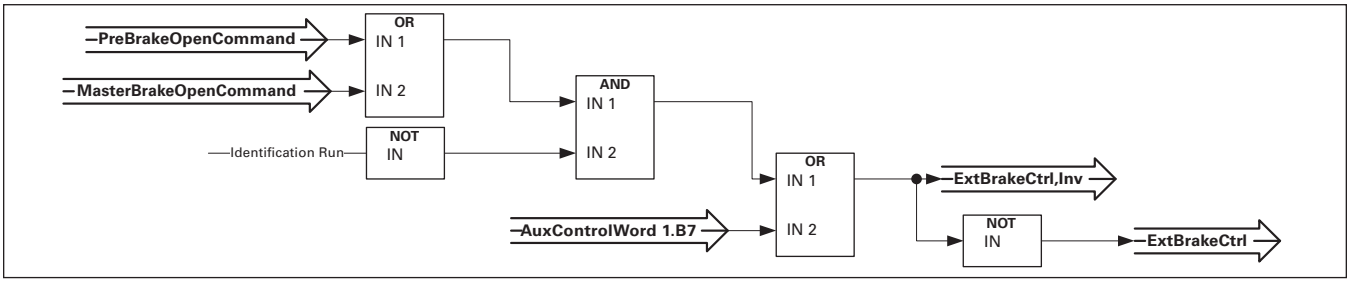
5.5.1.1 Brake control

The mechanical brake control has two parts that need to be synchronically controlled. The first part is the mechanical brake release and the second is the speed reference release.

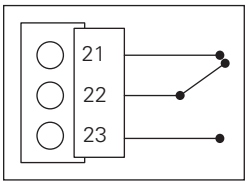
Conditions to open the brake:

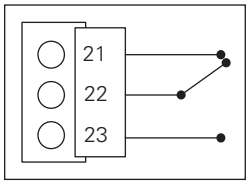
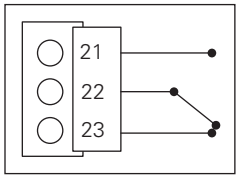


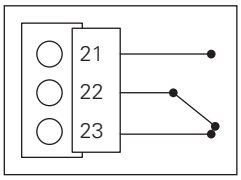
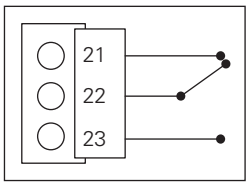
The final brake open command: It is possible that in a Master/Follower system the master drive opens the brake. Also an overriding system may do this without any control from the drive using AucControlWord1.B7. During identification run the brake will not open.



Relay state when control unit is not powered



Code	ID	Parameter	Notes
P1.5.1.16	**447**	**External brake control "Ext Brake Contrl"** See detailed description about brake operation in G1.15 Brake Control. External brake ON/OFF control Example: OPTA2 board RO1 : Brake function ON: Terminals 22-23 are connected (Relay is energized). Brake function OFF: Terminals 22-23 are open (Relay not energized).  **Brake open command** **Brake function OFF**  **Brake close command** **Brake function ON** When using the Master Follower function, the follower drive will open the brake at the same time as the Master even if the Follower's conditions for brake opening have not been met.	When power from control board is removed terminals 22-23 are open.

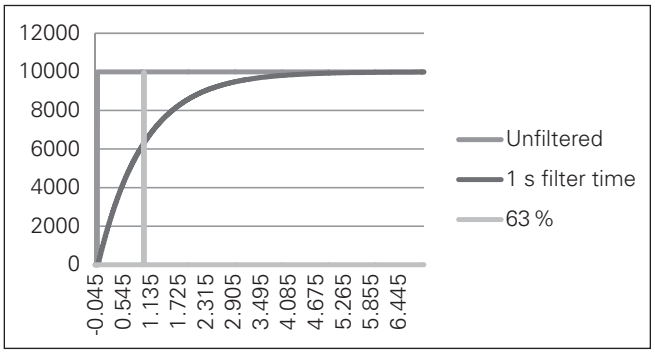
Code	ID	Parameter	Notes
P1.5.1.17	**448**	**External brake control, inverted "ExtBrakeCtrl,Inv"** See detail description about brake operation in G2.15 Brake Control Example: OPTA2 board RO1 : Brake function ON: Terminals 22-23 are open. (Relay not energized) Brake function OFF: Terminals 22-23 are connected. (Relay is energized).  **Brake open command** **Brake function OFF**  **Brake close command** **Brake function ON** When using the Master Follower function, the follower drive will open the brake at the same time as the Master does even if the Follower's conditions for brake opening have not been met.	
P1.5.1.18	**449**	**Output frequency limit 1 supervision "FreqOut SupvLim1"** The output frequency goes outside the set supervision limits defined in Supervision Lim parameter group. The function can be set to monitor either the high or the low limit. Limit and functions are selected in G2.5.8 Supervision Limits.	
P1.5.1.19	**450**	**Output frequency limit 2 supervision ID450 "FreqOut supvLim2"** The output frequency goes outside the set supervision limits 2 defined in Supervision Lim parameter group. The function can be set to monitor either the high or the low limit. Limit and functions are selected in G2.5.8 Supervision Limits.	
P1.5.1.20	**451**	**Reference limit supervision "Ref lim superv."** Active reference goes beyond the set supervision low limit/high limit defined in Supervision Lim parameter group. The function can be set to monitor either the high or the low limit Limit. The functions are selected in G2.5.8 Supervision Limits.	
P1.5.1.21	**452**	**Temperature limit supervision "temp lim superv."** The drive temperature goes beyond the set supervision limits defined in Supervision Lim parameter group. The function can be set to monitor either the high or the low limit. Limit and functions are selected in G2.5.8 Supervision Limits.	
P1.5.1.22	**453**	**Torque limit supervision "torq lim superv.** The motor torque goes beyond the set supervision limits defined in Supervision Lim parameter group. The function can be set to monitor either the high or the low limit. Limit and functions are selected in G2.5.8 Supervision Limits.	
P1.5.1.23	**454**	**Motor thermal protection "MotTherm flt/wrn"** Motor thermistor initiates an over temperature signal which can be led to a digital output. The response is selected with P1.12.5.6 ThermistorF.Resp.	
P1.5.1.24	**460**	**Analog input supervision limit "Ain Supv Lim"** The selected analog input signal goes beyond the set supervision limits defined in G2.5.8 Supervision Lim parameter group. The function can be set to monitor either the high or the low limit.	
P1.5.1.25	**459**	**Limit Control active "limit control on"** One or more of the drive limit controllers is active.	

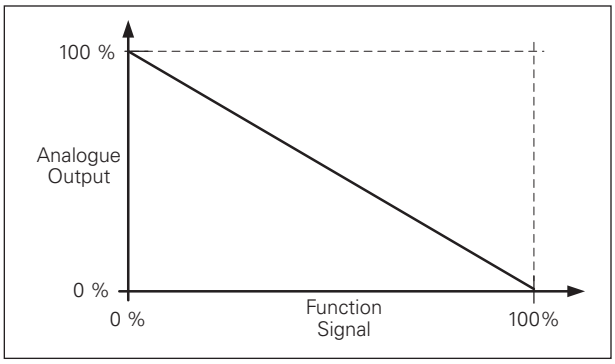
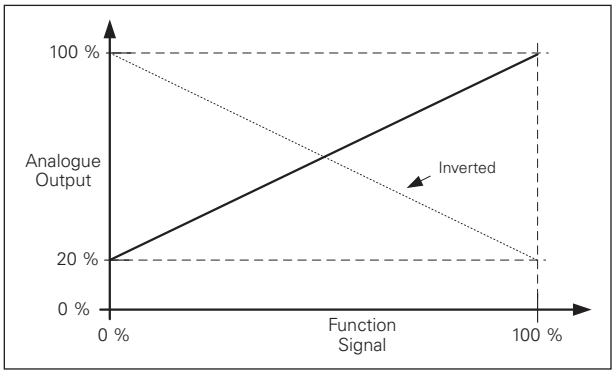
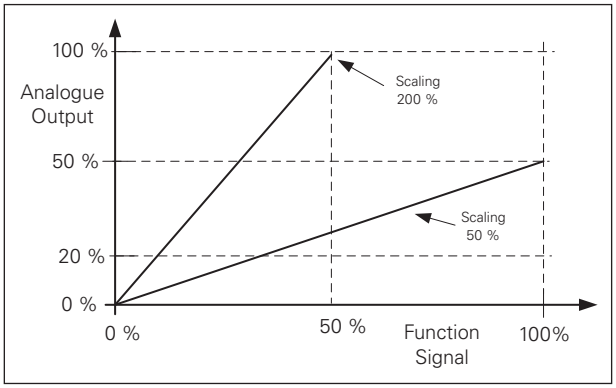
5.5.1.2 Fieldbus digital inputs connection

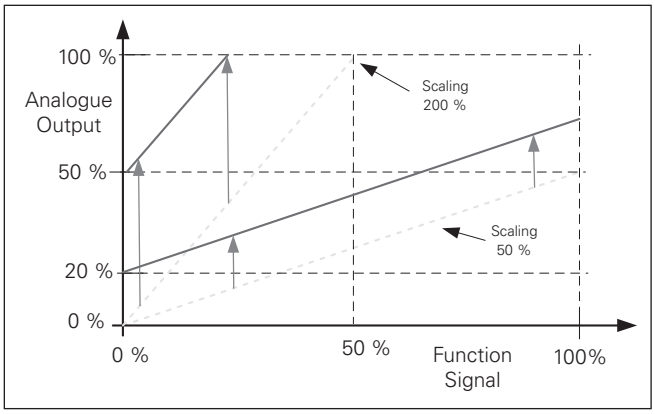
Code	ID	Parameter	Notes
P1.5.1.26	455	**Fieldbus input data 1 "FB dig input 1"**	
P1.5.1.27	456	**Fieldbus input data 2 "FB dig input 2"**	
P1.5.1.28	459	**Fieldbus input data 3 "FB dig input 3"**	
P1.5.1.29	169	**Fieldbus input data 4 "FB dig input 4"**	
P1.5.1.30	170	**Fieldbus input data 5 "FB dig input 5"** The data from the Fieldbus main control word can be led to the drive's digital outputs. See used fieldbus board manual for location of these bits.	
P1.5.1.31	756	**Safe disable active "safe disable act"** Select the digital output to show the status of the Safe Torque Off.	
P1.5.1.32	458	**Charge switch state "charge switch"** Closed when the DC bus has passed the pre-charge complete threshold voltage	

5.5.2 Analog outputs 1 & 2 & 3 & 4

Code	ID	Parameter	Notes
P1.5.2.1	464	**Analog output 1 signal selection "Iout 1 signal"**	
P1.5.3.1	471	**Analog output 2 signal selection "Iout 2 signal"**	
P1.5.4.1	478	**Analog output 3, signal selection "Iout 3 signal"**	
P1.5.5.1	1527	**Analog output 4, signal selection "Iout 4 signal"** Connect the AO1 signal to the analog output of your choice with this parameter.	
P1.5.2.2	307	**Analog output function "Iout content"**	
P1.5.3.2	472	**Analog output 2 function "Iout 2 content"**	
P1.5.3.2	479	**Analog output 3, function "Iout 3 content"**	
P1.5.3.2	1520	**Analog output 4, function "Iout 4 content"** This parameter selects the desired function for the analog output signal. 0 "Not used" Analog output is forced to 20 % (= 2 V/4 mA) 1 "O/P Freq" – Drive Output Frequency Output frequency from zero to maximum frequency. 2 "Freq Ref" - Freq. reference from zero to maximum frequency 3 "Motor speed " Motor speed from zero speed to motor synchronous speed 4 "O/P Current" – Drive Output Current Drive output current from zero to motor nominal current 5 "Motor Torque " Motor torque from zero to motor nominal torque (100 %) 6 "Motor Power" Motor power from zero to motor nominal power (100 %) 7 "Mot Voltage" Drive output voltage from zero to motor nominal voltage 8 "DC-link volt" 500 V unit: DC voltage from zero to 1000 Vdc 690 V unit: DC voltage from zero to 1317 Vdc 9 "AI1" Unfiltered Analog input 1 signal 10 "AI2" Unfiltered Analog input 2 signal 11 "Fout,min-max" Output frequency from minimum frequency to maximum frequency	

Code	ID	Parameter	Notes
P1.5.3.2	**1520**	**Analog output 4, function "Iout 4 content"** 12 "(-2Tn)-(2Tn)" Motor torque from negative two times motor nominal to positive two times motor nominal torque 13 "(-2Pn)-(2Pn)" Motor power from negative two times motor nominal to positive two times motor nominal power 14 "PT100 Temp." Maximum PT100 temperature value from used input scaling from -30 C to +200 C 15 "FB Data In4" FB analog output fieldbus process data value can be connected to analog output by using monitoring signal ID48. 16 "(-2nN)-(2nN)" Motor speed from negative two times nominal to positive two times nominal speed 17 "Enc 1 speed" Encoder 1 speed from zero speed to motor synchronous speed 18 "Unit temp" Unit temperature scaled from 0 degree to 100 degree. 19 "Value control" Value control output 20 "Drive output power" Drive output power scaled from zero to Motor nominal power (P1.1.8).	
P1.5.2.3	**308**	**Analog output filter time "Iout Filter time"**	
P1.5.3.3	**473**	**Analog output 2 filter time "Iout 2 Filter T"**	
P1.5.4.3	**480**	**Analog output 3, filter time "Iout 3 Filter T"**	
P1.5.5.3	**1521**	**Analog output 4, filter time "Iout 4 Filter T"** First order filtering is used for analog output signals.  	
P1.5.2.4	**309**	**Analog output inversion "Iout Invert"**	
P1.5.3.4	**474**	**Analog output 2 inversion "Iout 2 invert"**	
P1.5.4.4	**481**	**Analog output 3 inversion "Iout 3 invert"**	

Code	ID	Parameter	Notes
P1.5.5.4	**1522**	**Analog output 4 inversion "Iout 4 invert"** Inverts the analog output signal: 	
P1.5.2.5	**310**	**Analog output minimum**	
P1.5.3.5	**475**	**Analog output 2 minimum**	
P1.5.4.5	**482**	**Analog output 3 minimum**	
P1.5.5.5	**1523**	**Analog output 4 minimum** Defines the signal minimum to either 0 mA or 4 mA (living zero). 0 Set minimum value to 0 mA (0 %) 1 Set minimum value to 4 mA (20 %) 	
P1.5.2.6	**311**	**Analog output scale "Iout scale"**	
P1.5.3.6	**476**	**Analog output 2 scaling "Iout 2 scale"**	
P1.5.4.6	**483**	**Analog output 3 scaling "Iout 3 scale"**	
P1.5.5.6	**1525**	**Analog output 4 scaling "Iout 4 scale"** 	

Code	ID	Parameter	Notes
P1.5.2.7	375	**Analog output offset "Iout Offset"**	
P1.5.3.7	477	**Analog output 2 offset "Iout 2 Offset"**	
P1.5.4.7	484	**Analog output 3 offset "Iout 3 Offset"**	
P1.5.5.7	1524	**Analog output 4 offset "Iout 4 Offset"** Define the offset for the analog output signal. In picture below 50 % scaling signal has been given 20 % offset and for 200 % scaling 50 % offset. 	

5.5.3 Delayed digital output 1 & 2

Code	ID	Parameter	Notes
P1.5.6.1	486	**Digital output 1 signal selection "dig.out 1 signal"**	
P1.5.7.1	489	**Digital output 2 signal selection "dig.out 2 signal"** Connect the delayed digital output signal to the digital output of your choice with this parameter. For more information about the TTF programming method, see chapter 2.	
P1.5.6.2	312	**Digital output function "DO1 Content"**	
P1.5.7.2	490	**Digital output 2 function "DO2 content"** 0 = "Not used" 1 = "Ready" The AC drive is ready to operate. Common reasons when 'Ready' signals are missing: • Run enable signal is low • DC Voltage is too low • DC Voltage is too high 2 = "Run" The frequency converter is modulating. 3 = "Fault " A fault trip has occurred 4 = "FaultInvert" No active faults in the drive. 5 = "OverheatWarn" Drive temperature has exceeded normal operation conditions. Temperature limit may vary depending on drive type and size. 6 = "ExtFaul/Warm" External fault or warning depending on parameter response to external fault 7 = "RefFaul/Warn" Fault or warning depending on parameter Response to the 4mA reference fault - occurs if analog reference is 4-20 mA and signal is <4mA 8 = "Warning" Always if a warning is on	

Code	ID	Parameter	Notes
P1.5.7.2	**490**	Digital output 2 function "DO2 content" 9 = "Reversed" Drive output frequency is negative 10 = "JogSpeedSel" The jogging, preset or inching speed has been activated with digital input. 11 = "At speed" Induction motor: speed is within nominal slip of the reference. PMS motor: output frequency is within 1 Hz of the reference. 12 = "MotorRegAct" One of the limit regulators is active. 13 = "FreqLim1Sup" Output frequency limit 1 supervision The output frequency goes outside the set supervision low limit/high limit. 14 = "FreqLim2up" Output frequency limit 2 supervision The output frequency goes outside the set supervision low limit/high limit. 15 = "TorqLimSprv" Torque limit supervision The motor torque goes beyond the set supervision low limit/high. 16 = "RefLimSprv" Reference limit supervision Active reference goes beyond the set supervision low limit/high limit. 17 = "ExtBrakeCont" External brake control External brake ON/OFF control with programmable delay 18 = "I/O ContAct" Control from I/O terminals IO control place is active. 19 = "TempLimSprv" Drive temperature limit supervision. Drive temperature goes beyond the set supervision limits (par. ID354) 20 = "WrongDirecti" Motor rotation direction is different from the requested one. This happens in situation when an external force makes the motor to rotate into different direction or when a command for direction change has been given and the drive is still ramping down to change direction. 21 = "ExtBrakeInv" External brake control inverted External brake ON/OFF control; Output active when brake control is OFF. 22 = "ThermFlt/Wrn" Thermistor fault or warning The thermistor input of option board indicates overtemperature. Fault or warning depending on the response parameter. 23 = "AI Supervis" Analog input supervision Analog input supervision function, Set Reset type output function. 24 = "FB DigInput1" Fieldbus digital input data 1 25 = "FB DigInput2" Fieldbus digital input data 2 26 = "FB DigInput3" Fieldbus digital input data 3 27 = "Warning SR" Warning indication that requires pressing of Reset button. Normally the drive will remove warning indication when the fault situation has passed. This output requires that reset button is pressed before signal goes low after there has been a warning trigger. If a new warning comes while previous is active this output goes low for 1 second. 28 = "ID.Bit" Select the signal for controlling the DO. The parameter has to be set in format xxxx.yy where xxxx is the ID number of a signal and yy is the bit number. For example, the value for DO control is 1174.02. 1174 is the ID number of Warning Word 1. So the digital output is ON when bit number 02 of the warning word (ID no. 1174) i.e. Motor underload is high.	

Code	ID	Parameter	Notes
P1.5.6.3	487	Digital output 1 on-delay "DO1 ON delay"	
P1.5.6.4	488	Digital output 1 off-delay "DO1 OFF delay"	
P1.5.7.3	491	Digital output 2 on-delay "DO2 ON delay"	
P1.5.7.4	492	Digital output 2 off-delay "DO2 OFF delay" With these parameters you can set on- and off-delays to digital outputs.	

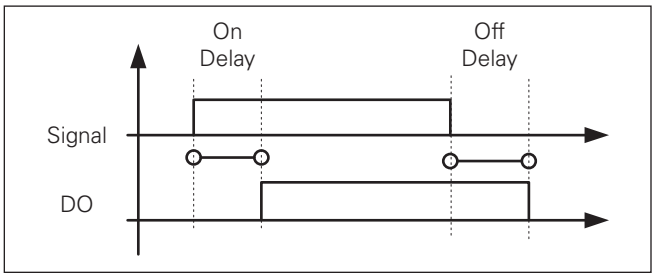
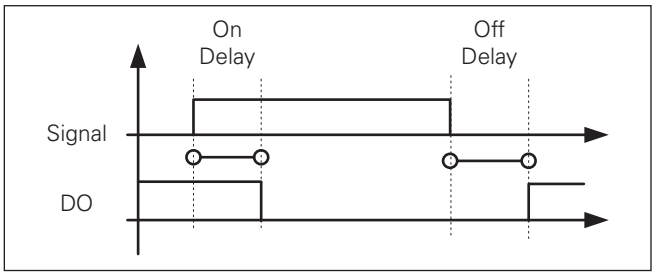


Figure 5-10. Digital outputs 1 and 2, on- and off-delays

P1.5.6.5	1587	Invert digital output 1 "INV delayed DO1"	
P1.5.7.5	1588	Invert digital output 2 "INV delayed DO2" Inverts delayed digital output operation.	



P1.5.6.6	1217	ID.Bit free DO 1	
P1.5.7.6	1385	ID.Bit free DO 2 Select the signal for controlling the DO. The parameter has to be set in format xxxx. yy where xxxx is the ID number of a signal and yy is the bit number. For example, the value for DO control is 1174.02. 1174 is the ID number of Warning Word 1. So the digital output is ON when bit number 02 of the warning word (ID no. 1174) i.e. Motor underload is high.	

5.5.4 Supervision limits

Supervision function gives you the possibility to monitor certain values with the limit setting. When the actual value exceeds or goes below the set value a message through a digital output can be given. The torque limit supervision is scalable.

Code	ID	Parameter	Notes
P1.5.8.1	315	Output frequency limit supervision function "Freq Supv Lim 1"	
P1.5.8.3	346	Output frequency limit 2 supervision function "freq supv lim 2"	
P1.5.8.5	348	Torque limit, supervision function "torque supv lim"	
P1.5.8.8	350	Reference limit, supervision function "ref superv lim"	

Code	ID	Parameter	Notes
P3.6.8.10	354	**Drive temperature limit supervision function "temp lim superv."** 0 No supervision 1 Low limit supervision 2 High limit supervision 3 ABS(Torque), Low limit supervision 4 ABS(Torque), High limit supervision The following five parameters are used to set a limit value to be monitored with the corresponding parameter above.	
P1.5.8.2	316	**Output frequency limit supervision value "freq dupv val 1"**	
P1.5.8.4	347	**Output frequency limit 2 supervision value "freq supv val 2"**	
P1.5.8.6	349	**Torque limit, supervision value "torque supv val"**	
P1.5.8.9	351	**Reference limit, supervision value "ref superv value"**	
P1.5.8.11	355	**Drive temperature limit value "temp supv value"**	

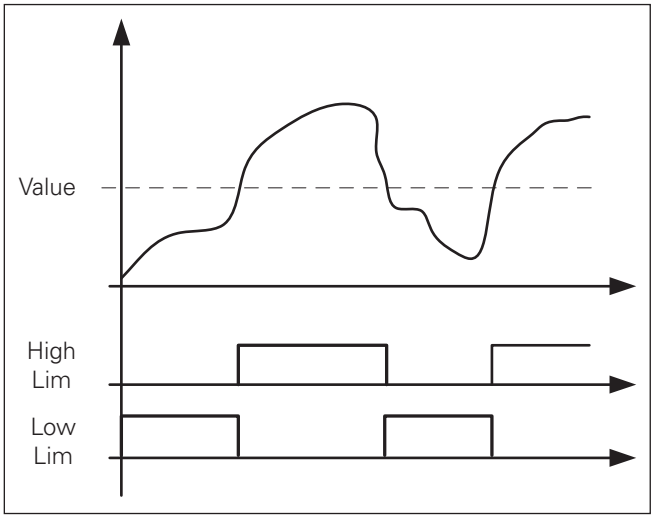


Figure 5-11. Supervision function

P1.5.8.7	402	**Torque supervision value scaling input "torque superv scl"** This parameter is used to change the torque limit supervision level between zero and P1.5.8.6 Torque Supv Val 0 = Not used 1 = AI1 2 = AI2 3 = AI3 4 = A14 5 = FBLimScaling	

5.5.4.1 Analog input supervision function

The analog input supervision function will control the selected digital output to close when the analog input signal has exceeded the high limit and open when the signal goes below the low limit.

Code	ID	Parameter	Notes
P1.5.8.12	356	**Analog input supervision signal "ain supv input"** With this parameter you can select the analog input to be monitored. 0 = Not used 1 = AI1 2 = AI2 3 = AI3 4 = AI4 5 = FBLimScaling	

Code	ID	Parameter	Notes
P1.5.8.13	357	Analog Low supervision control limit “Ain supv llim”	
P1.5.8.14	358	Analog High supervision control limit “Ain supv hlim”	

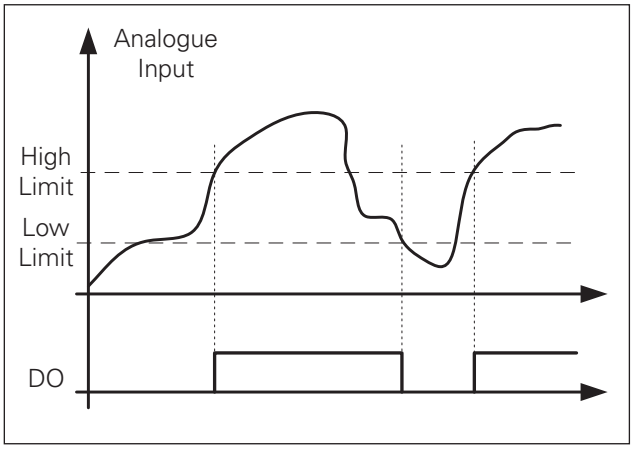


Figure 5-12. An ex ample of On/Off-control

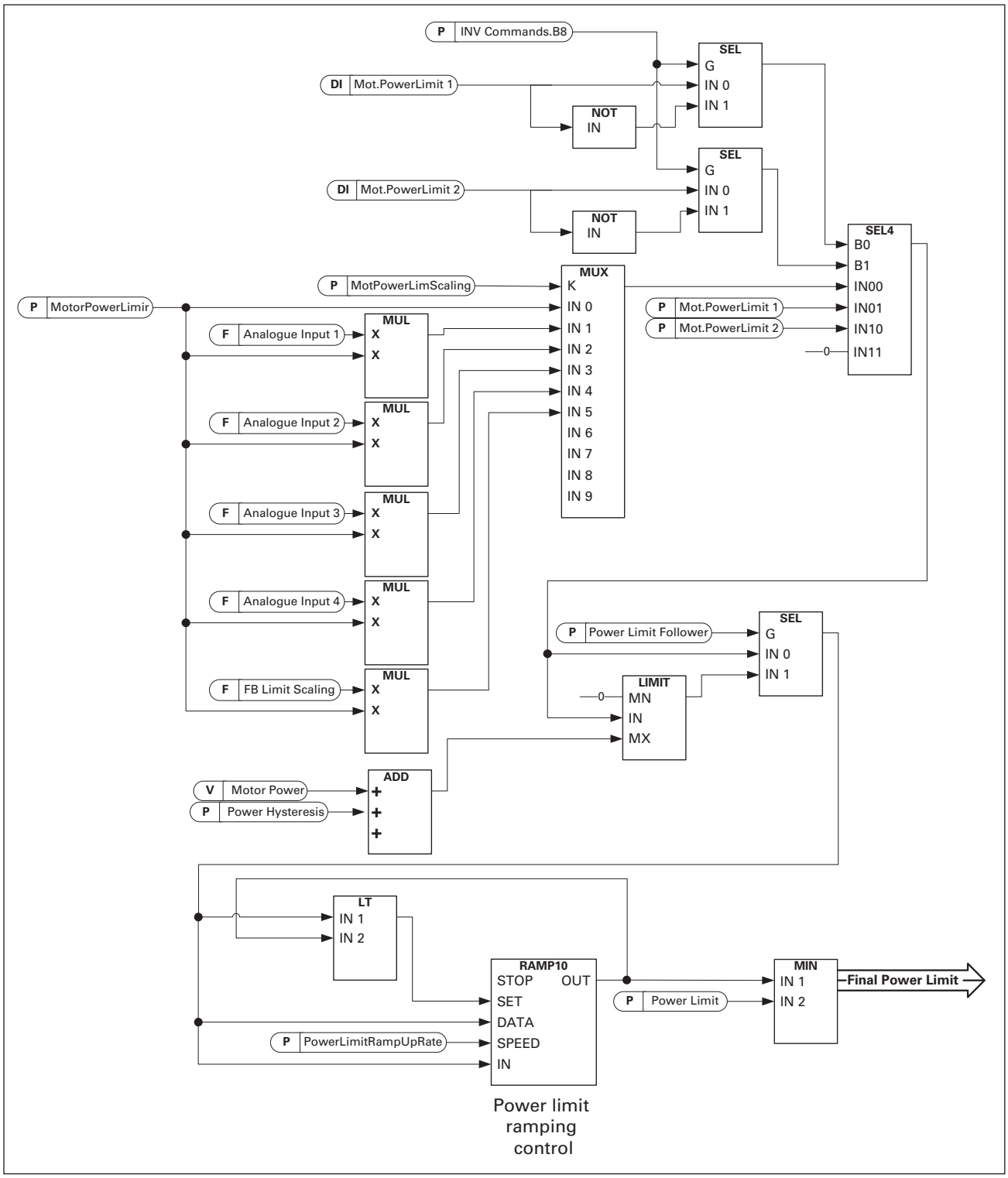
5.6 Limit settings

5.6.1 Current limit handling

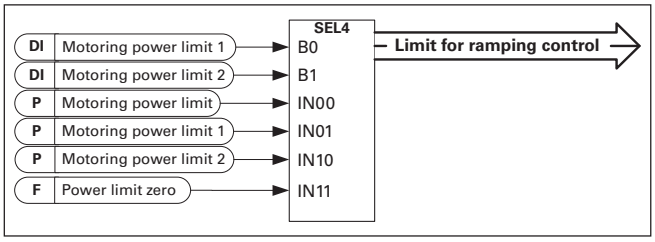
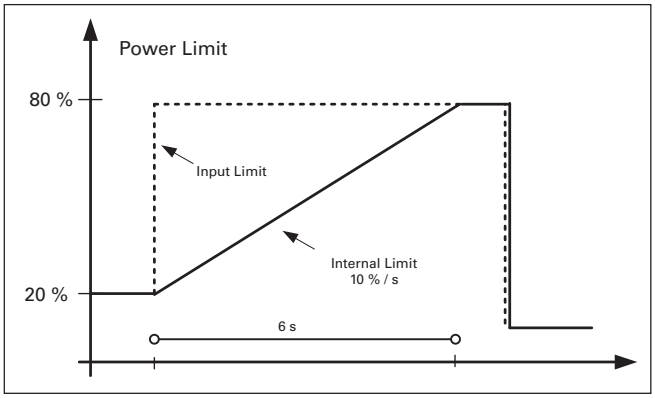
Code	ID	Parameter	Notes
P1.6.1.1	107	**Current limit “Current Limit”** This parameter determines the maximum motor current from the AC drive. The parameter’s value range differs from size to size. When the Current limit is changed the Stall current limit is internally calculated to 90% of the current limit (if the Stall current limit is greater than the Current limit). When the current limit is active the drive output frequency is reduced until current is below the set limit. In closed loop control, the current limit affects the torque producing current limit, not total current. This can be changed in options group with the “LimitTotalCurrent” parameter. In drive synch operation limiting is for average current of units.	
P1.6.1.2	399	**Scaling of current limit “Currnt Lim Scln g”** 0 = Not used 1 = AI1 2 = AI2 3 = AI3 4 = AI4 5 = FB Limit Scaling ID46 Monitoring value This signal will adjust the maximum motor current between 0 and the parameter Motor Current Limit.	
P1.6.1.3	1451	**Current limit Kp**	
P1.6.1.4	1452	**Current limit Ki**	

5.6.2 Current limit handling

Power limit function is meant to limit the drive output power to the motor. The general way to do this is to give a limiting signal from a primary system that gives information about how much power is available for drive operations.

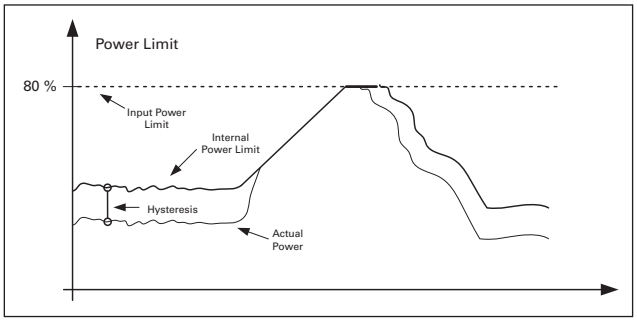


Power limit ramping control

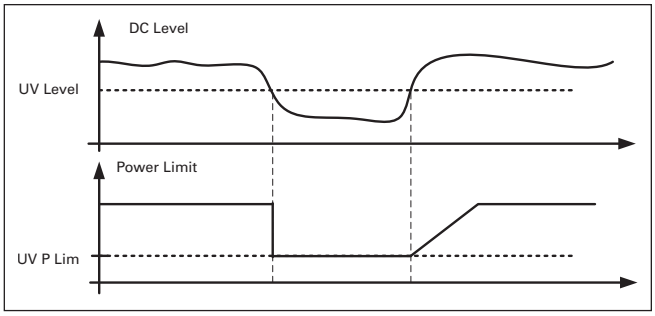
Code	ID	Parameter	Notes
P1.6.2.1	1722	**Power limit "Power limit"** General power limit for both motoring and generator side. This value is the final limit for all scaling functions. This value should not be used for scaling but for the maximum safety limit because the ramp up rate function is ineffective when this parameter is changed.	
P1.6.2.2	1290	**Generator power limit "GenerPowerLimit"** Generator side power limit. This limit value is used for all scaling functions and power limit ramp rate functions.	
P1.6.2.3	1289	**Motoring power limit "MotorPowerLimit"** Motoring side power limit. This limit value is used for all scaling functions and power limit ramp rate functions.	
P1.6.2.4	1513	**Generator power limit 1 "Gen.PowerLimit 2"** Generator side power limit values when limits are activated by digital inputs. When both digital inputs are activated the power limit is forced to zero.	
P1.6.2.6	1503	**Motoring power limit 1 "Mot.PowerLimit 1"**	
P1.6.2.7	1504	**Motoring power limit 2 "Mot.PowerLimit 2"** Motoring side power limit values when limits are activated by digital inputs. When both digital inputs are activated the power limit is forced to zero. 	
P1.6.2.8	1502	**Power limit increase rate "PowerLimInc.rate"** Defines the power limit increase rate. Decreasing power limit will be in effect immediately. 	

5.6.2.1 Power follower function

The power follower function will keep the internal power limit near the actual power so that when power demand increases the increase rate is controlled by the power limit increase rate parameter. This function makes the power increase smoother for the ship generator when e.g. speed reference is increased or when propeller gets air and comes back to the water.

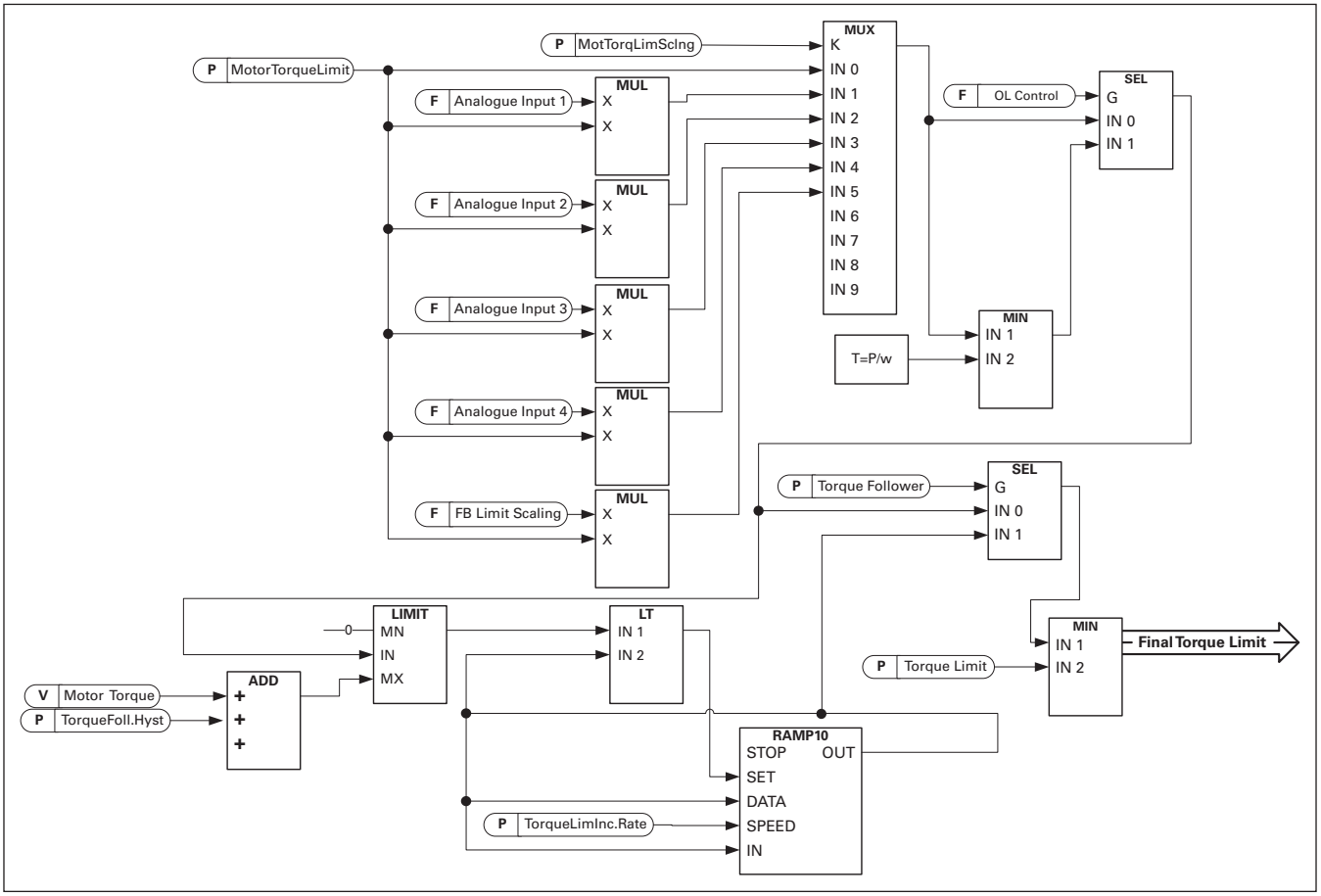
Code	ID	Parameter	Notes
P1.6.2.9	**1705**	**Power follower "power follower"** Activates the power follower function.	
P1.6.2.10	**1529**	**Power limit follower hysteresis "PowerFoll.Hyst"** Defines the hysteresis of the actual power where the internal power limit is kept while the input power limit is higher than the actual power.  	
P1.6.2.11	**179**	**Scaling of motoring power limit "MotPowerLimScIng"** The motoring power limit is equal to parameter Motoring Power Limit if value 'Not Used' is selected. If any of the inputs is selected the motoring power limit is scaled between zero and parameter P1.6.2.3 Motoring Power Lim. 0 = Parameter 1 = AI1 2 = AI2 3 = AI3 4 = AI4 5 = Fieldbus Scaling ID46 (Monitoring Value)	
P1.6.2.12	**1088**	**Scaling of Generating power limit "GenPowerLimScIng"** The generator power limit is equal to parameter Generator Power Limit if value 'Not Used' is selected. If any of the inputs is selected the generator power limit is scaled between zero and parameter P1.6.2.2 Generator Power Lim. 0 = Parameter 1 = AI1 2 = AI2 3 = AI3 4 = AI4 5 = FieldBus Scaling ID46 (Monitoring Value)	
P1.6.2.13	**1611**	**Under voltage power limit DC level "UV Power C Levl"** This parameter defines the DC voltage level when the special power limit function is activated. When DC voltage goes below this level the power level defined by under voltage power limit will be activated.	

Code	ID	Parameter	Notes
P1.6.2.14	1612	**Under voltage power limit "UV power lim."** Defines the power limit that is used when DC voltage is below parameter Undervoltage power limit DC level (P1.6.2.13). The function is deactivated when this parameter value is zero.	



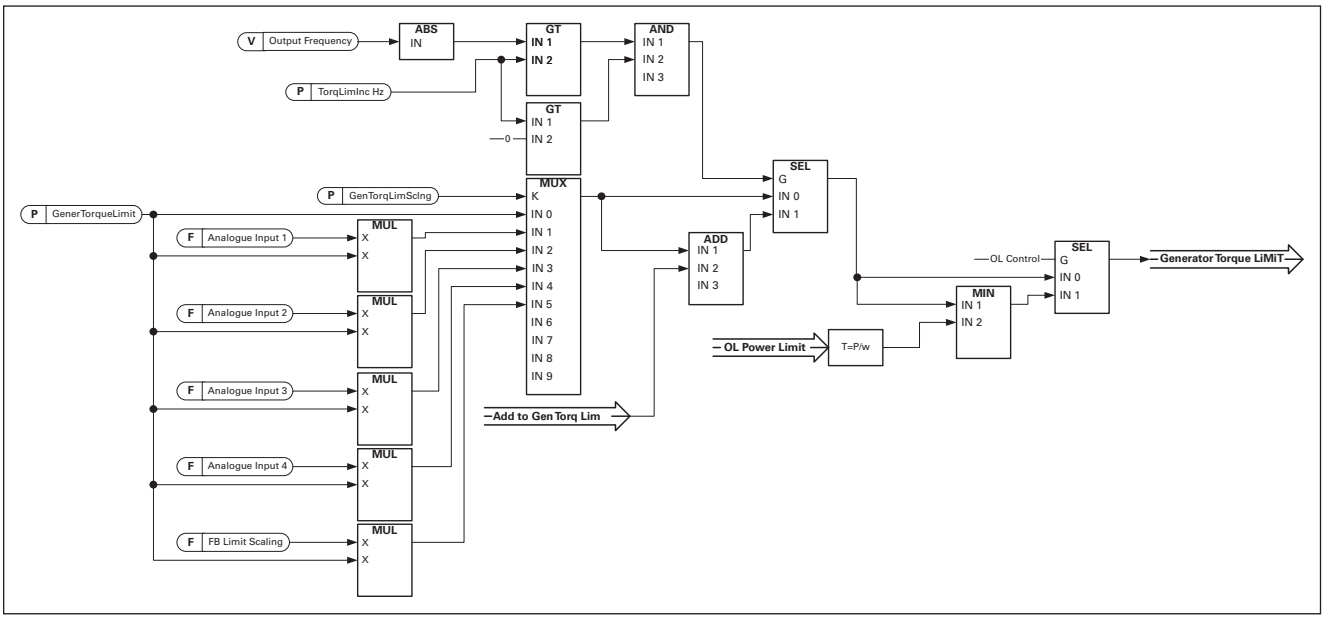
5.6.3 Torque limit handling

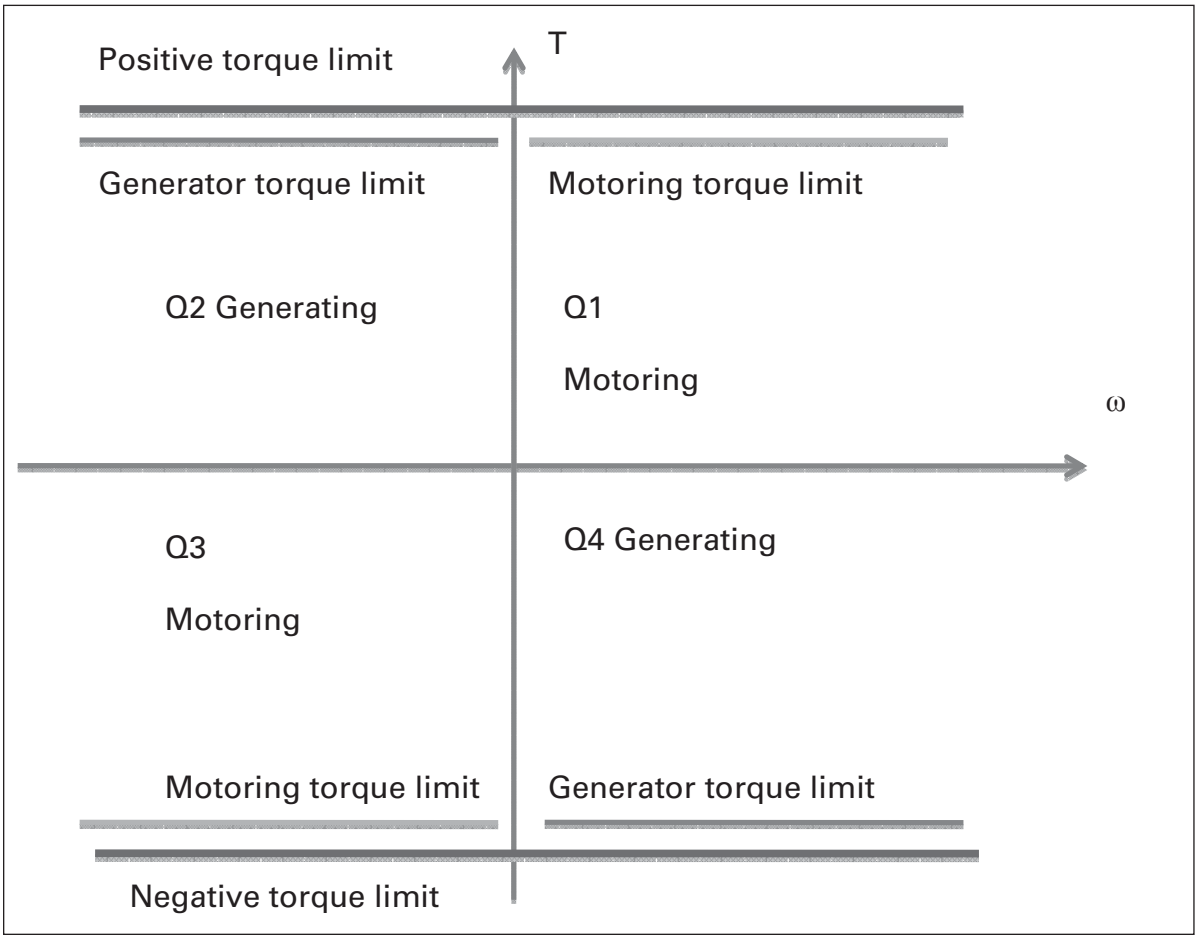
5.6.3.1 Motoring torque limit function



5.6.3.2 Generator torque limit function

Details of "Add to Gen Torq Lim" can be find from Brake Control chapter.





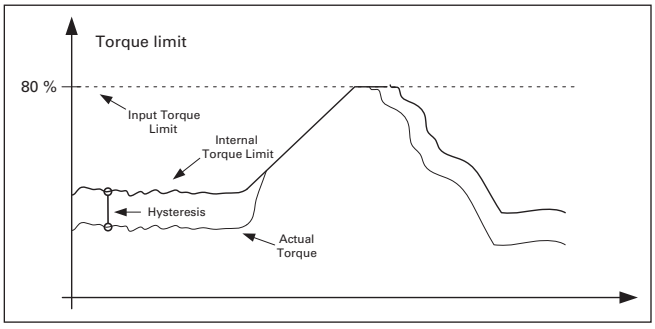
Code	ID	Parameter	Notes
P1.6.3.1	609	**Torque Limit "Torque limit"** The general torque limit for both motoring and generator sides. This value is the final limit for all scaling functions. This value should not be used for scaling but for maximum safety limit because the ramp up rate function is ineffective when this parameter is changed. Only the motoring side torque limit has a ramp up limiting function.	
P1.6.3.2	1287	**Motoring torque limit "MotorTorqueLimit"** Motoring side torque limit. This limit value is used for all scaling functions and torque limit ramp rate functions if activated.	
P1.6.3.3	1288	**Generator torque limit "GenerTorqueLimit"** Generator side torque limit. This limit is used for all scaling functions generator side torque limit is not included in ramp up rate function.	
P1.6.3.4	1625	**Motoring torque limit 1 "Mot.TorqueLim 1"** Motoring side torque limit that is activated by digital input	
P1.6.3.5	1627	**Generator torque limit 1 "Gen. Torque lim 1"** Generator side torque limit that is activated by digital input.	

5.6.3.3 Torque follower function

Torque follower function will keep the internal torque limit near the actual torque so that when the torque demand increases, the increase rate is controlled by the torque limit increase rate parameter.

This function can be used together with the power limit ramp rate function because a low power limit at low speed will give high torque and may cause mechanical stress in the system.

Code	ID	Parameter	Notes
P1.6.3.6	1706	**Torque follower "Torque follower"** Activates the torque follower function and ramp rate limiter function for torque limit. 0 = Not used 1 = Motoring 2 = Generator 3 = Motoring + Generator	
P1.6.3.7	1502	**Torque limit increase rate "TorqueLimInc.rate"** Defines the torque limit increase rate. Decreasing power limit will be in effect immediately.	
P1.6.3.8	1533	**Torque limit follower hysteresis "TorqueFoll.Hyst"** Defines the hysteresis of the actual torque where the internal torque limit is kept while the input torque limit is higher than the actual torque.	



Code	ID	Parameter	Notes
P1.6.3.9	485	**Motoring torque limit scaling "MotTorqLimScIng"** The motoring torque limit is equal to parameter Motoring Torque Limit if value 'Not Used' is selected. If any of the inputs is selected the motoring torque limit is scaled between zero and parameter Motorin Torque Limit. 0 = Not used 1 = AI1 2 = AI2 3 = AI3 4 = AI4 5 = FB Limit Scaling ID46 Monitoring value	
P1.6.3.10	1087	**Generating torque limit scaling "GenTorqLimScIng"** The generator torque limit is equal to parameter Generator Torque Limit if value 'Not Used' is selected. If any of the inputs is selected the generator torque limit is scaled between zero and parameter generator torque limit. 0 = Not used 1 = AI1 2 = AI2 3 = AI3 4 = AI4 5 = FB Limit Scaling ID46 Monitoring value	

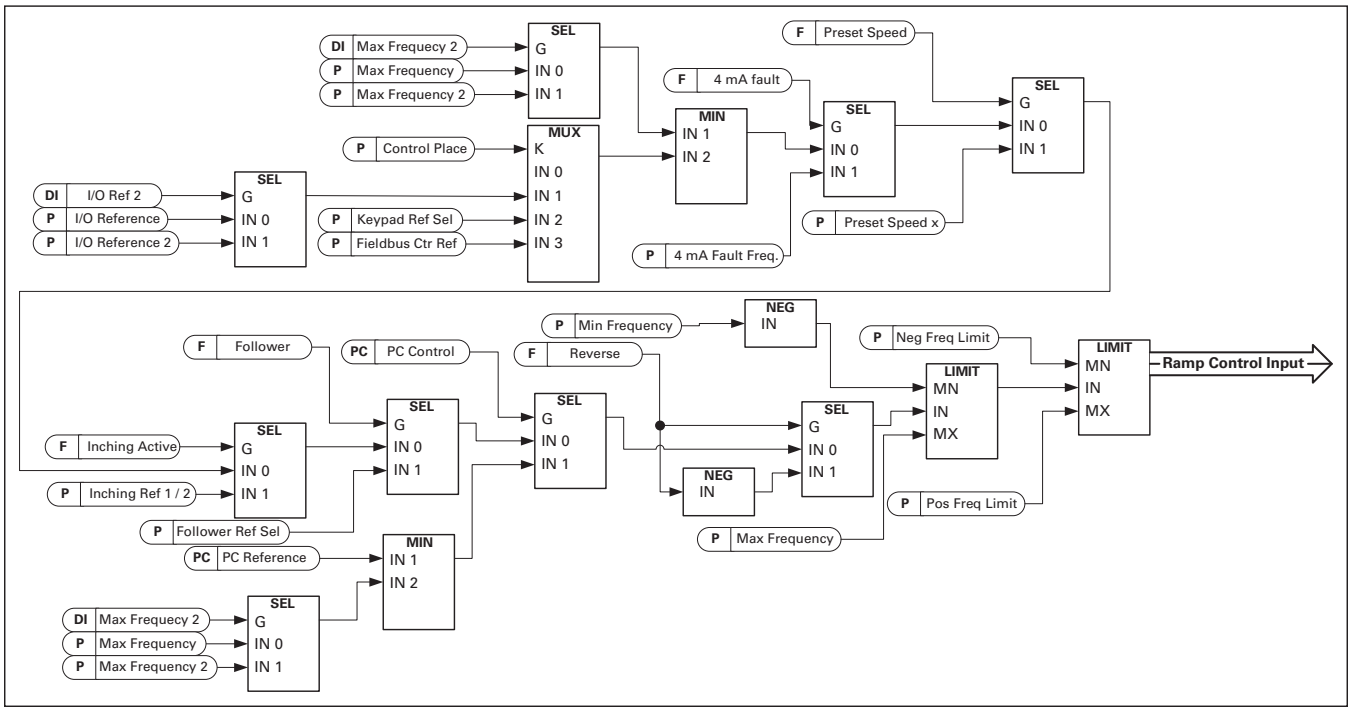
5.6.3.4 Open loop settings only

Code	ID	Parameter	Notes
P1.6.3.9.1	610	**Torque limit control P-gain "TorqLimCtrl P"** This parameter defines the gain of the torque limit controller. It is used in Open Loop control mode only.	
P1.6.3.9.2	611	**Torque limit control I-gain "TorqLimCtrl I"** This parameter determines the I-gain of the torque limit controller. It is used in Open Loop control mode only.0 = Not used	

5.6.3.5 Closed loop settings only

Code	ID	Parameter	Notes
P1.6.3.10.1	1382	**Speed control output limit "SPC out limit"** Torque limit for the speed controller. It affects both the positive and negative direction torques.	
P1.6.3.10.2	646	**Speed control positive limit "SPC pos limit"** Positive torque limit for speed controller output.	
P1.6.3.10.3	645	**Speed control negative limit "SPC Neg limit"** Negative torque limit for speed controller output.	

5.6.4 Frequency limit handling



Code	ID	Parameter	Notes
P1.6.4.1	1512	**Maximum frequency limit 2 "Max frequency 2"** This parameter defines the maximum frequency when the digital input "Max Frequency 2" is activated. This limit does not affect the reference values that are of constant type, e.g. preset speed references. If actual speed is higher than Max Frequency 2, limited reference is activated by ramp.	
P1.6.4.2	1286	**Negative frequency limit "Neg freq limit"** Positive direction frequency limit. When changed in closed loop control mode change is made without ramp. DriveSynch operation The maximum recommended frequency is 100 Hz.	
P1.6.4.3	1285	**Positive frequency limit "Pos freq limit"** Negative direction frequency limit. When changed in closed loop control mode change is made without ramp. DriveSynch operation The maximum recommended frequency is 100 Hz.	
P1.6.4.4	1283	**Zero Frequency limit "Zero Freq. Limit** Defines the zero frequency limit. Used to determine when load drooping is set to zero if load drooping removal function 1 is selected	

5.6.5 DC link handling

Code	ID	Parameter	Notes
P1.6.5.1	610	**Overvoltage controller "Overvolt contr"** The parameter selects the behaviour of the overvoltage controller in open loop control. It also activates the closed loop overvoltage controller but the operation is always of type 'PI' in closed loop control modes. 0 "Off" - Controller switched off Both open and closed loop overvoltage controllers are off. 1 "On:NoRamping" – Activated P-Controller type operation Both open and closed loop controllers are activated. Open loop controller is a P-type controller. Closed loop controller is a PI-type controller. 2 "On: Ramping" – Activated PI-Type controller Both open and closed loop controllers are activated. Open loop controller is a PI-type controller. Closed loop controller is PI-type controller (as in selection 1).	
P1.6.5.2	1262	**Overvoltage reference select "OverVolt.Ref.Sel"** Overvoltage reference level depending on the status of the brake chopper. In closed loop control, the overvoltage controller level is adjusted by "OverVoltageRef." The parameter can be found in the CL setting parameter group.	
P1.6.5.3	504	**Brake chopper "Brake chopper"** 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 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. Brake chopper test mode generates pulse to resistor every second. If the pulse feedback is wrong (resistor or chopper is missing) fault F12 is generated.	

ID1262	Brake chopper in use	Brake chopper not in use
0/High voltage	500 V Unit: 844 V 690 V Unit: 1164 V	500 V Unit: 797 V 690 V Unit: 1099 V
1/Norm.Voltage	1.25*Estimated DC nominal voltage	1.18*Estimated DC nominal voltage
2/BrakeChLevel	1.07*brake chopper level	Brake chopper level

Over voltage reference select	Brake chopper level
0/High voltage	500 V Unit: 797 V 690 V Unit: 1099 V
1/Norm.Voltage	1.18* Estimated DC nominal voltage
2/BrakeChLevel	Brake chopper level

0 = "Not Used" - No brake chopper used
Brake chopper not active or present in the DC link.

1 = "On, Run" - Brake chopper in use and tested when running.
The drive's own brake chopper is activated and operational when the drive is in Run state. The drive also sends test pulses for feedback from the brake resistor.

2 = "External" - External brake chopper (no testing)
The system has an item that handles the DC link voltage. This could be a system with AFE or there is an external BCU unit. When this option is selected the drive overvoltage level is set a little higher so that its operation does not conflict with AFE or BCU units.

3 = "On, Run+Stop" - Used and tested in READY state and when running
Brake chopper is also active when the drive is not in Run state. This option can be use e.g. when other drives are generating but energy levels are low enough to be handled with only one drive.

4 = "On, No test" - Used when running (no testing)
Brake chopper is active in Run state but no test pulse to resistor is generated.

The overvoltage controller level is set to a little lower, see parameter P1.6.5.2.

In the system menu there is a parameter "InternBrakeRes". This parameter is used for brake resistor overheating calculations. If an external brake resistor is connected to the drive the parameter should be set to 'Not connected' to disable temperature calculation for the brake resistor.

Code	ID	Parameter	Notes
P1.6.5.4	1267	**Brake chopper level "BrakeChopperLevel"** Brake chopper control activation level in volt. This parameter is active when "OverVolt.Ref.Sel" is 2/"BrakeChLevel" **For 400V Supply:** 400*1.35*1.18 = 638V **For 500V Supply:** 500*1.35*1.18 = 808V **For 690V Supply:** 690*1.35*1.18 = 1100V	
P1.6.5.5	608	**Undervoltage controller "undervolt contr"** Overvoltage reference level depending on the status of the brake chopper. In closed loop control, the overvoltage controller level is adjusted by "OverVoltageRef." The parameter can be found in the CL setting parameter group. 0 "Off" – Controller switched off Both open and closed loop overvoltage controllers are off. 1 "On:NoRamping" – Activated PI-Controller type operation Both open and closed loop controllers are activated. If power comes back while drive is at under voltage the controller output frequency will regain the reference value. 2 "On: Ramping" – PI controller type and ramping down. Both open and closed loop controllers are activated. If power comes back after under voltage controller has been active, drive will ramp to zero speed using ramp time 2 and generate an under voltage fault (F9) with sub code S3.	In closed loop control, also parameter "CLrmpFollEncFreq" needs to be activated to achieve identical operation.
P1.6.5.6	1537	**Under voltage reference select "UnderVoltRef.Sel"** Select the operation level for open loop under voltage controller. 0 "UnderVoltRef" Under voltage operation level is select with P1.6.5.7 1. "0,8 * Estimated DC Voltage" Automatic DC voltage level	
P1.6.5.7	1538	**Under Voltage Reference OL "UnderVoltage Ref"** Set the operation level for open loop under voltage controller when P1.6.5.6 is 0/ UnderVoltageRef.	

5.6.5.1 CL Settings

Code	ID	Parameter	Notes
P1.6.5.8.1	1528	**Overvoltage reference "OverVoltageRef."** Defines the overvoltage reference level in Closed Loop control mode. Percentage value related to unit nominal voltage DC voltage. Default 118 %. 690 Vac * 1,35 * 118 % = 1099 Vdc 500 Vac * 1,35 * 118 % = 796 Vdc	
P1.6.5.8.2		**Overvoltage controller motoring torque limit** Defines motoring torque limit, when drive is operating under over voltage controller.	
P1.6.5.8.3		**CL Under voltage reference** Defines the under voltage reference level in Closed Loop control mode. Percentage value related to unit nominal voltage DC voltage. Default 65 %. 690 Vac * 1,35 * 65 % = 605 Vdc 500 Vac * 1,35 * 65 % = 438 Vdc	

5.6.6 Limit controls

Code	ID	Parameter	Notes
P1.6.6.1	1901	**Limit total current "LimitTotalCurrent"** This function activates the total current limit function in close loop control. Normally in closed loop the current limit only affects the torque producing current.	

5.6.7 Limit warnings

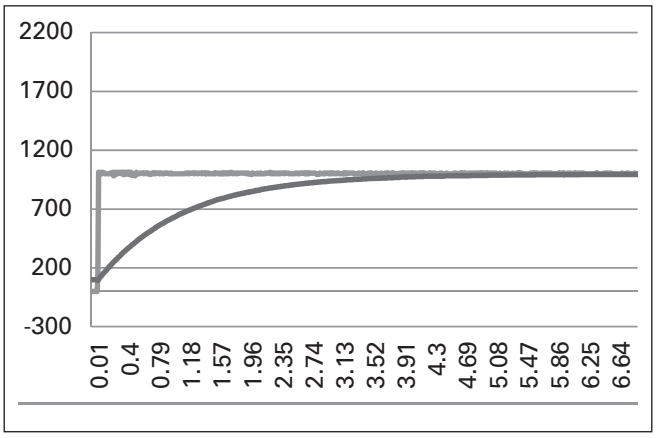
Code	ID	Parameter	Notes
P1.6.7.1	757	**Current regulator response "CurrentRegResp"** When set to warning Drive will display A90 Current Limit, if the drive is operating in the current limit regulator	
P1.6.7.2	758	**Overvoltage regulator response "OvervoltRegResp"** When set to warning Drive will display A91 UnderVoltReg, if the drive is operating in the Undervoltage regulator	
P1.6.7.3	759	**Under voltage regulator response "UndervoltRegResp"** When set to warning Drive will display A92 OverVoltReg, if the drive is operating in the Over Voltage regulator	
P1.6.7.4	760	**Torque regulator response "TorqueRegResp"** When set to warning Drive will display A93 TorqueReg, if the drive is operating in the Torque Limit regulator	

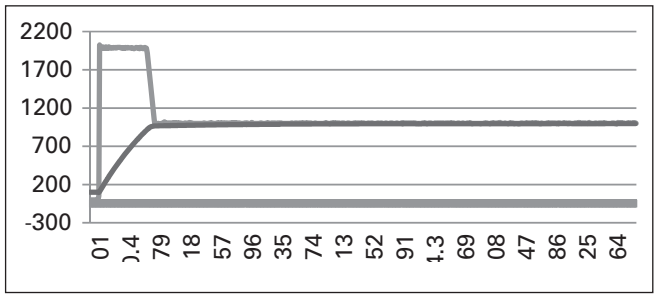
5.7 Current and magnetization handling

The DC brake can be used to hold the motor in place (nominal torque at nominal slip). It can be also used to keep the motor warm in places with high humidity and to speed up the generation of rotor flux. Rotor flux is needed in the induction motor to generate torque.

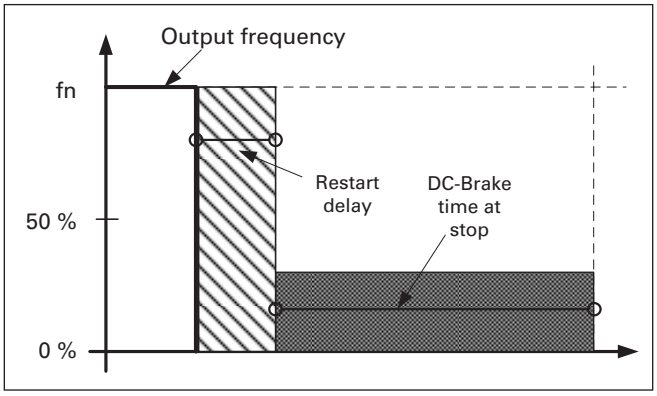
The current that is needed to make the nominal flux is defined by the magnetization current parameter but, depending on motor size, nominal flux takes a different time to produce after start command.

Giving a higher current on start to the motor will decrease the time when the motor is able to generate nominal torque. Blue: Motor Current. Red: Rotor Flux.

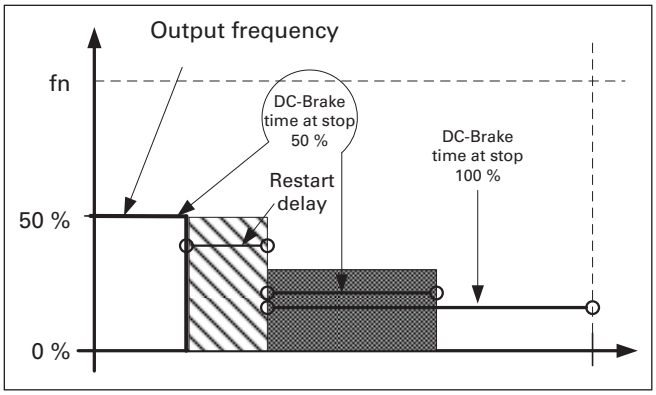




5.7.1 Limit warnings

Code	ID	Parameter	Notes
P1.7.1.1	507	**DC-Braking current "DC-Brake current"** Defines the current injected into the motor during DC-braking. On start this parameter is used together with DC Brake time to decrease the time when motor is able to produce nominal torque. When DC brake current is applied to the motor the output frequency is zero.	
P1.7.1.2	516	**DC-Braking time at start "Start DC-BrakeTm"** DC-brake is activated when the start command is given. This parameter defines for how long DC current is given to the motor before acceleration starts. DC brake current at start is used in order to magnetize the motor before running which will improve torque performance at start. Needed time depends on motor size, value varying between 100 ms to 3 second. The bigger the motor the more time is needed. The default setting 0,00 s means that 200 ms is spent to magnetize motor. This 200 ms can be set to zero with parameter "MakeFluxTime". Activating flying start will disable the DC brake functions at start.	
P1.7.1.3	508	**DC-Braking time at stop "Stop D-BrakeTm"** Defines the time to use DC brake at stop. The operation is different depending on the selected stop mode (coasting or ramping). Stop function = 0/Coasting: After the stop command, the motor coasts to a stop without control of the 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 at the moment of stop command. If the frequency is the nominal frequency of the motor or higher, the set value of DC braking time at stop is used as the braking time. When the frequency is below the nominal frequency, the relation between the nominal frequency and the output frequency at the time of stop command will determine the DC braking time. For example, 50-hertz motor is running at 25 Hz when the stop command is given. The DC brake time will be 50 % of the DC braking time at stop. If the frequency is below 5 Hz the minimum DC braking time is 10 % of the DC braking time at stop. DC braking is started after a short restart delay following the stop command if stop function is coasting.  **Figure 5-13. DC-Braking time when Stop mode = Coasting, from nominal speed and 50 % of nominal speed.** Stop function = Ramp: After the Stop command, the speed of the motor is reduced according to the set deceleration parameters, to the speed defined with parameter DC braking frequency at stop, where the DC braking starts.	

Code	ID	Parameter	Notes
P1.7.1.3	508	**DC-Braking time at stop "Stop D-BrakeTm"**	



The braking time is defined with parameter DC braking time at stop. If high inertia exists, it is recommended to use an external braking resistor for faster deceleration.
See Figure 5-14.

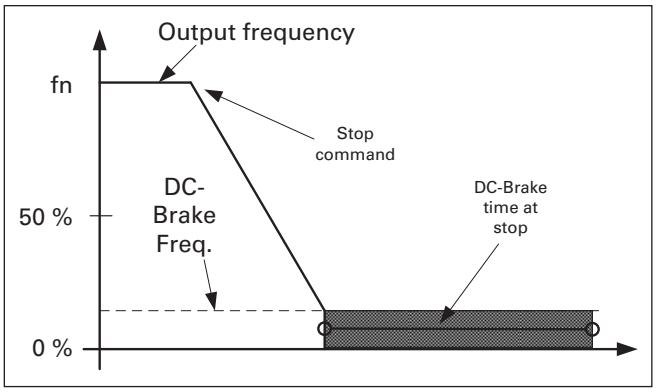
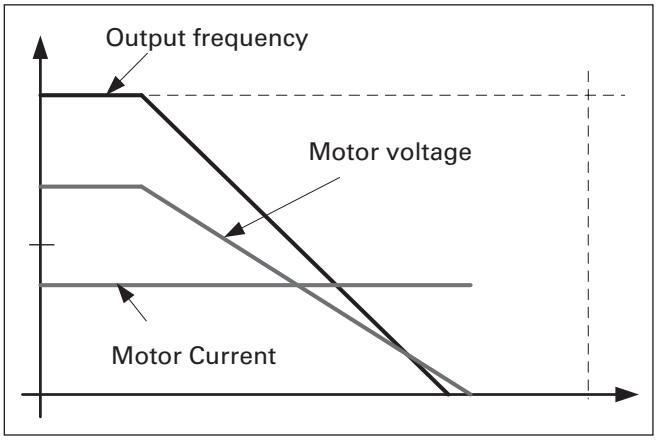
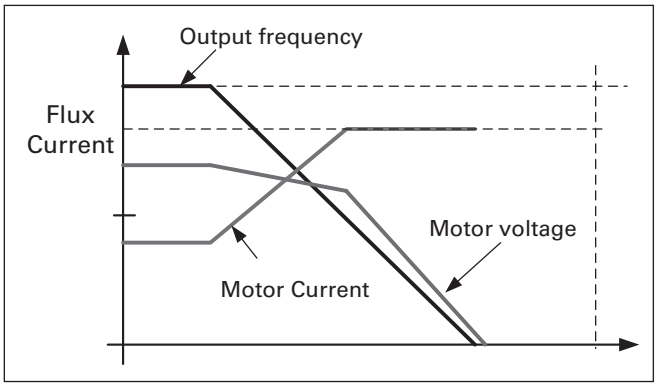


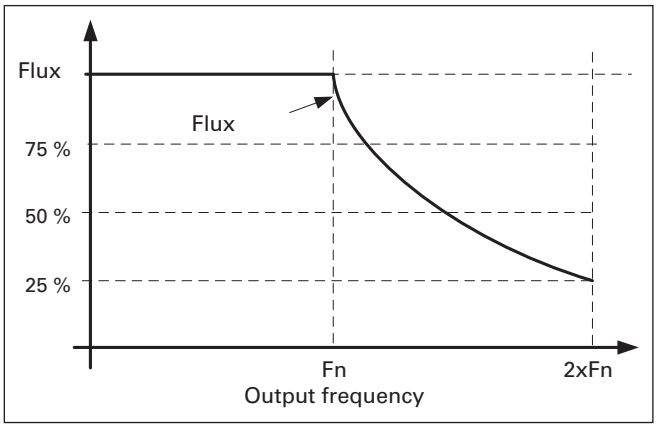
Figure 5-14. DC-braking time when stotop mode = Ramp

P1.7.1.4	515	**DC Braking frequency at stop "Stop D-BrakeFr"** The output frequency at which the DC braking is applied when making ramping stop.	
P1.7.1.5	400	**Scaling of DC-braking current "DC-currnt Scln"** The DC braking current can be reduced with the free analog input signal between zero current and the current set with parameter DC Braking Current. 0 = Not used 1 = AI1 2 = AI2 3 = AI3 4 = AI4 5 = FB Limit Scaling ID46 Monitoring value	
P1.7.1.6	1080	**DC Brake current in stop "DCBrakeCurInStop"** Defines the current injected to the motor in stop state when the digital input signal "DC Brake Command" is used to activate the DC brake when no run request is active. When the DC brake is activated the drive will indicate being in Run state.	

5.7.1.1 Flux braking

Code	ID	Parameter	Notes
P1.7.1.7	520	**Flux brake "Flux Brake"** 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. This increases losses on motor, which in turn increases the motor's capability to brake. Unlike in 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  	
P1.7.1.8	519	**Flux braking current "FluxBrakeCurrent"** Defines the flux braking current value. The value setting range depends on the used unit size.	

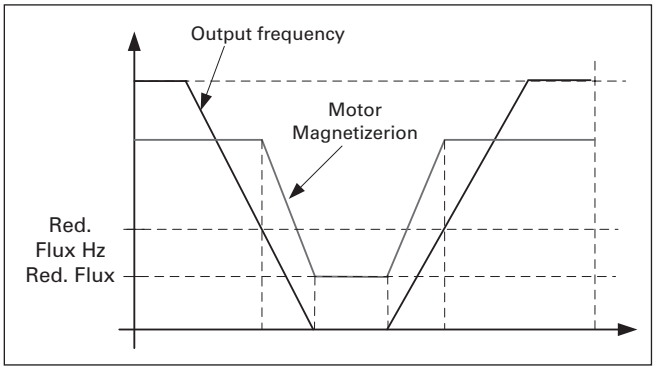
5.7.2 Closed loop settings

Code	ID	Parameter	Notes
P1.7.2.1	627	**Magnetizing current at start "start magn curr"** Defines the current that is applied to the motor when the start command is given in closed loop control. At start this parameter is used together with Magnetizing time at start to decrease the time when the motor is able to produce nominal torque. In closed loop control output frequency is not forced to zero while magnetization current is applied to motor.	
P1.7.2.2	628	**Magnetizing time at start "start magn time"** Defines the time for how long magnetization current is applied to motor at start. Magnetizing current at start is used to shorten the time when flux is at nominal level. This will improve the torque performance at start. The time needed depends on the motor size, value varying between 100 ms to 3 second. The bigger the motor the more time it needs. Set this time so that the rotor flux is more than 90 % before speed is released (Start Zero Speed Time ID615) or mechanical brake is released.	
P1.7.2.3	1250	**Flux reference "FluxReference"** Reference value for rotor flux. Rotor flux can be reduced by changing the magnetization current. This, however, also affects the motor model making the torque calculations a little less accurate. When using this parameter the motor model can compensate the effect of the different magnetization current in torque calculations. $= \left(\frac{f\,(\text{MotorNomFreq})}{f\,(\text{Out})}\right)^2$ when f (Out) > f (MotorNomFreq) [FW]RotorFlux  	
P1.7.2.4"	1402	**Flux off delay "Flux off delay"** The Flux off delay function will keep the motor magnetized after a stop command thus making the next start faster because flux is already available in the motor. The function is used e.g. in a system where several repeated starts are made in short cycles. The flux level can be adjusted by parameter Stop State Flux. 0 = Flux is not maintained in the motor >0 = Flux off delay in seconds. -1 = Flux is maintained indefinitely in the motor	
P1.7.2.5	1401	**Stop state flux "Stop state flux"** The amount of flux in percentage of the motor nominal flux maintained in the motor after the drive is stopped. The flux is maintained for the time set by parameter ID1402 Flux Off Delay. This parameter can only be used in closed loop motor control.	

5.7.2.1 Reduced flux function

Reduced flux function is used to decrease the magnetization current below a certain frequency limit. This function is used in systems where high starting torque is not needed. This function CAN NOT be used in any situation where motor nominal torque from zero speed is required.

Code	ID	Parameter	Notes
P1.7.2.6	627	**Reduced Flux frequency** A frequency point where flux starts to reduce to a level defined by Reduced Flux Level toward the zero speed.	
P1.7.2.7		**Reduced flux level** This parameter defines the flux level when the output frequency is zero. The flux is reduced linearly from ID1614 to zero frequency.	



5.8 Motor control

Open Loop control

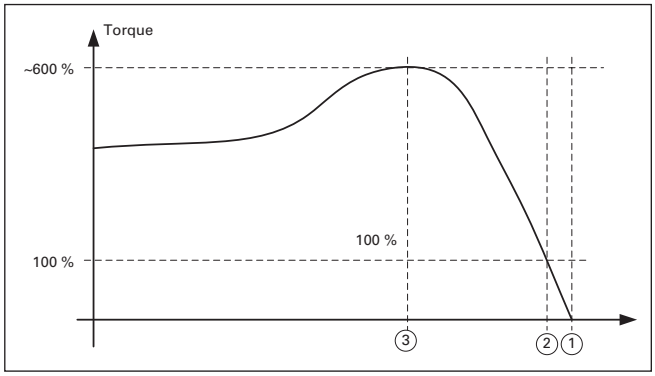
Open loop control controls the motor without encoder feedback from the motor shaft. Control mode selections 0, 1 and 2 are open loop control modes.

Slip

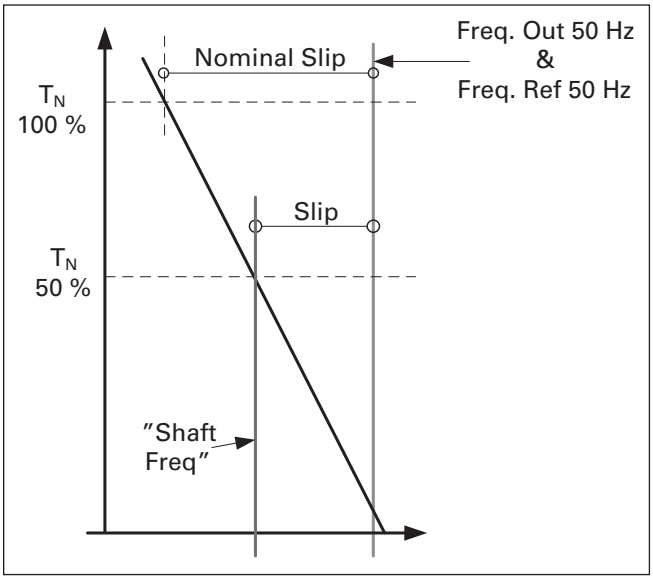
Induction motor torque is based on slip. When load increases also slip will increase. Slip is the speed that rotor is behind of stator electrical frequency.

Right hand side picture presents torque that is produced by induction motor when connected directly on line.

1. Motor Synchronous speed. Motor is taking only magnetization current
2. Motor nominal operation point. Motor is producing 100 % of rated torque and power. Actual shaft speed is motor nominal speed and motor takes nominal current
3. Pullout torque. This is point where motor produced torque start to decrease when slip increases. After this point motor will stop if load is not reduced

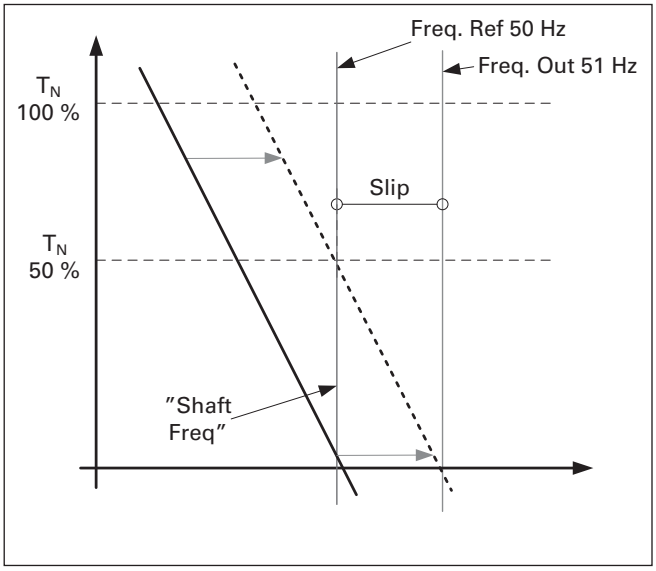


In frequency control, the load will determine the actual shaft speed



Slip compensation in open loop control

The drive uses motor torque and motor nominal rpm to compensate slip. If the motor nominal rpm is 1440 -> the nominal slip is 60 rpm. and when the motor torque is 50 % the slip is 30 rpm. To keep the reference speed the drive must increase the output frequency by 1 Hz.



Closed Loop control

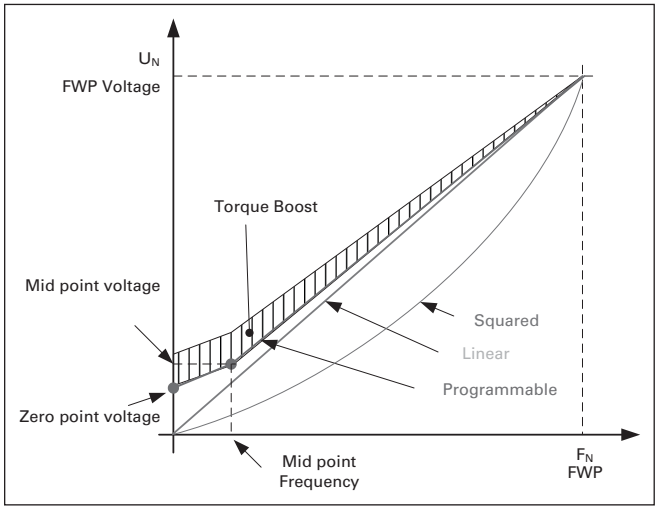
Closed loop control controls the motor using the exact information of the motor speed from the encoder. Control mode selections 3 and 4 are closed loop control modes. Using these modes without encoder board (and encoder) will result in encoder fault.

Code	ID	Parameter	Notes
P1.8.1	**600**	**Motor control mode "motor ctrl mode" (2.6.1)** 0 "Freq Control" Open loop frequency control: Drive frequency reference is set to output frequency without slip compensation. Motor speed is defined by motor load. 1 "OL SpeedCont" Open loop speed control: Drive frequency reference is set to motor speed reference. Motor speed stays the same regardless of motor load. 2 "OLSpeed/Torq" Open loop Speed or Torque control In this control mode the drive can be selected to run in torque control mode. The operation is selected by parameter TorqueSpeedLimit in the Torque Reference parameter group. The default selection is torque control mode speed limited by ramp generator output. 3 "CL SpeedCtrl" Close loop speed control Drive frequency reference is set to motor speed reference. Motor speed stays the same regardless of motor load. 4 "CLSpeed/Torq" Closed loop speed or torque control In this control mode the drive can be selected to run in torque control mode. The operation is selected by parameter TorqueSpeedLimit in the Torque Reference parameter group. The default selection is torque control mode speed limited by ramp generator output. When the drive is follower and drive synch is enabled the motor control mode is internally set to Frequency control.	
P1.8.2	**521**	**Motor control mode 2 "Motor Ctrl Mode2"** With this parameter you can set another motor control mode which is activated with parameter Mot Ctrl Mode1/2.	The Motor control mode cannot be changed between open loop and closed loop while the drive is in Run state.

Code	ID	Parameter	Notes
P1.8.3	**1278**	**Torque Select ID1278 "Torque select"** This parameter defines the speed limiting mode in torque control mode. This parameter can be used as single motor control mode selection when no change is made between open loop and closed loop controls. 0= "SpeedControl" - Speed control mode The drive is forced to operate in speed control mode while the motor control mode parameter is set to torque control mode thus allowing selection of speed control and torque control mode with single parameter e.g. from Fieldbus. 1 ="MaxFreqLimit" - Positive and negative frequency limits Speed is not limited by speed reference, only maximum frequency or Positive and Negative frequency limit if set lower than maximum frequency parameter. 2 ="RampOutput" – Ramp output for both directions Speed is limited by reference after ramp generator, thus speed will increase with set ramp time until actual torque is equal to reference torque. If speed is below reference when load is removed from the shaft the speed will increase without ramp. This is the default selection. For master follower system it is recommended to use selection that allows a little higher reference for torque follower that load will be balanced equally e.g. window control. 3 ="Min" – Minimum from speed reference and torque reference. The minimum of the speed controller output and the torque reference is selected as final torque reference. 4 ="Max" – Maximum from speed reference and torque reference The maximum of the speed controller output and the torque reference is selected as final torque reference. 5 ="Window" – Window control Speed is limited within window from speed reference. Speed control activation limit is different from the speed limit. Speed needs, therefore, to go first to "Window Pos" or "Window Neg" limit before the speed controller activates, when speed controller is active speed will be restricted to limit defined by "Window Pos Off" and "Windows Neg Off" from the "FinalFreqRef"	

5.8.1 U/f Settings

U/f settings are mainly used in open loop control modes with the exception of the Field weakening point voltage that is also used in closed loop control mode as a limit for voltage. U/f settings are used to control the voltage level that are applied to the motor at different frequencies and different load situations.



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

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

Option 1: Automatic functions

Step 1: Make identification with rotating motor

Step 2 (If needed): Activate speed control or U/f optimization (Torque boost).

Step 3 (If needed): Activate both speed control and U/f optimization.

Option 2: Manual tuning

Step 1: Run the motor using 2/3 of motor nominal frequency as the frequency reference. Read the motor current in the monitoring menu or use 9000xDrive for monitoring. This current shall be set as the motor magnetization current.

Change the U/f curve ratio selection to programmable (= 2).

Run the motor with zero frequency reference and increase the motor zero point voltage until the motor current is approximately same as the motor magnetising current. (If the motor is in a low frequency area for only short periods, it is possible to use up to 65 % of the motor nominal current).

Set then the midpoint voltage to VÖ2 * Zero Point Voltage and the midpoint frequency to (Zero Point Voltage/100%)*Nominal frequency of motor)

Step 2 (If needed): Activate speed control or U/f optimization (Torque boost).

Step 3 (If needed): Activate both speed control and U/f optimization.

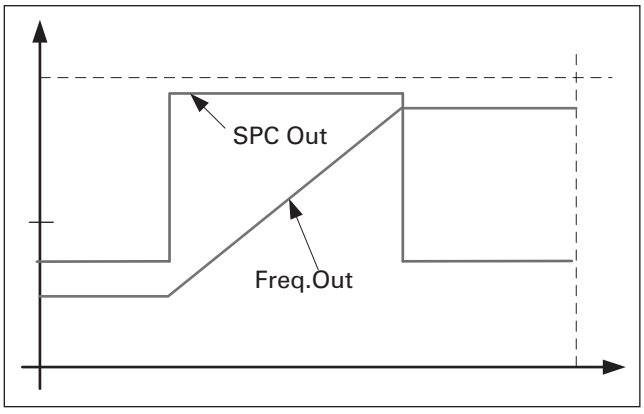
Note: In high torque – low speed applications – it is likely that the motor will overheat. If the motor has to run long times under these conditions, special attention must be paid to cooling of the motor. Use external cooling for the motor if the temperature tends to rise too high.

Code	ID	Parameter	Notes
P1.8.4.1	**109**	**U/f Optimisation "U/f optimization"** Automatic torque boost The voltage to the motor changes proportionally to required torque which makes the motor produce more torque at start and when running at low frequencies. Automatic torque boost can be used in applications where starting torque due to starting friction is high, e.g. in conveyors. Even with linear U/f curve, the torque boost has an affect but the best result will be achieved after the identification run when programmable U/f curve is activated.	
P1.8.4.2	**108**	**U/f Ration selection "U/f ratio select"** Linear: 0 The voltage of the motor changes linearly from zero point voltage to the field weakening point where the voltage at FWP is supplied to the motor. Squared: 1 The voltage of the motor changes from zero point voltage following the squared curve form zero frequency to the field weakening point. The motor runs under magnetised below the field weakening point and produces less torque. Squared U/f ratio can be used in applications where torque demand is proportional to the square of the speed, e.g. in centrifugal fans and pumps. Programmable U/f curve: 2 The U/f curve can be programmed with three different points. 1. Zero point voltage 2. Midpoint frequency and Midpoint voltage 3. Field weakening point and field weakening point voltage Programmable U/f curve can be used if more torque is needed at low frequencies. Make the Identification run for optimal setting (ID631). Linear with flux optimisation: 3 The frequency converter starts to search for the minimum motor current in order to save energy. This function can be used in applications with constant motor load, such as fans, pumps etc.	
P1.8.4.3	**602**	**Field weakening point "Field weakngPnt"** The field weakening point is the output frequency at which the output voltage reaches the field weakening point voltage.	
P1.8.4.4	**603**	**Voltage at field weakening point "Voltage at FWP"** 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. When the parameter Motor nominal frequency is set, the parameter Field weakening point is automatically given the corresponding value. If you need different values for the field weakening point and the maximum output voltage, change these parameters after setting the Nominal frequency. In closed loop control this defines maximum voltage to the motor, can be increases if sufficient DC voltage is available.	
P1.8.4.5	**604**	**U/f Curve, middle point frequency "U/f Mid Freq"** If the programmable U/f curve has been selected with parameter U/f ratio this parameter defines the middle point frequency of the curve. See also parameter Middle point voltage. When the programmable U/f curve is selected this value is set to 10 % of motor nominal frequency.	

Code	ID	Parameter	Notes
P1.8.4.6	605	**U/f Curve, middle point voltage "U/f mid voltg"** If the programmable U/f curve has been selected with the parameter U/f ratio this parameter defines the middle point voltage of the curve. See also parameter Middle point frequency. When the programmable U/f curve is selected this value is set to 10 % (of motor nominal voltage).	
P1.8.4.7	606	**Output voltage at zero frequency "Zero freq voltg"** This parameter defines the zero frequency voltage of the U/f curve. The default value is unit size dependent.	If the value of parameter U/f Ratio Select is changed this parameter is set to zero.

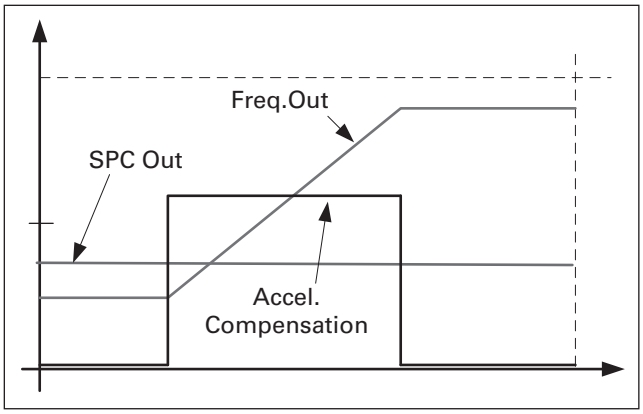
5.8.2 Close loop settings

Code	ID	Parameter	Notes
P1.8.5.1	617	**Current control P gain "CurrentControlKp"** Sets the gain for the current controller. The controller generates the voltage vector reference to the modulator. The gain is also used in open loop flying start. When the Sine filter parameter (parameter P6.7.5 in the System menu) has been set to Connected the value of this parameter is changed to 20.00 %. The value is also identified when using a PMS motor and making identification run with rotating motor. At low speed the motor values may increase up to 300 %. At high speed motor gain and motor with sine filter may have gain values of 10...40 %.	
P1.8.5.3	657	**Current control Ti "CurrentControlTi"** Current controller integrator time constant.	
P1.8.5.3	619	**Slip adjust "Slip adjust"** The motor name plate speed is used to calculate the nominal slip. This value is used to adjust the voltage of motor when loaded. The name plate speed is sometimes inaccurate and this parameter can therefore be used to trim the slip. Reducing the slip adjust value increases the motor voltage when the motor is loaded.	
P1.8.5.4	626	**Acceleration compensation "Accel.Compens."** Sets the inertia compensation to improve the speed response during acceleration and deceleration. The time is defined as acceleration time to nominal speed with nominal torque. This function is used when the inertia of the system is known to achieve the best speed accuracy when reference is changed. Acceleration compensation is added to TorqueReferenceActual i.e. torque is added after speed controller. The speed controller can, therefore, be tuned only for speed error and the acceleration compensation makes sure that the system inertia does not affect the speed controller.	



Acceleration compensation not in use

Code	ID	Parameter	Notes
P1.8.5.4	626	**Acceleration compensation "Accel.Compens."**	



Acceleration compensation in use

$$\text{AccelCompensation TC} = J.\frac{2\pi \cdot f_{nom}}{T_{nom}} = J.\frac{(2\pi \cdot f_{nom})^2}{P_{nom}}$$

J = System inertia (kg*m2)

f_{nom} = Motor nominal frequency (Hz)

T_{nom} = Motor nominal torque

P_{nom} = Motor nominal power (kW).

P1.8.5.5	1311	**Speed error filtering time constant "SpeedErrorFiltTC"** Filter time constant for speed reference and actual speed error. May be used to remove small disturbances from encoder signal.	
P1.8.5.6	618	**Encoder filter time "Encoder1FiltTime"** Sets the filter time constant for speed measurement. The parameter can be used to eliminate encoder signal noise. Too high a filter time reduces speed control stability. Values over 10 ms are not recommended in normal cases.	
P1.8.5.7	1595	**Encoder selection "Encoder Selector"** With this parameter it is possible to select which encoder input is used for closed loop control. Encoder board OPT-A7 is needed because of the possibility to connect two encoders. 0,1 = Encoder input 1 2 = Encoder input 2	
P1.8.5.8	1577	**Speed Control Torque Chain Select "SCTorqueChainSel"** Values are bit coded. For example, after identification run with rotating motor the value will be 96. If you want to activate an external acceleration compensation you need to add +2 to the existing value. B0 +1 = Additional torque limit The torque reference chain can be used as an additional torque limit. This option is available in closed loop control mode only. B1 +2 = External acceleration compensation The torque reference is added to the speed control output, allowing the external controller to give inertia compensation for the drive in speed control mode. This option is available in closed loop control mode only. B5&B6, +96 = Internal motor temperature compensation When the motor cools down or warms up the slip of the motor will change. When this function is activated in closed loop control mode the drive will estimate changes in motor resistance and correct the changes of motor slip automatically to achieve the best torque estimation. This function is automatically activated when identification run with rotating motor is successfully finished. This option is available in closed loop control mode only.	

5.8.3 Permanent magnet synchronous motor settings

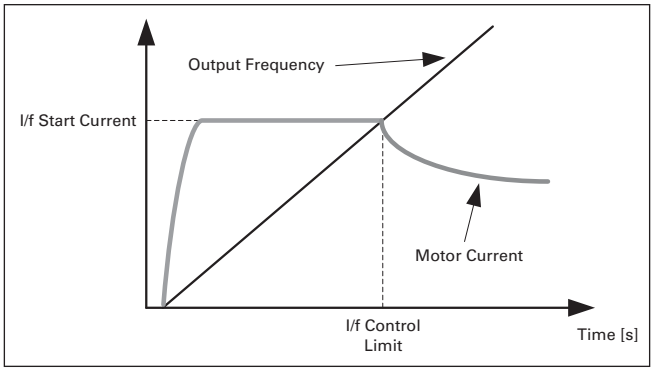
There are three ways to know the magnet positions when using the closed loop control. The first one will identify the motor magnet position during every stat when using incremental encoder without Z-pulse.

Second one uses incremental encoder Z-pulse and the third one uses absolute encoder information. See details of selecting correct mode from chapter "Identification function for permanent magnet synchronous motor".

Code	ID	Parameter	Notes
P1.8.6.1	**649**	**PMSM shaft position "PMSMShaftPositio"** Absolute encoder position value corresponding to the shaft position where rotor magnet axis is aligned with the stator U-phase magnet axis will be stored here as a result of the encoder identification run. If incremental encoder with a z-pulse is used, z-pulse position will be stored instead. Depending on the motor shaft mechanical position, this parameter can have different values, as there is one right value for each pole-pair of the motor. If incremental encoder and the z-pulse is utilized, the first start after power up is less optimal and i/f-control (see 6.8.3.2) will be used until the drive finds the z-pulse and is able to synchronize in that.	
P1.8.6.2	**1691**	**Start angle Identification Mode "StartAngleIdMode"** Start angle, i.e. rotor magnet axis position in respect to the stator U-phase magnet axis, identification is needed if there are no absolute encoder or incremental encoder with z-pulse used. This function defines how the start angle identification is made in those cases. Identification time depends on the motor electrical characteristics but takes typically 50ms...200ms. In case of absolute encoders, start angle will read directly from the encoder absolute angle value. On the other hand, incremental encoder z-pulse will be used automatically for synchronization if it's position is defined different from zero in P1.8.5.1. Also for absolute encoders, P1.8.5.1 must be different from zero, otherwise it is interpreted that the encoder identification run has not been done and the running will be prohibited except if the absolute channel is bypassed by the start angle identification. 0 = Automatic Decision to use start angle identification is made automatically based on the encoder type connected to the drive. This will serve common cases. Supports: OPT-A4, OPT-A5, OPT-A7 and OPT-AE boards. 1 = Forced Bypasses the drive automatic logic and forces the start angle identification to be active. Can be used, for example, with absolute encoders to bypass absolute channel information and to use start angle identification instead. 2 = On Power UP As a default, start angle identification will be repeated in every start if the identification is active. This setting will enable identification only in a first start after drive is powered up. In consecutive starts, angle will be updated based on the encoder pulse count. 10 = Disabled Used when Z- pulse from encoder is used for start angle identification.	ModulatorType (P1.10.2) need to be > 0 to be able to use this function.
P1.8.6.3	**1759**	**Start angle identification current "StartAngleIdCurr"** This parameter defines the current level that is used in start angle identification. The correct level depends of the motor type used. In general, 50% of motor nominal current seems to sufficient, but depending for example on the motor saturation level, higher current might be needed.	
P1.8.6.4	**1566**	**Polarity pulse current "PolarityPulseCur"** This parameters defines the current level for the magnet axis polarity direction check during the start angle identification (P1.8.5.2). Value 0 means that the internal current level is used, which is typically slightly higher than the normal identification current defined by P1.8.5.3. Polarity direction check is seldom needed because the identification itself gives already the right direction. Hence in most cases, this function can disabled by setting any negative parameter value, which is recommended especially if there occurs F1 faults during the identification.	
P1.8.6.5	**1755**	**Start Angle Identification Time "StartAngleIdTime"** Start angle can be determined also by feeding dc-current into the motor. Then dc-current will align the rotor magnet axis with the stator magnet axis. This function is activated by determining the time duration dc-current is injected to the motor. Motor must be free to move during the alingment and the time need to be long enough for shaft oscillations to damp out. Hence, this method is not so pracatical and is intednded to be used mainly for testing purposes or to improve starting in together with i/f-control. Dc-current level is determined by P1.8.5.6. Also P1.8.5.2 need to disabled otherwise overriding this function.	

5.8.3.1 I/f Control

I/f-control can be used to start the motor using a constant current control. This is useful especially, if the motor stator resistance is low, which makes the motor current sensitive for u/f-curve tuning at low speed area. I/f-control is activated by setting AdvancedOptions2.B9 = 1 (P1.10.6) for PM-motors. Also software modulator is required.



Code	ID	Description	Notes
P1.8.6.6	**1693**	**I/f current "I/f current"** This parameter defines the current level during I/f control, in percent of the motor nominal current Zero position with incremental encoder and Z-Pulse In closed loop control utilizing the encoder z-pulse, defines also the current level used in starting before the z-pulse is received to synchronize with. DC Start Angele identification This parameter defined DC Current level when Start Angle Identification Time is set greater than zero. See P1.8.5.5 Start Angle Identification Time.	I/f Current parameter is used for several different purposes.
P1.8.6.7	**1790**	**I/f control limit "I/f control lim"** This parameter sets the frequency limit for I/f-control in per cent of the motor nominal frequency. I/f-control is used if the frequency is below this limit. The operation changes back to normal when the frequency is above this limit with 1 Hz hysteresis.	

5.8.3.2 Flux current controller

The flux current controller is used with a PMS motor when running in closed loop control in the field weakening area. This function controls negative Id current to PM motor in the field weakening area that motor terminal voltage do not increase above maximum level (set by field weakening point voltage, maximum drive output voltage).

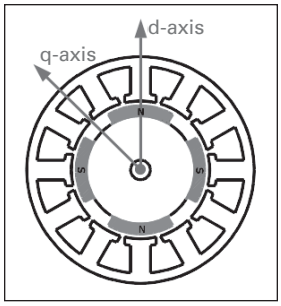
Field weakening area operation depends on motor construction and motor construction may prohibit operation above field weakening area.

If there is instability in the field weakening area, gain can be decreased and/or time constant increased.

Code	ID	Description	Notes
P1.8.6.8	**551**	**Flux current Kp "FluxCurrent Kp"** Defines gain for the flux current controller when using a PMS motor. Depending on motor construction and the ramp rate that is used to go to field weakening area high may be needed that output voltage do not reach maximum limit and prevent proper motor control. Too high gain may also lead to unstable control. Integration time is more significant in this case for control.	I/f Current parameter is used for several different purposes.
P1.8.6.9	**652**	**Flux current Ti "FluxCurrent Ti"** Defines the integration time for the flux current controller when using a PMS motor. Depending on motor construction and the ramp rate that is used to go to field weakening area, short integration times may be needed that output voltage do not reach maximum limit and prevent proper motor control. Too fast integration time may also lead to unstable control.	
P1.8.6.10	**1730**	**ExtIdRef "ExtIdRef"** This reference value can be used for the external control of the motor id-current i.e. reactive current. Normally there is no need for that as the control uses already the optimal value. This reference value is additive to drive internal values but, for example, field-weakening controller can override the given reference in field-weakening operation.	
P1.8.6.11	**654**	**EnableRsIdentifi "EnableRsIdentifi"** This parameter enables the Rs identification during DC brake current operations and in closed loop control for every start. If the identification run was made successfully it is recommended to keep this parameter disabled.	

5.8.3.3 D And Q axis voltage drops

If d-axis and q-axis reactance's (voltage drops) are defined, drive calculates the optimal d-axis current reference based on the reactance values and the motor torque in order to account motor reluctance torque part. In this way, motor Torque/Current ratio can be increased.



Code	ID	Description	Notes
P1.8.6.12	**1757**	**Lsd voltage drop "Lsd Voltage Drop"** D-axis reactance voltage drop 2560 = 100%. Gives the % voltage drop across the stator inductance at nominal current and frequency. X_d [Drive scale] = $\frac{X_d [\Omega] * I_n [A] * \sqrt{3} * 2560}{U_n [V]}$	
P1.8.6.13	**1758**	**Lsq voltage drop "Lsq Voltage Drop"** Q-axis reactance voltage drop 2560 = 100%. Gives the % voltage drop across the stator inductance at nominal current and frequency. X_q [Drive scale] = $\frac{X_d [\Omega] * In [A] * \sqrt{3} * 2560}{U_n [V]}$	
P1.8.6.14	**1734**	**Encoder ID current %**	
P1.8.6.15	**1737**	**Polarity ID mode**	
P1.8.6.16	**1742**	**Polarity pulse length ms**	
P1.8.6.17	**1748**	**Polarity detection angle deg**	
P1.8.6.18	**1749**	**Angle identification mode**	
P1.8.6.19	**1761**	**Current control Kpd %**	
P1.8.6.20	**1759**	**Voltage margin %**	

5.8.4 Stabilization settings

5.8.4.1 Torque stabilizer

The torque stabiliser is basically a first order high-pass filter for the estimated torque [T]. The output of the filter is a frequency correction term df added to the output frequency reference. The purpose of the torque stabiliser is to stabilise the possible oscillations in the estimated torque.

The controller gain is changing linearly between the zero and field weakening point frequencies. The zero and field weakening point gains can be controlled independently with gains. The stabiliser operates at frequencies above 3 Hz.

The discrete implementation of the filter is:

$$\frac{1000}{Torqstabdamp}\, df_k = \frac{1000}{Torqstabdamp}\, G\,(T_K - T_{K-1}) + df_{k-1} = G_f\,(T_K - T_{K-1}) + df_{k-1}$$

Where Gf is the total gain of the filter. The gain and the corner frequency of the filter is controlled by the following parameters

Code	ID	Description	Notes
P1.8.7.1	1413	**Torque stabilizer damping "TorqStabDamp"** If a PMS motor is used in open loop control mode it is recommended to use value 980 instead of 800. The value '980' is set automatically when PMS motor is selected. This parameter defines the corner frequency of the high-pass filter. The time constant of the filter is calculated as $T_c = T_s \frac{TorqStabDamp}{1000 - TorqStabDamp} = 1ms \frac{TorqStabDamp}{1000 - TorqStabDamp}$ It follows that the corner frequency of the filter is obtained from For example, if Torque stabilizer damping = 600, it follows that Tcc = 1.5 ms and ω_c = 667 rad/s. $\omega_c = \frac{1}{T_c} rad/s$	
P1.8.7.2	1412	**Torque stabilizer gain "TorqStabGain"** These parameters define together with the Torque Stabiliser Damping the actual gain of the filter. Torque Stabiliser Gain is the gain at the zero frequency. Torque stabiliser Gain in FWP is the gain at the field-weakening frequency. The gain changes linearly with the frequency between these two points so that the gain is $G = TorqStabGainFWP + TorqStabGain - \frac{f}{f_{FWP}} TorqStabGain, \quad if \ f < f_{FWP}$ $G = TorqStabGainFWP, \quad if \ f \geq f_{FWP}$ The final gain is obtained by considering the value of Torque Stabiliser Damping and the scaling in which 256 means the gain 1. So, the final and the actual gain of the filter is obtained from $G_f = \frac{1000 * G}{256 * TorqStabDamp}$	
P1.8.7.3	1414	**Torque stabilizer Gain in FWP area "TorqStabGainFWP"** Gain of the torque stabiliser at field weakening point in open loop motor control operation. See details from Torque Stabiliser Gain.	
P1.8.7.4	1720	**Torque stabilizer Limit "TorqStabLimit** This defines how much torque stabiliser can affect output frequency.	

5.8.4.2 Flux circle stabilizer

Code	ID	Description	Notes
P1.8.7.5	1550	**Flux Circle stabiliser Gain "FluxCircleStabG"** Gain for flux circle stabiliser. This will control the flux to origin when error is detected. Controller output is added to output frequency. Affect decreases at low frequencies where flux stabiliser has more affect. Used at frequencies where output voltage is at maximum limit (set by field weakening point voltage or maximum drive output voltage).	

5.8.4.3 Flux stabilizer

Flux stabilizer is a first order high-pass filter for the estimated flux producing current Id. The output of the filter is correcting term dU added to the output voltage reference.

The gain and the corner frequency of the filter is controlled by the following parameters.

Code	ID	Description	Notes
P1.8.7.6	1797	**Flux stabiliser Gain "Flux stab gain"** Flux stabilizer gain is 0 at the zero speed and is increased linearly with the frequency to value defined by the Flux Stab Gain which is reached at the 1 Hz. $G = FluxStabGain * f$, if $f < 1$ Hz $G = FluxStabGain * f$, if $f \geq 1$ Hz The gain is scaled by 1000 and the actual gain of the filter is obtained from $G_f = \frac{G}{1000} = \frac{FluxStabGain}{1000}$	
P1.8.7.7	1551	**Flux stabilizer TC "Fluxstab TC"** Flux Stabilizer TC defines the corner frequency of the high-pass filter. The time constant of the filter is calculated from: $T_C = T_S \frac{65536 - 2 * FluxStab\ TC}{2 * FluxStab\ TC} = 1ms\ (\frac{65536}{2 * FluxStab\ TC} - 1)$ For example , if Flux stabilizer TC = 64 , it follows that T_C = 511MS and ω_C = 1.96 rad/s.	

5.8.4.4 Voltage stabilizer

The voltage stabilizer is similar to the torque stabilizer controlling the change in DC-link voltage at frequencies above 3 Hz. It is a first order high-pass filter for the measured DC-link voltage Udc. The output of the filter is a frequency correction term df added to the output frequency reference. Gain is adjusted relative to the estimated torque.

As the torque increases from 10% to 50 % of the motor nominal torque, the controller gain decreases from the voltage stabiliser Gain down to zero. The gain and the corner frequency of the filter are controlled by the following parameters:

Code	ID	Description	Notes
P1.8.7.9	1552	**Voltage stabilizer TC "VoltageStab TC"** This parameter defines the corner frequency of the high-pass filter. The time constant of the filter is calculated as $T_c = T_s \frac{VoltageStabTC}{1000 - VoltageStabTC} = 1ms \frac{VoltageStabTC}{1000 - VoltageStabTC}\ ms$	
P1.8.7.8	1738	**Voltage stabilizer Gain "VoltStabGain"** Voltage Stabilizer Gain is a function of a torque. If the torque is below 15%, the gain is the value defined by the Voltage Stabilizer Gain. If the torque is above 50% the gain is 0. Between 15-50% the gain decreases linearly with the torque from Voltage Stabilizer Gain to 0. In other words, $G = G\ VoltStabGain$, if $T < 15\%$ $G = \frac{VoltStabGain}{35\%}\ (50\% - T(\%))$, if $15\% \leq T < 50\%$ $G = 0$ if $T > 15\%$ The final gain is obtained by considering the value of Voltage stabiliser TC and the scaling in which 256 means the gain 1. So, the final and the actual gain of the filter is obtained from $G = G\ VoltStabGain$, if $T < 15\%$ $G = \frac{VoltStabGain}{35\%}\ (50\% - T(\%))$, if $15\% \leq T < 50\%$	

Code	ID	Description	Notes
P1.8.7.10	**1553**	**Voltage stabilizer limit "VoltStabLimit"** This parameter sets the limits for the voltage stabilizer output. The maximum and the minimum value for the correction term in FreqScale.	

5.8.5 Tuning settings

Flux stabilizer is a first order high-pass filter for the estimated flux producing current Id. The output of the filter is correcting term dU added to the output voltage reference.

Code	ID	Description	Notes
P1.8.8.1	**1610**	**Flying start options** B0 =+1= Disable movement to reverse direction B1 = +2=Disable AC Scanning B2 = +4=Reserved (No function). B3 = +8=Use encoder information for frequency estimate B4 = +16=Use frequency reference for initial guess B5 = +32=Disable DC scanning for step-up application	
P1.8.8.2	**1740**	**Motor control options** B00 = +1 = Use switching frequency of 3,6 kHz during flying start if below. B01 = +2 = Analog output selection 12; torque sign in open loop shows negative on negative direction on motoring side. B02 = +4 = Enable angle identification in open loop control for PM Motor B03 = +8 = Reserved B04 = +16 = Reserved B05 = +32 = Reserved	
P1.8.8.3	**1760**	**Resonance damping select** Feature can be used to dampen the constant frequency torque oscillations in the drive system. 0 Not in use Only monitoring if Resonance damping frequency > 0,0 Hz. See FW: ResonanceFrequency and FW: ResonanceAmplitude. 1 Band pass, Speed Error. Oscillation damping with band pass filter from speed error. 2 Band Stop + Band pass, Speed error.Oscillation damping with band stop and band pass filter from speed error. 3 Band Pass. Iq Current. Oscillation damping with band pass filter from Iq actual.	
P1.8.8.4	**1763**	**Resonance damping frequency** Frequency of torque oscillations to be damped in Hz.	
P1.8.8.5	**1764**	**Resonance damping gain** The gain for the oscillation damping. This changes amplitude of the compensating signal used for oscillation damping.	
P1.8.8.6	**1765**	**Resonance damping phase** The compensating signal used for oscillation damping can be phase shifted 0 to 360 degrees using this parameter.	
P1.8.8.7	**1770**	**Resonance damping activation frequency** Defines the frequency limit when resonance damping is started.	
P1.8.8.8	**1771**	**Resonance damping filtering TC** Filter TC for external feedback (Iq) signal	
P1.8.8.9	**1515**	**Over modulation limit** Output Voltage Limit for partial modulation in 1%. 100% means maximum sinusoidal modulation. 113% is full six step. If you have sini filter in use set this to 96 %.	
P1.8.8.10	**655**	**Modulation index limit** Modulation index in % for closed loop operation. Higher value of motor terminal voltage can be achieved by increasing this value.	
P1.8.8.11	**1591**	**DC voltage filtering time** Cut off frequency in 0.1Hz for 2nd order butterwort filter used in DCV-compensation.	

Code	ID	Description	9p4.5
P1.8.8.12	**1714**	**AC magnetizing current**	
P1.8.8.12	**1715**	**AC scan time**	
P1.8.8.14	**1716**	**DC magnetizing current**	
P1.8.8.15	**1704**	**Flux build time**	
P1.8.8.16	**1711**	**Flux build torque**	
P1.8.8.17	**1589**	**Motor pole pair**	

0=calculated from motor nom speed

5.8.6 Identification settings

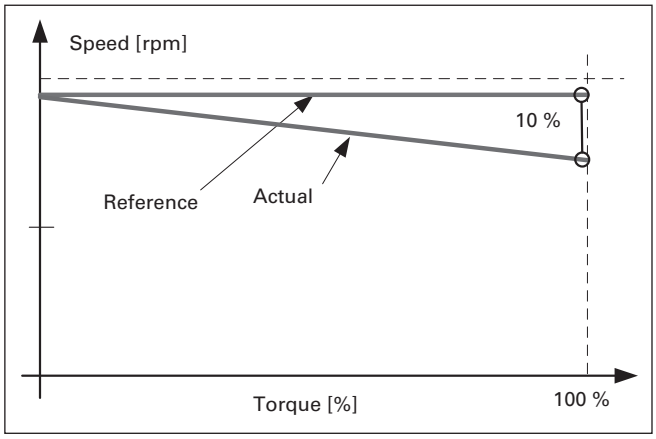
Code	ID	Description	Notes
P1.8.9.1 to P1.8.9.15	**1355-1369**	**Flux 10…150%** Motor voltage corresponding to 10%….150% of flux as a percentage of Nominal. Flux voltage. Measured during identification.	
P1.8.9.16	**662**	**Measured Rs voltage drop "RsVoltageDrop** The measured voltage drop at stator resistance between two phases with the nominal current of the motor. This parameter is identified during identification run. This parameter defines the motor stator resistance as a voltage drop at nominal current. The parameter value is defined according to motor nominal voltage and the current and the actual stator resistance as R_S [Drive scale] = $\frac{R_S[\Omega] * I_n[A] * \sqrt{3} * 2560}{U_n[V]}$	
P1.8.9.17	**664**	**Ir: Add zero point voltage "IrAddZeroPVoltag"** Defines how much voltage is applied to motor in zero speed when torque boost is used.	
P1.8.9.18	**665**	**Ir: Add generator scale "IrAddGeneScale"** Defines the scaling factor for generator side IR-compensation when torque boost is used.	
P1.8.9.19	**667**	**Ir: Add motoring scale "IrAddMotorScale"** Defines the scaling factor for motoring side IR-compensation when torque boost is used.	
P1.8.9.20	**673**	**Measured Ls voltage drop "LsVoltageDrop"** Leakage inductance voltage drop with nominal current and frequency of the motor. This parameter defines the Ls voltage drop between two phases. Use identification run to determine the optimum setting.	
P1.8.9.21	**674**	**Motor BEM Voltage "Motor BEM Voltage"** Motor-induced back voltage.	
P1.8.9.22	**668**	**IU Offset "IU Offset"**	
P1.8.9.23	**669**	**IV Offset "IV Offset"**	
P1.8.9.24	**670**	**IW Offset "IW Offset"** Offsets the value for phase current measurement. Identified during identification run.	
P1.8.9.25	**1782**	**Estimator Kp "Estimator Kp"**	
P1.8.9.26	**1782**	**Estimator Ki "Estimator Ki"** Estimator gain and Ti for PMS motor. Identified during identification run.	
P1.8.9.27	**671**	**Votlage Drop "voltage drop"**	

5.9 Fine tuning parameters

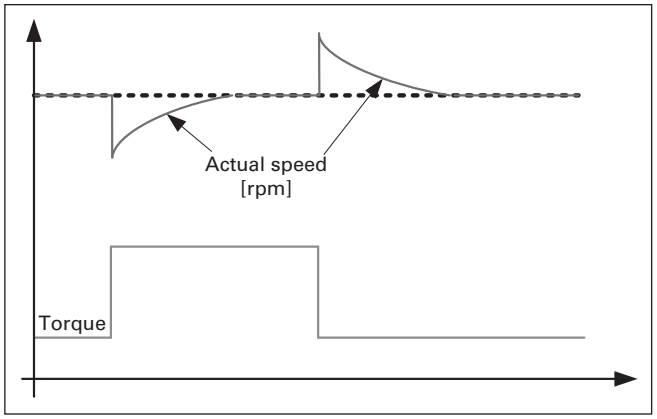
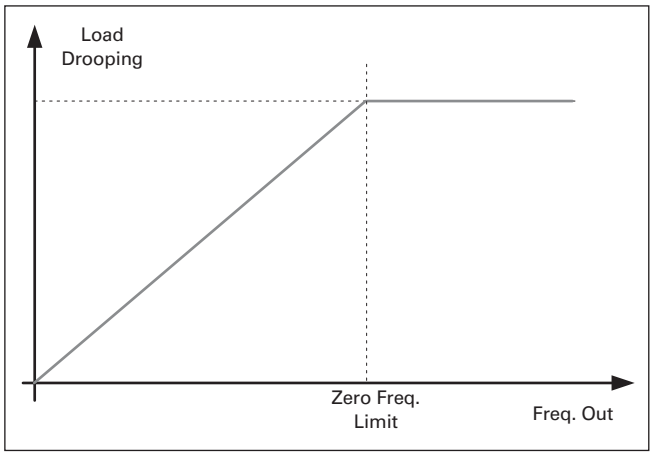
Code	ID	Description	9p4.5
P1.8.10.1	1751	DeadTimeComp.	
P1.8.10.2	1752	DeadTimeContCurL	
P1.8.10.3	1750	DeadTHWCompDisab	
P1.8.10.4	660	MakeFluxTime	
P1.8.10.5	1554	CurrMeasFCompTC	
P1.8.10.6	1576	TCDunDampGain	
P1.8.10.7	1577	TCDynDampTC	
P1.8.10.8	1702	CurrLimOptions	
P1.8.10.9	1701	AdConvStart Shift	
P1.8.10.10	1783	VoltageCorr. Kp	
P1.8.10.11	1784	VoltageCorr Ki	
P1.8.10.12	1558	GearRatioMultip	
P1.8.10.13	1559	GearRatioDivider	

5.10 Speed control settings

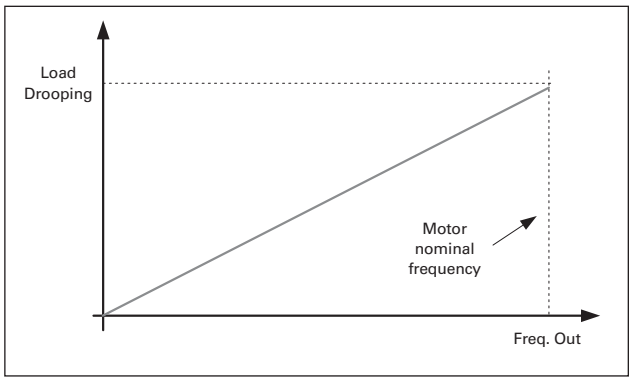
Code	ID	Description	Notes
P1.9.1	620	**Load drooping "LoadDrooping"** The drooping function enables speed drop as a function of load. This parameter sets the value corresponding to the nominal torque of the motor.	



Example: If load drooping is set to 10 % for a motor that has a nominal frequency of 50 Hz and is nominally loaded (100 % of torque) the output frequency is allowed to decrease 5 Hz from the frequency reference. The function is used for e.g. when balanced load is needed for mechanically connected motors.

Code	ID	Description	Notes
P1.9.2	656	**Load drooping time "LoaddroopingTime"** This function is used in order to achieve a dynamic speed drooping because of changing load. The parameter defines the time during which the speed is restored to the level it was before the load increase. 	
P1.9.3	1534	**Load drooping removal "LoadDroopRemoval"** This function defines how load drooping is removed with reference to speed. It is used in lifting situations when it is necessary to keep to load at the same position without closing the brake. When using option 'Normal' the load will slowly come down depending on load and the drooping factor. Normal 0 Load Drooping factor is constant through the whole speed range. Removed below zero frequency limit 1 Load drooping is removed linearly below the zero frequency limit (defined in G2.6.4 Freq. Handling). 	

Code	ID	Description	Notes
P1.9.3	1534	**Load drooping removal "LoadDroopRemoval"** Linearly increased to motor nominal frequency 2 Load drooping is removed linearly from nominal frequency to zero frequency.	



5.10.1.1 Open loop settings

Code	ID	Description	Notes
P1.9.4.1	637	**Speed controller P gain, open loop "OL speed reg P"** Defines the P gain for the speed controlled in Open Loop control mode.	
P1.9.4.2	638	**Speed controller I gain, open loop "OL speed reg I"** Defines the I gain for the speed controlled in Open Loop control mode.	

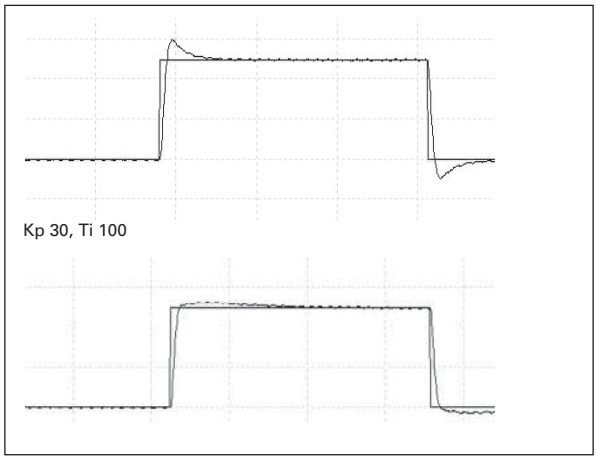
5.10.1.2 Closed loop speed control settings

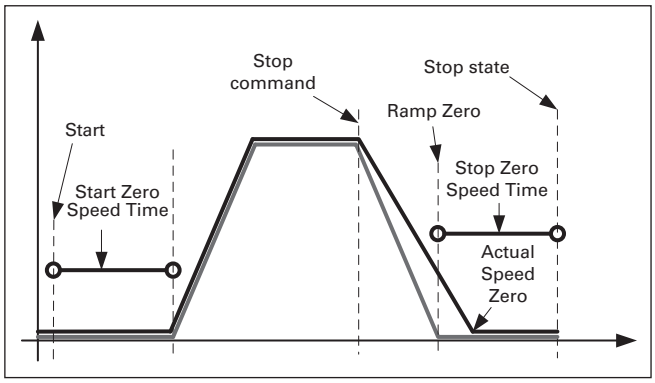
Speed control formula:

$$y = Kp\left[1 + \frac{1}{T i\, s}\right] e$$

$$u\,(k) = y\,(k-1) + Kp\,[e(k) - e\,(k-1) + \frac{Ts}{T i}\, e\,(k)\,]$$

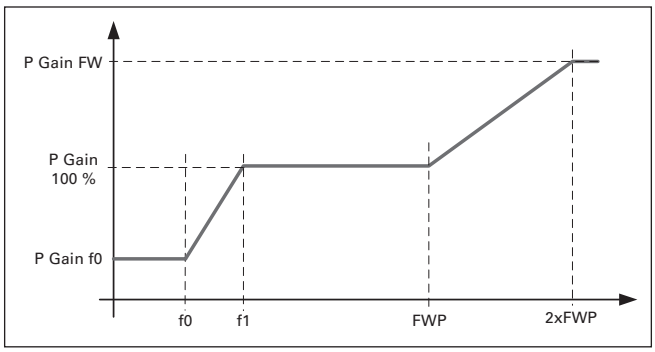
Code	ID	Description	Notes
P1.9.5.1	613	**Speed control P gain "speed control Kp"** Gain for the speed controller in closed loop motor control operation. Gain value 100 means that the nominal torque reference is produced at the speed controller output for the frequency error of 1Hz.	
P1.9.5.2	614	**Speed control I time "speed control Ti"** Sets the integral time constant for the speed controller. Increasing the I-time increases stability but lengthens the speed response time.	



Code	ID	Description	Notes
P1.9.5.3	615	**Zero speed time at start "Start 0SpeedTime"** After giving the start command the drive will remain at zero speed for the time defined by this parameter. The ramp will be released to follow the set frequency/speed reference after this time has elapsed counted from the instant when the command was given.	
P1.9.5.4	638	**Zero speed time at stop ID616 "stop 0 SpeedTime"** The drive will remain at zero speed with controllers active for the time defined by this parameter after reaching the zero speed when a stop command is given. This parameter has no effect if the selected stop function is Coasting. 	That the zero speed time starts when the ramp time is expected to reach the zero speed, not when the actual speed reaches zero. Such situation can happen when the generator power limit is small or the overvoltage controller is active while decelerating.

5.10.1.3 Speed controller tuning for different speed areas

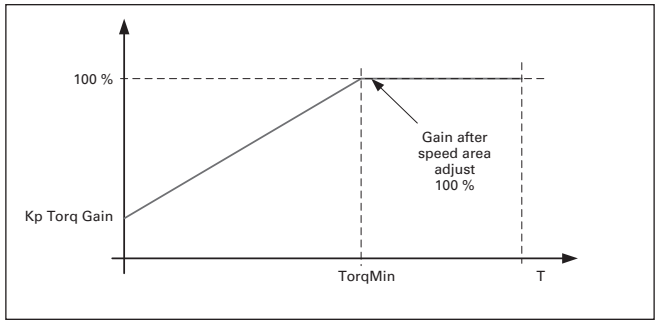
The speed controller can be tuned for different gains in different speed areas, for slow speed and above the parameter Field weakening point. Gains for different speed areas are percentages of the original Speed Controller Gain value.



Code	ID	Description	Notes
P1.9.5.5	1300	**Speed controller f0 point "SPC f0 Point"** The speed level in Hz below which the speed controller gain is Speed Controller gain f0.	
P1.9.5.6	13001	**Speed controller f1 point "SPC f1 Point"** The speed level in Hz above which the speed controller gain is Speed Controller P gain. Gain changes linearly between f0 and f1 points.	
P1.9.5.7	1299	**Speed controller gain f0 "SPC Kp f0"** The relative gain of the speed controller as a percentage of the Speed Controller P Gain when the speed is below the level defined by Speed Controller f0 point.	
P1.9.5.8	1298	**Speed controller gain in field weakening area "SPC Kp FWP"** Relative gain of the speed controller in field weakening area as a percentage of Speed Controller P Gain values. The set value is reached at two times the Field weakening point.	

5.10.1.4 Speed controller gain with different loads

The speed controller can also be tuned for different loads. Speed controller gain is first manipulated by the speed area gain function and this result is then further adjusted by torque related relative gain.



Code	ID	Description	Notes
P1.9.5.9	**1296**	**Speed controller torque minimum "SPC torq min"** The level of speed controller output which the speed controller gain is changed to with parameter P1.8.5.4.10 "Speed Controller torque minimum gain" using a filter set by parameter P1.8.5.4.11 "Speed Controller torque minimum filtering time". This is in percent of the motor nominal torque.	
P1.9.5.10	**1295**	**Speed controller torque minimum gain "SPC Kp torq min"** Relative gain as a percentage of the speed controller gain after speed area adjustment when the speed control output is less than the "Speed Controller torque minimum". This parameter is normally used to stabilise the speed controller for a drive system with gear backlash.	
P1.9.5.11	**1297**	**Speed controller torque minimum filtering time "SPC Kp TC torq"** Filtering time for torque. When the speed controller gain is changed below the Speed Controller torque minimum.	

5.11 Drive control

Code	ID	Description	Notes
P1.10.1	**601**	**Switching frequency "Switching freq"** Motor noise can be minimised using a high switching frequency. Note, however, that increasing the switching frequency increases losses of the frequency converter. Lower frequencies are used when the motor cable is long and the motor is small. The range of this parameter depends on the size of the frequency converter:.	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.
		Table 52. Size-dependent switching frequencies	If the switching frequency is changed it is necessary to redo the identification run.
		Type / **Min. [kHz]** / **Max. [kHz]** / **Default [kHz]** 0003—0061 4 0003—0061 2 / 1.0 / 16,0 / 3,6 0072—0520 4 / 1.0 / 10.0 / 3.6 0041—0062 5 0144—0208 5 / 1.0 / 6.0 / 1.5	
		DriveSynch operation When using DriveSynch the maximum switching frequency is limited to 3,6 kHz.	
P1.10.2	**1516**	**Modulator Type 'Modulator type"** Select modulator type. Some operations require use of a software modulator. 0 = ASIC modulator A classical third harmonic injection. The spectrum is slightly better compared to the Software 1 modulator.	An ASIC modulator cannot be used when using DriveSynch or PMS motor with an incremental type encoder.
		1 = Software Modulator 1 Symmetric vector modulator with symmetrical zero vectors. Current distortion is less than with software modulator 2 if boosting is used.	Recommended for DriveSynch (Set by default when DS activated) and needed when using PMS motor with an incremental encoder.
		2 = Software modulator 2 One phase at a time in IGBT switches is not modulated during a 60-degree period of the frequency cycle. The unmodulated phase is connected to either positive or negative DC-bus.	

Code	ID	Description	Notes
P1.10.2	**1516**	**Modulator type modulator type"** 3 = Software modulator 3 Unsymmetrical BusClamb in which one switch always conducts 120 degrees to negative DC-rail to reduce switching losses. However, upper and lower switches are unevenly loaded and the spectrum is wide. 4 = Software modulator 4: Pure sinewave, sinusoidal modulator without harmonic injection. Dedicated to be used in back to back test benches etc. to avoid circulating third harmonic current. Drawback is that required DC voltage is 15% higher compared to other modulator types.	
P1.10.3	**1084**	**Control options "Control options"** B01 = Disable open loop power limit function B06 = Activate Closed Loop type speed limit function in Open Loop B07 = Disables switching frequency decrease due to drive temperature rise B08 = Disable Encoder fault when brake is closed B12 = Disable Process Data locking function when Profibus communication fails. When using Profibus, an occurring communication fault will lock the process data to previous values. This bit will disable the locking of process data forcing the values to zero. B13 = Disable only acceleration when using DI Acc/Dec prohibit function	This bit can only be used with Profibus.
P1.10.4	**1798**	**Control options 2 "ControlOptions2"** B10 = Possibility to revert back to "old" operation. See details from Release Note.	
P1.10.5	**1560**	**Advanced Options 1 "AdvancedOptions1"** B00 = Disable Synchronous modulation B01 = Use encoder information to slip compensation in Open Loop Speed control B02 = Disable encoder fault B03 = Disable slip compensation for reverse direction B06 = Enable synchronous symmetrical modulation B07 = Automatically handled by application logic. B15 = Cosphii = 1 control. This controls the motor reactive power to zero. Possible to use only with PMS motors in closed loop control.	
P1.10.6	**1561**	**Advanced options 2 "AdvancedOptions1"** B00 = Sensorless control for PMS motors. This is an open loop control but uses the same control system than the normal closed loop control. Calculations try to estimate the encoder speed instead of using the encoder signal. This mode has speed and torque range limitations and therefore application limitations. A lower speed controller gain may be required to gain stability. Useful for generator applications. B04 = Enable Start Positioning damping active if PMSM B09 = I/f control for PMS motors. PMS motor can be started with I/f control. Used with high power motor when there is low resistance in motor and U/f is difficult to tune to be stable. B13 = Changes automatically depending on Drive Synch operation	
P1.10.7	**1563**	**Advanced options 4 "AdvancedOptions4"** Reserved for future use. Some bits are controlled by application software so value may not be always zero.	
P1.10.8	**1564**	**Advanced options 5 "AdvancedOptions5"** B11 = Current measurement anti-aliasing for low switching frequencies, prevents torque calculation distortions. Requires Software Modulator 1.	
P1.10.9	**1565**	**Advanced options 6 "AdvancedOptions6"** B05 = To reduce aliasing effects in current measurement, it is possible to take an average from all internal samples taken at fast time level. It must be noted, that this mode does not affect the motor control, only monitoring.	
P1.10.10	**1424**	**Restart Delay "Restart Delay OL"** The time delay within which the drive cannot be restarted after a coast stop and flying start is not in use. Closed Loop control mode and the flying start use a different delay see P1.9.11.	

Code	ID	Description	Notes
P1.10.11	**1516**	**Restart delay closed loop & flying start "Restart delay CL"** The time delay within which the drive cannot be restarted if flying start is used or the control mode is closed loop.	
P1.10.12	**1700**	**High speed mode "Highspeedmode"** When set to yes the maximum Frequency limit is changed from 320.00 to 599.0. The Resolution of the Frequency reference is reduced to .1 Hz in this mode.	

5.12 Master follower

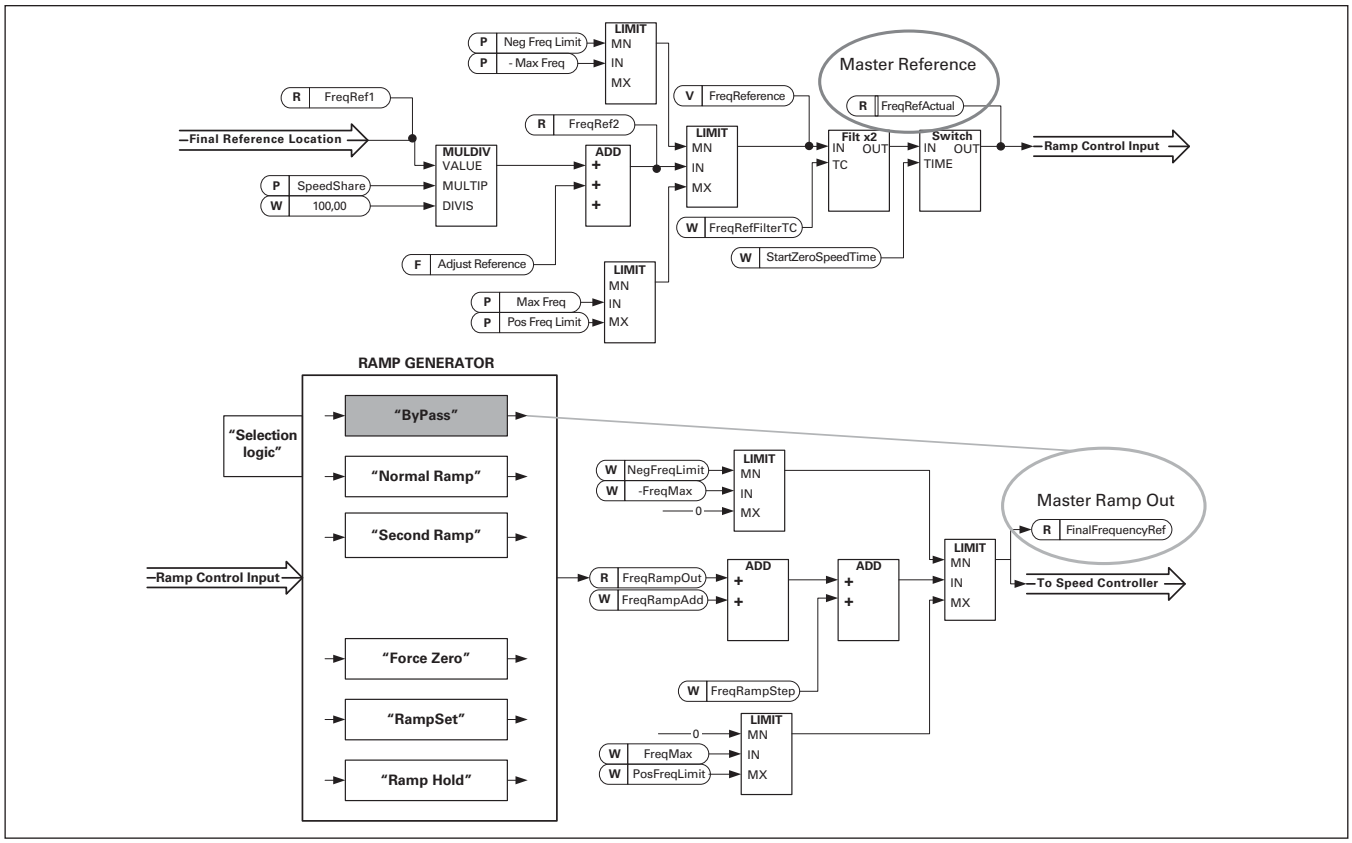
5.12.1 Master follower: Standard system

The Master/Follower function is designed for applications in which the system is run by several SPX drives and the motor shafts are coupled to each other via gearing, chain, belt etc. The SPX drives are in closed loop control mode.

The external control signals are connected to the Master SPX only. The Master controls the Follower(s) via a System bus. The Master station is typically speed-controlled and the other drives follow its torque or speed reference.

Torque control of the Follower should be used when the motor shafts of the Master and Follower drives are coupled solidly to each other by gearing, a chain etc., so that no speed difference between the drives is possible.

Speed control of the Follower should be used when the motor shafts of the Master and the Follower drives are coupled flexibly to each other so that a slight speed difference between the drives is possible. When both the Master and Followers are speed-controlled, drooping is typically also used.



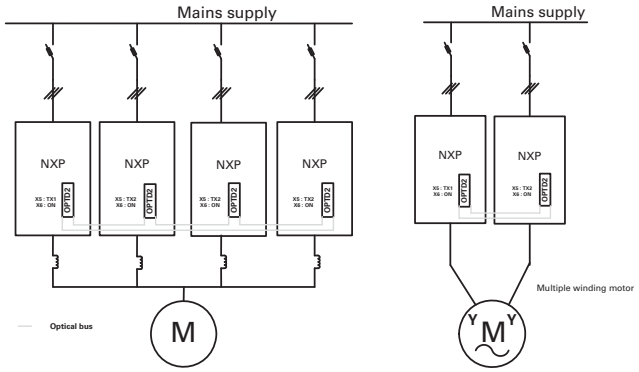
5.12.2 Master follower: Drivesynch system

DriveSynch is used to control parallel drives. Up to four drives can be connected in parallel. The motor can be a single winding motor or there can be several winding motors. DriveSynch works in open loop and closed loop motor control modes. With closed loop motor control, the encoder feedback needs to be wired only to the master drive.If case redundancy is required, it may be necessary to wire the encoder feedback also to follower drives using the double encoder option board OPTA7.

Note: In a DriveSynch system, only Master drive monitoring signals are reliable.
Only directly measured values are reliable in follower units. Even the Output Frequency of DriveSynch follower is not directly observed and thus may not show actual output frequency that is controlled by DriveSynch Master Drive.

The maximum switching frequency for the drives using DriveSynch is 3.6 kHz. Minimum recommended switching frequency in Open Loop control is 1.7 kHz. Minimum recommended switching frequency in Closed Loop control is 2.5 kHz.

The SPX control board must be VB00761 (SPX3) or newer. OPT-D2 boards needs to VB276J or newer. Master needs to be #1 and cannot be changed.



5.12.2.1 Redundancy

The units working in parallel with DriveSynch have a high level of redundancy. The system keeps running without interruption even if any of the follower units is non-functional. In case of a hardware failure, the failed unit need be isolated before the system can be restarted. The actual level of redundancy, however, needs to be carefully defined considering the motor, load and the requirements of the process. The master drive unit and the fast drive to drive optical communication has to be functional for the DriveSynch functionality. The auxiliary power (+24V) must be continuously provided for all the control units including the non-functional drive units in drive synch system. It is also a common practice to use (n+1) units, where n is the number of required units for full functionality of the system. In this case, the system is fully operational even if any follower is non-functional.

	Master (D1)	**Follower (D2)**	**Follower (D3)**	**Follower (D4)**
Parameter settings				
Motor nominal voltage	Motor nominal voltage from the motor name plate	Motor nominal voltage from the motor name plate	Motor nominal voltage from the motor name plate	Motor nominal voltage from the motor name plate
Motor nominal frequency	Motor nominal frequency from the motor name plate	Motor nominal frequency from the motor name plate	Motor nominal frequency from the motor name plate	Motor nominal frequency from the motor name plate
Motor nominal current	Motor nominal current from the motor name plate/Number of drives in parallel using Drive Synch	Motor nominal current from the motor name plate/Number of drives in parallel using Drive Synch	Motor nominal current from the motor name plate/Number of drives in parallel using Drive Synch	Motor nominal current from the motor name plate/Number of drives in parallel using Drive Synch
Motor COS PHI (motor nominal power factor)	Motor COS PHI from the motor name plate	Motor COS PHI from the motor name plate	Motor COS PHI from the motor name plate	Motor COS PHI from the motor name plate
Motor nominal power	Motor nominal power from the motor name plate/Number of drives in parallel using Drive Synch	Motor nominal power from the motor name plate/Number of drives in parallel using Drive Synch	Motor nominal power from the motor name plate/Number of drives in parallel using Drive Synch	Motor nominal power from the motor name plate/Number of drives in parallel using Drive Synch
Master follower mode	Master, DriveSynch	Follower, DriveSynch	Follower, DriveSynch	Follower, DriveSynch
Motor Control Mode (Open Loop)	Open Loop Frequency	If used as Secondary Master: Open Loop Frequency. When used as Follower: no meaning.	No meaning, internally handled. Recommended to have same setting as in master.	No meaning, internally handled. Recommended to have same setting as in master.
Motor Control Mode (Closed Loop)	Closed Loop Speed/Torque	If used as Secondary Master: Closed Loop Speed/Torque. When used as Follower: no meaning.	No meaning, internally handled Recommended to have same setting as in master.	No meaning, internally handled Recommended to have same setting as in master.
Magnetizing current (needed only for closed loop motor control)	Motor nominal magnetizing current/Number of drives in parallel using Drive Synch	Motor nominal magnetizing current/Number of drives in parallel using Drive Synch	Motor nominal magnetizing current/Number of drives in parallel using Drive Synch	Motor nominal magnetizing current/Number of drives in parallel using Drive Synch
Switching Frequency	Max 3.6 KHz	Same as in Master	Same as in Master	Same as in Master
Modulator Type	1, Software	Same as in Master	Same as in Master	Same as in Master
Follower Phase shift (single winding motor)	0 degrees	0	0	0
Follower Phase shift (multiple winding motor)	0 degrees	As per motor name plate	As per motor name plate	As per motor name plate

5.12.3 Master follower configuration

The OPTD2 board in the Master has default jumper selections, i.e. X6:1-2, X5:1-2. For the followers, the jumper positions have to be changed: X6:1-2, X5:2-3. This board also has a CAN communication option that is useful for multiple drive monitoring with 9000xDrive PC software when commissioning Master Follower functions or line systems. See Figure 5-15 below.

Code	ID	Description	Notes
P1.11.1	**1516**	**Master/Follower selection ID1324 "MF mode"** Select the Master Follower mode. When the drive is a follower, the Run Request command is monitored from Master but all references are selectable by parameters. 0 = Single drive System bus is deactivated 1 = Master Drive sends control word to follower drive. 2 = Follower Drive receives control word from Master and sends some diagnostic information to the Master drive. 3 = "DSynchMaster" – Drive Synch Master Drive number 1 must be selected as the parallel drive configuration master (in redundancy mode drive number 2 can be selected as master but certain diagnostic functions are no longer available). 4 = "DSynchFlwr" – Drive Synch Follower Selection for parallel drive configuration follower drive	

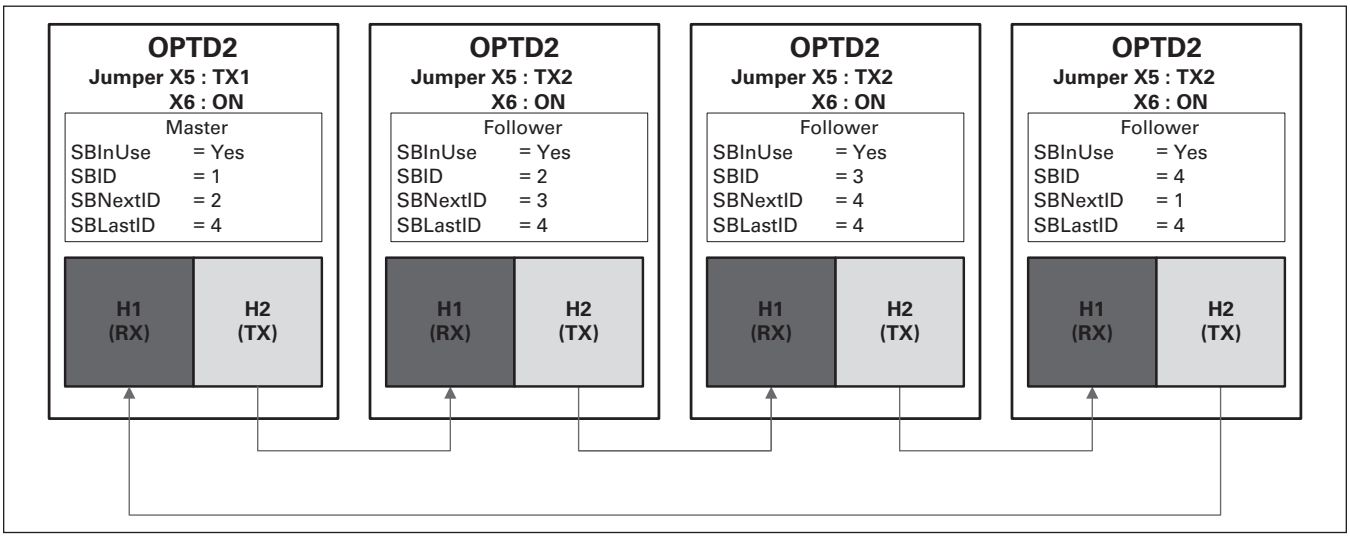


Figure 5-15. System bus physical connections with the OPT-D2 board

Code	ID	Description	Notes
P1.11.2	**11081**	**Follower reference selection "follower ref sel"**	
		Select where the follower drive receives its speed reference from. 0 = "AI1" – Analog Input 1 Signal scaling in "G: Input Signals\Analog Input 1" 1 = "AI2" – Analog Input 2 Signal scaling in "G: Input Signals\Analog Input 2" 2 = "AI1+AI2" – Analog Input 1 + Analog Input 2 With alternative reference scaling in Analog Input group, 100 % input values can be set to correspond 25 Hz. In other words, when both are 100% the final reference will be 50 Hz. 3 = "AI1-AI2" Analog Input 1 minus Analog Input 2. 4 = "AI2-AI1" Analog Input 2 minus Analog Input 1. 5 = "AI1xAI2" Analog Input 1 x Analog Input 2 6 = "AI1 Joystick" Analog input 1, –10 Vdc... +10 Vdc 7 = "AI2 Joystick" Analog input 2, –10 Vdc... +10 Vdc 8 = "Keypad Ref" Reference from keypad R3.2 9 = "Fieldbus"Reference is taken from fieldbus. AIternative scaling can be selected in "G: Fieldbus" 10 = "Motor Pot" - Motor potentiometer Reference handled with two digital inputs "G: Input Signals\Digital Inputs" (increase and decrease). Behaviour adjusted in "G: Ref Handling\Motor Poten.mete". 11 = "AI1, AI2 min" The smaller of Analog Input 1 and Analog Input 2 is used as reference. 12 = "AI1, AI2 max" The greater of Analog Input 1 and Analog Input 2 is used as reference. 13 = "Max Freq" – Maximum frequency P1.1.2 Max Frequency is used as reference. 14 = "AI1/AI2 Sel" – AI1/AI2 Selection The digital input "I/O Ref 1/2" is used to select between Analog Input 1 and Analog Input 2 reference. "I/O Ref 1/2" is used to elect between "I/O Reference" and "I/O Reference 2" if selection of this parameter is different from 14 (this one). 15 = "Encoder 1" Reference is read from encoder input 1. 16 ="Encoder 2" Reference is read from encoder input 2. This selection is usable with double encoder boards. Could be utilized e.g.for speed synchronization. 17 ="Master Reference" Master reference before ramp generator. When this is selected the follower drive's own ramp times are active and used. 18 ="Master Ramp Out" Master reference after ramp generator, before speed controller. When this is selected the follower drive will use the ramp times defined by the Master drive.	

Code	ID	Description	Notes
P1.11.3	**11081**	**Follower torque reference selection "FollowerTorq sel"** Select the source of torque reference for the follower drive. 0 = "Not Used" 1 = "AI1" – Analog Input 1 Signal scaling in "G: Input Signals\Analog Input 1" 2 ="AI2" – Analog Input 2 Signal scaling in "G: Input Signals\Analog Input 2" 3 = "AI3" 4 = "AI4" 5 = "AI1 Joystick" Analog input 1, –10 Vdc... +10 Vdc. For joystick inputs, the maximum negative reference is the negative of "Torq Ref Max".Analog input 2, –10 Vdc... +10 Vdc For joystick inputs maximum negative reference is the negative of "Torq Ref Max". 7 = "Keypad Ref"Torque reference from keypad R3.5 8 ="Fieldbus" Reference is taken from fieldbus. Alternative scaling can be selected in "G: Fieldbus" 9="Master Torque" Reference is taken from Master drive when using the Master Follower function.	
P1.11.4	**1089**	**Follower stop function "FollowerStopFunction"** When the follower drive does not use the Master Drive Ramp Output as reference this parameter defines how the follower drive will stop as Run request is removed from the Master drive. 0 = Coasting; the follower remains in control even if master has stopped to fault 1 = Ramping; the follower remains in control even if master has stopped to fault 2 = As master; the follower behaves as master	
P1.11.5	**1326**	**Master follower brake logic "MF brake logic"** This parameter defines brake functionality when operating Master-Follower mode. This parameter is not active when follower is operating in Ramp Follower mode (i.e. Follower reference selection is "18 = Master Ramp") or follower is a DriveSynch follower. In these cases follower brake is controlled by master drive. 0 = Master or Own (Default) Brake is opened when master or follower brake opening conditions are met in follower drive. 1 = Own Brake is opened when follower drive own brake opening conditions are met. Also brake is close if follower drive own conditions are met regardless of master status. 2 = Own & Master Speed Release Brake is opened when follower drive own brake opening conditions are met. Also brake is close if follower drive own conditions are met regardless of master status. But Speed is not released until drive has the feedback from the brake, actual or defined by Mechanical Brake Delay parameter and master has released speed. When this selection is made also in Master drive, Speed is not released until master drive has the feedback from the brake actual or defined by Mechanical Brake Delay parameter also from followers 3 = Master Master drive is controlling follower drive brake and speed release.	When follower reference selection is 17 = "Master Ref", speed limitation function from brake control are bypassed on follower side.

Code	ID	Description	Notes
P1.11.3	**11081**	**Follower torque reference selection "FollowerTorq sel"** Select the source of torque reference for the follower drive. 0 = "Not Used" 1 = "AI1" – Analog Input 1 Signal scaling in "G: Input Signals\Analog Input 1" 2 = "AI2" – Analog Input 2 Signal scaling in "G: Input Signals\Analog Input 2" 3 = "AI3" 4 = "AI4" 5 = "AI1 Joystick" Analog input 1, –10 Vdc... +10 Vdc. For joystick inputs, the maximum negative reference is the negative of "Torq Ref Max". 6 = "AI2 Joystick" Analog input 2, –10 Vdc... +10 Vdc For joystick inputs maximum negative reference is the negative of "Torq Ref Max". 7 = "Keypad Ref"Torque reference from keypad R3.5 8 = "Fieldbus" Reference is taken from fieldbus. Alternative scaling can be selected in "G: Fieldbus" 9 = "Master Torque" Reference is taken from Master drive when using the Master Follower function.	
P1.11.4	**1089**	**Follower stop function "FollowerStopFunction"** When the follower drive does not use the Master Drive Ramp Output as reference this parameter defines how the follower drive will stop as Run request is removed from the Master drive. 0 = Coasting; the follower remains in control even if master has stopped to fault 1 = Ramping; the follower remains in control even if master has stopped to fault 2 = As master; the follower behaves as master	
P1.11.5	**1326**	**Master follower brake logic "MF brake logic"** This parameter defines brake functionality when operating Master-Follower mode. This parameter is not active when follower is operating in Ramp Follower mode (i.e. Follower reference selection is "18 = Master Ramp") or follower is a DriveSynch follower. In these cases follower brake is controlled by master drive. 0 = Master or Own (Default) Brake is opened when master or follower brake opening conditions are met in follower drive. 1 = Own Brake is opened when follower drive own brake opening conditions are met. Also brake is close if follower drive own conditions are met regardless of master status. 2 = Own & Master Speed Release Brake is opened when follower drive own brake opening conditions are met. Also brake is close if follower drive own conditions are met regardless of master status. But Speed is not released until drive has the feedback from the brake, actual or defined by Mechanical Brake Delay parameter and master has released speed. When this selection is made also in Master drive, Speed is not released until master drive has the feedback from the brake actual or defined by Mechanical Brake Delay parameter also from followers 3 = Master Master drive is controlling follower drive brake and speed release.	When follower reference selection is 17 = "Master Ref", speed limitation function from brake control are bypassed on follower side.
P1.11.6	**1093**	**Master Follower mode 2 selection "MF mode 2"** Selects the Master Follower mode 2 that is used when the DI is activated. When Follower is selected the Run Request command is monitored from Master and all other references are selectable by parameters. This parameter can be used for redundancy purposes. If drive number one is unable to be operated through a digital input drive number 2 can be selected as master. 0 = Single Drive System bus is deactivated. 1 = Master Drive sends control word to follower drive. 2 = Follower Drive received control word from Master and sends some diagnostic information to the Master drive. 3 = "DSynchMaster" - Drive Synch Master Drive number 1 must be selected as the parallel drive configuration master (in redundancy mode drive number 2 can be selected as master but certain diagnostic functions are no longer available).	

Code	ID	Description	Notes
P1.11.6	**1093**	**Master Follower mode 2 selection "MF mode 2"** 4 = "DSynchFlwr" - Drive Synch Follower Selection for parallel drive configuration follower drive	
P1.11.7	**11082**	**SystemBus communication fault response "SB comm fault"** Defines the action when the System Bus heartbeat is missing. The master drive sends a heartbeat signal to all follower drives and this heartbeat is sent back to the master drive. 0 = No response 1 = Warning 2 = Fault, stop mode after fault according to Stop function 3 = Fault, stop mode after fault always by coasting	
P1.11.8	**1352**	**Systembus fault delay ID1352 "SB fault delay"** Defines the delay before fault generation when heartbeat is missing.	
P1.11.9	**1536**	**Follower fault "follower fault"** Defines the response in the Master drive when a fault occurs in any of the follower drives. When one of the drives trips to fault the master drive will send a command to trigger the Data Logger in all the drives for diagnostic purposes. 0 = No response 1 = Warning 2 = Fault, stop mode after fault according to Stop function	When follower reference selection is 17 = "Master Ref", speed limitation function from brake control are bypassed on follower side.

5.12.3.1 Drive synch control parameters

Code	ID	Description	Notes
P1.11.10.1	**1531**	**DriveSynch follower fault "DS follower fault"** Defines the response in the Master drive when a fault occurs in any of the follower drives. When one of the drives trips to fault the master drive will send a command to trigger the Data Logger in all the drives for diagnostic purposes. 0 = No response 1 = Warning 2 = Fault, stop mode after fault according to Stop function	
P1.11.10.2	**1518**	**Follower drive winding phase shift "FollPhaseShift"** Windings phase shift between master and follower drive. Used with drive synch operation when the motor has multiple windings.	
P1.11.10.3	**519**	**DC voltage balancing gain "DCVoltageBalGain"** Multiple wind motor option. Contact factory before changing this value.	
P1.11.10.4	**1799**	**SB last ID 2nd "SBLastID 2nd"** With this parameter is possible to change last ID number of the drive from fieldbus.	

5.13 Protections

5.13.1 General settings

Code	ID	Description	Notes
P1.12.1.1	**730**	**Input phase supervision "input ph. superv"** Defines the response when the drive notices that one of the input phases is missing. 0 = No response 1 = Warning 2 = Fault, stop mode after fault according to Stop Function 3 = Fault, stop mode after fault always by coasting 4 = Warning and Derate – This mode will derate the drive to the level defined in P1.12.1.	
P1.12.1.2	**748**	**Phase loss derate % "PHLoss derate%"** The current limit will be multipled by this % to limit current when a phase loss occurs.	

Code	ID	Description	Notes
P1.12.1.3	**727**	**Response to under voltage fault "UVolt fault resp"** In some applications it is normal that the drive will be powered down when in run state. With this parameter it is possible to choose whether undervoltage faults are stored to the fault history of the drive. 0 = Fault stored in fault history 1 = Fault not stored in fault history Under voltage fault limits: 500 V units: 333 Vdc 690 V units: 460 Vdc	
P1.12.1.4	**702**	**Output phase supervision OutputPh. superv"** Output phase supervision of the motor ensures that the motor phases have an approximately equal current. 0 = No response 1 = Warning 2 = Fault, stop mode after fault according to Stop Function 3 = Fault, stop mode after fault always by coasting	
P1.12.1.5	**734**	**Response to slot fault ID734 "SlotComFaultResp"** Set here the response mode for a board slot fault due to a missing or broken board. 0 = No response 1 = Warning 2 = Fault, stop mode after fault according to Stop Function 3 = Fault, stop mode after fault always by coasting .	
P1.12.1.6	**755**	**Safe torque off (STO) mode "SafeDisableResp."** With this parameter it is possible to choose whether the STO signal is handled as fault or warning. The STO input will stop the drive from modulating regardless of this parameter value.	
P1.12.1.7	**1903**	**Output contactor interlock fault response "O/P contactor"** This parameter determines the fault response when the O/P Contactor interlock input is open	

5.13.2 Temperature sensor protections

The temperature protection function is used to measure temperatures and issue warnings and/or faults when the set limits are exceeded. The SPX Advanced application supports two OPT-BH and OPT-B8 board simultaneously. One can be used for the motor winding and one for the motor bearings.

Code	ID	Description	Notes
P1.12.2.1	**739**	**Number of used inputs in board 1 "Board1 Channels"** Select used temperature sensor combination with this parameter. See also the I/O boards manual. 0 = Not used (ID Write, value of maximum temperature can be written from fieldbus) 1 = Sensor 1 in use 2 = Sensor 1 & 2 in use 3 = Sensor 1 & 2 & 3 in use 4 = Sensor 2 & 3 in use 5 = Sensor 3 in use	If the selected value is greater than the actual number of used sensor inputs, the display will read 200°C. If the input is short-circuited the displayed value is –30°C.
P1.12.2.2	**740**	**Board 1 temperature response "Board1 response"** 0 = No response 1 = Warning 2 = Fault, stop mode after fault according to Stop Function 3 = Fault, stop mode after fault always by coasting	
P1.12.2.3	**741**	**Board 1 warning limit "Board1Warn.Limit"** Set here the limit at which the PT100 warning will be activated. When individual warning and fault limits are activated this is first board first channel (1A).	

Code	ID	Description	Notes
P1.12.2.5	**742**	**Board 1 fault limit "Board1 fault Lim."** Set here the limit at which the PT100 fault (F56) will be activated. When individual warning and fault limits are activated this is first board first channel (1A).	
P1.12.2.5	**743**	**Number of used inputs in board 2 "Board2 channels"** If you have two temperature sensor boards installed in your frequency converter you can choose here the combination inputs in use in the second board. See also the I/O boards manual. 0 = Not used (ID Write, value of maximum temperature can be written from fieldbus) 1 = Sensor 1 in use 2 = Sensor 1 & 2 in use 3 = Sensor 1 & 2 & 3 in use 4 = Sensor 2 & 3 in use 5 = Sensor 3 in use	
P1.12.2.6	**766**	**Board 2 temperature response "Board2 response"** 0 = No response 1 = Warning 2 = Fault, stop mode after fault according to Stop Function 3 = Fault, stop mode after fault always by coasting	
P1.12.2.7	**745**	**Board 2 warning limit "Board2 Warn. Lim"** Set here the limit at which the second temperature sensor board warning will be activated. When individual warning and fault limits are activated this is second board first channel (2A).	
P1.12.2.8	**746**	**Board2 fault limit "Board2 FaultLim"** Set here the limit at which the second temperature sensor board fault (F61) will be activated. When individual warning and fault limits are activated this is second board first channel (2A).	

5.13.2.1 ndividual channel monitoring

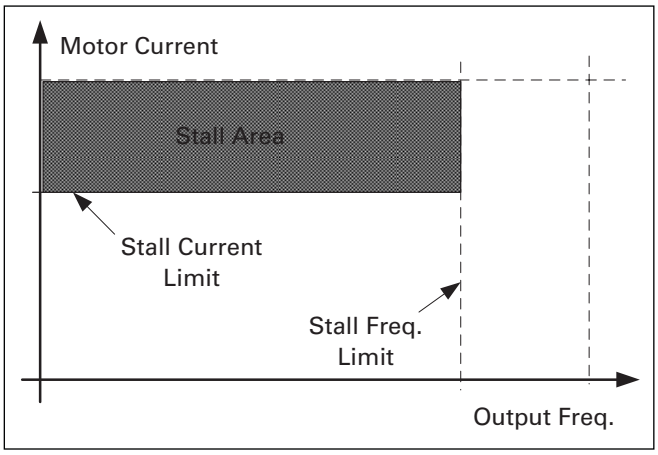
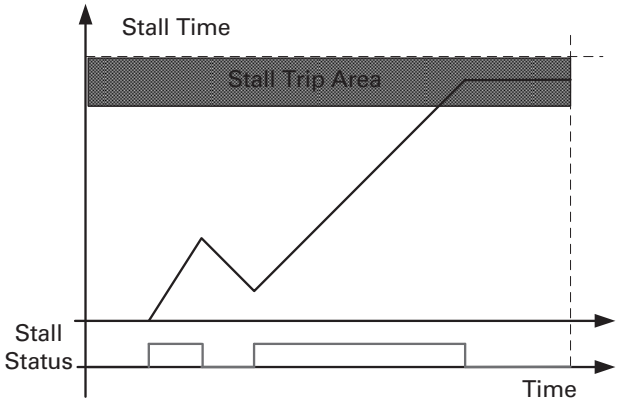
Individual channel monitoring is activated by setting one of the warning limits (per board) different than zero. Common limits in above parameters will be channel A warning and fault limits. Channel B and C limits are set with below parameters.

Code	ID	Description	Notes
P1.12.2.9.1	**764**	**Channel 1B warn**	
P1.12.2.9.2	**765**	**Channel 1B fault** First board second (1B) channel warning and fault limits.	
P1.12.2.9.3	**768**	**Channel 1C warn**	
P1.12.2.9.4	**769**	**Channel 1C fault** First board third (1C) channel warning and fault limits.	
P1.12.2.9.5	**770**	**Channel 2B warn**	
P1.12.2.9.6	**771**	**Channel 2B fault** Second board second (2B) channel warning and fault limits.	
P1.12.2.9.7	**772**	**Channel 2C warn**	
P1.12.2.9.8	**773**	**Channel 2C fault** Second board third (2C) channel warning and fault limits.	

5.13.3 Stall protection

The motor stall protection protects the motor from short time overload situations such as one caused by a stalled shaft. The reaction time of the stall protection can be set shorter than that of the motor thermal protection. The stall state is defined with two parameters, Stall current and Stall frequency limit.

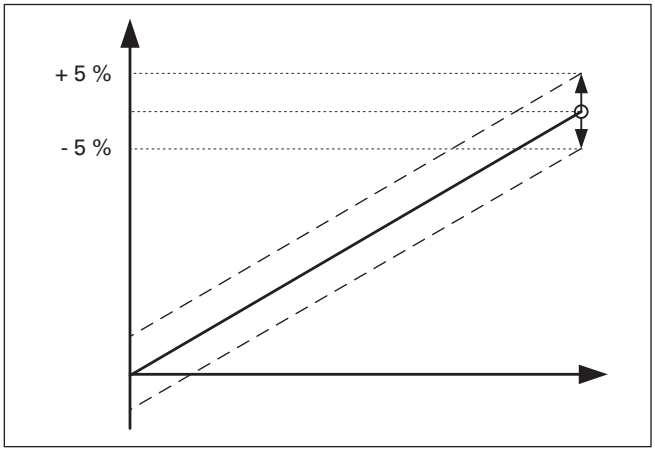
If the current is higher than the set limit and the output frequency is lower than the set limit, the stall state is true. There is actually no real indication of the shaft rotation. Stall protection is a kind of overcurrent protection.

Code	ID	Description	Notes
P1.12.3.1	**709**	**Stall protection "Stall Protection"** 0 = No response 1 = Warning 2 = Fault, stop mode after fault according to Stop Function 3 = Fault, stop mode after fault always by coasting	
P1.12.3.2	**710**	**Stall current limit "Stall Current"** The current can be set to 0 …2*I_H. For a stall stage to occur, the current must have exceeded this limit. The software does not allow entering a greater value than 2*I_H. If the motor current limit is changed this parameter is automatically recalculated to the value 90 % of motor current limit.	This limit must be set below the current limit in order for this function to operate.
P1.12.3.3	**712**	**Stall frequency limit "Stall Freq Lim"** The frequency can be set between 1-fmax (Max Frequency). For a stall state to occur, the output frequency must have remained below this limit for a certain time. This function requires that the output frequency is 1 Hz below the frequency reference before the stall time count is started. 	
P1.12.3.4	**711**	**Stall time "Stall Time Lim"** 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. 	

5.13.4 Speed Error

The Speed error monitoring function compares the encoder frequency and the ramp generator output. The function is used with a PMS motor to detect if the motor is off synchronization or to disable the open loop function using the encoder speed for slip compensation.

The slip compensation is disabled regardless of the response and needs to be re-activated once a speed error is detected (set parameter again or power down the drive).

Code	ID	Description	Notes
P1.12.4.1	**709**	**Speed error fault function "Speed error mode"** Defines the fault function when the speed reference and the encoder speed are above the set limits 0 = No response 1 = Warning 2 = Fault, stop mode after fault always by coasting	
P1.12.4.2	**753**	**Speed error maximum difference "Speed error limit"** Defines the limit when fault situation is noted. The difference between the speed reference and the encoder speed. Percentage value is in relation to motor nominal frequency. 	
P1.12.4.3	**754**	**Speed error delay "Speed Fault Delay"** Defines the delay after which a speed error is considered as a fault. When used to disable open loop slip compensation based on encoder frequency it is recommended to set this time to zero to avoid a speed jump at the time of encoder malfunction.	

5.13.5 Motor Protection

The Speed error monitoring function compares the encoder frequency and the ramp generator output. The function is used with a PMS motor to detect if the motor is off synchronization or to disable the open loop function using the encoder speed for slip compensation.

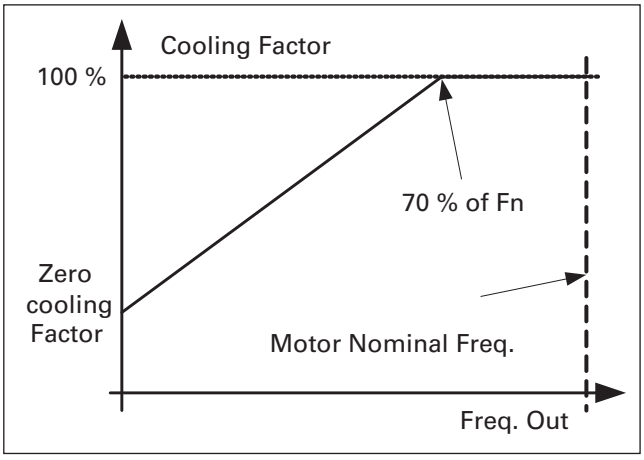
⚠ CAUTION

The calculated model does not prote ct the motor if the airflow to the motor is reduced by blocked air intake grill.

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

The motor thermal protection is based on a calculated model and it uses the output current of the drive to determine the load on the motor.

The motor thermal protection can be adjusted with parameters. The thermal current IT specifies the load current above which the motor is overloaded. This current limit is a function of the output frequency.

Code	ID	Description	Notes
P1.12.5.1	704	**Motor thermal protection response "Motor therm prot"** Defines the response when the calculated temperature of the motor has reached 105 % (monitoring signal). 0 = No response 1 = Warning 2 = Fault, stop mode after fault according to Stop Function 3 = Fault, stop mode after fault always by coasting	
P1.12.5.2	705	**Motor ambient temp. factor "MotAmbTempFactor** Defines the temperature factor for conditions where the motor is located. The factor can be set between -100.0%—100.0%. -100.0 % = 0°C, 0.0 % = 40°C, 100.0 % = 80°C	
P1.12.5.3	706	**Motor cooling factor at zero speed "MTP f0 Current"** Defines the cooling factor at zero speed in relation to the point where the motor is running at nominal speed without external cooling. 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).  Setting this parameter does not affect the maximum output current of the drive which is determined by parameter motor current limit alone.	The value is set as a percentage of the motor name plate data, (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.
P1.12.5.5	707	**Motor thermal protection: Time constant "MTP motor T"** 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 motor design and it varies between different motor manufacturers. The default value changes between unit sizes. 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.	

Code	ID	Description	Notes
P1.12.5.5	**708**	**Motor thermal protection: Motor duty cycle "Motor Duty Cycle"** The value can be set to 0%…150%. Setting value to 130 % motor calculated temperature will reach nominal temperature with 130 % of motor nominal current.	

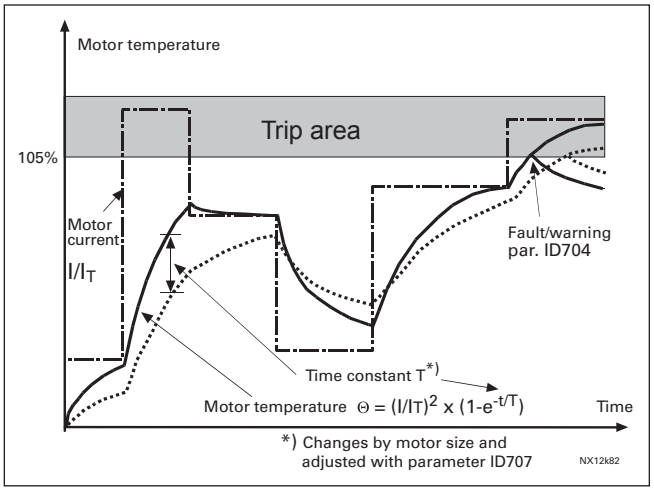


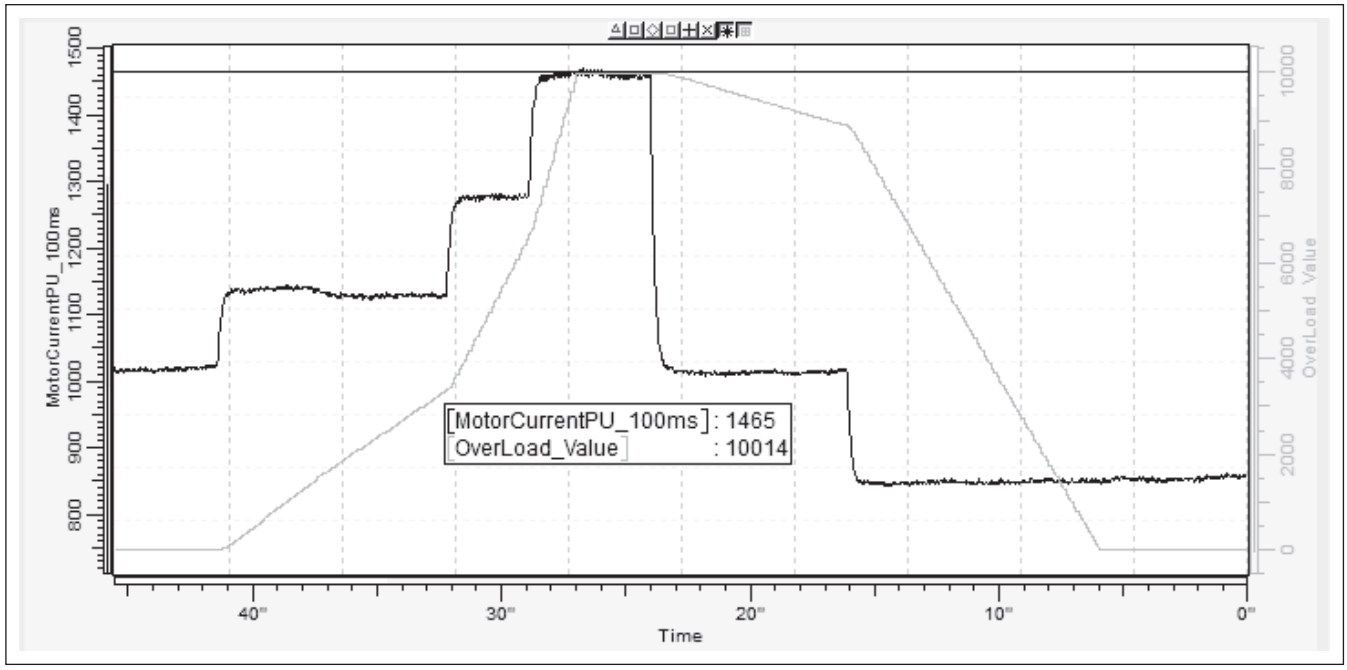
Figure 5-16. Motor temperature calculation

P1.12.5.6	**732**	**Response to thermistor fault "ThermistF.Resp"** 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.	

5.13.6 Over load protection

With this function it's possible to select between Current, Torque and Power what is used for over load protection. Over Load in based on internal counter that in increased when input value is above 105 % level and decreased when below 105 % level, increase and decrease is happening every 100 ms. Tripping is made when over load counter value is over 10 000.

With parameters it can be defined what is increase (Over load maximum step) at maximum defined input level (Over Load Maximum Input). These points defines slope for the function. e.g. if input value is middle of 105 % and Over Load Maximum Input values counter is increase half of the Over Load Maximum step.



Code	ID	Description	Notes
2.12.5.7	**1838**	**Response to over load "OverLoadResponse"** 0 = No response 1 = Warning 2 = Fault	
2.12.5.8	**1837**	**Over load signal "OverLoadSignal"** 0 = Not Used 1 = Output Current (FW: MotorCurrentPU_100ms) 2 = Motor Torque 3 = Motor Power	
2.12.5.9	**1839**	**Over load maximum Input "OverLoadMaxIN"** Input value level where over load counter is increased with maximum step defined by P1.12.5.10	
2.12.5.10	**1840**	**Over load maximum step "OverLoadMaxStep"** Step in the over load counter when input value is at maximum input level defined by P1.12.5.9.	

5.13.7 4mA Protection

The 4 mA protection monitors the analog input signal level from Analog input 1 and Analog input 2. The monitoring function is active when signal range 4 mA – 20 mA is selected. A fault or warning is generated when the signal falls below 3.5 mA for 5 seconds or below 0.5 mA for 0.5 seconds.

Code	ID	Description	Notes
P1.12.6.1	**1838**	**Response to the 4mA reference fault "4mA input fault"** 0 = No response 1 = Warning 2 = Warning, the frequency from 10 seconds back is set as reference 3 = Warning, the Preset Frequency is set as reference 4 = Fault, stop mode after fault according to Stop Function 5 = Fault, stop mode after fault always by coasting	
P1.12.6.2	**728**	**4mA Reference fault: preset frequency reference "4mA fault freq."** If value 3 in parameter P1.12.6.1 is selected and a fault occurs the frequency reference to the motor is the value of this parameter.	

5.13.8 Under load protection

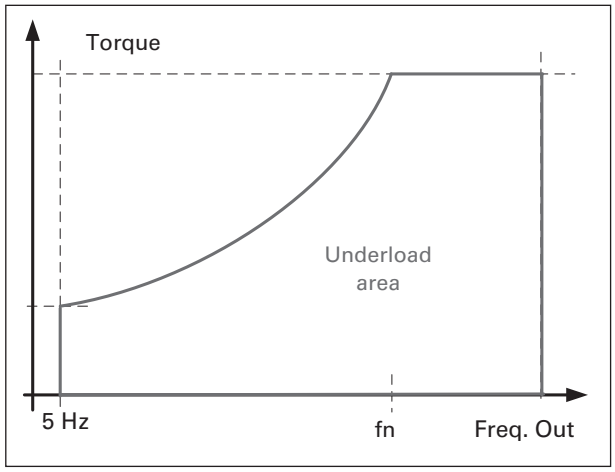
The purpose of the motor under load protection is to ensure that there is load on the motor when the drive is running. If the motor loses its load there might be a problem in the process, e.g. a broken belt or a dry pump.

The under load curve is a squared curve set between the zero frequency and the field weakening point. The protection is not active below 5Hz (the underl oad time counter is stopped).

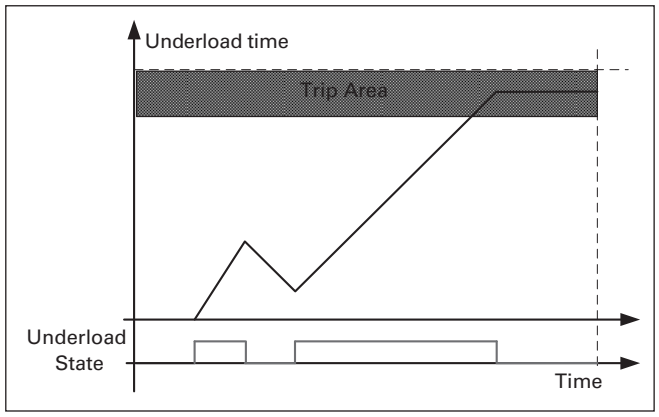
The torque values for setting the under load curve are set in percent which refers to the nominal torque of the motor. The motor's name plate data, parameter motor nominal current and the drive's nominal current IH are used to find the scaling ratio for the internal torque value.

Code	ID	Description	Notes
P1.12.7.1	**713**	**Under load protection "underload protec"** 0 = No response 1 = Warning 2 = Fault, stop mode after fault according to Stop Function 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.	
P1.12.7.2	**715**	**Under load protection, zero frequency load "UP f0 torque"** The torque limit can be set between 5.0—150.0 % x T_{nMotor}. This parameter gives the value for the minimum torque allowed with zero frequency.	

Code	ID	Description	Notes
P1.12.7.3	714	**Under load protection, field weakening area load "UP fnom torque"** 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.	



P1.12.7.4	716	**Underload time "UP time limit"** 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 Underload Protection.	



5.13.9 Under load protection

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

Code	ID	Description	Notes
P1.12.8.1	703	**Ground fault protection "ground fault"** 0 = No response 1 = Warning 2 = Fault, stop mode after fault according to Stop Function 3 = Fault, stop mode after fault always by coasting	
P1.12.8.2	1333	**Ground fault current limit "GNDFaultCurLim"** Maximum level for Earth current in % of the unit nominal current.	

5.13.10 Cooling protection

Protection for liquid cooled units. An external sensor is connected to the drive (DI: Cooling Monitor) to indicate if cooling liquid is circulating.

Code	ID	Description	Notes
P1.12.9.1	762	**Cooling fault response "CoolingFaultREsp"** In some cases it is more important to allow the drive to run even if the cooling liquid is not circulating. Then it is possible to select warning as the response. The drive will then continue running until its internal protection will stop it. If cooling signal loss happens on stop state indication is not stored to fault history if previous fault is already Cooling Fault. In Run State indication is always stored to fault history 0 = Stop State: No Action, Run State: Warning 1 = Stop State: Warning, Run State: Warning 2 = Stop State: Warning, Run State: Fault 3 = Stop State: No Action, Run State: Fault	
P1.12.9.2	751	**Cooling fault delay "cooling f delay"** This parameter defines the delay after which the drive goes to fault state when 'Cooling OK' signal is missing.	

5.13.11 Fieldbus communication

Drive will monitor at least three different indications for fieldbus fault when P1.13.22 State Machine "2/ProfiDrive" is used:

1. Internal monitoring form the fieldbus protocol
2. CW.B11 Watchdog pulse (If used)
3. CW.B10 Fieldbus Control (Depending on used State Machine)
4. CW.B15 (Profibus).

If any of these indicates problem in communication, all other control signals from fieldbus are frozen.

By "FB Fault Delay" parameter it's possible to select how long drive can stay running after the fault situation. Or by setting parameter to zero drive will remain in running "forever" when 4/Warning previous frequency is selected. When communication is established again drive will wait for 1 second before accepting commands from fieldbus. This allows use of CW.B10 to be indication from PLC side that communication is operational in controlled way.

Code	ID	Description	Notes
P1.12.10.1	762	**Fieldbus fault delay "FB fault delay"** This how long drive will stay in run state after the communication has been lost if fault response is set to 4/ Warning, previous reference. If time is set to zero, drive will remain running until communication is established and stop command is given.	
P1.12.10.3	1354	**Fieldbus watch dog delay "FB WD delay"** Defines delay when fault is generated when watch dog pulse is missing from fieldbus. Set the time to zero to disable watchdog monitoring.	

5.13.12 External fault function

Code	ID	Description	Notes
P1.12.11.1	701	**Response to external fault "external fault 1"**	
P1.12.11.2	747	**Response to external fault "external fault 2"** Defines the response to a digital input signal informing about an external condition where the drive needs to react to. The external warning/fault indication can be connected to a digital output. 0 = No response 1 = Warning 2 = Fault, stop mode after fault according to Stop function 3 = Fault, stop mode after fault always by coasting	

5.13.13 Encoder fault function

Encoder supervision gives fault in case there are no pulses from encoder. Requirement is that reference is above 1 Hz and torque can reach 100 % level. This torque level can be adjusted by Iq Fault limit parameter.

This limit may need adjustment when torque limit is below 100 %. Alternative method to detect encoder fault is Speed Error detection.

Code	ID	Description	Notes
P1.12.12.1	1801	**Encoder Fast Hz Limit** Frequency limit where detection is made using fast detection.	
P1.12.12.2	1805	**Fast Time Limit** Delay to encoder fault when fault happens above Encoder Fast Hz Limit.	
P1.12.12.3	1800	**Iq Fault Limit** This defined Iq current limit what must be exceeded before situation is determine to be encoder fault is pulses are missing from encoder at the same time.	

5.13.14 Cold weather function

The Cold Weather Function supply's a selectable ac voltage to the motor at a very low frequency for a desired period of time along with dropping the temperature fault level. This design is uses the current draw through the IGBT modules to warm up the unit temperature. The drive has a low temperature fault point of -10deg C which in most applications is sufficient. In extreme temperature regions this is to high, In these cases the Cold Weather Parameter can be enabled which takes the -10deg C fault level and moves it down to -30deg C with an Alarm at -20deg C. The adjustable frequency drive will start the motor up in its normal operation when the unit temperature is above the -20deg C level. If the drives unit temp is between -20deg C and -30deg C and the drive is stopped, when the run command is given the drive will go into the cold weather warm up feature.

The cold weather warm up feature runs the motor at 0.5Hz for the Cold Weather Voltage Percentage (0 to 20%) to base off motor name plate voltage for a desired time between (0 to 10 min) with an A85 alarm displayed on the keypad. If the drive does not warm up above -20deg C in the time set the drive will go into the F13 Under Temperature Fault, otherwise if the temp does go above -20deg C it will ramp up to the supplied reference signal. The fault can be reset and the sequence can be started again to get the motor running. If the unit temperature is below -30deg C the drive will fault on the F13 Under Temperature Fault.

There is also an override feature added but Eaton would suggest contacting the Support group before performing this action, when in this mode there will be an A86 Under Temp Override alarm.

Code	ID	Description	Notes
P1.12.13.1	1490	**Cold weather enable** Enables the cold weather function.	
P1.12.13.2	1491	**Cold weather voltage** This is the voltage used when the Cold weather mode is active	
P1.12.13.3	1492	**Cold weather timeout** This is the maximum time the drive will attempt to heat up, if this time is exceeded the drive will display a fault.	

5.13.15 Thermal De-rate

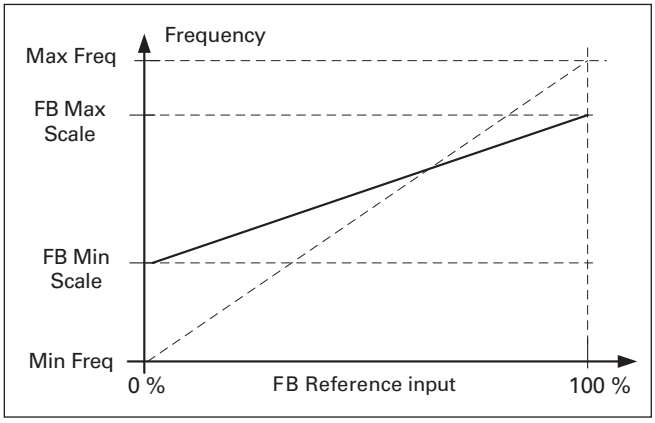
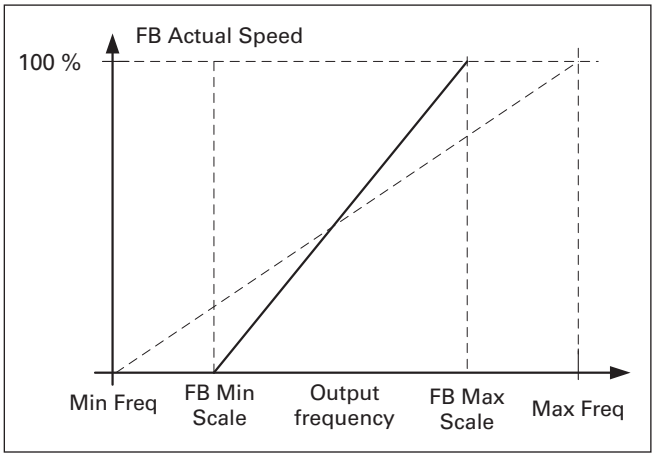
This function allows the user to set a temperature level and de-rate percentage that the drive will use when the user entered temperature is exceeded. This is useful in applications where running is preferred over a fault. This function allows the drive to reduce the motor current to attempt to avoid an over temperature fault. A PI loop is used to reduce the current limit until either the maximum de-rate limit is hit or the drives temperature stabilizes.

Code	ID	Description	Notes
P1.12.14.1	1680	**Thermal De-rate enable** Frequency limit where detection is made using fast detection.	
P1.12.14.2	1681	**Fast time limit** This is the voltage used when the Cold weather mode is active	
P1.12.14.3	1682	**De-rate percent** This is the maximum derating percentage. This value is applied to the current limit	

Code	ID	Description	Notes
P1.12.14.4	**1683**	**De-rate warning** The drive will normally display an alarm when the drive is derating this parameter allows the warning to be disabled.	

5.14 Fieldbus settings

5.14.1 General settings warm up feature.

Code	ID	Description	Notes
P1.13.1	**1850**	**Fieldbus reference minimum scaling "FB min scale"**	
P1.13.2	**851**	**Fieldbus reference maximum scaling "FB max scale"** Use these two parameters to scale the fieldbus reference signal. If both parameters have the same value the minimum and maximum frequency limits are used for scaling.  Using this custom scaling function also affects the scaling of the actual value.  	
P1.13.3 to P1.13.10	**852-859**	**Fieldbus data out selections 1 to 8 "FB data outX sel"** 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. See monitoring signals for full details of ID numbers.	

Default settings:

Data	Value	Unit	Scale	ID
Status word	Main status word			
FB General status word	MCStatus			64
FB Actual speed	Actual speed	%	0,01 %	
Process data OUT 1	Output frequency	Hz	0,01 Hz	1
Process data OUT 2	Motor speed	rpm	1 rpm	2
Process data OUT 3	Motor current	A	0,1 A	45
Process data OUT 4	Motor torque	%	0,1 %	4
Process data OUT 5	Motor power	%	0,1 %	5
Process data OUT 6	Motor voltage	V	0,1 V	6
Process data OUT 7	DC link voltage	V	1 V	7
Process data OUT 8	Active fault code	–	–	37

<table>
<tr><th>Code</th><th>ID</th><th>Description</th><th>Notes</th></tr>
<tr><td>P1.13.11 to P1.13.18</td><td>876-833</td><td>Fieldbus data IN selections 1 to 8 “FB data in X sel”
Using these parameters, you can control any monitoring or parameter value from the fieldbus. Enter the ID number of the item you wish to control for the value of these parameters. Monitoring signals that can be controlled from fieldbus are shadowed.
Default settings:
<table><tr><th>Data</th><th>Value</th><th>Unit</th><th>Scale</th><th>ID</th></tr><tr><td>Reference</td><td>Speed reference</td><td>%</td><td>0.01%</td><td>–</td></tr><tr><td>Control word</td><td>Main control word</td><td>–</td><td>–</td><td>–</td></tr><tr><td>Control word 2</td><td>General control word</td><td></td><td></td><td></td></tr><tr><td>Process data IN1</td><td>Torque reference</td><td>%</td><td>0.1%</td><td>1140</td></tr><tr><td>Process data IN2</td><td>Free analog input</td><td>%</td><td>0.01%</td><td>46</td></tr><tr><td>Process data IN3</td><td>Adjust input</td><td>%</td><td>0.01%</td><td>47</td></tr><tr><td>Process data IN4</td><td>FB Analog output</td><td>%</td><td>0.01%</td><td>48</td></tr><tr><td>PD4 – PD8</td><td>Not used</td><td>–</td><td>–</td><td>–</td></tr></table></td><td></td></tr>
<tr><td>P1.13.19</td><td>897</td><td>Fieldbus general status word
With this parameter it is possible to select which data are sent in FBGeneralStatusWord (see for details and availability in used fieldbus manual).</td><td></td></tr>
<tr><td>P1.13.20</td><td>1741</td><td>FB actual speed “FBActualsSpeed”
With this it is possible to select which Actual speed is shown on the fieldbus.
0 = Calculated
This selection shows what the ramp generator output is.
Open Loop
In frequency control mode when only the ramp output is shown on the fieldbus and, therefore, the motor slip or any other changes of speed due to load changes are not visible in the actual speed value. However, limiting functions are visible in the ramp output.
Closed loop
In closed loop control, the limiting functions take place after ramp generator. When speed is limited by e.g. motoring torque limit the actual shaft speed may be lower even if FB Actual Speed shows that speed is at reference.
1 = Actual
Open loop
Motor speed is a calculated value (Monitoring variable Motor Speed) showing the load affect on the speed and slip compensation. Closed loop Motor speed is taken from the actual encoder signal showing the real speed all the time.
Closed loop
Motor speed is taken from the actual encoder signal showing the real speed all the time.</td><td></td></tr>
<tr><td>P1.13.21</td><td>1440</td><td>Control slot selector “ControlSlotSel.”
This parameter defines which slot is used as the main control place when two fieldbus boards have been installed in the drive. When values 6 or 7 are selected, the drive uses the Fast fieldbus profile. When the Fast fieldbus profile is used, type ‘B’ boards or other C type boards cannot be used.
0 = All slots
4 = Slot D</td><td></td></tr>
</table>

Code	ID	Description	Notes
P1.13.21	**1440**	**Control slot selector "ControlSlotSel."** 5 = Slot E 6 = Slot D, Fast fieldbus support 7 = Slot E, Fast fieldbus support Restrictions when Fast fieldbus support is activated: 1. Set first the Slave Address and the PPO type before selecting the Fast fieldbus mode 2. Fast fieldbus profile is not available for all fieldbus board, contact factory for more detail 3. Service data of profibus board cannot be used 4. Fieldbus board parameters cannot be accessed 5. Profibus option board will operate only in ByPass mode 6. Standard F53 fault detection is not available. WD Pulse monitoring needs to be used to monitor communication faults	
P1.13.22		**State machine** Application has possibility to select what kind of state machine is used. 1: Standard This mode makes fieldbus control behave as in explained in used fieldbus board manual. 2: ProfiDrive This mode uses ProfiDrive type state machine in application level. This mode is possible to use on fieldbus boards that does not have state machine itself or has possibility to bypass state machine functionality in option board. See chapter 9: Status and Control Word in detail	
P1.13.23	**898**	Fieldbus custom minimum "FB custom min"	
P1.13.24	**899**	Fieldbus custom maximum "FB custom max" With these parameters its possible to define fieldbus reference input values scaling. default is 0...10000 (0...100%)	

5.15 ID functions

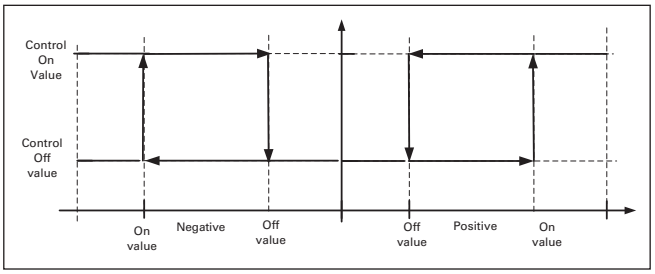
Listed here are the functions that use the parameter ID number to control and monitor the signal.

5.15.1 Value control

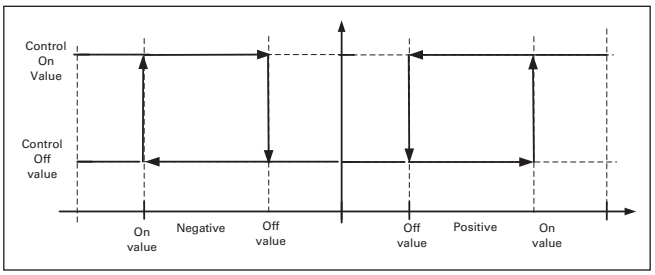
The value control parameters are used to control an input signal parameter.

Code	ID	Description	Notes
P1.14.1.1	**1580**	**Control input signal ID "ContrInSignal ID"** With this parameter you can select what signal is used tocontrol selected parameter.	
P1.14.1.2	**1581**	**Control off limit "Contrl off limit"** This parameter defines the limit when the selectedparameter value is forced to Off value.	
P1.14.1.3	**1582**	**Control on limit "contrl on limit"** This parameter defines the limit when the selected parameter value is forced to On value.	
P1.14.1.4	**1583**	**Control off value "contrl off value"** This parameter defines the value that is used when the used input signal is below Off limit.	
P1.14.1.5	**1584**	**Control on value"Contrl on value"** This parameter defines the value that is used when the used input signal is above On limit.	
P1.14.1.6	**1585**	**Control output signal"ContrlOutSignID"** This parameter defines which parameter is forced to On and Off values when selected input signal exceeds the set limits.	
P1.14.1.7	**1586**	**Control mode ID1586 "control mode"** This parameter defines how the value control output behaves. 0 = SR ABS Absolute input value is used to make a step change in the output between On and Off values.	

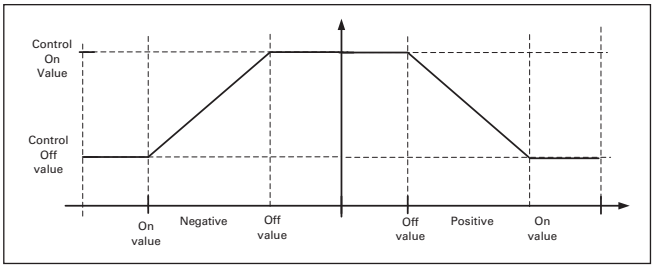
Code	ID	Description	Notes
P1.14.1.7	**1586**	**Control mode ID1586 "control mode"**	



1 = Scale ABS
Absolute input value is scaled linearly between On and Off values.



2 = Scale ABS Inverted
Inverted absolute value is scaled linearly between On and Off values.

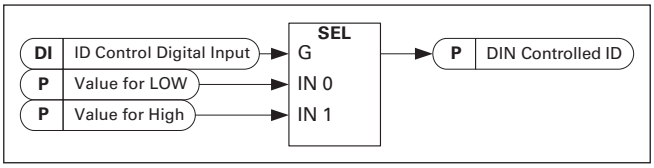


3 = SR
Input value is used to make a step change in the output between On and Off values.
4 = Scale
Input value is scaled linearly between On and Off values.
5 = Scale Inverted
Inverted value is scaled linearly between On and Off values

P1.14.1.8	**1586**	**Control signal filtering TC "Control filt TC"** This parameter is used to filter the scaling function output. Used e.g. when unfiltered torque is used to control a parameter that needs stabilization.	

5.15.2 DIN ID control

This function is used to control any parameter between two different values with a digital input. Different values are given for DI 'low' and DI 'high'.



Code	ID	Description	Notes
P1.14.2.1	**1570**	**ID control digital input "ID control DIN"**	
P1.14.3.1	**1590**	**ID control digital input "ID control DIN"**	
P1.14.4.1	**1578**	**ID control digital input "ID control DIN"** Select digital input to be used for controlling the parameter selected by ID1571, ID1575 and 1579.	
P1.14.2.2	**1571**	**DIN controlled ID ID1571 "controlled ID"**	
P1.14.3.2	**1575**	**DIN controlled ID "controlled ID"**	
P1.14.4.2	**1579**	**DIN controlled ID "controlled ID"** Select parameter ID controlled by ID1570.	
P1.14.2.3	**1572**	**Value for low digital input (FALSE) "false value"**	
P1.14.3.3	**1592**	**Value for low digital input (FALSE) "false value"**	
P1.14.4.3	**1594**	**Value for low digital input (FALSE) "false value"** Set here the controlled parameter value when the digital input (ID1570) is LOW for the parameter selected by ID1571. The function does not recognize decimals. Give, therefore, e.g. 10.00 Hz as '1000'.	
P1.14.2.4	**1573**	**Value for high digital input (TRUE) "true value"**	
P1.14.3.4	**1593**	**Value for high digital input (TRUE) "true value"**	
P1.14.4.4	**1596**	**Value for high digital input (TRUE) "true value"** Set here the controlled parameter value when the digital input (ID1570) is HIGH for the parameter selected by ID1571. The function does not recognize decimals. Give, therefore, e.g. 10.00 Hz as '1000'.	

5.15.3 ID-controlled DO

This function is used to control any Digital output by anystatus that can be presented as bit.The input signal is selected with the ID number and bit number.Example: Most of the faults and warnings are normallypresented in the common digital output. With theID-controlled DO function, it is possible to select a specificfault to be connected to the digital output.

Warning word 1 ID1174

	Fault	Comment
b0	Motor stalled	W15
b1	Motor over temperature	W16
b2	Motor under load	W17
b3	Input phase loss	W10
b4	Output phase loss	W11
b5	Safe disable	W30 (Not implemented)
b6	FieldBus communication fault in slot D	W53 (Not implemented)
b7	FieldBus communication fault in slot E	W67 (Not implemented)
b8	Drive over temperature	W14
b9	Analog input < 4mA	W50
b10	Not used	
b11	Emergency stop	W63 (Not implemented)
b12	Run disabled	W62 (Not implemented)
b13	Not used	
b14	Mechanical brake	W58
b15	Not used	

Code	ID	Description	Notes
P1.14.5.1	**1216**	**ID.Bit free digital output control 1 "ID.Bit free DO1"**	
P1.14.6.1	**1386**	**ID.Bit free digital output control 2 "ID.Bit free DO2"** Select the signal for controlling the DO. The parameter has to be set in format xxxx. yy where xxxx is the ID number of a signal and yy is the bit number. For example, the value for DO control is 1174.02. 1174 is the ID number of Warning Word 1. So the digital output is ON when bit number 02 of the warning word (ID no. 1174) i.e. Motor underload is high.	
P1.14.5.2	**1574**	**Free digital output selector "Free DO1 Sel."**	
P1.14.6.2	**1325**	**Free digital output selector "free DO2 sel."** Select the output terminal to be controlled with the parameter ID.bit Free Digital output control.	

5.15.4 Free din delay

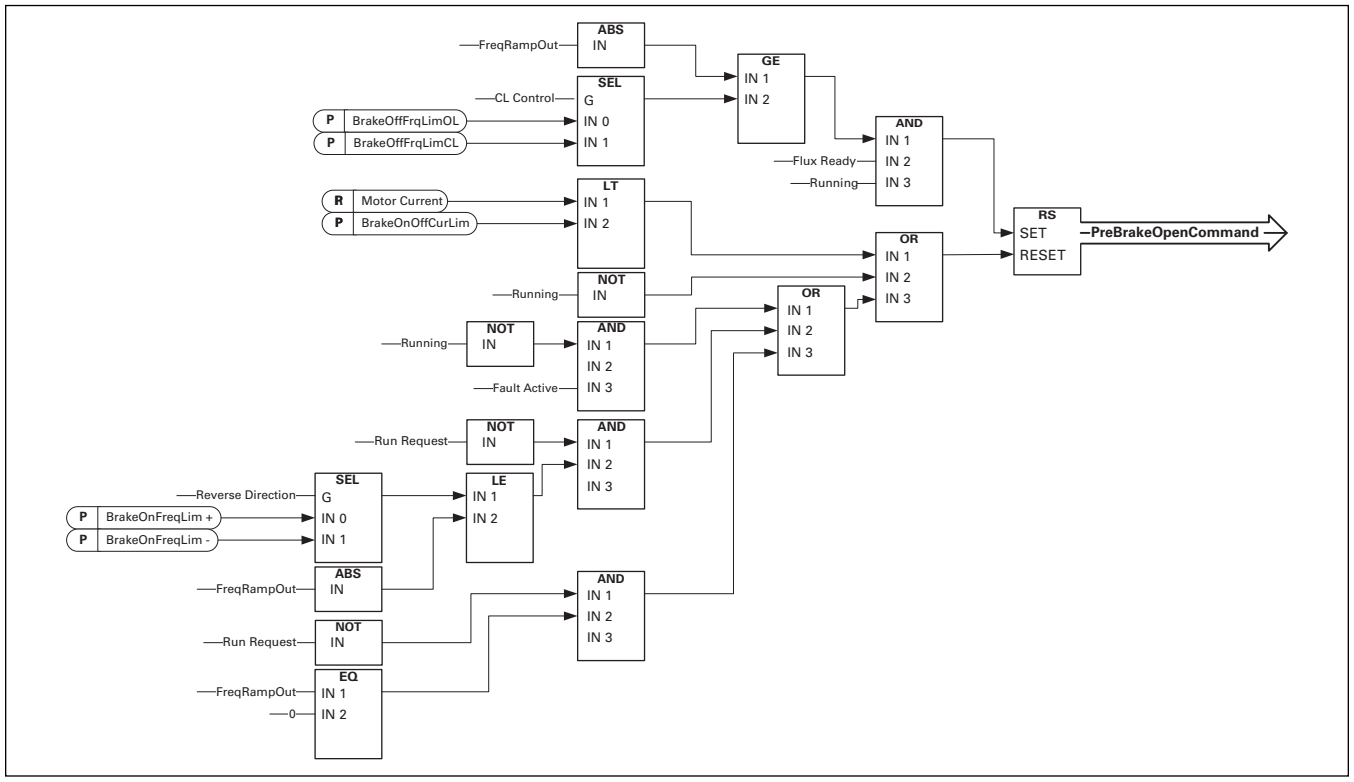
This function is mend to be used on situation when certainDIN signal needs On or Off delay before actual command isgiven. e.g. Reading from DIN Status Word: DIN1 status givingit a e.g. 1,00 s delay and then writing it by ID number toID403 Start 1, thus giving 1 second delay to start in drive side.

Code	ID	Description	Notes
P1.14.7.1	**1832**	**ID.Bit Free Digital input delay "ID.Bit Free DIN"** Select digital input from DIN Status Word to be delayed.	
P1.14.7.2	**1833**	**On Delay "On Delay"** This defines ON delay for the input signal.	
P1.14.7.3	**1834**	**Off Delay "Off Delay"** This defines OFF delay for the input signal.	
P1.14.7.4	**1836**	**Mono Time"Mono Time"** This timer makes a pulse that last defined time. Pulse will start after On Delay time.	
P1.14.7.5	**1835**	**Control Out ID"Control Out ID"** Select the signal ID to be controlled by input signal. If inversion or parameter value other than zero and one is needed this can be connected to DIN ID Control function ID1570, ID1590 or 1578 where desired values can be set and connected to correct parameter.	

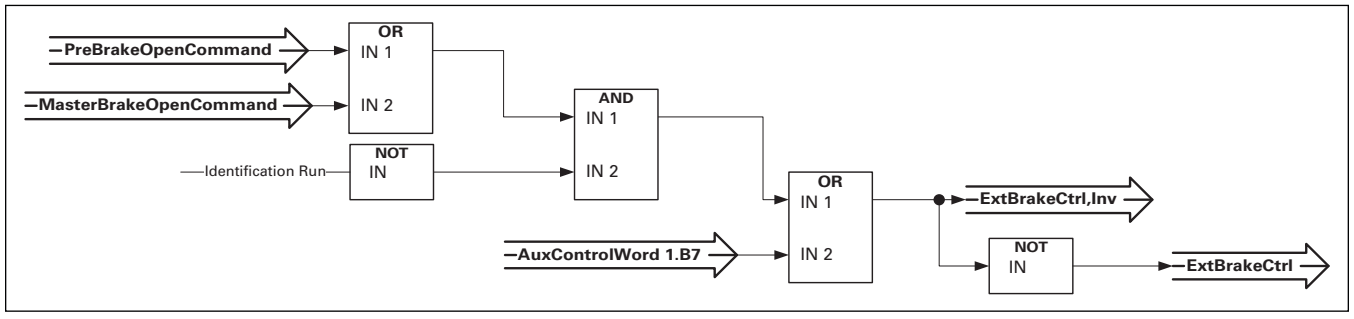
5.16 Brake control

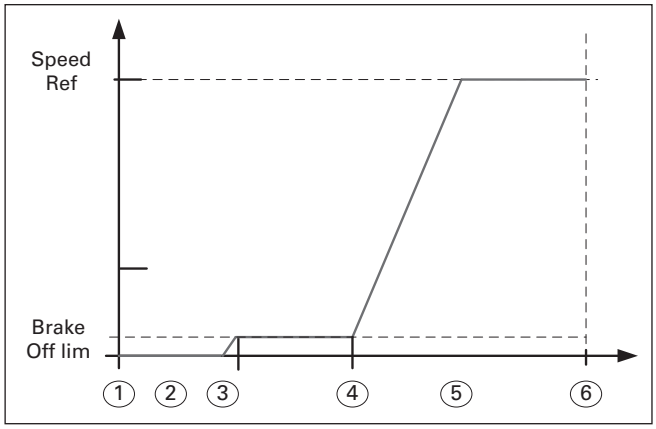
The mechanical brake control has two parts that needto be synchronically controlled. The first part is the mechanical brake release and the second is the speedreference release.

Conditions to open the brake:

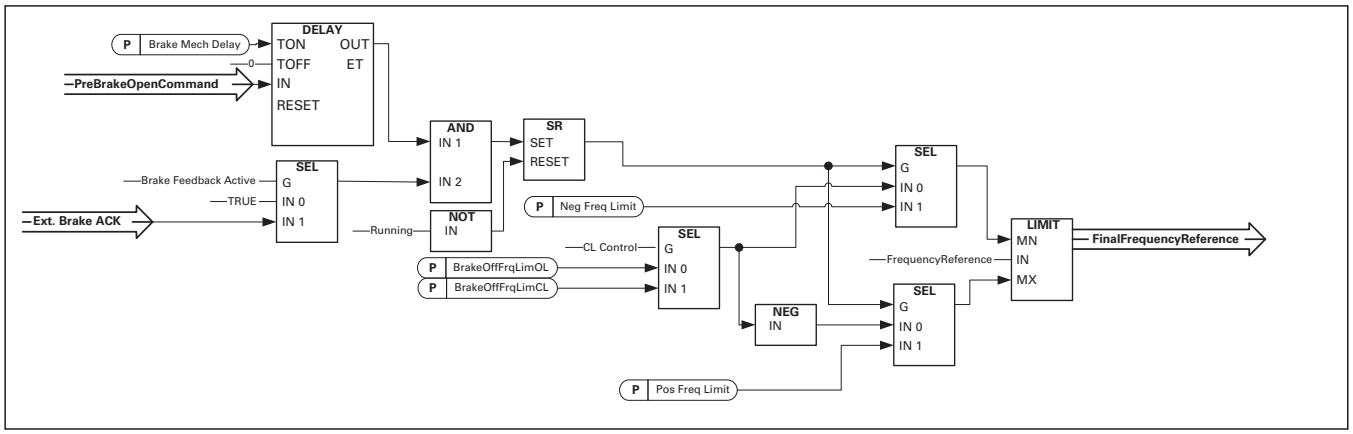


The final brake open command: It is possible that in aMaster/Follower system the master drive opens thebrake. Also an overriding system may do this without anycontrol from the drive using AucControlWord1.B7. Duringidentification run the brake will not open.





1. Start command
2. Start magnetization is used to build rotor flux fast. The drive Zero speed time is used during this
3. When the rotor flux is > 90 % and the start zero time has expired the speed reference is released to BrakeOpenFreq limit
4. Speed is kept at this speed until feedback is received from the brake acknowledge or when brake mechanical delay time has passed
5. Speed follows normal reference signal



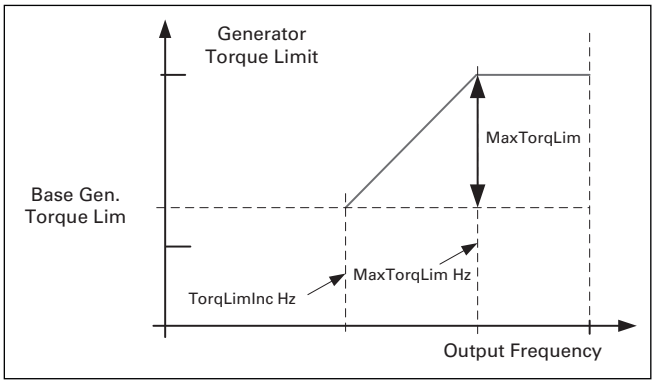
Code	ID	Description	Notes
P1.15.1	**1544**	**Mechanical brake reaction time "brake mech delay"** After the brake open command has been given, speed iskept at the Brake Open limit until the reaction time haspassed. This hold time should be set corresponding to themechanical brake reaction time. This function is used toavoid current and/or torque spikes eliminating a situationwhere the motor is run at full speed against the brake. Ifthis parameter is used when simultaneously with the brakeacknowledge input both time and brake acknowledgementsare needed before the speed reference is released..	
P1.15.2	**1535**	**Brake frequency limit open loop "BrakeOFFFrqLimOL"** This parameter defines the frequency limit to release the brake. This value also applies as the maximum frequency referencelimit while the brake is closed. In open loop control it isrecommended to use a value that is equal to the motor'snominal slip.	
P1.15.3	**1555**	**Brake frequency limit closed loop "BrakeOFFFreqLimCL"** This parameter defines the frequency limit to release the brake. This value also applies as the maximum frequency referencelimit while the brake is closed. In closed loop control itis recommended to use zero value so that the brake isreleased while the drive has zero speed at start. If torque isneeded to avoid position change at the moment the brakemechanically opens use the start-up torque function.	
P1.15.4	**1539**	**Closing frequency from forward direction "BrakeOnFreqLim +"** Output frequency limit to close the brake when the speedapproaches zero speed from positive direction. Liftingdirection must be given as positive frequency..	
P1.15.5	**1540**	**Closing frequency from reverse direction ID1540 "BrakeInFreqLim -"** Output frequency limit to close the brake when the speedapproaches zero speed from positive direction. Loweringdirection must be given as negative frequency.	
P1.15.6	**1085**	**Brake On/Off current limit "BrakeOnOffCurLim"** If motor current is below this value the brake is closed immediately. It is recommended to set this value to approximately 25 % of the magnetization current from the maximum used frequency.	

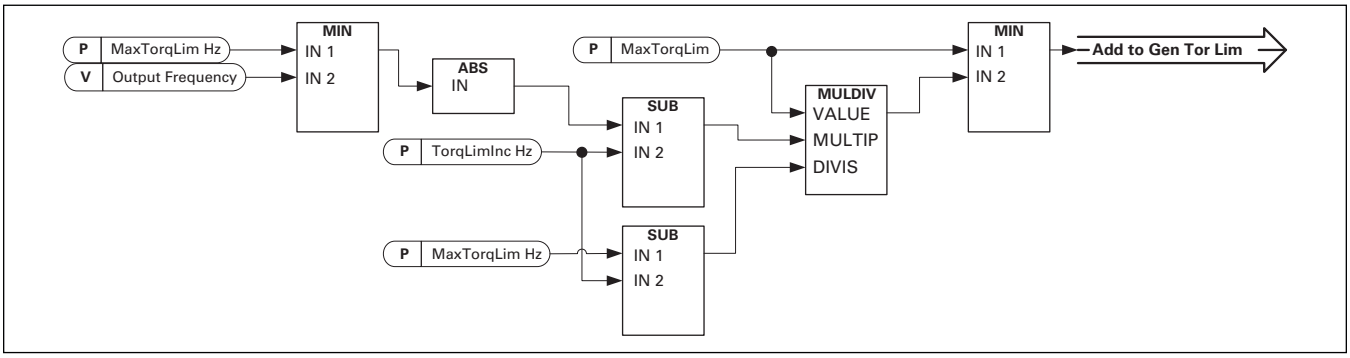
5.16.1 Run away load protection

Run away load protection is used to increase the generatortorque limit in case when the speed of the load isincreasing above the defined frequency limit. Used in caseswhen upper system is controlling generator torque limitand its needed to drive itself control situation when speedincreases too high.

Note: The maximum generator side torque limit is still limited by the General torque limit parameter.

Code	ID	Description	Notes
P1.15.7	**1547**	**Generator torque limit increase speed level "TorqLimInc Hz"** The frequency limit at which the generator side torque limitis started to increased when speed of the motor increases(over speed)..	
P1.15.8	**1548**	**Generator torque limit increase high speed limit "MaxTorqLim Hz"** The frequency level at which point the torque defined bythe "Generator Torque Limit increase maximum addition"is added entirely to the final torque limit.	
P1.15.9	**1549**	**Generator torque limit increase added torque "MaxTorqLim"** When this parameter is set greater than zero the generatortorque limit increases at high speed is activated. Thisparameter defines the torque that is added to generatortorque limit, linearly starting from ID1547 to ID1548. See Figure below.	





5.16.2 Brake monitoring function

The brake monitoring function is activated when thefunction Brake acknowledge is used. The brake monitoringfunction compares the brake feedback to the control signal.In other words, a fault will be issued if the feedback ismissing when drive is in Run state and the output frequencyis above the opening limit and the fault delay has expired. Afault is also triggered if the brake feedback indicates that thebrake is open while the drive is in stop state.In some cases it is possible that an encoder fault appearswhen the drive is run against closed brake. The encoderfault can be disabled with Control Options B8 when thedrive is controlling the brake to be closed.

Code	ID	Description	Notes
P1.15.10	**1316**	**Brake fault response ID1316 "brake fault"** Defines the action after detection of a brake fault. 0 = No response 1 = Warning 2 = Fault, stop mode after fault according to Stop Function 3 = Fault, stop mode after fault always by coasting	
P1.15.11	**1317**	**Brake fault delay "BrakeFaultDelay"** The delay before the brake fault (F58) is activated. Usedwhen there is a mechanical delay in the brake. See digitalinput signal External brake acknowledge.	

5.16.3 Closed loop settings

5.16.3.1 Start up torque

The start-up torque is used to generate torque against thebrake so that when the brake is mechanically opened therewill be no position change because the drive is alreadygenerating the torque needed to keep the load in place.

Settings the start-up torque time is set to –1 means thatthe start-up torque is removed when the drive noticesencoder movement. Setting the time greater than 0 willdenote the actual time for how long the start-up torqueis applied to the motor even if the motor shaft is alreadyrotating thus making the motor accelerate without controluntil time has expired.

Code	ID	Description	Notes
P1.15.12.1	**621**	**CL: startup torque "StartUp torque!** 0 = Not Used 1 = Torque Memory Torque memory uses the torque that was used by the speed controller last time the drive was in running state. Normally, this is the torque generated when the zero speed time at stop has expired and the drive has stopped modulation or started the flux off delay function. 2 = Torque Reference The normal torque reference chain is used (expect TorqueStep) for the start-up torque level. This can be used when the external system knows the load on the shaft when brake is released. 3 = Torque Forwad/Reverse Drive uses torque values defined by the start-up torque forward and reverse.	
P1.15.12.2	**633**	**Start-up torque, forward ID"StartupTorq FWD"** Sets the start-up torque for forward direction if selected with pararameter Startup Torque.	
P1.15.12.3	**634**	**Start-up torque, reverse "StartupTorq REV"** Sets the start-up torque for reverse direction if selected with pararameter Startup Torque.	
P1.15.12.4	**1371**	**Start-up torque time "StartupTorq time"** This parameter defines for how long the start-up torque will be used instead of the speed controller output. If thetime is set to –1 the drive will automatically start to use thespeed controller when speed change is read from encoder.When the setting is >0 the drive will use this defined torqueeven if speed changes are read from encoder.	

5.16.4 Roll back control for closed loop

P1.15.13.1	Roll Back	Kp ID1787
P1.15.13.2	Roll Back Torque	ID1788
P1.15.13.3	Roll Back Level	ID1789

5.17 Auto fault reset

The Auto reset function tries to reset the fault automaticallyduring the trial time. An individual fault can be defined tobe reset certain number of times before the actual faultindication is given. The function will operate as AutomaticRestart function if the start command is received as a staticsignal. In I/O control of the SPX Advanced application, thedefault start function requires a rising edge command afterfault trigger.

Code	ID	Description	Notes
P1.16.1	**717**	**Automatic reset: wait time "wait time"** Defines the time for the attempted fault reset after the fault trigger has passed.	In case of external fault, remove the cause of fault on the external device. The wait time count starts only when the cause of fault has been removed.
P1.16.2	**718**	**Automatic reset: trial time "trial time"** The Automatic reset function keeps trying to reset thefaults appearing during the time set with this parameter. Ifthe number of faults during the trial time exceed the valueof the respective parameter set with ID720 to ID725 apermanent fault is generated.	
P1.16.3	**719**	**Automatic restart: start function "start function"** The Start function for restart is selected with this parameter; restart will take place if there is a static Start command active when an automatic fault reset is made. 0 = Start with ramp 1 = Flying start 2 = Start according to Start Function parameter (Default) The following 'Number of tries' parameters determine the maximum number of automatic restarts during the trial time. The time count starts from the first autoreset. If the number of faults occurring during the trial time exceeds the values set by number of tries the fault state becomes active.	

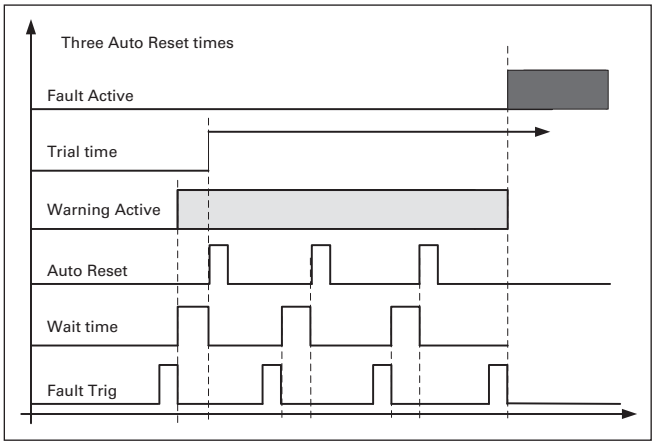


Figure 5-17. Example of Automatic restarts with three restarts

Code	ID	Description	Notes
P1.16.4	**720**	**Number of tries after under voltage fault trip "undervolt. tries"** This parameter determines how many automatic fault resets can be made during the trial time after under voltage trip. 0 = No automatic reset >0= Number of automatic fault resets after under voltage fault.	
P1.16.5	**721**	**Number of tries after overvoltage trip "overvolt. tries"** This parameter determines how many automatic fault resets can be made during the trial time after overvoltage trip. 0 = No automatic fault reset after overvoltage fault trip >0 = Number of automatic fault resets after overvoltage fault trip.	
P1.16.6	**722**	**Number of tries after overcurrent trip ID722 "overcurr. tries"** This parameter determines how many automatic fault resets can be made during the trial time after overcurrent trip. 0 = No automatic fault reset after overcurrent fault trip >0 = Number of automatic fault resets after overcurrent trip, saturation trip and IGBT temperature faults..	IGBT temp faults also included
P1.16.7	**723**	**Number of tries after reference trip "4mA fault tries"** This parameter determines how many automatic fault resets can be made during the trial time after 4 mA reference fault. 0 = No automatic fault reset after reference fault trip >0 = Number of automatic fault resets after the analog current signal (4…20mA) has returned to the normal level (>4mA)	
P1.16.8	**726**	**Number of tries after motor temperature fault trip "MotTempF tries"** This parameter determines how many automatic fault resets can be made during the trial time after calculated motor temperature fault trip. 0 = No automatic fault reset after Motor temperature fault trip >0 = Number of automatic fault resets after the motor temperature has returned to its normal level	
P1.16.9	**725**	**Number of tries after external fault trip "Ext.Fault tries"** This parameter determines how many automatic fault resets can be made during the trial time after external fault trip. 0 = No automatic fault reset after External fault trip >0 = Number of automatic fault resets after External fault trip	
P1.16.10	**738**	**Number of tries after underload fault trip "underload tries"** This parameter determines how many automatic fault resets can be made during the trial time after underload trip. 0 = No automatic fault reset after Underload fault trip >0 = Number	
P1.16.11	**731**	**Number of tries after cooling fault trip "cooling tries"** This parameter determines how many automatic fault resets can be made during the trial time after Cooling trip. 0 = No automatic fault reset after Cooling fault trip >0 = Number of automatic fault resets after Cooling fault trip	
P1.16.12	**735**	**Number of tries after output contactor fault trip"O/P Intlk tries"** This parameter determines how many automatic fault resets can be made during the trial time after Output Contactor Interlock trip. 0 = No automatic fault reset after Output Contactor Interlock fault trip >0 = Number of automatic fault resets after Output Contactor Interlock fault trip	
P1.16.13	**1569**	**Fault simulation "fault simulation"** With this parameter it's possible to simulate different faults without actually making e.g. over current situation. In drive interface point of view behaviour is identical to actual fault situation. B00 = +1 = Simulates over current fault (F1) B01 = +2 = Simulates over voltage fault (F2) B02 = +4 = Simulates under voltage fault (F9) B03 = +8 = Simulates output phase supervision fault (F11) B04 = +16 = Simulates earth fault (F3) B05 = +32 = Simulates system fault (F8)	

Code	ID	Description	Notes
P1.16.13	**1569**	This fault simulation cover wide range of different faults in drive, see fault description for details. B06 = +64 = Simulates encoder fault (F43) B07 = +128 = Simulates over temperature warning (W14) B08 = +256 = Simulates over temperature fault (F14) Warning bit needs to be active that fault will come in simulation. If fault bit is left active drive will go fault state at warning limit when drive temperature will rice to warning level. B09 = +512 = Reserved	

5.18 PI control

5.18.1 Basic settings

Code	ID	Description	Notes
P1.17.1.1	**118**	**PID controller gain ID118 "PID-contr gain"** This parameter defines the gain of the PID controller. If thevalue of the parameter is set to 100% a change of 10% inthe error value causes the controller output to change by10%. If the parameter value is set to 0 the PID controlleroperates as I-controller.	
P1.17.1.2	**119**	**PID controller I time "PID-contr I time"** The parameter ID119 defines the integration time of the PIDcontroller. If this parameter is set to 1,00 second a changeof 10% in the error value causes the controller output tochange by 10.00%/s. If the parameter value is set to 0.00 sthe PID controller will operate as P controller.	
P1.17.1.3	**132**	**PID controller D time"PID-contr D time"** ID 132 defines the derivative time of the PD controller. Ifthis parameter is set to 1.00 seconds a change of 10% inPID error value during 1.0 seconds cause the controlleroutput to change 10%. If the parameter is set to 0 the PIDcontroller operates as a PI controller.	
P1.17.1.4	**1795**	**Engineering unit "engineering unit"** This defines the unit used in the process setting the valueallow for easy set up and control of the PID controller byallowing the controller to display and control values thatmatch the process.	
P1.17.1.5	**359**	**PID minimum limit "PID min limit"** This parameter sets the low limit in engineering units of the process this will typically match the low limit of the measurement device measuring the feedback value.	
P1.17.1.6	**360**	**PID maximum limit "PID max limit"** This parameter sets the maximum limit in engineering unitsof the process this will typically match the maximum limit ofthe measurement device measuring the feedback value.	
P1.17.1.7	**342**	**Error inversion "error inversion"** This inverts the error in the PID allowing the output to be inverted. Not inverted = The drive will increase speed to increase the feedback value Inverted = The drive will increase speed to decrease the feedback value	

5.18.2 Set points

Code	ID	Description	Notes
P1.17.2.1	**332**	**PID set point source "setpoint source"** This parameter allows the selection of two independent setpoint sources source 1 or source 2 the section can also bemade with a digital input.	
P1.17.2.2	**334**	**PID source 1 select"source 1 sel"** This sets the source of the source 1 set point value this can come from an analog input, keypad, or fieldbus.	
P1.17.2.3	**335**	**PID source 2 select "source 2 sel"** This sets the source of the source 2 set point value this can come from an analog input, keypad, or fieldbus.	

Code	ID	Description	Notes
R1.17.2.4		**Keypad PID reference 1** Keypad PID set point 1	
P1.17.2.5	**361**	**Keypad PID set point 1 minimum "PID SP1 min"** This allows the range of keypad set point 1 to be limited	
P1.17.2.6	**362**	**Keypad PID set point 1 maximum "PID SP1 max"** This allows the range of keypad set point 1 to be limited	
R1.17.2.7		**Keypad PID reference 2** Keypad PID set point 2	
P1.17.2.8	**363**	**Keypad PID set point 2 minimum "PID SP2 min"** This allows the range of keypad set point 2 to be limited	
P1.17.2.9	**364**	**Keypad PID set point 2 maximum "PID SP2 max"** This allows the range of keypad set point 2 to be limited	
P1.17.2.10	**364**	**PID reference rise time "PID ref rise time"** This determines the rate of change of a rising PID set point	
P1.17.2.11	**344**	**PID reference fall time "PID ref fall time"** This determines the rate of change of a falling PID set point	
P1.17.2.12	**376**	**PID sum point reference"PID sumpoint ref"** This source is added to the PID output	

5.18.3 Feedbacks

Code	ID	Description	Notes
P1.17.3.1	**333**	**Feedback function "function"** This parameter determines the source of the PID controllerFeedback value. This allows for selection between 2 sourcesor math functions between 2 sources.	
P1.17.3.2	**334**	**PID source 1 select"source 1 sel"** This sets the source of the source 1 set point value this can come from an analog input, keypad, or fieldbus.	
P1.17.3.3	**337**	**Feedback 1 minimum scale "FB 1 min scale"** This is the minimum percentage of source 1.	
P1.17.3.4	**338**	**Feedback 1 maximum scale "FB 1 max scale"** This is the maximum percentage of source 1.	
P1.17.3.5	**339**	**Feedback source 2"FB source 2"** This selects the Analog source of source 2.	
P1.17.3.6	**340**	**Feedback 2 minimum scale "FB 2 min scale"** This is the minimum percentage of source 2.	
P1.17.3.7	**341**	**Feedback 2 maximum scale "FB 2 max scale"** This is the maximum percentage of source 2.	

5.18.4 Sleep

Code	ID	Description	Notes
P1.17.4.1	**1016**	**Sleep frequency ID1016 "sleep frequency"** This defines the level where the PID controller will go tosleep when the output frequency is below this level and hasexceeded the Sleep Delay time.	
P1.17.4.2	**119**	**PI controller I time "sleep delay"** This defines the level where the PID controller will goto sleep when the output frequency is below The Sleepfrequency level and has exceeded this delay time.	
P1.17.4.3	**1018**	**Wake up limit ID1018 "PID reference"** When the Feedback value exceeds or is below this limitas defined by Wake up action. The drive will start out ofsleep mode.	
P1.17.4.4	**1019**	**Wake up action "wake up action"** Sets if the sleep function will wake if above the wake up limit or below.	

5.19 Keypad control parameters

Unlike the parameters listed above, these parameters are located in the M2 menu of the control keypad.
The reference parameters do not have an ID number.

Code	ID	Description	Notes
P2.1	**125**	**Control place "control place"** The active control place can be changed with this parameter. 1 = Keypad L/R1 • The keypad LOC/REM button will cycle between local and remote 1, A Force control place input will override this setting 2 = Keypad L/R1/R2 • The keypad LOC/REM button will cycle between local and remote 1 and remote 2, A Force control place input will override this setting 3 = Local • Forces the control place to local and disabledforce inputs 4 = Remote 1 • Forces the control place to Remote 1 and disabled force inputs 5 = Remote 2 • Forces the control place to Remote 2 and disabled force inputs 6 = I/O Select • When no control place is selected with the force control place inputs the control place is local. This disable the loc/rem Button on the keypad	
R2.2		**Keypad reference No ID "keypad reference"** The frequency reference can be adjusted from the keypadwith this parameter.The output frequency can be copied as the keypadreference by pushing the Stop button for 3 seconds whenyou are on any of the pages of menu M2.	
P2.3	**123**	**Keypad direction "keypad direction"** 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.	
P2.4	**114**	**Stop button activated "StopButtonActive"** 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.	
R2.5		**Torque reference no ID "torque reference"** Define here the torque reference within 0.0…100.0%.	
R2.6		**Power reference no ID "power reference"** Define here the power reference within 0.0…100.0%.	
R2.7		**PID reference 1 no ID "PID reference 1"**	
R2.8		**PID reference 2 no ID "PID reference 2"** Define here the PID Reference in Engineering Units	

6. Data logger trigger word

There is a special trigger word in application level that can be used to trigger data logger. This word can be used for triggering when source is selected from Application and original SPX Advanced application vcn is used. Variable is called "DataLoggerTrigWord"

DataLoggerTrigWord ID97

	Function	Comment
b0	Fault status	Logger is triggered when there is a fault
b1	Warning status	Logger is triggered when there is a warning
b2	Auto reset warning	Logger is triggered when there is a fault that has been defined to be automatically reset. This bit can be used to get the first fault situation.
b3	Fault status OR warning status	B0 OR B1 triggering situation has happened
b4	Fault status OR auto reset warning	B0 OR B2 triggering situation has happened
b5		
b6		
b7		
b8		
b9		
b10		
b11		
b12		
b13		
b14		
b15		

7. Identification function for permanent magnet synchronous motor

PM Motor has several zero positioning identification modes. This chapter explains what kind of identification mode is needed to select when using different kind of hardware configuration.

This chapter is addition to P1.1.9 Identification parameter description and P1.8.5.2 Start Angle Identification mode description.

7.1 Zero position identification with absolute encoder.

When using absolute encoder identification is made only once. Remade is needed if encoder and rotor position changes related to each other.

Motor needs to be able to rotate freely that magnet positions can be identified.

Identification mode in this case is selected by "P1.1.9 Identification" selection "3/Enc.ID Run".

During identification drive feeds DC current to motor (~90 % of motor nominal), this causes motor to move zero position, there may be oscillatory movement on the shaft. When identification is successful "P1.8.5.1 PMSM Shaft Position" is updated, if not successful value is set to zero and identification warning is displayed for 10 seconds (W57). If identification is made several times, result may be different; there are as many positions as there are pole pairs in the motor.

Benefit to use absolute encoder is that magnet position is always known thus motor can be fully loaded from the start.

Code	ID	Description	Notes
P1.1.9	**631**	**Identification**	
P1.8.5.1	**649**	**PMSM shaft position**	

7.2 Start position with incremental encoder without Z-pulse input.

When using incremental encoder without Z-pulse, no actual identification is made. But start angle is find in every start. Identification mode can be selected by "P1.8.5.2 Start Angle Identification Mode" In this case encoder identification cannot be done because zero position cannot be identified without Z-pulse. But identification P1.1.9 Identification selection "2/ID With Run" is needed to make. Identification at every start will be automatically active if "P1.8.5.1 PMSM Shaft Position" parameter value is zero.

Best result is get when motor has a mechanical brake that prevents shaft movements. Acceptable result can be achieved also when motor has high load and/or inertia that prevent shaft movements during identification.

Angle identification is done in every start by feeding motor with a DC pulses that identifies magnet position. DC pulses are in two different groups. First one identifies zero position and second one makes polarity check. These DC current levels are adjusted by "P1.8.5.3 Start Angle Identification Current" and "P1.8.5.4 Polarity Pulse current", respectively.

Note: Not all motors are suitable for this identificationmode. Functionality needs to be tested beforeproduction use.

Benefit of this mode is that motor can be fully loaded from the start.

Related parameters:

Code	ID	Description	Notes
P1.8.5.2	**1691**	**Start Angle Identification Mode**	
P1.8.5.1	**649**	**PMSM Shaft Position**	
P1.8.5.3	**1759**	**Start Angle Identification Current**	
P1.8.5.4	**1566**	**Polarity Pulse current**	

7.3 Identification with incremental encoder with Z-pulse input.

When using incremental encoder with Z-pulse, identification is made only once. Remade is needed if encoder and rotor position changes related to each other.

Motor needs to be able to rotate freely that magnet positions can be identified. Identification mode in this case is selected by "P1.1.9 Identification" selection "3/Enc.ID Run".

During identification drive feeds DC current to motor (~90 % of motor nominal), this causes motor to move to zero position, there may be oscillatory movement on the shaft. When motor oscillatory movement has stopped motor is rotated until Z-pulse is received from the encoder.

When identification is successful "P1.8.5.1 PMSM Shaft Position" is updated, if not successful value is set to zero and identification warning is displayed for 10 seconds (W57). If identification is made several times result may be different, there are as many positions as there are pole pairs in the motor.

When motor is started and zero position is not "remembered": Drive will start to feed DC current to motor (Defined by "P1.8.5.6 I/f Current") till Z-pulse is received from the encoder. During this DC injection motor may not be able to produce 100 % torque. When running without load Z-pulse position can be seen in the motor current when current goes nearly to zero.

Related parameters:

Code	ID	Description	Notes
P1.1.9		**Identification**	
P1.8.5.1		**PMSM Shaft Position**	
P1.8.5.6		**I/f Current**	

8. Status and control word in detail

Combination	P7.x.1.4 Operate Mode	P1.13.22 State machine	
1	1/ProfiDrive	1/Basic	Control and status word are explained in fieldbus option board manual
2	2/ByPass Some fieldbus board operate by default in "ByPass" mode	2/ProfiDrive	Control word is ProfiDrive type and explained in this manual. Status Word is can be selected by ID number, default is ProfiDrive type ID65 V7.26.2 FB Status Word
3	2/ByPass	1/Basic	Control word is "Three Bit" control. Status Word is can be selected by ID number, default is ProfiDrive type ID65 V7.26.2 FB Status Word
4	1/ProfiDrive	2/ProfiDrive	Drive cannot be operated in this combination from fieldbus.

8.1 Combination 1, ProfiDrive – standard with profibus option board

8.1.1 Control word combination 1, ProfiDrive – basic with profibus option board

Main Control Word for Profibus in Combination 1

	False	True	Comment
b0	STOP 1 (by ramp)	ON 1	Keep this TRUE
b1	STOP 2 (by cost)	ON 2	Keep this TRUE
b2	STOP 3 (by ramp)	ON 3	Keep this TRUE
b3	RUN DISABLE	ENABLE	Use this for start and stop command
b4	No Action	START	Keep this TRUE
b5	No Action	START	Keep this TRUE
b6	No Action	START	Keep this TRUE
b7	No Action	Fault Reset 0 > 1	Use this for fault reset
b8	No Action	No Action	Not used
b9	No Action	No Action	Not used
b10	Disable profibus control	Enable fieldbus control	See profibus manual
b11	Fieldbus DIN1=OFF	Fieldbus DIN1=ON	See P1.5.1.17 -18
b12	Fieldbus DIN2=OFF	Fieldbus DIN2=ON	See P1.5.1.19 -20
b13	Fieldbus DIN3=OFF	Fieldbus DIN3=ON	See P1.5.1.21 -22
b14	Fieldbus DIN4=OFF	Fieldbus DIN4=ON	See P1.5.1.23 -24
b15	Fieldbus DIN5=OFF	Fieldbus DIN5=ON	Not used

8.1.2 Status word combination 1, ProfiDrive – basic with profibus option board

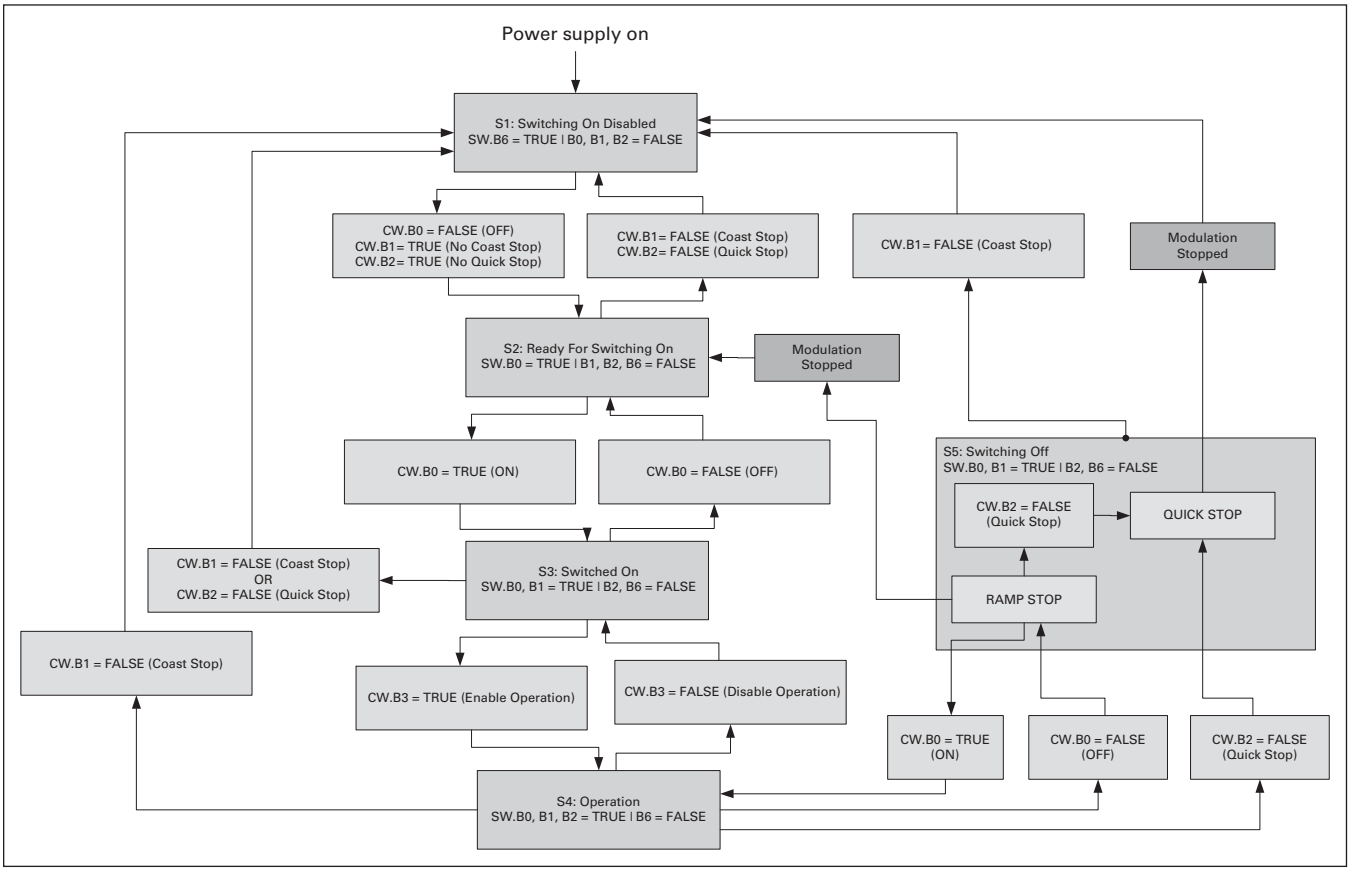
Main Status Word for Profibus in Combination 1

	False	True	Comment
b0	Not ready (initial)	READY 1 (SM)	See profibus manual
b1	Not Ready	READY 2 (SM)	See profibus manual
b2	DISABLE	ENABLE (SM)	See profibus manual
b3	NO FAULT	FAULT ACTIVE	Directly from the drive
b4	STOP 2	NO STOP 2 (SM)	See profibus manual
b5	STOP 3	NO STOP 3 (SM)	See profibus manual
b6	START ENABLE	START DISABLE (SM)	See profibus manual
b7	No warning	Warning	Directly from the drive
b8	Reference ≠ Actual value	Reference = Actual value	
b9	Fielbus control OFF	Fielbus control ON	See profibus manual
b10	Not used	Not used	
b11	Not used	Not used	
b12	FC Stopped	Running	Directly from the drive
b13	FC not ready	Ready	Directly from the drive
b14	Not used	Not used	
b15	Not used	Not used	

SM = Profibus board State Machine

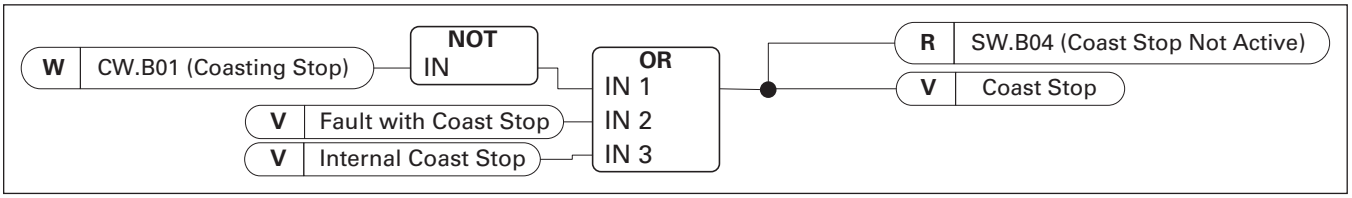
8.2 Combination 2, ByPass – ProfiDrive

8.2.1 State diagram

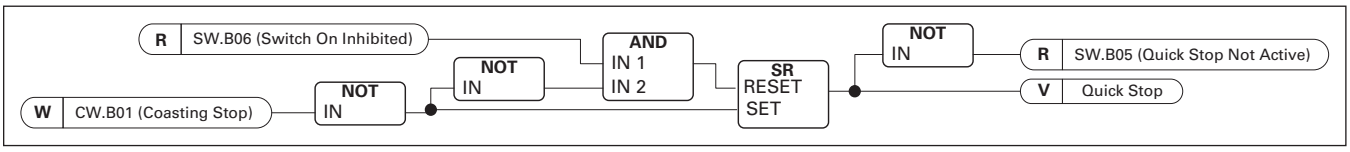


8.2.2 State machine

8.2.2.1 Costing stop

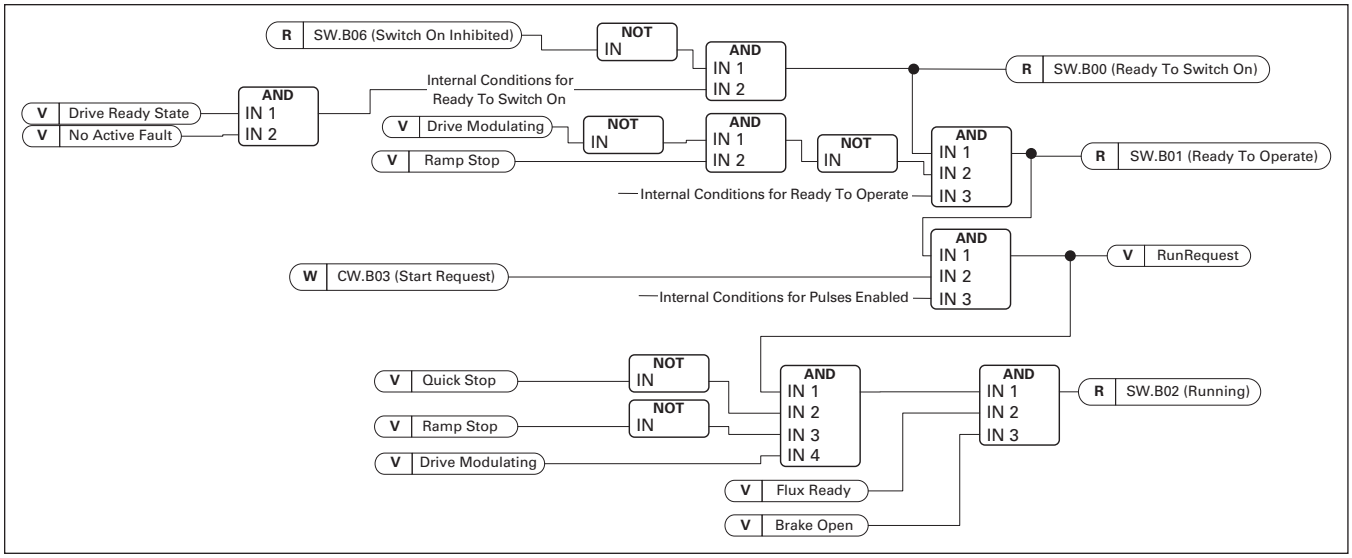


8.2.2.2 Quick stop



8.2.2.3 Switch on inhibit

8.2.2.4 Ready to switch-on, operate and running



8.2.3 FB Control word

FB Control Word

	Signal	Comment
b0	ON	0>1 will reset the switch on inhibit state and bring the drive to ready run. Should be reset after fault, coast stop (b1) and emergency stop (b2) .
b1	Coasting stop	0=Coast stop active 1=Coast stop NOT active
b2	Quick stop	0=Quick stop active 1=Quick stop NOT active
b3	Start	Normal start command 0=Stop the drive 1=Start the drive
b4	Ramp output to zero	0=Force speed ramp output to zero 1=Release speed ramp output
b5	Ramp hold	0=Hold speed ramp output 1=Release speed ramp
b6	Ramp input to zero	0=Force speed ramp input to zero 1=Release speed ramp input
b7	Fault reset	0=No action 1=Reset active faults
b8	Inching 1	Run the drive with defined constant speed 0=No action 1=Run with constant speed
b9	Inching 2	Run the drive with defined constant speed 0=No action 1=Run with constant speed
b10	Fieldbus control enable	Activate fieldbus control when P3.1 =3/Fieldbus 0=Fieldbus Control NOT active 1=Activate fieldbus control
b11	Watch dog	0>1>0>1…1 sec square wave clock. This is used to check data communication between profibus master and the drive. Used to generate FB communication -fault.
b12		
b13		
b14		
b15		

B00: FALSE = OFF 1, TRUE = ON 1
OFF 1: Drive will make ramping stop and goes to "Ready to switch-on". If drive is in "Switch on Inhibit" state this bit is used to reset this status.
ON: Voltage connected to drive and/or DC link charged if drive has the control.

B01: FALSE = Coast stop (OFF 2), TRUE = ON 2
Coast Stop: Drive will make coasting stop and goes to "Switch-on Inhibit" state
ON 2: No Coast Stop command

B02: FALSE = Quick Stop (OFF 3), TRUE = ON 3
Quick Stop: Drive will make stop function defined by Quick Stop function parameter.
ON 3: No Quick stop command.

B03: FALSE = Stop Request, TRUE = Start Request
Stop Request: Drive will make stop defined by stop function.
Start Request: Start Command to the drive.

B04: FALSE = Reset Ramp Generator, TRUE = Enable Ramp Generator
This bit has priority over B05 and B06 in Control Word.
Reset Ramp Generator: Closed Loop: Ramp generator is forced to zero, drive will make stop as fast as possible running against set torque limits or e.g. over voltage controller.
Enable Ramp Generator: Ramp Generator function is enabled.

To activate Jogging function from fieldbus B04, B05 and B06 needs to be zero.

B05: FALSE = Freeze Ramp Generator, TRUE = Unfreeze Ramp Generator
This bit has priority over B06 but not over B05.
Freeze Ramp Generator: Drive will not accept new reference from Fieldbus, drive remain in same speed.
Unfreeze Ramp Generator: Drive will follower reference from Fieldbus.

To activate Jogging function from fieldbus B04, B05 and B06 needs to be zero.

B06: FALSE = Disable Set point, TRUE = Enable Set point
This bit has lowers priority compared to B04 and B05.
Disable Set point: Reference (FW:FreqRef1) is forced to zero, drive will ramp to zero speed
Enable Set point: Drive will follow reference.

To activate Jogging function from fieldbus B04, B05 and B06 needs to be zero.

B07: FALSE = No significance, TRUE = Fault Acknowledge
Fault Acknowledge: The group signal is acknowledged with a positive edge; the drive reaction to a fault depends on the type of fault (refer to "alarm handling in Appendix A.8). If the fault reaction has isolated the voltage, the drive then goes into the "Switching On Inhibited" condition.

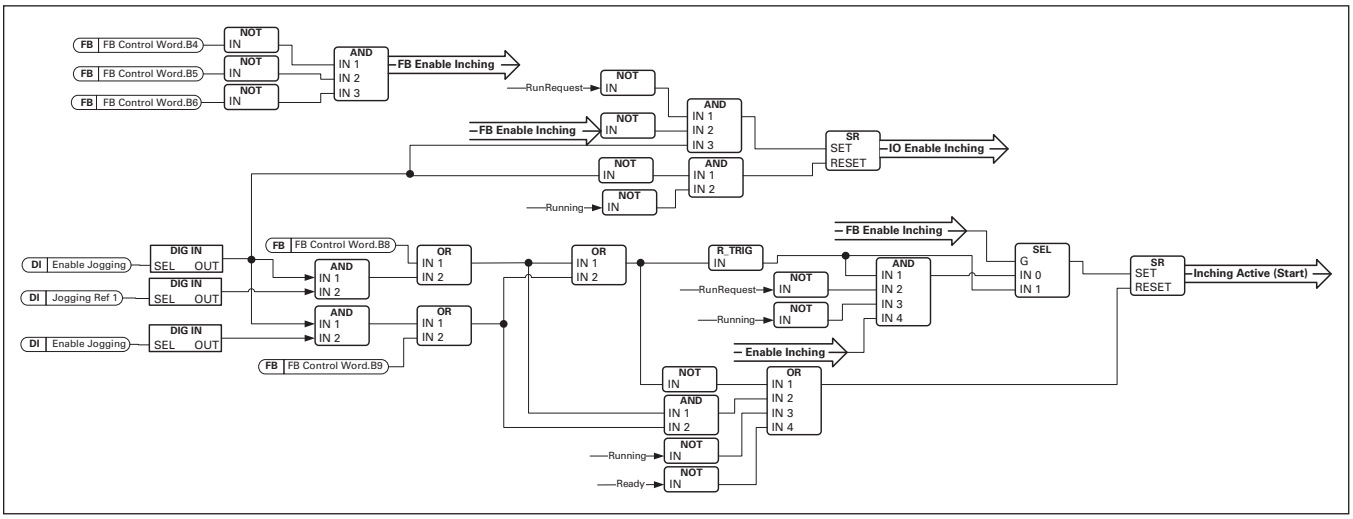
8.2.3.1 Jogging function

I/O Jogging Command: Jogging function will start the drive to reference without additional start command regardless of control place when given from IO. Jogging function requires enabling from digital input before command is accepted. Inching is also disabled if there is start command active from active control place. If both inching references are active at the same time drive will stop.

Fieldbus Jogging Command: Jogging command is activated by giving normal start command but the ramp control bits CW.B4, B5 & B6 needs to be zero. Drive needs to be at zero speed before command is accepted and CW.B4, B5 & B6 are active after drive is at zero speed when jogging function is stopped. See Figure below.

B08: FALSE = No Function, TRUE = Jogging 1
Inching 1: Drive follows reference set by Jogging Ref 1. Function needs to separately activated by Aux Control Word or by digital input Enable Jogging when IO control used for Jogging.

B09: FALSE = No Function, TRUE = Inching 2
Inching 2: Drive follows reference set by Jogging Ref 2. Function needs to separately activated by Aux Control Word or by digital input Enable Jogging when IO control used for Jogging.



B10: FALSE = FB Control disabled TRUE = FB Control Enabled
FB Control disabled: Drive will not follow main control word from Fieldbus. If removed while running drive will make coasting stop.
FB Control enabled: Drive follows control word from fieldbus

B11: FALSE = FB WD Pulse Low, TRUE = FB WD Pulse High
Watch dog pulse: This pulse is used to monitor that PLC is alive. If pulse is missing drive will go to fault state. This function is activated by P1.12.10.3 FB WD Delay. When value is zero pulse is not monitored.

8.2.4 FB Status word

	FB Status Word	
	Signal	**Comment**
b0	Ready to switch On	0=The drive NOT ready to switch ON 1=The drive is ready to switch ON
b1	Ready to operate	0=The drive is NOT ready to run 1=The drive is ready to run
b2	Running	0=The drive is NOT running 1=The drive is running and ready to release the reference
b3	Fault active	0=No fault active 1=Fault IS active
b4	Cost stop NOT active	0=Coast stop active 1=Coast stop NOT active
b5	EM Stop not active	0=Emergency stop active 1=Emergency stop NOT active
b6	Switch On Inhibit	0=No Inhibit 1=The drive is out of fault and coast/emergency stop state.
b7	Warning	0=NO alarm 1=Alarm IS active
b8	Speed at ref	0=Speed actual is NOT equal to speed reference 1=Speed actual is equal to speed reference
b9	FB Control active	0=Fieldbus Control NOT active 1=Fieldbus Control active
b10	Above limit	Indicate if speed actual is below the limit P1.4.16 0=Speed actual is below the speed limit 1=Speed actual is above the speed limit
b11		
b12		
b13		
b14		
b15	Watch dog feedback	

B00: FALSE = Not Ready to Switch On, TRUE = Ready to Switch On
Not Ready to Switch On:
Ready to Switch On: Power supply is switched on, electronics initialized, main contactor, if available, has dropped out, pulses are inhibited.

B01: FALSE = Not Ready To Operate, TRUE = Ready To Operate
Not Ready To Operate:
Ready To Operate:

B02: FALSE = Drive is not operating, TRUE = Drive is operational
Drive is not operating: Drive is not run state (modulating)
Drive is operational: Drive is in run state and modulating. Also rotor fulx is ready and brake is opened if feedback signal is sued.

B03: FALSE = No Fault, TRUE = Fault Present
No Fault: Drive is not on fault state.
Fault Present: Drive is in fault state.

B04: FALSE = Coast Stop Activated, TRUE = Coast Stop Not Activated
Coast Stop Activated: "Coast Stop (OFF 2)" command is present.
Coast Stop Not Activated: Coast stop command is not active.

B05: FALSE = Quick Stop Activated, TRUE = Quick Stop Not Activated
Quick Stop Activated: "Quick Stop (OFF 3)" command is present.
Quick Stop Not Activated: Quick stop command is not active.

B06: FALSE = Switching On Not Inhibit, TRUE = Switching On Inhibited
Switching On Not Inhibit:
Switching On Inhibited: The drive goes only again in the "Switched On" condition with "No Coast Stop AND No Quick Stop" followed by "ON". This means that the "Switching On Inhibited" bit is only set back to zero if the OFF command is set after "No Coast Stop AND No Quick Stop".

B07: FALSE = No Warning, TRUE = Warning Present
No Warning: There is no warning or the warning has disappeared again.
Warning Present: Drive still works; warning in the service/maintenance parameter;
no acknowledgement.

B08: FALSE = Speed Error Out Of Tolerance Range, TRUE = Speed Error Within Tolerance Range
Speed Error Out Of Tolerance Range:
Speed Error Within Tolerance Range:

B09: FALSE = No Control Requested, TRUE = Control Requested
No Control Requested: Control by the automation system is not possible, only possible
at the device or by another interface.
Control Requested: The automation system is requested to assume control.

B10: FALSE = f Or n Not Reached, TRUE = f Or n Reached Or Exceeded
f Or n Not Reached: Speed is below P1.6.4.5 Above Speed Limit.
f Or n Reached Or Exceeded: Speed is above P1.6.4.5 Above Speed Limit.

B15: FALSE = FB DW Feedback Low, TRUE = FB DW Feedback High
FB DW Feedback: FB Control Word B11 is echoed back to the Fieldbus. Can be use to monitor communication status from the drive.

8.3 Combination 3, ByPass – basic

8.3.1 Control word combination 3, ByPass – basic

Main Control Word for Profibus in Combination 3

	False	True	Comment
b0	STOP	START	
b1	Clockwise	Counter clockwise	
b2	No action	FAULT RESET (0 -> 1)	
b3	FB DIN1	FB DIN1	
b4	FB DIN2	FB DIN2	
b5	FB DIN3	FB DIN3	
b6	FB DIN4	FB DIN4	
b7	FB DIN5	FB DIN5	
b8	Not used	Not used	
b9	Not used	Not used	
b10	Not used	Not used	
b11	Not used	Not used	
b12	Not used	Not used	
b13	Not used	Not used	
b14	Not used	Not used	
b15	Not used	Not used	

8.3.2 Status word combination 3, ByPass – basic

Most of the field busses use "MCStatus" as Status word that is shown below. For profibus it can be selected what is the status word, default is Combination 2 Status Word, ProfiDrive type ID68 V7.3.2 MainStatusWord. Below Status Word can be selected with P1.10.17 GSW Data by setting it to ID64

Main status word for profibus in combination 3

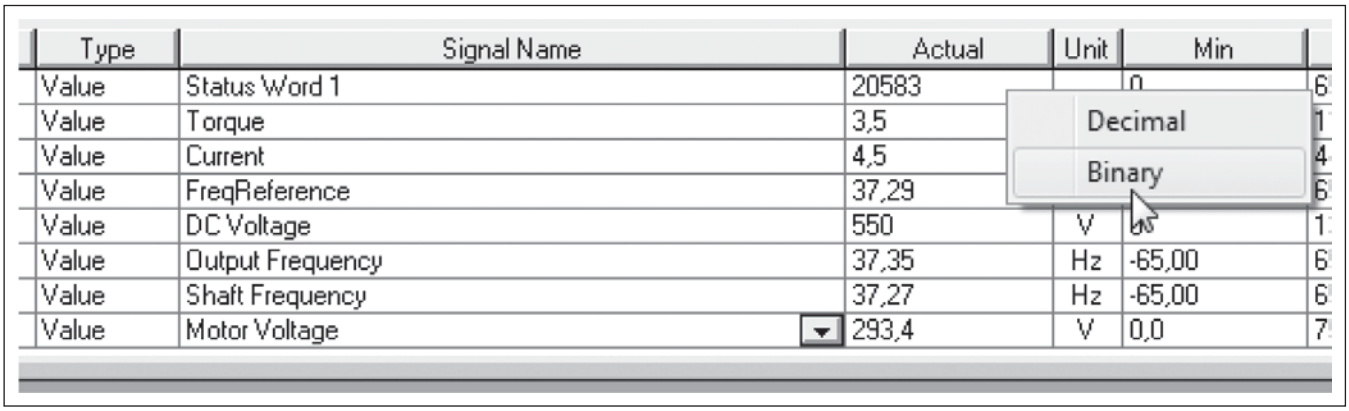
	False	True	Comment
b0	Not ready	READY	
b1	STOP	RUN	
b2	Clockwise	Counter clockwise	
b3	NO FAULT	FAULT ACTIVE	
b4	No warning	Warning	
b5	Reference ≠ Actual value	Reference = Actual value	
b6	Speed > Zero	At zero speed	
b7	Flux not ready	Flux ready	
b8	TC Speed limit active	TC Speed limit not active	
b9	Detected encoder direction clockwise	Encoder direction counter clockwise	
b10	UV Fast stop active	UV Fast stop not active	
b11	Not used	Not used	
b12	Not used	Not used	
b13	Not used	Not used	
b14	Not used	Not used	
b15	Not used	Not used	

SM = Profibus board state machine

9. Problem solving

While proper information is needed form the problem, it's also recommended to try with latest application- and system software versions available. Software is continuously developed and default settings are improved.

Figure 2. Recommended signals for 9000xdrive.



Use the fastest communication speed (Baudrate: 57 600) and a 50 ms update interval for signals for the RS232 communication.

For the CAN communication, use a 1 Mbit communication speed and 7 ms update interval for signals.

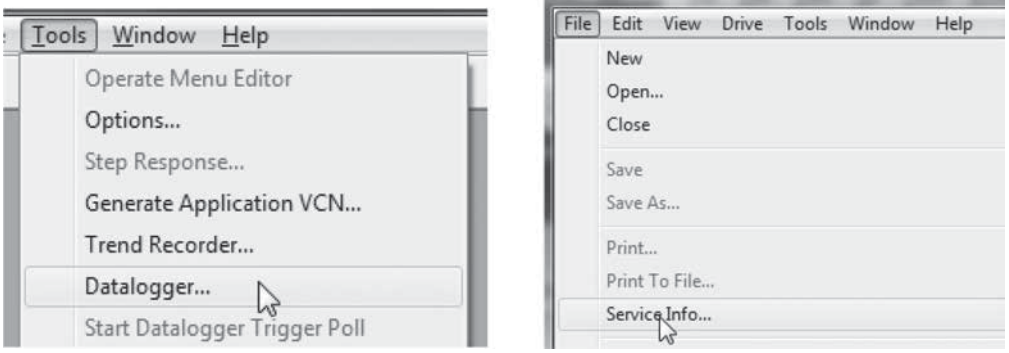
When you contact the support, send the *.trn, *.par and Service info (*.txt) files with a description of the situation. If the situation is caused by a fault, take also the Datalogger data from the drive.

Note that Datalogger settings can be changed to catch correct situation and it's also to possible make manual force trig for Datalogger.

Before storing the parameter file, upload the parameters from the drive and save when NCDrive is in the ON-LINE state. If it is possible, do this while the problem is active.

It's also helpful to have single line diagram from the system where problem is faced.

Figure 3. Data logger window opening and Service Info upload.



10. Fault codes

F1 Overcurrent fault

Drive has detected a high current in the output phase.

S1 = Hardware trip: Current above 4*Ih

S2 = Only in SVX unit

S3 = Current controller supervision. Current limit too low or current peak value too high.

Possible cause and solutions

1. Sudden increase in load
   - Check motor load
2. Short circuit in motor cables
   - Check motor and cables
3. Motor is under magnetized at start
   - Make identification run
4. Unsuitable motor
5. Sine filter is used but drive settings are not correct
   - Activate Sine filter parameter (P6.7.5) in system menu

F2 Overvoltage fault

DC-link voltage has exceeded the drive protection limits.

S1 = Hardware trip.

500 Vac unit DC voltage above 911 Vdc

690 Vac unit DC voltage above 1200 Vdc

S2 = Overvoltage control supervision (only 690 Vac unit).

DC voltage has been above 1100 Vdc for too long.

Possible cause and solutions

1. Too short a deceleration time
   - Increase deceleration time
   - Use brake chopper and brake resistor
   - Use Brake chopper unit
   - Use active front end unit (AFE ARFIFF02)
   - Activate overvoltage controller
2. High overvoltage spikes in supply
   - Activate overvoltage controller
3. 690 V unit operating too long above 1100 Vdc
   - Check input voltage

F3 Earth fault

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

S1 = Sum of motor current is not zero

Possible cause and solutions

1. Insulation failure in cables or motor
   - Check motor cables and motor

F5 Charge switch

Charge switch status is not correct when start command is given

S1 = Charge switch was open when START command was given

Possible cause and solutions

1. Charge switch was open when the START command was given
   - Check connection of the feedback from charging relay
   - Reset the fault and restart

Should the fault re-occur, contact your local distributor.

F6 Emergency stop

Emergency stop command has been given by using a special option board.

F7 Saturation fault

S1 = Hardware failure

Possible cause and solutions

1. If there is a brake chopper in use
   - Check the isolation resistance and the resistance on the brake resistor
2. FR4-FR8: Power module
   - Measure the power module directly from its terminals.
3. Hardware
   - Check the capacitors

F8 System fault

A system fault indicates several different fault situations in drive operation.

S1 = Reserved

- Disturbance. Reset the unit and try again
- If there is star coupler in the unit, check the fibre connections and phase order
- Driver board or IGBT broken
- FR9 and the bigger size drives, which includes not star coupler, ASIC board (VB00451) is broken
- FR8 and smaller size drives: control board broken
- FR8 and smaller size drives: if there is boardsVB00449/ VB00450 in use, failure might be in there

S2 = Reserved

S3 = Reserved

S4 = Reserved

S5 = Reserved

S6 = Reserved

S7 = Charge switch

S8 = No power to driver card

S9 = Power unit communication (TX)

S10 = Power unit communication (Trip)

S11 = Power unit comm. (Measurement)

S12 = SystemBus synchronization has failed in DriveSynch operation

S30 = Safe disable inputs are in different state (OPT-AF)

S31 = Thermistor short circuit detected (OPT-AF)

S32 = OPT-AF board has been removed

S33 = OPT-AF board EEPROM eror

S34-36 = OPT-AF supply voltage hardware problem detected.

S37-40 = Single hardware problem detected in STO inputs.

S41-43 = Single hardware problem detected in the thermistor input.

S44-46 = Single hardware problem detected in STO inputs or in the thermistor input.

S47 = OPT-AF board mounted in old SPX control board.

S48 = Parameter Expander boards/SlotB/Therm Trip(HW) is set to OFF even if the jumper wire X12 is not cut.

S49 = OPT-AF board mounted in SVX control board.

F9 Under voltage fault

DC-link voltage is below the fault voltage limit of the drive.

S1 = DC-link too low during run

S2 = No data from power unit

S3 = Under voltage controller has been active and speed is ramped to zero with ramp time 2.

Possible cause

1. Too low a supply voltage
2. Frequency converter internal fault
3. One of the input fuses is broken
4. External charge switch has not been closed

Correcting measures

- In case of temporary supply voltage break, reset the fault and restart the frequency converter
- Check supply voltage
- Check function of DC charge
- Contact your local distributor

F10 Input line supervision

S1 = Phase supervision diode supply

S2 = Phase supervision active front end

Possible cause:

1. Input line phase is missing

Correcting measures

- Check supply voltage, fuses and cable

F11 Output phase supervision

Current measurement has detected that there is no current in one phase or one phase current is considerably different from other phases.

Correcting measures

- Check motor cable and motor

F12 Brake chopper supervision

Brake chopper supervision generates pulses to the brake resistor for response. If no response is received within set limits a fault is generated.

Possible cause:

1. No brake resistor installed
2. Brake resistor is broken
3. Brake chopper failure
4. Correcting measures:
   - Check brake resistor and cabling
   - If these are ok the chopper is faulty. Contact your local distributor

F13 Drive under temperature fault

Possible cause:

1. Heatsink temperature is under –10°C

F14 Drive over temperature fault

Possible cause:

1. Heatsink temperature is over acceptable limits. See user's manual for the temperature limit. Over temperature warning is issued before actual trip limit is reached

Correcting measures

- Check correct amount and flow of cooling air
- Check the heatsink for dust
- Check ambient temperature
- Make sure that switching frequency is not too high in relation to ambient temperature and motor load

F15 Motor stalled

The motor stall protection protects the motor from short time overload situations such as one caused by a stalled shaft. The reaction time of the stall protection can be set shorter than that of motor thermal protection. The stall state is defined with two parameters, Stall current and Stall frequency limit. 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 over current protection.

- Check motor and load

F16 Motor over temperature

Motor overheating has been detected by frequency converter motor temperature model. Motor is overloaded. Calculated temperature has exceeded 105 %.

Possible cause:

1. Motor load is too high
2. Motor values are set incorrectly

Correcting measures:

- Decrease motor load
- If no motor overload exists, check the temperature model parameters

F17 Motor underload fault

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

The underload curve is a squared curve set between the zero frequency and the field weakening point. The protection is not active below 5Hz (the underload time counter is stopped).

The torque values for setting the underload curve are set in percentage which refers to the nominal torque of the motor. The motor's name plate data, parameter motor nominal current and the drive's nominal current IH are used to find the scaling ratio for the internal torque value.

Correcting measures:

- Check load

F22 EEPROM checksum fault

Possible cause:

1. Parameter save fault
2. Faulty operation
3. Component failure

Correcting measures:

- Should the fault re-occur, contact your local distributor.

F24 Counter fault

Possible cause:

1. Values displayed on counters are incorrect

Correcting measures:

- Have a critical attitude towards values shown on counters

F25 Microprocessor watchdog fault

Possible cause:

1. Faulty operation
2. Component failure

Correcting measures:

- Reset the fault and restart
- Should the fault re-occur, contact your local distributor

F26 Start-up prevention

Possible cause:

1. Start-up of the drive has been prevented
2. Run request is ON when a new application is loaded to drive

Correcting measures:

- Cancel prevention of start-up if this can be done safely
- Remove Run Request

F29 Thermistor fault

The thermistor input of the option board has detected too high a motor temperature.

Possible cause:

1. Motor is overheated
2. Thermistor cable is broken

Correcting measures:

- Check motor cooling and load
- Check thermistor connection (If thermistor input of the option board is not in use it has to be short circuited)

F31 IGBT Temperature hardware

IGBT Inverter Bridge over temperature protection has detected too high a short term overload current.

Possible cause:

1. Too high load
2. Identification run has not been made which causes the motor to start under magnetized

Correcting measures:

- Check load
- Check motor size
- Make identification run

F32 Fan cooling

Possible cause:

1. Cooling fan of the frequency converter does not start when ON command is given

Correcting measures:

F37 Device change

Option board or power unit changed.

Possible cause:

1. New device of same type and rating

Correcting measures:

- Reset. Device is ready for use

F38 Device added

Option board added.

Correcting measures:

- Reset. Device is ready for use. Old board settings will be used

F39 Device removed

Option board removed.

Correcting measures:

- Reset. Device no longer available

F40 Device unknown

Unknown option board or drive.

S1 = Unknown device

S2 = Power1 not same type as Power2

Correcting measures:

- Contact the distributor near to you

F41 IGBT Temperature software

IGBT inverter bridge over temperature protection has detected too high a short term overload current.

- Check load
- Check motor size
- Make Identification run

F42 Brake resistor over temperature

S1: Brake resistor high temperature

Calculation for internal brake resistor has exceeded the tripping limit. If the internal brake resistor is not in use set the brake chopper parameter in System menu to 'Not connected'.

S2: Brake resistor resistance is too high

S3: Brake resistor resistance is too low

S4: No brake resistor detected

F43 Encoder fault

Encoder fault is issued when the drive is not able to operate in closed loop control mode (encoder is used). See subcodes for details for the reason of the fault:

S1 =Encoder 1 channel A is missing

S2 =Encoder 1 channel B is missing

S3 =Both encoder 1 channels are missing

S4 =Encoder reversed

S5 =Encoder board missing

S6= Serial communication fault

S7=Ch A/Ch B Missmatch

S8=Resolver/Motor polepair mismatch

S9=Missed Start Angle

This fault comes when using PMS motor.

1. Modulation type is ASIC while incremental encoder is used

- Change modulator type to Software 1

2. Start identification do not work due low identification current

- Increase identification current

3. Start angle identification is not working at all because there is no saturation based saliency in the motor

- Use absolute encoder

4. There are too much noise pick-ups in encoder cable

- Check encoder cable shield and grounding in drive

F44 Device changed (default param.)

Possible cause:

1. Option board or power unit changed
2. New device of different type or different rating from the previous one

Correcting measures:

- Reset
- Set the option board parameters again if option board was changed. Set converter parameters again if power unit was changed

F45 Device added (default param.)

Possible cause:

1. Option board of different type added

Correcting measures:

- Reset
- Set the option board parameters again

F50 4mA Supervision

Possible cause:

1. Current at the analog input is below 4mA
2. Signal source has failed
3. Control cable is broken or loose

Correcting measures:

- Check the current loop circuitry

F51 External fault

Possible cause:

1. Digital input fault

Correcting measures:

- Remove fault situation from external device

F52 Keypad communication

Possible cause:

1. The connection between the control keypad or 9000xDrive and the AC drive is broken

Correcting measures:

- Check keypad connection and possible keypad cable

F53 Fieldbus communication

Possible cause:

1. The data connection between the fieldbus Master and the fieldbus board is broken.

Correcting measures:

- Check installation

F54 Slot fault

Possible cause:

1. Defective option board or slot

Correcting measures:

- Check board and slot

F56 Temperature sensor board 1 fault

Temperature protection function is used to measure temperature and give warning and/or fault when set limits are exceeded. SPX Advanced application supports two temperature sensor boards simultaneously. One can be used for the motor winding and the other for the motor bearings.

A1 – Temperature limit has been exceeded.

A2 – Sensor not wired or not working.

A3 – Short circuit.

Possible cause:

1. Temperature limit values set for the temperature board parameters have been exceeded

Correcting measures:

- Find the cause of temperature rise
- Check sensor wiring

F57 Identification

Identification run has failed.

Possible cause:

1. There was load on the motor shaft when making the identification run with rotating motor
2. Motoring or generator side torque/power limits are too low to achieve a stable run

Correcting measures:

- Run command was removed before identification was ready
- Motor is not connected to the AC drive
- There is load on the motor shaft

F58 Mechanical brake

This fault is generated when the acknowledge signal from the brake is used. If the status of the signal is opposite from the control signal for a longer period of time than the delay defined with P1.15.11 Brake Fault Delay a fault is generated.

Correcting measures:

- Check the condition and connections of mechanical brake

F59 SystemBus communication

The master drive sends pulses to all follower drives. If the pulses are missing a system bus communication fault is generated. The master drive also receives pulses back from the follower drives (max. four drives) and generates warnings if pulses are missing.

SystemBus communication is broken between master and follower.

Correcting measures:

- Check expander board parameters
- Check optical fibre
- Check option board jumpers

F60 Cooling

Protection for the liquid-cooled units. An external sensor is connected to the drive (DI: Cooling Monitor) to indicate if cooling liquid is circulating. If the drive is in Stop state only a warning is issued. In Run state a fault is issued and the drive makes a coast stop.

Possible cause:

1. Liquid cooled drive cooling circulation have been failed

Correcting measures:

Check reason for cooling failure from external system.

F61 Speed error

Speed error monitoring function compares the encoder frequency and the ramp generator output.

This function is used with PMS motors to detect if the motor is out of synchronization or to disable open loop function that uses encoder speed for slip compensation. The slip compensation is disabled regardless of the response and needs to be re-activated once speed error is detected (set parameter again or power down the drive).

Possible cause:

1. Motor speed is not the same as the reference. For example, motor speed is limited by torque limit
2. PMS motor has gone off synchronization
3. Encoder cable is broken

F62 Run disabled

Run Disable warning signal is issued when Run Enable signal has been removed from the IO.

F63 Emergency stop (not implemented)

Possible cause:

1. A command has been given from a digital input or the fieldbus to make an emergency stop

Correcting measures:

- New run command is accepted after the emergency stop is reset

F64 Input switch open (not implemented)

Possible cause:

1. Drive input switch is opened

Correcting measures:

- Check the main power switch of the drive

F65 Temperature sensor board 2 fault

Temperature protection function is used to measure temperature and give warning and/or fault when set limits are exceeded. SPX Advanced application supports two temperature sensor boards simultaneously. One can be used for the motor winding and the other for the motor bearings.

A1 – Temperature limit has been exceeded.

A2 – Sensor not wired or not working.

A3 – Short circuit.

Possible cause:

2. Temperature limit values set for the temperature board parameters have been exceeded

Correcting measures:

- Find the cause of temperature rise
- Check sensor wiring

F74 Follower fault

When using the normal master follower function this fault code is given if one or more follower drives trip to fault. This fault is visible also when fault is in master drive. See also what other faults may be active in master drive.

Possible cause:

1. Fault in follower drive or in Master drive

Correcting measures:

- Identify original fault and problem

F75 Drive synch follower

When using the normal master follower function this fault code is given if one or more follower drives trip to fault. This fault is visible also when fault is in master drive. See also what other faults may be active in master drive.

Possible cause:

1. Fault in follower drive or in Master drive

Correcting measures:

- Identify original fault and problem

F80 Output contactor interlock

- Digital Input for Output contactor must close in less than 250ms after run
- Check Programming of Digital inputs and ensure proper wiring to contactor

F81 External fault 2

Possible cause:

1. Digital input fault

Correcting measures:

- Remove fault situation from external device

F82 Over load

User defined over load limits has been exceeded.
See functional description from Motor Protection chapter.

F85 Cold weather

Cold Weather mode is in operation if Alarm is present,
If faulted the timeout time has been exceeded.

A90 Current limit

Current limit is limiting the output of the drive after ensuring the proper current limit setting, check motor and load.

A91 UndervoltReg

Drive is attempting to control low DC bus voltage by reducing motor speed.

A92 OverVoltReg

Drive is attempting to regulate DC bus voltage by extending decal times or increasing motor speed.

A93 TorqueReg

Motor torque is being limited to the torque limit settings

Notes

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