



USER'S MANUAL

NX FREQUENCY CONVERTERS

APFIF131

LINE SYNCHRONIZATION

APPLICATION MANUAL

VACON LINE SYNCHRONIZATION APPLICATION MANUAL

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LINE SYNCHRONIZATION APPLICATION

Software APFIF131

1. INTRODUCTION

This application is meant to run a motor to net frequency and make contactor change so that the motor is running directly from the network. This application supports up to eighth motors with own I/O. The motors used can be of different sizes but the nominal voltage needs to be the same with all motors. Line synchronization does not need additional chokes in output due to advanced control. The drive can compensate for delays which are faced in contactors.

1.1 General

This application is not considered to be backwards compatible. Read the application change note or the chapter in this application manual, "Version parameter compatibility issues" to see what needs to be noted when updating the application. See also updated parameter description from NCDrive when making commissioning.

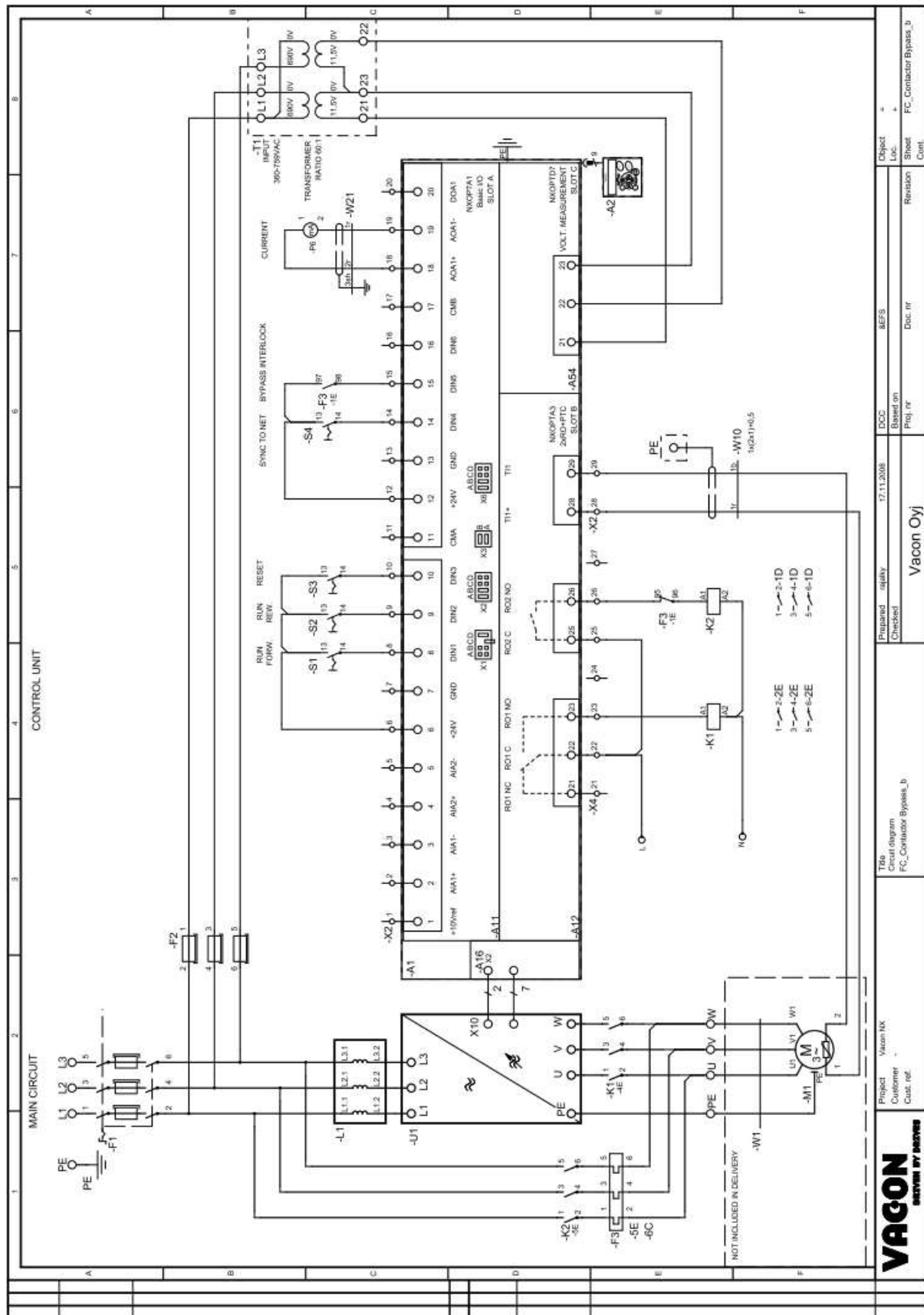
- The digital inputs and all the outputs are freely programmable and the application supports all I/O-boards

Additional functions:

- Line voltage monitoring
- Line frequency monitoring
- DC voltage monitoring
- CANOpen I/O communication monitoring
- Second ramps and S-shape ramp programming
- Programmable Start/Stop and Reverse logic
- DC-brake at start and stop
- Three prohibit frequency areas
- Programmable U/f curve and switching frequency
- Autofaultreset function
- Power limit functions
- Different power limits for motoring and generating side
- Different torque limits for motoring and generating side
- Cooling monitor input from heat exchange unit
- Possibility to connect the FB Process data to any parameter and some monitoring values

The parameters of the LineSynch Application are explained in Chapter 8 of this manual. The explanations are arranged according to the individual ID number of the parameter.

1.2 Connection example



2. LINE SYNCHRO GENERAL

2.1 Purpose

This application is meant to run motor to net frequency and make contactor change that motor is running directly from network.

2.2 Operation

The drive measures line voltage frequency and angle. When there is no synchronization command, the application works as a normal Multi-Purpose application.

2.2.1 To Net

When synchronization command is given [P:**ActiveSynchro** (DI:HIGH)], frequency reference is changed to net voltage frequency. When voltage frequency is within 0,10 Hz hysteresis with network voltage frequency the drive will make small adjustments to frequency reference so that line voltage angle and FC voltage angle are the same with given offset [P:**PhaseOffsetToNet**].

The drive remains at this synchronization until the command to end synchronization is given or the command to change network is given [P:**ActiveDirect**] (DI:HIGH)]. When the command to go to the network net is given (which can be given at the same time as synchronization command) the application checks for 40 ms that [P:**PhaseHyst**] is correct for change. When an internal decision is made:

- The drive stops modulation within given delay [P:**DelayToCoasting**].
- The drive opens FC contactor within given delay [P:**DelayToOpen**].
- The drive closed NET contactor within given delay [P:**DelayToClose**].

Drive remains in stop state until:

1. **SingleMotorControl** [P: **ControlMode** = 0 / Single Motor]
 - [P:**ActiveDirect**] (DI:LOW)].
2. **MultiMotorControl**: [P: **ControlMode** = 1 - 3 / MultiMotor, InSecuence]
 - Controller motor is changed:[P:**ControlledMotor**].
 - Controlled motor control status is reset [P: **Reset Direct**]

2.2.2 To FC

When controlled motor is in net:

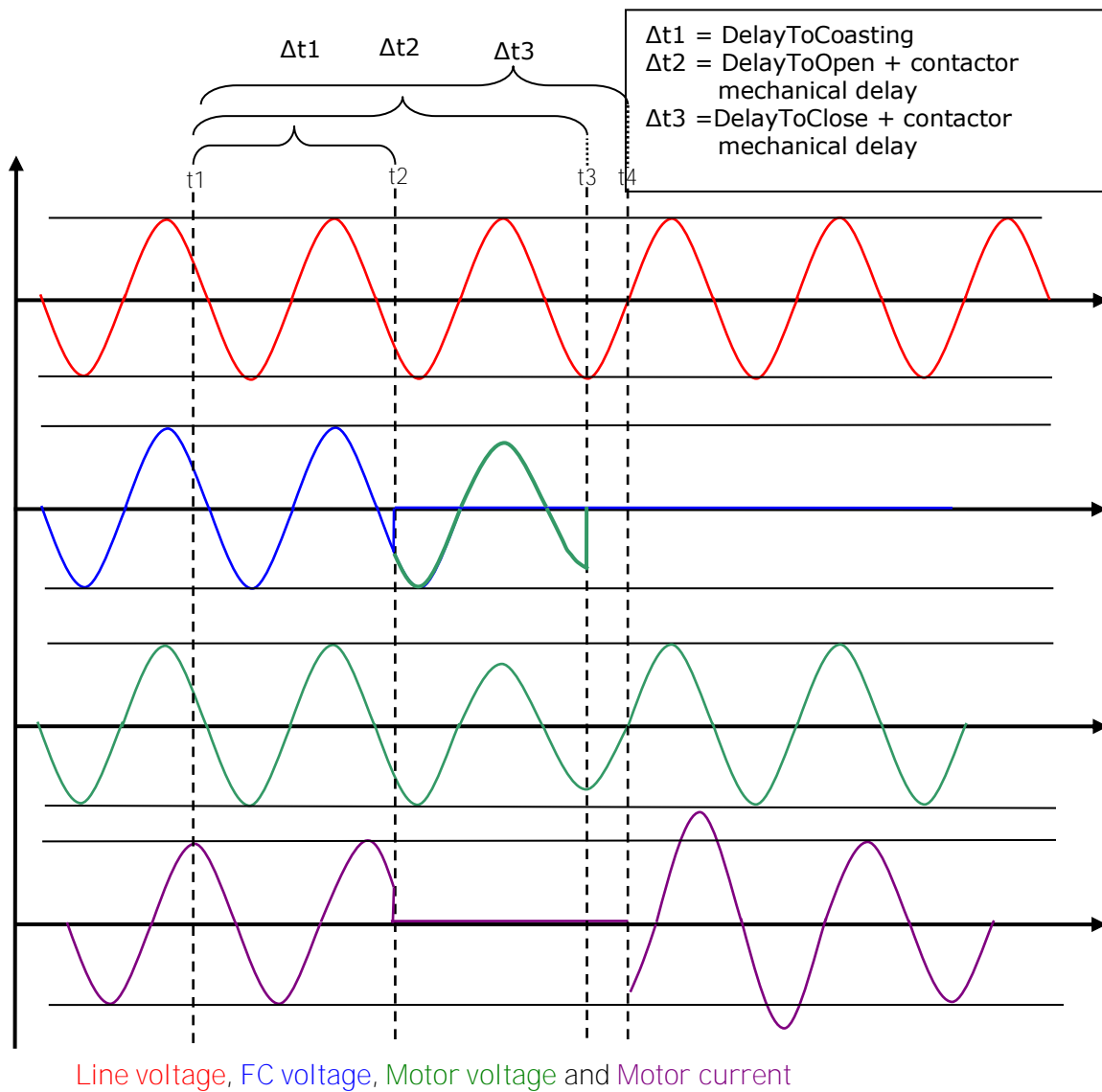
Drive waits for back to FC command [**ResetDirect** (HIGH)] or [**ActiveDirect** (LOW)].

When command is given drive:

- Opens Net contactor immediately.
- Closes FC Contactor within half of [P:**StartDelayToFC**] time.
- Makes start within [P:**StartDelayToFC**] time. (Note restart delays)

Depending on the status of [P:**ActiveSynchro**], the drive will keep synchronization on start or follow the given reference.

2.3 Timing



t1: Application makes decision to change to the network, command to open FC contactor is given.

t2: Drive stops modulation after delay [P:DelayToCoasting].

- a. Motor BEM voltage starts to decrease.
- b. Motor current goes to zero.
- c. FC sees motor BEM voltage

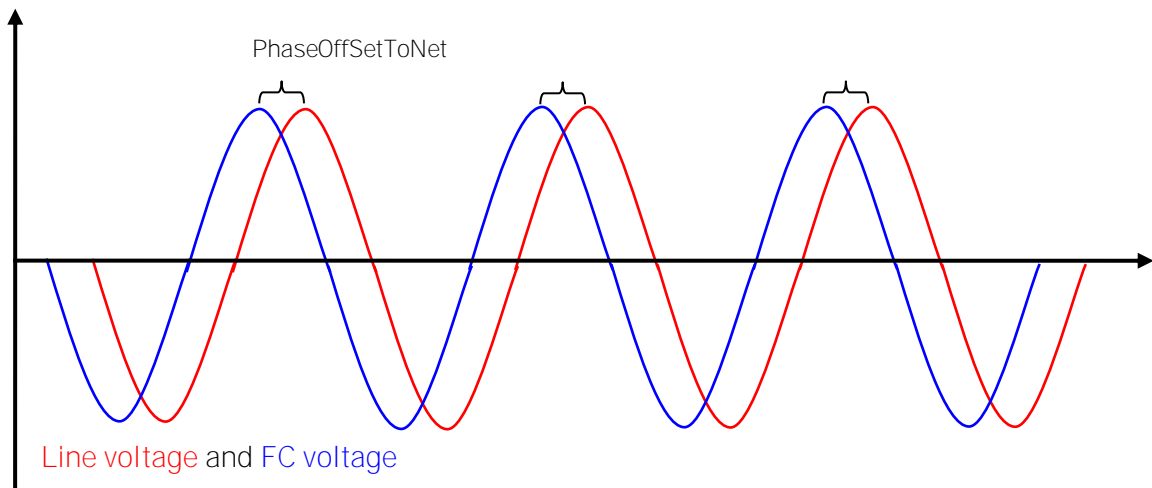
t3: FC Contactor is mechanically open.

- d. FC does not see motor voltage.

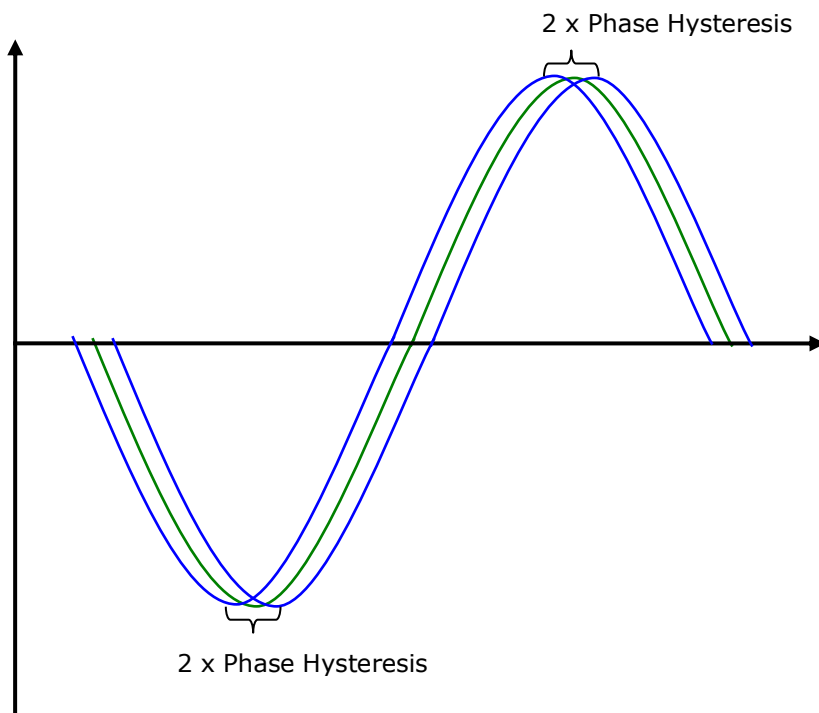
t4: NET contactor is mechanically closed

- e. Motor voltage is the same as line voltage
- f. Current goes to motor.

2.4 Phase Offset To Net

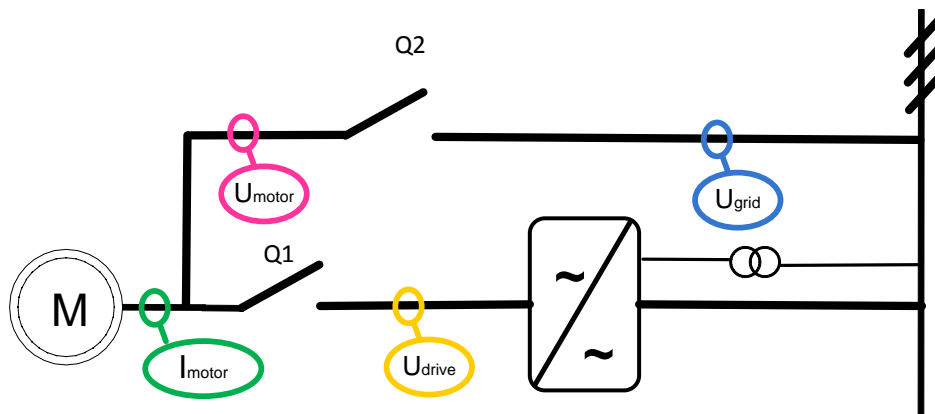


2.5 Phase Hysteresis



Voltage angle reference and FC voltage hysteresis area

2.6 Commissioning



During commission delay parameters should be set according to these rules:

- The drive should not be in run state when NET contactor is closed.
- The FC Contactor should not open until the drive is in stop state
- NET and FC contactors can be closed at the same time for a short period if the drive is not modulating.

During commissioning the following issues needs to be understood:

- Contactor delays may be from 3 ms up to 700 ms.
- NET and FC contactor delays may fluctuate from each other.
- Closing and opening delays may fluctuate.
- Contactor times may fluctuate even if application has same settings.

Use of interlocks:

- The NET contactor cannot have an interlock from FC contactor.
 - o What can be used momentarily if contactor delays are not know
- The FC Contactor can have an interlock from net contactor.
- If DOL thermal protection is used this trip should be connected to ByPass interlock and any situation that can cause motor input to interrupt.

Commissioning steps:

1. Use oscilloscope during commissioning.
 - a. Motor current
 - b. Line voltage
 - c. FC Voltage
 - d. Motor voltage
2. Make sure that the drive sees line voltages and frequency correctly.
 - a. V1.25.1 Line (main) voltage.
 - i. Only above 90% of motor nominal voltage is accepted.
 - b. V1.25.2 Line frequency voltage
 - i. Only positive frequency is accepted
3. Make sure that the direction of FC and NET is the same when synchronized.
 - a. Measure voltage between two phases from drive output and motor DOL input.
4. Make test runs without any load on motor shaft, if possible.
5. When the timing of system is known
 - a. Increase the coasting delay near the time when the FC contactor is mechanically open.
 - b. Decrease or Increase Net contactor delays so that the opening of FC and the closing of Net contactor happens right after modulation stops.
 - i. You may need to increase the modulation stop and FC opening delay if NET contactor closing delay is long.
6. Recommended time for no current situation is about 20 ms.
 - a. Half of a cycle (5 ms) is the minimum due contactors aging.
7. Change [P:PhaseOffsetToNet] so that the motor BEM voltage and line voltage are at the same position when the line contactor is mechanically closed.

TIP:

Adjusting field weakening point voltage higher so that motor BEM voltage is the same as line voltage at the moment of closing the NET contactor this may decrease current spike.

3. VERSION PARAMETER COMPATIBILITY ISSUES

1. Two manual exist for APFIF131 application, first ud01177 is for application version below V2xx. Different application manual will be for V2xx and later udxxxxx.
2. In V2xx logic has been redesigned and parameters from V1xx cannot be used or other way round.
 - a. In V2xx time delay scaling for phase error has been removed. In V1xx PhaseOffSetToNet is 0,0 degree, corresponding value for V2xx is -16,0 degree.
3. V2xx has "Back Synch" function, drive can be synchronized to grid while DOL contactor is closed and FC contactor is open. When synchronization is done change to FC is made.

4. CONTROL I/O

		OPTA1			
		Terminal	Signal	Description	
Reference potentiometer, 1...10 kΩ		1	+10V _{ref}	Reference voltage output Voltage for potentiometer, etc.	
		2	AI1+	Analogue input 1. Range 0-10V, R _i = 200Ω Range 0-20 mA R _i = 250Ω	Analogue input 1 frequency reference. Input range selected by jumpers. Default range: Voltage 0 – 10 V
		3	AI1-	I/O Ground	Ground for reference and controls
		4	AI2+	Analogue input 2. Range 0-10V, R _i = 200Ω Range 0-20 mA R _i = 250Ω	Analogue input 2 frequency reference Input range selected by jumpers. 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 G2.2.7	Contact closed = start forward Programmable start logic P2.2.1
		9	DIN2	Start reverse Programmable G2.2.7	Contact closed = start reverse Programmable logic P2.2.1
		10	DIN3	Fault reset Programmable G2.2.7	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	Activate synchronization Programmable G2.2.7	Drive will synchronize to net frequency and angle.
		15	DIN5	Activate change to net Programmable G2.2.7	Permission to make change to NET when voltage is in synch.
		16	DIN6	Reset Network run Programmable G2.2.7	Drive takes controlled motor off net. (Multi motor control feature)
		17	CMB	Common for DIN4–DIN6	Connect to GND or +24V
		18	AOA1+	Analogue output 1 Programmable P2.3.1.2	Output range selected by jumpers. Range 0–20 mA. R _L , max. 500Ω Range 0–10 V. R _i > 1kΩ
		19	AOA1-		
		20	DOA1	Digital output Programmable Open collector, I _s ≤50mA, U _s ≤48 VDC	
		OPTA2			
		21	RO1	Relay output 1 FC Contactor control Programmable G2.3.3	Switching capacity 24 VDC / 8 A 250 VAC / 8 A 125 VDC / 0.4 A
		22	RO1		
		23	RO1		
		24	RO2	Relay output 1 Net Contactor control Programmable G2.3.3	Programmable No function defined at default
25	RO2				
26	RO2				

Table 4-1. LineSynch application default I/O configuration and connection example.

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

Note: See jumper selections below. More information in Vacon NX User's Manual, Chapter 6.2.2.2.

Jumper block X3:
CMA and CMB grounding

- CMB connected to GND
CMA connected to GND
- CMB isolated from GND
CMA isolated from GND
- CMB and CMA internally connected together, isolated from GND

= Factory default

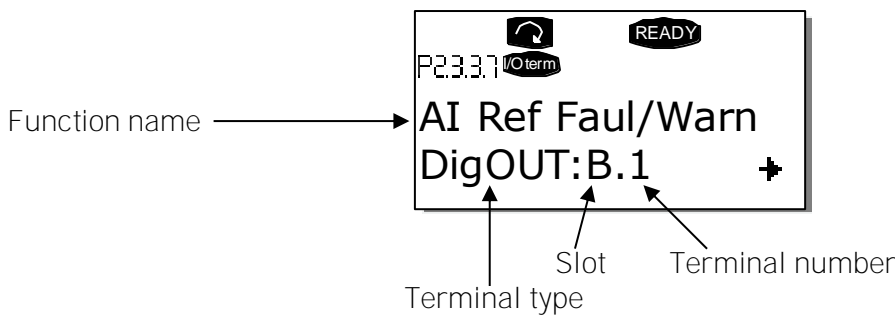
5. “TERMINAL TO FUNCTION” (TTF) PROGRAMMING PRINCIPLE

The programming principle of the input and output signals in the **Multipurpose Control Application NXP** as well as in the **Pump and Fan Control Application** (and partly in the other applications) is different compared to the conventional method used in other Vacon NX applications.

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 16.

5.1 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 Vacon NX control board (see Vacon NX User’s Manual, [Chapter 6.2](#)) and the *respective signal number*, see below.

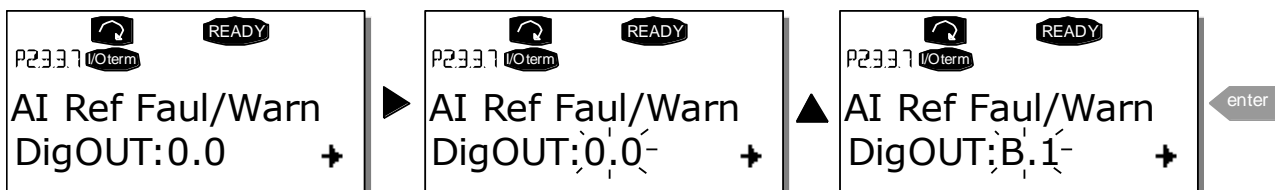


Example: You want to connect the digital output function *Reference fault/warning* (parameter 2.3.3.7) to the digital output DO1 on the basic board NXOPTA1 (see Vacon NX User’s Manual, Chapter 6.2).

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.#).

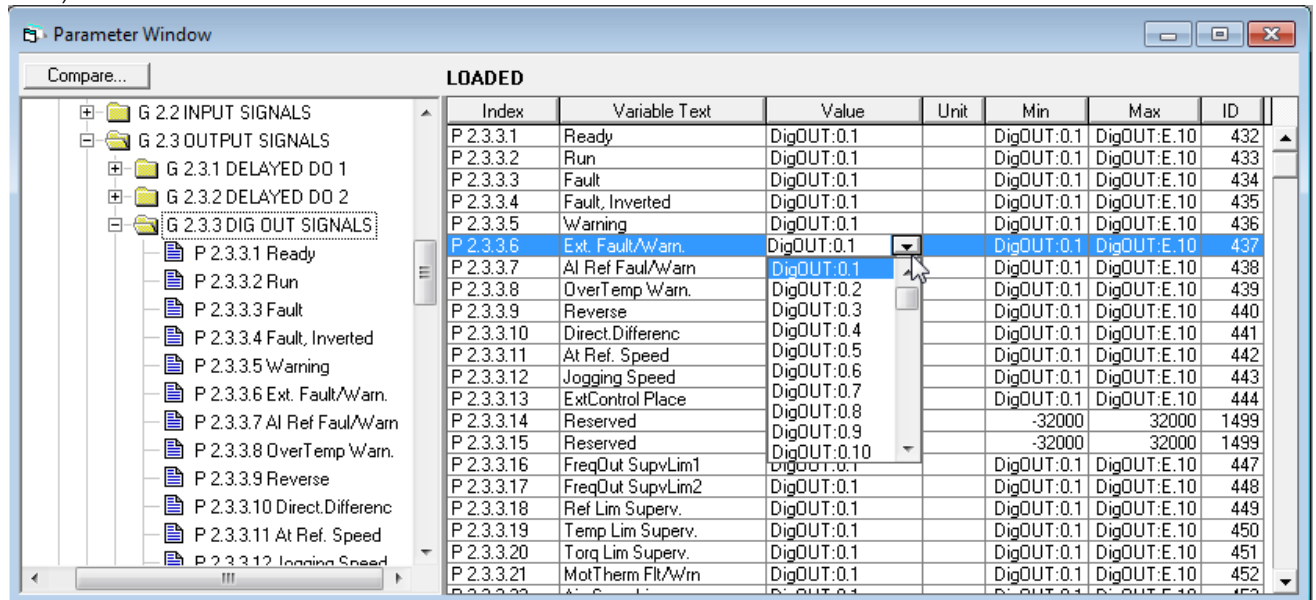
When the value is blinking, hold down the *Browser button up* or *down* to find the desired board slot and signal number. The program will scroll the board slots starting from 0 and proceeding from A to E and the I/O selection from 1 to 10.

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



5.2 Defining a terminal for a certain function with NCDrive programming tool

If you use the NCDrive 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 the Figure below).



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.

5.3 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 analogue 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.

6. LINESYNCH 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 59 to 151.

Column explanations:

Code	= Location indication on the keypad; Shows the operator the present param. number
Parameter	= Name of parameter
Min	= Minimum value of parameter
Max	= Maximum value of parameter
Unit	= Unit of parameter value; Given if available
Default	= Value preset by factory
Cust	= Customer's own setting
ID	= ID number of the parameter
	= 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 5)
	= Monitoring value is possible to control from fieldbus by ID number

6.1 Monitoring values (Control keypad: menu M1)

The monitoring values are the actual values of parameters and signals as well as statuses and measurements. See [Vacon NX User's Manual, Chapter 7](#) for more information.

Code	Parameter	Unit	ID	Description
V1.1	Output frequency	Hz	1	Output frequency to motor
V1.2	Frequency reference	Hz	25	Frequency reference to motor control
V1.3	Motor speed	rpm	2	Motor speed in rpm
V1.4	Motor current	A	3	
V1.5	Motor torque	%	4	In % of Motor nominal torque
V1.6	Motor Input Power	kW	5	With one decimal accuracy
V1.7	Motor voltage	V	6	
V1.8	DC link voltage	V	7	
V1.9	Unit temperature	°C	8	Heatsink temperature
V1.10	Motor temperature	%	9	Calculated motor temperature
V1.11	Analogue input 1	%	13	AI1
V1.12	Analogue input 2	%	14	AI2
V1.13	Analogue input 3	%	27	AI3
V1.14	Analogue input 4	%	28	AI4
V1.15	Analogue Out 1	%	26	AO1
V1.16	Analogue Out 2	%	50	AO2
V1.17	Analogue Out 3	%	51	AO3
V1.18	DIN1, DIN2, DIN3		15	Digital input statuses
V1.19	DIN4, DIN5, DIN6		16	Digital input statuses
V1.20	Torque reference	%	18	Used Torque Reference
V1.21	Measured temperature	°C	42	Highest temperature of OPTB8 board. 4 s filtering.
G1.22	Multimonitoring items			Displays three selectable monitoring values

Table 6-1. Monitoring values

6.1.1 Monitoring values 2 (Control keypad: menu M1.24)

Code	Parameter	Unit	ID	Description
V1.23.1	Current	A	1113	Unfiltered motor current
V1.23.2	Torque	%	1125	Unfiltered motor torque
V1.23.3	DC Voltage	V	44	Unfiltered DC link voltage
V1.23.4	Status Word		43	
V1.23.5	Measured temperature 1	C°	50	
V1.23.6	Measured temperature 2	C°	51	
V1.23.7	Measured temperature 3	C°	52	
V1.23.8	Analogue input 1	%	59	AI1
V1.23.9	Analogue input 2	%	60	AI2
V1.23.10	Analogue input 3	%	61	AI3
V1.23.11	Analogue input 4	%	62	AI4
V1.23.12	Final Frequency Reference	Hz	1131	
V1.23.13	Output power	kW	1508	Drive output power in kW
V1.23.14	Flux Current	%	72	

Table 6-2. Monitoring values 2

6.1.2 FieldBus Monitoring values (Control keypad: menu M1.24)

Code	Parameter	Unit	ID	Description
V1.24.1	FB Torque Reference	%	1140	Default Control of FB PD 1
V1.24.2	FB Limit Scaling	%	46	Default Control of FB PD 2
V1.24.3	FB Adjust Reference	%	47	Default Control of FB PD 3
V1.24.4	FB Analog Output	%	48	Default Control of FB PD 4
V1.24.5	Last Active Fault		37	
V1.24.6	FB Motor Current	A	45	Motor current (drive independent) given with one decimal point
V1.24.7	Din Status Word		56	
V1.24.8	Din Status Word 2		57	
V1.24.9	Last Active Warning		74	

Table 6-3. FieldBus Monitoring values

6.1.3 Line Synchro Monitoring values (Control keypad: menu M1.25)

Code	Parameter	Unit	ID	Description
V1.25.1	Line Voltage	V	1650	OPT-D7 measured line voltage
V1.25.2	Line Voltage Frequency	Hz	1654	OPT-D7 measured line voltage frequency
V1.25.3	Phase error	Dec	1659	Phase error in Dec. from reference.
V1.25.4	Synchronization Status		1651	Synchronization status for NCDrive in CAN communication. Values are updated at 1 ms interval.
V1.25.5	Contactors Status		1652	Relay control status from application
V1.25.6	FB Synchronization control		1640	Line Synchronization control Word from fieldbus.
V1.25.7	Controlled Motor		1641	
V1.25.8	Line voltage L1 - L2	V	1655	Real time
V1.25.9	Line voltage L2 - L3	V	1656	Real time
V1.25.10	Line voltage L3 - L1	V	1657	Real time
V1.25.11	Synch Status 1 ms		1682	

Table 6-4. Synchro Monitoring values

6.1.4 Flying Start Monitoring values (Control keypad: menu M1.26)

Code	Parameter	Unit	ID	Description
V1.26.1	End Frequency	Hz	1708	
V1.26.2	End Voltage	%	1713	

Table 6-5. Synchro Monitoring values

6.2 Monitoring values description

V1.1 *Output frequency* [#,## Hz] ID1

Output frequency to motor, updated at 10 ms time level.

V1.2 *Frequency reference* [#,## Hz] ID 25

Frequency reference to motor control, after speed share function. updates at 1 ms time level.

V1.3 *Motor speed* [# rpm] ID 2

Motor speed in rpm

V1.4 *Motor current* [A] ID 3

1 s linear filtering.

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	Scale
208 – 240 Vac	NX0001 – NX0011	100 – 0,01A
208 – 240 Vac	NX0012 – NX0420	10 – 0,1A
208 – 240 Vac	NX0530	1 – 1A
380 – 500 Vac	NX0003 – NX0007	100 – 0,01A
380 – 500 Vac	NX0009 – NX0300	10 – 0,1A
380 – 500 Vac	NX0385 – NX2643	1 – 1A
525 – 690 Vac	NX0004 – NX0013	100 – 0,01A
525 – 690 Vac	NX0018 – NX0261	10 – 0,1A
525 – 690 Vac	NX0325 – NX1500	1 – 1A

V1.5 *Motor torque* % ID 4

In % of Motor nominal torque
1 s linear filtering

V1.6 *Motor Power* % ID 5

Calculated motor power

V1.7 *Motor voltage* V ID 6

Calculated motor voltage

V1.8 *DC link voltage* V ID 7

Measured DC voltage, filtered.

V1.9 *Unit temperature* •C ID 8

Heatsink temperature

V1.10 *Motor temperature* % *ID 9*

Calculated motor temperature
105 % is tripping limit if response is fault.

V1.11 *Analogue input 1%* *ID 13*

V1.12 *Analogue input 2%* *ID 14*

Unfiltered analogue input level.
0 % = 0 mA / 0 V, -100 % = -10 V, 100 % = 20 mA / 10 V.
Monitoring scaling is determined by the option board parameter.

V1.13 *Analogue input 3%* *ID 27*

V1.14 *Analogue 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 analogue input from fieldbus and have all analogue input functions available for fieldbus process data.

V1.15 *Analogue Out 1* % *ID 26*

V1.16 *Analogue Out 2* % *ID 50*

V1.17 *Analogue Out 3* % *ID 51*

Analogue Output value 0 % = 0 mA / 0 V, 100 % = 20 mA / 10 V

V1.18 *DIN1, DIN2, DIN3* *ID 15*

V1.19 *DIN4, DIN5, DIN6* *ID 16*

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

V1.20 *Torque reference* % *ID 18*

Torque reference value before load share.

V1.21 *PT-100 Temperature* C° *ID 42*

Highest temperature of OPTB8 board. 4 s filtering.

6.2.1 Monitoring values 2

V1.23.1 *Current A* ID 1113

Unfiltered motor current, recommended signal for NCDrive monitoring.

V1.23.2 *Torque %* ID 1125

Unfiltered motor torque, recommended signal for NCDrive monitoring.

V1.23.3 *DC Voltage V* ID 44

Unfiltered DC link voltage, recommended signal for NCDrive monitoring.

V1.23.4 *Application Status Word* ID 43

Application Status Word combines different drive statuses to one data word. Recommended signal for NCDrive monitoring.

Application Status Word ID43		
	FALSE	TRUE
b0		
b1	Not in Ready state	Ready
b2	Not Running	Running
b3	No Fault	Fault
b4		
b5	Emergency Stop Active	Emergency Stop NOT Active
b6	Run Disabled	Run Enable
b7	No Warning	Warning
b8		FC Contactor Feedback
b9		Motor synchronized with grid
b10		NET Contactor Feedback
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		

V1.23.5 *Measured temperature 1* C° ID 50

V1.23.6 *Measured temperature 2* C° ID 51

V1.23.7 *Measured temperature 3* C° ID 52

Separate measurement from two PT100 board. The signal has 4 s filtering time.

V1.23.8 *Analogue input 1%* ID 13

V1.23.9 *Analogue input 2%* ID 14

Unfiltered analogue input level.

0 % = 0 mA / 0 V, -100 % = -10 V, 100 % = 20 mA / 10 V.

Monitoring scaling is determined by the option board parameter.

V1.23.10 Analogue input 3% ID 27

V1.23.11 Analogue 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 analogue input from fieldbus and have all analogue input functions available for fieldbus process data.

V1.23.12 Final Frequency Reference Hz ID 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.

V1.23.13 Output Power kw ID 1508

Unfiltered electrical drive output power.

V1.23.14 Flux Current % ID 72

Motor Flux Current. Can be used as actual value on separate excited motors. In open loop control it's not recommended to use this value below 5 Hz.

6.2.2 FieldBus Monitoring values

V1.24.1 FB Torque Reference % ID 1140

Torque reference value from fieldbus
Default Control of FB PD 1

V1.24.2 FB Limit Scaling % ID 46

Limit scaling input value from fieldbus.
Default Control of FB PD 2.

V1.24.3 FB Adjust Reference % ID 47

Reference adjustment value from fieldbus.
Default Control of FB PD 3.

V1.24.4 FB Analog Output % ID 48

Fieldbus value to control analogue output.
Default Control of FB PD 4.

V1.24.5 FB Motor Current A ID 45

Motor current (drive independent) given with one decimal point.

V1.24.6 Fault History ID 37

Fault number of the last active fault.

V1.24.7 *Din Status Word 1* *ID 56*

V1.24.8 *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
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	

V1.24.9 *Warning* *ID 74*

Last active warning.

6.2.3 Line Synchronization monitor

V1.25.1 Line Voltage ID 1650

Line Voltage measured by OPT-D7

V1.25.2 Line Voltage Frequency ID 1654

Line Voltage frequency measured by OPT-D7

V1.25.3 Phase Error ID 1659

Phase error between drive voltage angle and OPT-D7 measured angle.

V1.25.4 Synchronization Status Word: ID1651

Line Synch Status Word		
	Signal	Comment
b0	Drive Ready	Drive is in Ready state
b1	Drive Run	Drive is in Run state
b2	Active Synchro	Command to make synchronization is active
b3	Fine tuning Start	Line voltage frequency within 0,10 Hz from net frequency
b4	Fine tuning OK	Voltage angle is within hysteresis
b5	Active Direct	Command to change to net is active
b6	FC Active	Final control signal to FC relay
b7	Connect Direct	Internal command to close NET contactor
b8	Direct Active	Final control signals to NET relay
b9		
b10		
b11		
b12		
b13		
b14		
b15		

V1.25.5 Contactor status Word ID1652

Status of the relay outputs. Note that function that will open all relays e.g. emergency stop, will open all relays but here you will see status of the internal control. Thus you are able to give correct reset commands

Contactor Status Word ID1652		
	Signal	Comment
b0	Motor 1 FC Contactor	
b1	Motor 1 NET Contactor	
b2	Motor 2 FC Contactor	
b3	Motor 2 NET Contactor	
b4	Motor 3 FC Contactor	
b5	Motor 3 NET Contactor	
b6	Motor 4 FC Contactor	
b7	Motor 4 NET Contactor	
b8	Motor 5 FC Contactor	
b9	Motor 5 NET Contactor	
b10	Motor 6 FC Contactor	
b11	Motor 6 NET Contactor	
b12	Motor 7 FC Contactor	
b13	Motor 7 NET Contactor	
b14	Motor 8 FC Contactor	
b15	Motor 8 NET Contactor	

V1.25.6 FB Line Synchronization control word ID1640

FB Synch Control ID1640		
	Signal	Comment
b0	Activate synchronization	Drive will synchronize to net frequency
b1	Activate changeover to DOL	Drive will make change to DOL when synchronized
b2	Reset DOL contactor(s)	Drive will open closed net contactor(s)
b3		
b4	Single Start	Drive will not start automatically to next motor, rising edge start command required in FB control.
b5	Single to net	Drive will not make changeover to DOL automatically, rising edge for synchronization and changeover required. (ID1700.B1)
b6	Single reset	Rising edge of Reset DOL will open only one NET contactor. (ID1700.B3)
b7		
b8	Motor Bx control	B12 to 14 are used to select controlled motor in FB control.
b9	Start in sequence	Drive will put all motors to net while B0-B2 are active, cannot be used at the same time with B8.
b10		
b11		
b12	Motor select B0	
b13	Motor select B1	
b14	Motor select b2	
b15		

V1.25.7 Controlled Motor ID1641

Monitoring variable to show what is internally controlled motor.

V1.25.8 Line Voltage L1-L2 ID1655**V1.25.9 Line Voltage L2-L3 ID1656****V1.25.10 Line Voltage L3-L1 ID1657**

Real time monitoring values from OPT-D7 option board,. Needs to be monitored at 1 ms time level or faster (data logger).

V1.25.11 Synchronization Status 1 ms ID1682

Fast monitoring of synchronization status. Compared to ID1651 this value needs to be monitored at 1 ms time level to have accurate information.

Line Synch Status Word 1 ms		
	Signal	Comment
b0	Coasting to NET	Internal coasting command is active
b1	Active Synchro	Command to make synchronization is active
b2	Active Direct	Command to change to net is active
b3	Reset Direct	Multi Motor net contactor reset command
b4	Fine tunig	Line voltage frequency within 0,10 Hz from net frequency
b5	Fine tunig OK	Voltage angle is within hysteresis
b6	Connect Direct	Internal command to close NET contactor
b7	Direct Active	Final control signals to NET relay
b8	FC Active	Final control signal to FC relay
b9	Drive Ready	Drive is in Ready state
b10	Drive Run	Drive is in Run state
b11	RunEnable	Internal RunEnable status
b12	RunRequest	Internal RunRequest status
b13	FC Contactor Ack.	Feedback from M1 FC contactor
b14	Net Contactor Ack.	Feedback from M1 NET contactor
b15	Both ON when Run	Drive was running while Net and FC contactor were closed

6.2.4 Flying Start Monitor**V1.26.1 End Frequency ID 1708**

Detected motor frequency during flying start.

V1.26.2 End Voltage ID 1713

Detected motor voltage during flying start.

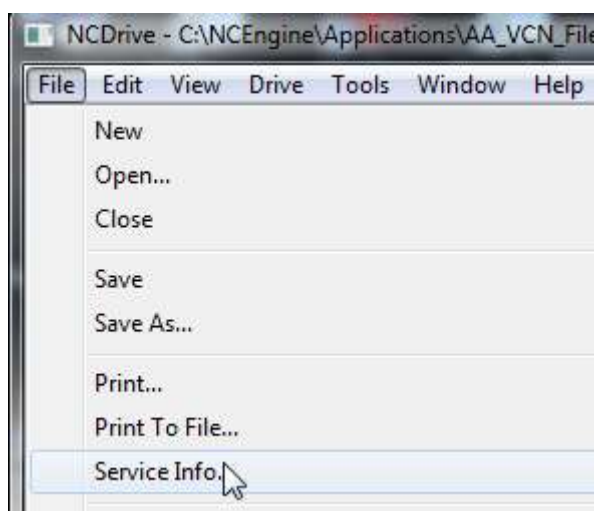
6.3 Recommended signals for NCDrive

Signal Name	Actual	Unit
Status Word	98	n
Current	2	
Torque	-0,2	
Output Frequency	0	Hz
ContactoStatus	0	0
Phase Error	0	Deg
LineVoltageFreq.	0	Hz
Synch.Status	1	0

In NCDrive use binary mode to monitor Application Status Word

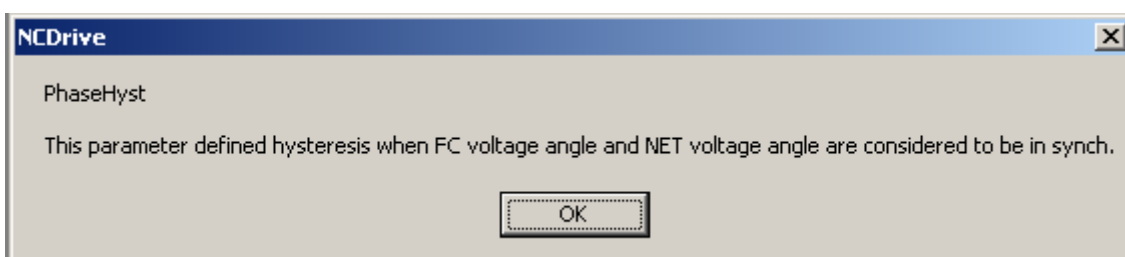
Status Word	0000 0000 0110 0010
ContactoStatus	0000 0000 0000 0000
Synch.Status	0000 0000 0000 0001

*.trn, *.par and Print Service info to file (*.txt) with situation description.



Tell at least application ID and version number.

To access Parameter help: Select parameter and press F1



7. LINESYNCH APPLICATION – PARAMETER LIST

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

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.1.1	Minimum frequency	0,00	P2.1.2	Hz	0,00		101	
P2.1.2	Maximum frequency	P2.1.1	320,00	Hz	50,00		102	NOTE: If f_{max} > than the motor synchronous speed, check suitability for motor and drive system
P2.1.3	Motor nominal voltage	180	690	V	NX2: 230V NX5: 400V NX6: 690V		110	Check the rating plate of the motor. Note also used connection Delta/Star
P2.1.4	Motor nominal frequency	8,00	320,00	Hz	50,00		111	Check the rating plate of the motor
P2.1.5	Motor nominal speed	24	20 000	rpm	1440		112	The default applies for a 4-pole motor and a nominal size frequency converter.
P2.1.6	Motor nominal current	$0,1 \times I_H$	$2 \times I_H$	A	I_H		113	Check the rating plate of the motor.
P2.1.7	Motor $\cos\phi$	0,30	1,00		0,85		120	Check the rating plate of the motor
P2.1.8	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!
P2.1.9	Motor type	0	2		0		650	0=Induction Motor 1=PMS Motor 2=Synchronous Machine

Table 7-1. Basic parameters G2.1

7.2 Reference Handling

7.2.1 Basic Settings

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.2.1	I/O Reference	0	14		0		117	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
P2.2.2	Keypad reference selector	0	9		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
P2.2.3	Fieldbus control reference	0	9		9		122	See par. 2.2.2
P2.2.4	Load Share	0,0	500,0	%	100,0		1248	

7.2.2 Constant Reference

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.2.5.1	Jogging speed reference	0,00	320,00	Hz	5,00		124	
P2.2.5.2	Preset speed 1	0,00	320,00	Hz	10,00		105	Multi-step speed 1
P2.2.5.3	Preset speed 2	0,00	320,00	Hz	15,00		106	Multi-step speed 2
P2.2.5.4	Preset speed 3	0,00	320,00	Hz	20,00		126	Multi-step speed 3
P2.2.5.5	Preset speed 4	0,00	320,00	Hz	25,00		127	Multi-step speed 4
P2.2.5.6	Preset speed 5	0,00	320,00	Hz	30,00		128	Multi-step speed 5
P2.2.5.7	Preset speed 6	0,00	320,00	Hz	40,00		129	Multi-step speed 6
P2.2.5.8	Preset speed 7	0,00	320,00	Hz	50,00		130	Multi-step speed 7
P2.2.5.9	Inching reference 1	-320,00	320,00	Hz	2,00		1239	
P2.2.5.10	Inching reference 2	-320,00	320,00	Hz	-2,00		1240	

7.2.3 Torque Reference

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.2.6.1	Torque reference selection	0	8		0		641	0=Not used 1=A11 2=A12 3=A13 4=A14 5=A11 joystick (-10 - 10 V) 6=A12 joystick (-10 - 10 V) 7=Torque reference from keypad, R3.5 8=FB Torque Reference
P2.2.6.2	Torque reference max.	-300,0	300,0	%	100		642	
P2.2.6.3	Torque reference min.	-300,0	300,0	%	0,0		643	
P2.2.6.4	Torque reference filtering time	0	32000	ms	0		1244	
P2.2.6.5	Torque Select	0	2		1		1278	0=Max Frequency 1=Freq Reference 2=Preset Speed 7
P2.2.6.6	Open loop torque control minimum frequency	0,00	50,00	Hz	3,00		636	
P2.2.6.7	Open loop torque controller P gain	0	32000		150		639	
P2.2.6.8	Open loop torque controller I gain	0	32000		10		640	

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

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.2.7.1	Prohibit frequency range 1 low limit	-1,00	320,00	Hz	0,00		509	0=Not used
P2.2.7.2	Prohibit frequency range 1 high limit	0,00	320,00	Hz	0,00		510	0=Not used
P2.2.7.3	Prohibit frequency range 2 low limit	-1,00	320,00	Hz	0,00		511	
P2.2.7.4	Prohibit frequency range 2 high limit	0,00	320,00	Hz	0,00		512	
P2.2.7.5	Prohibit frequency range 3 low limit	-1,00	320,00	Hz	0,00		513	
P2.2.7.6	Prohibit frequency range 3 high limit	0,00	320,00	Hz	0,00		514	
P2.2.7.7	Ramp time factor	0,1	10,0	x	1,0		518	Multiplier of the currently Selected ramp time between prohibit frequency limits.

Table 7-2. Prohibit frequencies (G2.5)

7.2.5 Motor Potentiometer (Control keypad: Menu M2 → G2.5)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.2.8.1	Motor potentiometer ramp rate	0,10	2000,00	Hz/s	1,00		331	Ramp rate for motor potentiometer
P2.2.8.2	Motor potentiometer frequency reference memory reset	0	2		1		367	0=No reset 1=Reset in stop state 2=Reset in powered down

Table 7-3. Motor potentiometer (G2.5)

7.2.6 Adjust Reference

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.2.9.1	Adjust input	0	5		0		493	0=Not used 1=AI1 2=AI2 3=AI3 4=AI4 5=Fieldbus
P2.2.9.1	Adjust minimum	0,0	100,0	%	0,0		494	Adjust limit to decrease ref.
P2.2.9.1	Adjust maximum	0,0	100,0	%	0,0		495	Adjust limit to increase ref.

7.3 Ramp Control

7.3.1 Basic Settings

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.3.1	Start function	0	1		0		505	0=Ramp 1=Flying start
P2.3.2	Stop function	0	1		0		506	0=Coasting 1=Ramp
P2.3.3	Acceleration time 1	0,2	3270,0	s	3,0		103	0 Hz to Max frequency
P2.3.4	Deceleration time 1	0,2	3270,0	s	3,0		104	Max frequency to 0 Hz
P2.3.5	Ramp 1 shape	0	100	%	2		500	0=Linear >0=S-curve ramp time
P2.3.6	Acceleration time 2	0,2	3270,0	s	10,0		502	
P2.3.7	Deceleration time 2	0,2	3270,0	s	10,0		503	
P2.3.8	Ramp 2 shape	0	100	%	4		501	0=Linear >0=S-curve ramp time
P2.3.9	Inching Ramp	0,01	320,00	s	1,00		1257	
P2.3.10	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
P2.3.11	IO Quick Stop Mode	0	1		0		1276	0=Coasting 1= Ramp
P2.3.12	FB Breaker Close Delay from Start Command	0	5000	ms	0		1712	

7.4 Input Signals

7.4.1 Basic Settings

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note		
P2.4.1.1	Start/Stop logic selection	0	7		5		300		Start signal 1 (Default: DIN1)	Start signal 2 (Default: DIN2)
								0	Start fwd	Start rvs
								1	Start/Stop	Reverse
								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								

Table 7-4. Input signals: basic settings, G2.2.1

* = Rising edge required to start

7.4.2 Digital inputs (Control keypad: Menu M2 → G2.2.4)

Code	Parameter	Min	Default	Cust	ID	Note
P2.4.2.1	Start signal 1	0.1	A.1		403	See P2.2.1.1.
P2.4.2.2	Start signal 2	0.1	A.2		404	See P2.2.1.1.
P2.4.2.3	Run enable	0.1	0.2		407	Motor start enabled (cc)
P2.4.2.4	Reverse	0.1	0.1		412	Direction forward (oc) Direction reverse (cc)
P2.4.2.5	Preset speed 1	0.1	0.1		419	See preset speeds in Basic Parameters (G2.1)
P2.4.2.6	Preset speed 2	0.1	0.1		420	
P2.4.2.7	Preset speed 3	0.1	0.1		421	
P2.4.2.8	Motor potentiometer reference DOWN	0.1	0.1		417	Mot.pot. reference decreases (cc)
P2.4.2.9	Motor potentiometer reference UP	0.1	0.1		418	Mot.pot. reference increases (cc)
P2.4.2.10	Fault reset	0.1	A.3		414	All faults reset (cc)
P2.4.2.11	External fault (close)	0.1	0.1		405	Ext. fault (F51) displayed (cc)
P2.4.2.12	External fault (open)	0.1	0.2		406	Ext. fault (F51) displayed (oc)
P2.4.2.13	Acc/Dec time selection	0.1	0.1		408	Acc/Dec time 1 (oc) Acc/Dec time 2 (cc)
P2.4.2.14	Acc/Dec prohibit	0.1	0.1		415	Acc/Dec prohibited (cc)
P2.4.2.15	DC braking	0.1	0.1		416	DC braking active (cc)
P2.4.2.16	Jogging speed	0.1	0.1		413	Jogging speed selected for frequency reference (cc)
P2.4.2.17	AI1/AI2 selection	0.1	0.1		422	cc = AI2 is used as reference, when ID117 = 14
P2.4.2.18	Control from I/O terminal	0.1	0.1		409	Force control place to I/O terminal (cc)
P2.4.2.19	Control from keypad	0.1	0.1		410	Force control place to keypad (cc)
P2.4.2.20	Control from fieldbus	0.1	0.1		411	Force control place to fieldbus (cc)
P2.4.2.21	Parameter set 1/set 2 selection	0.1	0.1		496	Closed cont.=Set 2 is used Open cont.=Set 1 is used
P2.4.2.22	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
P2.4.2.23	Cooling monitor	0.1	0.2		750	Used with liquid-cooled unit
P2.4.2.24	Enable inching	0.1	0.1		532	Enables Inching function
P2.4.2.25	Inching reference 1	0.1	0.1		530	Inching reference 1. (Default Forward 2 Hz. See P2.4.16) This will start the drive
P2.4.2.26	Inching reference 2	0.1	0.1		531	Inching reference 2. (Default Forward 2 Hz. See P2.4.17) This will start the drive
P2.4.2.27	Emergency stop	0.1	0.2		1213	Low signal activates EM
P2.4.2.28	Input switch acknowledgement	0.1	0.2		1209	Low signal generates fault (F64)
P2.4.2.29	Active synchronization	0.1	A.4		1600	
P2.4.2.30	Active direct	0.1	A.5		1601	
P2.4.2.31	Reset direct	0.1	A.6		1612	
P2.4.2.32	FC Contactor acknowledge	0.1	0.1		1630	
P2.4.2.33	Net contactor acknowledge	0.1	0.1		1631	
P2.4.2.34	Motor selection B0	0.1	0.1		1670	
P2.4.2.35	Motor selection B1	0.1	0.1		1671	
P2.4.2.36	Motor selection B2	0.1	0.1		1672	
P2.4.2.37	ByPass Inter Lock Falling (OC) Edge	0.1	0.2		1636	Interlock from device that monitors if motor input is OK. Falling edge will activate protection function F87.

P2.4.2.38	ByPass Inter Lock Rising (CC) Edge	0,1	0.1		1637	Interlock from device that monitors if motor input is OK. Rising edge will activate protection function F87.
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Table 7-5. Digital input signals, G2.2.4

7.4.3 Analogue input 1 (Control keypad: Menu M2 → G2.2.2)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.4.3.1	A11 signal selection	0.1	E.10		A.1		377	Slot . Board input No.
P2.4.3.2	A11 filter time	0,000	32,000	s	0,000		324	0=No filtering
P2.4.3.3	A11 signal range	0	3		0		320	0=0...100%* 1=20...100%* 4 mA Fault 2= -10V...+10V* 3= Custom range*
P2.4.3.4	A11 custom minimum setting	-160,00	160,00	%	0,00		321	Custom Range: Minimum input
P2.4.3.5	A11 custom maximum setting	-160,00	160,00	%	100,00		322	Custom Range: Maximum input
P2.4.3.6	A11 reference scaling, minimum value	0,00	320,00	Hz	0,00		303	Selects the frequency that corresponds to the min. reference signal
P2.4.3.7	A11 reference scaling, maximum value	0,00	320,00	Hz	0,00		304	Selects the frequency that corresponds to the max. reference signal
P2.4.3.8	A11 joystick Dead Zone	0,00	20,00	%	0,00		384	Dead Zone for joystick input
P2.4.3.9	A11 sleep limit	0,00	100,00	%	0,00		385	Drive goes to stop if input is below this limit for this time.
P2.4.3.10	A11 sleep delay	0,00	320,00	s	0,00		386	
P2.4.3.11	A11 joystick offset	-100,00	100,00	%	0,00		165	Press enter for 1s to set offset

Table 7-6. Analogue input 1 parameters, G2.2.2

*Remember to place jumpers of block X2 accordingly. See NX User's Manual, chapter 6.2.2.2

7.4.4 Analogue input 2 (Control keypad: Menu M2 → G2.2.3)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.4.4.1	AI2 signal selection	0.1	E.10		A.2		388	Slot . Board input No.
P2.4.4.2	AI2 filter time	0,000	32,000	s	0,000		329	0=No filtering
P2.4.4.3	AI2 signal range	0	3		1		325	0=0...100%* 1=20...100%* 4 mA Fault 2= -10V...+10V* 3= Custom range*
P2.4.4.4	AI2 custom minimum setting	-160,00	160,00	%	0,00		326	Custom Range: Minimum input
P2.4.4.5	AI2 custom maximum setting	-160,00	160,00	%	100,00		327	Custom Range: Maximum input
P2.4.4.6	AI2 reference scaling, minimum value	0,00	320,00	Hz	0,00		393	Selects the frequency that corresponds to the min. reference signal
P2.4.4.7	AI2 reference scaling, maximum value	0,00	320,00	Hz	0,00		394	Selects the frequency that corresponds to the max. reference signal
P2.4.4.8	AI2 joystick Dead Zone	0,00	20,00	%	0,00		395	Dead Zone for joystick input
P2.4.4.9	AI2 sleep limit	0,00	100,00	%	0,00		396	Drive goes to stop if input is below this limit for this time.
P2.4.4.10	AI2 sleep delay	0,00	320,00	s	0,00		397	
P2.4.4.11	AI2 joystick offset	-100,00	100,00	%	0,00		166	Press enter for 1s to set offset

Table 7-7. Analogue input 2 parameters, G2.2.3

7.4.5 Analogue input 3 (Control keypad: Menu M2 → G2.2.4)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.4.5.1	AI3 signal selection	0.1	E.10		0.1		141	Slot . Board input No. If 0.1 ID27 can be controlled from FB
P2.4.5.2	AI3 filter time	0,000	32,000	s	0,000		142	0=No filtering
P2.4.5.3	AI3 signal range	0	3		1		143	0=0...100%* 1=20...100%* 4 mA Fault 2= -10V...+10V* 3= Custom range*
P2.4.5.4	AI3 custom minimum setting	-160,00	160,00	%	0,00		144	Custom range always active. See ID326
P2.4.5.5	AI3 custom maximum setting	-160,00	160,00	%	100,00		145	Custom range always active. See ID327
P2.4.5.6	AI3 signal inversion	0	1		0		151	0=Not inverted 1=Inverted

Table 7-8. Analogue input 3 parameters, G2.2.4

**Remember to place jumpers of block X2 accordingly.
See NX User's Manual, chapter 6.2.2.2

7.4.6 Analogue input 4 (Control keypad: Menu M2 → G2.4.6)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.4.6.1	AI4 signal selection	0.1	E.10		0.1		152	Slot . Board input No. If 0.1 ID28 can be controlled from FB
P2.4.6.2	AI4 filter time	0,000	32,000	s	0,000		153	0=No filtering
P2.4.6.3	AI4 signal range	0	3		1		143	0=0...100%* 1=20...100%* 4 mA Fault 2= -10V...+10V* 3= Custom range*
P2.4.6.4	AI4 custom minimum setting	-160,00	160,00	%	0,00		155	Custom range always active. See ID326
P2.4.6.5	AI4 custom maximum setting	-160,00	160,00	%	100,00		156	Custom range always active. See ID327
P2.4.6.6	AI4 signal inversion	0	1		0		162	0=Not inverted 1=Inverted

Table 7-9. Analogue input 4 parameters, G2.2.5

7.5 Output Signals

7.5.1 Digital output signals (Control keypad: Menu M2 → G2.3.3)

Code	Parameter	Min	Default	Cust	ID	Note
P2.5.1.1	Ready	0.1	A.1		432	Ready to Run
P2.5.1.2	Run	0.1	0.1		433	Running
P2.5.1.3	Fault	0.1	0.1		434	Drive in fault state
P2.5.1.4	Inverted fault	0.1	0.1		435	Drive not in fault state
P2.5.1.5	Warning	0.1	0.1		436	Warning active
P2.5.1.6	External fault	0.1	0.1		437	External fault active
P2.5.1.7	Reference fault/warning	0.1	0.1		438	4 mA fault or warning active
P2.5.1.8	Overtemperature warning	0.1	0.1		439	Drive overtemperature active
P2.5.1.9	Reverse	0.1	0.1		440	Output frequency < 0 Hz
P2.5.1.10	Unrequested direction	0.1	0.1		441	Actual direction <> requested direction
P2.5.1.11	At speed	0.1	0.1		442	Reference = Output frequency
P2.5.1.12	Jogging speed	0.1	0.1		443	Jogging or preset speed command active
P2.5.1.13	I/O control place	0.1	0.1		444	IO control active
P2.5.1.14	Output frequency limit 1 supervision	0.1	0.1		447	See ID315.
P2.5.1.15	Output frequency limit 2 supervision	0.1	0.1		448	See ID346.
P2.5.1.16	Reference limit supervision	0.1	0.1		449	See ID350.
P2.5.1.17	Temperature limit supervision	0.1	0.1		450	Drive temperature supervision. See ID354.
P2.5.1.18	Torque limit supervision	0.1	0.1		451	See ID348.
P2.5.1.19	Thermistor fault or warning	0.1	0.1		452	
P2.5.1.20	Analogue input supervision limit	0.1	0.1		463	See ID356
P2.5.1.21	Motor regulator activation	0.1	0.1		454	
P2.5.1.22	Fieldbus DIN 1	0.1	0.1		455	See fieldbus manual
P2.5.1.23	Fieldbus DIN 2	0.1	0.1		456	See fieldbus manual
P2.5.1.24	Fieldbus DIN 3	0.1	0.1		457	See fieldbus manual
P2.5.1.25	Fieldbus DIN 4	0.1	0.1		169	See fieldbus manual
P2.5.1.26	Fieldbus DIN 5	0.1	0.1		170	See fieldbus manual
P2.5.1.27	DC ready pulse	0.1	0.1		1218	For external DC charger
P2.5.1.28	Safe Disable Active	0.1	0.1		756	
P2.5.1.29	Drive in Synch	0.1	0.1		1625	
P2.5.1.30	Motor 1 FC Control	0.1	B.1		1602	
P2.5.1.31	Motor 1 DL Control	0.1	B.2		1603	
P2.5.1.32	Motor 2 FC Control	0.1	0.1		1604	
P2.5.1.33	Motor 2 DL Control	0.1	0.1		1605	
P2.5.1.34	Motor 3 FC Control	0.1	0.1		1606	
P2.5.1.35	Motor 3 DL Control	0.1	0.1		1607	
P2.5.1.36	Motor 4 FC Control	0.1	0.1		1615	
P2.5.1.37	Motor 4 DL Control	0.1	0.1		1616	
P2.5.1.38	Motor 5 FC Control	0.1	0.1		1617	
P2.5.1.39	Motor 5 DL Control	0.1	0.1		1618	
P2.5.1.40	Motor 6 FC Control	0.1	0.1		1645	
P2.5.1.41	Motor 6 DL Control	0.1	0.1		1646	
P2.5.1.42	Motor 7 FC Control	0.1	0.1		1617	
P2.5.1.43	Motor 7 DL Control	0.1	0.1		1648	
P2.5.1.44	Motor 8 FC Control	0.1	0.1		1664	

P2.5.1.45	Motor 8 DL Control	0.1	0.1		1665	
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7.5.2 Analogue output 1 (Control keypad: Menu M2 → G2.3.5)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.5.2.1	Analogue output 1 signal selection	0.1	E.10		A.1		464	TTF programming See chapter 3.1 and 3.2
P2.5.2.2	Analogue output 1 function	0	16		1		307	0=Not used (4 mA / 2 V) 1=Output freq. (0– f_{max}) 2=Freq. reference (0– f_{max}) 3=Motor speed (0–Motor nominal speed) 4=Motor current (0– I_{nMotor}) 5=Motor torque (0– T_{nMotor}) 6=Motor power (0– P_{nMotor}) 7=Motor voltage (0– U_{nMotor}) 8=DC-link volt (0–1000V) 9=AI1 10=AI2 11=Output freq. (f_{min} - f_{max}) 12=-2xTorque...+2xTorque 13=-2xPower...+2xPower 14=PT100 temperature 15=FB Analog Output 16= Flux Current
P2.5.2.3	Analogue output 1 filter time	0,00	10,00	s	1,00		308	0=No filtering
P2.5.2.4	Analogue output 1 inversion	0	1		0		309	0=Not inverted 1=Inverted
P2.5.2.5	Analogue output 1 minimum	0	1		0		310	0=0 mA (0 %) 1=4 mA (20 %)
P2.5.2.6	Analogue output 1 scale	10	1000	%	100		311	
P2.5.2.7	Analogue output 1 offset	-100,00	100,00	%	0,00		375	

Table 7-10. Analogue output 1 parameters, G2.3.5

7.5.3 Analogue output 2 (Control keypad: Menu M2 → G2.3.6)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.5.3.1	Analogue output 2 signal selection	0.1	E.10		0.1		471	TTF programming See chapter 3.1 and 3.2
P2.5.3.2	Analogue output 2 function	0	16		4		472	See P2.5.2.2
P2.5.3.3	Analogue output 2 filter time	0,00	10,00	s	1,00		473	0=No filtering
P2.5.3.4	Analogue output 2 inversion	0	1		0		474	0=Not inverted 1=Inverted
P2.5.3.5	Analogue output 2 minimum	0	1		0		475	0=0 mA (0 %) 1=4 mA (20 %)
P2.5.3.6	Analogue output 2 scale	10	1000	%	100		476	
P2.5.3.7	Analogue output 2 offset	-100,00	100,00	%	0,00		477	

Table 7-11. Analogue output 2 parameters, G2.3.6

7.5.4 Analogue output 3 (Control keypad: Menu M2 → G2.3.7)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.5.4.1	Analogue output 3 signal selection	0.1	E.10		0.1		478	TTF programming See chapter 3.1 and 3.2
P2.5.4.2	Analogue output 3 function	0	20		5		479	See P2.5.2.2
P2.5.4.3	Analogue output 3 filter time	0,00	10,00	s	1,00		480	0=No filtering
P2.5.4.4	Analogue output 3 inversion	0	1		0		481	0=Not inverted 1=Inverted
P2.5.4.5	Analogue output 3 minimum	0	1		0		482	0=0 mA (0 %) 1=4 mA (20 %)
P2.5.4.6	Analogue output 3 scale	10	1000	%	100		483	
P2.5.4.7	Analogue output 3 offset	-100,00	100,00	%	0,00		484	

Table 7-12. Analogue output 3 parameters, G2.3.7

7.5.5 Delayed digital output 1 (Keypad: Menu M2 → G2.3.1)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.5.5.1	Digital output 1 signal selection	0.1	E.10		0.1		486	
P2.5.5.2	Digital output 1 function	0	27		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 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=D7 Measurement Point
P2.5.5.3	Digital output 1 on delay	0,00	320,00	s	0,00		487	0,00 = On delay not in use
P2.5.5.4	Digital output 1 off delay	0,00	320,00	s	0,00		488	0,00 = Off delay not in use

Table 7-13. Delayed digital output 1 parameters, G2.3.1

7.5.6 Delayed digital output 2 (Keypad: Menu M2 → G2.3.2)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.5.6.1	Digital output 2 signal selection	0.1	E.10		0.1		489	
P2.5.6.2	Digital output 2 function	0	28		0		490	See P2.5.6.2
P2.5.6.3	Digital output 2 on delay	0,00	320,00	s	0,00		491	0,00 = On delay not in use
P2.5.6.4	Digital output 2 off delay	0,00	320,00	s	0,00		492	0,00 = Off delay not in use

Table 7-14. Delayed digital output 2 parameters, G2.3.2

7.5.7 Supervision Limits

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.5.7.1	Output frequency limit 1 supervision	0	2		0		315	0=No limit 1=Low limit supervision 2=High limit supervision
P2.5.7.2	Output frequency limit 1; Supervised value	0,00	320,00	Hz	0,00		316	
P2.5.7.3	Output frequency limit 2 supervision	0	2		0		346	0=No limit 1=Low limit supervision 2=High limit supervision
P2.5.7.4	Output frequency limit 2; Supervised value	0,00	320,00	Hz	0,00		347	
P2.5.7.5	Torque limit supervision	0	2		0		348	0=Not used 1=Low limit supervision 2=High limit supervision
P2.5.7.6	Torque limit supervision value	-300,0	300,0	%	100,0		349	
P2.5.7.7	Reducing of torque supervision limit	0	5		0		402	
P2.5.7.8	Reference limit supervision	0	2		0		350	0=Not used 1=Low limit 2=High limit
P2.5.7.9	Reference limit supervision value	0,00	100,0	%	0,00		351	
P2.5.7.10	FC temperature supervision	0	2		0		354	0=Not used 1=Low limit 2=High limit
P2.5.7.11	FC temperature supervised value	-10	100	°C	40		355	
P2.5.7.12	Analogue supervision signal	0	4		0		356	0=Not used 1=A11 2=A12 3=A13 4=A14
P2.5.7.13	Analogue supervision low limit	0,00	100,00	%	10,00		357	Reset limit
P2.5.7.14	Analogue supervision high limit	0,00	100,00	%	90,00		358	Set limit

Table 7-15. Supervision Limit settings, G2.3.4

7.5.8 Delayed digital output 3 FAST (Keypad: Menu M2 → G2.3.2)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.5.8.1	Digital output 3 signal selection	0.1	E.10		0.1		1632	Possibility to invert by ID1091 INV Commands
P2.5.8.2	Digital output 3 function	0	28		0		1633	See P2.5.6.2
P2.5.8.3	Digital output 3 on delay	0,00	320,00	ms	0,00		1638	0,00 = On delay not in use
P2.5.8.4	Digital output 3 off delay	0,00	320,00	ms	0,00		1639	0,00 = Off delay not in use

Table 7-16.

7.5.9 M1 Pulse Control

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.5.9.1	M1 Pulse Time	0	10000	ms	2000		1850	
P2.5.9.2	M1 FC Close Pulse	0.1	E.10		0.1		1851	
P2.5.9.3	M1 FC Open Pulse	0.1	E.10		0.1		1852	
P2.5.9.4	M1 DOL Close Pulse	0.1	E.10		0.1		1853	
P2.5.9.5	M1 DOL Open Pulse	0.1	E.10		0.1		1854	

Table 7-17.

7.6 Limit Settings

7.6.1 Current handling

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.6.1	Current limit	0	$2 \times I_H$	A	I_L		107	Reaching the limit will lower output frequency
P2.6.2	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

7.6.2 Torque Handling

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.6.2.1	Torque Limit	0,0	300,0	%	300,0		609	General maximum limit
P2.6.2.2	Motoring Torque Limit	0,0	300,0	%	300,0		1287	Motoring side torque limit
P2.6.2.3	Generator Torque Limit	0,0	300,0	%	300,0		1288	Generator side torque limit
P2.6.2.4	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
P2.6.2.5	Scaling Generator Torque limit	0	5		0		1087	Scaling from 0 to ID1288 As parameter P2.6.3.9
P2.6.2.6	Torque limit control P-gain	0,0	32000		3000		610	
P2.6.2.7	Torque limit control I-gain	0,0	32000		200		611	

7.6.3 Frequency Handling

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.6.3.1	Negative frequency limit	-320,00	320,00	Hz	-320,00		1286	Alternative limit for negative direction
P2.6.3.2	Positive frequency limit	-320,00	320,00	Hz	320,00		1285	Alternative limit for positive direction

7.6.4 DC-Link Handling

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.6.4.1	Overvoltage controller	0	2		1		607	0=Not used 1=Used (no ramping) 2=Used (ramping)
P2.6.4.2	Over Voltage Reference selector	0	2		1		1262	0=High Voltage 1=Normal Voltage 2=BrakeChopperLevel
P2.6.4.3	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)
P2.6.4.4	Undervoltage controller	0	2		1		608	0=Not used 1=Used (no ramping) 2=Used (ramping to zero)
P2.6.4.5	Under Voltage Reference Sel	0	1		1		1537	0=Low 1=Automatic

7.7 Flux and DC Current handling

7.7.1 Flux and DC Current handling OL Settings

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.7.1	DC braking current	0,00	I_L	A	0,00		507	
P2.7.2	DC braking time at start	0,00	600,00	s	0,00		516	0=DC brake is off at start
P2.7.3	DC braking time at stop	0,00	600,00	s	0,00		508	0=DC brake is off at stop
P2.7.4	Frequency to start DC braking during ramp stop	0,10	10,00	Hz	1,50		515	
P2.7.5	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
P2.7.6	DC-Brake Current in Stop	0,00	I_L	A	Varies		1080	
P2.7.7	Flux brake	0	1		0		520	0=Off 1=On
P2.7.8	Flux braking current	0,00	I_L	A	I_H		519	

7.8 Motor Control

7.8.1 Motor Control Basic Settings

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.8.1	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
P2.8.2	Motor control mode 2	0	4		2		521	See P2.8.1

7.8.2 U/f Settings

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.8.3.1	U/f optimisation	0	1		0		109	0=Not used 1=Automatic torque boost
P2.8.3.2	U/f ratio selection	0	3		0		108	0=Linear 1=Squared 2=Programmable 3=Linear with flux optim.
P2.8.3.3	Field weakening point	6,00	320,00	Hz	50,00		602	
P2.8.3.4	Voltage at field weakening point	10,00	200,00	%	100,00		603	$n\% \times U_{nmot}$
P2.8.3.5	U/f curve midpoint frequency	0,00	P2.8.3.3	Hz	50,00		604	
P2.8.3.6	U/f curve midpoint voltage	0,00	100,00	%	100,00		605	$n\% \times U_{nmot}$ Parameter max. value = P2.6.5
P2.8.3.7	Output voltage at zero frequency	0,00	40,00	%	0,00		606	$n\% \times U_{nmot}$

7.8.2.1 *PMSM Control settings*

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.8.4.1	Start Angle Identification mode	0	10		0		1691	0=Automatic 1=Forced 2=After Power Up 3=Disabled
P2.8.4.2	Start Angle Identification DC Current	0,0	150,0	%	0,0		1756	
P2.8.4.3	Polarity Pulse Current	-10,0	200,0	%	0,0		1566	
P2.8.4.4	Start Angle ID Time	0	32000	ms	0		1755	
P2.8.4.5	I/f Current	0,0	150,0	%	50,0		1693	
P2.8.4.6	I/f Control Limit	0,0	300,0	%	10,0		1790	
P2.8.4.7	Flux Current Kp	0	32000		5000		651	
P2.8.4.8	Flux Current Ti	0	1000		25		652	
P2.8.4.9	External Id Reference	-150,0	150,0	%	0,0		1730	
P2.8.4.10	Enable Rs Identification	0	1		1		654	0=No 1=Yes
P2.8.4.11	Lsd Voltage Drop	-32000	32000		0		1757	
P2.8.4.12	Lsq Voltage Drop	-32000	32000		0		1758	

7.8.2.2 *Stabilators*

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.8.5.1	Torque Stabilator Gain	0	1000		100		1412	
P2.8.5.2	Torque Stabilator Damping	0	1000		800		1413	With PMSM use 980
P2.8.5.3	Torque Stabilator Gain in FWP	0	1000		50		1414	

7.8.2.3 *Flying Start Tuning parameters*

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.8.6.1	Current Controller Kp	0,00	320,00	%	40,00		617	
P2.8.6.2	Modulation Limit	0	150	%	100		655	
P2.8.6.3	AC magnetization Current	0,0	150,0	%	70,0		1701	
P2.8.6.4	AC Scanning Time	0	32000	ms	900		1702	
P2.8.6.5	DC magnetization Current	0,0	150,0	%	100,0		1703	
P2.8.6.6	Flux Build Time	0	10000		300		1704	
P2.8.6.7	Flux Build Torque	0,0	300,0		10,0		1711	
P2.8.6.8	Magnetization Phases	0	20		10		1707	
P2.8.6.9	Flying Start Options	0	65535		0		1710	

7.8.3 *Identification parameters (Control keypad: Menu M2 → G2.6.6)*

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.8.7.1	Rs voltage drop	0	30000		Varies		662	Used for torque calculation in open loop
P2.8.7.2	Ir add zero point voltage	0	30000		Varies		664	
P2.8.7.3	Ir add generator scale	0	30000		Varies		665	
P2.8.7.4	Ir add motoring scale	0	30000		Varies		667	
P2.8.7.5	Iu Offset	-32000	32000		0		668	
P2.8.7.6	Iv Offset	-32000	32000		0		669	
P2.8.7.7	Iw Offset	-32000	32000		0		670	

Table 7-18. Identification parameters, G2.6.4

7.9 Speed Control

7.9.1 Speed Control Basic settings

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.9.1	Load drooping	0,00	100,00	%	0,00		620	
P2.9.2	Load Drooping Time	0	32000	ms	0		656	For dynamic changes
P2.9.3	Speed controller P gain (open loop)	0	32767		3000		637	
P2.9.4	Speed controller I gain (open loop)	0	32767		300		638	

Table 7-19. Speed control basic settings

7.10 Drive Control

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.10.1	Switching frequency	1,0	Varies	kHz	Varies		601	
P2.10.2	Modulator Type	0	3		0		1516	
P2.10.3	Control Options	0	65535		64		1084	
P2.10.4	Advanced Options 1	0	65535		0		1560	
P2.10.5	Advanced Options 2	0	65535		0		1561	
P2.10.6	Advanced Options 4	0	65535		0		1563	
P2.10.7	Advanced Options 5	0	65535		0		1564	
P2.10.8	Advanced Options 6	0	65535		0		1565	
P2.10.9	Restart Delay	0	65535	s	Varies		1424	
P2.10.10	Restart Delay Flying Start	0	60,000	s	Varies		672	Flying Start

Table 7-20. Drive control

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

7.11.1 Common settings

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.11.1.1	Input phase supervision	0	3		0		730	0=No response 1=Warning 2=Fault,stop acc. to 2.3.2 3=Fault,stop by coasting
P2.11.1.2	Response to undervoltage fault	0	1		0		727	0=Fault stored in history 1=Fault not stored
P2.11.1.3	Output phase supervision	0	3		2		702	See P2.12.1.1
P2.11.1.4	Response to slot fault	0	3		2		734	See P2.12.1.1
P2.11.1.5	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
P2.11.1.6	Earth fault protection	0	3		2		703	0=No response 1=Warning 2=Fault,stop acc. to 2.3.2 3=Fault,stop by coasting
P2.11.1.7	Fieldbus Communication response	0	3		2		733	0=No Action 1=Warning 2= Fault 3= Fault,stop by coasting
P2.11.1.8	Cooling Fault Response	1	2		2		762	0= No Action, Warning 1= Warning, Warning 2= Warning, Fault 3= No Action, Fault
P2.11.1.9	Safe Disable Mode	1	2		1		755	1= Warning, Warning 2= Warning, Fault

Table 7-21. Common settings

7.11.2 Temperature sensor protections

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.11.2.1	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
P2.11.2.2	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
P2.11.2.3	Board 1 warning limit	-30,0	200,0	C°	120,0		741	
P2.11.2.4	Board 1 fault limit	-30,0	200,0	C°	130,0		742	

Table 7-22. PT-100 protections

7.11.3 Stall Protection

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.11.3.1	Stall protection	0	3		0		709	0=No response 1=Warning 2=Fault, stop acc. to 2.3.2 3=Fault, stop by coasting
P2.11.3.2	Stall current	0,1	2 x I _H	A	I _H		710	
P2.11.3.3	Stall time limit	1,00	120,00	s	15,00		711	
P2.11.3.4	Stall frequency limit	1,0	P2.1.2	Hz	25,0		712	

Table 7-23. Stall protection

7.11.4 Motor thermal protections

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.11.4.1	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
P2.11.4.2	Motor ambient temperature factor	-100,0	100,0	%	0,0		705	
P2.11.4.3	Motor cooling factor at zero speed	0,0	150,0	%	40,0		706	
P2.11.4.4	Motor thermal time constant	1	200	min	45		707	
P2.11.4.5	Motor duty cycle	0	100	%	100		708	
P2.11.4.6	Response to thermistor fault	0	3		2		732	See P2.12.5.1

Table 7-24. Motor thermal protections

7.11.5 4 mA (Living Zero) monitoring

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.11.5.1	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
P2.11.5.2	4mA reference fault frequency	0,00	P2.1.2	Hz	0,00		728	

Table 7-25. Living zero monitoring

7.11.6 Underload protection

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.11.6.1	Underload protection	0	3		0		713	0=No response 1=Warning 2=Fault, stop acc. to 2.3.2 3=Fault, stop by coasting
P2.11.6.2	Field weakening area load	10,0	150,0	%	50,0		714	
P2.11.6.3	Zero frequency load	5,0	150,0	%	10,0		715	
P2.11.6.4	Underload protection time limit	2,00	600,00	s	20,00		716	

Table 7-26. Underload protection

7.11.7 Line Synch Protection functions

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.11.7.1	DC Low Response	0	2		1		1680	0=No response 1=Warning 2=Fault, stop by coasting
P2.11.7.2	DC Low Limit	333	1200	V	470		1681	
P2.11.7.3	Line Voltage low response	0	2		1		1685	0=No response 1=Warning 2=Fault, stop by coasting
P2.11.7.4	Line Voltage low limit	180	800	V	180		1686	
P2.11.7.5	Line Voltage Fault Delay	0,00	5,00	s	0,00		1691	
P2.11.7.6	DOL Conflict Fault Mode	0	2		0		1687	0=No response 1=Warning 2=Fault, stop by coasting
P2.11.7.7	DOL Conflict Fault Delay	0,00	5,00	s	0,50		1688	
P2.11.7.8	Vac < 90 % Response	1	2		1		1689	1=Warning 2=Fault, stop by coasting

Table 7-27. Common settings

7.12 Fieldbus parameters (Control Keypad: Menu M2 →G2.12)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.12.1	Fieldbus min scale	0,00	320,00	Hz	0,00		850	
P2.12.2	Fieldbus max scale	0,00	320,00	Hz	0,00		851	
P2.12.3	Fieldbus process data out 1 selection	0	10000		1		852	Choose monitoring data with parameter ID Def: Output Frequency
P2.12.4	Fieldbus process data out 2 selection	0	10000		2		853	Choose monitoring data with parameter ID Def: Motor Speed
P2.12.5	Fieldbus process data out 3 selection	0	10000		3		854	Choose monitoring data with parameter ID Def: Motor Current to FB
P2.12.6	Fieldbus process data out 4 selection	0	10000		4		855	Choose monitoring data with parameter ID Def: Motor Torque
P2.12.7	Fieldbus process data out 5 selection	0	10000		5		856	Choose monitoring data with parameter ID Def: Motor Power
P2.12.8	Fieldbus process data out 6 selection	0	10000		6		857	Choose monitoring data with parameter ID Def: Motor Voltage
P2.12.9	Fieldbus process data out 7 selection	0	10000		7		858	Choose monitoring data with parameter ID Def: DC-Link Voltage
P2.12.10	Fieldbus process data out 8 selection	0	10000		37		859	Choose monitoring data with parameter ID Def: Last Active Fault
P2.12.11	Fieldbus process data in 1 selection	0	10000		1140		876	Choose controlled data with parameter ID. Def: FB Torque Reference
P2.12.12	Fieldbus process data in 2 selection	0	10000		46		877	Choose controlled data with parameter ID. Def: FB Limit Scaling

P2.12.13	Fieldbus process data in 3 selection	0	10000		47		878	Choose controlled data with parameter ID. Def: FB Adjust Reference
P2.12.14	Fieldbus process data in 4 selection	0	10000		48		879	Choose controlled data with parameter ID. Def: FB Analogue Output.
P2.12.15	Fieldbus process data in 5 selection	0	10000		0		880	Choose controlled data with parameter ID
P2.12.16	Fieldbus process data in 6 selection	0	10000		0		881	Choose controlled data with parameter ID
P2.12.17	Fieldbus process data in 7 selection	0	10000		0		882	Choose controlled data with parameter ID
P2.12.18	Fieldbus process data in 8 selection	0	10000		0		883	Choose controlled data with parameter ID

Table 7-28. Fieldbus parameters

7.12.1 Value Control (Keypad: Menu M2 → G2.2.9)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.13.1.1	Control Input Signal ID	0	10000	ID	0		1580	
P2.13.1.2	Control Input Off Limit	-32000	32000		0		1581	
P2.13.1.3	Control Input On Limit	-32000	32000		0		1582	
P2.13.1.4	Control Output Off Value	-32000	32000		0		1583	
P2.13.1.5	Control Output On Value	-32000	32000		0		1584	
P2.13.1.6	Control Output Signal ID	0	10000	ID	0		1585	
P2.13.1.7	Control Mode	0	5		0		1586	0=SR ABS 1=Scale ABS 2=Scale INV ABS 3=SR 4=Scale 5=Scale INV

Table 7-29. Power reference input signal selection, G2.2.8

7.13 Auto reset parameters (Control keypad: Menu M2 → G2.8)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.14.1	Wait time	0,10	10,00	s	0,50		717	
P2.14.2	Trial time	0,00	60,00	s	0,10		718	
P2.14.3	Start function	0	2		2		719	0=Ramp 1=Flying start 2=According to Stop Function
P2.14.4	Number of tries after undervoltage trip	0	10		0		720	
P2.14.5	Number of tries after overvoltage trip	0	10		0		721	
P2.14.6	Number of tries after overcurrent trip	0	3		0		722	
P2.14.7	Number of tries after reference trip	0	10		0		723	
P2.14.8	Number of tries after motor temperature fault trip	0	10		0		726	
P2.14.9	Number of tries after external fault trip	0	10		0		725	
P2.14.10	Number of tries after underload fault trip	0	10		0		738	

Table 7-30. Autorestart parameters, G2.16

7.14 Line Synch parameters (Control keypad: Menu M2 → G2.12)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.15.1	Control Mode	0	0		0		1626	0=Single motor 1=Multi motor 2=In Sequence
P2.15.2	Controlled motor	0	7		0		1611	Controlled motor when using multi motor mode
P2.15.3	Delay to Coasting	0	30000	ms	0		1621	
P2.15.4	Delay to Open	0	30000	ms	0		1623	
P2.15.5	Delay to Close	0	30000	ms	0		1624	
P2.15.6	Number of motors	1	8	Pcs	1		1627	

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.15.7.1	Smooth / Speed ratio	0	10		0		1690	0=Smoothest . . . 10=Fastest
P2.15.7.2	Phase Hysteresis	0,0	180,0	Dec	3,0		1620	
P2.15.7.3	Phase offset to NET	-179,0	179,0	Dec	0		1608	
P2.15.7.4	Generator Side Operation	0	1		0		1538	0=Enabled 1=Disabled
P2.15.7.5	Synchronization options	0	65535		0		1700	
P2.15.7.6	Start Delay to FC	0	30000	ms	200		1628	
P2.15.7.7	LineSynch Frequency Reference Filter TC	0	100	ms	10		1900	
P2.15.7.8	Frequcnly Hysteresis for Synchronization	0,00	50,00	Hz	0,60		1613	
P2.15.7.9	Frequency Hysteresis for Change	0,00	50,00	Hz	0,10		1614	
2.15.7.10	Delay To Synch	0	32000	ms	0		1619	
2.15.7.11	Commissioning Test modes	0	4		0		1634	0=Line Synchronization 1=FC, DL Timing 2=FC On, DL Off 3=FC Off, DL On
2.15.7.12	Commissioning test activation	0.1	E.10		0.1		1635	

Table 7-31. Line Synch parameters, G2.12

7.15 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 Vacon NX User's Manual.

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P3.1	Control place	1	3		2		125	0=PC Control 1=I/O terminal 2=Keypad 3=Fieldbus
R3.2	Keypad reference	P2.1.1	P2.1.2	Hz	0,00			
P3.3	Direction (on keypad)	0	1		0		123	0=Forward 1=Reverse
P3.4	Stop button	0	1		1		114	0=Limited function of Stop button 1=Stop button always enabled
R3.5	Torque reference	0,0	100,0	%	0,0			

Table 7-32. Keypad control parameters, M3

7.16 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 Chapter 7.3.6 in the Vacon NX User's Manual.

7.17 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 Chapter 7.3.7 in the Vacon NX User's Manual.

8. DESCRIPTION OF PARAMETERS

8.1 Basic Parameters

P2.1.1 Minimum frequency *ID101 "Min 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.

P2.1.2 Maximum frequency *ID102 "Max Frequency"*

Defines maximum frequency limit both negative and positive directions. Direction dependent frequency limits can be given in "G: Limit Settings \ Frequency Handling". Maximum frequency internally is 0,75 Hz higher than set parameter.

Note: Do not change this parameter to lower value than current output frequency if changed during running. The change will be executed without ramp.

P2.1.3 Motor Nominal Voltage *ID110 "Motor Nom Voltg"*

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

P2.1.4 Motor Nominal Frequency *ID111 "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".

P2.1.5 Motor nominal speed *ID112 "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]PolePairNumber.

P2.1.6 Motor nominal current *ID113 "Motor Nom Currnt"*

Find this value I_n on the rating plate of the motor. If magnetization current is provided set also Magnetization current P2.1.9 before identification run.

P2.1.7 Motor cos phi *ID120 "Motor Cos Phi"*

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

P2.1.8 Identification ID631 "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.

NOTE: Set motor control mode to Frequency Control before identification!

NOTE: 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.

NOTE: During identification run torque and power limits should be above 100 %. Also current limit should be above motor nominal current.

NOTE: During identification run acceleration time should be below 20 second.

NOTE: If switching frequency is changed after identification it's recommended to do identification run again.

NOTE: Small motor with long motor cabled may require reduction of switching frequency if identification is not successful.

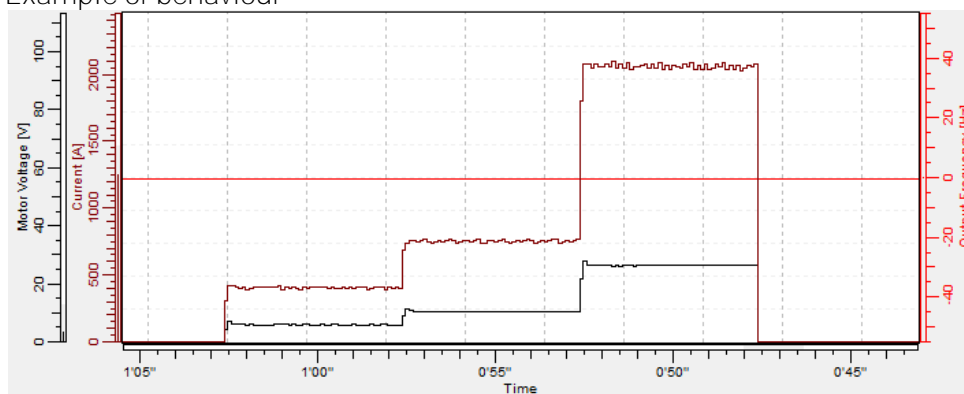
0 = "No Action" No action

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

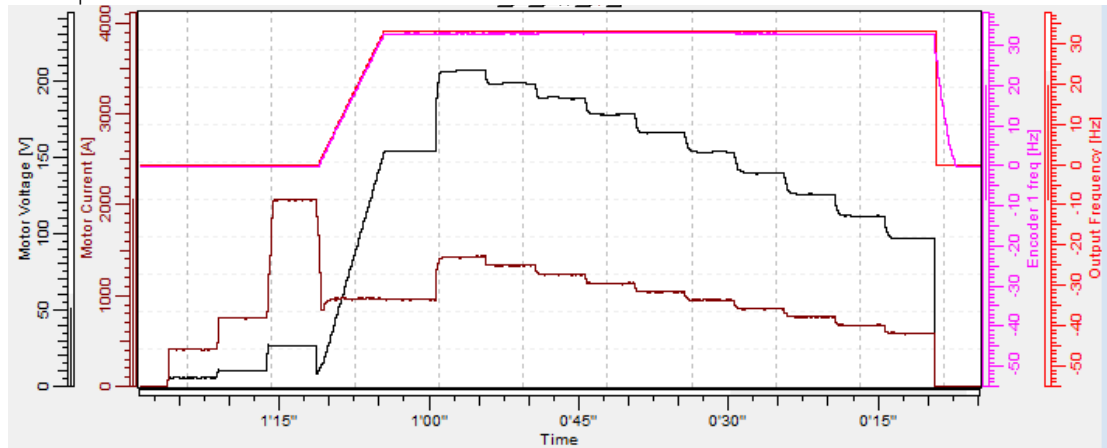


2 = "ID With Run" - Identification with motor rotating

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



The basic motor name plate data has to be set correctly before performing the identification run:

- P2.1.3 – P2.1.8. Motor basic data.
- P2.1.9 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.
- P2.1.11 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 default 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.

Note: After identification is made drive requires rising edge of start command.

Note: Marine application has all identified values stored to parameters, no need to redo identification if previous parameters are loaded back to the drive if e.g. control board is changed.

P2.1.9 *Motor Type* *ID650* **“Motor Type”**

Select used motor type with this parameter

- 0 **“Induction”** - Induction motor
 -Asynchronous motor
- 1 **“PMSM”** - Permanent magnet synchronous motor
 - Contact factory before using with externally magnetized motor.
- 2 **“Synch.Machin”** – Synchronous Motor
 - Separately excited motor.

8.2 Reference Handling – “Ref Handling”

8.2.1 Basic Parameters

P2.2.1 I/O frequency reference selection 1 ID117 “I/O Reference”

Defines which frequency reference source is used when control place is I/O terminal P3.1 Control Place

0=“AI1” - Analogue Input 1.

Signal scaling in “G2.4.2: Input Signals \ Analogue Input 1”

1=“AI2” - Analogue Input 2.

Signal scaling in “G2.4.3: Input Signals \ Analogue Input 2”

2=“AI1+AI2” - Analogue Input 1 + Analogue Input 2.

With alternative reference scaling in Analogue 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”

Analogue Input 1 - Analogue Input 2.

4=“AI2-AI1”

Analogue Input 2 - Analogue Input 1.

5=“AI1xAI2”

Analogue Input 1 x Analogue Input 2

6=“AI1 Joystick”

Analogue input 1, -10 Vdc... +10 Vdc

7=“AI2 Joystick”

Analogue 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 Poten.mete”.

11=“AI1, AI2 min”

The minimum of Analogue Input 1 and Analogue Input 2 is used as reference.

12=“AI1, AI2 max”

The maximum from Analogue Input 1 and Analogue Input 2 is used as reference.

13=“Max Freq” - Maximum Frequency

P2.1.2 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 Analogue Input 1 and Analogue Input 2 reference. “I/O Ref 1/2” is used to select between “I/O Reference” and “I/O Reference 2” if selection is different than 14 (this one).

P2.2.2 *Keypad frequency reference selection* **ID121** *"Keypad Ref Sel"*

Defines which frequency reference source is used when control place is keypad P3.1 Control Place

0="AI1" - Analogue Input 1.

Signal scaling in "G2.4.3: Input Signals \ Analogue Input 1"

1="AI2" - Analogue Input 2.

Signal scaling in "G2.4.4: Input Signals \ Analogue Input 2"

2="AI1+AI2" - Analogue Input 1 + Analogue Input 2.

With alternative reference scaling in Analogue Input group 100 % input values can be set to correspond 25 Hz. That is, when both are at 100 % final reference will be 50 Hz.

3="AI1-AI2"

Analogue Input 1 - Analogue Input 2.

4="AI2-AI1"

Analogue Input 2 - Analogue Input 1.

5="AI1xAI2"

Analogue Input 1 x Analogue Input 2

6="AI1 Joystick"

Analogue input 1, -10 Vdc... +10 Vdc

7="AI2 Joystick"

Analogue input 2, -10 Vdc... +10 Vdc

8="Keypad Ref"

Reference from keypad R3.2

9="Fieldbus"

Reference is taken from Fieldbus, alternative scaling can select in "G: Fieldbus"

P2.2.3 *Fieldbus frequency reference selection* **ID122** *"Fieldbus Ctr Ref"*

Defines which frequency reference source is selected when control place is Fieldbus P3.1. Control Place

0="AI1" - Analogue Input 1.

Signal scaling in "G2.4.3: Input Signals \ Analogue Input 1"

1="AI2" - Analogue Input 2.

Signal scaling in "G2.4.4: Input Signals \ Analogue Input 2"

2="AI1+AI2" - Analogue Input 1 + Analogue Input 2.

With alternative reference scaling in Analogue 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"

Analogue Input 1 - Analogue Input 2.

4="AI2-AI1"

Analogue Input 2 - Analogue Input 1.

5="AI1xAI2"

Analogue Input 1 x Analogue Input 2

6="AI1 Joystick"

Analogue input 1, -10 Vdc... +10 Vdc

7="AI2 Joystick"

Analogue input 2, -10 Vdc... +10 Vdc

8="Keypad Ref"

Reference from keypad R3.2

9="Fieldbus"

Reference is taken from Fieldbus, alternative scaling can select in "G: Fieldbus"

P2.2.4 Load Share ID1248 "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.

8.2.2 Constant Reference

P2.2.5.1 Jogging speed reference ID124 "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 P2.4.2.16 Jogging Speed

P2.2.5.2 Preset speed 1	ID105 "Preset Speed 1"
P2.2.5.3 Preset speed 2	ID106 "Preset Speed 2"
P2.2.5.4 Preset speed 3	ID126 "Preset Speed 3"
P2.2.5.5 Preset speed 4	ID127 "Preset Speed 4"
P2.2.5.6 Preset speed 5	ID128 "Preset Speed 5"
P2.2.5.7 Preset speed 6	ID129 "Preset Speed 6"
P2.2.5.8 Preset speed 7	ID130 "Preset Speed 7"

Parameter values define the Preset speeds references activated by digital inputs. These references will follow reverse command if given.

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

Table 8-1. Preset speeds 1 to 7

Related parameters

Digital inputs P2.4.2.5-7 Preset Speed 1-3

8.2.2.1 *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.

P2.2.5.9	<i>Inching reference 1</i>	ID1239	"Inching Ref 1"
P2.2.5.10	<i>Inching reference 2</i>	ID1240	"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
-

8.2.3 *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 P2.2.9.6 TorqSpeedLimit parameter.

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

P2.2.6.1	<i>Torque reference selection</i>	ID641	"Torq Ref Select"
-----------------	--	--------------	--------------------------

0="Not Used"

1="AI1" - Analogue Input 1.

Signal scaling in "G: Input Signals \ Analogue Input 1"

2="AI2" - Analogue Input 2.

Signal scaling in "G: Input Signals \ Analogue Input 2"

3="AI3"

4="AI4"

5="AI1 Joystick"

Analogue input 1, -10 Vdc... +10 Vdc. For joystick inputs the maximum negative reference is negated "Torq Ref Max".

6="AI2 Joystick"

Analogue 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"

P2.2.6.2 Torque reference scaling, maximum value ID641 "Torq Ref Max"

Maximum allowed torque reference for positive and negative values. This is also used for joystick input for negative maximum limit.

P2.2.6.3 Torque reference scaling, minimum value ID642 "Torq Ref Min"

Minimum torque reference for analogue input reference selections 1-4.

P2.2.6.4 Torque reference filtering time ID1244 "TorqRefFilterTC"

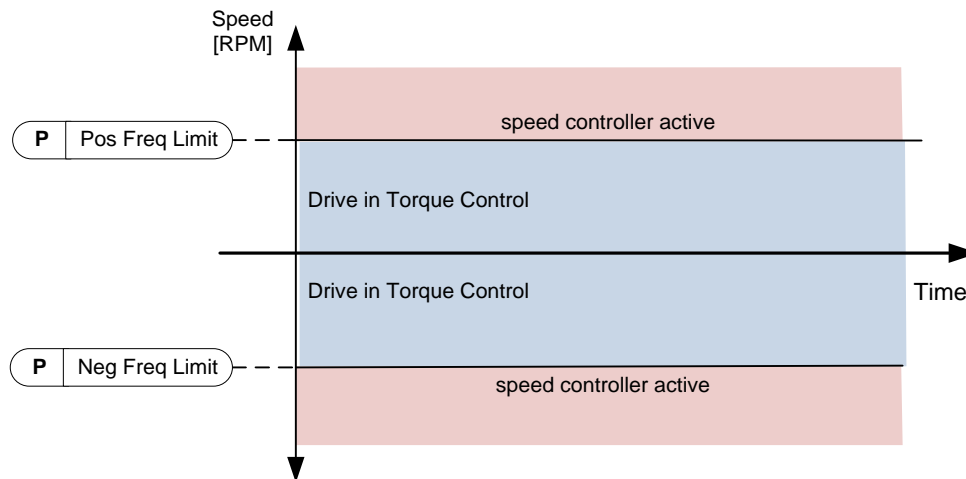
Defines the filtering time for torque reference. Filtering is after load share function and before torque step function.

P2.2.6.6 Torque Select ID1278 "Torque Select"

This parameter defines the speed limiting mode in torque control mode.

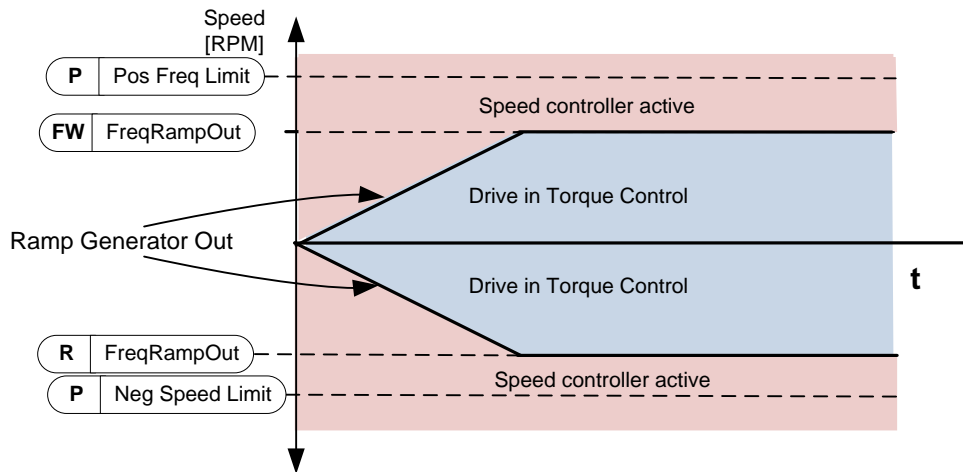
1="MaxFreqLimit" - Positive and negative frequency limits

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



2="Freq Ref" – 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.



3="Preset Sp 7" – Preset Speed 7 is limiting torque control speed.

P2.2.6.6 Open loop torque control minimum frequency ID636 "OL TC Min Freq"

Defines the frequency limit below which the frequency converter operates in *frequency control mode*.

P2.2.6.7 Open loop torque controller P gain ID639 "OL TorqCtrl P"

Defines the gain for open loop torque control.

P2.2.6.8 Open loop torque controller I gain ID640 "OL TorqCtrl I"

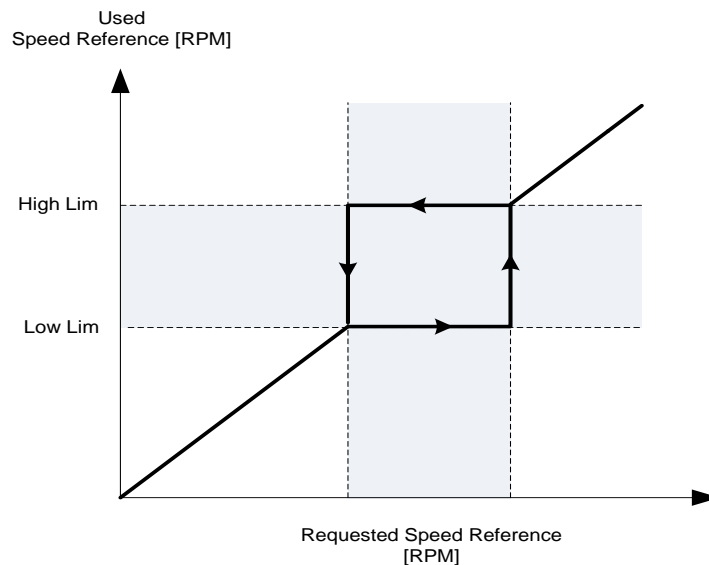
Defines the integration gain for open loop torque control.

8.2.4 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.

P2.2.7.1	Prohibit frequency area 1; Low limit	ID509 "Range 1 Low Lim"
P2.2.7.2	Prohibit frequency area 1; High limit	ID510 "Range 1 High Lim"
P2.2.7.3	Prohibit frequency area 1; Low limit	ID509 "Range 1 Low Lim"
P2.2.7.4	Prohibit frequency area 1; High limit	ID510 "Range 1 High Lim"
P2.2.7.5	Prohibit frequency area 1; Low limit	ID509 "Range 1 Low Lim"
P2.2.7.6	Prohibit frequency area 1; High limit	ID510 "Range 1 High Lim"

Range definition where a different ramp time defined by "RampTimeFactor" is used.



P2.2.10.3 Ramp time factor for prohibited range ID518 "RampTimeFactor"

Multiplier of the currently selected ramp time between prohibit frequency limits.

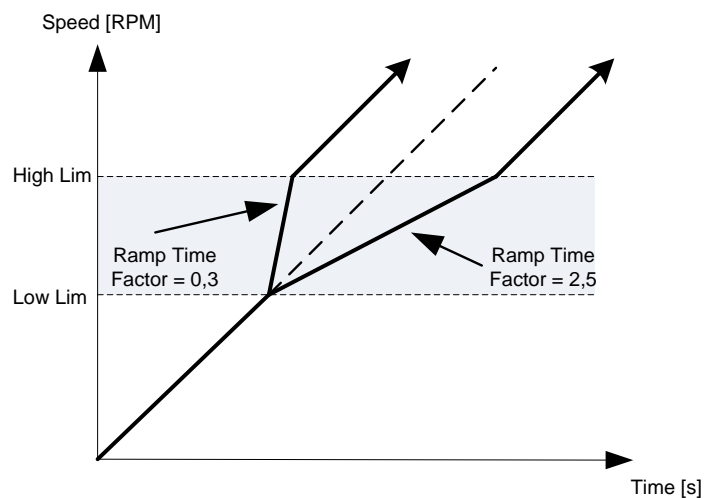
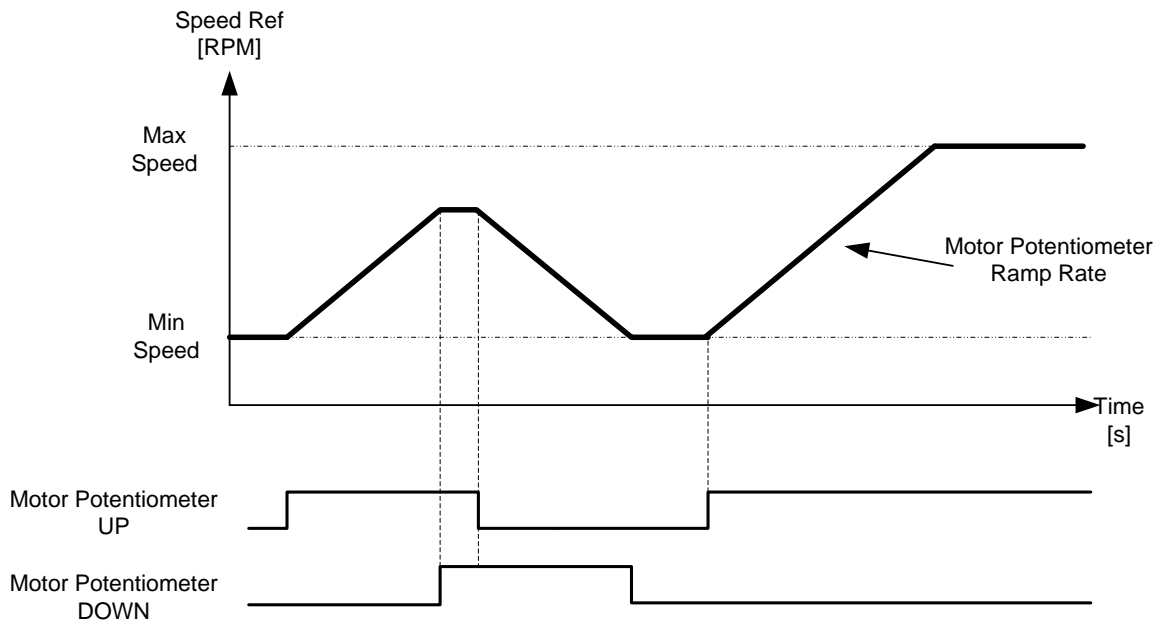


Figure 8-1. Ramp rate scaling between prohibit frequencies

8.2.5 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.



P2.2.11.1 Motor potentiometer ramp rate ID331 "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.

P2.2.11.2 Motor potentiometer reference reset ID367 "MotPotRef Reset"

0 "No reset"

Reference is kept past the stop state and stored to memory in case of a powerdown.

1 "Stop State"

Reference is set to zero when the drive is in stop state. This selection includes powerdown situations.

2 "Power Down"

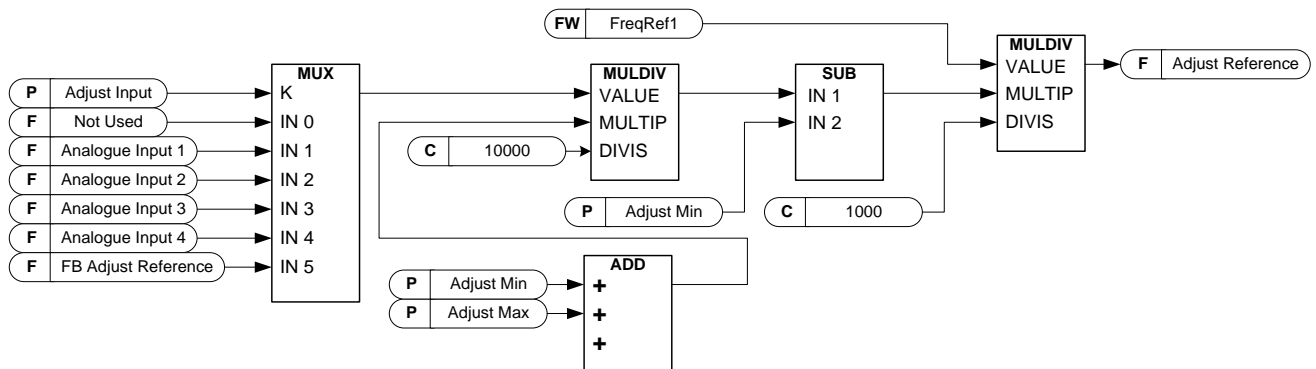
Reference is reset only in a powerdown situation.

Other parameters related to function

- P2.4.2.8 Motor potentiometer DOWN ID417 "Mot Pot Ref Down"
- P2.4.2.9 Motor potentiometer UP ID418 "Mot Pot Ref Up"

8.2.6 Adjust Reference

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



P2.2.12.1 Adjust input ID493 "Adjust Input"

With this parameter you can select the signal according to which the frequency reference to the motor is fine adjusted.

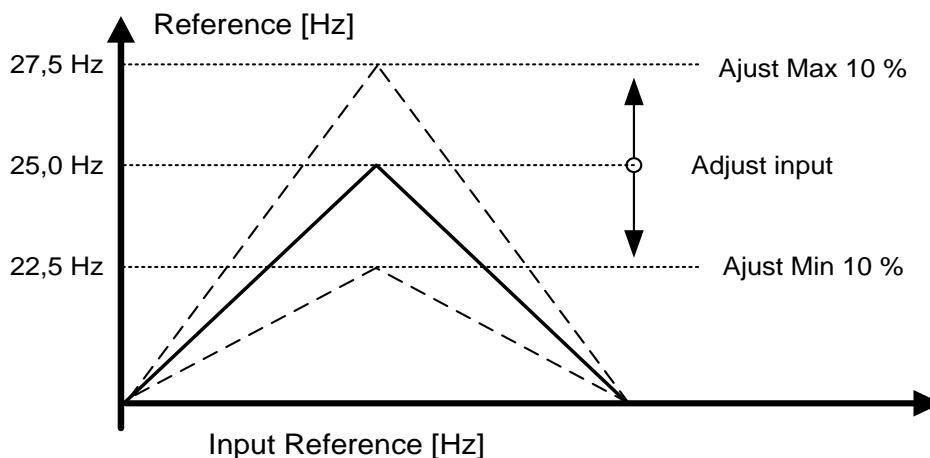
- 0 Not used
- 1 Analogue input 1
- 2 Analogue input 2
- 3 Analogue input 3
- 4 Analogue input 4
- 5 FB Adjust Reference ID47 Monitoring Signal

P2.2.12.2 Adjust minimum ID494 "Adjust minimum"

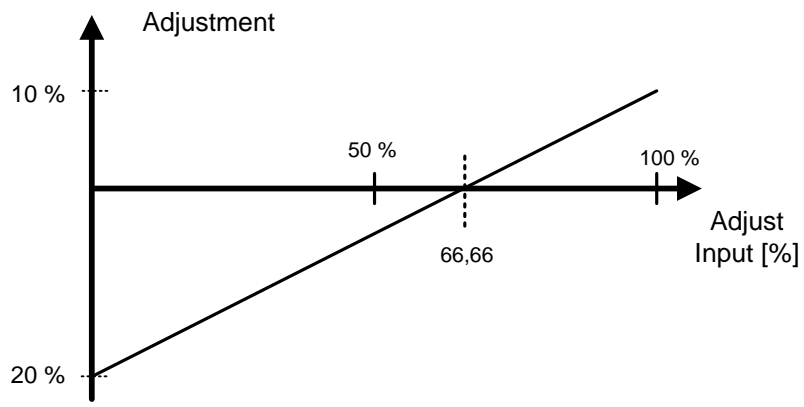
Percentage that is subtracted from the main reference when adjust input is at minimum.

P2.2.12.3 Adjust maximum ID495 "Adjust Maximum"

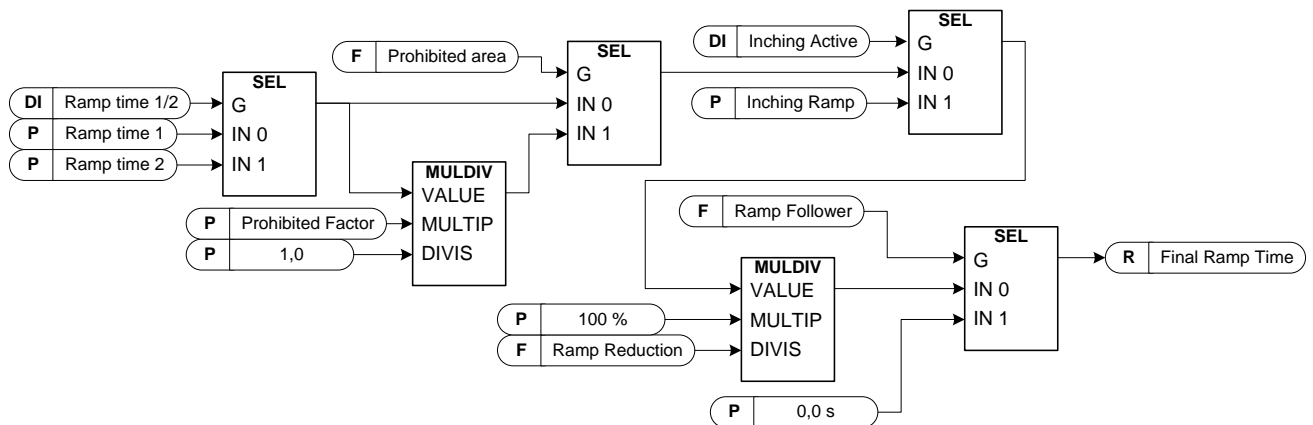
These parameters define the minimum and maximum of adjusted signals.



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



8.3 Ramp control

**P2.3.1 Start function ID505 "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 from 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.

P2.3.2 Stop function ID506 "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.

P2.3.3 Acceleration time 1 ID103 "Accel Time 1"

This parameter defines the time required for the output frequency to increase from the zero frequency to maximum frequency.

P2.3.4 Deceleration time 1 ID104 "Decel Time 1"

This parameter defines the time required for the output frequency to decrease from the maximum frequency to zero frequency.

P2.3.5 Acceleration/Deceleration ramp 1 shape ID500 "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.

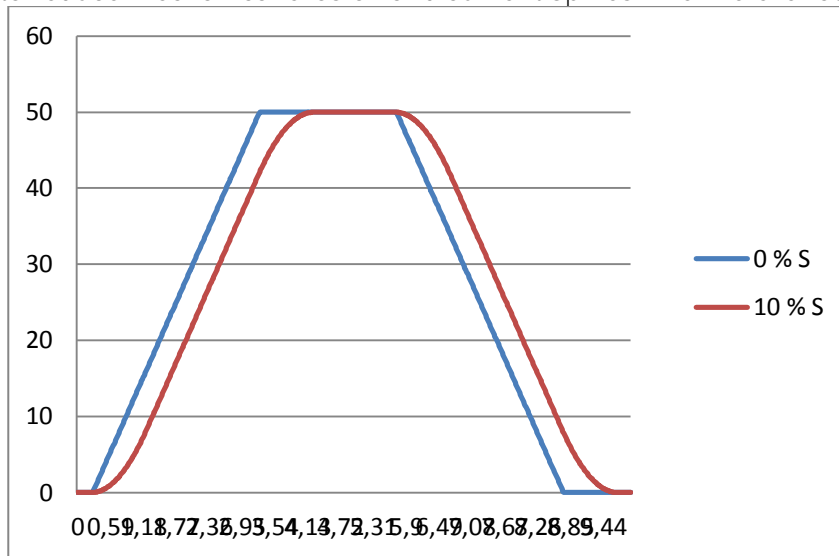


Figure 8-2. 10 % S ramp with 3 s ramp time compared to without S ramp

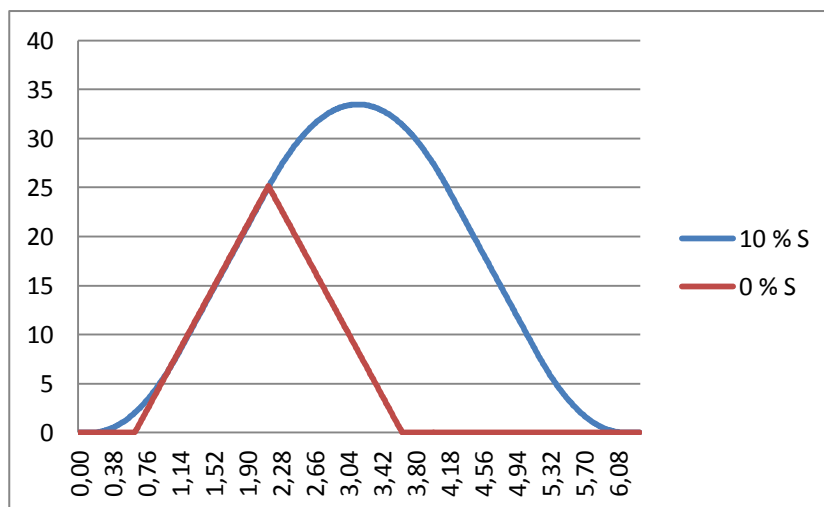


Figure 8-3. 10 % S ramp with 3 s ramp time when reference set to zero at 25 Hz

<i>P2.3.6</i>	<i>Acceleration time 2</i>	<i>ID502</i>	<i>“Accel Time 2”</i>
<i>P2.3.7</i>	<i>Deceleration time 2</i>	<i>ID503</i>	<i>“Decel Time 2”</i>
<i>P2.3.8</i>	<i>Acceleration/Deceleration ramp 2 shape</i>	<i>ID501</i>	<i>“Ramp 2 Shape”</i>

These ramp times and ramp shapes are used when the second ramp time is activated by digital input “Acc/Dec Time Sel”

P2.3.9 *Inching ramp* *ID1257* *“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: Enable Inching
- Digital input selection: Inching 1
- Digital input selection: Inching 2

P2.3.10 *Reduction of acceleration and deceleration times* *ID401*

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.

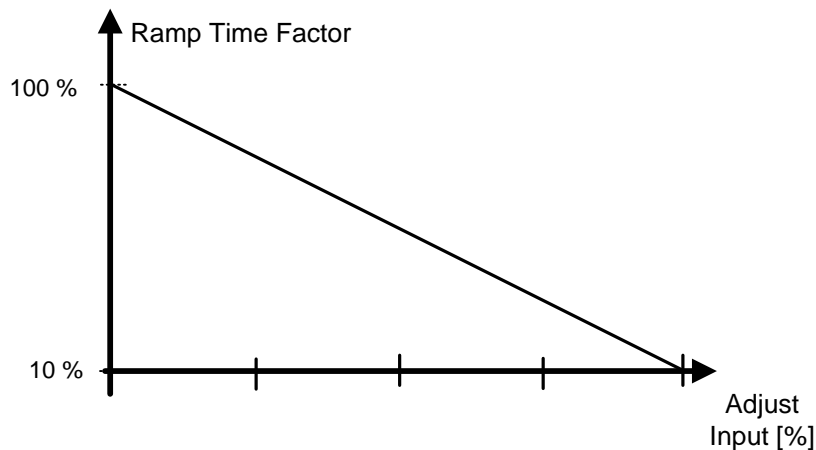


Figure 8-4. Reducing acceleration and deceleration times

P2.3.11 Quick stop mode ID1276 "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.

P2.3.12 FC Breaker Delay D1712 "FCBreakerDelay"

In some cases when motor is needed to stop before starting to follow reference. In these cases DC Brake is used. When DC Brake is used this time needs to be set longer than is FC contactor closing delay. DC Brake operates in current reference mode; if current is not reached output voltage will increase. If voltage reached e.g. motor nominal voltage while FC breaker is open drive will trip to over current when breaker closes.

NOTE: Can be used only when coasting stop of motor is allowed.

8.4 Input signals

8.4.1 Basic Settings

P2.4.1.1 Start/Stop logic selection ID300 "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"

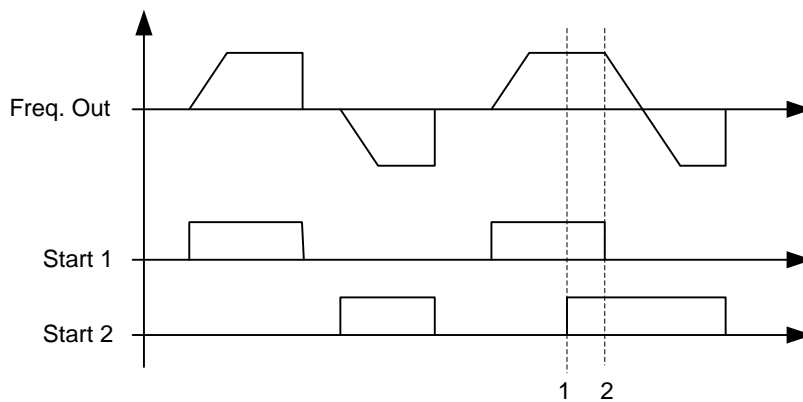


Figure 8-5. Start forward/Start reverse

- 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

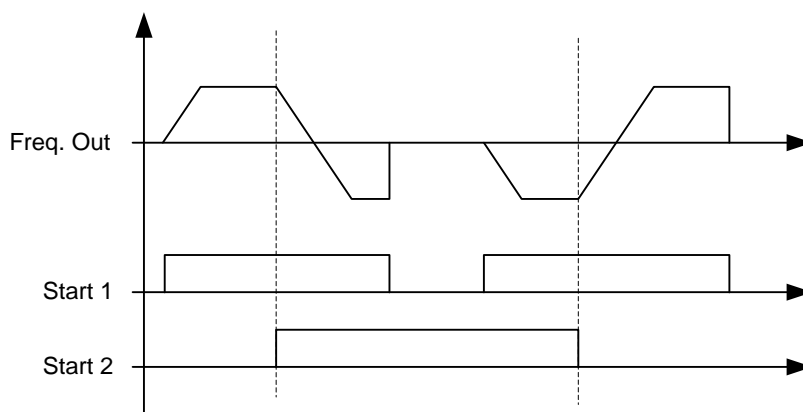


Figure 8-6. Start, Stop, Reverse

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.

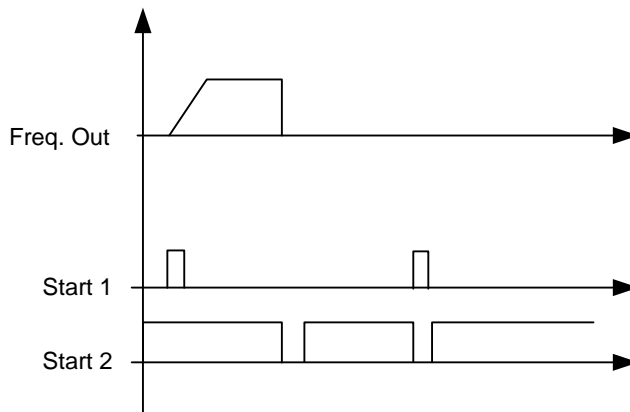


Figure 8-7. Start pulse/ Stop pulse.

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

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

8.4.2 Digital inputs

P2.4.2.1 Start signal 1 ID403 "Start Signal 1"

Signal selection 1 for the start/stop logic.
This is for Start Place A, selected with P2.4.2.39
Default programming A.1. Default Forward start.

P2.4.2.2 Start signal 2 ID404 "Start Signal 2"

Signal selection 2 for the start/stop logic.
This is for Start Place A, selected with P2.4.2.39
Default programming A.2. Default Reverse start.

P2.4.2.3 Run enable ID407 "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

P2.4.2.4 Reverse ID412 "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

P2.4.2.5 Preset speed 1 ID419 "Preset Speed 1"

P2.4.2.6 Preset speed 2 ID419 "Preset Speed 2"

P2.4.2.7 Preset speed 3 ID419 "Preset Speed 3"

Digital input selections for activating preset speeds.
References are set in the "Constant Reference" parameter group.

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
- G2.2.7 Constant Ref

P2.4.2.8 Motor potentiometer DOWN ID417 "Mot Pot Ref Down"

Contact closed: Motor potentiometer reference DECREASES until the contact is opened. See details in G2.2.11 Motor Pot.

P2.4.2.9 Motor potentiometer UP ID418 "Mot Pot Ref Up"

Contact closed: Motor potentiometer reference DECREASES until the contact is opened. See details in G2.2.11 Motor Pot.

P2.4.2.10 Fault reset ID414 "Fault Reset"

Rising edge required to reset fault.

P2.4.2.11 External fault closing contactor ID405 "Ext Fault Close"

External fault input closing contactor, response selected in protection parameter group G2.11.1 Protections / General. Gives fault "51 Ext Fault"

P2.4.2.12 External fault opening contactor ID406 "Ext Fault Open"

External fault input opening contactor, response selected in protection parameter group. Gives fault "51 Ext Fault"

P2.4.2.13 Acceleration/Deceleration time selection ID408 "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

P2.4.2.14 Acceleration/Deceleration prohibited ID415 "Acc/Dec Prohibit"

Contact closed: No acceleration or deceleration possible until the contact is opened.

With P2.9.3 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.

P2.4.2.15 DC-braking command ID416 "DC Brake Command"

Contact closed: In STOP mode, the DC braking operates until the contact is opened. Current level is set with P2.7.1.16 DCBrakeCurInStop parameter.

P2.4.2.16 Jogging speed ID413 "Jogging Speed"

Contact closed: Jogging speed selected for frequency reference
Reference for jogging speed is set in G2.2.7 Constant Reference group.

P2.4.2.16 I/O Reference 1/2 selection ID422 "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 P2.2.1 I/O Reference is other than "14 / AI1/AI2 Sel" this digital input will change reference between P2.2.1 I/O Reference and P2.2.4 I/O Reference 2.

8.4.2.1 Forced control place

Digital inputs can be used to bypass parameter P3.1 Control Place, for example, in an emergency situation when PLC is not able to send command to the drive.

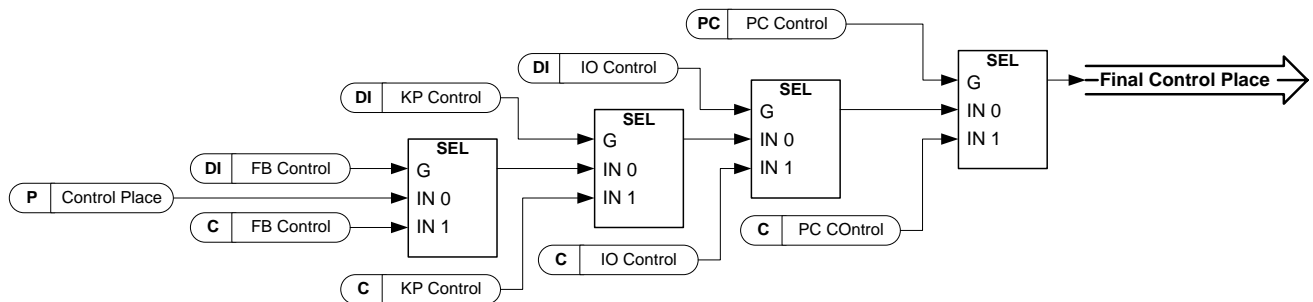


Figure 8-8. Control place selection priority order

P2.4.2.18 Control from I/O terminal ID409 "I/O Term Control"

Contact closed: Force control place to I/O terminal

P2.4.2.19 Control from keypad ID410 "Keypad Control"

Contact closed: Force control place to keypad

P2.4.2.20 Control from Fieldbus ID411 "Keypad Control"

Contact closed: Force control place to fieldbus

NOTE: 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 according to keypad control parameter P3.1 Control Place

P2.4.2.21 Parameter Set 1/Set 2 selection ID496 "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"

Note: The parameter values are stored only when selecting parameter P6.3.1 Parameter sets Store Set 1 or Store Set 2 or from NCDrive: Drive > Parameter Sets.

P2.4.2.22 Motor control mode 1/2 ID164 "Mot Ctrl Mode1/2"

This digital input is used to change between to motor control mode selection parameters:

- P2.8.1 Motor Ctrl Mode ID600
- P2.8.2 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.

P2.4.2.23 Cooling monitor ID750 "Cooling Monitor"

When using a liquid-cooled drive, connect this input to the *Cooling OK* signal from Vacon flow control application or any input that shows state of used cooling unit. See details of operation from G2.11.9 cooling parameters group.

8.4.2.2 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.

P2.4.2.24 Enable Inching ID532 "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.

P2.4.2.25 Inching reference 1 ID530 "Inching 1"**P2.4.2.26 Inching reference 2 ID531 "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

- | | | | | |
|---|-----------|---------------------|--------|-----------------|
| - | P2.3.9 | Inching Ramp | ID1257 | "Inching Ramp" |
| - | P2.2.7.9 | Inching reference 1 | ID1239 | "Inching Ref 1" |
| - | P2.2.7.10 | Inching reference 2 | ID1240 | "Inching Ref 2" |

P2.4.2.27 Quick Stop ID1213 "Quick Stop"

Digital input for Quick Stop function

P2.4.2.28 Input switch acknowledgement ID1209

Select the digital input to acknowledge the status of the input switch. The input switch is normally a switch fuse unit or main contactor with which the power is fed to the drive. If the input switch acknowledgement is missing, drive trips at *Input switch open* fault (F64).

P2.4.2.29 Active synchronization ID1600

This parameter defines what input is used to activate synchronization. When input is activated drive uses line frequency as frequency reference and will adjust voltage angle to correspond line voltage angle with given hysteresis.

P2.4.2.30 Active direct ID1601

This parameter defines what input is used to activate change to direct in line contactor. When synchronization is ready and active direct input is active drive will make change to net. See operation details from chapter 2. When using single motor control mode this input low signal will open the net contactor. For multi-motor control see [ID1612](#).

P2.4.2.31 Reset Direct ID1612

This parameter resets the NET contactor control signal when using multi-motor control mode. In single motor control Active Direct low command will be Reset Direct command

P2.4.2.32 FC Contactor acknowledgment ID1630

With this parameter select where connected feedback from the FC contactor is.

P2.4.2.33 NET Contactor acknowledgment ID1631

With this parameter select where connected feedback from the NET contactor is.

P2.4.2.34 Motor selection B0 ID1670**P2.4.2.35 Motor selection B1 ID1671****P2.4.2.36 Motor selection B2 ID1672**

These digital inputs are used to select the controlled motor. In none of these inputs are equal or higher than DigIN: A.1 parameter ID1608 is used for motor selection.

	4	2	1
	B2	B1	B0
Motor 1	0	0	0
Motor 2	0	0	1
Motor 3	0	1	0
Motor 4	0	1	1
Motor 5	1	0	0
Motor 6	1	0	1
Motor 7	1	1	0
Motor 8	1	1	1

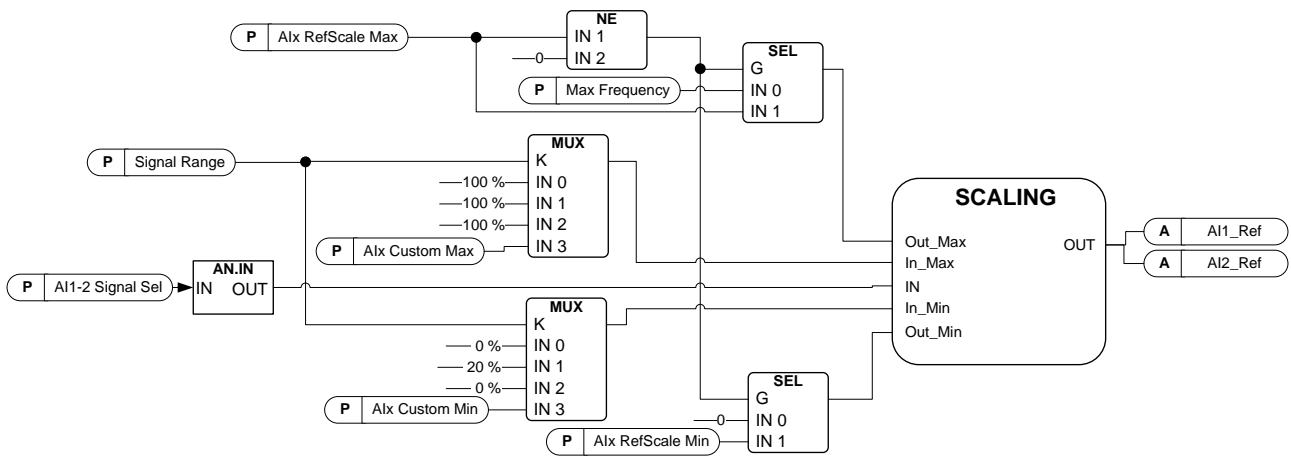
P2.4.2.37 ByPass Inter Lock Falling Edge ID1636

Input from external monitoring device. HIGH will mean that motor DOL input is OK. This input will generate fault 87. Used e.g. when motor DOL overload protection is opening motor contactor.

P2.4.2.38 ByPass Inter Lock Rising Edge ID1637

Input from external net monitoring device. LOW will mean that Net is OK. This input will generate fault 87. Used e.g. when motor DOL overload protection is opening motor contactor.

8.4.3 Analogue Input 1 & 2



P2.4.3.1 AI1 signal selection ID377 "AI1 Signal Sel"

P2.4.4.1 AI2 signal selection ID388 "AI2 Signal Sel"

Connect the AI1/AI2 signal to the analogue input of your choice with this parameter. For more information about the TTF programming method, see chapter 5.

P2.4.3.2 Analogue input 1 signal filter time ID324 "AI1 Filter Time"

P2.4.4.2 Analogue input 2 signal filter time ID329 "AI2 Filter Time"

First order filtering is used for analogue signals that are used to control e.g. the power limit. Second order filtering is used for frequency reference filtering.

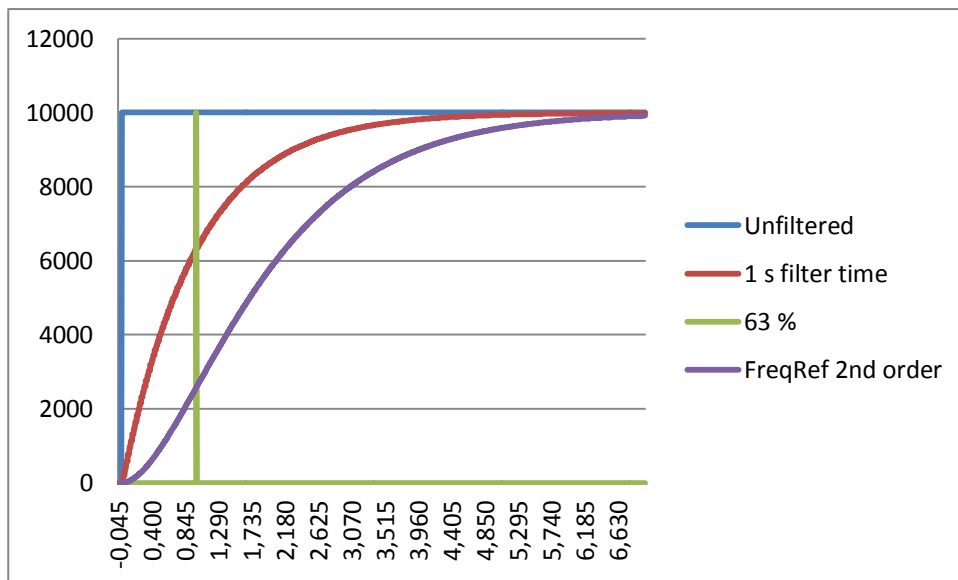
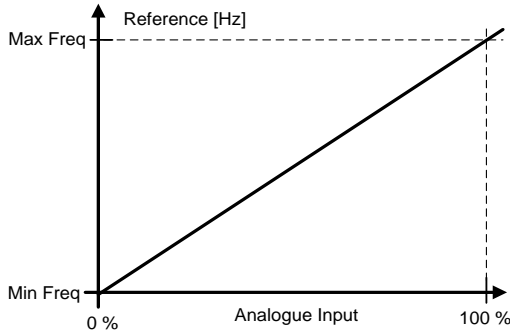


Figure 8-9. AI1 signal filtering

- P2.4.3.3 Analogue input signal 1 signal range ID320 "AI1 Signal Range"
- P2.4.4.3 Analogue input signal 2 signal range ID325 "AI2 Signal Range"

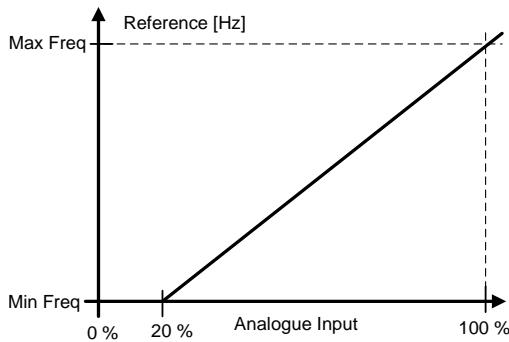
0 "0-20mA/10V"

Signal input ranges: 0...10 V and 0...20 mA.
Input signal is used from 0% to 100%.



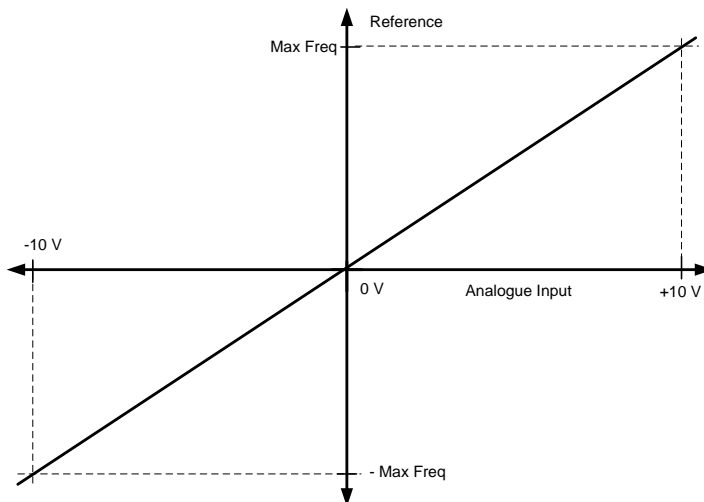
1 "4-20 mA"

Signal input ranges: 4 – 20 mA and 2 – 10 V
Input signal is used from 20 % to 100 %



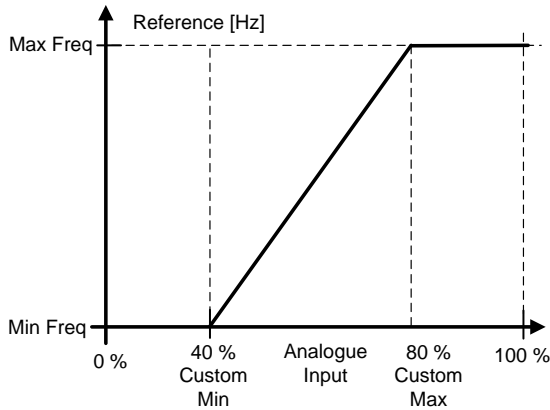
2 "-10 - + 10 V"

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.



P2.4.3.4 AI1 custom minimum setting ID321 “AI1 Custom Min”

P2.4.3.5 AI1 custom maximum setting ID322 “AI1 Custom Max”

P2.4.4.4 AI2 custom minimum setting ID326 “AI2 Custom Min”

P2.4.4.5 AI2 custom maximum setting ID327 “AI2 Custom Max”

These parameters set the analogue 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).

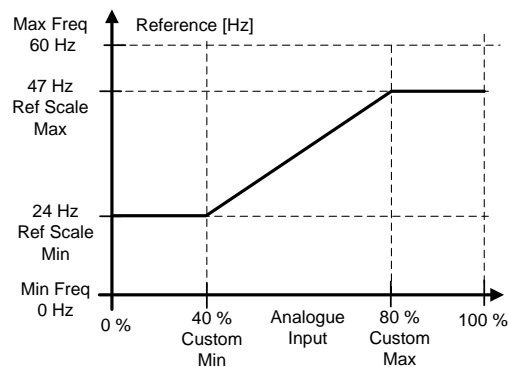
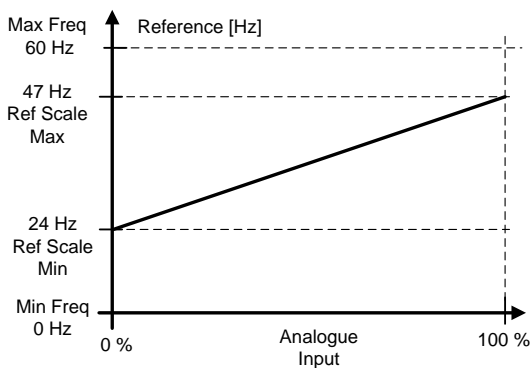
P2.4.3.6 AI1 Reference scaling, minimum value ID303 “AI1 RefScale Min”

P2.4.3.7 AI1 Reference scaling, maximum value ID304 “AI1 RefScale Max”

P2.4.4.6 AI2 reference scaling, minimum value ID393 “AI2 RefScale Min”

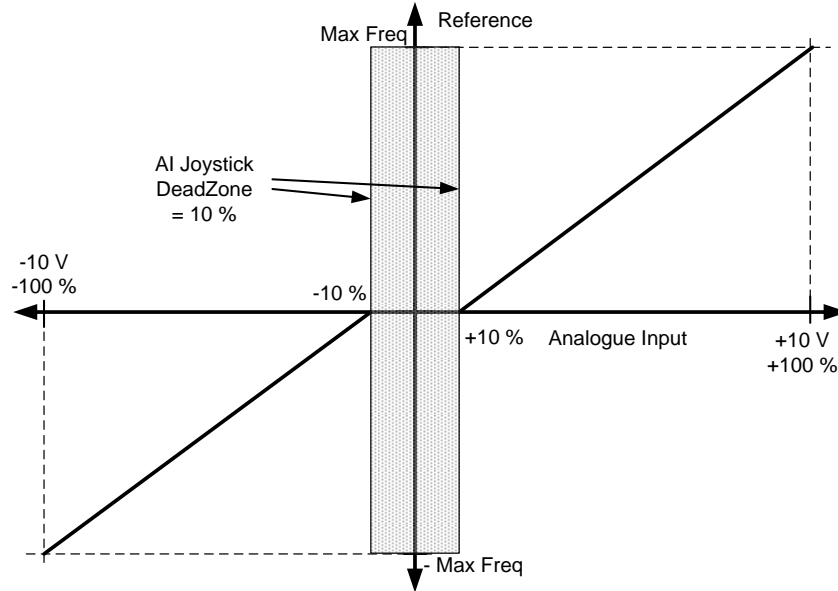
P2.4.4.7 AI2 reference scaling, maximum value ID394 “AI2 RefScale Max”

Additional reference scaling. Analogue input reference scaling can be set to a different value than the minimum and maximum frequency.



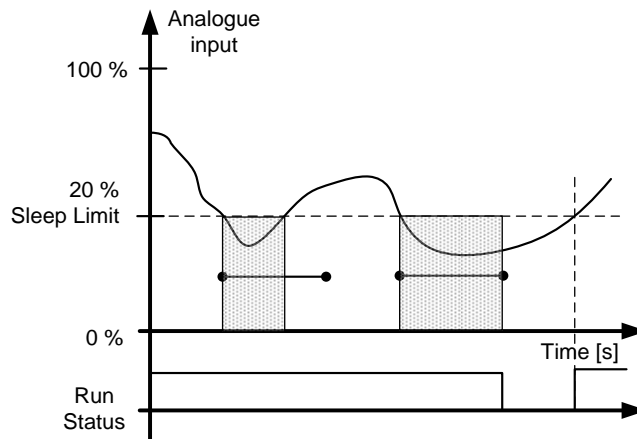
- P2.4.3.8 *Analogue Input 1 joystick input dead zone* ID382 "AI1 JoysDeadZone"
- P2.4.4.8 *Analogue Input 2 joystick input dead zone* ID395 "AI2 JoysDeadZone"

The small values of the reference around zero can be ignored by setting this value greater than zero. When the reference lies between zero and ± this parameter, it is forced to zero.



8.4.3.1 *Sleep function*

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



- P2.4.3.9 *AI1 sleep limit* ID385 "AI1 Sleep Limit"
- P2.4.4.9 *AI2 sleep limit* ID396 "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.

P2.4.3.10 AI1 sleep delay ID386 "AI1 Sleep Delay"**P2.4.4.10 AI2 sleep delay ID397 "AI2 Sleep Delay"**

This parameter defines the time the analogue input signal has to stay under the sleep limit in order to stop the drive.

P2.4.3.11 AI1 joystick offset ID165 "AI1 Joyst. Offset"**P2.4.4.11 AI2 joystick offset ID166 "AI2 Joyst. Offset"**

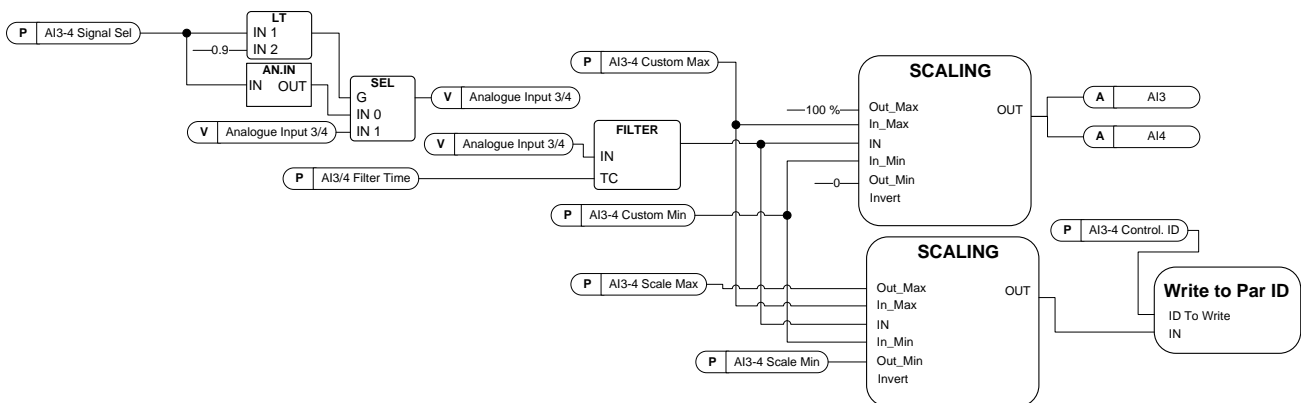
Defines the frequency zero point as follows:

With this parameter on display, place the potentiometer in the assumed zero point and press *Enter* on keypad.

Note: This will not, however, change the reference scaling.
Press *Reset* button to change the parameter value back to 0,00%.

8.4.4 Analogue input 3 & 4

Analogue 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.

**P2.4.5.1 AI3 signal selection ID141 "AI3 Signal Sel"****P2.4.6.1 AI4 signal selection ID152 "AI4 Signal Sel"**

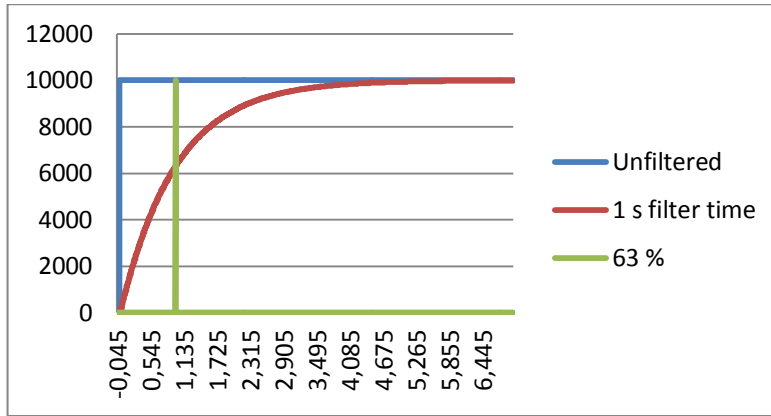
Connect the AI3/AI4 signal to the analogue input of your choice with this parameter. For more information, see Chapter 5 "Terminal To Function" (TTF) programming principle.

When the parameter for Analogue input signal selection is set to 0.1 you can control the analogue input monitoring variable from Fieldbus by assigning the Process Data Input ID number to the analogue input monitoring signal thus allowing the PLC input signals to be scaled with analogue input scaling functions.

P2.4.5.2 Analogue input 3 signal filtering time ID142 "AI3 Filter Time"

P2.4.6.2 Analogue input 4 signal filtering time ID153 "AI3 Filter Time"

First order filtering is used for analogue inputs signals 3 and 4.

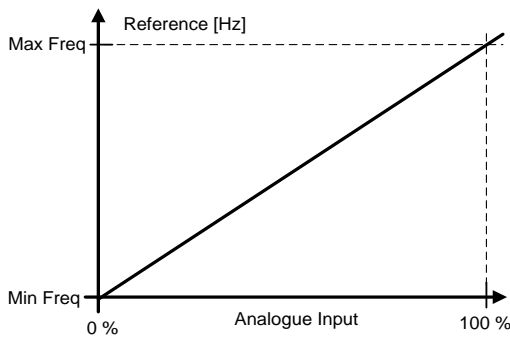


P2.4.3.3 Analogue input signal 3 signal range ID143 "AI3 Signal Range"

P2.4.4.3 Analogue input signal 4 signal range ID154 "AI4 Signal Range"

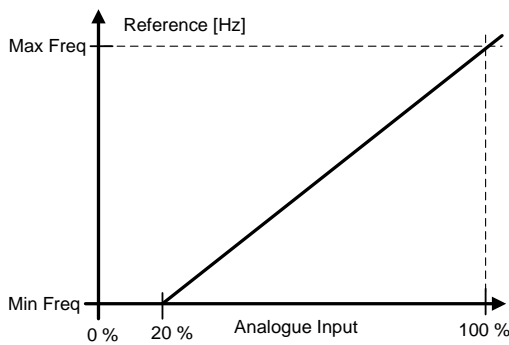
0 "0-20mA/10V"

Signal input ranges: 0...10 V and 0...20 mA.
Input signal is used from 0% to 100%.



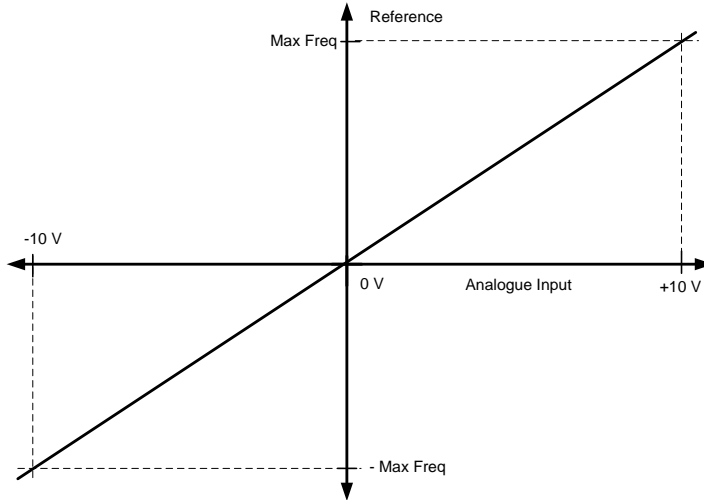
1 "4-20 mA"

Signal input ranges: 4 – 20 mA and 2 – 10 V
Input signal is used from 20 % to 100 %



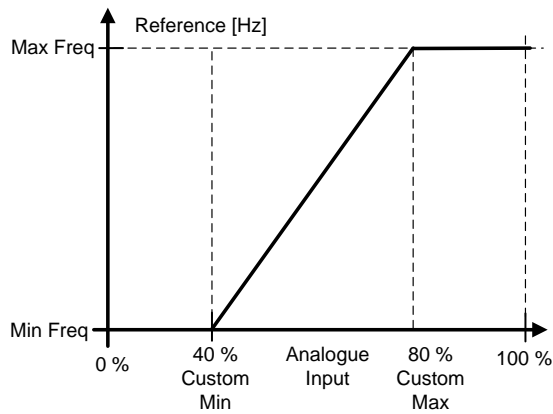
2 “-10 - + 10 V

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



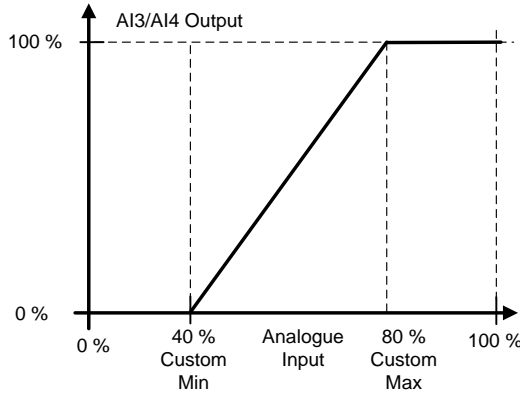
3 “Custom Range”

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



- P2.4.5.4 AI3 custom setting minimum ID144 "AI3 Custom Min"
- P2.4.5.5 AI3 custom setting maximum ID145 "AI3 Custom Max"
- P2.4.6.4 AI4 custom setting minimum ID155 "AI4 Custom Min"
- P2.4.6.5 AI4 custom setting maximum ID156 "AI4 Custom Max"

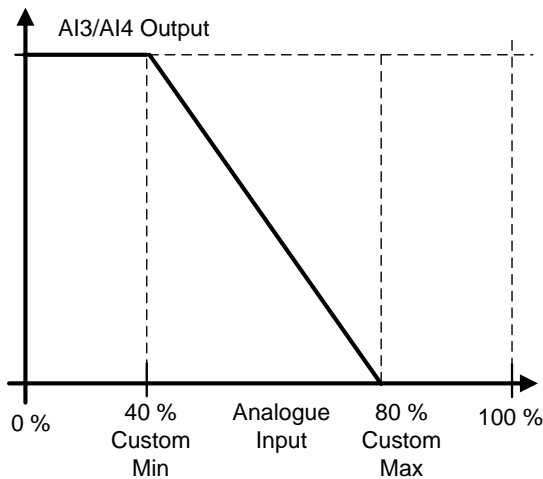
Set the custom minimum and maximum input levels for the AI3 signal within -160...160%.



- P2.4.5.6 AI3 signal inversion ID151 "AI3 Signal Inv"
- P2.4.6.6 AI4 signal inversion ID162 "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 an 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 Analogue input monitoring signals. See parameter P2.4.5.1 AI3 Signal selection for details.

- 0 = No inversion
- 1 = Signal inverted



8.5 Output signals

8.5.1 Digital output signals

In the Marine application, all output signals are not used by default.

P2.5.1.1 Ready ID432 "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

P2.5.1.2 Run ID433 "Run"

The frequency converter is modulating.

P2.5.1.3 Fault ID434 "Fault"

A fault trip has occurred.

P2.5.1.4 Inverted fault ID435 "Fault, Inverted"

No active faults in the drive.

P2.5.1.5 Warning ID436 "Warning"

General warning signal.

P2.5.1.6 External fault or warning ID437 "Ext. Fault/Warn."

Fault or warning depending on parameter Response to external fault. P2.4.2.11 Ext Fault Close and P2.4.2.12 Ext Fault Open are used to trigger a fault. P2.12.1 External fault is used to select response.

P2.5.1.7 Reference fault or warning (4mA) ID438 "AI Ref Faul/Warn"

Fault or warning depending on parameter Response to the 4mA reference fault. Response is selected in G2.11.6.

P2.5.1.8 Drive overtemperature warning ID439 "OverTemp Warn"

Drive temperature has exceeded normal operation conditions. Temperature limit may vary depending on drive type on size.

P2.5.1.9 Reverse ID440 "Reverse"

Drive output frequency is negative

P2.5.1.10 Wrong direction ID441 "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.

P2.5.1.11 At reference speed ID442 "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.

P2.5.1.12 Jogging speed ID413 "Jogging Speed"

Jogging speed command has been given.

P2.5.1.13 IO Control Place ID444 "IO Control Place"

Active control place is I/O terminal defined by the parameter for Control place (P3.1) or forced with digital input function.

P2.5.1.14 Output frequency limit 1 supervision ID447 "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.

P2.5.1.15 Output frequency limit 2 supervision ID448 "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.

P2.5.1.16 Reference limit supervision ID449 "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.

P2.5.1.17 Temperature limit supervision ID450 "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.

P2.5.1.18 Torque limit supervision ID451 "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.

P2.5.1.19 Motor thermal protection ID452 "MotTherm Flt/Wrn"

Motor thermistor initiates an overtemperature signal which can be led to a digital output. The response is selected with P2.12.5.6 ThermistorF.Resp.

P2.5.1.20 Analogue input supervision limit ID453 "Ain Supv Lim"

The selected analogue 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.

P2.5.1.21 Limit Control active ID454 "Limit Control ON"

One or more of the drive limit controllers is active.

8.5.1.1 Fieldbus digital inputs connection

P2.5.1.22 Fieldbus input data 1 ID455 "FB Dig Input 1"

P2.5.1.23 Fieldbus input data 2 ID456 "FB Dig Input 2"

P2.5.1.24 Fieldbus input data 3 ID457 "FB Dig Input 3"

P2.5.1.25 Fieldbus input data 4 ID169 "FB Dig Input 4"

P2.5.1.26 Fieldbus input data 5 ID170 "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.

P2.5.1.27 Charge DC link ID1218

Charge DC. Used to charge the inverter drive through OEVA type of input switch. When the DC link voltage is above the charging level a 2-second pulse train is generated to close the input switch. The pulse train is OFF when the input switch acknowledgement goes high.

P2.5.1.27 Safe disable active ID756 "Safe Disable Act"

Select the digital output to show the status of the Safe Torque Off.

P2.5.1.29 Drive in Synch ID1625

This digital output indicates when the drive has been synchronized to net.

- P2.5.1.30 Motor 1 FC Contactor control ID1602*
- P2.5.1.31 Motor 1 NET Contactor control ID1603*
- P2.5.1.32 Motor 2 FC Contactor control ID1604*
- P2.5.1.33 Motor 2 NET Contactor control ID1605*
- P2.5.1.34 Motor 3 FC Contactor control ID1606*
- P2.5.1.35 Motor 3 NET Contactor control ID1607*
- P2.5.1.36 Motor 4 FC Contactor control ID1615*
- P2.5.1.37 Motor 4 NET Contactor control ID1616*
- P2.5.1.38 Motor 5 FC Contactor control ID1617*
- P2.5.1.39 Motor 5 NET Contactor control ID1618*
- P2.5.1.40 Motor 6 FC Contactor control ID1645*
- P2.5.1.41 Motor 6 NET Contactor control ID1646*
- P2.5.1.42 Motor 7 FC Contactor control ID1647*
- P2.5.1.43 Motor 7 NET Contactor control ID1648*
- P2.5.1.44 Motor 8 FC Contactor control ID1664*
- P2.5.1.45 Motor 8 NET Contactor control ID1665*

Digital output to control FC and DOL contactors.

8.5.2 Analogue outputs 1 & 2 & 3 & 4

<i>P2.5.2.1</i>	<i>Analogue output 1 signal selection</i>	<i>ID464</i>	<i>"Iout 1 Signal"</i>
<i>P2.5.3.1</i>	<i>Analogue output 2 signal selection</i>	<i>ID471</i>	<i>"Iout 2 Signal"</i>
<i>P2.5.4.1</i>	<i>Analogue output 3, signal selection</i>	<i>ID478</i>	<i>"Iout 3 Signal"</i>

Connect the AO1 signal to the analogue output of your choice with this parameter.

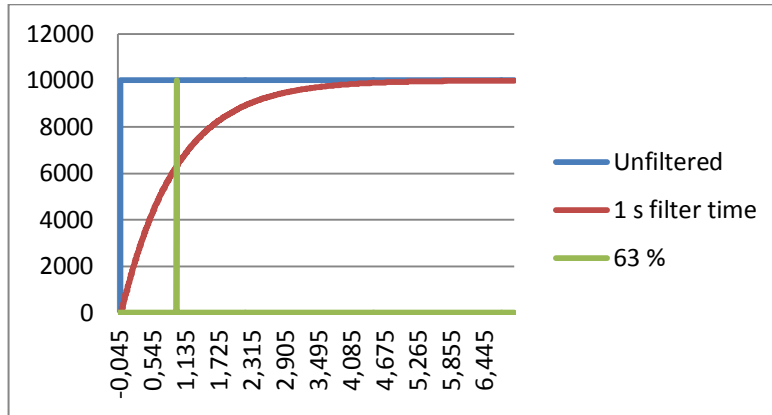
<i>P2.5.2.2</i>	<i>Analogue output function</i>	<i>ID307</i>	<i>"Iout Content"</i>
<i>P2.5.3.2</i>	<i>Analogue output 2 function</i>	<i>ID472</i>	<i>"Iout 2 Content"</i>
<i>P2.5.3.2</i>	<i>Analogue output 3, function</i>	<i>ID479</i>	<i>"Iout 3 Content"</i>

This parameter selects the desired function for the analogue output signal.

- 0 **"Not used"**
Analogue output is forced to 20 % (= 2 V/4 mA)
- 1 **"O/P Freq"**
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 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 Analogue input 1 signal
- 10 **"AI2"**
Unfiltered Analogue input 2 signal
- 11 **"Fout,min-max"**
Output frequency from minimum frequency to maximum frequency
- 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 analogue output fieldbus process data value can be connected to analogue output by using monitoring signal ID48 .

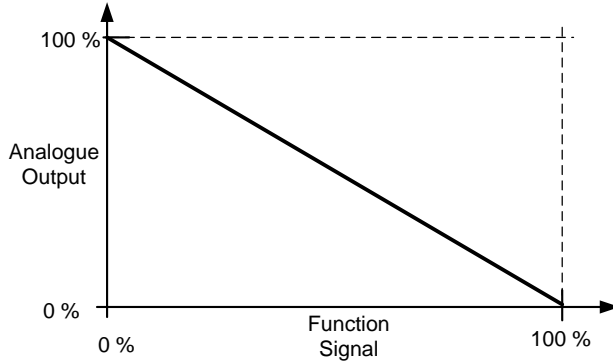
- P2.5.2.3 Analogue output filter time ID308 "Iout Filter Time"
- P2.5.3.3 Analogue output 2 filter time ID473 "Iout 2 Filter T"
- P2.5.4.3 Analogue output 3, filter time ID480 "Iout 3 Filter T"

First order filtering is used for analogue output signals.



- P2.5.2.4 Analogue output inversion ID309 "Iout Invert"
- P2.5.3.4 Analogue output 2 inversion ID474 "Iout 2 Invert"
- P2.5.4.4 Analogue output 3 inversion ID481 "Iout 3 Invert"

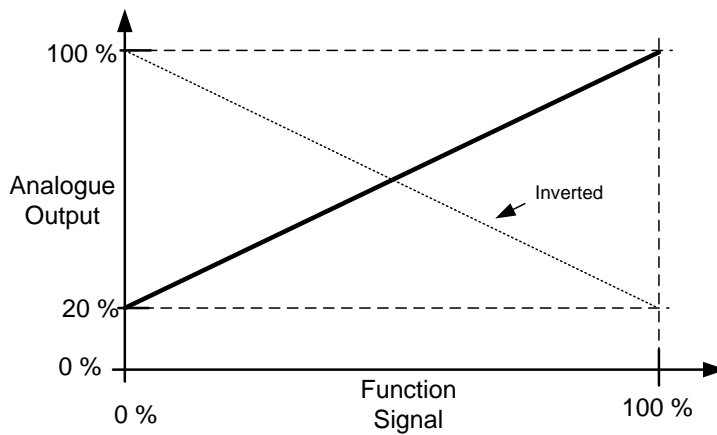
Inverts the analogue output signal:



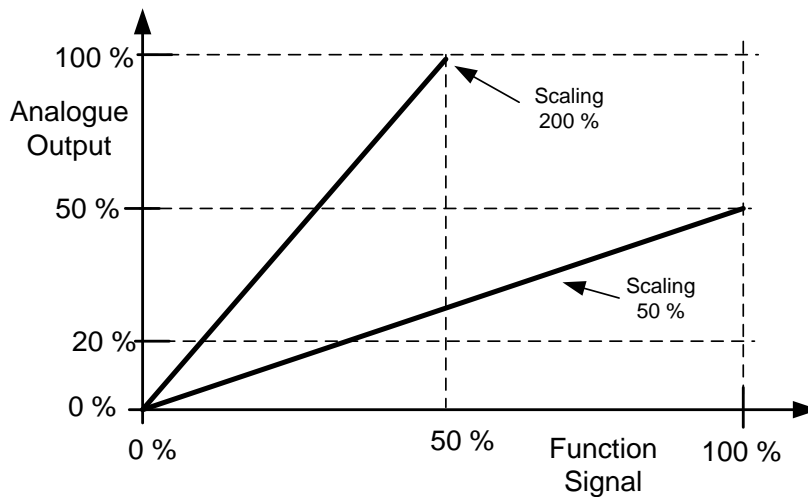
- P2.5.2.5 Analogue output minimum ID310
 P2.5.3.5 Analogue output 2 minimum ID475
 P2.5.4.5 Analogue output 3 minimum ID482

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 %)



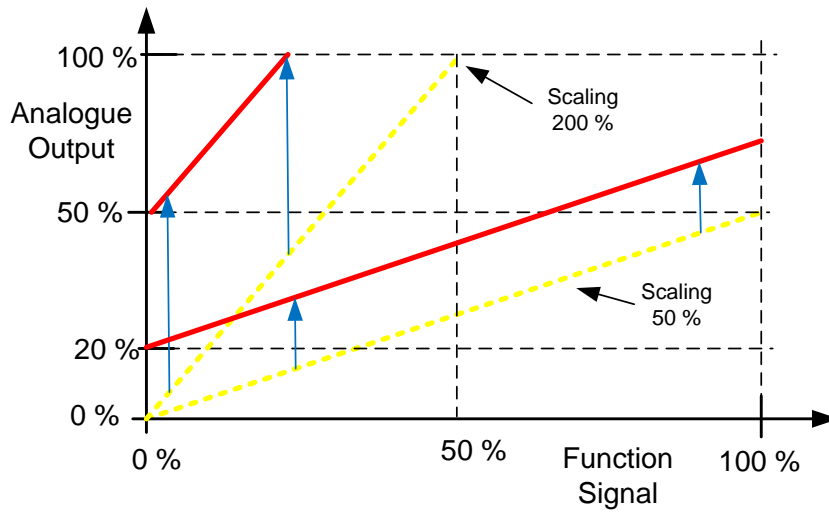
- P2.5.2.6 Analogue output scale ID311 "Iout Scale"
 P2.5.3.6 Analogue output 2 scaling ID476 "Iout 2 Scale"
 P2.5.4.6 Analogue output 3 scaling ID483 "Iout 3 Scale"



<i>P2.5.2.7</i>	<i>Analogue output offset</i>	<i>ID375</i>	<i>"Iout Offset"</i>
<i>P2.5.3.7</i>	<i>Analogue output 2 offset</i>	<i>ID477</i>	<i>"Iout 2 Offset"</i>
<i>P2.5.4.7</i>	<i>Analogue output 3 offset</i>	<i>ID484</i>	<i>"Iout 3 Offset"</i>

Define the offset for the analogue output signal.

In picture below 50 % scaling signal has been given 20 % offset and for 200 % scaling 50 % offset.



8.5.3 Delayed Digital Output 1 & 2 & 3

<i>P2.5.5.1</i>	<i>Digital output 1 signal selection</i>	<i>ID486 "Dig.Out 1 Signal"</i>
<i>P2.5.6.1</i>	<i>Digital output 2 signal selection</i>	<i>ID489 "Dig.Out 2 Signal"</i>
<i>P2.5.8.1</i>	<i>Digital output 3 signal selection</i>	<i>ID1632 "Dig.Out 3 Signal"</i>

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 5.

<i>P2.5.5.2</i>	<i>Digital output function</i>	<i>ID312 "D01 Content"</i>
<i>P2.5.6.2</i>	<i>Digital output 2 function</i>	<i>ID490 "D02 Content"</i>
<i>P2.5.8.2</i>	<i>Digital output 3 function</i>	<i>ID1633 "D03Content"</i>

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 analogue reference is 4—20 mA and signal is <4mA

8 = "Warning"

Always if a warning is on

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"

Analogue input supervision

Analogue 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 = "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.

<i>P2.5.5.3</i>	<i>Digital output 1 on-delay</i>	<i>ID487 "D01 ON Delay"</i>
<i>P2.5.5.4</i>	<i>Digital output 1 off-delay</i>	<i>ID488 "D01 OFF Delay"</i>
<i>P2.5.6.3</i>	<i>Digital output 2 on-delay</i>	<i>ID491 "D02 ON Delay"</i>
<i>P2.5.6.4</i>	<i>Digital output 2 off-delay</i>	<i>ID492 "D02 OFF Delay"</i>
<i>P2.5.8.3</i>	<i>Digital output 3 on-delay</i>	<i>ID1638 "D03 ON Delay"</i>
<i>P2.5.8.4</i>	<i>Digital output 3 off-delay</i>	<i>ID1639 "D03 OFF Delay"</i>

With these parameters you can set on- and off-delays to digital outputs.
Note that Delayed D03 is operating at ms time accuracy.

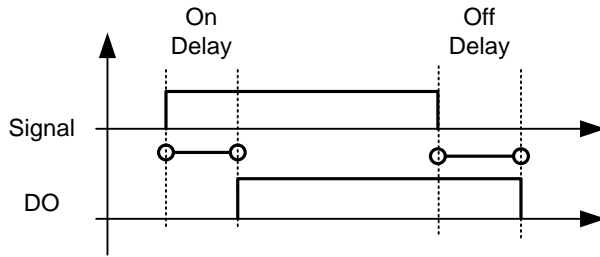


Figure 8-10. Digital outputs 1 and 2, on- and off-delays

8.5.4 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.

<i>P2.5.7.1</i>	<i>Output frequency limit supervision function</i>	<i>ID315</i>	<i>"Freq Supv Lim 1"</i>
<i>P2.5.7.3</i>	<i>Output frequency limit 2 supervision function</i>	<i>ID346</i>	<i>"Freq Supv Lim 2"</i>
<i>P2.5.7.5</i>	<i>Torque limit, supervision function</i>	<i>ID348</i>	<i>"Torque Supv Lim"</i>
<i>P2.5.7.8</i>	<i>Reference limit, supervision function</i>	<i>ID350</i>	<i>"Ref Superv Lim"</i>
<i>P3.6.7.10</i>	<i>Drive temperature limit supervision function</i>	<i>ID354</i>	<i>"Temp Lim Superv."</i>

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

The following five parameters are used to set a limit value to be monitored with the corresponding parameter above.

<i>P2.5.7.2</i>	<i>Output frequency limit supervision value</i>	<i>ID316</i>	<i>"Freq Dupv Val 1"</i>
<i>P2.5.7.4</i>	<i>Output frequency limit 2 supervision value</i>	<i>ID347</i>	<i>"Freq Supv Val 2"</i>
<i>P2.5.7.6</i>	<i>Torque limit, supervision value</i>	<i>ID349</i>	<i>"Torque Supv Val"</i>
<i>P2.5.7.9</i>	<i>Reference limit, supervision value</i>	<i>ID351</i>	<i>"Ref Superv Value"</i>
<i>P2.5.7.11</i>	<i>Drive temperature limit value</i>	<i>ID355</i>	<i>"Temp Supv Value"</i>

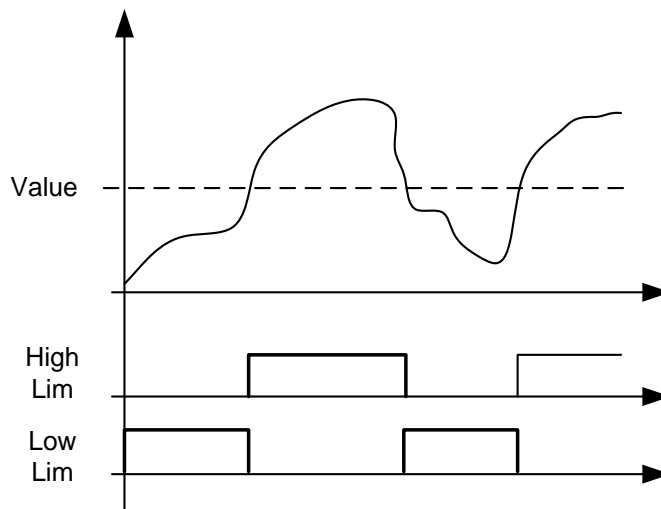


Figure 8-11. Supervision function

<i>P2.5.7.7</i>	<i>Torque Supervision value scaling input</i>	<i>ID402</i>	<i>"Torque Superv Scl"</i>
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This parameter is used to change the torque limit supervision level between zero and P2.5.8.6 Torque Supv Val

- 0 = Not used
- 1 = AI1
- 2 = AI2
- 3 = AI3
- 4 = AI4
- 5 = FBLimScaling

8.5.4.1 *Analogue input supervision function*

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

P2.5.7.12 *Analogue input supervision signal* ID356 "Ain Supv Input"

With this parameter you can select the analogue input to be monitored.

- 0 = Not used
- 1 = AI1
- 2 = AI2
- 3 = AI3
- 4 = AI4
- 5 = FBLimScaling

P2.5.7.13 *Analogue Low supervision control limit* ID357 "Ain Supv Llim"

P2.5.7.14 *Analogue High supervision control limit* ID358 "Ain Supv Hlim"

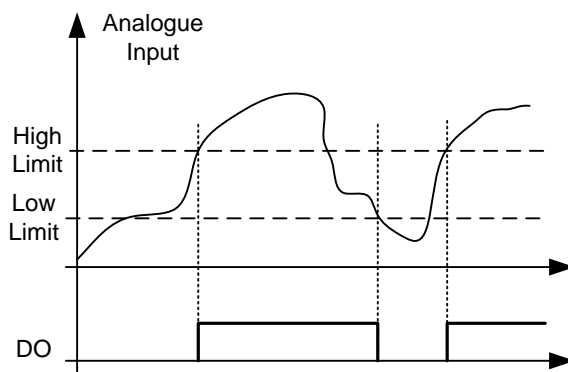


Figure 8-12. An example of On/Off-control

8.5.5 Motor 1 Contactors Pulse Control

Some cases breakers needs to be controlled by pulses.

P2.5.9.1 M1 Pulse Time ID1850

This defined pulse length to all below parameters P2.5.9.2 – P2.5.9.5

P2.5.9.2 M1 FC Close Pulse ID1851

P2.5.9.3 M1 FC Open Pulse ID1852

P2.5.9.4 M1 DOL Close Pulse ID1853

P2.5.9.5 M1 DOL Open Pulse ID1854

8.6 Limit settings

8.6.1 Current limit handling

P2.6.1.1 Current limit ID107 "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.

P2.6.1.2 Scaling of current limit ID399 "Currnt Lim Sclng"

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.

8.6.2 Torque limit handling

P2.6.2.1 Torque Limit ID609 "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.

P2.6.2.2 Motoring Torque limit ID1287 "MotorTorqueLimit"

Motoring side torque limit. This limit value is used for all scaling functions and torque limit ramp rate functions if activated.

P2.6.2.3 Generator Torque limit ID1288 "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.

P2.6.2.4 Motoring Torque limit scaling ID485 "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

P2.6.2.5 Generating torque limit scaling ID1087 "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

P2.6.2.6 Torque limit control P-gain ID610 "TorqLimCtrl P"

This parameter defines the gain of the torque limit controller. It is used in Open Loop control mode only.

P2.6.2.7 Torque limit control I-gain ID611 "TorqLimCtrl I"

This parameter determines the I-gain of the torque limit controller. It is used in Open Loop control mode only.

8.6.3 Frequency limit handling

P2.6.3.1 Negative frequency limit ID1286 "Neg Freq Limit"

Positive direction frequency limit. When changed in closed loop control mode change is made without ramp.

P2.6.3.2 Positive frequency limit ID1285 "Pos Freq Limit"

Negative direction frequency limit. When changed in closed loop control mode change is made without ramp.

8.6.4 DC Link handling

P2.6.4.1 Overvoltage controller ID607 "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).

P2.6.4.2 Overvoltage Reference Select ID1262 "OverVolt.Ref.Sel"

Overvoltage reference level depending on the status of the brake chopper.

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

P2.6.4.3 Brake chopper ID504 "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.

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

0 = "Not Used" - No brake chopper used

Brake chopper not active or present in the DC link. **NOTE:** The overvoltage controller level is set to a little lower, see parameter P2.6.5.2.

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 used 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.

Note: 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.

P2.6.4.4 Undervoltage controller ID608 "Undervolt Contr"

Undervoltage controller will decrease the output frequency in order to get energy from the motor when the DC voltage has dropped to a limit where the undervoltage controller activates trying to keep DC voltage at the minimum level.

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.

Both open and closed loop controllers are PI-type controllers.

If power comes back while drive is at undervoltage 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.

Both open and closed loop controllers are PI-type controllers.

If power comes back while drive is at undervoltage the controller drive will ramp to zero speed and generate an undervoltage fault.

P2.6.4.5 Under Voltage Reference Selector ID1537 "UnderVoltRef.Sel"

Overvoltage reference level depending on the status of the brake chopper.

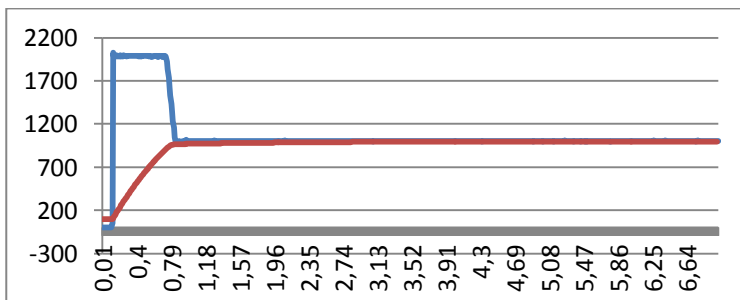
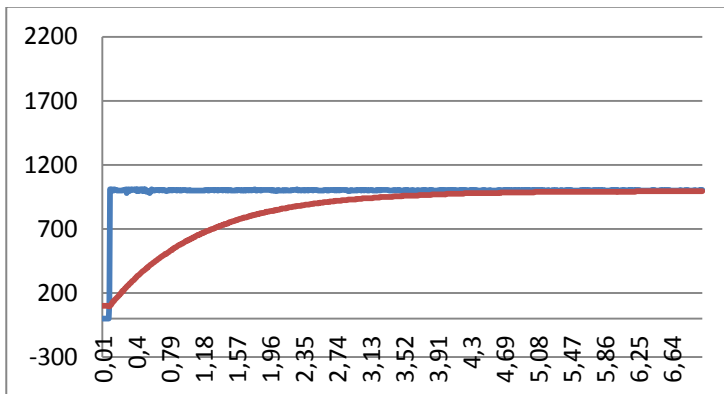
ID1537	
0 / Low Voltage	500 V Unit: 412 V 690 V Unit: 567 V
1 / Automatic	0,80*Estimated DC nominal voltage

8.7 DC 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.



8.7.1 Open loop settings

P2.7.1 DC-braking current ID627 "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.

P2.7.2 DC-braking time at start ID507 "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.

P2.7.3 DC-braking time at stop ID508 "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.

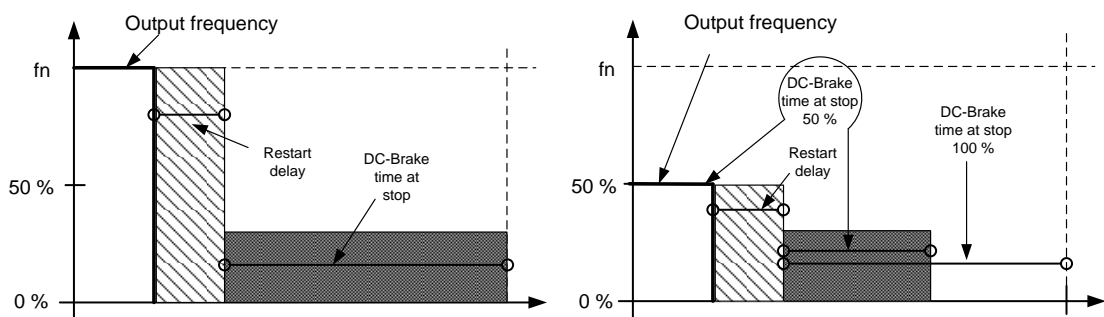


Figure 8-13. DC-braking time when Stop mode = Coasting, from nominal speed and 50 % of nominal speed.

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.

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 8-14.

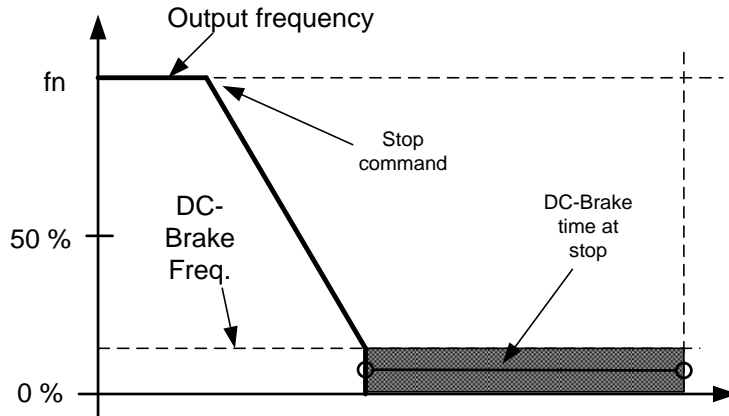


Figure 8-14. DC-braking time when Stop mode = Ramp

P2.7.4 DC braking frequency at stop ID515 "Stop D-BrakeFr"

The output frequency at which the DC braking is applied when making ramping stop.

P2.7.5 Scaling of DC-braking current ID400 "DC-currnt Sclng"

The DC braking current can be reduced with the free analogue 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

P2.7.6 DC brake current in stop ID1080 "DCBrakeCurlnStop"

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.

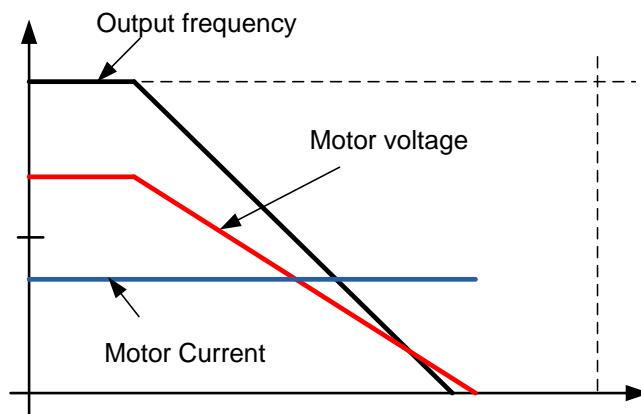
8.7.1.1 *Flux braking*P2.7.7 *Flux brake* ID520 "Flux Brake"

Instead of DC braking, flux braking is a useful way to raise the braking capacity in cases where additional brake resistors are not needed.

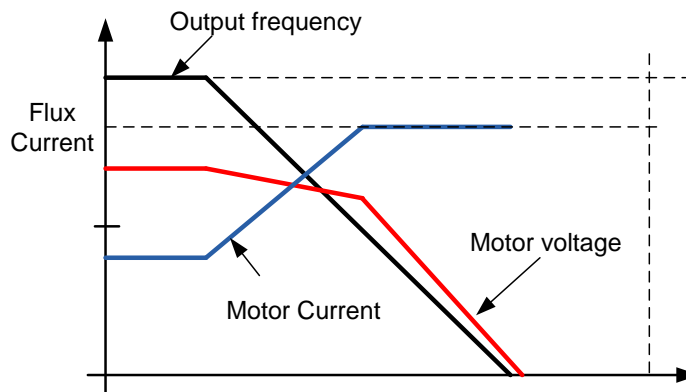
When braking is needed, the frequency is reduced and the flux in the motor is increased. This increases losses on motor, which in turn increases the motor's capability to brake. Unlike in DC braking, the motor speed remains controlled during braking.

The flux braking can be set ON or OFF.

0 = Flux braking OFF



1 = Flux braking ON

P2.7.8 *Flux braking current* ID519 "FluxBrakeCurrent"

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

8.8 Motor Control

Open Loop control

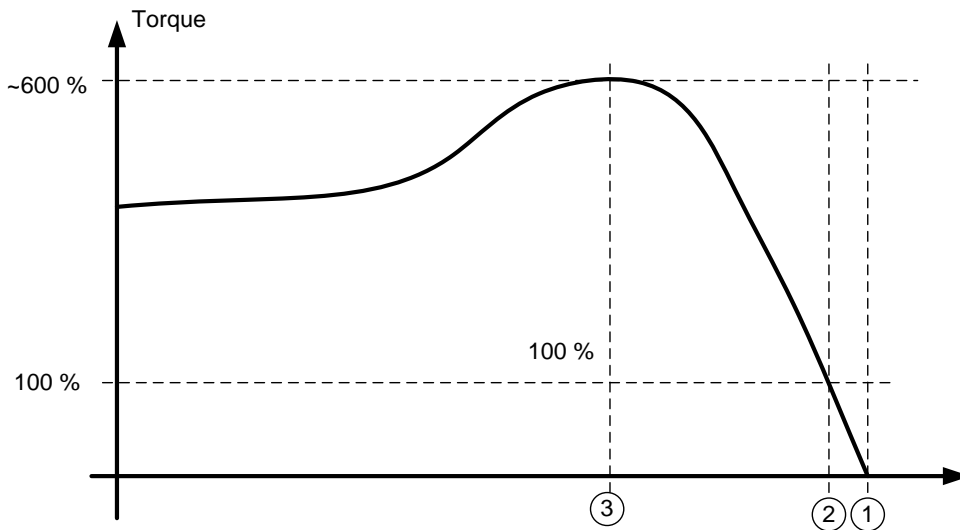
Open loop control controls the motor without encoder feedback from the motor shaft. Control mode selections 0, 1 and 2 are open loop control modes.

Slip

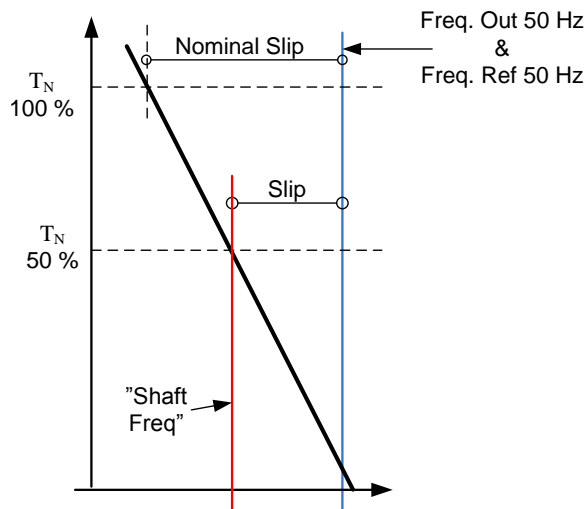
Induction motor torque is based on slip. When load increases also slip will increase. Slip is the speed that rotor is behind of stator electrical frequency.

Below 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.

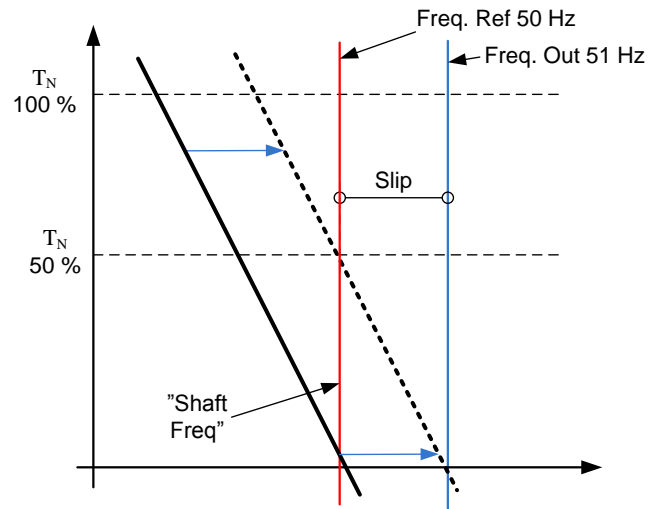


In frequency control, the load will determine the actual shaft speed



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.

P2.8.1 *Motor control mode* *ID600* **“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.

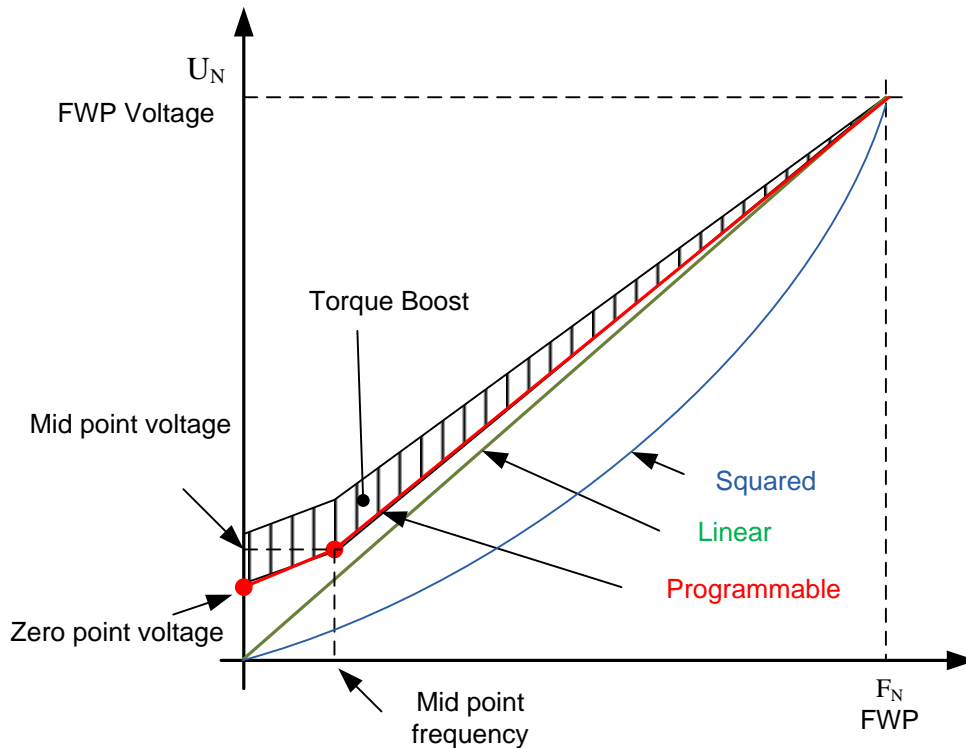
P2.8.2 *Motor control mode 2* *ID521* **“Motor Ctrl Mode2”**

With this parameter you can set another motor control mode which is activated with parameter *Mot Ctrl Mode1/2*.

Note: The Motor control mode cannot be changed between open loop and closed loop while the drive is in Run state.

8.8.1 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 NCDrive 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 $\sqrt{2} * \text{Zero Point Voltage}$
and

the midpoint frequency to $(\text{Zero Point Voltage}/100\%)*\text{Nominal frequency of motor}$

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.

P2.8.3.1 U/f optimisation ID109 “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.

P2.8.3.2 U/f ration selection ID108 “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 undermagnetised 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.

P2.8.3.3 Field weakening point ID602 "Field WeakngPnt"

The field weakening point is the output frequency at which the output voltage reaches the field weakening point voltage.

P2.8.3.4 Voltage at field weakening point ID603 "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.

P2.8.3.5 U/f curve, middle point frequency ID604 "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.

P2.8.3.6 U/f curve, middle point voltage ID605 "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).

P2.8.3.7 Output voltage at zero frequency ID606 "Zero Freq Voltg"

This parameter defines the zero frequency voltage of the U/f curve. The default value is unit size dependent.

NOTE: If the value of parameter *U/f Ratio Select* is changed this parameter is set to zero.

8.8.2 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 start 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".

P2.8.4.1 PMSM Shaft Position ID649 "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.

P2.8.4.2 Start Angle Identification Mode ID1691 "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 P2.8.5.1. Also for absolute encoders, P2.8.5.1 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.

NOTE!

ModulatorType (P2.10.2) need to be > 0 to be able to use this function.

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.

P2.8.4.3 Start Angle Identification Current *ID1759* *“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.

P2.8.4.4 Polarity Pulse Current *ID1566* *“PolarityPulseCur”*

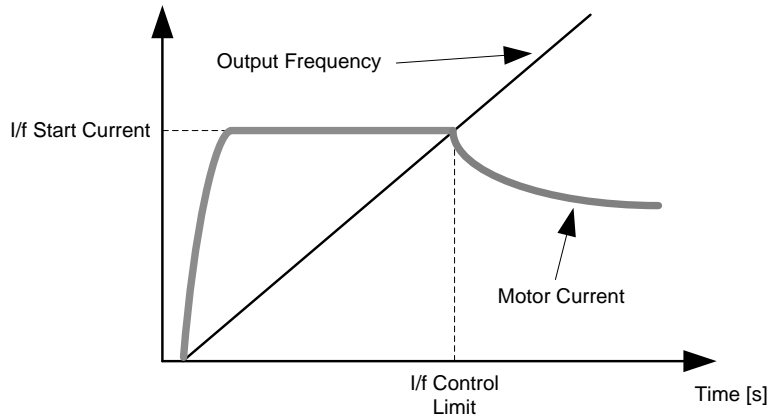
This parameters defines the current level for the magnet axis polarity direction check during the start angle identification (P2.8.5.2). Value 0 means that the internal current level is used, which is typically slightly higher than the normal identification current defined by P2.8.5.3. Polarity direction 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.

P2.8.4.5 Start Angle Identification Time *ID1755* *“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 P2.8.5.6. Also P2.8.5.2 need to disabled otherwise overriding this function.

8.8.2.1 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 (P2.10.6) for PM-motors. Also software modulator is required.



P2.8.4.6 I/f Current ID1693 "I/f Current"

NOTE: I/f Current parameter is used for several different purposes.

I/f Control

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 Angle identification

This parameter defined DC Current level when Start Angle Identification Time is set greater than zero. See P2.8.5.5 Start Angle Identification Time.

P2.8.4.7 I/f Control Limit ID1790 "I/f Control Lim"

This parameter sets the speed limit for I/f-control in percent of the motor nominal speed (1000 = 100.0%). I/f-control is used if the speed is below this limit. The operation changes back to normal when the speed is above this limit with 60 rpm hysteresis.

8.8.2.2 *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.

P2.8.4.8 Flux Current Kp ID551 "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.

P2.8.4.9 Flux Current Ti ID652 "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.

P2.8.4.10 ExtIdRef ID1730 "ExtIdRef"

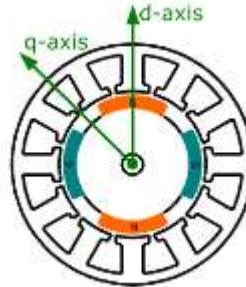
This reference value can be used for the external control of the motor id-current i.e. reactive current. Normally there is no need for that as the control uses already the optimal value. This reference value is additive to drive internal values but, for example, field-weakening controller can override the given reference in field-weakening operation.

P2.8.4.11 EnableRsIdentifi ID654 "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.

8.8.2.3 D and Q axis voltage drops

If d-axis and q-axis reactances (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.



P2.8.4.11 *Lsd Voltage Drop* ID1757 “Lsd Voltage Drop”

D-axis reactance voltage drop 2560 = 100%.

Gives the % voltage drop across the stator inductance at nominal current and frequency.

$$X_d[\text{Drive scale}] = \frac{X_d[\Omega] * I_n[A] * \sqrt{3}}{U_n[V] * 2560}$$

P2.8.4.12 *Lsq Voltage Drop* ID1758 “Lsq Voltage Drop”

Q-axis reactance voltage drop 2560 = 100%.

Gives the % voltage drop across the stator inductance at nominal current and frequency.

$$X_q[\text{Drive scale}] = \frac{X_q[\Omega] * I_n[A] * \sqrt{3}}{U_n[V] * 2560}$$

8.8.3 Stabilization settings

8.8.3.1 Torque stabiliser

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

P2.8.5.1 Torque stabiliser Gain ID1412 "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

$$G = TorqStabGainFWP + TorqStabGain - \frac{f}{f_{FWP}} TorqStabGain, \quad \text{if } f < f_{FWP}$$

$$G = TorqStabGainFWP, \quad \text{if } f \geq f_{FWP}$$

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

$$G_f = \frac{1000 * G}{256 * TorqStabDamp}$$

P2.8.5.2 Torque stabiliser damping ID1413 "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

$$\omega_c = \frac{1}{T_c} \text{rad/s}$$

For example, if Torque stabilizer damping = 600, it follows that $T_c = 1.5$ ms and $\omega_c = 667$ rad/s.

P2.8.5.3 Torque stabiliser Gain in FWP area ID1414 "TorqStabGainFWP"

Gain of the torque stabiliser at field weakening point in open loop motor control operation. See details from Torque Stabiliser Gain.

P2.8.5.4 Torque stabiliser Limit ID1720 "TorqStabLimit"

This defines how much torque stabiliser can affect output frequency.

8.8.4 Flying Start tuning

P2.8.6.1 Current control P gain ID617 "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 %.

P2.8.6.1 Over modulation limit ID1515

Output Voltage Limit for partial modulation in 1%. 100% means maximum sinusoidal modulation. 113% is full six step. If you have sine filter in use set this to 96 %.

P2.8.6.3 AC magnetization Current ID1701

Current reference during AC scanning phase.

P2.8.6.4 AC Scanning Time ID1702

Reference time for AC scanning when motor slip is 1 Hz. If slip is 0,50 Hz actual scanning time is double.

P2.8.6.5 DC magnetization Current ID1703

Current reference during DC scanning phase.

P2.8.6.6 Flux Build Time ID1704

Time when rotor flux is increased to nominal after flying start has found motor actual speed. If zero speed has find this is not used.

P2.8.6.7 Flux Build Torque DI1711

Torque reference during Flux built time.

P2.8.6.8 Magnetization Phases ID1707**P2.8.6.9 Flying Start Options ID1610**

b0 =+1= Disable movement to reverse direction

b1 = +2=Disable AC Scanning

b2 = +4=Disable Fly Brake phase

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

8.8.5 Identification settings

P2.8.7.1 *Rs voltage drop* ID662 "*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

$$RsVoltageDrop = 2560 \frac{I_n}{U_n} R_s$$

P2.8.7.2 *Ir: Add zero point voltage* ID664 "*IrAddZeroPVoltag*"

Defines how much voltage is applied to motor in zero speed when torque boost is used.

P2.8.7.3 *Ir: Add generator scale* ID665 "*IrAddGeneScale*"

Defines the scaling factor for generator side IR-compensation when torque boost is used.

P2.8.7.4 *Ir: Add motoring scale* ID667 "*IrAddMotorScale*"

Defines the scaling factor for motoring side IR-compensation when torque boost is used.

P2.8.7.5 *IU Offset* ID668 "*IU Offset*"

P2.8.7.6 *IV Offset* ID669 "*IV Offset*"

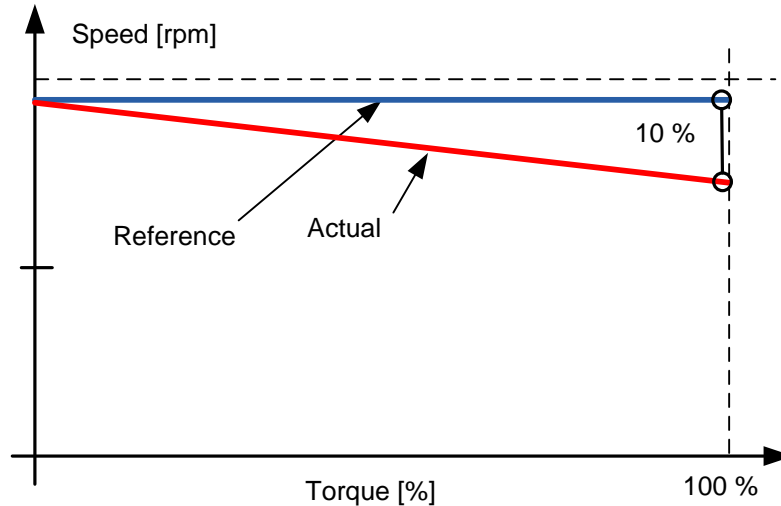
P2.8.7.7 *IW Offset* ID670 "*IW Offset*"

Offsets the value for phase current measurement. Identified during identification run.

8.9 Speed Control settings

P2.9.1 Load drooping ID620 "LoadDrooping"

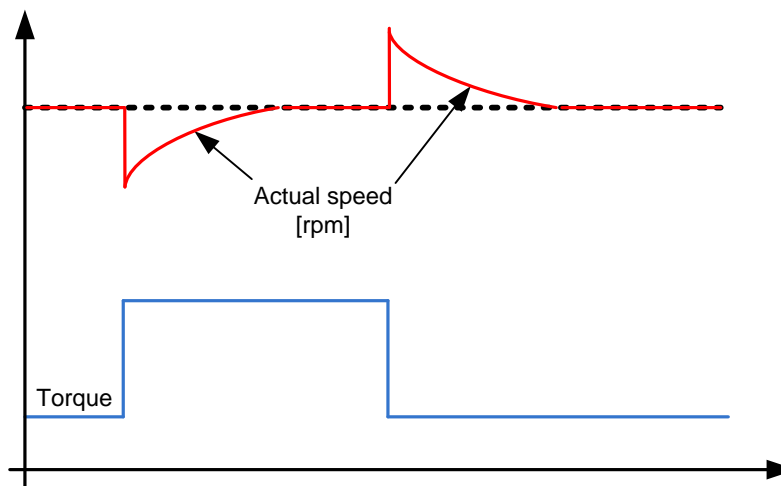
The drooping function enables speed drop as a function of load. This parameter sets the value corresponding to the nominal torque of the motor.



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.

P2.9.2 Load Drooping Time ID656 "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.



P2.9.4.1 Speed controller P gain, Open Loop ID637 "OL Speed Reg P"

Defines the P gain for the speed controlled in Open Loop control mode.

P2.9.4.2 Speed controller I gain, Open Loop ID638 "OL Speed Reg I"

Defines the I gain for the speed controlled in Open Loop control mode.

8.10 Drive Control

P2.10.1 Switching frequency ID601 "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:

Type	Min. [kHz]	Max. [kHz]	Default [kHz]
0003—0061 NX_5 0003—0061 NX_2	1.0	16,0	10.0
0072—0520 NX_5	1.0	10.0	3.6
0041—0062 NX_6 0144—0208 NX_6	1.0	6.0	1.5

Table 8-2. Size-dependent switching frequencies

Note!

The actual switching frequency might be reduced down to 1,5kHz by thermal management functions. This has to be considered when using sine wave filters or other output filters with a low resonance frequency.

Note!

If the switching frequency is changed it is necessary to redo the identification run.

P2.10.2 Modulator Type ID1516 "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.

1 = Software Modulator 1

Symmetric vector modulator with symmetrical zero vectors.

Current distortion is less than with software modulator 2 if boosting is used.

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.

This modulator type reduces switching losses up to two-thirds and all switches become evenly loaded.

BusClamp modulation is useful if the voltage is >80% of the maximum voltage, in other words, when the drive is operating near full speed. Then again, the motor ripple at low speeds is the double compared to selection 1.

3 = Software modulator 3

Unsymmetrical BusClamp 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.

P2.10.3 Control Options ID1084 "Control Options"

Reserved for future use.

P2.10.4 Advanced Options 1 ID1560 "AdvancedOptions1"

B00 = Disable Synchronous modulation

B03 = Disable slip compensation for reverse direction

B06 = Enable synchronous symmetrical modulation

P2.10.5 Advanced Options 2 ID1561 "AdvancedOptions1"

B08 = Current optimization for PMS motor. This function activates the current optimization for PMSM motor based on torque calculation and motor parameters. When activated, the optimization starts after 13 % of the motor nominal speed and below this a normal U/f curve is used. The activation of this selection requires a performed identification with run.

P2.10.6 Advanced Options 4 ID1563 "AdvancedOptions4"

Reserved for future use. Some bits are controlled by application software so value may not be always zero.

P2.10.7 Advanced Options 5 ID1564 "AdvancedOptions5"

Reserved for future use. Some bits are controlled by application software so value may not be always zero.

P2.10.8 Advanced Options 6 ID1565 "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.

P2.10.9 Restart Delay ID1424 "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 P2.9.11.

P2.10.10 Restart Delay Closed Loop & Flying Start ID672 "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.

8.11 Protections

8.11.1 General settings

P2.11.1.1 Input phase supervision ID730 "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

P2.11.1.2 Response to undervoltage fault ID727 "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

Undervoltage fault limits:

- 500 V units: 333 Vdc
- 690 V units: 460 Vdc

P2.11.1.3 Output phase supervision ID702 "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

P2.11.1.4 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

P2.11.1.5 Response to external fault ID701 "External Fault 1"

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

P2.11.1.6 Earth fault protection ID703 (2.7.7)

0 = No response
 1 = Warning
 2 = Fault, stop mode after fault according to [ID506](#)
 3 = Fault, stop mode after fault always by coasting
 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.

P2.11.1.7 Response to fieldbus fault ID733 "FBComm.FaultResp"

Set here the response for a fieldbus fault if the active control place is fieldbus. For more information, see the respective Fieldbus Board Manual.

- 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, Previous frequency. Forced fault after delay. Only for profibus communication

P2.11.1.8 Cooling fault delay ID755

This parameter defines delay after the drive goes to fault state when cooling OK signal is missing. If drive is in Stop state this is only warning, In Run state drive will make fault with coast stop.

8.11.2 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 marine application supports two OPT-BH and OPT-B8 board simultaneously. One can be used for the motor winding and one for the motor bearings.

P2.11.2.1 *Number of used inputs in board 1* **ID739** *“Board1 Channels”*

Select used temperature sensor combination with this parameter. See also the Vacon 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

Note: 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.

P2.11.2.2 *Board 1 Temperature response* **ID740** *“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

P2.11.2.3 *Board 1 warning limit* **ID741** *“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).

P2.11.2.5 *Board fault limit* **ID742** *“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).

8.11.3 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.

P2.11.3.1 Stall protection ID709 "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

P2.11.3.2 Stall current limit ID710 "Stall Current"

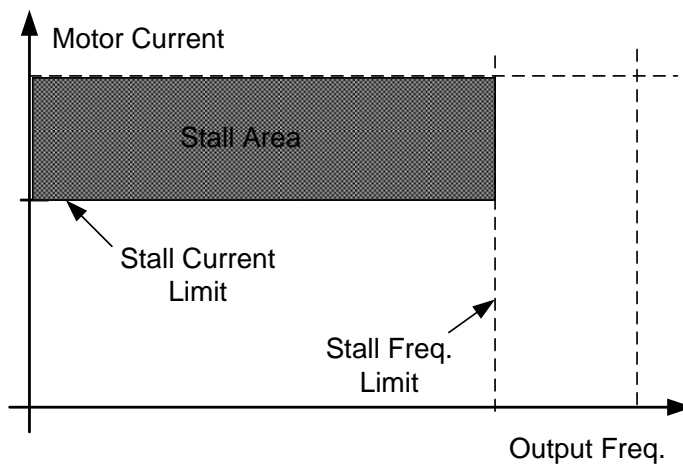
The current can be set to $0 \dots 2 \cdot I_H$. For a stall stage to occur, the current must have exceeded this limit. The software does not allow entering a greater value than $2 \cdot I_H$. If the motor current limit is changed this parameter is automatically recalculated to the value 90 % of motor current limit.

Note: This limit must be set below the current limit in order for this function to operate.

P2.11.3.3 Stall frequency limit ID712 "Stall Freq Lim"

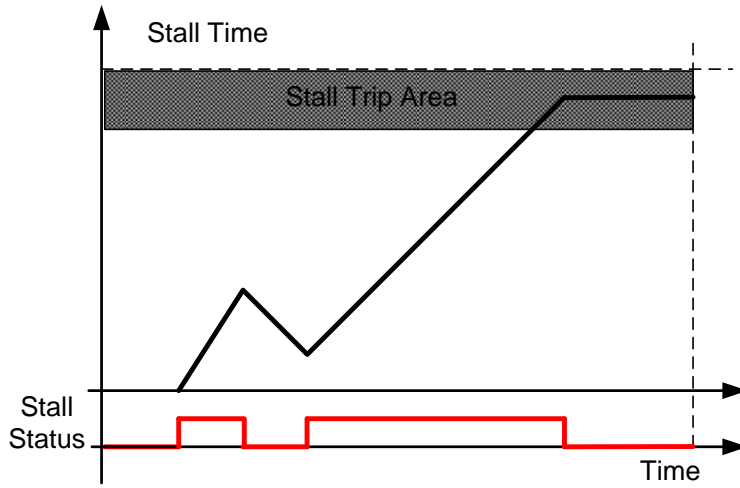
The frequency can be set between $1 - f_{max}$ (Max Frequency).

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.



P2.11.3.4 Stall time ID711 "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.



8.11.4 Motor Protection



CAUTION! *The calculated model does not protect 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 I_T specifies the load current above which the motor is overloaded. This current limit is a function of the output frequency.

P2.11.4.1 Motor thermal protection response ID704 "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

P2.11.4.2 Motor ambient temp. factor ID705 "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

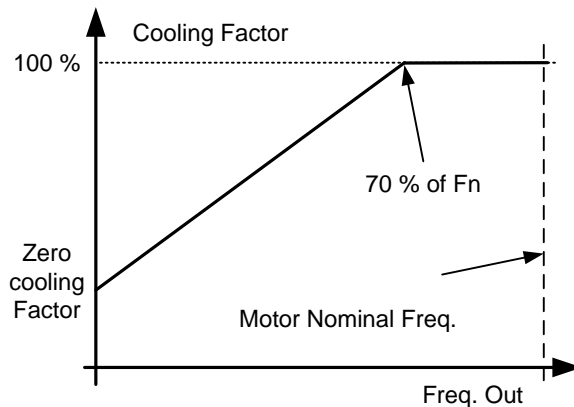
P2.11.4.3 Motor cooling factor at zero speed ID706 "MTP f0 Current"

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).

Note: 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.

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



P2.11.4.4 Motor thermal protection: Time constant ID707 "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 t_6 -time (t_6 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 $2 \times t_6$. 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.

P2.11.4.5 Motor thermal protection: Motor duty cycle ID708 "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.

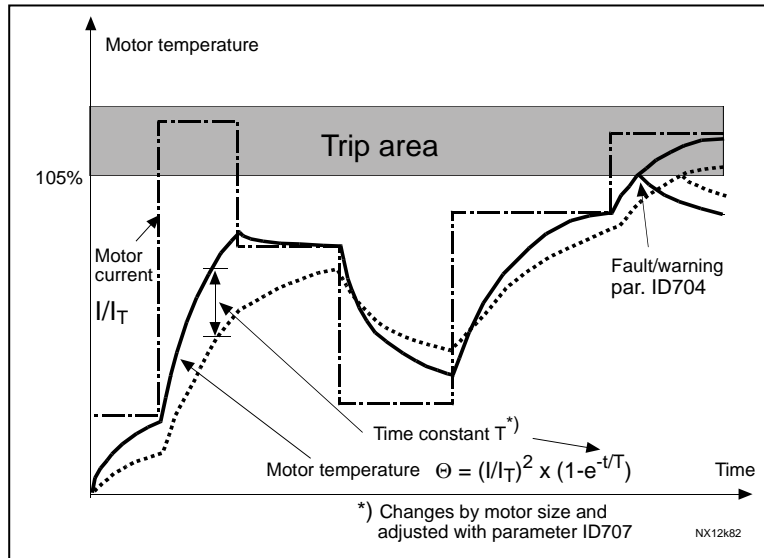


Figure 8-15. Motor temperature calculation

P2.11.4.6 Response to thermistor fault ID732 "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.

8.11.5 4mA Protection

The 4 mA protection monitors the analogue input signal level from Analogue input 1 and Analogue 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.

P2.11.5.1 Response to the 4mA reference fault ID700 “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

P2.11.5.2 4mA reference fault: preset frequency reference ID728 “4mA Fault Freq.”

If value 3 in parameter P2.12.6.1 is selected and a fault occurs the frequency reference to the motor is the value of this parameter.

8.11.6 Underload protection

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 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 I_H are used to find the scaling ratio for the internal torque value.

P2.11.6.1 Underload protection ID713 "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

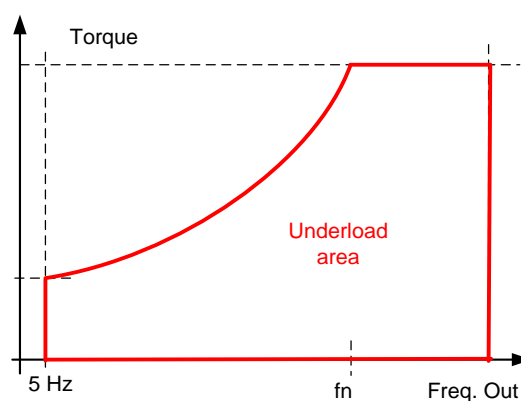
If tripping is set active the drive will stop and activate the fault stage. Deactivating the protection by setting the parameter to 0 will reset the underload time counter to zero.

P2.11.6.2 Underload protection, zero frequency load ID715 "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.

P2.11.6.3 Underload protection, field weakening area load ID714 "UP fnom Torque"

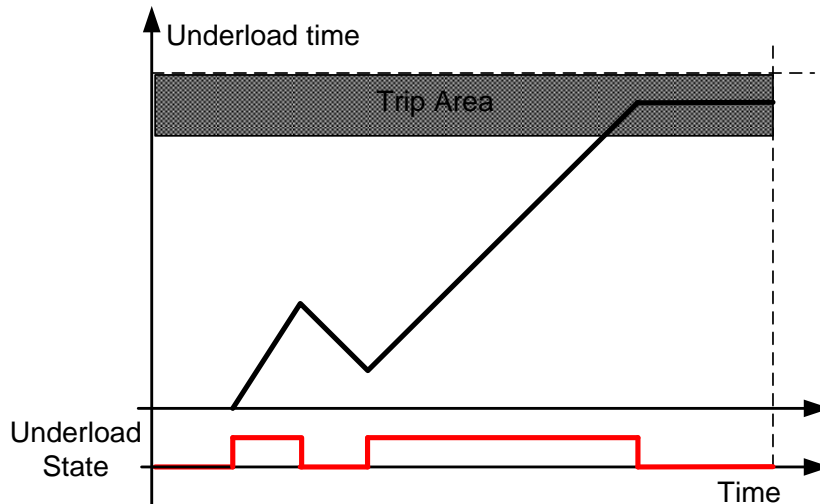
The torque limit can be set between 10.0—150.0 % x T_{nMotor} . This parameter gives the value for the minimum torque allowed when the output frequency is above the field weakening point.



P2.11.6.4 Underload time ID716 "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.



8.11.7 Line Synch protection Functions

P2.11.7.1 DC Low Response ID1680

Select response for DC Low fault. This function will activate Fault 85. See details in the Line Synchronization chapter on protection functions. Use selections 0 or 1 if Frequency Converter is disconnected from net when synchronization is finished.

0 = No action

1 = Warning

2 = Fault

Drive will open all contactors and wait until the reset command is given to open all contactors. After the DOL reset command the actual fault can be reset.

P2.11.7.2 DC Low Limit ID1681

DC voltage Fault limit for F85.

P2.11.7.3 Line Voltage low response ID1685

Select response for AC Low fault. This function will activate Fault 86. See details in the Line Synchronization chapter on protection functions. Use selections 0 or 1 if measurements are disconnected from net when synchronization is finished.

0 = No action

1 = Warning

2 = Fault

Drive will open all contactors and wait until the reset command is given to open all contactors. After the DOL reset command, the actual fault can be reset.

P2.11.7.4 Line Voltage low limit ID1686

AC voltage Fault limit for F86.

P2.11.7.5 Line Voltage Fault Delay "LineVolt.F. Delay" ID1691

Defines delay to line voltage low limit ID1686

P2.11.7.6 DOL Conflict Fault Mode ID1687

This parameter is used to select action if DOL control for M1 is opposite compared to feedback single. If feedback is not used, set value to no action.

P2.11.7.7 DOL Conflict Fault Delay ID1688

This parameter defines delay for DOL conflict fault.

P2.11.7.8 Vac < 90 % Response ID1689

Defines response for fault F83

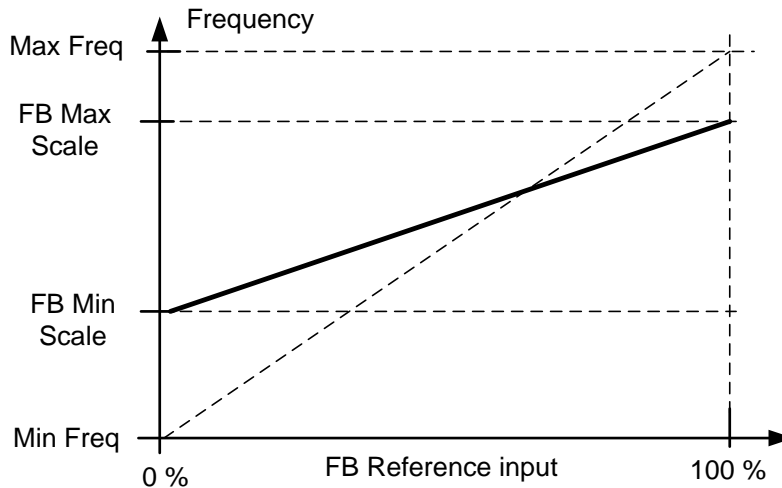
8.12 Fieldbus settings

8.12.1 General settings

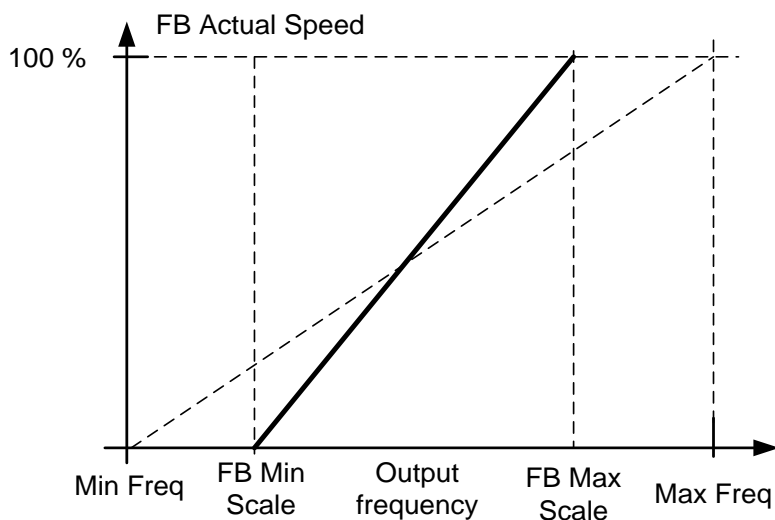
P2.12.1 Fieldbus reference minimum scaling ID850 "FB Min Scale"

P2.12.2 Fieldbus reference maximum scaling ID851 "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.



*P2.12.3 to**P2.12.10 Fieldbus data out selections 1 to 8 ID852-ID859 "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

*P2.12.11 to**P2.12.18 Fieldbus data IN selections 1 to 8 ID876-833 "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:

Data	Value	Unit	Scale	ID
Reference	Speed Reference	%	0.01%	-
Control Word	Main Control Word	-	-	-
Control Word 2	General Control Word			
Process Data IN1	Torque Reference	%	0.1%	1140
Process Data IN2	Free Analogue INPUT	%	0.01%	46
Process Data IN3	Adjust Input	%	0.01%	47
Process Data IN4	FB Analogue Output	%	0.01%	48
PD4 – PD8	Not Used	-	-	-

8.13 ID Functions

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

8.13.1 Value Control

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

P2.13.1.1 Control Input Signal ID ID1580 "ContrInSignal ID"

With this parameter you can select what signal is used to control selected parameter.

P2.13.1.2 Control Off Limit ID1581 "Contrl Off Limit"

This parameter defines the limit when the selected parameter value is forced to Off value.

P2.13.1.3 Control On Limit ID1582 "Contrl On Limit"

This parameter defines the limit when the selected parameter value is forced to On value.

P2.13.1.4 Control Off Value ID1583 "Contrl Off Value"

This parameter defines the value that is used when the used input signal is below Off limit.

P2.13.1.5 Control On Value ID1584 "Contrl On Value"

This parameter defines the value that is used when the used input signal is above On limit.

P2.13.1.6 Control Output Signal ID ID1585 "ContrlOutSignalID"

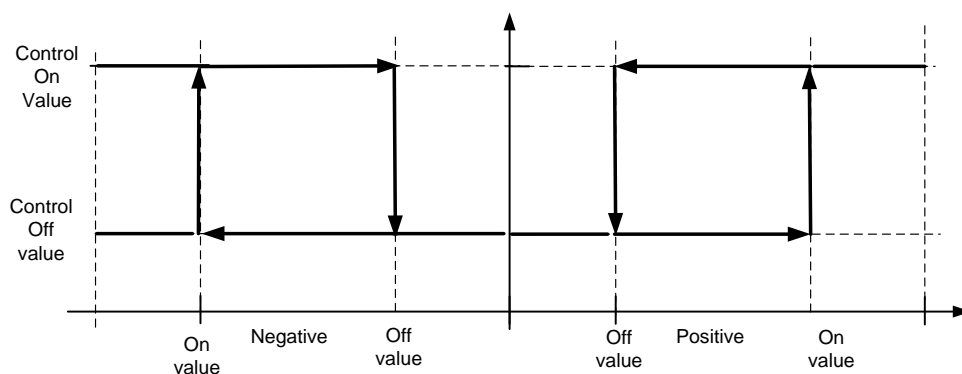
This parameter defines which parameter is forced to On and Off values when selected input signal exceeds the set limits.

P2.13.1.7 Control Mode ID1586 "Control Mode"

This parameter defines how the value control output behaves.

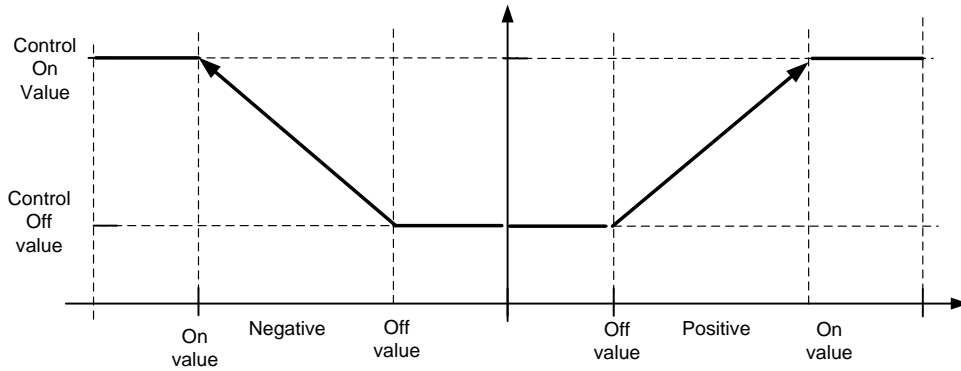
0 = SR ABS

Absolute input value is used to make a step change in the output between On and Off values.



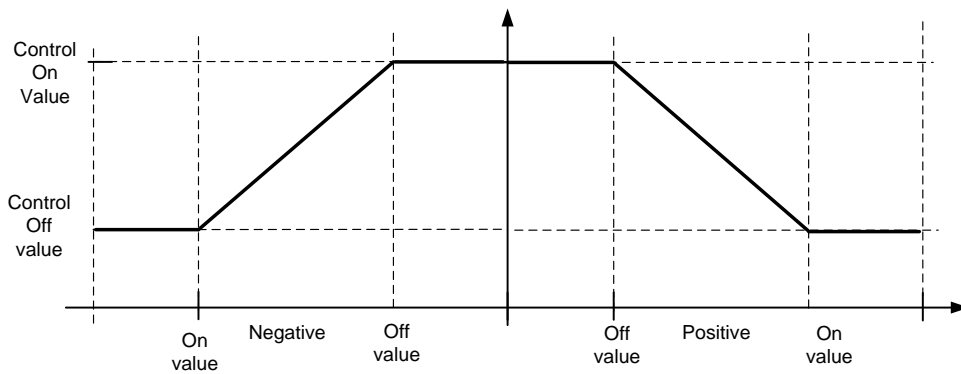
1 = Scale ABS

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

8.14 Auto Fault Reset

The Auto reset function tries to reset the fault automatically during the trial time. An individual fault can be defined to be reset certain number of times before the actual fault indication is given. The function will operate as Automatic Restart function if the start command is received as a static signal. In I/O control of the Marine application, the default start function requires a rising edge command after fault trigger.

P2.14.1 Automatic reset: Wait time ID717 "Wait Time"

Defines the time for the attempted fault reset after the fault trigger has passed.

Note: 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.

P2.14.2 Automatic reset: Trial time ID718 "Trial Time"

The Automatic reset function keeps trying to reset the faults appearing during the time set with this parameter. If the number of faults during the trial time exceed the value of the respective parameter set with ID720 to ID725 a permanent fault is generated.

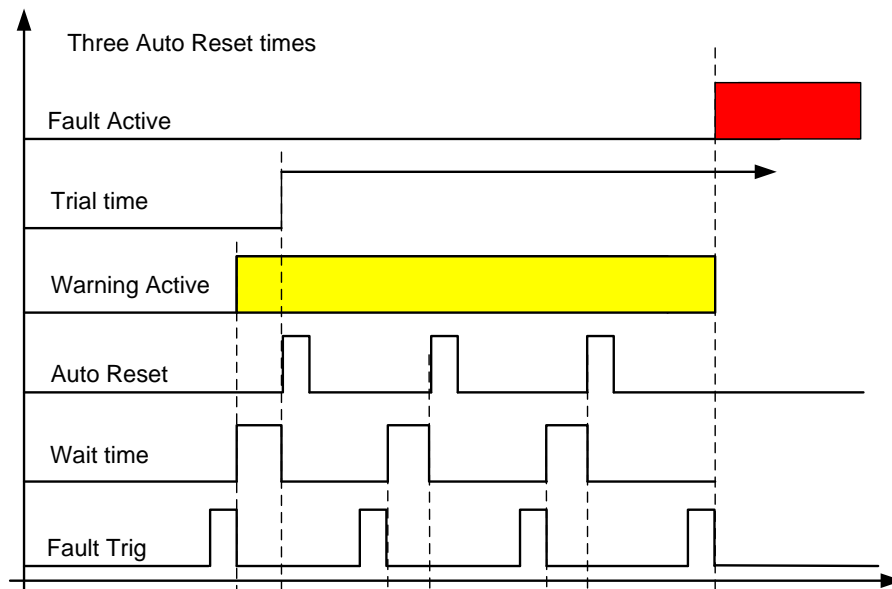


Figure 8-16. Example of Automatic restarts with three restarts

P2.14.3 Automatic restart: Start function ID719 "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.

P2.14.4 *Number of tries after undervoltage fault trip* **ID720** *“Undervolt. Tries”*

This parameter determines how many automatic fault resets can be made during the trial time after undervoltage trip.

- 0 = No automatic reset
- >0 = Number of automatic fault resets after undervoltage fault.

P2.14.5 *Number of tries after overvoltage trip* **ID721** *“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.

P2.14.6 *Number of tries after overcurrent trip* **ID722** *“Overcurr. Tries”*

(NOTE! IGBT temp faults also included)

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.

P2.14.7 *Number of tries after reference trip* **ID723** *“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 analogue current signal (4...20mA) has returned to the normal level ($\geq 4\text{mA}$)

P2.14.8 *Number of tries after motor temperature fault trip* **ID726** *“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

P2.14.9 *Number of tries after external fault trip* **ID725** *“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

P2.14.10 Number of tries after underload fault trip ID738 "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 of automatic fault resets after Underload fault trip

8.15 Line Synchronization

2.15.1 Control Mode ID1626

This parameter defines what kind of motor starting and stopping configuration is used.

0 = Single Drive

Only one motor is used in the system, Active direct command will also open the NET contactor when there is a LOW signal.

1 = Multi-Motor

Drive needs a command signal what motor will be synchronized to network. Also separate input is needed [Reset Direct] to open Net contactor. This parameter can also be used with one motor ID1627.

2 = In Sequence

All motors in the system are set to Net in sequence when synchronization and active direct commands are active. Use ID1700 to select if rising edge is required for these commands.

2.15.2 Controlled motor ID1611

This parameter defines what motor is controlled from the drive when using multi-motor control mode. Use of digital inputs for selection will bypass this parameter selection.

2.15.3 Delay to coasting ID1621

This parameter defines the delay when modulation will be stopped from internal decision to make the change. See operation details from chapter 2.

2.15.4 Delay to Open ID1623

This parameter defines the delay when the FC contactor will be opened from internal decision to make the change. See operation details from chapter 2.

2.15.5 Delay to Close ID1624

This parameter defines the delay when the NET contactor will be closed from internal decision to make the change net. See operation details from chapter 2.

2.15.6 Number of motors ID1627

Number of motors in the system. Used in multi-motor and In Sequence control modes.

8.15.1 *Line Synchronization Fine Tuning*

2.15.7.1 *Smoot / Speed ratio* ID1690

This parameter is used to select speed of synchronization; there are 10 settings, where selection 0 is smoothest and selection 10 fastest. To get maximum speed for synchronization brake resistor or AFE may be needed.

2.15.7.2 *Phase hysteresis* ID1620

This parameter defines hysteresis when FC voltage angle and NET voltage angle are considered to be in synch.

2.15.7.3 *Phase offset to NET* ID1608

This parameter defines the FC voltage angle advance to net voltage angle when the synchronization command is on. This parameter is adjusted depending on the motor load and the delay when the motor does not have current.

2.15.7.4 *Generator Side Operation* ID1538

0 = Enable

Drive will start phase synchronization regardless if frequency for synchronization needs to be increased or decreased.

1 = Disable

Drive will start phase synchronization only on motoring side. i.e. frequency is only increased when synchronization is made. May be used on high inertia system, when synchronized without load.

2.15.7.5 *Synchronization options* ID1700

This parameter is used to activate certain functions

b0 = Reserved

b1 = Single to Net

The drive will monitor the rising edge of synchronization command and change to net command. In sequence mode the drive starts the next motor but follows normal frequency reference until the rising edge command is given.

b2 = Reserved

b3 = Single Reset

Only one motor is taken from Net when this is active. If not active all motors that are in Net will be disconnected when Reset DOL command is given.

b4 = Reserved

b5 = Reserved

b6 = Reserved

b7 = Reserved

b8 = Reserved

b9 = Reserved

b10 = Reserved

b11 = Reserved

b12 = Disable Current Monitoring

Motor current is not monitored for interlock

b13 = Disable Volt Monitoring

Line voltage is not monitored from interlock

b14 = Disable Freq Monitoring

Line voltage frequency is not monitored for interlock

b15 = Disable Phase Current Monitoring

Motor Phase currents are not monitored for interlock.

2.15.7.6 *Start delay to FC* ID1628

This parameter defines the delay when the drive will start after the command to open the NET contactor has been given. FC Contactor will be closed half of this time.

2.15.7.7 *Line Frequency Reference Filter TC* ID1900

When synchronized to weak generator grid frequency of the generator may change during acceleration. This parameter can be used to filter out fast changes in grid frequency.

2.15.7.8 *Freq. Hysteresis for synch* ID1613

Frequency hysteresis when phase synchronization can be started.

2.15.7.9 *Frequency Hysteresis for Change* ID1614

Frequency hysteresis for DOL change. This parameter allow higher frequency range of change. i.e. if phase angle is within hysteresis but frequency not change can be made still made. Useful on weak/unstable grids.

2.15.7.10 *Delay To Synch ID1619*

When frequency is within Freq Hysteresis for Synch (P2.15.7.9) this parameter defines delay when phase synchronization is started. Useful when weak generator is used and frequency has destabilized during motor acceleration.

2.15.7.11 *Commissioning; Test modes ID1634*

Test modes for commissioning purposes, to activate test modes see also P2.15.7.12

0= Line synchronization mode

1= FC and NET contactor timing mode.

This mode will control motor 1 contactor without actual synchronization, only delay parameters for opening and closing are used. Change between FC and NET contactor is made with [Active Direct] command.

2= FC On, Net Off

This selection will force the FC contactor to close and the NET contactor to open.

3= FC Off, Net On

This selection will force FC contactor to open and Net contactor to close.

2.15.7.12 *Commissioning test activation ID1635*

This DI needs to be TRUE before test modes are activated. Use virtual input 0.2 if actual digital input is not available. This "extra" parameter has been added as a safety feature. When input is not active drive operates in normal Line Synch Mode.

8.16 Keypad control parameters

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

P3.1 Control Place ID125 "Control Place"

The active control place can be changed with this parameter.

Pushing the Start button for 3 seconds selects the control keypad as the active control place and copies the Run status information (Run/Stop, direction and reference).

0 = PC Control, Activeted by NCDrive

1 = I/O terminal

2 = Keypad

3 = Fieldbus

R3.2 Keypad Reference No ID "Keypad Reference"

The frequency reference can be adjusted from the keypad with this parameter.

The output frequency can be copied as the keypad reference by pushing the Stop button for 3 seconds when you are on any of the pages of menu **M3**.

P3.3 Keypad Direction ID123 "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.

P3.4 Stop button activated ID114 "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.

R3.5 Torque reference No ID "Torque Reference"

Define here the torque reference within 0.0...100.0%.

9. APPENDICES

In this chapter you will find additional information on special parameter groups. Such groups are:

- *Parameters of Motor thermal protection (Chapter 9.1)*
- *Parameters of Stall protection (Chapter 9.2)*
- *Parameters of Underload protection (Chapter 9.3)*
- *Fieldbus control parameters (Chapter 9.4)*
- *Line synchronization protections (Chapter 9.45)*

9.1 Parameters of motor thermal protection (ID's 704 to 708):

General

The motor thermal protection is to protect the motor from overheating. The Vacon 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 I_T specifies the load current above which the motor is overloaded. This current limit is a function of the output frequency.

The thermal stage of the motor can be monitored on the control keypad display V1.10 ID9. See the product's User's Manual.



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

9.2 Parameters of Stall protection (ID's 709 to 712):

General

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, [ID710 \(Stall current\)](#) and [ID712 \(Stall frequency limit\)](#). 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 overcurrent protection.

9.3 Parameters of Underload protection (ID's 713 to 716):

General

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.

Motor underload protection can be adjusted by setting the underload curve with parameters [ID714](#) (Field weakening area load) and [ID715](#) (Zero frequency load), see below. 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 I_H are used to find the scaling ratio for the internal torque value. If other than nominal motor is used with the drive, the accuracy of the torque calculation decreases.

9.4 Fieldbus control parameters (ID's 850 to 859)

The Fieldbus control parameters are used when the frequency or the speed reference comes from the fieldbus (Modbus, Profibus, DeviceNet etc.). With the Fieldbus Data Out Selection 1...8 you can monitor values from the fieldbus.

Process Data OUT (Slave → Master)

The fieldbus master can read the frequency converter's actual values using process data variables. *Basic, Standard, Local/Remote, Multi-Step, PID control and Pump and fan control* applications use process data as follows:

Data	Value	Unit	Scale	ID
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

The *Multipurpose* application has a selector parameter for every Process Data. The monitoring values and drive parameters can be selected using the ID number. Default selections are as in the table above.

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	Scale
208 – 240 Vac	NX0001 – NX0011	100 – 0,01A
208 – 240 Vac	NX0012 – NX0420	10 – 0,1A
208 – 240 Vac	NX0530	1 – 1A
380 – 500 Vac	NX0003 – NX0007	100 – 0,01A
380 – 500 Vac	NX0009 – NX0300	10 – 0,1A
380 – 500 Vac	NX0385 – NX2643	1 – 1A
525 – 690 Vac	NX0004 – NX0013	100 – 0,01A
525 – 690 Vac	NX0018 – NX0261	10 – 0,1A
525 – 690 Vac	NX0325 – NX1500	1 – 1A

Process Data IN (Master -> Slave)

ControlWord, Reference and Process Data are used with All-inOne applications as follows:

Basic, Standard, Local/Remote, Multi-Step applications

Data	Value	Unit	Scale
Reference	Speed Reference	%	0.01%
ControlWord	Start/Stop Command Fault reset Command	-	-
PD1 – PD8	Not used	-	-

Multipurpose control application

Data	Value	Unit	Scale
Reference	Speed Reference	%	0.01%
ControlWord	Start/Stop Command Fault reset Command	-	-
Process Data IN1	Torque Reference	%	0.1%
Process Data IN2	Free Analogue INPUT	%	0.01%
Process Data IN3	Adjust Input	%	0.01%
PD3 – PD8	Not Used	-	-

PID control and Pump and fan control applications

Data	Value	Unit	Scale
Reference	Speed Reference	%	0.01%
ControlWord	Start/Stop Command Fault reset Command	-	-
Process Data IN1	Reference for PID controller	%	0.01%
Process Data IN2	Actual Value 1 to PID controller	%	0.01%
Process Data IN3	Actual Value 2 to PID controller	%	0.01%
PD4–PD8	Not Used	-	-

9.5 Line synchronization protection functions

80	Both ON	Both contactors have been closed while drive is run state.	
81	CAN Communication	Communication to externals CAN I/O has stopped.	Communication can not be started again until drive is powered down.
82	Frequency error D7	Measured frequency is not within hysteresis.	Check that drive sees correct and positive frequency.
83	Voltage error D7	Measured voltage is not within hysteresis	Check that all phases are measured.
84	Motor Current	Motor current is not within hysteresis to make synchronization to net	FC Contactor has not been closed or motor nominal current has been set too high related to used motor.
85	DC Low	Measured DC voltage was too low	
86	AC Voltage	Measured line voltage was too low	
87	ByPass interlock	External line measurement indicated that line is down	

9.5.1 Fault 80, both contactor on while running

This fault is active when feedback from the first motor contactors is being used.

This fault will appear if feedback from both contactors indicates that contactors are closed and the drive is modulating. When this happens, the drive will stop modulation immediately. Check the timing of the coasting delay, contactor opening delay and contactor closing delay.

9.5.2 Fault 81, Can communication

Communication to external CAN I/O has interrupted. When this fault happens, the drive will internally force the contactor control to off and the fault will not reset until the drive is powered down.

9.5.3 Fault 82, Frequency error D7

Measured line frequency is not within hysteresis. Measured line voltage frequency must be higher than + 25 Hz and less than + 75 Hz. If frequency is not within these hysteresis, the drive will not try to make synchronization to net.

9.5.4 Fault 83, Voltage error D7

Measured line voltage is less than 90 % of motor nominal voltage. If measured voltage is zero, two or all phase measurements are not connected to net; if some voltage is measured then probably one phase is not connected to net. Drive will not make synchronization if voltage is below 90 % of motor nominal voltage.

9.5.5 Fault 84, Motor current

Measured motor current is less than 15% of motor nominal current while in FC control. This usually means that the FC contactor has not been closed properly. Drive will not make changeover to net if the current is below 15% of motor nominal current.

9.5.6 Fault 85, DC Low

This function monitors the drive's own DC voltage. If the voltage goes below a set limit, the drive will force open all contactors. This function is used to prevent DOL start if net is lost while motors are connected to net. If the drive is separated from net when synchronization is done, set response to No Response. When the fault has occurred give command to open all NET contactors. This fault is possible to reset when internal logic sees that no DOL control is active (contactor control word is zero).

9.5.7 Fault 86, AC Voltage

This function monitors line rms voltage. If voltage goes below a set limit, the drive will force all contactors open. This function is used to prevent DOL start if net is lost while motors are connected to net. If the measurements are isolated from net when synchronization is done, set response to No Response. When the fault has occurred give command to open all NET contactors. This fault is possible to reset when internal logic sees that no DOL control is active (contactor control word is zero).

9.5.8 Fault 87, ByPass Interlock

This function monitors DI where is connected input from any device that can indicate if three phase voltage input is interrupted to motor (NET monitor device, motor DOL thermal protection). This function is used to prevent DOL start if net is lost while motors are connected to net. When fault is activated drive will open all DO controls that are controlling DOL contactors. Normal operation can be started again when command to open all DO's has been given (contactor control word is zero).

9.5.9 OPT-AF and Emergency Stop

When emergency stop or OPT-AF functions are activated drive will force all contactors open. This is not however part of the Safe Torque Off functionality.

10. FAULT CODES

The fault codes, their causes and correcting actions are presented in the table below. The shadowed faults are A faults only. The items written in white on black background present faults for which you can program different responses in the application. See parameter group Protections.

Note: When contacting distributor or factory because of a fault condition, always write down all texts and codes on the keypad display.

Fault code	Fault	Possible cause	Correcting measures
1	Overcurrent	Frequency converter has detected too high a current ($>4 \cdot I_H$) in the motor cable: – sudden heavy load increase – short circuit in motor cables – unsuitable motor Subcode in T.14 : S1 = Hardware trip S2 = reserved S3 = Current controller supervision	- Check loading. - Check motor. - Check cables. - Make Identification run
2	Overvoltage	The DC-link voltage has exceeded the drive limit. See User manual. - Too short a deceleration time - high overvoltage spikes in supply Subcode in T.14 : S1 = Hardware trip S2 = Overvoltage control supervision	- Make the deceleration time longer. - Use brake chopper or brake resistor (available as options) - Activate over voltage controller. - Check input voltage
3	Earth fault	Current measurement has detected that the sum of motor phase current is not zero. – insulation failure in cables or motor	- Check motor cables and motor.
5	Charging switch	The charging switch is open, when the START command has been given. – faulty operation – component failure	- Reset the fault and restart. - Should the fault re-occur, contact your local distributor.
6	Emergency stop	Stop signal has been given from the option board.	- Check emergency stop circuit
7	Saturation trip	Various causes: – defective component – brake resistor short-circuit or overload	- Cannot be reset from the keypad. - Switch off power. - DO NOT RE-CONNECT POWER! - Contact your local distributor. - If this fault appears simultaneously with Fault 1, check motor cables and motor

8	System fault	<ul style="list-style-type: none"> - component failure - faulty operation Note exceptional fault data record Subcode in T.14 : S1 = Reserved S2 = Reserved S3 = Reserved S4 = Reserved S5 = Reserved S6 = Reserved S7 = Charging switch S8 = No power to driver card S9 = Power unit communication (TX) S10 = Power unit communication (Trip) S11 = Power unit comm. (Measurement)	Reset the fault and restart. Should the fault re-occur, contact your local distributor.
9	Undervoltage	DC-link voltage is under the drive fault voltage limit. See user manual. <ul style="list-style-type: none"> - most probable cause: too low a supply voltage - frequency converter internal fault - One of input fuse is broken. - External charge switch have not been closed. Subcode in T.14 : S1 = DC-link too low during run S2 = No data from power unit S3 = Undervoltage control supervision	<ul style="list-style-type: none"> - In case of temporary supply voltage break, reset the fault and restart the frequency converter. - Check the supply voltage. - If it is adequate, an internal failure has occurred. - Check input fuses - Check DC charge function - Contact your local distributor.
10	Input line supervision	Input line phase is missing. Subcode in T.14 : S1 = Phase supervision diode supply S2 = Phase supervision active front end	Check supply voltage, fuses and cable.
11	Output phase supervision	Current measurement has detected that there is no current in one motor phase.	Check motor cable and motor.
12	Brake chopper supervision	<ul style="list-style-type: none"> - no brake resistor installed - brake resistor is broken - brake chopper failure 	<ul style="list-style-type: none"> - Check brake resistor and cabling. - If ok, the chopper is faulty. Contact your local distributor.
13	Frequency converter under-temperature	Heatsink temperature is under -10°C	
14	Frequency converter over-temperature	Heatsink temperature is over 90°C Overtemperature warning is issued when the heatsink temperature exceeds 85°C.	<ul style="list-style-type: none"> - Check the correct amount and flow of cooling air. - Check the heatsink for dust. - Check the ambient temperature. - Make sure that the switching frequency is not too high in relation to ambient temperature and motor load.
15	Motor stalled	Motor stall protection has tripped.	Check motor and load.
16	Motor over-temperature	Motor overheating has been detected by frequency converter motor temperature model. Motor is overloaded.	Decrease the motor load. If no motor overload exists, check the temperature model parameters.
17	Motor underload	Motor underload protection has tripped.	Check load.

18	Unbalance (Warning only)	Unbalance between power modules in paralleled units. Subcode in T.14 : S1 = Current unbalance S2 = DC-Voltage unbalance	Should the fault re-occur, contact your local distributor.
22	EEPROM checksum fault	Parameter save fault – faulty operation – component failure	Should the fault re-occur, contact your local distributor.
24	Counter fault	Values displayed on counters are incorrect	Have a critical attitude towards values shown on counters.
25	Microprocessor watchdog fault	– faulty operation – component failure	Reset the fault and restart. Should the fault re-occur, contact your local distributor.
26	Start-up prevented	- Start-up of the drive has been prevented. - Run request is ON when new application is loaded to drive	- Cancel prevention of start-up if this can be done safely. - Remove Run Request.
29	Thermistor fault	The thermistor input of option board has detected too high a motor temperature	Check motor cooling and loading Check thermistor connection (If thermistor input of the option board is not in use it has to be short circuited)
31	IGBT temperature (hardware)	IGBT Inverter Bridge overtemperature protection has detected too high a short term overload current	- Check loading. - Check motor size. - Make identification Run
32	Fan cooling	Cooling fan of the frequency converter does not start, when ON command is given	Contact your local distributor.
34	CAN bus communication	Sent message not acknowledged.	Ensure that there is another device on the bus with the same configuration.
35	Application	Problem in application software	Contact your distributor. If you are application programmer check the application program.
37	Device changed (same type)	Option board or power unit changed. New device of same type and rating.	Reset. Device is ready for use. Old parameter settings will be used.
38	Device added (same type)	Option board added.	Reset. Device is ready for use. Old board settings will be used.
39	Device removed	Option board removed.	Reset. Device no longer available.
40	Device unknown	Unknown option board or drive. Subcode in T.14 : S1 = Unknown device S2 = Power1 not same type as Power2	Contact the distributor near to you.
41	IGBT temperature	IGBT Inverter Bridge overtemperature protection has detected too high a short term overload current	- Check loading. - Check motor size. - Make Identification run
43	Encoder fault	Problem detected in encoder signals. Sub code in T.14 : 1 =Encoder 1 channel A is missing 2 =Encoder 1 channel B is missing 3 =Both encoder 1 channels are missing 4 =Encoder reversed 5 =Encoder board missing	- Check encoder channel connections. - Check the encoder board. - Check encoder frequency in open loop
44	Device changed (different type)	Option board or power unit changed. New device of different type or different rating than the previous one.	Reset Set the option board parameters again if option board changed. Set converter parameters again if power unit changed.

45	Device added (different type)	Option board of different type added.	Reset Set the option board parameters again.
50	Analogue input $I_{in} < 4\text{mA}$ (sel. signal range 4 to 20 mA)	Current at the analogue input is $< 4\text{mA}$. – signal source has failed control cable is broken or loose	Check the current loop circuitry.
51	External fault	Digital input fault.	- Remove fault situation from external device.
52	Keypad communication fault	The connection between the control keypad or NCDrive and the frequency converter is broken.	Check keypad connection and possible keypad cable.
53	Fieldbus fault	The data connection between the fieldbus Master and the fieldbus board is broken	Check installation. If installation is correct contact the nearest Vacon distributor.
54	Slot fault	Defective option board or slot	Check board and slot. Contact the nearest Vacon distributor.
56	PT100 board temp. fault	Temperature limit values set for the PT100 board parameters have been exceeded	Find the cause of temperature rise
57	Identification (Warning only)	Identification run have been failed	- Run command was removed before identification was ready - Motor is not connected to frequency converter. - There is load on motor shaft.
58	Brake	Actual status of the brake is opposite than control signal.	Check mechanical brake condition and connections.
59	Follower Communication	SystemBus or CAN communication is broken between master and follower	Check parameters from expanderboard and optical fibre or CAN cable.
60	Cooling	Liquid cooled drive cooling circulation have been failed	Check reason for cooling failure from external system.
61	Speed Error	Motor speed is not the same than reference.	-Check encoder connegtion - PMS motor has been gone over pull out torque.
62	Run Disable	- Run Enable signal is Low	- Check reason for Run Enable signal.
63	Emergency stop (Warning only)	Digital input or fieldbus have give command to make emergency stop	New run command is accepted after emergency stop is reset.
64	Input switch open	Drive input switch is opened	Check the main power switch of the drive.
65	PT100 board two temp. fault	Temperature limit values set for the PT100 board parameters have been exceeded	Find the cause of temperature rise
80	Both ON	Both contactors have been closed while drive is run state	
81	CAN Communication	Communication to externals CAN I/O have stopped.	Communication can not be started again until drive is powered down.
82	Frequency error D7	Measured frequency is not within hysteresis.	Check that drive sees correct and positive frequency.
83	Voltage error D7	Measured voltage is not within hysteresis	Check that all phases are measured.
84	Motor Current	Motor current is not within hysteresis to make synchronization to net	FC Contactor has not been closed or motor nominal current has been set too high related to used motor.

85	DC Low	Measured DC voltage was going too low	
86	AC Voltage	Measured line voltage was going too low	
87	Net Is Down	External line measurement indicated that line is down	
88	DOL Conflict	Feedback and control signals are opposite	Check reason for DOL malfunction.

Table 10-1. Fault codes

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