vacon® nx

ac drives

Line Synchronization II

Apfiff44

application manual

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VACON® LINE SYNCHRONIZATION II APPLICATION MANUAL

INDEX

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1. VACON® LINE SYNCHRONIZATION II APPLICATION

Software APFIFF44

1.1 Introduction

The purpose of APFIFF44 Line Synchronization Application is to operate as a smooth soft starter.

This application is designed 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's. The motors that are used can be of different sizes, but the nominal voltage of the motors needs to be the same. Line synchronization itself does not need additional chokes in output due to advanced control. The drive can compensate for delays in contactors.

1.2 General

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

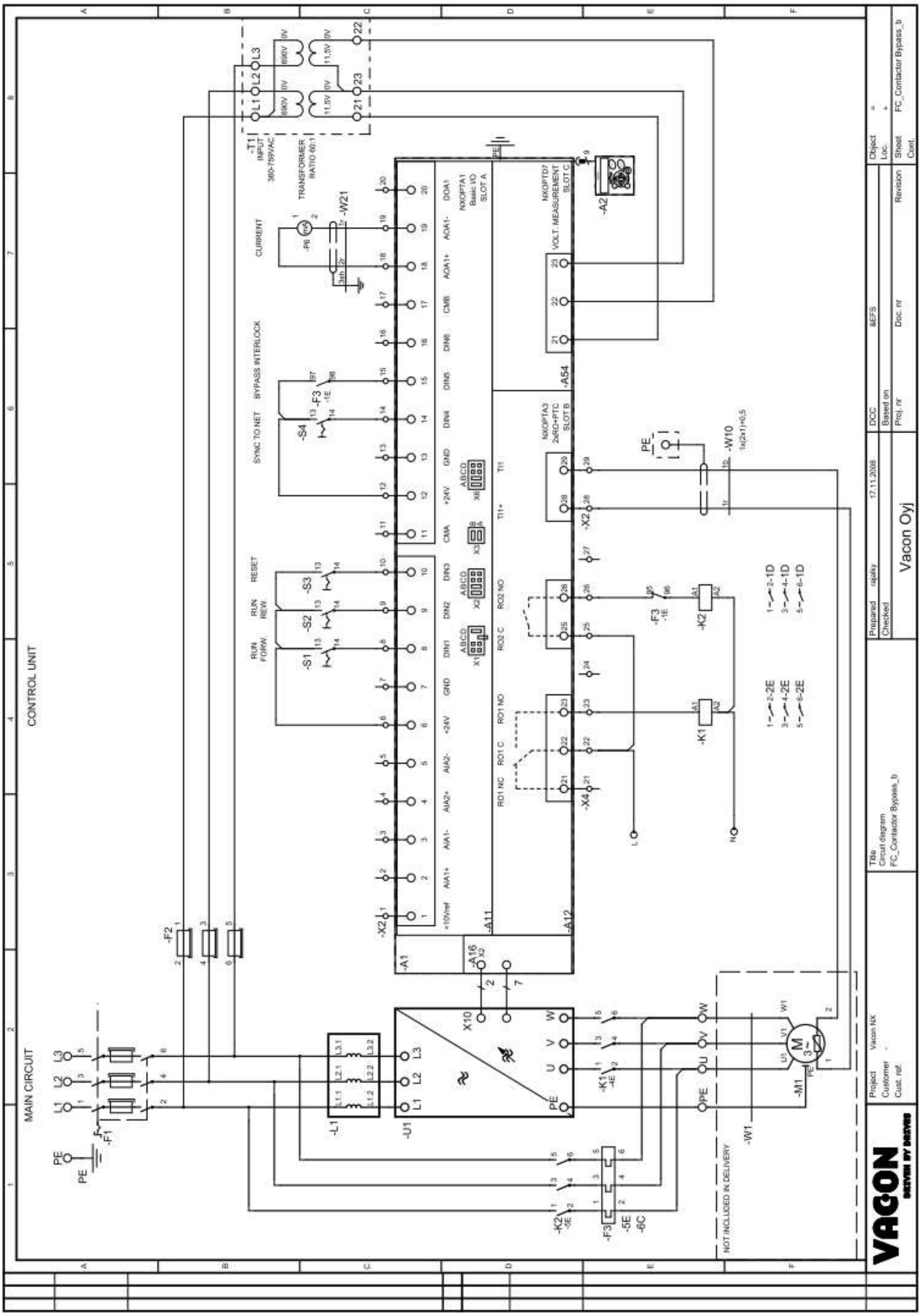
- Digital inputs and all outputs are freely programmable
- Application supports all I/O boards

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
- Auto fault reset function
- Power limit functions
- Different power limits for motoring and generating sides
- Different torque limits for motoring and generating sides
- 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 Line Synchronization Application are explained in chapter Description of parameters of this manual. The explanations are arranged according to the individual ID numbers of the parameters.

1.3 Connection example



1.4 OPT-D7

OPT-D7 is an AC sinusoidal voltage measurement board used with VACON® NXP drives. Using this board, VACON® NXP drive measures the line voltage, frequency and voltage angle. VACON® NXP can compare this information with its output voltage angle when it is running. This feature can be used to make synchronizations to gird that is measured.

The purpose of APFIFF44 Line Synchronization Application is to operate as a smooth soft starter.

The OPT-D7 board is delivered with a transformer that is suitable for voltage range up to 690 VAC. Note that the transformer cannot be used with the pulse-width modulated (PWM) voltage input.

It is possible to use a custom-built transformer when the input voltage to be measured is not within the voltage range of the OPT-D7 transformer. In such a case, the transformation ratio parameter can be adjusted as per the transformer primary to secondary ratio. See details from OPT-D7 User Manual.

2. LINE SYNCHRO GENERAL

2.1 Purpose

This application is designed to run a motor to net frequency and make contactor change so that the motor is running directly from the network. Also synchronization backwards is possible. Drive synchronizes to grid without the motor and changes to drive control. Application presentation is available from product managers.

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 a synchronization command is given [P:**ActiveSynchro** (DI:HIGH)], the frequency reference is changed to net voltage frequency. When the voltage frequency is within 0.10 Hz hysteresis with network voltage frequency, the drive makes small adjustments to frequency reference so that the line voltage angle and FC voltage angle are the same with the given offset [P:**PhaseOffSetToNet**].

The drive remains at this synchronization until a command to end synchronization or a command to change network [P:**ActiveDirect**] (DI:HIGH)] is given. When a 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 the change. When an internal decision is made:

- Drive stops modulation within given delay [P:**DelayToCoasting**].
- Drive opens FC contactor within given delay [P:**DelayToOpen**].
- 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)]

<u>2. MultiMotorControl:</u> [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 with flying start

When controlled motor is in the net:
Drive waits to receive back the FC command [**ResetDirect** (HIGH)] or [**ActiveDirect** (LOW)].
When the command is given and the drive start command is active:

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

Depending on the status of [P:**ActiveSynchro**], the drive keeps synchronization on start or follows the given reference.
If start command is not active, the NET contactor is opened without starting modulation.

2.2.3 To FC with synchronization (BackSynch)

When a controlled motor is connected to NET and P:SynchToMotor is active:
Keep or give drive a start command and keep the synchronization command active.
Now the drive waits for a command to reset DOL.

When the DOL Reset command is given:

- Drive starts directly to grid frequency (motor frequency).
  - FC contactor is open.
  - NET contactor is closed.
- Makes synchronization to grid phase angle.
- When the frequency and angle is within hysteresis, a decision to make the change is made.
- Depending on timing:
  - FC contactor is closed.
  - NET contactor is opened.
- After this, the synchronization command can be removed, and the drive follows normal frequency reference.

2.2.4 ***Contactors and breakers***

The mechanical timing of the breakers and contactors can change over time. It has been noticed that in some systems where the BackSynch feature has been used the timing of the breakers or contactors has changed considerably after few months. Thus, readjustment of the timing may be needed.

For example, when the motor was without current for approximately 6 ms during initial commissioning, the changeover happened without any problem. Few months after the initial commissioning overcurrent faults started to happen. When analyzing datalogger and oscilloscope information, it was notices that the motor was now without current for approximately 30 ms. This was causing the angle to change so much that the overcurrent trip limit was reached when the FC contactor was closed over.

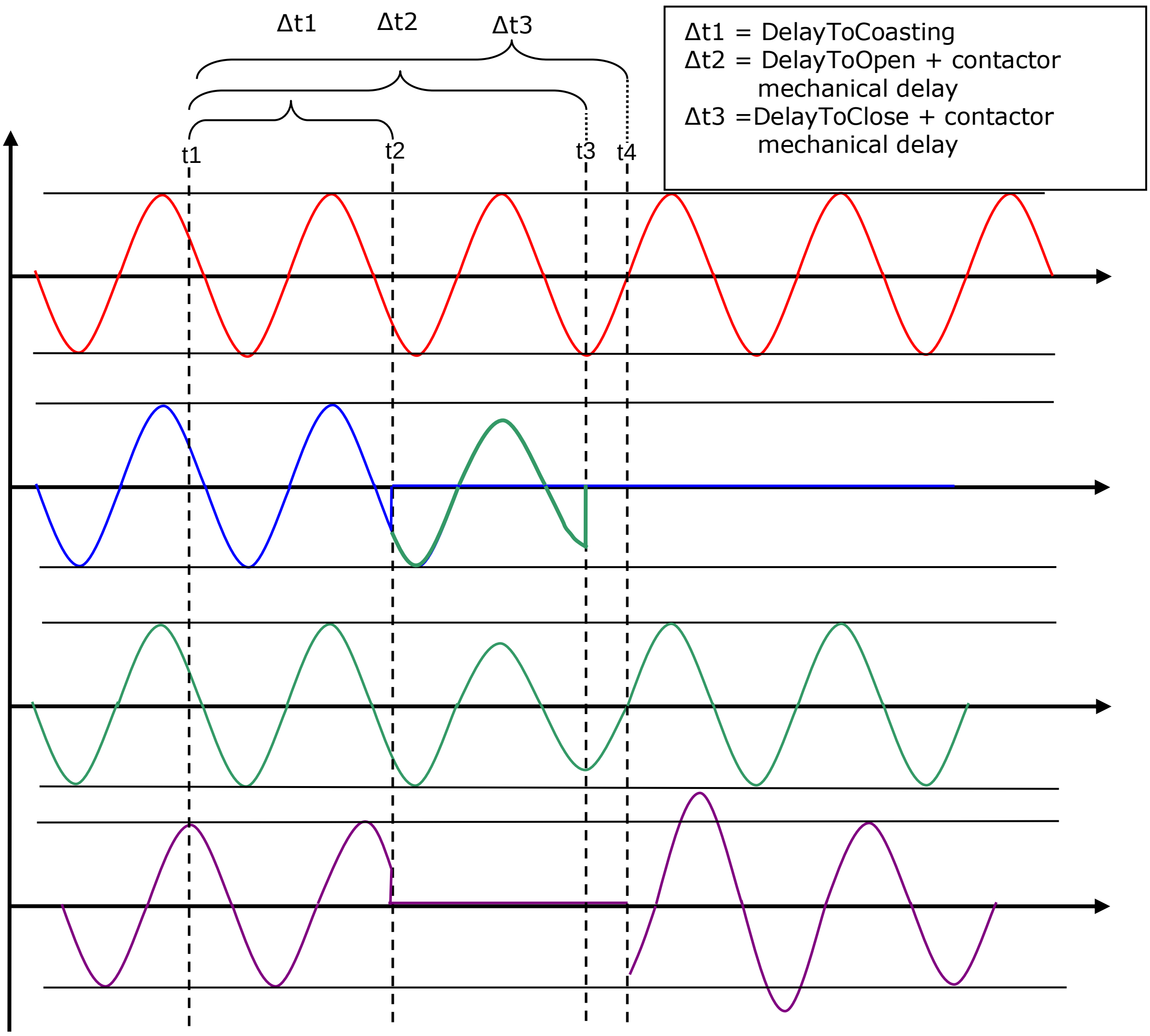
It is recommended to check/readjust contactor delays three months and/or six months after commission, and from then on every twelve months to ensure proper operation of synchronization.

The manufacturer does not take responsibility of timing changes of contactors/breakers over time.

2.2.5 ***Motors***

For line synchronization, it is recommended to select motors that have a relatively high slip frequency. When the motor has a high slip frequency, changeovers are easier to adjust. Low slip motors require more accurate timing.

2.3 Timing



Line voltage, FC voltage, Motor voltage and Motor current

t1: Application makes decision to change to the network, command to open FC contactor is given.
t2: Drive stops modulation after a delay [P:DelayToCoasting].

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

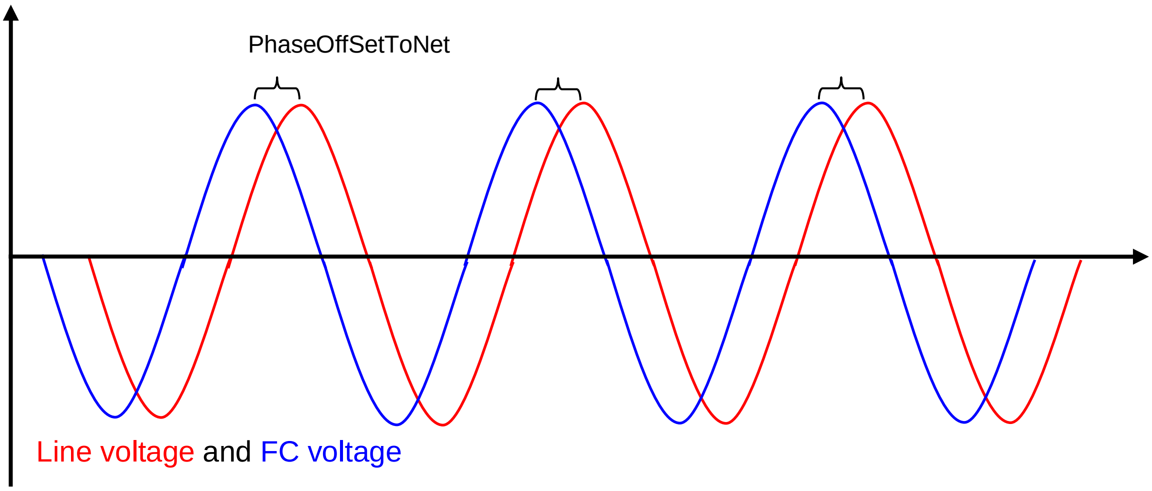
t3: FC contactor is mechanically opened.

- d. FC does not see motor voltage.

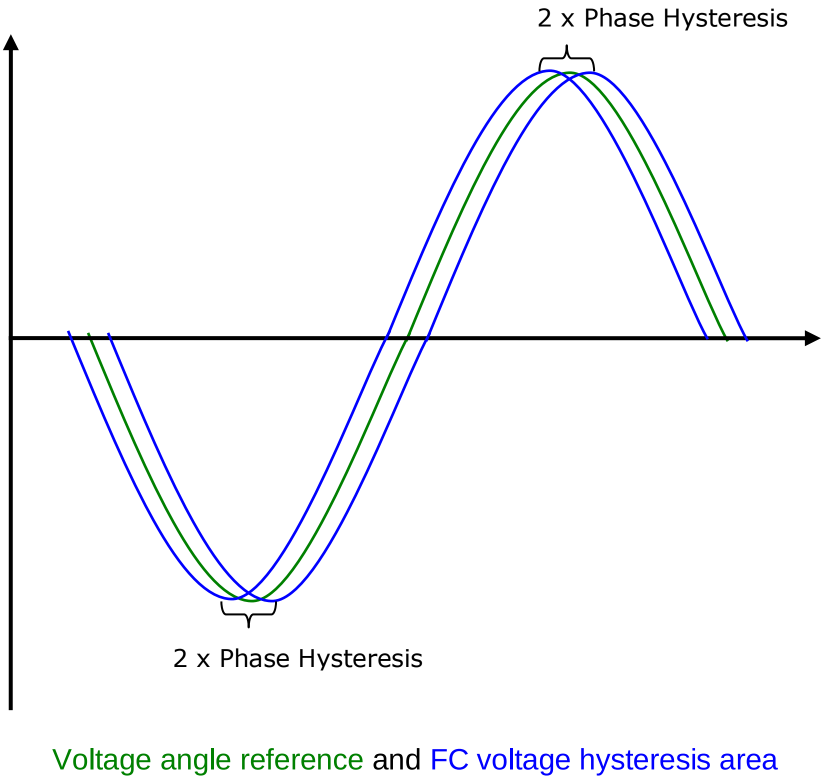
t4: NET contactor is mechanically closed

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

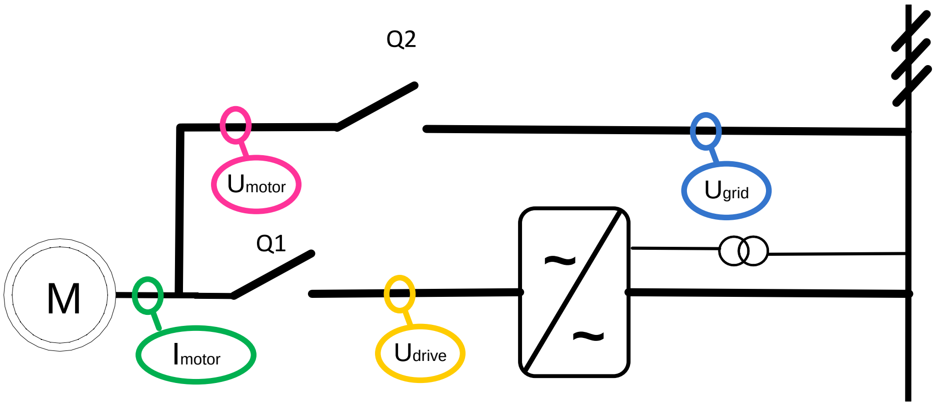
2.4 Phase Offset To Net



2.5 Phase Hysteresis



2.6 Commissioning



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

- Drive should not be in run state when NET contactor is closed.
- 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 time if the drive is not modulating.

During commissioning the following issues need 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 the same settings.

Use of interlocks:

- NET contactor cannot have an interlock from FC contactor.
    - Interlock can be used momentarily if contactor delays are not known during commissioning.
- 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. If possible, make test runs without any load on motor shaft.
5. When the timing of the 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 contactor and the closing of NET contactor happen immediately after modulation stops.
      i. Increase the modulation stop and FC contactor opening delay if the closing delay of the NET contactor is long.
6. Recommended time for no current situation is about 20 ms.
   a. Half of a cycle (5 ms) is the minimum time due to the aging of the contactors.
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.

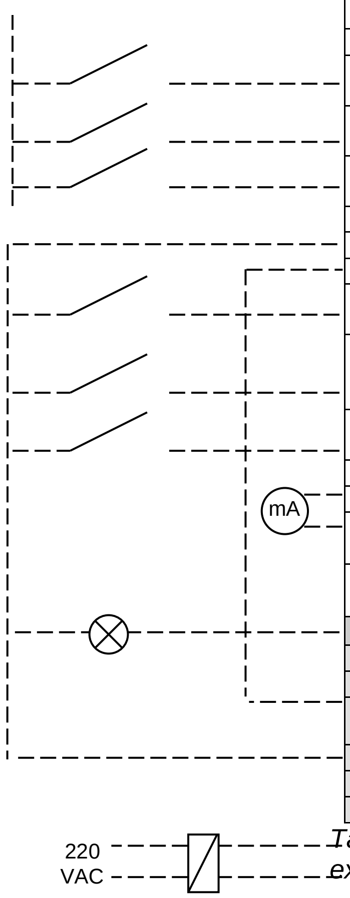
TIP:
Adjusting the field weakening point voltage higher so that the motor BEM voltage is the same as the line voltage at the moment of closing the NET contactor may decrease current spike.

3. VERSION PARAMETER COMPATIBILITY ISSUES

- No compatibility issues

4. CONTROL I/O

Reference potentiometer, 1…10 kΩ

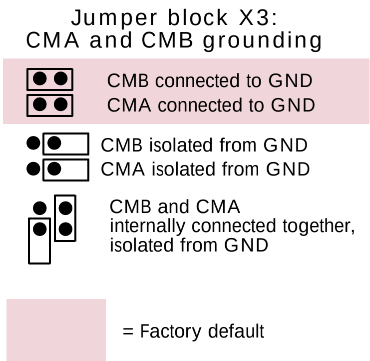


OPTA1			
Terminal		Signal	Description
1	+10V$_{ref}$	Reference voltage output	Voltage for potentiometer, etc.
2	AI1+	Analogue input 1. Range 0–10 V, R_i = 200 Ω Range 0–20 mA R_i = 250 Ω	Analogue input 1 frequency reference. Input range selected by jumpers. Default range: Voltage 0–10 V.
3	AI1-	I/O ground	Ground for reference and controls.
4	AI2+	Analogue input 2. Range 0–10 V, R_i = 200 Ω Range 0–20 mA R_i = 250 Ω	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 +24 V.
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 +24 V.
18	AOA1+	Analog output 1 Programmable P2.3.1.2	Output range selected by jumpers. Range 0–20 mA. R_L, max. 500 Ω. Range 0–10 V. R_L > 1 kΩ.
19	AOA1-		
20	DOA1	Digital output	Programmable Open collector, I≤50 mA, U≤48 VDC.
OPTA2			
21	RO1	Relay output 1 FC contactor control Programmable G2.3.3	Switching capacity 24 VCD / 8 A 250 VAC / 8 A 125 VDC / 0.4 A
22	RO1		
23	RO1		
24	RO2	Relay output 1 NET contactor control Programmable G2.3.3	Programmable No function defined at default.
25	RO2		
26	RO2		

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

Note: For hardware specifications and configuration, see chapter “Control Connections” in User Manual.

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



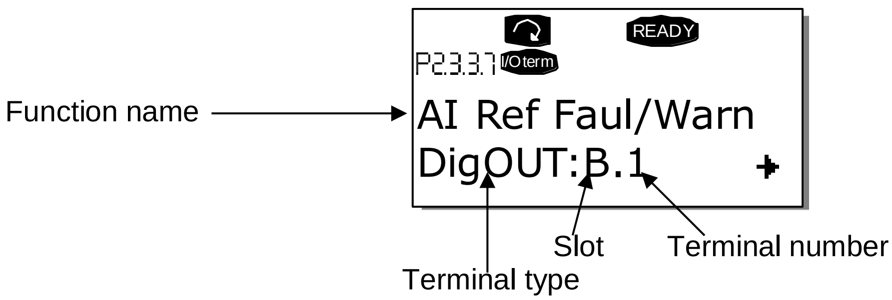
5. TERMINAL TO FUNCTION (TTF) PROGRAMMING PRINCIPLE

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 other applications) is different compared to the conventional method used in other VACON® NX applications.

In the conventional programming method, *Function to Terminal (FTT) programming method,* a certain function is defined for a fixed input or output. The applications mentioned above, however, use the *Terminal to Function (TTF) programming method* in which the programming process is carried out the other way round: Functions appear as parameters for which the operator defines a certain input/output. See Warning on page 19.

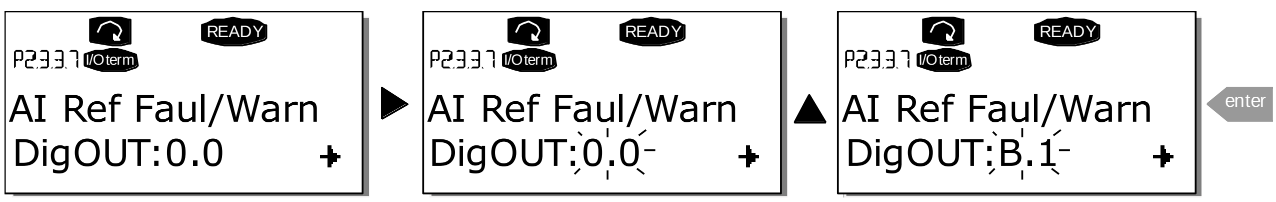
5.1 **Defining an input/output for a certain function on keypad**

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 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 Manual, chapter 6.2).

First, find the parameter 2.3.3.7 on the keypad. To enter edit mode, press the *Menu button right* once. On the left side on the value line, you will see the terminal type (DigIN, DigOUT, An.IN, An.OUT). On the right is the present input/output that the function is connected to (B.3, A.2 etc.). If the function is not connected to any input/output, the value is (0.#).
To find the desired option slot and signal number, hold down the *Browser button up* or *down* when the value is blinking. The program scrolls through the option slots, starting from **0** and proceeding from **A** to **E,** and the I/O selection from **1** to **10**.
After 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 must establish the connection between the function and input/output in the same way as with the control panel. Select the address code from the drop-down menu in the value column (see the following figure).

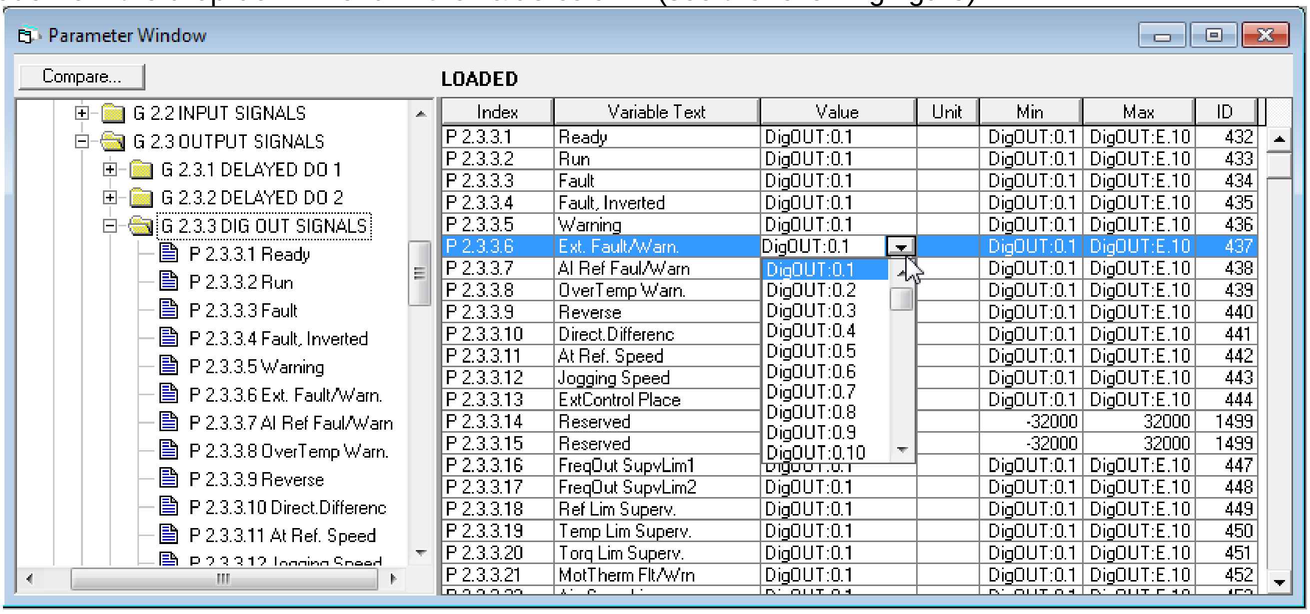


Figure 5-1. Screenshot of NCDrive programming tool; Entering the address code

WARNING	**In order to avoid function overruns and to ensure flawless operation, be ABSOLUTELY sure not to connect two functions to one and same output.**

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 option slot value **0** and the value **1** also for the terminal number. The value **0.1** is the default value for most of the functions. However, if you want to use the **values of a digital input signal**, for example for testing purposes only, you can set the option slot value to **0** and the terminal number to any number between 2 and 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. LINE SYNCH APPLICATION – MONITORING VALUES

This chapter contains lists of parameters within their respective parameter groups. The parameter descriptions are given on pages **Error! Bookmark not defined.** to 157.

Column explanations:

Code	=	Location indication on the keypad: shows the operator the present parameter number
Parameter	=	Name of parameter
Min	=	Minimum value of parameter
Max	=	Maximum value of parameter
Unit	=	Unit of parameter value, given if available
Default	=	Value preset by factory
Cust	=	Customer's own setting
ID	=	ID number of the parameter
(cyan)	=	On parameter code: Parameter value can only be changed after the FC has been stopped.
(grey)	=	Apply the Terminal to Function (TFF) method to these parameters (see chapter **Error! Reference source not found.**)
(yellow)	=	Monitoring value can be controlled from fieldbus by ID number

6.1 Monitoring values

The monitoring values are the actual values of parameters and signals as well as statuses and measurements. For more information, see VACON® NX User Manual, chapter 7.

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	ºC	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*

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	ºC	50	
V1.23.6	Measured temperature 2	ºC	51	
V1.23.7	Measured temperature 3	ºC	52	
V1.23.8	Measured temperature 4	ºC	54	
V1.23.9	Measured temperature 5	ºC	55	
V1.23.10	Measured temperature 6	ºC	63	
V1.23.11	Analogue input 1	%	59	AI1
V1.23.12	Analogue input 2	%	60	AI2
V1.23.13	Analogue input 3	%	61	AI3
V1.23.14	Analogue input 4	%	62	AI4
V1.23.15	Final Frequency Reference	Hz	1131	
V1.23.16	Output power	kW	1508	Drive output power in kW
V1.23.17	Flux Current	%	72	
V1.23.18	ID Run Status		49	

Table 6-2. Monitoring values 2

6.1.2 *Fieldbus monitoring values*

Code	Parameter	Unit	ID	Description
V1.24.1	FB Control Word		1160	
V1.24.2	FB Status Word		65	
V1.24.3	FB Torque Reference	%	1140	Default control of FB PD 1
V1.24.4	FB Limit Scaling	%	46	Default control of FB PD 2
V1.24.5	FB Adjust Reference	%	47	Default control of FB PD 3
V1.24.6	FB Analogue Output	%	48	Default control of FB PD 4
V1.24.7	Last Active Fault		37	
V1.24.8	FB Motor Current	A	45	Motor current (drive independent) given with one decimal point
V1.24.9	Din Status Word		56	
V1.24.10	Din Status Word 2		57	
V1.24.11	Last Active Warning		74	
V1.24.12	MC Status		64	

Table 6-3. Fieldbus monitoring values

6.1.3 *Line synchro monitoring values*

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	Contactor 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	
V1.25.12	FC1 CB Hours	h	1662	
V1.25.13	DL1 CB Hours	h	1663	
V1.25.14	FC1 Counter		1666	
V1.25.15	DL1 Counter		1667	

Table 6-4. Synchro monitoring values

6.1.4 *Flying start monitoring values*

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	100–0.01 A
208–240 VAC	NX0012–NX0420	10–0.1 A
208–240 VAC	NX0530	1–1 A
380–500 VAC	NX0003–NX0007	100–0.01 A
380–500 VAC	NX0009–NX0300	10–0.1 A
380–500 VAC	NX0385–NX2643	1–1 A
525–690 VAC	NX0004–NX0013	100–0.01 A
525–690 VAC	NX0018–NX0261	10–0.1 A
525–690 VAC	NX0325–NX1500	1–1 A

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

Heat sink 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 ºC 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 circuit breaker feedback
b9		Motor synchronized with grid
b10		NET circuit breaker 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	Connect direct	Internal command to close NET contactor

V1.23.5 Measured temperature 1 ºC ID 50

V1.23.6 Measured temperature 2 ºC ID 51

V1.23.7 Measured temperature 3 ºC ID 52

V1.23.8 Measured temperature 4 ºC ID 54

V1.23.9 Measured temperature 5 ºC ID 55

V1.23.10 Measured temperature 6 ºC ID 63

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

V1.23.11 Analogue input 1% ID 13

V1.23.12 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.

V1.23.13 Analogue input 3% ID 27

V1.23.14 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.

V1.23.15 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.

V1.23.16 Output Power kw ID 1508

Unfiltered electrical drive output power.

V1.23.17 Flux Current % ID 72

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

V1.23.18 ID Run Status ID49

6.2.2 *Fieldbus monitoring values*

V1.24.1 FB Control Word ID1160

Control word used in bypass mode. See P2.13.22 and option board ByPass.
More details in chapter 9 "Status and Control Word".

Bit	Description	
	Value = 0	Value = 1
0	OFF	ON, reset after fault or b1 and b2
1	Emergency stop by coast	ON, on normal operation: Keep TRUE
2	Emergency stop by ramp	ON, on normal operation: Keep TRUE
3	STOP REQUEST	RUN REQUST
4	Force ramp to zero	Enable ramp,
5	Freeze ramp	Enable ramp,
6	Force ref to zero	Enable ramp,
7	No action	FAULT RESET (0 -> 1)
8	No action	Inching 1
9	No action	Inching 2
10	Disable PROFIBUS control	Enable PROFIBUS control
11	Fieldbus DIN1=OFF	Fieldbus DIN1=ON (watchdog pulse)
12	Fieldbus DIN2=OFF	Fieldbus DIN2=ON
13	Fieldbus DIN3=OFF	Fieldbus DIN3=ON
14	Fieldbus DIN4=OFF	Fieldbus DIN4=ON
15	No action	No action

V1.24.2 FB Status Word ID65

PROFIdrive type status word. Not the same as used by PROFIBUS board in PROFIdrive mode. To be used, must to be selected with P2.14.19 GSW. See details in chapter 9 "Status and Control Word".

Bit	Description	
	Value = 0	Value = 1
0	Not ready to switch on	Ready to switch on
1	Not ready to operate	Ready to operate
2	Not running	Running
3	No fault	Fault
4	Coast stop active	Coast stop not active
5	Quick stop active	Quick stop not active
6	Switch not inhibited	Switch on inhibit
7	No warning	Warning
8	Speed error	Speed at reference
9	No FB control request	FB control active
10	Fout < Fmax	Fout > Fmax
11	Not used	Not used
12	Not used	Not used
13	Not used	Not used
14	Not used	Not used
15	Fieldbus DIN1=OFF	Fieldbus DIN1=ON (Watchdog pulse)

V1.24.3 FB Torque Reference % ID 1140

Torque reference value from fieldbus.
Default Control of FB PD 1.

V1.24.4 FB Limit Scaling % ID 46

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

V1.24.5 FB Adjust Reference % ID 47

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

V1.24.6 FB Analog Output % ID 48

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

V1.24.7 Fault History ID 37

Fault number of the last active fault.

V1.24.8 FB Motor Current A ID 45

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

V1.24.9 Din Status Word 1 ID 56

V1.24.10 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	

V1.24.11 Warning ID 74

Last active warning.

V1.24.12 MC Status ID 64

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

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

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 Synchronization	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	FC CB Feedback M1	Feedback status of drive Circuit Breaker Motor 1, if used.
b10	NET CB Feedback M1	Feedback status of NET Circuit Breaker Motor 1, if used.
b11		
b12		
b13		
b14	M1 FC CB Control	Motor 1 drive circuit breaker control status.
b15	M1 NET CB Control	Motor 1 NET circuit breaker control status.

V1.25.5 Contactor status Word ID1652

Status of the relay outputs. Note that the function that opens all relays, for example emergency stop, opens all relays but here is listed the 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 the 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.

V1.25.12 FC1 CB Hours h ID1662

V1.25.13 DL1 CB Hours h ID1663

V1.25.14 FC1 Counter ID1666

V1.25.15 DL1 Counter ID1667

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.

7. LINE SYNCH APPLICATION – PARAMETER LIST

7.1 Basic parameters

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	55.00		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: 230 V NX5: 400 V NX6: 690 V		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	20000	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 x I_H	2 x I_H	A	I_H		113	Check the rating plate of the motor.
P2.1.7	Motor cosφ	0.30	1.00		0.85		120	Check the rating plate of the motor.
P2.1.8	Magnetization Current	0.0		A	0.0		612	
P2.1.9	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!
P2.1.10	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 P 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***=*AI1* ***2***=*AI2* ***3***=*AI3* ***4***=*AI4* ***5***=*AI1 joystick (-10–10 V)* ***6***=*AI2 joystick (-10–10 V)* ***7***=*Torque reference from keypad, R3.5* ***8***=*FB Torque Reference*
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*

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

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 potentiomer (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
P2.2.9.2	Adjust minimum	0.0	100.0	%	0.0		494	Adjust limit to decrease ref.
P2.2.9.3	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	Quick Stop Mode	0	1		0		1276	**0**=Coasting **1**=Ramp
P2.3.12	FC Breaker Close Delay from Start Command	0	5000	ms	0		1712	
P2.3.13	Synchronization Ramp 2 Freq Limit	0.00	320.00	Hz	0.00		1669	

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*

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 brake 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 P2.6.1, P2.6.12
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		I600	
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 whether 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 whether motor input is OK. Rising edge will activate protection function F87.

Table 7-5. Digital input signals, G2.2.4

7.4.3 ***Analogue input 1***

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.4.3.1	AI1 signal selection	0.1	E.10		A.1		377	Slot. Board input No.
P2.4.3.2	AI1 filter time	0.000	32.000	s	0.000		324	**0**=No filtering
P2.4.3.3	AI1 signal range	0	3		0		320	**0**=0%–100%* **1**=20%–100%* 4 mA Fault **2**= -10–+10 V* **3**=Custom range*
P2.4.3.4	AI1 custom minimum setting	-160.00	160.00	%	0.00		321	Custom Range: Minimum input
P2.4.3.5	AI1 custom maximum setting	-160.00	160.00	%	100.00		322	Custom Range: Maximum input
P2.4.3.6	AI1 reference scaling, minimum value	0.00	320.00	Hz	0.00		303	Selects the frequency that corresponds to the min. reference signal.
P2.4.3.7	AI1 reference scaling, maximum value	0.00	320.00	Hz	0.00		304	Selects the frequency that corresponds to the max. reference signal.
P2.4.3.8	AI1 joystick Dead Zone	0.00	20.00	%	0.00		384	Dead zone for joystick input.
P2.4.3.9	AI1 sleep limit	0.00	100.00	%	0.00		385	Drive goes to stop if input is below this limit for this time.
P2.4.3.10	AI1 sleep delay	0.00	320.00	s	0.00		386	
P2.4.3.11	AI1 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 Manual, chapter 6.2.2.2

7.4.4 ***Analogue input 2***

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**= -10–+10 V* **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 1 s to set offset.

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

7.4.5 ***Analogue input 3***

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**= -10–+10 V* **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 Manual, chapter 6.2.2.2

7.4.6 *Analogue input 4*

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**= -10–+10 V* **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*

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	Themistor 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	
P2.5.1.46	Synch Problem	0.1	0.1		1793	F89
P2.5.1.47	FreqOut Supervision Limit 3	0.1	0.1		1914	
P2.5.1.48	FreqOut Supervision Limit 4	0.1	0.1		1915	

7.5.2 *Analogue output 1*

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 chapters 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 (0–1000 V) **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

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 chapters 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

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 chapters 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**=Motor Direct Active **28**=Freq. limit 3 superv. **28**=Freq. limit 4 superv.
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**=AI1 **2**=AI2 **3**=AI3 **4**=AI4
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
P2.5.7.15	Freq SupV Lim 3	0	2		0		1910	
P2.5.7.16	Freq SupV Value 3	0.00	320.00	Hz	0.00		1911	
P2.5.7.17	Freq SupV Lim 4	0	2		0		1912	
P2.5.7.18	Freq SupV Value 4	0.00	320.00	Hz	0.00		1913	

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

7.6 Limit settings

7.6.1 Current handling

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.6.1.1	Current limit	0	2 x I_H	A	I_L		107	Reaching the limit will lower output frequency.
P2.6.1.2	Scaling of current limit	0	5		0		399	Scaling from 0 to ID107 **0**=Not used **1**=AI1 **2**=AI2 **3**=AI3 **4**=AI4 **5**=FB Limit Scaling ID46

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

7.6.5 OPT-D7 freq. limits

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.6.5.1	D7 Min. Freq.	25.00	240.00	Hz	25.00		1717	
P2.6.5.2	D7 Max. Freq.	25.00	240.00	Hz	75.00		1716	

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	4		0		108	**0**=Linear **1**=Squared **2**=Programmable **3**=Linear with flux optim. **4**=Programmable, Multi
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% x 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% x 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% x U_{nmot}
P2.8.3.8	MC Options	0	65535		0		1740	
P2.8.3.9	U/f curve midpoint frequency 2	0.00	P2.8.3.3	Hz	50.00		1587	
P2.8.3.10	U/f curve midpoint voltage 2	0.00	100.00	%	100.00		1588	
P2.8.3.11	U/f curve midpoint frequency 3	0.00	P2.8.3.3	Hz	50.00		1589	
P2.8.3.12	U/f curve midpoint voltage 3	0.00	100.00	%	100.00		1591	

7.8.3 *PMSM control settings*

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.8.4.1	Start Angle Identification mode	0	10		0		169 1	**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		175 6	
P2.8.4.3	Polarity Pulse Current	-10.0	200.0	%	0.0		156 6	
P2.8.4.4	Start Angle ID Time	0	32000	ms	0		175 5	
P2.8.4.5	I/f Current	0.0	150.0	%	50.0		169 3	
P2.8.4.6	I/f Control Limit	0.0	300.0	%	10.0		179 0	
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		173 0	
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		175 7	
P2.8.4.12	Lsq Voltage Drop	-32000	32000		0		175 8	

7.8.4 *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	

7.8.5 *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	

7.8.6 *Identification parameters*

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	LsVoltageDrop	0	3000		512		673	
P2.8.7.6	Motor BEM Voltage	0.00	320.00	%	90.00		674	
P2.8.7.7	Iu Offset	-32000	32000		0		668	
P2.8.7.8	Iv Offset	-32000	32000		0		669	
P2.8.7.9	Iw Offset	-32000	32000		0		670	

Table 7-16. 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 7-17. 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 7-18.Drive control

7.10.1 *Master/slave settings*

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.11.1	MF Mode	0	2		0		1324	**0**=Not used **1**=Master DS **2**=Follower DS
P2.11.4	DS Follower Fault	0	2		1		1531	**0**=No response **1**=Warning **2**=Fault

Table 7-19. Speed control basic settings

7.11 Protections

7.11.1 Common settings

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.12.1.1	Input phase supervision	0	3		0		730	**0**=No response **1**=Warning **2**=Fault, stop acc. to P2.3.2 **3**=Fault, stop by coasting
P2.12.1.2	Response to undervoltage fault	0	1		0		727	**0**=Fault stored in history **1**=Fault not stored
P2.12.1.3	Output phase supervision	0	3		2		702	See P2.12.1.1.
P2.12.1.4	Response to slot fault	0	3		2		734	See P2.12.1.1.
P2.12.1.5	Response to external fault 1	0	3		2		701	**0**=No response **1**=Warning **2**=Fault, stop acc. to P2.3.2 **3**=Fault, stop by coasting
P2.12.1.6	Earth fault protection	0	3		2		703	**0**=No response **1**=Warning **2**=Fault, stop acc. to P2.3.2 **3**=Fault, stop by coasting
P2.12.1.7	Fieldbus Communication response	0	4		2		733	**0**=No response **1**=Warning **2**=Fault, stop acc. to 2.4.7 **3**=Fault, stop by coasting **4**=Fault, Open and Lock DOL contactors
P2.12.1.8	Cooling Fault Response	1	2		2		762	**0**=No Action, Warning **1**=Warning, Warning **2**=Warning, Fault **3**=No Action, Fault
P2.12.1.9	Safe Torque Off Response	1	2		1		755	**1**=Warning, Warning **2**=Warning, Fault
P2.12.1.1 0	FaultWarnIndicat	0	2		1		1940	**0**=Static **1**=Toggle **2**=Marine

Table 7-20. Common settings

7.11.2 *Temperature sensor protections*

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.12.2.1	No. of used inputs on board 1	0	5		0		739	**0**=Not used (ID Write) **1**=Sensor 1 in use **2**=Sensor 1 & 2 in use **3**=Sensor 1 & 2 & 3 in use **4**=Sensor 2 & 3 in use **5**=Sensor 3 in use
P2.12.2.2	Response to temperature fault	0	3		2		740	**0**=No response **1**=Warning **2**=Fault, stop acc. to P2.3.2 **3**=Fault, stop by coasting
P2.12.2.3	Board 1 warning limit	–30.0	200.0	ºC	120.0		741	
P2.12.2.4	Board 1 fault limit	–30.0	200.0	ºC	130.0		742	
P2.12.2.5	No. of uses inputs on board 2	0	5		0		743	**0**=Not used (ID Write) **1**=Sensor 1 in use **2**=Sensor 1 & 2 in use **3**=Sensor 1 & 2 & 3 in use **4**=Sensor 2 & 3 in use **5**=Sensor 3 in use
P2.12.2.6	Response to temperature fault	0	3		2		766	**0**=No response **1**=Warning **2**=Fault, stop acc. to P2.3.2 **3**=Fault, stop by coasting
P2.12.2.7	Board 2 warning limit	–30.0	200.0	ºC	120.0		745	
P2.12.2.8	Board 2 fault limit	–30.0	200.0	ºC	130.0		746	
P2.12.2.9.1	Channel 1B Warn	-30.0	200.0	ºC	0.0		764	
P2.12.2.9.2	Channel 1B Fault	-30.0	200.0	ºC	0.0		765	
P2.12.2.9.3	Channel 1C Warn	-30.0	200.0	ºC	0.0		768	
P2.12.2.9.4	Channel 1C Fault	-30.0	200.0	ºC	0.0		769	
P2.12.2.9.5	Channel 2B Warn	-30.0	200.0	ºC	0.0		770	
P2.12.2.9.6	Channel 2B Fault	-30.0	200.0	ºC	0.0		771	
P2.12.2.9.7	Channel 2C Warn	-30.0	200.0	ºC	0.0		772	
P2.12.2.9.8	Channel 2C Fault	-30.0	200.0	ºC	0.0		773	

Table 7-21. PT-100 protections

7.11.3 *Stall protection*

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.12.3.1	Stall protection	0	3		0		709	**0**=No response **1**=Warning **2**=Fault, stop acc. to P2.3.2 **3**=Fault, stop by coasting
P2.12.3.2	Stall current	0.1	2 x I_H	A	I_H		710	
P2.12.3.3	Stall time limit	1.00	120.00	s	15.00		711	
P2.12.3.4	Stall frequency limit	1.0	P2.1.2	Hz	25.0		712	

Table 7-22. Stall protection

7.11.4 *Motor thermal protections*

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.12.4.1	Thermal protection of the motor	0	3		2		704	**0**=No response **1**=Warning **2**=Fault, stop acc. to P2.3.2 **3**=Fault, stop by coasting
P2.12.4.2	Motor ambient temperature factor	–100.0	100.0	%	0.0		705	
P2.12.4.3	Motor cooling factor at zero speed	0,0	150.0	%	40.0		706	
P2.12.4.4	Motor thermal time constant	1	200	min	45		707	
P2.12.4.5	Motor duty cycle	0	100	%	100		708	
P2.12.4.6	Response to thermistor fault	0	3		2		732	See P2.12.5.1.

Table 7-23. Motor thermal protections

7.11.5 *4 mA (Living Zero) monitoring*

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.12.5.1	Response to 4mA reference fault	0	5		0		700	**0**=No response **1**=Warning **2**=Warning+Previous Freq. **3**=Wrng+PresetFreq P2.12.6.2 **4**=Fault,stop acc. to P2.3.2 **5**=Fault,stop by coasting
P2.12.5.2	4mA reference fault frequency	0.00	P2.1.2	Hz	0.00		728	

Table 7-24. Living zero monitoring

7.11.6 *Underload protection*

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.12.6.1	Underload protection	0	3		0		713	**0**=No response **1**=Warning **2**=Fault, stop acc. to P2.3.2 **3**=Fault, stop by coasting
P2.12.6.2	Field weakening area load	10.0	150.0	%	50.0		714	
P2.12.6.3	Zero frequency load	5.0	150.0	%	10.0		715	
P2.12.6.4	Underload protection time limit	2.00	600.00	s	20.00		716	

Table 7-25. Underload protection

7.11.7 *Line synch protection functions*

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.12.7.1	DC Low Response	0	2		1		1680	**0**=No response **1**=Warning **2**=Fault, stop by coasting
P2.12.7.2	DC Low Limit	333	1200	V	470		1681	
P2.12.7.3	Line Voltage low response	0	2		1		1685	**0**=No response **1**=Warning **2**=Fault, stop by coasting
P2.12.7.4	Line Voltage low limit	180	800	V	180		1686	
P2.12.7.5	Line Voltage Fault Delay	0.00	5.00	s	0.00		1691	
P2.12.7.6	DOL Conflict Fault Mode	0	2		0		1687	**0**=No response **1**=Warning **2**=Fault, stop by coasting
P2.12.7.7	DOL Conflict Fault Delay	0.00	5.00	s	0.50		1688	
P2.12.7.8	Vac < 90% Response	1	2		1		1689	**1**=Warning **2**=Fault, stop by coasting
P2.12.7.9	Synchronization time limit response	0	2		0		1792	**0**=No response **1**=Warning **2**=Fault, stop by coasting
P2.12.7.10	Synchronization time limit	0.0	320.0	S	10.0		1791	

Table 7-26. Common settings

7.12 Fieldbus parameters

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.13.1	Fieldbus min scale	0.00	320.00	Hz	0.00		850	
P2.13.2	Fieldbus max scale	0.00	320.00	Hz	0.00		851	
P2.13.3	Fieldbus process data out 1 selection	0	10000		1		852	Choose monitoring data with parameter ID. Def: Output Frequency.
P2.13.4	Fieldbus process data out 2 selection	0	10000		2		853	Choose monitoring data with parameter ID. Def: Motor Speed.
P2.13.5	Fieldbus process data out 3 selection	0	10000		3		854	Choose monitoring data with parameter ID. Def: Motor Current to FB.
P2.13.6	Fieldbus process data out 4 selection	0	10000		4		855	Choose monitoring data with parameter ID. Def: Motor Torque.
P2.13.7	Fieldbus process data out 5 selection	0	10000		5		856	Choose monitoring data with parameter ID. Def: Motor Power.
P2.13.8	Fieldbus process data out 6 selection	0	10000		6		857	Choose monitoring data with parameter ID. Def: Motor Voltage.
P2.13.9	Fieldbus process data out 7 selection	0	10000		7		858	Choose monitoring data with parameter ID. Def: DC Link Voltage.
P2.13.10	Fieldbus process data out 8 selection	0	10000		37		859	Choose monitoring data with parameter ID. Def: Last Active Fault.
P2.13.11	Fieldbus process data in 1 selection	0	10000		1140		876	Choose controlled data with parameter ID. Def: FB Torque Reference.
P2.13.12	Fieldbus process data in 2 selection	0	10000		46		877	Choose controlled data with parameter ID. Def: FB Limit Scaling.
P2.13.13	Fieldbus process data in 3 selection	0	10000		47		878	Choose controlled data with parameter ID. Def: FB Adjust Reference.
P2.13.14	Fieldbus process data in 4 selection	0	10000		48		879	Choose controlled data with parameter ID. Def: FB Analogue Output.
P2.13.15	Fieldbus process data in 5 selection	0	10000		0		880	Choose controlled data with parameter ID.
P2.13.16	Fieldbus process data in 6 selection	0	10000		0		881	Choose controlled data with parameter ID.
P2.13.17	Fieldbus process data in 7 selection	0	10000		0		882	Choose controlled data with parameter ID.
P2.13.18	Fieldbus process data in 8 selection	0	10000		0		883	Choose controlled data with parameter ID.
P2.13.19	General Status Word ID	0	10000		67		897	Choose monitoring data in General Status Word.
P2.13.20	State Machine	1	2		1		896	**1** = Standard **2** = PROFIdrive

Table 7-27. Fieldbus parameters

7.13 Value control (Keypad: Menu M2 → G2.2.9)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.14.1.1	Control Input Signal ID	0	10000	ID	0		1580	
P2.14.1.2	Control Input Off Limit	-32000	32000		0		1581	
P2.14.1.3	Control Input On Limit	-32000	32000		0		1582	
P2.14.1.4	Control Output Off Value	-32000	32000		0		1583	
P2.14.1.5	Control Output On Value	-32000	32000		0		1584	
P2.14.1.6	Control Output Signal ID	0	10000	ID	0		1585	
P2.14.1.7	Control Mode	0	5		0		1586	**0**=SR ABS **1**=Scale ABS **2**=Scale INV ABS **3**=SR **4**=Scale **5**=Scale INV

Table 7-28. Power reference input signal selection, G2.2.8

7.13.1 DIN ID control 1

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.14.2.1	ID Control DIN	0.1	E.10		0.1		1570	Slot. Board input No.
P2.14.2.2	Controlled ID	0	10000	ID	0		1571	Select ID that is controlled by digital input.
P2.14.2.3	False value	-32000	32000		0		1572	Value when DI is low.
P2.14.2.4	True value	-32000	32000		0		1573	Value when DI is high.

Table 7-29. DIN ID Control parameters

7.13.2 DIN ID control 2

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.14.3.1	ID Control DIN	0.1	E.10		0.1		1590	Slot. Board input No.
P2.14.3.2	Controlled ID	0	10000	ID	0		1575	Select ID that is controlled by digital input.
P2.14.3.3	False value	-32000	32000		0		1592	Value when DI is low.
P2.14.3.4	True value	-32000	32000		0		1593	Value when DI is high.

Table 7-30

7.14 Auto reset parameters

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.15.1	Wait time	0.10	10.00	s	0.50		717	
P2.15.2	Trial time	0.00	60.00	s	0.10		718	
P2.15.3	Start function	0	2		2		719	**0**=Ramp **1**=Flying start **2**=According to Stop Function
P2.15.4	Number of tries after undervoltage trip	0	10		0		720	
P2.15.5	Number of tries after overvoltage trip	0	10		0		721	
P2.15.6	Number of tries after overcurrent trip	0	3		0		722	
P2.15.7	Number of tries after reference trip	0	10		0		723	
P2.15.8	Number of tries after motor temperature fault trip	0	10		0		726	
P2.15.9	Number of tries after external fault trip	0	10		0		725	
P2.15.10	Number of tries after underload fault trip	0	10		0		738	
P2.15.11	Fault Simulation	0	65535		0		1569	

Table 7-31. Auto restart parameters, G2.16

Line Synch parameters

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.16.1	Control Mode	0	0		1		1626	**0**=Single motor **1**=Multi motor **2**=In Sequence
P2.16.2	Controlled motor	0	7		0		1611	Controlled motor when using multi-motor mode.
P2.16.3	Delay to Coasting	0	30000	ms	15		1621	
P2.16.4	Delay to Open	0	30000	ms	0		1623	
P2.16.5	Delay to Close	0	30000	ms	5		1624	
P2.16.6	Number of motors	1	8	Pcs	1		1627	

7.14.1 Back to FC SlyStart

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.16.7.1	Start Delay to FC	0	30000	ms	200		1628	

7.14.2 Back to FC Synch (BackSynch)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.16.8.1	Synch To Motor	0	1		0		1632	**0**=Disabled **1**=Enabled
P2.16.8.2	DOL Open Delay	0	32000	ms	0		1633	
P2.16.8.3	FC Delay To Close	0	30000	ms	50		1629	
P2.16.8.4	Phase Offset to FC	-179.0	179.0	Dec	-20.0		1609	
P2.16.8.5	Phase Hysteresis to FC	0.0	180.0	Deg	2.0		1638	
P2.16.8.6	Synch OK FC Delay	0	32000	ms	1000		1639	
P2.16.8.7	FWPV at Synch	0.00	150.00	%	9000		1642	

P2.16.8.8	FWPV Ramp Rate	0.00	100.00	%/s	10.00		1643	
P2.16.8.9	FWPV Switch Delay	0.00	320.00	s	0.10		1644	

Table 7-32. Line Synch parameters, G2.12

7.14.3 Synchronization tuning

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.16.9.1	Smoot / Speed ratio	0	10		3		1690	**0**=Smoothest . . . **10**=Fastest
P2.16.9.2	Phase Hysteresis	0.0	180.0	Dec	5.0		1620	
P2.16.9.3	Phase offset to NET	-179.0	179.0	Dec	-16.0		1608	
P2.16.9.4	Generator Side Operation	0	1		0		1538	**0**=Enabled **1**=Disabled
P2.16.9.5	Synchronization options	0	65535		0		1700	
P2.16.9.6	Line Synch Frequency Reference Filter TC	0	100	ms	10		1900	
P2.16.9.7	Frequency Hysteresis for Synchronization	0.00	50.00	Hz	0.60		1613	
P2.16.9.8	Frequency Hysteresis for Change	0.00	50.00	Hz	0.10		1614	
P2.16.9.9	Delay To Synch	0	32000	ms	500		1619	
P2.16.9.10	Synch OK Delay	0	32000	ms	40		1649	

Table 7-33. Line Synch parameters, G2.12

7.14.4 Commissioning

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
2.16.10.1	Commissioning Test modes	0	4		0		1634	**0**=Line Synchronization **1**=FC, DL Timing **2**=FC On, DL Off **3**=FC Off, DL On
2.16.10.2	Commissioning test activation	0.1	E.10		0.1		1635	

7.14.5 Counters

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
2.16.11.1	M1FC CB Hours	0	2^32	h			1673	
2.16.11.2	M1DL CB Hours	0	2^32	h			1674	
2.16.11.3	M1FB CB Count	0	2^32				1675	
2.16.11.4	M1DL CB Count	0	2^32				1676	

7.15 Keypad control (Control panel: Menu M3)

The parameters for the selection of control place and direction on the keypad are listed below. See the keypad control menu in VACON® NX User 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 7-34. Keypad control parameters, M3

7.16 System menu (Control panel: 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 VACON® NX User Manual, chapter 7.3.6.

7.17 Expander boards (Control panel: Menu M7)

The **M7** menu shows the expander and option boards attached to the control board and board-related information. For more information, see VACON® NX User Manual, chapter 7.3.7.

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".

Note: Set this value higher than the nominal frequency of the gird where the synchronization is made.

Note: If changed during running, do not change this parameter to lower value that current output frequency. 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. Also note nominal frequency.

In some cases motor nominal speed is shown with one decimal. In that case, the practice is to give nearest integer number and adjust motor nominal frequency so that the drive will calculate the 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 Magnetizing current ID612 "MagnCurrent"

Set here the motor magnetizing current (no-load current).
Can be measured by running motor without load at 2/3 of nominal speed.

When value is zero, the magnetization current is calculated from motor nominal parameters.

$$Motor\ Magnetization\ Current = \frac{5 * Sin\ \varphi - 1}{5 - Sin\ \varphi} * Motor\ Nominal\ Current$$

$$Motor\ Magnetization\ Current = \frac{5 * \sqrt{1 - (Cos\ \varphi)^2} - 1}{5 - \sqrt{1 - (Cos\ \varphi)^2}} * Motor\ Nominal\ Curren$$

$$[FW]RotorFlux = \left(\frac{f(MotorNomFreq}{f(Out)}\right)^2,\quad when\ f(Out) > f(MotorNomFreq)$$

If given before identification run, this is used as reference for U/f tuning when making identification without rotating the motor.

DriveSynch Operation
Motor Nominal magnetization current / Number of drives in parallel using VACON® Drive Synch.

P2.1.9 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 seconds.

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

NOTE: If identification is not successful, a small motor with long motor cabled may require reduction of switching frequency.

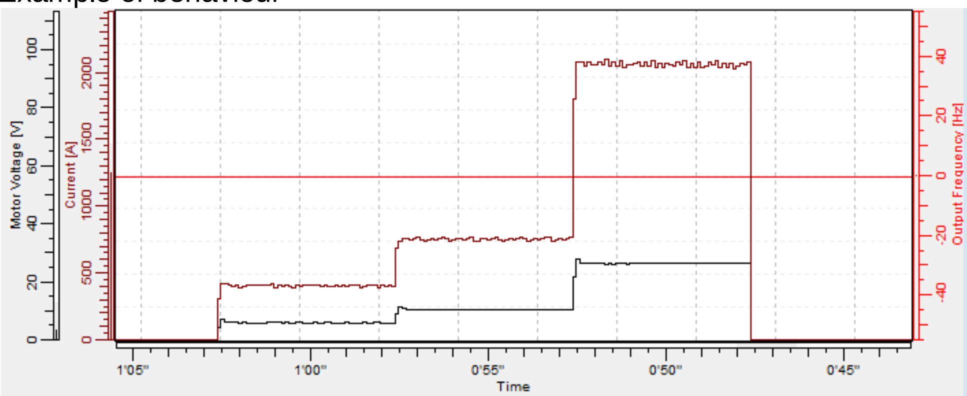
0 = "No Action" No action

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 a minimum requirement if the motor is only to be used in open-loop control. However, it is recommended to always make identification with rotating motor if need for closed-loop control comes after mechanics are connected to shaft.

Example of behaviour

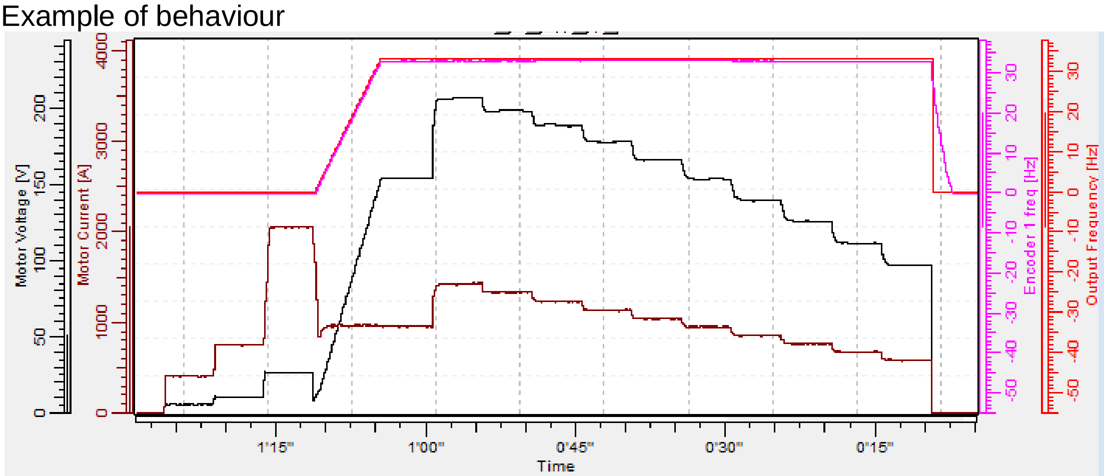


2 = "ID With Run" - Identification with motor rotating

Shaft is rotated during identification.

This identification must be run without load on motor shaft. U/f settings and magnetization current are identified. To get the best performance from the motor, this identification should be run regardless of the final operation mode (closed loop or open loop). When identification with motor rotation is successfully finished, the drive starts to use internal slip estimator to compensate the motor temperature changed. SCTorqueChainSelect B5 & B6.

Example of behaviour



3 = "Enc. ID Run" - Encoder identification run

The motor shaft needs to be able to rotate freely.

PMSM: This selection is used for a PMS motor if automatic angle identification is not suitable for the used motor (angle is identified automatically in every start if PMSM Shaft Position parameter is zero).

This identification run will update PMSM Shaft Position parameter based on absolute position of the encoder or Z-pulse position of incremental type encoder.

IM: If performed for induction motor, encoder pulse number and direction are identified. Can be used if the is no encoder information available, correct result can be achieved only when motor in unloaded.

Note: Identification needs to be remade if encoder position related to motor is changed, e.g. due to maintenance.

4 = "Ident All" - Identified All

The motor shaft needs to be able to rotate freely.

All the above identification selections are made in sequence.

The basic motor nameplate 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 is 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 at 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 is given if not all requested identification types have been completed successfully.
During identification run, the brake control is disabled.

Note: After identification is made, the drive requires rising edge of start command.
Note: The LineSynch-II Application has all identified values stored to parameters. There is no need to redo identification if previous parameters are loaded back to the drive after, e.g. the control board is changed.

P2.1.10 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 to 25 Hz. Thus when both are at 100%, the 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 – +10 V DC
7=”AI2 Joystick”
Analogue input 2, -10 – +10 V DC
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 inputs “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 references. If selection is different from 14 (this one), “I/O Ref 1/2” is used to elect between “I/O Reference” and “I/O Reference 2.

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 to 25 Hz. Thus when both are at 100%, the 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 – +10 V DC
7="AI2 Joystick"
Analogue input 2, -10 – +10 V DC
8="Keypad Ref"
Reference from keypad R3.2.
9="Fieldbus"
Reference is taken from fieldbus. Alternative scaling can be selected 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 to 25 Hz. Thus when both are at 100%, the 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 – +10 V DC
7="AI2 Joystick"
Analogue input 2, -10 – +10 V DC
8="Keypad Ref"
Reference from keypad R3.2.
9="Fieldbus"
Reference is taken from fieldbus. Alternative scaling can be selected 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 starts the drive to reference without additional start command regardless of the control place. Inching function must be enabled from digital input before the command is accepted. Inching is also disabled if there is a start command active from active control place.

P2.2.5.9 Inching reference 1 ***ID1239 "Inching Ref 1"***
P2.2.5.10 Inching reference 2 ***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 with P2.2.9.6 TorqSpeedLimit parameter.

For joystick inputs, the 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 Torque reference selection 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 – +10 V DC. For joystick inputs, the maximum negative reference is negated "Torq Ref Max".
6="AI2 Joystick"
Analogue input 2, -10 – +10 V DC. 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.

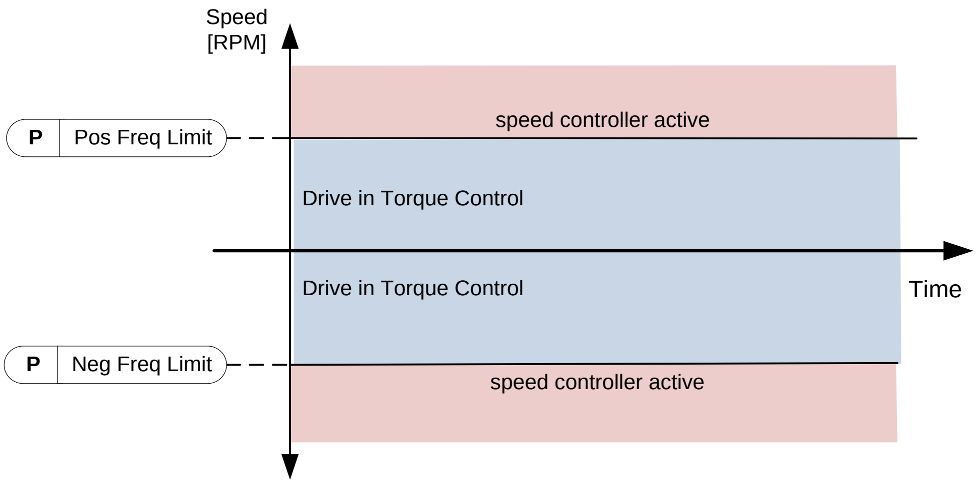
P2.2.6.4 Torque reference filtering time ID1244 "TorqRefFilterTC"

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

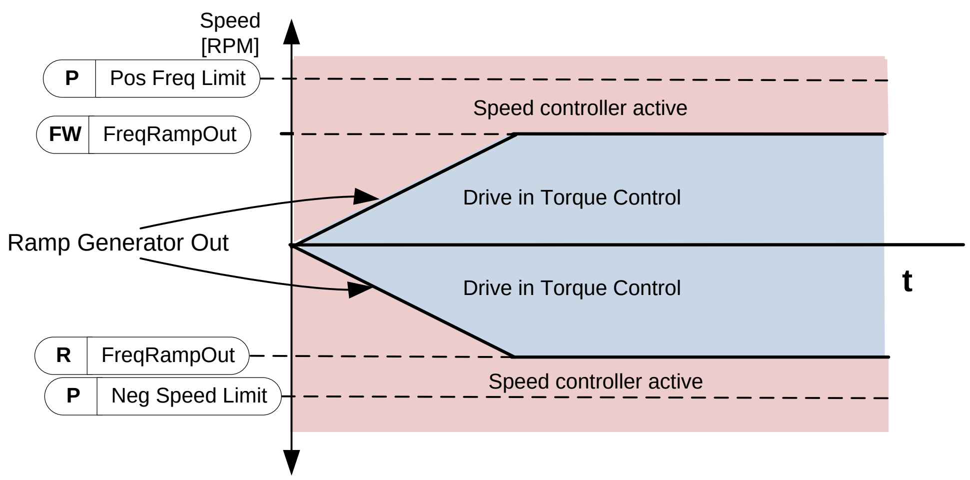
P2.2.6.5 Torque Speed Limit ID644 "Torq Speed Limit"

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

0="MaxFreqLimit" - Positive and negative frequency limits
Speed is not limited by speed reference. The speed is limited only by maximum frequency or positive and negative frequency limits if set lower than the maximum frequency parameter.



1="Freq Ref" – Ramp output for both directions
Speed is limited by reference after ramp generator. Thus speed increases with set ramp time until the actual torque is equal to reference torque. If speed is below reference when load is removed from the shaft, the speed increases 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"

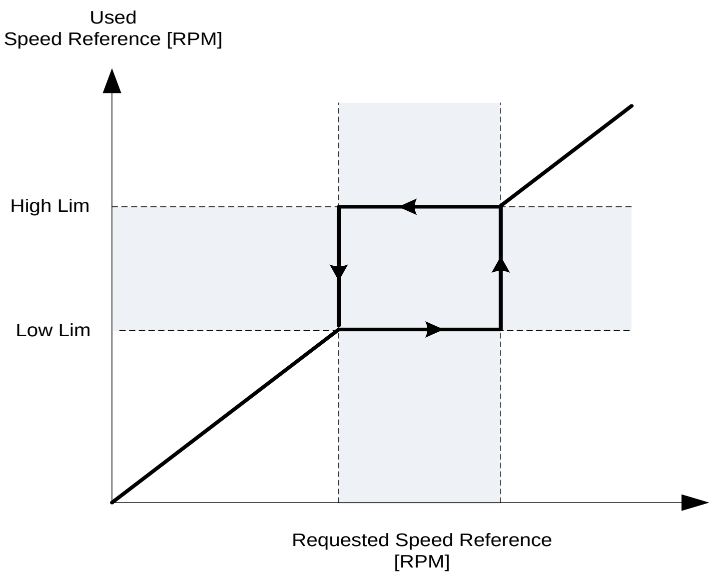
Defines the integration gain for open-loop torque control.

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 be used 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.



P2.2.7.7 Ramp time factor for prohibited range ID518 "RampTimeFactor"

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

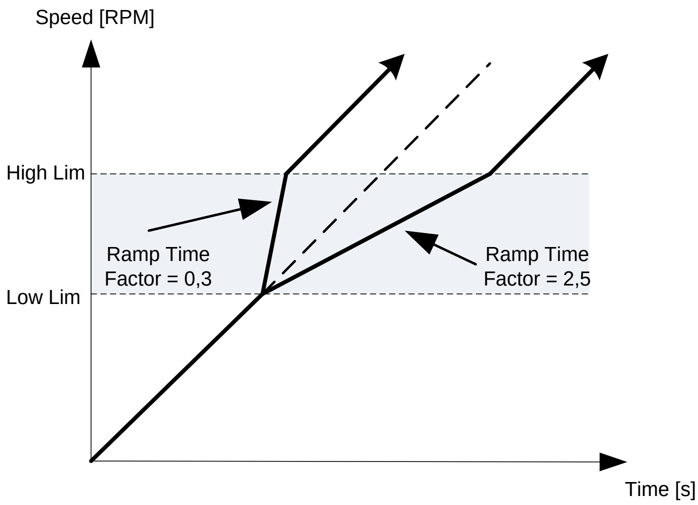
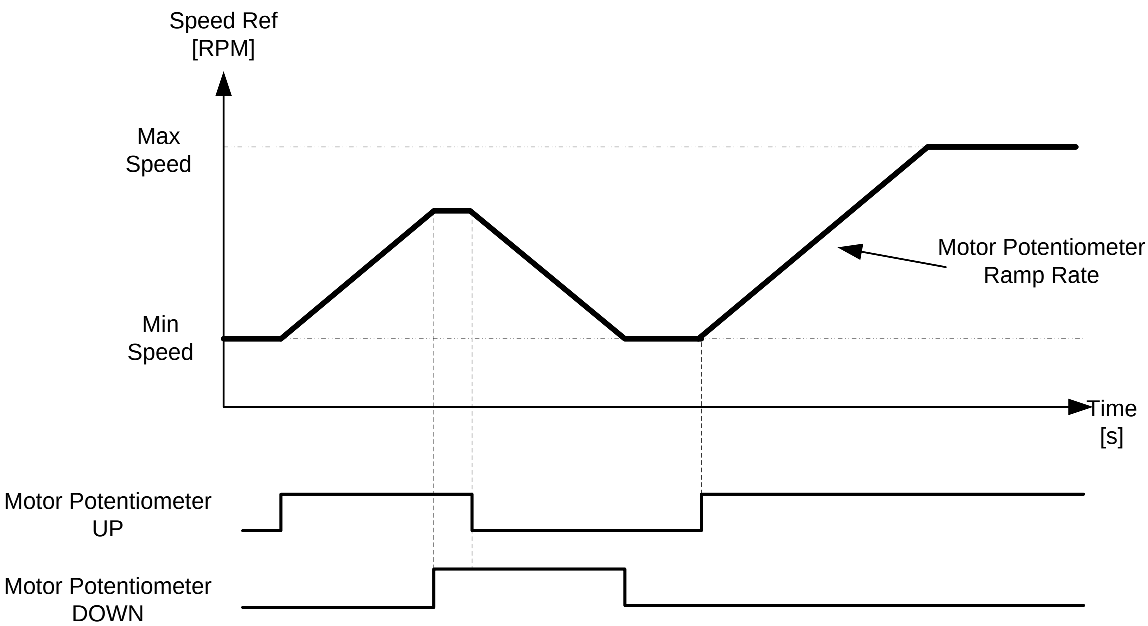


Figure 8-1. Ramp rate scaling between prohibit frequencies

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.



P2.2.8.1 Motor potentiometer ramp rate ID331 "MotPot Ramp Rate"

Defines the rate of change for the motor potentiometer reference value in Hz/s. Normal ramp times are still active and determine how fast the actual output frequency increases.

P2.2.8.2 Motor potentiometer reference reset ID367 "MotPotRef Reset"

0 "No reset"
Reference is kept through the stop state and stored to memory in case of a power down.

1 "Stop State"
Reference is set to zero when the drive is in stop state. This selection includes power down situations.

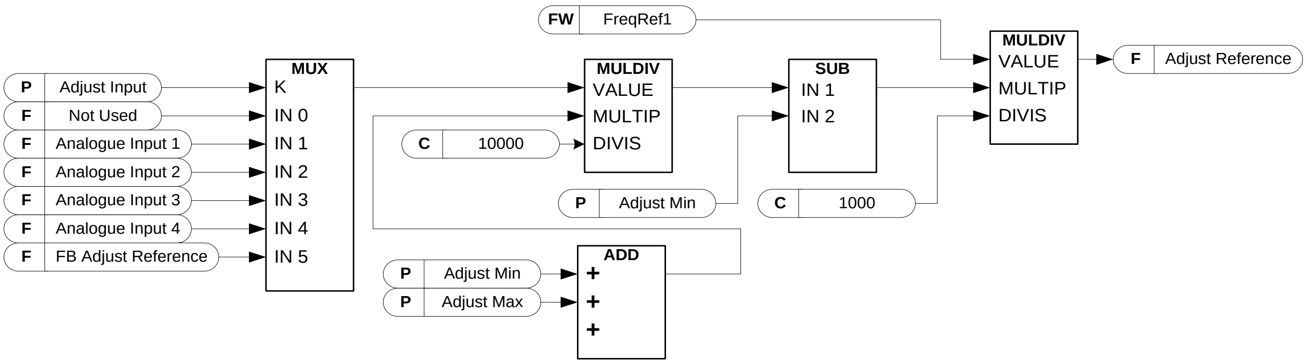
2 "Power Down"
Reference is reset only in a power down situation.

Other parameters related to function

- 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.



P2.2.9.1 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.

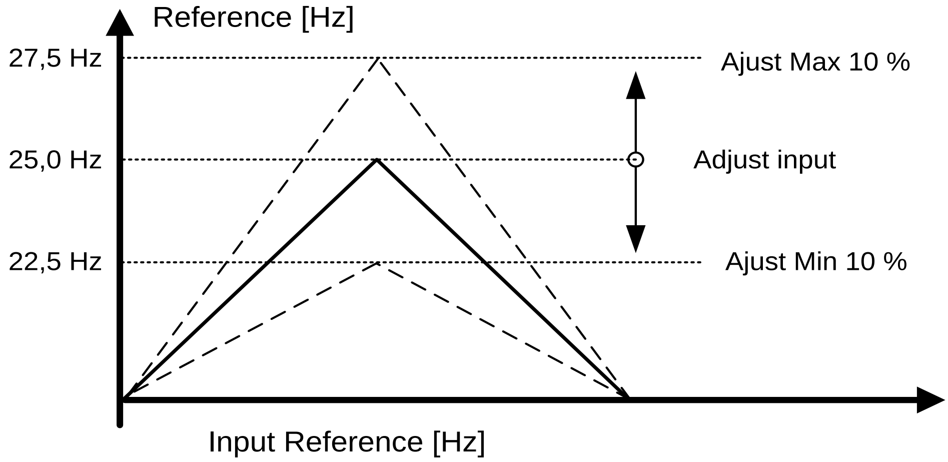
0 Not used
1 Analogue input 1
2 Analogue input 2
3 Analogue input 3
4 Analogue input 4
5 FB Adjust Reference ID47 Monitoring Signal

P2.2.9.2 Adjust minimum ID494 “Adjust minimum”

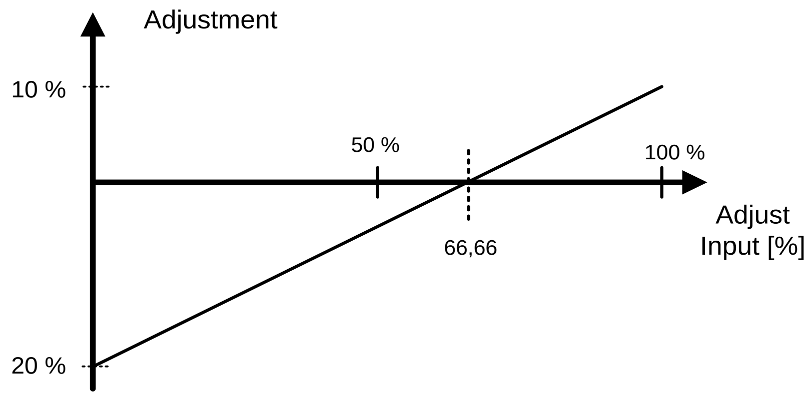
Percentage that is subtracted from the main reference when adjust input is at minimum.

P2.2.9.3 Adjust maximum ID495 "Adjust Maximum"

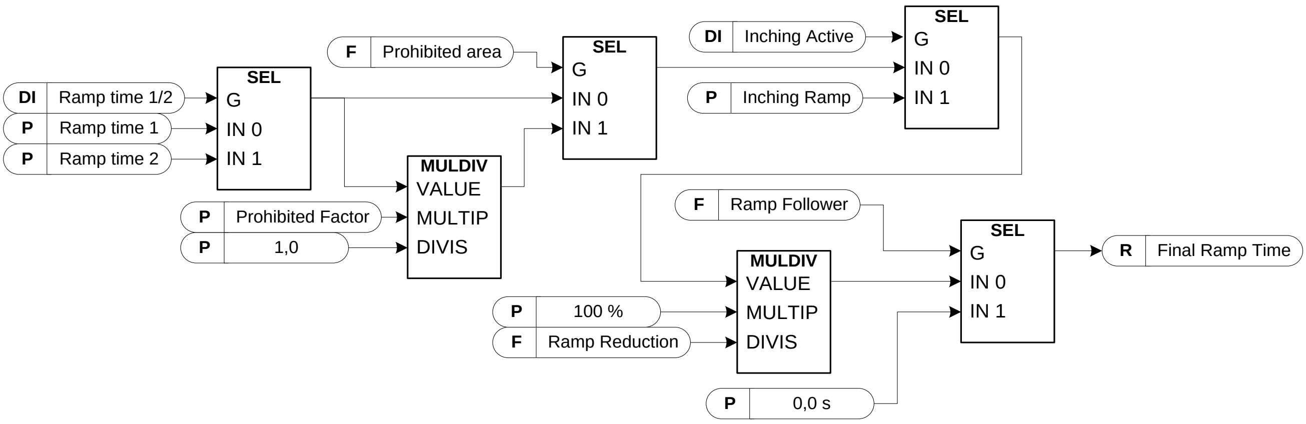
These parameters define the minimum and maximum of adjusted signals.



If the minimum and maximum are not equal to zero, adjustment is not at the midpoint of analogue input or at zero point if -10–+10 V DC input is used. In the following picture, the 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 the motor and searching for the frequency corresponding to the speed the motor is running at. Searching starts from the maximum frequency towards the zero frequency until the correct value is detected.

Use this mode if the motor is coasting when the start command is given. With the flying start it is possible to start motor form actual speed without forcing the speed to zero before ramping to reference.

Closed-loop control always starts 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 allows the motor to 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" makes coast stop regardless of the 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 the 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 the 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.

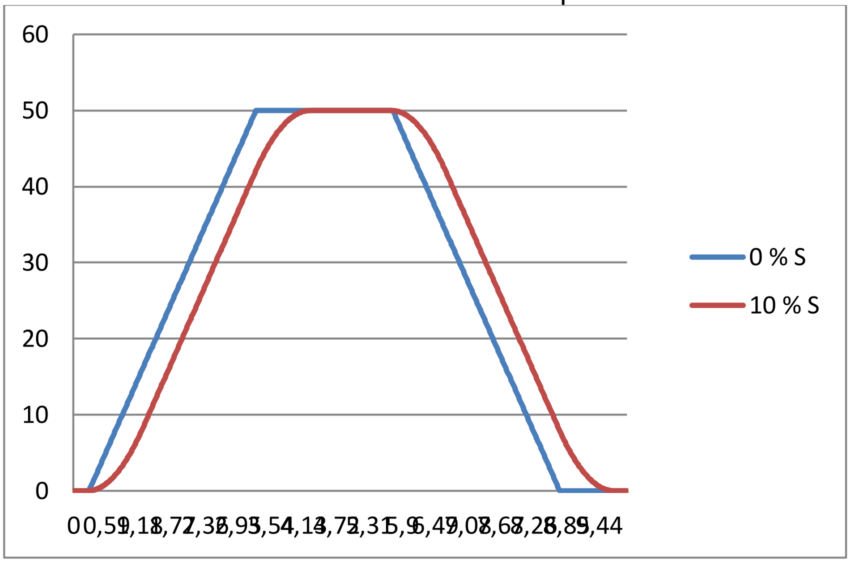


Figure 8-2. A 10% S-ramp with 3-s ramp time compared to without S-ramp

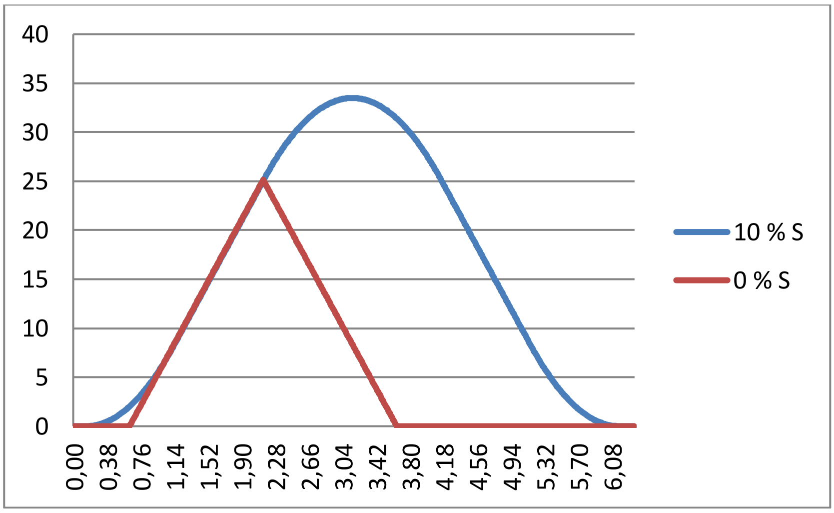


Figure 8-3. A 10% S-ramp with 3-s ramp time when reference is set to zero at 25 Hz.

P2.3.6 Acceleration time 2 ID502 "Accel Time 2"

P2.3.7 Deceleration time 2 ID503 "Decel Time 2"

P2.3.8 Acceleration/Deceleration ramp 2 shape ID501 "Ramp 2 Shape"

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

P2.3.9 Inching ramp ID1257 "Inching Ramp"

This parameter defines acceleration and deceleration times when inching is active. Inching function starts the drive to reference without an additional start command regardless of the control place. The inching function requires enabling from digital input before the command is accepted. Inching is also disabled if there is a start command active in 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.
The input signal level zero means ramp times set by parameters. Maximum level equals one tenth of the value set by parameter.

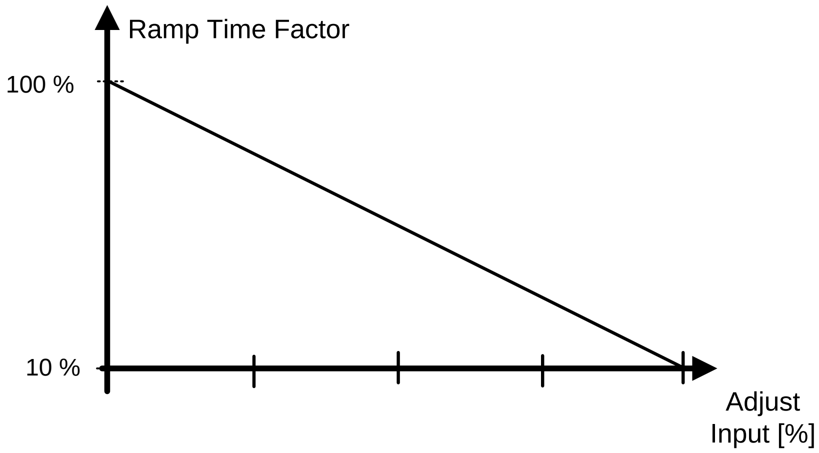


Figure 8-4. Reducing acceleration and deceleration times

P2.3.11 Quick stop mode ID1276 "Quick Stop Mode"

Selects the mode for stopping the drive when quick stop is active.

- It is recommended to use the same stop function in the follower drives.
- It is recommended to use the same ramp time in both drives.

0 Coast stop.
1 Ramp stop.

P2.3.12 FC Breaker Delay D1712 "FCBreakerDelay"

In some cases the motor is needed to stop before starting to follow the reference. In these cases, DC brake is used. When the DC brake is used, this time needs to be set longer than the closing delay of the FC contactor. The DC brake operates in current reference mode: if current is not reached, output voltage increases. If voltage reached e.g. motor nominal voltage while FC breaker is open, the drive trips to overcurrent when breaker closes.

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

P2.3.13 Synchro Ramp 2 Time Freq Limit ID1669 "SynchRamp2TFreqL"

If greater than zero, this parameter activates ramp time 2 when synchronization is active.

8.4 Input signals

8.4.1 Basic settings

P2.4.1.1 Start/Stop logic selection ID300 "Start/Stop Logic"

This parameter defines the start/stop logic when using I/O control. Some of the selections do not include 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"

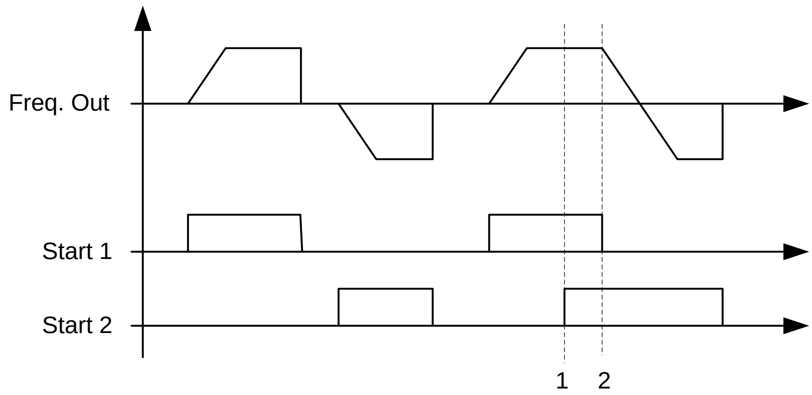


Figure 8-5. Start forward / Start reverse

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

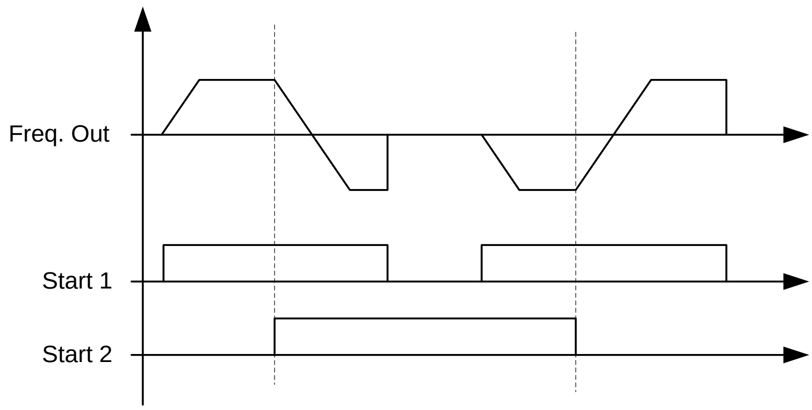


Figure 8-6. Start, Stop, Reverse

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

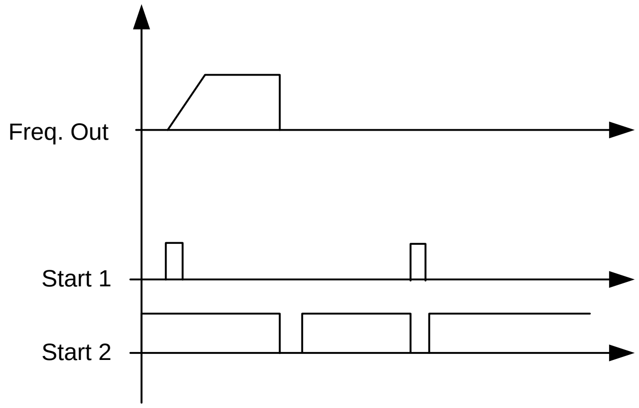


Figure 8-7. Start pulse / Stop pulse.

The selections including the text **'Rising edge required to start'** must 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. For more details, see Motor potentiometer function.

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, coast stop is always made.
Drive will also show a 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 of settings 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 it is possible to select that deceleration direction is allowed. Thus speed is reduced if reference is smaller than the drive speed at the time.

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

Contact closed: In STOP mode, the DC brake 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.

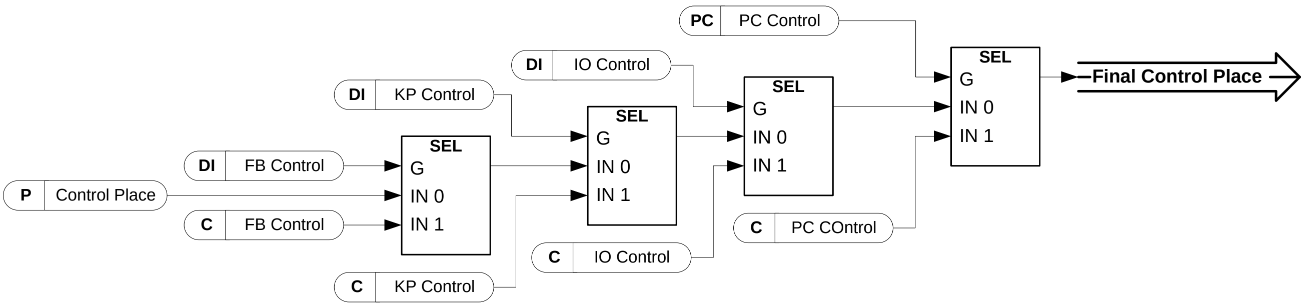


Figure 8-8. Priority order of control place selection

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 the 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 the same input for both parameter sets. 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 two 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 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 the state of the used cooling unit. See details for operation from G2.11.9 cooling parameters group.

8.4.2.2 Inching function

Inching function starts the drive to the reference without additional start command regardless of the control place. Inching must be enabled from digital input before the command is accepted. Inching is also disabled if there is a start command active in the active control place.

P2.4.2.24 Enable inching ID532 "Enable Inching"

If you are using the inching function, the given input must be set to 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 the 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 parameters 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 a 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 which input is used to activate synchronization. When an input is activated, the drive uses line frequency as the frequency reference and adjusts voltage angle to correspond to the line voltage angle with given hysteresis.

P2.4.2.30 Active direct ID1601

This parameter defines which input is used to activate change to direct in line contactor. When synchronization is ready and active direct input is active, the drive makes the change to the net. See operation details from chapter 2. When using a single motor control mode, this input low signal opens the NET contactor. For multi-motor control see ID1612.

P2.4.2.31 Reset Direct ID1612

This parameter resets the control signal of NET contactor 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 the terminal where feedback from the FC contactor is connected to. It is used for monitoring purposes and to generate F80.

P2.4.2.33 NET contactor acknowledgment ID1631

With this parameter select where feedback from the NET contactor is connected to. It is used for monitoring purposes and to generate F80.

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. If none of these inputs are equal to or higher than DigIN: A.1, parameter ID1608 is used for motor selection.

	4 B2	2 B1	1 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

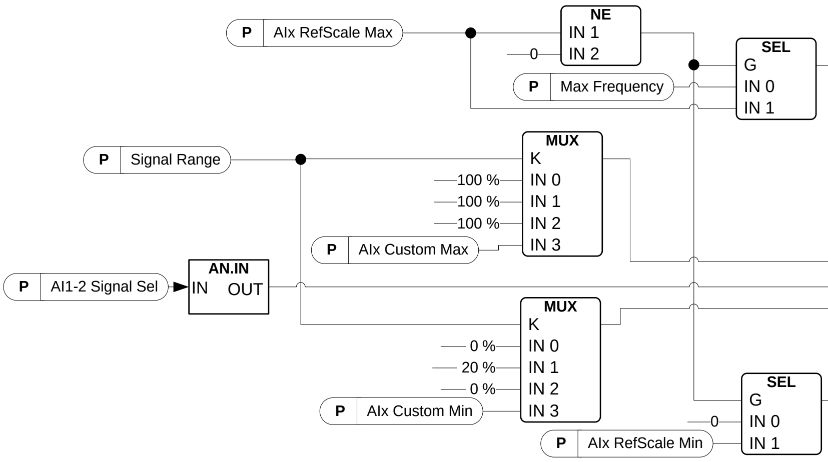
P2.4.2.37 ByPass Inter Lock Falling Edge ID1636

Input from external monitoring device. HIGH means that motor DOL input is OK. This input generates fault number 87. For example, used 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 means that Net is OK. This input generates fault number 87. For example, used 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 **Error! Reference source not found.**.

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.

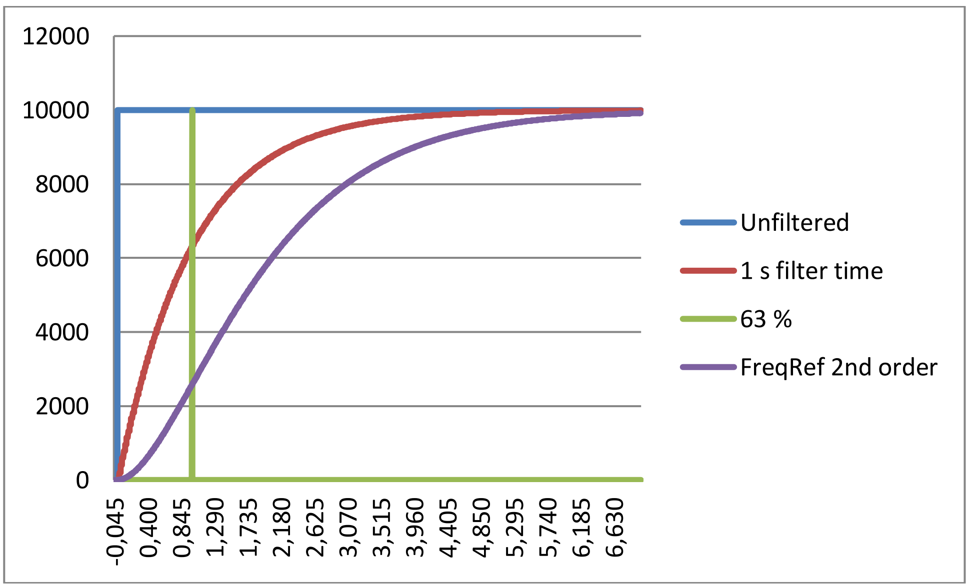


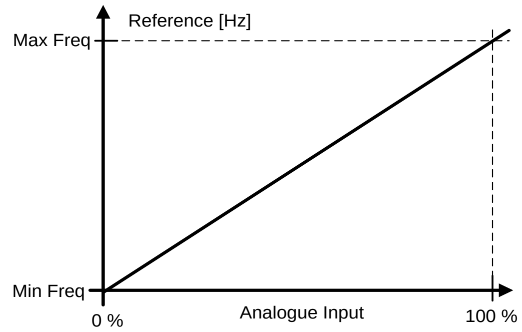
Figure 8-9. AI1 signal filtering

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"

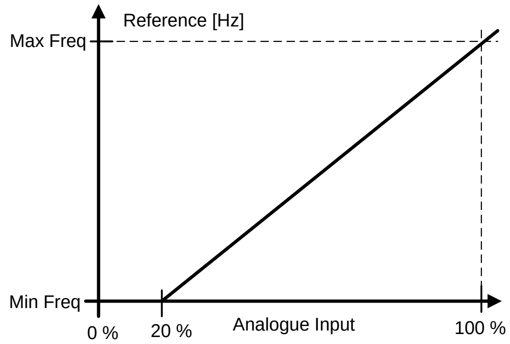
0 "0-20mA/10V

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



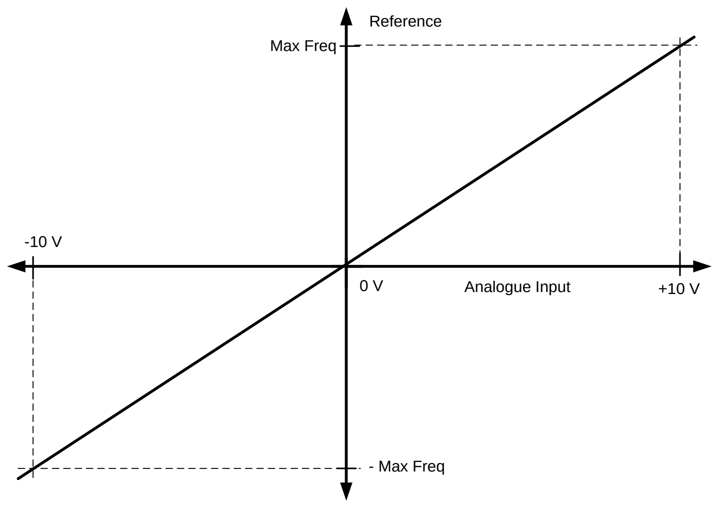
1 "4-20 mA

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



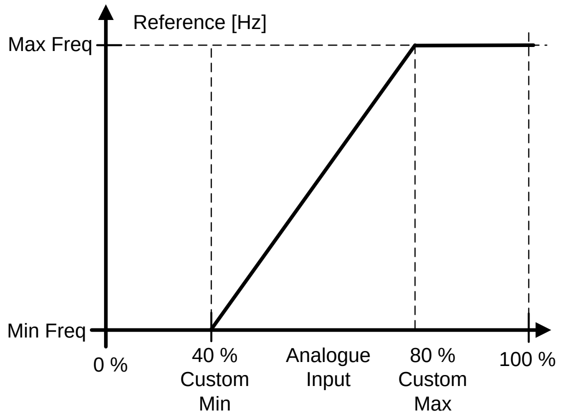
2 "–10 - + 10 V

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



3 "Custom Range"

With custom range it is possible to freely adjust which 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"

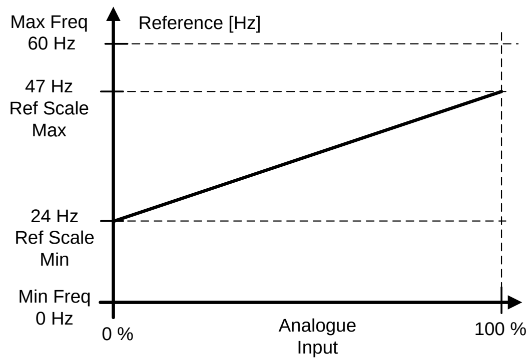
P2.4.4.4 AI2 custom minimum setting ID326 "AI2 Custom Min"
P2.4.4.5 AI2 custom maximum setting ID327 "AI2 Custom Max"

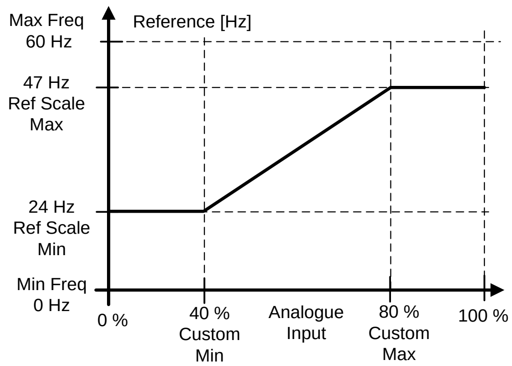
These parameters set the analogue input signal for any input signal span within -160%–160%. For example, if the signal input scaling is set to 40%–80%, the reference can be changed from 8 mA (for Minimum Frequency) to 16 mA (for Maximum Frequency).

P2.4.3.6 AI1 Reference scaling, minimum value ID303 "AI2 RefScale Min"
P2.4.3.7 AI1 Reference scaling, maximum value ID304 "AI2 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"

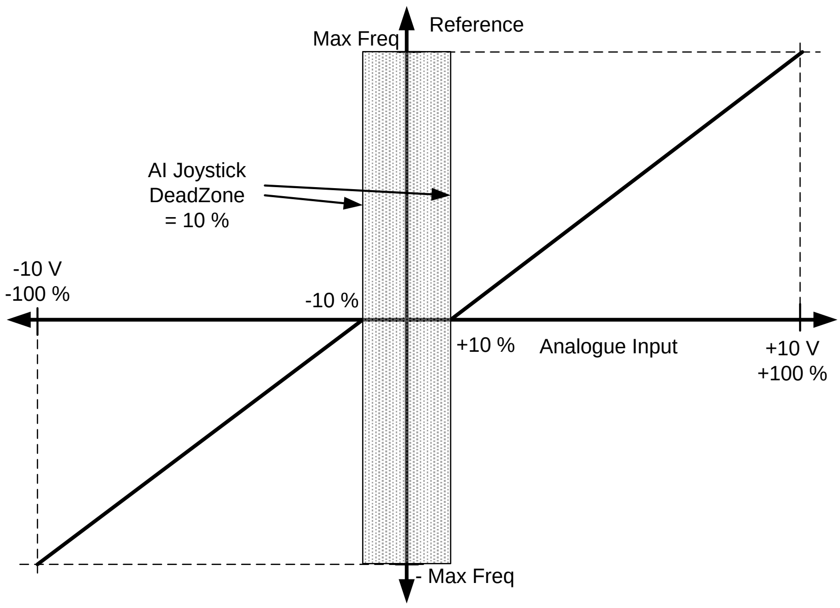
Additional reference scaling. Analogue input reference scaling can be set to a different value than the minimum and maximum frequency.





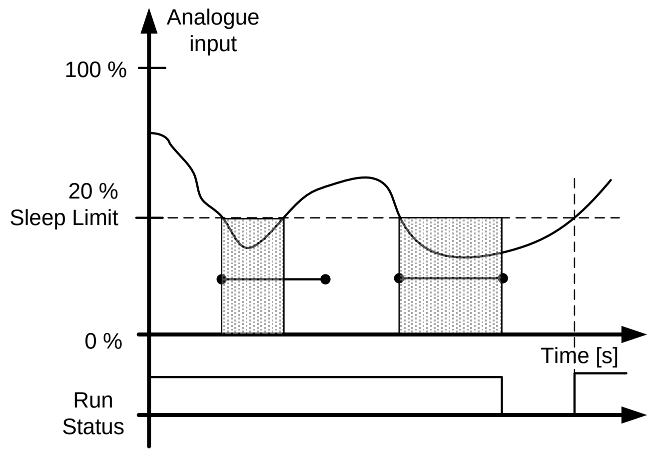
P2.4.3.8 Analogue Input 1 joystick input dead zone ID382 "AI1 JoysDeadZone"
P2.4.4.8 Analogue Input 2 joystick input dead zone ID395 "AI2 JoysDeadZone"

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 the 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 goes 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"

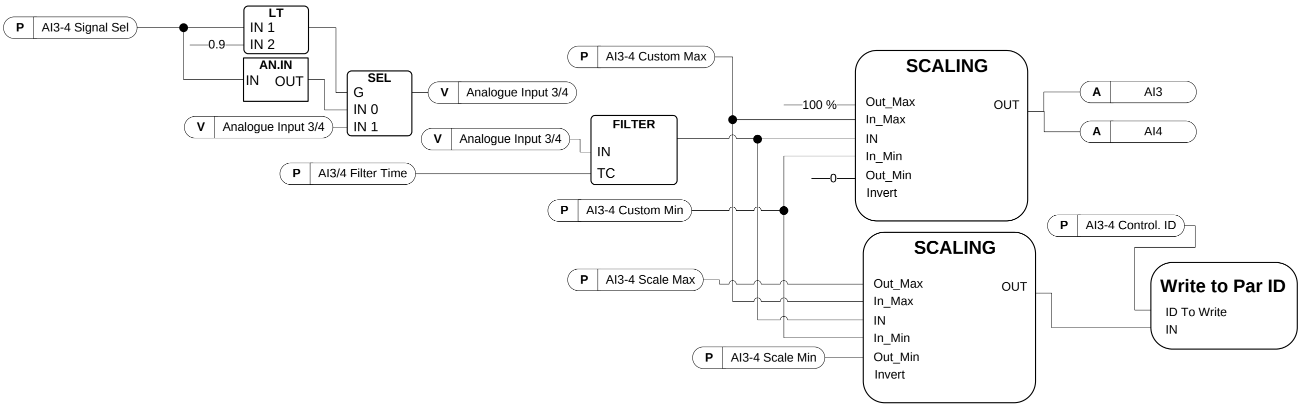
Defines the frequency zero point as follows:

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

Note: This will not, however, change the reference scaling.
Press the *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 from fieldbus. This allows signal scaling and inversion, which is useful, e.g. when PLC is not operational (value zero received). With inversion the value can be set to maximum.



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

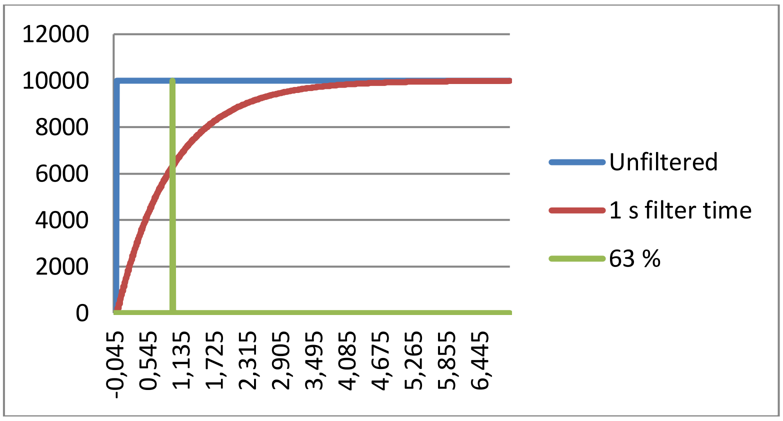
Connect the AI3/AI4 signal to the analogue input of your choice with this parameter. For more information, see chapter **Error! Reference source not found. Error! Reference so urce not found.**.

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"

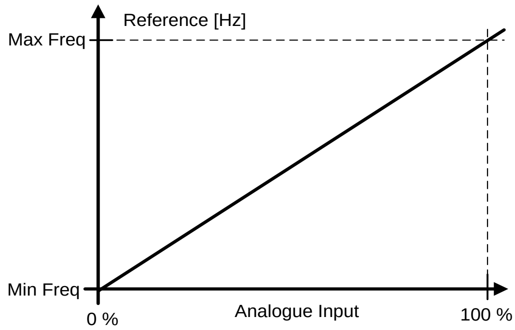
P2.4.6.2 Analogue input 4 signal filtering time ID153 "AI3 Filter Time"

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

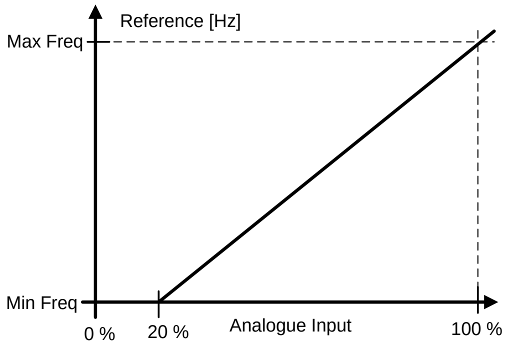


P2.4.3.3 Analogue input signal 3 signal range ID143 "AI3 Signal Range"
P2.4.4.3 Analogue input signal 4signal range ID154 "AI4 Signal Range"

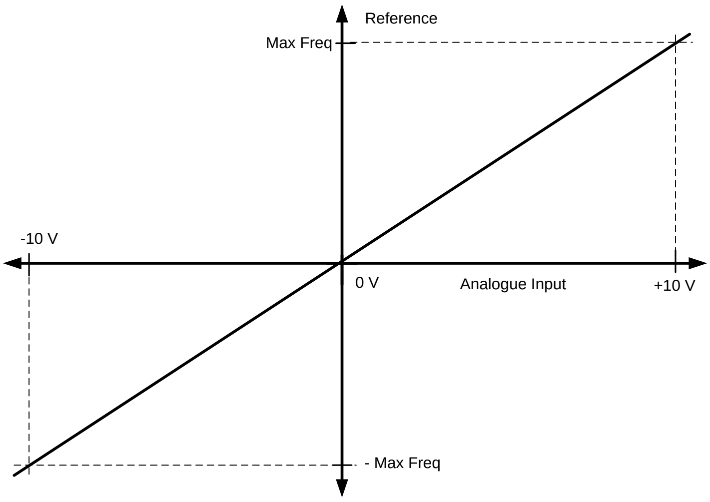
0 "0-20mA/10V
Signal input ranges: 0–10 V and 0–20 mA.
Input signal is used from 0% to 100%.



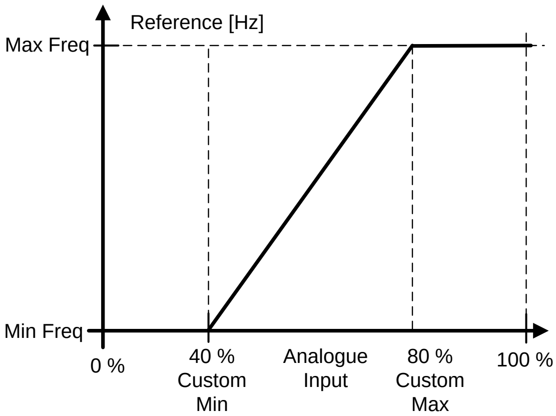
1 "4-20 mA
Signal input ranges: 4–20 mA and 2–10 V.
Input signal is used from 20% to 100%.



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



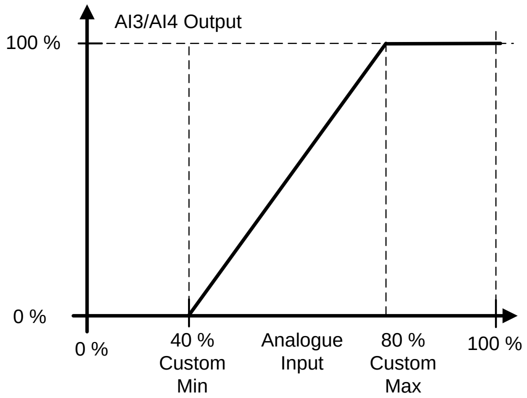
3 "Custom Range"
With custom range it is possible to freely adjust which input level corresponds to the minimum and maximum frequencies.



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"

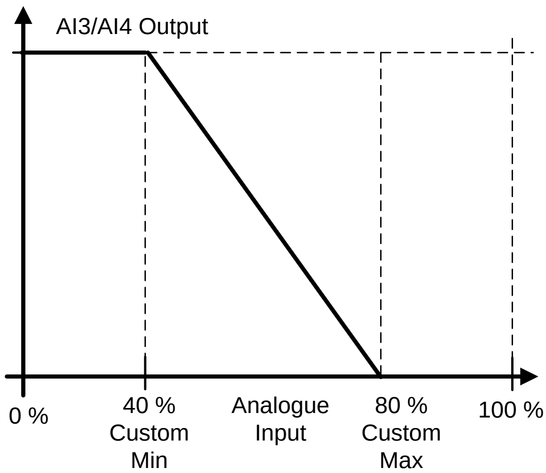
Set the custom minimum and maximum input levels for the AI3 signal within -160%–160%.



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, for example, 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 is zero. Using an inverted signal logic, zero value from PLC means maximum power limit. When inversion is needed for the process data signal, fieldbus values need to be written to analogue input monitoring signals. For details, see parameter P2.4.5.1 AI3 Signal selection.

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 why 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."

A fault or a 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 fault. P2.12.1 External fault is used to select the response.

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

A fault or a warning depending on parameter Response to the 4-mA 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 or 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 direction. This happens in a 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 the 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. Limits 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. Limits and functions are selected in G2.5.8 Supervision Limits.

P2.5.1.16 Reference limit supervision ID449 "Ref Lim Superv."

Active reference goes outside 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. 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. Limits 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 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. Limits 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 outside 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. For location of these bits, see manual for the fieldbus board in use.

P2.5.1.27 Charge DC link ID1218

Charge DC is 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.

P2.5.1.46 Synch Problem

Drive cannot reach synchronization frequency or angle within set time limit.

P2.5.1.47 Frequency Out supervision limit 3 ID1914 "FreqOut SupVLim3"

P2.5.1.48 Frequency Out supervision limit 3 ID1915 "FreqOut SupVLim4"

8.5.2 *Analogue outputs 1 & 2 & 3*

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

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

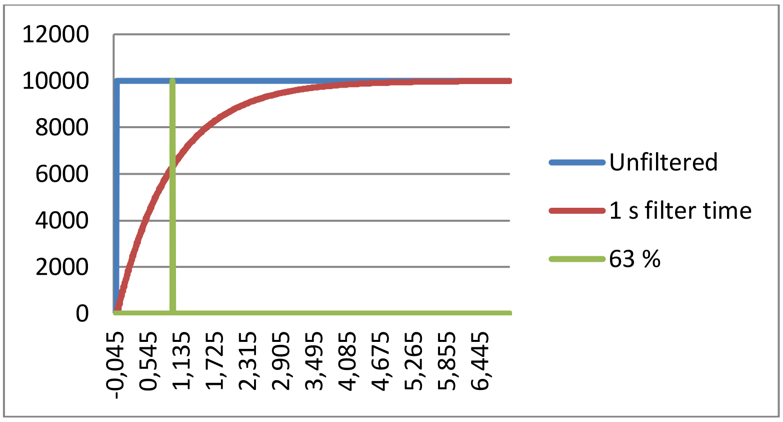
P2.5.2.2 Analogue output function ID307 "Iout Content"
P2.5.3.2 Analogue output 2 function ID472 "Iout 2 Content"
P2.5.3.2 Analogue output 3, function ID479 "Iout 3 Content"

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

0 "Not used"
Analog 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 V DC
690 V unit: DC voltage from zero to 1317 V DC
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 -30ºC to +200ºC
15 "FB Data In4"
FB analog output fieldbus process data value can be connected to analogue output by using monitoring signal ID48.

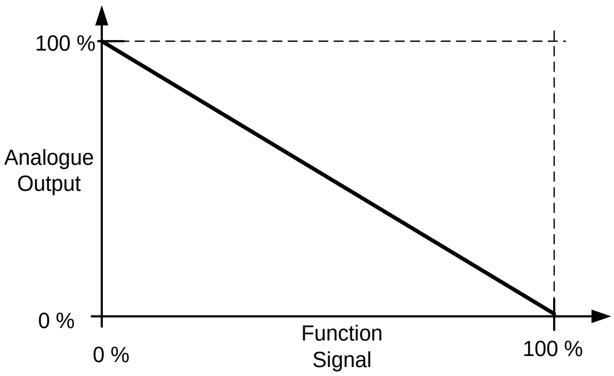
P2.5.2.3 Analogue output filter time ID308 "Iout Filter Time"
P2.5.3.3 Analogue output 2 filter time ID473 "Iout 2 Filter T"
P2.5.4.3 Analogue output 3 filter time ID480 "Iout 3 Filter T"

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"***

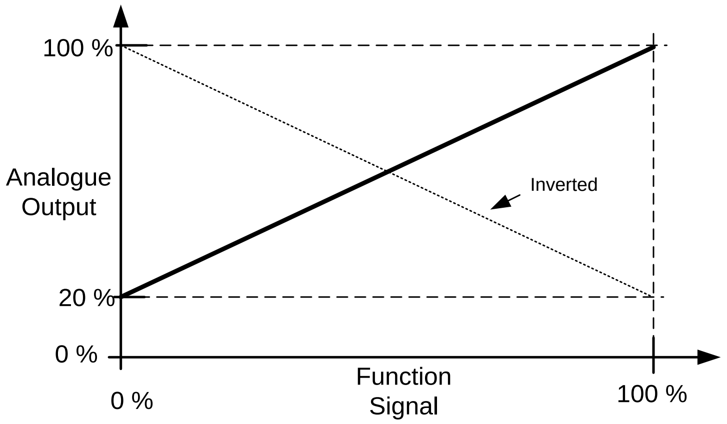
Inverts the analogue output signal:



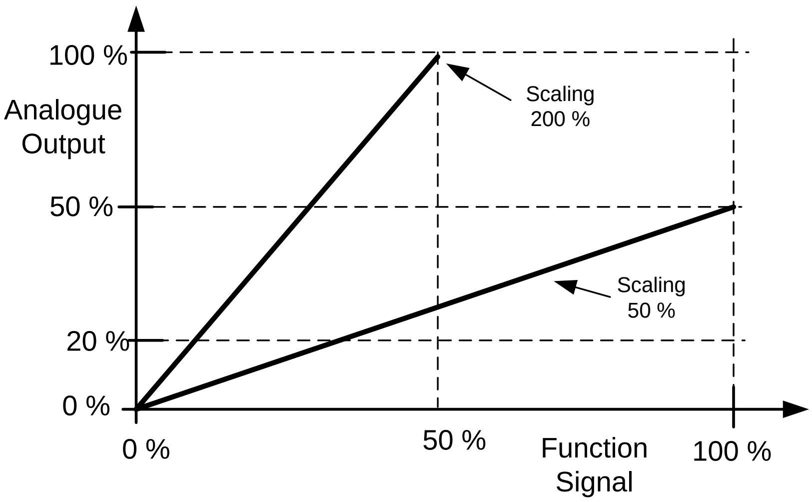
P2.5.2.5 Analogue output minimum ID310
P2.5.3.5 Analogue output 2 minimum ID475
P2.5.4.5 Analogue output 3 minimum ID482

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%)



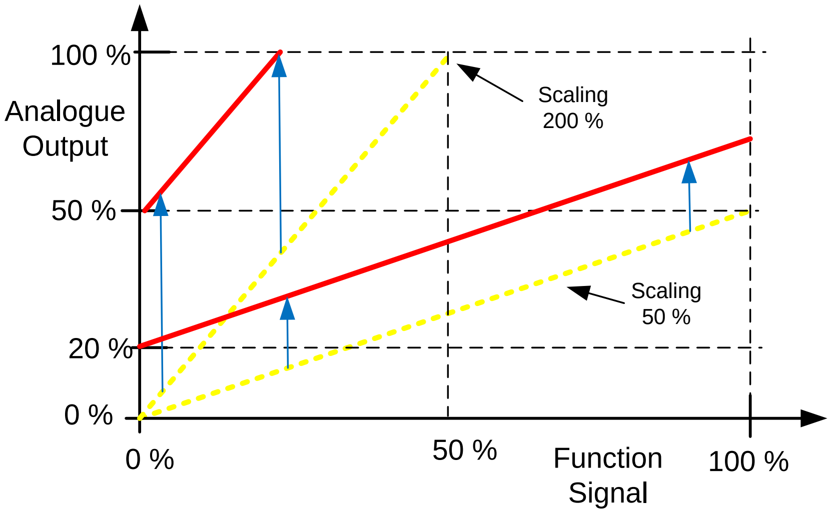
P2.5.2.6 Analogue output scale ID311 "Iout Scale"
P2.5.3.6 Analogue output 2 scaling ID476 "Iout 2 Scale"
P2.5.4.6 Analogue output 3 scaling ID483 "Iout 3 Scale"



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

Define the offset for the analogue output signal.

In the following picture, 50% scaling signal has been given 20% offset and for 200% scaling 50% offset.



*8.5.3 **Delayed digital output 1 & 2 & 3***

P2.5.5.1 Digital output 1 signal selection ID486 "Dig.Out 1 Signal"
P2.5.6.1 Digital output 2 signal selection ID489 "Dig.Out 2 Signal"

Connect the delayed digital output signal to the digital output of your choice with this parameter. For more information about the TTF programming method, see chapter **Error! Reference source not found.**.

P2.5.5.2 Digital output function ID312 "DO1 Content"
P2.5.6.2 Digital output 2 function ID490 "DO2 Content"

0 = "Not used"
1 = "Ready"
The AC drive is ready to operate.
Common reasons why 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"
An external fault or warning depending on parameter response to external fault
7 = "RefFaul/Warn"
A 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 outside the set supervision low limit / high limit.

16 = "RefLimSprv"
Reference limit supervision.
Active reference goes outside 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 outside 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 rotate in different direction, or when a command for direction change has been given and the drive is still ramping down to change the direction.
21 = "ExtBrakeInv"
External brake control inverted.
External brake ON/OFF control. Output active when brake control is OFF.
22 = "ThermFlt/Wrn"
A thermistor fault or warning.
The thermistor input of the option board indicates overtemperature. A 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 = "MotorDircAct"
Motor Direct Control active
28 = "FreqLim3Sup"
Output frequency limit 3 supervision.
The output frequency goes outside the set supervision low limit / high limit.
29 = "FreqLim4up"
Output frequency limit 4 supervision.
The output frequency goes outside the set supervision low limit / high limit.

P2.5.5.3 Digital output 1 on-delay ID487 "DO1 ON Delay"
P2.5.5.4 Digital output 1 off-delay ID488 "DO1 OFF Delay"

P2.5.6.3 Digital output 2 on-delay ID491 "DO2 ON Delay"
P2.5.6.4 Digital output 2 off-delay ID492 "DO2 OFF Delay"

With these parameters you can set on and off delays for digital outputs.
Note that Delayed DO3 operates at ms time accuracy.

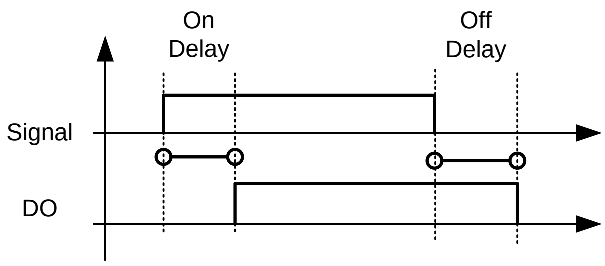


Figure 8-10. Digital outputs 1 and 2, on and off delays

8.5.4 ***Supervision limits***

Supervision function gives 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.

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

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.

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

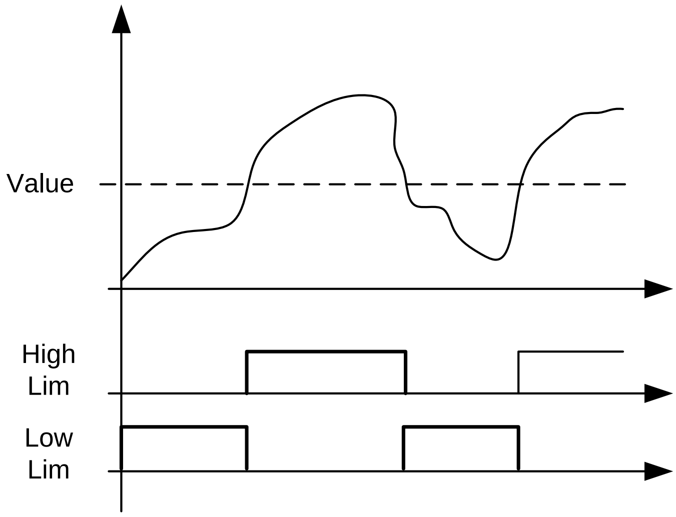


Figure 8-11. Supervision function

P2.5.7.7 Torque Supervision value scaling input ID402 "Torque Superv Scl"

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 controls 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"

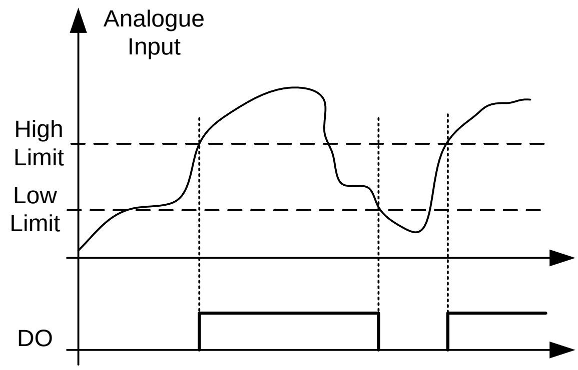


Figure 8-12. An example of on/off control

P2.5.7.15 Output frequency limit supervision function ID1910 "Freq Supv Lim 3"
P2.5.7.17 Output frequency limit supervision function ID1912 "Freq Supv Lim 4"

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.

P2.5.7.16 Output frequency limit supervision value ID1911 "Freq Supv Val 3"
P2.5.7.18 Output frequency limit supervision value ID1913 "Freq Supv Val 4"

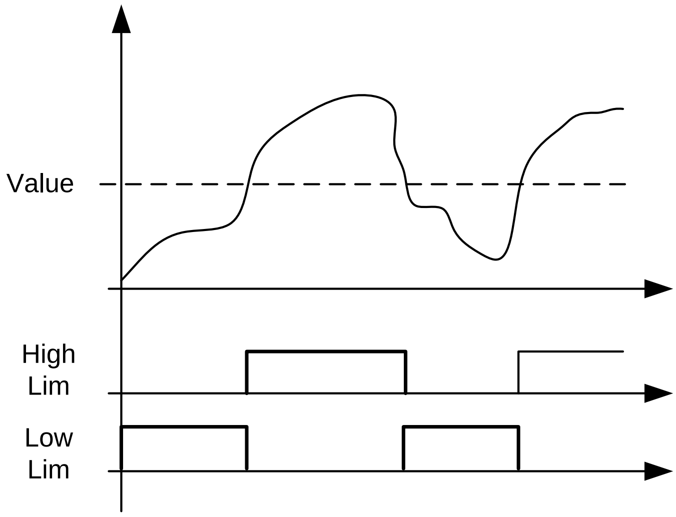


Figure 8-13. Supervision function

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 value range of the parameter 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 mode, the current limit affects the torque producing current limit, not total current. This can be changed in options group with parameter "LimitTotalCurrent".

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 adjusts 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. The value should not be used for scaling but instead for maximum safety limit, because the ramp up rate function is ineffective when the 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 "MotTorqLimSclng"

The motoring torque limit is equal to parameter "Motoring Torque Limit" if the value "Not Used" is selected. If any of the inputs are selected, the motoring torque limit is scaled between zero and the parameter "Motoring 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 "GenTorqLimSclng"

The generator torque limit is equal to the parameter "Generator Torque Limit" if the value "Not Used" is selected. If any of the inputs are selected, the generator torque limit is scaled between zero and the 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 defines 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 mode, the 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 mode, the 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 mode. It also activates the closed-loop overvoltage controller, but the operation is always of type "PI" in closed-loop modes.

0 "Off" - Controller switched off
Both open-loop and closed-loop overvoltage controllers are off.

1 "On:NoRamping" – Activated P-Controller type operation
Both open-loop and closed-loop controllers are activated.
Open-loop controller is a PI-type controller.
Closed-loop controller is a PI-type controller.

2 "On: Ramping" – Activated PI-Type controller
Both open-loop 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 the 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 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 overvoltage level of the drive is set a little higher so that its operation does not conflict with the AFE or BCU units.

3 = "On, Run+Stop" - Used and tested in READY state and when running
Also the brake chopper is 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 decreases 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 the DC voltage at the minimum level.

0 “Off” - Controller switched off
Both open-loop and closed-loop overvoltage controllers are off.

1 “On:NoRamping” – Activated PI-controller type operation
Both open-loop and closed-loop controllers are activated.
Both open-loop and closed-loop controllers are PI-type controllers.
If power comes back while the drive is at undervoltage, the controller output frequency regains the reference value.

2 “On: Ramping” – PI-controller type and ramping down
Both open-loop and closed-loop controllers are activated.
Both open-loop and closed-loop controllers are PI-type controllers.
If power comes back while the drive is at undervoltage, the controller drive ramps to zero speed and generates 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

8.6.5 ***OPT-D7 frequency limit***

P2.6.5.1 OPT-D7 Minimum Frequency ID1717

P2.6.5.1 OPT-D7 Maximum Frequency ID1716

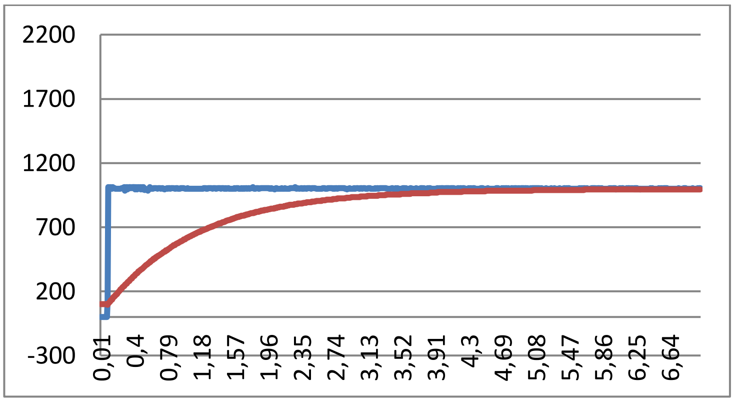
Measured Line Frequency must be between these minimum and maximum limits. Otherwise synchronization is not started to OPT-D7 signal.

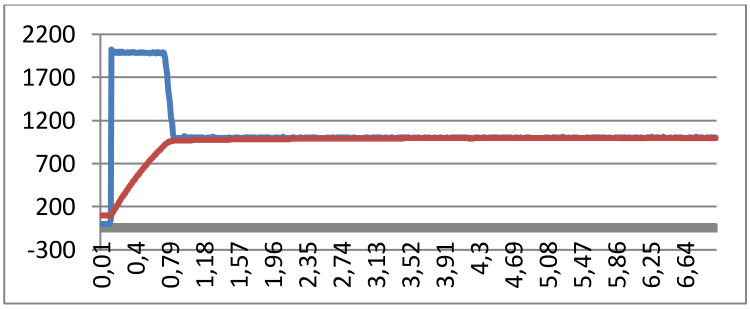
8.7 DC current and magnetization handling

The DC brake can be used to hold the motor in place (nominal torque at nominal slip). It can also be 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 frame size, nominal flux takes a different time to produce after start command.

Giving a higher current on start to the motor decreases the time in which 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 brake. On start this parameter is used together with DC braking time to decrease the time in which the 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 improves torque performance at start. The time needed depends on the motor frame size, value varying between 100 ms to 3 seconds. The bigger the motor, the more time is needed.
The default setting 0.00 s means that 200 ms is spent to magnetize the motor. This 200 ms can be set to zero with parameter "MakeFluxTime".
Activating flying start disables 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 brake resistor.

The braking time is scaled according to the frequency at the moment of the 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 determines the DC braking time.

For example, 50-Hz motor is running at 25 Hz when the stop command is given. The DC braking time is 50% of "DC-braking time at stop". If the frequency is below 5 Hz, the minimum DC braking time is 10% of "DC-braking time at stop".

DC brake is started after a short restart delay following the stop command if stop function is coasting.

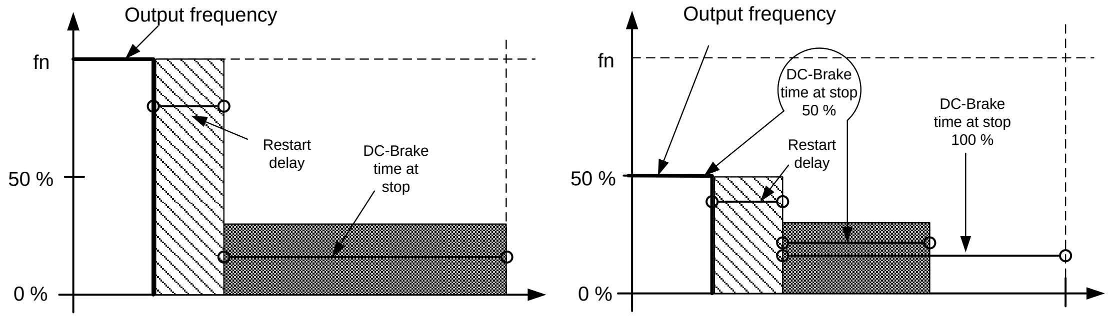


Figure 8-14. DC braking time when stop mode = coasting, from nominal speed and 50% of nominal speed.

Stop function = Ramp:

DC brake starts at 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”.
The braking time is defined with parameter “DC-braking time at stop”. If high inertia exists, it is recommended to use an external brake resistor for faster deceleration. See Figure 8-15.

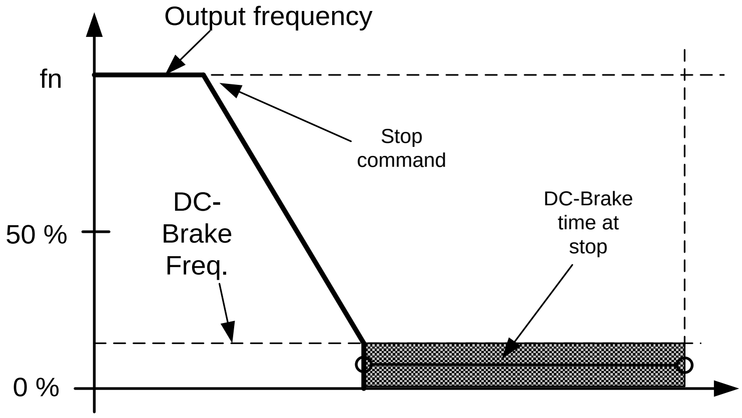


Figure 8-15. DC braking time when stop mode = ramp

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

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

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

The DC brake 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 "DCBrakeCurInStop"

Defines the current injected to the motor in stop state when the digital input signal "*DC Brake Command*" is used to activate the DC brake when no run request is active. When the DC brake is activated, the drive indicates that it is in RUN state.

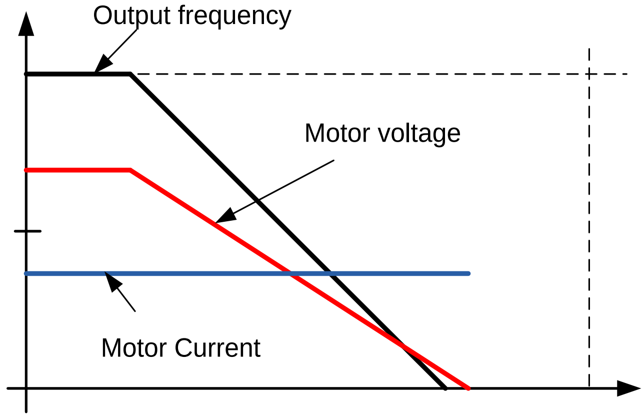
8.7.1.1 Flux braking

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

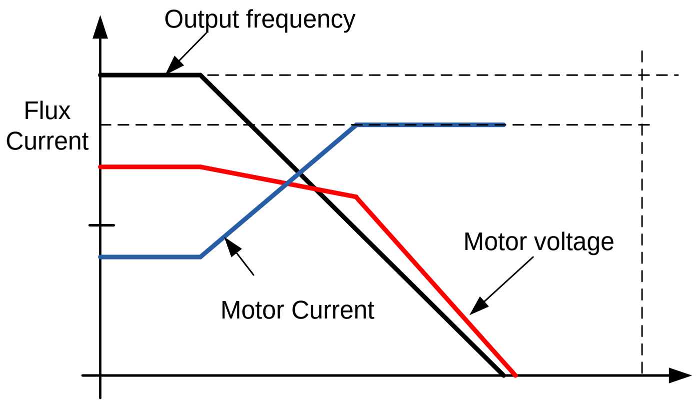
Instead of DC brake, flux braking is a useful way to raise the braking capacity in situations where additional brake resistors are not needed.
When braking is needed, the frequency is reduced and the flux in the motor is increased. This increases losses on motor which in turn increases the motor's capability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

8.8 Motor control

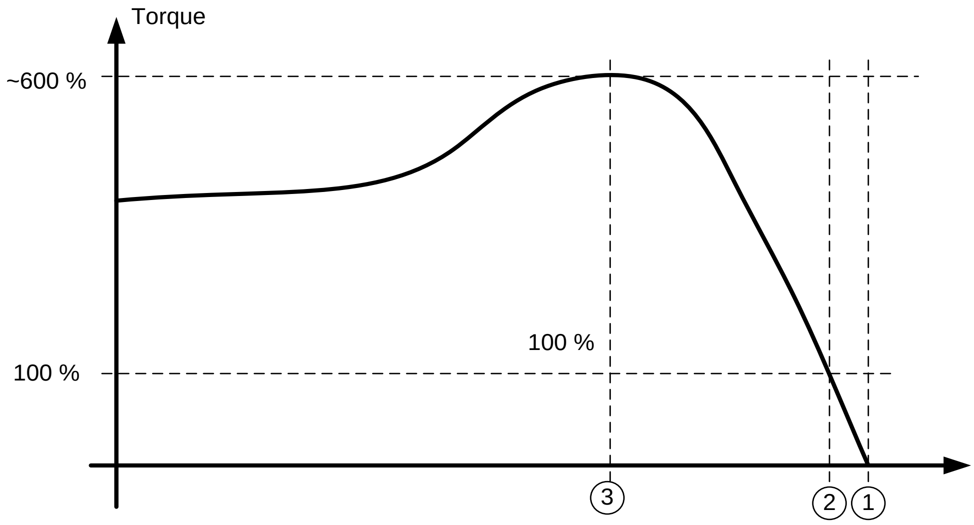
Open-loop control

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.

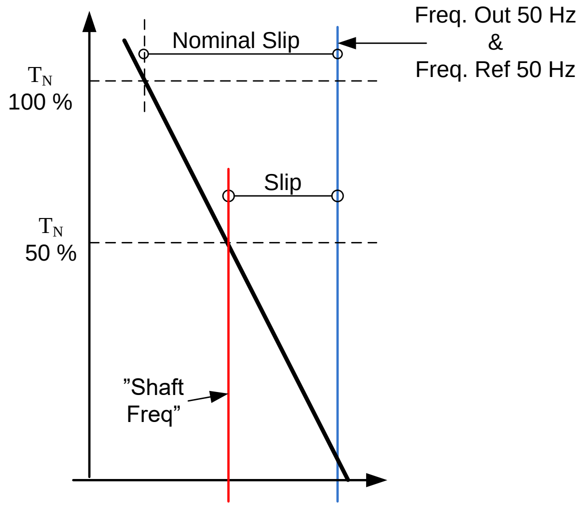
Slip

Induction motor torque is based on slip. When the load increases also the slip increases. Slip is the speed that the rotor is behind of stator electrical frequency.
The following picture presents the torque that is produced by an 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. Pull-out torque. This is the point where motor produced torque starts to decrease when slip increases. After this point the motor stops if the load is not reduced.

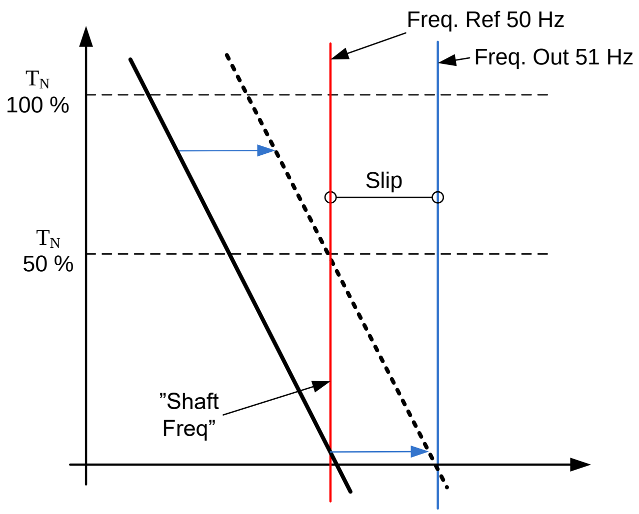


In frequency control, the load determines the actual shaft speed.



Slip compensation in open-loop control

The drive uses motor torque and motor nominal rpm to compensate slip. If the motor nominal rpm is 1,440, the nominal slip is 60 rpm. 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.



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 Parameter group Torque Reference. The default selection is torque control mode speed limited by ramp generator output.

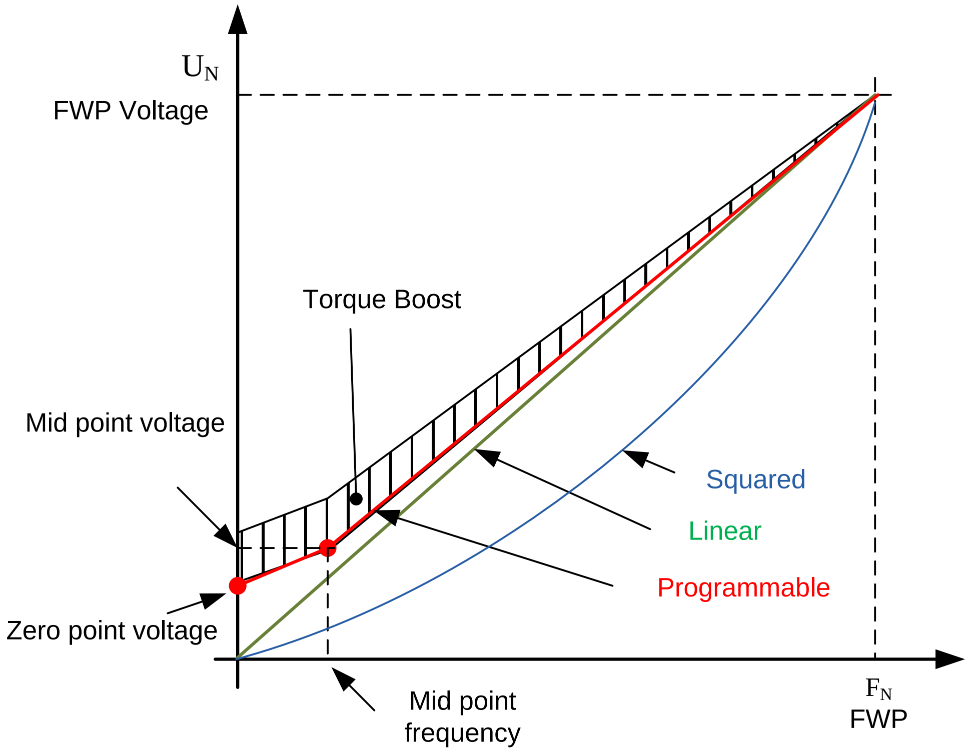
P2.8.2 Motor control mode 2 ID521 "Motor Ctrl Mode2"

With this parameter it is possible to 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 levels 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 the motor nominal frequency as the frequency reference. Read the motor current in the monitoring menu or use NCDrive for monitoring. This current must 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 the same as the motor magnetizing 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).

Then set the midpoint voltage to √2 * Zero Point Voltage
and
the midpoint frequency to (Zero Point Voltage/100%)*Nominal frequency of motor).

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

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

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

P2.8.3.1 U/f optimization 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 effect, but the best result is 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 undermagnetized 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 settings (ID631).

Linear with flux optimization:

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, e.g. fans and pumps.

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 settings 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 the maximum voltage to the motor. It can be increased 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 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 depends on the unit size.
NOTE: If the value of parameter *"U/f Ratio Select"* is changed, this parameter is set to zero.

P2.8.3.8 MC Options ID1740 "MC Options"

B00 =+1=
B01 = +2=
B02 = +4=Enable angle identification in open loop (PMSM)

P2.8.3.9 U/f curve, middle point frequency 2 ID604 "U/f Mid Freq 2"

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"*.

P2.8.3.10 U/f curve, middle point voltage 2 ID605 "U/f mid Voltg 2"

If the programmable U/f curve has been selected with parameter *"U/f ratio"*, this parameter defines the middle point voltage of the curve. See also parameter "*Middle point frequency"*.

P2.8.3.11 U/f curve, middle point frequency 3 ID604 "U/f Mid Freq 3"

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"*.

P2.8.3.12 U/f curve, middle point voltage 3 ID605 "U/f mid Voltg 3"

If the programmable U/f curve has been selected with parameter *"U/f ratio"*, this parameter defines the middle point voltage of the curve. See also parameter "*Middle point frequency"*.

*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 identifies the motor magnet position during every start when using incremental encoder without Z-pulse. The second one uses incremental encoder Z-pulse, and the third one uses absolute encoder information. See details for 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 an incremental encoder with a Z-pulse is used, the Z-pulse position is 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 are utilized, the first start after power up is less optimal and I/f-control (see 6.8.3.2) is used until the drive finds the Z-pulse and is able to synchronize to it.

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 is 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 50–200 ms.

In case of absolute encoders, start angle is read directly from the encoder absolute angle value. On the other hand, incremental encoder Z-pulse is used automatically for synchronization if its 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 made and running is be prohibited, except if the absolute channel is bypassed through start angle identification.

NOTE!
ModulatorType (P2.10.2) needs 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 serves 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 is repeated in every start if the identification is active. This setting enables identification only in the first start after the drive is powered up. In the consecutive starts, the angle is 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 used motor type. In general, 50% of motor nominal current seems to be sufficient, but for example depending on the motor saturation level higher current might be needed.

P2.8.4.4 Polarity Pulse Current ID1566 "PolarityPulseCur"

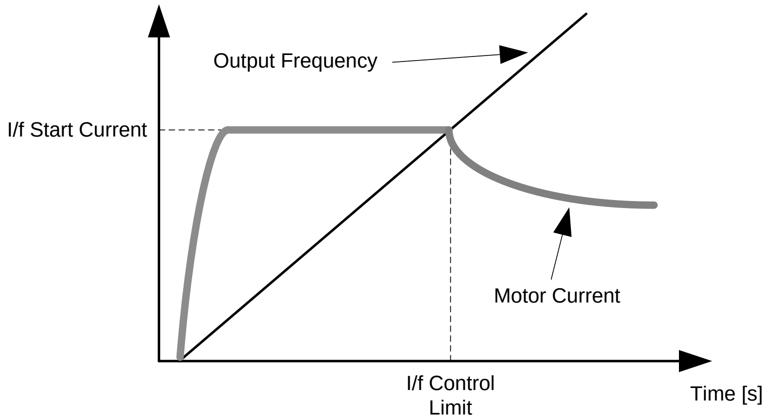
This parameters defines the current level for the magnet axis polarity direction check during the start angle identification (P2.8.5.2). Value 0 means that the internal current level is used which is typically slightly higher than the normal identification current defined by P2.8.5.3. Polarity direction check is rarely needed because the identification itself gives the right direction. Hence in most cases, this function can be disabled by setting any negative parameter value. This is recommended especially if F1 faults occur during 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 aligns the rotor magnet axis with the stator magnet axis. This function is activated by determining the time for how long DC current is injected to the motor. Motor must be free to move during the alignment and the time needs to be long enough for shaft oscillations to damp out. Hence this method is not practical and is meant to be used mainly for testing purposes or to improve starting together with I/f control. DC current level is determined by P2.8.5.6. Also P2.8.5.2 needs to be disabled or otherwise it overrides 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 in a low speed area. I/f control is activated by setting AdvancedOptions2.B9 = 1 (P2.10.6) for PM motors. Also a 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 Angele identification
This parameter defines 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 the PM motor in the field weakening area so that motor terminal voltage does not increase above the maximum level (set by field weakening point voltage, maximum drive output voltage). The field weakening area operation depends on motor construction, and the motor construction may prohibit operation above the 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 gain may be needed so that output voltage does not reach maximum limit and prevent proper motor control. Too high a gain may also lead to unstable control. For control, integration time is more significant in this case.

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 so that output voltage do not reach maximum limit and prevent proper motor control. Too fast an integration time may also lead to unstable control.

P2.8.4.10 ExtIdRef ID1730 "ExtIdRef"

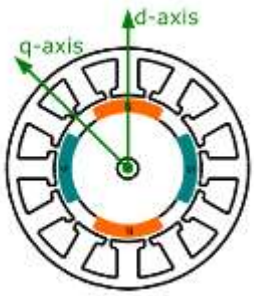
This reference value can be used for the external control of the motor Id current, i.e. reactive current. Normally there is no need for that because the control already uses the optimal value. This reference value is additive to drive internal values but, for example, field weakening controller can override 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 that this parameter is kept disabled.

8.8.2.3 D-axis and q-axis voltage drops

If the d-axis and q-axis reactances (voltage drops) are defined, the 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 in % across the stator inductance at nominal current and frequency.

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

P2.8.4.12 Lsq Voltage Drop ID1758 "Lsq Voltage Drop"

Q-axis reactance voltage drop 2560 = 100%.
Gives the voltage drop in % across the stator inductance at nominal current and frequency.

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

8.8.3 Stabilization settings

8.8.3.1 Torque stabilizer

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

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

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

The final gain is obtained by considering the value of Torque Stabiliser Damping and the scaling in which 256 means the gain 1. Thus the final and 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 a 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:

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

For example, if torque stabilizer damping = 600, it follows that T_cc = 1.5 ms and ω_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 the torque stabiliser can affect the 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 an identification run with rotating motor. At low speed the motor values may increase up to 300%. At high speed the motor gain and motor with sine filter may have gain values of 10%–40%.

P2.8.6.2 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, the 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 the motor actual speed. If zero speed is found, 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 the 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 Measured Ls voltage drop ID673 "LsVoltageDrop"

Leakage inductance voltage drop with nominal current and frequency of the motor. This parameter defines the Ls voltage drop between two phases. Use identification run to determine the optimum setting.

P2.8.7.6 Motor BEM Voltage ID674 "Motor BEM Voltage"

Motor-induced back voltage.

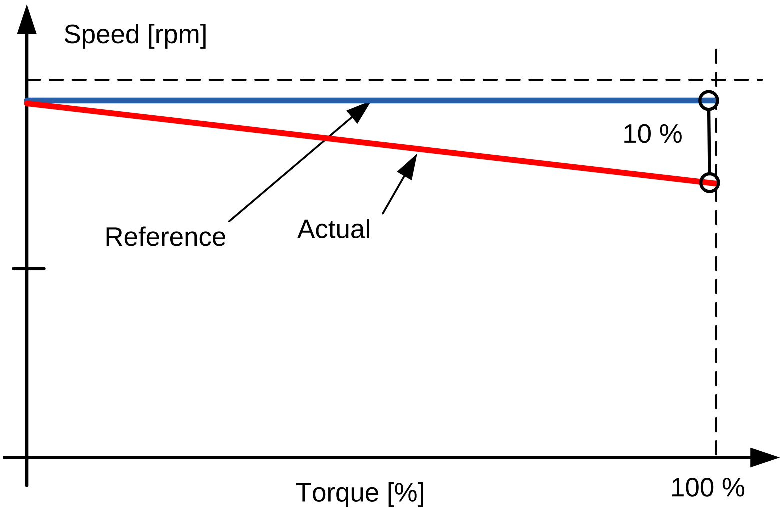
P2.8.7.7 IU Offset ID668 "IU Offset"
P2.8.7.8 IV Offset ID669 "IV Offset"
P2.8.7.9 IW Offset ID670 "IW Offset"

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

8.9 Speed control settings

P2.9.1 Load drooping ID620 "LoadDrooping"

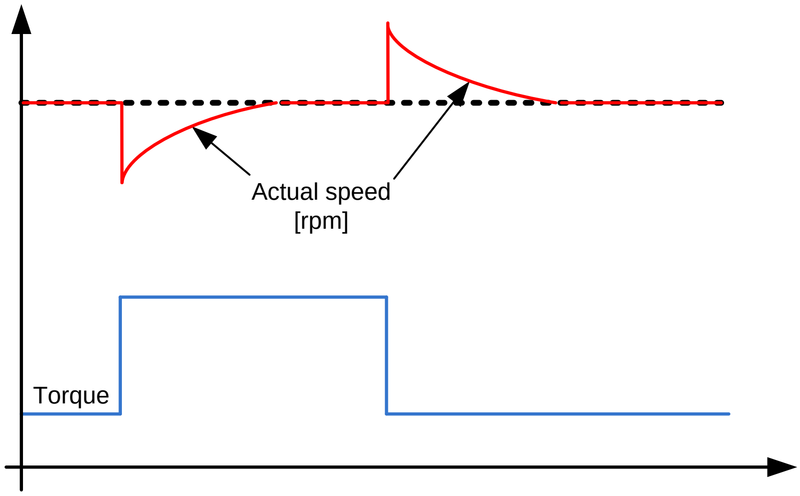
The drooping function enables speed drop as a function of load. This parameter sets the value corresponding to the nominal torque of the motor.



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 increased.



P2.9.3 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 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 minimized using a high switching frequency. However, note that increasing the switching frequency increases the 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	3.6
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 1.5 kHz 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 the 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. On the other hand, the motor ripple at low speeds is the double compared to selection 1.

3 = Software modulator 3

Unsymmetrical BusClamb in which one switch always conducts 120 degrees to negative DC rail to reduce switching losses. However, upper and lower switches are unevenly loaded and the spectrum is wide.

4 = Software modulator 4
Pure sine wave, sinusoidal modulator without harmonic injection. Dedicated to be used in, e.g. back to back test benches to avoid circulating third harmonic current. Its drawback is that the 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 a PMS motor. This function activates the current optimization for a 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 always be zero.

P2.10.7 Advanced Options 5 ID1564 "AdvancedOptions5"

Reserved for future use. Some bits are controlled by application software so value may not always be 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 a 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 Master/slave

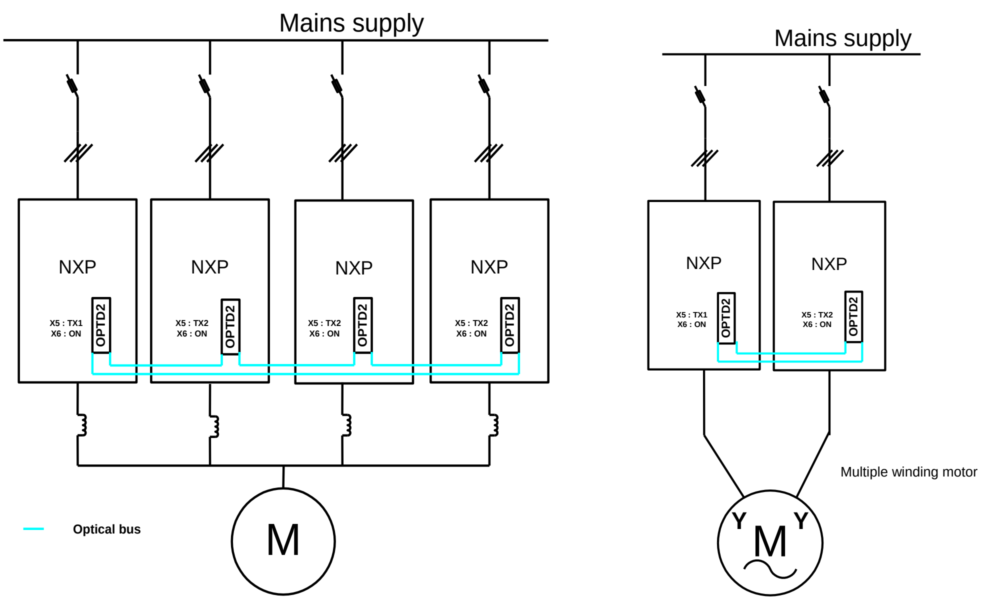
*8.11.1 **Maste/slave: DriveSynch system***

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

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

Note!
The maximum switching frequency for the drives using VACON® DriveSynch is 3.6 kHz.
The minimum recommended switching frequency in open-loop control is 1.7 kHz.
The minimum recommended switching frequency in closed-loop control is 2.5 kHz.

Note!
The VACON® NXP control board must be VB00761 (NXP3) or newer.
OPT-D2 boards need to be VB276J or newer.
Master needs to be #1 and cannot be changed.



	Master (D1)	Slave (D2)	Slave (D3)	Slave (D4)
Parameter settings				
Motor Nominal Voltage	Motor nominal voltage from the motor nameplate	Motor nominal voltage from the motor nameplate	Motor nominal voltage from the motor nameplate	Motor nominal voltage from the motor nameplate
Motor Nominal Frequency	Motor nominal frequency from the motor nameplate	Motor nominal frequency from the motor nameplate	Motor nominal frequency from the motor nameplate	Motor nominal frequency from the motor nameplate
Motor Nominal Current	Motor nominal current from the motor nameplate / Number of drives in parallel using VACON® Drive Synch	Motor nominal current from the motor nameplate / Number of drives in parallel using VACON® Drive Synch	Motor Nominal current from the motor nameplate / Number of drives in parallel using VACON® Drive Synch	Motor nominal current from the motor nameplate / Number of drives in parallel using VACON® Drive Synch
Motor cos phi (Motor nominal power factor)	Motor cos phi from the motor nameplate	Motor cos phi from the motor nameplate	Motor cos phi from the motor nameplate	Motor cos phi from the motor nameplate
Motor Nominal Power	Motor nominal power from the motor nameplate / Number of drives in parallel using VACON® Drive Synch	Motor nominal power from the motor nameplate / Number of drives in parallel using VACON® Drive Synch	Motor Nominal power from the motor nameplate / Number of drives in parallel using VACON® Drive Synch	Motor Nominal power from the motor nameplate / Number of drives in parallel using VACON® Drive Synch
Master Follower Mode	Master, DriveSynch	Slave, DriveSynch	Slave, DriveSynch	Slave, DriveSynch
Motor Control Mode (Open Loop)	Open-loop frequency	If used as secondary master: open-loop frequency. When used as slave: no meaning.	No meaning, internally handled. Recommended to have the same setting as in master.	No meaning, internally handled. Recommended to have the same setting as in master.
Motor Control Mode (Closed Loop)	Closed-loop speed /torque	If used as secondary master: closed-loop speed/torque. When used as slave: no meaning.	No meaning, internally handled Recommended to have the same setting as in master.	No meaning, internally handled Recommended to have the same setting as in master.
Magnetizing current (needed only for closed-loop motor control)	Motor nominal magnetizing current / Number of drives in parallel using VACON® Drive Synch	Motor nominal magnetizing current / Number of drives in parallel using VACON® Drive Synch	Motor nominal magnetizing current / Number of drives in parallel using VACON® Drive Synch	Motor nominal magnetizing current / Number of drives in parallel using VACON® Drive Synch
Switching Frequency	Max 3.6 KHz	Same as in master	Same as in master	Same as in master
Modulator Type	1, Software	Same as in master	Same as in master	Same as in v
Follower Phase shift (single winding motor)	0 degrees	0	0	0
Follower Phase shift (multiple winding motor)	0 degrees	As per motor nameplate	As per motor nameplate	As per motor nameplate

8.11.2 *Master/slave configuration*

The OPTD2 board in the master has a default jumper selection, X5:1–2. For the slaves, the jumper positions have to be changed: **X5:2–3**. This board also has a CAN communication option that is useful for multiple drive monitoring with VACON® NCDrive PC software when commissioning master/slave functions or line systems. Older boards have X6, leave this to ON (X6:1–2).

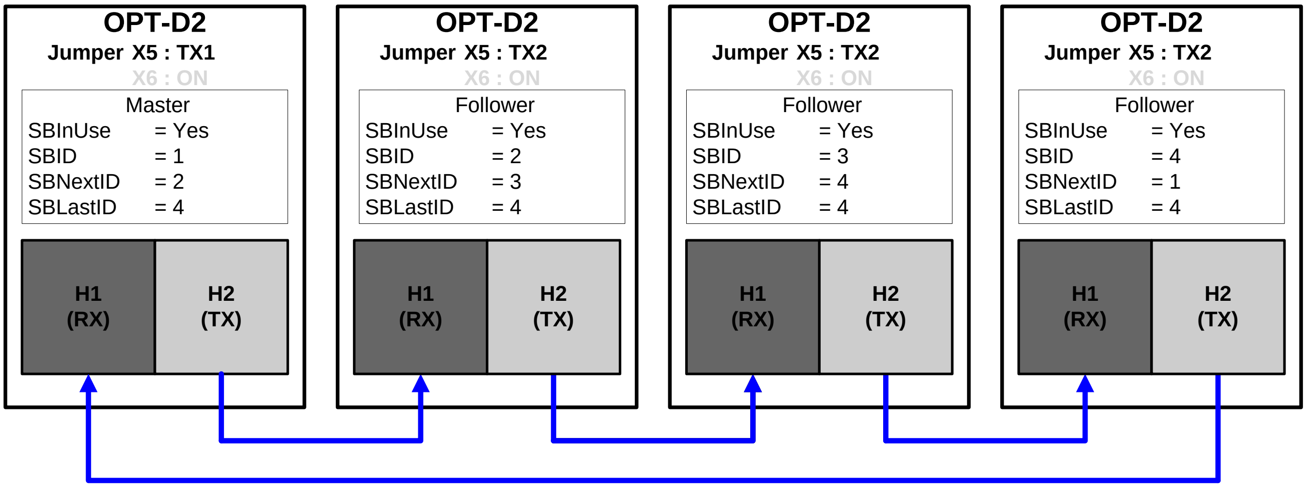


Figure 8-16. System bus physical connections with the OPT-D2 board

P2.11.1 Master/slave selection ID1324 "MF Mode"

Select the master/slave mode. When the drive is a slave, the run request command is monitored from the master but all references are selectable by parameters.

0 = Single drive
System bus is deactivated.
1 = "DSynchMaster" - Drive Synch Master
Drive number 1 must be selected as the parallel drive configuration master (in redundancy mode drive number 2 can be selected as master but certain diagnostic functions are no longer available).
2 = "DSynchFlwr" - Drive Synch Follower
Selection for parallel drive configuration slave drive

P2.11.2 DriveSynch Follower Fault ID1531 "DS Follower Fault"

Defines the response in the master drive when a fault occurs in any of the slave drives. When one of the drives trips to fault, the master drive sends a command to trigger the Data Logger in all the drives for diagnostic purposes.

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to stop function

8.12 Protections

8.12.1 General settings

P2.12.1.1 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

P2.12.1.2 Response to undervoltage fault ID727 "UVolt Fault Resp"

In some applications it is normal that the drive is powered down when in RUN state. With this parameter it is possible to choose whether or not 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 V DC
690 V units: 460 V DC

P2.12.1.3 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

P2.12.1.4 Response to slot fault ID734 "SlotComFaultResp"

Set here the response mode for a option 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

P2.12.1.5 Response to external fault ID701 "External Fault 1"

Defines the response to a digital input signal informing about an external condition to which the drive needs to react. 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

P2.12.1.6 *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.

P2.12.1.7 *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 ID506
3 = Fault, stop mode after fault always by coasting
4 = Fault, Open all DOL contactor and Lock
Normal start can be made after all DOL control has been reset.

P2.12.1.8 *Cooling fault delay* ID755

This parameter defines the delay after the drive goes to FAULT state when the signal for cooling OK is missing. If the drive is in stop state, this is only a warning. In run state, the drive gives a fault and makes coast stop.

P2.12.1.9 *Safe Torque Off Response* ID755

1= Warning, Warning
2= Warning, Fault

P2.12.1.10 *FaultWarnIndicat* ID1940

With this parameter it is possible to select how warning and fault indication as handled to digital outputs and to fieldbus

0 = Static

Static signal, as long as warning or fault is active.

1 = Toggle

New fault or warning toggles signal for one second.

2 = Marine

Signal toggles in new fault or warning and status needs to be reset to get signal down.

8.12.2 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 boards simultaneously. One can be used for the motor winding and the other for the motor bearings.

P2.12.2.1 Number of used inputs in board 1 ID739 "Board1 Channels"

Select the used temperature sensor combination with this parameter. See also the VACON® I/O board 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 reads 200ºC. If the input is short-circuited, the displayed value is -30ºC.

P2.12.2.2 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

P2.12.2.3 Board 1 warning limit ID741 "Board1Warn.Limit"

Set here the limit at which the PT100 warning is activated.
When individual warning and fault limits are activated, this is first board first channel (1A).

P2.12.2.5 Board 1 fault limit ID742 "Board1 Fault Lim."

Set here the limit at which the PT100 fault (F56) is activated.
When individual warning and fault limits are activated, this is first board first channel (1A).

P2.12.2.5 Number of used inputs in board 2 ID743 "Board2 Channels"

If there are have two temperature sensor boards installed in the frequency converter, choose here the combination inputs used in the second board. See also the VACON® I/O board 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

P2.12.2.6 Board 2 Temperature response ID766 "Board2 Response"

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

P2.12.2.7 Board 2 warning limit ID745 "Board2 Warn. Lim"

Set here the limit at which the second temperature sensor board warning is activated. When individual warning and fault limits are activated, this is second board first channel (2A).

P2.12.2.8 Board2 fault limit ID746 "Board2 FaultLim"

Set here the limit at which the second temperature sensor board fault (F61) is activated. When individual warning and fault limits are activated, this is second board first channel (2A).

8.12.2.1 Individual channel monitoring

Individual channel monitoring is activated by setting one of the warning limits (per board) different from zero. Common limits in the parameters described previously are channel A warning and fault limits. Channel B and C limits are set with the following parameters.

P2.12.2.9.1 Channel 1B Warn ID764

P2.12.2.9.2 Channel 1B Fault ID765

First board second (1B) channel warning and fault limits.

P2.12.2.9.3 Channel 1C Warn ID768

P2.12.2.9.4 Channel 1C Fault ID769

First board third (1C) channel warning and fault limits.

P2.12.2.9.5 Channel 2B Warn ID770

P2.12.2.9.6 Channel 2B Fault ID771

Second board second (2B) channel warning and fault limits.

P2.12.2.9.7 Channel 2C Warn ID772

P2.12.2.9.8 Channel 2C Fault ID773

Second board third (2C) channel warning and fault limits.

8.12.3 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 no real indication of the shaft rotation. Stall protection is an overcurrent protection of a sort.

P2.12.3.1 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

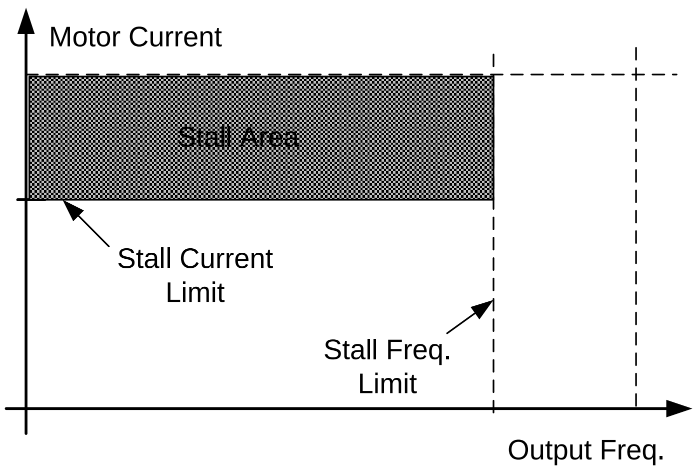
P2.12.3.2 Stall current limit ID710 "Stall Current"

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

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

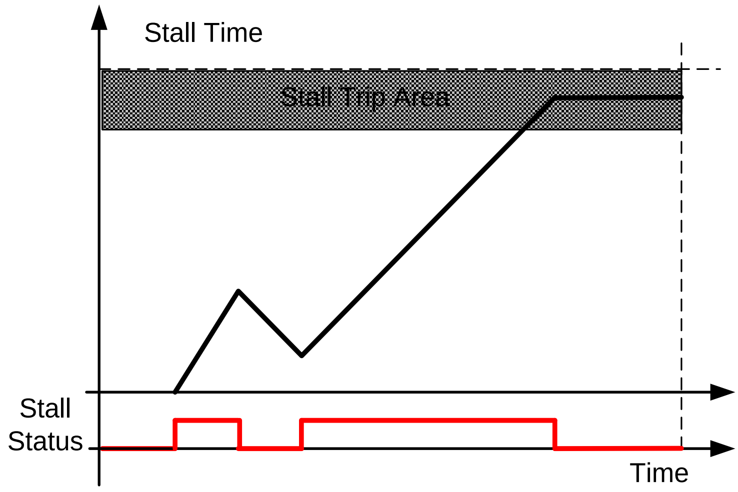
P2.12.3.3 Stall frequency limit ID712 "Stall Freq Lim"

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. The function requires that the output frequency is 1 Hz below the frequency reference before the stall time count starts.



P2.12.3.4 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 causes a trip.



8.12.4 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 protects the motor from overheating. The drive is capable of supplying higher current than nominal current to the motor. If the load requires this high current, there is a risk that the motor gets thermally overloaded. This is the case especially at low frequencies. At low frequencies the cooling effect of the motor and its capacity are reduced. 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.

P2.12.4.1 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

P2.12.4.2 Motor ambient temp. factor ID705 "MotAmbTempFactor

Defines the temperature factor for the conditions in which 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

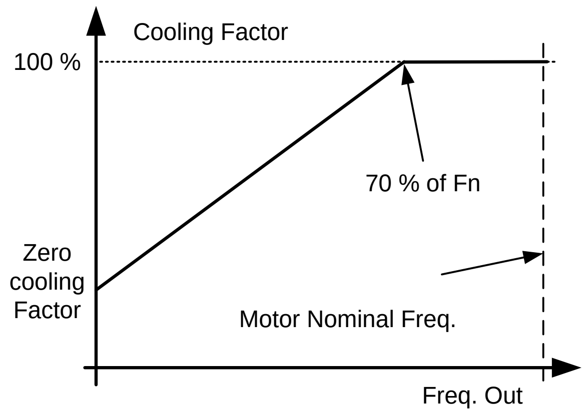
P2.12.4.3 Motor cooling factor at zero speed ID706 "MTP f0 Current"

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 nameplate data (nominal current of motor), not the nominal output current of the drive. 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.



P2.12.4.4 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 greater the time constant. The time constant is the time within which the calculated thermal stage has reached 63% of its final value.

The motor thermal time is specific to motor design and it varies between different motor manufacturers. The default value changes between unit sizes.

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

P2.12.4.5 Motor thermal protection: Motor duty cycle ID708 "Motor Duty Cycle"

The value can be set to 0%–150%.

Setting the value to 130% motor calculated temperature reaches nominal temperature with 130% of motor nominal current.

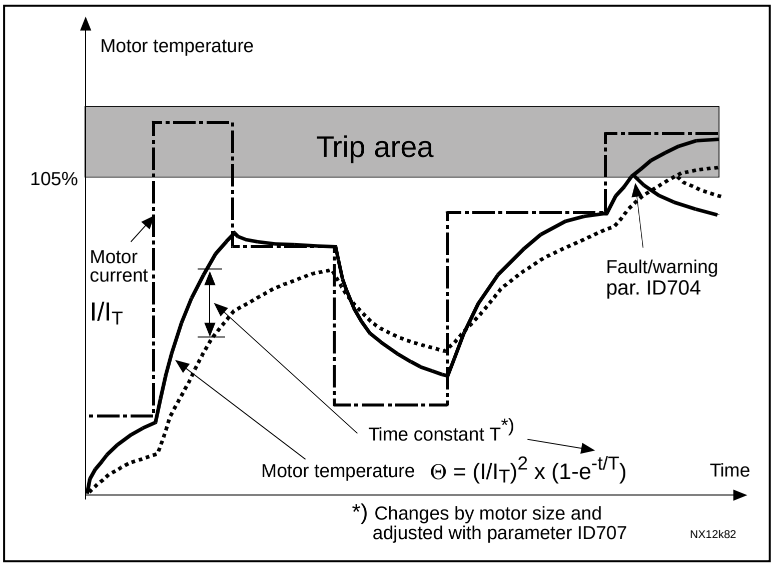


Figure 8-17. Motor temperature calculation

P2.12.4.6 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** deactivates the protection.

8.12.5 ***4mA protection***

The 4 mA protection monitors the signal level of analogue input from Analogue input 1 and Analogue input 2.
The monitoring function is active when a signal range 4–20 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.

P2.12.5.1 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

P2.12.5.2 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.

8.12.6 *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 5 Hz (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 nameplate 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.

P2.12.6.1 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 stops and activates the fault stage.
Deactivating the protection by setting the parameter to 0 resets the underload time counter to zero.

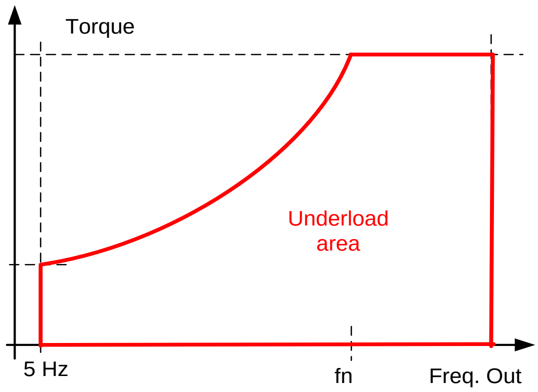
P2.12.6.2 Underload protection, zero frequency load ID715 "UP F0 Torque"

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

P2.12.6.3 Underload protection, field weakening area load ID714 "UP fnom Torque"

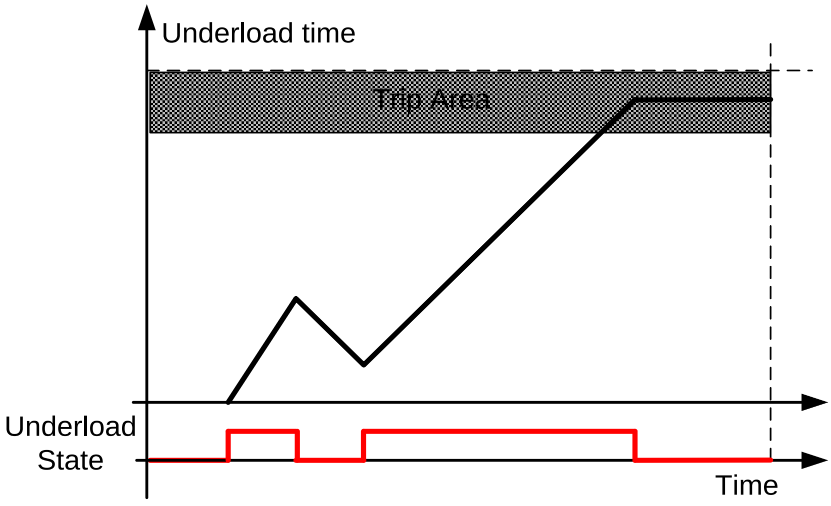
The torque limit can be set between 10.0%–150.0 % x T_{nMotor}.

This parameter gives the value for the minimum torque allowed when the output frequency is above the field weakening point.



P2.12.6.4 Underload time ID716 "UP Time Limit"

This time can be set between 2.0–600.0 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 causes a trip according to parameter *"Underload Protection"*.



8.12.7 ***Line synch protection functions***

P2.12.7.1 DC Low Response ID1680

Select response for DC Low fault. This function activates fault F85. See details on protection functions in the Line Synchronization chapter. Use selection "No Action" if the frequency converter is disconnected from net when synchronization is finished.

0 = No action
1 = Warning
Drive opens all contactors and waits until the reset command is given to open all contactors. After the DOL reset command, the actual warning resets automatically.
2 = Fault
Drive opens all contactors and waits until the reset command is given to open all contactors. After the DOL reset command, the actual fault can be reset.

P2.12.7.2 DC Low Limit ID1681

DC voltage fault limit for F85.

P2.12.7.3 Line Voltage low response ID1685

Select response for AC Low fault. This function activates fault F86. See details on protection functions in the Line Synchronization chapter. Use selections 0 or 1 if the measurements are disconnected from net when synchronization is finished.

0 = No action
1 = Warning
2 = Fault
Drive opens all contactors and waits until the reset command is given to open all contactors. After the DOL reset command, the actual fault can be reset.

P2.12.7.4 Line Voltage low limit ID1686

AC voltage fault limit for F86.

P2.12.7.5 Line Voltage Fault Delay "LineVolt.F. Delay" ID1691

Defines delay to line voltage low limit ID1686.

P2.12.7.6 DOL Conflict Fault Mode ID1687

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

P2.12.7.7 DOL Conflict Fault Delay ID1688

This parameter defines delay for DOL conflict fault.

P2.12.7.8 Vac < 90% Response ID1689

Defines response for fault F83.

P2.12.7.9 Synchronization time limit response ID1792

0 = No response
1 = Warning
2 = Fault, stop by coasting

P2.12.7.10 Synchronization time limit ID1791

Time limit if synchronization is not reached.

Active Synchro command time limit is acceleration time added to this parameter. If synchronization frequency is not reached within this time, action defined by P2.12.7.9 is taken.

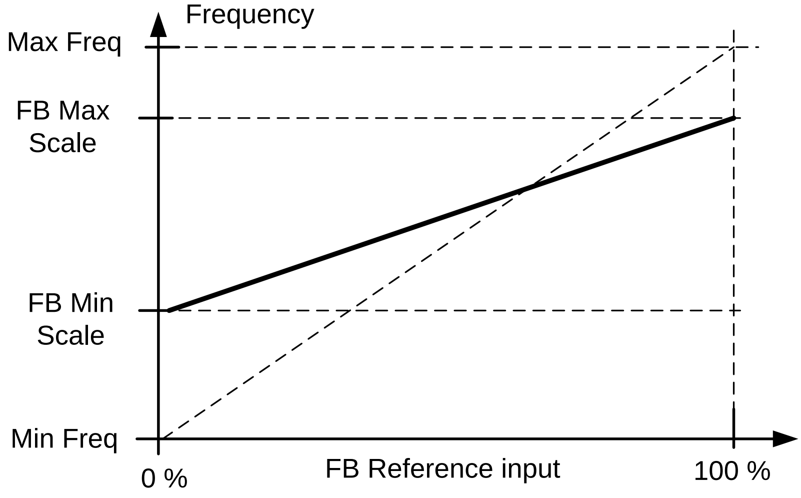
Active Direct command time limit is this parameter. If angle synchronization is not reached within this time, action defined by P2.12.7.9 is taken.

8.13 **Fieldbus settings**

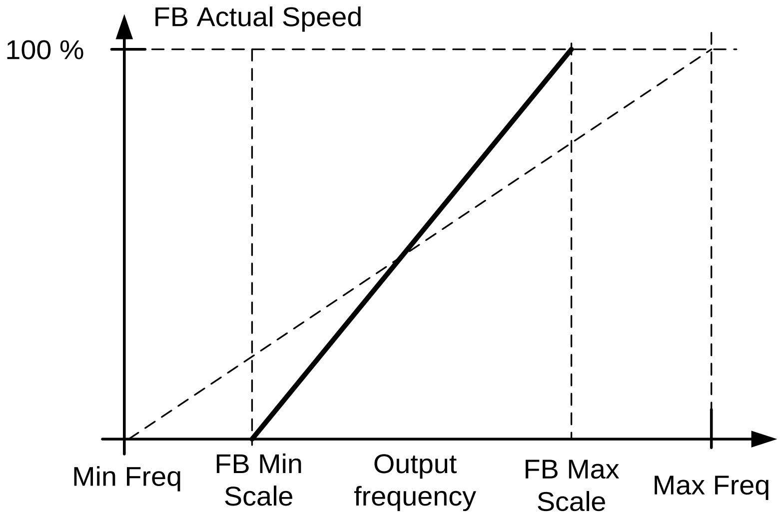
8.13.1 ***General settings***

P2.13.1 Fieldbus reference minimum scaling ID850 "FB Min Scale"
P2.13.2 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.



P2.13.3 to
P2.13.10 Fieldbus data out selections 1 to 8 ID852-ID859 "FB Data OutX Sel"

Using these parameters it is possible to monitor any monitoring or parameter value from the fieldbus. Enter the ID number of the item to be monitored for the value of these parameters. See monitoring signals for full details on the 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

P2.13.11 to

P2.13.18 Fieldbus data IN selections 1 to 8 ID876-833 "FB Data In X Sel"

Using these parameters it is possible to control any monitoring or parameter value from the fieldbus. Enter the ID number of the item to be controlled 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	-	-	-

P2.13.19 Fieldbus General Status Word ID ID897 "GSW ID"

With this parameter it is possible to select which data is sent in FBGeneralStatusWord (for details and availability see manual for fieldbus board that is in used).

P2.13.20 State Machine

Application has contains possibility to select what type of state machine is used.

1: Standard
This mode makes the fieldbus control behave as explained in the manual for the fieldbus board in use.

2: PROFIdrive
This mode uses PROFIdrive type state machine in application level. This mode can be used on fieldbus boards that do not have state machine itself or have possibility to bypass state machine functionality in option board.

For details, see chapter Status and Control Word.

8.14 ID functions

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

8.14.1 Value control

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

P2.14.1.1 Control Input Signal ID ID1580 "ContrInSignal ID"

Use this parameter to select what signal is used to control selected parameter.

P2.14.1.2 Control Off Limit ID1581 "Contrl Off Limit"

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

P2.14.1.3 Control On Limit ID1582 "Contrl On Limit"

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

P2.14.1.4 Control Off Value ID1583 "Contrl Off Value"

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

P2.14.1.5 Control On Value ID1584 "Contrl On Value"

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

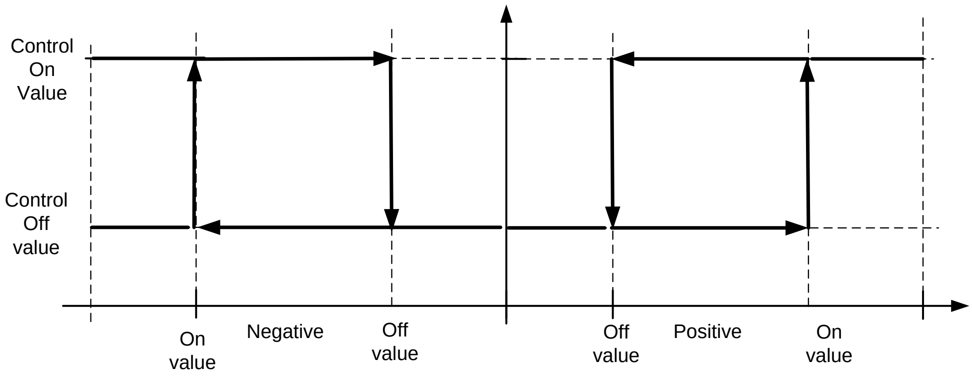
P2.14.1.6 Control Output Signal ID ID1585 "ContrlOutSignID"

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

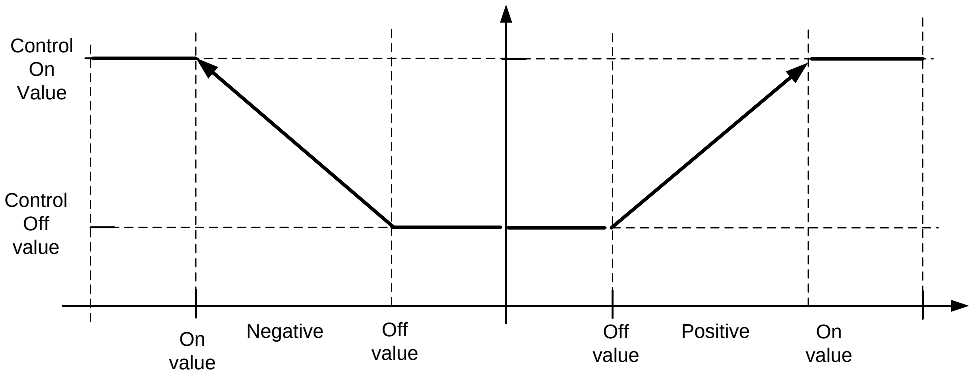
P2.14.1.7 Control Mode ID1586 "Control Mode"

This parameter defines how the value control output behaves.

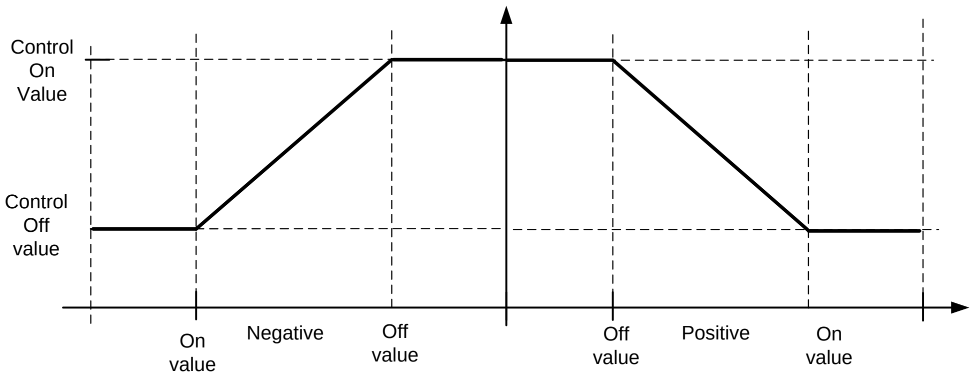
0 = SR ABS
Absolute input value is used to make a step change in the output between ON and OFF values.



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.



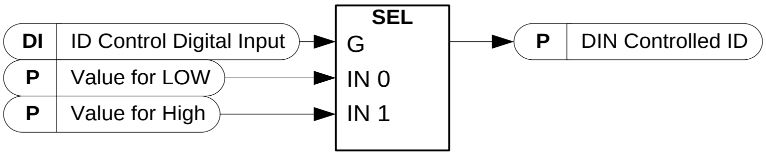
3 = SR
Input value is used to make a step change in the output between ON and OFF values.

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.

8.14.2 DIN ID control

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



P2.14.2.1 ID Control Digital Input ID1570 “ID Control DIN”

P2.14.3.1 ID Control Digital Input ID1590 “ID Control DIN”

P2.14.4.1 ID Control Digital Input ID1578 “ID Control DIN”

Select digital input to be used for controlling the parameter selected by ID1571, ID1575 and 1579.

P2.14.2.2 DIN Controlled ID ID1571 “Controlled ID”

P2.14.3.2 DIN Controlled ID ID1575 “Controlled ID”

P2.14.4.2 DIN Controlled ID ID1579 “Controlled ID”

Select parameter ID controlled by ID1570.

P2.14.2.3 Value for Low digital input (FALSE) ID1572 “FALSE Value”

P2.14.3.3 Value for Low digital input (FALSE) ID1592 “FALSE Value”

P2.14.4.3 Value for Low digital input (FALSE) ID1594 “FALSE Value”

Set here the controlled parameter value when the digital input (ID1570) is LOW for the parameter selected by ID1571. The function does not recognize decimals. Therefore give, e.g. 10.00 Hz as “1000”.

P2.14.2.4 Value for High digital input (TRUE) ID1573 “TRUE Value”

P2.14.3.4 Value for High digital input (TRUE) ID1593 “TRUE Value”

P2.14.4.4 Value for High digital input (TRUE) ID1596 “TRUE Value”

Set here the controlled parameter value when the digital input (ID1570) is HIGH for the parameter selected by ID1571. The function does not recognize decimals. Therefore give, e.g. 10.00 Hz as “1000”.

8.15 **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 for certain number of times before the actual fault indication is given. The function operates 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.

P2.15.1 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 the fault on the external device. The wait-time count starts only when the cause of the fault has been removed.

P2.15.2 Automatic reset: Trial time ID718 "Trial Time"

The automatic reset function tries to reset the faults that appear 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.

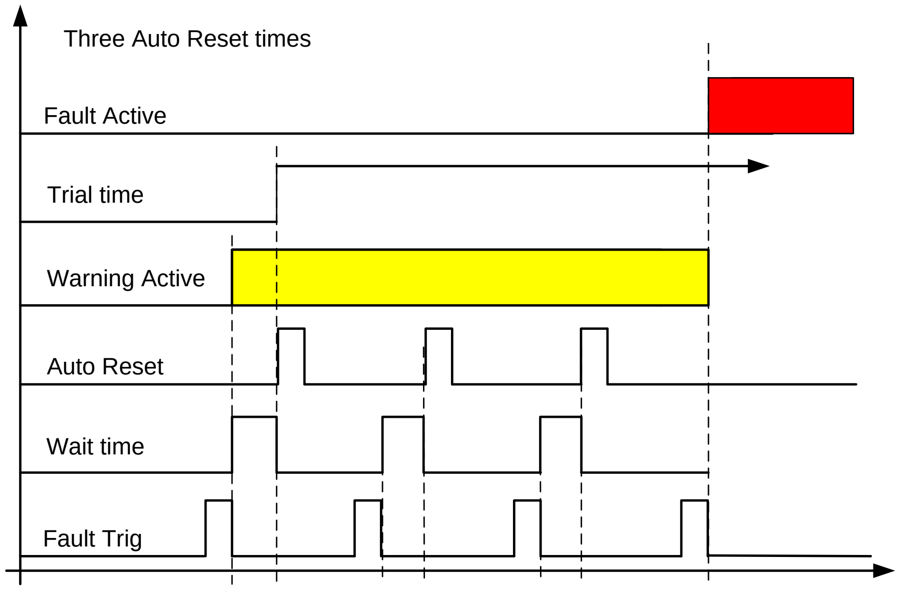


Figure 8-18. Example of automatic restarts with three restarts

P2.15.3 Automatic restart: Start function ID719 "Start Function"

The start function for restart is selected with this parameter. Restart takes 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 parameter "*Start Function"* (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 auto reset. If the number of faults that occur during the trial time exceeds the values set by number of tries, the FAULT state becomes active.

P2.15.4 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 an undervoltage trip.

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

P2.15.5 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 an overvoltage fault trip
>0 = Number of automatic fault resets after an overvoltage fault trip.

P2.15.6 Number of tries after overcurrent trip ID722 "Overcurr. Tries"

(NOTE! IGBT temp faults are also included)
This parameter determines how many automatic fault resets can be made during the trial time after an overcurrent trip.

0 = No automatic fault reset after an overcurrent fault trip
>0 = Number of automatic fault resets after an overcurrent trip, saturation trip and IGBT temperature faults

P2.15.7 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 a 4-mA reference fault.

0 = No automatic fault reset after reference fault trip
>0 = Number of automatic fault resets after the analog current signal (4–20 mA) has returned to the normal level (≥4 mA)

P2.15.8 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 a calculated motor temperature fault trip.

0 = No automatic fault reset after motor temperature fault trip
>0 = Number of automatic fault resets after motor temperature has returned to its normal level

P2.15.9 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 an external fault trip.

0 = No automatic fault reset after an external fault trip
>0 = Number of automatic fault resets after an external fault trip

P2.15.10 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 an underload trip.

0 = No automatic fault reset after an underload fault trip
>0 = Number of automatic fault resets after an underload fault trip

P2.15.11 Fault Simulation ID1569 "Fault Simulation"

With this parameter it is possible to simulate different faults without actually making, e.g. an overcurrent situation. From the drive's interface point of view, the behaviour is identical to an actual fault situation.

B00 = +1 = Simulates overcurrent fault (F1)
B01 = +2 = Simulates overvoltage fault (F2)
B02 = +4 = Simulates undervoltage fault (F9)
B03 = +8 = Simulates output phase supervision fault (F11)
B04 = +16 = Simulates earth fault (F3)
B05 = +32 = Reserved
B06 = +64 = Reserved
B07 = +128 = Simulates overtemperature warning (W14)
B08 = +256 = Simulates overtemperature fault (F14)
B09 = +512 = Reserved

8.16 Line synchronization

P2.16.1 Control Mode ID1626

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

0 = Single Drive
Only one motor is used in the system. Active direct command also opens the NET contactor when there is a LOW signal.
1 = Multi-Motor
Drive needs a command signal telling what motor is synchronized to network. Also a 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.

P2.16.2 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 bypasses this parameter selection.

P2.16.3 Delay to coasting ID1621

This parameter defines the delay when modulation is stopped from internal decision to make the change. For operation details, see chapter 2.

P2.16.4 Delay to Open ID1623

This parameter defines the delay when the FC contactor is opened from internal decision to make the change. For operation details, see chapter 2.

P2.16.5 Delay to Close ID1624

This parameter defines the delay when the NET contactor is closed from internal decision to make the change net. For operation details, see chapter 2.

P2.16.6 Number of motors ID1627

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

8.16.1 ***Back To FC Flying Start***

P2.16.7.1 Start Delay to FC ID1628

This parameter defines the delay when the drive starts after the command to open the NET contactor has been given. FC contactor is closed half of this time.

8.16.2 *Back to FC synchronization (BackSynch)*

P2.16.8.1 Synch To Motor ID1632

This parameter enables synchronization to motor when changing back to FC control. If disabled, the drive makes a normal flying start to motor when the same change command to FC control is given.

0 = Disabled
1 = Enabled

P2.16.8.2 DOL Open Delay ID1633

This parameter defines the delay when the DOL contactor is opened from internal decision to make the change.

P2.16.8.3 FC Delay To Close ID1629

This parameter defines the delay when the FC contactor is closed from internal decision to make the change FC control.

P2.16.8.4 Phase Offset to FC ID1609

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

P2.16.8.5 Phase Hysteresis to FC ID1638

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

P2.16.8.6 Synch OK FC Delay ID1639

Delay for how long internal status to change to FC control needs to be active before an actual decision to make change is made.

P2.16.8.7 FWPV at Synch ID1642

When motor is disconnected from grid, voltage of the motor starts to decrease immediately. First with a step and then with a motor time constant. This parameter should be adjusted to the same level that the motor voltage is at the time when FC contactor closes.

P2.16.8.8 FWPV Ramp Rate ID1643

This parameter defined ramp rate for voltage used to increase motor voltage back to nominal.

P2.16.8.9 FWPV Switch Delay ID1644

Delay when ramping of voltage is started after a FC contactor close command is given. This value should be longer than the contactor mechanical delay.

8.16.3 Line synchronization fine tuning

2.15.9.1 Smoot / Speed ratio ID1690

This parameter is used to select the speed of synchronization. There are 10 settings from which the selection 0 is the smoothest and selection 10 the fastest. To get the maximum speed for synchronization, a brake resistor or AFE may be needed.

2.15.9.2 Phase hysteresis ID1620

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

2.15.9.3 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.

2.15.9.4 Generator Side Operation ID1538

0 = Enable
Drive starts phase synchronization regardless of whether frequency for synchronization needs to be increased or decreased.
1 = Disable
Drive starts phase synchronization only on motoring side. In other words, frequency is only increased when synchronization is made. May be used in a high inertia system when synchronized without load.

2.15.9.5 Synchronization options ID1700

This parameter is used to activate certain functions.

b0 = Reserved
b1 = Single to Net
The drive monitors the rising edge of synchronization command and changes 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 are 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 for 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.

2.15.9.6 Line Frequency Reference Filter TC ID1900

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

2.15.9.7 Freq. Hysteresis for synch ID1613

Frequency hysteresis when phase synchronization can be started.

2.15.9.8 Frequency Hysteresis for Change ID1614

Frequency hysteresis for DOL change. This parameter allows a higher frequency range of change. In other words, if phase angle is within hysteresis but frequency is not, the change can still be made. Useful on weak/unstable grids.

2.15.9.9 Delay To Synch ID1619

When frequency is within *"Freq Hysteresis for Synch"* (P2.16.7.9), this parameter defines the delay after which phase synchronization is started. Useful when a weak generator is used and frequency has destabilized during motor acceleration.

P2.16.9.10 Synch OK Delay ID1649

Delay for how long the internal status to change to DOL needs to be active before the actual decision to change is made.

*8.16.4 **Commissioning***

P2.16.10.1 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 controls motor 1 contactor without actual synchronization, only delay parameters for opening and closing are used. Change between the FC contactor and the NET contactor is made with [Active Direct] command.

2= FC On, Net Off
This selection forces the FC contactor to close and the NET contactor to open.

3= FC Off, Net On
This selection forces the FC contactor to open and the Net contactor to close.

P2.16.10.2 Commissioning test activation ID1635

This DI needs to be TRUE before test modes are activated. Use virtual input 0.2 if an actual digital input is not available. This extra parameter has been added as a safety feature. When the input is not active, the drive operates in normal line synch mode.

8.17 **Keypad control parameters**

Unlike the parameters listed previously, the following parameters are located in the **M3** menu of the control panel. 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 panel as the active control place and copies the run status information (run/stop, direction and reference).

0 = PC control, activated 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 on any of the pages in 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"

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. PROTECTION FUNCTIONS

This chapter contains 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 protects the motor from overheating. The VACON® drive is capable of supplying higher current than the nominal current to the motor. If the load requires this high current, there is a risk that the motor gets thermally overloaded. This is the case especially at low frequencies. At low frequencies the cooling effect of the motor and its capacity are reduced. 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 panel display V1.10 ID9. See the user manual for the product in use.

⚠	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 the 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 no real indication of the shaft rotation. Stall protection is a overcurrent protection of a sort.

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 5 Hz (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 nameplate 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 (i.e. Modbus, PROFIBUS, DeviceNet). Monitor values from the fieldbus with Fieldbus Data Out Selection 1–8.

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 presented in the following table.

Current scaling for different unit sizes
Note: ID45, usually in Process data OUT 3, is scaled to be with one decimal always.

Voltage	Size	Scale
208–240 V AC	NX0001–NX0011	100–0.01 A
208–240 V AC	NX0012–NX0420	10–0.1 A
208–240 V AC	NX0530	1–1 A
380–500 V AC	NX0003–NX0007	100–0.01 A
380–500 V AC	NX0009–NX0300	10–0.1 A
380–500 V AC	NX0385–NX2643	1–1 A
525–690 V AC	NX0004–NX0013	100–0.01A
525–690 V AC	NX0018–NX0261	10–0.1A
525–690 V AC	NX0325–NX1500	1–1 A

Process Data IN (master -> slave)
ControlWord, Reference and Process Data are used with All-in-One 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 the drive is in RUN state.	
81	CAN communication	Communication to externals CAN I/O has stopped.	Communication cannot be started again until the drive is powered down.
82	Frequency error D7	Measured frequency is not within hysteresis.	Check that the 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 contactors on while running***

This fault is active when feedback from the first motor contactors is being used.
This fault appears if feedback from both contactors indicates that contactors are closed and the drive is modulating. When this happens, the drive stops 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 internally forces the contactor control off and the fault does not reset until the drive is powered down.

9.5.3 ***Fault 82, Frequency error D7***

Measured line frequency is not within hysteresis. The measured line voltage frequency must be higher than +25 Hz and less than +75 Hz. If frequency is not within this hysteresis, the drive does not make synchronization to net.

9.5.4 ***Fault 83, Voltage error D7***

Measured line voltage is less than 90% of motor nominal voltage. If the 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 does 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. The drive will not make changeover to net if the current is below 15% of motor nominal current.

9.5.6 ***Warning or Fault 85, DC Low***

This function monitors the drive's own DC voltage. If the voltage goes below a set limit, the drive forces all contactors open. 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 warning/fault has occurred, give command to open all NET contactors. This fault can be reset when the internal logic sees that no DOL control is active (contactor control word is zero). The warning resets automatically.

9.5.7 ***Fault 86, AC Voltage***

This function monitors line rms voltage. If the voltage goes below a set limit, the drive forces 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 can be reset when the internal logic sees that no DOL control is active (contactor control word is zero).

9.5.8 ***Fault 87, ByPass interlock***

This function monitors the digital input that is connected to a device that can indicate if 3-phase voltage input to motor is interrupted (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 the fault is activated, the drive opens all DO controls that are controlling DOL contactors. Normal operation can start again when the 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, the drive forces all contactors open. This is not however part of the safe torque off functionality.

10. CONTROL AND STATUS WORD IN DETAIL

NOTE: Combination 2 is not fully implemented as of 24.10.2013.

Combination	P7.x.1.4 Operate Mode	P2.13.20 State machine	
1	1 / PROFIdrive	1 / Standard	Control and Status Word are explained in fieldbus option board manual.
2	2 / ByPass Some fieldbus boards operate by default in “ByPass” mode	2 / PROFIdrive	Control word is ProfiDrive type and is explained in this manual. Status Word can be selected by ID number. Default is ProfiDrive type ID65 V1.26.2 FB Status Word.
3	2 / ByPass	1 / Standard	Control word is “Three Bit” control. Status Word can be selected by ID number. Default is ProfiDrive type ID65 V1.26.2 FB Status Word.
4	1 / ProfiDrive	2 / PROFIdrive	Drive cannot be operated in this combination from fieldbus.

10.1 Combination 1, PROFIdrive – Standard with PROFIBUS option board

10.1.1 Control Word Combination 1, PROFIdrive – Standard with PROFIBUS option board

	Main Control Word for PROFIBUS in Combination 1		
	FALSE	TRUE	Comment
b0	STOP 1 (by ramp)	ON 1	Keep this TRUE
b1	STOP 2 (by coast)	ON 2	Keep this TRUE
b2	STOP 3 (by ramp)	ON 3	Keep this TRUE
b3	RUN DISABLE	ENABLE	Use this for start and stop command
b4	No Action	START	Keep this TRUE
b5	No Action	START	Keep this TRUE
b6	No Action	START	Keep this TRUE
b7	No Action	Fault Reset 0 > 1	Use this for fault reset
b8	No Action	No Action	Not used
b9	No Action	No Action	Not used
b10	Disable Profibus control	Enable fieldbus control	See PROFIBUS manual
b11	Fieldbus DIN1=OFF	Fieldbus DIN1=ON	See P2.5.1.17–18
b12	Fieldbus DIN2=OFF	Fieldbus DIN2=ON	See P2.5.1.19–20
b13	Fieldbus DIN3=OFF	Fieldbus DIN3=ON	See P2.5.1.21–22
b14	Fieldbus DIN4=OFF	Fieldbus DIN4=ON	See P2.5.1.23–24
b15	Fieldbus DIN5=OFF	Fieldbus DIN5=ON	Not used

10.1.2 Status Word Combination 1, PROFIdrive – Standard with PROFIBUS option board

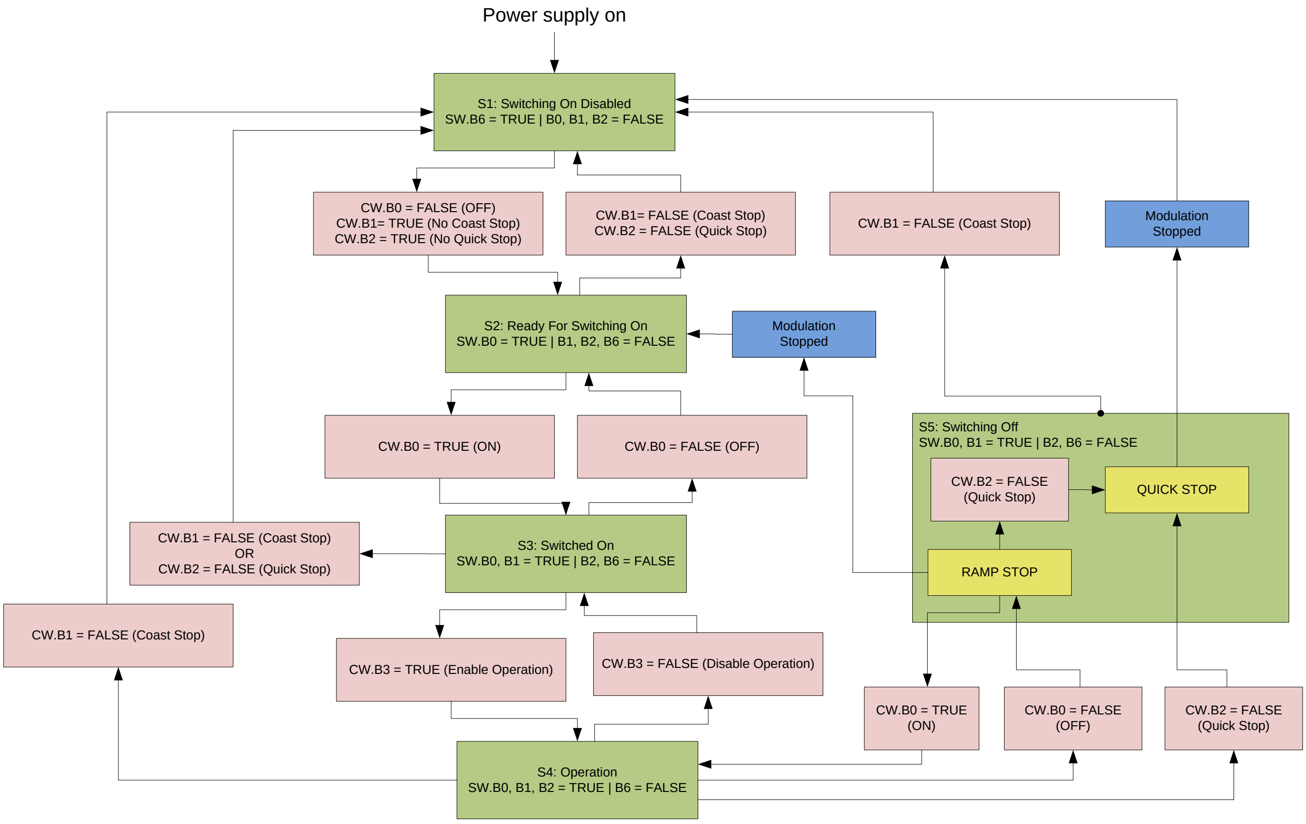
	Main Status Word for PROFIBUS in Combination 1		
	FALSE	TRUE	Comment
b0	Not Ready (initial)	READY 1 (SM)	See PROFIBUS manual
b1	Not Ready	READY 2 (SM)	See PROFIBUS manual
b2	DISABLE	ENABLE (SM)	See PROFIBUS manual
b3	NO FAULT	FAULT ACTIVE	Directly from the drive
b4	STOP 2	NO STOP 2 (SM)	See PROFIBUS manual
b5	STOP 3	NO STOP 3 (SM)	See PROFIBUS manual
b6	START ENABLE	START DISABLE (SM)	See PROFIBUS manual
b7	No Warning	Warning	Directly from the drive
b8	Reference ≠ Actual value	Reference = Actual value	
b9	Fieldbus control OFF	Fieldbus control ON	See PROFIBUS manual
b10	Not used	Not used	
b11	Not used	Not used	
b12	FC Stopped	Running	Directly from the drive
b13	FC not ready	Ready	Directly from the drive
b14	Not used	Not used	
b15	Not used	Not used	

SM = PROFIBUS board State Machine

10.2 Combination 2, ByPass – PROFIdrive

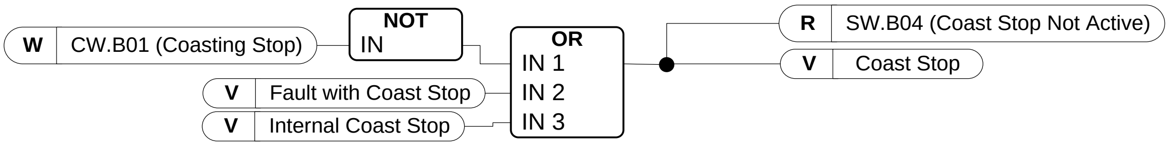
Combination 2 is not fully implemented as of 24.10.2013.

10.2.1 State diagram

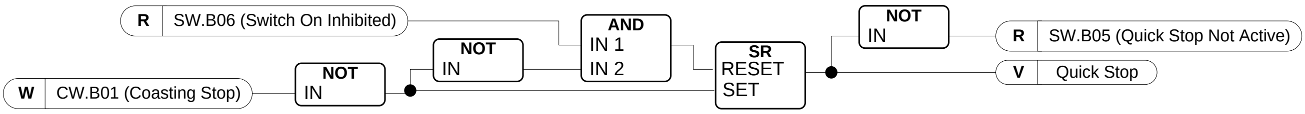


10.2.2 State machine

10.2.2.1 Coast stop

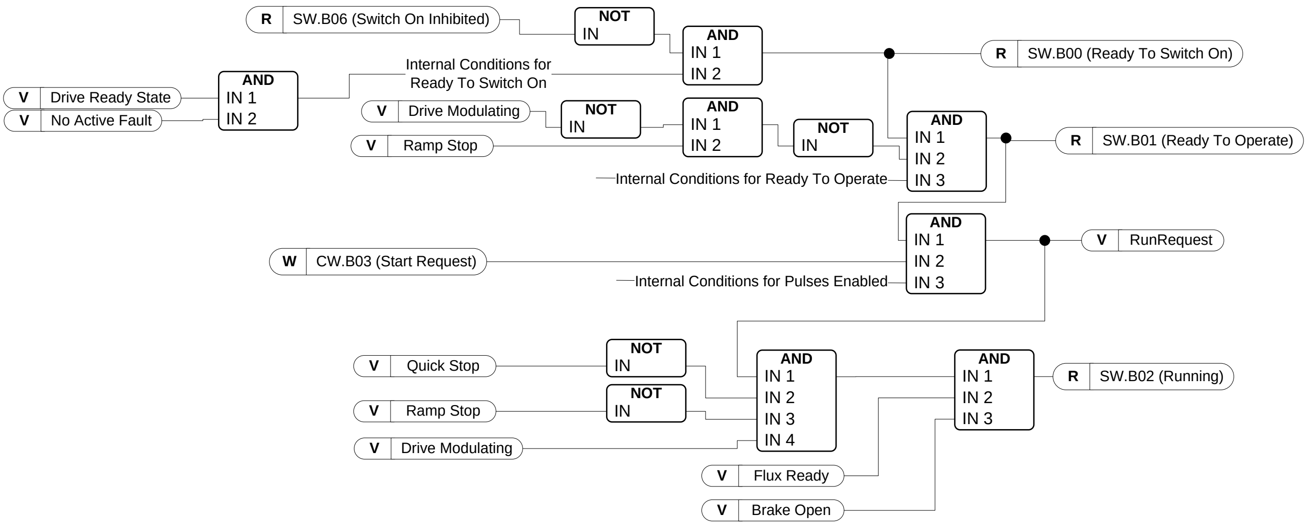


10.2.2.2 Quick stop



10.2.2.3 Switch on inhibit

10.2.2.4 Ready to switch-on, operate and running



10.2.3 *FB Control Word*

	FB Control Word	
	Signal	Comment
b0	ON	0>1 resets the "Switch On Inhibit" state and brings the drive to Ready Run. Should be reset after fault, coast stop (b1) and emergency stop (b2).
b1	Coasting Stop	0 = Coast stop Active 1 = Coast stop NOT active
b2	Quick Stop	0 = Quick stop Active 1 = Quick stop NOT active
b3	Start	Normal start command 0 = Stop the drive 1 = Start the drive
b4	Ramp Output to Zero	0 = Force speed ramp output to zero 1 = Release speed ramp output
b5	Ramp Hold	0 = Hold speed ramp output 1 = Release speed ramp
b6	Ramp Input to Zero	0 = Force speed ramp input to zero 1 = Release speed ramp input
b7	Fault Reset	0 = No action 1 = Reset active faults
b8	Inching 1	Run the drive with defined constant speed 0 = No action 1 = Run with constant speed
b9	Inching 2	Run the drive with defined constant speed 0 = No action 1 = Run with constant speed
b10	Fieldbus Control Enable	Activate fieldbus control when P3.1 = 3/Fieldbus 0 = Fieldbus control NOT active 1 = Activate fieldbus control
b11	Watch Dog	0>1>0>1…1 s square wave clock. This is used to check data communication between PROFIBUS master and the drive. Used to generate FB communication fault.
b12		
b13		
b14		
b15		

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

<u>B01: FALSE = Coast Stop (OFF 2), TRUE = ON 2</u>

Coast Stop: Drive makes coast stop and goes to "Switch on inhibit" state
ON 2: No Coast stop command

<u>B02: FALSE = Quick Stop (OFF 3), TRUE = ON 3</u>
Quick Stop: Drive makes stop function defined by parameter for Quick stop function.
ON 3: No Quick stop command.

<u>B03: FALSE = Stop Request, TRUE = Start Request</u>
Stop Request: Drive makes a stop defined by stop function.
Start Request: Start command to the drive.

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

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

B05: FALSE = Freeze Ramp Generator, TRUE = Unfreeze Ramp Generator
This bit has priority over B06 but not over B05.
Freeze Ramp Generator: Drive does not accept new reference from fieldbus, drive remains in same speed.
Unfreeze Ramp Generator: Drive follows reference from fieldbus.

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

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

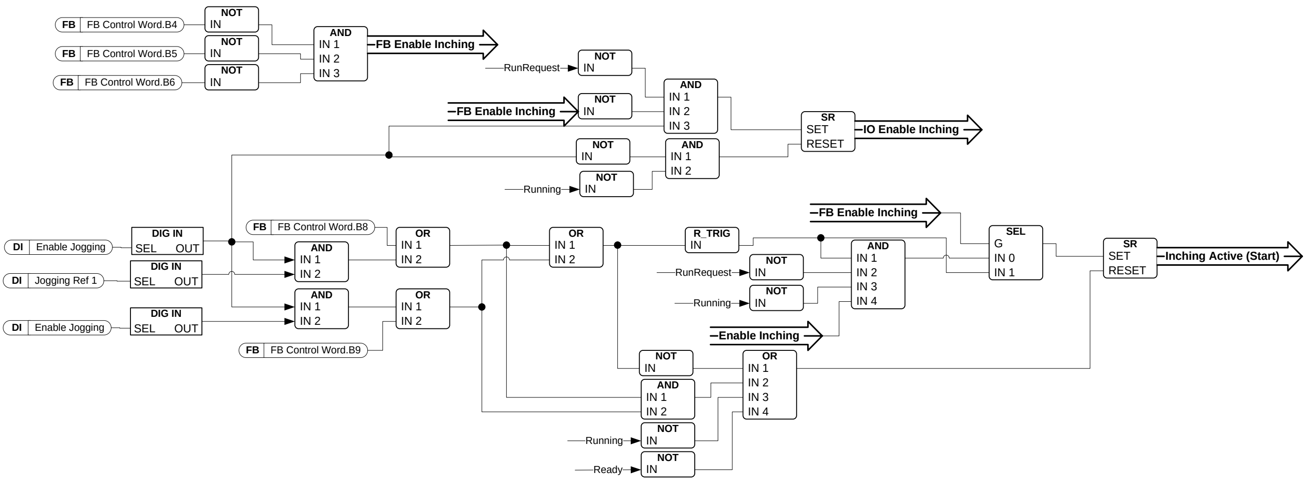
To activate Jogging function from fieldbus B04, B05 and B06 need to be zero.

B07: FALSE = No significance, TRUE = Fault Acknowledge

Fault Acknowledge: The group signal is acknowledged with a positive edge. Drive's reaction to a fault depends on the type of the fault (see Appendix A.8 "Alarm handling").If the fault reaction has isolated the voltage, then the drive goes into the "Switching on inhibited" state.

10.2.3.1 *Jogging function*

I/O Jogging Command: Jogging function starts the drive to reference without additional start command regardless of the control place when given from I/O. Jogging function requires enabling from digital input before the command is accepted. Inching is also disabled if there is start command active from the active control place. If both inching references are active at the same time, drive stops.
Fieldbus Jogging Command: Jogging command is activated by giving a normal start command but the ramp control bits CW.B4, B5 & B6 need to be zero. The drive needs to be at zero speed before the command is accepted, and CW.B4, B5 & B6 are active after the drive is at zero speed when jogging function is stopped.



B08: FALSE = No Function, TRUE = Jogging 1

Inching 1: Drive follows reference set by Jogging Ref 1. The function needs to be separately activated by Aux Control Word or by digital input Enable Jogging when I/O control is used for jogging.

B09: FALSE = No Function, TRUE = Inching 2

Inching 2: Drive follows reference set by Jogging Ref 2. The function needs to be separately activated by Aux Control Word or by digital input Enable Jogging when I/O control is used for jogging.

B10: FALSE = FB Control disabled TRUE = FB Control Enabled

FB Control Disabled: Drive does not follow main control word from fieldbus. If removed while running, the drive makes coast stop.
FB Control Enabled: Drive follows control word from fieldbus

B11: FALSE = FB WD Pulse Low, TRUE = FB WD Pulse High

Watch dog pulse: This pulse is used to monitor that PLC is alive. If the pulse is missing, the drive goes to FAULT state. This function is activated by P2.13.10.3 FB WD Delay. When the value is zero, the pulse is not monitored.

10.2.4 FB Status Word

	FB Status Word	
	Signal	Comment
b0	Ready to switch On	0 = The drive NOT ready to switch ON 1 = The drive is ready to switch ON
b1	Ready to Operate	0 = The drive is NOT ready to run 1 = The drive is ready to run
b2	Running	0 = The drive is NOT running 1 = The drive is running and ready to release the reference
b3	Fault Active	0 = No fault active 1 = Fault IS active
b4	Coast Stop NOT active	0 = Coast stop active 1 = Coast stop NOT active
b5	EM Stop not Active	0 = Emergency stop active 1 = Emergency stop NOT active
b6	Switch On Inhibit	0 = No Inhibit 1 = The drive is out of fault and coast / emergency stop state.
b7	Warning	0 = NO alarm 1 = Alarm IS active
b8	Speed At Ref	0 = Speed actual is NOT equal to speed reference 1 = Speed actual is equal to speed reference
b9	FB Control Active	0 = Fieldbus control NOT active 1 = Fieldbus control active
b10	Above Limit	Indicate if speed actual is below the limit P2.4.16 0 = Speed actual is below the speed limit 1 = Speed actual is above the speed limit
b11		
b12		
b13		
b14		
b15	Watch Dog Feedback	

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

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

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

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

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

Coast Stop Not Activated: Coast stop command is not active.

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

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

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

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

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

B10: FALSE = f Or n Not Reached, TRUE = f Or n Reached Or Exceeded
f Or n Not Reached: Speed is below P2.6.4.5 Above Speed Limit.
f Or n Reached Or Exceeded: Speed is above P2.6.4.5 Above Speed Limit.

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

10.3 Combination 3, ByPass – Standard

10.3.1 Control Word Combination 3, ByPass – Standard

	Main Control Word for PROFIBUS in Combination 3		
	FALSE	TRUE	Comment
b0	STOP	START	
b1	Clockwise	Counterclockwise	
b2	No action	FAULT RESET (0 -> 1)	
b3	Not used	Not used	
b4	Not used	Not used	
b5	Not used	Not used	
b6	Not used	Not used	
b7	Not used	Not used	
b8	Not used	Not used	
b9	Not used	Not used	
b10	Not used	Not used	
b11	Not used	Not used	
b12	Not used	Not used	
b13	Not used	Not used	
b14	Not used	Not used	
b15	Not used	Not used	

10.3.2 Status Word Combination 3, ByPass – Standard

Most of the fieldbuses use “MCStatus” as status word that is shown below. For PROFIBUS the status word can be selected. The default is Combination 2 Status Word, PROFIdrive type ID65 V1.24.2 FB Status Word. The following status word can be selected with P2.13.9 GSW ID by setting it to ID64.

	Main Status Word for PROFIBUS in Combination 3		
	FALSE	TRUE	Comment
b0	Not Ready	READY	
b1	STOP	RUN	
b2	Clockwise	Counterclockwise	
b3	NO FAULT	FAULT ACTIVE	
b4	No Warning	Warning	
b5	Reference ≠ Actual value	Reference = Actual value	
b6	Speed > Zero	At Zero Speed	
b7	Flux Not Ready	Flux ready	
b8	TC Speed Limit Active	TC Speed Limit Not Active	
b9	Detected Encoder Direction Clockwise	Encoder Direction Counterclockwise	
b10	UV Fast Stop Active	UV Fast Stop Not Active	
b11	Not used	Not used	
b12	Not used	Not used	
b13	Not used	Not used	
b14	Not used	Not used	
b15	Not used	Not used	

SM = PROFIBUS board State Machine

10.4 **Line synch control and status**

10.4.1 FB line synchronization control word ID1640

Control word for synchronization. Use synchronization status word to complete sequences correctly.

	FB Synch Control ID1640	
	Signal	Comment
b0	Activate synchronization	Drive synchronizes to net frequency.
b1	Activate changeover to DOL	Drive changes to DOL when synchronized.
b2	Reset DOL contactor(s)	Drive opens closed net contactor(s).
b3		
b4	Single Start	Drive does not start automatically to next motor, rising edge start command required in FB control.
b5	Single to net	Drive does not make changeover to DOL automatically, rising edge for synchronization and changeover required. (ID1700.B1)
b6	Single reset	Rising edge of reset DOL opens 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 puts 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		

B00: FALSE = No Synchronization, TRUE = Synchronization Active
No Synchronization: Drive operates in normal frequency reference control.

Synchronization Active: Drive uses OPT-D7 frequency information for reference and synchronizes voltage angles according to set parameters.

During synchronization and changeover, the command needs to be high until the changeover is completed. Otherwise the drive returns to normal reference operation.

If BackSynch is used, this bit needs to be high or otherwise normal flying start is made when changing back to drive control.

When making BackSynch, start command needs to be active.

B01: FALSE = No Action, TRUE = Change to DOL
No Action: No operation from drive.
Synchronization Active: If B00 command is active and the drive has synchronized to grid, change to DOL is made.

B02: FALSE = No Action, TRUE = Reset DOL Contactor
No Action: No operation from drive.
Reset DOL Contactor: DOL contactor is opened and, depending on setting coasting, flying start or BackSynch is made.

If BackSynch is made, this command needs to be high until change to FC control has been made.

BackSynch is made if :

- This is activated from parameter.
- Start Command is active.
- Synchronization command is active.

When DOL contactor command is given, the drive:

- Starts directly to OPT-D7 frequency.
- Makes synchronization to voltage angle.
- Closes FC contactor and opens DOL contactor in an order depending on set delay parameters.

When motor is in FC control, B02 and B00 can be set to zero (use synchronization status word to determine timing) and the drive will follow normal frequency reference.

10.4.2 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 is 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	*Start Command*	*Start command is active.*
b13		
b14		
b15		

<u>B02: FALSE = No Synchronization, TRUE = Active Synchronization</u>
No Synchronization: There is no active command to make synchronization.
Active Synchronization: There is command active to make synchronization.

<u>B03: FALSE = Freq Not In Hyst, TRUE = Frequency In Hysteresis</u>
Freq Not In Hyst: Frequency is not in hysteresis to start synchronization.
Frequency In Hysteresis: Frequency is within hysteresis to start synchronization.

<u>B04: FALSE = Angle not in Hysteresis, TRUE = Synchronization done</u>
Angle not in hysteresis: Voltage angle is not within hysteresis.
Frequency In Hysteresis: Drive voltage and grid voltage angles are within hysteresis.

<u>B05: FALSE = No Command, TRUE = Request to close direct</u>
No Command: There is no active command to make DOL change.
Request to close DOL: Request to close DOL contactor is active.

<u>B06: FALSE = No Command, TRUE = Close FC contactor</u>
No Command: No internal command to close FC contactor.
Close FC Contactor: Command to close FC contactor is active.

<u>B07: FALSE = No Command, TRUE = Close DOL contactor</u>
No Command: No internal command to close FC contactor.
Close DOL Contactor: Internal command to close DOL contactor is active (pulse).

<u>B08: FALSE = No Command, TRUE = DO command to DOL contactor</u>
No Command: No final command to close DOL contactor.
DO Command to DOL Contactor: Final command to close DOL contactor.

10.4.3 Synchronization Status Word 2 ID1682

	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 is 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.

<u>B01: FALSE = No Synchronization, TRUE = Active Synchronization</u>
No Synchronization: There is not active command to make synchronization.
Active Synchronization: There is command active to make synchronization.

<u>B02: FALSE = No Command, TRUE = Request to close direct</u>
No Command: There is no active command to make DOL change.
Request to close DOL: Request to close DOL contactor is active.

<u>B03: FALSE = No Command, TRUE = Reset DOL</u>
No Command:
Reset DOL:

<u>B04: FALSE = Freq Not In Hyst, TRUE = Frequency In Hysteresis</u>
Freq Not In Hyst: Frequency is not in hysteresis to start synchronization.
Frequency In Hysteresis: Frequency is within hysteresis to start synchronization.

B05: FALSE = Angle not in Hysteresis, TRUE = Synchronization done
Angle not in hysteresis: Voltage angle is not within hysteresis.
Frequency In Hysteresis: Drive voltage and grid voltage angles are within hysteresis.

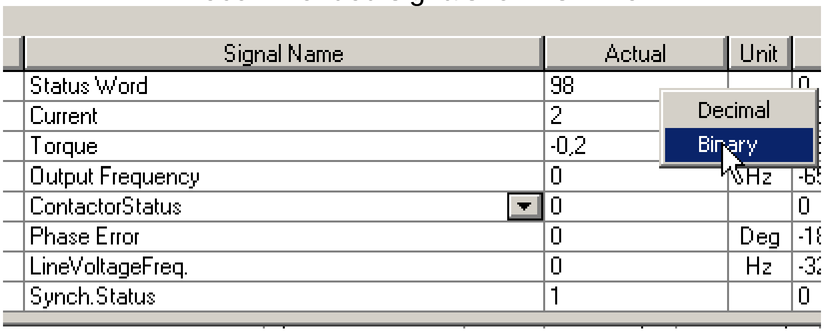
B06: FALSE = No Command, TRUE = Close DOL contactor
No Command: No internal command to close FC contactor.
Close DOL Contactor: Internal command to close DOL contactor is active (pulse).

B07: FALSE = No Command, TRUE = DO Command to DOL contactor
No Command: No final command to close DOL contactor.
DO Command to DOL Contactor: Final command to close DOL contactor.

11. PROBLEM SOLVING

While proper information about the problem is needed, it is recommended to update and try with the latest application and software versions. The software is continuously developed and the default settings are improved.

Recommended signals for NCDrive



Signal Name	Actual	Unit	
Status Word	98		0
Current	2		
Torque	-0,2		
Output Frequency	0	Hz	-6
ContactorStatus	0		0
Phase Error	0	Deg	-1
LineVoltageFreq.	0	Hz	-3
Synch.Status	1		0

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

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

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

Note that the datalogger settings can be changed to store the correct situation. It is also possible to make a manual force trig for the datalogger.

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

Also, it is helpful to have a single line diagram from the system where problem occurs.

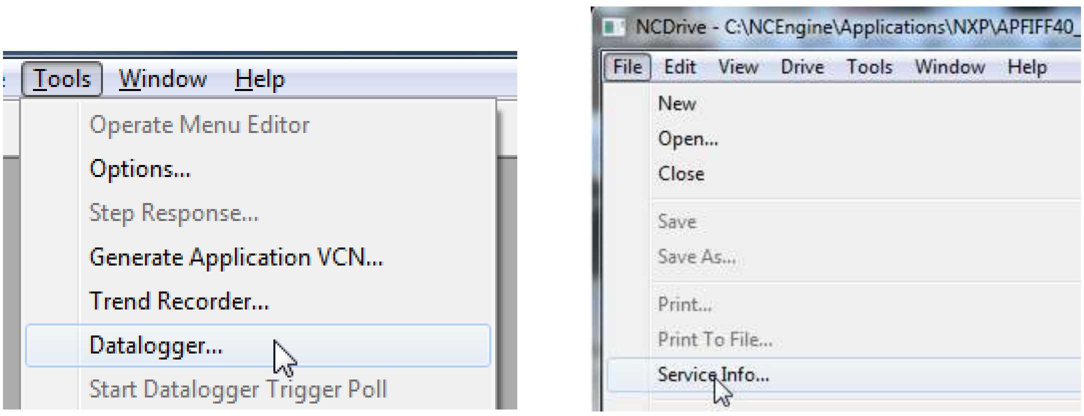


Figure 1. Datalogger window opening and service info upload.

12. FAULT CODES

The fault codes, their causes and correcting actions are presented in the following table. The shadowed faults are A faults only. The items written in white on black background present faults for which it is possible to 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*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 overvoltage 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. - If the fault re-occurs, 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 RECONNECT POWER! - Contact your local distributor. - If the fault appears simultaneously with Fault 1, check motor cables and motor.

8	System fault	- 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. If the fault re-occurs, contact your local distributor.
9	Undervoltage	DC-link voltage is under the drive fault voltage limit. See User Manual. – The most probable cause: too low a supply voltage – Frequency converter internal fault. – One of the input fuses is broken – External charge switch has not been closed Subcode in **T.14:** S1 = DC-link too low during run S2 = No data from power unit S3 = Undervoltage control supervision	- In case of temporary supply voltage break, reset the fault and restart the frequency converter. - Check the supply voltage. - If the supply voltage 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	– No brake resistor installed – Brake resistor is broken – Brake chopper failure	- Check brake resistor and cabling. - If OK, the brake chopper is faulty. Contact your local distributor.
13	Frequency converter under-temperature	Heatsink temperature is below –10°C	
14	Frequency converter over-temperature	Heatsink temperature is over 90°C. Overtemperature warning is issued when the heatsink temperature exceeds 85°C.	- 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.	If the fault re-occurs, contact your local distributor.

		Subcode in **T.14:** S1 = Current unbalance S2 = DC voltage unbalance	
22	EEPROM checksum fault	Parameter save fault – Faulty operation – Component failure	If the fault re-occurs, 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. If the fault re-occurs, 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 the drive.	- Cancel prevention of start-up if it 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 frame 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 your local distributor
41	IGBT temperature	IGBT Inverter Bridge overtemperature protection has detected too high a short term overload current	- Check loading. - Check motor frame 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. If option board changed, set the option board parameters again. If power unit changed, set converter parameters again.
45	Device added (different type)	Option board of different type added.	Reset. Set the option board parameters again.

50	Analogue input I_{in} < 4mA (sel. signal range 4 to 20 mA)	Current at the analogue input is < 4 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 control panel 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 your local distributor.
54	Slot fault	Defective option board or slot	Check board and slot. Contact your local 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 has 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 to control signal.	Check mechanical brake condition and connections.
59	Follower Communication	System bus or CAN communication is broken between master and follower	Check parameters from expander board and optical fiber or CAN cable.
60	Cooling	Liquid-cooled drive cooling circulation has failed	Check reason for cooling failure from external system.
61	Speed Error	Motor speed is not the same as reference.	-Check encoder connection - PMS motor has 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 has given 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 the temperature rise.
80	Both ON	Both contactors have been closed while drive is RUN state.	
81	CAN communication	Communication to external CAN I/O has stopped.	Communication cannot be started again until the drive is powered down.
82	Frequency error D7	Measured frequency is not within hysteresis.	Check that the 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 for the used motor.
85	DC Low	Measured DC voltage was too low.	
86	AC Voltage	Measured line voltage was 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.

89	Synch Limit	Drive cannot reach synchronization frequency or angle. This is usually a companion of other fault or warning.	Drive at current limit. Unstable grid.

Table 12-1. Fault codes

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