user's manual

nx frequency converters

mechanical brake control

application asfiff17

INDEX

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Mechanical Brake Control Application (ASFIFF17 V 1.18 or higher)

1. INTRODUCTION

Select the Mechanical Brake Control Application ASFIFF17 in menu **M6** on page *S6.1*.

The Mechanical Brake Control Application is typically used in applications where brake control is needed.

The hardware can be any Vacon NXS or NXP frequency converter. In closed loop motor control mode NXP drive and encoder option board is required (NXOPTA4 or NXOPTA5).

All outputs are freely programmable. Digital input functions are freely programmable to any digital input. Start forward and reverse signals are fixed to input DIN1 and DIN2 (see next page).

Additional functions:

- Programmable Start/Stop and Reverse signal logic
- Reference scaling
- One frequency limit supervision
- Second ramps and S-shape ramp programming
- Programmable start and stop functions
- DC-brake at stop
- One prohibit frequency area
- Programmable U/f curve and switching frequency
- Autorestart
- Motor thermal and stall protection: Programmable action; off, warning, fault
- Mechanical brake control related parameters
- 8 digital speed references selected by 3 digital inputs
- FWD and REV Safe speeds activated by digital inputs (NC)
- FWD and REV end limit stops (NC)
- Speed limit with programmable digital input
- Programmable Processdata for Fieldbus data mapping

2. PROGRAMMING PRINCIPLE OF THE DIGITAL INPUT SIGNALS

The programming principle of the input signals in the Mechanical brake control Application as well as in the Multipurpose Control Application (and partly in the other applications) is different compared to the conventional method used in other Vacon NX applications.

In the conventional programming method, Function to Terminal Programming Method (FTT), you have a fixed input that you define a certain function for. The applications mentioned above, however, use the Terminal to Function Programming method (TTF) in which the programming process is carried out the other way round: Functions appear as parameters that the operator defines a certain input for (see Figure 1).

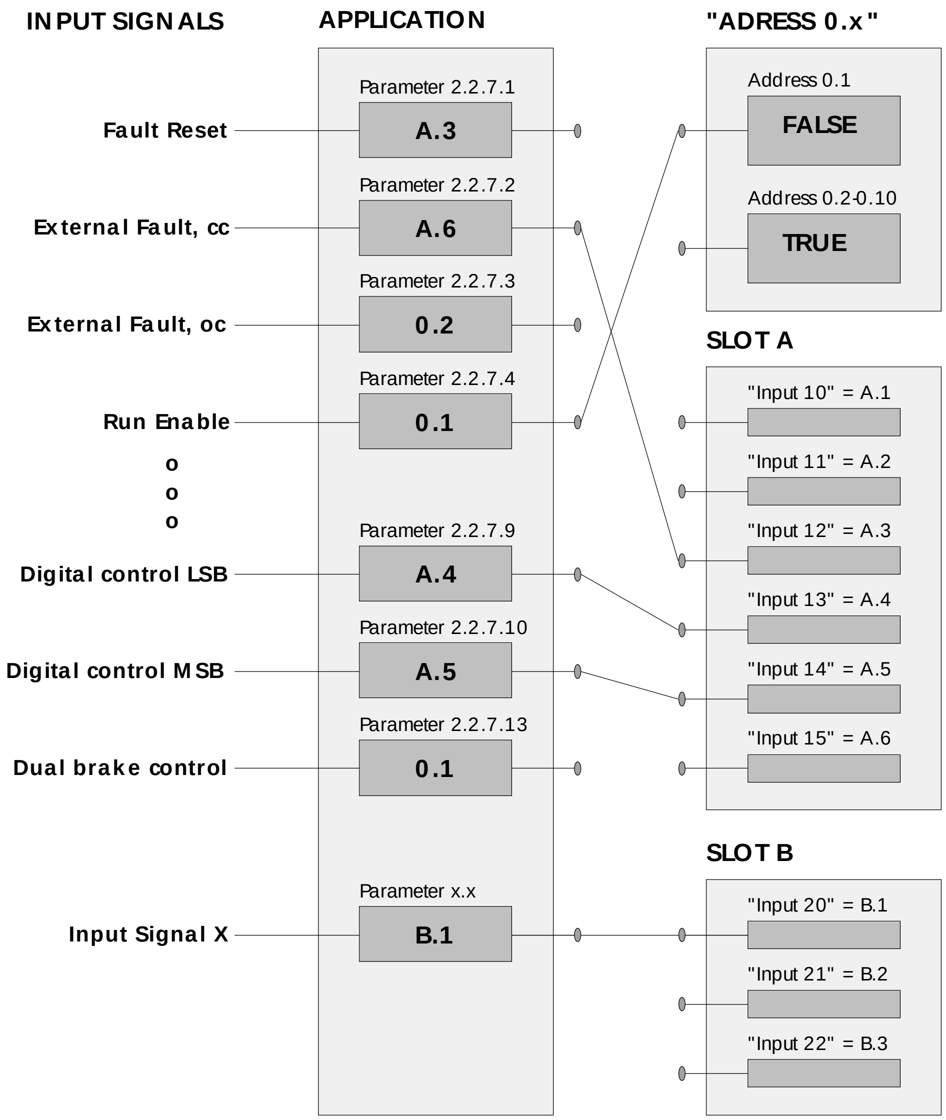
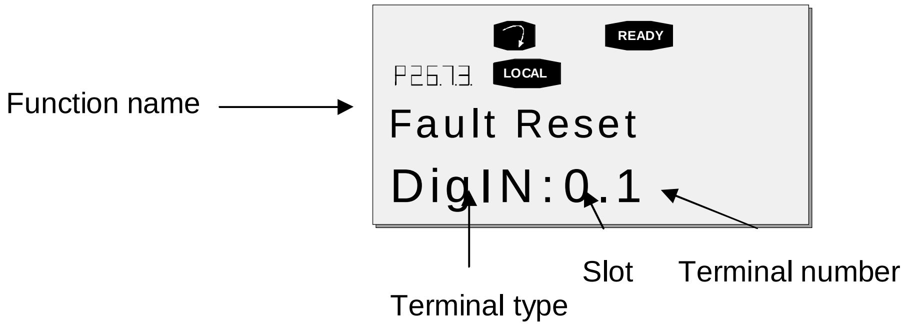


Figure 1. Basic principle of the Terminal to Function Programming method (TTF).

***Note**:*	*Constant value can be given to input signal. Value 0.1 is a constant FALSE and values from 0.2 through 0.10 are constant TRUE. (see* Figure 1*)*

2.1 Defining an input for a certain function on keypad

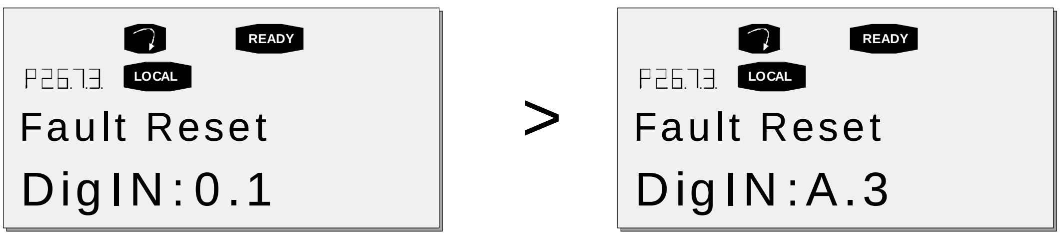
Connecting a certain function (input signal) to a certain digital input is done by giving the parameter an appropriate value. The value is formed of the *Board slot* on the Vacon NX control board (see Vacon NX User's Manual, Chapter 6.2) and the *respective signal number*, see below.



Example: You want to connect the digital input function *Fault Reset* (parameter 2.2.7.1) to a digital input A.3 on the basic board NXOPTA1, located in Slot A.

First find the parameter 2.2.7.1 on the keypad. Press the *Menu button right* once to enter the edit mode. On the *value line*, you will see the terminal type on the left (DigIN) and on the right, digital input where function is connected.

When the value is blinking, hold down the *Browser button up* or *down* to find the desired board slot and signal number. The program will scroll the board slots starting from **0** and proceeding from **A** to **E** and the I/O numbers from **1** to **10**.
Once you have set the desired value, press the *Enter button* once to confirm the change.



2.2 Defining a certain function with NC_Drive programming tool

If you use the NCDrive Programming Tool for parametrizing you will have to establish the connection between the function and input/output in the same way as with the control panel. Just pick the address code from the drop-down menu in the *Value* column (see Figure 2).

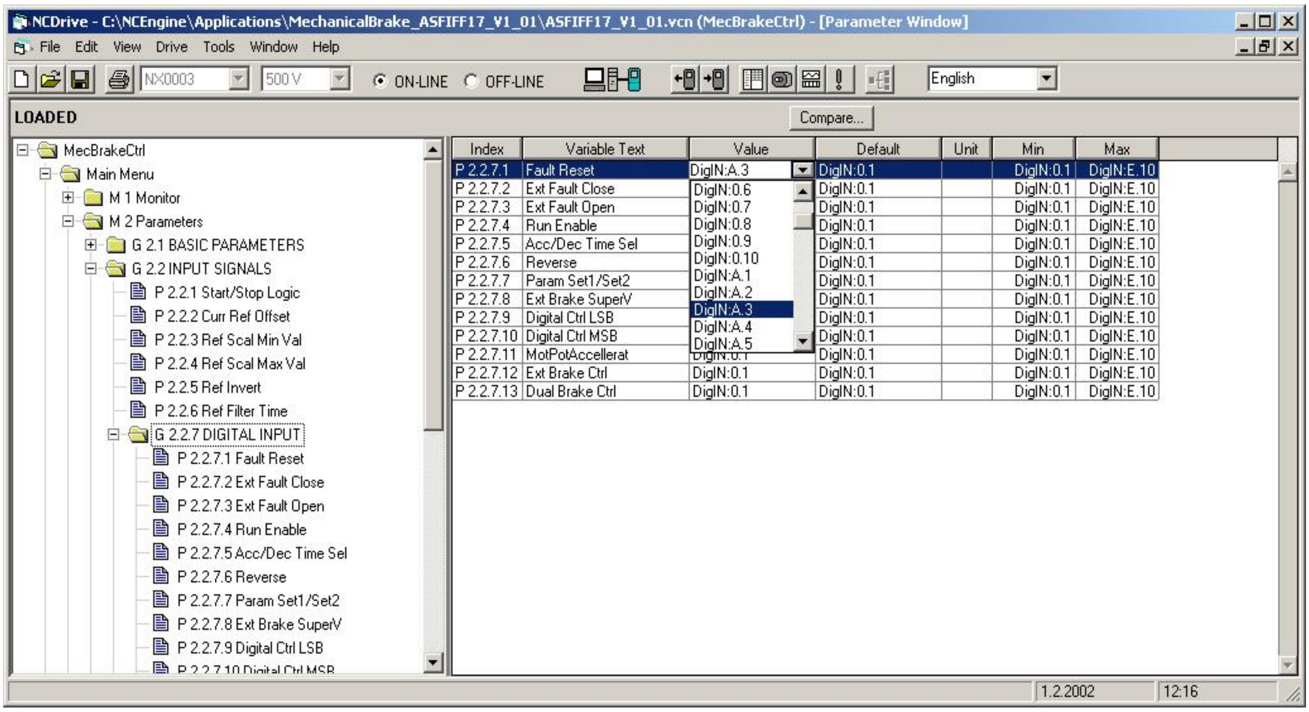
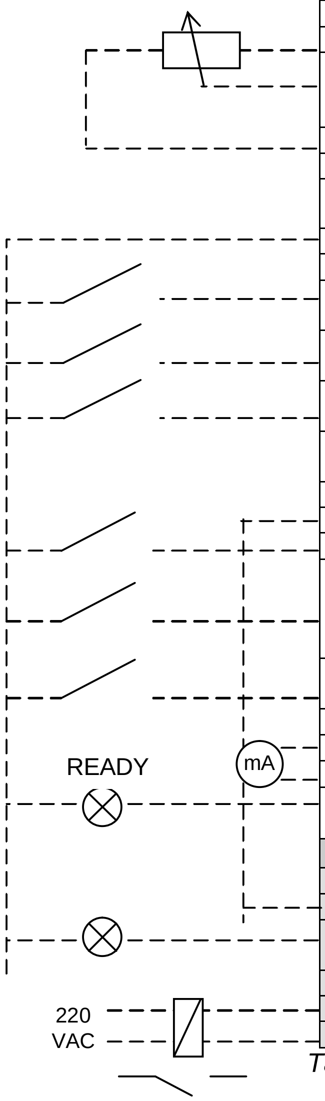


Figure 2. Screenshot of NCDrive programming tool; Entering the address code

Note:	*Two inputs signals can be connected to same digital input. Use this feature very considerably.*

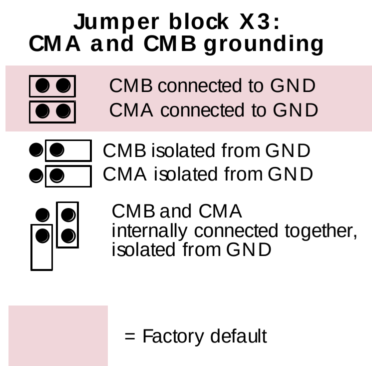
3. CONTROL I/O



NXOPTA1			
Terminal		Signal	Description
1	+10V$_{ref}$	Reference output	Voltage for potentiometer, etc.
2	AI1+	Analogue input, voltage range 0—10V DC	Voltage input frequency reference
3	AI1-	I/O Ground	Ground for reference and controls
4	AI2+	Analogue input, current range 0—20mA	Current input frequency reference
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)	Contact closed = start forward
9	DIN2	Start reverse (programmable)	Contact closed = start reverse
10	DIN3	External fault input (programmable)	Contact open = no fault Contact closed = fault
11	CMA	Common for DIN 1—DIN 3	Connect to GND or +24V
12	+24V	Control voltage output	Voltage for switches (see #6)
13	GND	I/O ground	Ground for reference and controls
14	DIN4	Programmable	.
15	DIN5	Programmable	
16	DIN6	Fault reset (programmable)	Contact open = no action Contact closed = fault reset
17	CMB	Common for DIN4—DIN6	Connect to GND or +24V
18	AO1+	Output frequency	Programmable
19	AO1-	Analogue output	Range 0—20 mA/R$_L$, max. 500Ω
20	DO1	Digital output READY	Programmable Open collector, I≤50mA, U≤48 VDC
NXOPTA2			
21	RO1	Relay output 1 Brake open signal	Programmable
22	RO1		
23	RO1		
24	RO2	Relay output 2 FAULT	Programmable
25	RO2		
26	RO2		

Table 1 Mechanical brake control application default I/O configuration.

Note: See jumper selections below. More information in the product\s User's Manual.



4. MECHANICAL BRAKE CONTROL APPLICATION – PARAMETER LISTS

On the next pages you will find the lists of parameters within the respective parameter groups. The parameter descriptions are given on pages 22 to 64.

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 (used with PC tools)
[grey] = In parameter row: Use TTF method to program these parameters.
[cyan] = On parameter code: Parameter value can only be changed after the frequency converter has been stopped.

4.1 Monitoring values (Control keypad: menu M1)

The monitoring values are the actual values of parameters and signals as well as statuses and measurements. Monitoring values cannot be edited.
See Vacon NX User's Manual, Chapter 7 for more information.

Code	Parameter	Unit	ID	Description
V1.1	Output frequency	Hz	1	Output frequency to motor
V1.2	Frequency reference	Hz	25	Frequency reference to motor control
V1.3	Motor speed	rpm	2	Motor speed in rpm
V1.4	Motor current	A	3	
V1.5	Motor torque	%	4	In % of the nominal motor torque
V1.6	Motor power	%	5	Motor shaft power
V1.7	Motor voltage	V	6	
V1.8	DC link voltage	V	7	
V1.9	Unit temperature	°C	8	Heatsink temperature
V1.10	Voltage input	V	13	AI1
V1.11	Current input	mA	14	AI2
V1.12	DIN1, DIN2, DIN3		15	Digital input statuses
V1.13	DIN4, DIN5, DIN6		16	Digital input statuses
V1.14	DO1, RO1, RO2		17	Digital and relay output statuses
V1.15	Analogue I_{out}	mA	26	AO1
V1.16	Encoder speed	rpm	1501	Encoder speed in rpm
V1.17	Calculated sync speed	rpm	1502	Calculated synchronous speed
V1.18	Torque	%	1125	Unfiltered motor torque
V1.19	Current	A	1113	Unfiltered motor current
V1.20	DC Voltage	V	44	Unfiltered DC Voltage
V1.21	Status Word		43	Drive status word
V1.22	Encoder 1 Freq	Hz	1124	Shaft Frequency
V1.23	Fault History		37	Last active fault code
G1.24	Multimonitor			Multimonitor page

Table 2 . Monitoring values

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

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.1.1	Min frequency	0,00	Par. 2.1.2	Hz	0,00		101	
P2.1.2	Max frequency	Par. 2.1.1	320,00	Hz	50,00		102	**NOTE**: If f_{max} > than the motor synchronous speed, check suitability for motor and drive system
P2.1.3	Acceleration time 1	0,1	3000,0	s	3,0		103	
P2.1.4	Deceleration time 1	0,1	3000,0	s	3,0		104	
P2.1.5	Current limit	0,1 x I_L	2,5 x I_L	A	1,5 x I_L		107	**NOTE**: This applies for frequency converters up to FR7. For greater sizes, consult the factory.
P2.1.6	Nominal voltage of the motor	180	690	V	NX2: 230V NX5: 400V NX6: 690V		110	
P2.1.7	Nominal frequency of the motor	30,00	320,00	Hz	50,00		111	Check the rating plate of the motor
P2.1.8	Nominal speed of the motor	300	20 000	rpm	1440		112	The default applies for a 4-pole motor and a nominal size frequency converter.
P2.1.9	Nominal current of the motor	1 x I_L	2,5 x I_L	A	I_L		113	Check the rating plate of the motor
2.1.10	Motor cosφ	0,30	1,00		0,85		120	Check the rating plate of the motor
2.1.11	I/O reference	0	3		0		117	**0**=AI1 **1**=AI2 **2**=Keypad **3**=Fieldbus **4**=Digital **5**=Joystick (Voltage input) **6**=Motor potentiometer
2.1.12	Keypad control reference	0	3		2		121	**0**=AI1 **1**=AI2 **2**=Keypad **3**=Fieldbus
2.1.13	Fieldbus control reference	0	3		3		122	**0**=AI1 **1**=AI2 **2**=Keypad **3**=Fieldbus
2.1.14	Digital reference 000	0,00	Par. 2.1.2	Hz	5,00		1506	Digital reference preset by operator
2.1.15	Digital reference 001	0,00	Par. 2.1.2	Hz	10,00		1507	
2.1.16	Digital reference 010	0,00	Par. 2.1.2	Hz	25,00		1508	
2.1.17	Digital reference 011	0,00	Par. 2.1.2	Hz	50,00		1509	
2.1.18	Digital reference 100	0,00	Par. 2.1.2	Hz	50,00		1600	
2.1.19	Digital reference 101	0,00	Par. 2.1.2	Hz	50,00		1601	
2.1.20	Digital reference 110	0,00	Par. 2.1.2	Hz	50,00		1602	
2.1.21	Digital reference 111	0,00	Par. 2.1.2	Hz	50,00		1603	
2.1.22	FWD Safe Speed	0,00	Par. 2.1.2	Hz	10,00		1604	Speed reference when digital input for FWD Safe speed is activated

2.1.23	REV Safe Speed	0,00	Par. 2.1.2	Hz	10,00		1605	Speed reference when digital input for REV Safe speed is activated
2.1.24	Speed Limit	0,00	Par. 2.1.2	Hz	30,00		1606	Speed limit when digital input for speed limit is active

Table 3. Basic parameters G2.1

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

Code	Parameter	Min	Max	Unit	Default	Cus	ID	Note
P2.2.1	Start/Stop logic	0	6		0		300	DIN1 / DIN2 0 Start fwd / Start rvs 1 Start/Stop / Rvs/Fwd 2 Start/Stop / Run enable 3 Start pulse / Stop pulse 4 Fwd* / Rvs* 5 Start*/Stop / Rvs/Fwd 6 Start*/Stop / Run enable
P2.2.2	Current reference offset	0	1		1		302	**0**=No offset **1**=4—20 mA
P2.2.3	Reference scaling minimum value	0,00	par. 2.2.5	Hz	0,00		303	Selects the frequency that corresponds to the min. reference signal 0,00 = No scaling
P2.2.4	Reference scaling maximum value	0,00	320,00	Hz	0,00		304	Selects the frequency that corresponds to the min. reference signal 0,00 = No scaling
P2.2.5	Reference inversion	0	1		0		305	**0** = Not inverted **1** = Inverted
P2.2.6	Reference filter time	0,00	10,00	s	0,10		306	**0** = No filtering
P2.2.7.x	**Digital Inputs**							
P2.2.7.1	Fault Reset	0	E.10		15		1510	
P2.2.7.2	External Fault, closing contact	0	E.10		12		1511	
P2.2.7.3	External Fault, opening contact	0	E.10		0		1512	
P2.2.7.4	Run Enable	0	E.10		0.2		1513	
P2.2.7.5	Acc/Dec Time selection	0	E.10		0		1514	
P2.2.7.6	Reverse	0	E.10		0		1515	
P2.2.7.7	Param Set ½	0	E.10		0		1516	
P2.2.7.8	External brake supervision	0	E.10		0		1517	
P2.2.7.9	Speed select 1	0	E.10		0		1518	
P2.2.7.10	Speed select 2	0	E.10		0		1519	
P2.2.7.11	Speed select 3	0	E.10		0		1523	
P2.2.7.12	MotPot Accelleration	0	E.10		0		1520	
P2.2.7.13	External brake control	0	E.10		0		1521	
P2.2.7.14	Dual brake control	0	E.10		0		1522	
P2.2.7.15	FWD Safe Speed	0	E.10		0.2		1610	Normally Closed (NC)
P2.2.7.16	FWD Stop	0	E.10		0.2		1611	Normally Closed (NC)
P2.2.7.17	REV Safe Speed	0	E.10		0.2		1612	Normally Closed (NC)
P2.2.7.18	REV Stop	0	E.10		0.2		1613	Normally Closed (NC)
P2.2.7.19	Speed Limit	0	E.10		0.1		1614	Limit given by P2.1.24
P2.2.7.20	DCBrInStopSel	0	E.10		0.1		1550	
P2.2.8.x	**Non-Linearization**							
P2.2.8.1	NonLin X_1 coordinate	0,00	100,00	%	40,00		1526	
P2.2.8.2	NonLin Y_1 coordinate	0,00	100,00	%	40,00		1527	
P2.2.8.3	NonLin X_2 coordinate	0,00	100,00	%	80,00		1528	
P2.2.8.4	NonLin Y_2 coordinate	0,00	100,00	%	80,00		1529	

Table 4. Input signals, G2.2

* = Rising edge required to start

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

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.3.1	Analogue output function	0	8		1		307	**0**=Not used **1**=Output freq. (0—f_{max}) **2**=Freq. reference (0—f_{max}) **3**=Motor speed (0—Motor nominal speed) **4**=Output current (0-I_{nMotor}) **5**=Motor torque (0—T_{nMotor}) **6**=Motor power (0—P_{nMotor}) **7**=Motor voltage (0-U_{nMotor}) **8**=DC-link volt (0—1000V)
P2.3.2	Analogue output filter time	0,00	10,00	s	1,00		308	
P2.3.3	Analogue output inversion	0	1		0		309	**0** = Not inverted **1** = Inverted
P2.3.4	Analogue output minimum	0	1		0		310	**0** = 0 mA **1** = 4 mA
P2.3.5	Analogue output scale	10	1000	%	100		311	
P2.3.6	Digital output 1 function	0	18		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**=Reversed **10**=Preset speed **11**=At speed **12**=Mot. regulator active **13**=OP freq. limit superv. **14**=Control place: IO **15**=Therm Fault/Warning **16**=FB DigIN 1 **17**=Open external Brake **18**=Open Enable
P2.3.7	Relay output 1 function	0	18		17		313	As parameter 2.3.6
P2.3.8	Relay output 2 function	0	18		3		314	As parameter 2.3.6
P2.3.9	Output frequency limit 1 supervision	0	2		0		315	**0**=No limit **1**=Low limit supervision **2**=High limit supervision
P2.3.10	Output frequency limit 1; Supervised value	0,00	320,00	Hz	0,00		316	
P2.3.11	Analogue output 2 signal selection	0			0.1		471	TTF programming method used.
P2.3.12	Analogue output 2 function	0	8		4		472	As parameter 2.3.1
P2.3.13	Analogue output 2 filter time	0,00	10,00	s	1,00		473	
P2.3.14	Analogue output 2 inversion	0	1		0		474	**0**=Not inverted **1**=Inverted
P2.3.15	Analogue output 2 minimum	0	1		0		475	**0**=0 mA **1**=4 mA
P2.3.16	Analogue output 2 scaling	10	1000	%	1000		476	

Table 5. Output signals, G2.3

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

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.4.1	Ramp 1 shape	0,0	10,0	s	0,0		500	**0** = Linear **>0** = S-curve ramp time
P2.4.2	Ramp 2 shape	0,0	10,0	s	0,0		501	**0** = Linear **>0** = S-curve ramp time
P2.4.3	Acceleration time 2	0,1	3000,0	s	10,0		502	
P2.4.4	Deceleration time 2	0,1	3000,0	s	10,0		503	
P2.4.5	Brake chopper	0	4		1		504	**0**=Disabled **1**=Used when running **2**=External brake chopper **3**=Used when stopped/running **4**=Used when running, no test
P2.4.6	Start function	0	1		0		505	**0**=Ramp **1**=Flying start
P2.4.7	Stop function	0	3		1		506	**0**=Coasting **1**=Ramp **2**=Ramp+Run enable coast **3**=Coast+Run enable ramp
P2.4.8	Flux brake	0	1		0		520	**0** = Off **1** = On
P2.4.9	Flux braking current	0,0	Varies	A	0,0		519	
P2.4.10	Ramp Change Frequency, Motor potentiometer	0,0	Par. 2.1.2	Hz	0,00		1530	Acc/dec. ramps 2 are used below this frequency
P2.4.11.x	**Prohibit freq**							
P2.4.11.1	Prohibit frequency range 1 low limit	0,00	par. 2.5.2	Hz	0,00		509	
P2.4.11.2	Prohibit frequency range 1 high limit	0,00	320,00	Hz	0,0		510	
P2.4.11.3	Prohibit acc./dec. ramp	0,1	10,0		1,0		518	
P2.4.12	DCBrCurrInStop	0	2,5 x I_L	A	0		1552	

Table 6. Drive control parameters, G2.4

4.6 Brake control parameters (Control keypad: Menu M2 → G2.5)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.5.1.x	**OPEN LOOP PARAMETERS**							
P2.5.1.1	Current limit fwd	0,0	P2.1.9	A	0,0		1531	
P2.5.12	Current limit rev	0,0	P2.1.9	A	0,0		1532	
P2.5.1.3	Torque limit fwd	0,0	100,0	%	0,0		1533	
P2.5.1.4	Torque limit rev	0,0	100,0	%	0,0		1534	
P2.5.1.5	Frequency limit fwd	0,00	P2.1.7	Hz	1,00		1535	
P2.5.1.6	Frequency limit rev	0,00	P2.1.7	Hz	1,00		1536	
P2.5.1.7	Opening delay fwd	0,00	10,00	s	0,50		1537	
P2.5.1.8	Opening delay rev	0,00	10,00	s	0,50		1538	
P2.5.1.9	Closing frequency fwd	0,00	P2.1.7	Hz	1,00		1539	
P2.5.1.10	Closing frequency rev	0,00	P2.1.7	Hz	1,00		1540	
P2.5.1.11	Closing delay fwd	0,00	10,00	s	0,00		1541	
P2.5.1.12	Closing delay rev	0,00	10,00	s	0,00		1542	
P2.5.1.13	Max frequency when brake is closed	0,00	P2.1.2	Hz	4,00		1543	
P2.5.1.14	Mechanical brake reaction time	0,00	10,00	s	0,50		1544	
P2.5.1.15	DC braking current	0,15 x I_n	1,5 x I_n	A	Varies		507	
P2.5.1.16	DC braking time at start	0,00	600,00	s	0,00		516	**0** = DC brake is off at start
P2.5.1.17	DC braking time at stop	0,00	600,00	s	0,00		508	**0** = DC brake is off at stop
P2.5.1.18	Frequency to start DC braking during ramp stop	0,10	10,00	Hz	0,00		515	
P2.5.1.19	Direction change mode	0	1		0		1545	**0**= No action **1**= Brake closed **2**= Stop state
P2.5.2.x	**CLOSED LOOP PARAMETERS**							
P2.5.2.1	Current limit	0,0	P2.1.9	A	0,0		1551	
P2.5.2.2	Torque limit	0,0	100,0	%	0,0		1553	
P2.5.2.3	Frequency limit	0,00	P2.1.7	Hz	1,00		1555	
P2.5.2.4	Opening delay	0,00	10,00	s	0,50		1557	
P2.5.2.5	Closing frequency	0,00	P2.1.7	Hz	1,00		1559	
P2.5.2.6	Closing delay	0,00	10,00	s	0,00		1661	
P2.5.2.7	Max frequency when brake is closed	0,00	P2.1.2	Hz	0,10		1563	
P2.5.2.8	Mechanical brake reaction time	0,00	10,00	s	0,50		1544	
P2.5.2.9	0 Hz time at start	0,000	32,000	s	0,100		615	
P2.5.2.10	0 Hz time at stop	0,000	32,000	s	0,100		616	
P2.5.2.11	Smooth start time	0,00	10,00	s	0,00		1564	
P2.5.2.12	Smooth start frequency	0,00	P2.1.2	s	0,00		1565	
P2.5.2.13	Direction change mode	0	1		0		1545	**0**= No action **1**= Brake closed **2**= Stop state
P2.5.2.14	Start magnetizing Current	0,00	I_L	A	0,00		627	Start magnetizing current
P2.5.2.15	Start magnetizing time	0	32000	ms	0		628	Start magnetizing time

Table 7. Brake control parameters, G2.5

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

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.6.1	Motor control mode	0	1		0		600	**0**= OL, Frequency control **1**= OL, Speed control **2**= OL, Torque control **3**= CL, Speed control **4**= CL, Torque control **5**= Advanced OL Freq **6**= Advanced OL Speedl
P2.6.2	U/f optimisation	0	1		0		109	**0**= Not used **1**= Automatic torque boost
P2.6.3	U/f ratio selection	0	3		0		108	**0**= Linear **1**= Squared **2**= Programmable **3**= Linear with flux optim.
P2.6.4	Field weakening point	30,00	320,00	Hz	50,00		602	
P2.6.5	Voltage at field weakening point	10,00	200,00	%	100,00		603	n% x U_{nmot} Parameter max. value = par. 2.6.7
P2.6.6	U/f curve midpoint frequency	0,00	par. P2.6.4	Hz	50,00		604	
P2.6.7	U/f curve midpoint voltage	0,00	100,00	%	100,00		605	n% x U_{nmot}
P2.6.8	Output voltage at zero frequency	0,00	40,00	%	0,00		606	n% x U_{nmot}
P2.6.9	Switching frequency	1,0	16,0	kHz	Varies		601	Depends on kW
P2.6.10	Overvoltage controller	0	1		1		607	**0**= Not used **1**= Used
P2.6.11	Undervoltage controller	0	1		1		608	**0**= Not used **1**= Used
P2.6.12	Open-loop slip compensation	0	1		0		1567	**0**= Calculated **1**= Encoder speed
P2.6.13	OL Speed Regulator P gain	0	32767		3000		637	
P2.6.14	OL Speed Regulator I gain	0	32767		300		638	
P2.6.15	Load Drooping	0,00	100,00	%	0		620	
P2.6.16	Identification	0	5		0		631	**0**= No action **1**= Identification w/o run **2**= Identification with run
P2.6.17.x	**CLOSED LOOP PARAMETERS**							
P2.6.17.1	Magn. current	0,0	1000,0	A			612	
P2.6.17.2	Speed control Kp	0	1000		30		613	Gain for the speed controller
P2.6.17.3	Speed control Ti	0,0	500,0	Ms	30,0		614	Time constant for the speed controller
P2.6.17.4	Current control Kp	0,00	100,00	%	40,00		617	
P2.6.17.5	Encoder filter time	0	1000	ms	0		618	
P2.6.17.6	Slip adjust	0	500	%	100		619	
P2.6.17.7	StartUp Torque Sel	0	1		0		621	**0**= Not Used **1**= TorqMemory
P2.6.17.8	Stop state flux	0,0	150,0	%	100,0		1401	Stop state magnetizing Current
P2.6.17.9	Flux off delay	-1	32000	s	0		1402	Max time for stop state magnetization
P2.6.18.x	**ADVANCED OPEN LOOP PARAMETERS**							
P2.6.18.1	Zero speed current	0,0	250,0	%	120,0		625	
P2.6.18.2	Minimum current	0,0	100,0	%	80,0		622	
P2.6.18.3	Flux reference	0,0	100,0	%	80,0		623	
P2.6.18.4	Frequency Limit	0,0	100,0	%	20,0		635	

P2.6.18.5	Stray flux current	0,0	100,0	%	40,0		624	
P2.6.19.x	**SPEED OPTIMIZATION PARAMETERS**							
P2.6.19.1	Enable speed optimization	0	1		0		1615	**0**= No **1**= Yes
P2.6.19.2	Frequency limit	0,00	320,00	Hz	50,00		1616	Frequency limit to activate speed optimization
P2.6.19.3	IL Limit Up	0,1 x I_L	2,5 x I_L	A	1 x I_L		1617	IL current limit UP
P2.6.19.4	IH Limit Up	0,1 x I_H	1 x I_H	A	1 x I_H		1618	IH current limit UP
P2.6.19.5	IH Limit Down	0,1 x I_H	1 x I_H	A	1 x I_H		1619	IH current limit DOWN

Table 8. Motor control parameters, G2.6

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

Code	Parameter	Min	Max	Unit	Default	Cus	ID	Note
P2.7.1	Response to reference fault	0	5		0		700	**0**=No response **1**=Warning **2**=Warning+Old Freq. **3**=Wrng+PresetFreq 2.7.2 **4**=Fault,stop acc. to 2.4.7 **5**=Fault,stop by coasting
P2.7.2	Reference fault frequency	0,00	Par. 2.1.2	Hz	0,00		728	
P2.7.3	Response to external fault	0	3		2		701	**0**=No response **1**=Warning **2**=Fault,stop acc. to 2.4.7 **3**=Fault,stop by coasting
P2.7.4	Input phase supervision	0	3		2		730	
P2.7.5	Response to undervoltage fault	1	3		2		727	
P2.7.6	Output phase supervision	0	3		2		702	
P2.7.7	Earth fault protection	0	3		2		703	
P2.7.8	Thermal protection of the motor	0	3		2		704	
P2.7.9	Motor ambient temperature factor	–100,0	100,0	%	0,0		705	
P2.7.10	Motor cooling factor at zero speed	0,0	150,0	%	40,0		706	
P2.7.11	Motor thermal time constant	1	200	min	10		707	
P2.7.12	Motor duty cycle	0	100	%	100		708	
P2.7.13	Stall protection	0	3		0		709	**0**=No response **1**=Warning **2**=Fault,stop acc. to 2.4.7 **3**=Fault,stop by coasting
P2.7.14	Stall current	0,1	6000,0	A	10,0		710	
P2.7.15	Stall time limit	1,00	120,00	s	15,00		711	
P2.7.16	Stall frequency limit	1,0	Par. 2.1.2	Hz	25,0		712	
P2.7.17	Underload protection	0	3		0		713	**0**=No response **1**=Warning **2**=Fault,stop acc. to 2.4.7 **3**=Fault,stop by coasting
P2.7.18	Underload curve at nominal frequency	10	150	%	50		714	
P2.7.19	Underload curve at zero frequency	5,0	150,0	%	10,0		715	
P2.7.20	Underload protection time limit	2	600	s	20		716	
P2.7.21	Response to thermistor fault	0	3		0		732	**0**=No response **1**=Warning **2**=Fault,stop acc. to 2.4.7 **3**=Fault,stop by coasting
P2.7.22	Response to fieldbus fault	0	3		0		733	See P2.7.21
P2.7.23	Response to slot fault	0	3		0		734	See P2.7.21
P2.7.24	Response to brake supervision fault	0	3		0		1570	
P2.7.25	Brake supervision time	0,00	10,00	s	3,00		1571	
P2.7.26	Response to brake logic fault	0	3		0		1572	
P2.7.27	Logic supervision time	0,00	10,00	s	5,00		1573	
P2.7.28	Response to under current fault	0	3		0		1574	

Code	Parameter	Min	Max	Unit	Default	Cus	ID	Note
P2.7.29	Under current limit	0,0	P2.1.15	A	0,0		1575	
P2.7.30	Response to shaft speed fault	0	3		0		1576	
P2.7.31	Shaft speed supervision hysteresis	0,00	10,00	Hz	5,00		1577	
P2.7.32	Shaft speed supervision time	0,00	2,00	s	0,50		1578	

Table 9. Protections, G2.7

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

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.8.1	Wait time	0,10	10,00	s	0,50		717	
P2.8.2	Trial time	0,00	60,00	s	30,00		718	
P2.8.3	Start function	0	2		0		719	0=Ramp 1=Flying start 2=According to par. 2.4.6
P2.8.4	Number of tries after undervoltage trip	0	10		0		720	
P2.8.5	Number of tries after overvoltage trip	0	10		0		721	
P2.8.6	Number of tries after overcurrent trip	0	3		0		722	
P2.8.7	Number of tries after reference trip	0	10		0		723	
P2.8.8	Number of tries after motor temperature fault trip	0	10		0		726	
P2.8.9	Number of tries after external fault trip	0	10		0		725	

Table 10. Autorestart parameters, G2.8

4.10 Identified parameters (Control keypad: Menu M2 → G2.9)

Parameters are updated when the automatic motor identification is done. The identification is activated by parameter P2.6.15 and start order within 20 seconds. It is also possible to change these parameters manually but then a very good knowledge in motor tuning is required.

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.9.1	Flux 10 %	0	250,0	%	10,0		1355	Flux linearisation point 10%
P2.9.2	Flux 20 %	0	250,0	%	20,0		1356	Flux linearisation point 20%
P2.9.3	Flux 30 %	0	250,0	%	30,0		1357	Flux linearisation point 30%
P2.9.4	Flux 40 %	0	250,0	%	40,0		1358	Flux linearisation point 40%
P2.9.5	Flux 50 %	0	250,0	%	50,0		1359	Flux linearisation point 50%
P2.9.6	Flux 60 %	0	250,0	%	60,0		1360	Flux linearisation point 60%
P2.9.7	Flux 70 %	0	250,0	%	70,0		1361	Flux linearisation point 70%
P2.9.8	Flux 80 %	0	250,0	%	80,0		1362	Flux linearisation point 80%
P2.9.9	Flux 90 %	0	250,0	%	90,0		1363	Flux linearisation point 90%
P2.9.10	Flux 100 %	0	250,0	%	100,0		1364	Flux linearisation point 100%
P2.9.11	Flux 110 %	0	250,0	%	110,0		1365	Flux linearisation point 110%
P2.9.12	Flux 120 %	0	250,0	%	120,0		1366	Flux linearisation point 120%
P2.9.13	Flux 130 %	0	250,0	%	130,0		1367	Flux linearisation point 130%
P2.9.14	Flux 140 %	0	250,0	%	140,0		1368	Flux linearisation point 140%
P2.9.15	Flux 150 %	0	250,0	%	150,0		1369	Flux linearisation point 150%
P2.9.16	Make flux time	0	60000		Varies		660	Time to magnetize the motor
P2.9.17	Make flux voltage	0	30000		Varies		661	Magnetizing voltage
P2.9.18	Rs voltage drop	0	65535		Varies		662	Measured voltage drop at stator resistance between two phases with nominal current of the motor
P2.9.19	Make flux voltage hardware	0	30000		Varies		663	Magnetizing voltage with hardware dead time compensation
P2.9.20	Ir add zero point voltage	0	100,0 0	%	Varies		664	IrAddVoltage for Zero frequency, used with torque boost.
P2.9.21	Ir add generator scale	0	200	%	Varies		665	Scaling factor for generator side IR-compensation.
P2.9.22	Ir add motoring scale	0	200	%	Varies		667	Scaling factor for motor side IR-compensation.
P2.9.23	Iu Offset	-32000	32000		0		668	Offsets value for phase U current measurement.
P2.9.24	Iv Offset	-32000	32000		0		669	Offsets value for phase V current measurement.
P2.9.25	Iw Offset	-32000	32000		0		670	Offsets value for phase W current measurement.

Table 11. Identified parameters

4.11 Fieldbus parameters (Control keypad: Menu M2 → G2.10)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.10.1	Fieldbus Min Scale	0,00	320,00	Hz	0,00		850	Min Scale of Fieldbus reference signal
P2.10.2	Fieldbus Max Scale	0,00	320,00	Hz	0,00		851	Max Scale of Fieldbus reference signal. **NOTE:** Min and Max frequency (P2.1.1 and P2.1.2) is used for scaling if P2.10.2 is set to 0
P2.10.3	Fieldbus data out 1 selection	0	10000		1		852	Choose Monitoring data with parameter ID
P2.10.4	Fieldbus data out 2 selection	0	10000		2		853	Choose Monitoring data with parameter ID
P2.10.5	Fieldbus data out 3 selection	0	10000		45		854	Choose Monitoring data with parameter ID
P2.10.6	Fieldbus data out 4 selection	0	10000		4		855	Choose Monitoring data with parameter ID
P2.10.7	Fieldbus data out 5 selection	0	10000		5		856	Choose Monitoring data with parameter ID
P2.10.8	Fieldbus data out 6 selection	0	10000		6		857	Choose Monitoring data with parameter ID
P2.10.9	Fieldbus data out 7 selection	0	10000		7		858	Choose Monitoring data with parameter ID
P2.10.10	Fieldbus data out 8 selection	0	10000		37		859	Choose Monitoring data with parameter ID
P2.10.11	Fieldbus data in 1 selection	0	10000		0		876	Choose Controlled data with parameter ID
P2.10.12	Fieldbus data in 2 selection	0	10000		0		877	Choose Controlled data with parameter ID
P2.10.13	Fieldbus data in 3 selection	0	10000		0		878	Choose Controlled data with parameter ID
P2.10.14	Fieldbus data in 4 selection	0	10000		0		879	Choose Controlled data with parameter ID
P2.10.15	Fieldbus data in 5 selection	0	10000		0		880	Choose Controlled data with parameter ID
P2.10.16	Fieldbus data in 6 selection	0	10000		0		881	Choose Controlled data with parameter ID
P2.10.17	Fieldbus data in 7 selection	0	10000		0		882	Choose Controlled data with parameter ID
P2.10.18	Fieldbus data in 8 selection	0	10000		0		883	Choose Controlled data with parameter ID

4.12 Keypad control (Control keypad: Menu M3)

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

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

Table 12. Keypad control parameters, M3

4.13 System menu (Control keypad: M6)

For parameters and functions related to the general use of the frequency converter, such as application and language selection, customised parameter sets or information about the hardware and software, see Chapter 7.3.6 in the Vacon NX User's Manual.

4.14 Expander boards (Control keypad: Menu M7)

The **M7** menu shows the expander and option boards attached to the control board and board-related information. For more information, see Chapter 7.3.7 in the Vacon NX User's Manual.

5. DESCRIPTION OF PARAMETERS

5.1 Basic Parameters

2.1.1, 2.1.2 Minimum/maximum frequency

Defines the frequency limits of the frequency converter.
The maximum value for parameters 2.1.1 and 2.1.2 is 320 Hz.
The software will automatically check the values of parameters 2.1.14, 2.1.15, 2.1.15, 2.1.17, 2.3.10 and 2.7.2

2.1.3, 2.1.4 Acceleration time 1, deceleration time 1

These limits correspond to the time required for the output frequency to accelerate from the zero frequency to the set maximum frequency (par. 2.1.2).

2.1.5 Current limit

This parameter determines the maximum motor current from the frequency converter. To avoid motor overload, set this parameter according to the rated current of the motor. The current limit is 1.5 times the rated current (I_L) by default.

2.1.6 Nominal voltage of the motor

Find this value U_n on the rating plate of the motor. This parameter sets the voltage at the field weakening point (parameter 2.6.5) to 100% x U_{nmotor}.

2.1.7 Nominal frequency of the motor

Find this value f_n on the rating plate of the motor. This parameter sets the field weakening point (parameter 2.6.4) to the same value.

2.1.8 Nominal speed of the motor

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

2.1.9 Nominal current of the motor

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

2.1.10 Motor cos phi

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

2.1.11 I/O frequency reference selection

Defines which frequency reference source is selected when controlled from the I/O control place. Default value is 0.

0 = Analogue voltage reference from terminals 2—3, e.g. potentiometer
1 = Analogue current reference from terminals 4—5, e.g. transducer
2 = Keypad reference from the Reference Page (Group M3)
3 = Reference from the fieldbus
4 = Digital reference, frequency is set according to parameters P2.1.14…P2.1.17
5 = Joystick control, U_{in} reference from terminals 2-3
6 = Internal motorized potentiometer

Digital input P2.2.7.11 can be used as internal motorized potentiometer. Drive is started and the digital input increases speed. The current speed is held as long as start command is active. Deceleration is made by stop command.

2.1.12 Keypad frequency reference selection

Defines which frequency reference source is selected when controlled from the keypad. Default value is 2.

0 = Analogue voltage reference from terminals 2—3, e.g. potentiometer
1 = Analogue current reference from terminals 4—5, e.g. transducer
2 = Keypad reference from the Reference Page (Group M3)
3 = Reference from the Fieldbus

2.1.13 Fieldbus frequency reference selection

Defines which frequency reference source is selected when controlled from the fieldbus. Default value is 3.

0 = Analogue voltage reference from terminals 2—3, e.g. potentiometer
1 = Analogue current reference from terminals 4—5, e.g. transducer
2 = Keypad reference from the Reference Page (Group M3)
3 = Reference from the Fieldbus

2.1.14-2.1.21 Digital reference 000-111

The frequency is set according to the combination of 3 digital inputs, (P2.2.7.9 - P2.2.7.11).
Parameter values are automatically limited between the minimum and maximum frequencies (par. 2.1.1, 2.1.2)

Speed select input 3 P2.2.7.11	**Speed select input 2 P2.2.7.10**	**Speed select input 1 P2.2.7.9**	**Digital reference used**
0	0	0	Digital Ref 000
0	0	1	Digital Ref 001
0	1	0	Digital Ref 010
0	1	1	Digital Ref 011
1	0	0	Digital Ref 100
1	0	1	Digital Ref 101
1	1	0	Digital Ref 110
1	1	1	Digital Ref 111

Table 13. Binary coded digital frequency reference

NOTE: If frequency reference is other than digital control the constant speed selections (001-111) from digital reference overrides the actual reference.

2.1.22 FWD Safe Speed

The frequency reference is limited to this parameter when the digital input specified by parameter P2.2.7.15 is deactivated (NC). This is used for ramping down before the FWD end limit stop.

2.1.23 REV Safe Speed

The frequency reference is limited to this parameter when the digital input specified by parameter P2.2.7.17 is deactivated (NC). This is used for ramping down before the REV end limit stop.

2.1.24 Speed Limit

The frequency reference is limited to this parameter when the digital input specified by parameter P2.2.7.19 is activated (NO).
Useful function when there is 2 control places and a limit of speed is required in one control place.

5.2 Input Signals

2.2.1 Start/Stop logic selection

0 DIN1: closed contact = start forward
DIN2: closed contact = start reverse

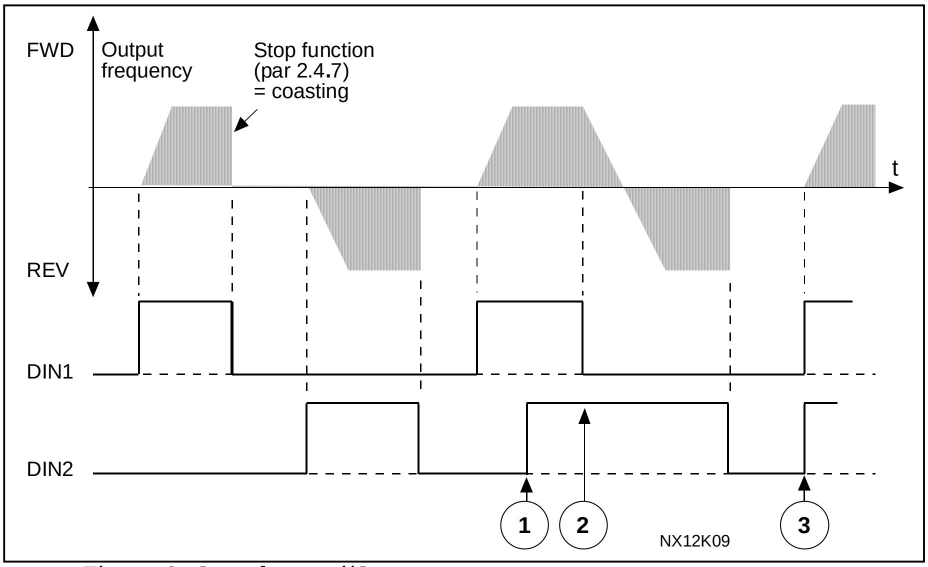


Figure 3. Start forward/Start reverse

① The first selected direction has the highest priority.

② When the DIN1 contact opens the direction of rotation starts the change.

③ If Start forward (DIN1) and Start reverse (DIN2) signals are active simultaneously the Start forward signal (DIN1) has priority.

1 DIN1: closed contact = start open contact = stop
DIN2: closed contact = reverse open contact = forward
See Figure 4.

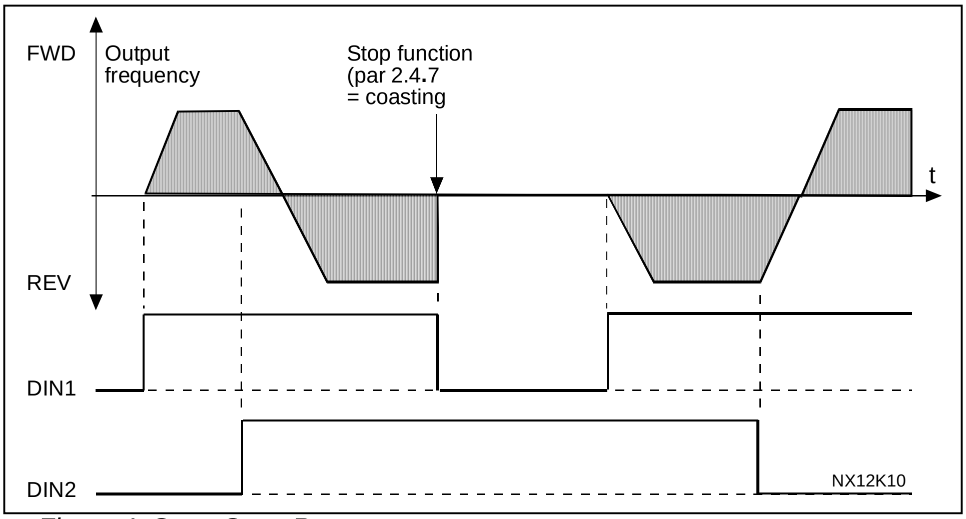


Figure 4. Start, Stop, Reverse

2 DIN1: closed contact = start open contact = stop

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

3 3-wire connection (pulse control):
DIN1: closed contact = start pulse
DIN2: open contact = stop pulse
(DIN3 can be programmed for reverse command)
See Figure 5.

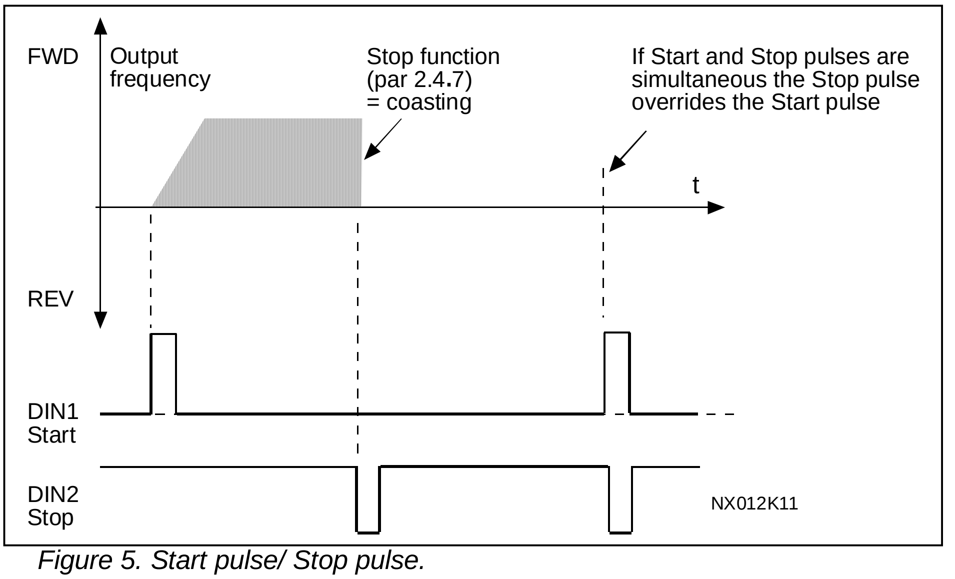


Figure 5. Start pulse/ Stop pulse.

The selections **4** to **6** shall be used to exclude the possibility of an unintentional start when, for example, power is connected, re-connected after a power failure, after a fault reset, after the drive is stopped by Run Enable (Run Enable = False) or when the control place is changed. The Start/Stop contact must be opened before the motor can be started.

4 DIN1: closed contact = start forward **(Rising edge required to start)**
DIN2: closed contact = start reverse **(Rising edge required to start)**

5 DIN1: closed contact = start **(Rising edge required to start)**
open contact = stop
DIN2: closed contact = reverse
open contact = forward

6 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

2.2.2 Reference offset for current input

0 No offset
1 Offset 4 mA ("living zero"), provides supervision of zero level signal. The response to reference fault can be programmed with parameter 2.7.1.

2.2.3

2.2.4 Reference scaling, minimum value/maximum value

Setting value limits: 0 ≤ par. 2.2.4 ≤ par. 2.2.5 ≤ par. 2.1.2. If parameter 2.2.5 = 0 scaling is set off. The minimum and maximum frequencies are used for scaling.

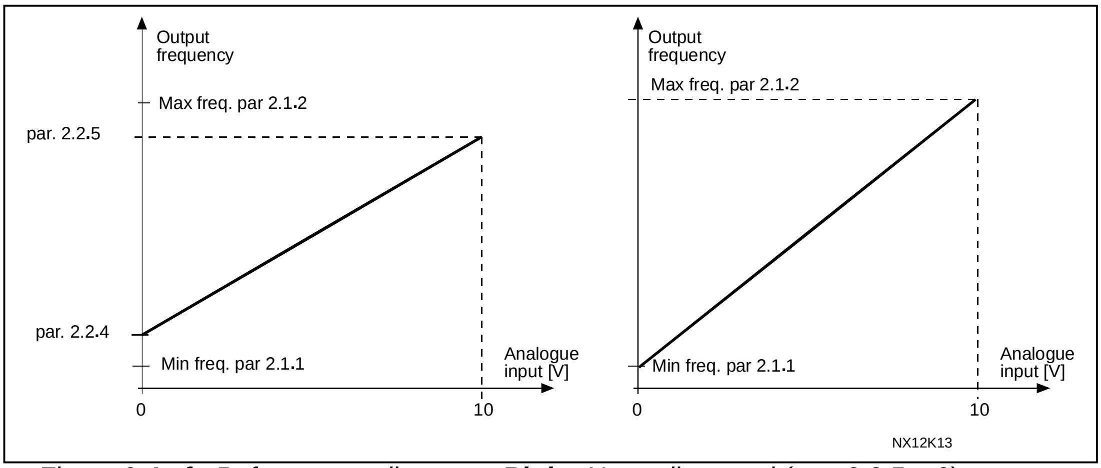


*Figure 6. **Left**: Reference scaling; **Right**: No scaling used (par. 2.2.5 = 0).*

2.2.5 Reference inversion

Inverts reference signal:
Max. ref. signal = Min. set freq.
Min. ref. signal = Max. set freq.

0 No inversion
1 Reference inverted

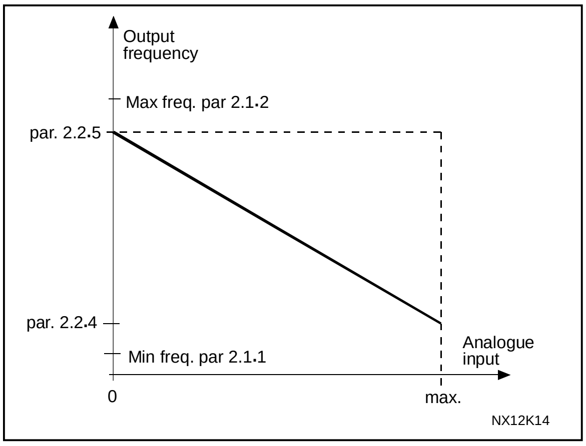


Figure 7. Reference invert.

2.2.6 Reference filter time

Filters out disturbances from the incoming analogue U_{in} signal. Long filtering time makes regulation response slower.

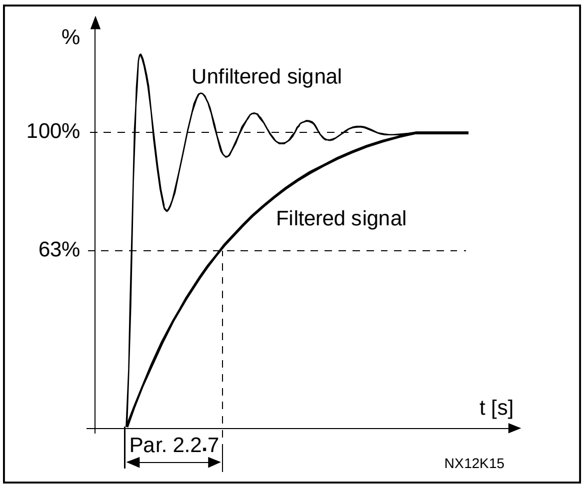


Figure 8. Reference filtering.

2.2.7.x DIGITAL INPUTS

All digital Inputs (not DIN1 and DIN2) shall be programmed using the Terminal To Function method (TTF). See instructions on Page 4.

In other words, all functions (parameters) that you wish to use shall be connected to a certain input on a certain option board.

2.2.7.1 Fault reset

Contact closed: All faults are reset

2.2.7.2 External Fault closing contact

Contact closed: Fault is displayed and motor stopped.

2.2.7.3 External Fault opening contact

Contact open: Fault is displayed and motor stopped.

2.2.7.4 Run Enable

Contact open: Start of motor disabled
Contact closed: Start of motor enabled

2.2.7.5 Acc/Dec time selection

Contact open: Acceleration/Deceleration time 1 selected
Contact closed: Acceleration/Deceleration time 2 selected

Set Acceleration/Deceleration times 2 with parameters P2.4.3 and P2.4.4

2.2.7.6 Reverse

Contact open: Direction forward
Contact closed: Direction reverse

2.2.7.7 Parameter set 1 / set 2

With this parameter you can select between Parameter Set 1 and Set 2.

Digital input = FALSE:

- The active set is saved to set 2
- Set 1 is loaded as the active set

Digital input = TRUE:

- The active set is saved to set 1
- Set 2 is loaded as the active set

Note: The parameter values can be changed in the active set only.

2.2.7.8 External brake supervision

External supervision of the mechanical brake. The Boolean value is forced to TRUE if function is not connected to a digital input.

Contact open: Mechanical brake closed
Contact closed: Mechanical brake opened

2.2.7.9-2.2.7.11 Speed select 1-3

Speed selection inputs for binary speed reference selection
8 different speeds can be set by 3 digital inputs.
Speed references are set by P2.1.14 –P2.1.21

2.2.7.12 Motorized potentiometer acceleration

Contact open: Maintain current speed
Contact closed: Acceleration
Acc/dec ramp times 2 can be used below frequency set by parameter P2.4.10.
Frequencies above the limit set by P2.4.10 uses acc/dec ramp times 1.

2.2.7.13 External brake control

Digital input can be used as an external opening condition in the brake opening logic. The Boolean value is forced to TRUE if function is not connected to a digital input.

Contact open: FALSE
Contact closed: TRUE

2.2.7.14 Dual brake control

If running the machine with two Vacon drives, this function is to gain synchronized brake and ramp control. The *Open enable* signal from the other drive is connected to the *Dual brake control* digital output and the other drive is connected the other way round. An example of the Dual brake control connections can be seen in Figure 9.

Contact open: The brake doesn't open
Contact closed: Open enable

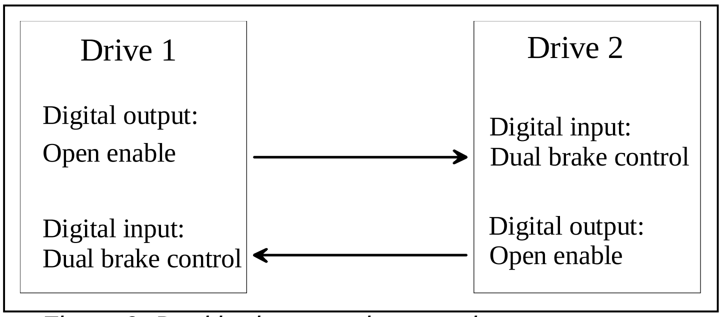


Figure 9. Dual brake control connections

2.2.7.15 FWD Safe Speed

When digital input (NC) is opened the frequency reference is limited to the value specified by parameter P2.1.22. Causes the drive to ramp down to Safe speed before reaching the end limit activated by digital input specified by P2.2.7.16.

2.2.7.16 FWD Stop

End limit switch (NC) for stop in Forward direction. Stop according to Stop function specified by parameter P2.4.7. Acts as the Run Enable input.
NOTE: Start order has to be removed to be able to restart after activation for safety reasons.
It is possible to run the drive in Reverse direction when Forward stop is active.

2.2.7.17 REV Safe Speed

When digital input (NC) is opened the frequency reference is limited to the value specified by parameter P2.1.23. Causes the drive to ramp down to Safe speed before reaching the end limit activated by digital input specified by P2.2.7.18

2.2.7.18 REV Stop

End limit switch (NC) for stop in Reverse direction. Stop according to Stop function specified by parameter P2.4.7. Acts as the Run Enable input.
NOTE: Start order has to be removed to be able to restart after activation for safety reasons.
It is possible to run the drive in Forward direction when Reverse stop is active.

2.2.7.19 Speed Limit

Contact open: Normal operation
Contact closed: Speed limit
The frequency reference is limited to P2.1.24 when this digital input is high.

2.2.7.20 DC Brake In Stop Selection

Contact open: DC Brake in stop not active
Contact closed: DC Brake in stop activated
The DC brake current in stop value is set P2.4.12.

2.2.8.x Non-linearization

Non-linear response of the analogue inputs

2.2.8.1 NonLinearization coordinate X_1

2.2.8.2 NonLinearziation coordinate Y_1

2.2.8.3 NonLinearization coordinate X_2

2.2.8.4 NonLinearization coordinate Y_2

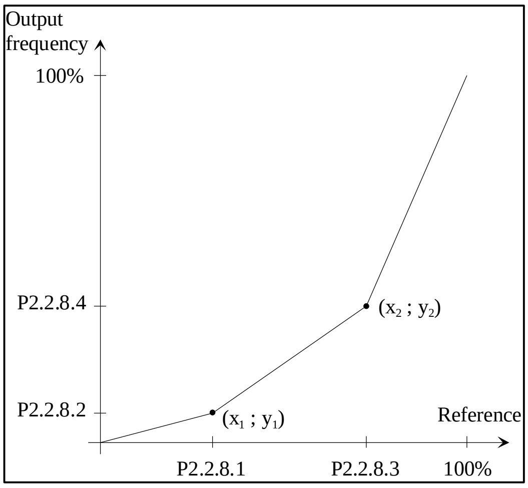


Figure 10. Non-Linearization of the analog inputs

5.3 Output Signals

2.3.1 Analogue output function

This parameter selects the desired function for the analogue output signal.
See Table 5 on page 12 for the parameter values.

2.3.2 Analogue output filter time

Defines the filtering time of the analogue output signal.

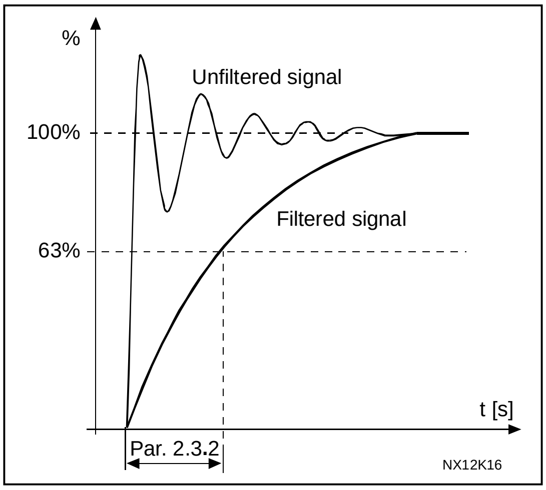


Figure 11. Analogue output filtering

2.3.3 Analogue output invert

Inverts the analogue output signal:

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

See parameter 2.3.5 below.

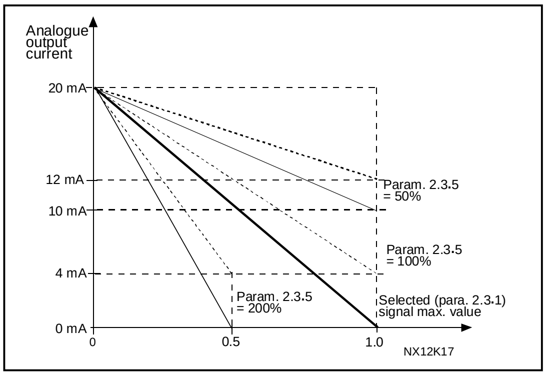


Figure 12. Analogue output invert

2.3.4 Analogue output minimum

Defines the signal minimum to either 0 mA or 4 mA (living zero). Note the difference in analogue output scaling in parameter 2.3.5 (Figure 2-9).

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

2.3.5 Analogue output scale

Scaling factor for analogue output.

Signal	Max. value of the signal
Output frequency	Max frequency (par. 2.1.2)
Freq. Reference	Max frequency (par. 2.1.2)
Motor speed	Motor nom. speed $1xn_{mMotor}$
Output current	Motor nom. current $1xI_{nMotor}$
Motor torque	Motor nom. torque $1xT_{nMotor}$
Motor power	Motor nom. power $1xP_{nMotor}$
Motor voltage	100% x U_{nmotor}
DC-link voltage	1000 V

Table 14. Analogue output scaling

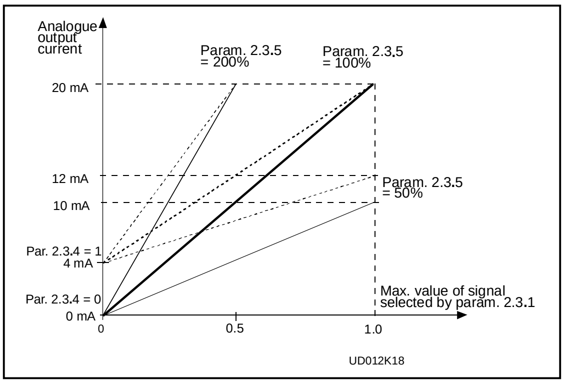


Figure 13. Analogue output scaling

2.3.6 Digital output function
2.3.7 Relay output 1 function
2.3.8 Relay output 2 function

Setting value	**Signal content**
0 = Not used	Out of operation
	Digital output DO1 sinks the current and programmable relay (RO1, RO2) is activated when:
1 = Ready	The frequency converter is ready to operate
2 = Run	The frequency converter operates (motor is running)
3 = Fault	A fault trip has occurred
4 = Fault inverted	A fault trip not occurred
5 = Vacon overheat warning	The heat-sink temperature exceeds +70°C
6 = External fault or warning	Fault or warning depending on par. 2.7.3
7 = Reference fault or warning	Fault or warning depending on par. 2.7.1 - if analogue reference is 4—20 mA and signal is <4mA
8 = Warning	Always if a warning exists
9 = Reversed	The reverse command has been selected
10 = Preset speed	The preset speed has been selected with digital input
11 = At speed	The output frequency has reached the set reference
12 = Motor regulator activated	Overvoltage or overcurrent regulator was activated
13 = Output frequency supervision	The output frequency goes outside the set supervision low limit/high limit (see parameters 2.3.9 and 2.3.10 below)
14 = Control from I/O terminals	I/O control mode selected (in menu M3)
15 = Therm. Fault/Warn	
16 = FB DigIN 1	
17 = Brake open	Brake open signal to the mechanical brake
18 = Open enable	Open enable signal (Dual brake control)

Table 15. Output signals via DO1 and output relays RO1 and RO2.

2.3.9 Output frequency limit supervision function

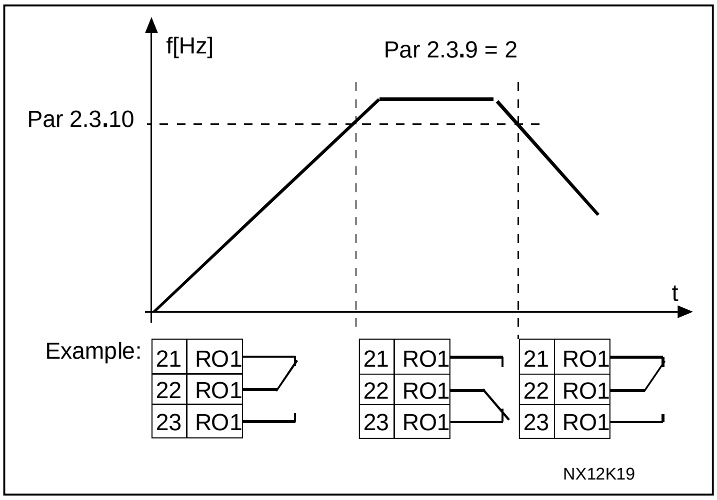
0 No supervision
1 Low limit supervision
2 High limit supervision

If the output frequency goes under/over the set limit (P 2.3.10) this function generates a warning message via the digital output DO1 and via the relay output RO1 or RO2 depending on the settings of parameters 2.3.6—2.3.8.

2.3.10 Output frequency limit supervision value

Selects the frequency value supervised by parameter 2.3.9.

Figure 14. Output frequency supervision



2.3.11 Analogue output 2 signal selection

Connect the AO2 signal to the analogue output of your choice with this parameter. For more information, see Pump and fan control application manual, Chapter 2.

2.3.12 Analogue output 2 function
2.3.13 Analogue output 2 filter time
2.3.14 Analogue output 2 inversion
2.3.15 Analogue output 2 minimum
2.3.16 Analogue output 2 scaling

For more information on these five parameters, see the corresponding parameters for the analogue output 1 on pages 31 and 32.

5.4 Drive Control

2.4.1 Acceleration/Deceleration ramp 1 shape
2.4.2 Acceleration/Deceleration ramp 2 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 0.1…10 seconds for this parameter produces an S-shaped acceleration/deceleration. The acceleration time is determined with parameters 2.1.3/2.1.4 (2.4.3/2.4.4).

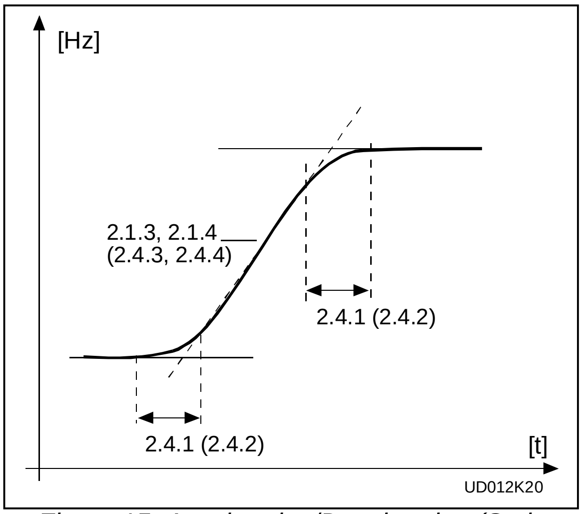


Figure 15. Acceleration/Deceleration (S-shaped)

2.4.3 Acceleration time 2
2.4.4 Deceleration time 2

These values correspond to the time required for the output frequency to accelerate from the zero frequency to the set maximum frequency (par. 2.1.2). These parameters give the possibility to set two different acceleration/deceleration time sets for one application. The active set can be selected with the programmable signal DIN3 (par. 2.2.2).

2.4.5 Brake chopper

0 = No brake chopper used
1 = Brake chopper in use when running
2 = External brake chopper
3 = Used when stopped/running
4 = Brake chopper in use when running, no test

When the frequency converter is decelerating the motor, the inertia of the motor and the load are fed into an external brake resistor. This enables the frequency converter 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.

2.4.6 Start function

Ramp:

0 The frequency converter starts from 0 Hz and accelerates to the set reference frequency within the set acceleration time. (Load inertia or starting friction may cause prolonged acceleration times).

Flying start:

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

Use this mode if the motor is coasting when the start command is given. With the flying start it is possible to ride through short mains voltage interruptions.

2.4.7 Stop function

Coasting:

0 The motor coasts to a halt without any control from the frequency converter, after the Stop command.

Ramp:

1 After the Stop command, the speed of the motor is decelerated according to the set deceleration parameters.
If the regenerated energy is high it may be necessary to use an external braking resistor for faster deceleration.

Normal stop: Ramp/ Run Enable stop: coasting

2 After the Stop command, the speed of the motor is decelerated according to the set deceleration parameters. However, when Run Enable is selected (e.g. DIN3), the motor coasts to a halt without any control from the frequency converter.

Normal stop: Coasting/ Run Enable stop: ramping

3 The motor coasts to a halt without any control from the frequency converter. However, when Run Enable signal is selected (e.g. DIN3), the speed of the motor is decelerated according to the set deceleration parameters. If the regenerated energy is high it may be necessary to use an external braking resistor for faster deceleration.

2.4.8 Flux brake

The flux braking can be set ON or OFF.

0 = Flux braking OFF
1 = Flux braking ON

2.4.9 Flux braking current

Defines the flux braking current value.

2.4.10 Ramp change frequency, Motorized potentiometer.

Acceleration and deceleration times 2 (P2.4.3 and P2.4.4) are used below this frequency when motorized potentiometer is selected.

2.4.11.x PROHOBIT FREQUENCIES

2.4.11.1, 2.4.11.2 Prohibit frequency area; Low limit/High limit

In some systems it may be necessary to avoid certain frequencies because of mechanical resonance problems. With these parameters it is possible to set limits for the "skip frequency" region. See Figure 16

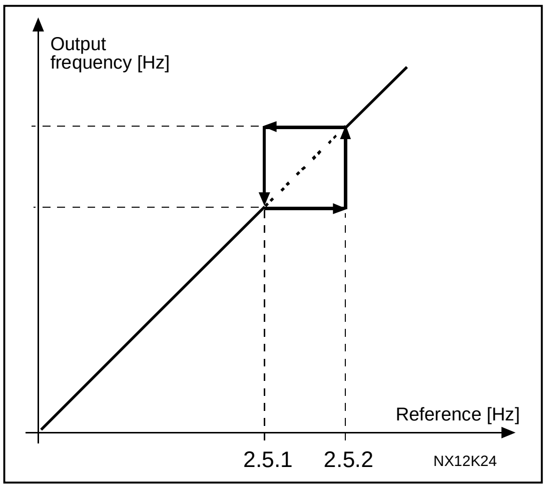


Figure 16. Prohibit frequency area setting.

2.4.11.3 Acc/dec ramp speed scaling ratio between prohibit frequency limits

Defines the acceleration/deceleration time when the output frequency is between the selected prohibit frequency range limits (parameters 2.5.1 and 2.5.2). The ramping speed (selected acceleration/ deceleration time 1 or 2) is multiplied with this factor. E.g. value 0.1 makes the acceleration time 10 times shorter than outside the prohibit frequency range limits.

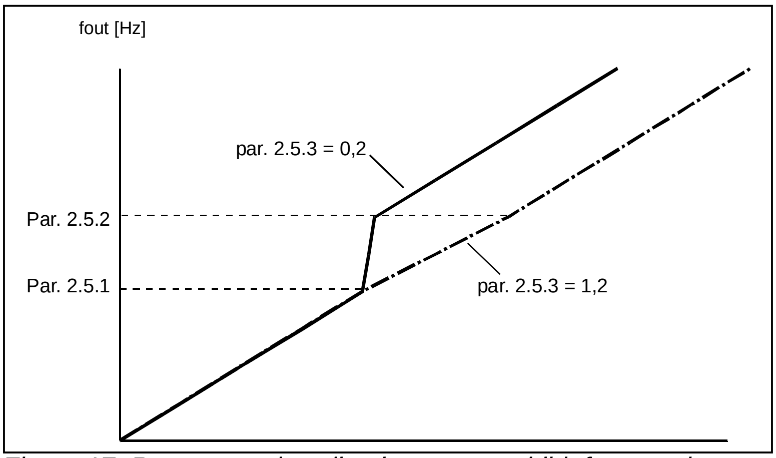


Figure 17. Ramp speed scaling between prohibit frequencies

2.4.12 DC Brake Current In Stop.

Value of DC Brake current in stop in current format. Max value is motor maximum current. DC Brake current in stop is activated via digital input selected with parameter P2.2.7.20.

5.5 Brake Control

Mechanical brake control parameters are affecting the mechanical brake control, the smooth start and stop function and the safety functions.
Mechanical brake can be set to release on current, on torque, on frequency or on external input. The closing can be performed by frequency, by external input or by run request signal. In case of fault the closing is done immediately without delay.

Mechanical brake control is different in open loop and in closed loop control mode. Parameters are divided in two different groups. Parameters in closed loop group are not affected in open loop mode and vice versa. Open loop brake control parameters are direction sensitive, different parameters for forward and reverse. There are also some common parameters. Typical start and stop sequences can be seen in Figure 18 and Figure 19. The mechanical brake control logic can be seen in Figure 20.

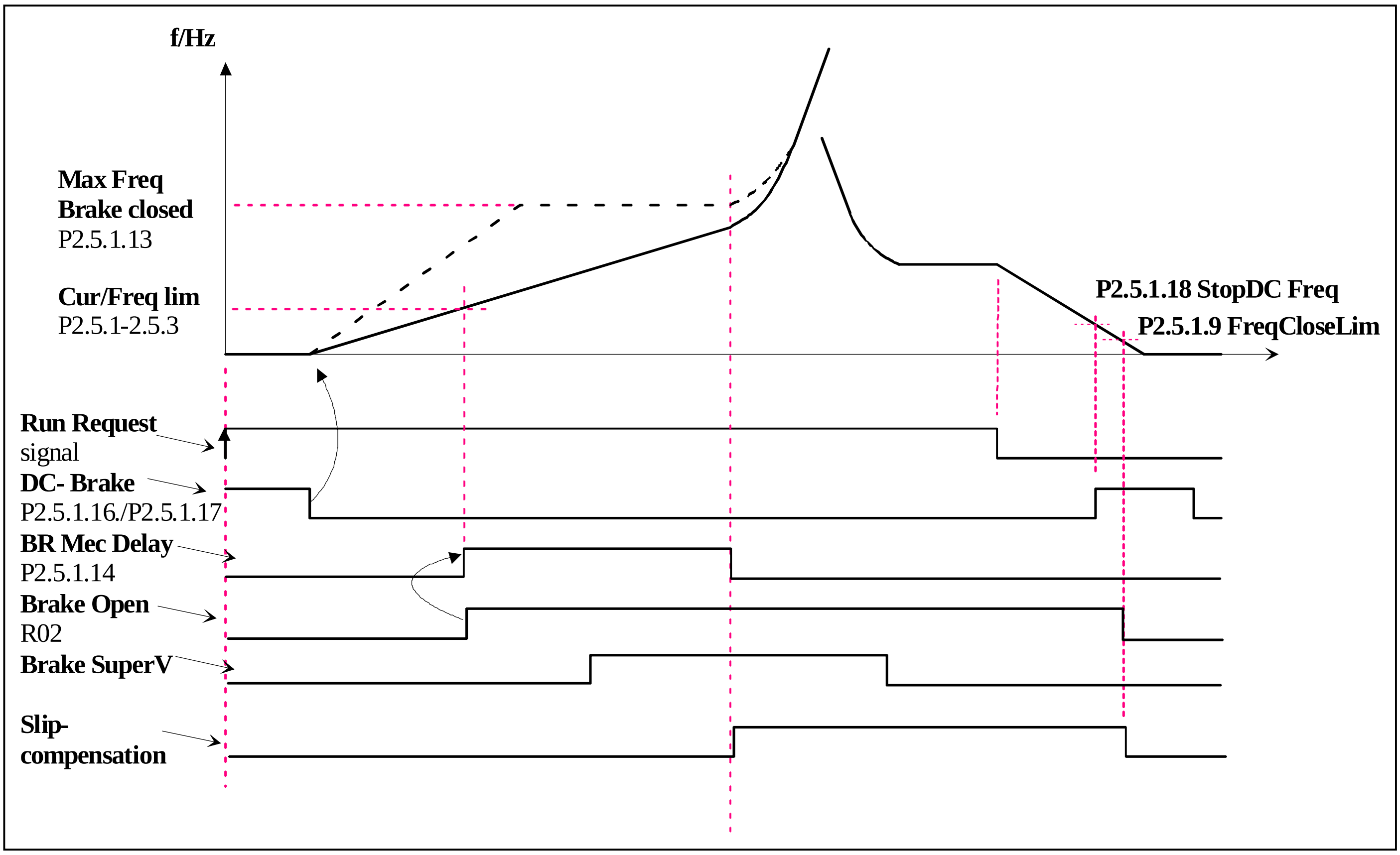


Figure 18 Mechanical brake control in open loop.

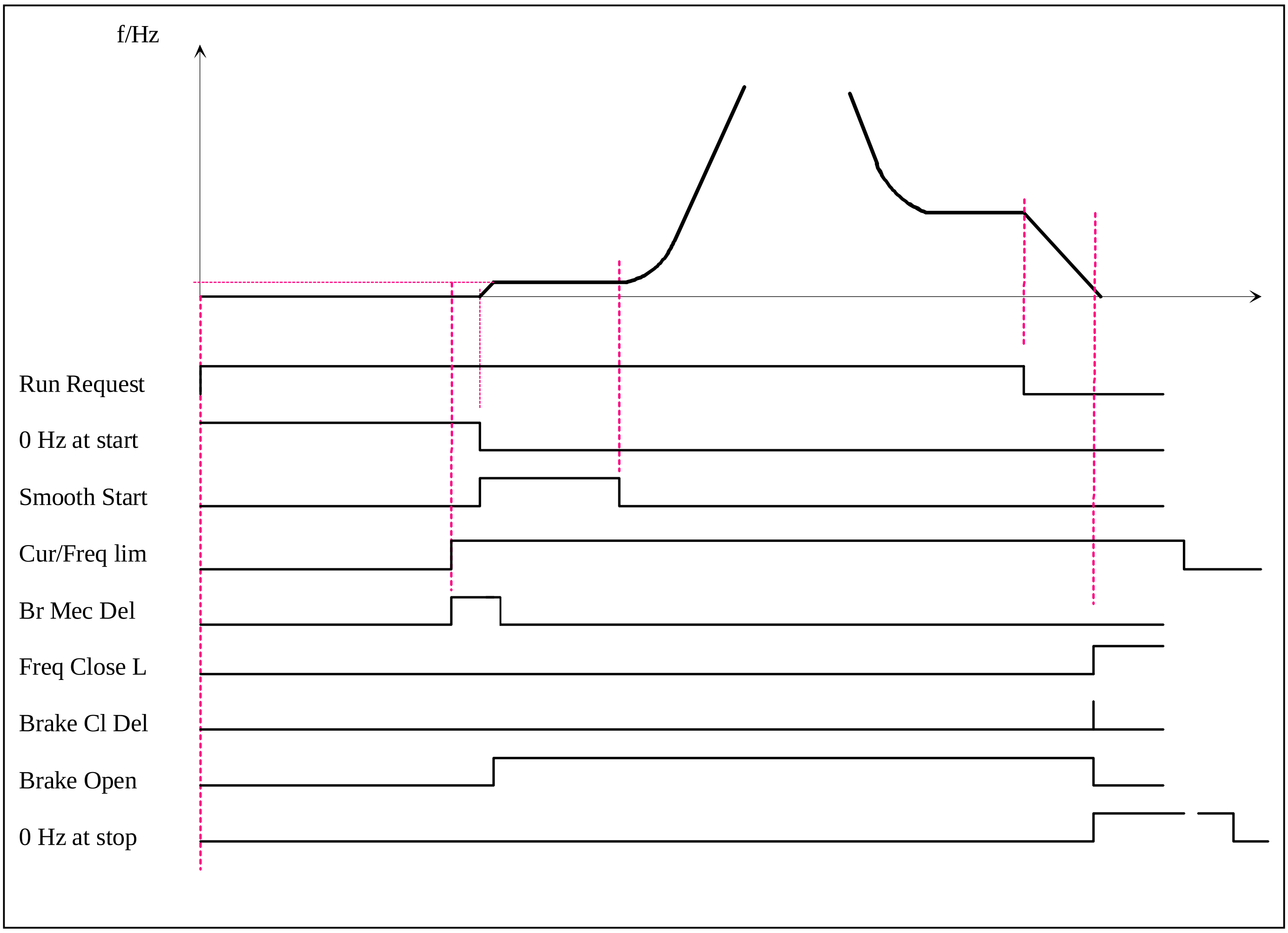


Figure 19 Mechanical brake in closed loop.

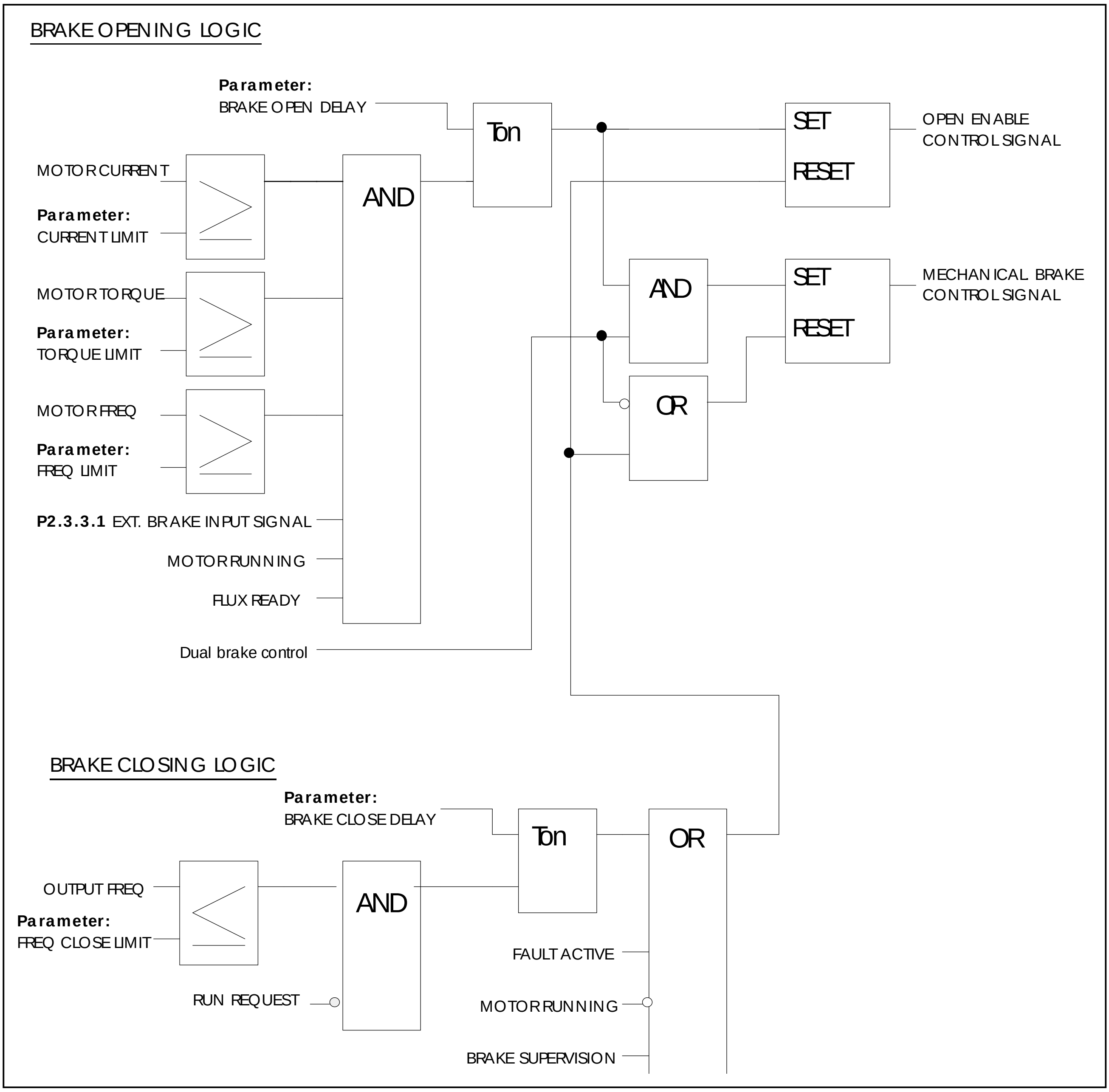


Figure 20 Mechanical brake control logic.

2.5.1.x OPEN LOOP BRAKE CONTROL PARAMETERS

2.5.1.1 Current limit forward
2.5.1.2 Current limit reverse

These parameters defines the motor current limit that has to be exceeded before releasing the mechanical brake. If set to zero this condition is excluded.

2.5.1.3 Torque limit forward
2.5.1.4 Torque limit reverse

These parameters defines the motor torque limit that has to be exceeded before releasing the mechanical brake. If set to zero this condition is excluded. 100% corresponds to calculated nominal torque of the motor.

2.5.1.5 Frequency limit forward
2.5.1.6 Frequency limit reverse

These parameters defines the frequency limit that has to be exceeded before releasing the mechanical brake. If set to zero this condition is excluded.

2.5.1.7 Opening delay forward
2.5.1.8 Opening delay reverse

Time delay before releasing the brake after the opening conditions are fulfilled.

2.5.1.9 Closing frequency forward
2.5.1.10 Closing frequency reverse

Output frequency limit that is closing the brake. The run request signal needs to be inactive to allow the signal to affect.

2.5.1.11 Closing delay forward
2.5.1.12 Closing delay reverse

Time delay before closing the brake after the closing conditions are fulfilled

2.5.1.13 Max frequency when the brake is closed

Output frequency cannot exceed this value when the brake is closed

2.5.1.14 Mechanical brake reaction time

After the brake is released is the speed reference in hold for a defined time. This hold time should be set corresponding to the mechanical brake reaction time.

2.5.1.15 DC-braking current

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

2.5.1.16 DC-braking time at start

DC-brake is activated when the start command is given. This parameter defines the time before the brake is released. After the brake is released, the output frequency increases according to the set start function by parameter 2.4.6.

2.5.1.17 DC-braking time at stop

Determines if braking is ON or OFF and the braking time of the DC-brake when the motor is stopping. The function of the DC-brake depends on the stop function, parameter 2.4.7.

0 DC-brake is not used
>0 DC-brake is in use and its function depends on the Stop function, (param. 2.4.7). The DC-braking time is determined with this parameter

Par. 2.4.7 = 0; Stop function = Coasting:

After the stop command, the motor coasts to a stop without control of the frequency converter.

With DC-injection, the motor can be electrically stopped in the shortest possible time, without using an optional external braking resistor.

The braking time is scaled according to the frequency when the DC-braking starts. If the frequency is ≥ the nominal frequency of the motor, the set value of parameter 2.5.1.17 determines the braking time. When the frequency is ≤10% of the nominal, the braking time is 10% of the set value of parameter 2.5.1.17.

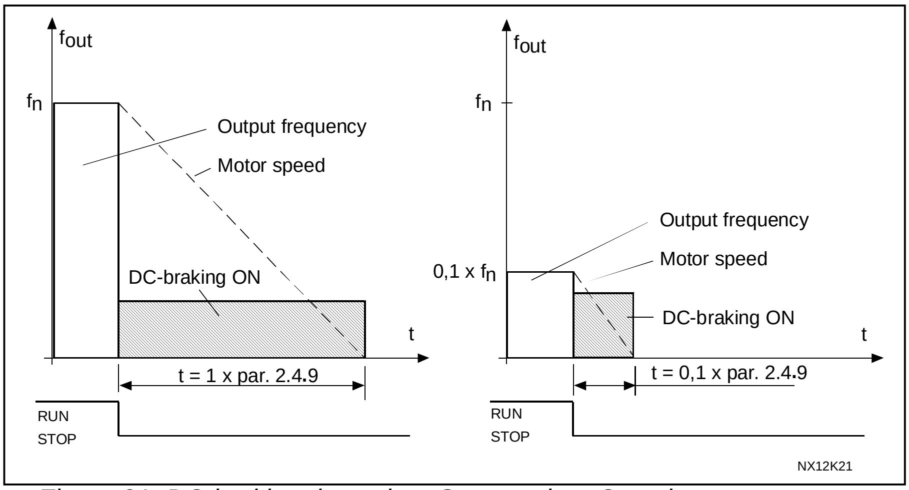


Figure 21. DC-braking time when Stop mode = Coasting.

Par. 2.4.7 = 1; Stop function = Ramp:

After the Stop command, the speed of the motor is reduced according to the set deceleration parameters, as fast as possible, to the speed defined with parameter 2.5.1.18, where the DC-braking starts.

The braking time is defined with parameter 2.5.1.17. If high inertia exists, it is recommended to use an external braking resistor for faster deceleration. See Figure 22.

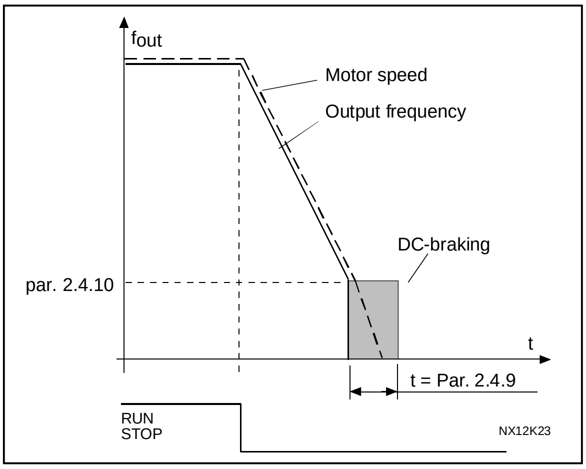


Figure 22. DC-braking time when Stop mode = Ramp

2.5.1.18 DC-braking frequency at stop

The output frequency at which the DC-braking is applied. See Figure 22.

2.5.1.19 Direction change mode

If direction change situation have to be handled with the mechanical brake is the function set with this parameter.

0 Inactive. The change of direction does not close the mechanical brake
1 Brake closed. The brake is closed when the frequency falls below the limits defined by parameters P2.5.1.9 and P2.5.1.10.
2 Stop state. The drive is stopped, the brake is closed and then started in the other direction.

2.5.2.x CLOSED LOOP BRAKE CONTROL PARAMETERS

2.5.2.1 Current limit

This parameters defines the motor current limit that has to be exceeded before releasing the mechanical brake. If set to zero this condition is excluded.

2.5.2.2 Torque limit

This parameters defines the motor torque limit that has to be exceeded before releasing the mechanical brake. If set to zero this condition is excluded. 100% corresponds to calculated nominal torque of the motor.

2.5.2.3 Frequency limit

This parameters defines the frequency limit that has to be exceeded before releasing the mechanical brake. If set to zero this condition is excluded.

2.5.2.4 Opening delay

Time delay before releasing the brake after the opening conditions are fulfilled.

2.5.2.5 Closing frequency

Output frequency limit that is closing the brake. The run request signal needs to be inactive to allow the signal to affect.

2.5.2.6 Closing delay

Time delay before closing the brake after the closing conditions are fulfilled

2.5.2.7 Max frequency when the brake is closed

Output frequency cannot exceed this value when the brake is closed

2.5.2.8 Mechanical brake reaction time

After the brake is released is the speed reference in hold for a defined time. This hold time should be set corresponding to the mechanical brake reaction time.

2.5.2.9 0 Hz time at start
2.5.2.10 0 Hz time at stop

Zero hertz time during start and stop. Motor can be magnetised and torque can be generated during that time. In closed loop mode this time should be used. Smooth start time (par 2.5.2.11) will start straight after zero hertz time. The mechanical brake should be set to release when this change takes place.

2.5.2.11 Smooth start time

The smooth start time function is used in closed loop mode. It cannot be used in open loop. After the start command has been given the drive is rotating the motor shaft with a very low frequency (par 2.5.2.12) to overcome the static friction.

Smooth start time will start straight after zero hertz time (par 2.3.2.9). The mechanical brake should be set to release when this change takes place. Setting same value for frequency limit (par 2.5.2.3) and smooth start frequency (par 2.3.2.12) will do this.

When smooth start time elapsed frequency will be released.

2.5.2.12 Smooth start frequency

Smooth start frequency is a reference frequency that is used with the smooth start time operation. Value should be set very small.

2.5.2.13 Direction change mode

If direction change situation have to be handled with the mechanical brake is the function set with this parameter.

0 Inactive. The change of direction does not close the mechanical brake
1 Brake closed. The brake is closed when the frequency falls below the limits defined by parameters P2.5.1.9 and P2.5.1.10.
2 Stop state. The drive is stopped, the brake is closed and then started in the other direction.

2.5.2.14 Start magnetizing current

With this parameter and P2.5.1.15 it is possible to have a higher magnetizing current at start to magnetize the motor faster. This will speed up the start in closed loop.

2.5.2.15 Start magnetizing time

Specify the time for start magnetizing current specified by P2.5.1.14

5.6 Motor Control

2.6.1 Motor control mode

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

1 Speed control: The I/O terminal and keypad references are speed references and the frequency converter controls the motor speed (accuracy ± 0,5%).

2 Torque control **Not supported**

3 Closed loop speed control: Closed loop speed control

4 Closed loop torque control **Not supported**

5 Advanced open loop frequency control

6 Advanced open loop speed control

2.6.2 U/f optimisation

Automatic torque boost The voltage to the motor changes automatically which makes the motor produce sufficient torque to start and run at low frequencies. The voltage increase depends on the motor type and power. Automatic torque boost can be used in applications where starting torque due to starting friction is high, e.g. in conveyors.

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

2.6.3 U/f ratio selection

Linear: **0** The voltage of the motor changes linearly with the frequency in the constant flux area from 0 Hz to the field weakening point where the nominal voltage is supplied to the motor. Linear U/f ratio should be used in constant torque applications. **This default setting should be used if there is no special need for another setting.**

Squared: **1** The voltage of the motor changes following a squared curve form with the frequency in the area from 0 Hz to the field weakening point where the nominal voltage is also supplied to the motor. The motor runs under magnetised below the field weakening point and produces less torque and electromechanical noise. Squared U/f ratio can be used in applications where torque demand of the load is proportional to the square of the speed, e.g in centrifugal fans and pumps.

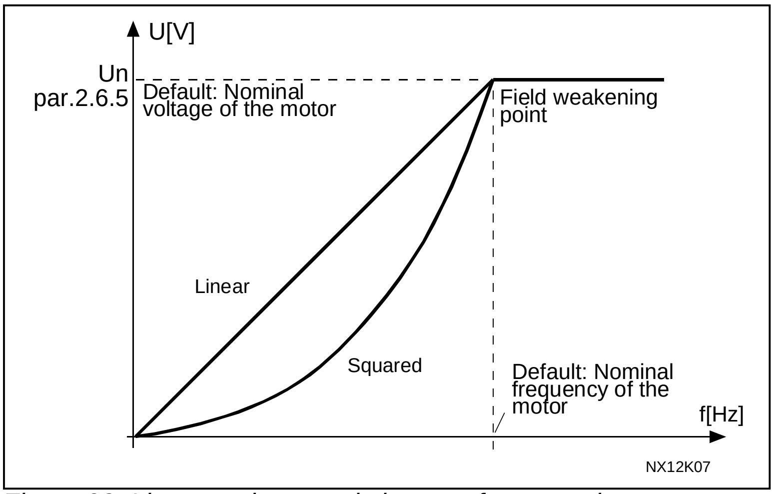


Figure 23. Linear and squared change of motor voltage

Programmable U/f curve:

2 The U/f curve can be programmed with three different points. Programmable U/f curve can be used if the other settings do not satisfy the needs of the application. See Figure 24.

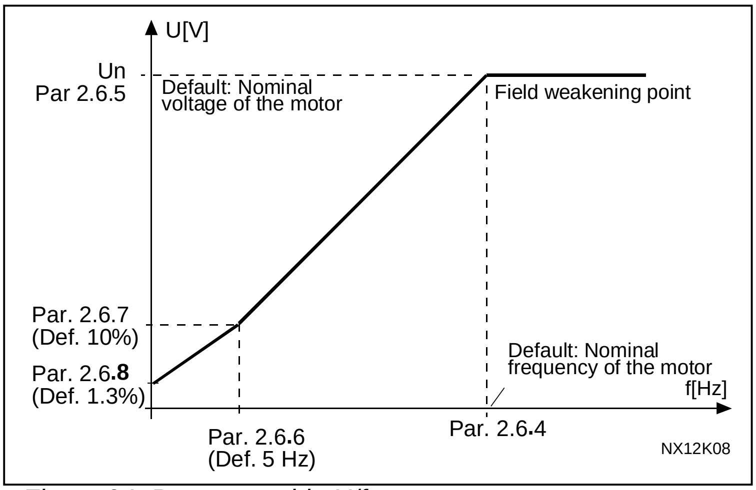


Figure 24. Programmable U/f curve

Linear with flux optimisation:

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

2.6.4 Field weakening point

The field weakening point is the output frequency at which the output voltage reaches the set (par. 2.6.5) maximum value.

2.6.5 Voltage at field weakening point

Above the frequency at the field weakening point, the output voltage remains at the set maximum value. Below the frequency at the field weakening point, the output voltage depends on the setting of the U/f curve parameters. See parameters 2.6.2, 2.6.3, 2.6.6 and 2.6.7.

When the parameters 2.1.6 and 2.1.7 (nominal voltage and nominal frequency of the motor) are set, the parameters 2.6.4 and 2.6.5 are automatically given the corresponding values. If you need different values for the field weakening point and the maximum output voltage, change these parameters **after** setting the parameters 2.1.6 and 2.1.7.

2.6.6 U/f curve, middle point frequency

If the programmable U/f curve has been selected with the parameter 2.6.3 this parameter defines the middle point frequency of the curve. See Figure 24.

2.6.7 U/f curve, middle point voltage

If the programmable U/f curve has been selected with the parameter 2.6.3 this parameter defines the middle point voltage of the curve. See Figure 24.

2.6.8 Output voltage at zero frequency

If the programmable U/f curve has been selected with the parameter 2.6.3 this parameter defines the zero frequency voltage of the curve. See Figure 24.

2.6.9 Switching frequency

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

Up to NX5 0061: 1…16 kHz
>NX5 0072: 1…10 kHz

2.6.10 Overvoltage controller
2.6.11 Undervoltage controller

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

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

0 Controller switched off
1 Controller switched on

2.6.12 Slip compensation

Real speed can be used as slip compensation in motor control mode 6, only NXP (Advance open loop speed control). NXOPTA4 or NXOPTA5 encoder option board has to be installed.
0 Calculated speed
1 Real speed (encoder)

2.6.13 Open loop speed regulator P-gain

Sets the Proportional-gain for the open loop speed controller

2.6.14 Open loop speed regulator I-gain

Sets the Integration-gain for the open loop speed controller

2.6.15 Load drooping

The drooping function enables speed drop as a function of load. The amount of allowed speed drop is proportional to the load or speed controller output (Iq reference). This parameter sets that amount corresponding to 100% load of the motor.

2.6.16 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. **Identification is made in open loop independent of selected motor control mode**.

0 = No action

1 = Identification without motor run

The drive is run without speed to identify the motor parameters. The motor is supplied with current and voltage but with zero frequency. Parameters for U/f cureve, Stator resistance and parameters for auto torque boost are identified. The magnetizing current for closed loop is estimated.

2 = Identification with motor run

The drive is run with speed to identify the motor parameters.
Same parameters as in identification without motor run are identified and additionally the magnetizing current and a 15 point flux linearization point curve is identified.

Note: The mechanical brake has to be opened manually due to safety reasons!
It is recommended to do this identification with no load on the motor for best results.

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

Nominal voltage of the motor (par. 2.1.6)
Nominal frequency of the motor (par. 2.1.7)
Nominal speed of the motor (par. 2.1.8)
Nominal current of the motor (par. 2.1.9)
Motor cos phi (par. 2.1.10)

For closed loop with encoder also the parameter for pulses / revolutions (in Menu M7) has to be set.
The automatic identification is activated by setting this parameter to the appropriate value followed by a start command in the requested direction. The start command to the drive has to be given within 20 s. If no start command is given within 20 s the identification run is cancelled and the parameter will be reset to its default setting.
The identification run can be stopped any time with normal stop command and the parameter is reset to its default setting. In case identification run detects fault or other problems, the identification run is completed if possible. After the identification is finished, the application checks the status of the identification and generates fault/ warning if any.
During Identification Run, the brake control is disabled.

2.6.15.x CLOSED LOOP PARAMETERS (NXP)

2.6.17.1 Magnetizing current

Set here the rated magnetizing current for the motor. This parameter is used for adjusting the motor in no-load conditions.

2.6.17.2 Speed control Kp

Sets the gain for the speed controller in % per Hz.

2.6.17.3 Speed control Ti

Sets the integral time constant for the speed controller

2.6.17.4 Current control Kp

Sets the gain for the current controller. This controller is active only in closed loop and advanced open loop modes. The controller generates the voltage vector reference to the modulator.

2.6.17.5 Encoder filter time

Sets the filter time constant for speed measurement.

2.6.17.6 Slip adjust

The motor name plate speed is used to calculate the nominal slip. This value should be used to adjust motor voltage when loaded. Reducing the slip adjust value increases the motor voltage when the motor is loaded.

2.6.17.7 Startup torque selection

Startup torque is used to reduce erratic motion after start. Torque Memory is used in crane applications.
0 = Not Used
1 = TorqMemory

2.6.17.8 Stop state flux

Stop state magnetization current in percent of nominal magnetizing current. Useful when there is a need to keep the motor magnetized during short stops to be able to get a faster restart. The stop state magnetization time is specified by P2.6.17.9

2.6.17.9 Flux off delay

Maximum time for the stop state magnetization specified by P2.6.17.8

2.6.18.x ADVANCED OPEN LOOP PARAMETERS (NXP)

If the value of par. 2.6.1 = 5, the advanced open loop mode is selected. Value 6 is advanced open loop with slip compensation. These modes are designed e.g. for lift and hoisting applications to give smoother operation with less tuning required. The operation is based on current control mode at low frequencies. Above a certain frequency limit, the operation is under standard V/Hz control. At low frequencies the motor current is adjusted between minimum current and zero speed current according to the load in order to maintain the flux. In the frequency corner, the U/f-boost parameter is used to optimise motor current and torque.

2.6.18.1 Zero speed current

At very low frequencies this parameter defines the constant current reference to the motor.

2.6.18.2 Minimum current

Minimum current to the motor in the current control frequency region. Larger value gives more torque, but increases losses.

2.6.18.3 Flux reference

Reference for flux below frequency limit. Larger value gives more torque, but increases losses.

2.6.18.4 Frequency limit

Corner frequency for transition to standard V/Hz control in % of motor nominal frequency.

2.6.18.5 Stray Flux Current

Stray flux at nominal load in % of motor nominal current.

2.6.19.x SPEED OPTIMIZATION PARAMETERS

Speed optimization is for running hoist faster during low loading conditions. Thus when there is no load in the crane this function can by utilized to set the motor run with higher speed within the limits specified by P2.6.19.2-5. Parameters limiting the overspeed run have to be set according to the utilized hoist & motor type.

Speeds limitation in upwards direction :
The motor current is compared with P2.6.19.3 IL Limit UP and the frequency reference is locked to actual output frequency when IL is reached.
If running more than 500 ms the frequency reference is lowered by 3,5 Hz/sec until motor current is less than the value defined by P2.6.19.3 IH Limit UP.
These two limits are needed as in upwards direction there is static and dynamic friction to overcome before reaching the constant speed phase. Thus IL limitation is active during and at the end of the acceleration phase. If the required current at constant speed remains at too high level speed & current are lowered to meet the limit set by P2.6.19.4.

Speeds limitation in downwards direction :
The motor current is compared with P2.6.19.5 IH Limit Down and the frequency reference is locked to actual output frequency when the current of P2.6.19.5 is reached.
In downwards direction there is only one limit as the gravity is constantly affecting the load. Thus the power needed to overcome frictions is low or the load stars moving immediately after the mechanical brake released. Motor is mainly keeping the load within defined frequency limits and generated power is dissipated in the braking resistor.

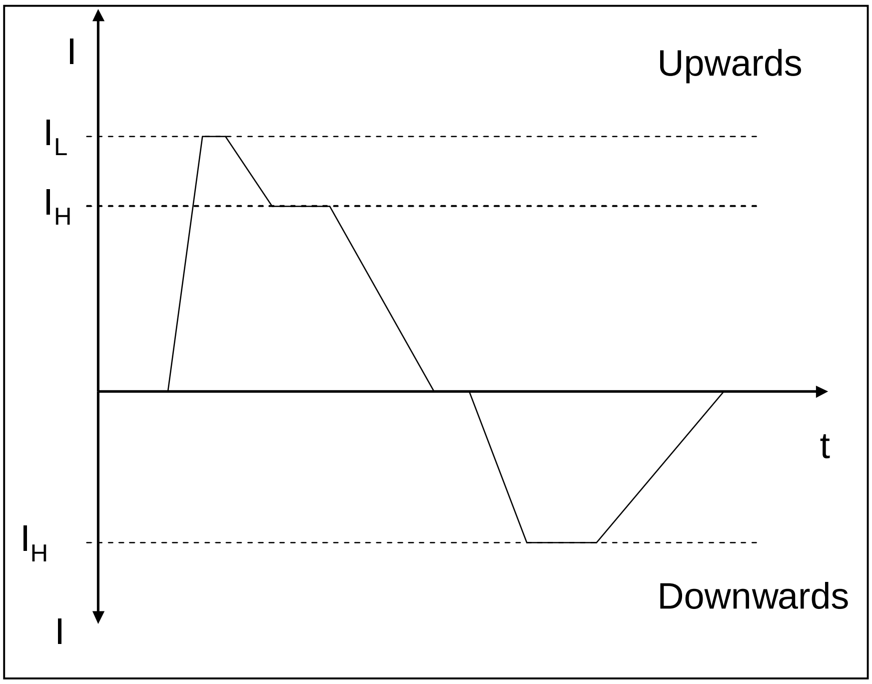


Figure 25. Speed optimization and current limits

2.6.19.1 Enable speed optimization

Enables speed optimization function
0 = No
1 = Yes

2.6.19.2 Frequency limit

Above this limit speed optimization is active.

2.6.19.3 IL Limit UP

IL current limit active in upwards direction. If output frequency is above P2.6.19.2 then frequency reference is freezed at the moment when motor current is greater than this IL current limit. After 500 ms frequency is decelerated until motor current equals to P2.6.19.4. Default for P2.6.19.3 is rated continous current IL.

2.6.19.4 IH Limit UP

IH current limit active in upwards direction. If output frequency is above P2.6.19.2 then frequency reference is freezed at the moment when motor current is greater than P2.6.19.3. After 500 ms time output frequency is decelerated until motor current is less than P2.6.19.4. If the limit of P2.6.19.3 is not exceeded at constant speed while still P2.6.19.4 limit is exceeded the output frequency is decelerated according to P2.6.19.4 after the constant speed phase. Default for P2.6.19.4 is rated continous current IH.

2.6.19.5 IH Limit DOWN

IH current limit active in downwards direction. If output frequency is above P2.6.19.2 then frequency reference is freezed at the moment when motor current is greater than this IH limit. Default for P2.6.19.5 is rated continous current IH.

5.7 Protections

2.7.1 Response to the reference fault

0 = No response
1 = Warning
2 = Warning, the frequency from 10 seconds back is set as reference
3 = Warning, the Preset Frequency (Par. 2.7.2) is set as reference
4 = Fault, stop mode after fault according to parameter 2.4.7
5 = Fault, stop mode after fault always by coasting

A warning or a fault action and message is generated if the 4…20 mA reference signal is used and the signal falls below 3.5 mA for 5 seconds or below 0.5 mA for 0.5 seconds. The information can also be programmed into digital output DO1 or relay outputs RO1 and RO2.

2.7.2 4 mA Fault: preset frequency reference

If the value of parameter 2.7.1 is set to 3 and the 4 mA fault occurs then the frequency reference to the motor is the value of this parameter.

2.7.3 Response to external fault

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 2.4.7
3 = Fault, stop mode after fault always by coasting

A warning or a fault action and message is generated from the external fault signal in the programmable digital inputs DIN3. The information can also be programmed into digital output DO1 and into relay outputs RO1 and RO2.

2.7.4 Input phase supervision

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 2.4.7
3 = Fault, stop mode after fault always by coasting

The input phase supervision ensures that the input phases of the frequency converter have an approximately equal current.

2.7.5 Response to undervoltage fault

1 = Warning
2 = Fault, stop mode after fault according to parameter 2.4.7
3 = Fault, stop mode after fault always by coasting

For the undervoltage limits see Vacon NX User's Manual, Table 4-7.

2.7.6 Output phase supervision

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 2.4.7
3 = Fault, stop mode after fault always by coasting

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

2.7.7 Earth fault protection

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 2.4.7
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.

Parameters 2.7.8—2.7.12, Motor thermal protection:

General

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

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

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

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

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

2.7.8 *Motor thermal protection*

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 2.4.7
3 = Fault, stop mode after fault always by coasting

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

2.7.9 *Motor thermal protection: Motor ambient temperature factor*

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

2.7.10 *Motor thermal protection: Zero frequency current*

The current can be set between 0—150.0% x I_{nMotor}. This parameter sets the value for thermal current at zero frequency. See Figure 26.

The default value is set assuming that there is no external fan cooling the motor. If an external fan is used this parameter can be set to 90% (or even higher).

Note: The value is set as a percentage of the motor name plate data, parameter 2.1.9 (Nominal current of motor), not the drive's nominal output current. The motor's nominal current is the current that the motor can withstand in direct on-line use without being overheated.

If you change the parameter Nominal current of motor, this parameter is automatically restored to the default value.
Setting this parameter does not affect the maximum output current of the drive which is determined by parameter 2.1.5 alone.

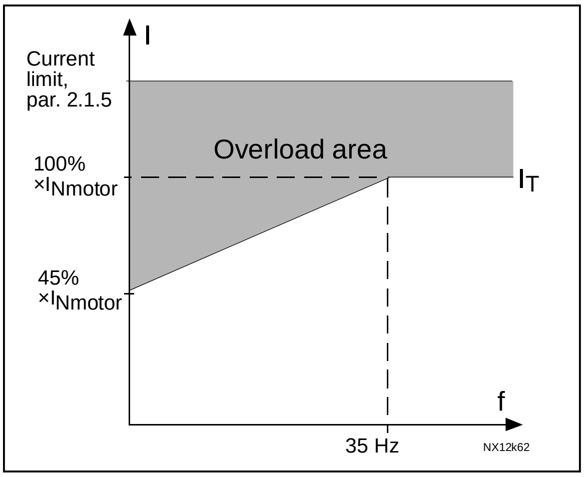


Figure 26. Motor thermal current I_T curve

2.7.11 Motor thermal protection: Time constant

This time can be set between 1 and 200 minutes.

This is the thermal time constant of the motor. The bigger the motor, the bigger the time constant. The time constant is the time within which the calculated thermal stage has reached 63% of its final value.

The motor thermal time is specific to the motor design and it varies between different motor manufacturers.

If the motor's t6–time (t6 is the time in seconds the motor can safely operate at six times the rated current) is known (given by the motor manufacturer) the time constant parameter can be set basing on it. As a rule of thumb, the motor thermal time constant in minutes equals to 2xt6. If the drive is in stop stage the time constant is internally increased to three times the set parameter value. The cooling in the stop stage is based on convection and the time constant is increased. See also Figure 27.

2.7.12 Motor thermal protection: Motor duty cycle

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

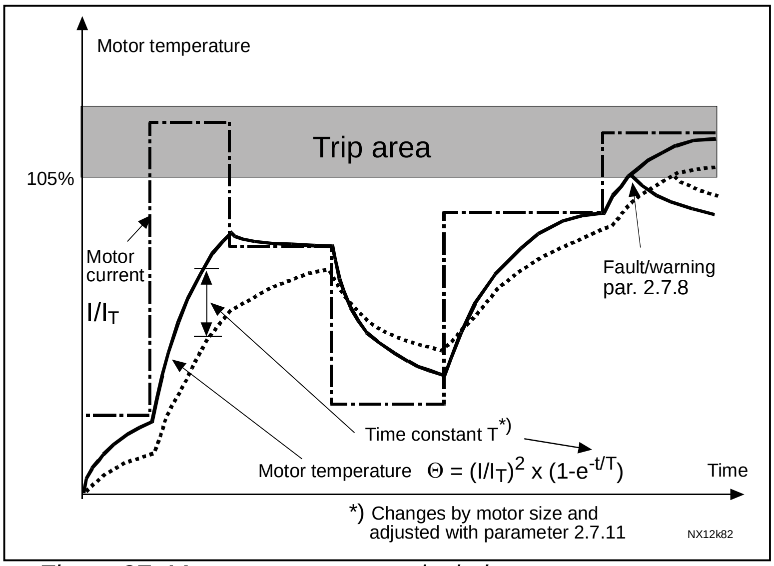


Figure 27. Motor temperature calculation

Parameters 2.7.13—2.7.16, Stall protection:
General

The motor stall protection protects the motor from short time overload situations such as one caused by a stalled shaft. The reaction time of the stall protection can be set shorter than that of motor thermal protection. The stall state is defined with two parameters, 2.7.14 (Stall current) and 2.7.16 (Stall frequency). If the current is higher than the set limit and output frequency is lower than the set limit, the stall state is true. There is actually no real indication of the shaft rotation. Stall protection is a type of overcurrent protection.

2.7.13 Stall protection

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 2.4.7
3 = Fault, stop mode after fault always by coasting

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

2.7.14 Stall current limit

The current can be set to 0.0…6000.0 A. For a stall stage to occur, the current must have exceeded this limit. See Figure 28. This value is set in percentage of the motor's name plate data (parameter 2.1.9). If the parameter 2.1.9 Nominal current of motor is changed, this parameter is automatically restored to the default value.

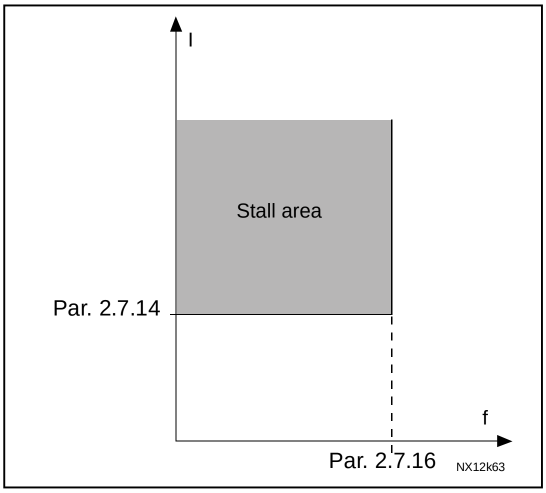


Figure 28 Stall characteristics settings

2.7.15 Stall time

This time can be set between 1.0 and 120.0s.
This is the maximum time allowed for a stall stage. The stall time is counted by an internal up/down counter.
If the stall time counter value goes above this limit the protection will cause a trip (see parameter 2.7.13).

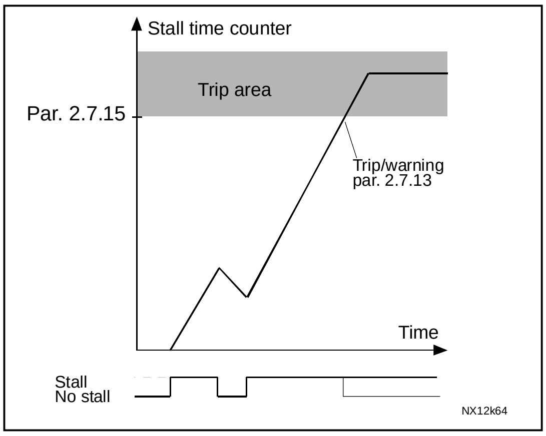


Figure 29. Stall time count

2.7.16 Maximum stall frequency

The frequency can be set between 1-f_{max} (par. 2.1.2). For a stall state to occur, the output frequency must have remained below this limit.

Parameters 2.7.17—2.7.20, Underload protection:
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 2.7.18 (Field weakening area load) and 2.7.19 (Zero frequency load), see below. The underload curve is a squared curve set between the zero frequency and the field weakening point. The protection is not active below 5Hz (the underload time counter is stopped).

The torque values for setting the underload curve are set in percentage which refers to the nominal torque of the motor. The motor's name plate data, parameter motor nominal current and the drive's nominal current I_{CT} 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.

2.7.17 Underload protection

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 2.4.7
3 = Fault, stop mode after fault always by coasting

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

2.7.18 Underload protection, field weakening area load

The torque limit can be set between 10.0—150.0 % x T_{nMotor}. This parameter gives the value for the minimum torque allowed when the output frequency is above the field weakening point. See Figure 30

If you change the parameter 2.1.9 (Motor nominal current) this parameter is automatically restored to the default value.

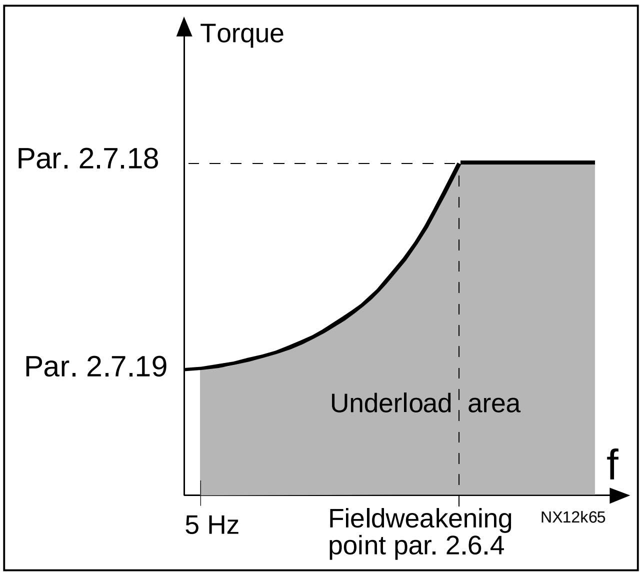


Figure 30 Setting of minimum load

2.7.19 Underload protection, zero frequency load

The torque limit can be set between 5.0—150.0 % x TnMotor.
This parameter gives value for the minimum torque allowed with zero frequency. See Figure 30

If you change the value of parameter 2.1.9 (Motor nominal current) this parameter is automatically restored to the default value.

2.7.20 Underload time

This time can be set between 2.0 and 600.0 s.
This is the maximum time allowed for an underload state to exist. An internal up/down counter counts the accumulated underload time. If the underload counter value goes above this limit the protection will cause a trip according to parameter 2.7.17). If the drive is stopped the underload counter is reset to zero. See Figure 31.

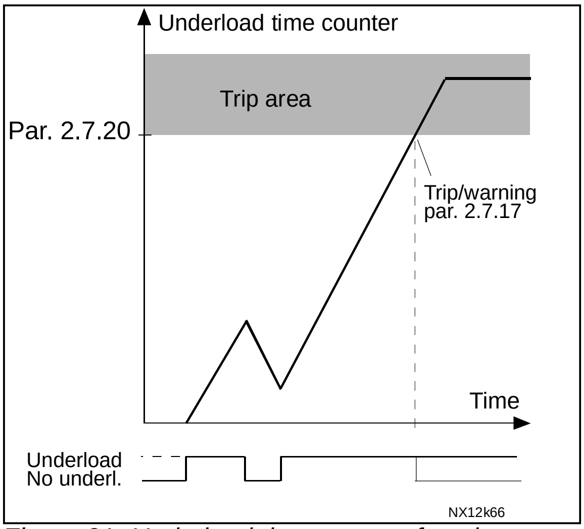


Figure 31. Underload time counter function

2.7.21 Response to thermistor fault

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 2.4.7
3 = Fault, stop mode after fault always by coasting

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

2.7.22 Response to fieldbus fault

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

See parameter 2.7.21.

2.7.23 Response to slot fault

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

See parameter 2.7.21.

2.7.24 Response to Brake supervision fault

Set here the response mode for brake supervision fault due to missing external brake supervision signal (P2.2.7.8) after the brake is opened.

2.7.25 *Brake supervision time*

The time window within the external brake supervision signal (P2.2.7.8) needs to be activated.

2.7.26 *Response to Brake logic fault*

Set here the response mode for brake logic fault.

2.7.27 *Brake logic supervision time*

The time window within the brake open signal needs to be activated after run request command.

2.7.28 *Response to under current fault*

Set the response mode for under current fault.

2.7.29 *Under current supervision value*

If motor current goes below this value when the brake is open the drive will generate fault according to the response mode set by parameter (P2.7.28).

2.7.30 *Response to shaft speed supervision fault*

Set the response mode for shaft speed fault. Actual shaft speed according to encoder and calculated shaft speed from motor control are compared and in a case the speed difference is more than the limit set by P2.7.31 for a defined time in P2.7.32 the set action is taken. See Figure 32. This fault is generated only when the mechanical brake is open. I.e. if running against mechanical brake this fault is not set.

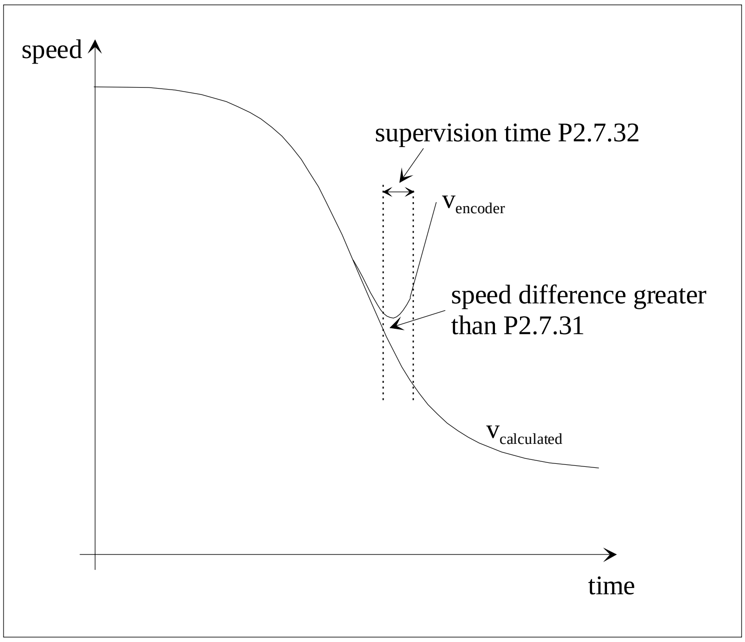


Figure 32. Shaft speed supervision

2.7.31 *Shaft speed supervision hysteresis*

The speed difference between encoder speed and the calculated speed that will cause a tripping according to the mode set by P2.7.30.

2.7.32 Shaft speed supervision time

Supervision time for the shaft speed fault.

5.8 Auto Restart Parameters

2.8.1 Automatic restart: Wait time

Defines the time before the frequency converter tries to automatically restart the motor after the fault has disappeared.

2.8.2 Automatic restart: Trial time

The Automatic restart function restarts the frequency converter when the faults selected with parameters 2.8.4 to 2.8.10 have disappeared and the waiting time has elapsed.

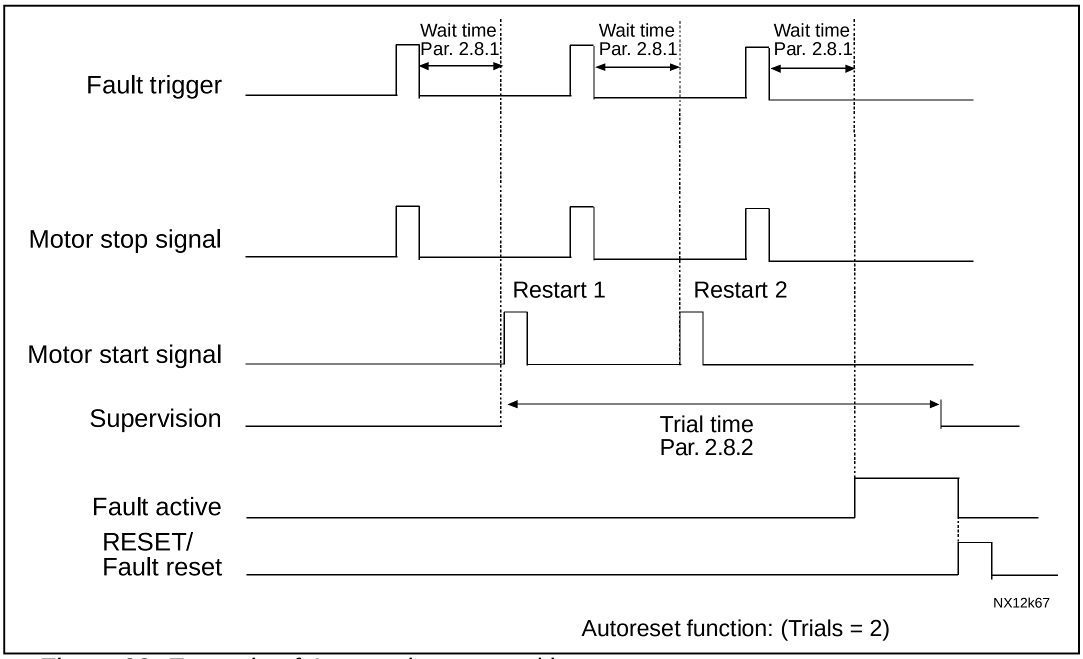


Figure 33. Example of Automatic restart with two restarts.

Parameters 2.8.4 to 2.8.10 determine the maximum number of automatic restarts during the trial time set by parameter 2.8.2. The time count starts from the first autorestart. If the number of faults occurring during the trial time exceeds the values of parameters 2.8.4 to 2.8.10, the fault state becomes active. Otherwise the fault is cleared after the trial time has elapsed and the next fault starts the trial time count again.

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

2.8.3 Automatic restart, start function

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

0 = Start with ramp
1 = Flying start
2 = Start according to par. 2.4.6

2.8.4 Automatic restart: Number of tries after undervoltage fault trip

This parameter determines how many automatic restarts can be made during the trial time set by parameter 2.8.2 after an undervoltage trip.

0 = No automatic restart after undervoltage fault trip
>0 = Number of automatic restarts after undervoltage fault. The fault is reset and the drive is started automatically after the DC-link voltage has returned to the normal level.

2.8.5 Automatic restart: Number of tries after overvoltage trip

This parameter determines how many automatic restarts can be made during the trial time set by parameter 2.8.2 after an overvoltage trip.

0 = No automatic restart after overvoltage fault trip
>0 = Number of automatic restarts after overvoltage fault. The fault is reset and the drive is started automatically after the DC-link voltage has returned to the normal level.

2.8.6 Automatic restart: Number of tries after overcurrent trip

(NOTE! IGBT temp Fault also included)
This parameter determines how many automatic restarts can be made during the trial time set by parameter 2.8.2.

0 = No automatic restart after overcurrent fault trip
>0 = Number of automatic restarts after overcurrent trip, saturation trip and IGBT temperature faults.

2.8.7 Automatic restart: Number of tries after reference trip

This parameter determines how many automatic restarts can be made during the trial time set by parameter 2.8.2.

0 = No automatic restart after reference fault trip
>0 = Number of automatic restarts after the analogue current signal (4…20 mA) has returned to the normal level (≥4 mA)

2.8.8 Automatic restart: Number of tries after motor temperature fault trip

This parameter determines how many automatic restarts can be made during the trial time set by parameter 2.8.2.

0 = No automatic restart after Motor temperature fault trip
>0 = Number of automatic restarts after the motor temperature has returned to its normal level.

2.8.9 Automatic restart: Number of tries after external fault trip

This parameter determines how many automatic restarts can be made during the trial time set by parameter 2.8.2.

0 = No automatic restart after External fault trip
>0 = Number of automatic restarts after External fault trip

5.9 Identified Parameters

P2.9.1 – P2.9.15 Flux linearization points

Flux 10…150%
Motor voltage corresponding to 10%….150% of flux as a percentage of Nominal Flux voltage.

P2.9.20 IR Add Zero Point Voltage

Ir Add Voltage for Zero frequency, used with automatic torque boost.

P2.9.21 IR Add Generator Scale

Scaling factor for generator side IR-compensation.

P2.9.22 IR Add Motor Scale

Scaling factor for motor side IR-compensation.

P2.9.16 Make flux time

Time to magnetize the motor. Use of DC Brake will overwrite this value

P2.9.17 Make flux voltage

Voltage used to magnetize motor during Make flux time

P2.9.18 Rs Voltage drop

Measured Voltage drop at stator resistance between two phases with nom current of motor.

P2.9.19 Make flux voltage, hardware

Magnetizing voltage with hardware dead time compensation.

P2.9.20 Ir: Add zero point voltage

IrAddVoltage for Zero frequency, used with torque boost.

P2.9.21 Ir: Add generator scale

Scaling factor for generator side IR-compensation.

P2.9.22 Ir: Add motoring scale

Scaling factor for motoring side IR-compensation.

P2.9.23 IU Offset
P2.9.24 IV Offset
P2.9.25 IW Offset

Offsets values for phase current measurements

5.10 Keypad Control Parameters

3.1 Control Place

The active control place can be changed with this parameter. For more information, see Vacon NX User's Manual, Chapter 7.3.3.1.

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

3.2 Keypad Reference

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

The output frequency can be copied as the keypad reference by pushing the *Stop button* for 3 seconds when you are on any of the pages of menu ***M3***. For more information, see Vacon NX User's Manual, Chapter 7.3.3.2.

3.3 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.

For more information, see Vacon NX User's Manual, Chapter 7.3.3.3.

3.4 Stop button activated

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

See also parameter 3.1.

6. CONTROL SIGNAL LOGIC IN MECHANICAL BRAKE CONTROL APPLICATION

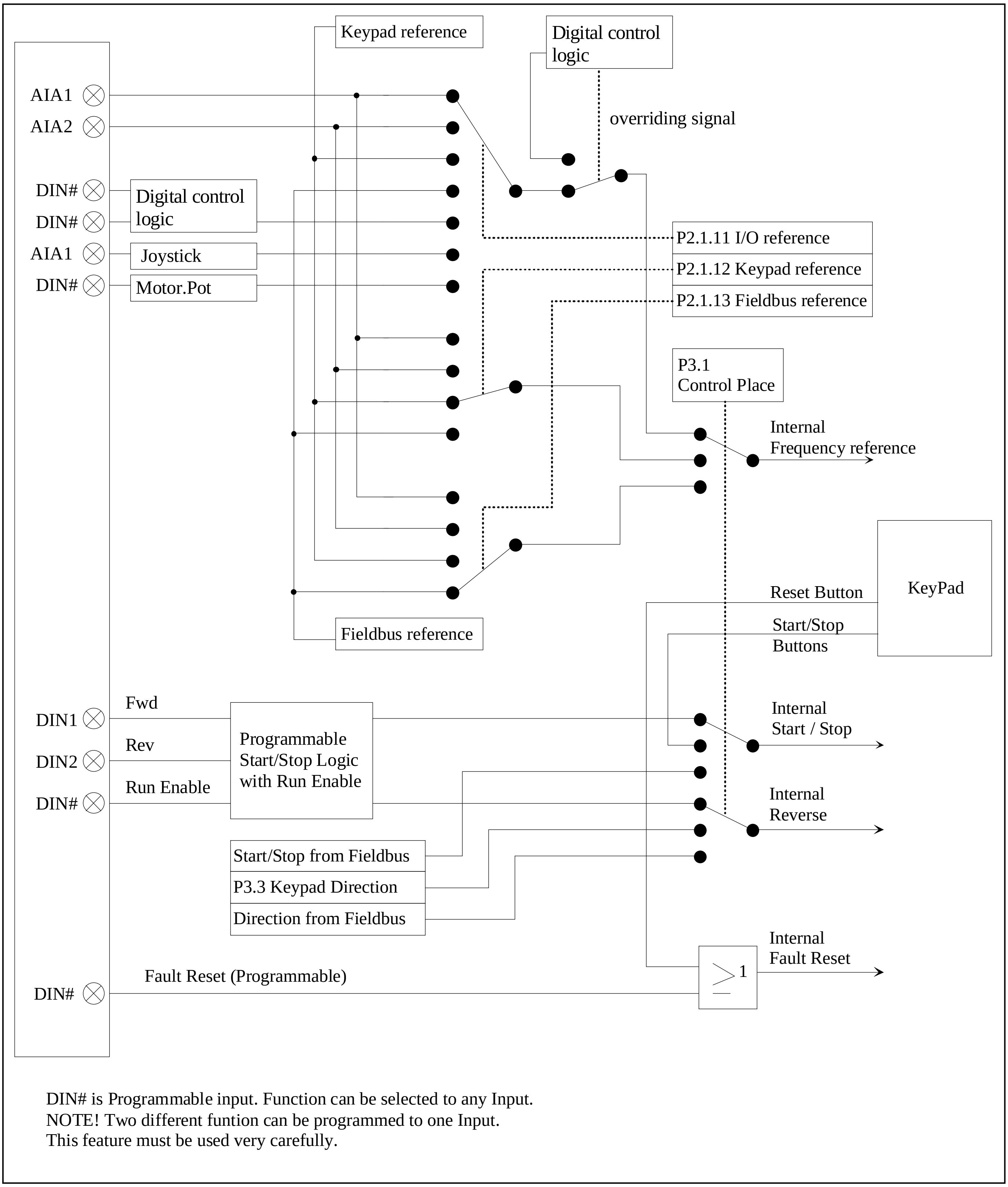


Figure 34. Control signal logic of the Mechanical Brake Control Application

7. FAULT TRACING

When a fault is detected by the frequency converter control electronics, the drive is stopped and the symbol F together with the ordinal number of the fault, the fault code and a short fault description appear on the display. The fault can be reset with the Reset button on the control keypad or via the I/O terminal. The faults are stored in the Fault History menu, which can be browsed.
The fault codes and their possible causes are presented in Table 16.

Fault code	Fault	Possible cause
1	Overcurrent	Frequency converter has detected too high a current (>4*I_n) in the motor cable: - sudden heavy load increase - short circuit in motor cables - unsuitable motor
2	Overvoltage	The DC-link voltage has exceeded the limits defined in Table 4-1. - too short a deceleration time - high overvoltage spikes in utility
3	Earth fault	Current measurement has detected that the sum of motor phase current is not zero. insulation failure in cables or motor
5	Charging switch	The charging switch is open, when the START command has been given. - faulty operation - component failure
6	Emergency stop	Stop signal has been given from the option board.
7	Saturation trip	Defective component
8	Unknown fault	The frequency converter troubleshooting system is unable to locate the fault.
9	Undervoltage	DC-link voltage is under the voltage limits defined in Table 4-2 of the Vacon NX User's Manual. Most probable causes: - too low a supply voltage - frequency converter internal fault
10	Input line supervision	Input line phase is missing.
11	Output phase supervision	Current measurement has detected that there is no current in one motor phase.
12	Brake chopper supervision	- no brake resistor installed - brake resistor is broken - brake chopper failure
13	Frequency converter under-temperature	Heatsink temperature is under –10°C
14	Frequency converter overtemperature	Heatsink temperature is over 90°C. Overtemperature warning is issued when the heatsink temperature exceeds 85°C.
15	Motor stalled	Motor stall protection has tripped.
16	Motor overtemperature	Motor overheating has been detected by frequency converter motor temperature model. Motor is overloaded.
17	Motor underload	Motor underload protection has tripped.
22 **23**	EEPROM checksum fault	- parameter save fault - faulty operation - component failure
24	Changed data warning	Changes may have occurred in the different counter data due to mains interruption
25	Microprocessor	- faulty operation

Fault code	Fault	Possible cause
	watchdog fault	- component failure
29	Thermistor fault	Thermistor is broken.
37	Device change	Option board changed. Different power rating of drive.
38	Device added	Option board added. Drive of different power rating added.
39	Device removed	Option board removed. Drive removed.
40	Device unknown	Unknown option board or drive.
41	IGBT temperature	
50	Analogue input I_{in} < 4mA (selected signal range 4 to 20 mA)	Current at the analogue input is < 4mA. - control cable is broken or loose - signal source has failed
51	External fault	Digital input fault.
52	Keypad communication fault	The connection between the control keypad and the frequency converter is broken.
53	Fieldbus communication fault	The connection from the fieldbus to the frequency converter is broken.
54	SPI communication fault	The connection between the component board and the control board is broken.
80	Brake supervision	External brake supervision signal has not been activated after the brake open signal is activated P2.7.24.
81	Brake logic supervision	Brake open signal has not been activated after defined time after run request P2.7.25
82	Under current	Motor current is less than set limit parameter P2.7.29
83	Shaft speed	Shaft speed from encoder differs from the calculated shaft speed P2.7.30.

Table 16. Fault codes

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