USER'S MANUAL

NX FREQUENCY CONVERTERS

EASY SYNCHRONIZATION APPLICATION

INDEX

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Easy Synchronization Application

1. INTRODUCTION

This application is an extended version of the *Standard application*. The application should be loaded as APPLICATION with the loader for drive software *NCLoad*. After loading, the application can be selected in menu M6 on page S6.2.

The application is suitable e.g. for synchronizing conveyor belts, conveyors, isolating parts upon transition from one conveyor to the next and similar needs.

One frequency converter is the master and the others function as slaves. All frequency converters follow the same speed reference and the slaves are counting pulses (<50Hz) from the shafts for the speed correction (±x% of reference frequency). The speed reference is chained with mA signal from drive to drive. Pulse sensor is a simple proximity type giving 1 pulse/round.

Components: Two or more Vacon NX's and two or more proximity switches (24V DC).

The accuracy can be ± 2 pulses during Start/Stop and ± 1 pulse during run.

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
- Auto restart
- Motor thermal and stall protection: Programmable action; off, warning, fault

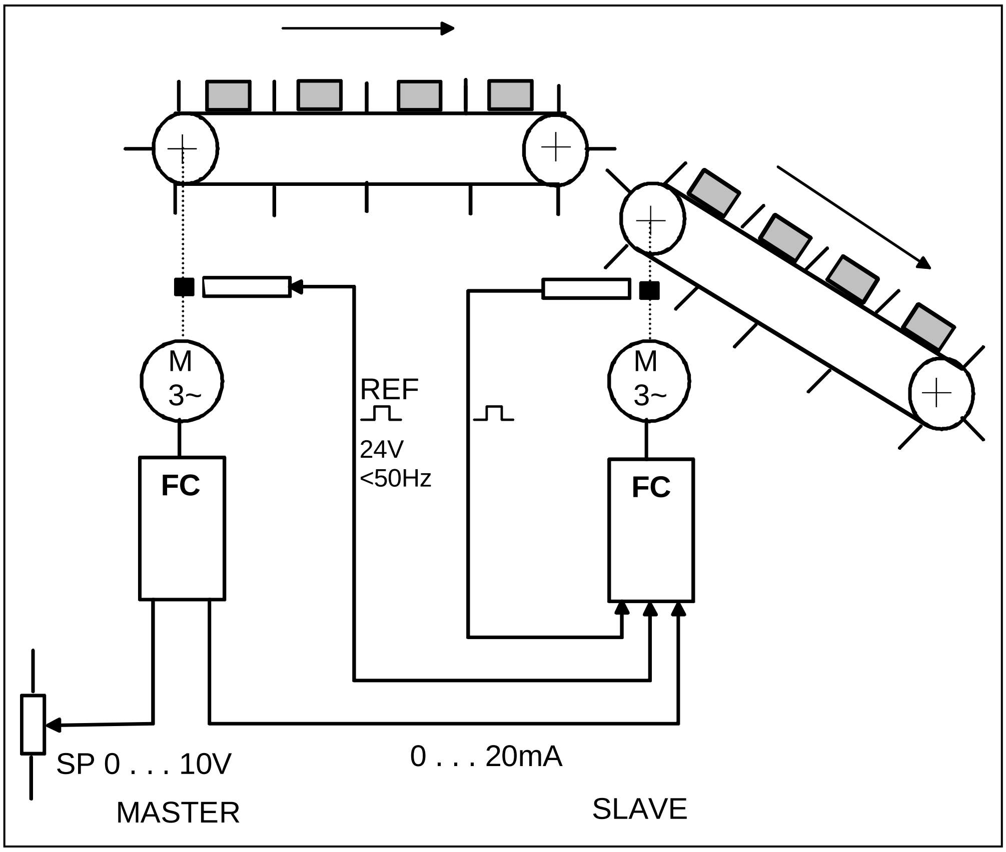


Figure 1. Synchronization of two conveyors.

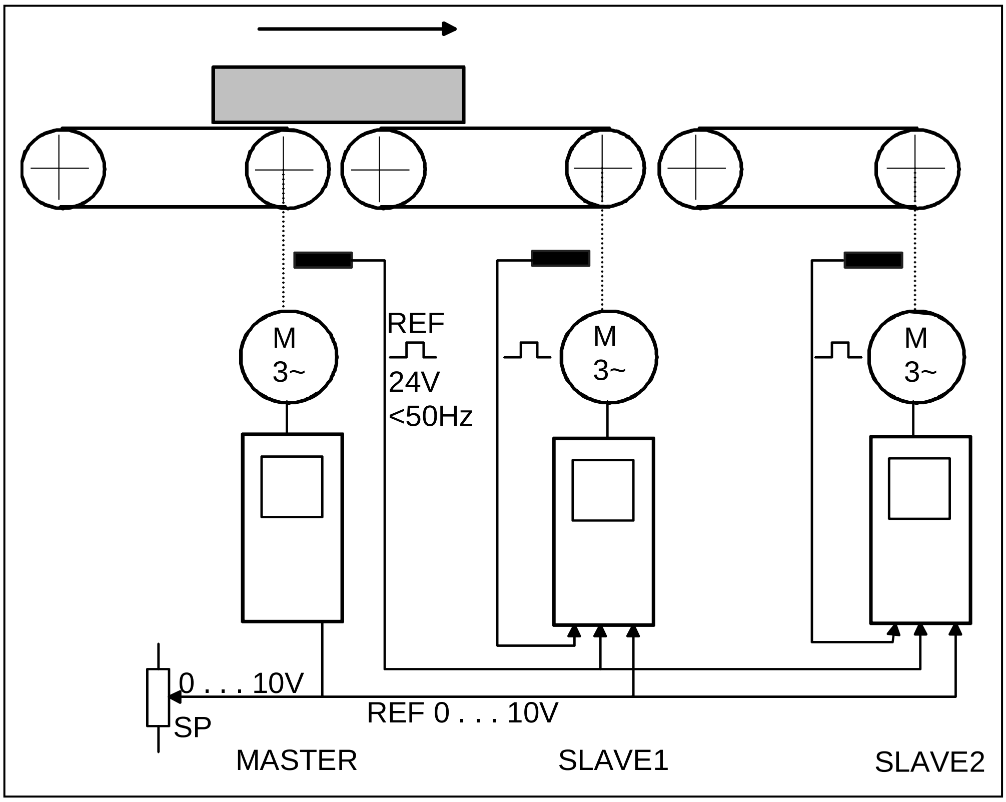


Figure 2. Synchronization of conveyor belts.

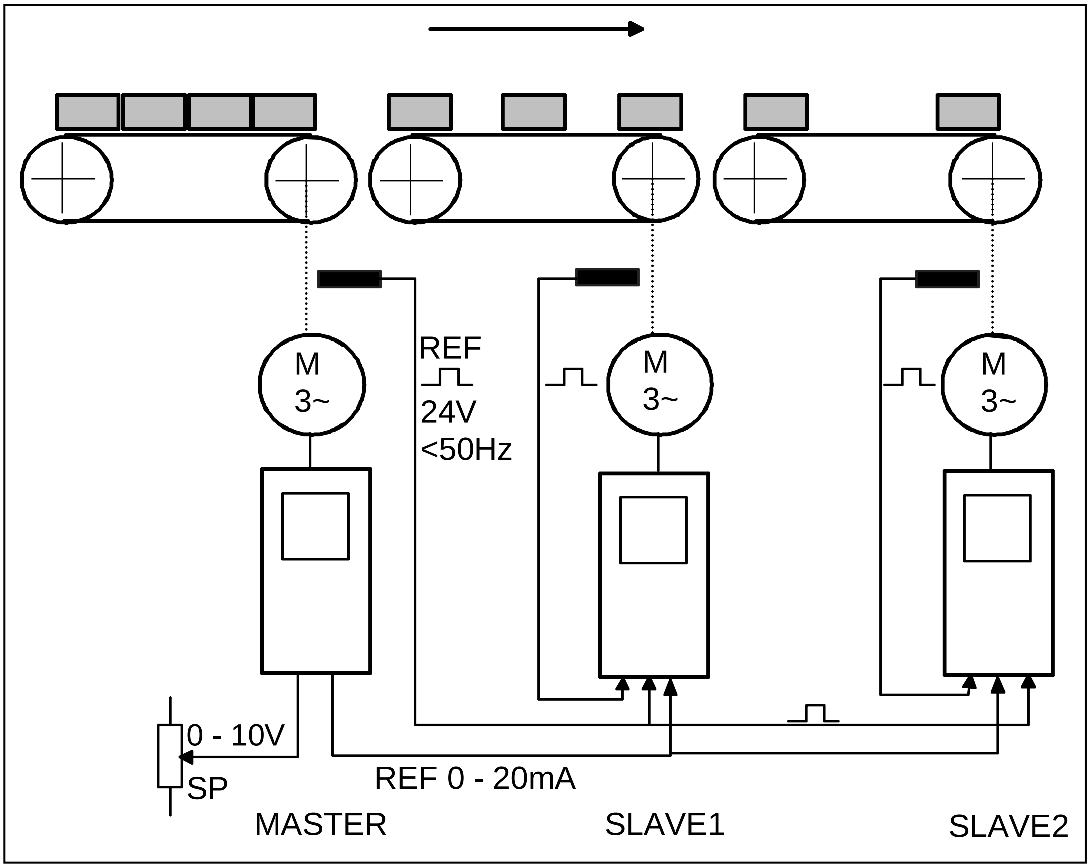


Figure 3. Electronic gear transmission ratio getting the most from isolate parts upon transition from one conveyor to the next.

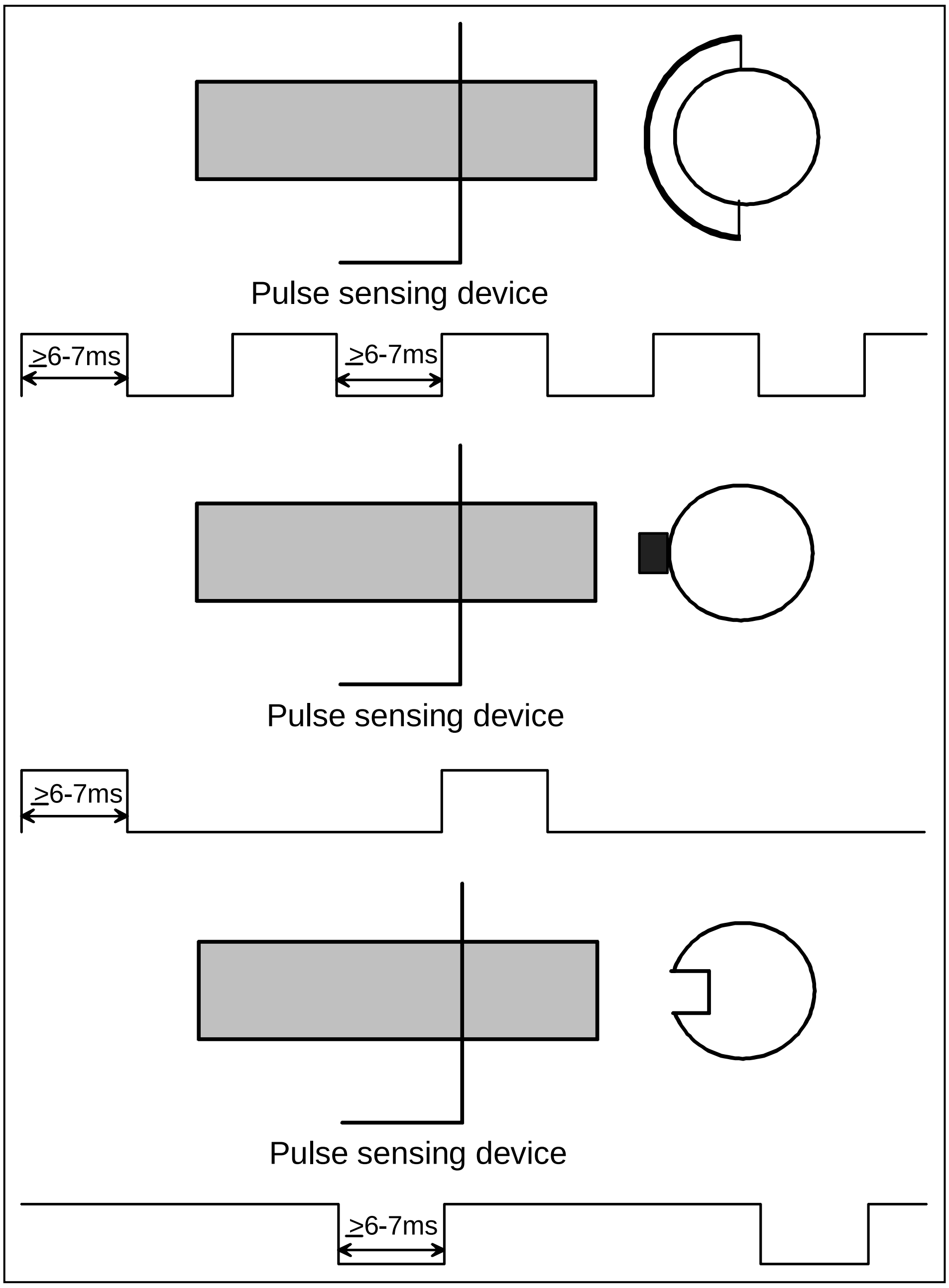


Figure 4. Pulse sensing device prospective pulses. The pulse on-time or off-time is ≥ 6-7ms.

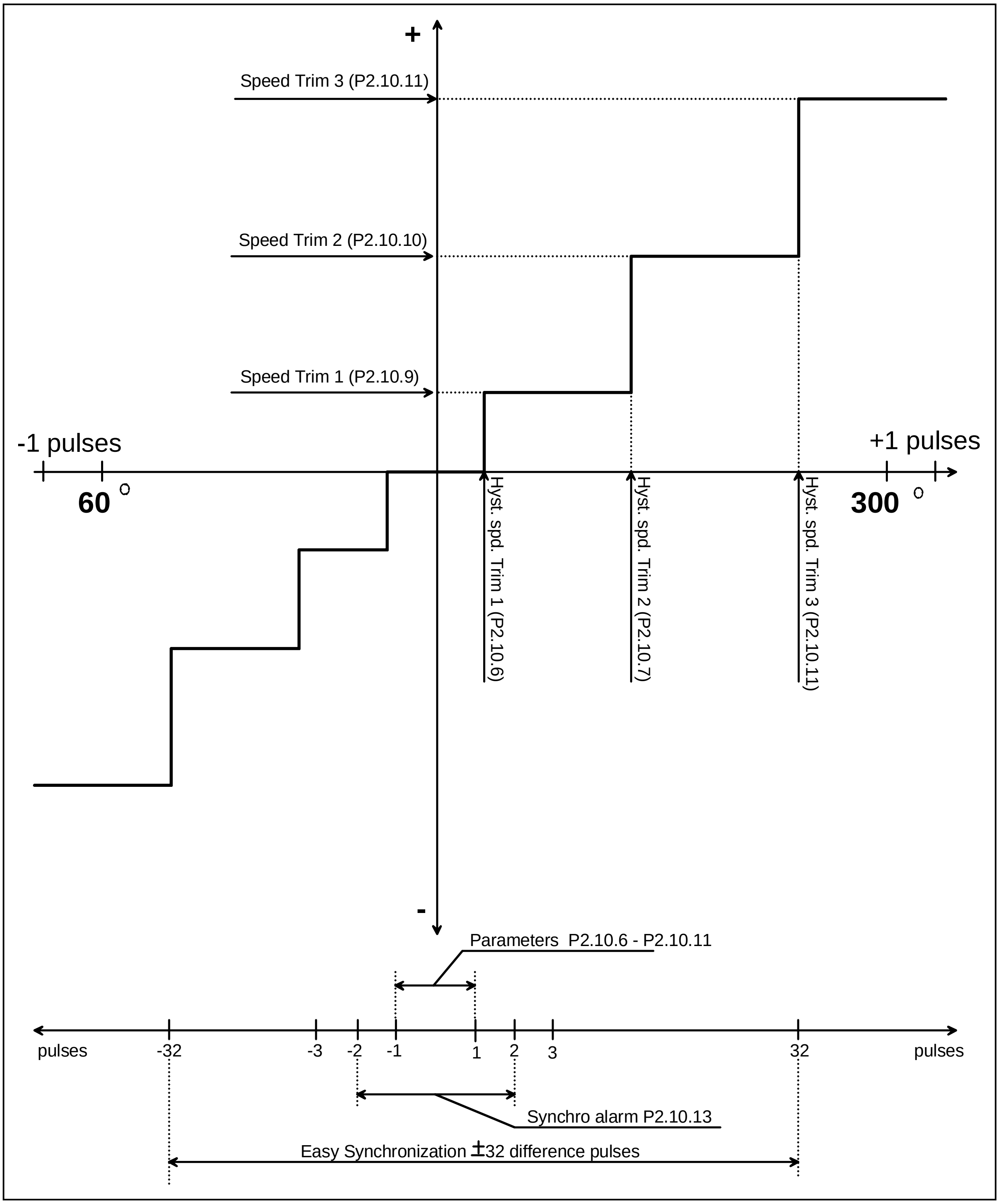
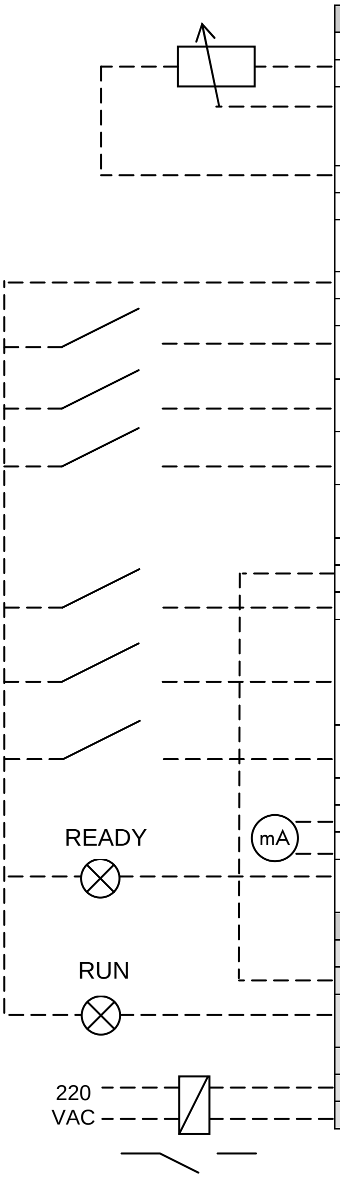


Figure 5. Synchronization regulator principle.

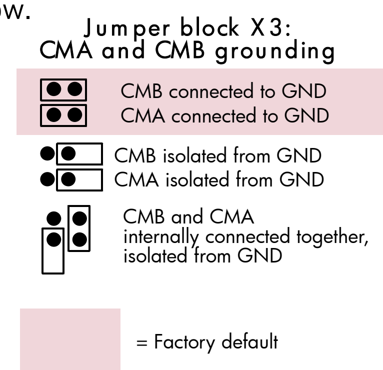
2. CONTROL I/O



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	Pulse input master	≥ 7ms
15	DIN5	Pulse input slave	≥ 7ms
16	DIN6	Fault reset	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 RUN	Programmable
22	RO1		
23	RO1		
24	RO2	Relay output 2 FAULT	Programmable
25	RO2		
26	RO2		

Table 1. Easy Synchro application default I/O configuration.

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



3. EASY SYNCHRONIZATION 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 21 to 53.

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.

3.1 Monitoring values (Control keypad: menu M1)

The monitoring values are the actual values of parameters and signals as well as statuses and measurements. Monitoring values cannot be edited.
See 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	Heat sink temperature
V1.10	Analogue input 1	V	13	AI1
V1.11	Analogue input 2	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	Diff. counter F1-F2	-	1530	Diff. counter actual value
V1.17	Diff. counter pls	pls	1531	Diff. pls counter
V1.18	Master rpm	rpm	1532	Actual rpm
V1.19	Slave rpm	rpm	1533	Actual rpm
V1.20	Speed trim	Hz	1534	Actual speed trim value
V1.21	Difference angle	°(deg)	1535	Actual diff. angle
V1.22	Active speed trim	-	1536	Active speed trim step (0…3)

Table 2. Monitoring values

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

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.1.1	Min frequency	0,00	Par. 2.1.2	Hz	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	0,4 x I_H	2 x I_H	A	I_L		107	
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	0,4 x I_H	2 x I_H	A	I_H		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
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

Table 3. Basic parameters G2.1

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

Code	Parameter	Min	Max	Unit	Default	Cust	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	DIN3 function	0	9		1		301	0=Not used 1=Ext. fault, closing cont. 2=Ext. fault, opening cont. 3=Run enable 4=Acc./Dec. time select. 5=Force cp. to IO 6=Force cp. to keypad 7=Force cp. to fieldbus 8=Rvs (if par. 2.2.1=3) 9=Synchronization
P2.2.3	Current reference offset	0	1		1		302	0=No offset 1=4—20 mA
P2.2.4	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
P2.2.5	Reference scaling maximum value	0,00	320,00	Hz	0,00		304	Selects the frequency that corresponds to the max. reference signal 0,00 = No scaling
P2.2.6	Reference inversion	0	1		0		305	0 = Not inverted 1 = Inverted
P2.2.7	Reference filter time	0,00	10,00	s	0,10		306	0 = No filtering

Table 4. Input signals, G2.2

* = Rising edge required to start

3.4 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	17		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 or warning 16=FB Digital input 1 17=Synchro warning
P2.3.7	Relay output 1 function	0	14		2		313	As parameter 2.3.6
P2.3.8	Relay output 2 function	0	14		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	

Table 5. Output signals, G2.3

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

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.4.1	Ramp 1 shape	0,0	10,0	s	0,0		500	0 = Linear >0 = S-curve ramp time
P2.4.2	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	3		0		504	0=Disabled 1=Used when running 2=External brake chopper 3=Used when stopped/running
P2.4.6	Start function	0	1		0		505	0=Ramp 1=Flying start
P2.4.7	Stop function	0	3		0		506	0=Coasting 1=Ramp 2=Ramp+Run enable coast 3=Coast+Run enable ramp
P2.4.8	DC braking current	0,4 x I_H	2 x I_H	A	I_H		507	
P2.4.9	DC braking time at stop	0,00	600,00	s	0,00		508	0 = DC brake is off at stop
P2.4.10	Frequency to start DC braking during ramp stop	0,10	10,00	Hz	0,00		515	
P2.4.11	DC braking time at start	0,00	600,00	s	0,00		516	0 = DC brake is off at start
P2.4.12	Flux brake	0	1		0		520	0 = Off 1 = On
P2.4.13	Flux braking current	0,4 x I_H	2 x I_H	A	I_H		519	

Table 6. Drive control parameters, G2.4

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

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.5.1	Prohibit frequency range 1 low limit	0,00	par. 2.5.2	Hz	0,00		509	
P2.5.2	Prohibit frequency range 1 high limit	0,00	320,00	Hz	0,0		510	
P2.5.3	Prohibit acc./dec. ramp	0,1	10,0		1,0		518	

Table 7. Prohibit frequency parameters, G2.5

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

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.6.1	Motor control mode	0	1/6		0		600	NXS: 0=Frequency control 1=Speed control Additionally for NXP: 3=Closed loop speed ctrl 4=Closed loop torque ctrl 5=Adv. open loop freq. control 6=Advanced open loop speed control
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	8,00	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}
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} Parameter max. value = par. 2.6.5
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	Varies	kHz	Varies		601	Depends on kW
P2.6.10	Over voltage controller	0	1		1		607	0=Not used 1=Used
P2.6.11	Under voltage controller	0	1		1		608	0=Not used 1=Used

Table 8. Motor control parameters, G2.6

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

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.7.1	Response to 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		0		730	
P2.7.5	Response to under voltage 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	I_{nMotor} x 2	A	I_L		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	Under load curve at nominal frequency	10	150	%	50		714	
P2.7.19	Under load curve at zero frequency	5,0	150,0	%	10,0		715	
P2.7.20	Under load 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

Table 9. Protections, G2.7

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

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.8.1	Wait time	0,10	10,00	s	0,50		717	
P2.8.2	Trial time	0,00	60,00	s	30,00		718	
P2.8.3	Start function	0	2		0		719	0=Ramp 1=Flying start 2=According to par. 2.4.6
P2.8.4	Number of tries after under voltage trip	0	10		0		720	
P2.8.5	Number of tries after over voltage trip	0	10		0		721	
P2.8.6	Number of tries after over current 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

3.10 Closed Loop parameters (NXP) (Control keypad: M2 → G2.9)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
2.9.1	Magnetizing current	0,00	100,00	A	0,00		612	
2.9.2	Speed control P gain	0	1000		30		613	
2.9.3	Speed control I time	0,0	500,0	ms	30,0		614	
2.9.4	0-speed time at start	0	32000	ms	100		615	
2.9.5	0-speed time at stop	0	32000	ms	100		616	
2.9.6	Current control P gain	0,00	100,00	%	40,00		617	
2.9.7	Encoder filter time	0	1000	ms	0		618	
2.9.8	Slip adjust	0	500	%	100		619	
2.9.9	Load drooping	0,00	100,00	%	0,00		620	
2.9.10	Start-up torque	0	1		0		621	0=Not used 1=Torque memory
Advanced Open Loop parameter group 2.9.11 (NXP only)								
2.9.11.1	Minimum current	0,0	100,0	%	80,0		622	
2.9.11.2	Flux reference	0,0	100,0	%	80,0		623	
2.9.11.3	Stray Flux Current	0,0	100,0	%	80,0		624	
2.9.11.4	Zero speed current	0,0	250,0	%	120,0		625	

Table 11. Closed Loop parameters, G2.9

3.11 Easy synchronization parameters (Control keypad: M2 → G2.10)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.10.1	Factor 1	1	10000		1000		1502	Multiplier for reference
P2.10.2	Factor 2	1	10000		1000		1503	Divisor for reference
P2.10.3	Sync. Ref. bias	-10,0	10,0	Hz	0,0		1504	Bias for reference
P2.10.4	Sync. Ref. Gain	0,000	10,000		1,000		1505	Gain for reference
P2.10.5	Diff angle	60	300	°(deg)	120		1506	Diff. angle for mode 1
P2.10.6	Hyst. Speed trim 1	0	300	°(deg)	0°		1507	Hysteresis for speed trim 1
P2.10.7	Hyst. Speed trim 2	0	300	°(deg)	40°		1508	Hysteresis for speed trim 2
P2.10.8	Hyst. Speed trim 3	0	1000	°(deg)	100°		1509	Hysteresis for speed trim 3
P2.10.9	Speed trim 1	0	10,0	%	0,2%		1510	Speed trim % of reference
P2.10.10	Speed trim 2	0	10,0	%	0,4%		1511	Speed trim % of reference
P2.10.11	Speed trim 3	0	100,0	%	5,0%		1512	Speed trim % of reference
P2.10.12	Mode selection	0	2		1		1513	0=Angle synchronization 1=Ratio synchronization 2=Speed ratio run
P2.10.13	Synchro alarm	0	30	pls	2		1514	Hysteresis for synchroalarm
P2.10.14	Master pls/rev	1	10	pls	1		1515	Master pulses / revolution
P2.10.15	Slave pls/rev	1	10	pls	1		1516	Slave pulses / revolution
P2.10.16	Mean value sel.	0	1		0		1517	Smoothing function
P2.10.17	Synchronization reference selection	0	1		1		1518	0=Voltage input 1=Current input
P2.10.18	Angle filtration	0	1		0		1519	0=No filtration 1=Filtration of diff. angle
P2.10.19	Angle filter time	0	1,00	s	0		1520	Low pass filter time

Table 12. Easy synchronization parameters, G2.10

3.12 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 13. Keypad control parameters, M3

3.13 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.

3.14 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.

4. DESCRIPTION OF PARAMETERS

4.1 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 2.3.10 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. The parameter value range differs from size to size.

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

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

4.2 Input signals

2.2.1 Start/Stop logic selection

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

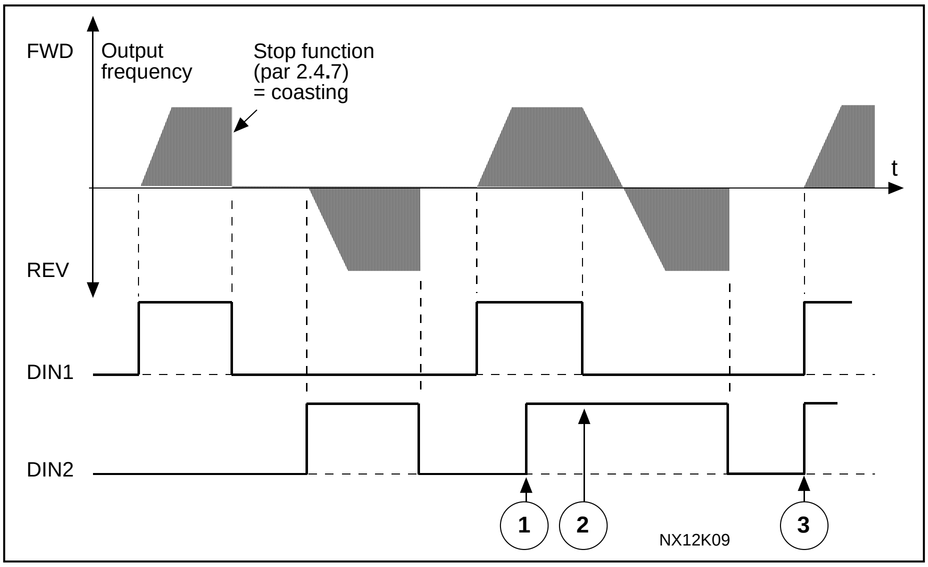


Figure 6. Start forward/Start reverse

① The first selected direction has the highest priority.
② When the DIN1 contact opens the direction of rotation starts the change.
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 7 below.

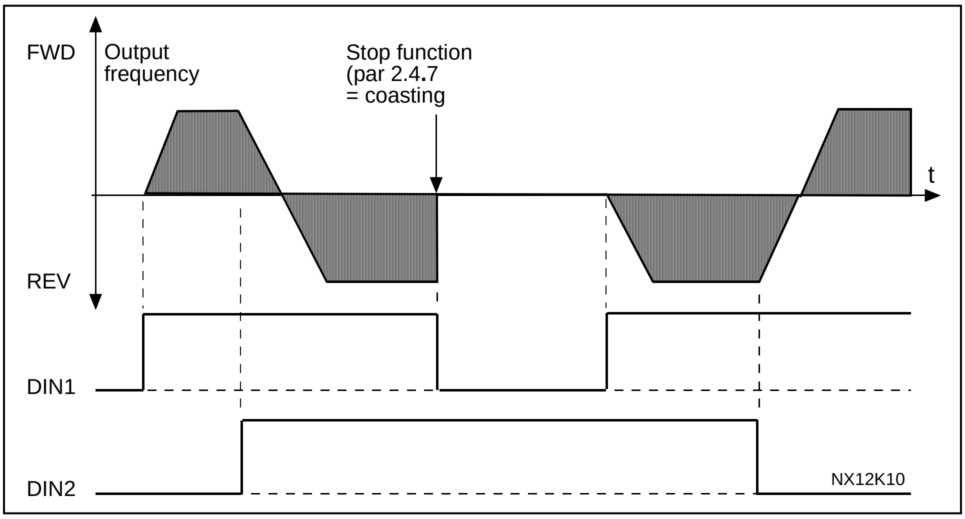


Figure 7. Start, Stop, Reverse

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 8.

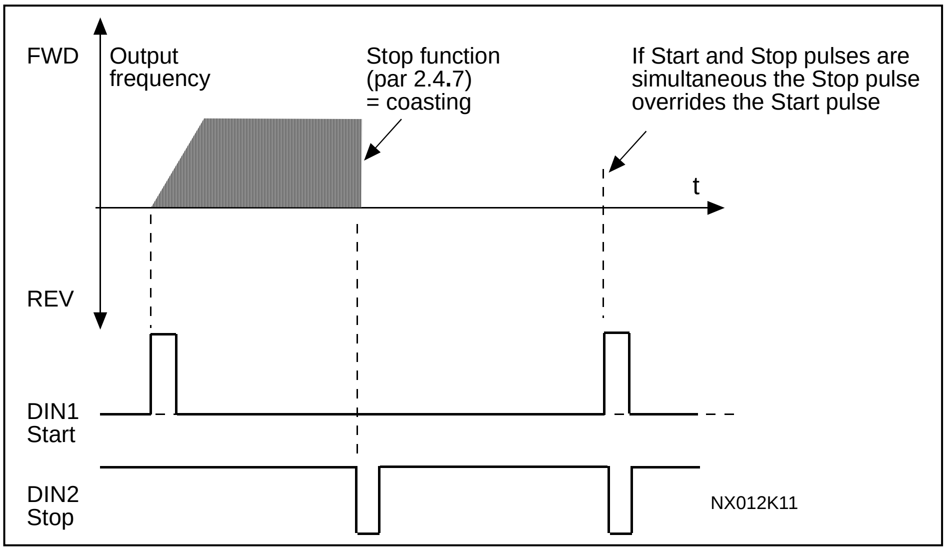


Figure 8. Start pulse/ Stop pulse.

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 *DIN3 function*

1	External fault, closing contact		=	Fault is shown and motor is stopped when the input is active.
2	External fault, opening contact		=	Fault is shown and motor is stopped when the input is not active.
3	Run enable,	contact open	=	Motor start disabled and the motor is stopped
		contact closed	=	Motor start enabled
4	Acc./Dec time select.	contact open	=	Acceleration/deceleration time 1 selected
		contact closed	=	Acceleration/deceleration time 2 selected

5 Closing contact: Force control place to I/O terminal
6 Closing contact: Force control place to keypad
7 Closing contact: Force control place to fieldbus

When the control place is forced to change the values of Start/Stop, Direction and Reference valid in the respective control place are used (reference according to parameters 2.1.11, 2.1.12 and 2.1.13).
Note: The value of parameter 3.1 Keypad Control Place does not change.
When DIN3 opens the control place is selected according to parameter 3.1.

8	Reverse	contact open	=	Forward
		contact closed	=	Reverse

Can be used for reversing if parameter 2.2.1 has value 3

9	Synchronization	contact open	=	No synchronization
		contact closed	=	Synchronization selected

2.2.3 *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.

2.2.4
2.2.5 *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.

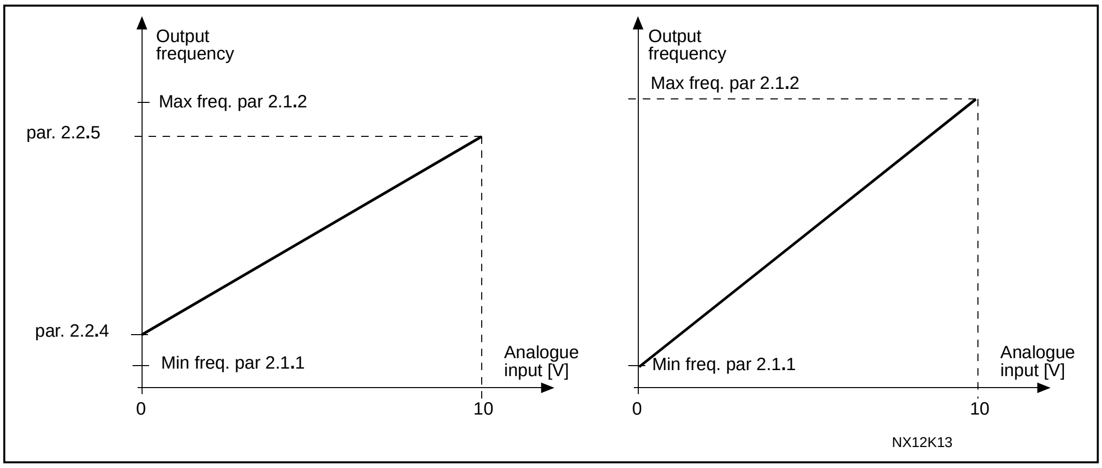


Figure 9. ***Left****: Reference scaling;* ***Right****: No scaling used (par. 2.2.5 = 0).*

2.2.6 Reference inversion

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

0 No inversion
1 Reference inverted

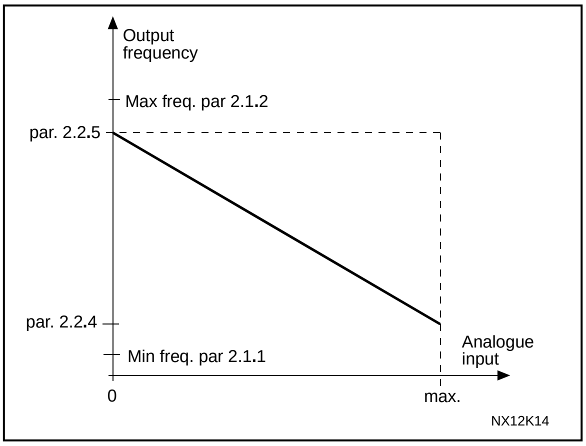


Figure 10. Reference invert.

2.2.7 Reference filter time

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

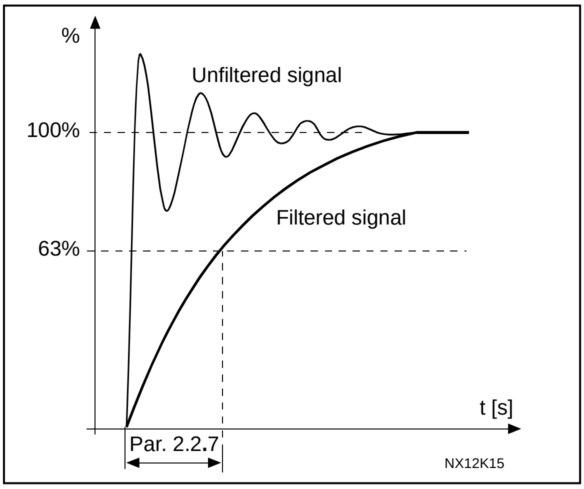


Figure 11. Reference filtering

4.3 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.

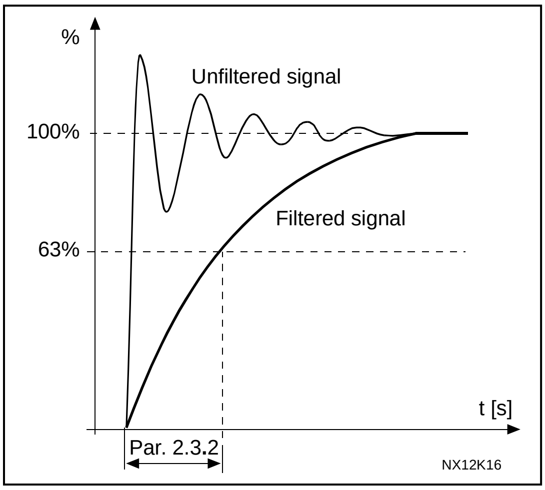


Figure 12. Analogue output filtering

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.

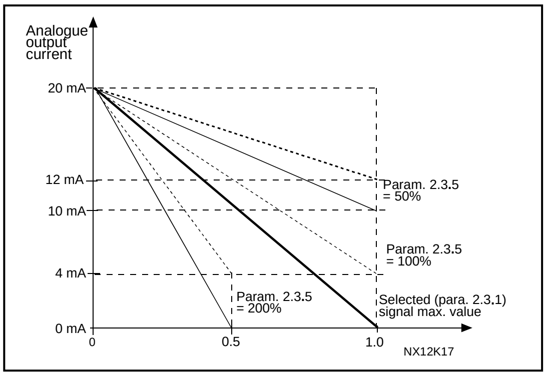


Figure 13. Analogue output invert

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 14).

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

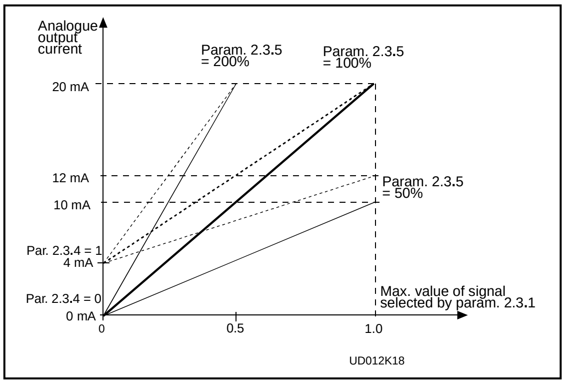


Figure 14. Analogue output scaling

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	Over voltage or over current 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 or warning	
16 = FB Digital input 1	
17 = Synchronization alarm	Difference counter pulses are outside hysteresis (P2.10.13)

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.

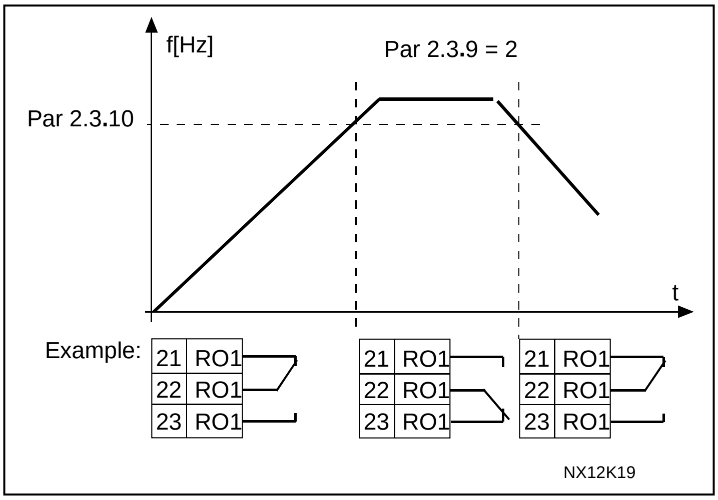


Figure 15. Output frequency supervision

4.4 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).

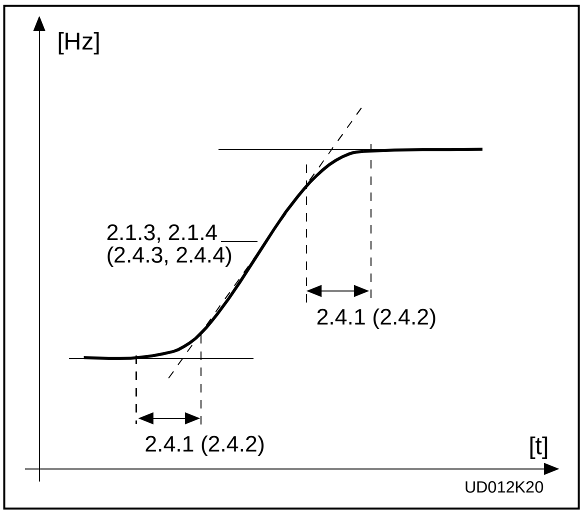


Figure 16. Acceleration/Deceleration (S-shaped)

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

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 *DC-braking current*

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

2.4.9 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

<u>Par. 2.4.7 = 0; Stop function = Coasting:</u>

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 2.4.9 determines the braking time. When the frequency is ≤10% of the nominal, the braking time is 10% of the set value of parameter 2.4.9.

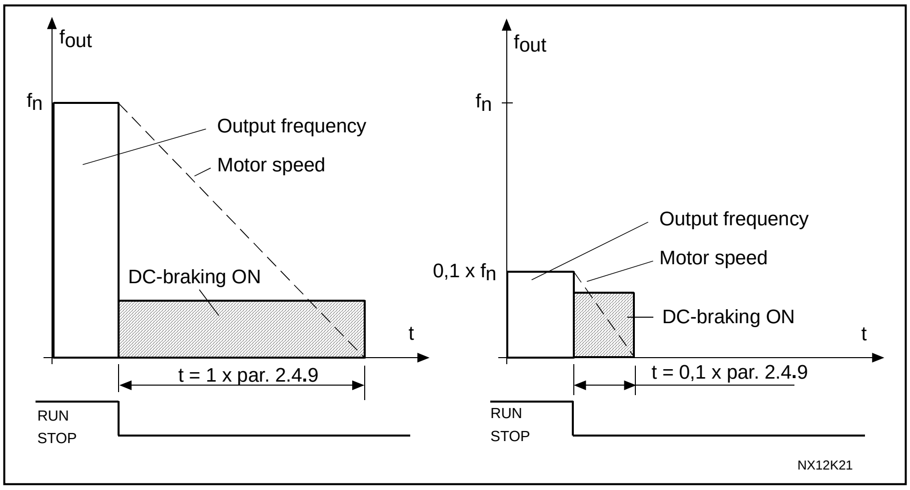


Figure 17. DC-braking time when Stop mode = Coasting.

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 2.4.10, where the DC-braking starts.

The braking time is defined with parameter 2.4.9. If high inertia exists, it is recommended to use an external braking resistor for faster deceleration. See Figure 18.

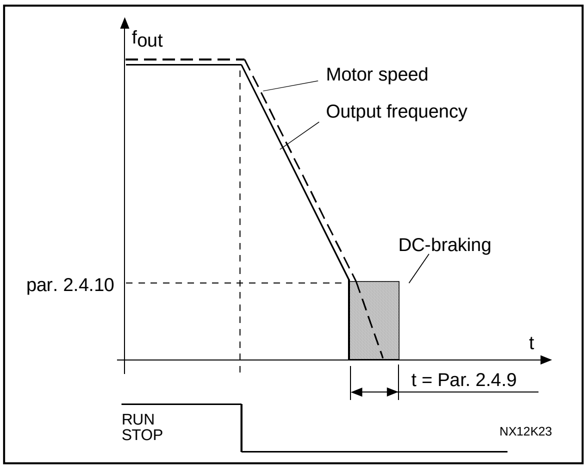


Figure 18. DC-braking time when Stop mode = Ramp

2.4.10 DC-braking frequency at stop

The output frequency at which the DC-braking is applied. See Figure 18.

2.4.11 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.

2.4.12 Flux brake

Instead of DC braking, flux braking is a useful form of braking with motors ≤15kW.
When braking is needed, the frequency is reduced and the flux in the motor is increased, which in turn increases the motor's capability to brake. Unlike DC braking, the motor speed remains controlled during braking.

The flux braking can be set ON or OFF.

0 = Flux braking OFF
1 = Flux braking ON

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

2.4.13 Flux braking current

Defines the flux braking current value. This value can be set between $0.4*I_H$ and the Current limit.

4.5 Prohibit frequencies

2.5.1, 2.5.2 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 19.

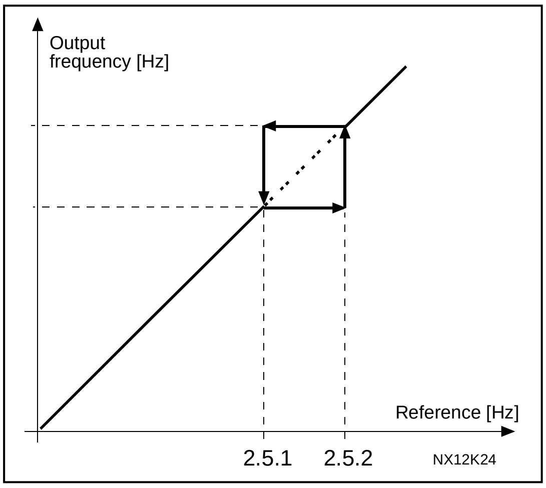


Figure 19. Prohibit frequency area setting.

2.5.3 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.

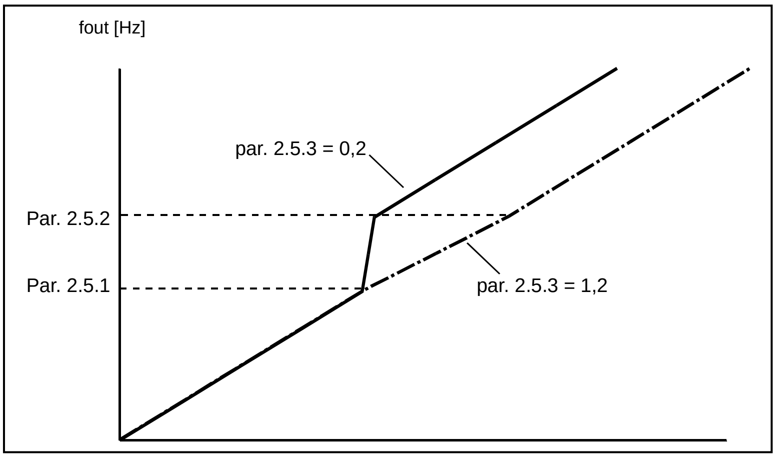


Figure 20. Ramp speed scaling between prohibit frequencies

4.6 Motor control

2.6.1 Motor control mode

NXS:

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	The I/O terminal and keypad references are torque references and the frequency converter controls the motor torque (accuracy ±3%).

Additionally for NXP:

3	Speed crtl (closed loop)	The I/O terminal and keypad references are speed references and the frequency converter controls the motor torque (accuracy ±0.01%).
4	Torque crtl (closed loop)	The I/O terminal and keypad references are torque references and the frequency converter controls the motor torque (accuracy ±1.5%).
5	Frequency control (advanced open loop)	
6	Speed control (advanced open loop)	

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: The voltage of the motor changes following a squared curve form
1 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.

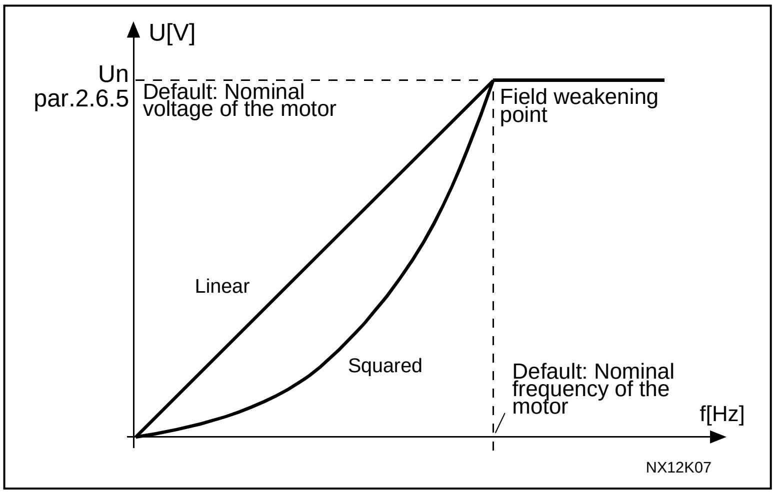


Figure 21. Linear and squared change of motor voltage

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

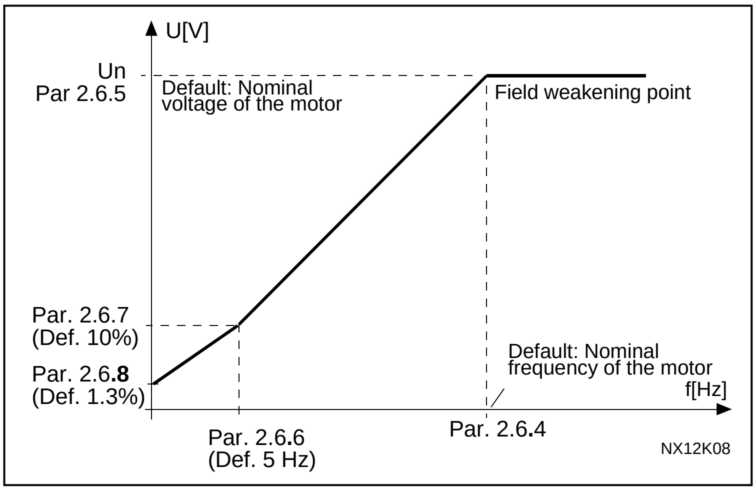


Figure 22. Programmable U/f curve

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 22.

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 22.

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 22.

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:

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

Table 16. Size-dependent switching frequencies

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

4.7 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 under voltage 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 under voltage limits see Vacon NX User's Manual, Table 4-4.

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 over current 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 Vacon NX User's Manual, Chapter 7.3.1.

⚠	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 23.

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.

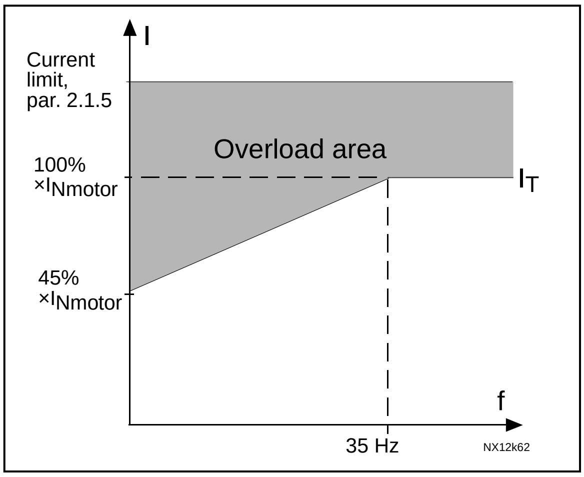


Figure 23. Motor thermal current I_T curve

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 24.

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%.

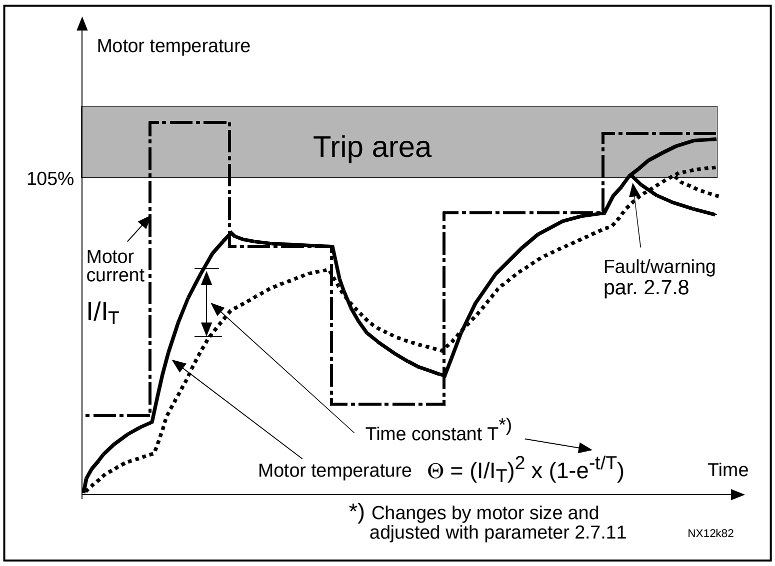


Figure 24. Motor temperature calculation

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 over current 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 0.1...I_{nMotor}*2. For a stall stage to occur, the current must have exceeded this limit. See Figure 25. The software does not allow entering a greater value than I_{nMotor}*2. If parameter 2.1.9 Nominal current of motor is changed, this parameter is automatically restored to the default value (I_L).

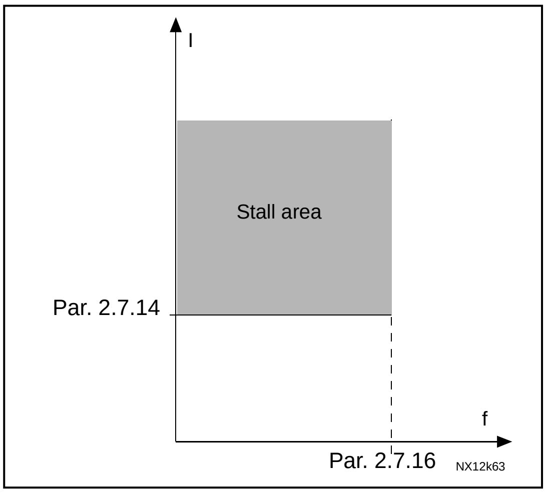


Figure 25. Stall characteristics settings

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).

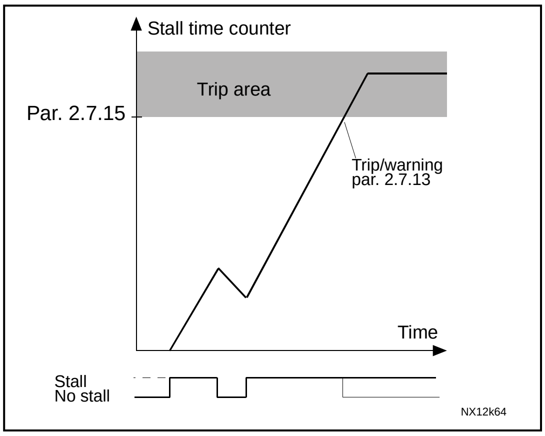


Figure 26. Stall time count

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, Under load protection:

General

The purpose of the motor under load protection is to ensure that there is load on the motor when the drive is running. If the motor loses its load there might be a problem in the process, e.g. a broken belt or a dry pump.
Motor under load protection can be adjusted by setting the under load curve with parameters 2.7.18 (Field weakening area load) and 2.7.19 (Zero frequency load), see below. The under load curve is a squared curve set between the zero frequency and the field weakening point. The protection is not active below 5Hz (the under load time counter is stopped).

The torque values for setting the under load curve are set in percentage which refers to the nominal torque of the motor. The motor's name plate data, parameter motor nominal current and the drive's nominal current I_H are used to find the scaling ratio for the internal torque value. If other than nominal motor is used with the drive, the accuracy of the torque calculation decreases.

2.7.17 Under load 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 under load time counter to zero.

2.7.18 Under load 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 27.

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

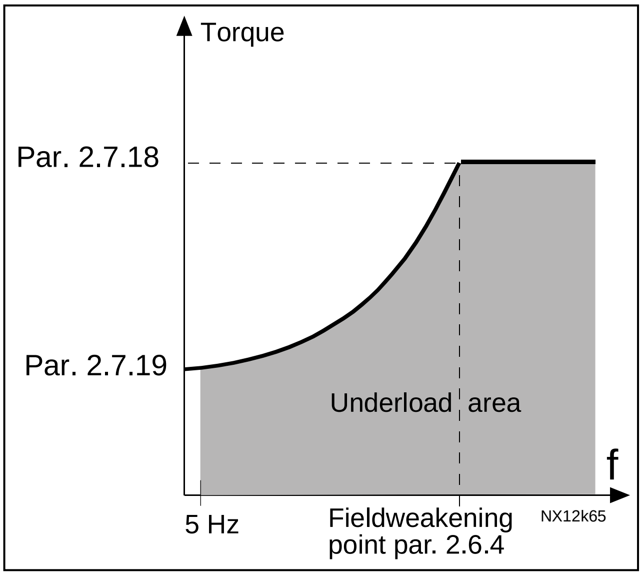


Figure 27. Setting of minimum load

2.7.19 *Under load protection, zero frequency load*

The torque limit can be set between 5.0—150.0 % x T_{nMotor}.
This parameter gives value for the minimum torque allowed with zero frequency. See Figure 27.

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 *Under load time*

This time can be set between 2.0 and 600.0 s.
This is the maximum time allowed for an under load state to exist. An internal up/down counter counts the accumulated under load time. If the under load counter value goes above this limit the protection will cause a trip according to parameter 2.7.17). If the drive is stopped the under load counter is reset to zero. See Figure 28.

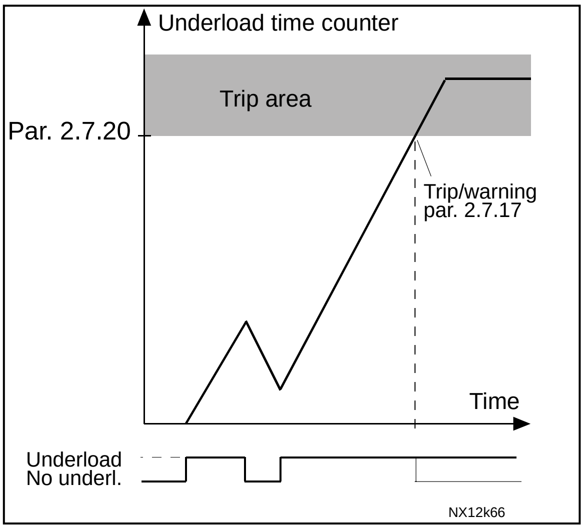


Figure 28. Underload time counter function

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.

4.8 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.

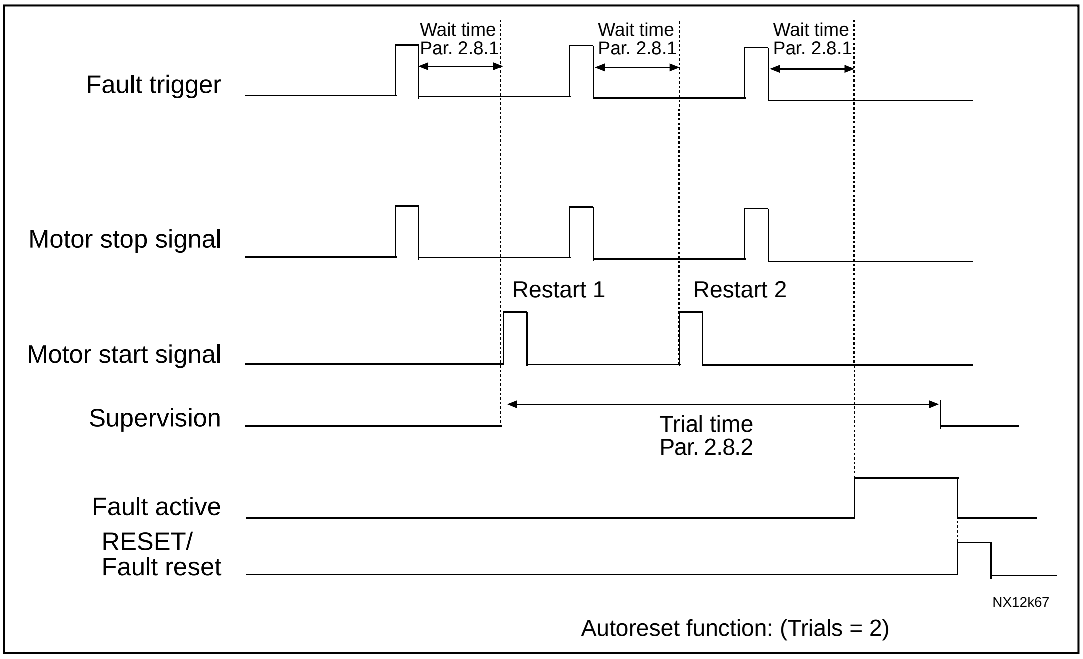


Figure 29. Example of Automatic restart with two restarts.

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 under voltage fault trip*

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

0	=	No automatic restart after under voltage fault trip
>0	=	Number of automatic restarts after under voltage 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 over voltage trip*

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

0	=	No automatic restart after over voltage fault trip
>0	=	Number of automatic restarts after over voltage 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 over current 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 after an over current trip.

0	=	No automatic restart after over current fault trip
>0	=	Number of automatic restarts after over current 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 after temperature fault trip.

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 after an external fault trip.

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

4.9 Closed loop parameters

Select the Closed loop control mode by setting value between 3 and 6 for parameter 2.6.1.
Closed loop control mode (see page 35) is used when enhanced performance near zero speed and better static speed accuracy with higher speeds are needed. Closed loop control mode is based on "rotor flux oriented current vector control". With this controlling principle, the phase currents are divided into a torque producing current portion and a magnetizing current portion. Thus, the squirrel cage induction machine can be controlled in a fashion of a separately excited DC motor.

Note: These parameters can be used with Vacon NXP drive only.

2.9.1 Magnetizing current

Set here the motor magnetizing current (no-load current).

2.9.2 Speed control P gain

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

2.9.3 Speed control I time

Sets the integral time constant for the speed controller. Increasing the I-time increases stability but lengthens the speed response time.

2.9.4 Zero speed time at start

After giving the start command the drive will remain at zero speed for the time defined by this parameter. The ramp will be released to follow the set frequency/speed reference after this time has elapsed from the instant where the command is given.

2.9.5 Zero speed time at stop

The drive will remain at zero speed with controllers active for the time defined by this parameter after reaching the zero speed when a stop command is given. This parameter has no effect if the selected stop function (par. 2.4.7) is *Coasting*.

2.9.6 Current control P gain

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.

2.9.7 Encoder filter time

Sets the filter time constant for speed measurement.
The parameter can be used to eliminate encoder signal noise. Too high a filter time reduces speed control stability.

2.9.8 Slip adjust

The motor name plate speed is used to calculate the nominal slip. This value is used to adjust the voltage of motor when loaded. The name plate speed is sometimes a little inaccurate and this parameter can therefore be used to trim the slip. Reducing the slip adjust value increases the motor voltage when the motor is loaded.

2.9.9 Load drooping

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

2.9.10 Startup torque

Choose here the startup torque.
Torque Memory is used in crane applications. Startup Torque FWD/REV can be used in other applications to help the speed controller.

0 = Not Used
1 = TorqMemory

2.9.11.1 Minimum current

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

2.9.11.2 Flux reference

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

2.9.11.3 Stray flux current

Stray reactive power increase with current increase.

2.9.11.4 Zero speed current

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

4.10 Easy synchronization parameters

2.10.1 Factor 1

Multiplier for reference.

Ratio	Master (F2)		Slave (F1)	Explanation
2:1	1000	:	500	Master moves with double speed
1:2	500	:	1000	Slave moves with double speed
1,05:1	1050	:	1000	Fine speed adaption

2.10.2 Factor 2

Divider for reference. Normally 0,1 ≤ F1:F2 ≤ 10.

2.10.3 Bias for the reference signal
2.10.4 Gain for the reference signal

Parameters P2.10.3 and P2.10.4 are for the speed trim between the master and the slave drive. The speed difference has to be under ± 1...3%.

2.10.5 Difference angle for mode 0

Angle synchronization. Working angle 60° – 180° and accuracy can be ±15°.

In the angle synchronization mode the shafts of master and slave are running in difference angle.

For example, if parameter 2.10.5 = 120° the shafts difference angle can be 120° ± 15°

2.10.6 Hysteresis value for speed trim 1

See Figure 5 on page 7.

2.10.7 Hysteresis value for speed trim 2

See Figure 5 on page 7.

2.10.8 Hysteresis value for speed trim 3

See Figure 5 on page 7.

Parameter P2.10.6 < P2.10.7 < P2.10.8

2.10.9 Speed trim 1

Step 0.1% of the speed reference.

2.10.10 Speed trim 2

Step 0.1% of the speed reference.

2.10.11 Speed trim 3

Step 0.1% of the speed reference.

Parameter P2.10.9 < P2.10.10 < P2.10.11 ≈ 1:2:10

2.10.12 Mode selector

0 = Angle synchronization. Speed ratio have to be (F1:F2) 1000:1000.
1 = Ratio synchronization. No drift during the time.
2 = Speed ratio run. Drifting during time.

2.10.13 Synchronization alarm

Hysteresis for the synchronization alarm on digital output.

2.10.14 Master pulses per revolution
2.10.15 Slave pulses per revolution

If the shafts are rotating very slowly, it is possible to use e.g 10 pulses/revolution.

2.10.16 Smoother function selection

Moving average value (four points) for the difference angle measurements.
0 = Direct value
1 = Moving average value

$$angle = \frac{a_n + a_{n-1} + a_{n-2} + a_{n-3}}{4}$$

2.10.17 Synchronization reference selection

0 = Voltage input
1 = Current input

Master parameters
Analog output function:
P2.3.1 = 3 Motor speed or
P2.3.1 = 2 Frequency
P2.3.2 = 0 No filtering
P2.3.4 = 0 0mA

2.10.18 Difference angle filtration

Low pass filtering of the difference angle
0 = No filtering
1 = Low pass filter

2.10.19 Difference angle filter time

Defines the time constant for the first order low pass filter.

4.11 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.

5. CONTROL SIGNAL LOGIC IN EASY SYNCHRONIZATION APPLICATION

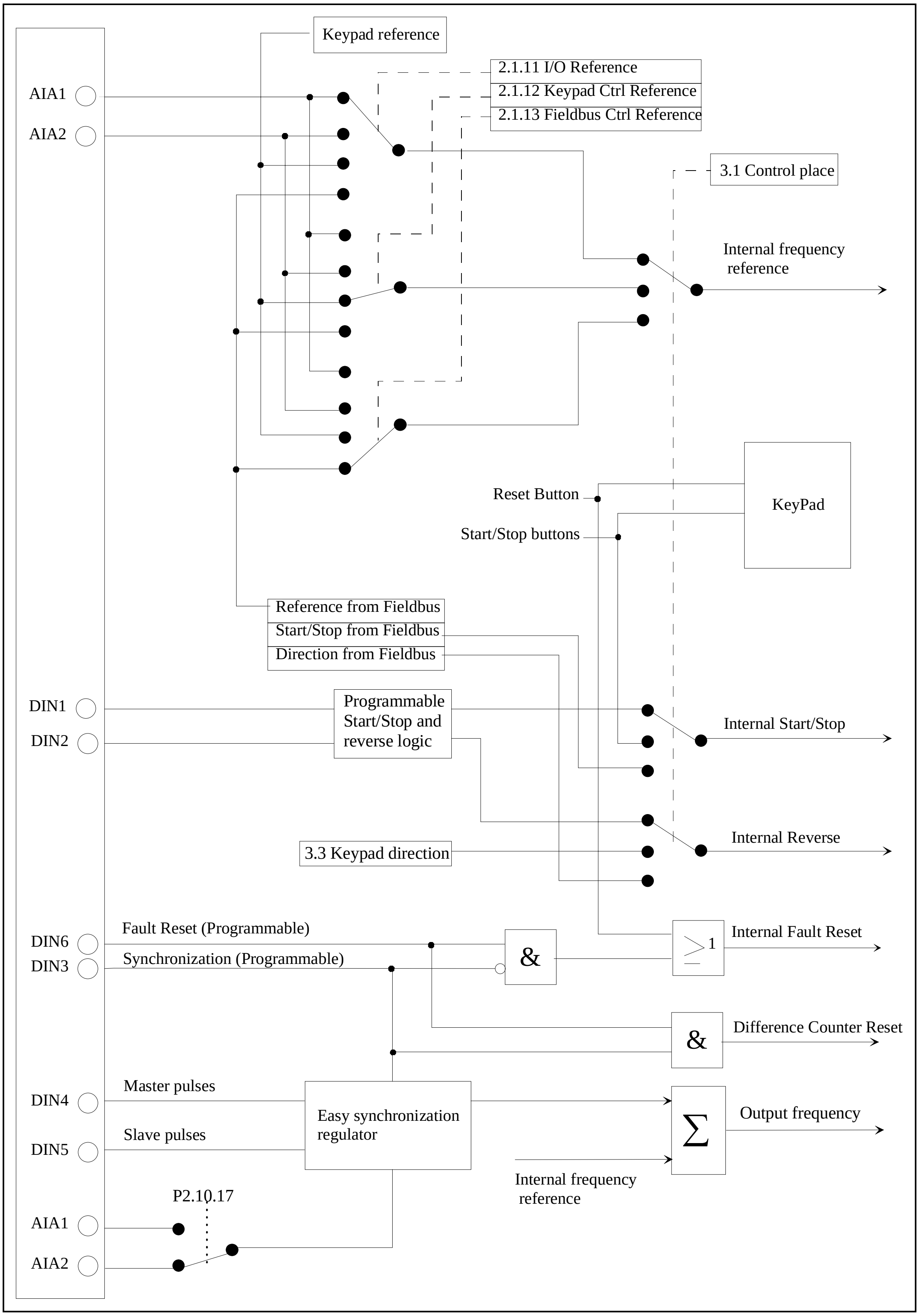


Figure 30. Control signal logic of the Easy Synchronization Application

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