vacon

DRIVEN BY DRIVES

# USER'S MANUAL

## NXL FREQUENCY CONVERTERS

# BRAKE CONTROL APPLICATION

## ALFIFF30

# VACON BRAKE CONTROL APPLICATION (SOFTWARE ALFIFF30) VER. 2.02 OR HIGHER

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# Brake Control Application

## 1. INTRODUCTION

The Brake Control Application is typically used in applications where mechanical brake control is needed.
The frequency reference can be selected from the analogue inputs, fieldbus, keypad, preset speeds, motor potentiometer or binary coded speed references.
The option board **OPT-AA** is recommended to be able to use the binary speed references. The Exp. digital output D01 and Exp. relay output RO1 is also on this board.

- Digital inputs DIN2, DIN3, (DIN4) and optional digital inputs DIE1, DIE2, DIE3 are freely programmable.
- Internal and optional digital/relay and analogue outputs are freely programmable.
- Analogue input 1 can be programmed as current input, voltage input or **digital input DIN4.**

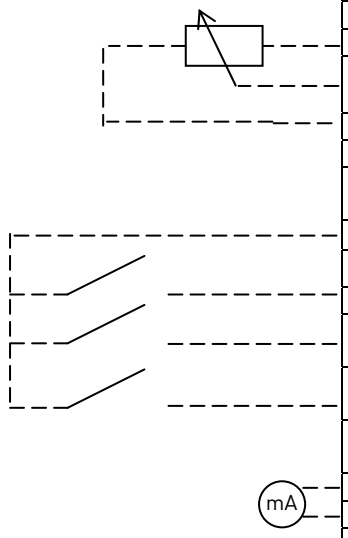
**NOTE! If the analogue input 1 has been programmed as DIN4 with parameter 2.2.6 (AI1 Signal Range), check that the jumper selections () are correct.**

Additional functions:

- Programmable Start/Stop and Reverse signal logic (DIN2 Function)
- 2 Preset speeds (overrides other I/O reference when activated)
- Analogue input range selection, signal scaling, inversion and filtering
- Frequency limit supervision
- DC-brake at start and stop
- S-shape ramp programming
- Mechanical brake control related parameters
- Binary coded speed references (optional digital inputs DIE1, DIE2, DIE3)
- Prohibit frequency area
- Programmable U/f curve and U/f optimisation
- Adjustable switching frequency
- Autorestart function after fault
- Protections and supervisions (all fully programmable; off, warning, fault):
    - Current input fault
    - External fault
    - Output phase
    - Under voltage
    - Earth fault
    - Motor thermal, stall and underload protection
    - Thermistor
    - Fieldbus communication
    - Option board

## 2. CONTROL I/O

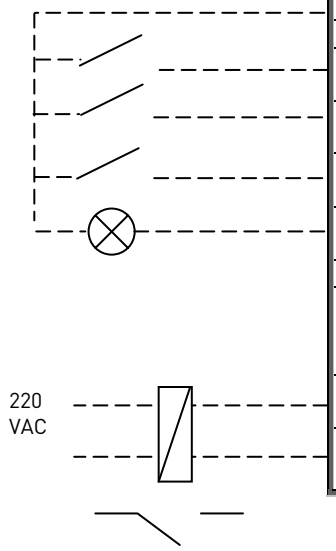
Reference potentiometer




| 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 Can be programmed as DIN4 |
| 3 | AI1- | I/O Ground | Ground for reference and controls |
| 4 | AI2+ | Analogue input, voltage range 0—10V DC, or current range 0/4—20mA | Current input frequency reference |
| 5 | AI2- /GND | | |
| 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 | Contact closed = start forward |
| 9 | DIN2 | Start reverse (programmable) | Contact closed = start reverse |
| 10 | DIN3 | Multi-step speed selection 1 (programmable) | Contact closed = multi-step speed |
| 11 | GND | I/O ground | Ground for reference and controls |
| 18 | AO1+ | Output frequency Analogue output | Programmable Range 0—20 mA/$R_L$, max. 500Ω |
| 19 | AO1- | | |
| A | RS 485 | Serial bus | Differential receiver/transmitter |
| B | RS 485 | Serial bus | Differential receiver/transmitter |
| 30 | +24V | 24V aux. input voltage | Control power supply backup |
| 21 | RO1 | Relay output 1 FAULT | Programmable |
| 22 | RO1 | | |
| 23 | RO1 | | |

*Table 1. Brake Control application default I/O configuration.*

### I/O terminals on option board OPT-AA




| Terminal | | Signal in application | Description |
|---|---|---|---|
| X3 | | | |
| 1 | +24V | Control voltage output | Voltage for switches etc, max. 150 mA |
| 2 | GND | I/O ground | Ground for reference and controls |
| 3 | DIN1 | DIE1 | Binary speed reference selection (programmable) |
| 4 | DIN2 | DIE2 | Binary speed reference selection (programmable) |
| 5 | DIN3 | DIE3 | Binary speed reference selection (programmable) |
| 6 | DO1 | Exp. D01, Ready | Open collector output, 50mA/48V, programmable |
| X5 | | | |
| 24 | RO1 | Exp R01, Mechanical brake | Relay output 1 (NO), function programmable Switching capacity: 24VDC/8A 250VAC/8A 125VDC/0,4A |
| 25 | RO1 | | |
| 26 | RO1 | | |

*Table 2. I/O terminals of option board NXOPTAA*

**Note!** The +24 V control voltage terminal can also be used to power the control module (but not the power module).

# 3. 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 16 to 48.

**Column explanations:**

Code = Location indication on the keypad; Shows the operator the present param. number
Parameter = Name of parameter
Min = Minimum value of parameter
Max = Maximum value of parameter
Unit = Unit of parameter value; Given if available
Default = Value preset by factory
Cust = Customer's own setting
ID = ID number of the parameter (used with PC tools)
= On the parameter code: parameter value can only be changed after the FC 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 NXL User's Manual, Chapter 7.3.1 for more information.

| Code | Parameter | Unit | ID | Description |
|---|---|---|---|---|
| V1.1 | Output frequency | Hz | 1 | Frequency to the motor |
| V1.2 | Frequency reference | Hz | 25 | |
| V1.3 | Motor speed | rpm | 2 | Calculated motor speed |
| V1.4 | Motor current | A | 3 | Measured motor current |
| V1.5 | Motor torque | % | 4 | Calculated actual torque/nom. torque of the motor |
| V1.6 | Motor power | % | 5 | Calculated actual power/nom. power of the motor |
| V1.7 | Motor voltage | V | 6 | Calculated motor voltage |
| V1.8 | DC-link voltage | V | 7 | Measured DC-link voltage |
| V1.9 | Unit temperature | ºC | 8 | Heat sink temperature |
| V1.10 | Analogue input 1 | | 13 | AI1 |
| V1.11 | Analogue input 2 | | 14 | AI2 |
| V1.12 | Analogue output current | mA | 26 | AO1 |
| V1.13 | Analogue output current 1, expander board | mA | 31 | |
| V1.14 | Analogue output current 2, expander board | mA | 32 | |
| V1.15 | DIN1, DIN2, DIN3 | | 15 | Digital input statuses |
| V1.16 | DIE1, DIE2, DIE3 | | 33 | I/O expander board: Digital input statuses |
| V1.17 | RO1 | | 34 | Relay output 1 status |
| V1.18 | ROE1, ROE2, ROE3 | | 35 | I/O exp. board: Relay output statuses |
| V1.19 | DOE 1 | | 36 | I/O exp. board: Digital output 1 status |

*Table 3. Monitoring values*

## 3.2 Basic parameters (Control keypad: Menu P2 → P2.1)

| 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 $I_L$ | 1,5 x $I_L$ | A | $I_L$ | | 107 | **NOTE**: Formulas apply approximately for frequency converters up to MF3. For greater sizes, consult the factory. |
| P2.1.6 | Nominal voltage of the motor | 180 | 690 | V | NXL2:230v<br>NXL5:400v | | 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 | 0,3 x $I_L$ | 1,5 x $I_L$ | A | $I_L$ | | 113 | Check the rating plate of the motor |
| P2.1.10 | Motor cosφ | 0,30 | 1,00 | | 0,85 | | 120 | Check the rating plate of the motor |
| P2.1.11 | Start function | 0 | 1 | | 0 | | 505 | **0**=Ramp<br>**1**=Flying start |
| P2.1.12 | Stop function | 0 | 1 | | 1 | | 506 | **0**=Coasting<br>**1**=Ramp |
| P2.1.13 | U/f optimisation | 0 | 1 | | 0 | | 109 | **0**=Not used<br>**1**=Automatic torque boost |
| P2.1.14 | I/O reference | 0 | 5 | | 0 | | 117 | **0**=AI1<br>**1**=AI2<br>**2**=Keypad reference<br>**3**=Fieldbus reference (FBSpeedReference)<br>**4**=Motor potentiometer<br>**5**=Binary coded inputs |
| P2.1.15 | AI2 signal range | 1 | 4 | | 2 | | 390 | Not used if AI2 Custom min <> 0% or AI2 custom max. <> 100%<br>**1**=0—20 mA<br>**2**=4—20 mA<br>**3**=0V – 10V<br>**4**=2V – 10V |
| P2.1.16 | Analogue output function | 0 | 12 | | 1 | | 307 | **0**=Not used<br>**1**=Output freq. (0—$f_{max}$)<br>**2**=Freq. reference (0—$f_{max}$)<br>**3**=Motor speed (0—Motor nominal speed)<br>**4**=Output current (0—$I_{nMotor}$)<br>**5**=Motor torque (0—$T_{nMotor}$)<br>**6**=Motor power (0—$P_{nMotor}$)<br>**7**=Mot. voltage (0—$U_{nMotor}$)<br>**8**=DC-link volt (0—$U_{nMotor}$)<br>**9**=PI controller ref. value<br>**10**=PI contr. act. value 1<br>**11**=PI contr. error value<br>**12**=PI controller output |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| P2.1.17 | DIN2 function | 0 | 10 | | 1 | | 319 | **0**=Not used<br>**1**=Start Reverse (DIN1=Start forward)<br>**2**=Reverse (DIN1=Start)<br>**3**=Stop pulse (DIN1=Start pulse)<br>**4**=External fault, cc<br>**5**=External fault, oc<br>**6**=Run enable<br>**7**=Preset speed 2<br>**8**= Motor pot. UP (cc)<br>**9**= Not used<br>**10**= Brake Open Enable |
| P2.1.18 | DIN3 function | 0 | 11 | | 6 | | 301 | **0**=Not used<br>**1**=Reverse<br>**2**=External fault, cc<br>**3**=External fault, oc<br>**4**=Fault reset<br>**5**=Run enable<br>**6**=Preset speed 1<br>**7**=Preset speed 2<br>**8**=DC-braking command<br>**9**=Motor pot. UP (cc)<br>**10**=Not used<br>**11**=Brake Open Enable |
| P2.1.19 | Preset speed 1 | 0,00 | Par. 2.1.2 | Hz | 10,00 | | 105 | |
| P2.1.20 | Preset speed 2 | 0,00 | Par. 2.1.2 | Hz | 50,00 | | 106 | |
| P2.1.21 | Automatic restart | 0 | 1 | | 0 | | 731 | **0**=Not used<br>**1**=Used |
| P2.1.22 | Parameter conceal | 0 | 1 | | 0 | | 115 | **0**=All parameters and menus visible<br>**1**=Only group P2.1 and menus M1 to H5 visible |

*Table 4. Basic parameters P2.1*

CP= control place

## 3.3 Input signals (Control keypad: Menu P2 → P2.2)

| Code | Parameter | Min | Max | Unit | Default | Cust | ID | Note |
|---|---|---|---|---|---|---|---|---|
| P2.2.1 | Expander board DIE1 function | 0 | 12 | | 12 | | 368 | 0=Not used<br>1=Reverse<br>2=External fault, cc<br>3=External fault, oc<br>4=Fault reset<br>5=Run enable<br>6=Preset speed 1<br>7=Preset speed 2<br>8=DC-braking command<br>9=Motor pot. UP (cc)<br>10=Not used<br>11=Brake open enable<br>12=Binary Input |
| P2.2.2 | Expander board DIE2 function | 0 | 12 | | 12 | | 330 | As par. 2.2.1 |
| P2.2.3 | Expander board DIE3 function | 0 | 12 | | 12 | | 369 | As par. 2.2.1 |
| P2.2.4 | DIN4 function (AI1) | 0 | 12 | | 2 | | 499 | Used if P2.2.6 = 0<br>Selections as in par.2.2.3 |
| P2.2.5 | AI1 signal selection | 0 | | | 10 | | 377 | 10=AI1 (1=Local,<br>0=input 1)<br>11=AI2 (1=Local,<br>1= input 2)<br>20=Exp. AI1<br>(2=exp.board<br>0=input 1)<br>21=Exp AI2<br>(2=exp.board<br>1=input 2) |
| P2.2.6 | AI1 signal range | 1 | 4 | | 3 | | 379 | 0=Digital input 4<br>1=0mA – 20mA (MF4-->)<br>2=4mA – 20mA (MF4-->)<br>3=0V – 10V<br>4=2V – 10V<br>Not used if AI2 Custom min > 0% or AI2 custom max. < 100%<br>**Note!** See NXL User's manual, chapter 7.3.6: **AI1 mode** |
| P2.2.7 | AI1 custom minimum setting | 0,00 | 100,00 | % | 0,00 | | 380 | |
| P2.2.8 | AI1 custom maximum setting | 0,00 | 100,00 | % | 100,00 | | 381 | |
| P2.2.9 | AI1 inversion | 0 | 1 | | 0 | | 387 | 0=Not inverted<br>1=Inverted |
| P2.2.10 | AI1 filter time | 0,00 | 10,00 | s | 0,10 | | 378 | 0=No filtering |
| P2.2.11 | AI2 signal selection | 0 | | | 11 | | 388 | As par. 2.2.5 |
| P2.2.12 | AI2 signal range | 1 | 4 | | 2 | | 390 | Not used if AI2 Custom min <> 0% or AI2 custom max. <> 100%<br>1=0—20 mA<br>2=4—20 mA<br>3=0V – 10V<br>4=2V – 10V |
| P2.2.13 | AI2 custom minimum setting | 0,00 | 100,00 | % | 0,00 | | 391 | |
| P2.2.14 | AI2 custom maximum setting | 0,00 | 100,00 | % | 100,00 | | 392 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| P2.2.15 | AI2 inversion | 0 | 1 | | 0 | | 398 | **0**=Not inverted<br>**1**=Inverted |
| P2.2.16 | AI2 filter time | 0,00 | 10,00 | s | 0,10 | | 389 | **0**=No filtering |
| P2.2.17 | Reserved | | | | | | | Reserved for future use |
| P2.2.18 | Reference scaling minimum value | 0,00 | P2.2.19 | | 0,00 | | 344 | |
| P2.2.19 | Reference scaling maximum value | P2.2.18 | 320,00 | | 0,00 | | 345 | |
| P2.2.20 | Keypad control reference selection | 0 | 5 | | 2 | | 121 | **0**=AI1<br>**1**=AI2<br>**2**=Keypad reference<br>**3**=Fieldbus reference (FBSpeedreference)<br>**4**=Motor potentiometer<br>**5**=Binary coded inputs |
| P2.2.21 | Fieldbus control reference selection | 0 | 5 | | 3 | | 122 | See above |

*Table 5. Input signals, P2.2*

CP=control place
cc=closing contact
oc=opening contact

## 3.4 Output signals (Control keypad: Menu P2 → P2.3)

| Code | Parameter | Min | Max | Unit | Default | Cust | ID | Note |
|---|---|---|---|---|---|---|---|---|
| P2.3.1 | Relay output 1 function | 0 | 16 | | 3 | | 313 | 0=Not used<br>1=Ready<br>2=Run<br>3=Fault<br>4=Fault inverted<br>5=FC overheat warning<br>6=Ext. fault or warning<br>7=Ref. fault or warning<br>8=Warning<br>9=Reversed<br>10=Preset speed<br>11=At speed<br>12=Mot. regulator active<br>13=OP freq. limit superv.1<br>14=Control place: IO<br>15=Thermistor fault/ warning<br>16=Mech. Brake off control |
| P2.3.2 | Expander board relay output 1 function | 0 | 16 | | 16 | | 314 | As parameter 2.3.1 |
| P2.3.3 | Expander board relay output 2 function | 0 | 16 | | 2 | | 317 | As parameter 2.3.1 |
| P2.3.4 | Expander board digital output 1 function | 0 | 16 | | 1 | | 312 | As parameter 2.3.1 |
| P2.3.5 | Analogue output function | 0 | 12 | | 1 | | 307 | See par. 2.1.16 |
| P2.3.6 | Analogue output filter time | 0,00 | 10,00 | s | 1,00 | | 308 | 0=No filtering |
| P2.3.7 | Analogue output inversion | 0 | 1 | | 0 | | 309 | 0=Not inverted<br>1=Inverted |
| P2.3.8 | Analogue output minimum | 0 | 1 | | 0 | | 310 | 0=0 mA<br>1=4 mA |
| P2.3.9 | Analogue output scale | 10 | 1000 | % | 100 | | 311 | |
| P2.3.10 | Expander board analogue output 1 function | 0 | 12 | | 0 | | 472 | As parameter 2.1.16 |
| P2.3.11 | Expander board analogue output 2 function | 0 | 12 | | 0 | | 479 | As parameter 2.1.16 |
| P2.3.12 | Output frequency limit 1 supervision | 0 | 2 | | 0 | | 315 | 0=No limit<br>1=Low limit supervision<br>2=High limit supervision |
| P2.3.13 | Output frequency limit 1; Supervised value | 0,00 | Par. 2.1.2 | Hz | 0,00 | | 316 | |

*Table 6. Output signals, G2.3*

## 3.5 Drive control parameters (Control keypad: Menu P2 → P2.4)

| 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<br>**>0**=S-curve ramp time |
| P2.4.2 | Brake chopper | 0 | 3 | | 0 | | 504 | **0**=Disabled<br>**1**=Used in Run state<br>**3**=Used in Run and Stop state |
| P2.4.3 | DC braking current | 0,15 x $I_n$ | 1,5 x $I_n$ | A | Varies | | 507 | |
| P2.4.4 | DC braking time at stop | 0,00 | 600,00 | s | 0,50 | | 508 | **0**=DC brake is off at stop |
| P2.4.5 | Frequency to start DC braking during ramp stop | 0,10 | 10,00 | Hz | 1,50 | | 515 | |
| P2.4.6 | DC braking time at start | 0,00 | 600,00 | s | 0,50 | | 516 | **0**=DC brake is off at start |
| P2.4.7 | Flux brake | 0 | 1 | | 0 | | 520 | **0**=Off<br>**1**=On |
| P2.4.8 | Flux braking current | 0,0 | Varies | A | 0,0 | | 519 | |

*Table 7. Drive control parameters, P2.4*

## 3.6 Prohibit frequency parameters (Control keypad: Menu P2 → P2.5)

| Code | Parameter | Min | Max | Unit | Default | Cust | ID | Note |
|---|---|---|---|---|---|---|---|---|
| P2.5.1 | Prohibit frequency range 1 low limit | 0,0 | Par. 2.5.2 | Hz | 0,0 | | 509 | **0**=Not used |
| P2.5.2 | Prohibit frequency range 1 high limit | 0,0 | Par. 2.1.2 | Hz | 0,0 | | 510 | **0**=Not used |
| P2.5.3 | Prohibit frequencies acc./dec. ramp scaling | 0,1 | 10,0 | Times | 1,0 | | 518 | Multiplier of the currently selected ramp time between prohibit frequency limits |

*Table 8. Prohibit frequency parameters, P2.5*

## 3.7 Motor control parameters (Control keypad: Menu P2 → P2.6)

| Code | Parameter | Min | Max | Unit | Default | Cust | ID | Note |
|---|---|---|---|---|---|---|---|---|
| P2.6.1 | Motor control mode | 0 | 1 | | 1 | | 600 | **0**=Frequency control<br>**1**=Speed control |
| P2.6.2 | U/f ratio selection | 0 | 3 | | 0 | | 108 | **0**=Linear<br>**1**=Squared<br>**2**=Programmable<br>**3**=Linear with flux optim. |
| P2.6.3 | Field weakening point | 30,00 | 320,00 | Hz | 50,00 | | 602 | |
| P2.6.4 | Voltage at field weakening point | 10,00 | 200,00 | % | 100,00 | | 603 | n% x $U_{nmot}$ |
| P2.6.5 | U/f curve midpoint frequency | 0,00 | par. P2.6.3 | Hz | 50,00 | | 604 | |
| P2.6.6 | U/f curve midpoint voltage | 0,00 | 100,00 | % | 100,00 | | 605 | n% x $U_{nmot}$<br>Parameter max. value = par. 2.6.4 |
| P2.6.7 | Output voltage at zero frequency | 0,00 | 40,00 | % | 0,00 | | 606 | n% x $U_{nmot}$ |
| P2.6.8 | Switching frequency | 1,0 | 16,0 | kHz | 6,0 | | 601 | Depends on kW |
| P2.6.9 | Overvoltage controller | 0 | 1 | | 0 | | 607 | **0**=Not used<br>**1**=Used |
| P2.6.10 | Undervoltage controller | 0 | 1 | | 1 | | 608 | **0**=Not used<br>**1**=Used |

*Table 9. Motor control parameters, P2.6*

## 3.8 Protections (Control keypad: Menu P2 → P2.7)

| Code | Parameter | Min | Max | Unit | Default | Cust | ID | Note |
|---|---|---|---|---|---|---|---|---|
| P2.7.1 | Response to 4mA reference fault | 0 | 3 | | 0 | | 700 | 0=No response<br>1=Warning<br>2=Fault,stop acc. to 2.1.12<br>3=Fault,stop by coasting |
| P2.7.2 | Response to external fault | 0 | 3 | | 2 | | 701 | 0=No response<br>1=Warning<br>2=Fault,stop acc. to 2.1.12<br>3=Fault,stop by coasting |
| P2.7.3 | Response to undervoltage fault | 1 | 3 | | 2 | | 727 | |
| P2.7.4 | Output phase supervision | 0 | 3 | | 2 | | 702 | |
| P2.7.5 | Earth fault protection | 0 | 3 | | 2 | | 703 | |
| P2.7.6 | Thermal protection of the motor | 0 | 3 | | 2 | | 704 | |
| P2.7.7 | Motor ambient temperature factor | –100,0 | 100,0 | % | 0,0 | | 705 | |
| P2.7.8 | Motor cooling factor at zero speed | 0,0 | 150,0 | % | 40,0 | | 706 | |
| P2.7.9 | Motor thermal time constant | 1 | 200 | min | 45 | | 707 | |
| P2.7.10 | Motor duty cycle | 0 | 100 | % | 100 | | 708 | |
| P2.7.11 | Stall protection | 0 | 3 | | 1 | | 709 | As par. 2.7.1 |
| P2.7.12 | Stall current limit | 0,1 | $I_{nmotor}$ x 2 | A | $I_{nmotor}$ x1.3 | | 710 | |
| P2.7.13 | Stall time limit | 1,00 | 120,00 | s | 15,00 | | 711 | |
| P2.7.14 | Stall frequency limit | 1,0 | P 2.1.2 | Hz | 25,0 | | 712 | |
| P2.7.15 | Underload protection | 0 | 3 | | 0 | | 713 | As par. 2.7.1 |
| P2.7.16 | Underload curve at nominal frequency | 10,0 | 150,0 | % | 50,0 | | 714 | |
| P2.7.17 | Underload curve at zero frequency | 5,0 | 150,0 | % | 10,0 | | 715 | |
| P2.7.18 | Underload protection time limit | 2,00 | 600,00 | s | 20,00 | | 716 | |
| P2.7.19 | Response to thermistor fault | 0 | 3 | | 2 | | 732 | As par. 2.7.1 |
| P2.7.20 | Response to fieldbus fault | 0 | 3 | | 2 | | 733 | As par. 2.7.1 |
| P2.7.21 | Response to slot fault | 0 | 3 | | 2 | | 734 | As par. 2.7.1 |
| P2.7.22 | Actual value supervision | 0 | 4 | | 0 | | 735 | 0=No response<br>1=Warning if below limit<br>2=Warning if above limit<br>3=Fault, if below limit<br>4=Fault, if above limit |
| P2.7.23 | Actual value supervision limit | 0,0 | 100,0 | % | 10,0 | | 736 | |
| P2.7.24 | Actual value supervision delay | 0 | 3600 | s | 5 | | 737 | |

*Table 10. Protections, P2.7*

## 3.9 Autorestart parameters (Control keypad: Menu P2 → P2.8)

| 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<br>**1**=Flying start<br>**2**=According to par. 2.4.6 |

*Table 11. Autorestart parameters, P2.8*

## 3.10 Mechanical Brake control parameters (Control keypad: Menu M2 → P2.10)

| Code | Parameter | Min | Max | Unit | Default | Cust | ID | Note |
|---|---|---|---|---|---|---|---|---|
| ***G2.9.1.x*** | OPENING BRAKE | | | | | | | |
| P2.9.1.1 | Current limit FWD | 0,15 x $I_N$ | par2.1.9 | A | 0 | | 1700 | |
| P2.9.1.2 | Current limit REV | 0,15 x $I_N$ | par2.1.9 | A | 0 | | 1701 | |
| P2.9.1.3 | Torque limit FWD | 0 | 100,0 | % | 30 | | 1702 | |
| P2.9.1.4 | Torque limit REV | 0 | 100,0 | % | 30 | | 1703 | |
| P2.9.1.5 | Frequency limit FWD | 0 | par2.1.7 | Hz | 1,00 | | 1704 | |
| P2.9.1.6 | Frequency limit REV | 0 | par2.1.7 | Hz | 1,00 | | 1705 | |
| P2.9.1.7 | Brake Open Delay | 0 | 10,00 | s | 0,15 | | 1706 | |
| P2.9.1.8 | MecBr React Time | 0 | 10,0 | s | 0,05 | | 1622 | Mechanical reaction time |
| P2.9.1.9 | MaxFreqBrClosed | 0 | MaxFreq | Hz | 4,0 | | 1621 | Max. allowed output frequency when brake is closed |
| ***G2.9.2.x*** | CLOSING BRAKE | | | | | | | |
| P2.9.2.1 | Freq. Limit close | 0,01 | par2.1.7 | Hz | 2,00 | | 1707 | |
| P2.9.2.2 | Brake close delay | 0 | 10,0 | s | 0,0 | | 1708 | |

*Table 12. Mechanical brake control parameters G2.9.*

## 3.11 Speed reference parameters (Control keypad: Menu P2 → P2.10)

| Code | Parameter | Min | Max | Unit | Default | Cust | ID | Note |
|---|---|---|---|---|---|---|---|---|
| P2.10.1 | Speed reference 0 | 0,00 | MaxFreq | Hz | 5,00 | | 1600 | Speed reference 0 when binary coded I/O reference is used |
| P2.10.2 | Speed reference 1 | 0,00 | MaxFreq | Hz | 5,00 | | 1601 | Speed reference 1 when binary coded I/O reference is used |
| P2.10.3 | Speed reference 2 | 0,00 | MaxFreq | Hz | 5,00 | | 1602 | Speed reference 2 when binary coded I/O reference is used |
| P2.10.4 | Speed reference 3 | 0,00 | MaxFreq | Hz | 5,00 | | 1603 | Speed reference 3 when binary coded I/O reference is used |
| P2.10.5 | Speed reference 4 | 0,00 | MaxFreq | Hz | 5,00 | | 1604 | Speed reference 4 when binary coded I/O reference is used |
| P2.10.6 | Speed reference 5 | 0,00 | MaxFreq | Hz | 5,00 | | 1605 | Speed reference 5 when binary coded I/O reference is used |
| P2.10.7 | Speed reference 6 | 0,00 | MaxFreq | Hz | 5,00 | | 1606 | Speed reference 6 when binary coded I/O reference is used |
| P2.10.8 | Speed reference 7 | 0,00 | MaxFreq | Hz | 5,00 | | 1607 | Speed reference 7 when binary coded I/O reference is used |

*Table 13. Speed reference parameters, P2.10*

## 3.12 Keypad control (Control keypad: Menu K3)

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

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

*Table 14. Keypad control parameters, M3*

## 3.13 System menu (Control keypad: Menu S6)

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

## 3.14 Expander boards (Control keypad: Menu E7)

The **E7** menu shows the expander boards attached to the control board and board-related information. For more information, see Chapter 7.3.7 in the Vacon NXL 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 2.1.19, 2.1.20, 2.3.13, 2.5.1, 2.5.2 and 2.6.5.

### *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 equal to the rated converter 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 2.6.4) 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 2.6.3) 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 Start function*

Ramp:

0 The frequency converter starts from 0 Hz and accelerates to maximum 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. The 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.

### *2.1.12 Stop function*

Coasting:

0 The motor coasts to a halt without 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.

### *2.1.13 U/f optimisation*

0 Not used

1 **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.*

### *2.1.14 I/O Reference selection*

Defines the selected frequency reference source when the drive is controlled from the I/O terminal.

0 AI1 reference (terminals 2 and 3, e.g. potentiometer)

1 AI2 reference (terminals 5 and 6, e.g. transducer)

2 Keypad reference (parameter 3.2)

3 Reference from Fieldbus (FBSpeedReference)

4 Motor potentiometer reference.

One digital input has to be programmed as internal motorized potentiometer UP.

Drive is started and the Motor pot UP digital input increases speed. The current speed is held as long as start command is active. Deceleration according to deceleration time is made by stop command.

5 Binary coded digital inputs, DIE1- DIE3 on option board. See P2.10.1-P2.10.8

### *2.1.15 AI2 ($I_{in}$) signal range*

1 Signal range 0...20 mA
2 Signal range 4...20 mA
3 Signal range 0...10V
4 Signal range 2...10V

**Note!** The selections have no effect if par. 2.2.12 > 0%, or par. 2.2.13 < 100%.

### *2.1.16 Analogue output function*

This parameter selects the desired function for the analogue output signal.
See the table on page 6 for the parameter values.

### *2.1.17 DIN2 function*

This parameter has 10 selections. If digital input DIN2 need not be used, set the parameter value to 0.

1 Start reverse
2 Reverse
3 Stop pulse
4 External fault
Contact closed: Fault is displayed and motor stopped when the input is active
5 External fault
Contact open: Fault is displayed and motor stopped when the input is not active
6 Run enable
Contact open: Start of motor disabled
Contact closed: Start of motor enabled
Coast stop if dropped during RUN
7 Preset speed 2
8 Motor potentiometer UP
Contact closed: Reference increases until the contact is opened.
9 Not used
10 Brake open enable
Contact open: Brake open disabled
Contect closed: Brake open enabled

### *2.1.18 DIN3 function*

The parameter has 11 selections. If digital input DIN3 need not be used, set the param. value to 0.

1 Reverse
Contact open: Forward
Contact closed: Reverse
2 External fault
Contact closed: Fault is displayed and motor stopped when the input is active
3 External fault
Contact open: Fault is displayed and motor stopped when the input is not active
4 Fault reset
Contact closed: All faults reset
5 Run enable
Contact open: Start of motor disabled
Contact closed: Start of motor enabled
Coast stop if dropped during RUN
6 Preset speed 1
7 Preset speed 2
8 DC braking command
Contact closed: In Stop mode, the DC braking operates until the contact is opened. DC-braking current is about 10% of the value selected with par. 2.4.3.
9 Motor potentiometer UP
Contact closed: Reference increases until the contact is opened.
10 Not used
11 Brake open enable
Contact open: Brake open disabled
Contect closed: Brake open enabled

### *2.1.19 Preset speed 1*
### *2.1.20 Preset speed 2*

Parameter values are automatically limited between the minimum and maximum frequencies. (par. 2.1.1 and 2.1.2)

**Note!** If Preset speed input is activated other I/O reference is bypassed.

### *2.1.21 Automatic restart function*

The automatic restart is taken into use with this parameter

**0** = Disabled
**1** = Enabled (3 automatic restarts, see par. 2.8.1 – 2.8.3)

### *2.1.22 Parameter conceal*

With this parameter you can hide all other parameter groups except the basic parameter group (B2.1).

**Note!** The factory default of this parameter is 0, i.e. all parameter groups are visible.

**0** = Disabled (all parameter groups can be browsed with the keypad)
**1** = Enabled (only the basic parameters, B2.1, can be browsed with the keypad)

## 4.2 INPUT SIGNALS

### *2.2.1 Expander board DIE1 function*

This parameter has 12 selections. If the expander board digital input DIN1 need not be used, set the parameter value to 0.

Selections are as in parameter 2.1.18, except:

**12** = Binary input 0. Active when P2.1.14 I/O reference is set to 5 (Binary coded input)

See descriptions for Parameters 2.10.1 – 2.10.8

### *2.2.2 Expander board DIE2 function*

The selections are the same as in parameter 2.2.1, except:

Same as parameter 2.2.1. See descriptions for Parameters 2.10.1 – 2.10.8

### *2.2.3 Expander board DIE3 function*

The selections are the same as in parameter 2.2.1.

Same as parameter 2.2.1. See descriptions for Parameters 2.10.1 – 2.10.8

### *2.2.4 DIN4 Function*

If the value of par. 2.2.6 is set to **0**, AI1 functions as digital input 4.

The selections are the same as in parameter parameter 2.1.18

**NOTE! If you program the analogue input as DIN4 check that the jumper selections are correct (see figure below).**

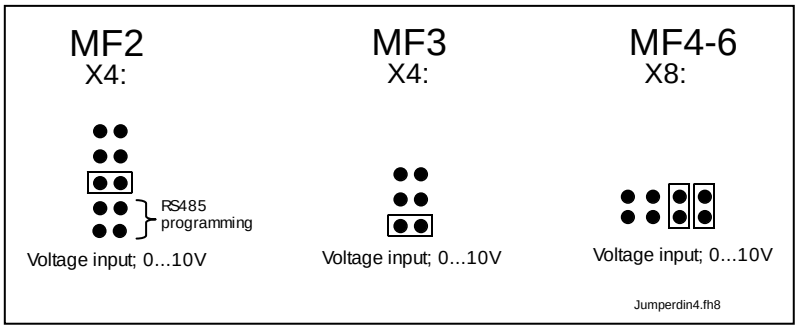



*Figure 1. Jumper selections of X4/X8 when AI1 functions as DIN4*

### *2.2.5 AI1 signal selection*

Connect the AI1 signal to the analogue input of your choice with this parameter.

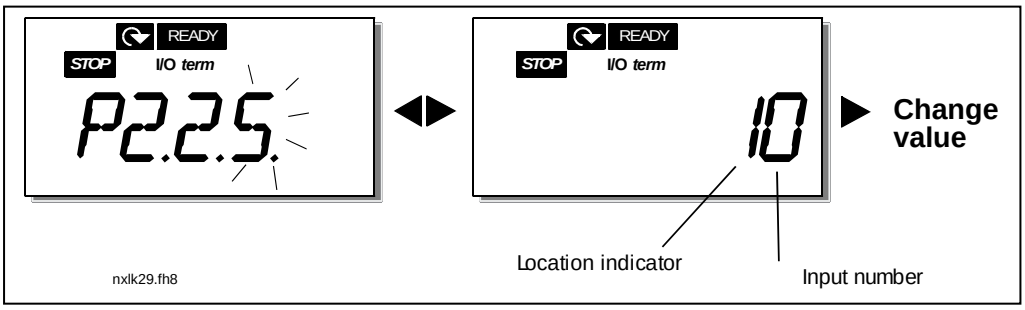



*Figure 2. AI1 signal selection*

The value of this parameter is formed of the *board indicator* and the *respective input terminal number*. See Figure 1- 2 above.

| | |
|---|---|
| Board indicator **1** | = Local inputs |
| Board indicator **2** | = Expander board inputs |
| | |
| Input number **0** | = Input 1 |
| Input number **1** | = Input 2 |
| Input number **2** | = Input 3 |
| ⋮ | |
| Input number **9** | = Input 10 |

Example:

If you set the value of this parameter to **10**, you have selected the local input **1** for the AI1 signal. Again, if the value is set to **21,** the expander board input **2** has been selected for the AI1 signal.

If you want to use the values of analogue input signal for e.g. testing purposes only, you can set the parameter value to **0** - **9**. In this case, value **0** corresponds to **0%**, value **1** corresponds to **20%** and any value between **2** and **9** corresponds to **100%**.

### *2.2.6 AI1 signal range*

With this parameter you can select the AI1 signal range.

**0** = DIN 4
**1** = Signal range 0...20mA (only for sizes MF4 and bigger)
**2** = Signal range 4...20mA (only for sizes MF4 and bigger)
**3** = Signal range 0...10V
**4** = Signal range 2...10V

**Note!** The selections have no effect if par. 2.2.7 > 0%, or par. 2.2.8 < 100%.

If the value of par. 2.2.6 is set to **0**, AI1 functions as digital input 4. See par. 2.2.4

### *2.2.7 AI1 custom setting minimum*
### *2.2.8 AI1 custom setting maximum*

Set the custom minimum and maximum levels for the AI1 signal within 0...10V.

### *2.2.9 AI1 signal inversion*

By setting the parameter value to **1** the AI1 signal inversion takes place.

### *2.2.10 AI1 signal filter time*

This parameter, given a value greater than 0, activates the function that filters out disturbances from the incoming analogue $U_{in}$ signal.

Long filtering time makes the regulation response slower. See Figure 3

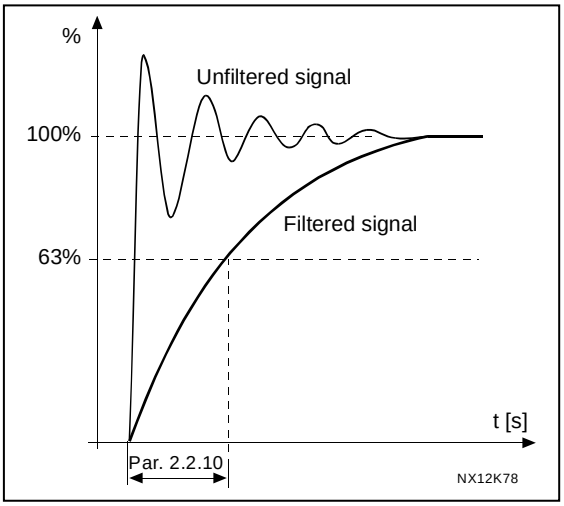



*Figure 3. AI1 signal filtering*

### *2.2.11 AI2 signal selection*

Connect the AI2 signal to the analogue input of your choice with this parameter. See par. 2.2.5 for the value setting procedure.

### *2.2.12 AI2 signal range*

**1** = Signal range 0...20mA
**2** = Signal range 4...20mA
**3** = Signal range 0...10V
**4** = Signal range 2...10V

**Note!** The selections have no effect if par. 2.2.13 > 0%, or par. 2.2.14 < 100%.

### *2.2.13 AI2 custom minimum*
### *2.2.14 AI2 custom maximum*

These parameters allow you to scale the input current signal between 0 and 20 mA.

Cf. parameters 2.2.7 and 2.2.8.

### *2.2.15 Analogue input AI2 signal inversion*

See corresponding parameter 2.2.9.

### *2.2.16 Analogue input AI2 signal filter time*

See corresponding parameter 2.2.10.

### *2.2.17 Reserved*

Reserved for future use

### *2.2.18 Reference scaling minimum value*
### *2.2.19 Reference scaling maximum value*

You can choose a scaling range for the frequency reference between the Minimum and Maximum frequency. If no scaling is desired set the parameter value to **0**.

In the figures below, voltage input AI1 with signal range 0...10V is selected for reference.

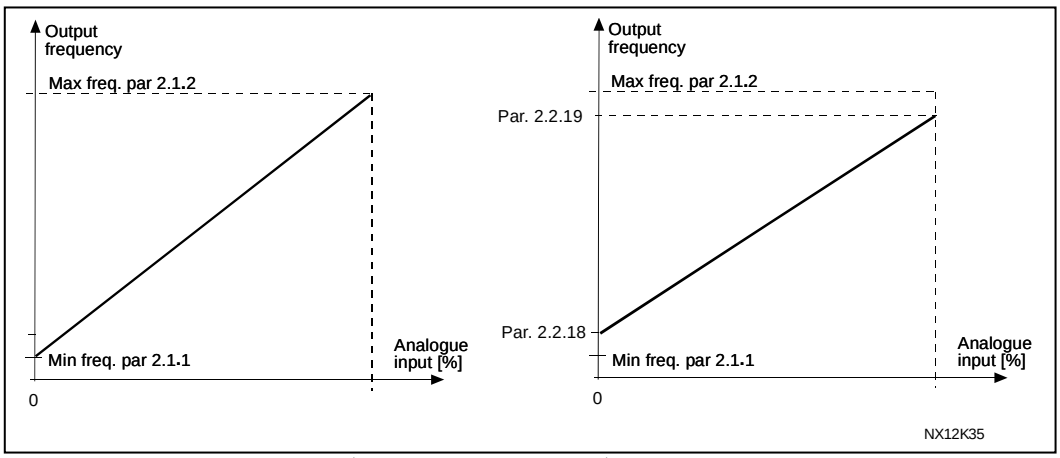



*Figure 4. Left: Par. 2.1.18=0 (No reference scaling) Right: Reference scaling*

### *2.2.20 Keypad frequency reference selection*

Defines the selected reference source when the drive is controlled from the keypad

**0** AI1 reference (by default AI1, terminals 2 and 3, e.g. potentiometer)
**1** AI2 reference (by default AI2, terminals 5 and 6, e.g. transducer)
**2** Keypad reference (parameter 3.2)
**3** Reference from Fieldbus (FBSpeedReference)
**4** Motor potentiometer reference
**5** Binary I/O reference (DIE1, DIE2, DIE3)

### *2.2.21 Fieldbus frequency reference selection*

Defines the selected reference source when the drive is controlled from the fieldbus. For the parameter values, see par. 2.2.20.

## 4.3 OUTPUT SIGNALS

### *2.3.1 Relay output 1 function*
### *2.3.2 Expander board relay output 1 function*
### *2.3.3 Expander board relay output 2 function*
### *2.3.4 Expander board digital output 1 function*

| Setting value | Signal content |
|---|---|
| 0 = Not used | Out of operation |
| | Relay output RO1 and expander board programmable relays (RO1, RO2) are 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 = Frequency converter overheat warning | The heat-sink temperature exceeds +70°C |
| 6 = External fault or warning | Fault or warning depending on par. 2.7.2 |
| 7 = Reference fault or warning | Fault or warning depending on par. 2.7.1<br>- 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 | A preset speed has been selected |
| 11 = At speed | The output frequency has reached the set reference |
| 12 = Motor regulator activated | Overvoltage or overcurrent regulator was activated |
| 13 = Output frequency limit 1 supervision | The output frequency goes outside the set supervision low limit/high limit (see parameters 2.3.12 and 2.3.13 below) |
| 14 = Control from I/O terminals | Selected control place (Menu K3; par. 3.1) is "I/O terminal" |
| 15 = Thermistor fault or warning | The thermistor input of option board indicates overtemperature. Fault or warning depending on parameter 2.7.19. |
| 16 = Mechanical brake off control | Opens the mechanical brakepar2719 |

*Table 1- 1. Output signals via RO1 and expander board RO1, RO2 and DO1.*

### *2.3.5 Analogue output function*

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

See the table on page 6 for the parameter values.

### 2.3.6 *Analogue output filter time*

Defines the filtering time of the analogue output signal.

If you set value **0** for this parameter, no filtering takes place.

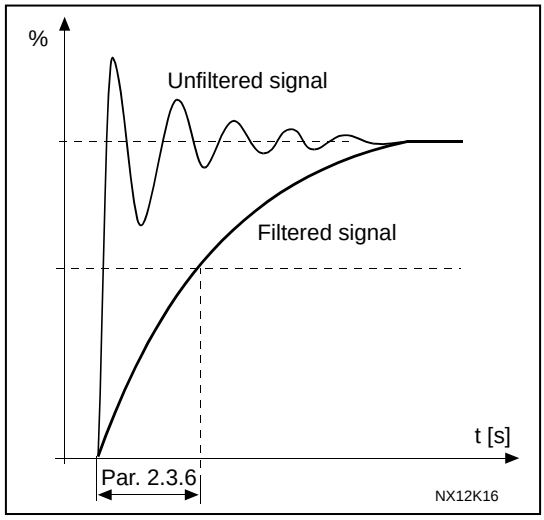



*Figure 5. Analogue output filtering*

### 2.3.7 *Analogue output invert*

Inverts the analogue output signal:

Maximum output signal = 0 %
Minimum output signal = Maximum set value (parameter 2.3.9)

**0** Not inverted
**1** Inverted

See parameter 2.3.9 below.

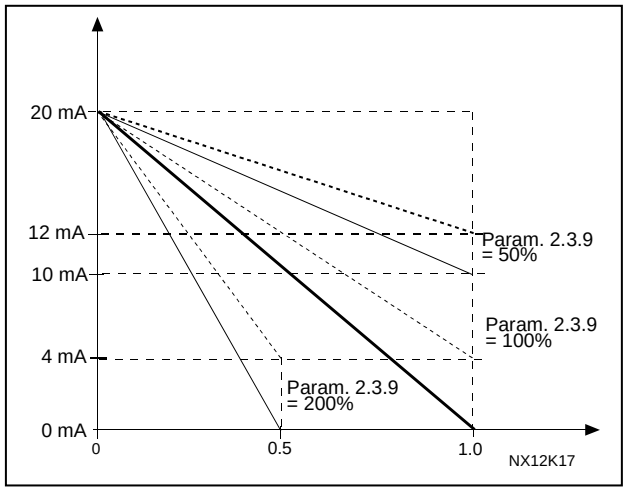



*Figure 6. Analogue output invert*

### 2.3.8 *Analogue output minimum*

Sets the signal minimum to either 0 mA or 4 mA (living zero). Note the difference in the analogue output scaling in parameter 2.3.9.

### 2.3.9 *Analogue output scale*

Scaling factor for the analogue output.

| Signal | Max. value of the signal |
|---|---|
| Output frequency | 100% x $f_{max}$ |
| Motor speed | 100% x Motor nom. speed |
| Output current | 100% x $I_{nMotor}$ |
| Motor torque | 100% x $T_{nMotor}$ |
| Motor power | 100% x $P_{nMotor}$ |
| Motor voltage | 100% x $U_{nmotor}$ |
| DC-link voltage | 1000 V |
| PI-ref. value | 100% x ref. value max. |
| PI act. value 1 | 100% x actual value max. |
| PI error value | 100% x error value max. |
| PI output | 100% x output max. |

*Table 15. Analogue output scaling*

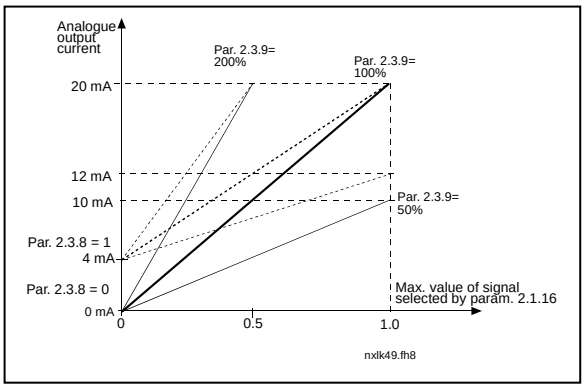



*Figure 7. Analogue output scaling*

### 2.3.10 *Expander board analogue output 1 function*
### 2.3.11 *Expander board analogue output 2 function*

These parameters select the desired functions for the expander board analogue output signals. See par. 2.1.16 for the parameter values.

### 2.3.12 *Output frequency limit 1 supervision function*

0 No supervision
1 Low limit supervision
2 High limit supervision

If the output frequency goes under/over the set limit (par. 2.3.13) this function generates a warning message via the relay outputs depending on the settings of parameters 2.3.1 – 2.3.4.

### 2.3.13 *Output frequency limit 1 supervised value*

Selects the frequency value supervised by parameter 2.3.12.

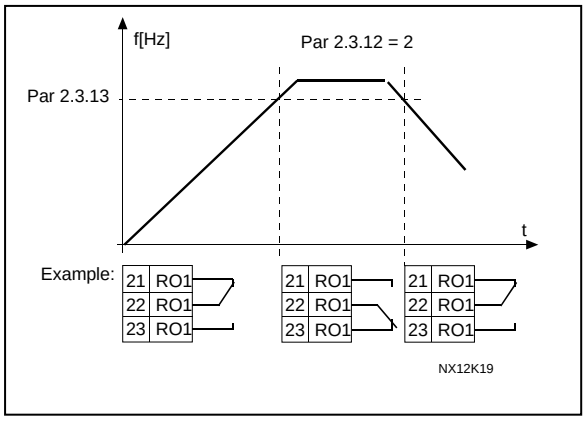



*Figure 8. Output frequency supervision*

## 4.4 DRIVE CONTROL

### *2.4.1 Acceleration/Deceleration ramp 1 shape*

The start and end of the acceleration and deceleration ramp can be smoothed with this parameter. 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

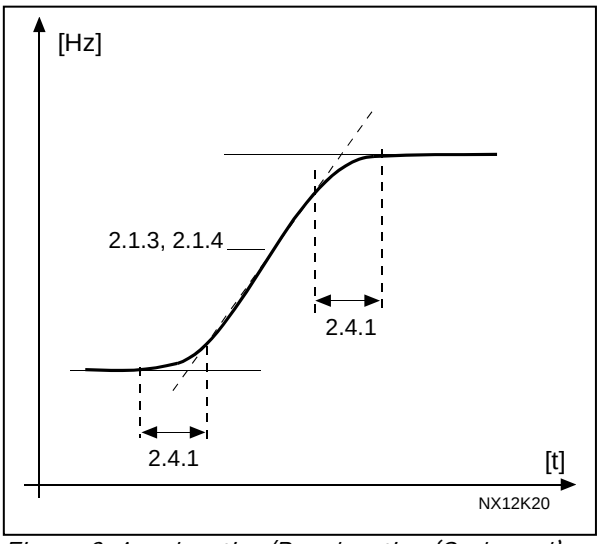



*Figure 9. Acceleration/Deceleration (S-shaped)*

### *2.4.2 Brake chopper*

**Note!** An internal brake chopper is installed in all other sizes but MF2

**0** No brake chopper used
**1** Brake chopper used in Run state
**3** Used in Run and Stop state

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.

### *2.4.3 DC-braking current*

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

### *2.4.4 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 2.1.12.

**0** DC-brake is not used

**>0** DC-brake is in use and its function depends on the Stop function, (par. 2.1.12). The DC-braking time is determined with this parameter

**Par. 2.1.12 = 0 (Stop function = Coasting):**

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

With the 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 by the frequency when the DC-braking starts. If the frequency is greater than the nominal frequency of the motor, the set value of parameter 2.4.4 determines the braking time. When the frequency is ≤10% of the nominal, the braking time is 10% of the set value of parameter 2.4.4.

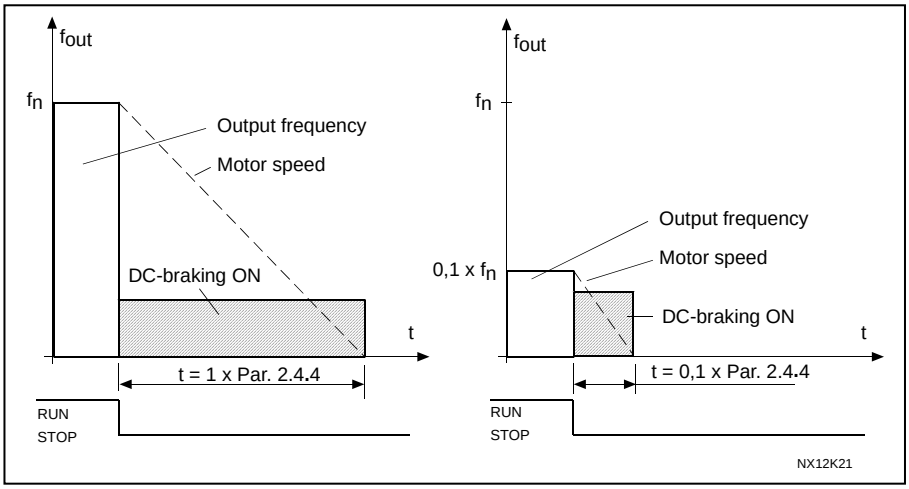



*Figure 10. DC-braking time when Stop mode = Coasting.*

Par. 2.1.12 = 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 2.4.5, where the DC-braking starts.

The braking time is defined with parameter 2.4.4. If high inertia exists, it is recommended to use an external braking resistor for faster deceleration. See Figure 11.

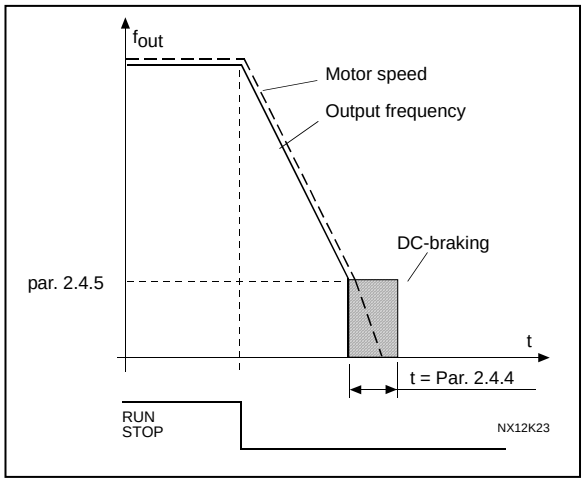



*Figure 11. DC-braking time when Stop mode = Ramp*

### *2.4.5 DC-braking frequency in ramp stop*

The output frequency at which the DC-braking is applied. See Figure 11.

### *2.4.6 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 2.1.11. See Figure 12.

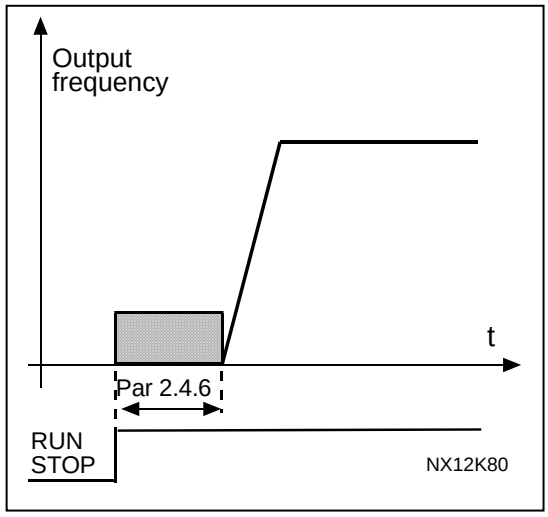



*Figure 12. DC braking time at start*

### *2.4.7 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

### *2.4.8 Flux braking current*

Defines the flux braking current value. It can be set between 0.3 x $I_H$ (approximately) and the Current limit.

## 4.5 PROHIBIT FREQUENCIES

### *2.5.1 Prohibit frequency area 1; Low limit*
### *2.5.2 Prohibit frequency area 1; 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 a limit for the "skip frequency" region. See Figure 13.

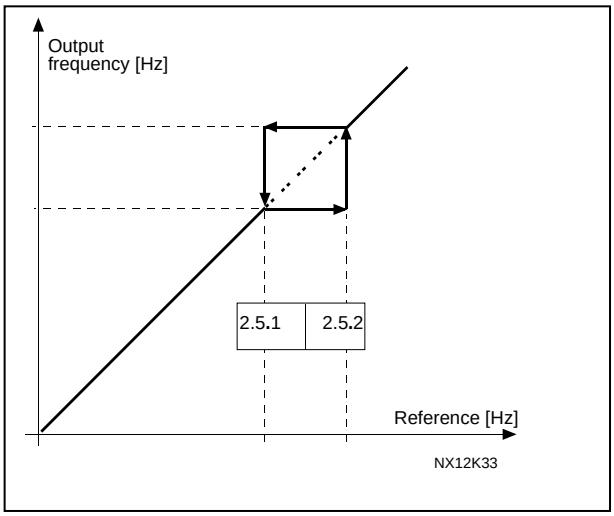



*Figure 13. Prohibit frequency area setting.*

### *2.5.3 Acceleration/deceleration 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 time (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.

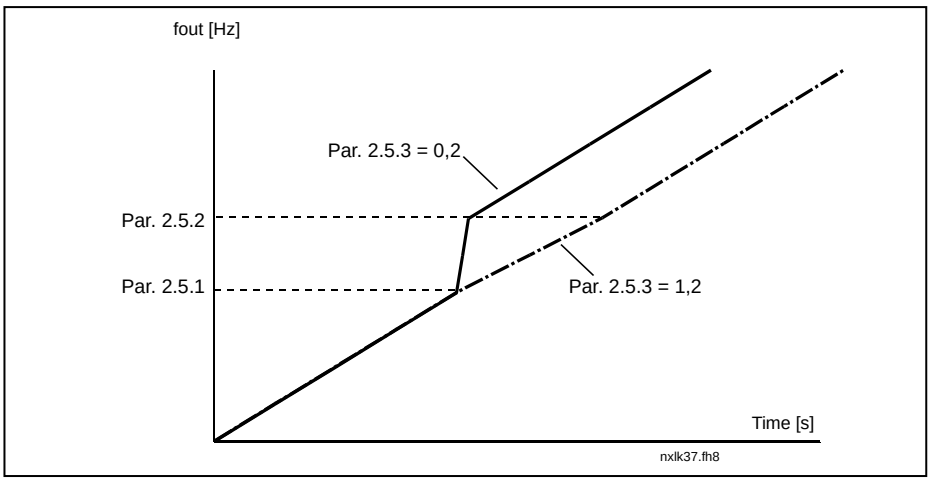



*Figure 14. Ramp time scaling between prohibit frequencies*

## 4.6 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%).

### *2.6.2 U/f ratio selection*

Linear: The voltage of the motor changes linearly with the frequency in the constant

0 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. See .

**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.

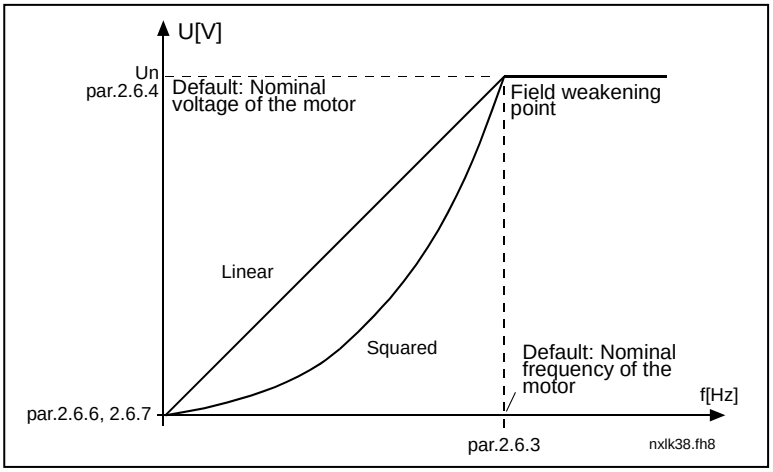



*Figure 15. Linear and squared change of motor voltage*

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.

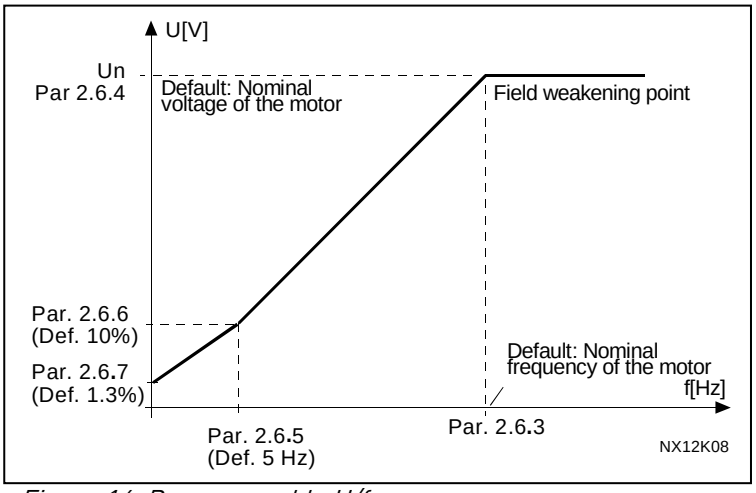



*Figure 16. Programmable U/f curve*

Linear with flux optimisation:

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

### *2.6.3 Field weakening point*

The field weakening point is the output frequency at which the output voltage reaches the value set with par. 2.6.4.

### *2.6.4 Voltage at field weakening point*

Above the frequency at the field weakening point, the output voltage remains at the value set with this parameter. Below the frequency at the field weakening point, the output voltage depends on the setting of the U/f curve parameters. See parameters 2.1.13, 2.6.2, 2.6.5 2.6.6 and 2.6.7 and .

When the parameters 2.1.6 and 2.1.7 (nominal voltage and nominal frequency of the motor) are set, the parameters 2.6.3 and 2.6.4 are automatically given the corresponding values. If you need different values for the field weakening point and the voltage, change these parameters **after** setting the parameters 2.1.6 and 2.1.7.

### *2.6.5 U/f curve, middle point frequency*

If the programmable U/f curve has been selected with parameter 2.6.2 this parameter defines the middle point frequency of the curve. See .

### *2.6.6 U/f curve, middle point voltage*

If the programmable U/f curve has been selected with the parameter 2.6.2 this parameter defines the middle point voltage of the curve. See .

### *2.6.7 Output voltage at zero frequency*

This parameter defines the zero frequency voltage of the curve. See .

### *2.6.8 Switching frequency*

Motor noise can be minimised using a high switching frequency. Increasing the switching frequency reduces the capacity of the frequency converter unit.

Switching frequency for Vacon NXL: 1...16 kHz

### *2.6.9 Overvoltage controller*
### *2.6.10 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. This 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 4mA reference fault*

**0** = No response
**1** = Warning
**2** = Fault, stop mode after fault according to parameter 2.1.12
**3** = 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 relay outputs.

### *2.7.2 Response to external fault*

**0** = No response
**1** = Warning
**2** = Fault, stop mode after fault according to parameter 2.1.12
**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. The information can also be programmed into relay outputs.

### *2.7.3 Response to undervoltage fault*

**1** = Warning
**2** = Fault, stop mode after fault according to parameter 2.1.12
**3** = Fault, stop mode after fault always by coasting

For the undervoltage limits see Vacon NXL, User's Manual, Table 4-3.
**Note:** This protection can not be inactivated.

### *2.7.4 Output phase supervision*

**0** = No response
**1** = Warning
**2** = Fault, stop mode after fault according to parameter 2.1.12
**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.

### *2.7.5 Earth fault protection*

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 2.1.12
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 2.7.6—2.7.10, 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.

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

### *2.7.6 Motor thermal protection*

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 2.1.12
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 model of the motor to 0%.

### *2.7.7 Motor thermal protection: Motor ambient temperature factor*

When the motor ambient temperature must be taken into consideration, it is recommended to set a value for this parameter. The value of the factor can be set between –100.0% and 100.0% where –100.0% corresponds to 0°C and 100.0% to the maximum running ambient temperature of the motor. Setting this parameter value to 0% assumes that the ambient temperature is the same as the temperature of the heatsink at power-on.

### *2.7.8 Motor thermal protection: Cooling factor at zero speed*

The cooling power can be set between 0—150.0% x cooling power at nominal frequency. See Figure 17.

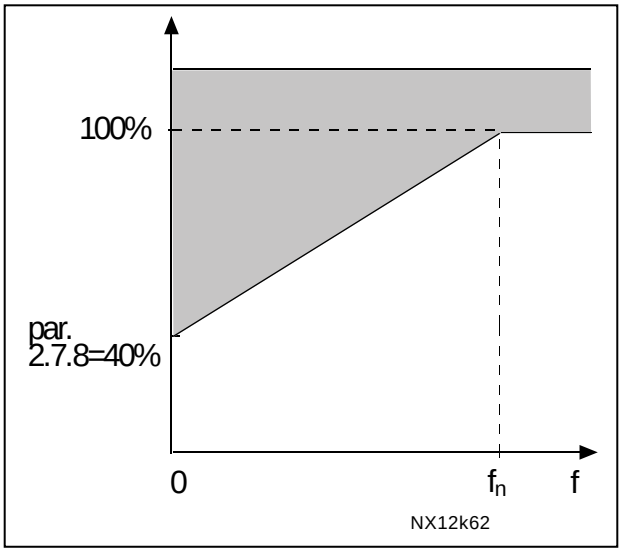



*Figure 17. Motor cooling power*

### *2.7.9 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 model 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 state the time constant is internally increased to three times the set parameter value. The cooling in the stop state is based on convection and the time constant is increased. See also .
**Note:** If the nominal speed (par. 2.1.8) or the nominal current (par. 2.1.9) of the motor are changed this parameter is automatically set to the default value (45).

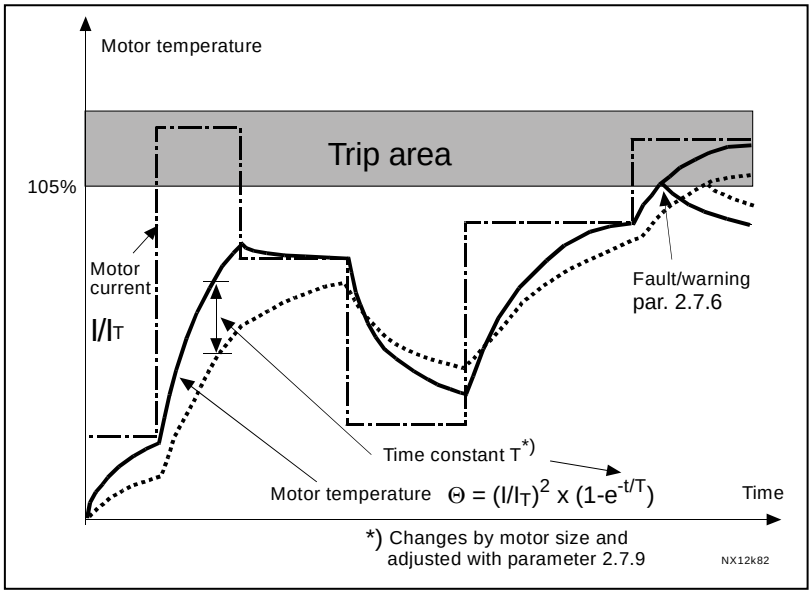



*Figure 18. Motor temperature calculation*

### *2.7.10 Motor thermal protection: Motor duty cycle*

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

## Parameter 2.7.11, 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, 2.7.12 (Stall current) and 2.7.13 (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.

### *2.7.11 Stall protection*

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 2.1.12
3 = Fault, stop mode after fault always by coasting

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

### 2.7.12 *Stall current limit*

The current can be set to 0.0...$I_{nMotor}$*2. For a stall stage to occur, the current must have exceeded this limit. See Figure 1- 20. The software does not allow entering a greater value than $I_{nMotor}$*2. If the parameter 2.1.9 Nominal current of motor is changed, this parameter is automatically restored to the default value ($I_{nMotor}$*1.3).

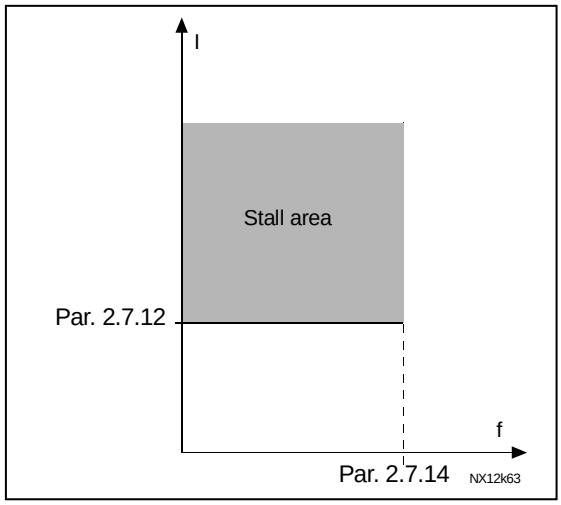



*Figure 19. Stall characteristics settings*

### 2.7.13 *Stall time*

This time can be set between 1.0 and 120.0s.

This is the maximum time allowed for a stall event detection. 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 Figure 20)

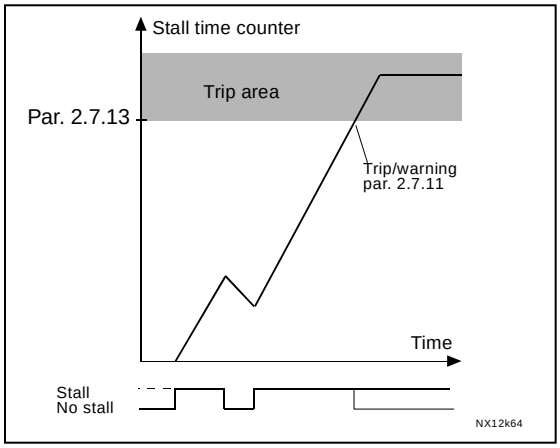



*Figure 20. Stall time count*

### 2.7.14 *Maximum stall frequency*

The frequency can be set between 1-$f_{max}$ (par. 2.1.2).

For a stall event to occur, the output frequency must have remained below this limit.

## Parameters 2.7.15—2.7.18, 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 2.7.16 (Field weakening area load) and 2.7.17 (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, the parameter Motor nominal current and the drive's nominal current $I_L$ 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.

### *2.7.15 Underload protection*

**0** = No response
**1** = Warning
**2** = Fault, stop mode after fault according to parameter 2.1.12
**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.

### *2.7.16 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 21.

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

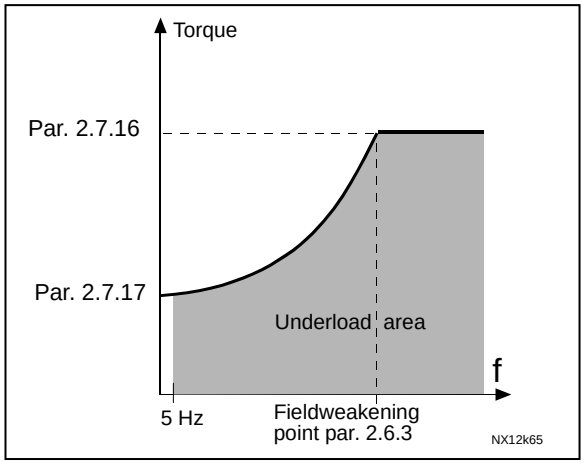



*Figure 21. Setting of minimum load*

### *2.7.17 Underload 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 21.

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

### *2.7.18 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 2.7.15). If the drive is stopped the underload counter is reset to zero. See Figure 22.

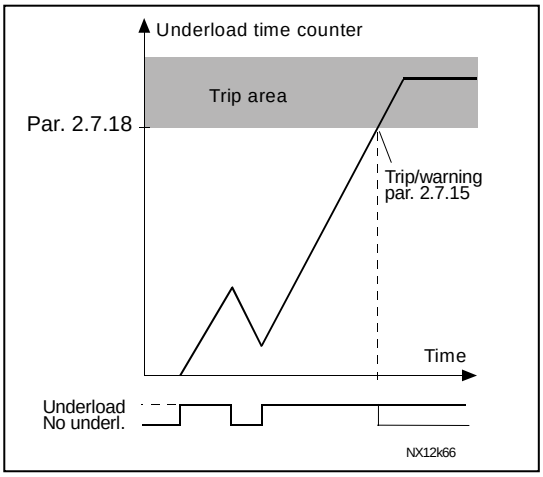



*Figure 22. Underload time counter function*

### *2.7.19 Response to thermistor fault*

0 = No response
1 = Warning
2 = Fault, stop mode after fault according to parameter 2.1.12
3 = Fault, stop mode after fault always by coasting

Setting the parameter to 0 will deactivate the protection.

### *2.7.20 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 2.7.19.

### *2.7.21 Response to slot fault*

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

See parameter 2.7.19.

### *2.7.22 Actual value supervision function*

**0** = Not used
**1** = Warning, if actual value falls below the limit set with par. 2.7.23
**2** = Warning, if actual value exceeds the limit set with par. 2.7.23
**3** = Fault, if actual value falls below the limit set with par. 2.7.23
**4** = Fault, if actual value exceeds the limit set with par. 2.7.23

### *2.7.23 Actual value supervision limit*

With this parameter you can set the limit of actual value supervised by par. 2.7.22

### *2.7.24 Actual value supervision delay*

Set here the delay for the actual value supervision function (par. 2.7.22)

If this parameter is in use, the function of par. 2.7.22 will be active only when the actual value stays outside the defined limit for the time determined by this parameter.

## 4.8 AUTO RESTART PARAMETERS

The automatic restart function is active if the value of par. 2.1.21 = 1. There are always three restart trials

### *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 have disappeared and the waiting time has elapsed.

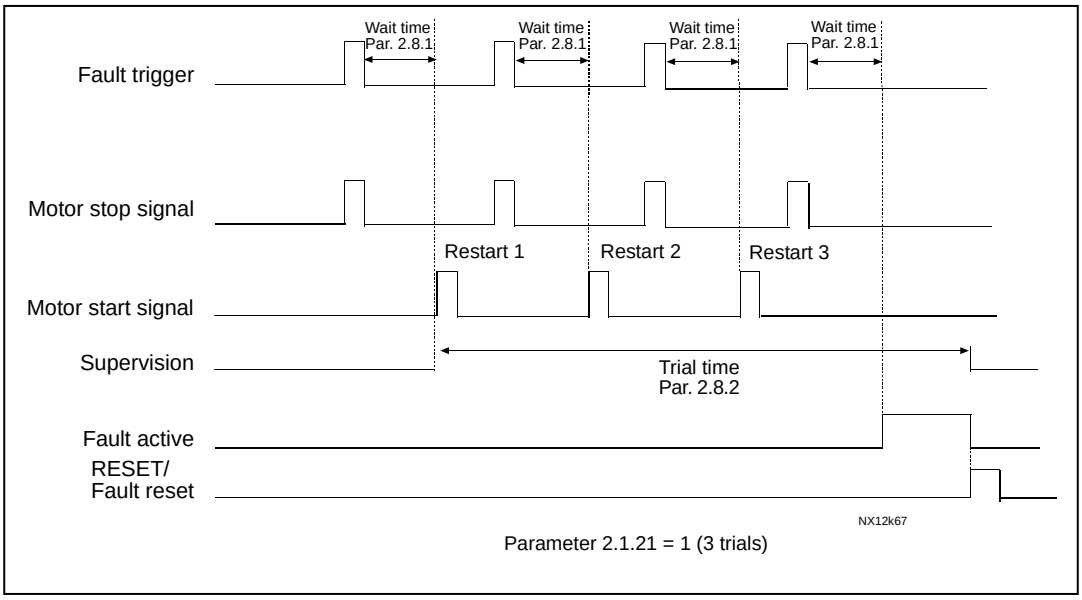



*Figure 23. Automatic restart.*

The time count starts from the first autorestart. If the number of faults occurring during the trial time exceeds three, 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. 2.1.11

## 4.9 MECHANICAL BRAKE CONTROL

The mechanical brake control parameters affect the mechanical brake control, the smooth start and stop function and the safety functions.

The mechanical brake can be set to release on current, on torque or on frequency.

These parameters can be set individually for forward and reverse direction

All digital inputs except DIN1 can be programmed for brake open Enable.

The closing is performed by frequency and by Run request signal. In case of fault the brake closes immediately without delay.

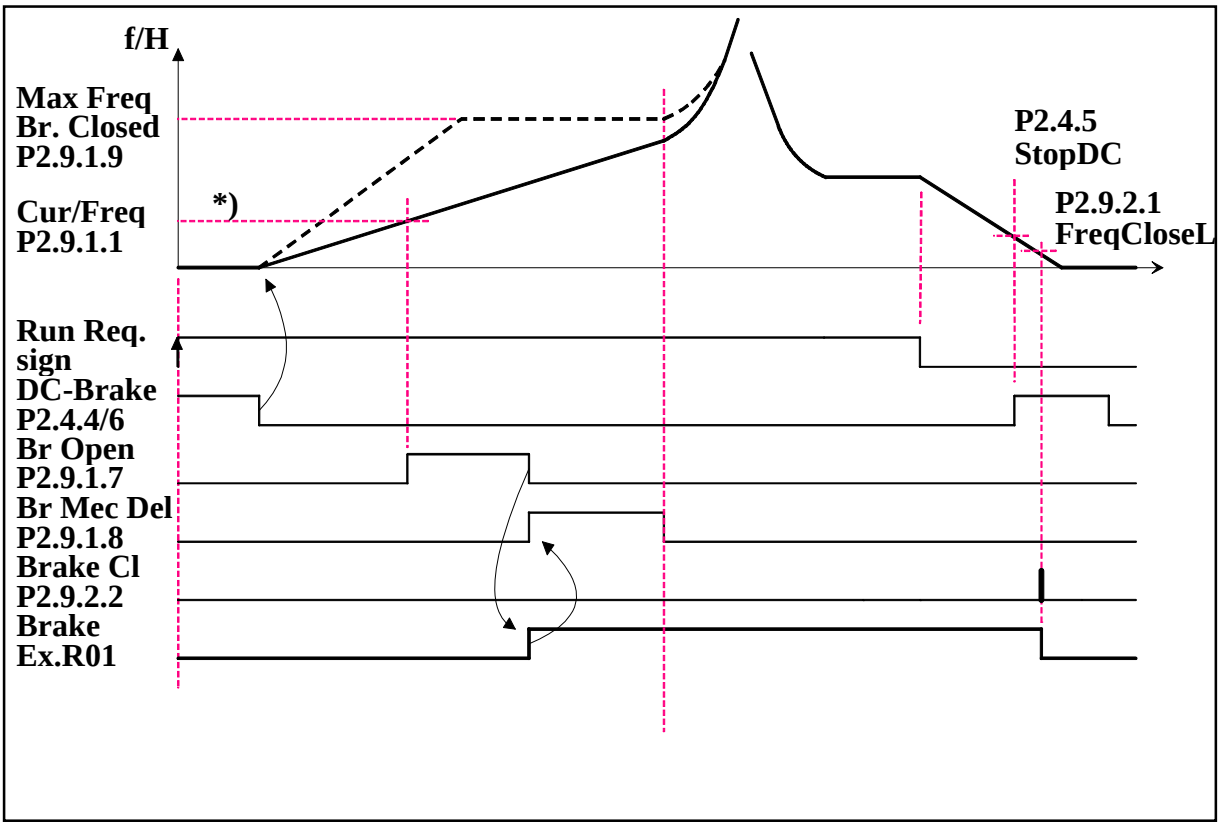



*Figure 24. Mechanical brake control logic.*

**) Start signal to Brake open delay when current, freq. and torque exceed limits defined by parameters.*

## Mechanical Brake Control Logic

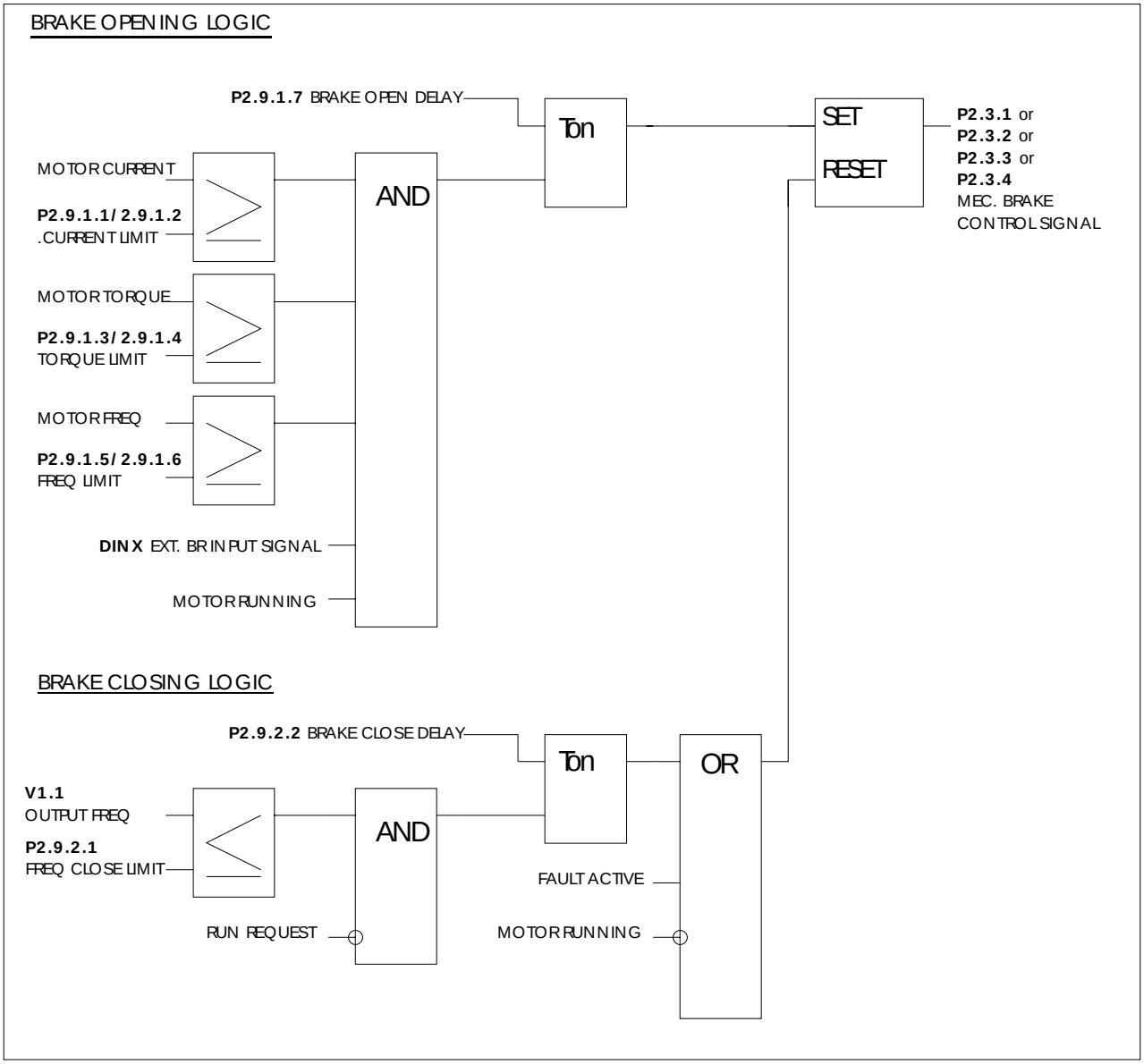



*Figure 25. Mechanical brake control logic.*

Mechanical brake control signal can be selected to any digital or relay output to control the external mechanical brake.

In the upper section of Figure 25 you can find the mechanical brake opening logic. Five signals and the delay are required for the mechanical brake to open. If current, torque or frequency signal is not needed for brake opening, then these parameters can be set to zero. The external brake input signal can be programmed for any digital input except DIN1.

In the lower section of Figure 25 you can find the mechanical brake closing logic. The brake close circuit has higher priority than the open circuit. So if closing signal is active the mechanical brake will be closed.

The brake will be closed immediately in case of fault or when the motor is stopped.

In normal operation the brake will be closed when frequency falls below the Frequency close limit (P2.9.2.1) AND when the Run Request signal is switched OFF. If the Frequency close limit signal is not needed for the closing logic it can be set to zero. After the conditions are true there is a brake close delay (P2.9.2.2) after which the brake will be closed.

### *Opening Brake Parameters (M2 -> G2.9.1)*

Please note that there are limitations parameters for both Forward (FWD) and Reverse (REV) direction.
Different values for FWD and REV can be set when application requires.

#### *2.9.1.1 Current Limit FWD*

Parameter defines the actual current limit that has to be exceeded for a brake release. If set to zero this condition is excluded. The value is updated always when the nominal current of the motor (parameter 2.1.9) is set (see Figure 25).

#### *2.9.1.2 Current Limit REV*

Parameter defines the actual current limit that has to be exceeded for a brake release. If set to zero this condition is excluded. The value is updated always when the nominal current of the motor (parameter 2.1.9) is set (see Figure 25).

#### *2.9.1.3 Torque limit FWD*

Parameter defines the actual torque limit that has to be exceeded for a brake release. If set to zero this condition is excluded.

100 % corresponds to the calculated nominal torque of the motor (see Figure 25).

#### *2.9.1.4 Torque limit REV*

Parameter defines the actual torque limit that has to be exceeded for a brake release. If set to zero this condition is excluded.

100 % corresponds to the calculated nominal torque of the motor (see Figure 25).

#### *2.9.1.5 Frequency limit FWD*

Parameter defines the actual frequency limit that has to be exceeded for brake release. If set to zero this condition is excluded (see Figure 25).

#### *2.9.1.6 Frequency limit REV*

Parameter defines the actual frequency limit that has to be exceeded for brake release. If set to zero this condition is excluded (see Figure 25).

### *2.9.1.7 Brake open delay*

Delay which starts when the opening conditions (see parameters 2.9.1.1-2.9.1.6) are TRUE (see Figure 25).

### *2.9.1.8 Mechanical brake reaction time*

Mechanical brake reaction time will hold the speed reference for a defined time. This hold time should be set according to the mechanical brake reaction time.

### *2.9.1.9 Maximum frequency brake closed*

Output frequency does not exceed this value when mechanical brake is closed. When modifying this parameter make sure that the brake release by frequency (see parameter 2.9.1.5/2.9.1.6) is possible with new value.

**Note!** If the mechanical is not used, set this parameter to the maximum frequency.

## *Closing Brake Parameters (M2 -> G2.9.2)*

### *2.9.2.1 Frequency limit closing*

The output frequency limit for the brake closing. The run request signal needs to be disabled to allow the signal to take affect.

### *2.9.2.2 Closing delay*

The brake closing is delayed with defined time. If set to zero there is no delay between the brake closing condition and the actual brake closing.

## 4.10 SPEED REFERENCES

### *2.10.1-2.10.8 Speed references*

Eight different constant speeds are selected according to binary word formed through the digital inputs DIE1, DIE2 and DIE3. It is not necessary to use 3 inputs. DIE3 can for example be used for another function but then only 4 speed references will work.

Parameter P2.1.14 I/O reference has to be set to 5 (Binary coded inputs) to use this function.

| DIE [1,2,3] | Parameter | Speed Reference used |
|---|---|---|
| [0;0;0] | 2.10.1 | Speed reference 0 |
| [**1**;0;0] | 2.10.2 | Speed reference 1 |
| [0;**1**;0] | 2.10.3 | Speed reference 2 |
| [**1**;**1**;0] | 2.10.4 | Speed reference 3 |
| [0;0;**1**] | 2.10.5 | Speed reference 4 |
| [**1**;0;**1**] | 2.10.6 | Speed reference 5 |
| [0;**1**;**1**] | 2.10.7 | Speed reference 6 |
| [**1**;**1**;**1**] | 2.10.8 | Speed reference 7 |

*Table 16. Binary speed reference.*

## 4.11 KEYPAD CONTROL PARAMETERS

### *3.1 Control place*

The active control place can be changed with this parameter. For more information, see Vacon NXL User's Manual, Chapter 7.3.3.

### *3.2 Keypad reference*

The frequency reference can be adjusted from the keypad with this parameter. For more information, see Vacon NXL 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 NXL 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 (default). See Vacon NXL User's Manual, Chapter 7.3.3.

See also parameter 3.1.

# 5. CONTROL SIGNAL LOGIC IN THE BRAKE CONTROL APPLICATION

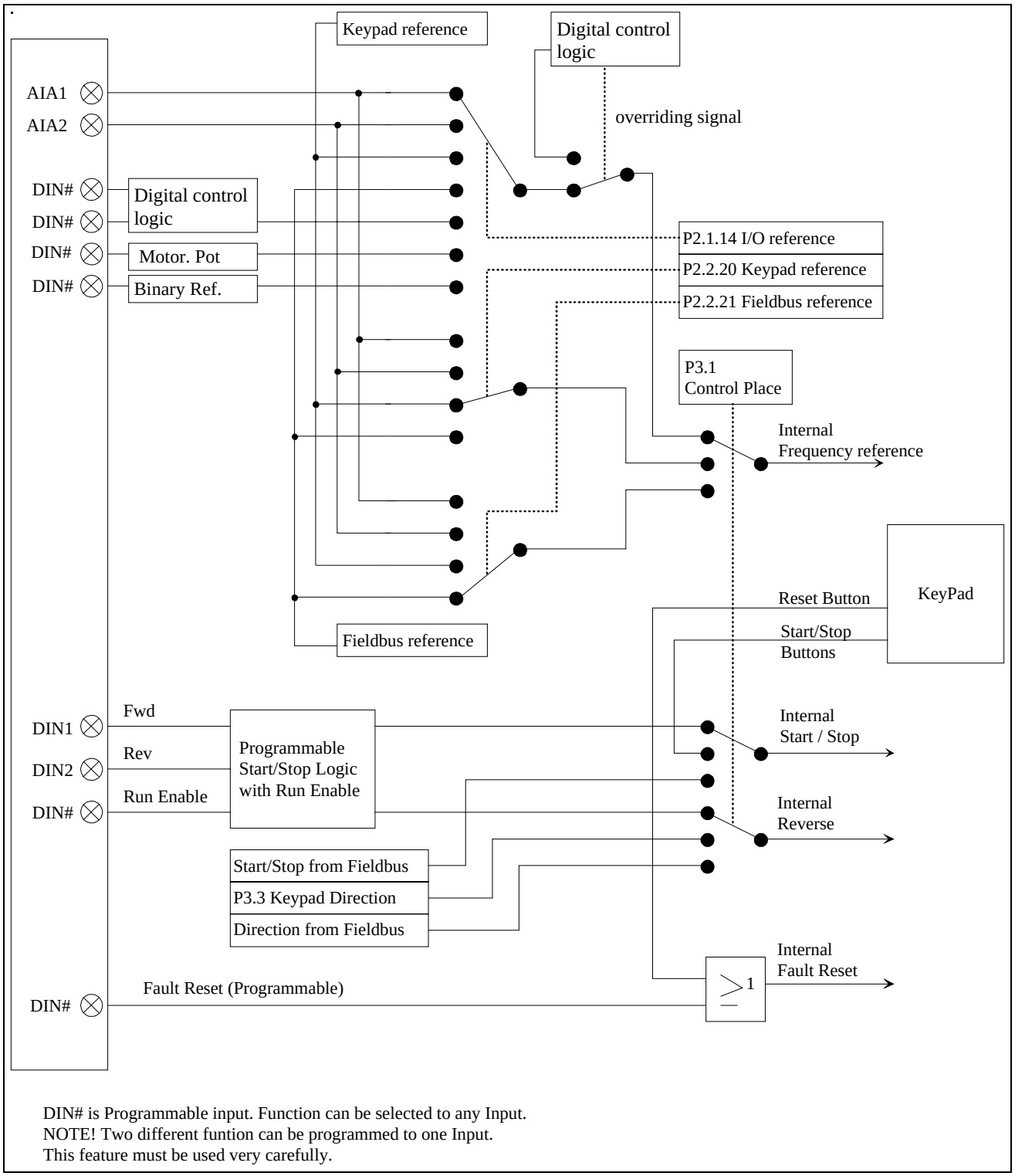



*Figure 26. Control signal logic of the Brake Control Application*

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