7. PUMP AND FAN CONTROL APPLICATION

Software code: ASFIFF07

7.1 Introduction

Select the Pump and Fan Control Application in menu **M6** on page *S6.2*.

The Pump and Fan Control Application can be used to control one variable speed drive and up to four auxiliary drives. The PID controller of the frequency converter controls the speed of the variable speed drive and gives control signals to start and stop the auxiliary drives to control the total flow. In addition to the eight parameter groups provided as standard, a parameter group for multi-pump and fan control functions is available.

The application has two control places on the I/O terminal. Place A is the pump and fan control and place B is the direct frequency reference. The control place is selected with input DIN6.

As already its name tells, the Pump and Fan Control Application is used to control the operation of pumps and fans. It can be used, for example, to decrease the delivery pressure in booster stations if the measured input pressure falls below a limit specified by the user.

The application utilizes external contactors for switching between the motors connected to the frequency converter. The autochange feature provides the capability of changing the starting order of the auxiliary drives. Autochange between 2 drives (main drive + 1 auxiliary drive) is set as default, see chapter 7.4.1.

- All inputs and outputs are freely programmable.

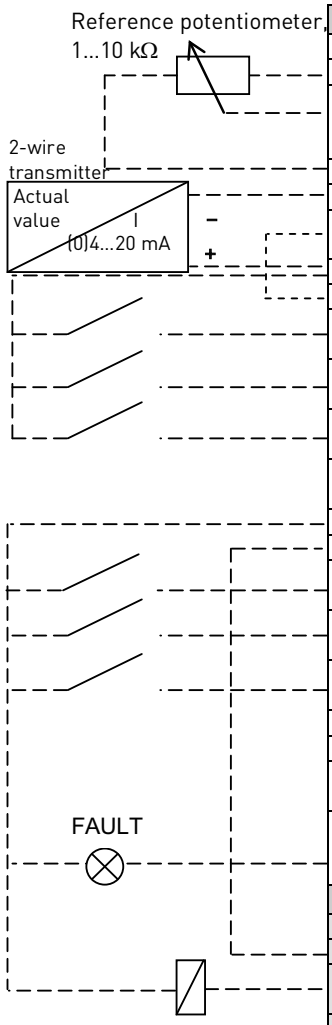
Additional functions:

- Analogue input signal range selection
- Two frequency limit supervisions
- Torque limit supervision
- Reference limit supervision
- Second ramps and S-shape ramp programming
- Programmable Start/Stop and Reverse logic
- DC-brake at start and stop
- Three prohibit frequency areas
- Programmable U/f curve and switching frequency
- Autorestart
- Motor thermal and stall protection: fully programmable; off, warning, fault
- Motor underload protection
- Input and output phase supervision
- Sleep function

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

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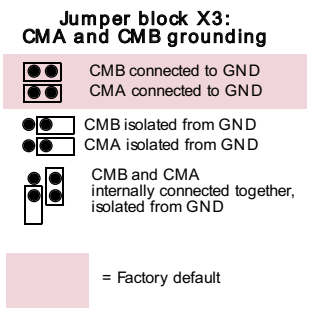
7.2 Control I/O



OPTA1			
Terminal		Signal	Description
1	+10V$_{ref}$	Reference output	Voltage for potentiometer, etc.
2	AI1+	Analogue input 1 Voltage range 0—10V DC	Analogue input 1 PID reference from I/O Default reference from keypad P3.4
3	AI1-	I/O Ground	Ground for reference and controls
4	AI2+	Analogue input 2 Current range 0—20mA Programmable (P2.2.1.9)	Analogue input 2 PID actual value 1
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	Place A: Start/Stop Programmable (G2.2.6)	Start signal for control place A PID Controller.
9	DIN2	Interlock 1 Programmable (G2.2.6)	Contact closed = Interlock used Contact open = Interlock not used
10	DIN3	Interlock 2 Programmable (G2.2.6)	Contact closed = Interlock used Contact open = Interlock not used
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	Place B: Start/Stop Programmable (G2.2.6)	Contact closed = Start
15	DIN5	Jogging speed selection Programmable (G2.2.6)	Contact closed = Jogging speed active
16	DIN6	Control place A/B selection Programmable (G2.2.6)	Contact open = Control place A is active Contact closed = Control place B is active
17	CMB	Common for DIN4—DIN6	Connect to GND or +24V
18	AO1+	Analogue output 1 Output frequency Programmable (P2.3.3.2)	See chapters 7.5.4.3, 7.5.4.4 and 7.5.4.5 Range 0—20 mA/R_L, max. 500Ω
19	AO1- (GND)		
20	DO1	Digital output FAULT Programmable (G2.3.1)	Open collector, I≤50mA, U≤48 VDC
OPTA2			
21	RO1	Relay output 1 Aux/Autochange 1 Programmable (G2.3.1)	See chapter 7.5.4.1
22	RO1		
23	RO1		
24	RO2	Relay output 2 Aux/Autochange 2 Programmable (G2.3.1)	See chapter 7.5.4.1
25	RO2		
26	RO2		

Table 7-1. Pump and fan control application default I/O configuration and connection example (with 2-wire transmitter).

Note: See jumper selections below. More information in the product's user's manual.



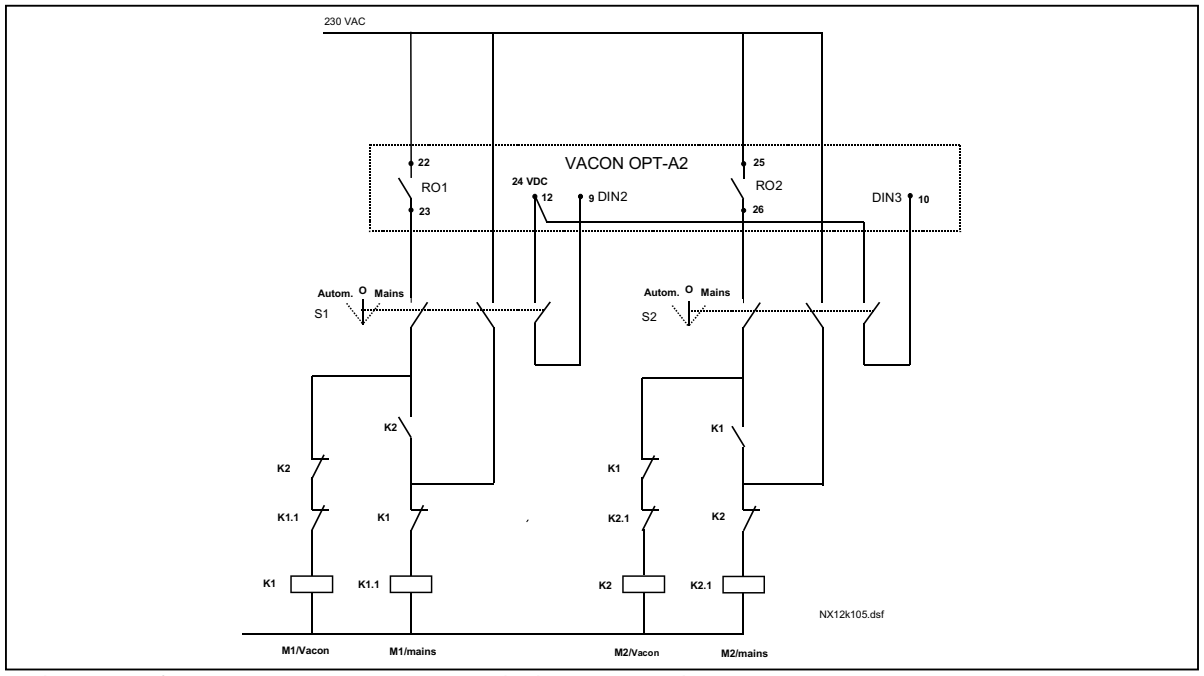


Figure 7-1. 2-pump autochange system, principal control diagram

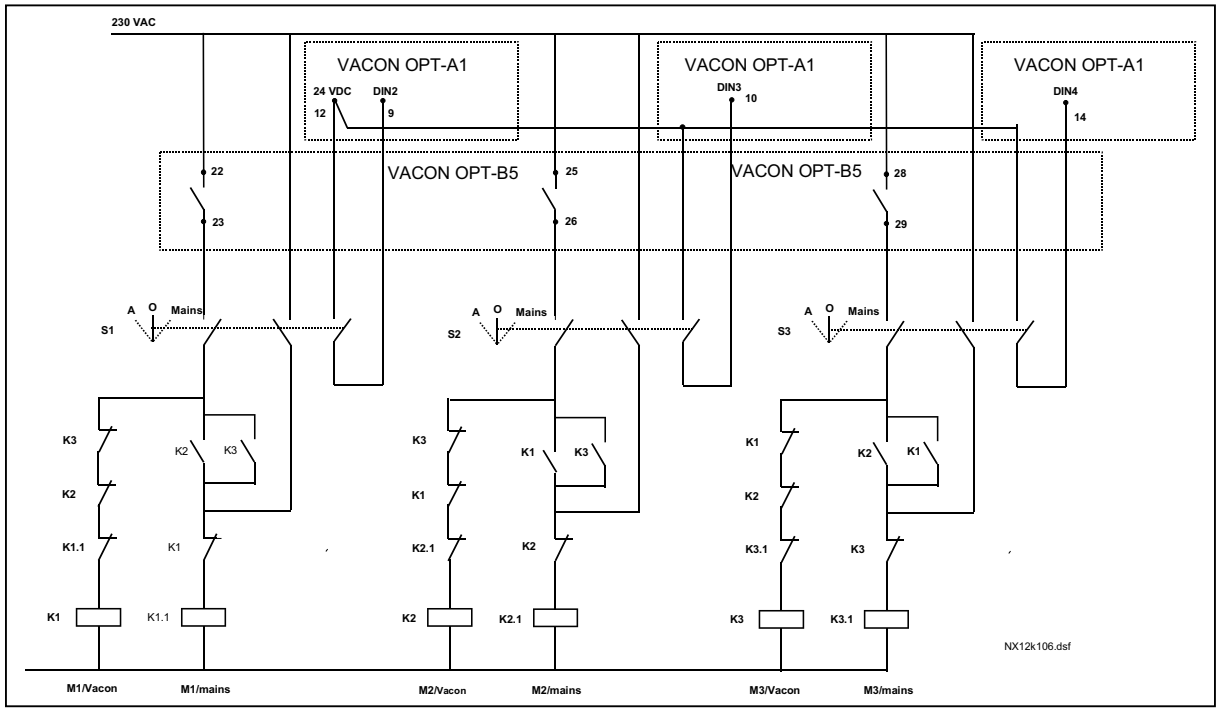


Figure 7-2. 3-pump autochange system, principal control diagram

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7.3 Control signal logic in Pump and Fan Control Application

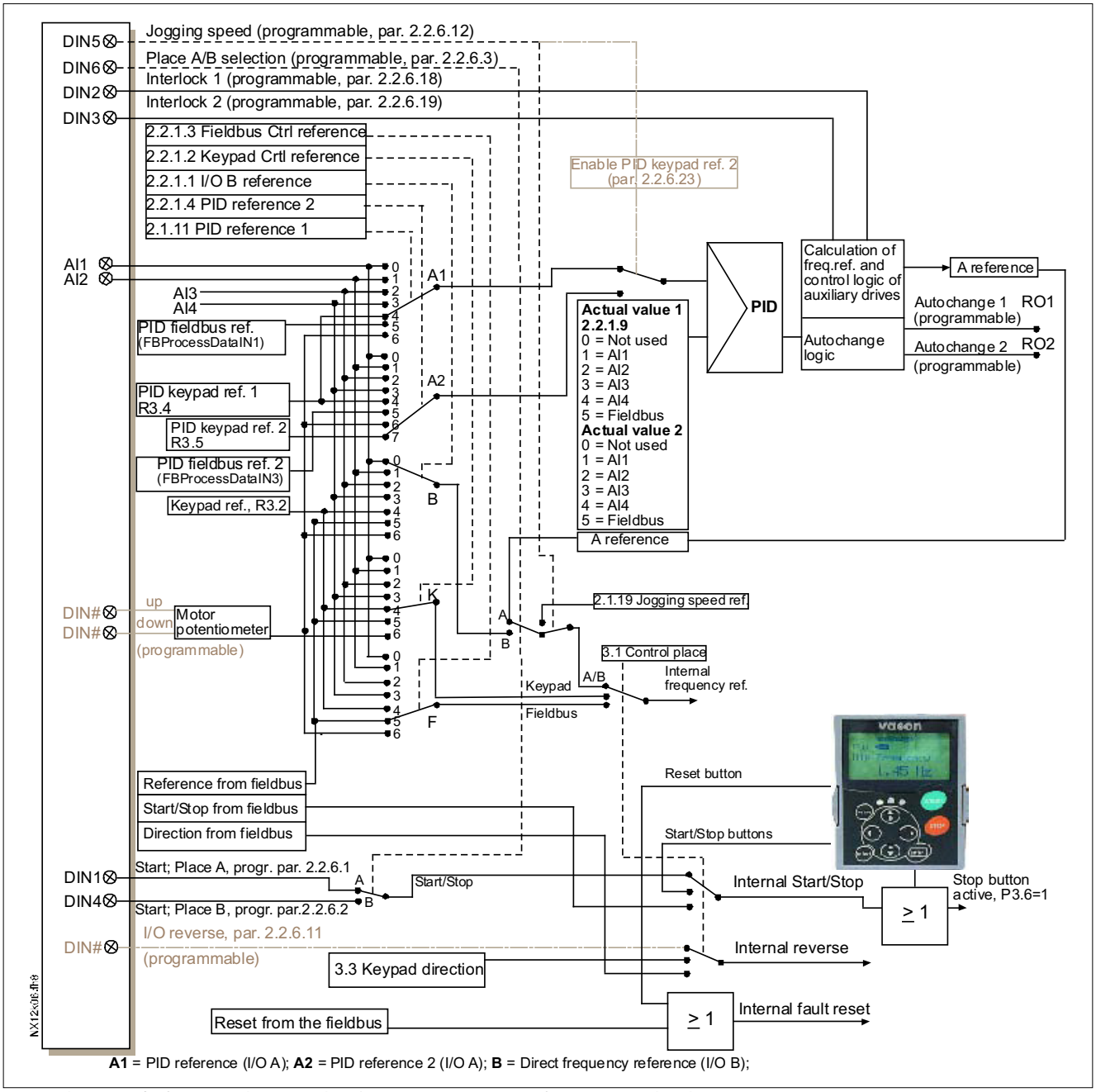


Figure 7-3. Control signal logic of the Pump and Fan Control Application

7.4 Short description of function and essential parameters

7.4.1 Automatic changing between drives (Autochange, P2.9.24)

The *Autochange function* allows the starting and stopping order of drives controlled by the pump and fan automatics to be changed at desired intervals. The drive controlled by frequency converter can also be included in the automatic changing and locking sequence (P2.9.25). The Autochange function makes it possible to equalize the run times of the motors and to prevent e.g. pump stalls due to too long running breaks.

- Apply the Autochange function with parameter 2.9.24, *Autochange*.
- The autochange takes place when the time set with parameter 2.9.26, *Autochange interval,* has expired and the capacity used is below the level defined with parameter 2.9.28, *Autochange frequency limit*.
- The running drives are stopped and re-started according to the new order.
- External contactors controlled through the relay outputs of the frequency converter connect the drives to the frequency converter or to the mains. If the motor controlled by the frequency converter is included in the autochange sequence, it is always controlled through the relay output activated first. The other relays activated later control the auxiliary drives (see Figure 7-5 and Figure 7-6).

Parameter 2.9.24, Autochange

0 Autochange not used
1 Autochange used

The automatic change of starting and stopping order is activated and applied to either the auxiliary drives only or the auxiliary drives **and** the drive controlled by the frequency converter. depending on the setting of parameter 2.9.25, *Automatics selection*. By default, the Autochange is activated for 2 drives. See Figure 7-1 and Figure 7-5.

Parameter 2.9.25, Autochange/Interlockings automatics selection

0 Automatics (autochange/interlockings) applied to auxiliary drives only

The drive controlled by the frequency converter remains the same. Therefore, mains contactor is needed for one auxiliary drive only.

1 All drives included in the autochange/interlockings sequence

The drive controlled by the frequency converter is included in the automatics and a contactor is needed for each drive to connect it to either the mains or the frequency converter.

Parameter 2.9.26, Autochange interval

After the expiry of the time defined with this parameter, the autochange function takes place if the capacity used lies below the level defined with parameters 2.9.28 (*Autochange frequency limit*) and 2.9.27 (*Maximum number of auxiliary drives*). Should the capacity exceed the value of P2.9.28, the autochange will not take place before the capacity goes below this limit.

- The time count is activated only if the Start/Stop request is active at control place A.
- The time count is reset after the autochange has taken place or on removal of Start request at control place A

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Parameters 2.9.27, Maximum number of auxiliary drives and 2.9.28, Autochange frequency limit

These parameters define the level below which the capacity used must remain so that the autochange can take place.
This level is defined as follows:

- If the number of running auxiliary drives is smaller than the value of parameter 2.9.27 the autochange function can take place.

- If the number of running auxiliary drives is equal to the value of parameter 2.9.27 and the frequency of the controlled drive is below the value of parameter 2.9.28 the autochange can take place.

- If the value of parameter 2.9.28 is 0.0 Hz, the autochange can take place only in rest position (Stop and Sleep) regardless of the value of parameter 2.9.27.

7.4.2 Interlock selection (P2.9.23)

This parameter is used to activate the interlock inputs. The interlocking signals come from the motor switches. The signals (functions) are connected to digital inputs which are programmed as interlock inputs using the corresponding parameters. The pump and fan control automatics only control the motors with active interlock data.

- The interlock data can be used even when the Autochange function is not activated
- If the interlock of an auxiliary drive is inactivated and another unused auxiliary drive available, the latter will be put to use without stopping the frequency converter.
- If the interlock of the controlled drive is inactivated, all motors will be stopped and re-started with the new set-up.
- If the interlock is re-activated in Run status, the automatics functions according to parameter 2.9.23, *Interlock selection*:

  0 Not used

  1 Update in stop

  Interlocks are used. The new drive will be placed last in the autochange line without stopping the system. However, if the autochange order now becomes, for example, [P1 → P3 → P4 → P2], it will be updated in the next Stop (autochange, sleep, stop, etc.)

  Example:

  [P1 → P3 → P4] → [P2 LOCKED] →[P1 → P3 → P4 → P2] → [SLEEP] → [P1 → P2 → P3 → P4]

  2 Stop & Update

  Interlockings are used. The automatics will stop all motors immediately and re-start with a new set-up

  Example:

  [P1 → P2 → P4] → [P3 LOCKED] → [STOP] → [P1 → P2 → P3 → P4]

  See Chapter 7.4.3, Examples.

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7.4.3 Examples

Pump and fan automatics with interlocks and no autochange

Situation: One controlled drive and three auxiliary drives.
Parameter settings: 2.9.1=3, 2.9.25=0
Interlock feedback signals used, autochange not used.
Parameter settings: 2.9.23=1, 2.9.24=0
The interlock feedback signals come from the digital inputs selected with parameters 2.2.6.18 to 2.2.6.21.
The Auxiliary drive 1 control (P2.3.1.27) is enabled through Interlock 1 (P2.2.6.18), the Auxiliary drive 2 control (P2.3.1.28) through Interlock 2 (P2.2.6.19) etc.

Phases:

1) The system and the motor controlled by the frequency converter are started.
2) The Auxiliary drive 1 starts when the main drive reaches the starting frequency set (P2.9.2).
3) The main drive decreases speed down to Auxiliary drive 1 Stop frequency (P2.9.3) and starts to rise toward the Start frequency of Auxiliary drive 2, if needed.
4) The Auxiliary drive 2 starts when the main drive has reached the starting frequency set (P2.9.4).
5) The Interlock feedback is removed from Aux. drive 2. Because the Aux. drive 3 is unused, it will be started to replace the removed Aux. drive 2.
6) The main drive increases speed to maximum because no more auxiliary drives are available.
7) The removed Aux.drive 2 is reconnected and placed last in the auxiliary drive start order which now is 1-3-2. The main drive decreases speed to the set Stop frequency. The auxiliary drive start order will be updated either immediately or in the next Stop (autochange, sleep, stop, etc.) according to P2.9.23.
8) If still more power is needed, the main drive speed rises up to the maximum frequency placing 100% of the output power in the system's disposal.

   When the need of power decreases, the auxiliary drives turn off in the opposite order (2-3-1; after the update 3-2-1).

Pump and fan automatics with interlocks and autochange

The above is also applicable if the autochange function is used. In addition to the changed and updated start order, also the change order of main drives depends on parameter 2.9.23.

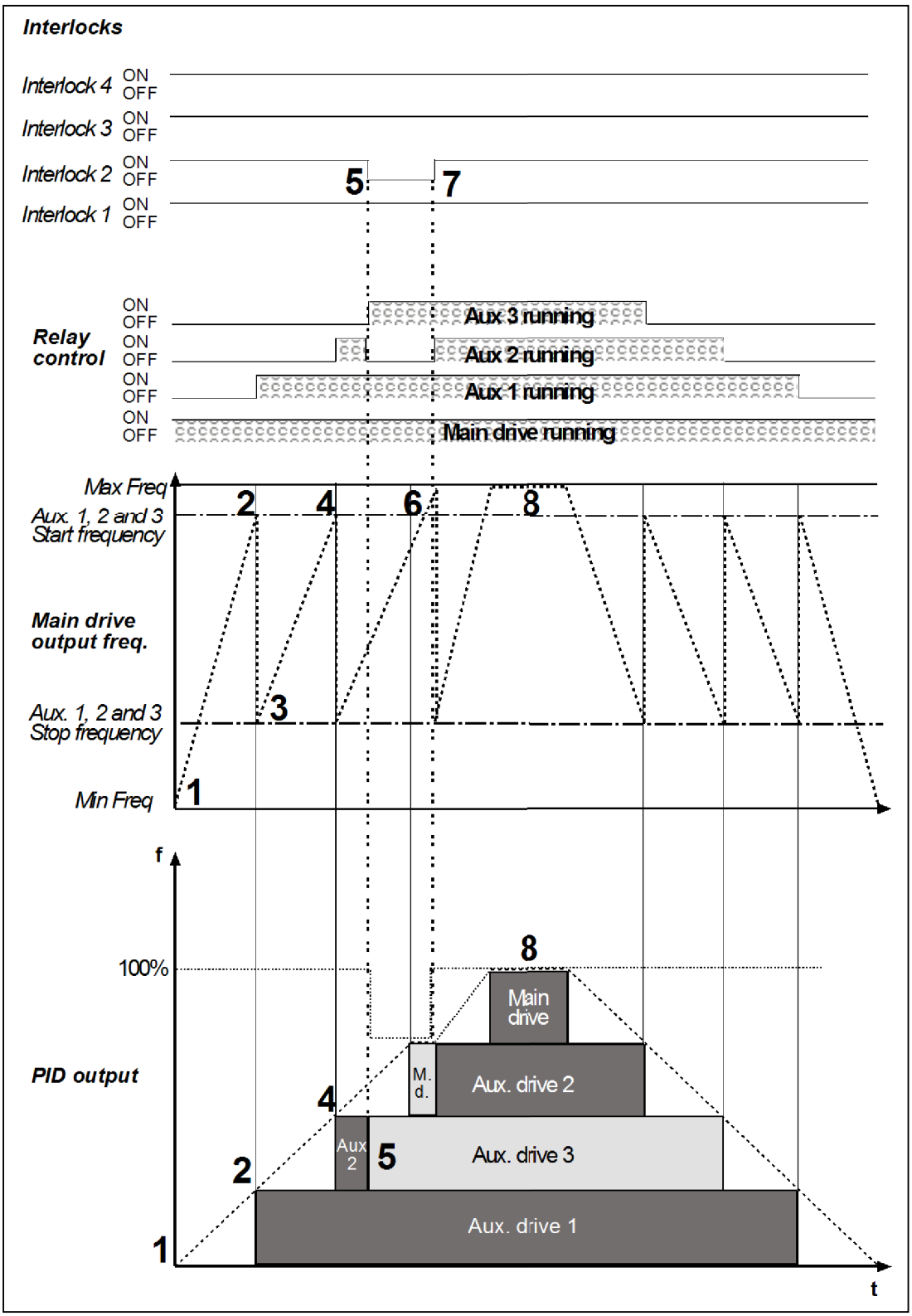


Figure 7-4. Example of the function of the PFC application with three aux. drives.

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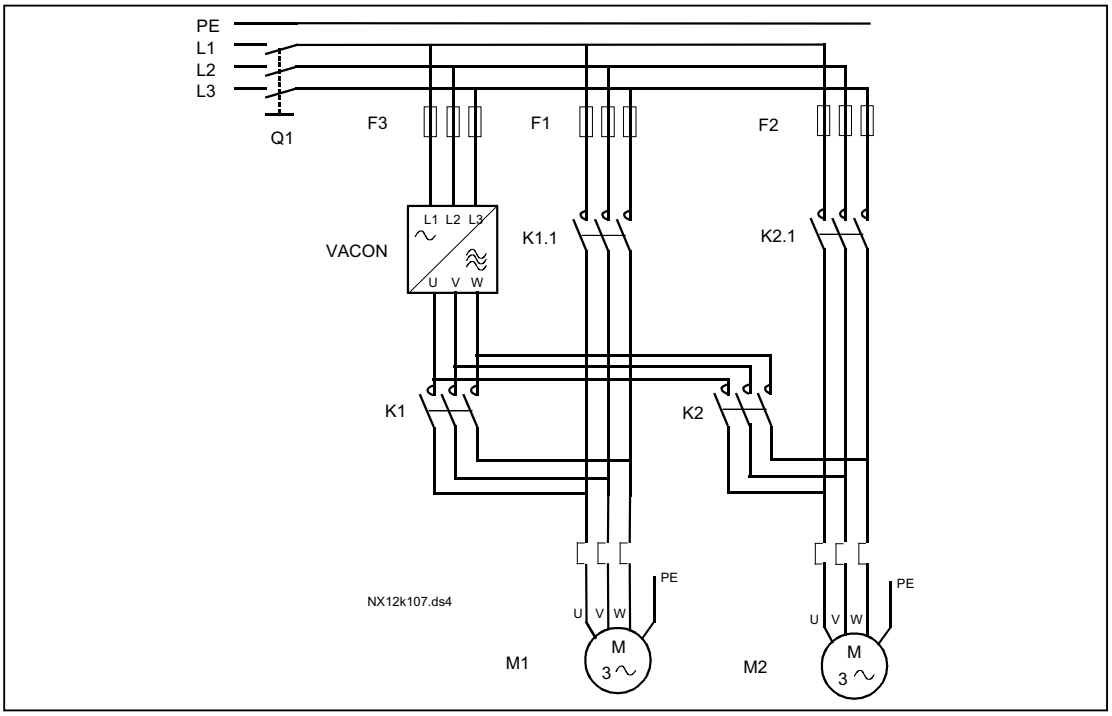


Figure 7-5. Example of 2-pump autochange, main diagram

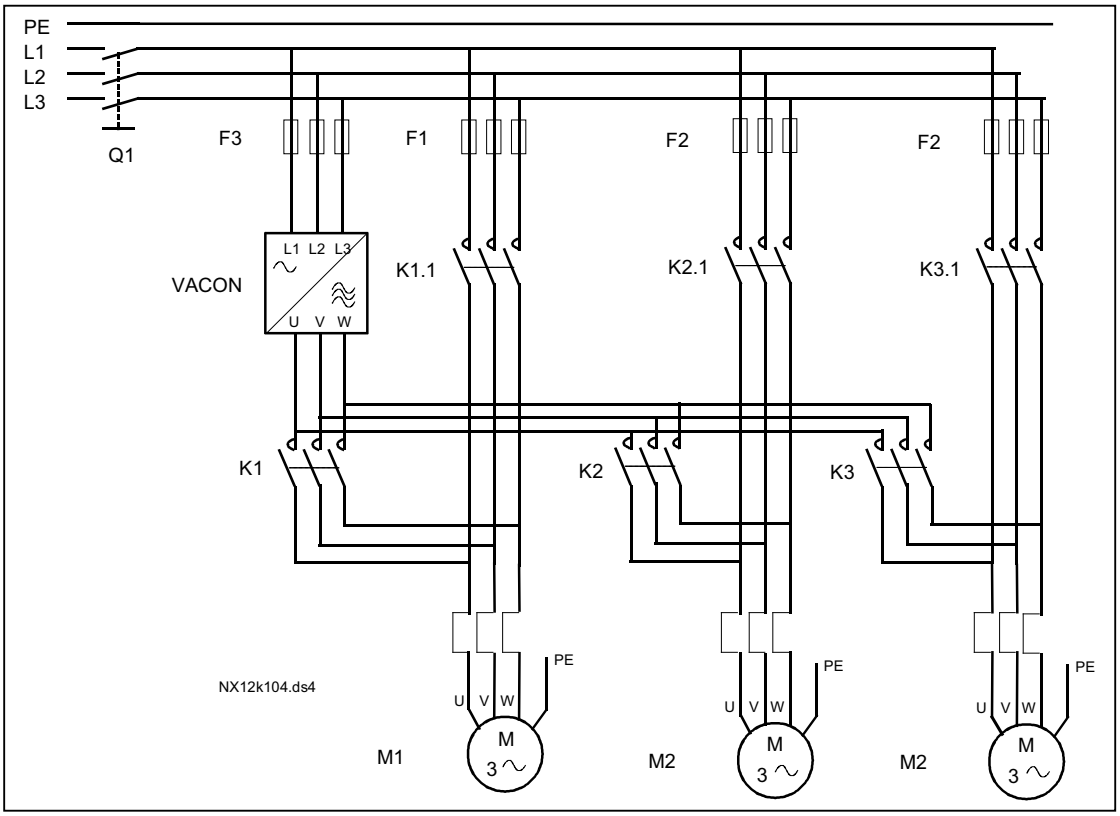


Figure 7-6. Example of 3-pump autochange, main diagram

7.5 Pump and Fan Control Application – Parameter lists

On the next pages you will find the lists of parameters within the respective parameter groups. The parameter descriptions are given on pages 124 to 217.

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 settings
ID = ID number of the parameter
= On parameter code: Parameter value can only be changed after the FC has been stopped.
= Apply the Terminal to Function method (TTF) to these parameters (see chapter 6.4)

7.5.1 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 the product's user's manual for more information. Note that the monitoring values V1.18 to V1.23 are available in the PFC control application only.

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	Calculated shaft torque
V1.6	Motor power	%	5	Motor shaft power
V1.7	Motor voltage	V	6	
V1.8	DC link voltage	V	7	
V1.9	Unit temperature	°C	8	Heatsink temperature
V1.10	Motor temperature	%	9	Calculated motor temperature
V1.11	Analogue input 1	V/mA	13	AI1 input value
V1.12	Analogue input 2	V/mA	14	AI2 input value
V1.13	DIN1, DIN2, DIN3		15	Digital input statuses
V1.14	DIN4, DIN5, DIN6		16	Digital input statuses
V1.15	Analogue I_{out}	mA	26	AO1
V1.16	Analogue input 3	V/mA	27	AI3 input value
V1.17	Analogue input 4	V/mA	28	AI4 input value
V1.18	PID Reference	%	20	In % of the max. frequency
V1.19	PID Actual value	%	21	In % of the max actual value
V1.20	PID Error value	%	22	In % of the max error value
V1.21	PID Output	%	23	In % of the max output value
V1.22	Running auxiliary drives		30	Number of running auxiliary drives
V1.23	Special display for actual value		29	See parameters 2.9.29 to 2.9.31
V1.24	PT-100 temperature	C°	42	Highest temperature of used PT100 inputs
G1.25	Multimonitoring items			Displays 3 selectable monitor. values

Table 7-2. Monitoring values

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

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.1.1	Min frequency	0,00	P2.1.2	Hz	0,00		101	
P2.1.2	Max frequency	P2.1.1	320,00	Hz	50,00		102	**NOTE**: If f_{max} > than the motor synchronous speed, check suitability for motor and drive system
P2.1.3	Acceleration time 1	0,1	3000,0	s	1,0		103	
P2.1.4	Deceleration time 1	0,1	3000,0	s	1,0		104	
P2.1.5	Current limit	0,1 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	8,00	320,00	Hz	50,00		111	Check the rating plate of the motor
P2.1.8	Nominal speed of the motor	24	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	0,1 x I_H	2 x I_H	A	I_H		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	PID controller reference signal (Place A)	0	6		4		332	**0**=AI1 **1**=AI2 **2**=AI3 **3**=AI4 **4**=PID ref from Keypad control page, P3.4 **5**=PID ref. from fieldbus (FBProcessDataIN1) **6**=Motor potentiometer
P2.1.12	PID controller gain	0,0	1000,0	%	100,0		118	
P2.1.13	PID controller I-time	0,00	320,00	s	1,00		119	
P2.1.14	PID controller D-time	0,00	10,00	s	0,00		132	
P2.1.15	Sleep frequency	0	P 2.1.2	Hz	10,00		1016	
P2.1.16	Sleep delay	0	3600	s	30		1017	
P2.1.17	Wake up level	0,00	100,00	%	25,00		1018	
P2.1.18	Wake up function	0	3		0		1019	**0**=Wake-up at fall below wake up level (P2.1.17) **1**=Wake-up at exceeded wake up level (P2.1.17) **2**=Wake-up at fall below wake up level (P3.4/3.5) **3**=Wake-up at exceeded wake up level (P3.4/3.5)
P2.1.19	Jogging speed reference	0,00	P2.1.2	Hz	10,00		124	

Table 7-3. Basic parameters G2.1

7.5.3 Input signals

7.5.3.1 Basic Settings (Control keypad: Menu M2 → G2.2.1)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.2.1.1	I/O B frequency reference selection	0	7		0		343	**0**=AI1 **1**=AI2 **2**=AI3 **3**=AI4 **4**=Keypad reference **5**=Fieldbus reference (FB SpeedReference) **6**=Motor potentiometer **7**=PID controller
P2.2.1.2	Keypad control reference selection	0	7		4		121	As in P2.2.1.1
P2.2.1.3	Fieldbus control reference selection	0	7		5		122	As in P2.2.1.1
P2.2.1.4	PID Reference 2	0	7		7		371	**0**=AI1 **1**=AI2 **2**=AI3 **3**=AI4 **4**=PID reference 1 from keypad **5**=Fieldbus reference (FBProcessDataIN3) **6**=Motor potentiometer **7**=PID reference 2 from keypad
P2.2.1.5	PID error value inversion	0	1		0		340	**0**=No inversion **1**=Inversion
P2.2.1.6	PID reference rising time	0,0	100,0	s	5,0		341	Time for reference value to change from 0% to 100%
P2.2.1.7	PID reference falling time	0,0	100,0	s	5,0		342	Time for reference value to change from 100% to 0%
P2.2.1.8	PID actual value selection	0	7		0		333	**0**=Actual value 1 **1**=Actual 1 + Actual 2 **2**=Actual 1 – Actual 2 **3**=Actual 1 * Actual 2 **4**=Max(Actual 1, Actual 2) **5**=Min(Actual 1, Actual 2) **6**=Mean(Actual1, Actual2) **7**=Sqrt (Act1) + Sqrt (Act2) See P2.2.1.9 and P2.2.1.10
P2.2.1.9	Actual value 1 selection	0	5		2		334	**0**=Not used **1**=AI1 (control board) **2**=AI2 (control board) **3**=AI3 **4**=AI4 **5**=Fieldbus (FBProcessDataIN2)
P2.2.1.10	Actual value 2 input	0	5		0		335	**0**=Not used **1**=AI1 (control board) **2**=AI2 (control board) **3**=AI3 **4**=AI4 **5**=Fieldbus (FBProcessDataIN3)
P2.2.1.11	Actual value 1 minimum scale	–1600,0	1600,0	%	0,0		336	**0**=No minimum scaling

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P2.2.1.12	Actual value 1 maximum scale	–1600,0	1600,0	%	100,0		337	**100**=No maximum scaling
P2.2.1.13	Actual value 2 minimum scale	–1600,0	1600,0	%	0,0		338	**0**=No minimum scaling
P2.2.1.14	Actual value 2 maximum scale	–1600,0	1600,0	%	100,0		339	**100**=No maximum scaling
P2.2.1.15	Motor potentiometer ramp time	0,1	2000,0	Hz/s	10,0		331	
P2.2.1.16	Motor potentiometer frequency reference memory reset	0	2		1		367	**0**=No reset **1**=Reset if stopped or powered down **2**=Reset if powered down
P2.2.1.17	Motor potentiometer PID reference memory reset	0	2		0		370	**0**=No reset **1**=Reset if stopped or powered down **2**=Reset if powered down
P2.2.1.18	B reference scale, minimum	0,00	320,00	Hz	0,00		344	**0**=Scaling off **>0**=Scaled min. value
P2.2.1.19	B reference scale, maximum	0,00	320,00	Hz	0,00		345	**0**=Scaling off **>0**=Scaled max. value

Table 7-4. Input signals, Basic settings

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

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.2.2.1	AI1 signal selection	0.1	E.10		A.1		377	TTF programming See chapter 6.4
P2.2.2.2	AI1 filter time	0,00	10,00	s	0,10		324	**0**=No filtering
P2.2.2.3	AI1 signal range	0	2		0		320	**0**=0—10 V (0—20 mA)* **1**=2—10 V (4—20 mA)* **2**=Customised*
P2.2.2.4	AI1 custom minimum setting	-160,00	160,00	%	0,00		321	
P2.2.2.5	AI1 custom maximum setting	-160,00	160,00	%	100,00		322	
P2.2.2.6	AI1 signal inversion	0	1		0		323	**0**=Not inverted **1**=Inverted

Table 7-5. Input signals, Analogue input 1

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

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.2.3.1	AI2 signal selection	0.1	E.10		A.2		388	TTF programming See chapter 6.4
P2.2.3.2	AI2 filter time	0,00	10,00	s	0,10		329	**0**=No filtering
P2.2.3.3	AI2 signal range	0	2		1		325	**0**=0—20 mA (0—10 V)* **1**=4—20 mA (2—10 V)* **2**=Customised*
P2.2.3.4	AI2 custom minimum setting	-160,00	160,00	%	0,00		326	
P2.2.3.5	AI2 custom maximum setting	-160,00	160,00	%	100,00		327	
P2.2.3.6	AI2 inversion	0	1		0		328	**0**=Not inverted **1**=Inverted

Table 7-6. Input signals, Analogue input 2

*Remember to place jumpers of block X2 accordingly.
See the product's User's Manual.

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

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.2.4.1	AI3 signal selection	0.1	E.10		0.1		141	TTF programming See chapter 6.4
P2.2.4.2	AI3 filter time	0,00	10,00	s	0,10		142	**0**=No filtering
P2.2.4.3	AI3 signal range	0	2		1		143	**0**=0—20 mA (0—10 V)* **1**=4—20 mA (2—10 V)* **2**=Customised*
P2.2.4.4	AI3 custom minimum setting	-160,00	160,00	%	0,00		144	
P2.2.4.5	AI3 custom maximum setting	-160,00	160,00	%	100,00		145	
P2.2.4.6	AI3 inversion	0	1		0		151	**0**=Not inverted **1**=Inverted

Table 7-7. Input signals, Analogue input 3

7.5.3.5 Analogue input 4, (Control keypad: Menu M2 → G2.2.5)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.2.5.1	AI4 signal selection	0.1	E.10		0.1		152	TTF programming See chapter 6.4
P2.2.5.2	AI4 filter time	0,00	10,00	s	0,10		153	**0**=No filtering
P2.2.5.3	AI4 signal range	0	2		1		154	**0**=0—20 mA (0—10 V)* **1**=4—20 mA (2—10 V)* **2**=Customised*
P2.2.5.4	AI4 custom minimum setting	-160,00	160,00	%	0,00		155	
P2.2.5.5	AI4 custom maximum setting	-160,00	160,00	%	100,00		156	
P2.2.5.6	AI4 inversion	0	1		0		162	**0**=Not inverted **1**=Inverted

Table 7-8. Input signals, Analogue input 4

*Remember to place jumpers of block X2 accordingly.
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7.5.3.6 Digital inputs (Control keypad: Menu M2 → G2.2.4)

Use TTF programming method for all these parameters. See chapter 6.4.

Code	Parameter	Min	Default	Cust	ID	Note
P2.2.6.1	Start A signal	0.1	A.1		423	
P2.2.6.2	Start B signal	0.1	A.4		424	
P2.2.6.3	Control place A/B selection	0.1	A.6		425	Control place A (oc) Control place B (cc)
P2.2.6.4	External fault (cc)	0.1	0.1		405	Ext. fault F51 displayed (cc)
P2.2.6.5	External fault (oc)	0.1	0.2		406	Ext. fault F51 displayed (oc)
P2.2.6.6	Run enable	0.1	0.2		407	Motor start enabled (cc)
P2.2.6.7	Acc/Dec time selection	0.1	0.1		408	Acc/Dec time 1 (oc) Acc/Dec time 2 (cc)
P2.2.6.8	Control from I/O terminal	0.1	0.1		409	Force control place to I/O terminal (cc)
P2.2.6.9	Control from keypad	0.1	0.1		410	Force control place to keypad (cc)
P2.2.6.10	Control from fieldbus	0.1	0.1		411	Force control place to fieldbus (cc)
P2.2.6.11	Reverse	0.1	0.1		412	Direction forward (oc) Direction reverse (cc)
P2.2.6.12	Jogging speed	0.1	A.5		413	Jogging speed selected for frequency reference (cc)
P2.2.6.13	Fault reset	0.1	0.1		414	All faults reset (cc)
P2.2.6.14	Acc/Dec prohibit	0.1	0.1		415	Acc/Dec prohibited (cc)
P2.2.6.15	DC braking	0.1	0.1		416	DC braking active (cc)
P2.2.6.16	Motor potentiometer reference DOWN	0.1	0.1		417	Mot.pot. reference decreases (cc)
P2.2.6.17	Motor potentiometer reference UP	0.1	0.1		418	Mot.pot. reference increases (cc)
P2.2.6.18	Autochange 1 Interlock	0.1	A.2		426	Activated if cc
P2.2.6.19	Autochange 2 Interlock	0.1	A.3		427	Activated if cc
P2.2.6.20	Autochange 3 Interlock	0.1	0.1		428	Activated if cc
P2.2.6.21	Autochange 4 Interlock	0.1	0.1		429	Activated if cc
P2.2.6.22	Autochange 5 Interlock	0.1	0.1		430	Activated if cc
P2.2.6.23	PID reference 2	0.1	0.1		431	Selected with P2.1.11 (oc) Selected with P2.2.1.4 (cc)

Table 7-9. Input signals, Digital inputs

cc = closing contact
oc = opening contact

7.5.4 Output signals

7.5.4.1 Digital output signals (Control keypad: Menu M2 → G2.3.1)

Use TTF programming method for all these parameters. See chapter 6.4.

Code	Parameter	Min	Default	Cust	ID	Note
P2.3.1.1	Ready	0.1	0.1		432	Ready to run
P2.3.1.2	Run	0.1	0.1		433	Running
P2.3.1.3	Fault	0.1	A.1		434	Drive in Fault state
P2.3.1.4	Inverted fault	0.1	0.1		435	Drive not in Fault state
P2.3.1.5	Warning	0.1	0.1		436	Warning active
P2.3.1.6	External fault	0.1	0.1		437	External fault active
P2.3.1.7	Reference fault/ warning	0.1	0.1		438	4 mA fault active
P2.3.1.8	Overtemperature warning	0.1	0.1		439	Drive overtemperature active
P2.3.1.9	Reverse	0.1	0.1		440	Output frequency < 0 Hz
P2.3.1.10	Unrequested direction	0.1	0.1		441	Ref <> Output frequency
P2.3.1.11	At speed	0.1	0.1		442	Ref = Output frequency
P2.3.1.12	Jogging speed	0.1	0.1		443	Jogging or preset speed command active
P2.3.1.13	External control place	0.1	0.1		444	IO control active
P2.3.1.14	External brake control	0.1	0.1		445	See explanations on page 166.
P2.3.1.15	External brake control, inverted	0.1	0.1		446	
P2.3.1.16	Output frequency limit 1 supervision	0.1	0.1		447	See ID315.
P2.3.1.17	Output frequency limit 2 supervision	0.1	0.1		448	See ID346.
P2.3.1.18	Reference limit supervision	0.1	0.1		449	See ID350.
P2.3.1.19	Drive temperature limit supervision	0.1	0.1		450	Drive temperature supervision. See ID354
P2.3.1.20	Torque limit supervision	0.1	0.1		451	See ID348.
P2.3.1.21	Motor thermal protection	0.1	0.1		452	Thermistor fault or wrng
P2.3.1.22	Analogue input supervision limit	0.1	0.1		463	See ID356
P2.3.1.23	Motor regulator activation	0.1	0.1		454	A limit controller is active
P2.3.1.24	Fieldbus DIN 1	0.1	0.1		455	
P2.3.1.25	Fieldbus DIN 2	0.1	0.1		456	
P2.3.1.26	Fieldbus DIN 3	0.1	0.1		457	
P2.3.1.27	Autochange 1/Aux 1 control	0.1	B.1		458	
P2.3.1.28	Autochange 2/Aux 2 control	0.1	B.2		459	
P2.3.1.29	Autochange 3/Aux 3 control	0.1	0.1		460	
P2.3.1.30	Autochange 4/Aux 4 control	0.1	0.1		461	
P2.3.1.31	Autochange 5	0.1	0.1		462	

Table 7-10. Output signals, Digital outputs

WARNING	Be ABSOLUTELY sure not to connect two functions to one and same output in order to avoid function overruns and to ensure flawless operation.

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7.5.4.2 Limit settings (Control keypad: Menu M2 → G2.3.2)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.3.2.1	Output frequency limit 1 supervision	0	2		0		315	0=No limit 1=Low limit supervision 2=High limit supervision
P2.3.2.2	Output freq. limit 1; Supervised value	0,00	320,00	Hz	0,00		316	
P2.3.2.3	Output frequency limit 2 supervision	0	2		0		346	0=No limit 1=Low limit supervision 2=High limit supervision
P2.3.2.4	Output freq. limit 2; Supervised value	0,00	320,00	Hz	0,00		347	
P2.3.2.5	Torque limit supervision	0	2		0		348	0=Not used 1=Low limit supervision 2=High limit supervision
P2.3.2.6	Torque limit supervision value	-300,0	300,0	%	100,0		349	
P2.3.2.7	Reference limit supervision	0	2		0		350	0=Not used 1=Low limit 2=High limit
P2.3.2.8	Reference limit supervision value	0,0	100,0	%	0,0		351	
P2.3.2.9	External brake-off delay	0,0	100,0	s	0,5		352	From brake off limits
P2.3.2.10	External brake-on delay	0,0	100,0	s	1,5		353	From Run request. Use time longer than P2.1.4
P2.3.2.11	FC temperature supervision	0	2		0		354	0=Not used 1=Low limit 2=High limit
P2.3.2.12	FC temperature supervised value	–10	100	°C	40		355	
P2.3.2.13	Supervised analogue input	0	3		0		372	0=AI1 1=AI2
P2.3.2.14	Analogue input limit supervision	0	2		0		373	0=No limit 1=Low limit supervision 2=High limit supervision
P2.3.2.15	Analogue input supervised value	0,00	100,00	%	0,00		374	

Table 7-11. Output signals, Limit settings

7.5.4.3 Analogue output 1 (Control keypad: Menu M2 → G2.3.3)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.3.3.1	Analogue output signal selection	0.1	E.10		A.1		464	TTF programming See chapter 6.4
P2.3.3.2	Analogue output function	0	14		1		307	**0**=Not used (20 mA / 10 V) **1**=Output freq. (0—f_{max}) **2**=Freq. reference (0—f_{max}) **3**=Motor speed (0—Motor nominal speed) **4**=Motor current (0—I_{nMotor}) **5**=Motor torque (0—T_{nMotor}) **6**=Motor power (0—P_{nMotor}) **7**=Motor voltage (0–U_{nMotor}) **8**=DC-link volt (0—1000V) **9**=PID controller ref. value **10**=PID contr. act.value 1 **11**=PID contr. act.value 2 **12**=PID contr. error value **13**=PID controller output **14**=PT100 temperature
P2.3.3.3	Analogue output filter time	0,00	10,00	s	1,00		308	**0**=No filtering
P2.3.3.4	Analogue output inversion	0	1		0		309	**0**=Not inverted **1**=Inverted
P2.3.3.5	Analogue output minimum	0	1		0		310	**0**=0 mA (0 V) **1**=4 mA (2 V)
P2.3.3.6	Analogue output scale	10	1000	%	100		311	
P2.3.3.7	Analogue output offset	–100,00	100,00	%	0,00		375	

Table 7-12. Output signals, Analogue output 1

7.5.4.4 Analogue output 2 (Control keypad: Menu M2 → G2.3.4)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.3.4.1	Analogue output 2 signal selection	0.1	E.10		0.1		471	TTF programming See chapter 6.4
P2.3.4.2	Analogue output 2 function	0	14		0		472	See P2.3.3.2
P2.3.4.3	Analogue output 2 filter time	0,00	10,00	s	1,00		473	**0**=No filtering
P2.3.4.4	Analogue output 2 inversion	0	1		0		474	**0**=Not inverted **1**=Inverted
P2.3.4.5	Analogue output 2 minimum	0	1		0		475	**0**=0 mA (0 V) **1**=4 mA (2 V)
P2.3.4.6	Analogue output 2 scale	10	1000	%	100		476	
P2.3.4.7	Analogue output 2 offset	–100,00	100,00	%	0,00		477	

Table 7-13. Output signals, Analogue output 2

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7.5.4.5 Analogue output 3 (Control keypad: Menu M2 → G2.3.5)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.3.5.1	Analogue output 3 signal selection	0.1	E.10		0.1		478	TTF programming See chapter 6.4
P2.3.5.2	Analogue output 3 function	0	14		0		479	See P2.3.3.2
P2.3.5.3	Analogue output 3 filter time	0,00	10,00	s	1,00		480	**0**=No filtering
P2.3.5.4	Analogue output 3 inversion	0	1		0		481	**0**=Not inverted **1**=Inverted
P2.3.5.5	Analogue output 3 minimum	0	1		0		482	**0**=0 mA (0 V) **1**=4 mA (2 V)
P2.3.5.6	Analogue output 3 scale	10	1000	%	100		483	
P2.3.5.7	Analogue output 3 offset	–100,00	100,00	%	0,00		484	

Table 7-14. Output signals, Analogue output 3

7.5.5 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	0,1		500	**0**=Linear **>0**=S-curve ramp time
P2.4.2	Ramp 2 shape	0,0	10,0	s	0,0		501	**0**=Linear **>0**=S-curve ramp time
P2.4.3	Acceleration time 2	0,1	3000,0	s	10,0		502	
P2.4.4	Deceleration time 2	0,1	3000,0	s	10,0		503	
P2.4.5	Brake chopper	0	4		0		504	**0**=Disabled **1**=Used when running **2**=External brake chopper **3**=Used when stopped/running **4**=Used when running (no testing)
P2.4.6	Start function	0	2		0		505	**0**=Ramp **1**=Flying start **2**=Conditional 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	0,00	I_L	A	0,7 x 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	1,50		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	0,00	I_L	A	I_H		519	

Table 7-15. Drive control parameters, G2.4

7.5.6 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	320,00	Hz	0,00		509	**0**=Not used
P2.5.2	Prohibit frequency range 1 high limit	0,00	320,00	Hz	0,00		510	**0**=Not used
P2.5.3	Prohibit frequency range 2 low limit	0,00	320,00	Hz	0,00		511	**0**=Not used
P2.5.4	Prohibit frequency range 2 high limit	0,00	320,00	Hz	0,00		512	**0**=Not used
P2.5.5	Prohibit frequency range 3 low limit	0,00	320,00	Hz	0,00		513	**0**=Not used
P2.5.6	Prohibit frequency range 3 high limit	0,00	320,00	Hz	0,00		514	**0**=Not used
P2.5.7	Prohibit acc./dec. ramp	0,1	10,0	x	1,0		518	

Table 7-16. Prohibit frequency parameters, G2.5

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

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.6.1	Motor control mode	0	1		0		600	**0**=Frequency control **1**=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	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 = P2.6.5
P2.6.8	Output voltage at zero frequency	0,00	40,00	%	Varies		606	n% x U_{nmot}
P2.6.9	Switching frequency	1,0	Varies	kHz	Varies		601	See Table 8-14 for exact values
P2.6.10	Overvoltage controller	0	2		1		607	**0**=Not used **1**=Used (no ramping) **2**=Used (ramping)
P2.6.11	Undervoltage controller	0	1		1		608	**0**=Not used **1**=Used
P2.6.12	Identification	0	1		0		631	**0**=No action **1**=Identification w/o run

Table 7-17. Motor control parameters, G2.6

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

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.7.1	Response to 4mA reference fault	0	5		4		700	0=No response 1=Warning 2=Warning+Previous Freq. 3=Wrng+PresetFreq 2.7.2 4=Fault,stop acc. to 2.4.7 5=Fault,stop by coasting
P2.7.2	4mA reference fault frequency	0,00	P2.1.2	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 undervoltage fault	0	1		0		727	0=Fault stored in history 1=Fault not stored
P2.7.6	Output phase supervision	0	3		2		702	0=No response 1=Warning 2=Fault,stop acc. to 2.4.7 3=Fault,stop by coasting
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	Varies		707	
P2.7.12	Motor duty cycle	0	150	%	100		708	
P2.7.13	Stall protection	0	3		1		709	0=No response 1=Warning 2=Fault,stop acc. to 2.4.7 3=Fault,stop by coasting
P2.7.14	Stall current	0,00	2 x I_H	A	I_H		710	
P2.7.15	Stall time limit	1,00	120,00	s	15,00		711	
P2.7.16	Stall frequency limit	1,0	P2.1.2	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	Field weakening area load	10	150	%	50		714	
P2.7.19	Zero frequency load	5,0	150,0	%	10,0		715	
P2.7.20	Underload protection time limit	2	600	s	20		716	
P2.7.21	Response to thermistor fault	0	3		2		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		2		733	See P2.7.21
P2.7.23	Response to slot fault	0	3		2		734	See P2.7.21
P2.7.24	No. of PT100 inputs	0	3		0		739	
P2.7.25	Response to PT100 fault	0	3		2		740	0=No response 1=Warning 2=Fault,stop acc. to 2.4.7 3=Fault,stop by coasting

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P2.7.26	PT100 warning limit	–30,0	200,0	C°	120,0		741	
P2.7.27	PT100 fault limit	–30,0	200,0	C°	130,0		742	

Table 7-18. Protections, G2.7

7.5.9 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 P2.4.6
P2.8.4	Number of tries after undervoltage trip	0	10		1		720	
P2.8.5	Number of tries after overvoltage trip	0	10		1		721	
P2.8.6	Number of tries after overcurrent trip	0	3		1		722	
P2.8.7	Number of tries after 4mA reference trip	0	10		1		723	
P2.8.8	Number of tries after motor temperature fault trip	0	10		1		726	
P2.8.9	Number of tries after external fault trip	0	10		0		725	
P2.8.10	Number of tries after underload fault trip	0	10		1		738	

Table 7-19. Autorestart parameters, G2.8

7.5.10 Pump and fan control parameters (Control keypad: Menu M2 → G2.9)

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P2.9.1	Number of auxiliary drives	0	4		1		1001	
P2.9.2	Start frequency, auxiliary drive 1	P2.9.3	320,00	Hz	51,00		1002	
P2.9.3	Stop frequency, auxiliary drive 1	P2.1.1	P2.9.2	Hz	10,00		1003	
P2.9.4	Start frequency, auxiliary drive 2	P2.9.5	320,00	Hz	51,00		1004	
P2.9.5	Stop frequency, auxiliary drive 2	P2.1.1	P2.9.4	Hz	10,00		1005	
P2.9.6	Start frequency, auxiliary drive 3	P2.9.7	320,00	Hz	51,00		1006	
P2.9.7	Stop frequency, auxiliary drive 3	P2.1.1	P2.9.6	Hz	10,00		1007	
P2.9.8	Start frequency, auxiliary drive 4	P2.9.9	320,00	Hz	51,00		1008	
P2.9.9	Stop frequency, auxiliary drive 4	P2.1.1	P2.9.8	Hz	10,00		1009	
P2.9.10	Start delay, auxiliary drives	0,0	300,0	s	4,0		1010	
P2.9.11	Stop delay, auxiliary drives	0,0	300,0	s	2,0		1011	
P2.9.12	Reference step, auxiliary drive 1	0,0	100,0	%	0,0		1012	
P2.9.13	Reference step, auxiliary drive 2	0,0	100,0	%	0,0		1013	
P2.9.14	Reference step, auxiliary drive 3	0,0	100,0	%	0,0		1014	
P2.9.15	Reference step, auxiliary drive 4	0,0	100,0	%	0,0		1015	
P2.9.16	PID controller bypass	0	1		0		1020	**1**=PID contr. bypassed
P2.9.17	Analogue input selection for input pressure measurement	0	5		0		1021	**0**=Not used **1**=AI1 **2**=AI2 **3**=AI3 **4**=AI4 **5**=Fieldbus signal (FBProcessDataIN3)
P2.9.18	Input pressure high limit	0,0	100,0	%	30,00		1022	
P2.9.19	Input pressure low limit	0,0	100,0	%	20,00		1023	
P2.9.20	Output pressure drop	0,0	100,0	%	30,00		1024	
P2.9.21	Frequency drop delay	0,0	300,0	s	0,0		1025	**0**=No delay **300**=No frequency drop nor increase
P2.9.22	Frequency increase delay	0,0	300,0	s	0,0		1026	**0**=No delay **300**=No frequency drop nor increase
P2.9.23	Interlock selection	0	2		1		1032	**0**=Interlocks not used **1**=Set new interlock last; update order after value of P2.9.26 or Stop state **2**=Stop and update order immediately

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P2.9.24	Autochange	0	1		1		1027	**0**=Not used **1**=Autochange used
P2.9.25	Autoch. and interl. automatics selection	0	1		1		1028	**0**=Auxiliary drives only **1**=All drives
P2.9.26	Autochange interval	0,0	3000,0	h	48,0		1029	**0,0**=TEST=40 s
P2.9.27	Autochange; Maximum number of auxiliary drives	0	4		1		1030	
P2.9.28	Autochange frequency limit	0,00	P2.1.2	Hz	25,00		1031	
P2.9.29	Actual value special display minimum	0	30000		0		1033	
P2.9.30	Actual value special display maximum	0	30000		100		1034	
P2.9.31	Actual value special display decimals	0	4		1		1035	
P2.9.32	Actual value special display unit	0	28		4		1036	See page 207.

Table 7-20. Pump and fan control parameters

7.5.11 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 product's user's manual.

Code	Parameter	Min	Max	Unit	Default	Cust	ID	Note
P3.1	Control place	1	3		1		125	**1**=I/O terminal **2**=Keypad **3**=Fieldbus
R3.2	Keypad reference	P2.1.1	P2.1.2	Hz				
P3.3	Direction (on keypad)	0	1		0		123	**0**=Forward **1**=Reverse
P3.4	PID reference 1	0,00	100,00	%	0,00		167	
P3.5	PID reference 2	0,00	100,00	%	0,00		168	
R3.6	Stop button	0	1		1		114	**0**=Limited function of Stop button **1**=Stop button always enabled

Table 7-21. Keypad control parameters, M3

7.5.12 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 the product's user's manual.

7.5.13 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 the product's user's manual.