PowerXL™

DA1 Variable Frequency Drives
PID Controller

Level 3	1 – Fundamental – No previous experience necessary 2 – Basic – Basic knowledge recommended 3 – Advanced – Reasonable knowledge required 4 – Expert – Good experience recommended

Powering Business Worldwide

Content

Danger! - Dangerous electrical voltage!

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally restarted.
- Verify isolation from the supply.
- Cover or enclose any adjacent live components.
- Follow the engineering instructions (AWA/IL) for the device concerned.
- Only suitably qualified personnel in accordance with EN 50110-1/-2 (VDE 0105 Part 100) may work on this device/system.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE, PES) must be connected to the protective earth (PE) or the potential equalization. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference does not impair the automatic control functions.
- Suitable safety hardware and software measures should be implemented for the I/O interface so that an open circuit on the signal side does not result in undefined states.
- Deviations of the mains voltage from the rated value must not exceed the tolerance limits given in the specification, otherwise this may cause malfunction and/or dangerous operation.
- Emergency stop devices complying with IEC/EN 60204-1 must be effective in all operating modes. Unlatching of the emergency-stop devices must not cause a restart.
- Devices that are designed for mounting in housings or control cabinets must only be operated and controlled after they have been properly installed and with the housing closed.
- Wherever faults may cause injury or material damage, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (e.g. by means of separate limit switches, mechanical interlocks etc.).
- Frequency inverters may have hot surfaces during and immediately after operation.
- Removal of the required covers, improper installation or incorrect operation of motor or frequency inverter may destroy the device and may lead to serious injury or damage.
- The applicable national safety regulations and accident prevention recommendations must be applied to all work carried on live frequency inverters.
- The electrical installation must be carried out in accordance with the relevant electrical regulations (e. g. with regard to cable cross sections, fuses, PE).
- Transport, installation, commissioning and maintenance work must be carried out only by qualified personnel (IEC 60364, HD 384 and national occupational safety regulations).
- Installations containing frequency inverters must be provided with additional monitoring and protective devices in accordance with the applicable safety regulations. Modifications to the frequency inverters using the operating software are permitted.
- All covers and doors must be kept closed during operation.
- To reduce the hazards for people or equipment, the user must include in the machine design measures that restrict the consequences of a malfunction or failure of the frequency inverter (increased motor speed or sudden standstill of motor). These measures include: – Other independent devices for monitoring safety related variables (speed, travel, end positions etc.).
  – Electrical or non-electrical system-wide measures (electrical or mechanical interlocks).
  – Never touch live parts or cable connections of the frequency inverter after it has been disconnected from the power supply. Due to the charge in the capacitors, these parts may still be alive after disconnection. Consider appropriate warning signs.

Disclaimer

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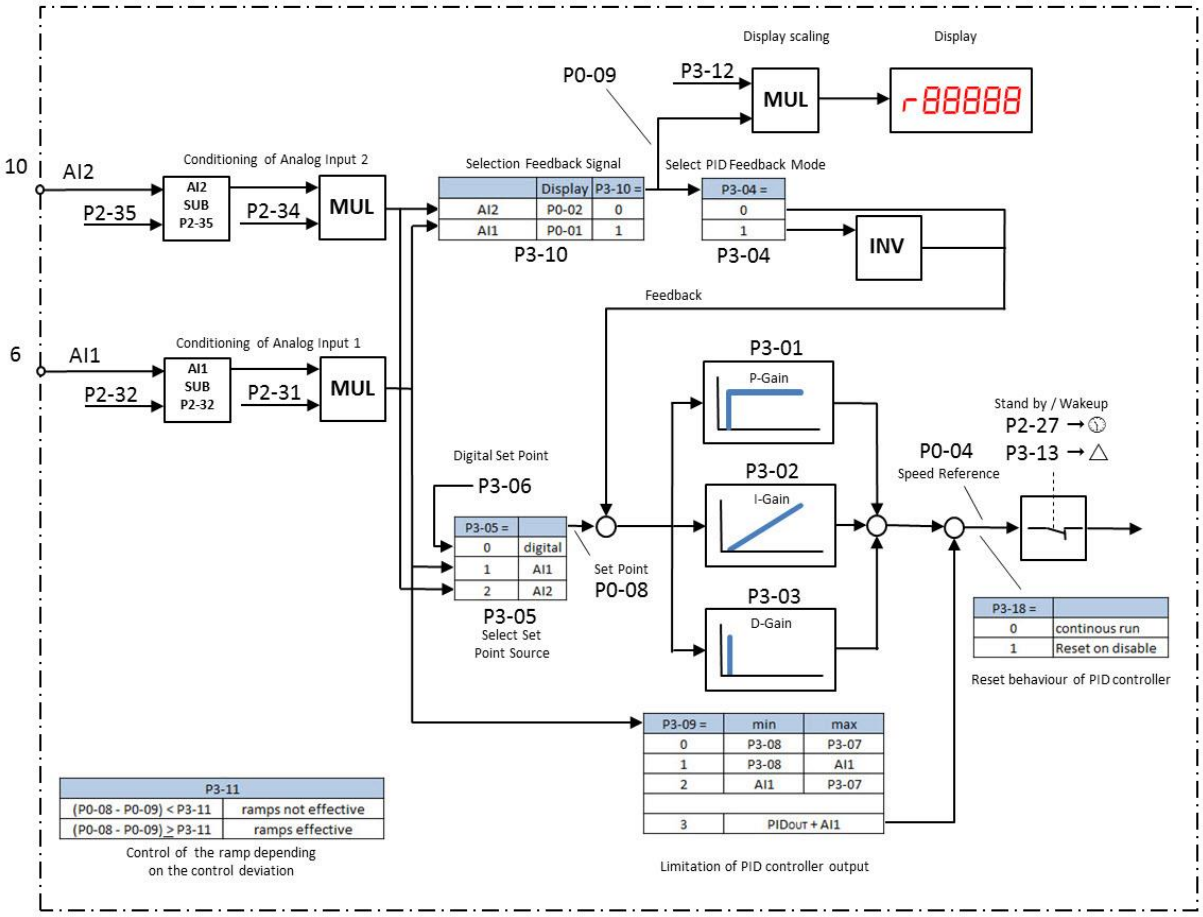
General

Variable Frequency Drives of the series **PowerXL™ DA1** have an internal PID controller, which enables the control of the motor speed depending on process variables like pressure or temperature.

General structure:



This Application Note describes

- the function of the specific parameters
- the mode of operation
- application examples

Some required parameters are inside Level 2 of the menu. This level has to be activated by prompting the „Password Level2“ (P2-40) into P1-14 (Password). Password Level2 is „101“ by default.

The functions described here, refer to an application software version 2.0 and above (see parameter P0-79).

Controller Topology

To operate the PID controller a selection with parameter P1-12 is necessary. In addition the controller topology can be defined with P3-09.

ProcessDataAccess (P1-12)

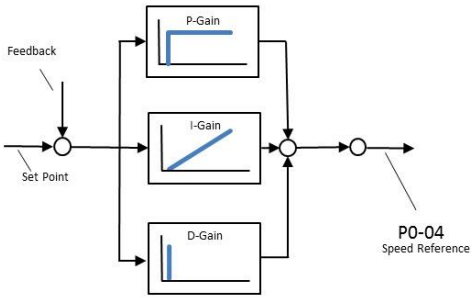
The PID controller of the devices DA1 operates with the setting P1-12 = 3.

PNU	Parameter	Name	Range	Default
928.0	P1-12	ProcessDataAccess	0: Terminal control 1: digital reference, 1 direction 2: digital reference, 2 directions 3: PID controller 4: Fieldbus control 5: Slave mode 6: CANopen 7: Reserved 8: Reserved 9: SWD control + reference 10: SWD control 11: SWD reference 12: not allowed 13: SWD control + reference, enable	0

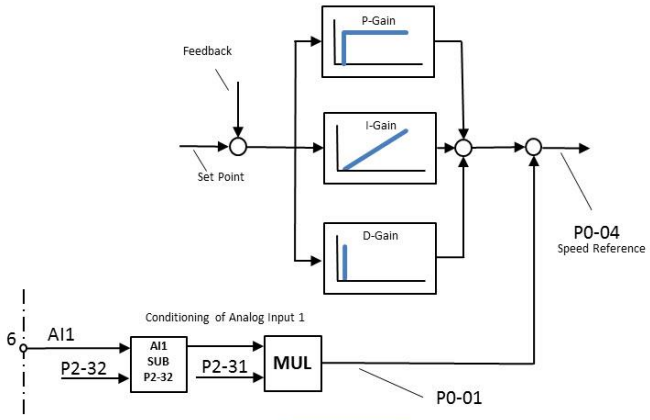
PID1 OutLimitSelect (P3-09)

In most of the cases the output of the PID controller is the speed reference for the drive. It is also possible to use the output of the PID controller as a correction value.

P3-09 = 0 … 2 → The output signal of the PID controller is the speed reference for the motor.
P3-09 = 3 → The output signal of the PID controller is a correction value and is added to the value coming from the Analog Input 1 (AI1).



P3-09 = 0, 1, 2



P3-09 = 3

Terminal configuration

The configuration of the terminals can be selected with P1-13 “DI Config Select” out of predefined sets. The assignment changes with the setting of P1-12. For PID controller operation the configuration is as follows:

P1-12 = 3: PID Controller					
P1-13	DI1 (Terminal 2)	DI2 (Terminal 3)	DI3 (Terminal 4)	DI4/AI1 (Terminal 6)	DI5/AI2 (Terminal 10)
0	user defined	user defined	user defined	user defined	user defined
1	not allowed				
2	not allowed				
3	START	DIR	Select PID REF / f-Fix1	defined by P3-05 / P3-10	defined by P3-05 / P3-10
4	not allowed				
5	START	DIR	Select PID REF / AI2 REF	PID feedback (P3-10 = 1)	AI2 REF
6	START	DIR	Select PID REF / f-Fix1	PID feedback (P3-10 = 1)	EXTFLT
7	not allowed				
8	not allowed				
9	not allowed				
10	not allowed				
11	not allowed				
12	not allowed				
13	FWD	REV	Select PID REF / f-Fix1	defined by P3-05 / P3-10	defined by P3-05 / P3-10
14	not allowed				
15	FWD	REV	Select PID REF / AI2 REF	PID feedback (P3-10 = 1)	AI2 REF
16	FWD	REV	Select PID REF / f-Fix1	PID feedback (P3-10 = 1)	EXTFLT
17	not allowed				
18	not allowed				
19	not allowed				
20	not allowed				
21	not allowed				

With P1-13 = 0 the function of the terminals can be arbitrarily defined in Menu 9. Following conditions have to be noted:

- Digital inputs → terminals 2 / 3 / 4 / 6 / 10
- Analog inputs → terminals 6 / 10
- External fault (EXTFLT) → always terminal 10

Terminals 6 and 10 can be used as analog and digital inputs. By selecting the terminal configuration, they are configured (digital or analog) automatically.

Abbreviations used:

AI2 REF	The signal at Analog Input AI2 (Terminal 10) is used as set point value. P2-33: Configuration (voltage input / current input …) P2-34: Scaling P2-35: Offset
defined by P3-05 / P3-10	The function depends on the settings of P3-05 and P3-10.
DIR	Is used in combination with the START command to select the sense of rotation. LOW = forward (FWD) HIGH = reverse (REV) ATTENTION: In case of wire break and when reverse operation is selected, it leads to a reversion of rotation. Alternative: Use configuration with FWD/REV.
EXTFLT	External fault. Enables the inclusion of an external signal into the fault messages of the drive. During operation a High signal has to be present at the terminal. A Low signal leads to a trip of the drive with the message „E-tr iP“.

FWD	START of the drive (FWD = Forward). With a High signal at the respective terminal the drive accelerates with the ramp set with P1-03. A disconnection if the signal leads to standstill . The behavior depends on the setting of P1-05 (Stop Mode). At standstill the drive is disabled. In applications with two directions “forward” is selected with FWD. If the signals FWD and REV are applied to the terminals at the same time, the drive stops with the quick stop ramp defined by P2-25.
PID Feedback (P3-10 = 1)	Feedback signal of the PID controller, when selected with P3-10.
REV	START of the drive (REV = Reverse). With a high signal at the respective terminal the drive accelerates with the ramp set with P1-03. A disconnection if the signal leads to standstill . The behavior depends on the setting of P1-05 (Stop Mode). At standstill the drive is disabled. In applications with two directions “reverse” is selected with REV. If the signals FWD and REV are applied to the terminals at the same time, the drive stops with the quick stop ramp defined by P2-25.
Select PID REF / AI2 REF	Selection between references. Low = Reference from PID controller output, High = AI2
Select PID REF / f-Fix1	Selection between references. Low = Reference from PID controller output, High = = f-Fix1, set with P2-01
START	Starts and stops the drive. When applying a High signal to the respective terminal, the drive accelerates with the selected ramp. A disconnection of the signal leads to a standstill. The behavior depends on the setting of P1-05 (Stop Mode). At standstill the drive is disabled. In applications with two directions, they are selected with the command DIR.

Connection of transducers

The connection of analog transducers has to be done according the drawings below.

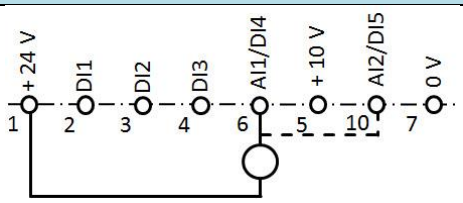
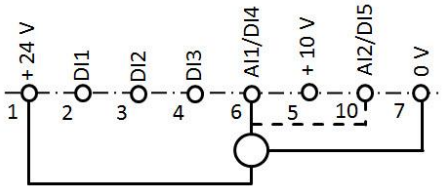
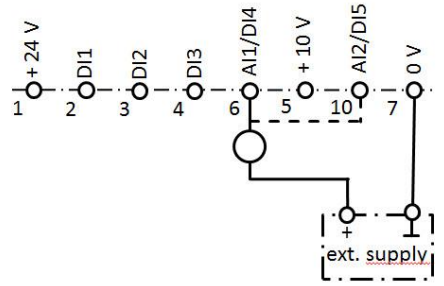
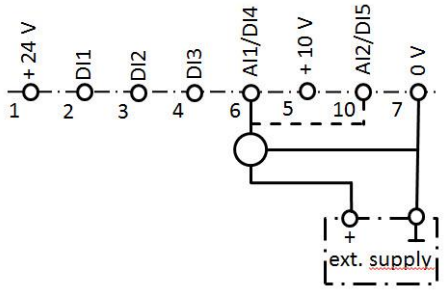
Internal burden for a current signal: 500 Ω

In case the transducer is supplied from the drive it has to be noted, that the transducer is rated for a 24 V supply.

The terminal, to which the transducer is connected, depends on the selection with P3-10

P3-10 = 0 → Terminal 10 (AI2)

P3-10 = 1 → Terminal 6 (AI1)

Kind of transducer	Connection
2 wire transducer Supply from DA1	
3 wire transducer Supply from DA1	
2 wire transducer External supply	
3 wire transducer External supply	

Analog Inputs

Depending on the selected terminal configuration, up to two analog inputs are available. They are used as reference and feedback input and, in case of P1-13 = 3 respectively 13, for the connection of the speed reference which can be used as an alternative to the PID controller. Both inputs can be adapted to the format (voltage or current) of the connected signal.

It is possible to scale the input signal and to consider an offset. This can be used to adapt the feedback signal to the transducer.

- Signal Range: Selection of the kind of signal at the analog input. The maximum value of the signal corresponds to the maximum speed / frequency set with P1-01.
- Gain: With the gain the analog input can be scaled. It applies to the value at AI1 respectively AI2 and as well as to the offset.
- Offset: Offset of the analog input. 100.0 % corresponds to the maximum speed / frequency set with P1-01.
    - ATTENTION: the offset is subtracted from the value at terminal 6 respectively 10. Means: positive values result in a reduction, negative ones in an increase.

Analog Input 1 (AI1 Signal Range (P2-30), AI1 Gain (P2-31), AI1 Offset (P2-32))

PNU	Parameter	Name	Range	Default
260.0	P2-30	AI1 Signal Range	0: 0 … 10 V (U 0- 10) 1: 10 … 0 V (U 10-0) 2: bipolar 0 … 10 V (- 10- 10) 3: 0 … 20 mA (A 0-20) 4: t 4 … 20 mA (trip in case of wire break) (t 4-20) 5: r 4 … 20 mA (ramps to f-Fix8 (P2-08) in case of wire break) (r 4-20) 6: t 20 … 4 mA (trip in case of wire break) (t 20-4) 7: r 20 … 4 mA (ramps to f-Fix8 (P2-08) in case of wire break)) (r 20-4)	0
261.0	P2-31	AI1 Gain	0.0 … 500.0 %	2000.0 %
262.0	P2-32	AI1 Offset	-500.0 % … + 500.0 %	0.0 %

Analog Input 2 (AI2 Signal Range (P2-33), AI2 Gain (P2-34), AI2 Offset (P2-35))

PNU	Parameter	Name	Range	Default
260.1	P2-33	AI2 Signal Range	0: 0 … 10 V (U 0- 10) 1: 10 … 0 V (U 10-0) 2: Thermistor (PtC-th) 3: 0 … 20 mA (A 0-20) 4: t 4 … 20 mA (trip in case of wire break) (t 4-20) 5: r 4 … 20 mA (ramps to f-Fix8 (P2-08) in case of wire break) (r 4-20) 6: t 20 … 4 mA (trip in case of wire break) (t 20-4) 7: r 20 … 4 mA (ramps to f-Fix8 (P2-08) in case of wire break)) (r 20-4)	0
261.1	P2-34	AI2 Gain	0.0 … 500.0 %	2000.0 %
262.1	P2-35	AI2 Offset	-500.0 % … + 500.0 %	0.0 %

Set Point

There are two possibilities to indicate the set point value

- with Parameter P3-06 (PID1 Set Point Digital) as a fixed value. 100.0 % corresponds to the maximum value of the feedback signal.
- via the analog inputs AI1 and AI2, taking scaling and offset into account.

Selection with Parameter P3-05 (PID1 Set Point 1 Source)

PID1 Set Point 1 Source (P3-05), PID1 Set Point Digital (P3-06)

PNU	Parameter	Name	Range	Default
2110.0	P3-05	PID1 Set Point 1 Source	0: digital set point, set with P3-06 1: Analog Input 1 (AI1, T 6) 2: Analog Input 2 (AI2, T 10)	0
2111.0	P3-06	PID1 Set Point Digital	Digital set point of the PID controller in case P3-05 = 0 0.0 … 100.0 %	0.0 %

Feedback

The feedback signal comes from analog transducers via terminals. The selection of the respective terminal is done with Parameter P3-10 (PID1 Feedback 1 Source). In addition it is possible to select with P3-04 (PID1 Mode), if an increase of the feedback signal leads to a reduction of the speed (direct mode) or to an increase (inverse mode). See examples.

PID1 Mode (P3-04), PID1 Feedback 1 Source (P3-10)

PNU	Parameter	Name	Range	Default
2123.0	P3-04	PID1 Mode	0: direct mode 1: inverse mode	0
2112.0	P3-10	PID1 Feedback 1 Source	0: Analog Input 2 (AI2, Kl. 10) 1: Analog Input 1 (AI1, Kl. 6)	0

PID1 Feedback 1 DispScale (P3-12)

The displayed value can be changed by pressing the **OK** button multiple times. It is possible to display the feedback value in units like bar etc. At the beginning of the line „⌐“ appears.

PNU	Parameter	Name	Range	Default
2113.0	P3-12	PID1 Feedback 1 DispScale	0.000…50.000	0.000

Example: At 100 % of the feedback „27.8“ shall be displayed.
P3-12 = 27.8 / 100 % = 0.278

Gain / Time Constant

PID1 Kp (P3-01), PID1 Ti (P3-02), PID1 Kd (P3-03)

The proportional gain Kp is set with P3-01. Higher values provide a greater change in the drive output frequency in respond to small changes in the feedback signal. Too high values can cause instability.

The integral time constant Ti is set with P3-02. Larger values provide a more damped response for systems where the overall process responds slowly.

The differential time constant is set with P3-03.

PNU	Parameter	Name	Range	Default
2100.0	P3-01	PID1 Kp	0.0 … 30.0	1.0
2101.0	P3-02	PID1 Ti	0.0 … 30.0 s	1.0 s
2102.0	P3-03	PID1 Kd	0.00…1.00 s	0.00 s

The right values for P3-01, P3-02 and P3-03 have to be evaluated during commissioning, because they strongly depend on the application. Inertias and time constants play an important role. Setting a value to 0.0 disables that certain part.

Control of the ramp depending on the control deviation

The output of the PID controller generates the speed reference, taking into account the ramp times set with P1-03 (t-acc) and P1-04 (t-dec). On one side one wants to react immediately to control deviations (set point value – feedback value), on the other side this can lead to instability of the system up to possible trips because of overvoltage and overcurrent. Parameter P3-11 “PID1 Error Ramp” has the possibility, to adapt the generation of the speed reference to the amount of control deviation. In case of small deviations the speed reference is generated directly without any ramp. In case the deviation is greater than the threshold set with P3-11, the ramps are effective.

PID 1 Error Ramp (P3-11)

PNU	Parameter	Name	Range	Default
2130.0	P3-11	PID1 Error Ramp	0.0 … 25.0 %	0.0 %

(P0-08 – P0-09) < P3-11 → ramps not effective

(P0-08 – P0-09) ≥ P3-11 → ramps effective

P0-08: PID1 set point value

P0-09: PID1 feedback value

See also block diagram in chapter „General“

Limitation of the PID controller output

The upper and lower values of the PID controller output (P0-04) can be limited. The limits depend on the setting of P3-09 “PID1 OutLimitSelect”.

PID1 OutLimitSelect (P3-09), PID1 Out upper Limit (P3-07), PID1 Out lower Limit (P3-08)

Parameter P3-09 is used for multiple purposes:

- to configure the limits of the PID controller output
- to configure the controller topology (see “controller topology”)

The limits of the PID controller output are determined by P3-07 and P3-08. It can also be variable by using a signal at Analog Input 1 (AI1). With P3-09 = 3 there is no limit (range 0.0 … 100.0 %).

PNU	Parameter	Name	Range	Default
2122.0	P3-09	PID1 OutLimitSelect	0: upper P3-07, lower P3-08 1: upper AI1, lower P3-08 2: upper P3-07, lower AI1 3: Addition PID controller out-put + signal at AI1	0
2121.0	P3-07	PID1 Out upper Limit	0.0…100.0 %	100 .0 %
2120.0	P3-08	PID1 Out lower Limit	0.0…100.0 %	0.0 %

Reset behavior

PID1 ResetControl (P3-18)

This parameter determines the behavior of the controller on Reset.

P3-18 = 0 → The PID controller is always active, as long as the proportional gain (P3-01) is not zero.
P3-18 = 1 → The PID controller will only run when the drive is enabled. If the drive is not running, the PID controller output will be reset to zero (including integral result).

PNU	Parameter	Name	Range	Default
2132.0	P3-18	PID1 ResetControl	0: PID controller always active 1: Reset, when drive is disabled	0

Standby Mode

In some applications it is not necessary to run the motor all the time. The devices of the series DA1 have the possibility, to disable the inverter output after a certain time and to activate it again when a defined control deviation (difference between set point and feedback signal) is exceeded. During standby mode is StndbY displayed.

t-Standby (P2-27), PID1 WakeUpLevel (P3-13)

Parameter P2-27 (t-Standby) defines the time, after which the standby mode is activated, when the speed reference (P0-04) is equal to the minimum frequency, set with P1-02. The drive will be reactivated as soon as the threshold, set with P3-13, is exceeded. P2-27 = 0.0 disables the standby mode.

P3-13 determines the control deviation at which the drive recovers from standby mode.

PNU	Parameter	Name	Range	Default
331.0	P2-27	t-Standby	0.0 … 25.0 s	0.0 s
2131.0	P3-13	PID1 WakeUpLevel	0.0 … 100.0 %	5.0 %

- Activation of the standby mode:
  - Speed reference (P0-04) is equal to f-min (P1-02) for the time, specified by P2-27. → PID controller output is set to zero and the inverter is disabled.
- Return to normal operation:
  - Control deviation is greater than P3-13 → PID controller starts to work → Activation of the inverter output, when the speed reference (P0-04) is at least equal to f-min (P1-02).

Examples for the application of the PID controller

Example 1: Setting the internal digital set point with P3-06

In a simple system, where only one set point value is necessary, the set point can be calculated based on the data of the feedback transducer.

- Required pressure: 1.5 bar
- Pressure transducer: 0 … 5 bar corresponds to 0 … 10 V

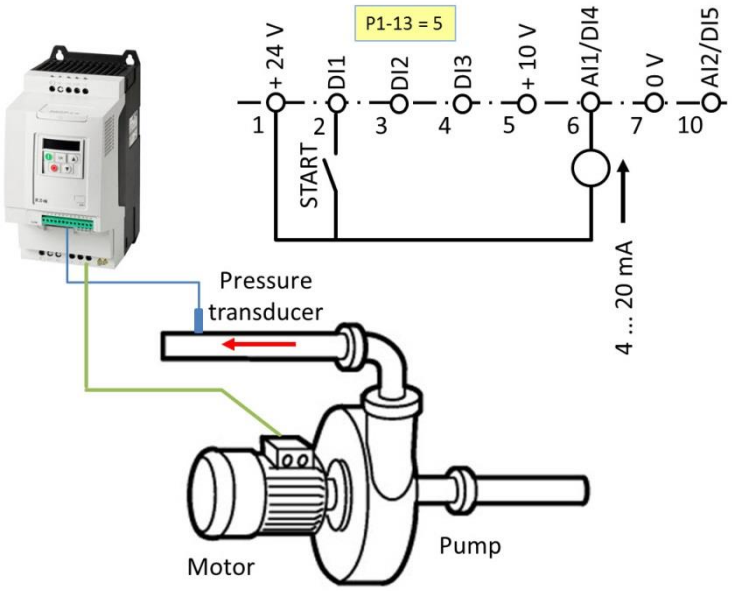
$$\text{P3-06} = \frac{1.5\ \text{bar}}{5\ \text{bar}} \cdot 100\ \% = 30.0\ \%$$

Example 2: Combinations of Terminals / Set Point Source / Manual-Auto / External Fault

The table below shows the possible combinations of terminal configuration, set point source and manual / auto operation. The term “auto” is used, when the speed reference is provided from the PID controller output. “Manual” means, that the speed is not depending on the PID set point, but on the fixed frequency (f-Fix1) or on an analog value at AI2. A digital command at DI3 (terminal 4) determines the changeover between manual and auto operation

DI configuration selection (P1-13)	Set point Auto	Manual / Auto changeover	External fault EXTFLT
3 or 13	Analog (AI1 or AI2) P3-05 = 1 or 2	DI3 = Low → Auto DI3 = High → Manual (f-Fix1)	-
5 or 15	Digital (P3-06) P3-05 = 0	DI3 = Low → Auto DI3 = High → Manual (AI2)	-
6 or 16	Digital (P3-06) P3-05 = 0	DI3 = Low → Auto DI3 = High → Manual (f-Fix1)	DI5 = Low → Fault DI5 = High → No fault

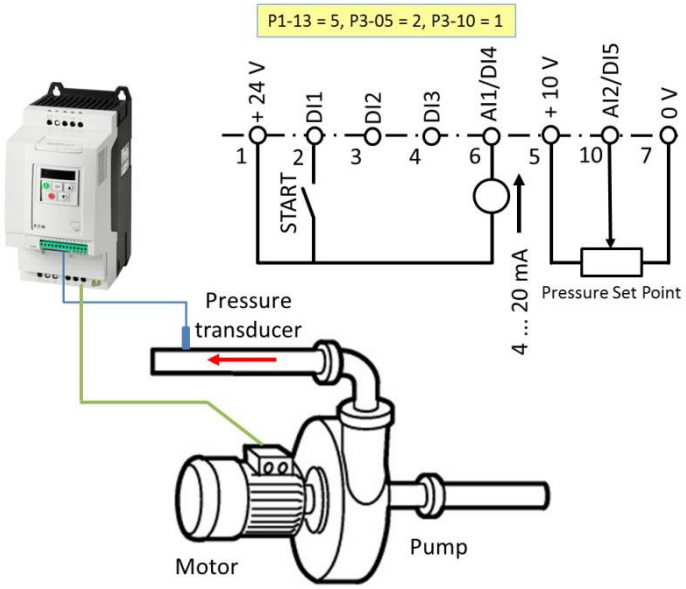
Example 3: Simple pressure control with digital set point, direct mode



For a simple pressure control, where the set point is always fixed, the following parameters have to be modified compared to default.

Parameter	Name	Value	Remark
P1-03	t-acc	10 … 30 s	Allows smooth starting and stopPIDng of the system
P1-04	t-dec	10 … 30 s	
P1-06	EnergyOptimizer	1	Energy optimizer enabled. Because of the square pump curve, energy savings can be expected.
P1-07	Motor Nom Voltage	…	Enter motor data
P1-08	Motor Nom Current	…	
P1-09	Motor Nom Frequency	…	
P1-12	ProcessDataAccess	3	Selection of the control mode
P1-13	DI Config Select	5	Selection of the terminal configuration
P1-14	Password	101	Allows access to Level 2 of the menu
P2-30	AI1 Signal Range	4 (4…20 mA)	Adaptation of Analog Input 2 to the signal of the pressure transducer (4…20 mA)
P3-01	PID1 Kp	0.5 … 2	Gain and time constant are system depend-ent.
P3-02	PID1 Ti	1 … 5 s	
P3-03	PID1 Kd	0.00 s	
P3-04	PID1 Mode	0	Direct mode
P3-05	PID1 Set Point 1 Source	0	Selection of the digital set point, set with P3-06
P3-06	PID1 Set Point Digital	…	Enter the necessary value, see also example 1

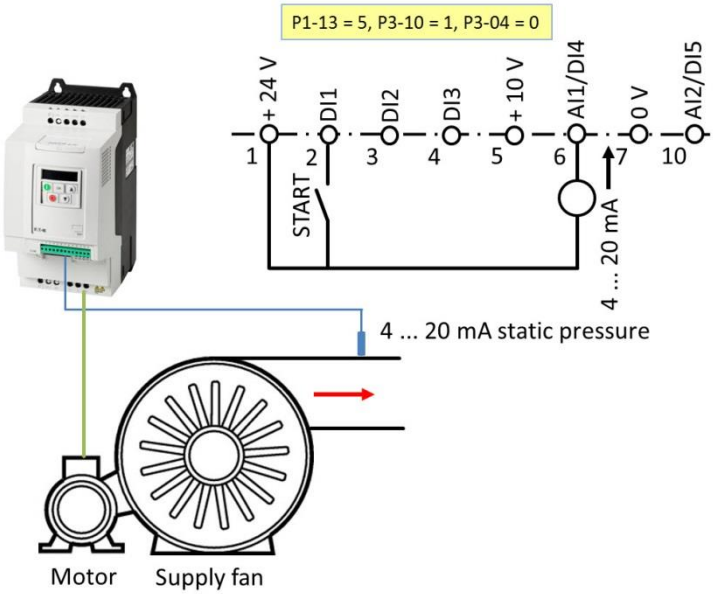
Example 4: Variable set point, direct mode



The pressure set point can be set with a potentiometer. If the set point value should not cover the complete range of the pressure transducer (e.g. pressure transducer 0 … 10 bar, range 6 … 8 bar), an adaptation of the input signal at AI2 can be done with P2-35 for an offset and P2-34 for scaling. The following parameters have to be modified compared to default.

Parameter	Name	Value	Remark
P1-03	t-acc	10 … 30 s	Allows smooth starting and stopPIDng of the system
P1-04	t-dec	10 … 30 s	
P1-06	EnergyOptimizer	1	Energy optimizer enabled. Because of the square pump curve, energy savings can be expected.
P1-07	Motor Nom Voltage	…	Enter motor data
P1-08	Motor Nom Current	…	
P1-09	Motor Nom Frequency	…	
P1-12	ProcessDataAccess	3	Selection of the control mode
P1-13	DI Config Select	5	Selection of the terminal configuration
P1-14	Password	101	Allows access to Level 2 of the menu
P2-30	AI1 Signal Range	4 (4…20 mA)	Adaptation of Analog Input 2 to the signal of the pressure transducer (4…20 mA)
P2-33	AI2 Signal Range	0 (0…10 V)	Set point signal 0 … 10 V
P2-34	AI2 Gain	…	Adaptation to the sensor signal, if required
P2-35	AI2 Offset	…	
P3-01	PID1 Kp	0.5 … 2	Gain and time constant are system depend-ent.
P3-02	PID1 Ti	1 … 5 s	
P3-03	PID1 Kd	0.00 s	
P3-04	PID1 Mode	0	Direct mode
P3-05	PID1 Set Point 1 Source	2	Selection of the analog set point at AI2
P3-10	PID1 Feedback 1 Source	1	Feedback assigned to AI1

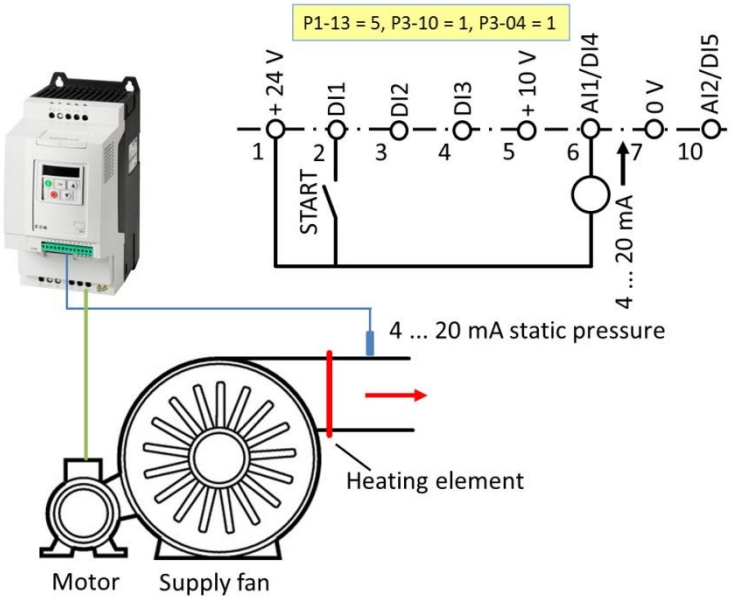
Example 5: Supply fan / compressor with pressure feedback, direct mode



The fixed pressure set point is defined by P3-06. The pressure increases with increasing speed → direct mode. The following parameters have to be modified compared to default.

Parameter	Name	Value	Remark
P1-03	t-acc	10 … 30 s	Allows smooth starting and stopping of the system
P1-04	t-dec	10 … 30 s	
P1-06	EnergyOptimizer	1	Energy optimizer enabled. Because of the square fan curve, energy savings can be expected.
P1-07	Motor Nom Voltage	…	Enter motor data
P1-08	Motor Nom Current	…	
P1-09	Motor Nom Frequency	…	
P1-12	ProcessDataAccess	3	Selection of the control mode
P1-13	DI Config Select	5	Selection of the terminal configuration
P1-14	Password	101	Allows access to Level 2 of the menu
P2-30	AI1 Signal Range	4 (4…20 mA)	Adaptation of Analog Input 1 to the signal of the pressure transducer (4…20 mA)
P3-01	PID1 Kp	0.5 … 2	Gain and time constant are system dependent.
P3-02	PID1 Ti	1 … 5 s	
P3-03	PID1 Kd	0.00 s	
P3-04	PID1 Mode	0	Direct mode
P3-05	PID1 Set Point 1 Source	0	Selection of the digital set point, set with P3-06
P3-06	PID1 Set Point Digital	…	Enter the necessary value, see also example 1
P3-10	PID1 Feedback 1 Source	1	Feedback assigned to AI1

Example 6: Supply fan, temperature control, inverse mode



The fixed temperature set point is defined by P3-06. The temperature decreases with increasing speed of the supply fan → inverse mode. The following parameters have to be modified compared to default.

Parameter	Name	Value	Remark
P1-03	t-acc	10 … 30 s	Allows smooth starting and stopPIDng of the system
P1-04	t-dec	10 … 30 s	
P1-06	EnergyOptimizer	1	Energy optimizer enabled. Because of the square pump curve, energy savings can be expected.
P1-07	Motor Nom Voltage	…	Enter motor data
P1-08	Motor Nom Current	…	
P1-09	Motor Nom Frequency	…	
P1-12	ProcessDataAccess	3	Selection of the control mode
P1-13	DI Config Select	5	Selection of the terminal configuration
P1-14	Password	101	Allows access to Level 2 of the menu
P2-30	AI1 Signal Range	4 (4…20 mA)	Adaptation of Analog Input 1 to the signal of the pressure transducer (4…20 mA)
P3-01	PID1 Kp	0.5 … 2	Gain and time constant are system depend-ent.
P3-02	PID1 Ti	1 … 5 s	
P3-03	PID1 Kd	0.00 s	
P3-04	PID1 Mode	1	Inverse mode
P3-05	PID1 Set Point 1 Source	0	Selection of the digital set point, set with P3-06
P3-06	PID1 Set Point Digital	…	Enter the necessary value, see also example 1
P3-10	PID1 Feedback 1 Source	1	Feedback assigned to AI1