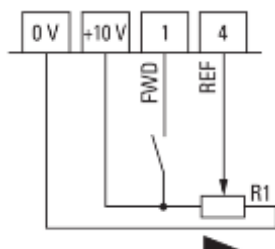


PowerXL™

DE1 Variable Speed Starter Set Point Setting



Level 2	1 – Fundamental – No previous experience necessary 2 – Basic – Basic knowledge recommended 3 – Advanced – Reasonable knowledge required 4 – Expert – Good experience recommended
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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.).
- Variable speed starters may have hot surfaces during and immediately after operation.
- Removal of the required covers, improper installation or incorrect operation of motor or variable speed starter 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 variable speed starters.
- 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 variable speed starters must be provided with additional monitoring and protective devices in accordance with the applicable safety regulations. Modifications to the variable speed starters 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 variable speed starter (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 variable speed starter 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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1 General

Variable speed starters of the series **PowerXL™ DE1** are used for the speed control of asynchronous motors. The speed set point can be provided in different ways:

- via an analog signal at the control terminals
- as a fixed frequency value, which is selected by a digital command
- as a digital reference, which is adjusted via keypad or control terminals
- via a connected fieldbus.

These possibilities are the same for all DE1 power ratings.

This Application Note describes:

- the different ways of set point setting
- the handling of the references

Set point setting via fieldbus is not handled inside this Application Note.

Further information:

AP040036EN I/O Configuration describes:

- the existing input and output terminals
- the technical data
- the assignment of functions to terminals

AP040029EN Starting, Stopping and Operation describes:

- the different possibilities at starting and stopping
- the respective control commands
- the setting of the relevant parameters
- the behavior in case of a fault

Some required parameters are inside Level 2 of the menu. This level has to be activated by prompting the "Password Level2" (P-38) into P-14 (Password). Password Level2 is "101" by default.

Note: The keypad mentioned inside this application note is not part of the basic unit, but available as option DEX-KEY-LED. It is connected to the RJ45 jack on the front of the basic device with a patch cable.

1.1 Settings in Hz or rpm

Parameter P-10 „Motor Nom Speed“ determines, if the setting is done in Hz or rpm:

P-10 = 0: Setting / display of the output frequency in Hz

P-10 > 0: all speed related parameters (P-01, P-02, P-20 ... P-23) are set and displayed in rpm.

PNU	Parameter	Name	Range	Default
217.0	P-10	Motor Nom Speed	0 / 200 ... 30000 rpm	0 rpm

1.2 Upper and lower speed limit

The speed range of the connected motor is determined by the parameters “f-min” (P-02) and “f-max” (P-01). The reference is linear between these two values.

Please note, that the value of P-01 cannot be exceeded, respectively the value of P-02 cannot be undercut. This is true for both senses of rotation.

$$\text{Frequency respectively speed} = P-02 + (\text{set point}_{\text{actual}} / \text{set point}_{\text{max}}) \cdot (P-01 - P-02)$$

Example 1:

P-10 = 0 (setting / display in Hz)

P-01 = 50 Hz

P-02 = 0.0 Hz

Set point via analog input: 0 ... 10 V

Set point actually set: 5 V

$$\text{Frequency} = 0 \text{ Hz} + (5 \text{ V} / 10 \text{ V}) \cdot (50 \text{ Hz} - 0 \text{ Hz}) = 0 \text{ Hz} + 0.5 \cdot 50 \text{ Hz} = 25 \text{ Hz}$$

Example 2:

P-10 = 1470 rpm (setting / display in rpm)

P-01 = 1470 rpm

P-02 = 300 rpm

Set point via analog input: 0 ... 10 V

Set point actually set: 5 V

$$\text{Speed} = 300 \text{ rpm} + (5 \text{ V} / 10 \text{ V}) \cdot (1470 \text{ rpm} - 300 \text{ rpm}) = 300 \text{ rpm} + 0.5 \cdot 1170 \text{ rpm} = 885 \text{ rpm}$$

PNU	Parameter	Name	Range	Default
20.1	P-01	f-max	P-02 ... 5 · P-09 (300 Hz max)	50.0 Hz
20.0	P-02	f-min	0.0 Hz ... P-01	0.0 Hz

Note:

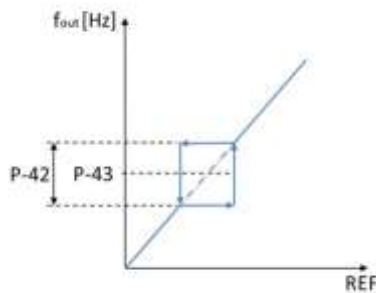
- With values of P-10 > 0 the setting is done in rpm instead of Hz.
- The value, which can be set with P-01 „f-max“, is limited to five times „Motor Nom Frequency“ (P-09) with a maximum of 300 Hz.

1.3 Behavior during change over between reference sources

During a change over between two reference sources, e.g. from an analog signal to a fixed frequency, the new reference is approached with the actual ramp. The ramp times are determined by “t-acc” (P-03) for acceleration and “t-dec” (P-04) for deceleration.

1.4 Skip frequencies to avoid resonances

In some applications an operation of the motor in a certain frequency band leads to mechanical resonances, which can end up in a destruction of machine parts. The devices of the series **PowerXL™ DE1...** have the possibility to skip this frequency band for steady operation to avoid this effect.



Fading out frequencies is possible with all kind of reference signals, not depending on where they come from, e.g. analog input, fixed frequency, digital reference ... , whatever is selected.

The band width is determined by P-42 "f-SkipBand1", while the center point is defined by P-43 "f-Skip1". The diagram on the left hand side shows the behavior. Setting P-26 to zero, deactivates the function.

REF = Reference

Example:

A motor runs up to 50 Hz. In the range between 15 Hz and 25 Hz mechanical resonances can occur. Therefore the motor may not run inside this range steadily.

Band width: $P-42 = 25 \text{ Hz} - 15 \text{ Hz} = 10 \text{ Hz}$

Center point: $P-43 = \frac{15 \text{ Hz} + 25 \text{ Hz}}{2} = 20 \text{ Hz}$

How it works:

The reference is below the disabled range. → Drive runs with the set frequency. → Increase of reference into the disabled range → Motor accelerates and remains at the lower limit (in this example: 15 Hz). → Increase of reference above the disabled range → Motor accelerates with the ramp, set with P-03 "t-acc" to the new speed. → Motor operates above the disabled range according to the reference. → Reduction of reference into the disabled area → Motor decelerates and remains at the upper limit (in this example: 25 Hz). → Reduction of reference below the disabled area → Motor decelerates with the ramp, set with P-04 "t-dec" to the new speed.

PNU	Parameter	Name	Range	Default
22.0	P-42	f-SkipBand1	0...P-01	0 Hz ¹⁾
21.0	P-43	f-Skip1	0...P-01	0Hz ¹⁾

¹⁾ The default setting of P-10 "Motor Nom Speed" = 0. In this case the values for P-42 and P-43 are given in Hz. When P-10 is different from „0“, P-42 and P-43 have to be set in min⁻¹.

2 Analog reference

Variable speed starters of the series DE1 have one analog input:

- Analog input AI1 terminal 4

The configuration of the inputs and outputs is described inside the Application Note „I/O Configuration“ (AP040036EN). Beside the setting of the signal format (voltage or current), a scaling factor can be used to adopt the speed to the input signal.

2.1 Selecting the sense of rotation

The analog value at terminal 4 determines the amount of speed.

The control commands FWD and REV select clockwise or counter clockwise sense of rotation. If a change of sense is required, the actual command (e.g. FWD) has to be removed first, before applying the other one (e.g. REV). Applying FWD and REV simultaneously leads to a coasting of the motor.

2.2 Format of the analog value

The speed reference signal can be a voltage signal as well as a current one. It is invertible with Parameter P-18 in a way that a minimum signal leads to the maximum speed and vice versa.

Format	P-18	counter clockwise rotation		clockwise rotation	
		f-min	f-max	f-min	f-max
0 ... 10 V (U 0-10)	0	0 V + REV	10 V + REV	0 V + FWD	10 V + FWD
	1	10 V + REV	0 V + REV	10 V + FWD	0 V + FWD
0 ... 20 mA (A 0-20)	0	0 mA + REV	20 mA + REV	0 mA + FWD	20 mA + FWD
	1	20 mA + REV	0 mA + REV	20 mA + FWD	0 mA + FWD
4 ... 20 mA (t 4-20)	0	4 mA + REV	20 mA + REV	4 mA + FWD	20 mA + FWD
	1	20 mA + REV	4 mA + REV	20 mA + FWD	4 mA + FWD
4 ... 20 mA (r 4-20)	0	4 mA + REV	20 mA + REV	4 mA + FWD	20 mA + FWD
	1	20 mA + REV	4 mA + REV	20 mA + FWD	4 mA + FWD

Note: In case a terminal configuration without the commands FWD and REV is selected with P-15, the sense of rotation is set with the commands START and DIR.

- Clockwise rotation → START
- Counter clockwise rotation → START + DIR

3 Fixed frequencies

Fixed frequencies are references, which are set once, e.g. during commissioning and which can be selected by a digital command when required. The devices of the series DE1 have up to 4 fixed frequencies f-Fix1 ... f-Fix4, which can be selected independently.

3.1 Setting the frequency value

The setting of the fixed frequencies is done with P-20 up to P-23. Each value can be between zero and the maximum frequency „f-max“ (P-01). It has to be noted, that the minimum frequency “f-min” (P-02) will not be undercut, even when the fixed frequency is set to a lower value than P-02.

Example:

P-02 (f-min) = 10 Hz

P-20 (f-Fix1) = 5 Hz

When f-Fix1 is selected, the drive runs with 10 Hz!

PNU	Parameter	Name	Range	Default
5.1	P-20	f-Fix1	0 ... f-max (P-01)	20.0 Hz
5.2	P-21	f-Fix2	0 ... f-max (P-01)	30.0 Hz
5.3	P-22	f-Fix3	0 ... f-max (P-01)	40.0 Hz
5.4	P-23	f-Fix4	0 ... f-max (P-01)	50.0 Hz

3.2 Selecting the sense of rotation

When using a fixed frequency the sense of rotation is determined by the commands FWD (clockwise) and REV (counter clockwise) respectively DIR.

3.3 Selecting the fixed frequency

The fixed frequencies can be activated via commands at the control terminals or via a field bus. The selection is binary coded → for 4 fixed frequencies 2 Bits (FF2⁰ and FF2¹) are required. The predefined terminal configurations selected with P-15 enable access to the fixed frequencies.

3.3.1 Selection with predefined terminal configurations (P-15)

P1-12 = 0: Terminal Mode				
P1-15	DI1 (terminal 1)	DI2 (terminal 2)	DI3 (terminal 3)	AI1 / DI4 (terminal 4)
0	FWD	REV	FF1	REF
1	FWD	REV	EXTFLT	REF
2	FWD	REV	FF2 ⁰	FF2 ¹
3	FWD	FF1	EXTFLT	REF
4	FWD	UP	FF1	DOWN
5	FWD	UP	EXTFLT	DOWN
6	FWD	REV	UP	DOWN
7	FWD	FF2 ⁰	EXTFLT	FF2 ¹
8	START	DIR	FF1	REF
9	START	DIR	EXTFLT	REF

P1-12 = 1 or 2: Keypad Mode				
P1-15	DI1 (terminal 1)	DI2 (terminal 2)	DI3 (terminal 3)	AI1 / DI4 (terminal 4)
0	FWD	REV	FF1	no function
1	FWD	REV	EXTFLT	no function
2	FWD	REV	FF2 ⁰	FF2 ¹
3	FWD	FF1	EXTFLT	no function
4	FWD	UP	FF1	DOWN
5	FWD	UP	EXTFLT	DOWN
6	FWD	REV	UP	DOWN
7	FWD	FF2 ⁰	EXTFLT	FF2 ¹
8	START	DIR	FF1	no function
9	START	DIR	EXTFLT	no function

Inside the Application Note „I/O Configuration” (AP040036EN) the configuration of the control terminals is described. The following commands are important for the selection of fixed frequencies:

Abbreviation	Function															
FF1	Selection between the analog speed reference at analog input AI1 (terminal 6) and the fixed frequency 1 (f-Fix1), set with P-20. Low = analog reference, High = f-Fix1.															
FF2 ⁰ / FF2 ¹	Selection of the digital frequencies f-Fix1 ... f-Fix4 with digital commands <table><tr><td></td><td>FF2⁰</td><td>FF2¹</td></tr><tr><td>f-Fix1 (P-20)</td><td>L</td><td>L</td></tr><tr><td>f-Fix2 (P-21)</td><td>H</td><td>L</td></tr><tr><td>f-Fix3 (P-22)</td><td>L</td><td>H</td></tr><tr><td>f-Fix4 (P-23)</td><td>H</td><td>H</td></tr></table>		FF2 ⁰	FF2 ¹	f-Fix1 (P-20)	L	L	f-Fix2 (P-21)	H	L	f-Fix3 (P-22)	L	H	f-Fix4 (P-23)	H	H
	FF2 ⁰	FF2 ¹														
f-Fix1 (P-20)	L	L														
f-Fix2 (P-21)	H	L														
f-Fix3 (P-22)	L	H														
f-Fix4 (P-23)	H	H														

3.3.2 Use of fixed frequencies in device functions

In certain situations, fixed frequencies are selected by a device function. Please take care, that there is no collision because of user specific settings.

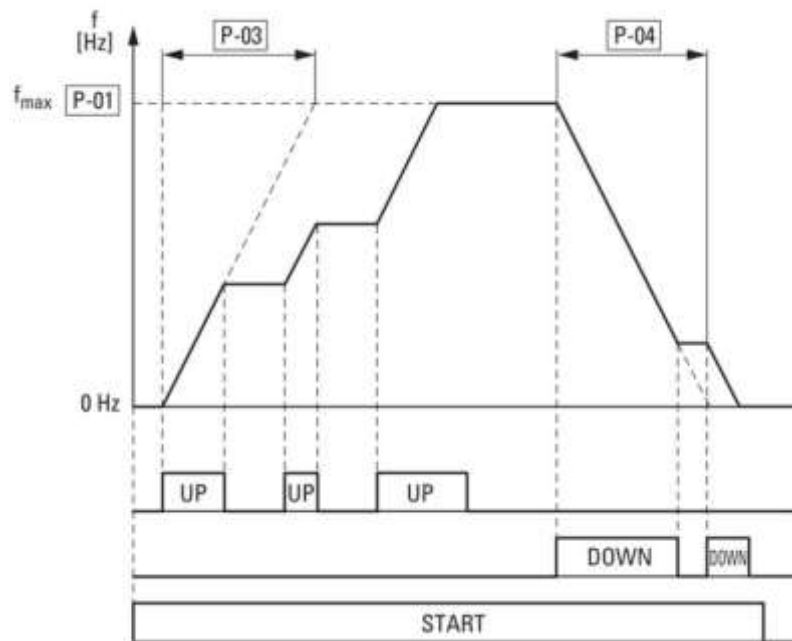
Fixed frequency	Function
f-Fix1	When P-16 = 4 (analog inputs with a signal 4 ... 20 mA) the drive ramps to f-Fix1, in case of wire break in the reference circuit.

4 Digital reference

The speed reference of the variable speed starters DE1 can also be given via digital commands. The command UP (faster) increases the content of the reference counter, while DOWN (slower) reduces it. The use of a digital reference has the advantage, that the reference can be set from different locations by paralleling push buttons, which is required in cases of large machines.

The setting occurs between the minimum speed / frequency (f-min, P-02) and the maximum frequency / speed (f-max, P-01) with the actual ramp. The setting can be done with the keypad as well as via terminals.

Example:



- When an enabled drive gets the “UP” command, the motor accelerates according to the actual ramp according to “t-acc” (P-03)
- When the „UP“ command is removed, the speed remains constant. Applying “UP” again leads to a further acceleration. The maximum frequency / speed is defined with “f-max” (P-01).
- Consequently, applying „DOWN“ leads to a speed reduction.
- When starting, the drive ramps to the speed determined by P-24 without an “UP” command.

4.1 Configuration

4.1.1 Terminals / Keypad

With the settings P-15 = 4, 5 or 6 UP and DOWN commands via terminals are possible. In case a keypad DEX-KEY-LED is used, the reference value can be modified by using the arrow keys in addition.

With P-12 = 1 or 2 the variable speed starter can be started and stopped with the keys on the keypad. The behavior depends on the setting of P-24 "Digital Reference Reset Mode" (see 4.1.2)

P1-12 = 0: Terminal Mode				
P1-15	DI1 (terminal 1)	DI2 (terminal 2)	DI3 (terminal 3)	AI1 / DI4 (terminal 4)
0	FWD	REV	FF1	REF
1	FWD	REV	EXTFLT	REF
2	FWD	REV	FF2 ⁰	FF2 ¹
3	FWD	FF1	EXTFLT	REF
4	FWD	UP	FF1	DOWN
5	FWD	UP	EXTFLT	DOWN
6	FWD	REV	UP	DOWN
7	FWD	FF2 ⁰	EXTFLT	FF2 ¹
8	START	DIR	FF1	REF
9	START	DIR	EXTFLT	REF

P1-12 = 1 or 2: Keypad Mode				
P1-15	DI1 (terminal 1)	DI2 (terminal 2)	DI3 (terminal 3)	AI1 / DI4 (terminal 4)
0	FWD	REV	FF1	no function
1	FWD	REV	EXTFLT	no function
2	FWD	REV	FF2 ⁰	FF2 ¹
3	FWD	FF1	EXTFLT	no function
4	FWD	UP	FF1	DOWN
5	FWD	UP	EXTFLT	DOWN
6	FWD	REV	UP	DOWN
7	FWD	FF2 ⁰	EXTFLT	FF2 ¹
8	START	DIR	FF1	no function
9	START	DIR	EXTFLT	no function

4.1.2 Reference at start and at changeover between speed sources

When starting a drive with a digital reference and when changing over from another speed source, e.g. a fixed frequency, to a digital reference the reference value to be ramped to is determined by the setting of P-24 "Digital Reference Reset Mode":

- P-24 = 0 or 2
 - Minimum speed
 - Example 1: Behavior at start
 - Drive runs with digital reference → switch OFF → restart → drive ramps to the minimum speed, set with P-02 „f-min“.

- Example 2: Behavior at changeover between speed sources
 - Drive runs with digital reference → Changeover to another speed source by applying a signal to the terminal → drive ramps to the speed required by the other speed source → Select “Digital reference” by removing the signal from the terminal → drive remains at the speed of the other speed source. The speed can now be changed with the keys on the keypad or with the signals UP and DOWN at the control terminals.
- P-24 = 1 or 3
 - Start with the latest speed before switching OFF or changing over to another speed source, set with the keypad or with the commands UP and DOWN at the terminals. This also applies to cases where another speed source was active at the time of switching OFF, but which is not selected at restart.
 - Example 1: The digital reference was set with the keypad to 1000 rpm. The speed source was changed from “Digital reference” to „Fixed Frequency 1” by means of a command at the control terminals. The drive is switched OFF when “Fixed Frequency1” is active.
 - Select „Digital reference” at the terminals → drive ramps to the 1000 rpm set with the keypad
 - „Fixed Frequency 1” was selected at the terminal when restarting → Drive ramps to Fixed Frequency 1
 - Changeover to “Digital reference” with the signal at the terminals → drive ramps to 1000 rpm
 - Example 2: Switching OFF when the drive runs with another speed source than the digital reference
 - Selection of the other speed source is still active at restart → drive ramps to the speed of the other speed source.
 - Selection of the other speed source is not active at restart → drive ramps to the latest digital reference.

P-24 „Digital Reference Reset Mode” also determines, how the drive can be started when P-12 = 1 or 2:

- P-24 = 0...1
 - Starting of the drive by pushing the green START button on the keypad.
 - To start, an additional signal at the terminals is necessary (START / FWD / REV)
- P-24 = 2...3
 - The start of the drive is carried out via the terminals (see also 4.1.1). A start with the button on the keypad is not possible.
 - Note: With P-12 = 2 it is still possible to reverse the drive by pushing the green button on the keypad.

PNU	Parameter	Name	Range	Default
620.3	P-24	Digital Reference Reset Mode	0 / 1: START via keypad 0: Minimum speed (P-02) 1: Previous speed from Keypad / terminals (UP/DOWN) 2 / 3: START via terminals 2: Minimum speed (P-02) 3: Previous speed from Keypad / terminals (UP/DOWN)	1

4.2 Bedienung

4.2.1 Starting / Stopping

Drives, which operate with a digital reference, can be started via terminals as well as via keypad. The possibilities depend on the setting of the parameters P-12 "Local ProcessData Source", P-15 "DI Config Select" and P-24 "Digital Reference Reset Mode".

Note:

It can also be selected, that a signal from the terminal as well as one from the keypad must be applied to start the drive. In this case the signal at the terminal must be present before the button on the keypad is pushed.

P-12	P-24	P-15	Starting via terminal only	Starting via keypad only	Starting via terminal AND keypad
P-12 = 0	P-24 = 0...3	P-15 = 4 / 5 / 6	YES	NO	NO
P-12 = 1 / 2	P-24 = 0 / 1	P-15 = 0 ... 9	NO	NO	YES
	P-24 = 2 / 3	P-15 = 0 ... 9	YES*	NO	NO

*In this case the keypad cannot be used to start the drive, but with P1-12 = 2 the green button can still be used to reverse it (see 4.2.3)

4.2.2 Increase / reduce speed

When using a digital reference the speed is changed via the commands UP and DOWN. For the duration of the commands the speed is increased respectively reduced. The commands are given via the keypad or via terminals.

The behavior of the drive is depending on keypad or terminal adjustment. While a command via terminals modifies the speed with the actual ramp directly, an adjustment with the keypad has a slope and works more smoothly. This results in a delay of about 1.5 s for every actuation.

With the setting of P-12 = 1 or 2 a speed adjustment via keypad is always possible, an adjustment via terminals only with the settings P-12 = 1 or 2 AND P-15 = 4 / 5 / 6.

Note:

- Simultaneous use of UP and DOWN (both via terminals or both via keypad) reduces the speed.
- The terminal command dominates the one from the keypad. This also means: DOWN via keypad and UP via terminal → the speed increases.
- A speed adjustment via keypad is also possible in cases where starting and stopping via keypad is disabled.

4.2.3 Change sense of rotation

The sense of rotation at start with a digital reference is basically determined by the terminal commands. With P12 = 2 one has the possibility to reverse the motor by pressing the green Start button on the keypad. Behavior at start: see column "Sense of rotation at START" in the table below.

P-12	P-24	P-15	Sense of rotation via terminal	Sense of rotation via keypad	Sense of rotation at START
P-12 = 0	P-24 = 0 ... 3	P-15 = 4 / 5	NO	NO	No change of sense of rotation possible
		P-15 = 6	YES		Sense of rotation as selected via terminals
P-12 = 1	P-24 = 0 ... 3	P-15 = 3 / 4 / 5 / 7	NO	NO	No change of sense of rotation possible
		P-15 = 8 / 9	YES (DIR)		Sense of rotation as selected via terminals
	P-24 = 2 / 3	P-15 = 0 / 1 / 2 / 6	YES (FWD / REV)		
P-12 = 2	P-24 = 0 ... 3	P-15 = 3 / 4 / 5 / 7	NO	YES (INV)	Sense of rotation as selected via terminals, taking into account a possible inversion at the time of stopping the drive (Start button on the keypad).
		P-15 = 8 / 9	YES (DIR)		
	P-24 = 2 / 3	P-15 = 0 / 1 / 2 / 6	YES (FWD / REV)		

Note:

- P-15 = 0 / 1 / 2 / 6:
 - Applying the FWD and REV commands simultaneously leads to a coasting of the motor
 - In applications with reversion, the Stop Mode should be set in a way, that the ramp is active (P1-5 = 1). If this is not the case a changeover between the commands FWD and REV is detected as stop command and the drive behaves according the setting with P-05. After this, it restarts into the opposite direction. Starting a motor, which is still turning can lead to an overcurrent trip.
- P-12 = 2
 - A possible inversion with the Start button on the keypad is stored at stop. The drive restarts with the same sense of rotation he had before stopping. Please note, that in this case the sense of rotation at restart cannot be clearly defined by the terminal commands..