PowerXL™

DE1 Variable Speed Starter
Starting, Stopping and Operation

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

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Contents

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

Depending on the application, demands on speed controlled systems can be much different. The spectrum reaches from a soft start up to cyclic operation in some seconds, from a spin start, where the motor is turning already at the time of starting up to dynamic braking, to mention only a few aspects.

At default, variable speed starters of the series **PowerXL^{TM} DE1** are configured to cover a plurality of applications. Additional adaptation can be achieved by changing parameter values.

This Application Note 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
- measures to prevent unintended trips

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.

2 Power-on

Switching on the device means applying a voltage to the terminals L and N in case of single phase supply respectively L1, L2 and L3 in case of three phase supply. The voltage rating depends on the device type.

DE1-12…

Mains, $U_{LN} = 1 \sim 200 - 240\ V \pm 10\ \%$
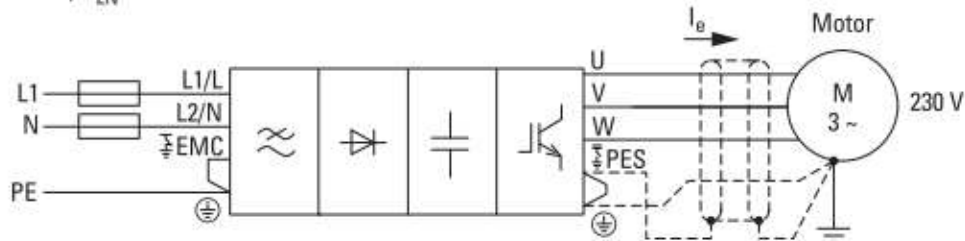
DE1-34…

Mains, $U_{LN} = 3 \sim 380 - 480\ V \pm 10\ \%$
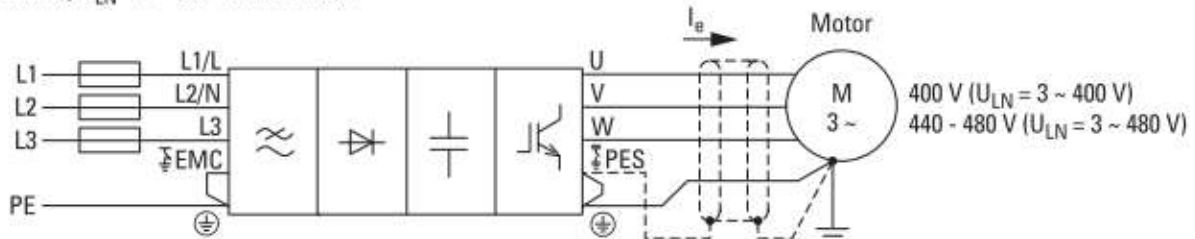
When applying the supply voltage, the d.c. link capacitor will be charged. Current limiting elements are used to prevent an inrush peak of the current. After the charging, the elements are bypassed. They are not effective during operation. It has to be noted that the current limiting elements are not foreseen for a continuous duty. Therefore the number of starts per time is limited. Typical value: 1 charging per 30 s.

If the application requires a more frequent starting, the starting and stopping of the motor has to be done by the signals at the control terminals. The supply voltage remains at the terminals continuously and is only removed when the machine is switched off.

3 Starting

3.1 Selection of the terminal configuration

The assignment of the terminals can be configured with parameter P-15 "DI Config Select". By default P-15 = 0. Terminal 4 can be used as digital input as well as analog input. The conversion is done automatically, based on the setting of P-15.

HIGH signal → 8 … 30 V DC

LOW signal → 0 … 4 V DC

Reference is always 0 V. The control inputs are galvanically separated from the power section, but not among each other.

3.1.1 DI Config Select (P-15)

P-12 = 0: Terminal control			
P-15	DI1 (Terminal 1)	DI2 (Terminal 2)	DI3/AI2 (Terminal 3)	DI4/AI1 (Terminal 4)
0	FWD	REV	FF1	REF
1	FWD	REV	EXTFLT	REF
2	FWD	REV	FF Select Bit 0	FF Select Bit 1
3	FWD	FF1	EXTFLT	REF
4	FWD	UP	FF1	DOWN
5	FWD	UP	EXTFLT	DOWN
6	FWD	REV	UP	DOWN
7	FWD	FF Select Bit 0	EXTFLT	FF select Bit 1
8	START	DIR	FF1	REF
9	START	DIR	EXTFLT	REF

3.1.2 1 sense of rotation, control with FWD (P-15 = 3, 4, 5, 7)
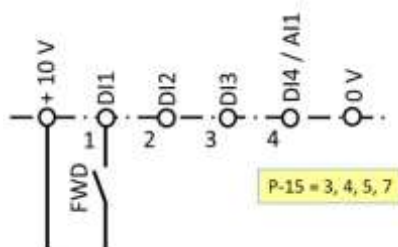
FWD

START in clockwise direction (FWD = forward). When applying a HIGH signal to terminal 1, the motor accelerates with the ramp set with P-03 "t-acc". Removing the signal leads to a stop. The behavior at stopping depends on the setting of P-05 "Stop mode". At standstill the variable speed starter is disabled.

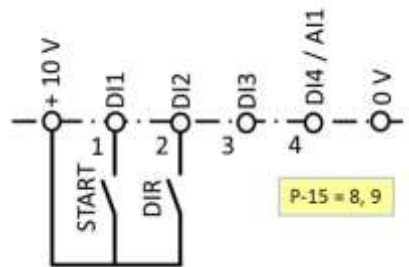### 3.1.3   2 senses of rotation, direction selected with DIR (P15 = 8, 9)

START

Starts the motor. Applying a HIGH signal to terminal 1 leads to an acceleration with the ramp set with P-03 "t-acc". Removing the signal leads to a stop. The behavior at stopping depends on the setting of P-05 "Stop mode". At standstill the variable speed starter is disabled.

DIR
Selection of the sense of rotation
LOW = clockwise (FWD)
HIGH = counterclockwise (REV)

ATTENTION: In case REV is selected and the wire breaks, the motor will reverse! Alternative: Select terminal configuration with FWD/REV

3.1.4   2 senses of rotation, direction selected with FWD and REV (P-15 = 0, 1, 2, 6)
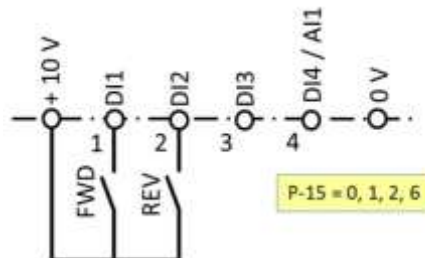
FWD
START in clockwise direction (FWD = forward). When applying a HIGH signal to terminal 1, the motor accelerates with the ramp set with P-03 "t-acc". Removing the signal leads to a stop. The behavior at stopping depends on the setting of P-05 "Stop mode". At standstill the variable speed starter is disabled.

REV
START in counterclockwise direction (REV = reverse). When applying a HIGH signal to terminal 2, the motor accelerates with the ramp set with P-03 "t-acc". Removing the signal leads to a stop. The behavior at stopping depends on the setting of P-05 "Stop mode". At standstill the variable speed starter is disabled.

In case FWD and REV are applied to the respective terminals at the same time, the output of the variable speed starter is disabled. At removing of one signal (FWD or REV) it restarts.

3.2 Selection of the Start Mode

3.2.1 Start Mode (P-30)

"Start Mode" determines the behavior of the motor in terms of enabling (Commands START, FWD, REV) and configures the automatic restart after the occurrence of a fault.

Edge-r
After applying the supply voltage or after a RESET, the motor will not start when the enable signal is still present at the terminal. To restart, a rising edge of the signal START/FWD/REV is necessary.

Auto-0
After applying the supply voltage or after a RESET, the motor will automatically start when the enable signal is still present at the terminal.

Auto-1 … Auto-9
After applying the supply voltage or after a RESET, the motor will automatically start when the enable signal is still present at the terminal. After a trip because of a fault the variable speed starter automatically starts up to 5 trials (Auto-0 = 0 trials … Auto-9 = 9 trials) in 20 s intervals to restart. As long as the supply voltage is still applied, the content of the counter remains. The number of restart trials is counted and if the motor doesn't restart with the last trial, it trips and displays a fault message. RESET has to be done manually.

ATTENTION!
An automatic restart is only possible, when the control commands are given via the terminals (P-12 = 0 and P-12 = 11).

Take care, that an automatic restart doesn't lead to a dangerous situation!

| PNU	Parameter	Name	Range	Default
620.0	P-30	Start-Modus	0: Edge-r 1: Auto-0 2: Auto-1 3: Auto-2 4: Auto-3 5: Auto-4 6: Auto-5 7: Auto-6 8: Auto-7 9: Auto-8 10: Auto-9	1 Auto-0

3.3 Starting a rotating motor

In some applications it can happen, that the motor turns already before switching on. One example are fans, which spin because of the chimney effect inside a wind tunnel. Another example are drive systems with high inertia, which didn't come to a stop after the latest switching off and which now have to be started again. A direct switching of a variable speed starter on a rotating motor without additional measures can lead to an overcurrent trip. To prevent this it is possible to stop the motor before restarting it.

This function is disabled by default, because it leads to a starting delay, which is not acceptable in some other applications. It can be activated with parameter P-25 "DCBrake".

3.3.1 DCBrake (P-25), t-DCBrake@Stop (P-26), DCBrake Voltage (P-27)
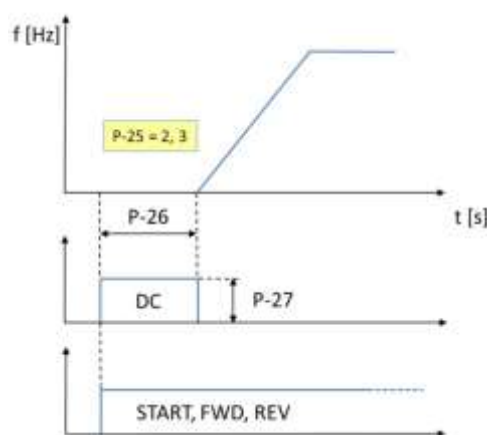
Parameter P-25 „DCBrake" determines, in which situations a DC braking is performed. In case the braking is required before starting, P-25 has to be set to 2 or 3.

When applying FWD, REV or START a DC braking starts (see also „5.2 DC braking to standstill"). The strength and the duration depend on the settings of P-26 "t-DCBrake@Stop" and P-27 "DCBrake Voltage" (in percent of the motor rated voltage P-07). With P-25 = 3 it has to be noted, that the braking time before a start is the same as after a stop.

During a DC braking the LED „Fault code" on the front of the variable speed starter lights yellow.

PNU	Parameter	Name	Range	Default
2221.0	P-25	DCBrake	0: OFF 1: ON at Stop 2: ON before Start 3: ON before Start and at Stop	0
2222.1	P-26	t-DCBrake@Stop	0.0…10 s	0.0 s
2220.0	P-27	DCBrake Voltage	0.0…100 %	0.0 %

3.4 Starting with the keypad

When using an external keypad DX-KEY-LED, parameter „Start Mode" (P-30) is not effective. To start the drive a HIGH signal at terminal 1 is necessary as well as a push of the START button on the keypad.
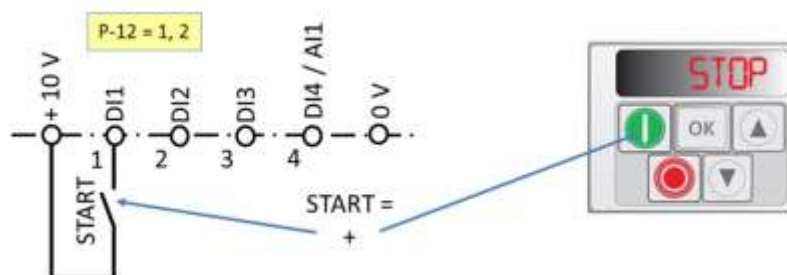
The drive starts with the ramp defined by P-03 „t-acc". Pushing the STOP button or removing the signal at terminal 1 leads to a stopping. The behavior depends on the setting of P-05 "Stop Mode".

ATTENTION! In case P-12 = 2 (digital reference, 2 directions) the START button of the keypad is also used to reverse the drive. It has to be noted that the drive will restart with the same sense of rotation, which was present before the last stop.

3.4.1 Digital Reference Reset Mode (P-24)

In case a digital reference is used, e.g. operation with a keypad, it can be determined, if the drive will restart with the speed, which it had before the latest stopping or with the minimum speed, set with P-02 (f-min).

PNU	Parameter	Name	Range	Default
620.3	P-24	Digital Reference Reset Mode	0: Start with f-min 1: Start with latest speed before stopping 2: Start with f-min (Auto-r) 3: Start with latest speed before stopping (Auto-r)	0

3.5 Frequency of starts

In applications with cyclic operation, a frequent starting and stopping can be required. It has to be noted, that there are measures inside a variable speed starter, which ensure a reliable operation on one hand and which are limitations at the same time on the other hand.

Limitations for the frequency of starts:
- charging circuit for the d.c. link (see chapter „Power-on")
  - permitted frequency of starts: one time every 30 s
  - remedy: apply supply voltage constantly and use commands at the terminals (FWD / REV / START)
- demagnetization time of the motor
  - In case it is selected, that the drive coasts to stop (P-05 „Stop Mode" = 0), it has to be ensured that the motor is demagnetized before the next start. Because of this, the next start is only possible after approximately 1 s.
  - remedy: select the stop mode with ramp (P-05 = 1). In this case the deceleration ramp (P-04) must not be set to 0.0 s!

4 Operation

4.1 The ramps

The variable speed starters of the series **PowerXL^{TM} DE1** have two independent ramps:

- an acceleration ramp „t-acc" (P-03)
- a deceleration ramp „t-dec" (P-04)

The set times refer to the time between standstill and the rated frequency of the motor (P-09 „Motor Nom Frequency") or vice versa.
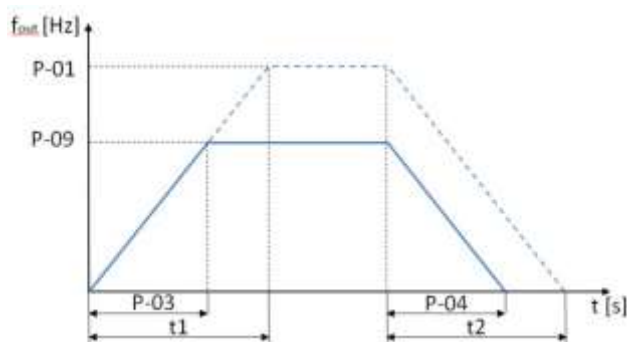
In most cases the rated frequency of the motor (P-09) is equal to the max frequency (P-01). In case a motor is operated above its rated speed, this has to be taken into account when setting the ramp times.

Calculation of the parameter values (P-03, P-04):

$$\text{P-03} = t1 \cdot \frac{\text{P-09}}{\text{P-01}} \qquad\qquad \text{P-04} = t2 \cdot \frac{\text{P-09}}{\text{P-01}}$$

4.1.1 t-acc (P-03), t-dec (P-04)

PNU	Parameter	Name	Range	Default
111.0	P-03	t-acc	0.00 s – 300 s	5.0 s
114.0	P-04	t-dec	0.00 s – 300 s	5.0 s

4.2 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**^{TM} **DE1…** have the possibility to skip this frequency band for steady operation to avoid this effect.
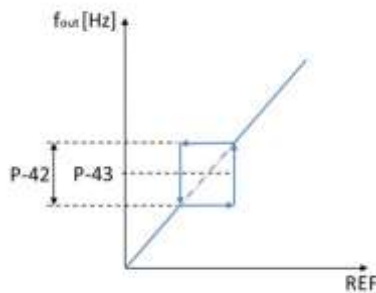
Fading out frequencies is possible with all kind of reference signals, not depending on where they come from, e.g. analog input, fixed frequency, digital reference … , whatever is selected.

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 Hz – 15 Hz = 10 Hz

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

4.3   Preventing overvoltage trips

4.3.1   Overvoltage Control (P-31)

When the deceleration time is set too short, overvoltage trips of the variable speed starter can occur because of energy feedback from high inertia loads into the DC link.

Variable speed starters DE1 have an internal algorithm to prevent overvoltage trips in regenerative mode. Output voltage and frequency are adopted in a way that energy feedback is prevented.

Application examples:
- Ramp down time set too short: the overvoltage control extends the ramp automatically to avoid regeneration
- The motor is driven by the load, e.g. washing machines and other applications with imbalance. To prevent overvoltage trips the variable speed starter increases the output voltage and frequency automatically. The result is a small increase in speed which is acceptable in many applications.

The overvoltage control can be disabled with parameter P-31 "Overvoltage Control". In this case an overvoltage trip can be prevented by increasing the ramp down time with P-04 "t-dec".

PNU	Parameter	Name	Range	Default
626.3	P-31	Overvoltage Control	0 = enabled 1 = disabled	0

4.4   Behavior in case of a fault

The variable speed starters of the series DE1 have multiple internal monitoring functions. When a deviation from proper operating conditions is detected, the variable speed starter is disabled and the contact between the terminals 13 and 14 opens.

Hint: on the variant DE11 the function of the relay can be configured with P-51. In this case the contact opens with P-51 = 0, 1, 3 or 8.

Fault indication by
- flashing of the LED "Fault Code" on the front of the device
- a message on the display in case the external keypad DX-KESY-LED is used.

Possible reasons and remedy can be found in chapter 4.3.3 "Fault messages – possible causes – remedy".

4.4.1   Last Fault (P-13)

The latest four fault messages are stored inside the fault register (P-13) in the sequence of their occurrence. The newest fault message is displayed first on the external keypad DX-KEY-LED. Other fault messages can be accessed by pressing the ▲ button on the keypad multiple times. Flashing dots on the seven segment display show the sequence.

Latest message = no dot
Last but one message = one flashing dot ….

The fault register will not be cleared in case the default settings are restored.

PNU	Parameter	Name	Range	Default
947.0	P-13	Last Fault	see „Fault messages …."	-

4.4.2   Reset after fault → Manual or automatic restart?

After the occurrence of a fault the reason has to be eliminated and after a RESET the drive can start again. The parameter "Start Mode" (P-30) determines, if a RESET has to be done manually or an automatic restart is possible. See 3.2 "Selection of the Start Mode". Take care, that an automatic restart doesn't lead to a dangerous situation!

Following measures lead to a manual reset:
- Pushing the STOP button on the external keypad DX-KEY-LED
- Disconnecting and reapplying the supply voltage
- Removing of the enable signal (FWD, REV, START) and reapplying

Note:

The fault messages h-OI , O-I and I.t-trP occur, because of an overcurrent trip of the device. A delay time between the occurence and a possible reset prevents damages of the device. The delay time is increased with each trial.

Reset	Delay time
1st trial	2 s
2nd trial	4 s
3rd trial	8 s
4th trial	16 s
5th trial	32 s
each further trial	63 s

4.4.3   Fault messages – possible causes – remedy

The column „Message" contains the code of the LED „Fault Code" on the front of the variable speed starter as well as the message on the display of the external keypad DX-KEY-LED.

Message	Possible causes and remedy
LED "RUN" flashes green StoP	No actual fault. Drive is disabled.
LED „Status" flashes red UVol t	Undervoltage in the d.c. link. Remark: This message generally appears when the supply voltage is disconnected from the drive and the d.c. link voltage is reduced. This is NO fault situation. When the message occurs during operation: • Supply voltage too low → please check • Check all components / devices, which are part of the supply circuit of the drive (protective devices, contactors, chokes…) for a proper connection and contact resistance.
„Fault Code": 1 x flash, 2 s OFF O-I	Instantaneous overcurrent on the variable speed starter output • Fault occurs immediately on drive enable or run command: • Check connection between drive and motor • Check motor windings on short circuit or ground fault. • Fault occurs during motor starting: • Check the motor is free to rotate and there are no mechanical blockages • Motor with mechanical brake: Check, if brake is released. • Check for the correct star-delta wiring • Check, if the motor nameplate current is correctly entered into P-08 (Motor Nom Current) • Increase the ramp time in P-03 (t-acc) • Reduce motor boost voltage setting in P-11. • Fault occurs when motor operates at constant speed: • Check, if motor is overloaded • Fault occurs during motor acceleration or deceleration: • The acceleration and deceleration ramp times are too short and require too much power. If P-03 / P-04 cannot be increased, a bigger drive may be required.

Message	Possible causes and remedy
„Fault Code" 2 x flash 2 s OFF E-tr iP	External fault (at terminal 3). • P-19 "DI3 Logic" = 0 (= Default): A HIGH signal must be applied to this input to operate the drive. In case a thermistor is connected: check motor temperature. • P-19 "DI3 Logic" = 1: A LOW signal must be applied to this input to operate the drive.
„Fault Code" 3 x flash 2 s OFF OVol t	Overvoltage in the d.c. link • Check if the supply voltage is inside the tolerance for the drive. • Check if the overvoltage control is enabled (P-31 = 0) • When the fault occurs while decelerating or stopping: increase ramp down time (P-04) or enable overvoltage control
„Fault Code" 4 x flash 2 s OFF I.t-trP	Motor is overloaded. The thermal protection has tripped after delivering > 100 % of the current set in P-08 for a certain time. • Check if the value of P-08 is equal to the motor rated current • Check motor connection (star / delta) • Flashing dots on the display indicate an operation with overload (> P-08). Increase ramp time or decrease load in this case. • Check the load mechanically to ensure it is free and no jams, blockages or other mechanical faults exist.
„Fault Code" 5 x flash 2 s OFF O-t	Heatsink overtemperature. The drive is too hot. • Check the ambient temperature around the drive is within the specified range (maximum 50 °C / 60 °C, partly with derating) • Ensure sufficient cooling air is free to circulate around the drive (distance to other devices above and below the variable speed starter). • Improve cooling of the control cabinet, when necessary. • The cooling slots may not be closed e.g. by pollution or by devices which are mounted too close
„Fault Code" 6 x flash 2 s OFF	Internal fault in power section → Please refer to your next Eaton sales office.
„Fault Code" 7 x flash 2 s OFF SC-trP	Loss of the serial communication • Check, if the connection to drives and other devices in the network is correct • Each participant in the network must have its own unique address. Two devices with the same address are not allowed.
„Fault Code" 8 x flash 2 s OFF P-dEF	Default parameters have been loaded
„Fault Code" 9 x flash 2 s OFF	Distorsion of the d.c. voltage
„Fault Code" 10 x flash 2 s OFF 4-20 F	Analog input current out of range • Check settings of P-16 for AI1 • In case of 4-20mA: Check reference signal on wire break

Message	Possible causes and remedy
„Fault Code" 11 x flash 2 s OFF U-t	Undertemperature. This message is displayed, when the ambient temperature is below – 10 °C. To start the drive, the temperature must be above this value.
„Fault Code" 12 x flash 2 s OFF th-FLt	Thermistor on the heatsink is faulty. Please refer to your next Eaton sales office.
„Fault Code" 13 x flash 2 s OFF dAtA-F	Fault in the internal memory. Parameters are not saved and default settings are reloaded. Try to save the (again modified) parameters again. If the message still appears: Please refer to your next Eaton sales office.

5 Stopping

There are multiple possibilities to stop a variable speed drive:

	Possible with DE1?	Accessories required
Switch off, drive coasts to standstill	YES	None
Ramp down to standstill	YES	None
Ramp down to standstill with overvoltage control	YES	None
Dynamic braking with brake resistor	No	-
DC braking	YES	None
Feedback energy to the mains	NO	-
Mechanical brake (Variant DE11 only)	YES	None. Control with DE11

5.1 Ramping down or coasting?

Parameter P-05 „Stop Mode" determines, if the motor coasts or if it ramps down when the enable signal (FWD, REV, STOP) is removed.

5.1.1 Stop Mode (P-05)

Coast to stop (P-05 = 0):

When the enable signal is removed, the output of the inverter is disabled and the motor coasts to stop.

Ramp to stop (P-05 = 1):

When the enable signal is removed, the motor ramps to standstill with the ramp set with P-04.

ATTENTION: In a drive system the energy always flows from the subsystem with the higher frequency to the one with lower frequency. If the output frequency of the variable speed starter is reduced too fast (deceleration ramp too short) and the motor still turns at a higher speed than the one corresponding to the output frequency of the inverter because of its inertia, the motor becomes a generator and feeds back energy into the d.c. link. This leads to an increase of the d.c. link voltage and possibly to a trip with the message O.Volt (Overvoltage).

To prevent this, variable speed starters have the function "Overvoltage control", which is enabled by default. More details see chapter 4.2.1.

PNU	Parameter	Name	Range	Default
620.1	P-05	Stop Mode	0: coast to stop 1: ramp to stop	0

5.2 DC braking to standstill

A DC current is injected into the motor, which generates a braking torque. The rotating energy of the machine is converted into heat, dissipated by the motor. This means that a DC braking must not be performed quite often, not to overload the motor.

A DC braking cannot be used for a speed reduction e.g. from 1000 rpm to 800 rpm, but to a braking to standstill only. The DC braking is also used to stop rotating motors (e.g. fans, which turn because of the chimney effect inside a wind tunnel) before they start. This is to prevent overcurrent trips. See chapter 3.3 "Starting a rotating motor".

5.2.1 DCBrake (P-25), t-DCBrake@Stop (P-26), DCBrake Voltage (P-27), f-DCBrake@Stop (P-28)
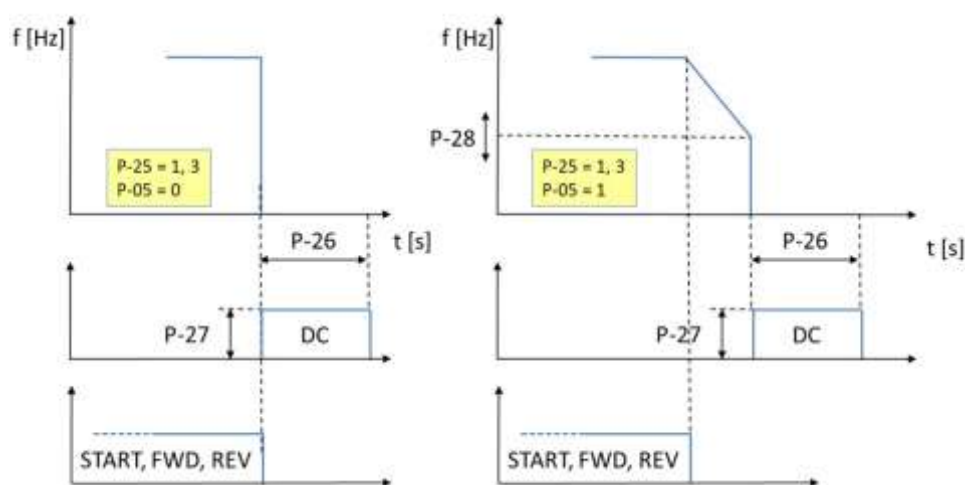
Parameter P-25 „DCBrake" determines, in which situations a DC braking is performed. In case a DC braking is required at stop, P-25 has to be set to 1 or 3.

The behavior at removal of the signals FWD / REV / START depends on the stop mode (P-05).

P-05 = 0 (coast to stop):
The DC braking starts, once the signal FWD / REV / START is removed.

P-05 = 1 (ramp to stop)
At removal of FWD / REV / START the motor decelerates with the ramp set with "t-dec" (P-04). Once the frequency set with "f-DCBrake@Stop" (P-28) is reached, the DC braking starts.

The strength and the duration depend on the settings of P-26 "t-DCBrake@Stop" and P-27 "DCBrake Voltage" (in percent of the motor rated voltage P-07). With P-25 = 3 it has to be noted, that the braking time before a start is the same as after a stop.

During a DC braking the LED „Fault code" on the front of the variable speed starter lights yellow.

PNU	Parameter	Name	Range	Default
2221.0	P-25	DCBrake	0: OFF 1: ON at Stop 2: ON before Start 3: ON before Start and at Stop	0
2222.1	P-26	t-DCBrake@Stop	0.0…10 s	0.0 s
2220.0	P-27	DCBrake Voltage	0.0…100 %	0.0 %
2223.0	P-28	f-DCBrake@Stop	0 … P-01 (f-max)	0.0 Hz

5.3 Control of a mechanical brake

HINT: The information is exclusively valid for the variant DE11!

When a mechanical brake is used it should be activated at a certain speed. The relay contact between the terminals 13 and 14 have the possibility to generate a speed dependent signal. The threshold is adjustable. It can be configured, if the relay contact closes above or below the threshold.

Die Funktion des Ausgangs ist entsprechend zu konfigurieren.

Kind of signal	Terminals	Function	Threshold
Normally open contact	13 / 14	P-51 „RO1 Function"	P-52 „RO1 Upper Limit"

5.3.1 RO1 Funktion (P-51), RO1 obere Grenze (P-52)

PNU	Parameter	Name	Wertebereich	Werk
451.0	P-51	RO1 Function	0: Drive running 1: Drive healthy 2: Motor at target speed 3: Drive tripped 4: Speed $\geq$ RO1 Upper Limit (P-19) 5: Motor current $\geq$ RO1 Upper Limit (P-19) 6: Speed $<$ RO1 Upper Limit (P-19) 7: Motor current $<$ RO1 Upper Limit (P-19) 8: Drive not enabled 9: Motor not at target speed	0
452.0	P-52	RO1 Upper Limit	0 % … 200 %[1]	100 %

1) The percentage rate is related to the parameter selected with P-18 / P-25, in this case it is related to the max. frequency, set with P-01.