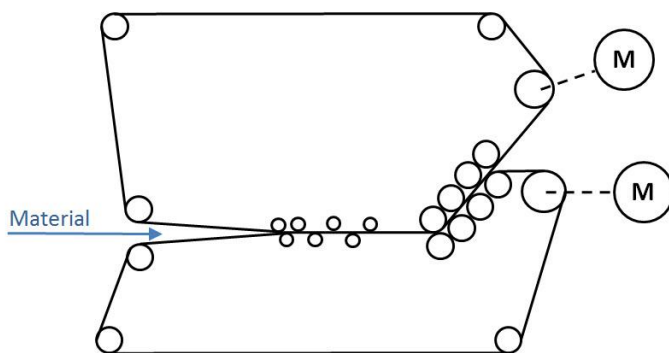


PowerXL™

DA1 Variable Frequency Drives
 Equal load sharing with the droop function



Level 3	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.).
- 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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1 General

In applications, in which multiple motors act on the same load, the load shall be shared equally between the motors involved. Small deviations and tolerances in the mechanical or electrical system lead to an unbalanced load sharing. In extreme cases one motor has to take the complete load and in the end it trips because of overload.

These effects cannot be eliminated by fine tuning the speed reference or similar measures, because they sometimes appear sporadically or they are different over the speed range. To have an equal load sharing despite of the effects described, the “droop function” was developed.

This application note

- describes the function
- shows an application example

Some required parameters are part of the menu inside level 3. These menus have to be activated by prompting the “Password Level3” (P6-30) into P1-14 (Password). By default, “Password Level3” is 201.

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

2 The Droop Function

In case speed controlled drive systems are mechanically connected through form fit or friction, the fastest drive takes the load and pulls the other ones, which are less, or in extreme cases, not loaded. To counteract this effect, the speed reference will be corrected, depending on the load. At load increase, the droop function reduces the resulting speed reference (set reference – speed reduction), the motor falls back a little bit in its speed and the other motors inside the system take more load automatically.

Application experience shows, that it is of advantage in many cases to have one motor inside the system, where the droop function is disabled (P6-09 = 0.0 %), while it is enabled (P6-09 different from 0.0 %) for all other motors inside the system.

In exceptional cases it can also be advantageous to enable the droop function for all motors.

2.1 DroopMax (P6-09) and DroopFeedback (P0-62)

„DroopMax“ (P6-09) determines the value, by which the speed is reduced at rated load. It is given as a percentage of “Motor Nom Frequency” (P1-09).

Speed reduction at rated load : $P1-09 \cdot P6-09$

Amount of speed reduction: $P1-09 \cdot P6-09 \cdot \frac{\text{actual torque}}{\text{rated torque}}$

Resulting speed: Speed reference – speed reduction

Parameter “DroopFeedback” (P0-62) shows the actual value of the speed reduction. The way how it is displayed depends on the setting of “Motor Nom Speed” (P1-10):

P1-10 = 0 displayed in Hz

P1-10 > 0 displayed in rpm

The value of „DroopMax“ is application depending and cannot be given in general. A good value to start with is 5 %. During commissioning the value can be increased or decreased in small steps until an equal load sharing between the motors is reached. The particular current can be read on the display.

The droop function is active in both senses of rotation.

PNU	Parameter	Name	Range	Default
2901.0	P6-09	DroopMax	25.0 % · P1-09	0.0 %
2901.1	P0-62	DroopFeedback	-	-

2.2 M-Max Generative (P4-09) and Overvoltage Currentlimit (P7-09)

The default parameter setting is based on experience, with which good results can be achieved in many cases. Depending on the application or the connected motor it can happen, that the droop function cannot work properly, because it bounces borders of the internal regulation. In most cases it helps to increase the values of the parameters “M-max Generative” (P4-09) and/or “Overvoltage Currentlimit” (P7-09).

M-Max Generative (P4-09)

When working in vector mode (P4-01 = 0 or 1) this parameter defines the maximum torque limit during regeneration.

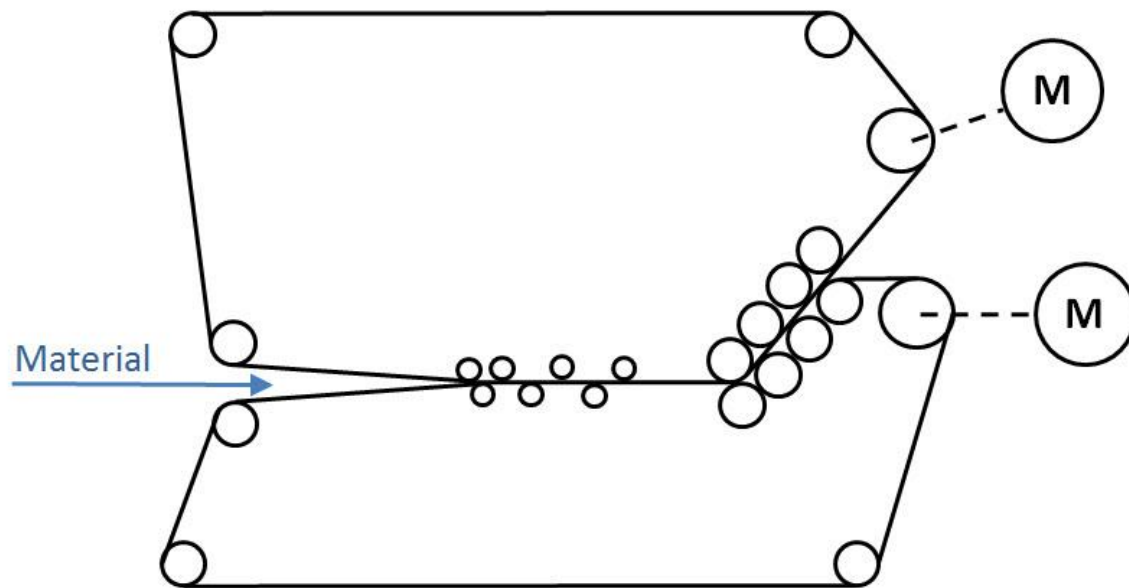
Overvoltage Currentlimit (P7-09)

Current limitation to prevent overvoltage trips

This parameter is only active at speed control with torque limit (P4-01 = 0) and becomes effective in case the DC link voltage exceeds a threshold. This value, set internally, is just below the one for a trip because of overvoltage. P7-09 limits the torque producing current at the output to prevent an overvoltage trip. A small value of P7-09 limits the torque of the motor when the DC link voltage exceeds the threshold. A high value can lead to current distortions and to a rough behavior of the motor.

PNU	Parameter	Name	Range	Default
31.1	P4-09	M-Max Generative	0 ... 200 %	100 %
241.0	P7-09	Overvoltage Currentlimit	0.0 ... 100.0 %	5.0 %

3 Application example



Material is transported through the machine by means of two conveyor belts. Each belt is driven by its own motor. Because of the contact pressure, the two belts are connected mechanically. In case one of the two motors tries to run a little bit faster than the other one, it leads to an unequal load sharing.

Without an enabled droop function, motor 1 takes 80 % of its rated load, motor 2 85 %. Because of the higher load, motor 2 becomes warmer than motor 1, possibly one can also see the difference in speed on the material which is transported between the belts.

Now the droop function will be enabled with P6-09. The system will change to equal load sharing iteratively. Values at the beginning (we are looking to the system at an output frequency of 40 Hz, P1-09 = 50 Hz):

Resulting speed of motor 1: $40 \text{ Hz} - ((10 \% \cdot 50 \text{ Hz}) \cdot 80 \%) = 36 \text{ Hz}$

Resulting speed of motor 2: $40 \text{ Hz} - ((10 \% \cdot 50 \text{ Hz}) \cdot 85 \%) = 35,75 \text{ Hz}$

Motor 2 now runs slower than motor 1 → The load of motor 1 increases → Therefore the load of motor 2 is reduced This is a repetitive process until an equal sharing of the load is achieved. Remaining differences in load can be adjusted with P6-09.