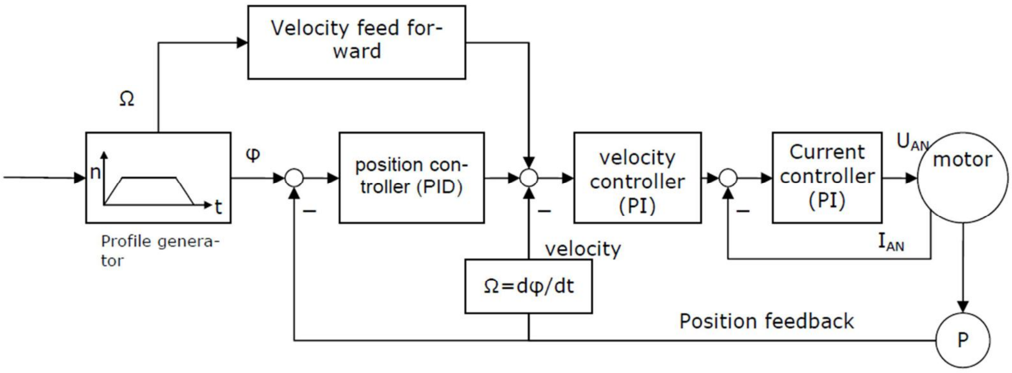
1. Control loop



2. General Information

The current and speed controller are built as PI controller whereas the position controller acts like a PID controller.

P-Part: If a deviation occurs, the controller produces immediately a corrective action. (How fast the controller acts, if a deviation occurs)

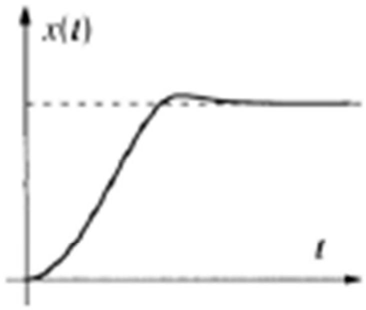
I-Part: The I-Part brings the deviation to 0 for t -> ∞ (How long the controller needs to push down the deviation to 0)

D-Part:

It is not possible to follow a commanded signal very fast and without overshoot and simultaneously to react as fast as possible to external disturbance.

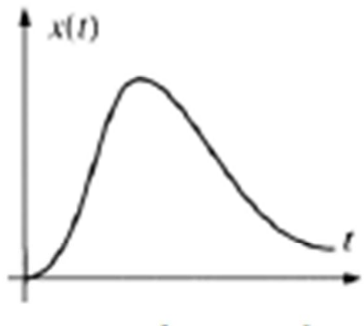
<u>Either this:</u>

Commanded signal in form of a jump



Less overshoot

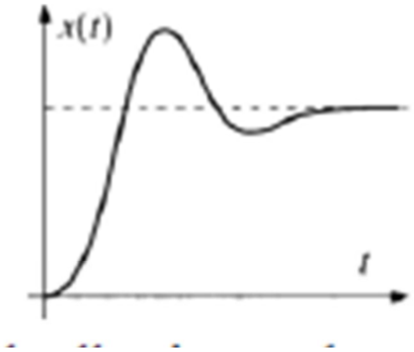
disturbance in form of jump



less reaction time

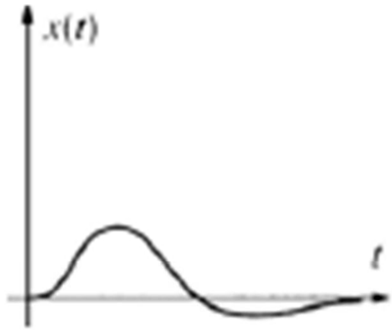
<u>Or this:</u>

Commanded signal in form of a jump



Much overshoot

disturbance in form of jump



fast reaction time

3. Motortuning – Effect of the parameters

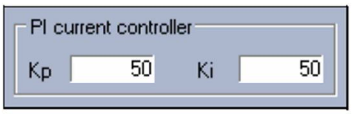
to parameterize this kind of controller, you have to do the following:

1. Start with the current loop
2. Go on with the speed loop
3. Finish with the position loop

3.1 Current controller (Current loop)

The parameters of the current loop are determined by motor characteristics, like winding resistance and winding inductivity. Therefore the current loop parameter depends of the motor itself and not of the application. This means each kind of BG motor have characteristic values like:

	CURR-Kp	CURR-Ki
BL 45	100	100
BL 65	50	50
BL 75	100	100



The parameter of the speed and position loop depends of:

- Inertia of the rotor and application
- Friction
- Torque

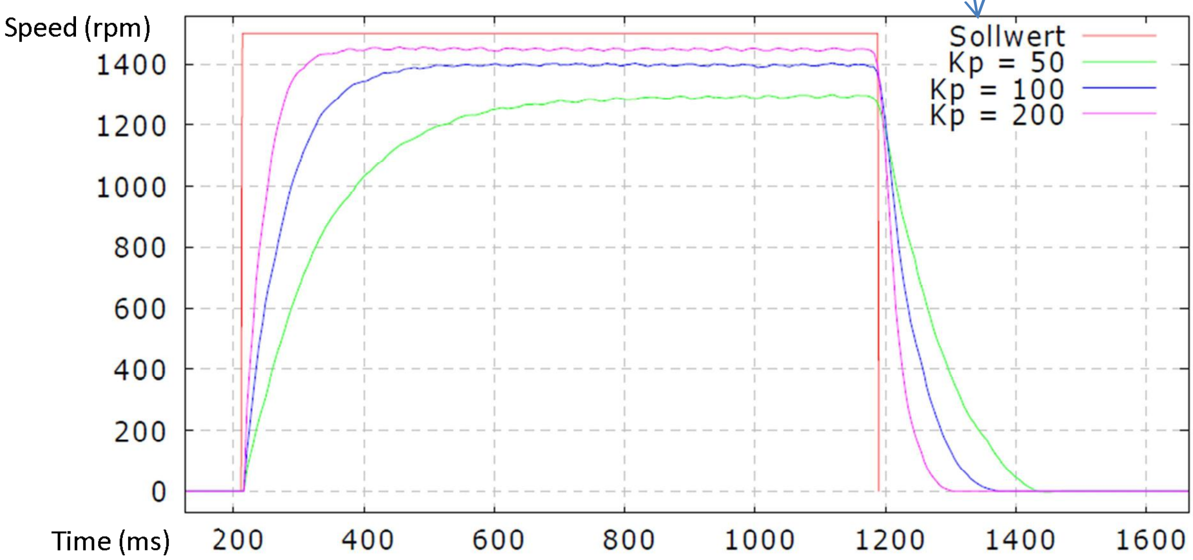
These parameters are determined by the application.

3.2 Speed controller (Speed loop)

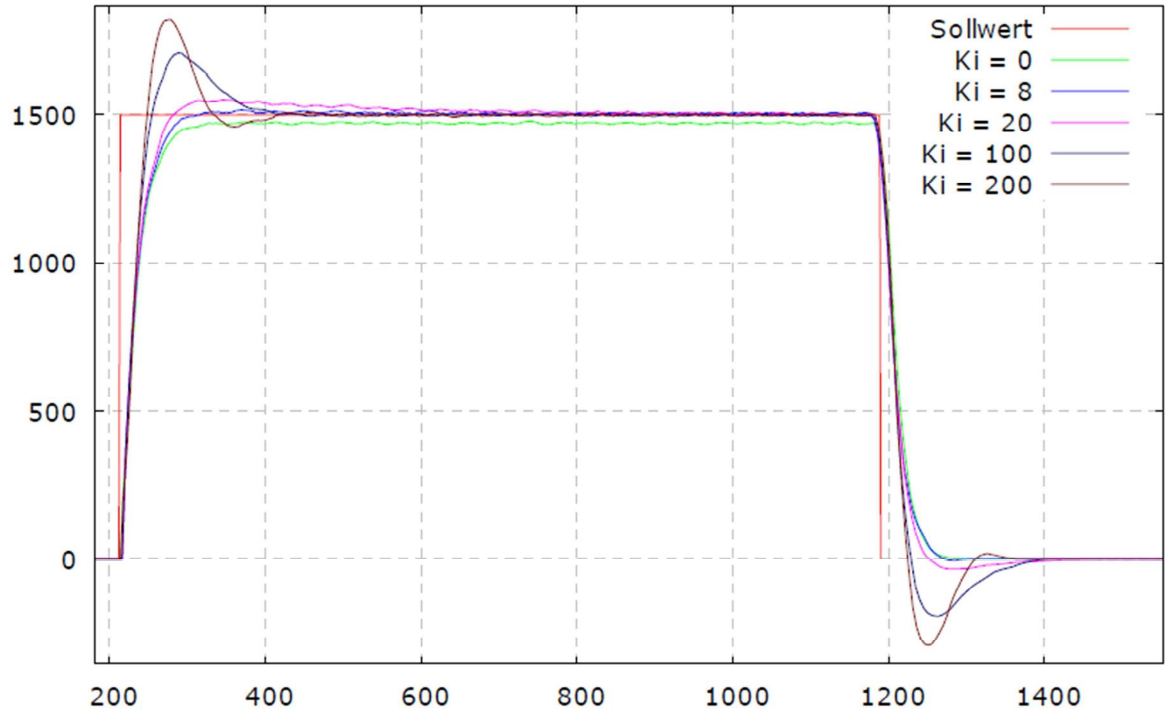
If the speed controller is used as a normal proportional controller (only the P-Part is active(Ki=0))an constant speed control deviation will happen (speed control failure). This deviation is smaller as bigger the Kp value is:

comanded velocity

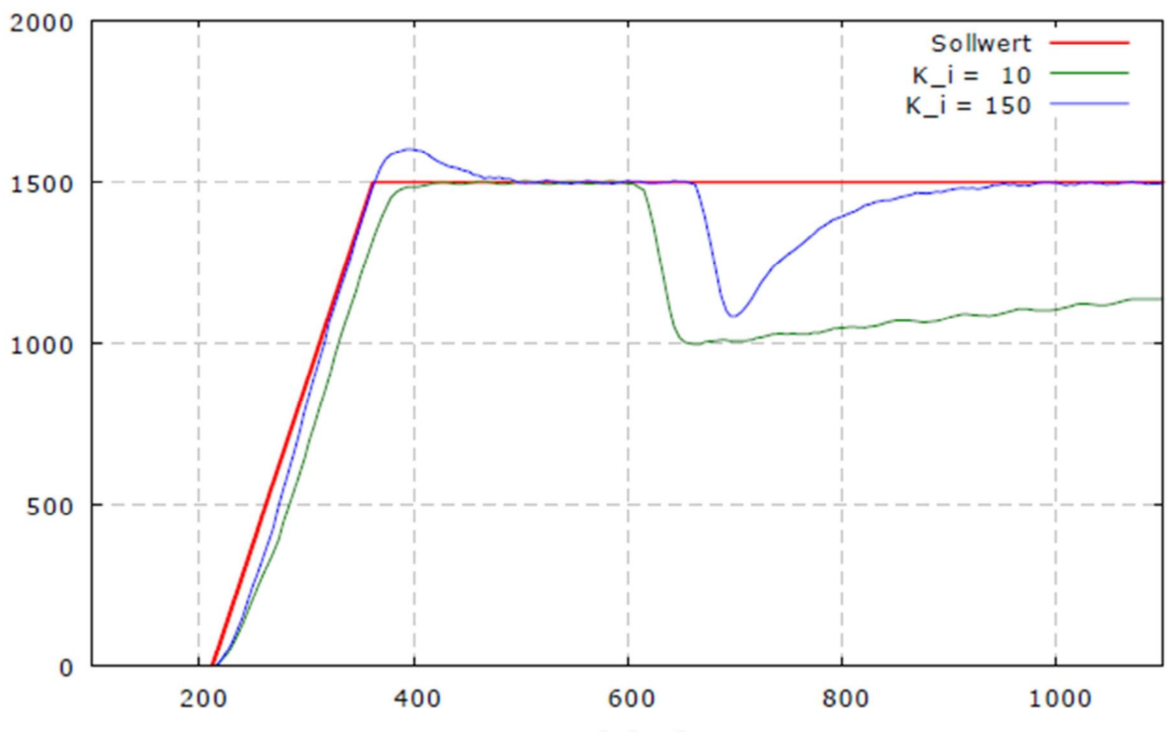
Deviation ~ 1/Kp



Is Ki≠0 the integral parts of the controller push down the deviation to 0 (at constant speed).

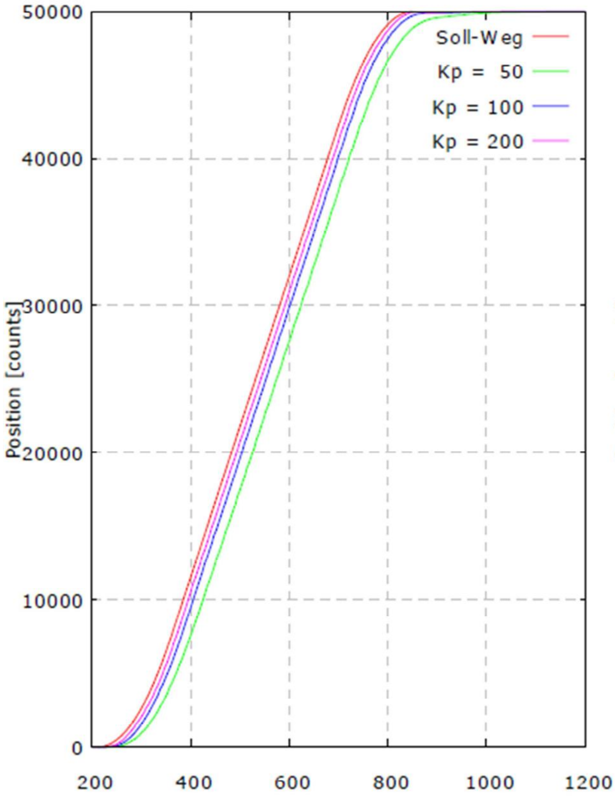


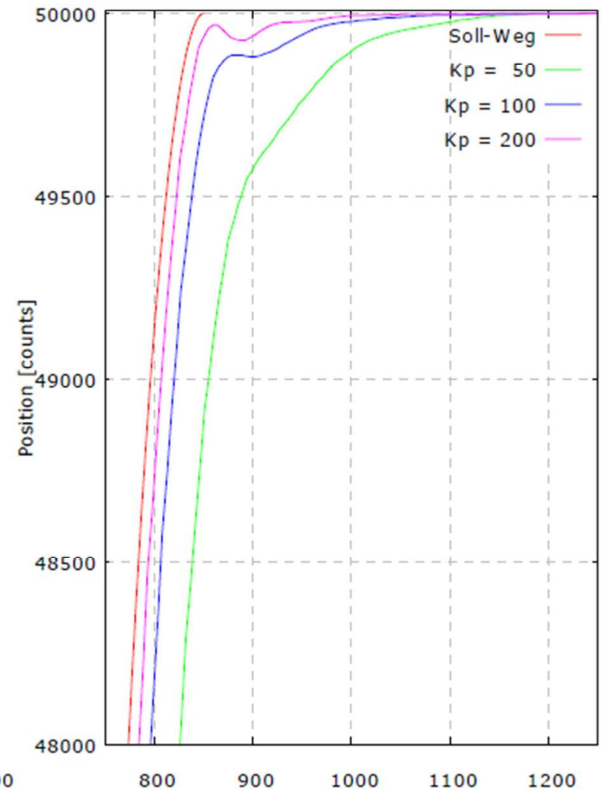
If an external disturbance occurs the motor behavior is as follows:



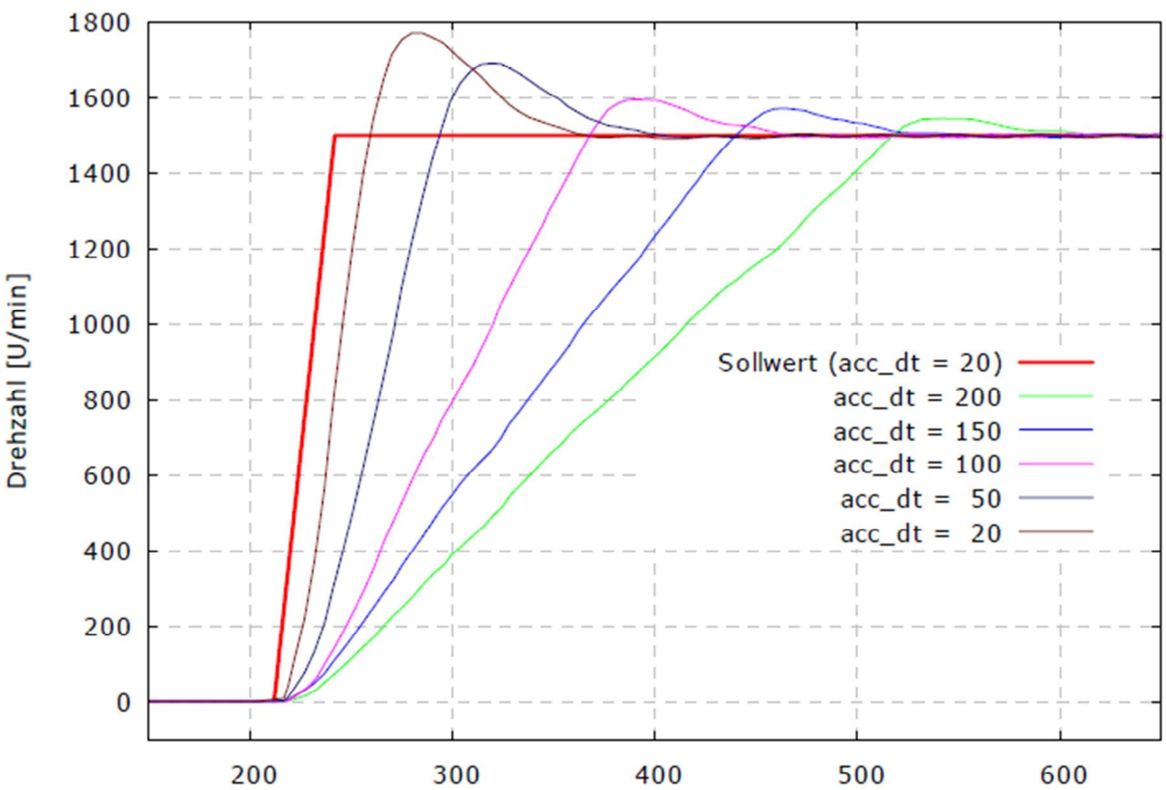
As already mentioned in chapter 2 the higher the Ki factor the faster the reaction time of the disturbance is, but the higher the overshoot will be.

3.3 position controller (position loop)





It can be observed, that a following error is occurring. The higher the Kp value of the controller the smaller the following error is. If the Kp value is too high, an overshoot can occur. This will also happen if the acceleration or deceleration is too high (> 10ms/1000rpm).



4. How to find out suitable parameter

To parameterize the controller, as already mentioned we have to

1. Start adjusting the current loop
2. Go on with adjusting the speed loop
3. Finish tuning with adjusting the position loop
4.

4.1 tuning the current loop

-> please use above mentioned values (chapter 2)

4.2 tuning the speed loop

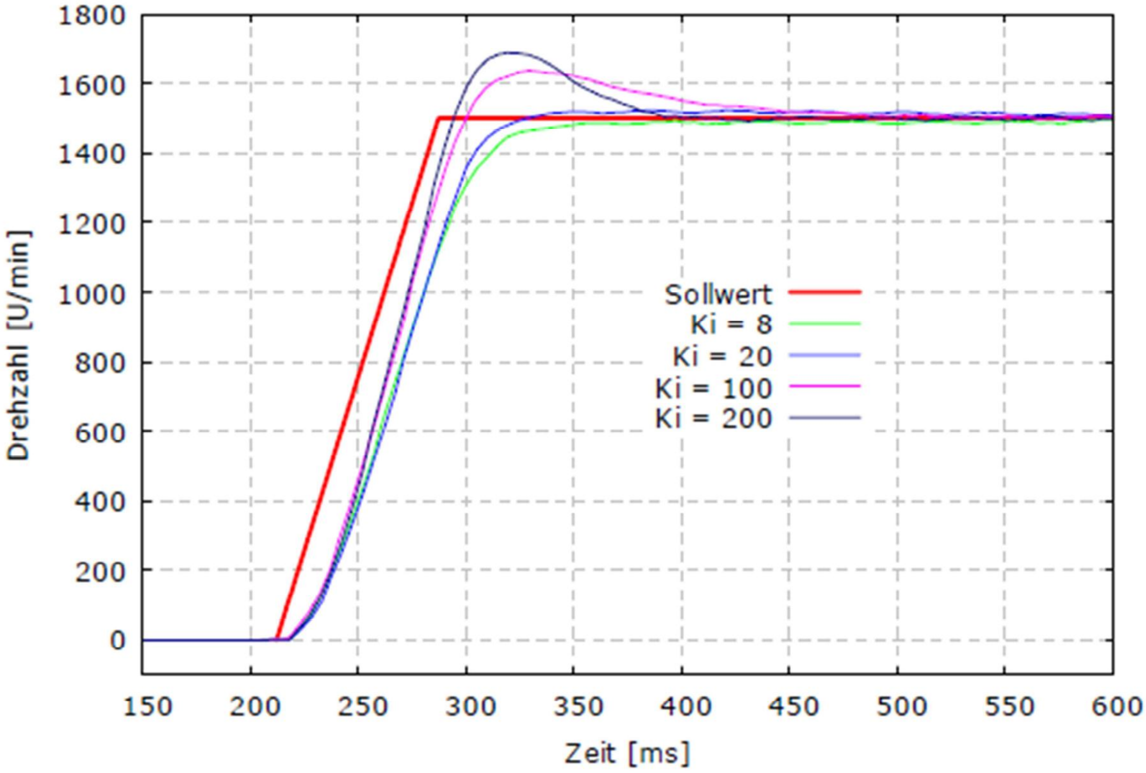
4.2.1 find out a suitable Kp value

Increase the Kp value to K_{pkrit} till the motor makes noise (like a humming). Empiric experiments shows, that 50% of the Kpkrit value is suitable.

$$K_P = 0{,}5 \cdot K_{P,krit}$$

4.2.2 find out a suitable Ki value

The next step is to search a suitable Ki value. This value depends of the application and the requirements of the customer (do the customer needs a fast reaction time against disturbances or less overshoot)



From experience a difference form Kp to Ki of 100 should be used.

4.3 tuning the position loop

4.3.1 find out the suitable Kp value

There is a connection between the Kp value of the position controller and the Ki value of the speed controller.