Application Note

Document Number	YEGA0909A1000-01
Application	**Positioning in Closed Loop Vector control with pulse encoders**
Industry	Miscellaneous
Yaskawa Product	GA700 in Closed Loop Vector control mode

1 Application description

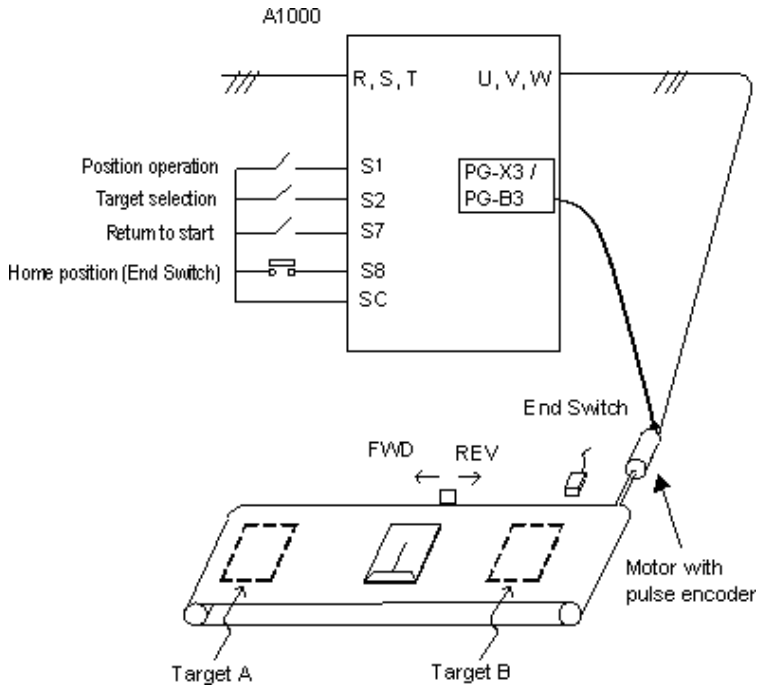

Figure 1: Application overview

Figure 1 shows the principle of the application. At a certain rotor position, the equipment coupled behind the motor (e. g. a conveyor belt like in figure 1) reaches a position, called *Home position*. At this position an *End Switch* will be closed automatically. This End Switch is input into the inverter as S_8 for to give information about the starting position (Rotor has moved zero pulses).

S_2 is used for switching between *Target A* and *Target B* (open = target position A, closed = target position B). These targets are set in parameters q1-02 and q1-03 respectively as the number of revolutions, the rotor shall move from starting position. The target positions are defined as absolute positions in relation to the home position; e. g. if Target B is set to 1 revolution and

Target A is set to 10 revolutions, switching from A to B position when Target A is reached means, the motor will move 9 revolutions in reverse direction for to reach Target B. Switching between targets is also possible if the rotor is just between two targets.

Position operation is started with digital input S_1. As long as the input is closed, the drive will calculate the number of pulses the rotor currently has moved from home position, subtract it from the number of pulses needed for to reach the target and feed this difference into a PI controller. The PI controller determines the speed reference for reaching the target. So the drive automatically accelerates and decelerates until the target is reached. When the target is reached, the run command remains set unless S_1 is opened. Because the controller will continue running, every deviation will cause an output of a frequency. A small amount of hunting around the target is possible. If S_1 or S_7 are opened, the motor stops calculating the rotor position. In this case a restart by returning to home position (S_7) is needed. Figure 2 shows the timing diagram for positioning operation.

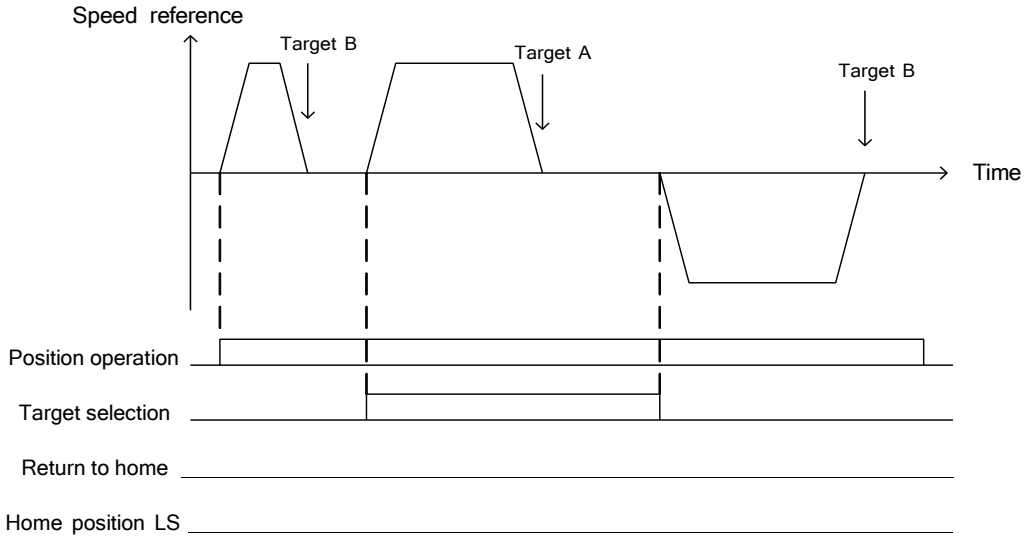

Figure 2: Positioning operation

The input S_7 ("Return to home") will cause the drive to output the frequency, set in q1-07. The frequency reference will keep the value in q1-07 until S_8 (End Switch) closes. Then, run command keeps applied but a frequency of 0 Hz is output (Zero Speed operation). Figure 3 shows the digital inputs while returning to home position. The picture shows that a low setting value for the deceleration time is essential for accurate positioning. The frequency reference is set to zero in the moment, the home position switch is closed, but the output reaches 0 Hz a short time later.

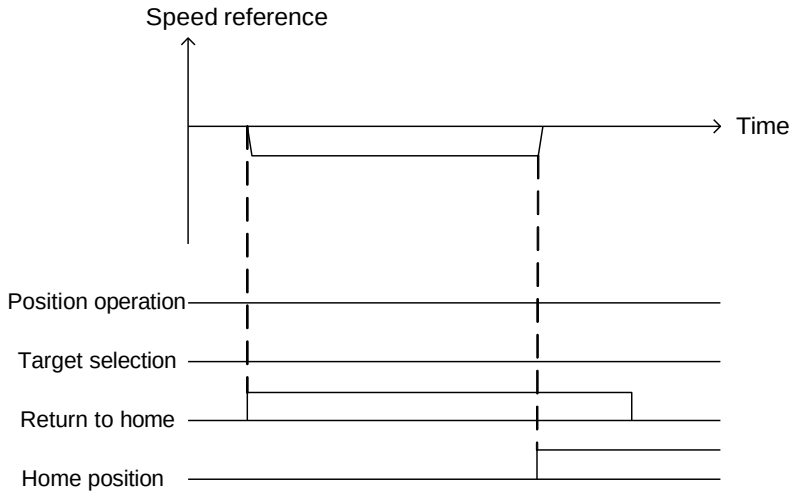

Figure 3: Returning to home position

2 Inverter Settings

Description	Recommended Values / Default Values
PPR * 4 • DWEZ user specified parameter • Set the number of pulses per revolution multiplied by 4 • 1 pulse means 0.01 %, i.e. for an encoder with 1024 pulses per revolution 40.96 % must be set • Setting range: 0.00 to 655.35 %	q1-01 = 4096 (default value, set according to factory setting of F1-01)
Target positions • DWEZ user specified parameters • Number of motor revolutions from home position to target A and B respectively • Setting with two decimal places is needed for correct calculation in DWEZ (e. g. 11.00 % means 11 revolutions) • Setting range: 0.00 % to 655.35 % • Resolution: 0.01 revolutions	Target A: q1-02 Target B: q1-03
Speed for returning to home position • DWEZ user specified parameter • Set as percentage of maximum output frequency (E1-04) • Setting range: 0.0% to -100% (only negative values) • Resolution: 0.1 %	q1-07
Acceleration/Deceleration times, S-curve settings • Drive standard parameters • Setting range: 0.0 s to 6000.0 s	C1-01 = 0.1 s C1-02 = 0 s C2-02 = 0 s C2-03 = 0 s
PG 1 Pulses per revolution • Drive standard parameter • Sets the number of encoder pulses per revolution • Setting range: 0 to 60000 per	F1-01 = 1024 (default value)
ASR Gain tuning • Drive standard parameter • Set according to the load • Setting range: 0.00 to 300.00	C5-01

Description	Recommended Values / Default Values
Properties of PI controller • DWEZ parameters	• PI output direct acting, signed: q6-01 = 2 • PI disable / Integral reset: q6-02 = 10_{HEX} • PI proportional gain: q6-03 = 3.75 • PI integral time: q6-04 = 0 s (integral disabled) • PI integral limit:: q6-05 = 100 % • PI output limit: q6-06 = 100 % • PI output gain: q6-07 = 1
Scaling for "Positioning deviation" • The scaling is applied to the Position deviation value, which is input to the PI controller	• Multiplier: q4-03 = 1 • Divisor q4-04 = 10 • Bias q4-05 = 0
Torque limits • Drive standard parameter	• L7-01 = L7-03 = L7-04 = 300 %

The digital inputs are used like follows:

Terminal input number	Description
S_1	Positioning operation
S_2	Selection between Target A and Target B
S_7	Return-to-home operation
S_8	End Switch (Home position reached)

3 Limitations

- After the input for “Return to home” has shut off, the motor shaft should not be allowed to rotate until the “Position operation” input has been activated again.
- After turning off the input power, the *Home* position must be achieved first for correct positioning because position information is only calculated relative to *Home* position.
- When using the described procedure, the resetting of the counter can only be detected when the motor rotates less than a half revolution per derivation. In A1000 the DWEZ monitors are updated each ms. This means, the theoretical maximum speed is lower than $\frac{0.5\,\text{revolutions}}{\text{ms}} = \frac{30000\,\text{revolutions}}{\text{min}}$
- Torque limit must be disabled (torque limit will cause shaft misalignment)
- If overvoltage is a problem during deceleration; either install a braking resistor or lower the position gain settings using the Q6 parameter

This application note should only show up helpful functions of our inverter, it does not cover all application aspects! Especially safety requirements of certain applications are not subject of this paper.

Please contact Yaskawa Electric Europe GmbH if your application requires additional functionality that is not mentioned here.