

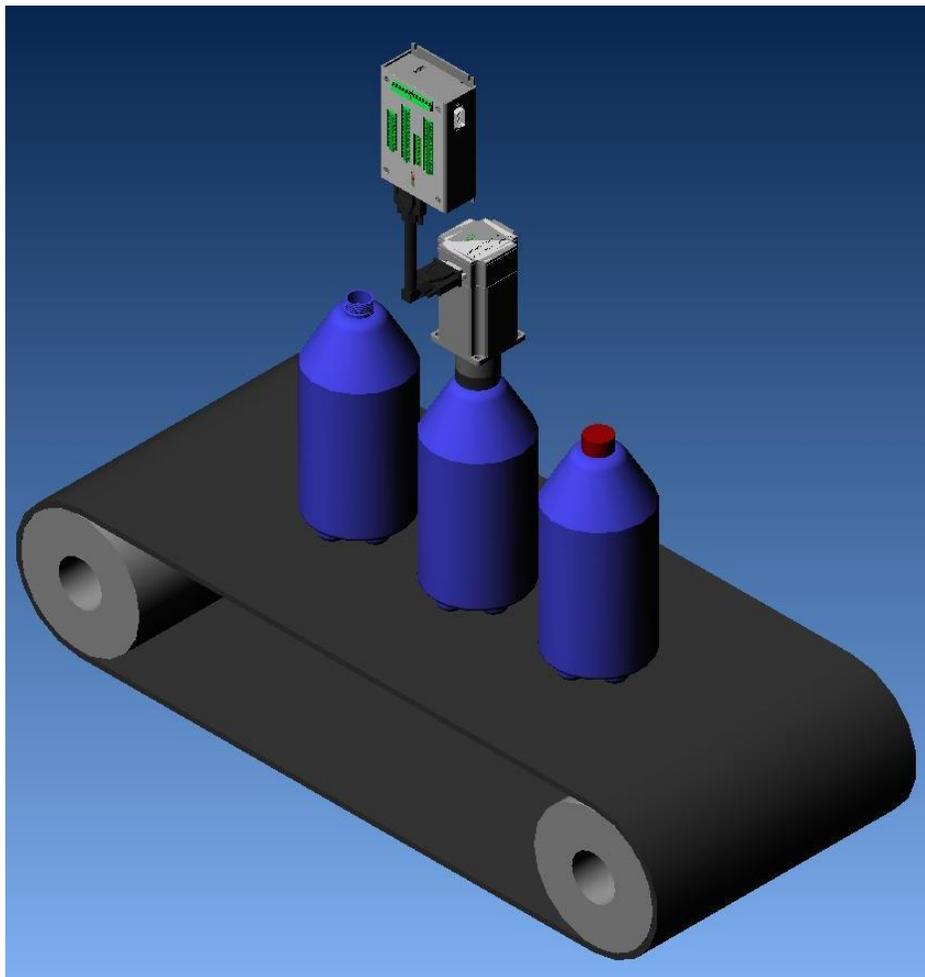
## Tighten

Associated Files:

- Tightener-Torque.qcp
- Tightener-Position.qcp

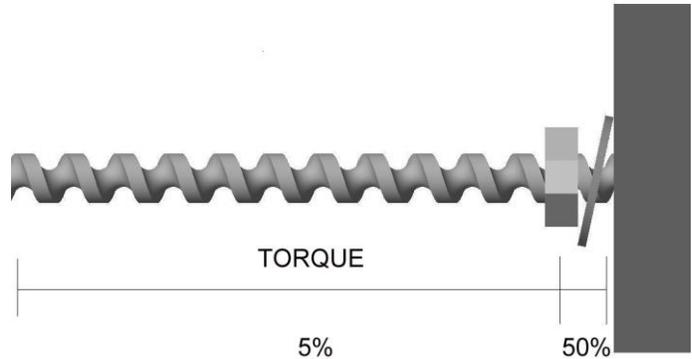
## Overview

This Application Note describes how to use the SilverDust controller in a tightening application. The most common tightening application would be a cap or bolt tightener. These types of applications require accurate control of torque and positioning to avoid stripping, under tightening, missing bottles, cross-threading, and mechanical jams. This application will monitor the position and the amount of torque being applied. The document will describe two methods of a tightener application.



### Bolt Tightening Application

The illustration demonstrates the amount of torque required to tighten a bolt. The motor will use a mechanical device to screw the bolt down until the washer begins to press against the hard stop. The controller will detect the hard stop and turn one revolution to secure the bolt tight. In this example, the I-grade 23H-5 motor has a max torque of 190 Oz-In at 15RPM (refer to the motor datasheets for torque charts). The motor will apply max torque of 190 Oz-In when the required torque is greater than 50%.



### Tightener-Torque.qcp

The program will perform the operation described in the bolt tightening application. The Wait on Bit State command (WBS) waits for I/O #1 to trigger to begin the operation. The trigger could be a sensor or a start switch for the application.

The Torque Limits command (TQL) sets the torque low to avoid stripping or damaging the bolt.

The Velocity Mode command (VMP) continually runs the motor at a fixed speed.

The ACR command causes commanded Torque (lower half of register 9) to be copied to register 25 through a 10Hz filter. The 10Hz filter smoothes out the servo's aggressive torque signal. Once ACR is configured, register 25 will continually be updated with the filtered Torque.

The Check Torque loop waits for the filtered torque (reg 25) to become greater than 30%.

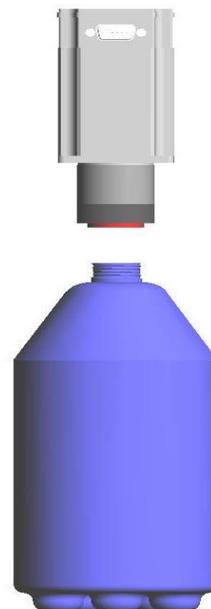
VMP stops the servo.

TQL increases the Torque Limit to 100% and then the MRV moves the servo a little further to secure the bolt.

Line# Oper	Label	Command
5:REM		Wait on Bit State command waits for I/O #1 to be cleared
6:WBS		Wait On Bit State Until "I/O #1" is HIGH/TRUE
7:REM		Enable multi-task allow the check torque loop to be running in the background while the VMP command is in motion
8:EMT		Enable Multi-Tasking
9:REM		Decrease the torque to 50%
10:TQL		Torque Limits: Closed Loop Holding = 50 % Closed Loop Moving = 50 % Open Loop Holding = 30 % Open Loop Moving = 30 %
11:REM		Velocity mode is keep going until a stop condition is called
12:VMP		Velocity Mode: acc=5000.17 cps/s, vel=2000 cps
13:REM		In the background, copy Torque (lower half of reg 9) to reg 25 through a 10Hz filter.
14:ACR		Analog Continuous Read: "Torque-Filtered[25]" = Torque 10 Hz Filter
15:REM	CHECK	Check Torque
16:JGE		Wait until Torque >= 30% Jump to "TIGHTEN"
17:JMP		When "Torque-Filtered[25]" >= 30 % Jump to "CHECK"
18:REM	TIGHTEN	Tighten
19:REM		Stop
20:VMP		Velocity Mode: acc=49999.6 cps/s, vel=0 cps
21:WBS		Wait On Bit State Until "Trajectory Active" is LOW/FALSE
22:REM		Increase torque and move a little more to secure nut
23:TQL		Torque Limits: Closed Loop Holding = 75 % Closed Loop Moving = 100 % Open Loop Holding = 30 % Open Loop Moving = 30 %
24:MRV		Move 8000 counts @ acc=20696.06 cps/s vel=2000 cps

### Cap Tightening Application

The cap tightening application uses the encoder position to detect when to increase torque and to monitor error conditions. The application is only useful when the distance from the mechanical setup and bottle do not vary. Mechanical stalls and missing bottles can be detected during operation and depending on the faults may be recoverable. The motor will move a certain distance until the cap just hits the bottom of the neck. The motor then does one last turn to secure the cap onto the bottle. The encoder position is then compared to the measured position of a good run to detect a stall or a missing bottle.



Line# Oper	Label	Command
1:KMC		Kill Motor Conditions: If Temp/Driver Enable Fault
2:ERL		Error Limits: Moving Limit = 50 counts Holding Limit = 50 counts Delay to Holding = 120 mSec
3:WBS	RESTA RT	Wait On Bit State Until "I/O #1" is HIGH/TRUE
4:TQL		Torque Limits: Closed Loop Holding = 25 % Closed Loop Moving = 25 % Open Loop Holding = 30 % Open Loop Moving = 30 %
5:MAV		Move to 80000 counts @ acc=1999.24 cps/s vel=5000 cps Stop when "Moving Error" is HIGH/TRUE
6:TTP		Target to Position
7:CIS		Clear Internal Status
8:JLT		Jump to "STALL" When "Actual Position[1]" < 43000
9:JGR		Jump to "TOO FAR" When "Actual Position[1]" > 46000
10:TQL		Torque Limits: Closed Loop Holding = 100 % Closed Loop Moving = 100 % Open Loop Holding = 30 % Open Loop Moving = 30 %
11:MRV		Move 8000 counts @ acc=10000.33 cps/s vel=20000 cps
12:ZTP		Zero Target and Position
13:JMP		Jump to "RESTART"
14:LRP	STALL	Load And Run Program: Program = "stall"
15:LRP	TOO FAR	Load And Run Program: Program = "too far"

#### Tightener-Position.qcp

The program will perform the operation described in the cap tightening application.

The KMC and ERL command settings allow the motor to hit a hard stop without exiting to a kill motor recovery routine.

The WBS command waits for I/O #1 to clear to begin the operation.

The TQL command sets the torque low to avoid stripping or damaging the cap.

The move absolute command is set to 80K counts to detect stalls and missing bottles. The fix distance to tighten the cap is 45K counts.

The JLT and JGR commands check the actual position for a stall or missing bottle then jump to a new program "stall" or "too far" if the condition is true. The programs can be modified to be error counters, recover routines and so on. If there is no stall or missing bottles the TQL settings will be set a "tighten" value and the motor will move one revolution to ensure the cap is tight. The ZTP will then set the encoder position back to zero and the JMP command will then jump back to the beginning of the program to wait for I/O #1 to trigger again.