APPLICATION NOTE

Industrial Automation Business Group

Note	Application Note for Torque Down Capper Application				
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Applicable to	ASD-A2 series AC servo motor and drive				

Application Note for Torque Down Capper using ASDA-A2 servo

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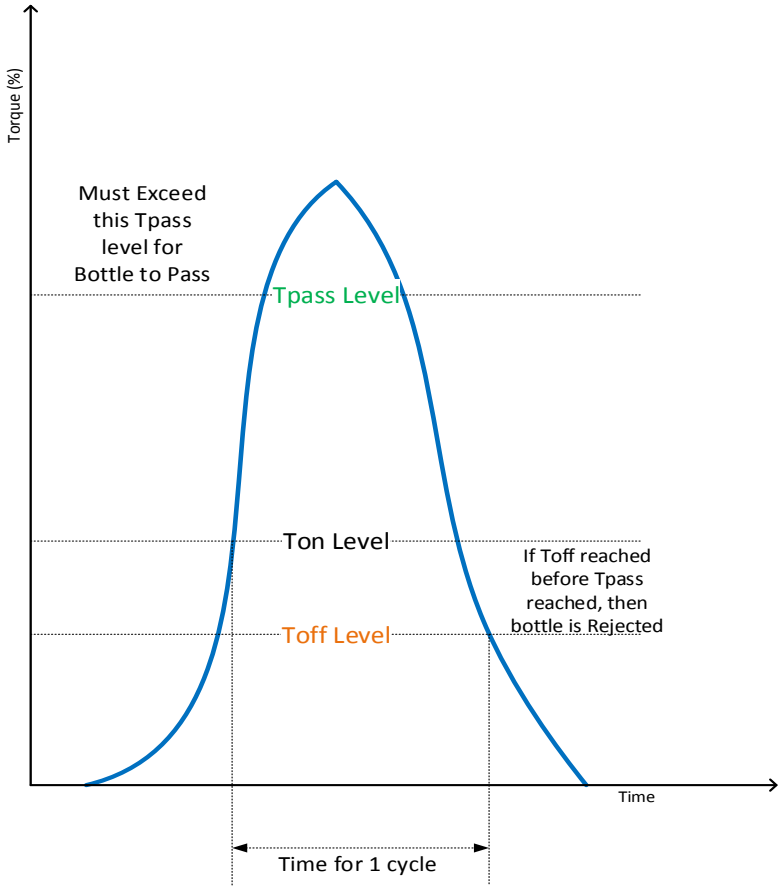
1 Description

A capper is a common application in bottle packaging machines where the cap needs to be secured to the bottle. A servo driven capper needs to be able to apply a certain amount of torque to the bottle cap to ensure the cap is sealed properly. Typical systems require a PLC to measure the torque levels and either accept or reject the bottle based on the torque level achieved.

Thanks to Delta's innovative A2 servo drive, the high performance torque control and torque monitoring can be handled by the servo drive node, resulting in simple plug-and-play functionality and quick startup of machine design. This also frees up the PLC to do simple frequency IO monitoring to handle the bottle queue.

1 System Architecture

For a capper system, there is typically a tighten down axis that will be running a constant torque/speed profile, then further down the line is a reject station. Below shows the typical torque profile seen by the servo axis, and criteria for a passed bottle.

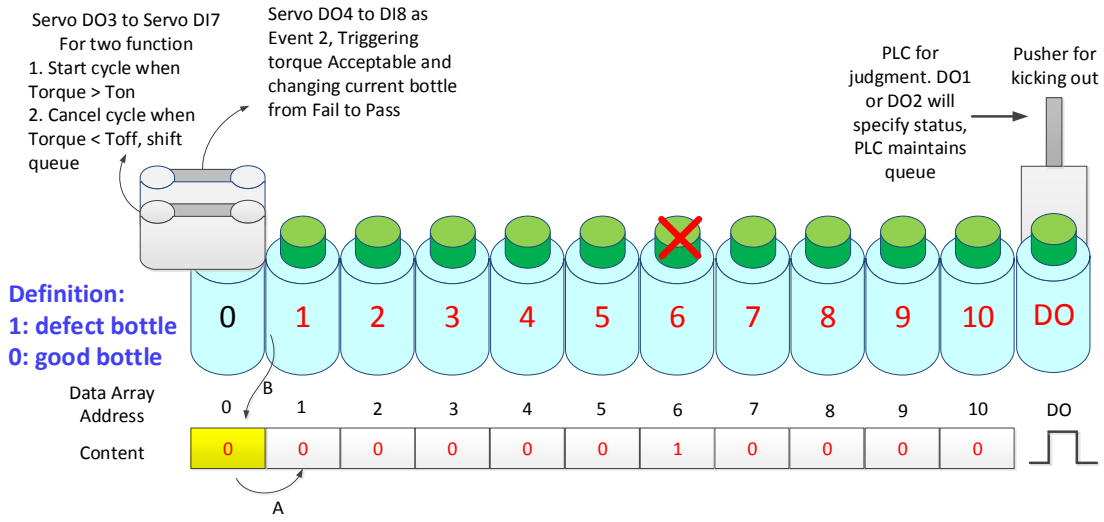


There is typically going to be a queue of bottles between the tightening servo and the reject pusher. The servo must indicate to the PLC the status of the bottle so that it can maintain the pass/fail queue for the reject station.

2 System setting

We will use the PR mode of the drive to command a constant speed move and also write to registers on the drive for monitoring torque. The DO and DI on the drive will be configured to trigger when specific torque levels are achieved. The torque level DOs will be looped back into the DI on the drive to trigger PR using the event trigger function. Both the Torque limit and Zon1 outputs will be used so that we can detect both conditions simultaneously whether the bottle passed an acceptable torque, and if the bottle finished the cycle without torque down.

Finally the Pass/Fail status will be indicated by two outputs. DO1 will indicate a FAIL, and DO2 will indicate a PASS.



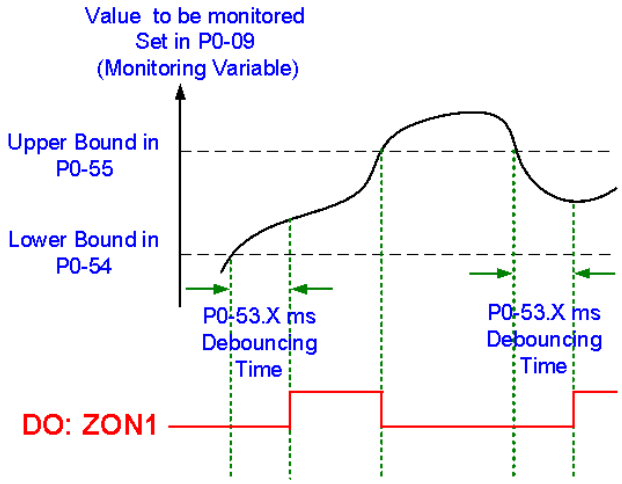
2.1 Torque Monitor function

We will use the Zon1 output function to monitor torque by setting P0-17 to 54 (torque level). When this is set, P0-54 and P0-55 will set the torque range for the output to fire.

Status Indicator DO

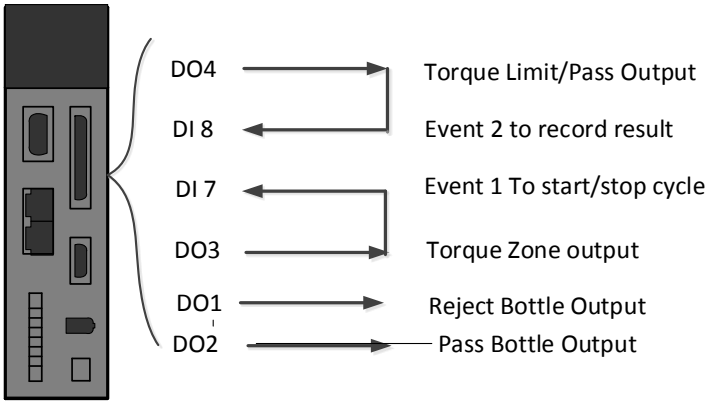
◆The Function Code 0x2C (Zon1) (V 1.045 Sub 0 & later)

■ Use DO to monitor the value within certain range



We will also use a standard torque limit for the high torque level.

2.2 I/O Configuration



- Configure DI7 Input to EV1. Example P2-16 = 0x0139
- Configure DI8 Input to EV2. Example P2-17 = 0x013A
- Configure one Output to Output Bit 00 of P4-06. Example DO1 = 0x0130
- Configure one Output to Output Bit 01 of P4-06. Example DO2 = 0x0131
- Configure DO3 will be wired to DI7. Configure as Zone output (P2-20= 0x012C)
- Configure DO4 will be wired to DI8. Configure as Torque limit setting Example P2-19 = 0x0106

3 System Programming

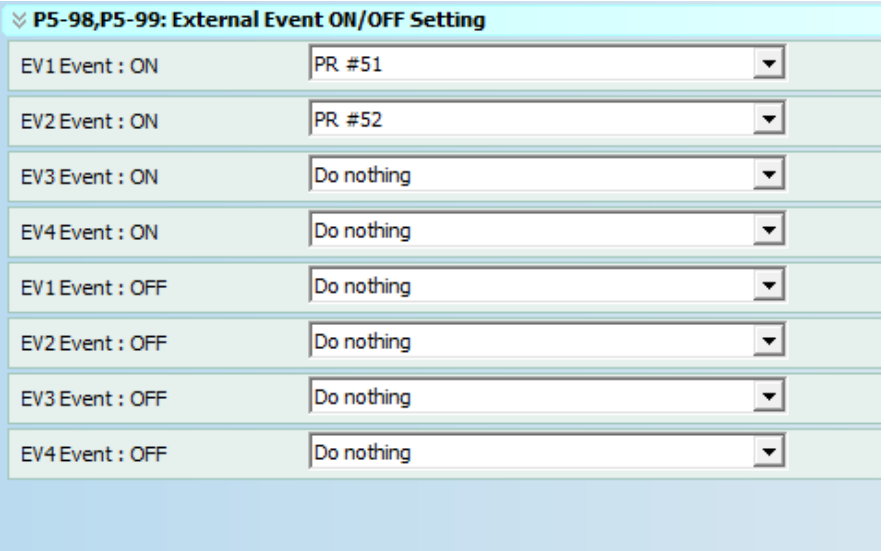
For this example of the capper system, we will assume we are using a single A2 servo to control the capping torque requirements. The following torque levels will be used as our trigger points

- Ton >= 40%
- Tpass >= 90%
- Toff <= 20%

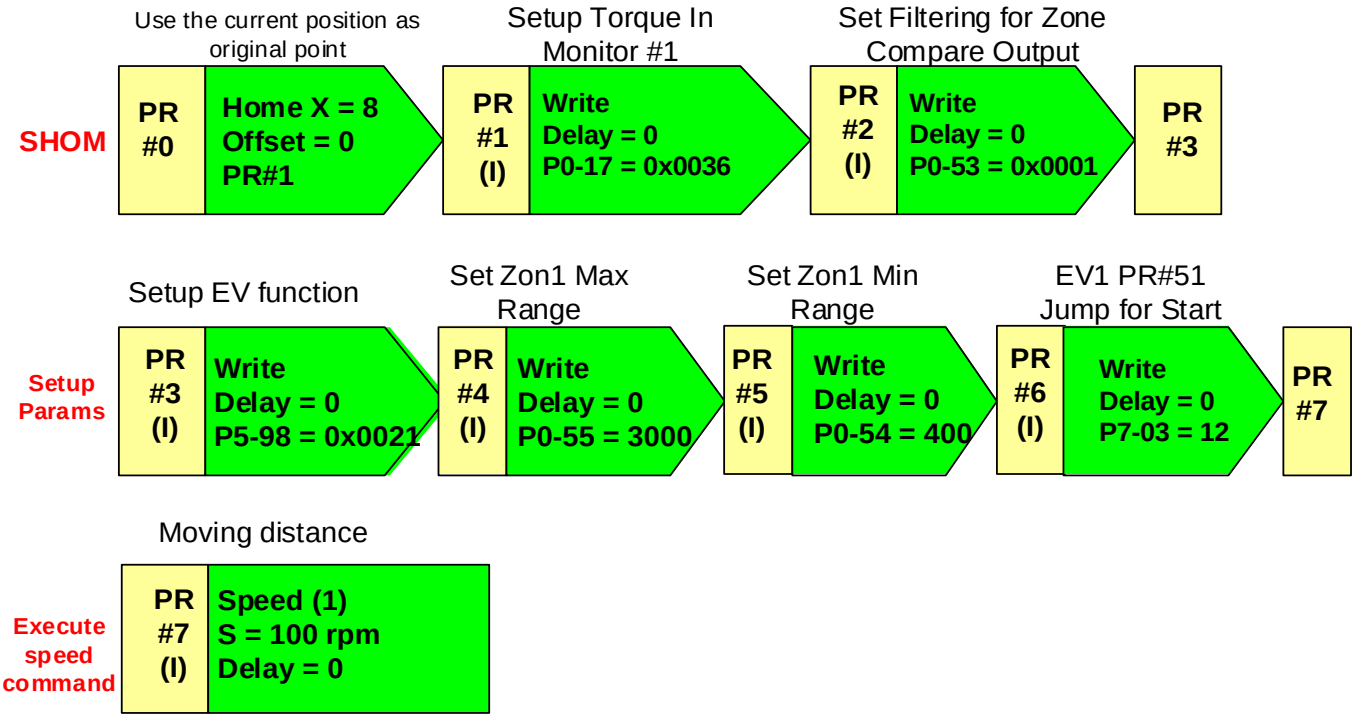
3.1 Program Configuration

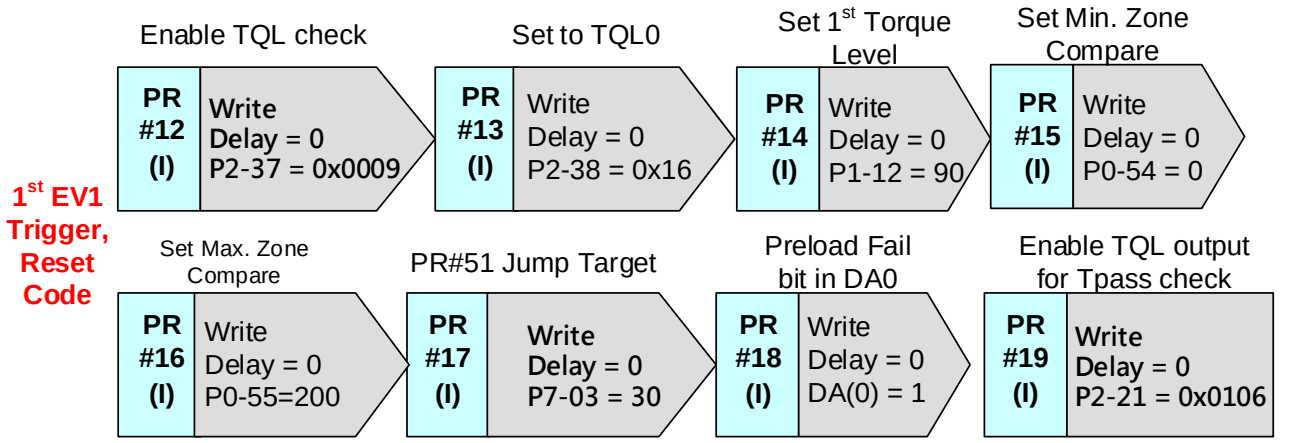
- Initialization
  - We will start by setting our Zon1 output to read Torque, and set P0-54 minimum = Ton level for detecting the start of cycle.
  - Once initialized, we command a constant speed move in PR
- Configure EV1 sequence.
  - We will use EV1 to trigger the start of the cycle when torque > Ton.
  - Once detected, Torque limit will be set at Tpass level and Zon1 will be configured to have P0-55 max setting at Toff level. We will preload the queue with a Reject value of 1 in Data Array (DA) 0
  - Subsequent EV1 will be triggered when torque goes below Toff level, indicating end of cycle.
  - On final EV1, the current Pass/Fail value in DA0 will be output to P4-06, indicating either the bottle will be rejected or not.
  - Once complete, we reset Zon1 to wait for torque to exceed Ton, indicating start of a new cycle.
- Configure EV2 sequence.
  - EV2 will be tied to Torque limit output set at Tpass level.
  - If EV2 is reached during cycle, then we override reject value preloaded in DA 0 with a 2 indicating bottle passed.
  - At this point, torque limit is removed until cycle starts again.

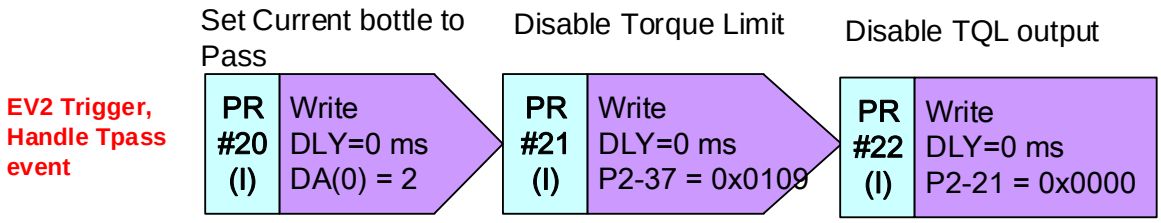
Below is the EV configuration:

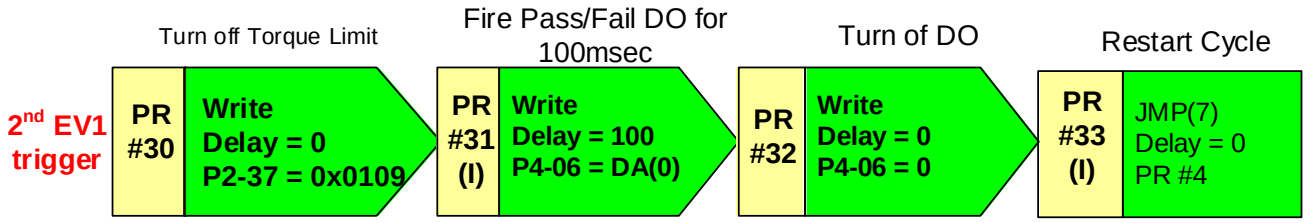

P5-98,P5-99: External Event ON/OFF Setting
EV1 Event : ON
PR #51
EV2 Event : ON
PR #52
EV3 Event : ON
Do nothing
EV4 Event : ON
Do nothing
EV1 Event : OFF
Do nothing
EV2 Event : OFF
Do nothing
EV3 Event : OFF
Do nothing
EV4 Event : OFF
Do nothing

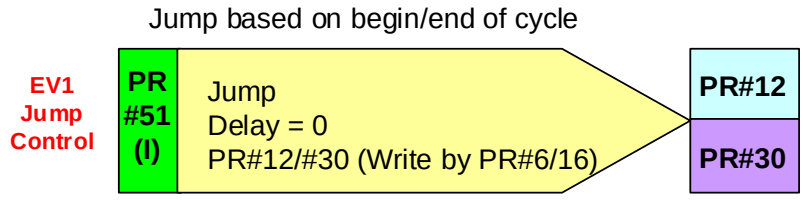
3.1 PR Map

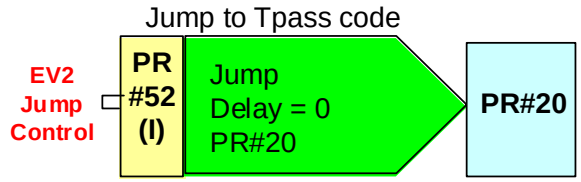

Use the current position as original point
Setup Torque In Monitor #1
Set Filtering for Zone Compare Output
SHOM
PR #0
Home X = 8
Offset = 0
PR#1
PR #1 (I)
Write
Delay = 0
P0-17 = 0x0036
PR #2 (I)
Write
Delay = 0
P0-53 = 0x0001
PR #3
Setup EV function
Set Zon1 Max Range
Set Zon1 Min Range
EV1 PR#51 Jump for Start
Setup Params
PR #3 (I)
Write
Delay = 0
P5-98 = 0x0021
PR #4 (I)
Write
Delay = 0
P0-55 = 3000
PR #5 (I)
Write
Delay = 0
P0-54 = 400
PR #6 (I)
Write
Delay = 0
P7-03 = 12
PR #7
Moving distance
Execute speed command
PR #7 (I)
Speed (1)
S = 100 rpm
Delay = 0


1st EV1 Trigger, Reset Code
Enable TQL check
PR #12 (I)
Write
Delay = 0
P2-37 = 0x0009
Set to TQL0
PR #13 (I)
Write
Delay = 0
P2-38 = 0x16
Set 1st Torque Level
PR #14 (I)
Write
Delay = 0
P1-12 = 90
Set Min. Zone Compare
PR #15 (I)
Write
Delay = 0
P0-54 = 0
Set Max. Zone Compare
PR #16 (I)
Write
Delay = 0
P0-55=200
PR#51 Jump Target
PR #17 (I)
Write
Delay = 0
P7-03 = 30
Preload Fail bit in DA0
PR #18 (I)
Write
Delay = 0
DA(0) = 1
Enable TQL output for Tpass check
PR #19 (I)
Write
Delay = 0
P2-21 = 0x0106


EV2 Trigger, Handle Tpass event
Set Current bottle to Pass
PR #20 (I)
Write
DLY=0 ms
DA(0) = 2
Disable Torque Limit
PR #21 (I)
Write
DLY=0 ms
P2-37 = 0x0109
Disable TQL output
PR #22 (I)
Write
DLY=0 ms
P2-21 = 0x0000


2nd EV1 trigger
Turn off Torque Limit
PR #30
Write
Delay = 0
P2-37 = 0x0109
Fire Pass/Fail DO for 100msec
PR #31 (I)
Write
Delay = 100
P4-06 = DA(0)
Turn of DO
PR #32
Write
Delay = 0
P4-06 = 0
Restart Cycle
PR #33 (I)
JMP(7)
Delay = 0
PR #4


EV1 Jump Control
Jump based on begin/end of cycle
PR #51 (I)
Jump
Delay = 0
PR#12/#30 (Write by PR#6/16)
PR#12
PR#30


EV2 Jump Control
Jump to Tpass code
PR #52 (I)
Jump
Delay = 0
PR#20
PR#20

4 Modification

4.1 Setting Different Torque levels

To adjust the torque levels that are used for Toff, Ton and Tpass, we can modify the PR values in the A2 servo drive to accomplish this. This can be pre-configured in advance, or an HMI can be connected to allow user modification during operation.

Toff:

- Adjust the value of PR#16 data (P6-33). Torque percentage is stored here as 0.1% units (Ex: To set Toff to 20%, store a value of 200 in P6-33)

Ton:

- Adjust the value of PR#5 data (P6-11). Torque percentage is stored here as 0.1% units (Ex: To set Ton to 40%, store a value of 400 in P6-11)

Tpass:

- Adjust the value of PR#14 data (P6-29). Torque percentage is stored directly. (EX: to set Tpass to 90%, store a value of 90 in P6-29)

4.2 Modifying Pass/Fail output time

To change the DO output time, simply change the delay time for PR#31. You can select a different delay time from the delay time table in the A2 servo, or you can change the current value in the delay time table.

5 Considerations

The application considered above assumes a PLC with a sensor to indicate that a bottle has reached the reject station. The PLC will contain code to monitor DO1 and DO2 from the servo to maintain a queue/shift register with the bottle status. Then, when the bottle reaches the reject station, the sensor will trigger and the PLC will take the last bottle status in the shift register to determine the function of the reject station.

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