Registration Moves with Kollmorgen AKD Motion Tasking Drive Rev. B Mar 2019

Overview

Often it is desirable in an application to move a set distance after seeing a mark via photo eye and a mark on material that travels through the machine as a web.

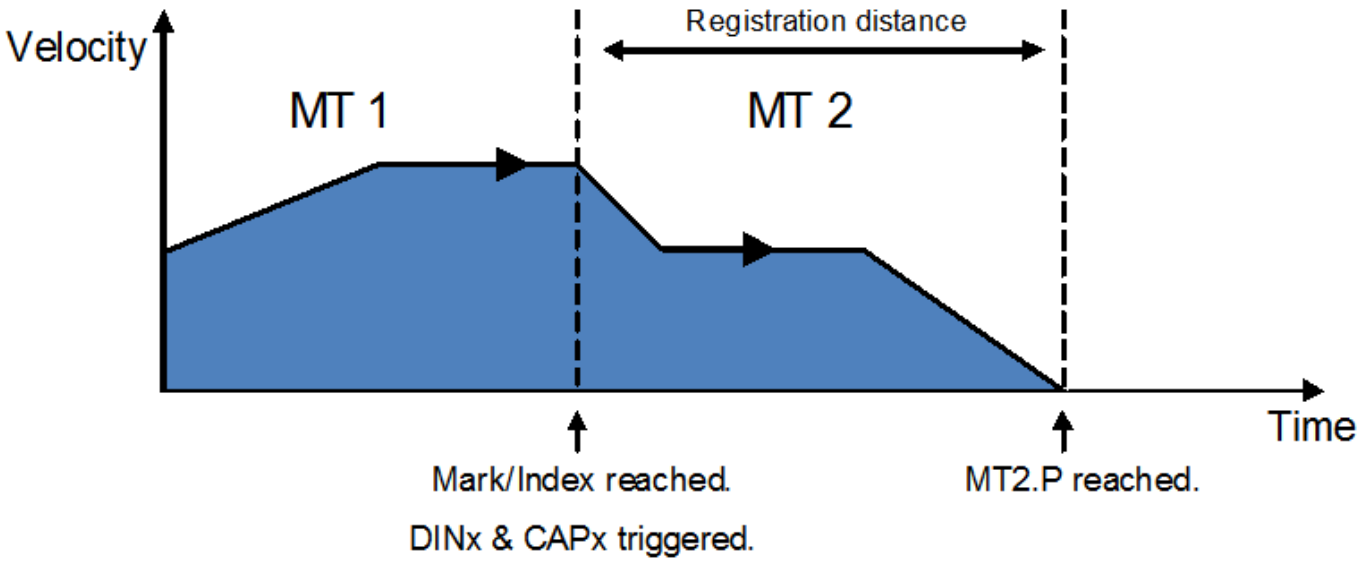
In the AKD Motion Tasking drive, a motion task can be setup for a registration move where the position capture is used to establish the position at the time of the registration trigger (photoeye, etc.) and move a precise distance after the registration mark is detected.

As noted in the Workbench Help:

Registration Moves

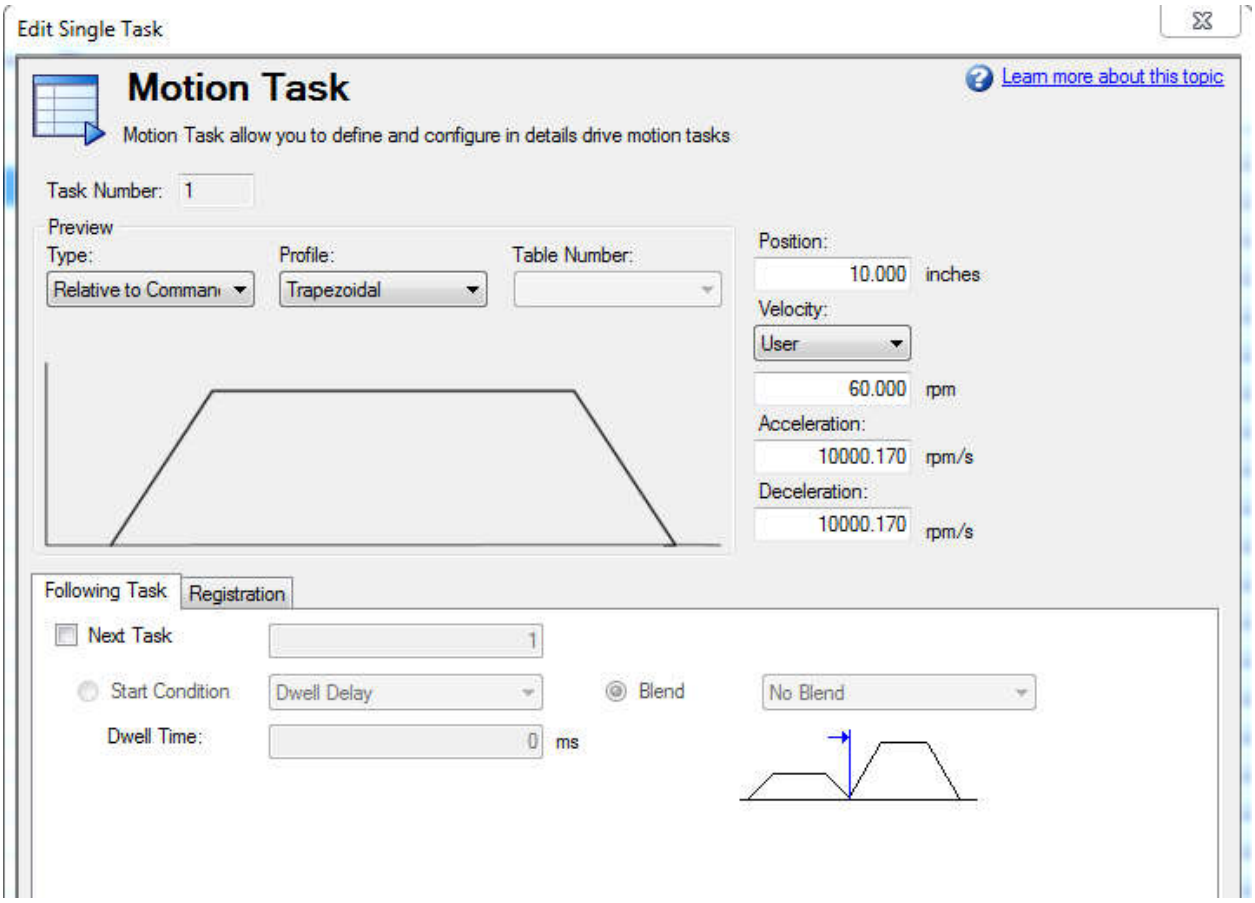
Registration moves are also known as “indexing on the fly”. In a registration move, a digital input interrupts a running motion task and starts a new one. The start position of the new motion task is latched at the time the digital input is activated. The target position of the new motion task is calculated based on the latched position value, for a very accurate target position.

Typical applications for using the registration move are feed-to-length applications which must guarantee proper positioning with respect to a special mark or index. If this mark is reached, an external trigger signal aborts the current move and starts the registration move.

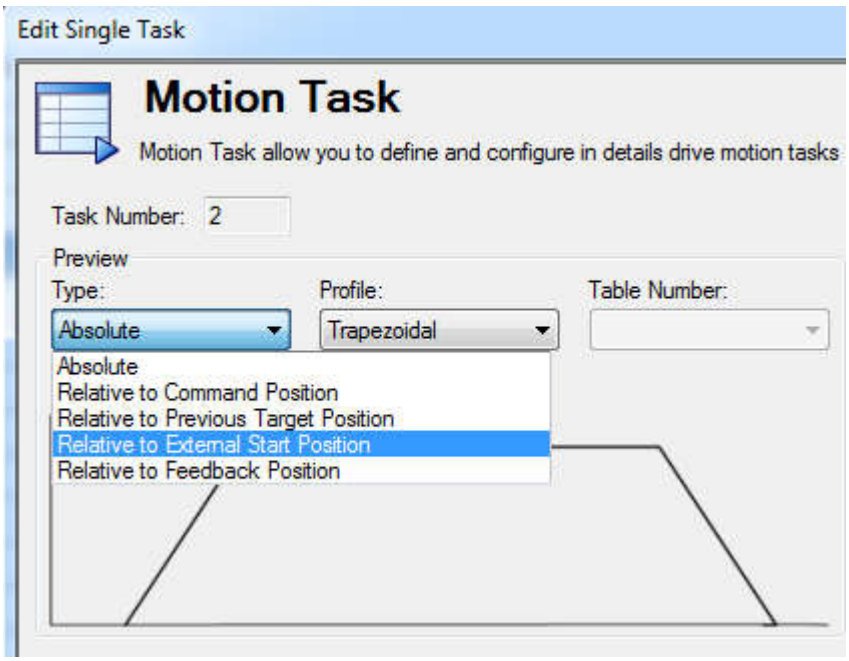


In this example and demonstration there are two motion tasks: one to move the material until the mark is seen and another one for the registration move.

Depending on the application you can set the move type to Relative to Command or Relative to Previous Target Position, etc. I chose Relative to Command. The position (length) for this move should be long enough to see the mark otherwise the move completes and the mark is not seen. In this example the move was set for 10 inches.



Next I chose Task Number 2 for the registration (“interrupt”) move. The move type needs to be “Relative to External Start Position” for a registration move.

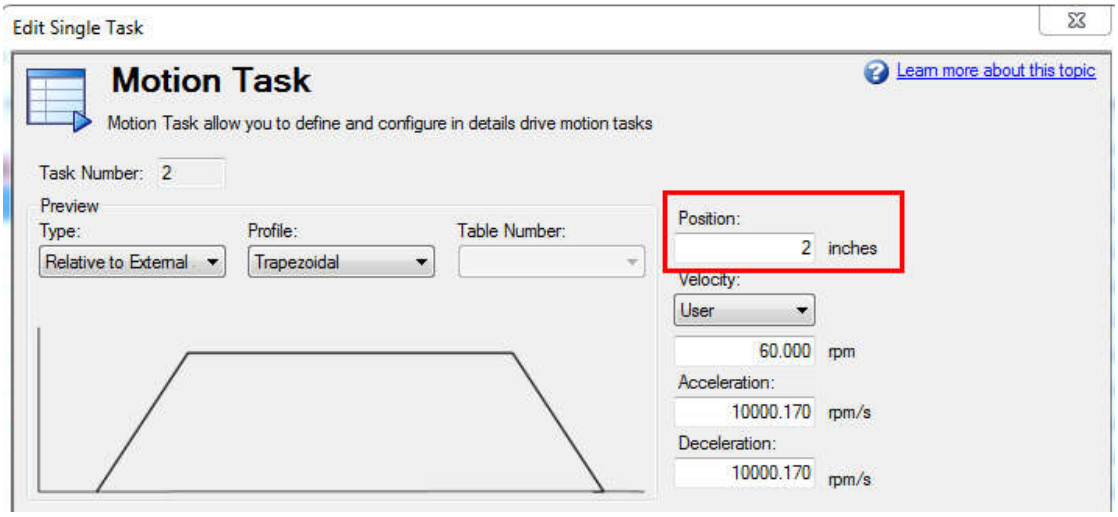


Per Workbench the definition of the move type is:

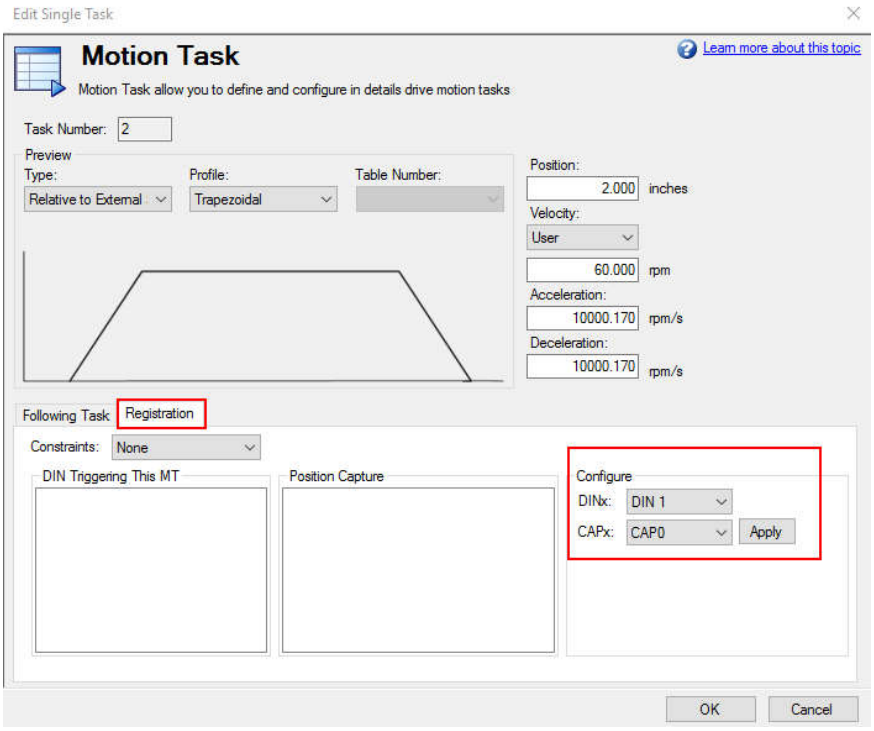
Table 2: MT Type

Bits 0, 1, 2, 3	Description
0000	Absolute. The target position is defined by the MT.P value.
1000	Reserved.
0001	Relative to Command Position. The target position is defined as: Target position = PL.CMD + MT.P
0011	Relative to Previous Target Position. The target position is defined as: Target position = Target position of the last motion task + MT.P
0101	Relative to External Start Position. The target position is defined as: Target position = External start position + MT.P
0111	Relative to Feedback Position. The target position is defined as: Target position = PL.FB + MT.P

Next I set the desired registration distance in the “Position” field; in this case 2 inches. I set the velocity, accel, and decel as desired.



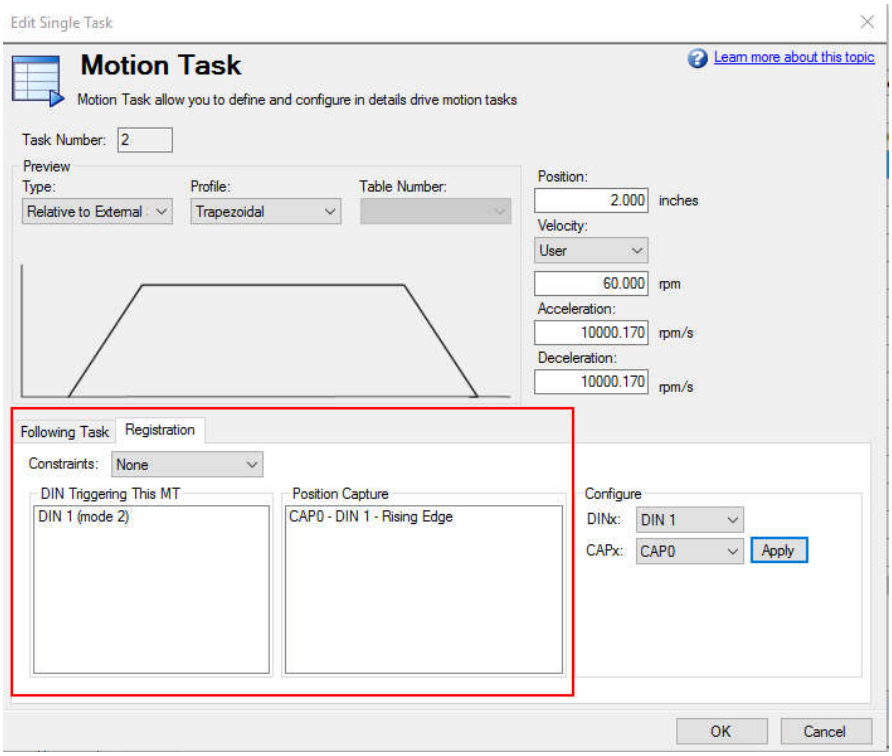
To setup the trigger for the registration move (interrupt) click on the “Registration” tab in the given motion task.



To configure the trigger under “Configure” on the Registration tab are 2 listboxes:

1. DINx to select the digital input of the drive the photoeye/mark sensor is wired to.
2. Which of the Position Capture engines are used to capture the position at the time the photoeye/mark is seen.

Press “Apply” to use those settings.



In this example (above) I chose DIN1 (which in addition to DIN2 is one of the 2 high speed digital inputs for the AKD drive).

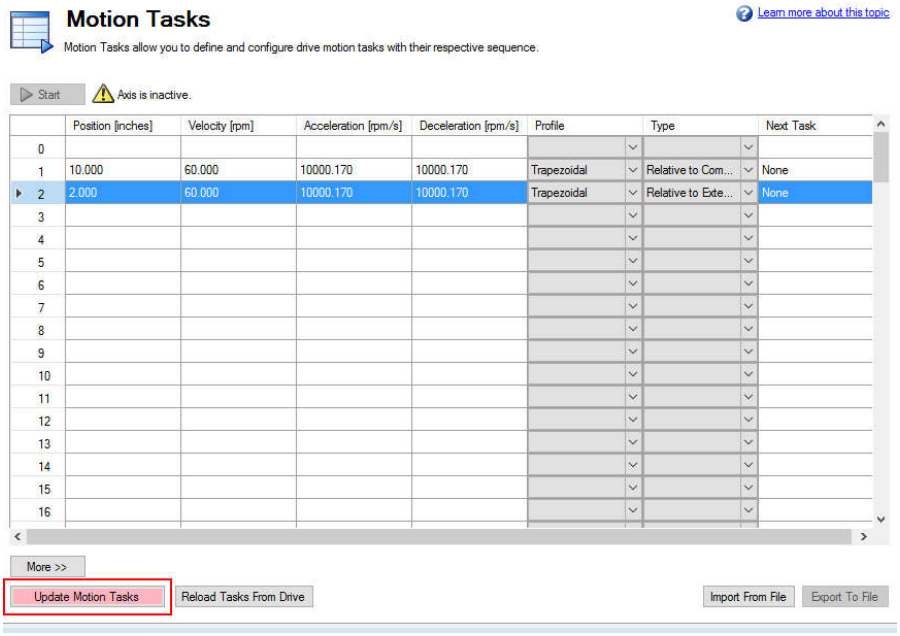
I also chose one of the 2 Position Capture engines in the AKD drive CAP0 in this case (CAP 1 is the other available capture engine).

On clicking “Apply” the DIN Triggering This MT and Position Capture fields are populated with the configuration (see above).

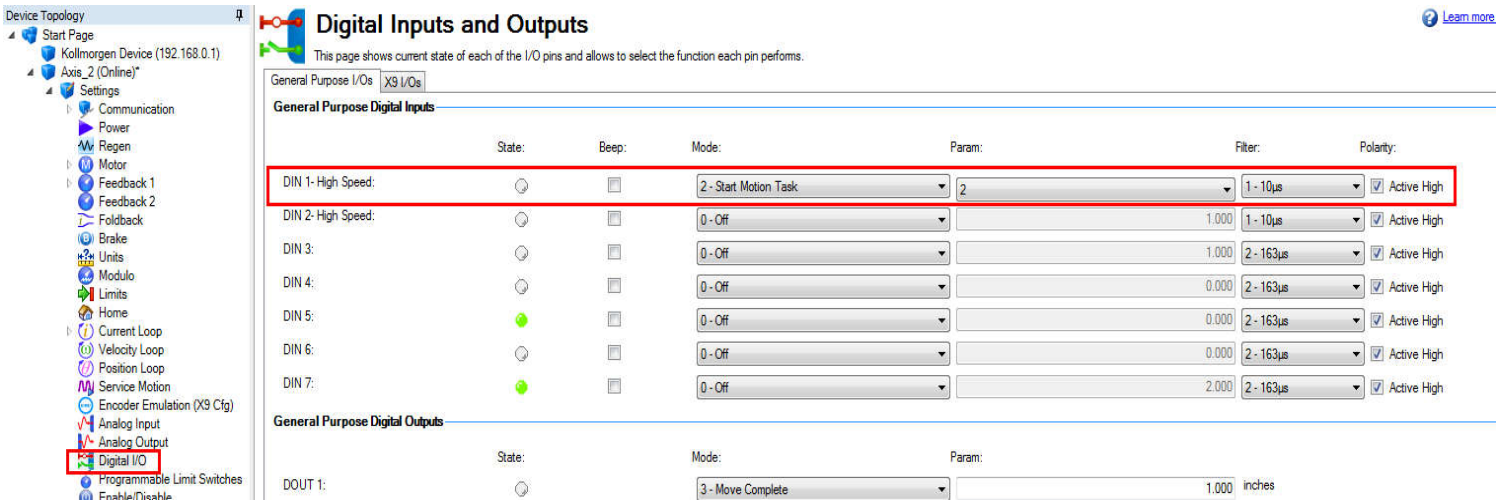
I left the listbox “Constaints” to None.

To finish the setup of Motion Task 2, click OK.

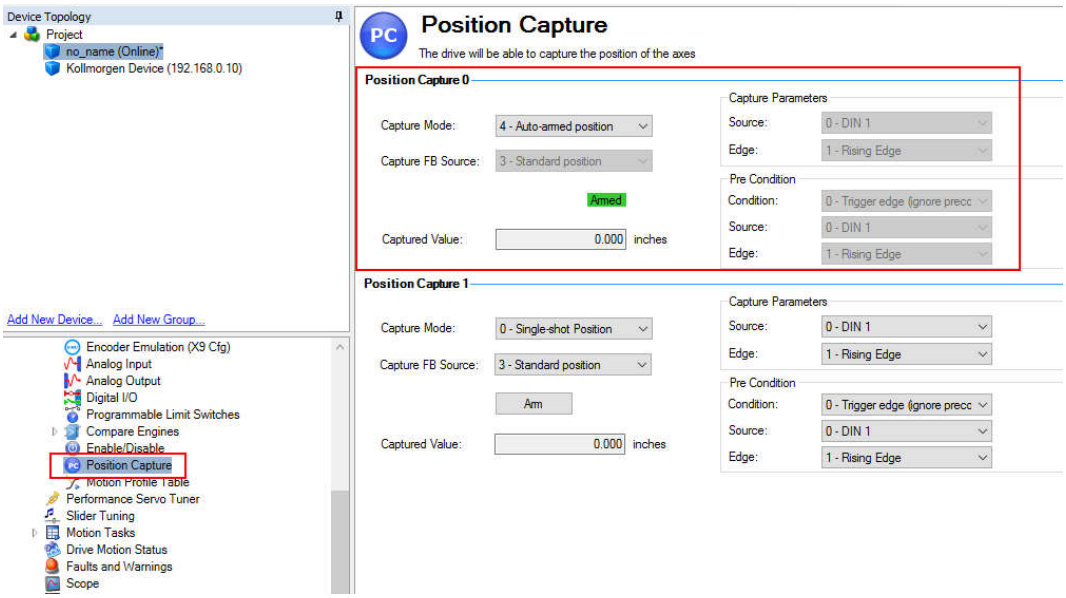
Next click on the “Update Motion Tasks” button.



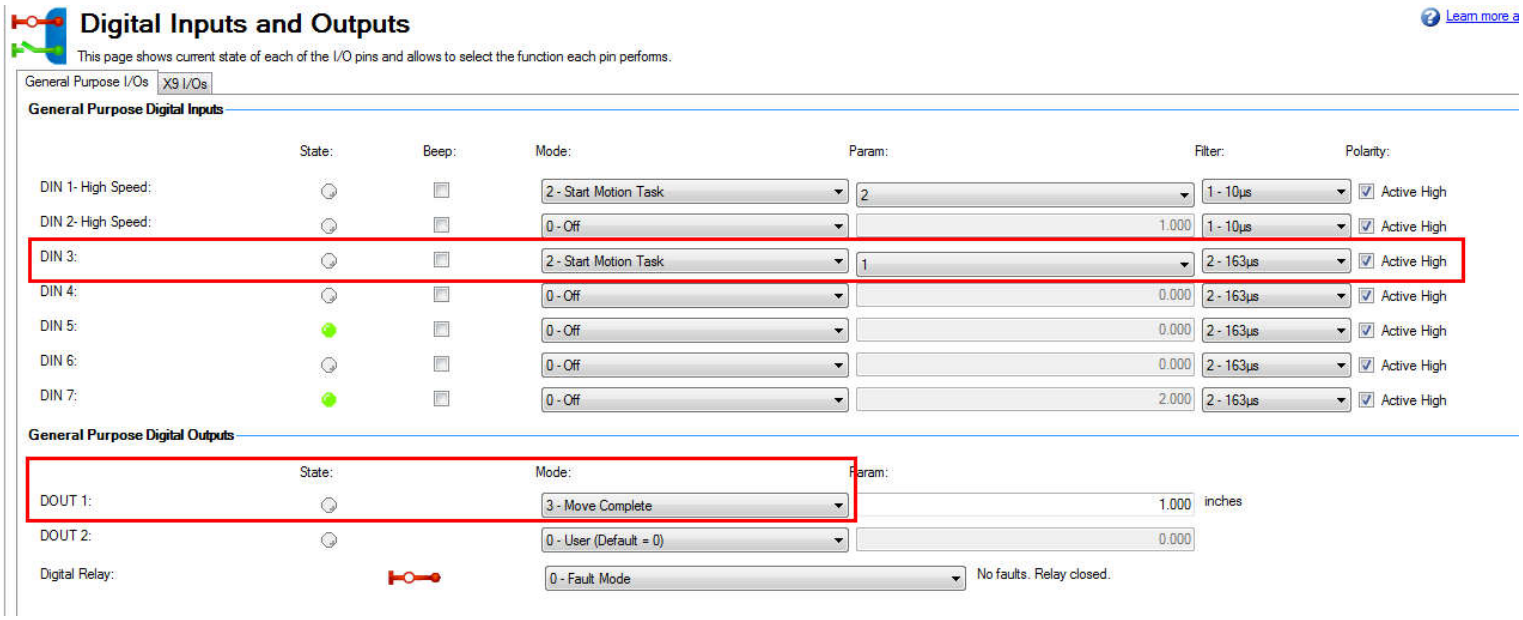
The Registration Setup does several things in the Digital IO and Position Capture configuration for you once the motion task is setup and saved. Note DIN1 is now set to Mode 2 “Start Motion Task” and the Param(eter) is 2. This indicates the registration move will be triggered when DIN1 (the photoeye/mark sensor) is seen with a rising edge.



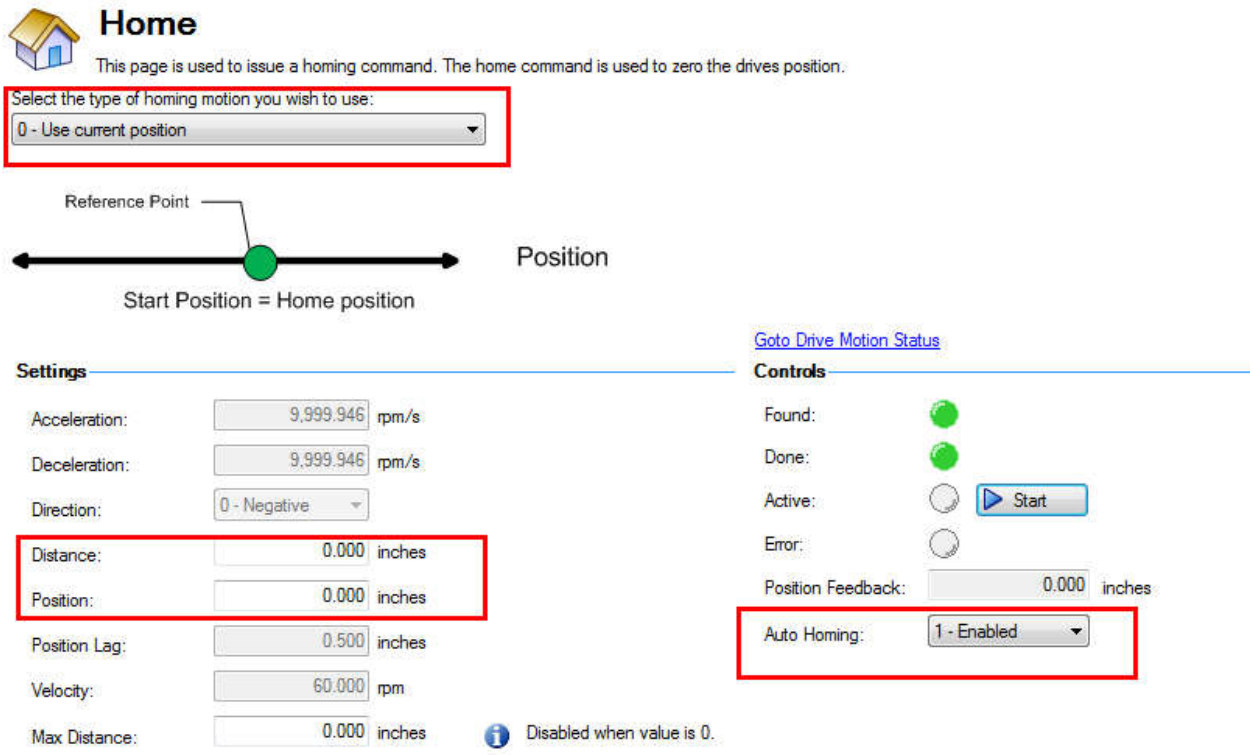
Besides the input setup since Position Capture 0 was selected in the Registration move configuration, under the Position Capture screen, Position Capture 0 is setup for Auto-armed position, standard position as the FB source, DIN1 rising edge is the Source of the trigger and the pre-condition is not used in this setup. For more details on these parameters see the Workbench Help and AKD User Guide.



To finalize the demonstration, I configured DIN3 to “Start Motion Task” and set the Param(eter) to 1. This input will start the initial move that will get interrupted on trigger of the registration move. I also programmed the DOUT1 to indicate “Move Complete”.

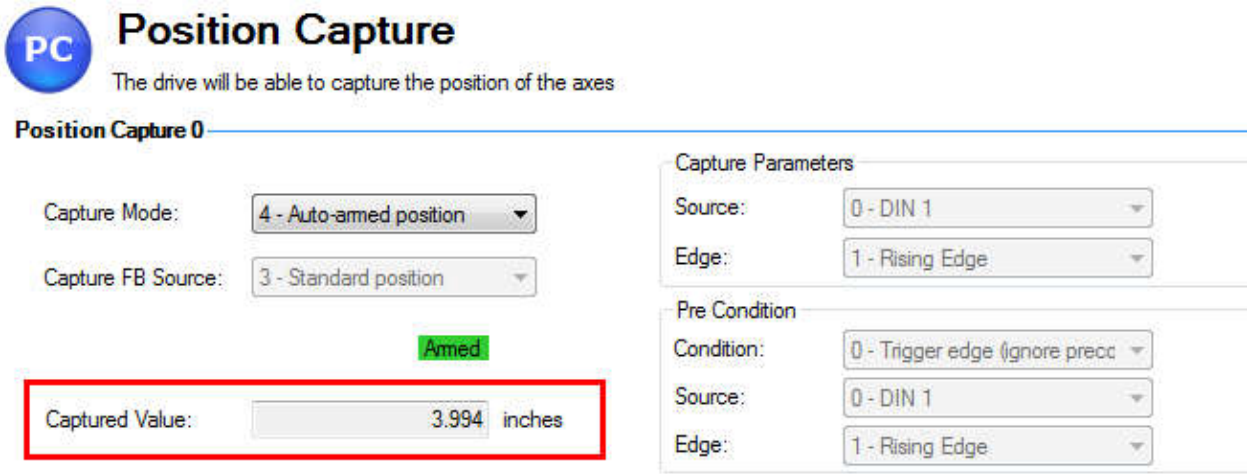


In order to use Motion Tasks during runtime, the axis must be homed. Since the motion tasks in this example are relative moves, the absolute position is not important. I set the Home to use the current position and set the feedback position to zero by executing the Home Move by pressing the “Start” button on the home screen. I also set the auto homing to Enabled so the axis is homed on power up and the drive is first enabled but using Auto Homing or not is up to the designer of the system.



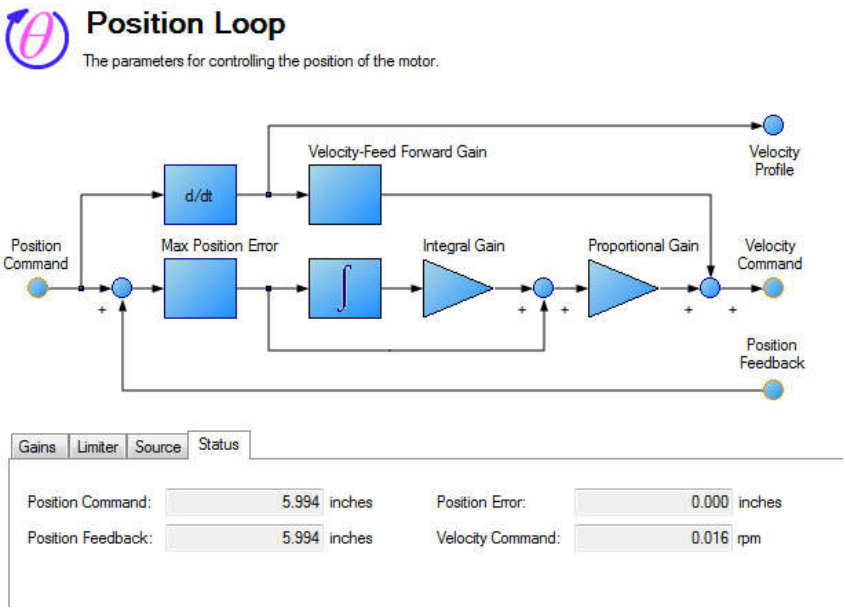
The captured position at the time of the mark’s rising edge was 3.994 inches.

Next I triggered Motion Task 1 and then while it was executing I triggered DIN1 to simulate the photoeye/mark.



Recall in this example the registration move distance was 2 inches so the expected final position after the registration move would be Captured Value+Registration Distance=Post Registration Position or

3.994 + 2.0 = 5.994 inches which is the case as seen in the status for position feedback:



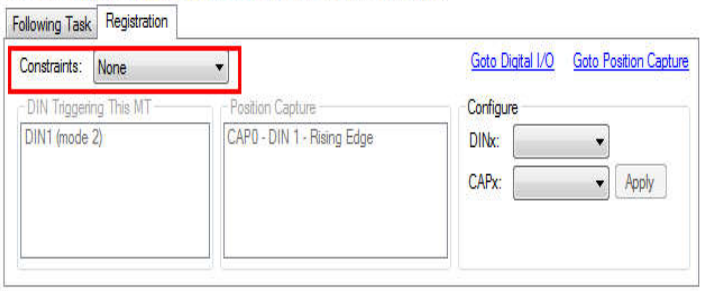
If Motion Task is run again and the photoeye is triggered again as well, a new position is captured and the registration move will go 2 inches past that.

Some additional notes regarding the Registration Move:

The example in this application note used “None” in the Contraints listbox. Per the Workbench Help, the contraint should be either 1) none 2)interruptable. Setting the contraint to “non-interruptable” will cause the registration move to not function properly.

Configuring Registration Moves in WorkBench

You can configure registration moves from the Motion Task editor:



Box	Description
Constraints	Configures bits 13 and 14 from the MT.CNTL keyword. For registration "none" or "interruptable" should be used. "Non-interruptable" will not function properly. See for information on constraints.
DIN Triggering (read-only)	Displays the list of all digital inputs that are configured to start motion tasks. These are potentially all digital inputs that can trigger this motion task. This field is read-only, indicating current configuration.
Position Capture (read-only)	Displays the list of capture engine that are configured with the proper Capture Mode (4-auto-armed position) in order to execute a registration move. These are potentially all registered position that can be used for this MT.
Configure (write-only)	Configures a digital input and the capture engine to be use as registration source for this MT.

More details are given as to “none” (standard registration move) and “interruptable”. Per the following, “none” a standard registration move can be interrupted and start regardless of the previous velocity. An “interruptable” move can be interrupted but will not start if the initial move’s (Motion Task 1 in this application example) velocity is 0.

In this application note interrupting the registration move was not demonstrated. In this case, see details on MT.CONTINUE for resuming an interrupted Motion Task.

Configuring Registration Moves from the Terminal View

You can also configure registration moves from the terminal view using drive parameters. To configure a registration move, you must configure three sets of parameters.

*other options are possible (Bit 13 & 14); see Registration Moves and the MT.CNTL parameter description.

- Digital input (DINx) : Configure DINx to mode 2 or 4 so that input x will trigger the registration move.
- Capture (CAPy): Either capture engine 0 or 1 may be used to trigger a registration move. Set CAPy.MODE to 4, where "x" indicates the capture engine to be used. CAPy.TRIGGER must be set to x-1, where x is the DIN used above. All other capture parameters can be set as desired (see capture parameter descriptions).
- Motion tasking (MT): A registration move requires the standard motion task parameters (ACC, DEC, V, P). It also requires that the motion control word be set as follows:

  0x0005 - standard registration move (this move can be interrupted and can start regardless of previous velocity)

  0x2005 - non-interruptible registration move (move must complete before any other motion task can start)

  0x4005 - interruptible registration move but will not start if velocity is 0

  0x6005 - non-interrutible registration move that will not start if velocity is 0

  After the motion task is configured MT.SET can be used to complete the setup of the motion task.

Example

Mark triggers digital input 2.

Capture machine 0 is used.

Motion task 3 is the registration move.

Motion task 3 is only activated if a preceeding motion task is active.

Motion task 3 is configured with 1,000 rpm/s^2 acceleration and deceleration , target velocity of 10 rpm and a relative position of 50,000 counts.

Per the above, this is a function of the MT.CNTL parameter.

Table 1: Motion Task (MT) Bit Descriptions

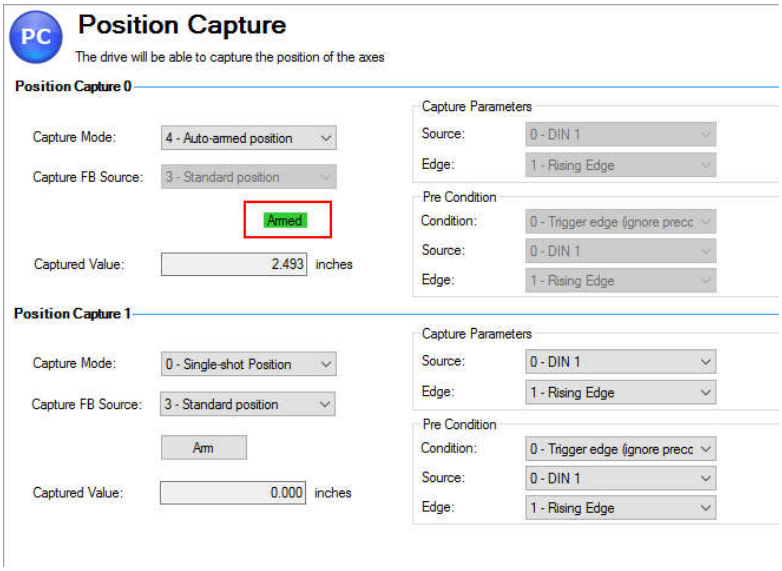
Bit	Meaning	Description
13	0x02000	If this bit is 0, then an attempt to trigger any new motion task will be accepted while this motion task is currently running. If this bit is 1, then an attempt to trigger any new motion task will be denied while this motion task is currently running.
14	0x04000	If this bit is set, the motion task that is supposed to be started cannot be started from velocity 0. The motion can be started if a motion task already running will be interrupted.

So a MT.CNTL of 0x0005 (bit 14=0) is a Move Type of Relative To External Start Position (registration) and the move will happen ANY time the registration sensor triggers the input.

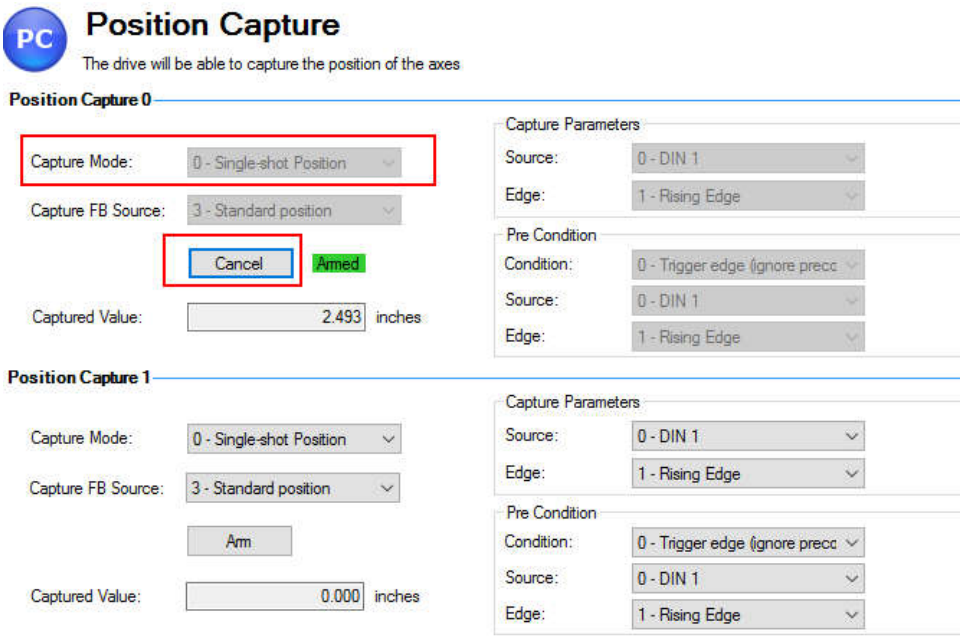
A MT.CNTL of 0x4005 (bit 14=1) is a Move Type of Relative To External Start Position (registration) and the move will happen only if another motion task is in progress (velocity>0).

In addition to the Constraints settings it is possible to use a pre-condition to ignore the registration sensor (input).

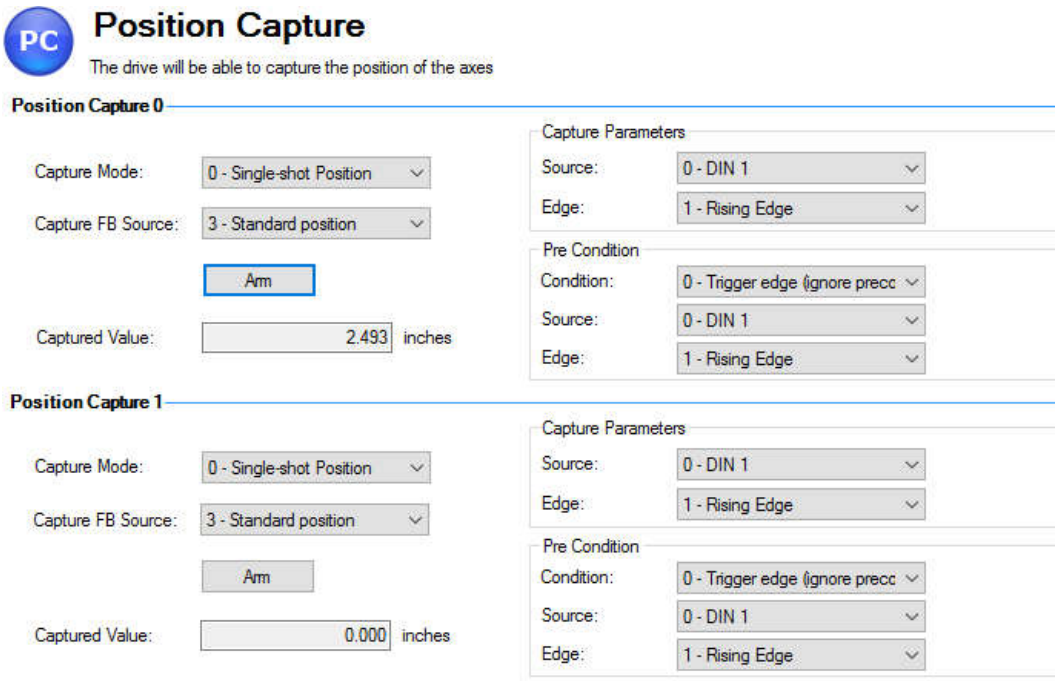
This is not super friendly as far as the usage of the GUI but it does work. This requires and consumes another one of the seven available digital inputs. With the original setup in this application note, the Position Capture is auto-armed as seen below. The Capture Parameters are disabled (greyed out). In order to change their settings the Capture must be dis-armed.



By changing the Capture Mode from 4-Auto-armed position to 0-Single-shot Position a Cancel button appears.



On press of the Cancel button the Armed status is removed and the Capture Parameters becomed enabled and possible to configure/change.



The focus is on the Pre-Condition Settings.

Condition=CAPx.EVENT

Source=CAPx.PRESELECT

Edge=CAPx.PREEDGE

To serve as an interlock to ignore the registration sensor, the CAPx.EVENT is set accordingly. From the Workbench Help there are 4 possible choices.

CAP0.EVENT, CAP1.EVENT

Description

The event mode controls use of the precondition logic. If this field is not 0, then the precondition input is selected by CAPx.TRIGGER. If this field is 1, then the precondition edge is selected by the CAPx.PREEDGE. The four event modes are listed below.

Event	Description
0	Precondition settings ignored.
1	Trigger on first trigger event after selected edge on precondition input.
2	Trigger on first trigger event to occur while precondition input is 1
3	Trigger on first trigger event to occur while precondition input is 0.

Event 2 setting will require the input used as a precondition to be ON or high if the registration sensor/input is to be active. If the input is OFF then the registration sensor/input is ignored.

Event 3 works the same as Event 2 except while the input used as a precondition is OFF or low the registration sensor/input is active. If the input is ON in this case then the registration sensor/input is ignored.

It is up to the user to decide which method to employ and verify proper operation for the application.

Per Workbench Help:

Events 2 and 3 (Trigger edge while precondition = 0 or 1)

In these events, the precondition logic samples the current (post-filter) state of the selected precondition source input. The capture engine looks for a trigger edge while the precondition input is at a "1" or "0" state.

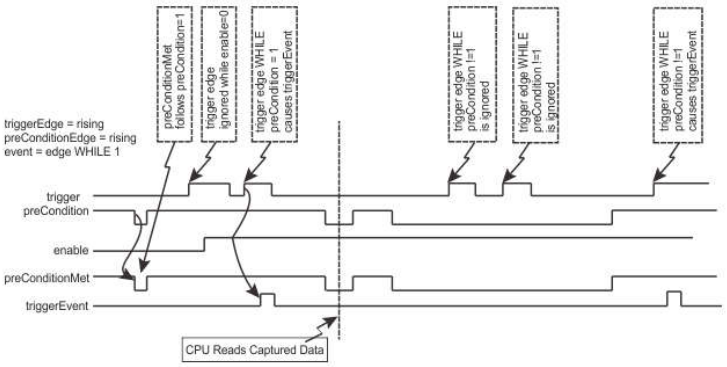
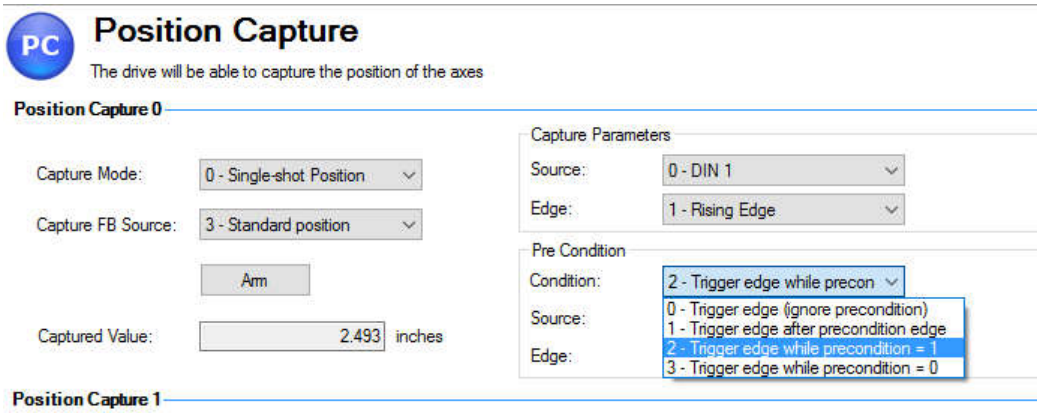
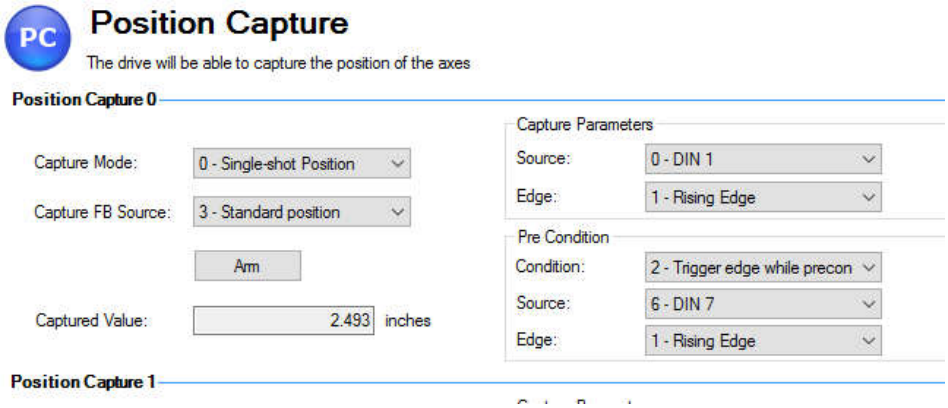


Figure 2: Trigger edge WHILE precondition edge

To demonstrate, in the Pre-Condition settings, condition is set to 2-Trigger edge while precondition=1.

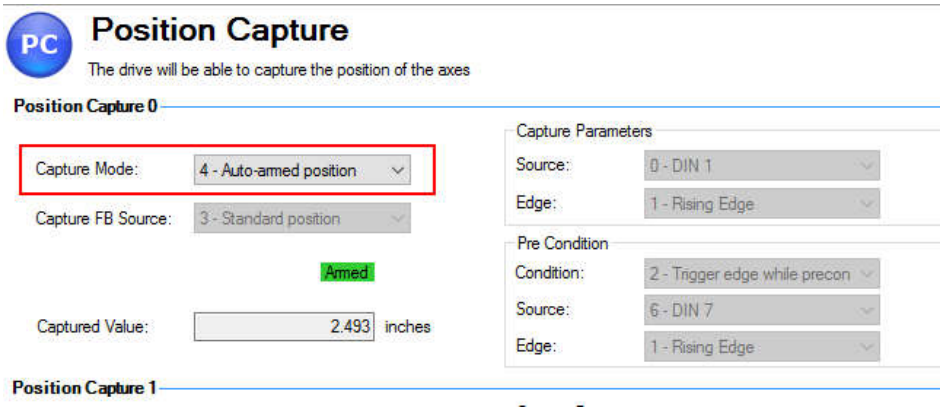


The Pre-Condition Source was arbitrarily set to DIN 7. Keep in mind you will get a warning if you attempt to set the Pre-Condition Source to the same input as the Capture Source. In general, this should be avoided. It is worth noting that the selection of an input as a source for the pre-condition does not affect the DIN.MODE.



From the Digital Inputs and Outputs screen:

Next to rearm the capture I changed the Capture Mode back to 4-Auto-armed.



Per the Workbench Help:

CAP0.MODE, CAP1.MODE

Description

Mode 0: Standard Position

Mode 0 is the standard position capture. The source of the captured position is determined by CAP0.FBSOURCE, CAP1.FBSOURCE. Data can be retrieved with CAP0.PLFB, CAP1.PLFB.

Mode 1: Drive Internal Time

Mode 1 is the drive internal time capture. Data can be retrieved with CAP0.T, CAP1.T.

Mode 2: Distributed Clock Time

Mode 2 is the KAS EtherCAT distributed clock time (DCT) capture. Instead of using a position value, the DCT is calculated. There is no user parameter to retrieve the captured DCT. Attempting to set Mode = 2 with anything other than an EtherCAT system will result in an invalid parameter error.

Mode 3: Primary Encoder Signal

Mode 3 is the capture of the primary encoder signal. This mode is used to home onto a feedback index. This mode sets the other parameters needed for this mode. These parameters can be changed later, but this is not recommended unless the input source of the index signal varies. Parameters set in this mode are:

- CAPx.TRIGGER 10: index mark of primary encoder
- CAPx.EDGE 1: rising edge
- CAPx.EVENT 0: ignore precondition

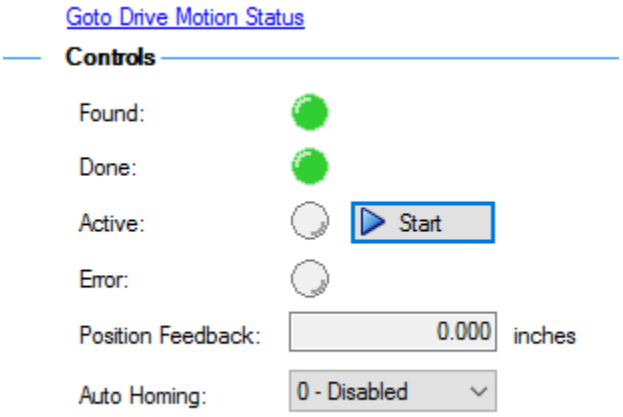
Also the capture engine is immediately enabled and is continuously triggered again.

Mode 4: Auto-Armed Position

Mode 4 is similar to Mode 0 (standard position capture), except that the re-enabling of the capture is done automatically. This mode can be used for the registration move.

Now the setup is complete, if desired Save To Device to save all the changes including the Motion Tasks to NV memory.

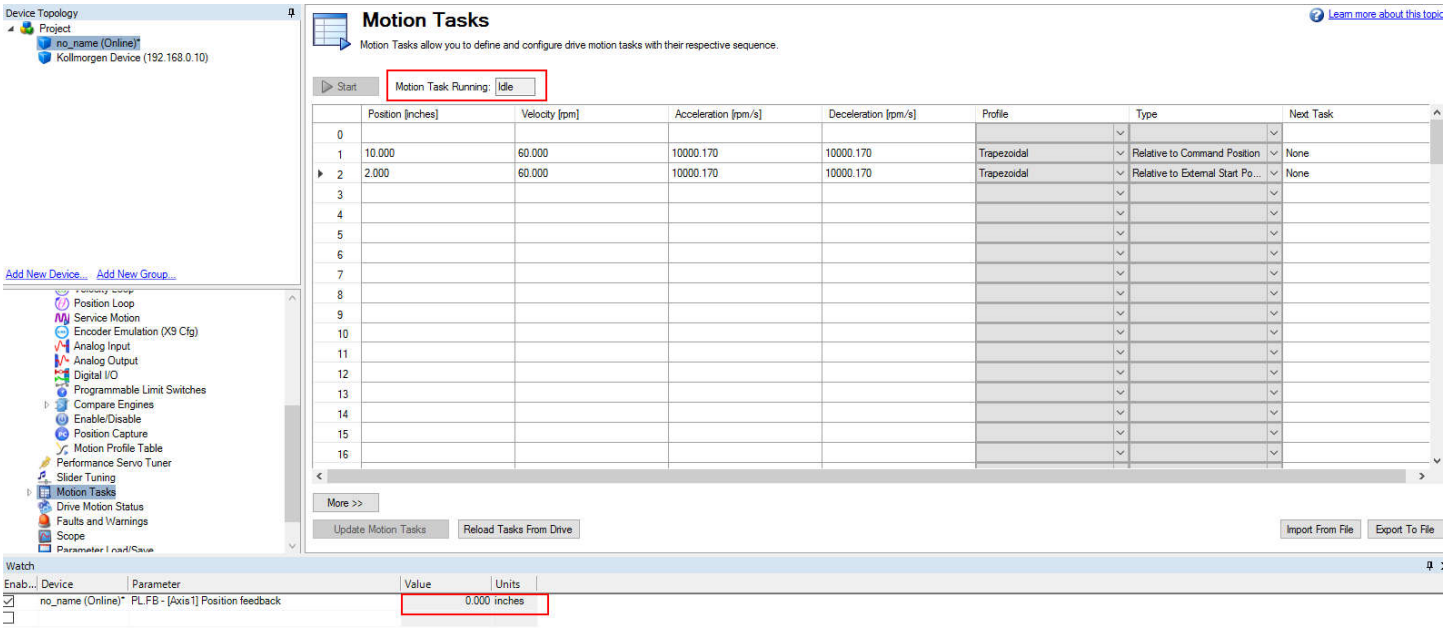
To test, re-home the drive go to the home screen and press “Start”. The feedback position should read 0.000.



Next make sure Digital Input 7 (DIN7) is OFF which will serve as an interlock to ignore the registration input (DIN1 in this example):

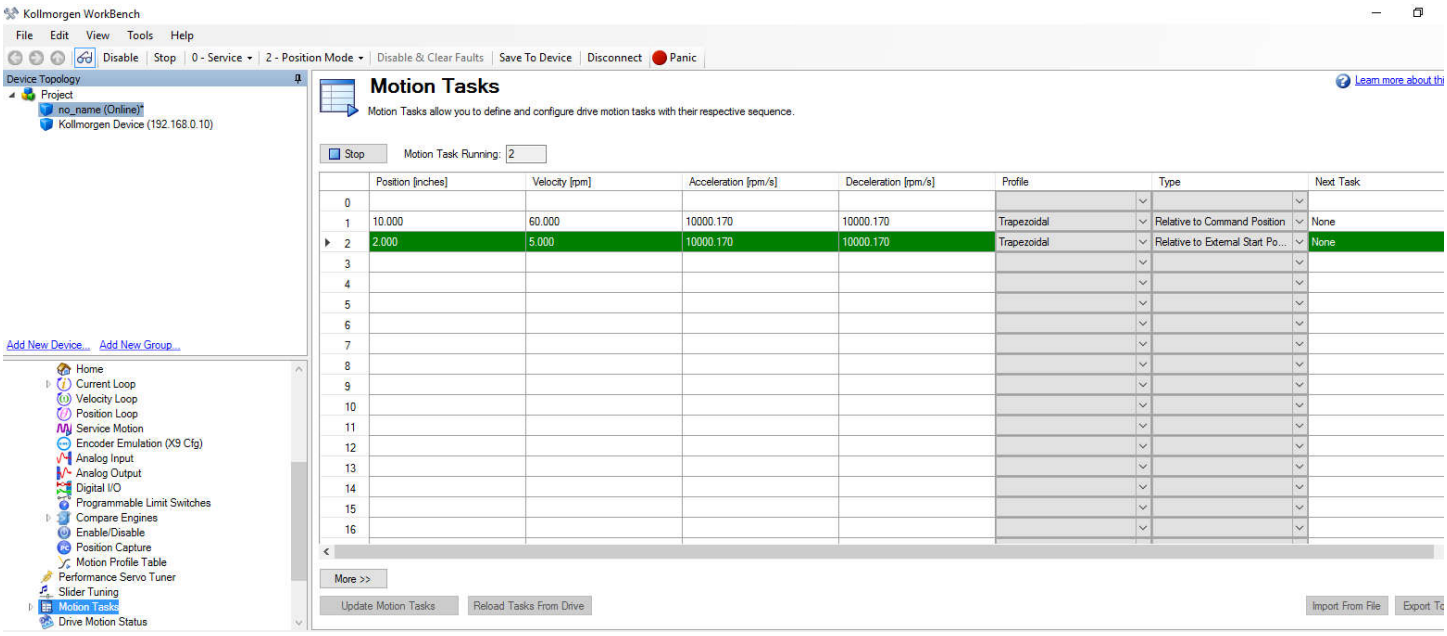
Next turn on the registration input. Recall that in this example the constraints in the motion task for the registration move was set to None which means anytime the registration sensor/input is triggered the registration move takes place. But in this case the precondition must also be met.

I looked at the Motion Task screen to monitor the execution of the motion tasks. Note no matter how many times I toggle the registration input (input 1) the Motion Task Running remains “Idle” and the feedback position remains 0.000.



Next to “enable” the registration input via the position capture pre-condition (DIN7 in this case), turn DIN7 ON.

Now turn on the registration input (DIN 1 in this case) and monitor the Motion Task screen as before. I kept the registration distance the same but lowered the velocity in Motion Task 2 in order to get the screenshot.



Note from the watch window once the move is done, the position feedback has incremented by 2 inches.

Watch

Enab...	Device	Parameter	Value	Units
☑	no_name (Online)*	PL.FB - [Axis1] Position feedback	2.000	inches
☐				

If you turn on DIN1 again then after the move you should see the position increment by 2s each time the input triggers the move and the move takes place.

If you turn OFF DIN7, then DIN1 will be ignored again and the position feedback should not increment.

Another method to ignore/disable the registration input without consuming an extra digital input on the AKD is to use an external relay to prevent the sensor from triggering the input.

Additional Notes:

1. The stop position has to be obtainable with the MT.ACC and MT.DEC values in the registration motion task. Otherwise, the motor could back up after reaching zero velocity and overshoot the target position.
2. There is a 0mS to 1mS delay between the trigger event and the start of the registration motion task. With high frequency registration moves, this could be a problem and should be taken into account.