Motion Control Products

Application note
Indexing Conveyor (PLCopen motion)

AN00246

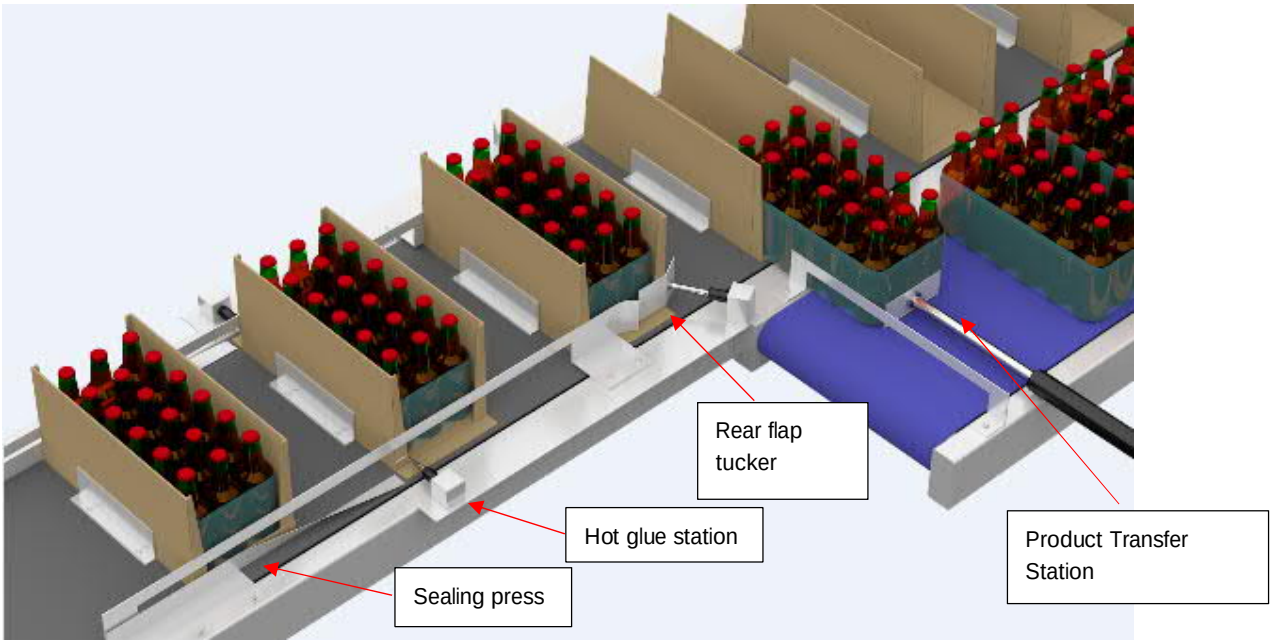
Rev A (EN)

ABB motion servo drive products are provided with high speed fast position capture (touchprobe) inputs which allow applications such as indexing conveyors to be realised with ease when used in conjunction with the AC500 PLC and PS552-MC-E motion control library

Introduction

A typical application for an indexing conveyor is illustrated below. A chain driven conveyor, fitted with flights at a regular pitch (often of an imperial dimension because chains are usually specified with either 0.25” or 0.5” links), is used to index cardboard blanks through a case erecting machine.
Products are pushed onto the cardboard blank and when this push is complete the conveyor is indexed by one pitch to carry the products to the next station and to allow the next set of products to be pushed onto the following blank. As each index occurs mechanical fixtures on the conveyor are used to bend the card into shape around the products. As part of this process glue guns are triggered at appropriate points in the index cycle to stick the flaps to the rest of the card as they are folded.

An ABB AC500 PLC could be used to control the entire case packing system, for this application note we will just consider the indexing conveyor, but in reality this would be just one part of the entire application.



Indexing conveyor example

Available to accompany this application note is an example Automation Builder v1.2 project. This project has been written for a PM591 processor fitted with CM579-ETHCAT coupler and a MicroFlex e190 drive connected via EtherCAT (but is easily converted to suit other configurations – note that a PM585 or any PM59x processor must be used for EtherCAT motion applications).

The project uses version 3.2.0 of the PS552-MC-E PLCopen motion control library so you will need a licensed version of this installed. The project references the MicroFlex e190 as a device included in Automation Builder via installation of the Mint servo drives package v1.2.4.1, so it may also be necessary to install this package via Tools>Installation Manager… before opening the example projects if you are not using a version of Automation Builder that ships with this package already installed. Please refer to the Automation Builder help system and application note AN00205 for further information about installing packages if needed. This application note includes the relevant Mint servo drives package file for convenience.

The project includes a DX561 eco I/O module to which an Emergency stop input (I0, active low) is wired. Codesys can be used to force operation of this input if necessary.
This module is used to provide two digital outputs, O0 is the operator side glue gun output and O1 is the gear side glue gun output (where operator side and gear side are common industry terms used to define one side of the machine or the other).

Please contact Motionsupport.uk@gb.abb.com if you would like to be sent a copy of this example Automation Builder project.

For this indexing conveyor example, a flighted conveyor similar in operation to the one shown above, feeds pre-folded cardboard display cases to a product transfer station. At this point the products are transferred into a waiting display case before the cases pass by a hot glue application station. The cases are then sealed using a series of guide rails and pressure plates.

The example is based on the following hardware implementation:

- A flighted conveyor with a 12 inch flight pitch, driven by a chain with 0.5” links and a 24 tooth sprocket (one revolution of the sprocket results in 12 inches of linear travel or one pitch)
- Between the drive sprocket and the AC servo motor is a 25:1 speed reduction gearbox
- An ABB brushless AC servo motor with encoder resolution of 131072 counts per revolution
- An ABB MicroFlex e190 servo drive
- Two hot melt glue application heads (one on the operator side of the machine, one on the far/gear side of the machine) – controlled by digital outputs on the AC500 PLC rack
- A proximity sensor for detecting conveyor flights and latching their position via digital input 1 (one of the fast digital inputs) on the drive

In a real application an ABB AC500 PLC may act as the main supervisory controller for this machine and ensure that the cardboard blank is in position and that the products have been successfully accumulated before transferring them to a waiting display case. However it is beyond the scope of this document to go into the detail of the PLC application. For the purposes of this application note we will use a button on a visualization included with the PLC project to trigger the index, signaling that products have been transferred and the index should start.

Our system also has a sensor to detect the flights as they pass by, connected to digital input 1 on the EtherCAT servo drive (not pictured in the above diagram). This sensor utilizes the drive’s fast latch functionality to capture the actual position of the flights as the index takes place and allows the drive to calculate a new target position “on the fly”. This ensures the conveyor always stops a known distance past the sensor and ensures there is no drift resulting from cumulative floating point inaccuracies and, to a certain extent, for stretch and wear of the mechanical setup.

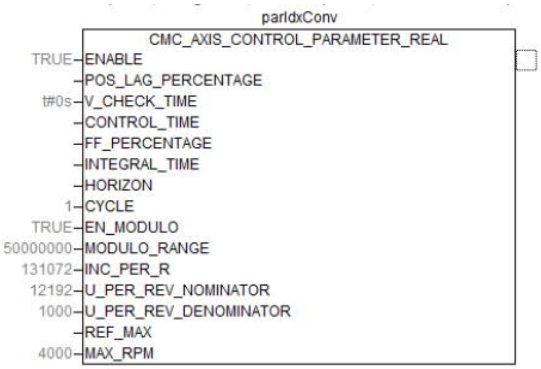
As the glue is to be applied to the case during motion the PLC will control two hot melt glue heads utilizing simple logic comparing the axis position against the programmed glue start positions and end positions which can be calculated from the start position summed with the glue bead length that has also been programmed.

Scale factor
The scale factor allows an axis to be scaled into engineering units for ease of use and can take into account any mechanical linkages such as gearing. The scale factor is applied to all motion variables for an axis (speed, acceleration, move distance, etc.). For this example we wish to scale our axis into linear mm of travel, so for the example mechanical setup of our indexing conveyor our scale factor can be worked out as follows:

We are driving our 24 tooth sprocket and 0.5” chain links via a 25:1 speed reduction gearbox…

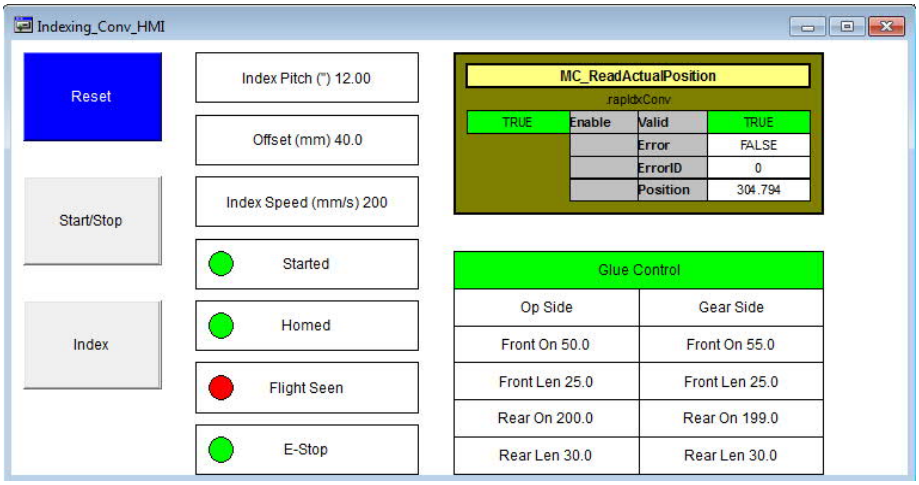
- 25 revolutions of the motor will produce one revolution of the pulley
- One pulley revolution = 12 inches of linear travel = 304.8mm of linear travel
- One motor revolution = 304.8 / 25 = 12.192 mm of linear travel (so there are 12.192 units per motor rev)
- One motor revolution = 131072 encoder counts

With this information we can program our PLCopen CMC_AXIS_CONTROL_PARAMETER_REAL function block as shown below…



CYCLE is set to 1ms to suit the EtherCAT cycle time set in our Automation Builder device configuration.
EN_MODULO is set to true because the axis continually runs in one direction and will eventually wrap position at the 32 bit boundary.
MODULO_RANGE is set to a high number of encoder counts, something much larger than the longest index length.
INC_PER_R is set to match the number of encoder counts in one revolution of our motor.
U_PER_REV_NOMINATOR and U_PER_REV_DENOMINATOR are set so that between them we arrive at our value of 12.192 units per motor rev (i.e. 12192 / 1000 = 12.192).

Indexing the conveyor
The example project is coded to enable the MicroFlex e190 drive automatically provided all interlocking conditions are met (i.e. the defined Emergency Stop input, I0 on the DX561 I/O module, must be on, the drive must have AC power applied, the drive's STO input must be inactive and there must be no error on the drive – the visualisation includes a 'Reset' button to clear any active drive errors).

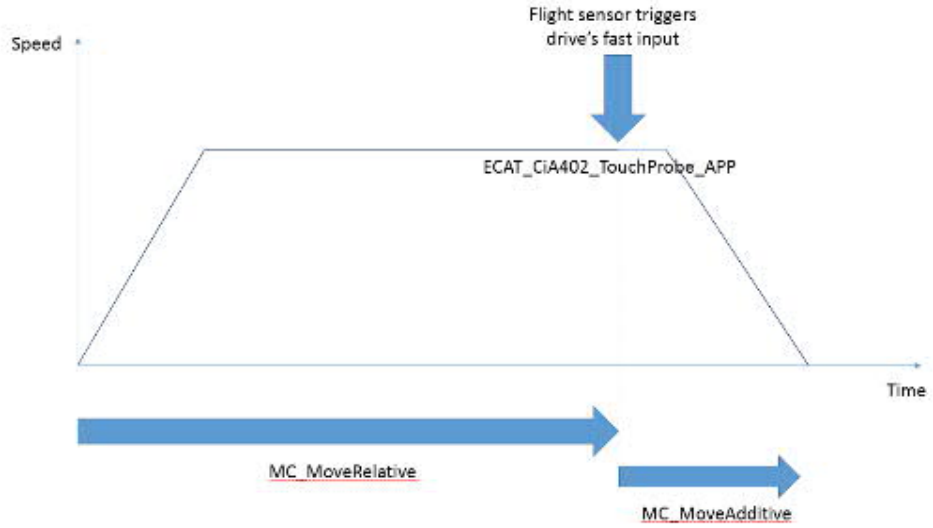


Once enabled the visualisation included with the PLC project provides the ability to "start/stop" the system. If the system is not started, indicated by a red 'led' mimic, it is not possible to index the axis. Once started operating the index button will either…

a. Perform an index at the pre-defined home speed (50mm/sec)
   Or
b. Perform an index at the adjustable index speed if it detects the axis has already been homed

Homing is effectively the same process as a normal index, just done at a slower speed – i.e. the axis initially aims to move by the programmed index pitch/distance and during this movement, if a fast interrupt from the flight sensor occurs, the target position for the move is modified to stop the axis the programmed offset distance past the point at which the fast interrupt occurred.
A led mimic indicates whether a home has ever been successfully completed. Until homed it is not possible to trigger the glue outputs. The pre-defined MC_ReadActualPosition visualisation block is included, linked to the instance of MC_ReadActualPosition in the project to display the current axis position at all times – this position is reset to zero at the start of every index.

A led mimic indicates whether a flight was seen during the index (i.e. whether a fast position latch occurred via the drive's fast input).
The diagram below illustrates the usage of the main PLCopen motion function blocks in this application…



Motion is initially started using MC_MoveRelative. The program loads the programmed pitch as the move distance for this block. If the flight sensor triggers the drive's fast digital input (input 1 in this case) during this movement then MC_MoveAdditive is executed with the 'Distance' input parameter for this function block calculated to ensure the axis stops the programmed 'Offset' distance past the axis position when the fast input occurred….

Distance = Latched Position + Offset – Original Move Distance

Note that if the offset distance is smaller than the distance the axis has to travel to decelerate from the index speed to zero speed then a backwards movement will result as the axis has to turn around to go back to the final target position. This can be avoided by ensuring the index speed and index deceleration values result in a stopping distance smaller than the programmed offset distance.

Triggering the glue guns
The example visualisation includes a glue control panel that allows the user to…

Turn glue firing on/off (click on the 'Glue control' button to turn this on/off, green indicates glue control is enabled)
Edit the start point for the front and rear glue bead on each side of the machine
Edit the length of each glue bead on each side of the machine

Logic in the PLC program continually monitors the axis position (as part of the EtherCAT synchronized task) and compares this with the programmed values to determine if the relevant digital output should be turned on or off. The glue outputs will de-activate if the axis stops moving, if glue control is disabled or if the axis is not considered to have been homed.

Contact us

For more information please contact your
local ABB representative or one of the following:

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