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ELEC5506:
Process Instrumentation Controls

PIC Design Project User Manual

Group 1:

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1. Intended Use

This document outlines the steps required to operate the Conveyor System Visualisation simulation on CodeSys. The following cases are explained in this document:

A) Fixed production mode: A desired number of boxes to produce is set and executed.
B) Continuous production mode: Conveyor system continues the box production process with no specified amount to produce.
C) Program interrupts: Factors that cause the program to exit the normal operation of the conveyor system.

2. Annunciation Panel

The annunciation panel is a critical tool which provides both control and oversight of the entire assembly line to the operator. The panel from Figure 1 can be broken down into two primary components which are depicted in greater detail within Figure 2 and Figure 3.

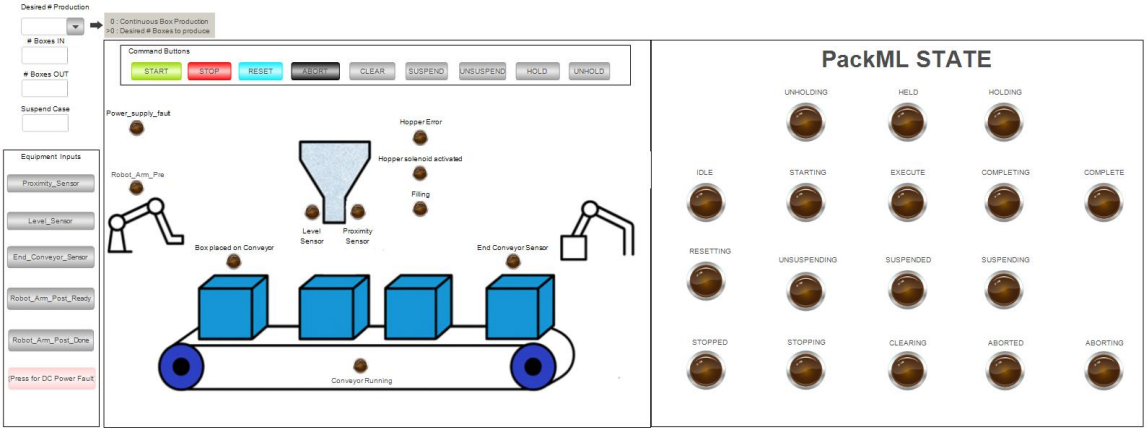

Figure 1. Full Annunciation Pannel

The primary control panel depicted in Figure 2 allows the operator to control the systems states and general operation. The key control buttons are placed at the top of the panel which include the Start, Stop, Reset and Abort buttons. Additionally, the Clear, Suspend, Unsuspend, Hold and Unhold buttons allow for the simulation to be operated and tested.

The drop-down box in the top left corner gives the operator the option to decide on the systems mode of operation. The operator can specify the number of boxes they wish to produce or set the system at continuous production. The number of boxes which are inputted and outputted through the system are then displayed below the drop-down box.

To test the validity of the CodeSys model all the proximity and level sensors need to be simulated. This is why the *'Equipment Inputs'* needed to be included within the visualisation panel. However, if the code is to be implemented it is recommended that these push buttons are removed to prevent potential trips. However, within the testbench scenario it allows the

operator to tell the system that a box is detected or has completed filling at the hopper. Additionally, the signals for both robot arms and power supply can be tested to confirm that the system moves into a fault state if the correct conditions aren't met.

The last component which provides clear information to the operator is the lamps spread out across the central image. They demonstrate what stage the Execute program is currently operating in and the state of each of the components. All proximity sensors, level sensors, Hopper Solenoid and state of the conveyor and robot arms are visually depicted. If the lamp lights up, then it indicates that the sensor detects a box or that the process is occurring.

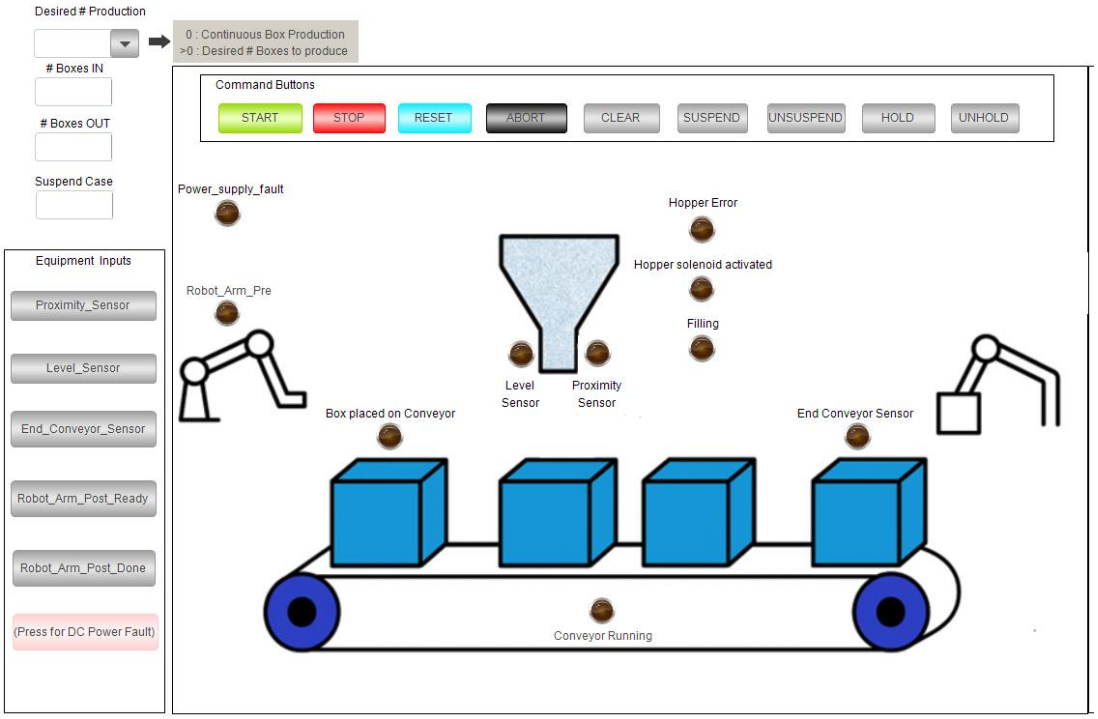

Figure 2. Annunciation Pannel: Control Buttons and Sensors

The secondary panel within Figure 1 can be seen below. The lamps provide a clear indication of which state the PLC is currently operating in. This information will the operator to identify potential faults and resolve any potential issues.

Figure 3. Annunciation Pannel: PackML State Lamps

3. How to use the simulation

3.1. Manufacturing Process

3.1.1. Fixed Production Mode

1. Set the '**Desired # Production**' to the number of boxes you wish to produce.
2. Press the '**Start'** Command. The Pre-Robot Arm will activate, indicating that a box is being placed on the conveyor. The conveyor will then activate.
3. Press the '**Proximity_Sensor**' Input to simulate a box triggering the proximity sensor located near the hopper. The following actions take place:
    a. Pre-Robot Arm activating to place a box on conveyor
    b. Hopper solenoid activated to fill the box
4. Press the '**Level_Sensor**' Input only when a new box has been placed on the conveyor (ie. '**Box placed on Conveyor**' lamp is activated).
   This is based on the assumption that it takes more time to fill a box than for a new box to be placed on the conveyor. The conveyor will activate again to move to the next box and the '**# Boxes IN**' will increment by 1.
5. Repeat Steps 3-4 until '**# Boxes IN**' is equal to the '**Desired # Production**' set in Step 1.
6. Press '**End_of_Conveyor_Sensor**' Input to simulate a box reaching the end of the conveyor. The '**# Boxes OUT**' will increment by one, indicating a box has been picked up by the Post-Robot Arm.
7. Repeat Step 6 until '**# Boxes OUT**' equals '**Desired # Production**'. The program will transition to the Completing State.

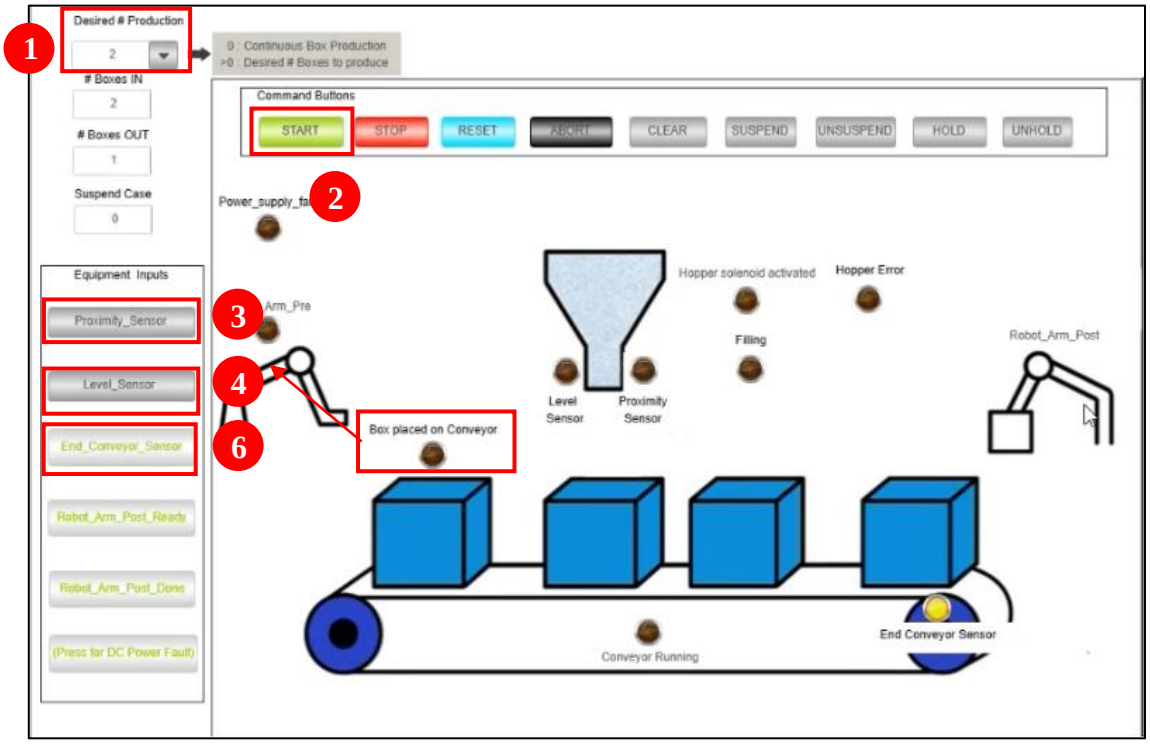

Figure 4. Fixed Production Mode

3.1.2. Continuous Production Mode

1. Set '**Desired # Production**' to '0' to set the program into Continuous Production Mode.
2. Repeat Steps 2-4 from Section 3.1.1
3. When '**# Boxes IN**' equals '3' (ie. 3 boxes filled, 4 boxes on conveyor), press both the '**Proximity_Sensor**' Input and '**End of Conveyor Sensor**' Input to simulate a new box arriving at the hopper and a filled box reaching the end of the conveyor to be picked up by the Post-robot arm.
4. Repeat Step 4 from Section 3.1.1
5. Repeat Steps 2-5 in this section to continue the program.

3.2. Program interrupts

3.2.1. Stop

1. Press the '**Stop**' Command. All outputs will be turned off and the program will transition to the Stopping State
2. The program will automatically transition from Stopping ⇒ Stopped
3. Press the '**Reset**' Command to reset the program.

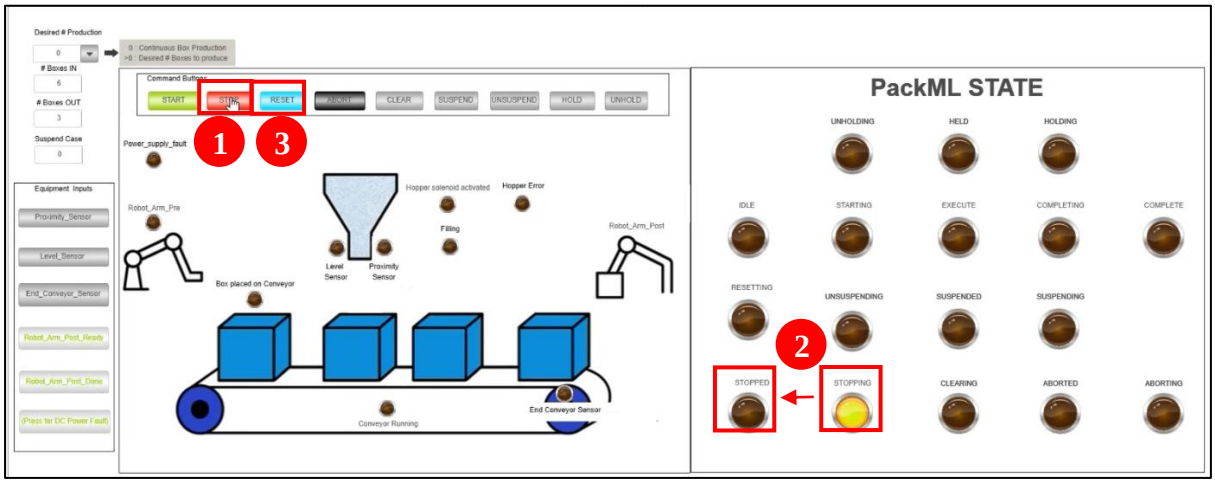

Figure 5. Stop Command Overview

3.2.2. Abort

Case A: Command Abort

1. Press the '**Abort**' Command. All outputs will be turned off and the program will transition to the Aborting State
2. The program will automatically transition from Aborting ⇒ Aborted
3. Press the '**Clear**' command to clear the program. The program will transition to the Clearing State
4. The program will automatically transition from Clearing ⇒ Stopped
5. Press the '**Reset**' command to reset the state of the program and return back to the Idle State.

Case B: Power Supply Fault

1. Press the '**(Press for DC Power Fault)**' button to simulate a DC supply fault. The '**Power_supply_fault**' indicator will activate, all outputs will be turned off and the program will transition to the Aborting State
2. Repeat Steps 2-5 from Case B.

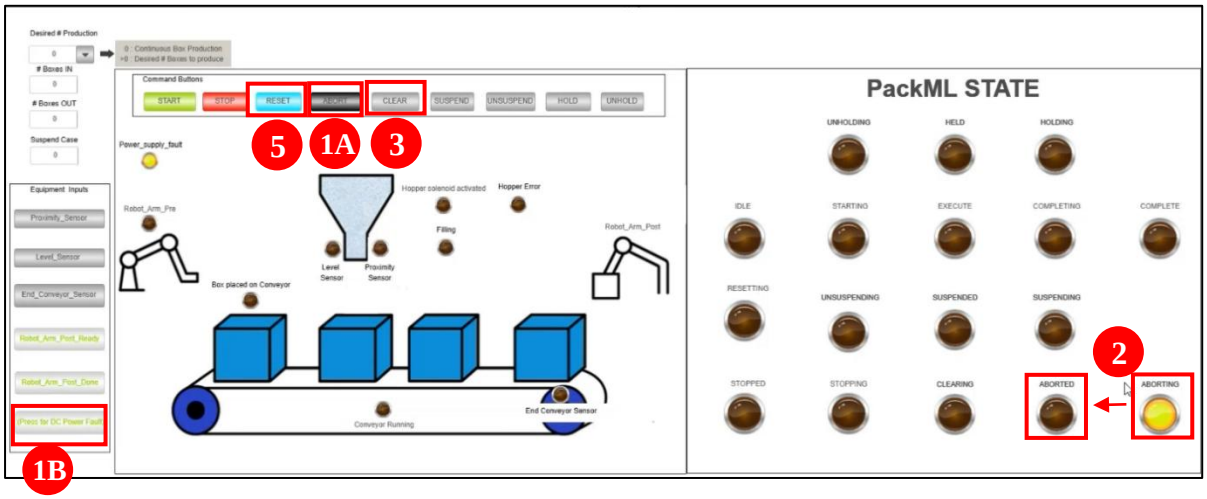

Figure 6. Abort Command Overview

3.2.3. Hold

Case A: Command Hold

1. Run the program until it is in the Execute State (ie. Step 2 in Section 3.1.1)
2. Press the '**Hold**' Command. All outputs will be turned off and the program will transition to the Holding State
3. The program will automatically transition from Holding ⇒ Held
4. Press the '**Unhold**' command to transition back to normal operation. The program will transition to the Execute state

Case B: Conveyor Jam or Delay

1. Run the program until it is in the Execute State (ie. Step 2 in Section 3.1.1)
2. DO NOT press the '**Proximity Sensor**' input for at least 15 seconds. This simulates a conveyor issue causing the box to take an extended amount of time to arrive at the hopper. The hopper will automatically transition to the Holding State
3. Repeat Steps 3-4 in Case A

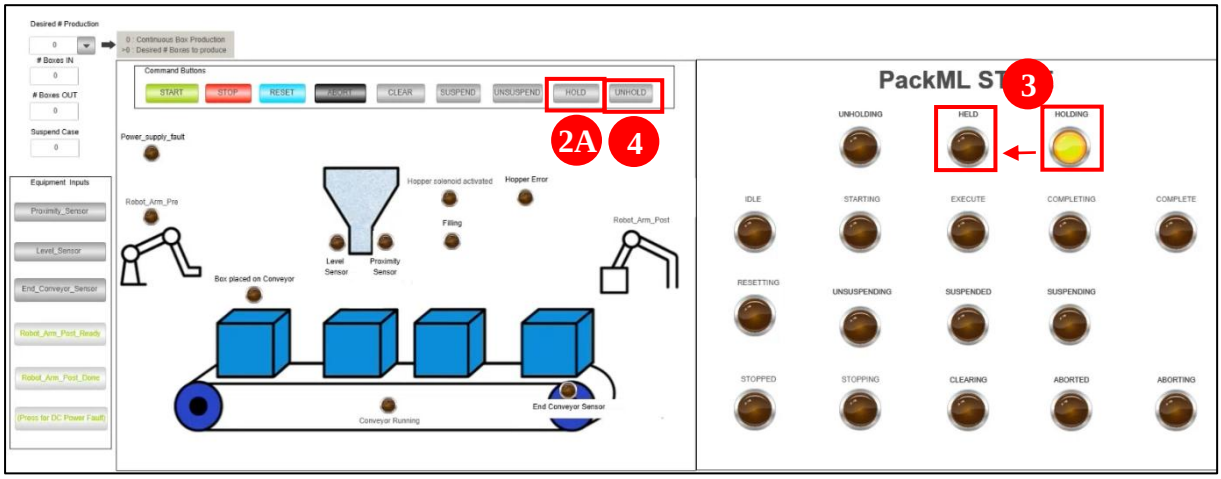

Figure 7. Hold Command Overview

3.2.4. Suspend

Case A: Post-robot arm is not ready to pick up box

1. Run the program until it is in the Execute State (ie. Step 2 in Section 3.1.1)
2. Untoggle the '**Robot_Arm_Post_Ready**' Input to simulate the post-robot arm being in a position that is not ready to pick up a box.
3. Press the '**End of Conveyor Sensor**' Input to simulate a box reaching the end of the conveyor while the post-robot arm is not ready. All outputs are de-activated and the program enters the Suspending State
4. The program will automatically transition from Suspending ⇒ Suspended
5. Press the '**Unsuspend** command to transition back to normal operation.

Case B: Box at the end of conveyor has not been picked up

1. Repeat Steps 1-5 in Section 3.1.1.
2. Untoggle the '**Robot_Arm_Post_Done**' Input to simulate the box at the end of the conveyor not being picked up by the post-robot arm.
3. Press the '**End Conveyor Sensor**' Input. The program will transition to the Suspending State.
4. Repeat Steps 4-5 in Case A

Case C: Extended amount of time taken to fill a box, indicating a hopper error

1. Repeat Steps 2-3 in Section 3.1.1
2. DO NOT press the '**Level Sensor**' input for at least 20 seconds. This simulates an issue in the hopper. The '**Hopper Error**' indicator will activate, the Hopper Solenoid will de-activate and the program will transition to the Suspending State
3. The program will automatically transition from Suspending ⇒ Suspended
4. Press the '**Unsuspend** command to transition back to normal operation. The program will transition to the Execute state and the Hopper Solenoid is re-activated.

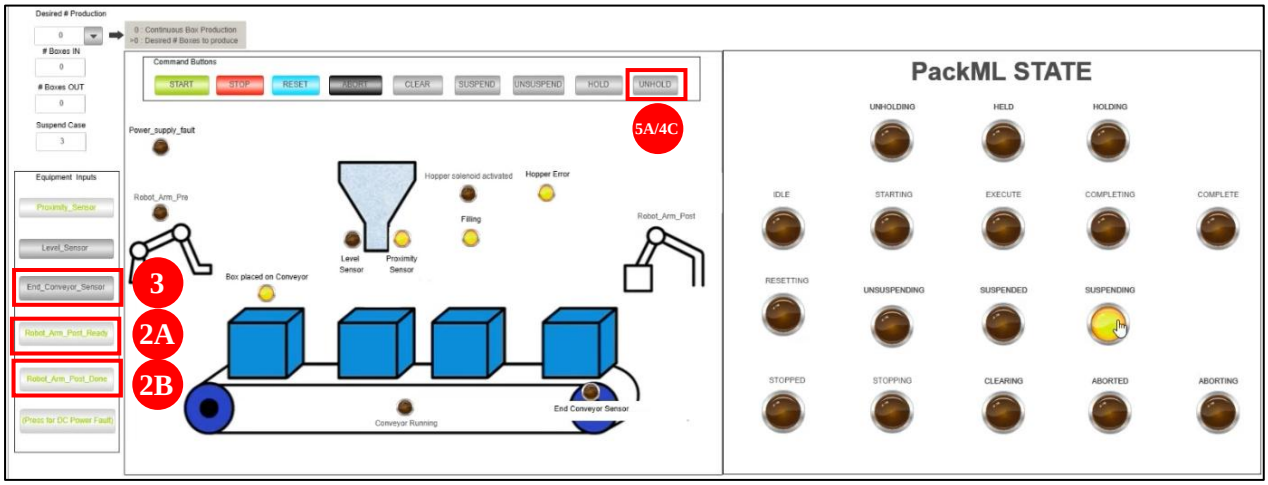

Figure 8. Suspend Command Overview