OPERATION MANUAL

For Bosch Manufacturing Line
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2005 Sigma Cell
A Senior Design Project
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INTRODUCTION

The purpose of this manual is to explain the startup, operation, and changeover procedures for the Bosch conveyor line.

MAIN COMPONENTS

The assembly line consists of several main components, as shown in Figure 1.

The conveyor has two workcells: Workcell A and Workcell B. The workcells are identical in construction and function. The control panel allows an operator to manually or automatically control the workcells. Emergency stop switches are included on either side of the conveyor to allow fast shutdown of the conveyor and workcells.

The PLC (programmable logic controller) Enclosure resides underneath the conveyor. It houses the PLC, electro-pneumatic valves, DC power supply, and emergency stop circuitry. The Starter Enclosure contains the switchgear and controls for the (4) 480VAC drive motors located on the conveyor. Both enclosures must be energized for the conveyor to operate.
STARTING THE CONVEYOR

To start the conveyor, perform the following steps:

- Perform a walk-around of the conveyor. Ensure that no obstructions are present around the belt and workcells.
- Verify that the (2) emergency stop push buttons are pulled outwards.

Figure 2, Starter Enclosure and Air Valve
- Rotate the air valve counterclockwise to pressurize the system. You may see movement in the workcell(s) immediately upon pressurizing the system.
- On the PLC Enclosure, rotate the power switch clockwise to the ON position. The PLC is now energized. Note: the conveyor cannot be started without the PLC energized. See Figure 3 for location of the switch.
• On the Starter Enclosure, push the main disconnect switch upward into the ON position. The Starter Enclosure is now energized.
• Rotate the Hand-Off-Auto (HOA) switch to the HAND position.
• Press the black RUN button. The conveyor will start.
OPERATING A WORKCELL

Figures 4 and 5 show the Control Panel and workcell. Note: the workcell is shown in a non-optimized configuration with the parallel gripper installed.

**Figure 4, Control Panel**

- Mode Switch
- Program Switch
- Run Button
- Pause Button

**Figure 5, Workcell**

- Primary Slide Switch
- Secondary Slide Switch
- Gate Switch
- Gripper Switch

Primary Slide
Secondary Slide
Gripper
Stop Gate
**Program Switch**

The Program switch is a 3-position switch that selects which software program the PLC will run. At the time this document was published, the Program switch serves no purpose, and all three positions run the same program. However, it adds flexibility to the conveyor for future additions or modifications.

**Mode Switch**

The Mode switch is a 3-position switch that selects which workcell will operate. (Only one workcell can operate at a time.) When “A” is selected, Workcell A will operate; when “B” is selected, Workcell B will operate. If the switch is set to HOME, both workcells will sit idle in their home position. The home position occurs when all electro-pneumatic solenoids are OFF. In this state, all slides are fully retracted, all grippers are open, and all stop gates are in the upward position.

**Run Button**

The Run button is a green illuminated pushbutton. When pressed, the selected workcell will enter into run mode, and the Run button will illuminate green. The workcell will perform its pick-and-place operation as long as a palette is present at the workcell.

If no palette is present after the Run button is pressed, the workcell will return to home position and remain idle until the next palette arrives. During the idle time, the Run button will flash indicating that the workcell is waiting for a palette.

**Pause Button**

The Pause button is a yellow pushbutton which pauses the running workcell in its current position. When pressed, the Run button will de-illuminate.

**Primary Slide Switch**

The Primary Slide switch is a 3-position rotary switch which allows manual operation of the primary slide of the selected workcell. If set to AUTO, the PLC will control the slide. If set to RETRACT, the slide is forced to fully retract; if set to
EXTEND, the slide is forced to fully extend. During normal operation, the Primary Slide switch should remain in AUTO.

**Secondary Slide Switch**

The Secondary Slide switch is a 3-position rotary switch which allows manual operation of the secondary slide of the selected workcell. If set to AUTO, the PLC will control the slide. If set to RETRACT, the slide is forced to fully retract; if set to EXTEND, the slide is forced to fully extend. During normal operation, the Secondary Slide switch should remain in AUTO.

**Gripper Switch**

The Gripper switch is a 3-position rotary switch which allows manual operation of the gripper of the selected workcell. If set to AUTO, the PLC will control the gripper. If set to OPEN, the gripper is forced to open (unclamp); if set to CLOSE, the gripper is forced to close (clamp). During normal operation, the Gripper switch should remain in AUTO.

**Gate Switch**

The Gate switch is a 3-position rotary switch which allows manual operation of the stop gate of the selected workcell. If set to AUTO, the PLC will control the gate. If set to UP, the gate is forced to extend (upward position); if set to DOWN, the gate is forced to retract (downward position). During normal operation, the Gate switch should remain in AUTO.

**Emergency Stop Switches**

The conveyor has two Emergency Stop switches. When pressed, the conveyor belt will stop, and the pneumatics will be de-pressurized via a supply-line solenoid valve. Upon resetting the Emergency Stop switch(s), the pneumatic supply line will re-pressurize, and the workcell will resume its previous state of operation. To start the conveyor, the black “Run” button must be pressed on the Starter Enclosure.
NON-OPTIMIZED CONFIGURATION

In the non-optimized configuration, the conveyor is configured with “standard components” which create a baseline for changeover time. Table A. summarizes all the components affected by a changeover.

<table>
<thead>
<tr>
<th>Changeover Component</th>
<th>Qty</th>
<th>Type</th>
</tr>
</thead>
</table>
| Actuator assembly fastener (for vertical adjust)         | 2   | Screw = M8 w/ 5mm alan head  
Nut = M8 T-nut (80-20, Inc)                                           |
| Actuator assembly fastener (for vertical adjust)         | 2   | Screw = M8 T-stud (80-20, Inc)  
Nut = M8 w/ 13mm hex head                                                |
| Actuator assembly fastener (for horizontal adjust)       | 4   | Screw = M6 w/ 5mm alan head  
Nut = M6 T-nut (80-20, Inc)                                              |
| Angular gripper fastener                                 | 2   | M4 w/ phillips head                                                   |
| Parallel gripper fastener                                | 2   | #6-32 w/ 5/64” alan head                                               |
| Pneumatic fitting                                         | 2   | 1/4” barb style w/ #10-32 threads                                     |
| Electrical connection                                    | 3   | stripped wire to terminal block on PLC enclosure                       |
| Palette fasteners for plastic cylinder configuration      | 1   | Screw = 1/4” w/ 7/16” hex head  
Nut = 1/4” w/ 7/16” hex head                                              |
| Palette fasteners for wood block configuration            | 2   | Screw = 1/4” w/ 7/16” hex head  
Nut = 1/4” w/ 7/16” hex head                                              |
| Stop gate fastener                                        | 2   | Screw = M8 T-stud (Bosch)  
Nut = M8 w/ 13mm hex head                                                |
| Vertical adjust stop blocks                               | None|                                                                        |
| Stop gate stop blocks                                     | None|                                                                        |
| Horizontal adjust jig                                     | None|                                                                        |
| Wire/Hose tie-down                                        | As Req’d| Plastic zip-ties                                                  |
The entire actuator assembly is held to the gantry via two sets of M8 fasteners. The top set requires a 5mm alan wrench, and the bottom set requires a 13 mm hex wrench. By loosening these fasteners, the gripper can be vertically adjusted during a changeover. The requirement for two types of wrenches illustrates the need for commonality. The result is increased tool retrieval time.

Also note that no stop blocks are installed on the gantry. Thus, alignment time drastically increases during the changeover process. See Figure 6a below.

![Figure 6a, Vertical Adjustment](image)

The primary slide is held into place via (4) M6 (5mm alan head) screws. By loosening these fasteners, the gripper can be horizontally aligned during a changeover. During the non-optimized changeover, an alignment jig is not used, and changeover time is increased. See Figure 6b.

![Figure 6b. Horizontal Adjustment](image)
The angular gripper is held into place with (2) M4 Phillips head screws. Unlike thumbscrews, the Phillips screws will require tool retrieval.

The (2) hoses that supply air to the gripper are connected to hose barbs. To ensure the hoses do not blow off during operation, zip ties are secured to the hose. To remove or install hoses, cutters are required for the zip ties. The use of tools during the changeover will increase changeover time.

See Figure 7 below.

Figure 7. Angular Gripper
The parallel gripper is held into place with (2) #6-32 screws (5/64” alan head). Unlike thumbscrews, the alan screws will require tool retrieval.

The (2) hoses that supply air to the gripper are connected to hose barbs. To ensure the hoses do not blow off during operation, zip ties are secured to the hose. See Figure 8 below.

![Figure 8, Parallel Gripper]

Note: ¼” to ¼” quick union used when hose barbs are connected to gripper.

#6-32 w/ 5/64” alan head (2) plc’s

¼” hose barb w/ #10-32 thread (2) plc’s. Zip tie attached.
Both angular and parallel grippers have an electrical cable connection. The cable contains (3) wires that connect to terminal blocks on the PLC Enclosure. A screwdriver must be used to connect the wires to the terminals. Thus, changeover time is increased because of the retrieval and use of tools. See Figure 9.

![Figure 9, Electrical Connection](image)

The terminal block consists of four wiring points:

1. Terminal 1 $\rightarrow$ +24VDC
2. Terminal 2 $\rightarrow$ Gnd
3. Terminal 3 $\rightarrow$ Signal for gripper connected to Workcell A.
4. Terminal 4 $\rightarrow$ Signal for gripper connected to Workcell B.

Important Note: Connect the black wire of the electrical cable to terminal 3 if the gripper is installed on Workcell A. Connect the black wire of the electrical cable to terminal 4 if the gripper is installed on Workcell B.
The form (for plastic cylinders) is held into place with a ¼” hex screw and nut. (2) 7/16” wrenches (or crescent wrenches) must be used to loosen and secure the form. Thus, changeover time is increased because of retrieval and use of tools. See Figure 10.

Figure 10, Form for Plastic Cylinder

The form (for wood blocks) is held into place with (2) ¼” hex screws and nuts. (2) 7/16” wrenches (or crescent wrenches) must be used to loosen and secure the form. Thus, changeover time is increased because of retrieval and use of tools. See Figure 11.

Figure 11, Form for Wood Block
The stop gate is held to the conveyor chassis via two M8 fasteners. A 13mm wrench is required to tighten or loosen the fasteners. Thus, changeover time is increased because of retrieval and use of tools.

Also note that no stop blocks are installed on conveyor chassis. Thus, alignment time increases during the changeover process. See Figure 12 below.

![Figure 12, Stop Gate](image1)

Screw = M8 T-stud (Bosch)
Nut = M8 w/ 13mm hex head
(2) plc’s.

To remove or install the electrical cable for the gripper, cutters are required for the zip ties. The use of tools during will increase changeover time. See Figure 13.

![Figure 13, Zip Ties](image2)

Note: zip ties are used to bundle and secure hoses and cables.
NON-OPTIMIZED CHANGEOVER

Start with the machine running. Five palettes are circulating about the conveyor. Each palette carries a plastic cylinder, which is picked up by the angular grippers and dropped into a bin. The following is a procedure for changing from an angular gripper to a rectangular gripper so that wood blocks can be handled instead.

1. POWER DOWN THE MACHINE
   1.1. Rotate the Mode switch to the Home position.
   1.2. Walk over to the Starter Enclosure and press the stop button.
   1.3. Rotate the HOA switch into the OFF position.
   1.4. Push the electrical disconnect to the OFF position.
   1.5. Turn the air valve to the OFF position.
   1.6. Walk over to the PLC Enclosure and turn the main switch to OFF. At this point, the machine is safe to work on.

2. REMOVE THE ANGULAR GRIPPER
   2.1. Remove the hoses to the gripper.
       2.1.1. Remove the zip ties from the hose barbs.
       2.1.2. Pull (2) hoses off of the hose barbs.
       2.1.3. Walk to trash bin and discard zip ties.
   2.2. Disconnect the gripper wiring.
       2.2.1. Walk to the workcell and identify how the electrical connection to the angular gripper is made.
       2.2.2. Walk to the tool cabinet and locate a flathead screwdriver.
       2.2.3. Walk to the workcell and loosen (3) screws that hold the wires to an electrical terminal block mounted exterior to the PLC Enclosure. The wires are now free from the terminal block.
       2.2.4. Walk to the tool cabinet and return the flathead screwdriver.
       2.2.5. Walk to the workcell and identify how the wires are secured.
       2.2.6. Walk to the tool cabinet and locate a pair of wire cutters.
       2.2.7. Walk to the workcell and cut approximately (5) plastic zip ties which secure the gripper wiring to the machine.
2.2.8. Pull out the gripper wiring from the main cable/hose bundle.
2.2.9. Walk to a trash bin and discard the zip ties.
2.2.10. Walk to the tool cabinet and return the wire cutters.
2.3. Remove the angular gripper mechanism.
   2.3.1. Return to the workcell and identify what type of screws hold the gripper onto the mounting plate.
   2.3.2. Walk to tool cabinet and locate a phillips head screwdriver.
   2.3.3. Walk to the workcell and remove (2) M4 phillips screws. The gripper is now removed from the mounting plate.
   2.3.4. Walk to workbench and put the (2) M4 phillips screws and angular gripper into bins.
   2.3.5. Walk to the tool cabinet and return the wrench.
3. INSTALL THE PARALLEL GRIPPER
   3.1. Install the parallel gripper mechanism.
      3.1.1. Determine the required screw size for the parallel gripper.
      3.1.2. Walk to tool cabinet and locate a 5/64” alan wrench.
      3.1.3. Walk to the work bench and retrieve the gripper and (2) #6-32 (5/64” alan head) screws.
      3.1.4. Walk to the workcell and install the gripper onto the mounting plate.
      3.1.5. Walk to the tool cabinet and return the 5/64” alan wrench.
   3.2. Connect the gripper wiring.
      3.2.1. Walk to the workbench and retrieve new zip ties.
      3.2.2. Walk to the workcell and install zip ties as the wire is routed down to the PLC enclosure’s exterior terminal block.
      3.2.3. Walk to the tool cabinet and retrieve the wire cutters.
      3.2.4. Trim the zip ties.
      3.2.5. Walk to the tool cabinet and return the wire cutters. Retrieve the flathead screwdriver.
      3.2.6. Walk to the workcell and fasten the wires to the electrical terminal block.
      3.2.7. Walk to the tool cabinet and return the flathead screwdriver.
   3.3. Install the hoses to the gripper.
3.3.1. Walk to workbench and retrieve (2) zip ties.
3.3.2. Install the hoses onto the (2) gripper hose barbs.
3.3.3. Install (2) zip ties to hold the hoses to the parallel gripper.
3.3.4. Walk to the tool cabinet and retrieve the wire cutters.
3.3.5. Trim the zip ties.
3.3.6. Walk to the tool cabinet and return the wire cutters.

4. ADJUST THE PALETTES TO HANDLE WOOD BLOCK PRODUCT.
4.1. Remove (5) palettes from conveyor and move them to the workbench.
4.2. Walk to the tool cabinet and retrieve a 7/16” wrench.
4.3. Walk to the workbench, and loosen the ¼” fastener with the wrench.
4.4. Remove the wooden form for handling the plastic cylinders.
4.5. Locate an additional ¼” screw and nut.
4.6. Install the wooden form for handling the wood blocks.
4.7. Install and tighten (2) sets of ¼” screws and nuts to secure the form to the palette.
4.8. Repeat 4.3 thru 4.7 for the remaining (4) palettes.
4.9. Return the palettes to the conveyor.
4.10. Return the 7/16” wrench to the tool cabinet.
4.11. Walk to the workbench and retrieve 5 wood blocks.
4.12. Walk to the conveyor, and set the wood block into the palettes.

5. VERTICALLY ALIGN THE GRIPPER
5.1. Identify what fasteners hold the actuator assembly to the gantry.
5.2. Walk to the tool cabinet and locate a 5mm alan wrench.
5.3. Walk to the conveyor and loosen (2) of the (4) screws holding the entire actuator assembly to the gantry.
5.4. Walk to the tool cabinet and locate a 13mm hex wrench.
5.5. Walk to the conveyor and loosen the remaining (2) M13 screws holding the actuator assembly to the gantry. As the remaining (2) screws are loosened, support the actuator assembly so it does not slide down the gantry.
5.6. Raise the gantry so that the gripper is at suitable height to pick up the wood block.
5.7. Tighten the (2) M13 hex head screws.
5.8. Tighten the (2) 5mm alan screws.
5.9. Return the 5mm and 13 mm wrenches to the tool cabinet.

6. HORIZONTALLY ALIGN THE GRIPPER
   6.1. Identify what fasteners hold the primary slide to the gantry.
   6.2. Walk to the tool cabinet and locate a 5mm alan wrench.
   6.3. Loosen all (4) M8 alan screws which secure the primary slide to the gantry.
   6.4. Adjust the slide horizontally such that the gripper will pick up the wood block when the primary slide is fully retracted.
   6.5. Tighten all (4) M8 alan screws with the 5 mm alan wrench.
   6.6. Return the 5mm alan wrench to the tool cabinet.

7. ADJUST THE STOP GATE
   7.1. Walk to the workcell and identify the type of stop gate fasteners.
   7.2. Walk to the tool cabinet and locate a 13mm wrench from the tool cabinet.
   7.3. Walk to the workcell and loosen the (2) M8 stop gate nuts.
   7.4. Adjust the stop gate position so that the wood block is positioned under the gripper when the gate is up.
   7.5. Tighten the (2) M8 stop gate nuts.
   7.6. Return the 13mm wrench to the tool cabinet.

8. POWER UP THE MACHINE
   8.1. Walk over to the PLC Enclosure and turn the PLC main switch ON.
   8.2. Walk over to the Starter Enclosure and push the main disconnect into the ON position.
   8.3. Rotate the HOA switch into the HAND position.
   8.4. Press the Start button.
   8.5. Turn the air valve to the ON position.
   8.6. Check to make sure the equipment is running properly, and return to the workcell.

9. TEST THE WORKCELL
   9.1. With the Mode switch still in HOME, manually run the primary, secondary, and gripper switches such that a complete pick-and-place sequence is tested.
9.2. Check for interferences during the manual run at each step of the pick-and-place sequence.

10. RUN THE WORKCELL

10.1. Ensure the primary, secondary, gripper, and stop gate switches are in the AUTO position.

10.2. Press the Start button.

10.3. Ensure the pick and place operation is working smoothly.

10.4. Changeover is complete.

11. CLEANUP

(Cleanup occurred during the entire procedure, as all tools and parts were put away after use. To be more efficient, this should be done after the machine is running.)
**OPTIMIZED CONFIGURATION**

In the optimized changeover, the conveyor is configured with “lean components” which create a reduced changeover time. Table B. summarizes all the components affected by a changeover.

<table>
<thead>
<tr>
<th>Changeover Component</th>
<th>Qty</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actuator assembly fastener (for vertical adjust)</td>
<td>4</td>
<td>Screw = M6 quick release</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nut = M6 self-holding T-nut</td>
</tr>
<tr>
<td>Actuator assembly fastener (for horizontal adjust)</td>
<td>4</td>
<td>Screw = M6 w/ 5mm alan head</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nut = M6 T-nut (80-20, Inc)</td>
</tr>
<tr>
<td>Angular gripper fastener</td>
<td>2</td>
<td>M4 thumbscrew</td>
</tr>
<tr>
<td>Parallel gripper fastener</td>
<td>2</td>
<td>#6-32 thumbscrew</td>
</tr>
<tr>
<td>Pneumatic fitting</td>
<td>2</td>
<td>1/8” quick connect w/ #10-32 threads</td>
</tr>
<tr>
<td>Electrical connection</td>
<td>1</td>
<td>Electrical quick connector near PLC Enclosure.</td>
</tr>
<tr>
<td>Palette fasteners for plastic cylinder configuration</td>
<td>1</td>
<td>Screw = 1/4” w/ 7/16” hex head</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nut = 1/4” w/ 7/16” hex head</td>
</tr>
<tr>
<td>Palette fasteners for wood block configuration</td>
<td>2</td>
<td>Screw = 1/4” w/ 7/16” hex head</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nut = 1/4” wing nut</td>
</tr>
<tr>
<td>Stop gate fastener</td>
<td>2</td>
<td>Screw = M8 T-stud (Bosch)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nut = M8 wing nut</td>
</tr>
<tr>
<td>Vertical adjust stop blocks</td>
<td>1</td>
<td>1.5 x 3” plate w/ 2 drilled holes</td>
</tr>
<tr>
<td>Stop gate stop blocks</td>
<td>1</td>
<td>1.5 x 3” plate w/ 2 drilled holes</td>
</tr>
<tr>
<td>Horizontal adjust jig</td>
<td>1</td>
<td>1 custom jig, plastic</td>
</tr>
<tr>
<td>Wire/Hose tie-down</td>
<td>As Req’d</td>
<td>Re-usable cable clamps</td>
</tr>
</tbody>
</table>
The entire actuator assembly is held to the gantry via (4) M6 quick release fasteners. Unlike the non-optimized configuration, all four fasteners are common. Additionally, they quick release fasteners require no tools. The result is decreased changeover time.

Also, stop blocks are installed on the gantry to allow fast positioning during a changeover. See Figure 14a below.

![Figure 14a, Gantry Fasteners]

The primary slide is held into place via (4) M6 (5mm alan head) screws. By loosening these fasteners, the gripper can be horizontally aligned during a changeover. During the non-optimized changeover, an alignment jig is used to reduce changeover time. See Figure 14b, 21, 22, and 23.

![Figure 14b. Horizontal Adjustment]
The angular gripper is held into place with (2) M4 thumbscrews. Thus, no tool retrieval is required.

The (2) hoses that supply air to the gripper are connected to pneumatic quick connects. Again, no tools are required, and changeover time is reduced.

See Figure 15 below.
The parallel gripper is held into place with (2) #6-32 thumbscrews. Thus, no tool retrieval is required.

The (2) hoses that supply air to the gripper are connected to pneumatic quick connects. Again, no tools are required, and changeover time is greatly reduced. See Figure 16 below.

Figure 16, Parallel Grippers

Note: 1/8” to ¼” quick union used when quick connects are connected to gripper.
(2) plc’s.

#6-32 thumbscrew
(2) plc’s

1/8” quick connect w/ #10-32 threads
(2) plc’s.
Both angular and parallel grippers have an electrical cable that needs to be connected to the PLC Enclosure. The angular and parallel grippers each utilize a 3-conductor male connector. The female end is electrically connected to the terminal blocks. During a changeover, the angular-gripper male connector is removed and replaced with the parallel-gripper male connector. In this case, the point of connection/disconnection occurs at the quick connector; not the terminal block. This action requires no tools, and changeover time is reduced. See Figure 17.

Figure 17, Electrical Connection

The terminal block consists of four wiring points:

5. Terminal 1 $\rightarrow$ +24VDC
6. Terminal 2 $\rightarrow$ Gnd
7. Terminal 3 $\rightarrow$ Signal for gripper connected to Workcell A.
8. Terminal 4 $\rightarrow$ Signal for gripper connected to Workcell B.

Important Note: Ensure the black wire of the electrical cable is electrically connected to terminal 3 if the gripper is installed on Workcell A. Ensure the black wire of the electrical cable is electrically connected to terminal 4 if the gripper is installed on Workcell B.
The form (for plastic cylinders) is held into place with a ¼” hex screw and wing nut. No tools are required to secure the form to the palette. Thus, changeover time is reduced. See Figure 18.

![Figure 18, Form for Plastic Cylinder](image)

Screw = 1/4” w/ 7/16” hex head
Nut = 1/4” wing nut
(1) plc.

The form (for wood blocks) is held into place with (2) ¼” hex screws and wing nuts. No tools are required to secure the form to the palette. Thus, changeover time is increased because of retrieval and use of tools. See Figure 19.

![Figure 19, Form for Wood Block](image)

Screw = 1/4” w/ 7/16” hex head
Nut = 1/4” wing nut
(2) plc’s.
The stop gate is held to the conveyor chassis via two M8 wing nuts. No tools are required, and changeover time is reduced.

Also note that stop blocks are installed on conveyor chassis. Thus, alignment time is decreased during the changeover process. See Figure 20 below.

Figure 20, Stop Gate
Horizontal alignment is achieved quickly by the use of an alignment jig. The jig consists of a main body and two attached "fingers". The jig is positioned by placing the main body against the gantry. See Figures 21, 22, and 23.

![Figure 21, Jig Position](image)

If the workcell is configured for the plastic cylinders, then the primary slide must touch the small finger, as illustrated in Figure 22.

![Figure 22, Horizontal Alignment for Cylinder](image)
If the workcell is configured for the wood blocks, then the primary slide must touch the large finger, as illustrated in Figure 23.

To remove or install the electrical cable for the gripper, cable clamps are used in lieu of zip ties. No cutters are required, and changeover time is reduced. See Figure 24.
OPTIMIZED CHANGEOVER

Start with the machine running. Five palettes are circulating about the conveyor. Each palette carries a plastic cylinder, which is picked up by the angular grippers and dropped into a bin. The following is a procedure for changing from an angular gripper to a parallel gripper so that wood blocks can be handled instead.

1. POWER DOWN THE MACHINE
   1.1. Rotate the Mode switch to the HOME position.
   1.2. Walk over to the STARTER Enclosure and press the stop button.
   1.3. Rotate the HOA switch into the OFF position.
   1.4. Push the electrical disconnect to the OFF position.
   1.5. Turn the air valve to the OFF position.
   1.6. Walk over to the PLC Enclosure and turn the main switch to OFF. At this point, the machine is safe to work on.

2. REMOVE THE ANGULAR GRIPPER
   2.1. Remove the hoses from the gripper.
       2.1.1. Remove the (2) hoses from the quick connect fittings.
   2.2. Disconnect the gripper wiring.
       2.2.1. Disconnect the gripper wiring by unplugging the quick connector near the PLC Enclosure.
       2.2.2. Loosen the cable clamps, and pull out the gripper wiring from the main cable/hose bundle.
   2.3. Remove the angular gripper mechanism.
       2.3.1. Remove (2) M4 fingertight screws. The end gripper is now removed from the mounting plate.
       2.3.2. Walk to the workbench and put the gripper and M4 fingertight screws into a bin.

3. INSTALL THE PARALLEL GRIPPER
   3.1. Install the parallel gripper mechanism.
       3.1.1. Retrieve the gripper and (2) #10-32 fingertight screws.
       3.1.2. Walk to the workcell and install the gripper onto the mounting plate.
3.2. Connect the gripper wiring.
   3.2.1. Route the gripper wiring through the cable clamps to the PLC Enclosure.
   3.2.2. Connect the electrical quick connector.
   3.2.3. Tighten all cable clamps.
3.3. Install the hoses to the gripper.
   3.3.1. Install the hoses to the gripper quick connects.

4. ADJUST THE PALETTES TO HANDLE WOOD BLOCK PRODUCT.
   4.1. Remove (5) palettes from conveyor and move them to the workbench.
   4.2. Loosen the (1) ¼” wing nut.
   4.3. Remove the wooden form for handling the plastic cylinders.
   4.4. Locate an additional ¼” screw and wing nut.
   4.5. Install the wooden form for handling the wood blocks.
   4.6. Install and tighten (2) sets of ¼” screws and nuts to secure the form to the palette.
   4.7. Repeat 4.2thru 4.6 for the remaining (4) palettes.
   4.8. Return the palettes to the conveyor.
   4.9. Walk to the workbench and retrieve 5 wood blocks.
   4.10. Walk to the conveyor, and set the wood block into the palettes.

5. VERTICALLY ALIGN THE GRIPPER
   5.1. Release (4) of the quick release levers. Support the actuator assembly so it does not slide down the gantry.
   5.2. Raise the gantry so until it hits the upper stops.
   5.3. Press (4) of the quick release levers to tighten.

6. HORIZONTALLY ALIGN THE GRIPPER
   6.1. Identify what fasteners hold the primary slide to the gantry.
   6.2. Walk to the tool cabinet and locate a 5mm alan wrench.
   6.3. Loosen all (4) M8 alan screws which secure the primary slide to the gantry.
   6.4. Using the jig, adjust the slide horizontally such that the gripper will pick up the wood block.
   6.5. Tighten all (4) M8 alan screws with the 5 mm alan wrench.
   6.6. Return the 5mm alan wrench to the tool cabinet.
7. ADJUST THE STOP GATE
   7.1. Loosen the (2) stop gate wing nuts.
   7.2. Adjust the stop gate until it hits the stop.
   7.3. Tighten the (2) stop gate wing nuts.

8. POWER UP THE MACHINE
   8.1. Walk over to the PLC Enclosure and turn the PLC main switch ON.
   8.2. Walk over to the Starter Enclosure and push the main disconnect into the
        ON position.
   8.3. Rotate the HOA switch into the HAND position.
   8.4. Press the start button.
   8.5. Turn the air valve to the ON position.
   8.6. Check to make sure the equipment is running properly, and return to the
        workcell.

9. TEST THE WORKCELL
   9.1. With the Mode switch still in HOME, manually run the primary, secondary,
        and gripper switches such that a complete pick-and-place sequence is
        tested.
   9.2. Check for interferences during the manual run at each step of the pick-and-
        place sequence.

10. RUN THE WORKCELL
    10.1. Ensure the primary, secondary, gripper, and stop gate switches are in
           the auto position.
    10.2. Press the Start button.
    10.3. Ensure the pick and place operation is working smoothly.
    10.4. Changeover is complete.

11. CLEANUP
    11.1. Return all remaining tools to the tool cabinet.
    11.2. Return all remaining parts to the workbench.
TROUBLESHOOTING

The Troubleshooting section identifies some common problems that may be encountered during conveyor and workcell operation. Each problem is given possible remedies, which are listed in order of priority.

Problem:
Conveyor will not start when Start button is pressed on Starter Enclosure.
Remedies:
1. Check to see that the PLC is turned ON.
2. Check that both emergency stop switches are pulled outwards.
3. Check to see that PLC enclosure is plugged into the floor outlet.
4. Open the enclosure, and verify that all (3) breakers are ON. Before doing this, ensure that the main disconnect on the Starter Panel is OFF and ensure that the PLC Enclosure power switch on panel door is OFF. If a breaker is tripped, reset to ON, close the panel, and re-energize. If the breaker trips again, the system will need to be electrically inspected to locate the fault.

Problem:
The workcell will not operate. The green Run button on the Operator Panel has been pressed, and the button is not flashing.
Remedies:
1. If the problem is on Workcell B, check to see that the small plastic ball valve located near the back of the PLC Enclosure is turned ON.
2. Ensure the black wire of the gripper cable is electrically connected to the proper signal terminal (either terminal 3 or terminal 4) of the terminal block located near the back of the PLC Enclosure.
3. Check to see that the workcell actuator is not being physically obstructed. The actuators must fully complete each motion before moving on to the next position.
4. Check to see that no hoses near the actuators are pinched.
5. Verify that the pneumatic connected to the gripper are not connected in reverse. To check this, the gripper must be fully open when the Mode switch is in the HOME position.

6. Check to see that each proximity switch on the actuators activates during the pick-and-place cycle. The easiest way to check proximity switches is to press an emergency stop switch to relieve pneumatic force and physically move the actuators to their limits.

7. Check to see that the gripper proximity switch is illuminating when the gripper is fully open. For the angular gripper, the LED is located on the proximity switch mounted in the gripper. For the parallel gripper, LED is located in the cable that is routed to the PLC Enclosure.

Problem:
The workcell will not operate. The green Run button on the Operator Panel has been pressed, and the button is flashing.

Remedy:

1. The PLC thinks that a palette is not present under the workcell. Check to see that the indicator LED on the stop gate proximity switch is illuminated while a palette is over the stop gate.

2. If the LED is not illuminating, verify that it is powered by touching it with a metal (ferrous) object. The LED should illuminate. If not, the wiring must be inspected. If it illuminates, try raising the proximity switch so that it comes closer to contacting the exposed metal on the palette.