ENGINEERING
W Booth School of Engineering
Practice and Technology

McMaster University

SEP 718

INDUSTRIAL AUTOMATION

Palletizer
Process Control Narrative

[Date]

Table of Contents

1 Introduction

1.1 References

The following documentation are pertinent to the discussion of this control narrative:

Document	Purpose
Palletizer – Factory I/O - Documentation	Visual demonstration of unit

1.2 Overview

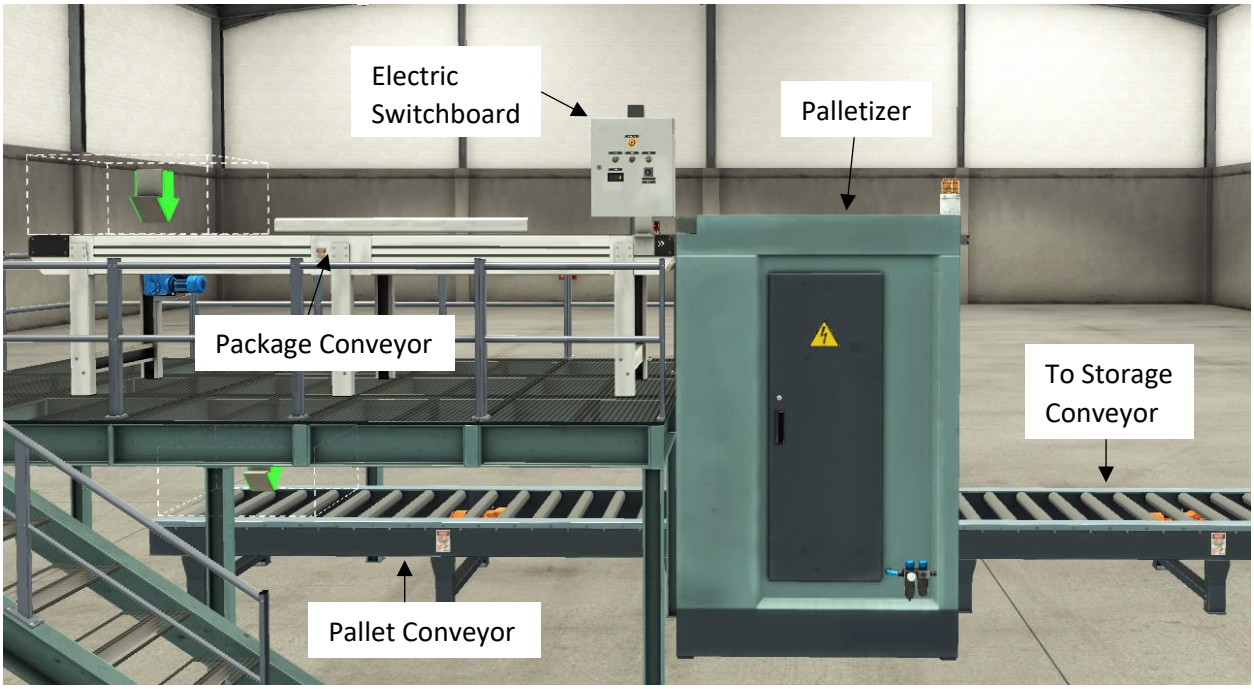
This document defines the unit controls for the palletizer unit.

The process objective is to stack packages of product onto a pallet before placing in storage. The mechanical arrangement is such that the palletizer stacks multiple packages at once. The control objective is to sort multiple packages in specific arrangements that will be stacked onto the pallet, which is done by manipulating the following devices:

- Conventional Palletizer
- Light load conveyors
- Heavy load conveyors

The control functions are automatically executed by the Process Control System (PCS); which consists of an Allen-Bradley ControlLogix 5570 PLC with digital and analog I/O modules.

The palletizer unit can be manually started, cooldown stopped, emergency stopped and automatically operated via an electric switchboard which is located on the top level of the palletizer with the light load conveyors.



1.3 Unit State Definitions

The palletizer unit can be in any of the following states:

- **Shutdown Lock Out.** The unit is isolated from the process, motors are off, and operator intervention is required (equipment reset)
- **Offline.** The unit is isolated from the process, motors are off and may be ready to start
- **Online.** Motors are on and the palletizer is stacking packages
- **Starting.** The unit has been commanded by an operator to sequence from offline to online
- **CStopping.** The unit has been commanded by an operator to go offline via the cooldown stop sequence. Hence the unit is sequencing from online to offline
- **EStopping.** The unit has been commanded by an operator to go shutdown lock out via the emergency stop sequence. Hence the unit is sequencing from any state to the shutdown lock out state.

2 Process Control Description

2.1 Palletizer Process Control

The palletizer unit will first wait for a pallet to be loaded onto the elevator via the heavy load conveyors. Then the pallet will be elevated just underneath the plate of the palletizer, this will be determined when a pallet passes by the elevator sensor. Whenever the elevator is moving, the warning light on the palletizer will light up.

When the pallet is in position, the light load conveyors will start loading packages onto the package load belt. The clamp, flipper, and pusher of the palletizer will manipulate the way the packages will be arranged for each layer that will be stacked on each pallet.

The palletizer will keep arranging the packages until three layers have been stacked onto the pallet. The elevator will then lower the stacked pallet onto the lower level of the palletizer. Once the stacked pallet is lowered, the stacked pallet exits the palletizer and moves towards the storage warehouse and is preparing for the next set of packages.

As the stacked pallet leaves, the counter on the digital display on the electric switchboard increase by one.

3 Unit Starting Sequence

3.1 Start Permissives

This sequence can be initiated while the unit is offline or has been fully reset.

3.2 Initiate Start Sequence

1. Press the start pushbutton

The PCS will now proceed automatically through the sequence steps below.

3.3 Start Step 0 – Start Pallet Conveyor

1. Start up the motor for the pallet conveyors

2. Wait for confirmation that pallets are running down the pallet conveyor before proceeding to step 1

3.4 Start Step 1 – Start Package Conveyor

The unit is now online.

4 Unit Cooldown Stop Sequence

4.1 Cooldown Stop Permissives

This sequence can be initiated while the unit is online or starting.

4.2 Initiate Cooldown Stop Sequence

1. Press the stop pushbutton

The PCS will now proceed automatically through the sequence steps below.

4.3 CStop Step 0 – Pause the Palletizer Unit

1. If there is an incomplete pallet, the system will finish filling the pallet and proceed with the following.
2. Stop the motors of all pallet and package conveyors
3. Stop all components of the palletizer (elevator, flipper, clamp, plate)
4. Wait for the following before proceeding to step 1
    a. Confirmation that there are no pallets entering the palletizer
    b. Confirmation that there are no packages entering the palletizer
    c. Confirmation that the palletizer unit is paused in its position

4.4 CStop Step 1 – CStop Sequence Complete

The unit is now offline. The unit may be starting on operator's command.

5 Unit Emergency Stop Sequence

5.1 Emergency Stop Permissives

This sequence can be initiated while the unit is online, offline, starting, or cooldown stopped.

5.2 Initiate Emergency Stop Sequence

Once the emergency stop button on the electric switchboard is pressed, the PCS will proceed automatically though the sequence of steps below.

5.3 EStop Step 0 – Pause the Palletizer Unit

1. Stop the motors of all pallet and package conveyors
2. Stop all components of the palletizer (elevator, flipper, clamp, plate)
3. Wait for the following before proceeding to step 1
    a. Confirmation that there are no pallets entering the palletizer
    b. Confirmation that there are no packages entering the palletizer
    c. Confirmation that the palletizer unit is paused in its position

5.4 EStop Step 1 – EStop Sequence Complete

The unit is now shutdown and locked out. The emergency button must be set back to its original position followed by the reset pushbutton being pressed in order for the palletizer unit to return to its original position. Once the palletizer is ready, the unit is ready to start.

6 Miscellaneous

6.1 Pallet Layer Arrangements

A fully stacked pallet will have three layers of stacked packages, each layer will have a specific arrangement as specified in the process control. The following images below indicates the arrangement of each layer, the left image is the arrangement for the first and third layer and the right image is the arrangement for the second layer. The bottom image shows all three layers stacked on a pallet.

7 Appendices

7.1 Appendix A – I/O List

Description	I/O Type	Slot #	Channel #
N.O. Pushbutton, 'Start'	Digital Input	1	0
N.C. Pushbutton, 'Stop'	Digital Input	1	1
N.O. Pushbutton, 'Reset'	Digital Input	1	2
N.C. Emergency Stop Button, 'Emergency stop'	Digital Input	1	3
Selector State, 'Manual'	Digital Input	1	4
Selector State, 'Auto'	Digital Input	1	5
Retroreflective Sensor, 'Pallet at entry'	Digital Input	1	6
Retroreflective Sensor, Pallet at exit'	Digital Input	1	7
Retroreflective Sensor, 'Box at entry'	Digital Input	1	8
Palletizer Sensor, 'Pallet loaded'	Digital Input	1	9
Palletizer Sensor, 'Elevator moving'	Digital Input	1	10
Palletizer Sensor, 'Plate limit'	Digital Input	1	11
Palletizer Sensor, 'Pusher limit'	Digital Input	1	12
Palletizer Sensor, 'Clamped'	Digital Input	1	13
Pilot Light, 'Start light'	Digital Output	2	0
Pilot Light, 'Stop light'	Digital Output	2	1
Pilot Light, 'Reset light'	Digital Output	2	2
Motor, 'Pallet feeder'	Digital Output	2	3
Motor, 'Box feeder'	Digital Output	2	4
Motor, 'Exit conveyor'	Digital Output	2	5
Palletizer Elevator, 'Elevator up'	Digital Output	2	6
Palletizer Elevator, 'Elevator down'	Digital Output	2	7
Palletizer Elevator, 'Move to limit'	Digital Output	2	8
Strobe Light, 'Warning light'	Digital Output	2	9
Palletizer Low-Level Actuator, 'Load pallet'	Digital Output	2	10
Palletizer High-Level Actuator, 'Load belt'	Digital Output	2	11
Palletizer High-Level Actuator, 'Clamp'	Digital Output	2	12
Palletizer High-Level Actuator, 'Open plate'	Digital Output	2	13
Palletizer High-Level Actuator, 'Push'	Digital Output	2	14
Palletizer High-Level Actuator, 'Turn'	Digital Output	2	15
Digital Display, 'Counter'	LOCAL TAG SIM_COUNTER_01		