

Robotics, Automation, and Integration

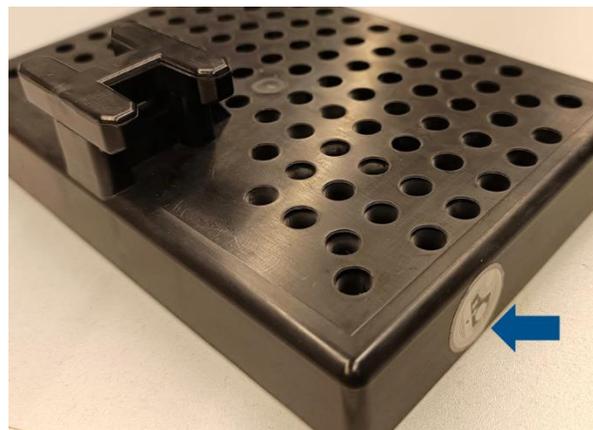
PROJECT 3 GUIDELINES AND SPECIFICATIONS

The following sections provide the specifications for the *Palletization* project as well as some tips that will help you overcome some of the more challenging items involved. Refer also to the rubric at the end of this document to see how you will be evaluated.

Specifications and Guidelines

Preparation and Setup

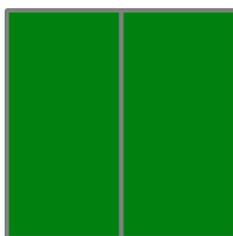
If the pallets you are using for the project do not have RFID tags, stick a tag onto each pallet (on the location shown in the image) before beginning the project.



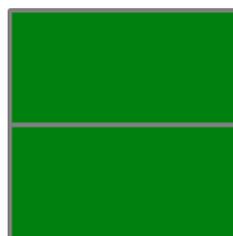
General Order of Operation

Two distinct production lines (both generating the same product: the green rectangular blocks) are presenting packages to the robot at the same time. One of these lines will be represented by the rotary table, and the other will be represented by the gravity feeder.

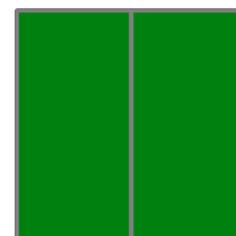
Each loaded pallet must have three layers, each with two packages, for a total of **six packages per pallet**. The loading pattern is an interlocking pattern, meaning that orientation of the packages in each layer alternates as shown.



Bottom layer



Middle layer



Top layer

The palletizing process is as follows:

1. Packages are (manually) loaded onto the rotary table and the gravity feeder.
2. An empty pallet is manually placed on the pallet by a “worker”.
3. Once the worker has left the area, the operator presses the *Start* button on the HMI.
4. The robot lifts the pallet and brings its RFID tag into range of an RFID read/write head.
5. The UID is read and is displayed on the HMI.
6. The loaded pallet is returned to the palletizing rack.
7. The robot then takes packages from both the rotary table and the gravity feeder. Each of these peripheral devices represents a different production line, and ultimately all of the packages from both lines must be palletized.
8. The robot moves to its home position.
9. The loaded pallet (with 6 blocks) is manually removed and replaced with an empty pallet.
10. The operator presses the *Start* button to initiate loading of the new empty pallet.

The Interface

Your HMI needs one operator’s screen with security clearance. The screen must show:

- The RFID tag UID of the pallet being loaded.
- The number of packages on the pallet that is currently being loaded.
- A *Start* button.
- A *Reset* button. The Reset button resets the system to its initial state.
- Instructions for what workers should do (e.g., “Press *Start*”, “Keep a safe distance”, “Replace pallet”, etc.).

Additional Specifications

These are some additional project specifications:

- All packages (rectangular blocks) stored on the rotary table and the gravity feeder must be loaded onto a pallet before they are replaced manually.
- On the rotary table, blocks may not be stacked.
- In order to maintain lot consistency, each loaded palette must contain blocks from both the rotary table and the gravity feeder, but the order of placement is unimportant.
- At least four (4) blocks must be stored in the gravity feeder before the system is initiated by the operator for the first time.
- The signal lamp must be illuminated red when the robot is in motion and green when the robot is stopped at the home position (and a worker can replace a pallet).

Tips and Suggestions

General Tips

Here are some general tips and suggestions to consider:

- Before you start integrating and programming in earnest, plan out a strategy for what you want to do and how you want to do it. Record your plan in writing and draw diagrams (such as a robot position map) that you can refer to later.
- If you are working on a team, you can split the load to save time. For example, one student integrator can program the robot, another the camera, and a third the PLC and HMI. Another way to save time is to perform most of the programming (both for the robot and PLC) offline and later download the programs to the relevant device. With regards to the robot, this is done by transferring JBI files via the pendant's USB port.
- Document all of your work (such as ladder routines and robot jobs) with legible comments.

Programming a Palletizing Job

For your 6-axis articulated robot, there are two primary ways to program the palletizing job or jobs:

- Program all points manually.
- Program calculated jobs. This means that only one position on the pallet is programmed manually, while the other positions are generated via shifting.

You can use whichever technique works best for you. However, keep in mind that if positions need to be modified, the first method becomes very time-consuming.

Material Handling Considerations

In order to facilitate the placement of pallets, the pallets are placed on the palletizing rack (the black rectangular plate with the holes) and should be secured with pins. The pins should also be inserted into the pallets as needed to help with the positioning of the bottom layer of packages.

Loaded pallets may not have any overhanging packages (green rectangular blocks), as this puts unnecessary stress on the product, and increases the chances of packages getting knocked off the pallet.

PROJECT 3 GRADING RUBRIC (REFERENCE)

The following rubric provides guidelines for evaluation of the various elements of the SmartCart project. This copy should be used by course participants and instructors as a reference. For grading purposes, instructors must complete the rubrics in the Assignment Submission item in this section.

The numbers in parenthesis indicate the number of points awarded for each criterion level.

| Criterion | Level 1 | Level 2 | Level 3 | Level 4 |
|-------------------------------------|---|--|---|--|
| Process Efficiency | The SmartCart is unable to complete any steps of the application process. (0) | The SmartCart completes some steps of the application process. (20) | The SmartCart completes the application process in its entirety. However, there may be some errors or faults, such as items being sorted in the incorrect locations. (30) | The SmartCart completes the application process in its entirety with no errors or faults. (35) |
| Continuity and Repeatability | The SmartCart is unable to repeat the process. (0) | The SmartCart is able to repeat the process. However, there are some problems with repeatability. (13) | The SmartCart is able to repeat the process with no observable errors or issues. (15) | |
| Operator Interface | There is no interface for the operator. (0) | The monitoring screen is poorly organized. Not all required elements (Start and reset buttons, pallet RFID, number of packages, and worker instructions) are present and functioning. (12) | The monitoring screen is somewhat clear, labelled, and organized. All required elements (Start and reset buttons, pallet RFID, number of packages, and worker instructions) are present and functioning. (18) | The monitoring screen is clear, labelled, and organized. All required elements (Start and reset buttons, pallet RFID, number of packages, and worker instructions) are present and functioning. (20) |
| Screen Security | The operator interface is accessible to all users. (0) | Authorized users must log in to gain access to the operator screen. (8) | | |

| Criterion | Level 1 | Level 2 | Level 3 | Level 4 |
|------------------------|--|--|--|---------|
| Program Clarity | PLC routines and robot jobs are unintelligible. (3) | PLC routines and robot jobs are generally clear and documented but also contain several superfluous or indecipherable instructions or rungs. (9) | PLC routines and robot jobs are clear and documented. (12) | |
| Signal Lamp | The signal lamp does not indicate if it is safe for workers to replace a pallet. (0) | The signal lamp indicates if it is safe for workers to replace a pallet. (10) | | |