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Chapter 1

Introduction

PalletWorld® is part of the Motoman family of standardized solutions. It is a fully integrated modular palletizing system, supported by Motoman, Inc. The PalletWorld system features a Motoman EPL-series robot and NX controller with menu-driven application software, complete palletizing package, operator interface, and a total safety environment.

1.1 About this Document

This manual is intended as an introduction and overview for personnel who have received operator training from Motoman, and who are familiar with the operation of this Motoman robot model. For more detailed information, refer to the manuals listed in Section 1.3. This manual contains the following sections:

This System Manual provides an overview of the Motoman PalletWorld® system. For detailed information on specific system component listed in this document, please refer to the documentation package included with your PalletWorld® system (refer to Section 1.3).

Note: This manual documents a standard Motoman system. If your system is custom or modified, please use this manual in conjunction with the drawings, schematics, and parts listing (Bill of Material) for your specific system. The drawings, schematics, and parts listing are included in the documentation package supplied with your Motoman system.

This System Manual contains the following chapters –

CHAPTER 1 - INTRODUCTION
Provides general information about the PalletWorld and its components, a list of reference documents, and customer service information.

CHAPTER 2 - SAFETY
This chapter introduces the PalletWorld® System Manual, provides an overview of the PalletWorld® system, lists reference documents that are included with the documentation package, and provides Motoman Customer Support contact information.

CHAPTER 3 - EQUIPMENT DESCRIPTION
This chapter provides a detailed description of the major component modules available with the PalletWorld system. This chapter also includes a table of component specifications.
CHAPTER 4 - INSTALLATION
This chapter provides instructions for set up and installation of the PalletWorld system.

CHAPTER 5 - OPERATION
This chapter provides instructions for basic operation of the PalletWorld system. This chapter provides procedures for start-up, loading, normal operation, fault recovery, and shutdown.

APPENDIX B, APPENDIX B, and APPENDIX C
These Appendices contain information specific to each of the grippers available with the PalletWorld system.

1.2 System Overview

The PalletWorld systems use a modular, flexible approach to configuring a palletizing system. The system is designed around a Motoman EPL160-robot and NX controller, and includes a complete palletizing package. Single or double infeed conveyors sort and deliver product to the robot. Several specially designed grippers are available, enabling the robot to palletize a variety of different products. Single or dual outfeed conveyors are available to process the palletized product. The cell provides a full complement of safety features designed to protect both personnel and equipment. Figure 1 illustrates one type of system layout for the PalletWorld cell.

The PalletWorld® system features a total safety environment that meets or exceeds the requirements of the ANSI/RIA R15.06 standard, and is designed to safeguard both personnel and equipment. Heavy-gauge wire mesh safety fencing prevents unintended entry of personnel into the work cell while it is in operation. An interlocked access door, at the rear of the work cell, provides convenient access to the robot, while providing a safety interlock to disable all equipment should the access door be opened while the robot is active. All operator controls, including those on the controller, are accessible from outside the robotic enclosure. In addition, a 3-color light beacon is located on the fencing above the controller to indicate cell status.

![Figure 1 System Layout Example](image-url)
1.2.1 System Layout

Major components of the PalletWorld® system are anchored individually to the floor, as this system does not use common equipment bases. Heavy-gauge, wire mesh safety fencing is provided for installation at the customer’s location. When installed, this safety fencing completely closes the work cell. The NX100 controller is located outside of the work cell. All system controls, including those on the programming pendant, NX100 controller is safely accessible from outside the PalletWorld® work cell (refer to your specific system prints for location of these components).

The PalletWorld includes the following major components:

- Motoman EPL160 manipulator and NX controller
- Robot riser
- Single or dual infeed case conveyor station kit
- Single or dual outfeed conveyor station kit
- Pallet floor locator
- Pallet rack assembly
- Gripper and gripper interface
- Safety equipment, including the following:
  - Safety fencing
  - Interlocked cell doors
  - Operator actuated emergency stops
  - 3-color light beacon

1.2.2 Optional Software

The following software packages are available for use with the PalletWorld:

- MotoPallet™
- MotoSim
- Ethernet
- Conveyor Tracking

1.2.3 Optional Equipment

The following optional equipment is available for use with the PalletWorld:

- Pallet rack assembly
- Pallet floor locator
- Slip sheet rack assembly
- Operator station
- Vacuum gripper
- Paddle gripper
- Bag gripper
- Pneumatic valve assembly
1.3 Reference to Other Documentation

For additional information refer to the following:

- Motoman EPL160 Manipulator Manual (P/N 150778-1)
- Motoman NX100 Controller Manual (P/N 149201-1)
- Motoman NX100 Maintenance Manual (P/N 150133-1)
- Motoman NX100 Operator’s Manual for General (P/N 150077-1)
- Motoman NX100 Concurrent I/O Parameter Manual (P/N 149230-1)
- Motoman NX100 Independent/Coordinated Control Function Manual (P/N 149648-1)
- Motoman INFORM User’s Manual (P/N 150078-1)
- Vendor manuals for system components not manufactured by Motoman

1.4 Customer Service Information

If you need assistance with any aspect of your PalletWorld® system, please contact Motoman Customer Support at the following 24-hour telephone number –

937. 847. 3200

For routine technical inquiries, you can also contact Motoman Customer Support at the following e-mail address –

techsupport@motoman.com

When using e-mail to contact Motoman Customer Support, please provide a detailed description of your issue, along with complete contact information. Please allow approximately 24 to 36 hours for a response to your inquiry.

Note: Please use e-mail for routine inquiries, only. If you have an urgent or emergency need for service, replacement parts, or information, you must contact Motoman Customer Support at the telephone number shown above.

Please have the following information ready before you call –

- SYSTEM — PalletWorld®
- ROBOTS — EPL160
- CONTROLLER — NX100
- PRIMARY APPLICATION — Handling
- SOFTWARE VERSION — Access this information on the Programming Pendant display screen by selecting MAIN MENU > SYSTEM INFO > VERSION
- ROBOT SERIAL No — Located on data plate of robot
- ROBOT SALES ORDER No — Located on data plate of NX100 controller
- WARRANTY ID CODE — Located on back of the Programming Pendant
Chapter 2
Safety

2.1 Introduction

It is the purchaser’s responsibility to ensure that all local, county, state, and national codes, regulations, rules, or laws relating to safety and safe operating conditions for each installation are met and followed.

We suggest that you obtain and review a copy of the ANSI/RIA National Safety Standard for Industrial Robots and Robot Systems (ANSI/RIA R15.06-1999). You can obtain this document from the Robotic Industries Association (RIA) at the following address:

RoboticIndustriesAssociation
900VictorsWay
P.O.Box3724
AnnArbor,Michigan48106
TEL:(734)994-6088
FAX:(734)994-3338
www.roboticsonline.com

Ultimately, well-trained personnel are the best safeguard against accidents and damage that can result from improper operation of the robot system. The customer is responsible for providing adequately trained personnel to operate, program, and maintain the robot cell. NEVER ALLOW UNTRAINED PERSONNEL TO OPERATE, PROGRAM, OR REPAIR THE ROBOT SYSTEM!

We recommend approved Motoman training courses for all personnel involved with the operation, programming, or repair of the robot system. This training is designed to familiarize personnel with the safe and correct operation of the robot system.
This safety section addresses the following:

- Standard Conventions (Section 2.2)
- General Safeguarding Tips (Section 2.3)
- Mechanical Safety Devices (Section 2.4)
- Installation Safety (Section 2.5)
- Programming, Operation, and Maintenance Safety (Section 2.6)

## 2.2 Important Advisory Information

Throughout this manual you will find advisory paragraphs (denoted by graphic symbols and bold typeface). All of these (except “NOTE”) direct the reader's attention to information and procedures that are essential to the safety of personnel or protection of equipment.

The type of information contained in the various advisories is described below. These are listed here in decending order of importance to the safety of personnel and protection of equipment.

**DANGER!**

Information appearing under the DANGER caption concerns the protection of personnel from an immediate and imminent hazards that, if not avoided, will result in immediate, serious personal injury or loss of life in addition to equipment damage.

**WARNING!**

Information appearing under the WARNING caption concerns the protection of personnel and equipment from potential hazards that can result in personal injury or loss of life in addition to equipment damage.

**CAUTION!**

Information appearing under the CAUTION caption concerns the protection of personnel and equipment, software, and data from hazards that can result in minor personal injury or equipment damage.

Note: Information appearing in a Note caption provides additional information that can be helpful in understanding the item being explained.

## 2.3 General Safeguarding Tips

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. All personnel involved with the operation of the equipment must understand potential dangers of operation. General safeguarding tips are as follows:

- Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation of this robot, the operator's manuals, the system equipment, and options and accessories should be permitted to operate this robot system.
• Do not enter the robot cell while it is in automatic operation. Programmers must have the teach pendant when they enter the robot cell.
• Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).
• The robot must be placed in Emergency Stop (E-Stop) mode whenever it is not in use.
• In accordance with ANSI/RIA R15.06-1999, section 4.2.5, Sources of Energy, use lockout/tagout procedures during equipment maintenance. Refer also to Section 1910.147 (29CFR, Part 1910), Occupational Safety and Health Standards for General Industry (OSHA).

2.4 Mechanical Safety Devices

The safe operation of the robot, positioner, auxiliary equipment, and system is ultimately the user's responsibility. The conditions under which the equipment will be operated safely should be reviewed by the user. The user must be aware of the various national codes, ANSI/RIA R15.06-1999 safety standards, and other local codes that may pertain to the installation and use of industrial equipment. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. The following safety equipment is provided as standard:

• Safety fences and barriers
• Light curtains and/or safety mats
• Door interlocks
• Emergency stop palm buttons located on operator station, robot controller, and programming pendant

Check all safety equipment frequently for proper operation. Repair or replace any non-functioning safety equipment immediately.

2.5 Installation Safety

Safe installation is essential for protection of people and equipment. The following suggestions are intended to supplement, but not replace, existing federal, local, and state laws and regulations. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. Installation tips are as follows:

• Be sure that only qualified personnel familiar with national codes, local codes, and ANSI/RIA R15.06-1999 safety standards are permitted to install the equipment.
• Identify the work envelope of each robot with floor markings, signs, and barriers.
• Position all controllers outside the robot work envelope.
• Whenever possible, install safety fences to protect against unauthorized entry into the work envelope.
• Eliminate areas where personnel might get trapped between a moving robot and other equipment (pinch points).

• Provide sufficient room inside the workcell to permit safe teaching and maintenance procedures.

2.6 Programming, Operation, and Maintenance Safety

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation, manuals, electrical design, and equipment interconnections of this robot should be permitted to program, operate, and maintain the system. All personnel involved with the operation of the equipment must understand potential dangers of operation.

• Inspect the robot and work envelope to be sure no potentially hazardous conditions exist. Be sure the area is clean and free of water, oil, debris, etc.

• Be sure that all safeguards are in place. Check all safety equipment for proper operation. Repair or replace any non-functioning safety equipment immediately.

• Do not enter the robot cell while it is in automatic operation. Be sure that only the person holding the programming pendant enters the workcell.

• Check the E-Stop button on the programming pendant for proper operation before programming. The robot must be placed in Emergency Stop (E-Stop) mode whenever it is not in use.

• Back up all programs and jobs onto suitable media before program changes are made. To avoid loss of information, programs, or jobs, a backup must always be made before any service procedures are done and before any changes are made to options, accessories, or equipment.

• Any modifications to PART 1, System Section, of the robot controller concurrent I/O program can cause severe personal injury or death, as well as damage to the robot! Do not make any modifications to PART 1, System Section. Making any changes without the written permission of Motoman will VOID YOUR WARRANTY!

• Some operations require standard passwords and some require special passwords. Special passwords are for Motoman use only. YOUR WARRANTY WILL BE VOID if you use these special passwords.

• The robot controller allows modifications of PART 2, User Section, of the concurrent I/O program and modifications to controller parameters for maximum robot performance. Great care must be taken when making these modifications. All modifications made to the controller will change the way the robot operates and can cause severe personal injury or death, as well as damage the robot and other parts of the system. Double-check all modifications under every mode of robot operation to ensure that you have not created hazards or dangerous situations.

• Check and test any new or modified program at low speed for at least one full cycle.
• This equipment has multiple sources of electrical supply. Electrical interconnections are made between the controller and other equipment. Disconnect and lockout/tagout all electrical circuits before making any modifications or connections.

• Do not perform any maintenance procedures before reading and understanding the proper procedures in the appropriate manual.

• Use proper replacement parts.

• Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).
Chapter 3

Equipment Description

3.1 Robot Description

The Motoman EPL160 robot and NX100 robotic controller represent state-of-the-art technology in robotics today. Designed specifically for palletizing applications, the four-axis EPL160 “Expert Palletizing” robot is a high-performance manipulator that features internally routed air lines and wiring between the base of the robot and the end-of-arm tool. The four-axis EPL160 robot has a payload of 160 kg. It features a 3,159 mm reach and has a repetitive positioning accuracy of ±0.5 mm.

The EPL160 can service multiple infeed conveyors and/or pallet build locations. Its fast axial speeds (up to 717° per second) reduce cycle times and increase production output. For more information, refer to the manipulator manual that came with your system, refer to Section 1.3.

3.2 NX100 Controller

The NX100 robotic controller, shown in Figure 2, features a Windows® CE programming pendant with color touch screen, high-speed processing, built-in Ethernet, and a robust PC architecture. The NX100 easily handles multiple tasks and can control up to four robots (up to 36 axes, including robots and external axes), and I/O devices. Advanced Robot Motion (ARM) control provides high-performance path accuracy and vibration control.

The NX100 coordinates the operation of the PalletWorld® system. It controls manipulator movement, processes input and output signals, and provides the signals to operate the palletizing system. It maintains variable data and performs numeric processing to convert to and from different coordinate systems. In addition, the controller provides main logic functions, servo control, program and constant data memory, and power distribution. The NX100 controller features an embedded real-time operating system (RTOS) and is programmed with the Motoman INFORM programming language. For more information, refer to the NX100 controller manual that came with your system, refer to Section 1.3.
3.2.1 Programming Pendant

The Programming Pendant (see Figure 3) provides the primary means of programmer / operator interaction with the PalletWorld® system. The pendant features the Windows® CE operating system and displays information on a 6½ -inch, color LCD, touch-screen display. The pendant also incorporates a Compact Flash® card slot for program backups. The Programming Pendant provides icon-driven system programming. It also features a menu-driven interface to simplify operator interaction with the robots. Most operator controls are located on the Programming Pendant. By using the Programming Pendant, the operator can teach robot motion; perform programming, editing, maintenance, and diagnostic functions. For detailed information on the pendant programming keys, programming functions, and display functions, refer to the NX100 Operator’s Manual for Handling included with your PalletWorld® system documentation package (refer to Section 1.3).
Note: The Programming Pendant LCD touch screen display features a “screen saver” that causes the screen to go dark after a few minutes of inactivity. Press any key to restore screen.

Note: Operator Station “enable” or “disable” is accomplished with the Programming Pendant MODE SELECT SWITCH. To transfer control of the PalletWorld® system to the Operator Station, set the Programming Pendant MODE SELECT SWITCH to REMOTE.
3.3 **Product Infeed Conveyors**

The product infeed conveyors move product into the robot work area for palletizing. The line shaft conveyors use a 3/4 HP AC motor to drive a series of skewed rollers that position the product against a skated rail. Dual product escapements for product singulation and accumulation zones with brake modules provide for product sorting. Sensors located on the conveyors provide product detection and escapements. For infeed conveyor specifications, refer to Table 4.

*Note: The standard infeed conveyors are designed for boxed product only. Custom conveyors are required for palletizing bagged product.*

**Table 4 Infeed Conveyor Specifications**

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>3.66 m (12')</td>
</tr>
<tr>
<td>Width</td>
<td>609.6 mm (24&quot;)</td>
</tr>
<tr>
<td>Roller Height</td>
<td>762 mm (30&quot;)</td>
</tr>
<tr>
<td>Roller Diameter</td>
<td>48.26 mm on 76.2 mm centers</td>
</tr>
<tr>
<td>Speed</td>
<td>0.3302 m/s (65 FPM)</td>
</tr>
<tr>
<td>Humidity (maximum)</td>
<td>Non-condensing 10-90% relative humidity</td>
</tr>
<tr>
<td>Shock (maximum)</td>
<td>Less than 0.5 G</td>
</tr>
<tr>
<td>Electrical Requirements</td>
<td>460V AC/Three-Phase supplied by NX controller</td>
</tr>
<tr>
<td>Maximum Product Width</td>
<td>533.4 mm (21&quot;)</td>
</tr>
</tbody>
</table>

3.4 **Pallet Outfeed Conveyors**

The product outfeed conveyors move the final palletized product out of the robot work area. A 1 HP AC motor drives fifteen feet of chain driven live roller (CDLR) on the pallet conveyor. Sensors located on the conveyors provide pallet detection. For infeed conveyor specifications, refer to Table 5.

**Table 5 Outfeed Conveyor Specifications**

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>4.57 m (15')</td>
</tr>
<tr>
<td>Width</td>
<td>1.314 m (51.75&quot;)</td>
</tr>
<tr>
<td>Height</td>
<td>457 mm</td>
</tr>
<tr>
<td>Roller Diameter</td>
<td>63.5 mm on 152.4 mm centers</td>
</tr>
<tr>
<td>Speed</td>
<td>0.1524 m/s</td>
</tr>
<tr>
<td>Humidity (maximum)</td>
<td>Non-condensing 10-90% relative humidity</td>
</tr>
<tr>
<td>Shock (maximum)</td>
<td>Less than 0.5 G</td>
</tr>
<tr>
<td>Electrical Requirements</td>
<td>460V AC/Three-Phase supplied by NX controller</td>
</tr>
<tr>
<td>Maximum Pallet Width</td>
<td>1219.2 mm (48&quot;)</td>
</tr>
</tbody>
</table>
3.5 **Grippers**

Motoman offers several different grippers for use with the PalletWorld system. Depending on your application, one of the following grippers is best suited for your application.

3.5.1 **MotoGrip Case Gripper**

The MotoGrip Case Gripper with Pallet Grab is designed to pick and place cardboard boxes. The Pallet Grab module uses a mechanical scissoring action to pick up standard 42 x 48 or 48 x 48 in. GMA pallets. Refer to the MotoGrip Case Gripper manual (P/N 146702-1) for more detailed information about the MotoGrip Case Gripper.

3.5.2 **Bag Gripper**

The Bag Gripper uses a set of roller forks to slide under bags of product. Clamps are actuated to hold the bag in place while it is moved to the pallet. The product is then placed onto the pallet. Please refer to Appendix B for more specific information about the Pallet Gripper.

3.5.3 **Paddle Gripper**

The Paddle Gripper uses a clamping action to pick up boxes of product and place them on the pallet. A moving plate clamps the box against a fixed plate using enough force to pick up the box without causing damage. Please refer to Appendix C for more specific information about the Box Gripper.

3.5.4 **Pneumatic Valve Module**

The pneumatic module mounts on the upper arm of the robot arm and features Namatics 2012- Series pneumatics. Each module consists of a valve pack, robot interface cable with Turck block connection, and mounting plate.

3.6 **Safety Features**

The PalletWorld system incorporates a host of safety equipment. When all standard safety precautions are taken, the safety equipment helps to ensure safe operation of the robotic cell. The ANSI/RIA R15.06 Robot Safety Standard stipulates the user is responsible for safeguarding. Users are responsible for determining whether the provided safeguards are adequate for plant conditions. Users must also ensure that safeguards are maintained in working order.

*Note: PalletWorld® safety features are independent of program logic. All safeguards are “hard wired” and provide protection that is independent of any software program. System safeguards do not depend upon a programmer correctly inputting an instruction in the operating program.*

*Note: PalletWorld® system safeguards are interfaced with normally closed (NC) “fail-to-safe” switch contacts. These components will stop work cell operation if they are disconnected or damaged.*
Note: Users are responsible for determining that the safeguards provided with the PalletWorld® system are adequate for their plant conditions. Users must also ensure that all safeguards are maintained in working order.

3.6.1 Safety Fencing

The heavy-gauge steel mesh safety fencing provided with the PalletWorld® system is designed to enclose the entire robotic work cell. After installation, it forms a physical barrier that prevents the movement of personnel or objects into the work cell during automatic operation. An interlocked sliding door is part of the safety fencing, and provides an entrance for personnel at the rear of the work cell (refer to Section 3.6.1).

3.6.2 Emergency Stops (E-Stops)

E-Stop is a primary safety feature of the PalletWorld® system. A work cell access door interlock, robot impact (collision) detection circuitry, and E-Stop push buttons can all trigger an E-Stop condition. An E-Stop condition immediately de-energizes the control system and activates the robot braking system (refer to Section 3.6.4). The E-Stop push buttons are used for an intentional shutdown of the PalletWorld® system, and are installed at the following locations –

- Programming Pendant
- NX100
- Operator Station (option)

To resume operation after an E-Stop system shutdown, the operator must clear and reset the action that caused the E-Stop condition (refer to Section 5.4.2).

3.6.3 Programming Pendant ENABLE Switch

The ENABLE switch is part of the Programming Pendant, and provides a safety feature that controls servo power while the system is in TEACH mode (see Figure 3 and Figure 4). When pressed in, this switch allows the operator to enable servo power. However, should the operator release the switch or grasp it too tightly, servo power is immediately disabled, thus preventing further robot movement. For detailed information about the operation of the ENABLE switch, refer to the *NX100 Operator’s Manual for Handling* that is included with your PalletWorld® system documentation package (refer to Section 1.3).
3.6.4 Emergency Braking System

The robot incorporates a braking system that protects personnel from injury and prevents equipment damage if servo power is disabled. Upon loss of servo power, the brake system activates to hold all robot axes in place. The brake system incorporates a feature that allows the operator to release the brake of a specific robot axis upon loss of servo power. Brake release is accomplished with the Programming Pendant (refer to Section 5.3.3).

3.6.5 Interlocked Cell Doors

A safety interlock on all cell entrance doors prevents entry into the cell during PLAY mode. Opening a cell door with the robot in PLAY causes an E-Stop. Brakes are applied to the robot and all servo power is removed from the system. The system E-Stop lights come on.

3.6.6 Light Beacon

A three color light beacon indicates cell status. Red indicates the cell is down and needs immediate intervention. Yellow indicates the cell is operating but attention is required (i.e. pallet is full). Green indicates the cell is operating normally.

![Figure 5 Light Beacon](image-url)
3.7 Optional Equipment

3.7.1 Pallet Rack Assembly

The optional pallet rack orients stacks of pallets for robot pickup. Using a forklift or hand truck, the rack can be used to quickly replenish pallet stacks. The pallet rack is designed to work with the pallet locator. Mating pins are used to guide the pallet rack into correct position, while the pallet locator registers the cart in proper position.

3.7.2 Pallet Locator

The optional pallet locator can be used to position a single pallet for floor stacking or to dock a pallet rack. A diffuse sensor is provided to indicate that the pallet or rack is in position.

3.7.3 Slip Sheet Rack Assembly

The optional slip sheet rack orients a stack of slip sheets for robot pickup. The rack is designed to allow access for hand loading and robot pickup from three sides. A diffuse sensor can be mounted to detect low or empty stack. An optional air knife can be added to assist in separating the individual sheets.

3.7.4 Floor Pedestal Operator Station

The optional operator station is a NEMA enclosure on a stand-alone pedestal. Functions include: E-Stop, Hold, Alarm Reset, Servo Power, Ready signal light, Alarm indicator, and Job Start button. Dual infrared Cycle Start switches and thumbwheel switch are also included.

3.7.5 MotoPallet EG Software

MotoPallet EG is Motoman’s expert robotic palletizing software that works with MotoSim EG. MotoPallet was designed to help create and modify complete robotic palletizing systems. It features a palletizing library and wizard that allow users to rapidly model these systems. Layer patterns can be defined using drag and drop and arranged to create pallet loads in various configurations.
Chapter 4
Installation

CAUTION!
The PALLETWORLD® system should be installed by qualified personnel who are familiar with the installation and set-up of a robotic system.

CAUTION!
Handle all system components with care. The PALLETWORLD® system is not extremely fragile, but it is a sophisticated robotic system that can be damaged by rough handling.

Note: The customer shall supply all anchoring hardware for the PalletWorld® system. Please refer to Appendix A of this document for suggested anchoring hardware and foundation specifications.

Two to three qualified technicians can install the PalletWorld® system in a reasonable amount of time. Always comply with established safety procedures throughout installation process (refer to Chapter 2).

4.1 Required Materials

All system components and most of the materials and fasteners needed for installation of the PalletWorld® system are included with shipment from the factory. However, the customer must supply some required items and installation tools (refer to Section 4.1.1 and Section 4.1.2).

4.1.1 Customer-Supplied Items

- Local electrical service
- Earth ground wires for the robot and the NX100 controller
- Earth ground rods and/or buried copper sheeting (quantity and placement depth as required to achieve specified resistance-to-ground reading of 100 ohms or less)
- Chemical (optional) to increase conductivity of soil in the vicinity of the earth ground system
- Forklift(s) and/or overhead crane
- Special anchor bolts and drill bits (refer to Appendix A for suggested anchoring hardware)
4.1.2  Recommended Hand Tools and Equipment

<table>
<thead>
<tr>
<th>Safety glasses</th>
<th>Hammer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face shields</td>
<td>Socket set (SAE and Metric)</td>
</tr>
<tr>
<td>Gloves</td>
<td>Forklift and/or overhead crane</td>
</tr>
<tr>
<td>Level</td>
<td>Air-impact gun with 3/4-in. socket</td>
</tr>
<tr>
<td>Ratchet with 3/4-in. socket</td>
<td>Open-end wrench set (SAE and Metric)</td>
</tr>
<tr>
<td>Adjustable wrench set</td>
<td>“Allen” wrench set (SAE and Metric)</td>
</tr>
<tr>
<td>Hammer drill with appropriate concrete bits</td>
<td>Open-end wrench sets (SAE and Metric)</td>
</tr>
<tr>
<td>Phillips and flat screwdrivers</td>
<td></td>
</tr>
</tbody>
</table>

4.2  Site Preparation

**WARNING!**
During installation planning, allow sufficient room for access to the work cell door, optional Operator Station, and system components that are exterior to the work cell. Failure to observe this warning could result in injury to personnel during system operation and maintenance.

To prepare your site, proceed as follows:

1. Clear floor space and overhead area needed for the PalletWorld® system (refer to the drawings, schematics, and parts listing provided with your system). Allow an additional 1.2 - 1.5 m (4 to 5 ft) on all sides of the work cell to provide the clearance needed for installation.

2. Gather all customer-supplied items and required tools (refer to Section 4.1, "Required Materials").
Figure 6  PalletWorld® – Example Installation Dimensions and Component Locations (Plan View)

Figure 7  PalletWorld® – Example Installation Dimensions and Component Locations (Elevation View)
4.3 Removal of System Components from Shipping Skids

System components are attached to wooden shipping skids and/or wooden blocks at the factory, prior to shipment to the customer. The customer is responsible for removing the shipping skids and/or blocks and inspecting the components for shipping damage.

*Note: If you notice any equipment damage, notify your shipping contractor as soon as possible.*

1. Unbolt each component from its shipping skid or block using a ¾-inch socket (see Figure 8).
2. Use forklift(s) or overhead crane to lift each component away from its shipping skid.
3. Discard or recycle the shipping skids and other shipping materials.

![Figure 8](image)

**Figure 8** Removal of Typical Shipping Bolt

4.4 Component Installation

To make sure the PalletWorld® work cell is complete and to verify the correct amount of floor space for the installation, Motoman recommends that all system components be set in place prior to anchoring the components to the foundation. Refer to the system drawings supplied with your PalletWorld® system, to correctly place system components.

*Note: Refer to Appendix A for anchor bolt requirements.*
4.4.1 Place System Components

Before permanently anchoring the cell components to the floor, set all pieces in place in the following order –

1. Place the robot (with riser) in the specified location relative to fencing and conveyors (refer to system drawings supplied).
2. Place infeed and outfeed conveyors according to your system drawings.
3. Interconnect the safety fence panels and place them in position so that they enclose the work cell (refer to fence installation documentation and system drawings supplied).
4. Install the work cell sliding door to the safety fencing (refer to safety fencing documentation supplied).
5. Place the NX100 controller (see Figure 7 and your system drawings for the correct location).

Note: Do not place the NX100 controller any closer than 152.4 mm (6 in) to the work cell safety fencing.

4.5 Installing the Robot

The robot and riser are shipped on a wooden shipping skid. To install the robot, proceed as follows:

CAUTION! Handle PalletWorld components carefully to avoid damage.

1. Unbolt robot riser from wooden shipping skid using a 3/4 in. socket.

WARNING! Be sure your crane or forklift is capable of handling the riser or damage to equipment or injury to personnel can result.

1. Using a forklift, remove robot riser from wooden shipping skid.
3. Place robot riser in position according to system drawings. 

**Note:** Make sure there is adequate room on all sides of the riser for the fencing, infeed conveyors, outfeed conveyors, and NX controller.

4. Insert concrete drill bit through center of lag holes in riser base and drill holes for lag bolts (refer to Appendix A for anchor bolt recommendations).

5. Vacuum concrete dust from holes.

6. Lag robot riser securely to floor.

**WARNING!**
Always attach the lifting device to the robot before removing shipping bolts to prevent the robot from toppling.


   - The robot weighs 1750 kg. Be sure your crane or forklift is capable of handling this much weight or damage to equipment or injury to personnel can result.
   - Be sure to use a spreader bar to keep the chains from pulling against the robot assembly and damaging it.

8. Using a forklift, remove robot from wooden shipping skid.

9. Position robot over riser and carefully align mounting holes (see Figure 10).
10. Bolt robot securely to riser using hardware provided
11. Carefully remove protective plastic wrapping from robot.
12. Inspect robot for shipping damage.

Note: Notify your shipping contractor if you notice any shipping damage.
4.5.1 Removing the Shipping Bolts and Brackets

**CAUTION!**
Failure to remove shipping brackets from robot before operating the PalletWorld may result in damage to the robot drive mechanisms. Before turning ON the power, check to be sure that the shipping bolts and brackets have been removed. The shipping bolts and brackets must be stored for future use, in the event that the robot must be moved.

Three yellow brackets (see Figure 11) prevent the robot from moving during shipping. After the robot is in place, remove the shipping brackets.

![Figure 11 Location of Shipping Brackets](image-url)
4.6 Installing the Conveyors

The infeed product conveyors and outfeed pallet conveyors are shipped on a separate wooden shipping skid. To install the conveyors, proceed as follows:

1. Unbolt infeed conveyors from shipping skid using 3/4-in. socket.

**WARNING!**
Be sure your crane or forklift is capable of handling the conveyors or damage to the equipment or injury to personnel can result.

1. Using a forklift, lift infeed conveyors and remove from shipping skid.
2. Place infeed conveyors in position according to system drawings (approximately 1.5 m in front of robot).

**WARNING!**
Be sure your crane or forklift is capable of handling the conveyor weight or damage to the equipment or injury to personnel can result.

4. Using a forklift, lift outfeed conveyors and remove from shipping skid.
5. Place outfeed conveyors in position according to system drawings (approximately 1.5 m behind robot).

4.7 Installing the Fencing

The fencing that makes up the cell’s protective walls is shipped on its own skid, along with the hardware needed for installation, and specific assembly documentation (see Figure 6). Additional documentation is included in the “Read Me First” documentation packet, connected to the side of the controller. To install the cell fencing, proceed as follows:

6. Place fence components on floor around system. Refer to system prints shipped with your system.
7. Assemble fencing according to system prints.
8. Install cell doors.
9. Adjust door hangers until latching mechanism latches firmly and securely.
10. Make sure cell walls are square.
11. Drill into floor through center of fence feet for anchor bolts.
12. Vacuum concrete dust from holes.
13. Anchor cell walls to floor using stud anchors provided.
4.8 Installing the NX100 Controller

The NX100 controller is shipped in a separate wooden shipping crate. To install the NX controller, proceed as follows:

1. Unbolt controller from wooden shipping skid by removing four shipping bolts using 3/4-in. socket.

**WARNING!**
Be sure your crane or forklift is capable of handling the controller weight or damage to the equipment or injury to personnel can result.

2. Using a forklift, lift controller and remove it from wooden shipping skid.
3. Place controller base approximately 0.6 m in front of cell (see Figure 6).
4. Carefully remove plastic wrapping from controller.
5. Remove any accessories boxes from and set safely aside.
6. Inspect controller for any shipping damage.

*Note: Notify your shipping contractor if you notice any shipping damage.*

7. Drill into floor through center of controller feet for anchor bolts.
8. Vacuum concrete dust from holes.

4.9 Securing the Conveyors

After the conveyors are positioned correctly with the fence, anchor the conveyors to the floor. To anchor the conveyors, proceed as follows:

1. Drill into floor through center of conveyor feet for anchor bolts.
2. Vacuum concrete dust from holes.
3. Anchor conveyors to floor (refer to Appendix A for anchor bolt recommendations).
4.10 Cable Connections

After the PalletWorld® system components and peripherals are anchored in their correct locations, locate the interconnect cables for the system components and route them according to the system drawings and schematics included in the PalletWorld® system documentation package. All cables and connectors are labelled to ensure correct connection to the mating connectors on the applicable system component.

Note: A small gap of approximately 100 mm (4 in) exists between the bottom of the work cell safety fence and the floor. This gap provides a passage for cables that link components outside the work cell with those that are inside the work cell.

CAUTION!
Route wires and cables away from hazardous work areas to avoid wire breakage and unnecessary interruption of cell operation.

4.10.1 Connection to Earth Ground

WARNING!
Do not use the PalletWorld® system unless specified components are connected to a low-resistance earth ground. Do not connect the earth ground wire with the wires for the other high voltage equipment. The low-resistance earth ground must be a “dedicated” ground that is a direct connection between a component and the earth ground point. Operator injury or death, as well as equipment damage, can result from an inadequate or defective earth ground system.

The robot and NX100 controller must be connected to a low-resistance earth ground. If a ground stake is used, it should be driven at least 2.43 m (8 ft) into the soil. The soil surrounding the driven ground stake should be treated with a chemical that increases the soil conductivity in the vicinity of the driven ground stake. The earth ground may require more than a single driven ground rod, depending on soil conditions. Often, multiple ground rods (bonded together) or even a bonded network of buried copper sheeting (plus conduction-enhancing chemicals) may be required, depending on local soil condition. In any event, the “low-resistance earth ground” must indicate a resistance of 100 ohms or less (when measured directly between grounded equipment and the earth ground system). Specialized electronic measuring equipment is usually required to get an accurate “resistance-to-ground” reading. Consult a specialist in this field, if required.

Note: The customer shall supply all wires associated with the earth ground. The customer is responsible for establishing the correct gauge of all wires associated with the earth ground and maintaining an adequate earth ground (measured resistance of 100 ohms or less).

Connect the robot and NX100 controller to the earth ground as follows –

1. Connect one end of an earth ground wire to the lug marked EARTH GROUND on the connector panel of robot. Connect the other end of the earth ground wire to the low-resistance earth ground. See Figure 6 for location of robot.

2. Connect one end of an earth ground wire to the COMMON GROUND BUS BAR located inside NX100 controller. Connect the other end of the earth ground wire to the low-resistance earth ground.
4.10.2 Connecting the Robot Cables

Four cables, 1BC, 2BC, 3BC, and 4BC, connect the robot to the controller. The 1BC cable provides communication between the controller and the robot. The 2BC and 3BC cables supply power to the robot servo motors. The 4BC cable provides communication between the controller and the gripper. To connect the robot cables, proceed as follows:

1. Unpack programming pendant and plug connector into receptacle on right side of the controller.
2. Unpack two large black manipulator cables, connected to the controller, and route to back of robot.
3. Carefully engaging connectors, connect the four cables (labeled 1BC, 2BC, 3BC, and 4BC) to the 1BC, 2BC, 3BC, and 4BC connections on back of robot.

4.10.3 Connection to Local Electrical Service

**WARNING!**
Local electrical service connection to the PalletWorld® system must be performed by a qualified, licensed electrician. Electrical and grounding connections must comply with the National Electrical Code (NEC), as well as all local electrical codes.

Note: The PalletWorld® system is configured for 3-phase 460/480V AC primary power. For additional information, refer to the electrical drawings and schematics that are included with your system documentation package (refer to Section 1.3).

After all of the system components have been properly installed and interconnected, connect local electrical service to the NX100 controller (refer to Section 4.10.3.1).

4.10.3.1 NX100 Controller

For detailed electrical service interconnect procedures for the NX100 controller assembly, refer to the *NX100 Controller Manual* and PalletWorld® system drawings / schematics that are included with your system documentation package (refer to Section 1.3).

4.11 Safety/Operation Check

Before installing the tooling and fixtures for your application, take a few minutes to perform a safety/operation check:

1. Check that all three yellow shipping brackets have been removed from robot (see Section 4.5.1).
2. Check that cell door is closed and latched.
3. Check that all cable connections are tight.
4. Verify that local electrical service complies with the power requirements for your PalletWorld® system.
5. Verify that local electrical service is correctly wired into the NX100 controller.
CAUTION!
The PalletWorld® system is now ready for power-up. Qualified, trained personnel, who are familiar with this system, should perform the power-up sequence.

6. Rotate the POWER ON-OFF Switch on NX100 controller to ON (see Figure 2).

Note: An electrical service disconnect box for the NX100 controller assembly shall be supplied (if desired) by the customer. It is not part of the PalletWorld® system shipment.

WARNING!
Before operating the robots, verify that each E-Stop push button disables servo power when activated (pushed in). Each E-Stop push button must immediately stop robot and positioner movement when activated (pushed in).

7. Check for correct operation of all E-Stop push buttons (refer to Section 3.6.2).
8. Check for correct operation of the system HOLD button on the Programming Pendant.
9. Check for correct action of the work cell access door safety interlock.
10. Remove power from the PalletWorld® system after completion of the safety / operation check.
Chapter 5
Operation

CAUTION!

The customer is responsible for providing trained operators to run the equipment. The customer is also responsible for making sure that the equipment is operated in accordance with the ANSI/RIA R15.06-1999 Robot Safety standard, as well as any other local or state standards.

This chapter provides a brief overview of the operating procedures and precautions for your PalletWorld® system. For more detailed operating information, refer to specific component manuals that are part of the PalletWorld® system documentation package (refer to Section 1.3).

The PalletWorld is a fully integrated robotic palletizing cell. Product enters the cell via the incoming conveyors. The robot receives the signal that there is product present and begins placing product onto the pallet. Once the robot finishes this process, the finished pallet is sent out of the cell via the outgoing conveyors. The robot then begins the process again.

5.1 Programming

The operation of the PalletWorld® system is programming dependent. The following operating instructions are based on one possible configuration for this system. Your system configuration and job structure may differ slightly from that presented here; however, basic operation will be the same. For additional programming procedures and information, refer to the NX100 controller documentation that is included with your PalletWorld® system documentation package (refer to Section 1.3).

Any changes made to your system configuration or job structure will alter the operation of the system. Motoman recommends that you DO NOT modify the original jobs and system configuration of your PalletWorld® system. If you determine a need to modify the original jobs and system configuration, make any modifications to a copy of the original. Keep the original as a backup. Do not modify the original. Modifications must be performed by trained and experienced personnel who are familiar with the operation of the PalletWorld® system. If you have questions concerning the configuration of your system, please contact Motoman 24 hour Customer Support (refer to Section 1.4).
5.2 Daily Operation

The procedures below represent the typical operating sequence from power up to shutdown. Your basic operating procedures may vary depending on your situation.

- Perform start-up procedures (refer to Section 5.2.1).
- Move robot to Home position (refer to Section 5.2.2).
- Select Master Job (refer to Section 5.2.3).
- Perform operation cycle (refer to Section 5.2.4)
- Perform shutdown procedures (refer to Section 5.2.5)

5.2.1 Start-Up

To start up the PalletWorld® work cell from a power-off condition, proceed as follows –

Note: Electrical service disconnect boxes shall be supplied (if desired) by the customer. They are not part of the PalletWorld® system shipment.

1. Rotate the NX100 controller POWER ON-OFF switch to ON (see Figure 2).
2. Make sure that the work cell access door is closed and door safety interlock engaged.
3. Make sure all E-Stop push buttons are released. E-Stop push buttons are installed at the following locations –
   - Programming Pendant
   - NX100
   - Operator Station (option)
4. Select TEACH mode on the Programming Pendant.
5. Place robot in Home position (refer to Section 5.2.2).

5.2.2 Robot Home Position

To move the robot to the Home position –

1. Select TEACH mode on the Programming Pendant.
2. Select MAIN MENU on Programming Pendant touch screen.
4. Select SELECT JOB on Programming Pendant touch screen (a job list appears on the screen).
5. Use the navigation cursor key to move the cursor to R1 SAFE job and press SELECT (the job appears on the display screen).
6. Turn servo power ON by pressing SERVO ON and holding in the ENABLE switch.
7. Use the FWD button on Programming Pendant to jog robot (R1) to Home position.
5.2.3 Master Job

With the system powered up and in TEACH mode, call up the Master Job –
1. Select JOB on Programming Pendant touch screen.
2. Select CTRL MASTER on Programming Pendant touch screen. Press SELECT twice to activate the Master Job.
3. Select PLAY mode on Programming Pendant and press the PLAY ENABLE button on the NX100 controller door (job playback operation is enabled).
4. Press SERVO ON button on the Programming Pendant.
5. Press START button on Programming Pendant.

The PalletWorld® work cell is now ready for operation.

5.2.4 Operation Cycle

The following is the typical sequence of operation for the PalletWorld cell after start-up:
1. Load pallet locator or outfeed conveyor with pallets.
2. Begin loading incoming conveyor(s) with product.
3. Robot begins palletizing product.
4. Unload palletized product from outgoing conveyor or pallet locator.

5.2.5 Shutdown

Use the following procedure to perform a normal shut down of the PalletWorld® system –
1. Make sure the robot is in Home position.
2. Turn off system servo power by pressing the E-Stop button on operator station or programming pendant.
3. Select TEACH mode on the programming pendant.
4. Rotate NX100 controller POWER ON-OFF switch to OFF (see Figure 2).

The PalletWorld® system is now shut down.
5.3 System Recovery

Under certain conditions you will be required to clear an alarm or error. Clearing an alarm or error requires different operator actions depending on the type. The paragraphs below describe the different types of alarms and errors you may encounter and how to remedy them when you do.

5.3.1 Alarms and Errors

Alarms and errors will cause the program to stop. There are three levels of alarms and errors: Error Messages, Minor Alarms, and Major Alarms. For more detailed information about alarm recovery, refer to manipulator manual that came with your system.

Error Messages

These are simple errors such as pressing the START button when the robot is not in PLAY mode, or enabling the programming pendant without the servo power being live. Errors like these are cleared by pressing the CANCEL button on the programming pendant.

Minor Alarms

Minor alarms are usually programming errors. Minor alarms might occur if a circle has been programmed with fewer than three circular points, etc. These alarms are cleared by pressing the RESET (F5) soft key on the programming pendant.

Major Alarms

Major alarms are hardware failures. Major alarms might occur because of a servo tracking error or an abnormal speed and are usually associated with crashes. To clear these alarms, you must turn off the controller and then turn it on again.

5.3.2 E-Stop Recovery

An E-Stop can occur under any of the following conditions:

- Pressing the E-Stop button on the programming pendant, or playback panel.
- Opening sliding door on robot enclosure when robot is in PLAY mode.
- Actuating shock sensor on gripper mount.

To restart the PalletWorld cell after an E-Stop condition occurs, follow the procedure below.

1. To clear E-Stop condition, perform any of the following actions that apply:
   - Release the E-Stop button on programming pendant, or playback panel.
   - Close sliding door.

2. Press SERVO ON button on or playback panel.

3. Press START button on playback panel.

The PalletWorld cell is now ready to continue operation.
5.3.3 Brake Release

The robot braking system is designed to protect the robots and other system components from damage in the event of a system / robot failure or loss of drive power. If a system / robot failure or loss of drive power occurs, you must release the brakes on the affected robot in order to move it.

To release the brakes, proceed as follows –

**WARNING!**
Always support the robot axis to be released BEFORE you release it. Without adequate robot axis support, brake release could cause personal injury or machine damage.

1. On the Programming Pendant, select TEACH mode and turn servo power OFF.
2. Select ROBOT on the pendant display (touch) screen.
3. Select the BRAKE RELEASE option.
4. Use the CURSOR key to select desired robot axis for release.
5. Press and hold the pendant ENABLE switch in its middle position (see Figure 3 and Figure 6), while pressing the INTERLOCK key and the SELECT key.
6. The brake for the selected axis releases.
Appendix A
Anchoring

The customer shall determine all anchoring and foundation requirements, and supply the appropriate anchoring hardware and foundation for a particular system installation. Table A.1 gives anchoring and foundation suggestions.

Table A.1  Suggested Anchor, Floor Plate, and Foundation Specifications

<table>
<thead>
<tr>
<th>SYSTEM EQUIPMENT</th>
<th>MINIMUM HILTI® ANCHOR ROD DIA / TYPE</th>
<th>MINIMUM FLOOR PLATE</th>
<th>MINIMUM FOUNDATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROBOTS</td>
<td>1/2&quot; HVA Chemical Anchor (Note 3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP3JC, HP3, HP3C, HP3CL, HP3XF, HP5, HP5C</td>
<td>380 mm (15 in) Length 380 mm (15 in) Width 19 mm (0.7 in) Thick</td>
<td>381 mm (15.0 in) Length 381 mm (15.0 in) Width 76 mm (3.0 in) Thick 4000 psi Reinforced Concrete</td>
<td></td>
</tr>
<tr>
<td>ROBOTS</td>
<td>5/8&quot; HVA Chemical Anchor (Note 3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UP6, UP20 UP20-6, EA1400, EA1900</td>
<td>600 mm (24 in) Length 600 mm (24 in) Width 38.1 mm (1.5 in) Thick</td>
<td>762 mm (30.0 in) Length 762 mm (30.0 in) Width 178 mm (7.0 in) Thick 4000 psi Reinforced Concrete</td>
<td></td>
</tr>
<tr>
<td>ROBOTS</td>
<td>5/8&quot; HVA Chemical Anchor (Note 3)</td>
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<td></td>
</tr>
<tr>
<td>HP6, HP6S, HP6R, HP20, HP20-6, EA1400N, EA1900N, DX1350N</td>
<td>600 mm (24 in) Length 600 mm (24 in) Width 38.1 mm (1.5 in) Thick</td>
<td>762 mm (30.0 in) Length 762 mm (30.0 in) Width 178 mm (7.0 in) Thick 4000 psi Reinforced Concrete</td>
<td></td>
</tr>
<tr>
<td>ROBOTS</td>
<td>7/8&quot; HVA Chemical Anchor (Note 3)</td>
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<tr>
<td>UP20M, UP50 SP80</td>
<td>900 mm (35.4 in) Length 900 mm (35.4 in) Width 50.8 mm (2.0 in) Thick</td>
<td>1524 mm(60.0 in) Length 1524 mm(60.0 in) Width 229 mm (9.0 in) Thick 4000 psi Reinforced Concrete</td>
<td></td>
</tr>
<tr>
<td>ROBOTS</td>
<td>7/8&quot; HVA Chemical Anchor (Note 3)</td>
<td></td>
<td></td>
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<td>HP50, HP50-20, HP50-35, EPL80</td>
<td>900 mm (35.4 in) Length 900 mm (35.4 in) Width 50.8 mm (2.0 in) Thick</td>
<td>1524 mm(60.0 in) Length 1524 mm(60.0 in) Width 229 mm (9.0 in) Thick 4000 psi Reinforced Concrete</td>
<td></td>
</tr>
<tr>
<td>ROBOTS</td>
<td>7/8&quot; HVA Chemical Anchor (Note 3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UP120,UP130 UP160,SP100 SP160,SP250 SP400</td>
<td>1200 mm(47.2 in) Length 1200 mm(47.2 in) Width 50.8 mm (2.0 in) Thick</td>
<td>1828 mm(72.0 in) Length 1828 mm(72.0 in) Width 229 mm (9.0 in) Thick 4000 psi Reinforced Concrete</td>
<td></td>
</tr>
<tr>
<td>ROBOTS</td>
<td>7/8&quot; HVA Chemical Anchor (Note 3)</td>
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<td></td>
</tr>
<tr>
<td>HP165, HP165N-100, HP165R, ES165RN, ES165N, ES165N-100, EPL100, EPL160</td>
<td>1200 mm(47.2 in) Length 1200 mm(47.2 in) Width 50.8 mm (2.0 in) Thick</td>
<td>1828 mm(72.0 in) Length 1828 mm(72.0 in) Width 229 mm (9.0 in) Thick 4000 psi Reinforced Concrete</td>
<td></td>
</tr>
</tbody>
</table>
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<th>MINIMUM FLOOR PLATE</th>
<th>MINIMUM FOUNDATION</th>
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<tbody>
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<td>ROBOTS UP200</td>
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<td>(Note 3) (Note 5)</td>
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<td></td>
<td>(Note 6)</td>
<td>50.8 mm (2.0 in) Thick</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1828 mm(72.0 in) Length</td>
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<td></td>
<td></td>
<td>1828 mm(72.0 in) Width</td>
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<td></td>
<td>229 mm (9.0 in) Thick</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4000 psi Reinforced Concrete</td>
<td></td>
</tr>
<tr>
<td>ROBOTS HP200, ES200N, HP200T, HP200RN, ES200RN, EPL300(ES200RN, EPL300)</td>
<td>7/8&quot; HVA Chemical Anchor</td>
<td>1200 mm(47.2 in) Length</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Note 3) (Note 5)</td>
<td>1200 mm(47.2 in) Width</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Note 6)</td>
<td>50.8 mm (2.0 in) Thick</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1828 mm(72.0 in) Length</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1828 mm(72.0 in) Width</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>229 mm (9.0 in) Thick</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4000 psi Reinforced Concrete</td>
<td></td>
</tr>
<tr>
<td>ROBOTS UP350, UP500, SK300X</td>
<td>7/8&quot; HVA Chemical Anchor</td>
<td>1500 mm(59.1 in) Length</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Note 3) (Note 5)</td>
<td>1500 mm(59.1 in) Width</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Note 6)</td>
<td>50.8 mm (2.0 in) Thick</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1828 mm(72.0 in) Length</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1828 mm(72.0 in) Width</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>229 mm (9.0 in) Thick</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4000 psi Reinforced Concrete</td>
<td></td>
</tr>
<tr>
<td>ROBOTS HP350, HP350-200, HP500, HP600, EPL450, EPL500(HP350, HP350-200, HP500, HP600, EPL450, EPL500)</td>
<td>7/8&quot; HVA Chemical Anchor</td>
<td>1500 mm(59.1 in) Length</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Note 3) (Note 5)</td>
<td>1500 mm(59.1 in) Width</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Note 6)</td>
<td>50.8 mm (2.0 in) Thick</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1828 mm(72.0 in) Length</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1828 mm(72.0 in) Width</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>229 mm (9.0 in) Thick</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4000 psi Reinforced Concrete</td>
<td></td>
</tr>
<tr>
<td>POSITIONER Rotary Turntable Type</td>
<td>5/8&quot; HVA Chemical Anchor</td>
<td>Not Applicable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Note 3) (Note 5)</td>
<td>Refer to Applicable Positioner Manual</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Note 6)</td>
<td>Refer to Applicable Positioner Manual</td>
<td></td>
</tr>
<tr>
<td>POSITIONER ”Ferris wheel” type with headstock and tailstock (HS/TS)</td>
<td>7/8&quot; HVA Chemical Anchor</td>
<td>Not Applicable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Note 3) (Note 5)</td>
<td>Refer to Applicable Positioner Manual</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Note 6)</td>
<td>Refer to Applicable Positioner Manual</td>
<td></td>
</tr>
<tr>
<td>PERIPHERAL EQUIPMENT</td>
<td>1/2&quot; Kwik Bolt II Expansion Anchor</td>
<td>Not Applicable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Note 4) (Note 6)</td>
<td>3&quot; min thickness or 1.3 Embedment Depth (whichever is larger), 4000 psi Reinforced Concrete</td>
<td></td>
</tr>
<tr>
<td>WORK CELL FENCE POSTS</td>
<td>3/8&quot; Kwik Bolt II Expansion Anchor</td>
<td>Not Applicable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Note 4) (Note 6)</td>
<td>3&quot; min thickness or 1.3 Embedment Depth (whichever is larger), 4000 psi Reinforced Concrete</td>
<td></td>
</tr>
</tbody>
</table>

**Notes**

1. Minimum robot lagging requirements are based on Maximum Repulsion Forces and Hilti® Anchor Design Program (v3.3b).
2. SP and EPL series robots require base plates and/or risers to be level to ± 2°. Grout if necessary.
3. Reference source: Hilti® Product Technical Guide (section 4.2.1) for hardware specifications or equivalent.
4. Reference source: Hilti® Product Technical Guide (section 4.3.3) for hardware specifications or equivalent.
5. Cast-in anchors are specified in some robot manuals. The Hilti® HVA Chemical Anchors listed in this table can be substituted for the cast-in anchors.
6. Refer to Hilti® Product Technical Guide for suggestions on the correct size and type of drill bit to use with each anchor type.

---

**Contact Information**

1-800-879-8000 (USA)  [http://us.hilti.com](http://us.hilti.com)
1-800-363-4458 (CAN)  [http://ca.hilti.com](http://ca.hilti.com)
Appendix B

Bag Gripper

B.1 Introduction

The Bag Gripper and valve module assembly is a complete end-of-arm solution for the EPL160 robot. The gripper is designed to pick up bags from the product conveyor. The Bag gripper is designed to pick up bags with a mass up to 75 kg. The maximum bag size is 620 x 1000 x 250 mm (wd. x lg. x ht.). The minimum bag size is 420 x 400 x 120 mm. Each cylinder on the gripper has sensors to detect open and close position. The gripper also has a part present sensor.

Figure B.1 Bag Gripper
The valve module assembly consists of a valve pack, robot interface cable with Turck block connection, and a plate to mount the valves to the end of the robot arm. The pneumatic valve module consists of three dual pressure regulators with a double solenoid, detented, four-way, three-position valves.

### Table B.1 Bag Gripper Specifications

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available Lifting Capacity</td>
<td>68 kg total, excluding gripper</td>
</tr>
<tr>
<td>Bag Size Range</td>
<td>420 X 400 X 120 mm to 620 X 1000 X 250 mm (W x L x H)</td>
</tr>
</tbody>
</table>

### B.2 Installation

Installation of the Bag Gripper should be performed by either an approved integrator or personnel who have received the appropriate training from Motoman and who are familiar with the particular robot model. Motoman application technicians are available to help with the installation. For more Customer Service information refer to Section 1.4.

**CAUTION!**
Installation of the Bag Gripper is not a task for the novice. Handle components with care. Rough handling can damage components.

### B.2.1 Mounting the Bag Gripper

Installation of the bag gripper is typically completed before shipment at Motoman facilities. However, if installation is required, please use the following instructions.

1. Mount the valve pack to the front of the U-axis using (4) M8 bolts provided.
2. Align the bag gripper to the T-Axis of the robot using the two dowel pins and mount the gripper using M10 bolts (recommended torque: 4.10 kgf·m).

Figure B.2 Mounting the Bag Gripper
### B.2.2 Air and Cable Connections

*Note: Maximum pressure for air line is 784 kPa (8 kgf/cm²) or less. (air line inside diameter: 8 mm dia.)*

1. Connect air supply to A and B air inlet connections at base of robot.
2. Carefully engaging the connectors, connect the 4BC cable to the 4BC connection on back of robot.

![Figure B.3 Air Inlet Connections](image)

3. Locate the 4BC cable connection behind the valve pack.
4. Disconnect the 4BC cable connection and connect the 4BC valve cable assembly between.
5. Disconnect all exhaust ports.
6. Route A and B exhaust ports to the port 1 (two locations) ports on the valve pack.

![Figure 1 Valve Pack Connections](image)
7. Connect air line from Port 2 of Valve 1 to Port A Exhaust.
8. Connect air line from Port 4 of Valve 1 to Port B Exhaust.
9. Connect air line from Port 2 of Valve 2 to Port C Exhaust.
10. Connect air line from Port 4 of Valve 2 to Port D Exhaust.
11. Connect air line from Port 2 of Valve 3 to Port E Exhaust.
12. Connect air line from Port 4 of Valve 3 to Port F Exhaust.
13. Locate the 4BC cable connection and air ports on the back of the integrated wrist-axis, cable routing package.
14. Route the 4BC cable from the connector on the back of the integrated wrist-axis, cable routing package to the Turk block located on the gripper.
15. Route the airlines to the T-fittings located on the gripper.
16. Make certain all cables are safely routed and firmly connected.
B.3 Operation

The gripper fingers are designed to enter the side of the conveyor between the rollers to pick up the bags. Two stabilizing cylinders extend to the top of the bag to hold it in position while the robot is moving. Two side paddles grip the bag allowing the gripper fingers to rotate out of the way when the bag is placed on the pallet.

B.4 Maintenance

The following procedures should be performed only as needed. Read through the instructions completely before performing any maintenance procedure. Be sure that you understand the procedure, have the proper tools, and observe all applicable safety precautions. For more Customer Service information refer to Section 1.4.

<table>
<thead>
<tr>
<th>Table B.2 Periodic Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
</tr>
<tr>
<td>Weekly</td>
</tr>
<tr>
<td>Monthly</td>
</tr>
</tbody>
</table>
Appendix C

Paddle Gripper

C.1 Introduction

The Paddle gripper assembly is a complete end-of-arm solution for the EPL160 robot. The gripper is designed to pick up boxes from a product conveyor. The gripper uses a sliding paddle to grip boxes against a stationary paddle. The gripper is designed to pick up boxes with a mass up to 72 kg. The maximum box size is 13" X 18" X 16" (wd. x lg. x ht.). The minimum box size is 9" X 14" X 10". Each cylinder on the gripper has sensors to detect open and close position. The gripper also has a part present sensor. The cylinder control valve is mounted on the gripper. The valve is a double solenoid, detented, four-way, three-position valve.

Figure C.1 Box Gripper
Table C.1  Box Gripper Specifications

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available Lifting Capacity</td>
<td>60 kg total, excluding gripper</td>
</tr>
<tr>
<td>Box Size Range</td>
<td>9 x 14 x 8 in. up to 13 x 18 x 16 in.</td>
</tr>
</tbody>
</table>

C.2  Installation

Installation of the Box Gripper should be performed by either an approved integrator or personnel who have received the appropriate training from Motoman and who are familiar with the particular robot model. Motoman application technicians are available to help with the installation. For more Customer Service information refer to Section 1.4.

CAUTION!
Installation of the Box Gripper is not a task for the novice. Handle components with care. Rough handling can damage components.

C.2.1  Mounting the Box Gripper

The Bag Gripper is mounted to the T-axis of the manipulator using six M8 bolts (recommended torque: 4.10 kgfm).
C.3 Operation

The robot positions the Box Gripper over the product. The positioning plate pushes the bag onto the rollers. The robot then places the bag in position on the pallet. The positioning plate opens and the rollers push the bag onto the pallet.
C.4 Maintenance

The following procedures should be performed only as needed. Read through the instructions completely before performing any maintenance procedure. Be sure that you understand the procedure, have the proper tools, and observe all applicable safety precautions. For more Customer Service information refer to Section 1.4.

Table C.2 Periodic Maintenance

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Component</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>Vacuum generator filter</td>
<td>Check vacuum generator filter for contaminants and replace filter element as needed.</td>
</tr>
<tr>
<td>Weekly</td>
<td>Regulator filter</td>
<td>Check regulator filter for contaminants and replace as needed</td>
</tr>
<tr>
<td>Monthly</td>
<td>Sliding members</td>
<td>Apply a small amount of General Purpose grease to the sliding members as required for normal operation.</td>
</tr>
</tbody>
</table>
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