OMRON

HD-1500 Platform

User's Manual

Copyright Notice

Table of Contents

Chapter 1: Introduction

This manual is OMRON's Original instructions describing the setup, operation, and user maintenance of an HD-1500 Autonomous Mobile Robot (AMR).

This manual does not describe all configuration steps that you perform using the software supplied with an HD-1500. The *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* describes configuration, and use of the HD-1500.

1.1 Definitions

This document uses the following terms to describe the HD-1500:

AMR (Autonomous Mobile Robot): This term describes the HD-1500 with an attached **payload structure**, creating a complete **Mobile Robot**.

We use the term AMR when talking about controlling or monitoring the full mobile robot with attached payload structure.

Fleet Manager: The operational mode of the computing appliance (**EM2100 appliance**) that runs the FLOW Core software to control a fleet of AMRs.

Fleet Operations Workspace (FLOW): A computing system that consists of software and hardware packages, and is used to set up, integrate and manage a fleet of AMRs within a factory environment. FLOW consists of two main elements: **FLOW Core** and **FLOW iQ**.

FLOW Core: All of the software used by **Fleet Operations Workspace**. The software runs on the EM2100 appliance(s), the AMRs, and the user's PC.

FLOW iQ: A software package that captures, analyzes, and reports data to users in order to measure, evaluate and constantly improve their AMR fleet performance in the factory.

Fleet: Two or more AMRs operating in the same workspace.

HD-1500: This is the model name of the AMR platform. This document uses the model name HD-1500 when describing the setup, configuration, and connections.

Mobile Robot: An alternative industry term for AMR.

Payload Structure: Any passive or dynamic device attached to and possibly powered by the HD-1500. This could be as simple as a crate for carrying objects such as factory parts or as sophisticated as a robotic arm that picks up and manipulates factory parts.

Platform: The most basic part of the AMR. It includes:

- The chassis, drive assemblies, light discs, light strips, suspension, casters, battery and lasers.
- An on-board AMR controller with built-in Inertial Measurement Units (IMU), navigation software, data and power connectors for a **payload structure**.
- An Operator Panel.
- The HD-1500 skins (external covers), and the chassis where you attach a **payload structure**.

1.2 Product Description

The HD-1500 is a general-purpose mobile robot, designed to work in an indoor industrial environment and around trained personnel. It is self-guided and self-charging, with an automated charging station. It has a maximum capacity of 1500 kg. Capacity includes the payload structure and any load carried by that structure.

It's Electrostatic Discharge (ESD) drive wheels discharge any accumulated electrical charge in the AMR to ground which, if discharged into sensitive components of the AMR, could result in serious damage of those components.

CAUTION: PROPERTY DAMAGE RISK
The AMR skins can accumulate electrical charge which, if discharged into ESD sensitive devices, can cause damage to those devices.
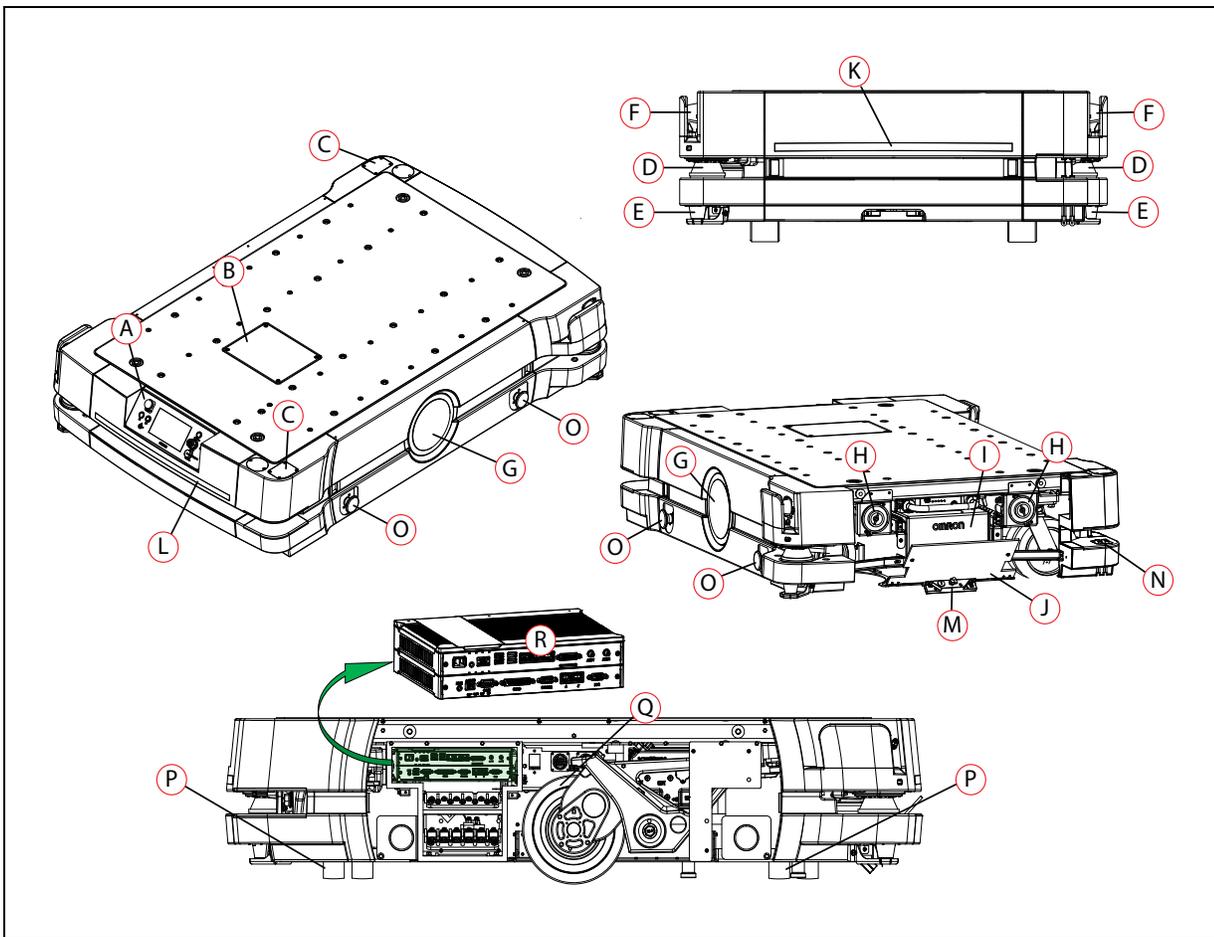
Figure 1-1. HD-1500 Platform Features

Callout	Description	Callout	Description
A	Operator Panel with E-Stop Button	K	Front Light Indication
B	User Access Panel	L	Back Light Indication
C	Wireless antenna x2	M	High-Accuracy Positioning System (HAPS) x2 - option
D	Safety Scanning Laser x2	N	Charging Contact x2 - top and bottom
E	Low Laser x2	O	E-stop Button x4 (two on each side)
F	Side Laser x2 - option	P	Front Caster x2, Rear Caster x2
G	Light Disc x2 - one on each side of the HD-1500	Q	Drive Wheel x2 - one on each side of the HD-1500
H	Speaker x2	R	AMR Controller
I	Battery		
J	Battery Door		
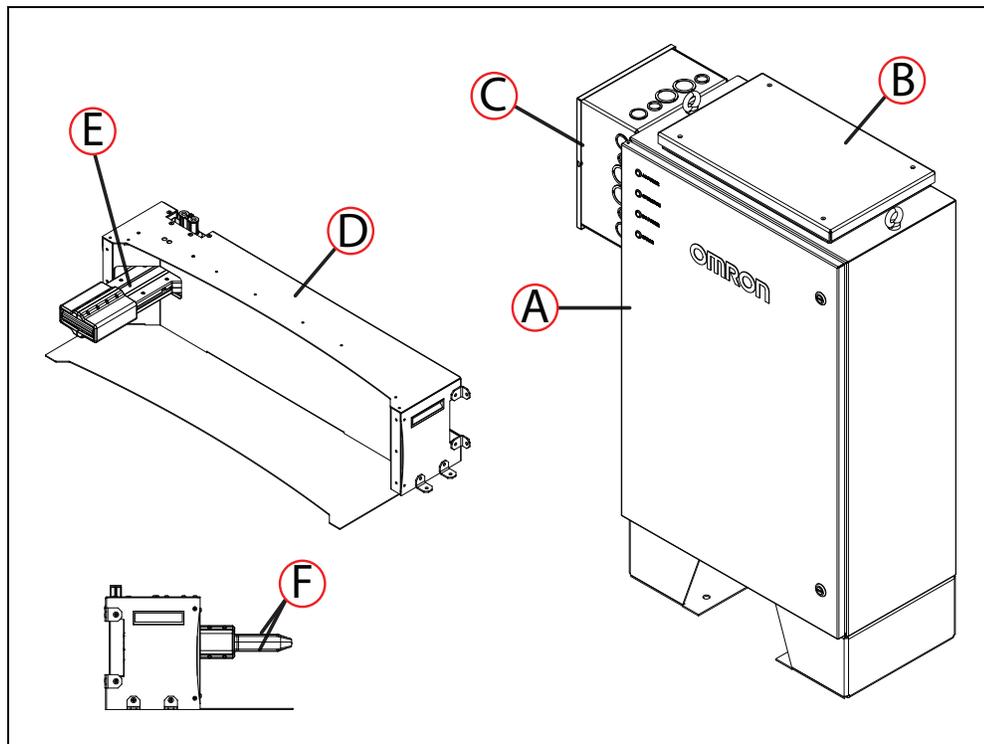
Figure 1-2. Charging Station Features

Callout	Description	Callout	Description
A	Power Supply Box	D	Docking Target
B	Cooling Duct Cover	E	Charging Paddle
C	Electrician Access Box	F	Charging Pads x2 - top and bottom

HD-1500 Autonomous Navigation

The HD-1500 combines hardware and mobile-robotics software to provide an adaptive, mobile-platform to transport your payload. The HD-1500 is equipped with Natural Feature Navigation system which enables the AMR to navigate, and perform its basic functions independently and without the need for facility modification. After it scans physical features in its environment, the HD-1500 navigates safely and autonomously to any accessible destination. It can move continuously and without human intervention, autonomously recharging itself as necessary.

The HD-1500 uses range data from a Safety Scanning Laser as its primary means of detecting obstacles and of maintaining an accurate understanding of its location in the environment. Additionally, it uses data from the following sensors:

- Two low lasers at the opposing corners of the AMR platform to detect objects below the plane of the Safety Scanning Lasers.

- Gyroscopes that detect and report HD-1500 rotational velocity.

- Two encoders on each drive motor provide information on the distance traveled by each drive wheel.

HD-1500 Localization

The encoders provide the navigation system with information on how far each wheel has traveled, and in which direction. In addition, the Gyroscopes track the AMR's rotational velocity. The encoder information, combined with gyroscope data, is used to deduce the odometry.

The AMR analyzes this odometry data together with the data received from the safety scanning lasers, low lasers, and the side lasers to calculate its position within the map. This process is called *localization*.

Custom Payload Structures

For most applications, you will want to customize the platform with a payload structure, attached to the top of the platform, for some combination of picking up, transporting, and dropping off your payload or material. The HD-1500 provides threaded mounting holes for payload attachment. The mounting holes provide a strong and adaptable method of attaching payload structures to the chassis. A payload structure can be as simple as a crate that contains manufacturing parts or a more sophisticated device such as a conveyor or robot arm. For more information on designing a payload structure, see: Payload Structures on page 136.

The platform also provides a variety of interfaces and power connections to support your application-specific sensors and accessories. For more information on available user connectors, see: Connectivity on page 150.

Body and Drive Train

The HD-1500 is a differential-drive AMR. It has two drive-wheels, and passive swivel-casters at its front and rear for balance. The drive-wheels are mounted on the rocker arms, and have solid polyurethane tread. Refer to the following figure for more information.

This drive style makes the HD-1500 highly maneuverable and allows it to rotate in place.
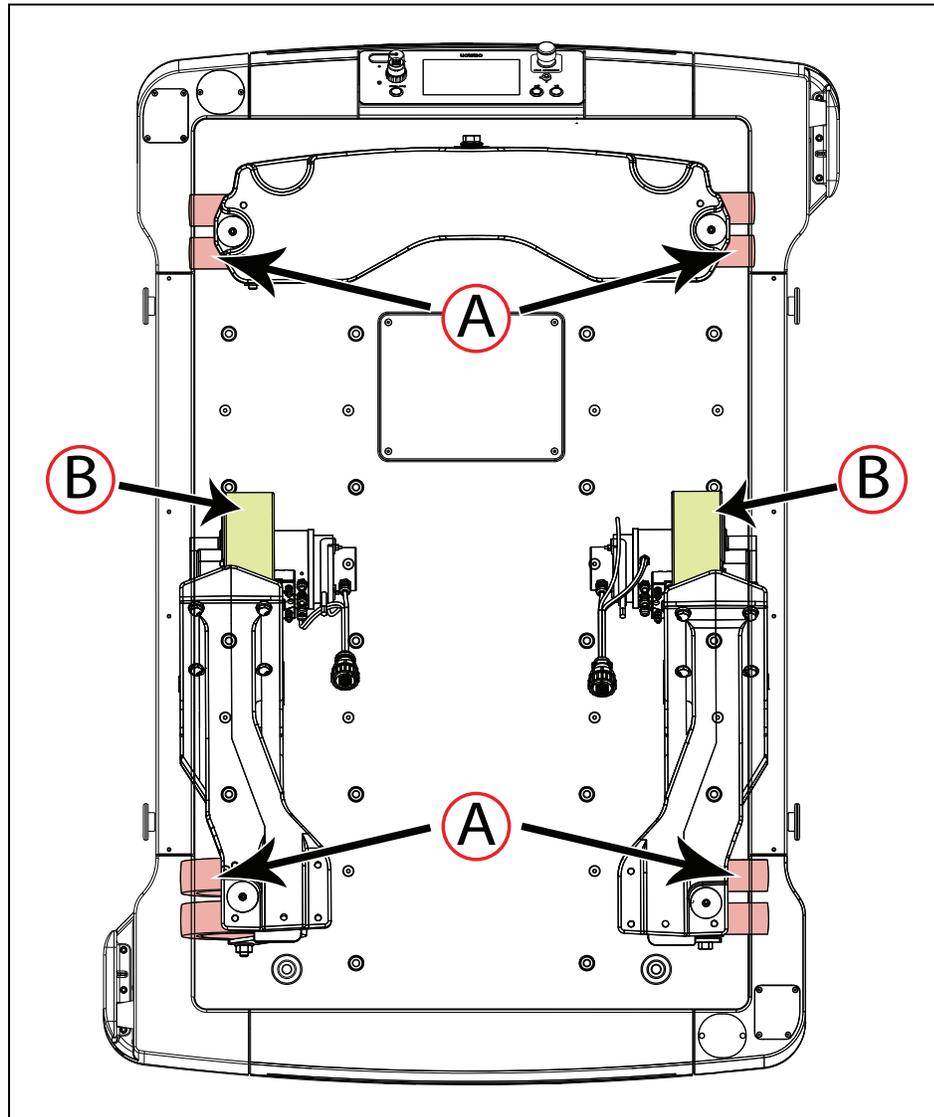
Figure 1-3. HD-1500 Drive Train - Top View, (A) Casters, and (B) Drive Wheels

Each front caster is mounted to the same rocker arm as one of the drive-wheels. The two rear casters are connected by another rocker that pivots about the AMR's longitudinal center-line. This arrangement allows the AMR to maintain contact with the floor over uneven areas or bumps, which benefits both traction and stability. Refer to the following figure for more information.
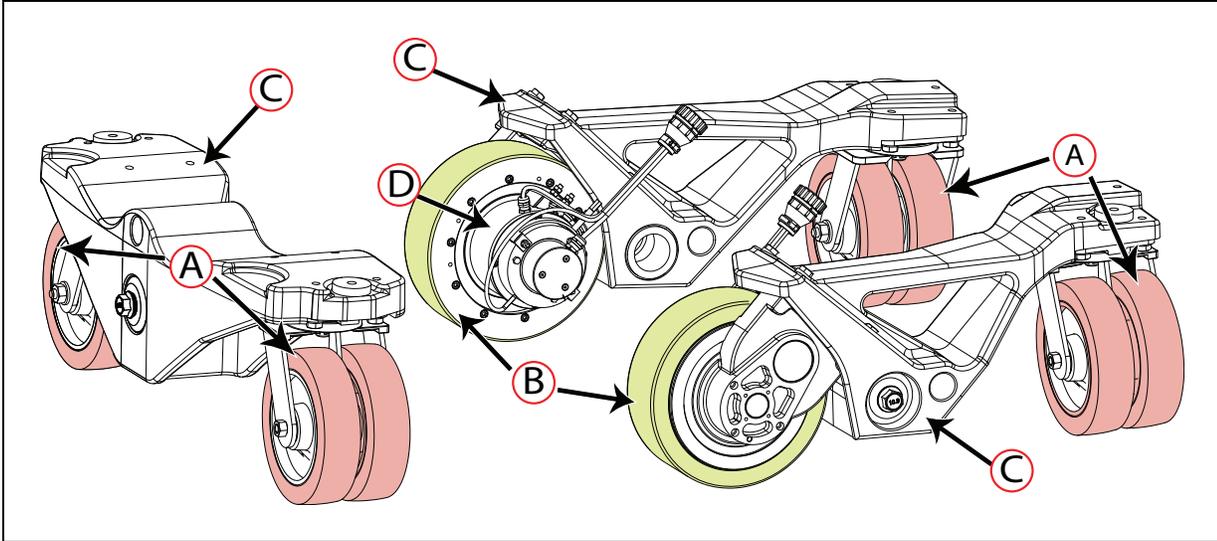
Figure 1-4. HD-1500 Drive Train (A) Casters, (B) Drive Wheels, (C) Rocker Arms, and (D) Drive Motor (one on each drive wheel)

What's Included - Basic Components

One fully-assembled HD-1500Platform which includes:

- Two OMRON OS32C Safety Scanning Lasers (main lasers).

- Two low lasers.

- Differential drive train.

- Skins.

- AMR Controller which includes:

  - A computing appliance that runs the SetNetGo operating system and the Advanced Robotics Automation Management (ARAM) software.

  - A system that runs a variant of the Mobile Autonomous Robot Controller (MARC), called Polo.
    The AMR Controller comes pre-loaded with ARAM and Polo firmware, and the SetNetGo OS. The AMR Controller is housed inside the platform as displayed in the following figure.
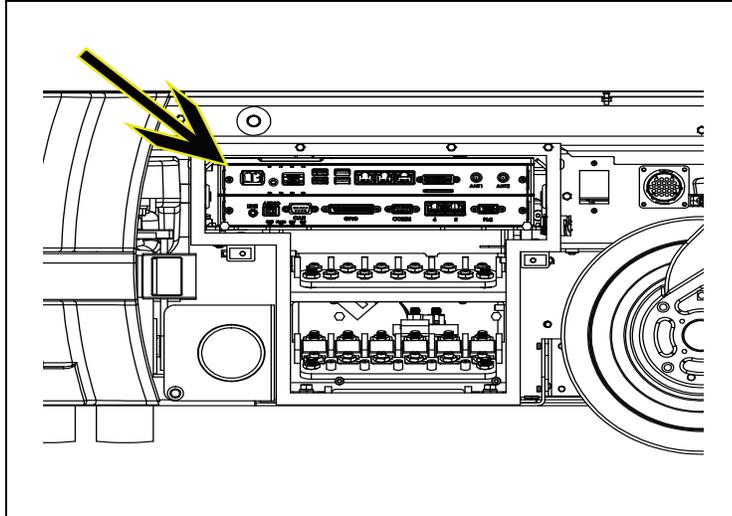
Figure 1-5. AMR Controller in the Platform

- ○ Other sensors including inertial sensing for use with AMR controls.

- One battery
  Shipped separately from the platform to comply with dangerous goods shipping regulations.

- Five emergency stop (E-Stop) buttons:
    - ○ One on the Operator Panel
    - ○ Two on each side of the platform

- Operator Panel
  The Operator Panel includes a screen, an E-Stop button, ON and OFF buttons, a brake release button, pendant port, Maintenance Ethernet connection, and a keyswitch (which you can lock ( ), or unlock ( ), and remove the key). When locked, the keyswitch disables the OFF button and prevents the AMR from getting turned off, accidentally, during the operation.
  You can move the operator panel to any preferred position on your payload structure. However, because the operator panel contains one of the five E-Stop buttons, there are important safety considerations when relocating or removing this panel. See: Positioning an Optional Payload E-Stop on page 197.

  For information on the dimensions of the Operator Panel, see: Operator Panel on the Payload on page 147.
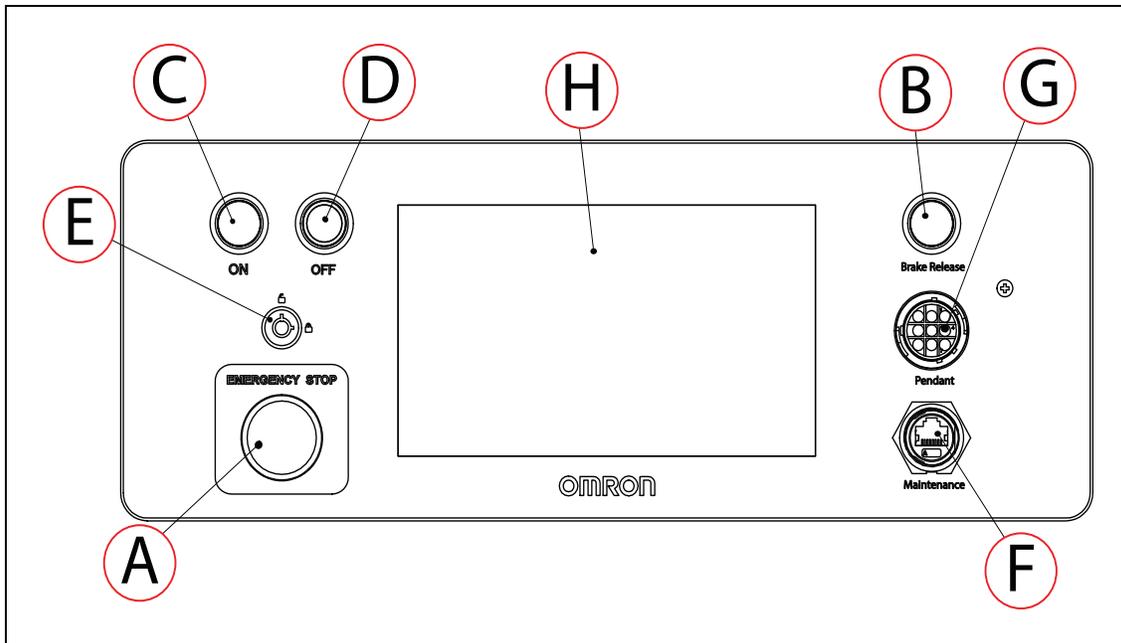
Figure 1-6. Operator Panel

Callout	Description	Callout	Description
A	Emergency Stop (E-Stop)	E	Keyswitch
B	Brake Release Button	F	Ethernet Connection
C	On Button	G	Pendant Connection
D	Off Button	H	Display Screen

- Automated charging station
  The automated charging station enables the HD-1500 to charge itself, without user inter-vention. It includes wall and floor mount brackets, for a choice of installation methods. See: Installing the Charging Station on page 110.
  The charging cord that connects the Power Supply box to the Docking Target which can also be used for charging a battery outside of the platform. See: Manually Charging the AMR's Battery on page 191.

- A USB flash drive containing software and documentation.

In addition to the items included with every HD-1500, you need at least one pendant per AMR fleet. Use this pendant to manually drive the HD-1500 and to create a digitized map of the work environment.

For a fleet of AMRs, the Fleet Operations Workspace Core (FLOW Core) software (running on an EM2100 appliance) shares the map between all AMRs in the fleet. This provides a common frame of reference for navigation and localization, preventing contention between AMRs.

Figure 1-8. and Figure 1-9. display the location of the pendant, and the Ethernet ports on the Operator Panel, installed on the rear of the HD-1500.
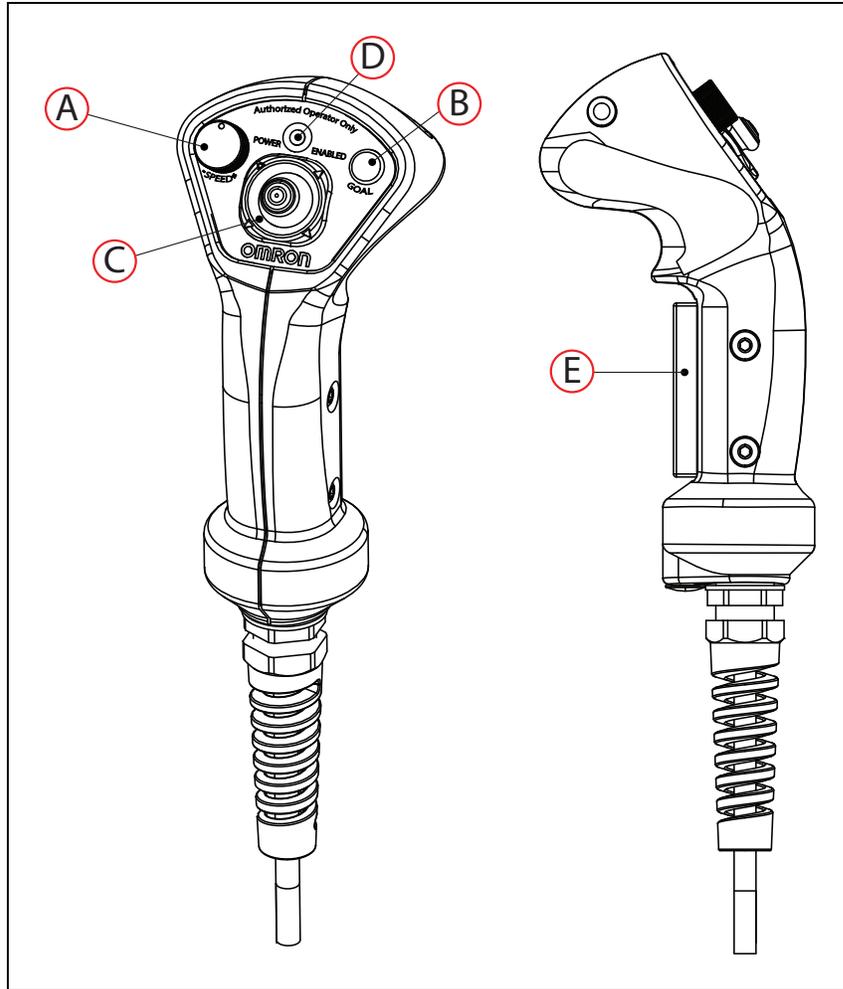
Figure 1-7. Pendant Controls

This is used for manually controlling the platform, mostly when making a scan to be used for generating a map.

Callout	Control Function	Callout	Control Function
A	Speed control	D	Power indicator LED
B	Goal button	E	Trigger switch Three-position enabling device
C	Directional control stick		
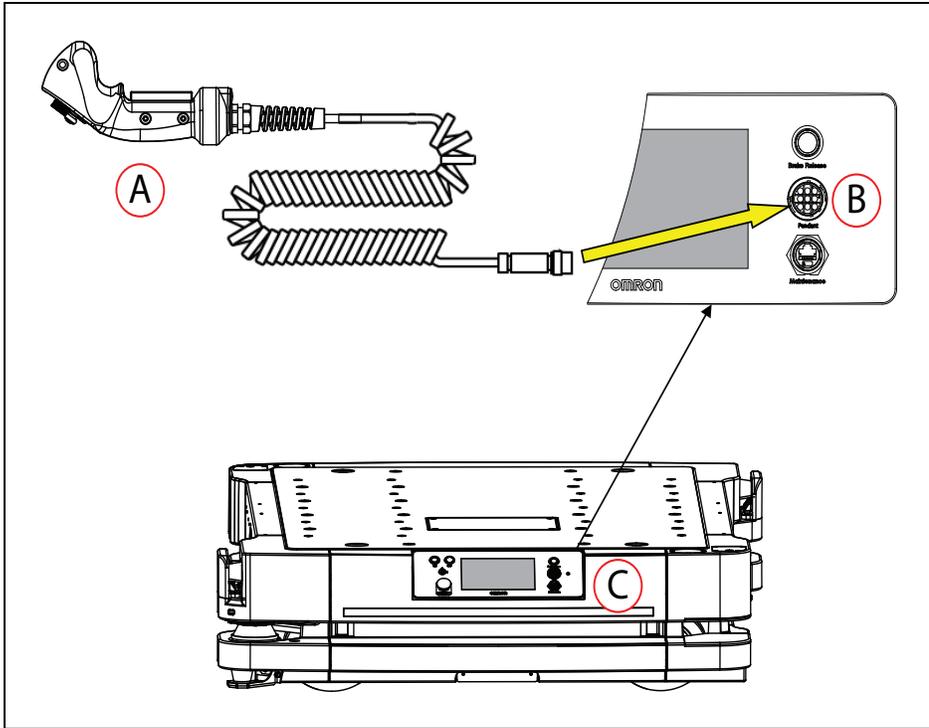
Figure 1-8. (A) Pendant, (B) Pendant port on the Operator Panel, and (C) Operator Panel Location on the HD-1500
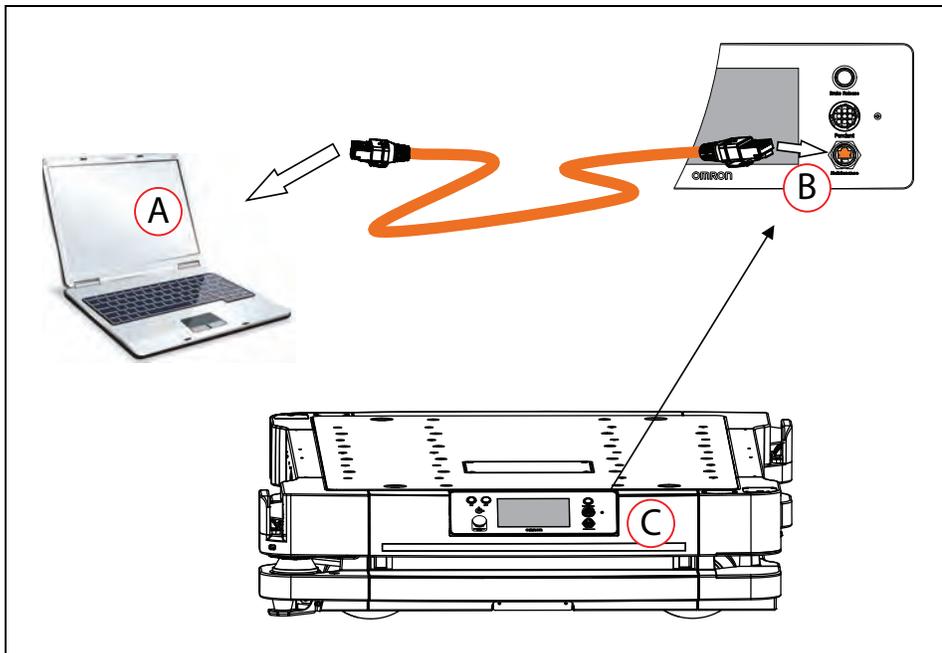
Figure 1-9. (A) PC, (B) Maintenance Ethernet Port on the Operator Panel, and (C) Operator Panel on the HD-1500

Optional Features and Components (Partial List)

Several additional options and features are available for the HD-1500. See: Options on page 268.

- **Fleet Manager**

  This system manages a fleet of AMRs, for multi-AMR coordination and job management. It includes the EM2100 appliance running the Fleet Operations Workspace software (FLOW).

- **Spare battery**

  While the HD-1500 offers an excellent recharge time, you can use a spare battery to further increase the productivity by manually exchanging an AMR's battery instead of allowing it to charge itself automatically.

- **High-Accuracy Positioning System (HAPS)**

  HAPS allows an AMR to achieve accurate alignment at a specific location, such as a fixed conveyor, using a sensor to detect magnetic tape on the floor at that location.

Options for Enhancing Your Payload Structures

- **Side Lasers**

  Side Lasers scan the vertical plane on each side of the AMR. These lasers detect obstacles that are outside the scanning plane of the Safety Scanning Lasers. There are standard mounting locations for the side lasers at opposite corners of the HD-1500, above each safety scanning laser. You may also install the side lasers in a custom location of your choice if your payload structure obstructs the side lasers' field of view in the standard location.

1.3 Software Overview

Your HD-1500 requires the licensed software described in this section. Software is factory-installed on its AMR Controller.

Access to software features is permitted by use of a USB license dongle that contains secure, encrypted electronic copies of the operating licenses. Some licenses might have a restricted term and expire after a specific date. You will receive several warning alerts before the license expires.

HD-1500 Software

The minimal operating configuration for an HD-1500 consists of the AMR managed by a human operator using a Microsoft Windows® PC or optionally from an Android or iOS tablet.

If you have more than one AMR, you must install and configure an EM2100 appliance (running the Fleet Operations Workspace software) to manage multiple AMRs as a fleet. Fleet management prevents job contention or collisions between AMRs and provides efficient processing of all tasks that you assign to the AMR fleet.

See the following documents for detailed information:

- *Enterprise Manager 2100 User's Guide (Cat. No. I631)*

- *Fleet Operations Workspace Core User's Manual (Cat. No. I635)*

Figure 1-10. shows the devices that you might use to manage one or more AMRs and the software components required for each device, if applicable.
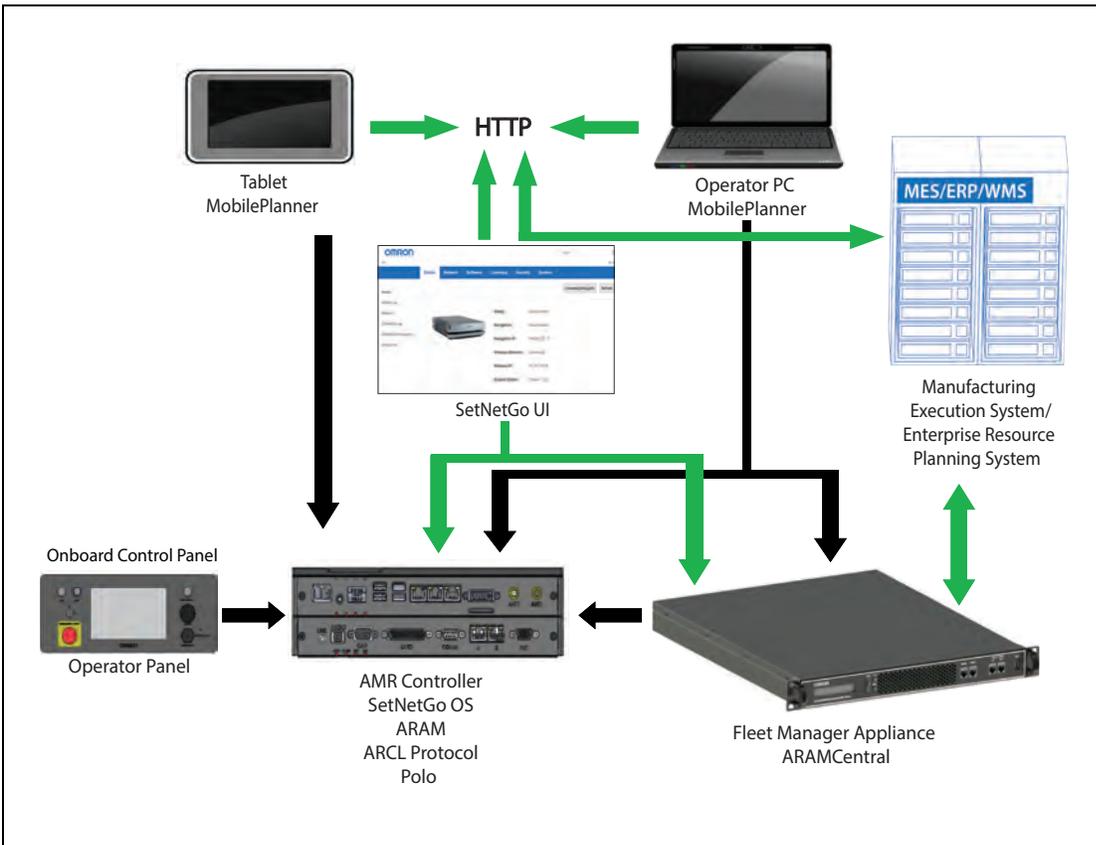
Figure 1-10. Devices and Software in the AMR's Operating Configuration

AMR administration includes both configuring and operating an AMR and also using the AMR (or a fleet of AMRs) to perform useful work. The software that enables you to do this management consists of:

- The FLOW Core software, an integrated set of programs that run on different devices in the environment (FLOW Core). You use the MobilePlanner or MobilePlanner Tablet graphical interfaces to manage individual AMRs or fleets of AMRs. You can also access lower-level functions through a command-line interface, ARCL. The Integration Toolkit (ITK) can also be used to interface your MES or WMS system with the Fleet Manager.

- The SetNetGo OS, a host operating system (OS) that provides a Web interface you use to assign network addresses, perform configuration, upgrade software, and obtain debugging files.

User-Supplied Components and System Requirements

To configure and manage an HD-1500 you require a personal computer (PC) running a supported version of Microsoft Windows®. The PC requires:

- 200 megabytes of available hard-disk storage.

- Ethernet connection. OMRON recommends that you use a stable and high-speed

wireless connection.

> **Additional Information**: Wireless is a requirement for managing multiple AMRs as a fleet. See: *Fleet Operations Workspace Core User's Manual (Cat. No. I635).*

Also, you may optionally use an Android or iOS tablet to run the MobilePlanner Tablet software.

ARAM

The Advanced Robotics Automation Management software (ARAM) runs on the AMR Controller. ARAM is responsible for the following AMR functions and features:

- Interaction with on-board sensors such as the safety scanning lasers, low lasers, and optional side lasers.

- High-level, autonomous robotics functions such as:

    ○ Obstacle avoidance

    ○ Path planning

    ○ Localization

    ○ Navigation

- Motion commands to the Polo firmware.

- Battery management.

ARAM provides the AMR with an interface to external entities by managing the following:

- Wired and wireless Ethernet communications with external software for external monitoring, development, and systems coordination.

- Fleet coordination of AMRs through the optional Fleet Manager.

- Integration with other systems.

- External monitoring, setup, and control via the MobilePlanner graphical interface.

- Digital and analog I/O ports accessible from the user access panel that enable you to integrate application-specific sensors and effectors into your payload structure. Refer to Fleet Operations Workspace Core User's Manual (Cat. No. I635) for instructions on how to configure I/O connections.

ARAMCentral

ARAMCentral runs on the Fleet Manager as part of the Fleet Operations Workspace software. When managing a fleet, the ARAMCentral software does the following:

- Stores and distributes:

    ○ The shared workspace map used by all AMRs in a fleet.

    ○ The common AMR configuration.

- Controls AMR traffic, including:

- Multi-AMR avoidance

- AMR Destinations

- AMR Standby

- Charging dock access

- Queuing of jobs

- Remote I/O (if used)

MobilePlanner Administrator Mode

MobilePlanner is part of the Fleet Operations Workspace software and runs on the user's PC, or as a portable tablet version (on Android and iOS tablets). It provides a tabbed graphical user interface on the PC and a touchscreen interface on tablets. Depending on your level of access (controlled by your account) the graphical interface provides many options, including:

- Managing AMR fleet jobs.

- Creating and editing workspace maps.

- Accessing the AMR through the SetNetGo Web interface.

- Commissioning and configuring an AMR and modifying its configuration by changing ARAM parameters.

- Issuing custom ARCL commands.

Operator access or View access restricts the tasks that you can perform when using MobilePlanner.

Before you assign tasks to an AMR, you use MobilePlanner to create and edit a digitized map of its work space. During this procedure, you use the pendant to drive the AMR around the workspace. In mapping mode, the safety scanning laser scans features of the workspace, such as walls, columns, doorways and corners. After you create the map, you open it in MobilePlanner and edit it to add or remove features. For example, if there is an area of the map where you want the AMR to follow a specific path, you can draw a *PreferredLine* feature on the map. Be aware that the AMR will deviate from the *PreferredLine* if an obstacle enters its path.

You then use MobilePlanner to configure ARAM operating parameters that control the AMR's operation in the mapped workspace. For example, you might assign a preferred charging Station (docking target) to the AMR or the Fleet Manager by specifying the unique map identifier for that docking target. This configuration can be shared with identically-equipped AMRs in your fleet. The map generated by one AMR can be shared across a fleet, with both identical and non-identical OMRON AMRs.

Refer to the separate *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for instructions about mapping a workspace and preparing the virtual elements, goals, routes, and tasks for your application. In particular, refer to the descriptions of the following software options:

- Working With Map Files - Editing a Map File

- Using the Drawing Tools - Adding Goals and Docks

MobilePlanner, Operator Mode

MobilePlanner can operate in a restricted Operator mode that permits only limited access to user interface features and functions.

MobilePlanner's Operator Mode allows you to monitor one or more AMR's activities and assign tasks in the mapped space. For more information, see: *Fleet Operations Workspace Core User's Manual (Cat. No. I635).*

Polo

The AMR Controller contains a powerful multi-processor that runs the Polo firmware.

This firmware controls low-level AMR functions, including:

- Maintaining the AMR's driving speed and heading (direction of travel).
- Acquiring sensor data from the encoders, and internal orientation sensors.
- Reading emergency stop (E-Stop) status to enable and disable the drive motors.
- Reading pendant input.
- Computing and reporting the AMR's odometry (the change in X, Y coordinates and the heading) and other low-level operating conditions to the ARAM software.

ARCL Protocol

The Advanced Robotics Command Language (ARCL) is a programming language integrated into ARAM and ARAMCentral. Its operating format is a text-based command and response server. Use ARCL to integrate an AMR (or fleet of AMRs) into an external automation system. You do not need access to MobilePlanner to use ARCL.

Typical uses of ARCL are:

- Operating and monitoring the AMR.
- Operating accessories and peripherals.
- Sending commands to your payload structure.

For more information, See: *Advanced Robotics Command Language Reference Guide*.

SetNetGo

The SetNetGo OS runs on the AMR Controller and EM2100 appliance. It is the host OS in which the FLOW components ARAM and ARAMCentral run. SetNetGo has a Web interface that you access either from a Web browser or from within MobilePlanner as a tab. After you use a wired Ethernet connection to configure the AMR's wireless settings you may choose to enable wireless access to SetNetGo from the web interface's Security tab.

To access the SetNetGo web interface, at a minimum, you need:

- A hardwired connection to the HD-1500 Maintenance Ethernet port, located on the Operator panel.
- A LAN connection or direct Ethernet port connection to the EM2100 maintenance port.

Your IT department can use SetNetGo to configure network settings without using MobilePlanner.

Use SetNetGo to configure Ethernet settings, upgrade software, or perform diagnostics such as retrieving log files.

1.4 How Can I Get Help?

Refer to the OMRON corporate website: http://www.ia.omron.com.

Related Manuals

This manual covers the installation, setup, operation, and maintenance of an HD-1500. There are additional manuals that cover configuring the platform. See the following table. These manuals are available on the USB flash drive delivered with your HD-1500.

Table 1-1. Related Manuals

Manual Title	Description
Mobile Robot HD Safety Manual (Cat. No. I647)	Contains general safety information for all OMRON HD-1500-based AMRs.
HD Platform Peripherals User's Manual (Cat. No. I646)	Covers peripherals, such as the , Side Lasers, HAPS, and Acuity Localization options.
Safety Laser Scanner OS32C Series User's Manual (Cat. No. Z296-E1)	Describes the use of the OS32C laser.
Fleet Operations Workspace Core User's Manual (Cat. No. I635)	Describes Fleet management, MobilePlanner software, the SetNetGo OS, and most of the configuration procedures for an HD-1500.
Enterprise Manager 2100 User's Guide (Cat. No. I631)	Describes the installation of an EM2100 appliance, which runs the Fleet Operations Workspace software to manage a fleet of AMRs.
Fleet Simulator User's Manual (Cat. No. I649)	Describes the configuration and use of the Fleet Simulator software on an EM2100 appliance.
Fleet Operation Workspace Core Integration Toolkit User's Guide (Cat. No. I637)	Contains information that is necessary to use the Integration Toolkit facilitating integration between the Fleet Manager and the end user's client application.
Advanced Robotics Command Language Enterprise Manager Integration Guide (Cat. No. I618)	Describes how to use the Advanced Robotics Command Language (ARCL) a text-based, command line operating language Use ARCL to integrate a fleet of AMRs with an external automation system.

Support

Contact your OMRON representative if you have further inquiries with your HD-1500 that are not described in this manual.

When you contact support, it is useful to provide a DebugInfo file. This is a collection of con-figuration, log, and system status files that support personnel can use for debugging and troubleshooting.

Visit the OMRON Web site for your locale to obtain local support telephone numbers and information.

Download a Debuginfo File for Support

You can download a debuginfo file for troubleshooting problems or if you need to contact your OMRON representative.

If your HD-1500 is already configured to use a wireless network:

1. Open MobilePlanner and connect to the AMR's IP address.

2. Click the SetNetGo tab to open its Web Interface.

3. Click **Status** and select **Debug Info** from the left pane.

4. Click **Download Debug Info** and then specify a location to save the file.

Otherwise, you must first create a TCP/IP connection to the AMR's Maintenance Ethernet port as described in: Network Setup on page 26.

Network Setup

If you have not configured your HD-1500 for access over a wireless network, you must follow the instructions provided in Maintenance Ethernet Connection on page 124. This is when you use a hardwired connection to the HD-1500 Maintenance Ethernet port.

Obtain a DebugInfo File from SetNetGo

After you access SetNetGo as described in the preceding sections, you will see the following screen:
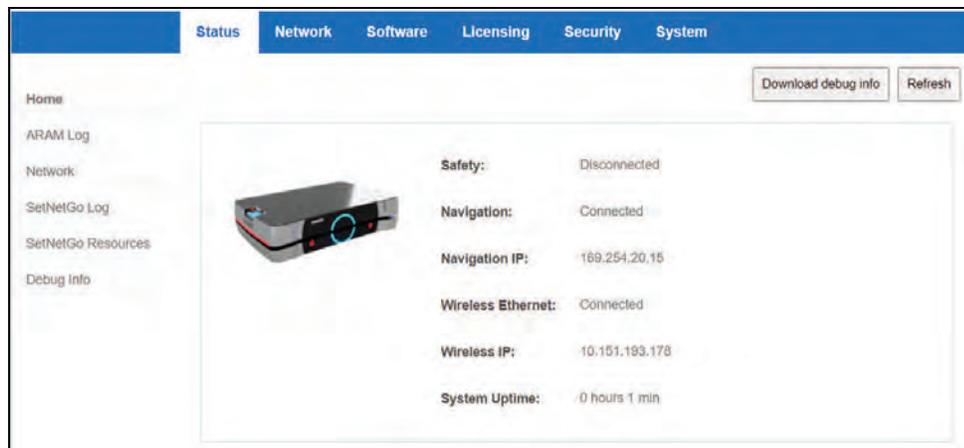
Figure 1-11. SetNetGo Status Tab

1. In the SetNetGo screen, click the **Status** tab and then select **Debug Info** to activate the **Download debug info** button.

2. Click **Download debug info**.

3. When prompted, save the downloaded file, and attach it to your support request email.

See: Support on page 25.

Chapter 2: Safety

This chapter provides an overview of important safety considerations for your HD-1500. All persons operating or working in the vicinity of an HD-1500 must thoroughly read and understand this information. For more information on safety, refer to the *Mobile Robot HD Safety Manual (Cat. No. I647)*.

2.1 General Hazards

This section describes potentially hazardous situations and conditions.

> ⚠️ **WARNING:** The following situations could result in injury or damage to the equipment.

- Do not ride on the AMR.

- Do not exceed the maximum weight limit.

- Do not drive the AMR on inclined floors or surfaces.

- Do not exceed the maximum recommended speed, acceleration, deceleration, or rotation limits. See Center of Gravity (CG) on page 143 and Acceleration, Deceleration, and Rotation Limits on page 132.

   Rotational speed becomes more significant when the payload's center of gravity is increasingly offset from the AMR's center of gravity.

- Do not drop the AMR, run it off a ledge, or otherwise operate it irresponsibly.

> ⚠️ **CAUTION:** PERSONAL INJURY RISK
> The user must not stand close to the AMR while it is rotating with no forward motion.

- Do not allow the AMR to drive through an opening that has an automatic gate or door unless the door and AMR are configured correctly with the Call/Door Box option.

- Do not throw an object in front of the AMR or suddenly step into the path of the AMR. The AMR braking system cannot be expected to function as designed and specified in such instances.

> ⚠️ **WARNING:** PERSONAL INJURY OR PROPERTY DAMAGE RISK
> Abrupt appearance of objects or persons in the path of the AMR could result in personal injury or property damage. You must make sure that the operating environment of the AMR is adequately controlled.

- Do not expose the AMR to rain or moisture.

- Do not use unauthorized parts to repair the AMR.

- Do not power on the AMR without its wireless antennas in place.

- Although the lasers used are Class 1 (eye-safe), OMRON recommends that you not look into the laser light.

- Reflective surfaces can interfere with the AMR's laser operation.

- Do not operate the AMR in areas where it may be exposed to intense interference light, such as direct sunlight.

- Do not operate the AMR in a flammable gas environment.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Do not operate the AMR in hazardous environments where there is explosive gas, and oil mist.

- Do not operate the AMR with the safety interlock switches disabled.

WARNING: ELECTRICAL SHOCK RISK, FIRE RISK, BURN RISK
The safety interlock switches shall not be defeated or bypassed as this could potentially result in short circuit.

- The HD-1500 shall only be powered by an HD-1500 battery. Do not use any other batteries.

- The HD-1500 battery shall only be charged by an HD-1500 charger. Do not use any other chargers.

2.2 Unprotected Areas

The HD-1500 charges its battery autonomously by driving itself to the docking target where it mates with the docking target's charging paddle, as displayed in the following figure.
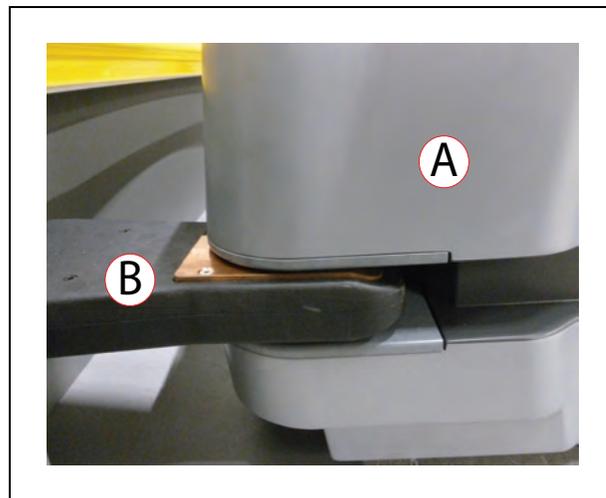
Figure 2-1. HD-1500 Mating with the Charging Paddle, (A) HD-1500, and (B) Charging Paddle

The HD-1500 travels at a low speed when docking:

- When traveling between 0 to 20 mm/s (or angular speed of less than 3 deg/s), there are no hardware-based safety laser protection zones. The HD-1500 beeps any time it moves at a linear speed below 20 mm/s, or an angular speed of less than 3 deg/sec for longer than 2 seconds. The AMR respects its software-based obstacle-avoidance clearances at all speeds, but it will not use a hardware-based safety laser protection zone at speeds below 20 mm/s or 3 deg/sec. This is done intentionally to allow operators to manually drive the AMR away from any obstacles that are too close to the AMR. It also allows the operators to back the AMR when needed.

- At speeds between 20 to 115 mm/s (or angular speed of less than 12 deg/s), the AMR's hardware-based laser protection zones exclude the area where the charging paddle enters the laser channel. The safety zones of the two safety scanning lasers are identical, and therefore, the unprotected areas are present at both front and rear ends of the AMR.

  The operator must take necessary precautions to ensure that the operator's hands or other body parts do not get stuck in between the charging pad and the platform when docking.

- At speeds above 115 mm/s, the hardware-based laser protective zones are fully active and there are no unprotected areas.

The following table lists the hardware-based safety laser protection zones for the speeds mentioned in the preceding paragraph:

Table 2-1. Hardware-Based Safety Laser Protective Zones

Linear speed (mm/s)	Angular speed (deg/s)	Hardware-based safety laser protective Zones
0≥ and < 20	0≥ and <3	No protective zones.
20≥ and <115	3≥ and <12	Two unprotected areas. Area where the charging paddle enters the laser channel (both at front and rear of the AMR).
≥115	≥12	No unprotected areas.

CAUTION: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Although the AMR respects its software-based obstacle-avoidance clearances at all speeds, the user must be aware of the location of the E-Stop buttons at all times, and keep out of the unprotected areas.

CAUTION: PERSONAL INJURY OR PROPERTY DAMAGE RISK
It is the end user's responsibility to ensure that the area within the radius of 2 m from the center of the HD-1500 is kept clear, when the AMR is traveling at less than 115 mm/s.
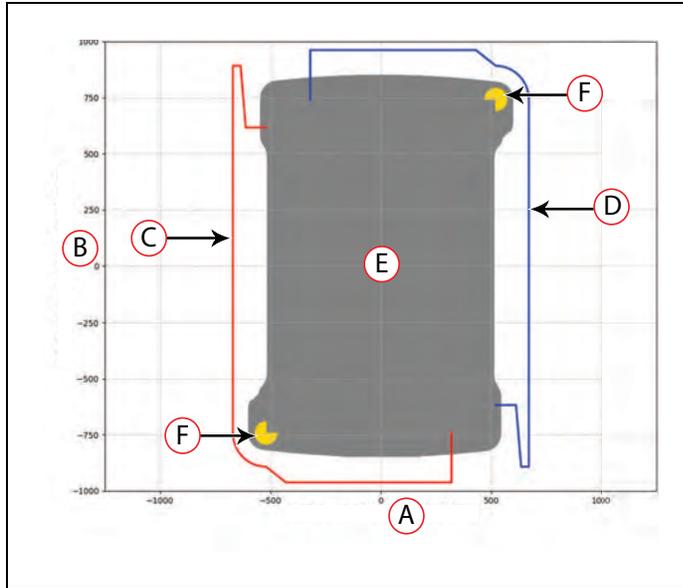
Figure 2-2. HD-1500 Protective Zones with Openings for the Charging Paddle - Movement at Less Than 115 mm/s (Dimensions are in mm)

ID	Description	ID	Description
A	AMR Y-axis	D	Front laser zone
B	AMR X-axis	E	HD-1500
C	Rear laser zone	F	Safety scanning laser

The following figure provides dimensions of the HD-1500 unprotected area. The same dimensions are true for the rear laser unprotected area.
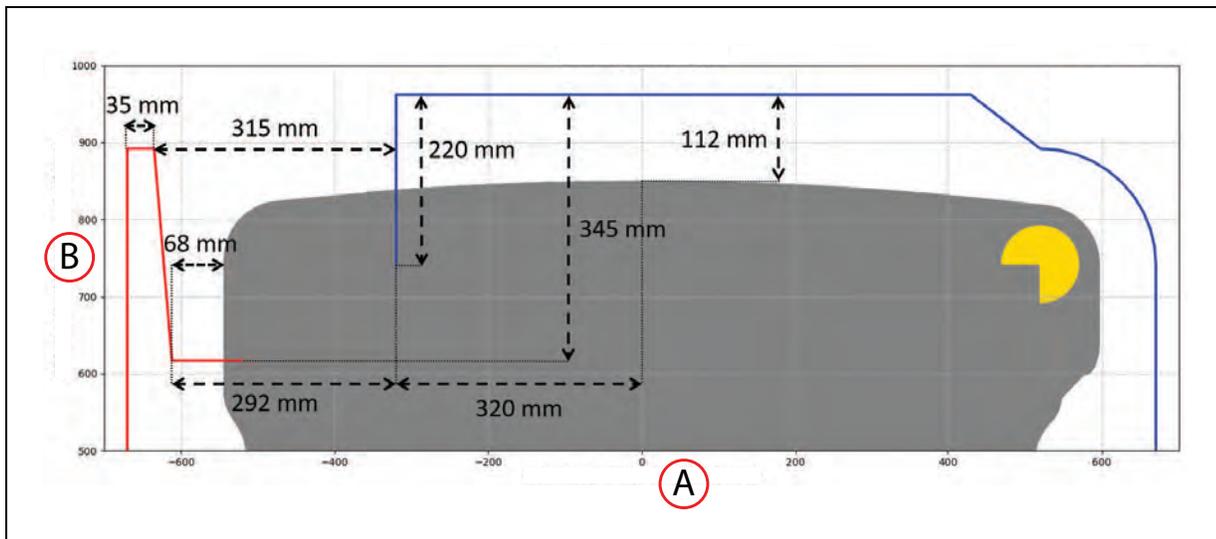
Figure 2-3. HD-1500's Unprotected Zone Dimensions - Movement at Less Than 115 mm/s, (A) AMR Y-Axis, and (B) AMR X-Axis

2.3 What to Do in an Emergency

In case of an emergency such as a fire or collision, you should stop the AMR quickly and safely. If the emergency situation is near the charging station, you must turn off the power using the main disconnect switch. See Figure 7-10.

> ⚠️ **CAUTION: Combustible Lithium Battery**.
> For AMR fire suppression use either foam, dry chemical extinguisher, ABC, AB, powdered graphite, copper powder, or a CO_2 extinguisher.

The HD-1500 has four E-Stop buttons, two on either side of the platform (a red push-lock button). The Operator Panel provides an additional E-Stop button (a red push-lock button on a yellow background). See the following figures.

Figure 2-4. E-Stop Button on the Platform

Figure 2-5. E-Stop Button on the Operator Panel

Use the User Safety Interface connection, located on the user access panel, to add E-Stop buttons to your payload structure, if required. See: SCPU on page 161.

In the event of an emergency stop:

- The AMR uses motor power to come to a controlled stop then engages its motor brakes and removes power to its drive motors.

- Indicator lights on the AMR, and the pendant (if attached) show the E-Stop state. See: Light Discs and Beacon on page 199 and Front and Back Light Strips on page 202.

A user-initiated E-Stop (category 1 stop) differs from a laser-initiated protective stop. The latter occurs when one or both of the AMR's safety scanning laser detects an object within its protected zone. In such cases, the AMR safely stops, and then resumes operation after a delay of at least two seconds, and after confirming that its protected zone is clear of obstacles. See: Protective Stops Initiated by AMR Safety Lasers on page 49.

The category 1 stop, which is activated by pressing one of the E-Stop buttons, is a controlled stop function. In this case, the power to the AMR motors remains on in order to achieve a controlled stop. Once the controlled stop is achieved, the power to the motors is disconnected. If for any reason the controlled stop function fails or does not function as expected, the power will still be disconnected to the motors. Category 1 stop function requires manual deactivation of the E-Stop button, and manual reset of the AMR through the ON button for the AMR to restart its operation. The AMR will not automatically recover from a category 1 stop, or any E-Stop initiated by custom inputs on the User Safety Interface.

To use an E-Stop button:

1. Push firmly on the red button so that it latches.

2. Follow your site-specific emergency and safety procedures.

If you need to move the AMR manually after correcting the emergency condition, press and hold the brake release button and move the AMR. You can also use the pendant to drive the AMR manually, if it is safe to do so. In order to use the pendant, you must first release the E-Stop.

To enable the AMR's drive motors and put it back into service, follow the procedure described in: Releasing an E-Stop on page 34.

Releasing the Brakes

In case of an emergency or abnormal situation, the AMR can be manually moved. However, only qualified personnel who have read and understood this manual and the *Mobile Robot HD Safety Manual (Cat. No. I647)* should manually move the platform. The brakes on the drive wheels can be released with the brake release button. This requires battery power, and an E-Stop must be pressed on the AMR.

> **NOTE:** You should move the HD-1500 manually only when absolutely necessary during an emergency, for safety, or if it is lost or stuck. If you find that you must frequently move the HD-1500, use MobilePlanner to reconfigure its route to avoid problem areas.

> **WARNING:** PERSONAL INJURY OR PROPERTY DAMAGE RISK
> Using the brake release button while the HD-1500 is positioned on a slope of greater than 3% will cause the HD-1500 to roll down. You must not use the brake release button to move the HD-1500 manually, when positioned on a slope of greater than 3%, unless necessary precautions have been taken to pre-

vent uncontrolled rolling of the HD-1500. The HD-1500 is not intended to be operated on ramps or sloped surfaces.

CAUTION: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Pushing an HD-1500 requires significant effort and might cause personal injury or property damage. Take appropriate care and follow all safety instructions.

Application-specific attachments can affect an AMR's stability. All operators should know the locations on the AMR (or its payload) where they can push safely without tipping the AMR over or damaging its components. This should be as low as possible and near the center of gravity.

OMRON recommends that you train personnel on the safe use of the brake release button, and procedures for safely pushing an HD-1500. For instructions on how to safely use the brake release button, see: Brake Release Button on page 198.

CAUTION: PERSONAL INJURY RISK
The pushing locations of the AMR are low. You must use safe pushing/pulling practices when manually moving the AMR.

Releasing an E-Stop

This section describes how to release an E-Stop and bring the AMR back into service.

CAUTION: PERSONAL INJURY OR PROPERTY DAMAGE RISK
If an AMR's E-Stop is triggered, ensure that the cause of the E-Stop is resolved, and all surrounding areas are clear before releasing the E-Stop.

To release an E-Stop:

1. Make sure that all surrounding areas are clear before you release the E-Stop button so that the AMR has room to maneuver.

2. Rotate the E-Stop button in the direction of the arrows on the button and allow it to pop up.

3. After you release the E-Stop button, you must enable the motors manually by pressing the green ON button on the operator panel.

After you enable the motors there is a delay of several seconds before the AMR can resume operation.

NOTE: If you manually move the AMR while it is powered off, it may not be able to determine its current location. Use the localization feature in MobilePlanner to localize the AMR.

Enabling motor power, either at the start-up or after an E-Stop release, must be done through a manual action at the system, and only after the operator has confirmed that it is safe to return

the AMR to operation. Enabling the motor power must be an additional act after releasing an E-Stop, and it is done by pressing the Operator Panel's On button.

2.4 Dangers, Warnings, and Cautions

Alert Levels

There are three levels of alert notation used in this document. In descending order of importance, they are:

DANGER: Identifies an imminently hazardous situation which, if not avoided, is likely to result in serious injury, and might result in fatality or severe property damage.

WARNING: Identifies a potentially hazardous situation which, if not avoided, will result in minor or moderate injury, and might result in serious injury, fatality, or significant property damage.

CAUTION: Identifies a potentially hazardous situation which, if not avoided, might result in minor injury, moderate injury, or property damage.

Alert Icons

The icon that starts each alert can be used to indicate the type of hazard. These will be used with the appropriate signal word - Danger, Warning, or Caution - to indicate the severity of the hazard. The text following the signal word will specify what the risk is, and how to avoid it.

Icon	Meaning	Icon	Meaning
	This is a generic alert icon. Any specifics on the risk will be in the text following the signal word.		This identifies a hazardous burn-related situation, or a Hot surface.
	This identifies a hazardous electrical situation.		This identifies a hazardous ESD situation.
	This warning icon warns against riding on the AMR.		This identifies a fire risk.
	This warning icon warns against hazardous magnetic field.		This identifies a tip hazard.

Falling Hazards

⚠ **WARNING:** PERSONAL INJURY OR PROPERTY DAMAGE RISK
The AMR can cause serious injury to personnel or damage to itself or other equipment if it drives off of a ledge, such as a loading dock, or down stairs.

Physical Barriers

Use physical barriers together with logical barriers (map restrictions) to prevent the AMR from approaching any fall hazard that is within its operating area. Such hazards include:

- The edge of a loading dock or ramp.

- Entrance to downward stairs.

- Any other vertical drop that exceeds the AMR's maximum step height.

Required characteristics of physical barriers are:

- **Strength**—The barrier must be attached to a solid wall or floor and should be strong enough to stop a fully-laden AMR traveling at maximum speed.

- **Continuity**—The barrier must extend around the hazard completely.

- **Visibility**—Mark all physical barriers to make sure that the AMR's safety lasers can detect them easily. Barriers must extend above and below the laser's sensing plane, particularly if the floor is not flat.

Logical Barriers

In addition to physical barriers, use MobilePlanner to create forbidden areas or lines on the workspace map to prevent AMRs from closely approaching a fall hazard. These restrictions must be continuous so that the AMR cannot plan a path around the logical barrier.

The map features mentioned in the preceding paragraph are not interlocked methods of preventing an AMR from entering a specific zone. These map features assume proper AMR localization, and therefore, if the AMR is not able to properly localize its current position it may enter the forbidden zones. You must always install physical barriers where there is a risk of property damage or safety hazard.

You can also use the configuration parameters *FrontPaddingAtSlowSpeed* and *FrontPaddingAtFastSpeed* to increase the AMR's safety clearances. This causes the AMR to decelerate as it approaches a hazard. See: *Fleet Operations Workspace Core User's Manual (Cat. No. I635)*.

Special Information

This manual uses the following typographic styles to identify specific types of information:

IMPORTANT: Information to ensure safe use of the product.

NOTE: Information for more effective use of the product.

Additional Information: Offers helpful tips, recommendations, and best practices.

Version Information: Information on differences in specifications for different versions of hardware or software.

2.5 User's Responsibilities

You are responsible for continuous safe use of the AMR.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Any modifications made to the AMR can lead to loss of safety or functionality of the AMR. It is the end-user's responsibility to perform complete risk assessment after making any modifications to the AMR, and to confirm that all safety features of the AMR are fully functional.

WARNING: PERSONAL INJURY RISK
It is the end-user's responsibility to perform a task-based risk assessment and to implement appropriate safety measures at the point of use of the AMR in accordance with local regulations.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
It is the end-user's responsibility to make sure that the AMR design and implementation complies with all local standards and legal requirements.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
It is the end-user's responsibility to make sure that the AMR is operated within its specifications, intended use, and intended environments.

Safe use of the AMR requires that you:

- Read the installation and operation instructions, in addition to the *Mobile Robot HD Safety Manual (Cat. No. I647)*, before using the AMR.

- Review, and understand the safety protections (E-Stops, safety laser stopping distances, overhanging load, etc.) associated with your specific application and environment.

- Make sure that the environment is suitable for safe operation of the AMR.

- Make use of the Fleet Manager when two or more AMRs are used in the same environment, and are not confined to separate workspaces. See: *Fleet Operations Workspace Core User's Manual (Cat. No. I635)*.

- Make sure that any person working with or near an AMR is trained, and has read the *Mobile Robot HD Safety Manual (Cat. No. I647)* for safe AMR operation.

- Mechanically maintain and service AMRs for proper operation of all control and safety functions.

Electrical Hazards

WARNING: ELECTROCUTION RISK
The charging station has AC power inside. Its covers are not interlocked. You must disconnect the power prior to maintenance work.

WARNING: FIRE RISK, ELECTRICAL BURN RISK
The HD-1500 battery, and the charger outputs have high current. You must
take appropriate precautions to avoid potential short circuit.

- Never access the interior of the platform with the charger attached.

- Avoid shorting the battery terminals or connectors.

- Do not use any charger or battery not supplied by OMRON. The charger shall only be
  used to charge an HD-1500 battery.

- The HD-1500 battery shall only be charged by an HD-1500 Charger.

- If any liquid is spilled on the AMR, power off the AMR, clean up all possible liquid,
  and allow the AMR to air dry thoroughly before restoring power.
  Contact your OMRON representative if you suspect that liquid has penetrated the skins
  or contaminated the AMR's interior.

- Avoid liquid near the charging station, and the AMR.

- Do not open the power supply box, electrician access box, or even the docking target
  until you have read the appropriate sections of this user's guide, and performed appro-
  priate Lock-Out, Tag-Out (LOTO) procedure. See: Lock-Out, Tag-Out Procedure on page
  216.

Magnetic Field Hazards

The rare-earth magnet embedded in the HD-1500 charging contacts create a strong magnetic
field. Persons with medical implants must not approach the HD-1500. See the following figure
for location of the charging contacts.

WARNING: MAGNETIC FIELD -
MEDICAL IMPLANT RISK
Magnetic fields can be hazardous if
you have a medical implant. Keep a
minimum of 30 cm away from the
HD-1500.
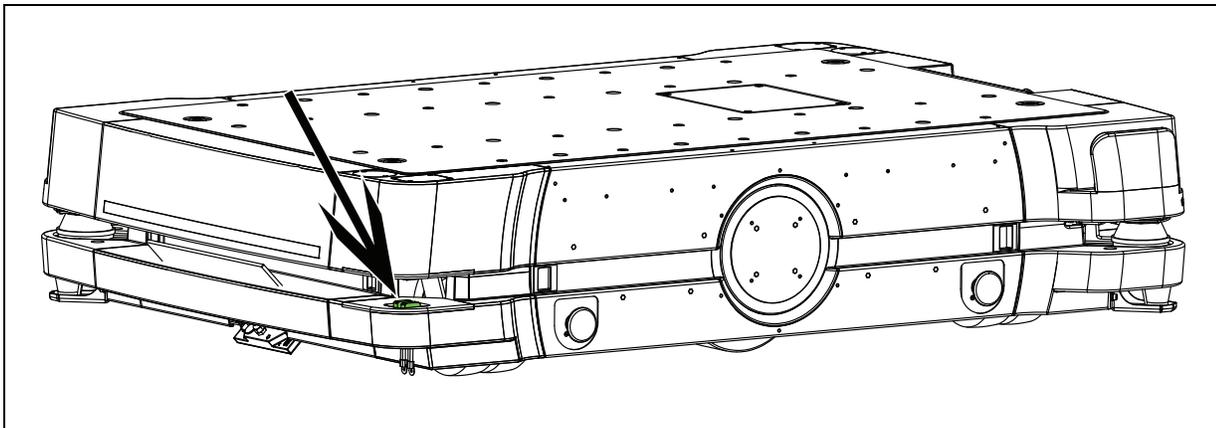
Figure 2-6. HD-1500 Charging Contacts Location

Burn Hazard

CAUTION: BURN RISK
The charging station and the charging contacts on both the docking target, and the AMR can get hot during the operation. The operator must allow for cool down prior to servicing.

CAUTION: BURN RISK
The AMR drive wheel motors can get extremely hot during the operation. The operator must allow the drive wheel motors to cool down prior to performing any maintenance work near or around them.

Qualification of Personnel

It is the end-user's responsibility to ensure that all personnel who will work with or around AMRs have attended an appropriate training, and have a working knowledge of the system. The user must provide the necessary additional training for all personnel who will be working with the system.

As described in this guide, and the *Mobile Robot HD Safety Manual (Cat. No. I647)*, you should allow only skilled persons or instructed persons to do certain procedures:

- **Skilled persons** have technical knowledge or sufficient experience to enable them to avoid either electrical or mechanical dangers.

- **Instructed persons** are adequately advised or supervised by skilled persons to enable them to avoid either electrical or mechanical dangers.

For example, replacing a battery is a task for a skilled person, while an instructed person can complete the task of charging a battery.

All personnel must observe industry-prescribed safety practices during the installation, operation, and testing of all electrically-powered equipment.

> **IMPORTANT:** Before working with the AMR, every person must confirm that they:

- Have the necessary qualifications and training.

- Have received the guides (both this user's guide, and the *Mobile Robot HD Safety Manual (Cat. No. I647)*).

- Have read the guides.

- Understand the guides.

- Will work in the manner specified by the guides.

Payload Movement and Transfer

A typical AMR application uses a payload structure to transport objects within a facility. For example, the AMR might pick up and carry a crate of engine parts from one conveyor belt then deliver it to another conveyor belt.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK

It is the end user's responsibility to ensure that the payload is properly secured to the HD-1500 platform, and that the payload does not experience any shifting during movement of the AMR. For example, when transporting containers of liquids, the operator must take necessary precautions to prevent sloshing of the fluid as it affects the stability of the AMR.

During movement and transfer, you must actively monitor and confirm the transfer operation to make sure that it completes successfully. If any operation fails, a fail-safe interlock must trigger an AMR E-Stop condition. An E-Stop condition prevents the AMR from moving until you resolve the problem and confirm that it is safe to restart operations.

Your facility should provide such fail-safe interlocks between the AMR and any facility equipment with which it interfaces. After you attach your payload to the AMR, verify the correct operation of the fail-safe as part of your risk assessment.

Configurable Warning Buzzer

The HD-1500 has a configurable warning buzzer. You should configure this buzzer as appropriate for the facility in which the AMR will be operating. The warning buzzer is configured with MobilePlanner.

The buzzer must be audible above the ambient noise of the environment that the HD-1500 operates in. In environments with higher levels of noise, you may need to supply and install an additional warning buzzer to an appropriate location on the payload structure. For information on how to install an additional warning buzzers, see: Warning Buzzer on page 137.

You can also configure the buzzer to activate in other specific situations, or to operate continuously whenever the AMR moves.

- Any time the AMR moves at a linear speed below 20 mm/s, or a rotational speed of less than 3 deg/sec for longer than 2 seconds. This is done to alert the users of a very slowly moving AMR which is not configured with hardware-based safety zones by default.

  NOTE: The software-based obstacle protection is used regardless of the AMR speed.

- For 2 seconds prior to starting motion any time it has stopped moving for at least 10 seconds. This includes the first motion after start-up.

- For 2 seconds when an emergency stop or a protective stop from hardware-based safety zones is triggered.

  NOTE: These parameters are only available with the Fleet Operations Workspace 1.1 and later.

CAUTION: PERSONAL INJURY RISK

Changing buzzer parameter values might make the AMR unsafe and affect its compliance to safety standards. Refer to the applicable safety standards for your locale before you change any parameter values.

Fleet Management

When two or more AMRs operate in the same workspace they may not be able to accurately detect each other or to precisely determine each other's dimensions. This is due to the fact that the AMRs' scanning lasers are positioned inside of the platform perimeter. There are channels along the front, rear, and sides of the platform that allow a clear line of sight for the scanning laser. When two similar AMRs approach each other their scanning lasers will detect the inner surface of that channel and not the outer perimeter of the other AMR. Operating an HD-1500 with any of its skins detached will worsen this effect. Typically this will not present a problem, however, in close proximity each AMR will plan its motion more accurately with information from the Fleet Manager about the position of the other AMR.

To manage and administer multiple AMRs in the same workspace, you must use a EM2100 appliance configured as a Fleet Manager, running the Fleet Operations Workspace (FLOW) software.

The Fleet Manager controls AMRs over a wireless network (WiFi), improving the efficiency of AMR operations by sharing the information between all AMRs in the fleet. The shared information includes: improving the efficiency of AMR operations.

- Dynamic position and heading (velocity and direction of travel) of the AMR.

- AMR size (including payload structure).

- Path planning information (the individual AMR's intended route).

CAUTION: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Improper path planning can result in personal injury or property damage.

AMRs factor this data into their path planning.

> **IMPORTANT:** Fleet Manager is not an interlocked method of collision prevention. It is your responsibility to implement interlocked methods of collision prevention where necessary.

For operational redundancy and fail-over you can add a second EM2100. See the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.

2.6 Environment

General Environmental Conditions

Make sure that the HD-1500's operating environment remains safe for the HD-1500.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
An AMR can be unsafe if operated under environmental conditions other than those specified in this manual.

- **Environmental Hazards**—These are areas where it is unsafe for the HD-1500 to operate. Provide physical barriers that the HD-1500 can detect accurately with its scanning laser

so that it does not attempt to drive near the hazard. Be aware that in addition to being easily detectable, a barrier must be strong enough to resist a fully-loaded HD-1500 traveling at its maximum speed.

- **Restricted Zones**—These are zones of inadequate clearance which cannot be protected by the AMR detection devices. Only authorized persons are permitted to enter. You can use map features such as forbidden areas to keep HD-1500s within their designated area of operation. See the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for information about editing your workspace map.

- **Operating Hazard Zones**—These operating zones are areas of inadequate clearance (less than 500 mm) between the sides of the AMR (or front/rear of the AMR) and an obstacle such as a wall that would not leave sufficient room for a person to escape and avoid getting crushed between the AMR and the obstacle. It can also be an area which cannot be protected by the AMR detection devices. These areas shall be clearly indicated by suitable signs or preferably floor markings. In this operating hazard zone, the AMR speed shall be in accordance with ISO 3691-4, and shall emit additional audible or visual warnings.

- **Confined Zones**—These are zones of inadequate clearance, and where the AMR detection devices may be omitted, at any speed. The confined zones shall be marked, and be enclosed with fixed guards that are at least 2.1 m high.

- **Load Transfer Station**s—These are the designated locations for load transfer. When the load transfer stations are outside the restricted or confined zones, these stations shall be designed to prevent personal injury by the rigid parts of the AMR or its payload. These load transfer stations shall be designated as operating hazard zones as defined in this section of the manual.

Although the HD-1500's software provides the option of using the map features to keep the HD-1500 within its designated workspace, you must always install physical barriers where there is a risk of property damage or personal hazard.

Public Access

The HD-1500 is designed to operate in indoor industrial environments, and in presence of trained personnel. You must deploy it only in applications where you anticipate and mitigate potential risks to personnel and equipment.

OMRON intends for the HD-1500 to be used in controlled areas for which a risk assessment has been conducted. OMRON does not intend the HD-1500 to be used in, for example, areas open to general public access.

Operating Clearances

This section provides information regarding the side clearances, rotation clearances, and the docking clearances when operating.

Side Clearances

The HD-1500 is designed to operate in environments that contain doors, passageways, or other constrained areas that are wide enough for it to traverse.

However, you must maintain adequate *side clearance* (free space) on both sides of the AMR so that it cannot trap a person against a wall or other fixed object. Consult the applicable Autonomous Vehicle and Robotics operating standards for your locale.

An AMR must often maneuver close to machinery, conveyors, or other fixed objects. In such cases, operating standards usually allow an exception to side clearance requirements.

For information about software parameters that you can use to control the HD-1500's front and side clearance zones, see: *Fleet Operations Workspace Core User's Manual (Cat. No. I635).*

Rotation Clearances

The HD-1500 travels in forward and backward directions. To change its direction, the HD-1500 rotates on its center of rotation (turns in place). The HD-1500 has a full safety coverage of 360°, and therefore, obstacles will trigger a safety system event when the AMR rotates.

The HD-1500's Light Discs as well as its front and back light strips display a distinct turn signal pattern when it rotates. For more information, see: Light Discs and Beacon on page 199 and Front and Back Light Strips on page 202.

Docking Clearances

You should set a 2.5 m distance between the docking target (the goal defined in the map) and the dock goal position of the AMR. This distance provides sufficient room for the AMR to align with the docking target when docking. See: Figure 2-7. and Figure 2-8.

When docked, the distance between the AMR and the docking target is less than 500 mm, and therefore, this area is considered to be a hazard zone.
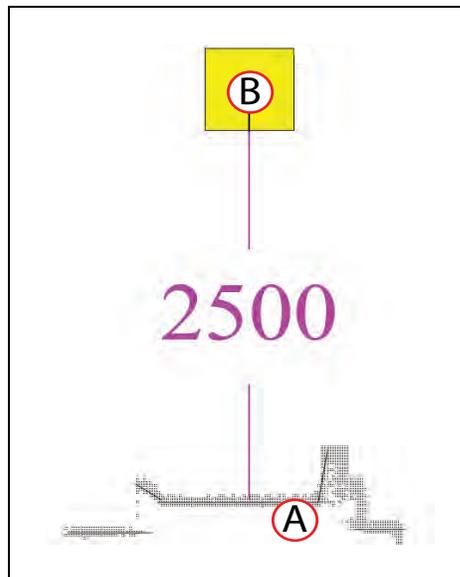
Figure 2-7. Goal Position - Measured From the Center of the Docking Target to the Center of the HD-1500, (A) Docking Target, and (B) HD-1500
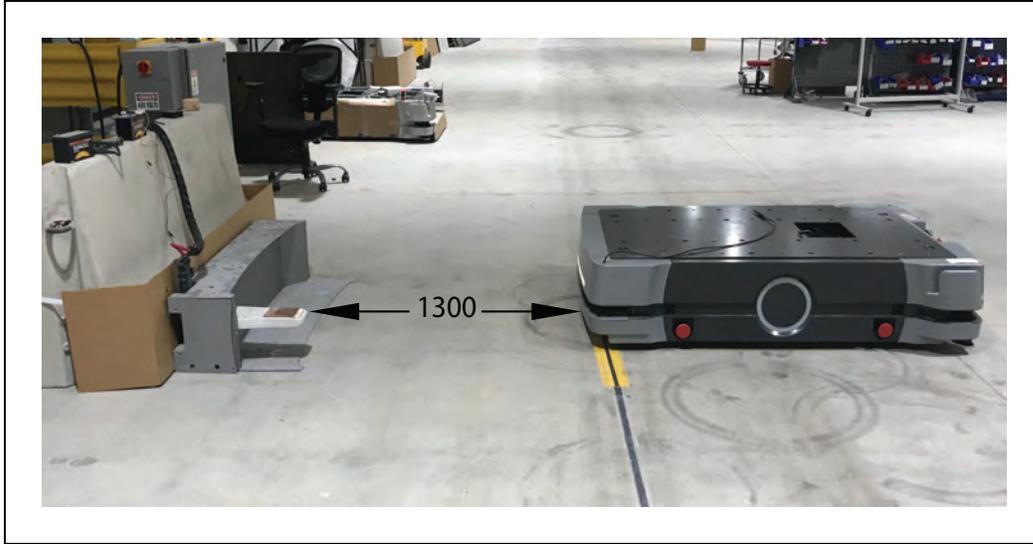
Figure 2-8. Goal Position - Measured from the Front Face of the HD-1500 to the Charging Paddle
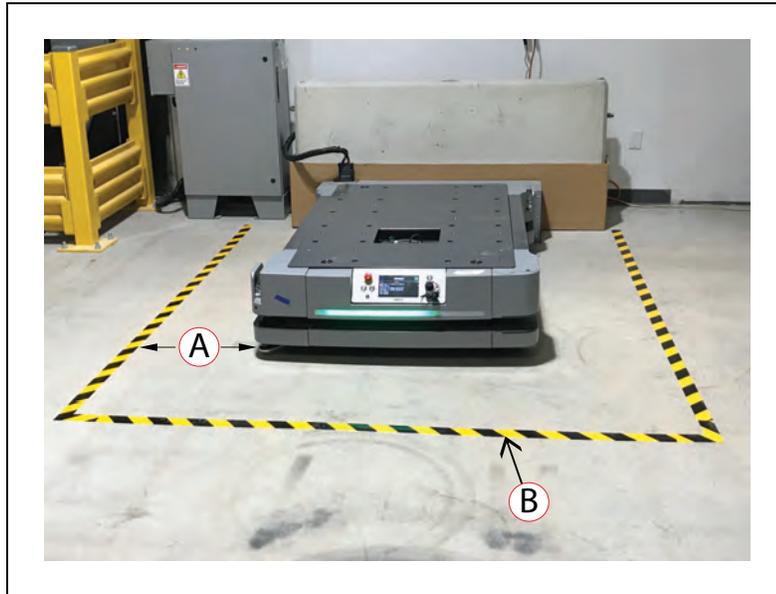
Figure 2-9. HD-1500 Docked with the Docking Target, (A) 500 mm, and (B) Floor Marking

Obstacles

Before an AMR enters a high-traffic area, you must take appropriate precautions to alert people working in those areas:

- The HD-1500 provides programmable warning features such as a warning buzzer, speech synthesis, and warning indicator lights.

- The user access panel provides user ports that enable you to add warning indicators to your payload structure. See: User Access Panel Connections on page 155

If high-traffic areas include other moving vehicles such as fork-lift trucks or autonomous mov-ing machines, consider adjusting the AMR's operating parameters to reduce the risk of a col-lision. You can do this by:

- Editing the workspace map to include features that restrict the AMR's operation in spe-cific areas, such as preferred lines, resisted areas, and movement parameter sectors to reduce speed.

- Editing the AMR's configuration to affect its behavior in all locations, such as restricting its maximum speed.

  Additional Information: For more information, see: *Fleet Operations Workspace Core User's Manual (Cat. No. I635)*.

  IMPORTANT: The safety scanning laser password, required to make any safety-critical changes to the safety scanning laser configuration, can be changed by the user. The user can change the password to limit access by unauthorized users. For instructions on how to change the password, refer to Safety Laser Scanner OS32C Series User's Manual (Cat. No. Z296-E1).

2.7 Intended and Non-intended Use

Intended Use

The intended use of the HD-1500 is to navigate autonomously in indoor industrial envir-onments, and reach the specific locations it is deployed to. The HD-1500 is capable of trans-ferring a payload of up to 1500 kg. You must ensure that the payload structure does not extend beyond the HD-1500's footprint. The HD-1500 shall be loaded and operated within its spe-cified CG. See: Center of Gravity (CG) on page 143.

OMRON does not provide the method of loading the payload onto or off the HD-1500. It is the end user's responsibility to perform a complete task-based risk assessment in accordance with EN ISO 12100, and ensure safe transfer of the payload. The HD-1500 shall be commissioned as instructed in this manual.

The HD-1500 is designed to operate in indoor industrial environments. This includes struc-tured or semi-structured workplaces such as warehouses, distribution and logistics facilities where general public access is restricted. The environment must be flat and level (maximum of 3% grade), free of clutter and debris, and with wide enough doorways to be navigable by an HD-1500. The HD-1500 can operate at its maximum speed through a 2200 mm opening, and will traverse at a slower speed through a 2100 mm opening.

DANGER: PERSONAL INJURY RISK
Improper operation of the AMR on inclined floors that do not comply with the applicable operating specifications can result in the AMR tipping over, and consequently a serious personal injury.

The following guidelines apply:

- **Floor**—Clean and dry floors that you sweep regularly and routinely keep free of debris, dust, and liquids.

- **Temperature**—5 to 40°C with a humidity range of 5% to 95%, non-condensing.

Operating the HD-1500 at high or low ambient temperatures (particularly with a full payload and high speeds) can cause the battery to exceed its operating temperature limits.

• **Altitude**—Up to 2,000 m.

The HD-1500 has an ingress protection rating of IP20. Do not expose the HD-1500 to liquid.

Non-Intended Use

When deploying an AMR, anticipate potential risks to personnel and equipment. OMRON intends the HD-1500 for use in a carefully controlled and managed environment with restricted access granted only to authorized and trained personnel.

You must conduct a risk analysis before you deploy the HD-1500 in a new environment. Application of the HD-1500 in environments other than those described in the preceding paragraph generally requires additional safety measures.

OMRON does not intend the HD-1500 for deployment in environments that contain:

• Hazardous (explosive or corrosive) atmospheres.

• Ionizing radiation.

• Intense interference light, such as direct sunlight.

• Extreme heat or humidity.

• Inclined floors or ramps.

• Soft surfaces such as carpet.

• Floors that are damp or have any standing water.

> **IMPORTANT:** The HD-1500 is not intended to operate in a damp/wet environment where it will be exposed to liquid or liquid ingress.

In addition, OMRON does not intend the HD-1500 for deployment in the following environments:

• Outdoor or uncontrolled areas without risk analysis.

• Environments with general public access.

• Life-support systems.

• Residential areas.

• Non-stationary areas, including moving floors or any type of land vehicle, watercraft, or aircraft. (HD-1500 navigation is assisted by sensing embedded in the AMR Controller that requires a stationary environment to be effective.).

> **IMPORTANT:** You must always observe the instructions for operation, installation, and maintenance provided in this guide and in the *Mobile Robot HD Safety Manual (Cat. No. I647).*

Other non-intended use of the HD-1500 includes:

- Towing applications.

- Personnel riding vehicle.

  IMPORTANT: The HD-1500 is not intended to be used with a battery that is not supplied by OMRON. Additionally, it is not intended to be charged by any charger other than the OMRON charging station.

Non-intended use of an HD-1500 can:

- Cause injury to personnel.

- Damage the HD-1500 or other equipment.

- Reduce reliability and performance.

If there is any doubt concerning the application, contact your OMRON representative for support.

HD-1500 Platform Modifications

OMRON recognizes that end-users or integrators make modifications to the HD-1500 to adapt it to a specific application. When doing so, make sure that:

- You use the User Safety Interface connection located on the user access panel, to include appropriate safety devices into the HD-1500's integrated safety systems. See: SCPU on page 161.

- The modification causes no hazardous sharp edges, corners, or protrusions and does not extend further than the HD-1500 footprint. If the modification causes extension beyond the HD-1500 footprint, you must contact your OMRON representative for assistance with modifying the safety zones.

- The final design of the HD-1500 meets all relevant local and national safety standards, and requirements for the new intended use.

- There is no reduction in functionality.

- All safety features (such as lasers and brakes) are functional and operate within the specifications determined by local product safety standards for AMRs.

- You add additional safety features if determined to be necessary based on risk assessment results.

- You perform proper risk assessment in accordance with EN ISO 12100, and identify any risks associated with the modification made to the HD-1500 platform. It is the end-user's responsibility to ensure that these risks are properly mitigated/eliminated, so the AMR does not cause personal injury or property damage.

2.8 Protective Stops Initiated by AMR Safety Lasers

Under certain conditions, the AMR safety systems might cause a protective stop.

For example, an AMR reacts to obstacles in its path by slowing and, if necessary, stopping safely. It then either plans a new path around the obstacle or (if the obstacle has moved) resumes its original path. The safety lasers initiate a protective stop any time they detect unavoidable obstacles in the AMR's path.

During the protective stop, the AMR decelerates to a stop at the maximum allowed rate. It then removes power to its motors and engages the brakes.

> **NOTE:** A protective stop initiated by an intrusion into a safety laser's protection field differs from pressing an E-Stop button. After you press an E-Stop button, you must first resolve the problem and then manually resume AMR operation. See: What to Do in an Emergency on page 32.

Other circumstances might cause a protective stop, such as:

- User-supplied sensors connected to the Safety Controller.

After the AMR comes to a complete protective stop caused by laser protection zone intrusion, it waits a minimum of two seconds before it resumes operation. No user intervention is necessary and the AMR does the following:

1. Verifies that there is adequate space to maneuver.

2. Plans a local path deviation around the obstacle and resumes its operation.

This may cause the AMR to turn around, and move in a different direction. If no such path is available, the AMR fails the current job, and waits for the Fleet Manager to assign a new job.

2.9 Safety System Overspeed Faults

The HD-1500 has an independent safety system that uses a Machine Automation Controller (Safety Controller) to redundantly monitor its velocity. This device makes sure that the AMR always operates within the speed limits.

If the AMR operates outside the specified velocity limit, its Safety Controller reports a Channel 1 or Channel 2 system fault to its operating firmware and begins an emergency stop (E-Stop) sequence. The fault causes the AMR's motion controllers to execute a controlled stop (stop category 1).

If motion is already disabled (for example, an E-Stop button is engaged) and you override the brake release, the safety system cannot stop the AMR. This is because power to the drive motors is already disabled. After you resolve the error condition, the safety system stops reporting the safety fault to the motion controllers. At this point the safety system allows for the normal start-up process to begin but it does not automatically restart the AMR's operations.

> **Additional Information**: Motion control configuration parameters in the ARAM software (such as *AbsoluteMaxTransVel* parameter) limit the maximum allowable velocities. Use MobilePlanner to modify the value of these parameters. See: *Fleet Operations Workspace Core User's Manual (Cat. No. I635)*.

2.10 Laser Safety

The safety scanning lasers, optional side lasers, and Low Lasers are all Class 1 lasers. The Class 1 laser, which is an invisible laser radiation, is safe under all conditions of normal use. However, the maximum permissible exposure cannot be exceeded when viewing the laser with the naked eye. OMRON recommends that you avoid long-term viewing of the laser.

2.11 Interlock Switches

The HD-1500 is equipped with the interlock switches located on the battery door, and the AMR side skins. The interlock switches continuously monitor and ensure that the battery door, and the side skins are properly attached to the platform. This is to ensure that the battery compartment as well as the electronics bay enclosure are isolated, and protected from unauthorized/unsafe access. If the battery door, or any of the side skins opens or get removed, the interlock switches disable the AMR's motion and disable power to the main bus bars.

CAUTION: BURN RISK
Do not touch the AMR drive wheel motors when the side skins are removed, as the drive wheel motors can get extremely hot during the operation. You must allow sufficient time for the drive wheel motors to cool down prior to coming into contact with them.
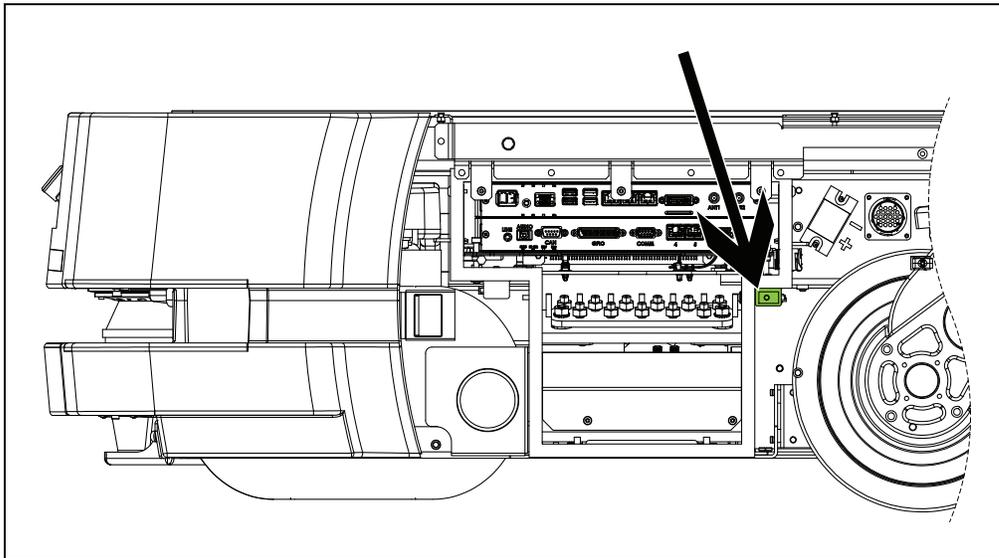
Figure 2-10. Location of the Interlock Switch on the Electronics Bay Access Door Frame
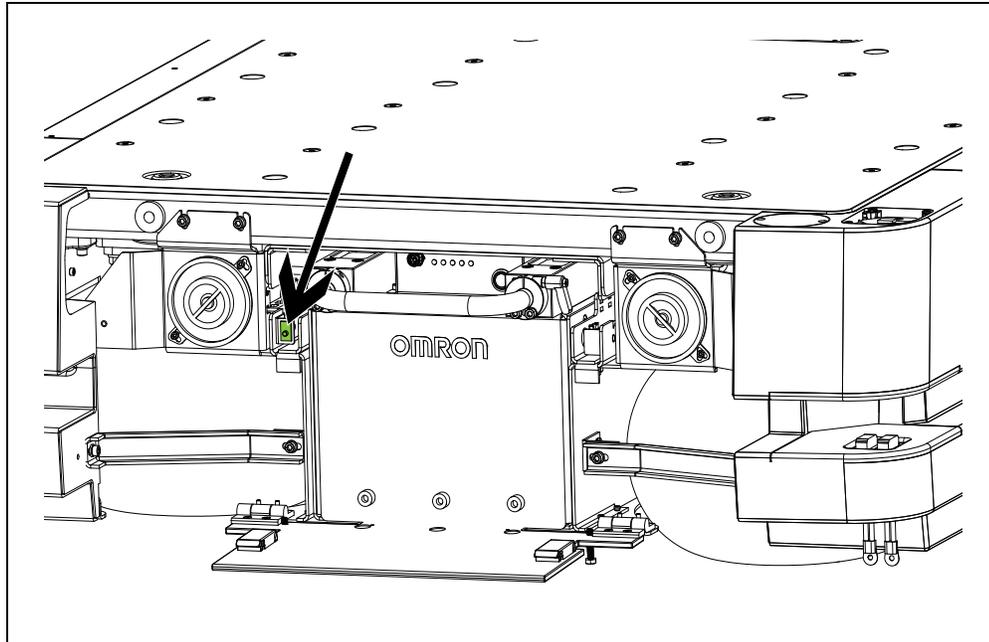
Figure 2-11. Location of the Interlock Switch on the Battery Door Frame

To restore power to the main bus bars, you must:

- Re-install the removed skin, or

- If the battery door was opened, close the battery door.

Once the above is done, the AMR will return to its normal operating mode.

> **IMPORTANT:** If you remove the side skins or open the battery door while the HD-1500 is docked, and is charging its battery, the charging will stop. Once the removed skin is re-installed or the battery door properly closed, the charging will not re-engage automatically. The AMR must repeat the normal docking process for autonomous charging, and re-start charging.

> **WARNING:** ELECTRICAL SHOCK RISK, FIRE RISK, BURN RISK
> The interlock switches shall not be defeated or bypassed as this would energize the AMR, and expose the user to potential electrical hazards.

2.12 Battery Safety

Effective April 1, 2016, IATA regulations (UN 3480, PI 965) require that air-shipped lithium ion batteries must be transported at a state of charge not exceeding 30%. To avoid total discharge, fully charge the battery immediately upon receipt. (The battery might arrive fully charged if it is not shipped by air.)

> **NOTE:** After receiving the battery, check its state of charge by pressing and holding in the push-button on the battery indicator. If the battery is in a low charge state, you must immediately charge to a full charge to avoid discharging the

battery below a usable state, which would require battery replacement. For information on the battery indicator, see: Battery Indicators and Controls on page 184.

Battery Safety Precautions

This section provides safety information and precautions when storing, transporting, and removing/installing the battery.

Storage

Store the batteries within the following temperature range:

- -20 to 35°C, 5-95% RH non-condensing

For transportation of up to 2 weeks, the manufacturer recommends:

- -20 to 60°C, 5-95% RH non-condensing

Storage Position

The batteries must be stored as displayed in the following figure. You must not lay the batteries on their sides, top, front or rear end.
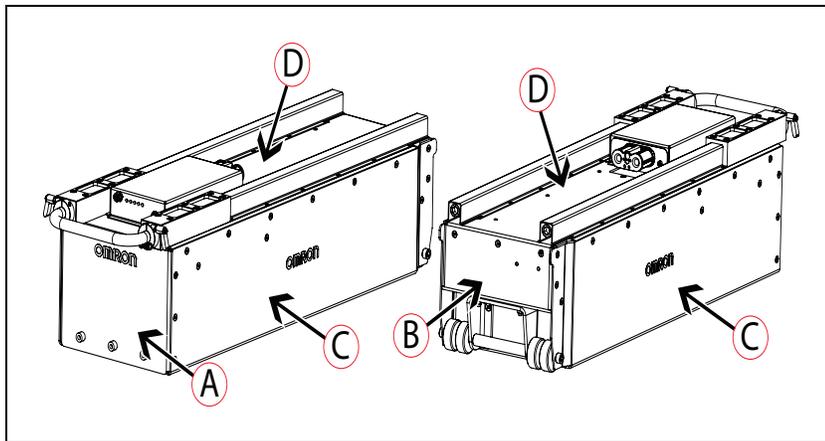
Figure 2-12. Position of the Battery for Storage

ID	Description	ID	Description
A	Front of the battery	C	Side of the battery
B	Rear of the battery	D	Top of the battery

Environmental Considerations

- Batteries stored at temperatures greater than 35°C or less than -20°C must stabilize for 4-8 hours until within the nominal operating temperature before use.

- Store the batteries on a flat surface, and in an area free of vibration.

- Do not stack anything on top of the batteries.

- Never expose the battery to water. If the battery is leaking, use a chemical neutralizer

(such as HF ACID EATER) to absorb the electrolyte. Then, clean up the electrolyte and the chemical neutralizer using a dry cloth, and put the cloth in a bag.

You should place the leaking battery in a bag or a drum containing the chemical neutralizer, and contact your OMRON representative.

> **IMPORTANT:** You must wear proper PPE when working around a leaking battery.

> **IMPORTANT:** Follow the appropriate disposal guidelines for your locale.

- Do not store in direct sunlight or near other heat sources.

- Do not store the batteries in a flammable environment.

- In case of fire use foam, dry chemical, ABC, AB, powdered graphite, copper powder or CO_2.

Battery Removal/Installation

Removal or installation of the battery must be performed by persons who have read and understood this manual as well as the *Mobile Robot HD Safety Manual (Cat. No. I647)*. Refer to Replacing the Battery on page 229 for instructions on how to replace the HD-1500 battery.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
If removal/replacement of the battery is not handled with care or in accordance with instructions provided in this manual, it can cause serious injury to personnel or damage to itself or other equipment.

WARNING: PERSONAL INJURY RISK
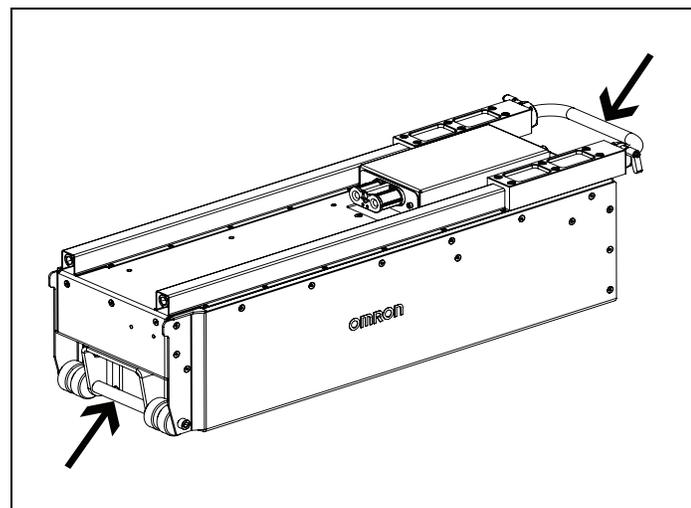Use safe lifting practices when removing or installing the battery. See the battery lift points below:

Figure 2-13. Battery Lift Points

> **IMPORTANT:** The battery weights 68 kg. There must be at least 3 persons lifting the battery. For rolling the battery around, one person is sufficient.

Operating the AMR at high ambient temperatures (particularly when carrying a full payload at high speeds) can cause the battery to exceed its operating temperature limits. If this happens, do not try to access the battery. You must allow several hours for an overheated battery to cool sufficiently before trying to remove/replace it.

Battery Maintenance

Every six months:

- Inspect the battery for damage or leaks.

- Connect the battery to a charger and allow to fully balance (battery indicator shows all solid blue LEDs when the state of charge is ≥ 80%).

2.13 Charging Station

The HD-1500 charging station consists of two main parts; the power supply box, and the docking target which the AMR drives itself into. The charging station provides both manual and automated methods of recharging the AMR's battery.

The power supply box outputs a maximum of 6.84 kW of power, and can charge a fully depleted battery pack in 40 minutes.

WARNING: FIRE RISK, ELECTRICAL BURN RISK
The HD-1500 battery, and the charger outputs have high current. You must take appropriate precautions to avoid potential short circuit.

WARNING: ELECTRICAL SHOCK RISK
The charging station transfers high electric power, and contains hazardous voltage. The user must take necessary precautions when working near the charging station, and follow appropriate Lock-Out, Tag-Out (LOTO) instructions prior to any maintenance work done on the charging station.

Due to high power transfer, OMRON has taken several safety measures to keep the users safe:

- The electrician access box has a main disconnect switch, as displayed in Figure 7-10. When the user turns the main disconnect switch ON, the access door locks automatically, and prevents access to the interior of the electrician access box. This is to block access to the hazardous electrical circuits in the electrician access box.

- The main electrical compartment door can only be accessed with a key; this prevents unauthorized access to the main electrical compartment.

- When the HD-1500 engages with the charging paddle, the docking target performs a voltage check. It verifies that the HD-1500 is present before it begins charging the HD-1500's battery. The docking target ensures that the voltage presented is between 40 to 57 volts. It also uses a detection sensor to verify the presence of the HD-1500.

The power supply box uses a 4 meter long power cord (25.4 mm diameter) to transfer power to the docking target.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
You must route, and secure the power cord properly. It must be secured in such a way that prevents straining of the connection points. There must be a physical protection that prevents the tripping hazard and cable crushing.

If the power cord is laid on the ground, use a visible cover (e.g. yellow and black tripped cover) that goes over the power cord, and prevents crushing of the power cord.

WARNING: HOT SURFACE HAZARD
The docking target charging contacts heat up during the charging process. Take necessary precautions to avoid burn dangers.

Safety Precautions

Lock-out, Tag-out (LOTO)

Prior to any maintenance work on the charging station, you must perform Lock-Out, Tag-Out (LOTO) procedure. For information on how to perform LOTO, see: Lock-Out, Tag-Out Procedure on page 216.

Decommissioning

Follow these steps to discontinue the operation of a power supply box, and remove it from service:

1. Cut power to the power supply box through the main disconnect switch. Turn the main disconnect switch to off position.
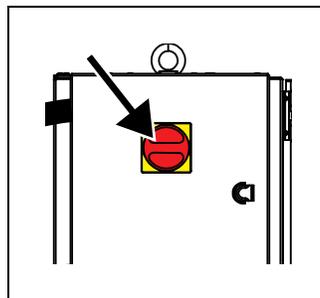
Figure 2-14. Main Disconnect Switch in OFF Position (Horizontal Position)

2. Verify that the AC power is disconnected from the power supply box. When there is no AC supplied to the power supply box, the blue LED is off.

3. Next, disconnect the facility power to the facility power cable. This will disconnect the facility AC power to the electrician access box.
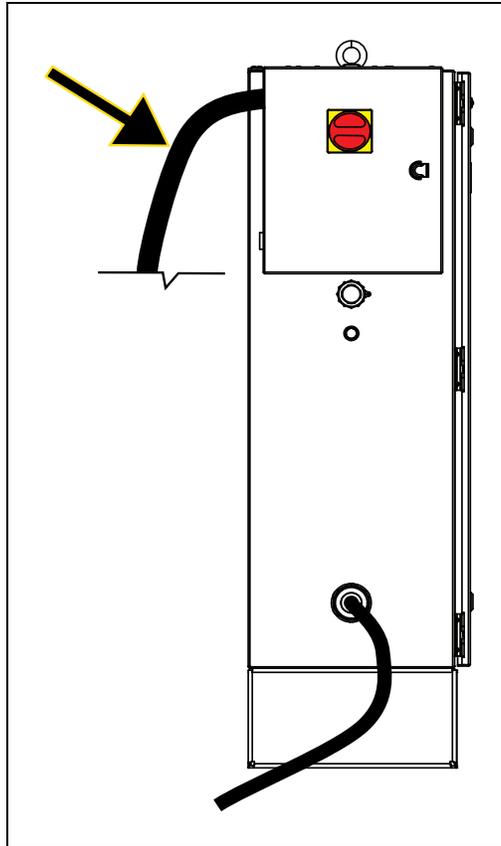
Figure 2-15. Facility Power Cable

4. Then, remove the facility power cable from the electrician access box.

Installation

You must follow the instructions provided in this document for safe and correct installation of the charging station. Consider the following safety measures for power supply box installation:

*   The power supply box and the docking target must be properly secured to the wall or floor prior to start-up. For instructions on how to install the power supply box and the docking target refer to Installing the Charging Station on page 110.

> **WARNING:** PERSONAL INJURY RISK
> Improper installation of the power supply box could result in tipping hazard. You must make sure that the power supply box is safely and properly installed.

*   For instructions on how to safely move the power supply box refer to Power Supply Box Unpacking on page 95.

*   The power supply box must be installed according to the local regulations or codes, and by authorized personnel or licensed electricians.

WARNING: ELECTRICAL SHOCK RISK

Improper installation of the power supply box could result in elecrical shock hazard. You must ensure of the safe and proper installation of the power supply box in accordance with the applicable rules and regulations, and by qualified personnel.

Storage

- Store both power supply box and the docking target at: -20 to 60°C

- Humidity: 5% to 95%, non-condensing

Environmental Considerations

- In case of fire, use a class C extinguisher: foam, dry chemical, or CO_2.

- IP rating for the power supply box is IP20.

- IP rating for the docking target is IP20.

  NOTE: The IP rating for the copper charging pads is IP10. Do not expose them to liquid.

2.14 Additional Safety Information

Contact your OMRON representative for other sources of safety information.

Mobile Robot HD Safety Manual (Cat. No. I647)

The Mobile Robot HD Safety Manual (Cat. No. I647) is included with your HD-1500 and provides detailed information about safe operation of your HD-1500. It also provides resources for information about relevant standards.

2.15 Disposal

Dispose of in accordance with applicable regulations.

Customers can contribute to resource conservation and protecting the environment by the proper disposal of WEEE (Waste Electronics and Electrical Equipment). All electrical and electronic products should be disposed of separately from the municipal waste system via designation collection facilities. For information about disposal of your old equipment, contact your OMRON representative.

Do not incinerate or dispose of the HD-1500 battery. Return the end-of-life or defective batteries to a designated facility per the appropriate local regulations.

Chapter 3: Setup

This chapter describes how to set up your HD-1500 and configure it for operation. It includes information for optional features.

3.1 Overview of HD-1500 Setup

Setup tasks consist of preparing the HD-1500 for use by unpacking it and completing some mechanical configuration such as installing the battery and the charging station. This includes software procedures such as commissioning the HD-1500, and communication tasks such as configuring the HD-1500 to use a wireless network.

Setup also includes creating and editing the workspace map that the HD-1500 uses for navigation. This manual provides an overview of the map creation procedure, which is described in detail in the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)*.

Preparing the platform might also include attaching your payload structure to the HD-1500 and then cabling the payload structure to the User Access Panel, Safety Controller, Machine Automation Controller, and Ethernet Switch for power, control, and data communications. The procedures described in this section assume that you independently complete and implement a design for your payload structure, using information and technical specifications provided in this guide or obtained from your OMRON representative.

Tasks

The tasks required to set up an HD-1500 are:

- Install the charging station. See: Installing the Charging Station on page 110.

- Fully charge the battery, either outside of or inside the platform.

- Install the battery in the platform. See: Installing the Battery on page 104.

- Set up the wireless Ethernet for the platform. See: Settings and Configuration on page 124.

- Design, build, and install a payload structure to suit your application. See: Payload Structures on page 136.

- Configure the AMR for your environment, so it can perform useful tasks.

  This includes generating the map that the AMR will use for its navigation. Mapping is covered briefly in Create a Workspace Map on page 130 and in detail in the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)*.

You might require additional steps to attach and configure a payload structure such as a robot arm.

3.2 Transport and Storage

HD-1500 Shipping and Storage

Ship and store the HD-1500 only under the conditions described in this section.

> **IMPORTANT:** To prevent damage to electronic safety components, and to ensure the safe operation of the HD-1500, observe the shipping and storage instructions in this section.

Ship and store the HD-1500 in:

- A temperature-controlled environment, ranging from -20 to 60°C. The humidity range is 5% to 95%, non-condensing.

- Its original shipping crate, which is designed to prevent damage from shock and vibration in transit. Protect the crate from excessive shock and vibration.

Use a rated forklift, pallet jack or similar devices to move the shipping crate.

Always ship and store the platform in an upright position in a clean and dry area. Do not lay the crate on its side or any other non-upright position. This could damage the platform.

For dimensions, and weight of the HD-1500 crate, see: HD-1500 Unpacking on page 65.

Battery Crate

Ship and store the HD-1500 battery only under the conditions described in this section.

Storage Requirements

OMRON recommends the following temperatures based on the duration of storage:

- -20 to 35°C, 5-95% RH non-condensing

For transportation of up to 2 weeks, the manufacturer recommends:

- -20 to 60°C, 5-95% RH non-condensing

The battery should start the storage period as fully-charged. If storing the battery for an extended period, recharge it periodically to avoid total discharge, which would damage the battery. Fully recharging a battery every six months is sufficient to keep it charged enough to avoid damage.

Storage Position

The batteries must be stored as displayed in the following figure. You must not lay the batteries on their sides, top, front or rear end. For information on the safety considerations, see: Battery Safety on page 52.
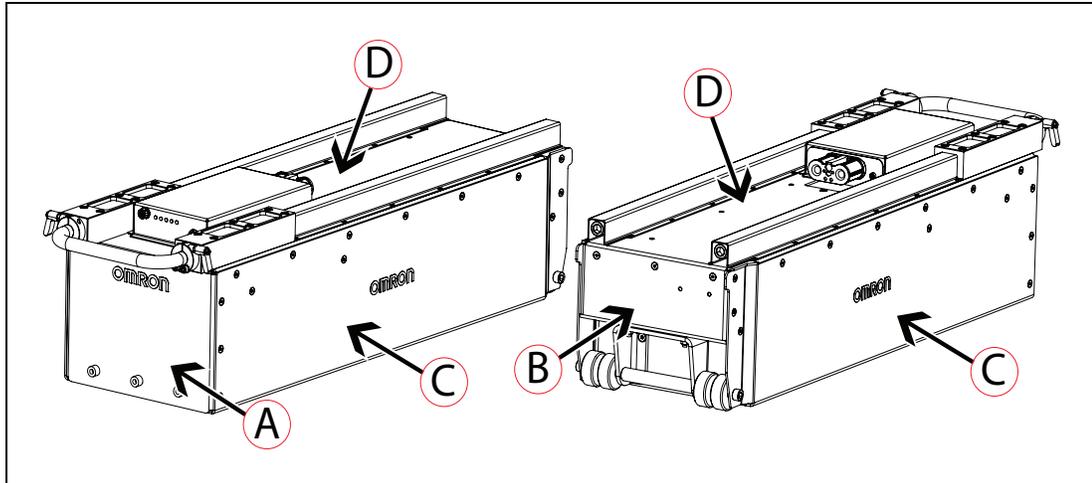
Figure 3-1. Battery Storage Position

ID	Description	ID	Description
A	Front of the battery	C	Side of the battery
B	Rear of the battery	D	Top of the battery

Maintenance

Every six months:

- Inspect the battery for damage or leaks.

- Connect the battery to a charger (power supply box) and allow to fully balance. To check the state of charge, press and hold the On button until the LED lights start blinking (battery shows all solid LEDs when fully balanced), see: Battery Indicators and Controls on page 184.

    For dimensions, and weight of the battery crate, see: Battery Unpacking on page 79.

Power Supply Box, and Docking Target Crates

Ship and store the power supply box, and the docking target only under the conditions described in this section.

> **IMPORTANT:** To prevent damage to electronic safety components, and to ensure the safe operation of the power supply box, and the docking target, observe the shipping and storage instructions in this section.

Ship and store the HD-1500 in:

- A temperature-controlled environment, ranging from -20 to 60°C. The humidity range is 5% to 95%, non-condensing.

- The original shipping crates, which are designed to prevent damage from shock and vibration in transit. Protect the crates from excessive shock and vibration.

Use a rated forklift, pallet jack or similar devices to move the shipping crates.

Always ship and store the power supply box, and the docking target in an upright position in a clean and dry area. Do not lay the crates on their side or any other non-upright position. This could damage the power supply box, and the docking target.

For dimensions and weight of the crates, see: Power Supply Box Unpacking on page 95, and Docking Target Unpacking on page 88.

3.3 Before Unpacking

Carefully inspect all shipping boxes and crates for evidence of damage during transit. If any damage is indicated, request that the carrier's agent be present at the time the crate is unpacked.

3.4 Unpacking Considerations

Before signing the carrier's delivery sheet, compare the actual items received (not just the packing slip) with your equipment purchase order. Verify that all items are present and that the shipment is correct and free of visible damage.

- If the items received do not match the packing slip, or are damaged, do not accept the delivery.

- If the items received do not match your order, contact your OMRON representative immediately.

Retain the containers and packaging materials. These items may be necessary to settle claims or, at a later date, to relocate the equipment.

At a minimum the shipment contains:

- A fully assembled HD-1500.

The power supply box, docking target, and the battery are packed in separate crates and ship separately. Any optional devices or accessories purchased with the HD-1500, are packed in a carton, and placed in the main crate containing the HD-1500.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Follow all unpacking safety instructions and use appropriate tools and equipment. Failure to do so could result in personal injury or property damage.

You require the following tools to unpack each crate (all tools and equipment except for the pendant are user-supplied):

Table 3-1. Required Tools and Equipment to Unpack the HD-1500 Crate

Tool	QTY	Description
PPE	N/A	Eye protection, toe protection and gloves.
OMRON Pendant	1	Pendant is needed to drive the HD-1500 down the ramp.
Forklift or similar device	1	The forklift or any other lifting machine you use must be safety rated for at least 1100 kg of weight.
13 mm socket	1	The impact driver is used to remove side screws connecting the

with impact driver		housing crate to the base pallet.
Screwdriver, or hammer	1	Screwdriver, or the hammer is used to remove the metal clips attaching the front panel to the housing crate.
Safety box cutter	1	The cutter is needed to cut the film wrapped around the HD-1500. **NOTE:** Do not use an open-blade knife such as a wall-board knife to cut into the packaging or the cling film because this might damage the contents.

Table 3-2. Required Tools and Equipment to Unpack the Battery Crate

Tool	QTY	Description
PPE	N/A	Eye protection, toe protection and gloves.

Table 3-3. Required Tools and Equipment to Unpack the Docking Target Crate

Tool	QTY	Description
PPE	N/A	Eye protection, toe protection and gloves.
13 mm socket with impact driver	1	The impact driver is used to remove side screws connecting the housing crate to the base pallet.
Screwdriver, or hammer	1	Screwdriver or hammer is used to remove the metal clips attaching the front panel to the housing crate.

Table 3-4. Required Tools and Equipment to Unpack the Power Supply Box Crate

Tool	QTY	Description
PPE	N/A	Eye protection, toe protection and gloves.
Safety-rated slings	4	The slings ship with the platform.
Forklift or similar device	1	The forklift or any other lifting machine you use must be safety rated for at least 1100 kg of weight.
14 mm socket wrench	1	Socket wrench is used to unscrew the bolts connecting the power supply box to the base pallet.
13 mm socket with impact driver	1	The impact driver is used to remove side screws connecting the housing crate to the base pallet.
Screwdriver, or hammer	1	Screwdriver, or the hammer is used to remove the metal clips attaching the front panel to the housing crate.

HD-1500 Unpacking

The HD-1500 arrives in a crate secured by straps to the base pallet. The HD-1500 crate measures 1969 x 1448 x 991 mm, and weighs 802 kg. You must use a rated device to move the crate.

The following figures display the HD-1500 crate and its main parts.

> **IMPORTANT:** The pallet jack, overhead hoist or forklift used to lift the HD-1500 crate must be rated for at least 1100 kg.

	Description	Image
A	Crate housing	
B	Crate front panel	
C	Plywood base pallet	
D	Crate top section - stores the ramps	
E	First ramp	
F	Second ramp	
G	Wood rails	

The following figure illustrates the movement of the HD-1500 down the ramp, and on to the floor.
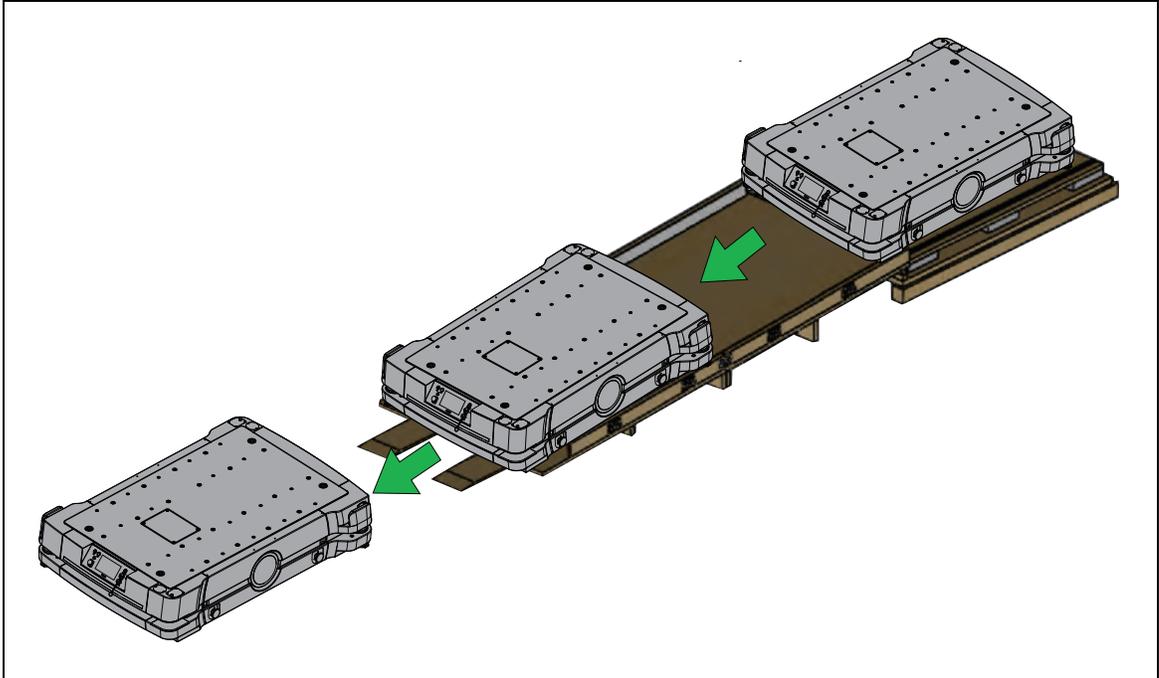
Figure 3-2. HD-1500 Moving Down the Ramp

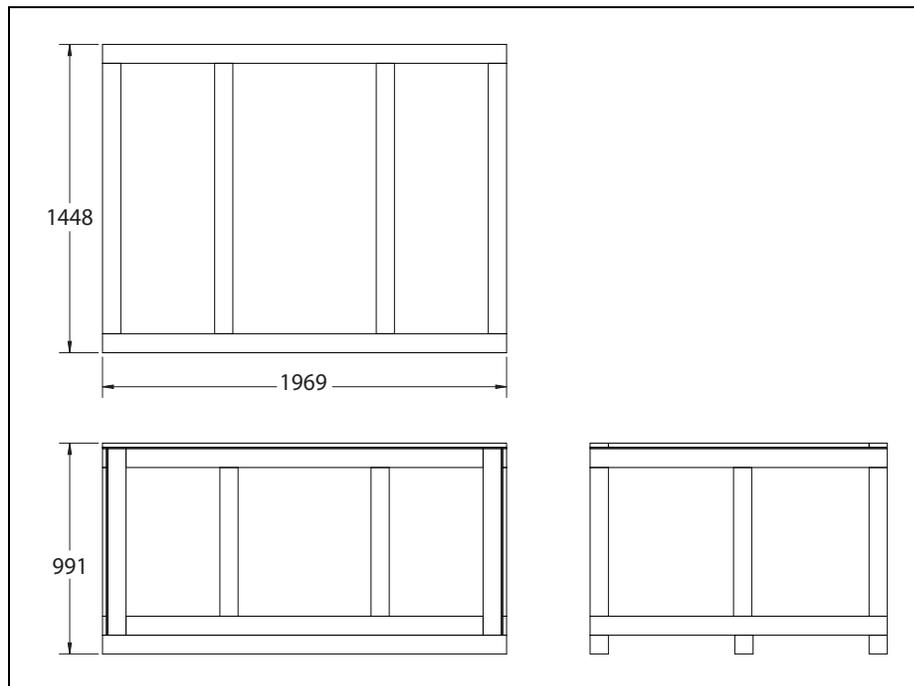The following figures display dimensions of the HD-1500 crate. All dimensions are in mm.

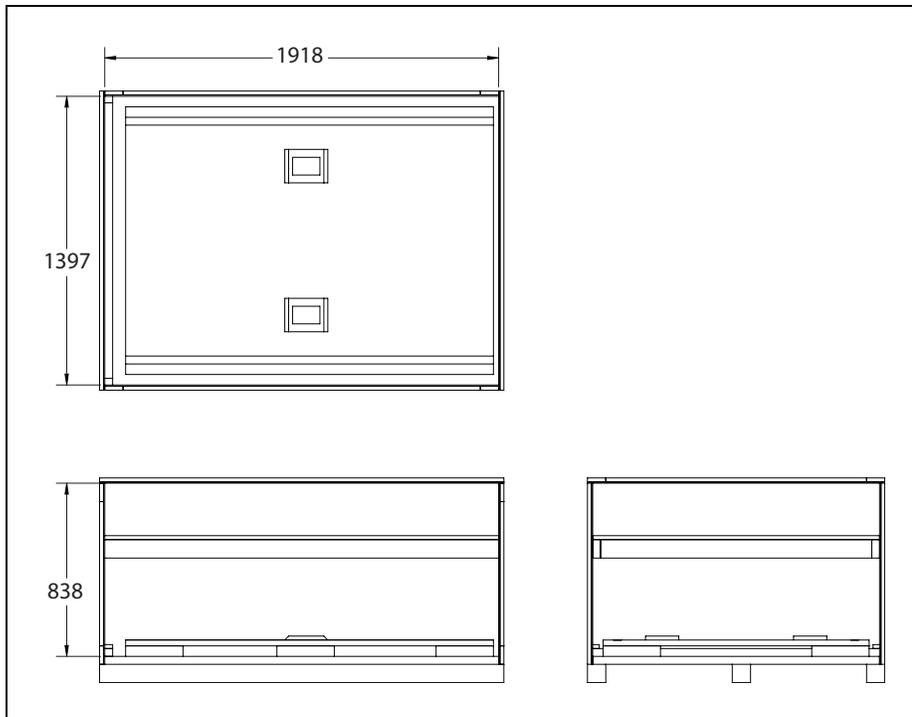*Figure 3-3. HD-1500 Shipping Crate Outer Dimensions*

Figure 3-4. HD-1500 Shipping Crate Inner Dimensions

Follow these steps to unpack the HD-1500:

1. Make sure you have 7 m of clear working space in front of the housing crate where the HD-1500 will be unloaded.

2. Remove any weatherproof film or plastic sheet material wrapped around the shipping crate using a safety box cutter.

3. Remove the carton containing the accessories or optional devices, and set aside. You need the pendant to drive the HD-1500 down the ramp. If you purchased the pendant with your HD-1500, look for the pendant in the optional devices carton before continuing with the rest of the unpacking instructions. For instructions on how to use the pendant, see: Pendant Controls and Operation Description on page 209.

   IMPORTANT: You must purchase at least one pendant per HD-1500 fleet to create a workspace map, and also to drive the HD-1500 down the ramp.

4. Remove the protective fillers.

5. Remove the side screws attaching the crate housing to the base pallet using the 13 mm socket with impact driver.

Figure 3-5. Removing the Side Screws

6. Remove the metal clips attaching the front panel to the housing crate using a screwdriver, or a hammer. Place the screwdriver or the hammer in between the crate and the metal clips, and apply enough force to remove the clips.

Figure 3-6. Removing the Metal Clips Attaching the Front Panel to the Housing Crate

7. Pull the front panel and detach it from the crate. The front panel should come off with little force as it is not bolted to the crate. The metal clips were the only means of attachment.

Figure 3-7. Removing the Front Panel

8. The HD-1500 crate contains two ramps (located on the top section of the crate, as displayed in the following figure). The ramps will be used to transport the HD-1500 onto

the floor.

Pull the ramps out of the crate, using two persons, and place on the floor as shown in the following figures. Use the ramp handles located on each side of the ramp to carry them.

Figure 3-8. Ramps in the Crate, (A) First Ramp, and (B) Second Ramp

Figure 3-9. Pulling the First Ramp Out of the Crate

Figure 3-10. Removing the Second Ramp from the Crate

Figure 3-11. Using the Handles to Carry the Ramp

Figure 3-12. First Ramp Placed on the Ground

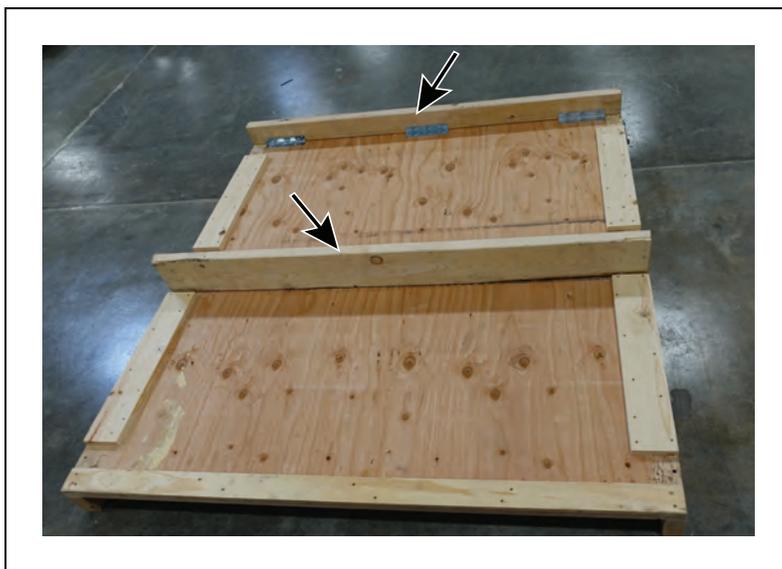9. Next, put the support bars in upright position.

Figure 3-13. Support Bars in Upright Position

10. Flip the ramp so the ramp sits on its support bars.

11. Then, put guard rails in upright position. The guard rails prevent the HD-1500 from tipping off the ramps.
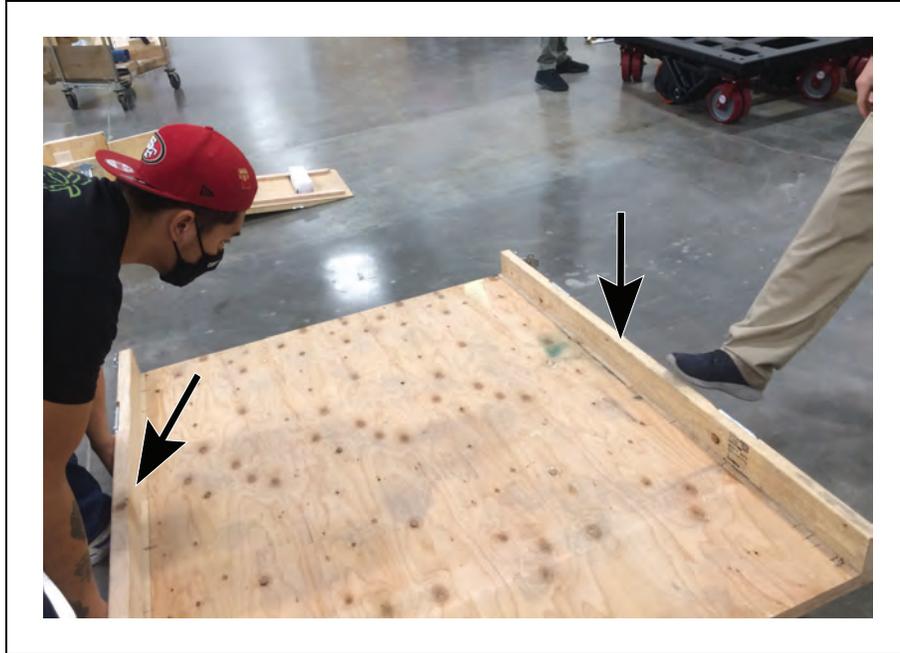
Figure 3-14. Guard Rails in Upright Position

12. Position the first ramp over the edge of the crate.
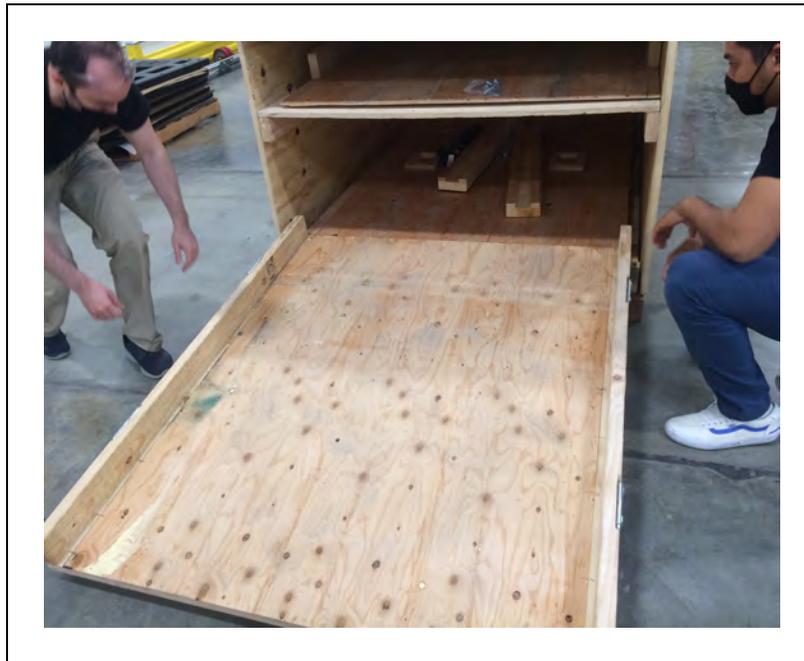
Figure 3-15. Placing the First Ramp Over the Edge of the Housing Crate

13. Position the second ramp so it is aligned with the first one. Connect and secure the two ramps using the locking clip.

Figure 3-16. The Two Ramps Installed

Figure 3-17. Ramps Connected and Secured by the Locking Clips

14. Remove the housing crate, using two persons, each pushing one side of the housing crate away from the base pallet.

Figure 3-18. Housing Crate Removed

15. Unbuckle the strap's lever, and then pull the lever all the way to the end of the strap.
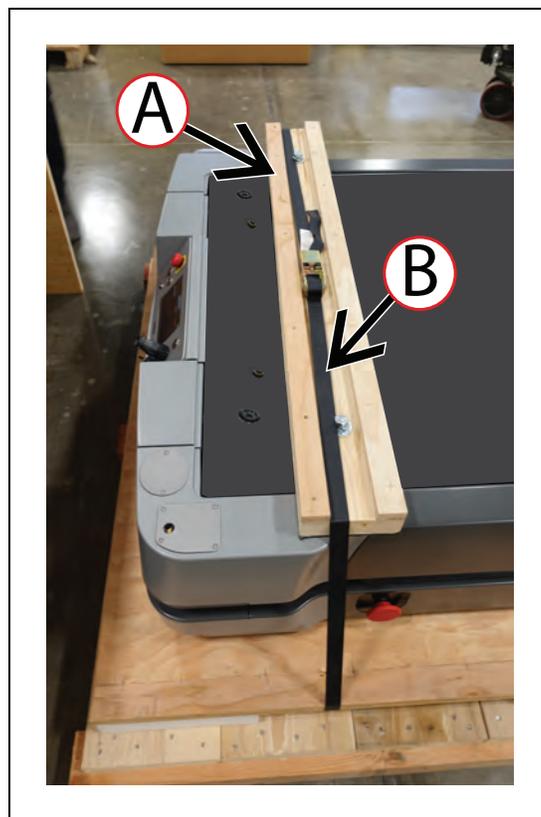
Figure 3-19. Unbuckling the Straps

16. Once the straps are loosened, you can remove the wood bars used to secure the HD-

1500 to the pallet.

17. Next, you need to install the battery into the HD-1500. Roll the battery up the ramp and install as displayed in the following figure. For instructions on how to install the battery, see: Installation on page 104.
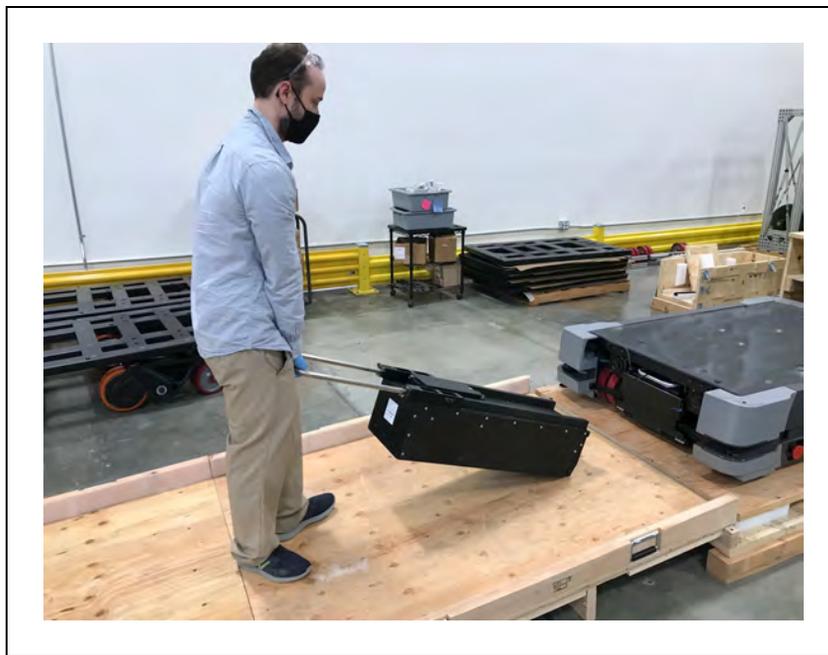
Figure 3-20. Installing the Battery

18. Once the battery is installed, you need to connect the pendant to the HD-1500 in order to drive the HD-1500 down the ramp. Connect the pendant to the pendant port located on the HD-1500 Operator Panel.
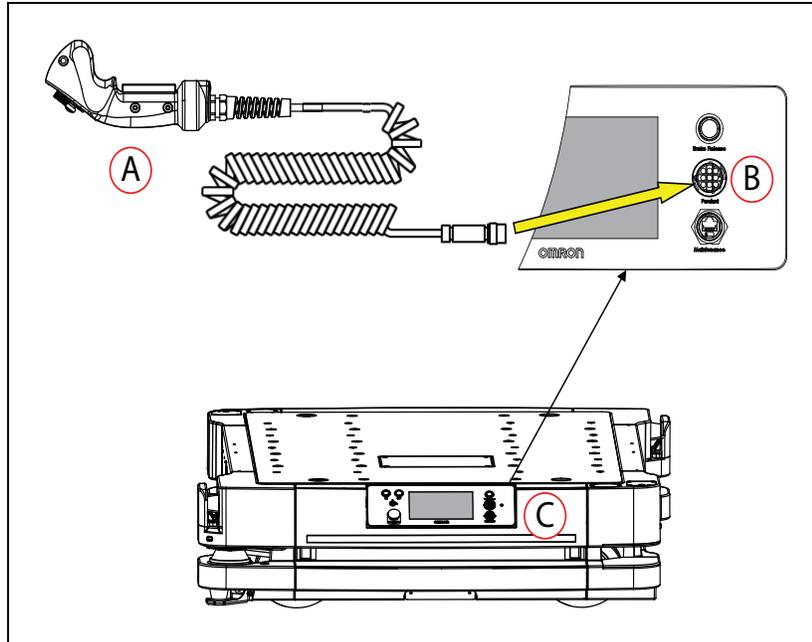
Figure 3-21. (A) Pendant, (B) Pendant port on the Operator Panel, and (C) Operator Panel Location on the HD-1500

19. Press the ON button on the operator panel, and use the pendant to drive the HD-1500 down the ramp and on to the floor.

Figure 3-22. Driving the HD-1500 Down the Ramp Using the Pendant

Figure 3-23. HD-1500 on the Floor

Battery Unpacking

The battery ships in a separate crate, and not inside the platform. The battery crate measures 1118 x 483 x 470 mm, and weighs 101 kg. Locate the crate that contains the battery before continuing. The following figure displays the battery crate.

Effective April 1, 2016, IATA regulations (UN 3480, PI 965) require that air-shipped lithium ion batteries must be transported at a state of charge not exceeding 30%. To avoid total discharge, fully charge the battery immediately upon receipt. (The battery might arrive fully charged if it is not shipped by air.)

> **NOTE:** After receiving the battery, check its state of charge by pressing and holding in the push-button on the battery indicator. If the battery is in a low charge state, you must immediately charge to a full charge to avoid discharging the battery below a usable state, which would require battery replacement. For information on the battery indicator, see: Battery Indicators and Controls on page 184.

> **WARNING:** PERSONAL INJURY RISK
> Use safe lifting practices when removing or installing the battery.

> **IMPORTANT:** The battery weighs 68 kg. There must be at least 3 persons lifting the battery.

	Description	Image
A	Crate top cover - to be used as a ramp	
B	Crate front panel	
C	Base pallet	
D	Latches	
E	Protective foams	

The following figures display dimensions of the battery crate. All dimensions are in mm.
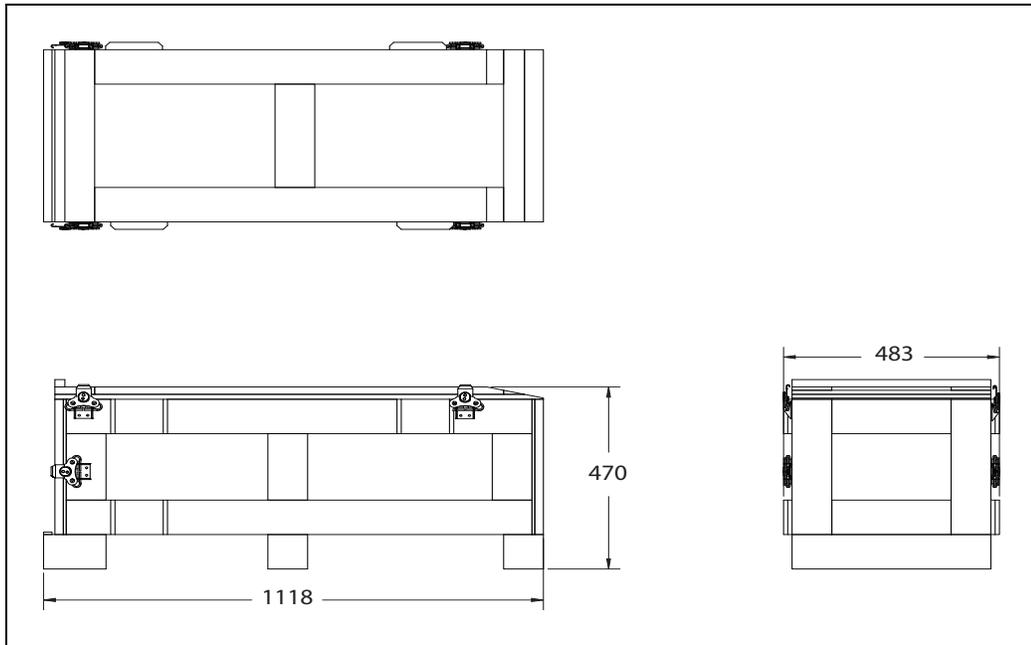
Figure 3-24. Battery Crate Outer Dimensions
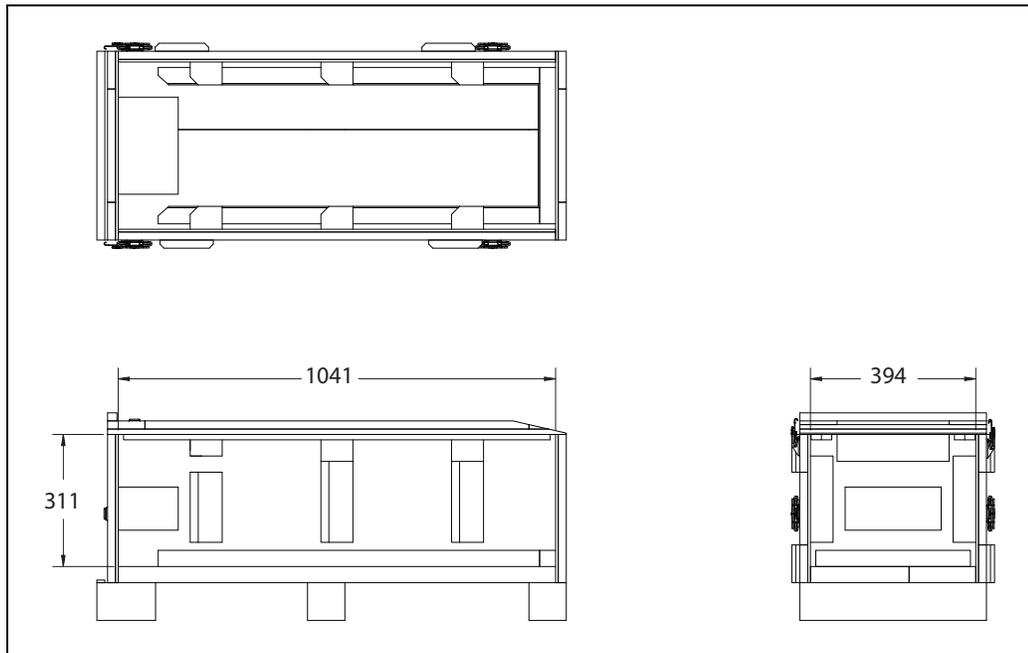
Figure 3-25. Battery Crate Inner Dimensions
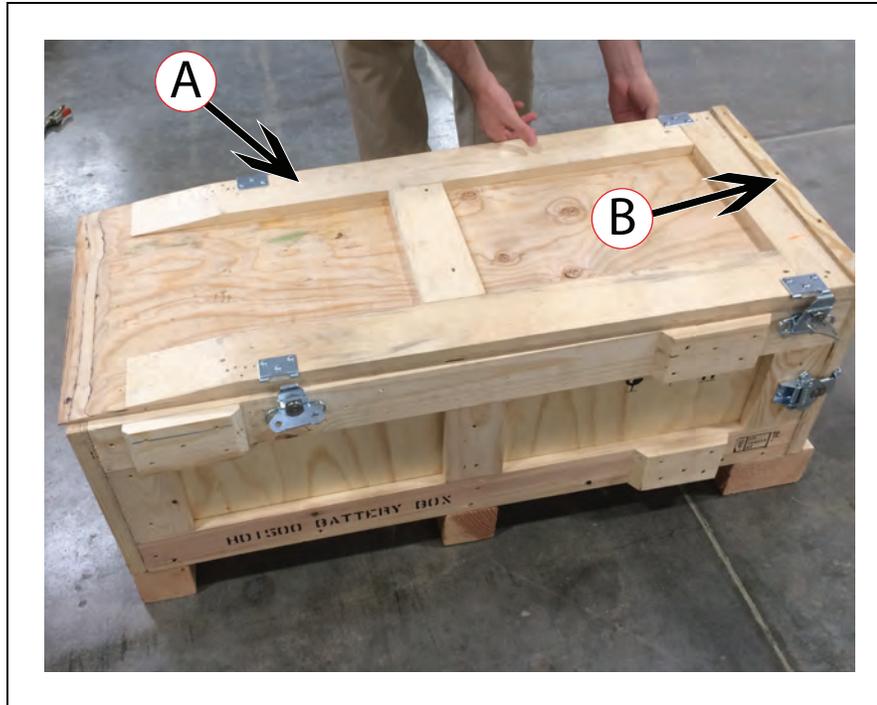
Figure 3-26. Battery Crate, (A) Top Cover (used as a ramp), and (B) Front Panel

Follow these steps to remove the battery from its shipping crate:

1. Unlock the top cover latches by twisting them, as displayed in the following figure.

Figure 3-27. Twisting the Latch to Unlock the Top Cover

2. Lift the top cover and remove completely, and set aside. You will use the top cover as a ramp to move the battery out of the crate, and onto the floor.

Figure 3-28. Removing the Top Cover

3. Unlock the front panel latches (similar to how it was done for the top cover), and remove the front panel.

Figure 3-29. Unlatching the Front Panel

Figure 3-30. Removing the Front Panel

4. Place the rear edge of the top cover over crate's front edge as displayed in the following figure. This allows you to use the top cover as a ramp.

Figure 3-31. Using the Top Cover as a Ramp

5. Next, remove the protective foams from the top cover.
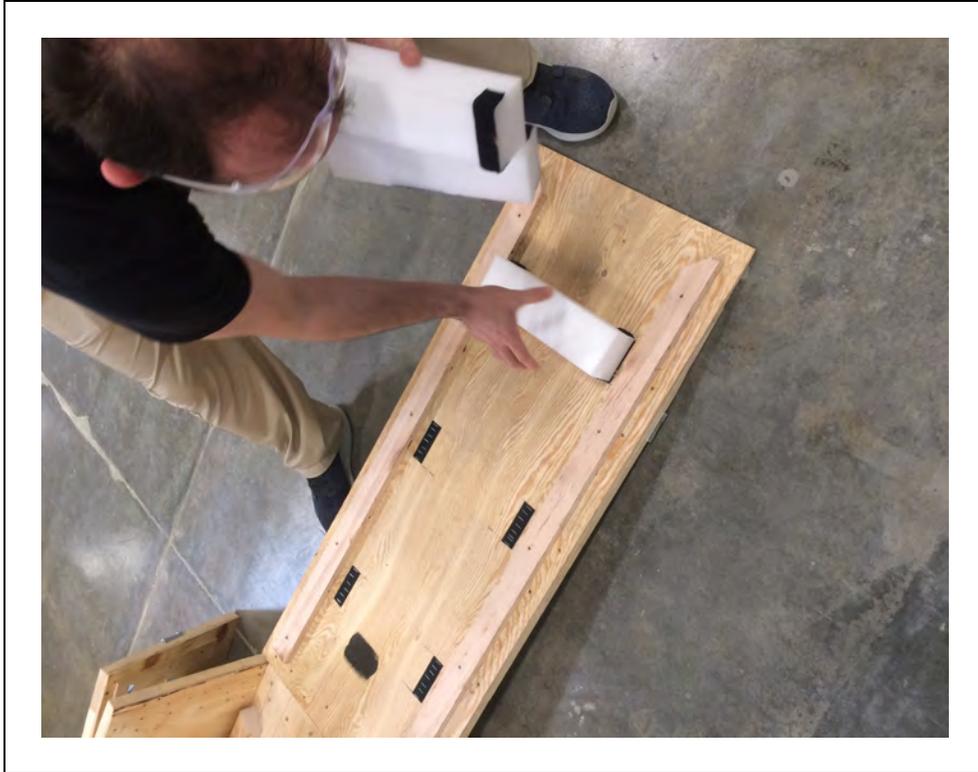
Figure 3-32. Protective Foams Removed

6. The battery has a handle that can extend out. Unlatch the battery locks and extend the handle out.
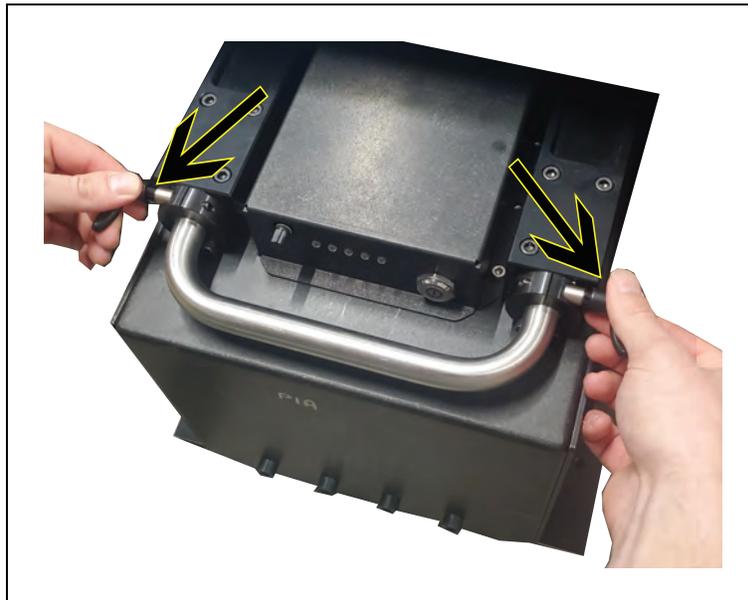
Figure 3-33. Unlatching the Battery Locks
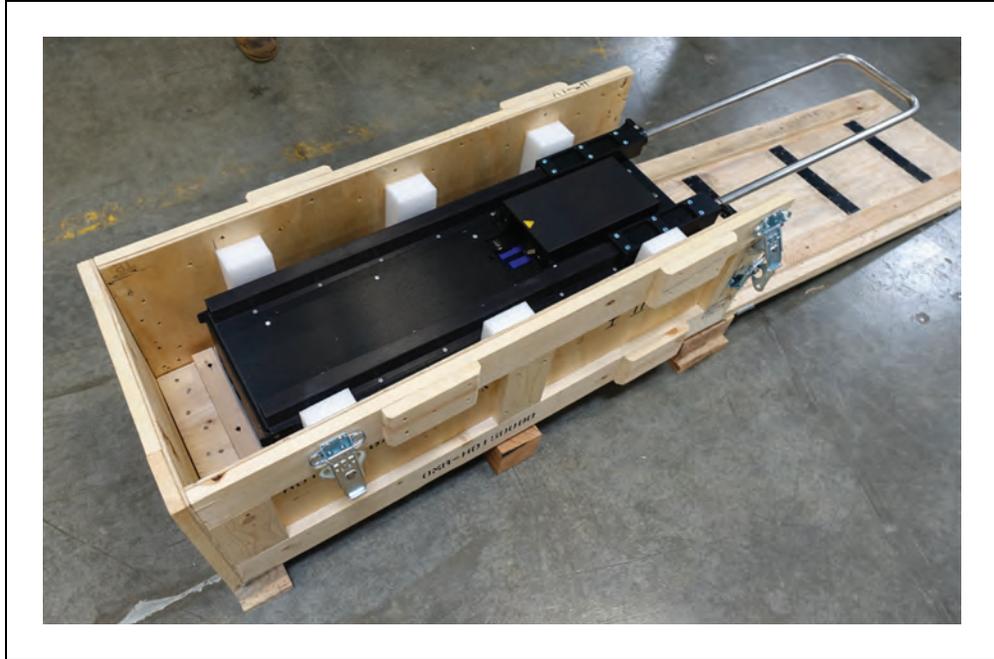
Figure 3-34. Extending the Battery Handle Out

7. Grab the extended handle, and pull the battery out of the crate and onto the ramp. The battery has two wheels on the back. These wheels allow you to roll the battery on the floor and carry it similar to how would you carry a suitcase.
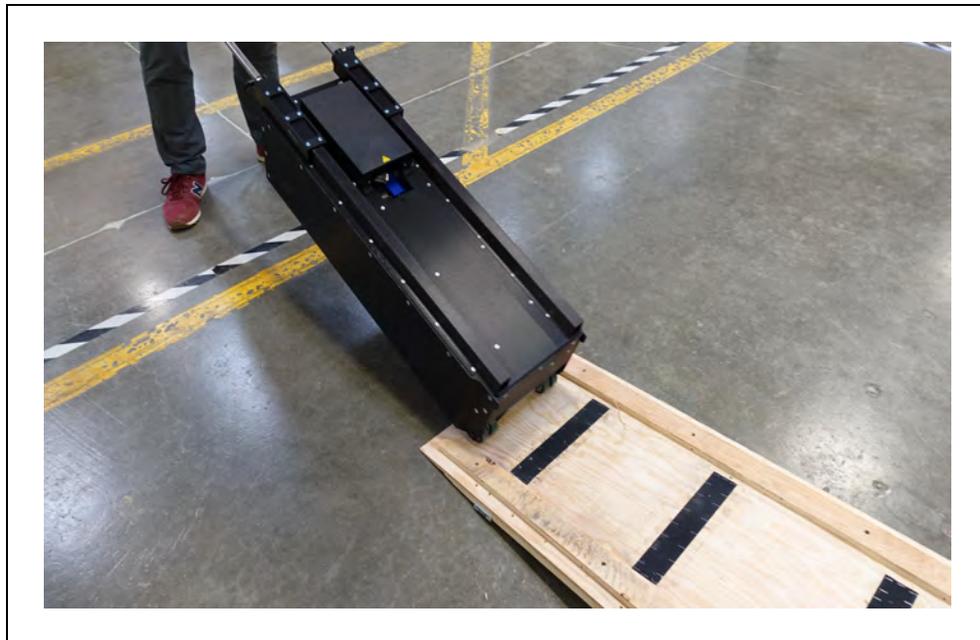
Figure 3-35. Rolling the Battery Down the Ramp

Figure 3-36. Battery Case Roller Wheels

After unpacking, you may install the battery in the platform. For information on how to install the battery, see: Installing the Battery on page 104.

Docking Target Unpacking

The docking target ships in a separate crate, and is not included in the HD-1500 crate. The docking target crate measures 1565 x 806 x 533 mm, and weighs 104 kg. The following figures display the docking target crate.

CAUTION: PERSONAL INJURY RISK
Use safe lifting practices when moving/lifting the docking target.

IMPORTANT: The docking target weighs 39 kg. There must be at least 2 persons lifting the docking target.

	Description	Image
A	Crate housing	
B	Crate front panel	
C	Base pallet	
D	Protective wood	
E	Wooden board	
F	Protective foam	

The following figures display dimensions of the docking target crate. All dimensions are in mm.
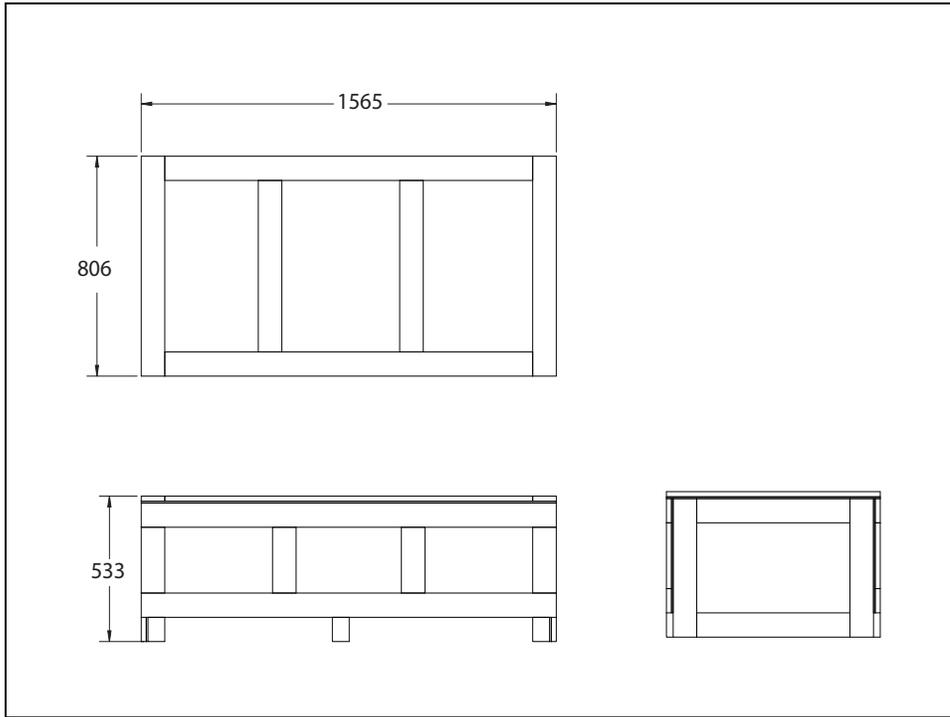
Figure 3-37. Docking Target Outer Dimensions
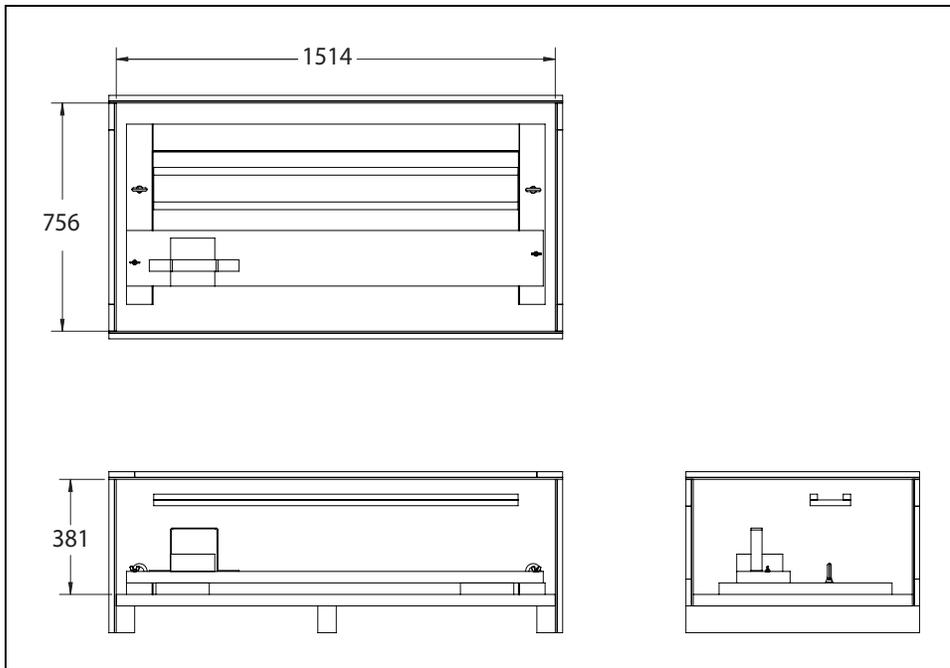
Figure 3-38. Docking Target Inner Dimensions

Follow these steps to remove the docking target from its shipping crate:

1. Remove the brackets holding the front panel to the housing crate using a screwdriver or any tool that allows you to pop open the brackets.

Figure 3-39. Brackets Holding the Front Panel to the Housing Crate

2. Remove the front panel.

Figure 3-40. Front Panel Removed

3. Remove the screws attaching the housing crate to the base pallet using a 13 mm socket with impact driver.

4. Next, remove the housing crate by pulling it away.

Figure 3-41. Housing Crate Removed

5. Loosen the strap securing the protective wood on top of the docking target. You can loosen the strap by unbuckling the strap lever, and then pulling the lever all to the to the end of the strap.

6. Once the strap is loosened, remove the protective wood along with the strap.

Figure 3-42. Protective Wood and Strap Removed

7. Untighten the bolts attaching the wooden board to the base pallet. Then, unstrap the protective foam, and remove the wooden board.

The protective foam prevents damage to the charging paddle during vibration or shock.

> **IMPORTANT:** Take care not to damage/scratch the copper charging pads during unpacking.
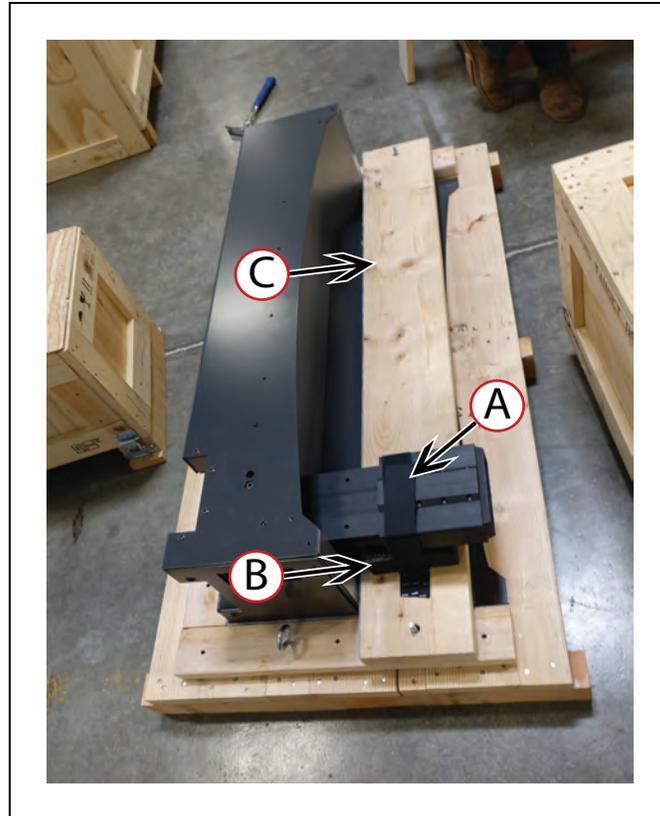
Figure 3-43. (A) Strap Holding the Protective Foam, (B) Protective Foam, and (C) Wooden Board

Figure 3-44. Bolt Securing the Wooden Board to the Base Pallet

8. Then, using lifting recesses, located on each side of the docking target, lift and place the

docking target on the ground.

Figure 3-45. Lifting Recesses on the Right and Left Side of the Docking Target

After unpacking, you may install the docking target to your designated location in the facility. For information on how to install the docking target, see: Installing the Charging Station on page 110.

Power Supply Box Unpacking

The power supply box ships in a separate crate, and is not included in the HD-1500 crate. The power supply box crate measures 1092 x 610 x 1454 mm, and weighs 165 kg. You must use a rated device to move the crate.

The following figures display the power supply box crate.

IMPORTANT: The pallet jack, overhead hoist or forklift used to lift the power supply box crate must be rated for at least 1100 kg.

CAUTION: PERSONAL INJURY RISK
Use safe lifting practices when moving the power supply box.

IMPORTANT: The power supply box itself weighs 105 kg. There must be at least 3 persons lifting the power supply box.

Description		Image
A	Crate housing	
B	Crate front panel	
C	Plywood base pallet	

The following figures display dimensions of the power supply box crate. All dimensions are in mm.
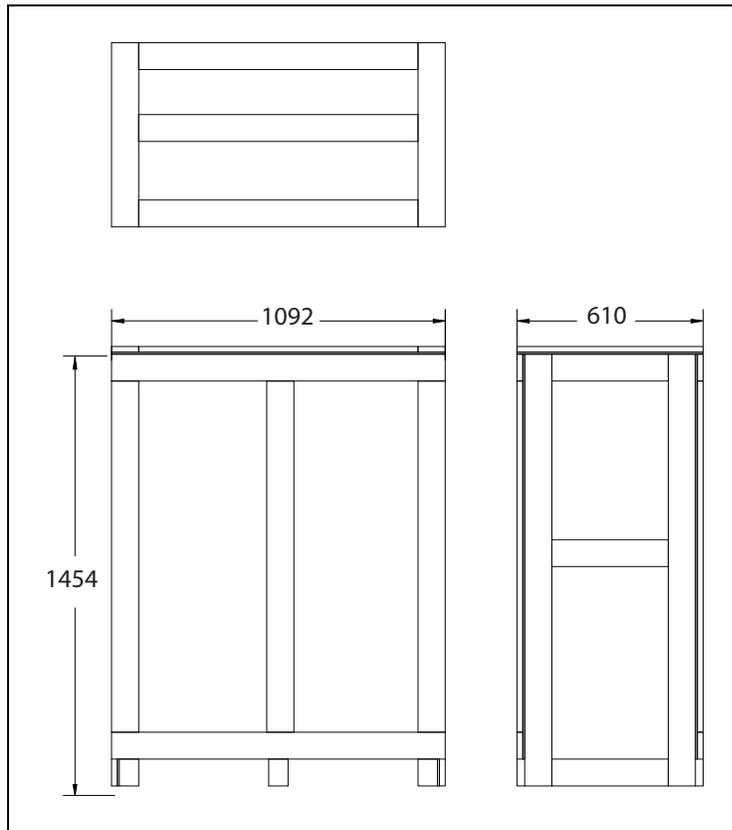
Figure 3-46. Power Supply Box Outer Dimensions
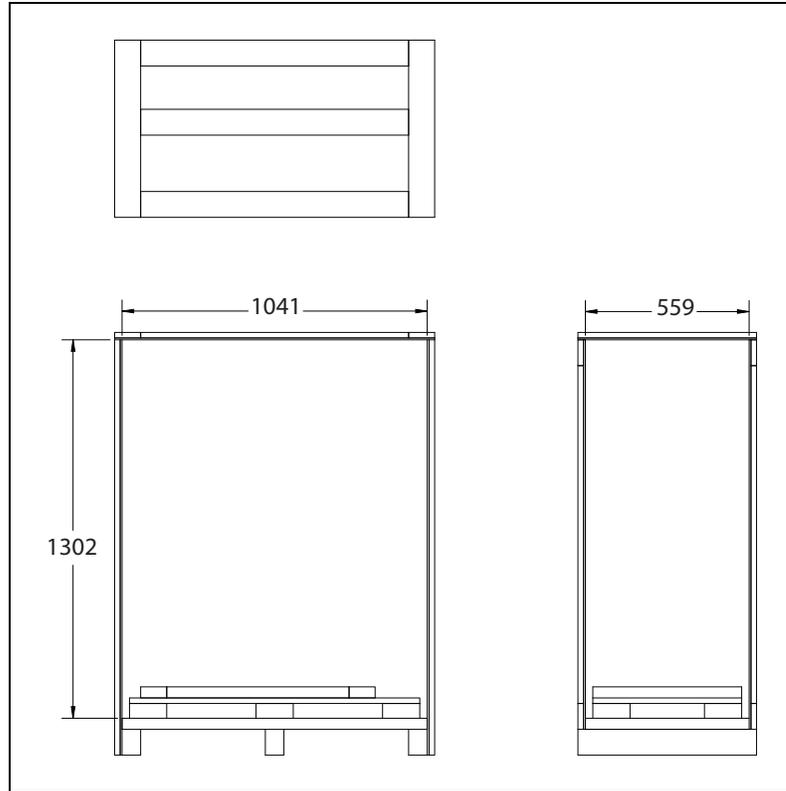
Figure 3-47. Power Supply Box Inner Dimensions
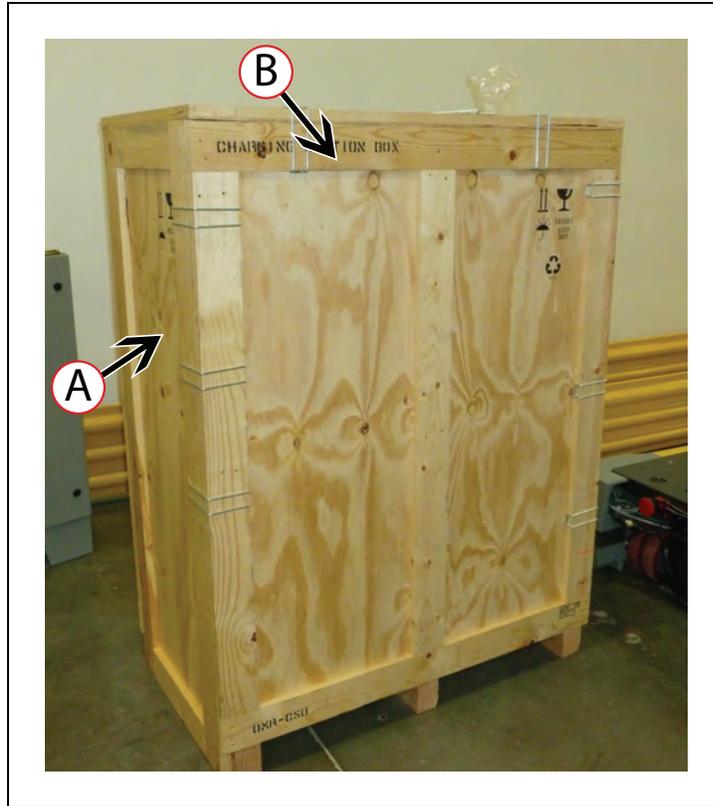
Figure 3-48. Power Supply Box Shipping Crate, (A) Crate Housing, and (B) Front Panel

Follow these steps to remove the power supply box from its shipping crate:

1. Remove the clips holding the front panel to the housing crate using a screw driver or any tool that allows you to remove the clips.

Figure 3-49. Removing the Clips

2. Pull the front panel and remove completely.

Figure 3-50. Removing the Front Panel

3. Remove the screws attaching the base pallet to the housing crate, using a 13 mm socket with impact driver.
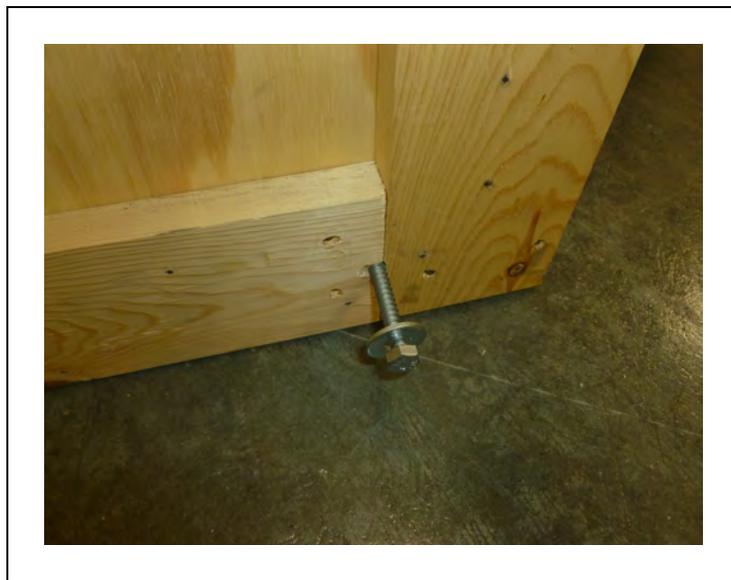
Figure 3-51. Removing the Screws Attaching Base Pallet to the Housing Crate

4. Remove the plastic wrap covering the power supply box.

Figure 3-52. Remove the Plastic Cover

5. Pull and remove the housing crate as displayed in the following figure.

Figure 3-53. Pulling the Housing Crate Away

6. Then, remove the six bolts attaching the power supply box to the base pallet, using a 14 mm socket wrench.

Figure 3-54. (3) Bolts on Each Leg

Figure 3-55. Removing the Bolts Attaching the Power Supply Box to the Base Pallet

7. Next, attach the safety-rated slings to the two eye bolts on the power supply box, as displayed in the following figure.

> ⚠ **WARNING:** PROPERTY DAMAGE RISK
> The slings must be evenly distributed to ensure that the power supply box is leveled when lifted up.

Figure 3-56. Passing the Safety-Rated Slings Through the Eye Bolt

Figure 3-57. Safety-Rated Slings Attached to the Power Supply Box

8. Using a rated crane or forklift carefully lift the power supply box off the base pallet. Then, gently and safely place on the ground.

> **IMPORTANT:** The crane or forklift must be rated for at least 1100 kg.

> **IMPORTANT:** It is the end user's responsibility to ensure that the person operating the crane or forklift, has successfully completed the required training, and is certified to operate these machines.

After unpacking, you may install the power supply box to your designated location in the facility. For information on how to install the power supply box, see: Installing the Charging Station on page 110.

3.5 Installing the Battery

Your HD-1500 ships fully-assembled, excluding its battery. Air shipping regulations require that the battery is packaged and shipped separately.

> **IMPORTANT:** You may only use the OMRON-supplied battery for the HD-1500 AMR.

Installation

Before you begin, press an E-Stop button and turn the HD-1500 off.

Make sure you install a fully-charged battery. For instructions on checking the battery's state of charge, see: Battery Indicators and Controls on page 184.

⚠️ **WARNING:** PERSONAL INJURY RISK
Use safe lifting practices when removing or installing the battery.

IMPORTANT: The battery weighs 68 kg. There must be at least 3 persons lifting the battery. For rolling the battery around, one person is sufficient.

IMPORTANT: You must wear proper Personal Protective Equipment (PPE) for lifting, and installing the battery.

Follow these steps to install the new battery:

1. Remove the AMR front skin to access the battery compartment. For instructions on removing AMR skins, see: Removing and Installing Skins on page 253

2. Unlatch and open the battery door. The battery door opens completely and rests on the floor. This allows you to use the battery door as a ramp as shown in the following figure.
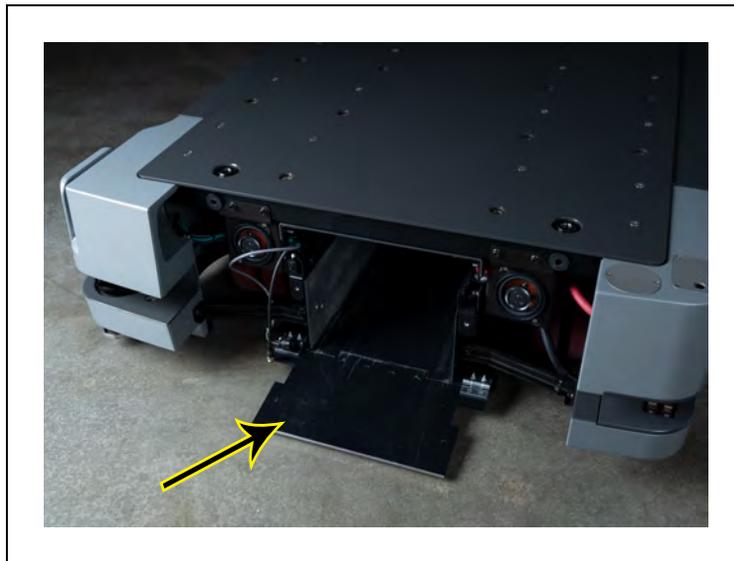
Figure 3-58. Battery Door Opens Out

3. Use the extended handle to push the battery into the platform. See: Figure 3-59.

   As the battery gets pushed in, the power connector installed on top of the battery case makes a blind-mate connection with the power connector attached to the chassis.

Figure 3-59. Lifting the Battery and Pushing into the Platform

4. Collapse the handle before pushing the battery all the way into the platform.
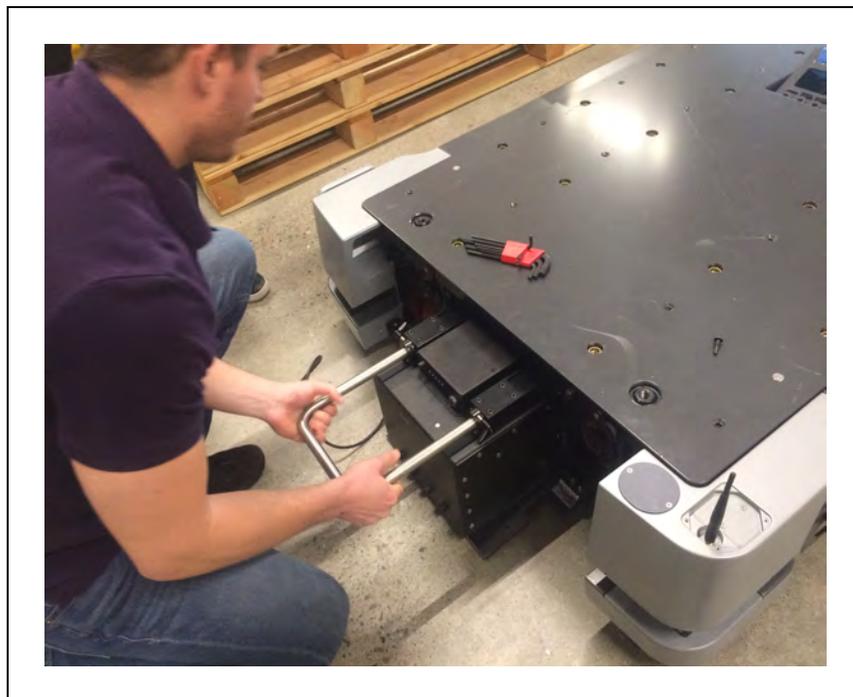
Figure 3-60. Collapsing the Battery Handle

5. Lock the two latches to secure the battery handle in place.

Figure 3-61. Locking the Handle Latches

6. Next, connect the Ethernet cable to the battery indicator box, as shown in
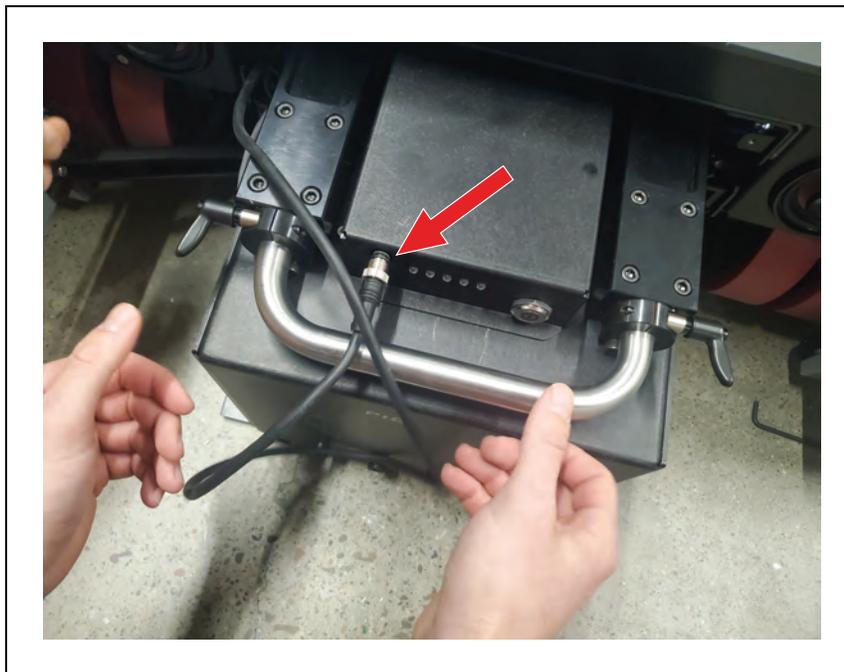
Figure 3-62. Ethernet Cable Connected to the Battery Indicator Box

7. Push the battery all the way in, and close the battery door. Take care not to tangle or crush the Ethernet cable when pushing the battery into the platform.
The battery door holds the battery tightly in place, and keeps it from shifting inside the

compartment.

8. Install the AMR front skin. See: Removing and Installing Skins on page 253.

Do not power on the HD-1500 until you have read the appropriate sections of this user's guide.

3.6 Attaching the Payload Structure and Options

You must perform a complete risk assessment for your payload structure design, and the new intended use of the AMR prior to its operation.

Attach the Payload Structure

You will need to attach the payload structure you designed and built to the platform. Because the payload structure is user-designed, OMRON only provides the mounting hole pattern information. Refer to: Payload Dimensions and Design on page 139.

For information about power, data signal, and warning light connections, see: Connectivity on page 150.

> **IMPORTANT:** If any portion of your payload structure extends beyond the footprint of the AMR, you must contact your OMRON representative for assistance with modifying the safety zones.

Attach the No Riding Warning Label

Two No Riding labels ship, unattached, with each platform. You must place them in a prominent location on a flat, horizontal surface on the payload structure or platform itself where a person could sit or stand. The labels should be placed where the operators will see them, and must be visible from at least two opposing sides of the platform.

When replacing the payload, you must place the No Riding labels on the new payload surface and follow the instructions noted above.

Other warning labels are applied at the factory.

Attach HD-1500 Optional Devices

If you ordered optional devices that shipped separately or were detached for safety, you need to attach them. See: User Access Panel Connections on page 155.

You can also attach your user-supplied devices. See: Optional Connections on page 148.

> ⚠ **WARNING:** PERSONAL INJURY OR PROPERTY DAMAGE RISK
> If the optional Side Lasers are purchased, the user must ensure that the payload structure does not obstruct the side lasers' field of view. This will affect the function of the Side Lasers, and reduce their effectiveness in detecting obstacles.

E-Stop Jumper on the User Access Panel

The user access panel requires either of the following attached to the SCPU port (User Safety Interface):

- An E-Stop jumper part number 68410-218L, or

- User-supplied E-Stop button (category 1 stop) along with a sensor

See: SCPU on page 161.
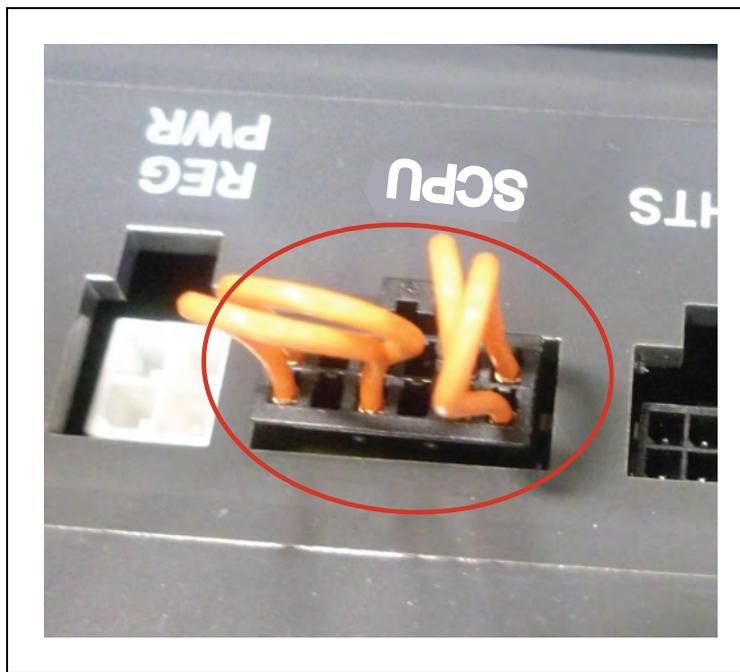
Figure 3-63. Jumper Installed in the SCPU Port (User Safety Interface)

Warning Buzzer

The LIGHTS port on the user access panel can support a user-supplied warning buzzer. See: User Access Panel Connections on page 155, and LIGHTS on page 163. You can install it in either the platform or in a location of your choice in your payload structure.

How you install the buzzer in the payload structure depends on the payload design, and is not covered here. To conform to applicable standards, the buzzer must be audible in all operating conditions and environments. Also, the buzzer shall be audible above the ambient noise of the environment that the HD-1500 operates in. It is the end-user's responsibility to verify this requirement.

Warning Light

Each AMR should have a visible flashing light, to warn people that the AMR is ready to move or is moving. The exact implementation of this warning light depends on the design of your payload. Use the LIGHTS port on the user access panel to power and control the warning light. See: User Access Panel Connections on page 155 and LIGHTS on page 163.

Make sure that the light remains visible under all operating conditions, and from all sides so that people can always see it. Consider the design of your payload structure for warning light visibility, including when the AMR is transporting objects.

3.7 Installing the Charging Station

The automated charging station can either manually or automatically charge your HD-1500's battery according to the charging parameters you set in MobilePlanner.

Install the charging station (power supply box, and the docking target) on a flat and level floor, in a location that is kept clear and is easily accessible to AMRs. If you have more than one AMR, make sure that your map contains features such as parking spaces or queuing lanes to accommodate AMRs that are approaching and leaving the charging areas.

The docking target's charging paddle is spring-loaded to accommodate slight variations in the floor surface.

Considerations and requirements when installing the charging station are described below.

- Temporarily use the docking target *free standing* (without fasteners). Do this only for testing or experimenting with the location of your charging station.

- The docking target's power connector ((**B**) in Figure 3-65. can install either horizontally, or vertically. There is a groove on the back of the docking target that allows you to reach the power connector, and connect the power cord sideways from either side of the docking target. See: Figure 3-74.

- The facility power cable ((**C**) in Figure 3-67. must be secured to the Figure 3-67.

- The docking target must be installed in a location where it allows for at least 2 m of clearance from the center of the HD-1500 all around. This is to ensure safe maneuver of the HD-1500 during docking.

- The power supply box must only be installed vertically, using floor mount holes to anchor to the floor or wall mount holes to secure to the wall.

⚠️ **WARNING:** FIRE RISK
The vertical installation of the power supply box allows for heat dissipation which prevents overheating and possible fire danger. Therefore, the horizontal installation of the power supply box is not allowed.

- Since the power cord is only 4 meters long, the docking target and the power supply box should be installed fairly close to each other.

- The power supply box air vents (top and bottom) must not be blocked. Blocking the air vents will trap the air inside the power supply box which could be hazardous since it

interferes with power supply box's cooling process. Refer to Power supply box cooling duct on page 227 for location of the air vents.

Required Tools and Fasteners

The tools and fasteners required for the installation of the charging station are described in Table 3-5. below.

> **IMPORTANT:** If you do not use appropriate fasteners for sustained use, the docking target will move during the docking attempts, causing docking and charging failures. The docking target mounting holes are 9 mm in diameter.

Table 3-5. Required Tools and Fasteners

Size	Qty	Description
As required	As required	Appropriate screwdriver, hex socket, or driver bit for the fasteners that you supply. (user-supplied)
M12	6	M12 bolts - used to anchor the power supply box to the floor. (user-supplied)
M12	6	M12 Fender washer - used with M12 bolts. (user-supplied)
M10	4	M10 bolts - used to mount the power supply box to the wall. (user-supplied)
M10	4	M10 washer - used with the M10 bolts. (user-supplied)
M8	8	M8 bolts - used to mount the docking target to the floor/wall. (user-supplied)
N/A	8	Docking target mounting brackets. (OMRON-supplied, part number 68910-105)
N/A	1	Cable clampFigure 3-67.

Charging Station Features and Parts

The HD-1500 charging station consists of two main parts: the power supply box, and the docking target. The docking target is the charging device that the AMR drives itself into, and mates with the charging paddle as shown the following figure. The power supply box, transfers power to the docking target using a power cord.
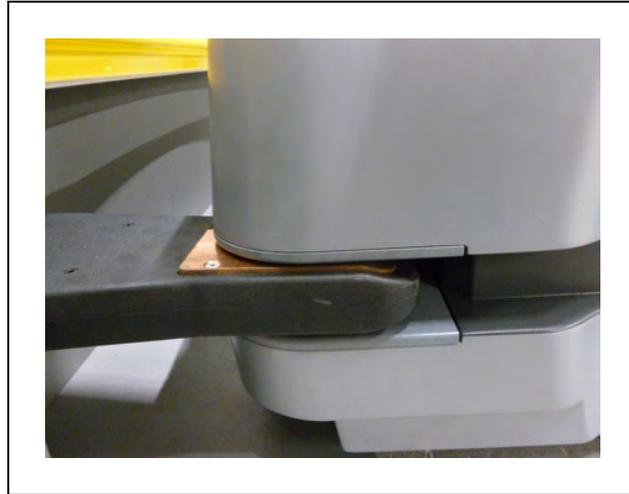
Figure 3-64. AMR Mating with the Charging Paddle

Docking Target - Features and Parts
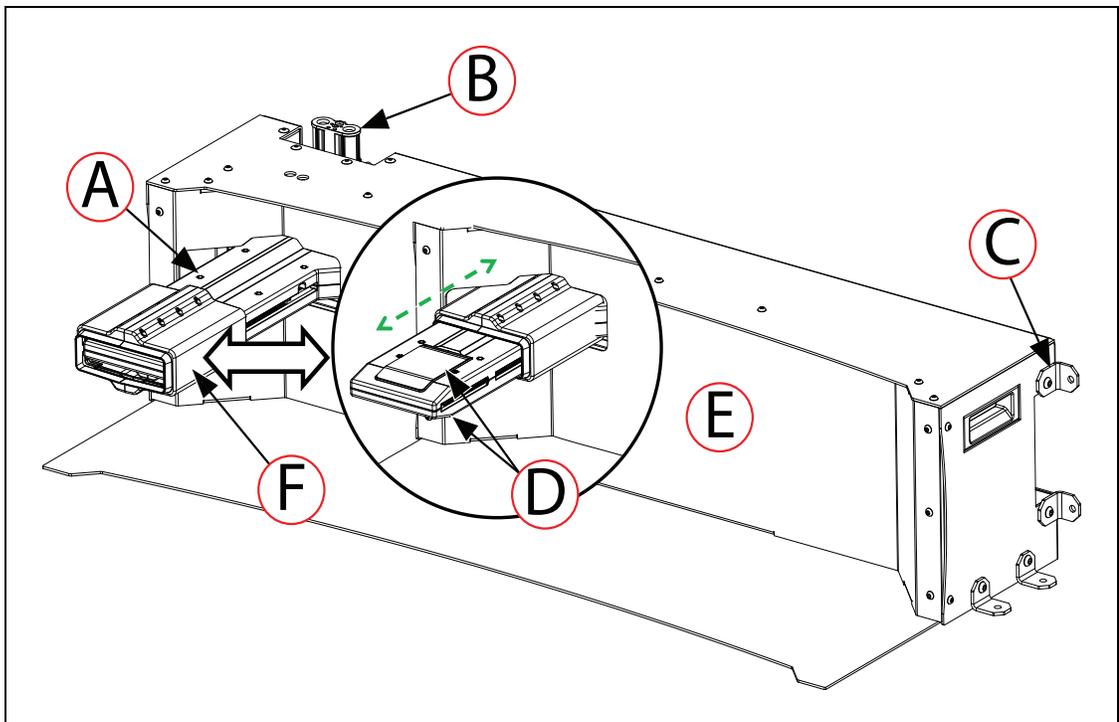
Figure 3-65. Docking Target - Features and Parts

Callout	Description	Callout	Description
A	Charging paddle	D	Copper charging pads (screwed to the top and bottom of the charging paddle)
B	Power connector	E	Trapezoid docking target. The trapezoidal shape of the docking target provides a laser reflection as a navigation cue for the AMR, enabling it to align itself accurately for charging.
C	Mounting brackets x8 (M8 bolts)	F	Retractable cover

Docking Target - Dimensions
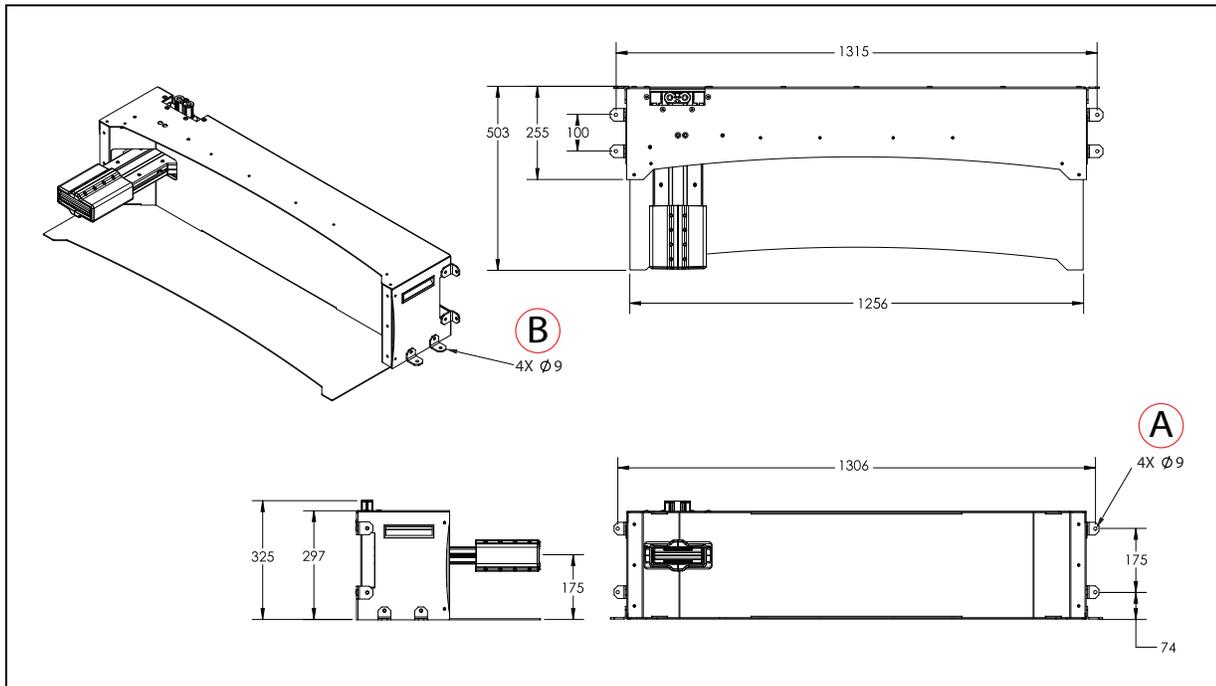
Figure 3-66. Docking Target Dimensions, (A) Wall Mount Brackets, and (B) Floor Mount Brackets (units are in mm)

Power Supply Box - Features and Parts
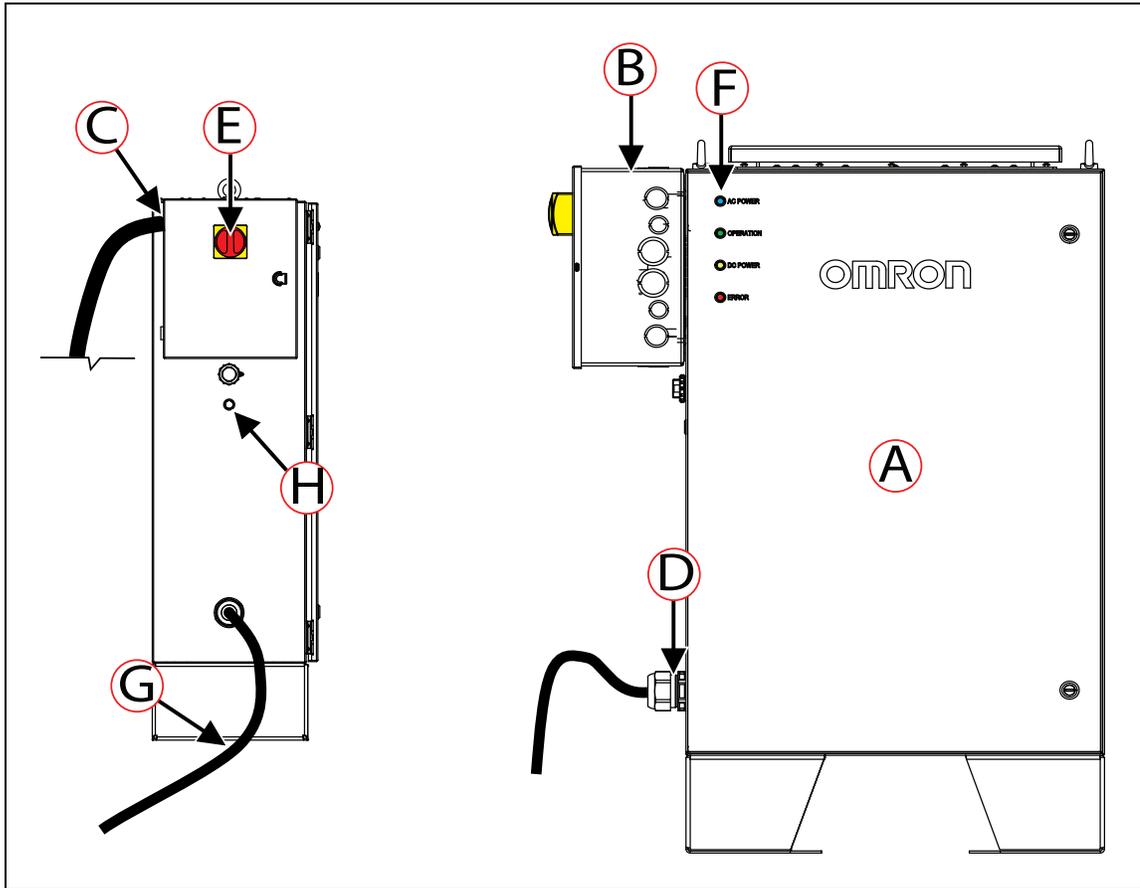
Figure 3-67. Power Supply Box - Features and Parts

Callout	Description	Callout	Description
A	Main electrical compartment	E	Main disconnect switch
B	Electrician access box	F	LED indicators
C	Facility power cable (user-supplied)	G	Outlet power cable
D	Output power cable strain relief (user-supplied)	H	Push button

There are four LED indicators on the power supply box, as displayed in Figure 3-67. For information on the power supply box LED indicators, see: Indicators, Controls, and Connections on page 189.

Power Supply Box - Dimensions

The following figure provides dimensions of the power supply box.
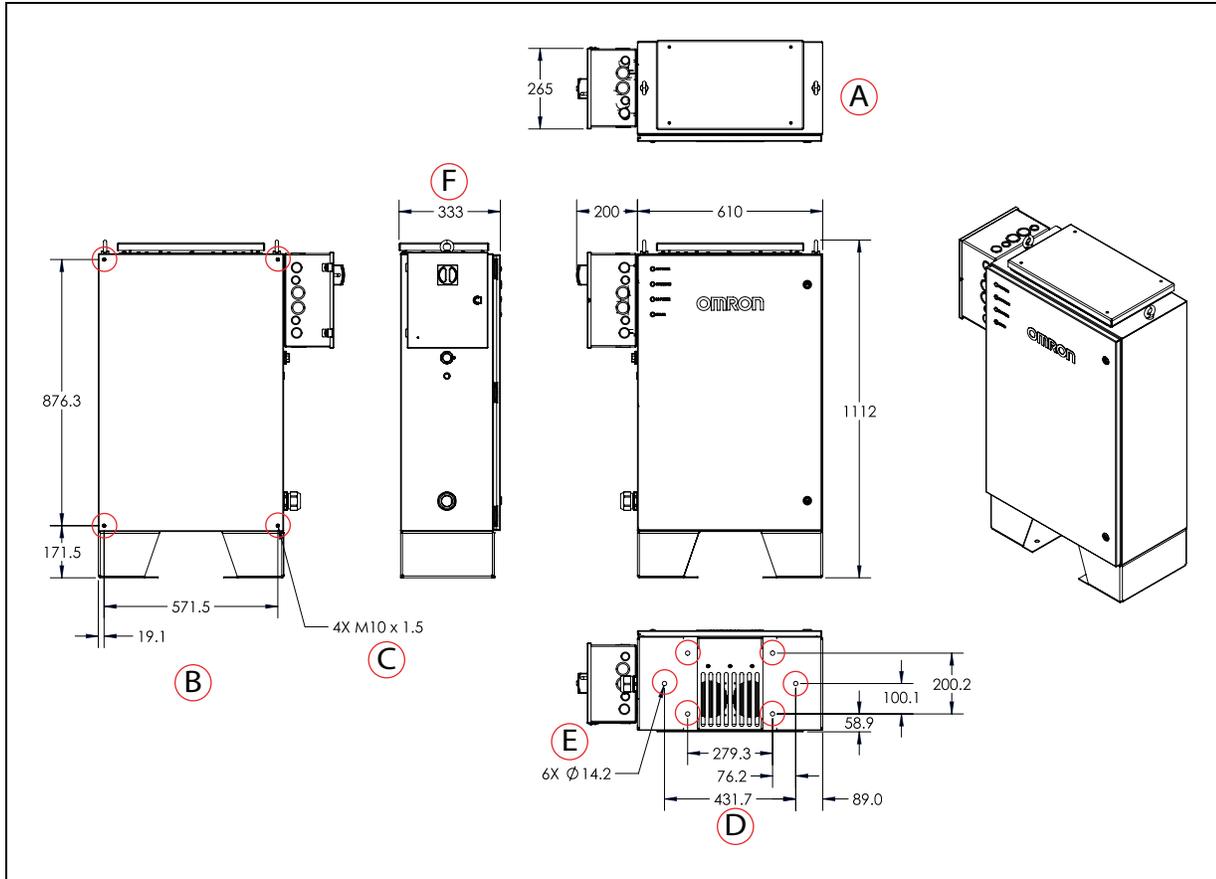
Figure 3-68. Power Supply Box Dimensions, (A) Top View, (B) Back View, (C) Wall Mount Holes, (D) Bottom View, (E) Floor Mount Holes, and (F) Side View (units are in mm)

Per relevant safety standards the working space around the power supply box shall allow for:

- at least 90 degrees clearance for the electrician access box door and the main electrical compartment door to swing open.

- at least 1 meter of clear space in front of the electrician access box and main electrical compartment. This distance is measured from the face of the electrician access box door and the main electrical compartment door.

Charging Station Environmental Requirements

- Ambient temperature range: 5 to 40°C

- Humidity: 5% to 95%, non-condensing

- Power supply box IP rating: IP20

- Docking target IP rating: IP20

> **NOTE:** The IP rating for the copper charging pads is IP10. Do not expose them to liquid.

Power Supply Box Installation

The power supply box can be mounted directly to the floor, or to the wall using user-supplied screws. For dimensions of the available mounting holes, refer to Figure 3-67. OMRON recommends using screws that are suitable for the substrate (wood, concrete, etc.).

Facility Electrical Installation

The power supply box is a permanently connected equipment, and therefore, the user must supply the power cord transferring power from the facility into to the electrician access box. The user must punch a hole through the back of the electrician access box (location (**C**) in Figure 3-67.), and install the user-supplied strain relief for the power cord. The strain relief attaching to the electrician access box is a user-supplied part, and shall be sized appropriately for the user-supplied power cord.

As displayed in Figure 3-67. the main disconnect switch is located on the electrician access box, and controls electrical current flow into the power supply box. When the switch is in the horizontal position, it is off and when it is in the vertical position it is on. See: Figure 7-10. The power supply box input electrical power is protected by a 25 A branch rated circuit breaker.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
The strain relief and the power cord must be installed by a licensed or appropriately certified electrician.

WARNING: PERSONAL INJURY RISK
You must make sure that the power cord connecting the power supply box to the docking target is visible as it poses tripping hazard.

The power supply box main electrical compartment ((**G**) in Figure 7-10.

The following table provides the necessary specifications for the electrical installation of the power supply box:

Description	Specification
Input current, max	25 A
Output current	120 A (nominal) Fused at 150 A
Input voltage	3 phase power 200-240 VAC, 50/60 Hz - Delta/Wye 380-415 VAC, 50/60 Hz - Wye
Output voltage	40-57 VDC
Input power consumption	7.75 kW
Max output power	6.84 kW
Frequency	50/60 Hz

Description	Specification
Short circuit current rating (SCCR)	5 kA
Branch circuit protection current	25 A
Type/material of Conductors (user-supplied)	Copper conductors only

The following figures provide the wiring connection configuration of the facility to the electrician access box.

WARNING: ELECTRICAL SHOCK RISK, FIRE RISK
You must configure, and connect the facility wiring to the electrician access box according to Figure 3-69. Wiring misconfiguration could potentially result in electric shock or fire.

Wiring Specifications

- Power is provided to the power supplies inside the electrician access box as (3) distinct phases derived from (3) phase input.

- Power supplies can withstand up to 305 VAC (nominal 277 VAC) on any given phase.

- Configuration depends on (3) phase scheme and voltage.

- Earth ground is separate, and always only ties to the ground distribution block.

- White wires are used to configure for delta or WYE input.

- Neutral terminal block accepts an abandoned neutral wire for the low voltage wye configuration.

- All field phase wires land into main disconnect switch. They do not directly go into the terminal.
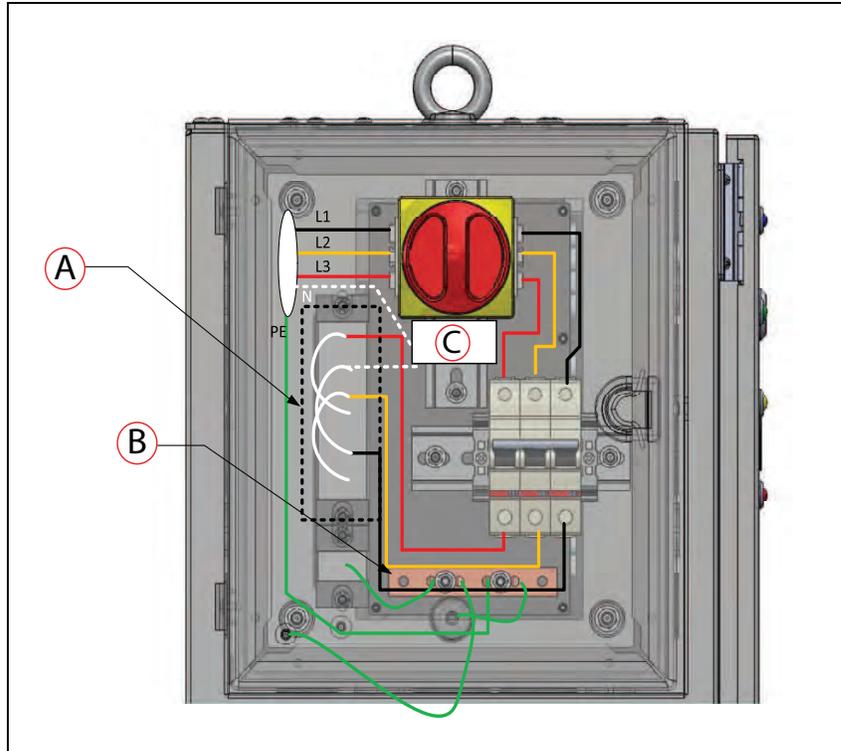
Figure 3-69. Electrician Access Box Wiring Configuration, (A) See AC Configuration Drawing for Details, (B) Ground Distribution Block, and (C) Neutral Terminal Block, (D) Input of Main Disconnect Switch, (E) Ground Bar Terminal, (F) Nuetral Conductor Terminal, (L) Configuration Jumpers
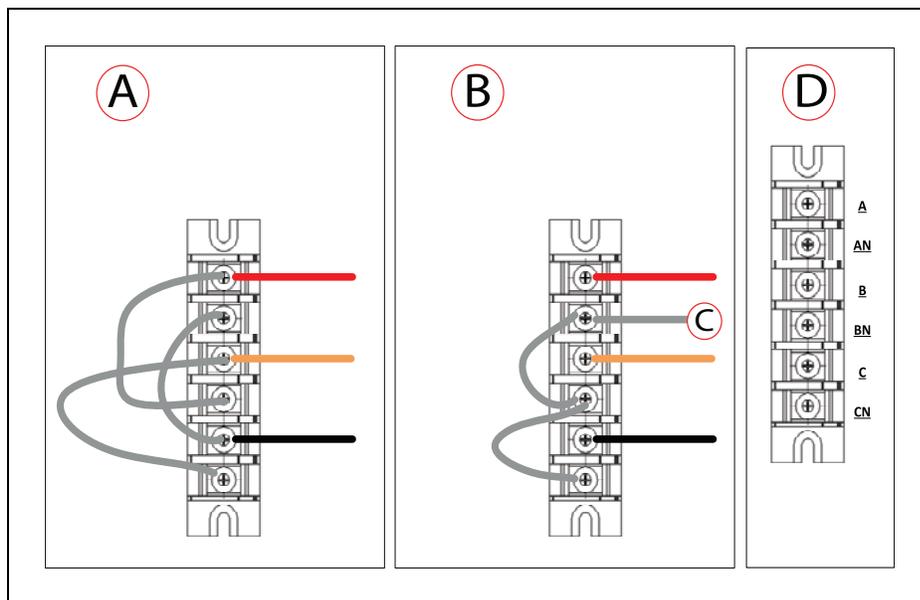
Figure 3-70. AC Configuration

ID	Description
A	Delta configuration

ID	Description
	• A Terminal jumps to BN • B Terminal jumps to CN • C Terminal jumps to AN
B	WYE configuration • Field neutral lands directly on the neutral terminal block • AN jumps to BN • BN jumps to CN
C	Field neutral
D	Net names

Voltage and Configurations

4 Wire Delta (jumper configuration as Delta)

- Supported down to 200 VAC
- Supported up to 240 VAC

5 Wire WYE (jumper configuration as WYE)

- Supported down to 380 VAC (line to line)
- Supported up to 415 VAC (line to line)

5 Wire WYE (jumper configuration as Delta)

- Supported down to 200 VAC (line to line)
- Supported up to 277 VAC (line to line)

Docking Target Installation

You can mount the docking target to the wall or to the floor, using OMRON-supplied mounting brackets. The docking target ships with the mounting brackets un-attached. If you cannot secure the wall brackets to a structural framing member with screws, use heavy-duty toggle (butterfly) bolts in drywall. Do not use drywall plugs or anchors.

The docking target power connector allows for horizontal and vertical connection of the power cord. Follow these instructions to change the orientation of the docking target power connector:

1. Remove four M6 screws ((**B**) in the following figure) attaching the power connector cover ((**C**) in the following figure), and the power connector ((**A**) in the following figure) to the docking target.

2. Then, remove the power connector and the cover completely.

3. Position the power connector in the desired orientation, and ensure that the power connector mounting holes are well aligned with the docking target mounting holes ((**D**) in the following figure).
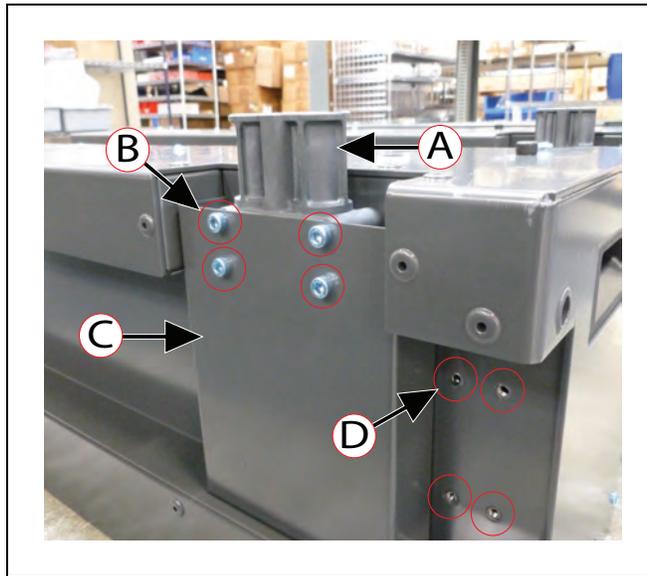
Figure 3-71. Repositioning the Docking Target Power Connector

Callout	Description	Callout	Description
A	Power connector	C	Power connector cover
B	M6 screws	D	Docking target mounting holes

4. Once the power connector mounting holes are well aligned with the docking target mounting holes, place the power connector cover over the power connector and screw them to the docking target.

Figure 3-72. Docking Target Power Connector Installed in Desired Orientation (Sideways)

Connect the power cord to its mating connector on the docking target as shown in the following figure, and ensure that the power cord connector is seated completely and secured. The power cord shall not lay in front of the docking target. It shall be properly protected, and must not pose any hazards to the users or equipments.
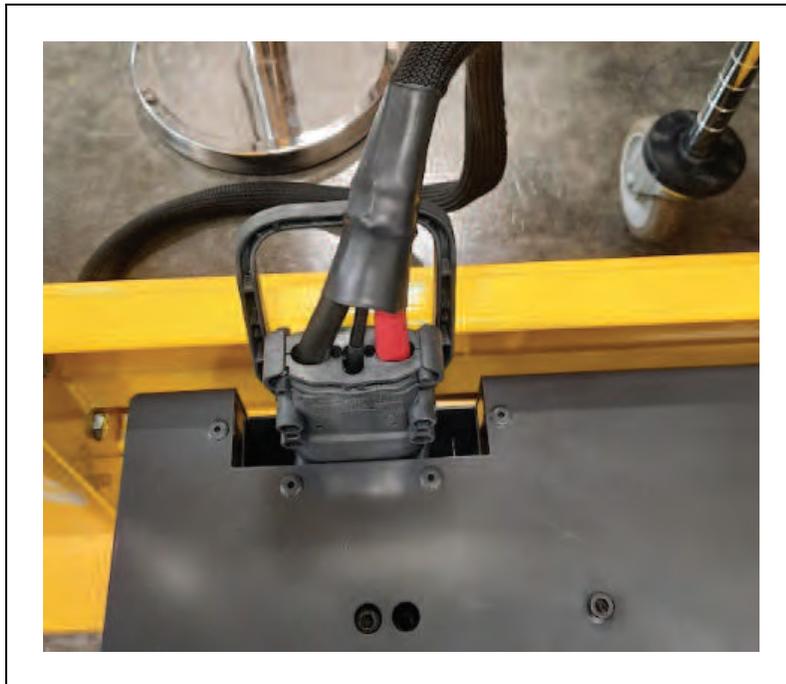
Figure 3-73. Power Cord Connected to the Docking Target Power Connector

NOTE: If you need to connect the power cord to the docking target power connector side ways, you must rotate it prior to mounting the docking target to the wall.

Screw the mounting brackets directly to the wall or to the floor, and tighten to 9 N·m. Use four M8 button-head cap screws.
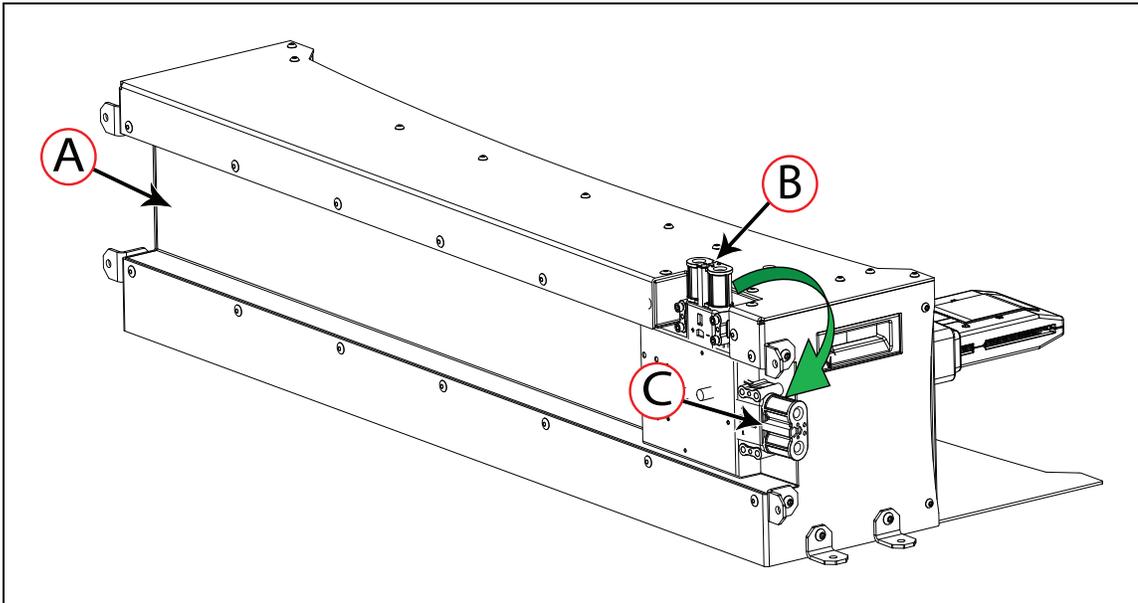
Figure 3-74. Rear View of the Docking Target, (A) Cut Out Groove For Side-way Connection, (B) Power Connector Installed Vertically, and (C) Power Connector Installed Horizontally

After you install the charging station:

1. Connect the power cord, from the power supply box to the docking target.

2. Turn the main disconnect switch to the ON position (vertical position). The blue LED indicator illuminates to indicate that power is present.

After you install the charging station, create a docking goal on the workspace map and configure your AMRs to use the docking target for recharging. See: *Fleet Operations Workspace Core User's Manual (Cat. No. I635)*.

Chapter 4: Configuration

This chapter describes the steps needed to configure your HD-1500.

Your HD-1500 ships with firmware and on-board software installed (EM2100 appliances have temporary licenses). If you need to add a feature, you must activate your licenses as described in the *Fleet Operations Workspace Core User's Manual (Cat. No. I635).*

The HD-1500 navigates using a digitized map of its workspace. You use the MobilePlanner client software on a Windows PC to create the map and download it to the HD-1500. Map creation is a required step before operation of the HD-1500.

You also use MobilePlanner to:

- Configure the HD-1500's operating parameters, which control its operation setup.

- Monitor and manually control the HD-1500 in addition to scheduling autonomous operation.

For more information, see: *Fleet Operations Workspace Core User's Manual (Cat. No. I635).*

Use SetNetGo's Web interface for other configuration and setup tasks such as configuring network communication. You can access the SetNetGo interface from within MobilePlanner, or through your preferred browser. This enables IT personnel to easily configure network settings without needing to know how to access and use MobilePlanner.

SetNetGo is also accessible through a direct RJ-45 Ethernet cable connection to the HD-1500's Maintenance Ethernet port. See: SetNetGo on page 24.

4.1 Settings and Configuration

Maintenance Ethernet Connection

To prepare an HD-1500 for autonomous mobile operation you must first configure its network. If you do not yet have wireless access, use the wired Ethernet port (Maintenance LAN) to connect MobilePlanner and set up the wireless network at a later time.

Also refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635).*

Default Network Settings

The HD-1500's network has the following default configuration. Your network administrator should review this information for compatibility with your existing network.

Table 4-1. HD-1500 Default Network Settings

Network Feature	Default Network Setting
Network Class	Class C
Netmask for all ports	255.255.255.0
Permanent Maintenance Ethernet IP address	192.254.10.15

Network Feature	Default Network Setting
Ethernet negotiation method	Auto-MDIX
Network method	Access Point (AP)
Identifier (SSID)	*Wireless Network*
Security method	Unsecured

Maintenance Ethernet Port Considerations

The following important considerations apply to the HD-1500's Maintenance Ethernet port:

- The HD-1500 Maintenance Ethernet port automatically assigns an IP address to the connecting PC.

- Do not connect the AMR's Maintenance Ethernet port to your LAN. OMRON intends that you use this port only for single connection for debugging or initial setup purposes. The User LAN port provides an Ethernet connection for your LAN.

- Access to the SetNetGo Web Interface is always enabled on this port. It does not require either a password or a software license.

Consult your network systems administrator before using SetNetGo to change any default settings. See the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for information about modifying network settings.

Configure the HD-1500's Network

To configure the HD-1500's network, you require:

- One Ethernet patch cable, minimum Cat-5 specification. This cable should be of sufficient length that you can connect your PC to the AMR and work comfortably.
- A PC with an available Ethernet port configured to use DHCP for IP address assignment.

Use the following procedure to set up the network on the HD-1500.

1. Connect an Ethernet cable from the Maintenance Ethernet port on the HD-1500 to an Ethernet port on your Microsoft Windows PC.
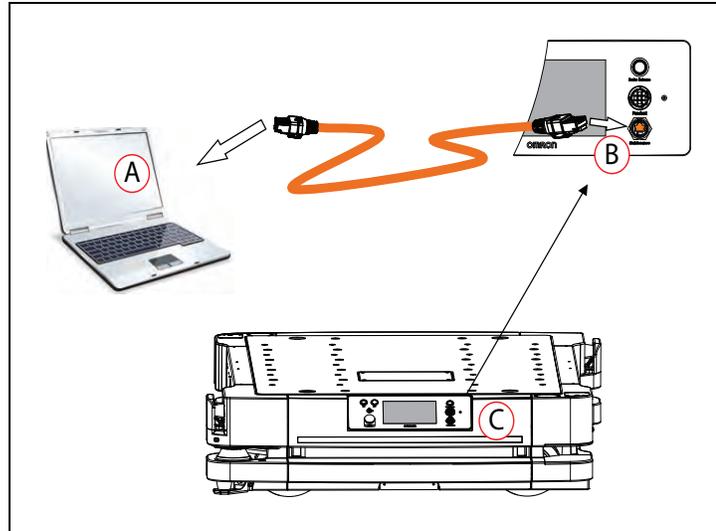
Figure 4-1. Connecting an Ethernet Cable

Callout	Description
A	Microsoft Windows PC with Ethernet port.
B	Maintenance Ethernet Port on the Operator Panel.
C	Operator Panel on the HD-1500.

2. Access the Network Connections area in Windows (this might appear differently depending on your version of Windows).

Figure 4-2. Network Connections Screen

3. Right-click on the **Ethernet** or **LAN Connection**.

4. Next, click **Status** and then select **Details**.

5. Make sure that the IPv4 address is in the range of 192.254.10.100 - 192.254.10.149.

6. Then, close the dialog boxes.

Test the TCP/IP port connection by accessing the SetNetGo Web Interface:

1. Open a Web browser on the PC and enter **https://192.254.10.15** as the URL.

2. If prompted to accept security certificates, confirm that you accept them.

3. Verify that the SetNetGo Web Interface opens.

Setting Up Wireless Ethernet

A single HD-1500 can operate without a wireless network. For example, if it is the sole AMR in a workspace and it does not need to share the workspace with other AMRs. However, if you have more than one AMR sharing the same workspace, you must manage them as a fleet. Fleet management requires continuous wireless network access. For more information, see: Fleet Manager, for Multi-AMR Coordination on page 268.

Before you configure wireless Ethernet on your HD-1500, contact your network administrator to confirm the IP, radio, and security settings.

Use one of the following methods to access the SetNetGo Web Interface:

*   Use the SetNetGo tab in the MobilePlanner software. See: *Fleet Operations Workspace Core User's Manual (Cat. No. I635).*

*   Open a Web browser on your PC and enter the URL: **https://192.254.10.15**, to connect directly to the SetNetGo Web Interface on your HD-1500. This enables your network administrator to set up the network for you.

Access the SetNetGo OS through the MobilePlanner software:

MobilePlanner > SetNetGo > Networking

> **NOTE:** You can use a web browser to connect directly to the SetNetGo OS on a platform. This allows your IT support to set up the network for you, without using MobilePlanner.

Set Up a Wireless Network on the Management Interface

To set up the wireless network, you need the following resources. Discuss this with your network administrator and use the following the table as a worksheet to gather the necessary data.

Description	Your Data			
A static IP address				
The netmask for your network				
Gateway				
DNS server(s)				
SSID for the AMR network				
Mode for the network	Infrastructure			
Radio Mode	Auto (802.11a/b/g Only)	802.11b/g	802.11ac/n	802.11
Channel Set				
Wireless Watchdog IP Address				
Wireless Watchdog Max Count (0 disables)				
Security encryption	Disabled	WEP 64-bit	WEP 128-bit	
	TKIP/RC4	CCMP/AES	TKIP/CCMP/AES	
Authentication Method	OPEN (not recommended			
	WPA2-PSK	Key is either: Passphrase (8-63 ASCII-only) Raw Hex (64 Hex-only)		
	WPA-PSK	Key is either: Passphrase (8-63 ASCII-only) Raw Hex (64 Hex-only)		
	PEAP-MSCHAPv2	following fields are required: Username: Password: Private key: Download or Create New		

Description		Your Data
		Private key length: 1024 or 2048 bit Host-name:
		Upload certificate:
		certificate password (if needed):
		Validate Server Certificate:
	EAP-TLS	following fields are required:
		Username:
		Password:
		Private key:
		Download or Create New
		Private key length: 1024 or 2048 bit Host-name:
		Upload certificate:
		certificate password (if needed):
		Validate Server Certificate:

Figure 4-3. Worksheet: Data required to Configure the Wireless Network

After you connect to the SetNetGo Web Interface, navigate to the Management Interface:

1. Click the **Network** tab.

2. Click **Management Interface** in the sidebar.

3. Follow the steps in the interface to enter the network data.

4. Click **Apply** for your changes to take effect.

Wireless Signal Availability

Your wireless network should provide constant service throughout the workspace. Consider the following network resource requirements:

- **Signal Availability**—If you have an AMR fleet, constant access is an operational requirement. For a single or segregated AMR's, partial signal cover might be acceptable in workspace areas where you do not need to send commands or receive status from the AMR.

- **Signal Strength**—A signal of >=-40 dBm is the ideal WiFi signal strength, -60 dBm is the recommended minimum.

  IMPORTANT: OMRON recommends that you use wireless network industry best practices to conduct a comprehensive workspace survey and test your wireless service.

The greater the number of AMR's in your fleet, the more wireless resources they consume. For more information about wireless resource requirements, see: *Fleet Operations Workspace Core User's Manual (Cat. No. I635).*

Bandwidth Considerations

All devices that access a Wireless network consume its bandwidth. Use a dedicated network to restrict wireless network access to AMRs and use security to prevent other devices from accessing the network.

Typical bandwidth consumption for a fleet is an average 50 Kbps per AMR. This increases when you connect multiple AMR's to an EM2100, and actively manage them with MobilePlanner. Bandwidth consumption might increase or decrease depending on the types of commands and debugging tools that you enable in MobilePlanner. Downloading debuginfo, uploading ARAM/SNG, and viewing the ARAM log on SNG are other examples of bandwidth usage.

However, the bandwidth consumption is unlikely to exceed 500 Kbps per AMR (0.5 Mbps). A value of 0.5 Mbps per AMR is within the capabilities of most wireless access points (>=54 Mbps). If you have multiple access points with overlapping coverage, this number is less of a concern.

The bandwidth usage varies by application. Payload accessories might affect your bandwidth requirements, for example if the AMR supports a video camera that streams digital video through the AMR's wireless interface.

For more information about fleet wireless resources, see: *Enterprise Manager 2100 User's Guide.*

4.2 Create a Workspace Map

Map Creation Overview

You connect a pendant to the AMR to create the map. The process is described in detail in the *Fleet Operations Workspace Core User's Manual (Cat. No. I635).*

> **NOTE:** You may use a smaller size AMR such as an LD-series model for convenience of mapping task.

For information on how to use a pendant to create a map, see: Pendant Controls and Operation Description on page 209.

When you use the HD-1500 to create a map:

- Put a minimal payload, or preferably no payload on the AMR.

- Map at low linear and rotational speed and acceleration.

This will ensure the map is more accurate.

If the workspace has open stairwells, docks, ledges or other vertical drops, make sure that you surround such areas with physical barriers. Barriers must be detectable by the safety lasers' scanning plane, which is at a height of 175 mm from the floor. Install the barriers before mapping a workspace.

Map Description

Before you can use your HD-1500, you must create a digitized map of its designated workspace. The map records the shape and location of permanent physical features in the workspace. These features are walls, corners, doors, columns and large immovable fixtures such as machines or fixed industrial shelving.

Moving objects (such as fork-lift trucks and carts) or transient objects (such as pallets loaded with finished goods) do not provide useful mapping data. Erase such objects from the map after you create it.

Map Laser Scan

The HD-1500's Safety Scanning Lasers scan the workspace to create the map. The lasers scan only a narrow horizontal plane, parallel to the floor. The scanning plane height is 175 mm above the floor, so the lasers cannot detect physical features above or below this plane, or features that are out of operating range and resolution. This means that some features are not recorded on the map such as:

- Overhanging objects, such as:
  ○ Shelves that are attached to a wall, but at a low height so that there is clear space underneath.
  ○ Tables with narrow supporting legs.

- Low-lying objects that are below the scanning plain such as a column plinth or a pallet that contains no cargo.

Map Creation and Editing

You use the MobilePlanner software to create and then edit your workspace map. You can add virtual elements to the map that modify the behavior of an AMR. Examples of virtual elements include:

- **Forbidden lines and areas**—Areas in the workspace where an AMR cannot enter or move across.

- **Movement parameters sectors**—Areas where an AMR must travel within a specified speed range.

- **Preferred lines**—Paths that you specify on the map which the AMR must consider when planning the most efficient path to follow autonomously to its goal.

- **Preferred-direction zones**—Areas where the AMR will prefer to travel in a specified direction. In a typical preferred direction zone (such as a narrow hallway) there is an opposite direction that you want the AMR to avoid. Use a preferred-direction zone to keep the AMR to the preferred side of a hallway. The AMR is able to travel on the alternate side of the zone if the preferred side is blocked.

Regardless of the constraint specified by any virtual element on the map, the AMR always operates according to its safety protocols. For example, when following a preferred line the AMR still responds to, and avoids, dynamic obstacles.

Maps contain a variety of goals, routes, and tasks that comprise the destinations and activities of the AMR in the workspace. Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for information about editing a map.

Mapping Tasks

Mapping includes the following tasks:

- Installing the automated charging station before you create a map file. The docking target's trapezoidal front will be helpful in locating it on the map.

- Driving the platform with the pendant to make a floor plan scan. OMRON recommends that you drive the platform near the docking target so the docking target can be placed in the correct location of the map.

    NOTE: To create a better floor plan scan, drive the platform around the workspace multiple times, and from various directions. Also, begin and end your mapping process at the same location for the most accurate outcome.

- Loading the scan into the MobilePlanner software on your PC to create and edit a digitized map.

- Adding job-related features such as routes, goals, and docks (targets) to your map. In particular, refer to:

    **Working With Map Files > Editing a Map File >
    Using the Drawing Tools > Adding Goals and Docks**

    See the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.

- Transferring the working map to the Fleet Manager, or back to the platform, if you have only one AMR, to perform autonomous mobile actions.

    The Fleet Manager automatically uploads the new map to each AMR in your fleet as soon as the AMR becomes idle.

- Saving map collections and deploy your AMR in any of your workspaces by selecting the appropriate map file.

4.3 Acceleration, Deceleration, and Rotation Limits

For safety, an AMR has default limits on its maximum linear and rotational acceleration, deceleration, and speed. You can change the parameters that control these limits. However, changing the limits might affect the AMR's stability, depending on the center of gravity (CG) of the combined HD-1500 and its payload.

CAUTION: PROPERTY DAMAGE RISK
If you change *AbsoluteMaxTransVel* parameter, you should commission the AMR before putting it into service.

If your payload's center of gravity is not within the guidelines given in the Center of Gravity (CG) on page 143, you will need to adjust the Absolute Movement Maximums parameters in the MobilePlanner software.

For payload applications where you cannot easily reduce the size and weight of the payload or if the AMR's CG is not within the recommended limits, contact your OMRON representative.

Table 4-2. lists the Absolute Movement Maximums parameter limits and defaults. All *Accel* and **Decel* parameters have a significant impact. If the payload is asymmetric, you might need to adjust the value of *AbsoluteMaxRotVel* parameter.

Table 4-2. Absolute Movement Maximum Parameters

Parameter	Default	Min	Max
AbsoluteMaxTransVel	1800	1	1800
AbsoluteMaxTransNegVel	-1800	-1800	-1
AbsoluteMaxTransAccel	900	1	1500
AbsoluteMaxTransDecel	1300	1300	2000
AbsoluteMaxRotVel	60	1	60
AbsoluteMaxRotAccel	150	1	200
AbsoluteMaxRotDecel	150	150	200

After you determine your parameter values, set them as follows:

1. Open the MobilePlanner software, **Config** tab.

2. Navigate to:

   Robot Physical > Absolute Movement Maximums

3. Check the box for **Show Expert Parameters** (top right of screen) to see or modify these parameters.

4. Adjust the parameter values according to Table 4-2.

Increasing the AMR's physical length or width by adding an overhanging payload requires that you:

- Increase the dimension of the AMR's safety zones. Contact your OMRON representative for more information on modifying the safety zones.

- Repeat the safety commissioning. See: E-Stop Commissioning on page 253.

4.4 Supplemental Information

Laser Setup

The default parameter settings for lasers should be appropriate for most installations. However, the following important considerations apply:

- **Config File**—When shipped, an AMR includes a model-specific Config File specifying the default parameter values for the AMR model-specific features. SetNetGo provides a **Restore** option to revert the HD-1500 to its default configuration. Although a few parameters concerning the location of the safety scanning lasers are included in the ARAM Config File, the safety scanning laser configuration, and safety parameters are not stored in the SNG **Restore** option.

   You can obtain the default Config File from your OMRON representative if you accidentally lose or overwrite it. You can also download the default configuration file from

SetNetGo in the **System/Backup & Restore Options**. See: Download a Debuginfo File for Support on page 26.

- **Safety Zone Configuration**—Contact your OMRON representative to configure the safety zones.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK OMRON is not responsible for any risks incurred by modifying safety zone sizes or other OS32C laser settings.

WARNING: You need to modify the safety zones:

- If your payload overhangs the AMR's default dimensions, and the size/shape of the laser safety zones need to be modified.

- If operating on a floor surface that has poor traction to the extent that the AMR cannot stop reliably within the default zones.

Chapter 5: Payload Structures

A payload structure is any mechanical equipment that you attach to the HD-1500 for the purpose of performing a task. It might be as simple as shelves to receive bins of parts or as complex as a robot arm. In some cases, OMRON designs and constructs a custom payload structure for a specific application. In most cases the OMRON customer or an integrator designs and implements their own payload structure.

The HD-1500 provides the mobility and navigation for the payload structure together with the electrical power and data signal connections required to operate a payload structure. This chapter describes considerations and requirements when designing payload structures for the HD-1500.

5.1 Safety

Warning Labels

The only warning labels that are shipped with the HD-1500, unattached to the platform, are the No Riding labels. All other labels are installed in the factory.

For information on where to attach the No Riding labels, see: Attach the No Riding Warning Label on page 108. Also, for information on label maintenance, see: Warning Labels on page 1.

Any additional safety labels for the payload structure or specific to the end-use application shall be evaluated by the user as part of the risk assessment.

Warning Lights

Your HD-1500 must include warning lights appropriate for its application. In most cases, the light discs and the light strips in front and back of the AMR provide sufficient light indication. However, for large payload structures you may need to install an additional warning light (user-supplied) to ensure visibility of the AMR.

> ⚠️ **CAUTION:** To comply with CE requirements, an AMR must have a readily-visible warning device, such as a flashing light (user-supplied) to indicate when it is either ready to move or is moving.

The HD-1500 provides the following:

- Colored light discs on each side that provide visual cues about the AMR's status and its pending movement. See: Light Discs and Beacon on page 199.

- Colored light strips in front and back of the AMR. Similar to light discs, these light strips provide visual cues about the AMR's movement status. See: Front and Back Light Strips on page 202.

- Provision for an auxiliary warning light on the AMR Controller (LIGHTS on page 163). You can use this connector to mount a warning light in a more prominent location, which might be more appropriate for AMRs that have taller payloads.

Warning Buzzer

The AMR Controller provides an output for controlling a warning buzzer as an auditory warning device. The warning buzzer is connected to the Safety Controller.

The buzzer must be audible above the ambient noise of the environment that the HD-1500 operates in. Depending on your environment's noise level, you may need to add an additional buzzer and install to a location on your payload structure where the buzzer noise level reaches higher than the ambient noise level.

You can optionally supply an LED signal tower which includes a built-in warning buzzer, or a dedicated warning buzzer. OMRON offers a variety of LED signal towers, and dedicated warning buzzers. Contact your OMRON representative for more information on the available options.

You require the following tools to install the additional warning buzzer:

- 3 mm allen wrench for M5 screws.

Before you begin, press an E-Stop button and turn the HD-1500 off.

Follow these steps to install your additional warning buzzer:

1. Remove the user access panel cover. See: Remove and Replace the User Access Panel Cover on page 264.

2. Locate the LIGHTS port on the user access panel. See: Figure 6-11.

3. Connect the buzzer cable to the LIGHTS port. For information on the type of connector required to connect to the LIGHTS port, see: LIGHTS on page 163.

4. Then, connect the other end of the buzzer cable to the buzzer device itself, if it isn't connected already.

5. Configure the buzzer as appropriate for the environment in which the HD-1500 operates.

6. Mount the buzzer on your desired location, and verify that the buzzer works properly.

5.2 Considerations

Performance

Performance factors to consider when designing a payload structure are:

- Size, weight, and center of gravity of the payload structure.

- Power requirements for any electrical devices on the payload.

- Serviceability and maintenance requirements.

Weight Constraints

The total operating weight of the AMR should comply with its specifications for payload and any objects carried. See: Performance on page 275.

DANGER: PERSONAL INJURY OR PROPERTY DAMAGE RISK
The end-user of the AMR must perform a risk assessment to identify and mitigate any additional personal and property damage hazards caused by the payload.

When designing and implementing your payload, consider the following:

- If you operate the HD-1500 on the recommended hard, flat surface, additional payload mass has a minimal effect on battery duration and operating time between recharges.

- If the payload is tall and also has substantial weight, consider its effect on the AMR's center of gravity.

- If the payload overhangs or extends outward dynamically from the AMR (such as a robot arm), it has a greater effect on the center of gravity. This is particularly important if the payload is also conveying objects that add additional mass.

- If the payload structure shifts during AMR movement, consider its effect on the AMR's center of gravity.

  IMPORTANT: You must ensure that the payload structure is properly secured to the platform.

- If the AMR transports containers of liquids, consider the effect of the fluid sloshing on the AMR's stability.

- If the AMR's center of gravity is too far from the platform's center of gravity (due to uneven load distribution), the maximum stable speed of the AMR may be lower than the platform's default operating parameters. It is the end user's responsibility to ensure that the AMR is configured for safe operation.

  NOTE: The total weight of your payload structure plus any objects carried by the payload must not exceed the maximum payload capacity of your HD-1500. See: Performance on page 275.

Power Consumption

Any electrical devices on your payload structure that consume significant power will noticeably shorten the AMR's run time. Examples of power-consuming payload structures are robot arms attached, or a motorized conveyor.

Minimize power consumption whenever possible. The battery is rated at 3696 W*hr (3.7 kWh).

Power Limits

The tables in the following sections describe the available power circuits and power output:

- USER PWR on page 159

- REG PWR on page 159

OMRON recommends that you use external current limiting devices to prevent transient current overload. The limits are:

- For Battery_Out max inrush peak current is 50A.

Momentary current spikes over these thresholds will activate current limiting protection causing power loss at the connector. Simultaneous inrush loads might trip the over current protection at the battery. The maximum permitted duration of an overcurrent level is as follows:

Current Protection Level (A)	Overcurrent Level (A)	Overload Duration (ms)
50	100	100
(user power)	205	1

Payload Attachment Location

The HD-1500 chassis is where you attach and secure your payload structure to the platform. The user panel allows you to make the necessary electrical connections from your payload structure to the AMR Controller.

Considerations when designing your payload structure are:

- Provide access to the payload attachment location for serviceability. You must ensure that the mechanical connection points, as well as the electrical connections are conveniently accessible.

- Always take care to not damage any cabling between your payload structure and the HD-1500. Provide adequate slack in all cables, or include connectors. Also, provide adequate strain relief where more flexibility is required.

- Label all cables for accurate reconnection.

Payload Dimensions and Design

To maintain safe operation of the AMR when adding a payload, the following considerations might apply.

Avoid Projections and Overhangs

Your payload structure should not overhang or project beyond the outer dimensions of the platform. Doing so might place parts of the structure outside the safety envelope provided by the safety lasers.

WARNING: If you do design an overhanging payload, you must:

- Contact your OMRON representative to change the size of the safety scanning lasers' safety zones.

- Repeat the safety commissioning. See: E-Stop Commissioning on page 253.

- Modify the *Robot Physical: General* parameters to change the AMR's width, LengthFront, LengthRear, and potentially its Radius. See: *Fleet Operations Workspace Core User's Manual (Cat. No. I635)*.
  When making these modifications, ensure that the AMR's accurate dimensions are used during path planning and obstacle avoidance.

Side lasers are useful if the overhang might cause the AMR to encounter obstacles that are not visible to the safety scanning lasers, or the low lasers.

Do Not Block AMR Lasers

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
The entire payload, and anything it carries, must be kept higher than the top of the platform. If the payload blocks any of the HD-1500's sensors, it cannot function correctly. This is important in the case of the side lasers.

The optional side lasers are mounted sideways to create vertical scanning planes and detect objects high enough that they are not detectable by the safety scanning lasers. Mount the side lasers in such a way, that they protrude enough to miss the payload structure itself with their laser beams. See: Side-Mount Lasers on page 268.

> **IMPORTANT:** It is the end user's responsibility to ensure that the payload structure does not obstruct the side lasers' beam.

If it is not possible to prevent some interference between the payload structure and the side lasers' sensing plane, you might be able to use the *LaserIgnore* parameter to constrain sensing to zones that do not include the payload structure. However, this might compromise the detection ability of the sensors, and you should avoid using *LaserIgnore* parameter if at all possible.

When installed in factory, the side lasers are mounted at the outer edge of the laser corners, above the safety scanning lasers, and are protected by aluminum cover fins. If you relocate the side lasers, consider using protective guards to protect them from damage. Make sure that guards do not block the lasers beam or extend outward too far.

Do Not Block Wireless Antennas

You must ensure that the payload structure does not obstruct the wireless antennas. If it is not possible to prevent some interference between the payload structure and the wireless antennas, you may relocate the wireless antennas to a payload position where the signal does not get attenuated. For information on how to relocate the wireless antennas, see Wireless Ethernet on page 152.

> **IMPORTANT:** It is the end user's responsibility to ensure that the payload structure does not attenuate the wireless antennas' signal.

Do Not Block E-Stop Buttons

You must ensure that the payload structure does not block or limit easy access to the E-Stop buttons. The E-Stop buttons shall be placed within 600 mm of reach. The operator should be able to easily reach an E-Stop button from any approach angle without the need to reach across the moving AMR or any moving payload parts.

The payload structure shall not be positioned in such a way that would put the operator in danger while trying to reach an E-Stop button.

Do Not Block Light Discs, Front and Back Light Strips

You must ensure that the payload structure does not block the light discs, front and back light strips as they provide visual indication of the AMR movement.

Mounting Locations in the Platform

The HD-1500 chassis provides the mounting structure necessary for the end user to attach their payload structure to the platform. The platform top cover is secured onto the chassis, and therefore, the user can attach the payload structure directly on to the top cover. See: Figure 5-1.

Payload Mount Points

The top cover has longitudinal and transverse mounting points. Figure 5-1. or the location of the mounting points and the center lines.

> **IMPORTANT:** Do not exceed 10 kN per mounting point.

For the location of the center of gravity, see: Dimension Drawings on page 270.

The chassis steel bars bear the main structural load of any payload. You can easily adjust and move your payload in relationship to the HD-1500's center of gravity. See: Center of Gravity (CG) on page 143.

Use mounting screws appropriate for the mass of your payload. To maintain access to the mounting locations or the user access panel, ensure that the mechanical connection points as well as the electrical connections are conveniently accessible.
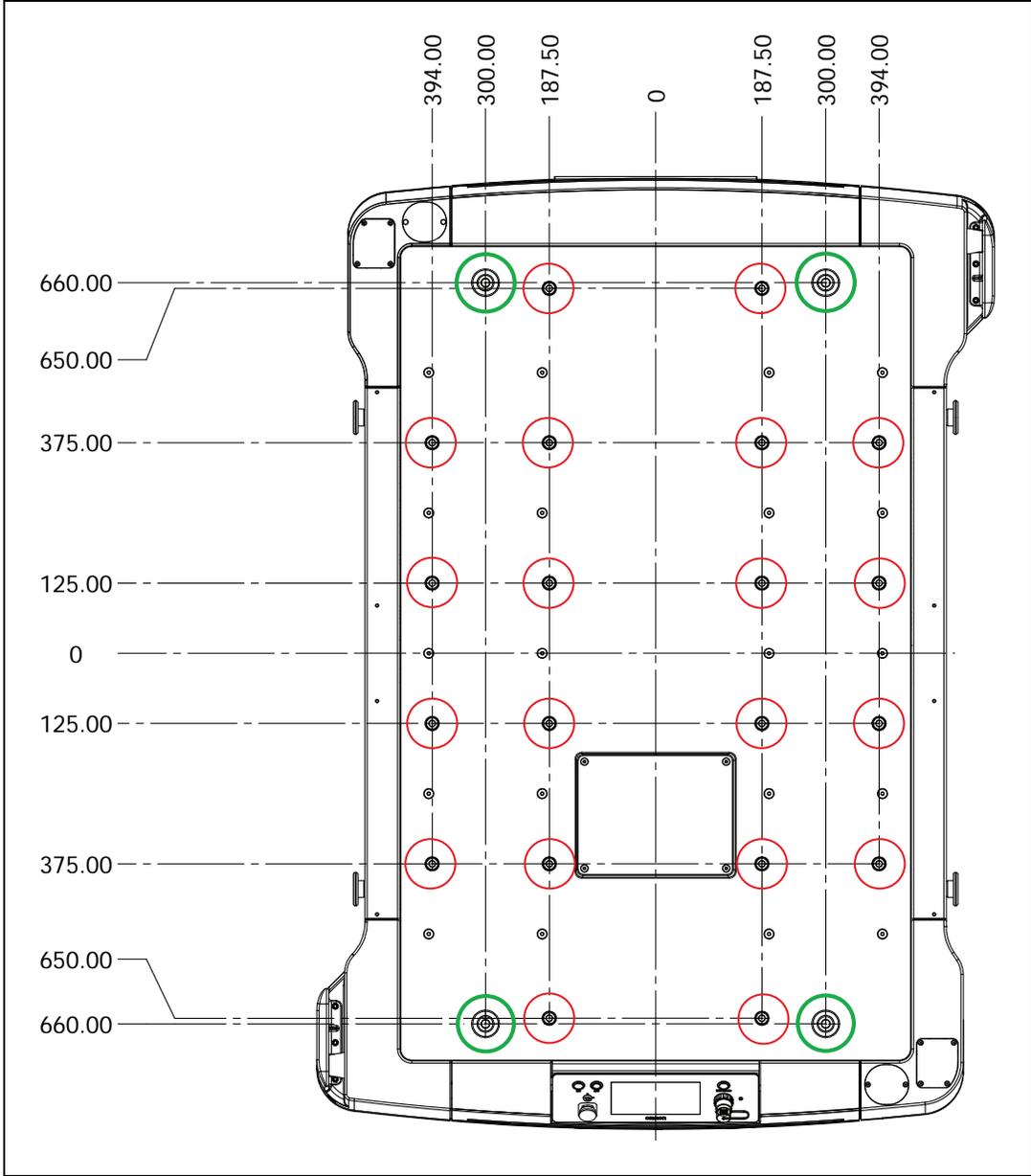
Figure 5-1. Chassis Payload Mount Locations - (20) M12 X 1.75 Threaded Holes, and (4) M16 X 2.0 Threaded Holes (units are in mm)

AMR Coordinate System

OMRON AMRs use the X, Y, Z and Theta (θ) coordinate system displayed in Figure 5-2. This information is relevant for some of the procedures used in this manual, such as identifying which are the left or right sides of the AMR. For example, the AMR Controller is located near the rear of the AMR, and the +X direction is the direction of AMR forward travel. Refer to the following figure.

The origin of the AMR coordinate system is the ideal point on the floor exactly half way between the center of the two drive wheels. The origin of the coordinate system is the AMR's center of rotation.

Coordinates are required for procedures such as installing and configuring options such as lasers, and for understanding the center of gravity envelope. The AMR's coordinates also relate to the map coordinates.

The rotation value Theta (θ) specifies the AMR's angle of rotation, which determines its heading, or direction of travel.

The origin of the vertical coordinate (Z) is set at ground level (Z=0). The value of Z is required when you calculate the mount position of options (such as side lasers). You then specify the position of the option in MobilePlanner.
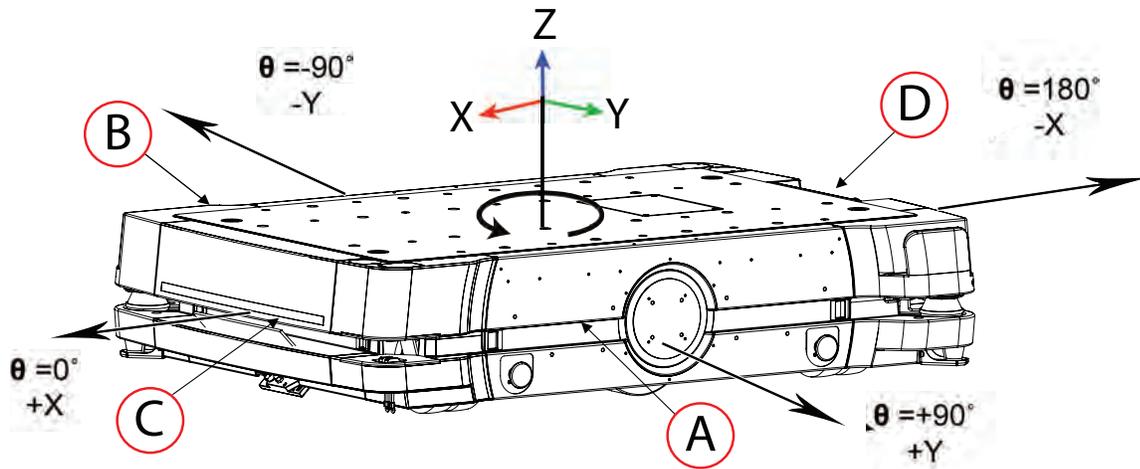
Figure 5-2. AMR Coordinate System

Callout	AMR Reference	Theta θ (Rotation)	X, Y Coordinate
A	Right side	+90 degrees	Positive Y
B	Left side	-90 degrees	Negative Y
C	Front	0 degrees	Positive X
D	Rear	180 degrees	Negative X

Additional Information: Dimension Drawings on page 270.

Center of Gravity (CG)

Keep your payload structure's center of gravity (CG) centered over the HD-1500's own center of gravity and as low (close to the HD-1500's top) as possible. This provides optimum stability, particularly when the HD-1500 crosses raised thresholds or irregularities in the floor.

See: Dimension Drawings on page 270 for information that will help you design and locate the payload, in particular:

- **Center of Rotation**—The mid-point of a line between the center of the drive wheel hubs, about which the HD-1500 will rotate.

- **Center of Gravity**—The unloaded HD-1500's center of gravity.

- **X and Y Axis Mid-lines**—Lines that cross in the HD-1500 center of rotation.

- **AMR Coordinate System**—The X,Y,Z, and Theta reference system relating the AMR to its environment, and to the relative position of other devices such as the optional side lasers. See: AMR Coordinate System on page 142.

Tilt Detection and Reporting

The tilt detection feature monitors the angle of the HD-1500 (with respect to flat ground) during its operation. If the AMR tilts 60 degrees or more in any direction, an E-Stop occurs and the power is discontinued to any user-supplied equipment. This will not prevent an improperly loaded AMR from tipping over.

Safe Payload Placement

The following figures show the calculated safe CG placements for HD-1500's maximum allowed payload weight (1500 kg). The payload structure's CG must be within the area shown.

Assumptions in these calculations are:

- The payload is securely attached to the AMR.

- The payload does not overhang the AMR.

- The AMR does not exceed its specified default limits for:

  - Acceleration, deceleration, and velocity.

  - Angular velocity.

  - Coefficient of friction (0.6 min).

- The casters and drive wheels are in good condition.

  You must inspect the casters and drive wheels for signs of damage, excessive wear/tear, or uneven spots as they could degrade the AMR stability.

In the following graphs:

- X is the direction of the AMR's motion (rear to front).

- Y is perpendicular to the AMR's direction of motion (side to side).

- Z is the vertical dimension (height).

All units are in millimeters (mm). See also: AMR Coordinate System on page 142.
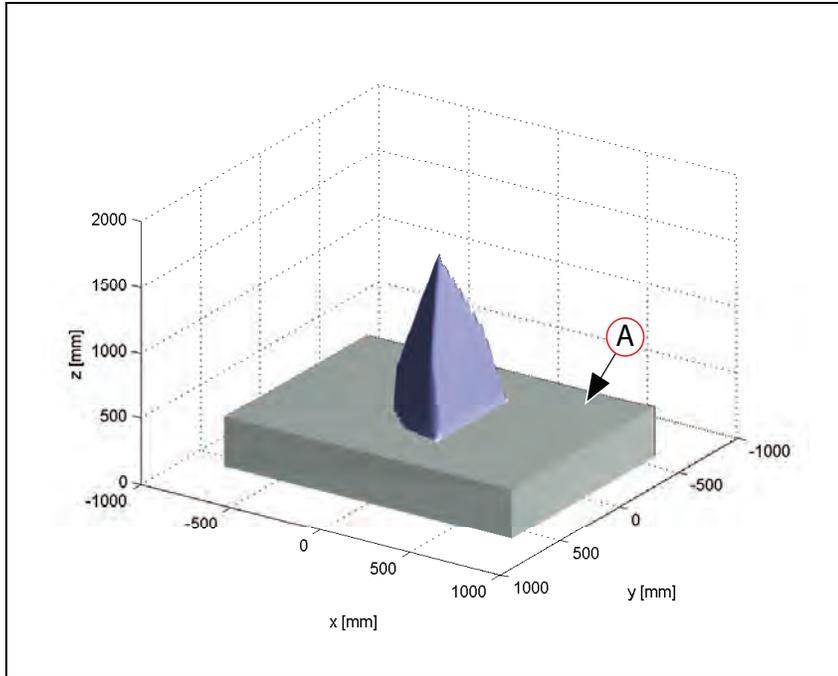
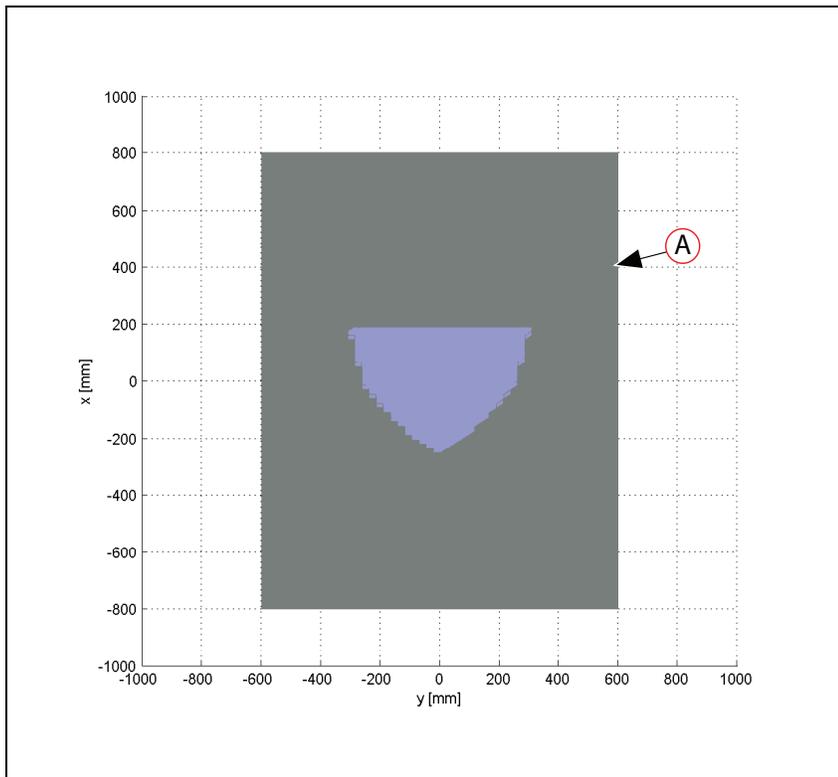*Figure 5-3. 3D View of Recommended Payload CG, (A) HD-1500*

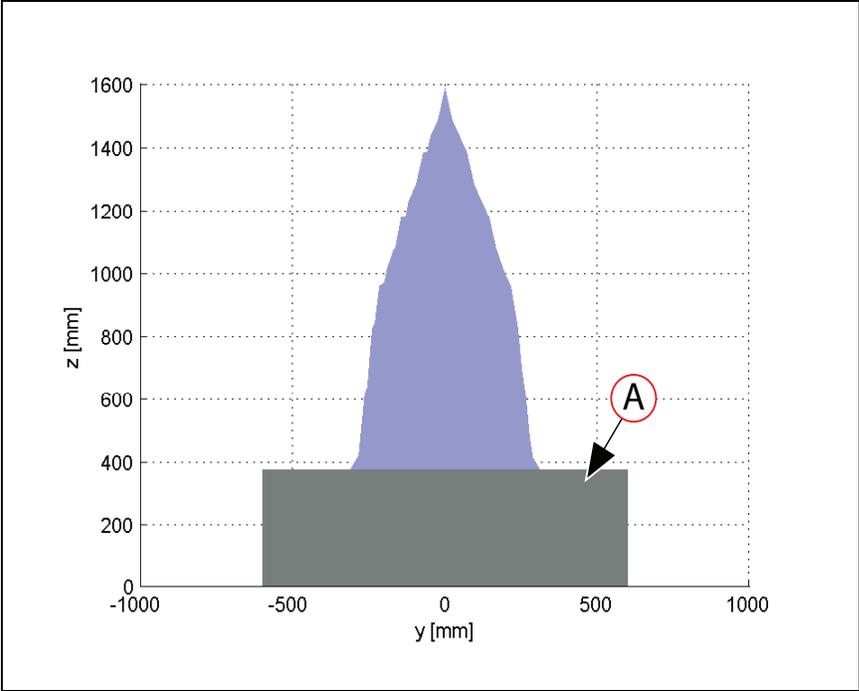*Figure 5-4. Top View of Recommended Payload CG, (A) HD-1500*

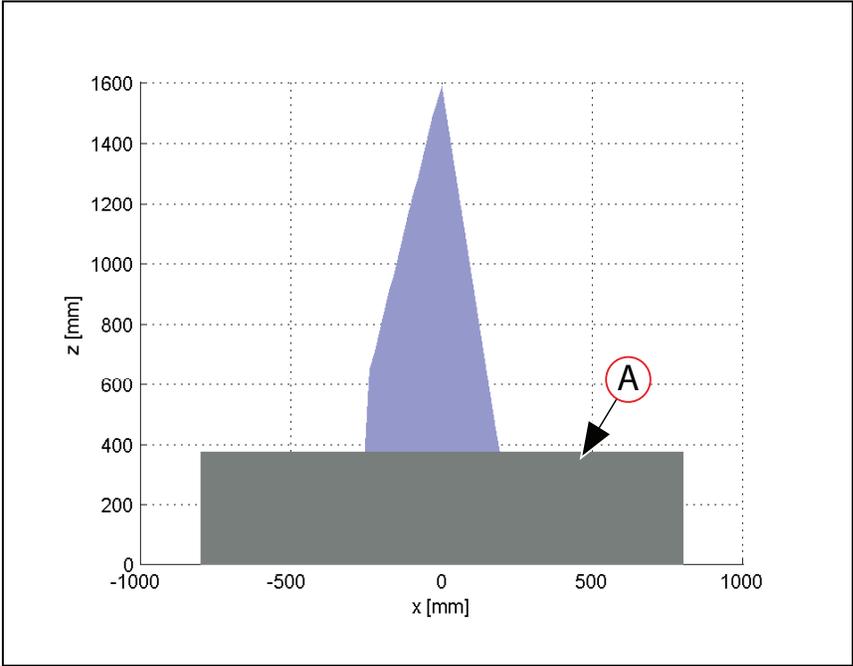*Figure 5-5. Front View of Recommended Payload CG, (A) HD-1500*

Figure 5-6. Side View of Recommended Payload CG, (A) HD-1500

5.3 Payload-Related Tradeoffs

If you extend your center of gravity beyond the guidelines given here, you must adjust various parameters in MobilePlanner software to compensate for changes in HD-1500 driving

characteristics. This is necessary so that the AMR remains consistent and safe in operation.

Contact your OMRON representative if your parameters differ from those described in this section.

5.4 Connections Between the HD-1500 Platform and Payload Structure

The user panel provides user connections for data communications (I/O) and power. Use these connections for OMRON optional devices, or for powering and controlling your payload structure. Refer to Fleet Operations Workspace Core User's Manual (Cat. No. I635) for instructions on how to configure I/O connections.

Operator Panel on the Payload

You can move the Operator Panel, with its integrated E-Stop, brake release, ON, and OFF buttons, keyswitch, pendant and Ethernet connections by routing a single connector cable (the Operator Panel connector).

This portability enables you to put many of the more common operator controls in a convenient location on the payload.
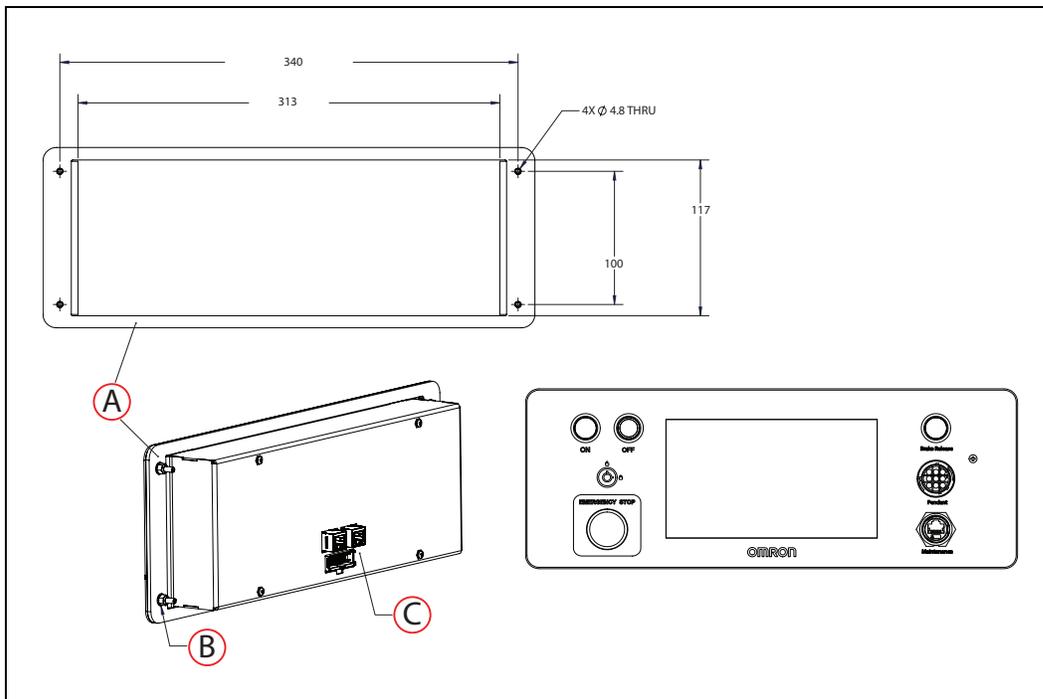

Figure 5-7. Operator Panel Mounting Bracket Dimensions (units are mm)

Callout	Description
A	Operator Panel mounting bracket
B	4x M4 flat washer, and 4x M4 nylon insert locknut
C	50 mm clearance behind the enclosure for connectors

Many other connections are available. For details and specifications of available connections, see: Connectivity on page 150.

Optional Connections

You can connect:

- Additional E-Stop button. See: SCPU on page 161.

- Additional warning lights. See: LIGHTS on page 163.

You will find most user-connections in the user access panel, located in the mid section of the electronics bay, as displayed in Figure 6-1. You can access the user access panel by removing the cover ((**C**) in Figure 6-1.) as instructed in Remove and Replace the User Access Panel Cover on page 264.

The electronics bay houses electronics, cables, signal (I/O), power connections, and the AMR Controller. You can access the electronics bay compartment from the right or left side of the AMR, once skins are removed. See: Removing and Installing Skins on page 253.

Figure 6-1. and Figure 6-2. display exploded views of the AMR top skin, electronics bay and its cover, and the user access panel.
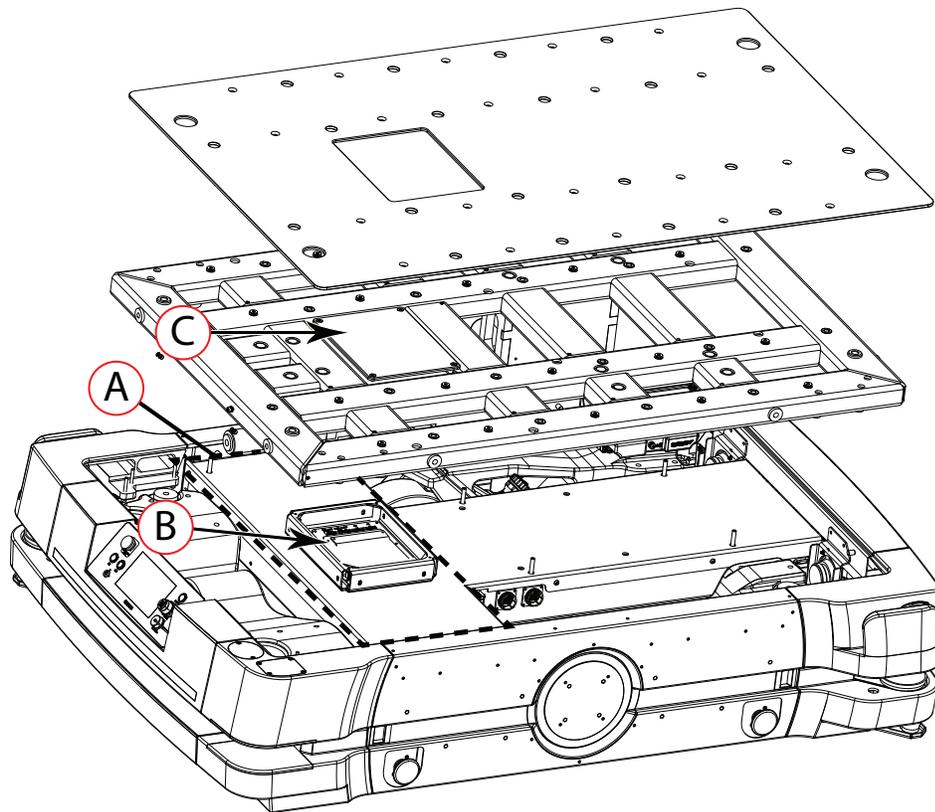

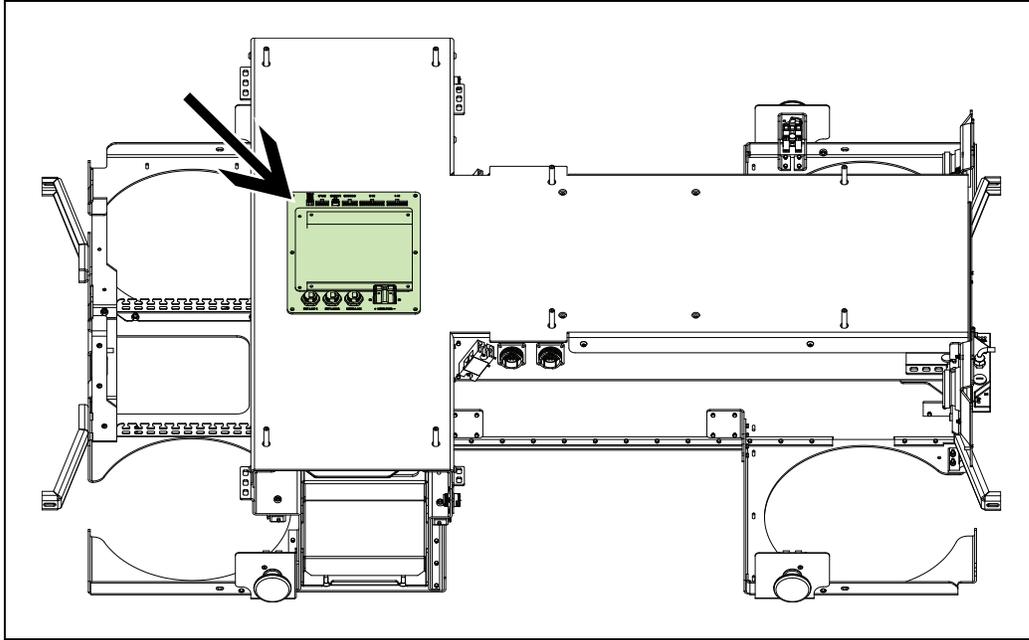*Figure 6-1. (A) Electronics Bay, (B) User Access Panel, and (C) User Access Panel Cover*

Figure 6-2. User Access Panel

6.1 Required Connections

Platform Required Connections

- Pendant port   In order to generate maps with the platform, you need to connect a pendant to the pendant port.

  The pendant port is available on the Operator Panel, located on the rear of the platform. See: Figure 6-4. .

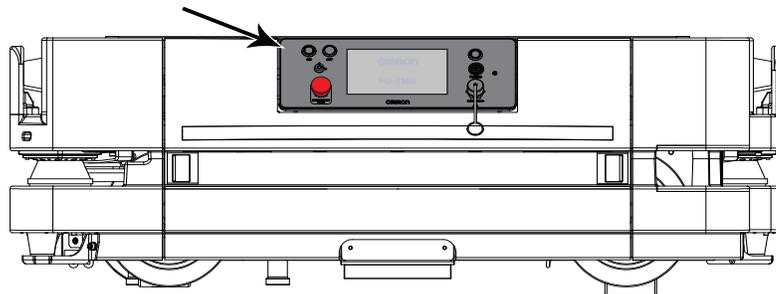 This is internally connected to the AMR Controller in the electronics bay.

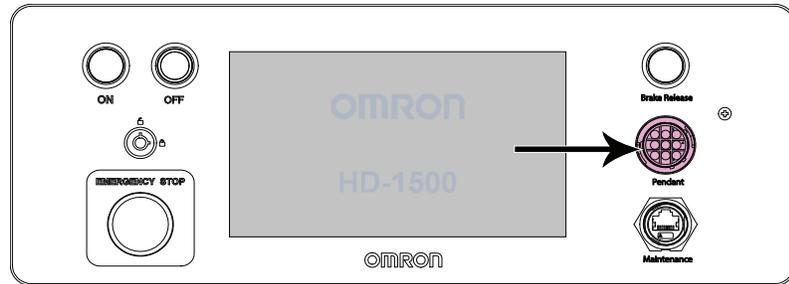*Figure 6-3. Operator Panel Located on the Rear of the AMR*

Figure 6-4. Pendant Port on the Operator Panel

- Maintenance Ethernet port

The Maintenance Ethernet port is available on the Operator Panel, located on the rear of the platform. See: HD-1500 Platform Features on page 11.

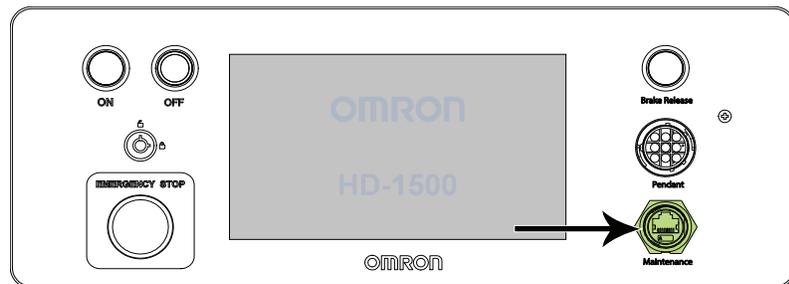This is internally connected to the Ethernet switch, on the Figure 6-13.

Figure 6-5. Maintenance Ethernet Port on the Operator Panel

- Wireless Ethernet

The AMR Controller provides two connections for wireless antennas. It is the end user's responsibility to ensure that the payload structure does not attenuate the wireless antennas' signal.

Two 2 m LMR-100, low loss extension cables, and two rubber-duck antennas are optionally available as part of the accessory kit(part number 68955-000) so the user can relocate the wireless antennas if necessary. The cable has two 7.94 mm RP-SMA hex nut connectors. Use the same specification if you require a longer cable for your payload.

> **IMPORTANT:** Do not relocate the antennas to a payload position where the signal might get attenuated.

To connect the extension cable to the wireless antenna, simply unscrew the wireless antenna connector ((**A**) in Figure 6-6.), and screw onto the extension cable male connector. Then, connect the extension cable female connector to the platform wireless connection ((**B**) in Figure 6-6. For more information on how to access the wireless antennas, and disconnect from the connector, see: Wifi Antennas on page 249.
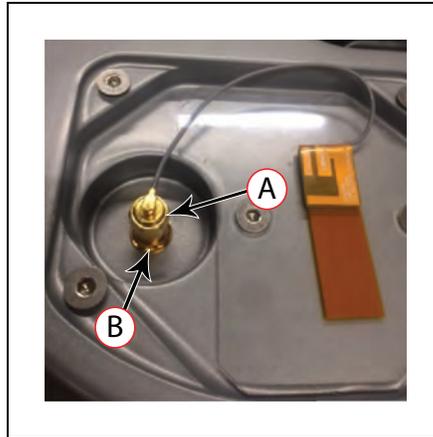
Figure 6-6. (A) Wireless Antenna Connector, and (B) Platform Wireless Connection

- Charging Contacts | The charging contacts on the AMR receive the power from the docking target and transfer to the AMR's battery ((**D**) in Figure 6-8.

Charging Station Required Connections

The charging station consists of two main parts:

- Power supply box which receives the AC power, and transfers to the docking target.

- Docking target which the AMR drives itself into.

The required connections are:

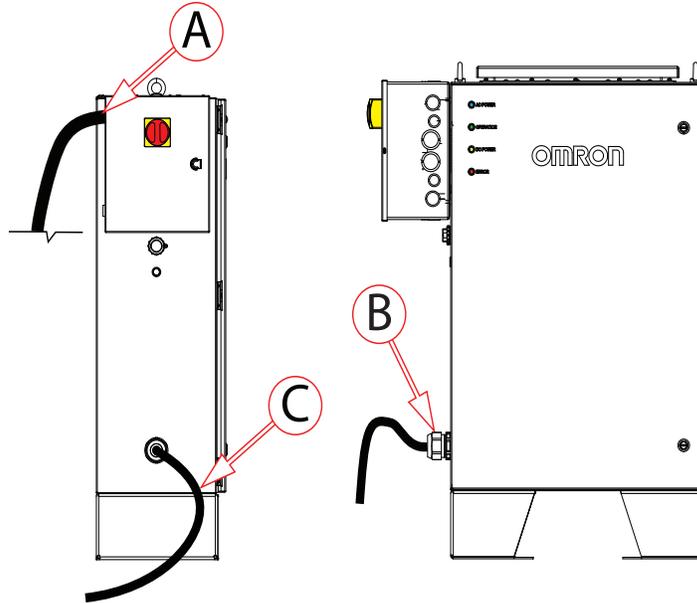- AC Power   The power supply box needs access to facility AC supply.

Figure 6-7. Power Supply Box, (A) Input Power, and (B) Output Power, and (C) Power Cord

- Connection from the Power Supply Box to the Docking Target

A power cord connects the power supply box to the docking target, and transfers power ((**C**) in Figure 6-4.).

- Charging Paddle

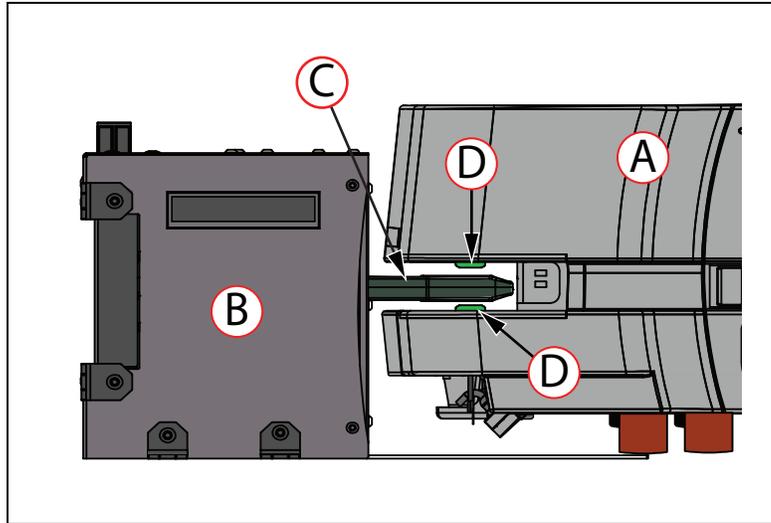The HD-1500 engages with the charging paddle, and charges its battery.

Figure 6-8. (A) HD-1500, (B) Docking Target, (C) Charging Paddle, and (D) HD-1500 Charging Contacts

6.2 User Access Panel Connections

Most of the connections users need to connect standard OMRON-supplied optional devices, and user-supplied accessories to the AMR, are available on the user access panel.

The user access panel can be reached from the top of the AMR, and by removing the user access panel cover. For instructions on how to remove the cover, see: Remove and Replace the User Access Panel Cover on page 264.
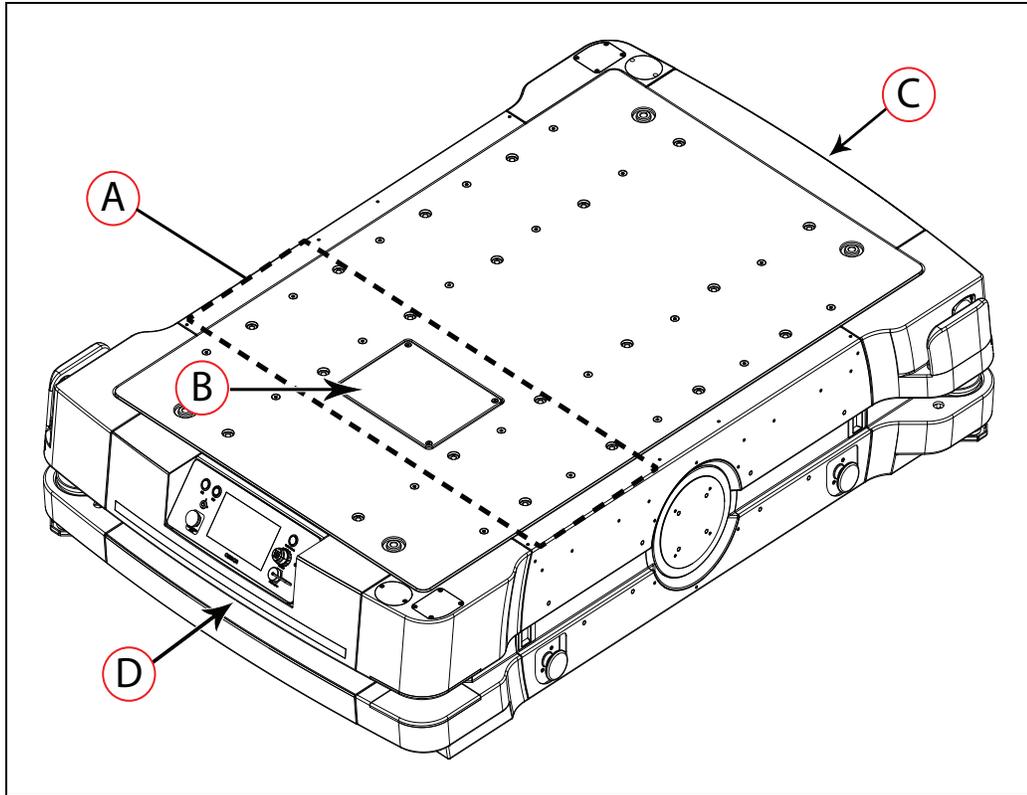
Figure 6-9. (A) Electronics Bay Location, (B) User Access Panel Cover, (C) Front and (D) Rear of the AMR

Figure 6-10. User Access Panel Location on the AMR (user access panel cover removed)

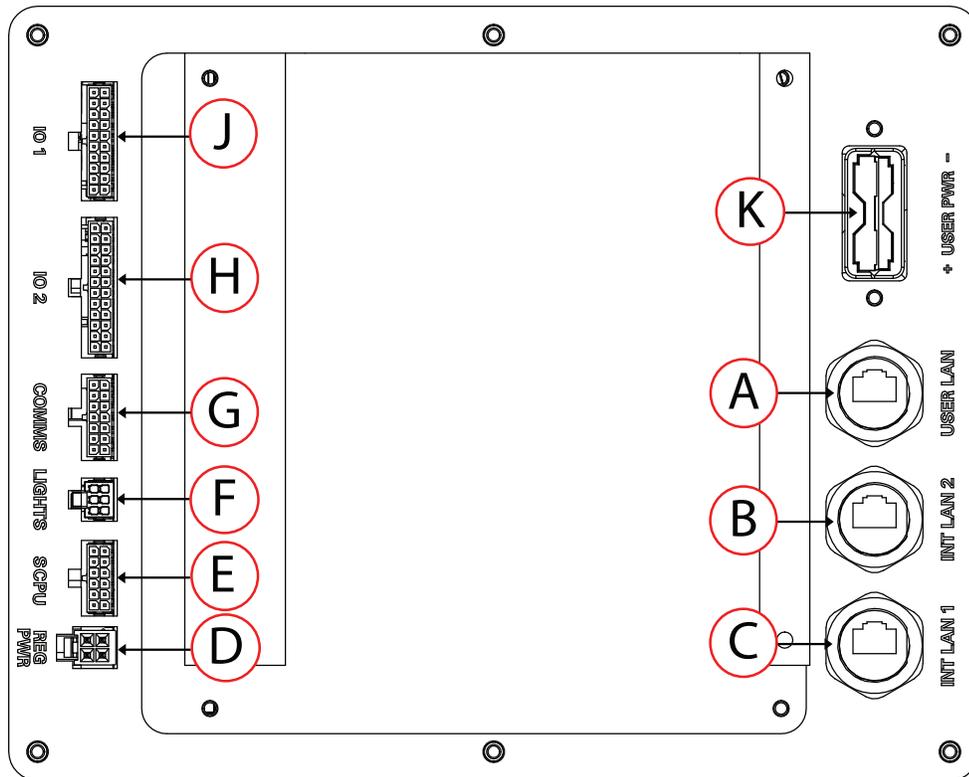The following connections are available on the user access panel:

Figure 6-11. Connectors on the User Access Panel

ID	Connection	Connector Type	Mating Connector (user-supplied item)	Description
A	USER LAN	RJ45 port	RJ45	Connection to the Operator Panel.
B	INT LAN 2	RJ45 port	RJ45	Ethernet connection to MQTT network.
C	INT LAN 1	RJ45 port	RJ45	Ethernet connection to MQTT network.
D	REG PWR	Mini-Fit Jr., 2 x 2	Molex P/N: 0469920410	Regulated user power. See: REG PWR on page 159.
E	SCPU	TE Micro-mate N Lok., 2 x 6	TE P/N: 1-794617-2	Connection to safety system. See: SCPU on page 161.
F	LIGHTS	Mini-Fit Jr., 2 x 3	Molex P/N: 0469920610	Optional device connection. See: LIGHTS on page 163.

ID	Connection	Connector Type	Mating Connector (user-supplied item)	Description
G	COMMS	TE Micro-mate N Lok., 2 x 7	TE P/N: 1-794617-4	Connections for RS-232, RS-422 and CAN Bus connections. See: COMMS - RS-232, RS-422, CAN Bus on page 164.
H	IO 2	TE Micro-mate N Lok., 2 x 12	TE P/N: 2-794617-4	Digital and Analog I/O Input. Machine Automation Controller input connection(digital and analog inputs). I/O 2 on page 164.
J	IO 1	TE Micro-mate N Lok., 2 x 10	TE P/N: 2-794617-0	Digital and Analog I/O Output. Machine Automation Controller output connection (digital and analog outputs). See: I/O 1 on page 163.
K	USER PWR	Anderson Power Pole SBS-50F	Anderson Power Pole SBS-50M	Unregulated 52.8 VDC power; connects to battery system. See: USER PWR on page 159.

USER PWR

Connector type   Anderson Power Pole SBS-50

Use   Battery power for payload devices

The User Power connection on the user access panel provides unregulated battery power for payload devices.

Refer also to Power Consumption on page 138 which specifies limits on power draw.

Pin No.	Designation	Notes
1	VBAT_OUT1	VBAT fused at 50 A
2	GND	

REG PWR

Connector type   Mini-Fit® 2 x 2

Use   user power control

The control power connector is fused with two separate 3 A resettable fuse connections. Although the voltage of these connections are 24 VDC regulated, the voltage can vary from 23.8 VDC to 25.2 VDC. Loads connected to this output must be capable of withstanding this voltage range.

> **NOTE:** Since the control power connection is protected by resettable fuses, it is the end user's responsibility to ensure that the over-current (including the in-rush current) is kept below the noted thresholds. See: Power Limits on page 138.

Pin No.	Designation	Notes
1	Control Voltage	Connections to the Battery Control
2	Control Voltage	
3	GND	
4	GND	

SCPU

Connector type   TE Micro-mate N Lok., 2 x 6

Use   Brake release, ON, OFF, E-Stop

Pin No.	Designation
1	E-STOP_USER_IN_1
2	E-STOP_USER_IN_2
3	USER_E-STOPPED_B
4	USER_PROTECTIVE_STOP_2
5	GND
6	USER_PROTECTIVE_24V_JUMPER
7	E-STOP_USER_OUT_1
8	E-STOP_USER_OUT_2
9	USER_E-STOPPED_A
10	USER_PROTECTIVE_STOP_1
11	GND
12	USER_PROTECTIVE_24V_JUMPER

NOTE: You must attach either an E-Stop jumper, or an E-Stop button (category 1 stop) along with a laser to the SCPU connector for the platform to function. The jumper is provided as part number 68410-218L. Both the E-Stop button, and the laser would be user-supplied.

Specification	
Internal I/O common	PNP (sinking inputs)
Rated input voltage	24 VDC (20.4 to 28.8 VDC)
Safety input current	3.0 mA

The user-initiated E-Stop (category 1 stop) which is activated by pressing one of the E-Stop buttons, is a controlled stop function. In this case, the power to the AMR motors remains on in order to achieve a controlled stop. Once the controlled stop is achieved, the power to the motors is disconnected. If for any reason the controlled stop function fails or does not function as expected, the power will still be disconnected to the motors. Category 1 stop function requires manual reset of the E-Stop for the AMR to restart. The AMR will not automatically recover from a category 1 stop, or any E-Stop initiated by custom inputs on the SCPU.

The E-Stop or the protective stop devices you install on the AMR must have dual channel circuit to ensure the same performance level as the other safety devices of the AMR.

The E-Stop button you install on the payload structure must be within 600 mm of reach. It must not be installed in a location that affects operator's safety in order to reach the E-Stop button.

Each of the HD-1500's emergency stop inputs has a direct connection to the Safety Controller and is not chained to any other device or input.

CAUTION: PERSONAL INJURY OR PROPERTY DAMAGE RISK
If you are using a user-supplied E-Stop, you must run the Safety Commissioning to verify the E-Stop's functionality before putting the AMR into service.

USER_PROTECTIVE_STOP input Behavior

Generally the two USER_PROTECTIVE_STOP input signals act like two E-STOP channels as they hault the AMR's motion or prevent the AMR from operating. Similar to the E-STOP channels both USER_PROTECTIVE_STOP input channels are normally high.

There are two main differences between the E-Stop behavior and the USER_PROTECTIVE_ STOP input behavior:

- The USER_PROTECTIVE_STOP input is conditioned based on whether the AMR is moving or stopped.

- The USER_PROTECTIVE_STOP input has a different relationship with the USER_ ESTOPPED_A and USER_ESTOPPED_B.

  The USER_ESTOPPED signals indicate to the operator whether the AMR is E-Stopped or not, and are intended to drive the safety relays. Therefore, they are normally high.

When the AMR is moving:

- If either one of the USER_PROTECTIVE_STOP input signals goes low, the AMR will do a normal protective stop, and remain E-Stopped until these signals are reasserted high.

  - Both USER_ESTOPPED signals go low.

- If neither of the USER_PROTECTIVE_STOP input signals goes low, the AMR will continue with its normal operation.

  - Both USER_ESTOPPED signals remain high.

When the AMR is not moving:

- If either one of the two USER_PROTECTIVE_STOP input signals goes low, the AMR will disable the motor controllers, and engage the drive wheel brakes.

  - USER_ESTOPPED signals remain high.

  NOTE: This behavior is the key difference between the USER_PROTECTIVE_ STOP input and the E-Stop input.

- If neither of the USER_PROTECTIVE_STOP input signals goes low, the AMR will continue with its normal operation.

  - USER_ESTOPPED signals remain high.

LIGHTS

Connector type   Mini-Fit® Jr., 2 x 3

Use   Light tower (user-supplied)

Pin	Designation	Notes	Pin	Designation	Notes
1	LIGHT_P1	Red (24VDC)	4	VBAT_IO_OUT4	Buzzer (24VDC)
2	LIGHT_P2	Yellow (24VDC)	5	GND	
3	LIGHT_P3	Green (24VDC)	6	GND	

I/O 1

Connector type   TE Micro-mate N Lok., 2 x 10

Pin No.	Designation	Notes
1	DIGITAL_INPUT_1	24VDC
2	DIGITAL_INPUT_2	24VDC
3	DIGITAL_INPUT_3	24VDC
4	DIGITAL_INPUT_4	24VDC
5	GND	
6	GND	
7	GND	
8	ANALOG_INPUT_1	+/- 10VDC
9	ANALOG_INPUT_2	+/- 10VDC
10	GND	
11	DIGITAL_INPUT_5	24VDC
12	DIGITAL_INPUT_6	24VDC
13	DIGITAL_INPUT_7	24VDC
14	DIGITAL_INPUT_8	24VDC
15	GND	
16	GND	
17	GND	
18	ANALOG_INPUT_3	+/- 10VDC
19	ANALOG_INPUT_4	+/- 10VDC
20	GND	

I/O 2

Connector type   TE Micro-mate N Lok., 2 x 12

Pin No.	Designation	Notes
1	DIGITAL_OUTPUT_1	0.5A @ 24VDC
2	DIGITAL_OUTPUT_2	0.5A @ 24VDC
3	DIGITAL_OUTPUT_3	0.5A @ 24VDC
4	DIGITAL_OUTPUT_4	0.5A @ 24VDC
5	GND	
6	GND	
7	ANALOG_OUTPUT_1	0.1A
8	ANALOG_OUTPUT_2	0.1A
9	GND	
10	GND	
11	DIGITAL_OUTPUT_5	0.5A @ 24VDC
12	GND	
13	DIGITAL_OUTPUT_6	0.5A @ 24VDC
14	DIGITAL_OUTPUT_7	0.5A @ 24VDC
15	DIGITAL_OUTPUT_8	0.5A @ 24VDC
16	GND	
17	GND	
18	ANALOG_OUTPUT_3	0.1A
19	ANALOG_OUTPUT_4	0.1A
20	GND	
21	GND	
22	GND	
23	GND	
24	GND	

COMMS - RS-232, RS-422, CAN Bus

Connector type   TE Micro-mate N Lok., 2 x 7

Pin No.	Designation	Pin No.	Designation
1	RS232 _0_RD	8	CANBUS_B_H
2	RS232 _0_TD	9	CANBUS_B_L
3	GND	10	GND
4	USER_BUMPER_RET	11	RS485_T+
5	USER_BUMPER_OUT	12	RS485_T-
6	GND	13	RS485_R+
7	GND	14	RS485_R-

6.3 Electronics Bay Connections

The connections described in this section are located on the AMR Controller. The AMR Controller is installed on the left rear of the AMR. See: Figure 6-12. There may not be many occasion when the user has to access the connections on the AMR Controller.

The HD-1500 ships with dual antennas that you can relocate if necessary. If you relocate the antennas, make sure that they are not in a position that might attenuate the WiFi signal, depending on the AMR's orientation. Standard connectors, such as audio, are not described here.
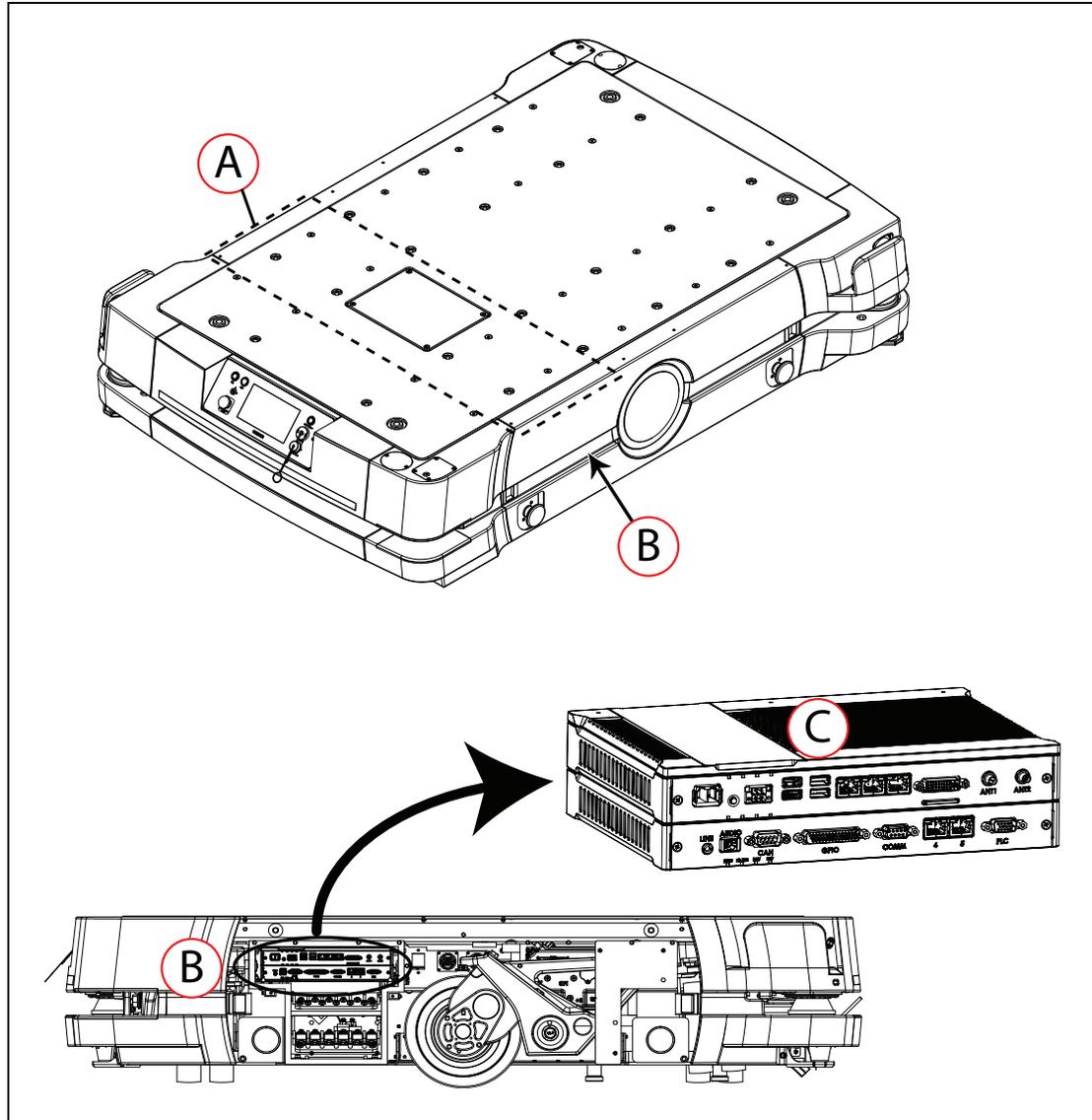
Figure 6-12. AMR Controller Location on the AMR, (A) Electronics Bay, (B) Left Rear of the AMR, and (C) AMR Controller

AMR Controller

The AMR Controller is an OMRON industrial PC. It is the HD-1500's main computing system that runs all navigational controls of the AMR. It also provides mobile robot application interfaces.

The AMR Controller consists of two main parts:

- (A) ARAM module - Contains all electronic components and standard PC interfaces.

- (B) Base module - Contains all electronic components for the processing of the HD-1500 control interfaces and network interface.

Figure 6-13. AMR Controller, (A) Expansion Module, and (B) Base Module

AMR Controller Connections

Figure 6-13. and Figure 6-15. display the AMR Controller connections. For information on the AMR Controller LED indicators, see: AMR Controller LED Indicator Lights on page 170.
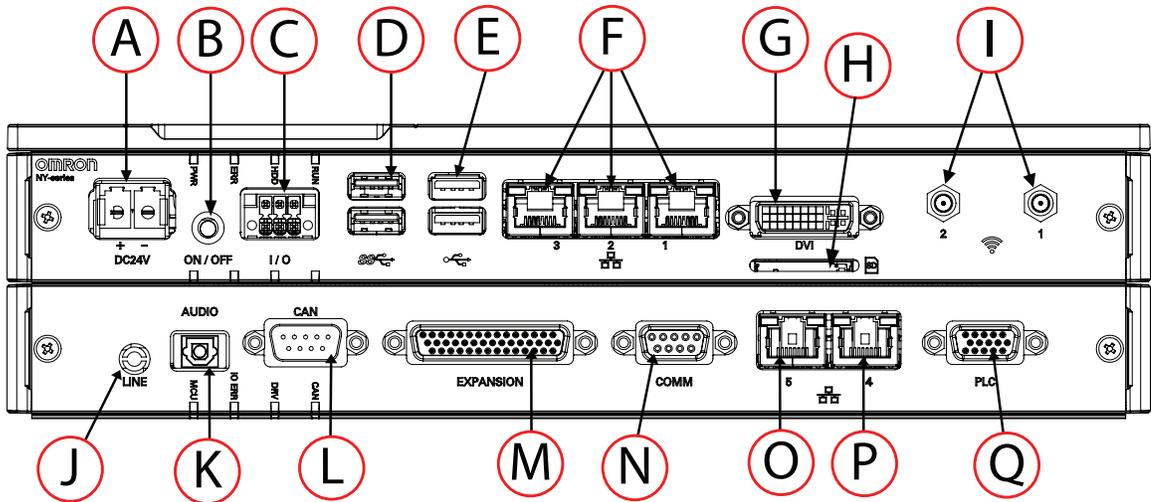
Figure 6-14. AMR Controller Connections - Front Connections
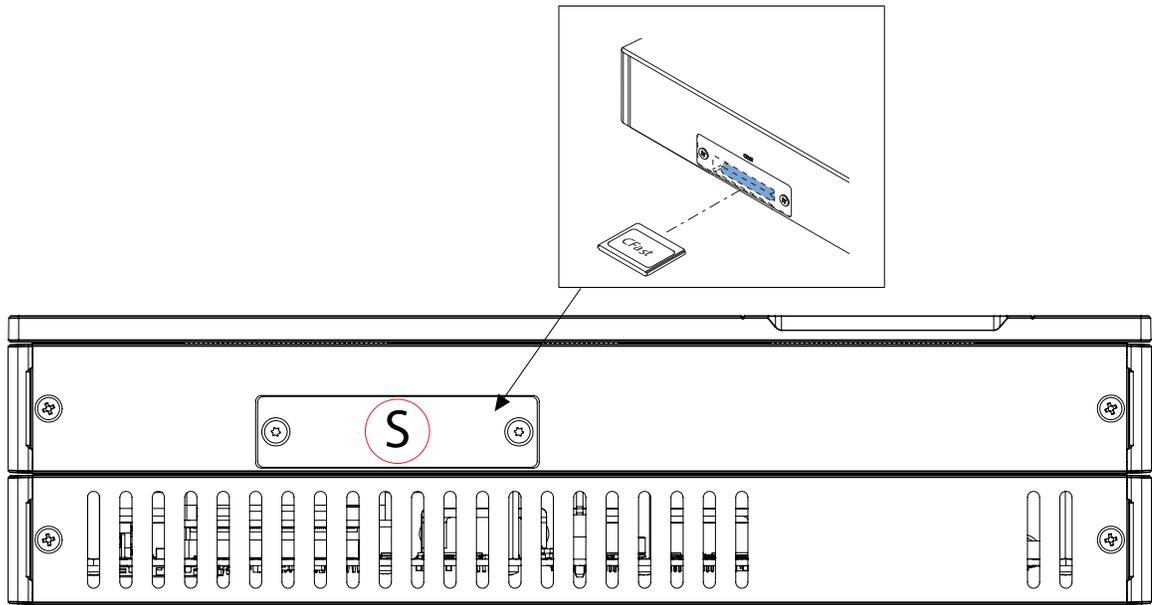
Figure 6-15. AMR Controller Connections - Rear Connections

Callout	Connection	Type	Description
A	DC24V	Pluggable Terminal Block SPC 5/2	Power connection - 24VDC input.
B	ON/OFF	Push Button	Power Button - Turns the AMR Controller on/off. **NOTE:** When pressed longer than 5 seconds, while on, a forced power-off is performed.
C	I/O	Pluggable Terminal Block DFMC 1, 5/3-ST-3,5-LR BK	I/O connector. 2 inputs (Power ON/OFF input and UPS mode input) and 1 output (Power status output).
D	USB	USB 3.0	(2) USB 3.0 USB connections for cameras - Reserved.
E	USB	USB 2.0	(2) USB 2.0 USB connections - Reserved.
F	3,2,1	10BASE-T / 100BASE-TX / 1000BASE-T Ethernet connectors	(3) RJ45 Gb Ethernet Ports - Reserved.
G	DVI	DVI connector	Digital Visual Interface connector.
H	SD memory card slot	SD memory card slot	The SD memory storage can support all commercial SD cards that comply with the 2.0 specification, however, only OMRON SD cards are guaranteed.
I	1 & 2	RP-SMA Female	Wireless interface.
J	LINE	STX-35061-4T	3.5 mm Analog port - Analog Audio Output.
K	AUDIO	TOTX1350F	Toslink S/P DIF - Digital Audio Output.
L	CAN	DB9M	Connects to one RS-232 and one RS-422.
M	GPIO	HD44F	Interface expansion with 1x

Callout	Connection	Type	Description
			CAN interface, 4x RS232, 2x RS422 and 4x digital outputs PNP 24V.
N	COMM	DB9F	Comm interface with 1x RS232 and 1x RS422.
O	5	EtherCAT 100BASE-T connector	RJ45 Gb EtherCAT interface connector.
P	4	10BASE-T / 100BASE-TX / 1000BASE-T Ethernet connector	RJ45 Gb Ethernet interface connector.
Q	PLC	HD15F	Digital Safety I/O for connection to a Safety Controller. 4 x 24V input from Safety Controller and 4x 24V output to Safety Controller.
S	CFast card slot	CFast card slot	Memory storage.

AMR Controller LED Indicator Lights

The AMR Controller has 12 indicator LEDs that give a quick visual status on the status of the Controller. The following figure displays the AMR controller LED indicator lights.
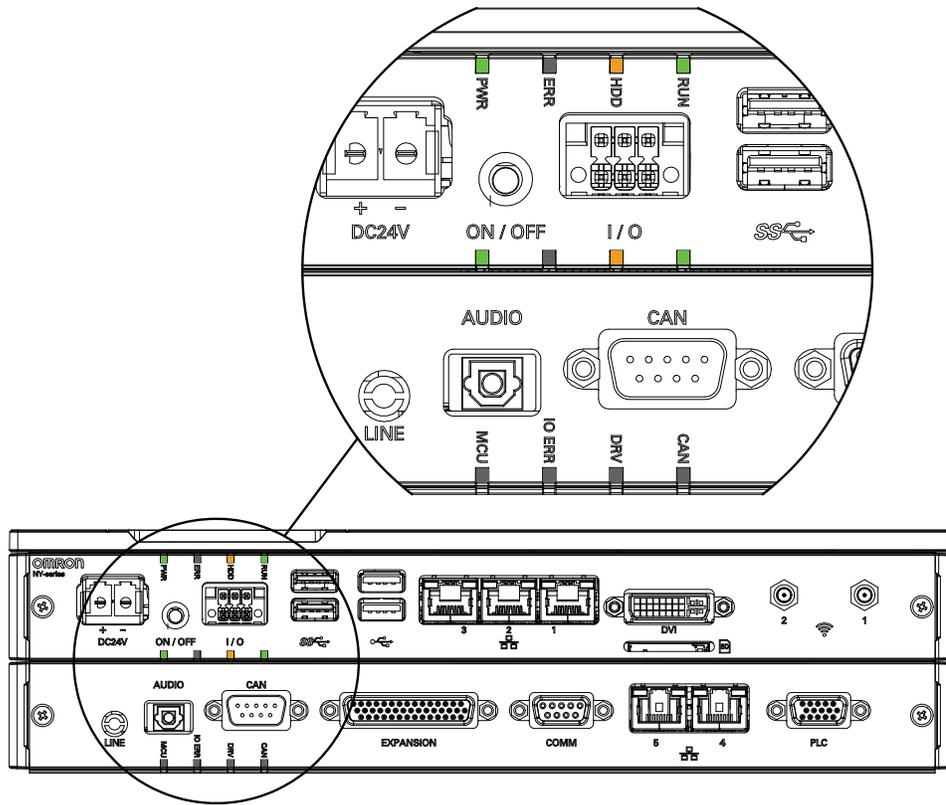
Figure 6-16. AMR Controller LED Indicator Lights

The following table provides description for the AMR Controller LEDs:

Table 6-1. AMR Controller LED Indicator Lights Description

LED	Color	Description
PWR	Off	not powered or system is off
	Blinking Green	system in standby mode
	Solid Green	powered on

LED	Color	Description
ERR	Off	no error
	Blinking Red	battery low - battery low error occurs when the battery charge is low. The AMR Controller battery is not a user-replaceable item. **NOTE:** The battery lifespan is 10 years.
	Solid Red	• thermal shut down - the thermal shut down occurs when the AMR Controller gets too hot. • power supply input under/over voltage or power supply defective - power supply errors occur when there is an issue with the incoming power to the AMR Controller. This error can also occur if the PSU (power supply unit) board inside the AMR Controller is broken. Such conditions could be the result of dropping the AMR Controller, or incorrect wiring of the AMR.
HDD	Flashing Orange	HDD (Hard Disk Drive) LED flashes orange when the disk is accessed. The flashing is not consistent or timed. It depends on what the user is doing with the system at that time.
RUN	Green	active drive under user control (via OS)
MCU	Off	MCU (Multipoint Control Unit) not active
	Blinking	MCU active
	Solid	MCU process hang
IO ERR	Off	no error
	Solid	I/O error detected
DRV	Off	no motion commanded
	Solid	motion being commanded
CAN	Off	no active link with motor controllers
	Solid	active link with motor controllers

NOTE: The LEDs in the middle row have the same meaning as the top LEDs.

Ethernet Switches

The HD-1500 has three Ethernet switches (Navigation switch, Obstacle Avoidance switch, and MQTT switch) located in the electronics bay, as shown in the following figure. The Ethernet switches allow for communication between the peripherals, lasers, Machine Automation Controller, and AMR Controller. Each Ethernet switch has eight available ports (total of 24 Ethernet ports), which connect to the peripheral devices as well as the main computing modules.

The AMR Controller has five available ports for Ethernet communication, and port No. 5 is reserved.

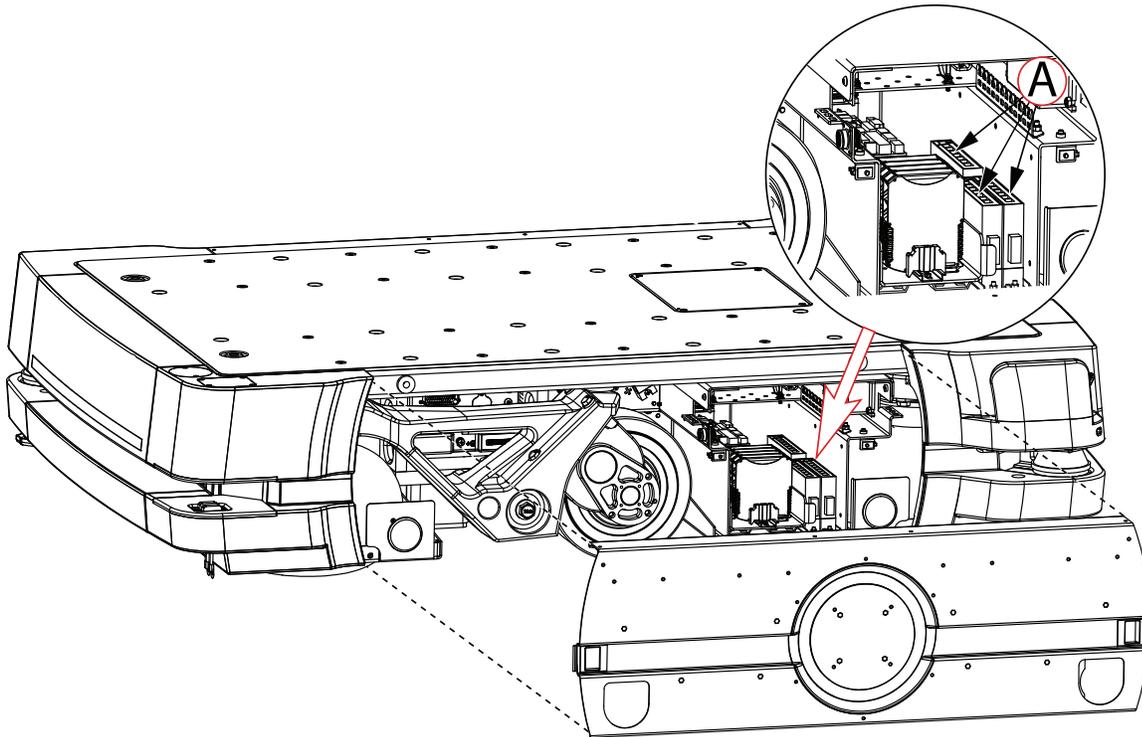**IMPORTANT:** Do not connect user-supplied equipment to the Ethernet switches.

Figure 6-17. (A) Ethernet Switches Located in the Electronics Bay

The following sections describe the mapping of the Ethernet switches.

Navigation Ethernet Switch

The Navigation Ethernet switch collects critical data. The most critical information communicated to the Navigation Ethernet switch is the safety scanning laser data.
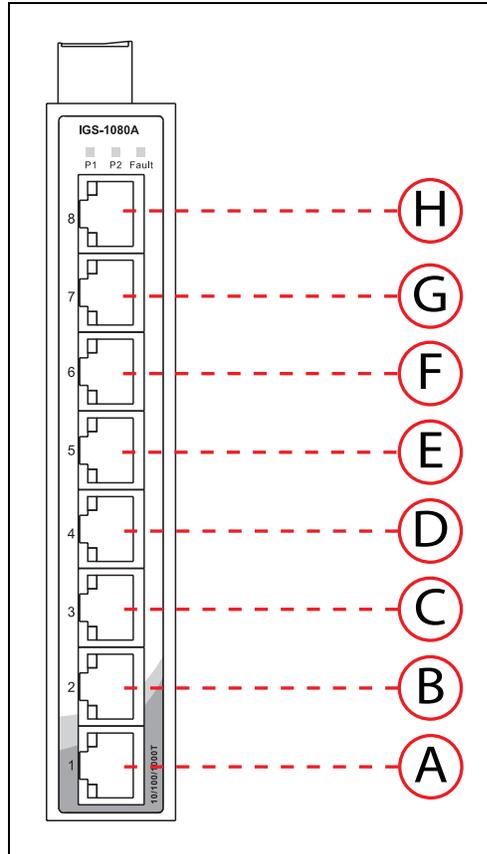
ID	Port No.	Connection	ID	Port No.	Connection
A	1	IPC Port No. 2 RJ45 2ft, Cat5e, Flat	E	5	Maintenance Front Panel RJ45, 2m, Cat5e, Flat
B	2	Safety scanning laser - Front M12 Right Angle, 2m, Cat5e	F	6	Reserved for future use.
C	3	Reserved for future use.	G	7	Reserved for future use.
D	4	Reserved for future use.	H	8	Safety scanning laser - Rear M12 Right Angle, 2m, Cat5e

Obstacle Avoidance Ethernet Switch

The Obstacle Avoidance Ethernet switch has semi-critical equipment connected to it that supplements the critical main navigation lasers in the Navigation Ethernet switch.
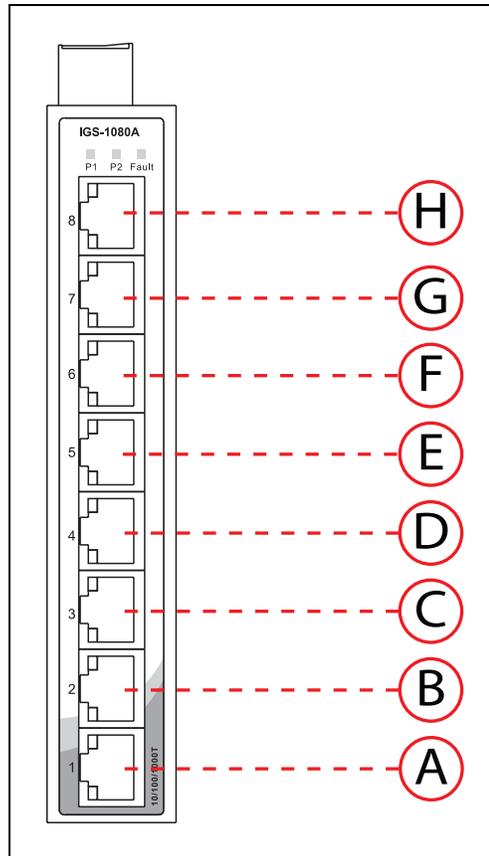
ID	Port No.	Connection	ID	Port No.	Connection
A	1	IPC Port No. 3 RJ45 2ft, Cat5e, Flat	E	5	Reserved for future use.
B	2	Low laser - Front M12 Straight, 2m, Cat5e	F	6	User Connection RJ45, 1ft, Cat5e Flat
C	3	Side laser - Front M12 Right Angle, *m, Cat5e	G	7	Side laser - Rear M12 Straight, *m, Cat5e
D	4	Reserved for future use.	H	8	Low laser - Rear M12 Straight, *m, Cat5e

MQTT Ethernet Switch

The MQTT Ethernet switch is responsible for non-critical tasks.
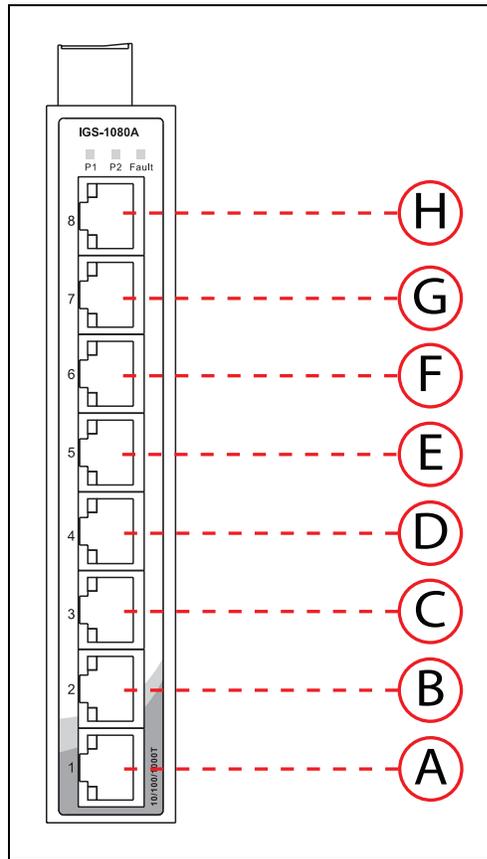
ID	Port No.	Connection	ID	Port No.	Connection
A	1	IPC Port No. 4 (base module) RJ45 2ft, Cat5e, Flat	E	5	Operator panel RJ45, 2m, Cat5e, Flat
B	2	IPC Port No. 1 (expansion mod-ule) RJ45 2ft, Cat5e, Flat	F	6	Machine Automation Con-troller
C	3	Battery No. 1 M12 Straight, 1m, Cat5e	G	7	Battery No. 3 M12 Straight, 1ft, Cat5e, Flat
D	4	Audio Visual Module RJ45, 2440 m, Cat5e, Flat	H	8	Battery No. 2 M12 Straight, 1ft, Cat5e, Flat

Chapter 7: Operation

Before proceeding with any tasks described in this chapter, you need to have performed the steps covered in the Setup and Getting Started chapters, so your platform has a map to operate from.

7.1 Operating Environment

Intended Use

The HD-1500 is designed for operating in indoor industrial environments. It is equipped with a Natural Feature Navigation system which enables the HD-1500 to independently navigate, and perform its basic functions without the need for the users to modify the facility. Although the HD-1500 AMR is equipped with highly advanced safety systems, it must still be deployed in a manner that takes into account potential risks to personnel and equipment. The product is not intended for outdoor use, or use in uncontrolled areas without risk analysis, for example, areas open to general public access. Use in such areas may require deployment of additional safety measures.

Clearance

The platform must operate in an environment that is generally flat and level, with no doors or other restricted areas that are too narrow for the AMR to pass through.

You must ensure that adequate clearance is maintained on each side of the AMR, so that a person cannot get trapped between the AMR and a wall or other fixed object. Consult the applicable standards for your locale for information about required safety clearances. Refer to the *Fleet Operations Workspace Core User's Guide* for information about software parameters that you can use to control the HD-1500's front and side clearance zones. These settings can help to prevent the platform from closely approaching obstacles.

An exception to side clearance requirements may apply at pickup and drop off locations, where the AMR must get close to conveyors or other fixed objects.

Narrow Passageway Behavior - Linear

If the AMR must operate in narrow passageways, consider the following:

- The practical minimum width for the hallway is 2 m, and the narrowest doorway is 1.5 m. In order for the AMR to pass through these narrow spaces, you may need to use specific map features or change the AMR's configuration to reduce the speed.

- Using the *Door Goals* feature on the map for pre-alignment can be useful.

These widths are practical for linear speeds of less than 300 mm/sec.

Minimum Lane Width When Two HD-1500s Passing Each Other

The minimum lane width for two AMRs passing each other, in a linear passageway, is 2.5 m. See the following figure.
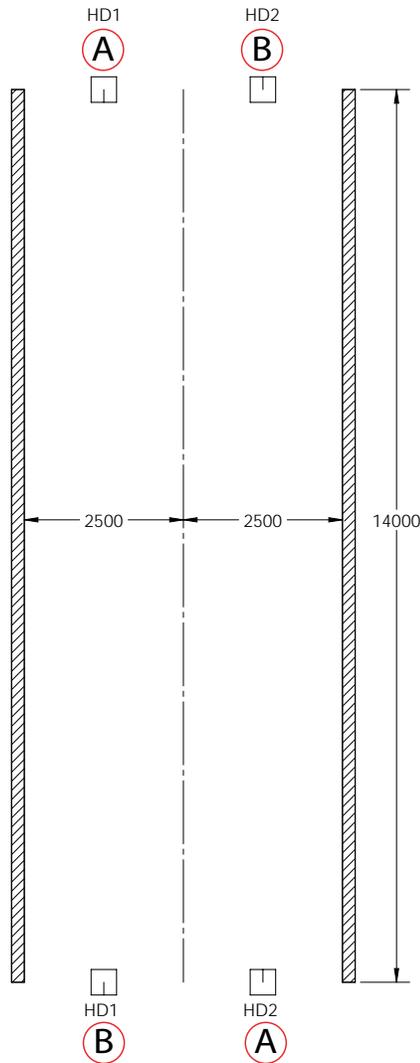

Figure 7-1. Minimum Lane Width When Two HD-1500s Passing Each Other, (A) Start Goal, and (B) End Goal (units are in mm)

Narrow Passageway Behavior - Non-Linear

This section presents various cases of non-linear narrow passageways and tight door openings, and describes the considerations that must be taken when operating the HD-1500 in such environments.

For all the cases presented in this section, the widths are practical for linear speeds of less than 300 mm/sec.

U-Turn in a Narrow Passageway

The following graph displays a situation where an HD-1500 must make a U-Turn in a narrow passageway (width of 2 m), with the U-Turn clearance of 3.5 m.

You may use robot tasks and configuration changes in narrow hallways for better navigation and operation of the AMR.
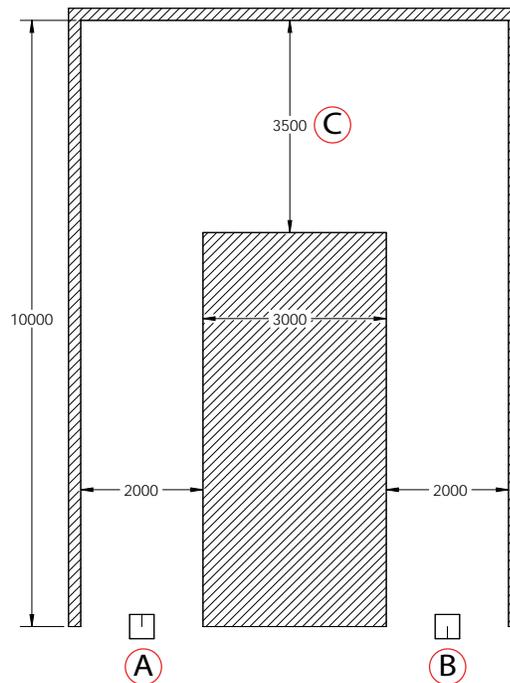
Figure 7-2. U-Turn in a Narrow Passageway, (A) Start Goal, (B) End Goal, and (C) U-Turn Clearance (units are in mm)

U-Turn Through a Narrow Doorway

The following graph displays the HD-1500 U-Turn behavior at a narrow doorway.

As displayed in the following figure, the distance between the edge of the door opening and the adjacent wall is 250 mm.

You may use robot tasks and configuration changes for operation of the AMR in narrow hallways. Also, for optimum performance in doorways, you can use configuration changes.
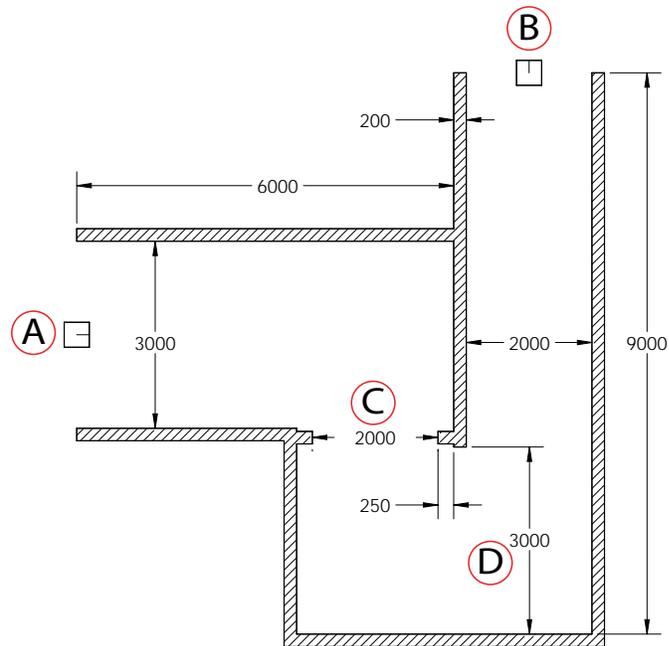
Figure 7-3. U-Turn at a Narrow Doorway, (A) Start Goal, (B) End Goal, (C) Doorway, and (D) U-Turn Clearance (units are in mm)

Obstacles

If the AMR will be entering high-traffic areas, take appropriate precautions to alert people in those areas that an AMR might enter. If the traffic consists of other machines, adjust the AMR's and/or the other machines' parameters to reduce the risk of a collision.

Take care to avoid:

- Glass/transparent doors and walls.

- Steps, or ledges taller than the HD-1500's specified step-traversal ability that do not have adequate physical barriers.

- Floors with access panels removed.

- Loose cables, hoses, etc.

- Large, highly-reflective objects.

Environment and Floor

Floors must provide good traction, typical of good walking conditions. Rough or uneven floors can affect safety of the AMR's operation as the laser's sensing plane is not always parallel to the floor.

WARNING: Even on smooth, level floors, dust, dirt, grease, and water (or other liquids) can affect wheel traction, as well as operation of the ESD drive wheels. If the drive wheels slip, it can potentially affect operating duration and navigation accuracy.

Rough or uneven floors can degrade the drive wheels, and shorten their life span.

> **IMPORTANT:** OMRON does not intend the HD-1500 for deployment in corrosive environments.

Characteristic	Operating Limits
Temperature	5 to 40°C
Humidity	5% to 95%, non- condensing
Altitude	Up to 2000 m above mean sea level
Step traversal	Up to 15 mm
⚠ **CAUTION:** PROPERTY DAMAGE RISK The platform is designed and intended for smooth, level floors. While it is capable of driving over a step or gap as listed, frequent or high-speed driving over steps or gaps will shorten the lifespan of the drivetrain components. **NOTE:** Any steps must have a smooth, rounded profile. At less than the recommended speeds, the AMR might not be able to traverse the step height listed.	
Gap traversal	Up to 20 mm
Atmospheric	Do not use the platform in hazardous environments (explosive gas, and oil mist). It has an IP rating of IP20.
Radiation	Do not use the HD-1500 in presence of ionizing radiation.
Dust and Smoke	Severe smoke and particulate matter may degrade the efficiency of safety scanning lasers, and result in unexpected halt of the AMR operation.

Getting Stuck (Immobilization Risk)

It is possible, though not likely, for the AMR to get into a position from which it cannot move without Operator assistance.

> ⚠ **WARNING:** PERSONAL INJURY OR PROPERTY DAMAGE RISK
> Immobilization might cause motors in the AMR to overheat, potentially resulting in a fire.

Some examples are shown in the following figure.
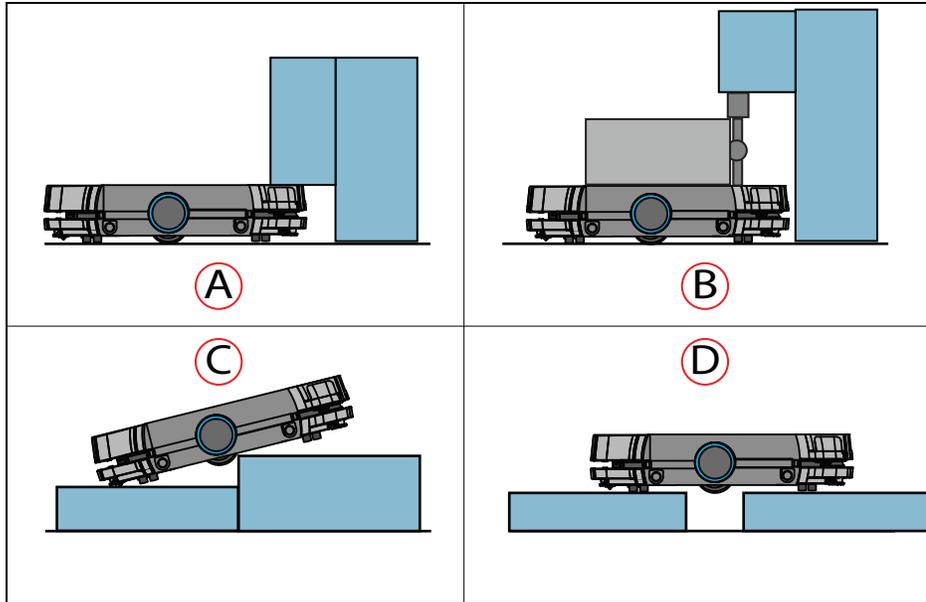
Figure 7-4. Examples of the Platform or AMR Getting Stuck

Callout	Description
A	Platform stuck under overhang
B	User payload stuck under overhang
C	Platform driven off ledge
D	Platform driven over excessive gap (drive wheels have no traction.)

Additional Information: Refer to Lifting the Platform Safely on page 220 and Releasing the Brakes on page 33

Side Lasers can help with detecting overhanging objects and floor obstacles. See: Side-Mount Lasers on page 268.

7.2 Typical Operation

During normal start-up, the AMR powers all its on-board systems[1] and runs its on-board software and your integrated processes automatically to provide an application-ready AMR. If it has been given a map of its workspace and knows where it is within that environment (localized), your AMR is ready to perform start-up - which requires human intervention. However, after the initial start-up the AMR will be capable of operating autonomously, without human intervention. See *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for information on start up procedure and localization.

---

[1]As configured either by the factory or through your own parameter changes.

An AMR initially generates its planned path based on known information in the map. As it moves, its path is updated dynamically in response to changes detected in its environment, such as temporary obstacles.

Paths are updated many times per second to maintain a smooth trajectory and to account for any obstacles that are detected by on-board sensors. Often the AMR will adjust its path to go around an obstacle. Navigational parameters are stored on the AMR Controller, and can be viewed and modified using the MobilePlanner software, which is covered in the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)*.

The MobilePlanner application, running on your computer, configures the many high-level operating characteristics of the AMR. The MobilePlanner software typically communicates with the AMR over the wireless network. A direct connection, through the Maintenance Ethernet port on the platform, is also possible.

> **IMPORTANT:** Protect the MobilePlanner Operator Mode with user ID and password access, to prevent unauthorized operation of an AMR.

7.3 Power and Charging

The HD-1500 battery supplies ample power for the motors, electronics, and accessories.

There are three ways to check the battery's state-of-charge (SOC) percentage (%):

- Manual status indicator, attached to the battery enclosure.

- Operator Panel screen.

- MobilePlanner software.

The platform ships separately from the battery. You must fully charge the battery prior to use, as noted in Battery Safety on page 52.

Typically, the AMR manages battery recharging. With the power provided by the automated charging station, all on board systems function continuously while the battery recharges.

> **NOTE:** Typical runtime with no load is approximately 12.5 hours. Typical fully-loaded runtime is approximately 9 hours. The primary factors that affect runtime are AMR speed, acceleration, idle time at goal locations, payload, and power consumed by accessories.

Battery Indicators and Controls

The battery indicator has five RGB LEDs, and one push-button (SHOW LEVEL). When the push-button is pressed and held in for approximately 30-45 seconds, the firmware attempts to communicate with the battery to determine the battery's state of charge. During this attempt, all five LEDs blink yellow. The blinking continues until the battery indicator is able to communicate with the battery, and receive information on the battery's state of charge. From left to right, the LEDs indicate:

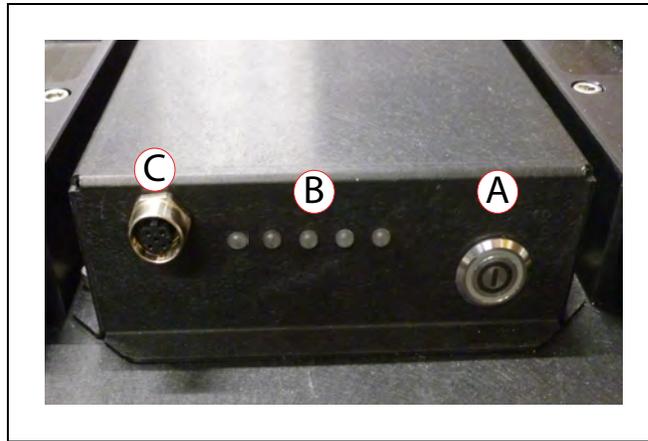| LED	Color	Meaning
1		≥ 0% state of charge
2		≥ 20% state of charge
3	Blue	≥ 40% state of charge
4		≥ 60% state of charge
5		≥ 80% state of charge

Figure 7-5. (A) Push-Button (Show Level), (B) LED Indicators, and (C) Ethernet Connection

Displaying the battery's state of charge in this way can be useful when a battery is in storage, and you want to know its state of charge.

Charging Station

The HD-1500 charging station consists of two main parts; the power supply box, and the docking target which the AMR drives itself into. The charging station provides both manual and automated methods of recharging the AMR's battery.

The power supply box outputs a maximum of 6.84 kW of power, and can charge a fully depleted battery pack in 40 minutes.

WARNING: FIRE RISK, ELECTRICAL BURN RISK
The HD-1500 battery, and the charger outputs have high current. You must take appropriate precautions to avoid potential short circuit.

WARNING: ELECTRICAL SHOCK RISK
The charging station transfers high electric power, and contains hazardous voltage. The user must take necessary precautions when working near the charging station, and follow appropriate Lock-Out, Tag-Out (LOTO) instructions prior to any maintenance work done on the charging station.

Due to high power transfer, OMRON has taken several safety measures to keep the users safe:

- ○ The electrician access box has a main disconnect switch, as displayed in Figure 7-10. When the user turns the main disconnect switch ON, the access door locks automatically, and prevents access to the interior of the electrician access box. This is to block access to the hazardous electrical circuits in the electrician access box.

- ○ The main electrical compartment door can only be accessed with a key; this prevents unauthorized access to the main electrical compartment.

- ○ When the HD-1500 engages with the charging paddle, the docking target performs a voltage check. It uses a sensor to verify that the HD-1500 is present before it begins charging the HD-1500's battery. The docking target ensures that the voltage presented is between 40 to 57 volts.

The power supply box uses a 4 meter long power cord (25.4 mm diameter) to transfer power to the docking target.

> **WARNING:** PERSONAL INJURY OR PROPERTY DAMAGE RISK
> You must route, and secure the power cord properly. It must be secured in such a way that prevents straining of the connection points. There must be a physical protection that prevents the tripping hazard and cable crushing.

If the power cord is laid on the ground, use a visible cover (e.g. yellow and black tripped cover) that goes over the power cord, and prevents crushing of the power cord.

> **WARNING:** HOT SURFACE HAZARD
> The docking target charging contacts heat up during the charging process. Take necessary precautions to avoid burn dangers.

Safety Precautions

Lock-out, Tag-out (LOTO)

Prior to any maintenance work on the charging station, you must perform Lock-Out, Tag-Out (LOTO) procedure. For information on how to perform LOTO, see: Lock-Out, Tag-Out Procedure on page 216.

Decommissioning

Follow these steps to discontinue the operation of a power supply box, and remove from service:

1. Remove power to the power supply box through the main disconnect switch. Turn the main disconnect switch to off position, see: Figure 7-11.

2. Verify that AC power is disconnected from the power supply box. When there is no AC supplied to the power supply box, the blue LED is off.

3. Remove the facility power cable from the electrician access box. This will disconnect the facility AC power to the electrician access box.

Storage

- Store both power supply box and the docking target at: -20 to 60°C

- Humidity: 5% to 95%, non-condensing

Environmental Considerations

- In case of fire, use a type D extinguisher: foam, dry chemical, or CO_2.

- IP rating for the power supply box is IP20.

- IP rating for the docking target is IP20.

> **NOTE:** The IP rating for the copper charging pads is IP10. Do not expose them to liquid.

Autonomous Charging

During normal, autonomous operation, the AMR charges its battery autonomously through the automated charging station. The AMR knows the approximate location of the docking target based on the map loaded onto the platform.

When the AMR arrives near the docking target, it looks for the trapezoidal shape of the docking target and drives frontward into the docking target to charge. When the AMR docks, it mates with the charging paddle, as displayed in Figure 7-8. After the docking target verifies that the AMR is present, and performs a series of checks. Then, it turns the power supply on and starts charging the AMR's battery. There is about a 10-second delay between when an AMR docks and the charging LED (yellow light), located on the power supply box, comes on. For information on the power supply box LED indicators, see: Indicators, Controls, and Connections on page 189

Connecting and disconnecting the AMR with network and onboard clients will not disturb the charging state. However, if you move the AMR while charging its battery, the charging state will be disturbed. The station supplies ample power for all onboard systems while charging its battery, so you can continue operating those systems while charging.
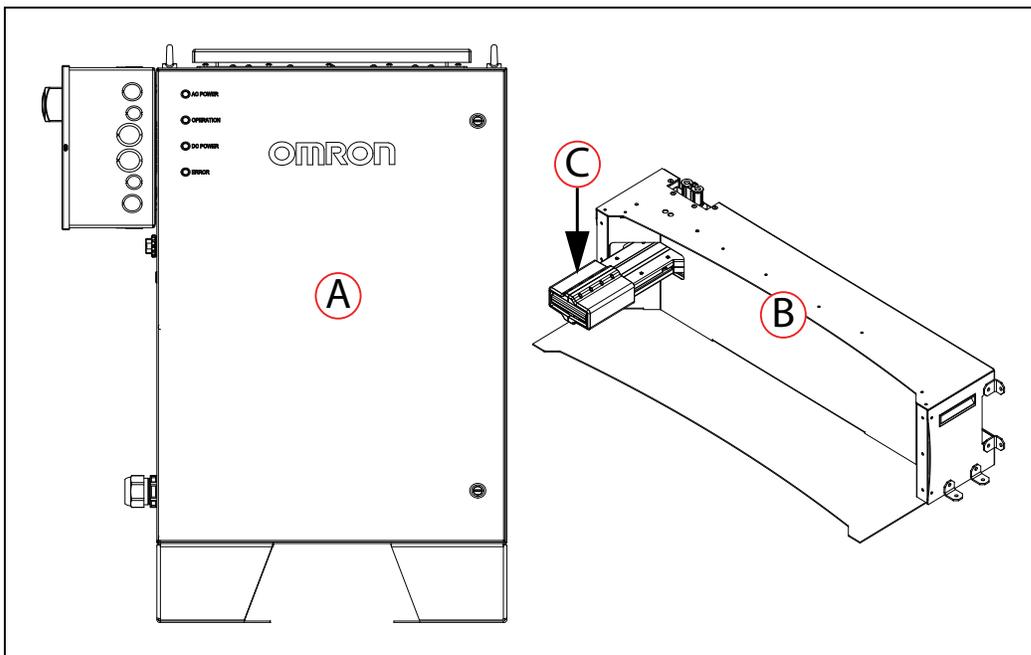
Figure 7-6. Charging Station, (A) Power Supply Box, (B) Docking Target, and (C) Charging Paddle

The following image displays the HD-1500 approaching the docking target to mate with the charging paddle.
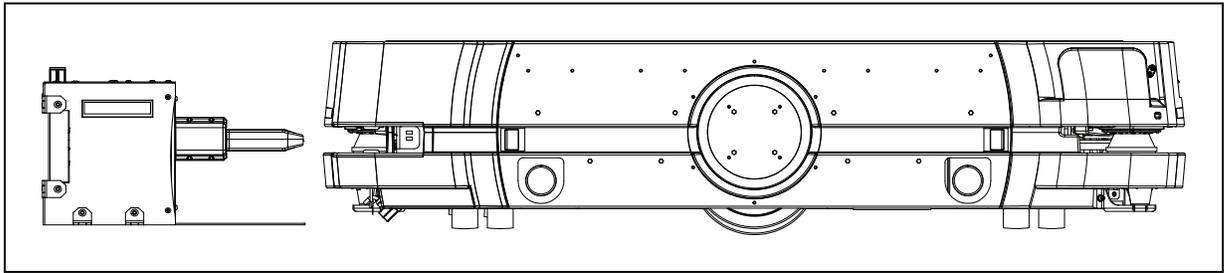
Figure 7-7. HD-1500 Approaching the Docking Target to Charge Its Battery
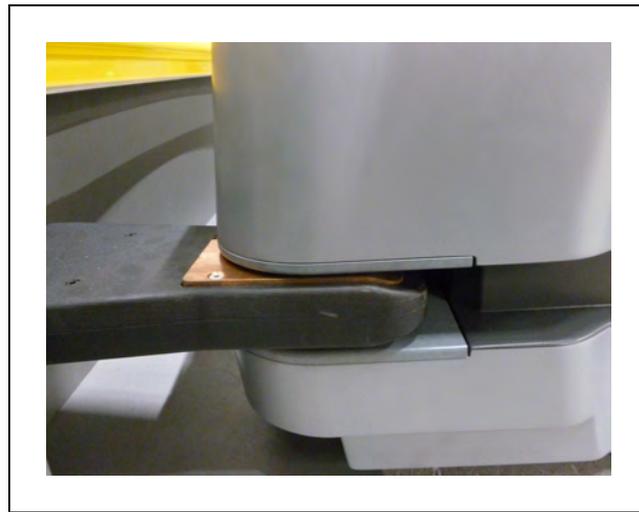
Figure 7-8. HD-1500 Mating with the Charging Paddle

As soon as the AMR begins charging its battery, the light discs display a green arc indicating the current state of charge (SOC). See the following figure:

Figure 7-9. AMR Light Disc Displaying the State of Charge (SOC)

Indicators, Controls, and Connections

The power supply box has a main disconnect switch which turns the unit on or off. When the main disconnect switch is placed in the vertical position (ON position) the unit powers on, and performs a lamp that illuminates all LEDs on the front panel of the power supply box for 1.5s. The LEDs then enter their operations state, displaying the status of the power supply box. The power supply box then becomes operational.

The power supply box performs several internal self-tests. If any of these fail, the power supply box enters a safe state where all outputs are turned off and the Red LED illuminates. The only way to clear faults like this is to power off the power supply box.

A push button on the side of the power supply box is provided for charging a battery that has been completely depleted. A battery in this condition can only be charged by direct connection to the power supply box, outside of an AMR. The power supply box will not automatically charge a battery in this state; after connecting the completely depleted battery to the power supply box you must momentarily press the power supply box's push button to allow charging to begin. For information on how to charge the battery outside of an AMR, see: Charging a Standalone Battery on page 192.

> **NOTE:** If the push button is depressed and held in place by tape (or by other means), the system will not recognize this as a confirmation for dead battery.

The following table provides description of each LED:

LED color	Description		
Blue	Power	On	AC power on
		Off	AC power off
Green	Operation state	On	Normal operation
		Off	Not in normal operation
		Blinking	Debug active
Yellow	Charging state	On	Charging
		Off	Not charging
		Blinking	Needs operator attention

When the yellow LED light is blinking, you must press the push button to confirm that you have connected the battery manually.

> **IMPORTANT:** Do not press the push button if the yellow LED light is blinking and there is no battery connected.

> **NOTE:** If the user connects a live battery to the charging station, manually, the yellow LED light will not blink. The system itself will confirm that a battery has been connected.

When the yellow LED light is solid (charging the battery manually or autonomously), pressing the push button will halt the charging, and the yellow LED light will turn off. To resume char-

ging, you must:

1. Remove the AMR from the docking target (if charging autonomously), or disconnect the power cord from the battery (if charging manually).

2. Then, drive the AMR back on to the docking target (if charging autonomously), or connect the power cord to the battery (if charging manually).

Red	Error	On	Non-critical error
		Off	Normal operation
		Blinking	Critical error

The power inlet is located at the rear of the electrician access box (**(C)** in Figure 7-10.). The output power plug is located below the electrician access box, on the left side of the station, as viewed from the front (**(D)** in Figure 7-11.

> **Additional Information**: The power supply box input electrical power is protected by a 25 A branch rated circuit breaker.
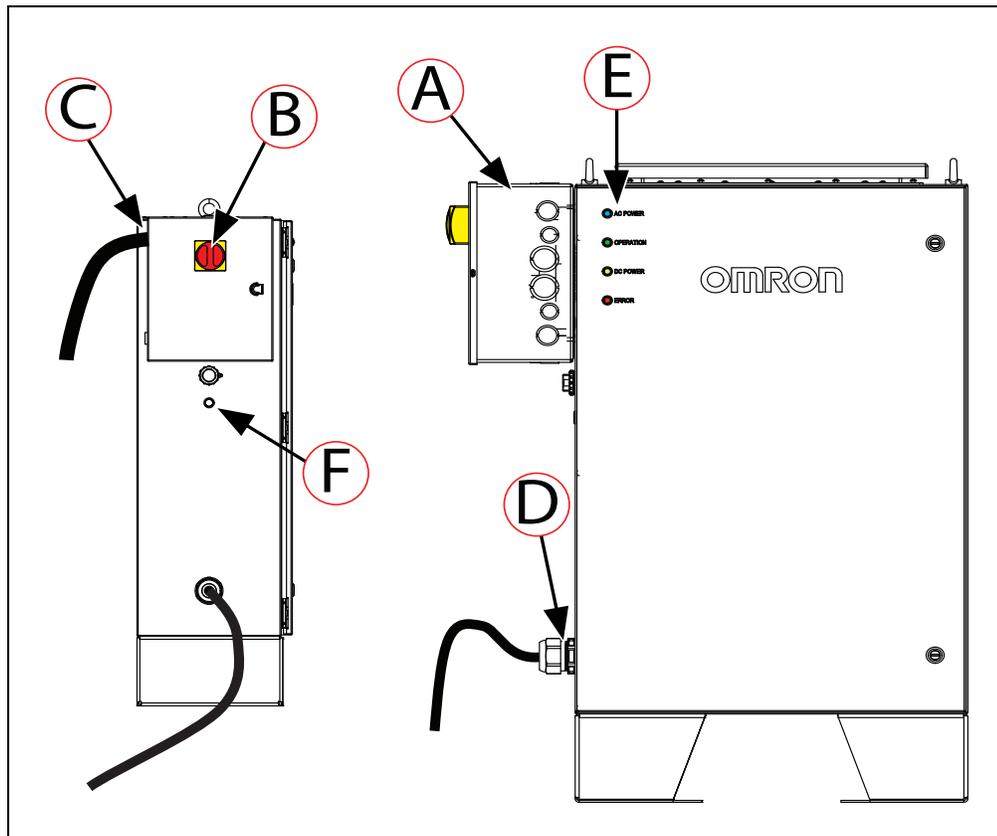
Figure 7-10. (A) Electrician Access Box, (B) Main Disconnect Switch, (C) Input Power Plug, (D) Output Power Plug, (E) LED Indicators, and (F) Push Button
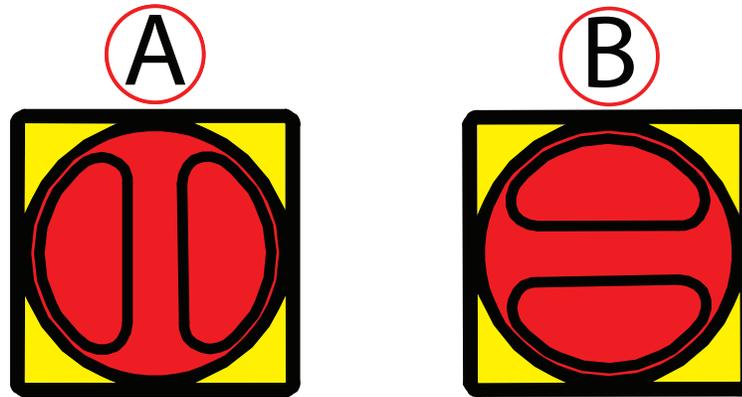
Figure 7-11. Main Disconnect Switch on the Electrician Access Box, (A) ON Position, and (B) OFF Position

Manually Charging the AMR's Battery

Under some operating conditions, the battery might become too hot to enable charging. To prevent battery damage, the AMR's operating software displays the following error message when the battery is too hot:

"WARNING - One of the battery modules is compromised and will not offer the same run-time per charge. Please contact OMRON for support."

Charging the Battery inside the AMR

> **NOTE:** The AMR must be powered on in order to charge.

To manually charge the battery inside the AMR:

1. Press an E-Stop button, and then press and hold the brake release button. Be aware that brake operation requires a small amount of battery power. If the battery is too low, you might need to charge it outside the platform.

2. While holding the brake release button, push the platform forward onto the docking target until the AMR mates with the charging paddle, as shown in the following figure. For instructions on how to push the AMR using the brake release button, see: Brake Release Button on page 198.

> **NOTE:** Push the AMR slowly, and only far enough to engage with the docking target charging paddle. Also, make sure that the AMR is be well aligned with the docking target.

Figure 7-12. HD-1500 Mating with the Charging Paddle

3. Make sure that the yellow LED, located on the power supply box, turns on and stays on.

Charging a Standalone Battery

You can charge the battery, outside of the platform, by using the charging cord connected to the power supply box; this is the same power cord you use to connect the power supply box to the docking target. Charging a standalone battery is typically used for charging a spare battery, while the second battery is still in the platform, and the AMR is in use.

Some users manually charge a spare battery, and exchange that for the battery inside the platform. Typically, this is done at the start of each shift, so the AMR is available for the entire shift without recharging.

> **NOTE:** The charging station cannot charge the battery inside the platform and the spare battery at the same time. There is only one charging cord, which means, when it is connected to the docking target, you can not charge a spare battery.

> **Additional Information**: There is about a 10-second delay between when you connect the charging cord and when the yellow LED turns on.

Balancing the Battery

The HD-1500's battery consists of eight individual lithium battery modules, and each battery module is composed of multiple cells which must stay balanced to maintain maximum runtime.

> **IMPORTANT:** The time interval between battery balancing events affects the length of time required to balance a battery. A battery that is significantly out of balance can take 10 or more hours to balance after charging.

There are three ways to manage battery balancing:

- **Balance the battery at every charge**

    Set the AMR's *DockUntilDoneCharging* parameter to **True**. In this case, the battery will balance before indicating charging is complete, so the battery will get balanced every time the AMR docks. You do not have to do anything extra to balance the battery.

    In this mode, the battery will typically take about 10 minutes to balance after charging.

    > **NOTE:** OMRON recommend this mode for applications where you do not manually exchange the battery.

- **Exchange the in-service battery, periodically, with a fully-charged, balanced spare battery**

    A spare battery plugged into a charging station will be balanced after it is charged. In this mode, you don't have to worry about battery balancing, although it does add the task of manually exchanging batteries.

    The interval between battery exchanges depends on the AMR's use. This includes the weight it carries, the electrical load of any accessories, and percentage of time it is in service. You will need to determine the optimum interval for your situation. exchanging the battery at every shift change is a commonly used interval.

    > **NOTE:** OMRON recommends this mode for battery exchanging, if you are not charging the battery while it is inside the AMR.

- **Exchange the battery after a longer interval (days) with a charged, balanced spare**

    Set the AMR's *DockUntilDoneCharging* parameter to **False**, to let the AMR get a partial charge by docking. The *StateOfChargeToChargeTo* and *MinutesToChargeFor* parameters need to be set to appropriate (non-zero) values. Then do a periodic battery exchange with a fully-charged and balanced battery, such as once a week.

    - *StateOfChargeToChargeTo* parameter determines the state of charge the battery needs to attain before the AMR can stop charging.

        A 80% value here would get the battery mostly charged, but not balanced.

    - *MinutesToChargeFor* parameter determines the number of minutes the battery needs to charge before the AMR can stop charging.

        The AMR will stop charging when the battery reaches either of these parameter values.

        > **NOTE:** If both of these parameters are left at the default of 0, and *DockUntilDoneCharging* is set to False, the AMR will dock, and never undock. It remains out of service until you correct the parameter values.

    In this charging mode, OMRON recommends that you exchange the batterys weekly, at a minimum. If you see a reduction in run-time, you should do an exchange more often than that.

7.4 Operator Panel

The Operator Panel is comprised of a screen, an E-Stop button, ON and OFF buttons, a brake release button, a pendant port, a Maintenance Ethernet port and a keyswitch. The panel will typically be mounted on the payload structure, so that it can easily be reached by an operator. You can relocate the Operator Panel to other positions on you payload structure, subject to the length limit of its cable connection to the AMR Controller.

Following figure displays the Operator Panel installed on the HD-1500 platform.

Figure 7-13. Operator Panel Installed on the HD-1500 Platform

Screen

The Operator panel screen is a color TFT, 800 x 480 pixels, 178 mm diagonal display. It is not touchscreen which results in increased brightness (400 cd/m²). The addition of anti-glare surface treatment, further increases the clarity of the screen display. It can display 256K colors, and is backlit.

Default/Sample Screen Contents

The following image shows the first screen that appears during boot-up:
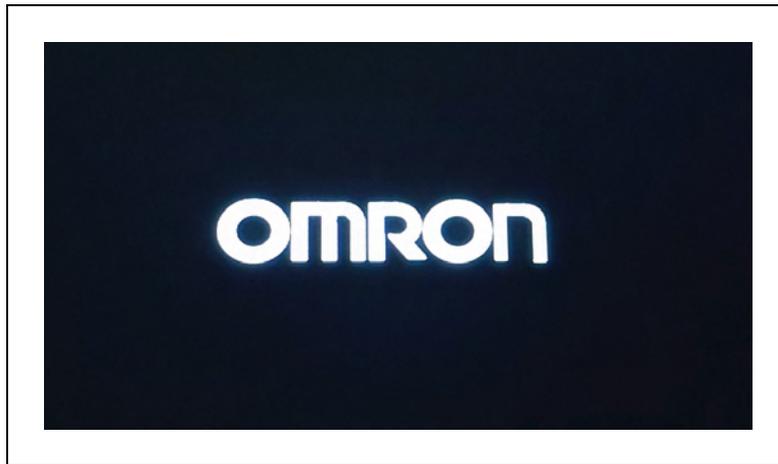
Figure 7-14. Initial Boot Screen

After the platform boots up, you will see the main screen:

Figure 7-15. Main Screen Fields

Callout	Description	Callout	Description
A	WiFi Signal Strength	D	Battery Level
B	IP Address	E	AMR ID
C	Screen The screen displays Status, Faults, or Instructions (up to six lines of text).		

- The screen can display up to six messages, in order of importance.

- The screen will display only one fault at a time.

- The screen will display any event or condition that causes an ARAM restart or AMR shutdown, and give the cause of the restart or shutdown.

E-Stop Buttons

The HD-1500 platform has five E-Stop buttons. Two on each side, and one on the Operator Panel. An E-Stop button is colored red and latches (locks) when pressed. Twist the button to release the E-Stop button.

When you press the E-Stop button, the AMR decelerates to a controlled stop, then disables its motors and engages the brakes. The motor controller is equipped with OSSD (Output Signal Switching Device) inputs to accommodate STO (Safe Torque Off) feature. The STO is an integrated safety function of the motor controller that discontinues all power to the motor, during the safety stop.
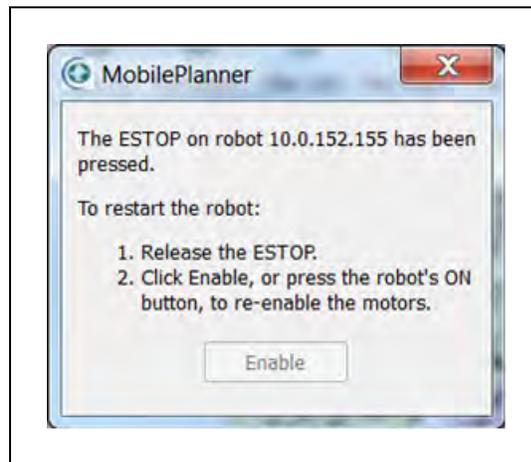
Figure 7-16. Motor Enable Pop-up Dialog

In normal use, there are three main reasons to activate the E-Stop button:

- Interrupting or stopping the AMR to keep it from performing its currently scheduled task (if you do not have access to MobilePlanner).

- Stopping the AMR for safety reasons.

- Stopping the AMR to use the Operator Panel's Brake Release button.

  NOTE: After releasing an E-Stop button you must then enable motor power by pressing the ON button on the Operator Panel. The AMR will not enable the motor power automatically after release of an E-Stop.
  There is a two-second delay between when the ON button is pressed, and the platform resumes its activity. During the two seconds, the platform scans its path for potential obstacles, and will resume its commanded motion if there is adequate space to maneuver.

Disengaging the E-Stop Button

To disengage an E-Stop button and enable the motors, twist the E-Stop button in the direction of its embossed arrows to release it. The AMR's drive motors remain disabled until you use one of the following enabling methods:

- Press the **ON** button on the Operator Panel. See: Operator Panel on the Payload on page 147.

- Click **Enable** in the E-Stop dialog window displayed by MobilePlanner. (If this dialog window is not visible, click **Map** and then click **Show Robot**.)

> **NOTE:** These methods can not be used to enable the motors if the AMR is docked or experienced a critical driving fault.

Positioning an Optional Payload E-Stop

Per relevant safety standards, E-Stop buttons must be placed within 600 mm reach of the operator. An operator should be able to easily reach an E-Stop button from any angle without having to reach across the moving AMR or any moving payload parts. Although, the side E-Stops on the platform satisfy this requirement, with the payload structure added on top of the platform, it may become necessary to use a sixth E-Stop button. OMRON has provided an additional connection to add an optional E-Stop button, if needed, to satisfy the 600 mm safety requirement.

 CAUTION: PERSONAL INJURY OR PROPERTY DAMAGE RISK
To make sure that all E-Stop buttons are within the 600 mm reach requirement, you must install a sixth E-Stop button in a location where it is accessible regardless of the AMR's direction of travel.

> **IMPORTANT:** It is the end user's responsibility to ensure that the additional E-Stop button is placed in a location where the operator can easily reach regardless of the AMR's direction of the travel.

You can satisfy the 600 mm reach requirement by:

- Maintaining the location of the Operator Panel within the 600 mm reach distance. This panel contains an integrated E-Stop button. If the panel is in its default location near the top of the platform, then the 600 mm requirement is satisfied.

- Relocating the Operator Panel to a position on the payload structure within the 600 mm reach distance, or adding a separate optional user E-Stop button to the Payload, withing the 600 mm reach distance (regardless of the direction of travel).

ON Button

The ON button restores power to the AMR after the OFF button was pressed. The ON button does not function until any in-progress shut down is complete.

It can also be used to re-enable motors after an E-Stop has been released.

OFF Button

The blue OFF button removes power from all systems except the charging hardware circuits. During shutdown, the platform's software systems prevent loss of data, and save the platform's last known location so it automatically localizes when it is next powered on.

> **NOTE:** You need to localize the AMR it was moved while powered off.

NOTE: You can use the key switch to disable and lock the OFF button. Remove the key to prevent unauthorized personnel from shutting down the AMR.

Brake Release Button

The brake release button is used when you need to manually move the AMR.

Releasing the brakes requires a small amount of battery power. Without power, the brakes remain engaged.

To move the AMR using brake release button, you must:

1. Press an E-Stop button.

2. Press and hold the brake release button on the Operator Panel.

3. Push the AMR at any of the designated locations on the platform. See: HD-1500 Unpacking on page 65.

CAUTION: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Do not push the AMR from a high position on its payload structure. This might cause the AMR to topple.

CAUTION: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Manually moving a fully-loaded AMR while using the brake release button is not recommended. If you must manually move a fully-loaded AMR, make sure to do this safely as this could result in personal injury or property damage.

If the loaded AMR is too heavy to move manually, it is recommended that you seek additional help or find an alternative method of moving the AMR.

Pendant Port

The Operator Panel comes with a pendant port. Use the pendant to drive the AMR manually and to create the scan used to make a map.

For more information on how to use the pendant, see: Pendant Controls and Operation Description on page 209.

Maintenance Ethernet Connection

The Operator Panel provides a Maintenance Ethernet connection. Connect a PC to Maintenance Ethernet port, and prepare your platform for autonomous mobile operation. You need to connect to the SetNetGo OS through the MobilePlanner SetNetGo interface.

The Maintenance Ethernet is internally connected to the Ethernet switch located in the middle section of the electronics bay.

Attach a pass-through or cross-over CAT5 (or better) Ethernet cable and connect the PC to the Maintenance Ethernet port of the Operator Panel. The platform Ethernet is Auto-MDIX, and will detect the type of cable you are using.

7.5 Other Controls and Indicators

A beacon or light tower is not included with the HD-1500. You can optionally supply and install such a device if required. To comply with relevant standards, the sequence of the lights, from top down, must be red, yellow, and green.

Factory-supplied payload structures often include a beacon.

This section describes light indicators on the platform and AMR Controller.

Light Discs and Beacon

The platform has circular lights on the sides that indicate motion, turns, and several other states.

A user-supplied beacon, typically mounted on the AMR payload structure, can provide extra signaling. The beacon indicates movement, and signals an Operator that the AMR is waiting for assistance. For information on user-supplied beacon connection, see: LIGHTS on page 163.

The light disc and user-supplied beacon states are described here, and summarized in the following tables.

Driving Straight

Blue arcs on each side of the platform will appear to rotate in the direction of the platform's travel, to let nearby people know that it is moving (or about to move). Beacon blinks green in this case.
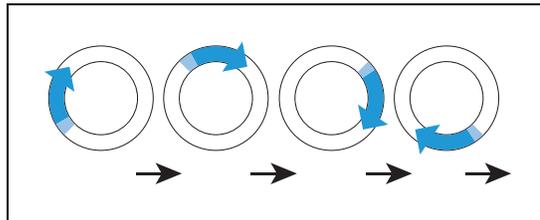
Turn Signal

The blue drive indicators will include a blinking orange segment at the front of one light disc to indicate that the platform is about to turn in the direction of the signal.
When the drive wheels rotate in opposite direction, the direction of the blue drive indicators will indicate the direction of the drive wheel rotation.
Beacon blinks green in this case.
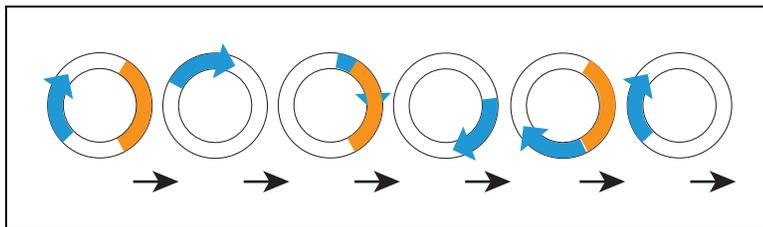
Stopped (no errors), or Booting

Entire light disc on each side pulses blue slowly (0.25 Hz). Beacon is steady green when stopped with no errors or booting.
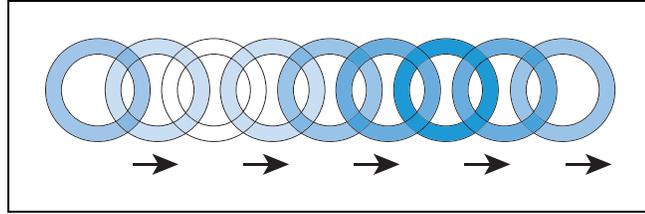
Stopped with Warning (such as low battery)

When Stopped with Warning, the light discs pulse orange instead of blue. Beacon blinks green in this case.
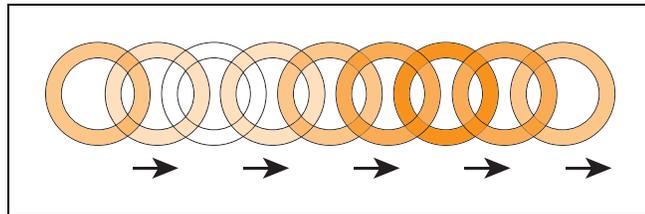
Obstacle Detected

The light disc blinks yellow if the AMR stops for an object in its safety zone. Beacon blinks yellow in this case.

> **NOTE:** There is a two-second delay between the end of an obstacle-detection condition and the platform resuming its activity. During the two seconds, the platform scans its path for potential obstacles. It will remain stopped until its path is clear.
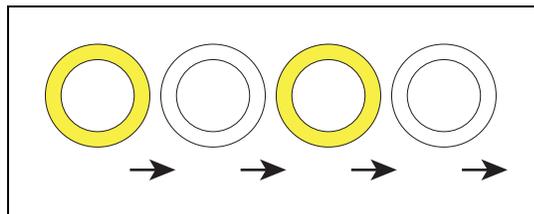
Lost

When the AMR is lost, the light discs each display two orange arcs, traveling from the 6 o'clock to the 12 o'clock position and back, in opposite directions.

- E-Stop NOT engaged: Beacon blinks green when E-Stop not engaged.
- E-Stop engaged: Beacon blinks red when E-Stop engaged.
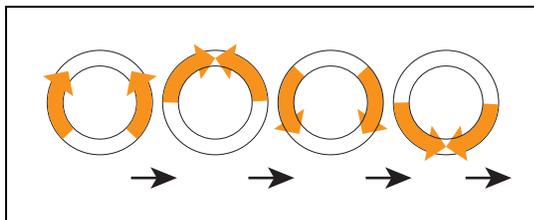
Charging

When docked, a green arc indicates the current state of charge (SOC), showing steady green from the top of the disc to the current SOC. A small white arc travels back and forth between the two ends of the green arc. Beacon blinks green when charging. If the E-Stopped is engaged while the AMR is charging the beacon will blink red.
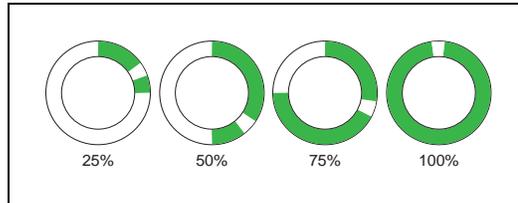
Platform Left Side	Platform Right Side	State of Charge
0 to 90 cw	0 to 270 ccw	25%
0 to 180 cw	0 to 180 ccw	50%
0 to 270 cw	0 to 90 ccw	75%
full circle	full circle	100%

NOTE: The state of charge displayed is continuous, not limited to 25% increments.

E-Stop

The light discs pulses red in an E-Stop condition. Beacon blinks red in this case.
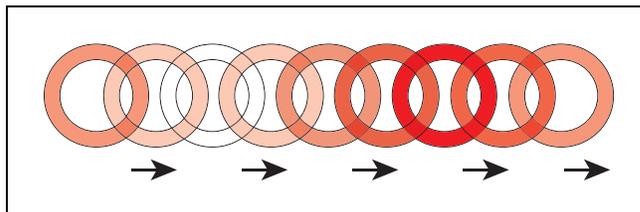
In the following table:

- Blink indicates that a disc or light is on for a period, then off for a period.

- Pulse indicates a 0.25 Hz fade on and off.

- Circle indicates that the lights appear to be going in a circle.

- Half-circles indicates two arcs, moving opposite each other between the top and bottom.

- Solid indicates that a light is on continuously.

- Alt indicates that the beacon switches between different lights, with no pause. Two lights with Alt means one light is always on, but not two at once.

Table 7-1. Indicator Meanings

Meaning	Light Disc		Beacon	
	Color	Pattern	Color	Pattern
Driving straight, all ok	Blue	Moving Circle	Green	Blink
Turning in direction of orange turn signal, all ok	Blue/ Orange @front	Moving Circle/ Blinking signal	Green	Blink
Stopped (all ok), or boot- ing	Blue	Pulse	Green	Solid
Stopped with warning	Orange	Pulse	Green normally	Blink
Object detected in safety zone	Yellow	Blink	Yellow	Blink
Lost	Orange	Left+Right Half-circles	Green normally, Red if E-Stopped	Blink
Charging	Green	Partial Circle/moving small arc	Green normally, Red if E-Stopped	Blink
E-Stop, stops driving	Red	Pulse	Red	Blink

Front and Back Light Strips

The HD-1500 has light strips in front and back of the platform. Similar to the light discs, they provide visual indication of the AMR's movement states.

See the following figures for location of the HD-1500 light strips.

Figure 7-17. Front Light Strip

Figure 7-18. Back Light Strip

The front and back light strips are mainly used to convey turning intentions, as the large width of the HD-1500 makes it difficult for the operator to see the light discs on the AMR's sides, especially when making a turn.

Their states are described below.

Driving Straight

When driving straight the front light strip displays solid white, and the rear light strip displays solid blue.

Right/Left Turn

When the AMR makes a right or left turn the front light strip displays white at the center and yellow blinking in the direction of the platform's turn, to let nearby people know that it is making a turn (or about to turn).
The rear light strip displays blue at the center and yellow blinking in the direction of the platform's turn.
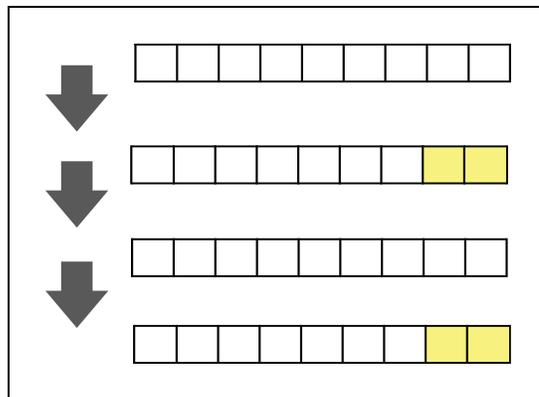
Figure 7-19. Front Light - Right Turn Indication
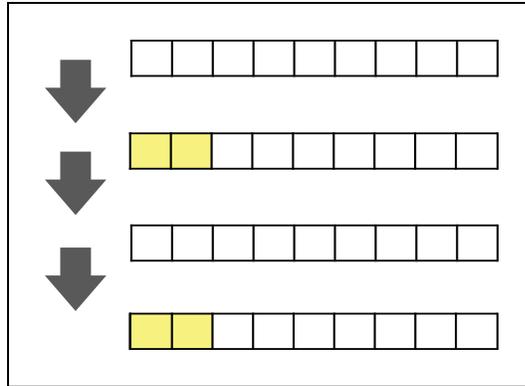
Figure 7-20. Front Light - Left Turn Indication
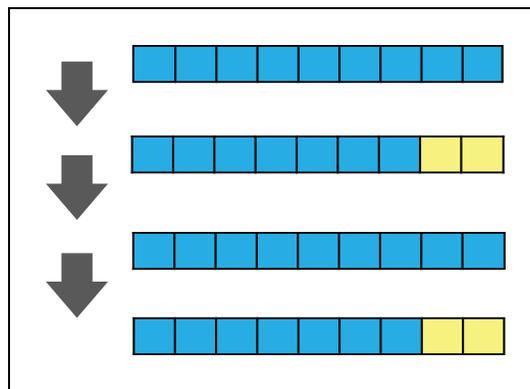
Figure 7-21. Rear Light - Right Turn Indication
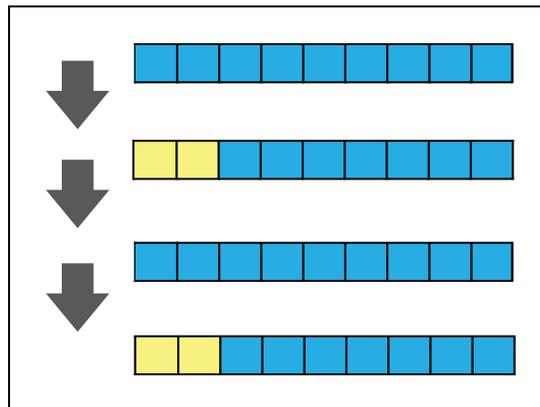
Figure 7-22. Rear Light - Left Turn Indication

E-Stop

The light strips pulse red in an E-Stop condition. The pulsing rate matches the pulsing rate of the light discs.
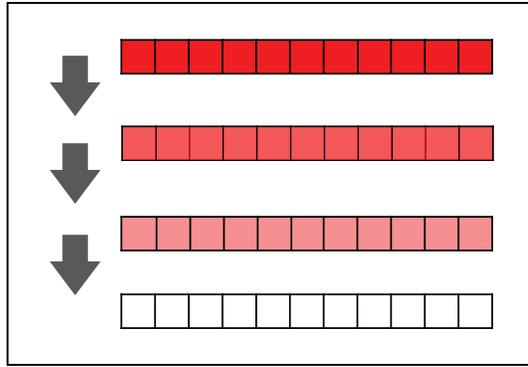
Figure 7-23. E-Stop Indication

Lost

When lost both front and rear light strips display two orange arcs, traveling from one edge to the middle, in opposite directions, and meeting in the middle, then repeats.
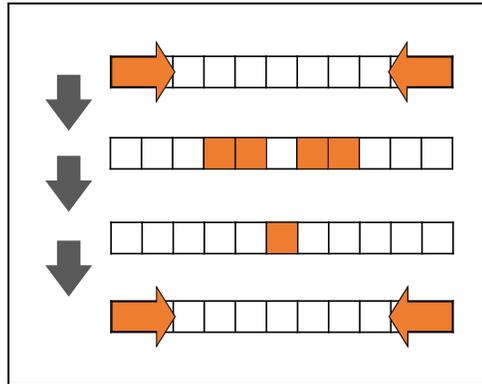
Figure 7-24. AMR Lost Indication

Stopped (no errors), or Booting

When booting, the light strip displays two blue arcs, traveling from one edge to the middle, in opposite directions, and meeting in the middle, then repeats. Pulsing at the center.
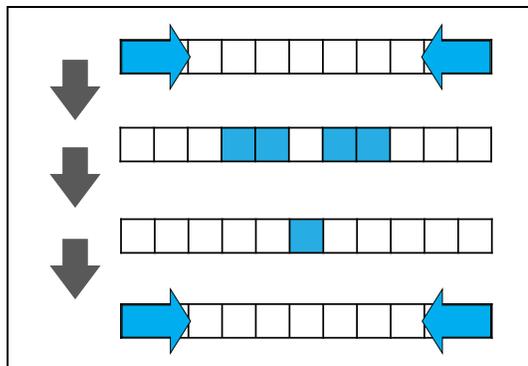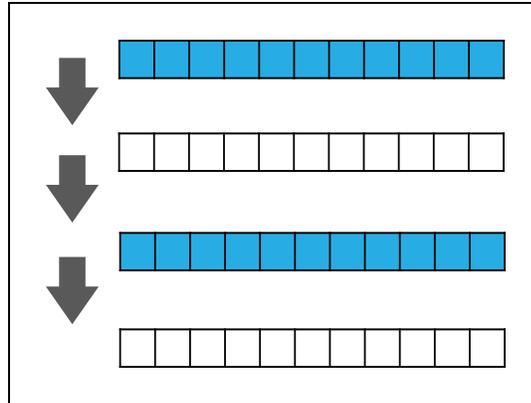
Figure 7-25. Stopped (no errors), or Booting Indication

Stopped with Warning (such as low battery)

The light strips display orange pulsing at the center.
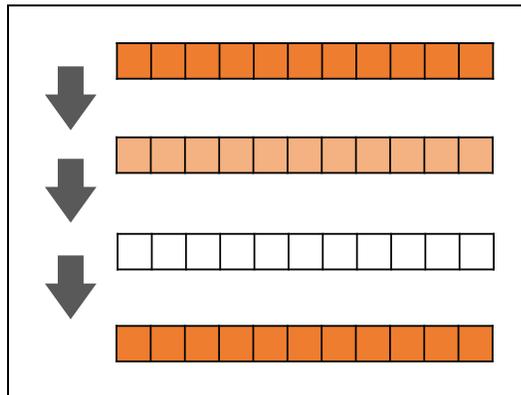
Figure 7-26. Stopped with Warning Indication

Obstacle Detected

The light strips display yellow blinking at the center.
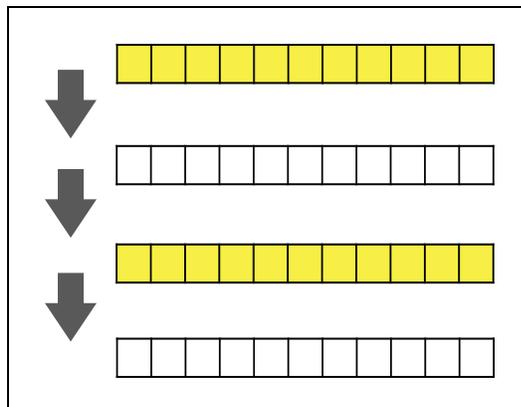
Charging

When docked, a green light indicates the current state of charge (SOC), showing steady green.
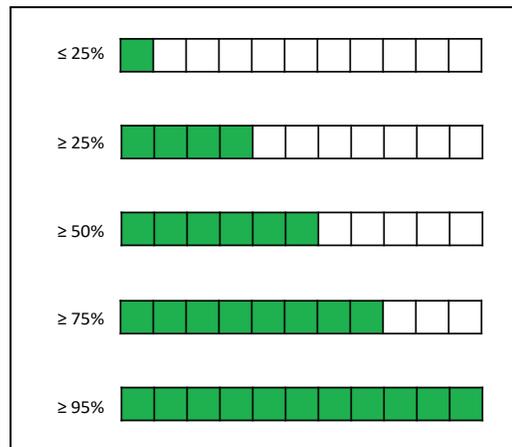
Figure 7-27. Charging Indication

Front and Back of the Platform	State of Charge
One LED lights up	25% ≥
Four LEDs light up	25% ≤ SoC < 50%
Six LEDs light up	50% ≤ SoC < 75%
Eight LEDs light up	75% ≤ SoC < 95%
All LEDs light up	95% ≤

NOTE: The state of charge displayed is continuous, not limited to 25% increments.

7.6 Sensors

Lasers

The HD-1500 platform has four lasers for navigation and safety; two installed in the front and two in the back. See: Figure 7-28. Optional side lasers ((**C**) in Figure 7-28.) are also available and may be purchased as peripheral devices. See: Side-Mount Lasers on page 268.

The safety scanning lasers, low lasers, and side lasers are all Class 1 lasers in accordance with IEC 60825-1 as well as CDRH 21 CFR 1040.10 and 1040.11. All OMRON supplied Class 1 lasers installed on HD-1500, are safe to be used under normal operating conditions as described in chapter 2. All HD-1500 lasers communicate through Ethernet.
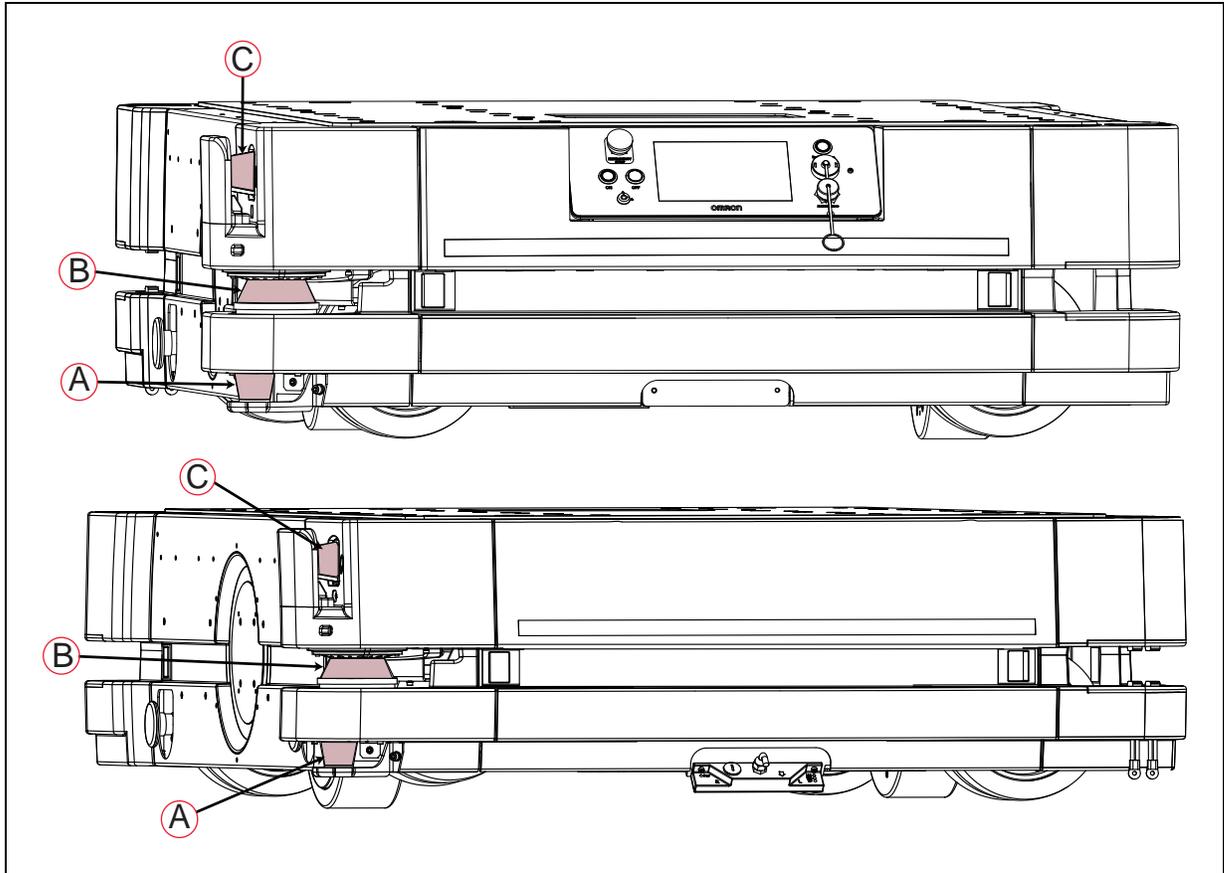
Figure 7-28. HD-1500 Lasers, (A) Low Lasers, (B) Safety Scanning Lasers, and (C) Side Lasers

Safety Scanning Lasers

Each safety scanning laser ((**B**) in Figure 7-28.) provides readings in a 270° field of view, with a typical maximum range of 30 m. With the two safety scanning lasers each covering a 270° field of view, the HD-1500 has a full safety coverage of 360°. The lasers operate in a single plane, positioned at 175 mm above the floor.

> ⚠️ **WARNING:** PERSONAL INJURY OR PROPERTY DAMAGE RISK
> Objects protruding out, above or below the HD-1500 lasers' scanning planes shall be configured as restricted zones during workspace map creation. This will eliminate possible collision risk during AMR operation.

The laser cannot reliably detect glass, mirrors, and other highly-reflective objects. Use caution when operating the platform in areas that have these types of objects. If the platform will need to drive close to these objects, we recommend that you use a combination of markings on the objects (e.g., tape or painted strips), and also use Forbidden Area in the map, so that the platform knows to plan paths safely around these objects.

Low Lasers

The two low lasers ((**A**) in Figure 7-28.) detect obstacles below the scanning plane of the safety scanning laser, such as an empty pallet or fork truck tines, which are too low for the safety

scanning laser to see. The low lasers are positioned 60.5 mm above the floor, and can detect objects that are at least 60.5 mm tall.

The low lasers also detects obstacles that might be significantly wider at the base, such as a column plinth, where the safety scanning laser might detect only the upper portion of the column.

Other Sensors

Encoders and Gyroscope

Each wheel has an encoder that tells the navigation system how far the wheel has turned, and in which direction.

The AMR Controller has internal inertial sensing to track the platform's rotation.

The HD-1500 combines the information from these sensors and from the safety scanning lasers to perform localization.

The HD-1500 has an additional rotation sensor on the motor, used by the safety system, that acts as a redundant sensor to measure speed.

7.7 Start up

Procedure

Press and hold the power ON button for half a second, then release. It takes about a minute for all the systems to start up and make their various interconnections. If the platform does not start up, try power OFF, check all connections, and then power ON. If it still does not start up you should check the battery's state of charge, and make sure there is sufficient charge for platform to start up.

Start up is complete when the light discs stop indicating booting (two blue light segments, moving in opposite directions from 6 o'clock to 12 o'clock and back).

By default, the AMR Controller, navigation lasers, and some auxiliary power start automatically when you press ON.

Pendant Controls and Operation Description

The pendant plugs into the right side of the Operator Panel, See Maintenance on page 214.

The HD-1500 pendant is a three-position enabling device. See the following table for description of each position:

Table 7-2. Pendant Three-Position Enabling Device Position Description

Three-Position Enabling Device Position	Description
three-position enabling device ((**E**) in Table 7-2.) pressed lightly or not pressed at all	power is off
three-position enabling device pressed with medium pressure	power is on
three-position enabling device pressed with high pressure	power is off

NOTE: The three-position enabling device enables the directional control stick.

The Operator Panel comes with a pendant jumper that you can attach to the pendant port when the pendant is not connected. As displayed in Figure 7-13.

IMPORTANT: OMRON recommends storing, and securing the pendant when not in use, to prevent an unauthorized person from operating an AMR.
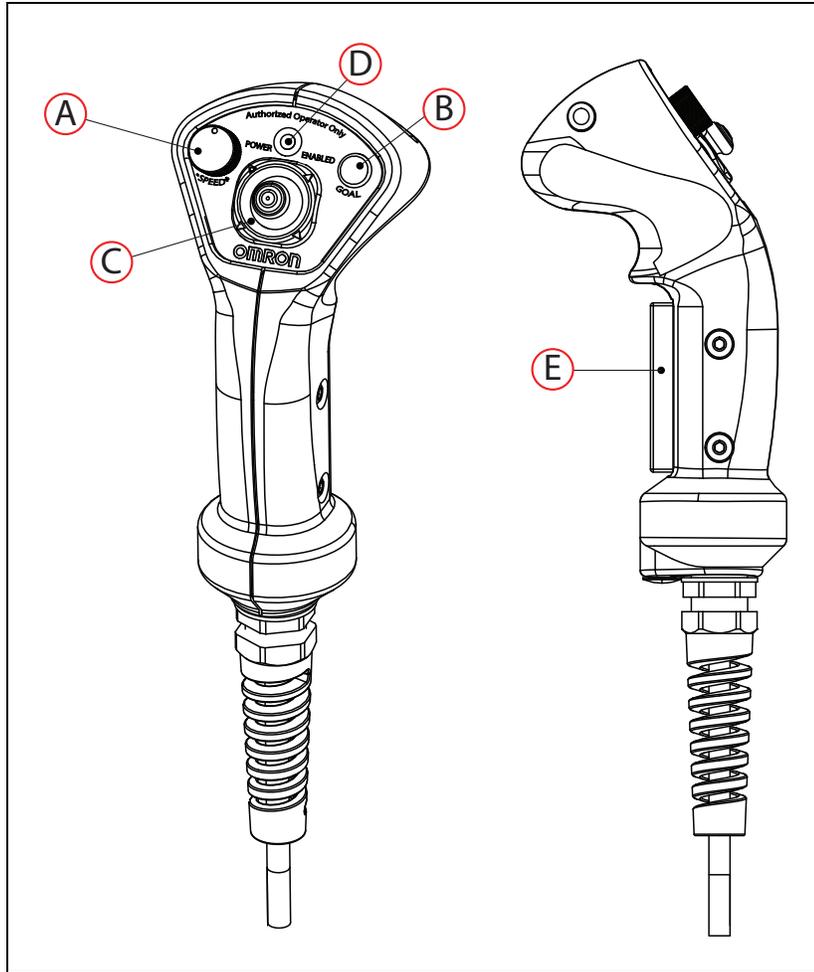
Figure 7-29. Pendant, (A) Speed Control, (B) Goal Button, (C) Directional Control Stick, (D) Power Indicator LED, and (E) Three-Position Enabling Device

Pendant Use

⚠️ **CAUTION:** PERSONAL INJURY OR PROPERTY DAMAGE RISK
Although the safety scanning laser is integrated with the E-Stop circuit at all times, the operator must maintain full control of the pendant and the platform when the pendant is connected to the AMR.

⚠️ **WARNING:** PERSONAL INJURY OR PROPERTY DAMAGE RISK
When operating the AMR with the pendant, it is the operator's responsibility to make sure that no people or objects are in the immediate vicinity of the moving AMR.

The pendant is intended for single-handed operation. Use your fingers to grip the handle, and control the three-position enabling device ((**E**) in Figure 7-29.), and your thumb to move the directional control stick ((**C**) in Figure 7-29.).

The pendant is equipped with high speed control feature which is configured with the speed control rotary. It is the end user's responsibility to make sure that the speed is appropriate for the task the AMR carries, and that the speed does not cause the AMR to move uncontrollably.

Use the pendant to drive the AMR manually and to create the scan used to make a map.

To use the pendant, follow these steps:

1. Press one of the E-Stop buttons on the AMR.

2. Locate the Operator Panel at the back of the platform, and remove the pendant connector cap.

3. Connect the pendant to the Operator Panel.

4. Release the E-Stop button.

5. Squeeze and hold the three-position enabling device ((**E**) in Figure 7-29.) with medium pressure (this will enable high power to the drive motors), and use the directional control stick ((**C**) in Figure 7-29.) to drive the AMR. See: Table 7-2.

6. Push the directional control stick forward or back to make the platform move in that direction. Push the directional control button to the left side to make the platform rotate in place counterclockwise. Push the directional control button to the right side to make the platform rotate in place clockwise. Diagonal positions of the directional control button move the platform in an arc.

7. Use the speed control switch ((**A**) in Figure 7-29.) to control the speed of the AMR, and achieve your desired velocity.

8. To stop the AMR, you can release the three-position enabling device, squeeze it too tightly or hold it loosely. This will disable the power, see: Table 7-2. You can also release the directional control stick which will bring the AMR to a full stop, however, does not disable power to the motors.

Use the pendant's GOAL button ((**B**) in Figure 7-29.) for marking positions while making a map scan.

Pendant Power Indicator LED

The pendant has a power indicator LED ((**D**) in Figure 7-29.) which gives visual indication of the HD-1500 operating state.

The following table provides description of each color displayed by the pendant power indicator LED.

Table 7-3. Pendant Power Indicator LED Description

LED Color	Pattern	AMR State
Red	Solid	AMR E-Stopped
Yellow	Solid	AMR transitioning from E-Stop
Green	Solid	Motors enabled
Green	Flashing	Motors enabled

LED Color	Pattern	AMR State
		and the AMR is moving

Chapter 8: Maintenance

This chapter covers periodic maintenance and user-serviceable parts replacement for the HD-1500 and the charging station. It does not cover maintenance of the payload structure, which is the user's responsibility.

> **WARNING:** PERSONAL INJURY OR PROPERTY DAMAGE RISK
> Use only the specified tools, equipment, and OMRON-supplied spare parts to service and maintain the HD-1500 according to the specified service interval. Failure to do so could result in an unsafe operating state that might result in personal injury or damage to property.

8.1 Safety Considerations when Performing Maintenance

This section describes important safety considerations when maintaining your AMR.

IMPORTANT: Only skilled or instructed persons, as defined in the *Mobile Robot HD Safety Manual (Cat. No. I647)*, should perform the procedures and replacement of parts covered in this section.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
When working near the encoder cables, take care not to disconnect or damage them. Improper connection or disconnection of encoder cables may result in erratic motion of the AMR during operation. The AMR might rotate uncontrollably during loss of encoder signals.

Electrical Hazards

WARNING: ELECTROCUTION RISK
During maintenance and repair, you must turn off power to the charging station. Remove and lock up the power cord along with all other electrical inputs to prevent unauthorized third parties from turning on power. The access covers on the charging station are not interlocked.

WARNING: ELECTROCUTION RISK
There are no user-serviceable parts inside the charging station. Do not remove the covers of the charging station. There is high voltage inside, and the covers are not interlocked.

WARNING: FIRE RISK, ELECTRICAL BURN RISK
The HD-1500 battery, and the charger outputs have high current. You must take appropriate precautions to avoid potential short circuit.

Electrical Hazard Precautions

- There are no user-serviceable parts inside of the battery. Do not open the battery.

- Do not use any charger not supplied by OMRON.

- If the AMR comes into contact with any liquid:

    1. Power off the AMR.

    2. Clean off as much liquid as is possible.

    3. Allow the AMR to air dry thoroughly before restoring power.

    4. Contact your OMRON representative if you suspect that liquid has penetrated the skins or contaminated the AMR's interior.

Burn Hazard

CAUTION: BURN RISK

The charging station and the charging contacts on both the docking target, and the AMR can get hot during the operation. The operator must allow for cool down prior to servicing.

CAUTION: BURN RISK

The AMR drive wheel motors can get extremely hot during the operation. The operator must allow the drive wheel motors to cool down prior to performing any maintenance work near or around them.

ESD Hazards

CAUTION: PROPERTY DAMAGE RISK

The electrical charge accumulated on the HD-1500's skins does not have a path to ground, and therefore can not discharge. This can be hazardous to electrostatic sensitive devices. Users must keep the electrostatic sensitive devices at least 30 cm away from the AMR skins.

8.2 Safety Measures Prior and After Maintenance

Prior to performing maintenance work (safety inspection, cleaning, removing parts, installing parts, etc.), following safety measures must be taken:

- Ensure that the AMR has come to a complete stop, by pressing an E-Stop button.

- Power off the AMR by pressing the **OFF** button on the Operator Panel.

Once maintenance work has completed, and the AMR is ready for use, press the **ON** button on the Operator Panel.

Lock-Out, Tag-Out Procedure

You must complete the appropriate Lock-Out, Tag-Out (LOTO) procedure prior to any maintenance work on the charging station or the AMR.

The following sections describe the LOTO procedure for the AMR, and the charging station.

LOTO Procedure for the AMR

Follow this LOTO procedure for the AMR:

1. Prepare the AMR for shutdown. You must make sure that the AMR is in a safe location, and that there are no hazards near it. There must be sufficient clearance around the AMR to allow for safe maintenance work.

2. Press an E-Stop button.

3. Shutdown the AMR by pressing the **OFF** button on the Operator Panel.

4. If the AMR is connected to the docking target, you must undock the AMR.

5. Remove the battery. You must keep the battery near you and in sight. This prevents unauthorized use of the battery.

6. Each motor controller is equipped with a capacitor that stores energy. You must check and make sure that the voltage left is less than 7 V. Probe the appropriate connector pins on the module displayed in Figure 8-1. using a digital multimeter. Prob the back of the pin 4 (positive), and pin 3 (negative) as shown in Figure 8-2.

WARNING: ELECTRICAL SHOCK RISK
Do not perform maintenance work on the AMR until the measured voltage is below 7 V.
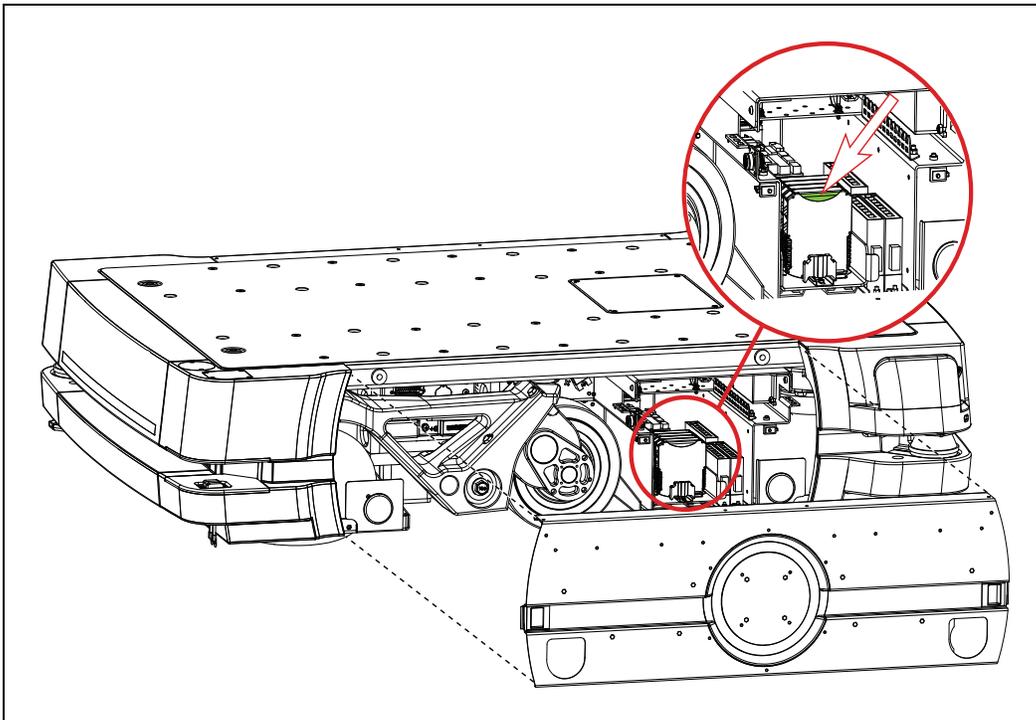
Figure 8-1. Location of the Module to be Probed
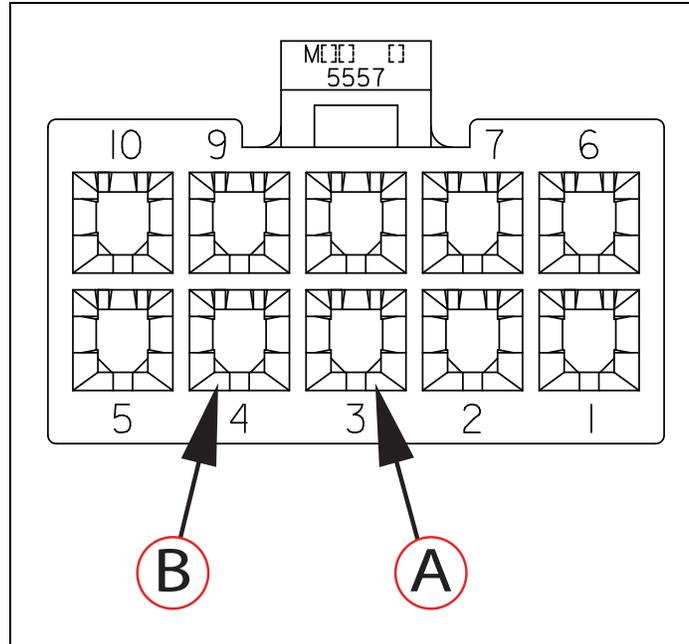
Figure 8-2. Module Connector Configuration - Viewed from the Rear, (A) Pin 3 (Negative), and (B) Pin 4 (Positive)

7. Continuously check and verify that the AMR is de-energized by pressing the **ON/OFF** button on the Operator Panel.

LOTO Procedure for the Charging Station

Follow this LOTO procedure for the charging station:

1. Turn the power off. You can do this by switching the main disconnect switch, located on the electrician access box, to **OFF** position.
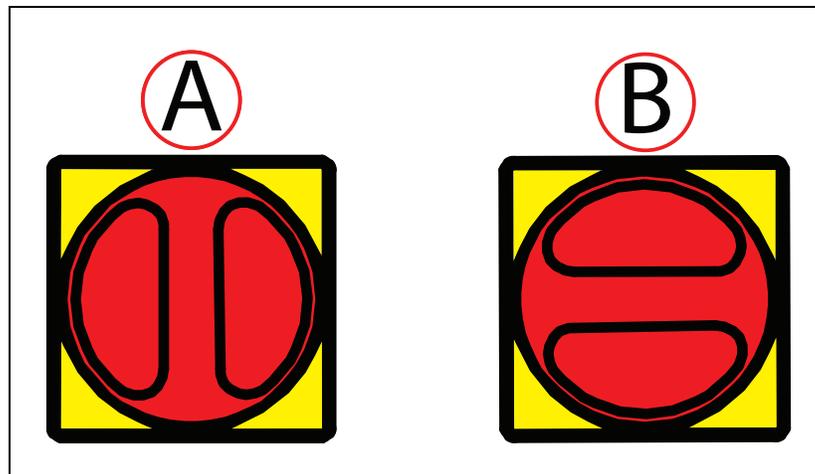
Figure 8-3. Main Disconnect Switch on the Electrician Access Box, (A) ON Position, and (B) OFF Position

Figure 8-4. Main Disconnect Switch Placed in OFF Position

2. Lock the main disconnect switch as displayed in the following figure. The type of lock used depends on your needs, and your facility LOTO requirements. You may also add your name to the lock, or have multiple names on the lock. This lets other users know who has locked the power supply box in case they must get in touch with that person.
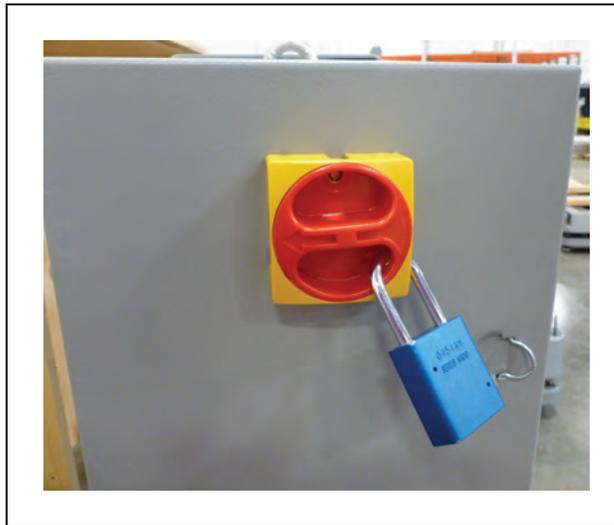
Figure 8-5. Main Disconnect Switch Locked

3. Verify that the power is off. You can do this by checking the LED indicators, located on the power supply box. When there is no power going through the power supply box, the

blue LED is off.

Figure 8-6. Blue LED Off

8.3 Lifting the Platform Safely

In the rare event that the platform needs to be lifted, follow the instructions in this section.

Before you begin, press an E-Stop button and put the HD-1500 into a safe state for maintenance work.

You need following equipment to lift the platform (all tools and equipment are user-supplied):

Tool	QTY	Description
Lifting rings	4	The lifting rings ship with the platform.
Safety-rated slings	4	The slings ship with the platform.
Forklift or similar device	1	The forklift or any other lifting machine you use must be safety rated for at least 1100 kg of weight.
14 mm Allen wrench	1	Allen wrench is used to tighten the lifting rings to the chassis.
PPE	N/A	Eye protection, toe protection and gloves.

To lift the platform safely, follow these steps:

1. Attach the OMRON-supplied lifting rings, using a 14 mm Allen wrench, to the locations shown in Figure 8-8. There are four bolt holes on the HD-1500 for attaching the lifting rings. Once the lifting rings are attached, tie and secure the strapsFigure 8-8.

IMPORTANT: Do not exceed 25 kN per lifting mount point.

IMPORTANT: Inspect the straps for signs of wear and tear or any damages before attaching to the lifting rings.
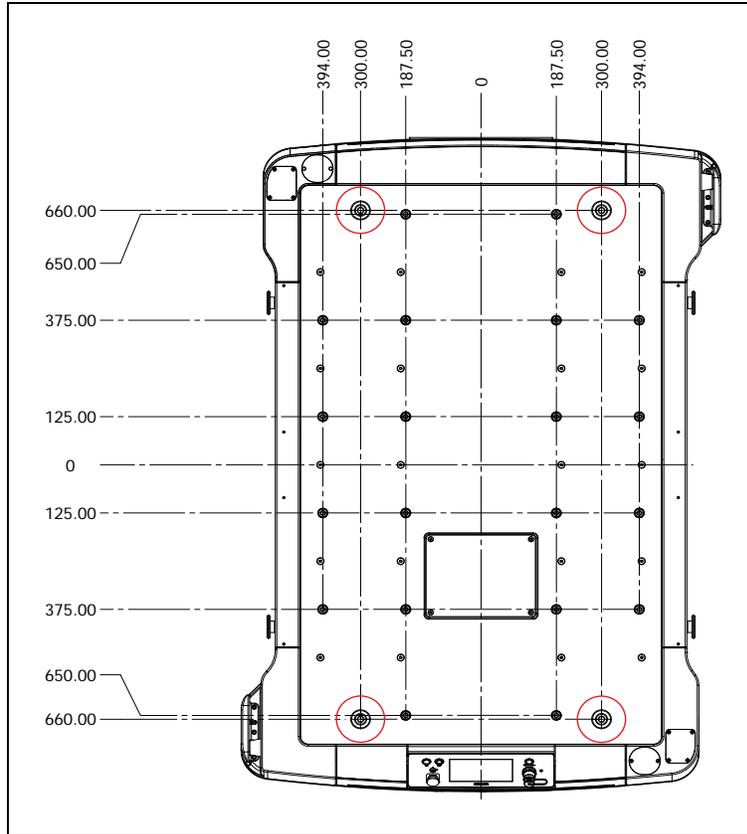
Figure 8-7. Lifting Mount Locations - (4) M16 X 2 Threaded Holes (units are in mm)
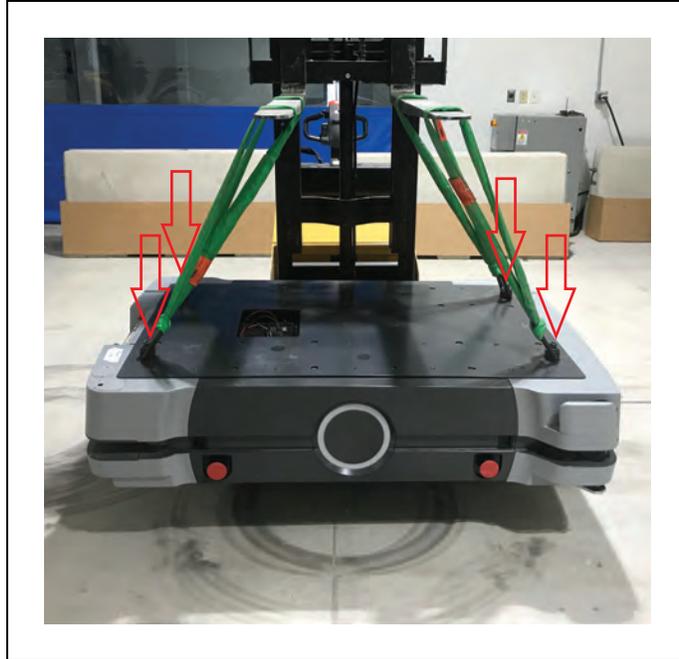
Figure 8-8. Attaching the Lifting Rings and Straps

⚠️ **WARNING:** The straps must be evenly distributed to ensure that the platform is leveled when lifted up. Uneven lifting or lowering, risks resting the weight of the platform on the low lasers, which could damage the low lasers.

2. Using an overhead hoist or a forklift lift up the platform, see: 8.3   Take caution not to hit the suspended platform.

⚠️ **CAUTION:** PROPERTY DAMAGE RISK
Do not attempt to lift the HD-1500 from the bottom with a forklift or similar devices. Doing so could damage the platform.

IMPORTANT: The overhead hoist or forklift must be rated for at least 1100 kg.

> **IMPORTANT:** It is the end user's responsibility to ensure that the person operating the overhead hoist or forklift, has successfully completed the required training, and is certified to operate these machines.

3. When placing the platform back on the floor, you must make sure that all safety precautions have been taken to prevent personal injury or property damage.

4. Remove the lifting rings and straps from the platform.

8.4 Safety Inspection

Warning Devices

Perform inspections of the following warning devices for proper function.

The E-Stop buttons must be inspected annually, and the rest of the warning devices listed in this section must be inspected weekly.

Flashing Light

Each AMR must have a readily visible flashing light, to serve as a warning whenever the AMR is ready to move or is moving. The exact nature of this light will vary depending on the design of the payload structure. See also: Warning Lights on page 136.

Light Discs

Check the light discs on each side of the AMR for proper function. See also: Light Discs and Beacon on page 199.

Front and Back Lights

Check the front and back lights of the AMR for proper function. See also: Front and Back Light Strips on page 202.

Buzzer

Check the warning buzzer for proper function. To comply with applicable standards, it is important that the buzzer be audible in all operating conditions and environments. The buzzer must exceed the ambient noise at the end use application. See also: Warning Buzzer on page 137.

E-Stop Buttons

Inspect the E-Stop buttons for any sign of physical damage, and check for proper function.

Warning Labels

The only warning labels that are shipped with the HD-1500, unattached to the platform, are the No Riding labels. All other labels are installed in the factory.

For information on where to attach the No Riding labels, see: Attach the No Riding Warning Label on page 108. Also, for information on label maintenance, see: Warning Labels on page 1.

Any additional safety labels for the payload structure or specific to the end-use application shall be evaluated by the user as part of the risk assessment.

8.5 Cleaning

Clean the following items on a regular weekly schedule.

⚠️ **WARNING:** PERSONAL INJURY OR PROPERTY DAMAGE RISK
Do not use organic solvents to clean any part of the AMR unless directed in the cleaning instructions. Organic solvents might damage electronics resulting in an unsafe operating state that could cause injury or damage to equipment.

Work Area Maintenance

Regularly maintain the workspace as follows:

- Immediately remove any material on the workspace floor, such as dust, dirt, grease, ice, or pooled liquid. Objects on the floor might interfere with safe driving and accurate navigation. Any material that affects the drive wheel traction impairs the AMR's ability to drive, stop, turn, and navigate. Pay particular attention to goal locations and commonly traveled paths.

- Keep the AMR workspace clean and free of moveable transient objects such as pallets, carts and furniture. Any objects that block the mapped permanent features of the workspace (such as walls, columns and doors) can interfere with navigation, causing the AMR to be less efficient.

- Clean the floor at goal locations such as charging stations or pick up and drop off points. Accumulated dust, debris, or grease can affect AMR traction, which reduces positioning accuracy and repeatability, potentially wasting battery power.

- If the HAPS option is installed, inspect and clean or replace HAPS magnetic tape.

  NOTE: If you make a permanent change to the workspace, such as by installing a large fixed machine, consider re-mapping the impacted area to incorporate the change. Particularly if the change blocks the AMR's ability to scan original workspace features.

Platform and Charging Station Cleaning

The following table gives a summary of cleaning interval for the HD-1500 platform.

Table 8-1. Platform Cleaning

Item	Interval
Clean the platform charging contacts	3 months
Clean caster treads	As needed
Clean ESD drive wheel treads	As needed
Clean dust and dirt from drive assembly	As needed
Clean all laser lenses	6 months/ as

Item	Interval
	needed

NOTE: The frequency of these procedures depend on your particular system, its operating environment, and the amount of use. Operating in a dusty or dirty environment requires more frequent cleaning. Use the intervals in this section as guidelines, and may need to be adjusted.

Platform Charging Contacts

WARNING: Do not use solvents or chemicals on the platform charging contacts as this could damage the surface of the contacts.

WARNING: ELECTROCUTION RISK
Prior to cleaning the platform charging contacts you must make sure that the AMR is powered off.

WARNING: BURN RISK
Do not clean the charging contacts if they are hot. The charging contacts can reach a very high temperature when charging, and pose burning risk. You must allow the charging contacts to cool down prior to cleaning.

To clean the platform charging contacts, you must use a 320 grit sand paper to remove surface dirt, oxidation, pitting or other contaminants.

IMPORTANT: Make sure not to reduce the charging surface of the charging contacts by sanding off the edges. Smaller charging surface will reduce the charging speed and charging operation.

Caster Treads

Occasionally clean the caster treads with a mild soapy solution. Remove any accumulated dirt or debris on the treads which can degrade the AMR's performance.

This applies to both the drive wheels and the casters.

ESD Drive Wheel Treads

ESD drive wheels are critical components as they provide electrical path to ground. As such, they require regular, periodic cleaning to preserve ESD protection capability.

You will need the following items:

- Gloves.

- Disposable lint-free wipes.

- Wire hook, tweezers, and sharp blade to remove any fibrous material wound around

the wheel's hub.

- Soft brush.

- Isopropyl alcohol.

CAUTION: Follow all appropriate local safety regulations for working with isopropyl alcohol, including fire safety, toxicity, and protective clothing and gear requirements.

Follow these steps to clean the ESD drive wheel treads:

1. Press an E-Stop button, and power off the HD-1500 so it is in a safe working state.

2. Remove the payload structure, if necessary.

3. Remove the right and left side skins, and set them aside. See: Removing and Installing Skins on page 253.

4. Use a wipe wetted with isopropyl alcohol to thoroughly clean the drive wheel treads. You should also remove the objects stuck in the drive wheel treads (such as small rocks, staples, and screws).

5. Re-install the two side skins you removed earlier.

6. Re-install the payload structure if it was removed.

NOTE: Clean the side skins if needed.

Lasers

Occasionally clean the lenses of all lasers. Use only a soft cloth with alcohol-based, non-abrasive cleaners, and wipe thoroughly.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
The operation of the lasers may be affected by substances in the AMR operating environment, such as fog, smoke, steam and other small particulate. You must clean the lenses of all lasers periodically, and as guided in this manual to avoid operation failure of the lasers.

Charging Station

WARNING: ELECTROCUTION RISK
Prior to cleaning the charging station, you must ensure that the AMR is not docked to the charging station.

WARNING: ELECTROCUTION RISK
The charging station must be LOTO prior to the cleaning. This is done by switching the main disconnect switch off.

The following table provides the cleaning intervals for the charging station items:

Table 8-2. Charging Station Cleaning

Item	Period
Power supply box cooling duct	6 months/ as needed
Docking target	3 months
Docking target charging contacts	3 months

Power supply box cooling duct

The cooling duct (displayed in the following figure) must be cleaned every 6 months or after 2,000 charge cycles. This is to ensure that the airflow from the inner duct does not get trapped by lint or dust.

Use compressed air or vacuum to remove lint, dust or buildup from the top and bottom air vents. The bottom air vent ((**B**) in the following figure) is where most debris build up.
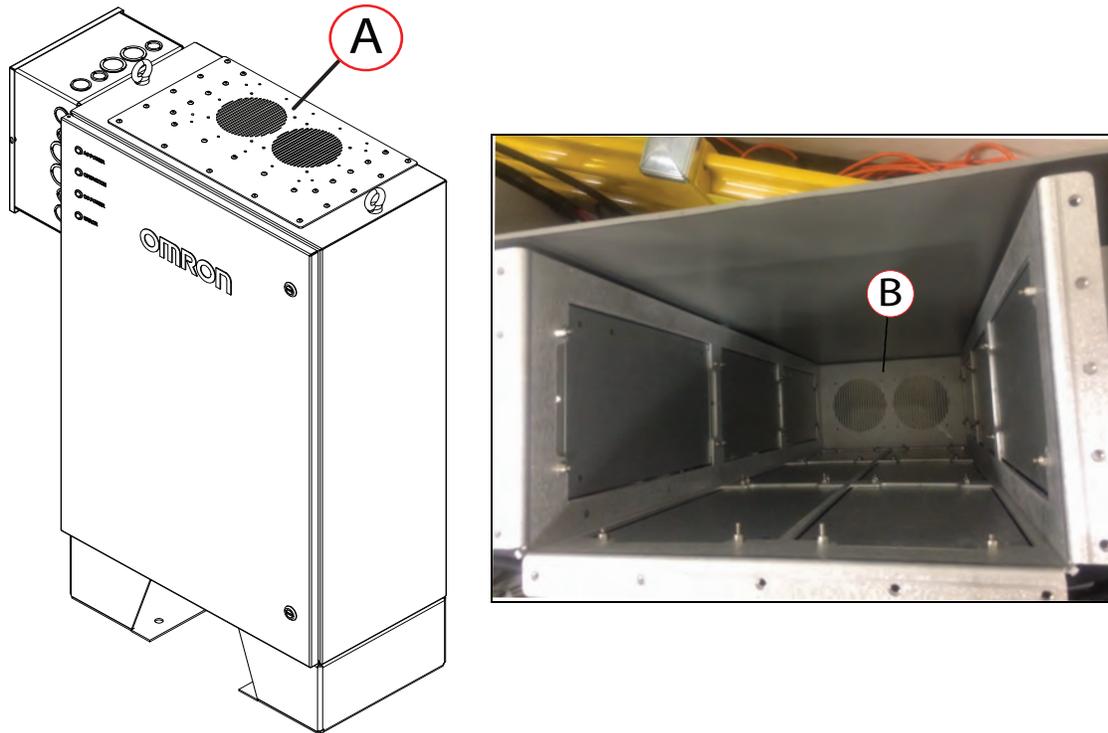
Figure 8-9. Cooling Duct, (A) Top Air Vent, and (B) Bottom Air Vent

Docking Target

Clean the docking target (excluding the charging contacts) using a soft cloth with isopropyl alcohol and wipe thoroughly.

Docking Target Charging Contacts

To clean the docking target's charging contacts, you must first use a 320 grit sand paper to remove surface dirt, oxidation, pitting or other contaminants. Then, use a soft cloth with Isopropyle alcohol, and wipe the surface of the charging contacts. Do not use any other cleaning agents or solvents.

8.6 Maintaining and Replacing Batteries

Maintaining Batteries

Maintain batteries as follows:

- Every six months, inspect batteries (both stored and in-use) for damage or leaks.

  Never expose the battery to water. If the battery is leaking, use a chemical neutralizer (such as HF ACID EATER) to absorb the electrolyte. Then, clean up the electrolyte and the chemical neutralizer using a dry cloth, and put the cloth in a bag.

  You should place the leaking battery in a bag or a drum containing the chemical neutralizer, and contact your OMRON representative.

  > **IMPORTANT:** You must wear proper PPE when working around a leaking battery.

  > **IMPORTANT:** Follow the appropriate disposal guidelines for your locale.

- Store batteries within the following temperature range

  - -20 to 35°C, 5-95% RH non-condensing

  For transportation of up to 2 weeks, the manufacturer recommends:

  - -20 to 60°C, 5-95% RH non-condensing

-
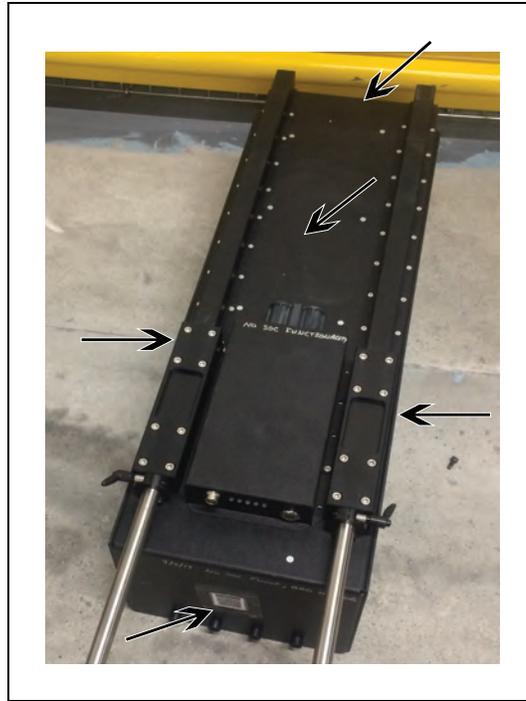
Figure 8-10. Position of the Battery for Storage

- Every six months, charge stored batteries to a full charge.

Replacing the Battery

The battery is expected to last for approximately 9000 recharge cycles.

⚠️ **WARNING:** FIRE RISK
There are no user-serviceable parts inside the battery case. Do not open it.

⚠️ **WARNING:** PROPERTY DAMAGE RISK
Replace the battery only with an OMRON factory-supplied battery intended for use in the HD-1500. Do not use batteries intended for use in other OMRON AMR models.

⚠️ **WARNING:** FIRE AND TOXICITY RISK
Do not dispose of the battery in a waste stream that might result in incineration or crushing. Safely dispose of the battery through a designated facility according to all local and national environmental regulations regarding lithium battery disposal.

Removal

Before you begin, press an E-Stop button and turn the HD-1500 off.

WARNING: PERSONAL INJURY RISK
Use safe lifting practices when removing or installing the battery.

IMPORTANT: The battery weighs 68 kg. There must be at least 3 persons lifting the battery. For rolling the battery around one person is sufficient.

IMPORTANT: You must wear proper Personal Protective Equipment (PPE) for removing, installing, and lifting the battery.

Follow these steps to remove the battery:

1. Remove the AMR front skin to access the battery compartment. For instructions on removing AMR skins, see: Removing and Installing Skins on page 253

Figure 8-11. Removing the Front Skin

Figure 8-12. AMR Front Skin Removed

2. Unlatch and open the battery door. The battery door opens all the way out and rests on the floor. This allows you to use the battery door as a ramp. See the following figures.

Figure 8-13. Unscrewing the Battery Door

Figure 8-14. Battery Door Opens Out, and Rests on the Floor

3. Grab the handle and pull out the battery just enough so you can disconnect the Ethernet cable as displayed in Figure 8-15.

Figure 8-15. Disconnecting the Ethernet Cable

4. Next, unlatch the handle locks so you can extend the handle out. See the following figure.

Figure 8-16. Unlatching the Handle Locks

5. Extend the battery handle out, and remove the battery from its compartment.Figure 8-17.

Figure 8-17. Extending the Battery Handle Out

Figure 8-18. Battery Power Connector

6. The battery case has roller wheels on the back. This allows you to roll the battery around similar to how you would roll a suitcase.
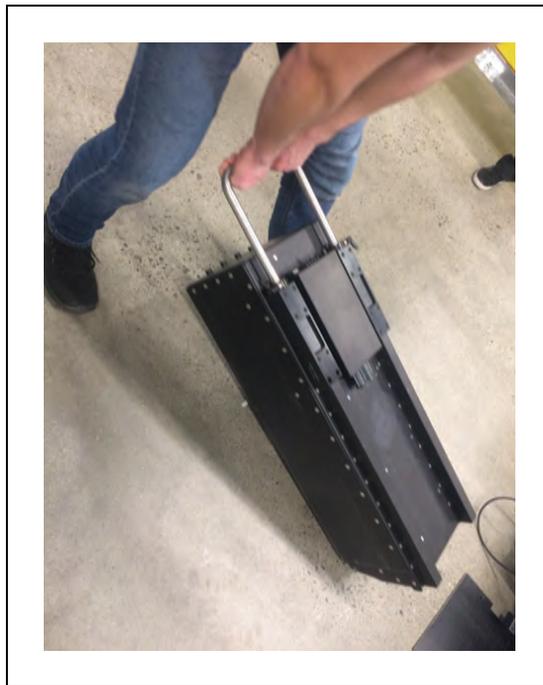
Figure 8-19. Rolling the Battery Around the Workspace

The shaft shown in the picture acts as a lift point when the battery needs to be lifted and not rolled.

Figure 8-20. Battery Case Roller Wheels

Installation

Make sure you install a fully-charged OMRON battery part number 68330-000. For instructions on checking the battery's state of charge, see: Battery Indicators and Controls on page 184.

Follow these steps to install the new battery:

1. Remove the AMR front skin to access the battery compartment. For instructions on removing AMR skins, see: Removing and Installing Skins on page 253

2. Unlatch and open the battery door. The battery door opens all the way out and rests on the floor. This allows you to use the battery door as a ramp. See: Figure 8-21.

Figure 8-21. Battery Door Opens Out

3. Use the extended handle to push the battery into the platform. See: Figure 8-22.

As the battery gets pushed in, the power connector installed on top of the battery case makes a blind-mate connection with the power connector attached to the chassis.

Figure 8-22. Lifting the Battery and Pushing into the Platform

4. Collapse the handle before pushing the battery all the way into the platform.
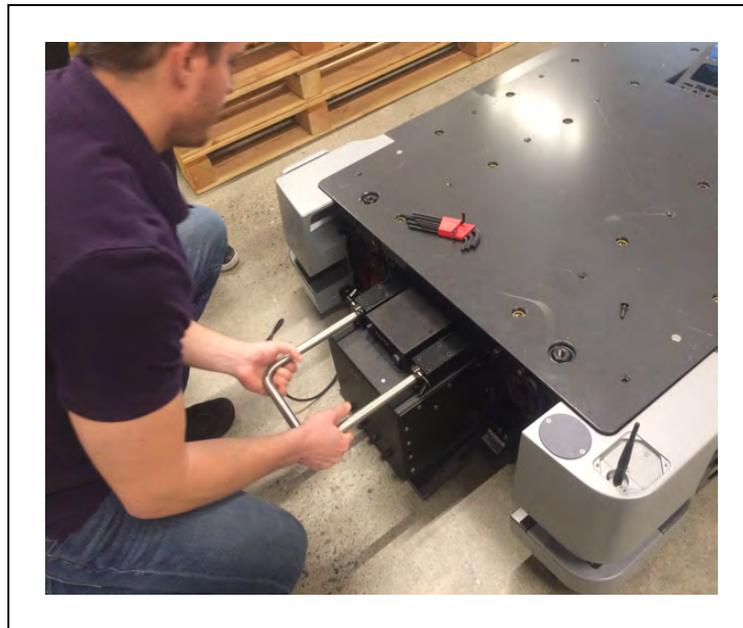
Figure 8-23. Collapsing the Battery Handle

5. Lock the two latches to secure the battery handle in place.

Figure 8-24. Locking the Handle Latches

6. Next, connect the Ethernet cable to the battery indicator box, as shown in
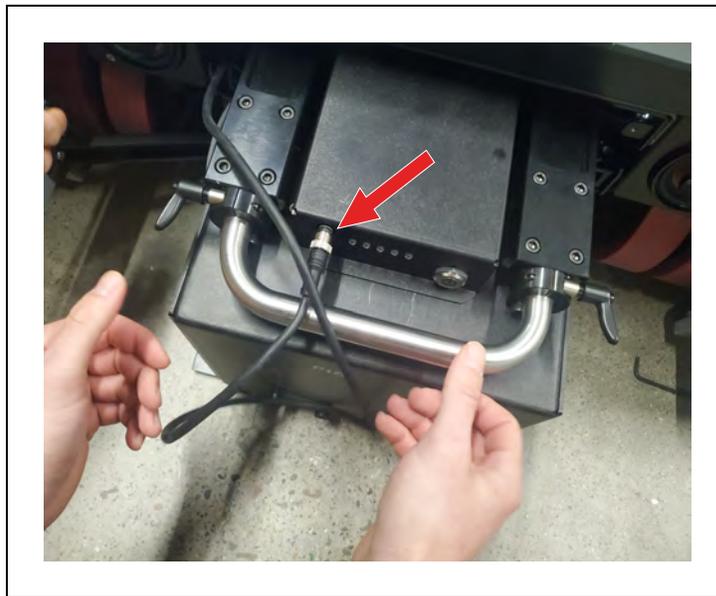
Figure 8-25. Ethernet Cable Connected to the Battery Indicator Box

7. Push the battery all the way in, and close the battery door. The battery door holds the battery tightly in place, and keeps it from shifting inside the compartment.

8. Install the AMR front skin. See: Removing and Installing Skins on page 253.

Do not power on the HD-1500 until you have read the appropriate sections of this user's manual.

8.7 Replacing Non-Periodic Parts

The non-periodic parts described in this section are user-replaceable, and shall be replaced on an as-needed basis.

The following table provides brief description of the non-periodic parts, along with their part numbers.

Table 8-3. Non-Periodic Parts

Non-Periodic Parts (User-Serviceable)	Part Number	Description
Light disc		
• LED mount plate	68121-107	The PCA electrical assembly, and the light strip mount on the LED mount plate.
• Diffuser plate	68121-104	Light ring diffuser plate.
• LED strip	68124-000	LED light strip, RGB, Addressable APA102, 40 LEDs, JST connector.
• PCA assembly	68122-000	LED differential receiver.
light strip		
• Light strip holding bracket	68125-111	The bracket holding the light strip in place.
• LED strip	68124-000	LED light strip, RGB, Addressable APA102, 40 LEDs, JST connector.
Operator Panel	68150-000	A Human-Machine Interface device. The Operator Panel includes a screen, an E-Stop button, ON and OFF buttons, a brake release button, Pendant port, Maintenance Ethernet connection, and a keyswitch.
Side laser	68220-400	Supplementary laser scanner.
• Extension cable kit	68970-000 or 68971-000	• Part number: 68970-000 (includes one meter long extension cable), or • Part number: 68971-000 (includes two meter long extension cable)
Wifi antenna	68530-401	Antennas for wireless Ethernet connection.
AMR charging contact	68129-120	The charging contacts located in the front left corner of the HD-1500.
AMR skins		
• front skin	68125-000	HD-1500 front skin assembly.
• rear skin	68126-000	HD-1500 rear skin assembly.

Non-Periodic Parts (User-Serviceable)	Part Number	Description
• side skin, left	68121-000	HD-1500 left side skin assembly.
• side skin, right	68123-000	HD-1500 right side skin assembly.
Battery pack	68330-000	OMRON battery pack used for HD-1500.

Light Discs

Before you begin, press an E-Stop button and turn the HD-1500 off.

You require the following tools to replace the light disc LED strip:

- 7 mm nut driver
- 1 N.m torque wrench
- 2.5 mm hex wrench
- Adhesive

Follow these steps to replace the LED strip in the light disc:

1. Unlatch the side skin, and pull away from the platform just enough so you can disconnect the cable as shown in the following figure.
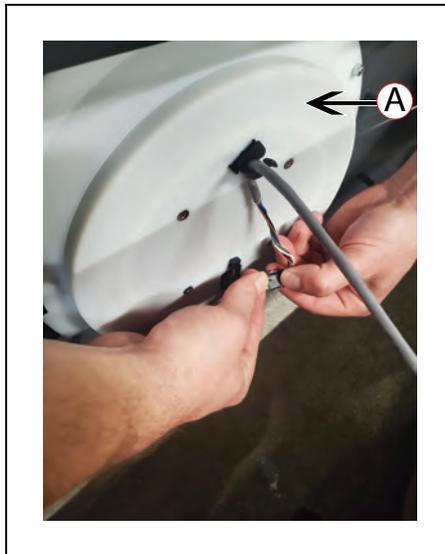
Figure 8-26. Disconnecting the Cable from the (A) LED Mount Plate

2. Once the cable is disconnected, remove the skin completely.

3. Next, unscrew the four screws holding the electronics bay seal cover ((**A**) in Figure 8-27.) as shown in the following figure. This will allow the LED mount plate ((**A**) in Figure 8-26.) to come off once unscrewed from the skin.
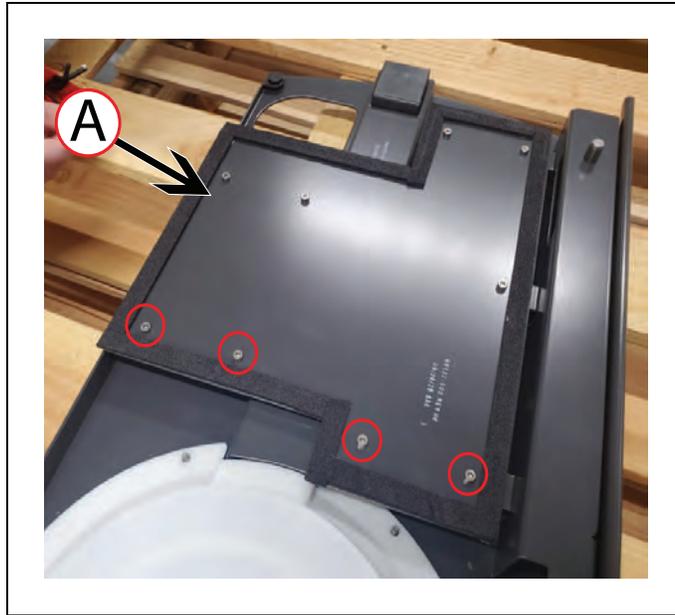
Figure 8-27. Removing Four Screws Holding the (A) Electronics Bay Cover Seal

4. Unscrew the six nuts holding the LED mount plate to the side skin.

    Retain the nuts and the outer cover for installing the new assembly.
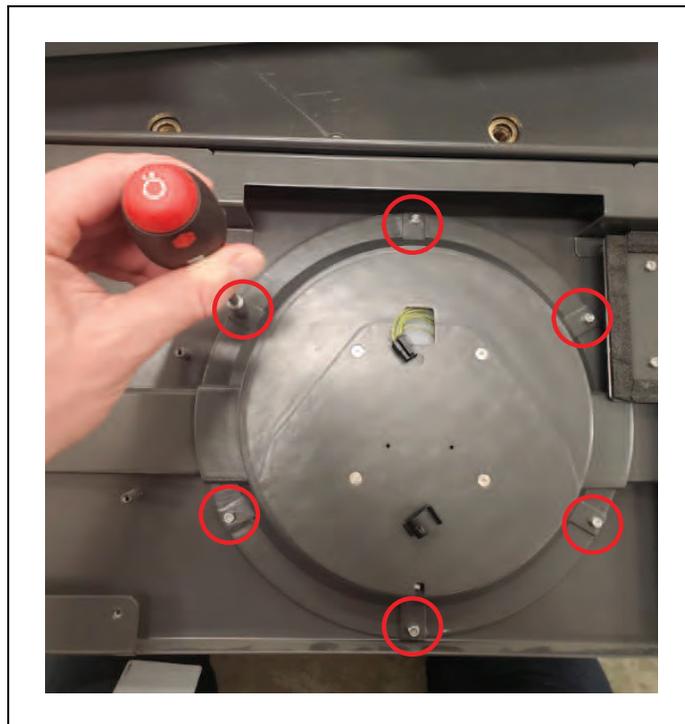
Figure 8-28. Unscrewing the LED Mount Plate

5. Carefully lift the electronics bay cover seal, and remove the LED mount plate

completely.

Figure 8-29. Lifting the Electronics Bay Cover Seal to Remove the LED Mount Plate

6. Remove the four screws holding the diffuser plate to the LED mount plate.

Figure 8-30. Removing the Diffuser Plate Screws

7. Remove the PCA assembly by disconnecting it from the LED mount plate.
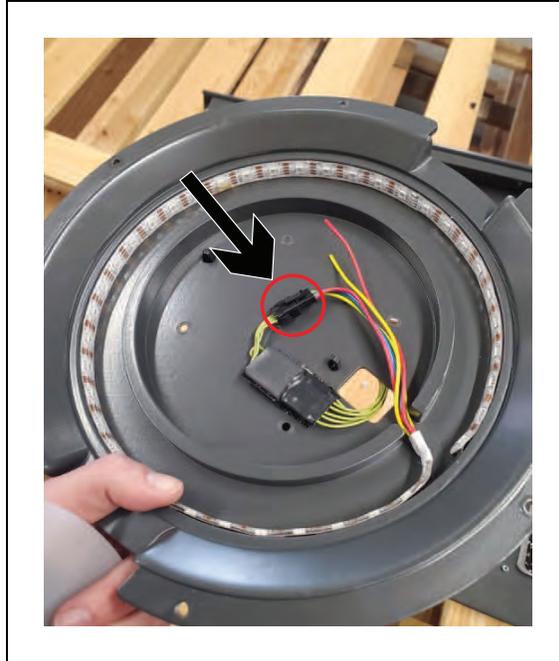
Figure 8-31. Disconnecting the PCA Assembly

8. Remove the LED strip by peeling it off the LED mount plate.
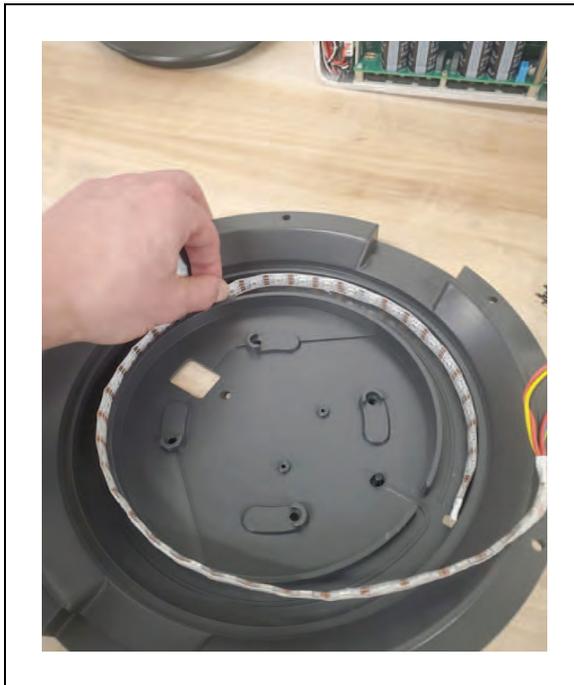
Figure 8-32. Peeling the LED Strip off the LED Mount Plate

9. Adhere the new LED strip to the LED mount plate. The direction of the LED strip is important and if installed incorrectly, the animations will be backwards. Figure 8-32.

shows graphic cast made into the LED mount plate that display the correct direction of LED strip installation.

Also, make sure to begin routing the LED strip at the slot shown below so that the end of the LED strip can be properly routed to the center.
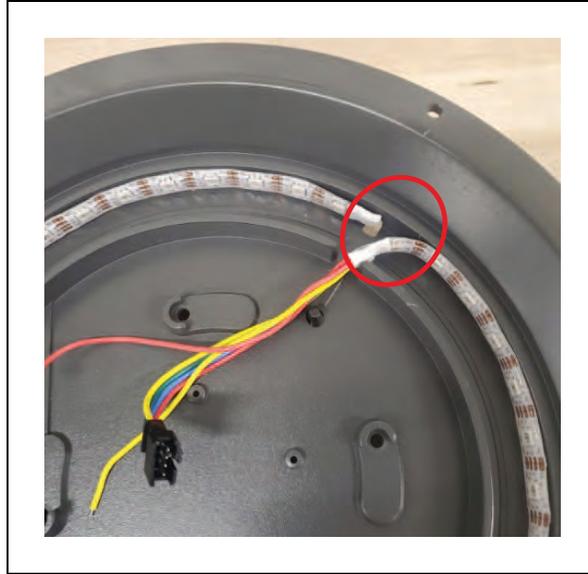
Figure 8-33. Routing the LED Strip at the Slot

10. Reverse steps 6 to 1, and re-install the skin.

11. Dispose of the old LED strip according to the local and national regulations concerning electronic components.

Light Strips

Before you begin, press an E-Stop button and turn the HD-1500 off.

You require the following tools to replace the light strip:

- 3 mm hex wrench
- Adhesive

Follow these steps to replace the light strip:

1. Unlatch the front or rear skin depending on which light strip you are replacing. Refer to Removing and Installing Skins on page 253.

2. Pull the skin away from the platform just enough so you can disconnect the LED connector as shown in the following figure.

Figure 8-34. Disconnecting Rear Skin LED Connector
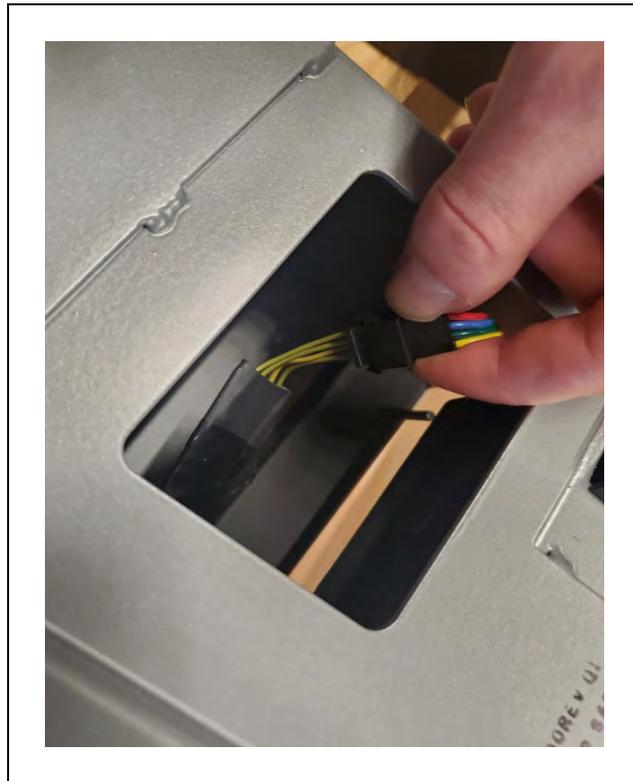
Figure 8-35. Disconnecting Front Skin LED Connector

3. Remove the holding bracket ((**A**) in Figure 8-36.) by unscrewing the four screws.

4. Next, remove the LED strip by pealing it off the holding bracket.
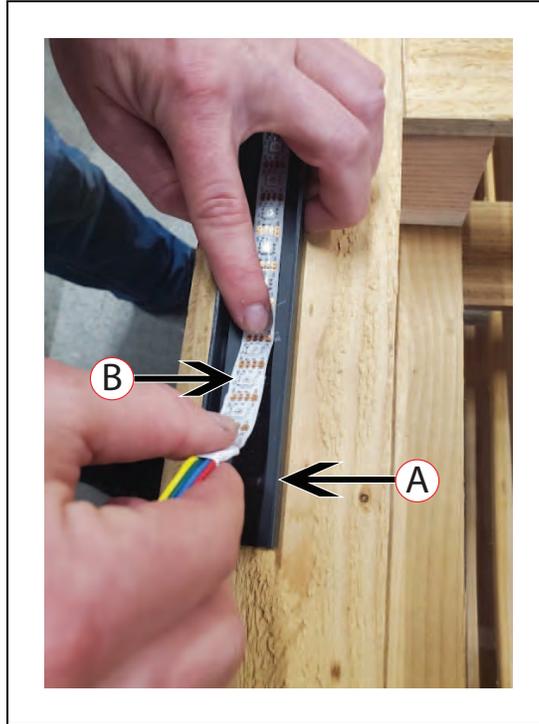
Figure 8-36. Peeling the LED Strip off the Holding Bracket, (A) Holding Bracket, and (B) LED Strip

5. Adhere the new LED strip to the holding bracket, and install the holding bracket back to the skin.

6. Connect the LED connector, and re-install the skin.

7. Dispose of the old LED strip according to the local and national regulations concerning electronic components.

Operator Panel

The Operator panel is typically relocated to the payload structure, and its replacement procedure varies accordingly. The Operator Panel connects to the Safety Controller, located in the electronics bay.

Remove the Operator Panel

Before you begin, press an E-Stop button and turn the HD-1500 off.

To remove the Operator Panel, follow these steps:

1. Unlatch the rear skin, and pull away from the platform just enough so you can disconnect the cable. See: Removing and Installing Skins on page 253.
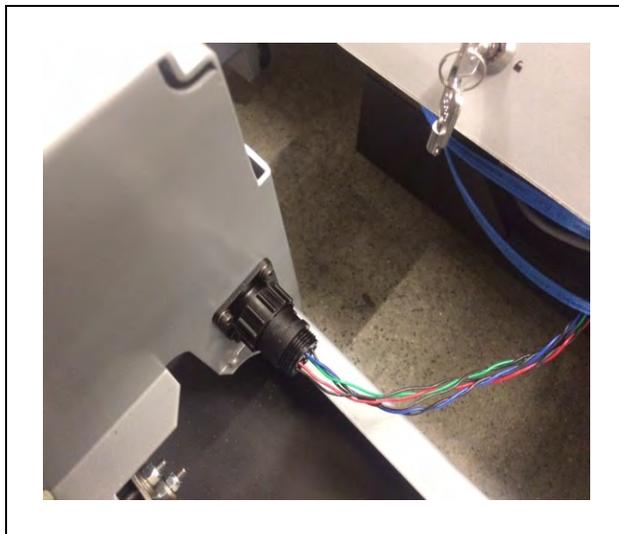
Figure 8-37. Pulling the Skin Just Enough to Disconnect the Cable

Figure 8-38. Disconnecting the Cable

2. Once the cable is disconnected, remove the rear skin completely. You can now access the back of the Operator Panel.

3. Unscrew the four M4 locknuts that attach the Operator Panel to the mount bracket.

4. Grab the Operator Panel and remove from the mount bracket.

Side-Mount Lasers (Side Lasers)

Side-mount optional lasers are an option for payload structure development. You need to relocate these side lasers if the payload structure obstructs their field of view.

> **IMPORTANT:** It is the end user's responsibility to ensure that the payload structure does not obstruct the side lasers' beam.

If you order your HD-1500 with the optional side lasers, the AMR will ship with the side lasers assembled and mounted onto the AMR. Therefore, if you decide to relocate them, you must first remove them from the AMR.

You must determine the mounting method for the optional side lasers.

Remove the Side Laser

You require the following tools to remove and relocate each side laser:

Tool	Qty	Description
Laser TiM-510	2	Laser part number: 68220-400L.
Extension cable kit	1	Extension cable kit options: • Part number: 68970-000 (includes one meter long extension cable), or • Part number: 68971-000 (includes two meter long extension cable)
Hex keys	3	2.5 mm, 3 mm, and 5 mm hex keys for M3, M4, and M6 socket head cap screws.
Loctite 243	as needed	Loctite 243

Before you begin, press an E-Stop button and turn the HD-1500 off.

Follow these steps to remove the side laser from the AMR:

1. Remove the front skin (for the front left side laser) or the rear skin (for the right rear side laser) to access the back of the laser corner. See: Removing and Installing Skins on page 253

   Once the skin is removed, you can access the back of the laser corner ((**A**) in Figure 8-39. and remove the side laser as instructed in the following steps.

2. Disconnect the power cable, and the data cables from the side laser.

3. Unscrew all three M6 screws ((**B**) in Figure 8-39.), and remove the laser cover fin ((**C**) in Figure 8-39.).

   > **IMPORTANT:** Care must be taken not to scratch the laser lens. The laser lens can easily get scratched and damaged.

   If you decide to install the laser cover fin back in place, you must torque the M6 screws properly (7.5 N-m), and use Loctite 243 to secure in place.
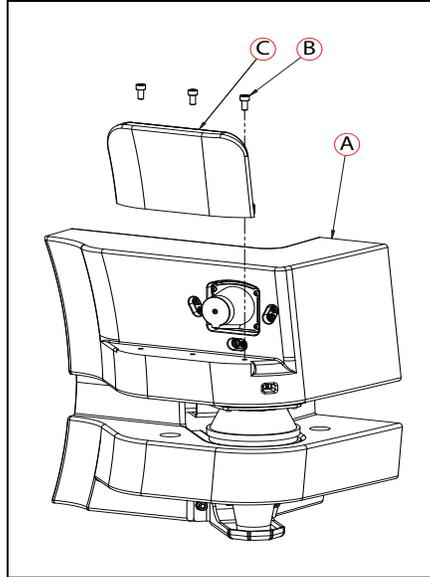
Figure 8-39. (A) Laser Corner, (B) M6 Screw, and (C) Laser Cover Fin

4. Unscrew three M4 screws (**(D)** in Figure 8-39.) that attach the side laser bracket to the laser corner (**(A)** in Figure 8-39.
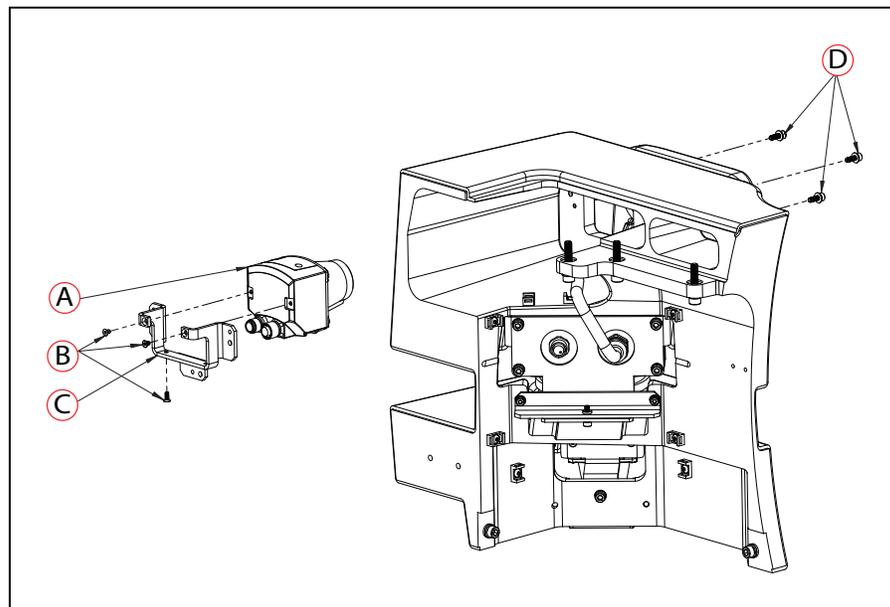
Figure 8-40. (A) Side Laser, (B) M3 Screw, (C) Laser Bracket, and (D) M4 Screw

5. Next, unscrew the three M3 screws (**(B)** in Figure 8-39.) that mount the bracket to the side laser as shown in Figure 8-39.

Once the side laser is removed from the laser bracket, you may replace the side laser with a new one or use the extension cable kit to relocate the side laser to your desired location. Whether you install the power and data cables to the side laser before or after mounting it to the new location, depends on your specific installation location on the payload structure.

You will need to change the configuration parameters in MobilePlanner and update the X, Y, and Z positions of the side lasers. For information on how to change the configuration parameters in MobilePlanner, see: *Fleet Operations Workspace Core User's Manual (Cat. No. I635).*

Wifi Antennas

You require the following tool to replace the Wifi antenna:

- 2.5 mm hex key for M4 flat head cap screws.

Before you begin, press an E-Stop button and turn the HD-1500 off.

Follow these steps to replace the Wifi antenna:

1. Unscrew all four M4 screws ((**A**) in Figure 8-41. that attach the cover ((**B**) in Figure 8-41. to the AMR.
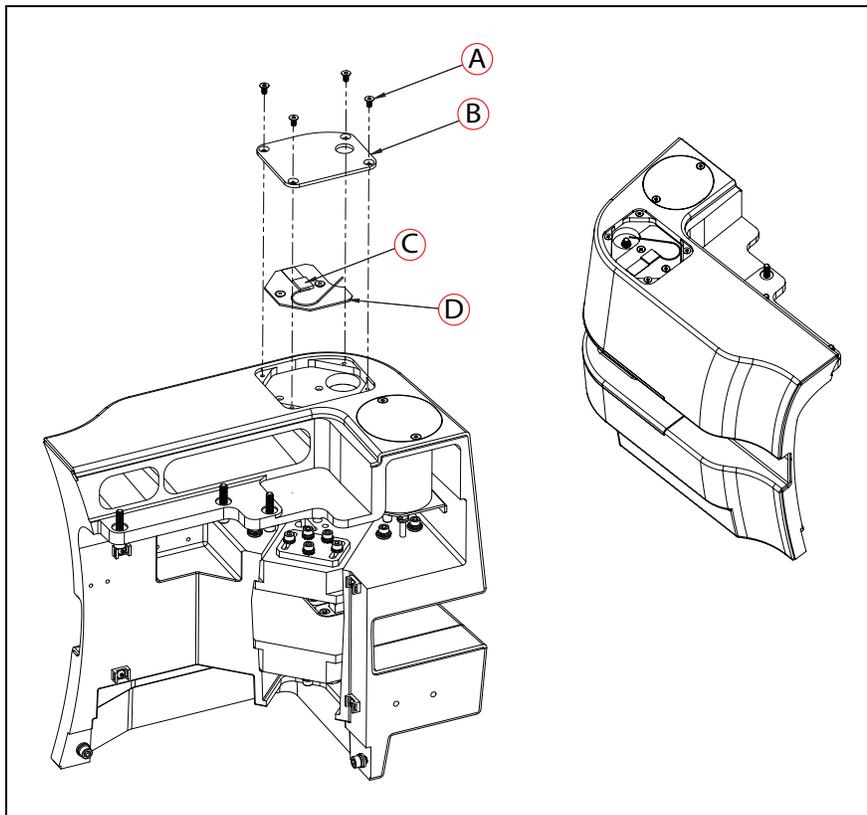
Figure 8-41. (A) M4 Screw, (B) Cover, (C) Wifi Antenna Taped to the Base Plate, and (D) Base Plate

2. The Wifi antenna ((**C**) in Figure 8-41. is taped to the base plate ((**D**) in Figure 8-41. Remove the Wifi antenna from the base plate.

3. The base plate is etched displaying the correct location of the antenna. Attach the new Wifi antenna to the etched location on the base plate. Simply peal the backing off, and stick the antenna to the base plate.

IMPORTANT: The position of the antenna is important. You must make sure to attach the new antenna to the correct location etched on the base plate.

4. Screw the cover back in place.

AMR Charging Contacts

The charging contacts on the AMR should be inspected every 3 months for signs of wear. To determine whether a charging contact needs to be replaced, measure the distance from the bottom of the charging contact, as displayed in Figure 8-42. to the surface of the charging contact. If the distance is less than 7.0 mm, the charging contact must be replaced.
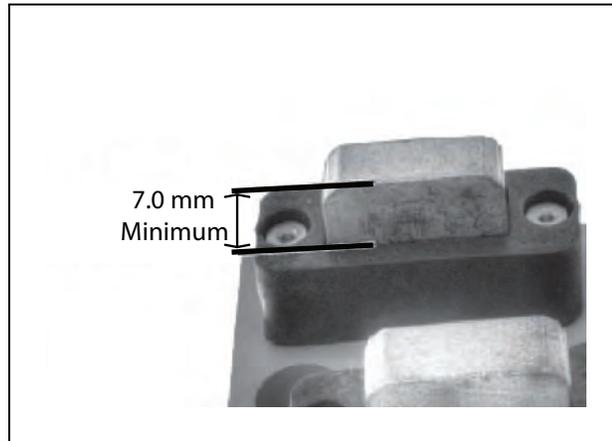
Figure 8-42. Inspecting the Charging Contacts for Signs of Wear

CAUTION: BURN RISK
The charging contacts can reach a very high temperature after charging. You must allow the charging contacts to cool down prior to performing any maintenance work on them.

Before you begin, press an E-Stop button and follow Log-Out, Tag-Out (LOTO) instructions. See: LOTO Procedure for the AMR on page 216.

You require the following tool to replace the charging contacts:

- 4 mm hex key for M5 socket head cap screws
- 4 mm allen wrench for M5 screws

As displayed in Figure 8-43. there are two sets of two charging contacts at the top and the bottom of the charging slot.
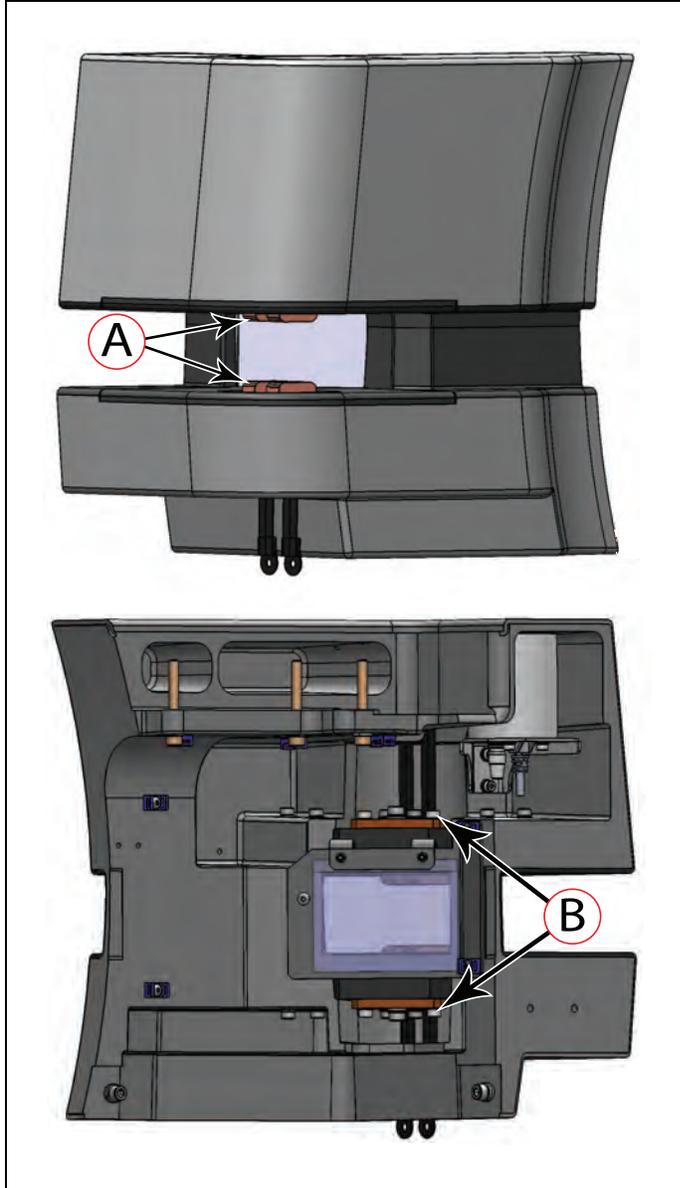
Figure 8-43. (A) Top and Bottom Charging Contacts, and (B) M5 Screws Attaching the Electrical Connections to the Corner Casting

Follow these steps to replace the charging contacts:

1. Unscrew the M5 screws ((**B**) in Figure 8-43.) attaching the top and the bottom electrical connections to the corner casting. Use the 4 mm wrench to remove these screws.

2. Next, unscrew all four M5 screws ((**A**) in Figure 8-44. that attach the contact holders ((**B**) in Figure 8-44. to the base plate ((**D**) in Figure 8-44.

   Retain the screws for installing the new charging contacts ((**C**) in Figure 8-44.
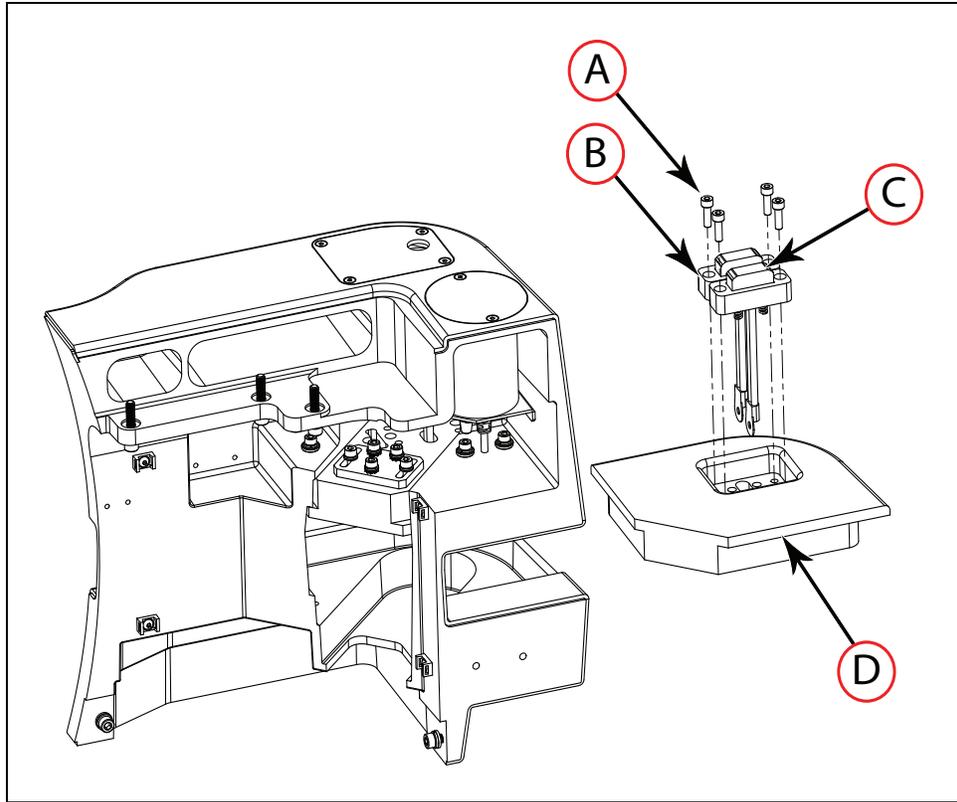
Figure 8-44. (A) M5 Screw, (B) Contact Holders, (C) Charging Contact, and (D) Base Plate

3. Pull the charging contacts out and remove.

4. Install the new charging contacts and screw the contact holders to the base plate.

E-Stop and Safety Laser Commissioning

WARNING: The AMR is commissioned at the factory. However, the user must perform the commissioning process as part of the initial setup upon receipt of the HD-1500.

Also, you must repeat the E-Stop Commissioning and the Safety Laser Commissioning procedures under the following circumstances:

- If the hardware detects a failure, the AMR may automatically decommission itself. If this happens, ARAM will display a fault pop-up in MobilePlanner.

- If you re-configure the shape/size of the laser safety zones due to the size of the payload structure or specific environmental conditions.

- If you are using a user-supplied E-Stop.

- If you want to perform the commissioning procedures on a regular basis as part of preventive maintenance process.

> **NOTE:** After performing either of these tests, you can access the other test by clicking **Next Test** on the final screen.

E-Stop Commissioning

This procedure verifies that pressing any E-Stop button triggers the E-Stop circuitry. The indicators are:

- The brakes activate with a distinctive click as the electromagnetic brake engages.

- The wheel light discs change from slow-pulsing blue to a more rapid blinking red.

You must repeat the test for each E-stop button, including the Operator Panel and any optional payload E-Stops.

1. Ensure that the E-Stop buttons are NOT depressed before starting.

2. In MobilePlanner software, select:

   Main Menu > Robot > Safety Commissioning

3. Follow the on-screen instructions to complete the test. You can print a certificate after successfully completing the commissioning.

Safety Laser Commissioning

This procedure verifies that the safety scanning lasers report the *MovementParametersSectors* information correctly, and the protective stop circuitry activates when an obstacle that the lasers should detect is placed in the lasers' FOV.

1. From the MobilePlanner software, select:

   Main Menu > Robot > Safety Commissioning

2. Follow the on-screen instructions to complete the test. You can print a certificate after successful completion of the commissioning.

Safety Decommissioning

If any safety mechanism detects a functional abnormality, automatic decommissioning of the safety circuit occurs. To continue operation you must complete a recommissioning process. See E-Stop and Safety Laser Commissioning on page 252.

Removing and Installing Skins

Most of the maintenance procedures require removing some of the platform's skins. With the exception of the user access panel cover, skins are secured to the chassis by two latches, one on each side of the skin. The following figure Figure 8-45.
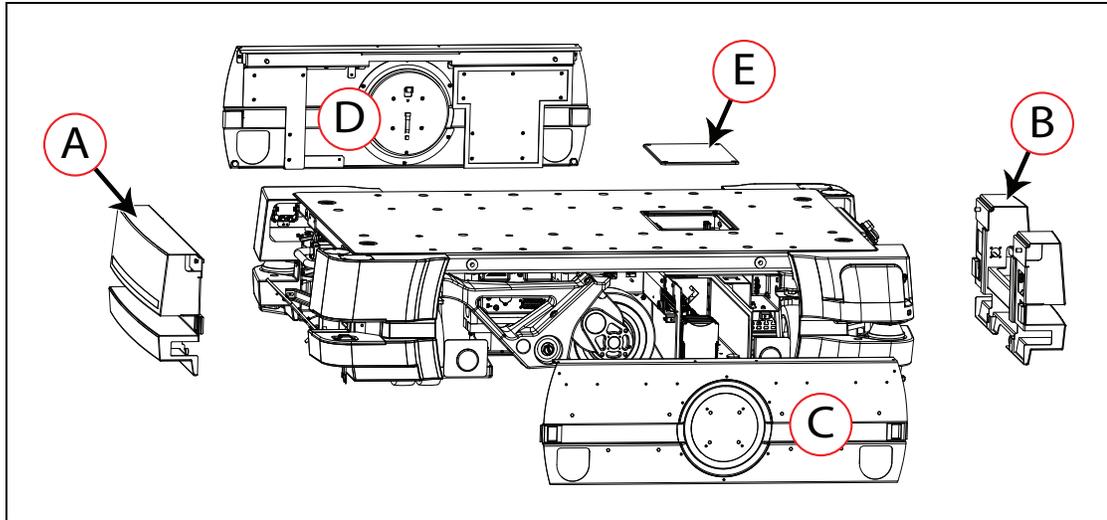
Figure 8-45. HD-1500 Skin Panels

Callout	Description
A	Front skin - houses the battery compartment and must be removed prior to installation or removal of the battery. The front light strip is installed on the front skin.
B	Rear skin - covers the rear caster assembly and houses the Operator Panel. The rear light strip is installed on the rear skin.
C	Left side skin - covers the left drive assembly. To access the AMR Controller, the left side skin must be removed.
D	Right side skin - covers the right drive assembly. To access the electronics bay compartment, the right side skin must be removed. **NOTE:** The right and left side skins are symmetric for the task of installation and removal. **NOTE:** Both side skins hold a light disc and cover.
E	User access panel cover - covers the user access panel.

The skins include alignment pins that fit into holes in the chassis to assist you in installing and aligning the skins.

The left side and right side E-Stop buttons are not attached to the skins, and remain attached to brackets on the chassis even when you remove all the skins.

You can remove the skins in the order in which they are listed above. Each skin can be removed without removing any other skins.

> **NOTE:** After removing the skin panels, place them inner-side down, so the outer surfaces don't get scratched.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
After you replace the skins, you must make sure that the light discs, as well as the front and back lights are operational once the AMR is powered back on.

Remove and Replace the Front Skin

The front skin encloses the battery compartment, and must be removed prior to installation or removal of the battery.

No tools are needed for either the removal or installation of the front skin.

Before you begin, press an E-Stop button and turn the HD-1500 off.

To remove the front skin:

1. Locate the front skin latches ((**A**) in Figure 8-46. in the laser cut-out groove as shown in the following figure. The latches also act as recessed handles for easy grip.
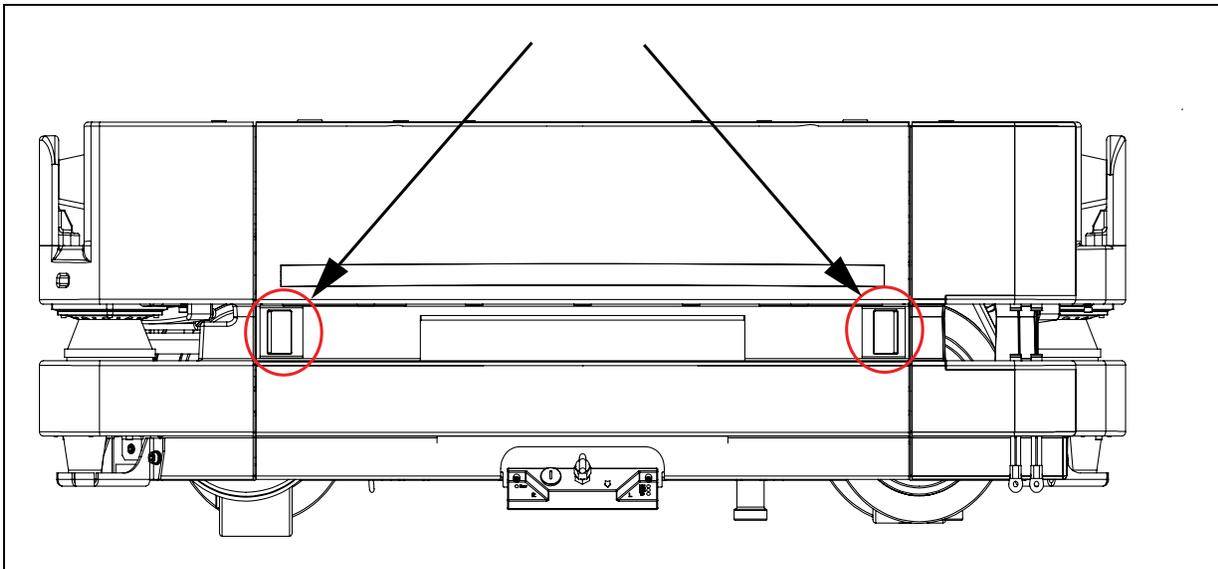
Figure 8-46. Front Skin Recessed Handles

2. Grip the skin at the two recessed handles, and press inward to unlatch.

3. Once unlatched, pull the skin away from the chassis just enough so you can reach and disconnect the front light connector.

Figure 8-47. Disconnecting the Front Light Connector

4. Next, Remove the skin completely.

To replace the front skin:

1. Grip the skin at the two recessed handles and lift the skin.

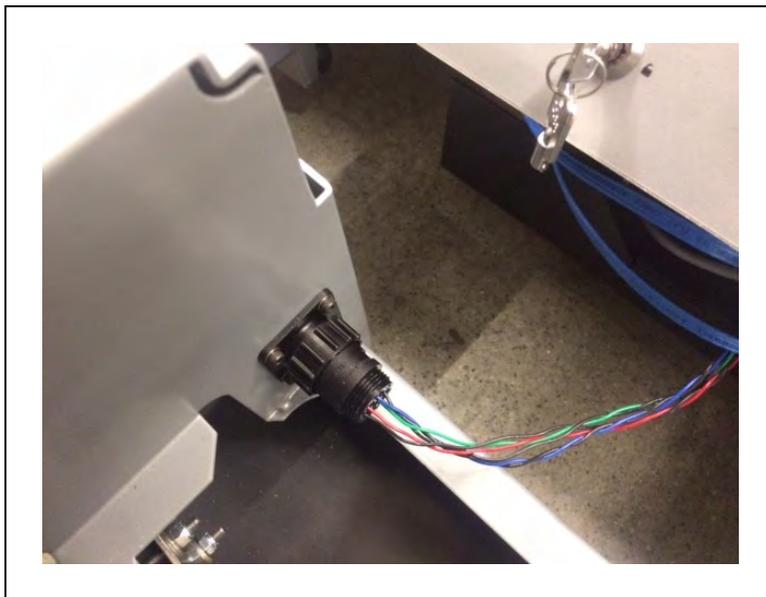2. Connect the front light connector to its receiver on the skin.
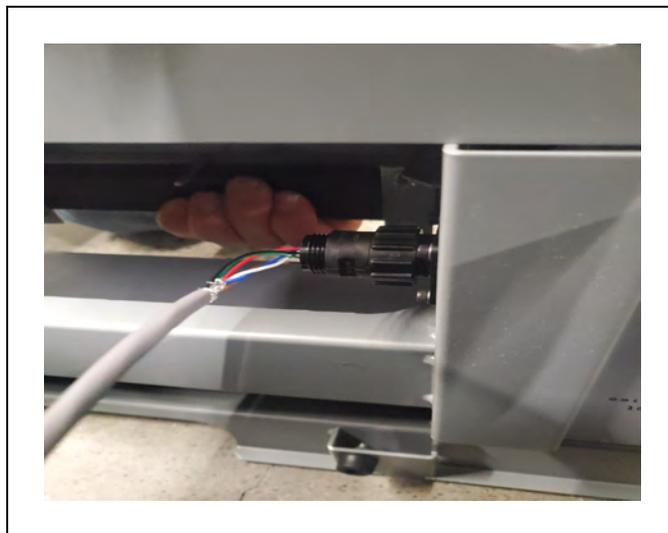
Figure 8-48. Front Light Cable Connected to the Skin

3. Next, locate the alignment receivers on the chassis.

Figure 8-49. Front Skin Pin Alignment

4. Lift the skin's alignment pins onto the receivers in the chassis, as shown in Figure 8-49.

5. Install the skin on to the chassis and ensure that it latches.

Release the E-Stop button to return the HD-1500 to service. See: Releasing an E-Stop on page 34.

Remove and Replace the Rear Skin

The rear skin covers the rear caster assembly and incorporates the rear light strip. Care must be taken not to scratch the light strip. Also, the Operator Panel is installed on the rear of the AMR. Care must be taken not to scratch or damage the Operator Panel.

No tools are needed for either the removal or installation of the rear skin.

Before you begin, press an E-Stop button and turn the HD-1500 off.

To remove the rear skin:

1. Locate the rear skin latches ((**A**) in Figure 8-50.) in the laser cut-out groove as shown in the following figure. The latches also act as recessed handles for easy grip.
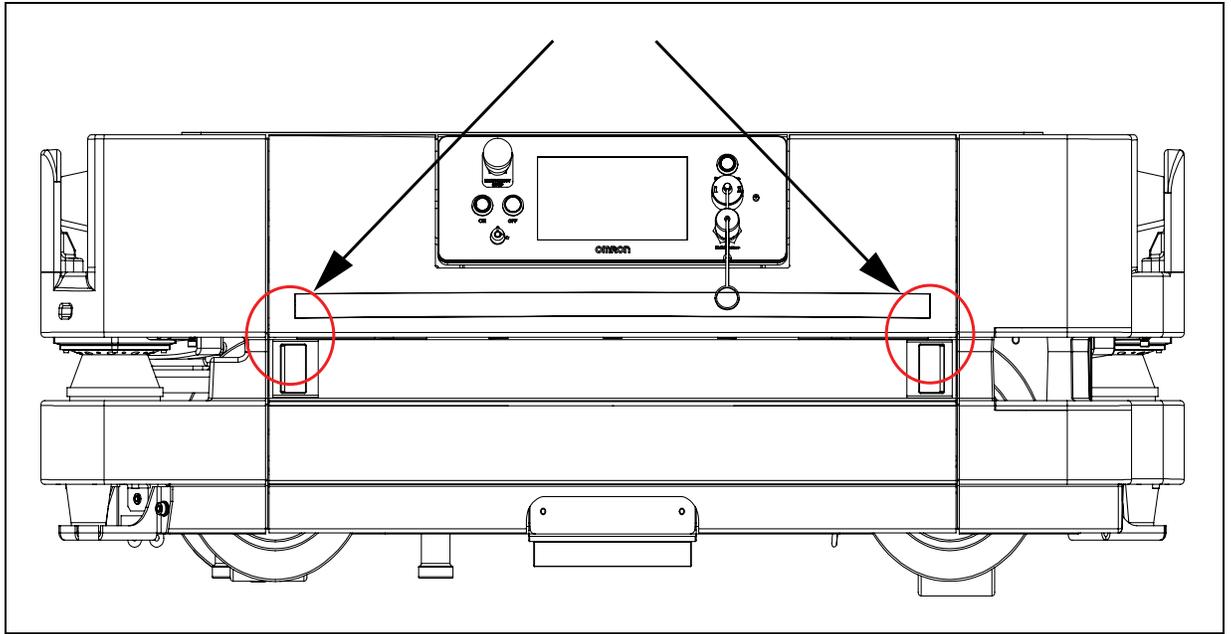
Figure 8-50. Rear Skin Recessed Handles

2. Grip the skin at the two recessed handles, and press inward to unlatch.

Figure 8-51. Gripping the Skin Recessed Handles

3. Once unlatched, pull the skin away from the chassis just enough so you can reach and disconnect the rear light connector.

Figure 8-52. Rear Light Cable Plugged into Its Connector

Figure 8-53. Disconnecting the Rear Light Connector

4. Next, Remove the skin completely.

To replace the rear skin:

1. Grip the skin at the two recessed handles and lift the skin.

2. Connect the rear light connector to its reciever on the skin.

Figure 8-54. Rear Light Cable Connected to the Skin

3. Next, locate the alignment receivers on the chassis.

4. Lift the skin's alignment pins onto the receivers in the chassis as shown in the following figure.

Figure 8-55. Rear Skin Pin Alignment

5. Install the skin on to the chassis and ensure that it latches.

Release the E-Stop button to return the HD-1500 to service. See: Releasing an E-Stop on page 34.

Remove and Replace the Side Skins

The side skins enclose the drive train assembly and the E-Stop button components. The side skins are symmetric. Use the same procedure to remove either a right-side or a left-side skin. However, you must not exchangethe side skins as this will cause the light discs to display incorrect light pattern motion. The side skins include the light discs assembly, which is connected by a lightweight cable.

No tools are needed for either the removal or installation of the side skins.

Before you begin, press an E-Stop button and turn the HD-1500 off.

> ⚠ **WARNING:** PERSONAL INJURY OR PROPERTY DAMAGE RISK
> Take care when working near the encoder cables to make sure that they are not-disconnected or damaged. Improper connection or disconnection of encoder cables may result in erratic motion of the AMR during operation. The AMR might rotate uncontrollably during loss of encoder signals.

To remove either side skin:

1. Locate the side skin latches ((**A**) in Figure 8-56.) as shown in the following figure. The latches also act as recessed handles for easy grip.
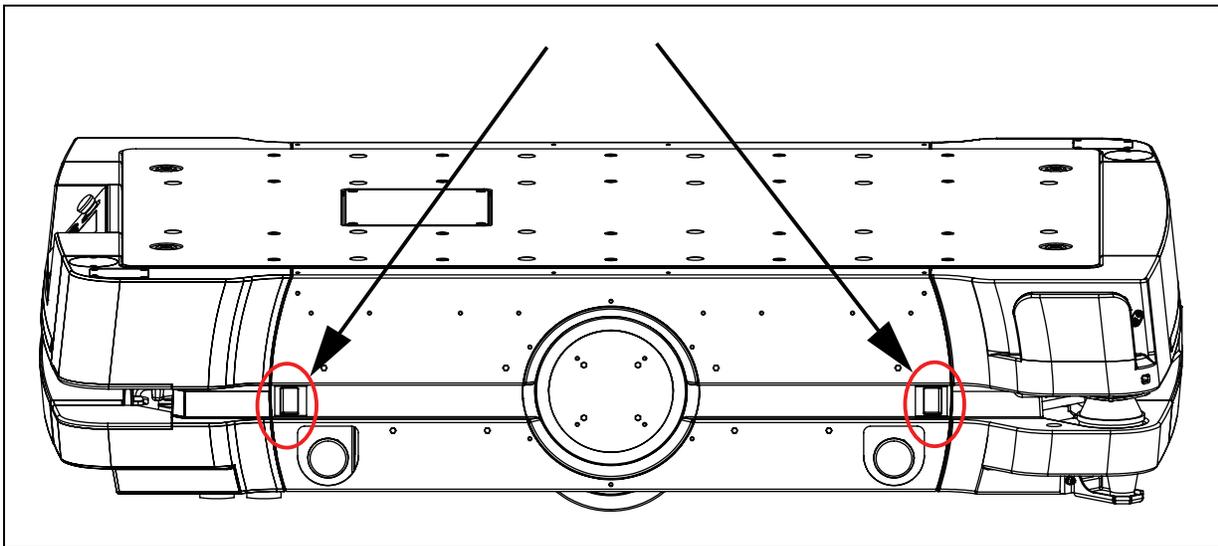
Figure 8-56. Side Skin Recessed Handles

2. Grip the skin at the two recessed handles, and press inward to unlatch. Do not pull the skin away at this point, it is secured by a light disc cable.

Figure 8-57. Gripping the Side Skin Recessed Handles

3. Remove the skin a few inches away from the chassis.

    The light disc cable plugs into its connector on the inside of the side skin.
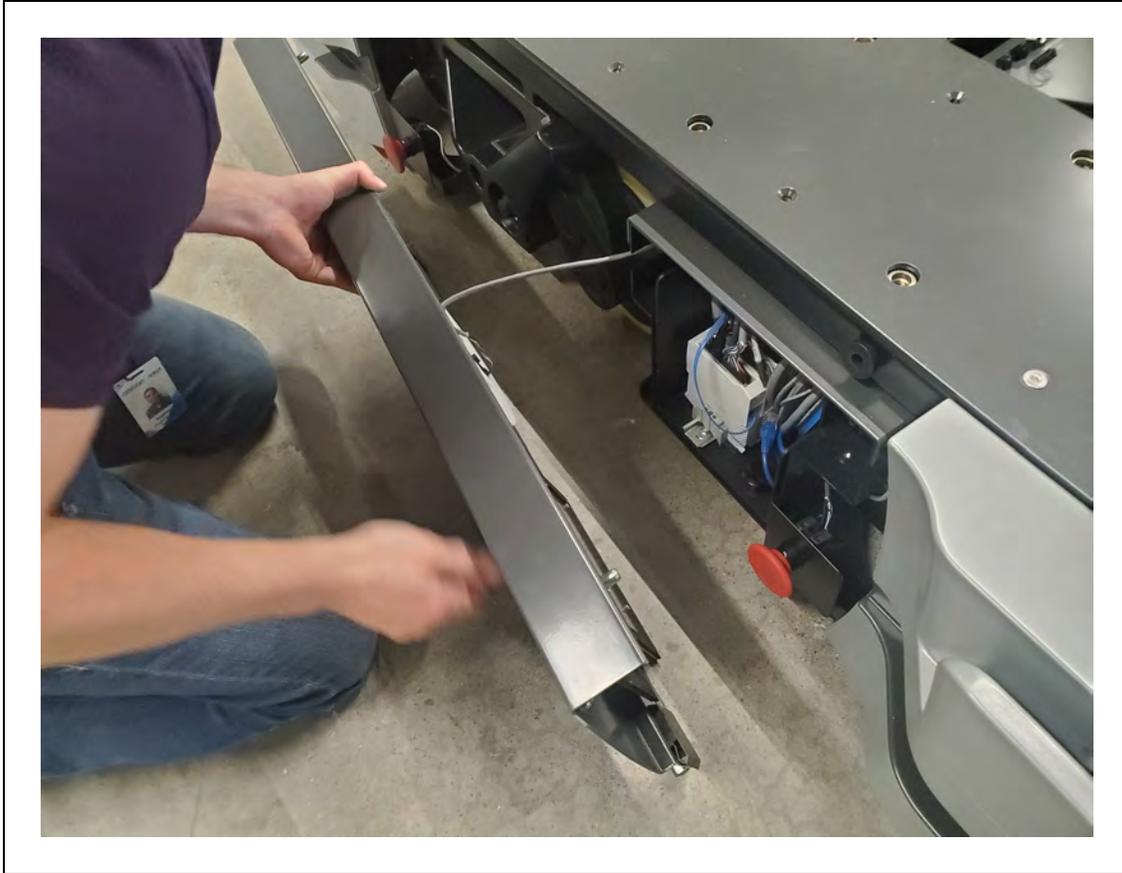
Figure 8-58. Light Disc Cable Plugged into Its Connector

4. Unplug the light dics connector, and move the side skin away from the platform.
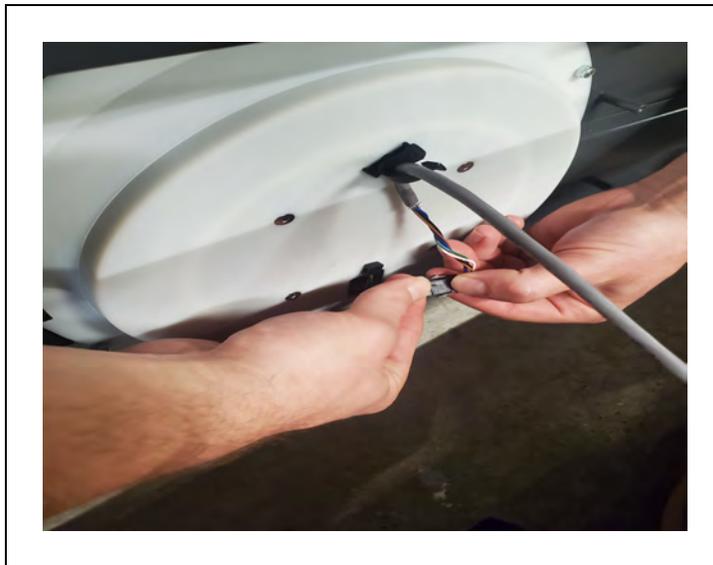
Figure 8-59. Disconnecting the Light Disc Connector

Repeat for the other side skin.

To replace the side skins:

1. Move the skin to within a few inches of the chassis, and plug in the light disc connector.

   Connect the light disc to the fitting on the inside of the side skin.

2. Locate the alignment receivers on the chassis.

3. Lift the skin's alignment pins onto the receivers in the chassis as shown in the following figure.

4. Install the skin on to the chassis and ensure that it latches.

Release the E-Stop button to return the HD-1500 to service. See: Releasing an E-Stop on page 34.

Remove and Replace the User Access Panel Cover

The user access panel cover encloses the user access panel, and must be removed in order to reach the available connections. Follow instructions provided in this section to remove or install the user access panel cover.

You require:

- 3 mm allen wrench for M5 screws.
- Small flat-blade screwdriver.

Before you begin, press an E-Stop button and turn the HD-1500 off.

To remove the user access panel cover:

1. Use a 4 mm allen wrench to unfasten the four M5 screws. Retain the screws for reattaching the skin.

2. To open the user access panel cover you can place a flat-blade screwdriver in the gap between the user access panel cover and the top cover, and push the user access panel cover up as displayed in the following figure. You could also thread a screw in a threaded hole on the user access panel cover, and use as a knob to open the user access panel cover.
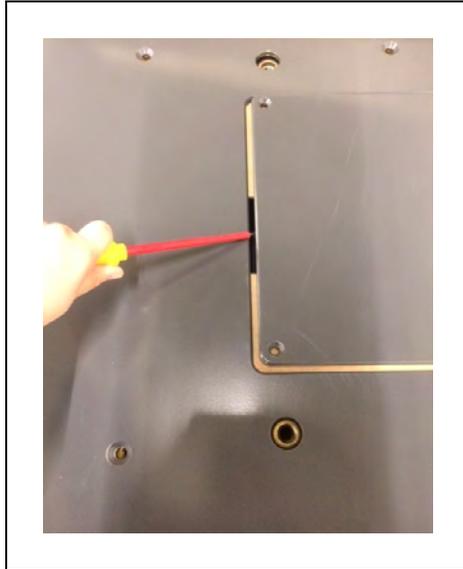
3. Grab the cover, and remove the completely.

Figure 8-60. Grabbing and Removing the Cover

Reverse these steps to replace the user access panel cover.

8.8 Field-Replaceable Periodic Parts

The following HD-1500 parts require an OMRON service engineer to replace them, and are not to be replaced by the end-user. Contact your OMRON representative to replace them.

Caster and Drive Wheel Treads

The caster wheels and drive wheel treads should be checked every 3 months. If they are missing big chunks of the thread which affects normal movement of the HD-1500, or display major tear that may result in breaking the thread into sections, they should be replaced. If the treads are worn, torn or cracked, contact your OMRON representative.

Caster, Drive Wheel, and Drive Assembly

The casters, drive wheels, and drive assemblies must be inspected every 3 months, and replaced if they show signs of cracking, excessive wear or any damage. If the casters, drive wheels, or the drive assemblies are worn or cracked, contact your OMRON representative.

Also, you must check to make sure that the swivels are not loose. You can tighten the swivels if they are loose.

8.9 Restoring the Configuration

You can restore the AMR's configuration from:

- A saved debuginfo or configuration file.
- A default model file distributed on the software USB thumbdrive.

A restore operation is required after replacing an AMR Controller.

You can use the SetNetGo operating system's backup and restore options to recover a configuration. For information about recovery procedures, see: *Fleet Operations Workspace Core User's Manual (Cat. No. I635).*

Chapter 9: Options

There are a number of options available for the HD-1500 AMRs to enhance their performance and abilities.

9.1 Fleet Manager, for Multi-AMR Coordination

The Fleet Manager is an operational mode of the computing appliance (EM2100 appliance) that runs the FLOW Core software to control a fleet of AMRs. You can use two EM2100 appliances as Fleet Managers in Autosync mode to reduce the risk of fleet service outages.

The Fleet Manager prevents traffic problems between fleet AMRs, and ensures completion of all jobs submitted to the job queue. This is covered in the *Fleet Operations Workspace Core User's Manual (Cat. No. I635).*

9.2 Pendant

Pendant is mainly used to manually drive the platform when doing a scan, in preparation for making a map of the workspace. You need at least one pendant for each fleet of HD-1500 AMRs. Once a map is generated, it can be shared with multiple HD-1500 AMRs working in the same space.

For information on pendant use and operation, see: Pendant Use on page 211.

9.3 Spare Battery

You need at least one spare battery if you opt to exchangethe AMR's battery, rather than having it automatically charge itself at a charging station. See: Manually Charging the AMR's Battery on page 191.

9.4 Side-Mount Lasers

Side-mount lasers are an option for payload structure development. Two side lasers mount on the front right and left rear corners of the platform, and detect obstacles that protrude into the AMR's path, but may not be detected by the safety scanning lasers or low lasers.

This is useful when the payload structure is tall enough that there is an increased risk of running into obstacles not detected by the safety scanning laser.

The side lasers connect to the circuit board located in the mid section of the electronics bay enclosure.

For information on installing and relocating the side lasers, see: Side-Mount Lasers (Side Lasers) on page 246.

9.5 High-Accuracy Positioning System (HAPS)

The High-Accuracy Positioning System (HAPS) is a sensor that detects magnetic tape applied to the floor. HAPS allows the AMR to very accurately align itself at a specific location, such as a fixed conveyor.

The High Accuracy Positioning System connects to the circuit board located in the mid section of the electronics bay enclosure.

A protective covering needs to be installed when applying the magnetic tape to the floor to prevent damage from the AMR traffic. OMRON does not provide the protective coverings with the HAPS option. The protective covering must be supplied by the user.

For information on installing and configuring HAPS, see: *HD Platform Peripherals User's Manual (Cat. No. I646).*

9.6 Charging Station

The HD-1500 charging station provides both manual and automated methods of recharging the AMR's battery. For more information on the HD-1500 charging station, see: HD-1500 Charging Station Specifications on page 276.

Chapter 10: Technical Specifications

10.1 Dimension Drawings

HD-1500 Platform

Following images display the physical dimensions of the HD-1500 platform.
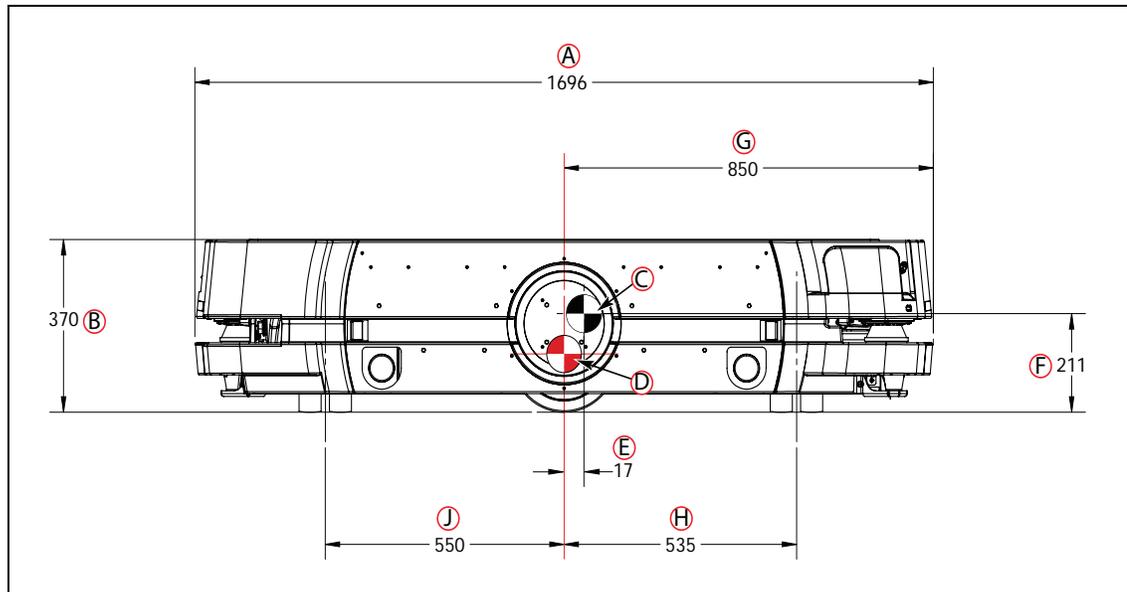
Figure 10-1. HD-1500 Platform Dimensions - Side View (units are in mm)

Callout	Description	mm
A	HD-1500 length	1696
B	HD-1500 height	370
C	Center of gravity (COG)	N/A
D	Center of rotation (COR)	N/A
E	COG to COR	17
F	COG to the floor	211
G	Front of the HD-1500 to COR	850
H	Front caster pivot point to COR	535
J	Rear caster pivot point to COR	550
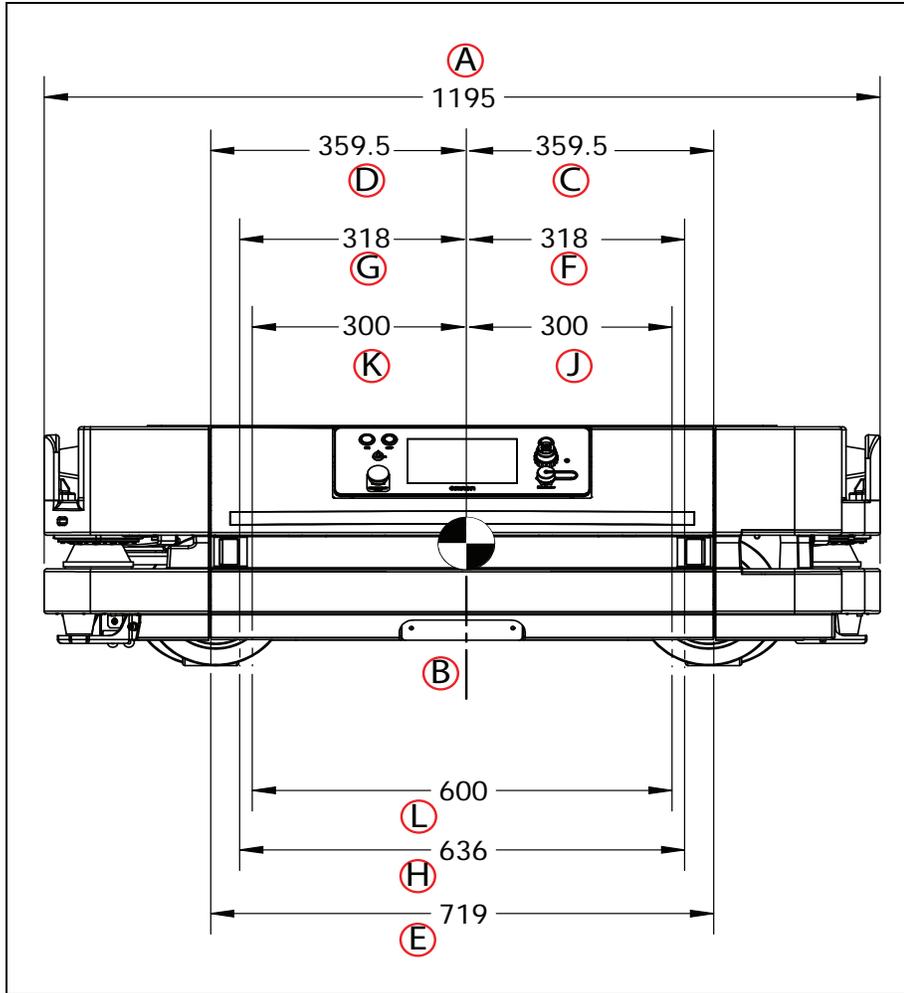
Figure 10-2. HD-1500 Platform Width Dimensions - Rear View (units are in mm)

Callout	Description	mm
A	HD-1500 width	1195
B	HD-1500 center-line	N/A
C	Right drive wheel to COG	359.5
D	Left drive wheel to COG	359.5
E	Distance between the drive wheels	719
F	Front right caster pivot point to COG	318
G	Front left caster pivot point to COG	318
H	Distance between the front casters pivot points	636
J	Right rear caster pivot point to COG	300
K	Left rear caster pivot point to COG	300

Callout	Description	mm
L	Distance between the rear casters pivot points	600

NOTE: Refer also to Figure 5-1. for mounting hole dimensions for the payload structure.

HD-1500 Charging Station

Following images display the physical dimensions of the HD-1500 power supply box and the docking target.
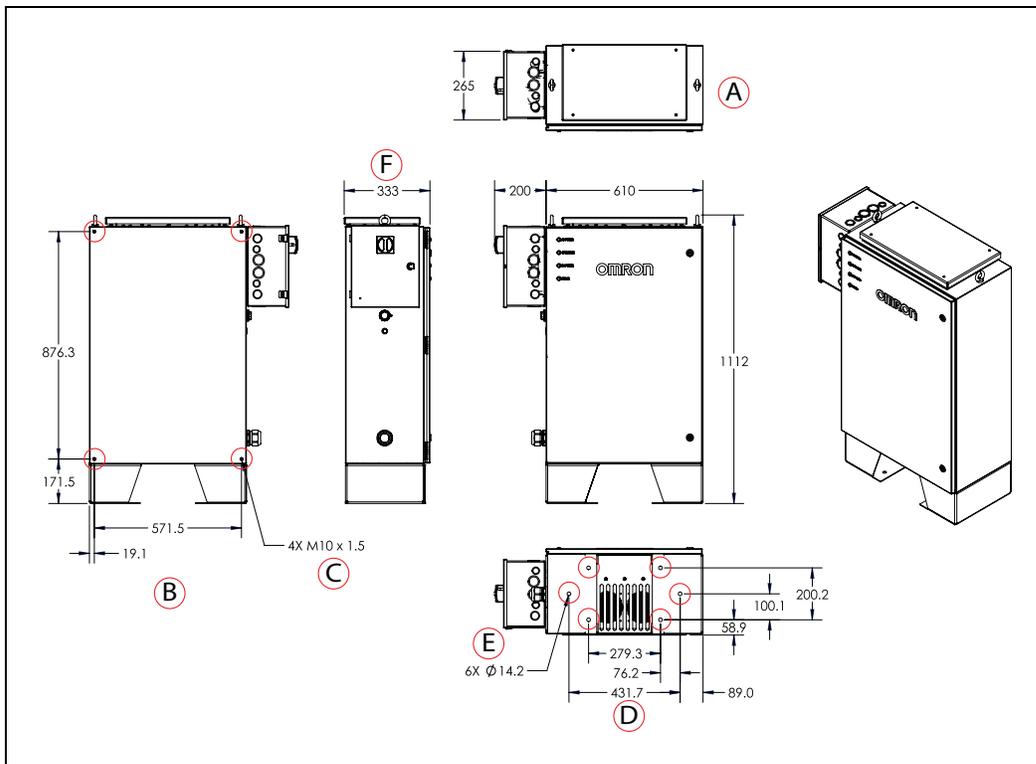
Figure 10-3. Power Supply Box Dimensions, (A) Top View, (B) Back View, (C) Wall Mount Holes, (D) Bottom View, (E) Floor Mount Holes, and (F) Side View (units are in mm)
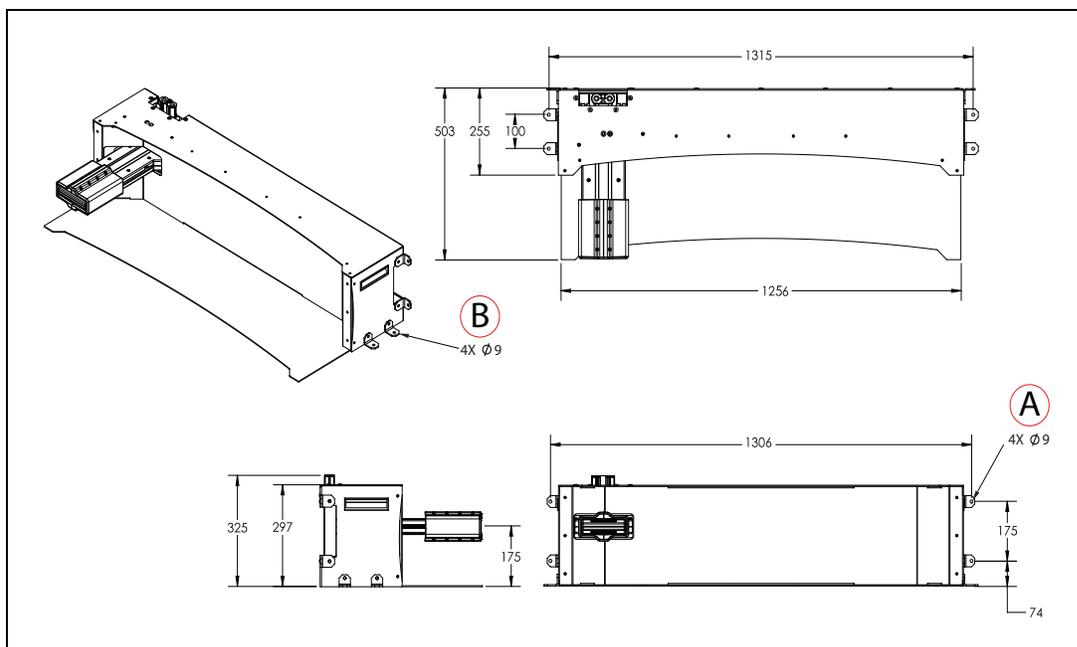
Figure 10-4. Docking Target Dimensions, (A) Wall Mount Brackets, and (B) Floor Mount Brackets (units are in mm)

10.2 HD-1500 Platform Specifications

Physical

HD-1500 Platform

Description	Specification
Length	1696 mm
Width	1195 mm
Height (body)	370 mm
Vehicle weight (without battery)	516 kg
Vehicle weight (with the battery)	584 kg
Humidity	5% to 95%, non-condensing
Storage and transportation humidity	5% to 95%, non-condensing
Operating temperature	5 to 40°C
Storage and transportation temperature	-20 to 60°C
Rating	
IP Rating	IP20
Cleanroom rating	No Cleanroom rating
Pendant IP rating	IP40

HD-1500 Drive Train

Description	Specification
Drive wheels	(2) ESD drive wheels, Cast Iron
Drive wheel dimensions	250 mm-dia. x 80 mm
Drive wheel motor	(2) 1500W PMS servo motor
Casters	(2) front, (2) rear, Polyurethane, Cast Iron
Caster dimensions	203.2 mm dia. x 120.65 mm
Brakes	195 N.m Holding Brake, 24 VDC
Steering	Differential

Performance

Description	Specification
Platform	
Max payload capacity	1500 kg
Swing radius	982 mm
Turn radius	0
Translational speed, max	1800 mm/s
Translational Acceleration, max	900 mm/s/s
Translational Deceleration, max	1300 mm/s/s
Rotational speed, max	60°/s
Rotational Accel/Decel, max	150°/s/s
Stop position repeatability	±50 mm for position, ±2° for rotation
-with the HAPS (option)	±10 mm for position, ±0.5° for rotation
Precision Drive Stop position repeatability	±50 mm
Traversable step, max	15 mm
Traversable gap, max	20 mm
Traversable terrain	Generally wheelchair accessible
Grade, max	Level surfaces
Minimum floor flatness	F_F25 (based on the ACI 117 standard)
NOTE: ACI 117 is the American Concrete Institute's standard for concrete floors. F_F is flatness, F_L is the level. Higher F_F numbers represent flatter floors. F_F 25 is a fairly lenient specification.	
Minimum floor levelness	F_L25 (based on the ACI 117 standard)
Minimum floor weight rating	2.1 MPa
Battery	
Run-time	with full payload: 9 hours, approx.
	with no payload: 12.5 hours, approx.
Duty cycle (depth of discharge)	80%
Weight	68 kg
Voltage	44-57VDC (52.8 VDC nominal)

Description	Specification
Capacity	70 Ah nominal
Energy	3.7 kWh nominal
Recharge time	40 minutes (from empty to full)
Life span	Approximately 9000 Cycle

Sensors

Description	Specification
Sensors	
Safety Scanning Laser	(2) at front and rear of platform (opposite corners) 175 mm above floor 270°, 15 m range, Class 1, eye-safe PLd Safety per ISO 13849-1
Side Lasers (option)	(2) at front and rear of the platform (opposite corners) factory-mounted, user-adjustable
Low Laser	(2) at front and rear of the platform (opposite corners). Both are installed below the Safety Scanning Laser. factory-mounted
Position encoders	(2) encoders (one each drive wheel) (2) Bearing sensors (one each drive wheel)

10.3 HD-1500 Charging Station Specifications

Power Supply Box Specifications

Description	Specification
Input current, max	25 A
Output current	120 A (nominal) Fused at 150 A
Input voltage	3 phase power 200-240 VAC, 50/60 Hz - Delta/Wye 380-415 VAC, 50/60 Hz - Wye
Output voltage	40-57 VDC
Power consumption	7.75 kW
Max output power	6.84 kW
Input protection method	25 A branch-rated circuit breaker

Description	Specification
Short circuit current rating (SCCR)	5 kA
Humidity	5% to 95%, non-condensing
Storage and transportation humidity	5% to 95%, non-condensing
Operating temperature	5 to 40°C
Storage and transportation temperature	-20 to 60°C
IP Rating	IP20
Dimensions - WxDxH	792 x 327 x 1065 mm
Weight	105 kg
Mounting	Mounting brackets, directly to floor
Connector	For connecting to the docking target and also out-of-platform battery charging
Lifting Location	Lifting eye bolts located on top of the power supply box

Docking Target Specifications

Description	Specification
Humidity	5% to 95%, non-condensing
Temperature	5 to 40°C
Dimensions - WxDxH with mounting brackets	1346 x 503 x 297 mm
Weight	39 kg
Material	Mild steel
Mounting	Mounting brackets (part number 68910-105), directly to floor or wall
Lifting Location	Lifting recesses on the right and left side of the docking target
IP Rating	IP20

Chapter 11: HD-1500 Default Safety Zones

This chapter describes the HD-1500 default safety zones.

Your HD-1500's safety scanning lasers (OS32C safety lasers) are pre-programmed with safety zones sized for the shape and dynamics of the platform.

11.1 Default Safety Zones

Each safety scanning laser has 70 safety zones (1-70). When the safety zones of the two safety scanning lasers overlap, they create 41 safety zone pairs. With each safety scanning laser covering 270° FOV, the combination offers a full safety coverage of 360°.

The safety zone pairs displayed in this section were created using a fully loaded HD-1500, and tested on a concrete floor with the coefficient of friction of 0.6. The individual zones are identical for both safety scanning lasers, and the AMR is equally protected when driving forward or in reverse.

> **NOTE:** The same safety zones are used when driving the AMR manually with the pendant or when the AMR is operating autonomously.

The following figures display the 41 safety zone pairs:
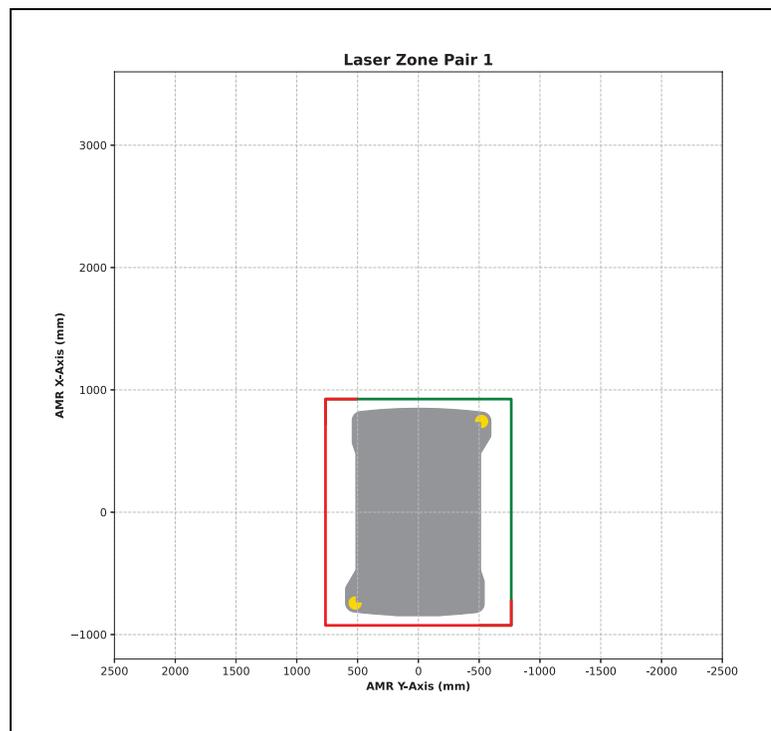
Figure 11-1. Laser Zone Pair 1
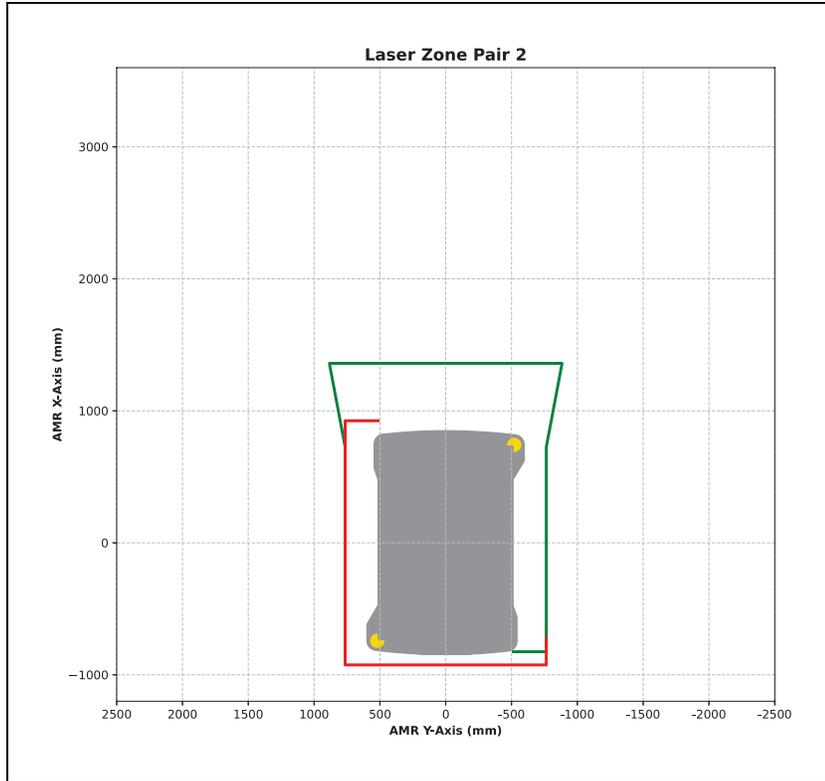
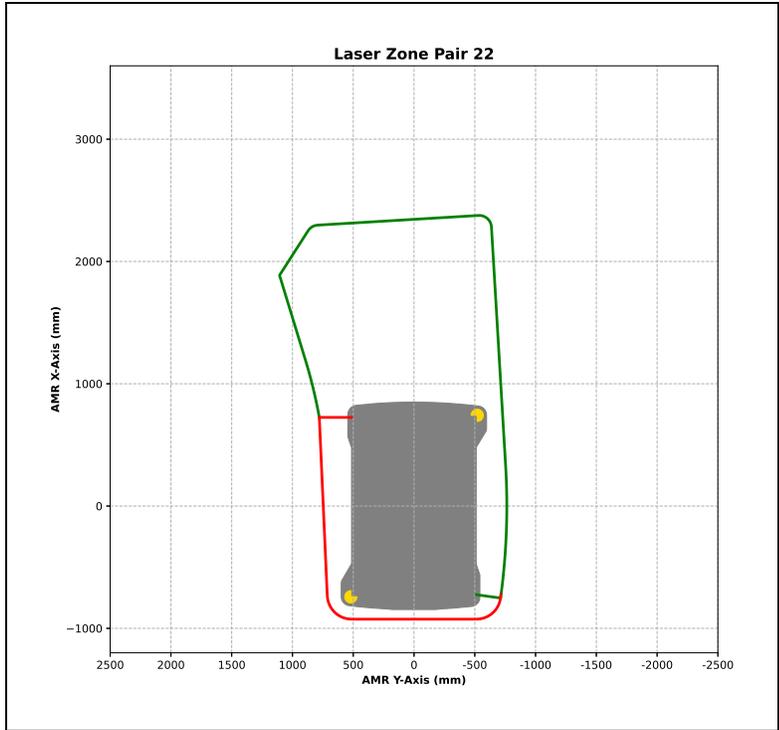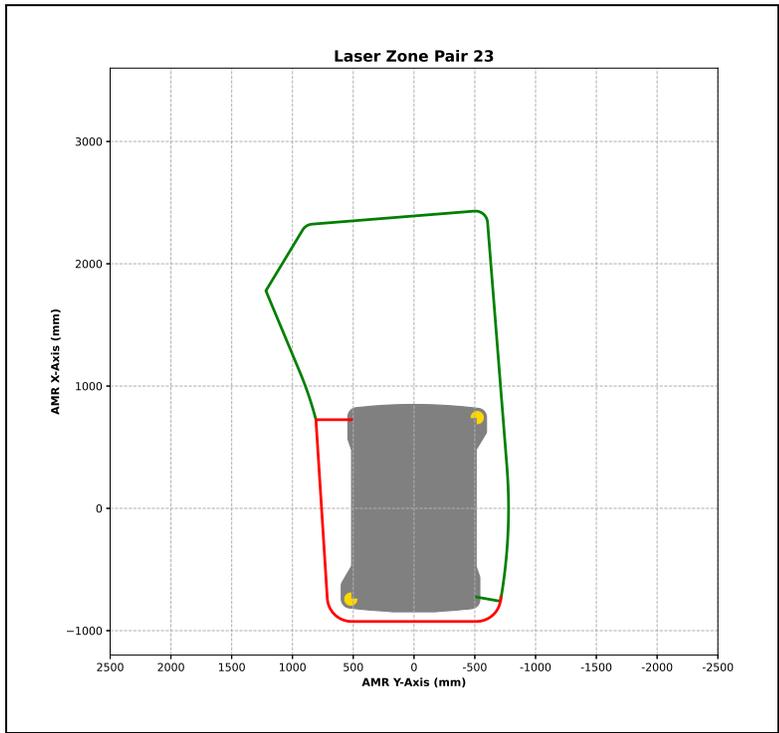*Figure 11-2. Laser Zone Pair 2*
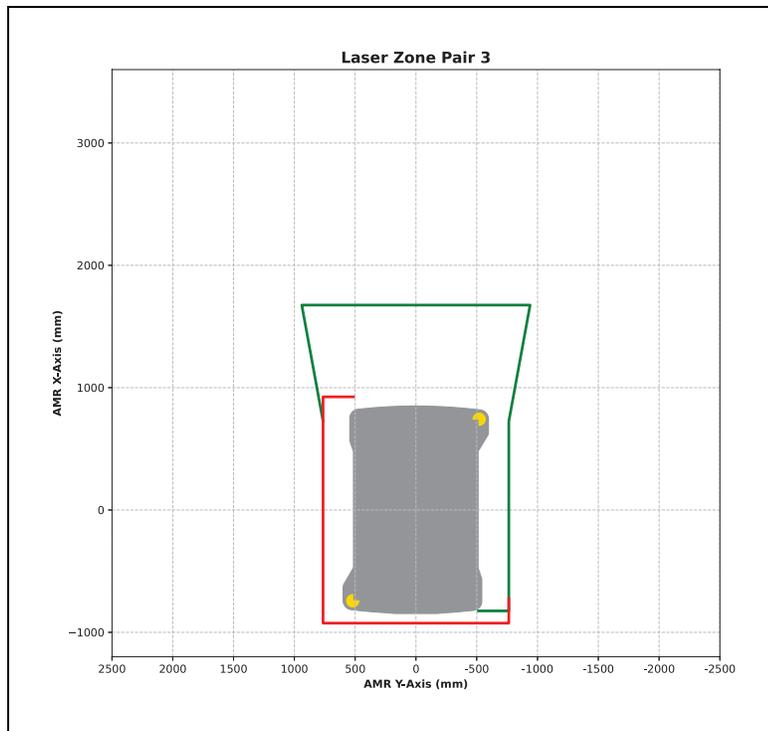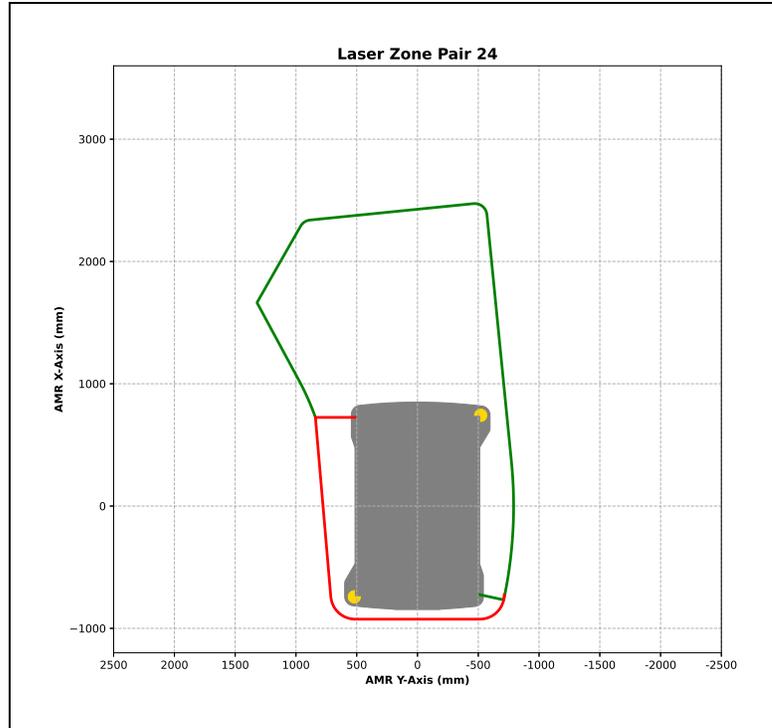

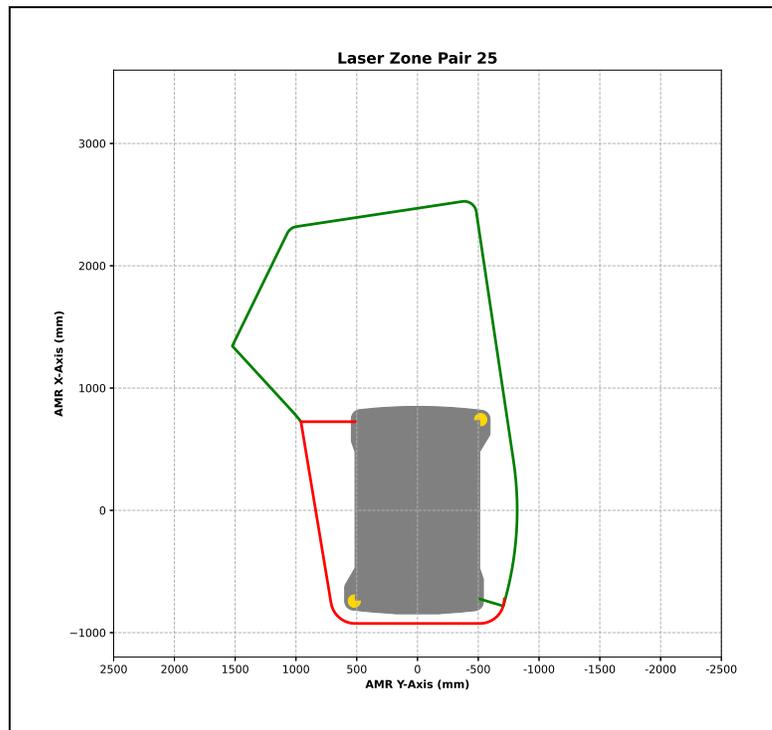*Figure 11-3. Laser Zone Pair 3*
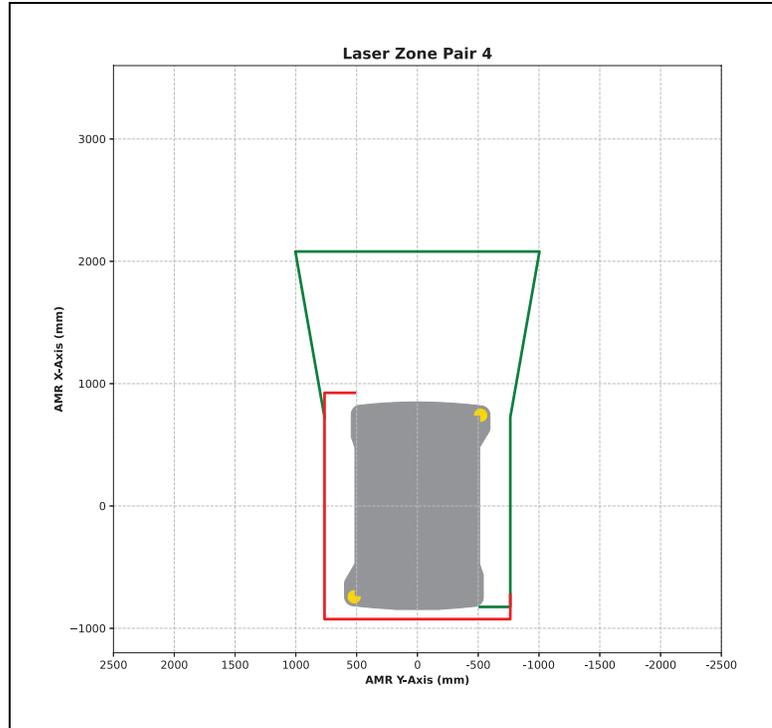
Figure 11-4. Laser Zone Pair 4
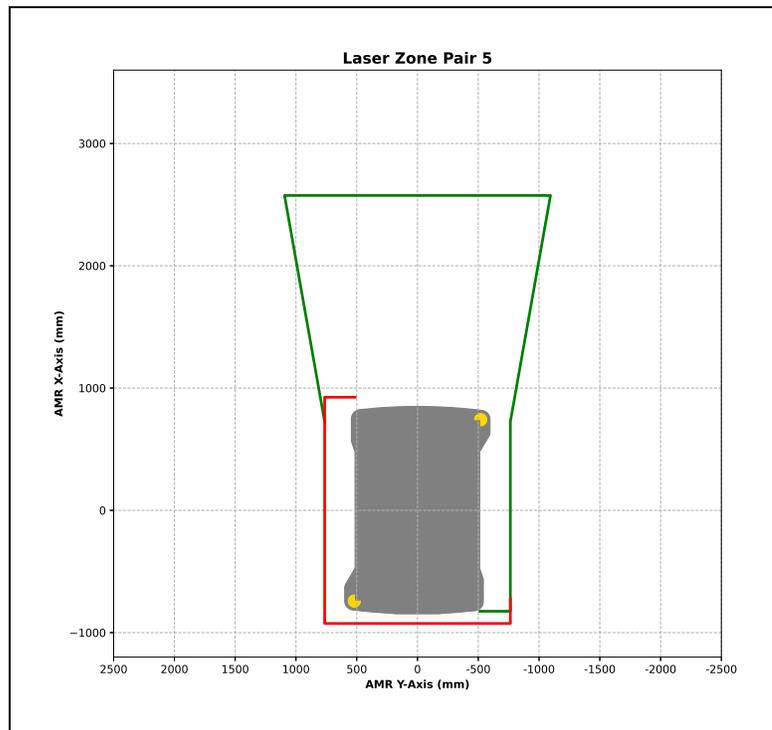
Figure 11-5. Laser Zone Pair 5
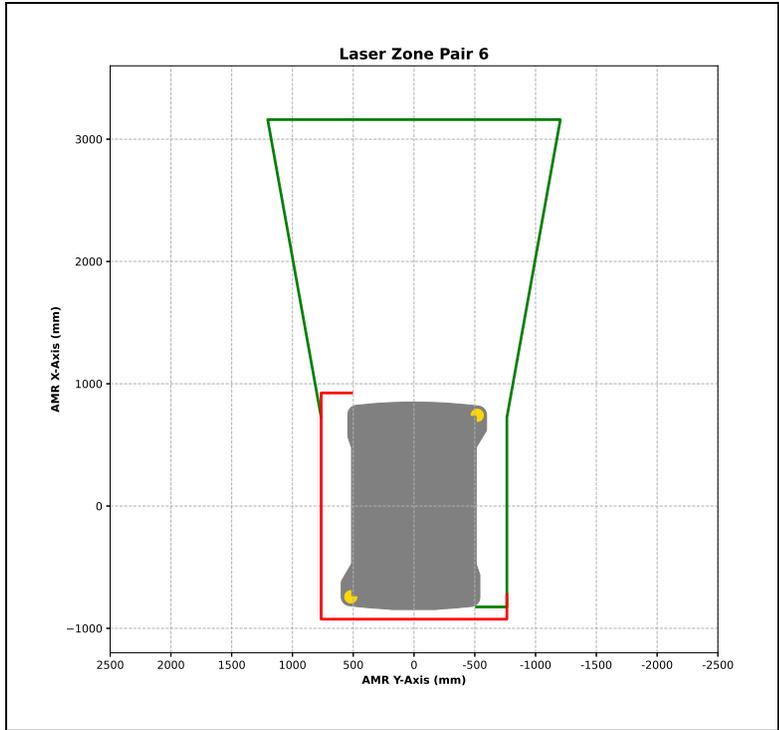
Figure 11-6. Laser Zone Pair 6
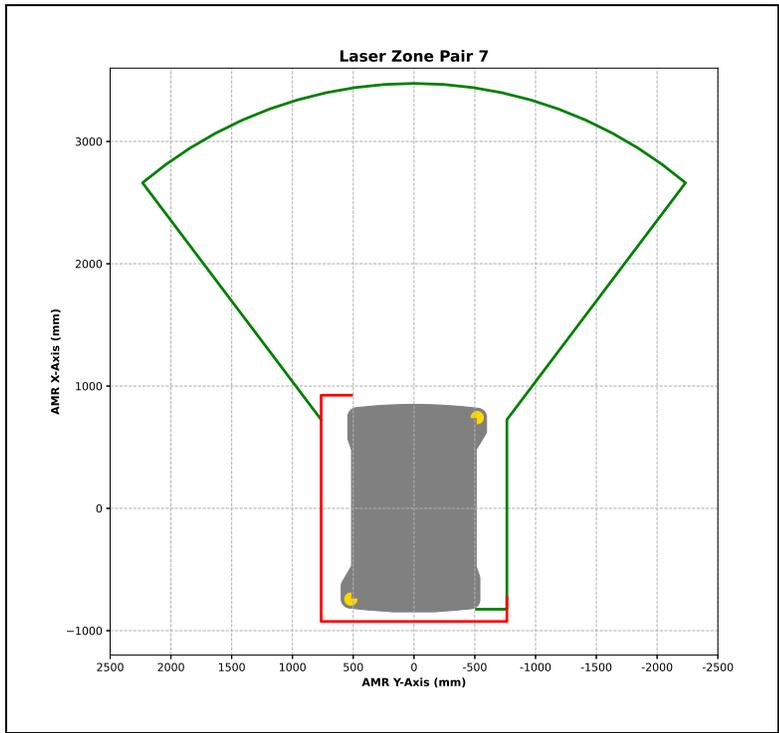
Figure 11-7. Laser Zone Pair 7
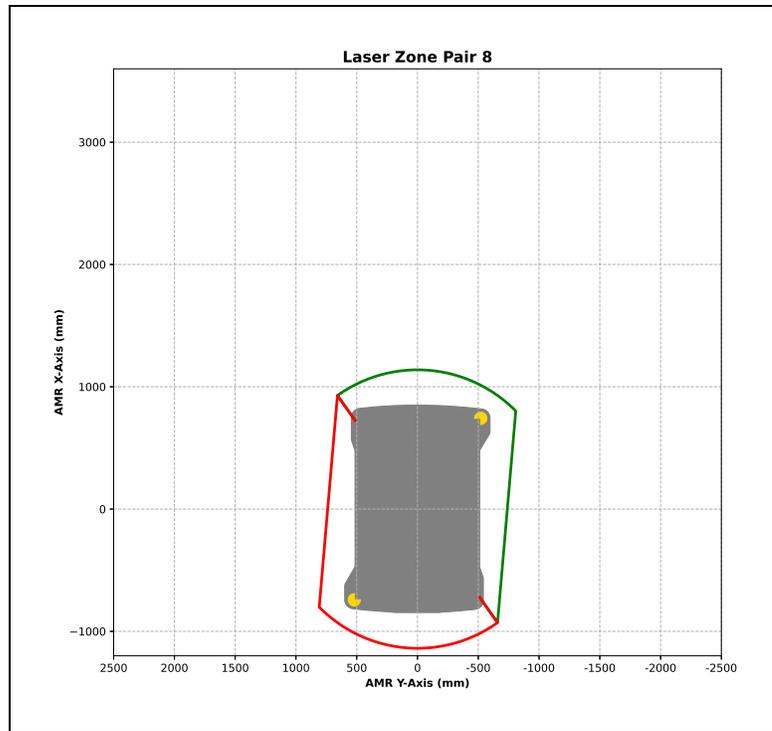
Figure 11-8. Laser Zone Pair 8
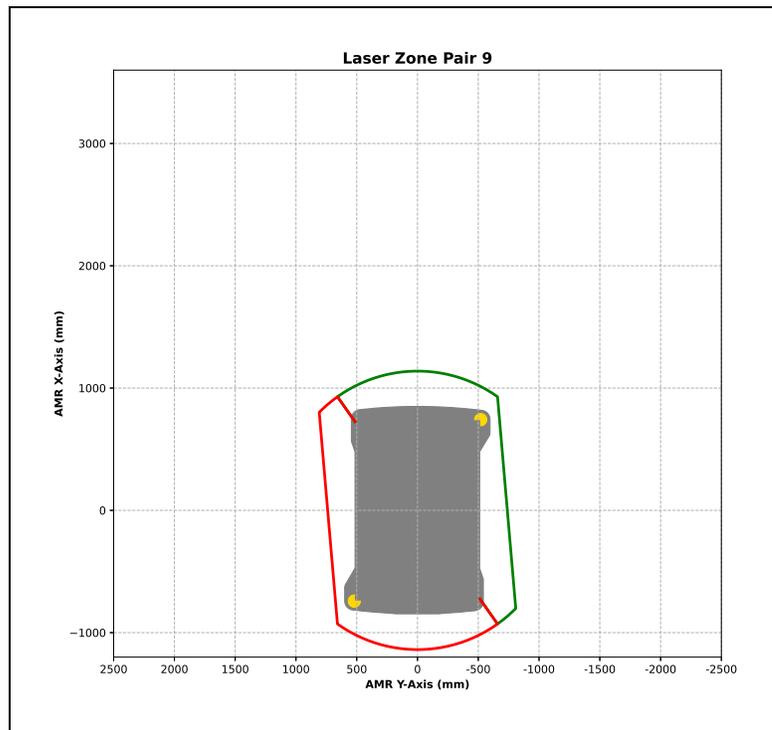
Figure 11-9. Laser Zone Pair 9
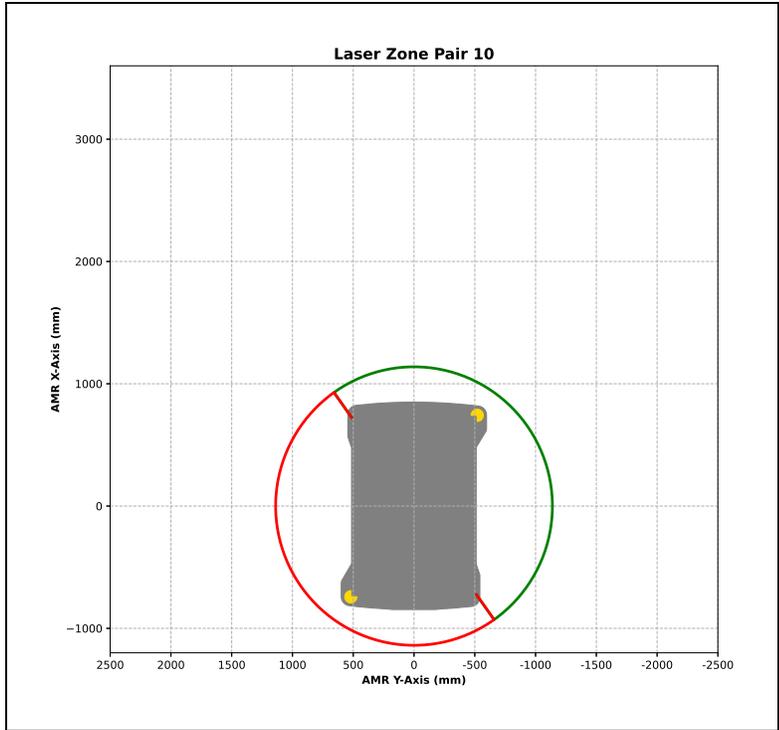
Figure 11-10. Laser Zone Pair 10
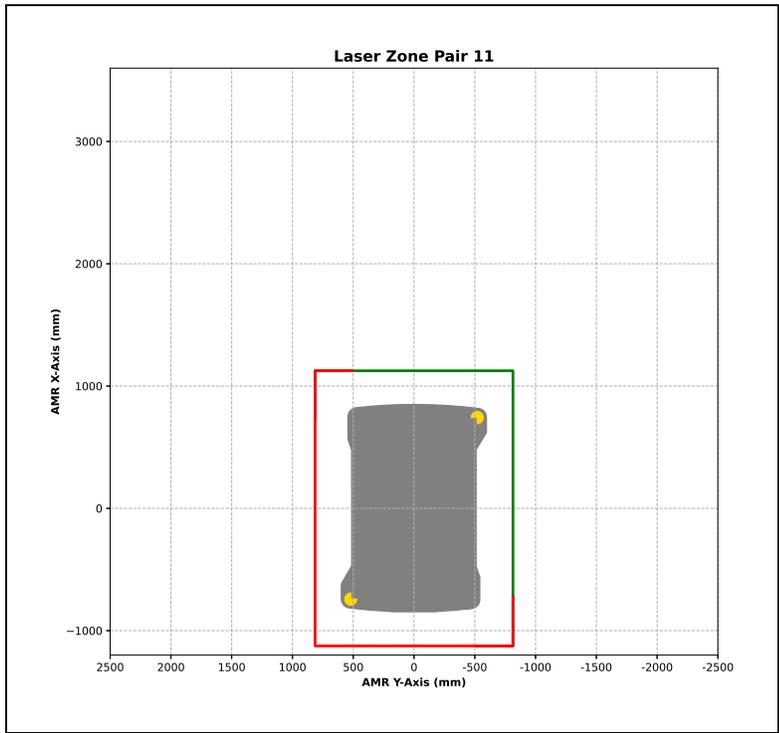
Figure 11-11. Laser Zone Pair 11
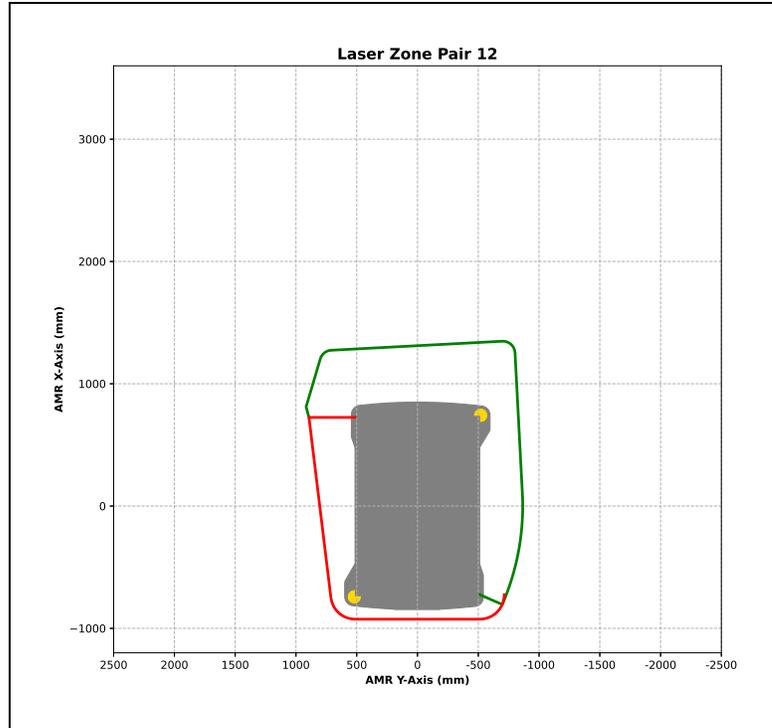
Figure 11-12. Laser Zone Pair 12
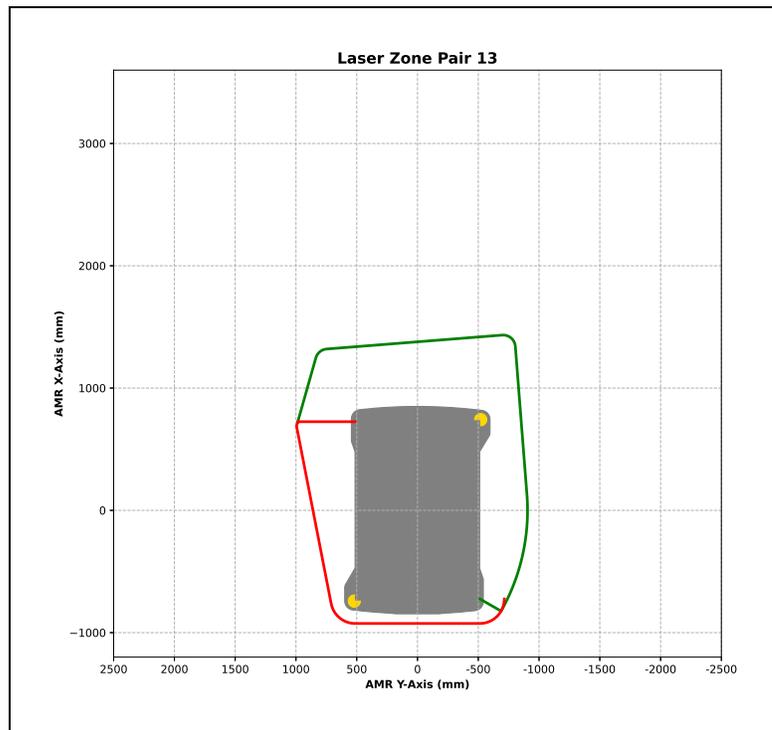
Figure 11-13. Laser Zone Pair 13

Figure 11-14. Laser Zone Pair 14
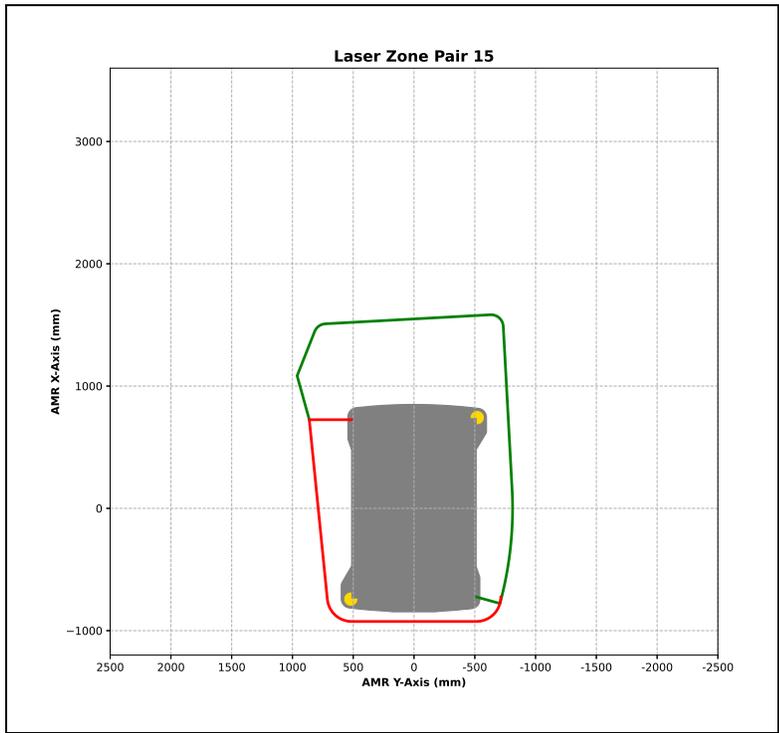
Figure 11-15. Laser Zone Pair 15
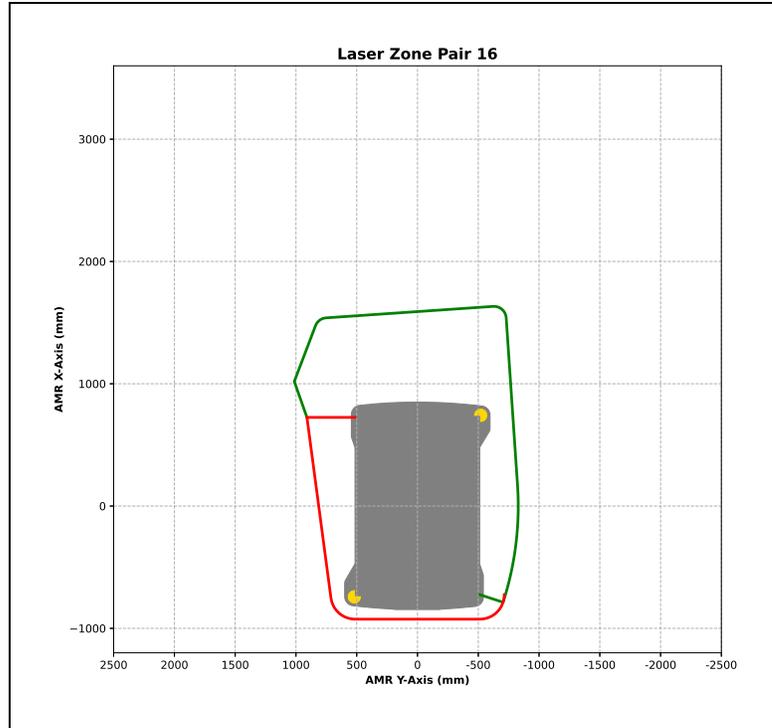
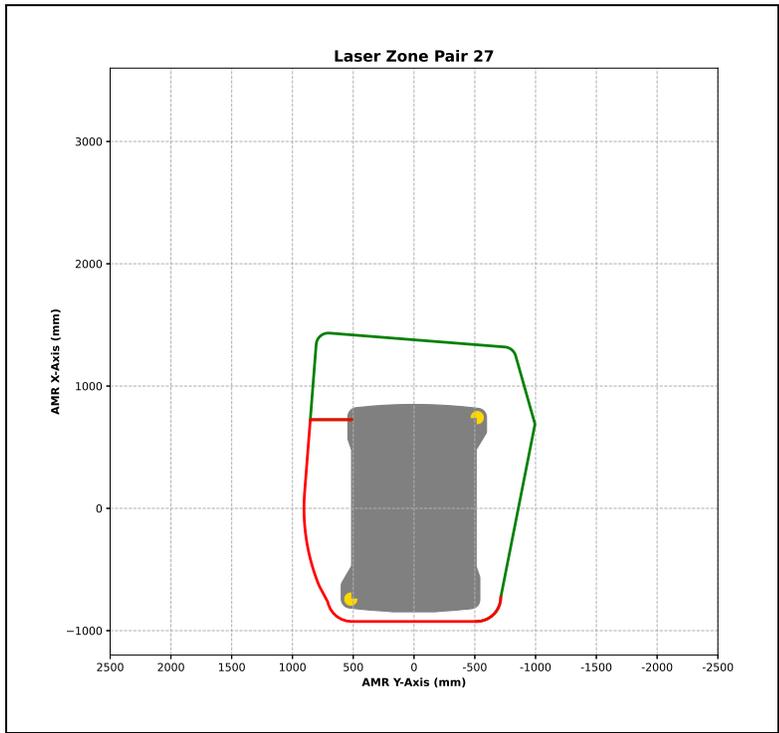*Figure 11-16. Laser Zone Pair 16*
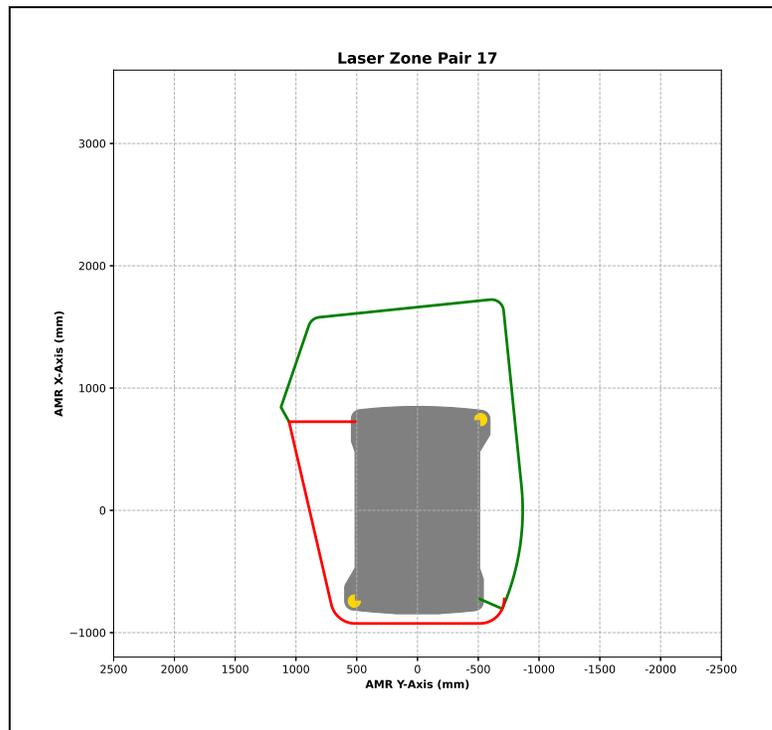
Figure 11-17. Laser Zone Pair 17

Figure 11-18. Laser Zone Pair 18
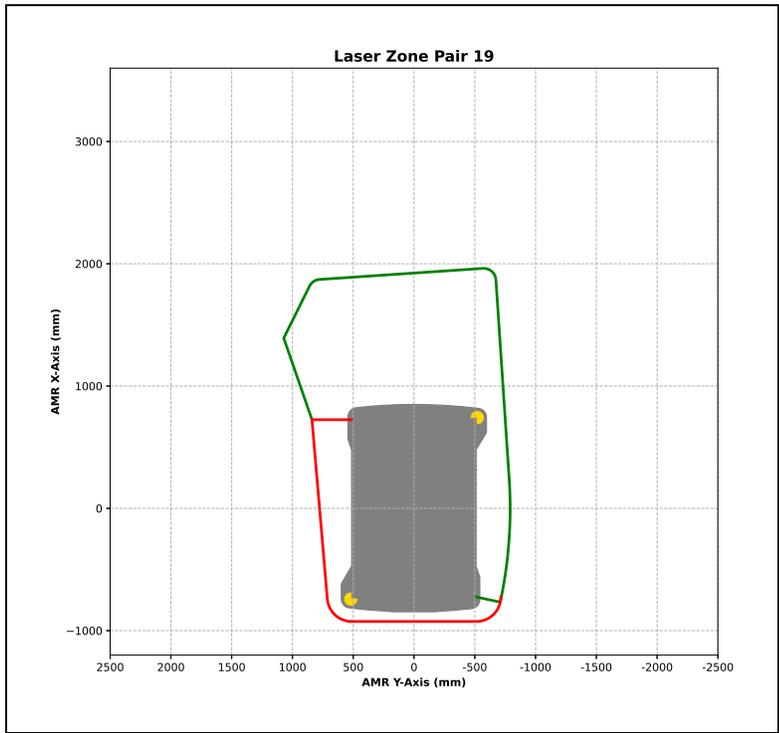
Figure 11-19. Laser Zone Pair 19
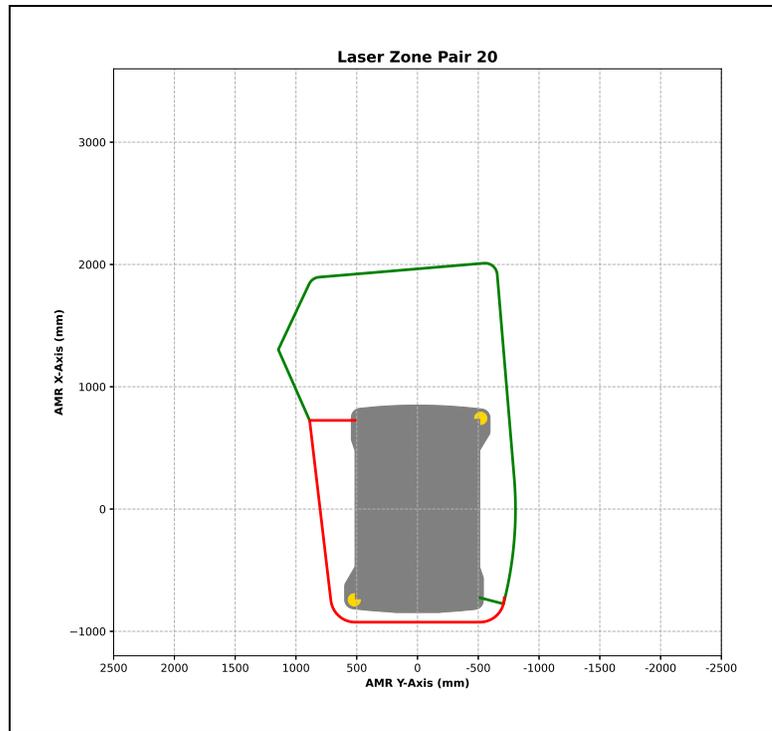
Figure 11-20. Laser Zone Pair 20
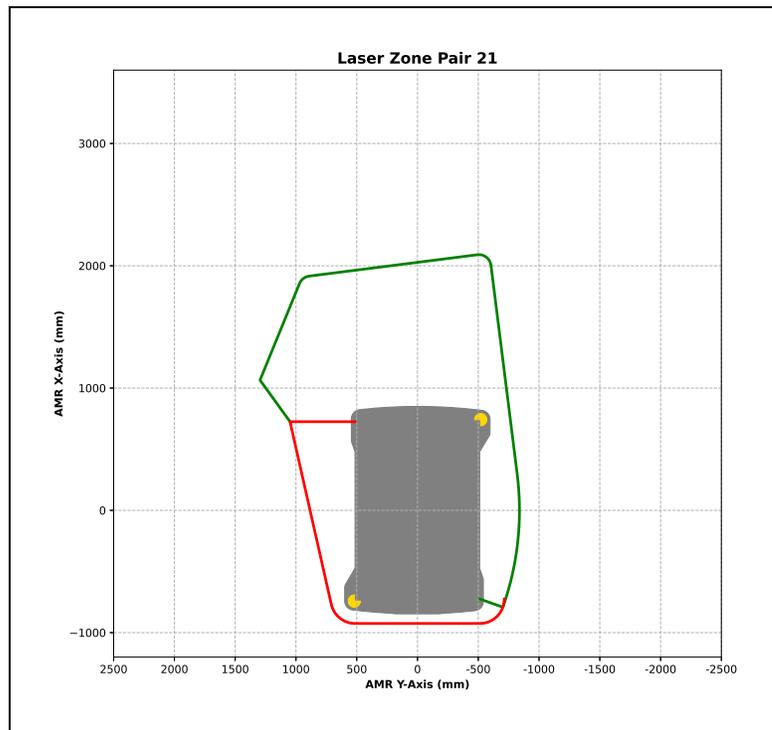
Figure 11-21. Laser Zone Pair 21

Figure 11-22. Laser Zone Pair 22

Figure 11-23. Laser Zone Pair 23

Figure 11-24. Laser Zone Pair 24

Figure 11-25. Laser Zone Pair 25

Figure 11-26. Laser Zone Pair 26
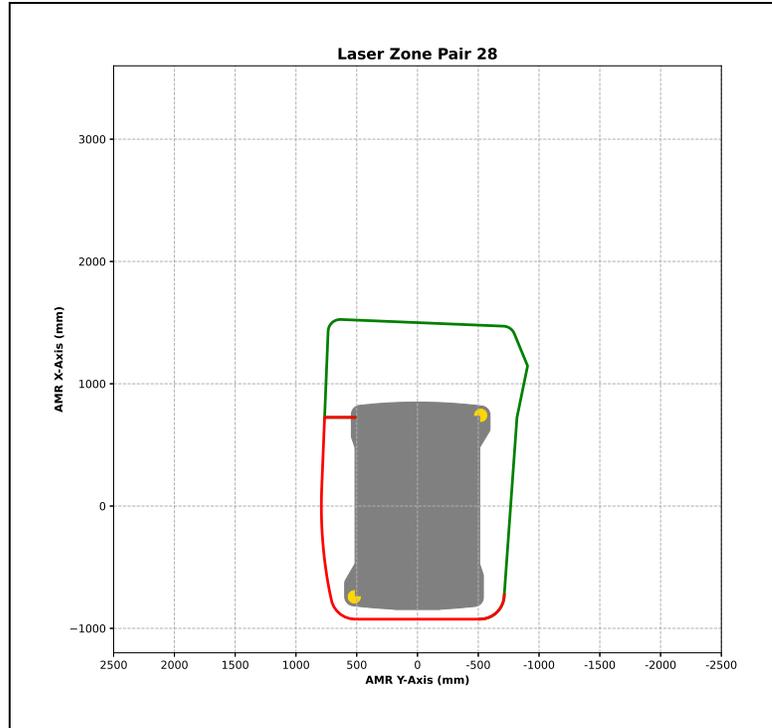

Figure 11-27. Laser Zone Pair 27
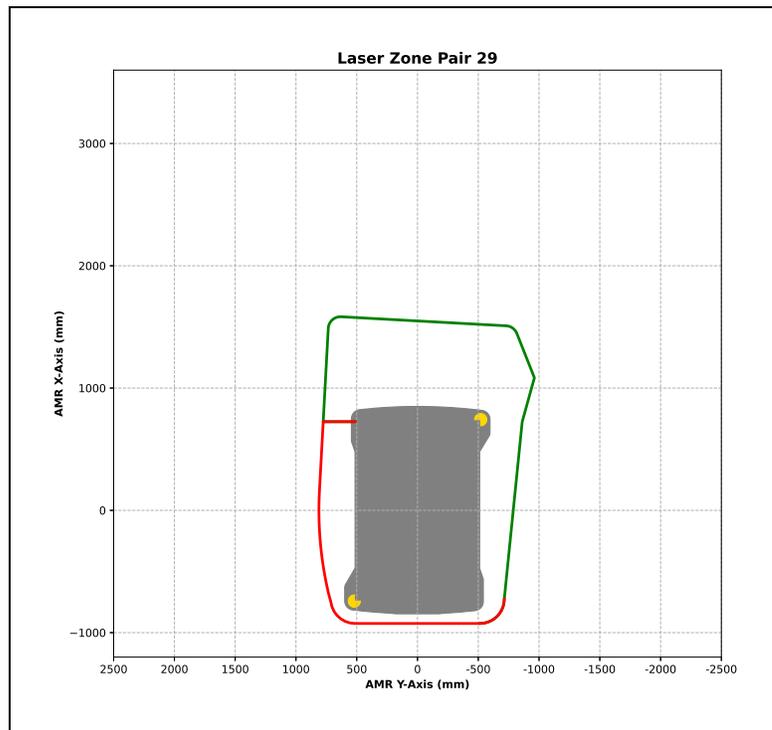
Figure 11-28. Laser Zone Pair 28

Figure 11-29. Laser Zone Pair 29

Figure 11-30. Laser Zone Pair 30

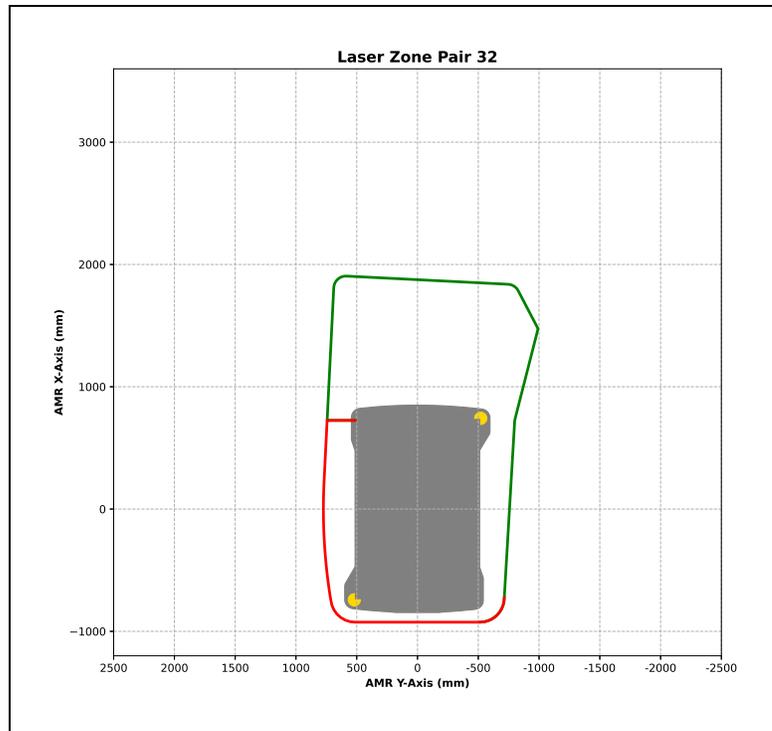*Figure 11-31. Laser Zone Pair 31*
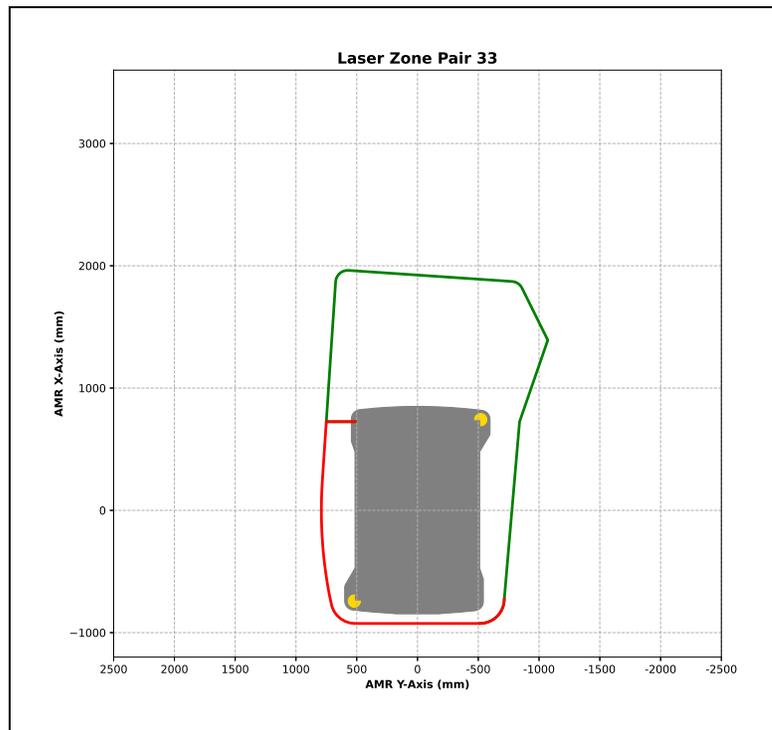
Figure 11-32. Laser Zone Pair 32

Figure 11-33. Laser Zone Pair 33
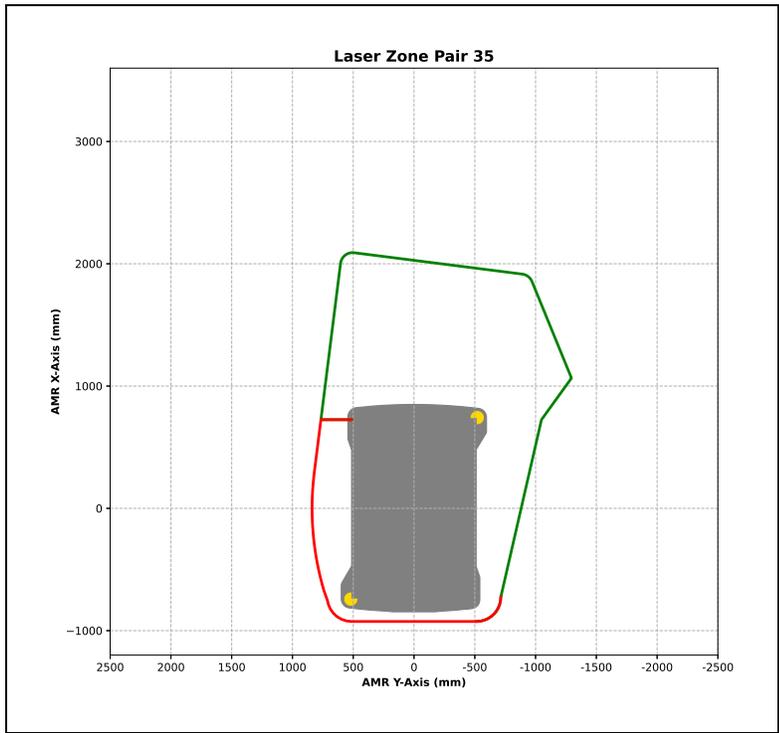
Figure 11-34. Laser Zone Pair 34

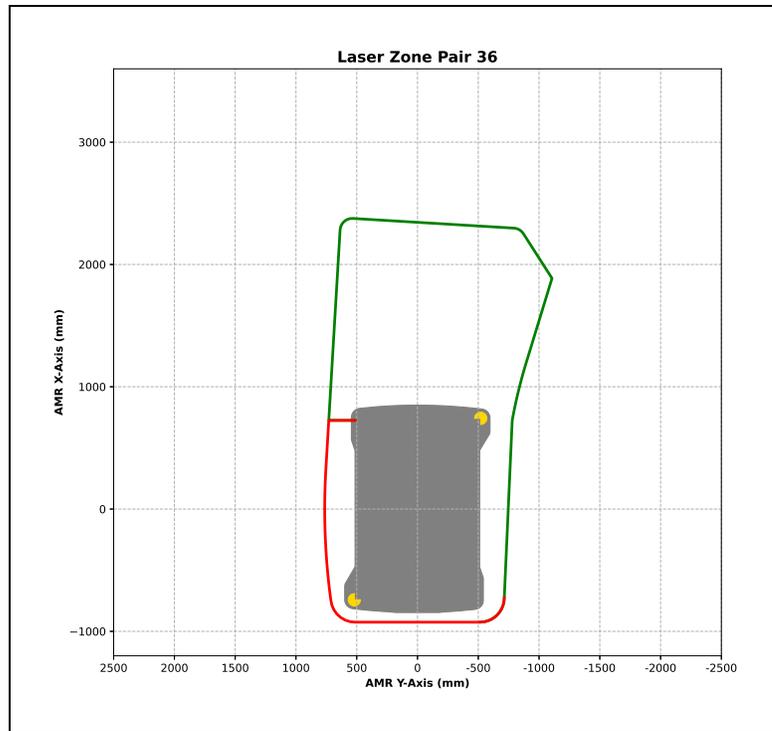*Figure 11-35. Laser Zone Pair 35*

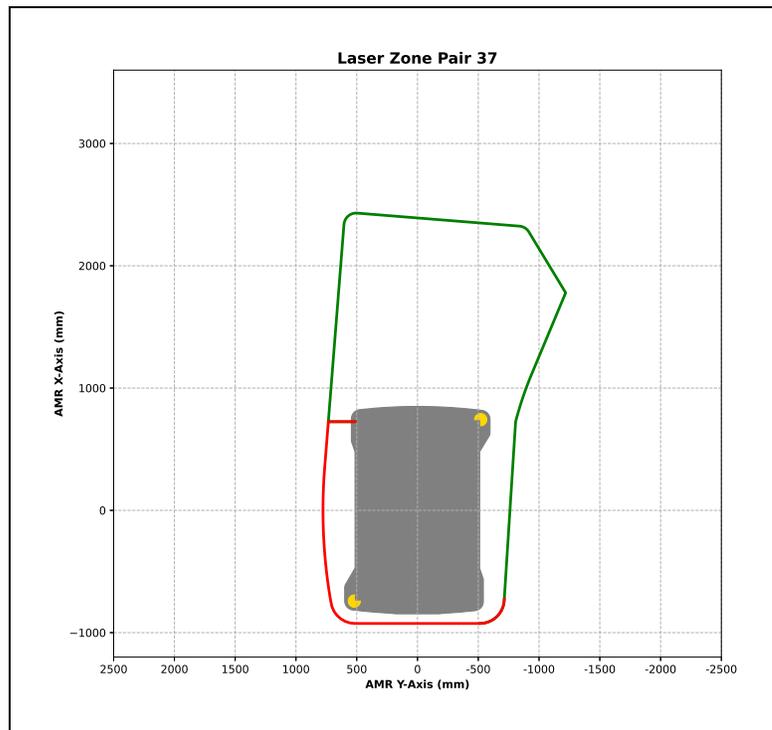*Figure 11-36. Laser Zone Pair 36*

Figure 11-37. Laser Zone Pair 37
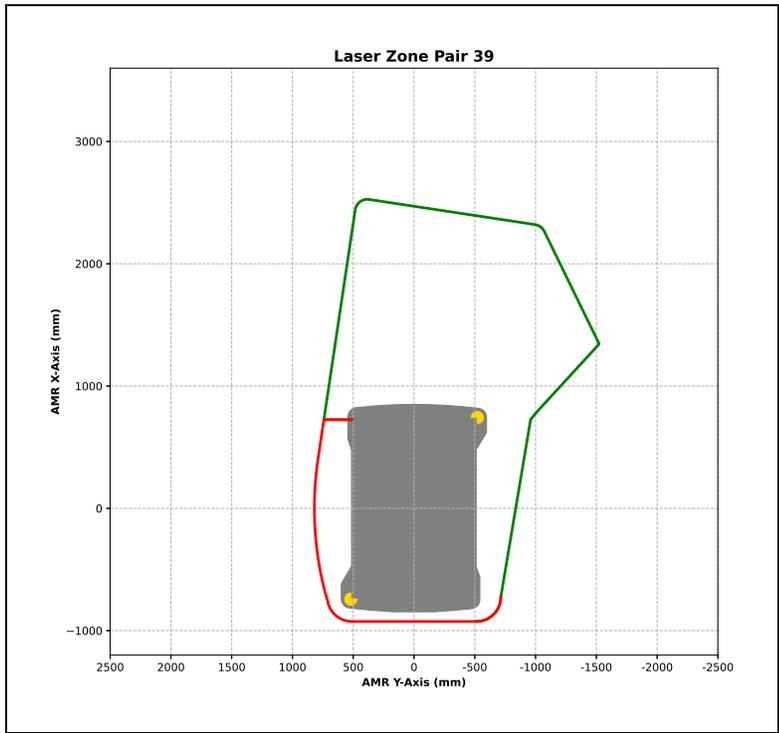
Figure 11-38. Laser Zone Pair 38

Figure 11-39. Laser Zone Pair 39

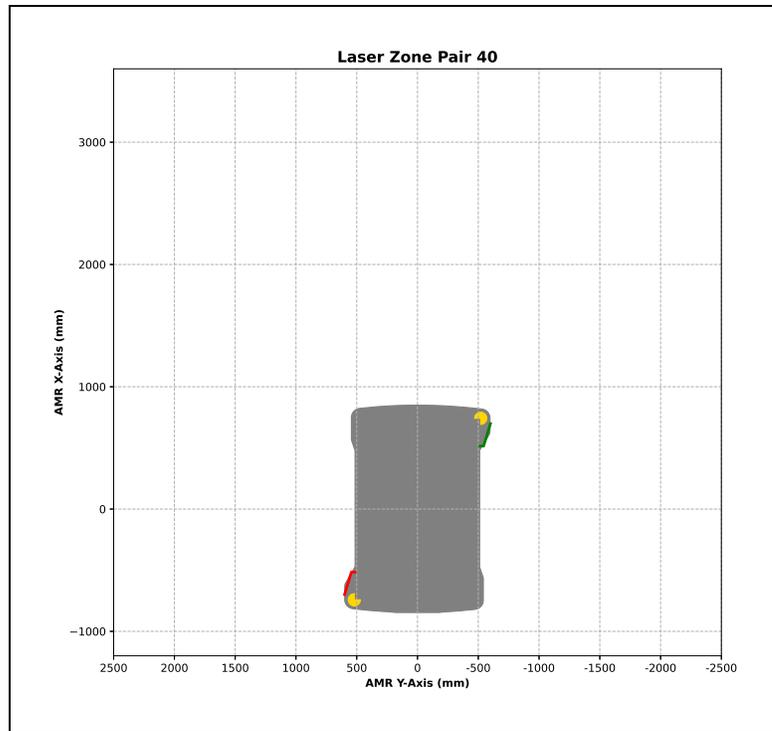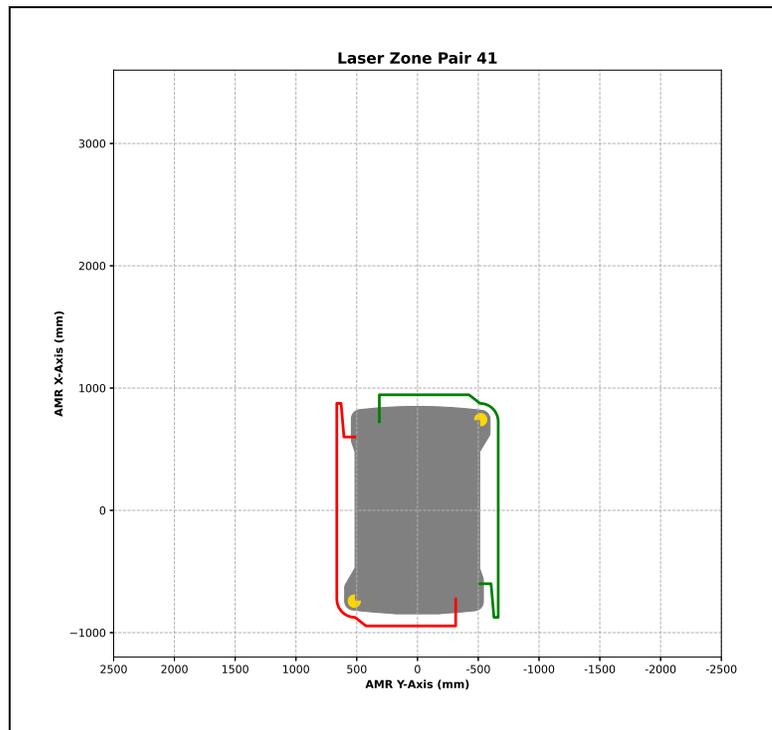*Figure 11-40. Laser Zone Pair 40*

Figure 11-41. Laser Zone Pair 41

Table 11-1. Translational and Rotational Velocity for Each Safety Zone Pair

RotVel (deg/s) → / TransVel (mm/s) ↓	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
20	40	41			8, 9						10									
115																				
275	1				11															
580	2				11			12, 26		13, 27				7						
890	3				14, 28		15, 29		16, 30	17, 31										
1228	4				18, 32		19, 33		20, 34	21, 35										
1530	5				22, 36		23, 37		24, 38	25, 39										
1800	6				7															

Special Zone Pairs

Zone pairs 7, 8, 9, 10, and 41 are used in special conditions:

- Zone pair 7 is used for protection from over-speed conditions, and will not be applied during normal operation of the AMR.

- Zone pairs 8, 9, and 10 are applied when the AMR is rotating in place.

- Zone pair 41 is applied at speeds below 20 mm/s and 3 deg/s. The purpose of this zone is to allow the AMR to be driven away from obstacles that have come to close to the AMR. The AMR will sound its buzzers when using this zone for 2 seconds or longer.

Chapter 12: Glossary

This glossary contains terms found in this manual, as well as general terms associated with robotics.

Term	Definition
802.11a, b, g, n, ac	A standard for wireless local area networks (WLAN) in the 2.4 GHz and 5 GHz frequency bands.
AMR	Autonomous Mobile Robot
AMR Controller	An IPC that runs the SetNetGo operating system, ARAM software, and Polo firmware.
ambient operating temperature	The temperature range of the AMR's environment in which continued operation is possible.
amplifier	The component that provides the power needed to drive the mobile robot motors.
ARAM	Advanced Robotics Automation Management. The software that performs all of the high-level, autonomous robotics functions, including obstacle avoidance, path planning, localization, and navigation.
ARAMCentral	The software running on the Enterprise Manager appliance. Manages the AMRs' map, configuration and traffic control, including multi-AMR avoidance, destination, standby, and docking.
ARCL	Advanced Robotics Command Language. A simple, text-based, command-and-response operating language. Used with the optional EM2100 appliance, ARCL can help manage a fleet of mobile robots.
Auto-MDIX	A connection port feature that automatically detects the Ethernet cable type being used (straight-through or crossover) and configures the connection appropriately.
balance (battery)	The charging procedure that equalizes each cell in the battery to increase the life span of a battery. The HD-1500's battery pack automatically performs this procedure at the end of a complete charge cycle.
beacon	An optional indicator lamp, mounted on the AMR to provide extra signaling.
brake release	A function that releases the AMR's motor brakes to allow manual positioning of the AMR.
Call/Door Box	A button or switch that allows an AMR to be requested from a remote location, or that enables the system to control an automated door so the AMR can pass through it.

Term	Definition
CAN bus	Controller Area Network. A serial communications protocol that allows electronic control units and devices to communicate with each other.
CAT5	Category 5 Ethernet cable
CG	Center of Gravity
debuginfo file	A zip file downloaded from SetNetGo that contains detailed information about the status of the system, used by Omron engineers for troubleshooting.
dongle	A small hardware device that contains the credentials (e.g., license key) required to run a specific program. A dongle is also used in each AMR Controller to enable the use of the ARAM software. A dongle is required to use the ACE software.
DROPOFF	A job segment typically used where an AMR's payload is transferred from the robot to the goal. See "PICKUP".
E-Stop	Emergency stop
emergency stop	A function that overrides an AMR's controls, and brings it to an immediate stop. After motion has stopped, the power is removed from the AMR's motors, and the motor brakes are engaged. This term also refers to the E-stop buttons that initiate this function. An emergency stop (E-Stop) button is typically a red push-button on a yellow background.
encoder	A device on each wheel of the mobile robot that tells the navigation system how fast, and in what direction, the wheel has turned.
EM2100	A network appliance that acts as a Fleet Manager.
Ethernet	A type of computer network used in local area networks (LANs). Typically uses a Category 5 (CAT5) or (CAT6) Ethernet cable; supports data speeds up to 100 Mbps.
fleet	Two or more mobile robots operating in the same area, governed by the same Enterprise Manager.
FM	Fleet Manager
Fleet Manager	The operational mode of the computing appliance (EM2100 appliance) that runs the FLOW Core software to control a fleet of AMRs.
Fleet Operations Workspace (FLOW)	A computing system that consists of software and hardware packages, and is used to set up, integrate and manage a fleet of AMRs within a factory environment.
forbidden (lines, areas)	The lines or areas (on an AMR's map) which the AMR is not permitted to drive or enter through or into on its own.
Forbidden Area	Area (on an AMR's map) which the AMR is not permitted to drive or enter through or into on its own.

Term	Definition
gateway	An access point that joins two networks so devices on one network can communicate with devices on another network.
goal	A map-defined virtual destination for mobile robots (e.g., pickup or drop-off points).
GUI	Graphical User Interface
gyroscope	A device that measures rotational velocity. Assists with the navigation of the AMR.
HAPS	High Accuracy Positioning System. Uses a sensor on the underside of the AMR to detect magnetic tape placed at locations, such as at a stationary conveyor, where you want the AMR to achieve particularly accurate positioning.
heading	The direction that the robot is facing.
I/O	Input/Output
Instructed persons	Persons that are adequately advised or supervised by skilled persons to enable them to avoid electrical and mechanical dangers.
Interlock	A mechanical or electrical device intended to prevent machines from operating unless certain conditions are met.
IP	Internet Protocol. A set of communication standards for transmitting data between networked devices. An IP address is a computer's unique internet "address" that allows the user to identify each device in the network.
IPC	Industrial Personal Computer.
IPXX	Ingress Protection. A rating given to electrical enclosures that defines the level of protection provided against the intrusion of solid objects, dust, and water. The first 'X' is a number between 1 and 7 that identifies the level of protection against solid objects (dust, tools, etc.). The second 'X' is a number between 1 and 9 that identifies the level of protection against moisture. The higher the rating, the greater the level of protection.
IMU	A sensor that measures, and reports linear acceleration, angular rate, and orientation using a combination of accelerometers, gyroscopes, and magnetometers.
job	An activity typically consisting of one or two segments which instruct the AMR to drive to a goal for material pickup or drop-off.
jumper	A short length of conductor that connects two points in an electrical circuit, often used to bypass optional safety devices.
keyswitch	A switch on the operator panel that can be toggled by turning a key. When in the locked position, disables the OFF button.
LD Platform Cart Transporter	An AMR designed to attach to movable carts and transport them from a pickup location to a drop off location.

Term	Definition
LD-series AMR	A self-navigating and self-charging AMR series, capable of moving payloads up to 250 kg, including models designed to move detachable carts.
light disc	The circular lights on the sides of the LD-series and HD-1500 platforms that indicate motion, turns, and other robot states.
LIGHTS	See "beacon".
localization	The process by which mobile robots determine their location in their operating environment. Laser localization uses the robot's laser to scan its environment, which it compares to its internal environment map.
macro	In MobilePlanner, a virtual "container" with a series or sequence of nested tasks and/or goals. Similar to routes. You can use macros as many times as needed to perform the same sequence of discrete functions in different tasks.
map	A representation of the robot's environment within MobilePlanner that the robot uses for navigation.
MobilePlanner	The primary software application for programming mobile robot actions. Provides the tools for all major AMR activities, such as observing a fleet of AMRs, commanding individual AMRs to drive, creating and editing map files, goals, and tasks, and modifying AMR configurations.
MobilePlanner (Operator Mode)	The most basic version of MobilePlanner that has tools to monitor robots, robot statistics, and add jobs. Does not have tools to create or edit maps.
Operator Panel	A user interface for mobile robots that provides access to an E-Stop button, ON and OFF buttons, a brake release button, and a keyswitch.
path	The line on an AMR's map between its current position and its destination; an indication of the AMR's intended motion.
payload	Anything the mobile robot carries.
payload bay	The area between the platform and the payload structure.
payload structure	Anything that gets attached to the platform and interacts with the payload being transported.
pendant	A handheld, external input device for manually driving AMRs, primarily used for map creation. Connects to the AMR's pendant connection port.
PICKUP	A job segment where an AMR typically acquires a payload. See "DROPOFF".
platform	The base mobile robot (with or without payload) – includes chassis, drive train, suspension, wheels, battery, safety scanning laser, sonar, on-board core with gyroscope and software to navigate, interface connections for payload, and covers.

Term	Definition
Polo	Polo firmware controls the AMR motors, and computes and reports the robot's pose (X, Y, and heading) readings and other low-level operating conditions to ARAM.
pose	AnAMR's position (location and heading).
preferred (lines, directions)	The lines or directions you want the mobile robot to travel. These are map items that can be drawn on a map using MobilePlanner.
route	A "to do" list or series of tasks, goals, or macros for the mobile robot to follow.
RS-232	Recommended Standard 232. Standard for serial communication that provides full-duplex unbalanced-transfer communications using a multi-conductor cable.
safety commissioning	The testing and commissioning (verification of proper function) of a robot's on-board safety systems. Uses a wizard to test E-Stop (tests brake activation) and Safety Laser (tests max speed limits, and ensures proper functionality of each safety scanning laser's output signal switching device (OSSD) lines). Commissioning must be done by specially trained people.
SetNetGo	The software OS that resides on mobile robots and the optional Enterprise Manager appliance. Used to configure mobile robots' communication parameters, gather debuginfo files, and upgrade the mobile software suite. Accessed via the SetNetGo tab in MobilePlanner.
skilled persons	Persons that have the technical knowledge or sufficient experience to enable them to avoid electrical or mechanical dangers.
SNG	SetNetGo
SSID	Service Set IDentification - identifies a wireless LAN.
swing radius	When an AMR rotates in place, its swing radius is the distance from its center of rotation to the furthest point on its perimeter.
tasks	Instructions for the robot to perform certain actions like reading inputs, setting outputs, movement commands, talking, waiting, etc.
turn radius	The radius of the circle that the mobile robot will use when turning while moving forward.
wheel light	See "light disc".
wizard	A guide within the software user interface that assists the user in setting up the software program.

Authorized Distributor:

Printed in USA

Cat. No. I645-E-01   0720

31500-000 A