OMRON

LD-250 Platform

User's Guide

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Revision History

Revision Code	Date	Revised Content
1.0, Rev (A)	November 2019	Original Release.
2.0, Rev (B)	December 2019	• Added missing information. • Correction of errors.

Chapter 1: Introduction

This manual describes the setup, operation, and user maintenance of an LD-250 Autonomous Mobile Robot (AMR).

This manual does not describe all configuration steps that you perform using the software supplied with an LD-250. The *Fleet Operations Workspace Core User's Guide* describes configuration, operation, and use of the LD-250.

This manual provides the original instructions for using an LD-250.

1.1 Definitions

This document uses the following terms to describe the LD-250:

- **AMR** (Autonomous Mobile Robot)—This term describes the LD-250 with an attached **payload structure**, creating a complete **mobile robot**.
- **Fleet Manager**—A rack-mount computing appliance that you use to manage a fleet of AMRs. The appliance consists of the EM2100 appliance (EM2100) and the FLOW Core software.
- **Fleet**—Two or more AMRs operating in the same workspace.
- **LD-250**—This is the model name of the **platform**. This document uses the model name LD-250 when describing the setup, configuration, and connections.
- **Mobile Robot**—An alternate industry term for AMR.
- **Payload Structure**—Any passive or dynamic device attached to and possibly powered by the LD-250. This could be as simple as a crate for carrying objects such as factory parts or as complicated as a robotic arm that picks up and manipulates factory parts.
- **Platform**—The base LD-250, including:
    - The chassis, drive motors, suspension, wheels and light discs, casters, battery, lasers, and rear sensors.
    - An on-board LD-250 Core with a built-in gyroscope, navigation software, and data and power connectors for a **payload structure**.
    - An Operator panel otherwise known as the Human-Machine Interface (HMI).
    - The LD-250 skins (external covers) and a payload bay for attaching a **payload structure**.

1.2 Product Description

The LD-250 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 docking station. It has a maximum capacity of 250kg (551 lbs). Capacity includes the payload structure and any load carried by that structure.

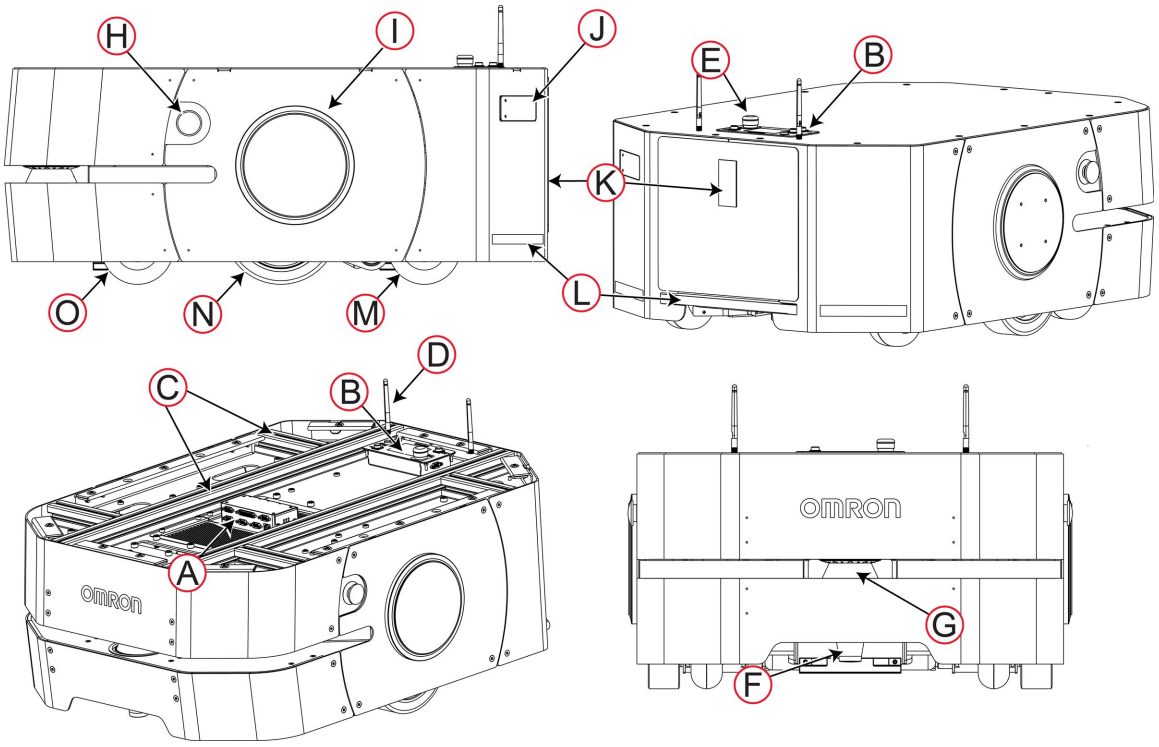


Figure 1-1 LD-250 Features.

Callout	Description	Callout	Description
A	LD-250 Core	**I**	Light discs (one each side)
B	Operator panel with E-Stop button	**J**	Joystick and communications panel
C	Payload attachment bars (X-profile)	**K**	Battery access panel and door
D	Dual wireless antenna	**L**	Rear Sensor
E	E-Stop button on the Operator Panel (HMI)	**M**	Rear caster (2)
F	Low front (toe) laser	**N**	Drive wheel (2)
G	Navigation and safety laser	**O**	Front caster (2)
H	E-Stop button (one each side)		

LD-250 Autonomous Navigation

The LD-250 combines hardware and mobile-robotics software to provide an adaptive, mobile platform to transport your payload. After it scans physical features in its environment, the LD-250 navigates safely and autonomously to any accessible destination. It moves continuously and without human intervention, autonomously recharging itself as necessary.

The LD-250 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:

- A low front or *toe* laser to detect objects below the plane of the main laser.
- A rear sensor that detects and stops the LD-250 if it senses objects close behind the AMR.
- A gyroscope in the LD-250 Core to detect and report LD-250 rotational velocity.
- An encoder on each drive motor that provides odometry data for the distance traveled by each drive wheel.

LD-250 Localization

Wheel encoders provide the navigation system with odometry information (how far each wheel has traveled, and in which direction.) In addition, the LD-250 Core contains an internal gyroscope to track the LD-250's rotational velocity.

The LD-250 analyzes this odometry data together with LIDAR data from its navigation laser to calculate its position. This process is called *localization*.

Acuity Localization Option

For dynamic work environments that are difficult for laser localization, Omron offers Acuity Localization. Acuity Localization uses a camera to detect overhead lights, enabling the AMR to localize itself in environments where laser localization alone is not an optimal solution. Laser localization is tolerant of changing environments. However, it becomes difficult if changing features exceed 80% of the objects detected by the laser. This includes workspaces such as warehouses, where objects such as shipping pallets or rolling carts either change locations often, or block the laser's view of mapped features. Acuity is also useful when wide-open spaces do not provide enough features to map for laser localization.

The *LD Platform Peripherals User's Guide* describes how to install and configure the Acuity option.

Custom Payload Structures

LD-250 users typically add attachments (a payload structure) to the LD-250 base platform to customize it for use in specific applications. The LD-250 provides a payload bay that includes aluminum extruded load bars. T-slots in the load bars provide a strong and adaptable method of attaching payload structures to the Platform.

A payload structure can be as simple as a crate that contains manufacturing parts or a more complicated device such as a conveyor or robot arm. The LD-250 Core provides power, logic, data communication, and safety connections for the payload structure. This includes user connections for warning lights and additional lasers. For more information, see:

- *Payload Structures* on page 77 for information about designing a payload.
- *Connectivity* on page 93, for information about available user connectors on the LD-250 Core.

Chassis and Drive Train

Each LD-250 uses a two-wheel, differential-drive, with passive casters front and rear for balance. The drive-wheels have independent spring suspension, with solid, polyurethane tread. The wheel axles are located near its center line, making the LD-250 highly maneuverable and able to rotate in place.

You can disengage the drive wheels by turning a cam lever on the gearbox. This is required for some set up and maintenance operations. See: *Engage and Disengage the Drive Wheel Motors* on page 148.

CAUTION: BRAKES DISABLED. When the drive wheels are disengaged, the AMR brakes are inoperable. Take care when you move the LD-250 on inclined surfaces.

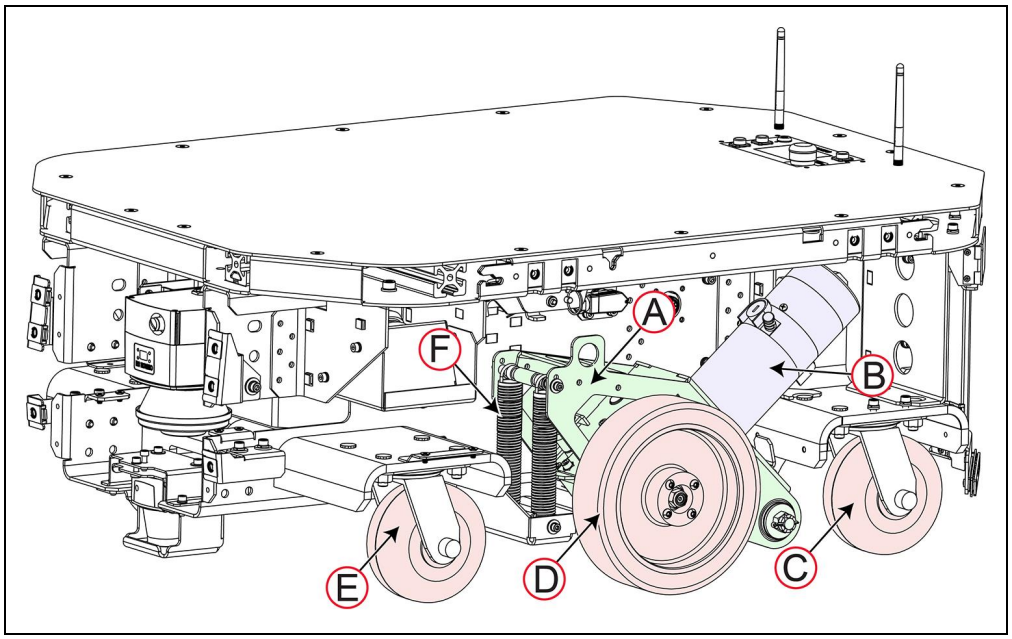


Figure 1-2 *Drive Assembly in LD-250 (skins removed).*

Callout	Description
A	Drive Train assembly (wheel, suspension and motor).
B	Drive motor assembly, containing the gears, encoders, and electric brake.
C	Rear caster.
D	Drive wheel, aluminum with polyurethane tread.
E	Front caster.
F	Suspension springs.

What's Included - Basic Components

- One fully-assembled LD-250 model platform that includes the following:
  - Omron OS32C Safety and Navigation Laser (main laser).
  - Low Front Laser.
  - Rear sensor.
  - Differential drive train.
- LD-250 Core housed inside the LD-250 which consists of:
  - A computing appliance that runs the SetNetGo operating system and the Advanced Robotics Automation Management (ARAM) software.
  - A microcontroller that runs the Mobile Autonomous Robot Controller (MARC) firmware.
  - Other sensor components such as a gyroscope and accelerometer.
  - The amplifiers that supply power to the drive wheels.

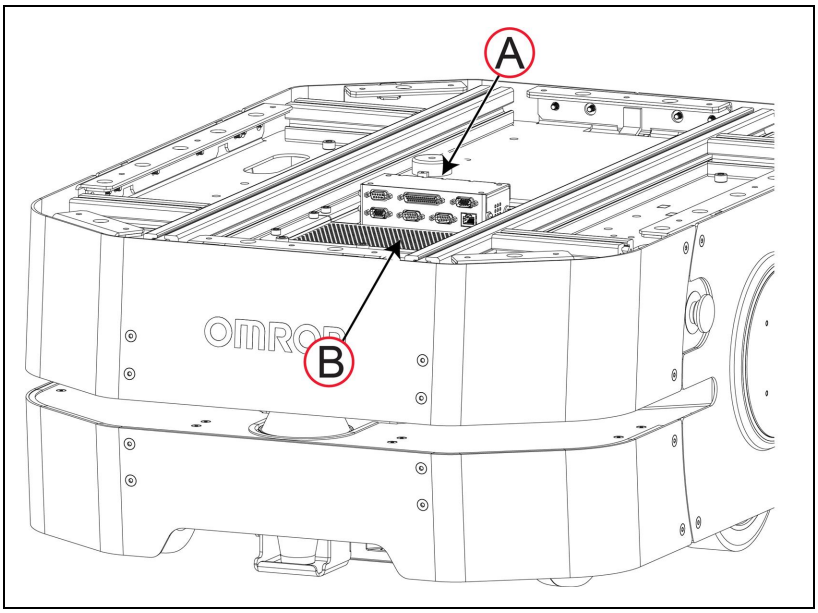


Figure 1-3 *LD-250 Core Location (A) in the LD-250,Secured by Two Vented Brackets (B)*

- One battery.

  Shipped separately from the LD-250 to comply with dangerous goods shipping regulations.
- Three emergency stop (E-Stop) buttons:
  - One on the Operator panel.
  - One on each side of the chassis.
- Operator Panel

You can move the operator panel to any preferred position on your payload structure. However, because the operator panel contains one of the three E-Stop buttons, there are important safety considerations when relocating or removing this panel. See: *Positioning an Optional Payload E-Stop* on page 126 and *Operator Panel (HMI) on the Payload* on page 90 for more information. The standard Operator Panel includes:

- 6-line status and message display screen.
- E-Stop button.
- Vehicle power ON and OFF buttons.
- Brake release button.
- 2-position key switch for access control. Lock the key switch to disable the off button and prevent accidental or unauthorized shutdowns.

Figure 1-4 *Operator Panel*

Also available is an optional touch screen that shows more AMR status information and provides additional functions. See *Touchscreen* on page 188.

- Automated docking station

  The docking station enables the LD-250 to charge itself, without user intervention. It includes a wall-mount bracket and a floor plate, for a choice of installation methods. See *Installing the Docking Station* on page 58.

  When the docking station is not occupied, a manual charging cord enables you to charge a battery outside the LD-250.

- A USB flash drive containing software and documentation.

In addition to the items included with every LD-250, you need at least one joystick per robot fleet. Use this joystick to manually drive the LD-250 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 a Fleet Manager 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 1-5 shows the joystick and Ethernet port, located on the right rear skin.

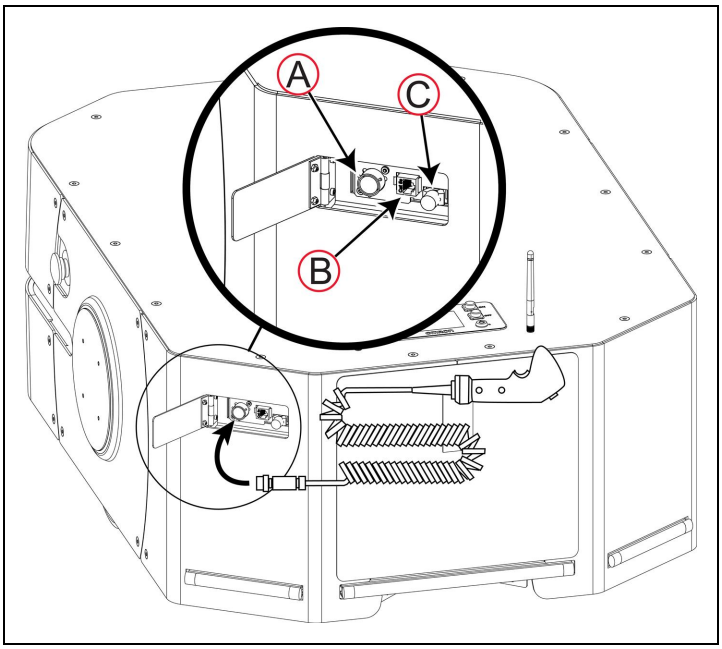


Figure 1-5 *Joystick Connection Point*

Callout	Feature
A	Joystick port.
B	Direct Ethernet connection that enables you to connect a PC to the SetNetGo OS. See: *Maintenance Ethernet Connection* on page 67.
C	Push latch.

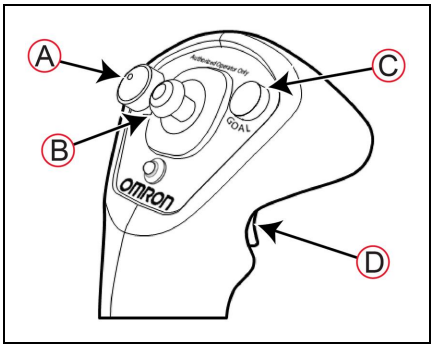


Figure 1-6 *Joystick Controls*

Callout	Control Function
A	AMR speed control.
B	AMR steering and direction of travel.
C	Map goal creation button.
D	Movement trigger.

Optional Features and Components (Partial List)

Several additional options and features are available for the LD-250. See also: *Options* on page 187.

- Fleet Manager—Use an EM2100 appliance and the Fleet Operations Workspace software to operate a fleet of AMRs, for multi-AMR coordination and job management. A second Fleet Manager provides redundancy and manual failover for fleet operations.
- Acuity Localization—Acuity uses an upward-facing camera to enable AMR localization. It detects unique patterns in the illumination fixtures (overhead lighting) used in your workspace.
- Spare battery—You might require one or more spare batteries to increase AMR productivity by eliminating the time spent recharging. Using the cable provided, you charge this battery outside the AMR and quickly exchange it with a discharged battery when necessary.
- Call Box or Door Box—A call box or door box is a signal device that:
  - Enables you to request an AMR from a remote location.
  - Controls an automated doorway, enabling an AMR to pass through it.
- High-Accuracy Positioning System (HAPS)— HAPS uses single or double under-body magnetic sensors on the AMR to detect magnetic tape strips adhered to the workspace floor. This enables an AMR to achieve highly accurate placement and alignment at a specific location in the workspace. For example, if an AMR pickup goal is a conveyor belt where it receives a crate of parts, use HAPS alignment to make sure that the AMR and the conveyor are aligned precisely.

Options for Enhancing Your Payload Structures

- **Rear Lasers**—A rear-facing obstacle-detection laser that scans the horizontal plane to the rear of the AMR.
- **Side Lasers**—Side-mount obstacle-detection lasers that scan the vertical plane on each side of the AMR. These lasers detect obstacles that are outside the scanning plane of the main safety laser. You might use side lasers on your payload structure to avoid obstacles that the main safety and navigation laser cannot detect.
- **Touchscreen**—The Touchscreen complements the standard Operator panel, enabling operators to interact with the AMR and the FLOW Core software directly from the payload structure.

  Operators can observe AMR status, select a goal, or do other operations. The Touchscreen does not provide manual operation buttons or an E-Stop. If you remove the Operator panel you must install alternate manual switches and an E-Stop. Otherwise, use a jumper (part number 13387-000) to bypass the operator panel E-Stop circuit. You must physically remove any bypassed E-Stop buttons to avoid operator confusion.

  Be aware that if you remove the operator panel you might need to add an E-Stop button elsewhere on the AMR to comply with safety requirements. See: *Positioning an Optional Payload E-Stop* on page 126.

  See the *LD Platform Peripherals User's Guide* for more information about the Touchscreen.

1.3 Software Overview

Your LD-250 requires the licensed software described in this section. Software is factory-installed on its LD-250 Core.

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.

LD-250 Software

The minimal operating configuration for an LD-250 consists of the AMR managed by a human Operator using a Microsoft Windows PC and optionally from an Android or iOS tablet.

If you have more than one AMR, you must install and configure a Fleet Manager 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:

- EM2100 Installation Guide
- Fleet Operations Workspace Core User's Guide

Figure 1-7 shows the devices that you might use to manage one or more AMRs and the software components required for each device, if applicable.

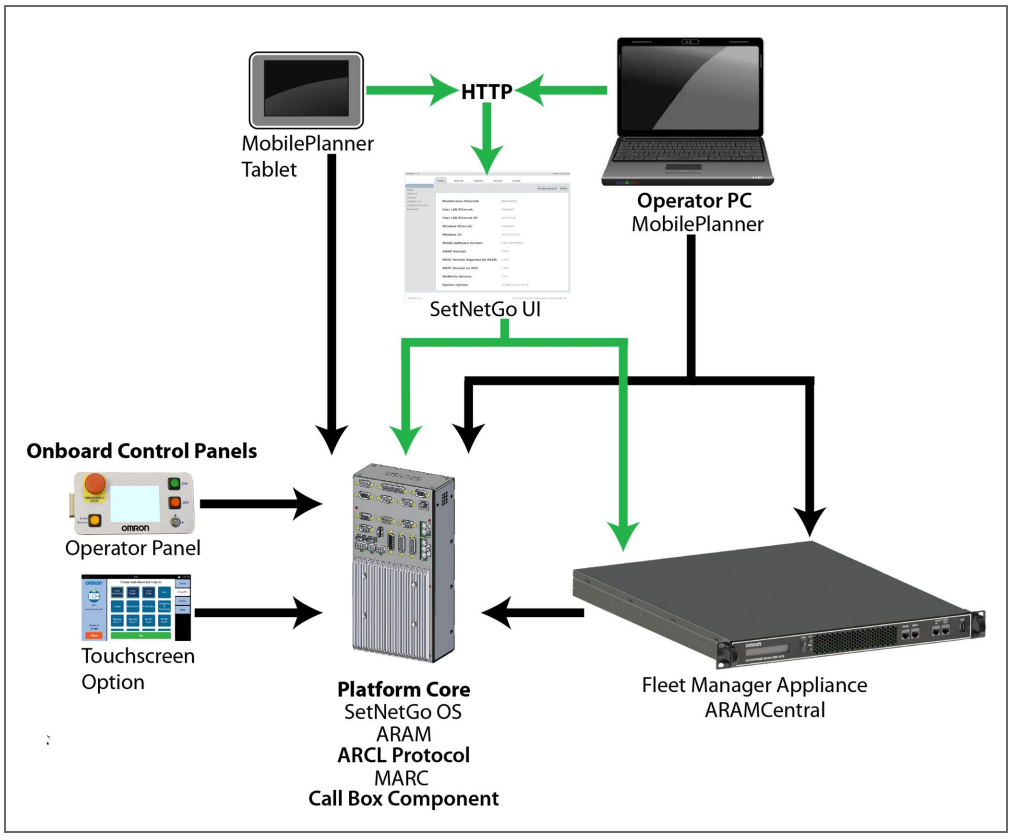


Figure 1-7 *Devices and Software in the AMR's Operating Configuration*

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

- The FLOW Core, an integrated set of programs that run on different devices in the environment. You use the MobilePlanner and MobilePlanner Tablet graphical interfaces to manage individual AMRs or fleets of AMRs. You can also access lower-level functions through a command-line interface.
- The SetNetGo OS, a host operating system (OS) which provides a Web interface that enables Operator access to the AMRs, enabling configuration tasks and tasks such as upgrading software or obtaining a debugging file.

User-Supplied Components and System Requirements

To configure and manage LD-250 you require a personal computer (PC) running a supported version of Microsoft Windows®. The PC requires:

- Ethernet connection. Omron recommends that you use a high-speed wireless connection.

  Wireless is a requirement for managing multiple AMRs as a fleet. See Fleet Operations Workspace Core User's Guide.

- 200 megabytes of available hard-disk storage.

Optionally, an Android or iOS tablet to run the MobilePlanner Tablet software.

ARAM

The Advanced Robotics Automation Management software (ARAM) runs on the LD-250 Core. It is software included with your FLOW Core license. ARAM is responsible for the following AMR functions and features:

- Interaction with on-board sensors such as the safety scanning laser, optional side laser or included rear sensor.
- High-level, autonomous robotics functions such as:
  - Obstacle avoidance
  - Path planning
  - Localization
  - Navigation
- Motion commands to the MARC firmware.
- Battery management.
- Digital I/O ports in the core that enable you to integrate application-specific sensors and effectors into your payload structure.

ARAM also provides the AMR with an interface to external entities:

- Manages wired and wireless Ethernet communications with external software for external monitoring, development, and systems coordination.
- Provides coordination of a fleet of AMRs through the optional Fleet Manager appliance.
- Manages integration with other systems, in addition to external monitoring, setup, and control via the MobilePlanner graphical interface.

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 fleet AMRs.
  - 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:

- Manage AMR fleet jobs.
- Create and edit workspace maps.
- Access the AMR through the SetNetGo Web interface.
- Commission and configure an AMR and modify its configuration by changing ARAM parameters.
- Run custom ARCL commands (See *ARCL Protocol* on page 23).
- Manually drive an AMR.

Operator access or View access restricts the tasks that you can do 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 joystick to drive the AMR around the workspace. In mapping mode, the main navigation 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.

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 dock to the AMR by specifying the unique map identifier for that docking station. If you have more than one AMR, you share the map and configuration with identically-equipped AMRs in your fleet.

Refer to the separate *Fleet Operations Workspace Core User's Guide* 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 also operates 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 Guide*.

Mobile Autonomous Robot Controller (MARC)

The LD-250 Core contains a digital signal processor (DSP) that runs the MARC 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 wheel encoders, rear sensors, and internal gyroscope.
- Reading emergency stop (E-Stop) status to enable and disable the drive motors.
- Joystick 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 require 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*.

Touchscreen Support

The FLOW Core suite includes support software for the optional graphical touchscreen.

Support for Call Boxes and Door Boxes

Call boxes and Door boxes require:

- A software component installed on the box itself.
- A second software component installed either on the Enterprise Manager, or on a single AMR.

SetNetGo

The SetNetGo OS runs on the LD-250 Core and EM2100 appliance. It is the host OS in which the FLOW components ARAM and ARAMCentral run. SetNetGo has a Web graphical user interface that you access either from a Web browser or from within MobilePlanner as a tab. Configuring wireless Ethernet access enables wireless access to SetNetGo.

At a minimum, you require:

- A hardwired connection to the LD-250 Ethernet maintenance port.
- A LAN connection or direct Ethernet port connection to the EM2100 appliance.

IT department can use SetNetGo to configure network settings without the need to run 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.

For questions and comments concerning this document, send email to: techpubs@omron.com.

Related Manuals

This manual describes the installation, setup, operation, and maintenance of an LD-250. There are additional manuals that describe configuring the LD-250. See the following table. These manuals are available on the software media delivered with your LD-250.

Table 1-1 Related Manuals

Manual Title	Description
Mobile Robot LD Safety Guide	Contains general safety information for all Omron AMRs.
Fleet Operations Workspace Core User's Guide	Describes Fleet management, MobilePlanner software, the SetNetGo OS, and most of the configuration procedures for an LD-250.
EM2100 Installation Guide	Describes the installation of an EM 2100 appliance, as a Fleet Manager, which runs the Fleet Operations Workspace software to manage a fleet of AMRs.
Advanced Robotics Command Language Reference Guide	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.
LD Platform Peripherals User's Guide	Describes optional peripherals (Touchscreen, Call box or Door box, Acuity Localization, HAPS, and rear-facing laser.)

Support

Contact your local Omron Support if you have problems with your LD-250 that are not described in this manual.

When you contact support, it is useful to provide a DebugInfo file. This is a collection of configuration, log, and system status files that support personnel can use for debugging and troubleshooting. See: *Download a Debuginfo File for Support* on page 24.

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 local Omron Support.

If your LD-250 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 UI.

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: *Configure the Maintenance Network* on page 25.

Configure the Maintenance Network

Use this procedure only if you have **not** configured your LD-250 for access over a wireless network. Instead, you use a hardwired connection to the LD-250 maintenance port. (See: *Maintenance Ethernet Connection* on page 67.)

1. Connect a Cat-5 (minimum) Ethernet cable from the maintenance Ethernet port on the LD-250 to an Ethernet port on your Windows PC.
2. In the Windows Open or Search box (or at a command prompt) type the following command and press Enter:

   ```
   ncpa.cpl
   ```

   This command opens the Network Connections screen, which might look different depending on your version of Windows.

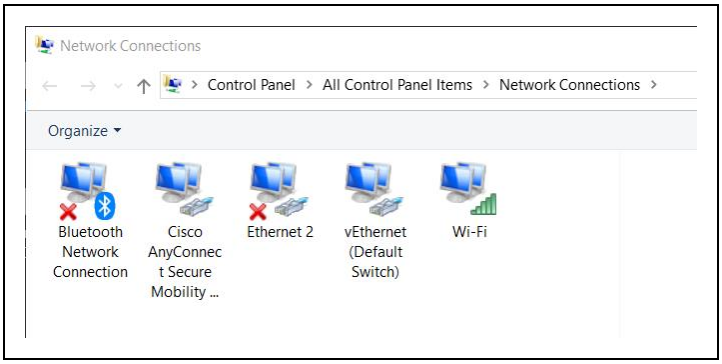


Figure 1-8 *Network Connections Screen.*

3. Right-click on the **Ethernet *N*** or **LAN Connection**.
4. Click **Properties**, and then double-click the **Internet Protocol Version 4** connection item to open its Properties window.

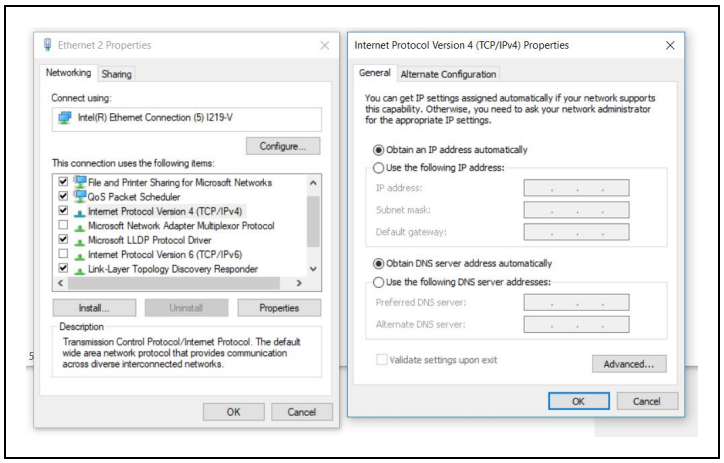


Figure 1-9 *Dialogs for the Ethernet Properties*

5. Click the radio button next to **Use the following IP address**.
6. Enter 1.2.3.5 as the **IP address** and 255.255.255.0 as the **Subnet mask**.
7. Click **OK** twice to exit both Properties dialogs, and then close the Network Connections screen.

You can now use this TCP/IP port connection to access the SetNetGo Web UI:

1. Open a Web browser on the PC and enter **https://1.2.3.4** as the URL.
2. If prompted to accept security certificates, confirm that you accept them.

To access the DebugInfo file, see: *Obtain a DebugInfo File from SetNetGo* on page 26.

Obtain a DebugInfo File from SetNetGo

After you access SetNetGo as described in the preceding sections, you will see the following screen:

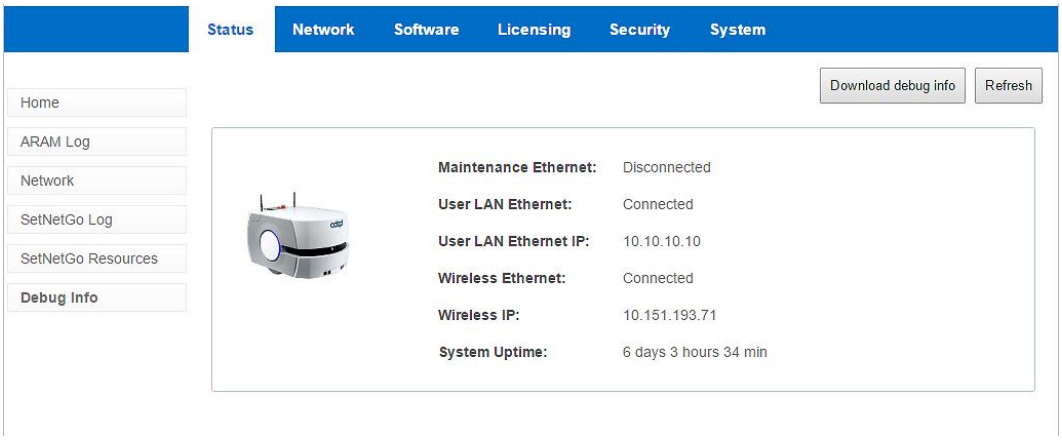


Figure 1-10 *SetNetGo Status Tab*

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 24.

Chapter 2: Safety

This chapter describes important personal safety considerations. All persons that operate an LD-250 or work in the vicinity of an LD-250 must read and understand this information.

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. Be aware that the maximum payload decreases as the floor's incline increases.
- Do not exceed the maximum recommended speed, acceleration, deceleration, or rotation limits. See *Center of Gravity (CG)* on page 86 and *Acceleration, Deceleration, and Rotation Limits* on page 74.

  Rotational speed becomes more significant when the payload's center of gravity is increasingly offset from the AMR's center of gravity.
- At speeds of less than 225 mm/sec, the safety laser is not active. There is a risk of injury or property damage.
- Do not disconnect the drive motor encoder cables unless required to do so as part of a maintenance procedure. See *Maintenance* on page 141.
- Do not drop the AMR, run it off a ledge, or otherwise operate it irresponsibly.
- 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 Box or Door Box option. Refer to the *LD Platform Peripherals User's Guide* for details on the Call Box or Door Box.
- Do not expose the AMR to rain or moisture.
- Do not continue to run the AMR if hair, yarn, string, or any other items have become wound around its axles, casters, or wheels.
- 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.
- Sunlight and reflective surfaces can affect the AMR's laser operation.
- Do not operate the AMR in a flammable gas environment.

2.2 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.

CAUTION: Combustible Lithium Battery. For AMR fire suppression, use either a type D foam or dry chemical extinguisher, or a CO_2 extinguisher.

The LD-250 has two E-Stop buttons, one on either side of the chassis (a red push-lock button on a yellow background). The Operator Panel (if used) provides an additional E-Stop button.

Use the User Interface port to add E-Stop buttons to your payload structure, if required. See *User Interface (Brake and E-Stop)* on page 103

Figure 2-1 *E-Stop Button*

A user-initiated E-Stop differs from a laser-initiated emergency stop. The latter occurs when the AMR's safety scanning laser detects an object within its protected zone. In such cases, the AMR safely stops autonomously and then resumes operation after a two second delay. See: *Emergency Stops that are Initiated by AMR Safety Lasers* on page 39.

To use an E-Stop button:

1. Push firmly on the red button until it locks:
    - The AMR uses motor power to come to a controlled stop then engages its motor brakes and cuts power to its drives.
    - Indicator lights on the AMR show the E-Stop state.
2. Follow your site-specific emergency and safety procedures.

After correcting the emergency condition, press and hold the brake button to manually move the AMR. You can also use the joystick to drive the AMR manually, if it is safe to do so.

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

Releasing the Brakes to Move the LD-250 Manually

You can move the LD-250 manually when required. For example, if the battery is too depleted to power the LD-250 or any other urgent condition. For safety reasons, only qualified persons should move an LD-250 manually.

NOTE: You should move the LD-250 manually only when absolutely necessary during an emergency, for safety, or if it is lost or deadlocked. If you find that you

must frequently move the LD-250, use MobilePlanner to reconfigure its route to avoid problem areas.

Move the LD-250 only after you have read and understood:

- This LD-250 user's guide.
- The Mobile Robot LD Safety Guide.

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 a location low down, close to the center of gravity. For the safe push points, see: *LD-250 Packaging* on page 48.

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

To move the LD-250 manually:

1. Check the battery status before moving an LD-250 manually. Battery power is required to release the wheel brakes. See the battery level indicator in: LD-250 Status Screen.
2. Verify that an E-Stop button is engaged (pressed in).
3. Press the brake release button in the Operator Panel.
4. Rotate and push the LD-250 in the required direction to a parking or charging station.
5. If you move an LD-250 while powered off it might be unable to determine its location when you power it on. Use the localization feature in MobilePlanner or the Localize at Goal feature in ARAM.

The LD-250 Core provides a brake release circuit that you can use to add a brake release button to your payload in a convenient location. See: *User Interface (Brake and E-Stop)* on page 103.

To bring the AMR back into service, see: *Releasing an E-Stop* on page 31.

An alternate method of manually moving an AMR is to disengage the drive motors. You might want to use this method if the AMR's battery has no charge, or if there is no battery installed. See: *Engage and Disengage the Drive Wheel Motors* on page 148.

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 the AMR's E-Stop is triggered, first correct any condition that caused the emergency stop. Make sure that all surrounding areas are clear before releasing the 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 and allow it to pop up.

3. After you release the E-Stop button, you must enable the motors manually by one of the following methods:
    - Dialogs in MobilePlanner that describe how to resume operation after an E-Stop.
    - Press the green ON button on the Operator Panel.
    - (Optional, if used) Press the GO button on the Touchscreen.

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

2.3 Dangers, Warnings, and Cautions

Alert Levels

There are three levels of alert notation used in our manuals. 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 entanglement situation.
	This identifies a hazardous electrical situation.		This identifies a fire risk.

Icon	Meaning	Icon	Meaning
	This identifies a hazardous burn-related situation.		This identifies a laser emitter eye damage situation.
	This identifies a hazardous ESD situation.		

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 and navigation laser 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, 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.

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 Guide.

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.

2.4 User's Responsibilities

You are responsible for continuous safe use of the AMR.

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.

Safe use of the AMR requires that you:

- Read the installation and operation instructions, in addition to the Mobile Robot LD Safety Guide, before using the AMR.
- Make sure that the environment is suitable for safe operation of the AMR.

  Two or more AMR's require a Fleet Management appliance unless you confine and operate each AMR in a separate workspace. See: Fleet Operations Workspace Core User's Guide.
- Make sure that any person working with or near an AMR is trained, and has read the Mobile Robot LD Safety Guide for safe AMR operation.
- Mechanically maintain and service AMRs for proper operation of all control and safety functions.

Understanding Electrical Hazards

WARNING: ELECTROCUTION RISK
The docking station has AC power inside. Docking station covers are not interlocked.

- Do not use power extension cords with the docking station unless properly rated.
- Never access the AMR's interior while it is attached to a charger.
- Immediately disconnect the battery after you open the battery compartment door.

  Avoid shorting the battery terminals.
- Do not use any charger not supplied by Omron.
- If the AMR comes into contact with any liquid:
  - Power off the AMR.
  - Clean off as much liquid as is possible.
  - Allow the AMR to air dry thoroughly before restoring power.
  - Contact your local Omron Support if you suspect that liquid has penetrated the skins or contaminated the AMR's interior.

Magnetic Field Hazards

The docking funnel creates a strong magnetic field. This component is located on the underside of the LD-250. Persons using medical implants should not approach the docking funnel.

WARNING: MAGNETIC FIELD - MEDICAL IMPLANT RISK
Magnetic fields can be hazardous if you have a medical implant. Keep a minimum of 30 cm (12 inches) away from the LD-250 when its underside is exposed during maintenance procedures.

Qualification of Personnel

You must make sure that all personnel who work with or around AMRs have appropriate training and have a thorough working knowledge. Provide the necessary additional training for all personnel that work with the system.

As described in this guide, and the *Mobile Robot LD Safety Guide*, 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 LD Safety Guide).
- 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.

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 interlock as part of your risk assessment.

Configurable Warning Buzzer

The LD-250 has a configurable warning buzzer. Configure this buzzer as appropriate for the facility in which the AMR operates. By default, the buzzer sounds when the AMR is moving in any direction other than forward motion.

You can also configure the buzzer to activate in other specific situations, or to operate continuously whenever the AMR moves. The buzzer does not have a volume control and you should make sure it is audible in all workspace locations, particularly where ambient noise levels are high.

MobilePlanner provides the buzzer configuration parameters described in Table 2-1.

CAUTION: PERSONAL INJURY RISK. Changing buzzer parameter values might make the AMR unsafe and affect compliance with safety standards. Refer to the applicable safety standards for your locale before you change any parameter values.

Table 2-1 Buzzer Parameters

Parameter	Default Setting
safetyBuzzerDisable_All	0 (Disabled)
safetyBuzzerDisable_Safedrive	0 (Disabled)
safetyBuzzerDisable_FwdMotion	1 (Enabled)
safetyBuzzerDisable_AllMotion	0 (Disabled)

Fleet Management

When two or more AMRs operate in the same workspace they might not be able to accurately detect other AMRs, or to precisely determine the dimensions of other AMRs. This might result in collisions or deadlocks where both AMRs must halt and wait for human intervention.

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.

Regardless of its safety laser type, an individual AMR always operates safely and within specifications. If a fleet includes different LD-series AMRs that also have different types of safety laser, all AMRs always operate safely and within specifications. However, a fleet that includes different LD-series AMRs that have the same type of safety laser will have improved fleet performance.

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

- Dynamic X, Y, 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 obstacle avoidance algorithm.

> **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 appliance. See the Fleet Operations Workspace Core User's Guide for more information.

2.5 Environment

General Environmental Conditions

Make sure that the LD-250's operating environment remains safe for the LD-250.

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 LD-250 to operate. For example, steep ramps (greater than 1:12 or 4.7 degrees unloaded), docks, or shelves.

Provide physical barriers that the LD-250 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 AMR traveling at speed.

- **Restricted Areas**—You can also use map features such as preferred lines and forbidden zones to keep AMRs within their designated area of operation. See the Fleet Operations Workspace Core User's Guide for information about editing your workspace map.

While you can use either or both physical barriers and map features to keep AMRs within their designated workspace, Omron recommends that you always install physical barriers where there is a risk of damage or personal safety.

Public Access

The LD-250 is designed to operate in indoor industrial environments. You must deploy it only in applications where you anticipate and mitigate potential risks to personnel and equipment.

Omron does not intend the LD-250 for use in uncontrolled areas without risk analysis. For example, in areas open to general public access. Use of the LD-250 in such areas requires that you deploy additional safety measures not described in this guide. For assistance, contact your local Omron Support.

Clearances when Operating

Side Clearances

The LD-250 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 more information, see: *Side Clearance* on page 114, and refer to the Fleet Operations Workspace Core User's Guide for information about software parameters that you can use to control the LD-250's front and side clearance zones.

Clearances During Rotation

The LD-250 generally travels in a forward direction and cannot do path planning in the reverse direction. It reverses only if you create a MobilePlanner macro task that requires it to move in reverse. Otherwise, the LD-250 only reverses onto its docking station to recharge. To change direction, the LD-250 rotates on its center of rotation (turns in place). However, when the LD-250 rotates, obstacles in its path do not trigger a safety system event.

The LD-250's Light Discs display a distinct turn signal pattern when it rotates. For more information, see:*Indications Provided by Light Discs Light Outputs* on page 127.

CAUTION: PERSONAL INJURY RISK
Personnel who work with or around the AMR should not stand close to the AMR when it is rotating with no forward motion.

Docking Clearances

You should set a 1.5 m (4.9 ft) distance between docking goals and physical docks to allow sufficient room to maneuver around other AMRs when docking.

Obstacles

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

- The LD-250 provides active warning features such as a warning buzzer, speech synthesis, and warning indicator lights.
- The LD-250 Core provides user ports that enable you to add warning indicators to your payload structure. See: *Indications Provided by Light Discs Light Outputs* on page 127.

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

- Editing the workspace map to include map features that restrict the AMR's **local** operation such as restricted entry zones, slow speed zones, or preferred lines.
- Editing the AMR's operating parameters to restrict its **global** operation, such as reducing its maximum speed or minimum approach distance.

For more information, see: *Fleet Operations Workspace Core User's Guide*.

Emergency Stops that are Initiated by AMR Safety Lasers

Under certain conditions, the AMR safety systems might cause an *emergency 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 laser initiates an emergency stop that occurs any time the laser detects unavoidable obstacles that are immediately in the AMR's path, but only when the AMR is moving faster than 300 mm/sec.

During the emergency stop, a controlled deceleration slows the AMR up to the maximum allowable rate and then applies the brakes.

> **NOTE:** An emergency stop initiated by an intrusion into the 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 30.

Other circumstances might cause an emergency stop, such as:

- Pushing the AMR in reverse faster than 300 mm/s might cause an over-speed fault that requires manual intervention to clear.
- User-supplied sensors connected to the LD-250 Core's User Interface port. *User Interface (Brake and E-Stop)* on page 103.

After the AMR comes to a complete emergency 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 task.

However, if the AMR cannot avoid the obstacle, the following outcomes might occur:

1. The AMR identifies and plans a revised path to its goal. (This might cause the AMR to turn around and move in a different direction.)
2. Fail the current job and wait for Fleet Manager to assign a new job.
3. If no alternate path is possible, signal an error state to the Fleet Operations Workspace software and wait for user intervention.

Safety System Overspeed Faults

The LD-250 has an independent safety system that uses a dual complex programmable logic device (CPLD) to redundantly monitor its velocity. This device makes sure that the AMR always operates within the speed limits specified by safety standards DIN EN 1525 and ANSI B56.5.

Both safety standards specify that an AMR's velocity is limited to less than 300 mm/s when traveling in any direction that is **not** scanned by its safety laser.

If the AMR operates outside this specified velocity limit, its CPLDs report a Channel 1 or Channel 2 system fault to its operating firmware and begins an emergency stop (ESTOP) sequence. In autonomous operation, the fault triggers the AMR's motion controllers to execute a controlled stop.

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 cut off. After you resolve the error condition the safety system stops reporting safety fault to the motion controllers and the normal start-up process begins.

Motion control configuration parameters in the ARAM software (such as AbsoluteMaxTransVel) limit the maximum allowable velocities. Use MobilePlanner to modify the value of these parameters. See *Fleet Operations Workspace Core User's Guide*.

2.6 Intended and Non-intended Use

Intended Use

The LD-250 is designed to operate in indoor industrial environments. In general, if a wheelchair user can safely and easily navigate the environment (open, and mostly flat with only gentle inclines and wide doorways), then it is navigable by an LD-250.

DANGER: PERSONAL INJURY RISK
There is risk of serious injury by crushing if the AMR tips over as a result of improper operation on inclines that do not comply with the operating specifications.

The following guidelines apply:

- **Floor**—Clean and dry floors that you sweep regularly and routinely keep free of debris, dust, and liquids.
- **Typical Inclines**—The LD-250 is intended to operate in a workspace that has a mostly

flat floor. If the workspace includes inclined areas, Omron recommends a gentle incline typical of wheelchair ramps. Be aware that the payload structure and any loads transported can:

- Reduce the AMR's ability to traverse an incline.
- Change its operating center of gravity (CG).

- **Inclines (Ramps)**—With a properly designed and stable payload, the LD-250 can operate on ramps at full payload capacity. However, extended periods of operation on ramps will affect battery duration and speed is limited to 600 mm/sec on inclines such as ramps. Operational recommendations are:

Slope	Payload Restriction	Speed Limit
1.7 degrees (3% grade)	No restriction	No restriction
3 degree slope	200 kg	600 mm/s
4.75 degrees (1:12 slope, typical wheelchair ramp)	165 kg	600 mm/s

- **Temperature**—5 to 40°C (41 to 104°F), with a recommended humidity range of 5% to 95%, non-condensing. Operating the LD-250 at high or low ambient temperatures (particularly with a full payload and high speeds) can cause the battery to exceed its operating temperature limits. If this happens, you are notified by escalating software messages as follows:
  - The battery is approaching a high or low temperature limit. Change the LD-250's operating conditions so that the battery can return to within its ambient temperature limits.
  - The battery has exceeded an initial limit, the LD-250 continues to operate but charging is deferred until the battery has returned to within its ambient temperature limits
  - The battery has exceeded its temperature limits and the LD-250 will shut down immediately.

The LD-250 has an ingress protection rating of IP20 and is not liquid-proof. Keep floors dry because liquids might get into the AMR. Damp, dusty, or greasy floors might also cause its drive wheels to slip or skid. Such traction problems can affect both braking and accuracy.

Non-Intended Use

When deploying an AMR, anticipate potential risks to personnel and equipment. Omron intends the LD-250 for use in a carefully controlled and managed environment with restricted access granted only to trained personnel.

You should conduct a risk analysis before you deploy the LD-250 in other environments. For example, deployments in areas that are open to general public access such as retail stores. Application of the LD-250 in such areas generally requires additional safety measures.

Omron does not intend the LD-250 for deployment in environments that contain:

- Hazardous (explosive or corrosive) atmospheres.
- Ionizing or non-ionizing radiation.

- Extreme heat or humidity.
- Floors that are damp or have any standing water.

  IMPORTANT: The LD-250 is not waterproof. Keep all floors dry. Dampness can cause drive wheels to slip, affecting both braking and navigation.

In addition, Omron does not intend the LD-250 for deployment in the following environments:

- Life-support systems.
- Residential installations.
- Mobile installations, including moving floors or any type of land vehicle, watercraft, or aircraft. (LD-250 navigation is assisted by a gyroscope embedded in the LD-250 Core. For accuracy, the gyroscope requires a stationary environment).

  IMPORTANT: Observe all instructions for operation, installation, and maintenance provided in this guide and in the Mobile Robot LD Safety Guide.

Non-intended use of an LD-250 can:

- Cause injury to personnel.
- Damage the LD-250 or other equipment.
- Reduce reliability and performance.

If there is any doubt concerning the application, ask your local Omron Support to determine whether it is an intended use.

LD-250 Modifications

Omron recognizes that customers or integrators make modifications to the LD-250 to adapt it to a specific application. When doing so, make sure that:

- You use the LD-250 Core's User Interface connection to include appropriate safety devices into the LD-250's integrated safety systems.
- The modification causes no hazardous sharp edges, corners, or protrusions and does not extend further than the LD-250 footprint. (This might affect the safety zones.)
- There is no reduction in functionality.
- All safety features (such as lasers and brakes) are functional and operate within the specifications determined by local standards for AMRs.

2.7 Battery Safety

The LD-250 requires one lithium ion battery. Use only the battery of the correct model number supplied by Omron. The FLOW software determines whether the battery is the correct type for the LD-250.

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%. Fully charge the battery immediately upon receipt to avoid total discharge. (The battery might arrive fully charged if it is not shipped by air.)

CAUTION: BATTERY DAMAGE RISK
Fully charge the battery immediately after delivery. Failing to do so might cause the battery to discharge below a usable state, requiring its replacement.

See also: *Battery Shipment* on page 47.

Battery Safety Precautions

- Store batteries upright and within the following temperature range:
  - One month: +5 to 45°C (41 to 113°F)
  - One year: 20 to 25°C (68 to 77°F)
- Batteries stored at temperatures greater than 54°C (129.2°F) or less than -6°C (39.2°F) must stabilize for an hour or longer until within the nominal operating temperature before use.
- Never expose the battery to water. If the battery is leaking, submerge it in mineral oil and contact your local Omron Support.
- In case of fire, use a type D extinguisher: foam, dry chemical, or CO_2.

Battery Maintenance

Every six months:

- Inspect the battery for damage or leaks.
- Connect the battery to a charger and allow it to fully balance all cells.

2.8 Additional Safety Information

Contact your local Omron Support for other sources of safety information.

Mobile Robot LD Safety Guide

The Mobile Robot LD Safety Guide is included with your LD-250 and provides detailed information about safe operation of your LD-250. It also provides resources for information about relevant standards.

2.9 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 designated collection facilities. For information about disposal of your old equipment, contact your local Omron Support.

Chapter 3: Setup

This chapter describes how to set up your LD-250 and configure it for operation. It includes information for optional features.

3.1 Overview of LD-250 Setup

Setup tasks consist of preparing the LD-250 for use by unpacking it and completing some mechanical configuration such as installing the battery and the docking station. This includes software procedures such as commissioning the LD-250 and communications tasks such as configuring the LD-250 to use a wireless network.

Setup also includes creating and editing the workspace map that the LD-250 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 Guide*.

Preparing the platform might also include attaching your payload structure to the LD-250 and then cabling the payload structure to the LD-250 Core 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 Omron Robotics and Safety Technologies, Inc. consultants.

Tasks

The tasks required to set up an LD-250 are:

- Install the docking station. See *Installing the Docking Station* on page 58.
- Fully charge the battery, either outside of or inside the LD-250.
- Install the battery in the LD-250. See *Installing the Battery* on page 53.
- Set up the wireless Ethernet for the LD-250. See *Settings and Configuration* on page 67.
- Install your payload structure to suit your application. See *Payload Structures* on page 77.
- Configure the AMR for your environment, so it can perform useful tasks.

  This includes creating a workspace map that the AMR uses for navigation. Mapping is described briefly in *Create a Workspace Map* on page 72 and in more detail in the *Fleet Operations Workspace Core User's Guide*.

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

3.2 Transport and Storage

LD-250 Shipping and Storage

Ship and Store the LD-250 only under the conditions described in this section.

> **IMPORTANT:** To prevent damage to electronic safety components, and to ensure the safe operation of the LD-250, observe the shipping and storage instructions in this section.

Ship and store the LD-250 without its battery installed in:

- A temperature-controlled environment, ranging from -20 to 60°C (-4 to 140°F). The recommended humidity range is 5% to 95%, non-condensing.
- Its original shipping carton, which is designed to prevent damage from shock and vibration in transit. Protect the crate from excessive shock and vibration.

Use only a forklift, pallet jack, or similar device to move the shipping crate.

Keep the LD-250 in an upright position in a clean, dry area that is free from condensation. Do not lay the crate on its side or any other non-upright position. This could damage the LD-250.

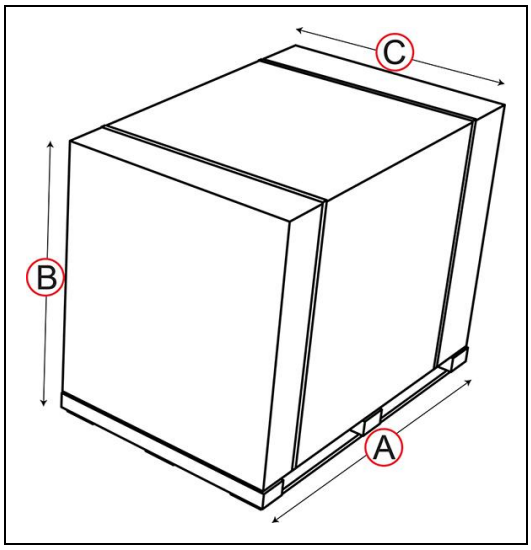


Figure 3-1 *LD-250 Shipping Carton*

The crate with pallet for the LD-250 has the following physical characteristics:

- Size:
  - 132 cm (51.8 inches) wide (A)
  - 105 cm (42.4 inches) high (B)
  - 88 mm (34.6 inches) deep (C)
- Shipping weight 196.6 kg (433 lb).
- Material - Corrugated fiberboard carton over a plywood and wood pallet.

- Moisture resistance - none, unless wrapped with a waterproof sheet material. Do not store the unprotected carton outdoors.

Battery Shipment

The LD-250 requires one Omron-supplied lithium-ion battery, model 2045. The operating software reports an error if you install an incorrect battery model.

After installation, the AMR's software verifies the battery model and reports an error if the battery model is incorrect.

This section applies also to spare (backup) batteries.

Battery Operating Environment

Table 3-1 lists the battery operating temperature limits.

Table 3-1 Battery Low and High Temperature Limits

Battery Temperature				Action
Min °C	Min °F	Max °C	Max °F	
5°C	41°F	40°C	104°F	Nominal operating temperature range.
4°C	39.2°F	44°C	111.24°F	Charging Limits - Battery charging is either shut off or cannot start.
-6°C	39.2°F	54°C	129.2°F	Operating Limits - The Battery shuts down and there is no power to the LD-250 Core.

The LD-250's software alerts you in the Operator Panel and the MobilePlanner software UI when the Battery temperature is within 3°C (37.4°F) of any limit.

It might take several hours for an overheated battery to cool sufficiently to resume operation or begin charging.

Other considerations apply to these environmental limits:

- Even at the nominal operating temperature limit, the battery might exceed its upper charging limit temperature if the LD-250:
  - Is fully loaded.
  - Runs continuously for an hour or longer.
- If the LD-250 is docked but the battery is too hot to charge:
  - Charging begins only when the battery temperature is within the operating range.
  - Only the docking station power LED illuminates, not the charge LED.

3.3 Before Unpacking

Carefully inspect all shipping boxes and containers for evidence of damage during transit. If you observe any damage, request that the carrier's agent is present when you unpack the shipment.

3.4 Unpacking Considerations

Before signing the carrier's delivery sheet, compare the 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 sign the receipt.
- If the items received do not match your order, contact your local Omron Support immediately.

Retain the containers and packaging materials. You might require these items to settle claims or, at a later date, to repack and relocate the AMR.

At a minimum the shipment contains:

- A fully assembled LD-250.
- Torx Plus T30 driver for removing and replacing skins.
- A Motor Lift tool part number: 20829-000 used for maintenance operations. This is stored on board the LD-250.

WARNING: Do not attempt to lift the LD-250 off its pallet with a forklift or other lifting device. Doing so might cause damage to the skins or under-body components.

LD-250 Packaging

The LD-250 arrives in a carton secured by poly strapping to a pallet. Use only the pallet, and a rated lifting device to move the shipment.

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.

The docking station and any options are packed in a separate carton positioned on top of the main crate.

You require the following tools:

- Forklift or pallet jack.
- Safety box cutter. Do not use a open-blade knife such as a wallboard knife to cut into packaging, you might damage the contents.
- Eye protection, toe protection and gloves.

NOTE: Poly strapping might be under considerable tension. Hold it firmly as you cut it.

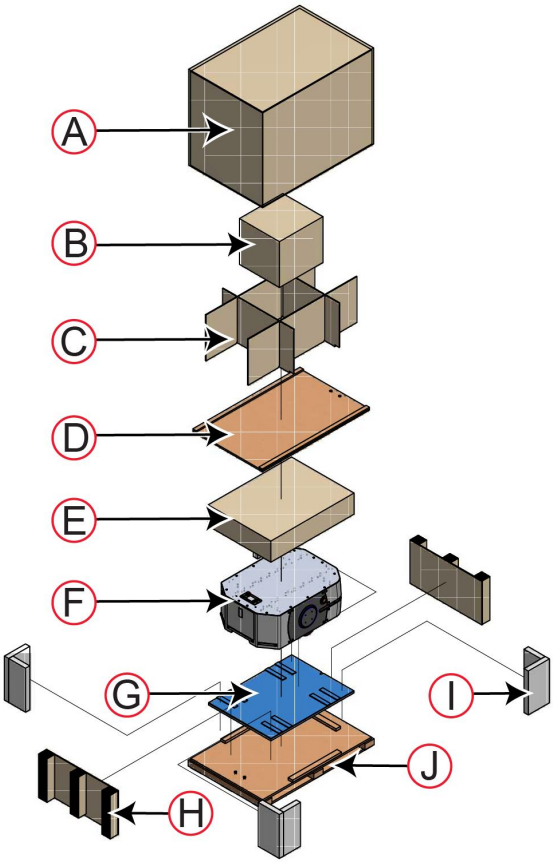
Description		Image
A	Main carton	
B	Docking station carton	
C	Docking station filler. (Might contain options.)	
D	Unloading ramp	
E	LD-250 cover carton	
F	LD-250	
G	Shipping base, with wheel chocks	
H	Protective filler (2)	
I	Foam corners (4)	
J	Plywood pallet	

Figure 3-2 *LD-250 Packaging*

Unpack as follows:

1. Make sure you have 1.5 m (5 feet) of clear working space around the pallet.
2. Remove any weatherproof film or plastic sheet material and carefully cut the poly strapping with a sharp safety blade.

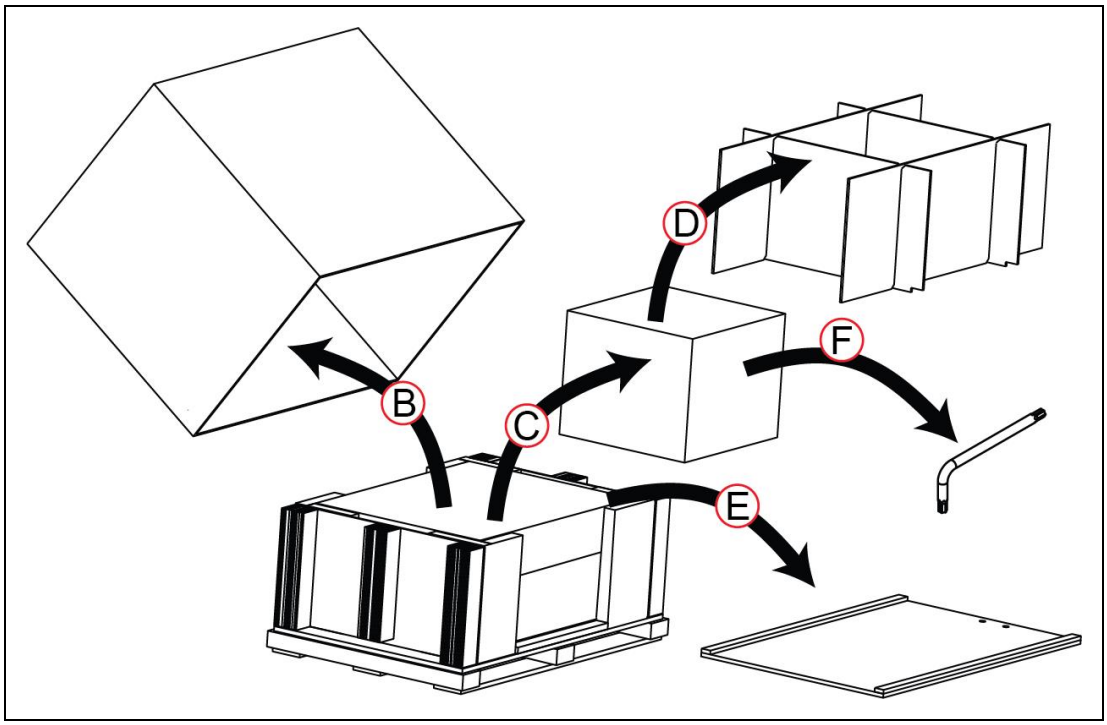


Figure 3-3 *Unpacking the Docking Station and Accessories*

1. Referring to Figure 3-3, lift the main carton (A) upward and off the pallet.
2. Remove any other accessories or options included in the filler (D). Locate one of the included accessories, a T30 Torx driver (F), which you will need later to move theLD-250.
3. Remove the filler (D) and carton (C) containing the docking station, and then lift the filler off the carton.
4. Lift off the plywood ramp and set it aside temporarily.

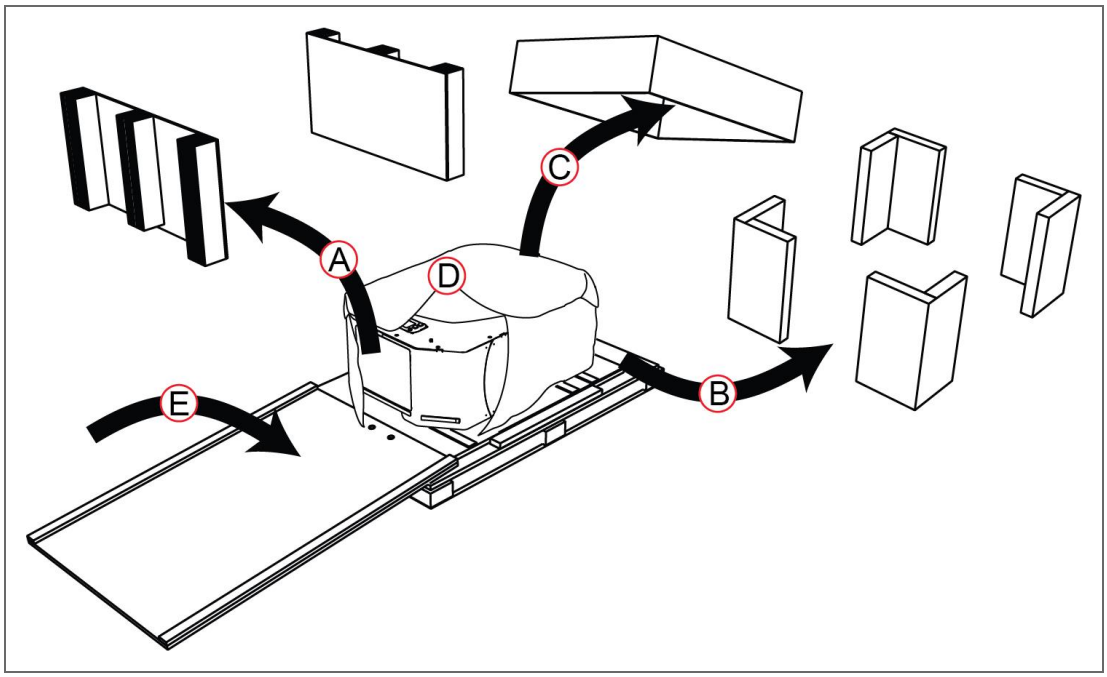


Figure 3-4 *Unpacking the LD-250.*

3. Referring to Figure 3-3, Remove the protective filler (A) from each end of the pallet.
4. Remove the four foam corners (B).
5. Remove the corrugated fiberboard cover from the LD-250 (C). There is padding underneath to protect the top surface of the LD-250.
6. Remove the padded wrapping (D) from the LD-250.
7. Place the ramp in the end of the pallet, so that the two bolts in the pallet engage with the holes in the ramp (E).

Before you can move the LD-250 off its pallet, you must first disengage the drive motors to allow the drive wheels to move freely. To do this:

- Remove both side skins so that you can access the drive train. See: *Remove and Replace the Side Skins* on page 183.
- Disengage the drive wheel motors. See: *Engage and Disengage the Drive Wheel Motors* on page 148.

After you disengage the drive wheel motors, complete the unpacking procedure as follows:

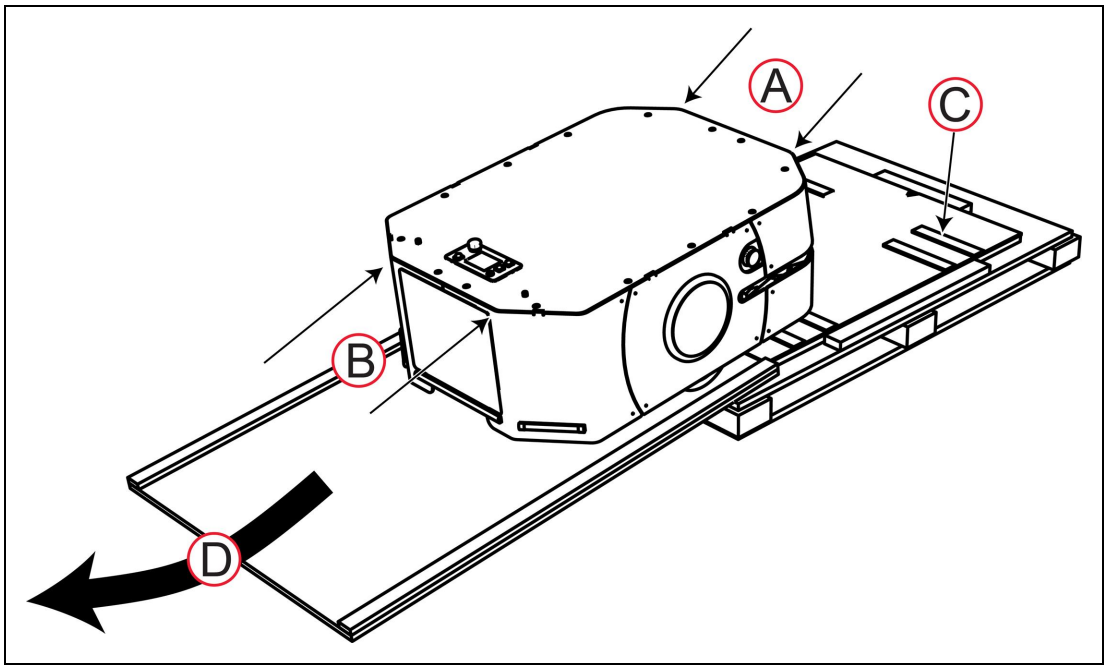


Figure 3-5 *Move the LD-250 Down the Ramp*

1. Referring to Figure 3-5, Identify the safe push points (A) and (B) at the top edge of the skins. Do not push lower down on the chassis because it might damage the skins or other components.
2. During shipping, the casters are prevented from movement by chocking strips on the plywood package base. Be aware that it requires some effort to push the LD-250 over these strips.
3. Pushing from the top edge of the chassis using the push points (A) and steadying the LD-250 at push points (B), carefully roll the LD-250 over the caster chocks and down the ramp.

After unpacking, the next steps are:

- Locate and install the battery, which is shipped separately. See: *Installing the Battery* on page 53.
- Engage the drive wheel motors. See: *Engage and Disengage the Drive Wheel Motors* on page 148.

If you intend to proceed with commissioning the LD-250, read that section before you replace the side skins or engage the drive wheel motors. See: *E-Stop and Safety Laser Commissioning* on page 176.

Battery Carton

The battery ships in a separate carton, not inside the LD-250. The battery box measures 311 x 540 x 457 mm (12.25 x 21.25 x 18 inches). Locate the carton that contains the battery before continuing. Refer to the following figure.

Figure 3-6 *Battery Shipping Carton*

Remove the battery from the carton. The battery has recessed lifting grips at either end of its casing.

Install the battery as described in: *Battery Installation Procedure* on page 55.

3.5 Installing the Battery

Your LD-250 ships fully-assembled, excluding its battery. Air shipping regulations require that the battery is packaged and shipped separately.

Access the Battery Compartment

Remove the LD-250's battery access skin to access the battery compartment door.

1. Make sure that the LD-250 is powered off and that you press and lock one of its E-Stop buttons.
2. Lift the latch (A) to detach the battery access skin, and lift the skin up and away from the chassis (B).

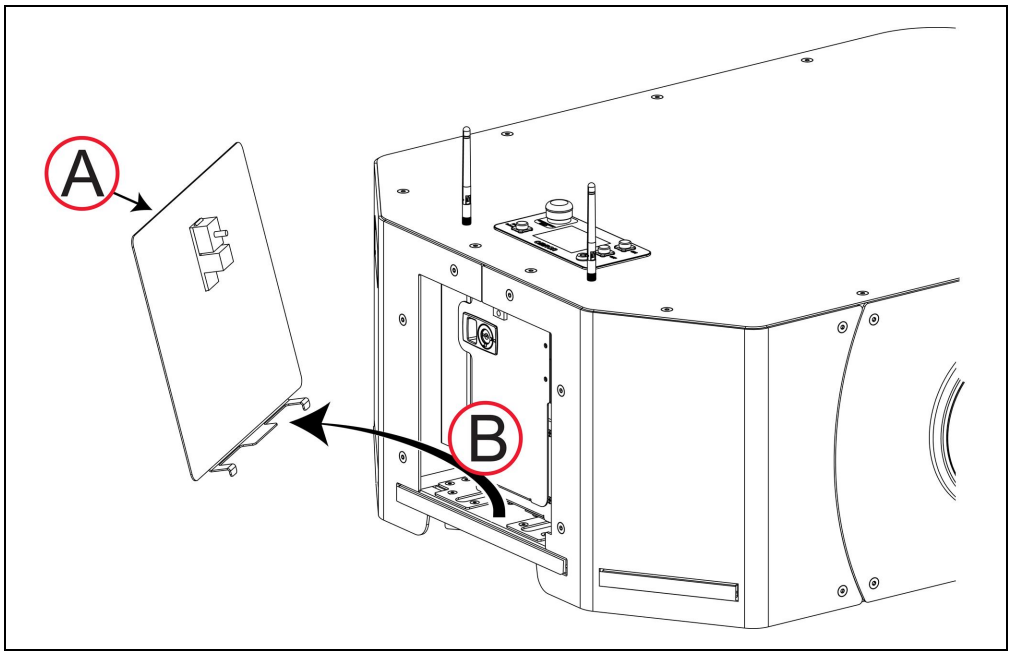


Figure 3-7 *Remove the LD-250's Latched Battery Access Skin*

3. If necessary, use the security key (A) to unlock the battery compartment door and slide the latch (B) to open the door. Observe the correct power cable routing as you open the door.

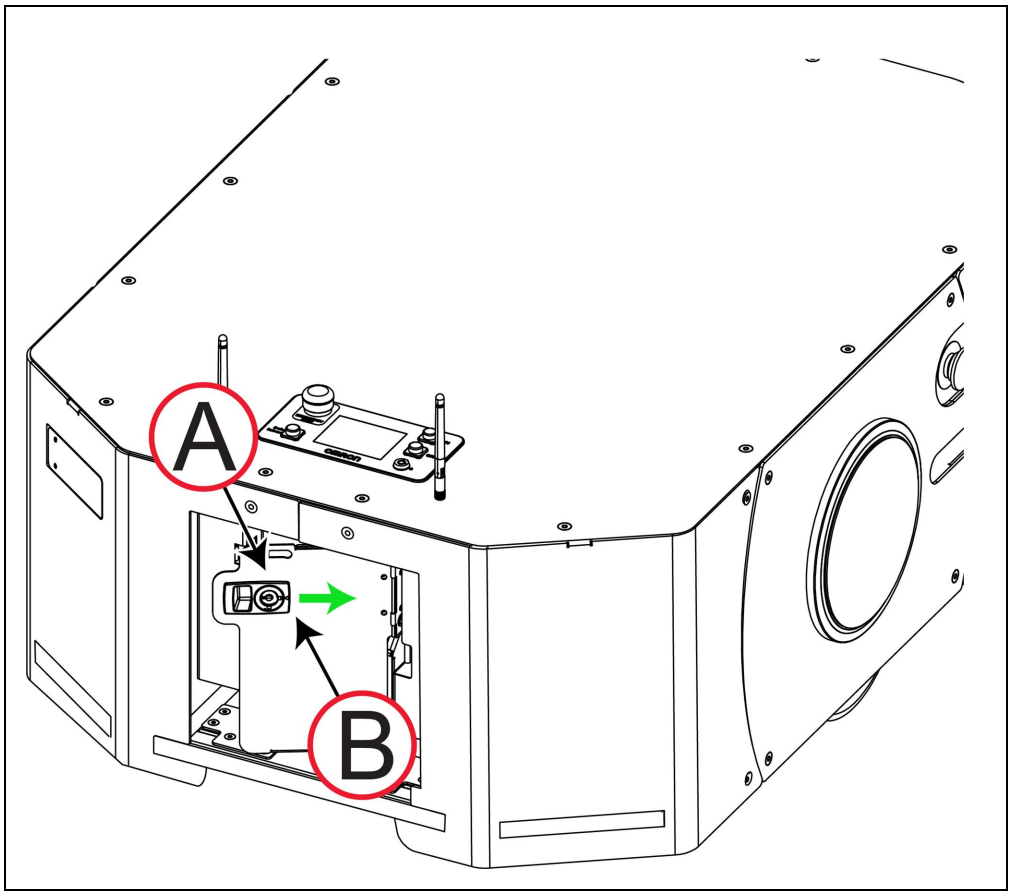


Figure 3-8 *Open the LD-250's Lockable Battery Door*

Battery Installation Procedure

Make sure you install a fully-charged battery. The battery has recessed handles at each end for easier lifting.

The battery weighs 19 kg (42 lb). You might require a two-person lift to handle it safely.

Figure 3-9 *Recessed Handles for Lifting the Battery.*

Figure 3-10 *Correct Way to Lift the Battery*

1. Lift and slide the new battery into the battery compartment, with its connection ports facing outward, toward the rear of the LD-250.
2. Attach the battery power and data cables to the connectors at the rear of the battery.

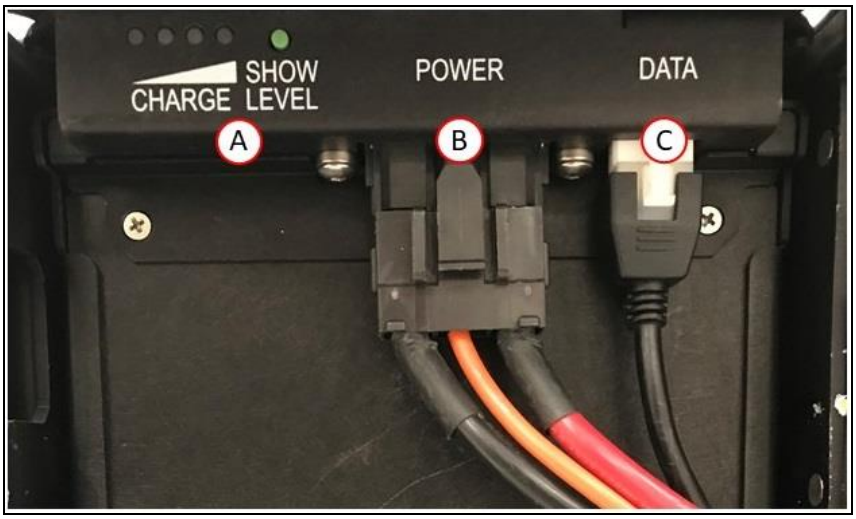


Figure 3-11 *Battery Cable Connectors, (A) Battery Charge Level, (B) Power Connector, (C) Data Connector*

3. Close the battery compartment door to secure the battery in place and to prevent it from shifting inside the compartment. Lock the door to prevent unauthorized access.
4. Reinstall the LD-250's battery access skin and close the latch to secure it in place.

Do not power on the LD-250 until you have read the appropriate sections of this user's guide.

3.6 Attaching the Payload Structure and Options

Attach the Payload Structure

At this point in AMR set up, attach your payload structure to the load-bearing bars located beneath the top cover. Omron provides only the mount point options described in: *Payload Dimensions and Design* on page 80.

For information about power, data signal, and warning light connections, see: *Connectivity* on page 93.

Attach LD-250 Options

If you ordered optional devices such as Acuity Localization that shipped separately, attach them next. See: *Optional Connections* on page 91.

E-Stop Jumper on the LD-250 Core

The LD-250 Core requires either of the following attached to the E-STOP port (User Interface):

- A jumper (part number 12730-000L).
- User-supplied E-Stop button.

See: *User Interface (Brake and E-Stop)* on page 103.

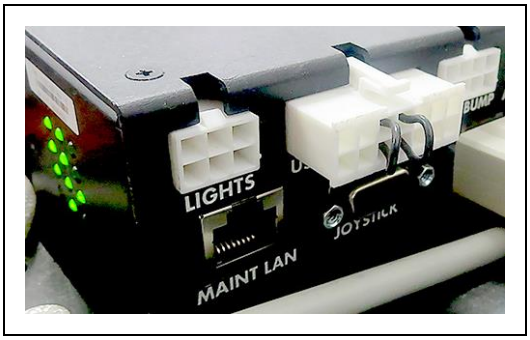


Figure 3-12 *Jumper Installed in the E-STOP port (User Interface)*

NOTE: A different jumper (part number 13387-000) is required if you remove the Operator Panel. See: *Operator Panel (HMI) on the Payload* on page 90.

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 LD-250 Core's *Light Pole* connector to power and control the warning light.

Make sure that the light remains visible under all operating conditions 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 Docking Station

The docking station enables you to either manually or autonomously charge the LD-250's battery according to charging parameters that you set in MobilePlanner.

Install the docking station 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 station's charging paddle is spring-loaded to accommodate slight variations in the floor surface so that it engages with the AMR's charging funnel. You might need to adjust the paddle's height if the floor is uneven.

Considerations and requirements when installing the docking station are:

- Secure the docking station through its base by threaded wood or concrete fasteners that are appropriate for the substrate.
- Additionally secure the docking station by the supplied bracket, fastened to an adjacent wall. Omron recommends both floor fasteners and the wall bracket for the LD-250. If you cannot secure the wall bracket to a structural framing member with screws, use heavy-duty toggle (butterfly) bolts in drywall. Do not use drywall plugs or anchors.
- Temporarily use the docking station *free standing* (without fasteners) but attached to its optional floor plate. Do this only for testing or experimenting with the location of your docking stations. Secure the floor plate to the ground with strong fabric tape or light-duty fasteners.
- Maintain 1.5 m (4.9 ft) of unrestricted space around the docking station to enable the

AMR's to maneuver. Obstacles close to the docking station might prevent successful docking.

- Each docking station requires an adjacent wall power outlet. In highly-automated fleet environments, consider using a redundant power supply.

IMPORTANT: If you do not use appropriate fasteners for sustained use, the docking station might move during docking attempts, causing docking and charging failures. The maximum fastener diameter is 6 mm (0.25").

Docking Station Features and Parts

Figure 3-13 shows the exterior features and parts of the docking station. This figure does not include the optional floor plate for free-standing installation.

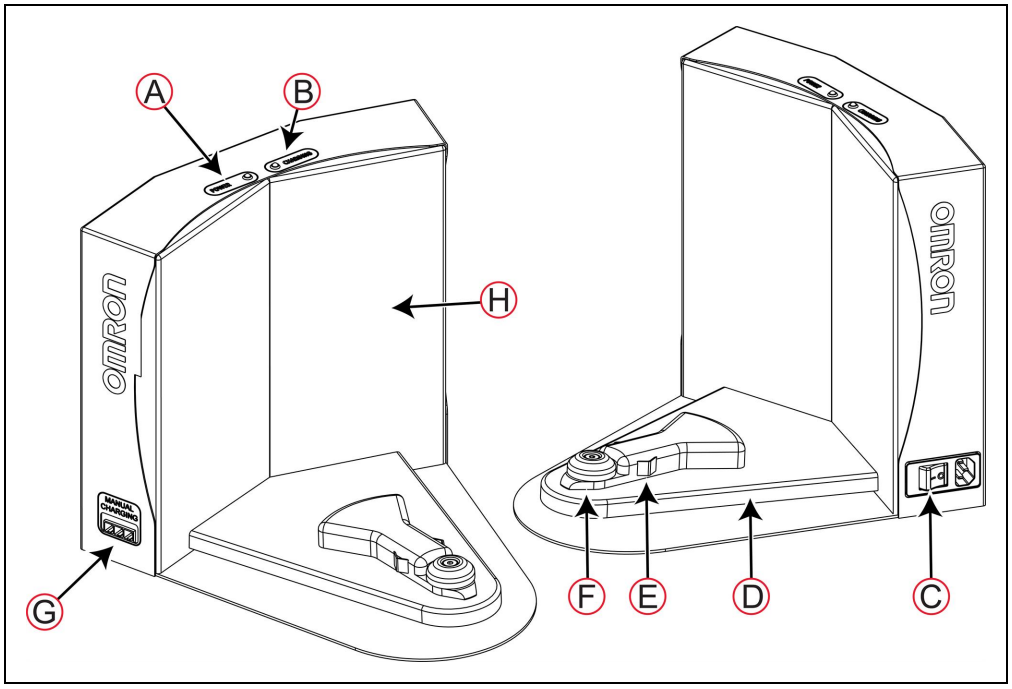


Figure 3-13 *Docking Station—Features and Parts*

Table 3-2 describes the parts of the docking stations that are of interest to the user.

Table 3-2 Description of the Docking Station Features and Parts

Callout	Description
A	Power indicator LED (blue).
B	Charging indicator LED (amber).
C	Power inlet socket and power switch.
D	Charging paddle. This is articulated and spring loaded to make good contact with the AMR's charging contacts.
E	Electrical contacts.

Callout	Description
F	Engagement roller. Guides the AMR's charging funnel onto the docking station. This is a replaceable wear item.
G	Manual charging connector. Use for charging spare batteries outside the AMR.
H	Triangle target. The concave triangular back of the charging station provides a laser reflection as a navigation cue for the AMR, enabling it to align itself accurately for charging.

Docking Station Requirements

The input circuit must provide overcurrent protection consisting of one or more circuit breakers, cartridge fuses, or Type S plug fuses of an acceptable type and rating in accordance with National Electrical Code (NFPA 70) or other local standards.

CAUTION: FIRE RISK
Use only on circuits provided with 10 amperes branch circuit protection in accordance with National Electrical Code, NFPA70, or other local electrical standards.

Operational requirements for the docking station are:

- 100-240 VAC, 50/60 Hz, 8 A (The docking station's power converter automatically detects the source voltage.)
- Ambient operating temperature: 5 to 40°C (41 to 104°F)
- 5% to 95% humidity, non-condensing

Required Tools and Fasteners

You require the tools and fasteners described in Table 3-3.

Table 3-3 Required Tools and Fasteners

Size	Qty	Description
#2	1	Cross-point (Phillips) screwdriver.
As required	1	Appropriate screwdriver, hex socket, or driver bit for the fasteners that you supply.
3.175 mm (1/8 inch)	4	User-supplied toggle bolts (if not using screws into a framing member)
#10 (4.762 mm, 3/16 inch)	4	User-supplied structural screws such as decking screws (f not using toggle bolts into drywall)
M5 x 4	2	Stainless steel shoulder bolts and washers (supplied with the docking station.

Refer to Figure 3-14 for dimensions and fastener placement.

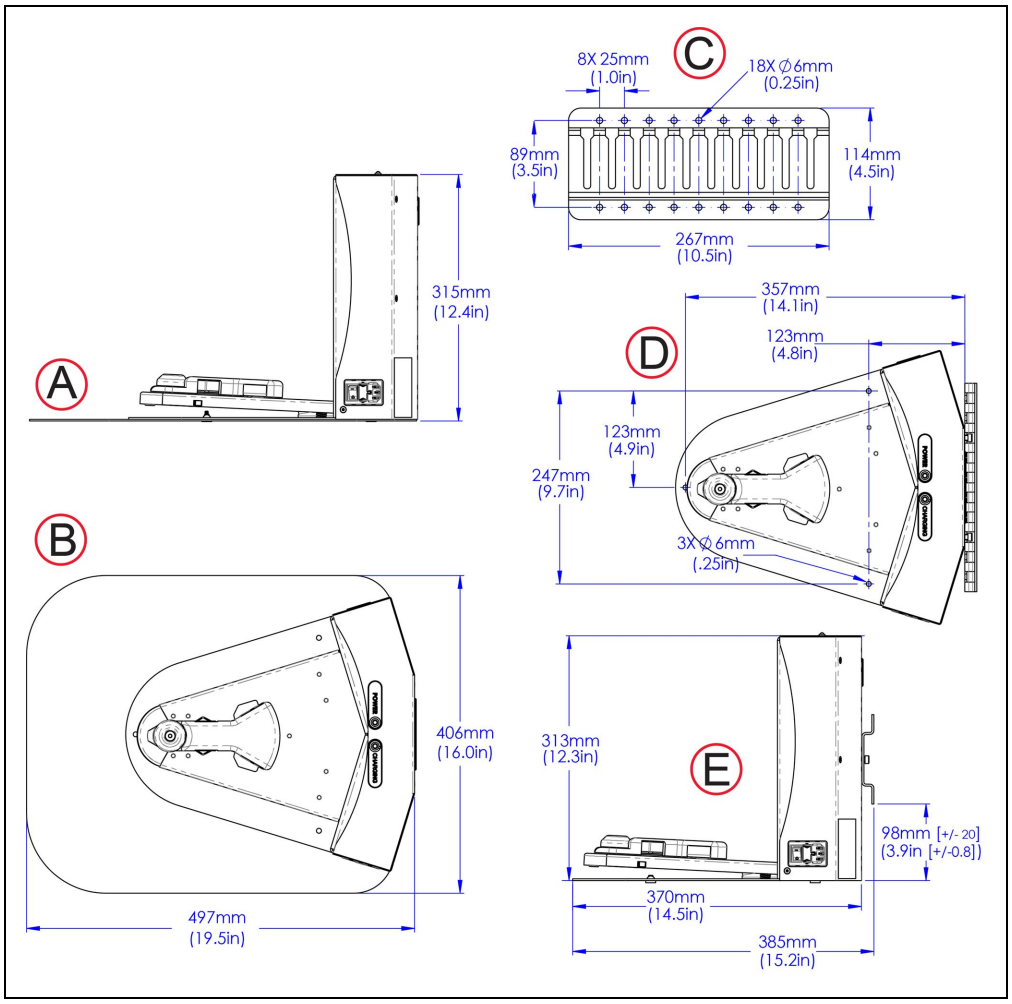


Figure 3-14 *Docking Station Dimensions*

Callout	Installation Method and Orientation
A	Free standing, side view
B	Free standing, side view
C	Wall mount bracket
D	Wall and floor mount, top view
E	Wall and floor mount, side view

Wall Bracket Mount

1. Fasten the docking station mounting bracket to a wall, with the bottom edge of the bracket 98±20 mm (3.8±0.8 inches) above the floor.
2. Fasten two shoulder bolts, each with a washer, into the rear of the docking station. Tighten to 9 N·m (80 in-lb).

3. Lower the docking station down, so the two bolts on the back of the docking station slide into the bracket, securing the docking station to the wall.

Floor-mount, without Floor Plate

Screw the base of the docking station directly to the floor, using three user-supplied screws. For dimensions of the available holes in the base, refer to Figure 3-14. Omron recommends M5 self-tapping screws that are suitable for the substrate (wood, concrete, etc.)

Floor-mount, with Floor Plate (Temporary Use Only)

Use this method temporarily, and only for experimenting with docking locations. The docking station does not ship with the floor plate attached, it is included in the same carton.

1. Tip the docking station onto its back, so you can access the underside.
2. Remove the two lowest screws (M4 x 12 flat-head), if present.

   In the following figure, these screws are circled. The location of the third screw hole is also circled.
3. Attach the floor plate to the base of the docking station with three M4 x 12 flat-head stainless steel screws.

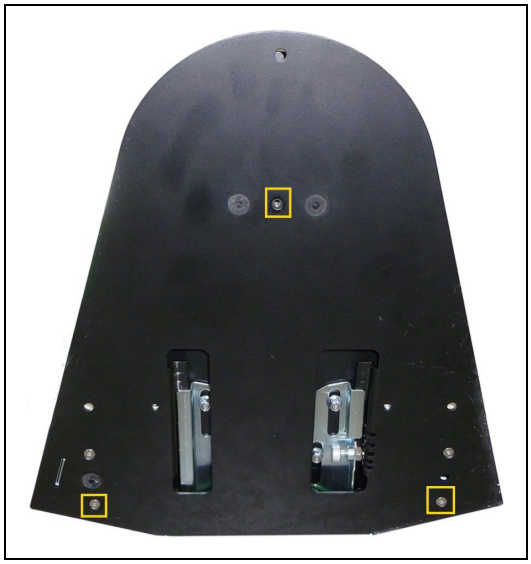


Figure 3-15 *Underside of Docking Station Foot, Showing Screw Locations*

NOTE: These are the three locations for the M4 x 12 flat-head screws. Two are already in place. Remove them before attaching the plate.

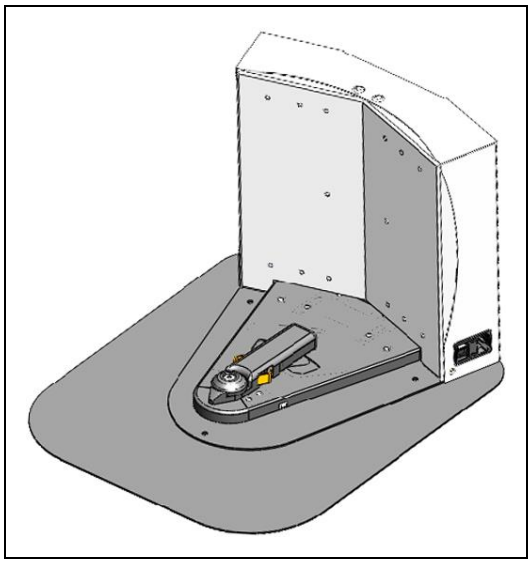


Figure 3-16 *Docking Station, Mounted on Floor Plate*

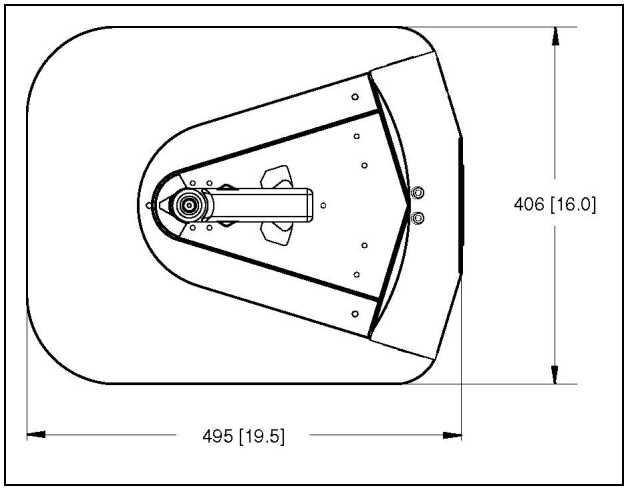


Figure 3-17 *Docking Station Floor Plate Dimensions (units are mm [inches])*

After you install the docking station:

1. Connect the power cord to the docking station and plug it in to a wall outlet.
2. Set the power switch to ON. The blue power LED indicator illuminates to indicate that power is present.

See: *Docking Station AC Power Fuse* on page 164 if the blue LED does not illuminate.

After you install the docking station, create a docking goal on the workspace map and configure your AMRs to use the dock for recharging. (See the *Fleet Operations Workspace Core User's Guide*.)

Docking Station Contact Adjustment

The contacts on the docking station have five height settings to compensate for variations in floor flatness at the docking station's location. The default is the highest setting, which should be appropriate in most cases.

The height adjustment mechanism is on the underside of the docking station's floor plate, shown in Figure 3-18.

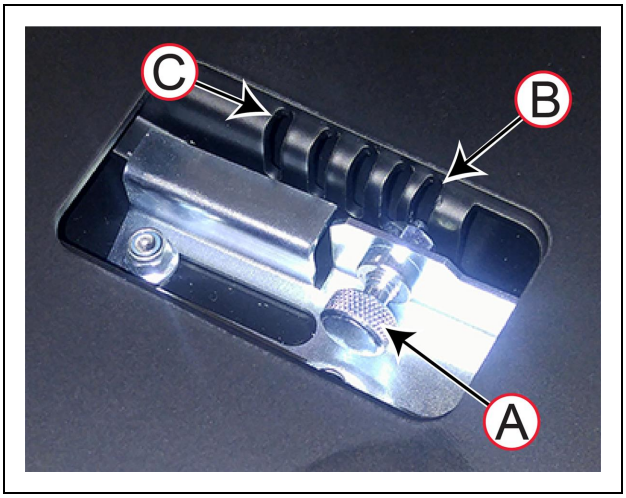


Figure 3-18 *Adjusting the Height of the Docking Station Contacts*

Callout	Description
A	Spring loaded locking pin. (Pull out and quarter turn to lock it in the open position, turn to release.)
B	Highest adjustment (shipped default). Each notch adjusts the height by 4 mm (0.15 inch).
C	Lowest adjustment.

To test and adjust the height of the contacts:

1. Using MobilePlanner, send the AMR to the dock to recharge.
2. When the AMR reverses on to the dock, the operation should be smooth and quiet. If you hear a noise, it is likely that the docking funnel is bumping the guide wheel.
3. Disconnect the power cable and turn the docking station on its side.
4. Push down on the charging paddle and hold it in place to take the tension off the spring.
5. Pull out the pin (A) and slide it in the direction (C) to select a position slot (B) Adjust the position of the paddle as shown in Figure 3-18. The height changes by 4 mm (0.15 inch) for each notch.

Set the height of the contacts so that the roller is high enough to stay in contact with the LD-250 as it is docking, but low enough so that the roller guides the paddle under the LD-250.

3.8 Installing Software on your Windows PC

The LD-250's operating software is factory-installed. The accessories carton of your shipment includes a USB flash drive that contains backup software copies and product documentation files in PDF format.

To use the MobilePlanner software for set up tasks, install it on a Windows PC as described in the Fleet Operations Workspace Core User's Guide. That guide also provides information about the SetNetGo Web UI, which you also use to perform additional setup tasks.

Some software is licensed for a short period to enable you to set up and configure the LD-250. The software directs you to send an e-mail to Omron. to obtain a term license. See the software documentation for more information.

Chapter 4: Configuration

This chapter describes the configuration steps for an LD-250.

Your LD-250 ships with firmware and on-board software installed (with temporary licenses). Activate your licenses as described in the *Fleet Operations Workspace Core User's Guide*.

The LD-250 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 LD-250. Map creation is a required step before you can continue on to the Operation chapter of this manual.

You also use MobilePlanner to:

- Configure the LD-250's operating parameters, which control its operation.
- Monitor and manually control the LD-250 in addition to scheduling autonomous operation.

For more information, see: *Fleet Operations Workspace Core User's Guide*.

Use SetNetGo's Web interface for other configuration and set up tasks such as configuring network communication. You can access the SetNetGo interface from within MobilePlanner, or through a direct connection to the LD-250. This enables IT personnel to easily configure network setting without needing to know how to access and use MobilePlanner. SetNetGo is also accessible through a direct RJ-45 Ethernet cable connection to the LD-250's maintenance Ethernet port.

4.1 Settings and Configuration

Maintenance Ethernet Connection

To prepare an LD-250 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.

See also the *Fleet Operations Workspace Core User's Guide*.

Default Network Settings

The LD-250's network has the following default configuration. Your network administrator should review this information for compatibility with your existing network.

Network Feature	Default Network Setting
Network Class	Class C
Netmask for all ports	255.255.255.0
Permanent Maintenance Ethernet IP address	1.2.3.4
Configurable User LAN port IP address	10.10.10.10
Ethernet negotiation method	Auto-MDIX
Network method	Access Point (AP)

Network Feature	Default Network Setting
Identifier (SSID)	*Wireless Network*
Security method	Unsecured

LD-250 Default Network Settings.

Features of the Maintenance Ethernet Port

The following important considerations apply to the LD-250's Maintenance Ethernet port:

- You cannot change its default address (1.2.3.4) or use that same address elsewhere on the same network. Doing so could cause a network conflict, preventing proper and safe operation of the AMR.
- 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 UI 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 Guide* for information abut modifying network settings.

Configure the LD-250's Network

To configure the LD-250'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.
- An IP address in the range 1.2.3.0 to 1.2.3.255, excluding 1.2.3.4, which is the permanent address assigned to the LD-250 Maintenance port

Use the following procedure to set up the network on the LD-250.

1. Connect an Ethernet cable from the Maintenance Ethernet port on the LD-250 to an Ethernet port on your Microsoft Windows PC.

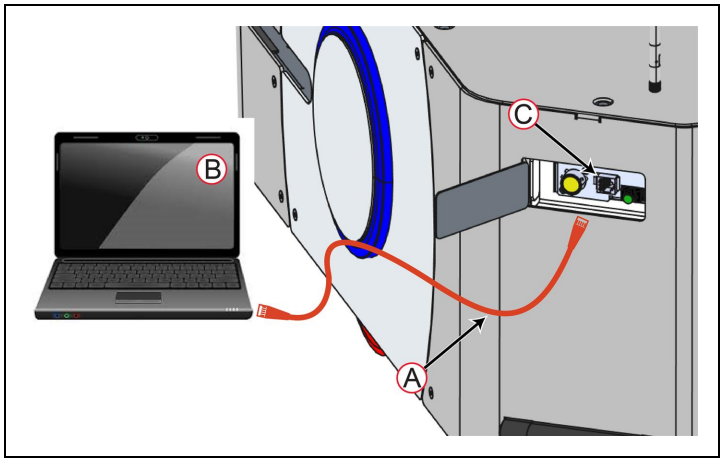


Figure 4-1 *Connecting an Ethernet Cable*

Callout	Description
A	Minimum specification Cat 5 Ethernet Cable.
B	Microsoft Windows PC with Ethernet LAN port.
C	LD-250 Maintenance Ethernet port (under a door in the rear skin).

2. In the Windows desktop Open or Search box (or at a command prompt) type the following command and press **Enter**:

   `ncpa.cpl`

   This command opens the Network Connections screen:

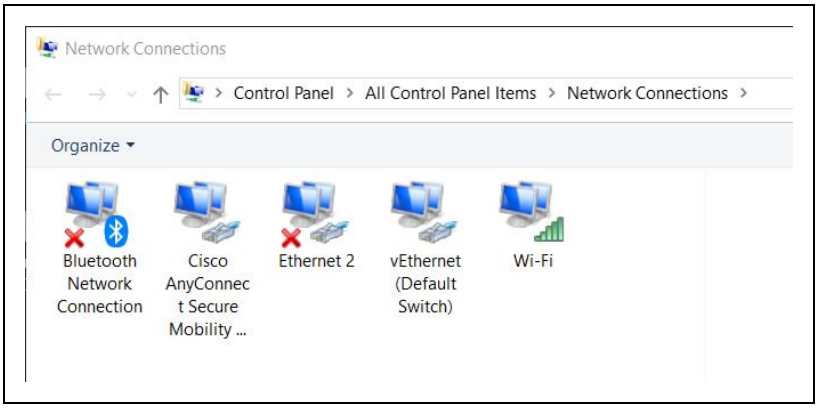


Figure 4-2 *Network Connections Screen.*

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

4. Click **Properties**, and then double-click the **Internet Protocol Version 4** connection item to open its Properties window.

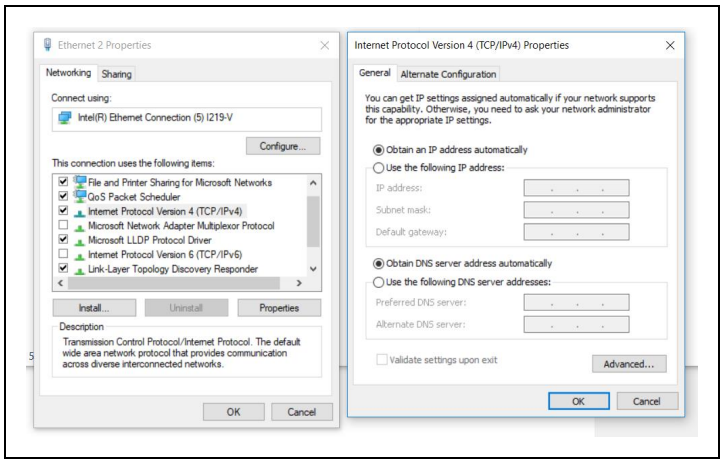


Figure 4-3 *Dialogs for the Ethernet Properties*

5. Click the radio button next to **Use the following IP address**.

6. Enter 1.2.3.X as the **IP address** and 255.255.255.0 as the **Subnet mask**.

   (Where x is any number 1 through 255 excluding 4.)

7. Click **OK** twice to exit both Properties dialogs, and then close the Network Connections screen.

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

1. Open a Web browser on the PC and enter **https://1.2.3.4** as the URL.
2. If prompted to accept security certificates, confirm that you accept them.
3. Verify that the SetNetGo Web UI opens.

Setting Up Wireless Ethernet

A single LD-250 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 187.

Before you configure wireless Ethernet on your LD-250, contact your network administrator to confirm the IP, radio, and security settings.

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

- Use the SetNetGo tab in the MobilePlanner software. See the Fleet Operations Workspace Core User's Guide.
- Open a Web browser on your PC and enter the URL: **https://1.2.3.4**, to connect directly to the SetNetGo Web UI on your LD-250. This enables your network administrator to set up the network for you, without using a licensed instance of 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	The only option is: Infrastructure		
Radio Mode	802.11a	802.11b/g	802.11a/g/b
Channel Set			
Wireless Watchdog IP Address			

Description	Your Data		
Wireless Watchdog Max Count (0 disables)			
Security encryption	Disabled	WEP (64 or 128-bit)	
	TKIP/RC4	CCMP/AES	TKIP/CCMP/AES
Authentication Method (OPEN is not recommended)	OPEN	WPA-PSK	WPA2-PSK
	EAP-TLS	PEAP-MSCHAPv2	

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

After you connect to the SetNetGo Web UI, 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.

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 Guide.

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.

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 cover, this number is less of a concern.

Payload structures might affect your bandwidth requirements, such as if the AMR supports a video camera that streams digital video through the AMR's wireless interface. Based on these possibilities, the bandwidth usage varies by application.

For more information about fleet wireless resources, see the EM2100 Installation Guide.

4.2 Create a Workspace Map

Map Creation Overview

You connect a joystick to the AMR to create the map. The process is described in detail in the *Fleet Operations Workspace Core User's Guide*. See: *Joystick Controls and Description* on page 138.

When you use the LD-250 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 make sure that wheel slip is minimal and 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 laser's scanning plane, which is at a height of 190 mm (7.48 inches) from the floor. Do this before you begin mapping the workspace.

Map Description

Before you can use your LD-250, 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 LD-250's Safety Scanning Laser scans the workspace to create the map. The laser scans only a narrow horizontal plane, parallel to the floor. The scanning plane height is 190 mm (7.48 inches) above the floor, so the laser 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:
    - cupboards 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 such as a column plinth that is below the scanning plane 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 zones**—Areas in the workspace where an AMR cannot enter or move across.
- **Speed zones**—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 Guide* for information about editing a map.

Mapping Tasks

Mapping includes the following tasks:

- Consider installing the docking station before you create a map file. This helps you to place the dock goals when you edit and customize the map.
- Drive the LD-250 with the joystick to make a workspace scan. We recommend that you drive it to and position it onto its automated docking station to prepare for the next steps.
- Load that workspace scan into the MobilePlanner software on your PC to create and edit a digitized map.
- Add job-related features such as routes, goals, and docks to your map. For example in MobilePlanner, you click **Working With Map Files** and then **Editing a Map File**. In the editing section, click **Using the Drawing Tools** and then **Adding Goals and Docks**.

  See the *Fleet Operations Workspace Core User's Guide* for more information.
- Transfer the working map to the Fleet Manager, or back to the LD-250, if you have only one AMR, to perform autonomous mobile actions.

  The Fleet Manager automatically downloads the new map to each AMR in your fleet as soon as the AMR becomes idle.
- Save 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 LD-250 and its payload.

CAUTION: PROPERTY DAMAGE RISK
If you change the value of the AbsoluteMaxTransVel parameter, re-commission the AMR before putting it into service.

If your payload's center of gravity is not within the guidelines provided in *Center of Gravity (CG)* on page 86, you might need to adjust the Absolute Movement Maximums parameter values 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 local Omron Support.

Table 4-1 lists the Absolute Movement Maximums parameter limits and defaults. The first four parameters have the least significant impact on the AMR's stability. All **Accel* and **Decel* parameters have a significant impact. If the payload is asymmetric, you might need to adjust the value of *AbsoluteMaxRotVel*.

Table 4-1 Absolute Movement Maximums Parameters

Parameter	Default	Min	Max	Your Min	Your Max
AbsoluteMaxTransVel	1200	1	32767		
AbsoluteMaxTransNegVel	-200	-32767[a]	32767		
AbsoluteMaxTransAccel	600	1	32767		
AbsoluteMaxTransDecel	2000	1000	32767		
AbsoluteMaxRotVel	120	1	32767		
AbsoluteMaxRotAccel	360	1	32767		
AbsoluteMaxRotDecel	360	-32767[a]	32767		

a: The LD-250's safety system generates a fault if the velocity is in the range -300 mm/s to -2500 mm/s.

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 4-1.

Reducing the value of the AbsoluteMaxTransDecel parameter requires that you:

- Increase the dimension of the AMR's safety zones. This is necessary to compensate for the increased stopping time. See: *Typical Operation* on page 117 and *Modify the Safety Zones* on page 197.
- Repeat the safety commissioning. See: *E-Stop Commissioning* on page 177.

The same considerations apply if you increase the AMR's physical length or width by adding an overhanging payload.

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 its lasers and for other model-specific features. SetNetGo provides a **Restore** option to revert the LD-250 to its default configuration

  You can obtain the default config file from your local Omron Support if you accidentally lose or overwrite it. Use MobilePlanner or the SetNetGo Web interface to preserve a copy of the original file. See: *Download a Debuginfo File for Support* on page 24.

- **Safety Zone Configuration**—Use the OS32C configuration tool to configure and modify safety zones. Before making any modifications, connect to the laser to export and save the original file.

  Typically, you modify the safety zones:

  - If your payload overhangs the AMR's default dimensions.
  - You reduce the value of AbsoluteMaxTransDecel.
  - If operating on a floor surface that has poor traction to the extent that the AMR cannot stop reliably within the default zones.

The parameter groups that control laser settings are:

- Laser_1 Settings are for the main scanning laser, used for localization.
- Laser_2 Settings are for the low front laser (TiM).
- Laser_3 Tilted and Laser_4 Tilted are for the optional side lasers (TiM).

  The position for these lasers is application-specific. You must specify the X, Y, Z, coordinates and the rotation of these lasers, relative to the center of rotation of the AMR and the floor.

- Laser_5 Settings are for the optional rear-facing laser.

You do not necessarily need to use lasers 3, 4, and 5 for these specific purposes, these are the Omron-recommended uses, so the default configurations for these lasers apply to these typical applications.

Chapter 5: Payload Structures

A payload structure is any mechanical equipment that you attach to the LD-250 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 LD-250 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 LD-250.

5.1 Safety

Warning Label

A No Riding label ships, unattached, with each LD-250. You must place this in a prominent location on the payload, so operators will see it.

Other warning labels are applied at the factory.

Warning Lights

Your AMR should include warning lights appropriate for its application.

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 LD-250 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* on page 109.
- Provision for an auxiliary warning light on the LD-250 Core (the Light Pole connector, described in *LD-250 Core Rear Upper Connectors* on page 100. You can use this connector

to mount a warning light in a more prominent location, which might be appropriate for AMRs that have taller payloads.

Warning Buzzer

The LD-250 Core provides an output for controlling a warning buzzer as an auditory warning device. The default behavior of the buzzer is to sound when the AMR is moving in reverse, or when its safety systems are off.

You can configure the buzzer's operation. For example, you can set it to make a warning noise whenever the AMR is moving.

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.

Adding weight to the LD-250 tends to have less effect on battery run time than does increasing electrical power consumption.

Operating your AMR over soft surfaces (such as carpet) significantly shortens battery runtime than compared to hard surfaces.

Weight Constraints

The total operating weight of the AMR should comply with its specifications for payload and any objects carried.

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 LD-250 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.
- The AMR might become unstable at lower speeds compared to the platform alone.

NOTE: The total weight of your payload structure plus any objects carried by the payload must not exceed the rated capacity of your LD-250. See: *Technical Specifications* on page 191.

Power Consumption

Any electrical devices on your payload structure that consume significant power will noticeably shorten the AMR's run time.

Minimize power consumption whenever possible. The battery is rated at 1840 W*hr (1.84 kWh). Examples of power-consuming payload structures are robot arms attached, or a motorized conveyor.

Power Limits

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

- *Aux Power* on page 105
- *User Power* on page 105
- *Power Connections* on page 101

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

- For the 5VDC, 12VDC and 20VDC connections max inrush peak current is 2A.
- For Battery_Out_1 and Battery_Out_2 max inrush peak current is 10A.
- For Battery_Out_3_and_4 max inrush peak current is 20A.

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:

Overcurrent Level	Overload Duration
40 A	8 sec
64 A	250 ms
96 A	250 us

Payload Bay Access

The area between the LD-250 and your payload structure is the payload bay. This is where you access the LD-250 Core's power and I/O connectors, in addition to any mechanical fasteners that secure your payload to the LD-250.

Considerations when designing your payload structure are:

- Provide access to the payload bay for serviceability.
- If the payload structure is small and light enough, you might be able lift it off the LD-250 or loosen it and slide it along the load bars to access the payload bay
- Always take care to not damage any cabling between your payload structure and the LD-250. Provide adequate slack in all cables, or include connectors
- Label all cables for accurate reconnection.
- Larger, heavier payload structure might require a hinge, so you can tilt the payload structure out of the way while you access the payload bay.

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 payload bay. Doing so might place parts of the structure outside the safety envelope provided by the safety laser.

If you do design an overhanging payload, be aware that you might also need to:

- Change the size of the main laser's safety zones. See:
  - *Lasers* on page 133.
  - *Modify the Safety Zones* on page 197.
- Repeat the safety commissioning. See: *E-Stop Commissioning* on page 177.
- Modify the **Robot Physical: General** parameters to change the AMR's width, LengthFront, LengthRear, and potentially its Radius

  These modifications make sure that the AMR's accurate dimensions are used during path planning and obstacle avoidance.
- Modify the value of the **AbsoluteMaxRotVel** parameter so that no part of the AMR exceeds a speed of 300 mm/sec during rotation. See: *Overhanging Payloads and the AMR Swing Radius* on page 194.

Side lasers are useful only if the overhang might cause the AMR to encounter obstacles that are not visible to the main scanning laser, or its low front laser.

Do Not Block AMR Sensors

The payload, and anything it carries, must not extend below the height of the payload bay. If the payload blocks any of the LD-250's sensors, it cannot function correctly.

If you install optional rear or side-mount lasers, make sure that the payload structure does not interfere with the laser's beams. Mount side (tilted) on each side of the payload structure in such a way that they do not detect the structure itself. See: *Side Lasers (Supplemental) Lasers* on page 189.

If it is not possible to prevent some interference between the structure and the side laser's 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 that sensor, and you should avoid using LaserIgnore if at all possible.

Consider using a protective guard over side lasers to protect them from damage. Make sure that guards do not block the laser beam or extend outward too far.

Mounting Locations in the Payload Bay

The payload bay is located under the LD-250's top skin. It provides access to the LD-250 Core for power and data connections, and attachment points for your payload structure.

Payload Mount Points - T-Slotted Extrusions

The top plate in the payload bay contains an longitudinal and transverse load-bearing extrusions that provide adaptable mount points. Additional clip nuts are provided around the edge of the plate. Figure 5-1 shows the location of mount points and the center lines. For the location of the center of gravity, see: *Dimension Drawings* on page 191.

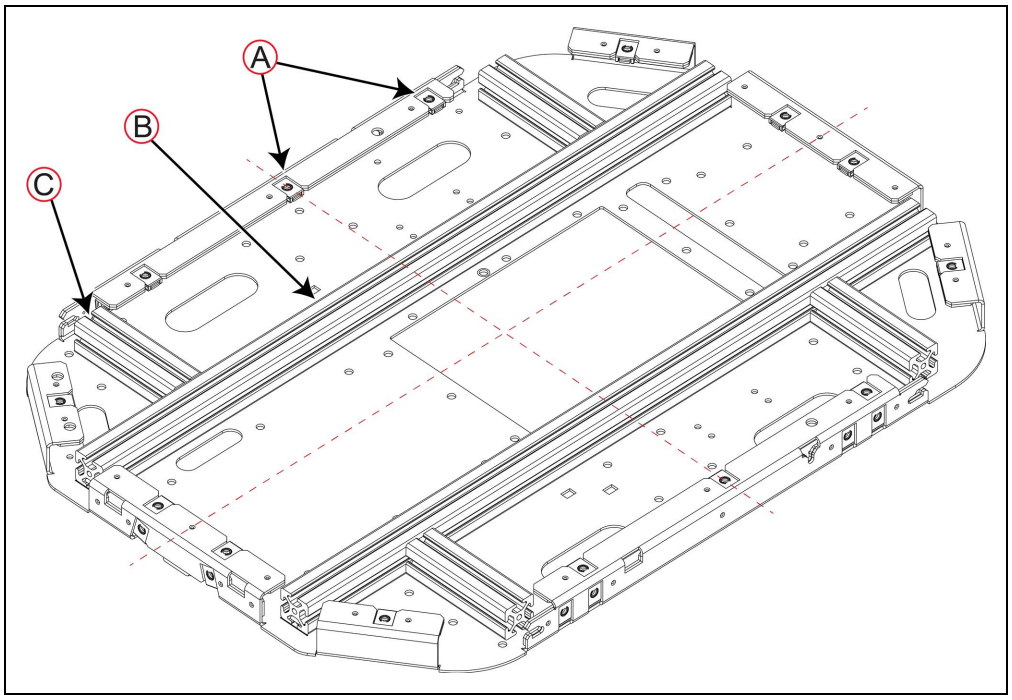


Figure 5-1 *Payload Mount Locations*

Callout	Description
A	Location of the clip nuts
B	Longitudinal T-nut extrusion
C	Transverse T-nut extrusion

The extrusion's cross section is a 40 mm x 40 mm (1.57 inches x 1.57 inches) square T-slot profile with three open T-slots, one on each 40 mm face.

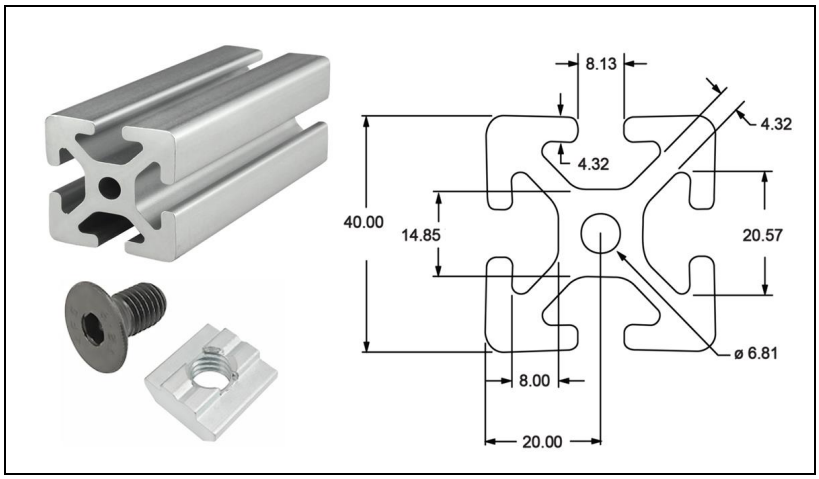


Figure 5-2 *Payload Mount Extrusion, Dimensions in Millimeters and T-nut*

These extrusions bear the main structural load of any payload, transferring stresses directly to the LD-250's formed steel chassis. You can easily adjust and move your payload in relationship to the LD-250's center of gravity (see: *Center of Gravity (CG)* on page 86).

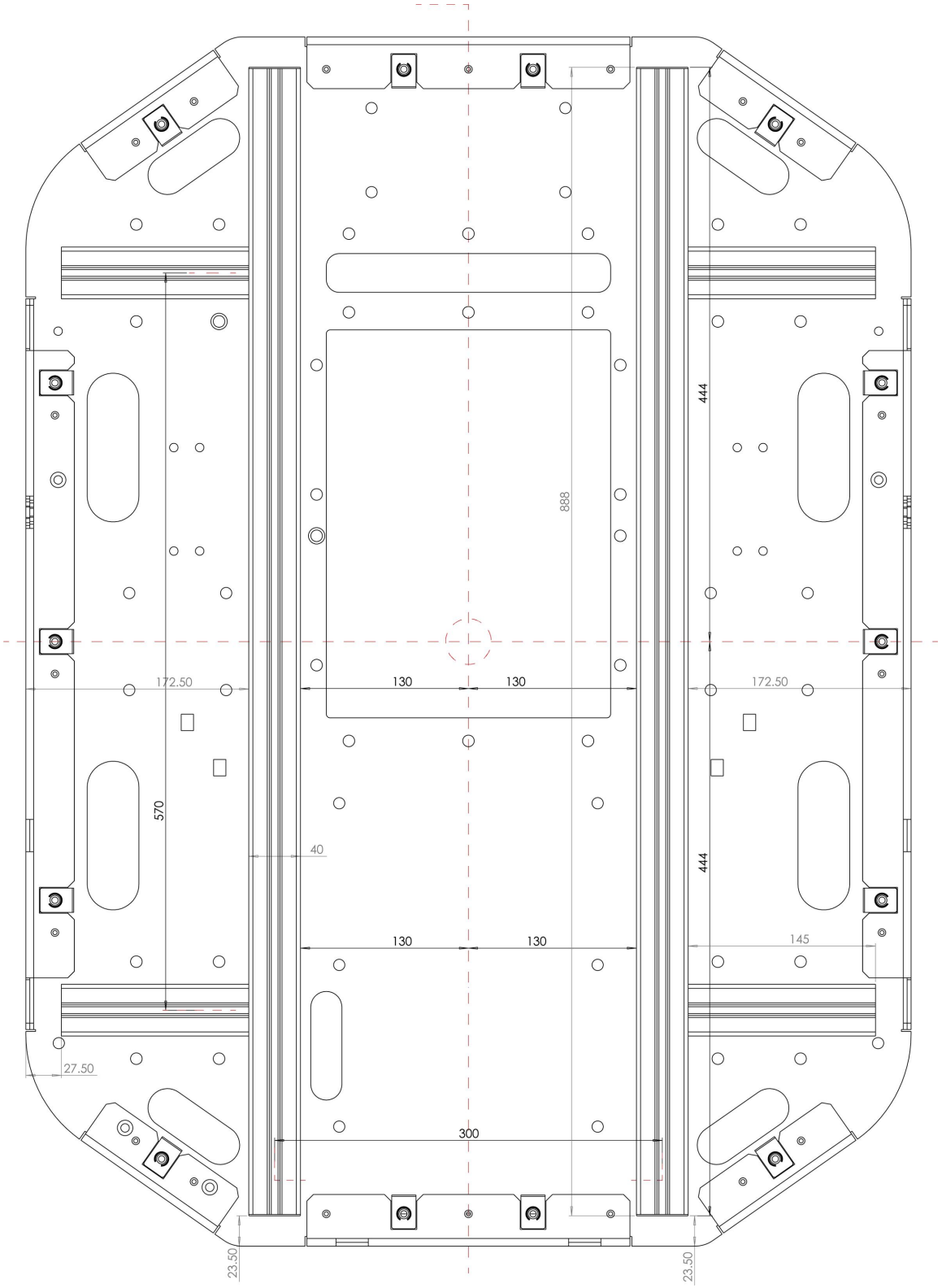


Figure 5-3 *T-Nut Extrusion Locations on the Top Plate*

Use T-nuts appropriate for the mass of your payload. To maintain access to the payload bay, consider incorporating hinged attachment points on one side of your payload structure so that you can tilt it away from the bay.

Secondary Mount Points - Top Plate Clip Nuts

Clip nuts (14) around the rim of the top plate can accept smaller loads such as payload skins or covers. These locking-thread M6 clip nuts provide attachment points for the standard top skin option provided for the LD-250.

> **IMPORTANT:** Do not use the clip nuts to support the payload itself, make all load-bearing attachments only to the T-slot aluminum extrusions.

Figure 5-4 shows the approximate positions of the clip nuts relative to the edge of the top plate and its center lines. You can obtain the CAD and engineering drawing sources from the Omron Web site if you need to determine the precise locations.

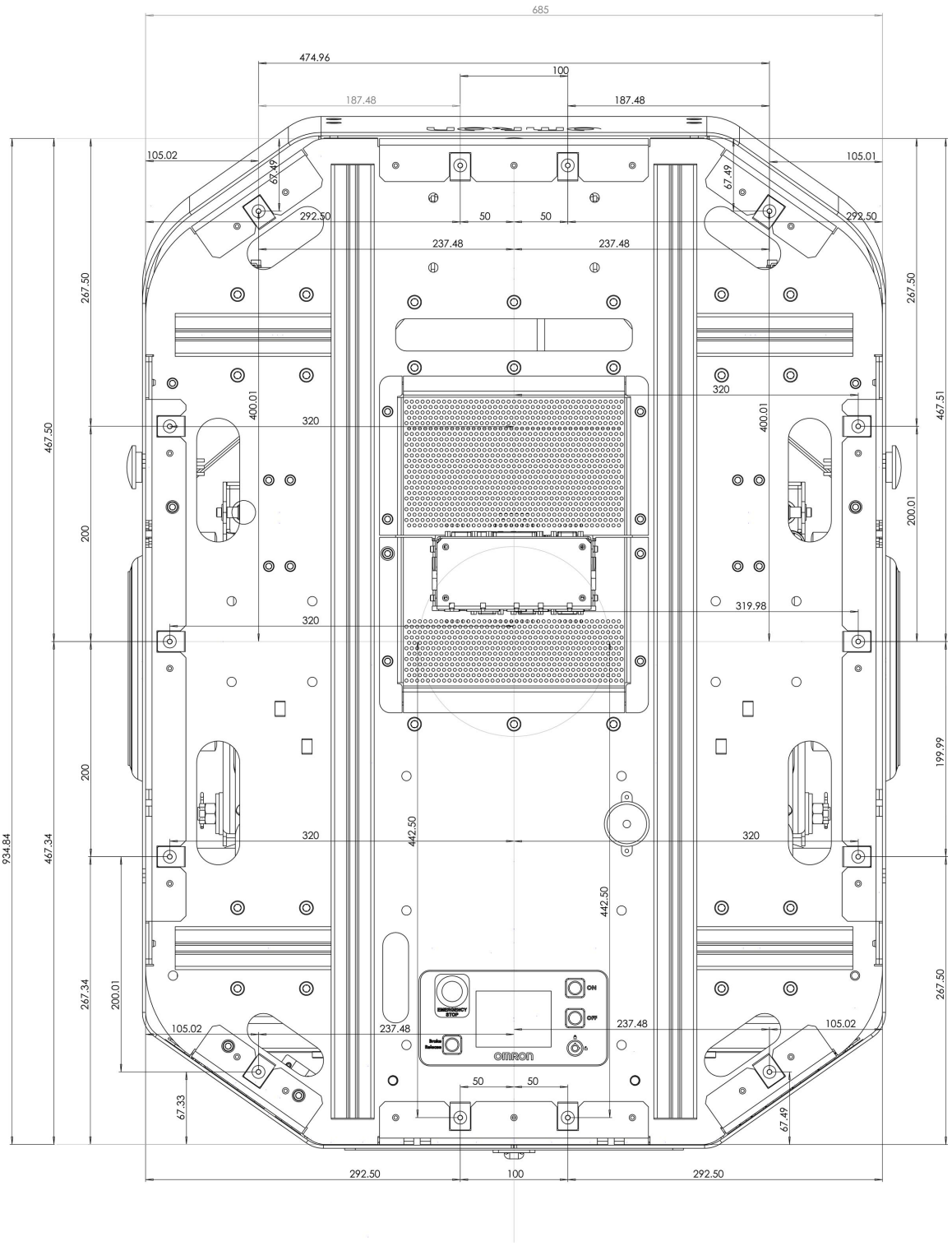


Figure 5-4 *Position of the Clip Nuts Around the Payload Bay*

AMR Coordinate System

Omron AMRs use the X, Y, Z and Theta (θ coordinate system. This information is relevant for some of the procedures used in this manual, such as identifying which are the left or right skins. For example, the joystick port is located in the rear left skin. The origin of the coordinate system is the AMR's center of rotation, not its geometric center.

Coordinates are required for procedures such as installing and configuring options such as lasers and the Acuity camera, 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 vertical coordinate (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.

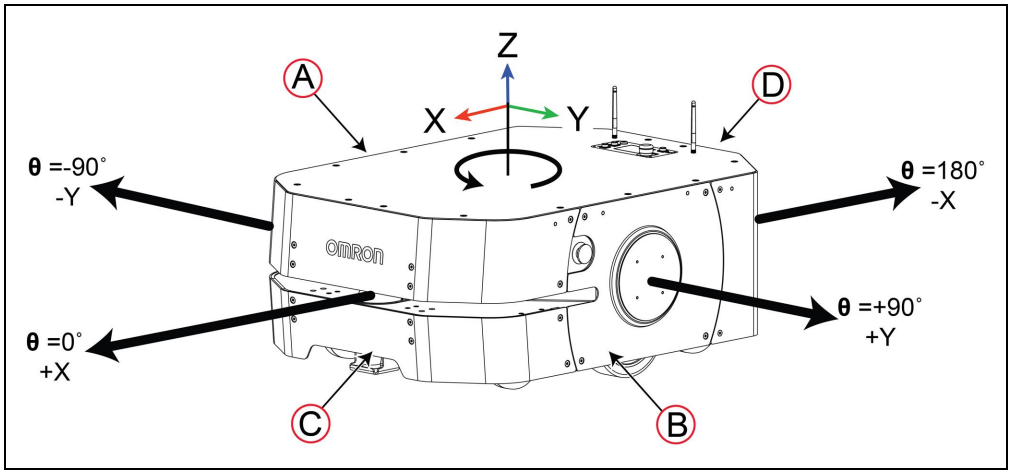


Figure 5-5 AMR Coordinate System

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

See: *Dimension Drawings* on page 191 for the location of the AMR's center of rotation.

Center of Gravity (CG)

Keep your payload structure's center of gravity (CG) centered over the LD-250's own center of gravity and as low (close to the LD-250's top) as possible. This provides optimum stability, particularly when the LD-250 crosses raised thresholds or irregularities in the floor.

See: *Dimension Drawings* on page 191 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 wheel hubs, about which the LD-250 will rotate.
- **Geometric Center**—The center of two lines bisecting the LD-250's outline.
- **Center of Gravity**—The unloaded LD-250's center of gravity.
- **X and Y Axis Mid-lines**—Lines that cross in the geometric center of the LD-250.
- **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 86.

Tilt Detection and Reporting

If the AMR tilts more than 60 degrees in any direction, an E-Stop event occurs. This is not intended to prevent the AMR from tipping over. However, it can notify you if the AMR runs off a ramp or tilts over for any reason. See: *Releasing an E-Stop* on page 31.

Safe Payload Placement

The graphics in this section show the calculated safe CG dimension and placement for payload structures (that must also comply with the specified weight limit). The payload structure's CG, in each instance, must be within the defined area.

Assumptions in these calculations are:

- The payload is securely attached to the AMR and does not overhang.
- The suspension is set at the factory default (2nd hole). If you adjust the suspension for any reason, it affects the payload center of gravity.
- The AMR does not exceed its specified maximum limits for:
  - Acceleration, deceleration, and velocity.
  - Angular velocity, particularly on inclines.
  - Incline angle (ramp).

In the following graphical representations:

- A is the top of the payload bay.
- B defines the recommended envelope of the payload.
- X is the direction of the AMR's motion (front to rear).
- Y is perpendicular to the AMR's direction of motion (side to side).
- Z is the vertical dimension (height).

All dimensions are in millimeters (mm). See also: *AMR Coordinate System* on page 86.

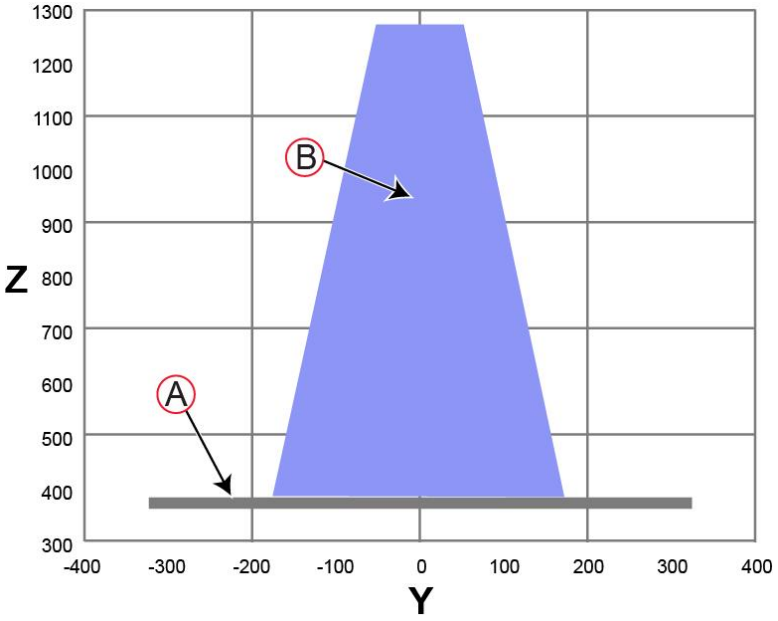


Figure 5-6 *Front View (Y) of Recommended Payload CG (mm)*

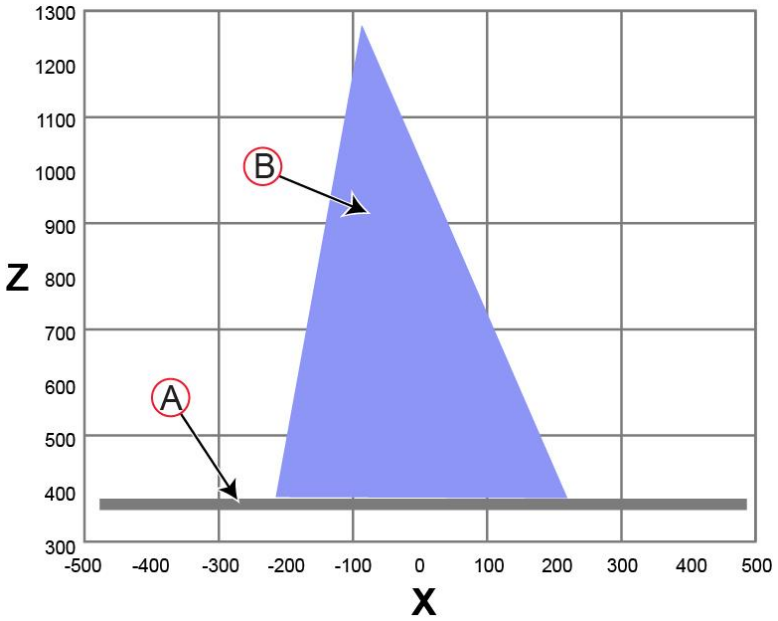


Figure 5-7 *Side View (X) of Recommended Payload CG (mm)*

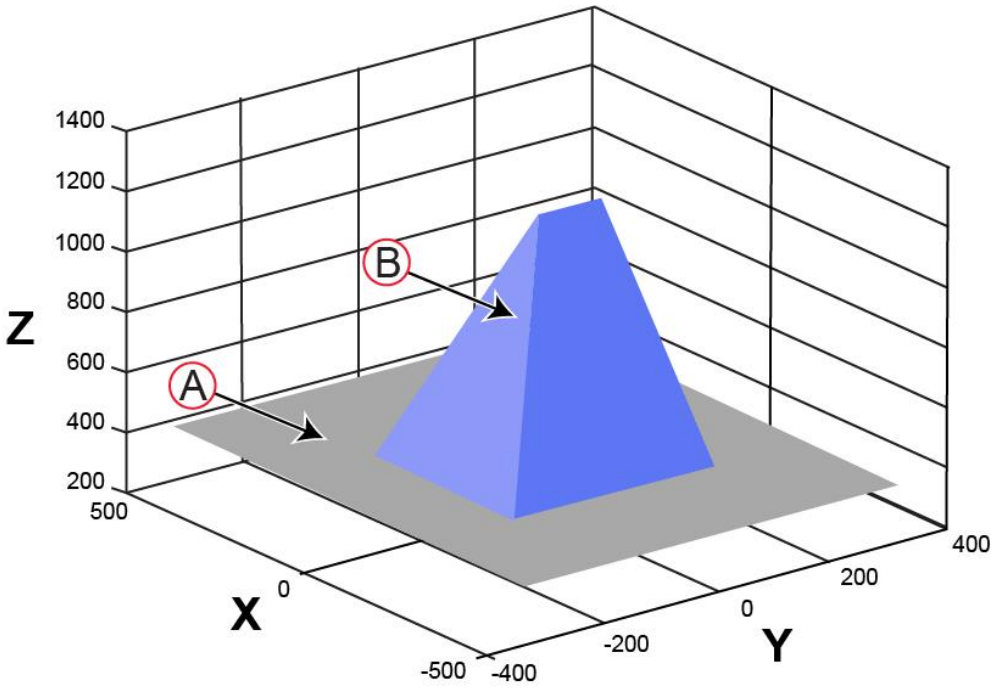


Figure 5-8 *3D View of Recommended Payload CG (mm)*

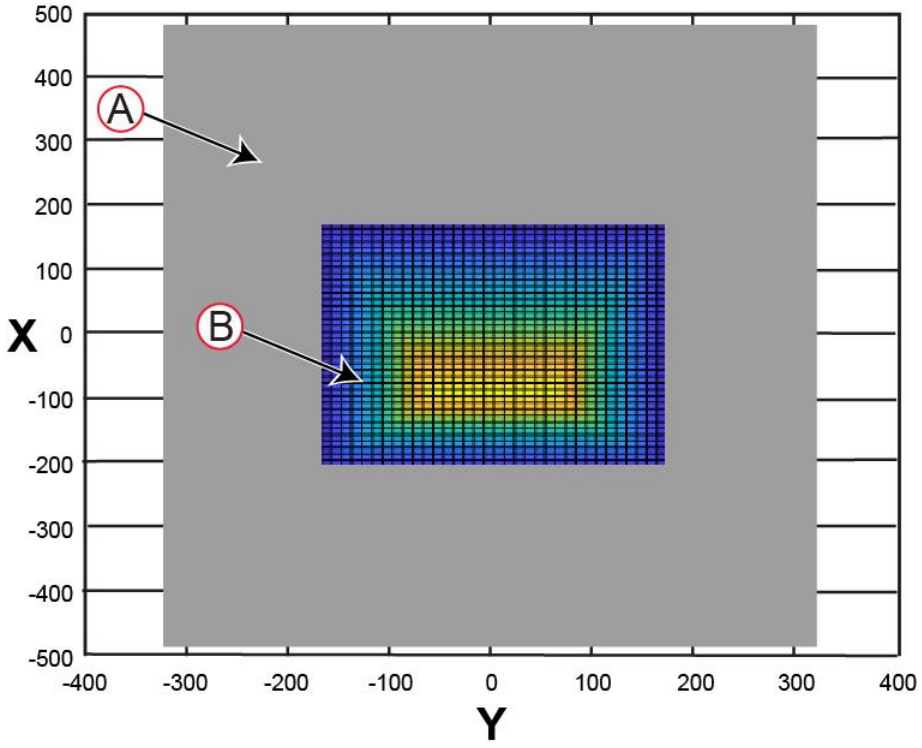


Figure 5-9 *Top View (Z) of Recommended Payload CG (mm)*

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 its driving characteristics. This is necessary so that the AMR remains consistent and safe in operation.

Contact your local Omron Support If your parameters differ from those described in this section. In general, you must reduce the maximum acceleration, deceleration, and rotational velocities. See: *Acceleration, Deceleration, and Rotation Limits* on page 74.

5.4 Connections Between the LD-250 and a Payload Structure

The LD-250 Core provides user connections for data communications (I/O) and power. Use these connections for Omron options, or for powering and controlling your payload structure.

Operator Panel (HMI) on the Payload

You can move the Operator panel, with its integrated E-Stop, Brake-release, ON, and OFF buttons, by routing a single connector cable (the HMI Panel connector).

This portability enables you to put many of the more common operator controls in a convenient location on the payload.

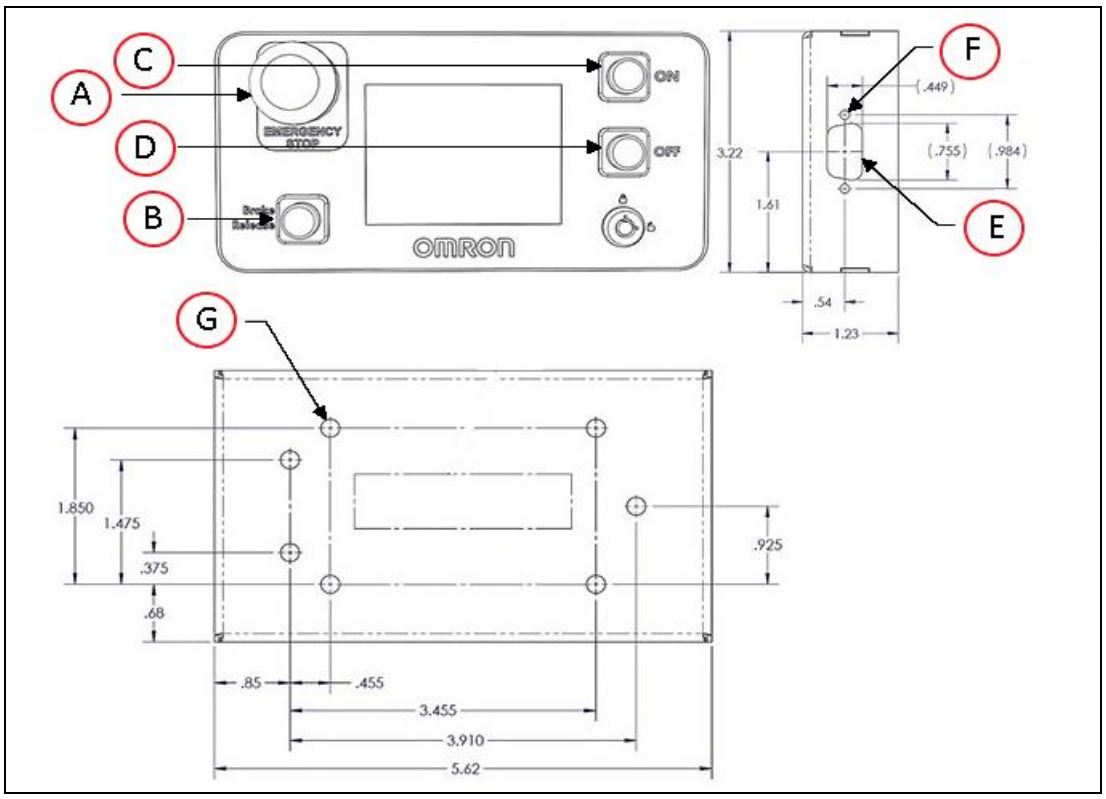


Figure 5-10 *Standard Operator Panel (units are mm)*

Callout	Description	Callout	Description
A	Emergency Stop	E	15 Pin High Density D-Sub
B	Brake Release	F	D-Sub hex nuts
C	On Button	G	7x 0.213 Through Hole
D	Off Button		

An additional touchscreen panel, is available as an option to display MR status, The touch-screen does not include the switch an button controls integrated into the Operator panel (HMI). See *Touchscreen* on page 188. Many other LD-250 Core connections are available. For details and specifications of available connections, refer to *Connectivity* on page 93.

E-Stop Considerations when Removing the Operator Panel

If you remove the Operator Panel, you should replace its E-Stop button with an alternate E-Stop button located on the payload. This E-Stop must be:

- Wired to the Operator Panel (HMI) E-Stop chain via the Operator Panel cable, and not through the User E-Stop.

  If not, you must properly terminate the Operator Panel E-Stop chain:

  1. Keep the Operator Panel's cable in place, connected to the LD-250 core.
  2. Securely attach a jumper (Part Number 13387-000) to terminate the end of the cable (in place of the Operator Panel).
  3. Loop the cable and secure it with zip ties within the payload bay so that it does not interfere with the payload or any other moving parts.
- Located within the 600 mm reach requirement. See: *Positioning an Optional Payload E-Stop* on page 126.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Failing to properly terminate the Operator Panel cable can prevent E-Stop buttons from operating correctly. This can prevent you from stopping the AMR during an emergency, and could result in injury or damage to property.

Optional Connections

You can connect:

- Optional user bumpers for your payload. See: *User Bumper* on page 105
- Warning lights. See:
  - *LIGHTS (Light Pole)* on page 102
  - *Indications Provided by Light Discs Light Outputs* on page 127

Chapter 6: Connectivity

LD Core connections available to the user are accessible in the payload bay under the LD-250's top cover plate. The payload bay provides strong mechanical connection points and access to data and signal (I/O) and electrical power connections.

The two connections outside of the payload bay are the Joystick port and the Maintenance Ethernet port, which are located under an access door on the rear of the LD-250 (see: Figure 4-1). Both external ports are connected to the LD-250 Core inside the payload bay.

6.1 Connections Required for Set Up

At a minimum, you require the following connections.

Connection Type	Purpose
Joystick port	To create a workspace map, connect a joystick to the LD-250's Joystick port. The Joystick port is located under a small access panel on the LD-250's rear skin. This is internally connected to the LD-250 Core in the payload bay.
Maintenance Ethernet	The Maintenance Ethernet port is located under a small access panel on the LD-250's rear skin. This is internally connected to the LD-250 Core in the payload bay. Connect to the port using an RJ-45 Ethernet cable.
Wireless Ethernet	The LD-250 Core provides two connections for wireless antennae. Two 2.3 m (7 feet) RG58A/U, 1C/20AWG low loss extension cables are provided. The cable has two 6.35 mm (0.25 in) SMA coaxial connectors. Use the same specification if you require a longer cable for your payload. Do not relocate the antenna to a payload position where the signal might attenuated.
Docking Station	Power only.

6.2 Payload Bay Connections - LD-250 Core

The connections described in this section are available for use with standard options and user-supplied accessories. The LD-250 ships with dual antennas that you can relocate if necessary. If you relocate the antenna, 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. This includes all of the connectors on the right side of the LD-250 Core.

LD-250 Core Front, Upper

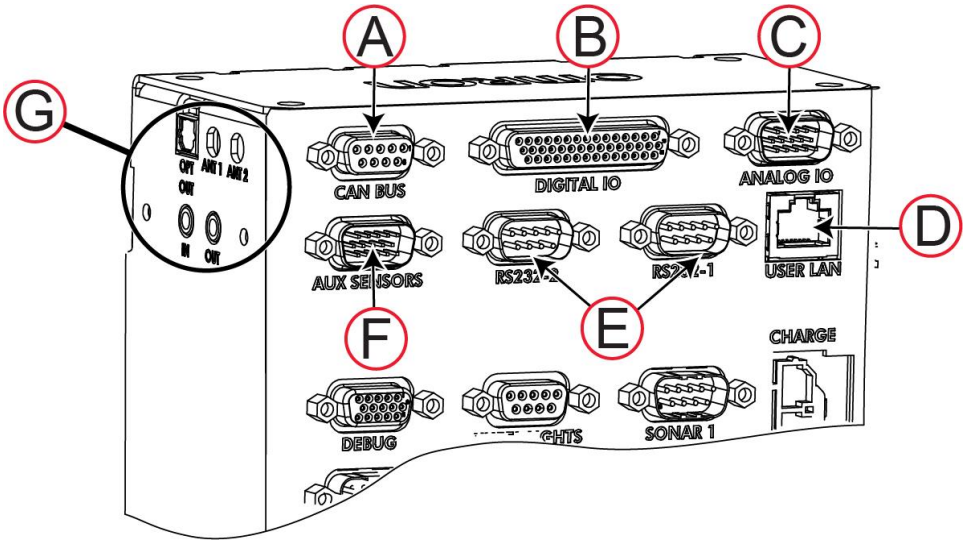


Figure 6-1 *Front Upper LD-250 Core*

ID	Connection	Type	Description
A	CAN Bus B	DB9F	Consult your local Omron Support for use.
B	Digital I/O[a]	HDB44F	16 digital inputs, in 4 banks of 4. Each bank can be wired as active high or active low depending on the connection of the BANK# terminal. V_{IN} range for each input is 0 to 30 V. The input is ON when V_{IN} > 4 V, OFF when V_{IN} < 1.3 V.
C	Analog I/O		General use.
D	User LAN	RJ45	General Ethernet, Auto-MDIX, shielded
E	RS-232 x 2	DB9M	Port 1 and Port 2, general use
F	Aux Sensors	HDB15M	Low front and optional side lasers
G	Right-Side Connectors	Various	Not described in this manual.

[a] 16 digital outputs, protected low-side drivers. Wire these outputs to positive voltage through the load. Output is open when OFF and grounded when ON. Each open-drain output is capable of sinking 500 mA. May be used with loads connected to VBAT, AUX_20V, _12V, or _5V. You must stay within the allowed current capacity of the VBAT or AUX power supplies.

Digital I/O

The LD-250 Core's Digital I/O HDB44F connector provides the user with digital inputs and outputs for payload customization.

	Designation		
Pin No.	**Hardware**	**Software**	**Notes**
1	INPUT_1.1	Input_1.1	0 – 30 V Range, R_{in} = ~3.9 kΩ
2	INPUT_1.2	Input_1.2	0 – 30 V Range, R_{in} = ~3.9 kΩ
3	INPUT_1.3	Input_1.3	0 – 30 V Range, R_{in} = ~3.9 kΩ
4	INPUT_1.4	Input_1.4	0 – 30 V Range, R_{in} = ~3.9 kΩ
5	BANK1		Common for INPUT_1.X
6	INPUT_2.1	Input_2.1	0 – 30 V Range, R_{in} = ~3.9 kΩ
7	INPUT_2.2	Input_2.2	0 – 30 V Range, R_{in} = ~3.9 kΩ
8	INPUT_2.3	Input_2.3	0 – 30 V Range, R_{in} = ~3.9 kΩ
9	INPUT_2.4	Input_2.4	0 – 30 V Range, R_{in} = ~3.9 kΩ
10	BANK2		Common for INPUT_2.X
11	INPUT_3.1	Input_3.1	0 – 30 V Range, R_{in} = ~3.9 kΩ
12	INPUT_3.2	Input_3.2	0 – 30 V Range, R_{in} = ~3.9 kΩ
13	INPUT_3.3	Input_3.3	0 – 30 V Range, R_{in} = ~3.9 kΩ
14	INPUT_3.4	Input_3.4	0 – 30 V Range, R_{in} = ~3.9 kΩ
15	BANK3		Common for INPUT_3.X
16	INPUT_4.1	Input_4.1	0 – 30 V Range, R_{in} = ~3.9 kΩ
17	INPUT_4.2	Input_4.2	0 – 30 V Range, R_{in} = ~3.9 kΩ
18	INPUT_4.3	Input_4.3	0 – 30 V Range, R_{in} = ~3.9 kΩ
19	INPUT_4.4	Input_4.4	0 – 30 V Range, R_{in} = ~3.9 kΩ
20	BANK4		Common for INPUT_4.X
21	OUTPUT_1	Output_1	
22	OUTPUT_2	Output_2	
23	OUTPUT_3	Output_3	
24	OUTPUT_4	Output_4	
25	OUTPUT_5	Output_5	
26	OUTPUT_6	Output_6	
27	OUTPUT_7	Output_7	
28	OUTPUT_8	Output_8	
29	OUTPUT_9	Output_9	
30	OUTPUT_10	Output_10	

	Designation		
Pin No.	**Hardware**	**Software**	**Notes**
31	OUTPUT_11	Output_11	
32	OUTPUT_12	Output_12	
33	OUTPUT_13	Output_13	
34	OUTPUT_14	Output_14	
35	OUTPUT_15	Output_15	
36	OUTPUT_16	Output_16	
37	VBAT_IO_OUT4		VBAT @ 0.5 A Max (shared with light pole)
38	VBAT_IO_OUT3		VBAT @ 0.5 A Max
39	VBAT_IO_OUT2		VBAT @ 0.5 A Max
40	VBAT_IO_OUT1		VBAT @ 0.5 A Max
41 - 44	GND		

Digital Input Specifications

The following tables describe specifications for the LD-250 Core's digital inputs.

Table 6-1 Digital Input Specifications

Parameter	Value
Operational voltage range	0 to 30 VDC
OFF state voltage range	0 to 1.3 VDC
ON state voltage range	4 to 30 VDC
Operational current range	0 to 7.5 mA
OFF state current range	0 to 0.5 mA
ON state current range	1.0 to 7.5 mA
Impedance (V_{in}/I_{in})	3.9 kΩ minimum
Current at V_{in} = +24 VDC	$I_{in} \leq 6$ mA

NOTE: The input current specifications are provided for reference. Voltage sources are typically used to drive the inputs.

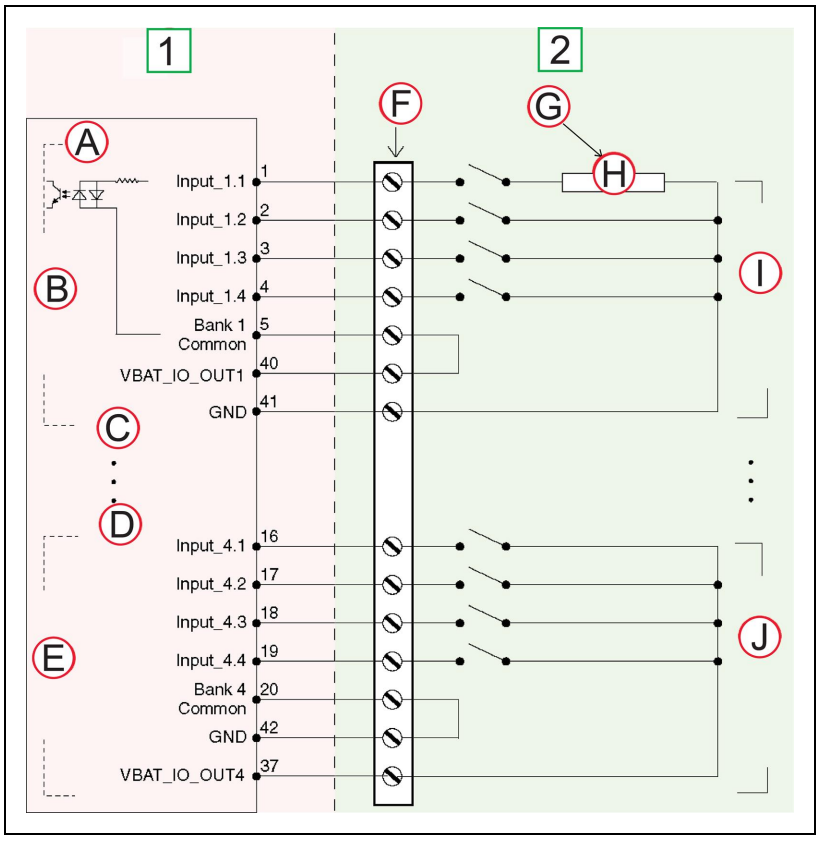


Figure 6-2 *Typical Digital Input Wiring Example*

Callout	Side 1 (Left) I/O Connector	Callout	Side 2 (Right) User-Supplied Equipment
A	Equivalent Circuit	F	Terminal Block
B	Input Bank 1	G	Typical User Input Signal
C	Input Bank 2	H	Part Present Sensor
D	Input Bank 3	I	Bank 1 configured for sinking (NPN) inputs
E	Input Bank 4	J	Bank 4 configured for sinking (PNP) inputs

NOTE: You can use all input signals for either sinking or sourcing configurations.

Table 6-2 Digital Output Specifications

Parameter	Value
Power supply voltage range	5 - 30 VDC
Operational current range, per channel	$I_{out} \leq 500$ mA
ON state resistance ($I_{out} = 0.5$ A)	$R_{on} \leq 0.14\ \Omega$ @ 85°C
Output leakage current	$I_{out} \leq 5\ \mu A$
DC short circuit current limit	$0.7\ A \leq I_{LIM} \leq 1.7\ A$

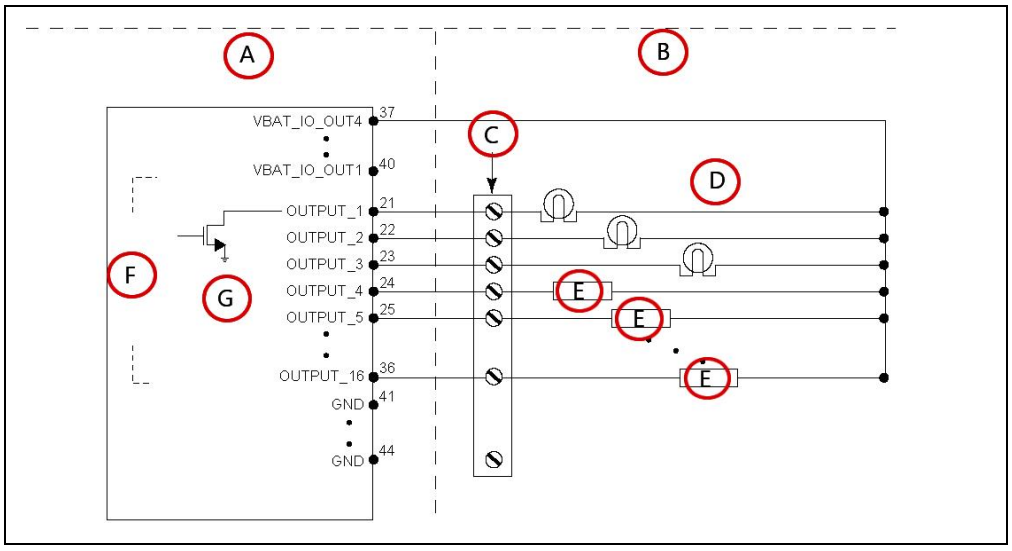


Figure 6-3 *Typical Digital Output Wiring Example*

Callout	Description	Callout	Description
A	Standard Equipment	E	Load
B	User-Supplied Equipment	F	Outputs 1-16
C	Wiring Terminal Block	G	Equivalent Circuit
D	Typical User Loads		

Analog I/O

The LD-250 Core's Analog I/O HDB15M connector is reserved for internal use only. Contact your local Omron Support before attempting to use these circuits.

Aux Sensors

The LD-250 Core's Aux Sensors HDB15M connector provides circuits used by the Low Front Laser and optional Side Lasers (tilted lasers).

	Designation		
Pin No.	Hardware	Software	Notes
1	RS232_VERT1_TXD		/dev/ttyUSB5 (side lasers)
2	RS232_VERT2_TXD		/dev/ttyUSB6 (side lasers)
3	RS232_FOOT_TXD		/dev/ttyUSB7 (low front laser)
4	5V_SW1	USB_1_and_2_Power	5 V @ 1 A (shared with USB port 1)
5, 10	SW_20V_VERT	Vertical_Laser_Power	20 V @ 300 mA (side lasers)
6, 7, 8	GND		
9	5V_SW2	USB_1_and_2_Power	5 V @ 1 A (shared with USB port 2)
11	RS232_VERT1_RXD		/dev/ttyUSB5 (side lasers)
12	RS232_VERT2_RXD		/dev/ttyUSB6 (side lasers)
13	RS232_FOOT_RXD		/dev/ttyUSB7 (low front laser)
14	5V_SW3	USB_3_Power	5 V @ 1 A (shared with USB port 3)
15	SW_20V_FOOT	Foot_Laser_Power	20 V @ 150 mA (low front laser)

RS232 1 and 2

The LD-250 Core's RS232 1 and 2 DB9M connector provides two ports for use with peripheral devices such as the HAPS sensors (See: *High-Accuracy Positioning System (HAPS)* on page 190.)

If not used for other devices, you can also use the ports for port forwarding information from other RS232 devices. See the SetNetGo chapter in the Fleet Operations Workspace Core User's Guide.

Pin No.	Designation	Notes
1, 4, 6, 9	No Connection	
2	RS232_USR#_RXD	#=1 or 2
3	RS232_USR#_TXD	#=1 or 2
5	GND	
7	RS232_USR#_RTS	#=1 or 2
8	RS232_USR#_CTS	#=1 or 2

LD-250 Core Rear Upper Connectors

Figure 6-4 shows the connectors on the LD-250 Core's upper rear interface panel. Some if these connectors are available for customer use.

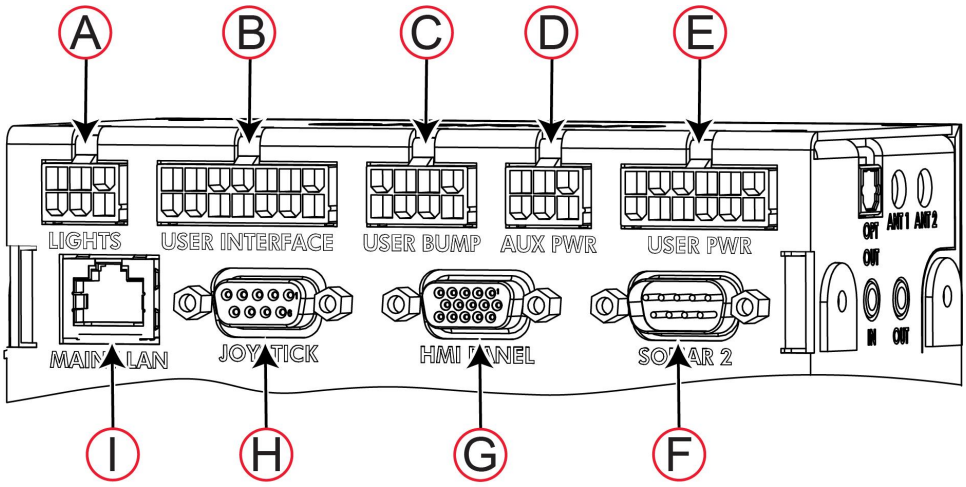


Figure 6-4 *LD-250 Core Rear Upper Interface Panel*

Table 6-3 describes the connector type and typical use of the connector.

Table 6-3 Connectors on the LD-250 Core's Rear Upper Interface Panel

ID	Connection	Type	Description
A	Lights	Mini-Fit 2 x 3	Connect to a supplied splitter that powers a buzzer using a default configuration, and provides power for a user-supplied light tower with 3 lights.
The following four functions are pins on the User Interface connector.			
B	Brake-release	Mini-Fit 2 x 7	Pins for user-supplied brake release
	ON		Pins for user-supplied ON button; same function as Operator Panel ON
	OFF		Pins for user-supplied OFF button; same function as Operator Panel OFF
	E-STOP		Pins for user-supplied E-Stop. Jumper if not used.
C	User Bumpers	Mini-Fit 2 x 4	Payload structure bumpers, user-supplied, connected between E-STOP_SRC and USER_BMP# (for each of the 6 inputs). Contacts 1 - 3 are for a front bumper, 4 - 6 for rear. Contacts should be 12 V @ 10 mA.
D	Aux Power	Mini-Fit 2 x 3	5, 12, and 20 VDC Outputs
E	User Power	Mini-Fit 2 x 6	Battery and switched battery power
F	Sonar 2	DB9M	Not used
G	HMI Panel	HDB15F	Operator screen, E-Stop, Brake_Rel, ON, OFF.
H	Joystick	DB9F	Directly connected to the externally-mounted Joystick port
I	Maint LAN	RJ45, Shielded	Directly connected to the externally-mounted Maintenance Ethernet, Auto-MDIX.
[a] Molex Mini-Fit Jr™ 5557 series receptacles.			

Joystick Connector

The LD-250 Core's Joystick DB9F connector is replicated on the AMR's exterior under a small door on the rear (see *LD-250 Features.* on page 12)

Use the Joystick for manual driving and mapping.

Power Connections

The LD-250's battery provides conditioned 5, 12, and 20 VDC, and raw (battery) 22 - 30 VDC power to the LD-250's accessory electronics, including the LD-250 Core and laser LIDAR (Light Detection And Ranging).

All power connectors are Mini-Fit®.

Refer also to *Power Consumption* on page 79

Nominal	Qty	Actual	Maximum Current	Description
5 VDC	1	5 VDC±5%	1 A	Switched Aux power
12 VDC	1	12 VDC±5%	1 A	Switched Aux power
20 VDC	1	20 VDC±5%	1 A	Switched Aux power
22 - 30 VDC	2	battery	4 A	Switched
22 - 30 VDC	1*	battery	10 A	Switched
22 - 30 VDC	1*	battery	10 A	Safe, Switched
* 10 A Switched and 10 A Safe, Switched share the 10 A of current.				

Each supply has an associated LED which, when lit, indicates that the port is actively powered. See *LD-250 Core Status Indicators* on page 132.

When you press an E-Stop button (or if a the rear sensor or a user bumper contacts an obstacle), it disconnects the Safe 22 - 30 VDC.

LIGHTS (Light Pole)

The LD-250 Core's light pole Mini-Fit® 2 x 3 connector enables you to connect a light pole or other payload warning lights.

Pin	Designation	Notes	Pin	Designation	Notes
1	GND	Cable shield	4	VBAT_IO_ OUT4	VBAT @ 0.5A Max (shared with DIO)
2	LIGHT_P1	Red	5	LIGHT_P3	Green
3	LIGHT_P2	Yellow or orange	6	LIGHT_P4	Buzzer

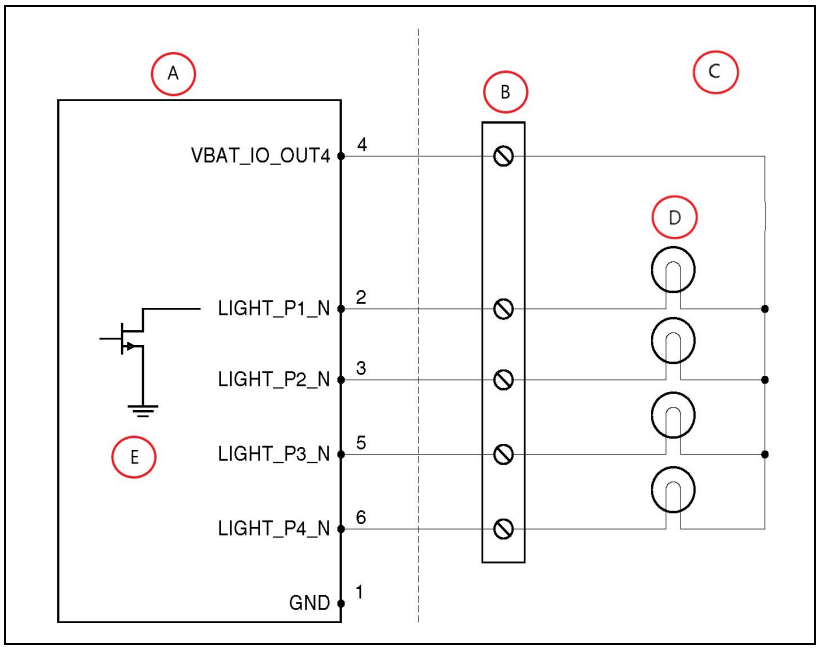


Figure 6-5 Sample Light Pole Diagram

Callout	Description	Callout	Description
A	Standard Equipment	D	Typical User Load
B	Wiring Terminal Block	E	Equivalent Circuit
C	User-Supplied Equipment		

User Interface (Brake and E-Stop)

The LD-250 Core's User Interface Mini-Fit® 2 x 7 connector provides circuits for the Brake release, ON, OFF, and E-Stop buttons.

Pin No.	Designation	Notes
1, 2, 3	FBAT_ALWAYS	Fused VBAT @ 500 mA
4	E-STOP_USR_1L	Short 4 & 11 to close E-STOP_USR_1
5	E-STOP_USR_2L	Short 5 & 12 to close E-STOP_USR_2
6	E-STOP_OUT_1L	Pins 6 & 13 short when E-STOP_CH1 is closed
7	E-STOP_OUT_2L	Pins 7 & 14 short when E-STOP_CH2 is closed
8	OFF_BUTTON	Short to FBAT_ALWAYS to signal OFF (min 1 s pulse)
9	START_BUTTON	Short to FBAT_ALWAYS to signal ON (min 1 s pulse)
10	MOTOR_BRAKE	Short to FBAT_ALWAYS for manual brake release
11	E-STOP_USR_1H	Short 4 & 11 to close E-STOP_USR_1
12	E-STOP_USR_2H	Short 5 & 12 to close E-STOP_USR_2
13	E-STOP_OUT_1H	Pins 6 & 13 short when E-STOP_CH1 is closed
14	E-STOP_OUT_2H	Pins 7 & 14 short when E-STOP_CH2 is closed

NOTE: You can attach an optional, user-supplied, E-Stop button to the E-STOP port on the User Interface connector.

E-Stop Operational Considerations

Engaging the E-Stop through the external connector (or Operator Panel) faster than 250 ms causes the drive motors to re-engage when you release the E-Stop.

Motor re-engagement occurs because the LD-250 Core is designed to receive a consistent E-Stop signal for at least 250 ms. Signals that engage and disengage in under 250 ms cause the LD-250 Core to interpret the signal as a bumper press, which automatically re-engages the motors.

No signal on the E-Stop chain can cause the robot to operate while the E-Stop remains engaged. Thus. you must keep the E-Stop engaged, if your intent is to keep the AMR in an E-Stop state.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
If you are using a user-supplied E-Stop, you must run the Safety

Commissioning to verify that the E-Stop functions properly before returning an AMR to service.

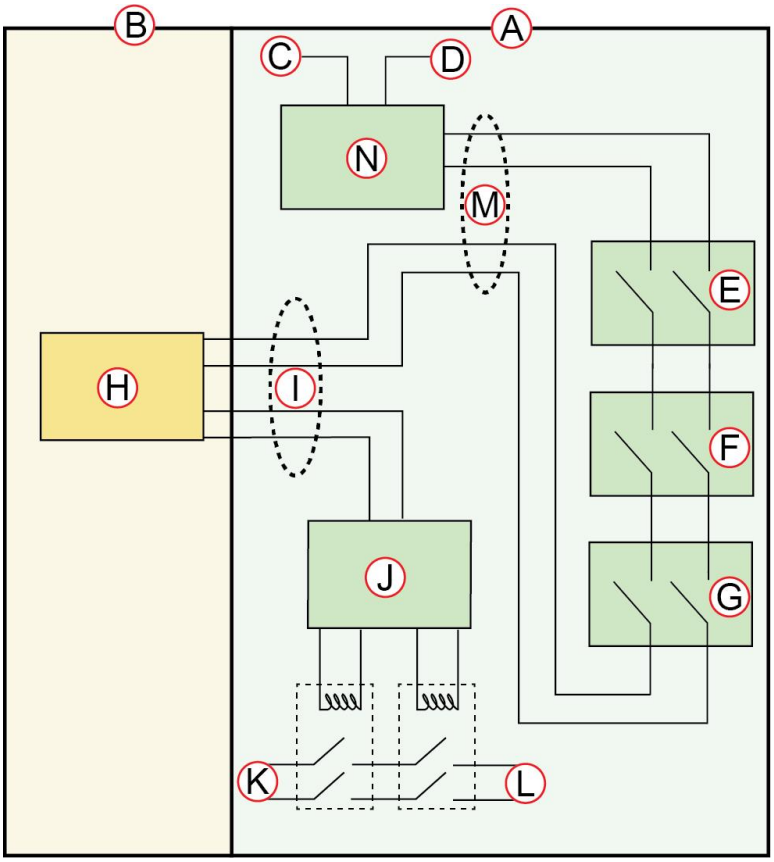


Figure 6-6 *E-Stop Chain Diagram*

Callout	Description	Callout	Description
A	Standard Circuits	H	User E-STOP[a]
B	User-Supplied Circuits	I	User Interface Connector
C	E-STOP Source	J	E-STOP Relay Control Logic
D	Ground	K	Voltage of the Battery
E	Operator Panel E-STOP	L	High Power to Amplifiers
F	Right E-STOP (LD-250 only)	M	HMI Connector
G	Left E-STOP (LD-250 only)	N	Factory E-STOP
[a] Close with a jumper if unused. Both channels must open independently when used.			

User Bumper

The LD-250 Core's User Bumper Mini-Fit® 2 x 4 connector provides 6 circuits for optional user-supplied payload bumpers.

Pin No.	Designation	Notes
1	USER_BUMPER_1	Short to E-STOP_SRC to signal bumper hit Front left bumper sensor.
2	USER_BUMPER_2	Short to E-STOP_SRC to signal bumper hit Front center bumper sensor.
3	USER_BUMPER_3	Short to E-STOP_SRC to signal bumper hit Front right bumper sensor.
4	USER_BUMPER_4	Short to E-STOP_SRC to signal bumper hit Rear right bumper sensor.
5	USER_BUMPER_5	Short to E-STOP_SRC to signal bumper hit Rear center bumper sensor.
6	USER_BUMPER_6	Short to E-STOP_SRC to signal bumper hit Rear left bumper sensor.
7, 8	E-STOP_SRC	12 V E-STOP Source Output @ 10 mA

Aux Power

The LD-250 Core's Aux Power Mini-Fit® 3 x 2. connector provides auxiliary power outputs.

Refer also to *Power Consumption* on page 79 which specifies limits on power draw.

	Designation		
Pin No.	Hardware	Software	Notes
1, 2, 3	GND		
4	AUX_5V_OUT	Aux_5V	5 V @ 1 A max
5	AUX_12V_OUT	Aux_12V	12 V @ 1 A max
6	AUX_20V_OUT	Aux_20V	20 V @ 1 A max

User Power

The LD-250 Core's User Power Mini-Fit® 2 x 6 connector provides battery power for payload devices.

Refer also to *Power Consumption* on page 79 which specifies limits on power draw.

IMPORTANT: Pressing an E-Stop interrupts the power output on pins 11 and 12 (SAFE_VBAT_OUT). This is useful if you want to interrupt power to both the AMR and its payload devices.

	Designation		
Pin No.	**Hardware**	**Software**	**Notes**
1, 2, 3, 4, 5, 6	GND		
7	SW_VBAT_OUT1	Battery_Out_1	VBAT @ 4 A max (switched in SW)
8	SW_VBAT_OUT2	Battery_Out_2	VBAT @ 4 A max (switched in SW)
9, 10*	SW_VBAT_OUT34	Battery_Out_3_and_4	VBAT @ 10 A max (switched in SW) Limit to < 5 A per pin.
11, 12*	SAFE_VBAT_OUT		SW_VBAT_OUT34 gated by dual-channel E-STOP relays
*9, 10, 11, and 12 share the 10 A of current.			

HMI Panel (Operator Panel)

The LD-250 Core's HMI panel HDB15F connector provides circuits for the Operator Panel screen and its buttons (ON, OFF, EMERGENCY OFF, and Brake Release.).

	Designation	
Pin No.	**Hardware**	**Software**
1	RS422_HMI_TX+	
2	RS422_HMI_TX-	
3	MOTOR_BRAKE	
4, 5	E-STOP_FP_1H, _2H	
6	RS422_HMI_RX+	
7	RS422_HMI_RX-	
8	START_BUTTON	
9, 10	E-STOP_FP_1L, _2L	
11	HMI_5V_SW	HMI_Power
12, 14	GND	
13	OFF_BUTTON	
15	FBAT_ALWAYS	

If you are using the optional touchscreen instead of the Operator Panel, it is possible to use this port for custom connections. However, Omron recommends that you use the User Interface port, which is intended for customization. See: *User Interface (Brake and E-Stop)* on page 103.

Important considerations if customizing this port are:

- You must provide buttons for ON (Start), OFF, Brake Release, and E-Stop functions, or at least jumper the E-Stop circuit using the jumper part number: 13387-000. Attach this jumper to the Operator Panel's cable, and not directly to the LD-250 Core.
- It is not possible to use the RS-422 data connections.

Sonar 1

The LD-250 Core's Sonar 1 DB9M connector is connected to the rear sensor in the LD-250.

Internal LD-250 Core Connections

This section describes internal LD-250 Core connections not normally accessible to the end-user. These connections are on the lower part of the LD-250 Core, below the payload bay and covered by a vented plate.

They are listed here only so that you can reconnect them during LD-250 Core replacement or other service operation.

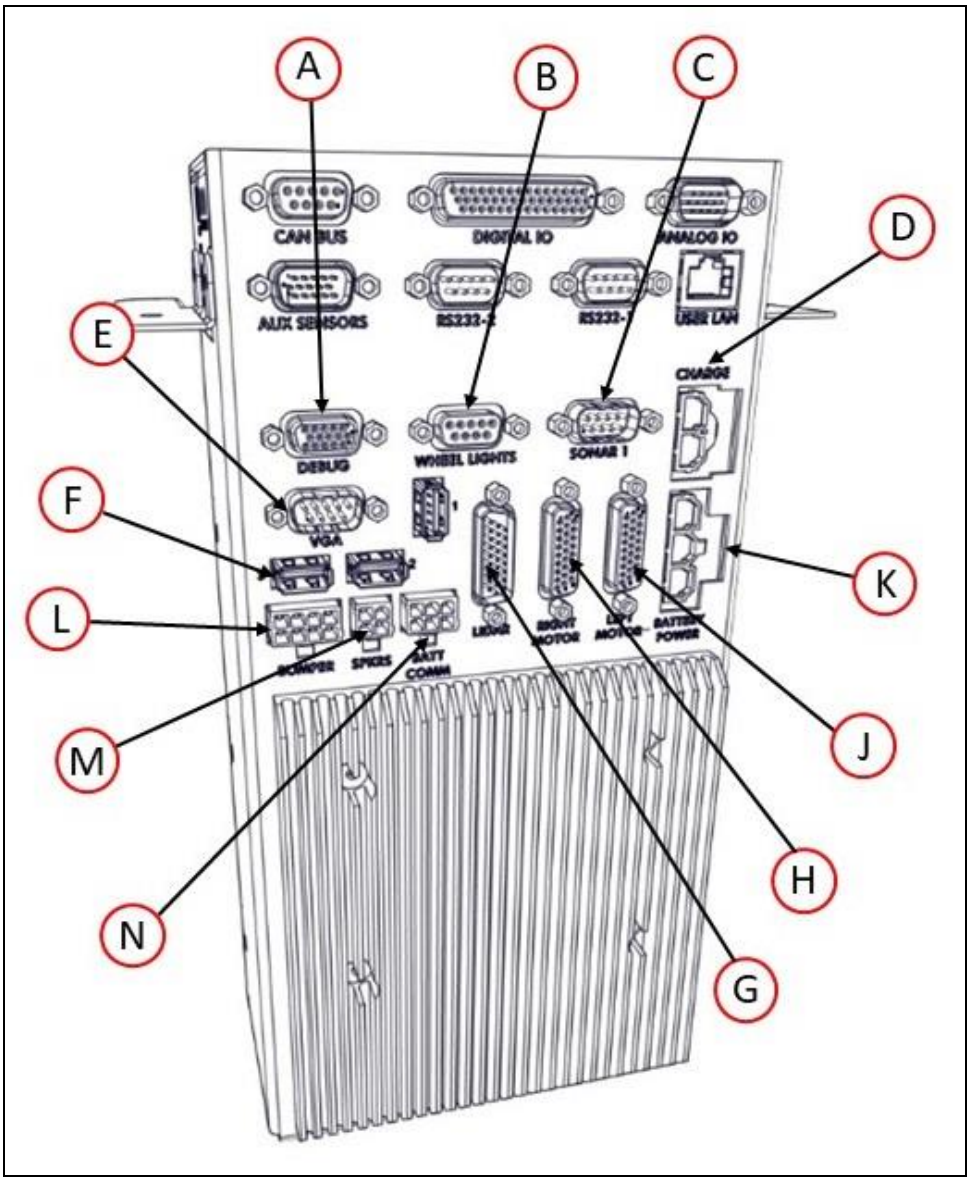


Figure 6-7 *Internal Connectors on the LD-250 Core (Front)*

NOTE: The Bumper, Speakers, and Batt Comm. connectors on the internal LD-250 Core mate with Molex Mini-Fit Jr™ 5557 series receptacles.

NOTE: The Charge Contacts and Battery Power connectors on the internal LD-250 Core mate with Molex Mini-Fit Jr™ 42818 series receptacles.

ID	Connection	Type	Description
A	Debug RS-232	DB9M	Rear-facing laser
B	Wheel Lights	DB9F	Motion and status indicator Light Discs on the LD-250 sides

ID	Connection	Type	Description
C	Sonar 1	DB9M	Rear sensor
D	Charge Contacts	Mini-Fit Sr., 2-pin	Charging input
E	VGA	HDB15F	Reserved
F	USB x 3	USB Type A	Reserved
G	LIDAR	HDB26M	Safety Scanning Laser
H	Right Motor	HDB26F	**NOTE**:The Right (red cable) and Left (white cable) Motor connectors use the same type of plug. Do not to reverse the connections.
J	Left Motor	HDB26F	
K	Battery Power	Mini-Fit Sr., 3-pin	Battery VDC; connects to battery
L	Bumper Switches	Mini-Fit 2 x 4[a]	LD-250 Chassis identification jumper, tethered to the chassis.
M	Speakers	Mini-Fit 2 x 2[a]	Drives built-in speakers
N	Battery Comm.	Mini-Fit 2 x 3[a]	Battery communication and control
[a] For Molex Mini-Fit Jr™ 5557 series receptacles			

Internal Data Pinouts

Light Discs

The LD-250 Core's Light Discs DB9F connector provides circuits for the Motion and status indicator light disc on each side of the LD-250.

	Designation		
Pin No.	**Hardware**	**Software**	**Notes**
1, 2	CANL_A		CAN Communication differential pair
3, 4	GND		Direct GND
5	SHIELD GND		Bead filter to GND
6, 7	CANH_A		CAN Communication differential pair
8, 9	SW_12V_WHEEL	WheelLight_Power	12 V @ 1 A Max (switched in SW)

LIDAR (Light Detection And Ranging)

The LD-250 Core's LIDAR DB26M connector provides circuits for the main navigation and safety laser.

Pin No.	Designation	
	Hardware	Software
1	RS422_LIDAR_RX+	
2	RS422_LIDAR_RX-	
3	OSSD1	
4	OSSD2	
5	WF_OUT	
6	O3_OUT	
7	STANDBY	
8	EDM	
9	No Connection	
10, 18	SW_20V_LIDAR	Main_Laser_Power Pin 10 + 18: Current < 600 mA
11 thru 17	GND	
19	RS422_LIDAR_TX+	
20	RS422_LIDAR_TX-	
21	IN_A1	
22	IN_A2	
23	IN_B1	
24	IN_B2	
25	IN_C1	
26	IN_C2	

Internal Power Pinouts

Bumper

This circuit contains only the Jumper 20758-000L that identifies an LD-250 Core. The Jumper is tethered to the chassis to make sure that you use the correct core type.

Speakers

The LD-250 Core's Speakers Mini-Fit® 2 x 2 connector provides circuits for the two loud-speakers.

Pin No.	Designation	Notes
1	RIGHT+	Right Speaker
2	RIGHT-	
3	LEFT+	Left Speaker
4	LEFT-	

Batt Comm

The LD-250 Core's Batt Comm Mini-Fit® 2 x 3 connector provides a battery control circuit

Pin No.	Designation	Notes
1	GND	Connections to the Battery Control
2	RS232_BATT_RXD	
3	RS232_BATT_TXD	
4	FBAT_ALWAYS	
5	START_BUTTON	
6	OFF_BUTTON	

Chapter 7: Operation

Before proceeding with any tasks described in this chapter, you should complete the procedures described in the Setup and Getting Started chapters, including map creation.

7.1 Operating Environment

Intended Use

The LD-250 is designed to operate in indoor industrial environments. In general, if a wheelchair user can safely and easily navigate the environment (open, and mostly flat with only gentle inclines and wide doorways), then it is navigable by an LD-250.

DANGER: PERSONAL INJURY RISK
There is risk of serious injury by crushing if the AMR tips over as a result of improper operation on inclines that do not comply with the operating specifications.

The following guidelines apply:

- **Floor**—Clean and dry floors that you sweep regularly and routinely keep free of debris, dust, and liquids.
- **Typical Inclines**—The LD-250 is intended to operate in a workspace that has a mostly flat floor. If the workspace includes inclined areas, Omron recommends a gentle incline typical of wheelchair ramps. Be aware that the payload structure and any loads transported can:
  - Reduce the AMR's ability to traverse an incline.
  - Change its operating center of gravity (CG).
- **Inclines (Ramps)**—With a properly designed and stable payload, the LD-250 can operate on ramps at full payload capacity. However, extended periods of operation on ramps will affect battery duration and speed is limited to 600 mm/sec on inclines such as ramps. Operational recommendations are:

Slope	Payload Restriction	Speed Limit
1.7 degrees (3% grade)	No restriction	No restriction
3 degree slope	200 kg	600 mm/s
4.75 degrees (1:12 slope, typical wheelchair ramp)	165 kg	600 mm/s

- **Temperature**—5 to 40°C (41 to 104°F), with a recommended humidity range of 5% to 95%, non-condensing. Operating the LD-250 at high or low ambient temperatures (particularly with a full payload and high speeds) can cause the battery to exceed its operating temperature limits. If this happens, you are notified by escalating software

messages as follows:

- The battery is approaching a high or low temperature limit. Change the LD-250's operating conditions so that the battery can return to within its ambient temperature limits.
- The battery has exceeded an initial limit, the LD-250 continues to operate but charging is deferred until the battery has returned to within its ambient temperature limits
- The battery has exceeded its temperature limits and the LD-250 will shut down immediately.

The LD-250 has an ingress protection rating of IP20 and is not liquid-proof. Keep floors dry because liquids might get into the AMR. Damp, dusty, or greasy floors might also cause its drive wheels to slip or skid. Such traction problems can affect both braking and accuracy.

Side Clearance

The LD-250 is intended to operate in an environment that has a generally flat and level floor. There should be no doors or other restricted areas that are too narrow for the AMR to pass through.

Make sure that you maintain adequate clearance 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 LD-250's front and side clearance zones. These settings can help to prevent the LD-250 from closely approaching obstacles.

An exception to side clearance requirements might apply at pickup and drop off locations, where the LD-250 must closely approach conveyors or other fixed objects.

CAUTION: PROPERTY DAMAGE RISK
Do not allow the AMR to drive through an opening that has an automatic gate or door unless a properly-configured Call box or Door box is present. Refer to the *LD Platform Peripherals User's Guide* for details.

Narrow Passageway Behavior

If the AMR operates in narrow passageways, the following considerations apply:

Table 7-1 Narrow Passageway Performance

Width	Mapping and Performance Constraints
1100 mm (43.3 inches)	AMR can operate at maximum speed.
1050 mm (41.3 inches)	The AMR can operate up to its maximum speed, but will generally be slower.

Performance improves when the passage is mapped. Unmapped, narrow passages will degrade performance.

Obstacles

If the LD-250 enters high-traffic areas, take appropriate precautions to alert people in those areas that an LD-250 might enter.

If the traffic consists of other machines, adjust the LD-250's operating parameters and the operating parameters of other machines to reduce the risk of a collision.

Take care to avoid:

- Glass doors and walls.
- Pits without railings or low bumpers.
- Floors with access panels removed.
- Loose cables, hoses, or any other articles that temporarily cross the workspace floor.
- Large, highly-reflective objects.

Environment and Floor

Environmental Limits

The following environmental limits apply.

Characteristic	Operating Limits
Temperature	5 to 40°C (41 to 104°F)
Humidity	5% to 95%, non-condensing
Altitude	Up to 1000 m above mean sea level
Atmospheric	**WARNING:** Do not use the LD-250 in hazardous environments (explosive gas and oil mist).
Radiation	Do not use the LD-250 in the presence of ionizing or non-ionizing radiation.

Floor Characteristics

Floors must provide good traction, typical of good walking conditions. The following specified limits assume that the AMR's wheels are in good operating condition.

- **Flatness and Texture**
  Driving on rough or uneven floors can affect traction and navigation and also reduce the life of drive train components. Safety might be affected because the laser's sensing plane is not always parallel to the floor.

  Even on smooth, level floors, dust, dirt, grease, and water (or other liquids) can affect traction. If the drive wheels slip it can potentially affect operating duration and navigation accuracy.

  Use a slip meter (such as the Reagan Scientific BOT-3000e) to measure the floor's coefficient of friction. The slip meter must:

- Conform to standards ANSI B101.3, A137.1, A326.3.
- Be validated according to ASTM F2508-13.

The recommended coefficient of friction for floors in the LD-250's work space is in the range: 0.55 – 1.0.

- **Steps and Gaps**
  Typical floor characteristics that are considered to be *steps* include any height difference caused by floor stab settling, expansion gaps, or cracks. Other environmental objects might create a temporary bump, such as a wood pallet fragment, dropped fasteners or a temporary floor covering.
- **Cleanliness and ESD grounding**
  A foreign object such as a screw or metal fragment embedded in a wheel can affect its operation over otherwise compliant floor surfaces. Liquid, dirt and dust can affect AMR operation and cause damage to the AMR over time. It might also affect the operation of the ESD casters (See *Cleaning ESD Casters* on page 156).

CAUTION: PROPERTY DAMAGE RISK. The LD-250 is intended for smooth, hard, and level floors. Although it is capable of driving over steps and gaps, frequent or high-speed driving over such obstacles shortens the lifespan of drive train components.

For best performance, Omron recommends that all floor steps or door thresholds have a rounded profile or are filled to ease the transition between surface planes.

The following limits apply for certain floor characteristics.

Characteristic	Operating Limits
Inclines and load	Incline (ramp) of 3% for maximum payloads. Be aware that if the AMR frequently operates on steep inclines its operational duration is reduced.
Step or door threshold height	Up to 10 mm (0.39 inch) at 600 mm/s.
Gap width	Up to 15 mm (0.6 inch) at 1200 mm/s

Avoiding Potential Immobilization Risks

While unlikely, it is possible for the AMR to drive into a position from which it cannot maneuver out of without human assistance.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Immobilization might cause motors in the AMR to overheat, exponentially resulting in a fire.

Some examples are shown in Figure 7-1.

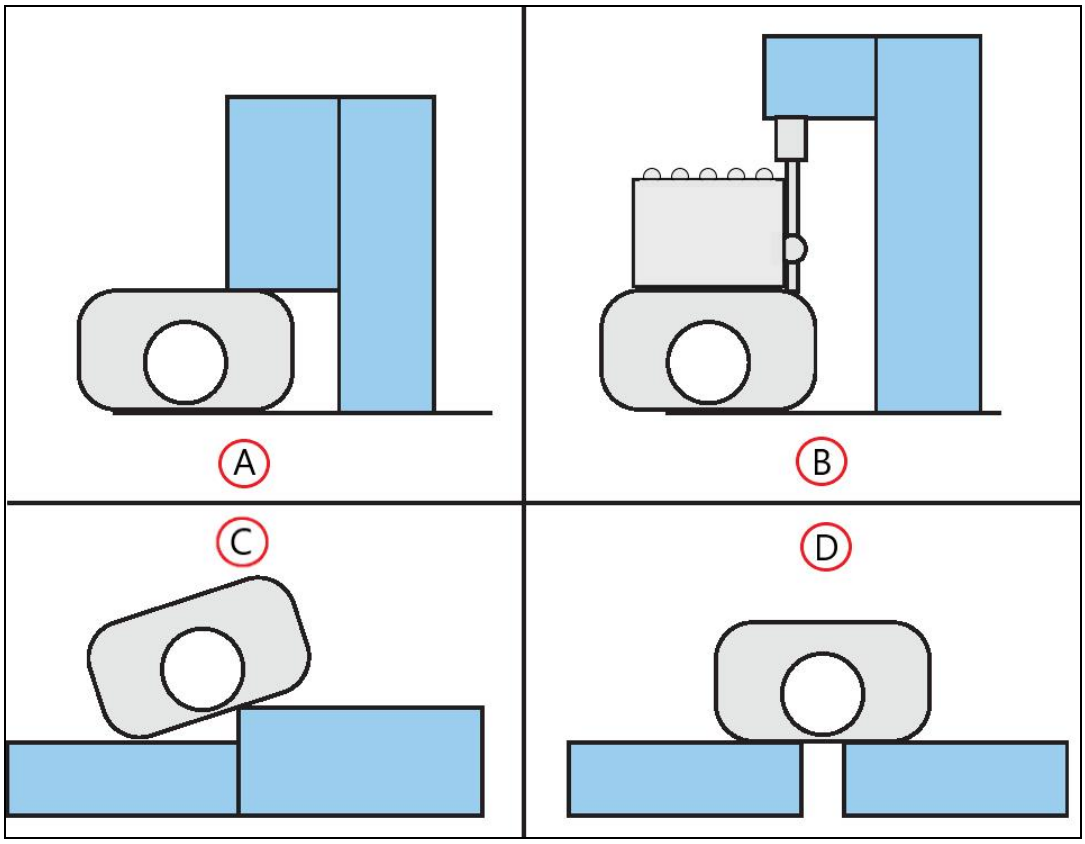


Figure 7-1 *Examples of the LD-250 or AMR Getting Stuck*

Callout	Problem
A	LD-250 caught under an overhanging obstacle
B	User payload caught under an overhang
C	LD-250 driven off a ledge
D	LD-250 driven over a wide floor gap (drive wheels have no traction.)

If you lift or manually push the LD-250 to correct any of these situations, refer to:

- *Lifting the LD-250 Safely* on page 145.
- *Releasing the Brakes to Move the LD-250 Manually* on page 30.

Side Lasers can help to detect and avoid overhangs and floor voids. See: *Side Lasers (Supplemental) Lasers* on page 189

7.2 Typical Operation

During a normal start-up, the LD-250 powers all its systems, runs its on-board software and then automatically runs your integrated processes. If you have created and uploaded a workspace map and the AMR is localized within that workspace, it is ready to operate autonomously. See: Fleet Operations Workspace Core User's Guide for more information about the start-up procedure and about localization.

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 avoid obstacles detected by the on-board sensors. Path planning parameters, together with constraints specified in the AMR's workspace map, define the path that the AMR will plan and follow through its environment. You use the MobilePlanner software to modify the AMR's path planning parameters as required for your environment. The *Fleet Operations Workspace Core User's Guide* describes how to change these parameters and how to edit a map. Customizable AMR features include:

- Speed and acceleration.
- Minimum battery level allowed before docking for recharging.
- Which map to use.

The MobilePlanner software typically communicates with the LD-250 securely over your wireless network. You can also connect an Ethernet cable directly from your Windows PC to the AMR's Maintenance Ethernet port.

7.3 Power and Charging

The LD-250 battery is a sealed unit with manual status indicators. The Operator screen and the MobilePlanner software show the percentage (%) state-of-charge (SOC) remaining.

Typically, the LD-250 recharges its battery autonomously when necessary all on-board systems function continuously while the battery recharges. Recharge time is approximately 4 hours.

Run-time (with no payload) is approximately 10 hours. This varies significantly depending on use and accessory power consumption.

> **NOTE:** The LD-250 ships separately from its battery. You must fully charge the battery before use, as described in *Manually Charging the Battery* on page 121.

Battery Indicators and Controls

The battery has (from left to right) one red and green bi-color and three green LEDs, and one push-button (labeled SHOW LEVEL). The firmware blinks LEDs 1 through 4, back and forth, one at a time. From left to right, the LEDs indicate:

LED	Color	Meaning
1	Red	Error condition[a]
	Green	25% state of charge[b]
2	Green	50% state of charge
3	Green	75% state of charge
4	Green	100% state of charge[c]
a	If the red light blinks after pressing the SHOW LEVEL button, the battery is depleted and needs a recharge. If the red light blinks constantly, the battery needs service. Connecting the battery to a LD-250 will write	

LED	Color	Meaning
	an error code to the log for troubleshooting purposes.	
b	While powered up, the LEDs blink back and forth from 1 - 4.	
c	When on docking station, the right-most LED blinks when the battery pack is balancing. When the battery is full and balancing is complete, all LEDs light solid.	

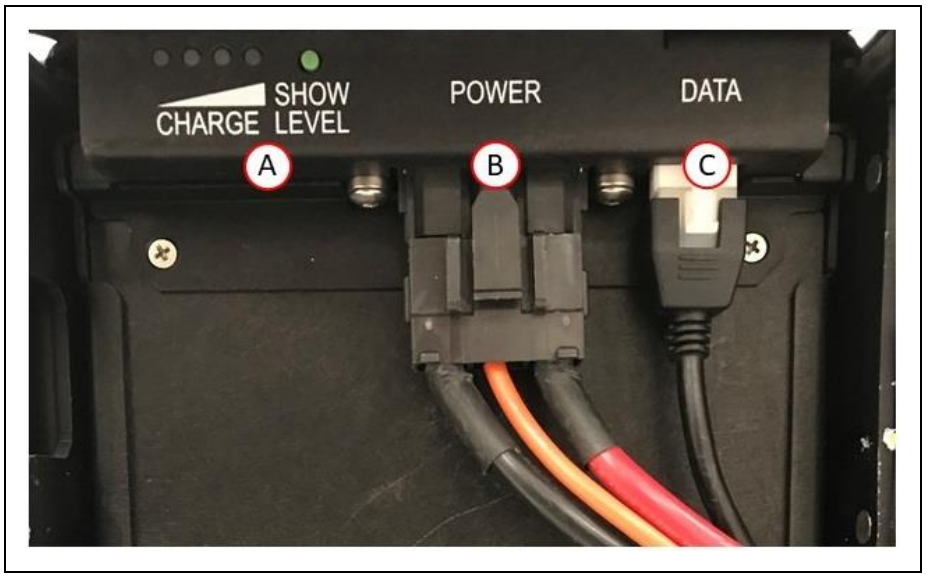


Figure 7-2 *(A) Battery LEDs and Push-Button (Show Level), (B) Power Cable, and (C) Data Cable*

Pushing the SHOW LEVEL button displays the battery's state of charge (SOC). This can be useful when a battery is in storage, and you want to know its state of charge.

After pressing the SHOW LEVEL push button, the battery illuminates all LEDs for a brief time, then blinks the LEDs back and forth one LED at a time, up to the LED representing the current state of charge. It will continue doing this for 4 hours, until it powers itself off. To turn off this display manually, press and hold the push button for 10 seconds.

Docking Station

The automated docking station provides both a manual and an automated method of recharging and balancing your LD-250 battery.

Autonomous Battery Charging on a Docking Station

During normal, autonomous operation, the AMR recharges its battery automatically at a docking station. The AMR faces the docking station as it approaches at low speed. It then rotates and reverses onto the docking station to charge. It generally takes under 30 seconds to dock, but on rare occasions the initial docking attempt might fail and restarts automatically. There is an approximate 10-second delay before the amber charging LED illuminates.

To protect the battery from damage:

- The operating software monitors battery level and send the AMR to a docking station if the state of charge is 10% or less. If anything prevents the AMR from recharging and the state of charge falls to 2% or less, the AMR ceases operation until it can recharge.
- If one or more individual battery cells becomes over-discharged then autonomous charging cannot start. You must examine the battery to determine whether it can be manually recharged or is no longer usable. Attempt to balance and charge the battery manually on a different docking station. If the battery is unrecoverable, you must recycle and replace it.

  NOTE: If the battery temperature exceeds its limits, charging cannot begin. The software and operator panel will notify you by an information message. See *Battery Operating Environment* on page 47.

The docking station supplies enough power for all the AMR's on-board systems, which can continue to operate during charging. If an AMR is powered off, it powers-on automatically when you push it manually onto a docking station.

Indicators, Controls, and Connections

The docking station has a power switch and two indicator LEDs:

- Blue—indicates that power is available.
- Amber—indicates that a charge is in progress.

The power entry module is located on the dock's right side. An integrated circuit breaker (thermal fuse in older models) shuts down the dock if it becomes too hot. Wait for the dock to cool down, turn the switch to off (0) and then back to on (1).

The power plug for AC supply is next to the power switch. Power requirements are 100 - 240 VAC, 50 - 60 Hz, and 8 A.

On the left side of the station (viewed from the front) is a manual charge outlet. Use this to charge spare batteries.

Environmental Requirements

- Ambient temperature range: 5 to 40°C (41 to 104°F)
- Humidity: 5% to 95% non-condensing

Docking Station Maintenance

CAUTION: FLAMMABLE IRRITANT
Follow all appropriate local safety regulations for working with isopropyl alcohol, including fire safety, toxicity, and protective clothing and gear requirements.

CAUTION: SHOCK RISK
To prevent accidental power-on during servicing, disconnect and remove the power cable during all docking station service operations. Store the power cable remotely from the in-service docking station.

Clean the docking station contacts quarterly with isopropyl alcohol. See *Docking Station* on page 119.

If you see evidence of wear:

- The guide roller is field-replaceable. See: *Docking Station Roller and Bearing* on page 162.

If necessary, you can also adjust the height of the docking station contacts. See *Docking Station Contact Adjustment* on page 64.

Manually Charging the Battery

Under some operating conditions, the battery might become too hot to enable charging. To prevent battery damage, the AMR's operating software displays error messages if the battery is too hot, and you must allow it to cool before charging.

Charge a Battery Inside the LD-250

To manually charge a battery inside the LD-250:

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 LD-250.
2. While holding the brake release button, push the LD-250 backward onto the docking station.

   Do not push the LD-250 too far back. It should remain approximately 50 mm (~2 inches) from the upright part of the docking station. See (A) in Figure 7-3.
3. Make sure that the amber charge LED illuminates after a few seconds. If the LED does not illuminate, adjust the position of the LD-250 on the docking station by moving it backward or forward an inch or so until the LED illuminates.

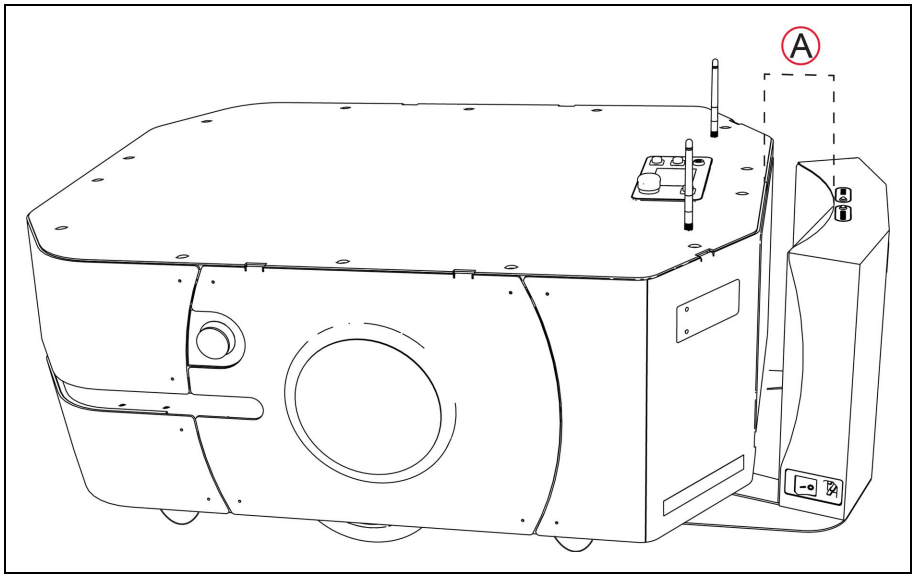


Figure 7-3 *Approximate 50 mm (~2 inch) Gap Between the LD-250 and the Docking Station*

Charge a Standalone Battery

The docking station provides a charging port on its left side. Use the supplied manual charge cable with this port. Manually charging a spare battery enables you to exchange batteries in approximately five minutes, minimizing the time that an AMR is not operating.

You can also use this port to charge a spare battery while the primary battery is in the LD-250. However, you cannot charge both batteries at the same time. The battery port is disabled while an AMR is on the dock and charging.

After you connect a battery, there is an approximate 10-second delay before the amber charging LED illuminates.

Balancing the Battery

The battery contains multiple cells, which must remain balanced to maintain maximum run time.

> **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**. The battery is balanced every time the AMR docks and charges. It takes approximately 10 minutes to balance the battery after charging, and the AMR does not report a full charge until balancing is complete.

  > **NOTE:** Omron recommends this mode for applications where you do not manually exchange batteries.

- **Exchange the battery after a short interval (hours) with a charged, balanced spare.**

  Periodically exchange the in-service battery with a fully charged spare battery.

  A spare battery plugged into a docking station is automatically balanced after charging. This eliminates the need to periodically remove the battery from the AMR for balancing. However, it requires that you manually exchange batteries.

  The optimum interval between exchanging batteries 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 must determine the optimum interval for your application. Exchanging batteries at each shift change is common.

  > **NOTE:** Omron recommends this mode for battery balancing 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. Then set the *StateOfChargeToChargeTo* and *MinutesToChargeFor* para-

meters to appropriate non-zero values. Then periodically exchange the battery with a fully-charged and balanced battery. Once weekly is a typical exchange interval.

- *StateOfChargeToChargeTo* determines the state of charge the battery needs to attain before the AMR can stop charging.

  A 90% value results in a battery that is almost fully charged, but not balanced.

- *MinutesToChargeFor* 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 you leave both parameters at their default value of 0, and you set *DockUntilDoneCharging* to False, the AMR will dock, but cannot undock. It remains out of service until you correct the parameter values.

In this charging mode, Omron recommends that you exchange batteries at least at a weekly interval. If you observe a reduction in AMR run time, decrease the exchange interval.

7.4 Operator Panel

The Operator Panel or HMI (human-machine interface) provides several functions. You can relocate the panel to other positions on your payload, subject to the length limit of its cable connection to the LD-250 Core.

Figure 7-4 shows the panel's dimensions and fastener locations.

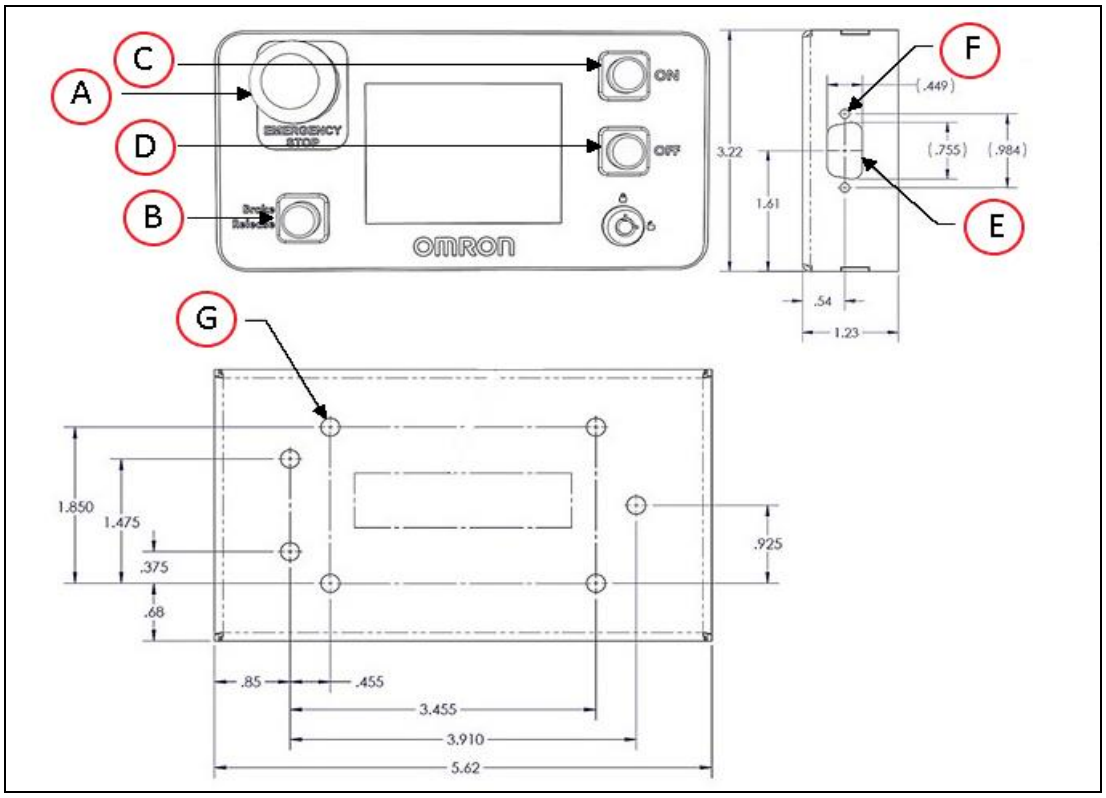


Figure 7-4 Standard Operator Panel (units are mm)

Callout	Description	Callout	Description
A	Emergency stop button (E-Stop)	E	Hole for 15-pin high density D-Sub connector
B	Brake release button (yellow)	F	2x 5.3 mm (0.120 inch) through hole
C	On button (green)	G	7x 5.4 mm (0.213 inch) through hole
D	Off button (red)		

A larger touch-screen is an available option. See: *Touchscreen* on page 188.

LD-250 Status Screen

The status video screen is a color TFT, 320 x 240 pixels, 3.5 inches diagonal. An optional color touchscreen supplements or replaces the status screen. See: *Touchscreen* on page 188.

It is normal for the status screen to go dark (sleep) during operation. Tap lightly on the screen to resume the display.

Default and Sample Screen Contents

The following image shows the first screen that appears during boot-up:

Figure 7-5 Initial Boot Screen

After the LD-250 starts up, you will see the main screen:

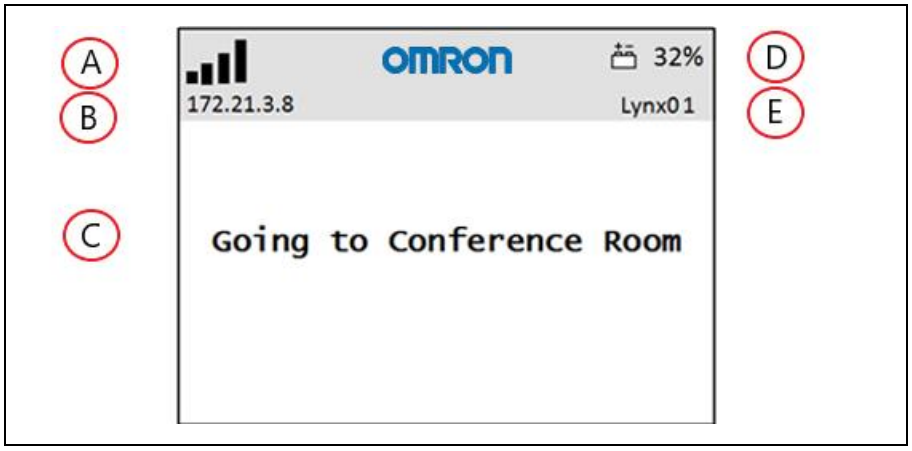


***Figure 7-6** Main Screen Fields*

Callout	Description	Callout	Description
A	WiFi Signal Strength	D	Battery Level
B	IP Address	E	Robot ID
C	Main panel that contains status, fault (error), or instruction messages. The main panel can contain up to six lines of text.		

The main panel contains:

- Up to six messages, in order of importance.
- Only one fault (error) at a time.
- Any event or condition that causes an ARAM restart or an AMR shutdown, including the cause of the restart or shutdown.

E-Stop Buttons

The LD-250 has three E-Stop buttons, one on each side and one on the Operator Panel (HMI). An E-Stop button is colored red and latches (locks) when pressed.

When you press an E-Stop button, The AMR decelerates to a controlled stop, then disables its motors and engages its brakes.

- Interrupting or stopping the LD-250 to keep it from performing its currently scheduled task (if you do not have access to MobilePlanner).
- When people are working near the LD-250 and you want to stop the AMR for their safety.
- To use the Operator panel's Brake Release button.

Positioning an Optional Payload E-Stop

The right side and left side E-Stop buttons alone do not meet the 600 mm reach requirement of relevant safety standards because the E-Stop buttons are close to the front of the LD-250. An operator should be able to easily reach an E-Stop button from any approach angle without need to reach across the moving AMR or any moving payload parts.

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 third E-Stop button in a location where it is accessible regardless of the AMR's direction of travel

You can satisfy the 600 mm reach requirement by:

- Maintaining the location of the Operator Panel (HMI) within the 600 mm reach distance. This panel contains an integrated E-Stop button. If the panel is in its default location on the top plate, then 600 mm requirement is satisfied.
- Either of the following:
    - Relocating the Operator Panel to a position on the payload within the 600 mm reach distance.
    - Removing it, and instead adding a separate optional user E-Stop button to the Payload. This must be within the 600 mm reach distance (regardless of the direction of travel).

Disengage an E-Stop Button

To disengage an E-Stop, rotate the button in the direction of its embossed arrows to release the latch. The AMR's drive motors remain disabled until you use any of the following enabling methods:

- Press the green **ON** button on the Operator Panel (HMI). See:*Operator Panel (HMI) on the Payload* on page 90.
- Click **Enable** in the E-Stop dialog displayed by MobilePlanner. (If this dialog is not visible, click **Map** and then click **Show Robot**.)

There is a two-second delay between enabling the AMR's motors and resuming operation.

NOTE: If you cannot enable the motors, check the AMR's operating software for any reported critical driving faults.

ON Button

The ON button restores power to the AMR and its components after you press the OFF button. The ON button does not function until any in-progress shut down is complete.

You also use the ON button to restore power to the AMR's drive motors after releasing an E-Stop.

OFF Button

The red OFF button removes power from all systems except the charging hardware circuits. During shutdown, the LD-250's control software prevents data loss and saves the LD-250's

last known location. This enables automatic localization at the next power-on.

> **NOTE:** You can use the key switch to disable and lock the OFF button. Remove the key to prevent anyone from shutting down the LD-250.

Brake Release Button

You might need to move an AMR manually when battery power is low or if you want to park in a constrained space. A small amount of battery power is required to release the brakes. Without power, the brakes remain engaged.

When moving an AMR manually, the following considerations apply:

- You cannot push the AMR in reverse above speeds of 300 m/sec.
- Push only at the designated locations. See: *LD-250 Packaging* on page 48.

CAUTION: Do not push the AMR from a high position on its payload structure. This might cause the AMR to topple. Push only from a low, designated safe push point.

1. Press any E-Stop button.
2. Press and hold the yellow brake release button on the Operator Panel.
3. Push the AMR at any of the designated safe push points. See: *LD-250 Packaging* on page 48.

7.5 Other Controls and Indicators

The LD-250 is not equipped with a beacon or light tower. You can optionally supply and install such a device if required,

This section also describes indicators on the LD-250 Core and the battery.

Indications Provided by Light Discs Light Outputs

The LD-250 has circular lights on the sides that indicate motion, turns, and several other states.

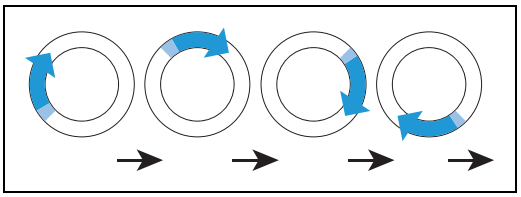
Optionally, add a user-supplied warning beacon to your payload structure. For safety standards compliance, the sequence of lights should be red, yellow, green from the top down.

This optional beacon provides additional extra signaling when connected to the LD-250 Core's LIGHTS output (*LIGHTS (Light Pole)* on page 102). The beacon can indicate movement, or signal an Operator that the AMR is waiting for assistance.

Light disc and optional beacon states are described here, and summarized in the following tables.

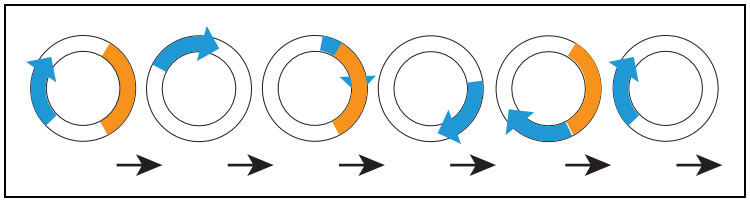
Driving Straight

Blue arcs on each side of the LD-250 will appear to rotate in the direction of the LD-250's travel, to let nearby people know that it is moving (or about to move). If used, the Beacon blinks green.



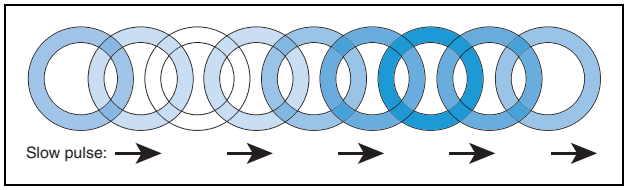
Turn Signal (for turns greater than 30 deg/sec)

The blue drive indicators will include a blinking orange segment at the front of one light disc to indicate that the LD-250 is about to turn in the direction of the signal. If used, Beacon blinks green.



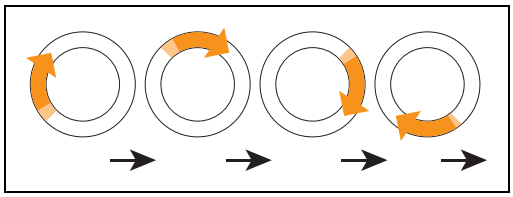
Stopped, no errors (ready)

Entire light disc on each side pulses blue slowly (0.25 Hz). If used, the Beacon is steady green.



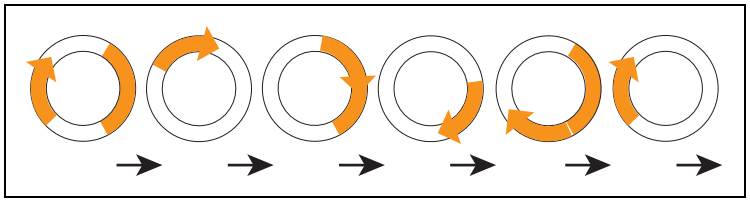
Driving with Warning (doesn't prevent driving, such as low battery)

The light disc will be orange instead of blue for Stopped, Driving, and Turn Signals. If used, the Beacon alternates green then yellow.



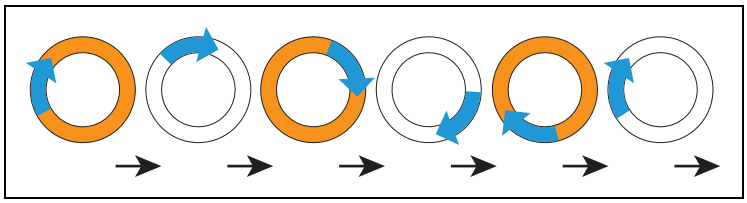
Turn Signal with Warning (doesn't prevent driving, such as low battery)

Same as Turn Signals, but both the blue rotating arc and blinking segment are orange. The moving arc and the blinking segment have independent timing.



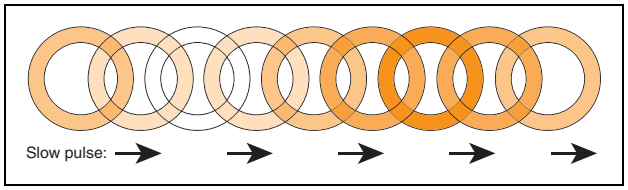
Driving Slowly, Scanning Laser E-Stop Inactive

When driving under 300 mm/s, the LD-250's Safety Scanning Laser does not generate an E-Stop, however it still actively performs safety checking and successfully avoids obstacles. The pattern is essentially the same as driving, except the background blinks orange. The moving arc and the blinking segment have independent timing.



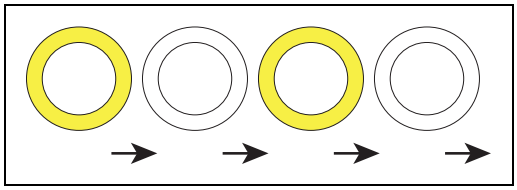
Stopped with Warning (such as low battery)

When Stopped with Warning, the light discs turn orange instead of blue. If used, the Beacon alternates long green with short yellow.



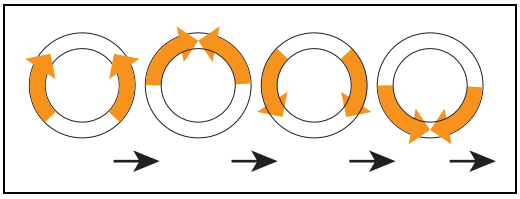
Obstacle Detected

The light disc blinks yellow if the AMR stops for an object in its safety zone. If used. the Beacon blinks yellow.



Lost

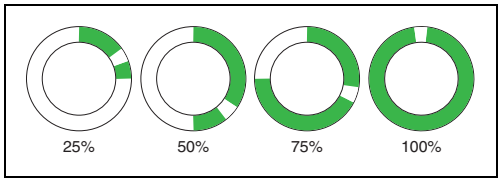
When the AMR is lost, the light discs each display two orange arcs, traveling from the 6 o'clock to the 12 o'clock position and back, in opposite directions. If used, the Beacon blinks yellow.



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. If used, the Beacon blinks green (or red if E-Stopped).

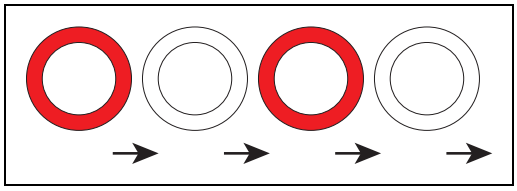


LD-250 Left Side	LD-250 Right Side	State of Charge
0 to 90 cw	0 to 270 ccw	25%
0 to 180 cw	0 to 180 ccw	50%
0 to 270 cw	0 to 90 ccw	75%
full circle	full circle	100%

NOTE: The state of charge displayed is continuous, not limited to 25% increments.

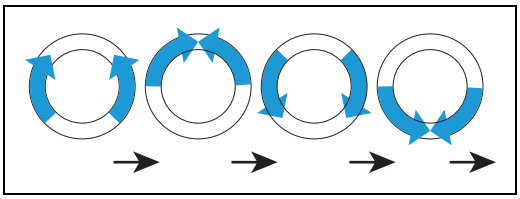
E-Stop

The light discs blinks red in an E-Stop condition. If used, the Beacon blinks red.



Booting

When booting, the light discs displays two blue arcs, traveling from the 6 o'clock to the 12 o'clock position and back, in opposite directions. If used, the Beacon alternates green, yellow, then red.



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 optional beacon switches between different lights, with no pause. Two lights with Alt means one light is always on, but not two at once.

Table 7-2 Indicator Meanings

Light Disc		Optional Beacon (If Used)		Meaning
Color	**Pattern**	**Color**	**Pattern**	
Blue	Moving Circle	Green	Blink	Driving straight, all ok
Blue/ Orange @front	Moving Circle/ Blinking signal	Green	Blink	Turning > 30° in direction of orange turn signal, all ok
Blue	Pulse	Green	Solid	Stopped, all ok
Orange	Moving Circle	Green /Yellow	Alt	Drive with warning, doesn't prevent driving e.g. low battery
Orange/Orange @front	Moving Circle/ Blinking signal	Green /Yellow	Alt	Turn with warning
Blue/ Orange	Moving Circle/ Blinking signal	Green	Blink	Driving slowly, <300 mm/s
Orange	Pulse	Green/Green/Green /Yellow	Alt	Stopped with warning
Yellow	Blink	Yellow	Blink	Object detected in safety zone
Orange	Left+Right Half-circles	Yellow	Blink	Lost
Green/White arc	Partial Circle/- moving small arc	Green normally, Red if E-Stopped	Blink	Charging
Red	Blink	Red	Blink	E-Stop, stops driving
Blue	Left+Right Half-circles	Green/Yellow/Red	Alt	Booting

LD-250 Core Status Indicators

The left side of the LD-250 Core has 12 indicator LEDs that indicate subsystem status. Labels on the payload bay provide a description of the LEDs.

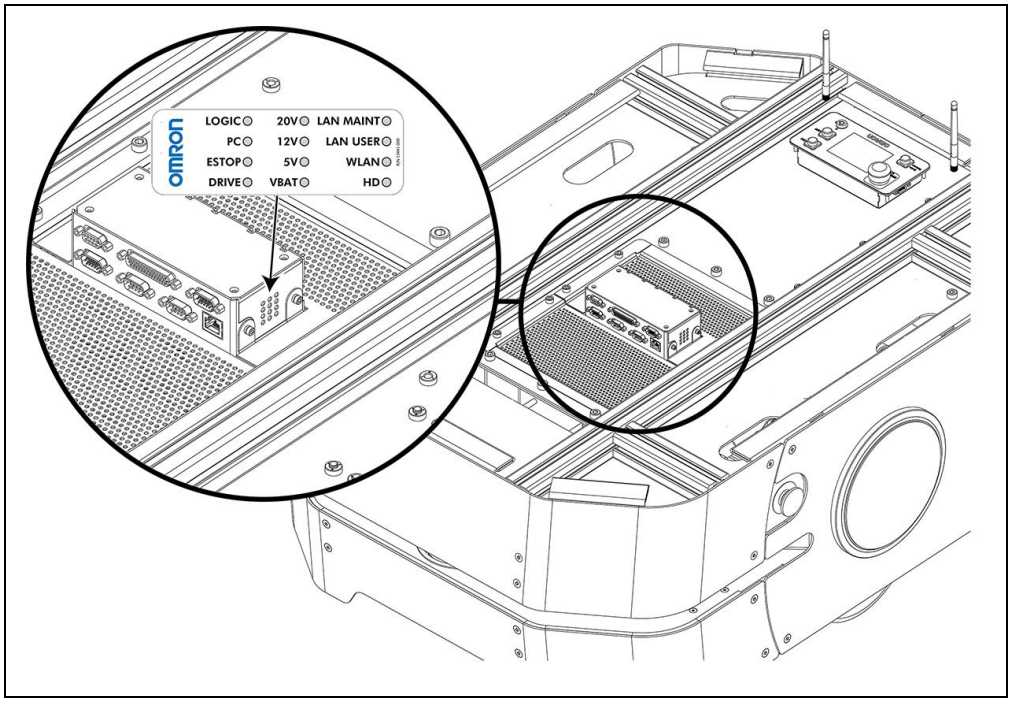


Figure 7-7 *LD-250 Core LED Status LED and Identification Label*

Table 7-3 provides descriptions for the status LEDs:

Table 7-3 LD-250 Core Status LED Description

LED Indicator	Meaning
Left Column	
LOGIC	The microcontroller has power
PC	The LD-250 Core and the servo controller are communicating
E-STOP	An E-Stop button is activated
DRIVE	The drive wheels are under servo control
Middle Column	
20V	20 V power is available
12V	12 V power is available
5V	5 V power is available
VBAT	Unregulated battery power is available
Right Column	

LED Indicator	Meaning
LAN MAINT	There is data traffic on the Maintenance Ethernet
LAN USER	There is data traffic on the USER LAN Ethernet
WLAN	There is data traffic on the WiFi Ethernet
HD	The LD-250 Core is writing data to, or reading data from the internal hard drive

7.6 Sensors

Lasers

The LD-250 uses an on-board laser for navigation and safety. A second low front laser detects obstacles that are too close to the ground for the main laser to detect. An optional rear-facing laser is also available. See: *Rear-Facing Laser* on page 188.

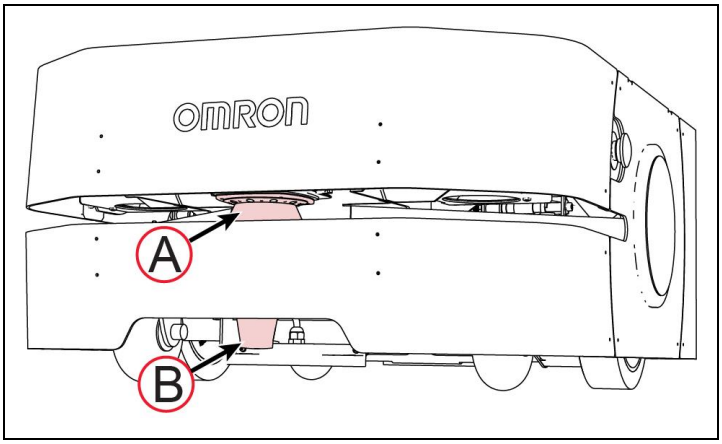


Figure 7-8 *LD-250 Lasers*

Callout	Laser
A	Safety and navigation (primary) laser.
B	Low (toe) laser.

Safety Scanning Laser

The LD-250 Safety Scanning Laser [(A) in Figure 7-8] is an Omron OS32C model. It is a precise scanning and navigation sensor with the following characteristics:

- Single horizontal plane, parallel to the floor at a height of 190 mm (7.48 inches).
- 601 beam readings in a 240° field of view (0.4 degrees per beam).
- Maximum safety protection range of 3 m (9.8 ft).
- Typical distance for range readings of 15 m (49 feet).

Constraints on Laser Operation

The laser cannot reliably detect glass, mirrors, and other highly-reflective objects. Use caution when operating the LD-250 in areas that contain such objects.

If the LD-250 must operate close to reflective objects, Omron recommends that you use a combination of markings on the objects, such as highly visible tape or painted stripes. In addition, specify forbidden sectors in the workspace map so that the LD-250 can plan paths to avoid these objects.

Low Front Laser

The low front laser [(B) in Figure 7-8] detects obstacles below the scanning plane of the safety laser, such as an empty pallet or a human foot. This laser also detects obstacles that might be significantly wider at the base, such as a column plinth, where the main safety laser might detect only the upper portion of the column.

Rear Sensor

The LD-250 includes a rear-facing sensor that detects obstacles that are close to the rear, such as person stepping behind the LD-250. The sensor also detects obstacles that the AMR might encounter when reversing or rotating.

The LD-250's rear sensor consists of an array of individual time-of-flight sensors in three segments (right, left and center) as shown in Figure 7-9.

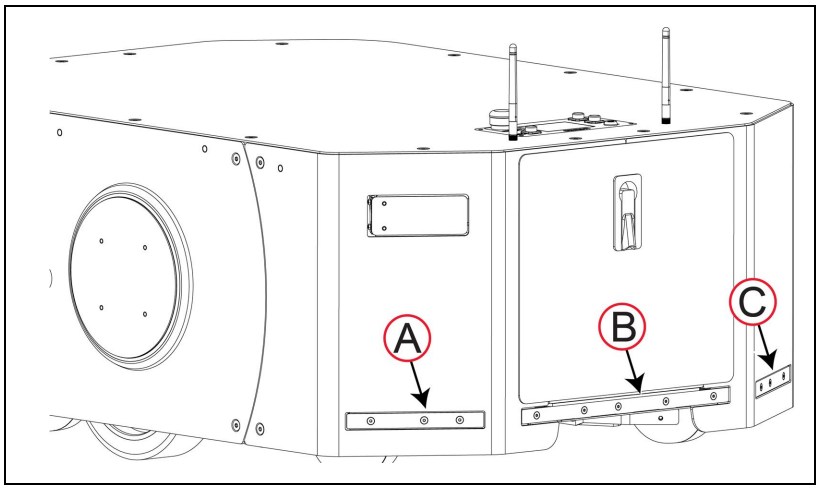


Figure 7-9 *Rear Sensor: Left (A), Center (B), and Right (C) Segments.*

These sensors not safety-rated. If the sensor detects an obstacle, the AMR stops, waits two seconds and then resumes operation under the following conditions:

- The object with which the AMR originally detected is no longer detected by the rear sensor or by supplemental lasers.
- No other obstacles are detected by the AMR's main laser and it can maneuver safely.

For information about cleaning the rear sensor, see: *Cleaning the Rear Sensor* on page 157.

Rear Sensor Operational Considerations

Figure 7-10 is a top-down view of the LD-250 showing the approximate locations of the sensor fields (not to scale). As this figure shows, there are sensor blind spots to the left and right of the AMR.

WARNING: PERSONAL INJURY RISK
To prevent the risk of a person approaching too close to a moving AMR, follow the operational guidelines in this section.

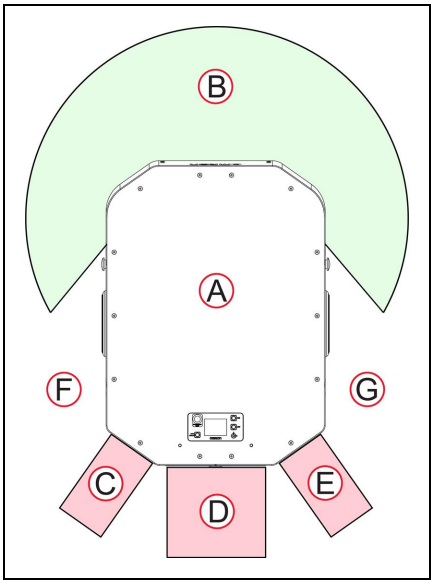


Figure 7-10 *Sensor Fields of View (Approximate)*

Callout	Description	Callout	Description
A	LD-250 top view	**E**	Right rear sensor
B	Safety and navigation laser 240-degree field of view.	**F**	Left potential blind spot
C	Left rear sensor	**G**	Right potential blind spot
D	Center rear sensor		

It is unlikely that an AMR can drive into a person because of these sensor blind spots, and when path planning, the AMR never drives autonomously in a reverse direction. However, under certain circumstances, the AMR can be commanded to move in a reverse direction and it is possible that a person or object might move into the sensor blind spot without being detected by the AMR.

The AMR is operating at a low speed (225 mm/sec) during such maneuver, but an AMR with its payload has considerable mass, and might tip a person over. If your AMRs operate in the same workspace as people, provide information and training for people so that they:

- Have complete allowance of the potential directions of movement that an AMR might take, such as rotating in place and reversing.
- Know not to stand in or move toward the immediate vicinity of a working AMR.
- Understand the significance of the warning buzzer.
- Do not leave or place obstacles where the AMR might not detect the obstacle.

To mitigate the possibility of an accident, adhere to the recommendations in the following sections.

Warning Buzzer When Reversing or Rotating

Make sure that the warning buzzer is configured to operate at least when the AMR is docking or moving in a commanded reverse direction. (The AMR will not reverse autonomously.)

Docking to Recharge

When docking, the AMR reverses onto the docking station. Its rear sensors are inactive during this maneuver.

Clearly mark the floor area around docking stations as No Step areas. For example, use yellow stripes on the floor to delineate the area. Inform and train any persons operating the AMR to avoid walking into these areas when an AMR is approaching to dock.

Using Move or GotoStraight in MobilePlanner

A **Move** task is a commanded operation that can cause the AMR to reverse if you specify a negative value. While the AMR is reversing, the rear sensor is operational.

You might need to adjust the value of the **FrontClearance** parameter to add a margin of safety. The default clearance is 200 mm. You can reduce this value if you want to approach an object more closely. However, when moving in a reverse direction lower values of FrontClearance will increase the risk of colliding with a person or object that might move into the AMR's path.

Similarly, the **GotoStraight** command might cause the AMR to reverse to a specified goal if the goal is behind the AMR's heading. During **GotoStraight** travel, the rear sensor is active and you should also consider adjusting the value of the **FrontClearance** parameter.

The goToStraight parameter provides a failSeconds attribute that enables you to make the AMR wait X seconds for the obstacle to move. If the obstacle is no longer detected within the elapsed time the AMR either proceeds or fails depending on the value of other goToStraight attributes/

Manual Driving

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
When driving the AMR either with the joystick or remotely from a computer it is your responsibility to make sure that no people or objects are in the immediate vicinity of the moving AMR. You must be able to see the AMR and its operating environment at all times.

You can drive the AMR manually by the attached joystick or remotely through MobilePlanner (teleoperation). The following considerations apply:

- **Joystick Driving** - During manual driving by Joystick (see *Driving by Joystick* on page 139) the rear sensor does not operate. Take care when driving the AMR in reverse.
- **Driving Remotely** - If you use Mobile Planner to drive the AMR remotely (either with the on-screen virtual joystick or through the computer keyboard) the rear sensor operates normally.

  IMPORTANT: When driving through the computer keyboard, if you press and hold the reverse key the AMR will persistently attempt to move in reverse. This might cause it to reverse into a person or obstacle.

Payload Overhangs

If your payload overhangs the LD-250's default footprint, there are several adjustments you must make to AMR operating parameters to stay within safe operation limits. (See: *Payload Dimensions and Design* on page 80.)

In particular, see: *Overhanging Payloads and the AMR Swing Radius* on page 194

Other Sensors

Encoders and Gyroscope

Each motor has two redundant wheel encoders that enable an accurate estimation of the AMR's speed.

Wheel encoders also provide the LD-250's navigation system with odometry information (how far each wheel has traveled, and in which direction.) In addition, the LD-250 Core contains an internal gyroscope to track the LD-250's rotational velocity.

Rear Sensor

An infrared time-of-flight (ToF) sensor array is mounted at the rear of the LD-250 for remote-sensing obstacles when traveling in reverse direction or when obstacles move close behind the LD-250.

A User Bumper connector enables you to add your own payload structure bumpers. The LD-250 Core's rear upper panel (in the payload bay) provides connections for front left, center, and right sensors, and rear right, center, and left sensors. See: *User Bumper* on page 105.

IMPORTANT: The User Bumpers connector is not safety-rated.

7.7 Start up the LD-250

LD-250 Start Up Procedure

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Make sure the encoder cables are properly secured before startup. 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 start the AMR:

1. Press and hold the power ON button momentarily.
2. Wait approximately one minute for all sub-systems to start up and connect with each other.

   Start up is complete When the light discs show two blue light segments, moving in opposite directions from 6 o'clock to 12 o'clock and back. See: *Indications Provided by Light Discs Light Outputs* on page 127.

3. If the AMR fails to start, power it OFF and:
    a. Verify the battery's state of charge and connection.
    b. If you have recently changed any connections, verify that they are properly connected.

The LD-250 Core, navigation laser, and some auxiliary power outlets start automatically when you press ON.

Modify start up parameters in MobilePlanner to change the default power-on behavior, or to assign AUX power to your payload accessories.

Joystick Controls and Description

The joystick plugs into an outlet the left rear side of the LD-250, under the small access door of the LD-250. See *Maintenance* on page 141. This outlet is internally connected to the joystick port located on the rear side of the LD-250 Core in the payload bay.

CAUTION: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Take care when driving the AMR in reverse. The standard rear-facing obstacle detection sensing does not operate when driving by joystick.

CAUTION: PERSONAL INJURY OR PROPERTY DAMAGE RISK
The safety scanning laser is not part of the E-Stop chain when driving with the joystick. Maintain full control of the joystick and the AMR when the joystick is connected to the AMR.

You can use MobilePlanner modify the **Robot Operation, Teleop Settings** parameters that control manual driving, such as the maximum translational and rotational speed. These settings are always subordinate to the absolute maximum settings in **Robot Operation, Robot Config**.

IMPORTANT: Omron recommends that you secure the joystick when it is not in use. This prevents unauthorized persons from operating an AMR.

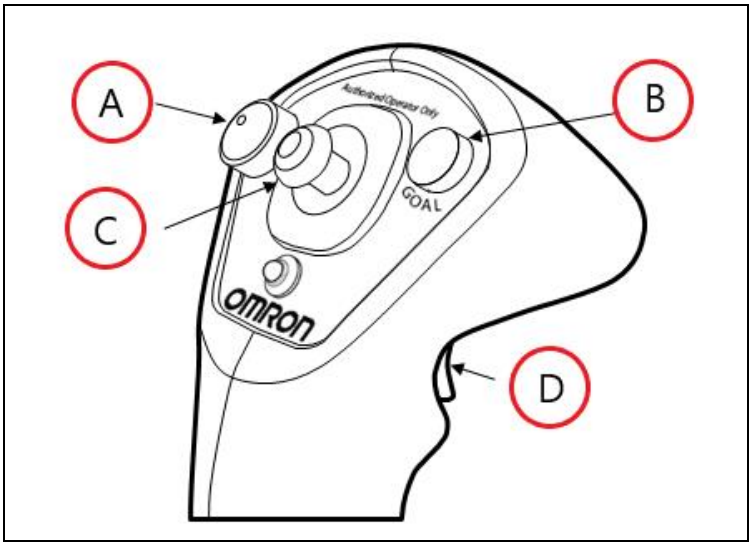


Figure 7-11 *Joystick, (A) Speed Control, (B) Goal Button, (C) Directional Control, and (D) Trigger*

Driving by Joystick

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
When operating the AMR with the joystick, it is the operator's responsibility to make sure that no people or objects are in the immediate vicinity of the moving AMR.

Use the joystick to drive the AMR manually and to create the scan used to make a map. Squeeze the trigger to enable the directional control button.

Push the directional control button forward or back to make the LD-250 move in that direction. Push the directional control button to the side to make the LD-250 rotate in that direction. Diagonal positions of the directional control button move the LD-250 in an arc.

Releasing the trigger causes the AMR to slow to a stop. To stop more quickly, continue to squeeze the trigger and pull or push the directional control button to its limit in the opposite direction of the LD-250's travel.

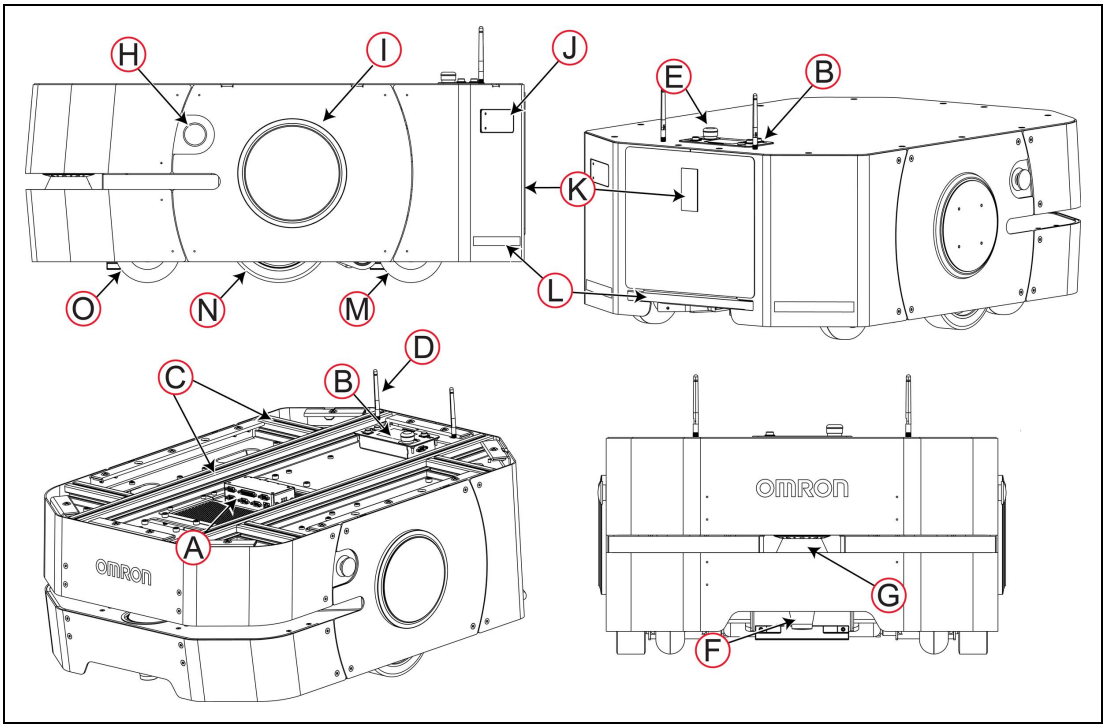
Use the joystick's GOAL button for marking positions while making a map scan.

Chapter 8: Maintenance

This chapter describes periodic maintenance and how to replace user-serviceable parts in an LD-250. See also: *Docking Station Maintenance* on page 120.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Use only the specified tools, equipment, lubricants, and Omron-supplied spare parts to service and maintain the LD-250 according to the specified service interval. Failure to do so could result in an unsafe operating state than might result in personal injury or damage to property.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Read and follow the Safety Data Sheet (SDS) for all chemicals, lubricants, and cleaning materials required for maintenance operations. Contact Omron support if you do not have the required SDS.



Location of Parts on the LD-250

Callout	Description	Callout	Description
A	LD-250 Core	**I**	Wheel light discs
B	Operator Panel (HMI)	**J**	Connection ports
C	Load bars	**K**	Battery skin (secured by a latch)

Callout	Description	Callout	Description
D	Wireless networking antenna (2)	**L**	Rear sensor
E	E-Stop button (One either side and one on the control panel)	**M**	Rear caster
F	Low front (toe) laser	**N**	Drive wheel
G	Safety and navigation laser	**O**	Front caster
H	Side E-Stop button.		

8.1 Considerations During Maintenance

Before doing any maintenance task:

- Read the guidelines for safe lifting and for chocking casters and obtain the necessary resources for working safely on the AMR.
- Read and observe any specific safety notices applicable to the procedure.
- Use the Operator Panel Off button to shut down the AMR. See: *OFF Button* on page 126. (If you have removed the Operator Panel, this willbe an alternate off button or switch.
- Put the AMR into a safe working state by either pressing an E-Stop or by removing the battery. Some procedures require that you remove the battery.
- If the procedure requires that you remove any skins, take care to avoid damaging or disconnecting any cables during the procedure (unless disconnecting a cable is part of a procedure).

IMPORTANT: Damaged or disconnected sensor cables can cause the AMR to move unpredictably during start-up, or to fail to detect obstacles and people after start-up.

CAUTION: FLAMMABLE IRRITANT
Follow all appropriate local safety regulations for working with isopropyl alcohol, including fire safety, toxicity, and protective clothing and gear requirements.

8.2 After Completing Maintenance

Perform the checks described in this section before you put the AMR back into service.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
During initial operation after installation or maintenance, no objects should be within 2 meters of the AMR to ensure adequate clearance should a fault occur.

- Check that all cables are properly connected and have no visible damage before you replace skins.

- Replace the battery, if removed. Verify that it is charged.
- Reset the E-Stop button, if pressed.
- Open MobilePlanner, connect to the AMR. Localize it and verify that all sensors are detected and returning data.
- Check the operation of the Light Discs and, if used, the optional beacon.
- Connect the joystick and manually drive the AMR, forward and reverse, turning in both directions to verify safe operation.
- Make sure that the surrounding area is clear of people and obstacles for a distance of at least 2 meters. Unexpected movement might result from:
    - A disconnected or damaged encoder cable.
    - An incorrect setting of the gearbox drive engagement lever.
    - Damaged or disconnected sensors.
- Check E-Stop operation by pressing an E-Stop Button.
- Check laser and rear sensor operation with a test obstacle.

After performing these checks, return the AMR to autonomous driving.

8.3 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 LD Safety Guide*, should perform the procedures and replacement of parts covered in this section.

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.

Figure 8-1 shows the location of the drive wheel power and encoder cables, and their connection through the chassis. Disconnecting either cable is typically not required for any normal maintenance procedure. Disconnecting the encoder cable can lead to loss of control of the AMR if the cable is not properly reconnected and secured with thread locking fluid.

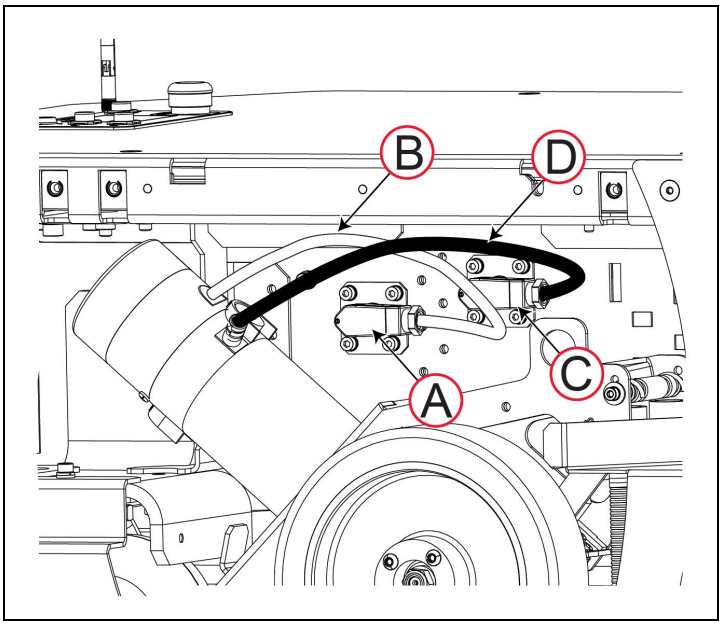


Figure 8-1 *Drive Wheel Encoder and Power Cables.*

Callout	Description	Callout	Description
A	Connector for the encoder signal cable.	**C**	Connector for the encoder signal cable.
B	Encoder signal cable (light grey).	**D**	Motor Power cable (black).

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
During initial operation after installation or maintenance, no people or objects should be within 3 feet of the AMR for safe clearance if a fault occurs.

Understanding Electrical Hazards

WARNING: ELECTROCUTION RISK
The docking station has AC power inside. Docking station covers are not interlocked.

- Do not use power extension cords with the docking station unless properly rated.
- Never access the AMR's interior while it is attached to a charger.
- Immediately disconnect the battery after you open the battery compartment door.

  Avoid shorting the battery terminals.
- Do not use any charger not supplied by Omron.
- If the AMR comes into contact with any liquid:
  - Power off the AMR.
  - Clean off as much liquid as is possible.
  - Allow the AMR to air dry thoroughly before restoring power.
  - Contact your local Omron Support if you suspect that liquid has penetrated the skins or contaminated the AMR's interior.

Understanding Burn Hazards

CAUTION: BURN RISK
Parts of the drive train can get hot during operation. Allow the LD-250 to cool before servicing.

Understanding Magnetic Field Hazards

Docking Funnel Magnets

WARNING: MAGNETIC FIELD - MEDICAL IMPLANT RISK
Magnetic fields can be hazardous to medical implant wearers. Medical Implant wearers should stay at least 30 cm (12 inches) away from the underside of the LD-250, which is exposed during certain maintenance procedures when the LD-250 is on a raised work surface.

8.4 Lifting the LD-250 Safely

If you need to lift the LD-250 for any reason, take care to lift from safe lifting points and secure it with safety straps to prevent falling. An appropriate number of persons is required to manually lift an AMR, depending on the base platform weight and the additional weight of its payload. Omron recommends using a mechanical lift when possible. See: *Component Weight* on page 192.

CAUTION: PROPERTY DAMAGE RISK
Lifting the LD-250 from the wrong points can cause damage.

DANGER: PERSONAL INJURY OR PROPERTY DAMAGE RISK
When lifting the LD-250 take all precautions to lift it safely at only the designated lift points and to secure the LD-250 when it is in an elevated position. Do not work under the LD-250 if it is not secured in the lifted position with safety straps. Failure to do so might result in serious personal injury or death or damage to property.

Safe lifting points are:

- load-bearing T-slotted extrusions in the payload bay.
- The caster mount points.
- Any part of the underside of the steel chassis that is not a sensor location.

Do not lift the LD-250 by:

- Any of the skins.
- Any part of the chassis that contains a sensor component.

8.5 Wheel Lift Tool

A wheel lift tool is provided so that you can lift the drive wheels for maintenance tasks. This tool is located on the right side of the LD-250, underneath the side skin as shown in Figure 8-2.

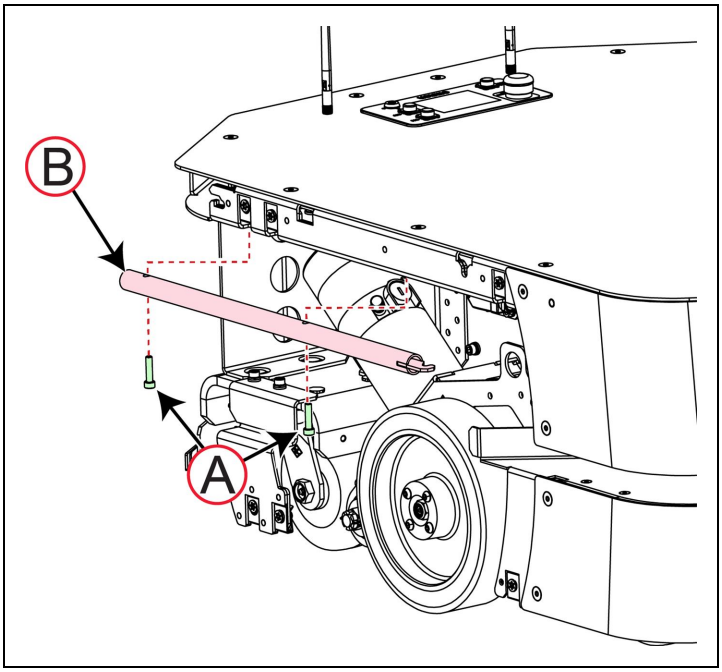


Figure 8-2 *Location of the Wheel Lift Tool*

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.

To access the wheel lift tool:

1. Remove the right side skin. See: *Remove and Replace the Side Skins* on page 183.
2. Use a 5 mm hex key to remove the two M6 screws (A), holding the tool (B) as you remove the second screw to prevent the tool from falling.

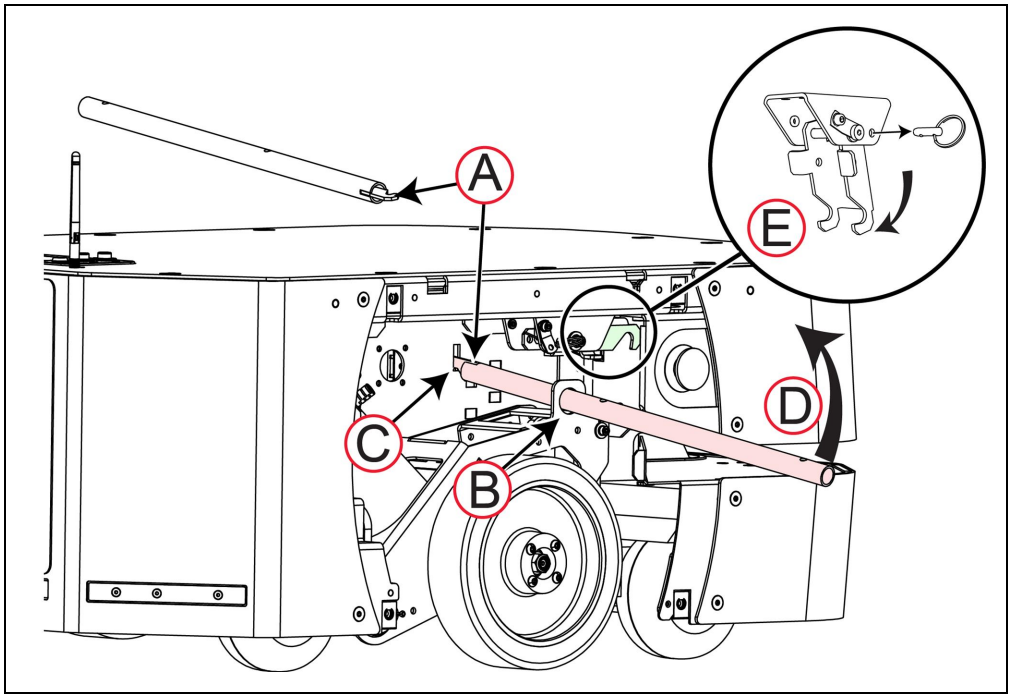


Figure 8-3 *Using the Wheel Lift Tool*

To use the wheel lift tool:

1. Insert the hook end of the tool (A) through the hole in the drive train (B) and into the slot in the chassis (C).
2. Raise up the end of the tool (D) to lift the drive wheel. This might take some effort because you are extending the suspension springs.
3. While keeping the wheel raised, pull out the detente pin to rotate retaining hook (E) downward. Set the hook under the top suspension bar to hold the suspension extended, keeping the drive wheel in the raised position.
4. Remove the left side skin. See: *Remove and Replace the Side Skins* on page 183.
5. Repeat Step 1 through Step 3 to raise the other drive wheel, if required.

To lower the wheel, refer to Figure 8-3 and:

1. Starting with the left side wheel. Insert the hook end of the tool through the hole in the drive train (B) and into the slot in the chassis (C).
2. Raise up the end of the tool (D) to take the tension off the retaining hook (E)
3. While keeping tension on the suspension spring, rotate the retaining hook upward, and secure it with the detente pin.
4. Replace the left side skin. See: *Remove and Replace the Side Skins* on page 183.
5. Repeat Step 1 through Step 3 to lower the right side drive wheel, if required.
6. Store the wheel lift tool as shown in Figure 8-2.
7. Replace the right side skin. See: *Remove and Replace the Side Skins* on page 183.

8.6 Engage and Disengage the Drive Wheel Motors

Some procedures, such as commissioning or shipping the LD-250 require that you engage or disengage the drive wheel motors. This enables the drive wheel to rotate freely. The drive gearbox provides a cam lever that disengages the main drive cog, disconnecting the motor from the drive wheels.

> **IMPORTANT:** For shipping, the LD-250's drive wheels motors are engaged, preventing you from rolling the LD-250 off its shipping pallet and down the ramp. You must disengage the drive wheel motors before you attempt to manually move the LD-250. See: *LD-250 Packaging* on page 48.

You can also disengage the drive wheel motors if you want to manually move the LD-250, as an alternative to using the Brake Release button. See: *Brake Release Button* on page 127.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Do this procedure only when the LD-250 is either on its shipping pallet, or on a level surface with the casters chocked and an E-Stop pressed to prevent movement.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Make sure the encoder cables are properly secured before startup. Improper connection or disconnection of encoder cables might cause erratic motion of the AMR during operation. The AMR might rotate uncontrollably during loss of encoder signals.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Make sure both gearbox cam levers are properly set and both drive wheels engaged before startup. Improper engagement of only one gearbox might cause erratic motion of the AMR during operation.

Figure 8-4 shows the location of the cam lever (A). The suspension is omitted from this illustration for clarity.

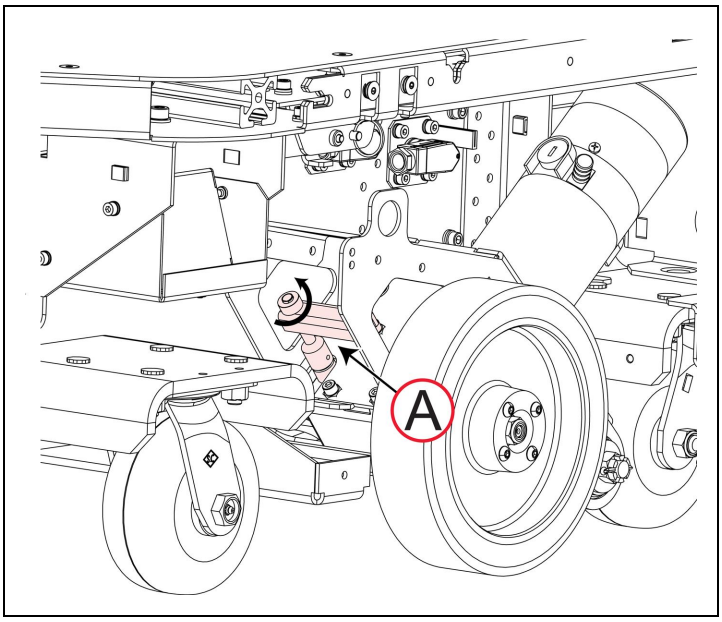
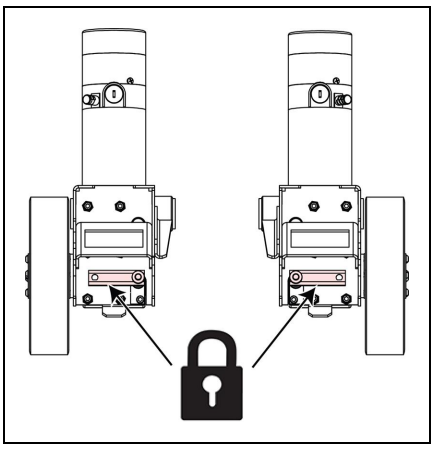


Figure 8-4 *Cam Lever to Engage or Disengage the Drive Motor*

To disengage the drive gear box and disable the drive wheel:

1. If the battery is installed, press an E-Stop button to disable power to the motors for safety during the procedure.
2. If the LD-250 is not on its shipping pallet, chock the casters to prevent the LD-250 from rolling.
3. Remove the side skin. See: *Remove and Replace the Side Skins* on page 183.
4. Do one of the following depending on cam lever's current position:
   - Turn both cam levers downward to the **gearbox locked** position to engage the drive motors.



   - Turn both cam levers upward to the **gearbox released** position to disengage the drive motors.
5. Release the E-Stop button. See: *Releasing an E-Stop* on page 31.

You can now:

- Move the LD-250 manually off its shipping pallet. See: *LD-250 Packaging* on page 48.
- Do the commissioning task (see: *E-Stop and Safety Laser Commissioning* on page 176.)
- Do any maintenance task that requires the drive wheels to rotate freely, or manually push the LD-250.

8.7 Safety Inspection

Warning Devices

Make sure that all warning devices function properly. You must inspect and test the following warning devices every week:

Flashing Light

Each AMR should have a flashing light that provides a visual warning whenever the AMR is ready to move or is moving. The design and position of the light depends on the design of your payload structure. See also: *Warning Lights* on page 77.

Light Discs

Every week, check the light discs on each side of the AMR for correct operation. See also: *Light Discs* on page 109.

Buzzer

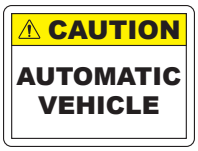
Check the warning buzzer for correct operation. For standards compliance, make sure that the buzzer is audible under typical operating conditions and environments. See also: *Warning Buzzer* on page 78.

Warning Labels

Check all warning labels on the AMR every week for presence and legibility. Contact your local Omron Support to obtain replacement parts for missing or illegible labels. or of you need to move a label to a different location.

Table 8-1 Warning Labels and Part Numbers

Label and Location	Part Number	Appearance (Not to scale)
Medical Implant - Magnetic Field Warning The docking funnel on the underside of the LD-250. (Exposed only during maintenance operations, if you turn the AMR on its side.)	18621-000	
E-Stop Button Emergency Stop		

Label and Location	Part Number	Appearance (Not to scale)
No Riding Label Depending on the design of your payload, you affix this label when you set up the AMR.	18178-000	
Automatic Vehicle Label, Rear skin of the LD-250.	18623-000	

8.8 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, ice, or pooled liquid. material 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.
- Every 6 months, measure the floor's coefficient of friction and make sure it is in the range: 0.55 – 1.0. (See *Environment and Floor* on page 115.)
- 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 area to incorporate the change. Particularly if the change blocks the AMR's ability to scan original workspace features.

Platform Cleaning

The following table gives a summary of cleaning procedures for the LD-250.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK
Before working on drive assemblies, make sure that you put the AMR into a safe state for maintenance operations. Press an E-Stop button or remove the battery. Make sure that its wheels are immobilized to prevent the AMR from moving.

Table 8-2 Cleaning

Item	Period
Clean docking station contacts	3 months
Clean axles and tires	As needed
Clean dust and dirt from drive assembly and suspension well.	As needed
Clean all lasers	6 months/ as 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 modify the schedule as needed.

Wheels

Occasionally clean the treads with a mild soapy solution. Remove any accumulated dirt or debris on the tires which can degrade performance.

This applies to both the drive wheels and the casters.

Axles

Keep the axles free of fibrous material, plastic film or any materials that might wrap around and bind up the LD-250's axles.

Drive Assemblies

Remove any accumulated dirt and dust.

1. Before and after cleaning, inspect all mechanical parts for breakage or signs of wear which might be indicated by:

- Leaking lubricants
- Heat discoloration
- Rust and oxidation
- Black sooty deposits, metal or plastic filings

2. Use a small amount of alcohol-based, non-abrasive cleaner on a disposable, lint-free cloth to wipe all dust from the drive assembly, including the motor.

   (There might be some residual grease around the pivot bar. Clean that area last.)

3. Use a vacuum cleaner to remove any dry foreign material from the suspension well, and wipe away any remaining material with a disposable, lint-free cloth.

Lasers

Occasionally clean the lenses of the navigation laser, low laser and any other lasers used on the payload.

Use only a soft cloth with alcohol-based, non-abrasive cleaners, and wipe thoroughly.

After cleaning, inspect the lens for cracks, scratches or abrasion.

Docking Station Contacts

The two docking station contacts need occasional cleaning. The suggested interval is 3 – 6 months, depending on frequency of charging.

WARNING: ELECTROCUTION RISK
Unplug power from the docking station before starting. Remove the power cord.

Clean the contacts with isopropyl alcohol.

CAUTION: PROPERTY DAMAGE RISK
Do not lubricate the docking station paddle because it reduced reduce its working life.

Lubricating ESD Casters

The ESD casters require regular lubrication every three months and inspection to make sure that they rotate freely in both axes.

If the casters fail to rotate, it can affect navigation accuracy and reduce operational duration. The AMR might waste battery power in the differential drives, attempting to overcome problems with sticking casters.

Examine casters for wear or damage during the lubrication procedure. See: *Cleaning ESD Casters* on page 156.

You need the following tools and resources:

- Gloves.
- Disposable lint-free wipes.
- Detergent-based cleaning liquid.
- Grease gun with flexible nozzle for a grease (Zerk) nipple.
- Seal pick to remove O-ring seal.
- NLGI-2 bearing and O-ring grease.
- Four replacement O-rings

NOTE: Even though a Zerk fitting is provided on the caster axle, do not lubricate the caster axle.

Use the following ESD caster lubrication procedure:

1. Press an E-Stop button and power off the LD-250 to put it into a safe working state. and safely lift up the LD-250 so that you can access the casters.
2. Remove the front lower and rear right and left skins. See: *Removing and Installing Skins* on page 178.
3. Remove the caster wheel. See the procedure to remove a caster wheel in: *Replacing a Caster Wheel* on page 171.
4. The caster yoke's bearing race (A) is covered by an O-ring (B). Remove the O-ring by pulling it down with a seal pick and dispose of it.

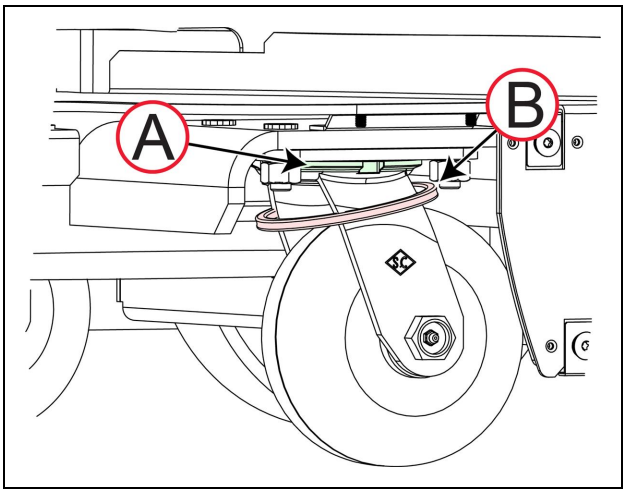


Figure 8-5 *Caster Yoke Bearing and O-Ring*

5. Use disposable wipes to remove old grease and dirt from the yoke bearing [(A) in Figure 8-5].
6. Use the grease gun to apply only two pumps of grease through the Zerk fitting in the yoke bearing [(A) in Figure 8-6]. Avoid applying grease to the wheel.

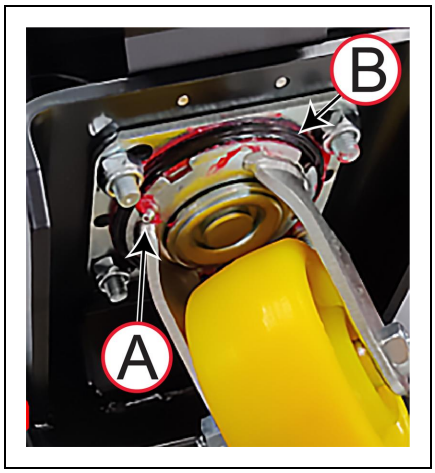


Figure 8-6 *Installed and Lubricated Caster O-ring.*

7. Lubricate a new O-ring with a small amount of grease and install it as shown by (B) in Figure 8-6.
8. After lubrication, make sure that the caster yoke rotates freely. Inspect the caster wheels and axles for wear or damage.
9. Replace the caster wheel. See: *Replace Front or Rear Casters* on page 171.
10. Repeat Step 3 through Step 9 for each caster in turn.
11. Reinstall the front lower and rear left and right skins. See: *Removing and Installing Skins* on page 178.

DANGER: Used wipes are a potential fire and environmental toxicity hazard. Dispose of them in accordance with safety regulations for your locale.

Cleaning ESD Casters

Casters on the ESD platform are critical components because they provide the discharge path to ground. ESD require regular, periodic cleaning to preserve ESD protection capability.

You must also maintain the LD-250's operating surface to provide a conductive path to ground. See: *Environment and Floor* on page 115.

You need the following tools and resources:

- Gloves.
- Vacuum cleaner or compressed air to remove dry dust.
- Wire hook, tweezers, and sharp blade to remove any fibrous material wound around the caster's hub
- Disposable lint-free wipes.

- Soft brush.
- Isopropyl alcohol.

CAUTION: Follow all appropriate local safety regulations for working with Isotropy alcohol, including fire safety, toxicity, and protective clothing and gear requirements.

Use the following ESD caster cleaning procedure:

1. Press an E-Stop button and power off the LD-250 to put it into a safe working state.
2. Remove the payload structure, if any part of it prevents access top the skins or casters.
3. Remove the front lower and rear right and left skins. See: *Removing and Installing Skins* on page 178.
4. Lift the LD-250 safely.
5. Use a vacuum cleaner or compressed air to remove dust and loose material.
6. Use a wire hook or tweezers and sharp blade to carefully cut away any fibrous material from around the hub and axle.
7. Use disposable wipes and a soft brush dampened with isopropyl alcohol to thoroughly clean all four casters.
8. Dry the casters thoroughly with a clean wipe.
9. After cleaning, inspect the caster wheels, axles, and pivots for wear and damage.
10. Re-install the payload structure if it was removed.
11. Reinstall the front lower and rear right and left skins. See: *Removing and Installing Skins* on page 178.

DANGER: Used wipes are a potential fire and environmental toxicity hazard. Dispose of them in accordance with safety regulations for your locale.

Cleaning the Rear Sensor

The rear sensor might return false obstacle detection results if the cover surface is dirty or dusty. Lighter accumulations of dirt and dust might only reduce the sensing range.

The sensor cover is acrylic plexiglass and you cannot use abrasive cleaners or cleaning pads. Do not use any chemical cleaners, which might damage or cloud the surface.

For best results:

- Use only low-pressure air to blow off surface dust.
- Clean the sensor cover only with a soft anti-static cloth and a small amount of mild detergent solution. Clean in a circular motion to best preserve the surface.
- Use a clean cloth dampened with distilled water to remove any detergent residue.

Do not disassemble the sensor cover. If dust or dirt get onto a sensor it is not possible to safely clean it and you must replace the sensor array.

See also: *Rear Sensor* on page 134

8.9 Maintaining and Replacing Batteries

Maintaining Batteries

Maintain batteries as follows:

- Every six months, inspect batteries (both stored and in-use) for damage or leaks.

  If a battery is leaking, do not expose it to water. If possible, submerge it in mineral oil.

  Contact your local Omron Support immediately for disposal instructions.
- Store batteries fully charged and upright at (one month) +5 to 45°C (41 to 113°F); (one year) 20 to 25°C (68 to 77°F).
- Every six months, charge stored batteries to a full charge.

Replacing the Battery

The battery is expected to last for approximately 2000 recharge cycles. 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 LD-250. Do not use batteries intended for use in other Omron LD-series 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.

CAUTION: PROPERTY DAMAGE RISK
Follow appropriate ESD procedures during the removal and replacement operations.

Removal

The battery lasts for approximately 2000 recharge cycles however, you might need to remove it more frequently if you use a daily manual charging schedule. Some service operations also require that you remove the battery for safety.

CAUTION: PERSONAL INJURY RISK
The battery weights 19 kg (42 lb). Use safe lifting practices when removing or installing the battery.

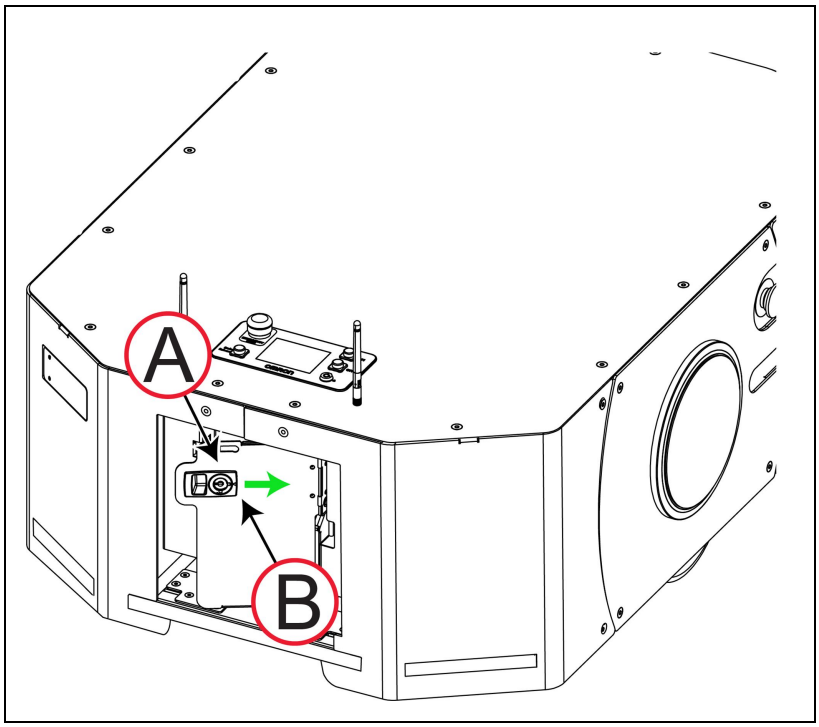


Figure 8-7 *Accessing the LD-250 Battery*

1. Shut down the AMR. See: *OFF Button* on page 126.
2. Remove the battery door LD-250 skin. See: *Access the Battery Compartment* on page 53.
3. Unlock (if required) then unlatch and open the battery compartment door by sliding the latch (A) to the right (B).
4. Examine how the cables are routed, and then disconnect the power and data cables.

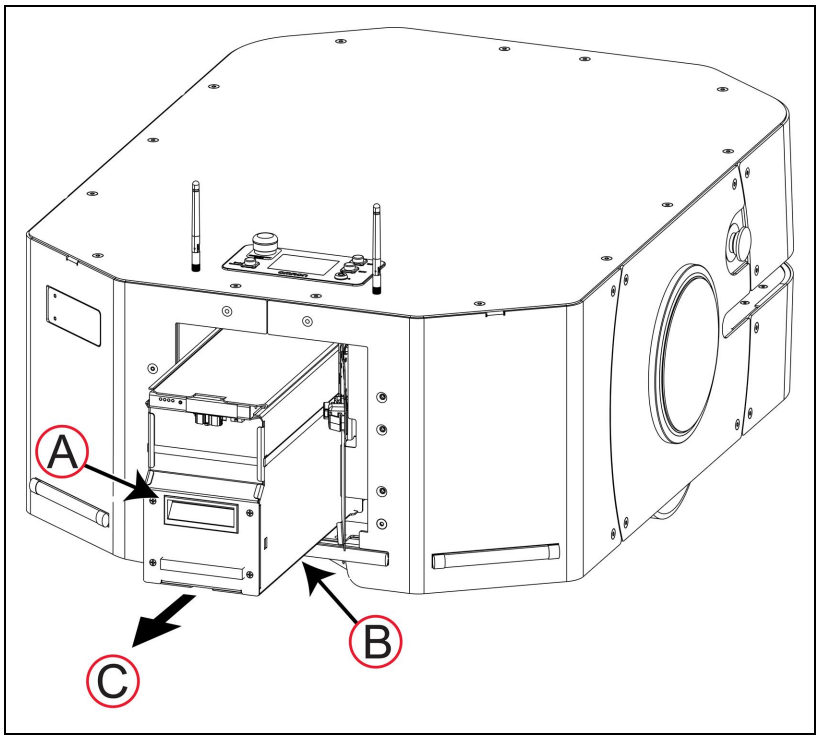


Figure 8-8 *Pull out the LD-250 Battery*

5. Using only the hand grip (A) in Figure 8-8, slide the battery out of the LD-250.
6. Support the battery at the bottom (B) as you pull it in the direction of the arrow (C) to prevent it from falling.

Use only the handles at the front and rear of the battery to carry it. If you are storing the battery, see: *Battery Shipment* on page 47. If manually charging the battery, see: *Manually Charging the Battery* on page 121.

Battery Installation

Refer to *Removing and Installing Skins* on page 178 for information about accessing internal LD-250 components.

The battery weight is specified in: *Dimension Drawings* on page 191. Determine whether you need assistance to safely lift and carry the battery.

Use only the recessed handles at each end of the battery to lift and carry it.

1. Remove the rear battery door skin.
2. Unlock (if required), then unlatch and open the battery compartment door.
3. Lift and slide the battery into the LD-250 body.

Figure 8-9 *Battery Handles*

The connectors for power and data go toward the rear of the LD-250.

4. Connect the battery power and data cables, making sure that the connections lock into place,

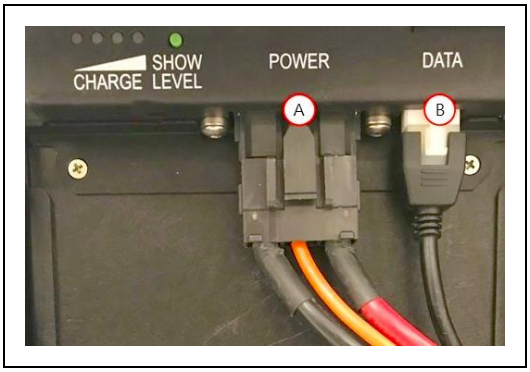


Figure 8-10 *Battery Connectors, (A) Power and (B) Data*

5. Close and latch the battery compartment door. Optionally, lock the door for security.

   The battery compartment door holds the battery firmly in place so that it cannot move inside the compartment.

6. Reinstall the battery door LD-250 skin. See: *Access the Battery Compartment* on page 53.

8.10 Replacing Non-Periodic Parts

Replace the parts described in this section accordance to their wear specification or if visual inspection indicates wear or damage.

CAUTION: SHOCK RISK
To prevent accidental power-on during servicing, disconnect and remove the power cable during all docking station service operations. Store the power cable remotely from the in-service docking station.

Distance Traveled by the AMR

In some instances, the distance traveled by an AMR indicates the service interval. Determine distance traveled as follows:

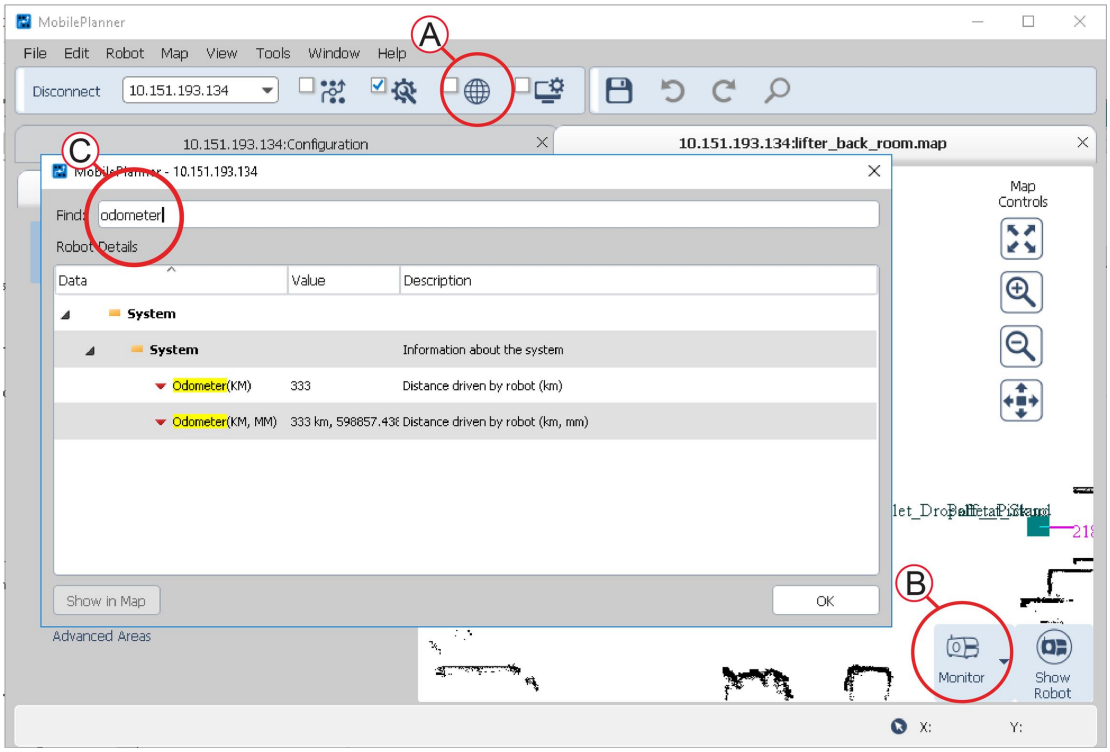


Figure 8-11 *Determine the Distance Traveled by an AMR.*

1. In MobilePlanner, connect to the AMR and open its Map tab (A).
2. Click **Monitor** (B) in the bottom right of the screen to open the monitor fly-out menu, and then click **Details**.
3. In the **Robot Details** dialog window, type *odometer* in the **Find:** field (C) and then press **Enter**.

The value of the System, Odometer parameter is the distance traveled in kilometers.

Docking Station Roller and Bearing

The roller and bearing guide the AMR onto the docking station, and can become worn after extended use. Symptoms of wear might include the AMR failing to dock accurately and charge or repeated docking attempts.

Figure 8-12 *New Roller P/N 12416-000*

- Visually inspect the roller for wear or damage. Look for:
  - Worn or abraded (flattened) surfaces
  - Cracks
  - Flat spots
  - Small pieces of material flaking off the roller.
- Check on and around the roller bearing for metal filings or black powdery residue that indicates abrasion damage.
- Spin the roller manually to make sure it turns freely and does not bind or lock up.

Refer to the following figure for the location of the roller.

Figure 8-13 *(A) Docking Station Roller, and (B) Switch*

WARNING: ELECTROCUTION RISK
Unplug power from the docking station before starting. Remove the power cord at the docking station.

1. Switch off power and disconnect the power cable from the wall outlet.
2. Use a 5 mm hex wrench to remove the M6 shoulder bolt from the center of the roller. Retain the shoulder bolt and washer.
3. Remove the roller and bearing from the docking station.
4. Replace the worn roller with a replacement roller, P/N 12416-000.
5. Apply Loctite 242 to the shoulder bolt, then insert and tighten to 65.0 in-lb (7.4 N·m).
6. Connect the power cable from to wall outlet and put the power switch in the on position. Verify that the blue power light illuminates.
7. Send an AMR to the docking station and confirm that charging starts (the amber Charging light illuminates).

If either light does not illuminate, see: Docking Station AC Power Fuse.

Docking Station AC Power Fuse

Recent model docking stations contain a circuit breaker that you can reset after correcting a problem such as overheating or short circuit. For older models (depending on the docking station model) it might contain either of the following fuses:

- **A thermal fuse in the power switch**.

  This part is not user-serviceable. Contact your local Omron Support if the docking station's blue power light does not illuminate when connected to a known good power source.

- **Two ceramic cartridge fuses**.

  These fuses are located in the power outlet, between the power switch and the AC power plug. You can replace these fuses if they burn out.

Obtain P/N 04563-000 02212-000L replacement fuses from Omron. Equivalent generic fuses must be 250 V, 10 A, and Time-lag. An example of a compliant model fuse is the *LittelFuse 0215010.XP, 5x20 mm cartridge type*.

WARNING: ELECTROCUTION RISK
Unplug power from the docking station before performing any maintenance operations. Remove the power cord from the charger.

To replace a fuse:

1. Verify that the fuse has burned out by plugging the docking station into a known good AC power source. If the blue power light does not illuminate, the fuse might be burned out.
2. [Optional] If you have a spare battery, attempt to charge it manually. If the battery begins to charge, then the docking station might have a burned-out internal fuse. Go to the procedure described in: *Docking Station Internal Fuse* on page 165.
3. Set the power switch to the off position and disconnect the power cord before proceeding.
4. Squeeze the two side tabs on the fuse holder and pull it out of its socket.

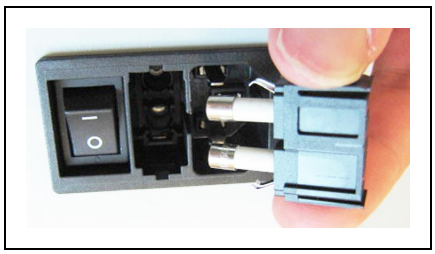


Figure 8-14 *Removing the Docking Station Fuse Holder*

5. Replace both fuses with Omron P/N 04563-000 02212-000L or equivalent.
6. Insert the fuse holder and press it in firmly so that the tabs engage.
7. Reconnect the power cord to a known good power source and set the power switch to the on position. Make sure that the blue power light illuminates.
8. See "Docking Station Internal Fuse"
9. Send an AMR to the docking station and confirm that charging starts (the amber Charging light illuminates).

Contact your local Omron Support if either the power or charging light does not illuminate, or the fuse burns out a second time.

Docking Station Internal Fuse

Depending on the docking station model, it might contain an internal fuse. The internal fuse might be burned out if:

- The blue power light does not illuminate.
- You have checked or replaced the external AC power fuses (Docking Station AC Power Fuse
- You can successfully charge a spare battery on a manual charge, but a docked AMR will not change.

Obtain P/N 13091-000 replacement fuses from Omron. There are no acceptable generic alternates.

WARNING: ELECTROCUTION RISK
Unplug power from the docking station before you remove fuses. Remove the power cord from the charger.

To replace a fuse:

1. Remove eight screws from the back cover of the docking station and one each from the bottom side panel.

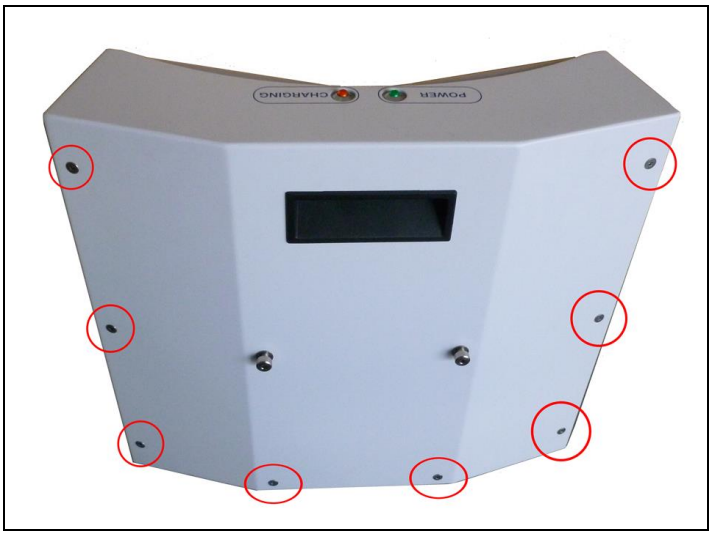


Figure 8-15 *Docking Station Rear Cover Screws (8 of 10)*

   Retain the screws for reassembly.

2. Remove the docking station's rear cover.
3. Identify the fuse holder shown in Figure 8-16. It is close to the top of the bus-bar (A) in a black screw-top holder (B)

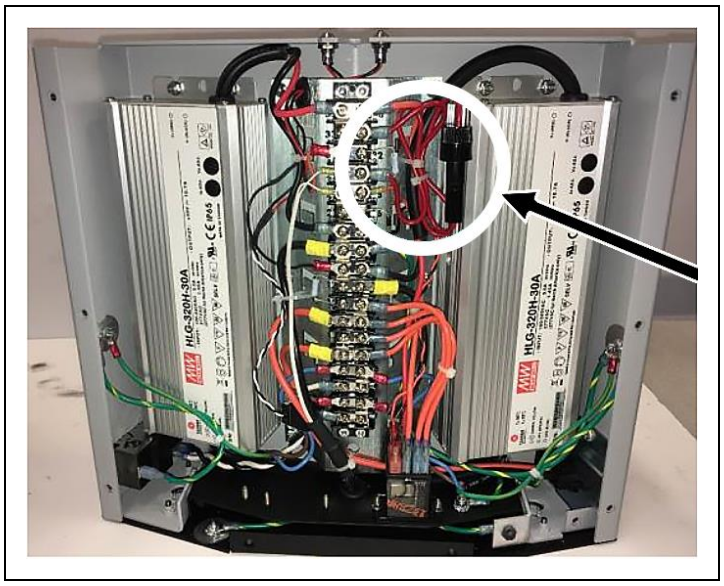


Figure 8-16 *Location of the Internal Fuse Holder*

4. Unscrew the knurled top of the holder and replace the fuse.
5. Reinstall the docking station rear cover, and secure with the ten screws previously removed.
6. Send an AMR to the docking station and confirm that charging starts (the amber Charging light illuminates).

Contact your local Omron Support if either the power or charging light does not illuminate, or the fuse burns out a second time.

Light Discs

Both light discs and their controllers are single units, so replacing a controller also replaces all of the lights on that side of the LD-250.

1. Remove the side skin from the side that needs the light disc replaced.

   See: *Remove and Replace the Side Skins* on page 183.

2. Unscrew the four fasteners holding the light disc PCA to the side skins.

   Retain the fasteners and round cover for installing the new assembly.

3. Remove the light disc PCA.
4. Align the black connector on the new PCA with the square notch in the skin. Then, attach the new PCA and round cover to the side skin, using the fasteners from the old assembly.
5. Reinstall the side skin, connecting the cable to the new light disc PCA.

   See: *Remove and Replace the Side Skins* on page 183.

6. Dispose of the old light disc PCA according to local and national regulations concerning electronic components.

Operator Panel

The Operator panel is usually relocated to the payload structure, and its removal and replacement procedure varies accordingly. It connects to the into the HMI Panel connector on the LD-250 Core.

Replace the Motor Brushes

The LD-250 uses drive motors in which the brushes are a wear item. Replace the brushes every 8000 km until 24000 km. At that distance, you must replace the entire motor. To determine the distance traveled, see: *Distance Traveled by the AMR* on page 162.

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.

You require:

- A set of four replacement spring-loaded brushes, part number 21471-000.
- 0.25 inch (7 mm) 90-degree offset flat-blade screwdriver, end height 15.8 mm (0.625 inch.)

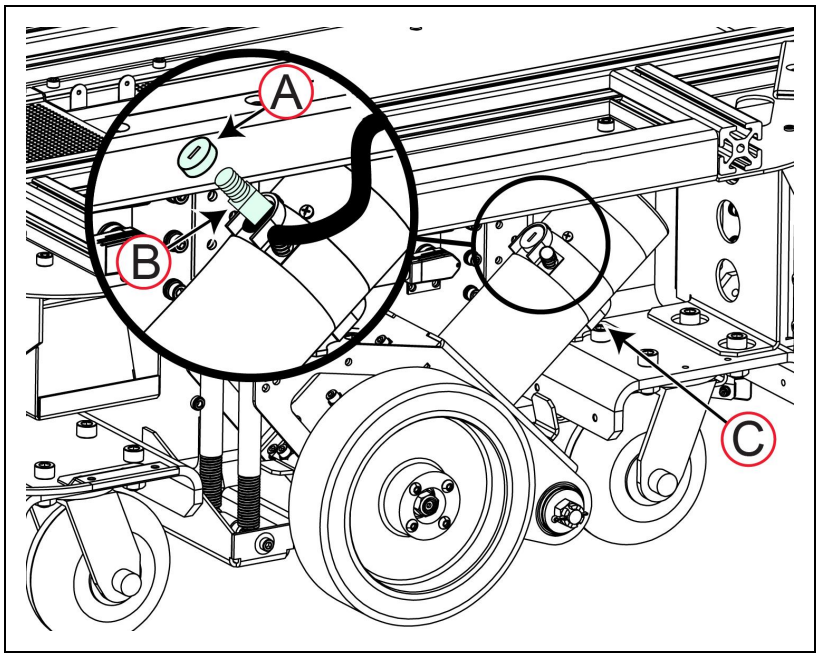


Figure 8-17 *Replace the Motor Brushes*

Before you begin, press an E-Stop button to disable the AMR.

To replace the brushes, do this procedure on both sides of the AMR:

1. Starting on either the left side or the right side of the LD-250 remove the rear skin. See: *Remove and Replace the Rear Skins* on page 184.
2. Remove the side skin on the same side. See: *Remove and Replace the Side Skins* on page

183.

3. Follow the procedure to remove the drive wheel. See: *Replace the Drive Wheels* on page 169. This provides easier access to the underside brush.
4. Use an 0.25 inch (7 mm) flat-blade offset screwdriver to remove the brush cover (A).
5. Insert a new replacement brush as shown by (B) in Figure 8-17.
6. Replace the brush cover. Do not over-tighten.
7. Repeat Step 3 through Step 6 for the underside brush (C).
8. Replace the drive wheel. See: *Replace the Drive Wheels* on page 169.
9. Replace the side and rear skins. See: *Removing and Installing Skins* on page 178.
10. Release the E-Stop and enable the drive motors. See: *Releasing an E-Stop* on page 31.

Replace the Drive Wheels

The LD-250 has solid aluminum wheels with polyurethane treads. Depending on the AMR application, the wheel treads have a duration of 10,000 km (6200 miles) before replacement is necessary. See: *Distance Traveled by the AMR* on page 162.

Inspect the wheels daily and remove any surface-embedded foreign material such as stones, screws, or metal swarf.

Thoroughly inspect and clean wheels and treads every 3 months and replace any wheels that show signs of excessive wear or damage.

Tread damage might be indicated by:

- Abnormal or uneven wear patterns. Damage to the metal wheel or bearing can also cause abnormal wear.
- Cracks, chips, or cuts in the polyurethane tread.
- Flat spots.
- Abraded rough surface.
- Delamination or debonding (separation) of the polyurethane tread.

Metal wheel damage might be indicated by:

- Binding or indications of metal-on-metal wear such as metal filings or a black powdery deposit.
- Oil or grease leaking from bearings.
- Cracks in the metal part of the wheel.

Replacing Drive Wheels

Replace both wheels at the same time. Differences in wear between drive wheels might affect the repeatability and accuracy of navigation.

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.

You need the following resources:

- 4 mm hex key and torque driver bit.
- Torque driver.
- Rubber mallet.
- Isopropyl alcohol, paper towels, cotton swabs.
- Loctite 242.

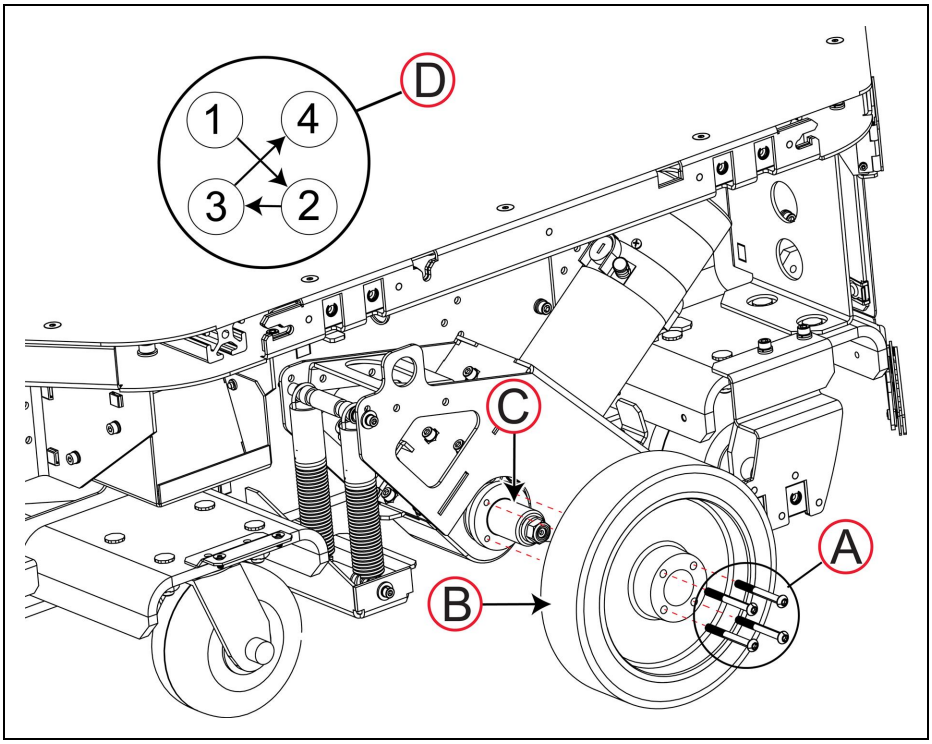


Figure 8-18 *Replace the Drive Wheel (Additional Skins Removed for Clarity).*

Remove the drive wheel as follows:

1. Put the LD-250 into a safe state by pressing an E-stop button.
2. Remove only the side skin. See: *Remove and Replace the Side Skins* on page 183.
3. Use a 4 mm hex key to only loosen the four 60 mm M6 bolts (A).
4. Raise the LD-250 on its casters until the drive wheel is off the floor.
5. Use a 4 mm hex key to completely remove the four 60 mm M6 bolts (A).
6. Pull the drive wheel (B) off the axle hub (C). If the wheel is difficult top remove, tap

lightly with a rubber mallet on the inside face.

7. Clean the bolts and the threaded holes with a small amount of isopropyl alcohol to remove any loose cured thread locking fluid..
8. Align the bolt-holes on the replacement wheel with the threaded holes in the axle hub and push the replacement wheel onto the hub.
9. Apply a drop of threadlocking fluid to each M6 bolt and fasten the bolts by hand, finger-tight.
10. Lower the LD-250 to the floor so that the drive wheel touches the floor in its normal driving position.
11. Use an M4 hex key to hand-tighten each bolt only two turns each in the cross-wise pattern (D). Tighten until the wheel is completely mounted on the hub, up to the hub flange.
12. Torque each M6 bolt to 11.8 N·m (8.7 ft-lb) using quarter-turns in a cross-wise pattern (D).
13. Repeat Step 2 to Step 12 for the second drive wheel.

Replace Front or Rear Casters

Examine the casters every 3 months, and replace them if they show signs of cracking, excessive wear or damage. When operating on the recommend floor surface, the service life of the caster exceeds 10,000 km (6200 miles).

Measure the diameter of the casters. When new, the casters are 127 mm (5.0 inches). The maximum permissible wear is 3.05 mm (0.012 inches).

Replacing a Caster Wheel

If the wheel or wheel bearing is worn or damaged you can replace only the wheel. All four caster wheels are identical, and are mounted in the same way.

You require

- Replacement caster wheel P/N
- Two 19 mm wrenches or sockets.

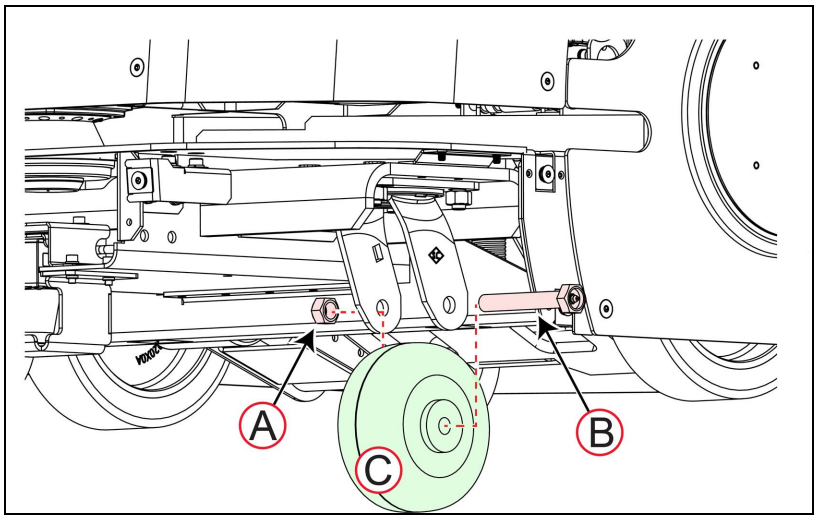


Figure 8-19 *Replacing a Caster Wheel*

To replace a caster wheel:

1. Put the LD-250 into a safe working state by pressing an E-Stop button. Safely lift up the LD-250 so that you can work underneath.
2. Remove the lower front or rear skin. See: *Remove and Replace the Lower Front Skin* on page 182 and *Remove and Replace the Rear Skins* on page 184.
3. Use two 19 mm wrenches or sockets (one on each side) to unfasten the retaining nut (A) and axle (B).
4. Slide out the axle (B) to remove the caster (C).
5. Place a new caster in the yoke and replace the axle (B).
6. Replace and tighten the retaining nut (A). Verify that the caster rotates freely.
7. Replace the lower front or rear skin. See: *Remove and Replace the Lower Front Skin* on page 182 or *Remove and Replace the Rear Skins* on page 184.
8. Safely lower the LD-250 back onto its wheels.

Replacing a Caster Assembly

If the bearing is worn or damaged you must replace the entire caster assembly, not just the wheel.

All four casters assemblies are identical, and are mounted to the LD-250 in the same way.

> **NOTE:** If you can lift the LD-250 enough to access the nuts and bolts that retain the caster, you can avoid removing the payload structure and the battery. Removing the payload structure and battery is necessary only if you tilt the LD-250 onto its side.

WARNING: MAGNETIC FIELD - MEDICAL IMPLANT RISK
Magnetic fields can be hazardous to medical implant wearers. Medical

Implant wearers stay back 30 cm (12 inches) from the underside of the LD-250, which is exposed during certain maintenance procedures.

You require:

- 16 MM wrench for M10 locking hex nut.
- Caster part no 20301-121.

To replace a caster:

1. Put the LD-250 into a safe working state by pressing an E-Stop button. Safely lift up the LD-250 so that you can work underneath.
2. Remove the lower front or rear skin. See: *Remove and Replace the Lower Front Skin* on page 182 and *Remove and Replace the Rear Skins* on page 184.
3. Remove the four M10 hex nuts (A) that fasten the caster to the chassis. (Retain the four nuts to attach the replacement caster.)

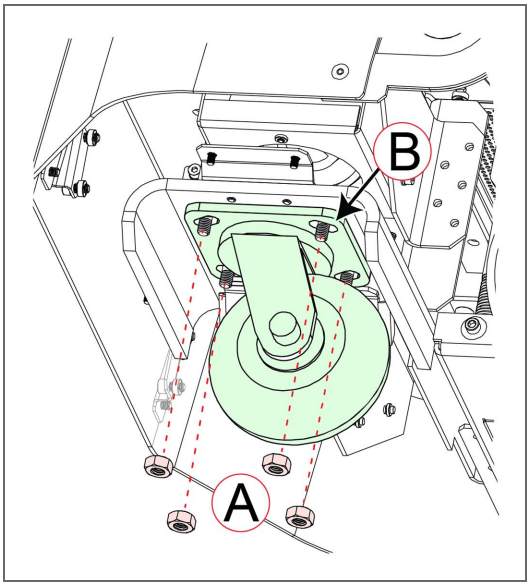


Figure 8-20 *Replacing an LD-250 Caster Assembly*

4. Remove the caster and replace it with a new caster.
5. Fasten the caster loosely with four M10 locking hex nuts. Tighten all four nuts in a crosswise pattern.
6. Center the caster on its elongated holes (B) and make sure that it is square with the chassis.
7. Replace the lower front or rear skin. See: *Remove and Replace the Lower Front Skin* on page 182 or *Remove and Replace the Rear Skins* on page 184.
8. Safely lower the LD-250 back onto its wheels.

LD-250 Core

The LD-250 Core is an enclosed computing appliance, with internal fans as the only moving parts. There are no user-serviceable parts inside the enclosure and you must exchange the entire LD-250 Core if it fails for any reason.

If the LD-250 Core is software-accessible, make sure that you download its configuration information in the Debuginfo file. You might require this information to reconfigure the AMR after you replace the LD-250 Core. See: *Obtain a DebugInfo File from SetNetGo* on page 26

If you have installed options such as an Acuity Camera or Side Lasers, refer to the LD Platform Peripherals User's Guide for specific information about removing and reconnecting those options.

> **IMPORTANT:** The LD-250 Core used in other LD-series models has exactly the same physical appearance. Make sure you use part number 11736-100 or later revision. A jumper (tethered to the chassis) prevents operation with an incorrect model core.

You require the following tools:

- Replacement LD-250 Core. This must be part number 11736-100
- A jumper, part number 20758-000L is tethered to the LD-250 chassis. Insert this in the Bumper connector on the LD-250 Core.
- 5 mm hex key (or bit).
- 2.5 mm hex key (or bit).
- Pliers and flat-blade screwdriver for loosening connector lock screws.
- Masking tape and a marker pen to label cables and connectors.
- Either an ESD wrist strap or shoe straps, or use an ESD mat in the workspace area.

Before you begin:

- Move the LD-250 to a clean and clear workspace.
- Press the Off button to shut down the LD-250. See: *OFF Button* on page 126.
- Press an E-Stop button.

Figure 8-21 shows the mounting brackets and fasteners that you remove to access the LD-250 Core. Retain all fasteners to use when installing the replacement core.

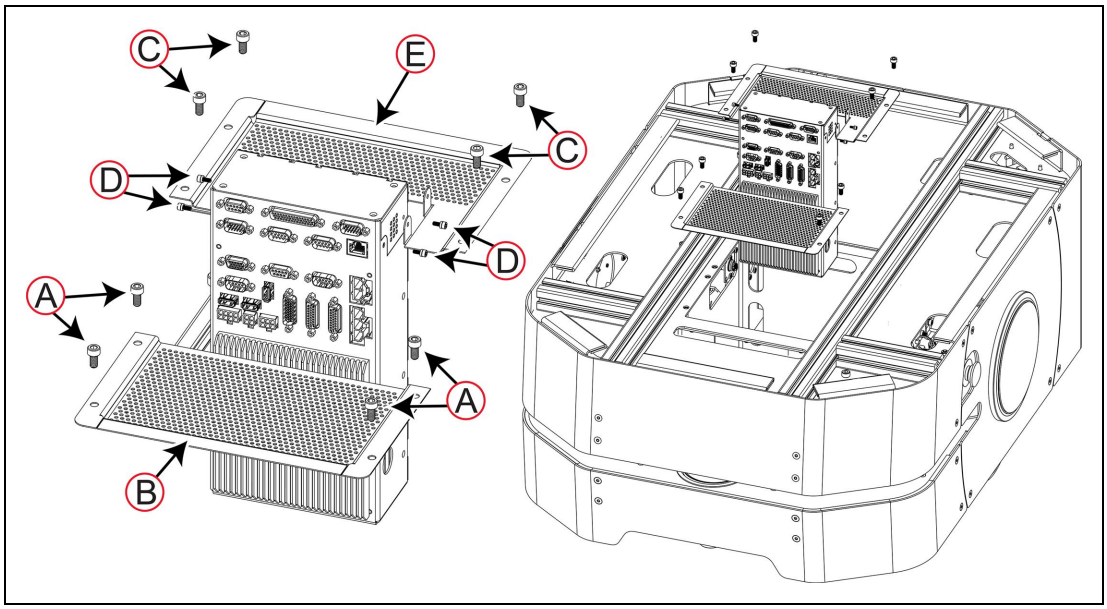


Figure 8-21 *LD-250 Core Mounting Brackets and Fasteners*

Callout	Fastener Description	Quantity
A, C	12 mm M6 socket head cap screw	8
D	8 mm M3 socket head cap screw	4

Remove an LD-250 Core

Use the following procedure to remove the LD-250 Core:

1. Move or remove the payload structure to provide full access to the payload bay.
2. Remove the battery door skin at the rear of the LD-250. See *Access the Battery Compartment* on page 53.
3. Unlock (if required), unlatch, and then open the battery compartment door.
4. Disconnect the battery power and data cables.
5. Label and disconnect all of the cables attached to the upper portion of the LD-250 Core.

   See: *Payload Bay Connections - LD-250 Core* on page 93.
6. Use a 5 mm hex key to remove four 12 mm M6 socket head cap screws (A) and then remove the perforated cover plate [(B) in Figure 8-21].
7. Use a 2.5 mm hex key to remove the four 8 mm M3 socket head cap screws and washers (D) to detach the LD-250 Core from its mounting bracket (E).
8. Use a 5 mm hex key to remove four 12 mm M6 socket head cap screws (C) and then remove the perforated mounting bracket [(E) in Figure 8-21].
9. Gently lift up the LD-250 Core up, until you can reach the internal connections.
10. Label and remove all cables attached to the internal LD-250 Core connector panel. Pay

particular attention to the Left Motor and Right Motor connectors, which have the same connector and might easily be reversed.

See: *Internal LD-250 Core Connections* on page 107.

11. Remove from the USB sockets, and safely store any license dongles.
12. Remove the uncabled LD-250 Core.

Install an LD-250 Core

Use the following procedure to install an LD-250 Core:

1. Reconnect all the labeled cables to the internal connector panel (the lower part of the LD-250 Core). make sure that you connect the Left Motor and Right Motor connectors to the correct sockets.

   See: *Internal LD-250 Core Connections* on page 107.

2. Carefully lower the LD-250 Core into the chassis. Make sure that it slides into its bottom bracket (attached to the chassis) and that no cables are trapped beneath the core.
3. Use a 2.5 mm hex key to attach the mounting bracket [(E) in Figure 8-21] to the LD-250 Core with four 8 mm M3 socket head cap screws and washers (D).
4. Use a 5 mm hex key to attach the perforated mounting bracket [(E) in Figure 8-21].
5. Use a 5 mm hex key to attach the perforated cover plate [(B) in Figure 8-21] using four 12 mm M6 socket head cap screws (A).
6. Reconnect all of the labeled cables to the top portion of the LD-250 Core. Make sure that you also connect the tethered jumper.

   See: *Payload Bay Connections - LD-250 Core* on page 93.

7. Reconnect the battery power and data cables to the battery.
8. Close, latch and optionally lock the battery compartment door.
9. Install the battery door skin at the rear of the LD-250. See *Access the Battery Compartment* on page 53.
10. Replace the payload structure.
11. Dispose of the failed LD-250 Core according to local and national regulations concerning electronic components.

See: *Restoring the Configuration* on page 186.

E-Stop and Safety Laser Commissioning

Under normal circumstances, the AMR is commissioned at the factory, and will not need to be re-commissioned. However, you must repeat the E-Stop Commissioning and the Safety Laser Commissioning procedures under the following circumstances:

- You replace the LD-250 Core.
- The hardware detects a failure, the AMR might automatically decommission itself. (ARAM displays a fault dialog in MobilePlanner.)

- The payload includes an optional user-supplied E-Stop.
- The commissioning procedures are included in the regular preventive maintenance.

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 relays and solenoids close
- The wheel light disks 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 an optional payload E-Stop, if you added one.

1. Make that all E-Stop buttons are disengaged (up) before you begin the test.
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 and navigation laser correctly reports speed zone information;
- E-Stop circuitry trips when you place a detectable obstacle in front of the AMR.

To do this test, you must first disable the drive wheels. See: *Engage and Disengage the Drive Wheel Motors* on page 148.

Table 8-3 lists the maximum speed for each speed zone. For the LD-250, each speed zone represents 225 mm/s, so if the maximum speed is 1440, five zones are reported. (Later, when you press the **Drive** button in the commissioning wizard, it reports the maximum AMR speed.)

Table 8-3 LD-250 Speed Zones

Zone	Maximum Speed (mm/s)
1	225
2	450
3	675
4	900
5	1125
6	1350

Zone	Maximum Speed (mm/s)
7	1575
8	1800

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 an anomaly, automatic decommissioning of the safety circuit occurs. To continue operation you must complete a recommissioning process (see Section 8.6 E-Stop and Safety Laser Commissioning).

The following safety mechanisms might cause decommissioning:

- Mismatched channels: ESTOP redundant lines are not in agreement.
- Mismatched speed zone: Speed detection redundant channels are not in agreement.
- Forward speed exceeds 1600 mm/s.
- Reverse speed exceeds 225 mm/sec.

Accessing the Payload Bay

Access to the payload bay depends on the design of your payload structure. If you have a small, light payload structure, you might be able to disconnect it and lift it off (taking care not to damage the connection cables).

Depending on the location of fasteners, the load-bearing bars in the payload bay might also permit you to loosen and slide the payload forward or backward to access the LD-250 Core or its cables.

A taller or heavier payload structure might include a hinged mount, so that you can tilt it off the LD-250 after you disconnect its retaining fasteners. For most payload structures, this design enables a technician to access the payload bay without assistance.

Take care when accessing the payload bay, that the cables between the LD-250 and the payload structure are not disturbed when you tilt the payload structure.

Removing and Installing Skins

Figure 8-22 shows the 8 separate skin panels.

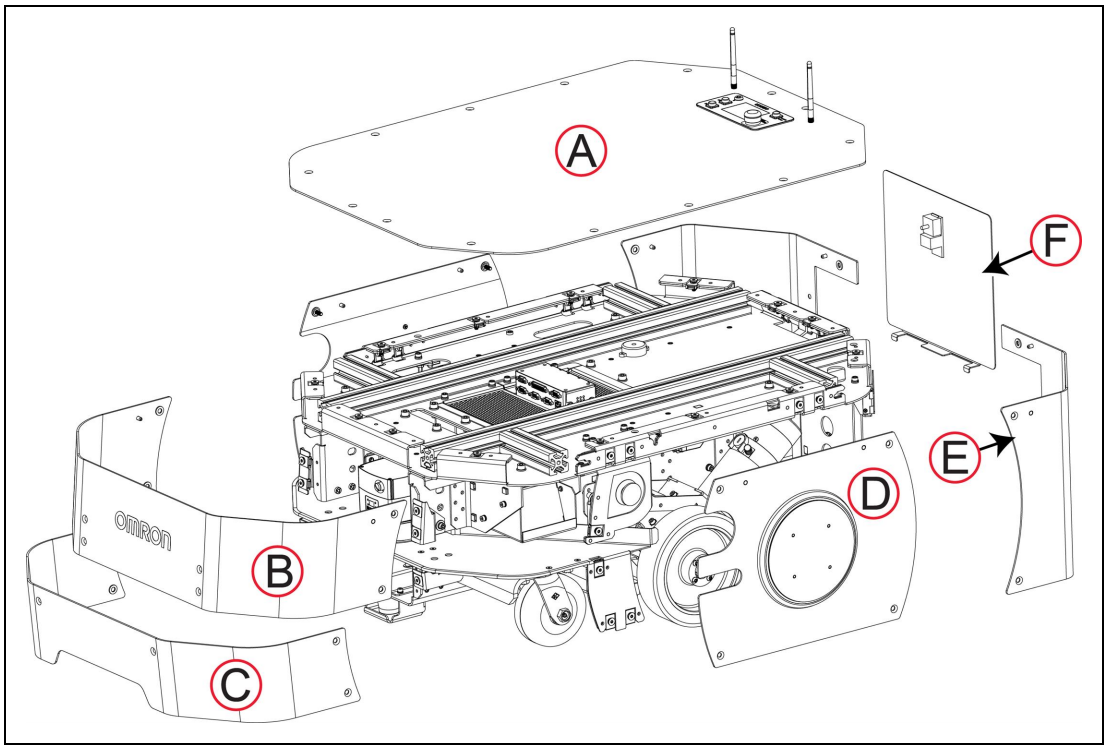


Figure 8-22 *Left Side View of LD-250 Skins*

Callout	Skin Description
A	Top cover, incorporating the Operator Panel. This skin covers the payload bay and is often removed completely for payload attachment.
B	Upper front skin, covering the main safety and navigation laser.
C	Lower front skin, covering the low (toe) laser.
D	Left side skin, incorporating the wheel light disk and covering the drive assemblies. The right and left side skins are symmetric for the task of installation and removal.
E	Left rear skin. The right and left rear skins are symmetric for the task of installation and removal. The left rear skin includes a door that covers the Joystick and Ethernet ports.
F	Battery skin, secured by a rotating latch. (There is a separate lockable battery door underneath this skin.)

With the exception of the battery door, skins are secured to the chassis by captive M6 flat head *Torx plus* screws into clip nuts. A Torx driver is supplied with the LD-250.

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 skins.

Remove and Replace the Top Cover

The top cover encloses the payload bay and incorporates the Operator Panel and two wireless antennae wired to the LD-250 Core.

You require:

- T30 Torx Plus driver (supplied).
- Small flat-blade screwdriver.
- Electrical pliers.

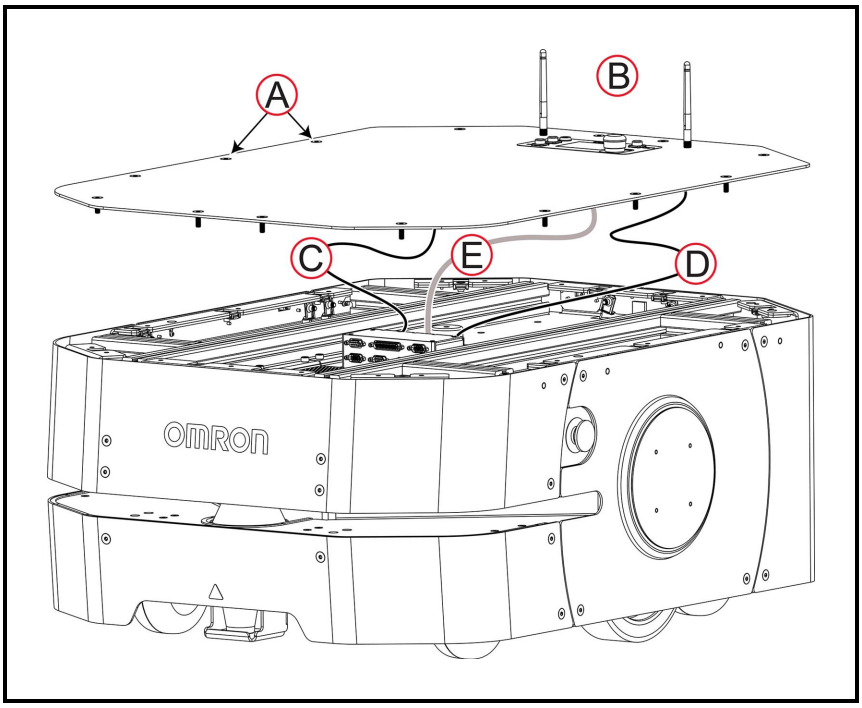


Figure 8-23 *Remove the Top Cover*

Before you begin, press a side E-Stop button to put the LD-250 into a safe state for maintenance work.

To remove the top cover:

1. Use the Torx driver to unfasten all 14 M6 captive screws (A).

   Do not remove the top cover yet, you must first disconnect three cables.

2. Tilt the top cover up a few inches on one side and mark, then disconnect the following cables:

   a. Use pliers to loosen the left and right coaxial cables connected to both antennae, and then disconnect the cables (C) and (D).

b. Use a flat-blade screwdriver to unscrew and disconnect the Operator Panel's DB9 connecter (E).

3. Remove the top cover completely.

To replace the top cover:

1. Pull out a short length of the antennae coaxial cables and the Operator Panel cable so that they overhang the chassis.
2. Lay the top cover at right angles across the chassis. Connect and tighten the cables to prevent vibration from loosening them during normal AMR operation:
   a. Connect the coaxial cables (C) and (D) connected to both antennae and then tighten with pliers.
   b. Connect the Operator Panel's DB9 connecter (E) and use a flat-blade screwdriver to tighten the connector screws.
3. Use the Torx driver to fasten all 14 M6 screws (A).

Release the E-Stop button to return the LD-250 to service. See: *Releasing an E-Stop* on page 31.

Remove and Replace the Upper Front Skin

The front upper skin covers the main safety and navigation laser. Take care that you do not scratch the laser lens or damage the laser when removing the skin.

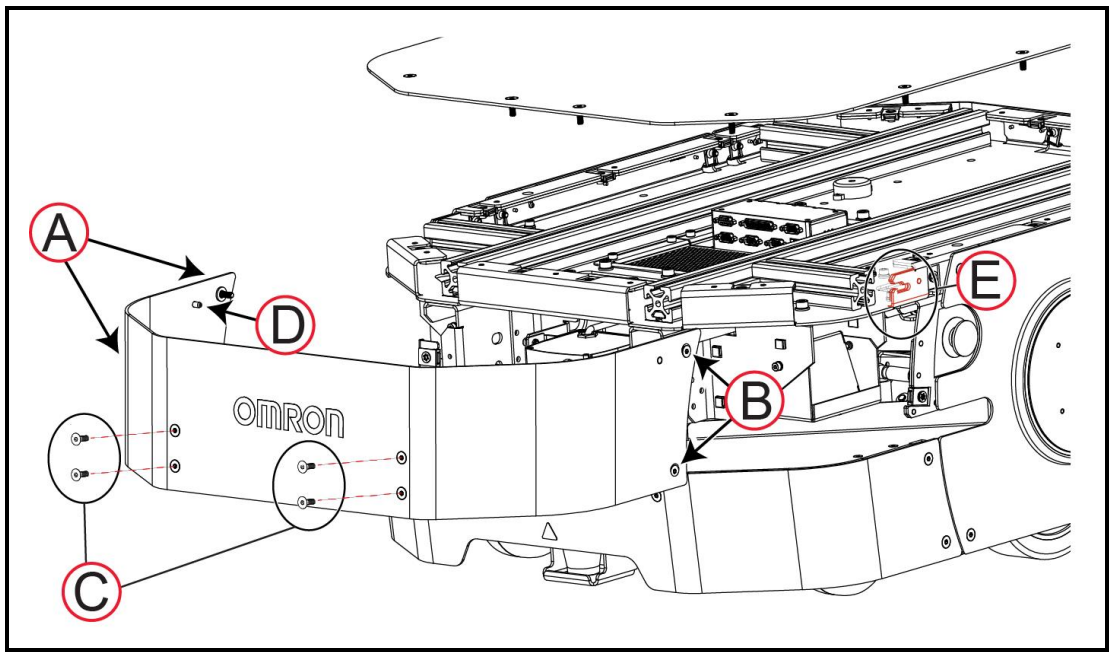


Figure 8-24 *Remove the Upper Front Skin*

Before you begin, press an E-Stop button to put the LD-250 into a safe state for maintenance work.

To remove the upper front skin:

1. From the bottom screw up, use the supplied Torx driver to unfasten the two right side captive Torx screws (A).
2. From the bottom screw up, use the Torx driver to unfasten the two left side captive Torx screws (B).
3. From the bottom screw up, use the Torx driver to unfasten the four front Torx screws (C). Retain the screws to re-attach the skin.
4. Lift the pins (D) out of the cutouts in the chassis (E).

Reverse these steps to replace the upper front skin.

Release the E-Stop button to return the LD-250 to service. See: *Releasing an E-Stop* on page 31.

Remove and Replace the Lower Front Skin

The lower front skin covers the low (toe) laser and front casters. Take care that you do not scratch the laser lens or damage the Low Front Laser when removing the skin.

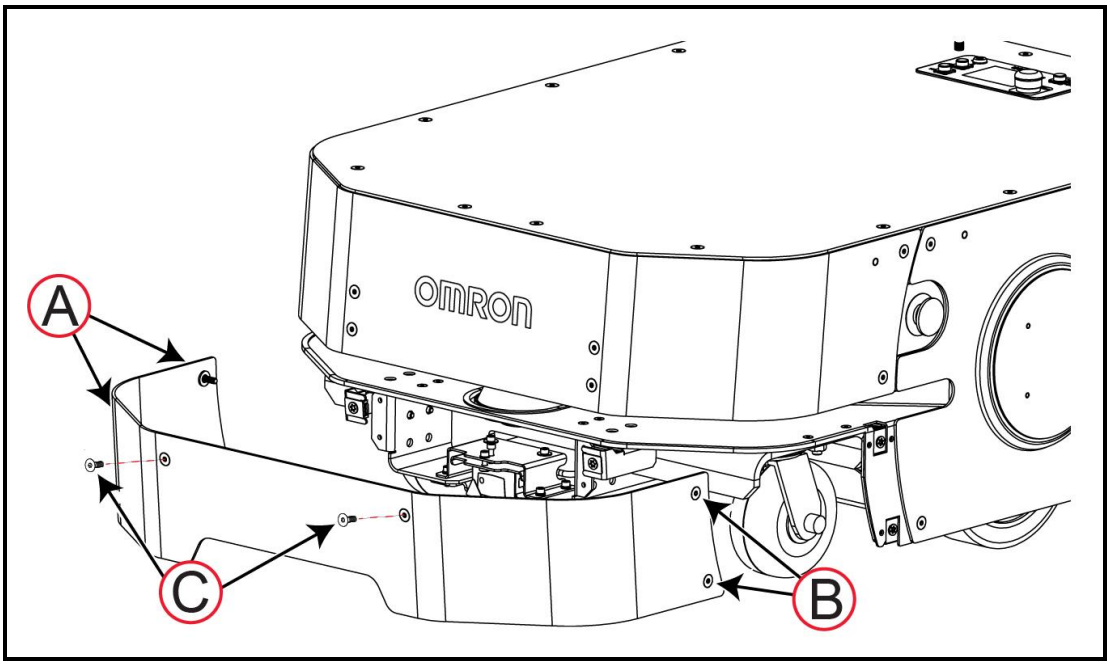


Figure 8-25 *Remove the Lower Front Skin*

Before you begin, press an E-Stop button to put the LD-250 into a safe state for maintenance work.

Use the supplied Torx driver to remove the lower front skin:

1. From the bottom screw up, use the Torx driver to unfasten the two left side captive Torx screws (A).
2. From the bottom screw up, use the Torx driver to unfasten the two right side captive Torx screws (B).
3. While holding the bottom of the skin to prevent it from falling, unfasten the two front Torx screws (C). Retain the screws for reattaching the skin.

Reverse the steps to replace the skin.

Release the E-Stop button to return the LD-250 to service. See: *Releasing an E-Stop* on page 31.

Remove and Replace the Side Skins

The side skins provide access to drive train and E-Stop button components. The skins are symmetric. Use the same procedure to remove either a right-side or a left-side skin.

This skin includes the Light Discs assembly, which is connected by a lightweight cable.

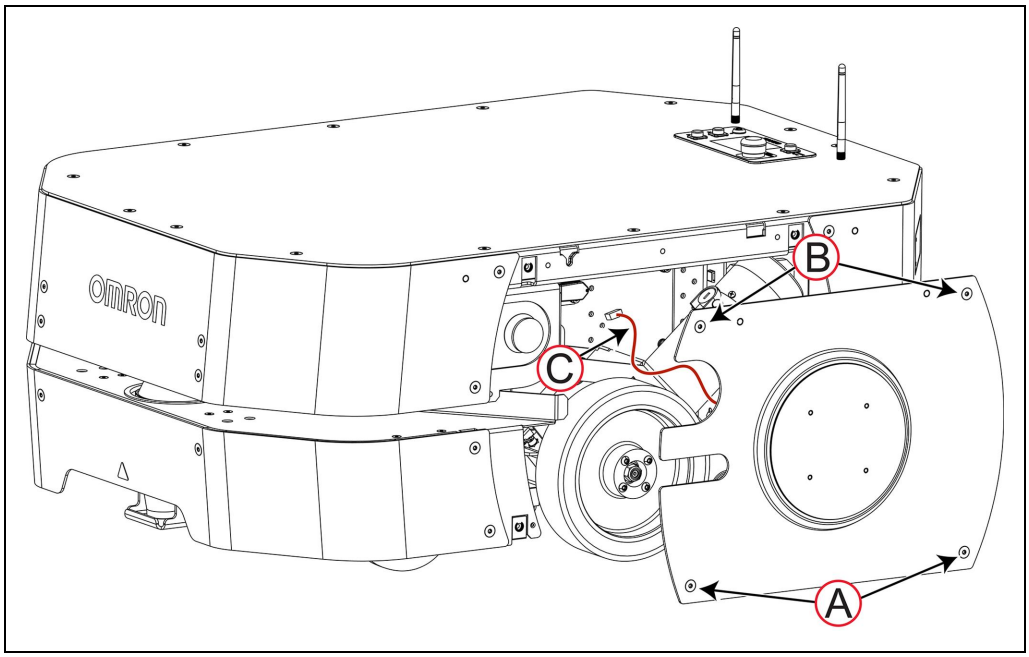


Figure 8-26 *Remove the Side (Light Discs) Skins.*

Before you begin, press an E-Stop button to put the LD-250 into a safe state for maintenance work.

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.

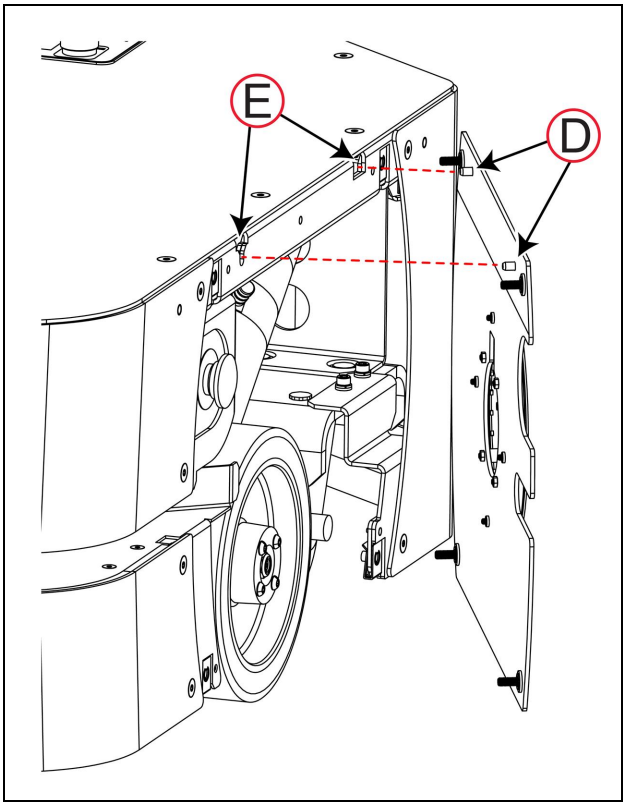
To remove the side skins:

1. Use the supplied Torx driver to unfasten the two bottom M6 captive screws (A).
2. Use the Torx driver to unfasten the two top M6 captive screws (B).

   Do not pull the skin away at this point, it is secured by a the Light Discs cable.
3. Carefully lift the skin off its alignment pins a few inches.
4. Pull only on the connector plug to disconnect the Light Discs cable (C) from its socket.

To replace the skins:

1. Move the skin close to the LD-250 and connect the Light Discs cable (C).
2. Lift the skin's alignment pins (D) onto the receivers in the chassis (E) as shown in the following figure:



3. Use the Torx driver to fasten the two top Torx screws (B).
4. Use the Torx driver to fasten the two bottom Torx screws (A).

Release the E-Stop button to return the LD-250 to service. See: *Releasing an E-Stop* on page 31.

Remove and Replace the Rear Skins

The rear skins provide access to the rear sensors, rear casters and drive train components. The skins are symmetric. Use the same procedure to remove either a right-side or a left-side skin.

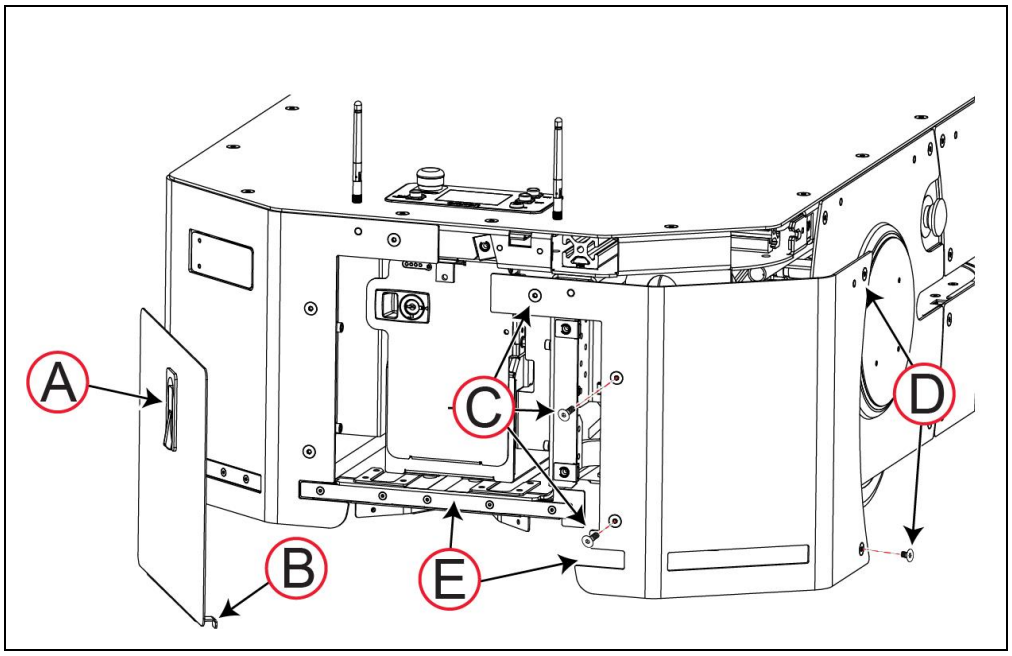


Figure 8-27 *Remove the Rear Skins*

Before you begin, press and E-Stop button to put the LD-250 into a safe state for maintenance work.

> **IMPORTANT:** During this procedure, take care that you do not scratch or damage the rear sensor array.

To remove either rear skin:

1. Open the battery skin (A) by lifting and rotating the latch.
2. Carefully lift the battery door tabs (B) over the rear sensor.
3. Use the supplied Torx driver to unfasten the two bottom Torx screws (C). Retain the screws for reattaching the skin.
4. Use the Torx driver to unfasten the top captive screw (C).
5. Use the Torx driver to unfasten the bottom side Torx screw (D), and then the top captive screw (D).
6. Carefully lift the skin outward and away from the sensor (E).

To replace either rear skin:

1. Insert the skin's alignment pins at the top and carefully press the skin over the sensor (E) at the bottom.
2. From the top (captive) screw down, use the Torx driver to fasten the three Torx screws (C).
3. From the top (captive) screw down the Torx driver to fasten the two side Torx screws (D).
4. Insert the battery skin (A) and close it by rotating and pressing down the latch.

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 LD-250 Core.

If you accidentally upload an incorrect configuration file for a different LD model the LD-250 cannot operate. During start up, it detects the incorrect file type and an error message instructs you to run the Recovery Mode procedure.

You 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 Guide.

Chapter 9: Options

This chapter describes the options available for an LD-250 that enhance its performance and abilities.

9.1 Fleet Manager for Multi-AMR Coordination

The Fleet Manager is a computing 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.

Fleet management prevents traffic contention problems between fleet AMRs, and makes sure that AMRs complete all jobs that you submit to the job queue.

Hybrid LD-60, LD-90, and LD-250 AMR Fleets

Hybrid fleets contain both LD-250 and other LD models such as the LD 90. The following constraints apply to hybrid fleet operations when adding an LD-250 to existing LD-60 and LD-90 fleets.

Support for hybrid LD-model fleets depends on your local application, and might require both operation or configuration changes and specific software and hardware versions . For information about hybrid fleet operation, see the Fleet Operations Workspace Core User's Guide. Contact your local Omron Support if you have questions about using different LD models in the same fleet.

Examples of configuration requirements are:

1. Path Planning parameters differ depending on the LD model.
2. The Fleet Manager controls docking operations for the AMR fleet. However, if you add LD-250 models to an existing LD-60 or LD-90 fleet, you must configure appropriate docking parameters for each LD-250.
3. Check all docking goal physical clearances to make sure that they can accommodate all the LD models in the hybrid fleet. The recommended clearance for the LD-250 is 1.5 m (4.9 ft) distance between docking goals and physical docks.
4. If you use HAPS, be aware that a magnetic track designed for the LD-60 or LD-90 might not accommodate an LD-250, which is significantly wider. See the *LD Platform Peripherals User's Guide* for information about magnetic track placement.
5. The LD-250 requires more room to operate in confined areas and passageways . See: *Side Clearance* on page 114.

9.2 Spare Battery

You need at least one spare battery if you opt to manually change the AMR's battery instead of using a docking station. See: *Manually Charging the Battery* on page 121.

9.3 Payload Structure Bumpers

The LD-250 Core provides User Bumpers connector provides 6 circuits for payload bumpers.
See: *User Bumper* on page 105.

> **IMPORTANT:** The User Bumpers connector is not safety-rated and is not part of the E-Stop chain.

9.4 Call Buttons and Door Boxes

Use optional Call buttons to send an AMR to associated goals. Even in an installations with a single AMR, you can install multiple Call buttons.

Optional Door Boxes open powered doors so the AMR can pass through.

For more information about these options, see: *LD Platform Peripherals User's Guide*.

9.5 Acuity Localization

If the workspace contains many transient obstacles, such as pallets or carts, these objects are not recorded on the workspace map and they might block environmental features that are on the map. Such dynamic environments can make accurate laser localization more difficult, slowing the AMR's progress and accuracy.

Acuity Localization is an optional supplemental method of navigation. The primary safety and navigation laser still provides data for local path planning and obstacle avoidance.

Acuity localization uses an upward-facing camera to localize the AMR. It does this by comparing a dynamic scan of the overhead environmental lighting with a stored image in its workspace map. Each overhead light provides a reference point, and groups of lights provide navigation cues. You can mount the camera on your payload structure, provided it has an uninterrupted upward view of the environmental overhead lights.

9.6 Touchscreen

The Touchscreen is an optional full-color, touch-sensitive screen. Information such as messages and status data from the AMR appears on this screen. Use it to input operational commands directly at the AMR, instead of remotely from MobilePlanner.

See the *LD Platform Peripherals User's Guide* for detailed information.

9.7 Rear-Facing Laser

You can configure an additional laser either as a rear-facing laser or as a vertical laser. In the latter case, mount the laser so that its scan plane is perpendicular to the floor plane and parallel to the AMR's X axis.

The laser kit consists of the following items.

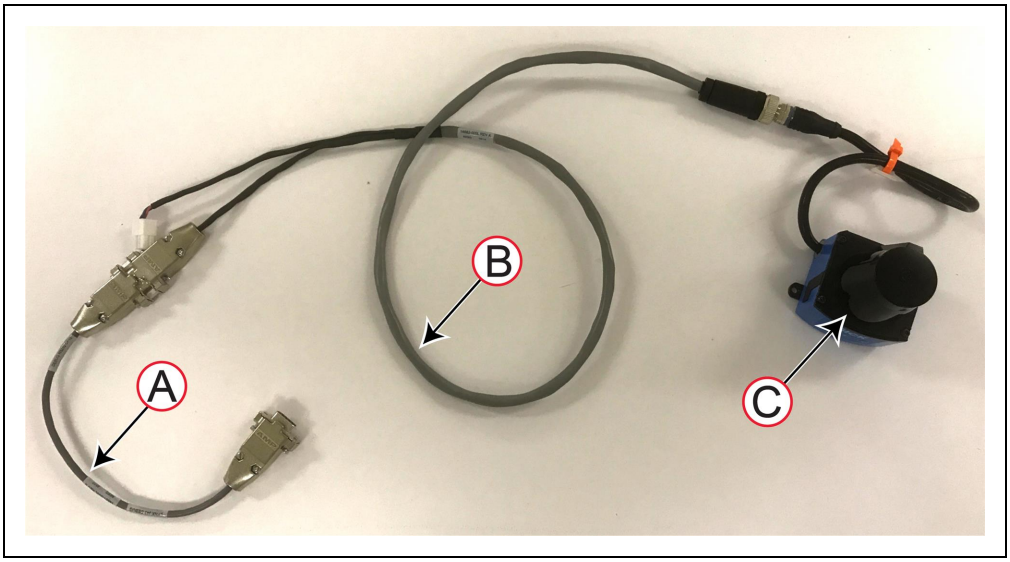


Figure 9-1 *Rear-facing Laser Kit*

Callout	Part Number	Description
A	14851-000L	Debug Port DB9 adapter cable.
B	14682-000L	TiM to DB9 adapter cable with Aux Power split.
C	3438-000	TiM-510 laser, firmware version 3.15

For installation information, see: *LD Platform Peripherals User's Guide*.

9.8 Side Lasers (Supplemental) Lasers

Side-mounted (tilted) lasers are an option for payload structure development. Up to two supplemental lasers mount on the left and right sides of the payload structure to detect obstacles that intrude into the payload operating space. An additional rear-facing laser is also supported. See. *Rear-Facing Laser* on page 188.

Side lasers are also useful when the payload structure is tall enough that it might collide with obstacles not detected by the primary navigation laser. Lasers can be orientated to detect obstacles at floor level.

The optional side lasers connect to the RS-232 Aux Sensors connector on the LD-250 Core. See: *Aux Sensors* on page 99.

Install Side Lasers

You require the laser kit consisting of:

- laser TiM-510, part number 13438-000.
- 2-meter J8 cable, part number 13523-103L. The cable supports up to three lasers.

You must determine the mounting method for lasers, which might bracket require options from the laser manufacturer. The following procedure assumes that you have put the AMR into a safe state for work by disconnecting power or disabling the AMR with an E-Stop.

Install the lasers as follows:

1. Remove necessary components to access the LD-250 Core.
2. Connect the J8 cable into the Aux Sensors port on the LD-250 Core.
3. Mechanically mount the lasers to your payload
4. Route the cable to the lasers, using cable ties to keep it clear of moving parts. Allow enough slack for removing the payload. (The connectors are labeled left, right, and foot.)
5. Connect the cable to the lasers.

Configure Side Lasers

To configure Side Lasers:

1. Open MobilePlanner and connect to the AMR.
2. Open the **Robot Physical** tab and check the **Show Expert Parameters** option.
3. Under the section titled Laser_3, do the following:
    a. Enable the **LaserAutoConnect** option.
    b. Select LaserType **tim3XX**.
    c. Select LaserPortType **serial**
    d. Select LaserPort **/dev/ttyUSB6**
    e. Select LaserPowerOutput **Vertical_Laser_Power**
4. [Optional] Set LaserIsTilted to **true** if you use the lasers for vertical obstacle detection.
5. Save the configuration and wait for the AMR to reboot.
6. Open the workspace map and verify the laser readings.
7. Enter the laser coordinates as measured for the corresponding laser.
8. Repeat Step 3 to Step 7 for the second laser, Laser_4 using **/dev/ttyUSB5** for the Laser-Port.

Configure the laser's coordinates as described for the rear-facing laser in the LD Platform Peripherals User's Guide.

9.9 High-Accuracy Positioning System (HAPS)

The High-Accuracy Positioning System (HAPS) is a sensor that detects magnetic tape applied to the floor. This allows an AMR to align itself at a specific location with better accuracy and repeatability that by its laser alone. You might want to use HAPS at locations where AMRs must position themselves accurately every time, and often very close to a machine such as a conveyor.

For information about installing and configuring HAPS, see: LD Platform Peripherals User's Guide.

Chapter 10: Technical Specifications

This chapter lists the LD-250's specifications, operating requirement and system limits.

10.1 Dimension Drawings

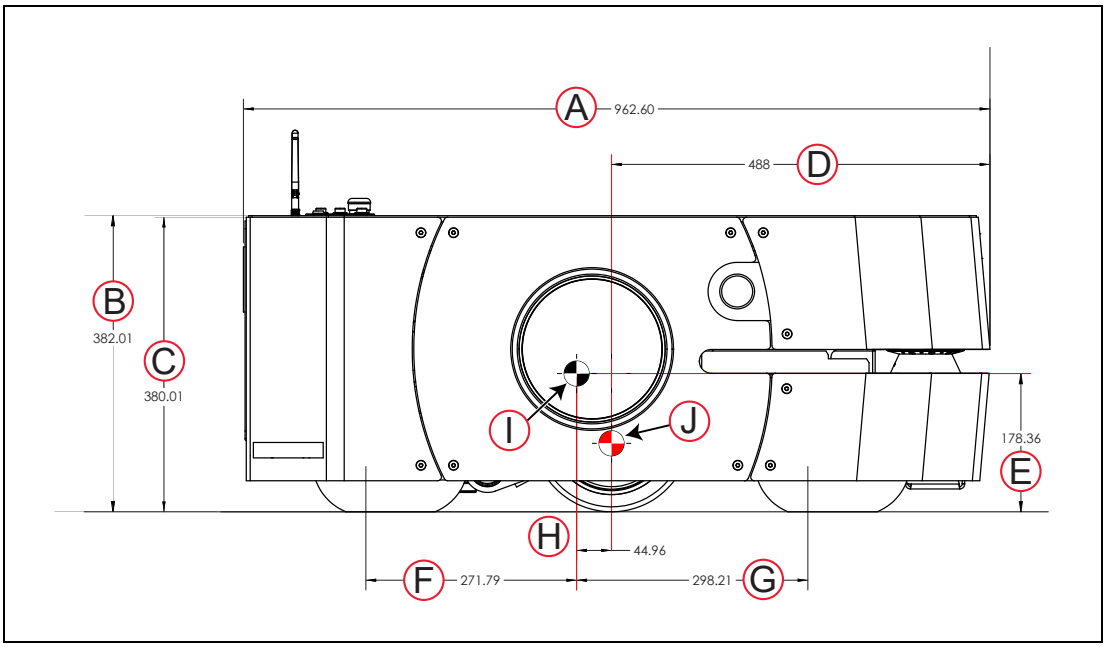


Figure 10-1 *Length Dimensions From Side of AMR*

Callout	Description	MM	Inch
A	Length	963	38
B	Height to top cover plate	383	15
C	Height to load bars in the payload bay	380	15
D	Front to wheel axis	488	19
E	Center of gravity to the floor	178	7
F	Rear caster axle to center of gravity	272	11
G	Front caster axle to center of gravity	298	12
H	Wheel axis to center of gravity	45	2
I	Center of gravity	N/A	N/A
J	Center of rotation	N/A	N/A

Width Measurements

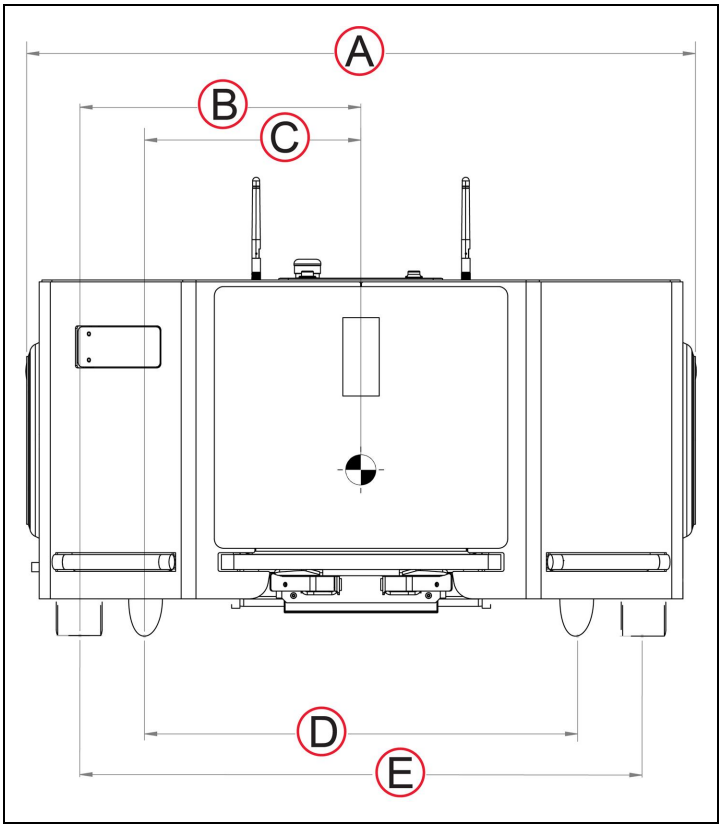


Figure 10-2 Width Dimensions From Rear of AMR

Callout	Description	MM	Inch
A	Width, including light discs	718	28
B	Drive wheel to center of gravity	301	12
C	Caster to center of gravity	232	9
D	Caster wheelbase	465	18
E	Drive wheel wheelbase	605	35

Component Weight

Mass Characteristic	kg	lbs
Vehicle weight with skins and battery installed	146	321.9
Vehicle weight without skins	126	277
Battery weight	18.5	41

Capabilities

	LD-250Capability	Value
	Vehicle Max Speed	1.2 m/sec
	Run time	8-10 hours

NOTE: Refer also to *Payload Structures* on page 77 for information about the payload mount point location and dimensions.

10.2 LD-250 Specifications

Physical Dimensions

Description	Specification
Default LengthFront	488 mm
Default Lengthrear	480.8 mm
Rating	
IP Rating	IP20
Cleanroom rating	None
Joystick IP rating	IP56
Drive Train	
Drive wheels	Aluminum with polyurethane tread
Passive Casters	2 front, 2 rear, ESD
Brakes	2 (one each motor)
Steering	Differential

Performance

Description	Specification
Performance	
Max payload – level	250 Kg
AMR Radius	1050 mm
Swing radius (see note below)	525 mm
Turn radius	0 degrees
Translational speed, max	1200 mm/sec
Rotational speed, max	120 mm/sec
LIDAR Stop position repeatability	+/-100 mm

Description	Specification
Triangle Target Drive Stop position repeatability	+/-50 mm
Traversable step, max [a]	10 mm
Traversable gap, max	15 mm
Climb grade.	3% (Frequent operation on grades affects battery duration.)
Traversable terrain	Generally, "wheelchair accessible"
Noise Level - Ambient	38 Db(A)
Noise Level - Peak	60 Db(A)
Minimum floor flatness [b]	F_F25 (based on the ACI 117 standard)
Battery	
Run-time	8 hrs
Typical Lifespan	2000 charge cycles
Weight	19 Kg
Voltage	22-30 VDC
Capacity	72 Ah (Battery cell nominal)
[a] Steps should have smooth, rounded profiles. A speed limit of 600 mm/s is required for traversing steps. Faster or frequent driving over such steps or gaps will shorten the lifespan of the drive train components. Lower speeds may not traverse the step.	
[b] 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.	

Overhanging Payloads and the AMR Swing Radius

If your payload overhangs the default LD-250 footprint, it alters the AMR's swing radius and exponentially affects its maximum safe rotational speed. Should the AMR size increase significantly, you might need to adjust the AMR's maximum rotation speed to stay within 300 mm/sec or slower.

If you increase the AMR's default swing radius, reduce the value of the **HeadingRotSpeed** parameter to compensate for its increased size and increased rotational speed.

For example, if you increase the AMR's radius to 625 mm and v represents threshold linear velocity of 300 mm/s:

$\omega = v / r$

ω = (300 mm/s) / (625 mm) = 0.48 radians/s

$\omega = 0.48 \text{ rad/s} * 180/\pi = 27.5 \text{ deg/s}$

In MobilePlanner, set the value of the HeadingRotSpeed parameter to 27.5 deg/sec.

Sensors

Description	Specification
Sensors	
Safety Scanning Laser	1 at front of LD-250 Single horizontal plane, parallel to the floor at a height of 190 mm (7.48 inches). 601 beam readings in a 240° field of view (0.4 degrees per beam). Maximum safety protection range of 3 m (9.8 ft). Maximum distance for range readings of 15 m (49 feet). Class 1, eye-safe. PLd Safety per ISO-13849
Position encoders	One encoder for operation and navigation. A second encoder for safety.
Analog gyroscope (LD-250 Core)	320 deg/sec max rotation
Rear sensor	1 at rear of LD-250 The sensor has right, center, and left segments. (MobilePlanner indicates which segment is activated by an obstacle.)
Low Front Laser (Toe Laser)	1 in toe-laser well.
Side Lasers (option)	One rear-facing. 2 on sides of payload structure, user-mounted.
Upward-facing camera (Acuity option)	1 on payload structure, user-mounted
Payload Structure bumpers (option)	6 inputs, user-designed and mounted sensors (3 front, 3 rear)

ESD Compliance

The LD-250 provides a path for ESD grounding through the casters. While adequate to protect the LD-250 and any other equipment it touches, this method is not IEC compliant.

Keep both the floor and casters clean so that there is adequate conductivity. See:

- *Cleaning ESD Casters* on page 156.
- *Environment and Floor* on page 115

10.3 Docking Station Specifications

Description	Specification
Current	8 A
Circuit protection	Thermal circuit breaker rated at 10A (IEC) or 15A (UL).
Contacts	2
Voltage	100-240 VAC, 50/60 Hz
Power consumption	800 W
Short circuit current rating (SCCR)	Fuse: 1500 A, Circuit Breaker 2000 A
Humidity	5% to 95% non-condensing
Temperature	5 to 40°C (41 to 104°F)
Dimensions - WxDxH with Floor plate	349 x 369 x 315 mm [13.75 x 14.5 x 12.4 inches] 495 x 495.5 x 317 mm [16 x 19.5 x 12.5 inches]
Weight	8.2 kg (18 lbs)
Mounting	Wall bracket, directly to floor, or on floor with floor plate
Indicators	Power on - blue Charging - amber
Connector	For manual charging of spare batteries

NOTE: The LD-250 can also use older model docking stations that use a 10 A time-lag fuse.

Chapter 11: Modify the Safety Zones

This section describes how to modify the Omron OS32C safety laser's integrated safety zones.

Your LD-250's OS32C safety laser is pre-programmed with safety zones sized for its shape and kinematics. If your payload overhangs the AMR's default dimensions or you change the value of AbsoluteMaxTransDecel, you must adjust the AMR's safety zones accordingly.

Omron intends this information as a general guideline only, and not as a substitute for assessing each application built on the AMR with regard to the applicable standards for a specific locale.

WARNING: PERSONAL INJURY OR PROPERTY DAMAGE RISK Omron Robotics and Safety Technologies, Inc. is not responsible for any risks incurred by modifying safety zone sizes or other OS32C laser settings.

Make certain that the AMR cannot collide with any obstacles that trigger its ESTOP circuit via the laser's safety outputs when traveling at high speed. Test all safety zone modifications in a location representative of the actual work environment before using the AMR in production.

11.1 Default Safety Zones

The LD-250 has 8 safety zones (1-8).

IMPORTANT: The safety zone speed for the LD-250 is the value of the SpeedZoneSize parameter, which defaults to 225 mm/s. At any speed below 225 mm/s, the safety scanning laser does not operate to detect obstacles. Therefore, zone 0 (zero) has no physical dimension.

Figure 11-1 shows the default zone sizes and specifications.

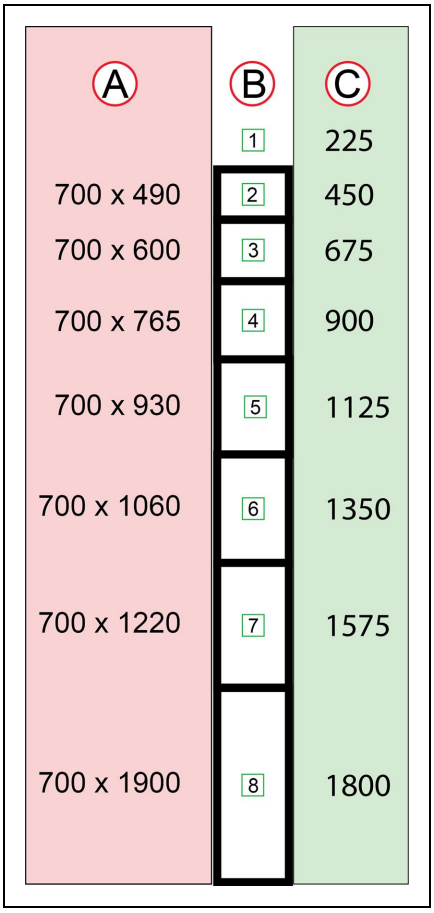


Figure 11-1 *LD-250 Safety Zone Sizes and Speeds*

Callout	Description
A	Safety zone dimension in mm, width by length.
B	Safety zone number and relative size. The safety zone length increases with AMR speed.
C	Safety zone speed, calculated as zone number multiplied by the value of the SpeedZoneSize parameter (225 mm/s).

11.2 Relevant AMR Operating Parameters

Safety zone sizes depend on the permitted deceleration of the AMR, which is determined by the value of the AbsoluteMaxTransDecel parameter. (This parameter is located in: Robot Configuration > Robot Physical.)

Do not reduce the value of AbsoluteMaxTransDecel after you change any safety zone sizes. If you do so, it will invalidate the safety zones.

11.3 Equipment Required to Modify OS32C Safety Zones

You require the following:

1. OS32C Laser configuration cable model OS32C-ECBL-XXM, where XX is 02, 05 or 15 meters representing the length of the cable.

2. PC running a supported version of Windows (see the Configuration Tool specifications).
3. The OS32C Configuration Tool. See: https://industrial.omron.us/en/products/os32c.
4. OS32C Laser, properly installed, leveled, and cabled on the target AMR.

Follow the instructions in the Laser documentation, available for download from the Omron Web site in your locale.

You should follow an iterative process of testing and adjusting the safety zone sizes using suitable sample obstacles (specified in industry standards) to determine that the fully-loaded AMR can decelerate and stop safely.

Chapter 12: Glossary

This glossary contains terms found in this manual, in addition to general terms associated with autonomous mobile robots.

Build mobile-only.

Term	Definition
802.11a, b, or g	A standard for wireless local area networks (WLAN) in the 2.4 GHz and 5 GHz frequency bands.
Acuity	A mobile robot localization system using an upward-facing camera to detect overhead lights instead of using its laser.
AMR	Autonomous Mobile Robot
ambient operating temperature	The temperature range of the robot's environment in which continued operation is possible.
amplifier	The component within the core 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, culminating in the mobile robot's motion.
ARAMCentral	The software running on the EM2100 appliance. Manages the AMR's 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 pack to increase the life span of a battery. The LD 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 robot brakes to allow manual positioning of the robot.
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.
CAN bus	Controller Area Network. A serial communications protocol that allows electronic control units and devices to communicate with each other.

Term	Definition
CG	Center of Gravity
D-Sub	D-subminiature. A common type of multi-pin connector, typically used for serial interfaces such as RS-232.
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 attached to an AMR core or an EM2100 appliance that contains the credentials (license keys) required to run FLOW Core software.
DROPOFF	A job segment typically used where an AMR's payload is transferred from the robot to the goal. See "PICKUP".
E-Stop (button)	Emergency Stop. see also: *emergency stop*. An emergency stop (E-Stop) button is typically a red push-button on a yellow background.
ESTOP	The safety circuit that executes automatic (laser-initiated) emergency stops.
EM2100	A network computing device that functions as the Fleet Manager appliance. It runs ARAMCentral. Manages a fleet of AMRs, and provides a central location to manage maps and configurations, has a queuing manager to match jobs to available robots, is a central point of communication for integrating fleet robots, and coordinates fleet traffic.
emergency stop	A procedure that uses motor power to bring the robot to controlled halt, then disables power to the motors and applies the brakes. Use the E-Stop button to initiate an emergency stop.
encoder	A device on each wheel of the mobile robot that tells the navigation system how far, and in what direction, the wheel has turned.
ESD Castors	Electrostatic Discharge castors provide a skin-to-chassis-to-wheel grounding path that drains off any static charge the AMR might accumulate during operation.
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.
FIFO	First-In-First-Out, refers to the method used to prioritize jobs by the order in which they were received.
fleet	Two or more mobile robots operating in the same area, governed by the same Fleet Manager.
FLOW Core	A set of mobile-robotics software applications for programming and operating one or a fleet of mobile robots and the Fleet Manager.
forbidden (lines, areas)	The lines or areas (on a mobile robot's map) through or into which the robot is not permitted to drive or enter on its own. In special cases, you can direct a robot to enter a forbidden area.

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.
HAPS markers	The short sections of magnetic tape applied to the floor that signal to the robot where to stop. Used at conveyors or other tight-tolerance drop-off/pickup locations.
heading	Describes the direction that the robot is facing. In the future, will need to verify that this is true both while the robot is moving and stationary. This is currently true for the LD.
HMI	Human Machine Interface. The operator panel is an example.
HMI post	A post on the LD Platform Cart Transporter that supports the two side lasers, the rear facing laser, and the Operator Panel.
I/O	Input/Output
instructed personnel	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.
IPnn	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 'n' is a number between 1 and 7 that identifies the level of protection against solid objects (dust, tools, etc.). The second 'n' 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.
job	A robot activity - usually consists of either one or two “job segments” (either PICKUP or DROPOFF). The Enterprise Manager receives all job requests from Advanced Robotics Command Language.
joystick	A hand-held, external input device for manually driving mobile robots, primarily used for map creation. Connects to the mobile robot’s JOYSTICK connection port.

Term	Definition
jumper	A short length of conductor that connects two points in an electrical circuit, often used to bypass optional safety devices.
keyswitch	A switch that can be toggled by turning a key. When in the locked position, disables the OFF button.
light disc	The circular lights on the sides of the LD platform that indicate motion, turns, and other robot states.
light pole	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. In light localization, the mobile robot uses a camera and overhead lights to determine its location.
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.
MARC	The Mobile Autonomous Robot Controller (MARC) firmware controls the mobile robot's motors, and computes and reports the robot's pose (X, Y, and heading) readings and other low-level operating conditions to ARAM.
MDOC	Manufacturer's Declaration of Conformity
MDOI	Manufacturer's Declaration of Incorporation
MobilePlanner	The primary software application for programming mobile robot actions. part of FLOW Core, it provides the tools for all major AMR activities, such as observing a fleet of AMRs, commanding an individual AMR 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 route a mobile robot takes to drive from place to place in its environment.
patrol route	A specific route (a series of tasks, goals, or macros) that the robot will follow without human intervention.
payload	Anything the mobile robot carries.
payload bay	The area between the platform and the payload structure.

Term	Definition
payload structure	Anything that gets attached to the platform and interacts with the payload being transported.
PCA	Printed Circuit Assembly. This is a printed circuit board that is populated with electronic components.
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.
pose	A mobile robot'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, to reduce the cost of grid cells under the line. See: *cost*.
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 obstacle detection). Per EN-1525, commissioning must be done by specially trained people.
sector	User defined map regions that direct specific AMR actions, like ignoring sensor readings, driving on the right or left, limiting the number of robots in the area at one time, etc.
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 personnel	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.
Stay	A touchscreen function that delays the departure of the AMR. Each touch of the Stay button adds to the time the AMR will wait before continuing to its next goal.
swing radius	The radius of the circle that a mobile robot will use when turning in place (with no forward motion).
tasks	Instructions for the robot to perform certain actions like reading inputs,

Term	Definition
	setting outputs, movement commands, talking, waiting, etc.
touchscreen	A full-color touch-sensitive screen on mobile robots. Used for displaying information to the Operator, as well as receiving input from the Operator.
turn radius	The instantaneous radius of curvature of the arc that the AMR is traveling on at a given moment in time.
wheel light	See "light disc".
wheel pin	For the LD 60/90 and CArt transporter only, a small pin that is inserted into the rear side of the drive assembly after compressing the drive wheel springs, to keep the wheel in the up position. Mobile robots are shipped with wheel pins installed, to protect the drive assembly from damage during transport.

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