LD Platform OEM

User's Guide

Copyright Notice

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Revision History

Revision Code	Date	Revised Content
01	April, 2017	Original release
02	March, 2017	Added 2-second delay after E-Stop recovery; dimensions updated; MaxVelxxx parameters updated; removed procedure for user replacement of wheels and tires; changed pacemaker/magnet warning to say medical implant; changed gap and step specs; added notes that User Bumper connection is not safety-rated; removed reference to a cleanroom version, which is not offered; rewrote joy-stick warning.
03	August, 2017	Updated manual to include information on the electro-static discharge (ESD) skin option (specs, maintenance, and caster cleaning), and CALB Battery upgrade information. Also updated with corrected dimension drawing of LD Platform OEM top plate payload screw hole locations.
04	February, 2018	Update format of safety chapter. Update alert levels throughout user guide. Update CG graphs to show 60 kg and 90 kg payloads. Update "No Riding" label. Remove note that cleanroom Class 10 is attainable. Update navigation laser height from 201 mm to 200 mm. Corrected weight of platform from 132 lb to 137 lb.
05	October, 2018	Updated manual for translation. Prepared graphics (changed text in graphics to callouts); added low front laser info; deleted low front laser removal instructions. Icons for ESD and Fire were added, Explosion icon deleted. A note regarding flipping E-Stop switch very quickly, was added to User Interface section. "Repeatability" replaced "Accuracy" in Platform Specification Performance section. Unpacking section modified. Added an extra graphic in Body and Drive section. Changed wording in Navigation Laser. Changed wording of LED lights blinking in Battery Indicators and Controls section. Added a note to Brake-Release Button section regarding LD-90x. Added a note regarding LD-90x, in Product Description section. Added Windows 10 Network Setup information. Added a note regarding damp floors. Removed "Same as 9 Pin D-Sub". Reworded "Driving Slowly, Safety Inactive" section. Changed Battery Life Cycle to " Approximately 2000 Cycles". Made Enterprise Manager generic (removed 1100), except in Related Manuals section. Added " Safety System Overspeed Faults" section. Removed "Limit to <5 A per Pin" in User Power section and reworded the note regarding 10A of current.
06	February, 2019	The term AIV has been replaced by AMR (Autonomous Mobile Robot). Revised "Autonomous Charging" section, noting that AMRs can be turned off while on the docking station. Added WEEE logo and Disposal section (the disposal section only applies to English ver-

Revision Code	Date	Revised Content
		sion of this manual). Revised transportation and storage temperature to -20 to 60°C. Revised operating temperature to 5°C to 40°C. Added a section to Maintenance chapter regarding applying E-stop and powering off the robot, prior and after maintenance.

Chapter 1: Introduction

This manual covers the setup, operation, and user maintenance of an LD Platform OEM.

Other than the basics, this manual does not cover configuration performed using the software that comes with the platform. That is covered in the *Mobile Robot Software Suite User's Guide*.

1.1 Definitions

AMR (Autonomous Mobile Robot): A platform with a payload structure attached to it. This is your complete mobile robot, which will transport your products, parts, or data.

When referring to the initial setup, configuration, and connections, we will refer to the platform.

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

Enterprise Manager: A system that manages a fleet of AMRs. This includes the Enterprise Manager appliance and the software that runs on it.

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

Platform: The most basic part of the robot. It includes the chassis, drive assemblies, suspension, wheels, battery, lasers, sonar, an on-board LD Platform core with a built-in gyroscope, navigation software, connectors for interfacing with and powering the payload structure, and the platform skins (external covers).

LD Platform OEM: Either the LD-60 or LD-90 platform for 60 or 90 kg payloads.

Payload Structure: Anything you attach to the platform. This could be as simple as a box for holding parts or documents that you want transported, or as complicated as a robotic arm that will be used to pick up parts to transport.

1.2 Product Description

The LD Platform OEM is a general-purpose, mobile robot platform, designed to work indoors and around people. It is self-guided and self-charging, with an automated docking station. The LD Platform OEM is available in two versions, designed to carry loads up to 60 kg (132 lb) for the LD-60 and 90 kg (198 lb) for the LD-90 platform. Where appropriate, differences between the models are called out. Otherwise, this manual applies to both platforms.

> **NOTE:** The LD-90x is a variant of the LD-90, with the drive train of the Cart Transporter CT130. In general, it is not covered in this manual, although it is mentioned in a few places where its higher gear ratio is a factor.
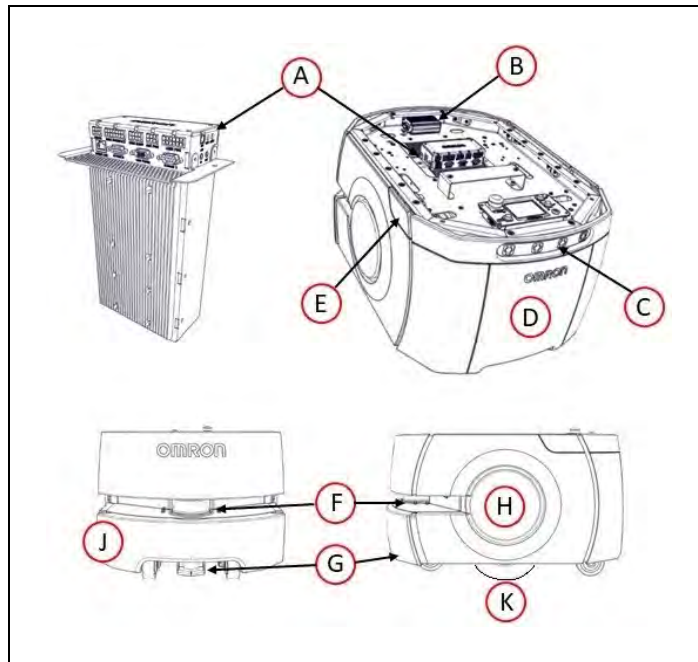
Figure 1-1. LD Platform OEM Layout

Callout	Description	Callout	Description
A	LD Platform Core	F	Safety Scanning Laser
B	Platform Sonar Controller	G	Low Front Laser
C	Rear Sonar X4 (2 pairs transducers)	H	Light Disc x2
D	Battery Door Skin	J	Front Bumper
E	Joystick/Ethernet Access Panel	K	Front Caster x2, Drive Wheel x2, Rear Caster x2

The platform combines hardware and mobile-robotics software to provide an intelligent, mobile platform to transport your payload. Once it scans its environment, the platform knows where it is within a workspace, and can navigate safely and autonomously to any accessible destination within that workspace, continuously and without human intervention.

The LD Platform OEM uses a Safety Scanning Laser as its primary guidance to navigate, comparing the laser readings to a digital map stored in the platform's Core. The laser is backed up by a low front laser, two rear-facing sonar pairs, a front bumper, a gyroscope mounted on the LD Platform core, and encoders and Hall sensors on each drive wheel.

For situations that are so dynamic that laser localization becomes difficult, we offer the Acuity Localization option, which localizes the platform using an upward-facing camera to recognize overhead lighting patterns. This is covered in detail in the *LD Platform Peripherals User's Guide*. This would apply to areas where objects, such as pallets or carts, are moved so frequently that they can't be mapped, or where they block the laser's view of the mapped features.

For most applications, you will want to customize the platform with a payload structure, attached to the top of the platform, for some combination of picking up, transporting, and

dropping off your parts, samples, or documents. Refer to Payload Structures on page 61 for guidelines on designing a payload structure.

The platform provides a variety of interfaces and power connections to support your application-specific sensors and accessories, mounted on your payload structure. Refer to Connectivity on page 73, for information on the available connectors on the platform.

Body and Drive

The LD Platform OEMs are relatively small, lightweight, and highly maneuverable. Their strong aluminum chassis and solid construction make them very durable, and they have an IP rating of IP20.

Each platform uses a two-wheel, differential-drive, with spring-loaded passive casters front and rear for balance. The drive-wheels have independent spring-suspension, with solid, foam-filled tires. The wheels are at the platform's mid-line, so the platform can turn in place.
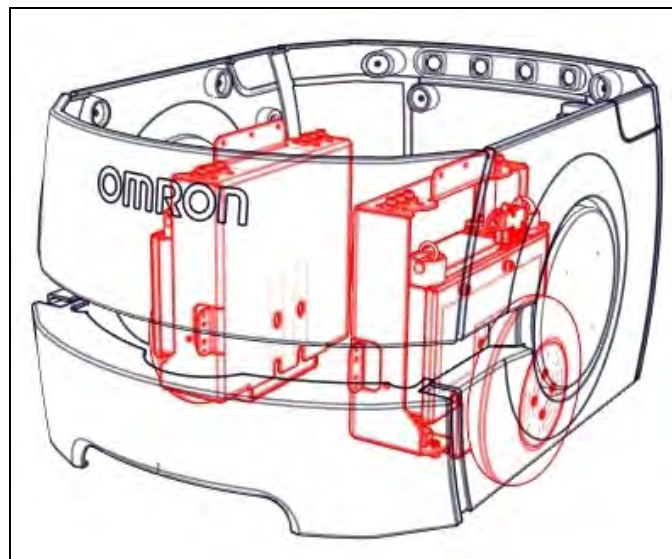
Figure 1-2. Drives in LD Platform (in red)
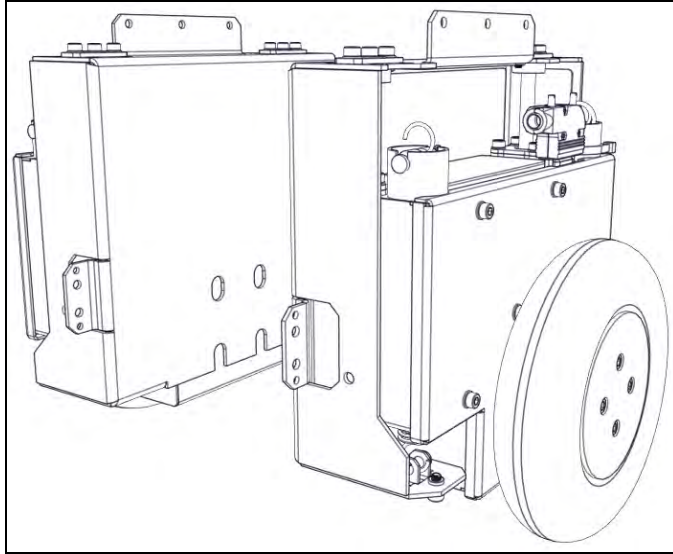
Figure 1-3. LD Drives

What's Included - Basic Components

- One fully-assembled LD Platform OEM

  The platform includes a navigation laser, front bumper with low front laser, and two rear-facing sonar pairs. Each pair is a transmitter and a receiver.

- LD Platform Core, includes an integrated computer, running Advanced Robotics Automation Management (ARAM) and a microcontroller with Mobile Adept Robot Controller (MARC) firmware. It also runs the SetNetGo OS. The core is housed inside the platform.
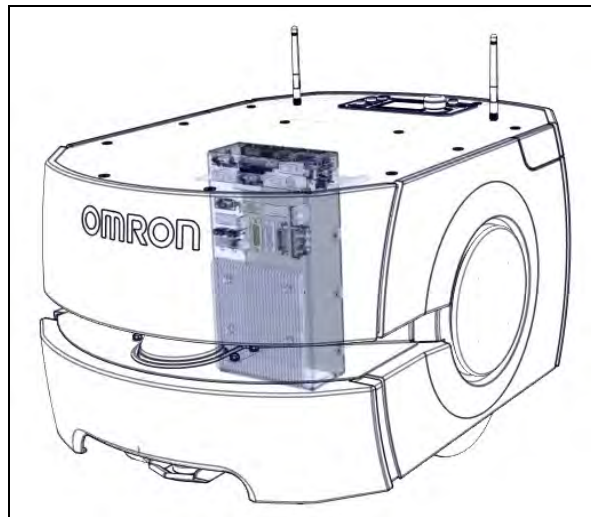
Figure 1-4. LD Platform OEM Core location

The core comes pre-loaded with ARAM and MARC firmware, and the SetNetGo OS.

The core has an internally mounted gyroscope, and each drive wheel has an encoder and a Hall sensor to complement the safety scanning laser.

- One battery

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

- Operator Panel

The operator panel includes a screen, an E-Stop button, ON and OFF buttons, a brake-release button, and a keyswitch (which you can lock, in either position, and remove the key).

Figure 1-5. Operator Panel

This will usually be mounted on the user-designed and -built payload structure.

An optional touchscreen is available. See Touchscreen on page 148.

- Automated docking station

This allows the platform 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 49.

Also included is a manual charging cord, so you can charge the battery or a spare battery outside of the platform.

- Joystick (option)
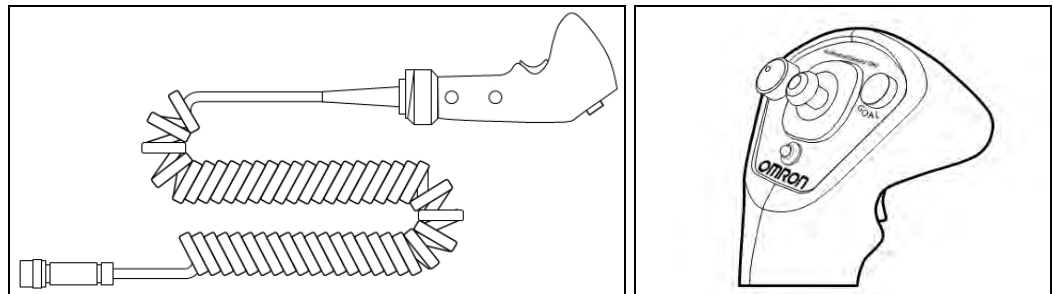
This is used for manually controlling the platform, mostly when making a scan to be used for generating a map.
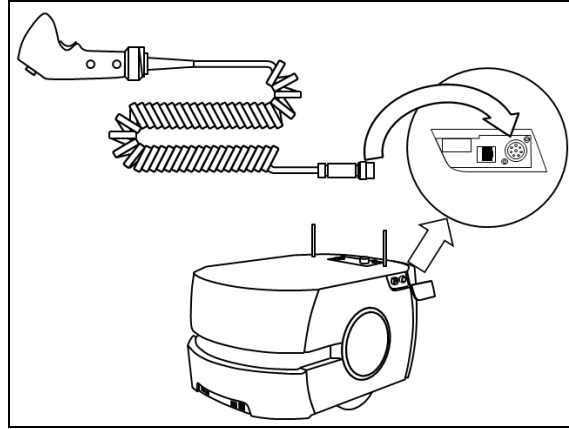
Figure 1-6. Joystick Connection Point

You need at least one joystick for each fleet of AMRs. Once a map is generated, the map can be shared with multiple AMRs working in the same space.

- User documentation

Optional Components (Partial List)

Refer also to Options on page 147.

- Enterprise Manager system

This system manages a fleet of AMRs, for multi-AMR coordination and job management. It includes the Enterprise Manager appliance running the Mobile Robot Software Suite.

- Acuity Navigation

For dynamic environments in which a map can't be kept current, or where the area is too large for the navigation laser to see, the robot can use Acuity to navigate using overhead light patterns seen with an upward-facing camera.

- Electrostatic Discharge (ESD) Skins

ESD skins are black. They are made of a conductive thermoplastic sheet, grounded to the chassis in a way that prevents electrostatic buildup.

Figure 1-7. LD Platform OEM with ESD Skins

They do this by providing a path to ground through the skin, to the robot's chassis and wheels, and provide resistance of $1X10^9$ Ω (measured from skin to ground). These skins are available for robot applications in electrostatic discharge protected areas.

- Spare battery

  A spare battery can help keep the AMR on the job without stopping to re-charge.

- Call/Door Box

  This allows an AMR to be requested from a remote location, or allows the system to control an automated door, so the AMR can pass through it.

- High-Accuracy Positioning System (HAPS)

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

For Payload Structure Development

- Side-mount obstacle-detection lasers

  Two lasers that scan the vertical plane on each side of the AMR. These detect obstacles that are at heights the navigation laser can't see.

- Touchscreen

  Allows an Operator to interact with an AMR at the AMR's location, select the AMR's next goals, check status, etc.

  Refer to the *LD Platform Peripherals User's Guide* for details on the touchscreen.

1.3 Software Overview

A fair amount of software is involved in setting up and running an LD Platform OEM.

The platform comes with the following software:

Mobile Robot Software Suite

The Mobile Robot Software Suite includes all of the software used by the LD Platform OEMs and the Enterprise Manager appliance. The SetNetGo OS is not part of the suite, but is included.

User-Supplied Components / System Requirements

PC with Microsoft Windows®

- Ethernet (wireless preferred)

  Wireless is required for an installation with multiple AMRs.

- 100 megabytes of available hard-disk storage

ARAM

The Advanced Robotics Automation Management software (ARAM) runs on the LD Platform core. It operates ranging sensors like the safety scanning laser and sonar, and performs high-level, autonomous robotics functions like obstacle avoidance, path planning, localization, navigation, and so on, culminating in motion commands to the MARC firmware. ARAM also controls the battery and light discs, and manages digital and analog I/O, which, along with platform power, provide for integration of application-specific sensors and effectors that the user adds.

ARAM manages wired and wireless Ethernet communications with off-board software for external monitoring, development, and systems coordination, including coordination of a fleet of AMRs through the optional Enterprise Manager. It also manages integration with other systems, as well as external monitoring, setup, and control with the MobilePlanner application.

ARAMCentral

ARAMCentral is the software that runs on the Enterprise Manager appliance. This software and the appliance combined are referred to as the Enterprise Manager.

For a fleet, the ARAMCentral software manages:

- the map that all of its AMRs use

- the configuration that all of its AMRs use

- traffic control of the AMRs

  This includes multi-AMR avoidance, destination, standby, and dock control.

- queuing of jobs for the AMRs

- remote I/O, if you are using it

MobilePlanner (licensed)

Before your AMR can perform autonomous mobile activities, you need to make a map of its operating space, and configure its operating parameters. MobilePlanner software has the tools to make this map and perform this configuration.

Refer to the separate *Mobile Robot Software Suite User's Guide* for details on how to map a working space and prepare the virtual elements, goals, routes, and tasks for your application. In particular, refer to:

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

The MobilePlanner software requires a license. You will need at least one license for MobilePlanner for each fleet of AMRs or for a single AMR installation. After generating the map, the Enterprise Manager appliance shares the map between multiple AMRs in one fleet.

MobilePlanner, Operator Mode

MobilePlanner's Operator Mode allows you to monitor one or more AMR's activities and have them perform mobile tasks in the mapped space. If you start MobilePlanner without a license dongle, it automatically starts in Operator Mode. Refer to the separate *Mobile Robot Software Suite User's Guide* for details.

Mobile Adept Robot Controller (MARC)

At the lowest level, a microcontroller running MARC firmware handles the details of platform mobility, including maintaining the platform's drive speed and heading, as well as acquiring sensor readings, such as from the encoders and gyroscope, and managing the platform's emergency stop systems, bumper, and joystick. The MARC firmware computes and reports the platform's odometry (X, Y, and heading) and a variety of other low-level operating conditions to ARAM.

Touchscreen Support

Mobile Software suite includes support software for the optional touchscreen.

Call/Door Box Support

Call/Door boxes have one software component on the boxes and another on either the Enterprise Manager or on the single AMR, when there is no Enterprise Manager.

ARCL Protocol

The Advanced Robotics Command Language (ARCL) is a function of ARAM and ARAMCentral, which is included as part of this suite.

ARCL is a simple text-based command and response server for integrating an AMR (or fleet of AMRs) with an external automation system.

ARCL allows you to operate and monitor the AMR, its accessories, and its payload devices over the network, with or without MobilePlanner.

SetNetGo

The SetNetGo OS runs on the LD Platform core and Enterprise Manager appliance. It is the host OS in which ARAM and ARAMCentral run.

The SetNetGo interface in the MobilePlanner software is for configuring the platform's Ethernet settings, upgrading software, and performing systems diagnostics, such as retrieving log files. It is accessible when connected via the maintenance and management Ethernet ports, or via wireless Ethernet if enabled.

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

1.4 How Can I Get Help?

Refer to the corporate website:

http://www.ia.omron.com

Support

If, after reading this manual, you are having problems with your platform, contact your local Omron Support.

Related Manuals

This manual covers the installation, setup, operation, and maintenance of an LD Platform OEM. There are additional manuals that cover configuring the platform. See the following table. These manuals are available on the software media delivered with your system.

Table 1-1. Related Manuals

Manual Title	Description
Mobile Robot LD Safety Guide	Contains general safety information for all Omron Adept Technologies, Inc.LD Platform OEM-based AMRs.
Mobile Robot Software Suite User's Guide	Covers MobilePlanner software, the SetNetGo OS, and most of the configuration of an LD Platform OEM.
Enterprise Manager 1100 User's Guide	Covers the Enterprise Manager 1100 system, which is hardware and software used for managing a fleet of AMRs.
LD Platform Peripherals User's Guide	Covers peripherals, such as the Touchscreen, Call/Door box, and Acuity Localization options.

Including a Debuginfo File

If the platform has been set up on a wireless network, skip to SetNetGo Access.

Network Setup

If the platform has not been set up on a wireless network, you will have to set up a local area network on a separate PC, configured to talk to the platform over a TCP/IP port. Set the IP address to: 1.2.3.5. The Subnet Mask should be 255.255.255.0.

(Windows 7) **Start > Control Panel > (Network and Internet >) Network and Sharing Center > Change adapter settings**

(Windows 10) **Start > Settings > Network and Internet > Change adapter options**

Right-click on the **LAN Connection**, and click on **Properties**.

In the Properties dialog, scroll to and double-click the **Internet Protocol (TCP/IP or TCP/IPv4)** option. In Internet Protocol Properties, click both "**Use the following...**" radio buttons to enable them, and then type in the IP and Subnet mask values. See the following figure:

Figure 1-8. Internet Protocol Properties Pop-up Dialog

SetNetGo Access

If MobilePlanner is available, use MobilePlanner's SetNetGo interface to access SetNetGo. Otherwise, open a web browser, enter the URL: https://1.2.3.4, then confirm security certificates.

Regardless of how you accessed SetNetGo, you should now have a window similar to the following:
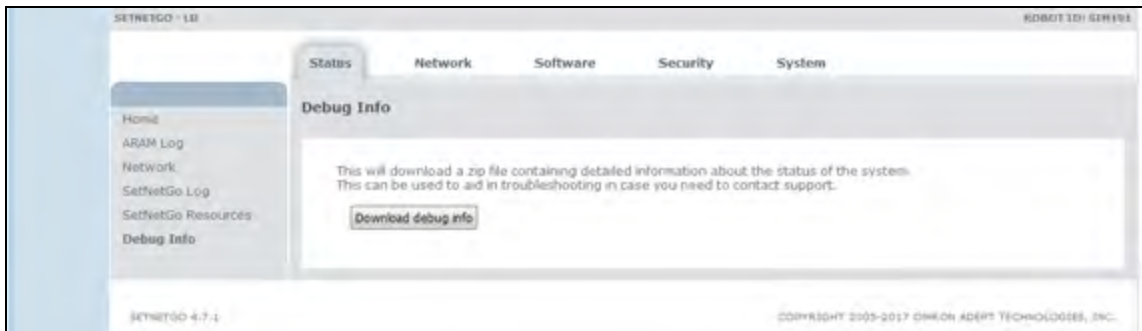
Figure 1-9. SetNetGo Pop-up Window

1. From the SetNetGo screen, select:

   System > Debug Info

   This will activate the "Download debug info" button.

2. Click **Download debug info**.

3. Save the downloaded file, and attach it to your support request.

Chapter 2: Safety

2.1 What to Do in an Emergency /Abnormal Situation

Press the E-Stop button (a red push-button on a yellow background) and then follow the internal procedures of your company or organization for a robot emergency situation. If a fire occurs, use a type D extinguisher: foam, dry chemical, or CO_2.

Releasing the Brakes

In case of an emergency or abnormal situation, the AMR can be manually moved. However, only qualified personnel who have read and understood this manual and the Mobile Robot LD Safety Guide should manually move the platform. The brakes on the drive wheels can be released with the brake release button. This requires battery power, and an E-Stop must be pressed on the AMR.

> **NOTE:** The LD-90x has a high gear ratio, and is very difficult to move, even with the brakes released. This NOTE does not apply to the standard LD-90.

General Hazards

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

- Do not ride on the platform.

- Do not exceed the maximum weight limit.

  Payload decreases as slope increases.

- Do not exceed the maximum recommended speed, acceleration, deceleration, or rotation limits. See Center of Gravity (CG) on page 66 and Acceleration, Deceleration, and Rotation Limits on page 59.

  Rotational speed becomes more significant when the payload's center of gravity is farther away (vertically and/or horizontally) from the platform's center of gravity.

- 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/door unless the door and AMR are configured correctly with the Call/Door Box option. Refer to the *LD Platform Peripherals User's Guide* for details on the Call/Door Box.

- Do not get the AMR wet. Do not expose the AMR to rain or moisture.

- Do not continue to run the AMR after hair, yarn, string, or any other items have become wound around the platform's axles, casters, or wheels.

- Do not use unauthorized parts.

- Do not turn on the platform without the antennas in place.

- Although the lasers used are Class 1 (eye-safe), we recommend you not look into them.

Releasing an E-Stop

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

After the E-Stop button has been manually released, the AMR will wait until the motors are manually enabled.

There are two ways to enable the motors:

- Use MobilePlanner

- Press the green ON button on the Operator Panel or the GO button on the Touchscreen.

Once the motors are enabled, the AMR will wait two seconds and then resume commanded motion, if there is adequate space to maneuver.

2.2 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.
	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

The edge of a loading dock, the entrance to downward stairs, or any other substantial drop that is within the AMR's expected operating area should be physically marked so that the AMR's navigation laser will see the barrier, and stop before reaching it. The AMR is designed to detect objects 200 mm tall, so the barrier must be at least that tall. However, because of variations in floor flatness, we recommend a barrier that is 250 mm tall.

The barrier needs to be continuous at the site, so that the AMR can't drive around or through it to the dropoff.

Logical Barriers

You should also use forbidden areas, sectors, or lines with several feet of safety zone (padding) before the actual dropoff, to ensure the the AMR will not try to drive there.

These need to be continuous at the site, so that the AMR can't plan a path to drive around or between them to the dropoff.

Special Information

There are several types of notation used to call out special 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.

2.3 User's Responsibilities

Safe use of the AMR is your responsibility. Safe use includes:

- Reading the installation and operation instructions, as well as the Mobile Robot LD Safety Guide, before using the equipment.

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

  If a fleet of AMRs (two or more) is installed, the Enterprise Manager must be used, unless no two AMRs will ever operate in the same area.

- Ensuring that anyone working with or near an AMR has been adequately trained, and is following this guide and the Mobile Robot LD Safety Guide for safe AMR operation.

- Maintaining the AMRs so that their control and safety functions are working properly.

Electrical Hazards

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

- Do not use power extension cords with the docking station unless properly rated.

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

- Immediately disconnect the battery after opening the battery compartment door.

  Avoid shorting the terminals of the battery.

- Do not use any charger not supplied by Omron Adept Technologies, Inc.

- If any liquid is spilled on the AMR, power off the AMR, clean up all possible liquid, and allow the AMR to air dry thoroughly before restoring power.

Pinch Hazard

Platform Skins

CAUTION: PINCH RISK
Strong magnets hold the skins in place, and can pinch you if you are not careful. Follow the instructions in the Maintenance chapter for handling skins.

Magnetic Field Hazards

Platform Skins

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 platform skins, which are held in place with strong magnets.

Docking Funnel

> ⚠️ **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 platform, which is exposed during certain maintenance procedures when the platform is tipped on its side.

Qualification of Personnel

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

As noted in this and the *Mobile Robot LD Safety Guide*, certain procedures should be performed only by skilled or instructed persons. For a description of the level of qualification, we use the standard terms:

- **Skilled persons** have technical knowledge or sufficient experience to enable them to avoid the dangers, electrical and/or mechanical

- **Instructed persons** are adequately advised or supervised by skilled persons to enable them to avoid the dangers, electrical and/or mechanical

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 entrusted person must confirm that they:

- Have the necessary qualifications

- 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

You should actively monitor and confirm the status of AMR payload movement, and transfer to or from facility equipment.

Payload transfer problems must trigger an AMR E-Stop that prevents the AMR from moving until an Operator resolves the problem and confirms the system is safe to use.

Your facility should provide an interlock between the AMR and facility equipment.

Multi-AMR Avoidance

When multiple AMRs are operating in the same workspace, they must be connected to an Enterprise Manager (EM) via WiFi. The EM helps prevent collisions by sharing AMRs'

dynamic X, Y, Theta, size, and path-planning information with each other. AMRs then factor this data into their obstacle avoidance. This is not an interlocked method of preventing collisions. Ultimately, it is the end-user/integrator's responsibility to provide an interlocked method of preventing collisions.

> **NOTE:** If two AMRs are approaching each other, neither will see the other because each interprets the incoming laser beams as reflected beams. Because of this, any installation with more than one AMR operating in the same workspace must be managed by the same Enterprise Manager.

2.4 Environment

General Environmental Conditions

You must always ensure that the platform's operating environment remains safe for the platform. If there are unsafe areas for the platform, physically block those areas off so the platform's scanning laser will detect the barriers, and the platform will not attempt to drive there. You can also block off these area using forbidden zones in the MobilePlanner software, but that should be in addition to physical barriers.

Public Access

The platform is designed for operating in indoor industrial or professional environments. It must be deployed in a manner that takes into account potential risks to personnel and equipment. The product is not intended for use in uncontrolled areas without risk analysis, for example, areas open to general public access. Use in such areas may require deployment of additional safety measures.

Clearance

The platform is designed to operate in an environment that is generally level and has no doors or other restricted areas too narrow for the AMR. It is the user's responsibility to ensure that adequate clearance is maintained on each side of the AMR, so that a person cannot get trapped between the AMR and a wall or other fixed object. You should consult the applicable standards for your area. An exception to side clearance can exist at pickup and dropoff locations where the AMR must get close to conveyors or other fixed objects.

The primary direction of travel of the platform is forward. When the platform is turning in place, with no forward movement, the detection of an obstacle in its path of rotation will not trigger an obstacle-detection condition.

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

Obstacles

If the AMR will be entering high-traffic areas, the user must take appropriate precautions to alert people in those areas that a AMR will enter. If the traffic consists of other machines, the user must adjust the AMR's and/or the other machine's parameters to reduce the risk of a collision.

Safety Scanning Laser Emergency Stop

If an obstacle enters the AMR's immediate path, the safety scanning laser will trigger an emergency stop. After the AMR has come to a complete stop, it will wait a minimum of two seconds before resuming commanded motion, with no human intervention necessary.

- If the obstacle is still in the AMR's path, and there is adequate room, it will first attempt to safely path plan and maneuver around the obstacle.

- If the AMR can't simply maneuver around the obstacle, it will search for another path to reach its goal.

  If it can't find another path, it will wait for human intervention.

Safety System Overspeed Faults

A CPLD Channel 1 or 2 fault, is a system fault, reported by independent safety system to the firmware controlling the robot. A fault signal from the safety system, indicates that the robot is operating outside of the defined boundaries of safety standards EN1525/ANSI B56.5.

Both referenced standards state, that the speed of motion in directions not covered by the operator detection devices, reverse direction for the LD Platform, must be limited to <300 mm/s.

If an LD Platform is operated in a manner that exceeds this reverse speed limit, the safety system will generate and report a fault signal. In normal, autonomous operation, this condition triggers motion controllers to execute a controlled stop. However, if motion is disabled (E-Stop button is pressed) and the brake release is overridden, the safety system cannot stop the LD Platform since power to the motors has already been cut off. Once the fault condition is resolved, the safety system will stop reporting safety fault to the motion controllers, and the normal start-up process will initiate.

Following table displays overspeed fault conditions.

> **NOTE:** The motion settings such as AbsoluteTransVelMax, that limit maximum allowable velocities in the robot software (ARAM), have no effect on the safety system.

Table 2-1. Overspeed Limits for Different LD Models

Model	Gear Ratio	Forward Limit (mm/s)[i,ii]	Reverse Limit (mm/s)[i]
LD-60	30:1	2100	300
LD-90	40:1	1575	225
LD-90x	60:1	1050	150
LD-105CT	40:1	1575	225
LD-130CT	60:1	1050	150

[i] These values are approximate and represent the upper limit. Maximum speeds should be set to at least 30-50 mm/s below these values, to prevent erroneous safety overspeed faults.

[ii] The forward limits indicate where the safety system will report a fault. These speeds may not be achievable by the robot under its own power. The max forward speed, should always be set

to the defined maximum (or lower) speed, found in the default configuration shipped with the robot.

2.5 Intended and Non-intended Use

Intended Use

The LD Platform OEM is designed to operate in indoor industrial or professional environments. In general, if a wheelchair can safely and easily navigate the environment (open, with gentle slopes), then it is safe for the robot.

Guidelines for safe use:

- Clean, dry floors — floors that are regularly swept, and routinely kept free of debris and liquids.

    IMPORTANT: Since the robot is not water proof (IP20), floors must be kept relatively dry, as any dampness can cause the wheels to slip. This can cause problems for braking as well as navigation. Refer to 13849-2 for instructions on how to test the robot in non-standard environments.

- Gentle slopes — wheelchair ramps are a good example of the amount of slope the robot can safely climb.

- Temperature — 5 to 40°C (41 to 104°F), with a recommended humidity range of 5% to 95%, non-condensing.

Non-Intended Use

You must deploy the robot in a manner that takes into account potential risks to personnel and equipment. The product is not intended for use in uncontrolled areas without risk analysis, for example, areas open to general public access. Use in such areas may require deployment of additional safety measures.

The LD Platform OEMs are not intended for use in any of the following situations:

- In hazardous (explosive) atmospheres

- In the presence of ionizing or non-ionizing radiation

- In life-support systems

- In residential installations

- Where the equipment will be subject to extremes of heat or humidity

- In mobile, portable, marine, or aircraft systems

    NOTE: The gyroscope used to assist in platform navigation requires a stationary environment for optimum accuracy. Therefore, we do not recommend them for use on a ship, train, aircraft, or other moving environment.

IMPORTANT: The instructions for operation, installation, and maintenance given in this guide and the AMR user's guide must be strictly observed.

Non-intended use of LD Platform OEMs can:

- Cause injury to personnel

- Damage itself or other equipment

- Reduce system reliability and performance

IMPORTANT: Since the robot is not water proof (IP20), floors must be kept relatively dry, as any dampness can cause the wheels to slip. This can cause problems for braking as well as navigation. Refer to 13849-2 for instructions on how to test the robot in non-standard environments.

If there is any doubt concerning the application, ask your local Omron Support to determine if it is an intended use or not.

Platform Modifications

If the user or integrator makes any changes to the platform, it is their responsibility to ensure that there are no sharp edges, corners, or protrusions.

Note that any change to the platform can lead to loss in safety or functionality. The user or integrator must ensure that all safety features are operational after modifications.

2.6 Battery Safety

CAUTION: BATTERY DAMAGE RISK

After receiving the battery, immediately charge to a full charge to avoid discharging the battery below a usable state, which would require battery replacement.

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

NOTE: If the battery was not sent by air, it may be fully-charged.

Safety Precautions

- Store batteries upright at:

    - One month: +5 to 45°C (41 to 113°F)
    - One year: 20 to 25°C (68 to 77°F)

- Never expose the battery to water. If the battery is leaking, submerge in mineral oil and contact your local Omron Support.
- In case of fire, use a type D extinguisher: foam, dry chemical, or CO_2.

Maintenance

Every six months:

- Inspect battery for damage or leaks

- Place battery on a charger and allow to fully balance (battery shows all solid LEDs when fully balanced).

2.7 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 provides detailed information on safety for LD Platform OEMs. It also gives resources for information on relevant standards. It ships with each platform.

2.8 Disposal

Dispose of in accordance with applicable regulations.

Customers can contribute to resource conservation and protecting the environment by the proper disposal of WEEE (Waste Electronics and Electrical Equipment). All electrical and electronic products should be disposed of separately from the municipal waste system via

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

Chapter 3: Setup

3.1 Overview

In general, setup is physically and logically preparing the platform, configuring the wireless network, and installing the docking station. Physically preparing the platform includes attaching your payload structure to the platform.

Setup also includes generating the map the platform will use for navigation. This manual provides an overview of that process, which is covered in detail in the *Mobile Robot Software Suite User's Guide*.

Tasks

Most of the steps in setting up a platform are straightforward. You need to tailor the design and construction of the payload structure to your application.

- Install the docking station. See Installing the Docking Station on page 49.

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

- Install the battery in the platform. See Installing the Battery on page 44.

- Set up the wireless Ethernet for the platform. See Settings and Configuration on page 55.

- Design, build, and install a payload structure to suit your application. See Payload Structures on page 61.

  This is the most involved task in getting your AMR working the way you want.

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

  This includes generating the map that the AMR will use for its navigation. Mapping is covered briefly in Mapping on page 58 and in detail in the *Mobile Robot Software Suite User's Guide*.

3.2 Transport and Storage

Platform

Ship and store the platform in a temperature-controlled environment, from -20 to 60°C (-4 to 140°F). The recommended humidity range is 5% to 95%, non-condensing. It should be shipped and stored in the supplied shipping crate, which is designed to prevent damage from normal shock and vibration. You should protect the crate from excessive shock and vibration.

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

Always ship and store the platform 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 platform.

The crate with pallet for the platform measures 1441 x 787 x 762 mm (56.75 x 31 x 30 inches), and weighs 70 kg (152 lb).

Battery

> **NOTE:** If you purchased a spare battery, this section applies to it also.

Storage Requirements

If the battery needs to be stored, the manufacturer recommends:

- One month: +5 to 45°C (41 to 113°F)
- One year: 20 to 25°C (68 to 77°F)

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

Always store batteries upright.

Maintenance

Every six months:

- Inspect the battery for damage or leaks

- Place the battery on a charger and allow to fully balance (battery shows all solid LEDs when fully balanced). Fully recharging a battery every six months is sufficient to keep it charged enough to avoid damage.

3.3 Before Unpacking

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

3.4 Unpacking

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

- If the items received do not match the packing slip, or are damaged, do not sign the receipt.

- If the items received do not match your order, contact your local Omron Support immediately.

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

Battery

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

Figure 3-1. Battery Shipping Carton

Remove the battery from the carton. The battery has recessed hand grips at the ends of the battery, for lifting.

Platform

The platform comes packed in a box, wrapped with cling wrap, and secured by plastic bands on a pallet. Refer to the following figure.

The Docking station and Starter kit, if present, are packed in a separate box sitting on top of the platform box.

1. Remove plastic bands and unwrap the cling film.

Figure 3-2. Boxes Ship Wrapped with Cling Wrap

2. Unload the top box, if present. This contains the Docking station and Starter kit.

Figure 3-3. Unloading Top Box

3. Open lower box containing the Platform.

Figure 3-4. Padding at the Corners

4. Remove the rectangular box cap, placed on top of the Platform for protection.

Figure 3-5. Rectangular Box Cap

5. Remove all corner padding.

Figure 3-6. Corner and Top Padding

6. Lift the outer box up.

Figure 3-7. Outer Box Slides up

7. Lift the robot using two people holding the grips at each side of the cardboard carrier.

Figure 3-8. Robot Being Lifted by its Cardboard Carrier

8. Remove the plastic protective sheet.

Figure 3-9. Protective Plastic Sheet Being Removed

9. Roll the robot off of the cardboard and onto the floor. Since the wheels are pinned up, the LD is just sitting on its casters, so no brake release is needed.

Figure 3-10. Robot Rolled onto the Floor

10. If the robot came with a top plate, connect the antennas as shown in following figure.

Figure 3-11. Robot Antennas Circled in Red

11. Remove the two wheel pins that held the wheels up during transit.

   The wheels are pinned up to protect the motors and drives. When you receive your platform, the drive wheels will not touch the ground until you remove the wheel pins.

   For each side of the platform:

   a. Remove the platform side skins.

      See Removing and Installing Skins on page 140.

b. Lift the wheel slightly to relieve pressure on the pin, then remove the pin by pulling the attached ring. See the following figures.

Save these pins for later service of the drive assemblies.
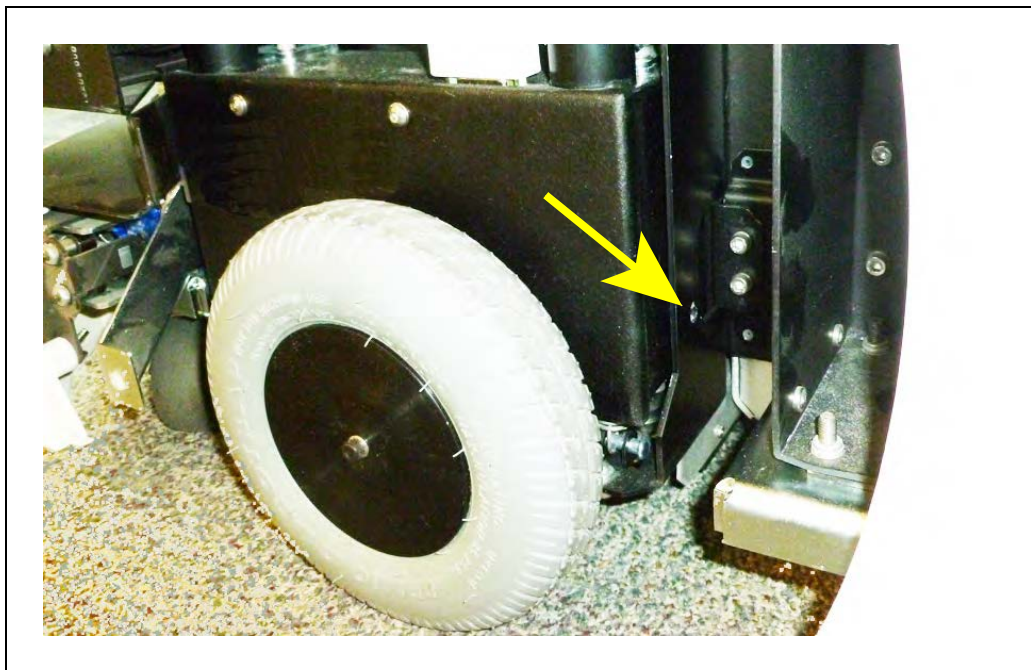
Figure 3-12. Wheel Pin Hole (Yellow Arrow)

Figure 3-13. Wheel Pin

c. Reinstall the two side skins.

12. Install the battery in the platform.

The platform brakes cannot be released until the battery is installed. Refer to Installing the Battery on page 44.

3.5 Battery

> **NOTE:** If you purchased a spare battery, this section applies to it also.

Storage Requirements

If the battery needs to be stored, the manufacturer recommends:

- One month: +5 to 45°C (41 to 113°F)
- One year: 20 to 25°C (68 to 77°F)

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

Always store batteries upright.

Maintenance

Every six months:

- Inspect the battery for damage or leaks

- Place the battery on a charger and allow to fully balance (battery shows all solid LEDs when fully balanced). Fully recharging a battery every six months is sufficient to keep it charged enough to avoid damage.

3.6 Installing the Battery

Your platform comes fully-assembled, less the battery.

> **NOTE:** Air shipping regulations require that the battery be shipped separately.

Removing the Battery Door Skin

Accessing the battery compartment requires removing the platform's rear battery skin, which is held in place with magnets.

CAUTION: PINCH RISK
The magnets holding the skin in place are strong enough to pinch you if you are not careful.

No tools are needed for either the removal or installation of the battery door skin.

> **NOTE:** After removing the skin, place it inner-side down, so the outer surface doesn't get scratched.

Figure 3-14. Pulling the Bottom of the Rear Platform Cover Out

Figure 3-15. Lowering the Battery Door Platform Skin

Refer to Removing and Installing Skins on page 140 for details on removing and installing skins.

1. Remove the battery door skin.

   a. Pull the bottom of the skin away from the platform chassis.

      This is easiest if you grip it with two hands, toward the center.

   b. Lower the skin down enough that its top tab clears the rear skin.

2. Unlatch and open the battery compartment door.

   The battery compartment door is lockable, and you might need to unlock it.

3. Lift and slide the new battery into the platform body.

   The battery weighs 19 kg (42 lbs).

   The battery has recesses at the front and the back for easier lifting.

Figure 3-16. Battery Recesses, for Gripping

A single person can lift and replace the battery. Use one hand in each of the grips, as shown in the following figure.

Figure 3-17. Lifting the Battery

The connectors for power and data go toward the rear of the platform.

4. Attach the battery power and data cables to the connectors at the rear of the battery.
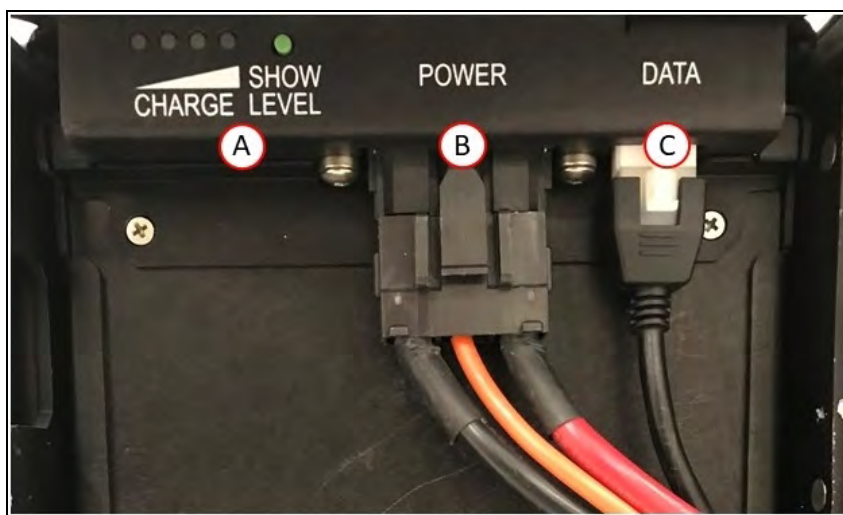
Figure 3-18. Battery Cable Connectors, (A) Battery Charge Level, (B) Power Connector, (C) Data Connector

5. Close the battery compartment door to secure the battery in place.

    Closing the battery compartment door holds the battery tightly in place to keep it from shifting inside the compartment.

6. Reinstall the battery door platform skin.

3.7 Attaching the Payload Structure and Options

Payload Structure

You will need to attach the payload structure you designed and built to the platform. Because the payload structure is user-designed, we only provide the hole pattern for how you can attach it. Refer to Dimensions and Design on page 63.

The connections, both power and signal, that are available on the platform are covered in Connectivity on page 73.

Options

You may need to attach any accessories that were shipped separately or detached for safety. See Payload Structures on page 61.

> **NOTE:** There must be either an E-Stop jumper or a user-supplied E-Stop button attached to the E-STOP port (User Interface) for the platform to function. The jumper is provided as P/N 12730-000L. An E-Stop button would be user-supplied. Refer to User Interface on page 85.

> **NOTE:** See the following figure.

Figure 3-19. E-Stop Jumper on LD Platform Core

Warning Buzzer

The Light Pole connector on the core can power a warning buzzer. You can install it in either the platform or in a location of your choice in your payload structure. In either case, the buzzer will sound intermitently whenever the AMR is moving in reverse.

How you install the buzzer in the payload structure depends on the payload design, and is not covered here. To conform to applicable standards, the buzzer must be audible in all operating conditions and environments.

Warning Light

Each AMR must have a readily visible flashing light, to warn people that the AMR is ready to move or is moving. The exact nature of this light depends on how the payload is designed and built. The user-suppled warning light can be driven from the Light Pole connector on the core.

You should ensure the light remains visible under all operating conditions, so that, regardless of your payload structure design, any people near the AMR can see it.

3.8 Installing the Docking Station

The automated docking station can either manually or automatically charge your platform's battery.

The docking station sits on the floor. You can attach it to a wall with the wall bracket, directly to the floor with screws through its base, or it can sit stand-alone on the floor with the floor plate, all of which will keep the docking station from moving when the AMR docks. Each docking station includes both the wall bracket and floor plate.

> NOTE: It is very important that you mount the docking station with one of these methods, or the AMR will simply move the docking station when it tries to dock, rather than docking successfully.

For all mounting methods:

- Place the docking station near an AC outlet with 1 - 2 m (3.25 - 6.5 ft) of clear space in front to ease the AMR's maneuvers, especially automated ones, onto the docking station.

- The top of the docking station foot is spring-loaded, and lifts off of the bottom of the base slightly to accommodate variations in the floor surface. The weight of the AMR will push the top of the foot down.

Requirements

- 100-240 VAC, 50/60 Hz, 8 A

  The 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

Wall Bracket Mount

1. Attach 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, using user-supplied anchors and screws. There is leeway, so you can adjust the height a little bit.

   Refer to the following figure:
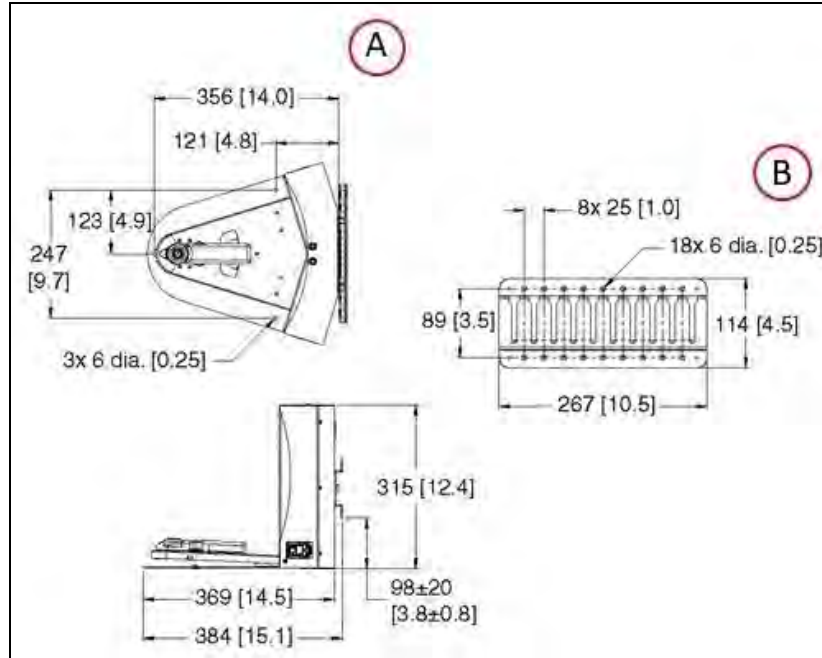
Figure 3-20. Docking Station, (A) Wall Mount and (B) Wall Mount Bracket (units are mm [inches])

2. Screw the two shoulder bolts, each with a washer, into the rear of the docking station. The shoulder bolts are M5 x 4, stainless steel. Their locations are shown in the following figure. Tighten to 9 N·m (80 in-lb).

Figure 3-21. Rear View of Docking Station with Wall Bracket

3. Lower the docking station down, so the two bolts on the back of the docking station slide into the bracket, to secure 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 3-20. We recommend M5 self-tapping screws for this.

Floor-mount, with Floor Plate

This mounting method uses the floor plate. The floor plate is not shipped attached to the docking station, so you must attach it for this type of mount. It will be in the crate with the platform, right behind the docking station.

Attaching the Floor Plate

Refer to the following figures.

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.

   The floor plate comes with three screws, so you will have two spares.

The docking station and floor plate do not need to be attached to the floor, as the weight of the AMR on the floor plate will keep the docking station from moving.

Figure 3-22. 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, and need to be removed before attaching the plate.
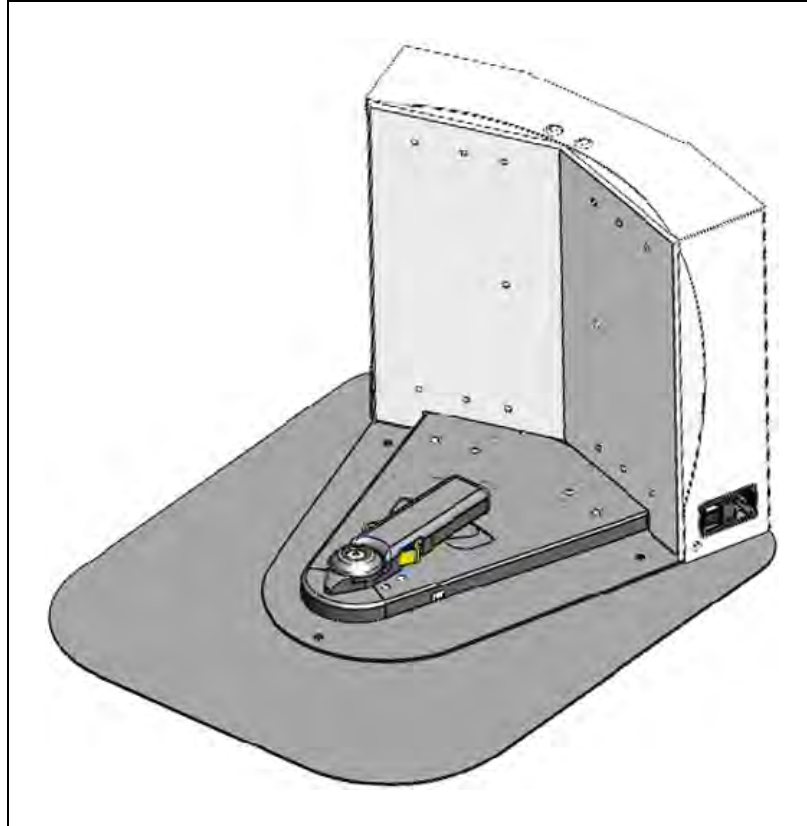
Figure 3-23. Docking Station, Mounted on Floor Plate

406 [16.0]

495 [19.5]
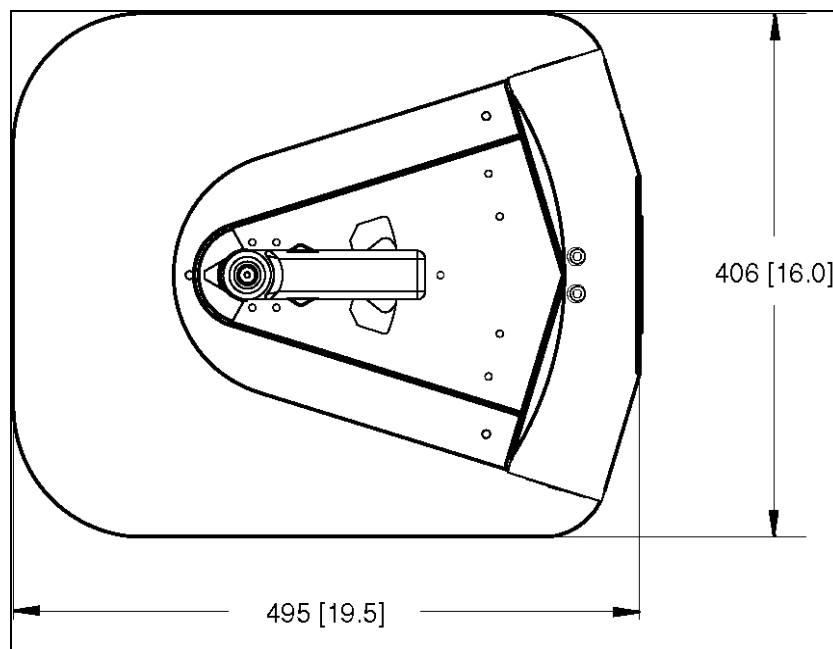
Figure 3-24. Docking Station Floor Plate Dimensions (units are mm [inches])

All Mounting Methods

Install the power cord and turn the power switch to ON. The power switch is next to the power plug. The blue power LED indicator should light.

Docking Station Contact Adjustment

The contacts on the docking station have five height settings. The station ships with the height in the middle setting, which should be correct in most cases. The height can be changed by tilting the station enough to see the bottom of the base, making the adjustment accessible.

> **Additional Information**: Squeeze and keep the docking station's foot against the base to make this adjustment easier.

Adjust the height of the contacts by using the pull-knob on the bottom of the dock. The height changes by 4 mm (0.15 inch) for each notch. See the following figure.
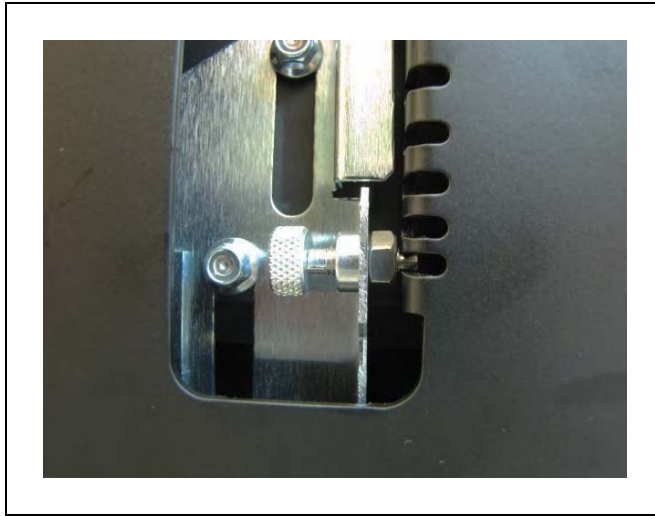
Figure 3-25. Docking Station Contact Adjusting Pull-Knob

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

Chapter 4: Configuration

This chapter describes the steps needed to configure your new platform.

The LD Platform OEM comes with firmware and on-board software installed.

The platform navigates using a map, generated with the MobilePlanner software. The map must be generated and downloaded to the platform before you can perform the steps covered in the Operation chapter of this manual.

Though the platform is autonomous, you can monitor and manually control the robot through the MobilePlanner software, which also allows you to configure parameters. The *Mobile Robot Software Suite User's Guide* covers using this software, and downloading a map to the platform.

> **IMPORTANT:** Lock up the MobilePlanner dongle, which contains the license for running the software, when not in use, to prevent unauthorized modifications to your system configuration. Turn off the software when not in use.

Other setup, mostly for communication, is handled with the SetNetGo OS, which is accessed through the MobilePlanner software. It can also be accessed through a direct connection, so your IT support can set up your wireless without needing the MobilePlanner license.

4.1 Settings and Configuration

Maintenance Ethernet Connection

To prepare your platform for autonomous mobile operation, attach a PC to the platform's maintenance Ethernet port, and connect with the SetNetGo OS through the MobilePlanner SetNetGo interface.
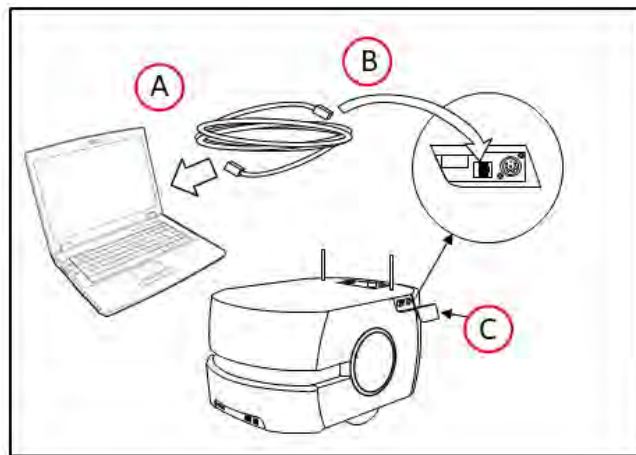
Figure 4-1. (A) PC, (B) Cat 5 Ethernet, and (C) Maintenance Access Panel

If you do not have wireless yet, you can connect MobilePlanner through the wired Ethernet port (Maintenance LAN) and set up the wireless network later.

The core is preset and tested on a Class-C network (netmask for all ports 255.255.255.0). The Maintenance Ethernet port is set to IP address 1.2.3.4 and the wireless IP comes set with an AP-based ("managed") SSID of "Wireless Network", unsecured. Consult with your network systems administrator before modifying these network details through the SetNetGo OS.

The User LAN port is set to IP address 10.10.10.10.

Refer to the *Mobile Robot Software Suite User's Guide*.

The Maintenance Ethernet plugs into the left side of the platform, under the small access panel at the upper right corner of the platform (the joystick port is also there). The access panel is held in place with a push-push latch, and retained by a lanyard. See Figure 8-1. This is internally connected to the Ethernet port located on the rear side of the LD Platform core in the payload bay.

The Maintenance Ethernet port is permanently set to IP address 1.2.3.4, with a netmask of 255.255.255.0, for direct, wired access to the onboard systems. Access to the SetNetGo OS is always enabled on this interface, and does not require a password or a license. Accordingly, when accessing the port, manually set the off-board computer's Ethernet to an IP 1.2.3.x, where x is any number 1 through 254 except 4, and with a netmask of 255.255.255.0. No special DNS or gateway settings are needed.

Attach a pass-through or cross-over CAT5 (or better) Ethernet cable between the PC and the Maintenance Ethernet port of the platform. The platform Ethernet is Auto-MDIX, and will detect the type of cable you are using.

Start the Network Connections: Local Area Connection dialog for the ETH 0 Ethernet port:

> (Windows 7) **Start > Settings > Network Connections > Local Area Connection**

> (Windows 10) **Start > Settings > Network and Internet > Change Adaptor Options > Local Area Connection**

Select **Properties**, and, from its dialog, scroll to and double-click the **Internet Protocol (TCP/IP or TCP/IPv4)** option. In the Internet Protocol (TCP/IP) Properties dialog, click both '**Use the following...**' associated radio buttons to enable them, and then type in the IP and Subnet mask values.

Setting Up Wireless Ethernet

Use SetNetGo OS to configure the wireless Ethernet, among other things. Refer to the *Mobile Robot Software Suite User's Guide* for details.

> **NOTE:** The AMR can work without wireless Ethernet. If there are no other AMRs that it needs to know about (and avoid), you can have an installation in which the AMR simply uses its map, knows its patrol route, and performs without human intervention.

> **NOTE:** For all of the following settings, work with your IT group to verify the correct IP, radio, and security settings.

The following applies to the wireless Ethernet supported by the platform.

Access the SetNetGo OS through the MobilePlanner software:

MobilePlanner > SetNetGo > Networking

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

IP Address, Netmask, Gateway, DNS1

Choose Static (DHCP is not recommended), and fill in the IP address, netmask, gateway, and DNS1, as supplied by your network administrator.

> **NOTE:** See your IT department for the following settings.

Radio Settings

- SSID (e.g. AGV)

  Fill in the appropriate wireless SSID for your wireless network.
  The SSID is case sensitive.

- Mode

  Managed/STA, Ad-Hoc, or Master/AP

- Radio Mode

  Auto, 802.11a, 802.11b, 802.11g

- Channel Set

- Wireless Watchdog IP Address

- Wireless Watchdog Max Count

  0 disables this.

Security Settings

Encryption:

- Disabled

- WEP 64-bit

- WEP 128-bit

- TKIP/RC4

- CCMP/AES

- TKIP/CCMP/AES

Authentication:

- OPEN

- WPA-PSK

- WPA2-PSK

WEP

- WEP Key Number (Key 1 - Key 4)

- WEP Keys

WPA/WPA2-PSK

- PSK

- PSK-Type (Passphrase or Raw Hex)

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

Wireless Coverage

There must be wireless coverage for multi-AMR installations, or in areas where you wish to send new commands to or receive status updates from the AMR.

For these cases, ensure you have adequate wireless coverage. Because of the possible variations in different environments, we don't specify what components or techniques to use.

We do suggest that you conduct a comprehensive site survey to ensure adequate wireless coverage. You can test your wireless setup coverage by trying to ping it from various locations.

>= -40 dBm is the ideal WiFi signal strength, -60 dBm is the recommended minimum.

Bandwidth Considerations

The typical bandwidth for a fleet averages about 50 Kbps/AMR. This would increase if the AMR is connected to the Enterprise Manager, and is actively viewed by MobilePlanner. This number can increase or decrease depending on the types of commands and debugging tools that are enabled in MobilePlanner. In any case, the bandwidth is not likely to exceed 500 Kbps per AMR (0.5 Mbps).

0.5 Mbps per AMR would easily fit within the capabilities of access points (>=54 Mbps). If you have multiple access points, this number becomes even less of a concern.

Also, other factors will affect the bandwidth requirements, such as if the AMR supports a camera on top and streams the video through the AMR's WiFi interface. Based on such possibilities, the bandwidth usage will vary by application.

4.2 Mapping

Mapping Overview

Out-of-the-box, the platform does not have a working map, and its wired or wireless network settings are unlikely to match your network. Consequently, it will not do anything autonomously. To have your platform perform autonomously, you need to make a map of its operating space. Use the MobilePlanner application to make maps.

You develop maps with the MobilePlanner software. You can add a variety of virtual elements that modify the behavior of an AMR. Virtual elements include forbidden lines and areas, speed zones, preferred-direction zones, and more, all working to help you configure your workspace for efficient and safe performance of your mobile application. You can also create your own virtual elements for application-specific AMR-workspace interactions.

Maps contain a variety of goals, routes, and tasks that comprise the destinations and activities of the AMR in the workspace.

Refer to the *Mobile Robot Software Suite User's Guide*.

Mapping Tasks

- Install the automated docking station before you create a map file. Its distinctive front angle will be helpful in locating it on the map.

- Drive the platform with the joystick to make a floor plan scan. We recommend that you drive it to and position it onto its automated docking station to prepare for the next steps.

- Load that floor plan scan into the MobilePlanner software on your PC to make and edit a map.

- Add goals and docks to your map. In particular, refer to:

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

   in the *Mobile Robot Software Suite User's Guide*.

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

   The Enterprise Manager will automatically download 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 working spaces by selecting the appropriate map file.

4.3 Acceleration, Deceleration, and Rotation Limits

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

Reducing the absolute max allowable linear and rotational acceleration, deceleration, and speed will affect the size of the allowable CG envelope, but could do so in non-obvious ways. For use-cases where the payload can't be decreased, or the CG can't be brought within the recommended limits, our Field Service department can work with your system designer to input your needs into our models.

Contact your local Omron Support for details.

If your payload's center of gravity is not within the guidelines given in the Center of Gravity (CG) on page 66, you will need to adjust the Absolute Movement Maximums parameters in the MobilePlanner software.

From the MobilePlanner software, Config:

   Robot Physical > Absolute Movement Maximums

Check the **Show Expert + Parameter**s to see or modify these parameters.

The first six parameters and *AbsoluteMaxRotVel* are not likely to have significant impact on the AMR's stability. The Accel and Decel parameters will have a major impact. In certain cases, if the payload is lopsided, you might need to adjust the *AbsoluteMaxRotVel*.

The limits and defaults for these parameters are listed in the following table.

Parameter	Default	Min	Max
AbsoluteMaxTransVel (LD-60)	1800	1	2500
AbsoluteMaxTransVel (LD-90)	1350	1	2500
AbsoluteMaxTransNegVel (LD-60)	-280	-2500[a]	-1
AbsoluteMaxTransNegVel (LD-90)	-210	-2500[a]	-1
AbsoluteMaxTransAccel	1000	1	2000
AbsoluteMaxTransDecel	2000	1	2000
AbsoluteMaxRotVel	180	1	180
AbsoluteMaxRotAccel	360	1	360
AbsoluteMaxRotDecel	360	1	360

a: Although the Min value, in software, is -2500, the hardware safety system on the platform will generate a fault if the velocity is anything from -300 to -2500 mm/s.

4.4 Supplemental Information

Laser Setup

For most installations, the defaults for the lasers should be appropriate, and will not require any user adjustment.

The specific parameters for these lasers will come in the model config file that ships on the unit, or can be provided on request if needed.

- Laser_1 Settings are for the main scanning laser, used both for safety and localization.

- Laser_2 Settings are for the low front laser (TiM).

- Laser_3 Tilted and Laser_4 Tilted are for the side lasers (TiM).

Chapter 5: Payload Structures

Everything that you attach to the LD Platform OEM is referred to as the payload structure. In some custom cases, we design and build the payload structure. In most cases, you will need to design a payload structure that suits your application.
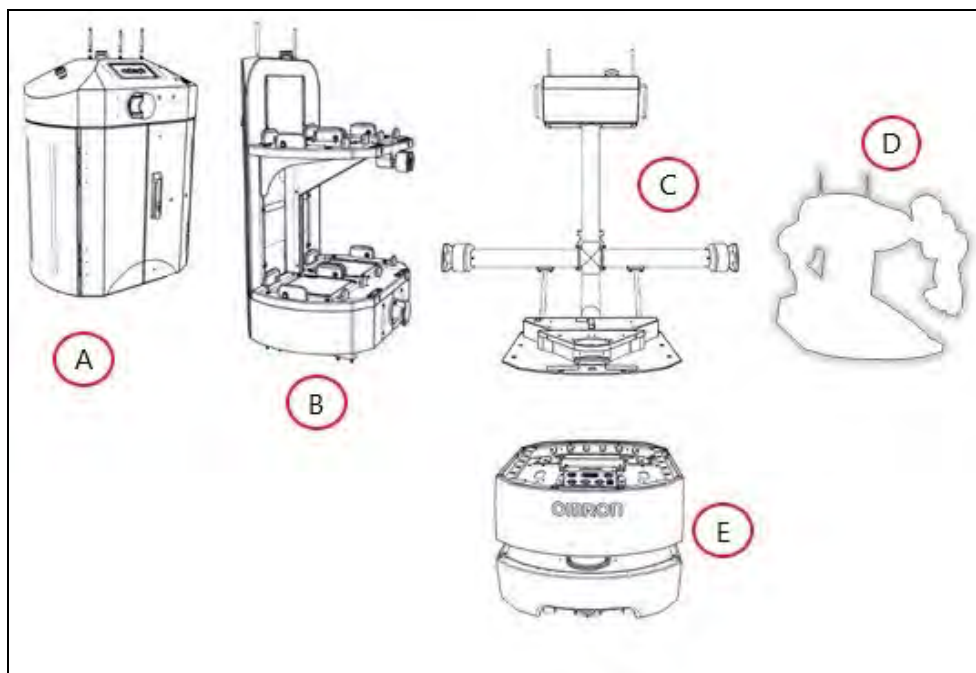
Figure 5-1. LD Platform OEM-Compatible Payload Structure Examples, (A) Courier, (B) Smif Pod Transporter, (C) Cart Transporter, (D) User Custom, and (E) LD Platform OEM

The image above shows some of the available pre-designed Omron payload structures, as well as an outline of a user custom-designed payload structure. The platform provides the mobility and navigation you will need, as well as power and I/O connections between the platform and your payload structure, so the two can work effectively together.

This chapter discusses considerations to be aware of when you design a payload structure for your platform.

5.1 Safety

Warning Label

A No Riding label ships, unattached, with each platform. 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

To comply with CE requirements, an AMR must have a readily-visible warning device, such as a flashing light, when it is either ready to move or is moving. The platform comes with light discs on each side that do this. The core also provides an output, so you can add your own warning device. This may be necessary for taller payloads, which may make the side light discs not always visible. The core has a Light Pole connector, which is covered in LD Platform Core Rear, Upper on page 82. This can be used to drive a warning device in a more prominent location for taller AMRs.

Warning Buzzer

The core provides an output for driving a warning buzzer. The default behavior of the buzzer is to sound when the AMR is moving in reverse, or when the safety systems are off. Its behavior is configurable by the user, so it can be used to sound, for example, whenever the AMR is moving.

5.2 Considerations

Performance

The main performance factors to consider in designing a payload structure are the size, weight, and center of gravity of the payload structure, and power requirements. Adding weight to the platform tends to have less effect on run-time than adding electrical power requirements. Operating your AMR on carpet will have a significantly shorter run-time than on hard surfaces.

Weight

On a hard surface, a certain amount of extra weight will not shorten the AMR's run-time very much. When adding a payload structure with substantial weight, the center of gravity of the entire AMR needs to be considered. This is particularly important if you intend to equip the platform with a robot arm, which would be lifting items off-center from the platform. A heavy payload structure, with most of its weight concentrated just above the platform, will be much more stable than the same weight payload structure in which the weight is either off-center or high above the top of the platform.

> **NOTE:** The weight of your payload structure plus the weight of the parts it is carrying must not exceed the rated capacity of your platform.

Power Consumption

Using devices on your payload structure that consume significant power will noticeably shorten the run-time of the AMR. You should try to minimize such power consumption whenever possible. The battery is rated at 1800 W*hr (1.8 kWh). Examples of power-consuming payload structures would be one with a robot arm attached, or any motorized fixture, such as a conveyor, as part of the payload structure. The standard Operator screen and light discs consume some power, but are not significant compared to the rest of the platform.

Payload Bay Access

The area between the platform and your payload structure is the payload bay. You will occasionally need to access the platform and the connectors in the payload bay. This is where you can access all of the platform power and I/O connectors. It's a good idea to provide for access to this when designing your payload structure. If the payload structure is small and light enough, you can lift it off of the platform to access the connectors in the payload bay. Always take care to not damage any wiring between your payload structure and the platform. A larger, heavier payload structure might need some form of hinge, so you can tilt the payload structure out of the way while you access the payload bay. You should consider harness length and position so you can accomplish this without disconnecting or damaging any connectors or harnesses.

Dimensions and Design

Keep your payload structure no wider and no longer than the platform. Add whatever features your application needs above the platform itself.

Keep all of the payload structure higher than the top of the platform. If the payload blocks any of the platform's sensors, it won't be able to function correctly. This is critical in the case of the lasers. If you have the optional side-mount lasers for your payload structure, ensure that the payload structure will not interfere with the laser's beams. Typically, the side lasers are mounted on the sides of the payload structure so that they protrude enough to miss the payload structure itself with their laser beams.

Many customers have found it prudent to build a protective guard over the side lasers, to protect the lasers from impact. Ensure that any such guard does not block the laser beam.
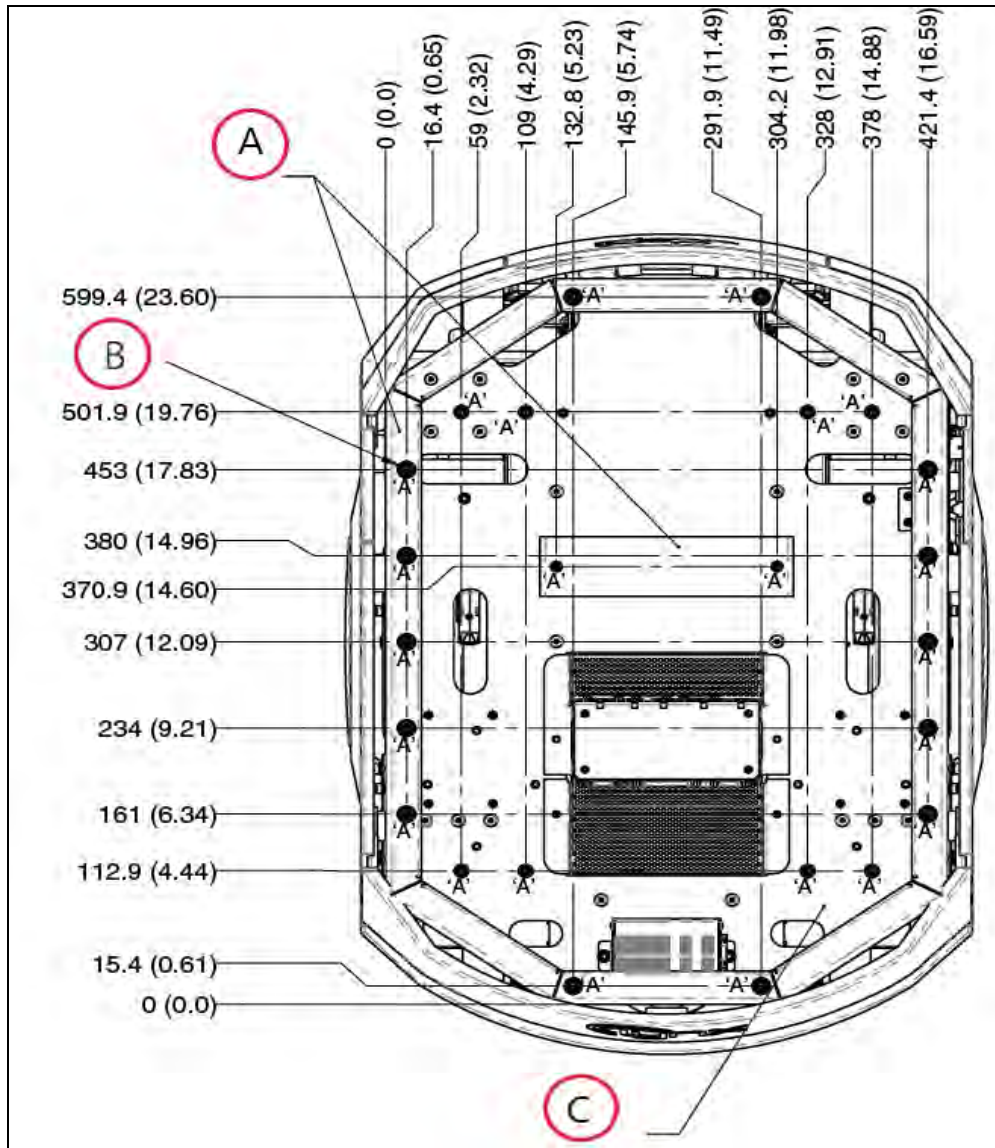
Figure 5-2. PlatformDeck Dimensions, with M6-threaded Holes (units are mm (inches))

Callout	Description
A	Upper Mounting Surface
B	24x M6 Threads
C	Lower Mounting Surface 40.7 [1.60] below Upper Surface

In the preceding figure, all of the M6 self-clinching nuts (B) have a torque limit of 3 N·m (26.6 in-lb$_f$).

⚠ **CAUTION:** PROPERTY DAMAGE RISK
Do not exceed this torque when attaching your payload structure to these self-clinching nuts. See NOTE that follows.
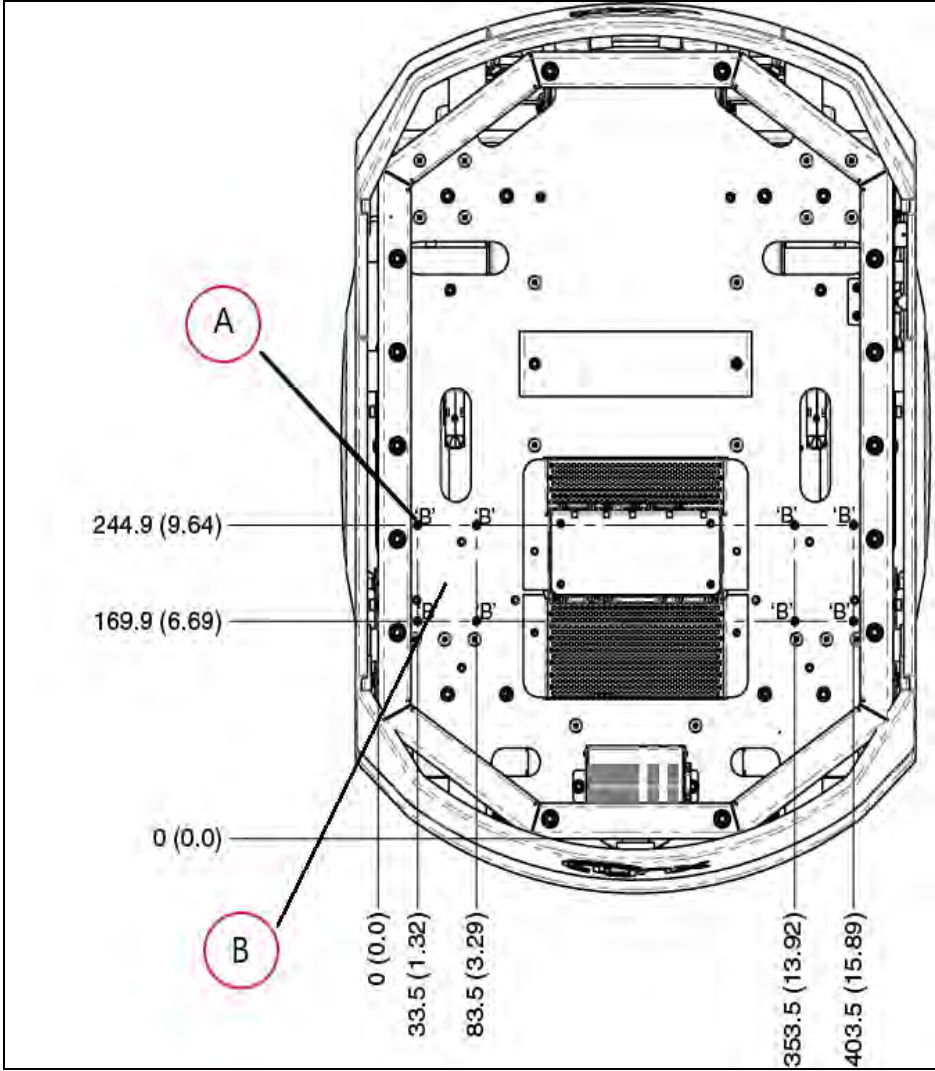
Figure 5-3. PlatformDeck Dimensions, with M5-threaded Holes (units are mm (inches))

Callout	Description
A	8x M5 Threads
B	Lower Mounting Surface 40.7 [1.60] below Upper Surface

In the preceding figure, all of the M5 self-clinching nuts have a torque limit of 14 N-m (124 in-lb$_f$).

NOTE: The M6 self-clinching nuts are inserted differently than the M5 self-clinching nuts, to increase the usable thread length. This also decreases the torque that you can apply to them, so the M5s have a much higher torque limit than the M6s in this application.

Center of Gravity (CG)

As much as possible, you should keep the payload structure CG centered on the platform, and as low (close to the platform top) as possible. This will give you the best stability, particularly when crossing thresholds or irregularities in the floor. Keep the payload centered on the platform left-to-right, but biased toward the rear of the platform according to the following figures. The following figure shows the platform's center of gravity, without payload structure.
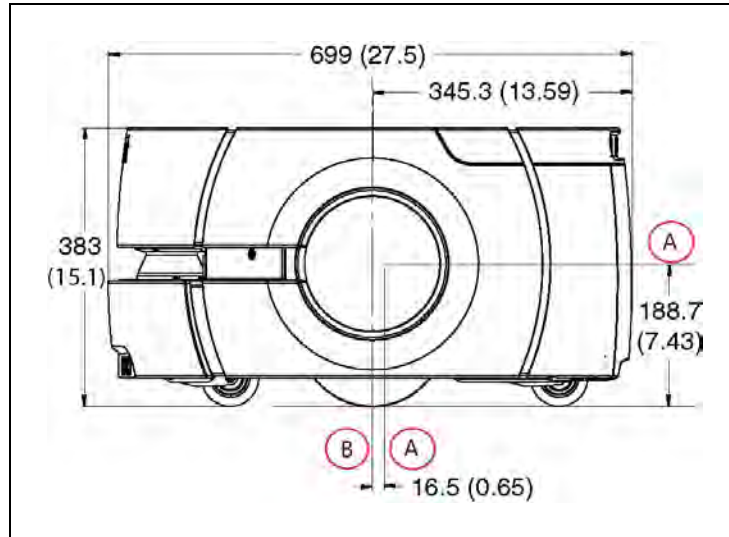
Figure 5-4. Platform Center of Gravity (CG), (A) CG, (B) Wheel Axis (units are mm (inches))

The following figures show the calculated safe CG placements for payload structures with the listed weights. The payload structure's CG, in each instance, needs to be within the area shown. All units are mm.

> **NOTE:** These figures show the limits of where to place the payload structure CG. You should try to keep your CG as close to the center of these figures as possible.

60 kg
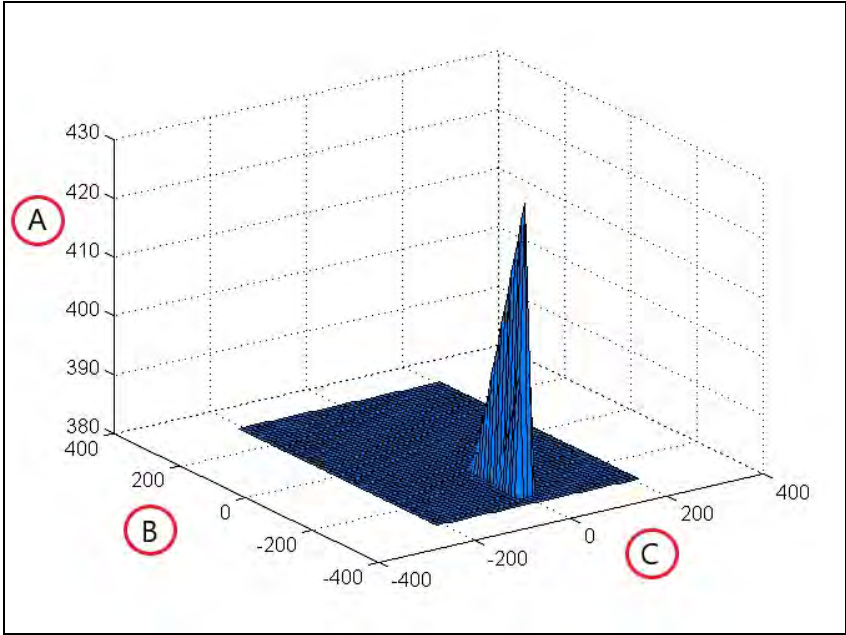
Figure 5-5. Isometric View, 60 kg, (A) Vertical Direction, (B) Longitudinal Direction, (C) Transverse Direction (units in mm)
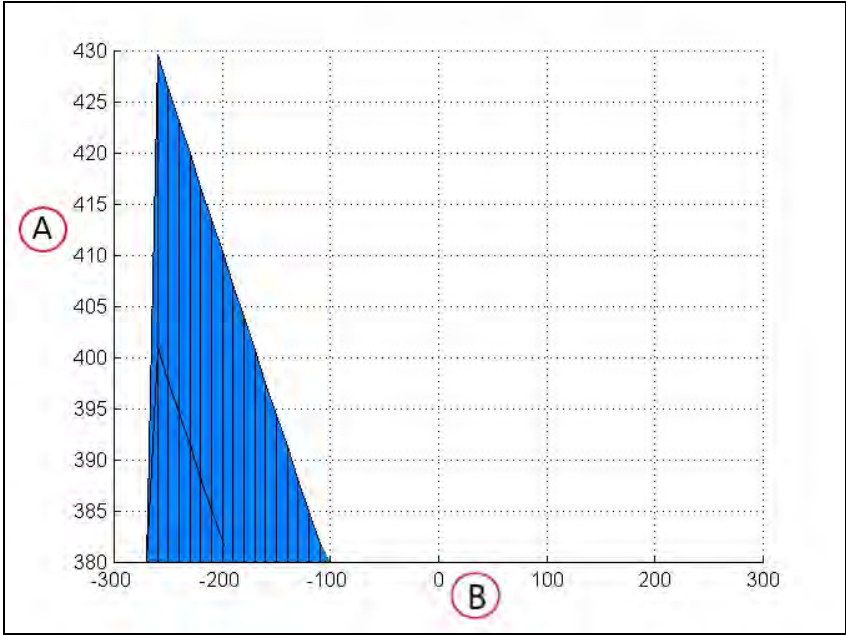
Figure 5-6. Longitudinal View, 60 kg, (A) Vertical Direction, (B) Longitudinal Direction (units in mm)
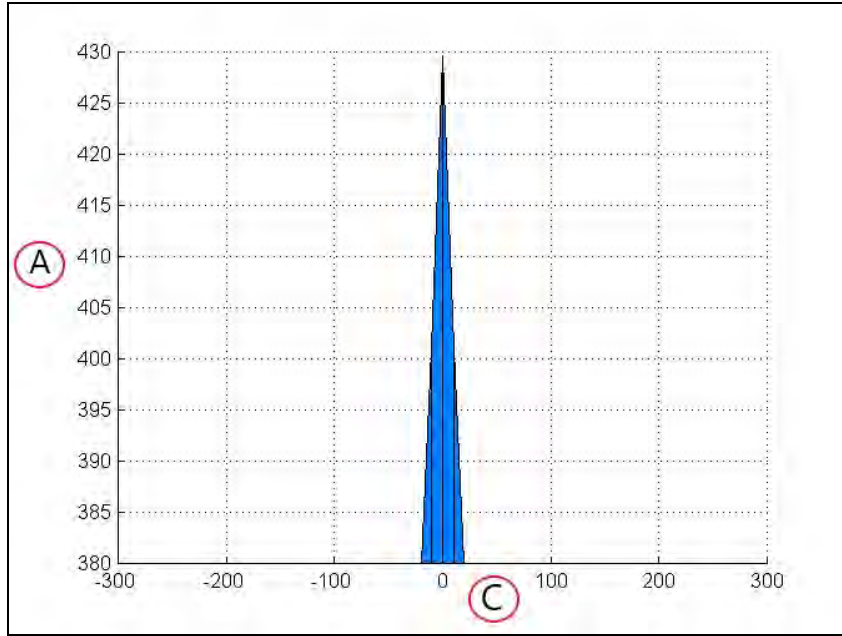
Figure 5-7. Transverse View, 60 kg, (A) Vertical Direction, (C) Transverse Direction (units in mm)
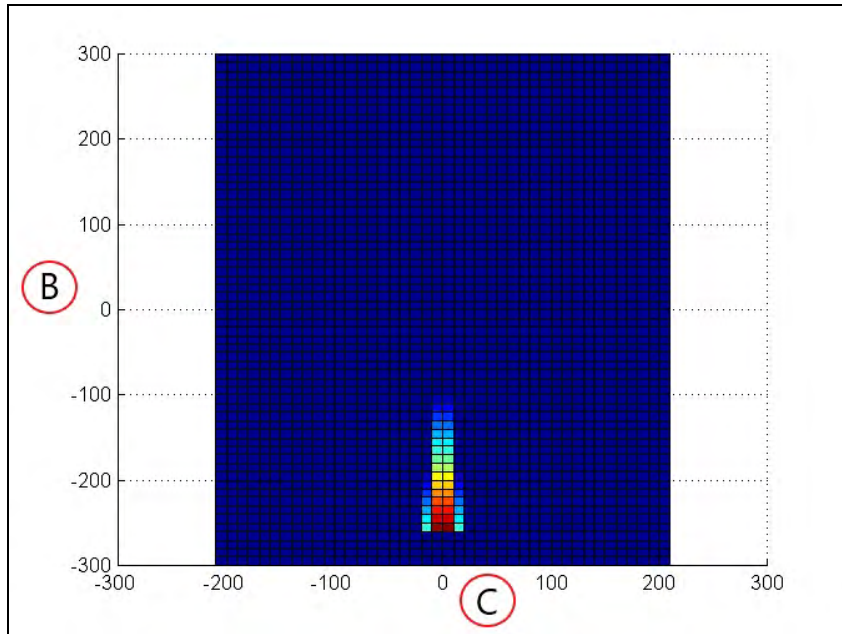
Figure 5-8. Top View, 60 kg, (B) Longitudinal Direction, (C) Transverse Direction (units in mm)

90 kg
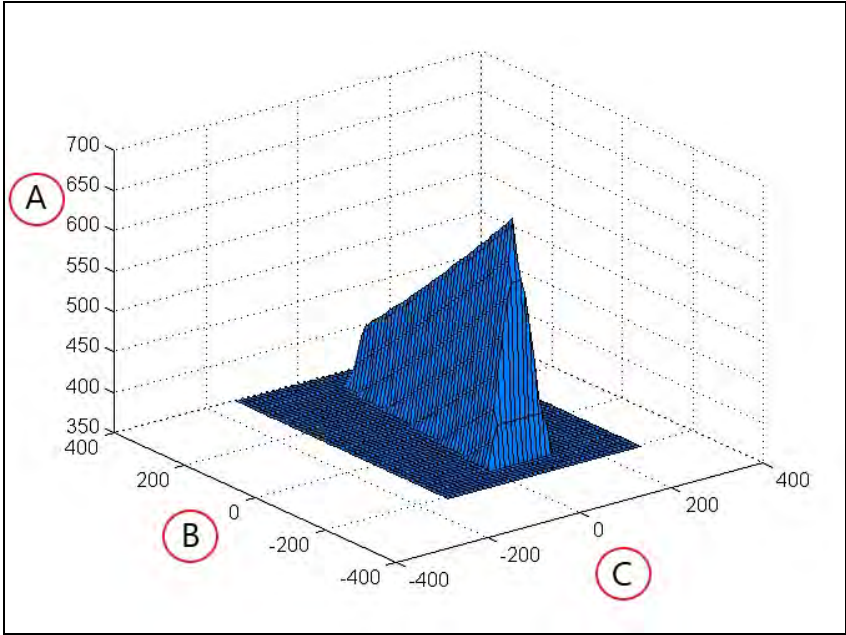
Figure 5-9. Isometric View, 90 kg, (A) Vertical Direction, (B) Longitudinal Direction, (C) Transverse Direction (units in mm)
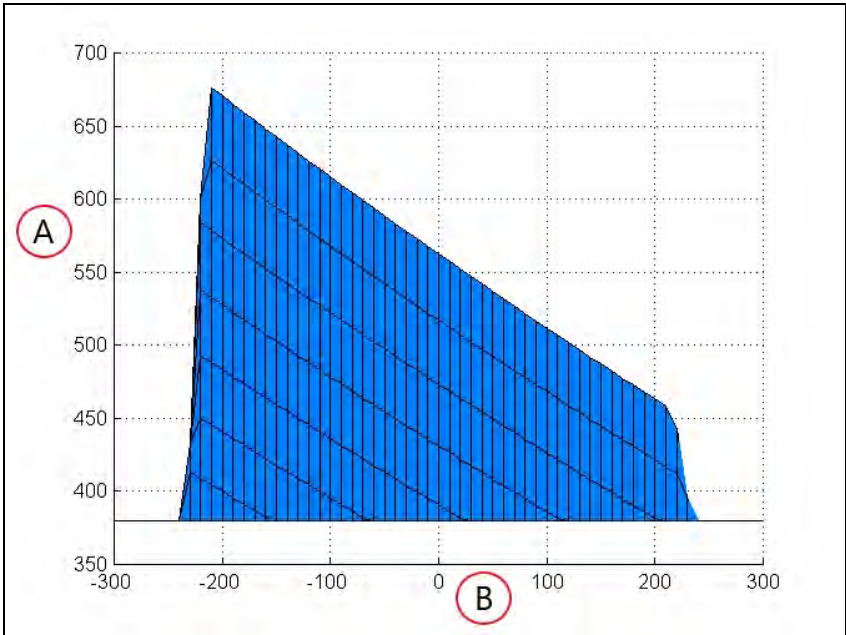
Figure 5-10. Longitudinal View, 90 kg, (A) Vertical Direction, (B) Longitudinal Direction (units in mm)
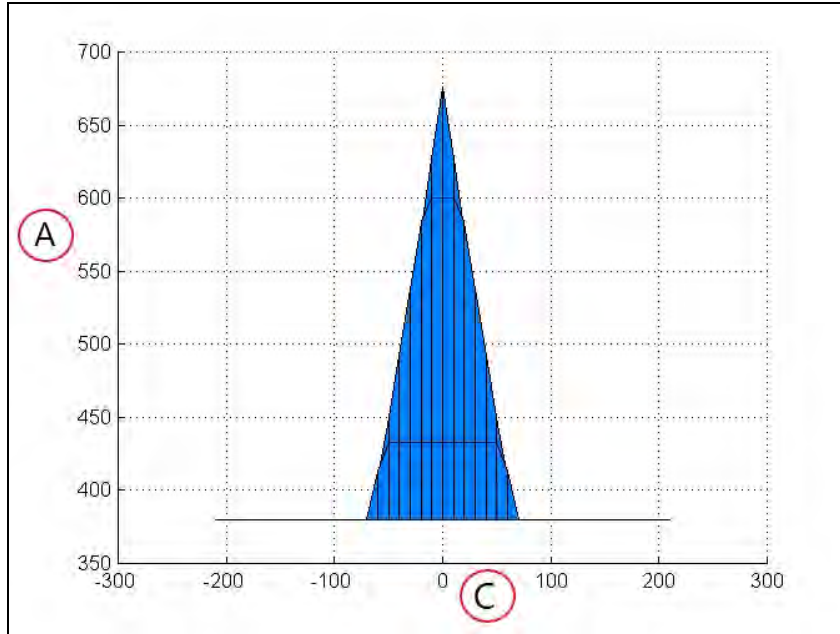
Figure 5-11. Transverse View, 90 kg, (A) Vertical Direction, (C) Transverse Direction (units in mm)
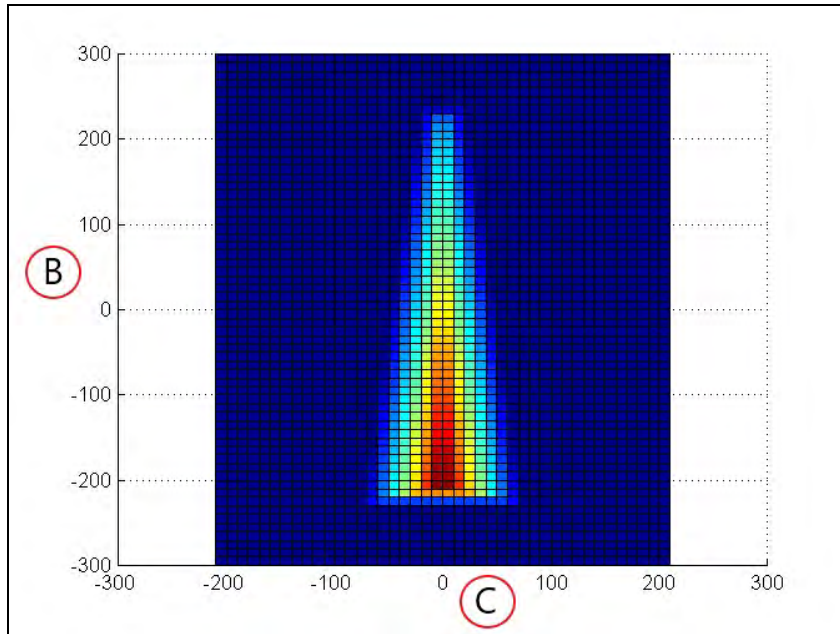
Figure 5-12. Top View, 90 kg, (B) Longitudinal Direction, (C) Transverse Direction (units in mm)

5.3 Payload-Related Tradeoffs

If you have to extend your center of gravity beyond the guidelines given here, you will need to adjust various parameters in MobilePlanner software to compensate for that. If your parameters differ from those shown here, contact your local Omron Support. In general, you will need to lower the maximum accel, decel, and rotation speeds. Refer to Acceleration, Deceleration, and Rotation Limits on page 59.

5.4 Connections Between Platform and Payload Structure

The platform provides a variety of I/O and power connections, which you can use to make your AMR more effective.

Operator Panel

The Operator screen, E-Stop, Brake-release, ON, and OFF can be "moved" using a single connector (the HMI Panel connector). This allows you to put many of the more common operator controls somewhere on your payload structure with just one cable.
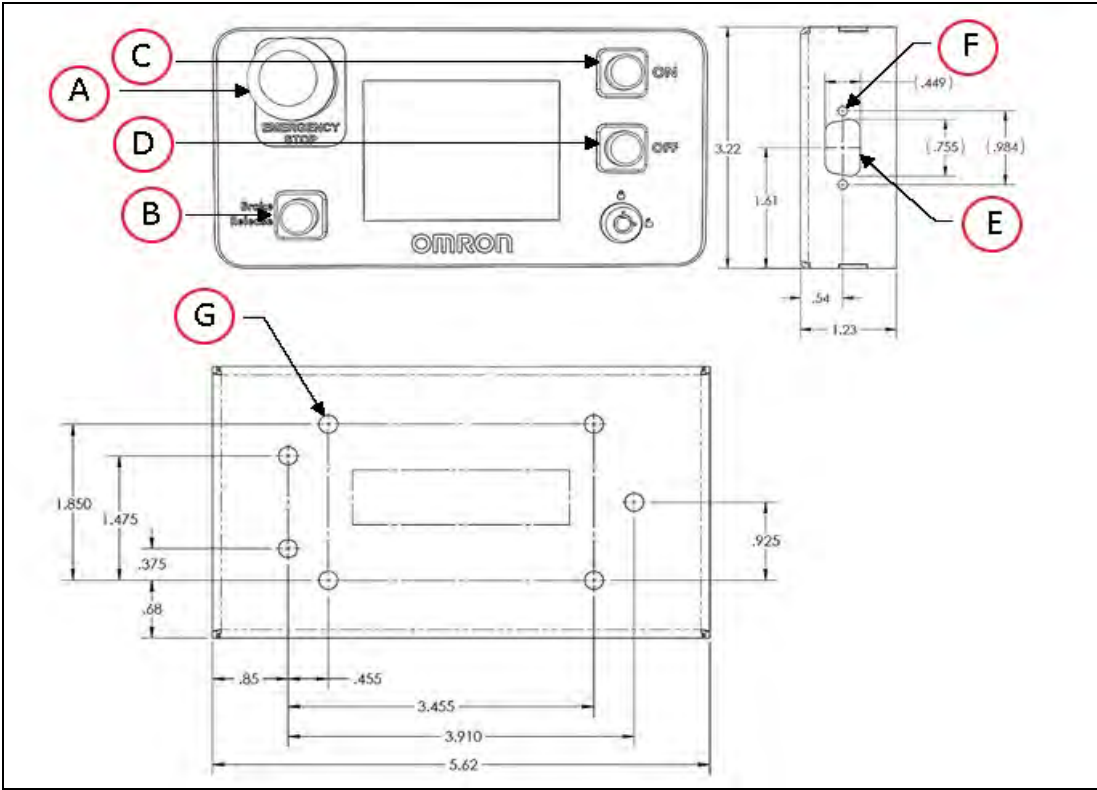
Figure 5-13. Standard Operator Panel (units are mm)

Callout	Description	Callout	Description
A	Emergency Stop	E	15 Pin High Density D-Sub Punch
B	Brake Release	F	2x 0.120 Through Hole
C	On Button	G	7x 0.213 Through Hole
D	Off Button		

A larger Operator panel, with a touchscreen, is available as an option. See Touchscreen on page 148. Many other connections are available. For details and specifications of available connections, refer to Connectivity on page 73.

Option Connections

The platform provides connectors for user-supplied payload bumpers that you can place on the payload structure.

Chapter 6: Connectivity

Most of the connections that are available to the user are in the payload bay, which is the space between the platform and any payload structure placed on top of it. These include I/O and power connections. Some are required, others are available if needed.

The two connections outside of the payload bay are the Joystick port and the Maintenance Ethernet port, which are located under a small access panel on the left side of the platform, in the upper-right corner. See Figure 8-1.

Both of these ports are connected to the core inside the payload bay.

6.1 Required Connections

- Joystick port   In order to generate maps with the platform, you need to connect a joystick to Joystick port.

  The Joystick port is located under a small access panel on the left side of the platform, in the upper-right corner.

  This is internally connected to the core in the payload bay.

- Maintenance Ethernet   The Maintenance Ethernet port is located under a small access panel on the left side of the platform, in the upper-right corner. This is internally connected to the core in the payload bay.

  The Maintenance Ethernet port is permanently set to IP address 1.2.3.4, with a netmask of 255.255.255.0, for direct, wired access to the onboard systems. Access to the SetNetGo OS is always enabled on this interface, and does not require a password or a license. Accordingly, when accessing the port, manually set the off-board computer's Ethernet to an IP 1.2.3.x, where x is any number 1 through 254 except 4, and with a netmask of 255.255.255.0. No special DNS or gateway settings are needed.

- Wireless Ethernet   For multi-AMR installations, or where you wish to send new commands or receive status updates from the AMR, you need to have wireless Ethernet.

- Docking Station   The AMR needs access to a docking station so it can charge itself. The docking station needs access to AC power.

6.2 Payload Bay Connections - Core

These connections are available for use with standard and user-supplied accessories. The antennas come with the platform.

The joystick is an option, but at least one is required per fleet for map-making.

NOTE: Standard connectors, such as audio, are not covered here. This includes all of the connectors on the right side of the core, labeled (G) in the following figure.

LD Platform Core Front, Upper
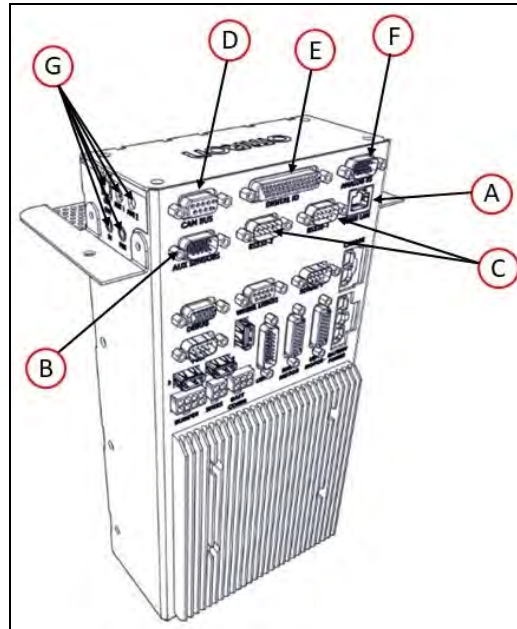
Figure 6-1. Front Upper Core

ID	Connection	Type	Description
A	User LAN	RJ45	General Ethernet, Auto-MDIX, shielded
B	Aux Sensors	HDB15M	Low front and optional side lasers
C	RS-232 x 2	DB9M	Port 1 and Port 2, general use
D	CAN Bus B	DB9F	Consult your local Omron Support for use.
E	Digital I/O (HDB44F)	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.
			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.
F	Analog I/O	HDB15M	General use
G	Right-Side Connectors	Var.	Not covered in this manual.

CAN Bus B

Connector type   DB9F

Use   CAN Bus

Pin No.	Designation	Notes
1, 4, 8	No Connection	
2	CANL_B	CAN Communication differential pair
3, 6	GND	Direct GND
5	SHIELD GND	Bead filter to GND
7	CANH_B	CAN Communication differential pair
9	CANB_12V_OUT_SW	12 V @ 0.5 A Max (switched in SW)

Digital I/O

Connector type   HDB44F

Pin No.	Designation		Notes
	Hardware	Software	
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

Pin No.	Designation		Notes
	Hardware	Software	
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	
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

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.
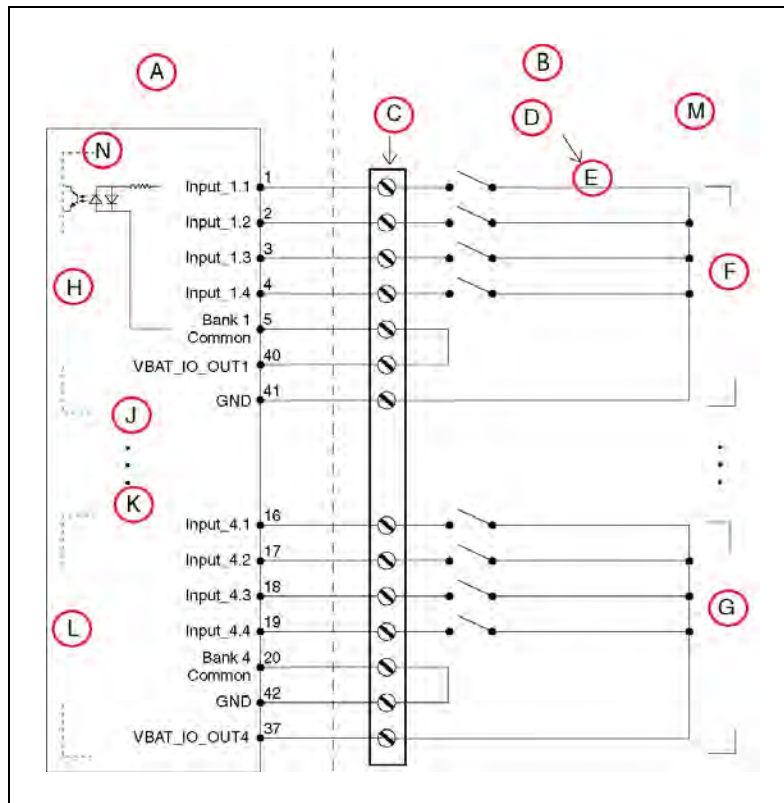
Figure 6-2. Typical Digital Input Wiring Example

Callout	Description	Callout	Description
A	Supplied Equipment	H	Input Bank 1
B	User-Supplied Equipment	J	Input Bank 2
C	Wiring Terminal Block	K	Input Bank 3
D	Typical User Input Signal	L	Input Bank 4
E	Part Present Sensor	M	Note: all input signals can be used for either sinking or sourcing configurations.
F	Bank 1 configured for sinking (NPN) inputs	N	Equivalent Circuit
G	Bank 4 configured for sinking (PNP) inputs		

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	$0.7\ A \leq I_{LIM} \leq 1.7\ A$
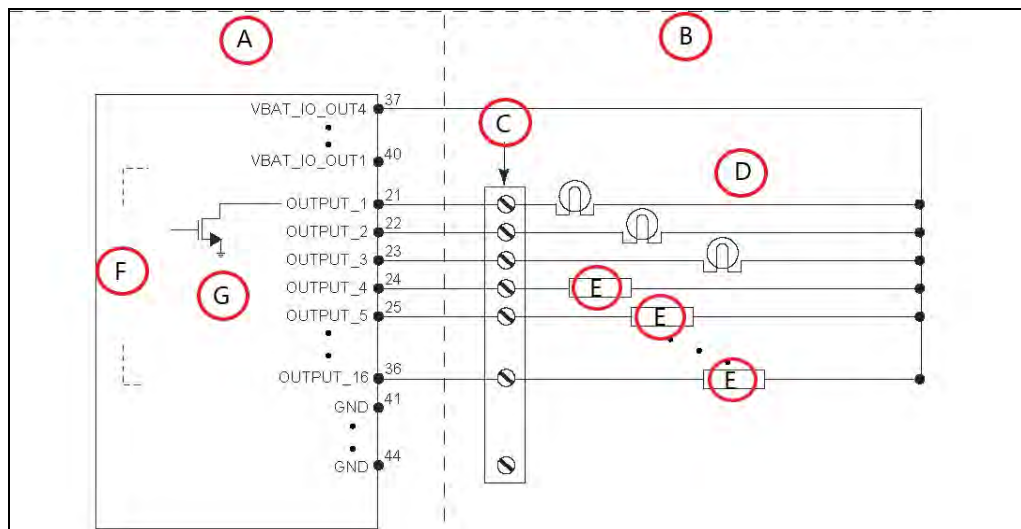
Figure 6-3. Typical Digital Output Wiring Example

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

Connector type   HDB15M

Pin No.	Designation	Notes
1	ANALOG_IN1	0 – 10 V Range
2	ANALOG_IN2	0 – 10 V Range
3	ANALOG_IN3	0 – 10 V Range
4	ANALOG_IN4	0 – 10 V Range
5	ANALOG_IN5	0 – 30 V Range
6	ANALOG_IN6	0 – 30 V Range
7	ANALOG_IN7	0 – 30 V Range
8	ANALOG_IN8	0 – 30 V Range
9	ANALOG_OUT1	0 – 20 V Range
10	ANALOG_OUT2	0 – 20 V Range
11	ANALOG_OUT3	0 – 20 V Range
12	ANALOG_OUT4	0 – 20 V Range
13, 14, 15	GND	

- The 0-10 V analog inputs have an input impedance of about 35 kΩ.

- The 0-30 V analog inputs have an input impedance of about 110 kΩ.

- The analog outputs have an output impedance of about 200 Ω.

  The maximum output current of each analog output is 10 mA. Exceeding the maximum output current will result in damage to the analog output module.

Aux Sensors

Connector type   HDB15M

Use   Low Front Laser, optional Side 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 & 2

Connector type   DB9M

Use   Port 1 and 2, General Use

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 Platform Core Rear, Upper
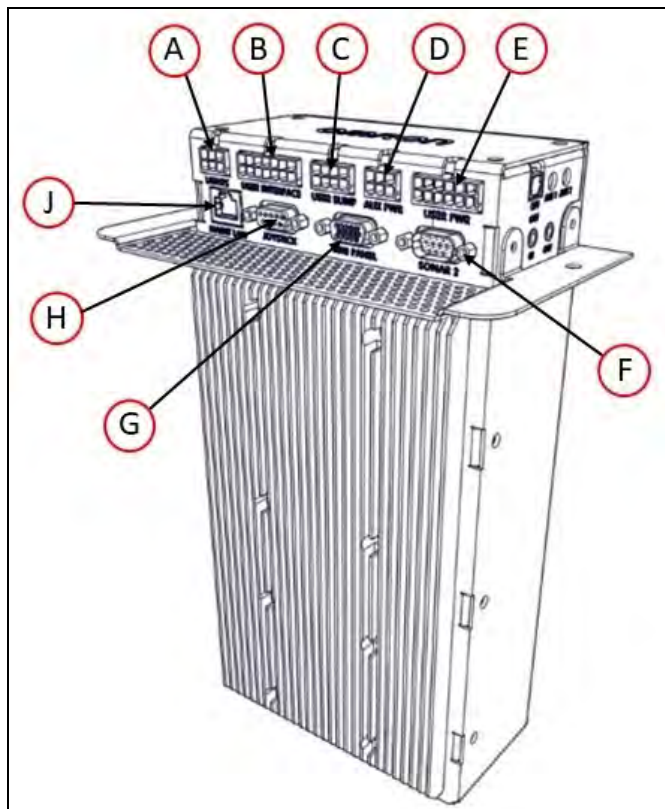
Figure 6-4. Rear Upper Core

NOTE: The connectors in the top row of the rear upper core mate with Molex Mini-Fit Jr™ 5557 series receptacles.

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.
	NOTE: 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 (must be used or jumpered)
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
J	Maint LAN	RJ45, Shielded	Directly connected to the externally-mounted Maintenance Ethernet, Auto-MDIX.
H	Joystick	DB9F	Directly connected to the externally-mounted Joystick port
G	HMI Panel	HDB15F	Operator screen, E-Stop, Brake_Rel, ON, OFF
F	Sonar 2	DB9M	Not used

Joystick

Connector type   DB9F

Use   Joystick

Pin	Designation	Notes	Pin	Designation	Notes
1	JOY_XAXIS	Analog X input	6	JOY_EN_2L	Enable channel 2
2	JOY_YAXIS	Analog Y input	7	No Connection	
3	JOY_SPEED	Analog SPEED input	8	GND	
4	JOY_GOAL	Goal Button Input	9	5V	5 V @ 100 mA
5	JOY_EN_1H	Enable channel 1			

Power Connections

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

All power connectors are Mini-Fit®.

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 Platform Core Status Indicators on page 111.

The Safe 22 - 30 VDC supply automatically gets disconnected when the E-Stop button is pressed, an obstacle is detected, or the bumper touches something.

Light Pole

Connector type   Mini-Fit® 2 x 3

Use   Light tower (user-supplied)

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
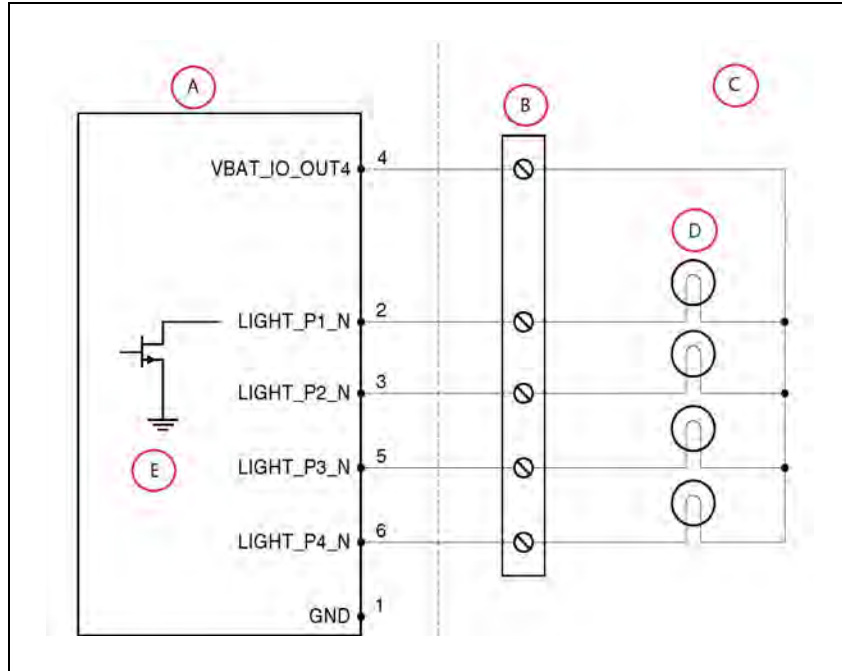
Figure 6-5. Sample Light Pole Diagram

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

User Interface

Connector type   Mini-Fit® 2 x 7

Use   Brake release, ON, OFF, E-Stop

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

Pin No.	Designation	Notes
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: An E-Stop jumper or a user-supplied E-Stop button needs to be attached to the E-STOP port on the User Interface connector for the platform to function. The jumper is provided as part number 12730-000L. An E-Stop button would be user-supplied.

NOTE: Engaging the E-Stop through the external connector or Operator Panel (faster than 250 ms), will cause motors to re-engage after E-stop is released. Motor re-engagement occurs because the core is designed to receive a consistent E-Stop signal for at least 250 ms. Signals that engage and disengage in a time period shorter than 250 ms, will cause LD to assume that the change was due to a bumper press, which will automatically re-engage the motors. No signal on the E-Stop chain can cause the robot to operate while the E-Stop remains engaged. Thus it is necessary to leave the E-Stop engaged, if the intent is to keep the robot in a E-Stop state.

CAUTION: PERSONAL INJURY OR PROPERTY DAMAGE RISK
If you are using a user-supplied E-Stop, you must run the Safety Commissioning to verify the E-Stop's functionality before putting the AMR into service.
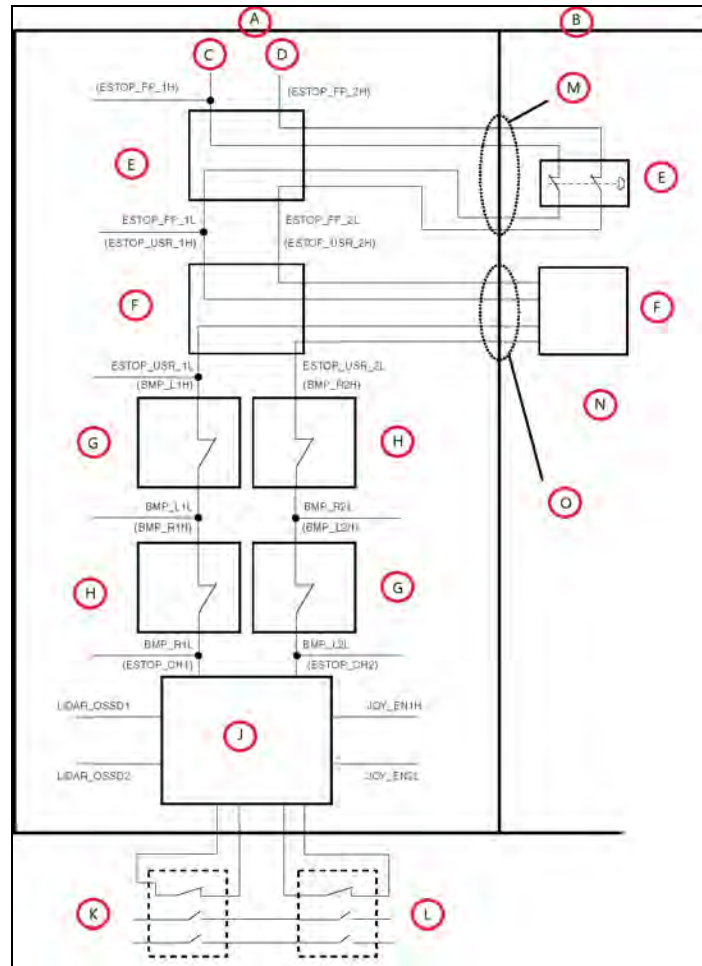
Figure 6-6. E-Stop Chain Diagram

Callout	Description	Callout	Description
A	Standard Circuits	H	Bumper Right
B	User-Supplied Circuits	J	E-STOP Relay Control Logic
C	E-STOP-Source	K	Voltage of the Battery
D	Ground	L	High Power to Amplifiers
E	Front Panel E-STOP	M	HMI Connector
F	User E-STOP	N	Note: Jumper closed when not used, MUST open both channels independently if used.
G	Bumper Left	O	User Interface Connector

User Bumper

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

NOTE: Pins 1 through 3 are for a front-mounted bumper, 4 through 6 are for a rear-mounted bumper.

Connector type   Mini-Fit® 2 x 4

Use   Optional bumper for payload structure

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

User Power

Connector type   Mini-Fit® 2 x 6

| Pin No. | Designation | | Notes |
	Hardware	Software	
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

Connector type   HDB15F

Use   Operator screen, E-Stop, Brake_Rel, ON, OFF

Pin No.	Designation		Notes
	Hardware	**Software**	
1	RS422_HMI_TX+		
2	RS422_HMI_TX-		
3	MOTOR_BRAKE		
4, 5	E-STOP_FP_1H, _2H		Connections to HMI Panel
6	RS422_HMI_RX+		If using the optional touchscreen instead of the HMI panel, the RS422_HMI connectors are not needed, but the user will have to provide buttons for ON (Start), OFF, Brake Release, and E-Stop functions.
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		

Sonar 1

Connector type   DB9M

Use   Platform (rear) sonar

NOTE: Sonar 1 is part of the Internal LD Platform Core connections.

Pin No.	Designation		Notes
	Hardware	**Software**	
1, 4, 8	No Connection		
2	RS422_SNR_RX+		
3	RS422_SNR_TX+		
5	GND		Connections to Sonar Module
6	RS422_SNR_RX-		
7	RS422_SNR_TX-		
9	SW_12V_SNR	Sonar_1_Power	

Internal LD Platform Core Connections

The following connections are internal (under the platform's top deck), and not normally available for the user. They are listed here so that you can reconnect them in the event that they need to be disconnected for parts replacement.
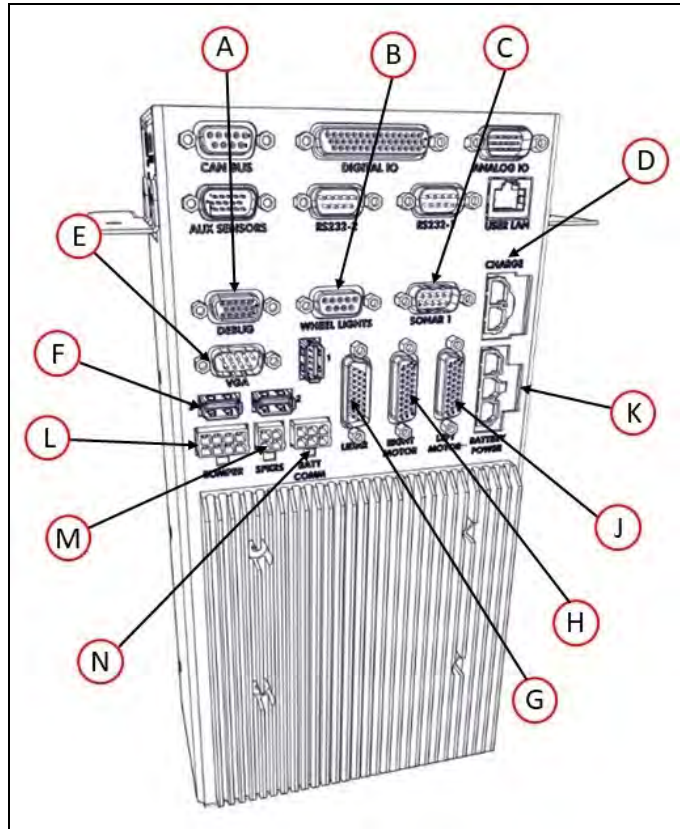
Figure 6-7. Internal Connectors on the LD Platform Core (Front)

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

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

ID	Connection	Type	Description
A	Debug RS-232	DB9M	Reserved
B	Wheel Lights	DB9F	Motion and status indicator Light Discs on the platform sides
C	Sonar 1, RS-422	DB9M	Connection to Sonar Module (Rear sonar sensors)
D	Charge Contacts	Mini-Fit Sr., 2-pin	

ID	Connection	Type	Description
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 and Left Motor connectors use the same type of plug. Take care not to reverse them.
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	Connect to standard bumper contacts
M	Speakers	Mini-Fit 2 x 2	Drives built-in speakers
N	Battery Comm.	Mini-Fit 2 x 3	Battery communication/control

Internal Data Pinouts

Wheel Lights (Light Discs)

Connector type   DB9F

Use   Motion and status indicator light disc on the platform sides

	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)

NOTE: Sonar 1 is covered in Sonar 1 on page 89.

LIDAR (Light Detection And Ranging)

Connector type   DB26M

Use   Front navigation 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
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	

Pin 10 + 18: Current < 600 mA

Internal Power Pinouts

Bumper

Connection   Mini-Fit® 2 x 4

Connector type   DB9F

Use   Front bumpers

NOTE: The single front bumper uses four sensors for operation.

Pin No.	Designation	Notes
1	BUMPER_R2L	Right, Channel 2, Low
2	BUMPER_R1L	Right, Channel 1, Low
3	BUMPER_L2L	Left, Channel 2, Low
4	BUMPER_L1L	Left, Channel 1, Low
5	BUMPER_R2H	Right, Channel 2, High
6	BUMPER_R1H	Right, Channel 1, High
7	BUMPER_L2H	Left, Channel 2, High
8	BUMPER_L1H	Left, Channel 1, High

Speakers

Connector type   Mini-Fit® 2 x 2

Use   Speakers

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

Batt Comm.

Connector type   Mini-Fit® 2 x 3

Use   Battery control

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

Chapter 7: Operation

Before proceeding, you need to have performed the steps covered in the Setup and Getting Started chapters, so your platform has a map to work from.

7.1 Operating Environment

Intended Use

The LD Platform OEM is designed to operate in indoor industrial or professional environments. In general, if a wheelchair can safely and easily navigate the environment (open, with gentle slopes), then it is safe for the robot.

Guidelines for safe use:

- Clean, dry floors — floors that are regularly swept, and routinely kept free of debris and liquids.

    IMPORTANT: Since the robot is not water proof (IP20), floors must be kept relatively dry, as any dampness can cause the wheels to slip. This can cause problems for braking as well as navigation. Refer to 13849-2 for instructions on how to test the robot in non-standard environments.

- Gentle slopes — wheelchair ramps are a good example of the amount of slope the robot can safely climb.

- Temperature — 5 to 40°C (41 to 104°F), with a recommended humidity range of 5% to 95%, non-condensing.

Clearance

The platform can operate in an environment that is generally level, with no doors or other restricted areas that are too narrow for the AMR.

You must ensure that adequate clearance is maintained on each side of the AMR, so that a person cannot get trapped between the AMR and a wall or other fixed object. You should consult the applicable standards for your area.

An exception to side clearance can exist at pickup and drop off locations, where the AMR must get close to conveyors or other fixed objects.

CAUTION: PROPERTY DAMAGE RISK
Do not allow the platform to drive through an opening that has an automatic gate/door unless the door and platform are configured correctly with the Call/Door Box option.

Refer to the *LD Platform Peripherals User's Guide* for details on the Call/Door Box.

Obstacles

If the AMR will be entering high-traffic areas, take appropriate precautions to alert people in those areas that an AMR might enter. If the traffic consists of other machines, adjust the AMR's and/or the other machine's parameters 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, etc.

- large, highly-reflective objects

Environment and Floor

Floors must provide good traction, typical of good walking conditions.

- Slope   Up to 60 kg, up to 1:12 slope

  Slope must provide adequate traction.

- Temperature   5 to 40°C (41 to 104°F)
- Humidity   5% to 95%, non-condensing
- Altitude   Up to 1000 m above mean sea level

  NOTE: Read the warning that follows step and gap traversal. Any steps must have a smooth, rounded profile.

- Step traversal, LD-60   Up to 15 mm (0.6 inch) at 250 - 300 mm/s
- Step traversal, LD-90   Up to 10 mm (0.4 inch) at 250 mm/s only
- Gap traversal   Up to 15 mm (0.6 inch)

CAUTION: PROPERTY DAMAGE RISK
The platform is designed and intended for smooth, level floors. While it is capable of driving over a step or gap as listed, frequent or high-speed driving over steps or gaps will shorten the lifespan of the drivetrain components.

NOTE: At less than the recommended speeds, the AMR might not be able to traverse the step height listed.

Do not use the platform in hazardous environments (explosive gas, and oil mist). It has an IP rating of IP20.

Do not use the platform in the presence of ionizing or non-ionizing radiation.

Getting Stuck

It is possible, though not likely, for the AMR to get into a position from which it cannot move without Operator assistance.

Some examples are shown in the following figure.

If the platform has to be lifted to be free to drive again, refer to Lifting the Platform Safely on page 117.
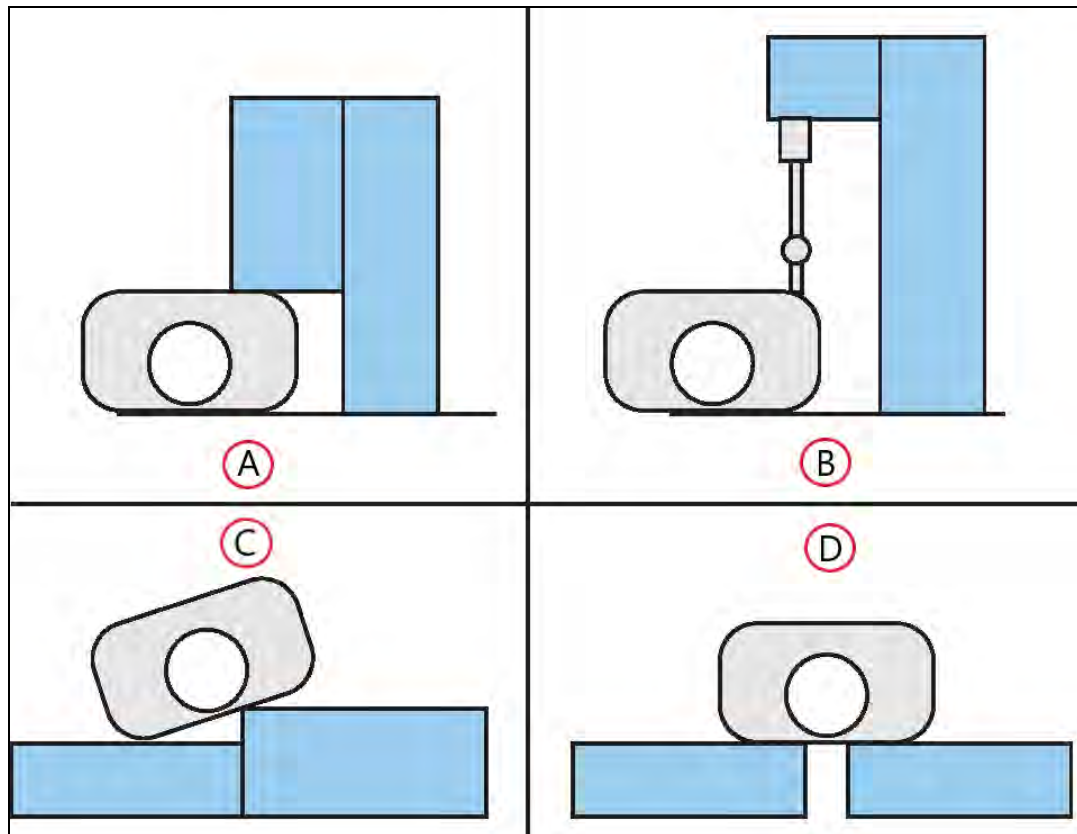
Figure 7-1. Examples of the Platform or AMR Getting Stuck, (A) Platform Stuck Under Overhang, (B) AMR Option Stuck Under Overhang, (C) Driven off Ledge, and (D) Driven Over Excessive Gap

7.2 Typical Operation

During normal start-up, the platform powers all its onboard systems[1] and runs its onboard software and your integrated processes automatically to provide an application-ready AMR. If it has been given a map of its workspace and knows where it is within that environment (localized), your AMR is ready to perform start-up and operate autonomously, without human intervention.

Paths are not pre-programmed, but instead are generated dynamically onboard the platform. Paths are updated many times per second to maintain a smooth trajectory and to account for

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[1]As configured either by the factory or through your own parameter changes.

any obstacles that are detected by the onboard sensors. Navigational parameters are stored onboard the platform, and can be viewed and modified using the MobilePlanner software, which is covered in the *Mobile Robot Software Suite User's Guide*.

The MobilePlanner application, running on your computer, configures the many high-level operating characteristics of the platform, including speeds and accelerations, sensor safety zones, minimum battery level allowed before docking for recharging, which map to use, and many other parameters. The MobilePlanner software typically communicates with the platform over the wireless network. A direct connection, through the Maintenance Ethernet port on the platform, is also possible.

> **IMPORTANT:** Protect the MobilePlanner Operator Mode with user ID and password access, to prevent unauthorized operation of an AMR.

7.3 Power and Charging

The platform battery is sealed. It supplies ample power for the motors, electronics, and accessories.

The platform ships separately from the battery. You should have fully-charged battery as noted in Battery on page 44.

Typically, the platform manages battery recharging. With the power provided by the automated docking station, all on board systems function continuously while the battery recharges.

The Operator screen shows % state-of-charge (SOC) remaining for battery.

Run-time, with no load, is approximately 15 hours. This will vary significantly depending on use and accessory power consumption.

Recharge time is approximately 4 hours.

Battery Indicators and Controls

The battery has (from left to right) one red/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 platform will write an error code to the log, which will allow Service to better troubleshoot the problem.	

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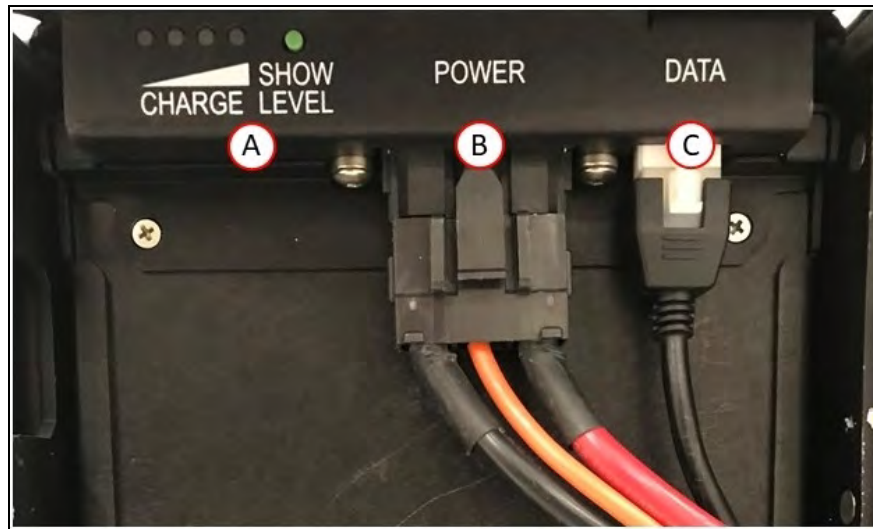
Figure 7-2. (A) Battery LEDs and Push-Button (Show Level), (B) Power Cable, and (C) Data Cable

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

NOTE: After pressing the SHOW LEVEL push button, the battery will light 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 means for recharging your platform battery.

Autonomous Charging

During normal, autonomous operation, the AMR manages charging automatically through the automated docking station. The AMR approaches the docking station frontward, and then turns around and backs onto the docking station to charge. There is about a 10-second delay between when an AMR docks and the charging LED turns on.

Connecting and disconnecting the AMR with network and onboard clients will not disturb the charging state (though moving the AMR will, of course). The station supplies ample power for all onboard systems while charging its battery, so you can continue operating those systems while charging.

If the AMR is powered off, it will turn on automatically when pushed onto the docking station. The robots can be turned off while on the docking station. If the robot is turned off, it must be removed from the docking station to be started.

Figure 7-3. Docking Station

Indicators, Controls, and Connections

The docking station has a power switch and two LEDs:

- blue indicates that power is available.

- yellow indicates that a charge is in progress.

The power switch, located on the right side of the dock, has an integrated thermal fuse, which can shut down the dock if it becomes too hot. If this happens, you have to wait for the fuse to cool down, turn the switch to off (0) and then back to on (1).

Legacy versions of the dock used two fuses in a fuse drawer to protect the dock. Their replacement is covered in Docking Station AC Power Fuse on page 127.

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

The plug for connecting the manual charging cable is on the left side of the station, as viewed from the front.

Environmental Requirements

- Ambient temperature range: 5 to 40°C (41 to 104°F)

- Humidity: 5% to 95% non-condensing

Maintenance

Clean the docking station contacts quarterly with isopropyl alcohol. See Docking Station on page 99.

The guide roller is field-replaceable. See Docking Station Roller and Bearing on page 126.

If necessary, you can adjust the height of the docking station contacts. See Docking Station Contact Adjustment on page 54.

Manually Charging the Battery

Battery in Platform

To manually charge a battery inside the platform, push the AMR backwards, with E-Stop engaged, so that the rear of the platform slides over the docking station contacts.

> **NOTE:** Press and hold the brake-release button to move the platform.

> **NOTE:** If you push the platform too far onto the docking station, it will not charge. Make sure that the yellow charge light comes on and stays on.

Standalone Battery

You can charge the battery, outside of the platform, by using the connector on the left side of the docking station (viewed from the front) with the provided charging cable. This will most likely to be used for charging a spare battery, while the second battery is still in the platform, and the AMR is in use.

There is about a 10-second delay between when you connect the battery cable and when the charging LED turns on.

> **NOTE:** The docking station cannot charge a platform and a separate battery at the same time. If a platform is on the station, the power to the manual charge connector is cut off.

Some users manually charge a spare battery, and swap that for the battery inside the platform. Typically, this is done at the start of each shift, so the AMR is available for the entire shift without recharging.

Balancing the Battery

The battery is composed of multiple cells, which must stay balanced to maintain maximum run-time.

There are three ways to manage battery balancing:

- Set the AMR's *DockUntilDoneCharging* parameter to **True**. In this case, the battery will balance before saying it's done charging, so the battery will get balanced every time the AMR docks. You do not have to do anything extra to balance the battery.

  In this mode, the battery will typically take about 10 minutes to balance after charging.

  > **NOTE:** We recommend this mode for installations that aren't doing battery swapping.

- Exchange the in-service battery, periodically, with a fully-charged spare battery.

  A spare battery plugged into a docking station will be balanced after it is charged. In this mode, you don't have to worry about battery balancing, although it does add the task of manually swapping batteries.

  The interval between battery swaps depends on the AMR's use. This includes the weight it carries, the electrical load of any accessories, and percentage of time it is in service. You will need to determine the best interval for your situation. Swapping the battery at every shift change is a commonly used interval.

  > **NOTE:** We recommend this mode for battery swapping, if you are not charging the battery while it is inside the AMR.

- Set the AMR's *DockUntilDoneCharging* parameter to **False**, to let the AMR get a partial charge by docking. The *StateOfChargeToChargeTo* and *MinutesToChargeFor* parameters need to be set to appropriate (non-zero) values. You would then do a periodic battery swap with a fully-charged and balanced battery, such as once a week.

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

    A 90% value here would get the battery mostly 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 both of these parameters are left at the default of 0, and *DockUntilDoneCharging* is set to False, the AMR will dock, and never undock.

  In this charging mode, we recommend that you swap batteries weekly, at a minimum. If you see a reduction in run-time, you should do a swap more often than that.

  > **NOTE:** The longer you wait to balance a battery, the longer it will take to balance. A battery that is badly out of balance can take well over 10 hours to balance after charging.

7.4 Operator Panel

The Operator screen, E-Stop, Brake-release, ON, and OFF can be "moved" using a single connector (the HMI Panel connector). This allows you to put many of the more common operator controls somewhere on your payload structure with just one cable.
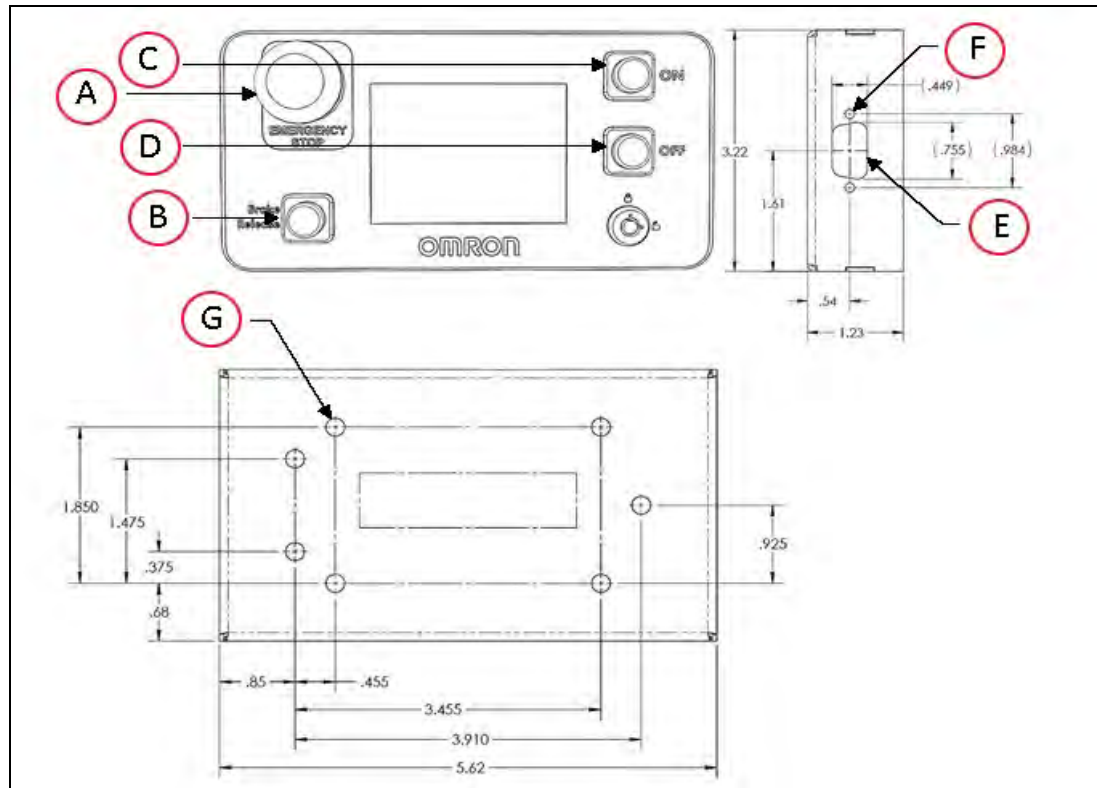
Figure 7-4. Standard Operator Panel (units are mm)

Callout	Description	Callout	Description
A	Emergency Stop	E	15 Pin High Density D-Sub Punch
B	Brake Release	F	2x 0.120 Through Hole
C	On Button	G	7x 0.213 Through Hole
D	Off Button		

A larger Operator panel, with a touchscreen, is available as an option. See Touchscreen on page 148. Many other connections are available. For details and specifications of available connections, refer to Connectivity on page 73.

Screen

The screen is a color TFT, 320 x 240 pixels, 3.5 inches diagonal. It can display 256K colors, and is backlit.

> **NOTE:** If the backlight times out, tapping lightly on the screen turns it back on.

NOTE: This is not the same as the Touchscreen option.

Default/Sample Screen Contents

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

Figure 7-5. Initial Boot Screen

After the platform boots 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	Status/ Faults/ Instructions (up to six lines)		

- The main screen can display up to six messages, in order of importance.

- The main screen will display only one fault at a time.

- The main screen will display any event or condition that causes an ARAM restart or AMR shutdown, and give the cause of the restart or shutdown.

E-Stop

When pressed, the red, latching push-button prevents any AMR motion by disabling the motors. To reset the E-Stop, twist the button slightly, so it pops up.

The motors must also be explicitly enabled, either with the dialog box that will pop up or with the ON button; this is not the case if the AMR is docked or experienced a critical driving fault. This can be done either with the MobilePlanner (with **Map > Show Robot** on) software, or with an ARCL command. See the following figure:
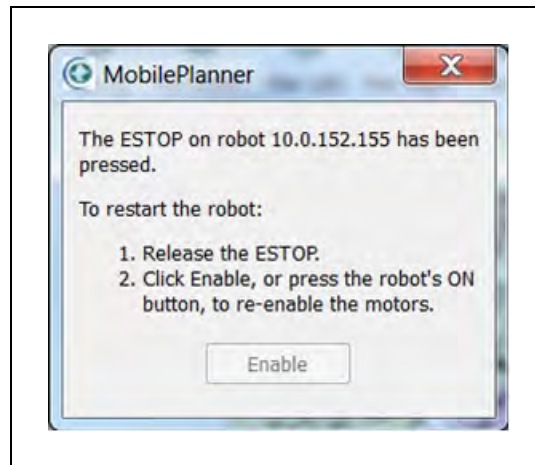
Figure 7-7. Motor Enable Pop-up Dialog

In normal use, the E-Stop button has three primary purposes:

- You need to interrupt or stop the platform for some reason, to keep it from performing its currently scheduled task (and don't have access to MobilePlanner).

- You are working near the platform and don't want it to move.

- You want to use the Brake Release button.

  NOTE: There is a two-second delay between the release of an E-Stop and the platform resuming its activity. During the two seconds, the platform scans its path for potential obstacles, and will resume commanded motion if there is adequate space to maneuver.

ON Button

The ON button restores power after the OFF button was pressed, and the software finishes shutting down the AMR.

It can also be used to restore power after an E-Stop has been released.

OFF Button

The red OFF button removes power from all systems except the charging hardware circuits. The platform's software systems prevent loss of data on shutdown, and save the platform's

last known location so it automatically localizes when it is next powered on.

> **NOTE:** The OFF button can be disabled by the keyswitch, which can be locked and the key removed.

Brake-Release Button

The brake release is used when you need to manually move the AMR.

Releasing the brakes requires battery power and pressing an E-Stop. The brake-release button must be held in for the brakes to remain released.

> **NOTE:** The LD-90x has a high gear ratio, and is very difficult to move, even with the brakes released.

7.5 Other Controls and Indicators

When sold by itself, the platform does not come with a beacon or light tower, which are user-supplied. Factory-supplied payload structures often include a beacon.

Light Discs and Beacon

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

A user-supplied beacon, typically mounted on the AMR payload structure, can provide extra signaling. The beacon indicates movement, and signals an Operator that the AMR is waiting for assistance.

Their states are described here, and summarized in the following tables.

Driving Straight

Blue arcs on each side of the platform will appear to rotate in the direction of the platform's travel, to let nearby people know that it is moving (or about to move). Beacon blinks green.
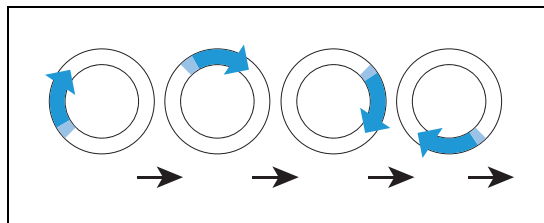
Turn Signal (for turns >30°)

The blue drive indicators will include a blinking orange segment at the front of one light disc to indicate that the platform is about to turn in the direction of the signal.
Beacon blinks green.
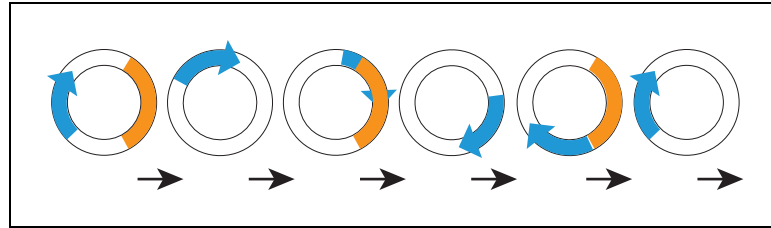
Stopped, no errors (ready)

Entire light disc on each side pulses blue slowly (0.25 Hz). Beacon is steady green.
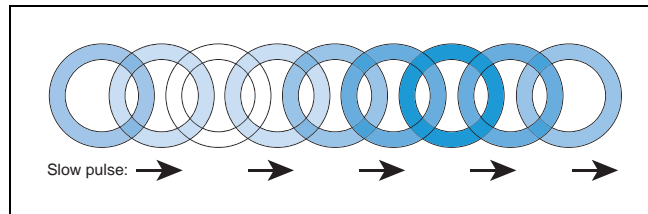
Driving with Warning (doesn't prevent driving, such as low battery)

The light disc will be orange instead of blue for Stopped, Driving, and Turn Signals. Beacon alternates green then yellow.
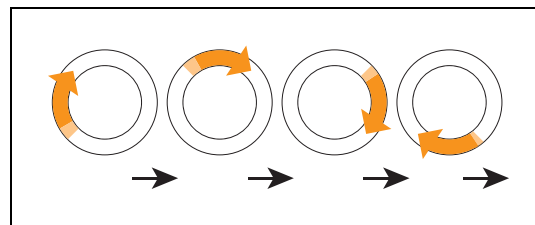
Turn Signal with Warning (doesn't prevent driving, such as low battery)

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.
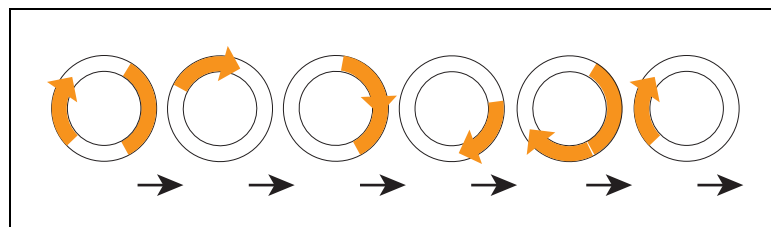
Driving Slowly, E-Stop Inactive

When driving under 300 mm/s, the LD does not generate 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.
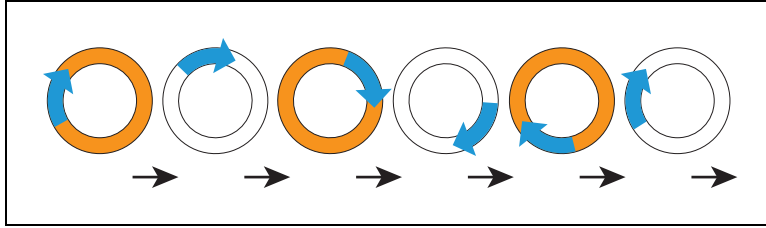
Stopped with Warning (such as low battery)

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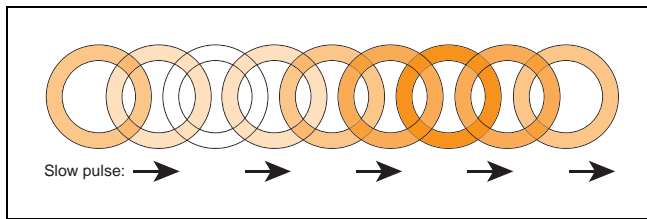
Obstacle Detected

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

> **NOTE:** There is a two-second delay between the end of an obstacle-detection condition and the platform resuming its activity. During the two seconds, the platform scans its path for potential obstacles. It will remain stopped until its path is clear.
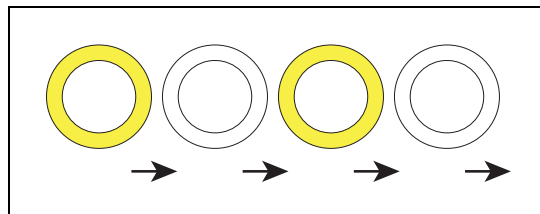
Lost

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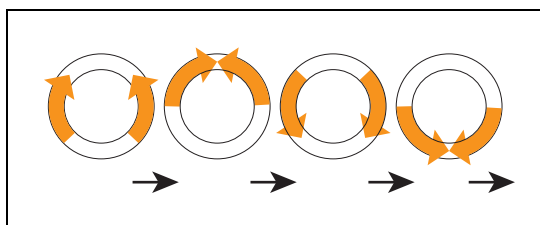
Charging

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. Beacon blinks green (red if E-Stopped).
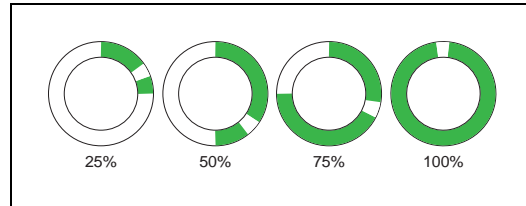
Platform Left Side	Platform Right Side	State of Charge
0 to 90 cw	0 to 270 ccw	25%
0 to 180 cw	0 to 180 ccw	50%
0 to 270 cw	0 to 90 ccw	75%
full circle	full circle	100%

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

E-Stop

The light discs blinks red in an E-Stop condition. Beacon blinks red.
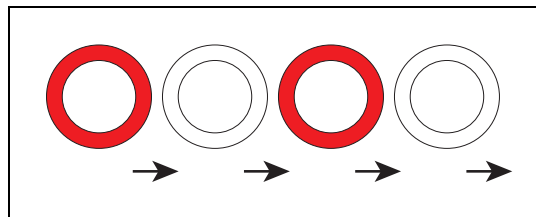
Booting

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. Beacon alternates green, yellow, then red.
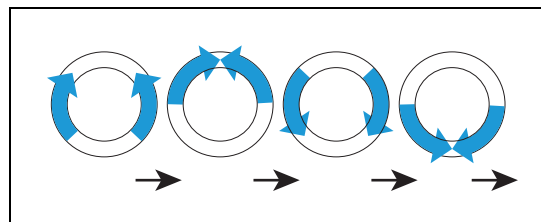
In the following table:

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

Table 7-1. Indicator Meanings

Light Disc		Beacon		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 Platform Core Status Indicators

The left side of the LD Platform OEM Core has 12 indicator LEDs that give a quick visual status on the health of the Core (see inset below). There are also two stickers mounted on the main deck and left side of the LD Platform to provide explanations of the LED meanings.
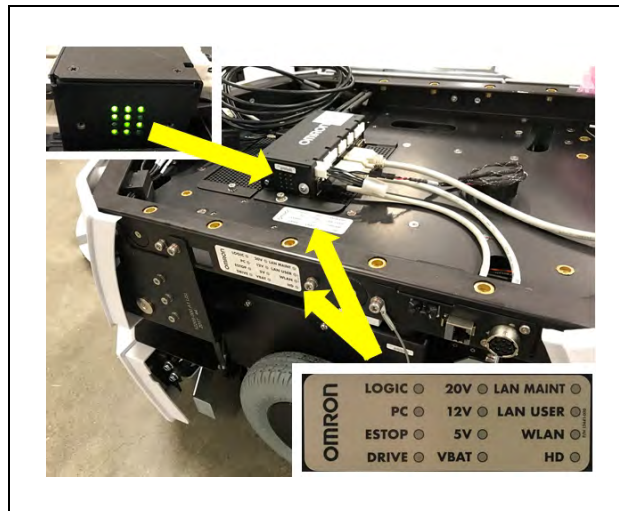
Figure 7-8. LD Platform Core LED Status Indicator Stickers

The following table gives the meanings of the Core's twelve status LEDs:

Indicator	Meaning
Left Column	
LOGIC	The microcontroller has power
PC	The core and the servo controller are communicating
E-STOP	An E-Stop has been 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	Raw battery power is available
Right Column	
LAN MAINT	The Maintenance Ethernet connector is showing activity
LAN USER	The USER LAN connector is showing activity
WLAN	The WiFi is showing activity
HD	The hard drive is showing activity

7.6 Sensors

Lasers

The LD Platform OEM has two on-board lasers for navigation and safety.
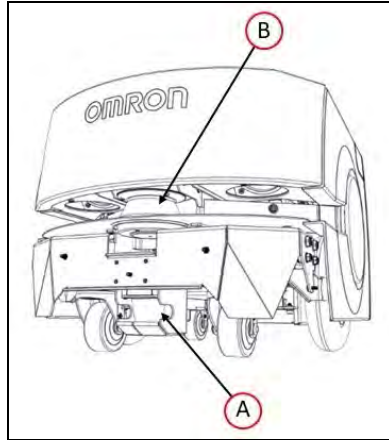
Figure 7-9. LD Platform OEM Lasers (bumper skin removed), (A) Low Front laser, and (B) Safety Scanning Laser

Safety Scanning Laser

The onboard navigation laser is a very precise scanning sensor that provides 500 readings in a 240° field of view, with a typical maximum range of 15 m (50 ft). The laser operates in a single plane, positioned at 200 mm (7.9 inches) above the floor. In most environments, the sensor provides highly-accurate data.

The laser cannot reliably detect glass, mirrors, and other highly-reflective objects. Use caution when operating the platform in areas that have these types of objects. If the platform will need to drive close to these objects, we recommend that you use a combination of markings on the objects (e.g., tape or painted strips), and also use forbidden sectors in the map, so that the platform knows to plan paths safely around these objects.

Low Front Laser

The low front laser, mounted to the front bumper ((A) in the image above), detects obstacles in front of the robot, such as an empty pallet, which might be too low for the safety scanning laser to see.

Sonar

Each sonar pair consists of one emitter and one receiver. The sonar emitters and receivers are identical physically, but the platform uses them differently. The range is up to 5 m (16 ft), though the typical accurate range is only about 2 m (10 ft).

The platform's two rear-facing sonar pairs are for obstacle-sensing while backing up.

The only two times the platform will back up is when docking on the docking station, or when the bumper has hit an obstacle. In the latter case, the platform will back up just enough to freely rotate without touching the obstacle.

Other Sensors

Encoders and Gyroscope

Each wheel has an encoder that tells the navigation system how far the wheel has turned, and in which direction. Each wheel also has a Hall sensor.

The core has an internal gyroscope to track the platform's rotation.

The platform uses a combination of rotation and distance traveled to back up the navigation laser during localization. These limit the area on the platform's map that the platform needs to search.

Bumper

A bumper, with a low-sensing laser, is mounted at the front of the platform, in case the obstacle-avoidance systems fail to detect an obstacle.

You can add optional user (payload structure) bumpers using the User Bumper connector on the rear upper core, in the payload bay. There are six pins for front left, center, and right sensors, and rear right, center, and left sensors. The core provides the connector, but the payload bumpers are user-supplied.

> **NOTE:** The User Bumpers connector is not safety-rated.

7.7 Start up

Procedure

Press and hold the power ON button for half a second, then release. It takes about a minute for all the systems to start up and make their various interconnections. If the platform doesn't start up, try power OFF, check your connections, and then power ON.

Startup is complete when the light discs stop indicating boot (two blue light segments, moving in opposite directions from 6 o'clock to 12 o'clock and back).

By default, the core, navigation laser, and some auxiliary power start automatically when you press ON. To change that behavior, or to assign AUX power to your own accessories, modify their related parameters in MobilePlanner software. You can also control power from a client connected with the core.

Joystick

The joystick plugs into the left side of the platform, under the small access panel at the upper-right corner of the platform. See Location of Parts on the Platform on page 115. This is internally connected to the joystick port located on the rear side of the core in the payload bay.

> **IMPORTANT:** We recommend locking the joystick up when not in use, to prevent an unauthorized person from operating an AMR.
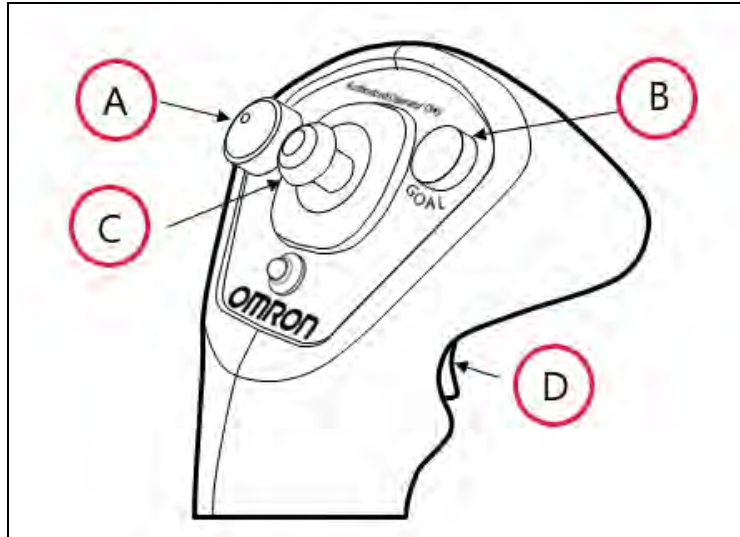
Figure 7-10. Joystick, (A) Speed Control, (B) Goal Button, (C) Directional Control, and (D) Trigger

Joystick Use

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 platform move in that direction. Push the directional control button to the side to make the platform rotate in that direction. Diagonal positions of the directional control button move the platform 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 platform's travel.

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

⚠️ **CAUTION:** PERSONAL INJURY OR PROPERTY DAMAGE RISK
The safety scanning laser is not tied into the E-Stop chain when driving with the joystick. The Operator should maintain control of the joystick and the platform when the joystick is connected to the platform.

Chapter 8: Maintenance

This chapter covers periodic maintenance and user-serviceable parts replacement for the LD Platform OEMs and the docking station. It does not cover maintenance of the payload structure, which is the user's responsibility.
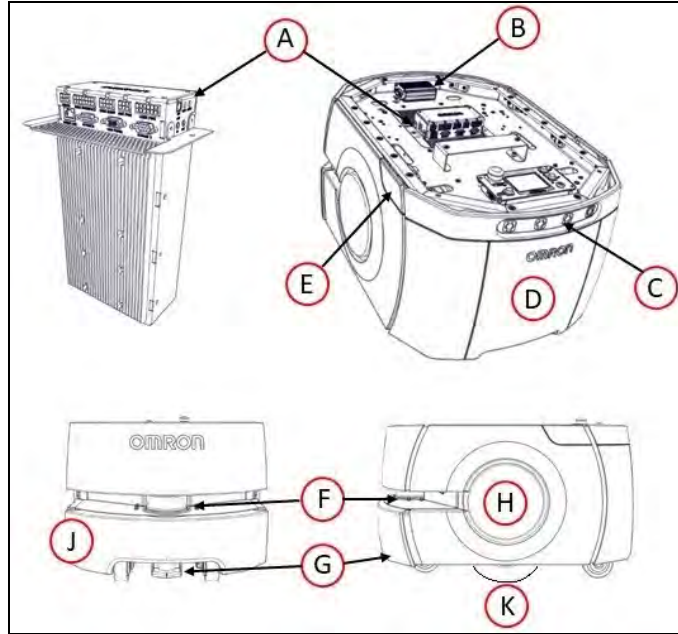
Figure 8-1. Location of Parts on the Platform

Callout	Description	Callout	Description
A	LD Platform Core	F	Safety Scanning Laser
B	Platform Sonar Controller	G	Low Front Laser
C	Rear Sonar X4 (2 pairs transducers)	H	Light Disc x2
D	Battery Door Skin	J	Front Bumper
E	Joystick/Ethernet Access Panel	K	Front Caster x2, Drive Wheel x2, Rear Caster x2

8.1 Safety Aspects While Performing Maintenance

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.

Electrical Hazards

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

- Do not use power extension cords with the docking station unless properly rated.

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

- Immediately disconnect the battery after opening the battery compartment door.

  Avoid shorting the terminals of the battery.

- Do not use any charger not supplied by Omron Adept Technologies, Inc.

- If any liquid is spilled on the AMR, power off the AMR, clean up all possible liquid, and allow the AMR to air dry thoroughly before restoring power.

Burn Hazard

CAUTION: BURN RISK
Parts of the drivetrain can get hot during operation. Allow the platform to cool before servicing.

Pinch Hazard

Platform Skins

CAUTION: PINCH RISK
The skins are held in place with strong magnets, which can pinch you if you are not careful. Follow the instructions in the Maintenance chapter for handling skins.

Magnetic Field Hazards

Platform Skins

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 platform skins, which are held in place with strong magnets.

Docking Funnel

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 under-side of the platform, which is exposed during certain maintenance procedures when the platform is tipped on its side.

8.2 Safety Measures Prior and After Maintenance

Prior to performing maintenance work (safety inspection, cleaning, removing parts, installing parts, etc.), following safety measures must be taken:

- Ensure that the AMR has come to a complete stop, by pressing the E-Stop button on the Operator Panel
- Power OFF the AMR by pressing the OFF button on the Operator Panel

Once maintenance work has completed, and the AMR is ready for use, take following actions:

- Power ON the AMR by pressing the ON button on the Operator Panel
- Release the E-Stop

8.3 Lifting the Platform Safely

If, for any reason, you need to lift the platform by hand, take care to lift from safe lifting points.

CAUTION: PROPERTY DAMAGE RISK
Lifting the platform from the wrong points can damage the platform.

Front Lifting Points

Lift on each side of the laser, under the upper side of the laser slot. Do not lift at the center - there is no supporting frame. Do not lift anywhere else! Refer to the following illustration:
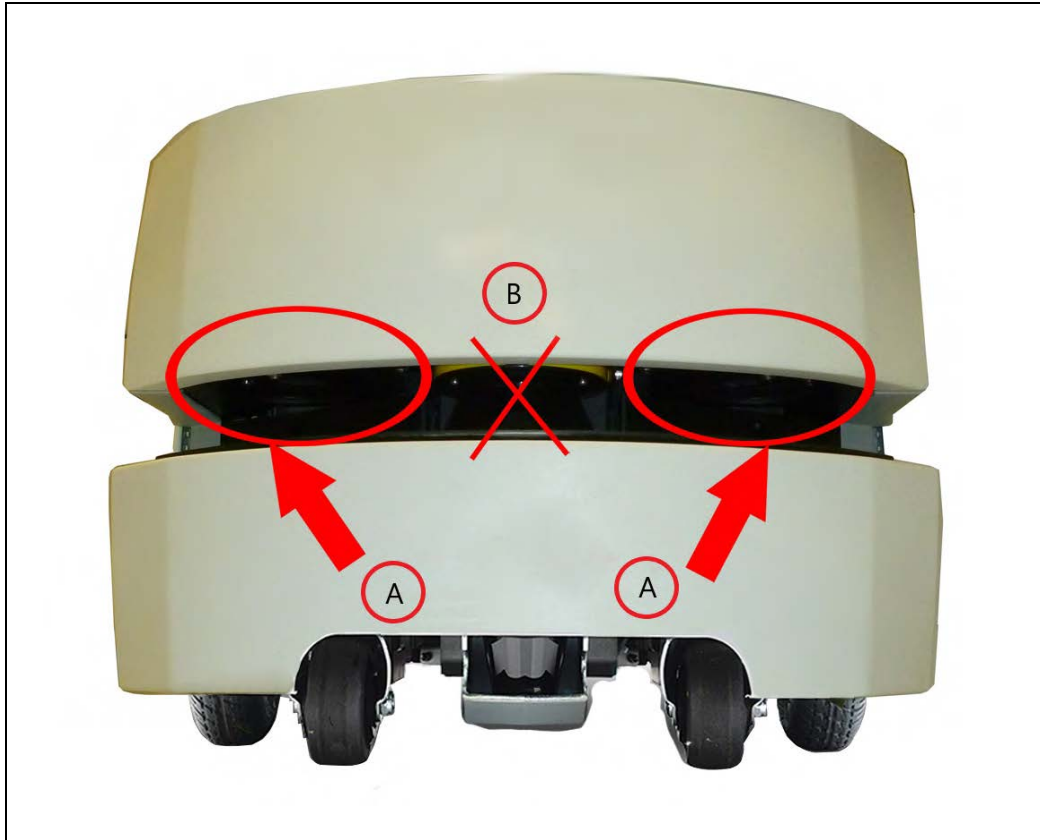
Figure 8-2. The Upper Surface of the Laser Slot. (A) Lift Here Only, and (B) No Lift

Rear Lifting Area

Lift at the center underside of the platform, where the skin has a cutout section. Do not lift anywhere else! Lift from the frame, not the skin. Refer to the following illustration:

Figure 8-3. Bottom of Battery Door Skin. (A) Lift Here

8.4 Safety Inspection

Warning Devices

Do weekly inspections of the following warning devices for proper function.

Flashing Light

Each AMR must have a readily visible flashing light, to serve as a warning whenever the AMR is ready to move or is moving. The exact nature of this light will vary depending on the design of the payload structure.

Light Discs

Every week, check the light discs on each side of the AMR for proper function.

Buzzer

Check the warning buzzer for proper function. To comply with applicable standards, it is important that the buzzer be audible in all operating conditions and environments.

Warning Labels

Check all warning labels on the AMR every week for presence and legibility. Replace any labels that are missing or illegible. The labels, with our part numbers, are:

- Laser Aperture Label, 13308-000L

One of these labels will be on each of these lasers:

  ○ Low Front Laser

  ○ Left and Right Side lasers, if present (option)

- Invisible Laser Aperture Label, 13307-000L
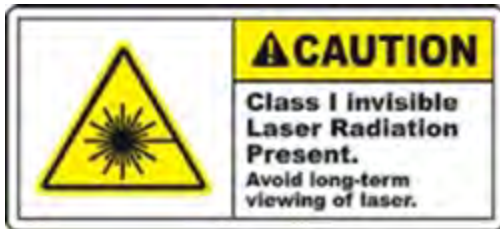
One of these labels will be on the front navigation laser.

- Medical Implant, Magnetic Field Warning Label, 18621-000

  ○ Docking funnel, underside of platform

There is a medical implant label on the underside of the platform, on the docking funnel. This magnet is only exposed during maintenance, when the platform is tipped on its side.

- Yellow circle surrounding the E-Stop button, 11229-167

This is labeled EMERGENCY STOP.

- No Riding Label, 18178-000

Because of variability of payload structures, we can't specify where this label will be. The Setup instructions say to place it in a prominent location on the payload structure. Verify that the label is there and legible.

- Incline Limit Label, 18622-000
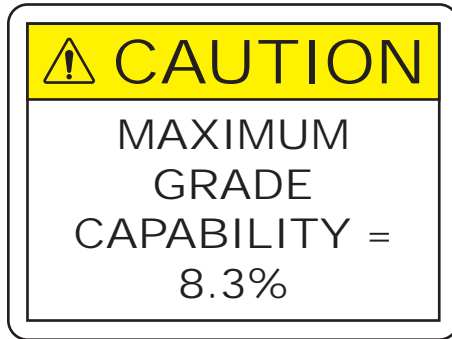
The Incline label is placed on the front-right of the top plate.

- Automatic Vehicle Label, 18623-000
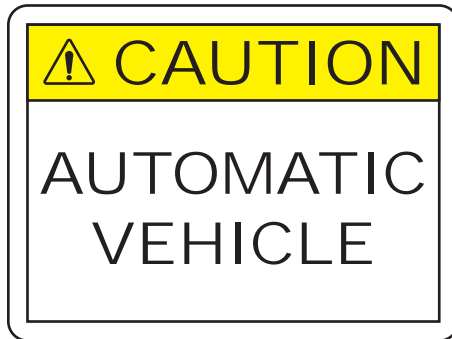
An Automatic Vehicle label is attached to the rear skin of the platform.

8.5 Cleaning

The drive motors and gearboxes are sealed and permanently lubricated, so they do not require periodic maintenance.

Work Area Maintenance

In general, keep the AMR's work area clean and free from clutter that could block it.

Immediately remove anything spilled on the work area floor (e.g., dust, ice, pooled water, etc.) which would interfere with the AMR's ability to drive safely and navigate. Any substance that reduces the AMR's traction with the floor will impair the AMR's ability to drive, stop, turn, and navigate. Pay particular attention to goal locations and commonly traveled paths.

Platform Cleaning

The following table gives a summary of cleaning procedures for the platform.

Table 8-1. Cleaning

Item	Period
Clean docking station contacts	3 months
Clean axles and tires	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 an environment with a lot of dust or dirt will require more frequent cleaning. Use the intervals in this section as guidelines, and modify the schedule as needed.

Tires

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

This applies to both the drive wheels and the casters.

Axles

Keep the axles free of carpet, hair, string, or anything that could wrap around and bind up the platform's drive.

Lasers

Occasionally clean the lenses of the navigation laser and any other lasers used. Use only a soft cloth with alcohol-based, non-abrasive cleaners, and wipe thoroughly.

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 charger's power cord.

Clean the contacts with Isopropyl alcohol.

> **CAUTION:** PROPERTY DAMAGE RISK
> Do not lubricate the docking station paddle, which will reduce its life.

8.6 Maintaining and Replacing Batteries

Maintaining Batteries

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

  If a battery is found to be 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.

> **NOTE:** There are no user-serviceable parts inside the battery case. Do not open it.

> **IMPORTANT:** Replace the battery only with a Omron Adept Technologies, Inc. factory-supplied battery.

Dispose of the battery according to all local and national environmental regulations regarding electronic components.

> **CAUTION:** PROPERTY DAMAGE RISK
> Follow appropriate ESD procedures during the removal/replacement phases.

Removal

⚠ **CAUTION:** PERSONAL INJURY RISK
The battery is heavy (19 kg/42 lbs). Use safe lifting practices when removing or installing the battery.

1. Remove the battery door platform skin.

    a. Pull the bottom of the skin away from the platform chassis.

       This is easiest if you grip it with two hands, toward the center.

    b. Lower the skin down, so its top tab clears the rear outer skin.

2. Unlatch and open the battery compartment door, at the back of the platform.

   The battery compartment door is capable of being locked. You may need to unlock it before opening.

3. Disconnect the power and data cables before removing the battery.

4. Slide the battery back and out of the platform.

   There is a hand grip at the front and the rear of the battery, to help you lift it.

Installation

Refer to Removing and Installing Skins on page 140 for details on removing and installing skins.

1. Remove the battery door skin.

    a. Pull the bottom of the skin away from the platform chassis.

       This is easiest if you grip it with two hands, toward the center.

    b. Lower the skin down enough that its top tab clears the rear skin.

2. Unlatch and open the battery compartment door.

   The battery compartment door is lockable, and you might need to unlock it.

3. Lift and slide the new battery into the platform body.

   The battery weighs 19 kg (42 lbs).

   The battery has recesses at the front and the back for easier lifting.

Figure 8-4. Battery Recesses, for Gripping

A single person can lift and replace the battery. Use one hand in each of the grips, as shown in the following figure.

Figure 8-5. Lifting the Battery

The connectors for power and data go toward the rear of the platform.

4. Attach the battery power and data cables to the connectors at the rear of the battery.
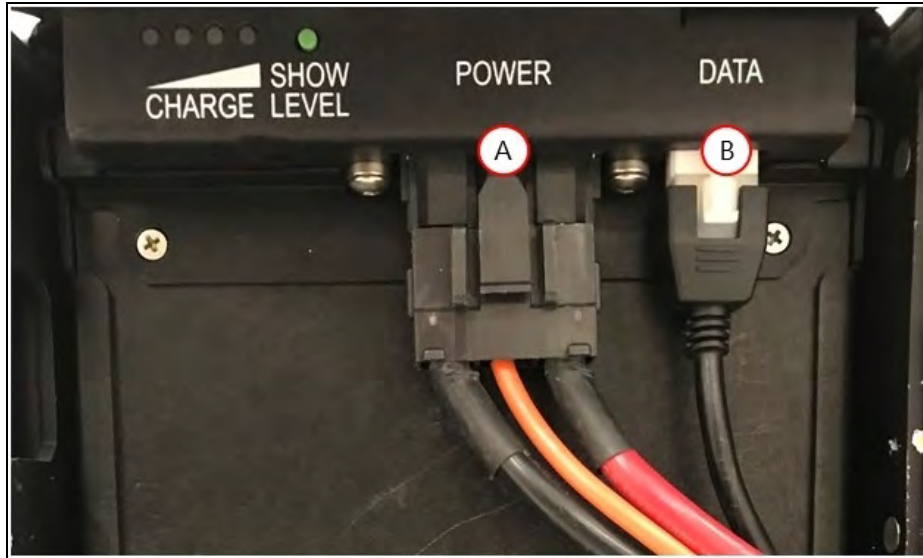
Figure 8-6. Battery Cable Connectors, (A) Power and (B) Data

5. Close the battery compartment door to secure the battery in place.

    Closing the battery compartment door holds the battery tightly in place to keep it from shifting inside the compartment.

6. Reinstall the battery door platform skin.

8.7 Replacing Non-Periodic Parts

Replace the following parts on an as-needed basis.

Docking Station Roller and Bearing

The roller, which guides the AMR onto the docking station, can become worn after extended use. The time to replace the roller should be based on your visual inspection and judgment of when it is too worn. We do not specify a quantitative measure for this.

Refer to the following figure for the location of the roller.

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

A shoulder bolt holds the roller to the docking station.

1. Remove the shoulder bolt from the center of the roller. Retain the shoulder bolt.

2. Remove the roller and bearing from the docking station.

3. Install the new roller and bearing, using the retained shoulder bolt.
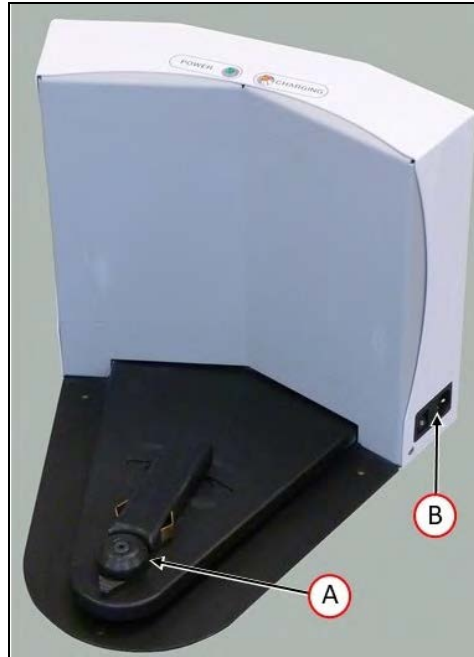
Figure 8-7. (A) Docking Station Roller, and (B) Switch

Docking Station AC Power Fuse

NOTE: The current version of the docking station uses a thermal fuse, built into the power switch. There are no user-serviceable fuses.

NOTE: The following procedure applies only to legacy docking stations.

The only user-serviceable fuses are in the docking station. The two external AC fuses are located between the power switch and the AC power plug.

Symptoms: When the docking station is switched on, the blue power light does not come on. (Verify that the unit is plugged into AC power.)

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

Remove the fuse assembly by squeezing the two tabs toward each other, and pulling it away from the docking station. See the following figure.

Figure 8-8. Docking Station Fuse

The fuses are available from the factory as P/N 02212-000L. Equivalent fuses are available generically. The fuses need to be 250 V, 10 A, and Time-lag. An example of a fuse that meets this is:

LittelFuse 0215010.XP, 5x20 mm cartridge type

Docking Station Internal Fuse

NOTE: The following procedure applies only to legacy docking stations. There are no user-serviceable fuses on the current docking station.

Symptoms: When the docking station is switched on, the blue power light does not come on, but the docking station can charge a battery manually.

WARNING: ELECTROCUTION RISK
Unplug power from the docking station before starting. The docking station cover is NOT interlocked. Remove the power cord at the charger.

1. Remove the ten screws from the back cover of the docking station.

Two of these are on the sides, near the bottom.

Figure 8-9. Docking Station Rear Cover Screws (8 of 10)

Retain the screws for reassembly.

2. Remove the rear cover of the docking station.

3. Locate the in-line fuse.

   It will be near the top of the docking station, just to the right of the central terminal bar.

4. Remove the old fuse, and replace it with a new fuse.

   The fuse is P/N 13091-000.

5. Reinstall the docking station rear cover, and secure with the ten screws previously removed.

Rear Sonar Units

The platform's four rear sonar units can be replaced individually. All four sonar units are identical, although two are used as emitters and two as receivers, in pairs.

1. Remove the inner and outer rear covers from the platform.
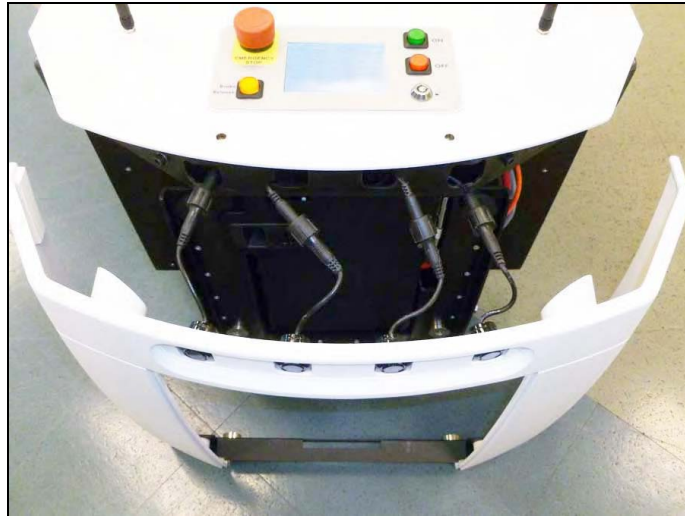
Figure 8-10. Sonar Connectors with Connectors Exposed

2. Unscrew the connection between the sonar cable and the sonar unit's lead.

    Ensure that both the connectors and leads are labeled, and match. If not, label them.

3. Compress the two flat springs holding the sonar unit, and remove it from the cover.

4. Press the new sonar unit through the hole in the rear outer cover, from the outside.

5. Connect the sonar cable to the new sonar unit's lead.

6. Reinstall the rear covers.

Sonar Controller

The sonar controller is located in the payload bay.
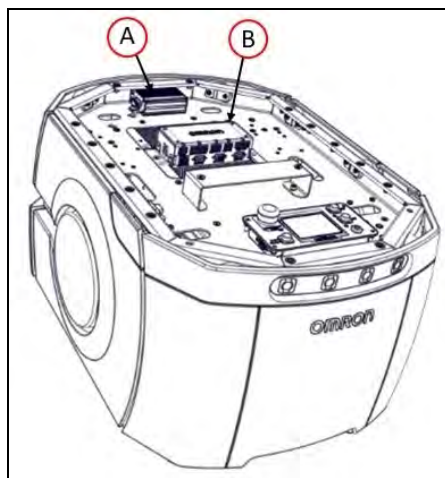
Figure 8-11. (A) Sonar Controller, (B) Core

1. Move the payload structure out of the way, so you have access to the payload bay.

2. Locate the sonar controller.

   The controller is at the front of the payload bay, screwed into the payload bay deck with two screws, and is plugged into the Sonar 1 connector on the core. This connector is not accessible from the payload bay, but does not need to be unplugged for this procedure.

3. Unscrew the controller from the payload bay deck by removing two screws.

   Retain the screws for mounting the replacement controller.

4. Unplug the larger cable from the sonar controller.

   Be careful not to let the cable end slip into the chassis.

5. Unplug the four sonar unit cables from the controller.

   These are the smaller cables that go to the individual sonar units. Make sure these are labeled and tied up, so they can't slip into the chassis.

6. Connect the four sonar unit cables to the new controller.

   Ensure that the cable labels match the controller labels.

7. Plug the larger cable into the new controller.

8. Screw the new controller to the payload bay deck, using the two screws removed from the old controller.

9. Reinstall the payload structure.

10. Dispose of the old controller according to local and national regulations concerning electronic components.

Light Discs

The two light discs and their controllers are single units, so replacing a controller also replaces all of the lights on that side of the platform.

1. Remove the side skin from the side that needs the light disc replaced.

   Refer to Removing and Installing Skins on page 140.

2. Unscrew the four screws holding the light disc PCA to the side skins.

   Retain the screws and round cover for installing the new assembly.

3. Remove the light disc PCA.

4. Screw the new assembly and round cover to the side skin, using the screws from the old assembly. The PCA is keyed so that it can only be installed in one orientation.

5. Reinstall the side skin, connecting the cable to the new light disc PCA.

6. Dispose of the old light disc PCA according to local and national regulations concerning electronic components.

Operator Panel

The Operator panel will typically be located on a user-supplied payload structure, so the removal and replacement of this will vary from one AMR to another. It plugs into the HMI

Panel connector on the core.

Wheels and Tires

The wheels and tires should be checked every 3 months. If they show signs of cracking, excessive wear, or any damage they should be replaced. Refer to the following figure.

Figure 8-12. Samples of Tire Wear

The wheels/tires are not user-serviceable parts. If the tires are worn or cracked, contact your local Omron support.

Drive Assemblies

The platform drive assemblies are field-replaceable. This will replace the drive motor, gearbox, encoder, and wheel/tire assembly.

Removal

1. Remove the inner rear skin.

2. Unlatch and open the battery compartment door, at the back of the platform.

   The battery compartment door is lockable. You may need to unlock it before opening.

3. Disconnect battery power by unplugging the two cables at the rear of the battery.

4. Remove the side skin a small distance from the platform on the side where you want to replace the drive assembly. Refer to Removing and Installing Skins on page 140.

   The light disc PCA cable will still be attached.

5. Disconnect the cable from the light disc PCA, so you can move the side skin completely away from the platform.

This will expose the drive assembly.
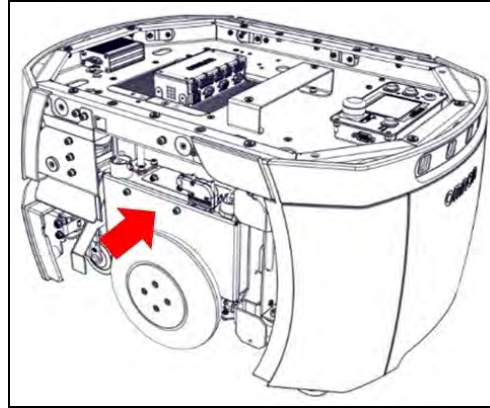
Figure 8-13. LD Drive Assembly (arrow)

6. Lift the drive wheel up, compressing its springs enough so that you can insert a 6-dia. x 10 mm (0.24-dia. x 0.4 inch) pin into the hole on the rear side of the assembly (there is a hole on each side). This will keep the springs compressed (the wheel will be in the up position), and make removal easier. If you saved a wheel pin when you uncrated the platform, you can use that. An M5 x 10 screw also works well for this.
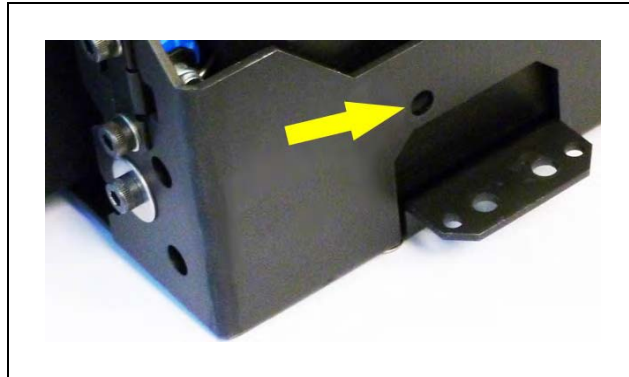
Figure 8-14. Spring-Compression Hole (arrow)

7. The drive assembly is held in place with three nuts on studs across the top, and two sets of two screws at each side, near the bottom of the assembly.

   Remove the three nuts and four screws (and their washers) holding the drive assembly to the platform.

   Retain these nuts, screws, and washers for attaching the new drive assembly.
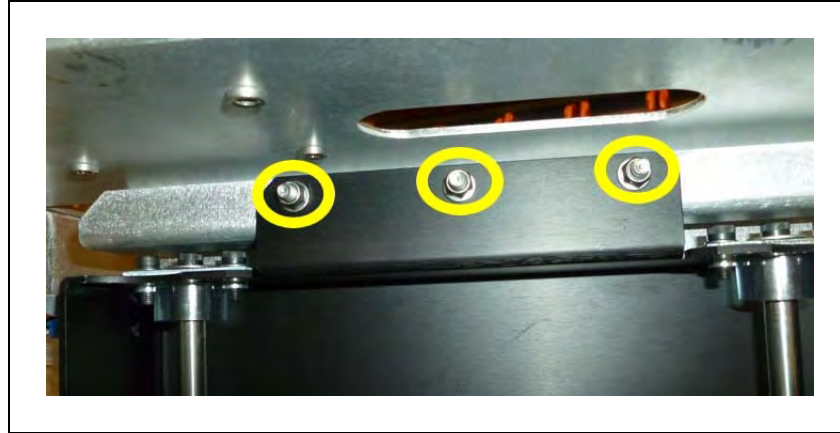
Figure 8-15. Mounting Studs and Nuts at top of Drive Assembly

Figure 8-16. Mounting Screws at Bottom-Right of Drive Assembly

8. Remove the drive assembly from the platform.

   The motor cable to the core will still be attached.

9. Disconnect the motor cable at the drive assembly.

Installation

1. Lift the new drive wheel up, compressing its springs, enough so that you can insert a 6-dia. x 10 mm (0.24-dia. x 0.4 inch) pin into the hole on the rear side of the assembly (there is a hole on each side).

   This will keep the springs compressed (the wheel will be in the up position), and make installation easier.

   If you saved a wheel pin when you uncrated the platform, you can use that. An M5 x 10 screw also works well for this. See Spring-Compression Hole (arrow) on page 133.

> **NOTE:** Make sure that the pin is short enough that you can pull it out after the assembly is in place.

2. Connect the motor cable to the new drive assembly.

3. Install the new drive assembly over the three studs at the top of its bracket.

   Use the nuts, screws, and washers you removed from the old drive assembly.

4. Remove the pin or screw you used to hold the wheel in the up position.

5. Put the side skin next to the platform, and attach the cable to the light disc PCA.

6. Reinstall the side skin.

7. Connect the battery power and data cables, and close the battery compartment door.

8. Reinstall the rear skin.

Front or Rear Casters

Check the casters every 3 months, and replace them if they show signs of cracking, excessive wear, or any damage.

All four casters are identical, and are mounted to the platform in the same way.

> **NOTE:** If you can lift the platform enough to access the screw that holds on the caster, you can avoid removing the payload structure and the battery, which is only necessary to tilt the platform on its side.

1. Move the payload structure out of the way.

   If the payload structure can be completely removed, do so. This enables you to tip the AMR on its side, so you have access to the casters underneath.

2. Remove the inner rear skin.

3. Unlatch and open the battery door skin, at the back of the platform.

   The battery compartment door is lockable. You may need to unlock it before opening.

4. Disconnect the battery by unplugging the two cables at the rear of the battery.

5. Remove the battery from the platform.

6. Remove the side skins.

7. Lay the body of the platform on its side, exposing the casters.

> **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 platform, which is exposed during certain maintenance procedures when the platform is tipped on its side.

Regardless of whether you removed the battery:

1. Remove the M10 x 30 mm screw holding the caster to the platform.

    The screw was installed with Loctite 263.

    Retain the screw for attaching the new caster.
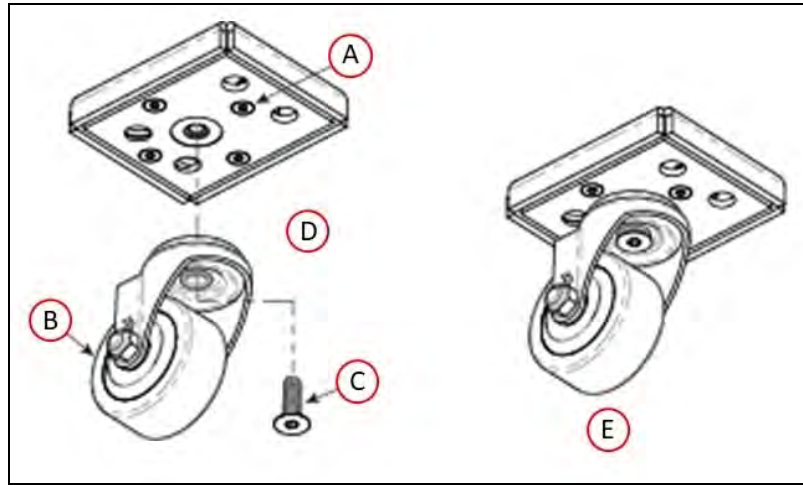
Figure 8-17. Platform Caster Replacement

Callout	Description
A	(4) M6 x 22 Screw, Flat Head Socket
B	Caster, Heavy Duty, with Bolt Hole Fitting
C	M10 x 30 mm Screw, Flat Head Socket
D	Use Locktite 263 on the M10 x 30 Screw
E	Completed Assembly

2. Remove the caster from the platform.

3. Put the new caster in place, and attach with the M10 x 30 mm screw you removed from the old caster.

    Use Loctite 263.

    Torque to 27 N·m (20 ft·lb$_f$).

If you removed the battery for this procedure:

1. Return the platform to its upright position.

2. Reinstall the battery, connect the power and data cables, and close the battery compartment door.

3. Reinstall the battery door skin.

4. Reinstall the side skins.

Cleaning Casters on ESD Platforms

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

CAUTION: PERSONAL INJURY OR PROPERTY DAMAGE RISK
This procedure requires placing the platform on its side. Unless you can do this safely with the payload attached, you will need to remove the payload.

You will need the following tools:

- Gloves

- Wipes

- Isopropyl Alcohol

- Protective, supporting material on which to rest the platform (e.g., foam)

1. Remove the payload structure, if necessary.

2. Remove the right and left side skins, and set them aside.

3. Lift and pin the drive assemblies to more easily maneuver the platform. This puts entire robot weight on casters.

4. Place the protective, supporting material on the right side of the platform. Using the right side prevents possible damage to the maintenance access panel.

5. Carefully tilt the platform onto its right side onto the protective, supporting material.

6. Use a wipe wetted with Isopropyl Alcohol to thoroughly clean the casters.

7. After cleaning all casters, carefully tilt the platform upright.

8. Un-pin and lower the drive assemblies.

9. Re-install the payload structure if it was removed.

10. Re-install the two side skins you removed earlier.

11. Clean the side skins if needed.

Safety Scanning Laser

The Safety Scanning Laser is not user-serviceable. If it needs to be replaced, contact your local Omron Support.

LD Platform Core

The LD Platform core is an enclosed unit, with internal fans as the only moving parts.

1. Move the payload structure out of the way, so you can access the payload bay.

2. Remove the battery door skin.

3. Unlatch and open the battery compartment door, at the rear of the platform.

   The battery compartment door can be locked. You may need to unlock it.

4. Disconnect the battery power and data cables from the rear of the battery.

5. Disconnect all of the cables attached to the top portion of the core.

   Refer to Payload Bay Connections - Core on page 73.

6. Remove the core mounting bracket from around the core.

   The bracket is two pieces, held in place with four screws down into the chassis, with four more going sideways into the core itself. Retain all of these screws for installing the new core. See the following figure:
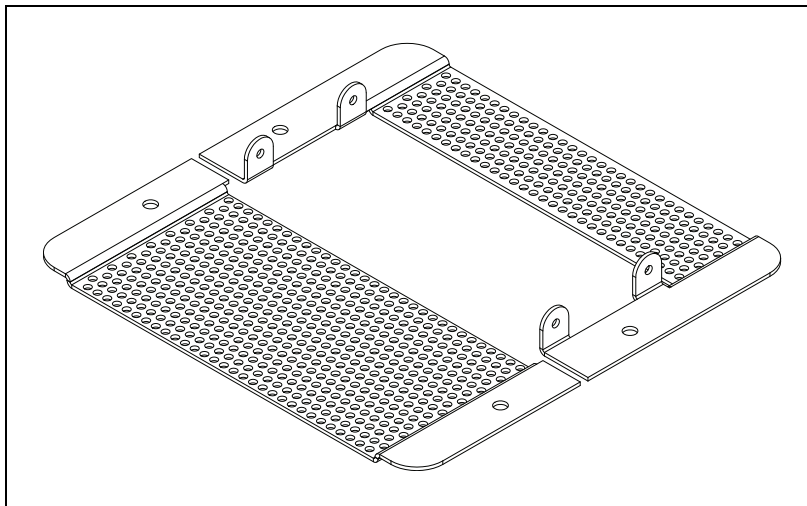
Figure 8-18. Core Mounting Bracket

7. Remove the Sonar 1 cable from the core.

   This cable is too short to allow the core to be lifted until the cable is removed.

8. Gently lift the core up, until you have access to the internal connections.

9. Remove all of the cables that are attached to the internal core connector panel.

   The Left Motor and Right Motor connectors use the same type of plug, and can be inadvertently reversed. Ensure that you can clearly identify the left from the right.

   See Internal LD Platform Core Connections on page 90.

10. Remove the old core.

11. Connect all of the cables that were attached to the internal core connector panel to the new core internal connector panel. See Internal LD Platform Core Connections on page 90.

    Wait until after the next step to reconnect the Sonar 1 cable.

12. Put the core into the chassis.

13. Connect the Sonar 1 cable to the core.

14. Install the core mounting brackets around the new core.

    Using the screws and washers you removed from the old core, put four screws into the sides of the core, with four more going down into the platform chassis.

15. Reconnect all of the cables to the top portion of the core.

    Refer to Payload Bay Connections - Core on page 73.

16. Reconnect the battery power and data cables to the battery.

17. Close and latch the battery compartment door.

18. Reinstall the inner rear skin.

19. Reinstall the payload structure.

20. Dispose of the old core according to local and national regulations concerning electronic components.

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 redo the E-Stop Commissioning and the Safety Laser Commissioning procedures under the following circumstances:

- If you replace the core.

- If the hardware detects a failure, the AMR may automatically decommission itself. If this happens, ARAM will display a fault pop-up in MobilePlanner.

- If you are using a user-supplied E-Stop.

- If you want to perform the commissioning procedures on a regular basis as part of their preventive maintenance process.

    NOTE: After performing either of these tests, you can access the other test by clicking **Next Test** on the final screen.

E-Stop Commissioning

This procedure verifies that pressing the E-Stop button triggers the E-Stop circuitry. This is verified by ensuring that you hear the brakes activate after pressing the E-Stop button.

1. Ensure that the E-Stop button is NOT depressed before starting.

2. In MobilePlanner software, select:

    Main Menu > Robot > Safety Commissioning

3. Follow the on-screen instructions to complete the test. You can print a certificate after successfully completing the commissioning.

Safety Laser Commissioning

This procedure verifies that the navigation laser reports speed zone information correctly, and the E-Stop circuitry trips when an obstacle that the laser should detect is placed in front of the AMR. The speed zones are listed in the table that follows. For the LD-60, each speed zone rep-

resents 300 mm/s, so if the maximum speed is 1500, five zones should be reported. (When you press the Drive button in the wizard, the wizard will display the maximum AMR speed.)

	Maximum Speed (mm/s)		
Zone	LD-60	LD-90 LD-105CT	LD-130CT
0	300	225	150
1	600	450	300
2	900	675	450
3	1200	900	600
4	1500	1125	750
5	1800	1350	900
6	1800	1350	900
7	1800	1350	900

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.

Accessing the Payload Bay

Access to the payload bay depends on the design of your payload structure. A small, light payload structure may be easily disconnected and simply lifted off, taking care not to damage any of the wires connected to the platform.

A taller or heavier payload structure may have hinges, so that it can be tilted off of the platform after being mechanically disconnected. For most payload structures, this will enable a single technician to access the payload bay without assistance. Use care when accessing the payload bay, that the wires and connections between the platform and the payload structure are not disturbed when the payload structure is tilted.

Removing and Installing Skins

Most of the maintenance procedures require removing some of the platform's skins, most of which use strong magnets to hold them in place. The rear skin has an additional brace for support, the front bumper uses screws and magnets, and the access panel uses a push-push latch.

CAUTION: PINCH RISK
The magnets holding the skins in place are strong enough to pinch.

Additional Information: In general, it is better to install the payload structure before installing the skins.
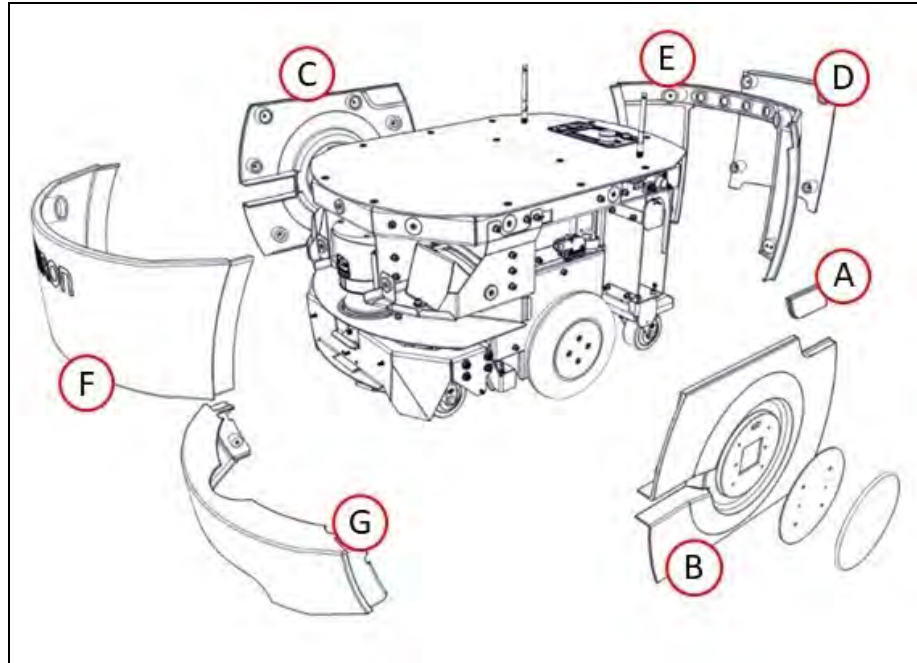
Figure 8-19. LD Platform OEM Skins

Callout	Description
A	Access Panel - covers the maintenance Ethernet port and joystick connector.
B	Left side skin - covers the LD left drive train.
C	Right side skin - covers the LD right drive train. **NOTE:** Both side skins hold a light disc and cover.
D	Battery door skin - covers the battery access door.
E	Rear skin - covers the LD rear components, and houses the sonar transducer pairs.
F	Front upper skin - Above the safety scanning laser and speakers.
G	Bumper - Above the lower bumper assembly and low front laser.

With the exception of the bumper, no tools are needed for either the removal or installation of the platform's skins.

Removing Skins

> **NOTE:** After removing skins, place them inner-side down, so the outer surfaces don't get scratched.

You can remove the skins in the order in which they are listed above.

- Remove the battery door skin before removing the rear skin and side skins.

- The front upper must wait for the two side skins.

- You can remove the two side skins, rear skin, and bumper without removing any other skins (note that you must remove the access panel before removing the left skin).

  > **NOTE:** The light disc covers are not covered here because they are only removed from the side skins to replace one of the light disc controllers.

Battery Door Skin

This provides access to the battery compartment door.

1. Pull the bottom of the skin away from the platform chassis.

   This is easiest if you grip it with two hands, toward the center.

2. Lower the skin down, so its top tab clears the rear skin.

Access Panel

This provides access to the Maintenance Ethernet and the Joystick ports.

1. Push the left (front) side of the panel in, until the latch releases it.

   Pushing the panel a second time will reattach it to the platform.

2. Pull the left side out, and slide the panel to the left.

   The panel is attached with a lanyard.

You will need to place this panel out of the way when removing the left side skin.

Side Skins

1. For the left side skin, put the access panel out of the way.

2. Pull the bottom of the skin, near both sides, away from the chassis.

3. Work your way up the edges of the skin, pulling it away from the chassis as you go.

4. Remove the skin a few inches from the chassis.

   The light disc wires plug into connectors on the inside of each side skin.

5. Unplug the light disc connector, and move the side skin away from the platform.

Repeat for the other side skin.

Front Upper Skin

This skin attaches to the chassis the most tightly of any of the skins.

1. Grip the skin at the two outer edges.

2. Pry the skin away from the chassis.

Bumper Skin

This is the only skin that requires tools to remove.

1. Remove the screws at the sides of the skin.

   Retain the screws for installing the new bumper skin.

2. Unscrew the retaining screws, then pull the skin off of the bumper.

Rear Skin

This skin houses the two rear sonar pairs, which you will disconnect once the skin is part-way off the chassis. Each pair consists of one emitter and one receiver.

1. Pull the top of the skin away from the chassis a few inches.

   The skin will pivot on the metal brace at its bottom edge.

2. Pull the four sonar wires, with their connectors, out of the chassis holes.

   Refer to the following two figures.

Figure 8-20. Sonar Leads, with Connectors Still in Chassis

3. Unscrew all four sonar connectors.

   Ensure that both sides of all connectors are labeled, and match. If not, label them.
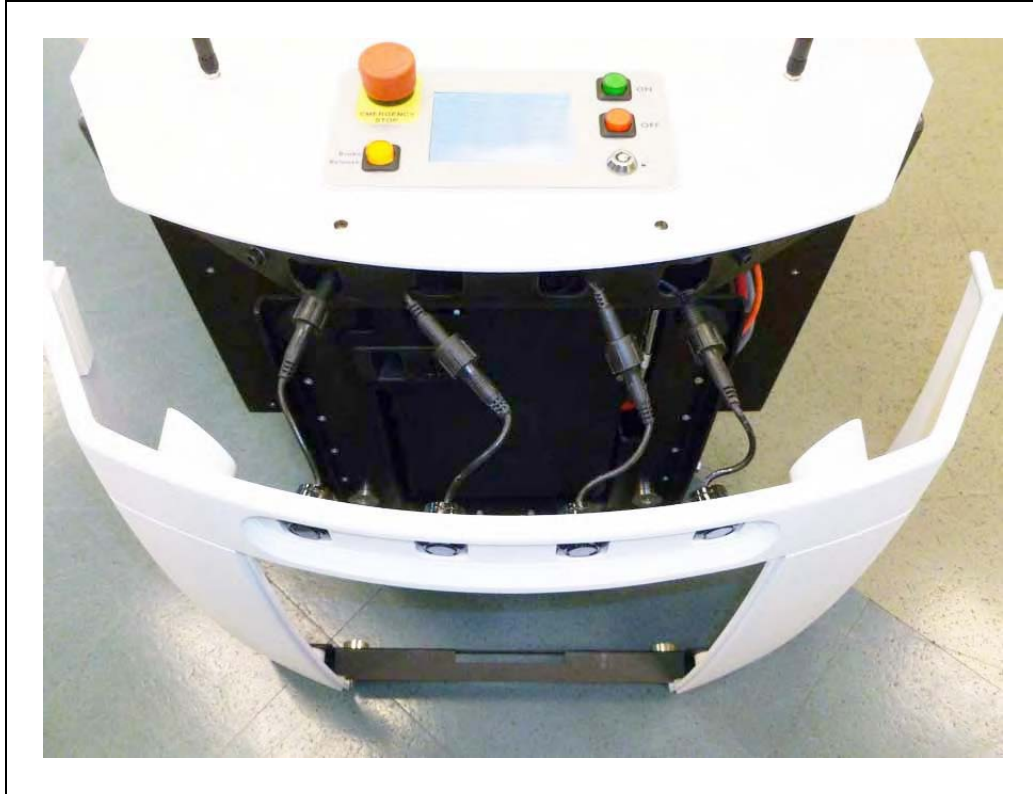
Figure 8-21. Sonar Connectors, with Connectors Exposed

4. Tilt the skin down to about 45°, and slide the brace on the bottom of the skin out of its clip.

   This will separate two pairs of magnets, so you will feel some resistance at first.

Installing Skins

Install the skins in the reverse of the order in which they are listed above.

- You must install the front upper and rear outer skins first and second.

- The access panel must wait for the left side skin.

Bumper Skin

This is the only skin that requires tools to install.

1. Place the skin on the bumper (held on with magnets and screws).

2. Install the screws (removed during the skin removal) at the sides of the skin.

Front Upper Skin

1. Grip the skin at the two outer edges.

2. Align the bottom edge of the skin so it slides under the chassis support.

3. Tilt the top of the skin into position.

Rear Skin

Because this skin houses the rear sonar units, you must reconnect them once the metal brace across the bottom is in the clip just below the battery access hole.

1. Slide the metal brace into the chassis clip.

   Watch the two magnets on the bottom of the skin and align them with the magnets on the chassis. This is your best guide for getting this skin in its proper place.

   These are inboard of the clip holding the brace, so you will have to look on each side of the skin to check their alignment.

2. After aligning the magnets at the bottom, tilt the skin up to within a few inches of the chassis.

3. Pull the sonar connectors out of the chassis (if not already out).

4. Screw the four sonar connectors to their corresponding sonar leads.

   Ensure that the labels for the connectors and leads match.

5. Tuck the connectors into the four holes in the chassis, until just an inch of sonar lead is sticking out.

6. Tilt the top of the skin up to meet the chassis.

Side Skins

1. Move the skin to within a few inches of the chassis, and plug in the light disc connector.

   Connect the light disc to the fitting on the inside of the side skin.

2. Place the top edge of the skin on the chassis, so the magnets hold it there.

   Make sure the gaps on each side of the skin are the same width.

3. Tilt the bottom edge of the skin down.

4. Check each side of the skin to ensure that the skin edges on each side of the gap stick out the same amount away from the chassis.

   This is most likely to be uneven near the top of the skin.

5. If either edge sticks out more than the neighboring skin, pull the neighboring skin away from the side skin slightly, and release.

   This should allow the side skin to snap into place, so both sides of the gap stick out the same amount.

Repeat for the other side skin.

Figure 8-22. Right Side Skin, Showing Even Gaps at Edges

> **NOTE:** The gaps between the side skins and the bumper will be smaller than the other gaps, and will not be even.

Access Panel

1. Slide the panel to the right, so its tab goes under the left side skin.

   A lanyard attaches the panel to the skin to prevent getting lost.

2. Press the left (front) side of the panel in, and the latch will hold it.

   This is a toggle latch - pressing it once engages it, pressing it a second time releases it.

Battery Door Skin

1. Slide the skin up, so its top tab fits under the rear skin.

   ⚠️ **CAUTION:** PINCH RISK
   This skin is the most likely to pinch you if you are not careful, particularly at its bottom edge. Hold the skin at the bottom, in the center, with two hands.

2. Hold the skin near the center and, with both hands, tilt the bottom of the skin down, towards the platform chassis.

Chapter 9: Options

There are a number of options available for the LD Platform OEMs to enhance their performance and abilities.

9.1 Enterprise Manager, for Multi-AMR Coordination

This is a network appliance, and the Mobile Software suite which runs on it.

It prevents traffic problems between different AMRs in a fleet, and ensures completion of all jobs submitted to its queue. This is covered in the *Enterprise Manager user's guide*.

9.2 Joystick

This is mainly used to manually drive the platform when doing a scan, in preparation for making a map of the workspace. You need at least one joystick for each fleet of AMRs. Once a map is generated, it can be shared with multiple AMRs working in the same space.

9.3 Spare Battery

You need at least one spare battery if you opt to swap the AMR's battery, rather than having it charge itself at a docking station. See Manually Charging the Battery on page 101.

9.4 Payload Structure Bumpers

This is in addition to the standard front bumper on the platform. Up to one front and one rear user-supplied bumpers are supported, each with left, right and center sensors.

> **NOTE:** The User Bumpers connector is not safety-rated.

9.5 Call Buttons/Door Boxes

Call buttons issue a request for an AMR to go to the goal associated with the button. There may be multiple call buttons, even in an installation where there is only one AMR.

Door Boxes are used to open an automated door, so the AMR can pass through. See *LD Platform Peripherals User's Guide*.

9.6 Acuity Localization

Acuity localization uses an upward-facing camera to localize the platform by imaging overhead lights, which it compares with lights stored in its map.
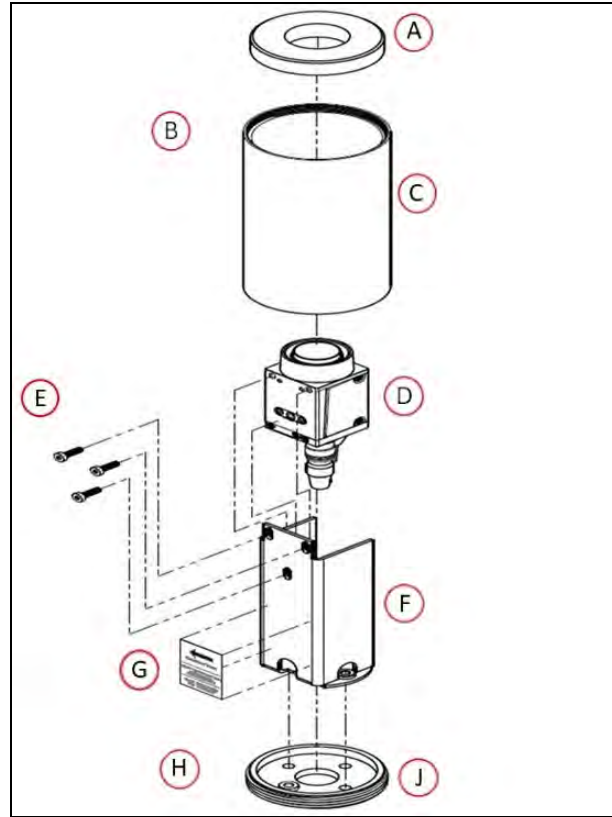
Figure 9-1. Acuity Parts

Callout	Description	Callout	Description
A	Foam Dust Seal	F	Bracket
B	NOTE: Top ND filter not shown.	G	Direction of Travel label
C	Tube	H	M4 x 12 screws go up through base
D	Camera	J	Base
E	Camera mounting screws		

This can be used in circumstances where laser localization is difficult, either because the environment has too many changing features or simply not enough features for laser localization.

If there are many objects, such as pallets or carts, which change location frequently, they may not be on the platform's map, and may also block the laser's view of features that are on the map. In such cases, Acuity localization may be a better choice than using the safety scanning laser for localization.

9.7 Touchscreen

The Touchscreen is a full-color touch-sensitive screen for displaying information to the Operator, as well as receiving input from the Operator. It is covered in detail in the *LD Platform*

Peripherals User's Guide.

9.8 Side-Mount Lasers

This is an option for payload structure development. The two lasers mount on the sides of the payload structure to detect obstacles that protrude into the AMR's path, but may not be detected by the navigation laser.

This is useful when the payload structure is tall enough that it might run into obstacles not detected by the navigation laser.

> **NOTE:** Side-Mount lasers are standard with the Cart Transporter.

The optional side lasers connect to the RS-232 Aux Sensors connector on the core.

9.9 High-Accuracy Positioning System (HAPS)

This system uses magnetic tape applied to the floor, which the AMR's HAPS sensor detects. This allows an AMR to very accurately align itself at a specific location, such as a fixed conveyor.

9.10 Electrostatic Discharge (ESD) Skins

The bumpers and skins of a non-ESD AMR can accumulate an electrical charge which, if discharged into ESD sensitive components, could damage those components.

The optional ESD skins (P/N: 18452-001) encase the AMR in an electro-conductive surface that provides a skin-to-chassis-to-wheel grounding path that drains off any charge the AMR might accumulate during operation.

Figure 9-2. LD Platform OEM with ESD Skins

Chapter 10: Technical Specifications

10.1 Dimension Drawings
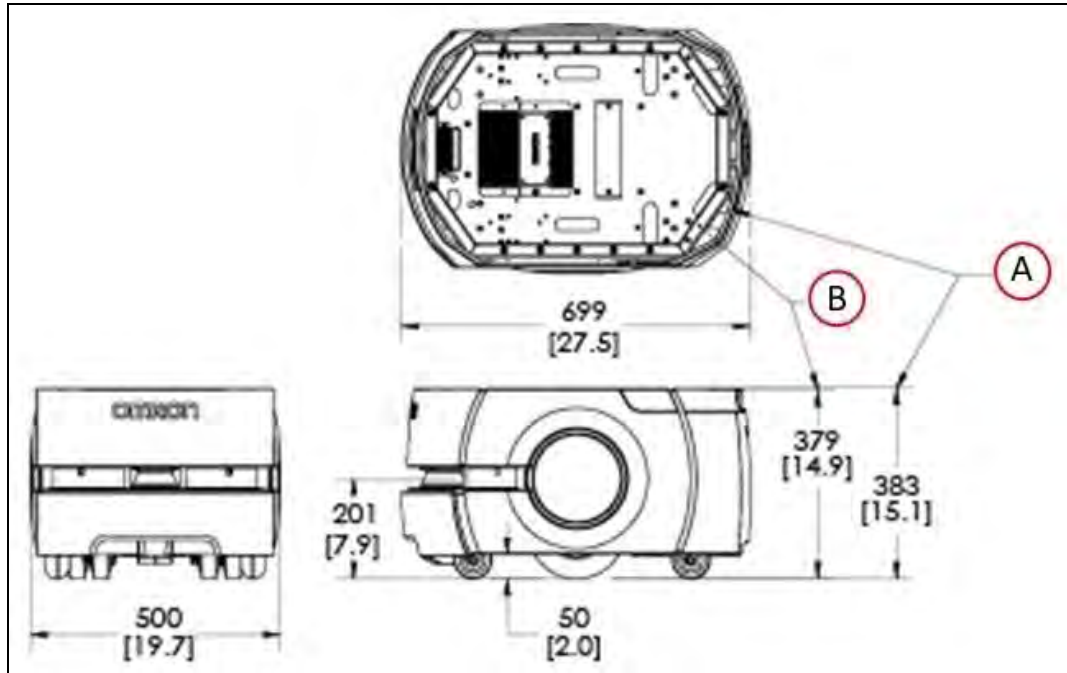
Figure 10-1. Platform Top, Side, and Front Dimensions Showing, (A) Top of Covers, and (B) Mounting Surface (units are in mm [inches])

NOTE: Refer also to Figure 5-2. and Figure 5-3. for mounting hole dimensions for the payload structure.
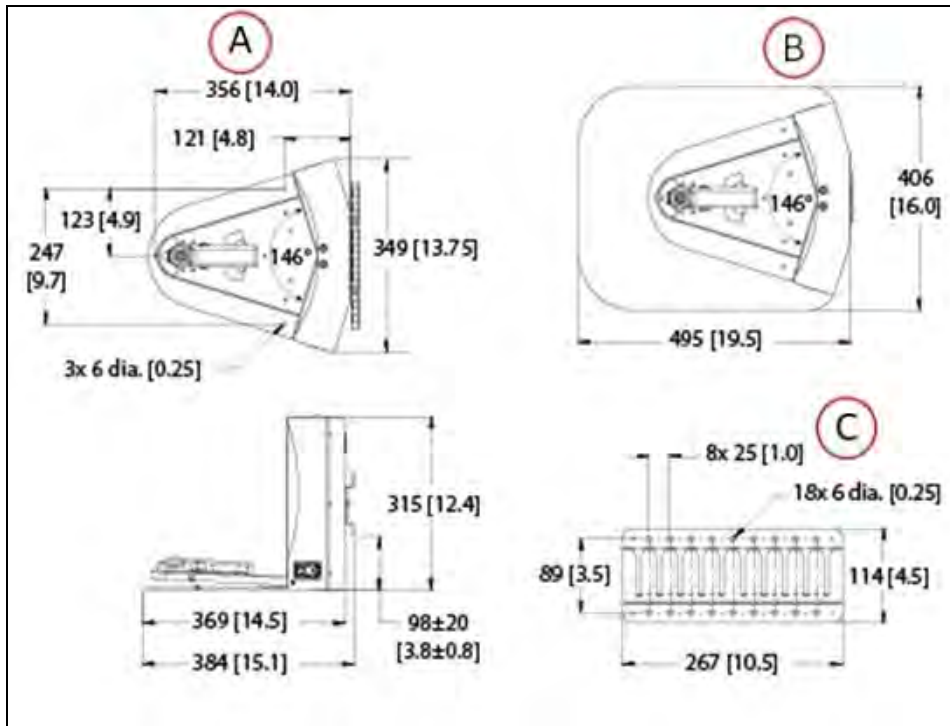
Figure 10-2. Docking Station Dimensions for, (A) Wall/Floor Mounts, (B) Free Standing, and (C) Wall Mount Bracket (units are in mm [inches])

10.2 Platform Specifications

Physical

Description	Specification
Length	699 mm (27.5 inches)
Width	500 mm (19.7 inches)
Height (body)	383 mm (15.1 inches)
Body clearance	50 mm (2.0 inches)
Weight (with battery)	62 kg (137 lb)
Rating	
IP Rating	IP20
Cleanroom rating	Fed Class 100, ISO Class 5
Joystick IP rating	IP56

Description	Specification
Drive Train	
Drive wheels	2 grey non-marking foam-filled rubber
Wheel dimensions	200 x 50 mm (7.9 x 2.0 inches) nominal
Passive Casters	2 front, 2 rear, spring-loaded
Caster diameter	75 mm (3 inches) nominal
Brakes	2 (one each axle)
Steering	Differential

Performance

Description	Specification
Performance	
Max payload – level	LD-60: 60 kg (132 lb) LD-90: 90 kg (198 lb)
Swing radius	343 mm (13.5 inches)
Turn radius	0 mm
Translational speed, max	LD-60: 1800 mm/s (70.9 inches/s) LD-90: 1350 mm/s (53.1 inches/s)
Rotational speed, max	LD-60: 180°/s LD-90: 180°/s
Stop position repeatability	±100 mm for position, ±2° for rotation
-with the HAPS option	±10 mm for position, ±0.5° for rotation
Traversable step, max	LD-60: 15 mm (0.6 inch) LD-90: 10 mm (0.4 inch)
NOTE: A speed of 250 -300 mm/s for the LD-60 and 250 mm/s for the LD-90 is required for these steps. Faster or frequent driving over such steps or gaps will shorten the lifespan of the drivetrain components. Lower speeds may not traverse the step. Steps should have smooth, rounded profiles.	
Traversable gap, max	LD-60 and LD-90: 15 mm (0.6 inch)
Climb grade, 60 kg max	1:12
Traversable terrain	Generally wheelchair accessible
Minimum floor flatness	F_F25 (based on the ACI 117 standard)
NOTE: ACI 117 is the American Concrete Institute's standard for concrete floors. F_F is flatness, F_L is the level. Higher F_F numbers represent flatter floors. F_F 25 is a fairly lenient specification.	

Description	Specification
Battery	
Run-time	15 hours, approx., no payload
Duty cycle	80%
Weight	19 kg (42 lb)
Voltage	22 to 30 VDC
Capacity	72 Ah
Energy	1.84 kWh nominal
Recharge time	4 hours, approx.
Life span	Approximately 2000 Cycles

Sensors

Description	Specification
Sensors	
Safety Scanning Laser	1 at front of platform 200 mm (7.9 inches) above floor 240°, 15 m range, Class 1, eye-safe PLd Safety per ISO-13849
Sonar Pairs (Each pair is one emitter and one receiver, working together)	2 at rear of platform, 2 m range
Position encoders	2 encoders (one each wheel) 2 Hall sensors (one each wheel)
Analog gyroscope (Core)	320°/s max rotation
Bumper	1 at front of platform
Side Lasers (option)	2 on sides of payload structure, user-mounted
Low Front Laser	1 in bumper
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)

Battery Outputs

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.				

10.3 Docking Station Specifications

Description	Specification
Current	8 A Thermal fuse in AC power switch (10 A Time-lag fuse at switch for legacy dock)
Contacts	2
Voltage	100-240 VAC, 50/60 Hz
Power consumption	800 W
Short circuit current rating (SCCR)	1500 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 - yellow
Connector	For out-of-platform battery charging

Chapter 11: Glossary

This glossary contains terms found in this manual, as well as general terms associated with robotics.

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.
A/V	Audio/Visual
absolute encoder	A type of encoder that outputs the position of a motor, relative to an absolute reference point.
ACE	Automation Control Environment. A PC-based software package that contains a collection of tools for configuring, programming, controlling, and monitoring Omron Adept Technologies, Inc. (OAT) equipment in a workcell. These tools are accessed through the ACE graphical user interface (GUI), which provides a user friendly, point-and-click environment.
ACE PackXpert	An extension of ACE software that provides a point-and-click interface for configuring and programming robot systems specifically for packaging applications.
Acuity	A mobile robot localization system using an upward-facing camera to detect overhead lights instead of using its laser.
Adept Cycle	A continuous path, straight-line motion cycle in which the robot tool moves up 25 mm, over 305 mm (for standard cycle) or over 700 mm (for extended cycle), down 25 mm, and back along the same path.
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.
amplifier	The component that provides the power needed to drive the fixed robot motors. In iCS-ECAT and eCS-ECAT components, this is combined with the controllers.
AnyFeeder	A vision-controlled device that uses servo-electric drives to dispense parts from a storage container onto a surface, where they can be identified and picked up by the robot.
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 Enterprise Manager appliance.

Term	Definition
	Manages the AMRs' map, configuration and traffic control, including multi-AMR avoidance, destination, standby, and docking.
ARCL	Advanced Robotics Command Language. A simple, text-based, command-and-response operating language. Used with the optional Enterprise Manager (EM) 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.
AUTO (Automatic) mode	A mode in which executing programs control the robot, and the robot can run at full speed. See "manual mode".
AWG	American Wire Gauge. A standardized wire gauge system in which larger gauge values indicate smaller wire diameters. A size 1 AWG wire has a cross-sectional area of 42.4 mm^2, while a size 15 AWG wire has a cross-sectional area of 1.7 mm^2.
axis	A direction (X, Y, or Z) used to specify the robot's linear motion.
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.
ball screw	An assembly that converts rotational motion to linear motion, consisting of a threaded rod and a nut containing ball bearings. Typically used on SCARA robots to enable Z-axis motion.
battery backup	A battery pack that provides a backup power supply for the data stored by the encoders.
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.
burst (motion)	A rapid rate of movement that the robot is capable of maintaining only for a short period of time. See "ACE PackXpert"
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.
cart	A frame mounted on four casters, that attaches to an LD Platform Cart Transporter. Increases the payload capacity, and allows the payload to be decoupled from the mobile robot.

Term	Definition
CAT5	Category 5 Ethernet cable
CG	Center of Gravity
collaborative robot	A robot that is specifically designed to physically interact with humans in a shared workspace.
controller	A component that converts the requested movement of a robot into commands, to an amplifier, for sending appropriate power to the robot motors. In eAIB and eMB components, this is combined with the amplifiers.
cost	An arbitrary numeric value assigned to map grids, lines, routes, etc. to determine the cumulative, net effect of a robot's actions. Breaks maps into discrete squares called grids. Squares with walls, etc. have an infinite cost, and free squares, by default, have a value of 0.1. By design, mobile robots always seek to execute their assigned tasks and goals at the lowest possible cost.
Cost-Based Path Planning	A method of planning optimal, "least expensive" paths from "point a" to "point b" for the robot to follow.
coupled	A robot configuration in which the cart transporter and the cart are attached to one another via coupling plates, and the cart moves with the transporter.
coupling laser	A laser mounted in the cart transporter's coupling plate for aligning the transporter and cart during coupling.
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.
DeviceNet	A low-cost, CIP-compliant communications link that connects industrial devices to a network and eliminates expensive hard-wiring. Provides improved communication between devices as well as important device-level diagnostics not easily available using hard-wired I/O interfaces.
dongle	A small hardware device attached to a computer that contains the credentials (e.g., license key) required to run a specific program. Without a dongle, MobilePlanner will only open in Operator Mode. A dongle is also used in each mobile robot core to enable the use of the ARAM software. A dongle is required to use the ACE software.
DROPOFF	A job segment typically used where an AMR's payload is transferred from the robot to the goal. See "PICKUP".
duty cycle	The percentage of time that the robot system can be continuously operated, without experiencing overheating.

Term	Definition
E-Stop	Emergency Stop
eAIB	Amplifiers In Base. Provides closed-loop servo control of the robot amplifiers, as well as robot I/O. It is the platform on which the eV+ operating system runs.
EM	Enterprise Manager
eMB-XXY	eMotionBlox, where XX represents the number of joints times ten, and Y indicates the robot series. A distributed servo controller and amplifier with a dedicated digital signal processor to communicate, coordinate, and execute servo commands. It is the platform on which the eV+ operating system runs.
emergency stop	A function that overrides robot controls and removes power from the robot and stops robot motion. An emergency stop (E-Stop) button is typically a red push-button on a yellow background.
enabling switch	A user-operated switch that permits robot motion when continuously activated. Releasing the switch deactivates robot motion. This type of switch is usually found on manual control pendants.
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.
encoder	A device on each motor of the fixed robot that provides current robot joint position data to the controller.
end-effector	A device or tool that is specifically designed to attach to the robot tool flange and enables the robot to attach to and pick up objects.
Enterprise Manager	A network appliance that 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.
ESD skins	ElectroStatic Discharge skins encase the AMR in an electro-conductive surface. Provides a skin-to-chassis-to-wheel grounding path that drains off any 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.
eV+	A low-level programming language that provides an integrated solution to all fixed robot programming needs, including safety, robot motion, vision operations, force sensing and I/O.
FIFO	First-In-First-Out, refers to the method used to prioritize jobs by the order in which they were received.

Term	Definition
fleet	Two or more mobile robots operating in the same area, governed by the same Enterprise Manager.
flying lead cable	A cable that features a standard connection interface on one end and exposed wires on the other end, for connecting user input and outputs.
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.
Front Panel	A control panel that provides access to an E-Stop button, a Manual/Automatic mode switch, a Power-On LED, and a high power push-button.
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.
Hall sensor	A sensor that uses magnets to track a mobile robot's wheel rotation. This device provides a back up to the optical encoders on each wheel.
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.
hardstop	A physical barrier installed on the robot to limit the work envelope of the robot.
Harmonic Drive®	A compact and lightweight strain wave gear that converts high-speed low torque into low-speed high torque.
heading	Describes the direction that the robot is facing.
high power	The high voltage power that drives the fixed robot motors, as opposed the 24 VDC system used for controls.
HMI	Human Machine Interface. An operator panel The Front Panel is an example of an HMI.
HMI post	A post on the LD Platform Cart Transporter that supports the two side lasers, the rear facing laser, and the Operator Panel.
Hornet	OAT's three-arm parallel robot.

Term	Definition
I/O	Input/Output
*i*4	One of OAT's four-joint SCARA industrial robots.
IEEE 1394	An interface standard for a serial bus.
instructed personnel	Persons that are adequately advised or supervised by skilled persons to enable them to avoid electrical and mechanical dangers.
Intelligent Force Sensing System	The hardware and software package that allows robots to react to sensed forces and moments at the tool flange. Reduces force overshoot and stopping time when forces or moments exceed preset thresholds, allowing assembly operations to be performed at higher speeds.
interlock	A mechanical or electrical device intended to prevent machines from operating unless certain conditions are met.
IO Blox	An expansion module designed for adding digital input and output capability.
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.
J1, J2, J3, etc.	Joint 1, Joint 2, Joint 3, etc.
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.
jog	A function that allows the user to fine-tune the robot position in small increments.
joint	One of the moveable parts of a fixed robot.
joystick	A handheld, external input device for manually driving mobile robots, primarily used for map creation. Connects to the mobile robot's JOYSTICK connection port.
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.
lamp	A light used to indicate different robot states.

Term	Definition
latching mechanism	The motorized locking system that secures the LD Platform Cart Transporter and the cart together.
LD Platform Cart Transporter	An AMR designed to attach to movable carts and transport them from a pickup location to a drop off location.
LD Platform OEM	A self-navigating and self-charging AMR, designed for moving material indoors and around people.
light disc	The circular lights on the sides of the LD platform that indicate motion, turns, and other robot states.
light pole	See "beacon".
light ring	The circular light on some fixed robots that indicates different robot states.
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.
lockout/tagout	A safety procedure that disables machinery or equipment, typically during maintenance activities, to protect individuals from hazardous energy (electrical or mechanical).
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.
manual mode	A mode in which the user controls the robot with a pendant. Robot speed and torque are limited, so that the user can safely work in the cell. See "AUTO (Automatic) mode".
map	A representation of the robot's environment within MobilePlanner, that the robot uses for navigation.
MARC	The Mobile Adept 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
Mobile Robot Software Suite	A set of mobile-robotics software applications for programming and operating one or a fleet of mobile robots and the Enterprise Manager.
MobilePlanner	The primary software application for programming mobile robot actions. Provides the tools for all major AMR activities, such as observing a fleet of AMRs, commanding individual AMRs to drive, creating and editing map files, goals, and tasks, and modifying AMR configurations.

Term	Definition
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.
motion controller	A standalone component that directs amplifiers in supplying power to a robot, to achieve the desired movement. The SmartController EX is a motion controller.
muted E-Stop	A deactivation of the emergency stop function to allow access to the robot's workspace in Manual Mode.
NC	Normally-Closed electric contacts
NO	Normally-Open electric contacts
OAT	Omron Adept Technologies, Inc.
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	The maximum amount of weight the fixed robot can lift or manipulate in a normal and continuous operation.
payload	Anything the mobile robot carries.
payload bay	The area between the platform and the payload structure.
payload structure	Anything that gets attached to the platform and interacts with the payload being transported.
PCA	Printed Circuit Assembly. This is a printed circuit board that is populated with electronic components.
PCB	Printed Circuit Board. This is a printed circuit board that has traces, but no electronic components installed.
PE	Protective Earth. A type of ground connection.
pendant (teach pendant)	A hand-held control unit used by an operator to manually program (teach) or move the robot.
PICKUP	A job segment where an AMR typically acquires a payload. See "DROPOFF".
PL (a-e)	Performance Level. The probability that a safety component will perform its intended function under foreseeable conditions. PL is divided into five levels (a-e) where PL-e represents the best reliability and is equivalent to that required at the highest level of risk.
platform	A fixture at the end of the parallel robot's outer arms that con-

Term	Definition
	nects to and holds the robot tool flange. Converts the motion of the robot motors into Cartesian motion.
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.
PLC	Programmable Logic Controller
PoE	Power over Ethernet. A variant of the Ethernet standard that enables the transmission of low-voltage power, in addition to data signals, over network cables. Used with the SmartVision MX to provide power needed for a GigE camera.
pose	A mobile robot's position (location and heading).
positioning pin	A locating pin that provides fine tolerance alignment of the robot on the mounting surface. Minimizes positional deviations that may be caused by the removal/installation of the robot for maintenance and reduces vibration during operation.
power supply	A device that supplies the required stabilized DC power converted from commercial AC power or DC power.
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".
protective earth	A grounding connection that protects users from electric shock by ensuring that all exposed conductive components are at the same electrical potential as the surface of the Earth.
Quattro	OAT's four-arm parallel robot.
quill	A ball screw cylinder for vertical movement on a SCARA robot.
repeatability	A quantitative measure of positional variation the robot experiences when completing the same movement under the same conditions.
resisted (lines, areas)	The lines and/or areas the mobile robots resists (attempts to avoid) crossing or entering. These are map items can be drawn on a map within MobilePlanner, to increase the cost of grid cells under the line or area. See "cost".
robot interface panel	A panel on the eAIB, eMB, or on the robot itself, that provides connectors for power, Ethernet, and various I/Os.
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.

Term	Definition
RS-485	Recommended Standard 485. Standard for serial communication that uses half-duplex communications with two wires.
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.
SCARA	Selective Compliance Assembly Robot Arm
SCEX	SmartController EX
sDIO	An expansion module that provides 32 optically-isolated digital inputs, 32 optically-isolated outputs, and an IEEE 1394 interface. Requires a SmartController EX.
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.
singularity	A condition caused by the collinear alignment of two or more robot axes resulting in unpredictable robot motion and velocities.
skilled personnel	Persons that have the technical knowledge or sufficient experience to enable them to avoid electrical or mechanical dangers.
SmartController EX	A compact, high-performance, distributed robot motion controller capable of managing multiple robots.
SmartVision MX	An industrial PC that provides vision-oriented connectivity, as well as extra I/O.
SNG	SetNetGo
soft envelope	The portion of the work envelope to which a robot is restricted by the software.
softstop	A motion limit set within the software that stops the robot from moving beyond a specific location. The area available to the robot within the softstops should be smaller than the area within the hardstops, so the software stops the robot before it comes into contact with a hardstop.
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.

Term	Definition
sustained (motion)	A rate of movement the robot can maintain indefinitely, without exceeding duty cycle. See "burst (motion)".
SVMX	SmartVision MX
swing radius	The radius of the circle that a mobile robot will use when turning in place (with no forward motion).
T20 Pendant	An OAT teach pendant.
T55 Pendant	An OAT teach pendant.
tasks	Instructions for the robot to perform certain actions like reading inputs, setting outputs, movement commands, talking, waiting, etc.
Teach Restrict	A safety function within eAIBs and eMBs that limits the maximum speed of the robot when operated in Manual mode. Provides a hardware backup that disables power to the system if the software fails to limit the robot speed.
tool flange	The mechanical interface on the robot that holds an end-effector.
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.
transporter	Another name for the LD Platform Cart Transporter. This should not be confused with the Semi Transporter, which is a mobile robot designed to move wafer pods in semiconductor fabrication plants.
TriangleDrive	A navigation feature of the mobile robot that uses physical triangular-shaped features in the environment to aid in more accurate maneuvering. Triangles can be placed on locations where you need accurate positioning.
turn radius	The radius of the circle that the mobile robot will use when turning while moving forward.
Viper	OAT's six-joint articulated robot.
virtual doors	An area on a mobile robot's map that, when a robot plans a path through this area, causes the robot to stop at a designated door goal prior to passing through. The user may designate tasks to execute at those door goals, for example, toggling outputs to open a door, or enunciating to warn human operators before entering a busy aisle.
wheel light	See "light disc".
wheel pin	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.

Term	Definition
wizard	A guide within the software user interface that assists the user in setting up the software program.
work envelope	The maximum area that the robot, including the end-effector, is designed to cover with its movements.
XIO Breakout Cable	The cable that connects to the XIO connector on the amplifier, and provides flying leads on the user's end. Used for connecting input and output signals.
XIO Termination Block	A termination block for the connection and test of digital I/O signals.
XMCP	The connection port that connects a teach pendant to the XSYSTEM port on the robot interface panel or the XMCP port on the SmartController EX.

OMRON Corporation   **Industrial Automation Company**

Kyoto, JAPAN

Contact: www.ia.omron.com

Regional Headquarters

OMRON EUROPE B.V.
Wegalaan 67-69, 2132 JD Hoofddorp
The Netherlands
Tel: (31)2356-81-300/Fax: (31)2356-81-388

OMRON ASIA PACIFIC PTE. LTD.
No. 438A Alexandra Road # 05-05/08 (Lobby 2),
Alexandra Technopark,
Singapore 119967
Tel: (65) 6835-3011/Fax: (65) 6835-2711

OMRON ELECTRONICS LLC
2895 Greenspoint Parkway, Suite 200 Hoffman Estates,
IL 60169 U.S.A.
Tel: (1) 847-843-7900/Fax: (1) 847-843-7787

OMRON ADEPT TECHNOLOGIES, INC.
4550 Norris Canyon Road, Suite 150, San Ramon, CA 94583 U.S.A.
Tel: (1) 925-245-3400/Fax: (1) 925-960-0590

OMRON (CHINA) CO., LTD.
Room 2211, Bank of China Tower, 200 Yin Cheng Zhong Road,
PuDong New Area, Shanghai, 200120, China
Tel: (86) 21-5037-2222/Fax: (86) 21-5037-2200

Authorized Distributor:

Printed in USA
0219 (0117)

Cat. No. I611-E-05

11970-000 L