LD Cart Transporter

User's Guide

I612-E-01

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Chapter 1: Introduction

This manual covers the setup, operation, and user maintenance of an LD Cart Transporter system.

The basic configuration performed using the software that comes with the system is covered. Full details of that configuration are covered in the *Mobile Robot Software Suite User's Guide*.

Definitions

Platform: The most basic part of the robot. It includes the chassis, drive assemblies, suspension, wheels, battery, safety scanning laser, obstacle-avoidance lasers, sonar, an on-board robot core with built-in gyroscope, software needed to navigate, connectors for interfacing with and powering the Operator panel and cart coupling system, Operator panel, and the platform covers.

LD Cart Transporter: A Platform with the HMI post (including extended arms) and the coupling plate attached, set up to transport a cart. This is also referred to as just a transporter.

Cart: A cart, on four casters, that can be attached to an LD Cart Transporter, for increasing the transporter's payload capacity. The cart has brakes on two casters, which can be released either by coupling with a transporter, or by using a manual brake-release lever on the cart.

AIV (Autonomous Intelligent Vehicle): The transporter with a cart attached to it. This is the complete mobile robot, which will transport your payload on the cart.

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

For controlling or monitoring the full mobile robot, with a cart attached, we will refer to the AIV or robot.

1.1 Product Description

The LD Cart Transporter is a general-purpose mobile robot designed for moving a detachable cart indoors and around people. It is self-guided and self-charging, with an automated docking station.

The transporter, which moves the cart, comes complete with the ability to know where it is within your workspace, and to navigate safely and autonomously to any accessible destination within that workspace, continuously and without human intervention.

The cart is intended to expand the range of payloads that can be moved by an transporter, both in weight and size.

The LD Cart Transporter is available in two models, designed to transport carts with a total weight up to 105 kg (231 lb) for the LD-105CT and 130 kg (287 lb) for the LD-130CT platform. Where appropriate, differences between the models are called out. Otherwise, this manual applies to both LD Cart Transporters.

Figure 1-1. Cart and LD Cart Transporter, Separate

Figure 1-2. Cart and LD Cart Transporter, Coupled

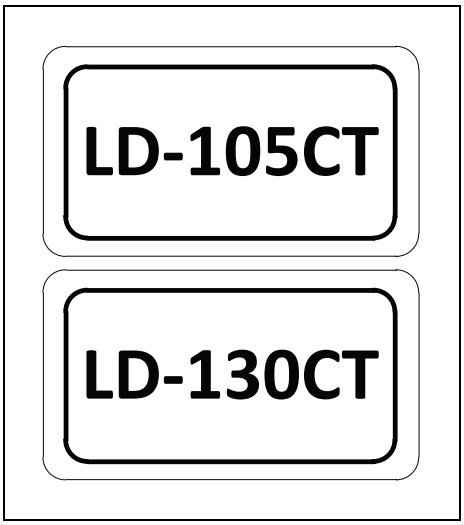


Figure 1-3. LD Cart Transporter Model Labels

LD Cart Transporter

The transporter is a mobile robot platform, designed for working around people while moving a cart. It is self-guided and self-charging, with an automated docking station. The transporter combines hardware and mobile-robotics software to provide an intelligent, mobile platform to transport your payload on the cart. Its primary guidance uses a safety scanning laser to navigate, comparing the laser readings to a digital map stored on the platform. The laser is backed up by a gyroscope mounted on the internal core, and encoders and Hall sensors on each drive wheel.

In addition to the front safety scanning laser, each transporter has two side lasers, for detecting potential obstacles in its path, a low front laser in the bumper to detect obstacles lower than the safety scanning laser, and a rear-facing obstacle-detection laser, to ensure that it is safe for the transporter to back up or turn in place.

For situations that are so dynamic that laser localization becomes difficult, we offer the Acuity Localization option, which localizes the AIV using an upward-facing camera to recognize overhead lighting patterns. 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 features that are mapped. This is covered in the *LD Platform Peripherals Guide*.

Body and Drive

The transporter is relatively small, lightweight, and highly maneuverable. It has a strong aluminum chassis and solid construction that makes it very durable.

The platform is a two-wheel, differential-drive vehicle, with spring-loaded passive casters front and rear, and independent drive-wheel spring-suspension for balance. Its solid, foam-filled wheels are at the mid-line of the platform, so that the transporter can turn in place.

Safety Scanning Laser

The onboard safety scanning laser is a very precise scanning sensor. The laser provides 500 readings in a 250 degree field of view, with a typical maximum range of 15 m (49.2 ft). The laser operates in a single plane, positioned at 203 mm (8 in.) above the floor. In most environments, the sensor will provide highly-accurate data.

Glass, mirrors, and other highly-reflective objects cannot be reliably detected by the laser. Caution must be exercised when operating the robot in areas that have these types of objects. If the robot will need to drive in close proximity of these objects, we recommend that you use a combination of markings on the objects, such as tape or painted strips, and also use forbidden sectors in the map, so that the robot knows to plan paths safely around these objects.

Side Lasers

These two lasers are used to detect obstacles that protrude into the robot's path, but may not be detected by the safety scanning laser.

This is needed when obstacles higher than the safety scanning laser (but low enough to be obstacles) protrude into the robot's path.

Low Front Laser

This laser is mounted to the front bumper. It detects obstacles that are low and in front of the transporter, such as an empty pallet, which might be too low for the safety scanning laser to see.

Rear-Facing Laser

This laser gives better coverage of what's behind the transporter than sonar alone. It is used during both turning in place and backing up when the transporter and cart are coupled.

Coupling Laser

A laser mounted in the transporter coupling plate is used to locate a triangle on the underside of the cart's coupling plate. This is used by the transporter to accurately align with the cart, so it can couple with it.

Sonar

The transporter's two rear-facing sonar pairs are for obstacle-sensing while backing up. The range is up to 5 m (16 ft), though the typical accurate range is only up to 2 m (10 ft). Each pair consists of one emitter and one receiver. The sonar emitters and receivers are identical physically, but the transporter uses them differently.

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 robot core has a gyroscope mounted on it, to track the platform's rotation.

The combination of rotation and distance traveled are used by the platform to back up the safety scanning laser during localization. These limit the area on the platform's map that the platform needs to search when localizing.

What's Included with an LD Cart Transporter

- One fully-assembled platform

  The platform includes a safety scanning laser, a low front laser, two side lasers, a rear-facing laser, and two rear-facing sonar pairs. Each pair is one transmitter and one receiver.

- One battery

  This is shipped separately from the platform, due to air shipping regulations.

  If the battery was shipped by air, it will be at less than 30% charge per IATA regulations.

- Top plate and coupling plate

  The platform top plate covers the payload bay of the platform, and supports the lower (platform) coupling plate, which engages the cart coupling plate, attached to the cart, and the coupling laser.

- Robot Core, which includes an integrated computer, running Advanced Robotics Automation Management (ARAM) and a microcontroller with MARC firmware. The core is housed inside the platform. It also runs the SetNetGo OS.

  ARAM and MARC firmware and the SetNetGo OS are pre-loaded on the robot core.

- An HMI post

  This supports the two side lasers and the rear-facing laser, both for obstacle avoidance. It also supports the Operator Panel.

- Operator Panel

  This includes a touchscreen, an E-Stop button, ON and OFF buttons, a brake-release button, and a keyswitch, which can be locked, and key removed, in either position. The panel's frame supports two WiFi antennas and a beacon.

  There are LATCH and UNLATCH buttons below the E-Stop.

  The optional Acuity Localization camera mounts on top of the Operator panel frame, on the same plane as the antennas and beacon.

- Automated docking station

  This allows the LD 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 50.

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

- Joystick (option)

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

  At least one joystick is needed for each fleet of robots. Once a map is generated, the map can be shared with multiple robots working in the same space.

Cart

The Cart is a frame mounted on four casters, designed so that it can couple with an LD Cart Transporter. Once coupled, the cart moves with the transporter. When the transporter arrives at the intended goal, it uncouples from the cart and leaves, while the cart remains at the goal. Brakes automatically engage on the cart casters, preventing it from rolling in case the floor isn't completely level.

The cart has a manual brake-release lever, so it can be moved manually.

Coupling

The transporter can attach to a cart at a pickup goal, move the cart to a dropoff goal, and leave it at that goal, with no human intervention.

When the cart and transporter are coupled, the transporter automatically presses a lever that releases the cart's brakes, so it is free to move with the transporter.

The coupling system has:

- a motorized Latching Mechanism
- a coupling laser

  This is mounted in the coupling plate, and is used to align the transporter with the cart when coupling.
- LATCH and UNLATCH override buttons, on the Operator Panel

Coupling plates

Each cart has one coupling plate, and each platform has one coupling plate. The plates are mounted so that, when the platform moves under the cart, the plates can attach to each other, allowing the platform to move the cart. The software is aware of whether or not a cart is attached.

- The cart coupling plate includes a slot that can be latched with the platform coupling plate. The cart coupling plate is passive.
- The platform coupling plate includes a laser, for aligning the platform before coupling, and a motorized Latching Mechanism, for latching the cart coupling plate.

Optional Components

Refer to Options on page 141 for details.

- Acuity Navigation

  For environments that are very dynamic, such that a map can't be kept current, or where the area is too large for the navigation laser to see, Acuity can be used to navigate using overhead light patterns seen with an upward-facing camera.
- Enterprise Manager 1100

  This system manages a fleet of robots, for multi-robot traffic coordination and job management. It includes the Enterprise Manager appliance running the Mobile Software suite.
- Spare battery

  A spare battery can be used to minimize down-time. Swapping the battery for a fully-charged battery avoids taking the robot out of service for more than a few minutes.
- Call/Door Boxes

  These allow a robot to be requested from a remote location, or allow the robot system to control an automated door, so the robot can pass through it.

User-Supplied Components / System Requirements

PC with Microsoft Windows®

- Ethernet (wireless preferred)

  Wireless is required for a fleet (more than one robot).

- 100 megabytes of available hard-disk storage

1.2 Software Overview

Mobile Robot Software Suite

The Mobile Robot Software Suite includes all of the software used for platforms and the Enterprise Manager appliance, with the exception of the SetNetGo OS.

ARAM

The Advanced Robotics Automation Management software (ARAM) runs on the Robot Core. It operates ranging sensors like the safety scanning laser and sonar, and performs all the high-level, autonomous robotics functions, including 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 offboard software, for external monitoring, development, and systems coordination, including coordination of a fleet of robots through the optional Enterprise Manager 1100. 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 1100.

For a fleet, the ARAMCentral software manages:

- the map that all robots use
- the configuration that all robots use
- traffic control of the robots

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

- queuing of jobs for the robots
- remote I/O, if you are using it

MobilePlanner (licensed)

In order to have your robot perform autonomous mobile activities, you need to make a map of its operating space, and configure its operating parameters. The MobilePlanner software is used 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 to run. You will need at least one license for MobilePlanner for each fleet of robots. Once you generate a map for an area, it can be shared between multiple robots in one fleet.

MobilePlanner, Operator Mode

The MobilePlanner Operator Mode is used to monitor one or more robot's activities and have them perform mobile tasks in the mapped space. When MobilePlanner is started without its license dongle, it automatically starts in this 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

Whenever the Mobile Software suite is downloaded, it includes support software for the optional touchscreen.

Call/Door Box Support

Call/Door boxes have one software component on the box and another on either the Enterprise Manager 1100 or on the single robot, when there is no Enterprise Manager 1100.

ARCL Protocol

ARCL is a function of ARAM and ARAMCentral, which is included as part of this suite.

The Advanced Robotics Command Language, or ARCL, is a simple text-based command and response server for integrating a robot (or fleet of robots) with an external automation system.

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

SetNetGo

The SetNetGo OS runs on the Robot Core and Enterprise Manager appliance. It is the host OS in which ARAM and ARAMCentral run.

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

NOTE: It is possible to connect directly to the SetNetGo OS on a platform through a web browser. The main intent of this is to allow your IT support to set up the network for you, without using MobilePlanner, which requires a license.

1.3 How Can I Get Help?

Refer to the corporate websites:

http://www.ia.omron.com

and

http://www.adept.com

Related Manuals

This manual covers the installation, setup, operation, and maintenance of a Mobile Robot - LD Platform. There are additional manuals that cover these actions for the platform. See the following table.

Table 1-1. Related Manuals

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

Support

If, after reading this manual, you are having problems with your cart transporter or cart, contact Omron Adept Technologies, Inc.

- In the body of your e-mail message, provide your platform's serial number and describe the problem you are having in as much detail as possible.
- Attach your debuginfo file to the email. Refer to the next section for details on retrieving your debuginfo file. See the following section for generating your debuginfo file.

Tell us when and how we can best contact you. We will assume e-mail is the best format, unless otherwise notified. We will try to resolve the problem through communication. If the cart transporter must be returned to the factory for repair, obtain a Repair Authorization Code and shipping details from us first.

Including a DebugInfo File

If the platform has been set up on a wireless network, skip to SetNetGo Access on page 18.

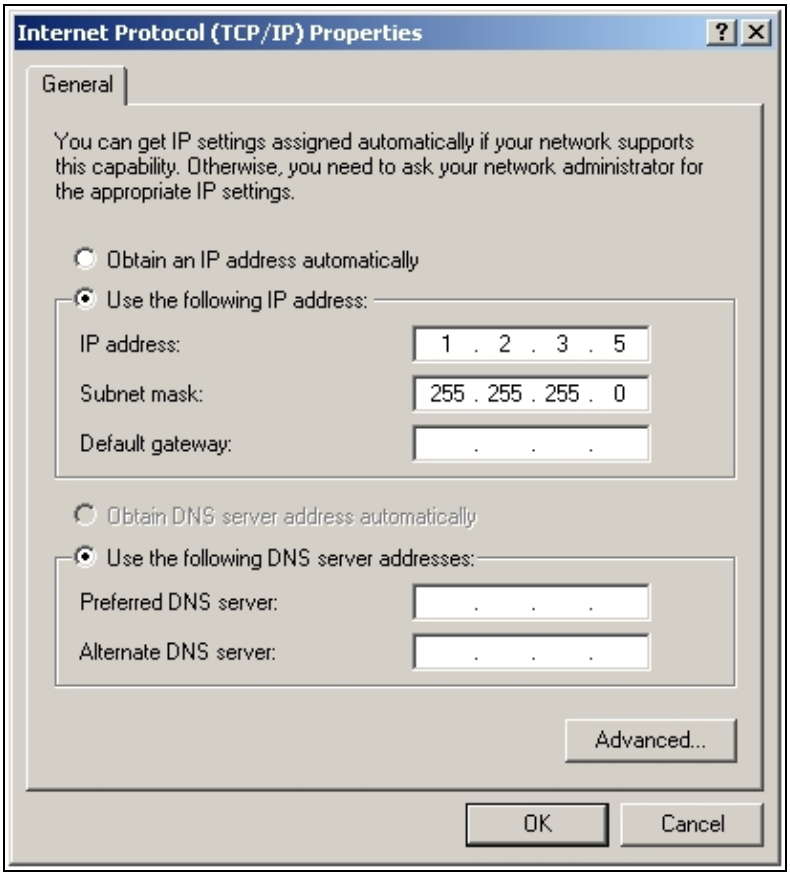
Network Setup

If the robot has not been set up on a wireless network, a local area network will have to be set up on a separate PC, and configured to talk to the robot over a TCP/IP port. The IP address should be set 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**

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

From 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 netmask values.



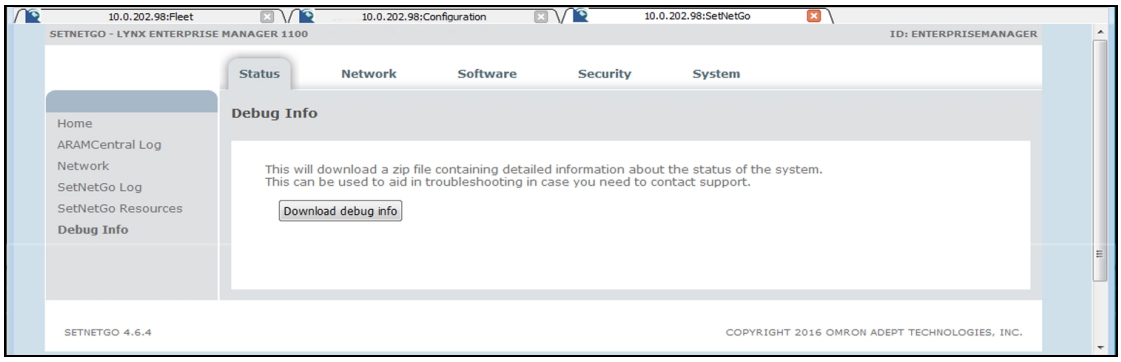
Connect the network port of your computer to the platform's Maintenance port. See the figure Location of Parts in the Payload Bay on page 144.

SetNetGo Access

If the MobilePlanner software is available, use the SetNetGo interface within that software to access SetNetGo. Otherwise, open a web browser and enter the URL: https://1.2.3.4:

You will be requested to confirm security certificates.

Regardless of how you accessed SetNetGo, you should now have a window similar to the following:



1. From the SetNetGo screen, select:

   Status > Debug Info

   This will display 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 Dangers, Warnings, Cautions, and Precautions

There are six levels of special alert notation used in this manual. In descending order of importance, they are:

DANGER: This indicates an imminently hazardous electrical situation which, if not avoided, will result in death or serious injury.

DANGER: This indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING: This indicates a potentially hazardous electrical situation which, if not avoided, could result in serious injury or major damage to the equipment.

WARNING: This indicates a potentially hazardous situation which, if not avoided, could result in serious injury or major damage to the equipment.

CAUTION: This indicates a situation which, if not avoided, could result in minor injury or damage to the equipment.

Precautions for Safe Use: This indicates precautions on what to do and what not to do to ensure safe use of the product.

2.2 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 an emergency /abnormal 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 transporter 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 robot.

Releasing an E-Stop

WARNING: If the robot's E-Stop is triggered, ensure that the cause of the E-Stop is resolved, and all surrounding areas are clear and safe before releasing the E-Stop.

2.3 User's Responsibilities

It is the end-user's responsibility to ensure that the mobile robots are used safely. This 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 robot.

  If a fleet of mobile robots (two or more) is installed, the Enterprise Manager 1100 must be used, unless no two robots will ever operate in the same area.
- Ensuring that anyone working with or near a mobile robot has been adequately trained, and is following this user's guide and the *Mobile Robot LD Safety Guide*, for safe robot operation.
- Ensuring that the robots are maintained, so that their control and safety functions are working properly.

General Hazards

CAUTION: The following situations could result in minor injury or damage to the equipment.

- Do not ride on the transporter or cart.
- Do not exceed the maximum weight limit.
- Do not exceed the maximum recommended speed, acceleration, deceleration, or rotation limits. See Center of Gravity on page 76 and Acceleration, Deceleration, and Rotation Limits on page 72.

  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 robot, run it off a ledge, or otherwise operate it in an irresponsible manner.
- Do not allow the robot to drive through an opening that has an automatic gate/door unless the door and robot are configured correctly with the Door Box option.

  Refer to the *LD Platform Peripherals Guide* for details on the Door Box.
- Do not get the robot wet. Do not expose the robot to rain or moisture.
- Do not continue to run the robot after hair, yarn, string, or any other items have become

wound around the platform's axles, casters, or wheels.

- Do not use parts not authorized by Omron Adept Technologies, Inc.
- Do not turn on the robot without the antennas in place.
- Although the lasers are Class 1 (eye-safe), we recommend you not look directly into them.

Falling Hazards

WARNING: A mobile robot 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 robot's expected operating area should be physically marked so that the robot's navigation laser will see the barrier, and stop before reaching it. The robot's navigation laser scans at 203 mm (8 in.) from the floor, so the barrier must cover at least that height.

This needs to be continuous at the site, so that the robot 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 that the robot will not try to drive there.

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

Electrical Hazards

WARNING: 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 docking station attached.
- Immediately disconnect the battery after opening the battery compartment door.

  Avoid shorting the battery terminals.
- Do not use any charger not supplied by Omron Adept Technologies, Inc.
- If any liquid is spilled on the robot, power off the robot, clean up all possible liquid, and allow the robot to air dry thoroughly before restoring power.

Pinch Hazards

Latching System Latch

CAUTION: Pinch hazard. The latch of the LD Cart Transporter can pinch you if you are not careful. Keep your hands clear of the transporter when it is in action.

Latching System Belt/Pulley

CAUTION: Pinch hazard. During maintenance on the latch mechanism, the belt and pulley can pinch you if you are not careful. Keep your hands clear of the belt and pulley when they are in action.

HMI Post-Cart Gap

CAUTION: Pinch hazard. The coupling action of the LD Cart Transporter and cart can pinch you if the cart payload is incorrectly designed, and you are not careful. Keep your hands clear of the space between the HMI post and cart when the transporter and cart are coupling.

Robot Covers

CAUTION: Pinch hazard. The covers 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 covers.

NOTE: The hazard presented by the platform cover magnets is slight enough that the covers and their magnets do not have warning labels.

Magnetic Field Hazards

Robot Covers

WARNING: Magnetic fields can be hazardous to pacemaker wearers. Pacemaker wearers stay back 30 cm (12 in.) from the covers, which are held in place with strong magnets.

Docking Funnel

WARNING: Magnetic fields can be hazardous to pacemaker wearers. Pacemaker wearers stay back 30 cm (12 in.) from the underside of the cart transporter, which is exposed during certain maintenance procedures for which the transporter is tipped on its side.

Cart Magnet

The underside of the cart has a strong magnet, used to signal the transporter that it is in place. This can be a hazard to pacemaker wearers, if they get too close to it.

WARNING: Magnetic fields can be hazardous to pacemaker wearers. Pacemaker wearers stay back 30 cm (12 in.) from the bottom of the cart.

Qualification of Personnel

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

WARNING: Before working with the robot, every entrusted person must confirm that they:

- Have the necessary qualifications
- Have received the guides (both this 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

Monitoring and confirmation of the status of robot payload movement and transfer to or from facility equipment is the end-user's responsibility.

Payload transfer problems must trigger a robot E-Stop, preventing the robot from moving until an Operator has resolved the problem and confirmed that the system is safe to use. This handling of payload transfer problems is the end-user's responsibility.

Providing an interlock between the robot and facility equipment is the user's responsibility.

Configurable Warning Buzzer

The LD Cart Transporters have a configurable warning buzzer. It is the user's responsibility to configure this buzzer as appropriate for the facility in which the robot will be operating.The buzzer will sound whenever the robot is moving backwards or is turning. Other situations are configurable.

The buzzer is configured with MobilePlanner, using the following parameters:

NOTE: These parameters are only available with the Mobile Robot Software Suite 5.0 and later.

- DriveWarningEnable

  NOTE: If this parameter is set to False, the remaining parameters will not be displayed.

  WARNING: Disabling the DriveWarningEnable parameter violates the JIS D 6802 standard. It is strongly recommended that you leave this set to True.

- DoNoWarnDrivingForwards

  Default: False

- DoNotWarnTurningInPlace

  Default: False

- DriveWarningLoudMilliseconds

  Default: 500. If DriveWarningQuietMilliseconds is 0, this parameter is irrelevant.

- DriveWarningQuietMilliseconds

  Default: 500. This is the length of time between warnings that the buzzer is silent. Setting this to 0 will cause a continuous warning.

Multi-Vehicle Avoidance

When multiple vehicles are operating in the same operating space, they must be connected to an Enterprise Manager 1100 (EM) via WiFi. The EM helps prevent collisions by sharing vehicles' dynamic X, Y, Theta, size, and path-planning information with each other. Vehicles 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 robots are approaching each other, neither will not see the other because the incoming laser beams are detected as reflected beams. Because of this, any installation with more than one robot working in the same operating space must be managed by the same Enterprise Manager 1100.

Traffic Control

A "switchable forbidden area" can be programmed on the map to prevent the robot from entering an area based on the state of a discrete input. If this input is set from another vehicle, such as a forklift, while it is in that area, then the robot shall not be allowed to enter that area.

Passing Lanes

Since the LD Cart Transporter technology does not use fixed tracks to guide the robots, the concepts of passing lanes and human safety areas are not relevant.

2.4 Environment

General Environmental Conditions

It is the end-user's responsibility to ensure that the operating environment of the platform remains safe for the platform. If there are areas that are not safe for the platform to travel in, those areas should be physically blocked off so that the platform's scanning laser will detect the barriers, and the platform will not attempt to drive there. These areas can also be blocked off with forbidden zones in the MobilePlanner software, but that should be in addition to physical barriers.

Public Access

The LD Cart Transporter 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 LD Cart Transporter is designed to operate in an environment that is generally level and has no doors or other restricted areas too narrow for the robot. It is the user's responsibility to ensure that adequate clearance is maintained on each side of the robot, so that a person cannot get trapped between the robot 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 robot must get close to conveyors or other fixed objects.

The primary direction of travel of the LD Cart Transporter is forward. When the transporter is turning in place, with no forward movement, the detection of an obstacle in its path of rotation will not trigger an E-Stop.

WARNING: Personnel who work with or around the robot should not stand close to the robot when it is turning in place (with no forward motion).

Obstacles

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

2.5 Intended Use

The LD Cart Transporter is not intended for use in any of the following situations:

- In hazardous (explosive) atmospheres
- Uncontrolled areas, for example, areas open to general public access.

  Application in such areas may require deployment of additional safety measures, and risk analysis.

  LD Cart Transporters are designed for operating in industrial or professional environments. They must be deployed in a manner that takes into account potential risks to personnel and equipment.
- 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 navigation in LD Cart Transporters requires a stationary environment for optimum accuracy. Therefore, we do not recommend them for use on a ship, train, aircraft, or other moving environment.

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

Non-Intended Use

Non-intended use of LD robots can:

- Cause injury to personnel
- Damage the robot or other equipment

- Reduce system reliability and performance

The body of the robot must not come into contact with liquids. The drive wheels can tolerate damp floors, but the body of the robot must remain dry.

If there is any doubt concerning the application, ask Omron Adept Technologies, Inc. to determine if it is an intended use or not.

Robot Modifications

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

Note that any change to the platform or cart can lead to loss in safety or functionality. It is the responsibility of the user or integrator to ensure that all safety features are operational after modifications.

2.6 Battery Safety

- Batteries must be stored upright at 5° to 60° C (41° to 140° F).
- Do not expose batteries to water.
- If a battery is found to be leaking, do not expose it to water. If possible, submerge it in mineral oil and contact Omron Adept Technologies, Inc.
- In case of a fire, use a type D extinguisher: foam, dry chemical, or CO_2.

2.7 Additional Safety Information

Accidental Cart Separation

In the unlikely event that the cart becomes unlatched from the LD platform while in motion, the brakes are designed to stop the cart within six feet.

Mobile Robot LD Safety Guide

Omron Adept Technologies, Inc. provide other sources for more safety information:

The *Mobile Robot LD Safety Guide* provides detailed information on safety for LD Platforms. It also gives resources for information on relevant standards. It ships with each mobile robot.

Chapter 3: Setup

CAUTION: Possible battery damage. Immediately charge the battery to a full charge upon receipt to avoid the risk of discharging the battery below a usable state, which would require battery replacement.

NOTE: Effective April 1, 2016, IATA regulations require that air-shipped lithium ion batteries (UN 3480, PI 965) must be transported at a state of charge not exceeding 30%. You should charge the battery completely as soon as you receive it.

Overview

In general, setup is the physical preparation of the platform and cart and physically marking parking goal locations on your facility floor. Marking the parking goals on the floor is for human use. An LD Cart Transporter doesn't use those markings, although we recommend you mark them in any case, to prevent someone from placing something there that would prevent a cart from being parked.

The physical preparation of the platform includes attaching the horizontal tubes that support the side lasers to the HMI post.

Setup also includes generating a map of the workspace and configuring the robot with the MobilePlanner software to perform useful tasks.

Tasks

This overview covers the LD Cart Transporter starter kit, which includes the transporter with all components needed for use with a cart, a docking station, and software needed for navigation.

- Install the battery in the platform. See Installing the Battery on page 45.
- Fully charge the battery, either outside of or inside the platform.
- Set up the wireless Ethernet for the platform. See Configuration on page 61.
- Install the HMI post's side laser support tubes.
- Install the docking station. See Installing the Docking Station on page 50.
- Install the cart's manual brake-release cable and lever.
- Configure the robot for your environment, so it can perform useful tasks.

  This includes generating the map that the LD Cart Transporter will use for its navigation. This procedure and parameter configuration is covered in the *Mobile Robot Software Suite User's Guide*.
- Mark the location and orientation of the goals where the cart can be parked. This allows a person to place a cart where the transporter can find it.

It will also help keep someone from putting something other than a cart in that area, which could prevent a cart from being parked there.

- Configure the MobilePlanner software, so an transporter can pick up and drop off carts.

  This includes modifying the map that the transporter uses for its navigation. The configuration is covered in the *Mobile Robot Software Suite User's Guide*.

3.1 Transport and Storage

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

The containers must always be shipped and stored in an upright position in a clean, dry area that is free from condensation. Do not lay the containers on their sides or any other non-upright position.

LD Cart Transporter

The LD Cart Transporter system, which includes a cart, is shipped in one crate, along with the docking station, joystick, and all components except for the battery.

The system must be shipped and stored in a temperature-controlled environment, from 5° to 60° C (41° 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.

The transporter alone weighs 79 kg (175 lb).

The crate for the transporter measures 1156 x 794 x 1765 mm (45.5 x 31.25 x 69.5 in.), and weighs 98 kg (216 lb). The weight, as shipped, is 199 kg (439 lb).

Battery

NOTE: If you purchased spare batteries, this section applies to them, also.

The battery is shipped in a separate carton, not inside the platform or platform crate.

If the battery needs to be stored, the manufacturer recommends 5° to 60° C (41° to 140° F).

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

The battery must be stored upright, in a dry location.

Standalone Cart

Carts can be purchased as an option, if you need more carts than transporters.

The box measures 1092 x 635 x 711 mm (43 x 25 x 28 in.). The cart in the box weighs 28 kg (62 lb) alone. If the cart and box are on a pallet the weight is 44.5 kg (98 lb).

The standalone cart weighs 22.7 kg (50 lb).

Each cart comes with caster brakes, which require the installation of a brake-release lever. See Installing the Cart Brake Release on page 55.

3.2 Before Unpacking

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

3.3 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, please contact Omron Adept Technologies, Inc. immediately.

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

A complete LD Cart Transporter will come in two packages:

- The battery is shipped in a cardboard carton.
- The transporter and cart are shipped in a wooden crate.

  This includes the HMI post, with the detached side laser support tubes.

  This also includes the joystick, docking station, and any accessories ordered, all in cardboard cartons inside the transporter crate.

Battery

The battery is shipped separately from the transporter. Locate the box that contains the battery before continuing. Refer to the following figure.

Figure 3-1. Battery Shipping Container

The battery box measures 311 x 540 x 457 mm (12.25 x 21.25 x 18 in.).

> **NOTE:** The battery weighs 17 kg (37 lbs). There are recesses at the front and the back of the battery, to aid in lifting it.

LD Cart Transporter

Figure 3-2. Cart and LD Cart Transporter in Crate

The cart crate measures 1156 x 794 x 1759 mm (45.5 x 31.25 x 69.25 in.).

NOTE: The preceding figure includes accessory boxes for Call/Door Boxes.

Removing the Front Panel

The front panel of the transporter crate doubles as a ramp, for rolling the transporter off of the crate base.

1. Release the latches that hold the front panel to the crate.

   There are four spring-loaded latches.

Figure 3-3. Spring-loaded Latch

2. Remove the front panel, and set it aside.

   This will be used as a ramp, to roll the transporter off of the crate base.

Removing the Cart

The cart is strapped, on its side, to a shelf in the upper part of the transporter crate.

1. Slide the shelf out of the crate far enough to access the restraining strap.
2. Remove the cardboard box from the cart shelf.

   CAUTION: Due to the weight and height of this cardboard box, two people should work together to lift it down.

   This contains the dock and the joystick, as well as miscellaneous cords.

   If accessories, such as call boxes, are ordered, they will be on the shelf, but not in the large cardboard box.

   You may need to loosen the strap to remove the box or boxes.
3. Remove the straps from the cart, and then the cart itself.

   CAUTION: Due to the weight and height of the cart, two people should work together to lift it down.

4. Remove the shelf from the crate.

Removing the Upper Body of the Crate

1. Remove the two lag bolts and washers from the back of the crate, at the bottom.

Figure 3-4. Crate Bottom-rear Lag Bolts

2. Remove two Klimp fasteners at each side holding the upper body of the crate to the base.

Figure 3-5. Removing a Klimp Fastener

3. Slide the upper body of the crate off of the base.

Take care as you slide it over the HMI post, watching the clearance between the crate and the HMI post components.

The transporter will still be held securely by the base of the crate.

Repacking for Relocation

If the transporter or other equipment needs to be relocated, reverse the steps in the installation procedures in this chapter. Reuse the original packing crates and materials and follow all safety notes used for installation. Improper packing for shipment will void your warranty.

The transporter must always be shipped in an upright orientation.

3.4 Setting Up an LD Cart Transporter

The transporter is shipped with the HMI post installed. This includes the Operator panel at the top of the HMI post. You will have to:

- Mount the horizontal support tubes, with side lasers, to the post

  The side lasers are already mounted on the outer ends of these tubes, and their cables are already connected through the openings in the HMI post.
- Roll the transporter off of the crate, down the ramp
- Remove the pins holding the drive wheels up
- Install the battery
- Install the dock, for charging the transporter's battery

  This should have already been removed from the crate.
- Set up your wireless system

  This is covered in Settings and Configuration on page 61.

Mounting the Side Lasers

The two side lasers are mounted on the ends of horizontal tubes that will be attached to the HMI post, and braced to the HMI post base.

As shipped, the horizontal tubes with side lasers will not be attached to the HMI post. A wooden board that spans the width of the transporter supports them during shipping. See the following figure.

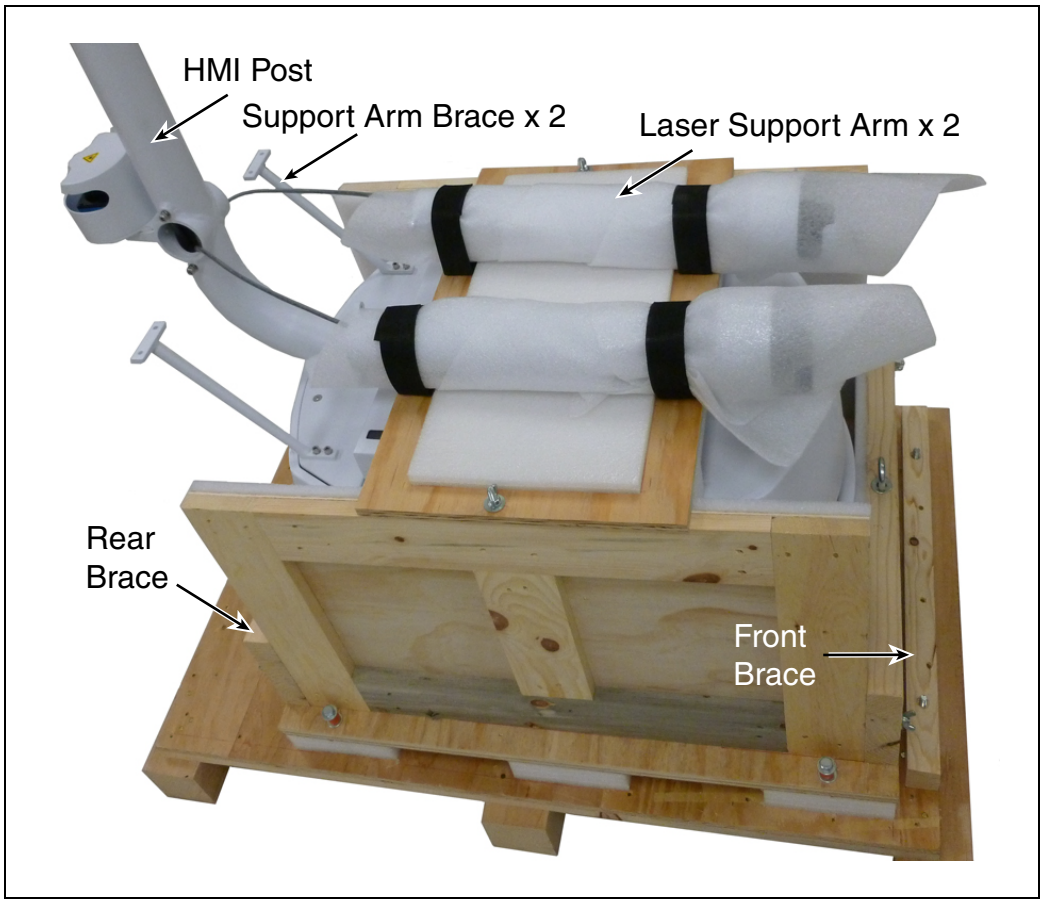


Figure 3-6. LD Cart Transporter on Crate Base

Mounting the Side Laser Support Tubes

This procedure involves minor routing of wiring for the rear-facing laser. This wiring must be in place before the support tubes are fully-installed.

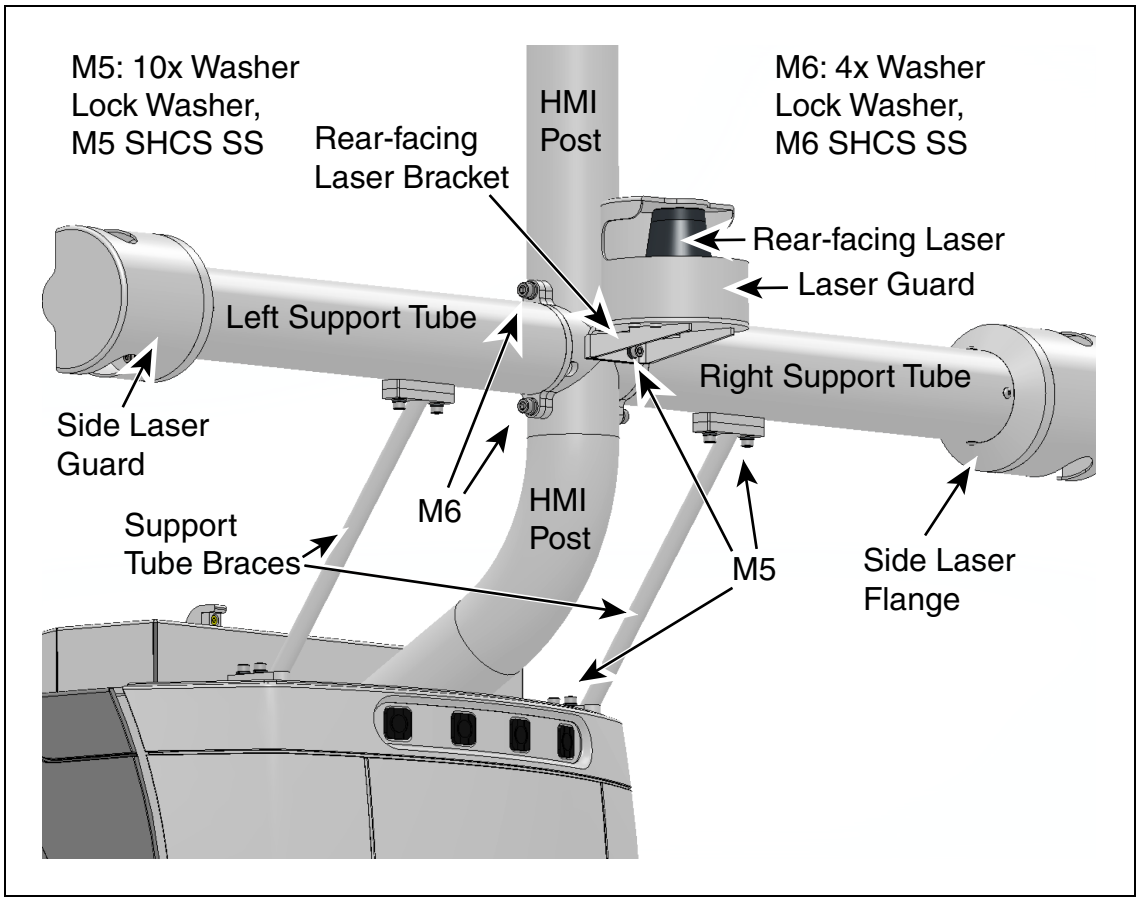


Figure 3-7. Side Lasers, Support Tubes, Rear-facing Laser

There are two side laser support tubes that attach to support braces that are anchored to the HMI post base. As shipped, all wiring is already connected, and the support braces are attached to the HMI post base.

1. Attach each support tube to a support brace with two M5 screws, lock washers, and washers.
2. For the left support tube, ensure that:
    - the cable and connector for the rear-facing laser, coming from the HMI post, are tucked inside the left support tube
    - the cable is connected to the cable from the rear-facing laser.

      See the following figure.
    - the cable for the rear-facing laser goes through the notch in the HMI post, where it attaches to the support tube flange

Figure 3-8. Connector and Cable for the Rear Laser

3. Attach the flange of each support tube to the HMI post with two M6 screws, lock washers, and flat washers.

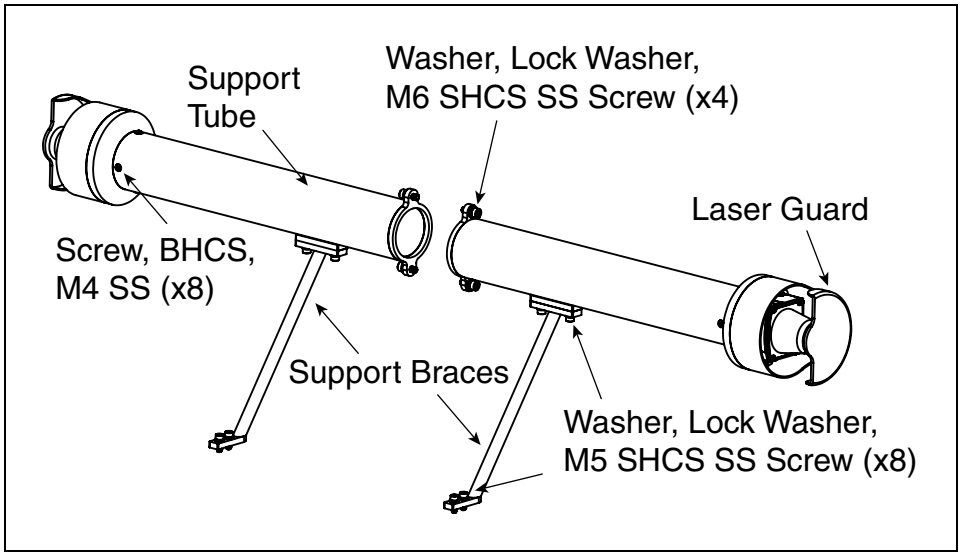


Figure 3-9. Side Laser Support Tubes

4. Remove the horizontal board that spans the top of the transporter by removing the two wing nuts. See Figure 3-6.

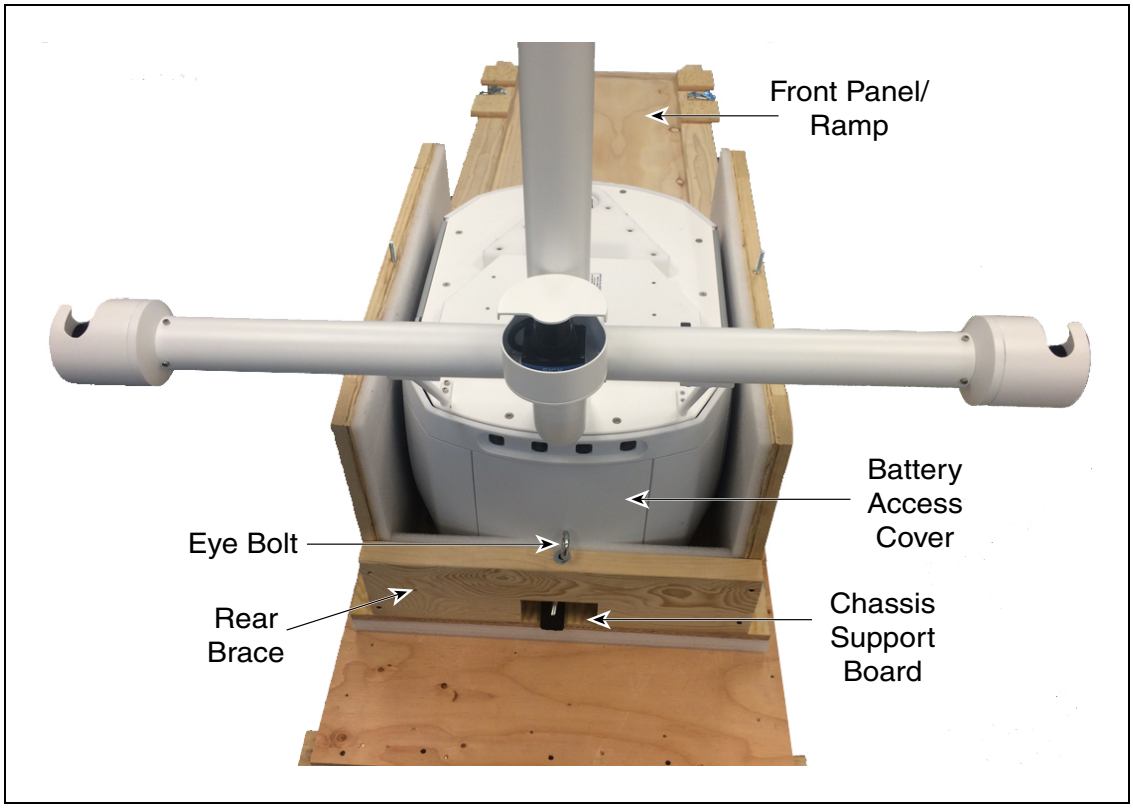


Figure 3-10. Side Lasers Installed

Removing the Lower Crate Braces

For the following steps, refer to the preceding figure.

1. Unscrew the two eye bolts that run vertically down through the front and rear braces, to lower and ultimately free the chassis support board.

   The support board runs between the two transporter drive wheels, and is used to support the transporter during transit.

2. Remove the front brace (wing nuts).

3. Remove the rear brace.

   This will expose the platform battery cover, which you will need to remove to install the battery.

Rolling the LD Cart Transporter off of the Crate Base

1. Install the crate front onto the crate base, to serve as a ramp.

   There are two hanger bolts that stick up out of the front of the crate base. These fit into two holes in the end of the ramp.

2. Roll the transporter off of the crate base and down the ramp.

Figure 3-11. LD Cart Transporter on Crate Base, with Ramp

3. 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 transporter, the drive wheels will not touch the ground until you remove the wheel pins. The wheel pin hole is shown in the following figure.

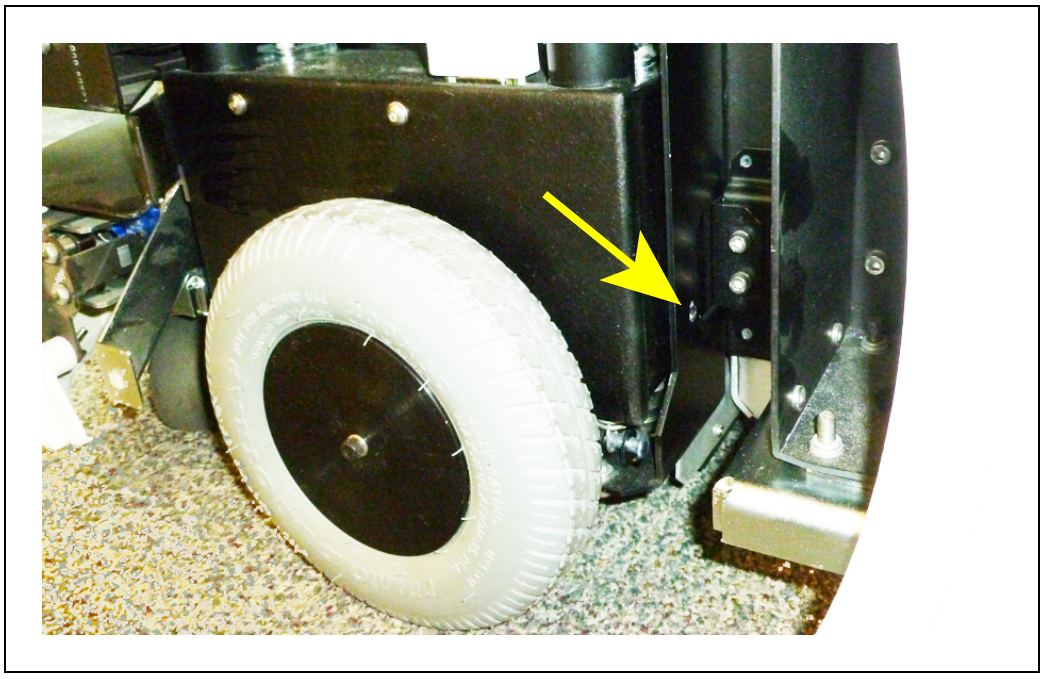


Figure 3-12. Wheel Pin Hole Location

For each side of the platform:

a. Remove the side cover a small distance from the platform. Refer to Removing Covers on page 154.

   The light disc PCA cable will still be attached.

b. Disconnect the cable from the light disc PCA, so the side cover can be moved completely away from the platform.

   This will fully expose the wheel and tire.

c. Lift the wheel slightly to relieve pressure on the pin.

d. Remove the pin by pulling the ring that is attached.

   These pin can be used for later service of either the wheel/tire assemblies or the entire drive assemblies.

Figure 3-13. Wheel Pin

e. Lower the wheel to the floor.

   The wheels are spring-loaded, and the wheel brakes will be on.

f. Put the side cover next to the platform, and attach the light disc cable to the light disc PCA.

g. Reinstall the side cover.

Installing the Battery

Your platform battery comes with less than 30% charge, to comply with air-shipping regulations. It should be charged as soon as possible, to a full charge.

NOTE: Air shipping regulations require that the LD Cart Transporter be shipped without the battery installed.

Removing the Battery Cover

Accessing the battery compartment requires removing the platform's rear cover. This is held in place with magnets.

CAUTION: Pinch hazard. The magnets holding the cover 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 cover.

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

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

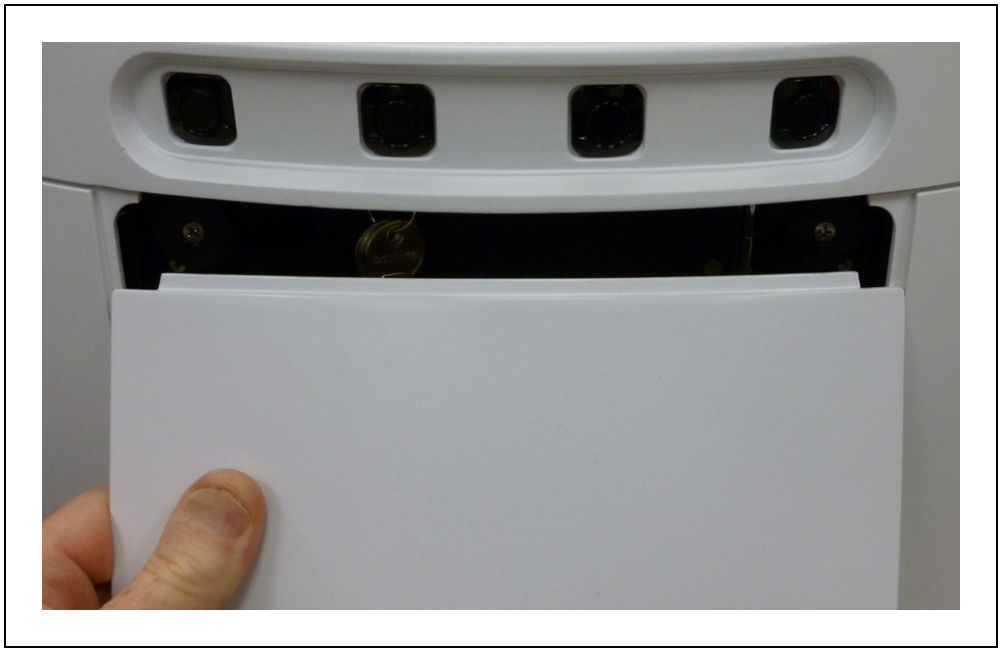


Figure 3-15. Lowering the Rear Cover

Refer to Removing and Installing LD Cart Transporter Covers in the Maintenance section for cover removal and installation.

1. Remove the inner rear platform cover.
    a. Pull the bottom of the cover away from the platform chassis.

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

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

Figure 3-16. Battery Compartment, Connectors

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

   The battery weighs 17 kg (37 lbs).

   There are recesses at the front and the back of the battery, to aid in lifting it.

Figure 3-17. Battery Recesses, for Gripping

The battery is designed to be lifted and replaced by one person, using one hand in each of the grips, as shown in the following figure.

Figure 3-18. 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.
5. Close the battery compartment door to secure the battery in place.

   The battery compartment is designed to hold the battery tightly, so that it will not move within the compartment, once the door is closed.
6. Reinstall the inner rear platform cover.

Installing the Docking Station

The automated docking station can be used for either manual or automated charging of your transporter's battery.

The docking station sits on the floor. It can be attached to a wall with the wall bracket, attached 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 transporter docks. Each docking station comes with a wall bracket and floor plate.

CAUTION: It is very important that the docking station be mounted with one of these methods, or the transporter will simply move the docking station when it tries to dock, rather than docking successfully.

Regardless of mounting method:

- Locate the docking station near an AC outlet with 1 - 2 meters (3.25 - 6.5 ft) of clear space in front to ease the transporter's maneuvers onto the docking station.
- When docked, the rear-facing laser extends almost 5 in. beyond the back of the docking station. Ensure that you leave enough free space behind the back of the docking station to allow clearance for this.

  The wall-mount bracket provides enough room for this.
- The top of the docking station foot is spring-loaded, and lifts off of the bottom of the foot slightly to accommodate variations in the floor surface. The weight of the transporter will push the top of the foot down.

Requirements

- 100 to 240 VAC, 50 to 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

NOTE: This is the recommended method for mounting the docking station.

1. Attach the docking station mounting bracket to a wall, with the bottom edge of the bracket 98 ± 20 mm (3.9 ± 0.8 in.) 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:

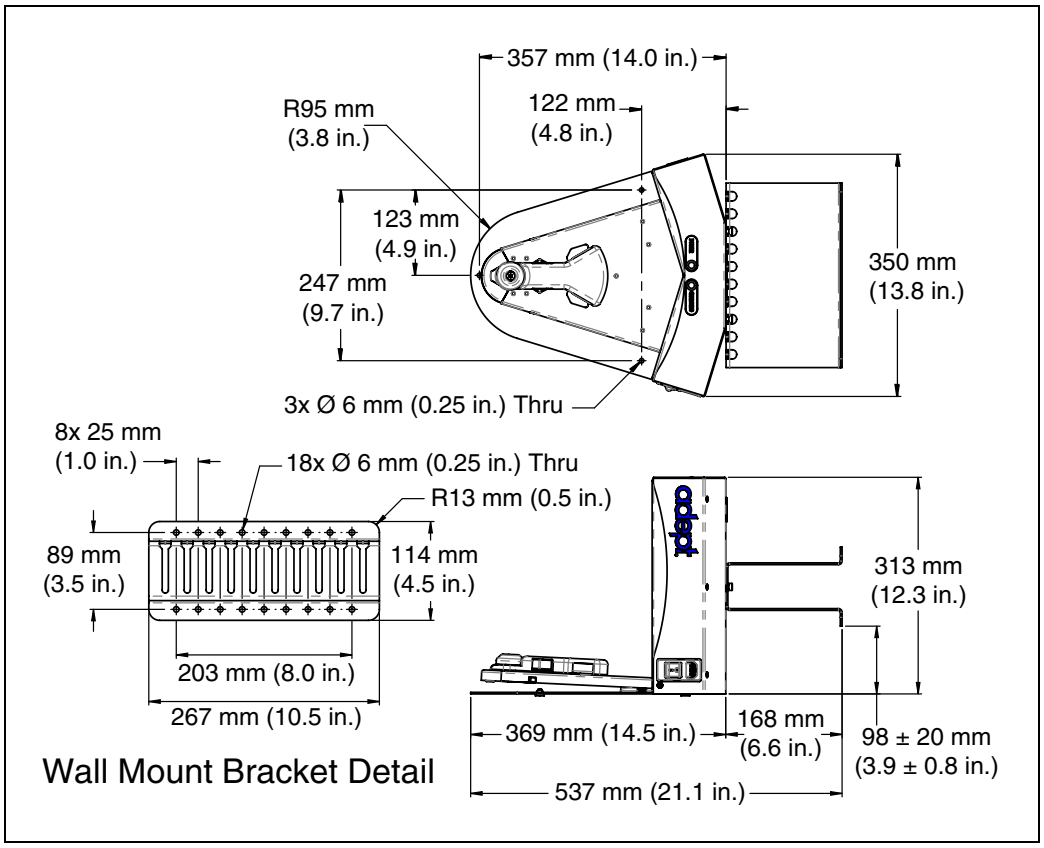


Figure 3-19. Docking Station, Wall Mount

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).

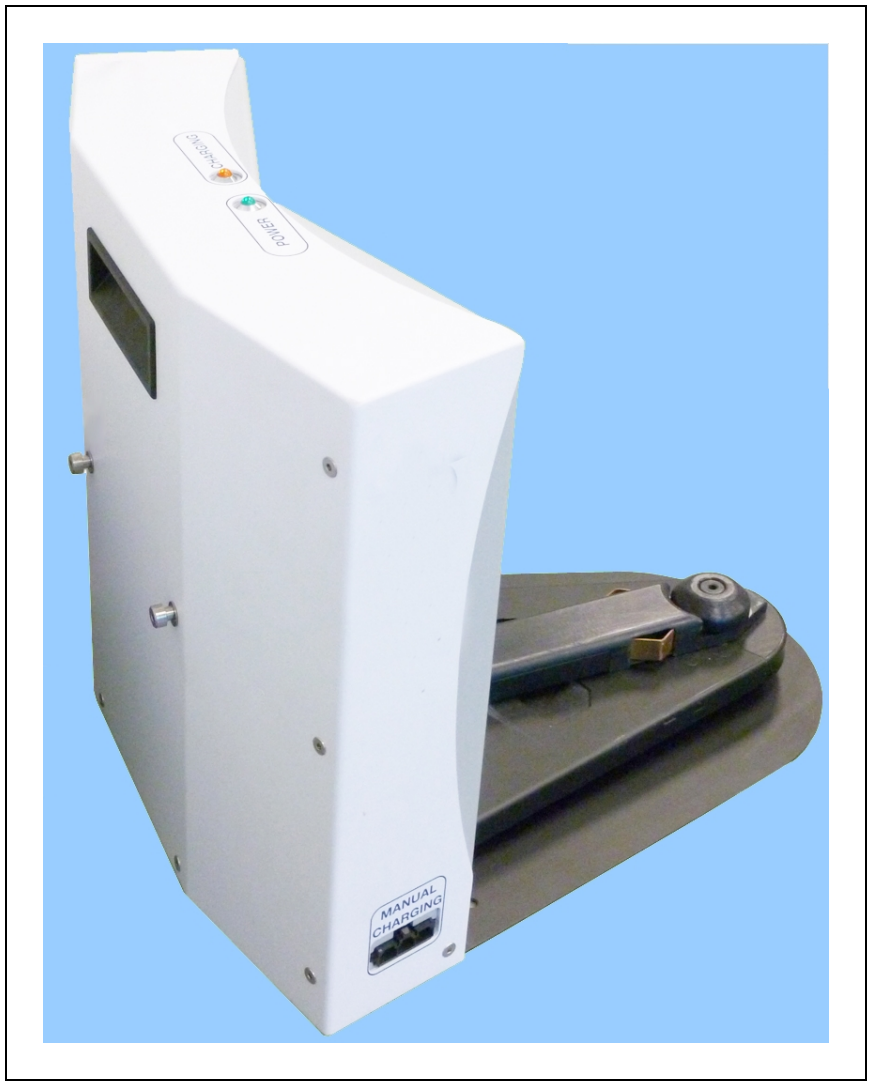


Figure 3-20. Rear View of Docking Station with Shoulder Bolts

3. Lower the docking station down, so the two shoulder 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

> **NOTE:** Because this method permanently attaches the dock to the floor, it may be subject to building code regulations. It is the user's responsibility to verify that the installation is in compliance with local regulations.

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 3-19. We recommend M5 self-tapping or M4 drywall 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 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 platform on the floor plate will keep the docking station from moving.

Figure 3-21. 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.

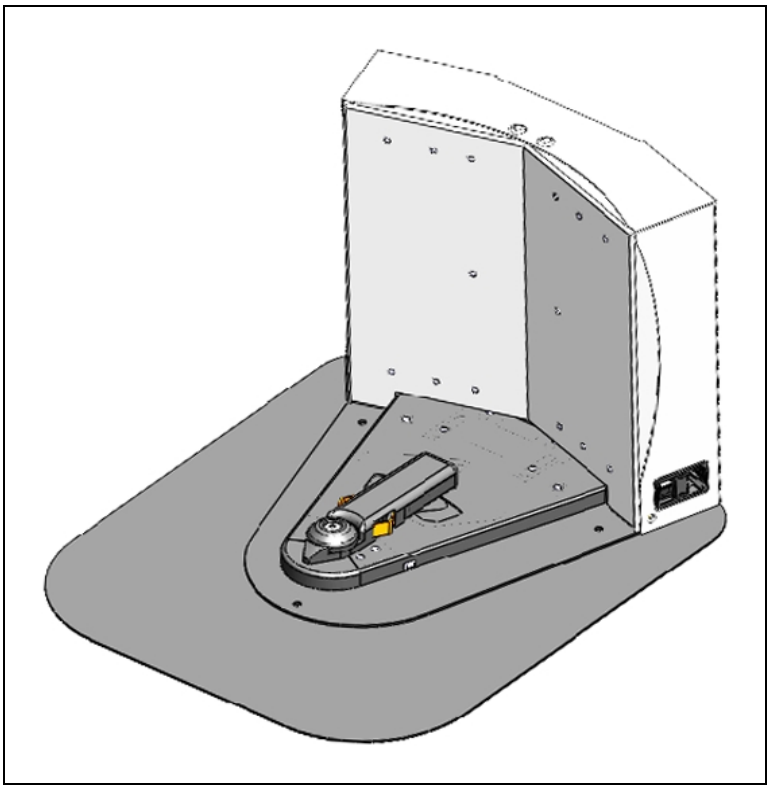


Figure 3-22. Docking Station, Mounted on Floor Plate

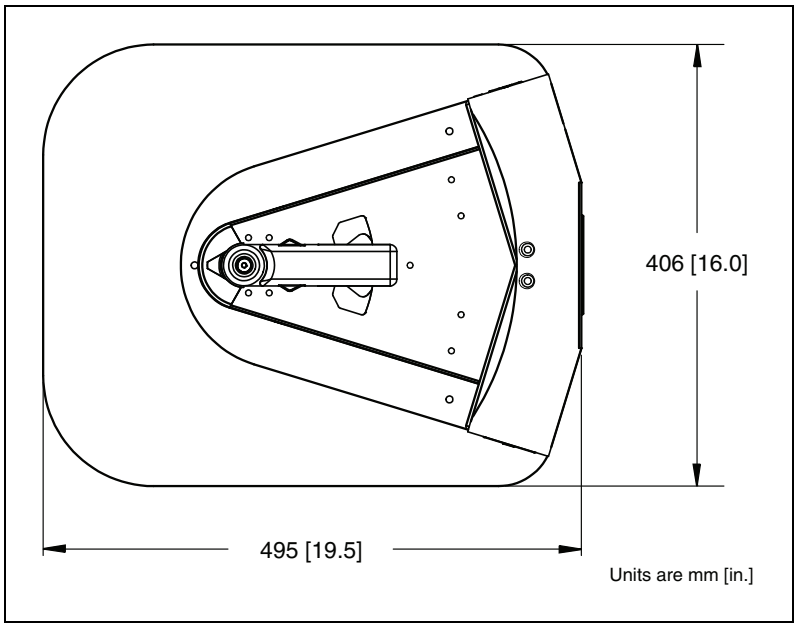


Figure 3-23. Docking Station Floor Plate Dimensions

Power On

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 is shipped 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.

> **NOTE:** Squeeze and keep the docking station foot against the bottom of the docking station 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 in.) for each notch. See the following figure.

The height of the contacts should be set 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.

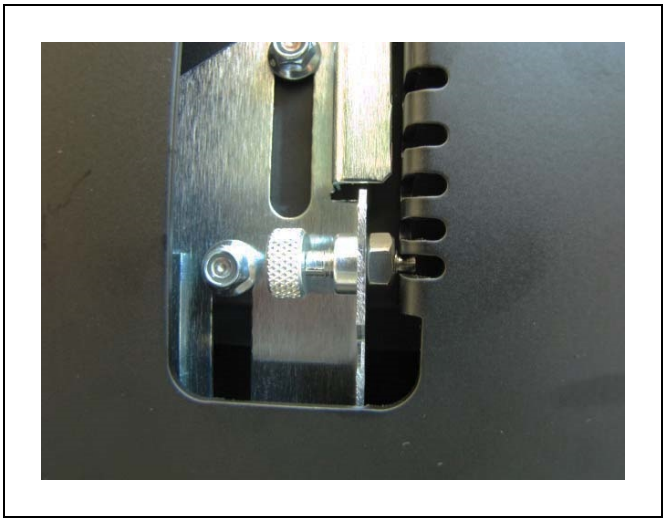


Figure 3-24. Docking Station Contact Adjusting Pull-Knob

3.5 Installing the Cart Brake Release

The two rear casters of the cart have brakes, which push a blunt pin against the caster rolling surface to prevent the cart from rolling when it is parked on a floor that is not perfectly level.

Figure 3-25. Cart Caster Brake, Showing Spring and Pin

To allow an Operator to release the cart brakes when there is no cart transporter present, each cart comes with a brake-release cable and lever, similar to a bicycle brake, that releases the cart brakes when squeezed.

> **NOTE:** The cart brake-release mechanism is actuated by the cart transporter when it couples with the cart, so the cart will roll freely with the transporter. This part of the brake release does not requires any user setup or adjustment.

Installation

The cart brake cable is attached on one end to the cart brake-release mechanism, and outfitted on the other end with a bicycle-style brake lever, to release the cart's brakes and allow an Operator to move the cart manually. It is up to the user to mount the brake-release lever at some location on the cart, and route the brake-release cable from the brake-release lever to the actuator. The brake-release lever comes with a 1524 mm (60 in.) cable. The lever has a clamp the fits a 22 mm (7/8 in.) tube.

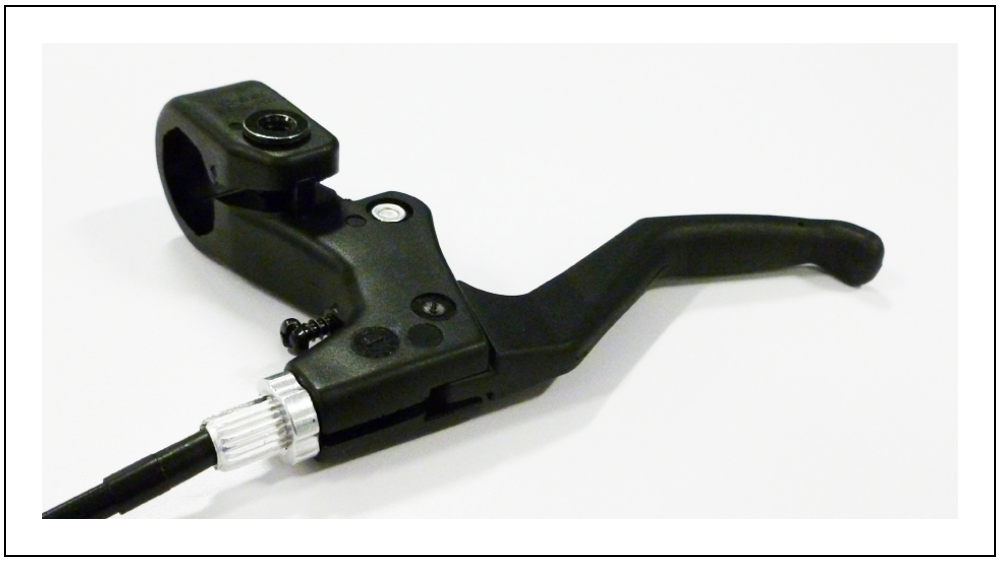


Figure 3-26. Brake-release Lever

CAUTION: It is important that the brake-release handle be mounted in an ergonomically-suitable location, so an Operator can repetitively release the brakes without risking injury.

The actual mounting location and procedure for the brake-release handle are not covered here due to the variability that is possible in cart structure designs. Ensure that no part of the cart brake-release cable bends more than a 76 mm (3 in.) radius.

There is a 6.4 mm (0.25 in.) horizontal hole through the rear horizontal tube of the cart. See the following two figures.

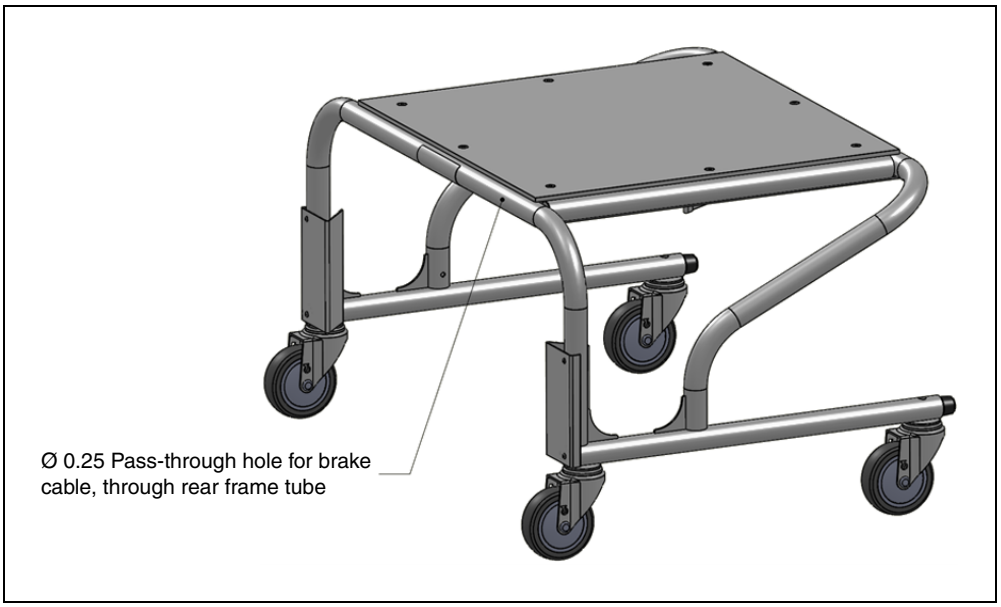


Figure 3-27. Thru-hole for Brake-release Cable

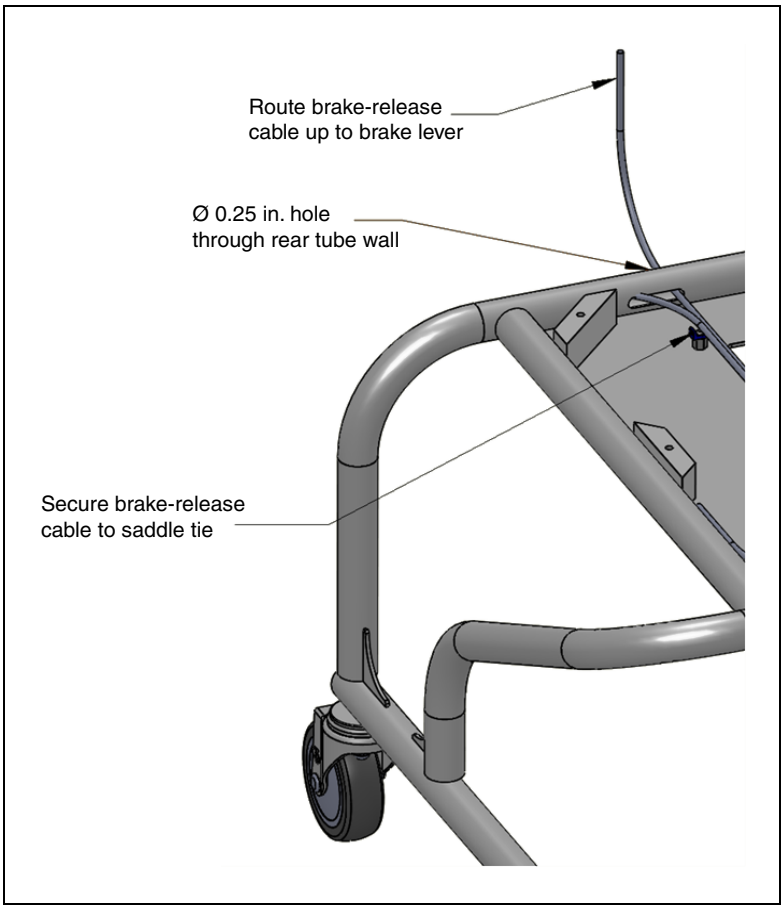


Figure 3-28. Thru-holes for Brake-release Cable, Plate Removed

After the brake-release lever has been mounted on the cart payload:

1. Push the free end of the lever cable through the hole in the cart's upper-rear horizontal tube.

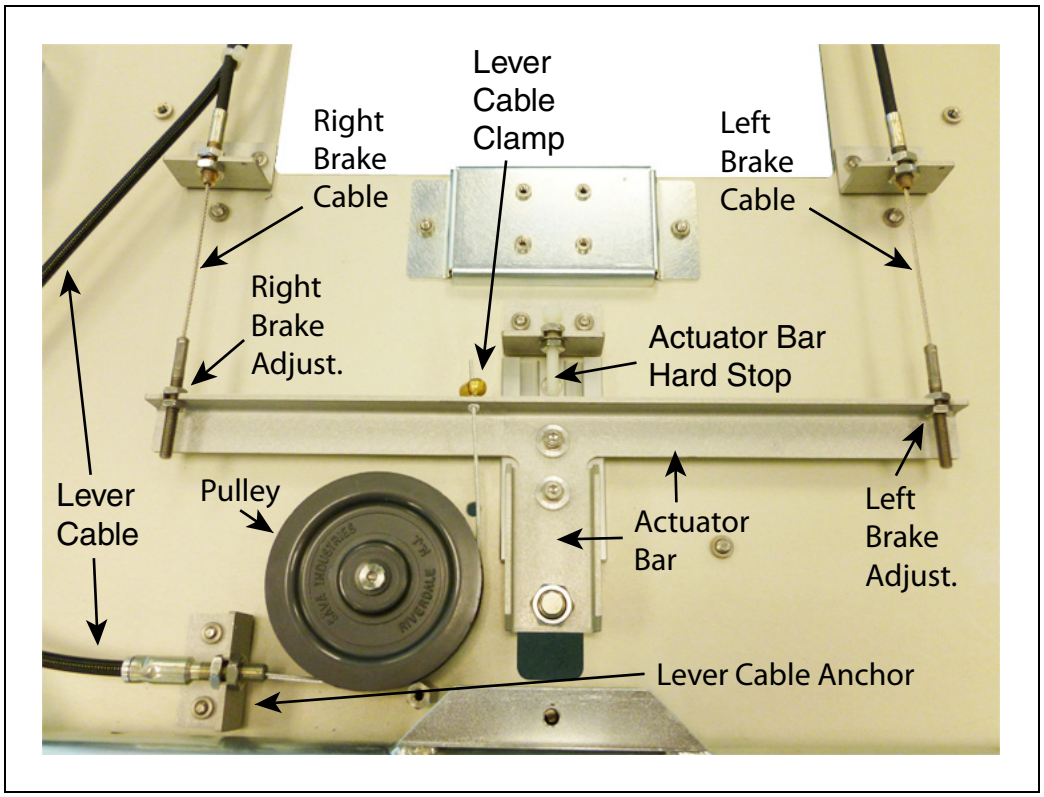


Figure 3-29. Internal Brake-Release Mechanism

2. Route the cable to the lever cable anchor.
3. Attach the actuator end of the cable to the lever cable anchor.
4. Run the inner wire of the cable around the pulley, through the bushing in the actuator bar, and through the lever cable clamp.
5. Pull the inner wire tight enough to remove slack, and tighten the lever cable clamp on it.
6. Cut off the excess inner wire, leaving a small amount protruding past the clamp.
7. Make a service loop of any excess lever cable, at least 152 mm (6 in.) in diameter.
8. Attach the lever cable housing to the saddle tie. See Figure 3-28.

Adjustment

The brake lever cable needs to be adjusted so there is no excess slack, but so the brakes are engaged when the lever is not being actuated. The two caster brake cables will be adjusted at the factory.

Brake Lever Cable

The brake lever cable should be adjusted at the lever cable clamp, shown in the prededing figure. There should be just enough slack so the actuator bar touches its hard stop.

Caster Cables

These should be adjusted correctly from the factory. If any adjustment is needed, refer to the preceding figure for the adjustment location. The brake pins should be able to go down as far as the caster surface allows, without any slack. The jam nuts on the two brake adjustments should be installed using a threadlocker.

Actuator Bar Hard Stop

After the caster cables are adjusted correctly, ensure that the actuator bar just touches its hard stop. This will keep the actuator bar in position if you have to adjust the lever cable.

Chapter 4: Configuration

The LD Cart Transporter comes with firmware and on-board software installed.

Configuration of an LD Cart Transporter is done using the MobilePlanner software. Configuration includes generation of the map that the robot will use for navigation. The cart parking goals need to be added to that map. This manual only provides an overview of that process, which is covered in detail in the *Mobile Robot Software Suite User's Guide*.

CAUTION: The MobilePlanner dongle, which contains the license for running the software, should be locked up when not in use, to prevent unauthorized modifications to your system configuration. The software should be turned off when not in use.

Other setup, mostly for communication, is handled by 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.

The transporter navigates using a map, generated with the MobilePlanner software. The operation of this software, as well as the downloading of the resultant map to the platform, is covered in the *Mobile Robot Software Suite User's Guide*.

> **NOTE:** The map must be generated and downloaded to the platform before you can perform the steps covered in this chapter.

By default, the robot core, safety scanning laser, and some auxiliary power start automatically when you press ON.

4.1 Settings and Configuration

Maintenance Ethernet Connection

To prepare your robot 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. 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 robot 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 port is on 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 10-3. This is internally connected to the Ethernet port located on the rear side of the robot 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. Accordingly, when accessing the port, manually set the offboard 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) **Start > Settings > Network Connections > Local Area Connection**

Select Properties, and, from its dialog, scroll to and double-click the Internet Protocol (TCP/IP) 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 netmask values.

Setting Up Wireless Ethernet

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

NOTE: Although an LD Cart Transporter is capable of working without wireless Ethernet if there are no other LD Cart Transporters that it needs to know about (and to avoid), that is the exception. In most cases, wireless Ethernet will be needed.

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.

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

Access the SetNetGo OS through the MobilePlanner software:

MobilePlanner > SetNetGo > Network

NOTE: It is also possible to connect directly to the SetNetGo OS on a platform through a web browser. The main intent of this is to allow 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: The following settings have to be provided by your IT department.

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

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

Ensure that, in such cases, you have adequate wireless coverage. Because of the variation possible in different environments, we don't specify what components or techniques should be used to obtain this coverage.

We suggest that you conduct a comprehensive site survey to ensure adequate wireless coverage. You can test the coverage of your wireless setup 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 in a fleet will average about 50 Kbps/AIV. This would increase if the robot is connected to the Enterprise Manager 1100, 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 robot (0.5 Mbps).

0.5 Mbps per robot 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.

4.2 Mapping

There are many options for configuring and tuning your transporter to best suit your application.

In order to have your LD Cart Transporter perform autonomous mobile activities, you need to make a map of its operating space. Configuration includes generation of the map that the LD Cart Transporter will use for navigation. The cart parking goals need to be added to that map. Use the MobilePlanner application to make the map. This manual only provides an overview of that process, which is covered in detail in the *Mobile Robot Software Suite User's Guide*.

Maps may contain a variety of virtual elements which act to modify the behavior of an robot. 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 robot-workspace interactions.

Maps contain a variety of goals, routes, and tasks that comprise the destinations and activities of the robot in the workspace. There needs to be a goal at every location where you want the transporter to be able to pick up or drop off a cart. Make sure that the goal orientations leave room for the platform to maneuver.

The tasks involved are:

- Make a floor plan scan while driving the cart transporter with the joystick.
- Load that floor plan scan into MobilePlanner, on your PC, to make and edit the 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 1100, or back to the platform, if you have only one platform, to perform autonomous mobile actions.

  The Enterprise Manager will automatically download the new map to each robot in your fleet as soon the robot becomes idle.

- If you have multiple, separate working spaces, which will each require their own map, you can save map collections and deploy your platform in any of your working spaces by selecting the appropriate map file.

NOTE: It is a good idea to have the automated docking station installed prior to creating the map scan. Its distinctive diagonal face will be useful in locating and setting it up in the map.

Setting Up Cart-Parking Goals

Any location where you want a cart to be picked up or dropped off needs to have a corresponding goal on the map. Pay special attention to the direction of the goals, as the transporter may need extra room to maneuver into the correct position for coupling.

Marking Cart-Parking Goals on Floor

The purpose of marking the parking goals on your floor is so that a human being knows where to leave a cart, so that the transporter will find it and be able to couple with it.

Even if people will never be moving carts, this step is recommended, so that someone doesn't place other items where a cart needs to be parked.

If people will be moving carts, make sure that your markings include the direction of the goal, so the transporter will be approaching from the correct direction.

The easiest way to accurately mark the goals where a cart may be parked is to send the transporter to each cart-parking goal, and, while the transporter is at the goal, put down tape markings that include the size of the cart, as well as the transporter's orientation. The transporter will always approach the goal from the same direction, so the cart needs to be oriented correctly.

4.3 Configuring a Touchscreen

You configure the touchscreen's appearance and behavior with the MobilePlanner software. The tasks include setting the mode to use, setting up goals for relocalization, and specifying a custom screen logo and the language to be used for the display.

Touchscreen Ethernet Setup

The touchscreen plugs into the User LAN port on the platform's core.

NOTE: After making and saving changes within User LAN Ethernet Settings, the platform has to be power-cycled for those changes to take effect. If the only change is to enable DHCP, then the platform does not have to be power-cycled.

In the MobilePlanner software, select:

MobilePlanner > SetNetGo

Network > User LAN Ethernet

Ensure that:

- the IP address subnet doesn't conflict with the Wireless Ethernet IP subnet
- Interface mode is set to Accessory
- DHCP Server for Accessories is set to Enable
- DHCP IP Range is large enough to provide IP addresses for all connected devices

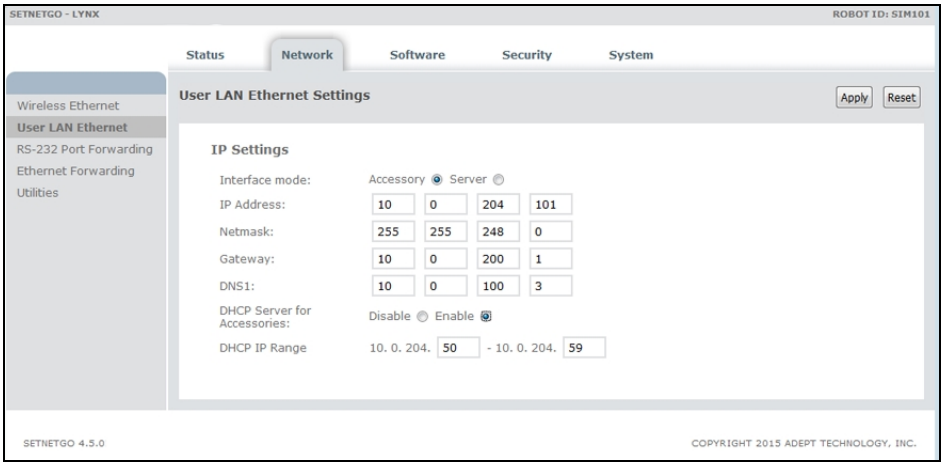


Figure 4-1. Accessory and DHCP Server for Accessories Enabled

Operating Modes

Specify the touchscreen mode: either Choose Dropoff or Patrol Route.

- Choose Dropoff mode allows the Operator to input the next dropoff goals.
- Patrol Route mode simply drives around a specific route. The robot will have goals that it stops at, but the Operator will not be able to alter the order of those goals.

For Choose Dropoff, you specify how many dropoff buttons there will be, and how each button is labeled, as well as the goal on the robot's map that gets associated with each button.

For Patrol Route, you specify the name of the route and whether to start the patrol on bootup. The route will include whatever goals the robot will stop at, and how long it will wait at each specific goal.

These parameters are accessed from:

MobilePlanner > Config, then **Robot Interface > Touchscreen**

Select either Choose Dropoff or Patrol Route with the **Pages > MainPage** parameter, which has a dropdown selection box.

Choose Dropoff Mode

The following parameters only apply to the Choose Dropoff mode.

Dropoff Priority

This is accessed under **Pages > ChooseDropoffPage**.

You can enable high-priority dropoffs, which will be serviced before normal-priority dropoffs. The Operator can specify that a goal is high-priority when it is being selected for the upcoming dropoff.

AllowHighPriorityDropoffs

This allows some dropoffs to be specified as high-priority. This is enabled by default, and you can disable or re-enable it in the MobilePlanner software.

HighDropoffPriority

This is the priority assigned to any dropoff that is specified as high-priority. Higher priority jobs will be serviced before lower-priority jobs by the queuing manager. This has no effect if AllowHighPriorityDropoffs is disabled.

Dropoff Buttons

This is accessed under **Pages > ChooseDropoffPage**.

DropoffButtonCount

This specifies the total number of buttons that will be available on the touch-screen page. You can scroll the page to see other buttons, if all of the buttons cannot be displayed at once.

DropoffButtonx

There will be a DropoffButton1 through DropoffButtonx, where x = DropoffButtonCount. Each contains the two following parameters:

GoalName

This is a combo box that lists all of the goals that have been created on the map. Select the map goal to be serviced when this dropoff button is pressed.

> **NOTE:** A goal can have a wait time associated with it, to give an Operator time to load or unload the robot. This is configured, in the map, using the MobilePlanner software.

You can eliminate a button from the screen by making GoalName blank. The other buttons will fill in, so there will be no blank spaces in the screen.

ButtonLabel

This is the text label displayed on the dropoff button. If empty, the GoalName is displayed.

Patrol Route Mode

The following parameters only apply to the Patrol Route mode.

In this mode you need to specify the name of the Patrol Route that the robot will patrol. The route needs to have already been set up using the MobilePlanner software. You also need to specify if the robot will start its patrol automatically, or if it requires an Operator to press Go.

Select **Pages > PatrolRoutePage**

- In RouteName, enter the route to be patrolled.
- Check AutoStartRoute for the robot to start its patrol as soon as the Patrol Route screen is displayed (the touchscreen has finished booting).

Localization Goals

You need to configure at least one localization goal. You can configure more if you want. A localization goal is needed to relocalize a lost robot from the touchscreen.

Each localization goal should have:

- a heading

  The robot will need to be aligned with the heading when relocalizing.

  This applies to both laser and Acuity localization.

- mapped features that don't change much

  Things that get moved frequently, such as pallets, chairs, or carts do not make good mapped features, because the map will not match what the laser is seeing.

- mapped features that don't get blocked

  If a mapped wall is often used for stacking boxes or storing carts, the laser may have trouble seeing the wall behind those objects.

- multiple visible lights, when using Acuity localization

  The more lights the robot can see, the better.

- a high localization score

  This represents the percent of readings that the robot currently sees that match the features on its map.

NOTE: Localization goals do not have to be dedicated to localization - they can also be used as normal goals for regular use.

In MobilePlanner, select:

Config > Robot Interface > Touchscreen

From there, use ChooseLocalizationPage to set LocalizationButtonCount to the number of localization goals you want, and then specify the GoalName and ButtonLabel for each.

Figure 4-2. Localization Goal Parameters

Screen Logo

In MobilePlanner, select

Config > Robot Interface > Touchscreen

From there, use Style/Appearance.

A logo is displayed in the upper-left corner of the touchscreen. The default logo is Omron, as shown in the following figure.

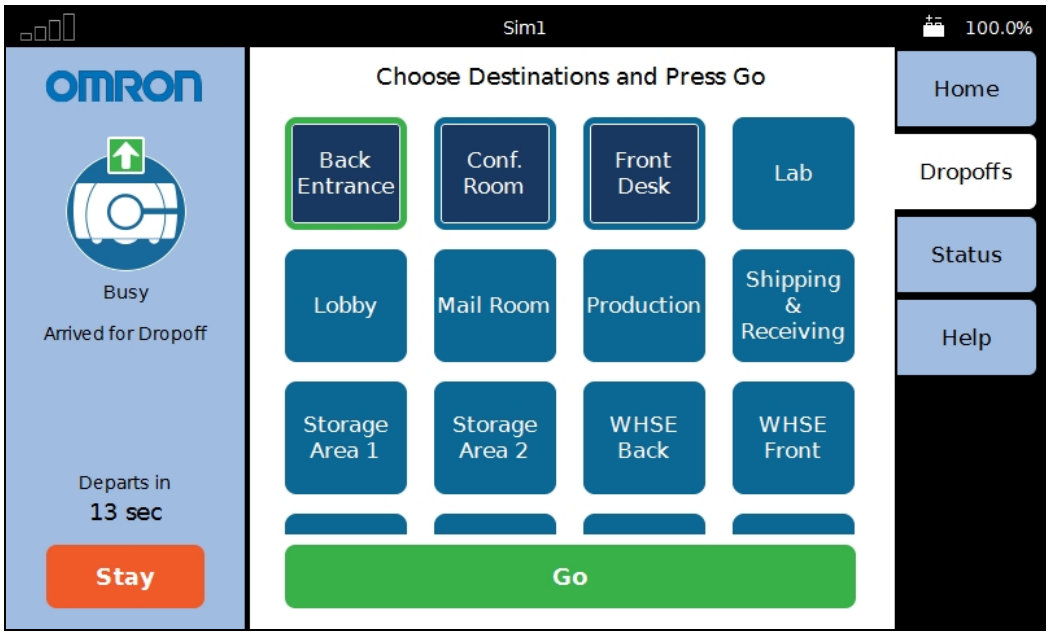


Figure 4-3. Sample Touchscreen, with Omron Logo, in Choose Dropoff Mode

You can customize this with a logo of your choosing using the following steps:

1. Upload a PNG image file to the robot using the MobilePlanner software:

   File > Download/Upload

2. Open the robot Configuration window and choose:

   Robot Interface > Touchscreen

3. Edit the SmallLogo parameter.

   a. Click the file-select button to open the file chooser.

   b. Select the newly-uploaded file.

   c. Click Open.

4. Click Save, to save the configuration.

NOTE: If the SmallLogo field is left blank, the default Omron logo will be displayed.

NOTE: If a different version of the same file name is uploaded to the robot, you will need to power cycle the robot to see the change.

Screensaver

In MobilePlanner, select

Config > Robot Interface > Touchscreen

From there, use Screensaver.

If the robot is in motion when the screensaver comes on, it will use the Busy icon, and display a status message (where it's going). If the robot is not in motion, it will display the Available icon. The rounded rectangle, icon, and any text inside the rectangle will move around the touchscreen display area.

Screensaver Enabled

This is a checkbox that determines whether a screensaver is displayed when the touchscreen is inactive. Checking the box enables the screensaver.

TimeoutSeconds

This is the number of seconds that will elapse before the screensaver is turned on. This has no effect if the Screensaver Enabled box is not checked. The range is 1 - 999 seconds.

StayOnTouch

This is a checkbox that determines if touching the screensaver has the same effect as touching Stay. If this is checked, the robot will stay when the screensaver is touched.

Display Language

You can select what language is used for the display from a dropdown box in the MobilePlanner software.

> **NOTE:** Some messages from the robot will be in English, regardless of the language set here. These include status and mode messages.

From MobilePlanner, select:

> **Config > Robot Interface > Language/Location**

Select RobotLanguage, which has a dropdown selection box.

This parameter is not touchscreen-specific, so it may affect other displays that involve written language. As of this writing, only the touchscreen is affected. This parameter does not affect synthesized speech.

Contact Information

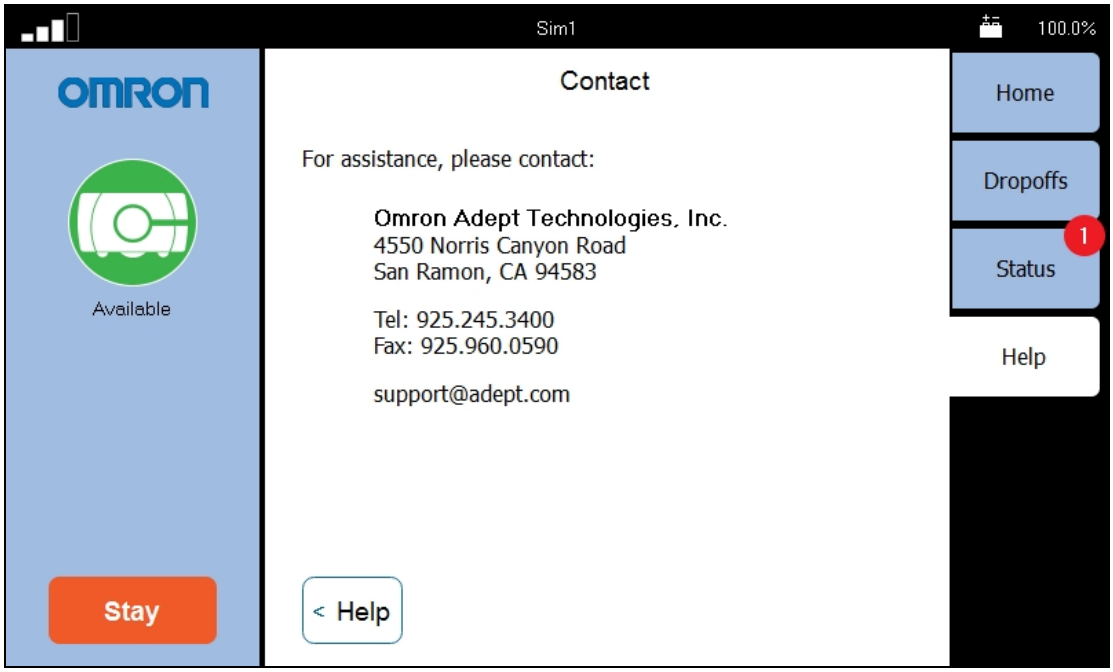


Figure 4-4. Help Screen, with Contact Information

Help shows installed software and contact information.

> **NOTE:** No contact information will be displayed unless it is set up in the MobilePlanner software.

In **MobilePlanner > Config**:

- **Robot Interface > Touchscreen > ContactInformation**
- Check the ShowContactPage checkbox.
- Enter appropriate information in ContactName and the fields following it.

4.4 Acceleration, Deceleration, and Rotation Limits

Reducing the absolute max allowable linear and rotational acceleration, deceleration, and speed will affect the size of the allowable CG envelope, but it may 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, Service can work with your system designer to input your needs into our models.

Contact Omron Adept Technologies, Inc. for details. See Support on page 17.

If your payload's center of gravity is not within the guidelines given in the Payloads chapter, you will need to adjust the Absolute Movement Maximums parameters in the MobilePlanner software.

From the MobilePlanner software, Config:

Robot Physical > Absolute Movement Maximums

Show Expert + Parameters needs to be checked to see or modify these parameters.

The first two parameters and AbsoluteMaxRotVel are not likely to have significant impact on the robot's stability. The Accel and Decel parameters will have a major impact. In certain cases, if the payload is lopsided, the AbsoluteMaxRotVel may need to be adjusted.

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

Parameter	Default	Min	Max
AbsoluteMaxTransVel (LD-105CT)	1300	1	2500
AbsoluteMaxTransVel (LD-130CT)	900	1	2500
AbsoluteMaxTransNegVel	-250	-2500	-1
AbsoluteMaxTransAccel	500	1	2000
AbsoluteMaxTransDecel	500	1	2000
AbsoluteMaxRotVel	100	1	180
AbsoluteMaxRotAccel	180	1	360
AbsoluteMaxRotDecel	180	1	360

4.5 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 (S300), 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).
- Laser_5 Settings are for the coupling laser (TiM).
- Laser_6 Settings are the rear-facing laser (TiM).

Chapter 5: Payloads

5.1 Safety

Drive Warning Light

For CE compliance, a mobile robot is required to have a readily-visible warning light, when it is either ready to move or is moving. The platform comes with light discs on each side, and the HMI post has a beacon, designed to be higher than a normal payload, to do this.

If you have a payload that blocks the beacon, 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 beacon not always visible. The core has a Light Pole connector, which is covered in the Connectivity chapter in Robot Core Rear, Upper on page 97. This can be used to drive a warning light in a more prominent location for taller payloads.

Turn Warning Lights

A mobile robot is also required, for CE compliance, to have readily-visible turn warning lights, when it is either turning or about to turn. The platform's light discs indicate that the robot is turning, and in which direction.

If you have a payload that blocks the beacon, 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 beacon not always visible. The core has a Light Pole connector, which is covered in the Connectivity chapter in Robot Core Rear, Upper on page 97. This can be used to drive a warning light in a more prominent location for taller payloads.

5.2 Considerations

Dimensions

You must keep your payload no wider and no longer than the cart.

Take care to keep all of the sensors exposed. If any of the sensors get blocked, the robot won't be able to function as intended. This is critical in the case of the lasers.

The payload design must not obstruct the side lasers' field of view.

If you have Acuity localization, you need to make sure that the height of your payload does not obstruct the camera's field-of-view. The Acuity camera lens has a 140° field-of-view, so take care that nothing higher than the camera lens is close beside the camera.

Pinch Hazard

There is a potential, with an improperly-designed cart payload, to create a pinch hazard between the payload and the HMI post.

CAUTION: Potential pinch hazard. Ensure that there is enough space between the HMI post and your payload, when the transporter and cart are coupling, that it is not a pinch hazard.

Weight

Run-time between charges is a function of payload weight. A heavier payload will result in a shorter run-time. If you have added any options to the transporter that draw power from the transporter battery, that will also result in decreased run-time.

Center of Gravity

When adding payload, the center of gravity of the entire cart and payload needs to be considered.

As much as possible, you should keep the payload center of gravity centered on the cart, and as low (close to the platform top) as possible. This will give you the best stability, particularly when turning or crossing irregularities in the floor.

The payload should be centered on the cart left-to-right, but biased toward the rear of the cart according to the following plots.

The following figures show the calculations of safe placements for the center of gravity for payloads with the weights listed. The center of gravity, in each instance, needs to be within the area shown. All units are mm.

WARNING: These figures show centers of gravity for the listed parameter settings only. They do not apply to any other parameter settings. Even small changes in these parameters can change the safe CG area drastically.

105 kg

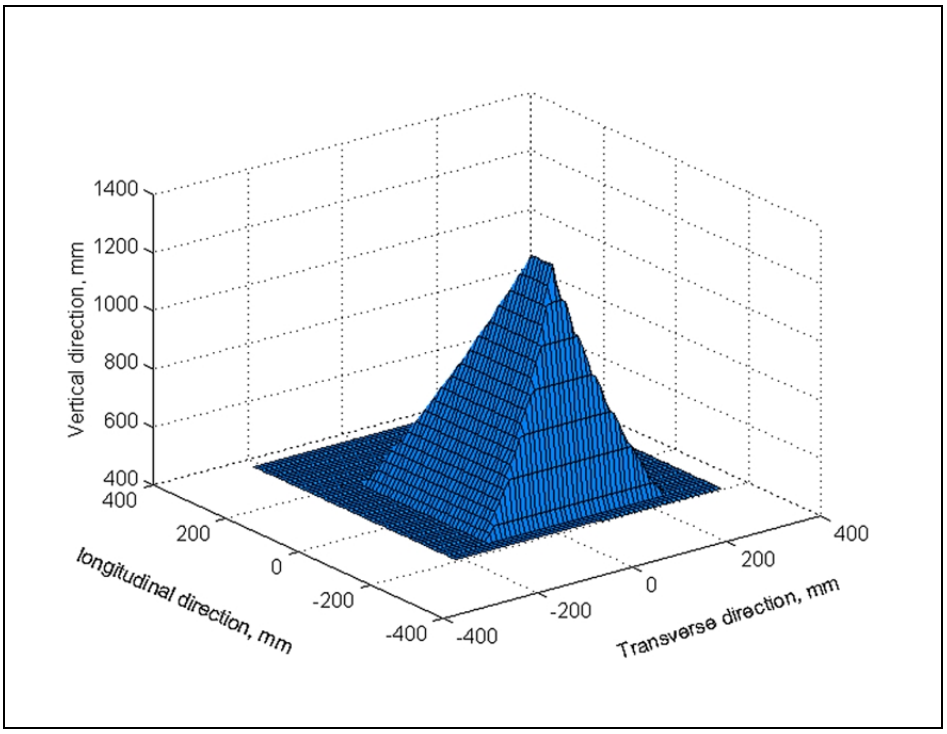


Figure 5-1. Isometric View, 105 kg

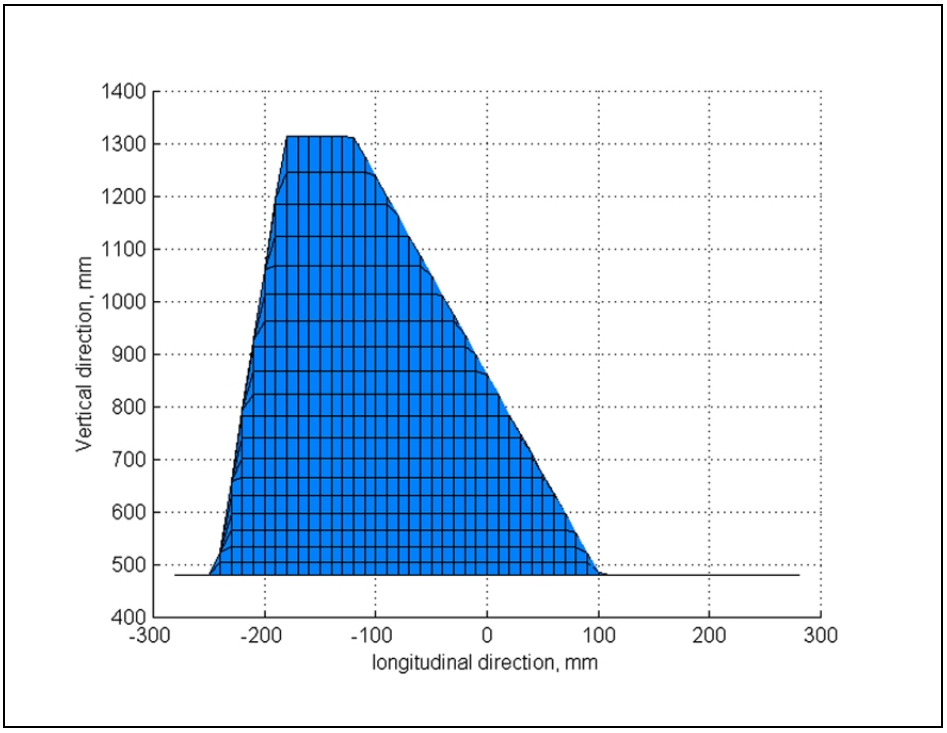


Figure 5-2. Longitudinal View, 105 kg

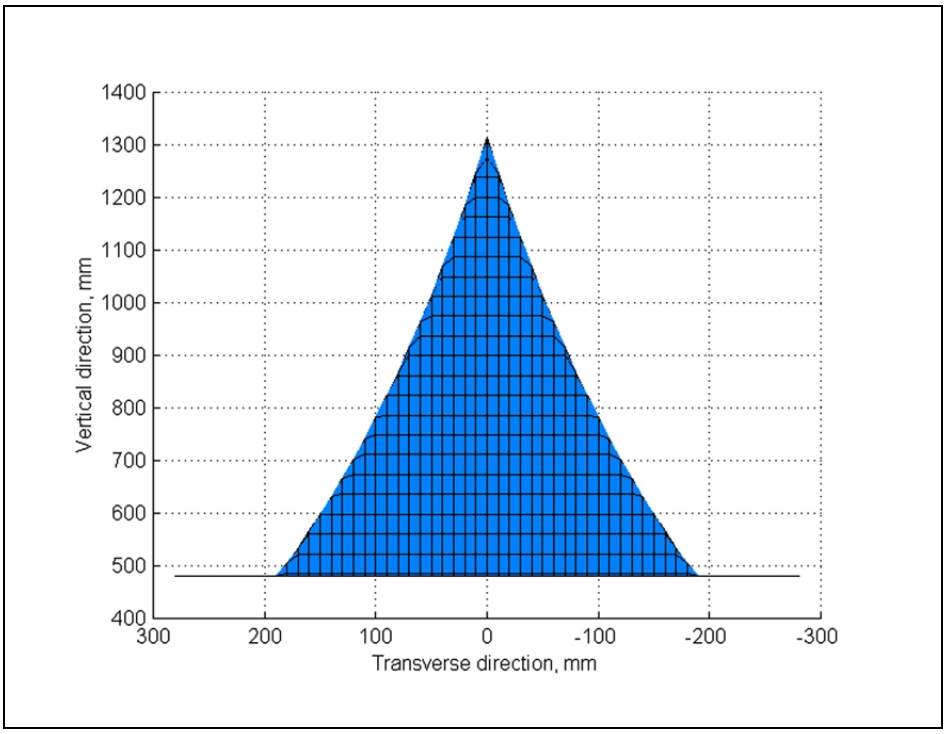


Figure 5-3. Transverse View, 105 kg

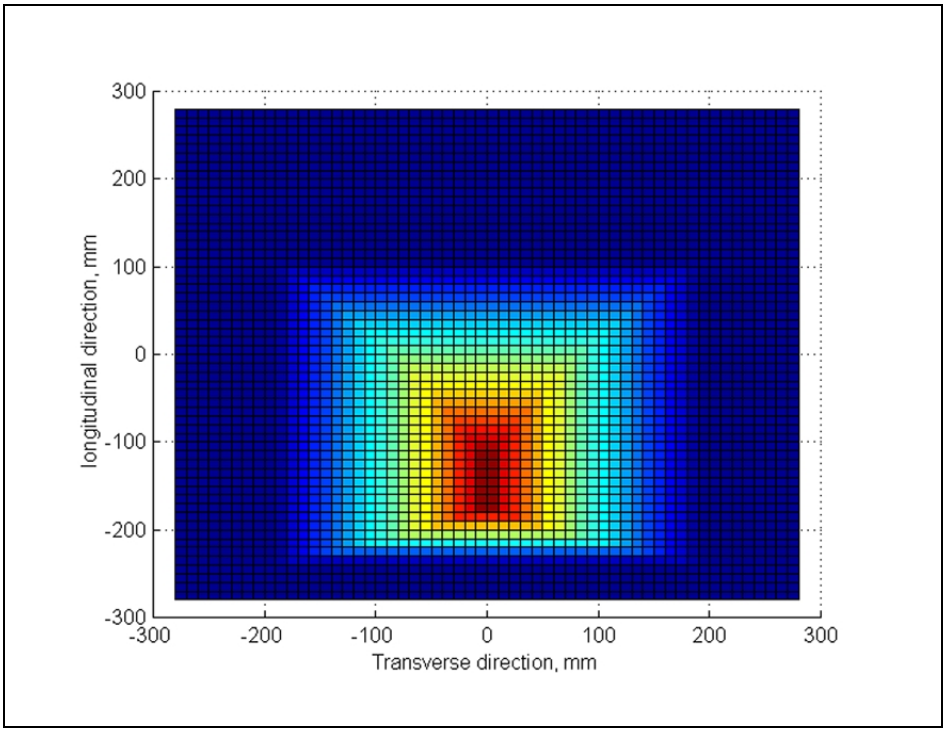


Figure 5-4. Top View, 105 kg

130 kg

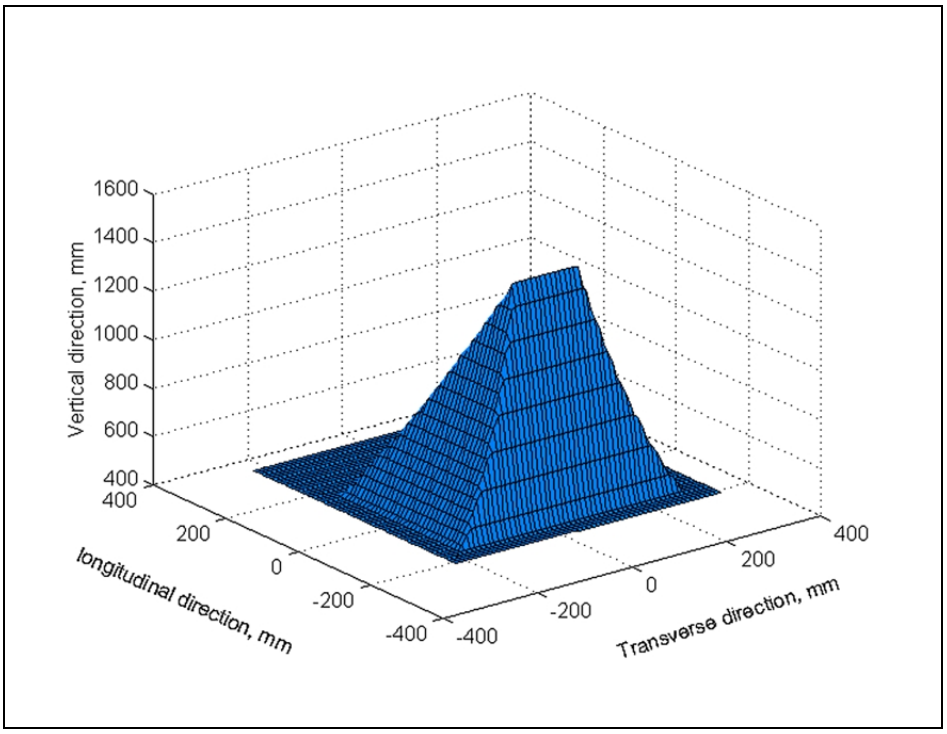


Figure 5-5. Isometric View, 130 kg

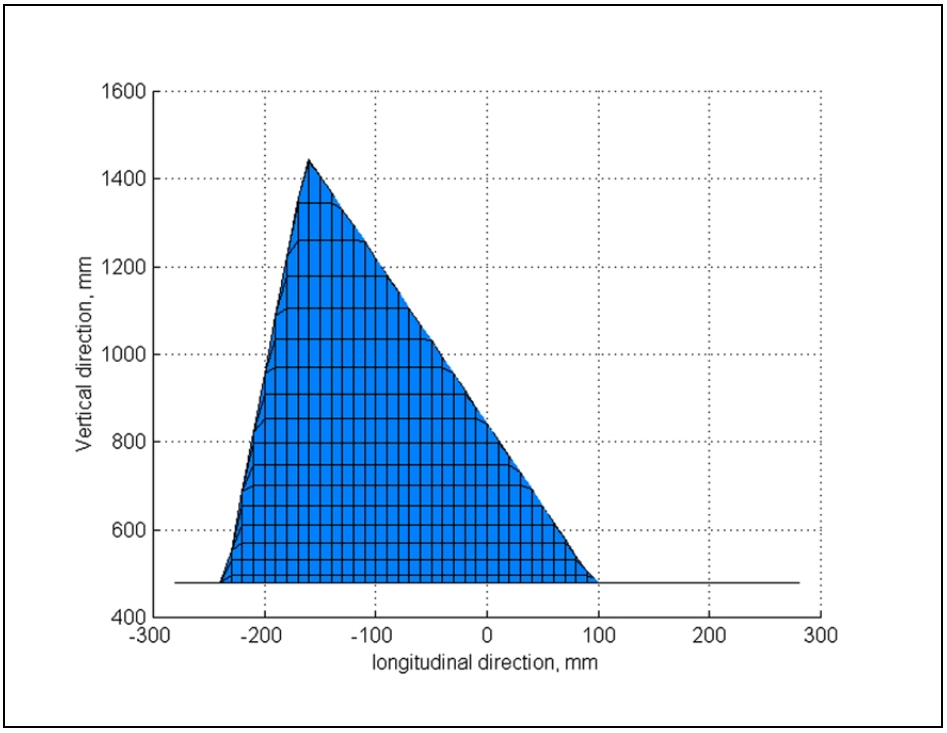


Figure 5-6. Longitudinal View, 130 kg

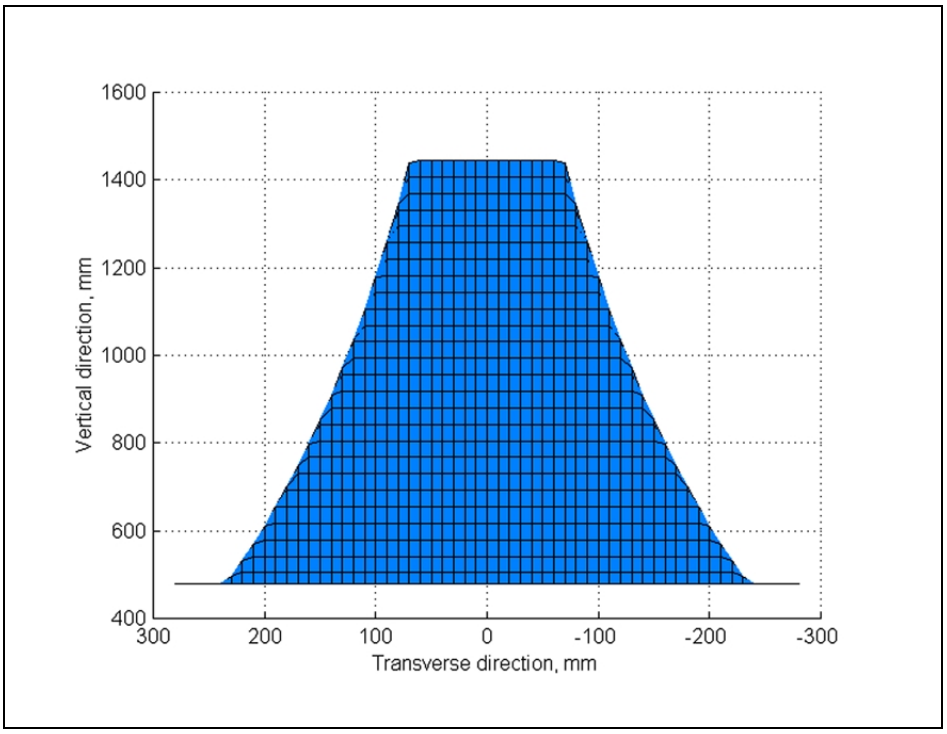


Figure 5-7. Transverse View, 130 kg

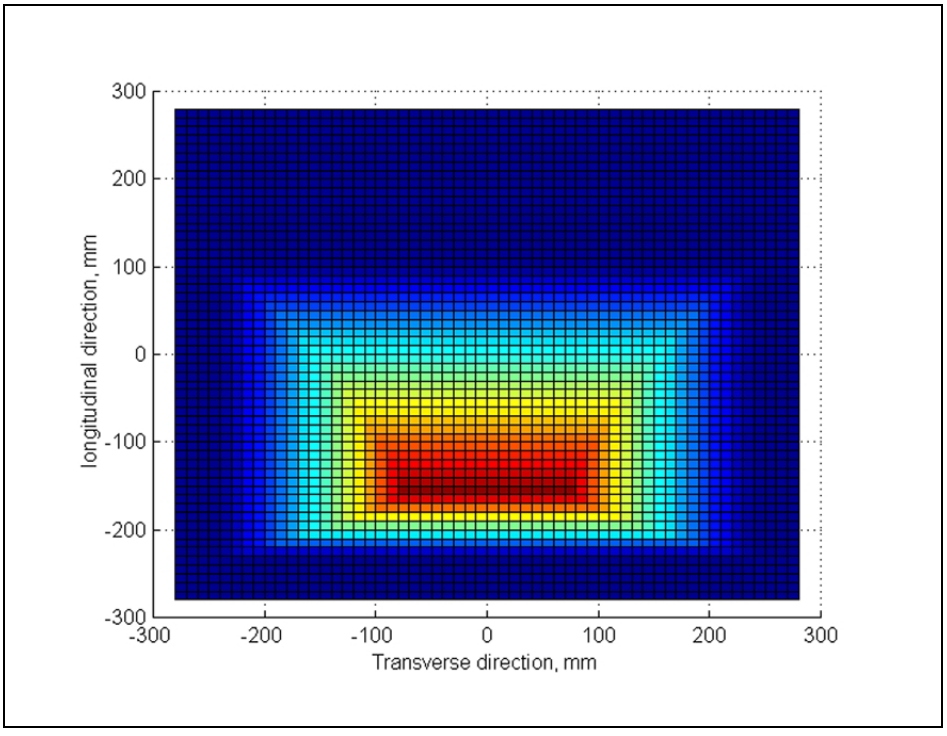


Figure 5-8. Top View, 130 kg

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 the MobilePlanner software to compensate for that.

Contact your robot provider to get a new set of plots based on parameters that differ from those used to produce the plots shown here.

In general, lowering the maximum accel, decel, and rotation speeds will be required. Refer to Acceleration, Deceleration, and Rotation Limits on page 72.

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 the platform top plate. These include I/O and power connections. Access to the payload bay is covered in Accessing the Payload Bay on page 152.

For a cart transporter system, most of these connections will not usually be used.

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. Both of these ports have a second, connected port inside the payload bay.

6.1 Required Connections

- Joystick port — In order to generate maps with the transporter, you need to connect a joystick to its 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 another Joystick port 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.

  Its IP address is 1.2.3.4, with Netmask 255.255.255.0.
  Access to the SetNetGo OS is always enabled on this interface, and does not require a password or a license.

  This is internally connected to another Maintenance Ethernet port in the payload bay.

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

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

6.2 LD Cart Transporter Connections

NOTE: All of these are in the payload bay.

NOTE: If a connection is covered in this subsection, it means that the description in the subsection Standard Platform Connections on page 89 does not apply to the transporter, because that connection is being used for a cart-specific use.

Core

- RS232-2 is used for the rear-sensing laser.
- Both the Debug Port and Aux Power are used by the coupling laser.
- Digital I/O connector.

  The transporter uses pins 9 - 16, both Input and Output.

  Pins 1-8 are available on the cart PCA.
- User Power is used for cart PCA power.
- User Interface goes through the PCA to the Operator panel.
- Aux Sensors is used for both side lasers and the low front laser.
- Light Pole goes through the PCA to the Operator panel.
- User LAN goes to the Ethernet switch in the payload bay. Two ports are spares.

Cart-Specific PCA

NOTE: Contact Omron Adept Technologies, Inc. for details.

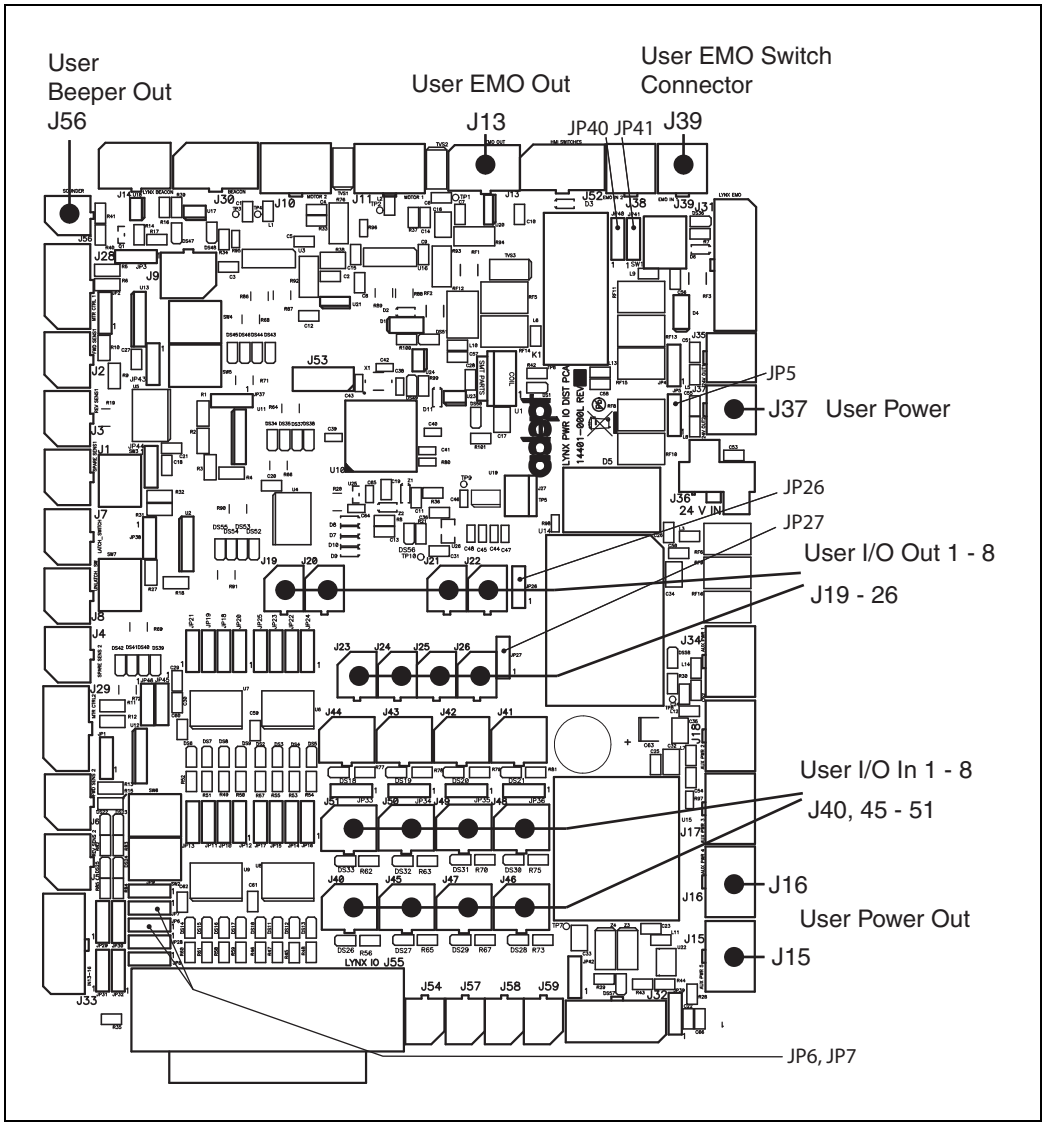


Figure 6-1. PCA Silkscreen with Callouts

User E_Stop (USER EMO OUT), J13. Micro MATE-N-LOK, mates with TE 6C 794617-6.

Pin No.	Designation	Notes
1	ESTOP 2A	Dry contact
2	ESTOP 2B	Dry contact
3	BRAKE	Use switch to connect to BATTERY (pin 5) for external brake release
4	ESTOP CTRLD POWER	(BAT) 1 A limit

Pin No.	Designation	Notes
5	BATTERY	1 A limit
6	GND	

User E-Stop Switch (USER EMO SWITCH), J39. Jumpers JP40 and JP41 must be moved to pins 1-2 for this to be functional. MiniFit Jr™, mates with MOLEX 4C 39-01-2045.

Pin No.	Designation	Notes
1	ESTOP 1A	
2	ESTOP 2A	
3	ESTOP 1B	
4	ESTOP 2B	

User Power, J15 & J16. MiniFit Jr™, mates with MOLEX 6C 39-01-2065.

Pin No.	Designation	Notes
1	GND	
2	GND	
3	GND	
4	5 V	2 A total
5	12 V	1.5 A total
6	BATTERY	22-28 V 1 A total

User Power, J37. Jumper JP5 selects battery (1/2) or E-Stop-controlled battery (2/3). MiniFit Jr™, mates with MOLEX 4C 39-01-2045.

Pin No.	Designation	Notes
1	BATTERY	1.8 A
2	GND	
3	N.C.	
4	SHIELD GND	

User I/O Outputs, J19 - J26. Micro MATE-N-LOK, mates with TE 2C 794617-2.

The return is common for each bank of four outputs, with the indicated jumper.

Connector	Designation	Notes
J19	OUT1	JP13, LED DS14
J20	OUT2	JP11, LED DS15
J21	OUT3	JP10, LED DS16

Connector	Designation	Notes
J22	OUT4	JP12, LED DS17
JP26	RETURN	Selects HI or LO for J19-J22
J23	OUT5	JP17, LED DS10
J24	OUT6	JP15, LED DS11
J25	OUT7	JP14, LED DS12
J26	OUT8	JP16, LED DS13
JP27	RETURN	Selects HI or LO for J23-J26

Pin No.	Designation	Notes
1	RETURN	0 or Battery, 22 - 29 VDC
2	OUTPUT	HI (BAT) or LO (GND)

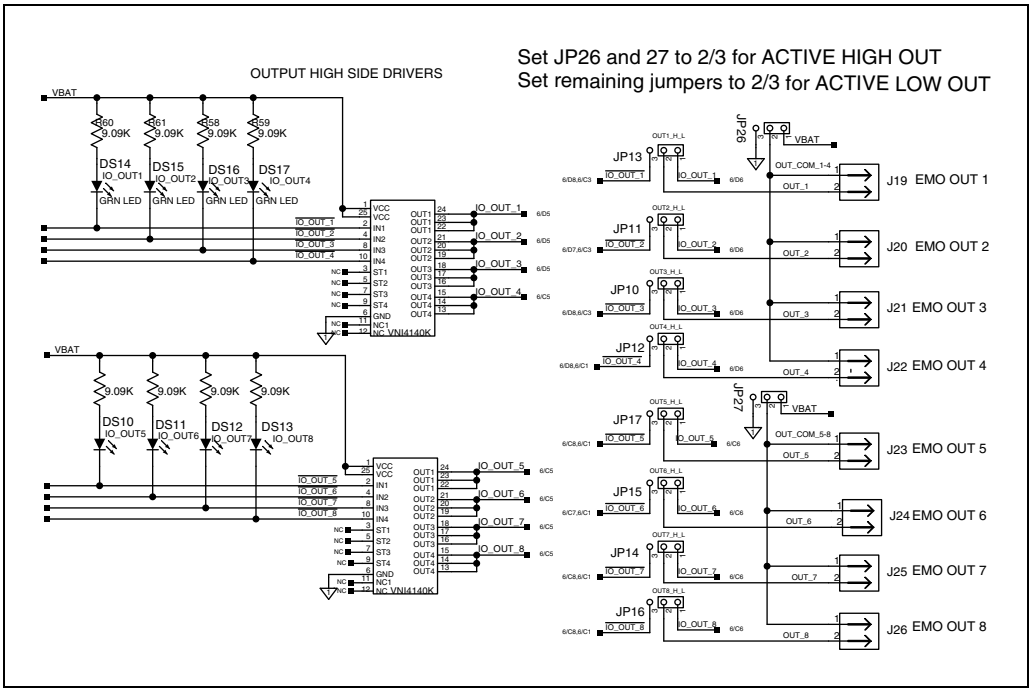


Figure 6-2. Output Schematic

User I/O Inputs, J40, J45 - J51. Micro MATE-N-LOK, mates with TE 4C 794617-4.

The return is common for each bank of four inputs, with the indicated jumper.

Connector	Designation	Notes
J40	IN1	LED DS26
J45	IN2	LED DS27

Connector	Designation	Notes
J47	IN3	LED DS29
J46	IN4	LED DS28
JP6	RETURN	Selects SINK LO or SOURCE HI for J40, J45-47
J51	IN5	LED DS33
J50	IN6	LED DS32
J49	IN7	LED DS31
J48	IN8	LED DS30
JP7	RETURN	Selects SINK LO or SOURCE HI for J48 - J51

Pin No.	Designation	Notes
1	BATTERY	22-29 VDC, 0.4 A TOTAL
2	GND	HI (BAT) or LO (GND)
3	SENSOR	
4	SHIELD GND	

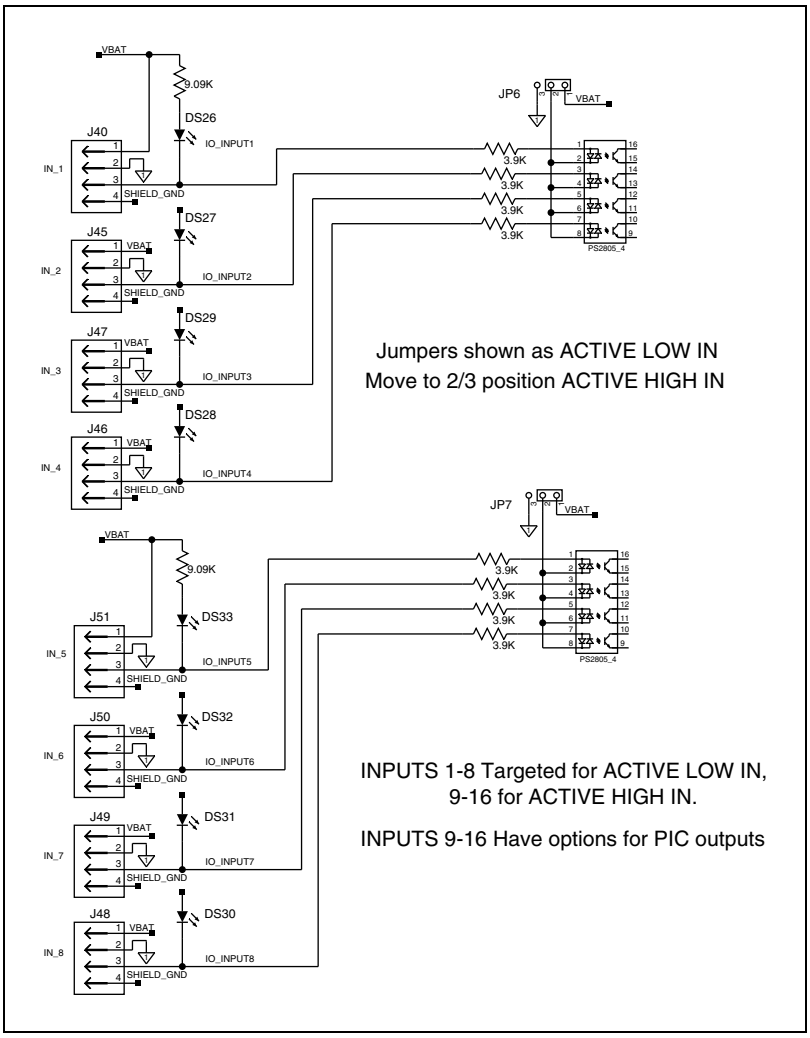


Figure 6-3. Input Schematic

User Beeper, J56. Micro MATE-N-LOK, mates with TE 2C 794617-2.

This signal goes low when the platform is moving. It can be used to drive a beeper.

Pin No.	Designation	Notes
1	BATTERY	22-29 VDC, 0.1 A
2	SOUNDER	ACTIVE LOW

6.3 Standard Platform Connections

NOTE: All of these are in the payload bay.

If there is no conflicting connection in the Connectivity on page 83, these connections are available for use with standard- and user-supplied accessories. The antennas and joystick come with the platform.

NOTE: If a connection is in Connectivity on page 83, it means that the description here does not apply to the transporter, because that connection is being used for a cart-specific use.

NOTE: Standard connectors, such as audio, are not covered here. These are on the right side of the core, shown in the following figure:

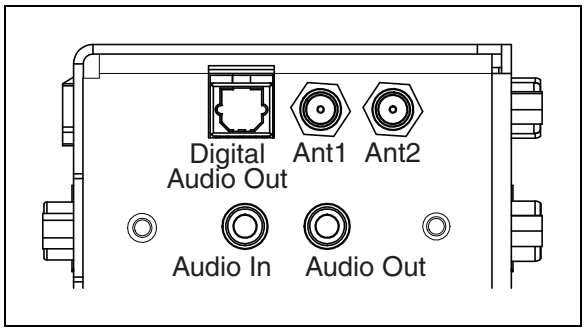


Figure 6-4. Right Side of the Core

The left end of the robot core has 12 indicator lights. Their meanings are covered in Robot Core Indicators on page 126.

Robot Core Front, Upper

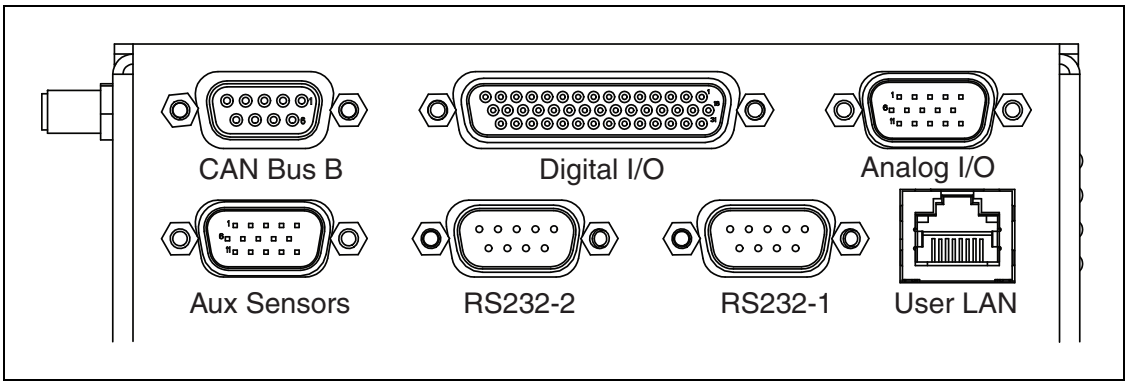


Figure 6-5. Front Upper Core

Connection	Type	Description
User LAN	RJ45, Shielded	General Ethernet, Auto-MDIX.
Aux Sensors	HDB15M	Side lasers
RS-232 x 2	DB9M	Port 1 and Port 2, general use
CAN Bus B	DB9F	Consult Support for use.
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.

Connection	Type	Description
		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. These outputs should be wired 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.
Analog I/O	HDB15M	General use

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

	Designation		
Pin No.	Hardware	Software	Notes
1	INPUT_1.1	Input_1.1	0 – 30 V Range, R_{in} = ~3.9 kΩ
2	INPUT_1.2	Input_1.2	0 – 30 V Range, R_{in} = ~3.9 kΩ
3	INPUT_1.3	Input_1.3	0 – 30 V Range, R_{in} = ~3.9 kΩ
4	INPUT_1.4	Input_1.4	0 – 30 V Range, R_{in} = ~3.9 kΩ
5	BANK1		Common for INPUT_1.X
6	INPUT_2.1	Input_2.1	0 – 30 V Range, R_{in} = ~3.9 kΩ
7	INPUT_2.2	Input_2.2	0 – 30 V Range, R_{in} = ~3.9 kΩ

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

	Designation		
Pin No.	**Hardware**	**Software**	**Notes**
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, 42, 43, 44	GND		

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.

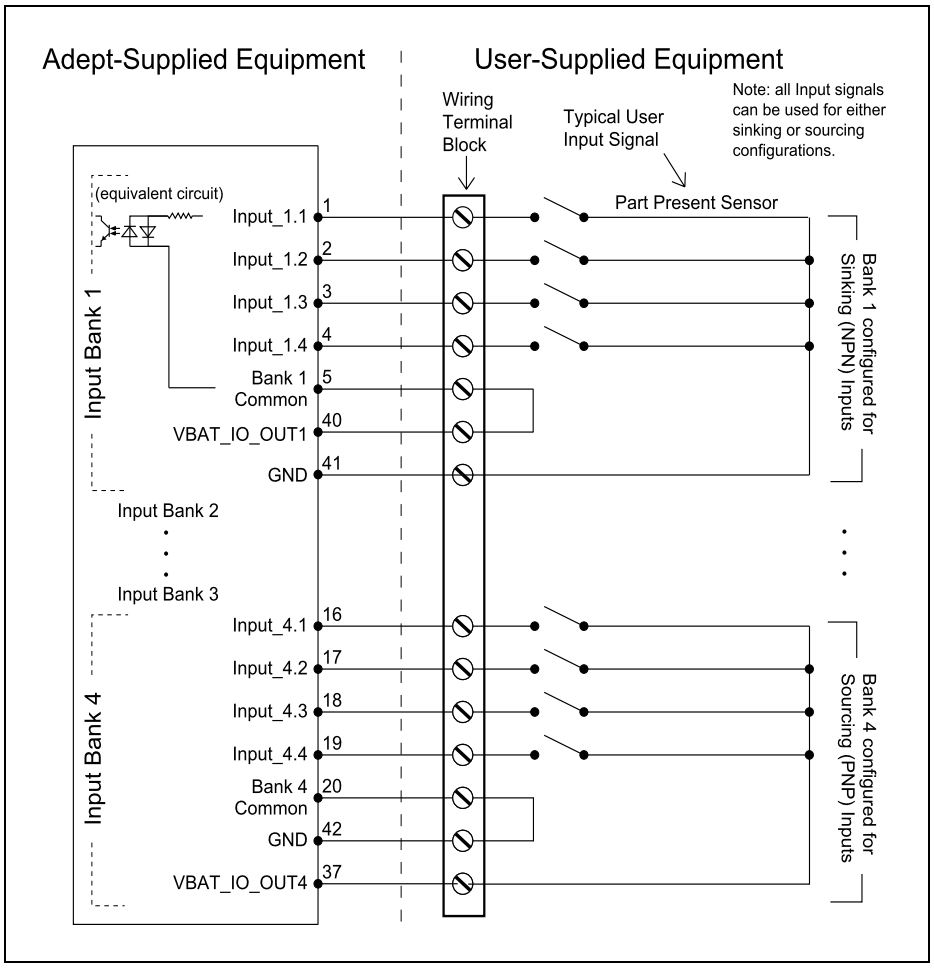


Figure 6-6. Typical Digital Input Wiring Example

Table 6-1. 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	$0.7\ A \leq I_{LIM} \leq 1.7\ A$

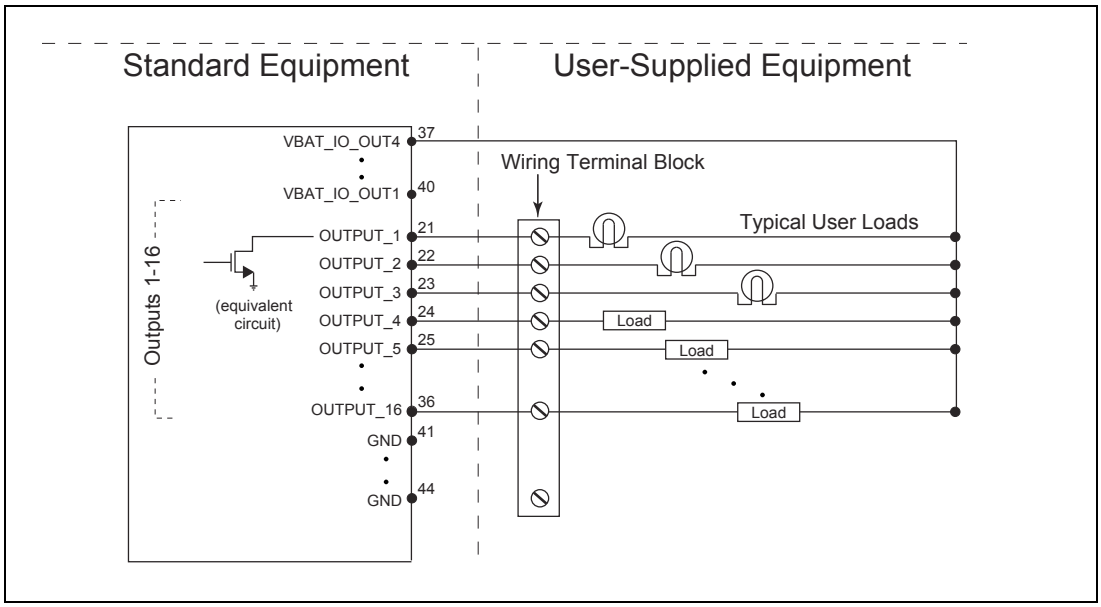


Figure 6-7. Typical Digital Output Wiring Example

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 Side (vertical) and low sensing (foot) lasers

	Designation		
Pin No.	**Hardware**	**Software**	**Notes**
1	RS232_VERT1_TXD		/dev/ttyUSB5
2	RS232_VERT2_TXD		/dev/ttyUSB6
3	RS232_FOOT_TXD		/dev/ttyUSB7
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
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
12	RS232_VERT2_RXD		/dev/ttyUSB6
13	RS232_FOOT_RXD		/dev/ttyUSB7
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

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

Robot Core Rear, Upper

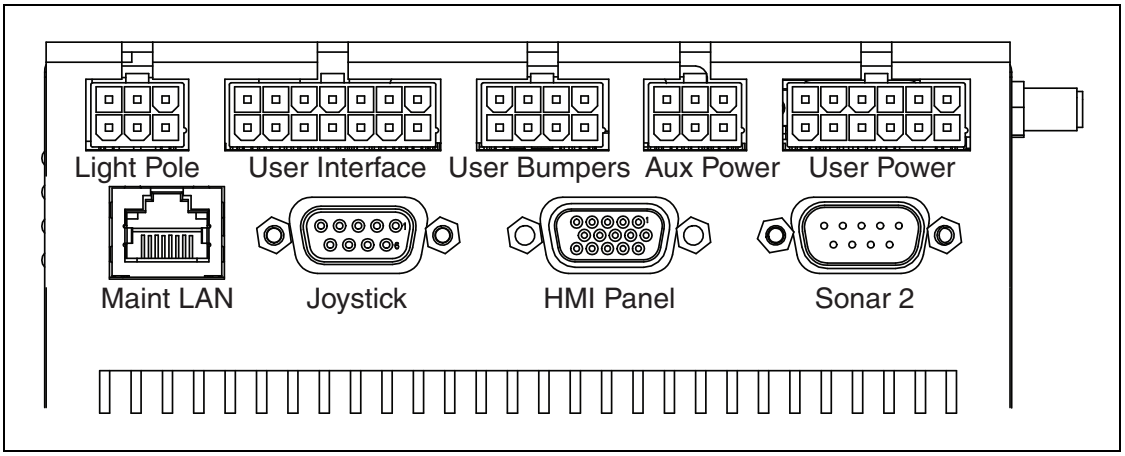


Figure 6-8. Rear Upper Core

NOTE: The connectors in the top row of the Rear Upper Core mate with Molex Mini-Fit Jr™ 5557 series receptacles.

Connection	Type	Description
Light Pole	Mini-Fit 2 x 3	Connects to a user-supplied light tower with 3 lights and 1 buzzer, using a default configuration
NOTE: The following four functions are pins on the User Interface connector.		
Brake-release	Mini-Fit 2 x 7	Pins for user-supplied brake release
ON		Pins for user-supplied ON button
OFF		Pins for user-supplied OFF button
ESTOP		Pins for user-supplied E-Stop (must be used or jumpered)
User Bumpers	Mini-Fit 2 x 4	This connection is not used with a cart transporter.
Aux Power	Mini-Fit 2 x 3	5, 12, and 20 VDC Outputs
User Power	Mini-Fit 2 x 6	Battery and switched battery power
Maint LAN	RJ45, Shielded	Directly connected to the externally-mounted Maintenance Ethernet, Auto-MDIX.
Joystick	DB9F	Directly connected to the externally-mounted Joystick port
HMI Panel	HDB15F	Operator screen, E-Stop, Brake_Rel, ON, OFF
Sonar 2	DB9M	This connection is not used with a cart transporter.

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 robot core and safety scanning 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 Robot Core Indicators on page 126.

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

Light Pole

Connector type Mini-Fit® 3 x 2

Use Light tower (user-supplied)

Pin No.	Designation	Notes
1	GND	Cable shield
2	LIGHT_P1	Red
3	LIGHT_P2	Yellow or orange
4	VBAT_IO_OUT4	VBAT @ 0.5A Max (shared with DIO)
5	LIGHT_P3	Green
6	LIGHT_P4	Buzzer

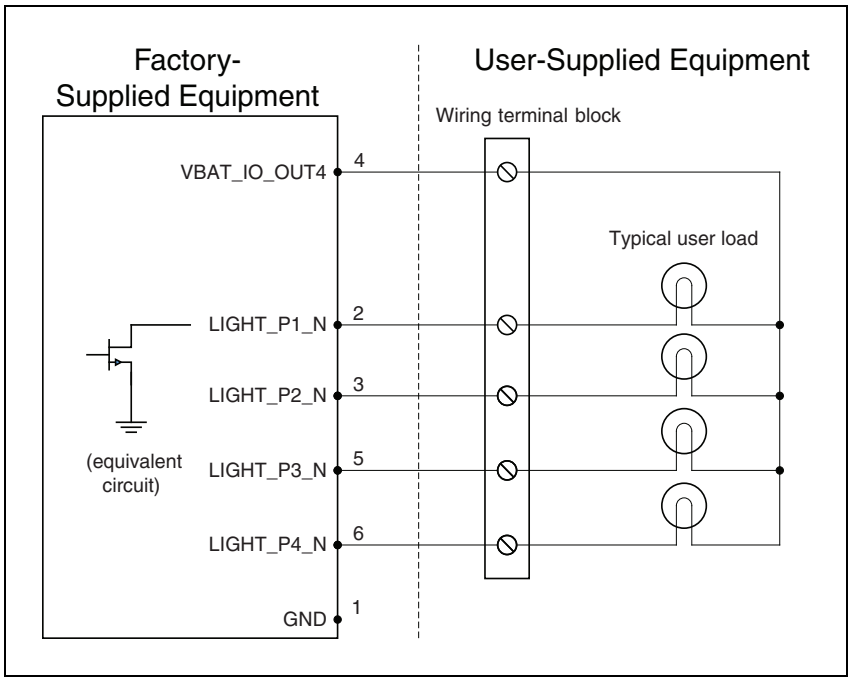


Figure 6-9. Sample Light Pole Diagram

User Interface

Connector type Mini-Fit® 7 x 2

Use Brake release, ON, OFF, E-Stop

Pin No.	Designation	Notes
1, 2, 3	FBAT_ALWAYS	Fused VBAT @ 500 mA
4	ESTOP_USR_1L	Short 4 & 11 to close ESTOP_USR_1
5	ESTOP_USR_2L	Short 5 & 12 to close ESTOP_USR_2
6	ESTOP_OUT_1L	Pins 6 & 13 short when ESTOP_CH1 is closed
7	ESTOP_OUT_2L	Pins 7 & 14 short when ESTOP_CH2 is closed
8	OFF_BUTTON	Short to FBAT_ALWAYS to signal OFF (min 1 s pulse)
9	START_BUTTON	Short to FBAT_ALWAYS to signal ON (min 1 s pulse)
10	MOTOR_BRAKE	Short to FBAT_ALWAYS for manual brake release
11	ESTOP_USR_1H	Short 4 & 11 to close ESTOP_USR_1
12	ESTOP_USR_2H	Short 5 & 12 to close ESTOP_USR_2
13	ESTOP_OUT_1H	Pins 6 & 13 short when ESTOP_CH1 is closed
14	ESTOP_OUT_2H	Pins 7 & 14 short when ESTOP_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.

CAUTION: 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 robot into service.

NOTE: See the following figure.

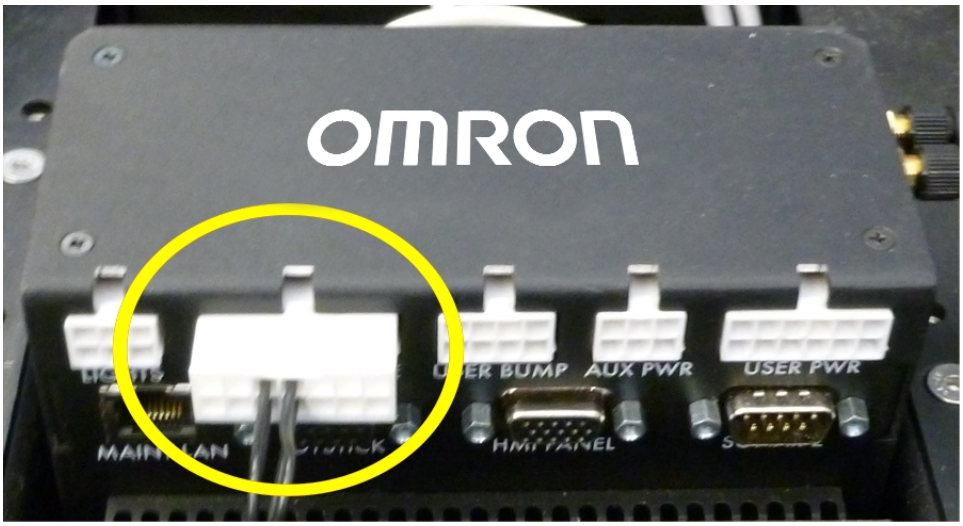


Figure 6-10. E-Stop Jumper on Platform Core

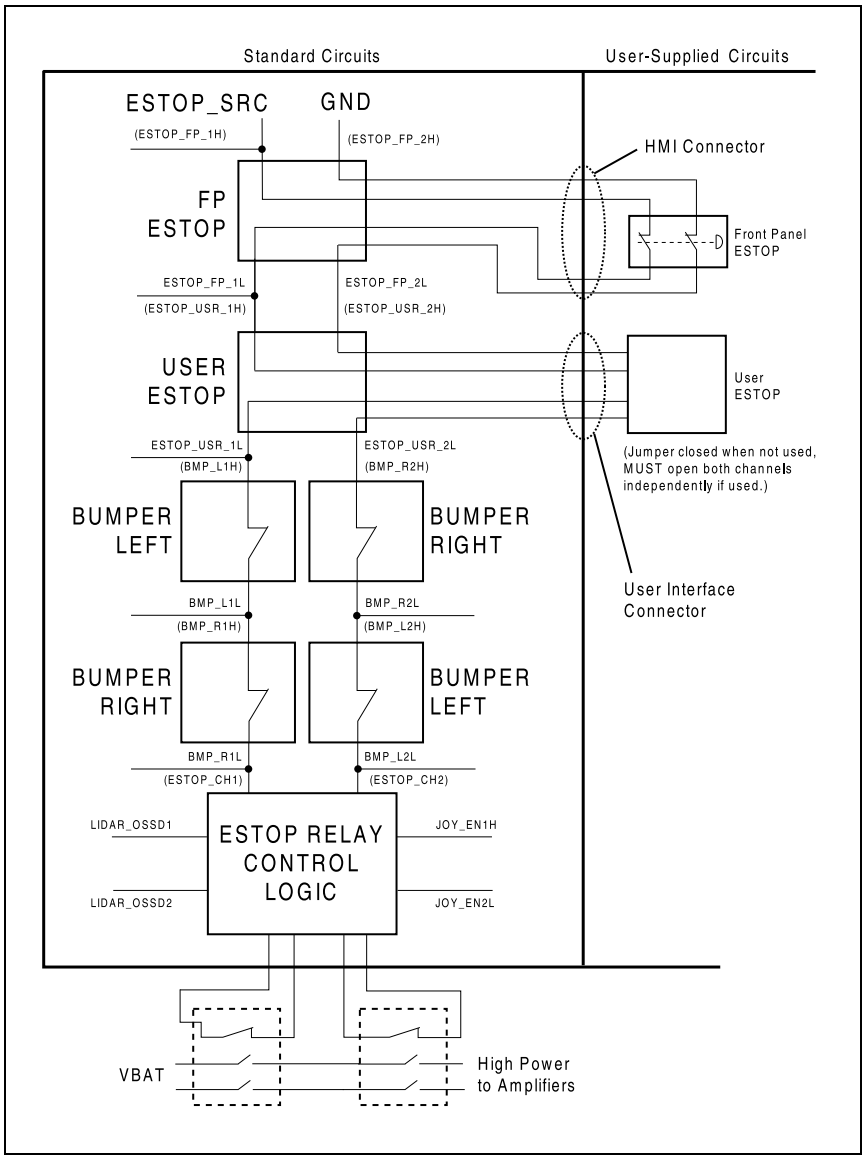


Figure 6-11. E-Stop Chain Diagram

User Bumper

This connection is not used with a cart transporter.

Aux Power

Connector type Mini-Fit® 3 x 2

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

User Power

Connector type Mini-Fit® 6 x 2

	Designation		
Pin No.	**Hardware**	**Software**	**Notes**
1, 2, 3, 4, 5, 6	GND		Limit to < 5 A per pin
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 ESTOP relays.
*9,10 and 11,12 share the 10 A of current.			

Joystick

Connector type DB9F

Use Joystick

Pin No.	Designation	Notes
1	JOY_XAXIS	Analog X input
2	JOY_YAXIS	Analog Y input
3	JOY_SPEED	Analog SPEED input

Pin No.	Designation	Notes
4	JOY_GOAL	Goal Button Input
5	JOY_EN_1H	Enable channel 1
6	JOY_EN_2L	Enable channel 2
7	No Connection	
8	GND	
9	5V	5 V @ 100 mA

HMI Panel

Connector type HDB15F

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

NOTE: The HMI panel that this connects to is not the touchscreen used for the LD Cart Transporter. The HMI panel is not used with the LD Cart Transporter, so this connector is not used.

	Designation		
Pin No.	**Hardware**	**Software**	**Notes**
1	RS422_HMI_TX+		Connections to HMI Panel **NOTE**: This is not the touch-screen.
2	RS422_HMI_TX-		
3	MOTOR_BRAKE		
4, 5	ESTOP_FP_1H, _2H		
6	RS422_HMI_RX+		
7	RS422_HMI_RX-		
8	START_BUTTON		
9, 10	ESTOP_FP_1L, _2L		
11	HMI_5V_SW	HMI_Power	
12, 14	GND		
13	OFF_BUTTON		
15	FBAT_ALWAYS		

Sonar 1 & 2

This connection is not used with a cart.

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

Internal Robot 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.

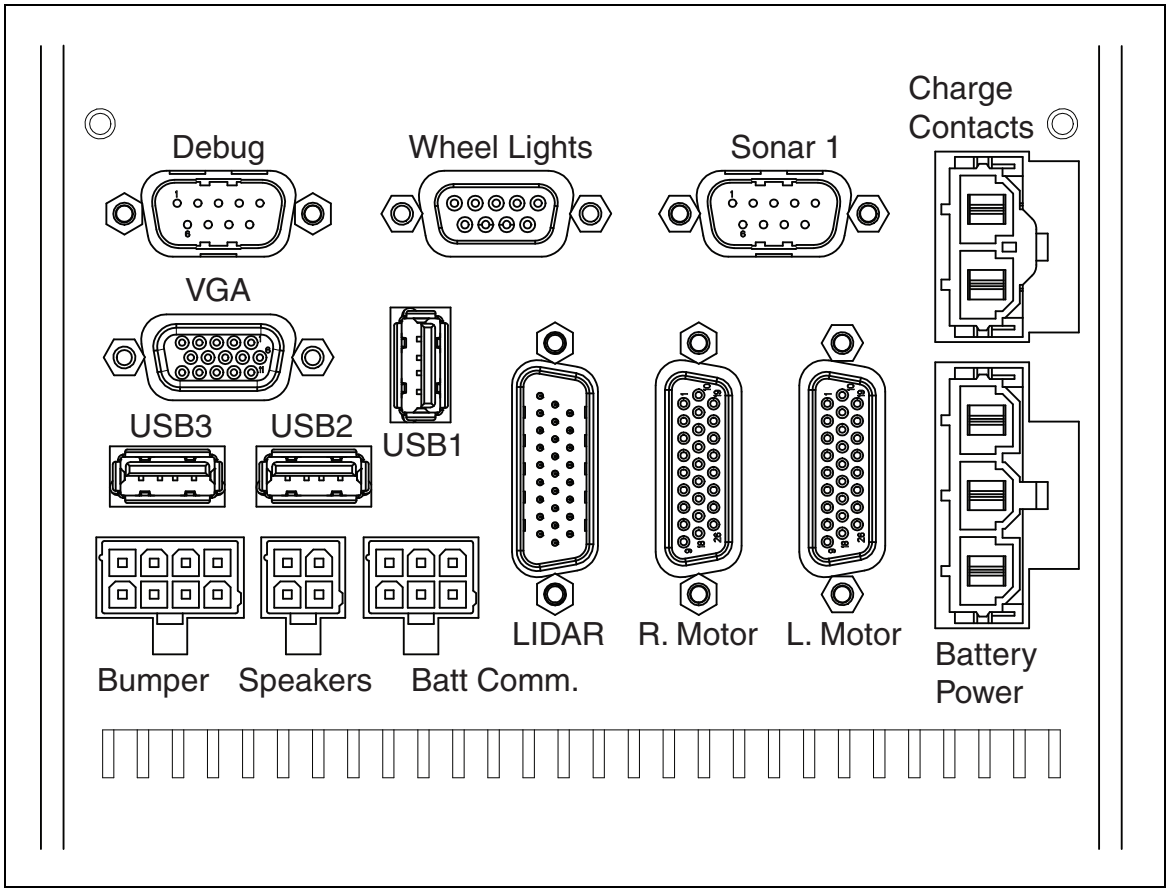


Figure 6-12. Internal Connectors on the Robot Core (Front)

Connection	Type	Description
Debug RS-232	DB9M	Reserved
Wheel Lights	DB9F	Motion and status indicator Light Discs on the platform sides
Sonar 1, RS-422	DB9M	Connection to Sonar Module (Rear sonar sensors)
Charge Contacts	Mini-Fit Sr., 2-pin	
VGA	HDB15F	Reserved
USB x 3	USB Type A	Reserved
LIDAR	HDB26M	Safety Scanning Laser

Connection	Type	Description
Right Motor	HDB26F	**NOTE**:The Right and Left Motor connectors use the same type of plug. Take care not to reverse them.
Left Motor	HDB26F	
Battery Power	Mini-Fit Sr., 3-pin	Battery VDC; connects to battery
Bumper Switches	Mini-Fit 2 x 4	This connection is not used with a carttransporter.
Speakers	Mini-Fit 2 x 2	Drives built-in speakers
Battery Comm.	Mini-Fit 2 x 3	Battery communication/control

Core Internal Data Pinouts

Wheel Lights (Light Discs)

Connector type DB9F

Use Motion and status indicator Light Discs 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 at the end of Core, Upper Rear.

LIDAR (Light Detection And Ranging)

Connector type DB26M

Use Front safety scanning laser

	Designation		
Pin No.	**Hardware**	**Software**	**Notes**
1	RS422_LIDAR_RX+		Connections to Factory-Supplied LIDAR
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

Robot Core Internal Power Pinouts

Bumper

Connection Mini-Fit® 4 x 2

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-	
3	LEFT+	Left Speaker
4	LEFT-	

Batt Comm.

Connector type Mini-Fit® 3 x 2

Use Battery control

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

Chapter 7: Operator Interface

The Operator panel comprises a touchscreen, an E-Stop button, ON and OFF buttons, a brake-release (BRAKE) button, a keyswitch, and LATCH and UNLATCH buttons. The panel is mounted on the HMI post, so that it is easily reached by an Operator.

Figure 7-1. Operator Panel, with Acuity Option Shown

7.1 Touchscreen

Touchscreen Initialization

When first powered up, the bottom of the touchscreen will display its boot status.

1. Initializing robot core connection...

   NOTE: This may take a minute or two to initialize.

2. Initializing touchscreen software...
3. Connecting to the robot core...
4. Downloading data from the robot core...

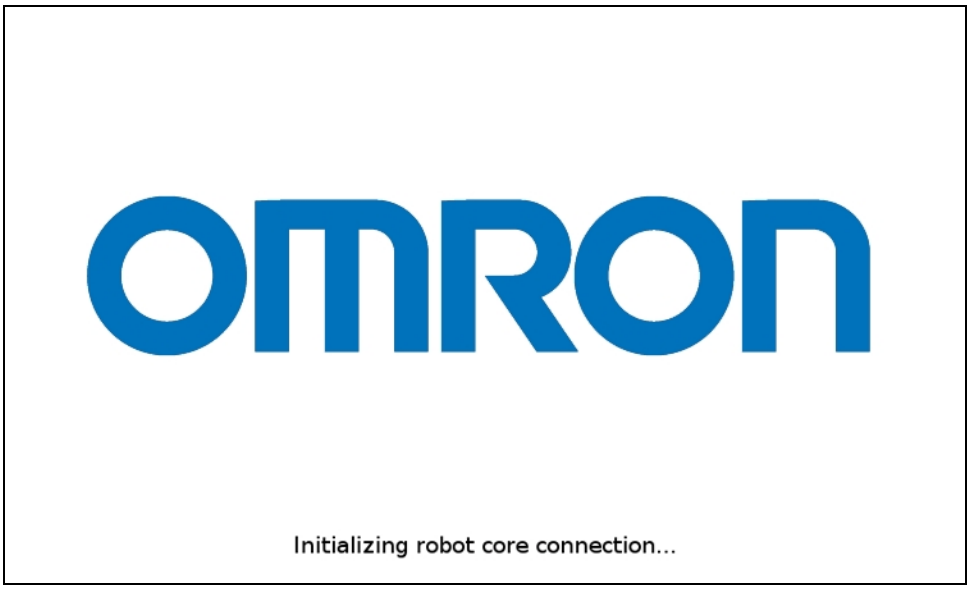


Figure 7-2. Screen Initialization Status Display

After initialization, either the Choose Dropoff or Patrol Route screen will be displayed.

Touchscreen Configuration

The behavior of the touchscreen is highly configurable. See Configuring a Touchscreen on page 65.

Screen Top Bar

The top of the screen shows basic robot information. This includes a bar graph indicating the WiFi signal strength, the name of the robot, and the battery state of charge. If the robot is connected to an Enterprise Manager 1100, it will also be specified here.

Left Screen Pane

The screen logo is displayed in the upper part of the left pane. This doesn't change, regardless of the mode you are in. See Screen Logo on page 69.

Below the screen logo, the robot status is displayed, first graphically, and below that, in text.

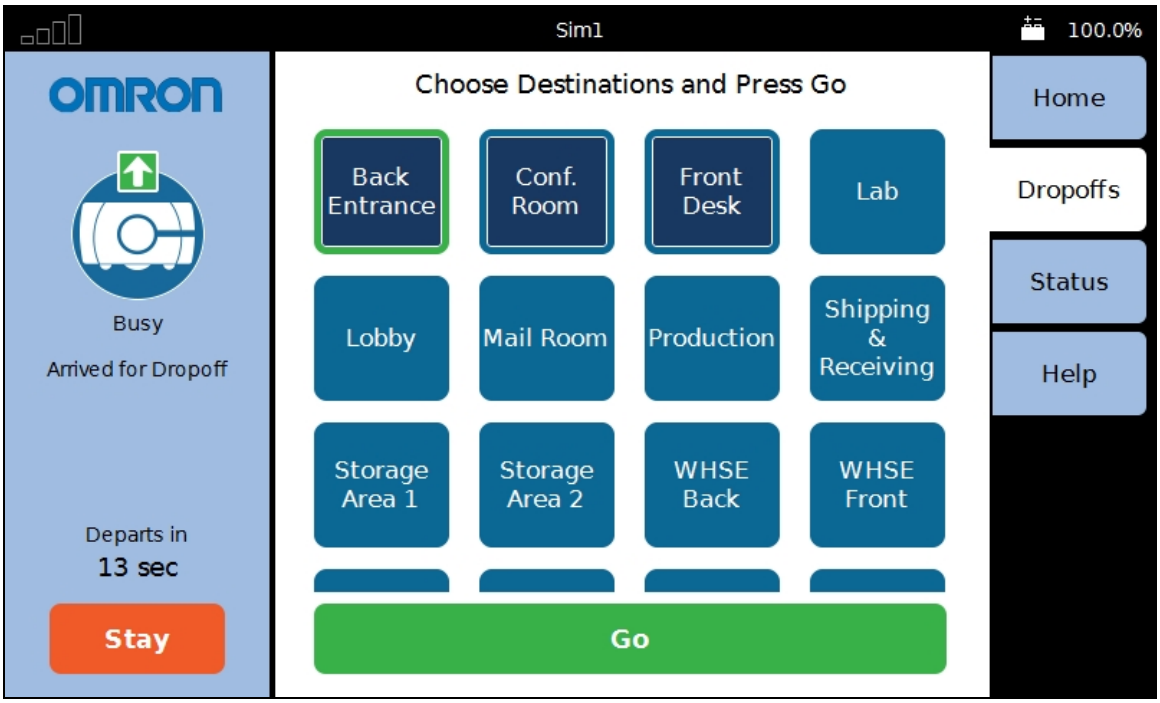


Figure 7-3. Screenshot Showing Top Bar and Left, Right, and Center Panes

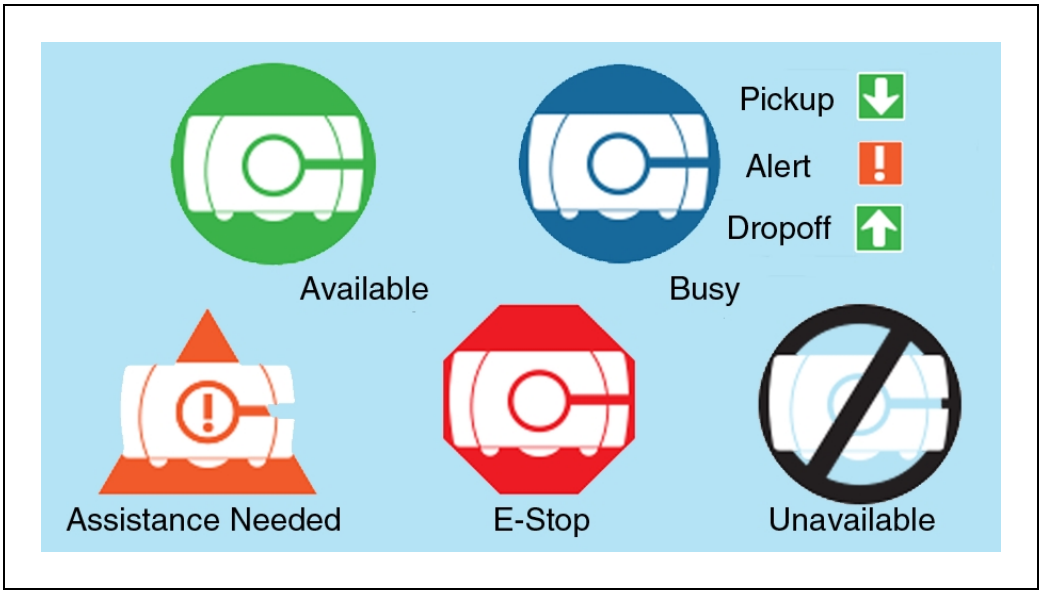


Figure 7-4. LD Cart Transporter Status Icons

NOTE: The Busy icon may also include an arrow pointing down, indicating a pickup, an arrow pointing up, indicating it is doing a dropoff, or an exclamation mark, indicating an alert condition. Figure 7-3. shows a dropoff.

The bottom of the left side of the touchscreen provides a Stay button, to delay the departure of the robot, and a count-down timer, indicating when the robot will depart.

Each touch of the Stay button adds 1 minute to the time the robot will wait before continuing to its next goal.

- If you touch Stay while the robot is stopped, it will add 1 minute to the time the robot is scheduled to wait before continuing to its next goal.
- If you touch Stay while the robot is moving, it will stop, and stay for 1 minute.

NOTE: The Stay count-down timer can be zeroed at any time by touching Go at the bottom of the center pane.

The screensaver can be set up to behave the same way the Stay button does, so that touching the screensaver adds 1 minute to the time the robot will wait. See Screensaver on page 70.

Right Screen Pane

The right side of the touchscreen displays Home, Dropoffs, Status, and Help tabs. touching one of these tabs changes the context of the center pane.

Home Tab

NOTE: The Dropoffs tab is not displayed in Patrol Route mode.

The Home tab is used to switch the center pane to show the robot's current mission. If an error condition exists, such as the robot overheating or being lost, the software will automatically select the Home tab. See the following figure.

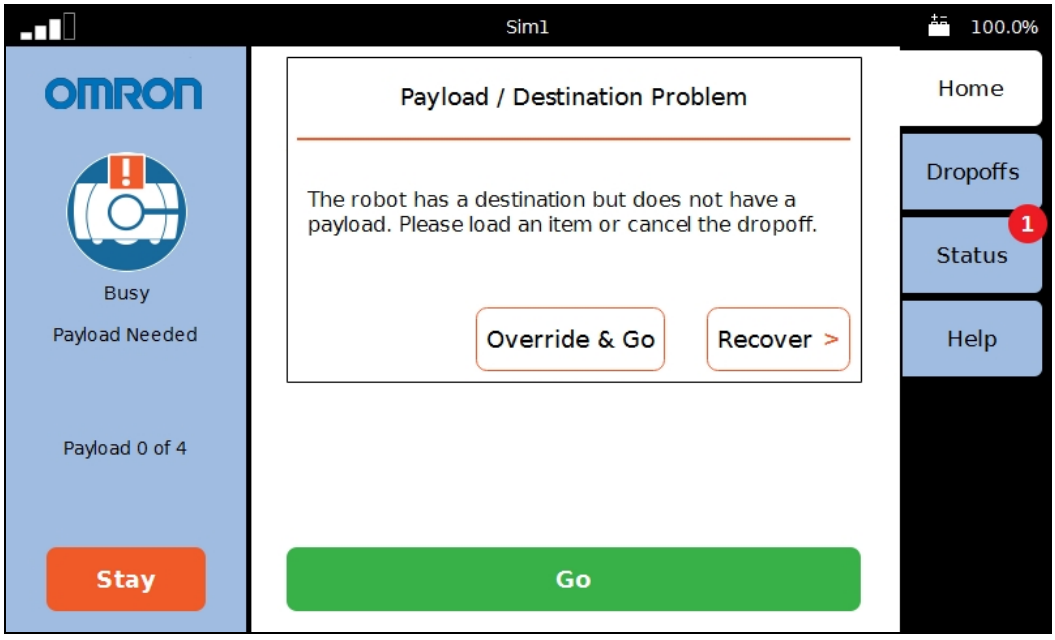


Figure 7-5. Payload Alert, Displayed from the Home Tab

The preceding screen will not be displayed unless the configuration has been set up in the MobilePlanner software:

Config > Robot Physical > Payload > NumSlots

This must be set to a non-zero value, i.e. the number of payload slots.

Config > Robot Interface > Payload Present Messages and Behavior

- The AlertWhenPayloadNeededForDropoff must be checked.
- The PayloadNeededForDropoffShortDescription must have a value. In this case, the value is “Payload Needed”, which is displayed in the screen’s left pane.
- The PayloadNeededForDropoffLongDescription must have a value. In this case, the value is “The robot has a destination but does not have a payload. Please load an item or cancel the dropoff.” This will be displayed in the screen’s center pane.

> **NOTE:** The payload parameter section will not be displayed unless the payload slots at the top of the Payload Present Messages and Behavior are set to a non-zero value.

The Home screen also has an entry for relocalizing a lost robot from the touchscreen. See Relocalization on page 116.

When you select Home from the right pane tabs (rather than when the software switches to Home), the center pane will display information about the robot's current mission, such as the job details or the current route task.

Dropoffs Tab - Choose Dropoff mode only

Dropoffs shows the available goals, giving the Operator the ability to choose the next goals, and shows the status of the robot with respect to the goals it has been assigned.

In Patrol mode, this option isn’t displayed.

Status Tab

After touching the Status tab, you will be given a choice of either Alerts, Robot, I/O, or Peripherals (which accesses screen-cleaning mode).

The number of alert messages that are available for viewing is indicated by a number in a red circle on the Status button. See the preceding figure.

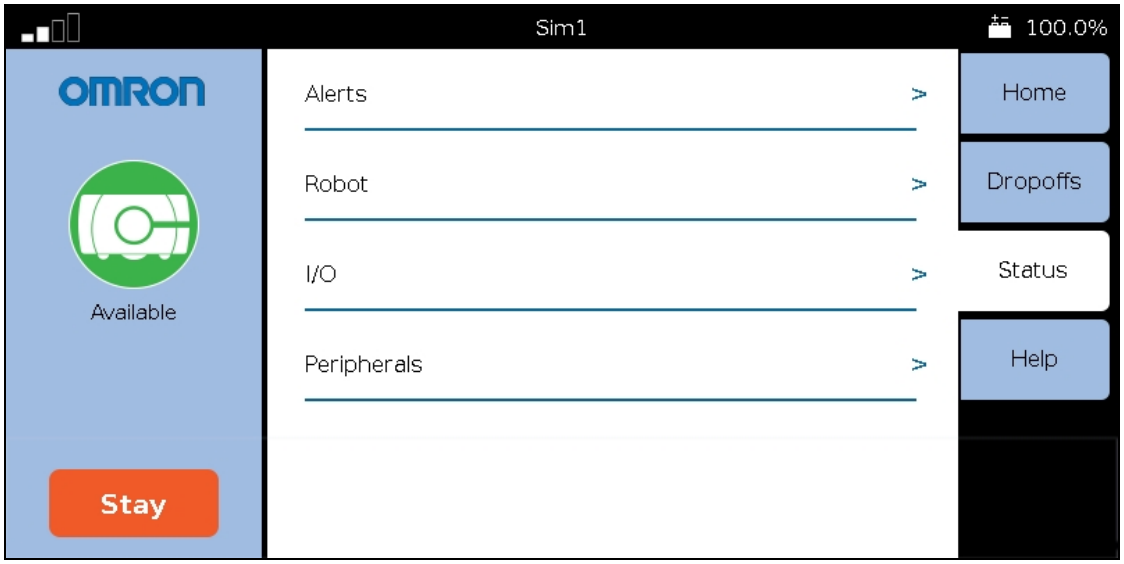


Figure 7-6. Status Tab and Sub-menu

- Alerts shows an abbreviated list of all active alert messages.

  Touching on a specific message will display that full message.

- Robot shows robot status, such as the IP address, current task, and its mode.

  Position Details, within the Robot Status screen, shows the robot's position, heading, velocity, and localization score.

- I/O will display any of the Core Digital Inputs / Outputs that have been configured as a "custom" type

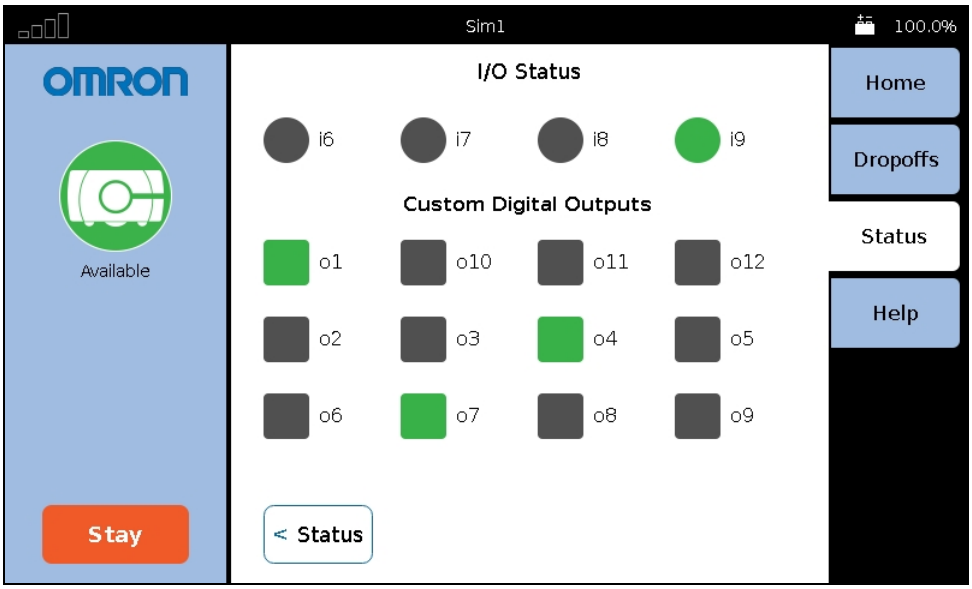


Figure 7-7. Status > I/O Screen (Top Inputs are not shown in this example)

- Peripherals > Touchscreen allows you to lock the touchscreen, so that you can clean the screen without it interpreting that as input. The screen stays locked for one minute, and then returns to normal function.

Help Tab

Help shows information on the installed software and contact information.

NOTE: No contact information will be displayed unless it is set up in the MobilePlanner software. See Contact Information on page 72.

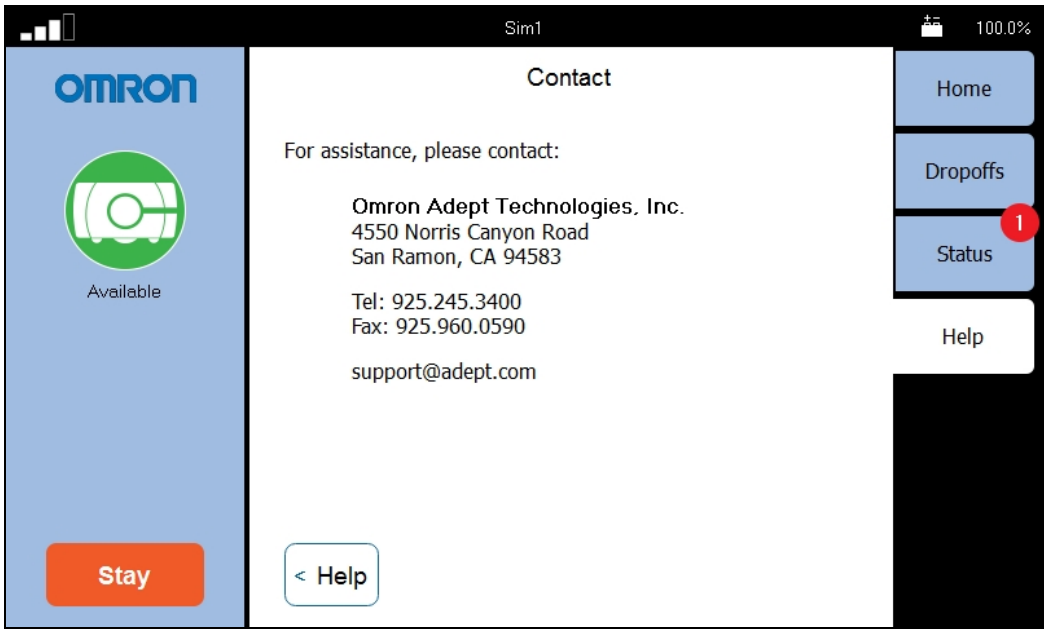


Figure 7-8. Help > Contact Information

Help also provides access the Replay Recorder page.

Replay Recorder

The replay recorder will record data for troubleshooting. Once the start page is opened, you just touch Start. When you are done recording, touch Stop. The Duration and Replay File fields are filled in by the recorder. After the recording is completed, use the MobilePlanner software to download the file generated.

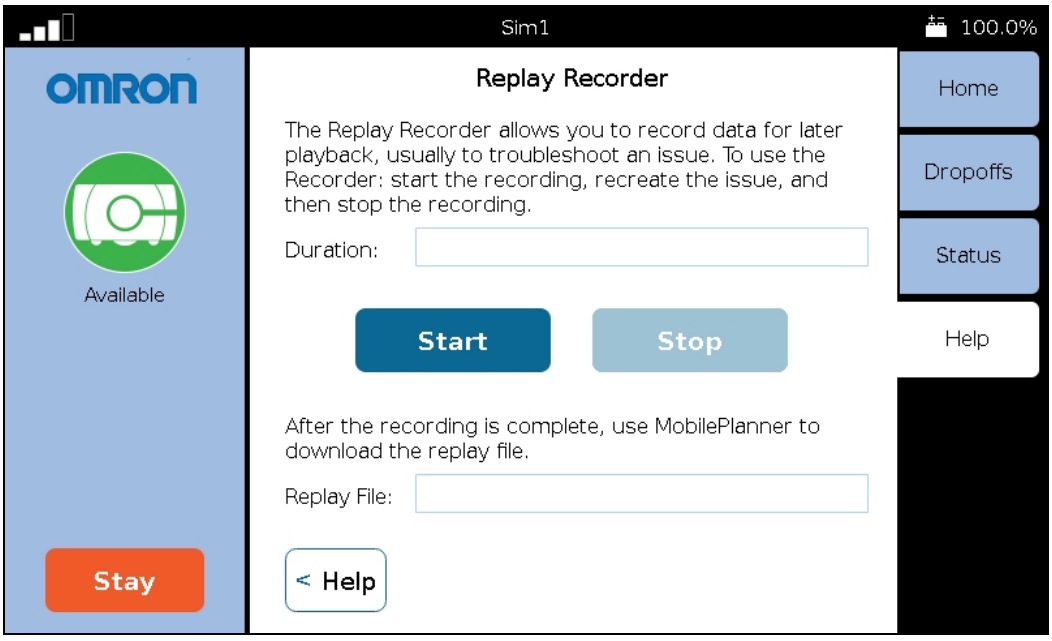


Figure 7-9. Replay Recorder Start Page

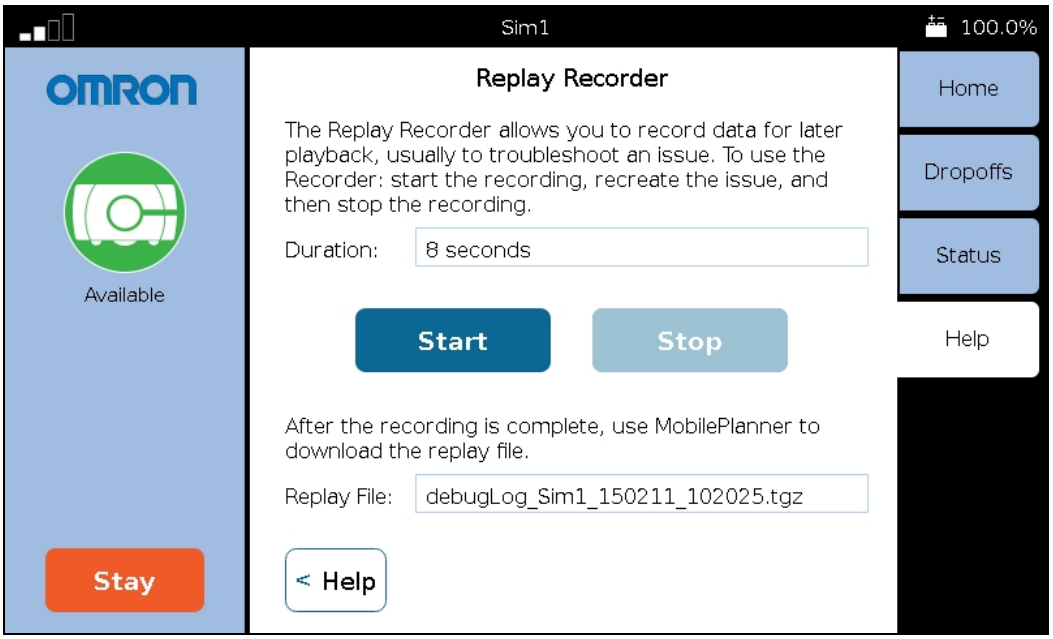


Figure 7-10. Replay Recorder, After Touching Stop

Center Pane

The content of the center pane changes depending on what has been selected from the right pane. The bottom of the center pane will almost always have a Go button, to zero the Stay count-down timer, and tell the robot to proceed to its next goal.

Relocalization

The touchscreen gives you a way to relocalize the robot if it becomes lost. Before you can do that, you need to have set up at least one localization goal, with a heading, at which the robot can localize. You can set up multiple such goals, if you like. See Localization Goals on page 68.

If the robot becomes lost, the touchscreen will automatically select the Home tab (from the right pane), and display a message indicating that the robot is lost. It will also offer an option to Recover.

1. Touch Recover.
2. Follow the on-screen instructions.

   You will be instructed to manually move the robot to a localization goal, and then tell the software which goal you moved the robot to.

Choose Dropoff Mode

In this mode, the touchscreen communicates with the queuing manager, which then communicates with the robot.

Dropoffs

> **NOTE:** Until the queuing manager has been enabled, the touchscreen will not display any of the dropoff goal buttons. Refer to the *Mobile Robot Software Suite User's Guide*.

In this mode, the center of the screen displays touch-sensitive dropoff buttons, indicating the goals associated with them. If there are more buttons than can be displayed at once, a sliver of the adjacent row of buttons is shown, to indicate their existence. See Screenshot Showing Top Bar and Left, Right, and Center Panes on page 111.

Navigation of the center pane, when there are more buttons than can be displayed at one time, is done by touching the screen, between buttons, and dragging the pane up or down.

The color and border of a dropoff button indicate the status of the associated job.

Status	Color	Border	Cancel	Priority
Ready	Blue	None	n/a	n/a
Planned	Dark Blue	None	Yes	Yes
Requested	Dark Blue	None	Yes	Yes
Pending	Dark Blue	Med. Blue	Yes	Yes
In progress	Dark Blue	Green	Yes	No
Interrupted	Dark Blue	Orange	Yes	No
Completed/Canceled	Blue	None	n/a	n/a

The Operator can use this pane for entering the goals where they want the robot to go for dropoffs, after leaving its current location.

Touching a dropoff button and then Go requests that the robot be sent to that goal. Touching several buttons in sequence, followed by touching Go, requests that the robot be sent to all of those goals, in the order in which the dropoff buttons were touched. The order may be altered by assigning high-priority to any of the goals.

The number of buttons, the content of each button, and the goal associated with each button is configured with the MobilePlanner software.

- Goals will be serviced by the robot in the order in which you touch their buttons.
- The selected dropoff goals are not sent to the queuing manager until you touch Go. After being received by the queuing manager, each goal is considered to be a job.
- Touching a Planned (selected) dropoff button will de-select it, without affecting other Planned dropoff buttons.

  Simply touching a Pending or In-Progress goal button will not affect the associated job. An explicit Cancel is required to cancel a job in either of those states.
- Buttons will change appearance when you select/de-select them, change their priority, when the job is received by the queuing manager, when an AIV is on its way to the button's goal, and when the job is completed (and robot dismissed).

Cancel Request (X)

When a dropoff button has a blue or green border, meaning its job is Pending or In Progress, the Operator can touch the button and a Cancel pop-up button (X) will be displayed on the button. Touching that pop-up will cancel the job for that goal. This does not affect any other jobs. See Touchscreen Dropoff Goals Page, with Cancel and Hi-Priority Pop-ups on page 118.

High Priority (!)

If you touch-and-hold the dropoff button for a goal that is planned or requested, or simply touch the button for a job that is pending, a High-Priority pop-up button (!) is displayed. Touching this pop-up will toggle the priority for the goal or job between high and normal priority. See the following graphic.

When a job is assigned high priority, its dropoff button will display a visible high-priority indicator (!). A high-priority job will be serviced before all normal-priority jobs, even if those jobs were entered at an earlier time.

This means that if you touch Goal1, then Goal2+HighPriority, then Goal3, they will be serviced in this order: Goal2, Goal1, Goal3.

If you de-select a high-priority dropoff button, and then re-select it, it will appear as normal priority (the high-priority flag is not persistent).

NOTE: Changing a high-priority dropoff button or job to normal priority will move that button or job to the end of the queue, so it will be serviced last.

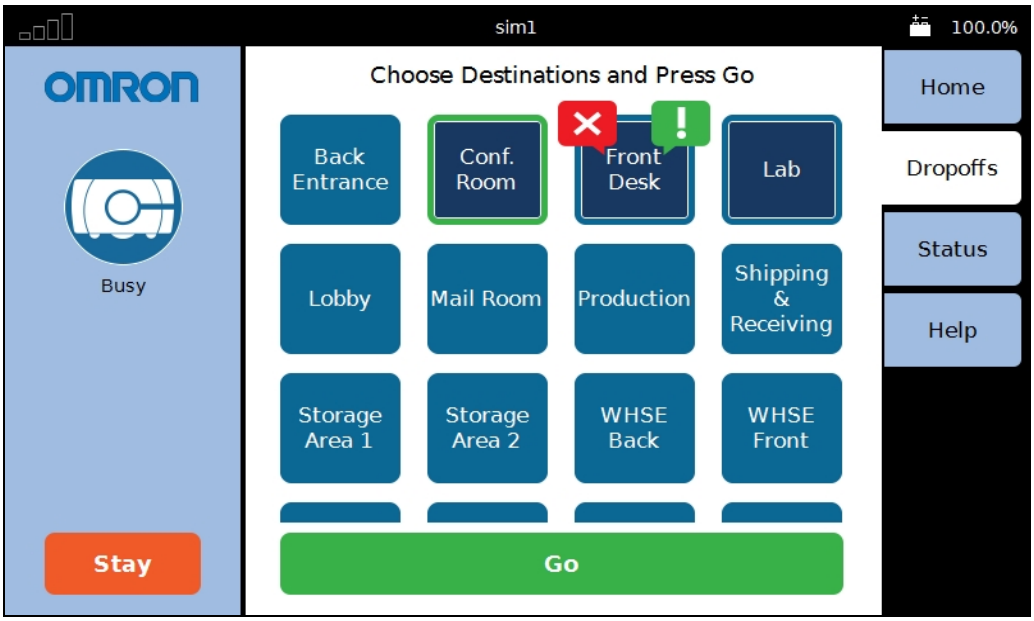


Figure 7-11. Touchscreen Dropoff Goals Page, with Cancel and Hi-Priority Pop-ups

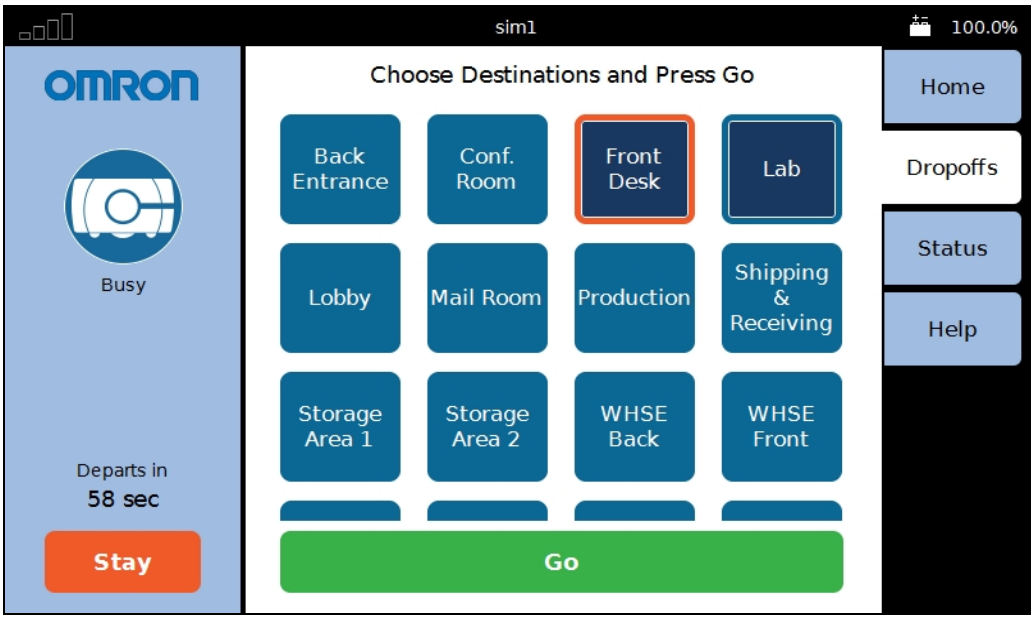


Figure 7-12. Touchscreen Dropoff Goals Page, with Stay and Count-down Timer

Stay Button

If the robot is en route to a goal when Stay is touched, that goal's button will be turn dark blue with an orange border.

If the robot has entered a wait task associated with a goal or job, touching Stay merely extends that wait, and the button border stays green. (The job isn't interrupted from the queuing manager's perspective, the wait task has just been prolonged.)

Go Button

The bottom of the center pane, in Dropoffs and user-selected Home mode, is a Go button. This zeroes the countdown timer, and causes the robot to immediately proceed to its next goal. This can be used in conjunction with the Stay button to pause the robot, and give the Operator more time to load or unload the payload.

Patrol Route Mode

The robot does not communicate with the queuing manager in this mode.

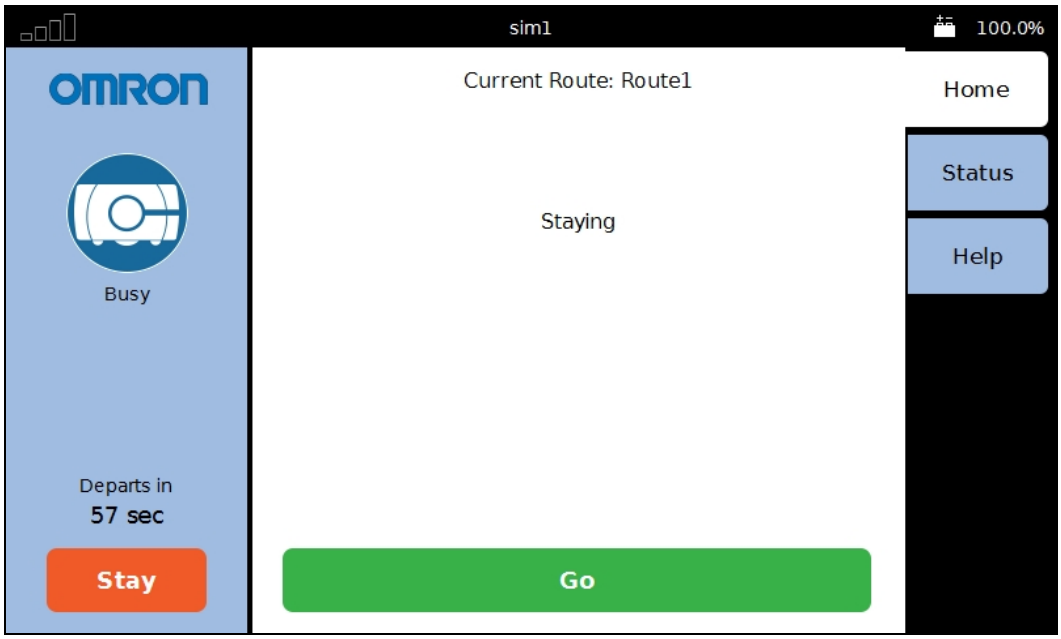


Figure 7-13. Touchscreen, Patrol Route Page, in Stay Mode

An Operator can touch Stay, to pause the robot, and Go to release it, but the Operator cannot select the robot's next goal. That is determined by the patrol route.

7.2 Operator Panel

E-Stop Button

When pressed, the red, latching push-button removes power from the platform's motors and from the E-Stop power port after a 1 second delay, giving the software time to stop the robot safely. To reset the E-Stop, twist the button slightly, so it pops up.

The motors must be explicitly enabled, either with the dialog box that will pop up (MobilePlanner software with **Map > Show Robot** on), with the ON button, or with an ARCL command. See the following figure:

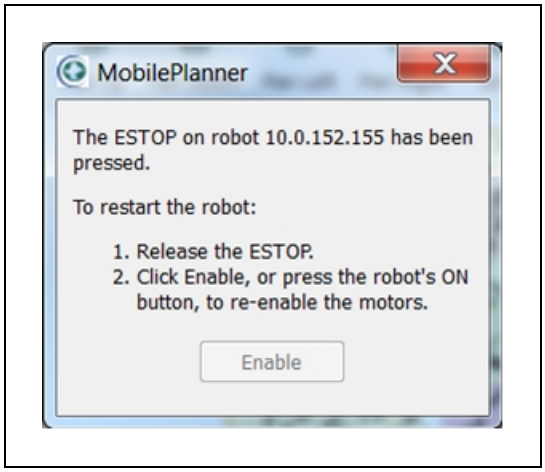


Figure 7-14. Motor Enable Pop-up Dialog

ON Button

The ON button is used for restoring power after the OFF button has been pressed, and the software has finished shutting down the platform.

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

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 robot'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 (BRAKE) Button

The brake-release releases the brakes on the platform. It is used when you need to manually move the robot.

Battery power is required and an E-Stop must be pressed to release the brakes.

The BRAKE button must be held in to keep the brakes released.

Keyswitch

The keyswitch can be used to disable the OFF button. The key can be removed in either the locked or unlocked positions.

LATCH Button

The Operator can manually make the platform latch to the cart by pressing this button. The platform must be in the correct position for latching with the cart for this to work. The button's light will be lit blue when this is enabled.

UNLATCH Button

The Operator can manually unlatch the platform from the cart by pressing this button. The button's light will be lit blue when this is enabled.

7.3 Other Controls and Indicators

A beacon is mounted on the top of the HMI post. See Operator Panel, with Acuity Option Shown on page 109.

Light Discs and Beacon

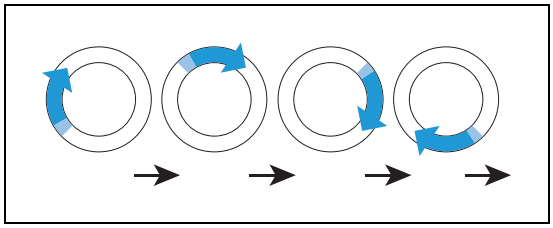
Circular lights on the sides of the platform are used to indicate motion, turns, and several other states.

A beacon is used to indicate movement and to signal an Operator that the robot is waiting for assistance.

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

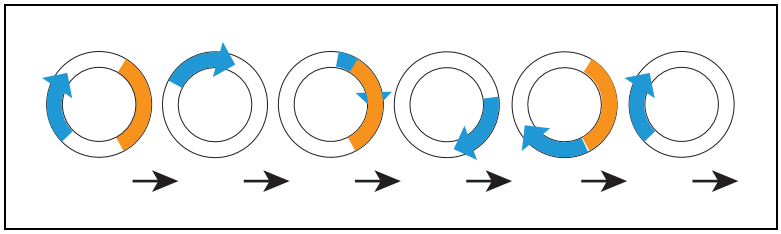
Driving Straight

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.



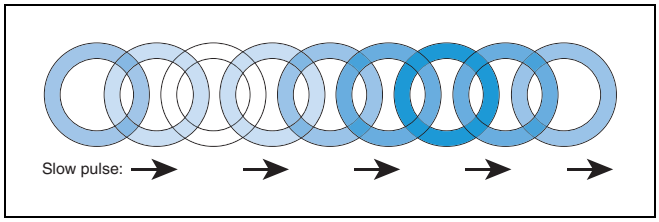
Turn Signal (for turns >30 degrees)

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.



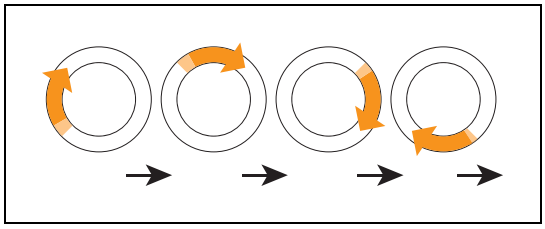
Stopped, no errors (ready)

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



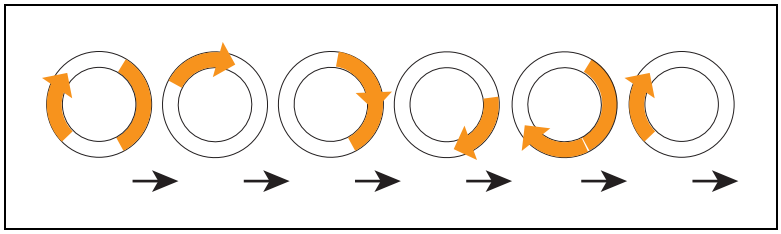
Driving with Warning (doesn't prevent driving, such as low battery)

The Light Discs will be orange instead of blue for Stopped, Driving, and Turn Signals.
Beacon alternates green then yellow.



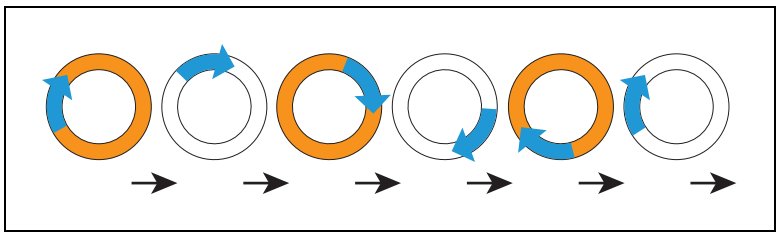
Turn Signal with Warning (doesn't prevent driving, such as low battery)

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.



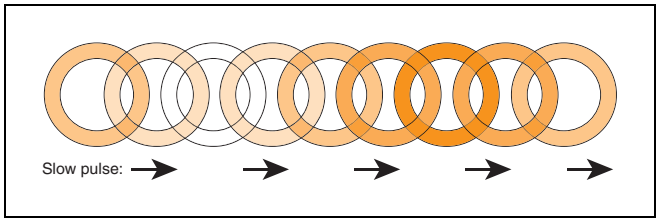
Driving Slowly, Safety Inactive

Under 300 mm/sec, the platform stops safety checking. The pattern is essentially the same as driving, except the background blinks orange. The moving arc and the blinking segment have independent timing.



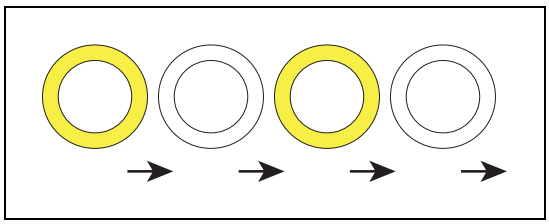
Stopped with Warning (such as low battery)

The light discs will be orange instead of blue for Stopped with Warning. Beacon alternates long green with short yellow.



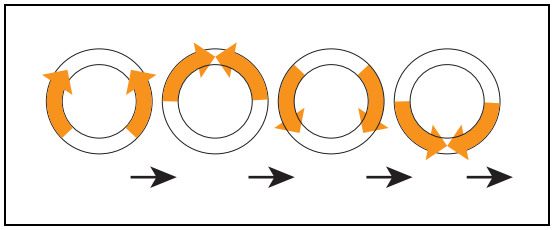
Obstacle Detected

The Light Discs will blink yellow if the robot is stopped for an object in its safety zone. Beacon blinks yellow.



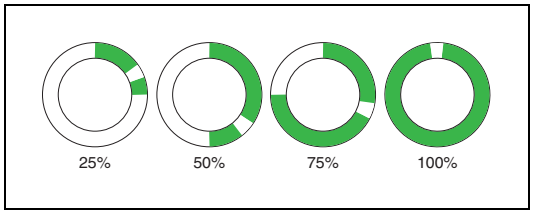
Lost

When the robot is lost, the Light Discs will 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 will indicate 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).

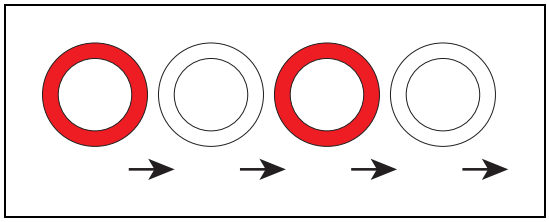


Left Side	Right Side	State of Charge
0 to 90 cw	0 to 270 ccw	25%
0 to 180 cw	0 to 180 ccw	50%
0 to 270 cw	0 to 90 ccw	75%
full circle	full circle	100%

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

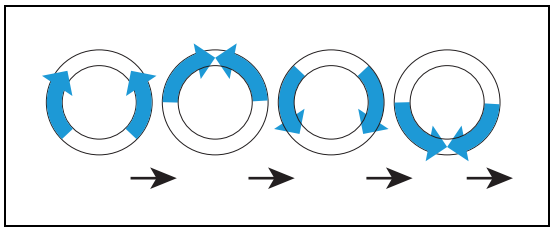
E-Stop

The Light Discs will blink red in an E-Stop condition. Beacon blinks red.



Booting

When booting, the Light Discs will display 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 degrees 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/sec
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

Light Disc		Beacon		Meaning
Color	**Pattern**	**Color**	**Pattern**	
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

Robot Core Indicators

The left end of the robot core has 12 indicator lights.

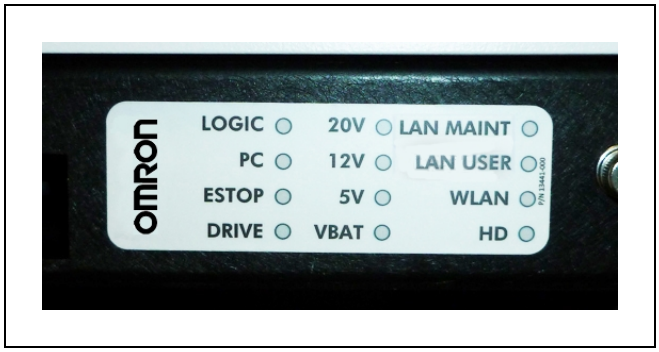


Figure 7-15. Core Indicator Lights

The following table gives their meanings:

Indicator	Meaning
Left Column	
LOGIC	The microcontroller has power
PC	The robot core and the servo controller are communicating
DRIVE	The drive wheels are under servo control
ESTOP	An E-Stop has been activated
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

Indicator	Meaning
WLAN	The WiFi is showing activity
HD	The hard drive is showing activity

Battery and Docking Station

For the battery, see Battery Indicators and Controls on page 132.

For the docking station, see Docking Station on page 133.

Chapter 8: Operation

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

8.1 Operating Environment

Intended Use

The LD Cart Transporter system 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 LD Cart Transporter is designed to operate in an environment that is level and has no doors or other restricted areas too narrow for the cart or transporter.

It is the user's responsibility to ensure that adequate clearance is maintained on each side of the robot, so that a person cannot get trapped between the robot 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 robot must get close to conveyors or other fixed objects.

WARNING: Do not allow the platform to drive through an opening that has an automatic gate or door unless the door and platform are configured correctly with the Door Box option.

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

Obstacles

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

Care must be taken to avoid:

- glass doors and walls
- pits without railings or low bumpers
- floors with access panels removed
- loose cables, hoses, etc.

This specifically includes wires hanging from above the robot, which could pose a hazard if the robot ran into them.

- large, highly-reflective objects

Environment and Floor

Floors must be level and provide good traction, typical of good walking conditions.

- 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 Up to 5 mm (0.2 in.) at 250 mm/sec. only
- Gap traversal Up to 5 mm (0.2 in.) at 250 mm/sec. only

WARNING: The transporter with cart 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 speed, the transporter may not be able to traverse the step height listed.

The LD Cart Transporter is not intended for use in hazardous environments (explosive gas, water, dust, oil mist). It has an IP rating of IP40.

The LD Cart Transporter is not intended for use in the presence of ionizing or non-ionizing radiation.

Getting Stuck

It is possible, though not likely, for the robot 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 145.

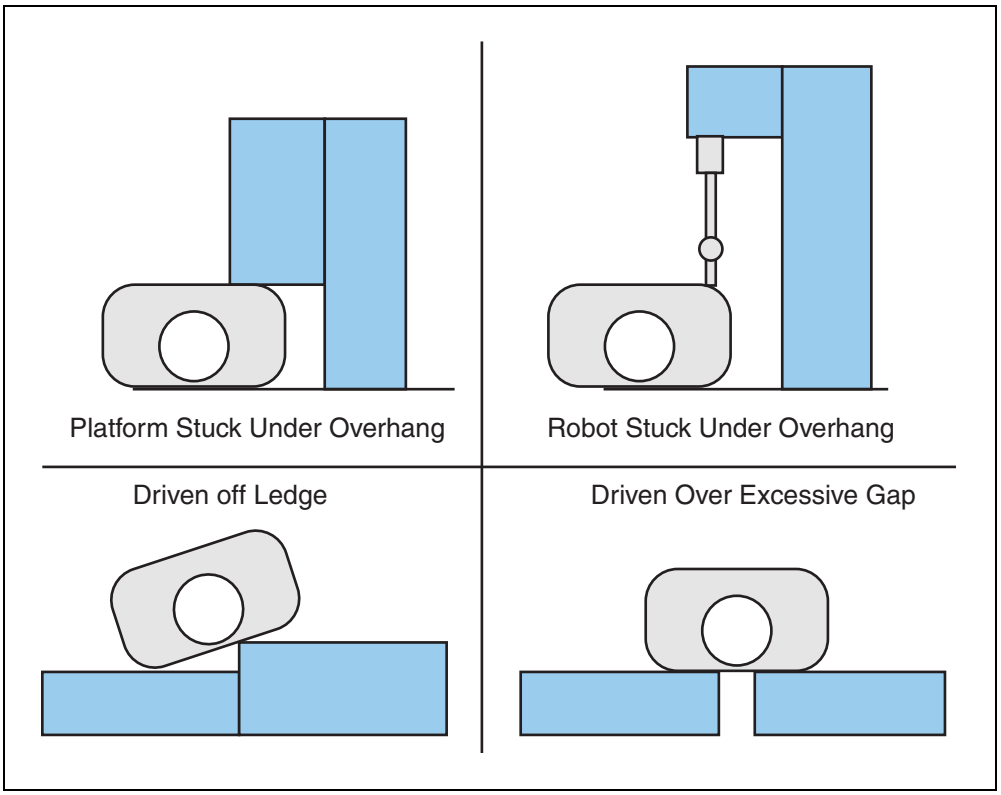


Figure 8-1. Robot Getting Stuck Examples

8.2 Typical Operation

During normal startup, your platform powers all its onboard systems[1] and runs its onboard software automatically to provide an application-ready AIV. If it has been given a map of its workspace and knows where it is within that environment (localized), your AIV is ready to perform on startup and will 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 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, is used to configure 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.

CAUTION: The Operator Mode of the MobilePlanner software, which does not require a license to run, should be protected with user ID and password access, to prevent unauthorized operation of an AIV.

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

8.3 Power and Charging

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

The platform ships separately from the battery. The battery is shipped at less than 30% charge, to comply with air-shipping regulations. You should have installed the battery in the platform in Installing the Battery on page 45. You should fully-charge it as soon as possible, to avoid battery damage from a full discharge.

Battery recharging is typically managed by the platform. With ample power, as is provided by the automated docking station, all onboard 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 12 hours. This will vary significantly depending on operating conditions.

Recharge time is approximately 3.5 hours.

Battery Indicators and Controls

The battery has one push-button and four LEDs. From left to right, they indicate:

LED	Color	Meaning
1	Red	Error condition
	Green	25% state of charge
2	Green	50% state of charge
3	Green	75% state of charge
4	Green	100% state of charge

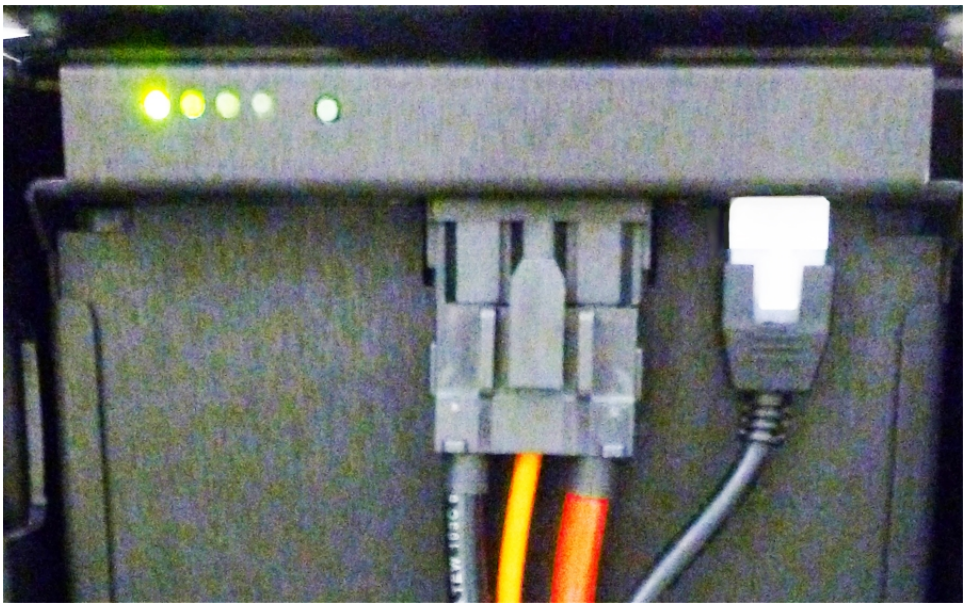


Figure 8-2. Battery LEDs, Push-Button, Power Cable, and Data Cable

The push-button "wakes up" the battery, so it displays its state of charge. This can be useful when a battery is in storage, and you want to know its state of charge.

Docking Station

The automated docking station is both a manual and an automated means for recharging your platform battery.

Autonomous Charging

During normal, autonomous operation of the AIV in the workspace, the platform manages charging automatically through the automated docking station. The platform will approach the docking station frontward, and then turn around and back onto the docking station to charge. There is about a 10-second delay between when a platform docks and when the charging LED turns on.

Connecting and disconnecting the platform with network and onboard clients will not disturb the charging state. (Moving the platform 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 platform is powered off, it will turn on automatically when it is pushed onto the docking station. A platform cannot be turned off while on the docking station.

Figure 8-3. 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, toggle the switch to off (0) and then back to on (1).

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

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

The docking station contacts should be cleaned quarterly with isopropyl alcohol. See Docking Station Contacts on page 152.

The guide roller can be replaced in the field. See Docking Station Roller and Bearing on page 160.

If necessary, the height of the docking station contacts can be adjusted. See Docking Station Contact Adjustment on page 55.

Manually Charging the Battery

Battery in Platform

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

There is about a 10-second delay between when the platform is in position and when the charging LED turns on.

NOTE: You will need to press and hold the brake release button before moving 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

The battery can be charged, 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 be used for charging a spare battery, while a second battery is still in the platform, and the platform is in use. Some users choose to manually charge a spare battery, and swap that for the battery inside the platform.

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.

Balancing the Battery

The platform battery is composed of multiple cells, which need to stay balanced in order to maintain maximum run-time.

There are three ways for managing battery balancing:

- Set the platform'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 platform 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:** This is the mode that is recommended for platforms that aren't doing battery swapping.

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

  A spare battery that remains plugged into a docking station will be balanced. 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 how the AIV is used. This includes the weight it carries, and what percent of the 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:** This is the mode that is recommended for battery swapping, if you are not charging the battery while it is inside the platform.

- Set the platform's DockUntilDoneCharging parameter to False, to let the platform 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 battery swap with a fully-charged and balanced battery periodically, such as once a week.
  - StateOfChargeToChargeTo determines the state of charge the battery needs to attain before the platform 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 platform can stop charging.

    The platform will stop charging when the battery reaches either of these parameter values.

    CAUTION: If both of these parameters are left at the default of 0, and DockUntilDoneCharging is set to False, the platform will dock, and never undock.

  We recommend that you do a battery swap 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.

8.4 Startup

Procedure

Press and hold the 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).

Joystick

The joystick lets you quickly move the platform to its destination. This can be used to drive it from the shipping dock to an automated docking station.

CAUTION: The joystick should be locked up when not in use, to prevent unauthorized operation of an AIV.

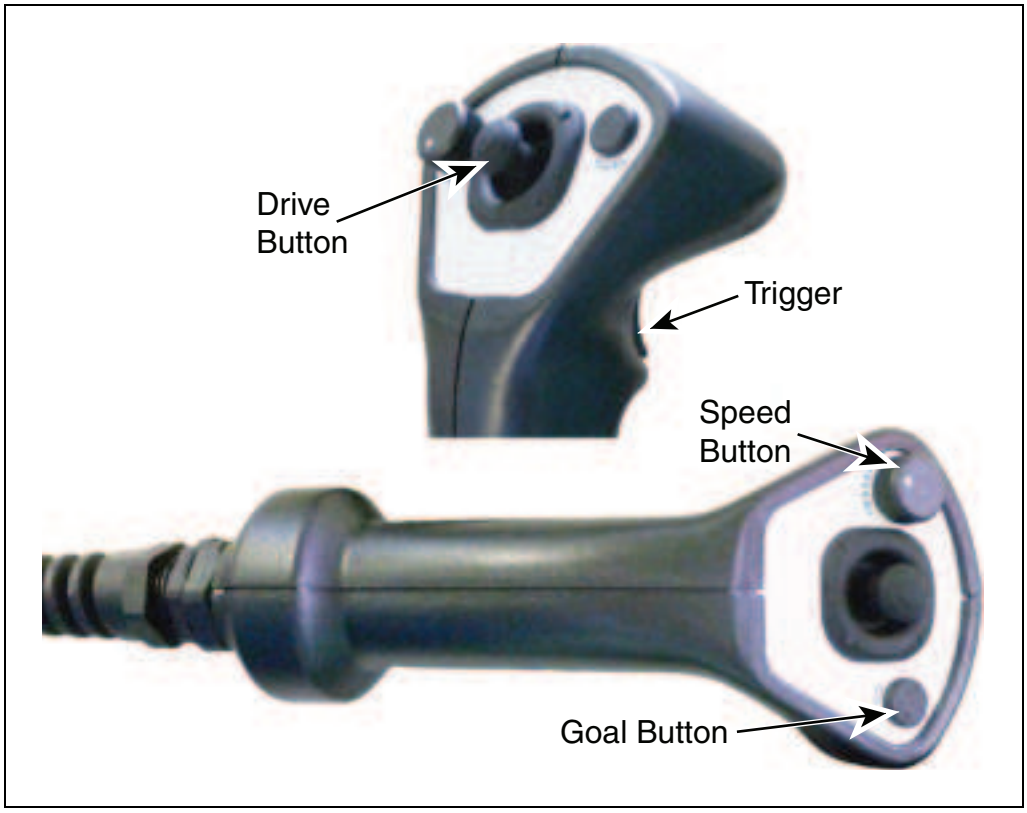


Figure 8-4. Joystick

The joystick plugs into the left side of the platform, under the small access panel at the upper right corner of the platform. (The Maintenance Ethernet port is also there.) The access panel is held in place with a push-push latch, and retained by a lanyard.

CAUTION: The platform safety scanning laser is not tied into the E-Stop chain when driven using the joystick. The platform will still avoid obstacles detected by the safety scanning laser. The sonar, on the other hand, are disabled entirely when driving with the joystick.

Joystick Use

Use the joystick to drive the platform manually. Squeeze the trigger to enable the drive button.

Push the drive button forward or back to make the platform move in that direction. Push the drive button to the side to make the platform rotate in that direction. Diagonal positions of the drive button move the platform in an arc.

The platform slows to a stop when you release the trigger. To stop more quickly, continue to squeeze the trigger and pull or push the drive button to its limit in the opposite direction of the platform's travel.

8.5 Working with Carts

Goals

The parking goals and the transporters need to be set up in the MobilePlanner software. Refer to Configuration on page 61 for details on MobilePlanner configuration, and see the *Mobile Robot Software Suite User's Guide*.

Operation

The transporter locates the cart, couples with it, transports it to the dropoff goal, and uncouples from the cart, leaving the cart at the dropoff goal while it proceeds to its next assigned job.

Cart-Locating

If a cart is at a parking goal, the transporter can navigate close enough to the cart for the Latching Mechanism to take over.

The Latching Mechanism pulls the transporter and cart together, which enables a sensor to detect that they are fully-coupled. Once the coupling sensor is triggered, the transporter will be able to move the cart.

CAUTION: Pinch hazard. The latch on the transporter can pinch you if you are not careful. Keep your hands clear of the Latching Mechanism when it is in action.

CAUTION: Pinch hazard. The coupling action of transporter and cart can pinch you if you are not careful. Keep your hands clear of the space between the HMI post and cart when the platform and cart are coupling.

NOTE: If the sensor does not get triggered, the transporter's software will prevent it from moving.

Cart Brakes

The two rear casters of the cart have brakes, which push a blunt pin against the caster rolling surface to prevent a cart from rolling when it is parked on a floor that is not perfectly level.

Cart brakes are only intended to prevent rolling on a slightly unlevel floor. They will not immediately stop a moving cart, or prevent a cart from rolling down a slope.

Although it is possible to push the cart with the brakes engaged, this is not recommended, because it will accelerate wear of both the braking pins and the casters themselves. When a cart needs to be moved, the Operator should always release the brakes with the brake release handle.

In the unlikely event that the cart becomes unlatched from the LD platform while in motion, the brakes are designed to stop the cart within six feet.

Automatic Brake Release

When the cart transporter couples with the cart, it actuates a lever that releases the cart brakes, so the cart can move freely with the transporter.

Manual Brake Release

When there is no cart transporter present, the cart brakes can be released manually. Each cart comes with a release cable and lever, similar to a bicycle brake handle, that releases the cart brakes when squeezed. Installation of this cable and lever is covered in Installing the Cart Brake Release on page 55. As long as the brake release handle is squeezed, the brakes will be released.

Chapter 9: Options

The Cart is available with a number of options to enhance its performance and abilities.

Enterprise Manager 1100

The Enterprise Manager 1100 manages a fleet of AIVs, for multi-AIV coordination and job management. It includes the Enterprise Manager appliance running the Mobile Software suite.

It is covered in the *Enterprise Manager 1100 User's Guide*.

MobilePlanner Software (licensed)

In order to have your cart transporter perform autonomous mobile activities, you need to make a map of its operating space, and configure its operating parameters. The MobilePlanner software is used 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.

The MobilePlanner software requires a license to run. You need at least one MobilePlanner license for each fleet of transporters. Once a map is generated, it can be shared with multiple transporters working in the same space.

Joystick

This is mainly used to 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 transporters. Once a map is generated, it can be shared with multiple transporters working in the same space.

Spare Battery

At least one spare battery is needed if you opt to swap the platform's battery, rather than having it charge itself at a docking station. See Manually Charging the Battery on page 135.

Spare Carts

Extra carts can be ordered, because a cart installation can use more carts than transporter.

The part number is 75020-000.

The following options are documented in the LD Platform Peripherals Guide.

Call Buttons/Door Boxes

Call buttons are used to issue a request for an AIV to go to the goal associated with the button. There may be multiple call buttons, even in an installation where there is only one transporter.

Door Boxes are used to open an automated door, so the AIV can pass through.

See *LD Platform Peripherals Guide*.

Acuity Localization

Acuity localization uses an upward-facing camera to localize the platform using overhead lights, which it compares with lights stored in its map. 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.

High-Accuracy Positioning System

This allows an AIV to achieve accurate alignment at a specific location, typically at a fixed conveyor, using a sensor to detect magnetic tape at that location.

Chapter 10: Maintenance

This chapter covers periodic maintenance and user-serviceable parts replacement for the LD Cart Transporter.

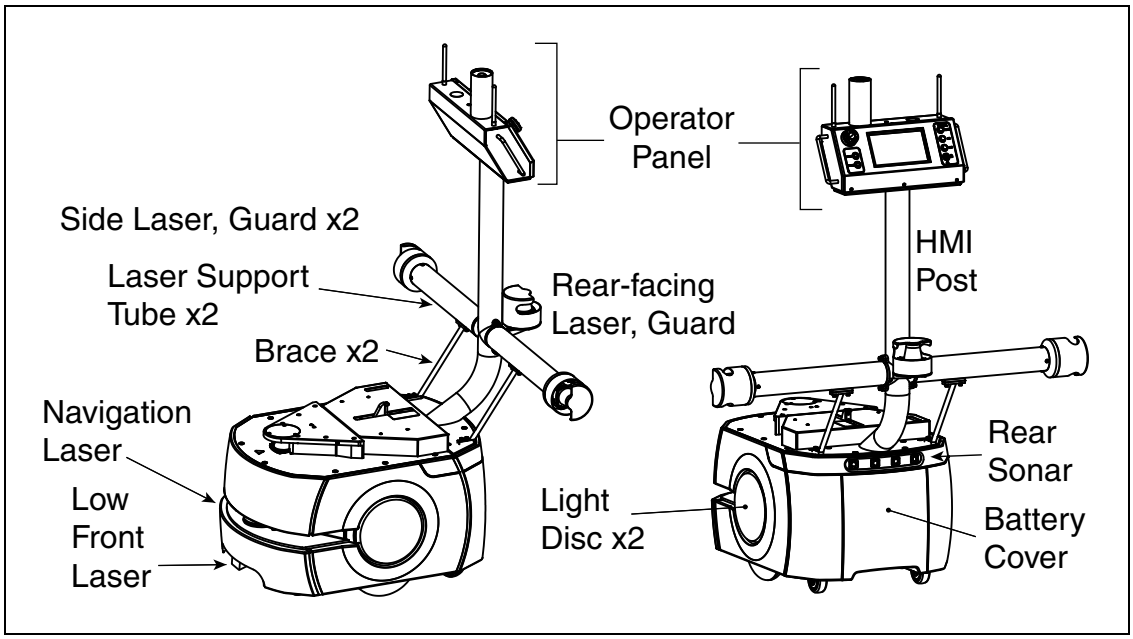


Figure 10-1. Major LD Cart Transporter System Parts, with Acuity Camera

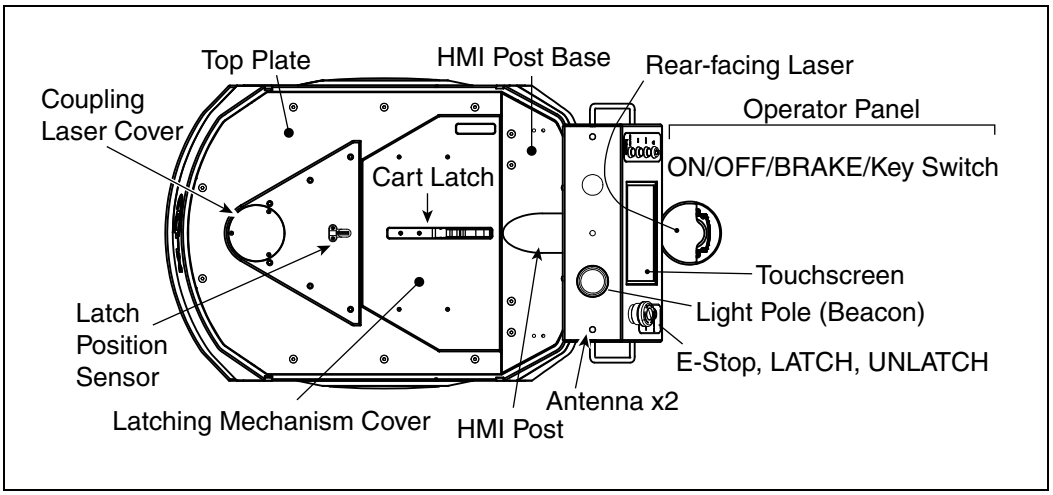


Figure 10-2. Top View of an LD Cart Transporter, Side Laser Support Tubes Removed

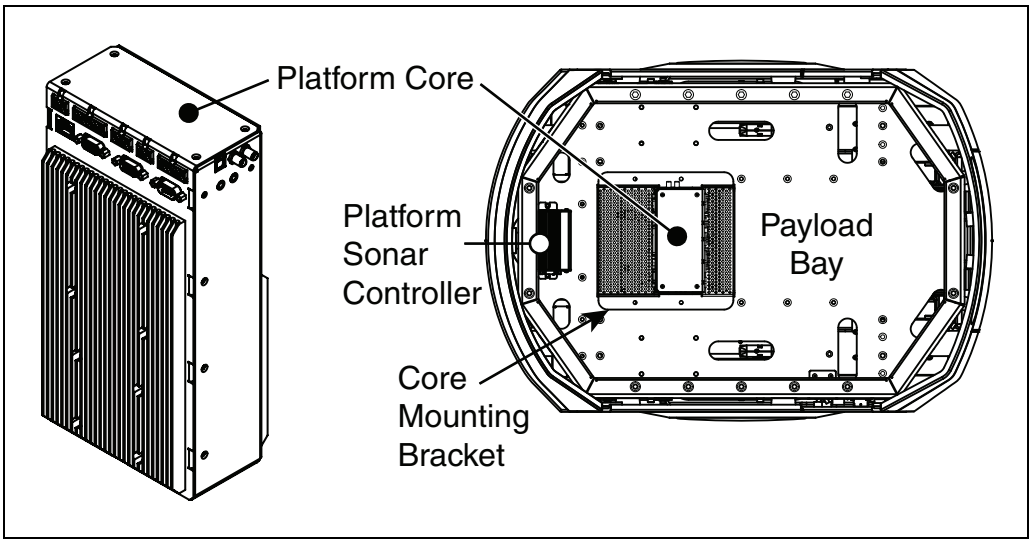


Figure 10-3. Location of Parts in the Payload Bay

10.1 Safety Aspects While Performing Maintenance

Electrical Hazards

DANGER: During maintenance and repair, the power to the docking station must be turned off. Remove and lock up the power cord to prevent unauthorized third parties from turning on power. The access covers on the docking station are not interlocked.

DANGER: There are no user-serviceable parts inside the docking station. Do not remove the covers of the docking station. There is high voltage inside, and the covers are not interlocked.

DANGER: 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.

DANGER: During maintenance and repair of the transporter, turn off the transporter and disconnect the battery as soon as possible. Avoid shorting the terminals of the battery.

WARNING: Parts of the drivetrain can get hot during operation. Allow the robot to cool down before servicing.

Pinch Hazard

Platform Covers

CAUTION: Pinch hazard. The covers 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 covers.

Magnetic Field Hazards

Platform Covers

WARNING: Magnetic fields can be hazardous to pacemaker wearers. Pacemaker wearers stay back 30 cm (12 in.) from the covers, which are held in place with strong magnets.

WARNING: Magnetic fields can be hazardous to pacemaker wearers. Pacemaker wearers stay back 30 cm (12 in.) from the underside of the platform, which is exposed during this maintenance procedure when the platform is tipped on its side.

Docking Funnel

WARNING: Magnetic fields can be hazardous to pacemaker wearers. Pacemaker wearers stay back 30 cm (12 in.) from the underside of the platform, which is exposed during certain maintenance procedures for which the platform is tipped on its side.

10.2 Lifting the Platform Safely

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

WARNING: Platform damage. Lifting the platform from the wrong points can damage the platform.

Front Lifting Points

On each side of the laser, under the upper side of the laser slot. Do not lift at the center - there is no frame supporting it there. Do not lift anywhere else! Refer to the following illustration:

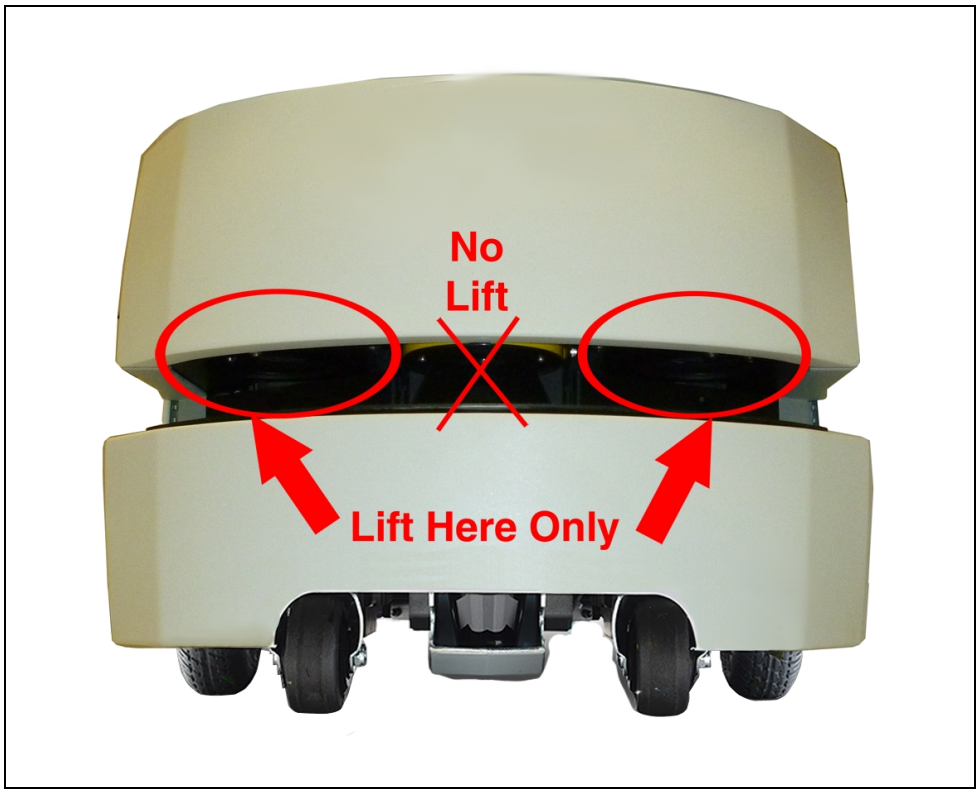


Figure 10-4. The upper surface of the laser slot, at both sides, not the center.

Rear Lifting Area

The center underside of the platform, where the cover has a raised section. Do not lift anywhere else! Refer to the following illustration:

Figure 10-5. Bottom of Inner Rear cover. Lift from the frame, not the cover.

10.3 Safety Inspection

Item	Period	Reference
Warning Devices	1 week	Warning Devices on page 147
Warning Labels	1 week	Warning Labels on page 147
Informative Labels	1 week	Informative Labels on page 149

Warning Devices

The following warning devices should be inspected for proper function on a weekly basis.

Light Discs

The light discs on each side of the transporter should be checked.

Flashing Light(s)

The beacon on top of the HMI post should be checked.

If there is a user-installed beacon or light tower that has been installed to warn people of the AIV's movement or imminent movement, it should be checked for proper function every week.

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

Buzzer

The warning buzzer should be checked for proper function. In order to maintain conformity with applicable standards, it is important that the buzzer be audible in all operating conditions and environments.

Warning Labels

See Figure 10-6. and Figure 10-7.

All warning labels on the LD Cart Transporter system should be checked on a weekly basis for being present and legible. If any of the labels are missing or illegible, they should be replaced. The labels, with part numbers, are:

- Laser Aperture Label, 13308-000L

  There is one laser warning label for each of the six lasers.

- Pinch Point Label, 12992-000

A pinch point label is on top of the latch mechanism cover.

- Hand-entanglement Label, 18180-000

A hand entanglement label is under the latch mechanism cover, near the belt and pulley.

See Removing Latching Mechanism Cover on page 152 for instructions on removing the cover.

- Pacemaker, Magnetic Field Warning Label, 13306-000L

One magnetic field/pacemaker label is on the transporter rear cover.

A second is on the top rear bar of the cart.

A third is on the underside of the transporter, on the docking funnel. This magnet is only exposed during maintenance, when the transporter is tipped on its side.

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

  This is labeled EMERGENCY STOP. It is located on the Operator Panel, at the top of the HMI post.

- No Riding Label, 18178-000

One of these labels is located on the cart transporter top plate, near the front.

Another is on the top rear bar of the cart.

- No Incline Label, 18179-000

A no incline label is attached on the top plate of the transporter, in front and to the side of the plastic triangle for aligning with a cart.

Informative Labels

The following labels are on the Operator Panel, at the top of the HMI post.

They should be checked on a weekly basis for being present and legible. If any of the labels are missing or illegible, they should be replaced. The labels, with part numbers, are:

- HMI post button label, 14463-000

  This includes the BRAKE, ON, OFF, and Keyswitch labels.

- HMI post LATCH, UNLATCH button labels, 14628-000

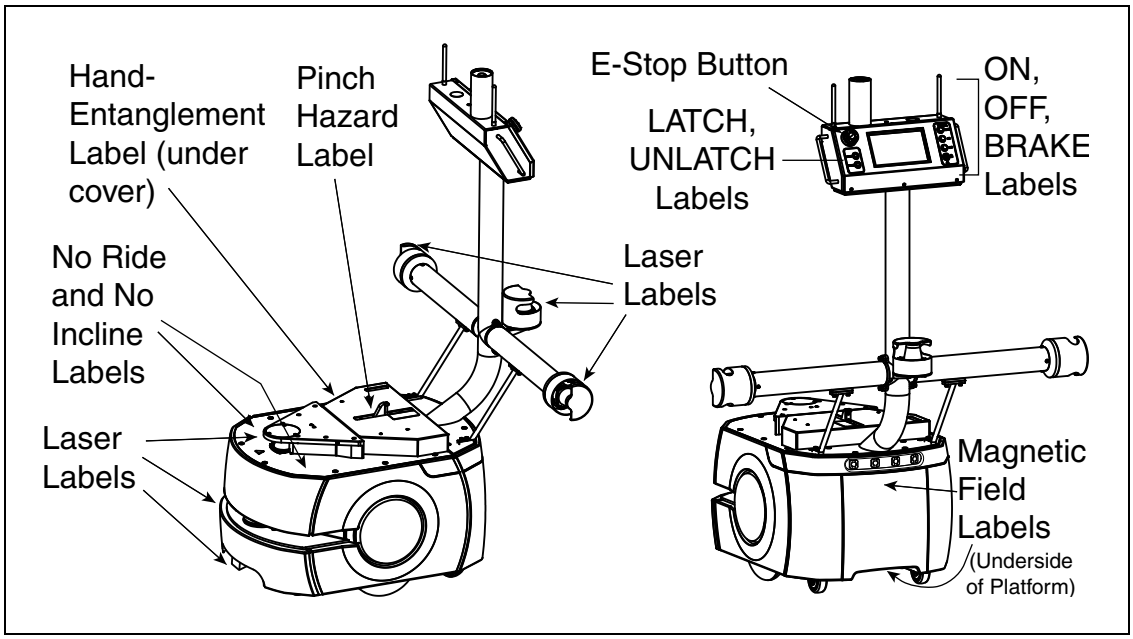


Figure 10-6. Locations of Labels on LD Cart Transporter

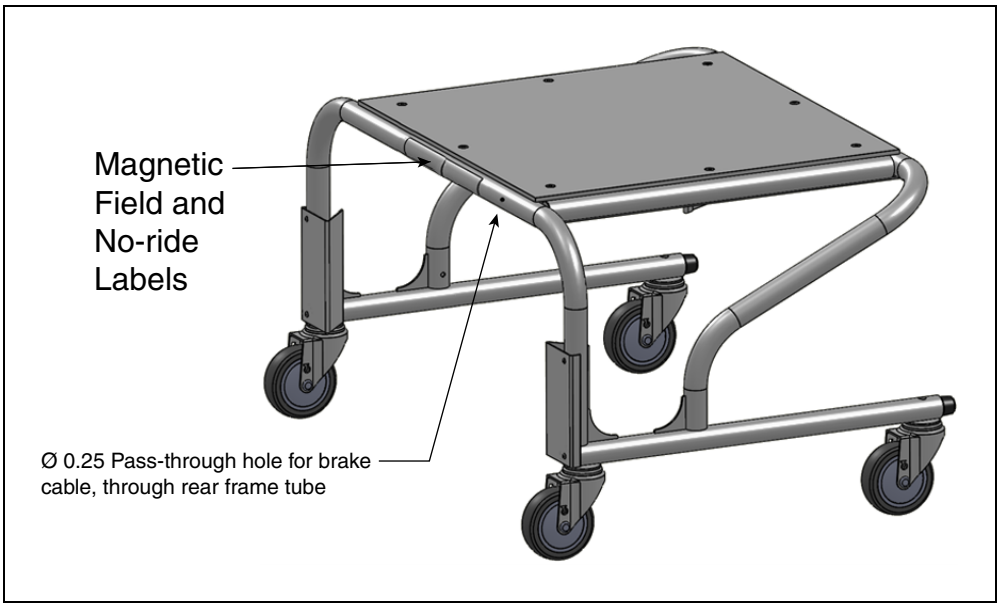


Figure 10-7. Magnetic Field/Pacemaker, No Riding Labels on Cart

10.4 Cleaning

Work Area Maintenance

The work area of the AIVs must be kept generally clean and free from clutter that could block an AIV.

Anything spilled on the floor of the work area, such as dust, ice, pooled water, etc., must be removed immediately, as this would interfere with the AIV's ability to drive safely, as well as

navigate. Any substance that reduces the AIV's traction with the floor will impair its ability to drive, stop, turn, and navigate. Pay particular attention to areas around goals and frequently-traveled paths.

LD Cart Transporter and Cart

Some parts of the transporter require periodic cleaning. The following table gives a summary of cleaning procedures for the LD Cart Transporter system.

Table 10-1. Cleaning

Item	Period	Reference
Clean docking station contacts	3 months	Docking Station Contacts on page 152
Clean axles and tires	As needed	Tires on page 151
Clean casters	As needed	Casters on page 151
Clean all laser lenses - wipe clean	6 months/ as needed	Lasers on page 152
NOTE: The safety scanning laser will display a flashing icon of a windshield and wiper when it detects that its lens needs cleaning.		

NOTE: When the tires or floor get dirty, the wheels will tend to slip, and the AIV can fail to localize. This is common near goals. Both the floor and the tires need to be kept clean.

NOTE: The frequency of these procedures will depend on your particular system, its operating environment, and the amount of usage. 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 dirt or debris that may accumulate on the tires, because these can degrade the AIV's performance.

Casters

Occasionally clean the casters with a mild soapy solution. Remove any dirt or debris that may accumulate on them, because these can degrade the AIV's performance.

This applies to the casters on the cart transporter as well as on the cart.

Axles

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

Lasers

Occasionally clean the lenses of all lasers. Use only alcohol-based, non-abrasive cleaners, and wipe thoroughly.

Docking Station Contacts

The two docking station contacts occasionally need to be cleaned. The suggested interval is 3 – 6 months, depending on frequency of charging.

WARNING: Unplug power from the docking station before cleaning. Remove the power cord at the charger.

Clean the contacts with isopropyl alcohol.

CAUTION: Do not lubricate the docking station paddle. Lubrication will reduce the life of the paddle.

10.5 Accessing the Payload Bay

The payload bay is the area between the transporter top plate and the top of the platform itself. Care must be taken, when accessing the payload bay, that the wires and connections between the platform and the HMI post and coupling plate are not damaged. See Top View of an LD Cart Transporter, Side Laser Support Tubes Removed on page 143.

The top plate is held on with eight M6 socket-head screws and two M5 cap screws. You should not remove the HMI post base. The sheet metal cover of the Latching Mechanism needs to be removed to access the two M5 screws. The top plate and the rest of the coupling plate will come off together.

CAUTION: When lifting the top plate off, take extra care not to scratch the coupling laser's lens with the top plate itself.

Removing Latching Mechanism Cover

1. Remove the four M3 screws holding the Latching Mechanism cover to the top plate.

   These go into four 45 mm standoffs in the top plate.

   Retain the M3 screws for reassembly.

2. Lift off the Latching Mechanism cover.

   Retain the cover for reassembly.

Removing Top Plate

1. Remove the two stainless M5 screws that were covered by the Latching Mechanism cover.

   Retain the M5 screws for reassembly. These are socket-head cap screws.

2. Remove the eight M6 screws along the sides and front of the top plate.

   Retain the M6 screws for reassembly. These are flat head, stainless screws.

3. Disconnect the cables going to the latching assembly and sensors in the Latching Mechanism.

4. Carefully lift off the top plate.

   As you remove the top plate:

CAUTION: Take care not to scratch the laser lens when removing the top plate.

At this point, you will have access to the payload bay.

Installing Top Plate

1. Resintall the top plate.

CAUTION: Take care not to scratch the laser lens when reinstalling the top plate.

2. Reconnect the cabling to the latching motor assembly and its sensors.

3. Reinstall the eight M6 screws along the sides and front of the top plate.

   Use the screws previously removed from the top plate.

4. Reinstall the two M5 screws that were covered by the Latching Mechanism cover.

   Use the screws previously removed from the top plate.

Installing Latching Mechanism Cover

1. Place the Latching Mechanism cover back onto the top plate.

2. Reinstall the four M3 screws holding the Latching Mechanism cover to the top plate.

   Use the screws previously removed from the Latching Mechanism cover.

   These go into four 45 mm standoffs in the top plate.

10.6 Removing and Installing LD Cart Transporter Covers

Many of the maintenance procedures require removing some of the platform's covers. Most covers are held in place with just magnets. The rear outer cover has an additional brace at the bottom for support, the bumper cover uses screws and magnets, and the access panel uses just a push-push (toggle) latch.

CAUTION: Pinch hazard. The magnets holding the covers in place are strong enough to pinch you if you are not careful.

The covers are:

- Rear Inner (Battery)
- Access Panel
- Left Side

  Both side covers include a light disc and cover.
- Right Side
- Front Upper
- Bumper
- Rear Outer

With the exception of the bumper cover, no tools are needed for either the removal or installation of the covers.

Removing Covers

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

The covers can be removed in the order in which they are listed above.

- The rear outer must wait for the rear inner and the two side covers.
- The front upper must wait for the two side covers.
- The two sides, the rear inner, and the bumper cover can all be removed without removing any other covers, except that the left cover must wait for the access panel.

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

Rear Inner Cover (Battery)

This provides access to the battery compartment door.

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

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

2. Lower the cover down, so its top tab slides down, and clears the rear outer cover.

Access Panel

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

1. Push the left (front) side of the panel in, and the latch will release it.

   Pushing the panel a second time will engage the latch.

2. When released, pull the left side out, and slide the panel to the left.

   The panel is attached with a lanyard, to prevent getting lost.

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

Side Covers

1. For the left side cover, put the access panel out of the way.
2. Pull the bottom of the cover, at both sides, away from the chassis.
3. Work your way up the edges of the cover, pulling it away from the chassis as you go.
4. Remove the cover a few inches from the chassis.

   The light disc wires plug into connectors on the inner side of each side cover.

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

Repeat for the other side cover.

Front Upper Cover

This cover is held onto the chassis the most tightly of any of the covers.

1. Grip the cover at the two outer edges.
2. Pry the cover away from the chassis.

Bumper Cover

This is the only cover that requires tools to remove.

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

   Retain the screws for reinstalling the bumper cover.

2. Pull the cover off of the bumper.

   It is held on with magnets, as well as screws.

Rear Outer Cover

This cover houses the two rear sonar pairs, which must be disconnected once the cover is part-way off the chassis. Each pair consists of one emitter and one receiver.

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

   The cover 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 10-8. 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.

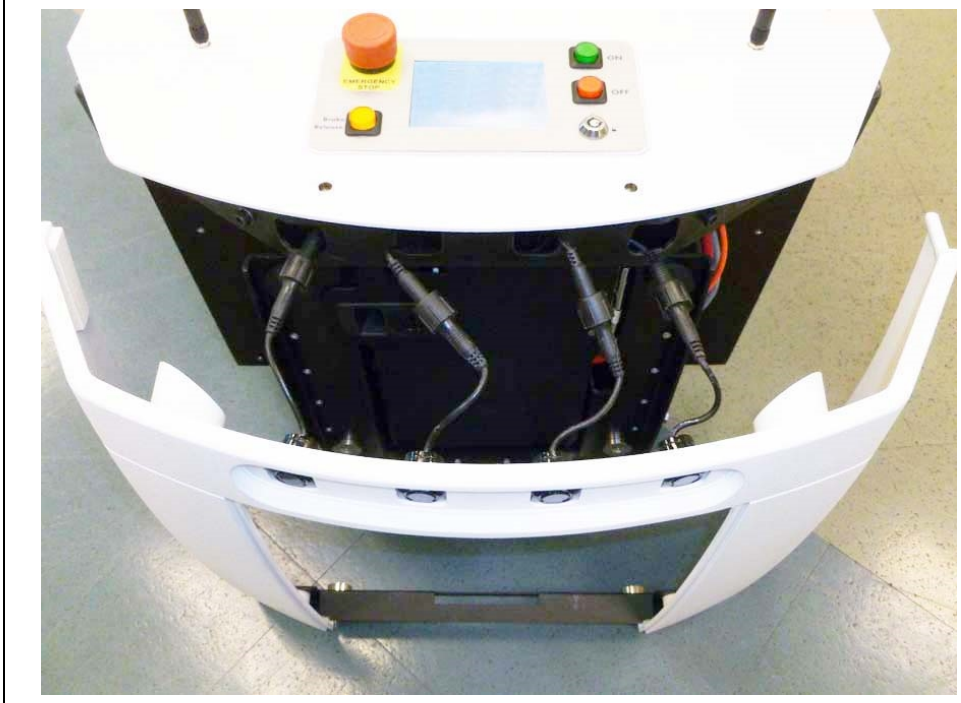


Figure 10-9. Sonar Connectors, with Connectors Exposed

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

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

Installing Covers

The covers can be installed in the reverse of the order in which they are listed above.

- The front upper and rear outer covers must be installed first and second.
- The access panel must wait for the left side cover.

Bumper Cover

This is the only cover that requires tools to install.

1. Place the cover on the bumper.

   It is held on with magnets, as well as screws.

2. Install the screws, removed during the cover removal, at the sides of the cover.

Front Upper Cover

1. Grip the cover at the two outer edges.
2. Align the bottom edge of the cover so it slides under the chassis support.
3. Tilt the top of the cover into position.

Rear Outer Cover

Because this cover houses the rear sonar units, they must be reconnected once the metal brace across the bottom is in the clip just below the battery access door.

1. Slide the metal brace into the clip in the chassis.

   Watch the two magnets on the bottom of the cover, to align them with their mating magnets on the chassis. This is your best guide for getting this cover in its proper place.

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

2. When the magnets at the bottom are lined up, tilt the cover up to within a few inches of the chassis.
3. Pull the sonar connectors clear of the chassis, if they are not already out.

   See the preceding figure.

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 cover up to meet the chassis.

Side Covers

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

   The light disc connector is accessible on the inner side of the side cover.

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

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

3. Tilt the bottom edge of the cover down.

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

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

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

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

Repeat for the other side cover.

Figure 10-10. Right Side Cover, Showing Even Gaps at Edges

NOTE: The gaps between the side covers and the bumper cover 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 cover.

   The panel is attached with a lanyard, 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.

Rear Inner (Battery) Cover

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

CAUTION: Pinch hazard. This cover is the most likely to pinch you if you are not careful, particularly at its bottom edge. Hold the cover at the bottom, in the center, with two hands.

2. Holding the cover near the center, with both hands, tilt the bottom of the cover down, towards the platform chassis.

10.7 Replacing Periodic Parts

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

Battery Replacement

The battery is expected to last for approximately 7 years of 16 hours/day, 5 days/week. Life expectancy for 19/7 is 4 years. (19 hours/day is full-time, with time-out to recharge.)

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

WARNING: Replace the battery only with an Omron Adept Technologies, Inc. battery.

Dispose of the battery according to all local and national environmental regulations regarding electronic components. Contact Omron Adept Technologies, Inc.

WARNING: Follow appropriate ESD procedures during the removal/replacement phases.

Removal

WARNING: The battery is heavy (17 kg/37 lbs). Observe safe lifting practices when removing or installing the battery.

1. Remove the inner rear platform cover.
   a. Pull the bottom of the cover away from the platform chassis.

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

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

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.

   See the following figure.

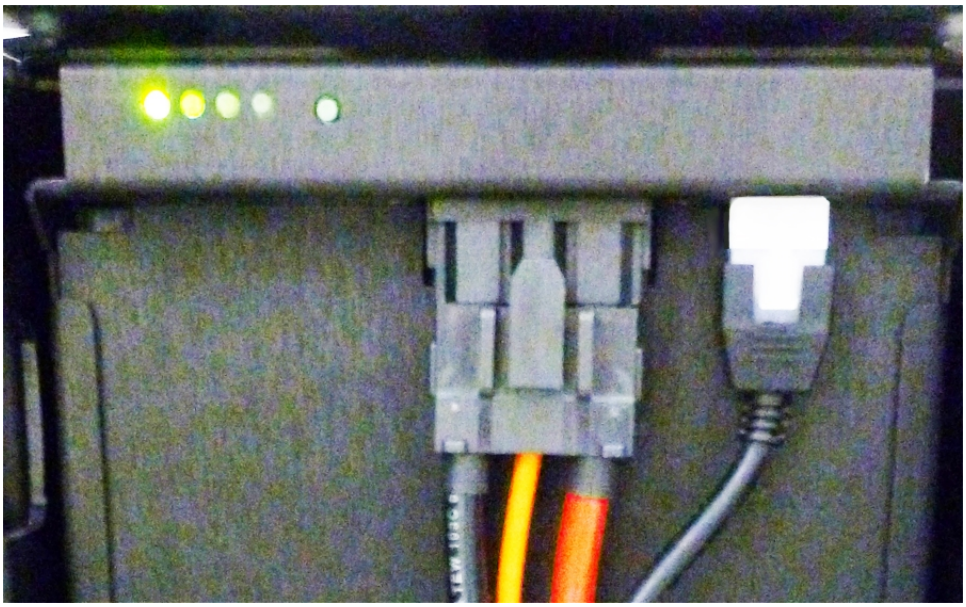


Figure 10-11. Battery Cable Connectors

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 Installing the Battery on page 45 for instructions on installing the battery.

10.8 Replacing Non-Periodic Parts

All of the following parts are replaced on an as-needed basis.

Docking Station Roller and Bearing

WARNING: There are no user-serviceable parts inside the docking station. Do not remove the covers of the docking station. There is high voltage inside, and the covers are not interlocked.

The roller, which guides the platform onto the docking station, may be subject to wear 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: Unplug power from the docking station before starting. Remove the power cord at the charger.

The roller is held to the docking station with a shoulder bolt.

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.

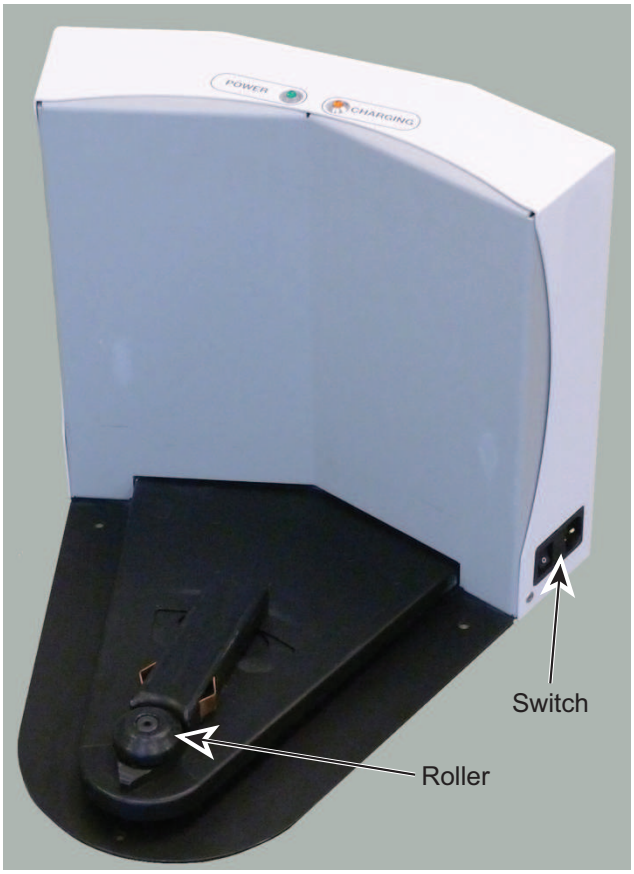


Figure 10-12. Docking Station Roller Location

Safety Scanning Laser

1. While supporting the laser, unscrew the two screws and washers from the bracket holding the laser, to remove the laser from the platform chassis.

   Retain these screws and washers for installing the new laser.

2. Unscrew the four screws holding the black cap on top of the laser.

   Retain the four screws and top cap for reassembly.

   You will use this top cap on the new laser. Do not unplug it from the platform chassis.

CAUTION: The programming for the laser is contained in the cap. If you replace the cap, this programming will be lost, and must be restored by factory personnel.

Figure 10-13. Safety Scanning Laser

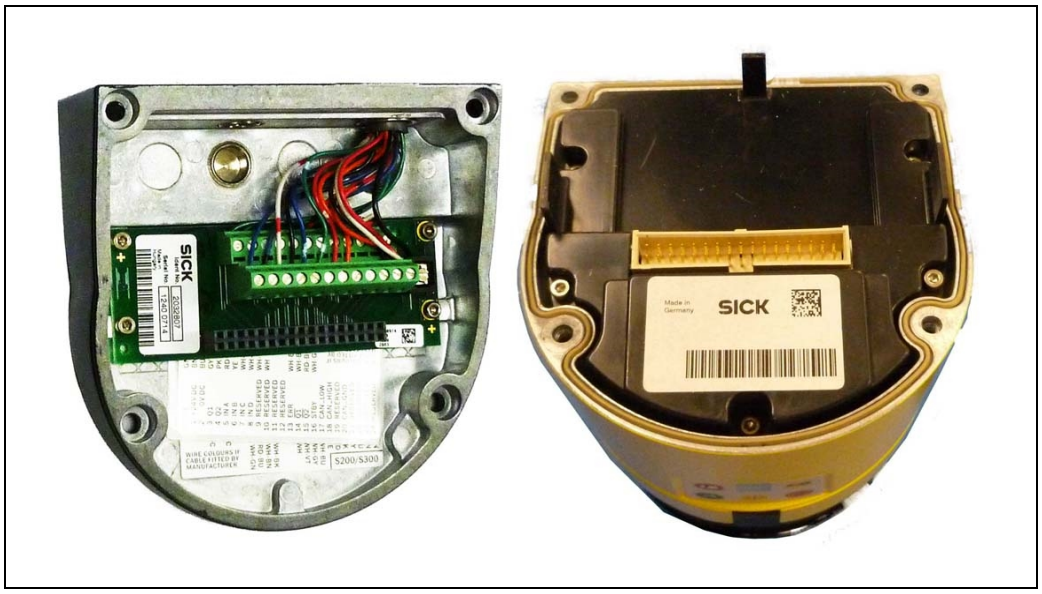


Figure 10-14. Connectors Inside Laser Cap and Laser

The underside of this plate has a connector that makes an electrical connection with a mating connector inside the laser.

3. Put the existing laser top cap onto the new laser.

   You will feel slight resistance as the two connectors plug into each other.

4. Connect the black top cap to the new laser, using the four retained screws.

5. Attach the laser to the chassis using the two screws and washers from the old laser.

   NOTE: The laser orientation can be adjusted. Be careful to mount the laser horizontal with respect to the floor.

Obstacle Detection and Coupling Lasers

All of the lasers on the cart transporter, other than the Safety Scanning Laser, are the same model laser. The front of these lasers have two LEDs. Green indicates ready status, flashing red indicates an error. No LEDs lit indicates no power.

These lasers come with an attached cable, about 0.3 m (12 inches) long, with a male M12 connector.

Low Front Laser

1. Remove the four M5 screws holding the laser guard to the mounting plate along with their lock washers and flat washers.

   This will free the guard from the plate.

   Retain the M5 screws, lock washers, and flat washers for reassembly.

CAUTION: Take care not to scratch the laser lens during this procedure.

2. Remove the two M4 screws, lock washers, and flat washers holding the laser to the plate.

   This will free the laser from the plate.

   Retain the two screws, lock washers, and flat washers for reassembly.

3. Disconnect the laser cable from the cable to the platform core.

   Cut the cable ties holding the cable to the cable tie anchors.

4. Connect the platform core cable to the new laser's cable.

5. Mount the new laser to the plate with the M4 screws, lock washers, and washers previously removed.

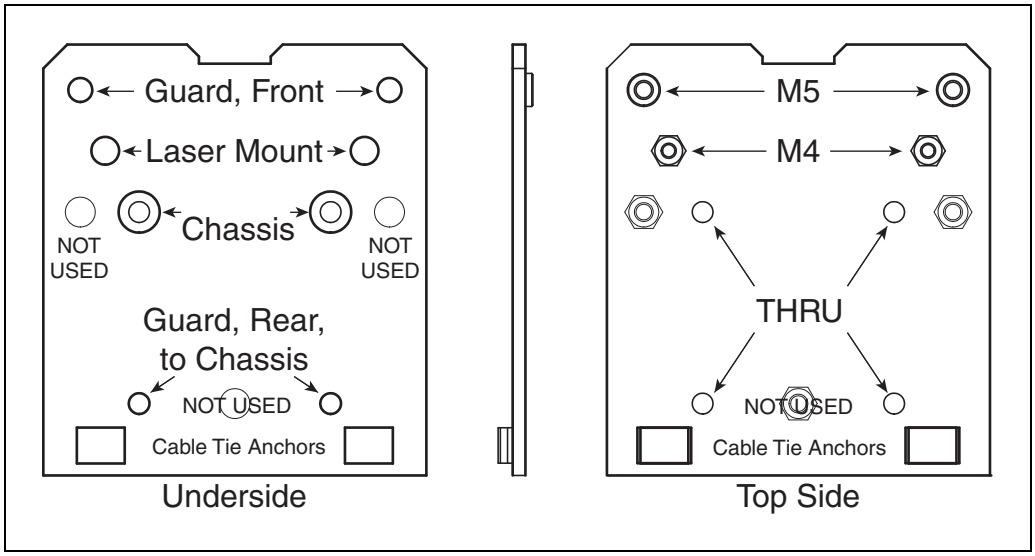


Figure 10-15. Mounting Plate for Low Front Laser and Guard

6. Mount the laser guard to the plate with the M5 screws, lock washers, and washers previously removed.

   Take care not to scratch the laser lens during this procedure.

7. Cable-tie excess cable to the two anchors so it cannot touch the floor or the tires.

Side Lasers

Each side laser assembly includes the laser, guard, and flange. They mount to the ends of the horizontal support tubes. The flanges should be left attached to the horizontal support tubes.

1. Loosen the two M4 screws holding the laser guard to the mounting flange.

   The screws go through two slots in the guard, so the guard can slide off after the screws are loosened.

2. Slide the guard back enough to free it, and remove it from the assembly.

CAUTION: Take care not to scratch the laser lens when removing the laser guard.

3. Remove the two M4 screws holding the laser to the mounting flange.

   This will free the laser from the mounting flange.

   Retain the two screws, flat washers, and lock washers for reassembly.

4. Detach the cable from the old laser.

   Do not let the cable slip into the flange or support tube, where you can't reach it.

5. Attach the cable to the replacement laser.

6. Mount the laser to the mounting flange, using the M4 screws and washers you removed from the old laser assembly.

7. Mount the laser guard to the mounting flange, sliding its tabs under the M4 screws that you previously loosened.

   Take care not to scratch the laser lens during this step.

   Ensure that the laser guard opening faces the front of the transporter.

   Tighten the screws to hold the guard in place.

Rear-facing Laser

A rear laser assembly includes the laser, guard, and mounting bracket. The bracket mounts to the HMI Post between the horizontal support tubes.

Replacing this laser requires accessing wires and a connector inside the left horizontal support tube, which is attached to the HMI post.

1. Remove the two M6 screws, lock washers, and flat washers holding the left laser support tube to the HMI post.

   Save the screws and washers for reassembly.

2. Loosen, but do not remove, the two M5 screws securing the support tube to the HMI base.

3. Loosen the two M4 screws holding the rear-facing laser guard to the bracket.

   The screws go through two slots in the guard, so the guard can slide off after the screws are loosened.

4. Slide the guard back enough to free it, and remove it from the assembly.

CAUTION: Take care not to scratch the laser lens when removing the laser guard.

5. Remove the two M4 screws, lock washers, and flat washers holding the laser to the

bracket.

This will free the laser from the bracket.

Retain the two screws, lock washers, and flat washers for reassembly.

6. Carefully twist the left laser support tube on its brace, to expose the cables inside.

   Pull out the laser cable, until you have access to the connection between the cable to the laser, and the cable going down inside the HMI post (to the platform core).

7. Disconnect the laser cable from the cable to the platform core.

   Take care that the connector doesn't slip down inside the HMI post.

8. Connect the new laser cable to the cable from the platform core.

9. Tuck the connector inside the left laser support tube, so that the cable goes through the small notch in the left support tube flange.

10. Mount the new laser to the bracket with the M4 screws, lock washers, and washers previously removed.

11. Reattach the left laser support tube to the HMI post, using the M6 screws, lock washers, and washers previously removed.

12. Put the guard over the laser, and slide its tabs under the previously-loosened M4 screws.

    Take care not to scratch the laser lens during this step.

    Tighten the screws to hold the guard in place.

Coupling Laser

The coupling laser is mounted in the platform's payload bay, protruding up through the top plate, into the coupling plate. It enables the transporter to position itself close enough to a cart for the Latching Mechanism to couple with the cart.

Remove the Latching Mechanism cover and the platform top plate. Refer to Accessing the Payload Bay on page 152.

1. Remove the two M4 screws holding the laser to the bracket.

   This will free the laser from the bracket.

   Retain the two screws, flat washers, and lock washers for reassembly.

2. Disconnect the laser cable from the cable to the platform core.

3. Connect the new laser cable to the cable going to the platform core.

4. Mount the new laser to the bracket with the M4 screws, lock washers, and washers previously removed.

Reinstall the top plate and the Latching Mechanism cover. Refer to Accessing the Payload Bay on page 152.

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. Refer to Removing and Installing LD Cart Transporter Covers on page 154.
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.

   Press the new sonar unit through the hole in the rear outer cover, from the outside.
4. Connect the sonar cable to the new sonar unit's lead.
5. Insert the new sonar unit through the hole in the rear outer cover.
6. Reinstall the rear covers.

Sonar Controller

The sonar controller is located in the payload bay.

1. Refer to Accessing the Payload Bay on page 152 to access the payload bay.
2. Locate the sonar controller.
   - The controller is plugged into the Sonar 1 connector on the robot core. This connector is not accessible from the payload bay, but does not need to be unplugged for this procedure.
   - The controller will be at the very front of the payload bay, screwed into the payload bay deck with two screws.

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

      Retain the screws for mounting the replacement controller.

   b. Unplug the larger cable from the sonar controller.

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

   c. Unplug the 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.

   d. Remove the controller from the payload bay, and replace it with the new one.

   e. Connect the sonar unit cables to the new controller.

      Ensure that the cable labels match the controller labels.

   f. Plug the larger cable into the new controller.

   g. Screw the new controller to the payload bay deck, using the two screws removed from the old controller.
3. Reinstall the platform top plate and Latching Mechanism cover. Refer to Accessing the Payload Bay on page 152.
4. Dispose of the old controller according to local and national regulations concerning electronic components.

Cart Latching Mechanism

CAUTION: The latch mechanism belt adjustment is for Omron Adept Technologies, Inc. Field Service only. Changing the belt tension can lead to premature failure.

The Delrin end of the Latching Mechanism is subject to wear, and may need replacement.

When the Delrin on the cart Latching Mechanism has worn through a quarter of its original thickness, or when either of the two screws holding the Delrin block in place becomes flush with the Delrin block, the block needs to be replaced.

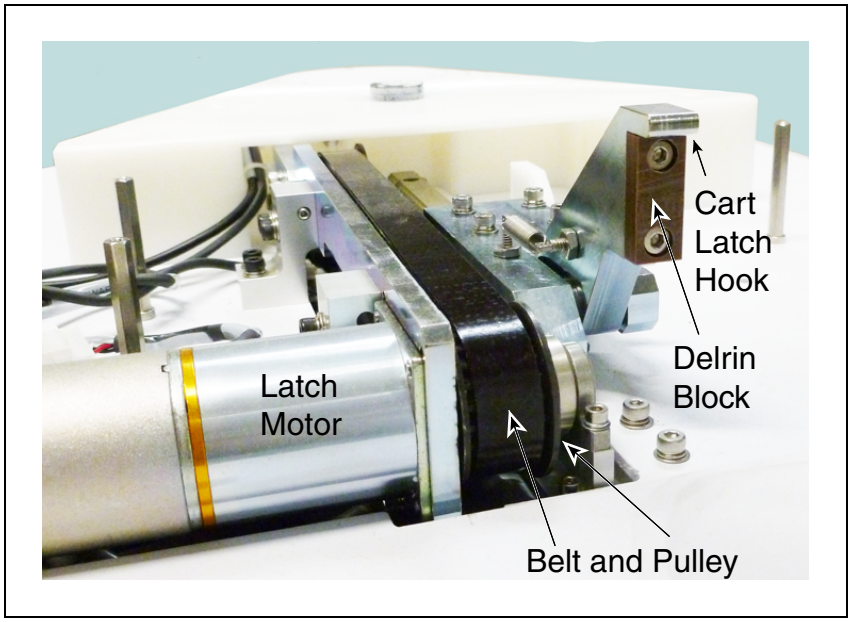


Figure 10-16. Cart Latch Mechanism with Delrin Block, Vertical Position

NOTE: The color of the Delrin block may vary.

CAUTION: Pinch hazard. The latch of the cart transporter can pinch you if you are not careful. Keep your hands clear of the Latching Mechanism when it is in action.

WARNING: Entanglement hazard. The belt and pulley of the cart transporter can entangle your hand during maintenance. Keep your hands clear of the belt and pulley when they are moving. This is only a hazard during maintenance of this part of the cart transporter.

1. Remove the latching mechanism cover.

   See Removing Latching Mechanism Cover on page 152.

2. Rotate the cart Latching Mechanism up on its pivot:

In order to replace the Delrin block, the cart latch hook has to be rotated up to its vertical position. If the hook-lowering block shown in the following figure is removed, the latch hook will be pulled up to its vertical position.

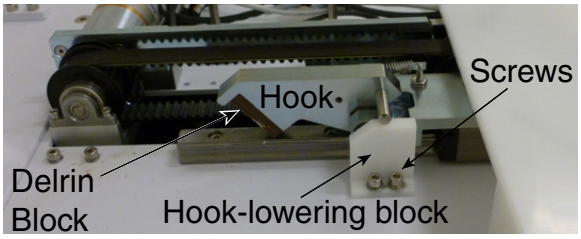


Figure 10-17. Hook-lowering Block and Screws

- Remove the two screws holding the hook-lowering block in place.

  Retain the screws for re-assembly.

- Remove the block, allowing the latch hook to spring up.

  Retain the block for re-assembly.

3. Unscrew the two screws holding the Delrin block on the end of the latch hook.

   These were installed with threadlocker.

   Retain these screws for attaching the replacement Delrin block.

4. Remove the Delrin block, and replace it with the new block.

5. Attach the new Delrin block with the two screws previously removed.

   Use Loctite® 222MS (blue) on the screws.

6. Reinstall the hook-lowering block.

   - Manually lower the latch hook, and insert the block, which will keep the latch hook in the down position.
   - Insert the two screws previously removed to hold the hook-lowering block in place.

7. Reinstall the latching mechanism cover.

   See Installing Latching Mechanism Cover on page 153.

Light Discs

The two light disc assemblies 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 cover, on the side that needs the light disc assembly replaced.

   Refer to Removing and Installing LD Cart Transporter Covers on page 154.

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

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

3. Remove the light disc PCA.
4. Screw the new assembly and retained round cover to the side cover, using the screws retained from the old assembly. The PCA is keyed so that it can only be installed in one orientation.
5. Reinstall the side cover, 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.

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.

The wheel and tire assembly is p/n 11210-000.

Figure 10-18. Samples of Tire Wear

Removal

1. Remove the side cover a small distance from the platform on the side where you want to replace the wheel and tire. Refer to Removing and Installing LD Cart Transporter Covers on page 154.

   The light disc PCA cable will still be attached.
2. Disconnect the cable from the light disc PCA, so the side cover can be moved completely away from the platform.

   This will fully expose the wheel and tire.
3. Lift the drive wheel up, compressing its springs, enough so that you can insert a Ø6 x

10 mm (Ø0.24 x 0.4 in.) pin into the hole on the rear side of the assembly (there is a hole in front of and another to the rear of each assembly). This will keep the springs compressed (the wheel will be in the up position), and make wheel replacement easier. An M5 x 10 screw or the wheel pin used during shipment of the AIV work well for this. See the following figure and Figure 3-13.

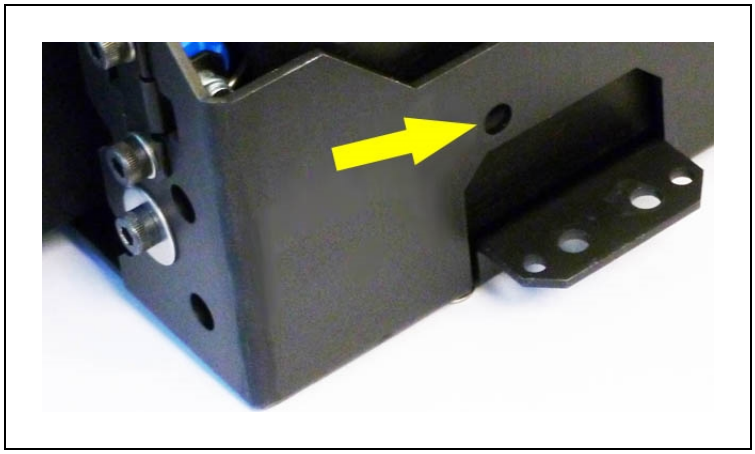


Figure 10-19. Spring-Compression Hole

4. The wheel is held in place with a single screw through the center.

   NOTE: The screw is secured with threadlocker.

   Remove the screw (and washer) holding the wheel to the drive assembly.

   Retain the screw and washer for attaching the new wheel.

5. Remove the wheel from the drive assembly.

   The motor drive shaft is keyed with the wheel. Retain the key for installing the new wheel.

Installation

1. Put the key you removed into the drive shaft keyway.
2. Install the new wheel and tire onto the drive shaft.

   Ensure that the wheel keyway lines up with the key in the drive shaft.
3. Secure the wheel to the drive assembly with the screw and washer previously removed.

   Use Loctite® 220 threadlocker on the screw.
4. Remove the pin or screw you used to hold the wheel in the up position.
5. Put the side cover next to the platform, and attach the light disc cable to the light disc PCA.
6. Reinstall the side cover.

Drive Assemblies

The platform drive assemblies have been designed to be field-replaceable. This will replace the drive motor, gearbox, encoder, and wheel/tire assembly.

Removal

1. Remove the inner rear cover.
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 battery power by unplugging the two cables at the rear of the battery.
4. Remove the side cover a small distance from the platform on the side where you want to replace the drive assembly. Refer to Removing and Installing LD Cart Transporter Covers on page 154.

   The light disc PCA cable will still be attached.
5. Disconnect the cable from the light disc PCA, so the side cover can be moved completely away from the platform.

   This will expose the drive assembly.
6. Lift the drive wheel up, compressing its springs, enough so that you can insert a Ø6 x 10 mm (Ø0.24 x 0.4 in.) 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. An M5 x 10 screw works well for this. If you saved the wheel pin, it should be used for this. See Figure 3-13. See also Figure 10-19.
7. The drive assembly is held in place with three nuts on studs across the top, and two pairs of 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.

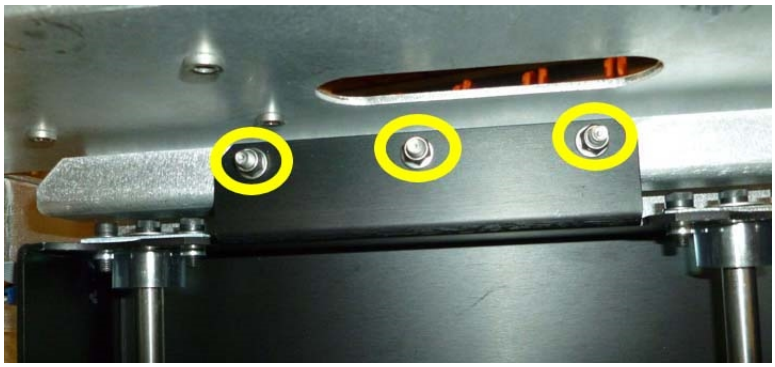


Figure 10-20. Mounting Studs and Nuts at top of Drive Assembly

Figure 10-21. Mounting Screws at Bottom-Right of Drive Assembly

8. Remove the drive assembly from the platform.

   The motor cable to the robot 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 Ø6 x 10 mm (Ø0.24 x 0.4 in.) 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 on page 171.

   NOTE: Make sure that the pin is short enough so 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 cover next to the platform, and attach the cable to the light disc PCA.
6. Reinstall the side cover.
7. Connect the battery power and data cables, and close the battery compartment door.
8. Reinstall the rear cover.

Platform Casters

The platform casters should be checked every 3 months. If they show signs of cracking, excessive wear, or any damage they should be replaced.

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

> **NOTE:** If you have a means of lifting the chassis of the platform enough to access the screw that holds on the caster, you can avoid removing the battery, which is only necessary to tilt the platform on its side.

If you cannot lift the chassis enough to access the caster screw:

1. Remove the inner rear cover.
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 battery by unplugging the two cables at the rear of the battery.
4. Remove the battery from the platform.
5. Remove the side covers.
6. Lay the body of the platform on its side, exposing the casters.

WARNING: Magnetic fields can be hazardous to pacemaker wearers. Pacemaker wearers stay back 30 cm (12 in.) from the underside of the platform, which is exposed during this maintenance procedure when the platform is tipped on its side.

Whether or not you had to remove 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.

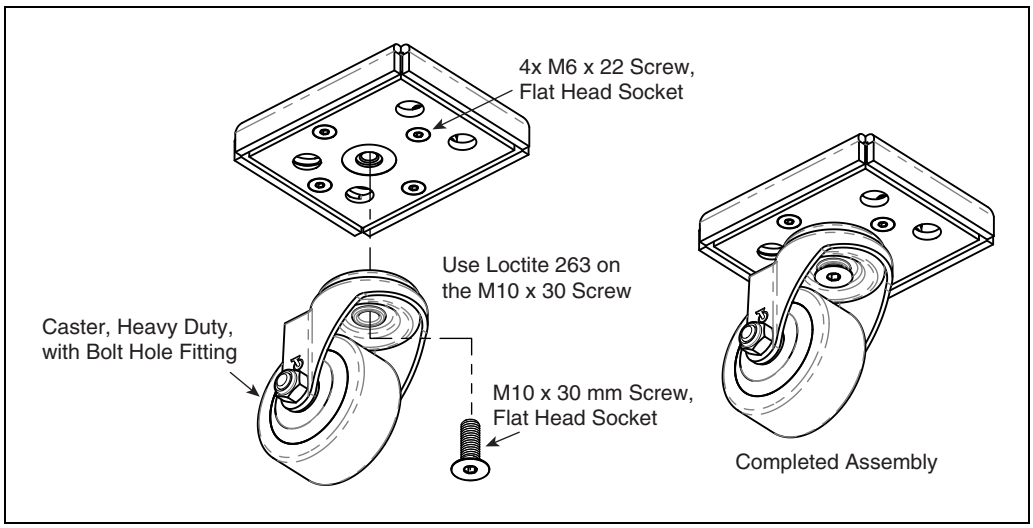


Figure 10-22. LD Cart Transporter Caster Replacement

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·lbf).

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 inner rear cover.
4. Reinstall the side covers.

Cart Casters

The cart casters should be checked every 3 months. If they show signs of cracking, excessive wear, or any damage they should be replaced.

Front Caster Removal

The two front casters are identical, and are mounted to the cart in the same way.

Figure 10-23. Front Cart Caster Screw Assembly

1. Remove the M10 screw and washer holding the caster to the cart.

   Threadlocker was used on this screw during assembly.

Retain the screw, washer, and lock washer for mounting the new caster.

2. Remove the caster from the cart.

Front Caster Installation

1. Put the new caster in place, and attach with the M10 screw and washers you removed from the old caster.

   Use Loctite 263 on the screw.

2. Torque to 73.2 N-m (54 ft-lbf).

Rear Caster Removal

The two rear casters are the same as each other, but different from the front casters, due to the fact that the rear casters have brakes.

1. Remove the top plate of the cart. See Removing Top Plate on page 153.
2. Unscrew the lock nut from the axle screw going through the caster wheel.
3. Remove the axle and caster wheel.

   The axle screw, lock nut, and caster wheel can be discarded.

4. Loosen the outer brake-adjust jam nut at the actuator bar for the caster you are replacing.

   See Figure 10-25.

   Lift the cable and brake-adjust assembly out of the slot in the actuator bar.

5. Push the inner wire into the brake cable housing until the brake pin, which presses against the caster wheel surface, slides out of the caster mounting screw.

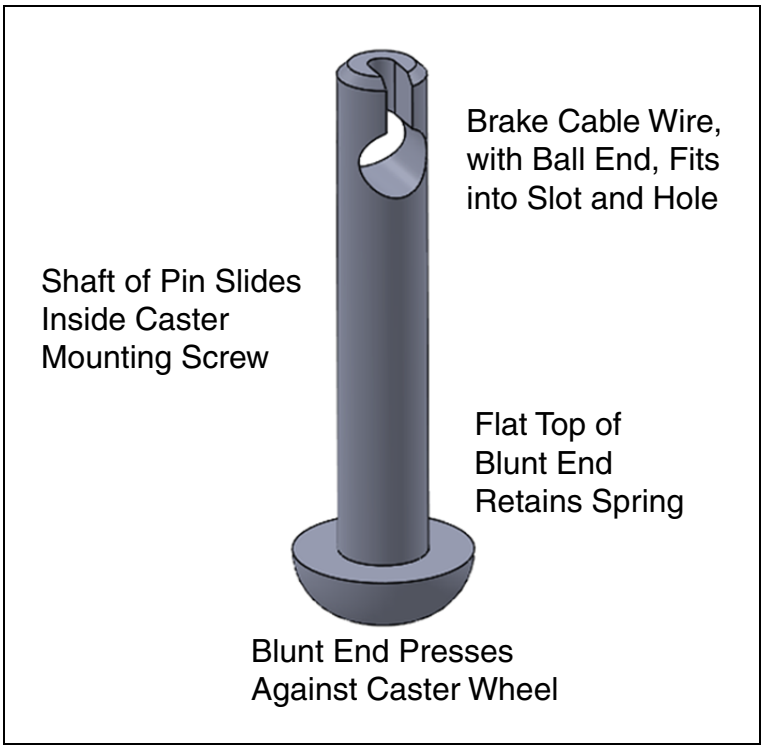


Figure 10-24. Brake Pin

6. Remove the brake pin with spring from the inner brake cable wire.

   Save the brake pin and spring for reassembly.

7. Pull the brake cable inner wire up far enough to be out of the way for removing the caster mounting screw.

8. Unscrew the caster mounting screw, to remove the caster assembly from the cart body.

   Retain the caster mounting screw and lock washer for mounting the new caster.

Rear Caster Installation

1. Unscrew the lock nut from the axle going through the new caster wheel.

   Retain the lock nut for reassembly.

2. Remove the axle and caster wheel from the caster. Do not discard.

   Retain the axle and caster wheel for reassembly.

3. Attach the caster body to the cart body using the caster mounting screw and lock washer previously removed.

   Take care not to damage the brake cable inner wire.

   NOTE: Do not use threadlocker on the rear caster mounting screws.

   Torque to 73.2 N-m (54 ft-lbf).

4. Push the brake cable inner wire back into the cable housing, so the ball end slides out of

the caster mounting screw.

5. Make sure the spring, previously removed from the brake pin, is in place on the brake pin. The wide end goes up, against the caster mounting screw.
6. Insert the ball end of the inner wire into the hole in the brake pin, with the inner wire in the slot above the hole.
7. Slide the brake pin up inside the caster mounting screw, and hold it in place for the next step.
8. Install the caster wheel into the caster frame with the axle screw.

   Fasten with the lock nut, previously removed.

   Torque the lock nut to 41 N-m (30 ft-lbf). Ensure that the wheel spins freely.

   The wheel will hold the brake pin inside the caster mounting screw, so it can't fall out.
9. Pull the inner wire of the cable through the actuator bar, and lock in place with the jam nut previously removed. Use Loctite 242 on the jam nut.

Cart Brake Release

Refer to the following figure for replacement and adjustment.

The Cart Brake Release consists of the lever cable with handle, and the caster brake system.

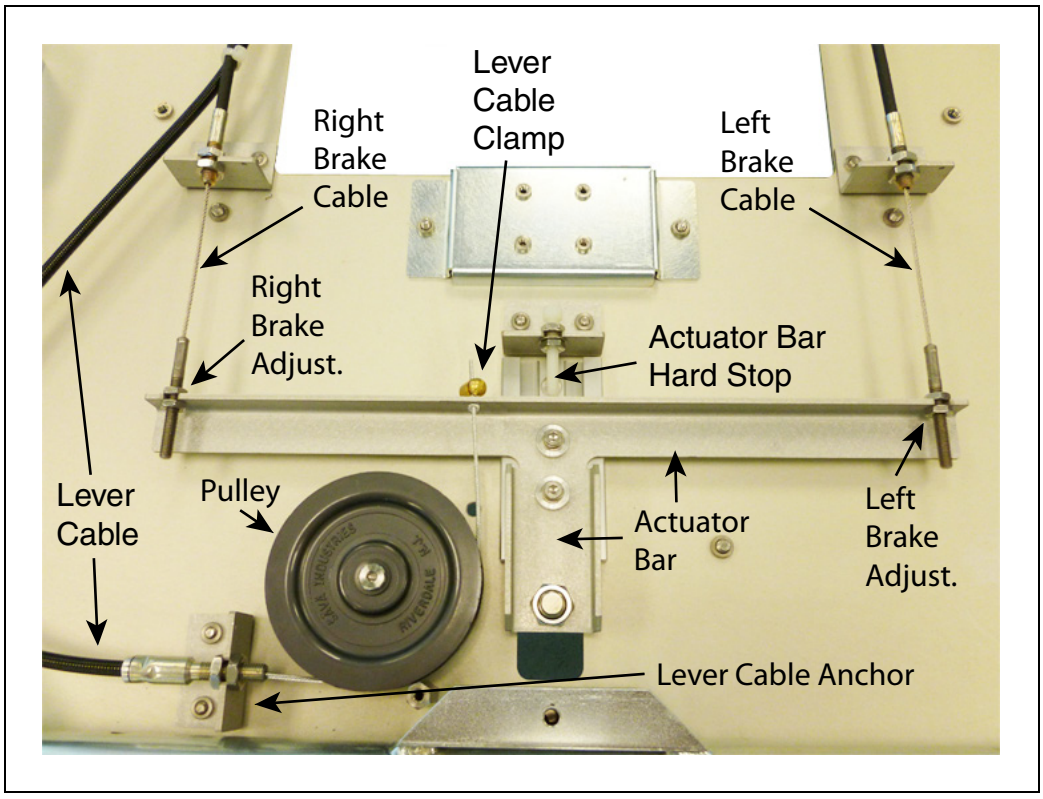


Figure 10-25. Internal Brake-Release Mechanism

Replacing Brake Lever Cable

To replace the cart brake-release cable:

1. Remove the cart top plate. See Removing Top Plate on page 153.
2. Disconnect the end of the cable from the brake control mechanism.
    a. Disconnect the inner wire from the lever cable clamp.
    b. Disconnect the lever cable from the lever cable anchor.
3. Feed the lever cable out through the hole in the horizontal back bar of the cart.

    You will need to cut the cable tie at the saddle.
4. Disconnect the brake-release lever from its mounting place.

    This will vary, depending on how and where you mounted it.

Adjusting the Lever Cable

The brake lever cable needs to be adjusted so there is no excess slack, but so the brakes are engaged when the lever is not being actuated.

The brake lever cable should be adjusted at the lever cable clamp, shown in the prededing figure. There should be just enough slack so the actuator bar touches its hard stop.

Adjusting the Caster Brake Cables

The two caster brake cables are adjusted at the factory. They will normally not need to be adjusted by the user.

If any adjustment is needed, refer to the preceding figure for the adjustment location. The brake pins should be able to go down as far as the caster surface allows, without any slack.

After the caster cables are adjusted correctly, ensure that the actuator bar just touches its hard stop. This will keep the actuator bar in position if you have to adjust the lever cable.

Robot Core

The robot core is a sealed unit, with internal fans as the only moving parts.

1. Access the payload bay. Refer to Accessing the Payload Bay on page 152.
2. Remove the inner rear cover.
3. Unlatch and open the battery compartment door, at the rear of the platform.

    The battery compartment door is capable of being 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 that are attached to the top portion of the robot core.

    Refer to Standard Platform Connections on page 89.
6. Remove the core mounting bracket from around the robot core.

    This is two pieces, held in place with four screws down into the chassis, with four more going sideways into the robot core itself. Retain all of these screws for installing the new robot core.

    See the following figure:

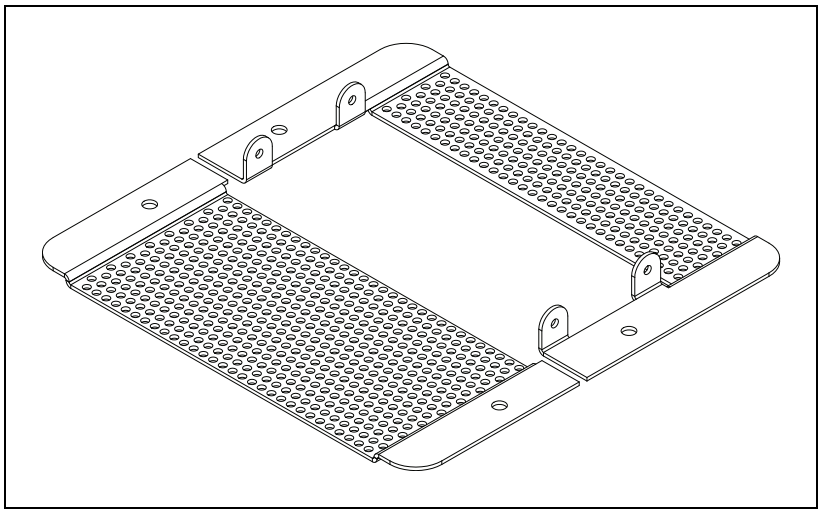


Figure 10-26. Core Mounting Bracket

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 robot core up, until you have access to the internal connections.

9. Remove all of the cables that are attached to the internal robot 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 identify the left from the right.

   See Internal Robot Core Connections on page 104.

10. Remove the old robot core.

11. Connect all of the cables that were attached to the internal robot core connector panel to the new core internal connector panel. See Figure 6-12.

    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 robot core.

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

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

    Refer to Standard Platform Connections on page 89.

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

17. Close and latch the battery compartment door.

18. Reinstall the inner rear cover.

19. Reinstall the platform top plate and Latching Mechanism cover.

Refer to Accessing the Payload Bay on page 152.

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 AIV is commissioned at the factory, and will not need to be re-commissioned. However:

- If the core gets replaced, it will be necessary to redo the E-Stop Commissioning and the Safety Laser Commissioning procedures.
- If the hardware detects a failure, the AIV may automatically decommission itself, and the AIV will have to be re-commissioned to recover. In this event, ARAM will display a fault popup in MobilePlanner.
- If you are using a user-supplied E-Stop.
- Some customers have expressed a desire 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 the E-Stop circuitry is triggered when the E-Stop button is pressed. 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. From the MobilePlanner software, select:

   Main Menu > Robot > Safety Commissioning
3. Follow the on-screen instructions to complete the test. You can print a certificate after successful completion of the commissioning.

Safety Laser Commissioning

This procedure verifies that the safety scanning laser reports speed zone information correctly, and that the E-Stop circuitry is tripped when an obstacle that should be detected by the laser is placed in front of the AIV. Each speed zone represents 300 mm/sec, 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 AIV speed.)

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.

Chapter 11: Technical Specifications

11.1 Dimension Drawings

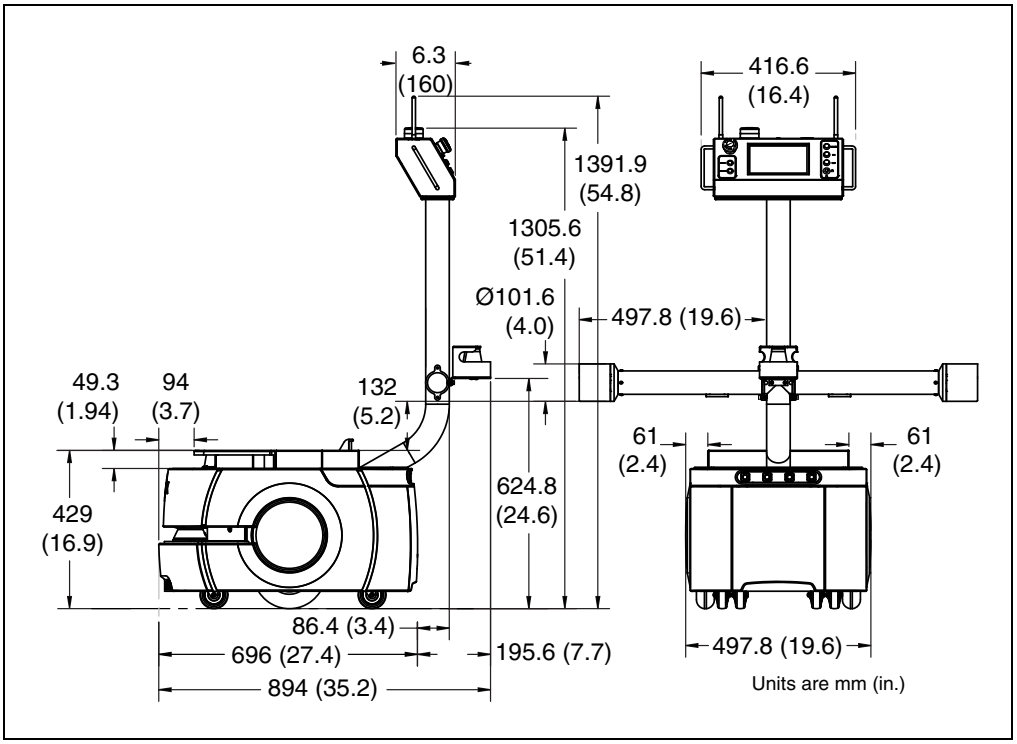


Figure 11-1. Overall LD Cart Transporter Dimensions

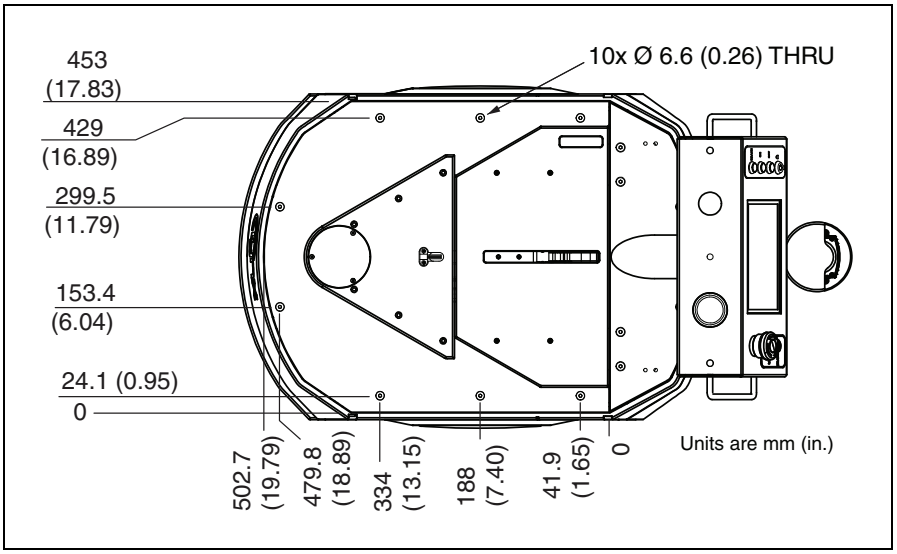


Figure 11-2. Coupling Plate Dimensions, Arms Removed

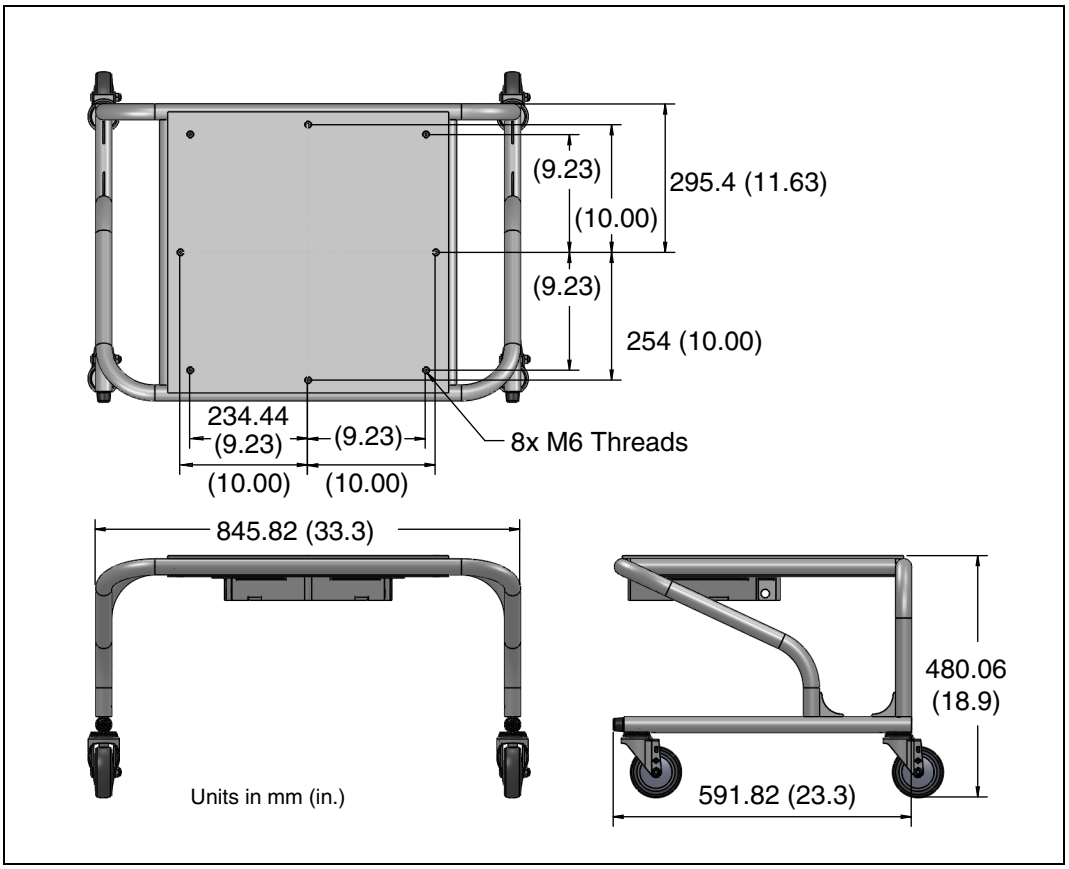


Figure 11-3. Cart Dimensions

If you have a factory-supplied cart, these preceding dimensions show where you will attach your payload.

11.2 Specifications

LD Cart Transporter Physical

Description	Specification
Physical	
Length	686 mm (27 in.)
Width (at side lasers)	1143 mm (45.0 in.)
Height (body)	380 mm (15.0 in.)
Overall Height (with HMI post)	1372 mm (54.8 in.)
Weight (with battery)	79 kg (175 lb)
Frame clearance	27 mm (1.1 in.)
Suspension	
Drive wheels	2 grey non-marking foam-filled rubber

Description	Specification
Wheel diameter	200 x 50 mm (7.9 x 2.0 in.) nominal
Brakes	2 (one each axle)
Steering	Differential
Passive Casters	2 front, 2 rear, spring-loaded
Caster diameter	75 mm (3 in.) nominal

LD Cart Transporter Performance

Description	Specification
Performance	
Max payload (cart + contents)	LD-105CT: 105 kg (231 lb) LD-130CT: 130 kg (287 lb)
Run-time	12 hours continuous, approx.
Swing radius	Platform or Platform and Cart: 698.5 mm (27.5 in.)
Turn radius	0 mm
Translational speed, max	LD-105CT: 1300 mm/sec (51.2 in./sec) LD-130CT: 900 mm/sec (35.4 in./sec)
Traversable step	5 mm (0.2 in.) with cart, 130 kg
Traversable gap	5 mm (0.2 in.) with cart, 130 kg
WARNING: The transporter with a cart is capable of driving over a gap or step of 5 mm (0.2 in.) at a speed of 250 mm/sec, but this should not be regarded as normal use. Regular driving over such gaps or steps will shorten the lifespan of the drivetrain components.	
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.	
Battery	
Duty cycle	80%
Weight	17 kg (37 lb)
Voltage	22 - 30 VDC
Capacity	60 Ah
Energy	1.5 kWh nominal

Description	Specification
Recharge time	3.5 hours, approx.
Life span	7 years, approx., 16 hrs/day, 5 days/wk 4 years, approx., 19/7 (full-time)
Sensors	
Safety Scanning Laser	1 at front of platform, 203 mm (8 in.) height 250°, 15 M range, Class 1, eye-safe PLd Safety per ISO-13849
Side Lasers	2 on horizontal tubes of HMI post 270°, 4 M range, Class 1, eye-safe
Low Level Laser	1 at front of platform, in bumper 270°, 4 M range, Class 1, eye-safe
Coupling Laser	1 on platform deck, passing through the top plate into the coupling plate 270°, 4 M range, Class 1, eye-safe
Rear-facing laser	1 on HMI post 270°, 4 M range, Class 1, eye-safe
Sonar (Each pair is one emitter and one receiver)	2 pairs at rear of platform, 2 M range
Bumper	1 at front of platform, triggers 4 sensors
Position encoders	2 encoders (one each wheel) 2 Hall sensors (one each wheel)
Analog gyroscope (core)	320 degrees/sec max rotation
Acuity localization (option)	1 camera on HMI post Operator Panel

Battery Output

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.				

Cart

Description	Specification
Physical	
Length	592 mm (23.3 in.)
Width	846 mm (33.3 in.)
Height	480 mm (18.9 in.)
Weight	23 kg (50 lb)
Rating	
Caster ESP	ESP rated
Suspension	
Passive Casters	2 front, 2 rear, spring-loaded
Caster diameter	100 mm (4 in.) nominal
Caster Brakes	2 rear casters

Docking Station

Description	Specification
Current	8 A, thermal fuse built into power switch
Contacts	2
Voltage	100 to 240 VAC, 50 to 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 in.) 495 x 495.5 x 317 mm (16 x 19.5 x 12.5 in.)
Weight	8.2 kg (18 lb)
Mounting	Directly to floor, wall bracket (included), or on floor (free-standing) with included floor plate
Indicators	Power on - blue Charging - yellow
Connector	For out-of-platform battery charging

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