

Mobile Robot LD

Safety Guide



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<p>Even if it conforms to all instructions in this safety guide, it isn't possible to guarantee that a robot system will be free from an accident resulting in injury or death or considerable damage to property caused by the industrial robot. It is the customer's responsibility to implement appropriate security measures based on their own risk assessment.</p>

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Chapter 1: Alert Notation

There are six levels of alert notation used in our manuals. 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.



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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 product use.

Chapter 2: Operational Safety

2.1 What To Do in an Emergency or Abnormal Situation

Press any 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 or abnormal situation. If a fire occurs, use a type D extinguisher: foam, dry chemical, or CO₂.

Releasing the Brakes

In case of an emergency or abnormal situation, the Mobile Robot LD can be manually moved. However, only qualified personnel who have read and understood this manual and the robot User's Guide should manually move the robot. 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.

2.2 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 this Safety Guide, before using the equipment.
- Ensuring that the environment is suitable for safe operation of the LD Platform.
If a fleet of robots (two or more) is installed, the Enterprise Manager must be used, unless no two robots will ever operate in the same area.
- Ensuring that anyone working with or near an LD Platform has been adequately trained, and is following the robot manual and this guide for safe robot operation.
- Ensuring that the robots are maintained, so that their control and safety functions are working properly.

General Hazards

- Do not ride on the robot.
- Do not exceed the maximum payload.
Payload decreases as slope increases. Refer to the user's guide. The LD Platform with a cart is not intended to operate on any slope.
- Do not exceed the maximum recommended speed, acceleration, deceleration, or rotation

limits. See Center of Gravity in the robot User's Guide.

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 Call/Door Box option.

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

- Do not get the robot wet, or expose the equipment to rain or moisture.
- Do not continue to run the robot after hair, yarn, string, or any other items have become wound around the robot'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 used are Class 1 (eye-safe), we recommend you not look into them.

Falling Hazards



WARNING: The 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.), so the barrier must cover at least that height.

The barrier 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 the 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 charging dock unless properly rated.
- Never access the interior of the robot with the charger attached.
- Immediately disconnect the battery pack when removing the access cover.
Avoid shorting the battery terminals.
- Do not use any charging dock not supplied by Omron Adept Technologies, Inc.
- If any liquid is spilled on the mobile robot, power off the robot, clean up all possible liquid, and allow the robot to air dry thoroughly before restoring power.

Pinch Hazard

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 robot user's guide Maintenance chapter for handling covers.

Magnetic Field Hazards

Robot Covers

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



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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.

Qualification of Personnel

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

As noted in this and the robot user guides, 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 robot user's 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 Platforms 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 (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 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.

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

2.3 Environment

General Environmental Conditions

It is the end-user's responsibility to ensure that the operating environment of the mobile robot remains safe for the robot. If there are areas that are not safe for the robot to travel in, those areas should be physically blocked off so that the platform's scanning laser will detect the

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

Clearance

The LD Platform 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 facility objects.

The primary direction of travel of the LD Platform is forward. When the LD Platform 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 Platform 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.

2.4 Intended Use

The LD Platform 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.

The LD Platform is 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 Platforms requires a stationary environment for optimum accuracy. Therefore, we do not recommend the LD Platform 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

LD Platforms are intended for use on generally level floors, in wheelchair-accessible areas. Some LD Platforms, and any platform moving a cart, will not fit through a standard-width ADA door or opening.

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



WARNING: Any change to the robot can lead to loss in safety or functionality. It is the user's responsibility to perform a risk assessment for the whole (modified) robot after any such changes and to confirm that all safety features of the robot are operational.

Payload Structure

Attaching a payload that is larger than the footprint of the top of the robot or is outside the recommended CG may impact safety and functionality. It is the user's responsibility to perform a risk assessment and declare compliance for the whole (modified) robot.

Reprogramming or Reconfiguration

Reprogramming or reconfiguration of the robot safety components or parameters may impact safety and functionality. It is the user's responsibility to perform a risk assessment and declare compliance for the whole (modified) robot.

Sharp Edges, Protrusions

Adding a payload can introduce sharp edges, corners, or protrusions to the robot. It is the user's responsibility to perform a risk assessment and declare compliance for the whole (modified) robot.

Manufacturer's Declaration

The manufacturer's declaration applies to the robot as it was placed on the market. It is the responsibility of the end user to verify compliance of the system in the final application inclusive of any modifications or additions.

2.5 Safety Aspects While Performing Maintenance

Electrical Safety



DANGER: During maintenance of the charging dock, disconnect the AC power cord to the charging dock. Keep it locked up until you are done with maintenance.



DANGER: During maintenance and repair, disconnect the battery of the robot 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.

Battery Safety Information

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

Safety Precautions

- Batteries must be stored upright at 5° to 60° C (41° to 140° F)
- Do not expose to water
- If the battery is found to be leaking, do not expose to water. If possible, submerge in mineral oil and contact Omron Adept Technologies, Inc..
- In case of fire, use a type D extinguisher: foam, dry chemical, or CO₂.

Maintenance

Every six months:

- Inspect battery for damage or leaks.
- Place battery on a charger and allow to fully charge.

OMRON Corporation Industrial Automation Company
Kyoto, JAPAN

Contact: www.ia.omron.com

Regional Headquarters

OMRON EUROPE B.V.

Wegalaan 67-69, 2132 JD Hoofddorp
The Netherlands
Tel: (31)2356-81-300/Fax: (31)2356-81-388

OMRON ASIA PACIFIC PTE. LTD.

No. 438A Alexandra Road # 05-05/08 (Lobby 2),
Alexandra Technopark,
Singapore 119967
Tel: (65) 6835-3011/Fax: (65) 6835-2711

OMRON ELECTRONICS LLC

2895 Greenspoint Parkway, Suite 200 Hoffman Estates,
IL 60169 U.S.A.
Tel: (1) 847-843-7900/Fax: (1) 847-843-7787

OMRON ADEPT TECHNOLOGIES, INC.

4550 Norris Canyon Road, Suite 150, San Ramon, CA 94583 U.S.A.
Tel: (1) 925-245-3400/Fax: (1) 925-960-0590

OMRON (CHINA) CO., LTD.

Room 2211, Bank of China Tower, 200 Yin Cheng Zhong Road,
PuDong New Area, Shanghai, 200120, China
Tel: (86) 21-5037-2222/Fax: (86) 21-5037-2200

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