OMRON

LD-60/90 Platform

User's Manual

LD-60
LD-90
LD-90x

Introduction

Thank you for purchasing the LD-60/90 Autonomous Mobile Robot (referred to as AMR in this document).

This manual is OMRON's original instructions describing the setup, operations, and user maintenance of the product.

This document describes AMR functionality supported with FLOW v3.3.1.

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

Please read this manual and make sure you understand the functionality and performance of the AMR before attempting to use it.

Keep this manual in a safe place where it will be available for reference during operation.

Intended Audience

This manual is intended for the following personnel, who must also have knowledge of factory automation (FA) systems and robotic control methods.

- Personnel in charge of introducing FA systems.
- Personnel in charge of designing FA systems.
- Personnel in charge of installing and maintaining FA systems.
- Personnel in charge of managing FA systems and facilities.

Applicable LD Models

This manual provides information for all LD-60/90/90x series AMRs. When information varies between different AMR models, details are provided. When information is common to all AMR models, an illustration of a single AMR model is typically shown.
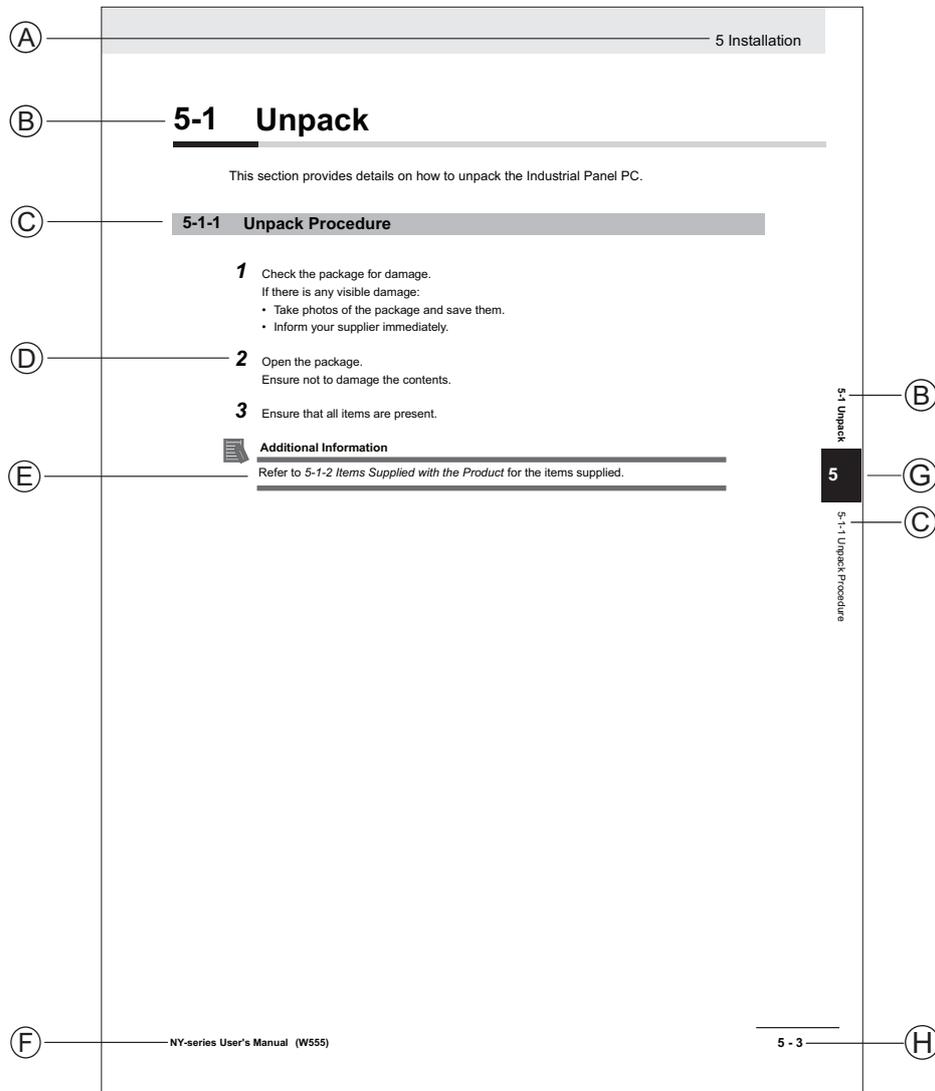
Units

All units are metric unless otherwise noted.

Manual Information

Page Structure

The following page structure is used in this manual.

Ⓐ ──────── 5 Installation

Ⓑ ────── **5-1 Unpack**

This section provides details on how to unpack the Industrial Panel PC.

Ⓒ ──── **5-1-1 Unpack Procedure**

1 Check the package for damage.
If there is any visible damage:
• Take photos of the package and save them.
• Inform your supplier immediately.

Ⓓ ──── **2** Open the package.
Ensure not to damage the contents.

3 Ensure that all items are present.

Additional Information

Ⓔ ──── Refer to *5-1-2 Items Supplied with the Product* for the items supplied.

5-1 Unpack ── Ⓑ

5 ── Ⓖ

5-1-1 Unpack Procedure ── Ⓒ

Ⓕ ──── **NY-series User's Manual (W555)**   **5 - 3** ── Ⓗ

Note: This illustration is provided as a sample. It will not literally appear in this manual.

Item	Explanation	Item	Explanation
A	Level 1 heading	E	Special Information
B	Level 2 heading	F	Manual name
C	Level 3 heading	G	Page tab with the number of the main section
D	Step in a procedure	H	Page number

Special Information

Special information in this manual is classified as follows:

Precautions for Safe Use

Precautions on what to do and what not to do to ensure safe usage of the product.

Precautions for Correct Use

Precautions on what to do and what not to do to ensure proper operation and performance.
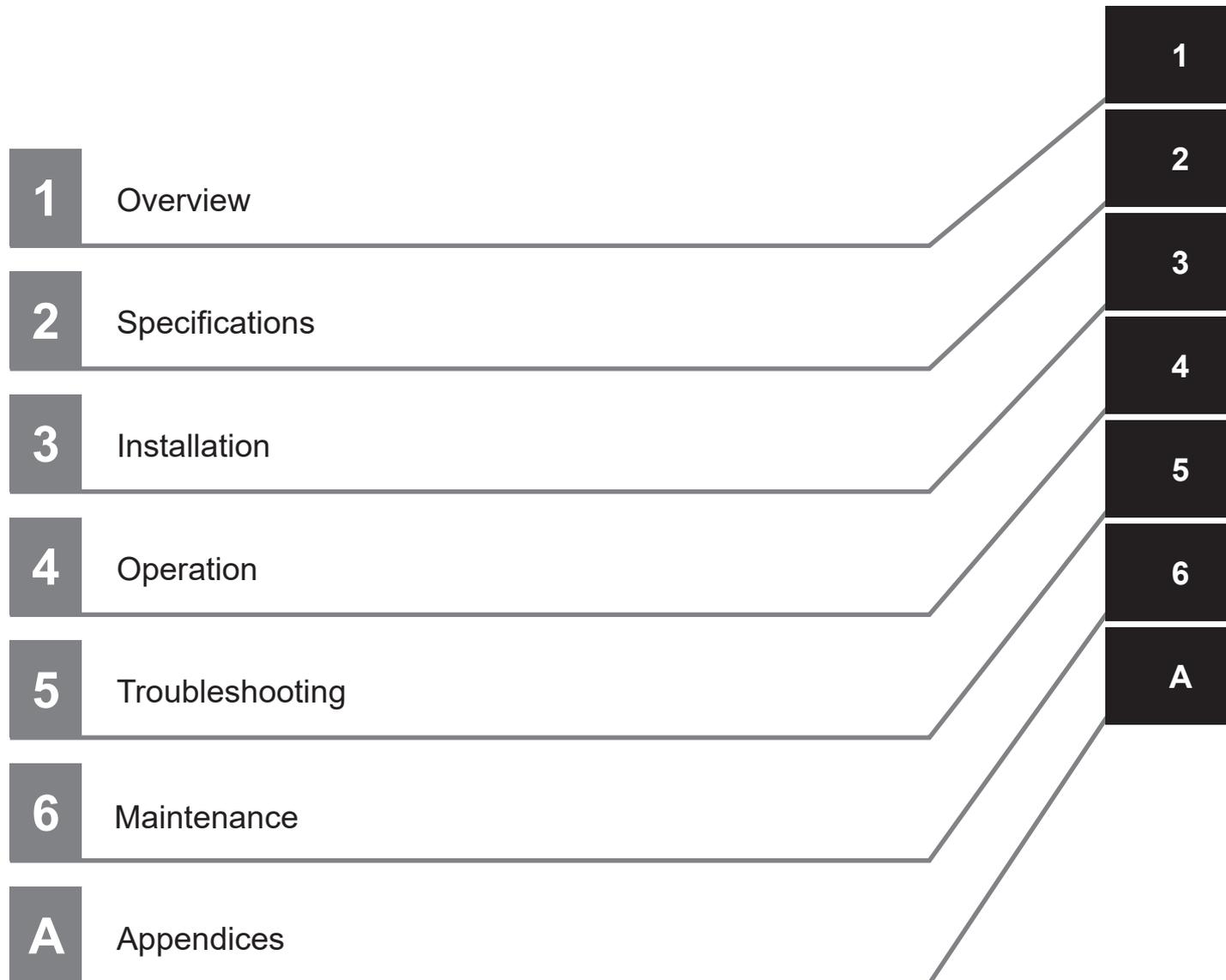
Additional Information

Additional information to read as required.
This information is provided to increase understanding or make operation easier.

Version Information

Information on differences in specifications and functionality between different versions.

Sections in this Manual

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Section 3 Installation

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Section 6   Maintenance

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Terms and Conditions Agreement

Warranty and Limitations of Liability

Warranty

- **Exclusive Warranty**
  Omron's exclusive warranty is that the Products will be free from defects in materials and workmanship for a period of twelve months from the date of sale by Omron (or such other period expressed in writing by Omron). Omron disclaims all other warranties, expressed or implied.

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Application Considerations

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Omron Companies shall not be responsible for conformity with any standards, codes or regulations which apply to the combination of the Product in the Buyer's application or use of the Product. At Buyer's request, Omron will provide applicable third party certification documents identifying ratings and limitations of use which apply to the Product. This information by itself is not sufficient for a complete determination of the suitability of the Product in combination with the end product, machine, system, or other application or use. Buyer shall be solely responsible for determining appropriateness of the particular Product with respect to Buyer's application, product or system. Buyer shall take application responsibility in all cases.

NEVER USE THE PRODUCT FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT(S) IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Programmable Products

- Omron Companies shall not be responsible for the user's programming of a programmable Product, or any consequence thereof.
- Omron Companies shall not be responsible for the operation of the user accessible operating system (e.g. Windows, Linux), or any consequence thereof.

Disclaimers

Performance Data

Data presented in Omron Company websites, catalogs and other materials is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of Omron's test conditions, and the user must correlate it to actual application requirements. Actual performance is subject to the Omron's Warranty and Limitations of Liability.

Change in Specifications

Product specifications and accessories may be changed at any time based on improvements and other reasons. It is our practice to change part numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the Product may be changed without any notice. When in doubt, special part numbers may be assigned to fix or establish key specifications for your application. Please consult with your Omron's representative at any time to confirm actual specifications of purchased Product.

Errors and Omissions

Information presented by Omron Companies has been checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical or proofreading errors or omissions.

Safety Precautions

Definition of Precautionary Information

The following notation is used in this manual to provide precautions required to ensure safe usage of the LD-series AMR. The safety precautions that are provided are extremely important to safety. Always read and heed the information provided in all safety precautions.
The following notation is used.

⚠ DANGER	Identifies an imminently hazardous situation which, if not avoided, is likely to result in serious injury, and might result in fatality or severe property damage.
⚠ WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury. Additionally, there may be severe property damage.
⚠ CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury, or property damage.

Symbols

🚫	The circle and slash symbol indicates operations that you must not do. The specific operation is shown in the circle and explained in text. This example indicates prohibiting disassembly.
⚠	The triangle symbol indicates precautions (including warnings). The specific operation is shown in the triangle and explained in text. This example indicates a precaution for electric shock.
⚠	The triangle symbol indicates precautions (including warnings). The specific operation is shown in the triangle and explained in text. This example indicates a general precaution.
●	The filled circle symbol indicates operations that you must do. The specific operation is shown in the circle and explained in text. This example shows a general precaution for something that you must do.
⚠	The triangle symbol indicates precautions (including warnings). The specific operation is shown in the triangle and explained in text. This example indicates a precaution for high temperatures.

Dangers

⚠ DANGER

The end-user of the AMR must perform a risk assessment to identify and mitigate any additional personal and property damage hazards caused by the payload.	❗
No modification is allowed that may affect functionality unless a complete risk assessment is performed. Any modifications made to the AMR can lead to loss of safety or functionality of the AMR therefore it is the end-user's responsibility to perform complete risk assessment after making any modifications to the AMR, and to confirm that all safety features of the AMR are fully functional.	❗
There is risk of serious injury by crushing if the AMR tips over as a result of improper operation on inclines that do not comply with the operating specifications.	⚠

Warnings

⚠ WARNING

General

It is the end-user's responsibility to make sure that the AMR is operated within its specifications, intended use, and intended environments.	❗
It is the end-user's responsibility to perform a task-based risk assessment and to implement appropriate safety measures at the point of use of the AMR in accordance with local regulations.	❗
It is the end-user's responsibility to make sure that the AMR design and implementation complies with all local standards and legal requirements.	❗
The user is responsible for the safety of the AMR, which includes confirming that the system is stable with any payload, payload structure, or other attachments while functioning in the specified operating environment.	❗
Follow all unpacking safety instructions and use appropriate tools and equipment. Failure to do so could result in personal injury or property damage.	❗
Use only the specified tools, equipment, lubricants, and OMRON-supplied spare parts to service and maintain the AMR according to the specified service interval. Failure to do so could result in an unsafe operating state than might result in personal injury or damage to property.	❗
While conducting any work on the AMR, make sure it is located on a flat, level surface with casters chocked and emergency stop active to prevent unexpected movement.	❗
Conduct regular maintenance of wheels and replace any damaged wheel.	❗

When working near the encoder cables, take care not to disconnect or damage them. Improper connection or disconnection of encoder cables may result in erratic motion of the AMR during operation. Operating the AMR with damaged, disconnected, or improperly connected encoder signals can cause potentially hazardous uncommanded rotation.

When operating the AMR with the pendant, it is the operator's responsibility to make sure that no people or objects are in the immediate vicinity of the moving AMR.

Do not allow use of the manual driving functions in MobilePlanner while controlling the AMR with the Pendant. Doing so can override Pendant control.

Do not walk, run, or suddenly throw objects in the travel path of the AMR or directly toward the AMR.

If the Operator Panel is removed, there must be a user-supplied emergency stop button connected to the safety circuit.

Using the brake release button while the AMR is positioned on a slope of greater than 3% will cause the AMR to roll down. You must not use the brake release button to move the AMR manually when it is positioned on a slope of greater than 3%, unless necessary precautions have been taken to prevent uncontrolled rolling of the AMR.

Do not attempt to lift the AMR with a forklift or other lifting device. Doing so might cause damage to the skins or other components.

Do not use organic solvents to clean any part of the AMR unless directed in the cleaning instructions. Organic solvents might damage electronics resulting in an unsafe operating state that could cause injury or damage to equipment.

Implementing methods to circumvent the need for a person to enable the AMR's motor power at start-up is prohibited.

OMRON is not responsible for any risks incurred by modifying safety zone sizes or other OS32C laser settings.

The AMR as a partly-completed machine is intended to be incorporated into other machinery and must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of EC Machinery Directive2006/42/EC, where appropriate. The assembly instructions shall then form part of the technical file for the final machine.

The USER BUMP connector is not safety-rated and is not connected to the E-STOP circuit.

Immobilization might cause motors in the AMR to overheat, resulting in a fire.

Battery and Docking Station

If any user-supplied emergency stop devices are added to the system, you must perform Safety Commissioning to verify proper operation.

If Docking Station power cords lie on the ground, you must make sure that they are highly visible to prevent tripping hazards and must be protected from physical damage with barriers or covers.	
Remove the AMR from a Docking Station when conducting any installation or maintenance actions.	
Do not damage the battery by subjecting it to impacts or shocks. Using a damaged battery can result in fire or other dangerous conditions.	
You must wear proper Personal Protective Equipment (PPE) when removing, installing, and lifting the battery or when working around a leaking battery.	
Do not dispose of the battery in a waste stream that might result in incineration or crushing. Safely dispose of the battery through a designated facility according to all local and national environmental regulations regarding lithium battery disposal.	
Replace the battery only with an OMRON factory-supplied battery intended for use in the AMR.	
The Docking Station charging contacts are energized when a magnet on the AMR is in close proximity. Do not place any magnetized objects near the Docking Station.	
The Docking Station has AC power inside. Docking Station covers are not interlocked.	
(Battery) Risk of Fire - No User Serviceable Parts AVERTISSEMENT: Risque d'incendie - Aucune des pièces ne peut être.	
There are no user-serviceable parts inside the Docking Station and high voltage may be present in this area. Do not remove the covers of the Docking Station.	

Payload

If the AMR transports containers of liquid or other non-solid material, consider the effect on the AMR's stability if their contents can shift. It is the end user's responsibility to ensure that the payload is properly secured to the AMR, and that payload shifting does not create AMR instability.	
The payload must be kept higher than the top of the AMR. If the payload or associated structure blocks any of the AMR's sensors, the AMR cannot function correctly.	
While it is possible to generally reduce AMR deceleration settings for normal operation, the maximum deceleration used in the case of emergency stops, or stops due to Safety Laser Scanner intrusions cannot be lowered below 2000 mm/s^2. It is your responsibility to ensure that the AMR and its load will remain stable in your operating environment at all times, including during an emergency stop.	
If a payload is beyond the footprint of the AMR it can compromise its safety function. Payloads beyond AMR footprint may require modifying safety zone size. The OMRON AMR Safety Zone Generator tool is available for safety zone resizing.	

Operating Environment

Do not expose the AMR to rain or moisture.	❗
Do not use the AMR in hazardous environments (explosive gas, and oil mist).	❗
Objects in the environment protruding out, above, or below the AMR lasers' scanning planes shall be configured as Forbidden Areas during workspace map creation. This will minimize possible collision risk during operation.	❗
The AMR can cause serious injury to personnel or damage to itself if a dangerous area is not properly configured in the map and blocked with a physical barrier.	⚠️
A physical barrier must be easily detectable by the AMR and also strong enough to stop a fully-loaded AMR traveling at its maximum speed.	⚠️
Exposure to ingress beyond the specifications can lead to system malfunction.	⚠️

Cybersecurity

To maintain the security and reliability of the system, a robust cybersecurity defense program should be implemented, which may include some or all of the following:

Anti-virus protection

- Install the latest commercial-quality anti-virus software on the computer connected to the control system and keep the software and virus definitions up-to-date.
- Scan USB drives or other external storage devices before connecting them to control systems and equipment.

Security measures to prevent unauthorized network access

- Install physical controls so that only authorized personnel can access control systems and equipment.
- Reduce connections to control systems and equipment via networks to prevent access from untrusted devices.
- Install firewalls to block unused communications ports and limit communication between systems. Limit access between control systems and systems from the IT network.
- Control remote access and adopt multifactor authentication to devices with remote access to control systems and equipment.
- Set strong password policies and monitor for compliance frequently.

Data input and output protection

- Backup data and keep the data up-to-date periodically to prepare for data loss.
- Validate backups and retention policies to cope with unintentional modification of input/output data to control systems and equipment.
- Validate the scope of data protection regularly to accommodate changes.
- Check validity of backups by scheduling test restores to ensure successful recovery from incidents.
- Safety design, such as emergency shutdown and fail-soft operations in case of data tampering and incidents.

Additional recommendations

- When using an external network environment to connect to an unauthorized terminal such as a SCADA, HMI or to an unauthorized server may result in network security issues such as spoofing and tampering.
- You must take sufficient measures such as restricting access to the terminal, using a terminal equipped with a secure function, and locking the installation area by yourself.
- When constructing network infrastructure, communication failure may occur due to cable disconnection or the influence of unauthorized network equipment.
- Take adequate measures, such as restricting physical access to network devices, by means such as locking the installation area.
- When using devices equipped with an SD Memory Card, there is a security risk that a third party may acquire, alter, or replace the files and data in the removable media by removing or unmounting the media.
- Please take sufficient measures, such as restricting physical access to the Controller or taking appropriate management measures for removable media, by means of locking and controlling access to the installation area.
- Educate employees to help them identify phishing scams received via email on systems that will connect to the control network.

Cautions

⚠ CAUTION

Personnel who work with or around the AMR should not stand close to the AMR when it is rotating with no forward motion.	🛈
Follow all appropriate local safety regulations for working with isopropyl alcohol, including fire safety, toxicity, and protective clothing and gear requirements.	🛈
Do not place any objects between the Docking Station and the AMR.	🛈
Removing side skins exposes the AMR drive wheel motors, which can become extremely hot during operation. Allow 15 minutes for the drive wheel motors to cool down prior to coming into contact with them.	🛈
Two or more people are required to push an AMR while following the proper pushing methods described in this document.	🛈
While driving the AMR with the Pendant, the operator must maintain full control and assumes full risk if not using the Pendant as described in this document.	🛈
Never connect electric loads directly to the battery bypassing protective circuits.	🛈
Do not exceed the torque limit when attaching your payload structure to the mounting point self-clinching nuts.	🛈
It is the end user's responsibility to ensure that a clearance of 200 mm from the edges of the AMR or payload structure is maintained when it is traveling below 225 mm/s (LD-90 and LD-90x) or 300 mm/s (LD-60).	🛈
Do not allow the AMR to operate in areas that are used for emergency personnel evacuation.	🛈
Avoid pushing an AMR that has a payload. Use the Pendant to manually move an AMR with a payload whenever possible.	🛈
The AMR can have unexpected motion if it is controlled by multiple instances of Mobile-Planner.	⚠
To comply with CE requirements, an AMR must have a readily-visible warning device, such as a flashing light (user-supplied) to indicate when it is either ready to move or is moving.	⚠
Riding on the AMR is strictly prohibited and could result in injury or damage to the equipment.	⚠
The charging contacts on both the Docking Station and the AMR can get hot during operation. Allow these items to cool down for at least 15 minutes prior to servicing.	♨

Precautions for Safe Use

- Do not use power extension cords with the Docking Station unless properly rated.
- Two or more people are required to lift the battery.
- You can contribute to resource conservation and protecting the environment by the proper disposal of Waste Electronics and Electrical Equipment (WEEE). All electrical and electronic products should be disposed of separately from the municipal waste system according to local ordinances using designated collection facilities.

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- Secure the Pendant when not in use to prevent an unauthorized user access to the AMR.
- AMR Skins are fastened with strong magnets. Removal and replacement of the skins creates a pinching hazard.
- Never access the interior of the AMR while it is connected to the Docking Station.
- You must comply with the latest version of the applicable laser safety regulations.
- Do not allow any foreign metal objects to be near the AMR or Docking Station charging contacts.
- It is the user responsibility to train operators and all other personnel on AMR proper use and safety.
- Bright, direct, or high-intensity light can interfere with the AMR's laser operation. Do not operate the AMR in areas where it may be exposed to these conditions.
- Operating the AMR at high ambient temperatures (particularly when carrying a full payload at high speeds) can cause the battery to exceed its operating temperature limits. If this happens, do not try to access the battery. You must allow several hours for an overheated battery to cool sufficiently before trying to remove or replace it
- In case of fire, use a type ABC or type BC dry chemical fire extinguisher.
- Although the lasers used are Class 1/1M (eye-safe), OMRON recommends that you not look into the laser light. The maximum permissible exposure cannot be exceeded when viewing lasers with the naked eye.
- The emergency stop or protective stop devices you install on the AMR must have a dual channel circuit to ensure the same performance level as the other safety devices of the AMR.
- The tilt detection feature will not prevent an improperly loaded AMR from toppling.
- The Docking Station must be properly secured to the wall or floor prior to operation.
- Payloads or payload structures must be fastened to the AMR with the mounting locations described in this document.
- Intentional movement of the payload structure (such as conveyor or arm) during the AMR movement is prohibited. It is the end-user's responsibility to design an appropriate interlock to prevent this.
- Magnetic fields can be hazardous to medical implant wearers. Medical Implant wearers stay back 30 cm from the platform skin magnetic fasteners.
- You must have floor markings at docking stations and pickup / dropoff locations with adequate clearance to prevent people from entering these hazard zones.
- It is the end user's responsibility to make sure that the speed is appropriate for the payload that the AMR carries, and that the AMR movement does not cause payload instability or loss of AMR control.
- The payload or payload structure shall not be positioned in such a way that would put the operator in danger while trying to reach an emergency stop button.

- Lasers cannot reliably detect glass, mirrors, and other highly-reflective objects. Use caution when operating the AMR in areas that have these types of objects. If the AMR will need to drive close to these objects, we recommend that you use a combination of markings on the objects (e.g., tape or painted strips), and also use Forbidden Areas in the map so that the AMR can plan paths safely around these objects.
- The Docking Station shall only be used to charge an LD-series AMR battery.
- Avoid shorting the battery terminals or connectors.
- If the Pendant movement trigger is released or the Pendant is unplugged at any time after the AMR is turned ON, other sources such as MobilePlanner or a Fleet Manager may control the AMR motion. Always follow the Pendant operation procedures to maintain control of the AMR with the Pendant.
- For optimal performance of an LD-series AMR in a fleet, use a map created by an LD-series AMR for the area in which it operates.
- Make use of the Fleet Manager when two or more AMRs are used in the same environment and are not confined to separate workspaces.
- If you suspect that liquid has penetrated the skins or contaminated the AMR's interior, do not attempt to power ON the system and contact your OMRON representative.
- Do not allow any foreign metal objects to be near the AMR or Docking Station charging contacts.
- When making any changes or connections to the buzzer or light discs, refer to application safety standards for your locale and confirm correct operation.
- Do not allow the battery to remain discharged for an extended period of time.
- Always follow best practices for proper grounding and anti-static methods before connecting or touching the MAINT LAN port. The Core may be damaged if an electrostatic discharge occurs at the MAIN LAN port.

Precautions for Correct Use

- Never remove the battery while the AMR is powered ON. Always turn the AMR OFF before attempting to remove a battery.
- When speakers are used as a means of notifying personnel of an approaching AMR, you must routinely verify that they are still functioning normally. Verify that the speakers are audible, and the sound level is at the same level as needed during the operation.
- Laser lenses can easily get scratched and damaged. Care must be taken to prevent scratching the laser lens during any maintenance or installation procedures.
- It is the end user's responsibility to ensure that the payload does not attenuate the wireless antennas' signal.
- The AMR is designed and intended to operate on smooth floors. While it is capable of driving over a step or gap, frequent or high-speed driving over steps or gaps will shorten the lifespan of the drive train components.
- Before you configure wireless Ethernet on your AMR, contact your network administrator to confirm the IP, radio, and security settings.
- The AMR safety circuit must have continuity on both safety channels in order for the AMR to operate.
- OMRON does not provide the protective coverings with the HAPS option. A protective covering needs to be installed when applying the magnetic tape to the floor to prevent damage from the AMR traffic. The protective covering must be supplied by the user.
- You cannot use the same marker tape configuration for different AMRs in hybrid fleets because of their different sizes and turn radiuses. To determine the distance between the AMR and its final alignment goal (such as a machine with which it interfaces), refer to the AMR User's Manual to obtain the exact dimensions of the platform.
- Always ship and store the AMR and the Docking Station in an upright position in a clean and dry area. Do not lay the shipping crates on their sides or any other non-upright position. This could damage the AMR and the Docking Station.
- You must route and secure the power cords properly. They must be secured in such a way that prevents straining of the connection points.
- The AMR must be powered ON in order to charge the battery while at the Docking Station.
- Avoid moving the AMR while it is powered OFF. If you manually move the AMR while it is powered OFF, it may not be able to determine its current location when it is powered ON again. Use the localization feature in MobilePlanner to localize the AMR if this occurs.
- You should move the AMR manually only when absolutely necessary during an emergency, for safety, or if it is lost or stuck. If you find that you must frequently move the AMR, use MobilePlanner to reconfigure its route to avoid problematic areas.
- OMRON recommends that you train personnel on the safe use of the brake release operations and procedures for safely pushing an AMR.
- IATA regulations (UN 3480, PI 965) require that air freight shipped lithium ion batteries not installed in the AMR must be transported at a state of charge not exceeding 30%. To avoid total discharge, fully charge the battery immediately upon receipt. The battery might arrive fully charged if it is not shipped by air freight.
- The Docking Station can only be connected directly to the AMR or to one battery. Simultaneous charging configurations are not possible.

- Only qualified personnel who have read and understood this manual should manually move or operate the AMR.
- Maintenance of the payload structure is not described in this document and is the responsibility of the end-user.
- The frequency of cleaning intervals depends on your particular system, its operating environment, and the amount of use. Cleaning intervals may need to be shortened for certain environments.
- Do not use solvents or chemicals other than isopropyl alcohol on the AMR charging contacts, as this could damage the AMR surfaces near the contacts. Do not expose any of the surfaces surrounding the charging contacts to isopropyl alcohol.
- Do not reduce the charging surface area of the charging contacts while cleaning. A smaller charging surface will reduce the charging speed and affect charging operations.
- The operation of the lasers may be affected by substances in the AMR operating environment, such as fog, smoke, steam, and other small particulates. You must clean the lenses of all lasers periodically and as guided in this document to avoid operational failures.
- After removing the skin panels, place them inner-side down so that the outer surfaces do not get scratched.
- The AMR's internal clock must be set correctly to ensure that accurate timestamps are present in the Debug Info file.
- Using the Fleet Manager or map features is not a substitute for physical methods of preventing collisions, such as interlocked gateways or barriers. It is the user's responsibility to provide a physical method of preventing collisions where necessary.
- Rough or uneven floors can degrade the drive wheels, and shorten their life span.
- Always observe the proper disassembly and handling of components for disposal.
- Consult your network systems administrator before changing any network settings.
- If the loaded AMR is too heavy to move manually, it is recommended that you seek additional help or remove the payload.
- Exceeding the current limit on pins 9 to 12 of the USER PWR Connector may damage components internal to the AMR Core requiring service or replacement.
- An emergency stop interrupts power output at USER PWR pins 11 and 12.
- Momentary USER PWR load current spikes that are over the thresholds specified will activate current limiting protection and cause power loss at the USER PWR connector. Simultaneous inrush loads might trip the over current protection at the battery. Use external current limiting devices to prevent transient current overload.
- Do not use the battery button to turn OFF the AMR. Turning the battery OFF while the AMR is ON results in an uncontrolled AMR shutdown. Always use the AMR OFF button on the Operator Panel to turn the AMR OFF in a controlled manner.
- Never remove the battery or disconnect the battery's data cable while the AMR is ON. Always power OFF the AMR and then disconnect the power and data cables before removing the battery.
- Any electrical charge that accumulates on the AMR skins does not have a path to ground, and therefore cannot discharge. This can be hazardous to electrostatic sensitive devices. Always keep electrostatic sensitive devices at least 30 cm away from the AMR skins.
- Do not operate the AMR on soft surfaces such as carpet.

Regulations and Standards

Conformance to EU Directives

The AMR complies with the following EU Directives.

Directives

- 2006/42/EC
  Machinery Directive
- 2014/30/EU
  EMC Directive

EN / IEC Standards

The AMR system conforms to the following EN standards.
- EN ISO 12100
  Safety of Machinery.
  General Principles for Design.
  Risk Assessment and Reduction.
- EN ISO 13849-1
  Safety of Machinery.
  Safety Related Parts of Control Systems SRP/CS – Part 1.
- EN 60204-1
  Safety of Machinery.
  Electrical equipment of machines, Part 1 General Requirements.
- EN 61000-6-4
  EMC, Part 6-4: Emissions Standard for Industrial Environments.
- EN 61000-6-2
  EMC, Part 6-2: Immunity Emissions Standard for Industrial Environments.

Related Manuals

Use the following related manuals for reference.

Manual Title	Description
Mobile Robot Software Suite User's Guide (Cat. No. I614)	Covers the basic procedures for installing and using the Mobile Robot Software Suite
EM1100 User's Guide (Cat. No. I615)	Describes the installation and operation of an EM1100 appliance, which runs the Fleet Operations Workspace software to manage a fleet of AMRs.
Advanced Robotics Command Language AMR Reference Guide (Cat. No. I617)	Contains information about the text-based command-and-response system.
Advanced Robotics Command Language Enterprise Manager Integration Guide (Cat. No. I618)	Describes how to use the Advanced Robotics Command Language (ARCL) a text-based, command line operating language Use ARCL to integrate a fleet of AMRs with an external automation system.
EM2100 Installation Guide (Cat. No. I634)	Describes the installation of an EM2100 appliance, which runs the Fleet Operations Workspace software to manage a fleet of AMRs.
Enterprise Manager 2100 User's Guide (Cat. No. I631)	Describes the operation of a Fleet Manager appliance, which runs the Fleet Operations Workspace software to manage a fleet of AMRs.
Fleet Operations Workspace Core User's Manual (Cat. No. I635)	Describes Fleet management, MobilePlanner software, the SetNetGo OS, and most of the configuration procedures for an AMR.
Fleet Simulator User's Manual (Cat. No. I649)	Describes the configuration and use of the Fleet Simulator software on a Fleet Manager appliance.
Fleet Operations Workspace (FLOW) Migration Guide (Cat. No. I636)	Provides information to upgrade an existing fleet to the FLOW Core solution or downgrade any newly purchased mobile robots or Fleet Manager appliances to be compatible with an existing fleet software solution.
Fleet Operation Workspace Core Integration Toolkit User's Manual (Cat. No. I637)	Contains information that is necessary to use the Integration Toolkit facilitating integration between the Fleet Manager and the end user's client application.
Sysmac Studio Version 1 Operation Manual (Cat. No. W504)	Describes the operating procedures of the Sysmac Studio.
LD-Series Integration Guide (Cat. No. I680)	Describes the steps and considerations needed to properly integrate LD-series AMRs into a factory environment.
Safety Laser Scanner OS32C Series User's Manual (Cat. No. Z296)	Provides information regarding the use and safety of the OS32C Safety Laser Scanner.
Mobile I/O Box User's Manual (Cat. No. I677)	Contains information for setting up and using a Mobile I/O box with the AMR.

Glossary

Term / Abbreviation	Description
Acuity	A supplemental system using an upward-facing camera to recognize overhead lighting for localization purposes.
Amplifier	The component within the core that provides the power needed to drive the AMR motors.
AMR	This term is used to refer to an autonomous mobile robot.
AMR Core	The AMR's main computing system that provides all navigational controls and application interfaces.
ARCL	Advanced Robotics Command Language that provides a simple, text-based, command-and-response operating language. Used with the optional Fleet Manager appliance, ARCL can help manage a fleet of AMRs.
Auto-MDIX	A connection port feature that automatically detects the Ethernet cable type being used (straight-through or crossover) and configures the connection appropriately.
Balance	The charging operation that equalizes each cell in the battery to maintain consistent runtime and performance.
Beacon	An optional indicator lamp mounted on the AMR to provide additional visual indication and signaling of the operating state.
Brake Release	A function that releases the mechanical AMR brakes to allow manual movement.
Cart	A frame mounted on four casters, that attaches to an LD-90x AMR. It increases the payload capacity and allows the payload to be decoupled from the AMR.
Center of Gravity	The average location of weight for an object.
Center of Rotation	The midpoint of a line between the center of the drive wheel hubs about which the AMR will rotate.
Commissioning	Testing and commissioning for verification of proper function the AMR's on-board safety systems using a software wizard.
Coordinate System	The X, Y, Z, and theta reference system relating the AMR to its environment and to the relative position of other devices.
Debug Info File	A zip file downloaded from SetNetGo that contains detailed information about the status of the system used by OMRON engineers for troubleshooting.
Docking Station	A fixed object that the AMR engages with for autonomous charging.
Dropoff	A Job segment typically used where the payload is transferred from the AMR to the Goal.
E-STOP	Emergency stop button.
Emergency stop	A function that overrides an AMR's controls and brings it to a rapid stop for safety purposes.
Encoder	A sensor on each drive motor of the AMR that is used to collect and transmit information about distance traveled and direction.
ESD Casters	Electrostatic Discharge casters provide a skin-to-chassis-to-wheel grounding path that drains off any static charge that the AMR might accumulate during operation.
ESD Skins	Electrostatic Discharge skins (covers) provide a grounding path to the chassis (and then to the casters) that drains off any static charge that the AMR might accumulate on the skins during operation.
FA	Factory Automation

Term / Abbreviation	Description
Fleet	Two or more AMRs operating in the same workspace controlled by a single Fleet Manager.
Fleet Manager	The operational mode of the computing appliance that runs the FLOW Core software to control a Fleet of AMRs.
Fleet Operations Workspace (FLOW)	A computing system that consists of software and hardware packages and is used to set up, integrate, and manage a Fleet of AMRs within a factory environment.
FLOW Core	A set of mobile-robotics software applications for programming and operating one or a Fleet of AMRs and the Fleet Manager.
Forbidden Lines and Areas	The lines or areas on the map through or into which the AMR is not permitted to enter autonomously.
Goal	A map-defined virtual destination for mobile AMRs (e.g., pickup or dropoff points).
HAPS	High Accuracy Positioning System that uses a sensor(s) on the underside of the AMR to detect magnetic tape placed at locations where you want the AMR to achieve particularly accurate positioning.
HAPS Markers	The short sections of magnetic tape applied to the floor that signal to the AMR where to stop.
Heading	Describes the direction that the AMR is traveling.
I/O	Input and output signals that are transmitted to and from a device.
Immobilization	An AMR state where it cannot physically move due to circumstances related to physical, electrical, and other limiting factors.
Instructed persons	Persons that are adequately advised or supervised by skilled persons to enable them to avoid electrical and mechanical dangers.
Interlock	A mechanical or electrical device intended to prevent machines from operating unless certain conditions are met.
Job	An activity typically consisting of one or two segments that instruct the AMR to drive to a Goal for material pickup or dropoff.
Jumper	A conductive device that electronically bridges two connection points.
Light Disc	The circular lights on the sides of the AMR that indicate motion, turns, and AMR states.
Localization	The process by which an AMR determines its location within the operating environment.
Lock-out Tag-out	A procedure to ensure equipment is properly turned OFF so that hazardous energy sources are isolated and rendered inoperative during tasks such as maintenance, installation, or other actions that require access to electrical components.
Macro	In MobilePlanner, a virtual container with a series or sequence of nested Tasks or Goals typically used to perform the same sequence of discrete functions in different Tasks.
Map	A representation of the AMR's environment within MobilePlanner used for autonomous navigation.
Mobile I/O Box	An external unit that summons an AMR to a Goal or controls connected devices for AMR related actions
Path	The line on an AMR's map between its current position and its destination that provides an indication of the AMR's intended motion.
Patrol Route	A specific route (a series of Tasks, Goals, or Macros) that the robot will follow without human intervention.
Payload	Any item(s) that are placed on the AMR for the purposes of securing, transporting, and transferring some object.

Term / Abbreviation	Description
Payload Structure	Any passive or dynamic device attached to and possibly powered by the AMR to support or manipulate a payload.
PCA	A Printed Circuit Assembly (PCA) is a circuit board that is populated with electronic components.
Pendant	A handheld, external input device for manually driving AMRs that is typically used for map creation. This may also be referred to as a Joystick in some cases.
Pickup	A Job segment where an AMR typically acquires a payload.
Platform	The base AMR without a payload or payload structure.
Preferred Lines and Directions	The lines or directions you want the AMR to travel.
Resisted Lines and Areas	The lines and/or areas the AMRs resists (attempts to avoid) crossing or entering.
Route	A series of Tasks, Goals, or Macros for the AMR to execute.
Safety Controller	A device present in the AMR that provides all safety functions and operations.
Sector	User defined map regions that direct specific AMR actions, like ignoring sensor readings, driving on the right or left, limiting the number of AMRs in the area at one time, etc.
Skilled persons	Persons that have the technical knowledge or sufficient experience to enable them to avoid electrical or mechanical dangers.
SSID	Service Set IDentification - identifies a wireless LAN.
Swing radius	The distance from the AMR center of rotation to the furthest point on its perimeter when it rotates in place.
Tasks	Instructions for the AMR to perform certain actions like reading inputs, setting outputs, movement commands, talking, waiting and other functions.
Turn radius	The radius of the circle that the AMR will travel when turning while moving forward.
Workspace	The intended operating area of the AMR.

Revision History

A manual revision code appears as a suffix to the catalog number on the front and back covers of the manual.

Cat. No. | **I611-E-08**

Revision code

Revision code	Date	Revised content
08	July 2024	Reformat, corrections, and updates.
07	December 2021	Corrections and improvements.
06	April 2021	Corrections and improvements.
05	February 2019	Corrections and improvements.
04	October 2018	Corrections and improvements.
03	February 2018	Corrections and improvements.
02	August 2017	Corrections and improvements.
01	April 2017	Original production

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<div style="text-align:right">**1**</div>

Overview

This section provides an overview of the AMR.

1-1   Intended Use

The AMR is designed to work in an indoor, industrial environment, and in the presence of trained personnel. This includes structured or semi-structured workplaces such as warehouses, distribution, and logistics facilities where general public access is restricted. You must deploy it only in applications where you anticipate and mitigate potential risks to personnel and equipment.

The AMR is not intended to be used in the following environments.

- Outdoor or uncontrolled areas without risk analysis.
- Areas with general public access.
- Areas with life-support systems.
- Residential areas.

Although the AMR is equipped with highly advanced safety systems, it must be deployed in a manner that takes into account potential risks to personnel and equipment.

OMRON does not provide the method of loading the payload on or off the AMR. It is the end user's responsibility to perform a complete task-based risk assessment in accordance with EN ISO 12100, and ensure safe transfer of the payload.

The AMR shall be commissioned as instructed in this manual.

⚠ DANGER

- The end-user of the AMR must perform a risk assessment to identify and mitigate any additional personal and property damage hazards caused by the payload.
- No modification is allowed that may affect functionality unless a complete risk assessment is performed. Any modifications made to the AMR can lead to loss of safety or functionality of the AMR therefore it is the end-user's responsibility to perform complete risk assessment after making any modifications to the AMR, and to confirm that all safety features of the AMR are fully functional.

⚠ DANGER

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

⚠ WARNING

- It is the end-user's responsibility to make sure that the AMR is operated within its specifications, intended use, and intended environments.
- It is the end-user's responsibility to perform a task-based risk assessment and to implement appropriate safety measures at the point of use of the AMR in accordance with local regulations.
- It is the end-user's responsibility to make sure that the AMR design and implementation complies with all local standards and legal requirements.

⚠ WARNING

The AMR as a partly-completed machine is intended to be incorporated into other machinery and must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of EC Machinery Directive2006/42/EC, where appropriate. The assembly instructions shall then form part of the technical file for the final machine.

⚠ CAUTION

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

⚠ CAUTION

Riding on the AMR is strictly prohibited and could result in injury or damage to the equipment.

Precautions for Safe Use

- It is the user responsibility to train operators and all other personnel on AMR proper use and safety.
- It is the end user's responsibility to make sure that the speed is appropriate for the payload that the AMR carries, and that the AMR movement does not cause payload instability or loss of AMR control.

1-2 Features and Components

This section provides an overview of the basic features and components of the AMR.
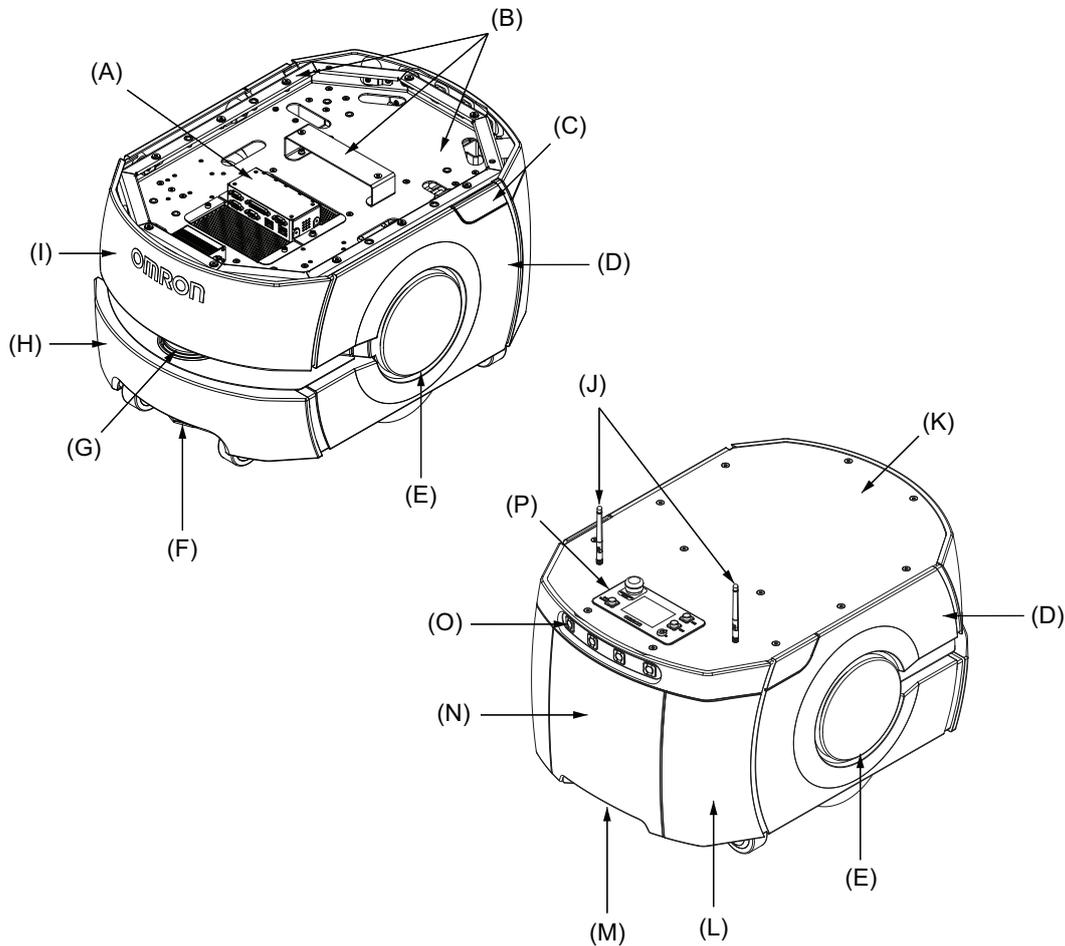
Item	Description	Item	Description
A	AMR Core	I	Front Upper Skin
B	Payload Mounting Areas	J	Wireless Antennas
C	Access Panel	K	Top Plate
D	Side Skin	L	Rear Skin
E	Light Disc	M	Charging Contacts
F	Low Laser	N	Battery Door Skin
G	Safety Laser Scanner	O	Rear Sonar Sensors
H	Bumper Skin	P	Operator Panel

1-2-1 Lasers

Several laser sensors are provided on the AMR for navigation and safety.
The Safety Laser Scanner, optional Side Lasers, and Low Lasers are Class 1/1M type that use invisible laser radiation and are safe under all conditions of normal use.

> **Precautions for Safe Use**
>
> - Although the lasers used are Class 1/1M (eye-safe), OMRON recommends that you not look into the laser light. The maximum permissible exposure cannot be exceeded when viewing lasers with the naked eye.
> - Lasers cannot reliably detect glass, mirrors, and other highly-reflective objects. Use caution when operating the AMR in areas that have these types of objects. If the AMR will need to drive close to these objects, we recommend that you use a combination of markings on the objects (e.g., tape or painted strips), and also use Forbidden Areas in the map, so that the AMR can plan paths safely around these objects.
> - You must comply with the latest version of the applicable laser safety regulations.

> **Additional Information**
>
> Optional Side Lasers may be purchased and added for additional object detection. Refer to *1-6-5 Side Lasers* on page 1-21 for more information.

Safety Laser Scanner

The Safety Laser Scanner provides detection in a 240° field of view. The laser operates in a single plane positioned at 190 mm above the floor, with a range of 3 m.

Low Laser

One Low Laser detects obstacles below the scanning plane of the Safety Laser Scanner, such as an empty pallet or fork truck blades, which are too low for the Safety Laser Scanner's detection plane. The Low Laser is positioned near the floor and can detect objects that are at least 65 mm tall.
The Low Laser also detects obstacles that might be significantly wider near the floor, such as a column base, while the Safety Laser Scanner might detect only the upper, narrow portion of the column.

1-2-2 Skins

Skins are removable panels at various locations on the exterior of the AMR.
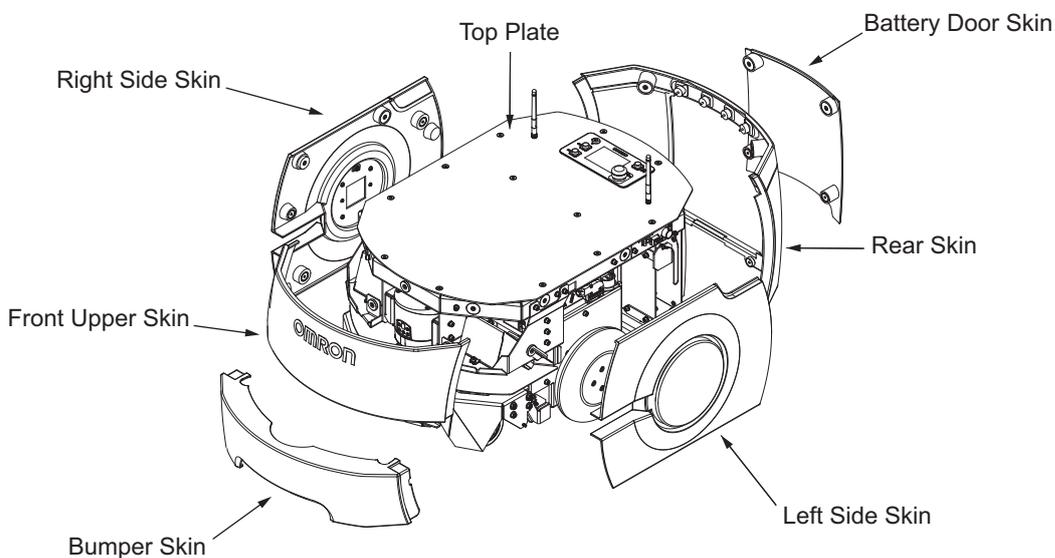
Removal of the upper front skin provides access to the Safety Laser Scanner.

Removal of the rear skin provides access to the following items.

- Rear sonar
- Drive train components
- Caster assemblies (rear).
- HAPS sensor (optional).

Removal of the battery door skin provides access to the battery compartment.

Removal of the side skins provide access to the drive wheels. This skin includes the Light Disc assembly, which is connected by a lightweight cable.

Removal of the top plate provide access to the Payload Bay. The top plate incorporates the Operator Panel and two wireless antennas wired to the AMR Core.

1-2-3 Payload Bay

The area between the AMR and the payload structure is the payload bay. This is where the AMR Core's power and I/O connectors are located, in addition to any mechanical fasteners that secure the payload to the AMR.

1-2-4 Operator Panel

The Operator Panel features are described below.

Additional Information

- The Operator Panel can be relocated if it becomes obstructed by the payload or payload structure. Refer to *3-7 Relocating the Operator Panel on page 3-35* for more information.
- If the Operator Panel is not needed, it can be removed. A jumper plug (part number 13387-000) is supplied with the AMR for use in this case. Use the jumper plug on the Operator Panel cable in place of the removed Operator Panel. This allows the AMR to operate without the Operator Panel's emergency stop button in place. Refer to *USER INTERFACE* on page 3-26 for more information about connecting devices to control the ON, OFF, and Brake functions.
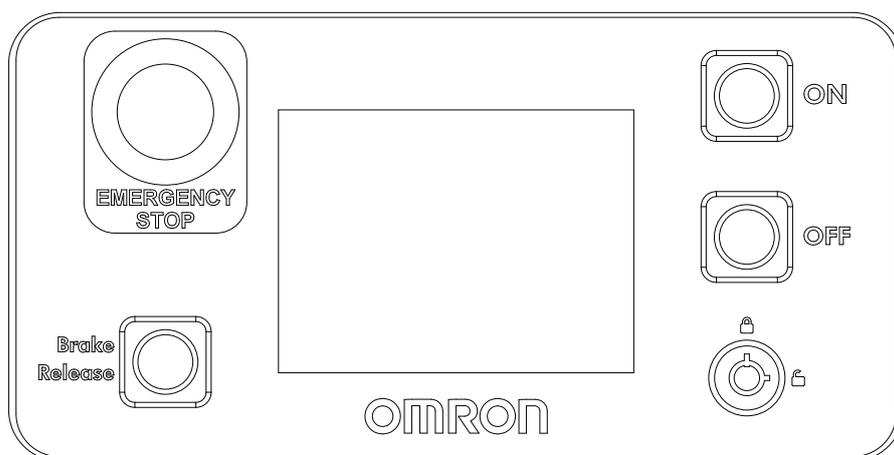
Screen

A high-resolution, high-brightness screen provides operational status, wireless signal strength, battery level, IP address, AMR identification, faults, and up to six lines of instructions.

ON and OFF Buttons

ON and OFF buttons are used to start-up and shut-down the AMR under normal operating conditions. Integrated LED ring lights are provided around the buttons for visual indication of the AMR operating states.

Emergency Stop Button

The emergency stop button is connected to the safety circuit and has the same function as all other emergency stop buttons on the AMR.

Brake Release Button

A brake release button is provided in the event of an emergency or abnormal situation where the AMR needs to be manually moved.

Keyswitch

A switch that can be toggled by turning a key. When in the locked position, disables the OFF button.

1-2-5 E-STOP Buttons

There are three E-STOP buttons located on the AMR. One button is located on the Operator panel and there is one button located on each side of the AMR.

Additional Information

Additional E-STOP buttons can be added to the system when required.

1-2-6 Wireless Antennas

Two wireless antennas are factory-installed on the top of the AMR to provide optimal range. These wireless antennas are tamper resistant and low profile. They can also be relocated if a payload structure obscures them.

1-2-7 Light Discs

Colored light discs are provided at highly visible locations on the exterior of the AMR. These provide visual indication about the AMR's status and its pending movement.

1-2-8 Access Panel

The Access Panel is located on the left rear skin of the AMR. Refer to the figure below for more information. The Access Panel is held in place with a push-push latch, and retained by a lanyard. This is where the Pendant Port and Maintenance Ethernet Port are located. These are described in the following sections.

Maintenance
Ethernet Port

Pendant Port

Access Panel
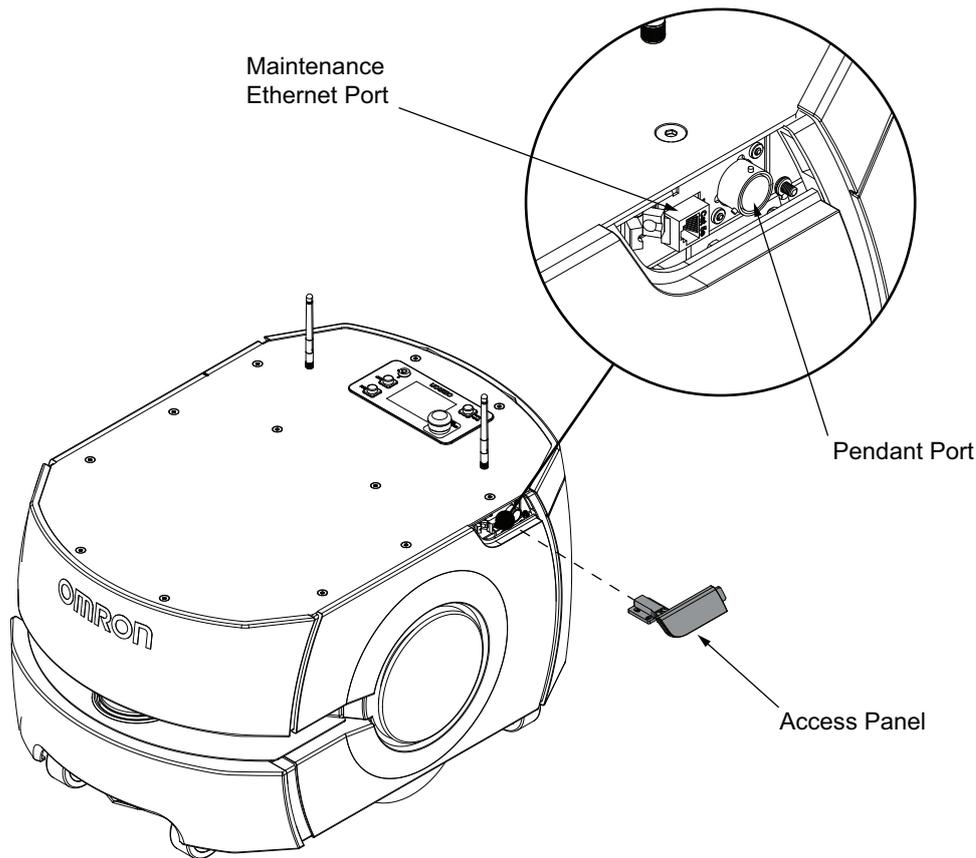
Maintenance Ethernet Port

Use the Maintenance Ethernet Port to connect a PC directly to the AMR when using software for con-
figuration or troubleshooting.

> **Precautions for Safe Use**
>
> Always follow best practices for proper grounding and anti-static methods before connecting or
> touching the MAINT LANor Maintenance Ethernet port. The Core may be damaged if an elec-
> trostatic discharge occurs at these ports.

Pendant Port

The pendant port is used to connect a handheld pendant to the AMR. This is typically used when driv-
ing the AMR manually. Disconnect the pendant from the pendant port during normal operation.

1-2-9   Rear Sonar Sensors

The AMR has two pairs of rear-facing sonar sensors.
Each sonar pair consists of one emitter and one receiver. The sonar emitters and receivers are physi-
cally identical, but the platform uses them differently. The typical accurate sonar range is approximate-
ly 2 m, but the range can extend up to 5 m.
The AMR's two rear-facing sonar pairs are for obstacle-sensing while backing up.

The AMR uses rear sonar for backing up when docking with the docking station, or when the front bumper has hit an obstacle. In the latter case, the platform will back up just enough to freely rotate without touching the obstacle.

These sensors are not safety-rated.

1-2-10   Charging Contacts

Charging contacts are used to mate with the Docking Station to transfer power to the battery during autonomous recharging.

1-2-11   Battery

A rechargeable lithium ion battery provides power to the entire AMR and any accessories.

The battery can be automatically recharged while in the AMR, or it can be removed and charged separately.
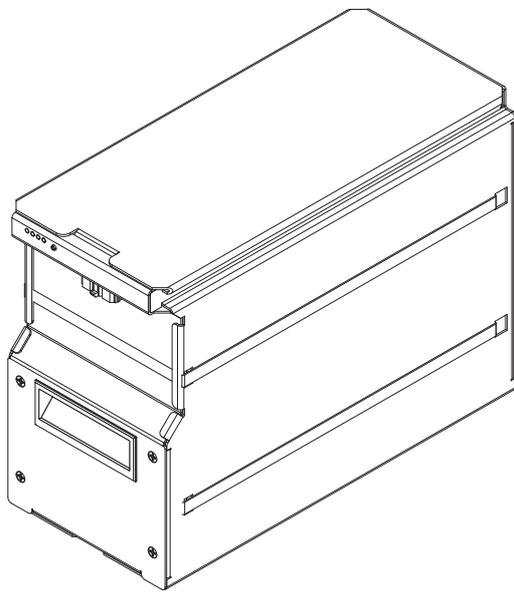
1-2-12   Pendant

Connect a Pendant to manually drive the AMR. A pendant is typically used when generating a map of the workspace.

The pendant has a trigger switch that enables the directional control joystick while an operator is present and holding the switch.

Precautions for Safe Use

Secure the Pendant when not in use to prevent an unauthorized user access to the AMR.

Additional Information

A Pendant is required for initial map creation.

Speed Control   Directional Control Stick

Goal Button

Indicator Light   Trigger
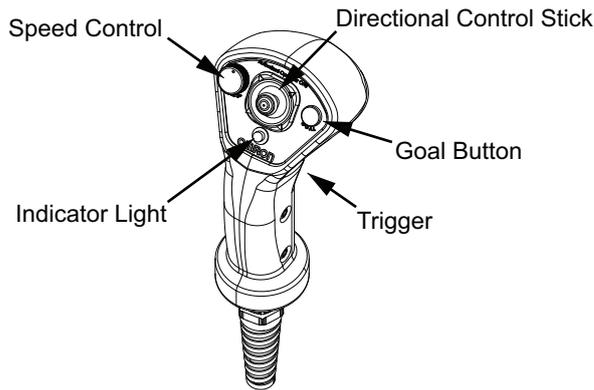
1-2-13   Drive Train and Suspension

The AMR utilizes a differential-type drive train with two drive-wheels. This drive train style makes the AMR highly maneuverable and allows it to rotate in place. The drive wheels have foam-filled rubber treads for traction and durability.

There are springs on the AMR's drive assembly that affect the down-force of its drive wheels. This allows the AMR to maintain contact with the floor over uneven areas or bumps.

.

1-2-14   AMR Core

The AMR Core is the AMR's main computing system that provides all navigational controls and application interfaces. The AMR Core consists of two main components: the Base Layer containing standard PC interfaces and the Mobile Robot Layer for the processing of the AMR control interfaces and network interface.

The AMR Core runs the SetNetGo operating system and the Advanced Robotics Automation Management (ARAM) software. It houses sensor components and the amplifiers that power the drive motors. The AMR Core is housed inside the payload bay as displayed in the following figure.
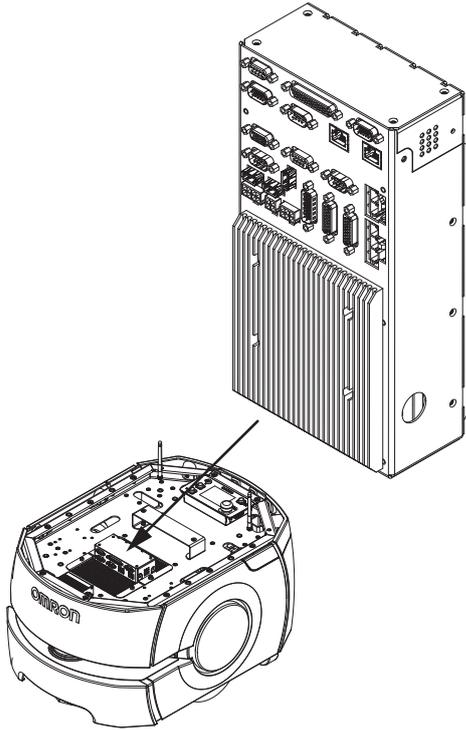
1-2-15 Speakers

Two speakers can be used as a means to audibly notify personnel of an approaching AMR. Speech and sound Tasks control the speakers' audio as the AMR navigates the workspace. Refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.
The locations of the speakers are provided below.

Precautions for Correct Use

When speakers are used as a means of notifying personnel of an approaching AMR, you must routinely verify that they are still functioning normally. Verify that the speakers are audible, and the sound level is at the same level as needed during the operation.
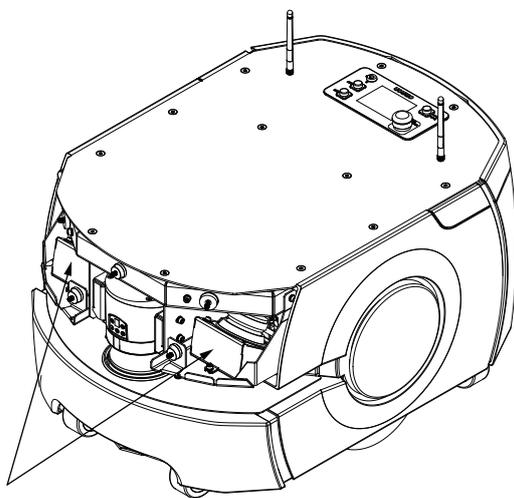
1-2-16 Docking Station

The Docking Station enables the AMR to charge autonomously. The Docking Station can also be used to charge a battery that has been removed from the AMR.

The Docking Station consists of the main components shown in the illustration below.

📝 **Additional Information**

- The Docking Station can manually or automatically charge the AMR battery according to the charging parameters set in MobilePlanner.
- If you have more than one AMR that use a single Docking Station, make sure that your map contains features such as parking spaces or queuing lanes to accommodate AMRs that are approaching and leaving the charging area. Refer to *Autonomous Charging* on page 4-21 for more information.
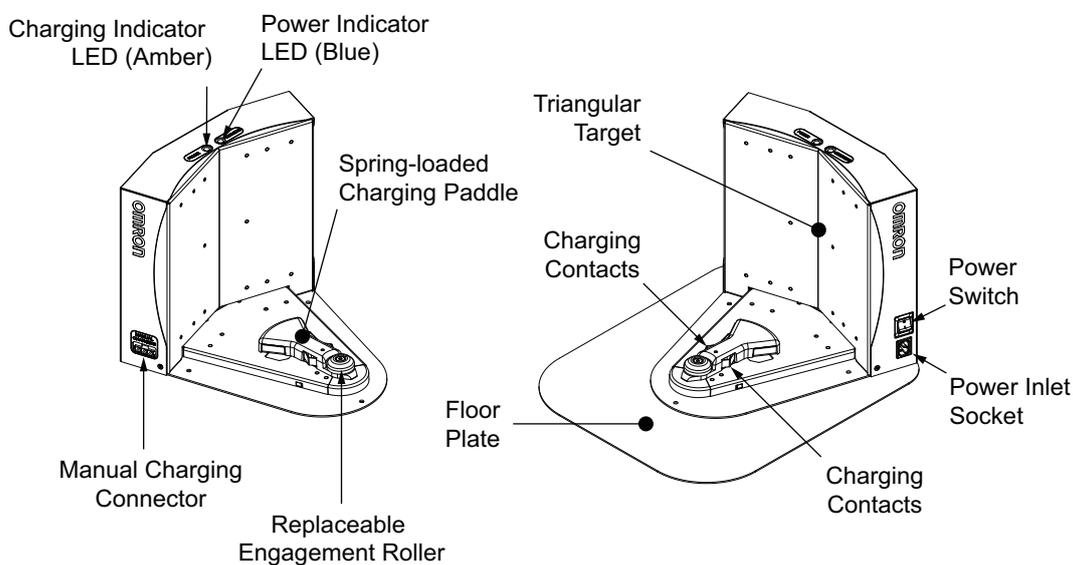
1-2-17 Localization Sensors

Localization is the process by which the AMR determines its location within its work environment. The AMR's primary method of localization utilizes the Safety Laser Scanner to scan and detect features in its environment.

Each drive wheel is equipped with an encoder that sends information to the navigation system about distance traveled and direction. The AMR Core has gyroscopic inertial sensing to track the AMR's rotation. There are also sensors on each motor that are used by the safety system to collect redundant speed information.

1-3   Autonomous Navigation

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

Navigation paths are updated many times per second to maintain a smooth trajectory and to avoid obstacles detected by the on-board sensors. An AMR reacts to obstacles in its path by slowing and if necessary, stopping safely. It then either plans a new path around the obstacle or, if the obstacle has moved, resumes its original path. If no such path is available, the AMR fails the current Job. Path planning parameters, together with constraints specified in the AMR's workspace map, define the path that the AMR will plan and follow through its environment. Use the MobilePlanner software to modify the AMR's path planning parameters as required for your environment.

The AMR can operate independently, without a wireless connection in areas where no other AMRs are present. In this mode, the AMR uses a map that is stored internally for all navigation and pre-configured Tasks. When an AMR operates in an area with other AMRs, wireless connectivity to a Fleet Manager is required. Refer to *1-6-1 Fleet Manager* on page 1-19 for more information.

Navigational parameters are stored on the AMR Core and can be viewed and modified using the MobilePlanner software.

⚠ WARNING
Do not walk, run, or suddenly throw objects in the travel path of the AMR or directly toward the AMR.

◁⧉ Precautions for Safe Use

It is the end user's responsibility to make sure that the speed is appropriate for the payload that the AMR carries, and that the AMR movement does not cause payload instability or loss of AMR control.

The MobilePlanner software configures the many high-level operating characteristics of the AMR and typically communicates with the AMR over a wireless network. A direct connection through the Maintenance Ethernet Port on the AMR is also possible.

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

* One Low Laser at the front of the AMR to detect objects below the plane of the Safety Laser Scanner.
* Two rear-facing sonar pairs to detect objects while moving in reverse.
* Encoders (one on each drive motor) provide information on the distance traveled by each drive wheel and direction of travel.
* Gyroscopic inertial sensors to track the AMR's rotation.
* Optional Acuity sensors can provide additional navigational data. Refer to *1-6-9 Acuity Localization* on page 1-22 for more information.

Before an AMR enters a high-traffic area, you must take appropriate precautions to alert people working in those areas. The AMR provides programmable warning features such as a warning buzzer, speech synthesis, and warning indicator lights. The AMR Core provides connectors that enable you to add additional warning indicators to your payload structure.

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

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

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

1-4 Labels

Labels provide important information about the AMR and Charging Station components. Use the following information to understand label details and placement locations.

1-4-1 AMR Information Label

The AMR information label is described below. The following example may differ slightly from your product's label.

Item	Name	Description
1	Part Number	The AMR part number is provided.
2	Product Type	The product type is provided.
3	AMR Information	General information about the AMR is provided.
4	Production Information	The following information is provided. • M/N indicates the model number and revision level. • SN indicates the serial number. • Lot. No. indicates the lot number in the format of DDMYYFF. Month number 1 to 9 for January to September, X for October, Y for November, and Z for December. FF is reserved for internal use.
5	Product Origin Information	Product origin information is provided.
6	Alerts and Compliance	General alerts and compliance information is provided.

1-4-2 AMR Core Information Label

The AMR Core information label is described below. The following example may differ slightly from your product's label.

Item	Name	Description
1	Part Number	The Core part number is provided.
2	Product Type	The product type is provided.
3	Alerts and Compliance	General alerts and compliance information is provided.
4	Production Information	The following information is provided. • SN indicates the serial number. • Lot. No. indicates the lot number in the format of DDMYYFF. Month number 1 to 9 for January to September, X for October, Y for November, and Z for December. FF is reserved for internal use.
5	Product Origin Information	Product origin information is provided.
6	Core Information	General information about the Core is provided.

1-4-3   Docking Station Information Label

The Docking Station information label is described below. The following example may differ slightly from your product's label.

Item	Name	Description
1	Part Number	The Docking Station part number is provided.
2	Product Type	The product type is provided.
3	Docking Station Information	General information about the Docking Station is provided.
4	Production Information	The following information is provided. • M/N indicates the model number and revision level. • SN indicates the serial number. • Lot. No. indicates the lot number in the format of DDMMYYFF. Month number 1 to 9 for January to September, X for October, Y for November, and Z for December. FF is reserved for internal use.
5	Product Origin Information	Product origin information is provided.
6	Alerts and Compliance	General alerts and compliance information is provided.

1-5　Model Numbers

AMR model numbers applicable to this document are provided in the table below.

Items	Model Number
LD-60	37032-00000
LD-60 with electrostatic discharge protection	37032-20000
LD-90	37042-00000
LD-90 with electrostatic discharge protection	37042-20000
LD-90x	37062-00000
LD-90x with electrostatic discharge protection	37062-20000

1-6   Optional Items

Information about optional items is provided in this section.

1-6-1   Fleet Manager

To manage and administer multiple AMRs in the same workspace, you must use a Fleet Manager running the Fleet Operations Workspace (FLOW) software. The Fleet Manager is a computing device with a processor capable of running the Fleet Operations Workspace Core suite.

For a fleet of AMRs, the Fleet Operations Workspace Core (FLOW Core) software running on a Fleet Manager shares the map between all AMRs in the fleet. This provides a common frame of reference for navigation and localization, preventing contention between AMRs while managing traffic flow and ensuring Job completion. Refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.

When two or more AMRs operate in the same workspace, they may not be able to accurately detect each other or to precisely determine each other's dimensions without a Fleet Manager. This occurs because the Safety Laser Scanner is positioned inside a channel along the front of the AMR. This channel along the front and sides of the AMR allows a clear line-of-sight for the Safety Laser Scanner. When two similar AMRs approach each other, their Safety Laser Scanners will detect the inner surface of that channel and not the outer perimeter of the other AMR. Typically this will not present a problem. However, in close proximity, each AMR will plan its motion more accurately with information from the Fleet Manager about the position of the other AMR.

Precautions for Safe Use

Make use of the Fleet Manager when two or more AMRs are used in the same environment and are not confined to separate workspaces.

Precautions for Correct Use

Using the Fleet Manager or map features is not a substitute for physical methods of preventing collisions, such as interlocked gateways or barriers. It is the user's responsibility to provide a physical method of preventing collisions where necessary.

The Fleet Manager can be configured for the following operating modes.

- Standalone Fleet Manager

  This has the ability to connect to, communicate with, and control the AMR fleet.
- Paired: Primary Fleet Manager

  This is similar to the Standalone Fleet Manager, but also communicates with a Secondary Fleet Manager, which serves as a backup if the Primary fails.
- Paired: Secondary Fleet Manager

  This functions as a backup appliance for the Primary.
- Fleet Simulator

  This can simulate up to ten AMRs divided between up to three fleets.

The Fleet Manager controls AMRs over a wireless network to share information between all AMRs in the fleet and improve efficiency through the following methods:

- Dynamic position and heading of the AMR (velocity and direction of travel).
- AMR size including payload structure consideration.

• Path planning information for the individual AMR's intended route.

> **Additional Information**
>
> • The AMR requires wireless communications when operating within a fleet. Refer to *3-4-3 Wireless Connection* on page 3-14 for more information.
> • Details for the use and configuration of the functions are covered in the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* and the *Fleet Simulator User's Manual (Cat. No. I649)*.

1-6-2 Additional E-STOP Buttons

Additional user-supplied E-STOP buttons can be added if necessary. An operator should be able to easily reach an E-STOP button from any angle without reaching across the moving AMR or any moving payload parts. Per relevant safety standards, E-STOP buttons must be placed within 600 mm reach of the operator. A large or complex payload structure may require additional E-STOP buttons.

> **Precautions for Safe Use**
>
> The emergency stop or protective stop devices you install on the AMR must have a dual channel circuit to ensure the same performance level as the other safety devices of the AMR.

> **Additional Information**
>
> • Refer to *3-5-1 Payload Bay Connections* on page 3-18 for more information about additional E-STOP connections.

1-6-3 Additional Signal Beacons

The AMR must include highly visible indicators appropriate for its application. In most cases, the light discs on the sides of the AMR provide sufficient indication, but this must be evaluated when a payload structure is implemented.

When using large or complex payload structures, you may need to install additional user-supplied signal beacons to ensure visibility of the AMR. The exact implementation of this signal beacon(s) depends on the design of your payload or payload structure. Make sure that the signal beacon(s) remains visible under all operating conditions, and from all sides so that people can always see it. Consider the design of your payload structure for high visibility, including when the AMR is transporting objects.

An additional signal beacon is not included with the AMR. You can optionally supply and install such a device if required. To comply with relevant standards, the sequence of the lights from top down must be red, yellow, and green.

A signal beacon may also be used to indicate movement and to signal that the AMR requires some interaction.

1-6-4 Additional Warning Buzzers

The AMR Core provides an output for controlling an additional warning buzzer as an auditory warning device. The warning buzzer is connected to the AMR Core.

The buzzer must be audible above the ambient noise of the environment that the AMR operates in. Depending on your environment's noise level, you may need to add an additional buzzer installed on

your payload structure so that the buzzer can be heard over the ambient noise level. It is the end-user's responsibility to verify this requirement.

The LIGHTS port in the Payload Bay on the AMR Core can support a user-supplied warning buzzer. You can install the buzzer in either the AMR or in a location of your choice in your payload structure. Refer to *3-5-1 Payload Bay Connections* on page 3-18 for more information.

> **Additional Information**
>
> You can optionally supply a signal tower which includes a built-in warning buzzer, or a dedicated warning buzzer. Contact your OMRON representative for more information on the available options.

1-6-5 Side Lasers

Side Lasers are optional sensors used to detect obstacles that protrude into the AMR's path, but may not be detected by the Safety Laser Scanners or Low Lasers. These are required when the payload structure is tall and there is an increased risk of collisions not detected by the Safety Laser Scanners. These optional sensors are oriented so that they scan in a vertical plane, offset 90 degrees from Safety Laser Scanners and Low Lasers.

Mount the Side Lasers in such a way that they protrude enough so that the payload does not interfere with the scanning plane. You must determine the mounting method for the optional Side Lasers when placing them on a payload structure.

Side Lasers are not safety-rated.

1-6-6 Mobile I/O Box

The Mobile I/O box is a small external unit that interfaces with an AMR or fleet of AMRs wirelessly. It can be used to:

1. Summon an AMR to a Goal with the Call Function.

2. Use External Digital I/O for control of connected devices. These can be associated with AMR related actions like opening a door for an AMR.

The Mobile I/O Box is intended to be part of an environment with AMRs controlled by a Fleet Manager. Refer to *Mobile I/O Box User's Manual (Cat. No. I677)* for more information.

1-6-7 High Accuracy Positioning System

The High Accuracy Positioning System (HAPS) is an optional hardware feature that allows the AMR to stop at a position with greater accuracy. This system uses AMR mounted sensors to detect magnetic tape applied to the floor near the stop position.

One sensor allows accurate positioning driving forward. If your AMR needs to drive both forward and backward along the magnetic tape, two sensors are required.

A typical HAPS application consists of a Goal on the AMR's map, a length of magnetic tape, and one marker. The Goal will have Tasks that direct the AMR to proceed to the tape, follow the tape, and stop at the marker.

The HAPS option is compatible with ARAM version 4.7.6 or later software.

Refer to *3-9 HAPS Installation and Configuration* on page 3-43 for more information.

1-6-8　Cell Alignment Positioning System

The Cell Alignment Positioning System (CAPS) is an optional software feature that provides higher re-peatability for AMR positioning. CAPS technology uses the AMR's sensors to detect a user-defined target shape and position itself in relation to the target with high repeatability. It does not require additional sensors or magnetic tape to be applied to the floor.

Flexible navigation allows the AMR to approach a station or cart from any angle so that docking can be achieved from any direction.

This feature also enables smoother and quicker loading and unloading of material, contributing to a shorter cycle time.

The CAPS license part number is 20271-805. Contact your local OMRON representative for more information.

> **Additional Information**
>
> Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information about standard target dimensions.

1-6-9　Acuity Localization

For dynamic environments in which a map can't be kept current, or where the area is too large for the navigation laser to see, the robot can use Acuity to navigate.

Acuity Localization uses a camera to detect overhead lights, enabling the AMR to localize itself in environments where laser localization alone is not an optimal solution. Laser localization is tolerant of changing environments. However, it becomes difficult if changing features exceed 80% of the objects detected by the laser. This includes workspaces such as warehouses, where objects such as shipping pallets or rolling carts either change locations often, or block the laser's view of mapped features.

Acuity is also useful when wide-open spaces do not provide enough features to map for laser localization.

1-6-10　Electrostatic Discharge (ESD) Protection

An AMR with ESD protection is equipped with special skins and casters that are electroconductive. This provides a low resistance (1 GΩ) path to ground and prevents electrostatic accumulation as the AMR operates, protecting ESD-sensitive components that may be present on the payload.

An AMR that is equipped with ESD protection has a black appearance from the special paint that is applied to the external surfaces at the factory.

1-6-11　Wireless Antenna Extension Kit

You may need to relocate the wireless antennas if the payload or payload structure causes signal degradation. A Wireless Antenna Extension Kit is available (part number 68955-000). Refer to *3-12 Wireless Antenna Relocation Procedure* on page 3-81 for more information.

1-6-12   Digital I/O Terminal Block Kit

The Digital I/O Terminal Block Kit provides a convenient method for connecting user-supplied input and output devices to the Digital IO connector on the AMR Core. The kit (part number 14165-000) includes a numbered terminal block, 0.76 m cable, and a mounting bracket.

> **Additional Information**
>
> The mounting bracket has four 5.5 mm diameter holes on a 50 mm x 75 mm pattern for fastening purposes.

1-7   FLOW Core Software

The FLOW (Fleet Operations Workspace) Core software package consists of different software components that provide specific functionality during AMR configuration and operation. The information in this section provides an overview of the different FLOW Core software components, their functions, and interactions within the AMR system.

- MobilePlanner (PC + Tablet)
- Fleet Management
- SetNetGo
- Mobile I/O Box
- Integration Toolkit (ITK)
- FLOW iQ
- Driving and Navigation
- Fleet Simulator
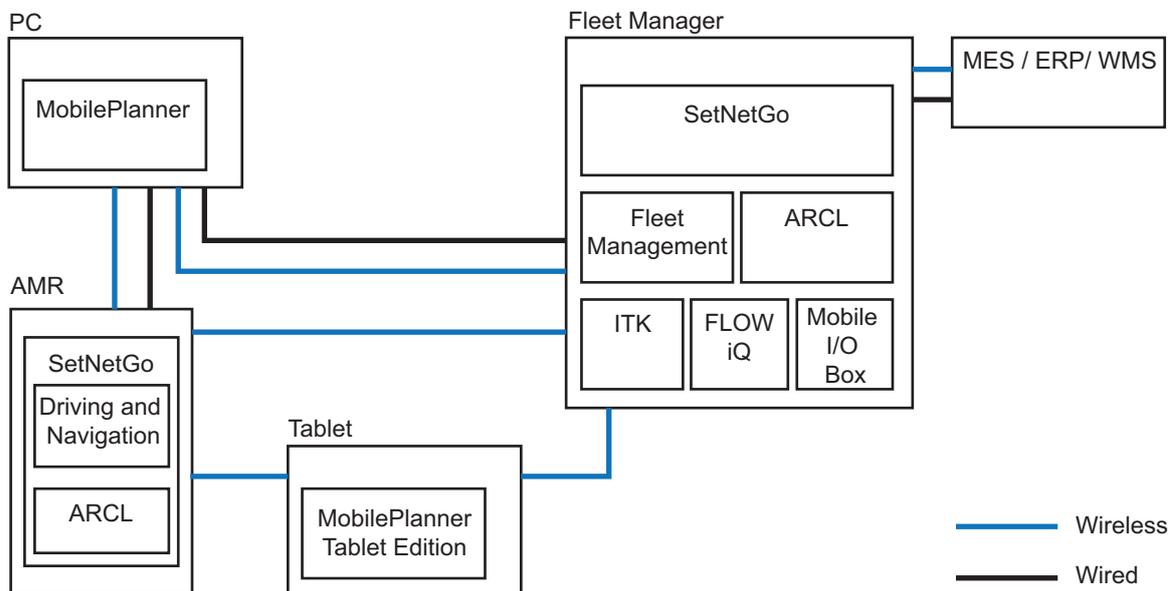
> **Additional Information**
>
> Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.

1-7-1   MobilePlanner Software

MobilePlanner is part of the Fleet Operations Workspace software and runs on the user's PC, or as a portable tablet version on Android® and iOS® devices. It provides a tabbed graphical user interface on the PC and a touchscreen interface on tablets.

MobilePlanner software typically communicates with the AMR securely over a wireless network during normal operation.

> ⚠ **CAUTION**
>
> The AMR can have unexpected motion if it is controlled by multiple instances of Mobi-
> lePlanner.

This software provides the following general functionality:

- Map creation and editing with Forbidden Areas, charging locations, Goals, and other workspace features.
- Creation and editing of Macros, Tasks, and Routes.
- Configure parameters that control the AMR's operation in the mapped workspace.
- Monitor the location and behavior of a single AMR or a fleet of AMRs.
- Accelerated installation of new fleets with configuration inheritance.
- Quick access buttons for fleet observability, map editing, configuration management, system management and data analytics.
- Manually controlling the AMR.
- Scheduling autonomous operations.
- Administrator accounts for full feature access or operator accounts for restricted access to features and functions.
- Supported languages of English, Japanese, German, French, Italian, Korean, Spanish, Polish, Simplified Chinese, and traditional Chinese.

System Requirements

MobilePlanner system requirement information is provided below for PC and Tablet Edition software.

Software Type		Requirements
PC		• CPU: 1.5 GHz dual-core CPU recommended • Main Memory: 1.5 GB minimum (4 GB or higher recommended) • Hard Disk: minimum of 200 MB of available space • Video Memory: 256 MB minimum • Display: XGA 1024 × 768, 16 million colors minimum
Tablet Edition	Android®	Android® version 9 or newer
	iOS®	iOS® version 10 or newer

Tablet Edition

The MobilePlanner tablet edition is an easy-to-use interface designed to monitor and control AMRs with a tablet. This software has a limited set of features and functions as described below.

- Localize or manually drive AMRs.
- Initiate the map creation process.
- Monitor individual AMRs or a fleet of AMRs for Job counts, current Job queue, locations, battery level, and travel speed.
- Send AMRs to up to 6 predefined positions with a single button press.
- Send AMRs to charging locations or other map objects.

• View alerts from AMRs.

1-7-2   Fleet Management Software

Fleet Management software runs on the Fleet Manager hardware. It provides the following general functionality for a fleet of OMRON AMRs.

• Intelligent Job assignment
  Reduces wasted time and movement by continuously looking ahead to anticipate which AMRs will be best positioned for upcoming Tasks.
• Managed motion
  Ensures smooth operations in busy environments by coordinating traffic flows and efficiently sequencing pick-up and drop-off at target locations.
• Traffic control
  Notifies converging AMRs of their predicted paths, allowing them to re-calculate and avoid collision in the most efficient way.
• Map updates
  Distributes map updates automatically across the entire Fleet.
• Charge management
  Tracks battery power of the entire Fleet, directing AMRs to their nearest available or preferred charging station on a schedule that ensures continuous Fleet operation.
• Skill administration
  Considers the capabilities of individual AMRs in the Fleet and ensures the correct AMR is assigned to the correct Job.

1-7-3   SetNetGo Software

The SetNetGo software runs on the AMR and the Fleet Manager. This software is a proprietary, immutable operating system developed by OMRON.

SetNetGo is used for configuration and setup, software upgrades, diagnostics, and retrieving log files for troubleshooting purposes. The SetNetGo interface is viewable from within MobilePlanner or with a web browser when a connection to the AMR or Fleet Manager has been established (wired or wireless).

Additional Information

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

Mobile I/O Box Package

The Mobile I/O Box package is a component in SetNetGo that communicates with the Mobile I/O Box. This package manages updates for Mobile I/O Box devices in the system.

Additional Information

Refer to the *Mobile I/O Box User's Manual (Cat. No. I677)* for more information.

Integration Toolkit (ITK) Package

The Integration Toolkit is OMRON's interface application that enables integration between the Fleet Manager and the end user's client application, manufacturing execution system (MES), or warehouse management system (WMS).

This integration layer facilitates autonomous control for a fleet of AMRs using standard communication methods including REST and SQL. The Integration Toolkit facilitates queuing and monitoring of all AMR Job types such as pickup, drop-off, and multi-segment.

> **Additional Information**
>
> Refer to the *Fleet Operation Workspace Core Integration Toolkit User's Manual (Cat. No. I637)* for more information.

● ARCL Programming Language

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

Typical uses of ARCL are:

- Operating and monitoring the AMR.
- Operating accessories and peripherals.
- Sending or receiving commands to or from your payload structure with a user-supplied controller.

> **Additional Information**
>
> Refer to the *Advanced Robotics Command Language AMR Reference Guide (Cat. No. I617)* for more information.

FLOW iQ Package

The FLOW iQ package provides visualization tools to generate graphics on the fly such as heat maps, robot path map, robot utilization, and more to track and optimize the AMR application. This package runs exclusively on a Fleet Manager device.

The FLOW iQ package is a licensed component in SetNetGo that enables the functionality described above.

> **Additional Information**
>
> Refer to the *Fleet Operations Workspace iQ User's Manual (Cat. No. I665)* for more information.

1-7-4 Driving and Navigation Software

Driving and Navigation software runs on the AMR within SetNetGo. This software provides all essential AMR functionality using various subsystems such as ARAM and MARCOS.

1-7-5   Fleet Simulator Software

Fleet Simulator software runs on the Fleet Manager hardware. It provides the following general functionality for a simulated Fleet of OMRON AMRs.

- Assess impact of map changes, scaling, route changes, and new software features.
- Simulate up to 10 AMRs in up to three separate Fleets.
- Visualize individual AMR path planning and interaction with other AMRs.
- Simulate custom environment based on real-world facilities.
- Identify traffic flow bottlenecks.
- Validate third-party software.
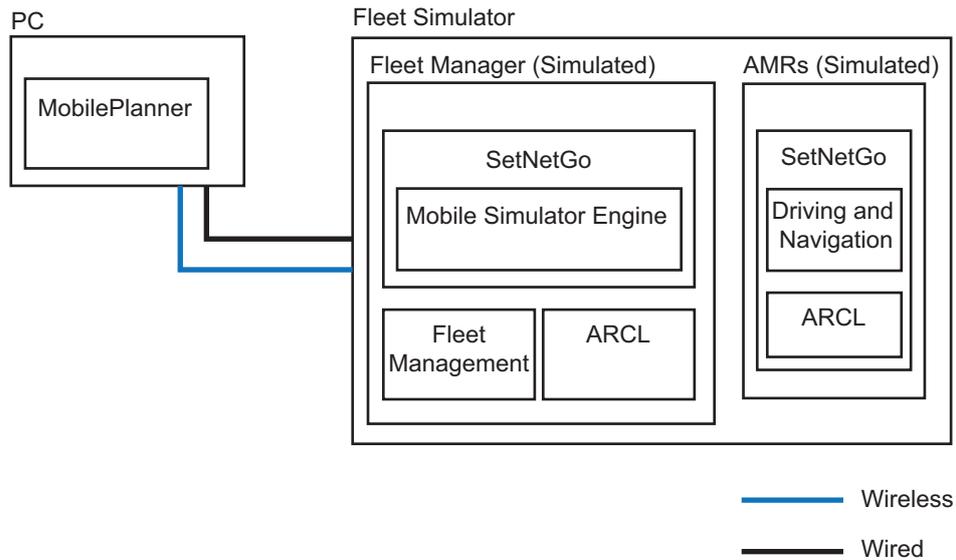
1-8 Payload Considerations

This section describes considerations and requirements for AMR payloads.

A payload is considered as any item(s) that are placed on the AMR for the purposes of securing, transporting, and transferring some object. A payload structure is typically required to secure an object during transport. The end user or an integrator is responsible for designing and implementing a payload structure system. This system may include controls and other mechanical items to facilitate various functions related to the operation of the AMR and the machinery that it interacts with.

Payloads are mounted beneath the top skin to the top of the AMR chassis. Several mounting points are available for various payload designs.

Make the following considerations when designing the payload structure.

- Provide access to the payload bay for serviceability.
- If the payload structure is small and light enough, it may be possible to lift it off the AMR.
- Always take care to not damage any cabling between the payload structure and the AMR. Provide adequate slack in all cables, or include connectors.
- Label all cables for accurate reconnection.
- Larger, heavier payload structures might require a hinge, so the payload structure can be tilted out of the way while accessing the payload bay.

Careful considerations for the center of gravity and moment of inertia of the payload must be made. Refer to *2-2-4 Payload Center of Gravity* on page 2-6 for more information.

⚠ DANGER

The end-user of the AMR must perform a risk assessment to identify and mitigate any additional personal and property damage hazards caused by the payload. 🛈

⚠ WARNING

- The user is responsible for the safety of the AMR, which includes confirming that the system is stable with any payload, payload structure, or other attachments while functioning in the specified operating environment.
- If the AMR transports containers of liquid or other non-solid material, consider the effect on the AMR's stability if their contents can shift. It is the end user's responsibility to ensure that the payload is properly secured to the AMR, and that payload shifting does not create AMR instability.
- The payload must be kept higher than the top of the AMR. If the payload or associated structure blocks any of the AMR's sensors, the AMR cannot function correctly.

Precautions for Safe Use

- It is the end user's responsibility to make sure that the speed is appropriate for the payload that the AMR carries, and that the AMR movement does not cause payload instability or loss of AMR control.
- The payload or payload structure shall not be positioned in such a way that would put the operator in danger while trying to reach an emergency stop button.

Additional Information

The AMR provides the electrical power and controls required to operate a payload structure.

1-8-1　Payload Structures

For typical AMR applications, a payload structure must be designed and constructed for operations such as pickup, dropoff, and transportation of the payload.

The AMR provides threaded mounting holes for payload structure attachment. The mounting holes provide a secure and adaptable method of attaching payload structures to the chassis. A payload structure can be as simple as a crate that contains manufacturing parts or a more sophisticated device such as a conveyor or robotic arm.

The AMR also provides a variety of interfaces and power connections to support your application-specific sensors and accessories that may be included in the payload structure.

Precautions for Safe Use

Intentional movement of the payload structure (such as conveyor or arm) during the AMR movement is prohibited. It is the end-user's responsibility to design an appropriate interlock to prevent this.

Payload Structure Location

Serviceability and maintenance requirements should be considered when designing a payload structure.

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

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

● Wireless Antennas

You must ensure that the payload does not obstruct the wireless antennas. If it is not possible to prevent some interference between the payload and the wireless antennas, you may relocate the wireless antennas to a payload position where the signal does not get attenuated. A Wireless Antenna Extension Kit (part number 68955-000) is available.

● E-STOP Buttons

User-supplied E-STOP buttons can be added to the payload structure.

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

Additional Information

If no additional E-STOP buttons are added, a jumper with a part number of 12730-000L must be present on the USER INTERFACE connector. Refer to *USER INTERFACE* on page 3-26 for more information.

● Light Discs

You must ensure that the payload does not block the light discs as they provide visual indication of the AMR movement.

● **Payload Center of Gravity**

Center of gravity is a critical factor when placing items on the AMR for transport. Keep the payload's center of gravity centered over the AMR's own center of gravity and as low as possible. This provides optimum stability, particularly when the AMR traverses irregularities in the floor.

The maximum payload includes the payload structure and any load carried by that structure. The center of gravity of the combined mass of the payload structure, including all onboard tooling and loads being transported, must be within the specified limits. These limits must be observed to ensure stability while in the AMR is in motion and also while loading and unloading payloads.

Make the following considerations when designing and implementing your payload.

- If the payload extends outward dynamically from the AMR (such as a robotic arm), it has a greater effect on the center of gravity. This is particularly important if the payload is also conveying objects that add additional mass.
- If the payload can shift during AMR movement, consider its effect on the AMR's center of gravity.
- If the payload is tall and also has substantial weight, consider the effect on the AMR's center of gravity.

📓 **Additional Information**

Refer to *AMR Dimensions* on page 2-3 for more information.

1-8-2　Exceeding the AMR Footprint

Some applications require that the payload exceeds the footprint of the AMR. Special considerations must be made for these types of applications. Safety Laser Scanner zones may need to be re-sized. Any change to Safety Laser Scanner zones may require validation using operational testing in accordance to your applicable standards.

> ⚠ **WARNING**
>
> - If a payload is beyond the footprint of the AMR, it can compromise the AMR's safety functions. Payloads beyond AMR footprint may require modifying safety zone size. The OMRON AMR Safety Zone Generator tool is available for safety zone resizing.
> - OMRON is not responsible for any risks incurred by modifying safety zone sizes or other OS32C laser settings.

1-8-3　Safety Laser Scanner Zone Obstruction

Some applications such as cart transportation may require modifying Safety Laser Scanner zones if a payload structure obstructs them. The OMRON AMR Safety Zone Generator tool is available for Safety Laser Scanner zone modification. Any change to Safety Laser Scanner zones may require validation using operational testing in accordance to your applicable standards.

> ⚠ **WARNING**
>
> OMRON is not responsible for any risks incurred by modifying safety zone sizes or other OS32C laser settings.

1-8-4   Power Consumption

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

Minimize payload power consumption whenever possible to prevent excessive battery drain.

> **Additional Information**
>
> Refer to the power limits specified in *AUX PWR* on page 3-29 and *USER PWR* on page 3-30 for more information.

1-9　Coordinate System

AMRs use the X, Y, Z, and Theta coordinate system displayed in the figure below. This information is relevant for some of the procedures used in this manual, such as identifying which are the left or right sides of the AMR. For example, the +X direction is the direction of AMR forward travel.

The origin of the AMR coordinate system is the ideal point on the floor exactly half way between the center of the two drive wheels. The origin of the coordinate system is the AMR's center of rotation. Coordinates are required for procedures such as installing and configuring options such as lasers, and also for understanding the center of gravity envelope. The AMR's coordinates are also associated with the map coordinates.

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

The origin of the vertical coordinate Z is set at ground level (Z=0). The value of Z is required when you calculate the mount position of optional items such as Side Lasers. Positions of optional items like this are set in MobilePlanner.
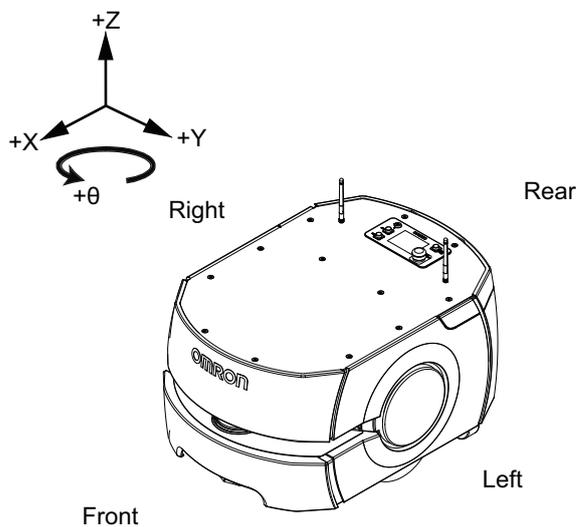
2

Specifications

This section provides specifications for the AMR and other associated items.

2-1   Performance Specifications

Performance specifications for the AMR are provided below.

Item	LD-60	LD-90	LD-90x
Maximum payload capacity	60 kg	90 kg	90 kg[*1]
Run time (no payload)	Approximately 15 hours		Approximately 20 hours
Run time (full payload)	Approximately 12 hours		Approximately 15 hours
Swing radius	354 mm		
Turn radius	0 mm		
Maximum forward translational speed	1800 mm/s	1350 mm/s	900 mm/s
Maximum reverse translational speed	280 mm/s	210 mm/s	140 mm/s
Maximum rotational speed	180 degrees/s		
Stop position repeatability (single AMR)[*2]	• To a position: ±65 mm • To standard target: ±25 mm, ± 2° • With HAPS: ±8 mm, ±0.4° • With CAPS: ±8 mm, ±0.5°		
Stop position repeatability (fleet)[*2]	• To a position: ±85 mm • To standard target: ±35 mm, ± 2° • With HAPS: ±10 mm, ±0.5° • With CAPS: ±12 mm, ±0.5°		

*1. The LD-90x is capable of moving up to 172 kg of self-supported payload in a cart transporting configuration.

*2. Stop position repeatability values were obtained using default AMR parameters and a map created by the LD-60/90 AMR.

2-2 Physical Specifications

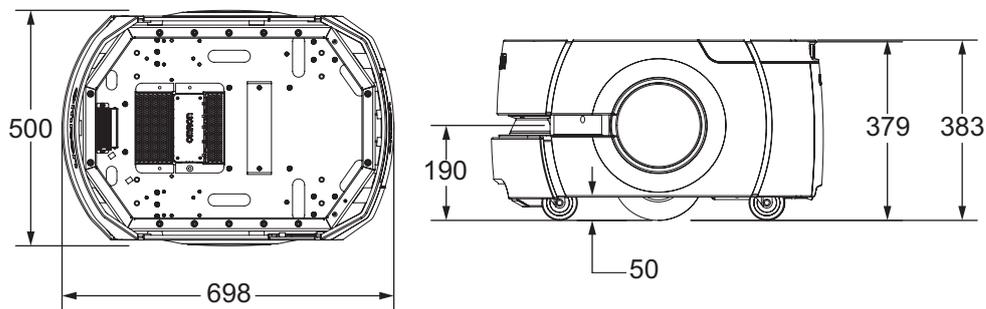Physical specification of the AMR and other items are provided below.

2-2-1 Dimensions

Dimensional specifications are provided in the following sections.

AMR Dimensions

Physical dimensions of the AMR are provided below.

Battery Dimensions

Physical dimensions of the battery are provided below.
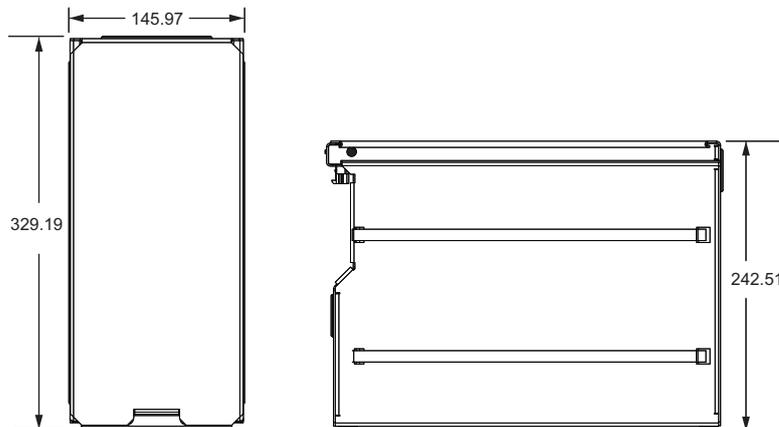
Docking Station Dimensions

Physical dimensions of the Docking Station are provided below.

Wall Mount
and Floor Mount

Free Standing

Wall Mount Bracket
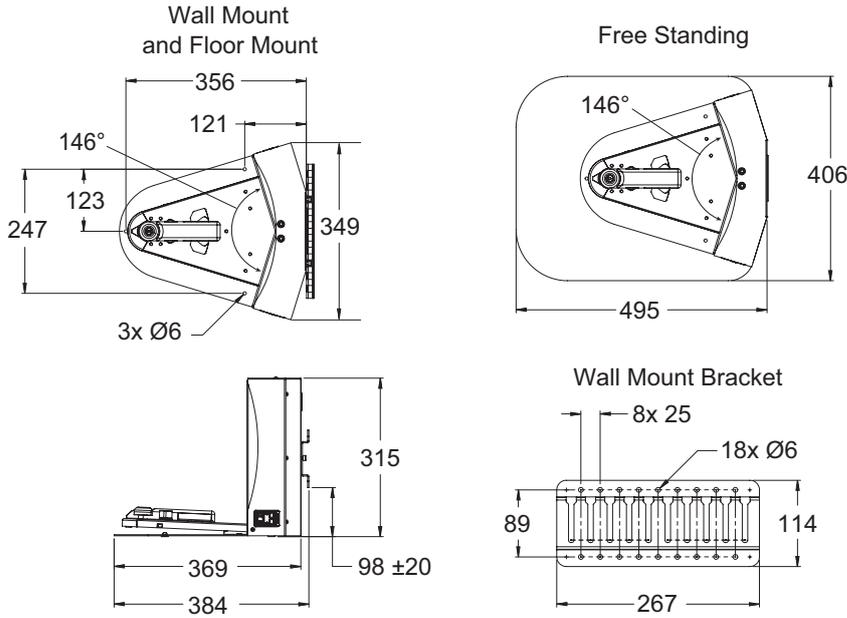
Operator Panel Dimensions

Physical dimensions of the Operator Panel are provided below.
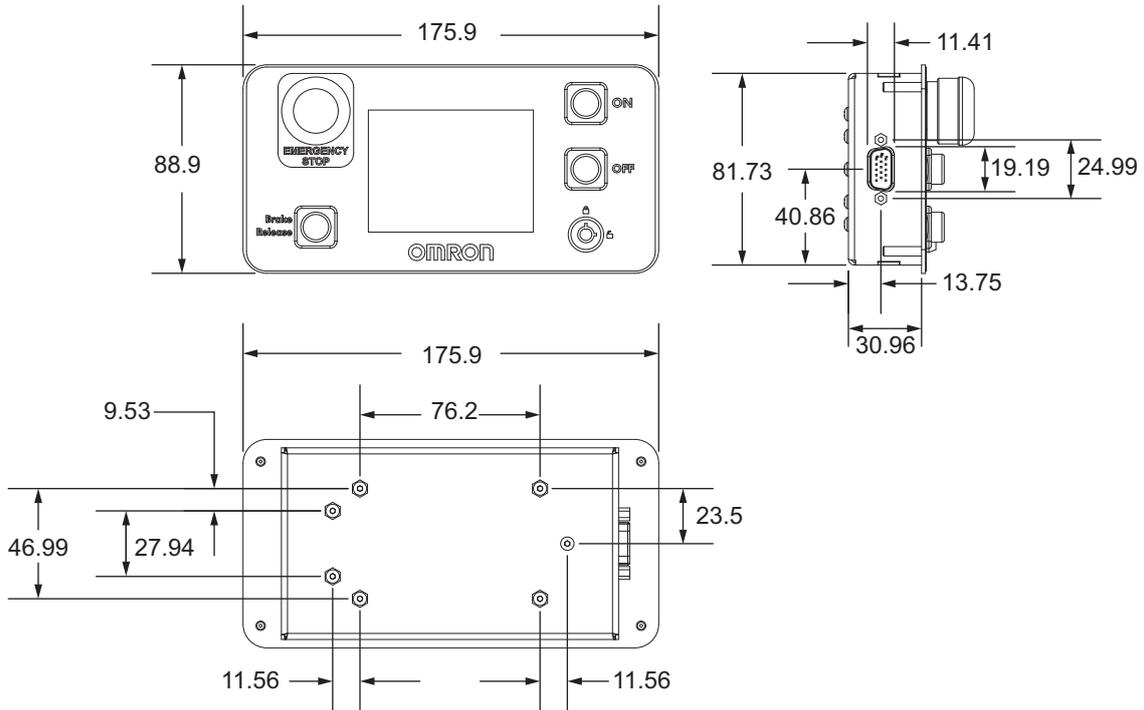
Side Laser Assembly Specifications

Physical dimensions of the Side Laser Assembly are provided below.
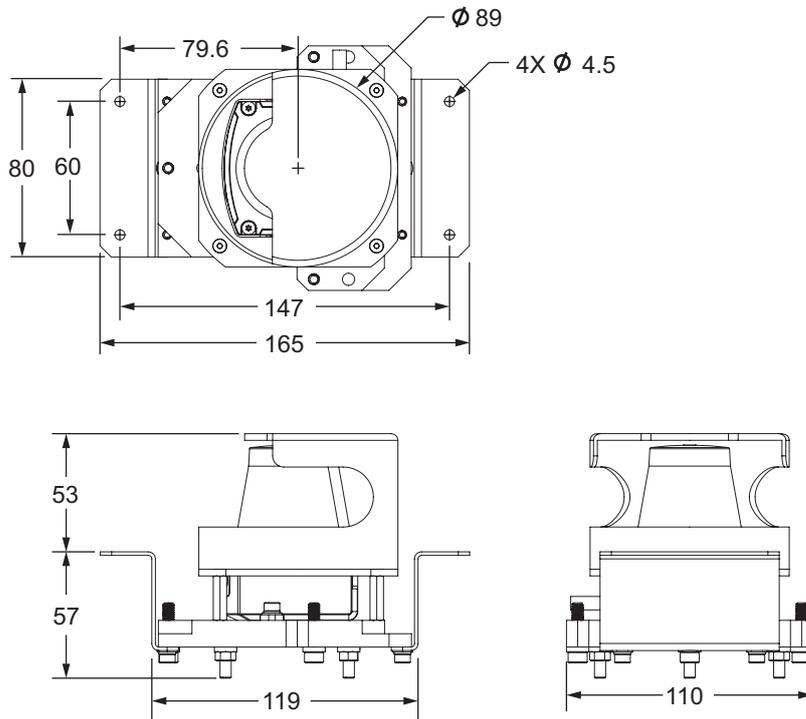
2-2-2 Center of Rotation

The dimensions of the AMR center of rotation is provided below.

Front View   Side View

(Rear)   (Front)

250   250   349   349

⊕ = Center of Rotation

2-2-3 Center of Gravity

The dimensions of the AMR center of gravity are provided below.

Front View   Side View

(Rear)   (Front)

189

250   250   324   345
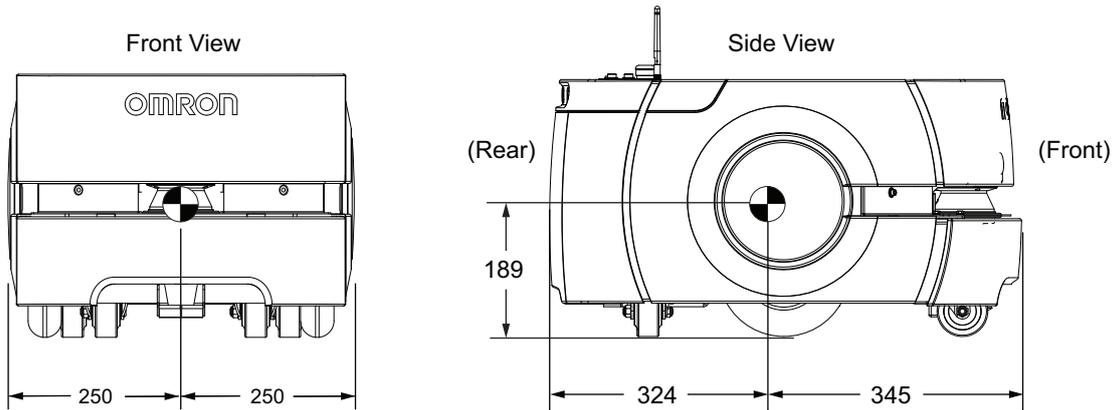
⬤ = Center of Gravity

2-2-4 Payload Center of Gravity

The following figures show the calculated safe center of gravity placements for the AMR's maximum allowed payload weight. The payload's center of gravity must be within the area shown.

These calculations assume the following conditions.

• The payload is securely attached to the AMR and it does not shift due to the AMR's motion.
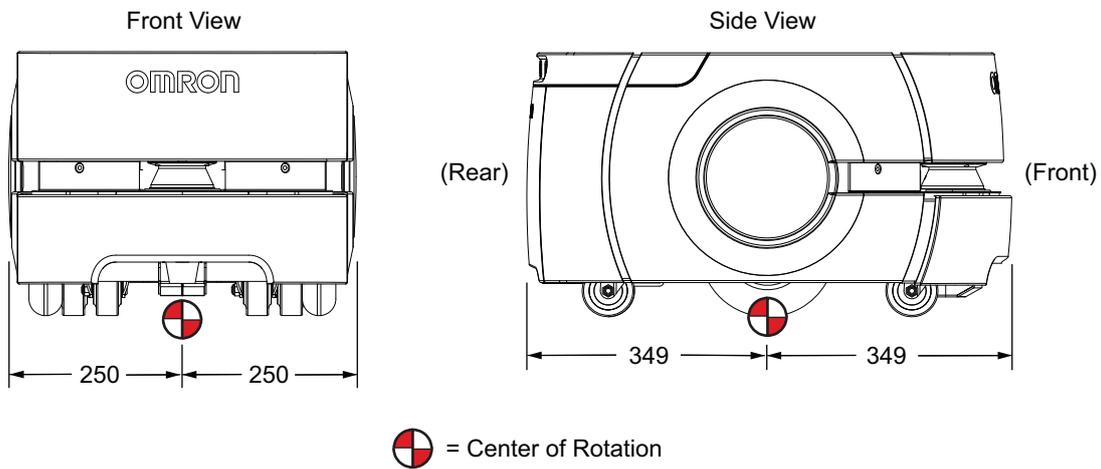• The AMR does not exceed its specified default limits for acceleration, deceleration, linear velocity, angular velocity, and coefficient of friction (0.6 minimum).
• The AMR is operating on a flat, level surface and not on an inclined surface.

In the following graphs, X represents the direction of the AMR's motion (front to rear). Y is perpendicular to the AMR's direction of motion (side-to-side). Z is the vertical dimension (height). Refer to *1-9 Coordinate System* on page 1-33 for more information.

A 3D view of the recommended payload center of gravity is shown below.

The following figures show the calculated safe center of gravity placements for payloads. All units are mm.

The payload center of gravity must to be within the area shown. Keep the payload center of gravity as close to the center of these figures as possible.

LD-60 Center of Gravity Limits

All figures below show the allowable center of gravity placement for a 60 kg payload.

The following figure shows an isometric view.
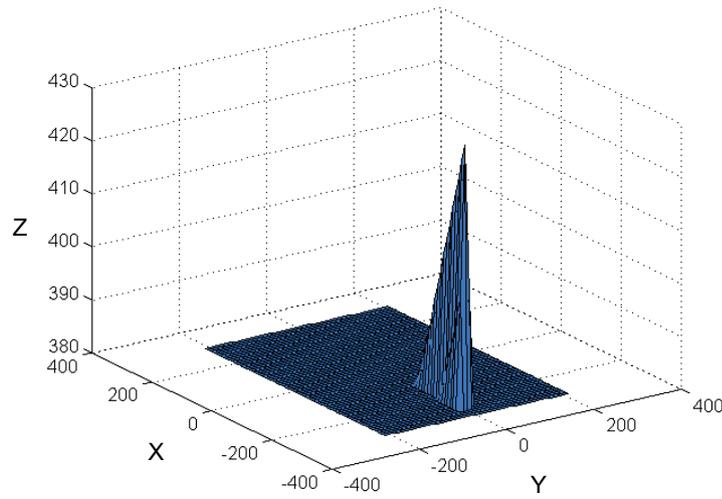
The following figure shows the longitudinal view.
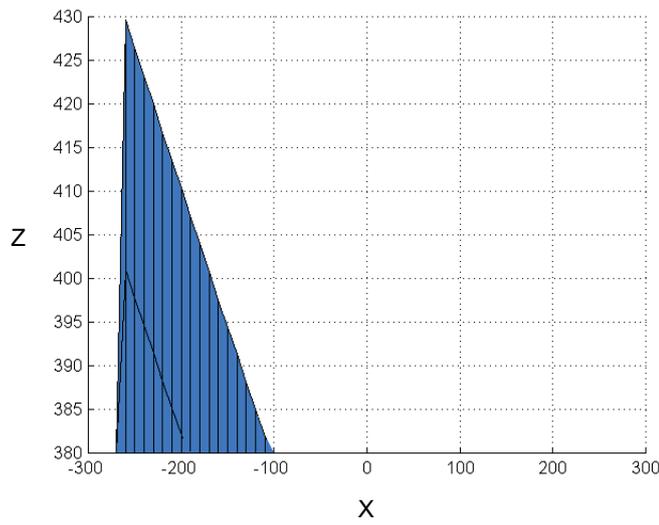
The following figure shows the transverse view.
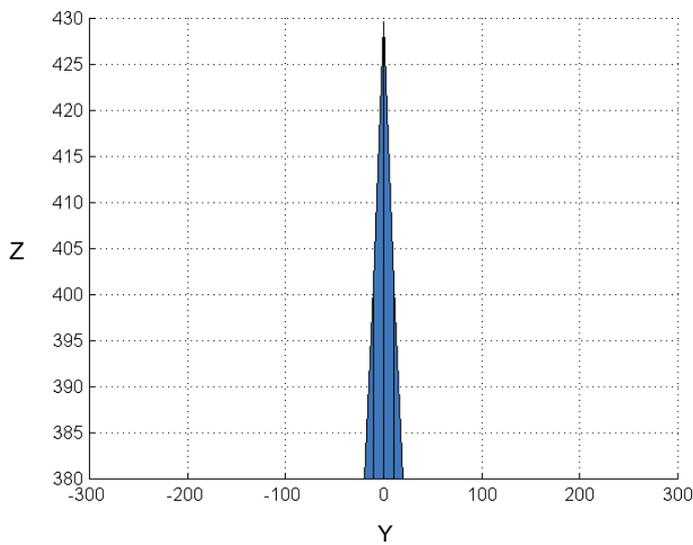
The following figure shows the top view
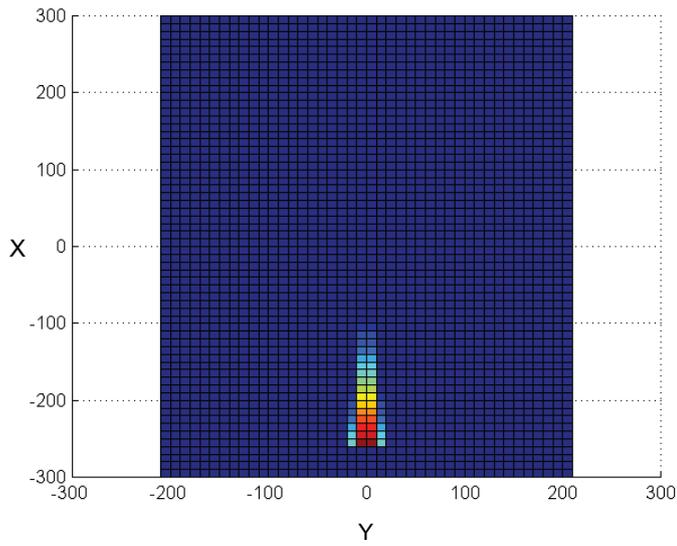
LD-90 / LD-90x Center of Gravity Limits

All figures below show the allowable center of gravity placement for a 90 kg payload.
The following figure shows the isometric view.
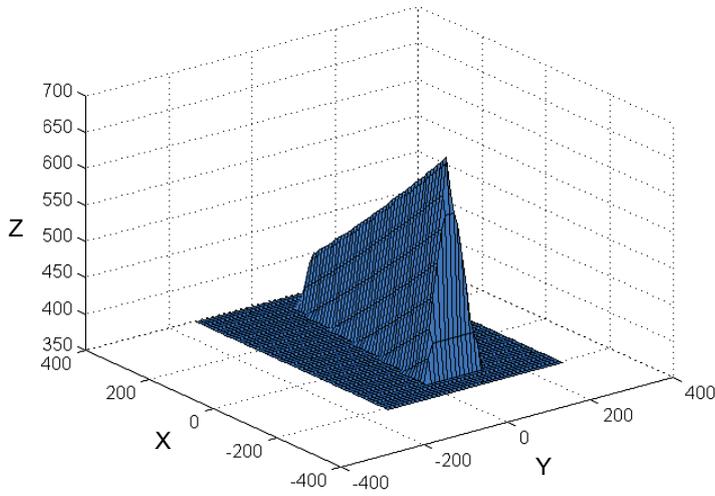
The following figure shows the longitudinal view.
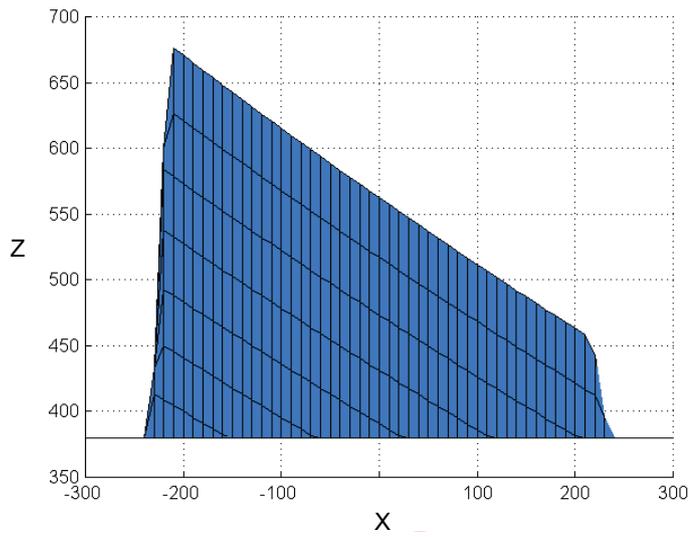
The following figure shows the transverse view.
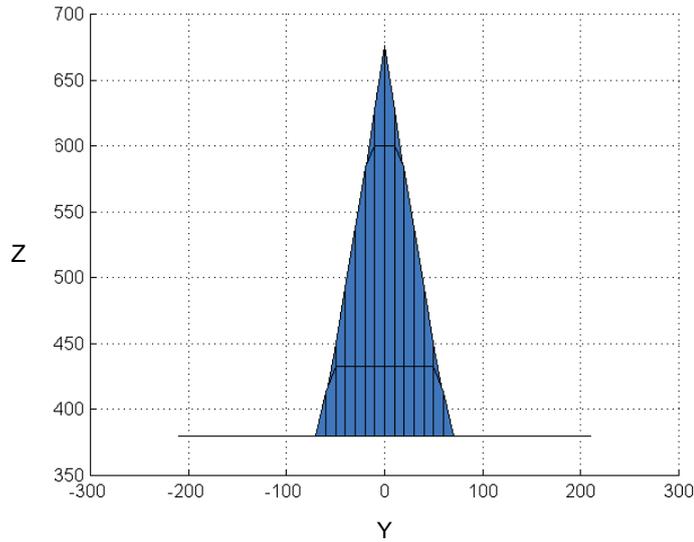
The following figure shows the top view.
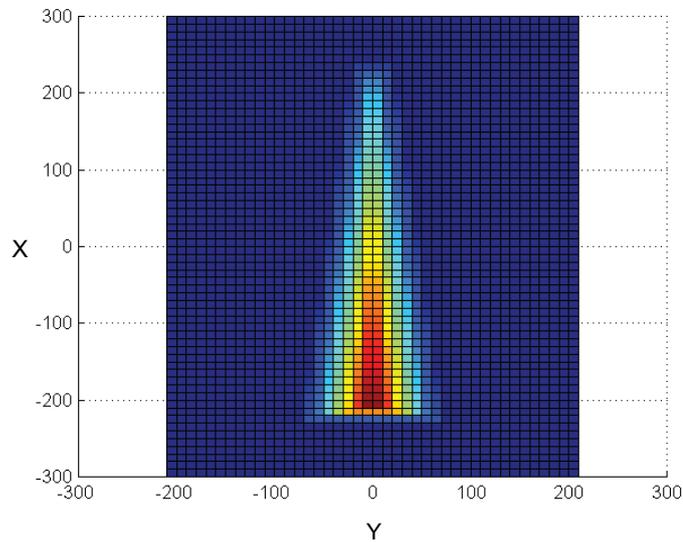
2-2-5   Weights

Weights are provided in the table below.

Item	Weight
AMR (no battery or accessories)	43 kg
Battery	19 kg
Docking Station	8.2 kg

2-3 Environmental Specifications

Environmental specifications are provided in the following sections.

2-3-1 AMR Environmental Specifications

Environmental specifications for the AMR are provided below.

> ### ⚠ WARNING
>
> • Do not expose the AMR to rain or moisture.
> • Do not use the AMR in hazardous environments (explosive gas, and oil mist).

> ### ⚠ WARNING
>
> Exposure to ingress beyond the specifications can lead to system malfunction.

Item		LD-60	LD-90 / LD-90x
Ambient operating temperature		5 to 40°C	
Ambient light interference		Wavelength: 870 to 940 nm Brightness: 150 lx max. (angle of laser scanning plane and disturbance light must be +/-5 degrees or more)	
Storage temperature		5 to 60°C	
Humidity		5% to 95%, non-condensing	
Altitude		1000 m above mean sea level maximum	
Pollution degree		2	
Ingress protection class		IP20	
Atmospheric		Non-hazardous environments (no explosive gas and oil mist).	
Radiation		Do not use the AMR in the presence of ionizing or non-ionizing radiation.	
Dust and smoke		Airborne particulate size: >37 μm Floor accumulation: <10 mL/m^2 Avoid smoky areas.	
Floor surface	Step traversal[1]	15 mm maximum	10 mm maximum
	Gap traversal[2]	15 mm maximum	
	Flatness	F_F25 (per ACI 117 standard)	
	Levelness	F_L25 (per ACI 117 standard)	
	Incline	Up to 60 kg: 4.8° / 8.3 % incline Over 60 kg: Level floor only	
	Coefficient of friction	0.6 minimum	
	Minimum compressive strength	2.6 MPa	3.27 MPa

[1]. A speed of 250 mm/s is recommended for traversing steps, and routine driving over steps should be avoided. Lower speeds may not traverse the step. Faster or frequent driving over steps will shorten the lifespan of the drivetrain components. All steps should have smooth, rounded profiles.

*2.   A speed of 250 mm/s is recommended for traversing steps, and routine driving over steps should be avoided. Lower speeds may not traverse the step. Faster or frequent driving over steps will shorten the lifespan of the drivetrain components. All steps should have smooth, rounded profiles.

2-3-2   Docking Station Environmental Specifications

Environmental specifications for the Docking Station are provided below.

Item	Specification
Ambient operating temperature	5 to 40°C
Storage temperature	5 to 60°C
Humidity	5% to 95%, non-condensing
Altitude	1000 m above mean sea level maximum
Pollution degree	2
Ingress protection class	IP20
Class of equipment	Class 1

2-3-3   Battery Environmental Specifications

Environmental specifications for the battery are provided below.

Item	Specification
Ambient operating temperature[2]	5 to 40°C
Storage temperature[1]	5 to 45°C (one month) 20 to 25°C (one year)
Humidity	5% to 95%, non-condensing
Altitude	Operation: 1000 m
Pollution degree	2
Ingress protection class	IP20

*1.   Refer to *4-8-6 Storing Batteries* on page 4-24 for more information.
*2.   Operating the AMR at high ambient temperatures, particularly with a full payload and at high speeds, may cause the battery to exceed its operating temperature limits.

2-3-4   Pendant Environmental Specifications

The Pendant has an ingress protection rating of 56.

2-4   Other Specifications

Specifications for other items are provided below.

2-4-1   Laser Specifications

Specifications for the lasers are provided below.

Item	Specification
Scanning Plane	240° field of view 190 mm from floor surface. Low Front Laser: 126° field of view 58 mm from floor surface.
Laser Class	Class 1 in accordance with the following standards: • IEC 60825-1 • CDRH 21 CFR 1040.10 • 1040.11

2-4-2   Battery Specifications

Battery specifications are provided below.

Item	Specification
Type	Lithium-ion (LifePO4)
Duty cycle (depth of discharge)	80%
Voltage	22 to 30 VDC (25.6 VDC nominal)
Output current[*1]	< 40 A (continuous) 60 A (300 ms) 80 A (8 ms)
Capacity	72 Ah nominal
Energy	1.84 kWh nominal
Recharge time	2 hrs. 10 min. for 20% to 80% charge
Life span	Approximately 2000 cycles[*2]
Weight	19 kg

*1.   Values correspond to the latest LD-series AMR battery (20452-700). Contact your local OMRON representative for older version battery specifications.

*2.   Approximately 80% of nominal battery capacity will be available after using the battery at 100% depth of discharge at temperatures between 15°C to 35°C.

2-4-3   HAPS Specifications

Specifications for HAPS are provided below.

Item	Specification
HAPS sensor depth x width	30 mm x 160 mm
Magnetic tape width x length	25 mm x 300 mm
Magnetic tape orientation	South up (markers north up)
Marker separation from tape	20 to 30 mm
Protective covering tape (recommended)	Mighty Line Safety Floor Tape, Solid (102 mm width)

2-4-4 Acuity Specifications

Specifications for the Acuity camera are provided below.

Feature	Specification
Field of View	140°
Power Input	12 VDC (±10%) supplied from platform, through power connector
Power Consumption	3.3 W maximum

2-4-5 Docking Station Specifications

Specifications for the Docking Station are provided below.

Description	Specification
Maximum input current	8 A
Maximum output current	20 A[*1]
Input voltage	100 to 240 VAC, 50/60 Hz
Output voltage	22 to 30 VDC
Power consumption	800 W
Maximum output power	600 W
Circuit Protection	Thermal circuit breaker rated at 10 A (IEC) or 15 A (UL).
Short circuit current rating (SCCR)	Fuse: 1500 A, Circuit Breaker 2000 A
Material	Aluminum sheet metal
User-supplied conductor type	Copper
Grounding class	Class 1
Power Cable	1830 mm
Battery Charging Cable	1145 mm

*1.   The AMR can also use older model docking stations that use a 10 A time-lag fuse.

2-4-6 Safety Function Performance Levels

The Performance Level (PL) calculation for safety functions of the AMR is based on the ISO 13849 standard. PL evaluation has been performed for the AMR including the pendant.
The PL achieved and the Probability of Dangerous Failure per Hour (PFHd) are calculated using SIS-TEMA as per ISO 13849-1 for the following safety functions.

Safety Function	Additional Safety Function Information	Safety Stop Type	Reset Type	PL	Category	PFHd
• Depressing the E-STOP button on the Operator Panel • Emergency stop circuit open	*4-12 Emergency Stop* on page 4-30	Emergency Stop	Manual Reset	e	3	3.4 x 10⁻⁸
User-supplied emergency stop devices	*4-12 Emergency Stop* on page 4-30	Emergency Stop	Manual Reset	e[*1]	3	3.4 x 10⁻⁸
Safety Laser Scanner detection	*4-13 Protective Stops* on page 4-32	Protective Stop	Automatic Reset	d	3	1.7 x 10⁻⁷
Forward overspeed	*4-14 Overspeed Protection* on page 4-33	Emergency Stop	Manual Reset	d	3	3.7 x 10⁻⁷

Safety Function	Additional Safety Function Information	Safety Stop Type	Reset Type	PL	Category	PFHd
Reverse overspeed	*4-14 Overspeed Protection* on page 4-33	Emergency Stop	Manual Reset	d	3	3.7×10^{-7}
Automatic battery charging	*4-8 Battery and Charging* on page 4-16	N/A	N/A	c	1	1.1×10^{-6}
Pendant (Joystick) Override	*4-16 Manual Driving* on page 4-38	Protective Stop	Manual Reset	e	3	4.6×10^{-8}
USER PWR pins 11, 12	*USER PWR* on page 3-30	Emergency Stop	Manual Reset	d	2	3.3×10^{-8}
USER INTERFACE pins 13, 14	*USER INTERFACE* on page 3-26	Emergency Stop	Manual Reset	e	3	3.3×10^{-8}

*1.   The user is responsible for calculating the overall PL and PFHd, inclusive of user-supplied components, and performing a final risk assessment.

2-4-7   Drive Train

Drive train specifications are provided below.

Description	Specification	
Drive wheels	2 gray non-marking nylon foam-filled rubber, non-conductive	
Drive wheel dimensions	195 mm diameter	
Drive wheel service life	Approximately 10,000 km	
Drive wheel motor	164 W brushless DC motor	
Casters	2 front, 2 rear, spring-loaded, conductive thermoplastic rubber on polyolefin	
Caster dimensions	75 mm diameter	
Caster service life	Approximately 5,000 km	
Brakes	30:1 gearbox	17.0 N·m minimum holding torque
	40:1 gearbox	22.6 N·m minimum holding torque
	60:1 gearbox	33.9 N·m minimum holding torque
Steering	Differential	

2-4-8   Operator Panel Screen

Operator Panel screen specifications are provided below.

Item	Specification
Display type	Color TFT backlit with 256 k colors, 88.98 mm diagonal
Resolution	320 x 240
Brightness	400 cd/m^2

2-4-9   Wireless Specifications

Wireless network specifications for the AMR are provided below.

Item	Description
Signal Strength	The minimum required signal strength is -60 dBm.

| Item	Description
Channel Interference	No more than two detectable access points at a level of -85 dBm at any given location. No more than one access point at a signal strength higher than -85 dBm at any given location.
Latency	Maximum recommended latency for round trip communication is 10 ms.
Standard	IEEE 802.11 a/b/g
Security	Encryption: TKIP/RC4/CCMP/AES Authentication: • WPA-PSK • WPA2-PSK • PEAP-MSCHAPv2 • EAP-TLS

2-4-10 Sonar Sensor Specifications

Refer to the figure below for details on the field of view for the AMR's sonar sensors.

Additional Information

The sonar sensor field of view provided below can vary depending on the obstacle surface type, shape, and orientation. Obstacles that have a large, flat, and acoustically reflective surface parallel to the rear of the AMR may be detected up to 2 m from the rear of the AMR.
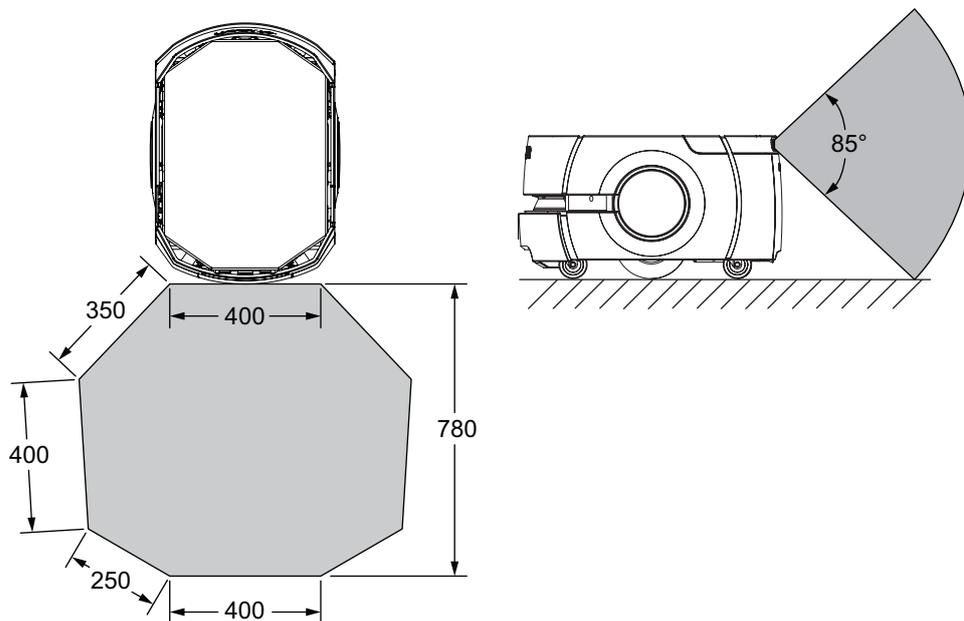
2-4-11 DIGITAL IO Connector

Electrical and other specifications for the DIGITAL IO connector are provided below.

Additional Information

Refer to *DIGITAL IO* on page 3-19 for connector signal information.

Item	Specification
AMR connector	HDB44F

2 Specifications

Item	Specification
VIN Range	0 to 30 V
Input Turn-On Voltage	> 4 V
Input Turn-Off Voltage	< 1.3 V

Digital Input Specifications

The following table describes specifications for the AMR Core's digital inputs.

Item	Value
Type	Sinking (NPN) / Sourcing (PNP)
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 (Vin/Iin)	3.9 kΩ minimum
Current at Vin = +24 VDC	Iin ≤ 6 mA[1]

*1. Input current specifications are provided for reference. Voltage sources are typically used to drive the inputs.

Digital Output Specifications

The following table describes specifications for the AMR Core's digital outputs.

Item	Value
Type	NPN / Sinking
Power supply voltage range[1]	22 to 30 VDC
Operational current range	Iout ≤ 500 mA (per signal bank)
ON state resistance (Iout = 0.5 A)	Ron ≤ 0.14 Ω @ 85°C
Output leakage current	Iout ≤ 5 µA
DC short circuit current limit	0.7 A ≤ ILIM ≤ 1.7 A

*1. Voltage level depends on battery state of charge.

2-4-12 AUX SENSORS Connector

Electrical and other specifications for the AUX SENSORS connector are provided below.

📝 **Additional Information**

Refer to *AUX SENSORS* on page 3-22 for connector signal information.

The AUX SENSORS connector a HDB15M connector.

Pin Number	Specification
4	5 VDC. 1 A current limit (shared with USB port 1)
5	20 VDC. 300 mA current limit (side lasers)
9	5 VDC. 1 A current limit (shared with USB port 2)
10	20 VDC. 300 mA current limit (side lasers)

Pin Number	Specification
14	5 VDC. 1 A current limit (shared with USB port 3)
15	20 VDC. 150 mA current limit (low front laser)

2-4-13 RS232 Connector

The RS232 connectors are DB9M types.

Additional Information

Refer to *RS232* on page 3-23 for connector signal information.

2-4-14 LIGHTS Connector

Electrical and other specifications for the LIGHTS connector are provided below.

Additional Information

Refer to *LIGHTS* on page 3-25 for connector signal information.

Item	Specification
AMR connector	Molex Mini-Fit 2 x 3 (part number 26013116)
User-supplied mating connector[1]	Molex Mini-Fit Jr. 2 x 3 receptacle (part number 39012060)
User-supplied connector pins[1]	Mini-Fit Female Crimp Terminal, Tin over Copper Plated Brass, 18-24 AWG (part number 39000039)
Maximum output current	500 mA[2]
Output voltage	22 to 30 VDC[3]

*1. Recommended user-supplied Molex components are provided. Other compatible options are available. Refer to Molex for more information.
*2. Shared with digital output common 4 (pin 37).
*3. Voltage level depends on battery state of charge.

2-4-15 USER INTERFACE Connector

Electrical and other specifications for the USER INTERFACE connector are provided below.

Additional Information

Refer to *USER INTERFACE* on page 3-26 for connector signal information.

Item	Specification
AMR connector	Molex Mini-Fit 2 x 7 (part number 39300140)
User-supplied mating connector[1]	Molex Mini-Fit Jr. 2 x 7 receptacle (part number 39012140)
User-supplied connector pins[1]	Mini-Fit Female Crimp Terminal, Tin over Copper Plated Brass, 18-24 AWG (part number 39000039)
ON, OFF, brake input voltage supply	22 to 30 VDC[2]
ESTOP maximum output current	1 A per ESTOP channel
ESTOP maximum output voltage	12 VDC
Safety output circuit	Resistive load: 4 A max. Inductive load: 500 mA max.

Item	Specification
Safety output maximum switching voltage	30 VDC
Safety output maximum switching current	1 A
Emergency stop dual-channel open circuit duration	250 ms min.

*1. Recommended user-supplied Molex components are provided. Other compatible options are available. Refer to Molex for more information.

*2. Voltage level depends on battery state of charge.

2-4-16 USER BUMP Connector

Electrical and other specifications for the USER BUMP connector are provided below.

Additional Information

Refer to *USER BUMP* on page 3-28 for connector signal information.

Item	Specification
AMR connector	Molex Mini-Fit 2 x 4 (part number 26013144)
User-supplied mating connector[1]	Molex Mini-Fit Jr. 2 x 4 receptacle (part number 39013085)
User-supplied connector pins[1]	Mini-Fit Female Crimp Terminal, Tin over Copper Plated Brass, 18-24 AWG (part number 39000039)
Rated output voltage	12 VDC
Maximum output current	10 mA

*1. Recommended user-supplied Molex components are provided. Other compatible options are available. Refer to Molex for more information.

2-4-17 AUX PWR Connector

Electrical and other specifications for the User Interface connector are provided below.

Additional Information

Refer to *AUX PWR* on page 3-29 for connector signal information.

Item	Specification
AMR connector	Molex Mini-Fit 2 x 3 (part number 26013116)
User-supplied mating connector[1]	Molex Mini-Fit Jr. 2 x 3 receptacle (part number 39012060)
User-supplied connector pins[1]	Mini-Fit Female Crimp Terminal, Tin over Copper Plated Brass, 18-24 AWG (part number 39000039)
Current limits	5 VDC: 1 A 12 VDC: 1 A 20 VDC: 1A

*1. Recommended user-supplied Molex components are provided. Other compatible options are available. Refer to Molex for more information.

*2. The total current consumed by loads at the AUX and USER PWR connector cannot exceed the limits specified in *2-4-18 USER PWR Connector* on page 2-20.

2-4-18 USER PWR Connector

Electrical and other specifications for the USER PWR connector are provided below.

Precautions for Correct Use

- Momentary current spikes that are over the thresholds specified will activate current limiting protection and cause power loss at the USER PWR connector. Simultaneous inrush loads might trip the over current protection at the battery. Use external current limiting devices to prevent transient current overload.
- Exceeding the current limit on pins 9 to 12 of the USER PWR Connector may damage components internal to the AMR Core requiring service or replacement.
- An emergency stop interrupts power output at USER PWR pins 11 and 12.

Additional Information

Item	Specification
AMR connector	Molex Mini-Fit 2 x 6 (part number 026013119)
User-supplied mating connector[1]	Molex Mini-Fit 2 x 6 receptacle (part number 39012120)
User-supplied connector pins[1]	Mini-Fit Female Crimp Terminal, Tin over Copper Plated Brass, 18-24 AWG (part number 39000039)

*1. Recommended user-supplied Molex components are provided. Other compatible options are available. Refer to Molex for more information.

Pin Number	Specification
1 to 6	Ground
7, 8	Voltage range: 22 to 30 VDC[1] 4 A max. per pin (inductive[2] / resistive)
9, 10	Voltage range: 22 to 30 VDC[1]
11, 12	5 A max. per pin[3] (inductive[2] / resistive)

*1. Voltage level depends on battery state of charge.
*2. Integrated surge suppression for inductive loads is provided on the latest generation AMR Core (15735-100). Add user-supplied surge suppression for older generation AMR Core models to protect against transient voltages.
*3. 10 A combined current limit shared across pins 9 to 12. Refer to *A-3 USER PWR Load Connection Examples (PINS 9 to 12)* on page A-7 for more information.

2-4-19 JOYSTICK Connector

The JOYSTICK connector is a DB9F type connector.

Additional Information

2-4-20 HMI PANEL Connector

The HMI PANEL connector is a HDB15F type.

> **Additional Information**
>
> Refer to *HMI PANEL* on page 3-31 for connector signal information.

2-4-21   OPT OUT Connector

The OPT OUT connector is an SPDIF type.

> **Additional Information**
>
> Refer to *OPT OUT* on page 3-32 for connector signal information.

2-4-22   ANT Connector

The ANT connector is a RP-SMAF connector.

> **Additional Information**
>
> Refer to *ANT* on page 3-32 for connector signal information.

2-4-23   AUDIO IN / AUDIO OUT Connectors

The AUDIO IN/OUT connectors are 3.5 mm type jacks.

> **Additional Information**
>
> Refer to *AUDIO IN/OUT* on page 3-32 for connector signal information.

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3

Installation

This section provides information about installing the AMR.

3-1 Installation Introduction

The general AMR installation steps are provided below.

> ### ⚠ WARNING
>
> While conducting any work on the AMR, make sure it is located on a flat, level surface with casters chocked and emergency stop active to prevent unexpected movement.

1 Install the Docking Station.

Refer to *3-2 Docking Station Installation* on page 3-4 for more information.

2 Configure the network connections.

Refer to *3-4 Network Connections* on page 3-13 for more information.

3 Install optional items.

Refer to *1-6 Optional Items* on page 1-19 for more information.

4 Attach warning labels.

Refer to *3-13 Attaching Warning Labels* on page 3-82 for more information.

5 Perform commissioning.

Refer to *3-14 Commissioning* on page 3-83 for more information.

6 Generate a map for the AMR.

Refer to *3-15 Map Creation Overview* on page 3-84 for more information.

3-2   Docking Station Installation

Make the following considerations before installing the Docking Station.

> ## ⚠ WARNING
>
> Remove the AMR from a Docking Station when conducting any installation or mainte-
> nance actions. ⊕

Precautions for Safe Use

The Docking Station must be properly secured to the wall or floor prior to operation.

- Install the Docking Station on a flat and level floor, in a location that is kept clear and is easily acces-
  sible to AMRs.
- Install the Docking Station away from forklift traffic or high traffic areas. This will prevent collisions
  between the docked AMRs and other operating vehicles in the area.
- Temporarily use the Docking Station free standing (without fasteners). Do this only for testing or ex-
  perimenting with the location of your Docking Station.
- The Docking Station must be installed near an AC outlet in a location where it allows approximately
  1-2 meters of clearance from the center of the AMR. This is to ensure safe maneuverability of the
  AMR during docking.
- Make considerations for the recommended Goal distance from the Docking Station (1500 mm) when
  choosing the installation location. Refer to *4-6-2 Docking Clearances* on page 4-12 for more infor-
  mation.

3-2-1   Mechanical Considerations

The Docking Station can be attached to a wall using the supplied mounting bracket or the floor with
user-supplied fasteners.

When fastening the Docking Station to drywall without a structural framing member available, use
heavy-duty toggle (butterfly) bolts. Do not use drywall plugs or anchors. If you do not use appropriate
fasteners, the Docking Station will move during the docking attempts and cause docking and charging
failures.

The Docking Station's charging paddle is spring-loaded to accommodate slight variations in the floor
surface. Adjustments to the charging paddle are necessary after attaching the Docking Station. Refer
to *3-2-6 Charging Paddle Alignment Procedure* on page 3-8 for more information.

The following hardware is required to fasten the Docking Station if not using toggle bolts.

Size	Qty	Description
#2	1	Cross-point (Phillips) screwdriver.
N/A	1	Docking Station wall mounting bracket (supplied with the unit).
3.175 mm (1/8 inch)	4	User-supplied toggle bolts (if not using screws into a framing mem-ber)
#10 (4.762 mm, 3/16 inch)	4	User-supplied structural screws such as decking screws (if not using toggle bolts into drywall)

Size	Qty	Description
M5 x 4	2	Stainless steel shoulder bolts and washers (supplied with the docking station.
As required	1	Appropriate screwdriver, hex socket, or driver bit for user-supplied fasteners.

3-2-2 Electrical Considerations

When connecting the power cord from a wall outlet to its mating connector on the Docking Station, ensure that the power cord connector is seated completely and secured. The power cord must be placed behind the Docking Station. It must be properly protected and must not pose any hazards to personnel or interfere with other equipment.

⚠ WARNING

If Docking Station power cords lie on the ground, you must make sure that they are highly visible to prevent tripping hazards and must be protected from physical damage with barriers or covers.

Precautions for Safe Use

Do not use power extension cords with the Docking Station unless properly rated.

Precautions for Correct Use

You must route and secure the Docking Station power cords properly. They must be secured in such a way that prevents straining of the connection points.

Additional Information

The Docking Station operates on 100-240 VAC. The station's power converter automatically detects the source voltage.

After installing the power cord, turn the power switch to ON. The power switch is next to the power plug. The blue power LED indicator should illuminate.

## 3-2-3 Attaching the Temporary Floor Plate

The supplied temporary Floor Plate is used to experiment with docking locations before permanently fastening the Docking Station.
The Docking Station and Floor Plate do not need to be attached to the floor, as the weight of the AMR on the floor plate will keep the Docking Station from moving.
The Floor Plate is not shipped attached to the Docking Station but is included in the shipping container. Use the following procedure to attach the Floor Plate.
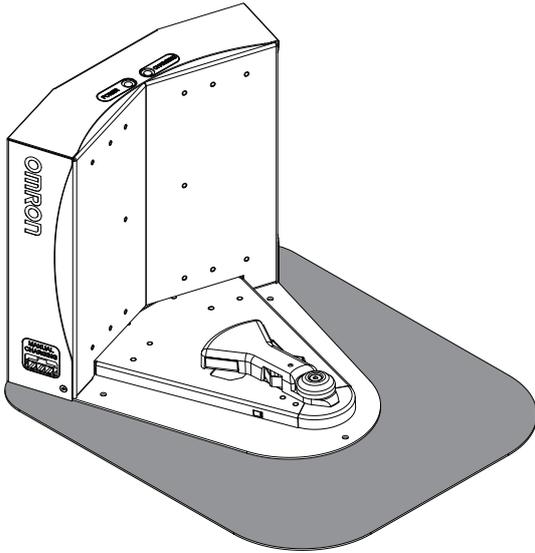
1 Tip the Docking Station onto its back, so you can access the underside.

2 Remove the two lowest screws (M4 x 12 flat-head), if present.
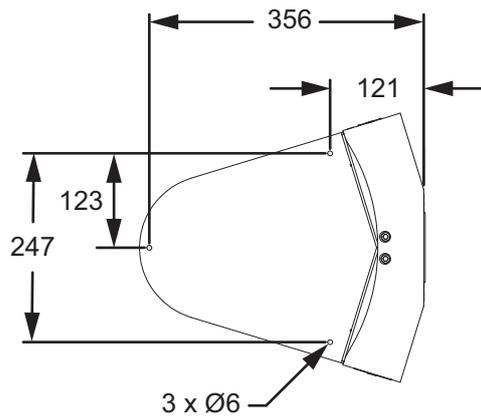Refer to the following figure for the locations of the screw holes.
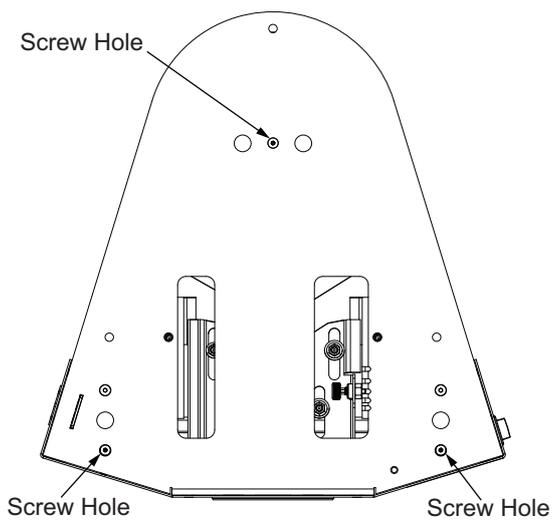
📝 **Additional Information**

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.

3 Attach the Floor Plate to the base of the Docking Station with three M4 x 12 flat-head stainless steel screws to complete this procedure.
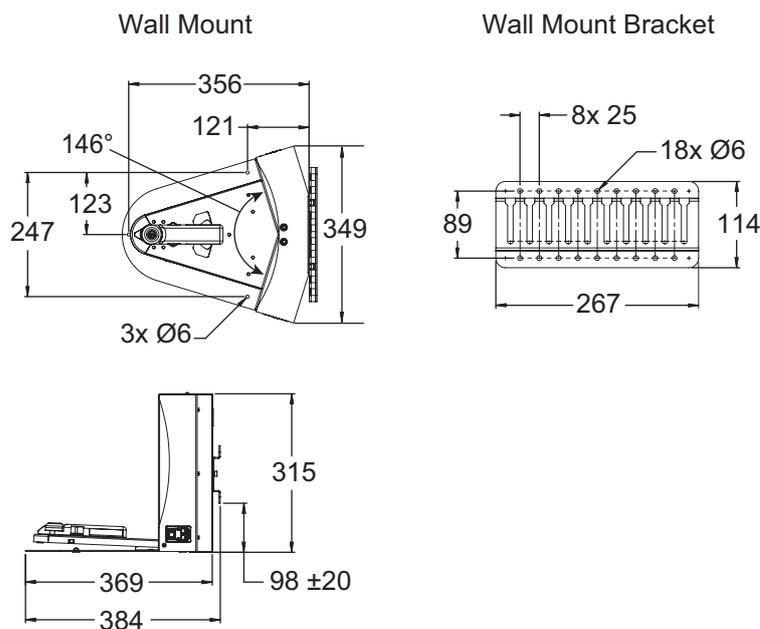
3-2-4 Attaching to a Floor

Screw the base of the docking station directly to the floor using three user-supplied screws that are adequate for the floor material type (typically M5 concrete screws).
Refer to the following figure for mounting hole placement information.

356

121

123

247

3 x Ø6

3-2-5   Attaching to a Wall

Use the following information to attach the Docking Station to the wall using the supplied mounting bracket. Refer to the following figure for dimensions and mounting hole locations.

Units: mm

Wall Mount

356

121

146°

123

247

349

3x Ø6

Wall Mount Bracket

8x 25

18x Ø6

89

114

267

315

369

98 ±20

384

1 Attach the Docking Station mounting bracket to a wall, with the bottom edge of the bracket 98 ± 20 mm above the floor, using user-supplied anchors and screws.

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.

Shoulder Bolt
Holes
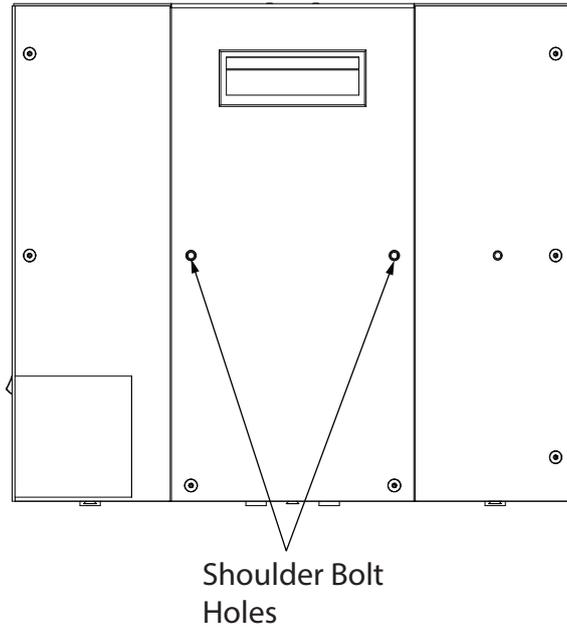
3 Lower the Docking Station down, so the two bolts on the back of the Docking Station slide into the bracket to secure the Docking Station to the wall and complete this procedure.

3-2-6   Charging Paddle Alignment Procedure

The Docking Station Charging Paddle vertical position must be checked and potentially adjusted for the correct height setting. The height must be correct to ensure that the AMR's docking funnel aligns with the Charging Paddle as it approaches the Docking Station.


Docking
Funnel
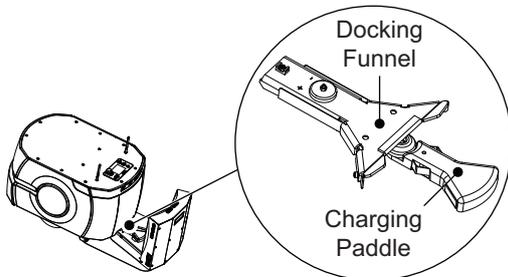
Charging
Paddle

The Charging Paddle on the Docking Station has five adjustable height settings to compensate for any floor irregularities. Each setting adjusts the tip of the Charging Paddle 4 mm in the vertical direction. The default setting is the middle position. The adjustment mechanism is located on the bottom of the Docking Station.
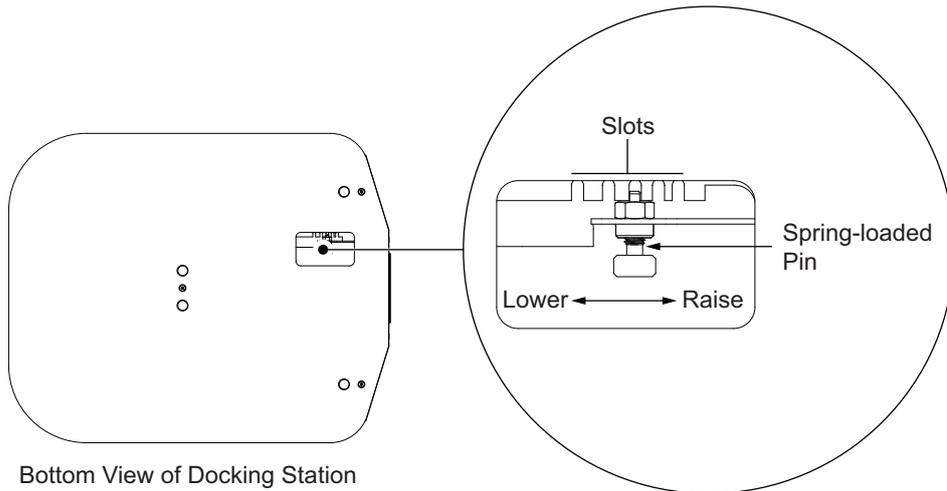
Bottom View of Docking Station

Slots

Spring-loaded Pin

Lower ← → Raise

The Charging Paddle roller height must be adjusted so that it engages with the AMR's docking funnel. If the height is too high, it will collide with the AMR docking funnel mechanism. If it is too low, the charging contacts will not mate and charging will not occur.
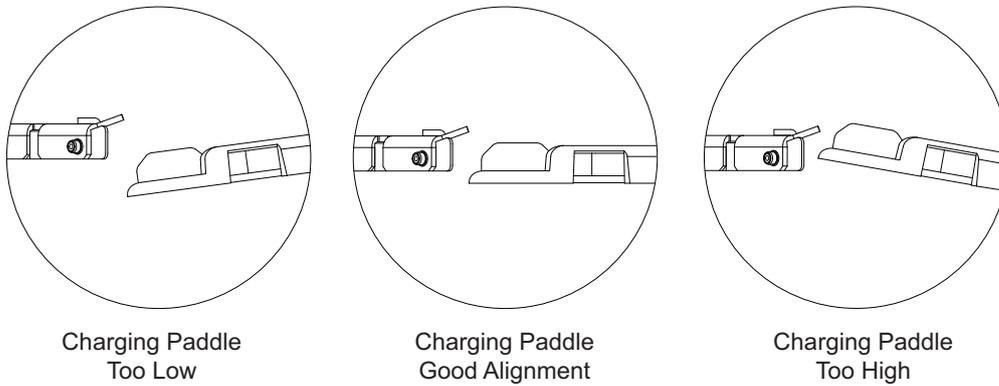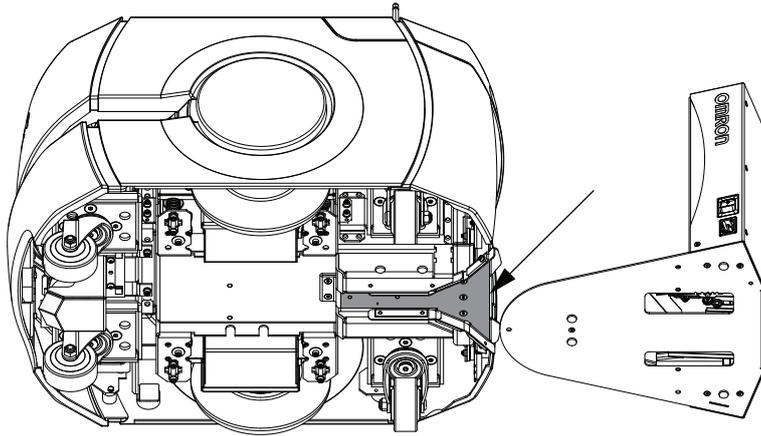

Charging Paddle
Too Low

Charging Paddle
Good Alignment

Charging Paddle
Too High

Use the following procedure to adjust the Charging Paddle for correct alignment with the AMR.
The following items must be available before beginning this procedure:

• An AMR that can be connected to a Docking Station (manually pushed or commanded to Docking Goal).
• A Docking Station at the location where it will be permanently installed.
• A distance measuring device such as a tape measure or ruler.

1 Command the AMR to a Docking Goal or push it manually to a position near the Docking Station.
Be prepared to stop the AMR before it engages with the Charging Paddle using an emergency stop button. Do not allow the AMR to engage with a misaligned Charging Paddle.

2 Stop the AMR as it approaches the Charging Paddle when it is in close proximity (50 to 100 mm from the Docking Funnel to the roller).

3 Remove the battery door skin.
Refer to *3-3 Battery Installation Procedure* on page 3-11 for more information.

4 Measure the distance from the floor to the lower surface of the docking funnel.

5 Measure the distance from the floor to the top of the Charging Paddle roller.
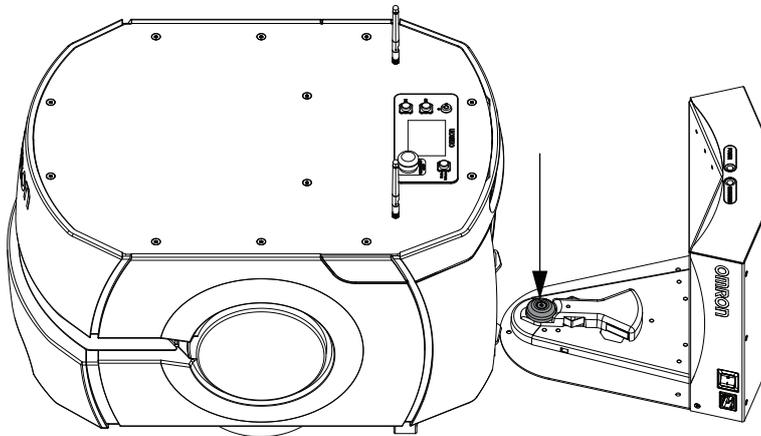
6 Set the position of the roller at a height slightly lower than the bottom surface of the docking funnel.
Use the Charging Paddle adjustment mechanism to make adjustments if necessary.
To adjust the height, pull the spring-loaded pin away from the slot, move to a new slot, and then release the pin to engage in a new slot.

7 Move the AMR away from the Docking Station and then command it or push it to the Docking Station while closely examining the alignment.
Be prepared to press an emergency stop button if alignment is not correct.
If alignment is not correct, repeat steps 4 through 7.
If alignment is correct, replace the rear skin to complete this procedure.

3-3　Battery Installation Procedure

The AMR platform comes fully-assembled except for the battery. Air shipping regulations require that the battery be shipped separately.

During the initial AMR installation and configuration, install a fully-charged battery. Follow these steps to install a battery.
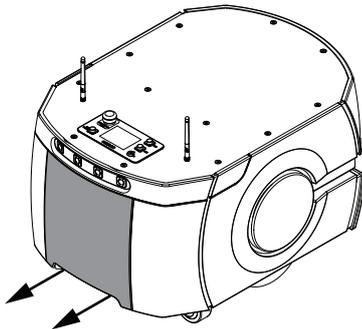
| ⚠ WARNING |
| --- |
| Replace the battery only with an OMRON factory-supplied battery intended for use in the AMR. ⚠ |

Precautions for Safe Use

Two or more people are required to lift the battery.

1 Remove the battery door skin.

Pull the bottom of the skin away from the AMR chassis. This is easiest if you grip it with two hands, toward the center.

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

2 Pull the skin downward to expose the upper retaining tab. This will free the skin completely. Set the skin aside.

3 Unlatch the battery compartment door and then swing it open.
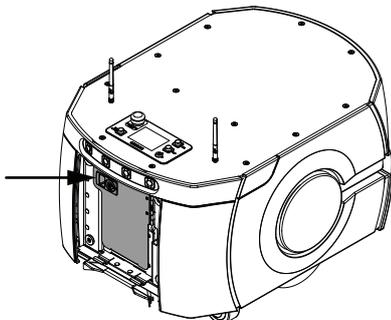
4 Lift and slide the new battery into the AMR body.

The connectors on the battery should be facing outwards towards the rear of the AMR while inserting.

The battery weighs 19 kg.

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

5 Attach the battery power and data cables to the connectors at the rear of the battery.

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

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

7 Inspect the skin retaining magnets and remove any debris that may be present.

8 Reinstall the battery door skin to completes the battery installation procedure.

3-4 Network Connections

Wireless and wired networks are available on the AMR. The wired network is typically used for initial configuration and troubleshooting. The wireless network is typically used during normal operation and can also be used for maintenance and troubleshooting. Use the information in this section to configure the network settings of the AMR.

Precautions for Correct Use

Consult your network systems administrator before changing any network settings.

3-4-1 Default Network Settings

The Maintenance Ethernet Port automatically assigns an IP address to the connected PC.

Additional Information

Access to the SetNetGo Web Interface is always enabled and accessible with the Maintenance Ethernet Port and does not require a password or a software license.

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

Item	Setting
Network Class	Class C
Netmask for all ports	255.255.255.0
Permanent Maintenance Ethernet Port IP address	1.2.3.4
Configurable user LAN port IP address	10.10.10.10
Ethernet negotiation method	Auto-MDIX
Network method	Access Point (AP)
Identifier (SSID)	Wireless Network
Security method	Unsecured

3-4-2 Wired Connection Procedure

Use the following procedure to establish a wired connection to the AMR.
Make the following considerations before beginning this procedure.

- A Cat-5 Ethernet cable is required.
- A PC with an available RJ45 Ethernet port is required.

1 Connect the Ethernet cable from the PC to the AMR Maintenance Ethernet Port.

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

ncpa.cpl

This command opens the Network Connections screen:
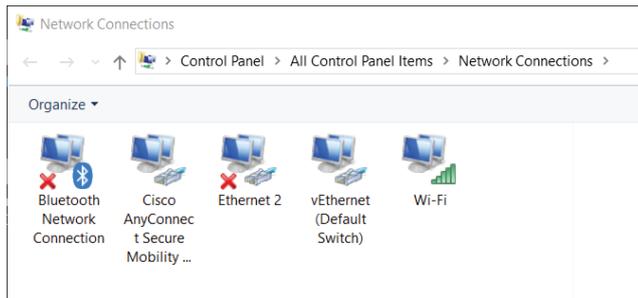
3   Right-click on the **Ethernet N** or **LAN Connection**.

4   Click **Properties**, and then double-click the **Internet Protocol Version 4** connection item to open its Properties window:
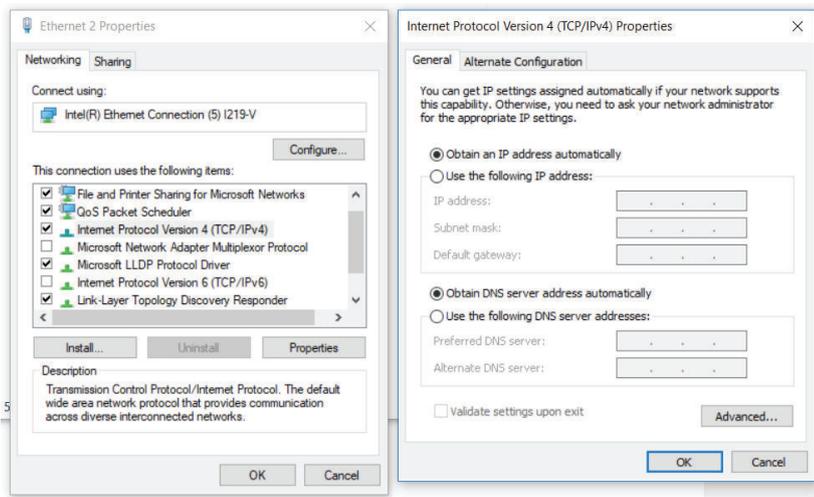
5   Click the radio button next to *Use the following IP address.*

6   Enter 1.2.3.X as the IP address and 255.255.255.0 as the Subnet mask. (Where x is any number 1 through 255 excluding 4.)

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

8   Verify the settings by opening a browser window and accessing **https://1.2.3.4**. If the settings are correct, this will display the SetNetGo web interface and complete this procedure.

3-4-3   Wireless Connection

A wireless connection is required when the AMR is operating in a workspace with other AMRs. The wireless configuration of the AMR is set using SetNetGo with one of the following methods. You must use a wired connection to access SetNetGo for the initial wireless connection configuration. Refer to *3-4-2 Wired Connection Procedure* on page 3-13 for more information.

📋 **Precautions for Correct Use**

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

- Use the SetNetGo tab in the MobilePlanner software.
- Open a Web browser on your PC and enter the URL: https://10.10.10.10 to connect directly to the SetNetGo Web Interface on the AMR.

> **Additional Information**
>
> A workspace with a single AMR can operate without a wireless network.

After accessing the SetNetGo interface, access the *Management Interface* area in the *Network* tab to enter the wireless connection network data.

Use the following table as a worksheet to collect all necessary information before configuring the wireless settings.

Item	Details	
Static IP Address for the AMR		
Netmask		
Gateway		
DNS Server		
SSID for the AMR Network		
Mode for the network	Infrastructure	
Radio Mode	Auto (802.11a/b/g Only)	802.11b/g
Channel Set		
Wireless Watchdog IP Address		
Authentication Method	OPEN (not recommended	
	WPA2-PSK	Key is either: Passphrase (8-63 ASCII only) Raw Hex (64 Hex-only)
	WPA-PSK	Key is either: Passphrase (8-63 ASCII only) Raw Hex (64 Hex-only)
	PEAP-MSCHAPv2	• Username: • Password: • Private key: • Download or Create New • Private key length: 1024 or 2048 bit Hostname: • Upload certificate: • Certificate password (if needed): • Validate Server Certificate:
	EAP-TLS	• Username: • Password: • Private key: • Download or Create New • Private key length: 1024 or 2048 bit Hostname: • Upload certificate: • Certificate password (if needed): • Validate Server Certificate:

3-4-4　Wireless Considerations

It is recommended to use wireless network industry best practices. Always conduct a comprehensive workspace survey and test your wireless service before AMR configuration and operation begins. Make the following considerations when the AMR is communicating with a wireless network. Refer to *2-4-9 Wireless Specifications* on page 2-15 for more information.

Signal Availability and Type

The wireless network should provide constant service throughout the workspace. Make the following considerations when choosing a wireless network type and ensuring signal availability.

- If you have an AMR fleet, constant access is an operational requirement. For a single or segregated AMR's, partial signal coverage might be acceptable in workspace areas where you do not need to send commands or receive status from the AMR.
- A signal strength of > -40 dBm is the ideal wireless signal strength. A signal strength of -60 dBm is the recommended minimum.
- Do not obstruct the wireless antenna areas with metal or other objects that can degrade the signal. Refer to *1-2 Features and Components* on page 1-5 for more information about the location of wireless antennas.
- Choosing a 2.4 GHz network versus a 5 GHz network will depend on workspace survey and analysis results to account for factors such as existing frequencies, interference, or other objects that can reduce signal strength and coverage.

A low quality wireless connection can cause problematic AMR behavior, such as:

- Unintended behavior may occur if Fleet Manager parameter edits are made while an AMR is not connected.
- Increased network traffic due to packet retransmission.
- Frequent disconnections may lead to an AMR failing to reconnect, requiring user intervention.
- Network packet loss leading to unexpected behavior, such as failure to perform Jobs or failure to move to a Goal.
- AMRs may collide when they are operating in close proximity.

Bandwidth

All devices that access a Wireless network consume its bandwidth. The greater the number of AMR's in your fleet, the more wireless resources they consume.

> **Additional Information**
>
> - Refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information about wireless resources.
> - The bandwidth usage varies by application. Payload accessories might affect your bandwidth requirements if they stream data through the AMR's wireless interface.

Use a dedicated network to restrict wireless network access to AMRs and use security to prevent other devices from accessing the network.

Typical bandwidth consumption for a fleet is an average 50 Kbps per AMR. This increases when you connect multiple AMR's to a Fleet Manager and actively manage them with MobilePlanner. Bandwidth consumption might increase or decrease depending on the types of commands and debugging tools

that you enable in MobilePlanner. Downloading Debug Info Files and viewing log files on SetNetGo are other examples of functions that may increase bandwidth usage.

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

Port Forwarding

User-added devices have the ability to communicate over the AMR's wireless signal. Devices connected to the following ports on the Mobile Robot Core can exchange information through port forwarding:

- LAN 2
- RS-232

The AMR's Core allows TCP and UDP port forwarding over the LAN 2 interface. This enables wireless access to onboard Ethernet devices, including OMRON Sysmac Machine Automation Controllers (MACs) and other Programmable Logic Controllers (PLCs). Through the controller, devices connected to the AMR's DIGITAL I/O can be written to and read.

Serial devices can also be reached using port forwarding over the RS-232 interface.

For information on choosing a mode for the LAN 2 interface, as well as configuring port forwarding, refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.

3-5 Electrical Connections

Use the following information to understand the AMR's electrical connections.

3-5-1 Payload Bay Connections

Use the following information to make all necessary payload bay connections.

> 📝 **Additional Information**
>
> Refer to *2-4 Other Specifications* on page 2-13 for more information on payload bay connector and electrical specifications.

AMR Core connections available to the user are accessible in the payload bay under the AMR's Top Plate. The payload bay provides load-bearing mechanical connection points and access to data and signal (I/O) and electrical power connections.

The connections described in the following sections are available for use with standard options and user-supplied accessories. The AMR ships with dual antennas that can be relocated if necessary. If relocating the antenna, make sure that they are not in a position that might attenuate the WiFi signal. The following figure shows the AMR Core front connections.
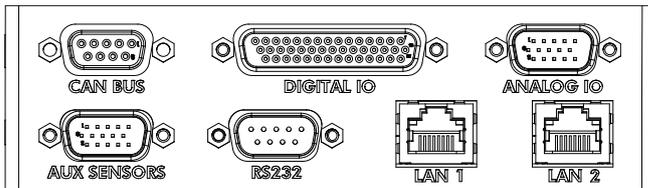
The following figure shows the AMR Core rear connections.
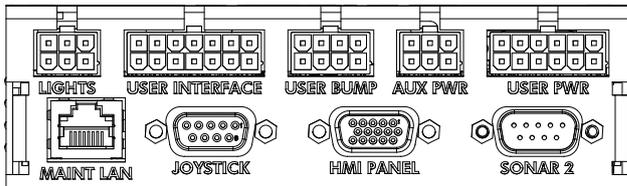
The following figure shows the AMR Core side connections.
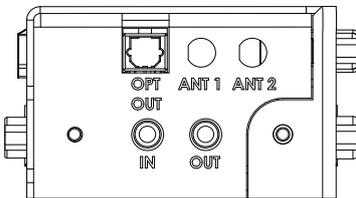
CAN BUS

The CAN BUS connector on the AMR Core is reserved for future use.

DIGITAL IO

The DIGITAL IO connector on the AMR Core provides digital inputs and outputs, typically used for payload control. Use the information below to understand all DIGITAL IO connections.

The connector consists of 16 digital inputs and 16 digital outputs. The inputs are arranged in 4 banks of 4. Each bank can be wired as sinking (NPN) or sourcing (PNP) depending on the connection of the Signal Bank Common terminals on pins 5, 10, 15, and 20. The output is a single bank of 16 wired as sinking (NPN).

Additional Information

Refer to *2-4-11 DIGITAL IO Connector* on page 2-16 for connector information and other specifications.

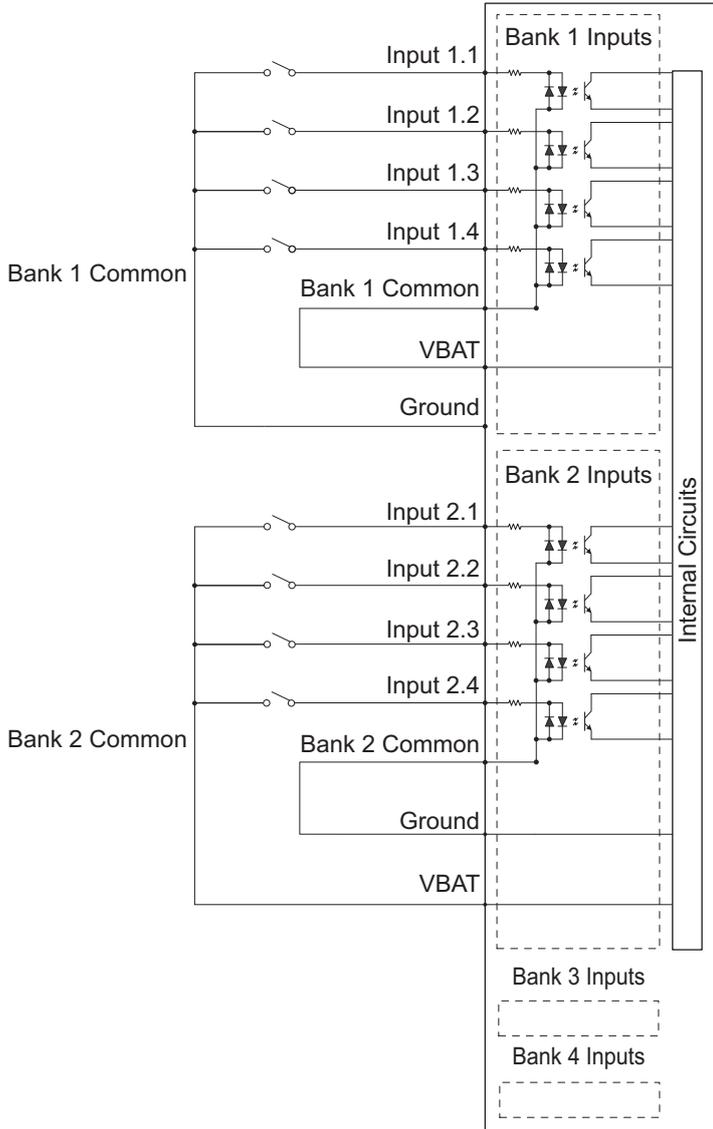The following figure shows the pin arrangements for the DIGITAL IO connector on the AMR.
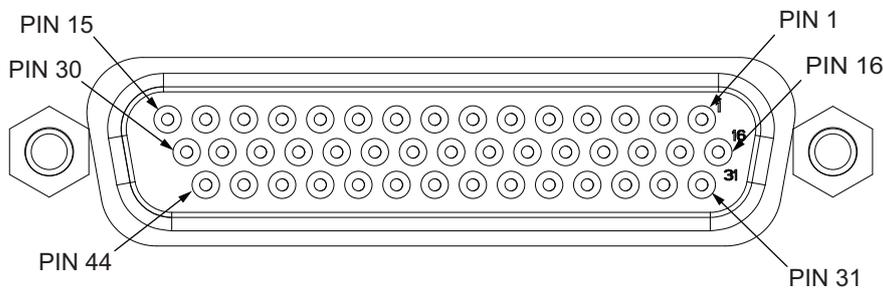
● Inputs

The information in the table below describes the input signal designations for the DIGITAL IO connector.

Pin Number	Designation	Details
1	Input 1.1	Input Signal Bank 1
2	Input 1.2	
3	Input 1.3	
4	Input 1.4	
5	Signal Bank 1 Common	
6	Input 2.1	Input Signal Bank 2
7	Input 2.2	
8	Input 2.3	
9	Input 2.4	
10	Signal Bank 2 Common	
11	Input 3.1	Input Signal Bank 3
12	Input 3.2	
13	Input 3.3	
14	Input 3.4	
15	Signal Bank 3 Common	
16	Input 4.1	Input Signal Bank 4
17	Input 4.2	
18	Input 4.3	
19	Input 4.4	
20	Signal Bank 4 Common	

The following diagram provides details about input wiring for banks of inputs. Bank 1 is shown with a Sinking (NPN) wiring scheme and Bank 2 is shown with a Sourcing (PNP) wiring scheme.
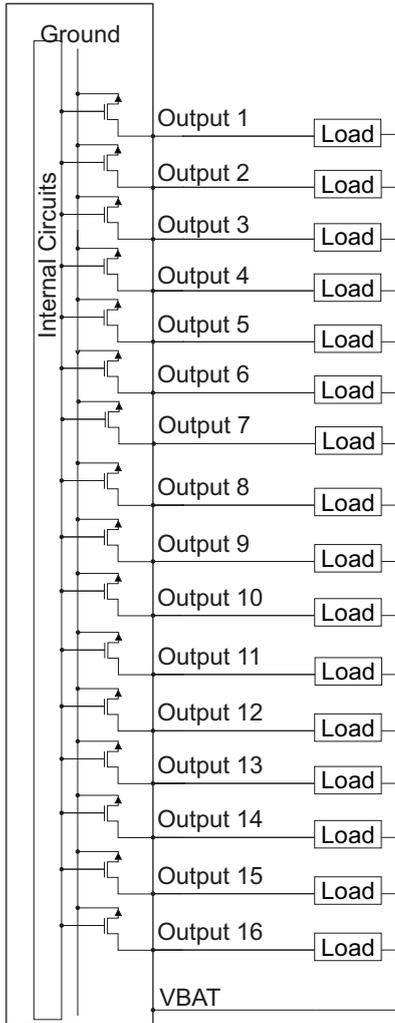

● **Outputs**

The information in the table below describes the output signal designations for the DIGITAL IO connector.

Pin Number	Designation	Details
21	Output 1	Outputs
22	Output 2	
23	Output 3	
24	Output 4	
25	Output 5	
26	Output 6	
27	Output 7	
28	Output 8	
29	Output 9	
30	Output 10	
31	Output 11	
32	Output 12	
33	Output 13	
34	Output 14	
35	Output 15	
36	Output 16	
37	Output Common 4[*1, *2]	500 mA max.
38	Output Common 3[*1]	500 mA max.
39	Output Common 2[*1]	500 mA max.
40	Output Common 1[*1]	500 mA max.
41 - 44	Ground	

*1. Varies with battery voltage. Refer to *2-4-2 Battery Specifications* on page 2-13 for more information.
*2. Shared with LIGHTS connector Pin 4.

The diagram below shows a typical example of a digital output wiring setup for the NPN / Sinking outputs.

ANALOG IO

The ANALOG IO connector on the AMR Core is reserved for future use.

AUX SENSORS

The AUX SENSORS connector on the AMR Core provides circuits used by the Low Front Laser and optional Side Lasers. Use the information below to understand all AUX SENSORS connections.

📝 **Additional Information**

Refer to *2-4-12 AUX SENSORS Connector* on page 2-17 for connector type and specifications.

The following figure shows the pin arrangements for the AUX SENSORS connector on the AMR.
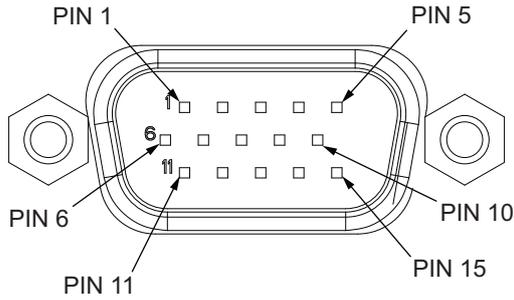
The information in the table below describes the signal designations for the AUX SENSORS connector.

Pin Number	Designation	Details
1	TXD Side Laser 1	/dev/ttyUSB5
2	TXD Side Laser 2	/dev/ttyUSB6
3	TXD Low Laser	/dev/ttyUSB7
4	5 VDC	USB Port 1
5	20 VDC	Side Lasers
6		
7	GND	
8		
9	5 VDC	USB Port 2
10	20 VDC	Side Lasers
11	RXD Side Laser 1	/dev/ttyUSB5
12	RXD Side Laser 2	/dev/ttyUSB6
13	RXD Low Laser	/dev/ttyUSB7
14	5 VDC	USB Port 3
15	20 VDC	Low Laser

RS232

The RS232 connector on the AMR Core provides communications for peripheral devices such as HAPS sensors. The single RS232 connector on the AMR Core provides two channels of serial communications as described below.

These ports can also be used for port forwarding from other RS232 devices. Refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.

Additional Information

- Serial communication settings can be accessed in the SetNetGo interface.
- A optional cable (part number 24010-00F) connected to the AMR Core splits these two serial communication channels into separate DB9 connectors in a similar arrangement to legacy AMR Core configurations. Refer to *Legacy Core RS232 Connector Arrangement* on page 3-24 for more information.
- Refer to *2-4-13 RS232 Connector* on page 2-18 for connector information.

Use the information below to understand all RS232 connector signals.
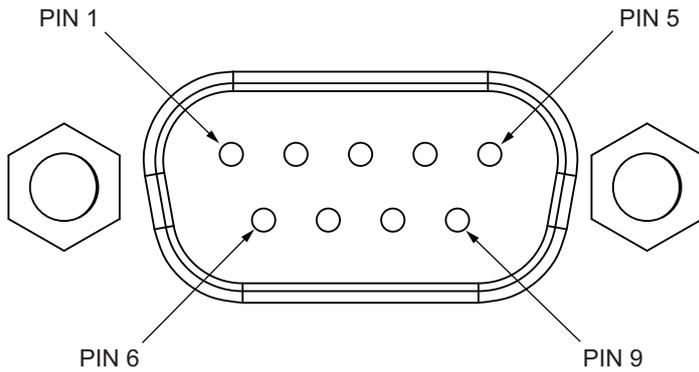
Pin Number	Designation	Communication Channel
3	TXD	RS232-1
2	RXD	
7	RTS	
8	CTS	
1	TXD	RS232-2
6	RXD	
4	RTS	
9	CTS	
5	Ground	

● **Legacy Core RS232 Connector Arrangement**

The following figure shows the RS232-1 and RS232-2 connector pin arrangements when the optional RS232 splitter cable is connected (part number 24010-000F). This optional cable provides two RS232 ports similar to legacy AMR Core connectors.
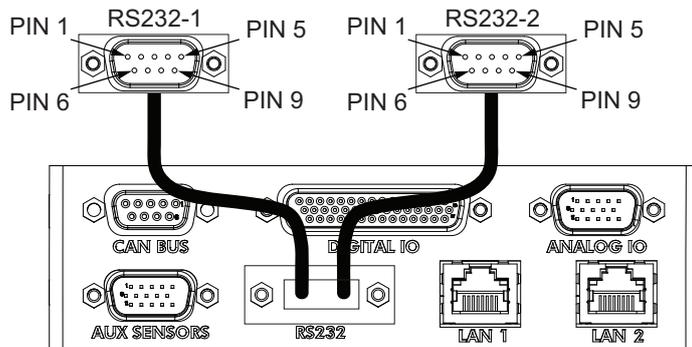
The information in the table below describes the signal designations for the RS232-1 and RS232-2 connector pins.

Pin Number	Designation
1	- - -
2	RXD
3	TXD
4	- - -
5	Ground
6	- - -
7	RTS
8	CTS
9	- - -

LAN 1

The LAN 1 connector on the AMR Core is reserved for future use.

LAN 2

The LAN 2 connector on the AMR Core is a general purpose, shielded, Auto-MDIX Ethernet port. It provides Ethernet connections for peripheral devices on a user LAN.

LIGHTS

The LIGHTS connector on the AMR Core provides outputs for user-supplied signaling devices such as signal beacons or buzzers.
Use the information below to understand all LIGHTS connections.

Precautions for Safe Use

When making any changes or connections to the buzzer or light discs, refer to application safety standards for your locale and confirm correct operation.

Additional Information

Refer to *2-4-14 LIGHTS Connector* on page 2-18 for connector information and other specifications.

The following figure shows the pin arrangements for the LIGHTS connector on the AMR.
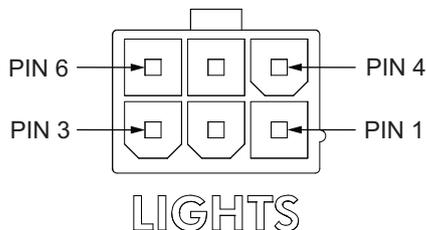
The information in the table below describes the signal designations for the LIGHTS connector.

Pin Number	Designation
1	Ground
2	Red light
3	Yellow light
4	22 to 30 VDC[*1]
5	Green light
6	Buzzer[*2]

*1. 500 mA max. shared with Digital Output circuit. Voltage level depends on battery state of charge.

*2. The buzzer signal will turn ON when the AMR warning buzzer turns ON.

USER INTERFACE

The USER INTERFACE connector on the AMR Core provides circuits for connecting various user-supplied control devices. A jumper must be present between pins 4, 11, and 5, 12 if user-supplied emergency stop devices are not used. Use the information provided below to understand the signals provided by the USER INTERFACE connector.

> ## ⚠ WARNING
>
> If any user-supplied emergency stop devices are added to the system, you must perform Safety Commissioning to verify proper operation. ❗

Precautions for Safe Use

The emergency stop or protective stop devices you install on the AMR must have a dual channel circuit to ensure the same performance level as the other safety devices of the AMR.

Precautions for Correct Use

The AMR safety circuit must have continuity on both safety channels in order for the AMR to operate.

Additional Information

Refer to *2-4-15 USER INTERFACE Connector* on page 2-18 for connector information and other specifications.

The AMR Core requires either of the following attached to the E-STOP port on the USER INTERFACE connector:

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

The following figure shows the pin arrangements for the USER INTERFACE connector on the AMR.
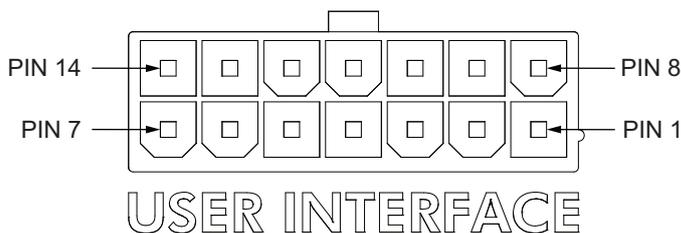
The information in the table below describes the signal designations for the USER INTERFACE connector.

Pin Number	Item	Description
1	22 to 30 VDC[*1]	For use with ON, OFF, Brake button inputs
2		
3		
4	Emergency stop channel 1 input[*2]	Dual-channel emergency stop circuit inputs. Monitored for simultaneous switching within 448 ms. Refer to *4-12 Emergency Stop* on page 4-30 for more information.
5	Emergency stop channel 2 input[*2]	

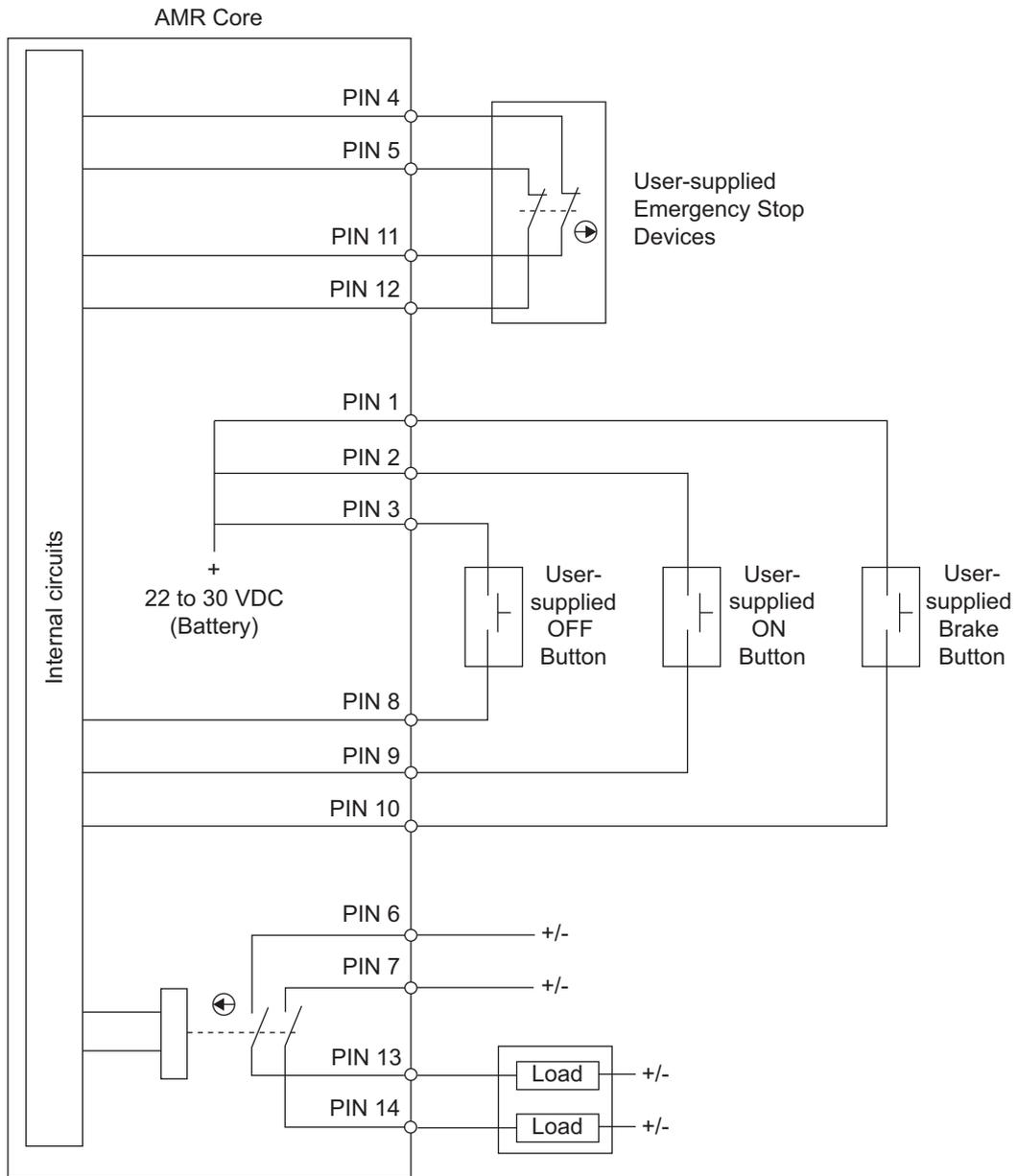| Pin Number	Item	Description
6	Safety circuit channel 1 output low side[*3]	Dual channel safety rated outputs to provide control of external systems. Channels are switched simultaneously within 100 ms of each other; and checked for proper state.
7	Safety circuit channel 2 output low side[*3]	
8	Off button input	Used for additional user-supplied OFF button.
9	On button input	Used for additional user-supplied ON button.
10	Brake button input	Used for additional user-supplied brake button.
11	Emergency stop channel 1 output	Dual channel emergency stop circuit outputs. Refer to *4-12 Emergency Stop* on page 4-30 for more information.
12	Emergency stop channel 2 output	
13	Safety circuit channel 1 output high side[*3]	Dual channel safety rated outputs to provide control of external systems. Channels are switched simultaneously within 100 ms of each other; and checked for proper state.
14	Safety circuit channel 2 output high side[*3]	

*1.   Voltage level depends on battery state of charge.

*2.   Open circuit duration must be at least 250 ms.

*3.   Internal switched contacts have current and power limitations. Refer to *2-4-15 USER INTERFACE Connector* on page 2-18 for more information.

● **E-STOP Operational Considerations**

The user-supplied emergency stop devices must be normally closed. An open circuit will trigger an emergency stop. A circuit diagram is provided below.

AMR Core

PIN 4

PIN 5

User-supplied
Emergency Stop
Devices

PIN 11

PIN 12

PIN 1

PIN 2

PIN 3

Internal circuits

+
22 to 30 VDC
(Battery)

User-supplied OFF Button

User-supplied ON Button

User-supplied Brake Button

PIN 8

PIN 9

PIN 10

PIN 6   +/-

PIN 7   +/-

PIN 13   Load   +/-

PIN 14   Load   +/-

USER BUMP

Use the information below to understand all USER BUMP connections.

⚠ WARNING

The USER BUMP connector is not safety-rated and is not connected to the emergency stop circuit.

⚠

📝 Additional Information

Refer to *2-4-16 USER BUMP Connector* on page 2-19 for connector information and other specifications.

The USER BUMP connector on the AMR Core provides 6 circuits for optional user-supplied payload structure bumpers. These circuits are used to add front left, center, and right sensors, and rear right, center, and left sensors.

When the Bumper output signal is connected to a Bumper input, the AMR will stop. A normally open contact should be used to activate individual bumper signals.

These signals are not safety-rated. If a bumper detects an obstacle, the AMR triggers a protective stop, waits two seconds, and then resumes operation under the following conditions:

• The object which the bumper originally detected is no longer detected.
• No other obstacles are detected by the AMR's main laser and it can maneuver safely.

The following figure shows the pin arrangements for the USER BUMP connector on the AMR.
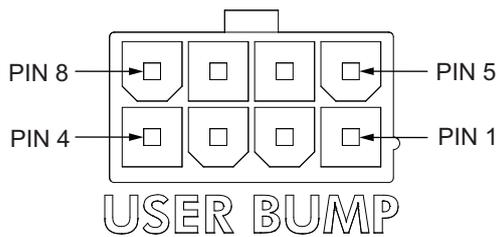
The information in the table below describes the signal designations for the USER BUMP connector.

Pin Number	Designation	Description
1	Bumper input 1	Front left bumper sensor.
2	Bumper input 2	Front center bumper sensor.
3	Bumper input 3	Front right bumper sensor.
4	Bumper input 4	Rear right bumper sensor.
5	Bumper input 5	Rear center bumper sensor.
6	Bumper input 6	Rear left bumper sensor.
7, 8	Bumper output	12 VDC

AUX PWR

The AUX PWR connector on the AMR Core provides auxiliary power outputs.

Use the information below to understand all AUX PWR connections.

⚠ CAUTION

Never connect electric loads directly to the battery bypassing protective circuits.
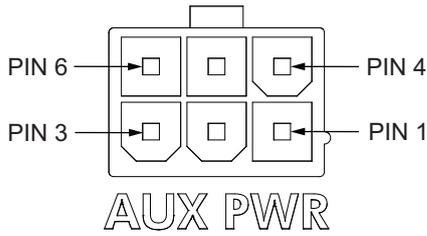
Additional Information

Refer to *2-4-17 AUX PWR Connector* on page 2-19 for connector information and other specifications.

The following figure shows the pin arrangements for the AUX PWR connector on the AMR.

The information in the table below describes the signal designations for the AUX PWR connector.

Pin Number	Designation
1, 2, 3	GND
4	5 VDC
5	12 VDC
6	20 VDC

USER PWR

The USER PWR connector on the AMR Core provides unregulated battery power, usually used for payload structure devices. High loads connected to this circuit may significantly impact AMR run time. Use the information below to understand all USER PWR connections.

⚠ CAUTION

Never connect electric loads directly to the battery bypassing protective circuits.

Precautions for Correct Use

- Momentary current spikes that are over the thresholds specified will activate current limiting protection and cause power loss at the USER PWR connector. Simultaneous inrush loads might trip the over current protection at the battery. Use external current limiting devices to prevent transient current overload.
- Exceeding the current limit on pins 9 to 12 of the USER PWR Connector may damage components internal to the AMR Core requiring service or replacement.
- An emergency stop interrupts power output at USER PWR pins 11 and 12.

Additional Information

Refer to *2-4-18 USER PWR Connector* on page 2-20 for connector information and other specifications.

The following figure shows the pin arrangements for the USER PWR connector on the AMR.
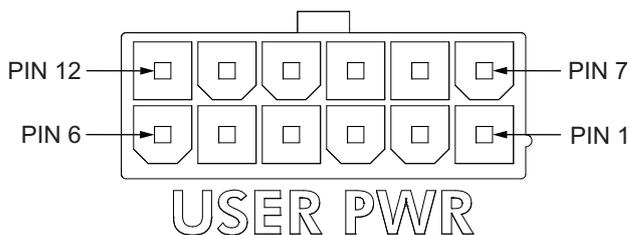
The information in the table below describes the signal designations for the USER PWR connector.

Pin Number	Description	Software Control
1 to 6	Ground	
7	Battery output 1.	Switchable in software: Battery_Out_1
8	Battery output 2.	Switchable in software: Battery_Out_2
9, 10	Battery output 3 and 4.	Switchable in software: Battery_Out_3_and_4
11, 12	Battery output 5 and 6. Turns OFF using dual-channel relays when emergency stop activated.	

MAINT LAN

The MAINT LAN connector is available for configuration and troubleshooting with a PC that is directly connected with a pass-through or cross-over CAT5 (or better) Ethernet cable.

The MAINT LAN connector on the AMR Core is also directly connected to the externally-mounted Maintenance Ethernet port.

This port should only be used as a single connection point. Do not connect the MAINT LAN connector or Maintenance Ethernet port directly to your LAN.

Precautions for Safe Use

Always follow best practices for proper grounding and anti-static methods before connecting or touching the MAINT LANor Maintenance Ethernet port. The Core may be damaged if an electrostatic discharge occurs at these ports.

JOYSTICK

The JOYSTICK connector on the AMR Core is directly connected to the externally-mounted Pendant port.

Additional Information

Refer to *2-4-19 JOYSTICK Connector* on page 2-20 for connector information.

HMI PANEL

The HMI PANEL connector on the AMR Core provides circuits for the Operator Panel.

Additional Information

Refer to *2-4-20 HMI PANEL Connector* on page 2-20 for connector information.

SONAR2

The SONAR2 DB9F connector on the AMR Core is reserved for future use.

OPT OUT

The OPT OUT connector is an isolated audio connector, and can be used to output sound or expand the existing speaker system with less noise than the analog IN/OUT connectors.

Additional Information

Refer to *2-4-21 OPT OUT Connector* on page 2-21 for connector information.

ANT

The ANT connectors on the AMR Core provide threaded ports for WiFi antennas.
Wireless antennas may need to be relocated from the factory installed position to new locations if the payload interferes with the signal. A Wireless Antenna Extension Kit is available (part number 68955-000).

Additional Information

- Refer to *3-12 Wireless Antenna Relocation Procedure* on page 3-81 for more information.
- Refer to *2-4-22 ANT Connector* on page 2-21 for connector information.

AUDIO IN/OUT

The AUDIO IN/OUT connectors on the AMR Core allows audio to be recorded through a microphone connected to the AUDIO IN port, using the ARAM function *record-soundfile*. AUDIO OUT can be used to output sound or expand the existing speaker system.

Additional Information

Refer to *2-4-23 AUDIO IN / AUDIO OUT Connectors* on page 2-21 for connector information.

3-6 Attaching the Payload

Use the information in this section to understand design considerations and other factors for attaching a payload to the AMR.

3-6-1 Payload Structure Mounting Points

Several mounting points are provided for various payload structure designs. These mounting points allow you to adjust and position your payload in relationship to the AMR's center of gravity. Refer to *2-2-4 Payload Center of Gravity* on page 2-6 for more information.

⚠ CAUTION

Do not exceed the torque limit when attaching your payload structure to the mounting point self-clinching nuts.

🚫

◁ Precautions for Safe Use

Payloads or payload structures must be fastened to the AMR with the mounting locations described in this document.

Make the following considerations when using payload structure mounting points.
- Use mounting screws appropriate for the mass of your payload.
- Ensure that the mechanical connection points as well as the electrical connections are conveniently accessible.
- Provide access to the payload bay for serviceability.
- Take care to avoid damaging any cabling between your payload structure and the AMR. Provide adequate slack in all cables, or include connectors.

Mounting points are arranged in a longitudinal and transverse pattern on Upper and Lower Mounting Surfaces. The Lower Mounting Surface is 40.7 mm below Upper Surface

Mounting points consist of both M5 and M6 self-clinching nuts.

📝 Additional Information

- All of the M5 self-clinching nuts have a torque limit of 5 N-m.
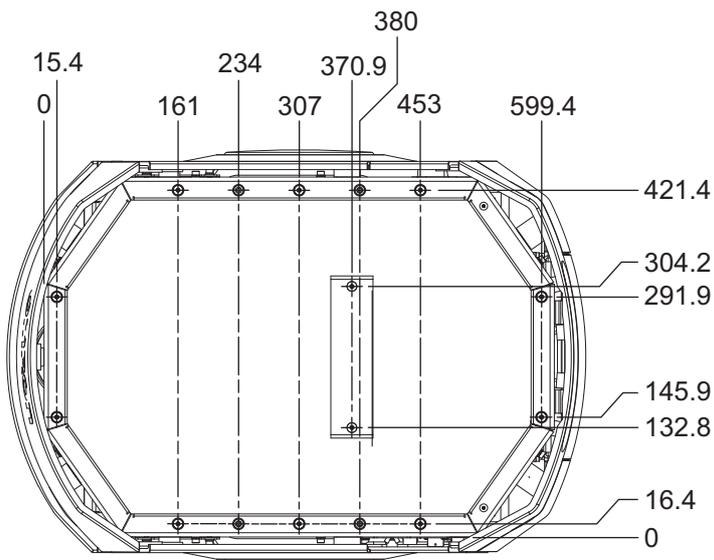- All of the M6 self-clinching nuts have a torque limit of 3 N·m.

The figure below shows the location of lower mounting points with M5 self-clinching nuts.
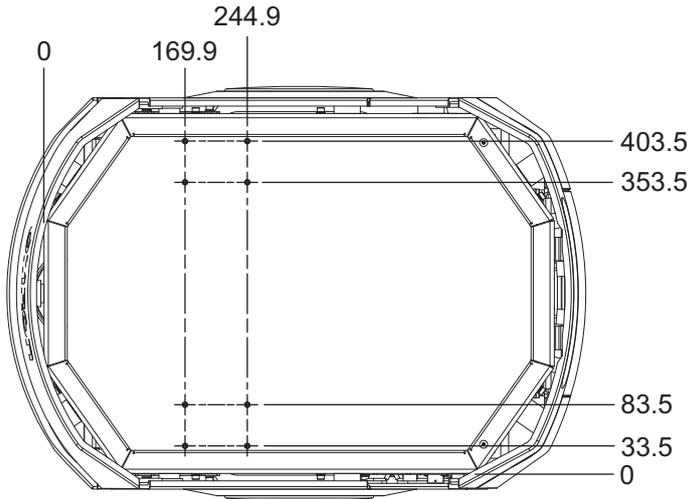
The figure below shows the location of lower mounting points with M6 self-clinching nuts.
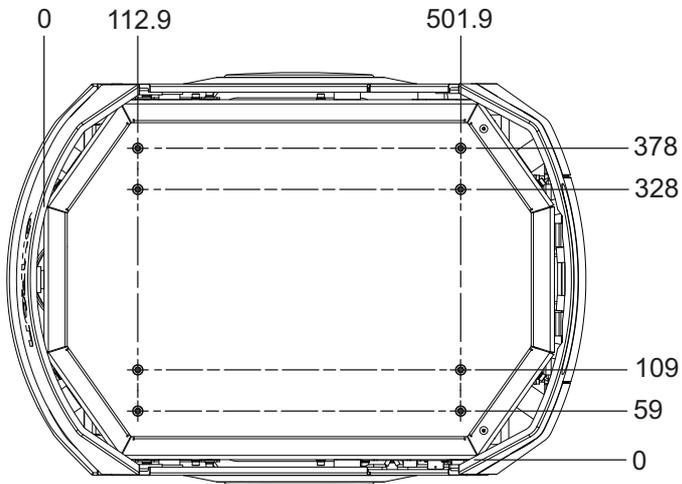
The figure below shows the location of upper mounting points with M6 self-clinching nuts.

3-7　Relocating the Operator Panel

Some applications may require relocating the Operator Panel if a payload structure obstructs it. The Operator Panel can be removed and relocated to a convenient location, typically on the payload structure.

If the Operator Panel is not needed, it can be removed. A jumper plug (part number 13387-000) is supplied with the AMR for use in this case. Use the jumper plug on the Operator Panel cable in place of the removed Operator Panel. This allows the AMR to operate without the Operator Panel's emergency stop button in place.

⚠ WARNING

If the Operator Panel is removed, there must be a user-supplied emergency stop button connected to the safety circuit.

Refer to *Operator Panel Dimensions* on page 2-4 for more information about Operator Panel dimensions.

Refer to *USER INTERFACE* on page 3-26 for more information about connecting devices to control the ON, OFF, and Brake functions.

3-8 Adding Additional Object Detection Sensors

The following sections provide details about side laser installation and other configuration requirements.

Adding additional side lasers is the most common solution for detecting objects that are not visible with the standard onboard sensors. Other sensor positions and orientations are also supported.

3-8-1 Installation

Prior to mounting the laser, the following points should be considered:

- The mounting location and angle must be appropriate for proper functionality.
- The lasers must be mounted in an orientation so that their sensing planes are vertical and parallel to the floor. The front of the lasers must not be aimed towards the ceiling or floor; this may result in false object detection.
- The cable routing should be such that it prevents cable abrasion, binding, or other strain.
- The laser guard has adequate clearance.

> **Additional Information**
>
> When mounting the lasers to a payload structure, custom brackets or optional brackets from the laser manufacturer may be required.

The dimensions (in mm) for the side laser assembly are provided below:
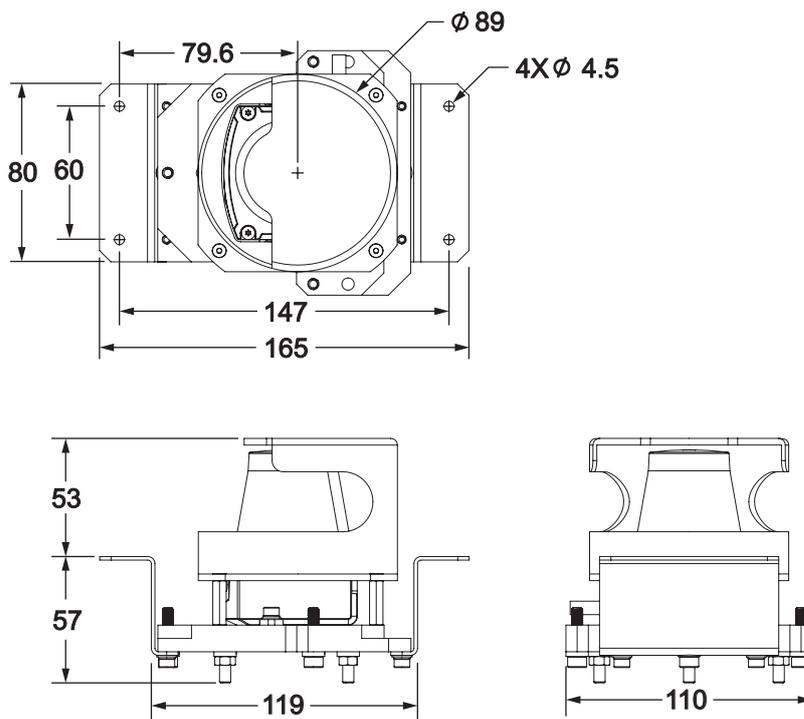
Listed below are the tools required for mounting the side laser assembly:

- 3.3 mm drill bit

• 3 mm hex key

Install the lasers as follows:

1 At the mounting location, create holes spaced at the proper distance for the mounting plates on each side.

2 Create holes for the laser guards to be installed. Ensure the position of the holes is such that the laser guards can be installed over the lasers without obstructing the sensing area.

3 Install the lasers using the provided M4 hex screws, applying a torque of 1 N-m.

4 Install the laser guards over the lasers using the provided M4 screws, applying a torque of 1 N-m.

5 Remove all necessary components to access the AMR Core. Detailed instructions for this procedure can be found in the AMR User's Manual.

6 Connect the provided cable to the Aux Sensor port on the AMR Core, if it was not previously installed.

7 Route the other ends of the cable to each side laser, as well as the low laser, and use cable ties to keep the cable clear of moving parts. Allow enough slack for removing the payload structure.

3-8-2 Configuration

This section covers configuration of the side lasers.

Initial Configuration

Configure the lasers as follows:

1 Open MobilePlanner and connect to the AMR.

2 Click on the AMR's **Configuration** tab, and enable *Show Expert Parameters*.

3 Click to expand **Robot Physical**. Ensure the value of *MaxNumberOfLasers* is set to a minimum of four lasers.

4 Under *Laser_3* (right) and *Laser_4* (left), configure the following parameters:
   1) *LaserAutoConnect*: Enable the option.
   2) *LaserType*: Select **tim3XX**.
   3) *LaserPortType*: Select **serial**.
   4) *LaserPort*: Type in */dev/ttyUSB5* for *Laser_3* and */dev/ttyUSB6* for *Laser_4*.
   5) *LaserPowerOutput*: Type in *Vertical_Laser_Power*.

6) *LaserFlipped*: Enable the option for the left laser only.

7) *LaserIsTilted*: Enable the option if the lasers are being used for vertical object detection.

8) *LaserTiltedNegativeSensor*: Disable the option if *LaserIsTilted* is enabled.

5   Save the configuration and wait for the AMR to reboot.

6   Open the workspace map and verify the laser readings.

Position & Orientation

To further configure the laser in MobilePlanner, its position and orientation must be known. Refer to the following illustrations for assistance in determining these items:
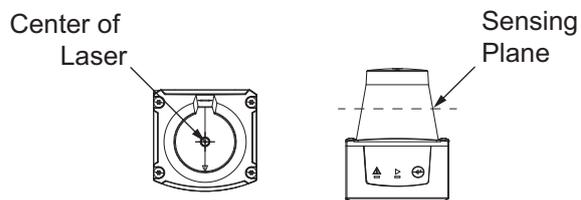
The illustration at left marks the center of the laser, the origin of the sensing field. The illustration at right shows the sensing plane: It is approximately 20 mm from the top of the sensor housing. These points are used to determine the laser's physical location relative to the AMR's center of rotation. Determine the following measurements for the corresponding parameters:

- Front to back, from AMR's center of rotation to center of laser (*LaserX*)
- Left to right, from AMR's center of rotation to center of laser (*LaserY*)
- Height, from floor to sensing plane of laser (*LaserZ*)

The following example depicts a side laser mounted to a payload structure, as well as sample measurements for *LaserX*, *LaserY*, and *LaserZ*:
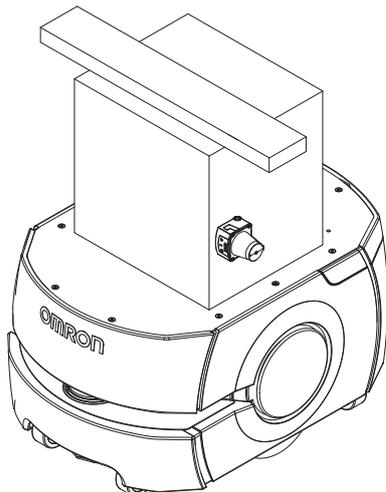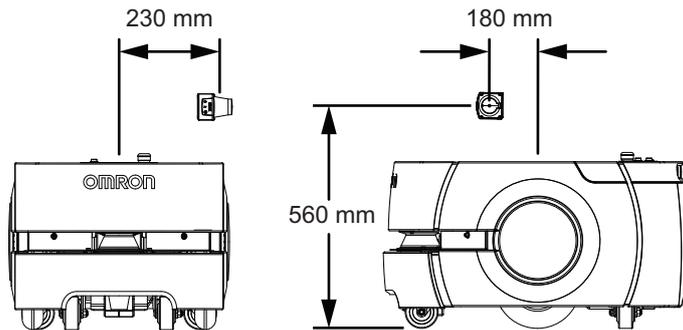
Ignored Segments

By default, the sensor scans an arc of 270 degrees. Segments of this arc may intersect with parts of the AMR, its payload, or laser protective covers. Therefore, these segments must be configured as ignored in the software. This will ensure the sensor does not detect parts of the AMR or AMR-mounted objects as obstacles, which could prevent motion.

When identifying these values:

- Degrees of arc relate to the AMR's coordinate system, and not the laser's angular range.
- 0° specifies the AMR's forward direction of travel.
- Specify values in the ranges 0° to +180° and 0° to -180°, in a clockwise direction (with respect to the top surface of the side laser).
- The value for an ignored segment cannot span +180° to -180°. Thus:
  - To ignore a 10° segment between +175° and -175°, two ranges must be specified: -175° to -180°, 180° to 175° (for example).
  - Specifying the range -175° to 175° causes the software to ignore a 350° segment, clockwise from 175° to -175°.
- Also consider the parameter *LaserTh*, which specifies the sensing field orientation, and whether the laser is tilted or flipped when calculating the ignored segment.

The format for inputting the segments in MobilePlanner is

<startangle1>:<stopangle1>,<startangle2>:<stopangle2>, etc. Readings inside these angles will be ignored. Input as many ignore segment angle pairs as necessary.

Consider the following example, showing an LD-60/90 AMR with a right side laser (tilted):
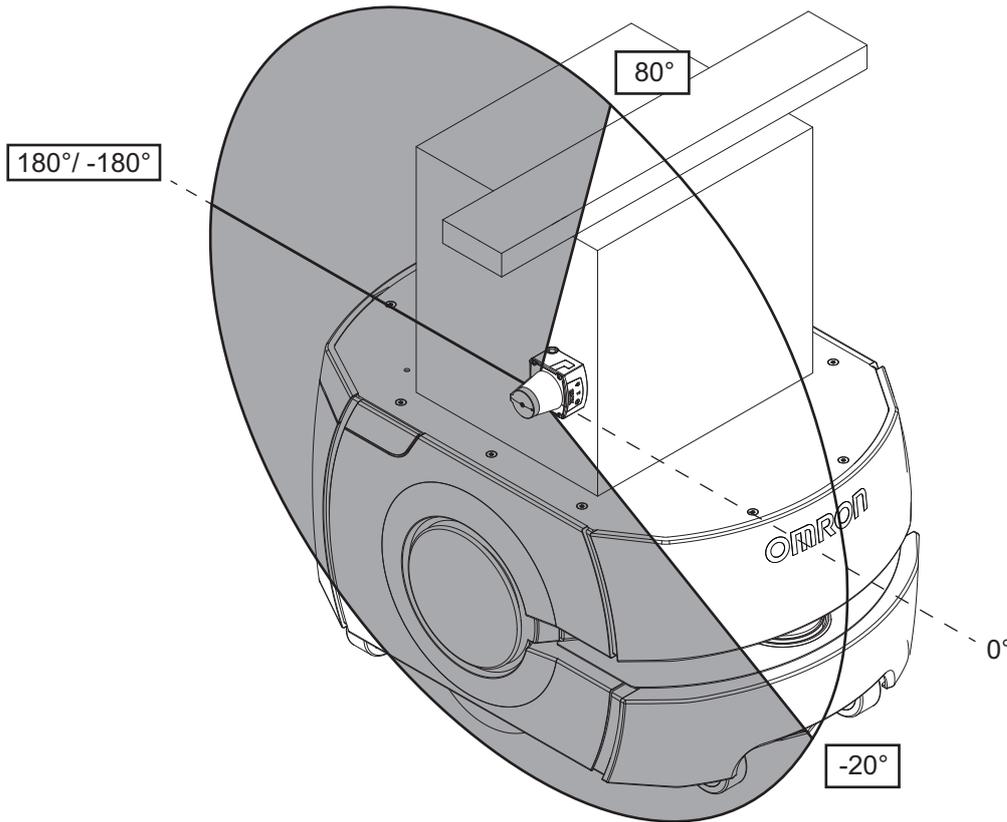
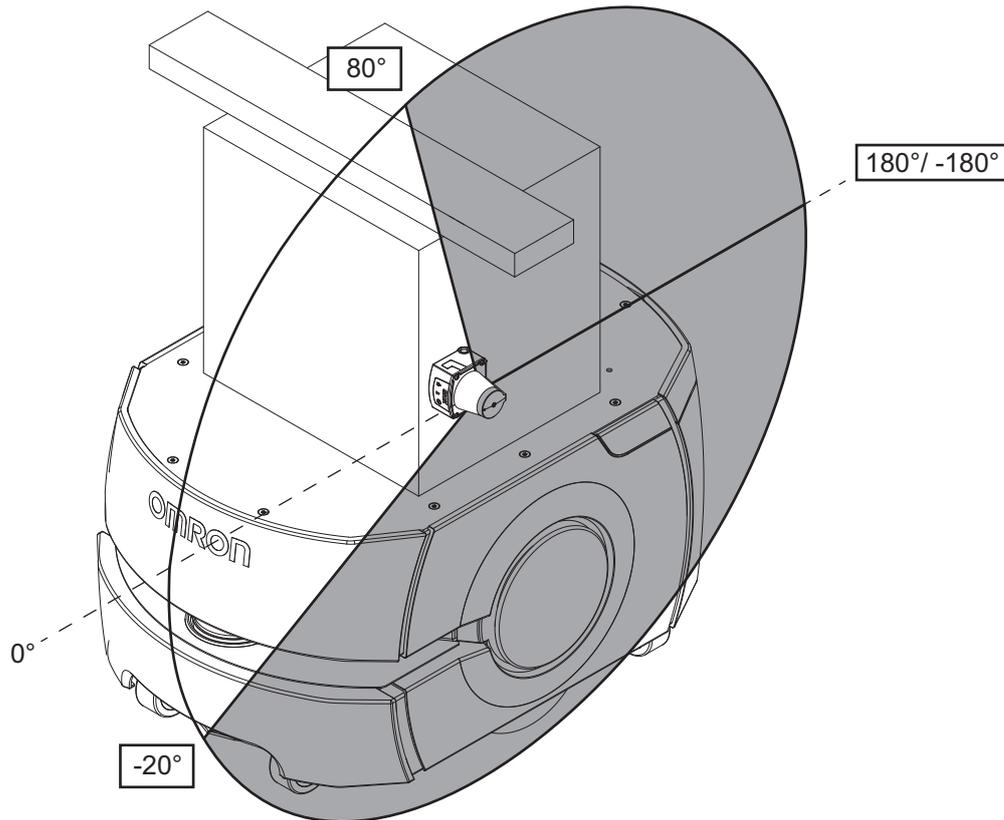Shaded areas represent segments to be ignored.

The procedure for identifying and inputting the ignored segments into MobilePlanner is as follows:

1. Begin at the 0° mark. Follow a counter-clockwise path along the positive range of the arc (between 0° and 180°) to identify the start and stop angles of segments to be ignored.

2. Continue to work counter-clockwise along the negative range of the arc (between -180° and 0°). Identify the start and stop angles, as in step 1.

3. Within MobilePlanner, input the angle pairs into the *LaserIgnore* parameter using the following format: *<startangle1>:<stopangle1>,<startangle2>:<stopangle2>*. Input as many pairs as needed, separated by commas.

The ignored segments for this example are configured in MobilePlanner as follows:

LaserIgnore: *80:180,-180:-20*

The next example shows an LD-60/90 AMR with a left side laser (tilted and flipped):

Shaded areas represent segments to be ignored.

The procedure for identifying and inputting the ignored segments into MobilePlanner is as follows:

1. Begin at the 0° mark. Follow a clockwise path along the positive range of the arc (between 0° and 180°) to identify the start and stop angles of segments to be ignored.

2. Continue to work clockwise along the negative range of the arc (between -180° and 0°). Identify the start and stop angles, as in step 1.

3. Within MobilePlanner, input the angle pairs into the *LaserIgnore* parameter using the following format: *<startangle1>:<stopangle1>,<startangle2>:<stopangle2>*. Input as many pairs as needed, separated by commas.

The ignored segments for this example are configured in MobilePlanner as follows:

LaserIgnore: *80:180,-180:-20*

Setting Values

To set the coordinate values and ignored segments for the lasers:

1   Open MobilePlanner and connect to the AMR.

2   Click on the AMR's **Configuration** tab, and enable *Show Expert Parameters*.

3   Click to expand **Robot Physical**. Under *Laser_3* and *Laser_4*, enter the lasers' mounting location coordinates for the following parameters:
   • *LaserX*
   • *LaserY*
   • *LaserZ*

4   Use the *LaserIgnore* parameter to specify any ignored segments of the sensing field.

5   Verify the laser configured as left is physically mounted on the left side of the AMR. This can be achieved by disabling one laser using *LaserAutoConnect* and watching the readings on the left side of the AMR.

6   Verify the installation to ensure the AMR can:
   • Stop before it collides with obstacles detected by the laser
   • Dock and charge

3-9 HAPS Installation and Configuration

The following sections provide details about HAPS tape and marker installation and other configuration requirements.

The following sections also provide details about HAPS sensor installation and software configuration. If HAPS sensors are required but not present on the AMR, contact your local OMRON representative for more information about ordering them.

The HAPS option is compatible with ARAM version 4.7.6 or later software.

3-9-1 HAPS Sensor Installation Overview

The instructions in this section show the procedures for both single and double HAPS sensor installation.

> **Additional Information**
>
> • Refer to *6-8-1 Removing and Replacing Skins* on page 6-17 for instructions that describe how to remove and replace skins.
> • Refer to *4-8-2 Battery Removal and Installation* on page 4-18 for instructions on how to remove the battery.

The following things are required for this procedure:

• Two or more people to lift the AMR and place it on its side.
• 4 mm hex driver for M5 socket head cap screws.
• Several small cable ties.
• Self-adhesive cable tie mounts.
• Floor padding to protect the AMR from damage.
• Straps or other method of securing the AMR safely while tipped on its side.
• Single or double HAPS sensor kit.
• Loctite 243

Single HAPS Sensor Installation Procedure

Use the following information to install a single HAPS sensor under the AMR in the position shown below.
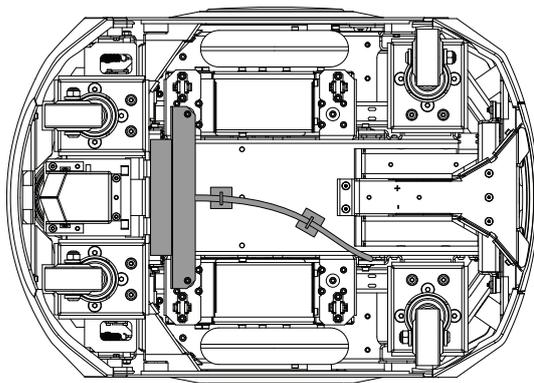
1 Remove both side Skins.

Refer to *6-8-1 Removing and Replacing Skins* on page 6-17 for more information.

2 Remove the payload structure to expose the payload bay and the Core.

3 Remove the battery. Refer to *4-8-2 Battery Removal and Installation* on page 4-18 for more information.

4 Tip the AMR onto its left side.

5 Attach two self-adhesive cable-tie mounts in the area behind the right drive wheel.
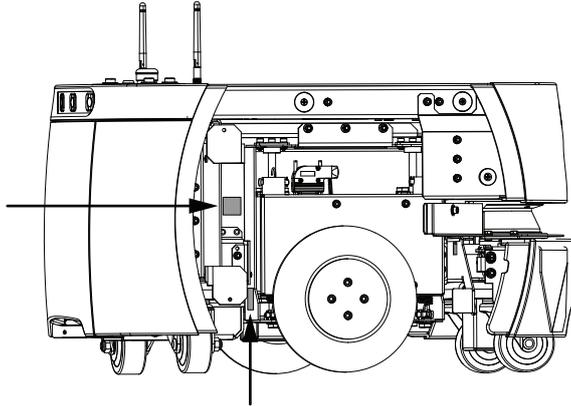

6 Remove two M5 stainless socket-head cap screws, split lock washers, and flat washers from the underside of the platform. See the following figure for the locations of the screws.
Save the screws and washers for installation of the sensor.
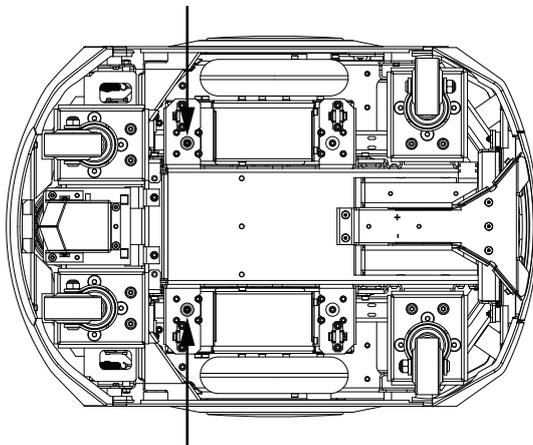
7 Use the M5 screws and washers that were previously removed to fasten the sensor and bracket assembly, using the existing holes from the previous step.
Route the cable between the HAPS bracket and the bottom surface of the AMR so that it does not protrude below the HAPS sensor.
Apply Loctite 243 or equivalent to the screws before inserting them.
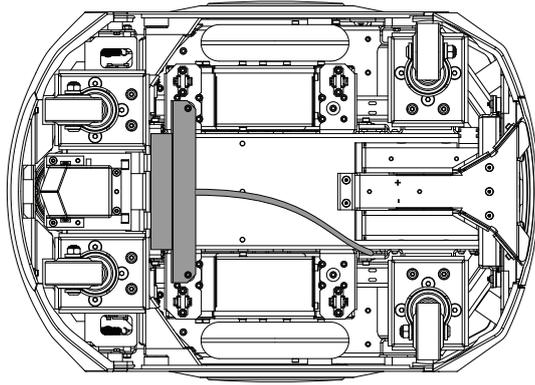
**8** Route the sensor wires back behind the right drive wheel.
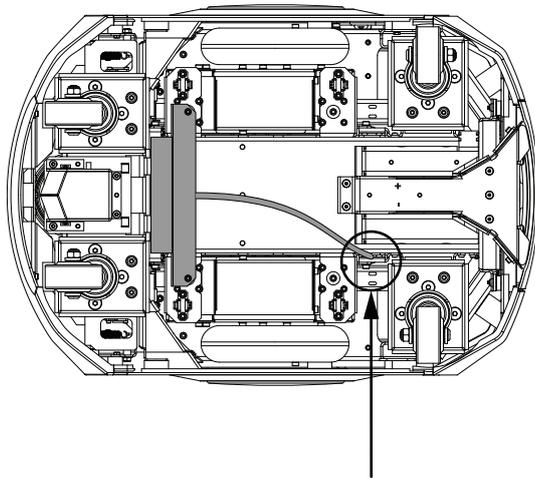
9 Install two self-adhesive cable-tie mounts to the underside of the AMR along the path of the cable.
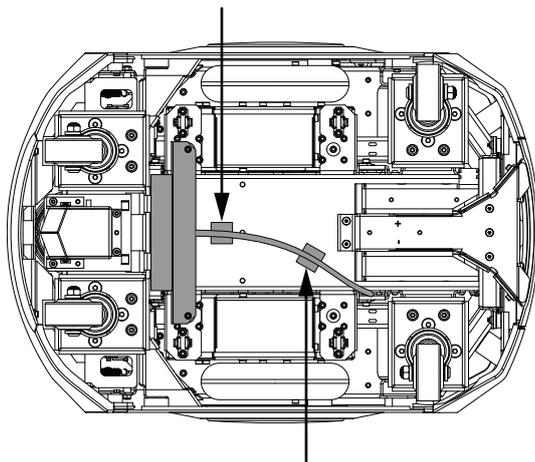

10 Use cable-ties to secure wires from the front sensor to the cable-tie mounts.

11 Route the sensor wires, both data and power, up through the AMR chassis just behind the right drive wheel through the cutout shown in the following figure.
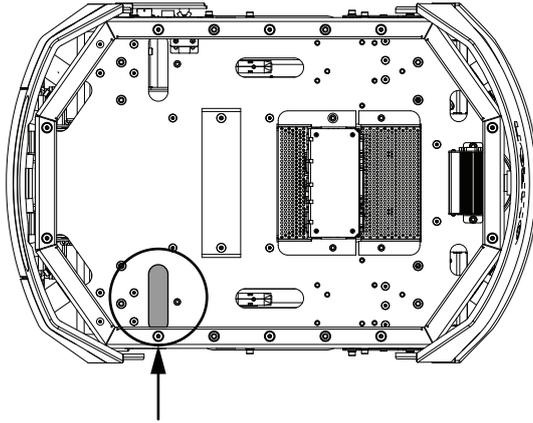
12 Secure the cable to the cable-tie mounts previously installed behind the right wheel.

13 Connect the sensor's DB9 plug to the RS232-1 connector.
Refer to *RS232* on page 3-23 for more information.

14 Connect the Molex Mini-fit plug power to the USER PWR connector on the back side of the AMR Core.

USER PWR Port
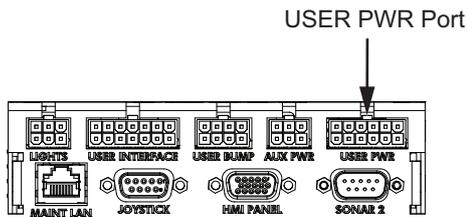
**15** Replace all previously removed items to complete this procedure.

Double HAPS Sensor Installation Procedure

Use the following information to install double HAPS sensors under the AMR in the position shown below.
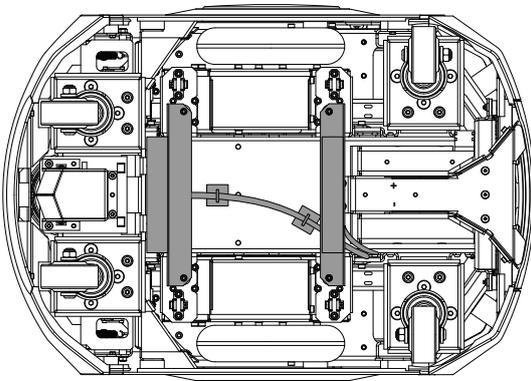
1 Remove both side Skins.
Refer to *6-8-1 Removing and Replacing Skins* on page 6-17 for more information.

2 Remove the payload structure to expose the payload bay and the Core.

3 Remove the battery. Refer to *4-8-2 Battery Removal and Installation* on page 4-18 for more information.

4 Tip the AMR onto its left side.

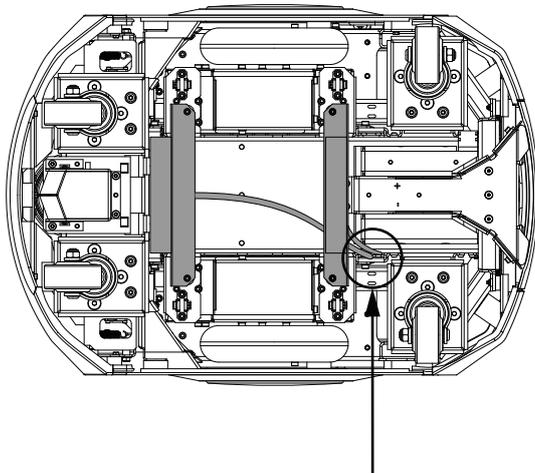**5** Attach two self-adhesive cable-tie mounts in the area behind the right drive wheel.
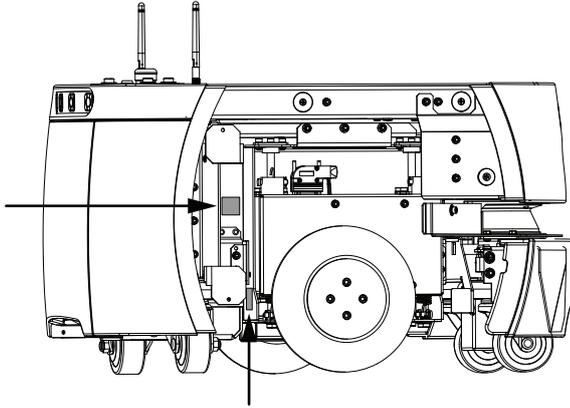
6 Remove four M5 stainless socket-head cap screws, split lock washers, and flat washers from the underside of the platform. See the following figure for the locations of the screws.
Save the screws and washers for installation of the sensor.
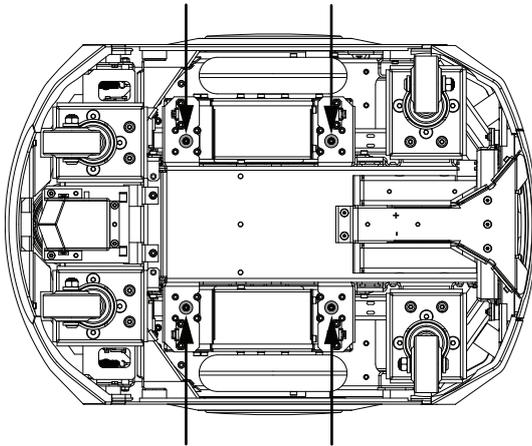
7 Use the M5 screws and washers that were previously removed to fasten both sensors and bracket assemblies, using the existing holes from the previous step.
Route the cable between the HAPS brackets and the bottom surface of the AMR so that it does not protrude below the HAPS sensors.
Apply Loctite 243 or equivalent to the screws before inserting them.
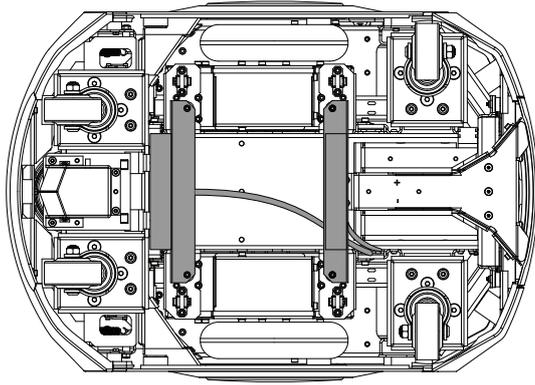
**8** Route the sensor wires back behind the right drive wheel.

9 Install two self-adhesive cable-tie mounts to the underside of the AMR along the path of the cable.
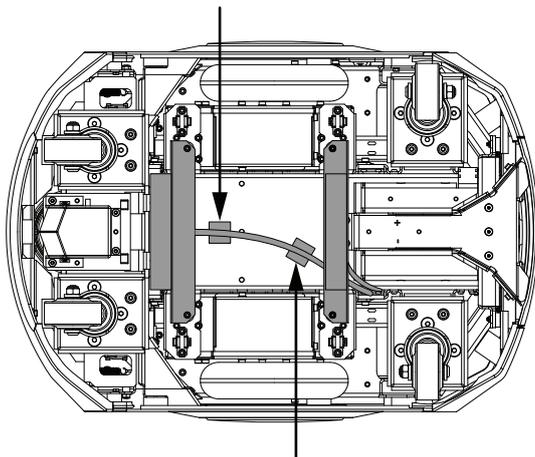
10 Use cable-ties to secure wires to the cable-tie mounts.

11 Route the sensor wires, both data and power, up through the AMR chassis just behind the right drive wheel through the cutout shown in the following figure.
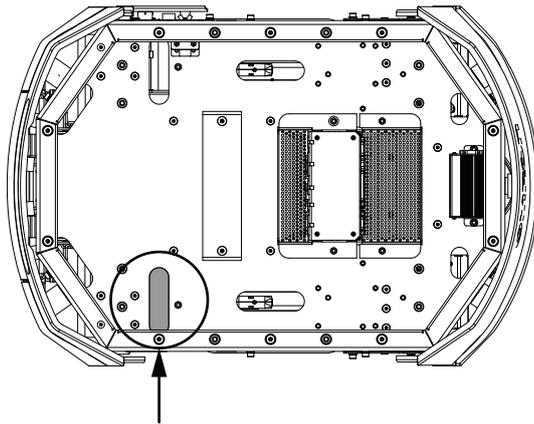
12 Secure the cable to the cable-tie mounts previously installed behind the right wheel.

13 Connect the front sensor's DB9 plug to the RS232-1 port and connect the rear sensor's DB9 plug to the RS232-2 port.
Refer to *RS232* on page 3-23 for more information.

14 Connect the Molex Mini-fit plug power splitter to the USER PWR connector on the back side of the AMR Core.

USER PWR Port
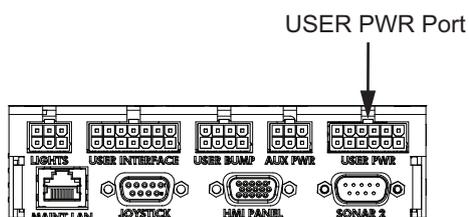
15 Connect each sensor's Molex Mini-fit power plug to the power splitter mating connectors.

16 Replace all previously removed items to complete this procedure.

3-9-2 Tape and Marker Application

Tape is applied to the floor leading up to the station or conveyor that you want the AMR to approach closely. Markers (short sections of the tape) are used to signal the AMR where to stop.

📝 **Precautions for Correct Use**

- OMRON does not provide the protective coverings with the HAPS option. A protective covering needs to be installed when applying the magnetic tape to the floor to prevent damage from the AMR traffic. The protective covering must be supplied by the user.
- You cannot use the same marker tape configuration for different AMRs in hybrid fleets because of their different sizes and turn radiuses. To determine the distance between the AMR and its final alignment goal (such as a machine with which it interfaces), refer to the AMR User's Manual to obtain the exact dimensions of the platform.

The following considerations apply to the installation of HAPS magnetic tape and markers.
- The recommended length of the marker is 250 to 350 mm (300 mm is optimal).
- The distance from one end of one marker to the end of the next marker must be at least 500 mm.

• The standard tape used is South-facing-up with adhesive on North. The markers always have the opposite polarity of the tape. If the tape is South up, the markers must be North up.

Consider the width of the AMR and payload when determining the placement of the main track to avoid interference with a conveyor or other similar structure.

To determine the distance between the AMR and its final alignment goal (such as a machine with which it interfaces), refer to *AMR Dimensions* on page 2-3.

Apply markers 20 to 30 mm to the right of the main tape track as detailed in the following figure (a two-stop arrangement is shown).
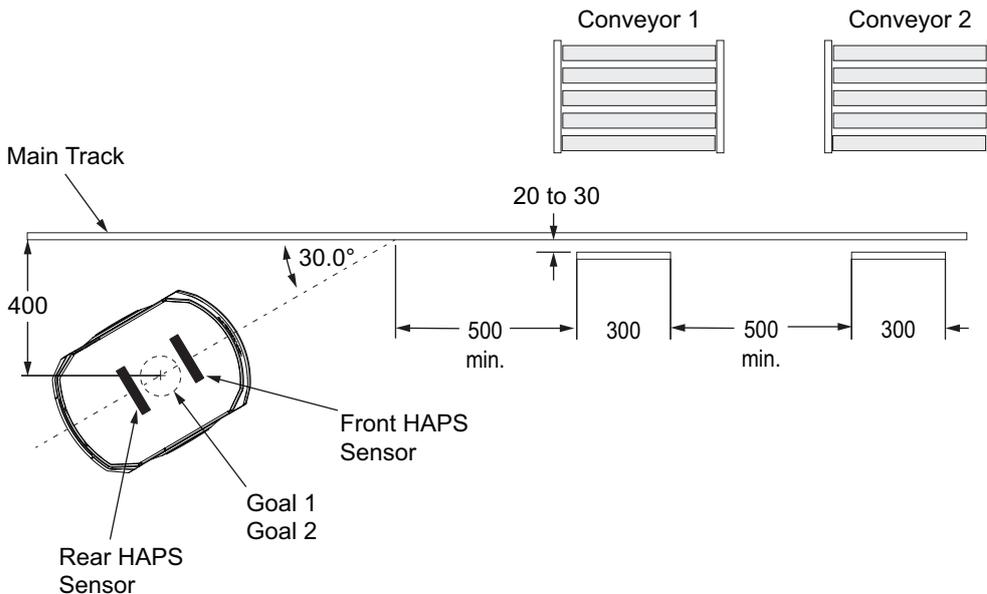
If you use the same magnetic tape for markers as for the main tape strip, apply the markers upside-down, relative to the tape. If you use tape with North side up ensure that the markers are applied with their South side up.

The AMR will stop with the front sensor at the front end of the marker. Note the model-dependent locations of the sensors to calculate where you should place the markers in relation to the location where you want the AMR to stop.

> **Additional Information**
>
> If you drive backward to reach a marker, the AMR will intentionally overshoot, and then drive forward to align its front sensor with the front of the marker.

Each marker needs its own goal placed near the start of the tape. A suggested goal location is 400 mm from the tape, near the start of the tape, with an orientation of 30° from the angle of the tape. This allows the AMR to approach the tape at normal speed without overshooting it. If you use a sharper angle, aimed more directly at the tape, you need to reduce the AMR's ApproachSpeed to prevent overshoot. Refer to the previous figure for more information.

For multiple markers, all Goals should be placed at the same location, with each Goal containing the Tasks associated with one marker.

3-9-3   Software Configuration

The HAPS parameters are configured using the MobilePlanner software. Use the following procedures to configure the AMR physical and operational configurations.

> **Additional Information**
>
> Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.

AMR Physical HAPS Configuration

Adjust the following parameters in the Robot Physical section of MobilePlanner to configure the use of the HAPS sensor.

GuideSensor_Front parameter settings:

- Check the *AutoConnect* Check Box.
- Set the *Port* parameter value to /dev/ttyUSB9.

GuideSensor_Rear parameter settings:

- Check the *AutoConnect* Check Box.
- Set the *Port* parameter value to /dev/ttyUSB10.

AMR Operational HAPS Configuration

Adjust the following parameters in the Robot Operation section of MobilePlanner to configure the use of the HAPS sensor.

> **Additional Information**
>
> Parameter settings described in *AMR Physical HAPS Configuration* on page 3-51 must be performed to make the following configuration items accessible.

Adjust the following parameters in the *FollowGuide* area according to your application requirements.

- *ApproachSpeed*: The speed, in mm/s, to drive when approaching the tape from the Goal.
- *FollowingSpeed*: The speed, in mm/s, to drive while following the tape.
- *ReverseFollowingSpeed*: The speed, in mm/s, while following the tape in reverse. Maximum is 300 mm/s. This only applies for a second sensor.
- *SlowCaptureSpeed*: The speed, in mm/s, to drive after deceleration when finding the end of a marker. This should be slow, such as 20 mm/s.
- *followingAccel*: AMR acceleration to use. 0 means default.
- *followingDecel*: AMR deceleration to use. 0 means default.
- *FrontClearance*: The minimum distance to an obstacle in front of the AMR before the AMR will stop. This needs to be small enough so the AMR does not stop too soon when approaching a conveyor or other fixed object that you want it to approach closely.
- *SideClearance*: The minimum distance to an obstacle on either side of the AMR before the AMR will stop.
  This needs to be small enough so the AMR does not stop too soon when approaching a conveyor or other fixed object that you want it to approach closely.
- *AvoidLocationDependentObstacles*: If True, will cause the AMR to avoid map obstacles like Forbidden Lines and Areas.

3-9-4   Goals and Tasks

HAPS can be used to make the AMR stop at multiple locations. Use a continuous tape strip with individual markers at each stop point, assigning one Goal for each marker and an Engage Task for each Goal. The Engage Tasks allow an AMR to follow the tape while performing Tasks from the successive Goals, without needing to return to the location of the Goals.

Information about configuring Goals and Tasks is provided in the following sections.

> **Additional Information**
>
> In this context, a Goal on the AMR's map is used as a starting point for Tasks that will drive the AMR along the tape, stopping at markers along the tape. There will be no Goals on the tape itself.

FollowGuide Task

The FollowGuide Task has the following parameters:

- *successCriteria*

  This will usually be *captureMarker*, to stop at a marker. It is possible to use either end of the tape, if two sensors are present, but markers offer more flexibility.

- *markerNumber*

  This represents which marker on the tape the AMR will stop at.

- *markerLength*

  This represents the physical length of the marker (300 mm is typical).

- *acquireTrackAfterMarker*

  This represents where the AMR will enter the tape, relative to the markers on the tape. This is determined by the location and angle of the Goal, relative to the tape and markers. Normally this will be 0 to indicate that the AMR will enter the tape before any markers.

Engage Task

The Engage Task calls a Macro when the AMR arrives at the Goal, so the AMR can be sent on a series of Tasks such as a FollowGuide Task to go to a marker.

If successive Goals are at the same location and each has the Engage Task on it, the AMR can be sent on multiple Tasks without returning to the Goal location. This allows you to have the AMR go to multiple markers without ever leaving the tape to return to the Goal location.

Make the following considerations when using the Engage Task.

- Each marker needs its own Goal.
- Each of the Goals needs to be at the same location.
- Each of the Goals needs to have the Engage Task.
- Each of the Engage Tasks will have a different Engage Macro.

If the next Goal assigned to that AMR is at the same location as the previous Goal and it has an Engage Task, the AMR will not drive back to the Goal when the Engage Macro finishes. It will instead execute the Engage Macro associated with the new Goal.

The parameters associated with the Engage Task are provided below.

- *EngageMacro*

  A Macro (generally containing the FollowGuide Task) that instructs how to arrive at the correct spot on the tape.

- *DisengageMacro*
  A Macro that determines how the AMR will remove itself from the tape safely from that marker position. If no Macro is given, the AMR will go to autonomous mode automatically.
- *UseGoalPosition*
  Determines how close Goals need to be for them to be considered as the same location. A tolerance larger than the distance between the Goals will indicate that the Goals are at the same location. After entering *True* for this value, you will be given a choice of distance. The defaults are generally suitable.
  This is the Goal position (not the position) that will result after the FollowGuide or Engage Tasks.
- *FaultEngageMacro*
  Determines how the AMR will manage failures when engaging.
- *FaultDisengageMacro*
  Determines how the AMR will manage failures when disengaging.
- *EngageOnlyIfFromGoal*
  This should be set to *False* or blank when using FollowGuide.
- *lockModeduringMacro*
  Boolean value to decide if the AMR mode will be locked during the engage process.
- *whenEngagedSupress*
  Selection to suppress the Goal driving so that the AMR does not drive back to the Goal location between Goals.
  Do not set this to suppress Macros as they are needed to use the Engage Macro of each successive Goal.

3-10 CAPS Configuration

The following sections provide details about CAPS software configuration.

The CAPS license part number is 20271-805. Contact your local OMRON representative for more information.

3-10-1 Normal Setup

This section covers the configuration steps for a Normal CAPS setup.

The figure below lists the default parameter values for PrecisionDrive. These default values are the recommended values for normal usage, in mm, and are measured from the center of the robot.

Target Shape

This dropdown controls which target the AMR will locate and move relative to in the operating space. The Standard shape is the default. Refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information on Standard targets. Other shapes can be used based on need and space requirements. Users should give preference to the Standard shape when designing and setting up an application. Both legs of the target must be in the field-of-view of Laser_1 (the front navigation laser) at the beginning of the Task. The AMR will not rotate to find the target.

Additional Information

The Standard target is the only target with listed accuracy specifications.

Final Settings

The following settings (X, Y, Angle) specify where the AMR will attempt to stop at the end of the Task execution. These are 2D spatial coordinates. Refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.
Final Offset X
Final Offset Y
Final Offset Angle

Additional Information

These values are relative to the target, not the AMR. This is to simplify setting up Tasks as they correlate directly to measurements taken from the target in geometric space.

Initial Settings

The following settings (X, Y, Angle) specify the position for the AMR, from which it will attempt to locate the target when first starting the Task. From the Initial position, the AMR should be able to see both legs of the target from the concave side. There is an associated search area to account for real world position uncertainty after arriving at the pre-Goal. Refer to *3-10-2 Advanced Setup* on page 3-56 for more information.

These three parameters are all that are needed to successfully set up and use the PrecisionDrive Task in most applications. Users should use the Normal setup whenever possible. All other parameters are optimized for most use cases with the Normal setup setting. Refer to *3-10-2 Advanced Setup* on page 3-56 for more information.
Initial X
Initial Y
Initial Angle

These are 2D spatial coordinates. For more information and setup instructions, refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635)*.

Additional Information

These values are relative to the target, not the AMR. This is to simplify setting up Tasks as they correlate directly to measurements taken from the target in geometric space.

Parameter Mode

This parameter toggles the Normal and Advanced setting menus. Normal only shows the parameters previously described in this section. Refer to *3-10-2 Advanced Setup* on page 3-56 for more information about the parameters in Advanced.

3-10-2   Advanced Setup

This section covers the configuration steps for an Advanced CAPS setup.
The figure below lists the default parameter values for Advanced Setup in PrecisionDrive.

Timeout

This sets the time before the AMR declares a timeout failure. The timer begins at the time the Task first starts looking for the reference target. If the Tasks has not reached the desired ending position before the specified time, the system will come to a stop, and signals failure of the Goal Task.

Path Shape

This parameter selects the desired path to the end position.
- PreAlign: This shape uses an arc-shaped path to first align with the vector path defined by the X,Y, and Angle Final position components, then follows the rest of the way moving straight with generally little or no final rotation required to achieve the desired final position. Some PreAlign moves may start and end with a straight path.
- Straight: This shape draws a straight line between the Initial position of the AMR and the desired Final location. In-place rotation at the beginning and end of the straight path is performed as necessary.

Search Mode

This parameter controls the amount of initial tolerance allowed. The general guideline is that larger tolerances are more likely to find a target, but more likely to choose the wrong item as the target. Smaller tolerances are more likely to fail to find a target, but less likely to choose the wrong target.

> **Additional Information**
>
> The Search coordinate frame is relative to the target, not AMR reference frames.

Mode	Tolerance		
	X	Y	Angle
Normal	500 mm	500 mm	15°
Wide	250 mm	750 mm	20°
Tall	750 mm	250 mm	20°
Minimum	200 mm	200 mm	8.5°
Max	750 mm	750 mm	30°
Rotation	350 mm	350 mm	45°

Match Mode

This parameter specifies how closely the laser data must match the selected TargetProfile.
- Normal: Balanced behavior between allowing for minor match errors with a reasonable guarantee that the target was correctly matched.
- Lenient: This behavior allows more error in the final line fit to decrease risk of failing the Task due to sensor noise or poor geometry. This mode should only be used when the target is in open space to decrease the likelihood of an incorrect match.
- Strict: This behavior allows very little error in final data fit, but has a higher guarantee that the target was correctly matched. This mode should only be used when incorrect target matches will have very

detrimental effects on the application. Using this mode will result in more failed Tasks, especially when operating large fleets as each scanning laser has its own intrinsic errors and noise profiles that affect the final match quality.

Fail Mode

This parameter controls the different failure modes that would cause the Task to immediately fail instead of attempting recovery to finish the Task within the FailTime timeout.

FailOnSafetyStop: Any Safety stop (either from E-STOP buttons or Safety Laser Scanner) will cause the Task to immediately fail.

Clearance

The *Clearance Mode* and *Clearance Shape* parameters control how the AMR deals with obstacles (both real and virtual) that are detected in close proximity to the AMR.

Clearance Mode controls how the clearances behave.

- Normal: uses the default settings.
  Approach Distance = 400 mm away from sensed obstacles.
- Variable: allows two different clearance sets to be used.
  Parameter *Clearance Switch Distance* controls when, during the Task, the clearance switches from the initial clearance to the final clearance. This parameter is defined by the distance to the final location.
  This also allows control of the Approach Distance parameter.
- Custom: allows control of the Approach Distance parameter.

Clearance Shape is the clearance relative to the footprint of the AMR.

This parameter allows control over the size of the clearances around the AMR. All of the clearances are defined from the front, rear, and side edges of the AMR.

In general, clearances should be set to fairly low values (<100 mm). Clearances are a supplement to the safety system but do not in any way replace the hardware safety. Clearance Shape options are as follows:

- Normal: Clearance sizes and definitions are set to give a good compromise between staying a safe distance away from the obstacle and still completing the required Task.

Front Clearance	Side Clearances	Back Clearance
50 mm	75 mm	20 mm

- Tight: Clearances sizes and definitions are set to minimize likelihood of Task failure. The AMR will be allowed to drive slowly past obstacles very close to the physical footprint of the AMR. Using this setting will result in fewer Task failures, but an increased chance of failure upon leaving the area (AMR can get into a space that it may not be able to extract itself from).

Front Clearance	Side Clearances	Back Clearance
20 mm	20 mm	5 mm

- Expanded: Clearances sizes and definitions are set to maximize the likelihood of the AMR being able to extract itself from a situation. The AMR will stop sooner due to the increased size of the clearances areas. Using this setting will result in more Task failures, but an increased chance of success upon leaving the area (AMR will stay out of a space that it may not be able to extract itself from).

Front Clearance	Side Clearances	Back Clearance
100 mm	250 mm	20 mm

- Custom: You can specify the area around the AMR for obstacle protection while moving to the final location. These parameters are only visible when Clearance Shape is set to Custom. Refer to the following figure.

Allows control over Front, Left, Right, and Back Clearances.

Negative clearances (clearances that allow obstacles internal to the defined shape of the AMR) can also be programmatically set. These should be used with caution, as they can lead to AMR collisions.

The clearances used in PrecisionDrive have a few key differences compared to other Clearance parameters within the FLOW Core software:

- The slowdown/stop behavior is different. The Approach Distance controls how far away the platform should stop instead of the Front Clearance (or Front Padding depending on the Task). This results in allowing smaller front clearances in most applications.
- Obstacles within 1m of the clearances but not within the clearances will cause the AMR platform to slow down.

Drive Mode

This parameter controls the driving behavior of the AMR.
* Normal: A balanced optimization giving the best all-around driving behavior.
* Precise: Minimizes Path and final error at the expense of being slower and with increased jitter in its motion.
* Fast: Minimizes time to Goal at the expense of being less precise and increased jitter in its motion.
* Smooth: Minimizes motion jitter at the expense of being slower and less precise in its motion.

Refer to the table below for an overview of Drive Mode behaviors.

Mode	Cycle Time	Smoothness	Precision
Precise	Increased	Decreased	Increased
Fast	Decreased	Decreased	Decreased
Smooth	Increased	Increased	Decreased

Forward Speed

This parameter controls the maximum forward translation velocity that the AMR could achieve during the motion. This does not represent the speed at which it will complete the Task (only the speed limit). The Drive Mode will dictate the local speed based on the optimization chosen. Depending on the Drive Mode setting and the application, increasing this parameter may have no effect on the resulting motion.

Reverse Speed

This parameter controls the maximum reverse translation velocity that the AMR could achieve during the motion. This does not represent the speed at which it will complete the Task (only the speed limit). The Drive Mode will dictate the local speed based on the optimization chosen. Depending on the Drive Mode setting and the application, increasing this parameter may have no effect on the resulting motion.

Rotational Speed

This parameter controls the maximum rotational velocity that the AMR could achieve during the motion. This does not represent the speed at which it will complete the Task (only the speed limit). The Drive Mode will dictate the local speed based on the optimization chosen. Depending on the Drive Mode setting and the application, increasing this parameter may have no effect on the resulting motion.

OffsetCorrection

The Safety Laser Scanner mounting alignment may vary across AMRs, which can affect CAPS accuracy. Parameters in the *OffsetCorrection* section in MobilePlanner can be adjusted to increase CAPS accuracy.

Customizations for Sim6

▷ **Robot Interface**

▷ **Robot Operation**

◢ **Robot Physical**

▷ Absolute Movement Maximums

▷ Battery_1

▷ General

▷ Laser_1

▷ Laser_2

▷ Laser_5

▷ LCD_1

▷ Safety Zones

▷ Battery Simulation

◢ *OffsetCorrection*

⌄ *Offset X* `0.0`

　AMR specific axial offset in mm in the coordinate system of the specified target (used in all PrecisionDrive Tasks)

⌄ *Offset Y* `0.0`

　AMR specific lateral offset in mm in the coordinate system of the specified target (used in all PrecisionDrive Tasks)

⌄ *Offset Angle* 0.0

　AMR specific rotational offset in degrees in the coordinate system of the specified target (used in all PrecisionDrive Tasks)

▷ Robot Type

▷ Time Of Flight

▷ **Fleet**

▷ **Debug**

Additional Information

- The OffsetCorrection parameters are only available to PrecisionDrive if there is a CAPS license activated.
- In typical applications, the AMR's overall approach and motion generally stay consistent and a single OffsetCorrection configuration is sufficient.

Only one OffsetCorrection (X, Y, and Angle) is allowed for each AMR. This will be applied to all PrecisionDrive Tasks for that AMR. It is not Task or Target-specific.

The OffsetCorrection parameter values are added to the final position requested in the PrecisionDrive Task as *Final Offset X*, *Final Offset Y*, and *Final Offset Angle* values.

The OffsetCorrection parameter values are relative to the target using the same coordinate reference frame for the Final Offset values. For example, if the *Final Offset X* value is –1000, and the individual AMR needs to have a *Final Offset X* of –1005, the *Offset X* parameter for that AMR would be set to –5. The same approach is used for *Offset Y* and *Offset Angle* parameters.

3-11 Acuity Installation Procedure

Use the following information to install and configure an Acuity system.

An optional Acuity Camera Kit is required for this procedure (part number 13700-000 with digital level, 13700-100 without digital level).

Acuity software is included in the FLOW Core software suite. No additional software installation is required for enabling Acuity localization.

The basic installation steps are provided below.

1. Make mounting location design considerations.

   Refer to *3-11-1 Mounting Location* on page 3-62 for more information.

2. Acuity hardware installation.

   Refer to *3-11-2 Acuity Hardware Installation* on page 3-63 for more information.

3. Acuity camera configuration and setup.

   Refer to *3-11-3 Configuration and Setup* on page 3-69 for more information.

4. Map configuration.

   Refer to *3-11-4 Mapping with Acuity* on page 3-73 for more information.

5. Other adjustments.

   Refer to *3-11-5 Other Acuity Adjustments* on page 3-80 for more information.

> **Additional Information**
>
> There are two models of Acuity camera:
> * Legacy, part number 13768-000
> * Production, part number 22718-000.
>
> Maps made with either camera will work with both cameras.
>
> Production cameras are only usable with Fleet Operations Workspace version 3.2.0 and later. Each Acuity camera has a unique calibration file keyed to the camera's serial number. FLOW software will not run if the camera's serial number does not match the calibration file in use. This applies to legacy and production cameras.
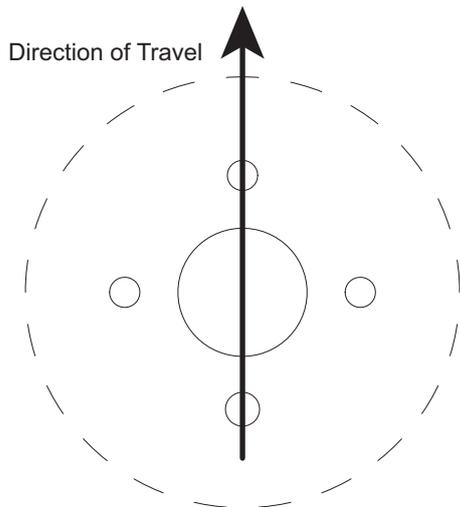
3-11-1 Mounting Location

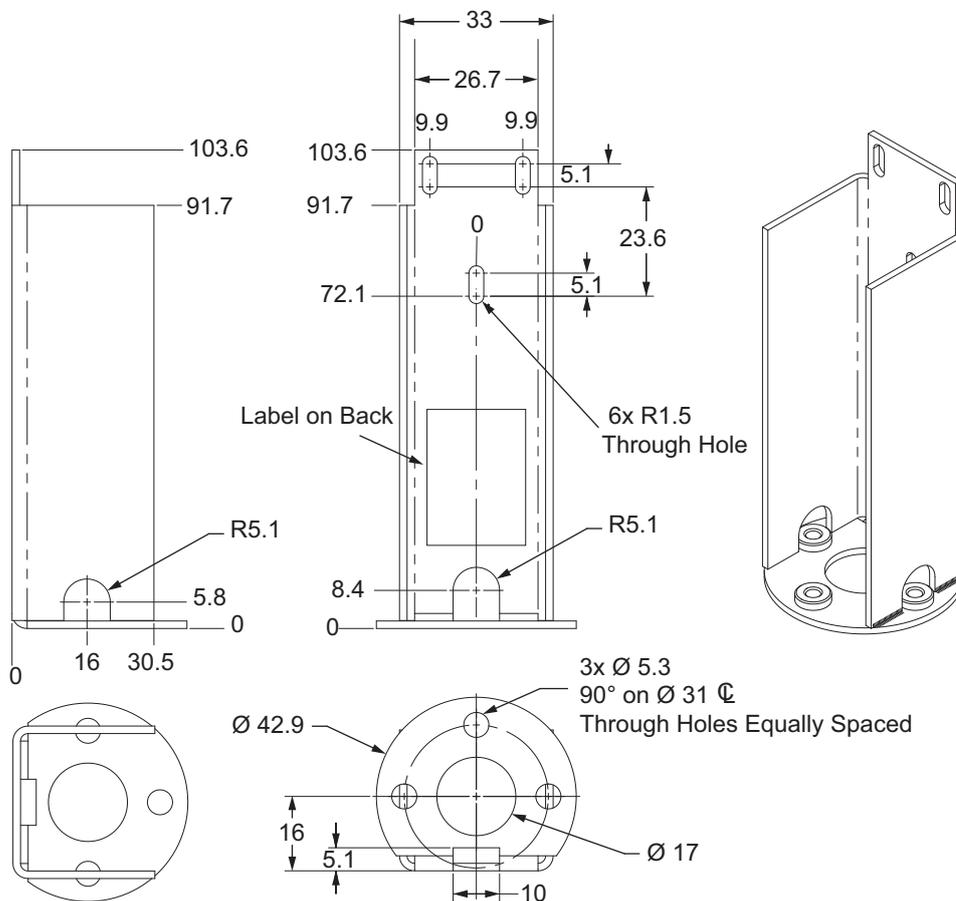This section describes considerations for the camera mounting location.

* The location for the camera needs to provide a flat, level surface at least 57.2 mm in diameter.
* The camera lens must not be obstructed by any other part of the AMR. It has a 140° field-of-view, so ensure that nothing higher than the camera lens is close beside the camera.
* The mounting location needs to provide a sturdy support for the camera, as any vibration or other movement of the camera makes localization difficult.
* The payload structure needs four 4.6 mm holes and one hole, at least 17 mm in diameter, in the center of that hole pattern. Refer to *Camera Installation Procedure* on page 3-63 for more information.

Two of the 4.5 mm holes and the 17 mm hole must line up with the AMR's direction of travel.

For localization, the holes and camera need to be aligned within one degree of rotation about the X and Y axes of the platform. Refer to the following figure for hole orientation.

Direction of Travel

Camera mounting hardware dimensions are provided below.

33

26.7

9.9   9.9

103.6   103.6

91.7   91.7

5.1

0

23.6

72.1   5.1

Label on Back   6x R1.5
Through Hole

R5.1   R5.1

5.8

8.4

0   0

0   16   30.5

3x Ø 5.3
90° on Ø 31 ₵
Through Holes Equally Spaced

Ø 42.9

16

5.1   Ø 17

10

3-11-2   Acuity Hardware Installation

Use the information in this section to understand how to install the Acuity hardware equipment.

Camera Installation Procedure

Use the following procedure to assemble the camera assembly and bracket attachment.

The figures in this section show the camera assembly being mounted to a bracket. This is only used to show where the screws will attach. A typical installation will have the mounting holes at the top of the AMR's payload structure.

The following tools and items are required for this procedure:

- Acuity Kit (part number 13700-000 with digital level, 13700-100 without digital level)
- 2 mm and 3 mm hex bits

1 Attach the camera enclosure base firmly to the payload structure using one of the supplied M4 screws. The screw has to be inserted from inside the payload structure, through the payload structure surface, and into the single clinched nut in the camera enclosure base.
To simplify installation and minimize the Theta offset, mount the camera base so that the hole with the clinched nut is facing toward the left of the AMR (+Y).

2 Mount the base to the mounting location using an M4 socket head screw.
Observe the orientation of the base with respect to the direction of AMR forward travel. Make sure the other three holes are aligned before tightening the screw.
You may need to use a longer screw depending on the thickness of your mounting location.
A washer and lock washer are recommended, though not shown here.
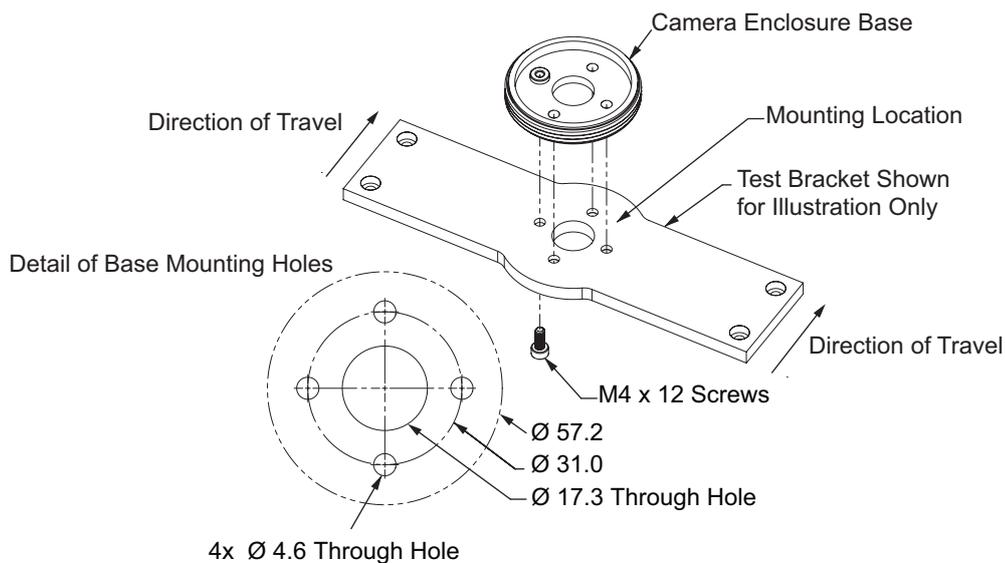
3 Mount the camera bracket to the camera enclosure base.

4 Attach the camera bracket firmly to the base using three M4 socket head screws.
Longer screws may be needed depending on the thickness of the mounting location.
Washers and lock washers are recommended, though not shown here.
There is a sticker on the camera bracket that shows the direction of travel of the AMR. Verify that the arrow on the sticker is pointing toward the front of the AMR.

Direction of Travel

**OMRON ROBOTICS
AND SAFETY
TECHNOLOGIES, INC.**
4225 Hacienda Dr.
Pleasanton, CA 94588

Model: Acuity
P/N: 73930-020
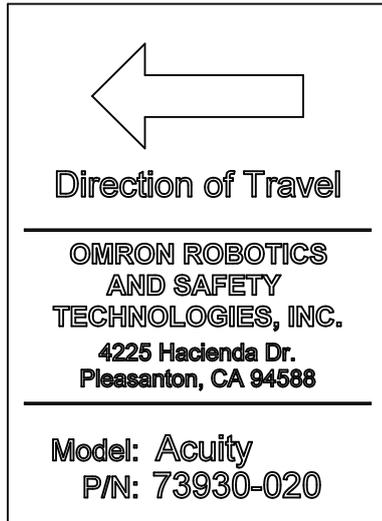
The screws have to be inserted from inside the payload structure, through the payload structure surface and camera enclosure base, and into the three clinched nuts in the bottom of the camera bracket.


Camera Mounting Bracket

Camera Enclosure Base

Test Bracket Shown
for Illustration Only

3x M4 x 12 screws
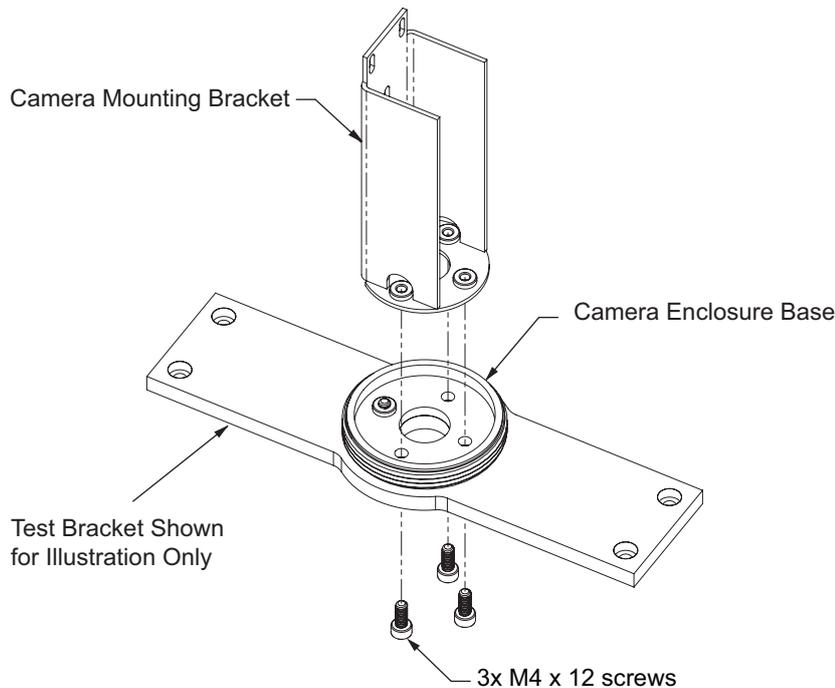
5 Attach the camera to the camera bracket.
The Acuity camera needs to be mounted as high in the bracket as possible, without its lens adapter interfering with the filter. This prevents the tube itself from limiting the camera's angle of view.
- Attach the power and ethernet cables to the camera before mounting the camera. Route these cables up through the 17 mm hole in the center of the base and bracket and then connect them to the appropriate connectors on the camera.
- Attach the camera to the mounting bracket using three M3 screws as shown in the following figure.

3x M3 x 4 Button Head Cap Screws

Camera Mounting Bracket
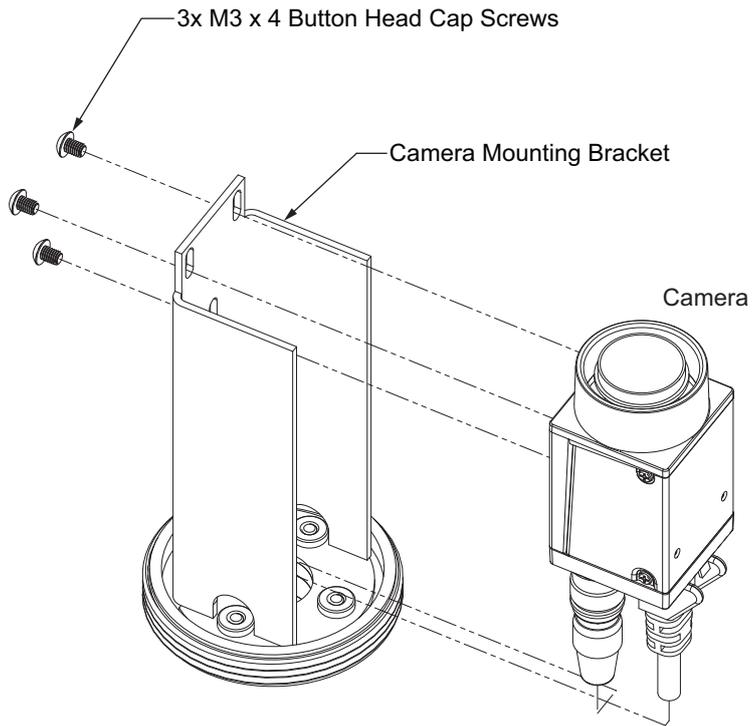
Camera

6 Attach the camera tube assembly onto the camera enclosure base.

The threads at the bottom of the tube are coarse, and match the threads on the base. The threads at the top of the tube are fine, and match the filter.

Tube

Base
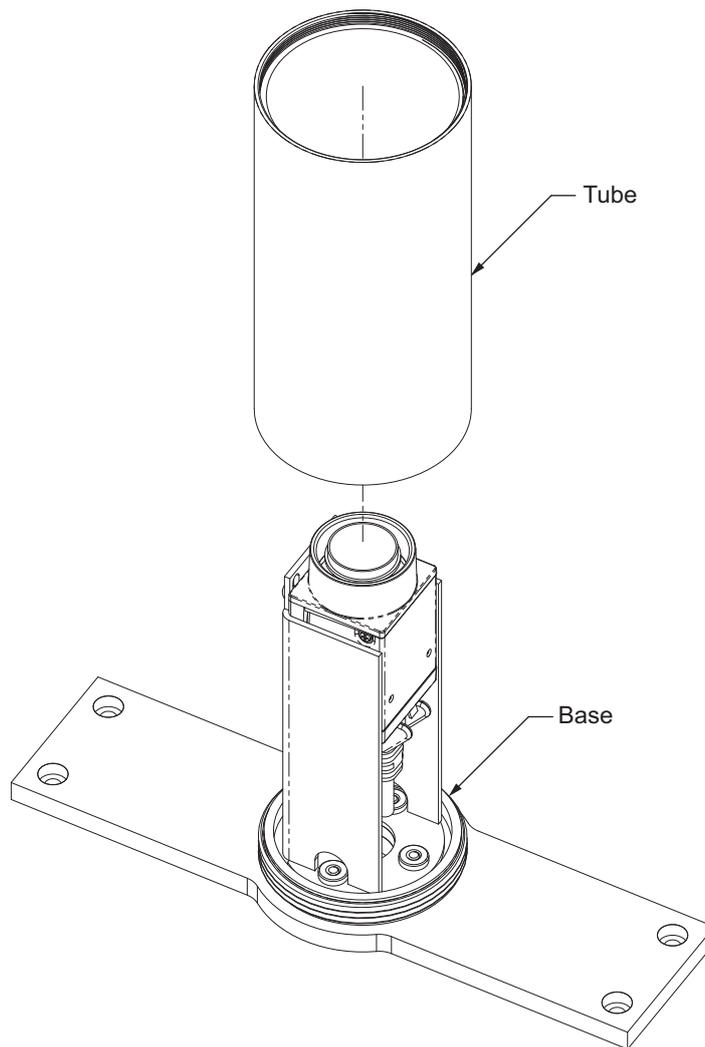
7 Install the foam dust seal and filter:
- Insert the foam seal around the camera lens and press into the tube until the seal sits on the camera body.
- Thread the filter onto the camera enclosure body (tube).

Completed Assembly
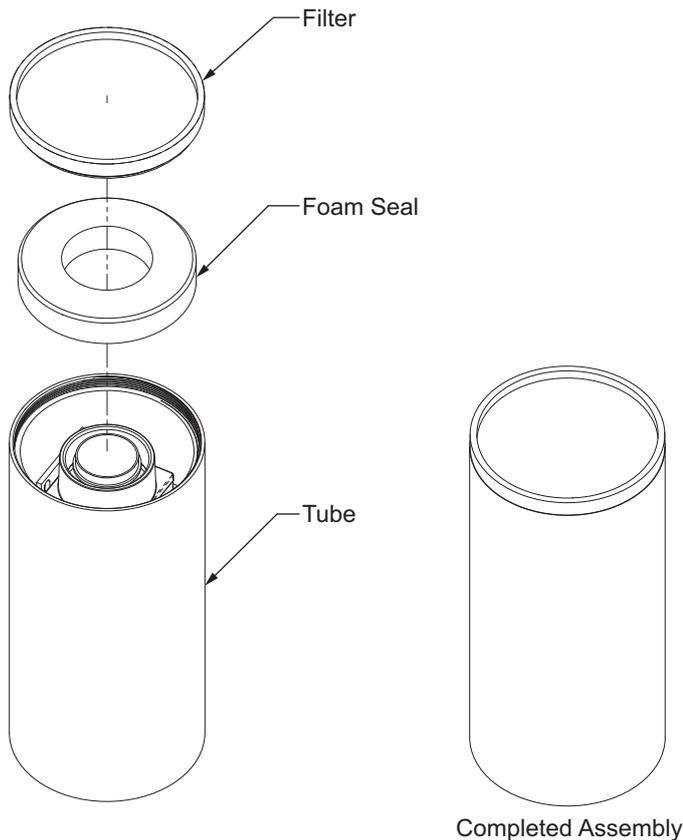
This completes the camera installation procedure.

Camera Connections Procedure

Use the following procedure to make the camera connections to the AMR.

The camera hardware should be mounted to the AMR with cables connected to the camera before beginning this procedure. Refer to *Camera Installation Procedure* on page 3-63 for more information.

📝 **Additional Information**

If other peripheral items also require the use of the LAN 2 connection, then a user-supplied ethernet switch will be required.

1 Route the power and ethernet cables to an area near the AMR Core.
The Acuity camera's signal cabling is sensitive to interference from noise. Route signal cables to avoid interference. If your payload's power demand is high, or you need to add other devices to the AUX power circuit, carefully test Acuity operation before deploying.

2 Connect the 3x2 Mini-Fit Jr. power cable from the camera to the 3x2 Mini-Fit Jr. power splitter cable.

3 Connect the Mini-Fit Jr. splitter to the AMR Core AUX POWER port.
The splitter will leave one available Mini-Fit Jr. power connector available for other uses.

4 Connect the Ethernet cable from the camera to the LAN 2 port on the AMR Core to complete this procedure.

3-11-3 Configuration and Setup

The following sections provide details about Acuity setup and other configuration considerations.

Enabling Acuity

Enable Acuity localization functionality in the following areas:

- MobilePlanner
- SetNetGo
- From the map

The following sections will describe actions to enable Acuity in these areas.

> **Additional Information**
>
> Light Localization and Laser localization are designed to be used at the same time. In cases where laser readings are unreliable, Laser Localization can be disabled to ensure that only Light Localization is being used. Optional instructions for disabling Laser Localization will also be included in the following sections.

● Enabling Acuity In MobilePlanner

In order to enable Acuity, check the *LightLocalization* parameter box in MobilePlanner > Config. The boxes are found under Robot Operation > Localization Modules. In this section, *DisableLaserLocalization* can also be checked in case only Light Localization is preferred.

> **Additional Information**
>
> Ensure that the AMR is localized using the laser correctly, prior to checking the *DisableLaserLocalization* setting.
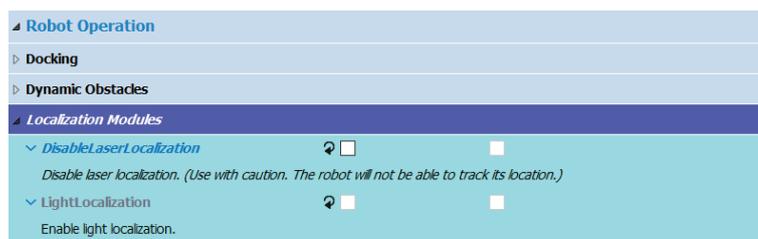
These checkboxes will only be visible if the Show Expert + Parameters box is checked. To make a change, click and drag the desired parameter from the expert Parameters tab into the Configuration tab.

For instances where only Acuity operation is desired both boxes should be checked. This will cause the AMR to use only the Acuity camera for localization.

After enabling Acuity, save the changes to the configuration. The AMR's software will reboot.

> **Additional Information**
>
> After making and saving Acuity changes within MobilePlanner, the robot has to be power-cycled for those changes to take effect.

● **Importing the Camera Calibration**

Acuity cameras are supplied with a calibration file, which you will need to import before Acuity localization can be used.

The *LightLocalization* parameter must be enabled as described in *Enabling Acuity In MobilePlanner* on page 3-69 before attempting to import the file.

The file name of the camera calibration file must match the camera's serial number. To verify the camera serial number, use the Command tool in the MobilePlanner toolbar to select *PopupCameraSerialNumber*.

> 📝 **Additional Information**
>
> If you do not see the Commands tool in MobilePlanner, right click in the blank space in the tool-bar area and then select *Custom Commands*.
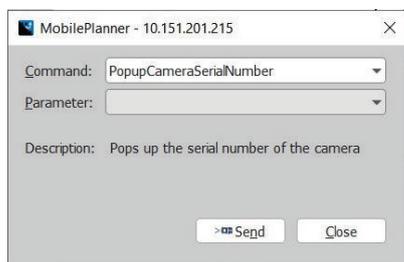
Import the camera calibration file using the MobilePlanner import function (*File > Import Config...*).

● **Enabling Acuity in SetNetGo**

Select *MobilePlanner > SetNetGo*.

Under the *Network* tab, select *User LAN Ethernet*.

Ensure the radio button for *Interface mode* is set for *Accessory* and *DHCP Server for Accessories* is set to *Enable*.
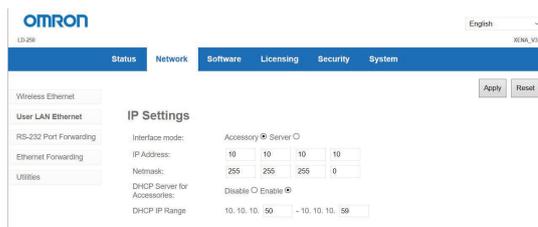
● **Enabling Acuity from the Map**

If the Laser localization is not disabled explicitly through the use of the *DisableLaserLocalization* parameter, then it can be disabled using a map Task. After enabling Acuity localization by checking the box for *LightLocalization* and saving the configuration, new configuration sections related to the *LightLocalization* parameter will become visible, as will a set of Tasks to be used in the AMR's map. This method of enabling or disabling modes of localization is for expert use only. You should not use this method unless you fully understand it.

Among these new Tasks will be:

• DisableLaserLocalization
• DisableLaserLocalizationCancel
• DisableLightLocalization
• DisableLightLocalizationCancel

These Tasks can be used to selectively switch between Acuity and laser localization.

These Tasks cannot be used while the AMR is moving. Place the Tasks in a Macro, in a virtual door, or after a Goal where the AMR is expected to switch localization modes.

Use the Custom Response, Startup to run the DisableLaserLocalization Task when the AMR boots. Later, if you want to switch localization methods, use the Tasks listed to disable one type and cancel the disabling of the other type.

Compensating for Camera Position and Tilt Procedure

Use the following procedure to compensate for camera position and tilt.

Enter the position of the camera with respect to the AMR into the MobilePlanner software. A dual-axis digital level (included in kit) is required for this procedure.
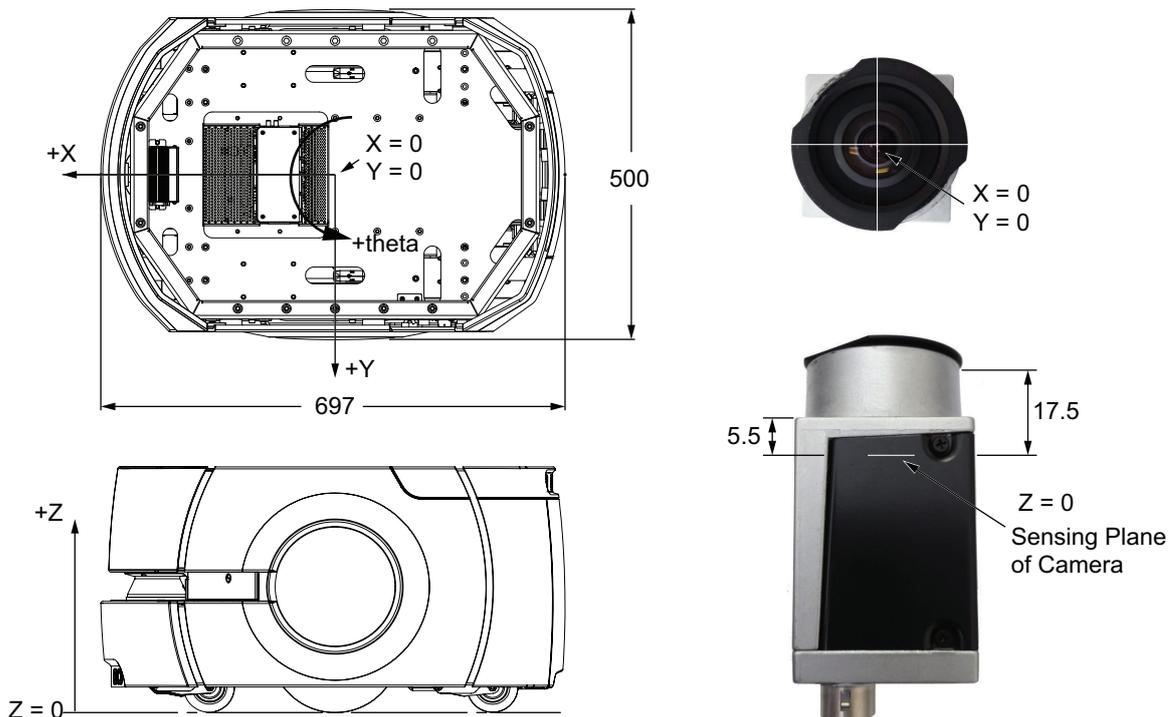
1 Measure the X and Y distance from the center of the AMR (X = 0, Y = 0) to the center of the camera (X = 0, Y = 0).

2 Measure the vertical distance from the floor to the plane of the camera's sensor.
To measure this distance, measure from the floor to the top of the camera (not the top of the lens) and subtract 17.5 mm.
Alternatively, measure from the floor to the top of the rectangular portion of the camera and subtract 5.5 mm. Round all measurements to the nearest millimeter.

3 Navigate to MobilePlanner > Config. This will open the Config window, if it is not already open. **Navigate to Robot Physical** > **Acuity Camera Position** and enter the measured values in the parameters CameraOffsetX, CameraOffsetY, and CameraOffsetZ.
If the camera is toward the front of the AMR it will have a positive X value. If it is toward the rear of the AMR it will have a negative X value.
If the base is mounted per instructions, the camera will have its rear side, with threaded holes for mounting it, facing +Y of the AMR (the AMR's left side). This will result in a CameraOffsetTh

(theta) of 0. If this is not the case, then a theta offset must be applied. For example, if the back of the camera is facing the rear of the AMR, the CameraOffsetTh will be 90, as a counter-clockwise rotation is positive.

4 Finally, measure the tilt of the camera with respect to the floor using the dual-axis digital level that is included with the Acuity Camera kit.

1) Bring the AMR to a level, hard floor. Do not use carpeted floor.

2) Place the digital level on the floor with the edge pressed against the right wheel cover, buttons toward the front of the AMR, and the display facing straight up. Refer to the following figure.

3) Zero the level. (Press ZERO.)
   The bubble on the display should be centered, and the values for X and Y tilt should be near zero.

Forward ⟶

Correct Level Orientation
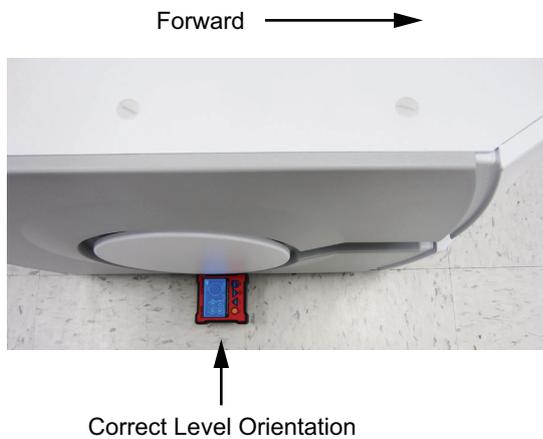
4) Place the level, facing up, over the camera and top of the bracket.
   The USB port on the level (which is not used in this procedure) should be on the same side of the level base as the slot for the camera bracket. The level and base should have been delivered to you this way. Refer to the following figure.

USB Port

Camera Slot
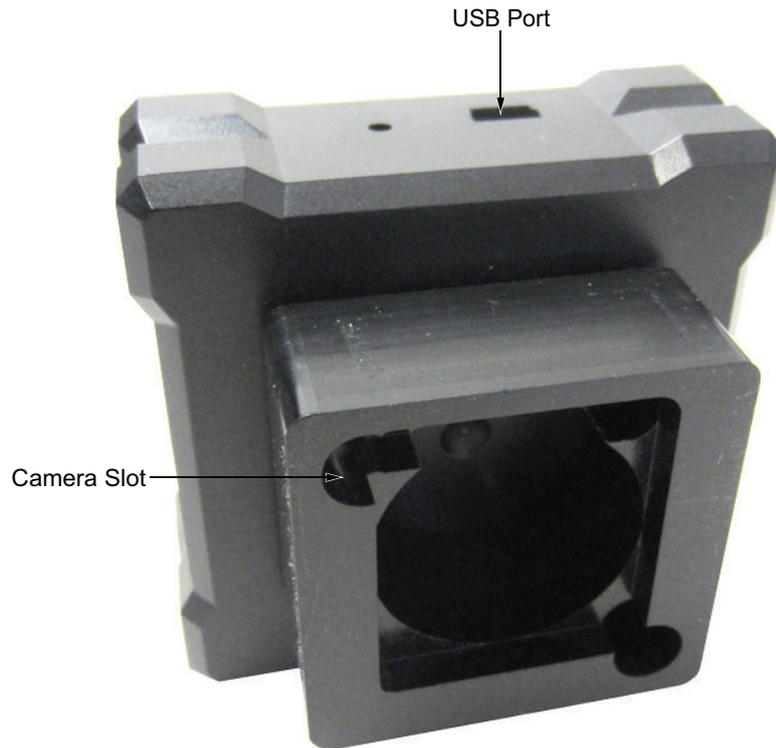
It will only fit one way, with the slot in the plastic base of the level fitting over the back side of the camera mounting bracket. The slot is called out in the preceding figure.

5 Enter the values directly from the display into MobilePlanner > Config
X AXIS = Robot Physical > Acuity Camera Position > CameraTiltX
Y AXIS = Robot Physical > Acuity Camera Position > CameraTiltY
Be sure to include the + or – sign. You can press the HOLD button on the level to lock the values.
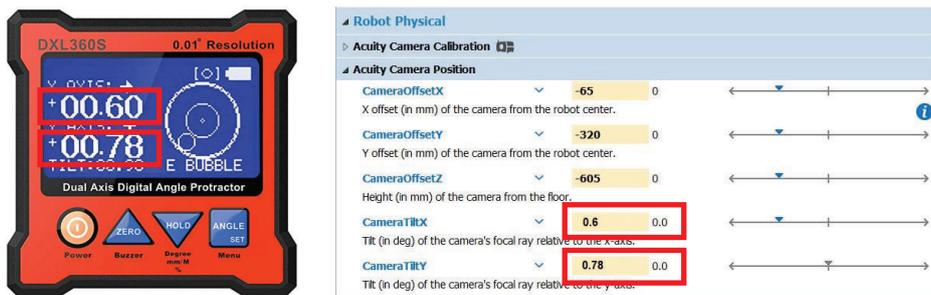
6 Reinstall the foam dust seal on the camera, and screw the camera tube back onto its base. Ensure that the camera's light filter is in place in the top of the tube. This completes the compensation procedure.

3-11-4 Mapping with Acuity

Use information in the following sections to understand mapping with Acuity. Refer to *3-15 Map Creation Overview* on page 3-84 for more information.

> **Additional Information**
>
> Maps created using legacy Acuity cameras are compatible with newer cameras that are provided with the Acuity Camera Kit.

Acuity Mapping Considerations

Make the following considerations when mapping with Acuity.

● Light-Related Parameters

This section describes the parameters related to light during the map creation process.

- Parameters in the Light Analysis Section are used for mapping only.
- Parameters in the Light Localization section apply only to runtime, not mapping.
- Light Video Analysis parameters apply to the images used for both mapping and localization. If the *MinRefreshInterval* (the rate at which new images are acquired) is higher than the *LightTimer* in the Light Localization section, then light localization will be limited to the *MinRefreshInterval* setting. The AMR cannot localize faster than it is receiving new images from the camera.

The laser and light data are generated from the same scan. You only have to drive the AMR through the environment once to gather the information necessary for a map containing points and lines generated from the laser data, as well as rectangles, used to represent facility lighting, generated from the camera images.

● Light Height

Before scanning, measure the height from the floor to the lights. Use the height of the lights, not the ceiling, as most lights are set away from the ceiling by some amount. For diffused fluorescent lights, in an office setting, the ceiling height is typically fine. Metal-halide dome lights in high-bay warehouses are typically hung from the ceiling by about one meter.

Enter the height of the lights in the AMR's configuration in the Robot Operation > Light Analysis section. The 3d: *MinLightHeight* parameter should be about 15% less than the measured height, and *3d:MaxLightHeight* should be 15% more than the measured height. All lights between those heights will be included when the map is created.

Enter the actual measured height into the *3d:DrawingLightHeight* parameter (this is strictly for display purposes, and does not affect AMR operation).

If there are areas within the environment that have different light heights, it is not necessary to scan the space again. Pick one light height to be first, and enter the values for Min and Max light height into the configuration before scanning. These can be adjusted later, and multiple maps can be processed from the same scan file.
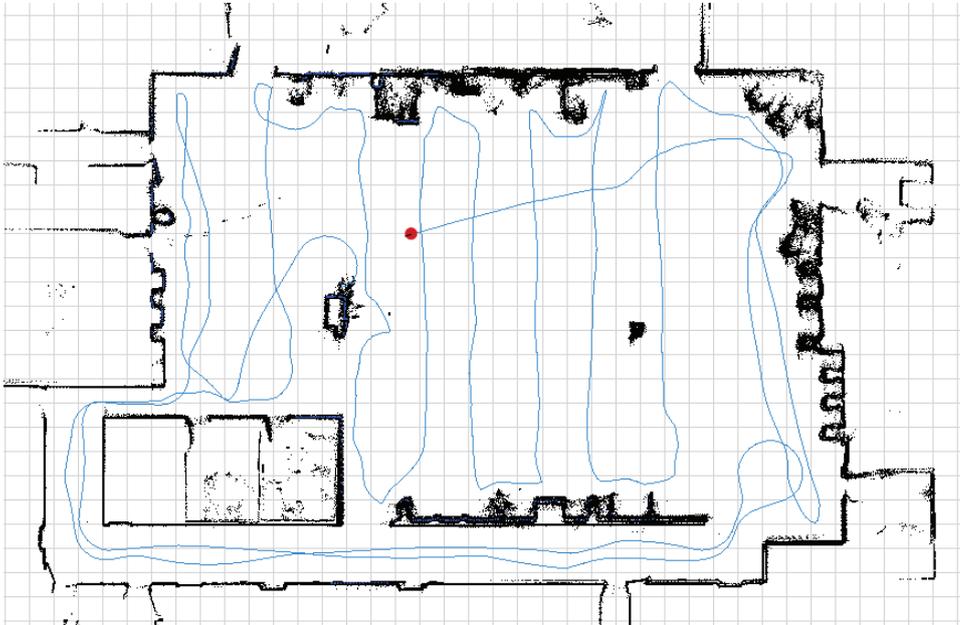
● Light Size

Measure the size of the lights. By default the maximum light length is set at 2000 mm to prevent the detection of large, erroneous lights on a map. If the lights are longer than this, you will need to increase the 3d:MaxLightLength parameter, which is in the Robot Operation > Light Analysis section. The AMR will not be able to scan lights which are long and continuous, such that the light cannot be captured in a single image. For particularly large lights, it may be necessary to change the 3d:DrawingMaxSize parameter, visible when the Show Expert + Parameters box is checked, which limits the perimeter of a light. The default for this is 10000 mm.

● Scan Pattern

Scanning for Acuity localization is carried out the same way as for the laser alone, starting and stopping the scan from the MobilePlanner software. When scanning for Acuity, make sure you drive the AMR underneath each light that is visible from any point you want the AMR to go. This generally requires more driving than for a laser-only scan.

For a space that is about 30 x 30 meters, the following path was used for the scan.

The image below shows the map created based on the scan above. Lights are represented as light blue rectangles on the map created from this scan.
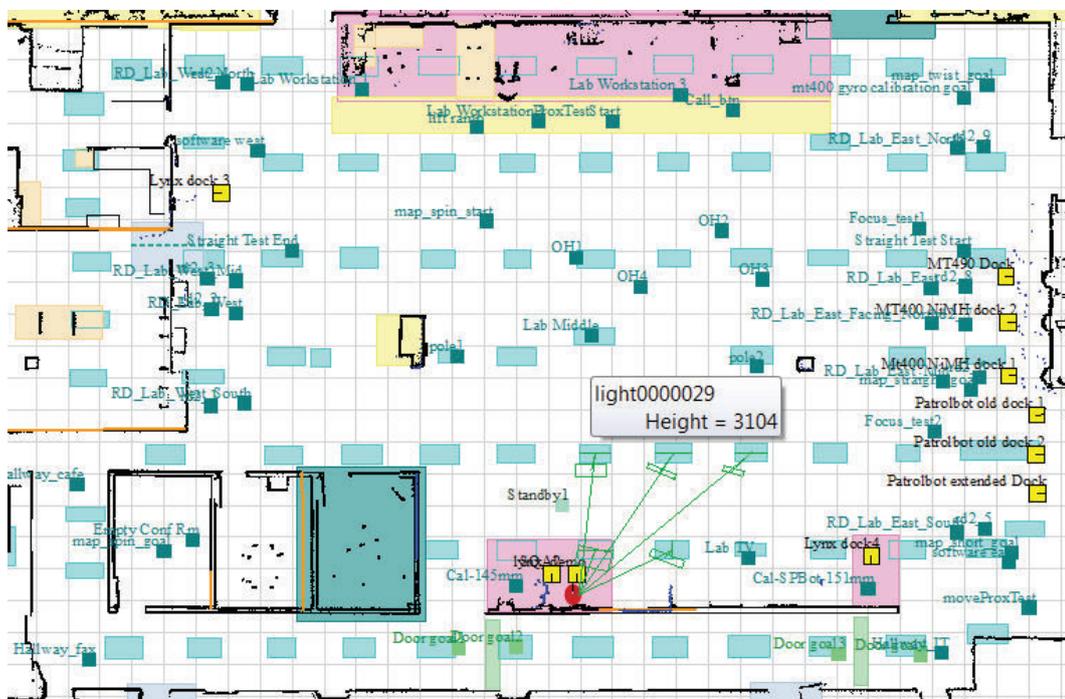
● Lights at Multiple Heights

The scan contains the necessary data for all of the lights in the environment. When creating a map from the scan, specify a height range for the lights you want included in that map. If the environment has lights at multiple heights, you will need to create multiple maps from one scan, using

different light heights. You will then insert the appropriate map sections into the initial map, which will add the lights from the adjusted light height range. This needs to be done for as many different light heights as there are in the environment.

Creating a Map Procedure

After finishing the scan, use the following procedure to create a map:

1 Open the scan file on the AMR using MobilePlanner > File > Open on Robot.
  • Select the IP address of the AMR.
  • Both a .2d and a .z2d version of the scan file you just created will exist on the AMR. Choose the .z2d version of the scan file, which contains both the light data and laser data.
  The laser scan will be processed first, followed by the extra processing for the lights. If all of the parameters were set properly, the light blue light items will be visible on the map overlaid on the points and lines from the laser data.
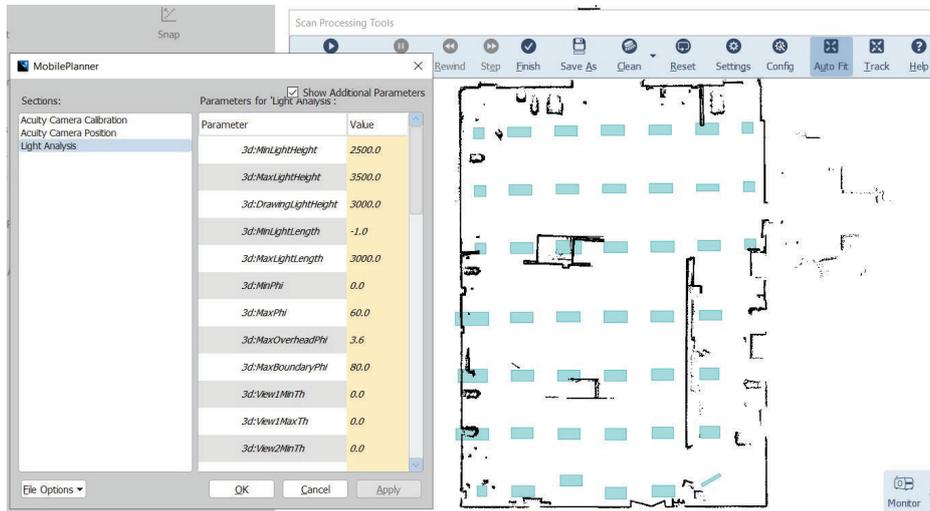
2 If you are satisfied with the map:
  1) Verify that the lights are where they should be, and their general dimensions are accurate.
  2) Save the map to the PC.
     If there are lights at multiple heights, do not click Finish on the Scan Processing Tools toolbar.
  3) Click Save on Robot, then select the IP address of either the AMR or the EM, if the AMR is part of a fleet.

3 If you are not satisfied with how the lights appeared on the map, click Config on the Scan Processing Tools toolbar to open the configuration dialog box. This gives access to the Light Analysis parameters, which can be changed as needed:
  • 3d:MinLightHeight
  • 3d:MaxLightHeight
  • 3d:MaxLightLength
  • 3d:DrawingMaxSize
  In the preceding image, the light length was 2.5 meters, so the default light length of 2 meters was too restrictive and needed to be changed.

Creating a Revised Map Procedure

Use the following procedure to create a revised map after saving the initial map, which included lights within the initial height range specified.

Additional Information

Do not click **Finish** on the Scan Processing Tools toolbar.

1 Click Config and change the 3d:MinLightHeight and 3d:MaxLightHeight parameters to bound the next light height in your environment.

2 Click Apply, and say Yes to the pop-up.
Applying the changes will cause only the light map to reprocess.

3 Verify that the lights are where they should be, and their general dimensions are accurate.

4 If you are satisfied with the appearance of the lights in this height range, save the new map with a different file name.

5 Repeat these steps for as many different light heights as are needed.

Inserting a Map Procedure

Use the following procedure to insert a map on the AMR.

1 Open the initial map file.

2 Select File > Insert Map.

3 Select the map file you want to insert. The figure below shows an inserted map.
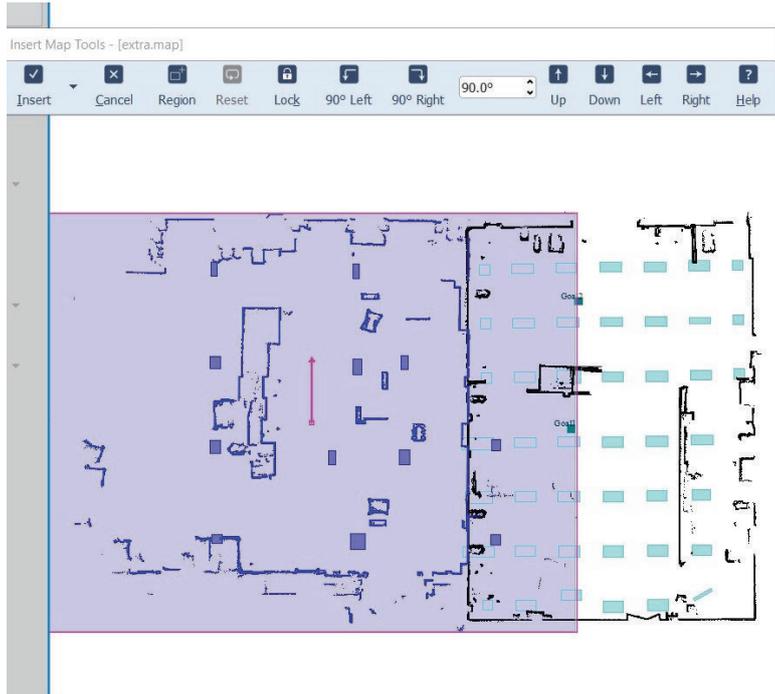
4 Click and drag the purple highlighted map to line it up with the initial map.

1) Try to get the features of the two maps close, dragging the purple insert.

2) Zoom in very close. The two laser maps should align perfectly, as they are identical maps with only differences in the lights. The figure below shows the two laser maps aligned.
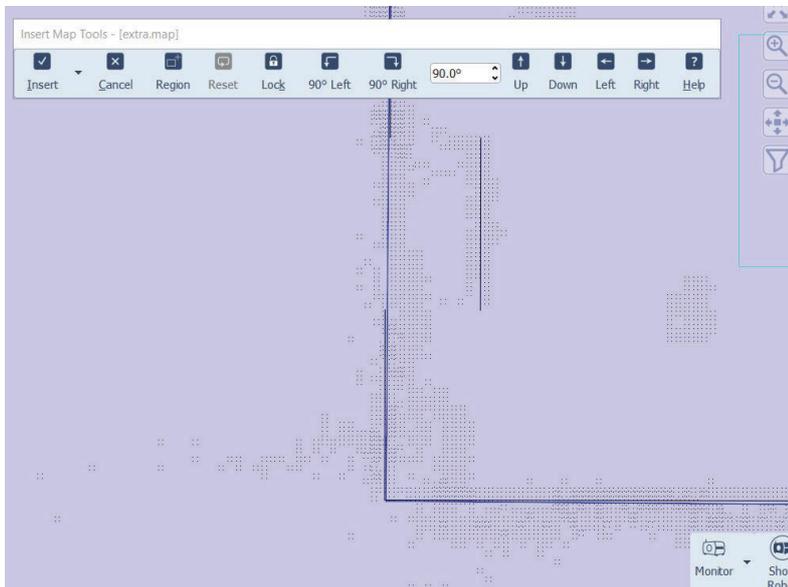
3) Click Insert to complete the insertion.

5 Zoom back out and use the Region Tool, from the Insert Map Tools toolbar, shown below, to click and drag a rectangular region that includes the lights you want inserted.
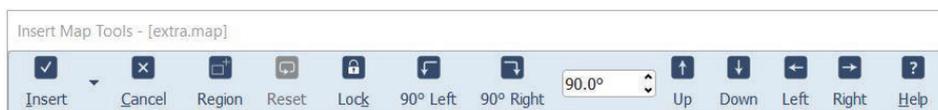
6 Click the dropdown arrow next to the Insert button on the Insert Map Tools toolbar and click Advanced.
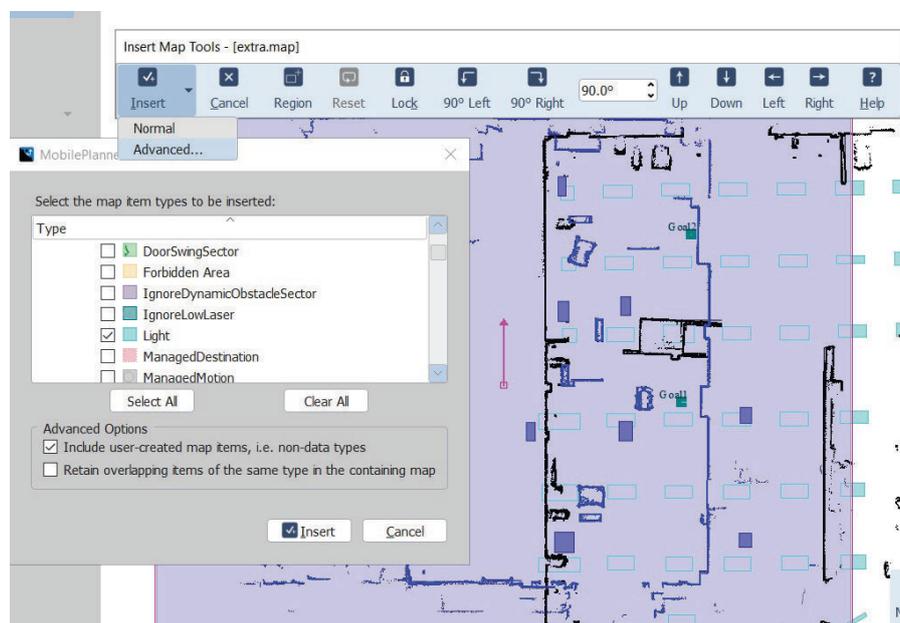This will open the Advanced Insert dialog box.

7 Click Clear All, then select just the Light check box in the Advanced Areas section.

8 In Advanced Options, check the boxes as shown in the figure below:

• Include user-created map items, i.e. non-data types.

• Retain overlapping items of the same type in the containing map.

If lights of different types are physically behind one another in the environment it may be necessary to scan that space twice, once with just each light type exclusively. This means that you would have to turn off lights at one height, then scan, and repeat with only the other lights turned on.

9 Click Insert on the Advanced Insert Dialog box and save your changes.

10 Repeat the steps in this section for all other map areas with different light heights.

11 If you are satisfied with the map:

1) Save it to your PC.
   If you have lights at multiple heights, do not click Finish on the Scan Processing Tools toolbar.

2) Click Save on Robot, then select the IP address of either the AMR or the EM, if the AMR is part of a fleet.

After mapping, do not manually move, resize, reorient, or otherwise modify the light items on the map.

If lights did not result as expected, some combination of parameter changes should allow reprocessing of the scan in order to achieve better results.

3-11-5   Other Acuity Adjustments

The following sections provide details about Acuity localization operation.

Localizing Manually

It is very important to localize the AMR well by hand when starting it on a new map for the first time, or re-localizing if it became lost. It is possible to offset the AMR up/down or left/right by a row of lights. This will cause the AMR to think it is one row of lights from where it really is, so it will not be able to drive to Goals, and might drive into Forbidden Areas.

Note that even with laser localization disabled, the laser stays active for obstacle avoidance, so the AMR will not run into physical objects.

After the initial localization, the AMR will continuously verify and adjust its position on the map as it moves through the environment.

Interpreting Light Objects on the Map

Lights are represented by light blue rectangles. If lights do not appear on the map, enable their display by using the Map > Map Data > Light Items menu item in MobilePlanner.

From Map > Robot Data > Other Robot Data:

- LightMatch compares the lights that an AMR has detected with its camera to the lights on the map. Light matches are displayed in green.
- LightMisses shows lights that are seen by the camera and meet the criteria for a proper light, but which do not match a known light on the map. Light misses are displayed in magenta.
- Lights3d displays all lights in red, regardless of their match or miss status. Generally this is left off to prevent cluttering the display.

3-12 Wireless Antenna Relocation Procedure

Use the following procedure to relocate the wireless antennas. This procedure details the relocation of one of the antennas and should be repeated if both antennas need to be relocated.

Precautions for Correct Use

It is the end user's responsibility to ensure that the payload does not attenuate the wireless antennas' signal.

The Wireless Antenna Extension Kit (part number 68955-000) includes the following items.
- Two low loss extension coaxial cables (2 m)
- Two low loss extension coaxial cables (0.6 m)
- Two dipole antennas with reverse SMA plug and 90° pivot (137 mm in length)

Additional Information

- The maximum thickness of the antenna mounting surface should not exceed 3 mm.
- Ensure the hole to mount the antenna in the new location is 6.5 mm in diameter.

The following tool is required for this procedure.
- 8 mm wrench

1 Shut down the AMR by pressing the OFF button on the Operator Panel.

2 If your AMR has a top plate, unscrew and remove the antenna by hand from the antenna connector on the top plate. Proceed to step 4.

3 If your AMR does not have a top plate, unscrew and remove the antenna by hand from the antenna connector (ANT 1 or ANT 2) on the right side of the AMR Core.

4 Connect the female end of the extension coaxial cable to the antenna connector from which you removed the antenna.

5 At the mounting location, insert the male threaded connector on the other end of the extension coaxial cable into the mounting hole and tighten the nut with the wrench.

6 Screw in the antenna to the male threaded connector and tighten by hand to complete the procedure.
You could reuse the antenna that was removed or use a new antenna that came with the kit.

3-13 Attaching Warning Labels

A No Riding warning label is provided with the AMR. This must be placed in a prominent location on a flat, horizontal surface on the payload structure or AMR itself, where a person could sit or stand. The label should be placed where the operators will see it and must be visible from at least two opposing sides of the AMR.

Additional Information

- All other warning labels are attached at the factory.
- When replacing the payload structure, you must place the provided labels on the new payload structure surface and follow the instructions noted above.
- Any additionally required safety labels for the payload structure or specific to the end-use application shall be evaluated by the user as part of the risk assessment.

3-14 Commissioning

The commissioning procedure is executed within MobilePlanner. Refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information. It is used to confirm the correct operation of the following equipment and functions:

- Emergency stop button on the Operator Panel
- User-supplied emergency stops

You must repeat the commissioning procedure under the following circumstances.

- Detection of an abnormality in any safety mechanism.
- Adding user-supplied E-STOP.
- During regular preventative maintenance procedures.

> **Additional Information**
>
> The AMR has a linear speed limit of 300 mm/s and a rotational speed limit of 18 degrees/s when it is in a decommissioned state. A protective stop will occur if these speeds are exceeded while in a decommissioned state.

3-14-1 Commissioning Procedure

This procedure verifies the correct safety stop functionality when any and all E-STOP buttons are pressed. You must repeat this procedure for every E-STOP button in the system.

> **Additional Information**
>
> Ensure that there are no E-STOP buttons depressed before beginning this procedure.

1 Connect to the AMR and start the MobilePlanner software.

2 Access the *Main Menu > Robot > Commissioning* area.

3 Follow the on-screen instructions to complete the test.
You can print a certificate after successful completion of the commissioning.

3-15 Map Creation Overview

A map is a scanned representation of the floor plan in the AMR's operating space. Maps contain the static features in the AMR's environment, such as walls, doors, permanent shelving, etc. They also contain user-definable sectors, lines, and areas that help the AMR perform its Job. Maps also contain a variety of Goals, Routes, and Tasks that comprise the destinations and activities of the AMR in the workspace.

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

> ⊲⊱ **Precautions for Safe Use**
>
> For optimal performance of an LD-series AMR in a fleet, use a map created by an LD-series AMR for the area in which it operates.

The AMR's Safety Laser Scanner scans the workspace to create the map. The laser scans only a narrow horizontal plane, parallel to the floor. The scanning plane height is 190 mm above the floor, so the laser cannot detect physical features above or below this plane, or features that are out of operating range and resolution. This means that some features are not recorded on the map such as overhanging objects like shelves or tables with narrow supporting legs. Other features that are below the scanning plane may not be recorded, such as low lying objects like a column base or a pallet that contains no cargo.

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

If the workspace has open stairwells, docks, ledges or other vertical drops, make sure that you surround such areas with physical barriers. Barriers must be detectable by the Front Safety Scanner's scanning plane, which are at a height of 105 mm from the floor. Install the barriers before mapping a workspace.

A connected Pendant is required to drive the AMR while creating the map. Refer to *4-16-1 Driving with the Pendant* on page 4-38 for more information.

To ensure the map is accurate, drive the AMR under the following conditions.
* Minimal or no payload.
* Drive at low rotational speed and acceleration.

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

* Forbidden Lines and Areas: areas in the workspace where an AMR cannot enter or move across.
* Movement parameters sectors: areas where an AMR must travel within a specified speed range.
* Preferred lines: paths that you specify on the map which the AMR must consider when planning the most efficient path to follow autonomously to its Goal.
* Preferred-direction zones: areas where the AMR will prefer to travel in a specified direction. In a typical preferred direction zone (such as a narrow hallway), there is an opposite direction that you want the AMR to avoid. Use a preferred-direction zone to keep the AMR to the preferred side of a hallway. The AMR is able to travel on the alternate side of the zone if the preferred side is blocked.

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

> **Additional Information**
>
> Refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for complete details about workspace map creation.

3-15-1 Basic Mapping Tasks

The basic mapping tasks are provided below. Refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for complete details about mapping tasks and functions.

• Install the Docking Station before you create a map file. The Docking Station's triangular back will be helpful in locating it on the map.

• Drive the AMR around the workspace multiple times, and from various directions. Also, begin and end your mapping process at the same location for the most accurate results.

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

• Add Job-related features such as Routes, Goals, and Docks (targets) to your map.

• Transfer the working map to the Fleet Manager when multiple AMRs are present, or back to the AMR if you have only one in operation. The Fleet Manager automatically uploads the new map to each AMR in your fleet as soon as the AMR becomes idle.

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

4

Operation

This section provides information about the operation of the AMR.

4-1　Payload Movement and Transfer

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

During movement and transfer, you must actively monitor and confirm the transfer operation to make sure that it completes successfully. If any operation fails, a fail-safe interlock must trigger an AMR emergency stop condition. This emergency stop condition prevents the AMR from moving until the problem is resolved and confirmation that it is safe to restart operation has occurred.

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

4-2   AMR Start-up

Ensure the battery is sufficiently charged before attempting to start-up the AMR. Refer to *4-8-4 Charging the Battery* on page 4-21 for more information.

Press and hold the power ON button for half a second, then release. It takes about one minute for all the systems to start-up and make their various interconnections. The AMR Core, navigation lasers, and auxiliary power systems automatically start when you press the ON button.
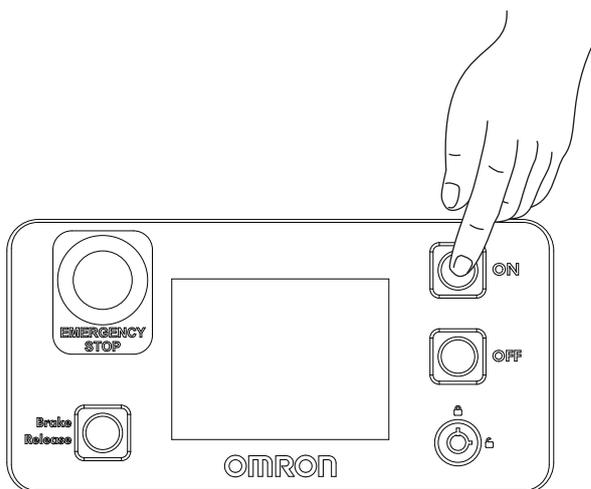
⚠ WARNING

| Implementing methods to circumvent the need for a person to enable the AMR's motor power at start-up is prohibited. | ⚠ |

🔊 **Precautions for Safe Use**

If you suspect that liquid has penetrated the skins or contaminated the AMR's interior, do not attempt to power ON the system and contact your local OMRON representative.

During normal start-up, the AMR powers all of its systems, including all factory and user configurations. It then automatically runs its on-board software and customer integrated processes to provide an application-ready AMR. If a map has been created and stored, and the AMR is localized, you need to press the ON button a second time to enable motor power, for autonomous operation start-up. Absent localization, you need to plug in a pendant in order to move the unit. After the initial, localized start-up is complete, the AMR will be capable of operating autonomously. Refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for information on map creation, start-up procedures, and localization.

4-3 AMR Shut-down

Pressing the OFF button will shut down the AMR in a controlled manner. The system will save the AMR's last known location so it can automatically localize when it is powered ON later.
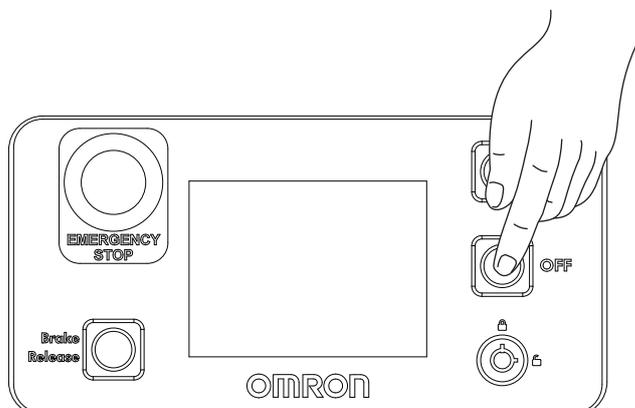
When the AMR is shut down using the OFF button, it enters a standby state. In this state, some systems remain active and consume low power. For prolonged periods of AMR shut-down, use the OFF button and then disconnect the battery to prevent battery drain.

Precautions for Correct Use

- Avoid moving the AMR while it is powered OFF. If you manually move the AMR while it is powered OFF, it may not be able to determine its current location when it is powered ON again. Use the localization feature in MobilePlanner to localize the AMR if this occurs.
- Do not use the battery button to turn OFF the AMR. Turning the battery OFF while the AMR is ON results in an uncontrolled AMR shutdown. Always use the AMR OFF button on the Operator Panel to turn the AMR OFF in a controlled manner

4-4   AMR Core LED Indicators

The AMR Core has 12 indicator LEDs that give a visual overview about its status. The following figure displays the AMR Core LED indicator lights.
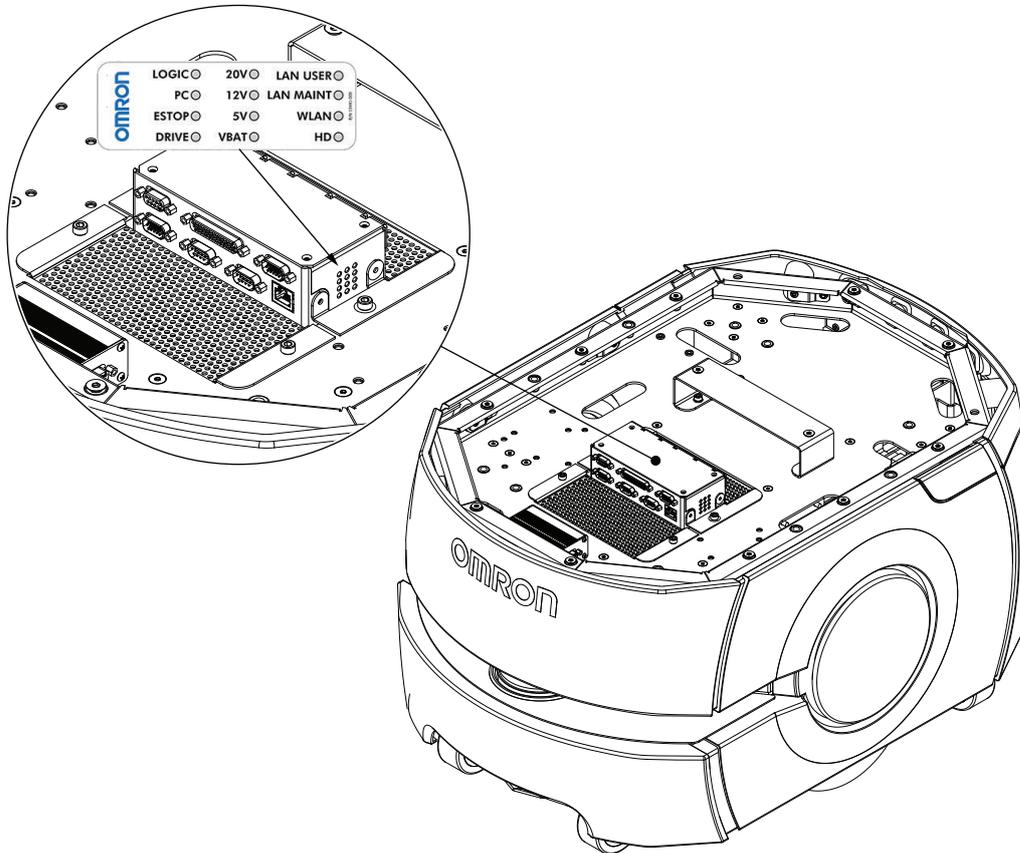
The following table describes the AMR Core LED indicator activity.

LED Indicator	Description
LOGIC	AMR Core power indicator.
PC	AMR Core and servo controller communication status.
E-STOP	Emergency stop circuit status. LED is ON when the emergency stop circuit is open.
DRIVE	AMR drive wheels status. LED is ON when drive wheels are under servo control.
20V	20 V power is available.
12V	12 V power is available.
5V	5 V power is available.
VBAT	Unregulated battery power is available.
LAN USER	LAN 2 Ethernet status. LED is ON when there is data traffic.
LAN MAINT	Maintenance Ethernet status. LED is ON when there is data traffic.
WLAN	WiFi Ethernet status. LED is ON when there is data traffic.
HD	AMR Core internal hard drive status. LED is ON when the AMR Core is writing data to, or reading data from, the internal hard drive.

4-5   Workspace

The workspace is considered to be any area where the AMR will travel. It must be carefully evaluated and prepared before the AMR is placed into operation. Use the information below to adapt your workspace for optimal AMR performance.

The workspace must be flat, free of clutter and debris, and have adequately wide doorways and corridors to allow navigation by an AMR.

> ## ⚠ WARNING
>
> Do not allow the AMR to operate in areas that are used for emergency personnel evacuation. 🛈

> ## ⚠ CAUTION
>
> Do not allow the AMR to operate in areas that are used for emergency personnel evacuation. 🛈

Precautions for Safe Use

Bright, direct, or high-intensity light can interfere with the AMR's laser operation. Do not operate the AMR in areas where it may be exposed to these conditions.

Precautions for Correct Use

- The AMR is designed and intended to operate on smooth floors. While it is capable of driving over a step or gap, frequent or high-speed driving over steps or gaps will shorten the lifespan of the drive train components.
- Do not operate the AMR on soft surfaces such as carpet.

Floors must provide good traction, typical of good walking conditions. Rough or uneven floors can affect safety of the AMR's operation as the lasers' sensing plane is not always parallel to the floor.

If operation is required in areas where an approaching AMR's visibility is obstructed, such as blind corners and doorways, perform a risk assessment and apply appropriate mitigation techniques according to applicable standards.

Take measures to keep problematic objects away from the AMR's path and operating area. Some examples of problematic objects are:

- Transparent doors, walls, or barriers.
- Floors with access panels removed.
- Cables, hoses, etc.
- Highly reflective objects.
- Chain-link fences.
- Overhanging objects.
- Objects that are supported by posts or legs (chairs, desks, ladders).

If an obstacle has protrusions outside of the plane of the AMR's Safety Laser Scanner, or indents in this plane, then the AMR will underestimate the obstacle's size. This will reduce the effectiveness of the AMR's protective clearances, or in extreme cases, lead to collisions. Optional Side Lasers may be

required to detect obstacles with these features. The AMR's Low Laser mitigates the risk presented by protrusions near the floor that are below the plane of the Safety Laser Scanner. Optional Side Lasers may also be required if an overhang or protrusion might cause the AMR to encounter obstacles that are not visible to the Safety Laser Scanner or the Low Laser.

Make the following considerations when traversing steps or gaps.

- Observe the maximum step and gap traversal details provided in *2-3-1 AMR Environmental Specifications* on page 2-11
- Frequent driving over steps or gaps will shorten the lifespan of the drivetrain components.
- Avoid steps or ledges taller than the AMR's specified step-traversal ability.
- The AMR might not be able to traverse the step height specified when traveling at lower speeds.
- Steps should have smooth, rounded profiles.

Regularly maintain the workspace as follows:

- Immediately remove any material on the workspace floor, such as dust, dirt, grease, ice, or pooled liquid. Objects on the floor might interfere with safe driving and accurate navigation. Any material that affects the drive wheel traction impairs the AMR's ability to drive, stop, turn, and navigate. Pay particular attention to Goal locations and commonly traveled paths.
- Keep the AMR workspace clean and free of movable transient objects such as pallets, carts and furniture. Any objects that block the mapped permanent features of the workspace (such as walls, columns and doors) can interfere with navigation, causing the AMR to be less efficient.
- Keep the floor of the workspace free of dust, debris, grease, or liquids. A floor that is not clean can impact AMR traction and cause dust accumulation on laser lenses which may lead to AMR operation disruption.
- If the HAPS option is installed, inspect and clean or replace HAPS magnetic tape.
- If you make a permanent change to the workspace, such as by installing a large fixed machine, consider re-mapping the impacted area to incorporate the change, particularly if the change blocks the AMR's ability to scan original workspace features.

4-5-1   Physical Barriers

Use physical barriers together with logical barriers (map restrictions) to prevent the AMR from approaching any fall hazards or other critical locations that are within its operating area.

> ## ⚠ WARNING
>
> - The AMR can cause serious injury to personnel or damage to itself if a dangerous area is not properly configured in the map and blocked with a physical barrier.
> - A physical barrier must be easily detectable by the AMR and also strong enough to stop a fully-loaded AMR traveling at its maximum speed.

Such areas may include:

- The edge of a loading dock or ramp.
- Entrance to downward stairs.
- Any other vertical drop that exceeds the AMR's maximum step height.
- Fire doors, firefighting equipment, access to stairways and exits, and all emergency shutdown switches in the facility.

Required characteristics of physical barriers are listed below.

- The barrier must be attached to a solid wall or floor and should be strong enough to stop a fully-laden AMR traveling at maximum speed.
- The barrier must extend around the hazard completely.

- Mark all physical barriers to make sure that the AMR's Safety Laser Scanners can detect them easily.
- Barriers must extend above and below the laser's sensing plane, particularly if the floor is not flat.
- Barriers should be flat and perpendicular to the Safety Laser Scanner sensing plane.
- The minimum detectable size of a barrier is 300 mm x 300 mm and must be mounted no higher than 100 mm from the floor.

4-5-2 Logical Barriers

In addition to physical barriers, use MobilePlanner to create Forbidden Areas or Lines as logical barriers on the workspace map to prevent AMRs from closely approaching a fall hazard. These map features assume proper AMR localization. These restrictions must be continuous so that the AMR cannot plan a path around the logical barrier. If the AMR is not able to properly localize its current position, it may enter the Forbidden Areas. You must always install physical barriers where there is a risk of property damage or safety hazard.

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

4-5-3 Obstacles

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

Positive obstacles are those which would block the AMR's path. Detecting positive obstacles is the primary and recommended use for Side Lasers.

Negative obstacles are voids in the driving area of the AMR, such as downward stairs, loading docks, or missing floor tiles. Negative obstacle detection with Side Lasers should not be used as the primary method for avoiding negative obstacles. It is intended to be used as a secondary method of detection. Primary methods employ traditional safety techniques to aid avoiding negative obstacles, such as blocking off areas or restricting traffic in dangerous areas.

Negative obstacle detection by the AMR is implemented in software only and does not consist of CAT 3/PLd safety lasers. A test plan should be developed and executed prior to adding new functionality to equipment that currently exists in a production environment. Perform testing with each specific application and configuration to ensure the AMR's safety. Test detection after changing parameters for each different expected obstacle. Dynamic testing must be completed for any payload design, at field application speed to ensure AMR safety.

4-5-4 Environmental Hazards

Environmental hazards create unsafe AMR operating conditions. Provide physical barriers that the AMR can detect accurately with its Safety Laser Scanner so that it does not attempt to drive near the hazard.

4-5-5   Restricted Zones

Restricted zones are areas of inadequate clearance which cannot be protected by the AMR detection devices.

You may need to provide physical barriers that the AMR can detect accurately with its Safety Laser Scanners so that it does not attempt to drive near these areas.

Only authorized persons are permitted to enter restricted zones.

You may need to implement map features such as Forbidden Areas to keep AMRs within their designated area of operation. Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for information about adding restricted zones to your workspace map.

4-5-6   Operating Hazard Zones

Operating hazard zones are areas between the AMR and an obstacle that would not leave sufficient room for a person to escape and avoid getting crushed. These are areas of inadequate clearance less than 500 mm between the sides or front / rear of the AMR and an obstacle. It can also be an area which cannot be protected by the AMR's detection devices.

You must make these areas visually distinct. Personnel that will work near these zones must be trained and informed about your chosen method used to make hazard zones visually distinct.

4-5-7   Confined Zones

Confined zones are areas of inadequate clearance where the AMR detection devices may be omitted, at any speed.

4-5-8   Payload Transfer Stations

Payload transfer stations are designated areas where the payload is transferred to or from the AMR. When the payload transfer stations are outside the restricted or confined zones, these stations shall be designed to prevent personal injury by the rigid parts of the AMR or its payload. These payload transfer stations shall be designated as operating hazard zones as defined in this section of the manual.

4-6 Clearances

The AMR must operate in an environment that is generally flat, with no doors or other restricted areas that are too narrow for the AMR to pass through. The AMR is designed to operate in environments that contain doors, passageways, or other constrained areas that are wide enough for it to traverse. You must ensure that adequate clearance is maintained on each side of the AMR, so that a person cannot get trapped between the AMR and a wall or other fixed object. The AMR must not navigate through doorways or pathways that are intended for personnel unless there is adequate room for both to pass without risk, and without interfering with travel paths per applicable standards.

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

An exception to side clearance requirements may apply at pickup and dropoff locations, where the AMR must get close to conveyors or other fixed objects.

⚠ CAUTION

It is the end user's responsibility to ensure that a clearance of 200 mm from the edges of the AMR or payload structure is maintained when it is traveling below 225 mm/s (LD-90 and LD-90x) or 300 mm/s (LD-60).

Precautions for Safe Use

You must have floor markings at Docking Stations and pickup / dropoff locations with adequate clearance to prevent people from entering these hazard zones.

Additional Information

Refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for information about software parameters that you can use to control the AMRs front and side clearance zones. These settings can help to prevent the AMR from closely approaching obstacles.

4-6-1 Rotational Clearances

The AMR travels in forward and backward directions and can rotate on its center of rotation (turns in place). When the AMR is rotating in place, adequate clearance must be provided.

Objects in the areas shown below (near the sides of the AMR) are not within the sensors' range and will not be detected while rotating in place. Refer to *2-4-1 Laser Specifications* on page 2-13 and *2-4-10 Sonar Sensor Specifications* on page 2-16 for more information.

Front
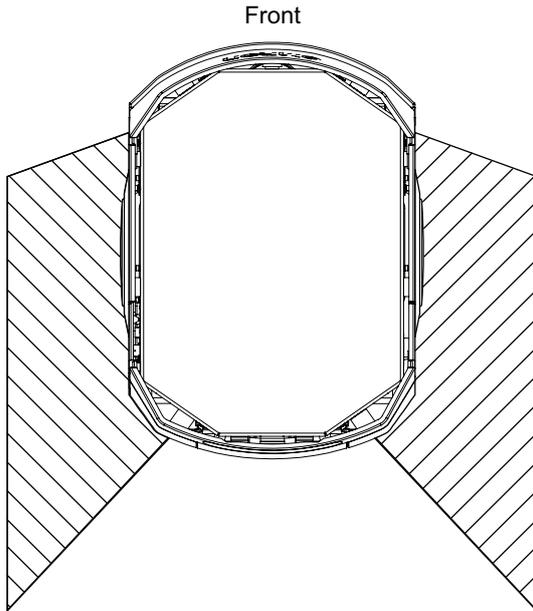
📋 **Additional Information**

The AMR's Light Discs display a distinct turn signal pattern when it rotates. Refer to *4-15 Light Discs and Optional Beacon States* on page 4-34 for more information.

4-6-2 Docking Clearances

Set a 1500 mm distance between the Docking Station Goal (defined in the map) and the dock Goal position of the AMR using MobilePlanner. This distance provides sufficient room for the AMR to align with the Docking Station during the docking operation. This distance is measured from the Docking Target to the center of the AMR.

⚠ **CAUTION**

Do not place any objects between the Docking Station and the AMR.

Docking Station

Dock Goal
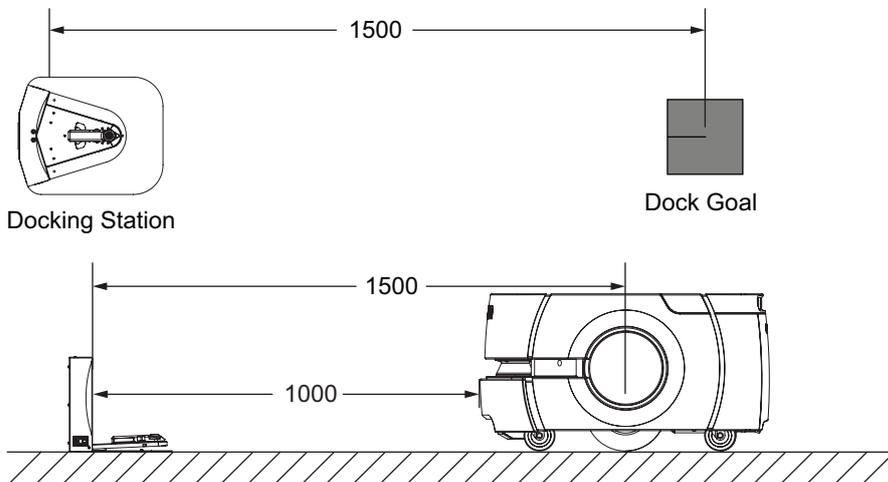
When docked, the distance between the AMR and the Docking Target is less than 500 mm.

When docked, the distance between the AMR and the Docking Station is approximately 50 mm. Operating areas where the clearance between the AMR and its surroundings is 500 mm or less are considered hazard zones. You must make these areas visually distinct. Personnel that will work near these zones must be trained and informed about your chosen method used to make docking area hazard zones visually distinct. An example of this is shown below, utilizing floor markings to draw attention to the docking area hazard zones.
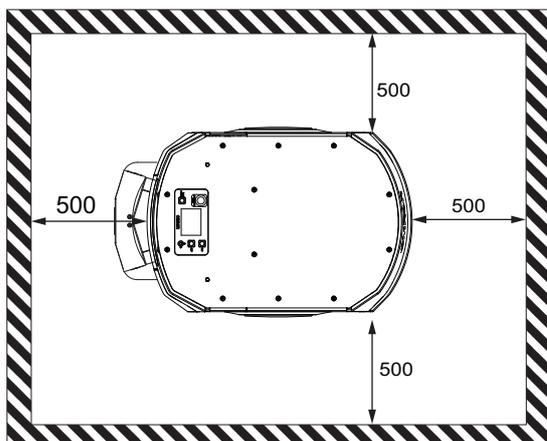
4-6-3 Narrow Passageway Behavior (Linear)

The AMR can travel at its maximum speed through linear passageways that are at least 1700 mm (LD-60) / 1200 mm (LD-90 wide.
The AMR may slow if it detects any other moving objects beyond this width.

📓 **Additional Information**

- Use the Door Goals feature on the map for pre-alignment when the AMR travels through narrow passageways.
- Contact your local OMRON representative for LD-90x passageway minimum width.

4-6-4 Narrow Passageway Behavior (Corners)

The AMR will travel between 300 mm/s and 500 mm/s when traversing narrow passageways with dimensions detailed in the illustration below.
Make AMR Tasks and configuration changes to optimize operation in narrow passageways with corners.
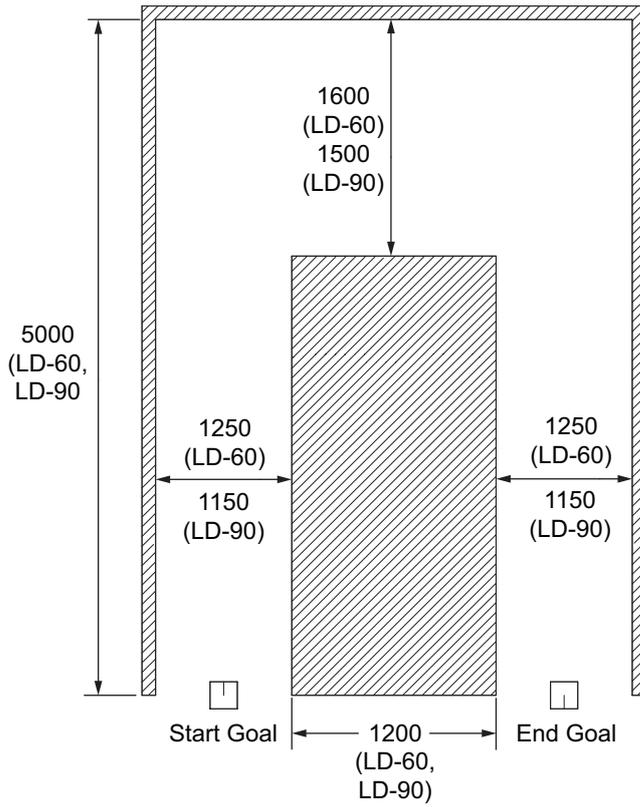
Additional Information

Contact your local OMRON representative for LD-90x passageway speeds and passageway dimensions.

4-7 Immobilization

In rare circumstances, it is possible for the AMR to become physically immobilized in a position from which it cannot move without operator assistance. Immobilization may also occur from a low battery or AMR error.

⚠ WARNING

Immobilization might cause motors in the AMR to overheat, resulting in a fire.

> **Additional Information**
>
> Side Lasers increase detection of overhanging objects and floor obstacles.
> Refer to *1-6-5 Side Lasers* on page 1-21 for additional information.

Some examples of physical immobilization are shown in the following figure.

AMR Immobilized by Overhanging Object — AMR Immobilized by Excessive Ledge — AMR Immobilized by Excessive Gap
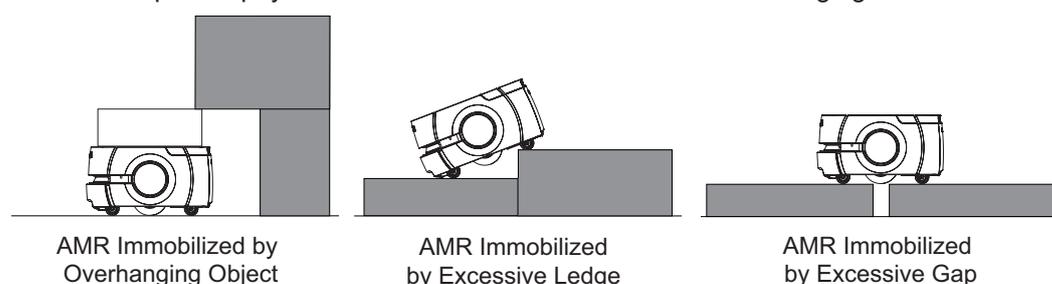
Refer to the following sections for information about recovering from immobilization.

- *6-4 Lifting the AMR* on page 6-5
- *4-10 Releasing the Brakes* on page 4-28.
- *4-11 Manually Pushing the AMR* on page 4-29.
- *5-2-2 Low Battery Recovery* on page 5-5.
- *Section 5 Troubleshooting* on page 5-1.

4-8 Battery and Charging

The AMR battery supplies adequate power for the motors, electronics, and accessories.

Typical runtime with no load is approximately 15 hours. Typical fully-loaded runtime is approximately 12 hours. The primary factors that affect runtime are AMR speed, acceleration, idle time at Goal locations, payload amount, and power consumed by accessories.

There are three ways to check the battery's state-of-charge (SOC) percentage (%):

• LED indicators on the battery.
• Operator Panel screen.
• MobilePlanner software.

All onboard systems function continuously while the battery recharges inside the AMR.

The charging contacts on the AMR and Docking Station become energized when they are properly connected. They are deactivated when the AMR is disengaged from the Docking Station.

Precautions for Safe Use

• Avoid shorting the battery terminals or connectors.
• Do not allow the battery to remain discharged for an extended period of time.

Additional Information

• The battery can be unplugged from the charging source during the charging operation without causing damage.
• Refer to *5-2-3 Battery Charging Problems* on page 5-5 for more information.

4-8-1 Battery Indicators and Controls

The battery includes four status LEDs and one button.
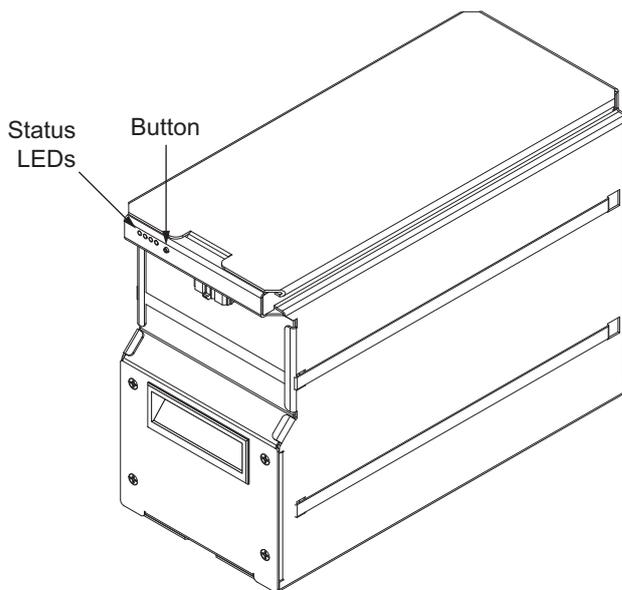
The button is used to turn the battery ON and OFF while it is removed from the AMR. Use the AMRs ON / OFF button on the Operator Panel to control the battery while it is installed in the AMR.

Precautions for Correct Use

Do not use the battery button to turn OFF the AMR. Turning the battery OFF while the AMR is ON results in an uncontrolled AMR shutdown. Always use the AMR OFF button on the Operator Panel to turn the AMR OFF in a controlled manner.

Pressing the button momentarily while the battery is ON will show the approximate charge level with the four LEDs as described in the table below. Use this method to determine the approximate charge level when the battery is removed from the AMR. Use the AMR's Operator Panel display to see an accurate charge level when the battery is installed in the AMR. The charge level is also displayed while the battery is charging.

If a battery problem is present, the Status LEDs will display a pattern representing an error code. Refer to *5-2 Battery Problems* on page 5-3 for more information.

LED State	Indication
○○○○	Battery is OFF or internal hardware problem.
●○○○ (red)	A battery problem has occurred. Refer to *5-2 Battery Problems* on page 5-3 for more information.
●●●● (flashing green)	Operating under normal conditions.
●○○○ (flashing green)	Less than 10% state of charge.
●○○○	10% to 25% state of charge
●●○○	25% to 50% state of charge
●●●○	50% to 75% state of charge
●●●● (last flashing green)	75% to 100% state of charge and balancing
●●●●	100% charged and balanced.
○: OFF ● : Solid Green ● : Flashing Green ● : Flashing Red	

Pressing the button for 10 seconds while the battery is ON will turn it OFF immediately. Use the button in this way when the battery is not installed in the AMR. The battery will automatically turn OFF after four hours of inactivity when it is removed from the AMR.

Additional Information

The details provided in this section apply to current LD batteries with a part number 20452-700. Previous generation batteries operate differently. Contact you local OMRON representative for more information.

4-8-2 Battery Removal and Installation

Removal or installation of the battery must be performed by persons who have read and understood this manual.

⚠ **WARNING**

- Do not damage the battery by subjecting it to impacts or shocks. Using a damaged battery can result in fire or other dangerous conditions.
- You must wear proper Personal Protective Equipment (PPE) when removing, installing, and lifting the battery or when working around a leaking battery.

Precautions for Safe Use

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

Precautions for Correct Use

Never remove the battery while the AMR is powered ON. Always turn the AMR OFF before attempting to remove a battery.

Additional Information

Inspect the empty battery compartment and remove any foreign objects before attempting to install a battery.

Use the following figure to understand the lifting points for the battery.
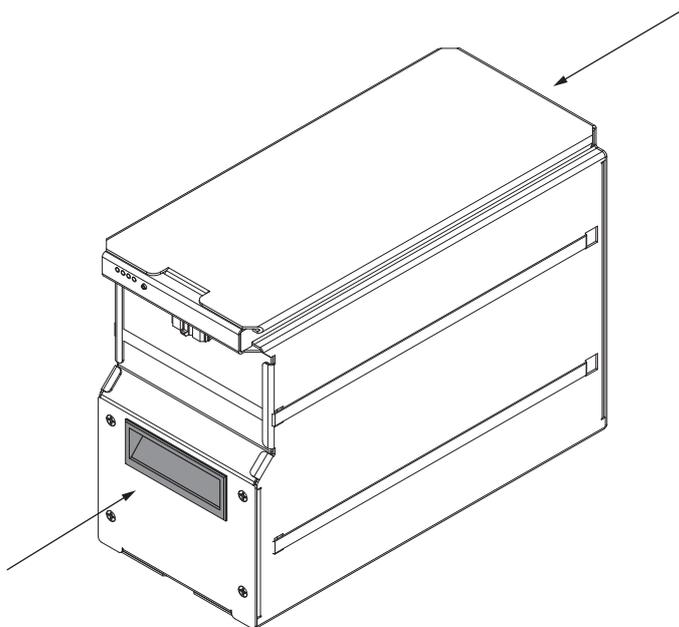
After installation, the AMR's software verifies the battery model and reports an error if the battery model is incorrect. This also applies to spare (backup) batteries.

Battery Removal Procedure

Use the following procedure to remove the battery from the AMR:

1 Shut down the AMR.

2 Remove the battery door skin to access the battery compartment. Refer to *3-3 Battery Installation Procedure* on page 3-11 for more information.

3 Unlatch and open the battery door by sliding the latch to the right, as shown in the figure below.


Battery Door Latch
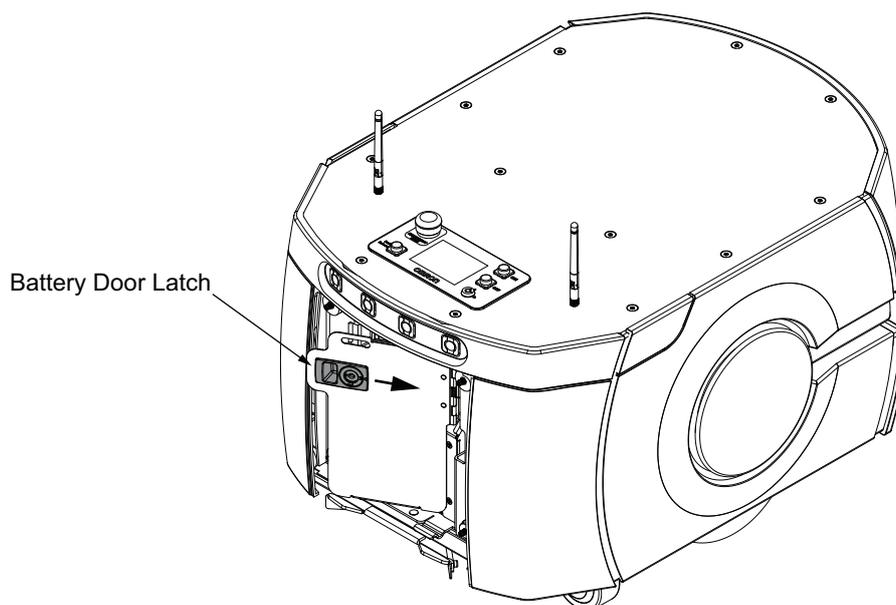
4 Take note of how the cables are routed, then disconnect the power and data cables.

![precaution icon] **Precautions for Correct Use**

Never remove the battery or disconnect the battery's data cable while the AMR is ON. Always power OFF the AMR and then disconnect the power and data cables before removing the battery.

5 Using the hand grip in the figure below, slide the battery out of the AMR.
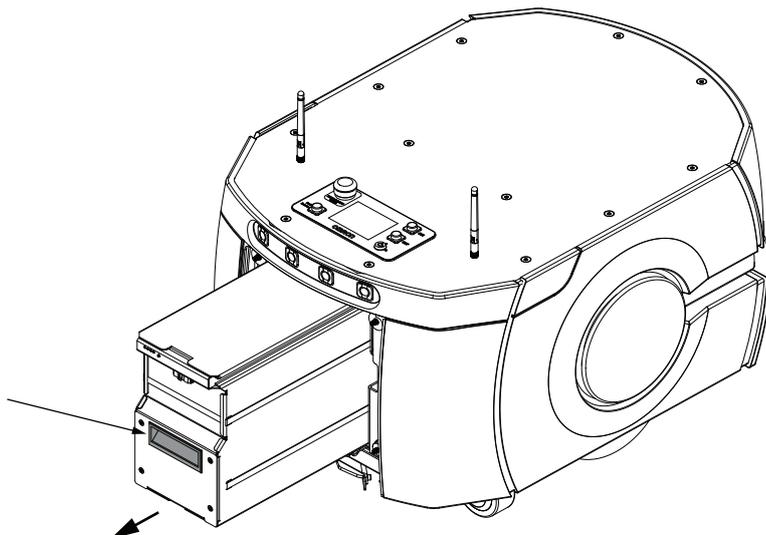
6 Support the battery at the bottom as you pull it in the direction of the arrow to prevent it from falling.

7 Pull the battery out and use the handles at the front and rear of the battery to carry it.
After the battery is removed from the compartment, this procedure is complete.

4-8-3 Docking Station

The Docking Station provides both manual and automated methods of recharging the AMR's battery. The Docking Station also provides an easily identifiable, triangular target for the AMR to locate when aligning for charging.

⚠ **WARNING**

The Docking Station charging contacts are energized when a magnet on the AMR is in close proximity. Do not place any magnetized objects near the Docking Station.

⚠ **CAUTION**

Do not place any objects between the Docking Station and the AMR.

Precautions for Safe Use

- Never access the interior of the AMR while it is connected to the Docking Station.
- In case of fire, use a type ABC or type BC dry chemical fire extinguisher.
- The Docking Station shall only be used to charge an LD-series AMR battery.
- Do not allow any foreign metal objects to be near the AMR or Docking Station charging contacts.

Precautions for Correct Use

The Docking Station can only be connected directly to the AMR or to one battery. Simultaneous charging configurations are not possible.

The Docking Station has a power switch and two indicator LEDs:
- Blue indicates that power is available.
- Amber indicates that a charge is in progress.

The power entry module is located on the Docking Station right side. An integrated circuit breaker activates if the Docking Station is overloaded. If this occurs, wait for the Docking Station to cool and then cycle the power.

Additional Information

Legacy Docking Stations do not include a circuit breaker. Refer to *6-8-5 Docking Station Power Switch Fuse Replacement Procedure* on page 6-27 for more information.

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

The AMR travels at a low speed when approaching the Docking Station in preparation for engaging with the charging paddle.

When the AMR successfully engages the charging paddle and the Docking Station determines charging is possible, charging will automatically begin.

The Docking Station outputs a maximum of 600 W of power and can charge an absolutely depleted battery in approximately four hours.

The following safety measures associated with high power transfer are described below.
- When the Docking Station detects an AMR or external battery, a series of interlocking checks are performed to confirm that all devices are in an operational state before charging will begin.

The Docking Station uses a 2.44 meter long power cord (rated for 13 A) to transfer power from a wall outlet to the Docking Station.

Additional Information

This power cord is for the docking station only and must not be used for other equipment.

4-8-4 Charging the Battery

A battery can be charged while inside the AMR or outside (removed from) the AMR.

Charging automatically begins when the Docking Station detects a connected battery, either inside the AMR when it is engaged with the Docking Station or when a battery is removed from the AMR and directly connected to the Docking Station. When the battery reaches 100%, the charging stops.

After receiving the battery, check its state of charge by pressing the SHOW LEVEL button. If the battery is in a low charge state, you must immediately charge to a full charge to avoid discharging the battery below a usable state, which would require battery replacement. Refer to *4-8-1 Battery Indicators and Controls* on page 4-16 for more information.

Precautions for Correct Use

The AMR must be powered ON in order to charge the battery while at the Docking Station.

Autonomous Charging

During normal operation, the AMR charges its battery autonomously by driving to the Docking Station under configurable conditions (battery level and opportunities). The AMR drives to the location of the

Docking Station based on the map loaded onto the AMR and it uses this information to autonomously recharge as configured.

When the AMR arrives near the Docking Station, it searches for a unique triangular shape integrated into the front of the Docking Station. The AMR uses this shape to locate the position of the charging paddle. After the Docking Station verifies that the AMR is present and connected, it performs a series of checks. After the checks are complete and it determines charging can proceed, it starts charging the AMR's internal battery. When the AMR's battery is recharged to capacity (100%), the Docking Station stops supplying a charge. Use the AMRs visual LED indicators to determine the charging state. Refer to *4-15 Light Discs and Optional Beacon States* on page 4-34 for more information.

> **Additional Information**
>
> There is a delay of up to 10 seconds between when an AMR docks and the amber charging LED on the Docking Station illuminates.

● **Autonomous Charging Considerations**

Make the following considerations when establishing your AMR charging strategy.

- The operating software monitors battery level and sends the AMR to a Docking Station if the state of charge is 10% or less. If anything prevents the AMR from recharging and the state of charge falls to 2% or less, the AMR will turn OFF.
- If one or more individual battery cells is discharged excessively, autonomous charging cannot start. Refer to *5-2 Battery Problems* on page 5-3 for more information.
- If the battery level becomes too low, the AMR is immobilized and autonomous charging will not be possible. User intervention will be required to recover. Refer to *4-7 Immobilization* on page 4-15 for more information.
- If an AMR is OFF or in an emergency stop state while docked, a Fleet Manager will consider that Docking Station as available and may send other AMRs to that Docking Station to charge.
- An AMR may occupy a Docking Station indefinitely after it is fully charged until it is commanded to another location.
- A Docking Station that has lost power is still considered available by the Fleet Manager until an AMR attempts to charge at that location. Use the *FailedDriveInAttemptsBeforeIgnore* parameter to determine when to ignore that Docking Station if charging attempts fail.
- By default, the AMR will automatically disengage from a Docking Station and then attempt to re-dock if Docking Station power is lost. This will only occur when the AMR is actively charging or attempting to charge.
- During typical operation, an AMR must be ON for charging to occur.
- The Docking Station supplies adequate power for all on-board systems while charging its battery. Significant loads may impact the time required to fully charge the AMR's battery.

Charging a Battery Outside of the AMR

Charging a battery outside the AMR is typically used for spare batteries. This method is also required if the AMR becomes immobilized due to a low battery.

The Docking Station provides a charging port on its left side. Charging a battery outside the AMR is accomplished by using the supplied manual charge cable with this port and connecting it directly to the battery. When the battery is connected to the Docking Station, a 10 second delay occurs during an automatic check sequence and then charging begins when the amber charging LED is ON solid.

Manually Charging a Battery Inside of the AMR

Charging a battery inside the AMR is accomplished by pressing the brake release button and pushing the AMR backwards onto the Docking Station. Do not push the AMR too far back. It should remain approximately 50 mm from the upright back of the Docking Station. Refer to figure below. Be aware that brake operation requires a small amount of battery power. If the battery is too low, it may need to be charged outside the AMR. When the battery is connected to the Docking Station, a 10 second delay occurs during an automatic check sequence and then charging begins when the amber charging LED is ON solid.

> ⚠ **CAUTION**
>
> Do not place any objects between the Docking Station and the AMR.

55 mm gap
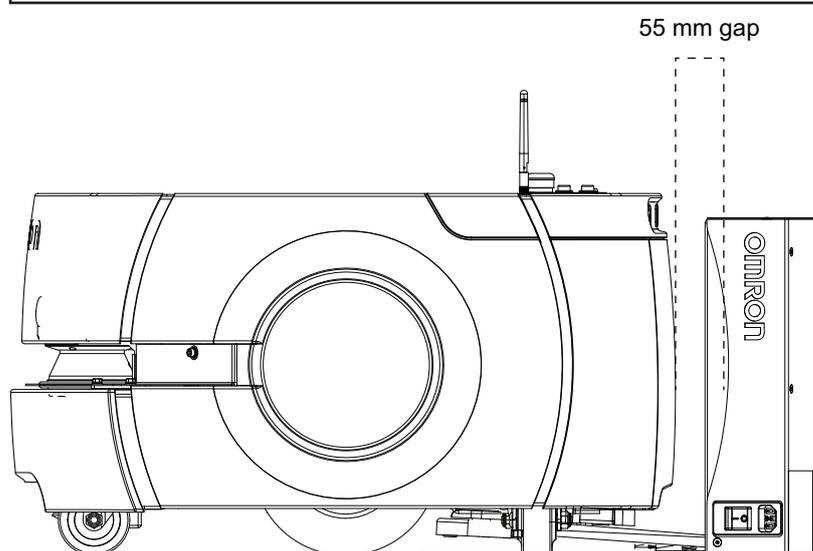
4-8-5　Balancing the Battery

The AMR's battery contains multiple cells, which must stay balanced to maintain maximum run-time. The time interval between battery balancing is related to the length of time required to balance a battery. A battery that is significantly out of balance can take 10 or more hours to balance after charging. A battery that is removed from the AMR and connected directly to the Docking Station will automatically balance when charging. Parameter settings do not affect battery balancing when charging with this method.

There are two ways to manage battery balancing:

• Balance the battery at every charge while the AMR is engaged with the Docking Station.
  Set the AMR's *DockUntilDoneCharging* parameter to True to balance the battery every time the AMR engages the Docking Station. In this mode, the battery will typically take about 10 to 30 additional minutes to balance after charging.

• Periodically exchange an un-balanced battery with a balanced battery.
  If the AMR's *DockUntilDoneCharging* parameter is set to False, this may allow the AMR to leave the Docking Station before battery charging and balancing is complete. With this setting, you must perform a periodic battery exchange with a completely charged and balanced battery at regular

intervals, such as once a month. The interval between battery exchanges depends on the AMR's use and will vary with the weight it carries, the electrical load of any accessories, and percentage of time it is in service. You will need to determine the optimum interval for your application. This mode is recommended if you are not charging the battery while it is inside the AMR. If you see a reduction in run-time, perform a battery exchange more frequently.

Additional Information

If the AMR's *DockUntilDoneCharging* parameter is set to False while the *StateOfChargeToChargeTo* and *MinutesToChargeFor* parameters are both set to a default value of 0, the AMR will never leave the Docking Station. Do not use this combination of parameter settings.

4-8-6   Storing Batteries

Use the following information when storing batteries.

The battery should start the storage period completely charged.

The batteries must be stored in the upright position (as it is positioned when installed in the AMR). Do not place the batteries on their sides, top, front, or rear.

When a battery is stored for a period of more than six months, perform the following tasks at six month intervals to properly maintain the battery.

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

Additional Information

• Refer to *2-3 Environmental Specifications* on page 2-11 for more information.
• Refer to *4-8 Battery and Charging* on page 4-16 for more information.

4-9   Operator Panel

The information below describes the operator panel components and functions.
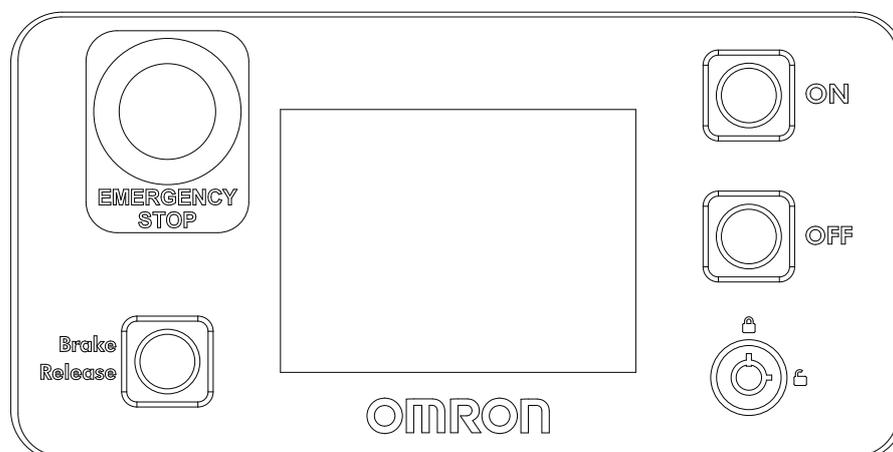
4-9-1   Main Screen

Information displayed on the main screen during AMR operation is described below.

WiFi Signal Strength →
IP Address →
Main panel →

← Battery Level
← Robot ID
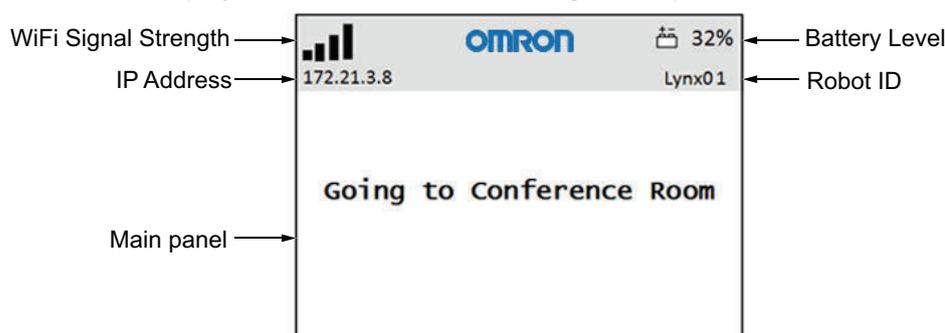
> **Additional Information**
>
> Refer to *5-6-1 Text Messages* on page 5-11 for more information.

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

Boot-up Screen

The following image shows the first screen that appears during boot-up when the AMR is turned ON.

4-9-2   Emergency Stop Button

The emergency stop button is connected to the safety circuit and has the same function as all other emergency stop buttons on the AMR.

4-9-3   ON Button

The ON button has the following functions.
- Turns the AMR ON. If the AMR is in the process of shutting down, the ON button is ignored until shut down is completed.
- Enable motors after an emergency stop has occurred.

> ## ⚠ WARNING
>
> Implementing methods to circumvent the need for a person to enable the AMR's motor power at start-up is prohibited.   ⚠

Precautions for Safe Use

If you suspect that liquid has penetrated the skins or contaminated the AMR's interior, do not attempt to power ON the system and contact your local OMRON representative.

Additional Information

There is a 2.5 second delay between when the ON button is pressed and the AMR resumes its activity. During this time, the AMR scans its path for potential obstacles and will resume its commanded motion if there is adequate space to maneuver. Refer to *4-2 AMR Start-up* on page 4-4 for more information.

4-9-4   OFF Button

The OFF button shuts down the AMR in a controlled manner. During shut-down after the OFF button is pressed, the system saves the AMR's last known location so it automatically localizes when it is powered ON again. Refer to *4-3 AMR Shut-down* on page 4-5 for more information.
When the AMR is shut down using the OFF button, it enters a standby state. In this state, some systems remain active and consume low power. For prolonged periods of AMR shut-down, use the OFF button and then disconnect or remove the battery to prevent battery drain.

Precautions for Correct Use

- Avoid moving the AMR while it is powered OFF. If you manually move the AMR while it is powered OFF, it may not be able to determine its current location when it is powered ON again. Use the localization feature in MobilePlanner to localize the AMR if this occurs.
- Do not use the battery button to turn OFF the AMR. Turning the battery OFF while the AMR is ON results in an uncontrolled AMR shutdown. Always use the AMR OFF button on the Operator Panel to turn the AMR OFF in a controlled manner

4-9-5 Brake Release Button

The brake release button is used when the AMR needs to be moved manually.

To release the brakes using this button, you must first press the E-STOP button on the Operator Panel and then press and hold the brake release button. The brakes remain released while pressing this button. When the button is released, the brakes are automatically enabled.

Releasing the brakes with the brake release button requires a small amount of battery power while the AMR is ON. If the AMR is OFF or there is insufficient battery power, the brakes remain engaged when using this method. Refer to *4-10 Releasing the Brakes* on page 4-28 for more information.

4-10 Releasing the Brakes

The brakes on the drive wheels can be released with the brake release button in case of an emergency or abnormal situation. This may be required to manually move the AMR. Refer to *4-11 Manually Pushing the AMR* on page 4-29 for more information.

The brake button must be pressed continuously. Releasing the brake button will activate the brakes. Battery power is required to release the brakes.

> ## ⚠ WARNING
>
> Using the brake release button while the AMR is positioned on a slope of greater than 3% will cause the AMR to roll down. You must not use the brake release button to move the AMR manually when it is positioned on a slope of greater than 3%, unless necessary precautions have been taken to prevent uncontrolled rolling of the AMR.

Precautions for Correct Use

OMRON recommends that you train personnel on the safe use of the brake release operations and procedures for safely pushing an AMR.

4-11 Manually Pushing the AMR

If the AMR becomes immobilized, it may need to be manually pushed to a new location.

> ⚠ **CAUTION**
>
> • Two or more people are required to push an AMR while following the proper push-ing methods described in this document.
> • Avoid pushing an AMR that has a payload. Use the Pendant to manually move an AMR with a payload whenever possible.

📝 **Precautions for Correct Use**

• Avoid moving the AMR while it is powered OFF. If you manually move the AMR while it is powered OFF, it may not be able to determine its current location when it is powered ON again. Use the localization feature in MobilePlanner to localize the AMR if this occurs.
• You should move the AMR manually only when absolutely necessary during an emergency, for safety, or if it is lost or stuck. If you find that you must frequently move the AMR, use Mobi-lePlanner to reconfigure its route to avoid problematic areas.
• If the loaded AMR is too heavy to move manually, it is recommended that you seek additional help or remove the payload.
• OMRON recommends that you train personnel on the safe use of the brake release opera-tions and procedures for safely pushing an AMR.

Payloads and other user-supplied equipment can affect an AMR's stability. All operators should know the locations on the AMR (or its payload) where they can push safely without toppling the AMR over or damaging its components. Push points are near the top edge of the skins and near the center of gravi-ty.

Make the following considerations when manually pushing the AMR.

• There is no appropriate point at which to pull the AMR. Only push the AMR when attempting to man-ually move it.
• Do not push the AMR with another motorized device.
• Only push on the safe push points of the AMR at the top edge of the chassis.
• The LD-90x AMR contains high gear ratios in the drive units, and may require additional effort when pushing the AMR.

4-12 Emergency Stop

When an emergency stop is triggered, the AMR decelerates to a controlled stop, de-energizes the safety outputs, and then disables its motors and engages the brakes.

The emergency stop circuit is classified as a Category 1 stop according to IEC 60204-1 (NFPA79).

Typical reasons to activate an emergency stop during normal operation are:

• Stopping the AMR for safety reasons.
• Manually interrupting or stopping the AMR to keep it from performing its currently scheduled Task if you do not have access to MobilePlanner.
• Preparing to control the AMR with the Pendant.

> **Additional Information**
>
> • Follow your site-specific emergency and safety procedures after initiating an emergency stop function.
> • The AMR will enter an Emergency Stop state if there is a disconnection or damage to the drive motor encoder cables.

The AMR will not automatically recover from an emergency stop. Refer to *4-12-1 Emergency Stop Recovery Procedure* on page 4-30 for more information.

Two additional safety outputs are also available for controlling user-supplied equipment during an emergency stop. These outputs are located at the USER INTERFACE connector in the Payload Bay. They are closed during normal operation and open when an Emergency Stop event occurs. When the Emergency Stop is reset, the outputs will close again. Refer to *3-5-1 Payload Bay Connections* on page 3-18 for more information.

An emergency stop differs from a protective stop. Refer to *4-13 Protective Stops* on page 4-32 for more information.

Indicator lights on the AMR provide the emergency stop state. Stop flags are also displayed on the Operator Panel. Refer to the following sections for more information.

• *4-15 Light Discs and Optional Beacon States* on page 4-34
• *4-9-1 Main Screen* on page 4-25
• *2-4-6 Safety Function Performance Levels* on page 2-14

4-12-1 Emergency Stop Recovery Procedure

Recovery from an emergency stop requires additional manual actions only after the operator has confirmed that it is safe to return the AMR to operation. The AMR's drive motors remain disabled until the procedure below is executed. This procedure cannot be used if the AMR is engaged with the Docking Station or has a critical driving fault present.

Use the following procedure to recover from an emergency stop event.

1 Reset the device that triggered the emergency stop.
This could be an E-STOP button or additional safety devices that may be connected to the emergency stop circuit.

2 Make sure that all surrounding areas are clear so the AMR has room to maneuver.

3 Press the ON button on the Operator Panel.

MobilePlanner can also be used instead of pressing the ON button by clicking **Enable** in the E-STOP dialog box.

> **Additional Information**
>
> There is a 2.5 second delay between when the ON button is pressed and the AMR resumes its activity. During this time, the AMR scans its path for potential obstacles and will resume its commanded motion if there is adequate space to maneuver.

4-13 Protective Stops

When a protective stop is triggered, the AMR decelerates to a stop at the maximum allowed rate. It then removes power to its motors and engages the brakes. After the AMR comes to a complete stop, it waits a minimum of 2.5 seconds before it resumes operation.

No user intervention is necessary to recover from a protective stop (automatic restart).

The protective stop circuit is classified as a Category 1 stop according to IEC 60204-1 (NFPA79). Protective stops can be triggered by one of the following events.

• Any time an object is detected within a Safety Laser Scanner Zone. Refer to *4-19 Safety Laser Scanner Zones* on page 4-52 for more information.

A protective stop differs from an emergency stop. Refer to *4-12 Emergency Stop* on page 4-30 for more information.

4-14 Overspeed Protection

The AMR has an independent safety system that uses a dual complex programmable logic device (CPLD) to monitor its velocity. This controller uses redundant monitoring and control methods to ensure that the AMR always operates within safe speed limits. This allows for sensing when traveling in any direction that is not scanned by a safety laser. Overspeed limits are not adjustable and independent of parameters detailed in *4-20 Motion Limits* on page 4-64.

The safe speed limits are provided below.

- LD-60 maximum forward linear speed: 2100 mm/s
- LD-90 maximum forward linear speed: 1575 mm/s
- LD-90x maximum forward linear speed: 1050 mm/s
- LD-60 maximum reverse linear speed: 300 mm/s
- LD-90 maximum reverse linear speed: 225 mm/s
- LD-90x maximum reverse linear speed: 150 mm/s

If the AMR operates outside the specified safe speed limit, the safety controller registers a system fault and begins a protective stop sequence. This event causes the AMR's motion controllers to execute a protective stop (Category 1 according to IEC 60204-1, NFPA79). When the protective stop is triggered, the system commands a controlled stop at the highest deceleration allowed. During the deceleration process, the safety controller continuously monitors the deceleration. If the AMR is not able to stop quickly enough, the safety controller disables the drive motors and engages the mechanical motor brakes in order to stop the AMR. Refer to *2-4-6 Safety Function Performance Levels* on page 2-14 for more information.

The motor brakes are powerful enough to stop a fully loaded AMR traveling at its top speed. However, engaging the mechanical motor brakes to stop the AMR is not a typical function. In the unlikely event that this occurs, you receive an error message in MobilePlanner and on the Operator Panel which should not be ignored. This error can occur if one of the following conditions is present.

- The AMR software fails to command a controlled stop for any reason.
- The floor is excessively slippery and does not provide good traction.
- The AMR is traveling down a slope steeper than its specified capability.

If this fault occurs frequently, the operating conditions leading up to this event should be investigated. Contact your OMRON representative for support. If the problem is not resolved, the AMR may stop operating in order to prevent the use of the potentially degraded brakes. Generally, the degradation of the motor brakes requires hundreds of these occurrences.

The use of the mechanical motor brakes to stop the AMR too many times will reduce the effectiveness of the motor brakes. This increases the distance required for the AMR to come to a full stop.

If motion is already disabled (for example, an E-STOP button is pressed) and you release the brakes manually, the safety system cannot stop the AMR. This is because power to the drive motors is already disabled.

After you resolve the overspeed condition, the safety system stops registering the safety fault. The safety system allows for the normal start-up process to begin, but it does not automatically restart the AMR's operations.

> 📝 **Additional Information**
>
> Motion control configuration parameters (such as *AbsoluteMaxTransVel* parameter) limit the maximum allowable velocities. Use MobilePlanner to modify the value of these parameters. Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.

4-15 Light Discs and Optional Beacon States

Light Discs located on the sides of the AMR provide a visual indication of its operational state. Use the following information to understand the operation of the Light Discs and any user-supplied beacons (light towers).

A user-supplied beacon provides extra signaling. The beacon can indicate movement or signal that the AMR is waiting for assistance. Refer to *LIGHTS* on page 3-25 for more information about connecting beacons to the AMR.

⚠ CAUTION

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

⚠

4-15-1 Driving Straight

Blue arcs on each side of the AMR will appear to rotate in the direction of the AMR's travel to indicate that it is moving or about to move.

An optional beacon will illuminate green during this operation.
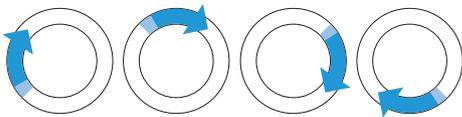
4-15-2 Turn Signal

In preparation for a turn and during a turn, the blue drive indicators will include a blinking orange segment at the front of one light disc in the direction of the signal. When the drive wheels rotate in reverse, the direction of the blue drive indicators will indicate the direction of the drive wheel rotation.

An optional beacon will illuminate green during this operation.
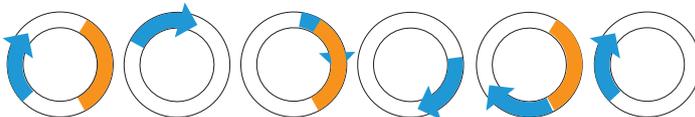
4-15-3 Emergency Stop

The light discs blinks red while the AMR is in an emergency stop state.

An optional beacon will illuminate red during this operation.
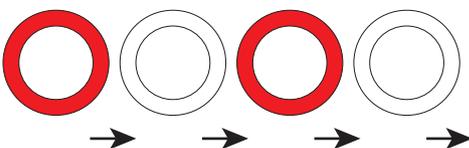
4-15-4   Lost

When the AMR is lost, the light discs each display two orange arcs traveling from the 6 o'clock to the 12 o'clock position and back in opposite directions.
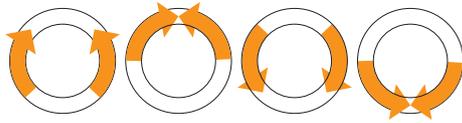
4-15-5   Stopped and Ready

When the AMR is stopped with no errors, the entire light disc on each side pulses blue slowly (0.25 Hz).
An optional beacon will be solid green during this operation.
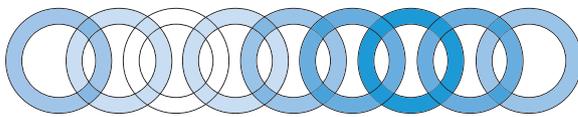
4-15-6   Stopped with Warning

When the AMR is stopped with a warning, the light discs pulse orange instead.
An optional beacon will illuminate green during this operation.
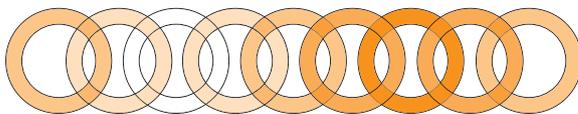
4-15-7   Driving with Warning

The light disc will be orange instead of blue for Stopped, Driving, and Turn Signals. If used, the Beacon alternates green then yellow.
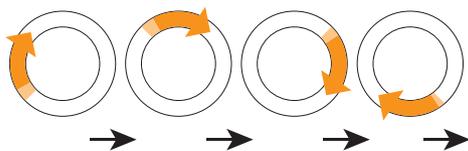
4-15-8   Turn Signal with Warning

In preparation for a turn and during a turn, the drive indicators will be orange and include a blinking orange segment at the front of one light disc in the direction of the signal. When the drive wheels rotate in reverse, the direction of the orange drive indicators will indicate the direction of the drive wheel rotation. The moving arc and the blinking segment have independent timing.
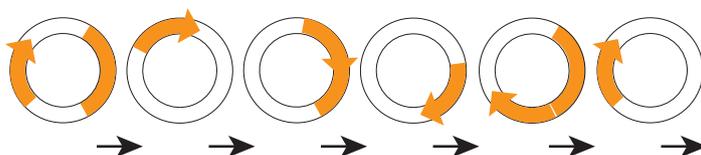
4-15-9 Driving Slowly, Scanning Laser E-STOP Inactive

When driving under 300 mm/second, the AMR's Safety Scanning Laser does not generate an E-STOP, however it still actively performs safety checking and successfully avoids obstacles. The pattern is the same as driving, except the background blinks orange. The moving arc and the blinking segment have independent timing.
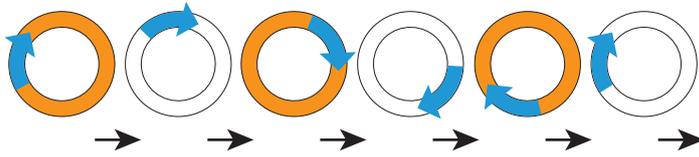
4-15-10 Obstacle Detected / Protective Stop

The light disc blinks yellow if the AMR stops for an obstacle detected in its safety zone.
An optional beacon will illuminate yellow during this operation.

> **Additional Information**
>
> There is a 2.5 second delay between the end of an obstacle detection condition and the AMR resuming its activity. During this time, the AMR scans its path for potential obstacles. It will remain stopped until its path is clear.
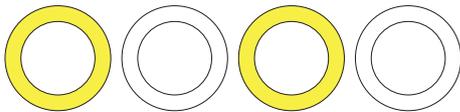
4-15-11 Charging

When the AMR is engaged with a Docking Station, a green arc indicates the current state of charge displaying steady green from the top of the disc to the current state. A small white arc travels back and forth between the two ends of the green arc.
An optional beacon will illuminate green during this operation.

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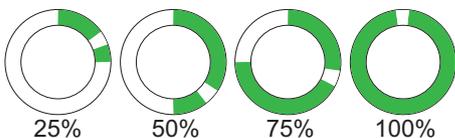
Left Side Light Disc	Right Side Light Disc	State of Charge
0 to 90 cw	0 to 270 ccw	25%
0 to 180 cw	0 to 180 ccw	50%
0 to 270 cw	0 to 90 ccw	75%
full circle	full circle	100%

> **Additional Information**
>
> The state of charge displayed is continuous and not limited to 25% increments.

4-15-12 Booting

When the AMR is booting, the light discs display two blue arcs, traveling from the 6 o'clock to the 12 o'clock position and back, in opposite directions. If used, the Beacon alternates green, yellow, then red.
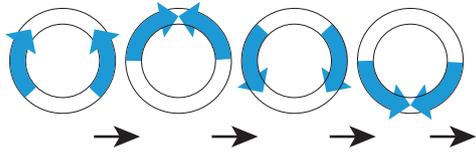
4-16 Manual Driving

The pendant is used to drive the AMR manually and to make a map. Use the information below to understand how to manually drive the AMR.

The AMR can also be driven remotely through MobilePlanner (teleoperation). The following considerations apply:

• Pendant Driving: Objects that are in the path of an AMR that is reversing will not stop AMR motion. Use caution when driving the AMR in reverse.

• Driving Remotely: If using MobilePlanner to drive the AMR remotely (either with the on-screen virtual Pendant or through the computer keyboard) the rear sensor operates normally.

The figure below shows the pendant and its buttons.
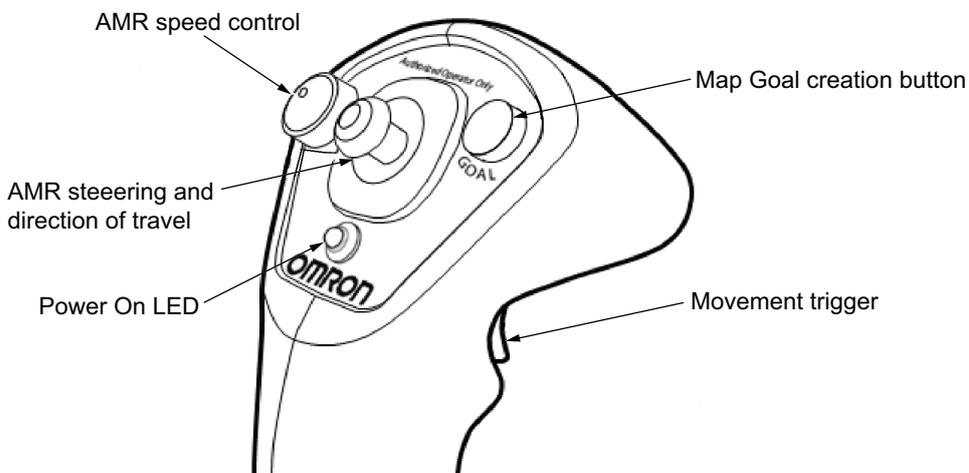
The pendant is intended for single-handed operation. While gripping the handle and squeezing the movement trigger, use your thumb to move the directional control stick to drive the AMR. If the trigger is not depressed, the drive motors are disabled and the AMR cannot move.

The pendant is equipped with a speed control rotary dial that is used to set the speed of the AMR when moving forward or reverse.

The pendant's Goal button is used for marking positions while making a map scan.

The pendant has a Power On indicator LED that illuminates green when the Pendant is successfully connected to the Pendant Port.

4-16-1 Driving with the Pendant

Use the following procedure to drive the AMR with the Pendant.

⚠ WARNING

• Do not allow use of the manual driving functions in MobilePlanner while controlling the AMR with the Pendant. Doing so can override Pendant control.
• When operating the AMR with the pendant, it is the operator's responsibility to make sure that no people or objects are in the immediate vicinity of the moving AMR.

⚠ CAUTION

While driving the AMR with the Pendant, the operator must maintain full control and assumes full risk if not using the Pendant as described in this document.

Precautions for Safe Use

- Secure the Pendant when not in use to prevent an unauthorized user access to the AMR.
- If the Pendant movement trigger is released or the Pendant is unplugged at any time after the AMR is turned ON, other sources such as MobilePlanner or a Fleet Manager may control the AMR motion. Always follow the Pendant operation procedures to maintain control of the AMR with the Pendant.

1 Press one of the E-STOP buttons on the AMR.

2 Connect the pendant to the Pendant port on the left rear side of the AMR.

3 Squeeze and hold the movement trigger so it remains fully depressed.

4 Release the E-STOP button.

5 Press the AMR ON button.

6 Turn the speed dial counterclockwise to the lower speed limit.

7 Move the directional control stick to drive the AMR in that direction.
Push the directional control stick forward or back to make the AMR move in that direction.
Push the directional control button to the left side to make the AMR rotate in place counter-clockwise. Push the directional control button to the right side to make the AMR rotate in place clockwise. Diagonal positions of the directional control button move the AMR in an arc.
Use the speed control dial to control the speed of the AMR.

8 Release the directional control stick to bring the AMR to a full stop. To stop more quickly, pull or push the directional control button to its limit in the opposite direction of the AMR's travel.
Do not release the movement trigger to stop the AMR. If the movement trigger is released while the AMR is ON, repeat steps 1 through 5 above.

9 To stop controlling the AMR with the Pendant:

1) Press one of the E-STOP buttons on the AMR.

2) Release the movement trigger.

3) Disconnect the Pendant.

4) Release the E-STOP button.

5) Press the AMR ON button to resume normal operation.

4-17 Warning Buzzer

The LIGHTS connector on the Core can power a warning buzzer that provides an audible alert during certain operating conditions. It can be installed in either the AMR platform or in a location of choice in the payload structure. In either case, the buzzer will sound intermittently whenever the AMR is moving in reverse.

How the buzzer is installed in the payload structure depends on the payload design, and is not covered here.

> **Additional Information**
>
> Warning buzzer parameter values are only available with Mobile Robot Software FLOW Core version 1.0 and later.

The warning buzzer must be audible above the ambient noise of the operating environment. In environments with high levels of ambient noise, it may be necessary to install an additional warning buzzer at an appropriate location on the payload structure. Refer to *1-6-4 Additional Warning Buzzers* on page 1-20 for information about additional warning buzzers.

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

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

Parameter	Default Setting
DriveWarningEnable[1]	True NOTE: If this parameter is set to False, the remaining parameters will not be displayed. Disabling the DriveWarningEnable parameter violate the JIS D 6802 standard. It is strongly recommended that you leave this set to True.
DoNotWarnDrivingForwards	False
DoNotWarnTurningInPlace	False
DriveWarningLoudMilliseconds	500; If DriveWarningQuietMilliseconds is 0, this parameter is irrelevant.
DriveWarningQuietMilliseconds	500; This is the length of time between warnings that the buzzer is silent. Setting this to 0 will cause a continuous warning.

[1]. The DriveWarningEnable parameter is not available by default. Setting an output to type *warn* and restarting ARAM will make the parameter accessible.

4-18 Back up and Restore the AMR

The following sections provide information about backing up and restoring the AMR.

The AMR configuration may need to be restored from a backup file under special circumstances, such as if the AMR Core has been replaced or if an AMR needs to be re-purposed with a different configuration.

You can back up and restore an AMR's configuration with one of the following methods:

- Create a restore-point and revert to this configuration later.

  Refer to *Create a Restore-Point* on page 4-41 and *Revert to a Restore-Point* on page 4-44 for more information.

- Save MobilePlanner AMR configuration settings and import them to an AMR or fleet.

  Refer to *Configuration File Backup* on page 4-42 and *Restore from Configuration File* on page 4-45 for more information.

- Save configuration settings and maps associated with an AMR or fleet, and then use them later to restore using a DebugInfo file.

  Refer to *Debug Info File Backup* on page 4-43 and *Restore from a Debug Info File* on page 4-46 for more information.

- Revert configuration settings to default ARAM values.

  Refer to *Revert to Default* on page 4-44 for more information.

> **Additional Information**
>
> - Although software parameters concerning the Safety Laser Scanners can be restored using a method above, the Safety Laser Scanner configuration and safety parameters are not stored in the SetNetGo restore function and will not be modified by restoring a configuration. Refer to the *Safety Laser Scanner OS32C Series User's Manual (Cat. No. Z296)* for more information about backup and restore functions for the Safety Laser Scanners.
> - Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information about using SetNetGo.

4-18-1 Creating Backup Files

Use the information in the following sections to create backup files.

Create a Restore-Point

SetNetGo provides a restore option to revert a specific AMR to a user-defined Restore-Point, which is saved locally on the AMR. This method will revert the ARAM and AMR settings on the **Configuration** Tab and the last 10 saved maps to the saved Restore-Point. You can create a Restore-Point from the **System** Tab's **Backup & Restore Options** in SetNetGo. Click the **Backup Now** Button to create a Restore-Point of the current configuration. Once a Restore-Point has been created, the date of its creation will appear above the Backup Now button.

> **Additional Information**
>
> Only one Restore-Point can exist on an AMR at a time. Creating a new Restore-Point will overwrite the existing one.
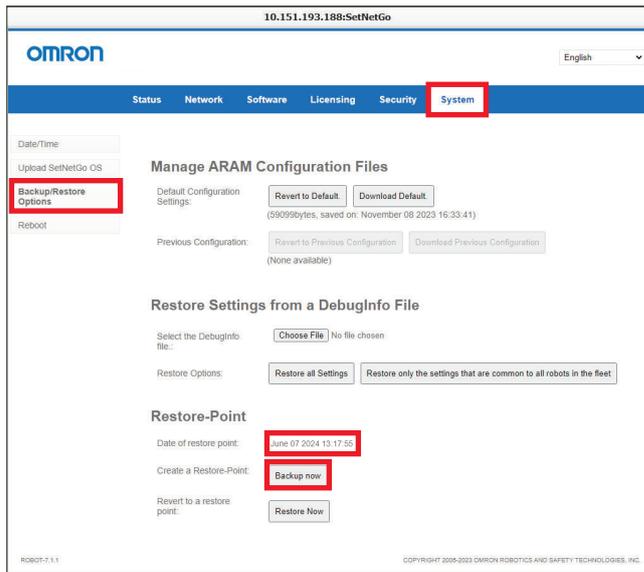
Configuration File Backup

SetNetGo provides a restore option to revert the AMR to a backed up configuration file. This method restores only user-defined software settings on the **Configuration** Tab.
Use the following procedure to back up an AMR configuration file.

1 Click the **Configuration** Icon to open the **Configuration** Tab in MobilePlanner.

2 While the **Configuration** Tab is active, select **File** > **Save As** to save a .xml configuration file.
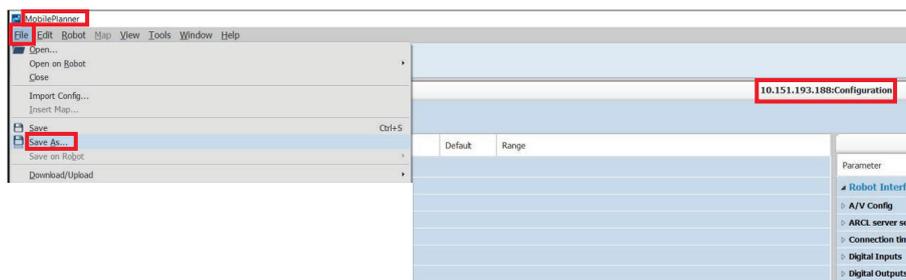
3 Select the type of configuration file and what sections to save.
- General Configuration files are applicable to any AMR connected to MobilePlanner.
- Robot Model files are applicable to AMRs of the same model.
- Calibration files are specific to the current AMR that is connected.
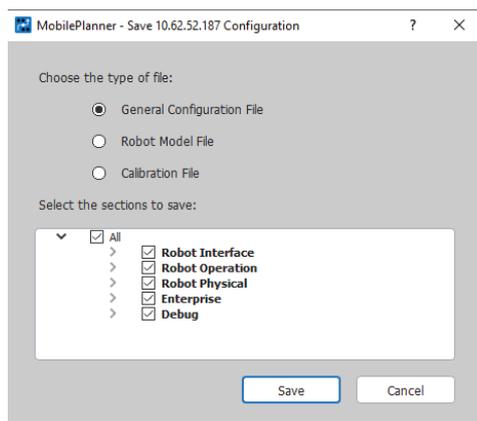
4 Click Save to complete the procedure.

Debug Info File Backup

SetNetGo provides a restore option to revert an AMR to a backed up Debug Info .zip folder saved on a PC. This provides an alternate backup location compared to a Restore-Point. This method will revert the ARAM and AMR settings on the **Configuration** Tab and the last 10 saved maps to the saved Debug Info parameters. This can be used to easily bring a new AMR up to date with an existing fleet, or to completely restore all software settings to an AMR with a new Core.

Access the **Status** Area in SetNetGo and then click the **Download Debug Info** button.

This will generate a .zip folder in the Downloads folder. A pop-up is presented to open the folder or close. Clicking **Open Folder** will open the Downloads folder to show the .zip folder.
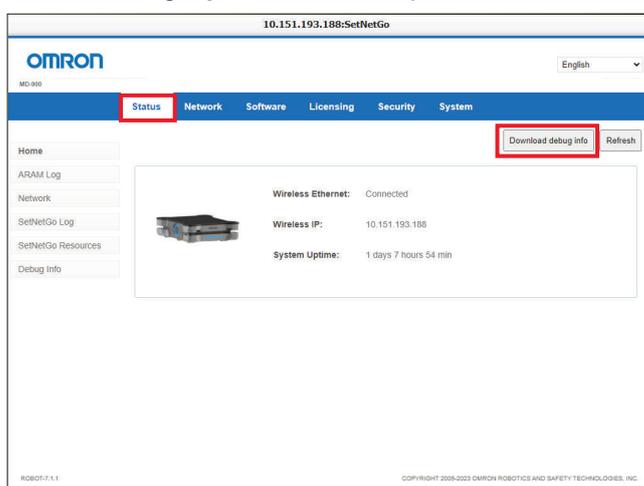
4-18-2   Restoring the AMR

The following sections describe how to restore an AMR with a Debug Info file, Configuration file, or other method.

Revert to a Restore-Point

SetNetGo provides a restore option to revert the AMR to a user-defined Restore-Point. You can revert to a Restore-Point from the **System** Tab's **Backup & Restore Options** in SetNetGo. Click the **Restore Now** Button to revert to a saved Restore-Point.

> **Additional Information**
>
> The MobilePlanner connection will be terminated when reverting to a Restore-Point.
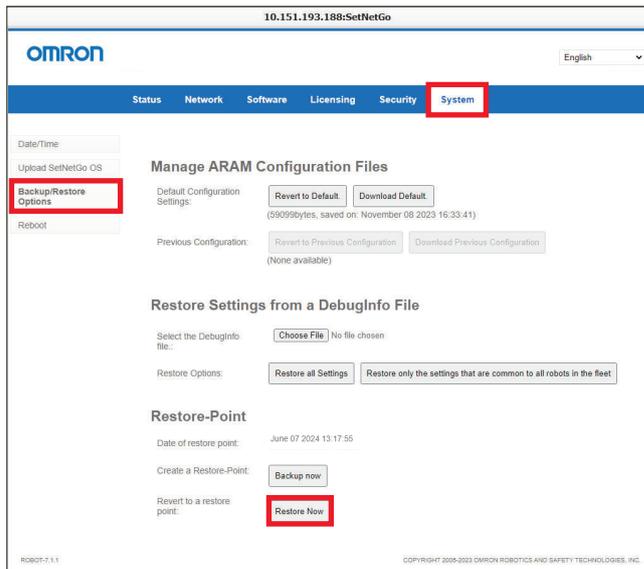
Revert to Default

SetNetGo provides a restore option to revert the AMR to its default configuration settings. This method restores the entire **Configuration** Tab back to default values as determined by ARAM during its initial setup. You can revert to the default configuration settings from the **System** Tab's **Backup & Restore Options** in SetNetGo. Click the **Revert to Default** Button.

You may also download the default configuration file for the AMR to your computer by clicking the **Download Default** Button.
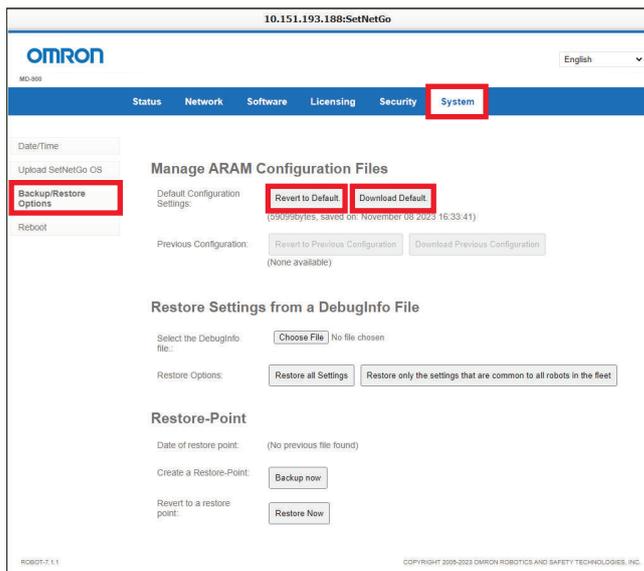
● **Revert to Previous Configuration**

SetNetGo provides a restore option to revert the AMR to its previous configuration settings by clicking the **Revert to Previous Configuration** Button. This method reverts the **Configuration**Tab to its previous settings before a change was made. Changes could include uploading a new Configuration file or reverting to default values.

You may also download the previous configuration file for the AMR to your computer by clicking the **Download Previous Configuration** Button.
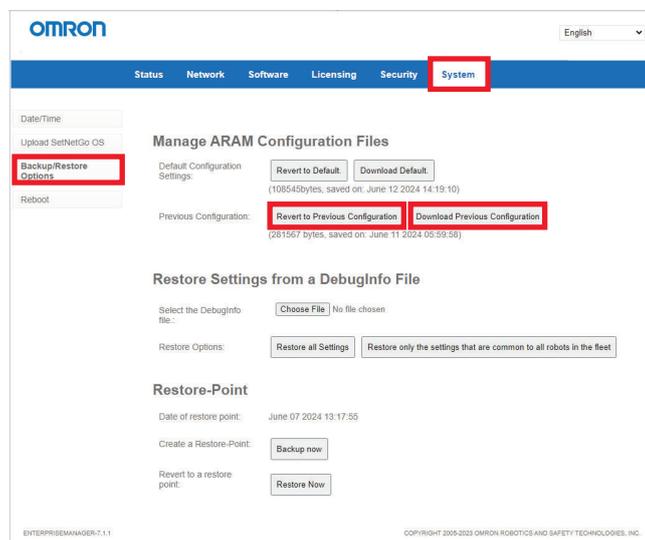
Restore from Configuration File

Use the following procedure to import a configuration file into MobilePlanner.

1 In the **Configuration** Tab, select **File** > **Import Config...**, then select a saved .xml configuration file to import.

2 Select the type of configuration file and what sections to import. Click **OK** to confirm the import.
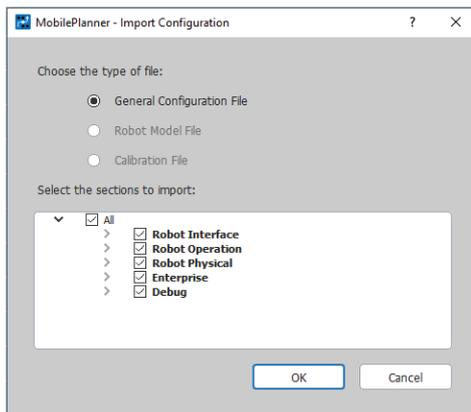
3 Save MobilePlanner using **File** > **Save** to upload the configuration to the AMRs. An asterisk will be present on the **Configuration** tab, which will clear when saving is complete. If no errors occur during importing or saving, the procedure is complete.

Restore from a Debug Info File

The following procedure describes how to use SetNetGo to restore an AMR from a DebugInfo File.

1 Access the **System** Tab and click on **Backup/Restore Options** in the left pane.
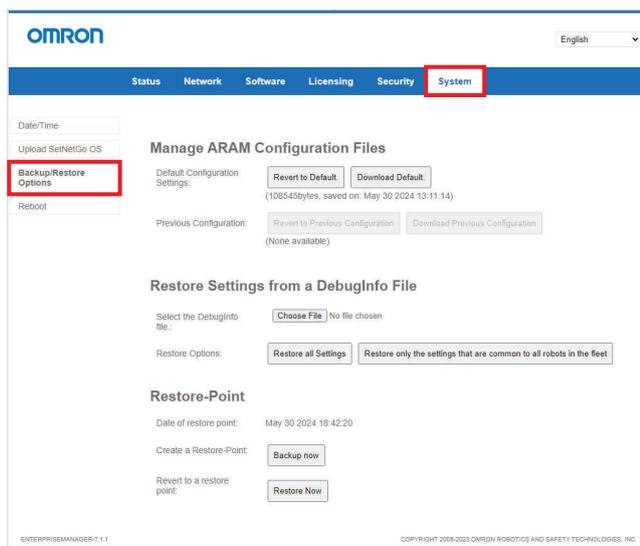
2 Click **Choose File** and select a saved DebugInfo zip folder from its saved location to upload.
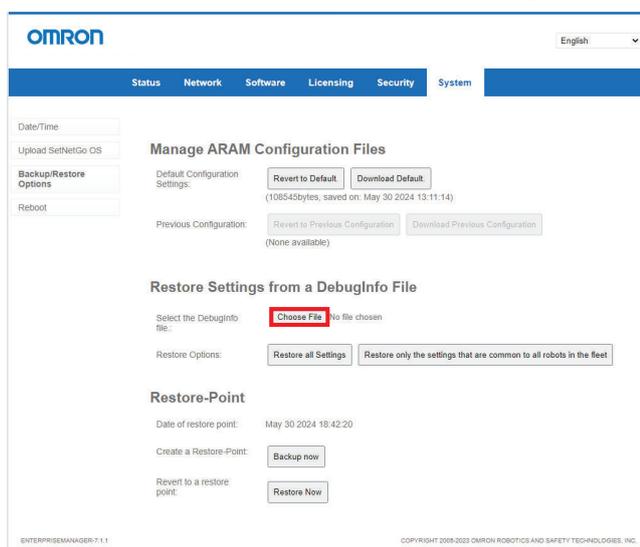
3 Click either the **Restore all Settings** or **Restore only the settings that are common to all robots in the fleet** button to select which settings to import.
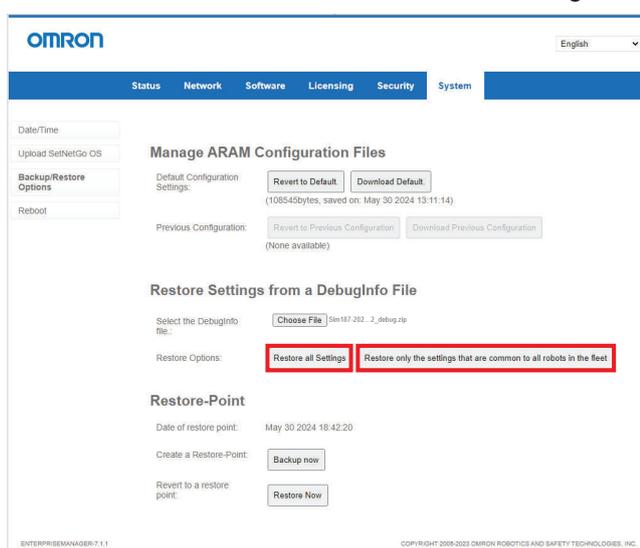
Hovering the mouse over each button will open a tooltip with more information.

- **Restore all Settings** button:

  "Use this operation to restore all settings in the selected DebugInfo file to this robot core. This feature is useful if you replace the robot core hardware. Note: You must update the WiFi security credentials (such as PSK and certificates) after you restore the core."

- **Restore only the settings that are common to all robots in the fleet** button:

  "Use this operation when you add a new robot to a fleet. It quickly restores settings that are common to all robots in the fleet. This operation does not affect robot-specific setting such as IP address and Identifier, or model-specific settings such as gear-ratio and optional hardware. Note: You must update the IP address and WiFi security credentials (such as PSK and certificates) after you restore the settings to a robot."

4 Click **OK** on the dialog box to confirm the restore operation to complete the procedure.

4-18-3   SetNetGo Recovery Mode

Use SetNetGo Recovery mode in the event that an AMR experiences a software problem, and reverting the system back to a stable and working default state is the preferred solution.

There are three Maintenance Options available in Recovery Mode as shown in the figure below.
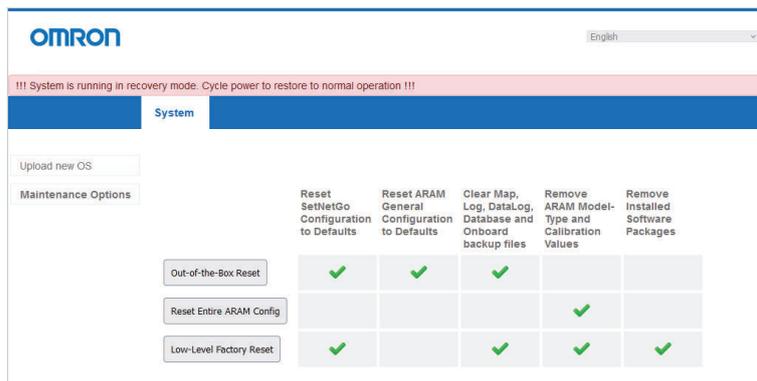
Each option will reset different combinations of configuration data, files, or software from the AMR. Exercise caution when selecting a recovery option. If you wish to cancel this procedure without making any changes, you can exit this mode by power cycling the AMR or by using the **Reboot** Button in the **Upload new OS** menu under the **System** Tab. This will revert the AMR back to normal mode in its current condition.

Refer to the table below for more information on what data or settings each Maintenance Option will reset.

Recovery Option	Details
Out-of-the-Box Reset[1]	Clears all SetNetGo configuration items (network, accounts, port-forwarding, timezone, etc) and disables all apps. Resets ARAM configuration to the defaults for that AMR type and for that ARAM version. This maintains the settings for robot type as well as mode, but uses default parameter values for everything else. Clears all files that would have been created during testing and runtime, such as maps, log files, data files, etc. Useful for resetting back to a factory-equivalent state..

Recovery Option	Details
Reset Entire ARAM Config	Resets the ARAM configuration settings to remove all defaults. Configuration settings will need to be restored after exiting Recovery Mode. MobilePlanner can then be used to set the appropriate **Robot_Type**.
Low-Level Factory Reset[1]	Removes all SetNetGo and ARAM configuration settings. Also deletes all content installed when uploading a FLOW package, but will preserve voice synthesis files.

*1. In SetNetGo version 8.0 and above, when performing a Low Level Factory Reset or Out-of-the-Box Reset in Legacy Mode, the Core will be automatically reset to FLOW Mode. It will need to be changed back to Legacy Mode if operation in Legacy Mode is desired

AMR Recovery

Follow the procedure below to reset the AMR's settings using Recovery Mode.

The following items are required for this procedure.

- PC
- Ethernet cable
- A web browser application

This procedure will remove all user-defined configurations and settings. Configuration and setup of the AMR must be performed after following this procedure.

1 Connect a PC to the AMR maintenance port with an Ethernet cable.

2 Open a browser and connect to SetNetGo by typing in the maintenance IP address, https:// 1.2.3.4.

3 Download a DebugInfo file from the AMR.
This can be used to restore AMR functionality after Recovery Mode options have been set. Refer to *Debug Info File Backup* on page 4-43 for more information.

4 Access the **System** Tab's **Upload SetNetGo OS** option in the left pane.

5 Click on the **Reboot and Enter Recovery Mode** Button.
You will be prompted to confirm if you want to enter the recovery mode after the selection is made.
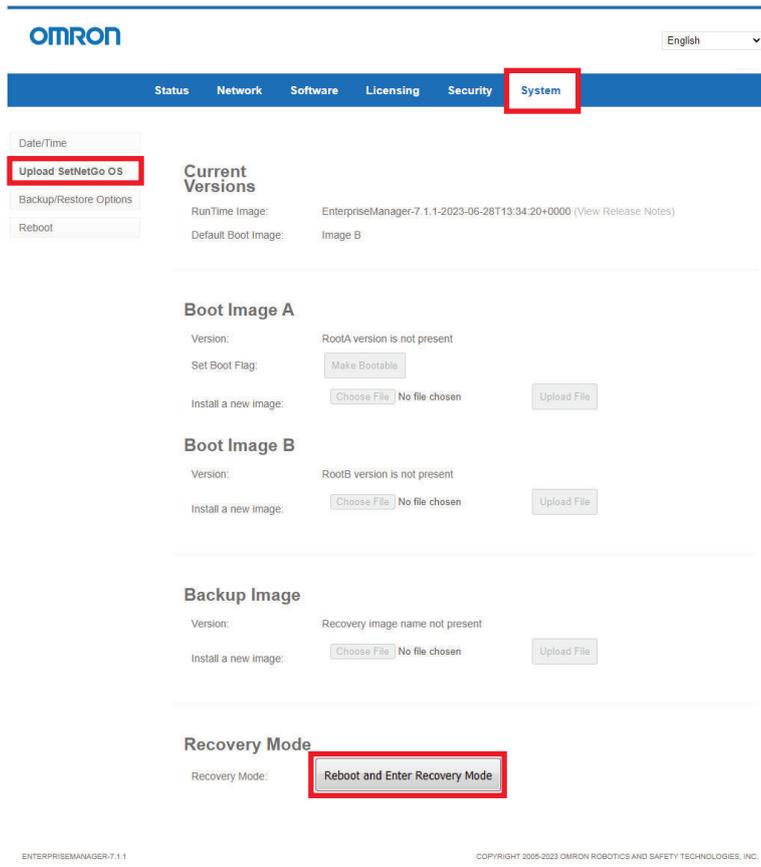
6 Wait approximately 30 seconds and then refresh the page after entering Recovery Mode.
The SetNetGo Recovery Mode URL changes from HTTPS:// to HTTP://.
After refreshing, the following will be displayed on the top bar to confirm the AMR is in Recovery Mode.
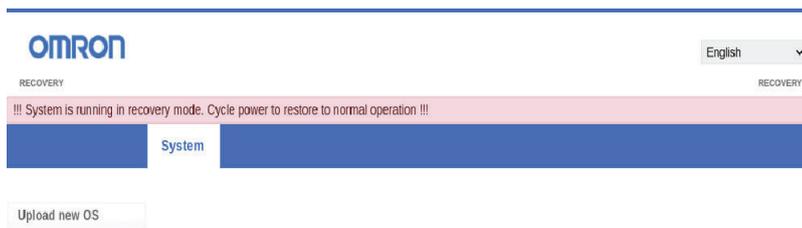
7 Access **Maintenance Options** in the left menu. There are three Maintenance Options available. Select the option appropriate for your needs.
Refer to *4-18-3 SetNetGo Recovery Mode* on page 4-48 for more information.
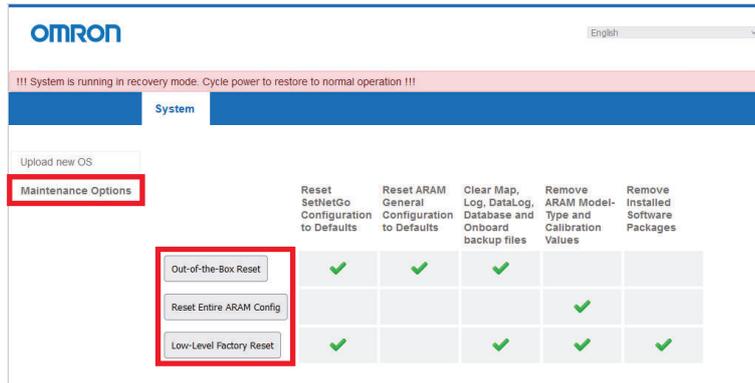
8 Confirm on the dialog box that pops up that you wish to reboot and disconnect all connections.

9 Wait for a message to appear stating that the change was made successfully.

10 Power cycle the AMR (push the OFF button and then push the ON button) or reboot the AMR using the Reboot Button under the **Upload new OS** Menu.
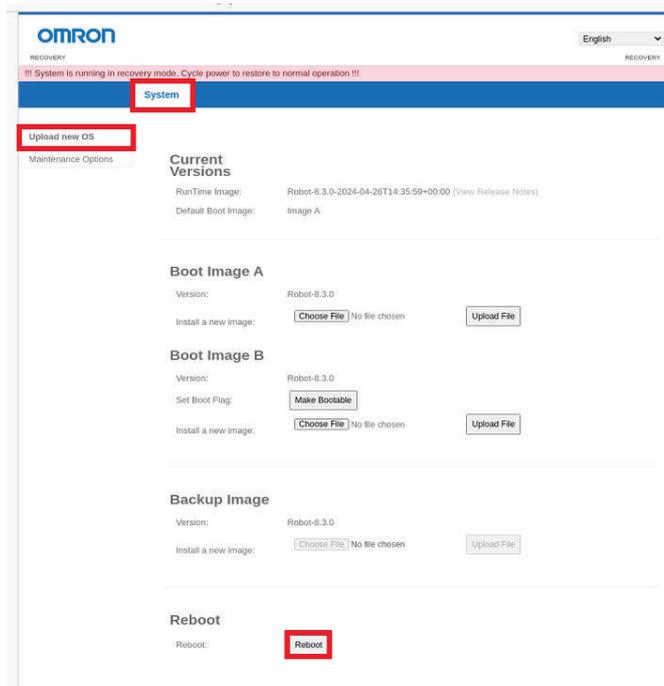
11 Allow the power cycle or reboot to complete and confirm the AMR's status. Once the AMR's status is confirmed to be in the intended post-recovery state, the procedure is complete.

4-19 Safety Laser Scanner Zones

The AMR's Safety Laser Scanner is pre-programmed with several default safety zones associated with the shape and dynamics of the standard system. The safety zones adjust their detection range and shape automatically as the AMR drives forward and reverse or turns in place.

The parameter groups that control laser settings are:

• Laser_1 Settings are for the main scanner laser, used for localization.
• Laser_2 Settings are for the low front laser.
• Laser_3 Tilted and Laser_4 Tilted are for the optional side lasers.
• Laser_5 Settings are for the optional rear-facing laser.

Lasers 3, 4, and 5 do not need to be used for these specific purposes, these are the OMRON-recommended uses, so the default configurations for these lasers apply to these typical applications.

⚠ WARNING

OMRON is not responsible for any risks incurred by modifying safety zone sizes or other OS32C laser settings.

⚠

Additional Information

• A password is required to make any safety-critical changes to the Safety Laser Scanner configuration and zones. This password can be changed by the user to limit access by unauthorized users. For instructions on how to change the password, refer to *Safety Laser Scanner OS32C Series User's Manual (Cat. No. Z296)* for more information.
• The software-based obstacle protection is used regardless of the AMR speed.

4-19-1 Safety Zones

The Safety Laser Scanner has several configurable safety zones.

There are a total of 8 safety zones for the default configuration. These safety zones are associated with the following operating states of the AMR.

Zone	Speed (mm/s)		
	LD-60	LD-90	LD-90x
0	0 to 300	0 to 225	0 to 150
1	301 to 600	226 to 450	151 to 300
2	601 to 900	451 to 675	301 to 450
3	901 to 1200	676 to 900	451 to 600
4	1201 to 1500	901 to 1125	601 to 750
5	1501 to 1800	1126 to 1350	751 to 900
6[*1]	1801 to 2100	1351 to 1575	901 to 1050
7[*1]	2101 to 2400	1576 to 1800	1051 to 1200

*1. These safety zones are established but not used in the default configuration.

LD-60 Safety Zone Sizes

The default LD-60 Safety Zone sizes are provided below.
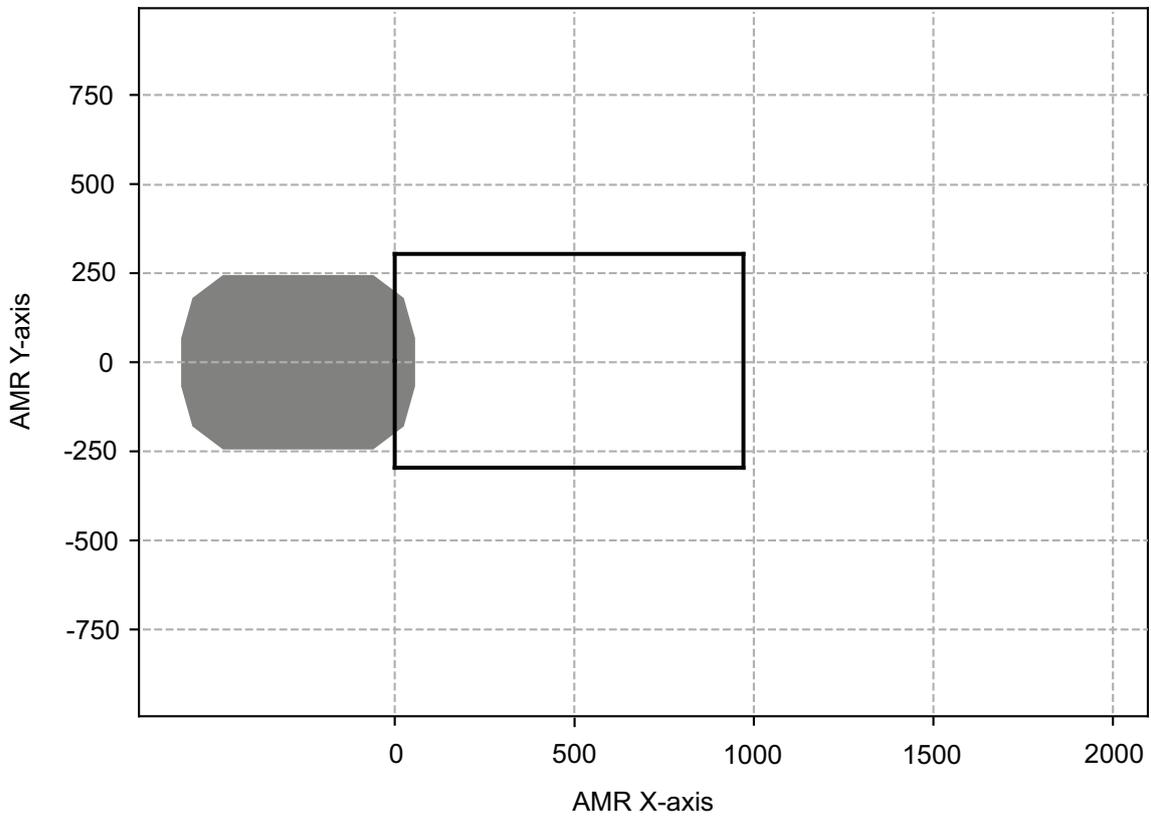
LD-60 Safety Zone 0 (92 mm Radius)
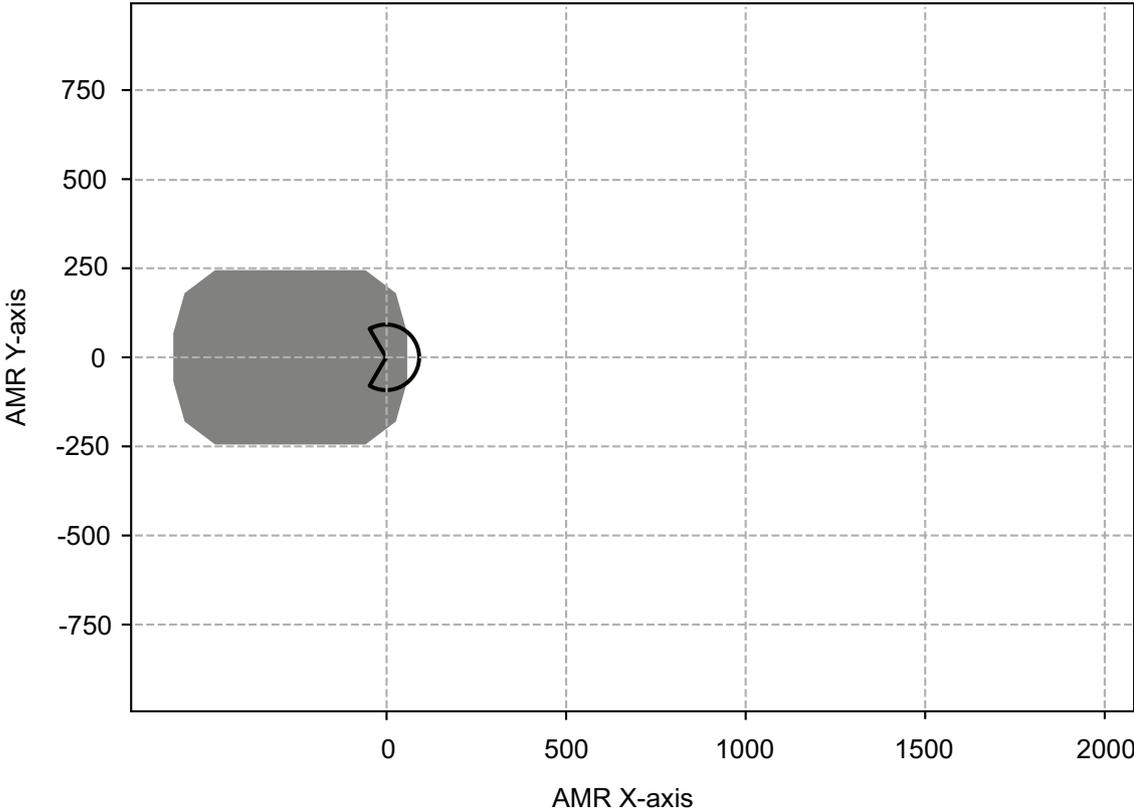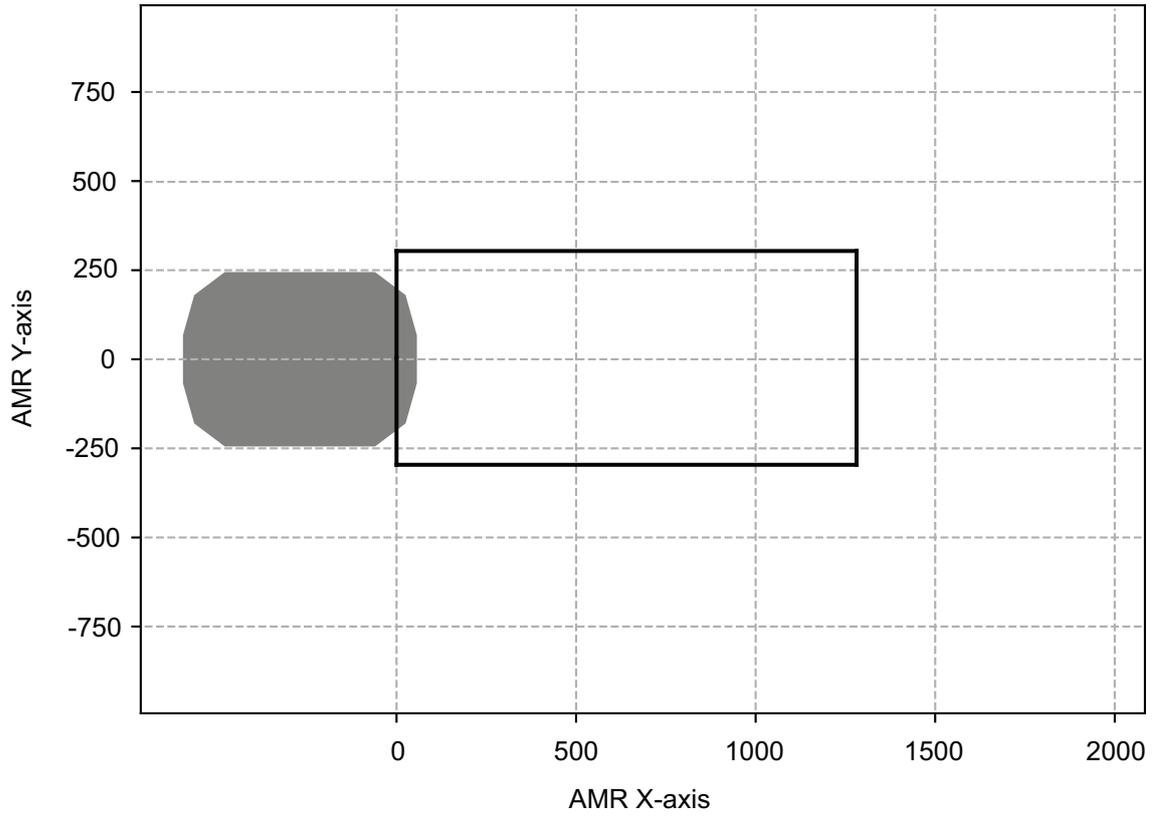

LD-60 Safety Zone 1 (521 mm x 600 mm)
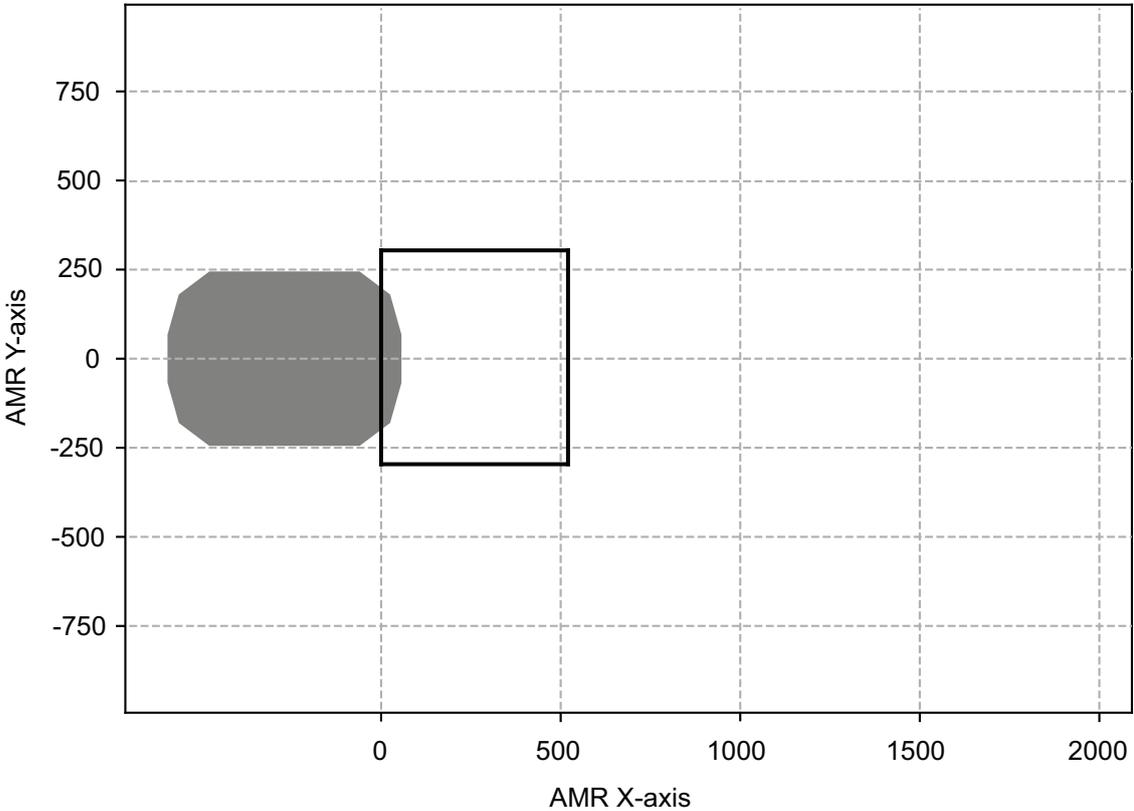
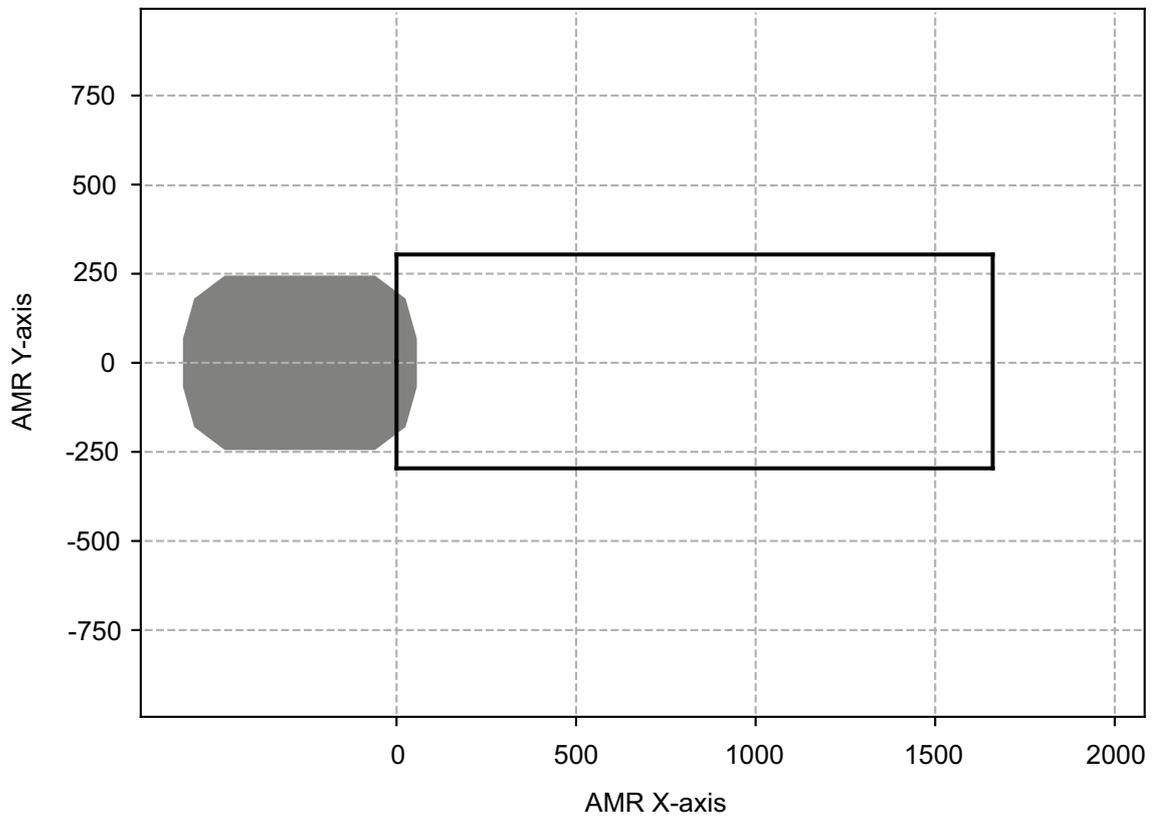LD-60 Safety Zone 2 (711 mm x 600 mm)
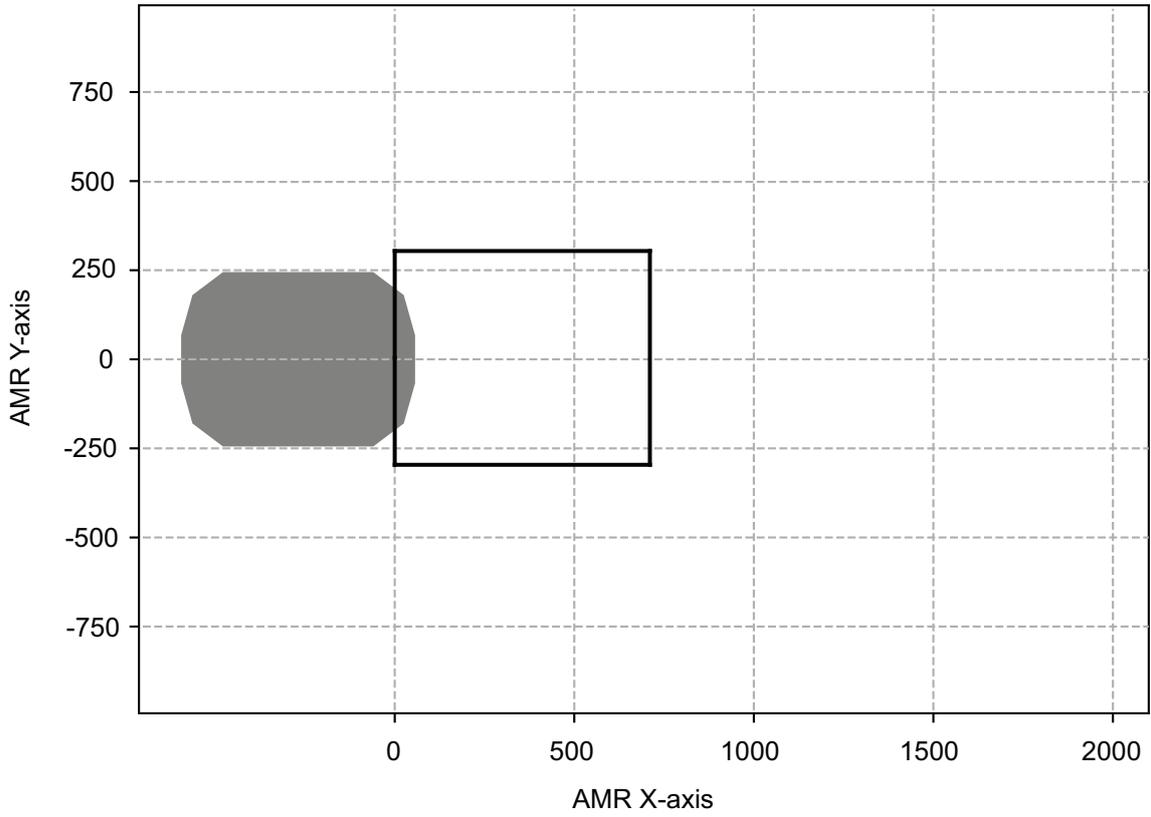
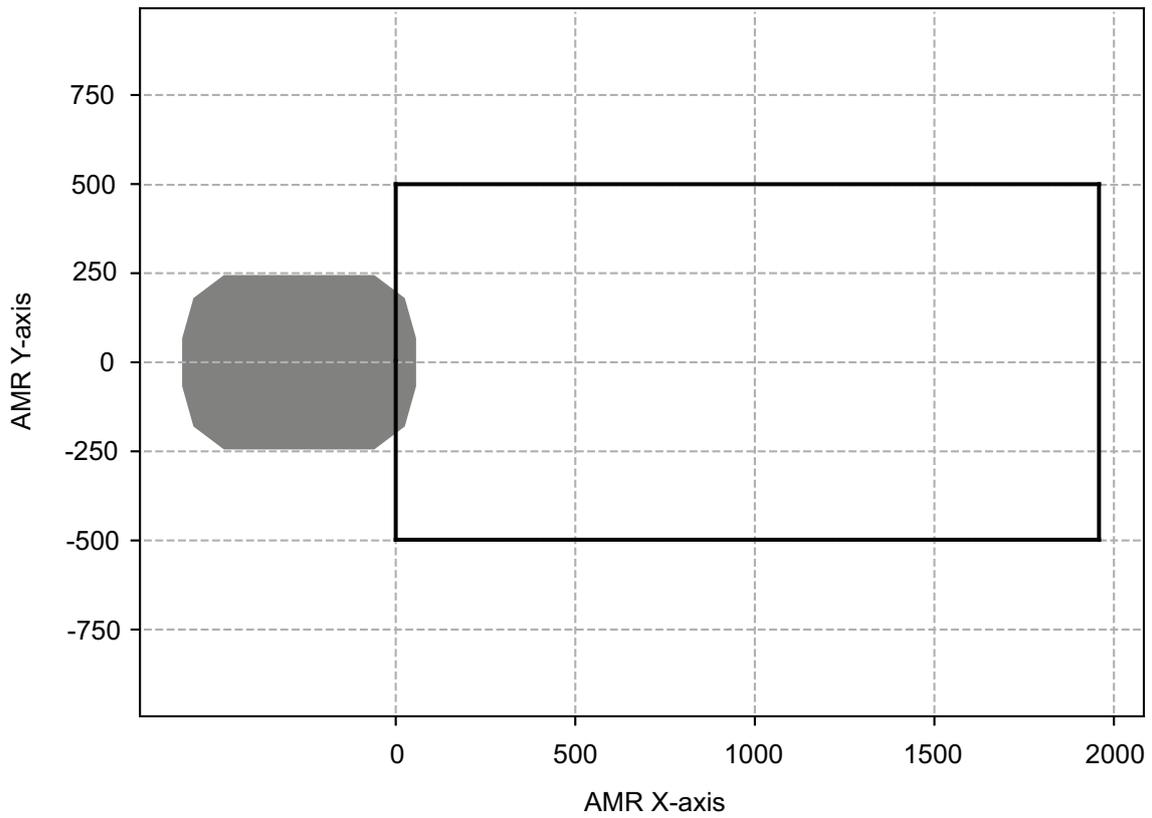
LD-60 Safety Zone 3 (971 mm x 600 mm)

LD-60 Safety Zone 4 (1281 mm x 600 mm)

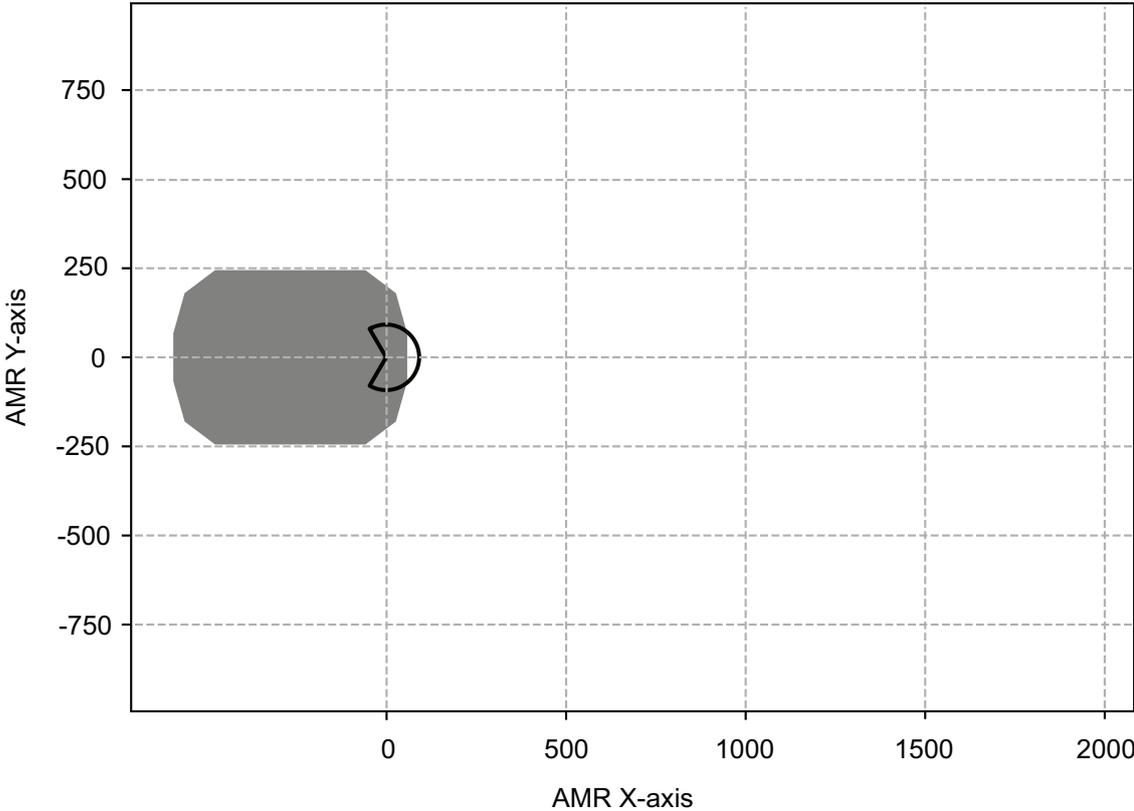LD-60 Safety Zones 5 and 6 (1661 mm x 600 mm)
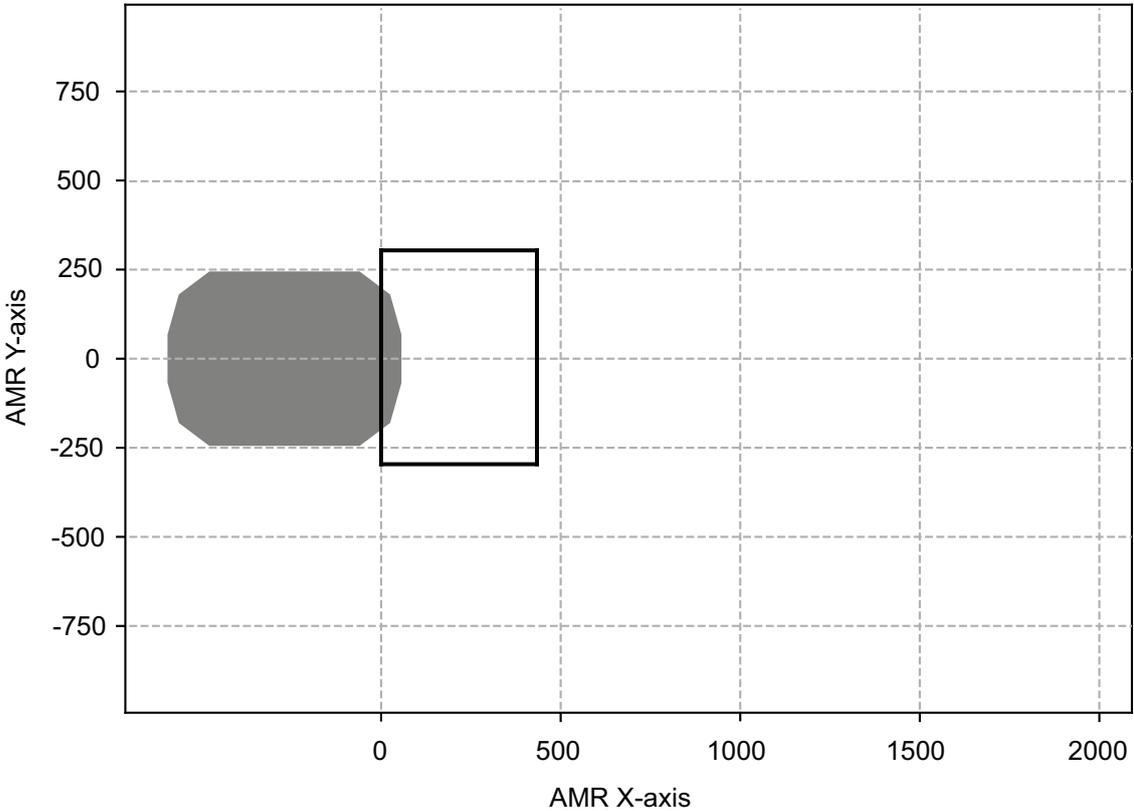
LD-60 Safety Zone 7 (1931 mm x 1000 mm)

LD-90 Safety Zone Sizes

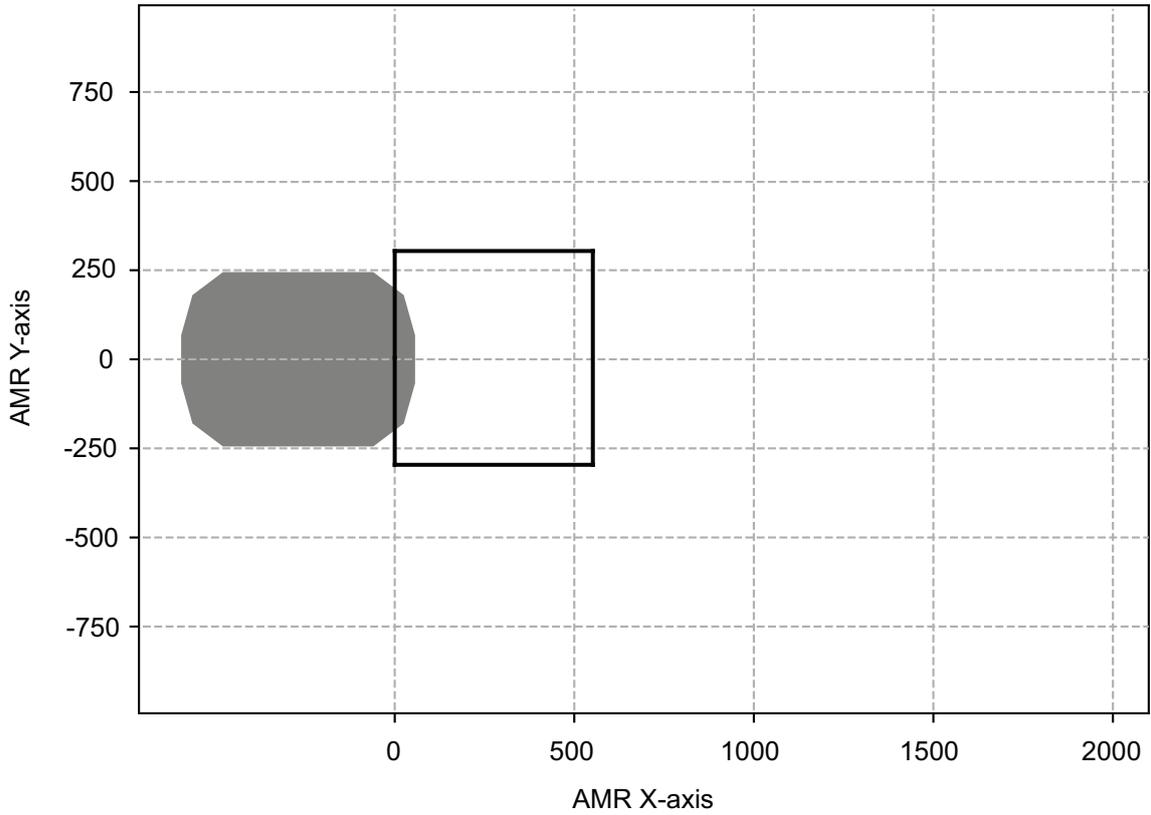The default LD-90 Safety Zone sizes are provided below.
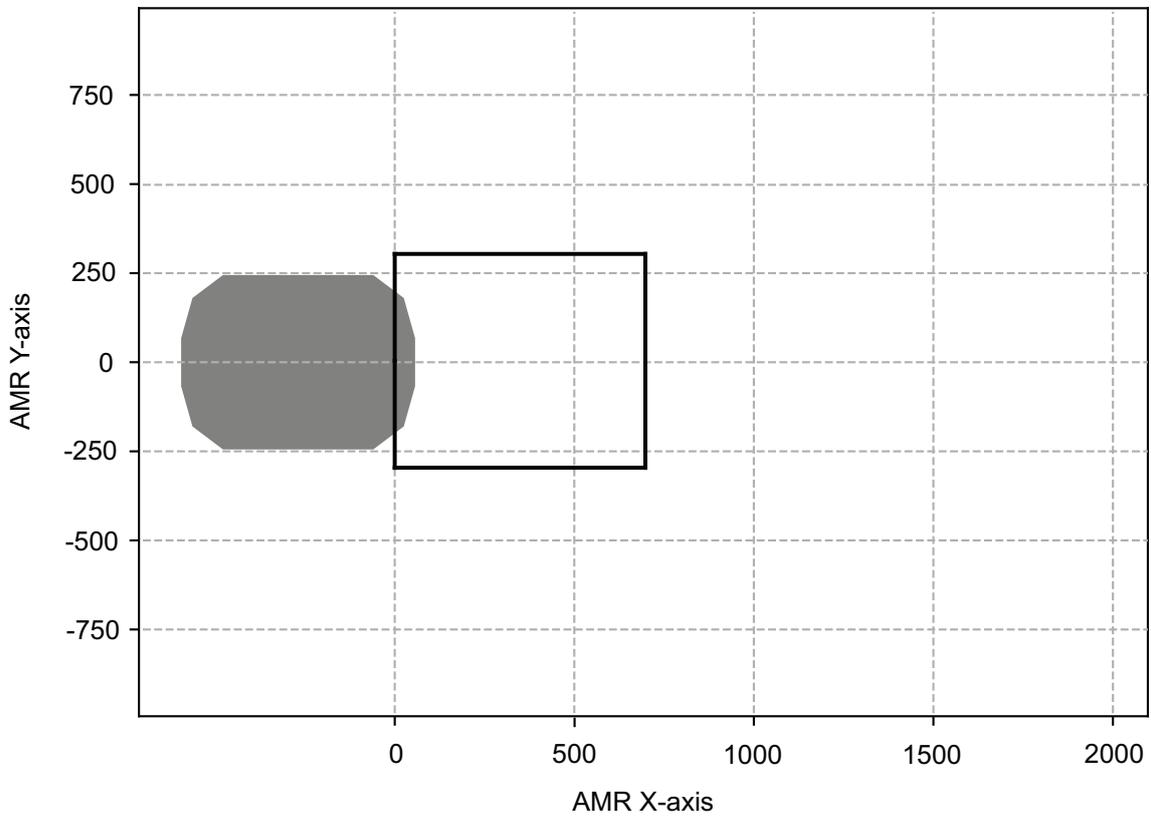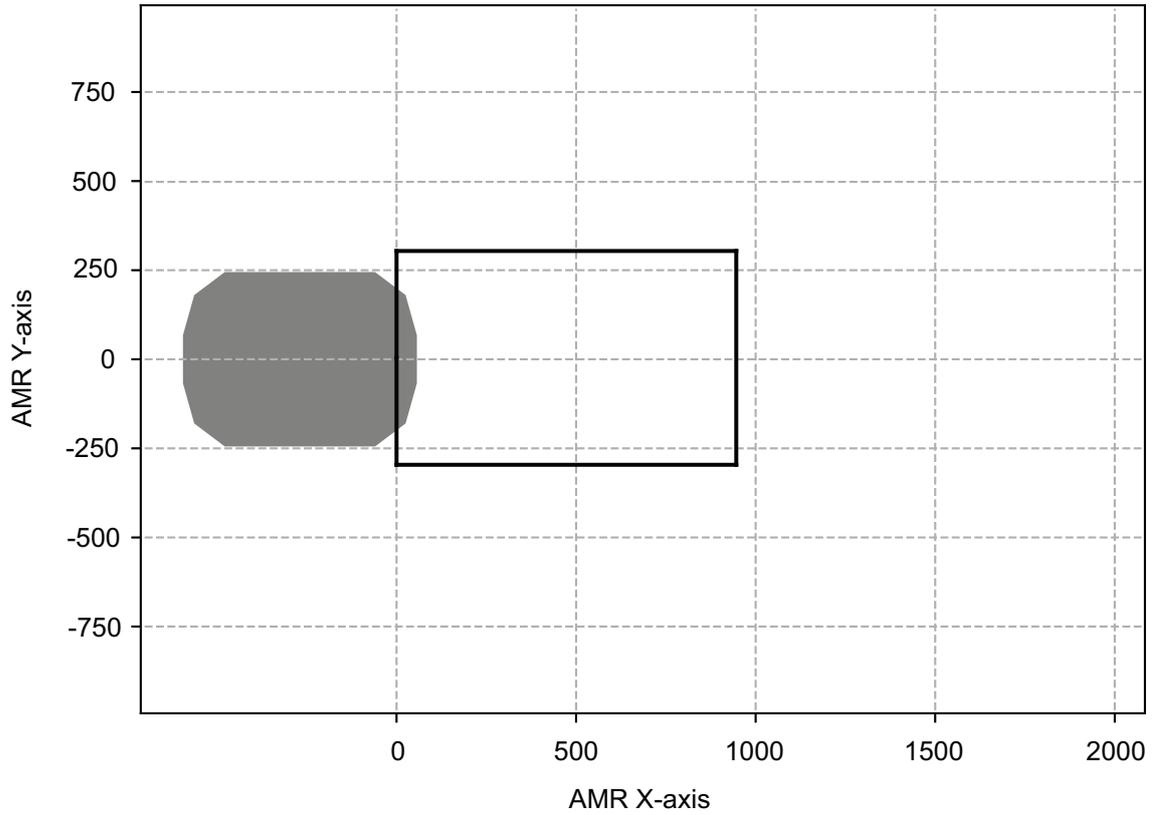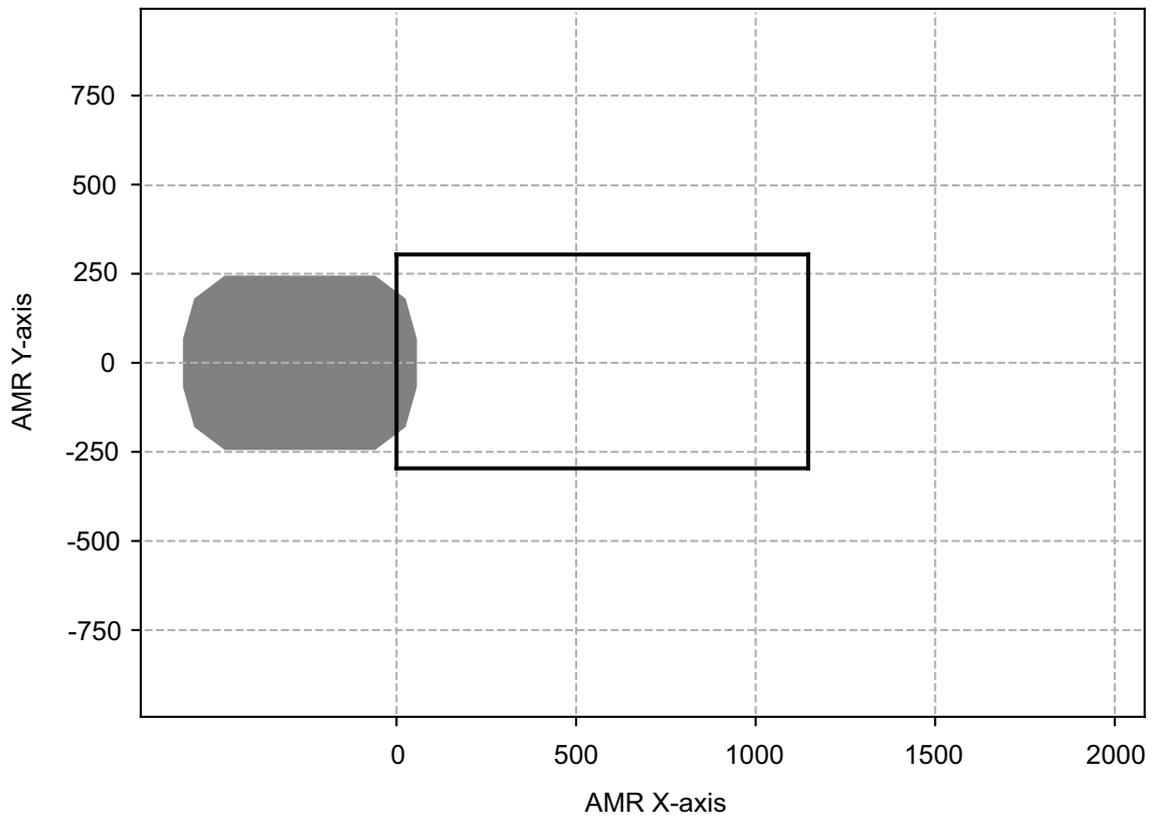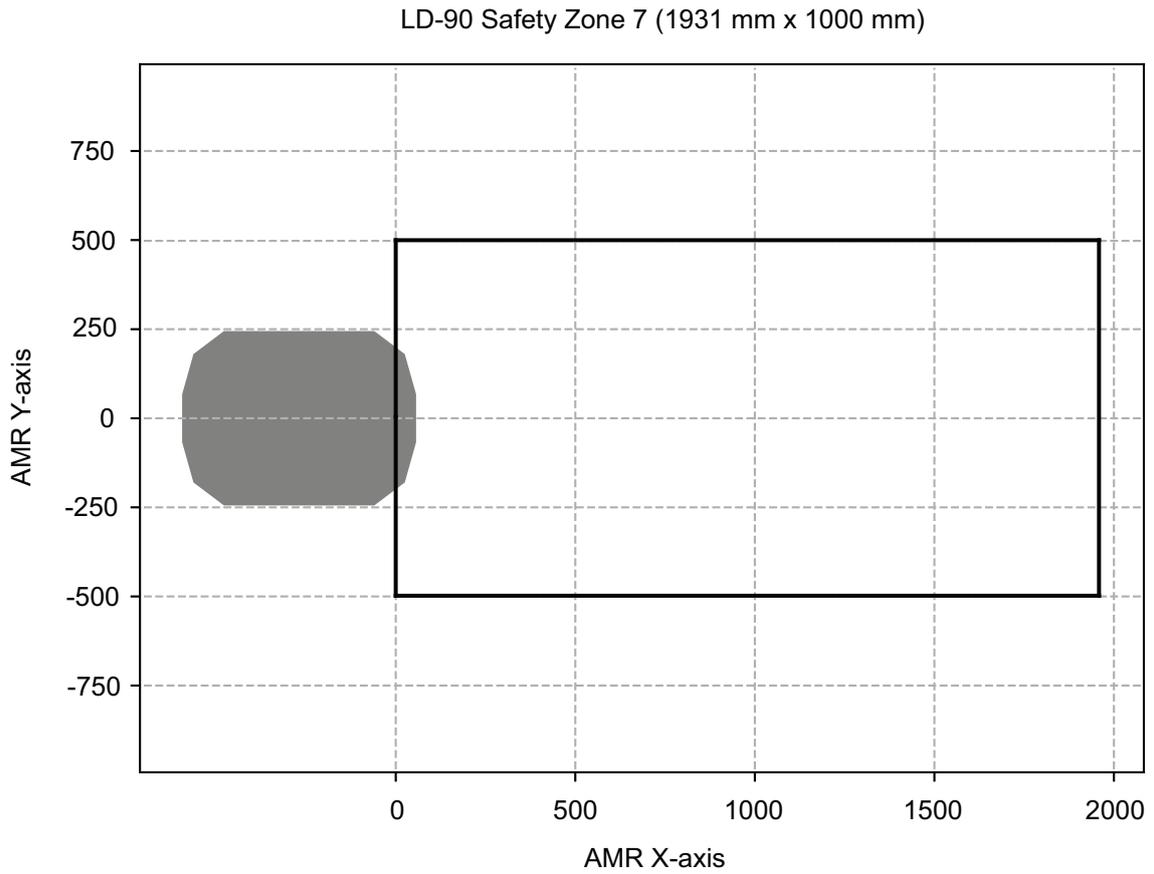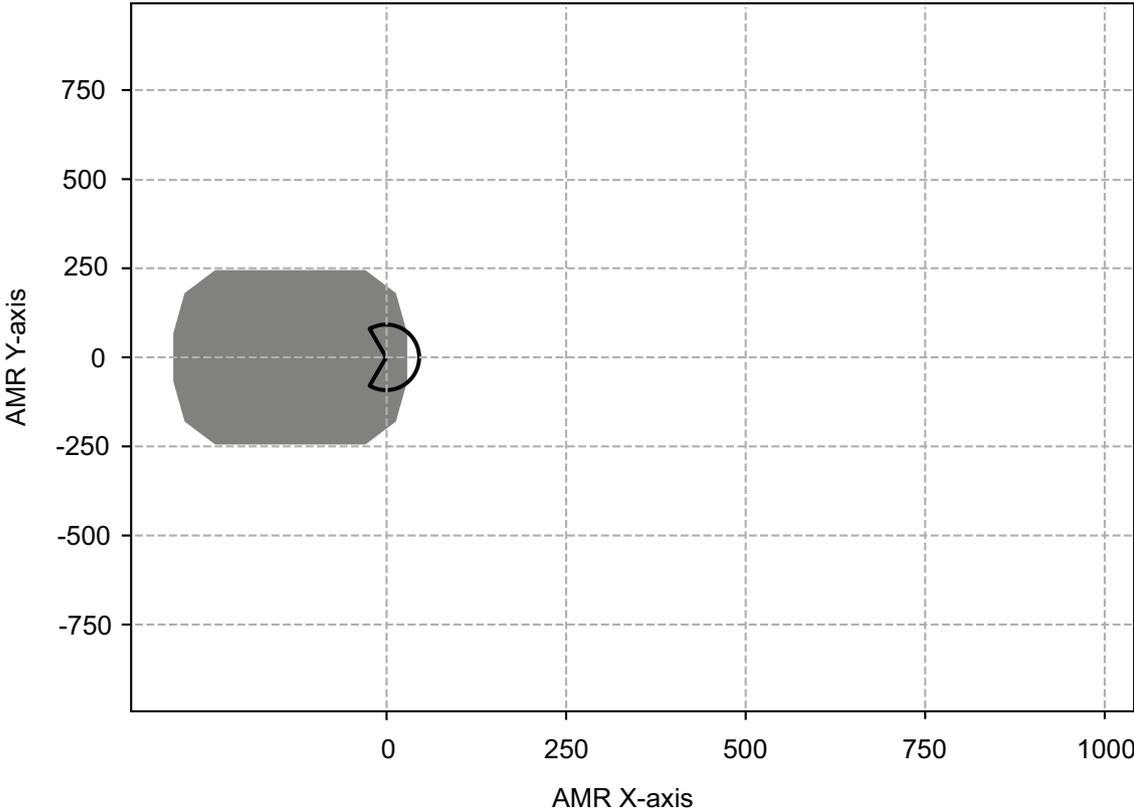
LD-90 Safety Zone 0 (92 mm Radius)

LD-90 Safety Zone 1 (450 mm x 600 mm)

LD-90 Safety Zone 2 (561 mm x 600 mm)

LD-90 Safety Zone 3 (710 mm x 600 mm)

LD-90 Safety Zone 4 (900 mm x 600 mm)

LD-90 Safety Zones 5 and 6 (1121 mm x 600 mm)

LD-90 Safety Zone 7 (1931 mm x 1000 mm)

LD-90x Safety Zone Sizes

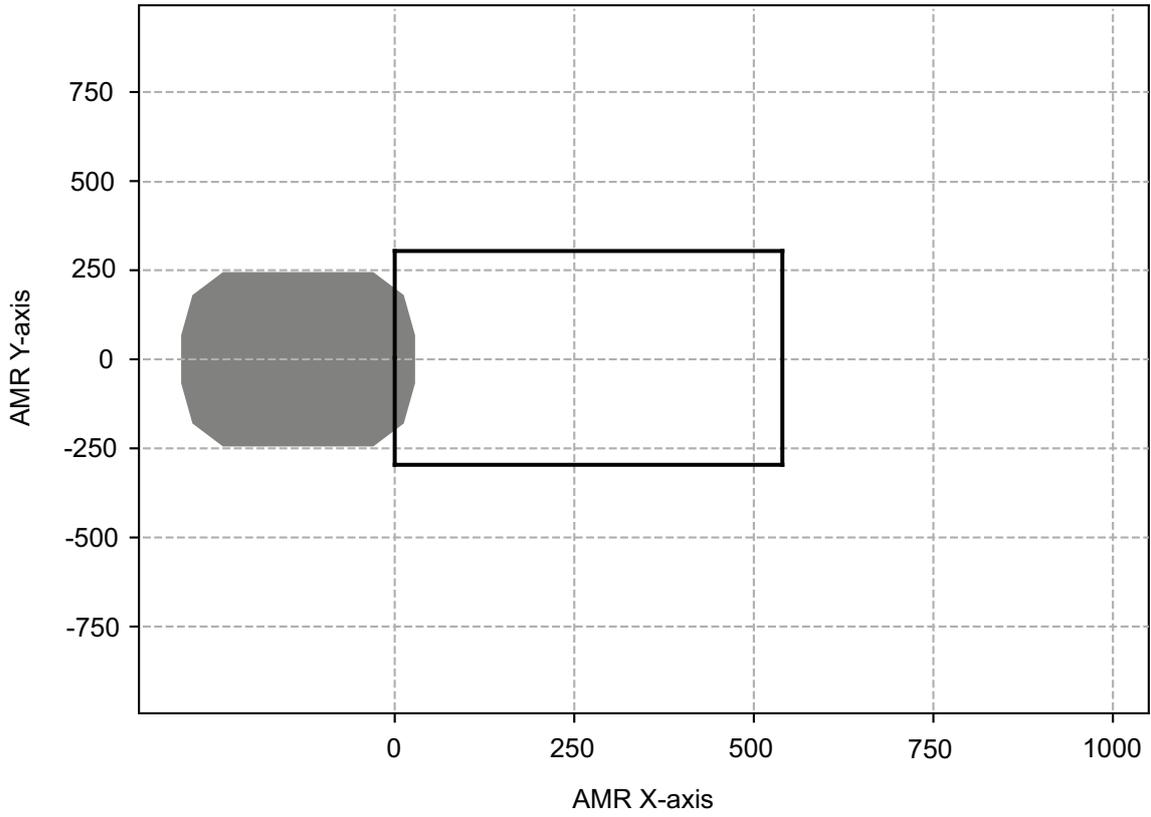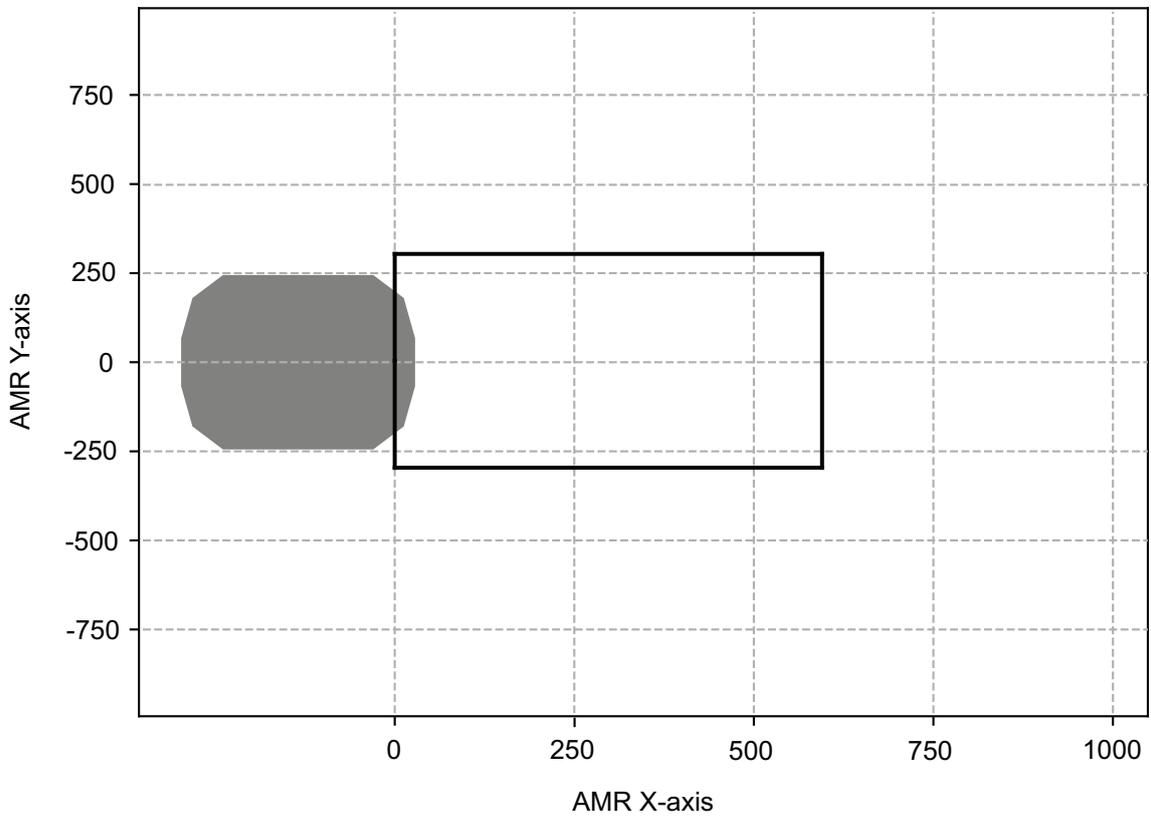The default LD-90x Safety Zone sizes are provided below.

LD-90x Safety Zone 0 and 1 (92 mm Radius)

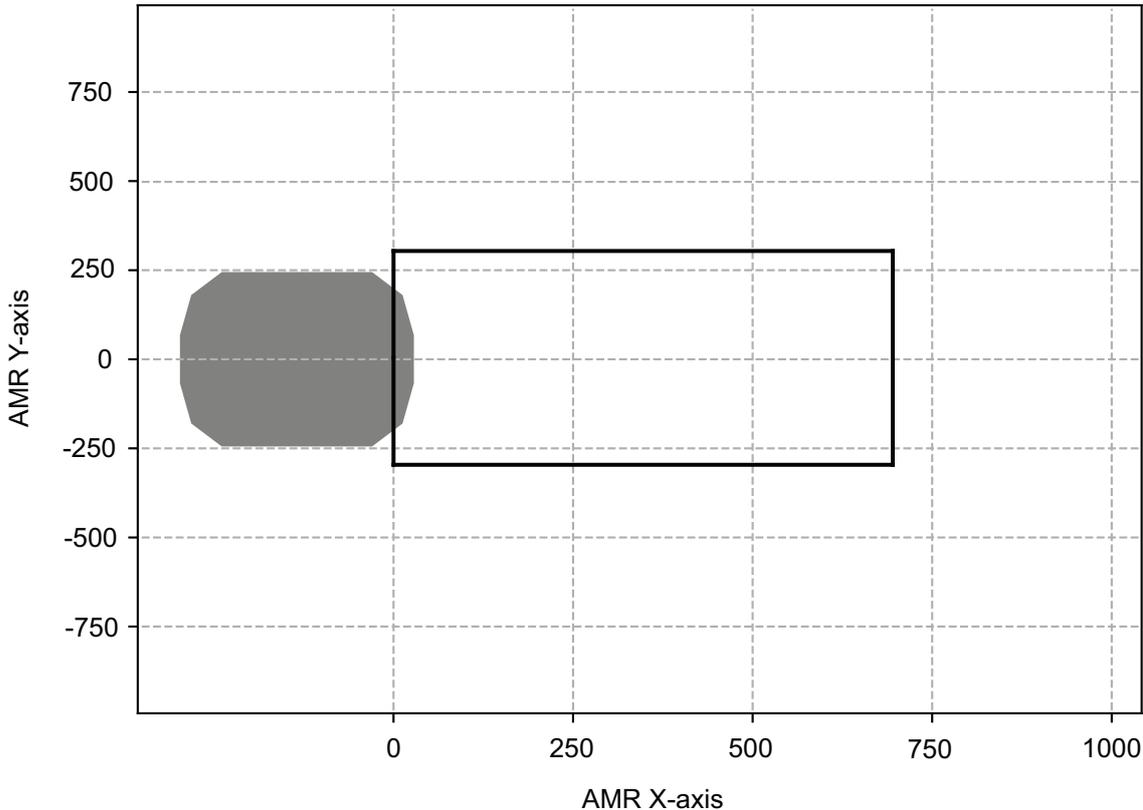LD-90x Safety Zone 2 (450 mm x 600 mm)
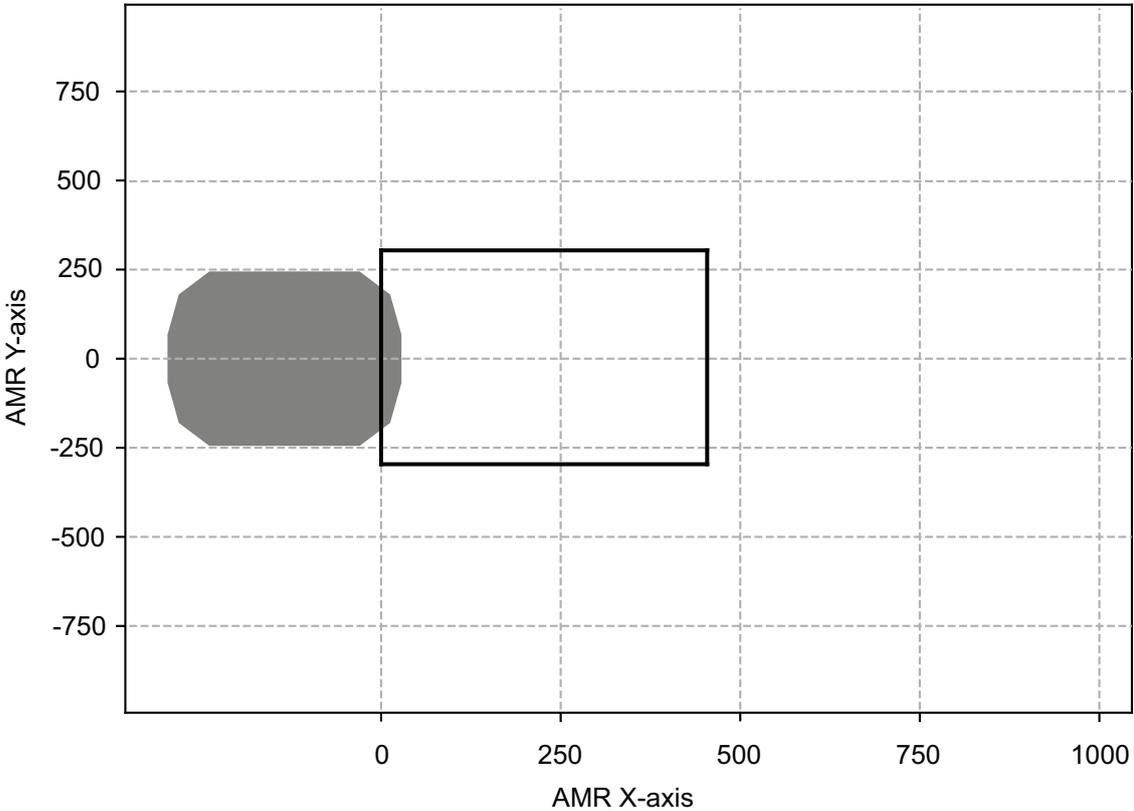
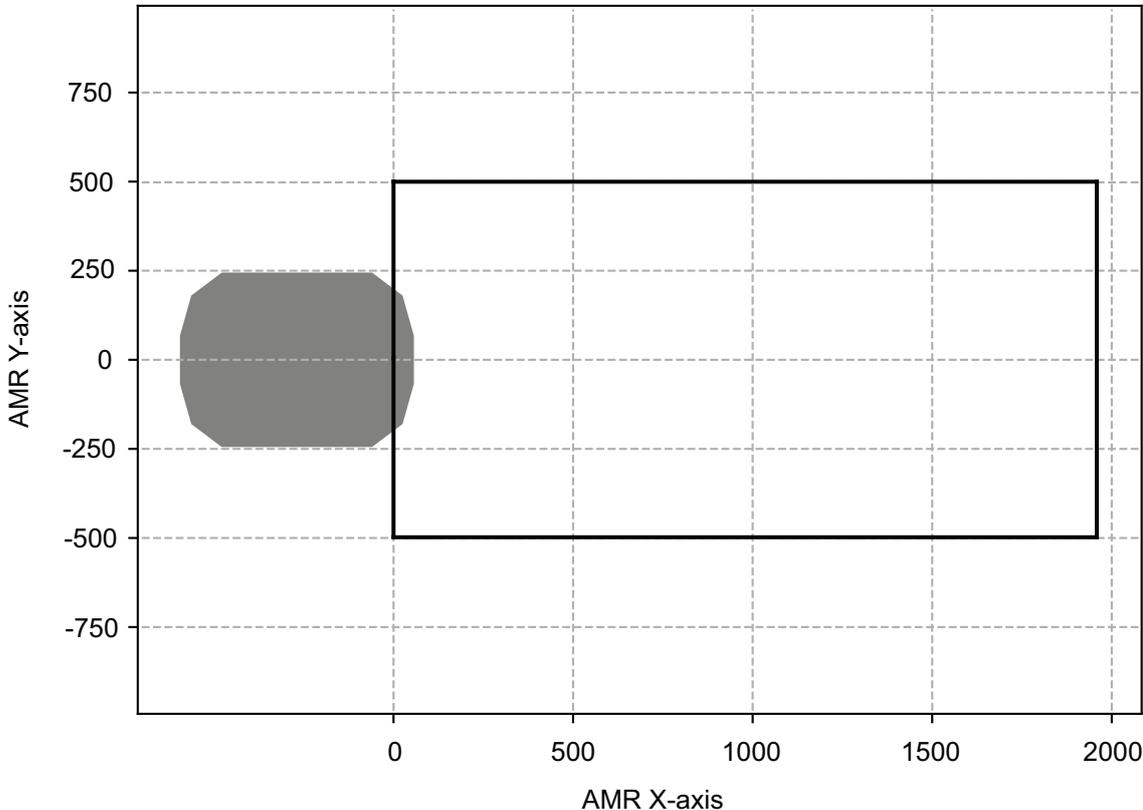LD-90x Safety Zone 3 (520 mm x 600 mm)

AMR X-axis

LD-90x Safety Zone 4 (610 mm x 600 mm)

AMR X-axis

LD-90x Safety Zones 5 and 6 (710 mm x 600 mm)

LD-90x Safety Zone 7 (1931 mm x 1000 mm)

4-20 Motion Limits

An AMR has default limits on its maximum linear and rotational acceleration, deceleration, and speed for safety purposes. Changing these limits might affect the AMR's stability, depending on the center of gravity of the combined AMR and its payload.

> ## ⚠ WARNING
>
> While it is possible to generally reduce AMR deceleration settings for normal operation, the maximum deceleration used in the case of emergency stops, or stops due to Safety Laser Scanner intrusions cannot be lowered below 2000 mm/s^2. It is your responsibility to ensure that the AMR and its load will remain stable in your operating environment at all times, including during an emergency stop.

> ## ⚠ WARNING
>
> OMRON is not responsible for any risks incurred by modifying safety zone sizes or other OS32C laser settings.

Additional Information

Use the configuration area in MobilePlanner to make parameter changes. Refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.

The *Absolute Movement Maximums* parameter limits and defaults are provided below. Adjusting acceleration and deceleration parameters will have a significant impact on AMR motion.

Reducing the value of the *AbsoluteMaxTransDecel* parameter requires that you increase the dimension of the AMR's Safety Laser Scanner zones. This is necessary to compensate for the increased stopping time. The OMRON AMR Safety Zone Generator tool is available for Safety Laser Scanner zone resizing. Any change to Safety Laser Scanner zones may require validation using operational testing in accordance to your applicable standards.

AMR Type	Parameter	Default	Minimum	Maximum
LD-60	*AbsoluteMaxTransVel* (mm/s)	1800	1	2500
LD-90		1350	1	2500
LD-90x		900	1	2500
LD-60	*AbsoluteMaxTransNegVel* (mm/s)	-280	-2500[1]	-1
LD-90		-210	-2500[1]	-1
LD-90x		-140	-2500[1]	-1

AMR Type	Parameter	Default	Minimum	Maximum
LD-60, LD-90, LD-90x	*AbsoluteMaxTransAccel* (mm/s^2)	1000	1	2000
	AbsoluteMaxTransDecel (mm/s^2)	2000	1	2000
	AbsoluteMaxRotVel (deg/s)	180	1	180
	AbsoluteMaxRotAccel (deg/s^2)	360	1	360
	AbsoluteMaxRotDecel (deg/s^2)	360	1	360

*1.   Although the minimum limit for this parameter is -2500, the hardware safety system on the platform will generate a fault if the velocity is anything from -300 to -2500 mm/s.

4

4-21 Emergency Situations

In case of an emergency such as a fire or collision, you should stop the AMR quickly and safely. If the emergency situation is near the Docking Station, you must turn OFF the Docking Station's power using the power switch.

Precautions for Safe Use

In case of fire, use a type ABC or type BC dry chemical fire extinguisher.

4-22 Tilt Detection

The tilt detection feature monitors the angle of the AMR with respect to flat ground during its operation. If the AMR tilts 60 degrees or more in any direction, motion will stop, a driving fault error is displayed in MobilePlanner, and power is removed from pins 11 and 12 of the USER PWR connector. Refer to *USER PWR* on page 3-30 for more information.

> **Precautions for Safe Use**
>
> The tilt detection feature will not prevent an improperly loaded AMR from toppling.

## 4-22-1 Tilt Detection Event Recovery

Use the following procedure to recover from a tilt detection event.

> **Additional Information**
>
> If the AMR has toppled, inspect it thoroughly for damage. If damage has occurred to items that are not user-replaceable, contact your local OMRON representative for support.

1 Move the AMR back to the level position.

2 Acknowledge the error message in MobilePlanner.
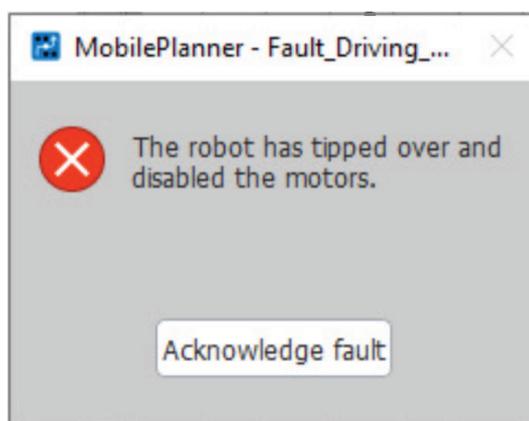
3 Press the ON button on the Operator Panel to return the AMR to the normal operating state.

5

Troubleshooting

This section provides troubleshooting information.

5-1 Collecting Troubleshooting Information

Troubleshooting information can be collected from the AMR by downloading a Debug Info File using SetNetGo. This is a collection of configuration, log, and system status files that support personnel can use for debugging and troubleshooting. Use the following procedure to download a Debug Info File for troubleshooting or diagnostic purposes.

Precautions for Correct Use

The AMR's internal clock must be set correctly to ensure that accurate timestamps are present in the Debug Info File.

Additional Information

A connection to the AMR must be established before attempting to access SetNetGo. If your AMR is already configured to use a wireless network, use the procedure below. If it is not, you must first create a TCP/IP connection to the AMR's Maintenance Ethernet Port.
- Refer to *3-4 Network Connections* on page 3-13 for more information.
- Refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.

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

2 Click the SetNetGo tab to open its Web Interface.

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

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

5-2 Battery Problems

If a problem is detected with the battery while it is in an operating AMR, a message will be displayed on the Operator Panel with information about the cause.

Use the following sections to troubleshoot and resolve other battery problems.

⚠ WARNING

Risk of Fire - No User Serviceable Parts
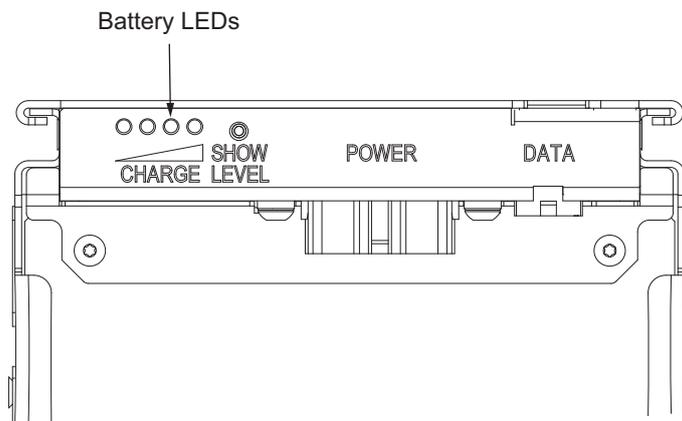AVERTISSEMENT: Risque d'incendie - Aucune des pièces ne peut être.

Precautions for Safe Use

In case of fire, use a type ABC or type BC dry chemical fire extinguisher.

5-2-1 Battery Errors

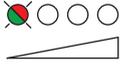Many battery problems can be diagnosed using the battery LED light patterns described below.
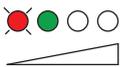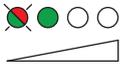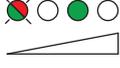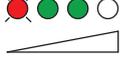
Battery LEDs

If a battery error is present, the leftmost LED will be flashing red. Use the green illumination patterns below to determine battery error, likely cause, and corrective action.
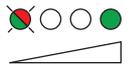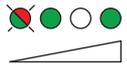
The error with the lowest code value is displayed if there are multiple errors present.

Some errors may resolve automatically when the problem is corrected. Check the ARAM log file using SetNetGo to find battery error history information. Refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.

Battery LEDs will not illuminate if there is a short circuit condition or if the battery is completely discharged. If you suspect that a short circuit condition is present in the AMR equipment, remove the battery from the AMR and then press the battery button. If the battery turns ON, check for and resolve any short circuit(s) present in the user-supplied equipment. If a short circuit condition is not present, the battery may be completely discharged.

If a charged battery that has been removed from the AMR will not turn ON, contact your local OMRON representative for support.

Error Code	LED Pattern	Error Description	Likely Cause	Corrective Action
00	● red, ○ ○ ○	Low temperature detected while charging.	The battery has been exposed to temperatures while charging that are lower than the specifications allow.	Place the battery in an environment within the specified operating temperatures while charging.
01[*1]	● red/green, ○ ○ ○	Cell over-voltage detected. Charging stopped. Error message: Battery_Overvoltage	An internal battery problem is present.	If the error persists, contact your local OMRON representative.
02	● red, ● green, ○ ○	Cell under-voltage detected. The battery will turn OFF. Error message: Battery_Undervoltage	The battery was uncharged or unbalanced for too long.	Attempt to recharge and balance. Replace battery if charging is not possible.
03	● red/green, ● green, ○ ○	Over-current condition detected. The battery will turn OFF. Error message: Over-current	Electrical loads connected to the battery exceeds limits. A short circuit may be present.	Reduce the amount of current consumed by user-supplied devices. Remove any short circuit conditions that may be present.
04	● red, ○ ● green, ○	Blown fuse. The battery will turn OFF. Error message: Blownfuse	The internal fuse inside the battery has blown.	Replace the battery or contact your local OMRON representative for service support.
05	● red/green, ○ ● green, ○	High battery management system temperature detected while discharging. Error message: RTC_Error	The battery has been exposed to temperatures while discharging that are higher than the specifications allow.	• Bring the battery to an environment within operating temperature • Replace the battery or contact your local OMRON representative for service support.
06	● red, ● green, ● green, ○	High switching circuit temperature detected. The battery will turn OFF. Error message: Over_Temperature	High temperature environment or battery malfunction.	• Reduce the environment's ambient temperature. • Replace the battery or contact your local OMRON representative for service support.
07	● red/green, ● green, ● green, ○	Hardware protection activated. The battery will turn OFF. Error message: Master_Switch_Fault	Short circuit or battery malfunction.	• Check battery cables, connections, and user-supplied loads for short circuits. • Replace the battery or contact your local OMRON representative for service support.

Error Code	LED Pattern	Error Description	Likely Cause	Corrective Action
09	🔴⚪⚪🟢	Docking Station voltage out of range. Charging stopped. Error message: Charger_Out_of_Voltage_Range	Docking Station malfunction or maintenance issue.	• Perform maintenance on the Docking Station. • Replace the Docking Station or contact your local OMRON representative for service support.
11	🔴🟢⚪🟢	Excessive charging current detected. Charging stopped.	Docking Station malfunction.	Replace the Docking Station or contact your local OMRON representative for service support.
12	🔴⚪🟢🟢	Hardware high current detected. Battery turned OFF.	Electrical loads connected to the battery exceeds limits.	Reduce the amount of current consumed by user-supplied devices.
14	🔴🟢🟢🟢	Low temperature detected while discharging.	The battery has been exposed to temperatures while discharging that are lower than the specifications allow.	Place the battery in an environment within the specified operating temperatures.
15	🔴🟢🟢🟢	High temperature detected while charging.	The battery has been exposed to temperatures while charging that are higher than the specifications allow.	Place the battery in an environment within the specified operating temperatures while charging.
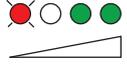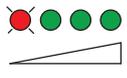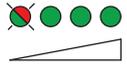
⚪: OFF 🟢 : Solid Green 🟢̸ : Flashing Green 🔴 : Flashing Red 🔴̸ : Alternating Red / Green

*1.   This error may appear briefly at the end of a charging cycle during normal operation.

5-2-2   Low Battery Recovery

If the AMR cannot drive to a Docking Station for charging due to a low battery, the battery must either be removed and charged outside of the AMR (refer to *Charging a Battery Outside of the AMR* on page 4-22 for more information), or the AMR must be physically pushed to a Docking Station for charging (refer to *4-11 Manually Pushing the AMR* on page 4-29 for more information).

After the AMR is connected to the Docking Station, verify the amber charge LED illuminates after a few seconds. If the LED does not illuminate, adjust the position of the AMR on the Docking Station by moving it forward or backward two to three cm until the LED illuminates.

🔊 **Precautions for Safe Use**

Do not allow the battery to remain discharged for an extended period of time.

5-2-3   Battery Charging Problems

Use the information in the table below to understand battery charging problem indications and solutions.

Condition	Assumed Cause	Remedy	Additional Information
A battery problem message is displayed on the Operator Panel screen.	Refer to *5-2-1 Battery Errors* on page 5-3 for more information.		
Charging does not occur when the AMR is at the Docking Station	Charging contacts may be worn or dirty.	Refer to *6-5-4 Docking Station Charging Mechanism Inspection* on page 6-7 for more information.	
When Docking Station is switched ON, blue power light does not illuminate. Battery cannot be charged manually.	Docking Station power switch fuse is blown.	Replace fuse assembly.	Refer to *6-8-5 Docking Station Power Switch Fuse Replacement Procedure* on page 6-27 for more information.
When Docking Station is switched ON, blue power light does not illuminate. Battery can still be charged manually.	Docking Station internal fuse is blown.	Contact your local OMRON representative for support.	
No problem indications.	A battery connection issue may present or a battery problem may be present.	• Ensure the Docking Station has power supplied. • Ensure the Docking Station power switch is in the ON position. • Check all cables and connections for damage or faulty connections.	Refer to *5-2-1 Battery Errors* on page 5-3 for more information.

5-2-4 Leaking Batteries

If the battery is leaking, discontinue use immediately. Isolate the spill or leak and keep unauthorized personnel away. Absorb all spilled material with an inert absorbent substance such as dry sand, and thoroughly clean the affected area. Place the leaking battery in a bag or drum and dispose of the materials properly in accordance with national, regional, and local environmental control regulations.

> ## ⚠ WARNING
>
> • You must wear proper Personal Protective Equipment (PPE) when removing, installing, and lifting the battery or when working around a leaking battery.
> • Do not dispose of the battery in a waste stream that might result in incineration or crushing. Safely dispose of the battery through a designated facility according to all local and national environmental regulations regarding lithium battery disposal.

Precautions for Safe Use

You can contribute to resource conservation and protecting the environment by the proper disposal of Waste Electronics and Electrical Equipment (WEEE). All electrical and electronic products should be disposed of separately from the municipal waste system according to local ordinances using designated collection facilities.

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5-3 Exposure to Liquids

Use the following procedure if the AMR comes into contact with any liquid.

1 Power OFF the AMR immediately.

2 Remove and dry as much liquid as possible.

3 Allow the AMR to air dry thoroughly before attempting to restore power.

5-4 AMR Start-up Problems

If the AMR does not start-up, press the power OFF button and then check all connections. Press and hold the power ON button for half a second, then release to power ON.

If the AMR still does not start-up, check the following item(s):

• Check the battery's state of charge to ensure sufficient power is available. Refer to *4-8-1 Battery Indicators and Controls* on page 4-16 for more information.

If the AMR does not start-up after the actions above, contact your local OMRON representative.

5-5   AMR Shut-down Problems

The following conditions may cause the AMR to shut down unexpectedly:

- Battery connection issue.

  Refer to *3-3 Battery Installation Procedure* on page 3-11 for more information.

- Battery problem detected.

  Refer to *5-2 Battery Problems* on page 5-3 for more information.

- Incorrect wiring or short circuit at USER PWR connector.

  Refer to *USER PWR* on page 3-30 for more information.

- Low battery state of charge.

  Refer to *4-8 Battery and Charging* on page 4-16 for more information.

- Faulty connection at the HMI PANEL connector or Operator Panel OFF Button.

  Refer to *HMI PANEL* on page 3-31 for more information.

- Internal component or connection problem.

  Contact your local OMRON representative for more information.

5-6   Operator Panel Information

Troubleshooting information about Operator Panel information is provided in the following sections. Refer to Main Screen for more information.

5-6-1   Text Messages

Several text messages may be displayed on the Operator Panel screen to indicate operational status, required actions, errors messages, or faults.

To troubleshoot specific error messages or faults, contact your local OMRON representative for more information.

6

Maintenance

This section provides information on the maintenance of the AMR.

6-1   Maintenance Introduction

Read and understand the following information before performing any maintenance tasks.

Only properly skilled, trained, and instructed personnel can perform maintenance procedures described in this document.

Prior to performing maintenance tasks on an AMR, you should make sure that the area you will be working in is adequately protected and cannot be interrupted by other AMRs.

> ## ⚠ WARNING
>
> * Use only the specified tools, equipment, lubricants, and Omron-supplied spare parts to service and maintain the AMR according to the specified service interval. Failure to do so could result in an unsafe operating state than might result in personal injury or damage to property.
> * While conducting any work on the AMR, make sure it is located on a flat, level surface with casters chocked and emergency stop active to prevent unexpected movement.
> * When working near the encoder cables, take care not to disconnect or damage them. Improper connection or disconnection of encoder cables may result in erratic motion of the AMR during operation. Operating the AMR with damaged, disconnected, or improperly connected encoder signals can cause potentially hazardous uncommanded rotation.

> ## ⚠ WARNING
>
> There are no user-serviceable parts inside the Docking Station and high voltage may be present in this area. Do not remove the covers of the Docking Station.

Precautions for Safe Use

Maintenance of the payload structure is not covered in this document and is the responsibility of the end-user.

6-2　AMR Lock-out Tag-out Procedure

Use the following procedure to execute Lock-out Tag-out before performing any maintenance or installation work on the AMR.

1 Press an E-STOP button.

2 Shut down the AMR by pressing the OFF button on the Operator Panel.

3 Remove the battery.

4 Lock and tag the battery door according to your facility requirement and regulations.

6

6-3 Docking Station Lock-out Tag-out Procedure

Use the following procedure to execute Lock-out Tag-out before performing any maintenance or installation work on the Docking Station.

⚠ WARNING
The docking station has AC power inside. Docking station covers are not interlocked.

1 Disconnect the Docking Station and then lock and tag the Docking Station power cord connector.

2 Turn the AC input power OFF by switching the main power switch to the OFF position, as indicated by the power-off symbol (circle).
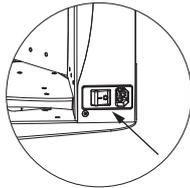
3 Lock and tag the main power switch according to your facility requirement and regulations.

4 Verify that all the Docking Station LEDs are OFF to complete this procedure.

6-4 Lifting the AMR

Use the following procedure to lift an AMR without a payload or payload structure.

⚠ WARNING

Do not attempt to lift the AMR with a forklift or other lifting device. Doing so might cause damage to the skins or other components.

Do not lift the AMR by:

• Any of the skins.

• Any part of the chassis that contains a sensor component.

1 Perform the appropriate Lock-out Tag-out procedures.

2 Locate the lifting points on the AMR, as indicated in the figure below.

Do not lift here
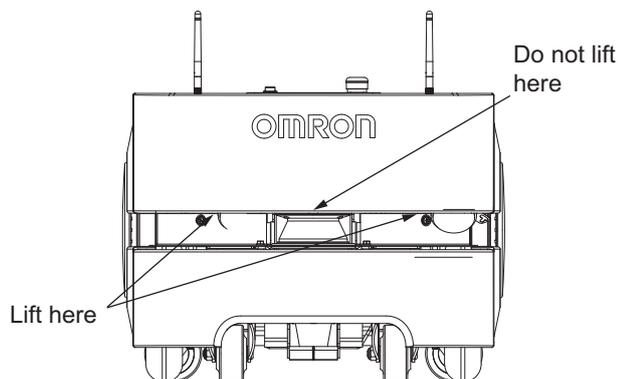
Lift here

3 Locate the rear lifting point on the AMR, as indicated in the figure below. Lift at the center underside of the platform, where the skin has a cutout section. Lift from the frame, not the skin. Do not lift anywhere else from the rear.
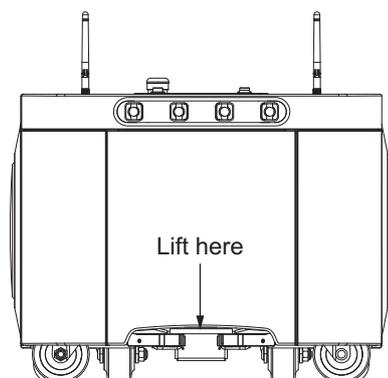
Lift here

4 Lift the AMR with two people and proper lifting techniques. One person should lift from the front of the AMR, and the second person should lift from the rear of the AMR. This completes the Lifting procedure.

6-5 Maintenance Items

Perform the maintenance items described below.

Item	Inspection Frequency	Additional Information
Inspect Signal Beacons (optional)	Weekly	Check for proper operation of any optional signal beacons.
Inspect Light Discs	Weekly	Check for proper operation of the light discs. Make sure all segments and colors are functioning properly.
Check Buzzer	Weekly	Check the audible buzzer for proper operation.
Check E-STOP Buttons	Weekly	Check for proper operation of the E-STOP buttons. Refer to *3-14 Commissioning* on page 3-83 for more information.
Check safety and warning labels	Weekly	Verify all labels are present, legible, and undamaged. Refer to *6-5-5 Safety and Warning Labels* on page 6-9 for more information.
Inspect Caster and Drive Wheel Treads	3 months	Check the AMR treads for wear or debris. Refer to *6-5-2 Drive Wheel Inspection* on page 6-7, *6-5-3 Caster Inspection* on page 6-7 for more information.
Inspect Caster Swivels	3 months	Check the caster swivels and tighten if loose.
Docking Station Charging Contact Assembly	3 months	Inspect the Docking Station Charging Contact assembly. Refer to *6-5-4 Docking Station Charging Mechanism Inspection* on page 6-7 for more information.
Inspect Docking Station Roller	3 months	Check the Docking Station roller for wear or damage. Refer to *6-5-4 Docking Station Charging Mechanism Inspection* on page 6-7 for more information.
Inspect Batteries (in-use and stored)	6 months	Check the battery for charge state, leaks, or damage. Refer to *4-8-6 Storing Batteries* on page 4-24 for more information.
Check Mechanical Brakes	6 months	Check for proper operation of the mechanical brakes. Refer to *6-5-1 Mechanical Brake Inspection Procedure* on page 6-6 for more information.
Check Speakers	As needed	Check the speakers for proper operation (if used).

6-5-1 Mechanical Brake Inspection Procedure

Perform annual inspection of the mechanical brakes for proper operation. Before you begin, make sure it is safe to manually move the AMR to an open area with level floor.
Use the following procedure to verify that the mechanical brakes engage and disengage properly.

1 Connect the pendant to the AMR and drive forward approximately 2 m in order to align the casters in the direction of motion.

2 Release the trigger to ensure that the AMR is in protective stop mode.

3 Press and hold the brake release button and then push the AMR straight forward. One or two people should be able to push an unloaded or lightly loaded AMR. For a heavily loaded AMR, you may need more people.

You will hear a click sound when the brake release button is pressed and then the AMR should roll smoothly. Contact your OMRON representative if the AMR does not move.
Refer to *4-11 Manually Pushing the AMR* on page 4-29 for more information.

4 Release the brake release button and then try to push the AMR forward with the same amount of force used in the last step, to confirm the brake is working. The AMR should not move or rotate. This completes the mechanical brake inspection procedure.
If the AMR moves while the brake is activated during this step, stop using the AMR and contact your local OMRON representative.

6-5-2 Drive Wheel Inspection

The LD-6090 has solid aluminum wheels with foam-filled rubber treads. Depending on the AMR application, the wheel treads have a duration of 10,000 km before replacement is recommended. Refer to *6-7 Distance Traveled by the AMR* on page 6-16 for more information.

Inspect the wheels daily and remove any surface-embedded foreign material such as stones, screws, or metal filings.

Thoroughly inspect and clean wheels and treads every 3 months and replace any wheels that show signs of excessive wear or damage.

⚠ WARNING

Conduct regular maintenance of wheels and replace any damaged wheel. 🛈

Tread damage might be indicated by:
- Abnormal or uneven wear patterns. Damage to the metal wheel or bearing can also cause abnormal wear.
- Cracks, chips, or cuts in the polyurethane tread.
- Flat spots.
- Abraded rough surface.
- Delamination or debonding (separation) of the polyurethane tread.

Metal wheel damage might be indicated by:
- Binding or indications of metal-on-metal wear such as metal filings or a black powdery deposit.
- Oil or grease leaking from bearings.
- Cracks in the metal part of the wheel.

6-5-3 Caster Inspection

Casters must be periodically inspected for excessive wear or damage.
Measure the overall diameter of each caster. If the overall diameter is less than 72 mm or damage to the surface is present, the caster must be replaced. Contact your local OMRON representative for more information.

6-5-4 Docking Station Charging Mechanism Inspection

The Docking Station charging assembly should be inspected every 3 months with the following actions.

⚠ WARNING

Remove the AMR from a Docking Station when conducting any installation or mainte-
nance actions.

⚠ CAUTION

The charging contacts on both the Docking Station and the AMR can get hot during
operation. Allow these items to cool down for at least 15 minutes prior to servicing.

◀← **Precautions for Safe Use**

Do not allow any foreign metal objects to be near the AMR or Docking Station charging con-
tacts.

- Inspect the charging contacts for dirt and debris build-up,discoloration, or pitting. The charging con-
tacts must be smooth and clean to maximize electrical conductivity.
Refer to *6-6-3 Cleaning Docking Station Charging Contacts* on page 6-12 for more information.
- Inspect the charging contacts to ensure they are securely attached and they do not have excessive
deflection.
Measure the contacts as shown in the illustration below. If the distance is 4 mm or less, charging
may not occur. Contact your local OMRON representative for contact replacement..

4 mm Minimum

4 mm Minimum
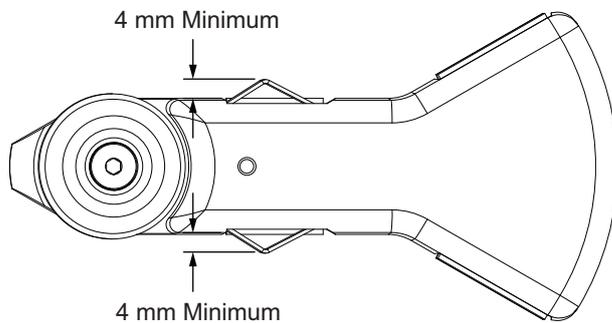
- Inspect the charging paddle assembly to ensure in moves freely and returns to a center position. If
the charging paddle assembly is binding and not returning to center, check for any debris around the
moving parts. If no debris is found, an internal component may be damaged.
Contact your local OMRON representative for more information about repairing a damaged charging
paddle assembly.
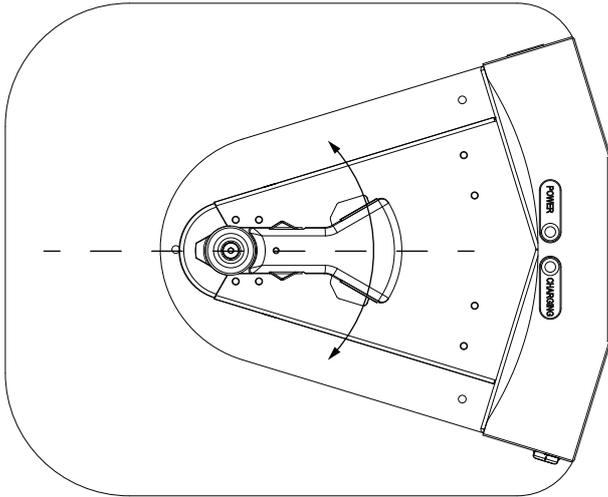
- Inspect the engagement roller for signs of excessive wear or damage.
  Check for worn or abraded (flattened) surfaces, cracks, or material flaking off the roller. Check around the roller bearing for metal filings or black powdery residue that indicates abrasion damage. Spin the roller manually to make sure it turns freely and does not bind.
  Replace the roller if excessive wear or damage is present. Refer to *6-8-4 Docking Station Roller Replacement Procedure* on page 6-27 for more information.

6-5-5   Safety and Warning Labels

This section identifies safety and warning labels and their locations on the AMR. Use this information to perform periodic checks to ensure safety and warning labels are not damaged or removed.

AMR Safety and Warning Label Locations

Use the following information to understand all safety and warning label locations on the AMR.
The following labels are located on the AMR as indicated below.

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

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

- No Riding Label, part number 18178-000

The no riding label is affixed based on payload design. Refer to *3-13 Attaching Warning Labels* on page 3-82 for more information. Verify that the label is there and legible.

- Incline Limit Label, part number 18622-000

The Incline label is placed on the front-right of the top plate.

- Automatic Vehicle Label, part number18623-000

The automatic vehicle label is attached to the rear skin of the AMR.

6-6   Cleaning

Use the following information to understand how to clean the AMR and its associated components.

⚠ WARNING
Do not use organic solvents to clean any part of the AMR unless directed in the cleaning instructions. Organic solvents might damage electronics resulting in an unsafe operating state that could cause injury or damage to equipment.

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

6-6-1   Cleaning Intervals

Use the following cleaning intervals as guidelines.

📑 **Precautions for Correct Use**

The frequency of cleaning intervals depends on your particular system, its operating environment, and the amount of use. Cleaning intervals may need to be shortened for certain environments.

Item	Interval	Additional Information
Clean the AMR charging contacts.	3 months	Refer to *6-6-2 Cleaning AMR Charging Contacts* on page 6-11 for more information.
Clean the Docking Station charging contacts.	3 months	Refer to *6-6-3 Cleaning Docking Station Charging Contacts* on page 6-12 for more information.
Clean all laser lenses.	1 month / as needed	Refer to *6-6-4 Cleaning Laser Lenses* on page 6-13 for more information.
Clean caster treads.	As needed	Refer to *6-6-5 Cleaning Caster Treads* on page 6-13 or *6-6-6 Cleaning ESD Caster Treads* on page 6-14 for more information.
Clean drive wheel treads.	As needed	Refer to *6-6-7 Cleaning Drive Wheels* on page 6-14 for more information.
Clean dust and dirt from drive assembly.	As needed	Inspect and clean any visible dust and dirt from the drive assembly as needed.

6-6-2   Cleaning AMR Charging Contacts

To clean the AMR charging contacts, use 320 grit sand paper to remove surface dirt, oxidation, pitting or other contaminants. Then, use a soft cloth with isopropyl alcohol to wipe and clean the surface of the charging contacts. Do not use any other cleaning agents or solvents.

⚠ CAUTION

The charging contacts on both the Docking Station and the AMR can get hot during operation. Allow these items to cool down for at least 15 minutes prior to servicing.


Precautions for Safe Use

Do not allow any foreign metal objects to be near the AMR or Docking Station charging contacts.

Precautions for Correct Use

- Do not use solvents or chemicals other than isopropyl alcohol on the AMR charging contacts, as this could damage the AMR surfaces near the contacts. Do not expose any of the surfaces surrounding the charging contacts to isopropyl alcohol.
- Do not reduce the charging surface area of the charging contacts while cleaning. A smaller charging surface will reduce the charging speed and affect charging operations.
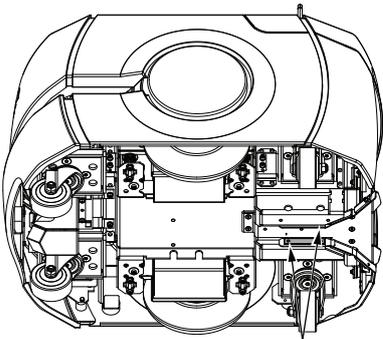
Charging Contacts

6-6-3   Cleaning Docking Station Charging Contacts

To clean the Docking Station charging contacts, use 320 grit sand paper to remove surface dirt, oxidation, pitting or other contaminants. Then, use a soft cloth with isopropyl alcohol to wipe and clean the surface of the charging contacts. Do not use any other cleaning agents or solvents.

⚠ WARNING

Remove the AMR from a Docking Station when conducting any installation or maintenance actions.

⚠ CAUTION

The charging contacts on both the Docking Station and the AMR can get hot during operation. Allow these items to cool down for at least 15 minutes prior to servicing.
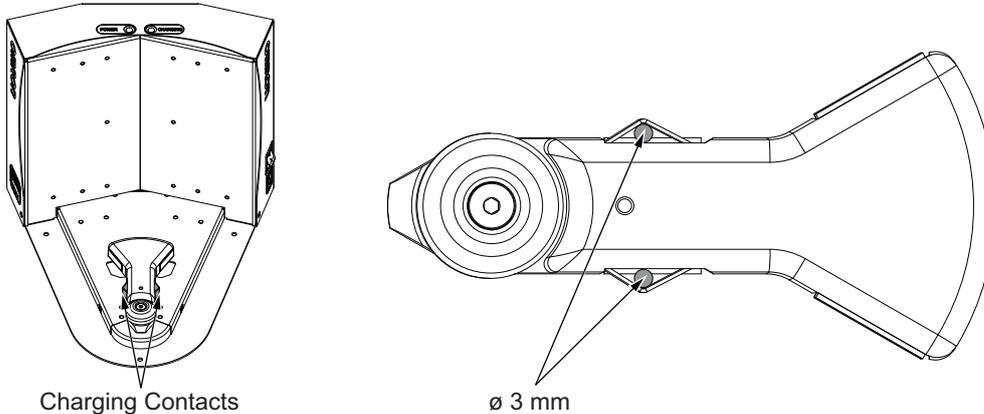

> **Precautions for Safe Use**
>
> Do not allow any foreign metal objects to be near the AMR or Docking Station charging contacts.

Insert a 3 mm diameter, non-conducting, cylindrical spacer to prevent deflection while cleaning or sanding, as shown in the illustration below.

Charging Contacts   ø 3 mm

6-6-4   Cleaning Laser Lenses

Use the following procedure to clean the AMR laser lenses.
The following items are required for this procedure.
- Microfiber cloth
- Cleaning fluid such as isopropyl alcohol based anti-static cleaner or lens cleaner.

1 If the AMR is ON, press one of the emergency stop buttons.

2 Moisten the microfiber cloth with the cleaning fluid.

3 Carefully wipe the lens to lift the dust away from the lens surface. Use a moist, clean area on the cloth for each stroke.
Dragging a cloth embedded with dust across the lens surface will scratch it and damage the laser lens.

4 Clean the dust detection surface using the same methods as in the previous step.

5 Carefully inspect the cleaned surfaces for dust or debris.
Continue cleaning until the lens is completely free of dust or debris to complete this procedure.

6-6-5   Cleaning Caster Treads

Remove any accumulated dirt or debris on the treads to prevent AMR's performance degradation.
Clean the caster treads with a mild soapy solution.

6-6-6   Cleaning ESD Caster Treads

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

You must also maintain the AMR's operating area to provide a conductive path to ground. Refer to *4-5 Workspace* on page 4-7 for more information.

You need the following tools and resources:

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

Use the following ESD caster cleaning procedure:

1. Press an E-STOP button and power off the AMR to put it into a safe working state.

2. Remove the payload structure, if any part of it prevents access to the skins or casters.

3. Remove the front lower and rear right and left skins. Refer to *6-8-1 Removing and Replacing Skins* on page 6-17 for more information.

4. Lift the AMR safely.

5. Use a vacuum cleaner or compressed air to remove dust and loose material.

6. Use a wire hook or tweezers and sharp blade to carefully cut away any fibrous material from around the hub and axle.

7. Use disposable wipes and a soft brush dampened with isopropyl alcohol to thoroughly clean all four casters.

8. Dry the casters thoroughly with a clean wipe.

9. After cleaning, inspect the caster wheels, axles, and pivots for wear and damage.

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

11. Reinstall the front lower and rear right and left skins. Refer to *6-8-1 Removing and Replacing Skins* on page 6-17 for more information.

6-6-7   Cleaning Drive Wheels

The drive wheels provide electrical path to ground and traction during normal operation. They require regular, periodic cleaning to preserve ESD protection capability and overall AMR performance.

Drive Wheel Cleaning Procedure

Use the following procedure to clean the drive wheels.

The following items are required for this procedure.

• Gloves.
• Disposable lint-free cloth(s).
• Wire hook, tweezers, and sharp blade to remove any fibrous material wound around the wheel hubs.

- Soft brush.
- Isopropyl alcohol.

1 Remove the right and left side skins and then set them aside.

2 Use a lint-free cloth wetted with isopropyl alcohol to thoroughly clean the drive wheel treads. You should also remove any foreign objects embedded in the drive wheel treads (such as small rocks, staples, or screws).

3 Re-install the right and left side skins to complete this procedure.

6-7   Distance Traveled by the AMR

In some instances, the distance traveled by an AMR indicates the service interval. Determine distance traveled as follows:
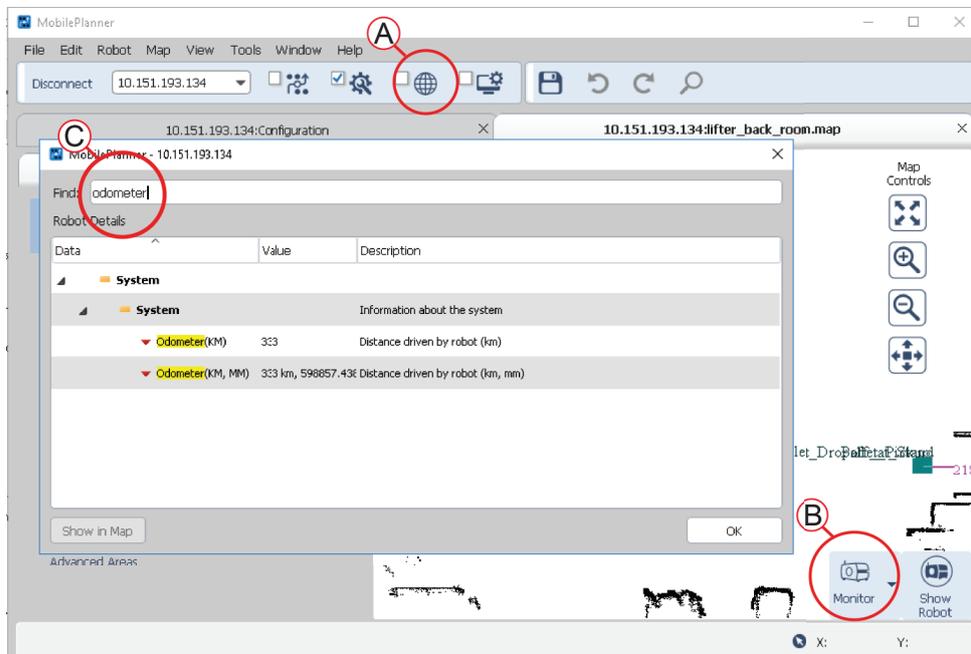
1. In MobilePlanner, connect to the AMR and open its Map tab (A).

2. Click **Monitor** (B) in the bottom right of the screen to open the monitor fly-out menu, and then click **Details**.

3. In the **Robot Details** dialog window, type odometer in the **Find**: field (C) and then press **Enter**.

The value of the System, Odometer parameter is the distance traveled in kilometers.

6-8 Replacing Items

Read and understand the following information before replacing any items.

Only properly skilled, trained, and instructed personnel can replace items described in this document.

Prior to replacing items on an AMR, you should make sure that the area you will be working in is adequately protected and cannot be interrupted by other AMRs.

6-8-1 Removing and Replacing Skins

Skins need to be removed or replaced during various maintenance and installation procedures.

> ### ⚠ CAUTION
>
> • Removing side skins exposes the AMR drive wheel motors, which can become extremely hot during operation. Allow 15 minutes for the drive wheel motors to cool down prior to coming into contact with them.
> • When making any changes or connections to the buzzer or light discs, refer to application safety standards for your locale and confirm correct operation.

Magnets hold the skins in place. The rear skin has an additional brace for support, the front bumper uses screws and magnets, and the access panel uses a push-push latch.

Precautions for Safe Use

• AMR Skins are fastened with strong magnets. Removal and replacement of the skins creates a pinching hazard.
• Magnetic fields can be hazardous to medical implant wearers. Medical implant wearers stay back 30 cm from the platform skin magnetic fasteners.
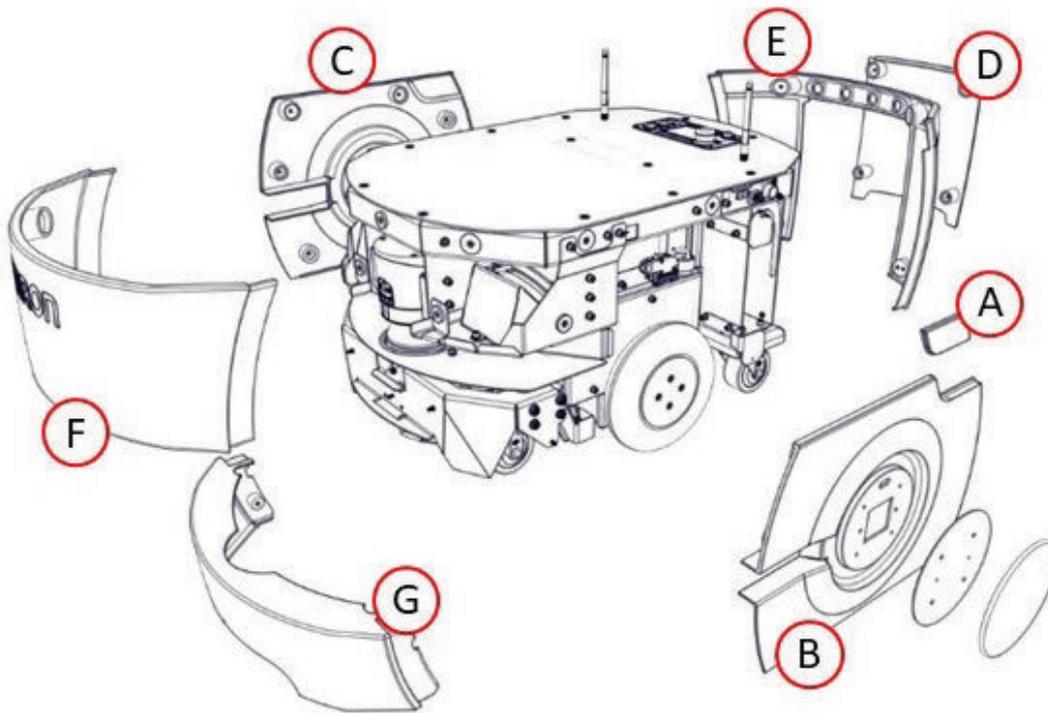
Precautions for Correct Use

After removing the skin panels, place them inner-side down so that the outer surfaces do not get scratched.

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

Use the figure and table below to understand the AMR skin configuration.

Callout	Description
A	Access Panel covers the maintenance Ethernet port and Pendant connector
B & C	Left and Right side skins cover the LD right and left drive trains. Both side skins hold a light disc and cover.
D	Battery door skin covers the battery access door
E	Rear skin covers the LD rear components and houses the sonar transducer pairs
F	Front upper skin
G	Bumper

Additional Information

Bumper skin removal is not required for any maintenance procedure. The Bumper skin should only be removed by qualified service personnel.

Remove the skins in the following order. Reverse this order when replacing skins.

1. Battery door skin

   Refer to *Battery Door Skin* on page 6-19 for more information.

2. Right skin

   Refer to *Side Skin Removal and Replacement Procedure* on page 6-19 for more information.

3. Access panel

   Refer to *Access Panel Replacement Procedure* on page 6-20 for more information.

4. Left skin

   Refer to *Side Skin Removal and Replacement Procedure* on page 6-19 for more information.

5. Bumper

6. Rear skin

   Refer to *Rear Skin Removal and Replacement Procedure* on page 6-21 for more information.

7. Front upper skin

Refer to *Front Upper Skin Removal and Replacement Procedure* on page 6-22 for more information.

Battery Door Skin

Use the following procedure to remove or replace the battery door skin on the AMR

The battery door skin provides access to the battery compartment door.

1 Pull the bottom of the skin away from the platform chassis. This is easiest if you grip it with two hands, toward the center.

2 Lower the skin down, so its top tab clears the rear skin and then pull it away from the AMR.

3 Inspect the skin retaining magnets and remove any debris that may be present.

4 To reinstall the battery door skin, slide the skin up, so its top tab fits under the rear skin.

5 Hold the skin near the center and with both hands. Tilt the bottom of the skin down towards the chassis until the retaining magnets secure it to the AMR to complete this procedure.

Side Skin Removal and Replacement Procedure

Use the following procedure to remove or replace the side skins on the AMR. The same procedure can be used for both the left and right side skins.

⚠ WARNING

When working near the encoder cables, take care not to disconnect or damage them. Improper connection or disconnection of encoder cables may result in erratic motion of the AMR during operation. Operating the AMR with damaged, disconnected, or improperly connected encoder signals can cause potentially hazardous uncommanded rotation.

⚠ CAUTION

When making any changes or connections to the buzzer or light discs, refer to application safety standards for your locale and confirm correct operation.

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

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

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

4 Remove the skin a few centimeters from the chassis.
The light disc wires plug into connectors on the inside of each side skin.

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

6 Inspect the skin retaining magnets and remove any debris that may be present.

7 To reinstall a side skin, move the skin to within a few centimeters of the chassis, and plug in the light disc connector.
Connect the light disc to the fitting on the inside of the side skin.

8 Place the top edge of the skin on the chassis, so the magnets hold it there.
Make sure the gaps on each side of the skin are the same width.

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

9 Tilt the bottom edge of the skin down.

10 Check each side of the skin to ensure that the skin edges on each side of the gap stick out the same amount away from the chassis.
This is most likely to be uneven near the top of the skin.

11 If either edge sticks out more than the neighboring skin, pull the neighboring skin away from the side skin slightly, and release.
This should allow the side skin to snap into place, so both sides of the gap stick out the same amount.

12 Repeat for the other side skin.

Access Panel Replacement Procedure

Use the following procedure to remove or replace the access panel on the AMR.
The access panel provides access to the Maintenance Ethernet and the Pendant ports. Remove the access panel first before removing the left side skin. Reinstall the left side skin before replacing the access panel

1 Push the left (front) side of the panel in, until the latch releases it. Pushing the panel a second time will reattach it to the platform.

2 Pull the left side out, and slide the panel to the left. The panel is attached with a lanyard.

3 To reinstall, the access panel, slide the panel to the right so its tab goes under the left side skin.
A lanyard attaches the panel to the skin to prevent getting lost.

4 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 Skin Removal and Replacement Procedure

Use the following procedure to remove or replace the rear skin on the AMR.

📓 **Additional Information**

- This skin houses the two rear sonar pairs, which you will disconnect once the skin is part-way off the chassis. Each pair consists of one emitter and one receiver.
- When reinstalling the rear skin, you must reconnect the sonar pairs once the metal brace across the bottom is in the clip just below the battery access hole

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

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

2 Pull the four sonar wires, with their connectors, out of the chassis holes. Refer to the figure below.

3 Unscrew all four sonar connectors.

Ensure that both sides of all connectors are labeled and match. If not, label them.
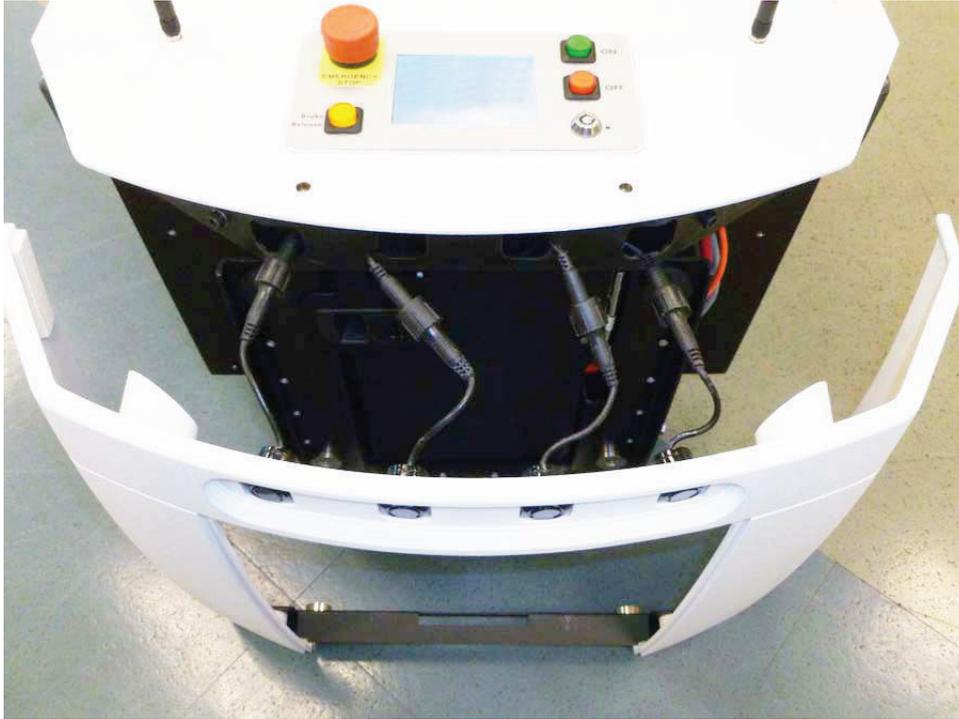
4   Tilt the skin down to about 45° and then slide the brace on the bottom of the skin out of its clip. This will separate two pairs of magnets and you will feel some resistance at first.

5   Inspect the skin retaining magnets and remove any debris that may be present.

6   To reinstall the rear skin, slide the metal brace into the chassis clip.
Watch the two magnets on the bottom of the skin and align them with the magnets on the chassis. This is your best guide for getting this skin in its proper place.
These are inboard of the clip holding the brace, so you will have to look on each side of the skin to check their alignment.

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

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

9   Screw the four sonar connectors to their corresponding sonar leads.
Ensure that the labels for the connectors and leads match.

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

11   Tilt the top of the skin up to meet the chassis until the retaining magnets secure it to the AMR to complete this procedure.

Front Upper Skin Removal and Replacement Procedure

Use the following procedure to remove or replace the front upper skin on the AMR.

> **Additional Information**
>
> This skin attaches to the chassis the most tightly of any of the skins.

1 Grip the skin at the two outer edges.

2 Pry the skin away from the chassis.

3 To reinstall the front upper skin, rip the skin at the two outer edges.

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

5 Tilt the top of the skin into position.

6-8-2 Drive Assemblies

The platform drive assemblies are field-replaceable. This will replace the drive motor, gearbox, encoder, and wheel/tire assembly. See the table below for part numbers. Care must be taken to order the correct drive assembly intended for either the LD-60, LD-90, or LD-90x. Installing a drive train assembly with an incorrect gear ratio for the AMR will result in reduced performance and potential damage to the robot.

> **Precautions for Correct Use**
>
> Drive assemblies of different gear ratios do not have obvious differentiating visual characteristics once unpacked. Care must be taken when maintaining Fleets with multiple LD-series AMR models that replacement drive train assemblies are properly organized to prevent servicing AMRs with incorrect parts.

AMR Model	Item	Part Number
LD-60 (30:1 Gear Ratio)	Right Drive Train Assembly	12745-000
	Left Drive Train Assembly	12746-000
LD-90 (40:1 Gear Ratio)	Right Drive Train Assembly	12745-040
	Left Drive Train Assembly	12746-040
LD-90x (60:1 Gear Ratio)	Right Drive Train Assembly	12745-060
	Left Drive Train Assembly	12746-060

Drive Assembly Removal Procedure

Use the following procedure to remove the Drive Assembly from the AMR.

⚠ WARNING

When working near the encoder cables, take care not to disconnect or damage them. Improper connection or disconnection of encoder cables may result in erratic motion of the AMR during operation. Operating the AMR with damaged, disconnected, or improperly connected encoder signals can cause potentially hazardous uncommanded rotation.


⚠ **CAUTION**

Removing side skins exposes the AMR drive wheel motors, which can become extremely hot during operation. Allow 15 minutes for the drive wheel motors to cool down prior to coming into contact with them.

The following items are required for this procedure.

- An AMR wheel pin or M5 X 10 screw to use as a wheel pin.
- 8 mm socket driver
- 4 mm hex key

1 Remove the rear skin. Refer to *Rear Skin Removal and Replacement Procedure* on page 6-21 for more information.

2 Remove the Battery door skin. Refer to *Battery Door Skin* on page 6-19 for more information.

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

4 Remove the side skin a small distance from the platform on the side where you want to replace the drive assembly. Refer to *Side Skin Removal and Replacement Procedure* on page 6-19 for more information.

5 Disconnect the cable from the light disc cable to move the side skin completely away from the platform.
This will expose the drive assembly.
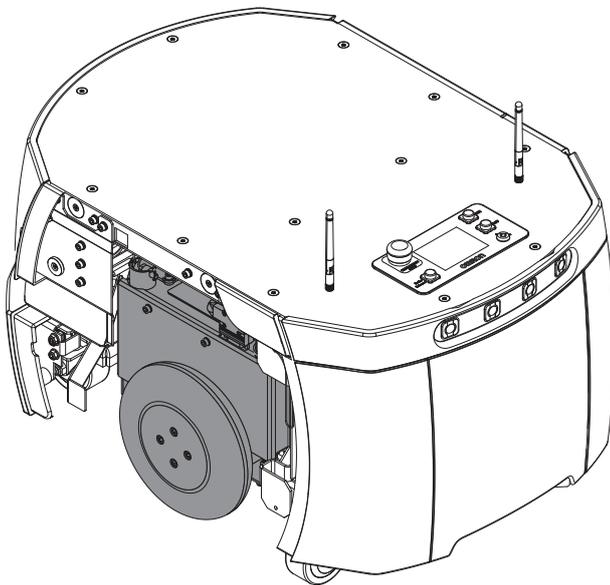
6 Lift the drive wheel up, compressing its springs enough to insert a wheel pin into the hole on the rear side of the assembly. The wheel pin ships with the AMR, or an M5 X 10 screw can be used as a replacement. This will keep the springs compressed (the wheel will be in the up position), and make removal easier.
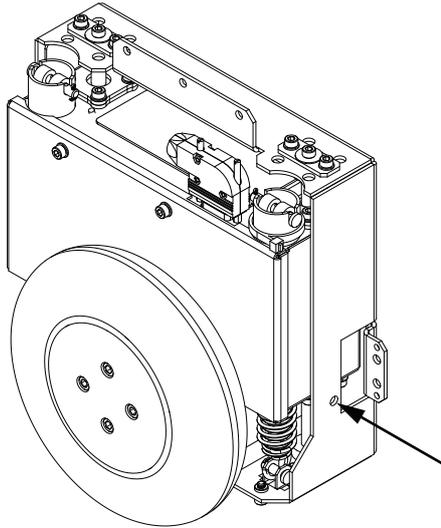
7 The drive assembly is held in place with three 8 mm nuts across the top, and sets of two 4 mm hex head screws at each side, near the bottom of the assembly. Using the 8 mm socket, re-move the three nuts on each side. Using the 4 mm hex key, remove the two sets of screws on each side. Retain these nuts, screws, and washers for attaching the new drive assembly.
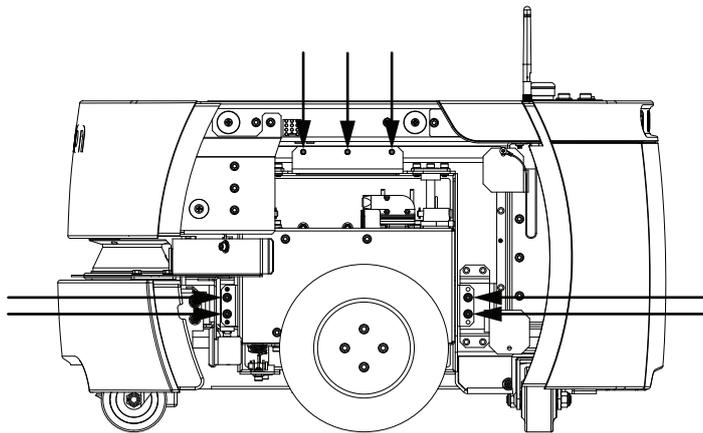
8 Remove the drive assembly from the platform.

9 Disconnect the motor cable at the drive assembly, completing the removal procedure.

Drive Assembly Installation Procedure

Use the following procedure to install the Drive Assembly on the AMR.

⚠ WARNING

When working near the encoder cables, take care not to disconnect or damage them. Improper connection or disconnection of encoder cables may result in erratic motion of the AMR during operation. Operating the AMR with damaged, disconnected, or im-properly connected encoder signals can cause potentially hazardous uncommanded rotation.

The following items are required for this procedure.

• An AMR wheel pin or M5 X 10 screw to use as a wheel pin.

- 8 mm socket driver
- 4 mm hex key

1 Lift the new drive wheel up, compressing its springs enough to insert a wheel pin into the hole on the rear side of the assembly. The wheel pin ships with the AMR, or an M5 X 10 screw can be used as a replacement. This will keep the springs compressed (the wheel will be in the up position), and make installation easier.
Make sure that the pin is short enough that you can pull it out after the assembly is in place.

2 Connect the motor cable to the new drive assembly.

3 Install the new drive assembly over the three studs at the top of its bracket. Use the nuts, screws, and washers you removed from the old drive assembly. Use the 8mm socket driver to fasten the nuts, and the 4 mm hex key to fasten the screws.

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

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

6 Reinstall the side skin. Refer to *Side Skin Removal and Replacement Procedure* on page 6-19 for more information.

7 Connect the battery power and data cables, and reinstall the battery door skin. Refer to *Battery Door Skin* on page 6-19 for more information.

8 Reinstall the rear skin. Refer to *Rear Skin Removal and Replacement Procedure* on page 6-21 for more information.

6-8-3 Wireless Antenna Replacement Procedure

Use the following procedure to remove and replace the wireless antenna located on the AMR.

Additional Information

If the wireless antenna(s) has been relocated to the payload structure, its replacement procedure will vary accordingly.

The following items are required for this procedure.
- Replacement wireless antenna
- Cross-head screwdriver
- Pliers

1 Unscrew and remove the antenna by hand.
If your AMR has a top plate, remove the antenna from the antenna connector on the top plate.
If your AMR does not have a top plate, remove the antenna from the ANT 1 or ANT 2 connector on the right side of the AMR Core.
If your AMR has a top plate and the antenna is fastened too tightly to remove by hand:

1) Use the Cross-head screwdriver to remove the screws securing the top plate to the AMR.

2) Use pliers to loosen the coaxial cable connected to the antenna, and then disconnect the cable.

2 Thread the replacement antenna onto the antenna connector and hand tighten to complete the procedure.

If you removed the AMR top plate screws in the previous step, use the Cross-head screwdriver to replace the screws securing the top plate to the AMR.

6-8-4 Docking Station Roller Replacement Procedure

Use the following procedure to replace the Docking Station Roller.

The roller and bearing guide the AMR onto the Docking Station, and can become worn after extended use. Symptoms of wear might include the AMR failing to dock accurately and charge or repeated docking attempts.

The following items are required for this procedure.

• A replacement roller, P/N 12416-000.

• 5 mm hex wrench.

• Loctite 242.

1 Use a 5 mm hex wrench to remove the M6 shoulder bolt from the center of the roller. Retain the shoulder bolt and washer.

2 Remove the roller and bearing from the Docking Station.

3 Replace the worn roller with the replacement roller.

4 Apply Loctite 242 to the shoulder bolt, then insert and tighten to 7.4 N·m.

5 Reconnect the power cable from the wall outlet and put the power switch in the on position. Verify that the blue power light illuminates.

6 Send an AMR to the Docking Station and confirm that charging starts (the amber Charging light illuminates).

6-8-5 Docking Station Power Switch Fuse Replacement Procedure

Recent model Docking Stations contain a circuit breaker that can be reset after correcting a problem such as overheating or a short circuit. The following procedure applies only to legacy Docking Stations.

The only user-serviceable parts are in the legacy Docking Station. The two external AC fuses are located between the power switch and the AC power plug.

The following items are required for this procedure.

• A replacement fuse, P/N 02212-000L.

Equivalent generic fuses are also available. The fuses need to be 250 V, 10 A, and Time-lag. An example of a fuse that meets these specifications is:

LittelFuse 0215010.XP, 5x20 mm cartridge type

1   Remove the fuse assembly by squeezing the two side tabs toward each other, and pulling away from the Docking Station. Refer to following figure.
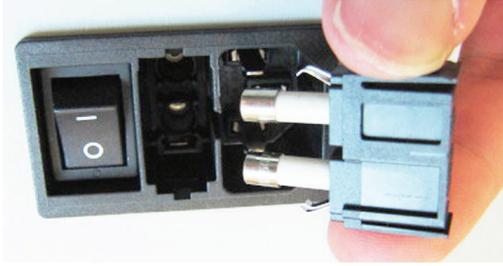
2   Insert replacement fuse. This completes the fuse replacement procedure.

6-8-6   Rear Sonar Units

The AMR'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.
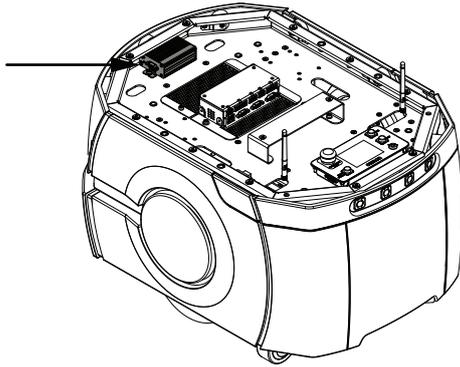
Rear Sonar Unit Replacement Procedure

Use the following procedure to remove and replace sonar units.

1   Remove the Rear Skin and Battery Door Skin from the AMR. Refer to *Rear Skin Removal and Replacement Procedure* on page 6-21 and *Battery Door Skin* on page 6-19 for more information.

2   Unscrew the connection between the sonar cable and the sonar unit's lead.
Ensure that both the connectors and leads are labeled and matching. If not, label them.

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

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

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

6   Reinstall the rear covers.

6-8-7   Sonar Controller

The sonar controller is located in the payload bay at the front of the AMR.

Sonar Controller Replacement Procedure

Use the following procedure to replace the Sonar Controller.
A 4 mm hex key is required for this procedure.

1 If a payload structure is present, move the payload structure out of the way to access to the payload bay.

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

3 Using the 4 mm hex key, remove the two screws that attach the controller to the payload bay deck.
Retain the screws for mounting the replacement controller.

4 Unplug the larger cable from the sonar controller.
Be careful not to let the cable end slip into the chassis.

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

6 Connect the four sonar unit cables to the new controller.
Ensure that the cable labels match the controller labels.

7 Plug the larger cable into the new controller.

8 Using the 4 mm hex key, screw the new controller to the payload bay deck using the two screws removed from the old controller.

9 Reinstall the payload structure, if applicable.

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

A

Appendix

A

A-1   Parts List

Standard AMR parts and accessories are provided in the following table.

Item	Part Number	Details	Included
Pendant (Joystick)	13558-000	Used for manually driving an AMR and map creation. 3 m cable. Included with Starter Kit.	Yes
LD-60 ESD Skin Set Assembly	21452-995F	ESD skin set assembly for LD-60 AMR. Includes the following ESD rated skins: • Front Bumper Skin • Front Upper Skin • Right Skin • Left Skin • Rear Skin • Battery Door Skin	Yes
LD-90 ESD Skin Set Assembly	21452-996F	ESD skin set assembly for LD-90 AMR. Includes the following ESD rated skins: • Front Bumper Skin • Front Upper Skin • Right Skin • Left Skin • Rear Skin • Battery Door Skin	Yes
LD-90x ESD Skin Set Assembly	21452-997F	ESD skin set assembly for LD-90x AMR. Includes the following ESD rated skins: • Front Bumper Skin • Front Upper Skin • Right Skin • Left Skin • Rear Skin • Battery Door Skin	Yes
Front Bumper Skin (No Low Laser)	12804-100	For use with AMRs that do not have a Low Laser.	Yes
ESD Front Bumper Skin (No Low Laser)	21452-151F	For use with AMRs that do not have a Low Laser.	Yes
Front Upper Skin	12804-200	Front top removable panel of the AMR.	Yes
ESD Front Upper Skin	21452-201F	ESD rated front top removable panel of the AMR.	Yes
Front Bumper Skin (Low Laser)	12804-101	Front removable bumper panel for use with AMRs that have a Low Laser.	Yes
ESD Front Bumper Skin (Low Laser)	21452-151F	ESD rated front removable bumper panel for use with AMRs that have a Low Laser.	
LD-60 Rear Skin	12804-701	Rear removable panel of the AMR.	
LD-60 ESD Rear Skin	21452-701F	ESD rated rear removable panel of the AMR.	Yes
LD-90 Rear Skin	12804-702	Rear removable panel of the AMR.	
LD-90 ESD Rear Skin	21452-702F	ESD rated rear removable panel of the AMR.	Yes
LD-90x Rear Skin	12804-705	Rear removable panel of the AMR.	
LD-90x ESD Rear Skin	21452-705F	ESD rated rear removable panel of the AMR.	Yes
Battery Door Skin	12804-801	Battery door removable panel of the AMR.	
ESD Battery Door Skin	21452-801F	ESD rated battery door removable panel of the AMR.	Yes
Right Skin	12804-350	Right removable panel of the AMR.	Yes

Item	Part Number	Details	Included
ESD Right Skin	21452-350F	ESD rated right removable panel of the AMR.	Yes
Left Skin	12804-450	Left removable panel of the AMR.	Yes
ESD Left Skin	21452-450F	ESD rated left removable panel of the AMR.	Yes
Left Hatch Skin	12804-600	Removable left hatch cover of the AMR.	Yes
ESD Left Hatch Skin	21452-600F	ESD rated removable left hatch cover of the AMR.	Yes
Operator Panel Assembly	12800-000	The Operator Panel includes a screen, an E-STOP button, ON and OFF buttons, and a brake release button.	Yes
Operator Panel to Core connector cable	12528-250F	Includes E-STOP connections. 500 mm cable length	Yes
Emergency Stop Buttons	20381-000F	Three emergency stop buttons.	Yes
Laser beam warning label	13308-000L	Triangular, ISO-3864-2.	Yes
Invisible Laser Radiation Caution Label	13307-000L	CAUTION Class I Invisible Laser Radiation Present. Avoid long-term viewing of laser.	Yes
E-Stop Yellow Ring	11229-167	Yellow ring surrounding the E- Stop button.	Yes
No Riding Label	18178-000	WARNING Riding on this truck is prohibited	Yes
Incline Limit Label	18622-000	CAUTION MAXIMUM GRADE CAPABILITY = 8.3%	Yes
Automatic Vehicle Label	18623-000	CAUTION AUTOMATIC VEHICLE	Yes
E-STOP Jumper	12730-000L	Jumper for the E-STOP port on the AMR Core.	Yes
Operator Panel E-STOP Jumper	13387-000	Jumper for the Operator Panel's E-STOP connection.	Yes
Docking Station	12477-000	Used to autonomously charge the battery inside an AMR or to charge an AMR battery outside of the AMR with a battery power cable.	Yes
Docking Station Roller	12416-000	Rollers on the lower section of the Docking Station.	Yes
Docking Station AC Power Switch Fuse	02212-000L	250 VDC, 10 A, and Time-lag fuse.	Yes
LD-60 Right Drive Train Assembly	12745-000	30:1 gear ratio	Yes
LD-60 Left Drive Train Assembly	12746-000		Yes
LD-90 Right Drive Train Assembly	12745-040	40:1 gear ratio	Yes
LD-90 Left Drive Train Assembly	12746-040		Yes
LD-90x Right Drive Train Assembly	12745-060	60:1 gear ratio	Yes
LD-90x Left Drive Train Assembly	12746-060		Yes
Battery Assembly	20452-700	AMR Battery.	No
Rear Sonar Unit	11714-000	Piezo ultrasonic sensor, 40KHz, with cable.	Yes
Sonar Controller	11711-000	Controller for the Rear Sonar Units.	Yes
Wireless Antenna, Reverse SMA	10616-000	Wireless Dipole Antenna.	Yes
Top Plate	12944-000	Optional top plate for improved environmental protection.	Optional

Item	Part Number	Details	Included
Wireless Antenna Extension Kit	68955-000	Kit includes the following: • Two Dipole antennas with RP-SMA connectors • Two 2 m coaxial cables • Two 0.6 m coaxial cables	Optional
Laser Kit (side)	13456-100	Includes the following items: • Two TiM-510 lasers • Cable assembly (2 m) • Two mounting kits	Optional
Laser Kit (rear)	21446-000	Includes one TiM-510 laser and cabling.	Optional
HAPS (single)	13660-100	Includes the following items: • One sensor • Mounting hardware • Power cable (65 mm) • RS-232 connector • Magnetic tape (49 m)	Optional
HAPS (double)	13660-000	Includes the following items: • Two sensors • Mounting hardware • Two power cables (65 mm) • RS-232 connector • Magnetic tape (49 m)	Optional
HAPS Magnetic Tape	14925-000	25 mm wide magnetic tape (south top side, 49 m roll). Included with AMR HAPS option.	Optional
CAPS	20271-805	CAPS Software License, activated on each AMR individually.	Optional
Acuity Localization Kit (with Digital Level)	13700-000	Includes the following items: • Camera • Mounting kit • Cables • Digital level	Optional
Acuity Localization Kit	13700-100	Includes the following items: • Camera • Mounting kit • Cables	Optional
Digital I/O Terminal Block Kit	14165-000	Includes DB-44HD breakout cable with breakout board (D-Sub 44 pin cable for digital I/O interface) and a mounting bracket.	Optional
RS232 Splitter Cable	24010-000F	Provides two serial communication connectors (RS232-1 and RS232-2) in an arrangement similar to the legacy AMR Core configuration. Cable length is 200 mm.	Optional

A-2   Network Port Allocation

Network ports are assigned as described in the table below.

Port	Protocol	Category	Initiator to Recipient	Details
37	TCP	Intra-fleet Communications Ports. Used to broadcast configuration updates to AMRs, to dispatch Job commands, and to share position and trajectory updates throughout the fleet.	AMR to Fleet Manager	Maintenance, Management, and Fleet ports use this.
5000	TCP/UDP			Fleet port uses this.
Range 10000 and up	UDP			For UDP Range 10000 connections and up, such as an AMR connecting to a Fleet Manager, this protocol grows with the number of robots. For best results, allocate at least twice as many UDP ports as there are AMRs in the fleet. For instance, a fleet of 20 AMRs should have an allocated range of 10000-10039.
7272	TCP/UDP			
1884	TCP			
5672	TCP	Integration Toolkit TCP Ports. Excludes dynamically allocated port numbers.	RabbitMQ AMQP	
8443	TCP		ITK REST	
5432	TCP		PostgreSQL	
443	TCP	Configuration and Monitoring of Fleet. Used for MobilePlanner connections to the Fleet Manager and AMRs for monitoring and configuration.	Client PC to Fleet Manager	Maintenance and Management ports use this.
Range 7272 and up	TCP/UDP		Client PC to Fleet Manager	This protocol uses as many ports as there are AMRs. Each AMR that connects uses the next available port >= 7272. For best results, allow a large number of ports, such as 7272-7999.
7272	TCP/UDP		Client PC to AMR	
Range 10000 and up	UDP		Fleet Manager Appliance to Client PC.	This protocol uses as many ports as there are AMRs. Each AMR that connects uses the next available port >= 10000. For best results, allow a large number of ports such as10000-10999.
10000	UDP		AMR to Client PC	

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Port	Protocol	Category	Initiator to Recipient	Details
7171	TCP	Job Monitoring and Submission (ARCL Interface). Used for managing Jobs on the Fleet Manager Appliance, typically submitted from a Warehouse Management System (WMS) or Manufacturing Execution System (MES).	WMS/MES to Fleet Manager.	If ARCL Server is enabled in the configuration (*Robot Interface* and then *ARCL Server Setup*), then this port is open on the Fleet Manager and accepts unlimited incoming connections. The port number is configurable. (This port might be available on the AMR, depending on the application.)
Configurable port #	TCP		Fleet Manager Appliance to WMS/MES.	If Outgoing ARCL Connection is enabled in the configuration (*Robot Interface* and then *Outgoing ARCL Connection Setup*), then the Fleet Manager initiates an outgoing connection to the specified hostname and TCP port number.
123	TCP	Optional.	Fleet Manager Appliance to NTP server.	If you enable an NTP client Fleet Manager Appliance (*SetNetGo* then *System* and then *Date/Time*), the Fleet Manager Appliance attempts to set its clock from the NTP sever at the specified IP address. (This function is available on the AMR, if you do not use a client Fleet Manager Appliance.)
Range 1000 - 65535	UDP/TCP		Offboard devices to AMR.	If RS232 or Ethernet Port Forwarding is enabled on the AMR (*SetNetGo* then *Network*) then the configured TCP ports are open on the AMR for incoming connections.

A-3 USER PWR Load Connection Examples (PINS 9 to 12)

Use the following sections to understand how to connect loads to the USER PWR connector pins 9, 10, 11, and 12. Using these methods will maximize the amount of available current while preventing overload conditions on these pins.

Refer to *2-4-18 USER PWR Connector* on page 2-20 for more information.

A-3-1 Good USER PWR Load Connections

The following illustrations provide good USER PWR load connections at pins 9, 10, 11, and 12.
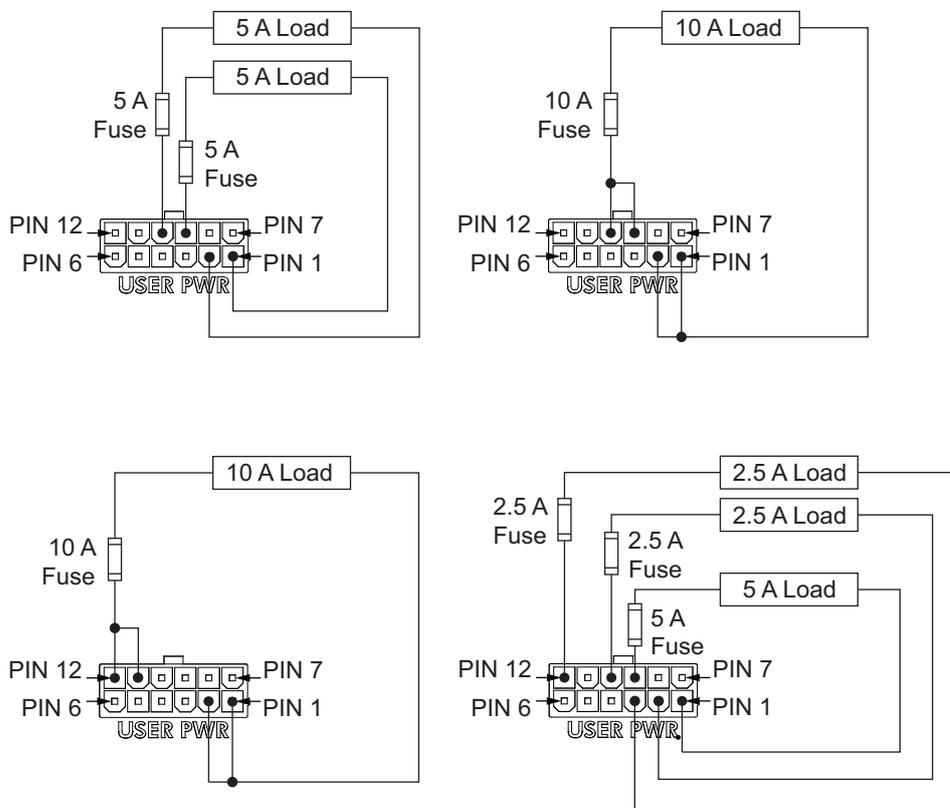
A-3-2 Bad USER PWR Load Connections

Do not connect loads in the following arrangement for the reasons described below. Connecting loads to pins 9, 10, 11, and 12 in this arrangement can cause overload conditions.

Diagram A

Diagram B
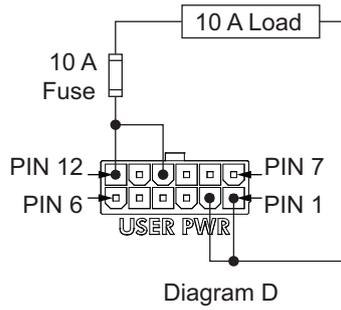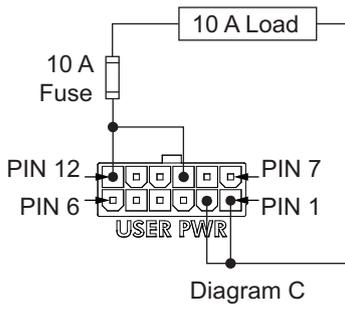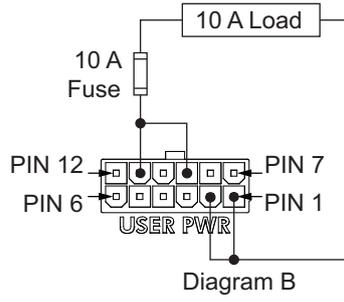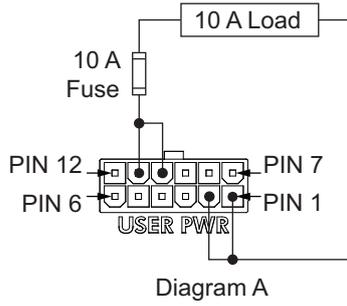
Diagram C

Diagram D

Diagram	Overload Condition
A	If an emergency stop condition occurs, power to pins 11 turns OFF creating an overload condition at pin 10.
B	If an emergency stop condition occurs, power to pins 11 turns OFF creating an overload condition at pin 9.
C	If an emergency stop condition occurs, power to pins 12 turns OFF creating an overload condition at pin 9.
D	If an emergency stop condition occurs, power to pins 12 turns OFF creating an overload condition at pin 10.

A-4   Unpacking

The fully assembled AMR, Docking Station, and Battery are packed and shipped in separate crates. Any optional devices or accessories purchased with the AMR are packed in a carton and placed in the main crate containing the AMR. Use the information in this section to understand the unpacking information for the AMR and other components supplied with the system.

⚠ WARNING

Follow all unpacking safety instructions and use appropriate tools and equipment.
Failure to do so could result in personal injury or property damage.

Make the following considerations before unpacking the equipment.

- Carefully inspect all shipping boxes and crates for evidence of damage during transit. If any damage is indicated, request that the carrier's agent be present at the time the crate is unpacked.
- Before signing the carrier's delivery sheet, compare the actual items received 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 have been damaged, do not accept the delivery.
  If the items received do not match your order, contact your local OMRON representative.
- Retain the containers and packaging materials. These items may be necessary to settle claims or to relocate the equipment at a later date.

The general unpacking steps are provided below.

1. Unpack the battery.
   Refer to *A-4-2 Battery Shipping Crate Information* on page A-15 for more information

2. Unpack the AMR and Docking Station.

A-4-1   AMR Unpacking Procedure

The platform comes packed in a box, wrapped with cling wrap, and secured by plastic bands on a pallet. Refer to the following figure.
The Docking station and Starter kit, if present, are packed in a separate box sitting on top of the platform box.

1   Remove plastic bands and unwrap the cling film.

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

3   Open lower box containing the Platform.

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

5 Remove all corner padding.

6 Lift the outer box up.

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

8 Remove the plastic protective sheet.

9 Roll the robot off of the cardboard and onto the floor. Since the wheels are pinned up, the LD is just sitting on its casters, so no brake release is needed.
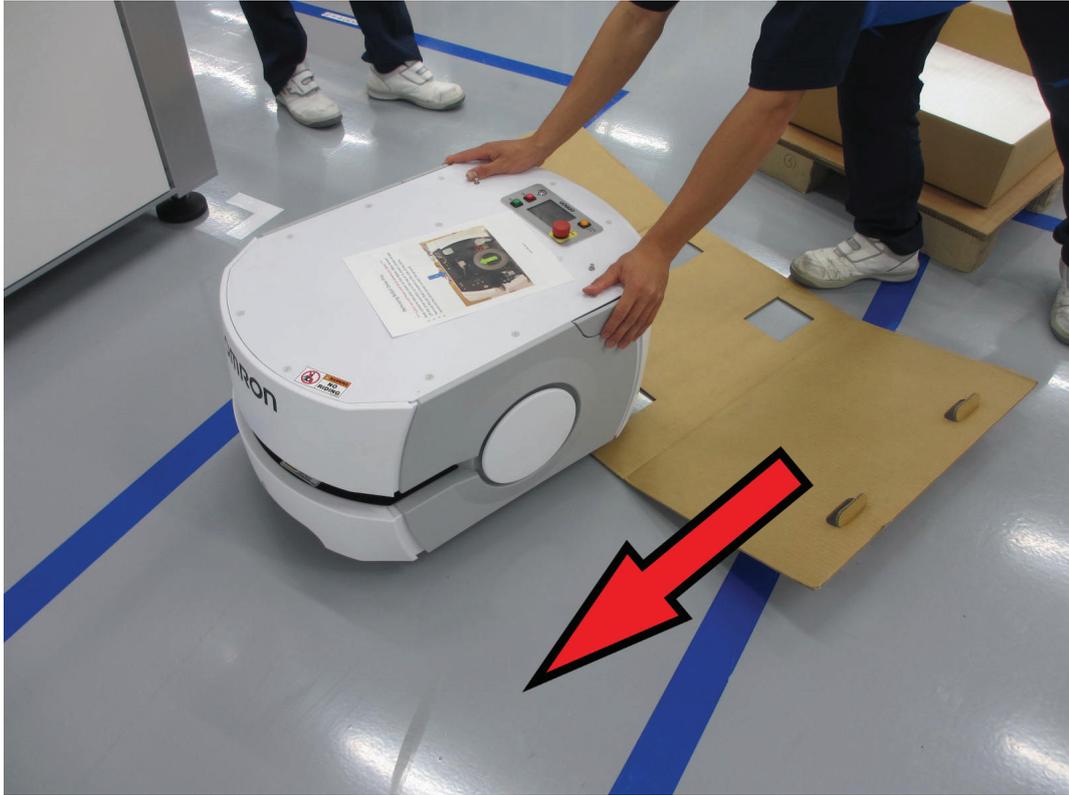
10 If the robot came with a top plate, connect the antennas as shown in following figure.

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

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

For each side of the platform:

1) Remove the platform side skins.

See *6-8-1 Removing and Replacing Skins* on page 6-17.

2) Lift the wheel slightly to relieve pressure on the pin, then remove the pin by pulling the at-tached ring. See the following figure for the location of the wheel pin hole.

Save these pins for later service of the drive assemblies.
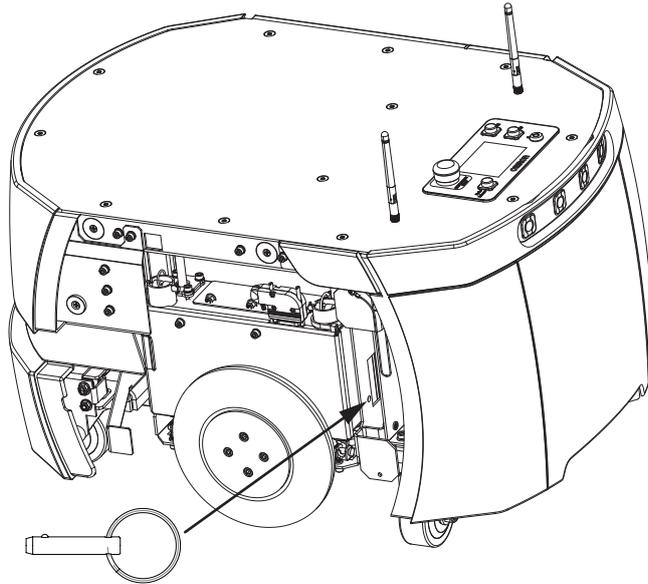
3) Reinstall the two side skins.

12 Install the battery in the platform.

The platform brakes cannot be released until the battery is installed. Refer to *3-3 Battery Installation Procedure* on page 3-11
for more information.

A-4-2 Battery Shipping Crate Information

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

Battery Unpacking Procedure

Use the following procedure to unpack the battery from its shipping crate. The battery ships in a separate carton, not inside the AMR crate.

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

Personal Protective Equipment including eye protection, toe protection, and gloves are required for this procedure.

Precautions for Safe Use

Two or more people are required to lift the battery.

1 Locate the carton that contains the battery.

2 Use the recessed lifting grips at either end of the battery's casing to remove the battery from the carton.

After the battery has been removed from the carton, this procedure is complete.

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