OMRON

AMR (Autonomous Mobile Robot)

MD-series Platform

User's Manual

MD-650
MD-900



I681-E-02

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Introduction

Thank you for purchasing the MD-series Autonomous Mobile Robot (referred to as AMR in this document).
This manual is OMRON's original instructions describing the setup, operation, and user maintenance of the AMR.
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.

It is the end-user’s responsibility to ensure that all personnel who will work with or around AMRs have attended an appropriate training and have a working knowledge of the system. The user must provide the necessary additional training for all personnel who will be working with the system.
As described in this document, you should allow only skilled persons or instructed persons to do certain procedures. Skilled persons have technical knowledge or sufficient experience to enable them to avoid either electrical or mechanical dangers. Instructed persons are adequately advised or supervised by skilled persons to enable them to avoid either electrical or mechanical dangers.
All personnel must observe industry-prescribed safety practices during the installation, operation, and testing of all electrically-powered equipment.
Before working with the AMR, every person must confirm that they:

- Have the necessary qualifications and training for normal, abnormal, and emergency situations.
- Have access to this document and other safety documentation.
- Have read and understand the related documentation.
- Have agreed work in the manner specified by the documentation.

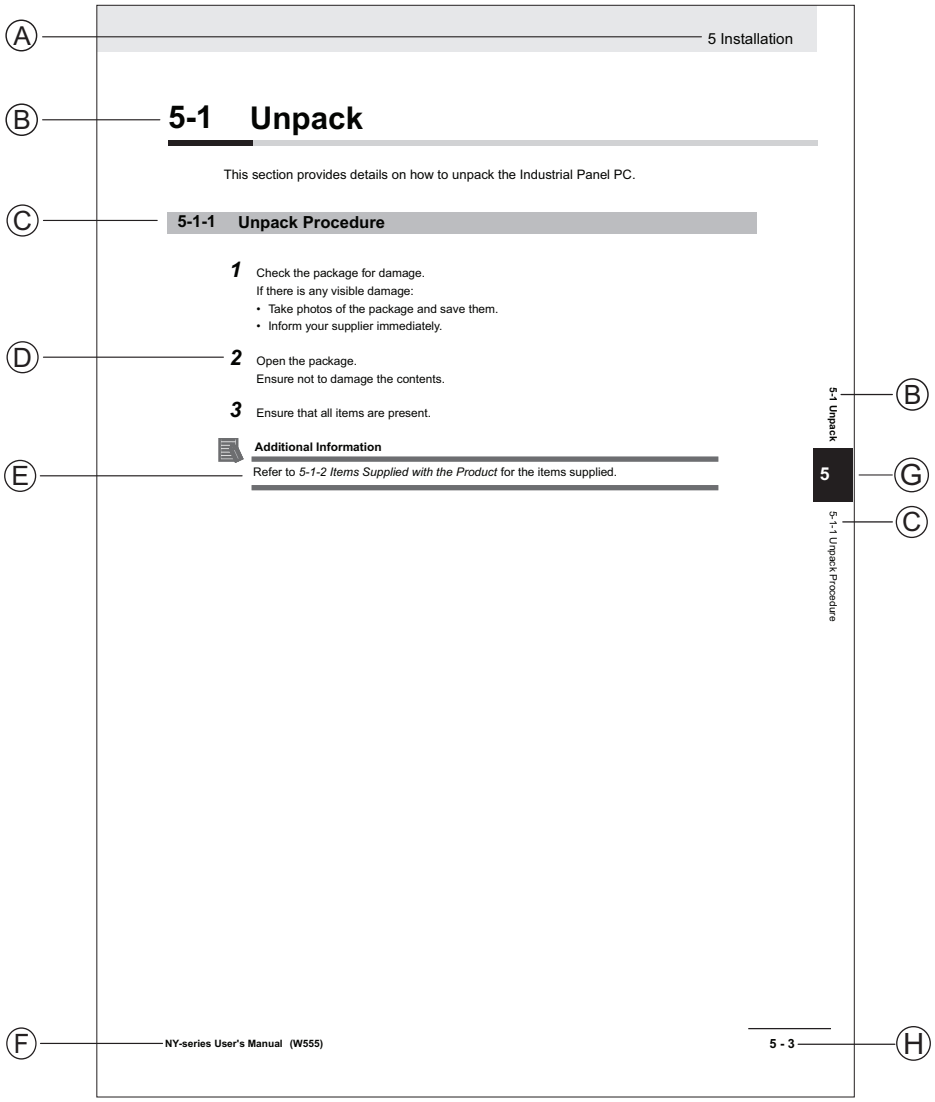
Units

All units are metric unless otherwise noted.
Distances are provided in mm unless otherwise noted.

Manual Information

Page Structure

The following page structure is used in this manual.



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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2 Specifications
3 Installation
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Warranty and Limitations of Liability

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Safety Precautions

Definition of Precautionary Information

The following notation is used in this manual to provide precautions required to ensure safe usage of the 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.
	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 laser radiation.

Dangers

⚠ DANGER

The AMR can cause serious injury to personnel or damage to itself or other equipment if it drives off of a ledge, such as a loading dock, or down stairs.	
Improper operation of the AMR on inclined floors that do not comply with the applicable operating specifications can result in the AMR tipping over, and consequently a serious personal injury.	
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.	

Warnings

⚠ WARNING

General

Implementing methods to circumvent the need for a person to enable the AMR's motor power at start-up is prohibited.	
Equipment used to lift the AMR must be adequately rated. It is the end user's responsibility to review lifting equipment and apply appropriate safety factors before lifting. Do not attempt to lift the AMR from the bottom with a forklift or similar devices. Doing so could damage the AMR.	
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.	

The following actions are strictly prohibited and could result in injury or damage to the equipment.

- Riding on the AMR.
- Towing applications.
- Exceeding the maximum payload limit.
- Operating in environments with life support systems.
- Operating in residential areas.
- Operating on non-stationary areas, including moving floors or any type of land vehicle, watercraft, or aircraft.
- Exceeding the maximum recommended speed, acceleration, deceleration, or rotation limits. Rotational speed becomes more significant when the payload's center of gravity is increasingly offset from the AMR's center of gravity.
- Dropping, driving off a ledge, or operating irresponsibly.
- Allowing the AMR to drive through an opening that has an automatic gate or door, unless the door and AMR are configured correctly with the Call / Door Box option.
- Throwing an object in front of the AMR or suddenly stepping into the path of the AMR. The AMR braking system cannot be expected to function as designed and specified in such instances.
- Exposing the AMR to rain or moisture.
- Using unauthorized parts to repair the AMR.
- Powering ON the AMR without its wireless antennas in place.
- Operating the AMR in hazardous environments where there is explosive gas, an oil mist, or a corrosive atmosphere.
- Operating the AMR in an environment that contains ionizing radiation.
- Using non-approved batteries or charging systems.



The Charging Station, battery, and AMR transfer high electric power and contain hazardous voltages. You must take necessary precautions to avoid electric shock. Follow appropriate Lock-Out, Tag-Out (LOTO) instructions prior to any installation and maintenance work performed on or near these items.



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.



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 Directive 2006/42/EC, where appropriate.
The assembly instructions shall then form part of the technical file for the final machine.



Use only the specified tools, equipment, and OMRON-supplied spare parts to service and maintain the AMR according to the specified service intervals. Failure to do so could result in an unsafe operating state that might result in personal injury or damage to property.



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.



If you are using a user-supplied E-STOP, you must perform commissioning to verify the emergency stop functionality before putting the AMR into service.



It is the end-user's responsibility to make sure that the AMR design and implementation complies with all local standards and legal requirements.

It is the end-user's responsibility to make sure that the AMR is operated within its specifications, intended use, and intended environments.	
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.	
Although the AMR is commissioned at the factory, the user must perform commissioning as part of the initial setup upon receipt.	
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 motor and motor assemblies will be exposed when the side skins are removed, exposing potential pinch points. Take necessary precautions when moving an AMR without its skins attached. The rear and top of the AMR also pose pinch hazards when the rear skin and the top plate are removed.	
You need to modify the safety zones if your payload overhangs the AMR's default dimensions and if operating on a floor surface that has poor traction to the extent that the AMR cannot stop reliably within the default zones. OMRON is not responsible for any risks incurred by modifying safety zone sizes or other Safety Laser Scanner settings.	
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 1300 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.	
Lifting straps must be fastened with consideration to even weight distribution to ensure that the AMR is level and stable when lifted. Uneven weight distribution while lifting may cause the AMR to shift or become unstable which may result in injury or damage to equipment.	
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.	
Follow all unpacking safety instructions and use appropriate tools and equipment. Failure to do so could result in personal injury or property damage.	
Use safe lifting practices when moving the heavy objects such as the Power Supply Box, Battery, Docking Target, and AMR.	
The rare-earth magnet embedded in the AMR charging contacts creates a strong magnetic field. Magnetic fields can be hazardous if you have a medical implant. Keep a minimum of 30 cm away from the AMR charging contacts.	
Do not attempt to lift the AMR from the bottom with a forklift or similar devices. Doing so could damage the AMR.	
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.	

You must comply with the latest version of the applicable laser safety regulations.	
Do not walk or run in the travel path of the AMR or directly toward the AMR.	
Do not approach the AMR from the side or the direction opposing travel.	
Removing side skins exposes the AMR drive wheel motors, which can become extremely hot during operation. You must allow sufficient time for the drive wheel motors to cool down prior to coming into contact with them.	
The accessible laser of the laser devices on the AMR are not hazardous as long as the beam cross section is not reduced by optical instruments, such as magnifying glasses, lenses, or telescopes.	

Battery and Charging Station

Improper installation of the Power Supply Box could result in a tipping hazard. You must make sure that the Power Supply Box is safely and properly installed.	
Do not damage the battery by subjecting it to impacts or shocks. Using a damaged battery can result in fire or other dangerous conditions.	
Charging Station strain reliefs and the power cords must be installed by a licensed or appropriately certified electrician.	
You must wear proper Personal Protective Equipment (PPE) for removing, installing, and lifting the battery or when working around a leaking battery.	
The AMR battery and the Charging Station outputs have high current. You must take appropriate precautions to avoid potential short circuit.	
Replace the battery only with an OMRON factory-supplied battery intended for use in the AMR. Do not use batteries intended for use in other OMRON AMR models.	
At least 2 people are required to lift the battery. Always use safe lifting practices when removing or installing the battery.	
At least 2 people are required to lift the Docking Target. Always use safe lifting practices when removing or installing the Docking Target.	
If 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.	
Improper installation or wiring misconfiguration of the Power Supply Box could result in electrical shock hazard. You must ensure the safe and proper installation of the Power Supply Box in accordance with the applicable rules and regulations, and by qualified personnel.	

The Power Supply Box, charging contacts on both the Docking Target and the AMR, and the drive wheel motors can get hot during operation. Allow these items to cool down prior to servicing.	
There are no user-serviceable parts inside the Charging Station and high voltage may be present in this area. Do not remove the covers of the Charging Station.	
(Battery) Risk of Fire - No User Serviceable Parts AVERTISSEMENT: Risque d'incendie - Aucune des pièces ne peut être.	

Payload

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.	
The total weight of your payload structure plus any objects carried by the structure must not exceed the maximum payload capacity of the AMR.	
Tipping hazards are more likely if the payload center of gravity is outside the recommended specifications.	
If a payload or payload structure projects or overhangs the outer dimensions of the AMR, make the following considerations. • Contact your OMRON representative to change the size of the Safety Laser Scanners' zones. • Modify parameters to change the AMR's *Width*, *LengthFront*, *LengthRear*, and potentially its *Radius*. When making these modifications, ensure that the modified parameters are used during path planning and obstacle avoidance.	

Operating Environment

Abrupt appearance of objects or persons in the path of the AMR could result in personal injury or property damage. You must make sure that the operating environment of the AMR is adequately controlled.	
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.	
Use caution when stopping the AMR on a ramp. The use of the brake release will cause direct rolling of AMR down the ramp. Powering OFF the AMR on a ramp should be avoided if possible to minimize the use of brake release on a ramp.	
Do not expose the AMR to rain or moisture.	
If the AMR is in an operational hazard or restricted zone, these areas must be properly marked or restricted according to applicable standards.	

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.	
An AMR can be unsafe if operated under environmental conditions other than those specified in this manual.	
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.	
Dust, dirt, grease, and water (or other liquids) can affect wheel traction, as well as operation of the drive wheels. If the drive wheels slip, it can potentially affect operating duration, stopping distance, and navigation accuracy.	
Do not expose the AMR to an ingress above IP22 or a high-humidity environment.	

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

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.	
All E-STOP buttons must be located in areas that are easy to reach and within 600 mm of personnel. It is the end user's responsibility to ensure that any additional E-STOP buttons are placed in a location where the operator can easily access them in an emergency situation.	
An AMR must have a readily visible warning device such as a user-supplied flashing light, to indicate when it is either ready to move or is moving.	
Pushing an AMR requires significant effort and might cause personal injury or property damage. Take appropriate care and follow all safety instructions.	
The pushing points of the AMR are low to the ground. You must use safe pushing practices when manually moving the AMR.	
When manually moving the AMR, do not push it from a high position on its payload or payload structure. This might cause the AMR to topple.	
Manually moving the AMR while the brakes are released is not recommended. If you must manually move the AMR, make sure to do this safely as this could result in personal injury or property damage.	
Although the Safety Laser Scanners are integrated with the emergency stop circuit at all times, the operator must maintain full control of the pendant functions and the AMR when the pendant is in use.	
Changing warning buzzer parameter values might make the AMR unsafe and affect its compliance to safety standards. Refer to the applicable safety standards for your locale before you change any parameter values.	
If you change *AbsoluteMaxTransVel* parameter, you should commission the AMR before putting it into service.	
Follow all appropriate local safety regulations for working with isopropyl alcohol, including fire safety, toxicity, and protective clothing and gear requirements.	
Although the AMR's software provides the option of using the map features to keep the AMR within its designated workspace, poor or improper localization may result in incorrect path planning. To ensure safety, you must always install physical barriers where there is a risk of property damage or personal hazard.	

Precautions for Safe Use

- The following actions are required for safe use of the AMR.
  - Review and understand the safety protections associated with your specific application and environment.
  - Make sure that the environment is suitable for safe operation of the AMR.
  - Make use of the Fleet Manager when two or more AMRs are used in the same environment and are not confined to separate workspaces. Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.
  - Make sure that any person working with or near an AMR is trained and has read and understands this document and the *Autonomous Mobile Robot (AMR) MD-series Platform Safety and Unpacking Guide (Cat. No. I682)*.
  - Mechanically maintain and service AMRs for proper operation of all control and safety functions.
- All equipment must be shipped and stored in a temperature-controlled environment, within specified temperature and humidity range. It should be shipped and stored in the supplied packaging, which is designed to prevent damage from normal shock and vibration.
- OMRON recommends storing and securing the Pendant when not in use to prevent an unauthorized person from operating the AMR.
- Prior to cleaning the Charging Station, you must ensure that the AMR is not engaged with the Docking Target.
- Use a rated forklift, pallet jack, or similar devices to move the shipping crates.
- To prevent damage to the lifting points, AMR chassis, or lifting rings, do not exceed a 30° angle from vertical when attaching the lifting straps to the lifting device.
- Do not exceed the maximum allowable tension force of 10 kN for designated M16 x 2.0 lifting points. Lifting points are rated for the AMR weight without a payload.
- Inspect lifting straps for signs of wear and tear or any damages before attaching to the lifting rings and lifting the AMR.
- When placing the AMR back on the floor after lifting, you must make sure that all safety precautions have been taken to prevent personal injury or property damage.
- Do not power ON the AMR until you have read the appropriate sections of this document.
- Do not tamper with any AMR control devices.
- It is the end user's responsibility to provide the necessary training to personnel to properly mark the floors around the payload transfer locations.
- It is the end user's responsibility to ensure that the person operating the lifting device has successfully completed the required training, and is certified to operate these machines.
- The operator must take necessary precautions to ensure that the operator's hands or other body parts do not get stuck in between the charging pad and the AMR when docking.
- Do not operate the AMR in areas where environmental conditions are beyond what is specified in this document.
- You must have floor markings to prevent people from entering the operating hazard zone for pick-up / dropoff locations with inadequate clearance.
- 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.



- 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.



- 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.
- Avoid liquid near the Charging Station and the AMR.
- 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.
- 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.
- 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.
- Consider all safety factors related to the location of the integrated E-STOP button when relocating the Operator Panel.
- 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.
- Any E-STOP buttons installed on the payload structure must be within 600 mm of reach. They must not be installed in a location that affects operator's safety in order to reach them in an emergency situation.
- You must ensure that the payload structure is properly secured to the AMR.
- 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 E-STOP button.
- You must perform a complete risk assessment for your payload design and the intended use of the AMR prior to its operation.
- No modifications shall be made that affect the AMR payload capacity.
- 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.
- For payload applications where you cannot easily reduce the size and weight of the payload, or if the AMR’s center of gravity is not within the recommended limits, contact your local OMRON representative for support.
- The tilt detection feature will not prevent an improperly loaded AMR from toppling.

- Damaged or worn casters and drive wheels can degrade the AMR stability. You must regularly inspect the casters and drive wheels for signs of damage, excessive wear, or uneven spots.
- The Power Supply Box must be installed according to the local regulations or codes, and by authorized personnel or licensed electricians.
- The Power Supply Box and the Docking Target must be properly secured to the wall or floor prior to operation.
- Never access the interior of the AMR while it is connected to the Docking Target.
- Only use charging equipment and batteries supplied by OMRON. The charger shall only be used to charge an HD-1500 or MD-series AMR battery.
- Avoid shorting the battery terminals or connectors.
- 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 speed does not cause the AMR to move uncontrollably.
- After you remove or replace the skins, you must make sure that the light strips and discs are operational once the AMR is powered back ON.
- Physical immobilization might cause motors in the AMR to overheat.
- The NX102 contains factory-installed programs and configurations that control the safety functions in the AMR. Do not attempt to modify the safety program or configuration.
- A minimum of 8 mm of thread engagement must be present for each lifting ring (11 mm if a Top Plate is present).
- It is the end user's responsibility to ensure that the person operating the overhead hoist or forklift has successfully completed the required training, and is certified to operate these machines.

Precautions for Correct Use

- Always observe the proper disassembly and handling of components for disposal.
- Never remove the battery while the AMR is powered ON. Always power OFF the AMR and then place the Main Disconnect Switch in the OFF position before removing the battery.
- Never expose the battery to water.
- Rough or uneven floors can degrade the drive wheels, and shorten their life span.
- Replacement of the differential drive train, casters, and wheels require an OMRON service engineer. Contact your local OMRON representative for more information.
- 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.
- 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.
- Do not leave an AMR that is not localized, not connected to the Fleet Manager, or not powered ON in a location that can be accessed by other AMRs.
- If it is not possible to prevent some interference between the payload and the Side Lasers' sensing plane, contact your local OMRON representative for advanced configuration settings.
- Laser lenses can easily get scratched and damaged. Care must be taken to prevent scratching the laser lens during any maintenance or installation procedures.
- Map creation is required before an AMR can be used for normal operation.
- For optimal performance of an MD-series AMR in a fleet, use a map created by an MD-series AMR for the area in which it operates.
- The Integration Toolkit only runs on a Fleet Manager device.
- Minimize payload power consumption whenever possible to prevent excessive battery drain.
- Vertical orientation of the Power Supply Box allows for heat dissipation, which prevents overheating and possible fire danger. Horizontal installation of the Power Supply Box is not allowed.
- The Docking Target will move during the docking attempts and cause docking and charging failures if appropriate fasteners are not used.
- Do not over-torque the charging paddle adjustment screws if they reach their limits.
- When making adjustments to the charging paddle adjustment screws, always begin by turning in the clockwise direction until the screw stops. Then, turn in the counter-clockwise direction to adjust for correct position, but do not exceed seven turns in the counter-clockwise direction. If the screw is turned beyond seven full rotations, correct charging paddle adjustment may not be possible and OMRON support may be necessary.
- After making adjustments to the charging paddle, carefully observe the AMR as it approaches the Docking Target and be prepared to press an E-STOP button if alignment is not correct.
- The Power Supply Box has cooling vents at the top and bottom of the unit. Do not block these areas.
- The Main Disconnect Switch located on the electrical access panel controls current flow into the Power Supply Box. When the switch is in the horizontal position, it is OFF and when it is in the vertical position, it is ON.
- Consult your network systems administrator before using SetNetGo to change any default settings. Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for information about modifying network settings.

- Before you configure wireless Ethernet on your AMR, contact your network administrator to confirm the IP, radio, and security settings.
- It is the end user's responsibility to ensure that the payload does not attenuate the wireless antennas' signal.
- You must attach either a jumper or some other safety-rated devices (typically E-STOP buttons) to the SCPU connector in order for the AMR to function.
- Do not exceed the maximum allowable tension force of 10 kN for M16 x 2.0 mounting points.
- Do not exceed the maximum allowable tension force of 4 kN for M6 x 1.0 mounting points.
- Do not use the M6 x 1.0 mounting points to lift the AMR.
- Insert screws provided in the Top Plate Seal Kit (part number 24861-000) into any unused M16 x 2.0 mounting point holes to maintain IP22 protection.
- 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.
- There may be future updates for the Safety Controller. Safety Controller updates cause the Safety Laser Scanner to decommission because the safety zone check will fail. After a Safety Controller update is complete, you must recommission the Safety Laser Scanner.
- Do not operate the AMR on soft surfaces such as carpet.
- 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.
- 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.
- Always ship and store the AMR, Power Supply Box, and the Docking Target 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 Power Supply Box and the Docking Target.
- You must route and secure the power cords properly. They must be secured in such a way that prevents straining of the connection points.
- It is safe to connect or disconnect the power cord from the Docking Target or battery without powering OFF the Power Supply Box.
- Always wait until the green OPERATION LED indicator on the Power Supply Box is ON solid before attempting to charge a battery.
- Do not press the Service button on the Power Supply Box if the yellow DC POWER LED indicator is flashing when there is no battery connected. Contact your OMRON representative if this condition is present.
- The AMR must be powered ON in order to charge the battery while at the Docking Target.
- 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.

- 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 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 Power Supply Box can only be connected directly to the Docking Target or to one battery. Simultaneous charging configurations are not possible.
- The Main Disconnect Switch should not be used as a frequent means of turning OFF the AMR. Use the OFF button to turn OFF the AMR with a controlled shut-down method.
- Only qualified personnel who have read and understood this manual and the *Autonomous Mobile Robot (AMR) MD-series Platform Safety and Unpacking Guide (Cat. No. I682)* should manually move the AMR.
- Maintenance of the payload structure is not covered 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 particulate. 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. Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.
- Do not place additional components in the User Connections area.
- When the battery is turned OFF, all internal calibration data about the charge level is lost. Turning the battery ON will activate the battery LED indicators, but the charge level may not be represented accurately. Charge the battery completely to recalibrate and display the charge level accurately.
- Always place the AMR in manual mode before connecting a Pendant. The Pendant cannot be used to control the AMR while in Automatic mode.
- The mechanical brake release can be used if battery power is not available.
- The electronic brake release will timeout after two minutes of operation to prevent bypassing. Re-depressing the button will resume the brake release function after a two minute timeout occurs.
- If alternate Safety Laser Scanner Zones are used for varying payload sizes, an alternate AMR footprint should also toggle for navigation purposes. Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information about configuring the AMR footprint clearances.

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.
- EN ISO 10218-1 Safety Requirements For Industrial Robots
- EN 61204-7 used in conjunction with EN 62477-1 low-voltage switch mode power supplies (Charging Station only).
- EN ISO 3691-4
  Industrial trucks
  Safety requirements and verification - Part 4: Driverless industrial trucks and their systems

U.S. / Canada / Industry Standards

- CAN/CSA-Z434 Industrial Robots and Robot Systems.
- UL 1012 Standards for Safety Power Units other than Class 2 (Charging Station).
- CAN/CSA C22.2.107.2 Battery Chargers (Charging Station).
- ANSI/CAN/UL/ULC 2271 Standards for Safety Batteries for use in Light Electric Vehicle (LEV) Applications (Battery).
- CAN/UL 3100 Automated Mobile Platforms (AMPs)

Conformance to KC Certification

When you use this product in South Korea, observe the following precautions.

사 용 자 안 내 문
이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다.

This product meets the electromagnetic compatibility requirements for business use.

Related Manuals

Use the following related manuals for reference.

Manual Title	Description
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.
Enterprise Manager 2100 User's Guide (Cat. No. I631)	Describes the installation of an EM2100 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 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.
Fleet Simulator User's Manual (Cat. No. I649)	Describes the configuration and use of the Fleet Simulator software on an EM2100 appliance.
AMR Controller User's Guide (Cat. No. I650)	Describes the information necessary to use the AMR Controller.
Fleet Operations Workspace iQ User's Manual (Cat. No. I665)	Describes functionality and operation of the Fleet Operations Workspace iQ application.
Autonomous Mobile Robot (AMR) MD-series Platform Safety and Unpacking Guide (Cat. No. I682)	Describes safety and unpacking of the MD-series AMR.
AMR (Autonomous Mobile Robot) Charging Station Safety, Unpacking, and Installation Guide (Cat. No. I683)	Describes safety and unpacking of the Charging Station.
Sysmac Studio Version 1 Operation Manual (Cat. No. W504)	Describes the operating procedures of the Sysmac Studio.
NX-series Digital I/O Unit User's Manual (Cat. No. W521)	Describes the information necessary to use NX-series Digital I/O Units.
NX-series NX102 CPU Unit Hardware User's Manual (Cat. No. W593)	Describes the information necessary to use the NX102 CPU Unit.

Glossary

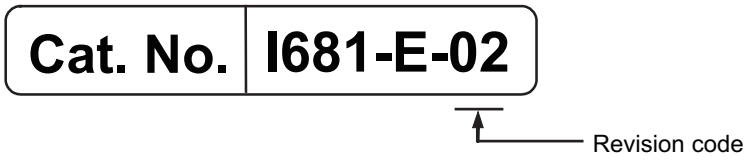
Term / Abbreviation	Description
Ambient Operating Temperature	The temperature range of the AMR's environment in which continued operation is possible.
AMR	This term is used to refer to the MD-series autonomous mobile robot.
AMR Controller	The AMR's main computing system that provides all navigational controls and application interfaces.
ARAM	Advanced Robotics Automation Management software that performs all of the high-level, autonomous robotics functions, including obstacle avoidance, path planning, localization, and navigation.
ARAMCentral	The software running on the Fleet Manager appliance. This manages the AMRs' map, configuration, and traffic control including multi-AMR avoidance, destination, standby, and docking.
ARCL	Advanced Robotics Command Language that provides a simple, text-based, command-and-response operating language. Used with the optional EM2100 appliance, ARCL can help manage a fleet of mobile robots.
Auto-MDIX	A connection port feature that automatically detects the Ethernet cable type being used (straight-through or crossover) and configures the connection appropriately.
Beacon	An optional indicator lamp mounted on the AMR to provide additional visual indication and signaling of the operating state.
CAN bus	Controller Area Network that provides a serial communications protocol allowing electronic control units and devices to communicate with each other.
CAT5	Twisted pair Ethernet cable that supports 100 Mhz frequency.
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.
Charging Station	System that is used to charge an AMR battery that is comprised of the Power Supply Box, the Docking Target, and the cable between these items.
Coordinate System	The X, Y, Z, and theta reference system relating the AMR to its environment and to the relative position of other devices.
Docking Target	A fixed object that is connected to the Power Supply Box that the AMR docks to that is used for autonomous charging.
Dongle	A small hardware device that contains the credentials (e.g., license key) required to run a specific program. A dongle is used in each AMR to enable the use of the ARAM software.
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.
EM2100	A network appliance that acts as a Fleet Manager or Fleet Simulator.
Ethernet	A type of network used in local area networks that typically uses a twisted pair cable and supports data speeds up to 100 Mbps.
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 (EM2100) 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.
Goal	A map-defined virtual destination for mobile robots (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.
I/O	Input and output signals that are transmitted to and from a device.
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.
IP	Internet protocol that provides a set of communication standards for transmitting data between networked devices. An IP address is used as a device's unique network identifier.
IPXX	Ingress protection rating designated for devices to describe the level of protection provided against the intrusion of solid objects, dust, and water.
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.
LED	A light emitting diode that illuminates to provide a visual indication of some operation.
Light disc	The circular lights on the sides of the AMR that indicate motion, turns, and AMR states.
Light strip	The linear lights on the front and rear 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.
Map	A representation of the AMR's environment within MobilePlanner that it uses for navigation.
MobilePlanner	The primary software application for programming AMR actions. It provides the tools for all major AMR activities, such as observing a fleet of AMRs, commanding individual AMRs to drive, creating and editing map files, goals, and tasks, and modifying AMR configurations.
Operator Panel	The primary interface on the AMR that provides user interaction functions.
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.
Payload	Any item(s) that are placed on the AMR for the purposes of securing, transporting, and transferring some object.
Payload structure	Any passive or dynamic device attached to and possibly powered by the AMR to support or manipulate a payload.

Term / Abbreviation	Description
Pendant	A handheld, external input device for manually driving AMRs that is typically used for map creation.
Pickup	A job segment where an AMR typically acquires a payload.
PoE Network Switch	Power over Ethernet technology allows network switches to transmit both power and data simultaneously through an Ethernet cable.
Polo	The AMR firmware that controls motors and also computes the AMR's heading readings and other low-level operating conditions to ARAM.
Power Supply Box	Unit that receives AC power from the facility and supplies power to the Docking Target and battery for charging purposes.
Safety commissioning	Testing and commissioning for verification of proper function the AMR's onboard safety systems using a software wizard.
Safety Controller	A device installed in the AMR that provides all safety functions and operations.
SetNetGo (SNG)	The software operating system that resides on the AMR and the optional EM2100 appliance. It is used to configure the AMR's communication parameters, gather Debug Info Files, and upgrade the software.
Skilled persons	Persons that have the technical knowledge or sufficient experience to enable them to avoid electrical or mechanical dangers.
Shut-down	The process of powering OFF in a controlled manner to allow for correct operation at the next start-up request.
Start-up	The process of booting and enabling all systems after being powered OFF to reach an operational state.
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.
Troubleshooting	Efforts such as information collection, diagnostics, and error recovery to resume normal operation.
Turn radius	The radius of the circle that the AMR will travel when turning while moving forward.
Wizard	A guide within a software user interface that assists the user in performing an operation or function.
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.



Revision code	Date	Revised content
02	October 2023	Corrections and improvements.
01	April 2023	Original production

1

Overview

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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

- Improper operation of the AMR on inclined floors that do not comply with the applicable operating specifications can result in the AMR tipping over, and consequently a serious personal injury.
- The AMR can cause serious injury to personnel or damage to itself or other equipment if it drives off of a ledge, such as a loading dock, or down stairs.



⚠ WARNING

Dust, dirt, grease, and water (or other liquids) can affect wheel traction, as well as operation of the drive wheels. If the drive wheels slip, it can potentially affect operating duration, stopping distance, and navigation accuracy.

The following actions are strictly prohibited and could result in injury or damage to the equipment.

- Riding on the AMR.
- Towing applications.
- Exceeding the maximum payload limit.
- Operating in environments with life support systems.
- Operating in residential areas.
- Operating on non-stationary areas, including moving floors or any type of land vehicle, watercraft, or aircraft.
- Exceeding the maximum recommended speed, acceleration, deceleration, or rotation limits. Rotational speed becomes more significant when the payload's center of gravity is increasingly offset from the AMR's center of gravity.
- Dropping, driving off a ledge, or operating irresponsibly.
- Allowing the AMR to drive through an opening that has an automatic gate or door, unless the door and AMR are configured correctly with the Mobile I/O Box option.
- Throwing an object in front of the AMR or suddenly stepping into the path of the AMR. The AMR braking system cannot be expected to function as designed and specified in such instances.
- Exposing the AMR to rain or moisture.
- Using unauthorized parts to repair the AMR.
- Powering ON the AMR without its wireless antennas in place.
- Operating the AMR in hazardous environments where there is explosive gas, an oil mist, or a corrosive atmosphere.
- Operating the AMR in an environment that contains ionizing radiation.
- Using non-approved batteries or charging systems.



⚠ WARNING

- 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.
- 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.
- It is the end-user's responsibility to make sure that the AMR is operated within its specifications, intended use, and intended environments.
- The rare-earth magnet embedded in the AMR charging contacts creates a strong magnetic field. Magnetic fields can be hazardous if you have a medical implant. Keep a minimum of 30 cm away from the AMR charging contacts.
- 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 Directive 2006/42/EC, where appropriate.
  The assembly instructions shall then form part of the technical file for the final machine.



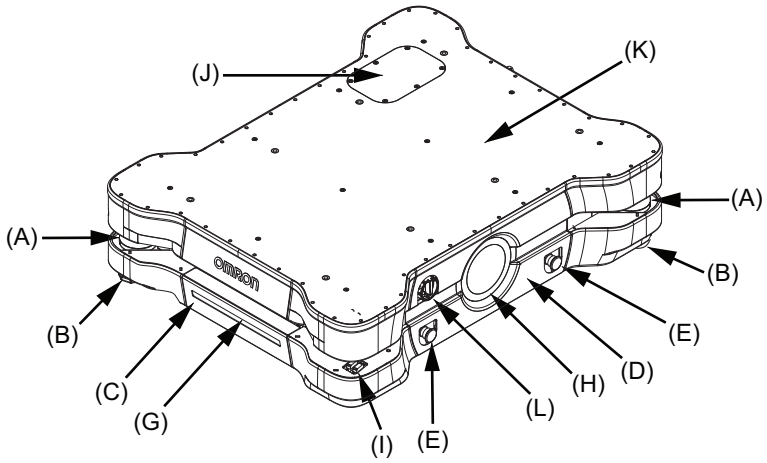
Precautions for Safe Use

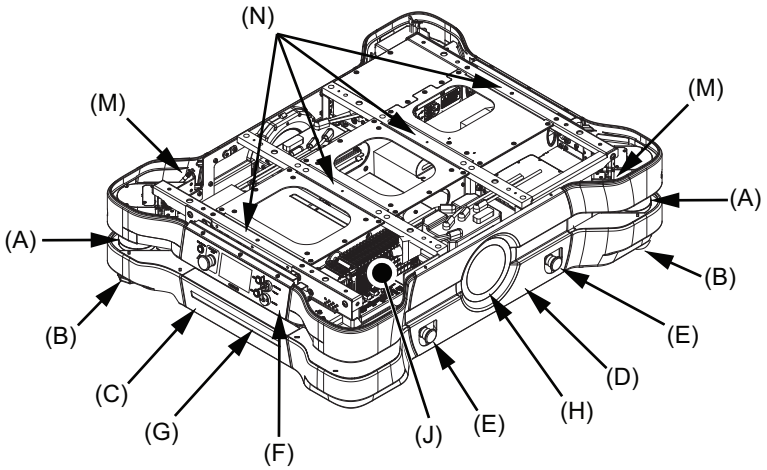
The following actions are required for safe use of the AMR.

- Review and understand the safety protections associated with your specific application and environment.
- Make sure that the environment is suitable for safe operation of the AMR.
- Make use of the Fleet Manager when two or more AMRs are used in the same environment and are not confined to separate workspaces. Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.
- Make sure that any person working with or near an AMR is trained and has read and understands this document and the *Autonomous Mobile Robot (AMR) MD-series Platform Safety and Unpacking Guide (Cat. No. I682)*.
- Mechanically maintain and service AMRs for proper operation of all control and safety functions.

1-2 Features and Components

This section provides an overview of the basic features and components of the AMR.





Item	Description	Item	Description
A	Safety Laser Scanner	H	Light Disc
B	Low Laser	I	Charging Contacts
C	Front / Rear Skin	J	User Connections area / Cover
D	Side Skin	K	Payload Mounting Surface / Top Plate
E	E-STOP Button*1	L	Main Disconnect Switch
F	Operator Panel	M	Wireless Antenna
G	Light Strip	N	Payload Cross-member

*1. Additional E-STOP buttons are provided on the Operator Panel and the Pendant.

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.

⚠ WARNING

You must comply with the latest version of the applicable laser safety regulations.

⚠ WARNING

The accessible laser of the laser devices on the AMR are not hazardous as long as the beam cross section is not reduced by optical instruments, such as magnifying glasses, lenses, or telescopes.



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.



Additional Information

Optional Side Lasers may be purchased and added for additional object detection. Refer to *1-6-5 Side Lasers* on page 1-28 for more information.

Safety Laser Scanner

Safety Laser Scanners are provided on the AMR for navigation and safety. Each Safety Laser Scanner provides detection in a 275° field of view. Both Safety Laser Scanners provide a complete 360° range of detection area around the AMR. The lasers operate in a single plane positioned at 175 mm above the floor.

⚠ WARNING

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.



Additional Information

Optional Side Lasers may be purchased and added for additional object detection. Refer to *1-6-5 Side Lasers* on page 1-28 for more information.

Low Lasers

Two Low Lasers detect 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 Lasers are positioned near the floor and can detect objects that are at least 60.5 mm tall. The Low Lasers also detect obstacles that might be significantly wider near the floor, such as a column base, while the Safety Laser Scanners 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.They are secured to the AMR with magnets for easy removal. Refer to *6-11-1 Removing and Replacing Skins* on page 6-17 for more information.

⚠ CAUTION

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.



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

- Battery compartment
- Circuit breaker panel
- Front LED light strip
- Front HAPS sensor (optional)

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

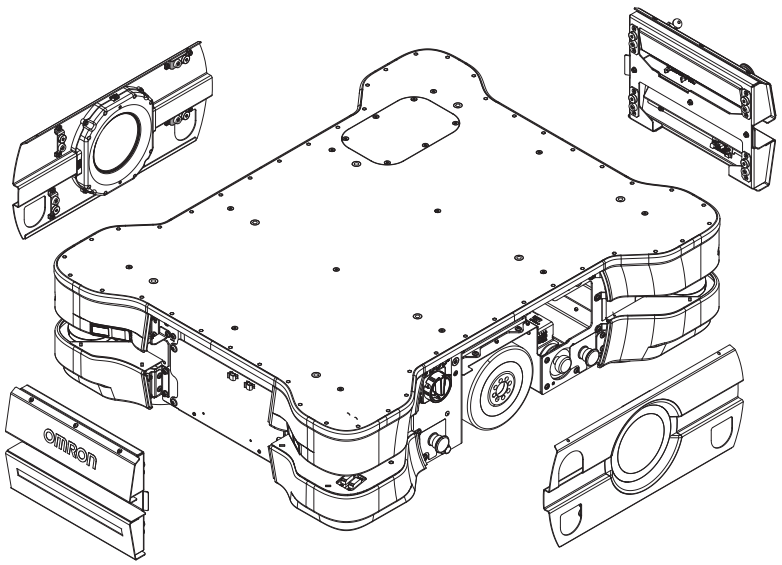
- Rear LED light strip
- AMR Controller
- Mechanical brake release lever
- Rear HAPS sensor (optional)

Removal of the left side skins provide access to the following items.

- Fuses
- Left skin light disc

Removal of the right side skins provide access to the following items.

- Right skin light disc



1-2-3 E-STOP Buttons

There are five E-STOP buttons located on the AMR. One button is located on the Operator panel and there are two buttons located on each side of the AMR.
The Pendant also has an integrated E-STOP button.

Additional Information

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

1-2-4 Operator Panel

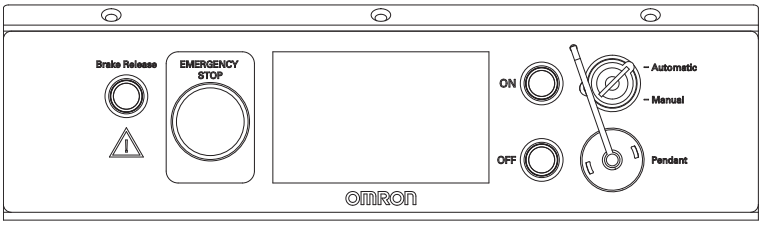
The Operator Panel features are described below.

Additional Information

The Operator Panel can be relocated if it becomes obstructed by the payload or payload structure. Refer to *3-14-2 Operator Panel Relocation Procedure* on page 3-48 for more information.

Precautions for Safe Use

Consider all safety factors related to the location of the integrated E-STOP button when relocating the Operator Panel.



The Operator Panel is a user replaceable part. Refer to *A-1 Parts List* on page A-2 for obtaining a replacement unit. Refer to *6-11-2 Removing and Replacing Operator Panel* on page 6-18 for more information.

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.

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.

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.

Mode Selection Switch

Use the mode selection switch to place the AMR in automatic or manual mode.

Pendant Port

Connect the Pendant to the pendant port when driving the AMR manually.

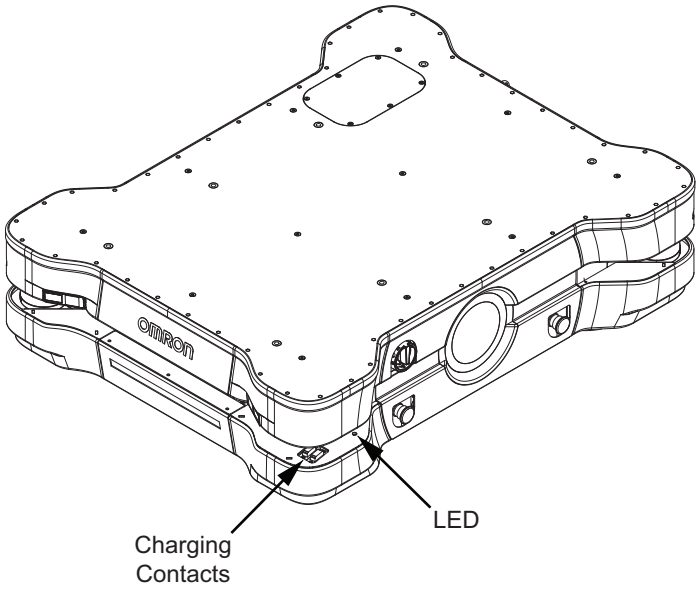
1-2-5 Light Discs and Strips

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.

1-2-6 Charging Contacts

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

A red LED charge light illuminates when power is present at the charging contacts.



1-2-7 User Connections Area

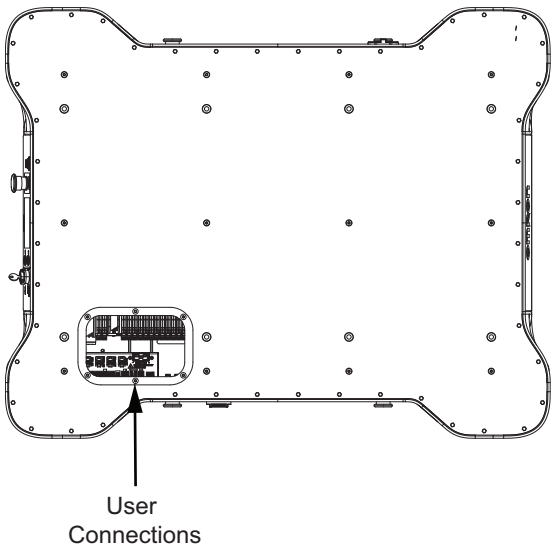
Connections for power, communications, safety devices, inputs, outputs, and other optional items are provided in the User Connections area. These connections are typically used for powering and controlling a payload structure.
The User Connections area is protected with a removable cover.

Precautions for Correct Use

Do not place additional components in the User Connections area.

Additional Information

If any covers or other items are removed from the AMR, the ingress protection (IP rating) will be compromised.



1-2-8 Payload Mounting Surface

Payloads are mounted directly to the top of the AMR chassis. Several mounting points are available for various payload designs.
Mounting points are aligned with internal cross-members for payload support purposes.

1-2-9 Main Disconnect Switch

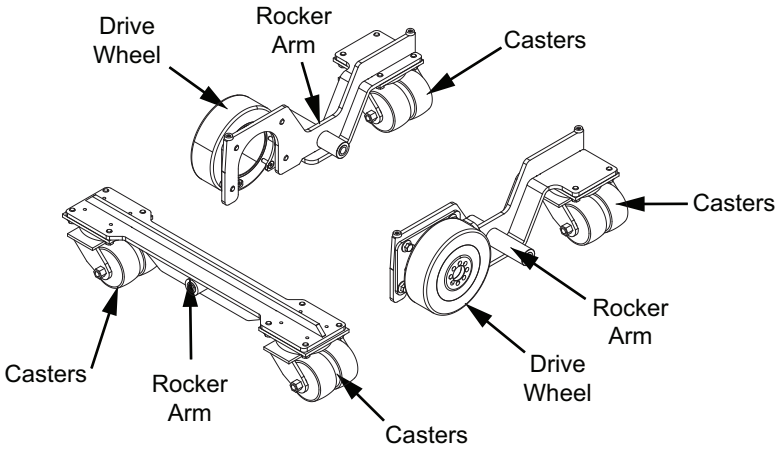
The Main Disconnect Switch completely removes all battery power from the AMR for maintenance or other abnormal situations.

1-2-10 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 for traction and durability. Casters are mounted to rocker arms and freely rotate 360° to provide stability during operation. This arrangement allows the AMR to maintain contact with the floor over uneven areas or bumps.

Precautions for Correct Use

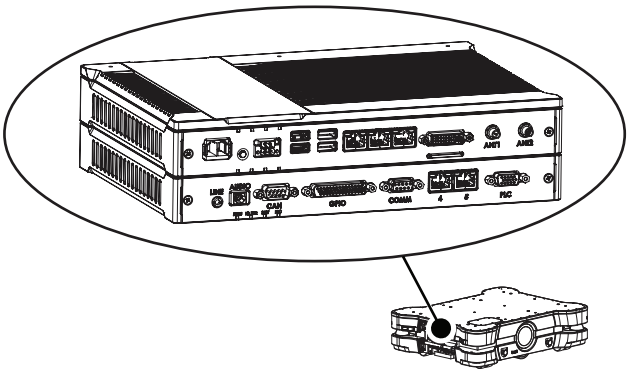
Replacement of the differential drive train, casters, and wheels require an OMRON service engineer. Contact your local OMRON representative for more information.



1-2-11 AMR Controller

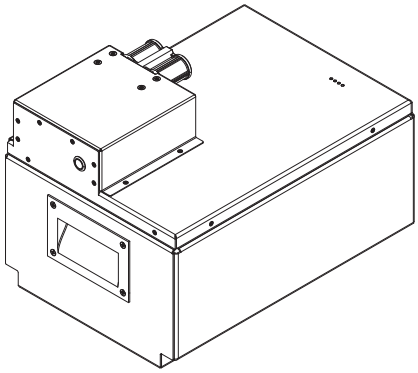
The AMR Controller is the AMR's main computing system that provides all navigational controls and application interfaces. The AMR Controller consists of two main components: the Base Layer containing standard PC interfaces and the Mobile Robot Layer for the processing of the AMR control interfaces and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

The AMR Controller runs the SetNetGo operating system and the Advanced Robotics Automation Management (ARAM) software. It also runs a variant of the Mobile Autonomous Robot Controller (POLO). The AMR Controller is housed inside the electronics bay as displayed in the following figure. Refer to the *AMR Controller User's Guide (Cat. No. I650)* for more information.



1-2-12 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.

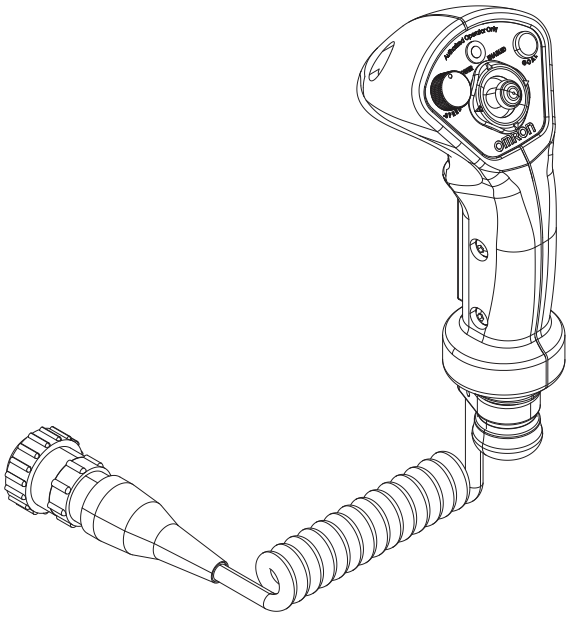


1-2-13 Pendant

Connect a Pendant to manually drive the AMR. A pendant is typically used when generating a map of the workspace.
The pendant has a 3-position enable switch that puts the AMR in a emergency stop state unless an operator is present and holding the switch in the center position.

Additional Information

A Pendant is required for initial map creation.

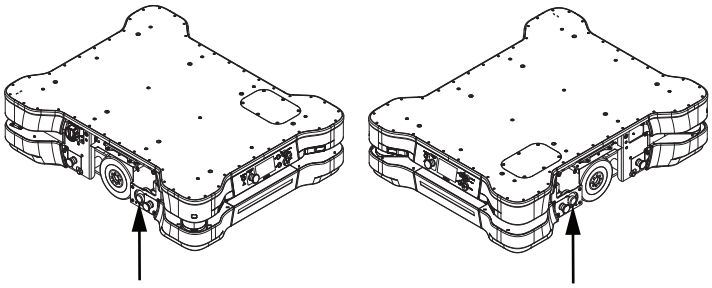


1-2-14 Speakers

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.



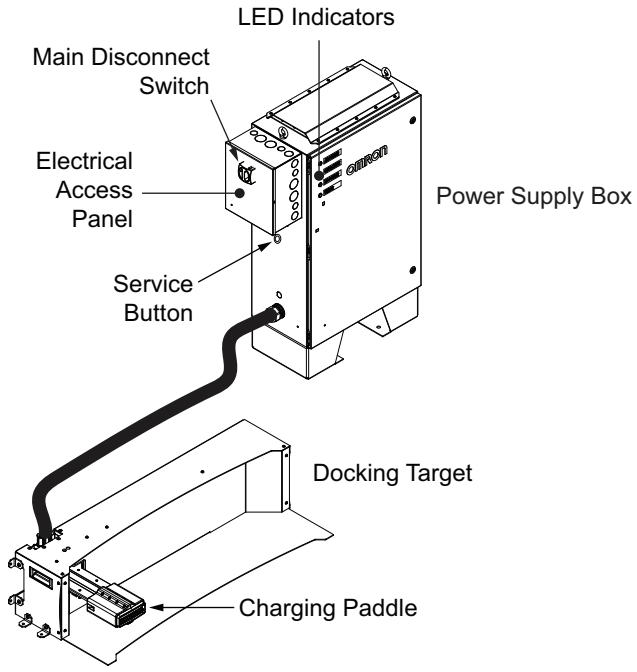
1-2-15 Charging Station

The Charging Station enables the AMR to charge autonomously.
The Charging Station consists of three main parts:

- Power Supply Box - supplies power to the Docking Target or can be used to directly charge a battery that has been removed from the AMR.
- Docking Target - fixed target connected to the Power Supply Box that the AMR docks to and initiates autonomous charging.
- A 4 m power cord that connects the Power Supply Box to the Docking Target.

Additional Information

- The automated Charging Station can either 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 Target, 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.
- Some first-generation Power Supply Box units (part number 68310-000) are not compatible with the MD-series AMRs. Check the Power Supply Box label for AMR compatibility.
- All Docking Targets are compatible with HD-series and MD-series AMRs.



1-2-16 Input and Output Control

Onboard inputs and outputs in the User Connections area are available on the built-in NX102 controller. This controller can be programmed to utilize these inputs and outputs for specific applications. Use Sysmac Studio and MobilePlanner to create custom programs.

1-2-17 Wireless Antennas

Two wireless antennas are factory-installed on either side of the AMR to provide optimal range. They can also be relocated if a payload structure obscures them. Refer to *1-6-11 Wireless Antenna Extension Kit* on page 1-30 and *3-13 Wireless Antenna Relocation Procedure* on page 3-46 for more information.

1-2-18 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 Controller 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 re-charging 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 1-26 for more information.

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

⚠ CAUTION

Although the AMR's software provides the option of using the map features to keep the AMR within its designated workspace, poor or improper localization may result in incorrect path planning. To ensure safety, you must always install physical barriers where there is a risk of property damage or personal hazard.



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:

- Two Low Lasers at the opposing corners of the AMR to detect objects below the plane of the Safety Laser Scanner.
- 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.

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 User Connections area provides user ports 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.



Additional Information

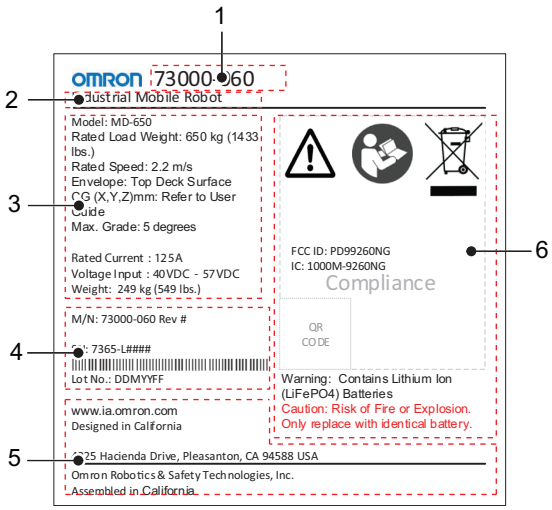
The AMR is capable of navigating autonomously while traveling in reverse, but special application-specific considerations and adjustments must be made. Contact your local OMRON representative for more information.

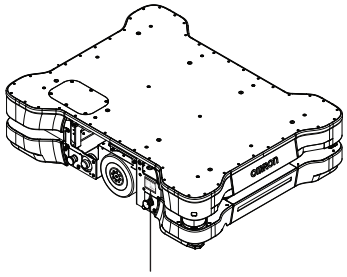
1-4 Labels

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.

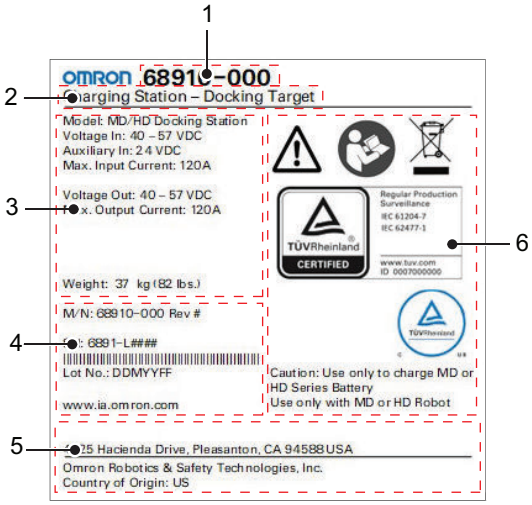


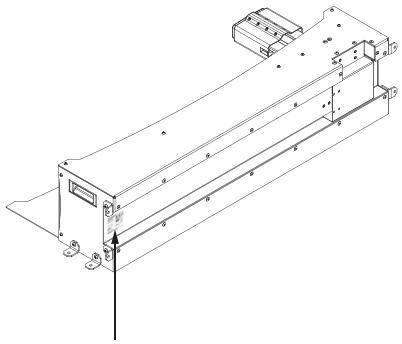


Item	Name	Description
1	Part Number	The AMR part number is provided.
2	Product Type	The product type is provided.
3	AMR Information	General information about the AMR is provided.
4	Production Information	The following information is provided. • M/N indicates the model number and revision level. • SN 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 Docking Target Information Label

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

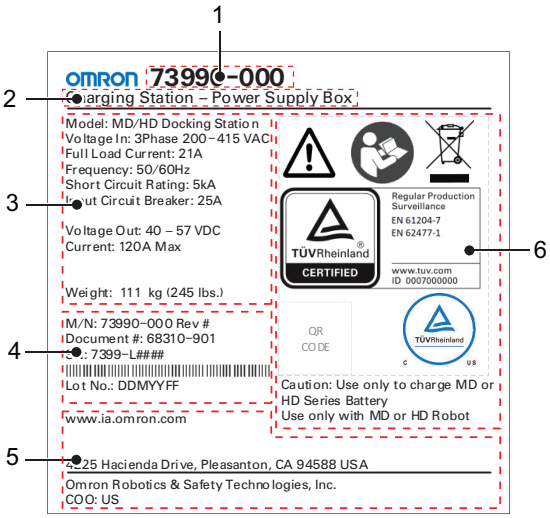


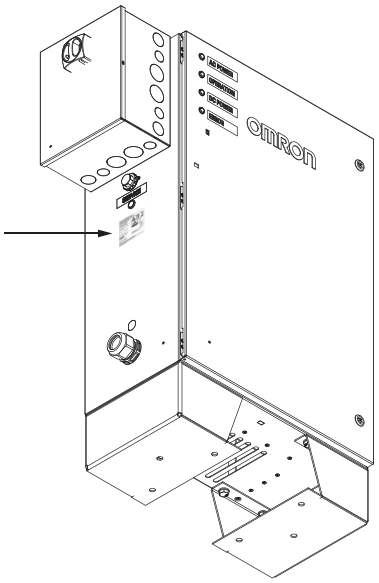


Item	Name	Description
1	Part Number	The Docking Target part number is provided.
2	Product Type	The product type is provided.
3	Docking Target Information	General information about the Docking Target is provided.
4	Production Information	The following information is provided. • M/N indicates the model 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.

1-4-3 Power Supply Box Information Label

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

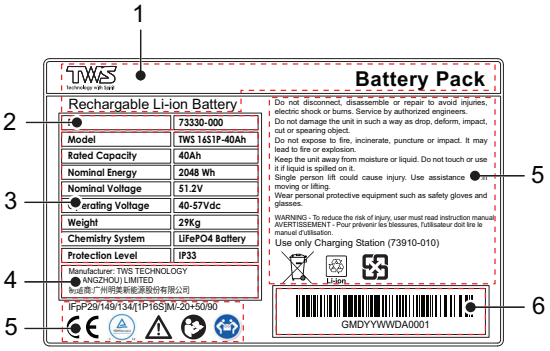


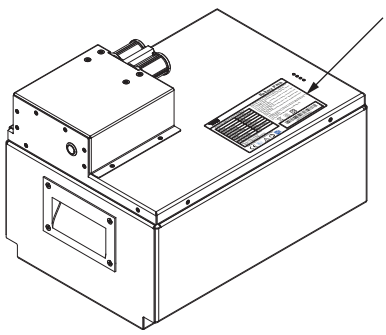


Item	Name	Description
1	Part Number	The Power Supply Box part number is provided.
2	Product Type	The product type is provided.
3	Power Supply Box	General information about the Power Supply Box is provided.
4	Production Information	The following information is provided. • M/N indicates the model number 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.

1-4-4 Battery Information Label

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



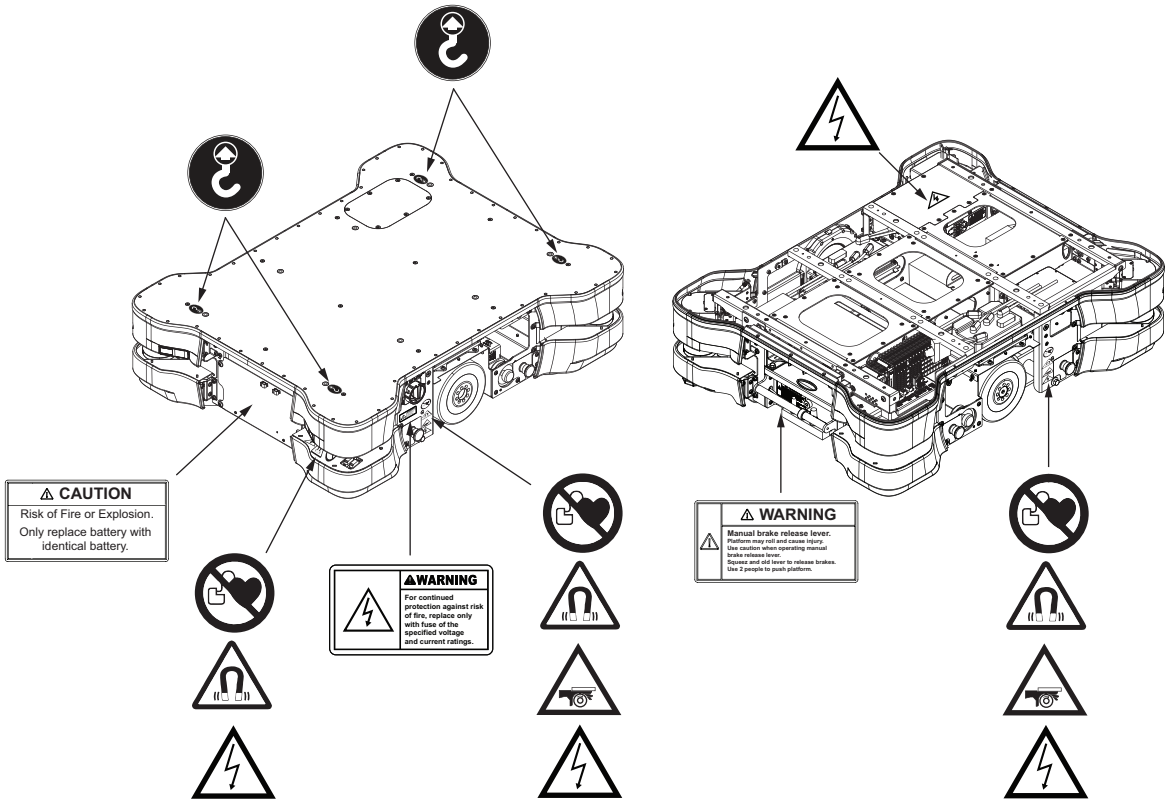


Item	Name	Description
1	Product Type	The product type is provided.
2	Part Number	The Battery part number is provided.
3	Information	Details about the Battery are provided.

Item	Name	Description
4	Product Origin Information	Product origin information is provided.
5	Alerts, Compliance, and Designation	General alerts, compliance, and battery designation information is provided.
6	Serial Number	

1-4-5 AMR Safety and Warning Label Locations

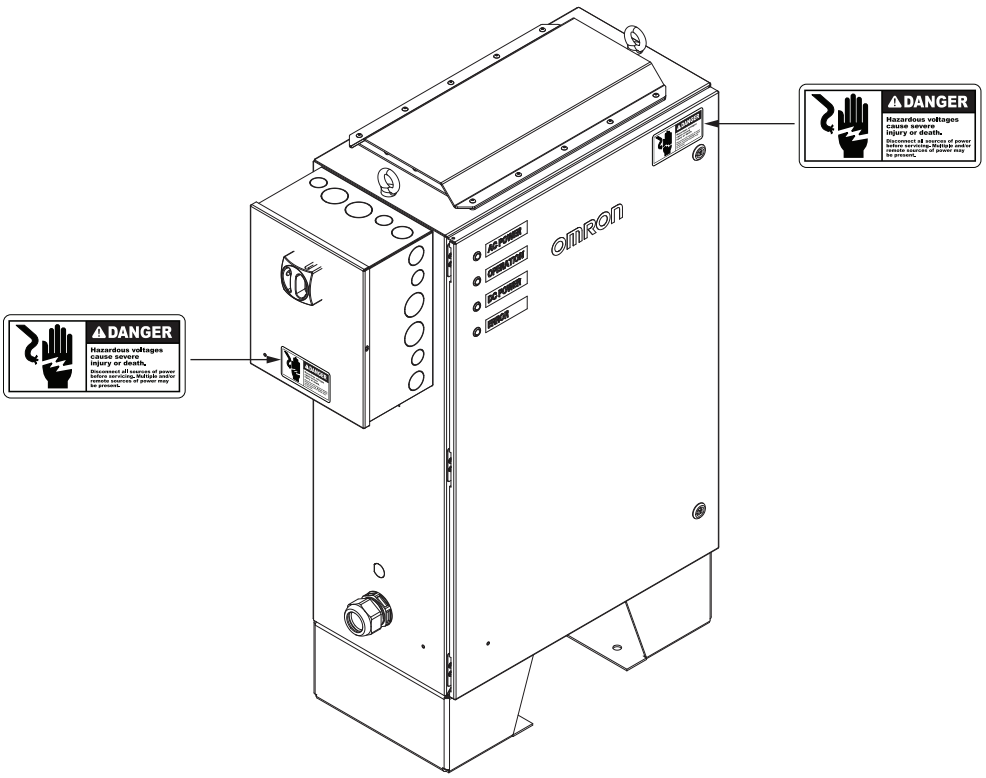
Use the following information to understand all safety and warning label locations on the AMR.



Symbol	Meaning
	Designated lift point
	Electric shock hazard
	Strong magnetic field hazard - pacemaker warning
	Strong magnetic field hazard
	Pinch point hazard

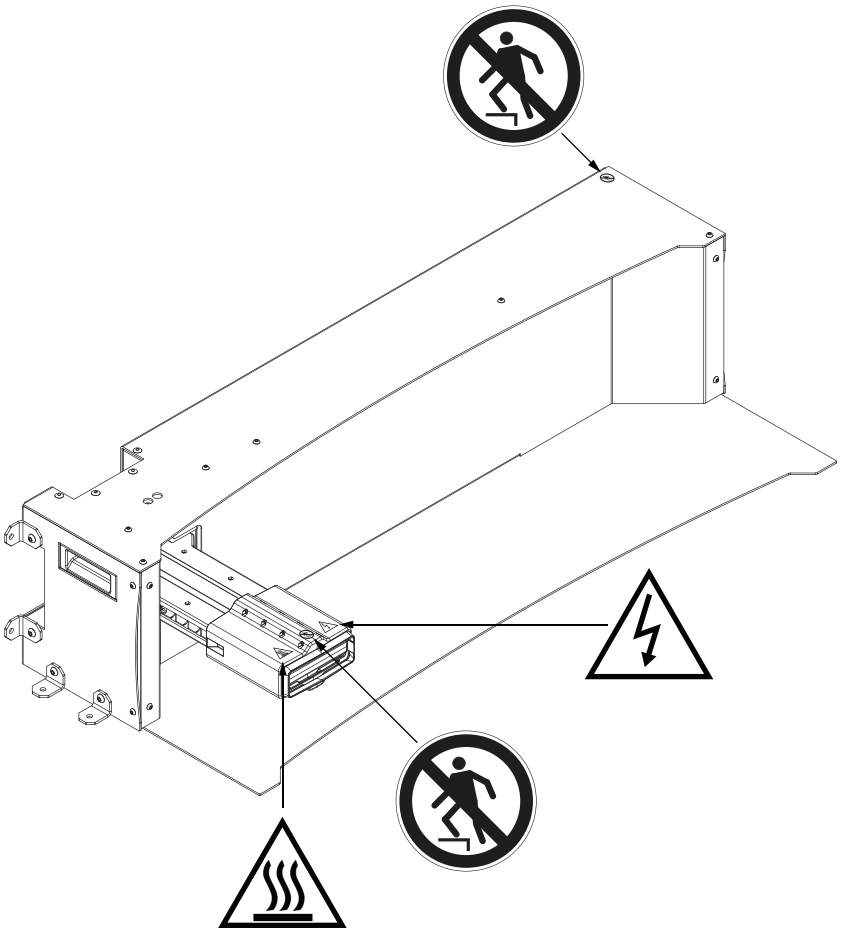
1-4-6 Power Supply Box Safety and Warning Label Locations

Use the following information to understand all safety and warning label locations on the Power Supply Box.



1-4-7 Docking Target Safety and Warning Label Locations

Use the following information to understand all safety and warning label locations on the Docking Target.



Symbol	Meaning
	Do not step or stand on this surface
	Electric shock hazard
	Heat hazard

1-5 Part Numbers

AMR and charging component part numbers are provided in the table below.
Refer to *A-1 Parts List* on page A-2 for other replacement and spare components.

Item	Part Number
MD-650 AMR	73000-060
MD-900 AMR	73000-090
Power Supply Box	73990-000
Docking Target	68910-000

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 of the same type 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 Scanners are positioned inside channels along the sides of the AMR. These channels along the front, rear, and sides of the AMR allow a clear line-of-sight for the Safety Laser Scanners. 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.
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.

⚠ CAUTION

Although the AMR's software provides the option of using the map features to keep the AMR within its designated workspace, poor or improper localization may result in incorrect path planning. To ensure safety, you must always install physical barriers where there is a risk of property damage or personal hazard.

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.
- Do not leave an AMR that is not localized, not connected to the Fleet Manager, or not powered ON in a location that can be accessed by other AMRs.

Additional Information

- The AMR requires wireless communications when operating within a fleet. Refer to *3-4-3 Wireless Connection* on page 3-17 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.

⚠ WARNING

If you are using a user-supplied E-STOP, you must perform commissioning to verify the emergency stop functionality before putting the AMR into service.

⚠ CAUTION

All E-STOP buttons must be located in areas that are easy to reach and within 600 mm of personnel. It is the end user's responsibility to ensure that any additional E-STOP buttons are placed in a location where the operator can easily access them in an emergency situation.

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 User Connections Area* on page 3-19 for more information about additional E-STOP connections.
- If no additional E-STOP buttons are added, a jumper must be placed on the SCPU port. Refer to *SCPU* on page 3-20 for more information.

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.

⚠ CAUTION

An AMR must have a readily visible warning device such as a user-supplied flashing light, to indicate when it is either ready to move or is moving.

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 Controller 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 BUZZ port in the User Connections area can support a user-supplied warning buzzer. You can install it on either the AMR or in a location of your choice in your payload structure. Refer to *3-5-1 User Connections Area* on page 3-19 for more information.

Additional Information

You can optionally supply an LED 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. They have a maximum range of 8 m. A Side Laser Kit (part number 73945-010) is available for purchase. Refer to *3-11 Side Laser Installation* on page 3-40 for more information.

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.

⚠ WARNING

If the optional Side Lasers are present, ensure that the payload structure does not obstruct their scanning plane. This will affect the function of the Side Lasers and reduce their effectiveness in detecting obstacles.



Precautions for Correct Use

- If it is not possible to prevent some interference between the payload and the Side Lasers' sensing plane, contact your local OMRON representative for advanced configuration settings.
- Laser lenses can easily get scratched and damaged. Care must be taken to prevent scratching the laser lens during any maintenance or installation procedures.

1-6-6 Spare Battery

At least one spare battery is required if you choose to exchange the AMR's battery rather than using the automatic charging function at a Docking Target. Avoid exchanging the battery frequently.
Refer to *Charging a Battery Outside of the AMR* on page 4-26 for more information.

1-6-7 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.

1-6-8 High Accuracy Positioning System (HAPS)

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 single sensor HAPS Kit (part number 73925-010) and a double sensor HAPS Kit (part number 73925-020) are available.
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.
Refer to *3-7 HAPS Installation and Configuration* on page 3-29 for more information.

1-6-9 Cell Alignment Positioning System

The Cell Alignment Positioning System (CAPS) is an optional software feature that provides higher repeatability 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.

1-6-10 Maintenance Port Extension Kit

The payload or payload structure design may restrict access to the Maintenance port on the Connector Panel in the User Connections area. A Maintenance Port Extension Kit (part number 73955-000) is available to relocate the port to the side of the AMR for convenient access. Refer to *3-12 Maintenance Port Extension Procedure* on page 3-44 for more information.

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 *3-13 Wireless Antenna Relocation Procedure* on page 3-46 for more information.

Precautions for Correct Use

It is the user's responsibility to ensure that the payload or the payload structure does not attenuate the wireless antennas' signal.

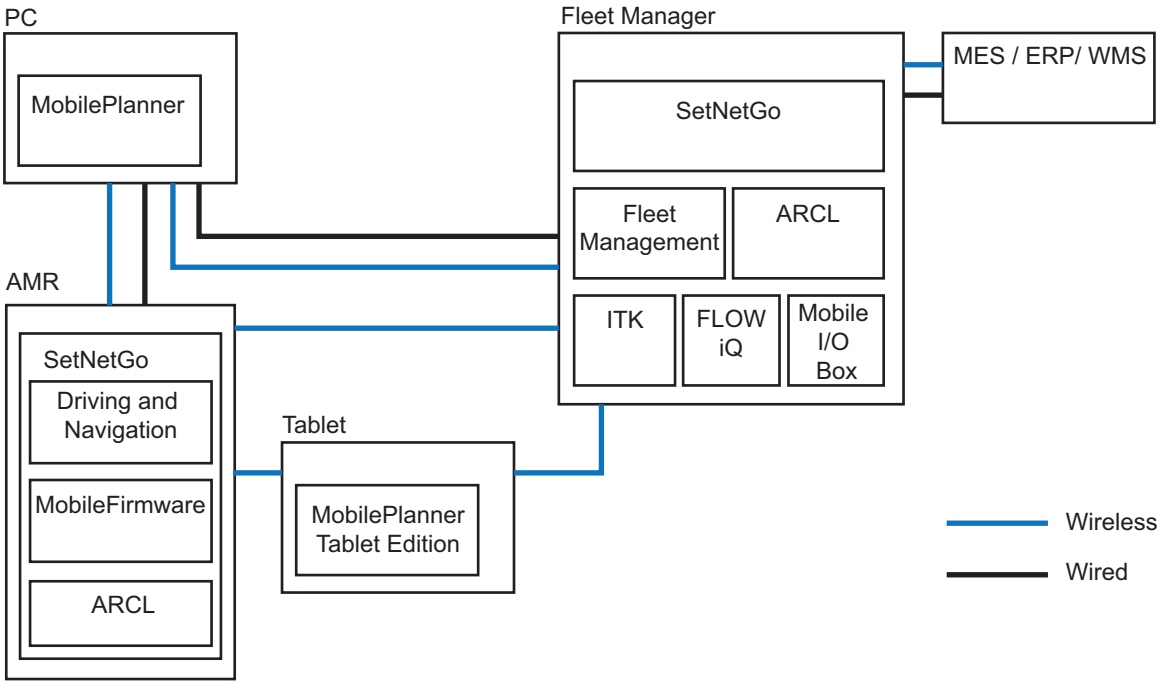
1-6-12 Operator Panel Relocation Kit

The Operator Panel may need to be relocated if it is obstructed by the payload structure or payload.
An Operator Panel Relocation Kit is available (part number 73953-000). Refer to *3-14 Operator Panel Relocation* on page 3-48 for more information.

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
- MobileFirmware
- 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.

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. You can access the SetNetGo interface from within MobilePlanner or with a web browser. SetNetGo is also accessible through a direct RJ-45 Ethernet cable connection to the AMRs Maintenance Ethernet Port or with a wireless connection if configured properly.

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 the onboard NX102 controller or 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 MobileFirmware

MobileFirmware runs on the AMR and provides functions for motion control and other system level operations.

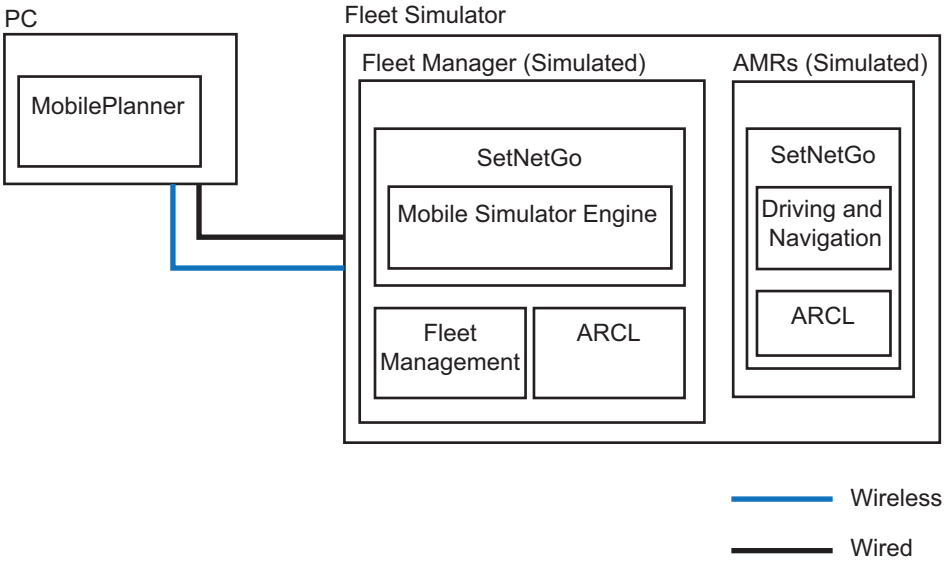
1-7-5 Driving and Navigation Software

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

1-7-6 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.
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 2-7 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 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.
- 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.
- The total weight of your payload structure plus any objects carried by the structure must not exceed the maximum payload capacity of the AMR.
- 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.





Precautions for Safe Use

- You must ensure that the payload structure is properly secured to the AMR.
- Damaged or worn casters and drive wheels can degrade the AMR stability. You must regularly inspect the casters and drive wheels for signs of damage, excessive wear, or uneven spots.
- 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 E-STOP button.



Precautions for Correct Use

It is the user's responsibility to ensure that the payload or the payload structure does not attenuate the wireless antennas' signal.



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.

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.

⚠ WARNING

If a payload or payload structure projects or overhangs the outer dimensions of the AMR, make the following considerations.
- Contact your OMRON representative to change the size of the Safety Laser Scanners' safety zones.
- Modify parameters to change the AMR's *Width*, *LengthFront*, *LengthRear*, and potentially its *Radius*. When making these modifications, ensure that the modified parameters are used during path planning and obstacle avoidance.



● 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.



Precautions for Safe Use

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 E-STOP button.



Additional Information

If no E-STOP buttons are added, a jumper must be present on the SCPU port. Refer to *SCPU* on page 3-20 for more information.

● Light Discs and Light Strips

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

● Access to User Connections Area

Connectors such as the MAINT port may need to be readily accessible without removing the payload structure. Design the payload structure for easy access to the User Connections area or extend the port to a new location on the payload structure. Refer to *3-12 Maintenance Port Extension Procedure* on page 3-44 for more information.

1-8-2 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.

Momentary current spikes that are over the thresholds specified below will activate current limiting protection and cause power loss at the USER power connector. Simultaneous inrush loads might trip the over current protection at the battery. Use external current limiting devices to prevent transient current overload.



Precautions for Correct Use

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



Additional Information

Refer to the power limits specified in *2-4-7 USER PWR Connector* on page 2-17 and *2-4-13 REG PWR Connector* on page 2-19 for more information.

Overload Duration	Overcurrent Level
Continuous	40 A
100 ms	100 A
Instantaneous	150 A

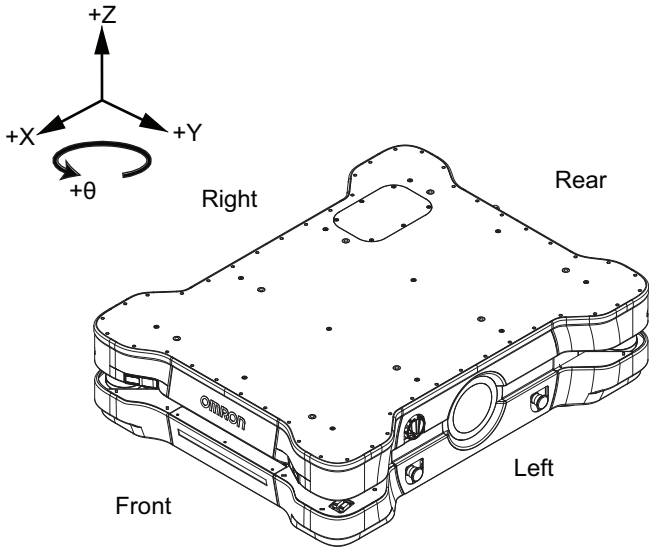
1-9 Coordinate System

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 AMR Controller is located near the rear of the AMR, and 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 of the AMR and other associated items.

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2-1 Performance Specifications

Performance specifications for the AMR are provided below.

Item	Specification	
AMR Model	**MD-650**	**MD-900**
Maximum payload capacity	650 kg	900 kg
Run time	Full payload: approximately 8 hours No payload: approximately 10 hours	
Swing radius	729 mm	
Turn radius	0 mm	
Maximum translational speed (forward and reverse)	2200 mm/s	1800 mm/s
Maximum translational acceleration	900 mm/s^2	
Maximum translational deceleration	1300 mm/s^2	
Maximum rotational speed*1	60 degrees/s	
Maximum rotational acceleration	100 $degrees/s^2$	
Maximum rotational deceleration	150 $degrees/s^2$	
Maximum moment of inertia	250 $kg\text{-}m^2$	300 $kg\text{-}m^2$
Stop position repeatability (single AMR)*2	• To a position: ±70 mm, ±2° • To standard target: ±25 mm, ± 2° • With HAPS: ±8 mm, ±0.5° • With CAPS: ±4 mm, ±0.4°	
Stop position repeatability (fleet)*2	• To a position: ±75 mm, ± 2° • To standard target: ±35 mm, ± 2° • With HAPS: ±10 mm, ±0.5° • With CAPS: ±16 mm, ±0.5°	

*1. The maximum rotational speed is reduced to 45 degrees/s when the AMR is traveling at speeds over 100 mm/s.

*2. Stop position repeatability values were obtained using default AMR parameters and a map created by the MD-series AMR.

2-2 Physical Specifications

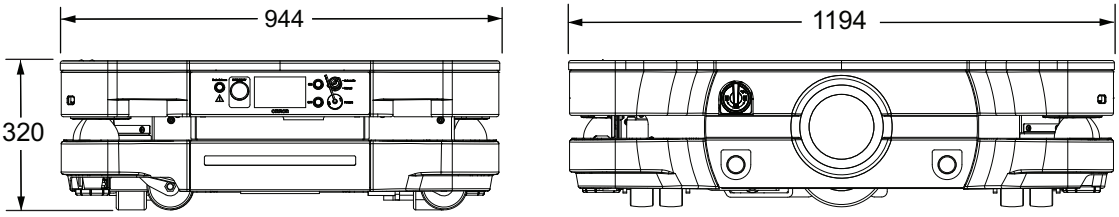
Physical specification of the AMR and other items are provided below.

2-2-1 Dimensions

Dimensional specifications are provided in the following sections.

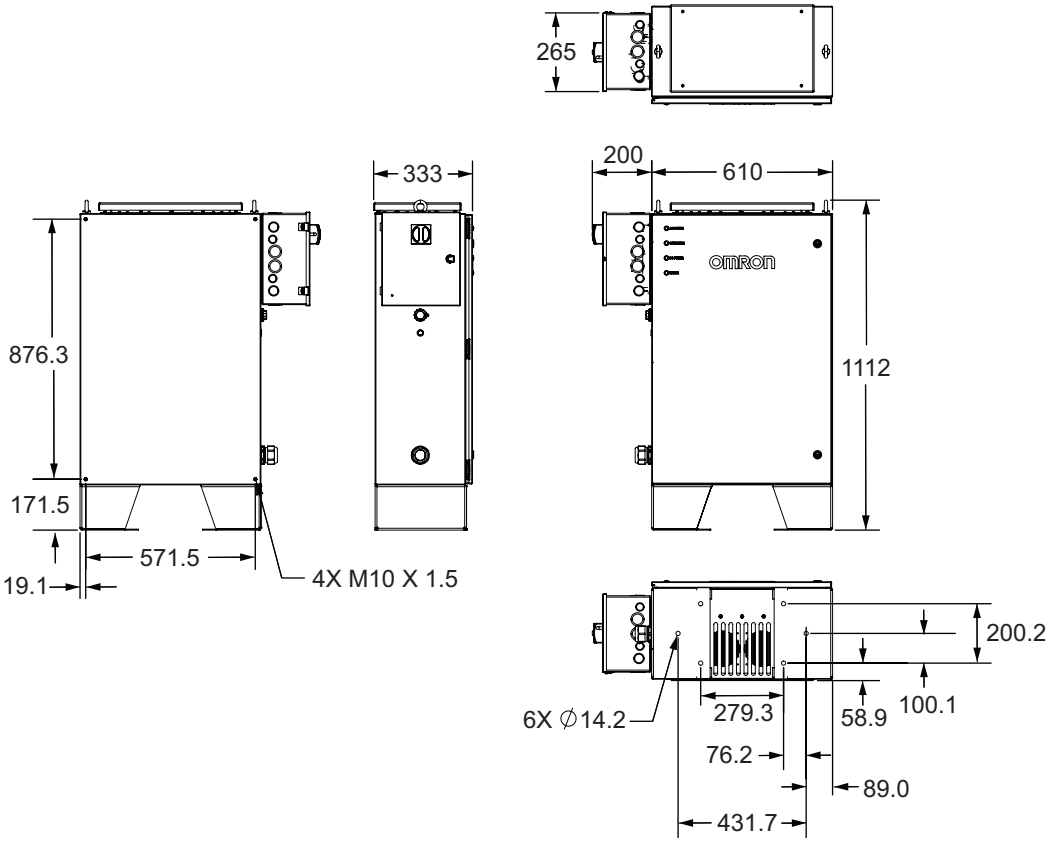
Overall Dimensions

The overall dimensions of the AMR are provided below.



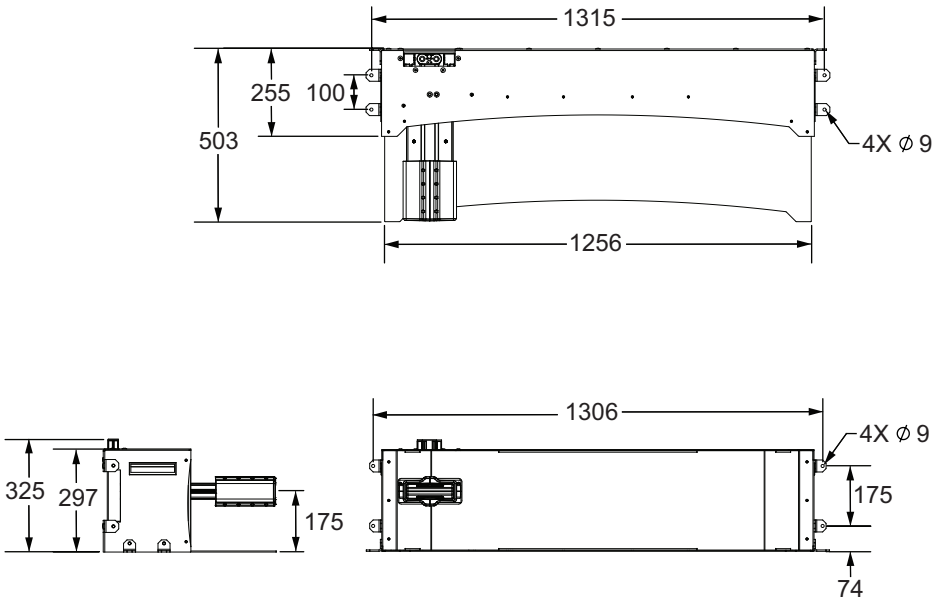
Power Supply Box Dimensions

Physical dimensions of the Power Supply Box are provided below.



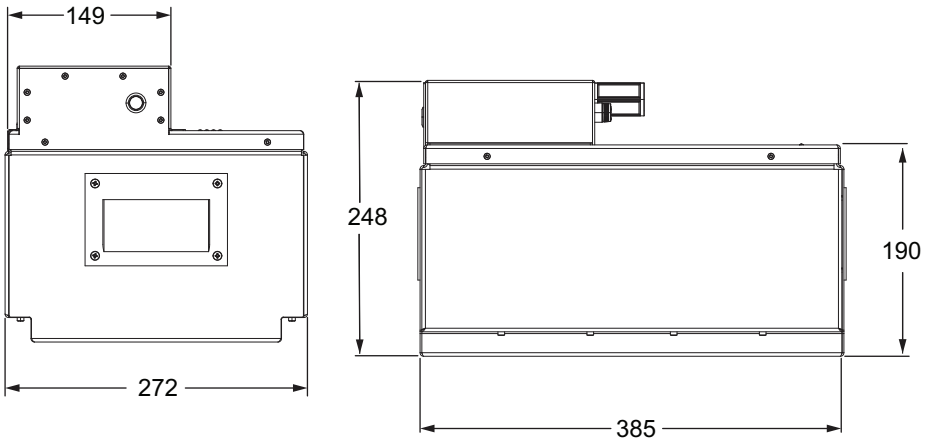
Docking Target Dimensions

Physical dimensions of the Docking Target are provided below.



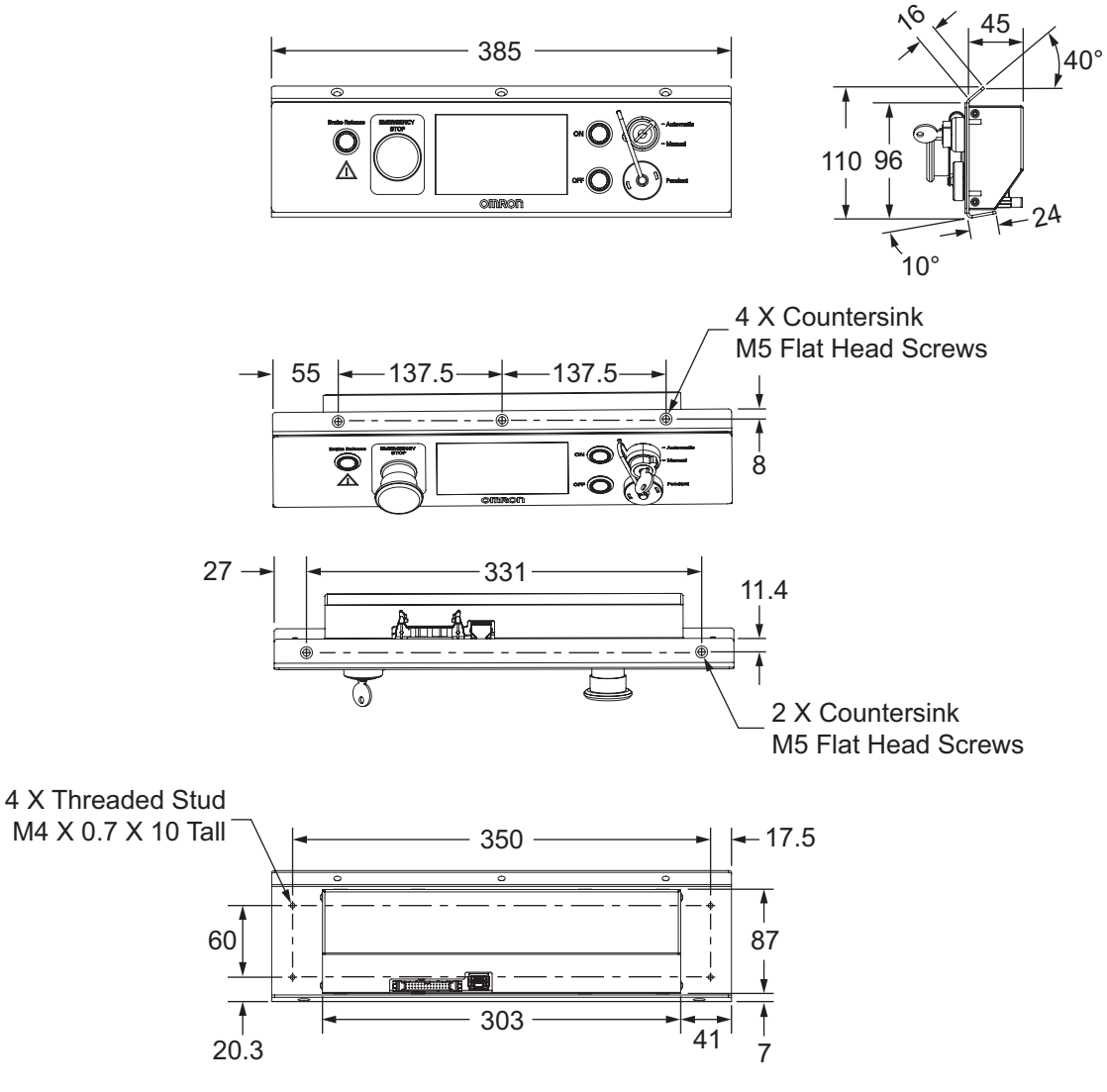
Battery Dimensions

Physical dimensions of the battery are provided below.



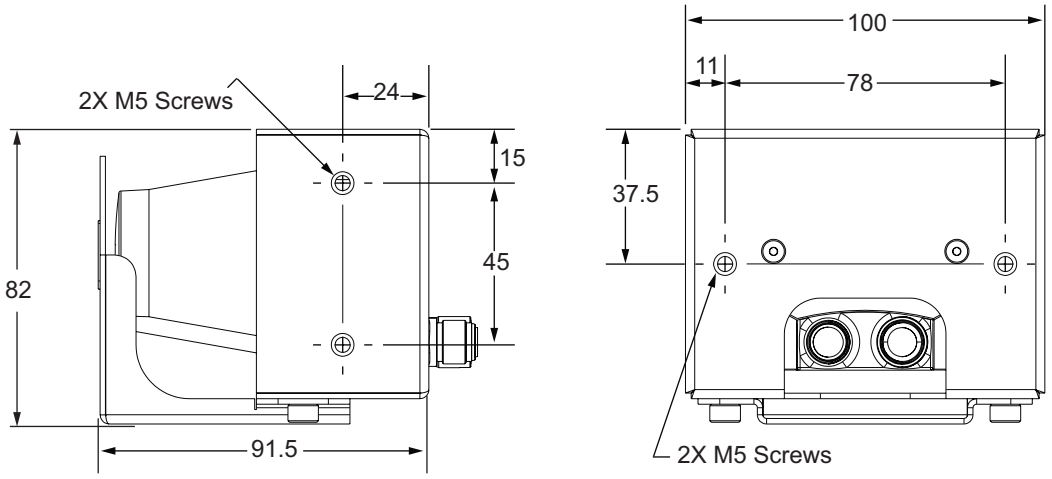
Operator Panel Dimensions

Physical Dimensions of the Operator Panel are provided below.



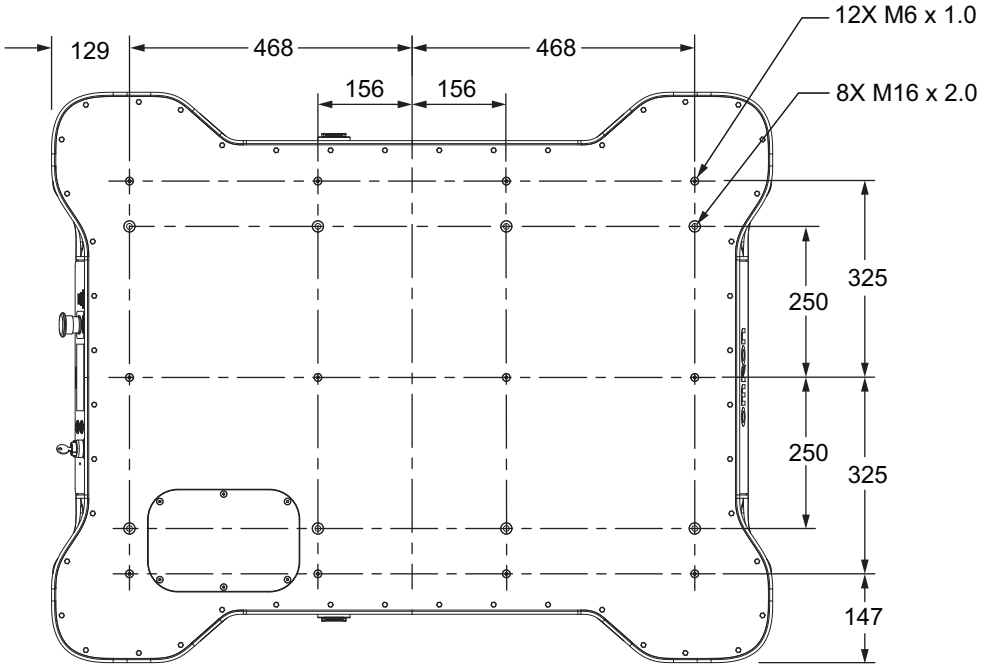
Side Laser Dimensions

Physical dimensions of the Side Laser are provided below.



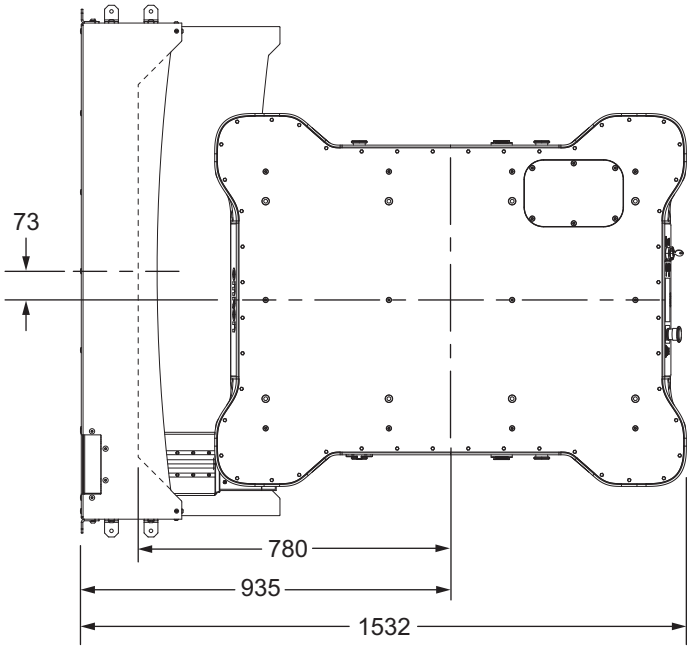
Payload Structure Mounting Point Dimensions

Payload structure mounting point dimensions are provided below. Refer to *3-6-1 Payload Structure Mounting Points* on page 3-27 for more information.



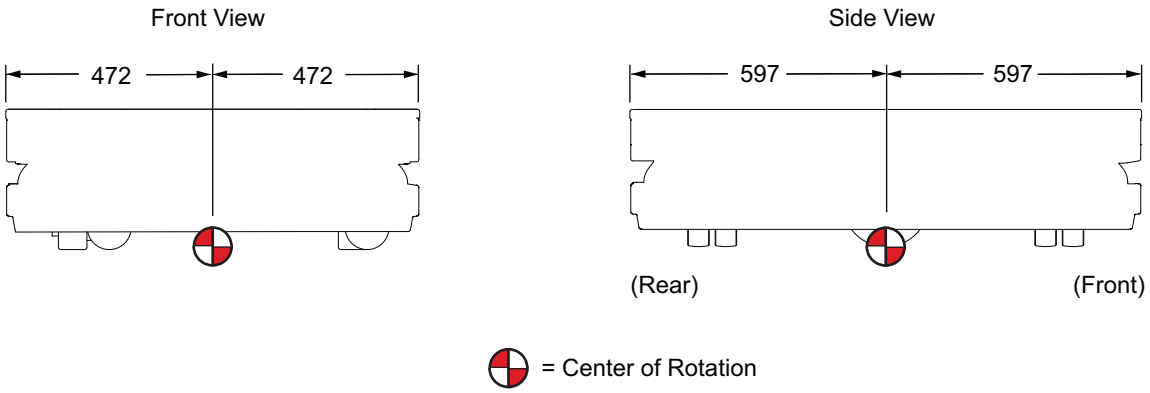
AMR Charging Position Dimensions

The AMR charging position dimensions are provided below.



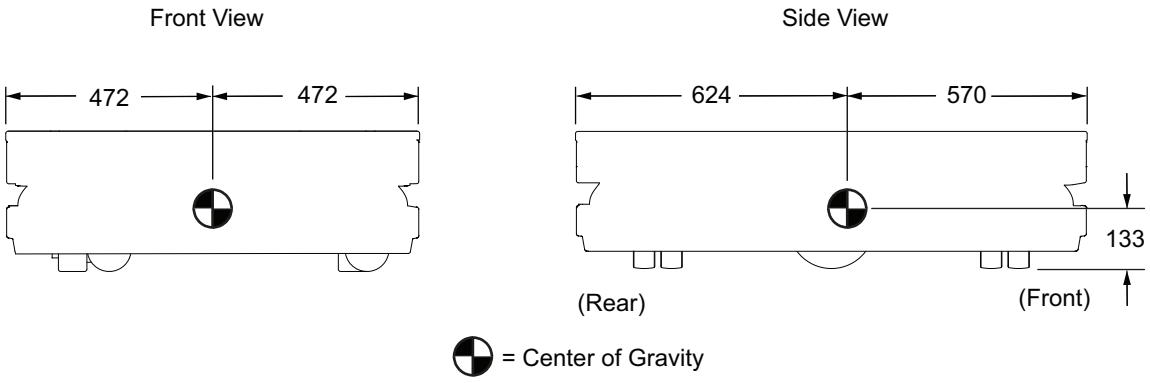
2-2-2 Center of Rotation

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



2-2-3 AMR Center of Gravity

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



2-2-4 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.
MD-650 has a maximum payload of 650 kg, while MD-900 has a maximum payload of 900 kg. This 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 un-loading payloads.

⚠ WARNING

Tipping hazards are more likely if the payload center of gravity is outside the recommended specifications.

Make the following considerations when designing and implementing your payload.

- If the payload overhangs or 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 AMR's center of gravity is offset from the payload's center of gravity due to uneven load distribution, the maximum stable speed of the AMR may need to be reduced from default settings. It is

the end user's responsibility to ensure that the AMR is configured for safe operation under these operating conditions.

- If the payload is tall and also has substantial weight, consider the effect on the AMR's center of gravity.

Additional Information

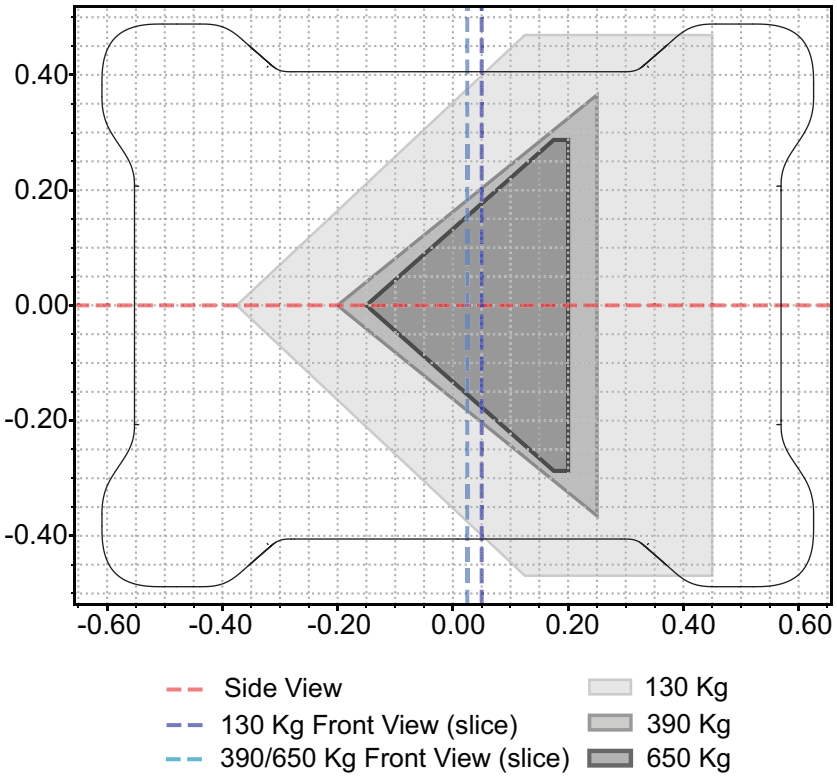
Refer to *2-2 Physical Specifications* on page 2-3 for more information.

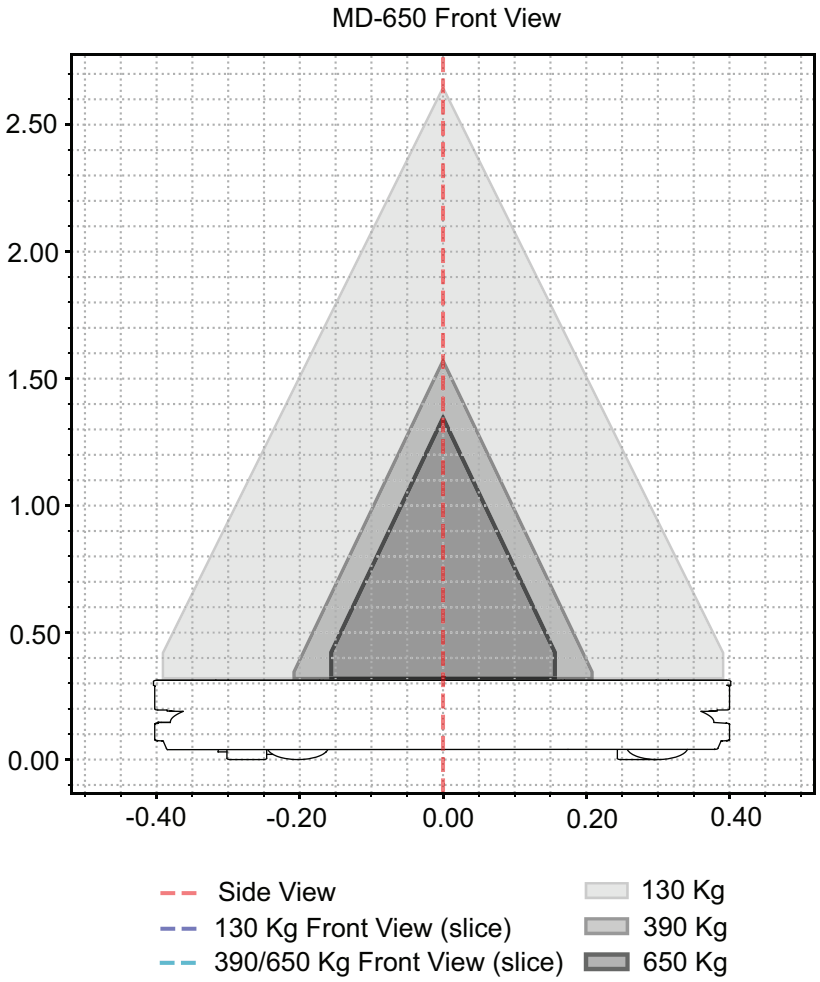
The following figures provide information about the payload's center of gravity allowable limits. Consider only the top view illustrations for a stationary AMR but all of the illustrations (top, front, and side view) for a moving AMR.

These figures assume the following conditions.

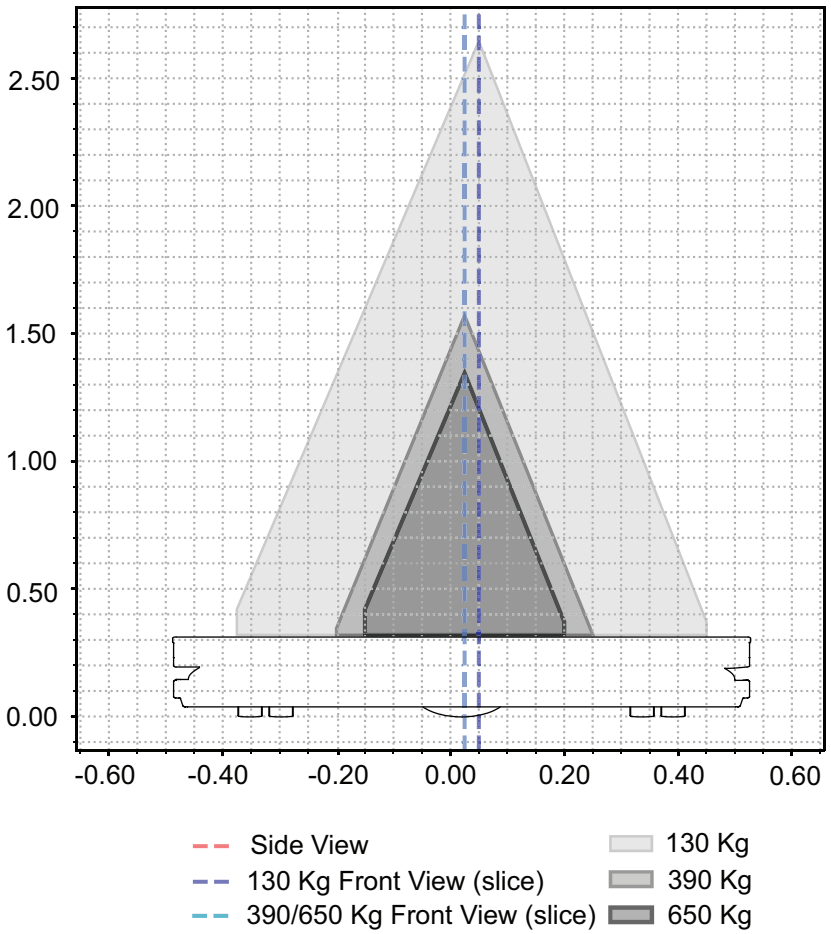
- The payload is securely attached to the AMR and it does not shift due to the AMR's motion.
- The AMR does not exceed its specified default limits for acceleration, deceleration, linear velocity, angular velocity.
- The floor coefficient of friction is within the required specifications.
- The AMR is operating on a flat, level surface and not on an inclined surface.
- If operating on a 5 degree / 8.75% incline, reduce the height of the shaded areas by 40% with respect to the 0 reference (ground).

MD-650 Top View

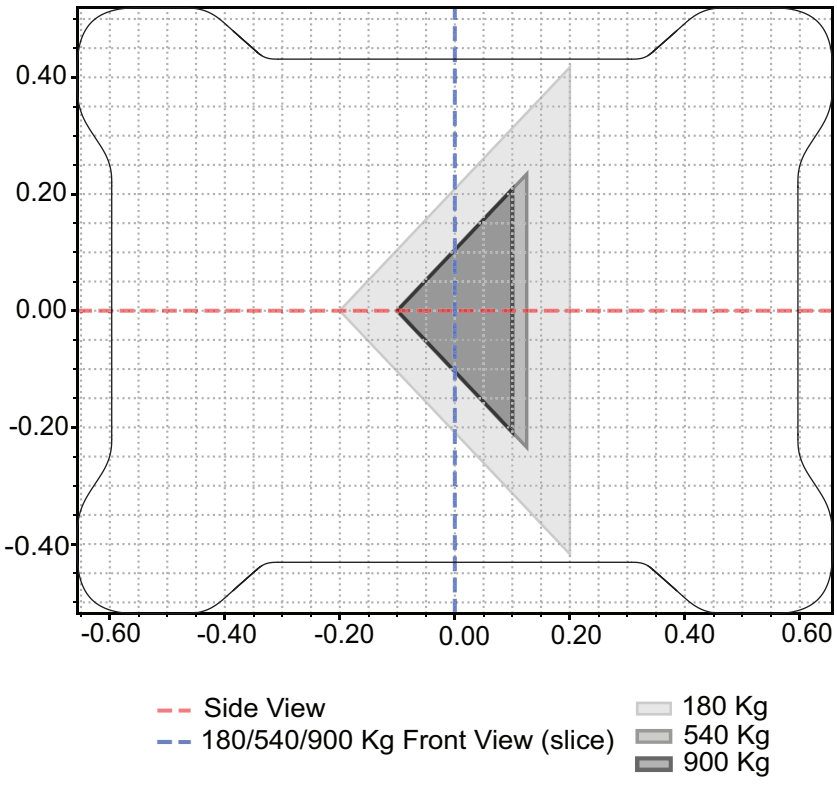


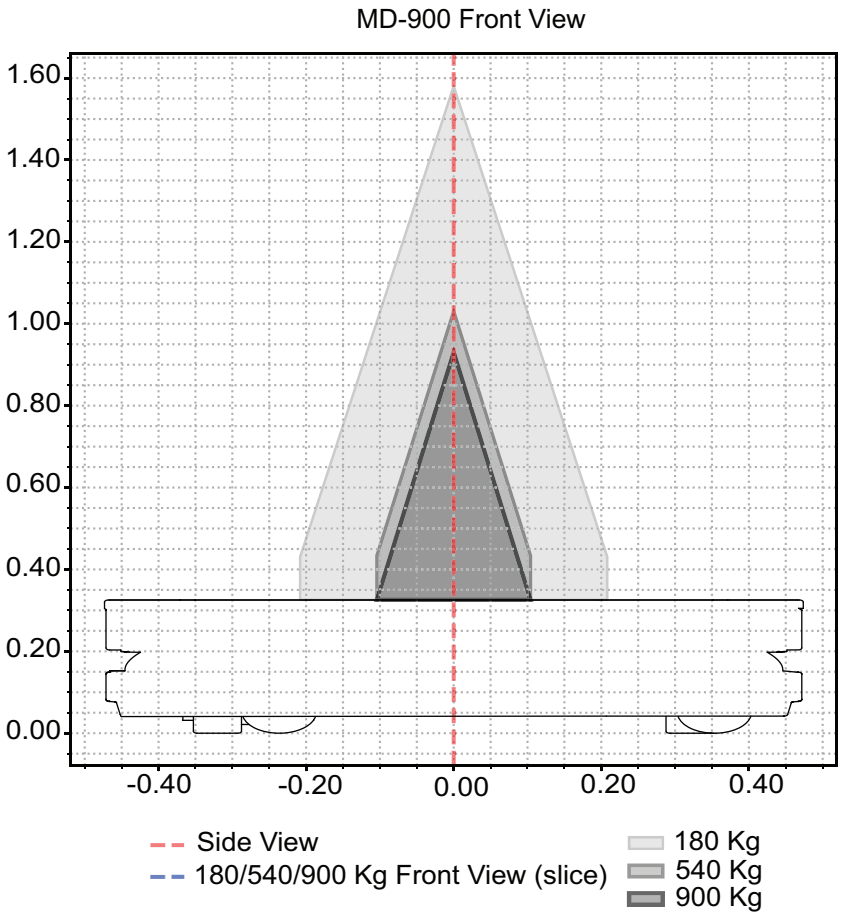

MD-650 Front View
2.50
2.00
1.50
1.00
0.50
0.00
-0.40
-0.20
0.00
0.20
0.40
Side View
130 Kg Front View (slice)
390/650 Kg Front View (slice)
130 Kg
390 Kg
650 Kg

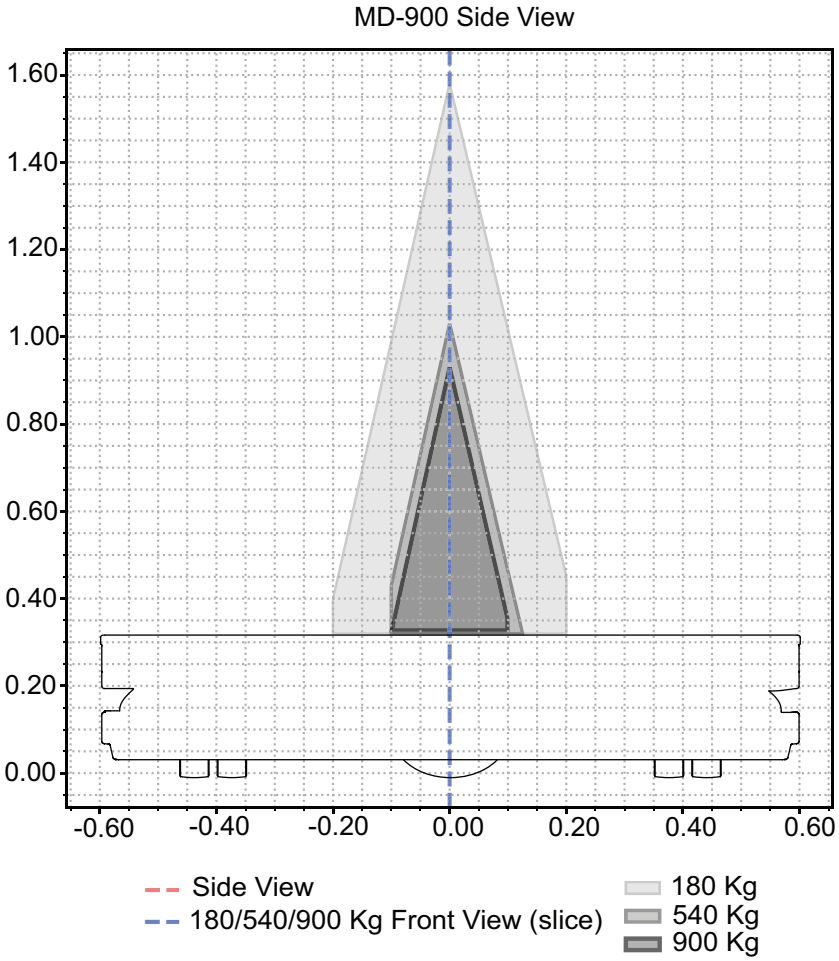
MD-650 Side View



MD-900 Top View




MD-900 Front View
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
-0.40
-0.20
0.00
0.20
0.40
Side View
180/540/900 Kg Front View (slice)
180 Kg
540 Kg
900 Kg



2-2-5 Weights

Weights are provided in the table below.

Item	Weight
AMR (no battery or accessories)	220 kg
Battery	29 kg
Power Supply Box	111 kg
Docking Target	28 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.

Item		Specification
Ambient operating temperature		5 to 40°C
Storage temperature		-20 to 60°C
Humidity		5% to 95%, non-condensing
Altitude		2000 m maximum
Pollution degree		2
Ingress protection class*1		IP22*5 (IP10 for charging pads)
Enclosure rating		Type 2
Atmospheric		Non-hazardous environments (no explosive gas and oil mist).
Radiation		No environments with ionizing radiation.
Wavelength		Avoid infrared devices in and near the range of 845 nm.
Electromagnetic field limits		3 V/m at 80-1000MHz, 10 V/m at 1400-6000 MHz
Dust Tolerance		PM10 particles: 70 µ-g/m^3 PM2.5 particles: 55 µ-g/m^3
Dust and smoke		Avoid severe smoke and particulate matter. It may degrade the efficiency of Safety Laser Scanners and result in unexpected halt of the AMR operation.
Floor surface	Maximum step traversal (speed limited*2,*3)	10 mm / 15 mm
	Maximum gap traversal*2	20 mm / 30 mm*4
	Maximum incline	5 degrees / 8.75%
	Flatness	F_F25 (per ACI 117 standard)
	Levelness	F_L25 (per ACI 117 standard)
	Minimum floor compressive strength	7.2 MPa for MD-650 9.4 MPa for MD-900
	Minimum coefficient of friction	Flat surfaces: 0.6 Inclined surfaces: 0.8

*1. If covers or other items are removed from the AMR (Top Plate, User Connection cover, Operator Panel, etc.), the IP rating will be compromised. Take measures to ensure all openings are properly covered to maintain the desired IP rating of the system.

*2. Frequent driving over steps or gaps will shorten the lifespan of the drivetrain components. Lower speeds may not traverse the step. Steps should have smooth, rounded profiles.

*3. Traversing a 10 mm step must occur at speeds below 500 mm/s in the forward direction and 400 mm/s in the reverse direction. Traversing a 15 mm step must occur at speeds below 300 mm/s in the forward and reverse directions.

*4. 20 mm gaps may be traversed at any speed. Traversing a 30 mm gap must occur at speeds below 2000 mm/s for MD-650 and below 1500 mm/s for MD-900.

*5. The AMR is supplied with open holes in the Top Plate for payload mounting. Ensure these holes are either covered or plugged using the provided Top Plate Seal Kit (part number 24861-000) to maintain IP22 protection.

2-3-2 Charging Station Environmental Specifications

Environmental specifications for the Power Supply Box and Docking Target are provided below.

Item	Specification
Ambient operating temperature	5 to 40°C
Storage temperature	-20 to 60°C
Humidity	5% to 95%, non-condensing
Altitude	2000 m maximum
Pollution degree	2
Ingress protection class	IP20 (IP10 for charging pads)
Class of equipment	Class 1

2-3-3 Battery Environmental Specifications

Environmental specifications for the battery are provided below.

Item	Specification
Ambient operating temperature	5 to 40°C
Storage temperature*1	-20 to 45°C (less than 1 month) -20 to 35°C (less than 3 months) 20 to 25°C (longer than 3 months)
Humidity	5% to 95%, non-condensing (operating)
	65% or less (storage)
Ingress protection class	IP33

*1. Refer to *4-12-5 Storing Batteries* on page 4-27 for more information.

2-3-4 Pendant Environmental Specifications

Environmental specifications for the pendant are provided below.

Item	Specification
Ambient operating temperature	0 to 40°C
Storage temperature	-20 to 65°C
Humidity	5% to 95%, non-condensing
Altitude	2000 m
Pollution degree	2
Ingress protection class	IP30

2-4 Other Specifications

Other specifications are provided in the following sections.

2-4-1 Laser Specifications

Specifications for the lasers are provided below.

Item	Specification
Safety Laser Scanner Sensing Plane	Horizontal plane 175 mm from floor surface to a range of 40 m.
Safety Laser Scanning Class	Class 1M in accordance with the following standards: • IEC 60825-1 • 21 CFR 1040.10 and 1040.11
Low Laser Scanning Plane	Horizontal plane 60.5 mm from floor surface to a range of 8 m.
Low Laser Class	Class 1 in accordance with the following standards: • IEC 60825-1 • 21 CFR 1040.10 and 1040.11

2-4-2 Battery Specifications

Battery specifications are provided below.

Item	Specification
Type	Lithium-ion (LifePO4)
Voltage	40 to 57 VDC (operating)
	51.2 VDC (nominal)
Capacity	40 Ah nominal
Energy	2048 Wh nominal
Recharge time	19.6 minutes (from 20% to 80%)*1
Duty cycle (depth of discharge)	80%
Life span	Approximately 3000 cycles*2*3
Weight	29 kg

*1. Charging time can vary based on battery cell temperature and state of charge to prolong battery life.

*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.

*3. Under the following conditions:
- Temperature: 25 ±3°C
- Relative humidity: 25% to 85%
- Charging at 57 VDC / 40 A
- Discharging at 40 VDC / 40 A
- 60 minutes of inactivity after charging or discharging

2-4-3 HAPS Specifications

Specifications for HAPS are provided below.

Item	Specification
HAPS sensor depth x width	30 mm x 165 mm

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

2-4-4 Charging Station Specifications

Specifications for the Charging Station are provided below.

Description	Specification
Maximum input current	25 A
Maximum output current	120 A (nominal)*1
Input voltage	3-phase 200 to 240 VAC, 50/60 Hz - Delta/Wye 380 to 415 VAC, 50/60 Hz - Wye
Output voltage (Power Supply Box / Docking Target)	40 to 57 VDC
Power consumption	7.75 kW
Maximum output power	6.84 kW
Input protection method	25 A branch-rated circuit breaker
Short circuit current rating (SCCR)	5 kA
Material	Aluminum and Mild steel
User-supplied conductor type	Copper
Grounding class	Class 1

*1. Fused at 150 A.

2-4-5 Operator Panel Screen

Operator Panel screen specifications are provided below.

Item	Specification
Display type	Color TFT backlit, 127 mm diagonal
Resolution	800 x 480
Brightness	1000 cd/m^2

2-4-6 Onboard I/O

Onboard I/O specifications are provided below.

Item	Specification
Digital Inputs	Unit: NX-ID4442 8 digital PNP / sourcing inputs Refer to *NX-series Digital I/O Unit User's Manual (Cat. No. W521)* for more information.
Digital Outputs	Unit: NX-OD4256 8 digital PNP / sourcing outputs Refer to *NX-series Digital I/O Unit User's Manual (Cat. No. W521)* for more information.

2-4-7 USER PWR Connector

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

Item		Specification
AMR connector		Anderson Power Pole SBS-50BLU
User-supplied mating connector		
User-supplied connector pins		Anderson Power Pole: • 16 mm^2 wire size: 1339G2 • 10 mm^2 wire size: 1339G5 • 2.5 mm^2 to 4 mm^2 wire size: 1339G3
Voltage range		40 to 57 VDC (unregulated) 51.2 VDC (nominal)
Current limits*1	Continuous	40 A
	100 ms	100 A
	Instantaneous	150 A

*1. Use external current limiting devices to prevent transient current overload. Momentary current spikes that are over the thresholds specified here will trip the USER PWR circuit breaker and cause power loss at the USER PWR power connector.

2-4-8 COMMS Connector

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

Item	Specification
AMR connector	Molex Mini-Fit Jr. 2 x 7 (part number 39300140)
User-supplied mating connector*1	Molex Mini-Fit Jr. 2 x 7 receptacle (part number 39012145)
User-supplied mating connector pins*1	Molex Mini-Fit Female Crimp Terminal, Tin over Copper Plated Brass, 18-24 AWG (part number 39000039)
Communication types	Reserved for future use

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

2-4-9 SCPU Connector

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

Item	Specification
AMR connector	Molex Mini-Fit Jr. 2 x 9 (part number 874271802)
User-supplied mating connector*1	Molex Mini-Fit Jr. 2 x 9 receptacle (part number 39012185)
User-supplied mating connector pins*1	Molex Mini-Fit Female Crimp Terminal, Tin over Copper Plated Brass, 18-24 AWG (part number 39000039)
Input type	PNP / sourcing
Rated input voltage	24 VDC (20.4 to 28.8 VDC)
Safety input current	3.0 mA

Item	Specification
Safety output current	500 mA

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

2-4-10 AUX PLC Connector

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

Item	Specification
AMR Connector	Molex MicroFit 1 x 2 (part number 430450200)
User-supplied mating connector*1	Molex MicroFit 1 x 2 receptacle (part number 430250200)
User-supplied connector pins*1	Molex MicroFit 3.0 Female Crimp Terminal, Tin Plated Phosphor Bronze contact, 20-24 AWG (part number 430300007)
Rated output voltage	24 VDC (22.7 to 24.36 VDC)
Maximum output current	0.75 A

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

2-4-11 LIGHTS Connector

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

Item	Specification
AMR connector	Molex Mini-Fit Jr. 2 x 3 (part number 26013116)
User-supplied mating connector*1	Molex Mini-Fit Jr. 2 x 3 receptacle (part number 39012065)
User-supplied mating connector pins*1	Molex Mini-Fit Female Crimp Terminal, Tin over Copper Plated Brass, 18-24 AWG (part number 39000039)
Output type	PNP / sourcing
Rated output voltage	24 VDC (20.4 to 28.8 VDC)
Maximum output current	500 mA

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

2-4-12 BUZZ Connector

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

Item	Specification
AMR connector	Molex Mini-fit Jr., 2 x 1
User-supplied mating connector*1	Molex Mini-Fit Jr., 2 x 1 receptacle (part number 39012020)
User-supplied mating connector pins*1	Molex Mini-Fit Female Crimp Terminal, Tin over Copper Plated Brass, 18-24 AWG (part number 39000039)
Output type	PNP / sourcing
Rated output voltage	24 VDC

Item	Specification
Maximum output current	80 mA per signal Overload protected with automatic positive temperature coefficient operation.

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

2-4-13 REG PWR Connector

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

Item		Specification
AMR connector type		Molex Mini-Fit Jr., 2 x 2
User-supplied mating connector*1		Molex Mini Fit Jr., 2 x 2 receptacle (part number: 0469920410)
User-supplied mating connector pins*1		Molex Mini-fit Female Crimp Terminal, Selective Gold and Selective Tin over Nickel, 18-24 AWG (part number: 0039000074)
Voltage range		23 to 25 VDC
Current limits*2	Continuous	1 A
	100 ms	5 A
	Instantaneous	20 A

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

*2. REG power is protected by an internal positive temperature coefficient fuse that automatically resets. Use external current limiting devices to prevent transient current overload. Momentary current spikes that are over the thresholds specified will activate current limiting protection and cause power loss at the REG power connector.

2-4-14 LASER PWR

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

Item	Specification
AMR connector	Weidmuller (part number: 1824440000)
Ferrule / wire size	24-16 AWG
Rated output voltage	24 VDC nominal
Maximum output current	0.75 A

2-4-15 Drive Train

Drive train specifications are provided below.

Description	Specification
Drive wheels	Steel wheels with ESD tread
Drive wheel dimensions	200 mm diameter x 65 mm width (MD-650); 160 mm diameter x 65 mm width (MD-900)
Drive wheel motor	1000 W PMS servo motor
Casters	Cast iron wheels with polyurethane tread
Caster dimensions	100 mm diameter x 50 mm wide

Description	Specification
Brakes	125 N·m holding torque
Steering	Differential

2-4-16 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 SISTEMA as per ISO 13849-1 for the following safety functions.

Safety Function	Safety Stop Type	Reset Type	Description	PL	Category	PFHd
E-STOP buttons on sides of AMR	Emergency Stop	Manual Reset	Pressing the E-STOP button results in an emergency stop (controlled stop). In this case, the power to the AMR motors remains ON in order to achieve a controlled stop. Once the controlled stop is achieved, the power to the motors is disconnected.	e	3	8.84×10^{-8}
• E-STOP button on Operator Panel • E-STOP button on Pendant	Emergency Stop	Manual Reset	Pressing the E-STOP button results in an emergency stop (controlled stop). In this case, the power to the AMR motors remains ON in order to achieve a controlled stop. Once the controlled stop is achieved, the power to the motors is disconnected.	e	3	6.62×10^{-8}

Safety Function	Safety Stop Type	Reset Type	Description	PL	Category	PFHd
Emergency stop connection(s)*2	Emergency Stop	Manual Reset	User-supplied E-STOP button(s) can be attached to the SCPU connection located in the User Connections area. Pressing the user-supplied E-STOP button(s) results in an emergency stop (controlled stop). In this case, the power to the AMR motors remains ON in order to achieve a controlled stop. Once the controlled stop is achieved, the power to the motors is disconnected. The final functional safety rating is to be calculated using the given PFHd value (logic and output) combined with the user-supplied emergency stop (input) PFHd values.	To be determined by the user	3	5.79×10^{-8}
Enabling device on Pendant	Emergency Stop	Manual Reset	When the enabling device is not depressed or completely depressed, an emergency stop (controlled stop) will occur. In this case, the power to the AMR motors remains ON in order to achieve a controlled stop. Once the controlled stop is achieved, the power to the motors is disconnected.	e	3	5.79×10^{-8}
Safety Laser Scanner detection	Protective Stop	Automatic Reset	If an obstacle intrudes into the safety zones, the Safety Laser Scanner will trigger a protective stop (category 1 stop*1). Since this is also a controlled stop, the power to the AMR motors remains ON in order to achieve a controlled stop. Once the controlled stop is achieved, the power to the motors is disconnected. If the safety zone intrusion is cleared of the obstacle, the AMR will automatically restart and resume operation after a delay of 2.5 seconds.	d	3	5.68×10^{-7}

Safety Function	Safety Stop Type	Reset Type	Description	PL	Category	PFHd
Overspeed protection	Protective Stop	Manual Reset	This function monitors for overspeed and speed inconsistency. The AMR linear speed is limited to 2200 (MD-650) and 1800 (MD-900) mm/s (both forward and backward). If the calculated speed exceeds this speed limit, the AMR protective stop is triggered.	d	3	4.85×10^{-7}
Protective Stop connection(s)*2	Protective Stop	Automatic Reset	User-supplied protective stop devices initiate a protective stop (category 1 stop*1) and resets automatically once the protective device signal is cleared after a two-second delay. The final functional safety rating is to be calculated using the given PFHd value (logic and output) combined with the user supplied protective device (input) PFHd values.	To be calculated by the user.		5.79×10^{-8}
Brake release monitoring	Protective Stop	Manual Reset	This function monitors the brake to avoid continuous braking when the AMR is traveling. The brake release monitoring initiates a category 1 stop.	b	B	4.23×10^{-6}
Warnings	N/A	N/A	This function is for the visual warning system.	b	B	5.71×10^{-6}
Automatic battery charging	N/A	N/A	This function is used to ensure that the AMR is properly connected to the Docking Target before the charging contacts are activated.	b	1	6.34×10^{-6}

*1. Stop Categories according to IEC 60204-1 (NFPA79).

*2. The SCPU connector is provided for use with a user-supplied external E-STOP along with a user-supplied protective device. The user is responsible for calculating the overall PL and PFHd, inclusive of user-supplied components, and performing a final risk assessment.

2-4-17 Stopping Distance and Time

The Stopping Distance and Time test has been performed for the AMR. For this evaluation, the AMR drove towards an obstacle with the path planning and obstacle avoidance features disabled. The AMR navigated to a stop using only the safety system. For the duration of this test, the AMR was monitored by a motion capture system that measured the time elapsed and distance traveled as the AMR came

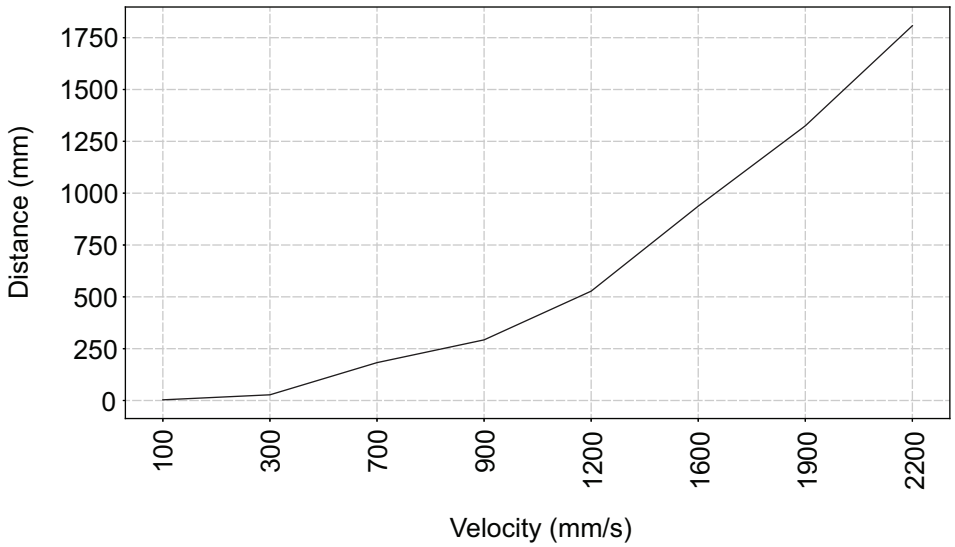
to a stop. The AMR traveled in a combination of straight and arced trajectories for the full range of valid translational and rotational velocities.

Test Assumptions:

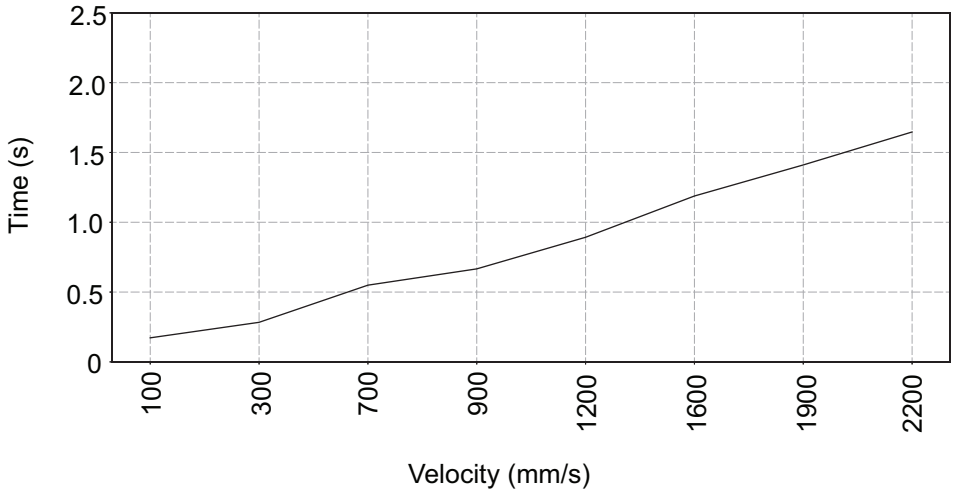
- Robot payload: 650 kg (MD-650), 900 kg (MD-900)
- Velocities tested (AMR maximum): 100 to 2200 mm/s (MD-650), 100 to 1800 mm/s (MD-900)
- Floor friction: 0.63 dynamic and 0.76 static coefficient of friction
- Specified Overall Floor Flatness (SOFF): 25 (Moderately Flat)
- Specified Overall Floor Levelness (SOFL): 15 (Conventional)

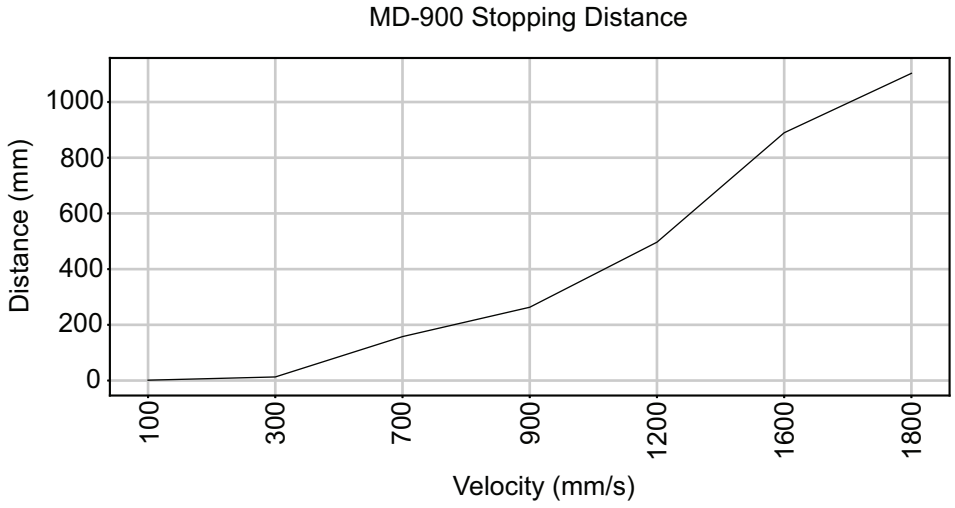
Stopping distance and time for the AMR are provided below. This information applies to all allowable payloads.

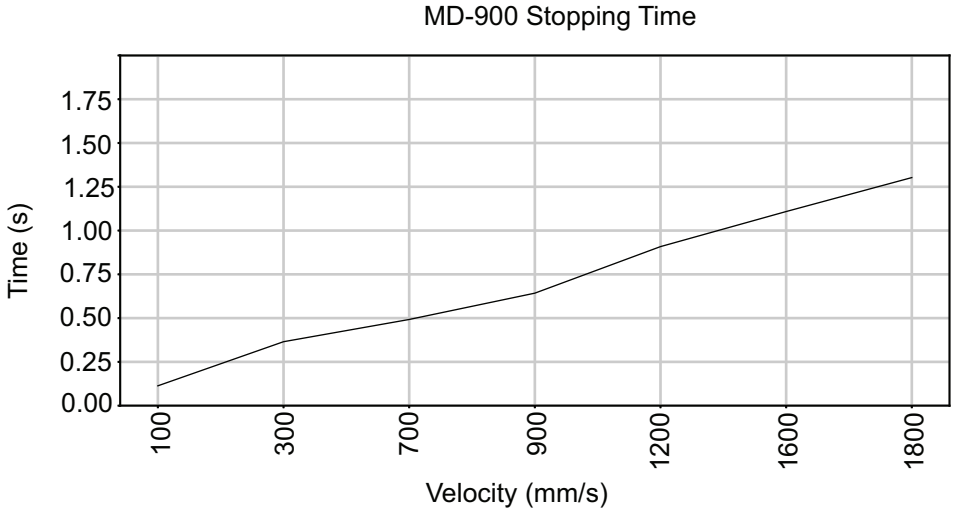
MD-650 Stopping Distance



MD-650 Stopping Time







2-4-18 Wireless Specifications

Wireless network specifications for the AMR are provided below.

Item	Description
Signal Strength	The minimum required signal strength is -60 dBm.
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	Authentication: WPA-PSK, WPA2-PSK, PEAP-MSCHAPv2, EAP-TLS Encryption: WEP (64 or 128 bit), TKIP/RC4, CCMP/AES, TKIP/CCMP/AES

2-4-19 Path Planning Specifications

Specifications for obstacle detection in path planning are provided below.

Item	Specification
Sensing range for detection of obstacles	40 m
Minimum obstacle height for detection	60.5 mm

Item	Specification
Maximum obstacle height above ground for detection	175 mm*1
Minimum obstacle width for detection at maximum range	70 mm
Minimum obstacle avoidance reaction time	250 ms

*1. Optional side lasers can be used to change the detection height of the robot. Refer to *1-6-5 Side Lasers* on page 1-28 for more information.

3

Installation

This section describes how to install and configure the AMR for operation.

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3-1 Installation Introduction

The general AMR installation steps are provided below.

⚠ WARNING

- Use safe lifting practices when moving the heavy objects such as the Power Supply Box, Battery, Docking Target, and AMR.
- The Charging Station, battery, and AMR transfer high electric power and contain hazardous voltages. You must take necessary precautions to avoid electric shock. Follow appropriate Lock-Out, Tag-Out (LOTO) instructions prior to any installation and maintenance work performed on or near these items.





Additional Information

Unpack all equipment before beginning the AMR configuration procedure.
Refer to *Autonomous Mobile Robot (AMR) MD-series Platform Safety and Unpacking Guide (Cat. No. I682)* and *AMR (Autonomous Mobile Robot) Charging Station Safety, Unpacking, and Installation Guide (Cat. No. I683)* for more information.

1 Install the Charging Station.
Refer to *3-2 Charging Station Installation* on page 3-4 for more information.

2 Charge the battery.
Refer to *4-12-3 Charging the Battery* on page 4-24 for more information.

3 Configure the network connections.
Refer to *3-4 Network Connections* on page 3-16 for more information.

4 Install the payload structure and make all electrical connections.
Refer to *3-6 Attaching the Payload* on page 3-27 and *3-5 Electrical Connections* on page 3-19 for more information.

5 Install optional items.
Refer to *1-6 Optional Items* on page 1-26 for more information.

6 Attach warning labels.
Refer to *3-8 Attaching Warning Labels* on page 3-36 for more information.

7 Perform commissioning.
Refer to *3-9 Commissioning* on page 3-37 for more information.

8 Generate a map for the AMR.
Refer to *3-10 Map Creation Overview* on page 3-38 for more information.

3-2 Charging Station Installation

Make the following considerations before installing the Charging Station.

- Install the Charging Station on a flat and level floor, in a location that is kept clear and is easily accessible to AMRs.
- Install the Docking Target away from forklift traffic or high traffic areas. This will prevent collisions between the docked AMRs and other operating vehicles in the area.
- The Power Supply Box must be installed in an orientation and location so that the LED indicators are always visible to the operator.
- Temporarily use the Docking Target free standing (without fasteners). Do this only for testing or experimenting with the location of your Charging Station.
- The Docking Target's power connector can install either horizontally or vertically. There is a groove on the back of the Docking Target that allows you to reach the power connector, and connect the power cord sideways from either side of the Docking Target. Refer to *3-2-1 Repositioning the Docking Target Power Connector* on page 3-5 for more information.
- The Power Supply Box needs access to the facility AC power.
- The facility power cable must be properly secured to the Power Supply Box.
- The Docking Target must be installed in a location where it allows for at least 2 m of clearance from the center of the AMR. This is to ensure safe maneuverability of the AMR during docking.
- The Power Supply Box must only be installed vertically, using floor mount holes to anchor to the floor or wall mount holes to secure to the wall.
- The Power Supply Box has cooling vents at the top and bottom of the unit. Do not block these areas.
- The power cord between the Power Supply Box and the Docking Target is 4 m long.
- Provide at least 90° clearance for the electrical access panel door and the main electrical compartment door to swing open.
- Provide at least 1 m of clear space in front of the electrical access panel and main electrical compartment. This distance is measured from the face of the electrical access panel door and the main electrical compartment door.

⚠ WARNING

Improper installation of the Power Supply Box could result in a tipping hazard. You must make sure that the Power Supply Box is safely and properly installed.



⚠ WARNING

Improper installation or wiring misconfiguration of the Power Supply Box could result in electrical shock hazard. You must ensure the safe and proper installation of the Power Supply Box in accordance with the applicable rules and regulations, and by qualified personnel.



Precautions for Safe Use

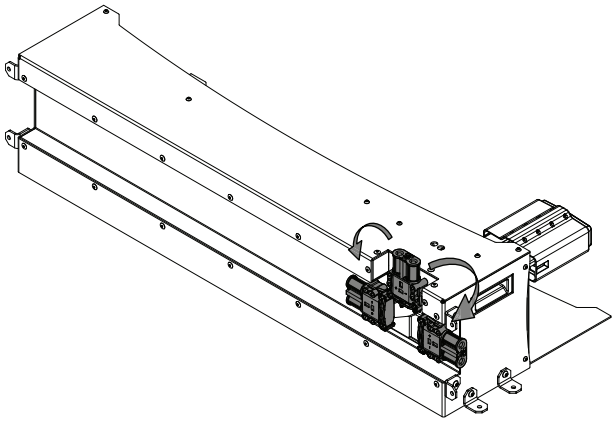
- The Power Supply Box must be installed according to the local regulations or codes, and by authorized personnel or licensed electricians.
- The Power Supply box and the Docking Target must be properly secured to the wall or floor prior to operation.

Precautions for Correct Use

Vertical orientation of the Power Supply Box allows for heat dissipation, which prevents overheating and possible fire danger. Horizontal installation of the Power Supply Box is not allowed.

3-2-1 Repositioning the Docking Target Power Connector

The Docking Target power connector allows for horizontal and vertical connection of the power cord to suit your mounting location requirements.



A 5 mm hex key is required for this procedure.
Use the following procedure to change the orientation of the Docking Target power connector.

1 Remove four M6 screws attaching the power connector cover and the power connector to the Docking Target.

2 Remove the power connector and the cover completely.
A spacer is present between the connector and the Docking Target housing.

3 Position the power connector in the desired orientation.
Ensure that the power connector mounting holes are aligned with the Docking Target mounting holes and the spacer is in place.

4 Once the power connector mounting holes and spacer are aligned with the Docking Target mounting holes, place the power connector cover over the power connector and fasten it to the Docking Target using the M6 screws that were previously removed. Tighten to a torque of 6.8 N·m to complete this procedure.

3-2-2 Mechanical Connections

The Power Supply Box and Docking Target can be fastened to the wall or the floor using the supplied mounting brackets.
When fastening the Docking Target to drywall without a structural framing member available, use heavy-duty toggle (butterfly) bolts. Do not use drywall plugs or anchors.
When fastening the Docking Target, screw the mounting brackets directly to the wall or to the floor and tighten to torque of 9 N·m.
When fastening the Power Supply Box, screw the mounting brackets directly to the wall or the floor and tighten to a torque of 61 N·m.

⚠ WARNING

- At least 2 people are required to lift the Docking Target. Always use safe lifting practices when removing or installing the Docking Target.



Precautions for Correct Use

- The Docking Target will move during the docking attempts and cause docking and charging failures if appropriate fasteners are not used.
- The Power Supply Box has cooling vents at the top and bottom of the unit. Do not block these areas.

The Docking Target's charging paddle is spring-loaded to accommodate slight variations in the floor surface.

The following user supplied hardware is required to fasten the Power Supply Box.

- Six M12 bolts and fender washers are required if fastening the Power Supply Box to the floor.
- Six M10 bolts and washers are required if fastening the Power Supply Box to a wall.

The following hardware is required to fasten the Docking Target.

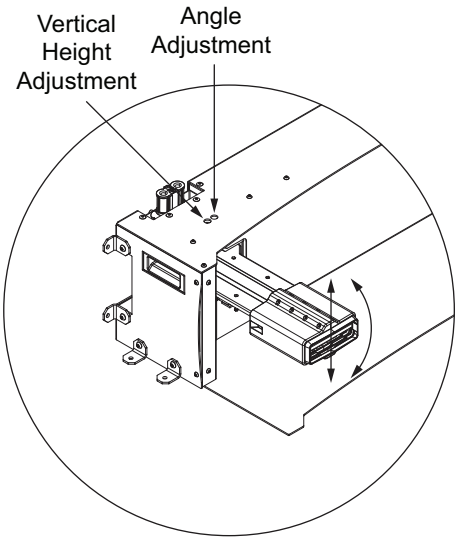
- Four screws and washers.
- Four Docking Target mounting brackets (supplied with the unit).

3-2-3 Charging Paddle Adjustments

The Docking Target charging paddle can be adjusted if alignment issues with the AMR charging contacts occur. The vertical height and angle of the charging paddle can be adjusted with the following screws.

Precautions for Correct Use

- When making adjustments to the charging paddle adjustment screws, always begin by turning in the clockwise direction until the screw stops. Then, turn in the counter-clockwise direction to adjust for correct position, but do not exceed seven turns in the counter-clockwise direction. If the screw is turned beyond seven full rotations, correct charging paddle adjustment may not be possible and OMRON support may be necessary.
- After making adjustments to the charging paddle, carefully observe the AMR as it approaches the Docking Target and be prepared to press an E-STOP button if alignment is not correct.
- Do not over-torque the charging paddle adjustment screws if they reach their limits.



Use a 6 mm hex key to adjust the charging paddle in the following manner.

- Turn the vertical height adjustment screw clockwise to increase the height of the charging paddle and counterclockwise to decrease the height of the charging paddle.
- Turn the angle adjustment screw clockwise to lower the angle and counterclockwise to raise the angle of the charging paddle.

3-2-4 Electrical Connections

The Power Supply Box is permanently connected equipment. The user must supply the power cord from the facility to the electrical access panel on the side of the unit.
The user must punch a hole through the electrical access panel and install a user-supplied strain relief for the power cord. The strain relief attaching to the electrical access panel must be sized appropriately for the user-supplied power cord.

Precautions for Correct Use

The Main Disconnect Switch located on the electrical access panel controls current flow into the Power Supply Box. When the switch is in the horizontal position, it is OFF and when it is in the vertical position, it is ON.

The Power Supply Box input power is protected by 25 A rated circuit breakers.
When connecting the power cord to its mating connector on the Docking Target, ensure that the power cord connector is seated completely and secured. The power cord must be placed behind the Docking Target. It must be properly protected and must not pose any hazards to personnel or interfere with other equipment.

⚠ WARNING

- Charging Station strain reliefs and the power cords must be installed by a licensed or appropriately certified electrician.
- If 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.

⚠ WARNING

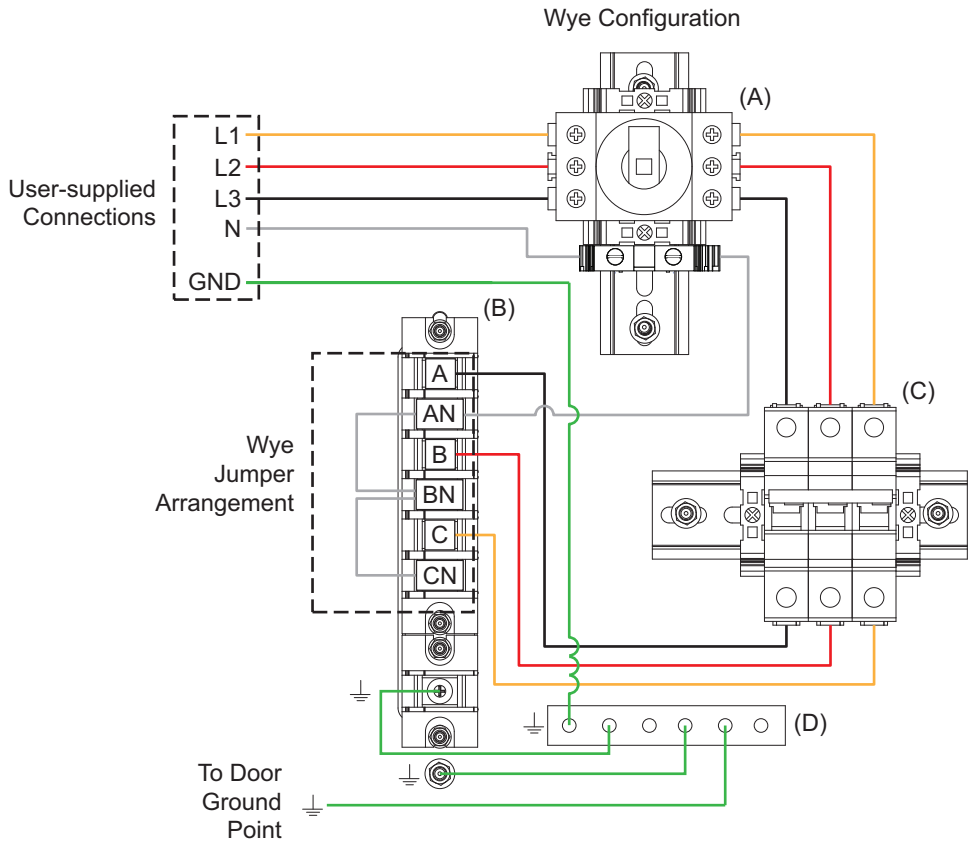
Improper installation or wiring misconfiguration of the Power Supply Box could result in electrical shock hazard. You must ensure the safe and proper installation of the Power Supply box in accordance with the applicable rules and regulations, and by qualified personnel.



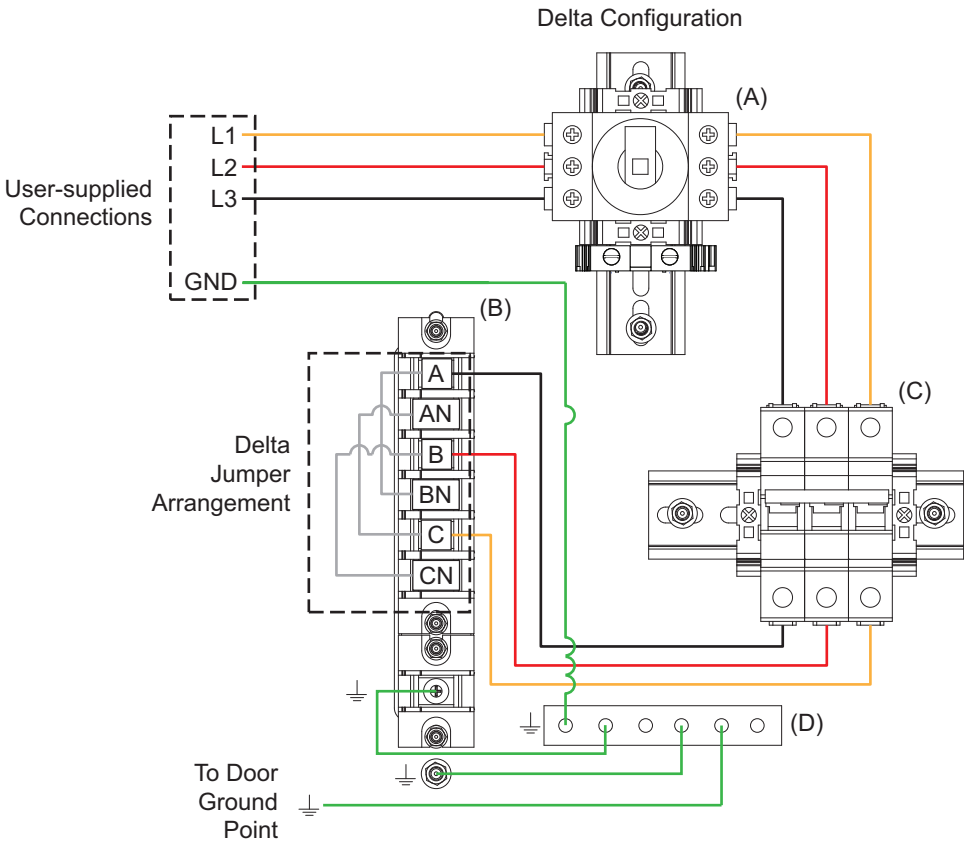
Other important electrical considerations are listed below.

- The minimum wire rating for user-supplied connections inside the electrical access panel and the AC supply are 10 AWG / 600 V.
- Power is provided to several power supplies inside the Power Supply Box as 3 distinct phases derived from a 3-phase input.
- The power supplies can withstand up to 305 VAC (nominal 277 VAC) on any given phase.
- Configuration depends on a 3-phase scheme and voltage.
- Earth ground is separate and always only connects to the ground distribution block.
- White wires (shown in gray in illustration below) are used to configure Delta or WYE input. The white wires might also jump to field neutral via the neutral terminal block. All white jumper wires are provided with Power Supply Box.
- The neutral terminal block can be used to terminate the abandoned neutral wire or aid in neutral jump to the AC input terminal block.
- All field phase wires must connect to the Main Disconnect Switch.
- 4 wire Delta (jumper configuration as Delta) supports 200 to 240 VAC.
- 5 wire WYE (jumper configuration as WYE) supports 380 to 480 VAC line to line.
- 5 wire WYE (jumper configuration as Delta) supports 200 to 277 VAC line to line.

Use the figures below to understand the 3-phase wiring configuration options.



(A) Disconnect Switch
(B) Terminal Strip
(C) Circuit Breakers
(D) Ground Bar



(A) Disconnect Switch
(B) Terminal Strip
(C) Circuit Breakers
(D) Ground Bar

3-2-5 Commissioning Procedure

Use the following procedure to commission the Power Supply Box.

1 Prepare the facility AC supply and its disconnect switch.

2 Make sure that the facility power is in the OFF state.

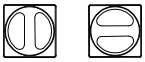
3 Make sure that the Main Disconnect Switch located on the electrical access panel is in the OFF (horizontal) position.

4 Wire the facility power to the electrical access panel as detailed in *3-2-4 Electrical Connections* on page 3-7. You must make sure to adjust the jumpers as required for the voltage range.

5 Once the wiring is complete and the facility power cable is connected to the electrical access panel properly, you can enable the AC facility power.

6 Confirm that the circuit breakers inside the electrical access panel are in ON positions (top / up position).

7 Turn the Power Supply Box Main Disconnect Switch located on the electrical access panel to ON position (vertical). This will allow the facility AC power to energize the Power Supply Box.



8 Confirm that the blue LED on the Power Supply Box turns ON to complete this procedure.

3-3 Battery Removal and Installation

Removal or installation of the battery must be performed by persons who have read and understood this manual.

Before you begin, press an E-STOP button, turn the AMR OFF, and then place the Main Disconnect Switch in the OFF position.

⚠ WARNING

- If removal or replacement of the battery is not handled with care or in accordance with instructions provided in this manual, it can cause serious injury to personnel or damage to itself or other equipment.
- 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) for removing, installing, and lifting the battery or when working around a leaking battery.
- At least 2 people are required to lift the battery. Always use safe lifting practices when removing or installing the 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.



Precautions for Correct Use

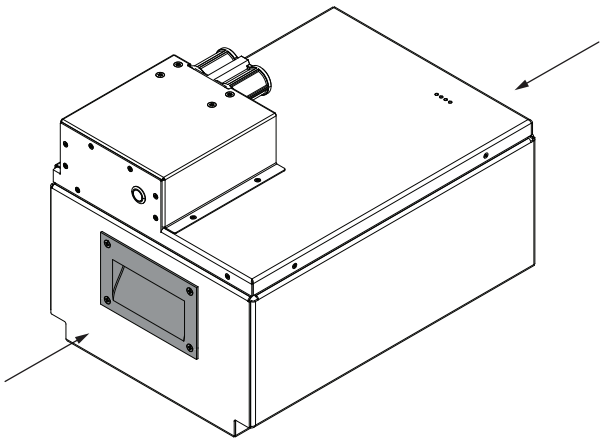
Never remove the battery while the AMR is ON. Always power OFF the AMR and then place the Main Disconnect Switch in the OFF position before removing the battery.



Additional Information

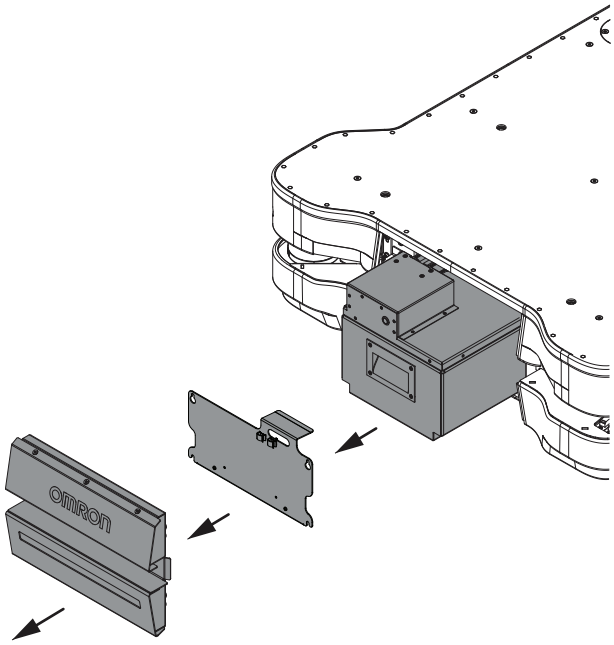
Inspect the empty battery compartment and remove any foreign objects before attempting to install a battery.

Use the following figure to understand the lifting points for the battery.



3-3-1 Battery Removal Procedure

Use the following procedure to remove the battery from the AMR.



The following tools are required for this procedure.

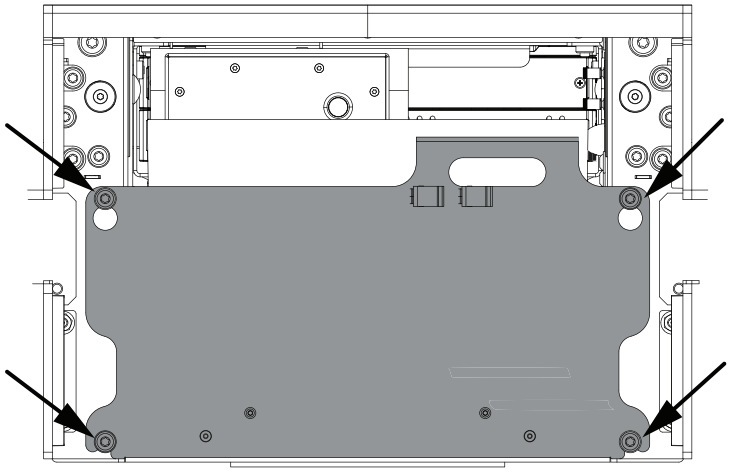
- T30 star bit
- Torque wrench

1 Turn the AMR OFF.

2 Place the Main Disconnect Switch in the OFF position.

3 Remove the Front Skin and then disconnect all cables.
Refer to *6-11-1 Removing and Replacing Skins* on page 6-17 for more information.

4 Use a T30 star bit to loosen the four captive M6 screws.



5 Slide up the battery compartment cover and remove it from the AMR.

6 Use the handle to pull the battery out of the battery compartment. Do not drop the battery while removing it.

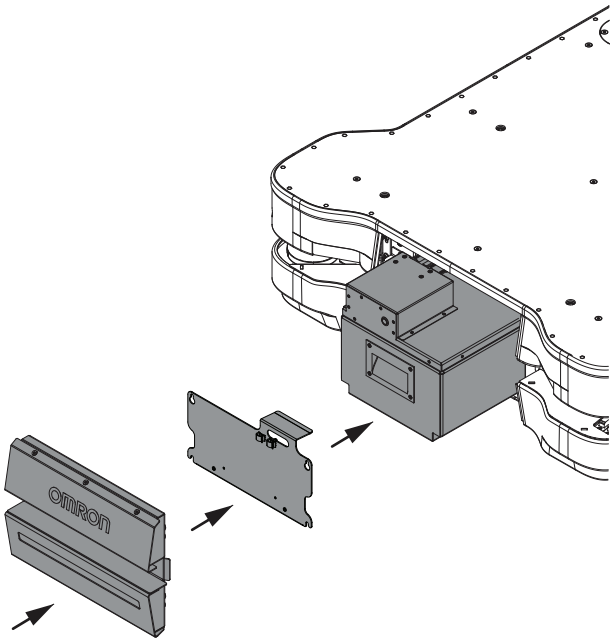
7 Align the battery compartment cover over the screws and slide it down to fit it in place.

8 Tighten the four M6 screws to a torque of 9 N-m.

9 Replace the Front Skin to complete this procedure.

3-3-2 Battery Installation Procedure

Use the following procedure to install a battery into the AMR.



The following tools are required for this procedure.

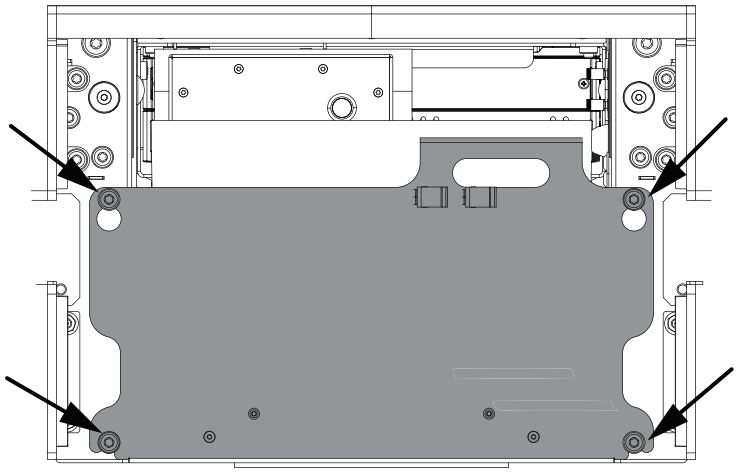
- T30 star bit
- Torque wrench

1 Turn the AMR OFF.

2 Place the Main Disconnect Switch in the OFF position.

3 Remove the Front Skin and then disconnect all cables.
Refer to *6-11-1 Removing and Replacing Skins* on page 6-17 for more information.

4 Use a T30 star bit to loosen the four captive M6 screws.



5 Slide up the battery compartment cover and remove it from the AMR.

6 Align the battery in the battery compartment and then slide it towards the rear of the AMR. Push the battery back until it stops. Alignment tabs keep the battery in position as it mates with the internal power connector.

7 Align the battery compartment cover over the screws and slide it down to fit it in place.

8 Tighten the four M6 screws to a torque of 9 N-m.

9 Replace the Front Skin to complete this 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.

3-4-1 Default Network Settings

The default network settings and functions associated with the Maintenance Ethernet Port are described in this section.
The Maintenance Ethernet Port automatically assigns an IP address to the connected PC.

Precautions for Correct Use

Consult your network systems administrator before using SetNetGo to change any default settings. Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for information about modifying network settings.

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	172.16.0.215
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. Verify the PC network settings by accessing the network adapter properties on your PC for the network that will be used as the AMR connection.

DHCP is used by default. If a static IP is preferred, set the range between 172.16.0.100 to 172.16.0.149.

3 Verify the settings by opening a browser window and accessing https://172.16.0.215. 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 3-16 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.

Additional Information

A workspace with a single AMR can operate without a wireless network.

- Use the SetNetGo tab in the MobilePlanner software.
- Open a Web browser on your PC and enter the URL: https://172.16.0.215 to connect directly to the SetNetGo Web Interface on the AMR.

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(s)			
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			
Security Encryption	Disabled	WEP 64-bit	WEP 128-bit

Item	Details	
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:

3-5 Electrical Connections

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

3-5-1 User Connections Area

The following information describes items in the User Connections Area. These items are typically used when integrating a payload system with the AMR.

Precautions for Correct Use

Do not place additional components in the User Connections area.

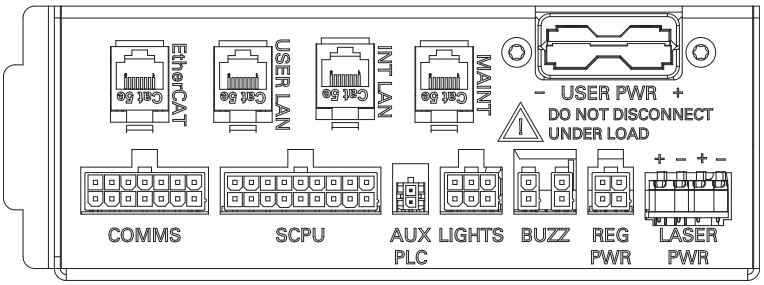
Additional Information

- If covers or other items are removed from the AMR (Top Plate, User Connection cover, Operator Panel, etc.), the IP rating will be compromised. Take measures to ensure all openings are properly covered to maintain the desired IP rating of the system.
- Refer to *Section 2 Specifications* on page 2-1 for more information about connector and electrical specifications.

A cover must be removed to access this area. This requires a 4 mm hex key to remove the six M6 screws.

Connector Panel

The following information describes the items found on the Connector Panel.



- **EtherCAT**

  The EtherCAT connector provides a method to extend the EtherCAT network. It is typically used to expand I/O capacity for the AMR.

- **USER LAN**

  The USER LAN connector in the User Connections area is used to establish a connection to the NX102 controller.
  The default IP address of the NX102 controller is 172.16.0.220.

- **INT LAN**

  The INT LAN connector in the User Connections area provides network connections for optional side lasers or other peripheral accessories.

● MAINT

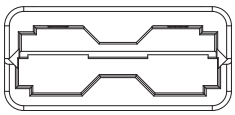
The MAINT Ethernet port is available for configuration and troubleshooting with a PC that is directly connected with a pass-through or cross-over CAT5 (or better) Ethernet cable.
The permanent Maintenance Ethernet Port IP address is 172.16.0.215. Refer to *3-4 Network Connections* on page 3-16 and *4-14 Maintenance Ethernet Port* on page 4-31 for more information.

Additional Information

Design the payload structure for easy access to the MAINT port or extend it to a new location on the payload structure. A Maintenance Port Extension kit (73955-000) is available. Refer to *3-12 Maintenance Port Extension Procedure* on page 3-44 for more information.

● USER PWR

The USER PWR connector in the User Connections area provides unregulated battery power for payload structure devices. Use the information below to understand all USER PWR connections.



● COMMS

The COMMS connector in the User Connections area is reserved for future use.

● SCPU

The SCPU connector in the User Connections area provides connections for user-supplied safety devices. The signals at this connector are directly connected to the onboard safety controller.
All input signal functions become active when the dual-channel circuit is switched open.
Use the information below to understand all SCPU connections.

⚠ WARNING

If you are using a user-supplied E-STOP, you must perform commissioning to verify the emergency stop functionality before putting the AMR into service.

⚠ CAUTION

- All E-STOP buttons must be located in areas that are easy to reach and within 600 mm of personnel. It is the end user's responsibility to ensure that any additional E-STOP buttons are placed in a location where the operator can easily access them in an emergency situation.
- If you are using a user-supplied E-STOP, you must perform commissioning to verify the emergency stop functionality before putting the AMR into service.

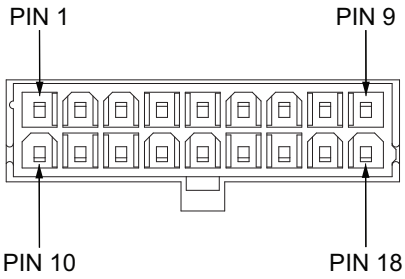
Precautions for Safe Use

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

You must attach either a jumper or some other safety-rated devices (typically E-STOP buttons) to the SCPU connector in order for the AMR to function.

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

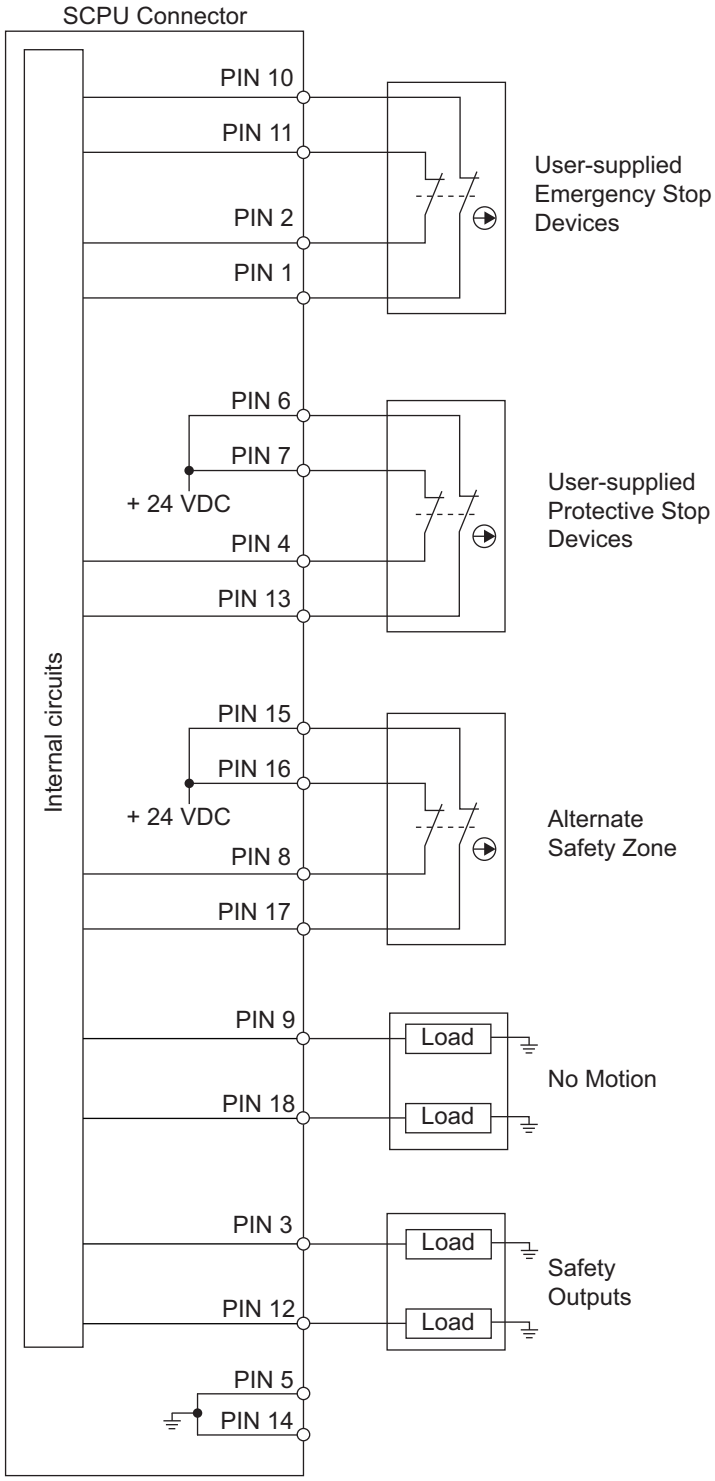


The information in the table below describes the signal designations for the SCPU connector.

Pin Number	Item	Description
1	Emergency stop channel 1 input	Dual-channel emergency stop circuit inputs. Monitored for simultaneous switching within 500 ms. Refer to *4-18 Emergency Stop* on page 4-36 for more information.
2	Emergency stop channel 2 input	
3	Safety output 1	Dual-channel safety output. Refer to *4-18 Emergency Stop* on page 4-36 for more information.
4	Protective stop channel 1 input	Dual-channel protective stop circuit input. Monitored for simultaneous switching within 500 ms. Refer to *4-19 Protective Stops* on page 4-38 for more information.
5	Ground	
6	24 VDC	For use with alternative safety zone / protective stop circuits. Do not connect external loads to 24 VDC terminals.
7		
8	Alternate safety zone input 1	Dual-channel alternate safety zone circuit input. Monitored for simultaneous switching within 500 ms. Refer to *4-25-2 Alternate Safety Laser Scanner Zones* on page 4-73 for more information.
9	No motion output 1	Dual-channel no motion output. Refer to *4-30 No Motion Signals* on page 4-79 for more information.
10	Emergency stop channel 1 output	Dual-channel emergency stop circuit outputs. Refer to *4-18 Emergency Stop* on page 4-36 for more information.
11	Emergency stop channel 2 output	
12	Safety output 2	Dual-channel safety output circuit. Refer to *4-18 Emergency Stop* on page 4-36 for more information.

Pin Number	Item	Description
13	Protective stop channel 2 input	Dual-channel protective stop circuit input. Monitored for simultaneous switching within 500 ms. Refer to *4-19 Protective Stops* on page 4-38 for more information.
14	Ground	
15	24 VDC	For use with alternative safety zone / protective stop circuits. Do not connect external loads to 24 VDC terminals.
16		
17	Alternate safety zone input 2	Dual-channel alternate safety zone circuit input. Monitored for simultaneous switching within 500 ms. Refer to *4-25-2 Alternate Safety Laser Scanner Zones* on page 4-73 for more information.
18	No motion output 2	Dual-channel no motion output. Refer to *4-30 No Motion Signals* on page 4-79 for more information.

The user-supplied emergency stop devices and user-supplied protective stop devices must be normally closed. An open circuit for either of these will trigger a stop. A circuit diagram is provided below.



Additional Information

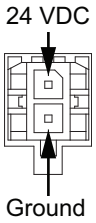
Refer to *2-4-16 Safety Function Performance Levels* on page 2-20 for more information.

● AUX PLC

The AUX PLC connector in the User Connections area provides 24 VDC for user-supplied NX units that may be added to the system.

Use the information below to understand AUX PLC connections.

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

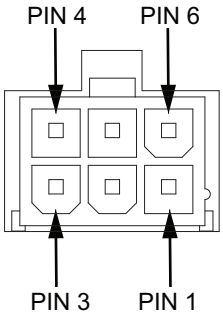


● LIGHTS

The LIGHTS connector in the User Connections area provides outputs for user-supplied signaling devices such as signal beacons or buzzers.

Use the information below to understand all LIGHTS connections.

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 I/O 1 connector.

Pin Number	Description
1	Red light
2	Ground
3	Yellow light
4	Green light
5	Ground
6	Buzzer*1

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

Additional Information

Refer to *4-21 Light Discs and Optional Beacon States* on page 4-41 for more information.

● BUZZ

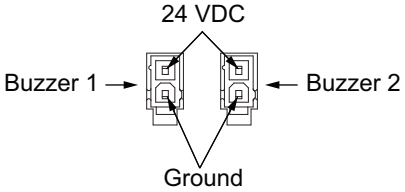
The User Connections area contains a connector used for adding extra buzzers.

Refer to the following sections for more information about the behavior of the BUZZ signals.

- *4-24 Warning Buzzer* on page 4-50
- *1-6-4 Additional Warning Buzzers* on page 1-28.

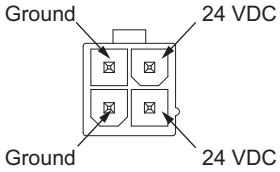
Use the information below to understand all buzzer connections.

The following figure shows the pin arrangements for the BUZZ connectors on the AMR.



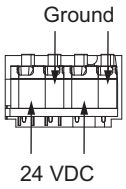
● REG PWR

The REG PWR connector in the User Connections area provides regulated 24 VDC power and is typically used for payload structure control devices. Use the information below to understand all REG PWR connections.



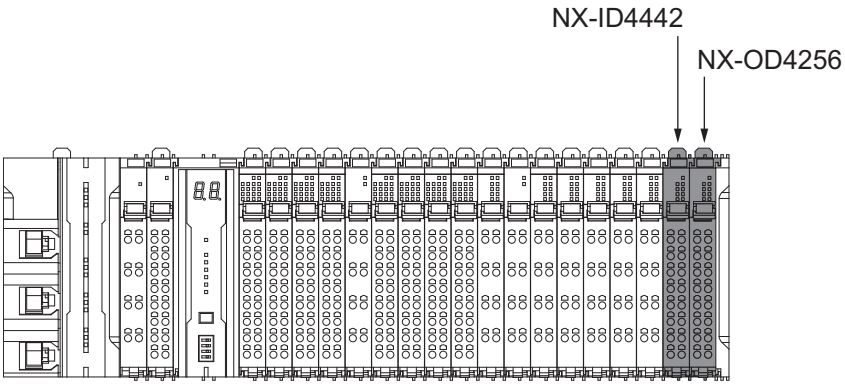
● LASER PWR

The LASER PWR connector in the User Connections area provides 24 VDC for optional Side Lasers. Use the information below to understand all LASER PWR connections.



NX102 Unit

The NX102 unit can be used to add non-safety functionality to the AMR. This is typically used for integrating payload systems with the AMR. The NX102 unit includes a spare digital input unit and digital output unit for control of user-supplied devices.
The USER LAN port in the User Connections area is used to establish a connection with the NX102.



The NX102 unit can also be expanded using an NX-series communication coupler with various NX-series I/O System units. Use the AUX PLC connector on the Connector Panel to provide power to additional NX-series expansion units.

Precautions for Safe Use

The NX102 contains factory-installed programs and configurations that control the safety functions in the AMR. Do not attempt to modify the safety program or configuration.



Additional Information

- Refer to *AUX PLC* on page 3-23 for more information.
- Refer to the *NX-series NX102 CPU Unit Hardware User's Manual (Cat. No. W593)*
- Refer to the *NX-series Digital I/O Unit User's Manual (Cat. No. W521)*

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.

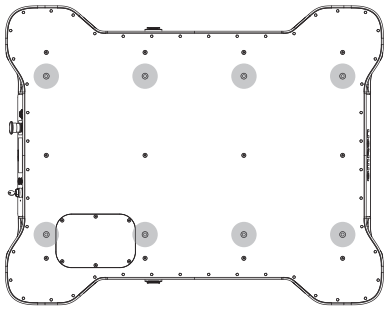
Precautions for Safe Use

You must perform a complete risk assessment for your payload design and the intended use of the AMR prior to its operation.

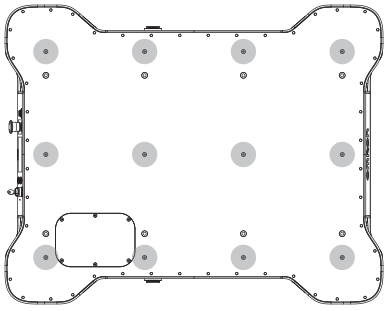
3-6-1 Payload Structure Mounting Points

Several payload structure mounting points are provided on the top of the AMR.

M16 Mounting Points



M6 Mounting Points



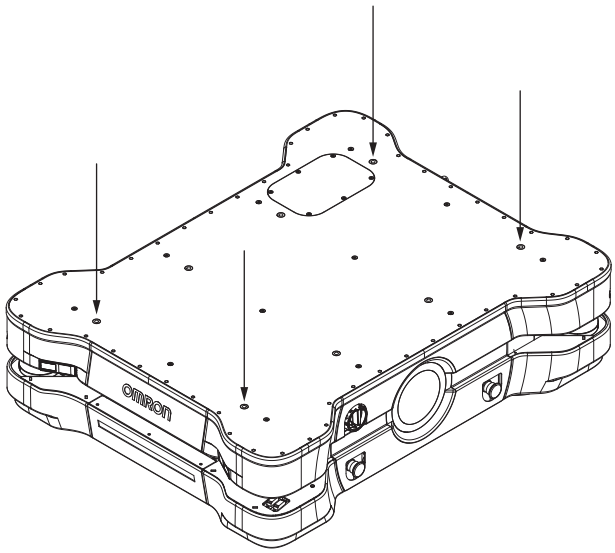
These mounting points allow for positioning of the payload to achieve maximum stability with various payload designs.

Refer to the following sections for more information.

- *2-2-4 Payload Center of Gravity* on page 2-7
- *Payload Structure Mounting Point Dimensions* on page 2-6

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.
- M16 x 2.0 mounting points have a torque limit of 70 N m.
- M16 x 2.0 mounting points have a maximum thread depth of 27 mm with a Top Plate present and 24 mm without a Top Plate present.
- M16 x 2.0 mounting points have a maximum allowable tension force of 10 kN.
- Only the following M16 x 2.0 mounting points can be used simultaneously to lift the AMR. These are rated to lift the AMR without a payload. Refer to *6-5 Lifting the AMR* on page 6-7 for more information.



- M6 x 1.0 mounting points have a torque limit of 12 N m.
- M6 x 1.0 mounting points have a maximum thread depth of 22 mm with a Top Plate present and 19 mm without a Top Plate present.
- M6 x 1.0 mounting points have a maximum allowable tension force of 4 kN.
- The payload structure may need to be removed to lift the AMR if the M16 x 2.0 holes are obscured.
- Design the payload structure in such a way that each cross-member does not support more than 225 kg.

Precautions for Correct Use

- Do not exceed the maximum allowable tension force of 10 kN for M16 x 2.0 mounting points.
- Do not exceed the maximum allowable tension force of 4 kN for M6 x 1.0 mounting points.
- Do not use the M6 x 1.0 mounting points to lift the AMR.
- Insert screws provided in the Top Plate Seal Kit (part number 24861-000) into any unused M16 x 2.0 mounting point holes to maintain IP22 protection.

3-6-2 Overhanging Payloads

Increasing the AMR's physical length or width by adding an overhanging payload requires that you increase the dimension of the AMR's safety zones. Contact your OMRON representative for more information on modifying the safety zones.

Refer to *4-25-2 Alternate Safety Laser Scanner Zones* on page 4-73 for more information.

⚠ WARNING

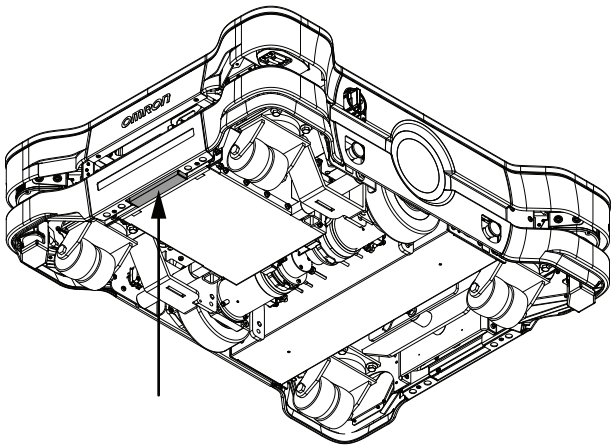
You need to modify the safety zones if your payload overhangs the AMR's default dimensions and if operating on a floor surface that has poor traction to the extent that the AMR cannot stop reliably within the default zones. OMRON is not responsible for any risks incurred by modifying safety zone sizes or other Safety Laser Scanner settings.

3-7 HAPS Installation and Configuration

The following sections provide information about HAPS sensor installation and other configuration details.

3-7-1 Front HAPS Sensor Installation

Use the following procedure to install a HAPS sensor on the front of the AMR.



Make the following considerations before attempting this procedure.

- The front and right skins will need to be removed during this procedure.
- Cable routing is easier when the Top Plate and payload structure are not present. Removing the Top Plate and payload structure is not required.
- The AMR must be turned OFF and the Main Disconnect Switch must be in the OFF position.

The following components are required for this procedure (included with double sensor HAPS kit 73925-020 or single sensor HAPS kit 73925-010).

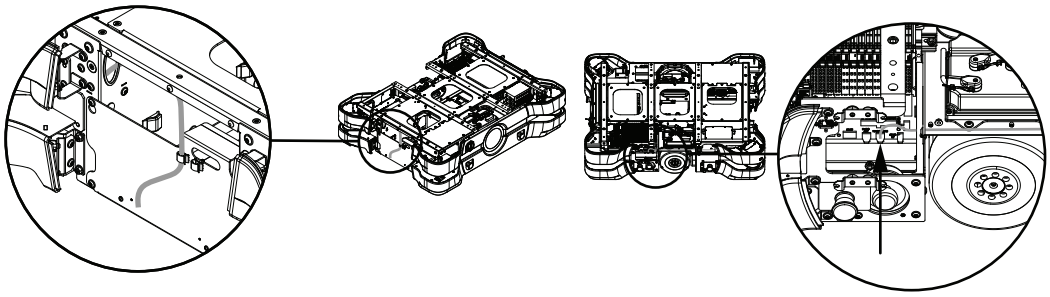
- Front HAPS sensor.
- M12 to Mini FIt Jr. cable (2 m).
- Two M3 x 8 T10 screws.
- Heat shrink tubing.

The following tools and supplies are required for this procedure.

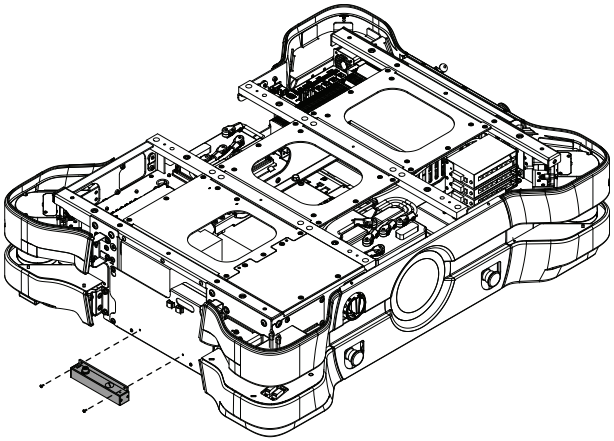
- T10 star bit.
- Torque wrench.

1 Remove the front and right skins.
Refer to *6-11-1 Removing and Replacing Skins* on page 6-17 for more information.

2 Route the cable as shown in the following figure and plug the Mini Fit Jr. connector into the HAPS FORE port.



3 Place the HAPS sensor in the following position and then insert two M3 x 8 screws using a T10 star bit.
Apply a torque of 1 N-m.

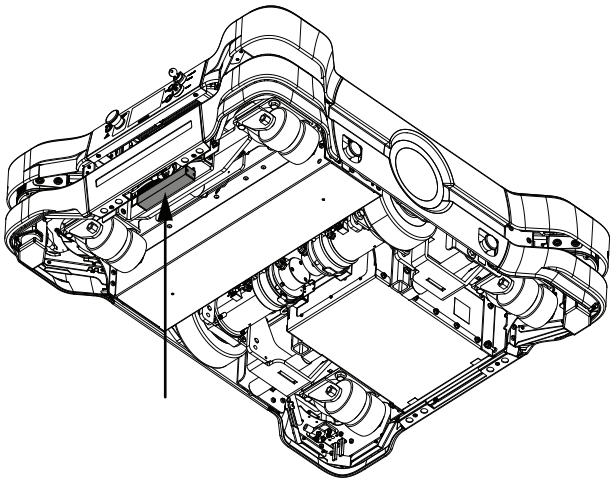


4 Plug the M12 connector on the cable into the HAPS sensor.

5 Replace the front and right skins to complete this procedure.

3-7-2 Rear HAPS Sensor Installation

Use the following procedure to install a HAPS sensor on the rear of the AMR.



Make the following considerations before attempting this procedure.

- The rear and right skins will need to be removed during this procedure.
- Cable routing is easier when the Top Plate and payload structure are not present. Removing the Top Plate and payload structure is not required.

- The AMR must be turned OFF and the disconnect switch must be in the OFF position.

The following components are required for this procedure (included with double sensor HAPS kit 73925-020).

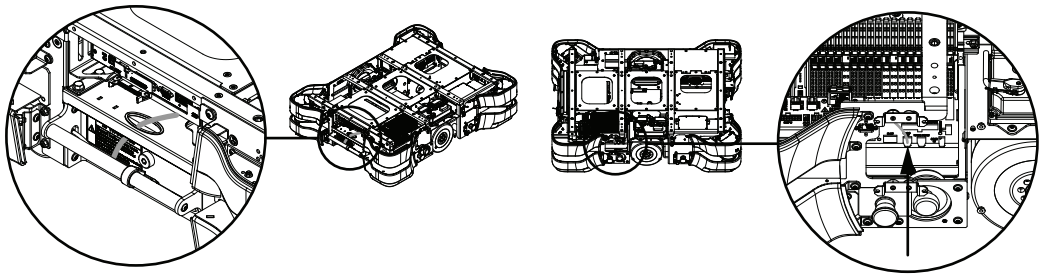
- Rear HAPS sensor.
- M12 to Mini FIt Jr. cable (2 m).
- Two M3 x 8 T10 screws.
- Heat shrink tubing.

The following tools and supplies are required for this procedure.

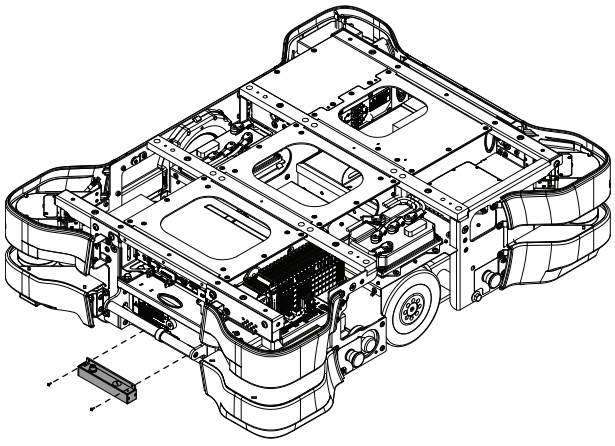
- T10 star bit.
- Torque wrench.

1 Remove the rear and right skins.
Refer to *6-11-1 Removing and Replacing Skins* on page 6-17 for more information.

2 Route the cable as shown in the following figure and plug the Mini Fit Jr. connector into the HAPS FORE port.
Do not route the cable in a position that can interfere with the mechanical brake release lever.



3 Place the HAPS sensor in the following position and then insert the M3 x 8 screws using a T10 star bit.
Apply a torque of 1 N-m.



4 Plug the M12 connector on the cable into the HAPS sensor.

5 Replace the rear and right skins to complete this procedure.

3-7-3 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.

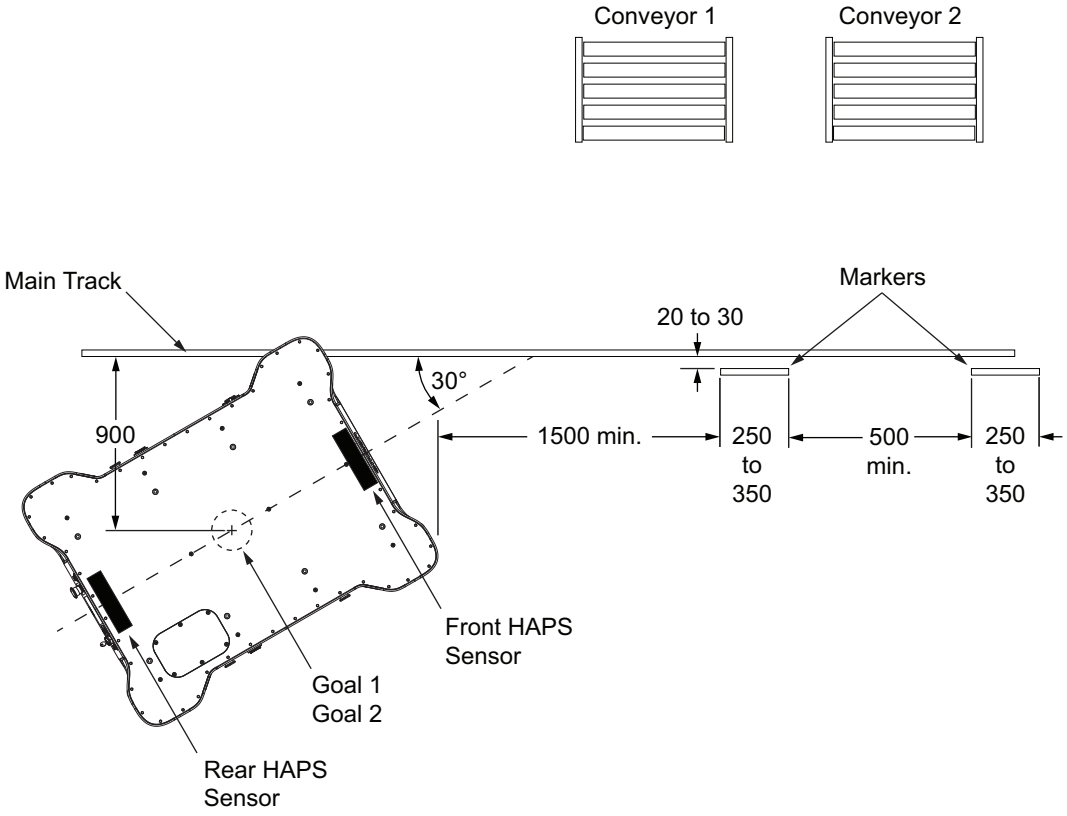
The following considerations apply to the installation of HAPS magnetic tape and markers.

- 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 or overhanging 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 *Overall 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 (Goal 1 and Goal 2 on the illustration above). The AMR needs at least 1500 mm of tape (Main Track) for alignment. A suggested goal location is 900 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. 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.

3-7-4 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 3-33 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.

3-7-5 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 is considered as a goal on the AMR's map. It 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.

3-8 Attaching Warning Labels

Two warning labels are provided with the AMR. These 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 labels should be placed where the operators will see them 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.

3-9 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:

- Self Health system check
- Emergency stop buttons on the sides of the AMR
- Emergency stop button on the Operator Panel
- Emergency stop function on the Pendant
- User-supplied emergency stops
- User-supplied protective stop devices

⚠ WARNING

Although the AMR is commissioned at the factory, the user must perform commissioning as part of the initial setup upon receipt.



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.
- Updating the safety controller program.



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.

3-9-1 Commissioning Procedure

Use the following procedure to execute commissioning.



Additional Information

Ensure that there are no E-STOP buttons depressed before beginning this procedure.

1. Start the MobilePlanner software and connect to the AMR.
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.

3-10 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.

⚠ WARNING

Objects in the environment protruding out, above, or below the AMR lasers' scanning planes shall be configured as restricted zones during workspace map creation. This will minimize possible collision risk during operation.



Precautions for Correct Use

For optimal performance of an MD-series AMR in a fleet, use a map created by an MD-series AMR for the area in which it operates.

The AMR's front Safety Laser Scanner scans the workspace to create the map. The front laser scans only a narrow horizontal plane, parallel to the floor. The scanning plane height is 175 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 plain may not be recorded, such as low lying objects like a column base or a pallet that contains no cargo.

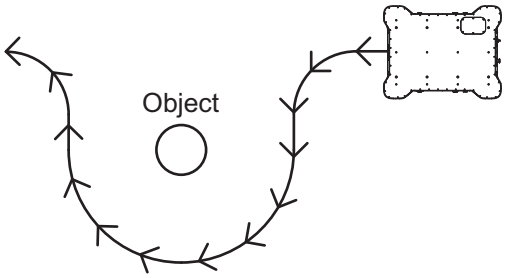
Moving objects such as fork-lift trucks and carts, or transient objects such as pallets loaded with finished goods do not provide useful mapping data. Erase such objects from the map after you create it.

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 Safety Laser Scanner's scanning plane, which are at a height of 175 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 *4-23-1 Driving with the Pendant* on page 4-49 for more information.

To ensure the map is accurate, drive the AMR under the following conditions.

- Drive in a way that the laser in the front, right corner of the AMR is exposed to objects while considering that it has a limited field of view. Keep objects to the right of the AMR as much as possible as you approach and drive around them. This ensures that the front laser detects the object completely and objects are mapped accurately.



- 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.

3-10-1 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 Charging Station before you create a map file. The Docking Target's trapezoidal front will be helpful in locating it on the map.
- Drive the AMR with the pendant to make a floor plan scan. It is recommended that you drive the AMR near the Docking Target so the Docking Target can be placed in the correct location of 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.

3-11 Side Laser Installation

The following sections describe the mounting, wiring, and configuration of the Side Lasers.

1 Make location considerations and mount the Side lasers.
Refer to *3-11-1 Mounting Considerations* on page 3-40 for more information.

2 Complete Side Laser wiring procedure.
Refer to *3-11-2 Side Laser Wiring Procedure* on page 3-40 for more information.

3 Configure the Side Laser.
Refer to *3-11-3 Side Laser Configuration* on page 3-43 for more information.

3-11-1 Mounting Considerations

Make the following considerations before mounting the Side Lasers to the payload structure.

- When mounting Side Lasers on the payload structure, you must determine an appropriate mounting location and method. The Side Lasers must be mounted in an orientation so that their scanning planes are vertical and parallel to the AMR X-axis. They must be in the same orientation that is used on the default AMR mounting location (rotation and X,Y-axis orientation).
- The Side Lasers must be mounted far enough away from physical objects on the AMR system so that the scanning plane is not impeded by part of the AMR or the structure itself.
- Select a location on the payload structure and mount the Side Laser using two user provided M5 screws. Refer to *Side Laser Dimensions* on page 2-5 for more information.
- Since Side Lasers may protrude from the payload structure, consider adding protective covers (included in Side Laser Kit part number 73945-01).
- Choose cable extension routes that avoids sharp bends, pinch points, and chaffing to prevent damage to the sheath. Securely fasten all cables to prevent entanglement.
- When installing Side Lasers on the payload structure, you will need to set the configuration parameters in MobilePlanner and update the X, Y, and Z positions of the Side Lasers. Refer to *3-11-3 Side Laser Configuration* on page 3-43 for more information.

3-11-2 Side Laser Wiring Procedure

Use the following procedure to install the Side Laser wiring after mounting the Side Lasers.
This procedure details the wiring procedure of one of the Side Lasers and should be repeated for the other Side Laser.
A Side Laser Kit is required for this procedure. The kit contains the following items:

- Two supplementary laser assemblies
- Two open ended M12 A coded power cables, 2 m
- Two M12 D coded RJ45 network cables, 2 m
- Four Ferrules

The following items are required for this procedure:

- Wire stripper
- Ferrule crimper

1 Turn the AMR OFF.

2 Place the Main Disconnect Switch in the OFF position.

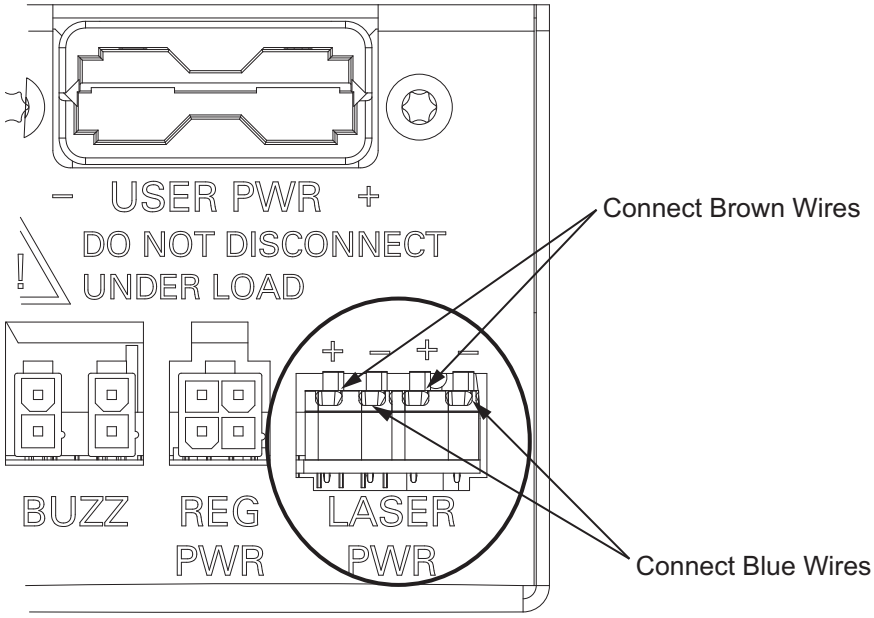
3 Remove the User Connections area cover, the Right and the Left Skins. Refer to *6-11-1 Removing and Replacing Skins* on page 6-17 for more information.

4 Prepare the M12 A coded power cable by trimming excess length and then stripping insulation to prepare it for ferrule attachment.

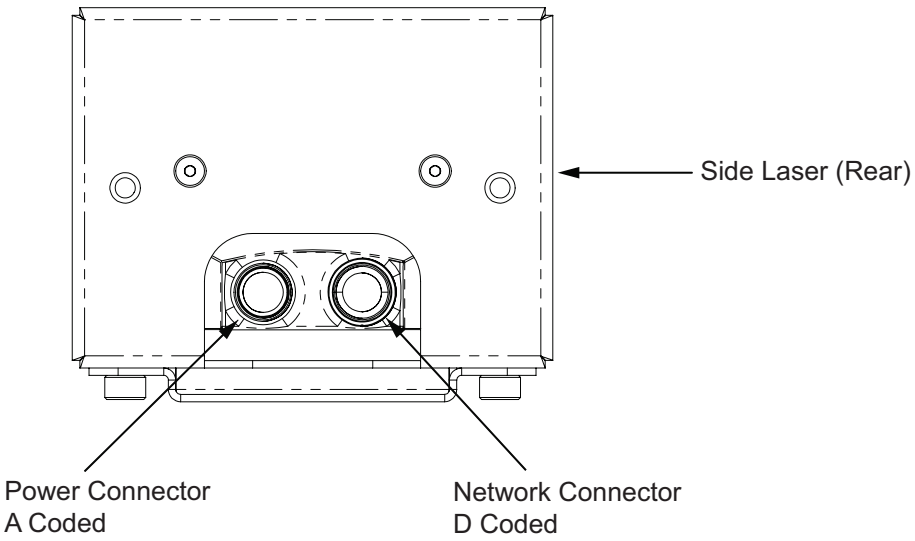
5 Insert the brown wire into the ferrule and crimp the ferrule using the crimper. Repeat for the blue wire.

6 Connect the negative blue wire connector to the negative terminal in the Laser PWR connector on the Connector Panel.

7 Connect the positive brown wire connector to the positive terminal in the Laser PWR connector on the Connector Panel.

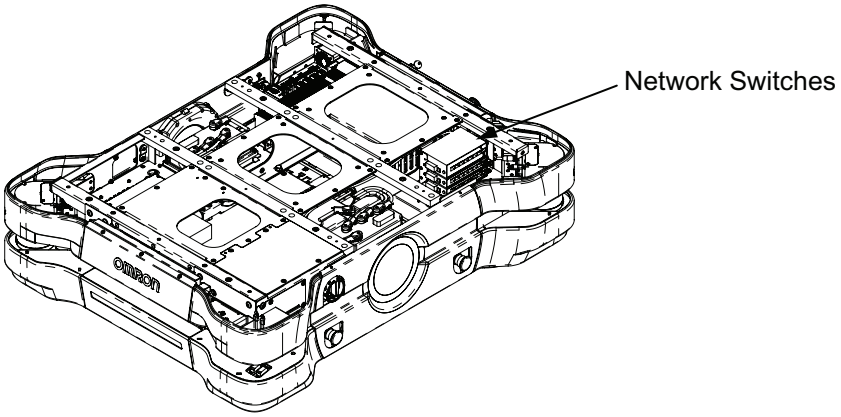


8 Connect the other end of the A coded M12 power cable to the A coded M12 power connector on the rear of the Side Laser.

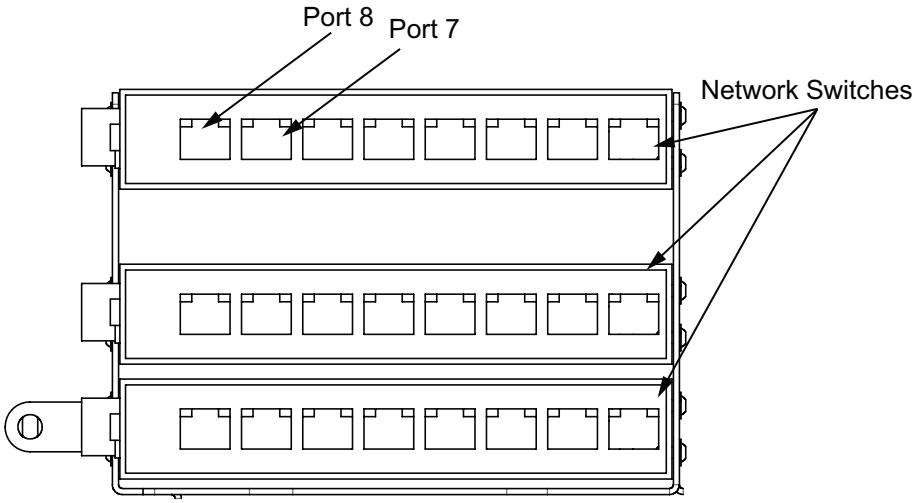


9 Connect the M12 D coded network cable to D coded M12 network connector on the rear of the Side Laser.

10 Route the M12 D coded network cable to the Network Switch on the rear left of the AMR. Avoid chafing, straining, or binding the cable.



11 Connect the M12 D coded network cable to port 7 or 8 of the top Network Switch.



12 Repeat steps 4 through 11 for the other Side Laser.

13 Replace the User Connections area cover.

14 Fasten the Right and Left Skins to the AMR to complete this procedure.

3-11-3 Side Laser Configuration

Configuring the Side Lasers is generally performed by importing the factory-supplied configuration into the AMR's current configuration or by adjusting parameters using MobilePlanner. Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.
Use the information below to manually configure a Side Laser.
You must enable *Scanner_5* and *Scanner_6* using MobilePlanner.
Scanner_5 parameters are associated with the front, right Side Laser and *Scanner_6* parameters are associated with the rear, left Side Laser.
All of the parameters to adjust are in the *Sensors* section under *2DLidar*. Parameter details are provided below.

- *Enabled*
  This should be enabled and indicates to the system that the laser exists and it should be connected at start-up.
- *X*, *Y*, and *Z*
  These values indicate the physical coordinate location of the laser on the AMR. These distances are measured to the sensing plane of each laser, which is about 20 mm from the top of the sensor housing. These parameters are located in the *SensorPosition* area.
  X is the x-axis (front-to-rear) distance in mm of the laser center to the AMR's center of rotation.
  Y is the y-axis (side-to-side) distance in mm of the laser center to the AMR's center of rotation.
  Z is the z-axis (vertical) distance in mm of the laser center to the floor.
- *RotationX*, *RotationY*, and *RotationZ*
  These values indicate the physical rotational location of the laser on the AMR. These parameters are located in the *SensorPosition* area.
- *IgnoreInsideOf*
  This indicates the method by which unused internal segments of the Side Laser scanning field can be ignored. The possible options are None, Internal, Polygon and Range. Contact your local OMRON representative for more information.
- *IgnoreOutsideOf*
  This indicates the method by which unused external segments of the Side Laser scanning field can be ignored. The possible options are None, Polygon and Range. Contact your local OMRON representative for more information.
- *HeightIgnoreMode*
  This indicates the method by which the range of Z values below *IgnoreBelowHeight* and a range of Z values above *IgnoreAboveHeight* can be ignored. The possible options are None, Normal and Custom. Contact your local OMRON representative for more information.

3-12 Maintenance Port Extension Procedure

Use the following procedure to extend access to the Maintenance Port.
A Maintenance Port Extension kit (73955-000) is required for this procedure. The kit contains the following items:

- Ethernet Passthrough connector
- Ethernet patch cable, 1 ft
- Two M3 screws and nuts

The following tools are required for this procedure:

- T10 star bit
- 5.5 mm wrench

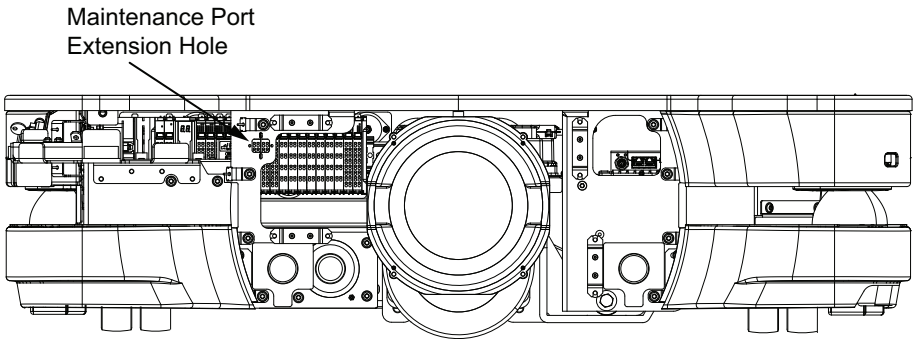
1 Turn the AMR OFF.

2 Place the Main Disconnect Switch in the OFF position.

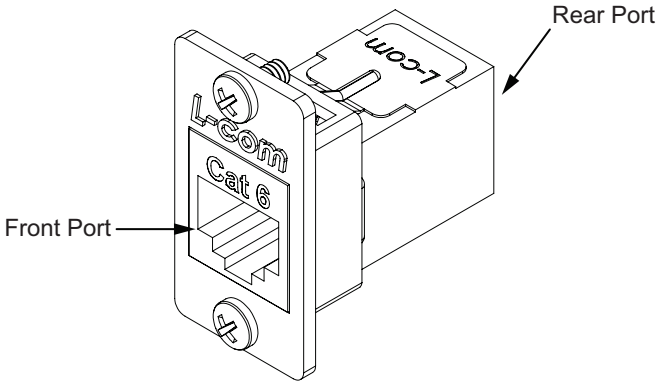
3 Remove the User Connections area cover to access the Connector Panel.

4 Remove the Right Skin. Refer to *6-11-1 Removing and Replacing Skins* on page 6-17 for more information.

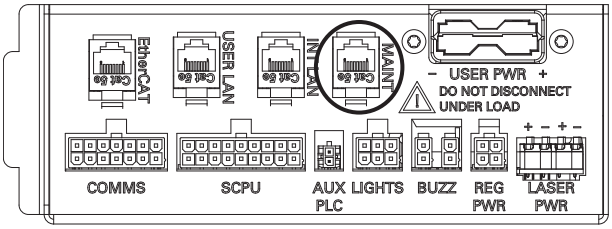
5 Locate the Maintenance Port extension hole on the AMR.



6 Install the Ethernet passthrough connector on the Maintenance Port extension hole using the provided screws and nuts.



7 Connect one end of the Ethernet patch cable to the Maintenance Port on the Connector Panel.



8 Connect the other end of the Ethernet patch cable to the rear port of the passthrough connector.

9 Replace the User Connections area cover.

10 Replace the Right Skin to complete this procedure.

3-13 Wireless Antenna Relocation Procedure

Use the following procedure to relocate the wireless antennas.
A Wireless Antenna Extension Kit (part number 68955-000) is required for this procedure. The kit includes the following items:

- Two Dipole antennas with RP-SMA connectors
- Two 2 m coaxial cables
- Two 0.6 m coaxial cables

This procedure details the relocation of one of the antennas and should be repeated if both antennas need to be relocated.
The following items are required for this procedure:

- Zip tie
- 8 mm wrench

Additional Information

- It is not necessary to uninstall the factory-installed antennas that come with your AMR. You can disconnect their coaxial cables from the AMR Controller.
- The maximum thickness of the antenna mounting surface should not exceed 3 mm.
- Ensure the hole to mount the new antenna is 6.5 mm in diameter.

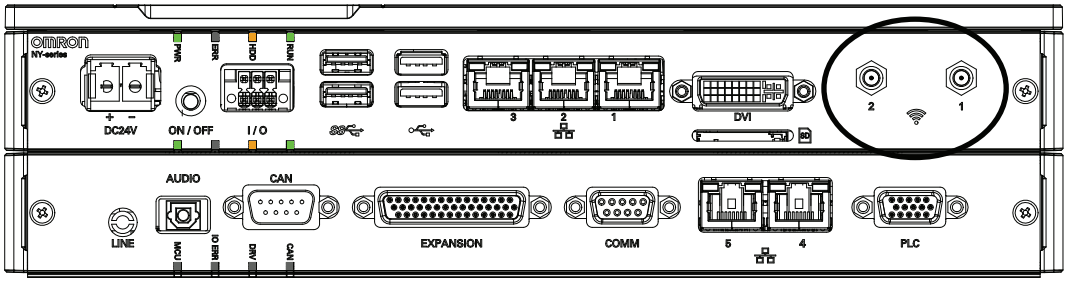
1 Turn the AMR OFF.

2 Place the Main Disconnect Switch in the OFF position.

3 Remove the Rear and Right Skins. Refer to *6-11-1 Removing and Replacing Skins* on page 6-17.

4 Remove the User Connections area cover.

5 Disconnect the coaxial cable of the factory-installed antenna from the antenna connector on the AMR Controller.



6 Tie-up the loose coaxial cable(s) with a zip tie.

7 Insert the threaded connector on one end of the coaxial cable into the mounting hole and tighten the nut with the wrench.

8 Screw the antenna into the thread and tighten with your fingers.

9 Route the other end of the coaxial cable through the User Connections Area and under the AMR Controller. Avoid chafing, straining, or binding the cable.

10 Connect the coaxial cable to the antenna connector on the AMR Controller.

11 Replace the User Connections area cover.

12 Replace the Rear and Right Skins to complete this procedure.

3-14 Operator Panel Relocation

Use the information in the following sections to relocate the Operator Panel.

3-14-1 Relocation Considerations

Make the following considerations when preparing to relocate the Operator Panel.

- The Operator Panel includes an E-STOP button.
- To mount the Operator Panel at a user specified location, you can use the five M5 screws included in the Operator Panel Relocation Kit (part number 73953-000) or alternatively, you can fabricate the mounting hardware to suit your mounting surface. Refer to *Operator Panel Dimensions* on page 2-4 for more information.
- The total extendable length of the ribbon cable is 600 mm. Consider this length when determining a suitable alternative location for the Operator Panel.
- Do not route the cables in a way that creates chafing, straining, binding. Avoid placing them near sources of high energy.
- The Rear Skin must be removed to access the Operator Panel fasteners.

Precautions for Safe Use

Any E-STOP buttons installed on the payload structure must be within 600 mm of reach. They must not be installed in a location that affects operator's safety in order to reach them in an emergency situation.

Additional Information

If covers or other items are removed from the AMR (Top Plate, User Connection cover, Operator Panel, etc.), the IP rating will be compromised. Take measures to ensure all openings are properly covered to maintain the desired IP rating of the system.

3-14-2 Operator Panel Relocation Procedure

Use the following procedure to relocate the Operator Panel. Refer to *3-14-1 Relocation Considerations* on page 3-48 before beginning the procedure.

The Operator Panel Relocation Kit (part number 73953-000) includes the following items:

- Blanking plate
- Passthrough connector
- Ethernet patch cable Cat 5e, 1 m
- Five M5 screws
- Two M3 screws and nuts
- Edge guard strip

The following tools are required for this procedure:

- T25 star bit
- T10 star bit
- 5.5 mm wrench

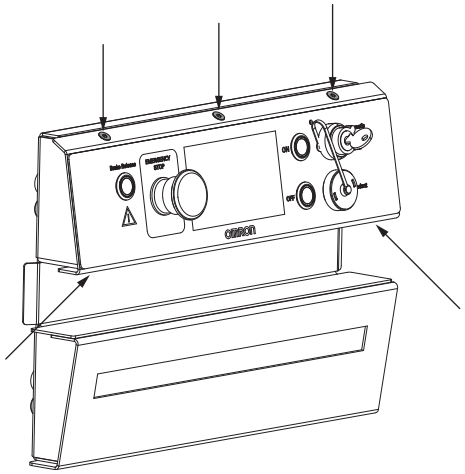
1 Turn the AMR OFF.

2 Place the Main Disconnect Switch in the OFF position.

3 Remove the Rear Skin.
Refer to *6-11-1 Removing and Replacing Skins* on page 6-17 for more information.

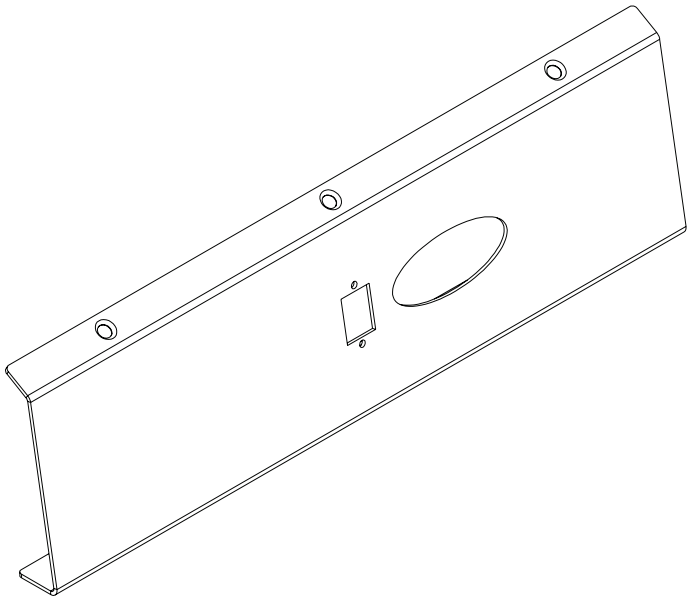
4 Disconnect the ribbon cable and the Ethernet cable from the rear of the Operator Panel.

5 Remove the five M5 screws using the T25 star bit from the following locations on the Rear Skin.

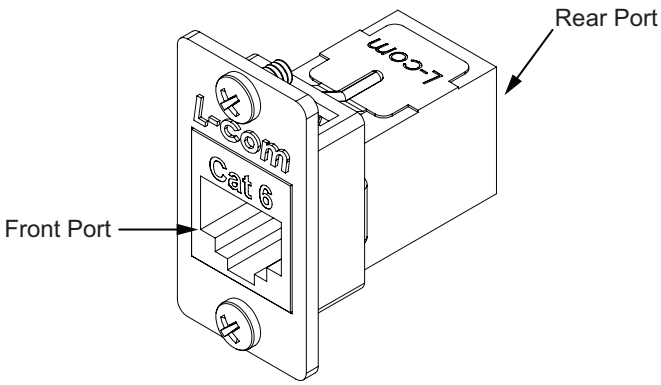


6 Remove the Operator Panel from the Rear Skin and set it aside.

7 Attach the edge guard strip around the oval hole on the blanking plate to prevent cable chaffing.



8 Install the Passthrough connector on the rectangular hole on the blanking plate using the M3 screws and nuts.



9 Reconnect the Ethernet cable on the AMR to the rear port of the Passthrough connector.

10 Route the ribbon cable on the AMR through the oval hole on the blanking plate and pull out the ribbon cable.

11 Fasten the blanking plate in the location where the Operator Panel was mounted using the five M5 screws.

12 Connect one end of the Ethernet patch cable to the front port of the Passthrough connector.

13 Mount the Operator Panel on the user-specified location.

14 Route the ribbon cable and Ethernet patch cable to the new location of the Operator Panel. Route cables in a path that avoids chaffing, pinching, flexing, straining, or damage. Avoid routing cables near high current conductors or other devices that can induce transient signals.

15 Connect the ribbon cable and the other end of the Ethernet patch cable to the rear of the Operator Panel.

16 Fasten the Rear Skin to the AMR to complete this procedure.

4

Operation

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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.

⚠ WARNING

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.



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.

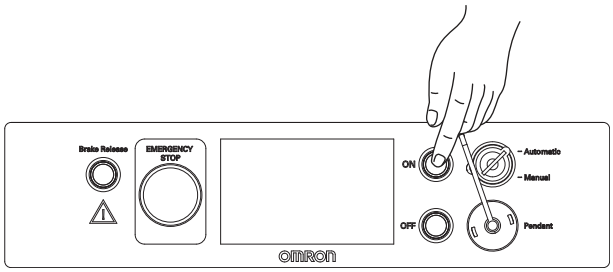
During movement and transfer, you must actively monitor and confirm the transfer operation to make sure that it completes successfully. If any operation fails, a fail-safe interlock must trigger an AMR emergency stop condition. This emergency stop condition prevents the AMR from moving until the problem 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 following conditions are present before attempting to start-up the AMR.

- The battery is sufficiently charged.
- The battery pushbutton is in the retracted (depressed) position.
- The Main Disconnect Switch is in the ON position.

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 Controller, navigation lasers, and auxiliary power systems automatically start when you press the ON button.



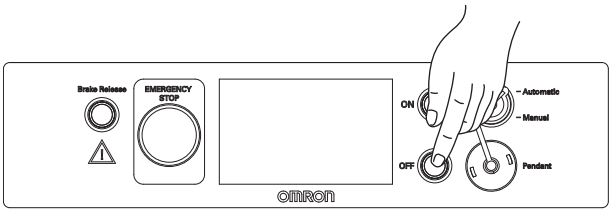
During normal start-up, the AMR powers all of its systems, including all factory and user configurations. It then automatically runs its on-board software and customer integrated processes to provide an application-ready AMR. If a map has been created and stored, and the AMR is localized, you need to 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.

⚠ WARNING

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

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.



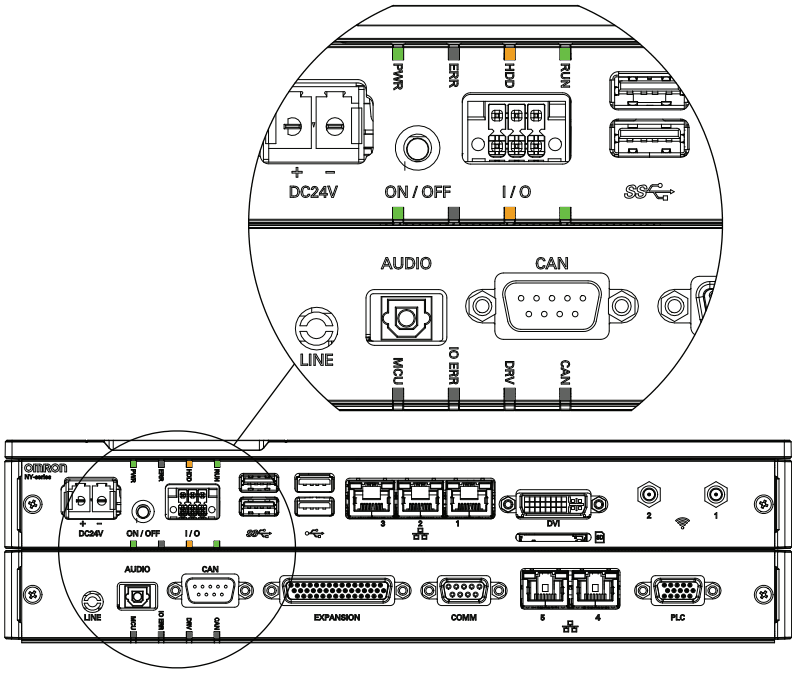
An LED ring around the button flashes red during the shut-down procedure.
When the AMR is shut down using the OFF button, it enters a standby state. In this state, some systems remain active and consume low power. For prolonged periods of AMR shut-down, use the OFF button and then turn OFF the Main Disconnect Switch to prevent battery drain.

Precautions for Correct Use

- The Main Disconnect Switch should not be used as a frequent means of turning OFF the AMR. Use the OFF button to turn OFF the AMR with a controlled shut-down method.
- 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.

4-4 AMR Controller LED Indicators

The AMR Controller has 12 indicator LEDs that give a visual overview about its status. The following figure displays the AMR Controller LED indicator lights.
Refer to the *AMR Controller User's Guide (Cat. No. I650)* for more information.



4-5 Workspace

The workspace must be flat, free of clutter and debris, and have adequately wide doorways and corridors to allow navigation by an AMR.
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).

Obstacle detection tests were conducted for the AMR using the following human analog test pieces:

- A horizontally placed cylinder with a diameter of 200 mm and a length of 600 mm.
- A vertically placed cylinder with a diameter of 70 mm and a length of 400 mm.

Surface reflectance of the cylinders was between 2 and 6 % and optical density was 1.22 (black).
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 2-13.
- 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.
- Steps should have smooth, rounded profiles.

⚠ DANGER

The AMR can cause serious injury to personnel or damage to itself or other equipment if it drives off of a ledge, such as a loading dock, or down stairs.



⚠ 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.
- Abrupt appearance of objects or persons in the path of the AMR could result in personal injury or property damage. You must make sure that the operating environment of the AMR is adequately controlled.
- Do not walk or run in the travel path of the AMR or directly toward the AMR.
- Do not approach the AMR from the side or the direction opposing travel.
- Do not expose the AMR to rain or moisture.



⚠ WARNING

- An AMR can be unsafe if operated under environmental conditions other than those specified in this manual.
- Dust, dirt, grease, and water (or other liquids) can affect wheel traction, as well as operation of the drive wheels. If the drive wheels slip, it can potentially affect operating duration, stopping distance, and navigation accuracy.
- Do not expose the AMR to an ingress above IP22 or a high-humidity environment.





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.
- Do not operate the AMR in areas where environmental conditions are beyond what is specified in this document.



Precautions for Correct Use

- Do not operate the AMR on soft surfaces such as carpet.
- 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 drivetrain components.

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.
- Clean the floor at goal locations such as Docking Targets or pick up and dropoff points. Accumulated dust, debris, or grease can affect AMR traction, which reduces positioning accuracy and repeatability, potentially wasting battery power.
- 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.

⚠ CAUTION

Although the AMR's software provides the option of using the map features to keep the AMR within its designated workspace, poor or improper localization may result in incorrect path planning. To ensure safety, you must always install physical barriers where there is a risk of property damage or personal hazard.

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.

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.

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.

4-5-4 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.

⚠ WARNING

If the AMR operates in restricted zones, these areas must be properly marked or restricted according to applicable standards.



Precautions for Correct Use

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.

4-5-5 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 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.

4-5-6 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 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 Ramps

The AMR can operate on ramps, but special considerations and precautions must be taken. Use the following information to understand limitations and other preventative measures that must be followed when the AMR operates on ramps.

⚠ 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.
- Use caution when stopping the AMR on a ramp. The use of the brake release will cause direct rolling of AMR down the ramp. Powering OFF the AMR on a ramp should be avoided if possible to minimize the use of brake release on a ramp.



Additional Information

Contact your local OMRON representative for advanced ramp traversal optimization techniques.

General considerations:

- The maximum slope that the AMR can travel on is 5 degrees / 8.75%.
- Do not exceed the default acceleration and deceleration settings of 500 mm/s^2. Exceeding these values can cause motor overcurrent conditions if the AMR stops or starts on a ramp.
- Do not exceed 1000 mm/s linear speed while operating on a ramp.
- The AMR must be traveling less than 500 mm/s as it approaches a ramp.
- The AMR must be aligned with centerline of a ramp during its approach and before it reaches the ramp.
- Observe the step traversal limits when the AMR transitions from a level surface to a ramp. Refer to *2-3-1 AMR Environmental Specifications* on page 2-13 for more information.
- The floor's coefficient of friction on a ramp must be a minimum of 0.8 at all times to avoid traction problems.
- The allowable location of the payload center of gravity is constrained if the AMR operates on a ramp. Refer to *2-2-4 Payload Center of Gravity* on page 2-7 for more information.
- Maximize AMR localization while operating on a ramp by installing physical and logical barriers.
- A ramp that is used by an AMR is considered a Hazard Zone and should be indicated in the facility accordingly.
- Ramps must have a minimum length of 1200 mm to prevent AMR immobilization.
- Ramps must be at least 1800 mm wide.

Operational Considerations:

- Avoid prolonged operation on ramps. Limit the AMR's operation on ramps to under 5 minutes.
- Avoid powering OFF the AMR on a ramp.
- Avoid stopping or turning on a ramp.
- The AMR will automatically apply mechanical brakes when it stops on a ramp.
- The ramp entrance and exit areas, as well as the ramp area itself, must be free of obstacles when the AMR operating in these areas.

- An IgnoreSensorSector may need to be created near an incline to avoid errant obstacle detection as the AMR approaches a transition between the ramp and the ground.
- Prevent the AMR from path planning while operating on a ramp by using Move:Path in AGV mode or the gotostraight task.

4-7 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 usually 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.

⚠ WARNING

If the AMR is in an operational hazard or restricted zone, these areas must be properly marked or restricted according to applicable standards.



Precautions for Safe Use

- You must have floor markings to prevent people from entering the operating hazard zone for pickup / dropoff locations with inadequate clearance.
- It is the end user's responsibility to provide the necessary training to personnel to properly mark the floors around the payload transfer locations.



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.

4-7-1 Rotational Clearances

The AMR travels in forward and backward directions and can rotate on its center of rotation (turns in place). Obstacles can trigger a safety system event when the AMR rotates. When turning in place, rotational clearances must be considered.



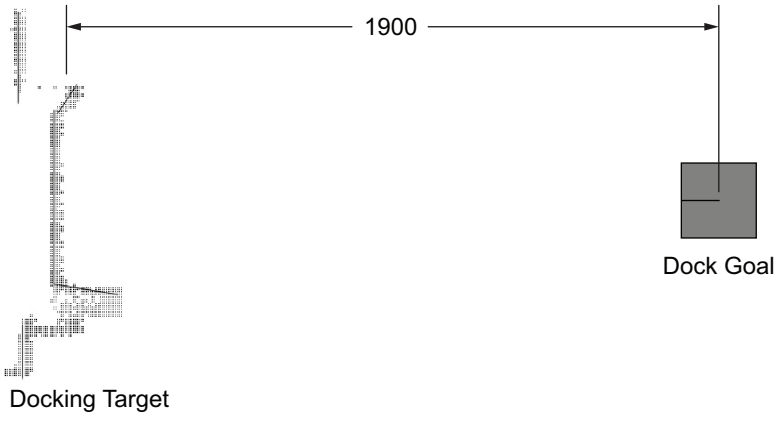
Additional Information

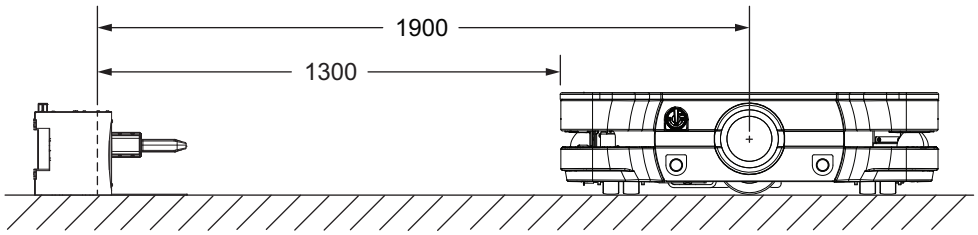
The AMR's Light Discs as well as its front and back light strips display a distinct turn signal pattern when it rotates. Refer to *4-21 Light Discs and Optional Beacon States* on page 4-41 and *4-22 Light Strips and Optional Beacon States* on page 4-44 for more information.

4-7-2 Docking Clearances

Set a 1900 mm distance between the Docking Target 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 Target during the docking operation. This distance is measured from the Docking Target to the center of the AMR.

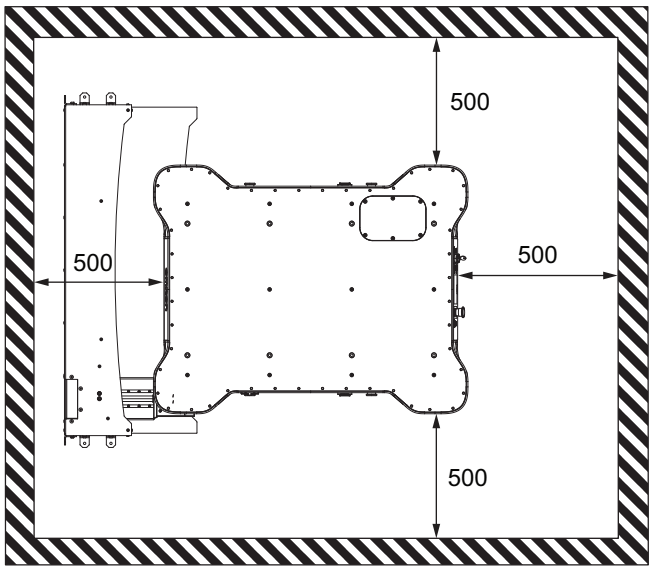




When docked, the distance between the AMR and the Docking Target is less than 500 mm. Refer to *Operate inside a designated MutePersonnelDetectionSector Area* on page 4-71 for more information. Operating areas where the clearance between the AMR and its surroundings is 500 mm or less are considered hazard 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.

⚠ WARNING

If the AMR is in an operational hazard or restricted zone, these areas must be properly marked or restricted according to applicable standards.



4-8 Narrow Passageway Behavior (Linear)

The AMR can operate at its maximum speed through a 1600 mm wide passageway, but speed is limited due to compliance to ISO-3691-4 requirements. It will travel at a slower speed when traversing through a passageway less than 1600 mm wide.
The practical minimum width for a passageway is 1400 mm. The most narrow passageway it can traverse is 1250 mm wide. In order for the AMR to pass through these narrow spaces, you may need to use specific map features or change the AMR's configuration to reduce the speed. These widths are practical for linear speeds of less than 300 mm/s.
These limitations are different from those described for minimum lane width behavior because the AMR needs more clearance when detecting another moving object versus fixed objects. Refer to *4-10 Minimum Lane Width* on page 4-18 for more information.



Additional Information

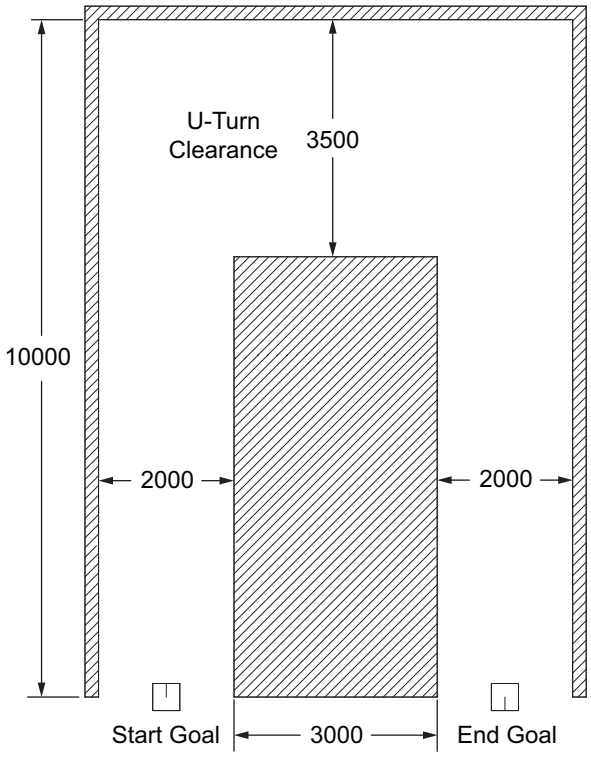
Use the Door Goals feature on the map for pre-alignment when the AMR travels through narrow passageways.

4-9 Narrow Passageway Behavior (Non-linear)

This section provides information about AMR behavior and other considerations when it travels through narrow passageways and doorways during non-linear motions.
For all the cases presented in this section, the passageway widths are practical for average AMR speeds of 300 to 500 mm/s.
These limitations are different from those described for minimum lane width behavior because the AMR needs more clearance when detecting another moving object versus fixed objects. Refer to *4-10 Minimum Lane Width* on page 4-18 for more information.

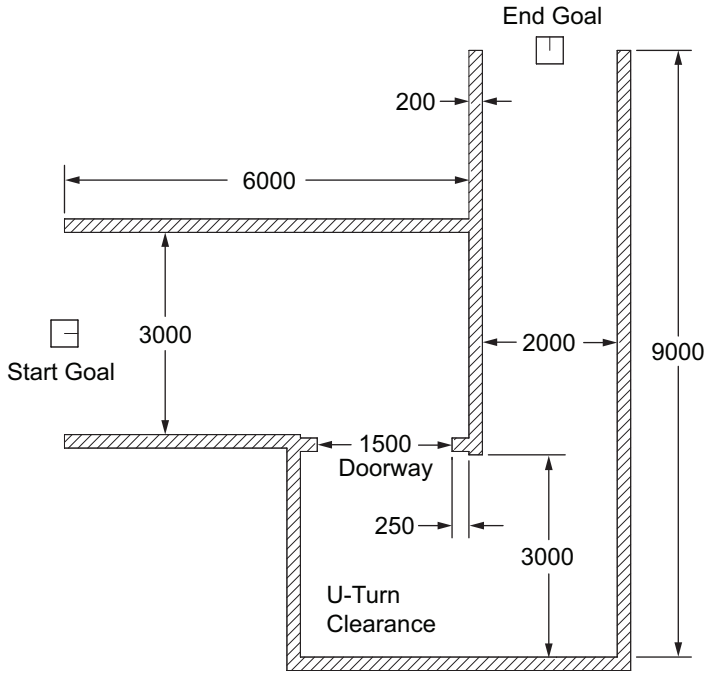
4-9-1 U-Turn in a Narrow Passageway

The following figure displays a situation where an AMR must make a U-Turn in a narrow passageway with a 2000 mm width and with the U-Turn clearance of 3500 mm.
Make AMR tasks and configuration changes to optimize operation during U-Turns in narrow passageways.



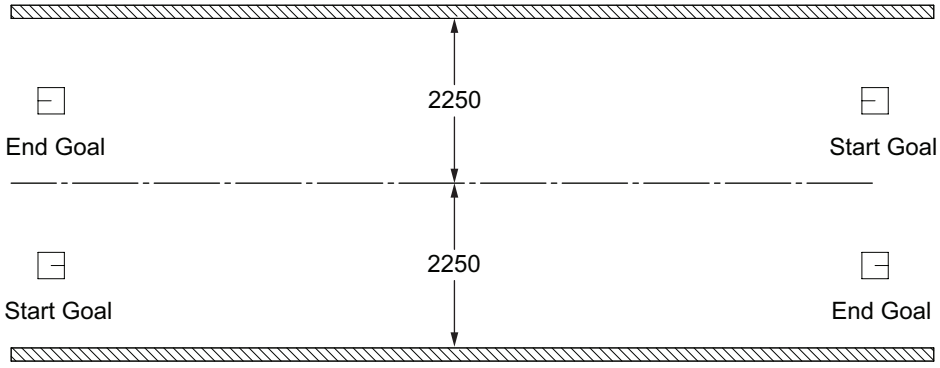
4-9-2 U-Turn Through a Narrow Doorway

The following figure displays the AMR U-Turn behavior at a narrow doorway.
As displayed in the following figure, the distance between the edge of the door opening and the adjacent wall is 250 mm.
Make AMR tasks and configuration changes to optimize operation of the AMR in narrow doorways.


End Goal
200
6000
3000
Start Goal
2000
9000
1500
Doorway
250
3000
U-Turn
Clearance

4-10 Minimum Lane Width

When an MD-series AMR operates in a corridor with other moving objects, it must have a minimum lane width of 2250 mm in order to travel at its maximum speed.
These limitations are different from those described for narrow passageway behavior because the AMR needs more clearance when detecting another moving object.
For example, corridors that have two MD-series AMRs traveling through it at once must be at least 4500 mm wide for operation at full speed. Corridors that are below 4500 mm wide may cause the MD-series AMRs to slow when traveling in the area in close proximity to one another.



4-11 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.

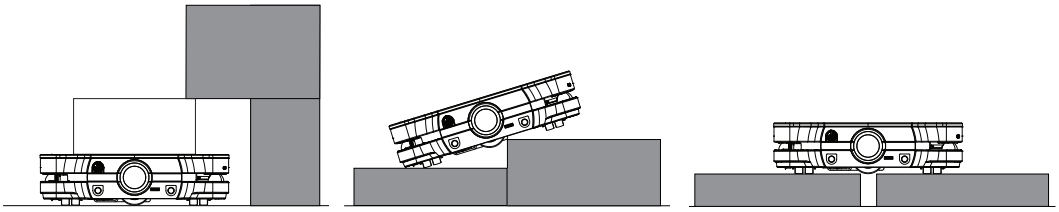
Precautions for Safe Use

Physical immobilization might cause motors in the AMR to overheat.

Additional Information

Side Lasers increase detection of overhanging objects and floor obstacles.
Refer to *1-6-5 Side Lasers* on page 1-28 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.

- *6-5 Lifting the AMR* on page 6-7
- *4-16 Releasing the Brakes* on page 4-33.
- *4-17 Manually Pushing the AMR* on page 4-35.
- *5-4-1 Low Battery Recovery* on page 5-6.
- *Section 5 Troubleshooting* on page 5-1.

4-12 Battery and Charging

The AMR battery supplies adequate power for the motors, electronics, and accessories.
Typical runtime with no load is approximately 10.5 hours. Typical fully-loaded runtime is approximately 8 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 Target become energized when they are properly connected. They are deactivated when the AMR is disengaged from the Docking Target.

⚠ WARNING

Replace the battery only with an OMRON factory-supplied battery intended for use in the AMR. Do not use batteries intended for use in other OMRON AMR models.



⚠ WARNING

Risk of Fire - No User Serviceable Parts
AVERTISSEMENT: Risque d'incendie - Aucune des pièces ne peut être.



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.



- 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.



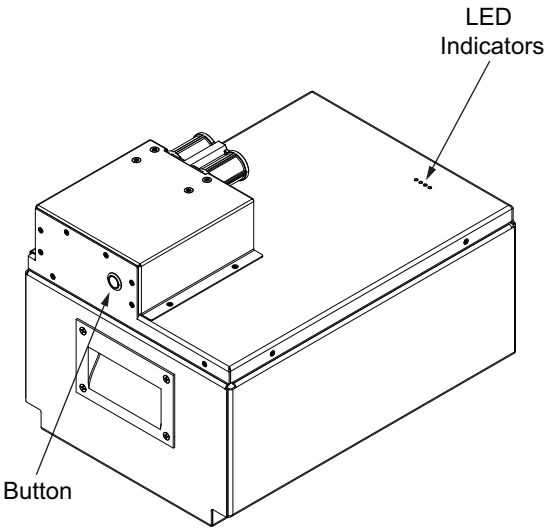
- Only use charging equipment and batteries supplied by OMRON. The charger shall only be used to charge an HD-1500 or MD-series AMR battery.

Additional Information

- The battery can be unplugged from the charging source during the charging operation without causing damage.
- Refer to *5-4-2 Battery Charging Problems* on page 5-6 for more information.

4-12-1 Battery Indicators and Controls

The battery has four LED indicators that display the charge level and one button to control the ON / OFF state.



Battery LED Indicators

The LED indicators provide information about the charge level when the battery is ON. Use the information below to understand LED indicator charge levels.
Refer to *Battery Pushbutton* on page 4-21 for more information about the battery ON / OFF state.

LED State	Indication
Four LEDs ON	Charge level is 75% to 100%.
Three LEDs ON	Charge level is 50% to 74%.
Two LEDs ON	Charge level is 25% to 49%.
One LED ON	Charge level is 11% to 24%.
One LED Flashing	Charge level is 1% to 10%.
Zero LEDs ON	Charge level is 0% or battery is OFF.

Battery Pushbutton

The battery pushbutton is used to turn the battery ON and OFF.
The pushbutton is an alternate operation (two-position) type. When the pushbutton is in the extended position, the battery is OFF. When the pushbutton is in the retracted position, the battery is ON.
When the battery is ON, the battery LED indicators are active. In this state, the battery consumes electricity and can be depleted. The battery should not remain ON during long periods of storage or unuse.
When the battery is OFF, the battery LED indicators are inactive. Turn the battery OFF for long periods of storage or unuse.

Additional Information

The battery must be ON when charging. Ensure the battery pushbutton is in the retracted position (depressed) before attempting to charge.

Precautions for Correct Use

When the battery is turned OFF, all internal calibration data about the charge level is lost. Turning the battery ON will activate the battery LED indicators, but the charge level may not be represented accurately. Charge the battery completely to recalibrate and display the charge level accurately.

Additional Information

Refer to *4-12-5 Storing Batteries* on page 4-27 for more information.

4-12-2 Charging Station

The Charging Station provides both manual and automated methods of recharging the AMR's battery. A 4 m power cable connects the Power Supply box to the Docking Target. This cable can also be used for charging a battery outside of the AMR. Refer to *Charging a Battery Outside of the AMR* on page 4-26 for more information..

The Power Supply Box outputs a maximum of 6.84 kW of power and can charge a completely depleted battery in 40 minutes.

⚠ WARNING

- The AMR battery and the Charging Station outputs have high current. You must take appropriate precautions to avoid potential short circuit.
- The Charging Station, battery, and AMR transfer high electric power and contain hazardous voltages. You must take necessary precautions to avoid electric shock. Follow appropriate Lock-Out, Tag-Out (LOTO) instructions prior to any installation and maintenance work performed on or near these items.
- If 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.



⚠ WARNING

The Power Supply Box, charging contacts on both the Docking Target and the AMR, and the drive wheel motors can get hot during operation. Allow these items to cool down prior to servicing.



Precautions for Safe Use

- In case of fire, use a type ABC or type BC dry chemical fire extinguisher.
- Never access the interior of the AMR while it is connected to the Docking Target.
- Avoid liquid near the Charging Station and the AMR.

Precautions for Correct Use

- Always ship and store the AMR, Power Supply Box, and the Docking Target 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 Power Supply Box and the Docking Target.
- 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 following safety measures associated with high power transfer are described below.

- When the Power Supply Box Main Disconnect Switch is ON, the electrical access panel door locks automatically to prevents access.
- The door on the Power Supply box can only be accessed with a key to prevent unauthorized access to the main electrical compartment.
- When the Docking Target 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 Power Supply Box uses a 4 meter long power cord (25.4 mm diameter) to transfer power to the Docking Target.

Power Supply Box

The Power Supply Box has LED indicators to display the status of the unit as described below. A Service button is also present for use when connecting a fully depleted battery.
The Power Supply Box has a Main Disconnect Switch that turns the unit ON or OFF. When the Main Disconnect Switch is placed in the vertical position (ON position), the unit powers ON and illuminates all LEDs on the front panel of the Power Supply Box for 2 seconds. The Power Supply Box is operational at this moment. Use the LEDs determine the operational status of the Power Supply Box. Placing the Main Disconnect Switch in the horizontal position (OFF position) will remove power from the Power Supply Box.
The Power Supply Box performs several diagnostic tests. If a problem is detected, the Power Supply Box enters a safe state in which all charging power turned OFF and the red LED flashes. Refer to *5-4-2 Battery Charging Problems* on page 5-6 for more information.
The Power Supply Box will not automatically charge a battery if it is absolutely depleted.
Pressing the Service button on the Power Supply Box during a charging session will interrupt charging. Disconnect the battery and then reconnect to resume charging.

Precautions for Correct Use

- It is safe to connect or disconnect the power cord from the Docking Target or battery without powering OFF the Power Supply Box.
- Always wait until the green OPERATION LED indicator on the Power Supply Box is ON solid before attempting to charge a battery.
- Do not press the Service button on the Power Supply Box if the yellow DC POWER LED indicator is flashing when there is no battery connected. Contact your OMRON representative if this condition is present.

Additional Information

- Some first-generation Power Supply Box units (part number 68310-000) are not compatible with the MD-series AMRs. Check the Power Supply Box label for AMR compatibility.
- Refer to *4-12-3 Charging the Battery* on page 4-24 for more information.

The following table provides descriptions of each LED state.

LED	State	Description
AC POWER	Blue ON	AC supply power is detected.
	Blue OFF	AC supply power is not detected.

LED	State	Description
OPERATION	Green ON	No load battery detected. Normal operation and ready to charge*1.
	Green OFF	Charging not possible.
	Green flashing	Service mode active.
DC POWER	Yellow ON	Charging.
	Yellow OFF	Not charging.
	Yellow flashing	A completely depleted battery has been detected.
ERROR	Red OFF	No error is present.
	Red ON	A non-critical error is present*2.
	Red flashing	A critical error is present*2.

*1. When no battery load is connected, the green OPERATION indicator can take up to 60 seconds to turn ON while the system performs diagnostics.

*2. Refer to *5-4 Battery Problems* on page 5-6 for more information.

Docking Target

The Docking Target provides an easily identifiable target for the AMR to locate when aligning for charging.

The AMR travels at a low speed when approaching the Docking Target in preparation for engaging with the charging paddle.

When the AMR successfully engages the charging paddle and the Power Supply box determines charging is possible, charging will automatically begin.

Additional Information

- Some first-generation Power Supply Box units (part number 68310-000) are not compatible with the MD-series AMRs. Check the Power Supply Box label for AMR compatibility.
- All Docking Targets are compatible with HD-series and MD-series AMRs.

4-12-3 Charging the Battery

A battery can be charged while inside the AMR or outside (removed from) the AMR.

Charging automatically begins when the Power Supply Box detects a connected battery, either inside the AMR when it is engaged with the Docking Target or when a battery is removed from the AMR and directly connected to the Power Supply Box.

Ensure the battery pushbutton is in the retracted position (depressed) before attempting to charge.

⚠ WARNING

The Power Supply Box, charging contacts on both the Docking Target and the AMR, and the drive wheel motors can get hot during operation. Allow these items to cool down prior to servicing.



Precautions for Safe Use

Avoid shorting the battery terminals or connectors.

Precautions for Correct Use

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.

Autonomous Charging

During normal operation, the AMR charges its battery autonomously by driving to the Docking Target under configurable conditions (battery level and opportunities). The AMR drives to the location of the Docking Target based on the map loaded onto the AMR and it uses this information to autonomously recharge as configured. The map must have a predefined MutePersonnelDetectionSector area around the Docking Target. This allows the AMR to mute the safety rated personnel detection means of the Safety Laser Scanners as it approaches the charging paddle (per applicable standards). Refer to *Operate inside a designated MutePersonnelDetectionSector Area* on page 4-71 for more information.
When the AMR arrives near the Charging Station, it searches for a unique trapezoidal shape integrated into the front of the Docking Target. The AMR uses this shape to locate the position of the charging paddle. After the Docking Target 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. A red LED charge light near the charging contacts will illuminate when power is present at the charging contacts. Refer to *1-2-6 Charging Contacts* on page 1-10 for more information.
There is a delay of up to 10 seconds between when an AMR docks and the yellow DC POWER LED located on the Power Supply Box turns ON to indicate a charging state. Light discs will also indicate charging. If the AMR has an E-STOP button depressed while charging, the light discs will display the emergency stop light pattern. Refer to *4-21 Light Discs and Optional Beacon States* on page 4-41 for more information.
If the battery level becomes too low, the AMR is immobilized and autonomous charging will not be possible. If this occurs, the following user interaction is required.

- The AMR can be physically moved to the Docking Target. The AMR must be able to power ON to resume charging once at the Docking Target. Refer to *5-4-1 Low Battery Recovery* on page 5-6 and *4-17 Manually Pushing the AMR* on page 4-35 for more information.
- If the battery level is absolutely depleted and the AMR cannot be moved, the internal battery must be removed and charged while outside the AMR. Refer to *Charging a Battery Outside of the AMR* on page 4-26 for more information.

If you move the AMR during the charging process, the charging will stop and re-docking is required to resume.

Precautions for Correct Use

The AMR must be powered ON in order to charge the battery while at the Docking Target.

Additional Information

The Charging Station supplies adequate power for all onboard systems while charging its battery, so you can continue operating those systems while charging. Significant user loads may impact the time required to fully-charge the AMR's battery.

The light discs display a green arc indicating the current state of charge while the battery is charging. Refer to *4-21 Light Discs and Optional Beacon States* on page 4-41 for more information.

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.
Charging a battery outside the AMR is accomplished by removing the cable from the Docking Target and connecting it directly to the battery. When the battery is connected to the Power Supply Box, a 10 second delay occurs during an automatic check sequence and then charging begins when the yellow DC POWER LED is ON solid. If the yellow DC POWER LED begins flashing, this indicates that the connected battery is absolutely depleted. You must press and release the Service button on the Power Supply Box to acknowledge this state, and then charging will begin.

Precautions for Correct Use

- The Power Supply Box can only be connected directly to the Docking Target or to one battery. Simultaneous charging configurations are not possible.
- Do not press the Service button on the Power Supply Box if the yellow DC POWER LED indicator is flashing when there is no battery connected. Contact your local OMRON representative if this condition is present.

4-12-4 Balancing the Battery

The AMR's battery is composed of multiple cells which must stay balanced to maintain maximum run-time.
The battery balancing process occurs after the battery is fully charged while still connected to the Charging Station.
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 48 hours or longer to balance after charging. A battery that is removed from the AMR and connected directly to the Power Supply Box 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 Target.
  Set the AMR‘s *DockUntilDoneCharging* parameter to True to balance the battery every time the AMR engages the Docking Target. In this mode, the battery will typically take about 15 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 Target 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 *StateOfChargeTo-ChargeTo* and *MinutesToChargeFor* parameters are both set to a default value of 0, the AMR will never leave the Docking Target. Do not use this combination of parameter settings.

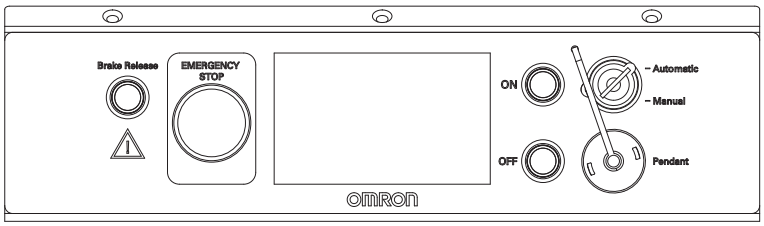
4-12-5 Storing Batteries

If the AMR is not used for 15 days or more, the battery should be removed and stored.
Make the following considerations when storing batteries.

- Lithium batteries must be stored in accordance with local regulations and ordinances.
- Always charge the battery to at least 50% capacity before long-term storage.
- Always turn OFF the battery before long-term storage.
- The batteries must be stored in the upright position. Do not place the batteries on the side, top, or end when storing.
- Stored batteries should be fully balanced and charged every 6 months to prevent significant deterioration. Failure to re-charge a stored battery periodically can damage it.
- Batteries stored at temperatures greater than 35°C or less than -20°C must stabilize for 4 to 8 hours until within the nominal operating temperature, with no condensation before use.
- Store the batteries on a flat surface in an area free of vibration.
- Do not place anything on top of the batteries.
- Never expose the battery to water or other liquids.
- Do not store in direct sunlight or near other heat sources.
- Do not store the batteries in a flammable environment.

4-13 Operator Panel

The information below describes the operator panel components and functions.



Precautions for Correct Use

Do not tamper with any AMR control devices.

4-13-1 Brake Release Button

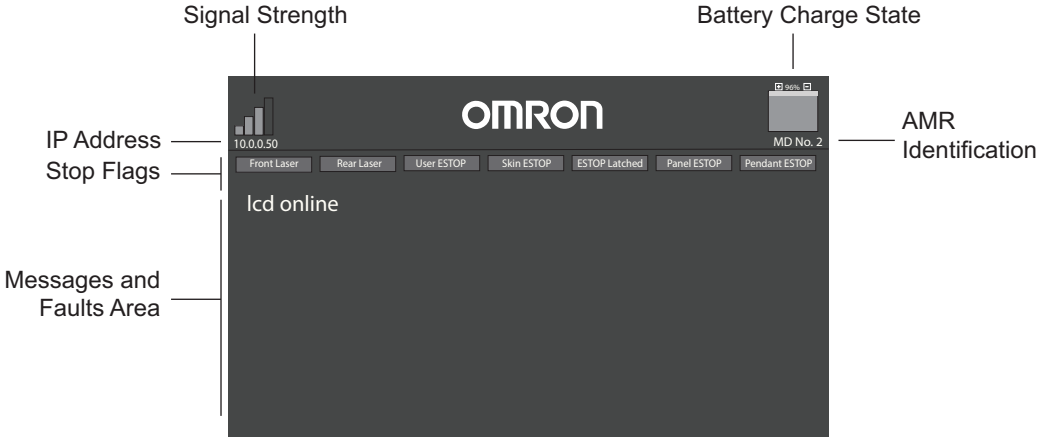
The brake release button is used when the AMR needs to be moved manually.
To release the brakes using this button, you must first press the E-STOP button on the Operator Panel and then press and hold the brake release button. The brakes remain released while pressing this button. When the button is released, 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 *4-16 Releasing the Brakes* on page 4-33 for more information.

4-13-2 Emergency Stop Button

The Emergency Stop button will activate an emergency stop when depressed.

4-13-3 Main Screen

Information displayed on the main screen during AMR operation is described below.



Boot-up Screen

The following image shows the first screen that appears during boot-up when the AMR is turned ON.



4-13-4 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.
- An LED ring around the button illuminates solid green when the AMR is ON while the brake is not engaged, and also during power-up, power-down operations.

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.

4-13-5 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. An LED ring around the button flashes red during the shut-down procedure. 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 turn OFF the Main Disconnect Switch to prevent battery drain.

Precautions for Correct Use

- The Main Disconnect Switch should not be used as a frequent means of turning OFF the AMR. Use the OFF button to turn OFF the AMR with a controlled shut-down method.
- 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.

4-13-6 Mode Selection Switch

The AMR mode is controlled with a key switch on the Operator Panel.

Automatic mode is used for typical operation under normal circumstances.
Manual mode must be selected to drive the AMR manually with a Pendant.
The AMR will enter an emergency stop state when the mode is changed. Pressing the ON button will return the AMR to a normal state.

Precautions for Correct Use

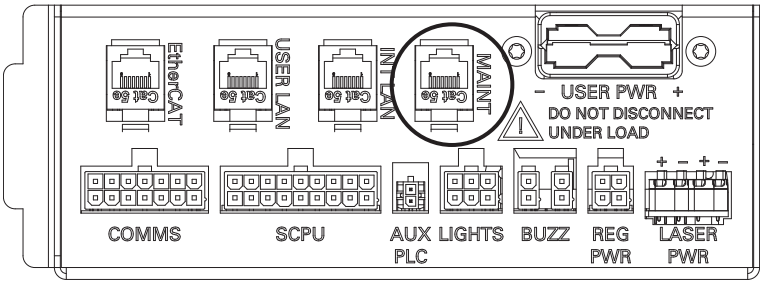
Always place the AMR in manual mode before connecting a Pendant. The Pendant cannot be used to control the AMR while in Automatic mode.

4-13-7 Pendant Port

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

4-14 Maintenance Ethernet Port

Use the maintenance Ethernet port to connect a PC directly to the AMR when using software for configuration or troubleshooting. This port should only be used as a single connection point. Do not connect the maintenance port directly to your LAN.
This port is located in the User Connections area on the Connector Panel.



This port automatically assigns an IP address to the connecting PC.
Access to the SetNetGo web interface is always enabled on this port and does not require a password or software license.

Additional Information

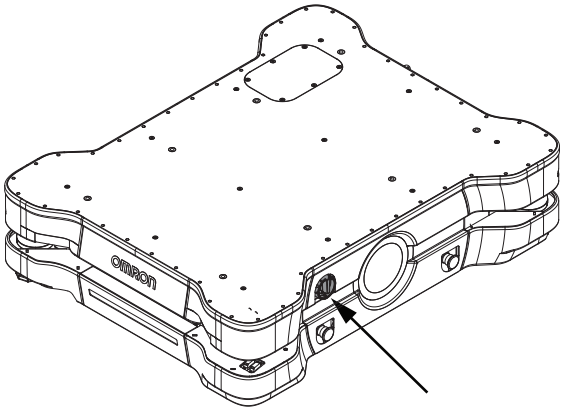
Refer to *3-4 Network Connections* on page 3-16 for more information.

4-15 Main Disconnect Switch

When the Main Disconnect Switch is in OFF (vertical) position, power is completely disconnected from the internal battery. All systems in the AMR will not be energized in this position. Rotating the Main Disconnect Switch to the ON (horizontal) position will establish a connection between the internal battery and all AMR systems.

Precautions for Correct Use

The Main Disconnect Switch should not be used as a frequent means of turning OFF the AMR. Use the OFF button to turn OFF the AMR as a controlled shut-down method.



4-16 Releasing the Brakes

The brakes on the drive wheels can be released in case of an emergency or abnormal situation. This may be required to manually move the AMR. Refer to *4-17 Manually Pushing the AMR* on page 4-35 for more information.

⚠ 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.
- Use caution when stopping the AMR on a ramp. The use of the brake release will cause direct rolling of AMR down the ramp. Powering OFF the AMR on a ramp should be avoided if possible to minimize the use of brake release on a ramp.



⚠ CAUTION

Manually moving the AMR while the brakes are released is not recommended. If you must manually move the AMR, make sure to do this safely as this could result in personal injury or property damage.



4-16-1 Electronic Brake Release

Use the Brake Release button on the Operator Panel to release the brakes electronically. Refer to *4-13-1 Brake Release Button* on page 4-28 for more information.

Make the following considerations when using the electronic brake release.

- The brake button on the Operator Panel must be pressed continuously. Releasing the brake button will activate the brakes.
- The AMR must be powered ON.
- The E-STOP button on the Operator Panel must be depressed before attempting to use the electronic brake release.



Precautions for Correct Use

- The mechanical brake release can be used if battery power is not available.
- The electronic brake release will timeout after two minutes of operation to prevent bypassing. Re-depressing the button will resume the brake release function after a two minute timeout occurs.

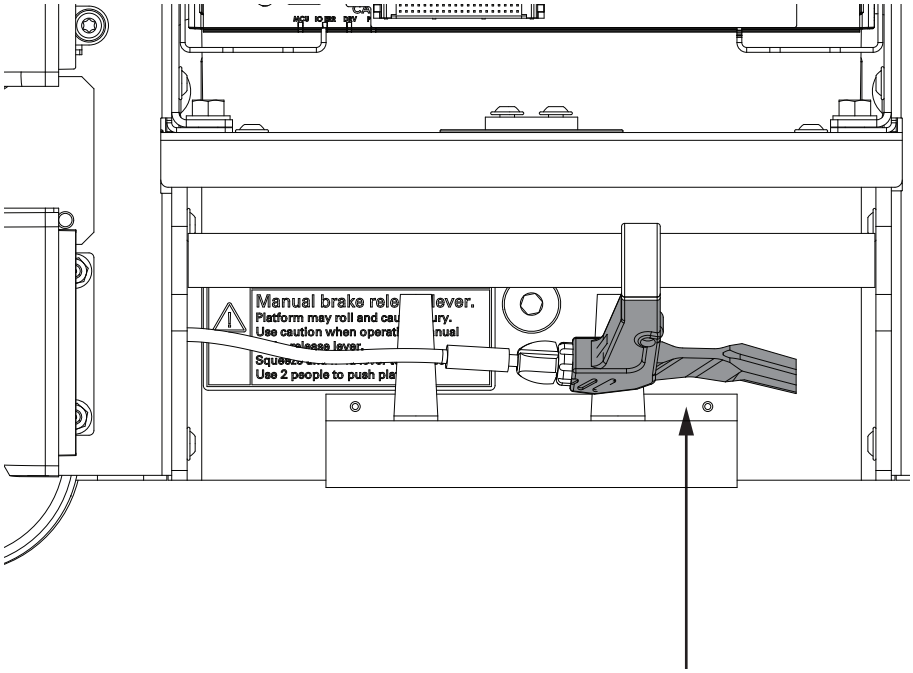
4-16-2 Mechanical Brake Release

A mechanical brake release is provided as an alternative to the electronic brake release. The mechanical brake release is typically used in the following situations.

- Releasing the brakes when the battery is removed or completely exhausted.
- Releasing the brakes when the AMR needs to be pulled backwards.

The mechanical brake release does not have a time limit like the electronic brake release. Refer to *4-16-1 Electronic Brake Release* on page 4-33 for more information.

The mechanical brake release lever is located behind the rear skin. Squeezing the lever shown below will mechanically release the brakes.



Ensure brake lever returns to original position after releasing.

4-17 Manually Pushing the AMR

If the AMR becomes immobilized, it may need to be manually pushed to a new location.
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 should be as low as possible and near the center of gravity.
Make the following considerations when manually pushing the AMR.

- Do not push the AMR by pressing on the skins.
- There is no appropriate point at which to pull the AMR. Only push the AMR when attempting to manually move it.
- Do not push the AMR with another motorized device.
- Only push from the top of the AMR or the bar near the mechanical brake release.
- Use at least 2 people to manually push the AMR. One person is required to operate the brake release during the pushing process. Refer to *4-16 Releasing the Brakes* on page 4-33 for more information.

⚠ WARNING

Use caution when stopping the AMR on a ramp. The use of the brake release will cause direct rolling of AMR down the ramp. Powering OFF the AMR on a ramp should be avoided if possible to minimize the use of brake release on a ramp.

⚠ CAUTION

- Pushing an AMR requires significant effort and might cause personal injury or property damage. Take appropriate care and follow all safety instructions.
- The pushing points of the AMR are low to the ground. You must use safe pushing practices when manually moving the AMR.
- When manually moving the AMR, do not push it from a high position on its payload or payload structure. This might cause the AMR to topple.
- Manually moving the AMR while the brakes are released is not recommended. If you must manually move the AMR, make sure to do this safely as this could result in personal injury or property damage.

Precautions for Correct Use

- 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.
- 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.
- If the loaded AMR is too heavy to move manually, it is recommended that you seek additional help or remove the payload.
- Only qualified personnel who have read and understood this manual and the *Autonomous Mobile Robot (AMR) MD-series Platform Safety and Unpacking Guide (Cat. No. I682)* should manually move the AMR.
- OMRON recommends that you train personnel on the safe use of the brake release operations and procedures for safely pushing an AMR.

4-18 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).
There are two typical reasons to activate an emergency stop during normal operation.

- 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.

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 *4-18-1 Emergency Stop Recovery Procedure* on page 4-36 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 SCPU connector in the User Connections area. They are energized with +24 VDC during normal operation and turn OFF when an emergency stop event occurs. Refer to *3-5-1 User Connections Area* on page 3-19 for more information.
An emergency stop differs from a protective stop. Refer to *4-19 Protective Stops* on page 4-38 for more information.
Indicator lights on the AMR and the pendant provide the emergency stop state. Stop flags are also displayed on the Operator Panel. Refer to the following sections for more information.

- *4-21 Light Discs and Optional Beacon States* on page 4-41
- *4-22 Light Strips and Optional Beacon States* on page 4-44
- *4-23 Pendant Operation* on page 4-48
- *4-13-3 Main Screen* on page 4-28
- *2-4-16 Safety Function Performance Levels* on page 2-20

Additional Information

If the AMR does not decelerate at the prescribed rate during an emergency stop, the mechanical brakes will be applied to achieve a category 0 (immediate) stop. User intervention is required for restarting the AMR.

4-18-1 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 Target 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, the enabling device on the pendant, 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.

Additional Information

- Pressing the ON button is not required if only the E-STOP button on the pendant was pressed to trigger the emergency stop. In this condition, use the three-position enabling device to recover.
- Pressing the ON button is not required if only the enabling device on the pendant was activated to trigger the emergency stop. In this condition, place the three-position enabling device in the middle position to recover.
- 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.

4-19 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). An automatic restart will not occur under the following conditions.

Left Side Clearance	Right Side Clearance	Front Clearance
100 mm to 500 mm		Not applicable
100 mm to 500 mm	Less than 100 mm	
Less than 100 mm	100 mm to 500 mm	
Less than 100 mm		Less than 500 mm

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 *4-25 Safety Laser Scanner Zones* on page 4-51 for more information.
- Overspeed conditions in confined spaces or during normal operation. Refer to *4-20 Overspeed Protection* on page 4-40 for more information.
- User-supplied protective stop devices connected to the SCPU connector in the User Connections area can initiate a protective stop. Refer to *3-5-1 User Connections Area* on page 3-19 for more information.

A protective stop differs from an emergency stop. Refer to *4-18 Emergency Stop* on page 4-36 for more information.
Two additional safety outputs are also available for controlling user-supplied equipment during a protective stop. The state of these safety outputs as well as the AMR response during a protective stop is dependent on several factors. Refer to the following sections for more information.

- *4-19-1 AMR Response During Protective Stops* on page 4-38
- *2-4-16 Safety Function Performance Levels* on page 2-20

Additional Information

If the AMR does not decelerate at the prescribed rate during a protective stop, the mechanical brakes will be applied to achieve a category 0 (immediate) stop. User intervention is required for restarting the AMR.

4-19-1 AMR Response During Protective Stops

The AMR response during a protective stop depends on the AMR driving state. Use the information below to understand how the AMR responds when a protective stop is triggered.

AMR State	Protective Stop Inputs	AMR Response	Safety Outputs
Driving	LOW	Protective Stop Automatic Reset	LOW
Driving	HIGH	No Change	HIGH
Stopped	LOW	Safe Torque Off (STO) Active, Motor power disabled, Brakes engaged	HIGH*1

AMR State	Protective Stop Inputs	AMR Response	Safety Outputs
Stopped	HIGH	No change	HIGH

*1. For user-supplied protective stop, the safety output is high only when safety zone pair 37 is clear. Refer to *Creating an Exclusion Zone* on page 4-72 for more information.

4-20 Overspeed Protection

The AMR has an independent safety system that uses an internal safety controller to monitor its velocity. This controller uses redundant monitoring and control methods to ensure that the AMR always operates within safe speed limits for driving straight and rotating. Overspeed limits are not adjustable and independent of parameters detailed in *4-27 Motion Limits* on page 4-76.

The safe speed limits are provided below.

- Maximum linear speed: 2380 mm/s for MD-650 and 1900 mm/s for MD-900

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 *2-4-16 Safety Function Performance Levels* on page 2-20 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.

4-21 Light Discs and Optional Beacon States

Light Discs located on the sides of the AMR provide a visual indication of its operational state. Light Discs supplement the Light Strips on the front and rear of the AMR for high visibility on all sides during operation. Use the following information to understand the operation of the Light Discs and an optional beacon (light tower).

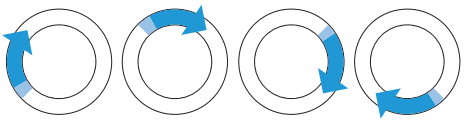
Refer to the following sections for more information.

- *LIGHTS* on page 3-24.
- *4-22 Light Strips and Optional Beacon States* on page 4-44

4-21-1 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.

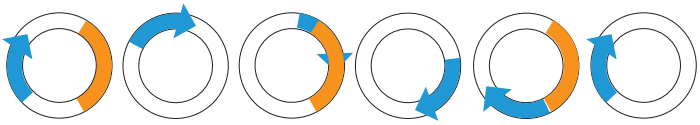
An optional beacon will illuminate green during this operation.



4-21-2 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.

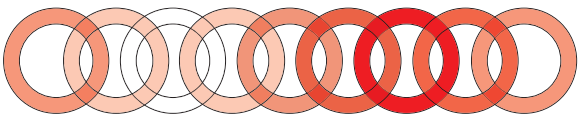
An optional beacon will illuminate green during this operation.



4-21-3 Emergency Stop

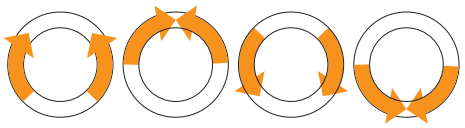
The light discs pulses red while the AMR is in an emergency stop state. The LED pulses at a 0.25 Hz frequency as it fades ON and OFF.

An optional beacon will illuminate red during this operation.



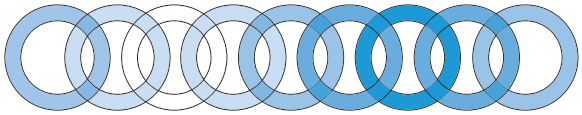
4-21-4 Lost

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.



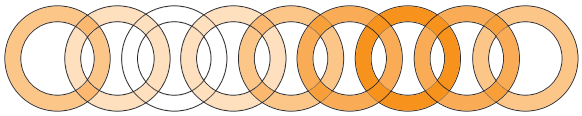
4-21-5 Stopped

When the AMR is stopped, the entire light disc on each side pulses blue slowly (0.25 Hz).
An optional beacon will illuminate green during this operation.



4-21-6 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.

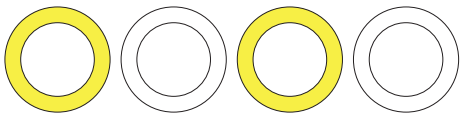


4-21-7 Obstacle Detected / Protective Stop

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.

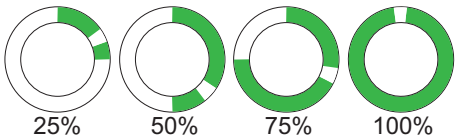
Additional Information

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.



4-21-8 Charging

When the AMR is engaged with a Docking Target, 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.



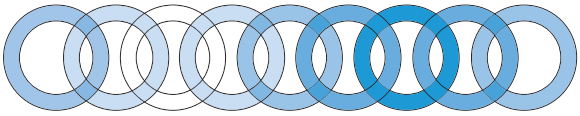
Left Side Light Disc	Right Side Light Disc	State of Charge
0 to 90 cw	0 to 270 ccw	25%
0 to 180 cw	0 to 180 ccw	50%
0 to 270 cw	0 to 90 ccw	75%
full circle	full circle	100%

Additional Information

The state of charge displayed is continuous and not limited to 25% increments.

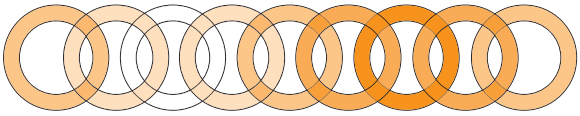
4-21-9 Booting

When the AMR is Booting, the entire light disc on each side pulses blue slowly (0.25 Hz).
An optional beacon will illuminate red during this operation.



4-21-10 Operating inside a designated MutePersonnelDetectionSector Area

When the AMR is operating inside a designated MutePersonnelDetectionSector area, the light discs pulse orange instead.
An optional beacon will flash yellow during this operation.



Refer to *Operate inside a designated MutePersonnelDetectionSector Area* on page 4-71 for more information.

4-22 Light Strips and Optional Beacon States

Light Strips located on the front and rear of the AMR provide a visual indication of its operational state. Light Strips supplement the Light Discs on the sides of the AMR for high visibility on all sides during operation. Use the following information to understand the operation of the Light Strips and an optional beacon (light tower).

Refer to the following sections for more information.

- *LIGHTS* on page 3-24.
- *4-21 Light Discs and Optional Beacon States* on page 4-41

4-22-1 Driving Straight

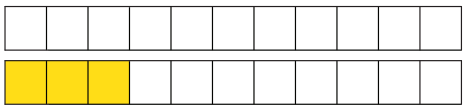
When driving straight, the front light strip displays solid white and the rear light strip displays solid blue.

An optional beacon will illuminate green during this operation.

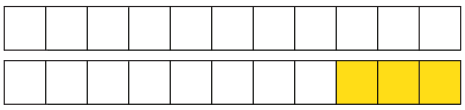
4-22-2 Turn Signal

In preparation for a turn and during a turn, the front light strip displays white at the center and yellow blinking in the direction of the AMR's turn. The rear light strip displays blue at the center and yellow blinking in the direction of the turn.

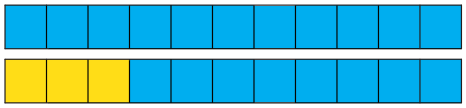
An optional beacon will illuminate green during this operation.



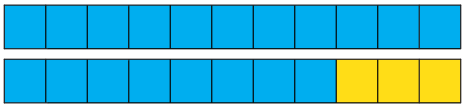
Front Light Strip - Left Turn



Front Light Strip - Right Turn



Rear Light Strip - Left Turn

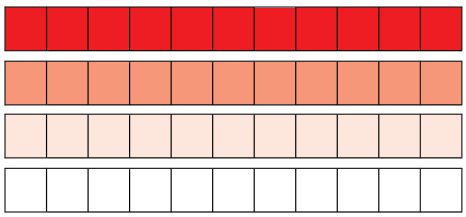


Rear Light Strip - Right Turn

4-22-3 Emergency Stop

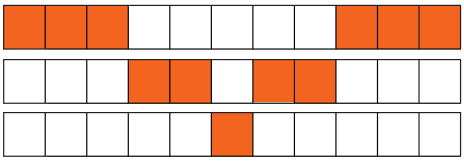
The light strip pulses red while the AMR is in an emergency stop state. The LED pulses at a 0.25 Hz frequency as it fades ON and OFF.

An optional beacon will illuminate red during this operation.



4-22-4 Lost

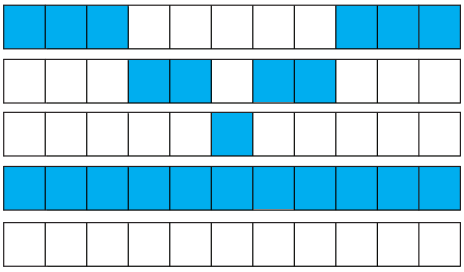
When the AMR is lost, both front and rear light strips repeatedly display two orange segments traveling from one edge to the middle in opposite directions.



4-22-5 Stopped

While the AMR is stopped, both front and rear light strips repeatedly display two blue segments traveling from one edge to the middle in opposite directions.It then pulses at a frequency of 0.25 Hz as it fades ON and OFF.

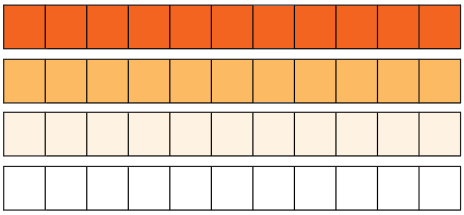
An optional beacon will illuminate green during this operation.



4-22-6 Stopped with Warning

When the AMR is stopped with a warning, both front and rear light strips display orange pulsing at the center.

An optional beacon will illuminate green during this operation.



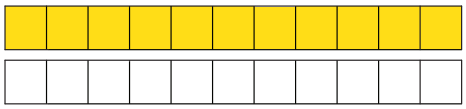
4-22-7 Obstacle Detected / Protective Stop

The front and rear light strips display yellow blinking at the center if the AMR stops for an obstacle detected in its safety zone.

An optional beacon will illuminate yellow during this operation.

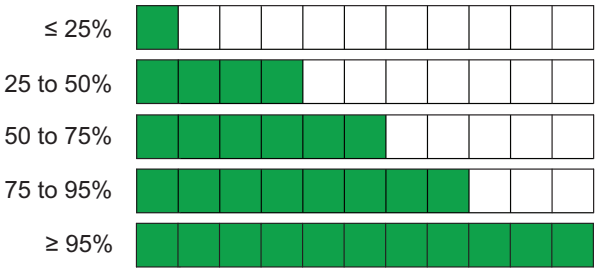
Additional Information

There is a 2.5 second delay between the end of an obstacle detection condition and the AMR resuming its activity. During the this time, the AMR scans its path for potential obstacles. It will remain stopped until its path is clear.



4-22-8 Charging

When the AMR is engaged with a Docking Target, the front and rear light strips indicate the current state of charge as described in the table below.
An optional beacon will illuminate green during this operation.

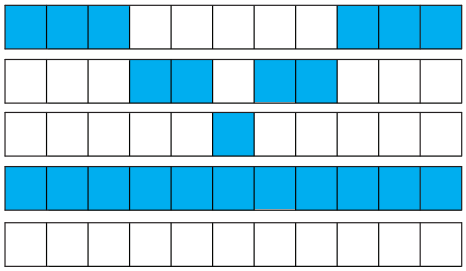


Additional Information

The state of charge displayed is continuous and not limited to 25% increments.

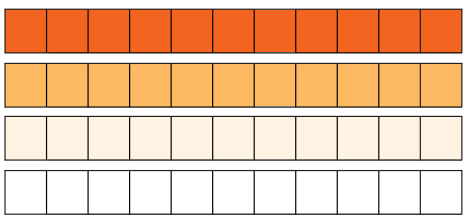
4-22-9 Booting

While the AMR is booting, both front and rear light strips repeatedly display two blue segments traveling from one edge to the middle in opposite directions.It then pulses at a frequency of 0.25 Hz as it fades ON and OFF.
An optional beacon will illuminate red during this operation.



4-22-10 Operating inside a designated MutePersonnelDetectionSector Area

When the AMR is operating inside a designated MutePersonnelDetectionSector area, both front and rear light strips display orange pulsing at the center.
An optional beacon will flash yellow during this operation.



Refer to *Operate inside a designated MutePersonnelDetectionSector Area* on page 4-71 for more information.

4-23 Pendant Operation

The Pendant is used to drive the AMR manually and to make a map. Use the information below to understand the Pendant operation and functions.

⚠ WARNING

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

Although the Safety Laser Scanners are integrated with the emergency stop circuit at all times, the operator must maintain full control of the pendant functions and the AMR when the pendant is in use.

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 speed does not cause the AMR to move uncontrollably.
- OMRON recommends storing and securing the pendant when not in use to prevent an unauthorized person from operating the AMR.

Precautions for Correct Use

Always place the AMR in manual mode before connecting a Pendant. The Pendant cannot be used to control the AMR while in Automatic mode.

The pendant is intended for single-handed operation. While gripping the handle and applying pressure to the three-position enabling device so that it is in the middle position, use your thumb to move the directional control stick to drive the AMR. If the three-position device is not depressed or completely depressed, or the E-STOP button is pressed, the drive motors are disabled and the AMR cannot move. The three-position device must be in the middle position with the emergency stop button released to enable the drive motors and allow the AMR to move. If the pendant E-STOP button or enabling switch is triggered, the AMR will activate an emergency stop. Refer to *4-18-1 Emergency Stop Recovery Procedure* on page 4-36 for more information.

The pendant is equipped with 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 AMR's ON button must be pressed after connecting or disconnecting the pendant.

While the pendant is connected, it is the only method by which the AMR can be controlled.

The pendant has a Power Enabled indicator LED to provide a visual indication of the following AMR operating states.

LED State	Description
Solid Red	AMR is in an emergency stop state.
Solid Yellow	AMR transitioning from an emergency stop state to a normal operational state.
Solid Green	The AMR motors are enabled.
Flashing Green	The AMR is in motion.

4-23-1 Driving with the Pendant

Use the following procedure to drive the AMR with the Pendant.

1. Press one of the E-STOP buttons on the AMR.
2. Place the AMR in manual mode using the mode selection switch on the Operator Panel.
3. Connect the pendant to the Operator Panel Pendant port.
4. Turn the speed dial counterclockwise to the lower speed limit.
5. Release the E-STOP button(s).
6. Press the AMR ON button.
7. Squeeze and hold the three-position enabling device with medium pressure so it is in the middle position.
   Check the E-STOP button on the Pendant and make sure it is released.
8. 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 counterclockwise. 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.
9. To stop the AMR, you can release the three-position enabling device or depress it completely. This will trigger an emergency stop and disable the drive motors. Refer to *4-18-1 Emergency Stop Recovery Procedure* on page 4-36 for more information. You can also release the directional control stick which will bring the AMR to a full stop (this does not disable power to the motors).

4-24 Warning Buzzer

The AMR has a warning buzzer that provides an audible alert during certain operating conditions.

⚠ CAUTION

Changing warning buzzer parameter values might make the AMR unsafe and affect its compliance to safety standards. Refer to the applicable safety standards for your locale before you change any parameter values.



Additional Information

Warning buzzer parameter values are only available with Fleet Operations Workspace version 1.1 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 1-28 for information about additional warning buzzers.

The default settings for the warning buzzer are provided below.

- The warning buzzer is active when the AMR is moving very slowly. It will turn ON for 500 ms at 2 second intervals when the AMR has a linear speed below 20 mm/s or a rotational speed below 3 degrees/sec for a duration of more than 2 seconds.
- The warning buzzer is active for 2 seconds prior to starting motion any time it has stopped moving for at least 10 seconds. This includes the first motion after start-up.
  This can be adjusted by changing a parameter value in MobilePlanner (safetyBuzzerDisable_FwdMotion).
- The warning buzzer is active for 2 seconds when an emergency stop or a protective stop from hardware-based safety zones is triggered.

4-25 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.

⚠ WARNING

You need to modify the safety zones if your payload overhangs the AMR's default dimensions and if operating on a floor surface that has poor traction to the extent that the AMR cannot stop reliably within the default zones. OMRON is not responsible for any risks incurred by modifying safety zone sizes or other Safety Laser Scanner settings.



Additional Information

- With the exception of safety zones 34 and 35, the same safety zones are used when driving the AMR manually with the pendant or when the AMR is operating autonomously.
- The software-based obstacle protection is used regardless of the AMR speed.

4-25-1 Safety Zone Pairs

Each Safety Laser Scanner has several individually configurable safety zones. With each Safety Laser Scanner scanning a 275° field of view, both Safety Laser Scanners can provide full coverage of a 360° area around the AMR. When two Safety Laser Scanners are working together to provide full coverage, a safety zone pair is in use.

There are a total of 37 safety zone pairs for the default configuration. These safety zone pairs are associated with the following operating states of the AMR.

- Driving straight with minimal turning.
- Rotating while driving slowly.
- Driving in an arc (turning).
- Driving at very slow speeds.
- Operating inside a designated MutePersonnelDetectionSector area.
- Creating an exclusion zone.



Additional Information

- Safety zone pairs were designed for AMR operation with the maximum payload on a floor with a coefficient of friction specified in *2-3-1 AMR Environmental Specifications* on page 2-13.

Safety Zone Pair Operational Details

The operational details of safety zone pairs are described below.



Additional Information

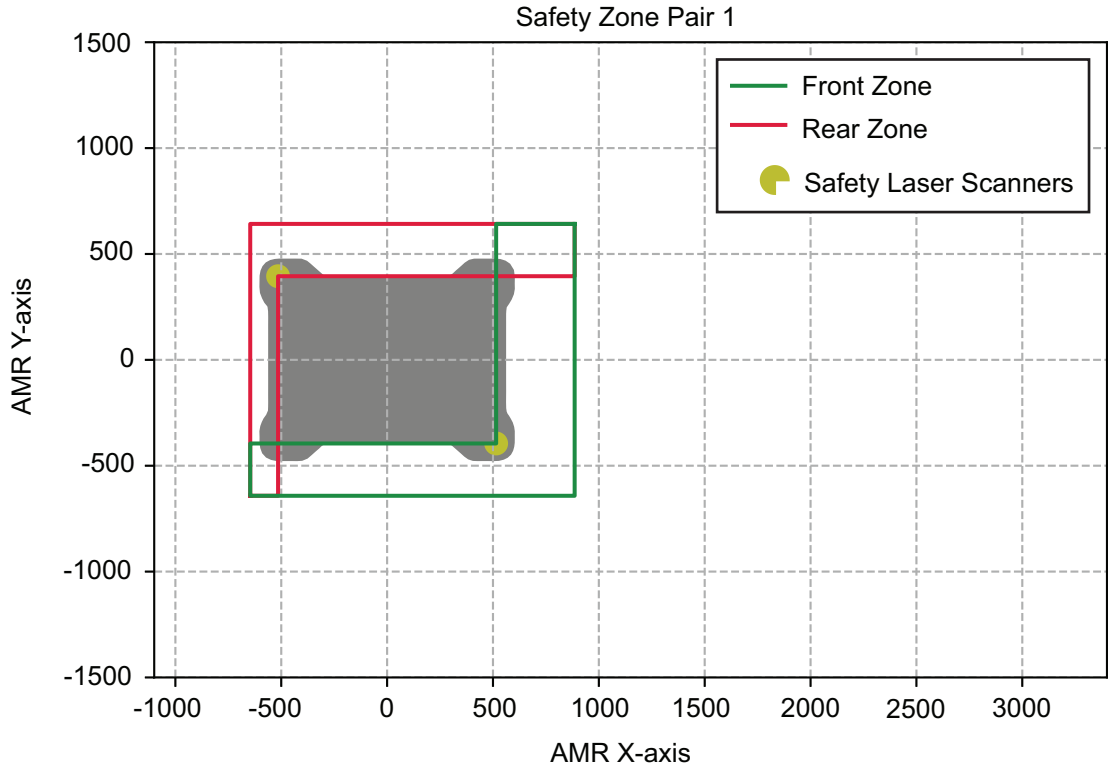
- Not all speeds are achievable for safety zone pairs associated with an operational condition.
- Speeds provided for safety zone pairs are accurate to within ± 10 mm/s and ± 2 degrees/s.

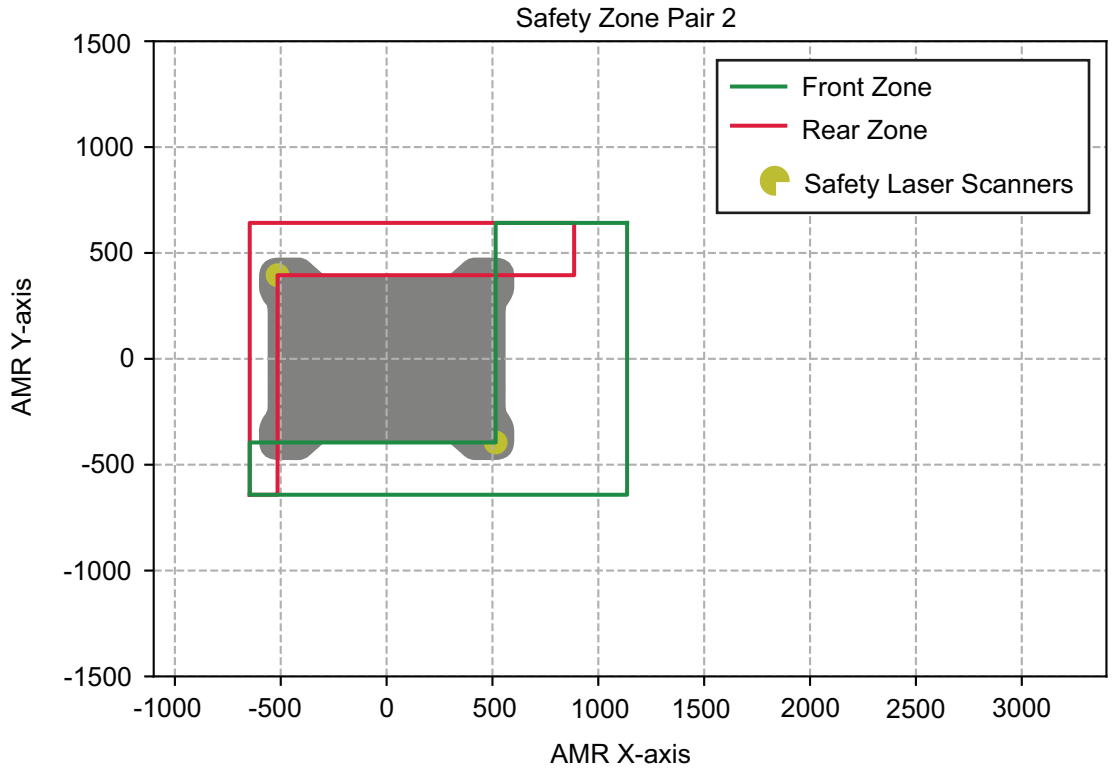
Safety Zone Pair(s)	Operational Conditions
1 to 7	Enabled when the AMR is driving straight with minimal turning. Refer to *Driving Straight with Minimal Turning* on page 4-52 for more information.
8 to 10	Enabled when the AMR is rotating while driving slowly. Refer to *Rotating While Driving Slowly* on page 4-56 for more information.
11 to 32	Enabled when the AMR is driving in an arc (turning). Refer to *Driving in an Arc (Turning)* on page 4-58 for more information.
33	Enabled when the AMR is traveling at slow speeds. Refer to *Traveling at Slow Speeds* on page 4-69 for more information.
34	Enabled when the AMR is driving at very slow speeds with the Pendant disconnected. Refer to *Moving at Very Slow Speeds with the Pendant Disconnected* on page 4-70 for more information.
35	Enabled when the AMR is driving at very slow speeds with the Pendant connected. Refer to *Moving at Very Slow Speeds with the Pendant Connected* on page 4-71 for more information.
36	Enabled when navigating inside a designated MutePersonnelDetectionSector area. Refer to *Operate inside a designated MutePersonnelDetectionSector Area* on page 4-71 for more information.
37	Enabled during a user-supplied protective stop when the AMR is not moving (even when muting). Refer to *Creating an Exclusion Zone* on page 4-72 for more information.

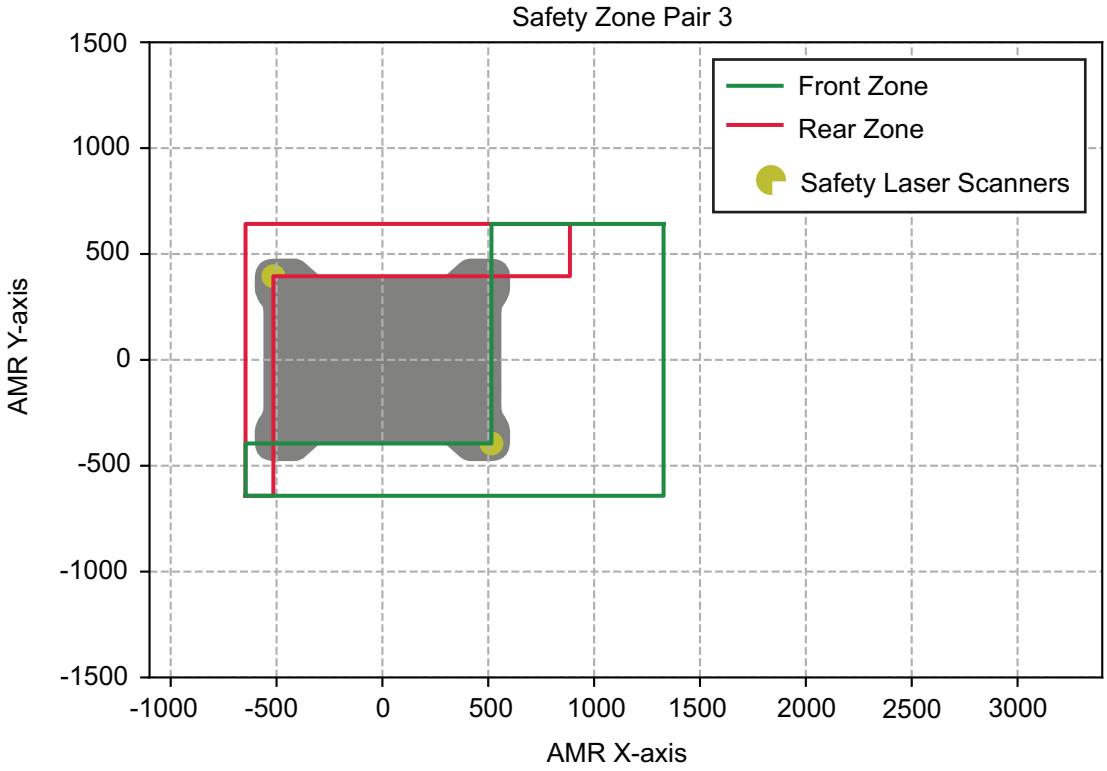
● Driving Straight with Minimal Turning

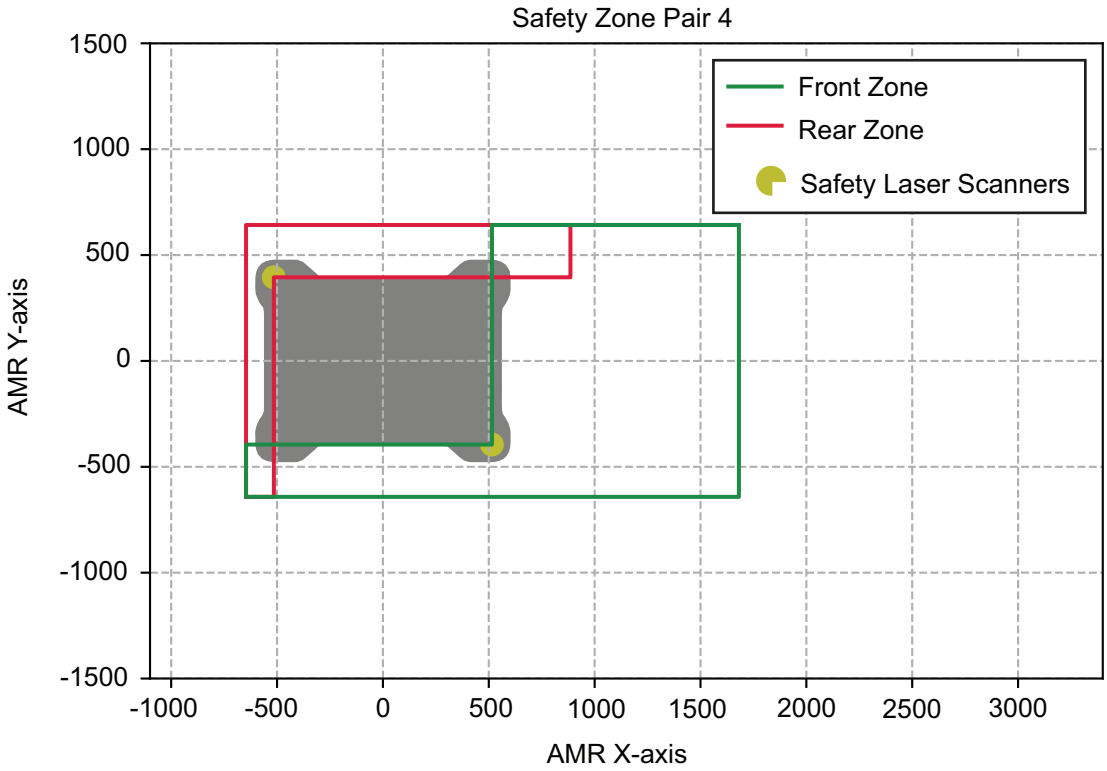
Safety zone pairs 1 to 7 are used when the AMR is driving straight with minimal turning with the following speeds.

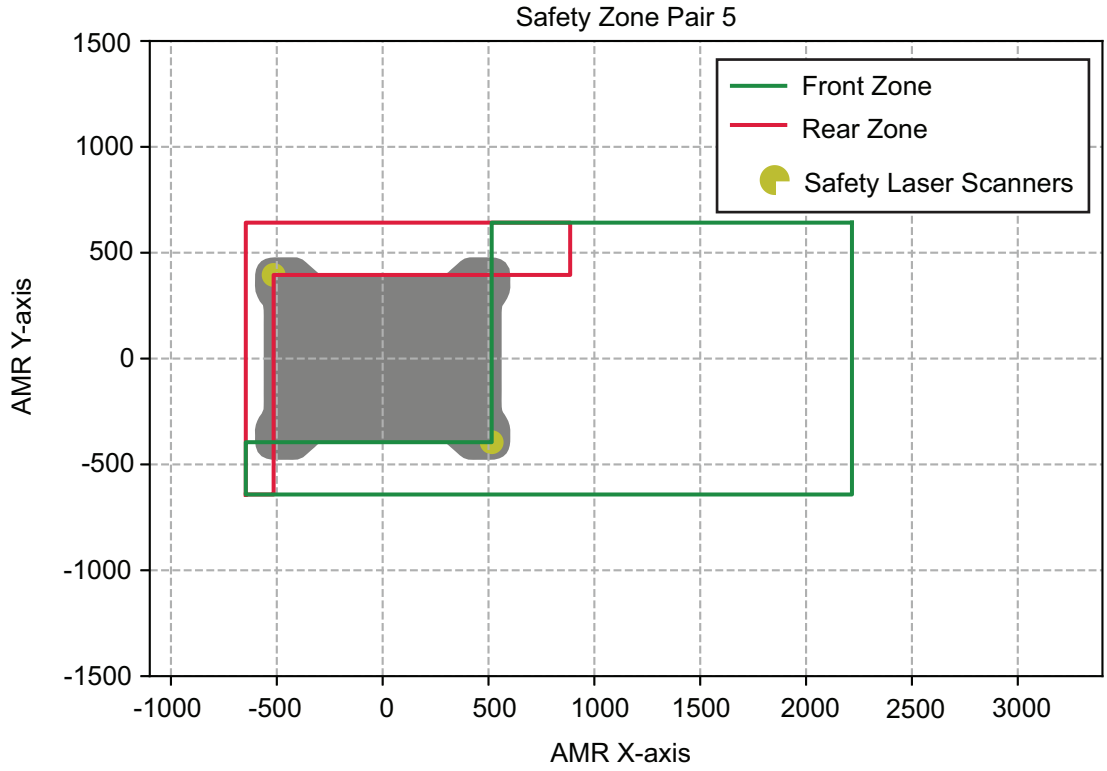
Safety Zone Pair	Applicable Speeds	
	Linear (mm/s)	Rotational (degrees/s)
1	101 to 300	0 to 10
2	301 to 700	
3	701 to 900	
4	901 to 1200	
5	1201 to 1600	
6	1601 to 1900 (for MD-650) 1601 to 1800 (for MD-900)	
7	1901 to 2200 (for MD-650) Not applicable for MD-900	

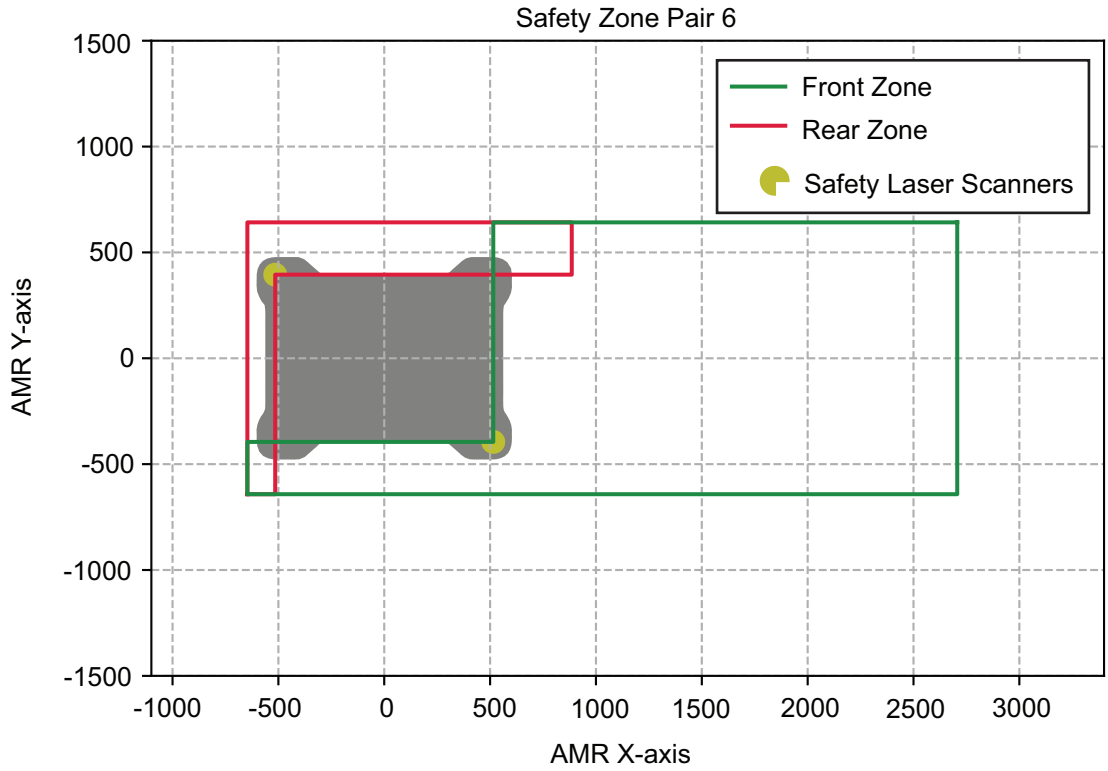

Safety Zone Pair 1
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000

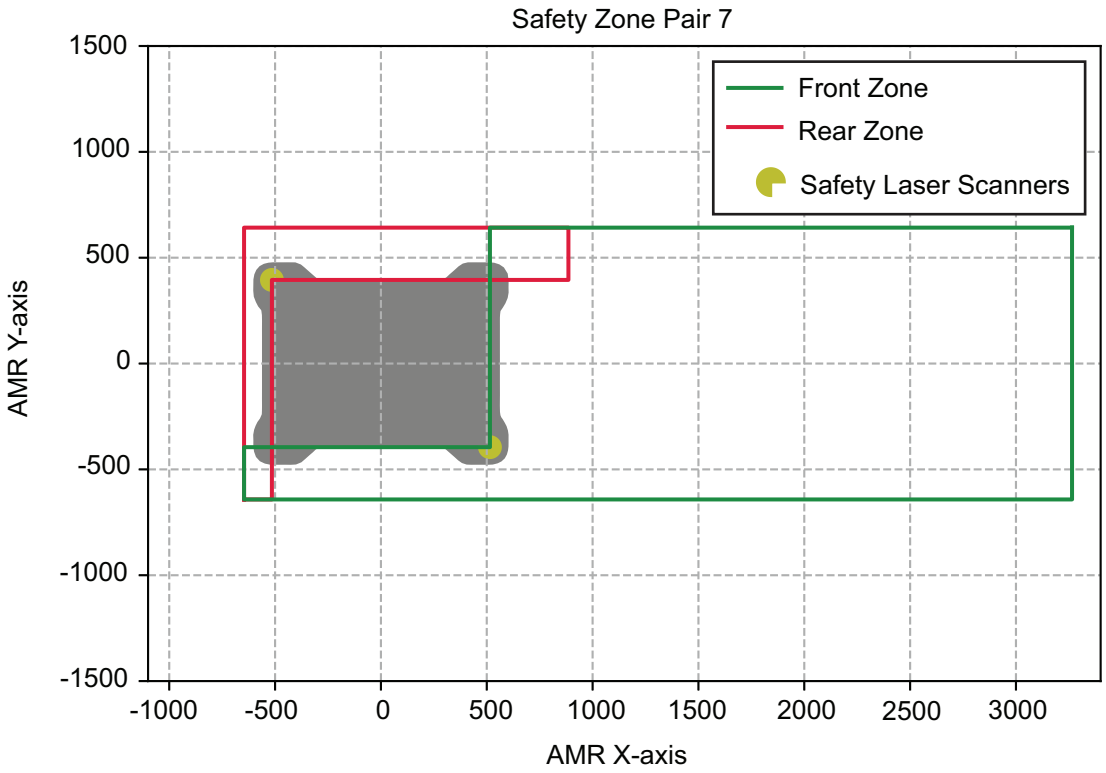

Safety Zone Pair 2
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000


Safety Zone Pair 3
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000


Safety Zone Pair 4
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000


Safety Zone Pair 5
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000

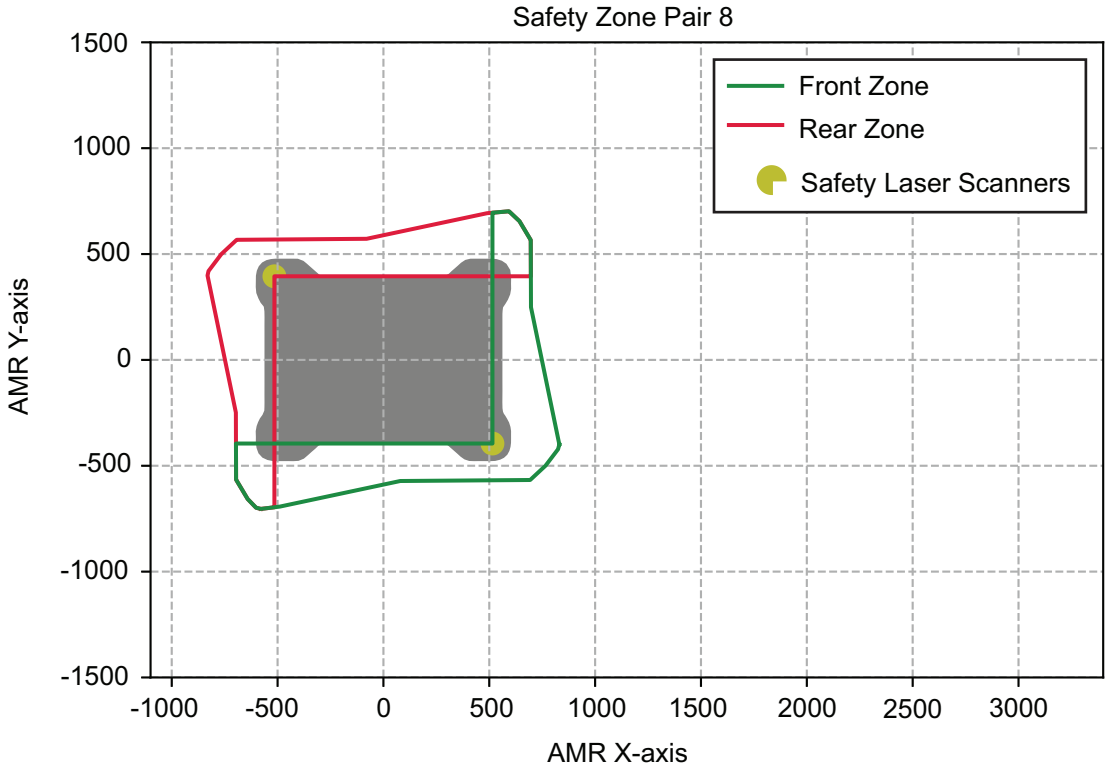

Safety Zone Pair 6
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000

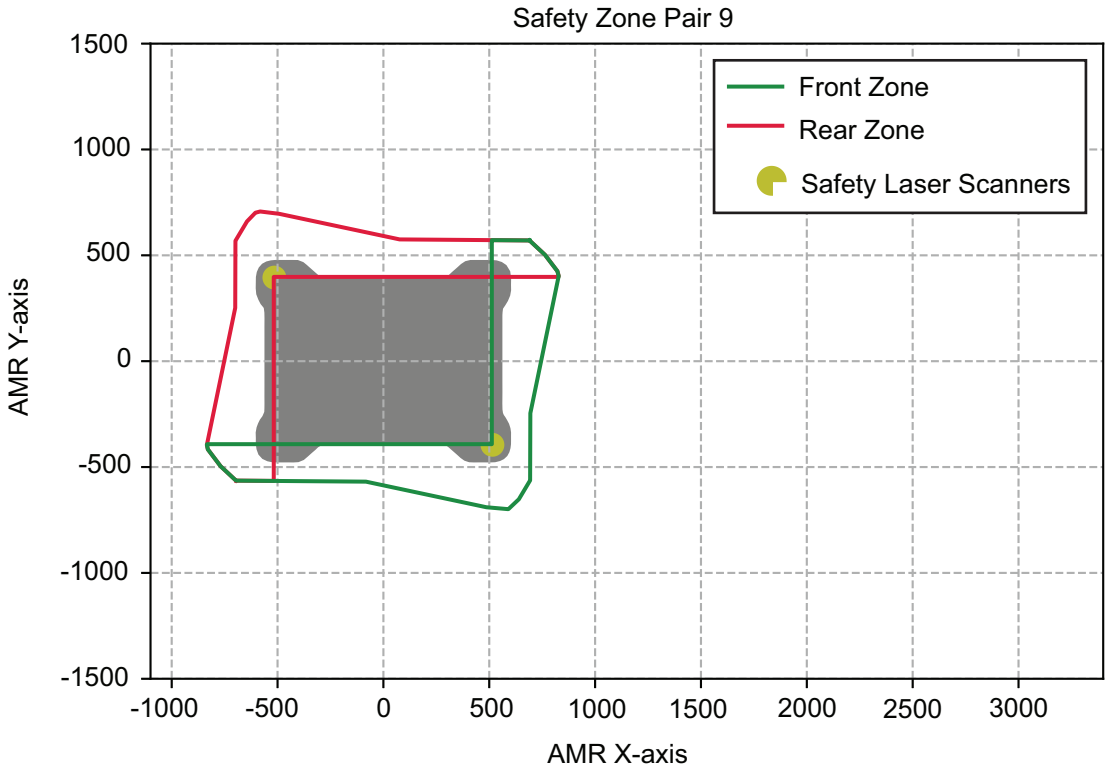


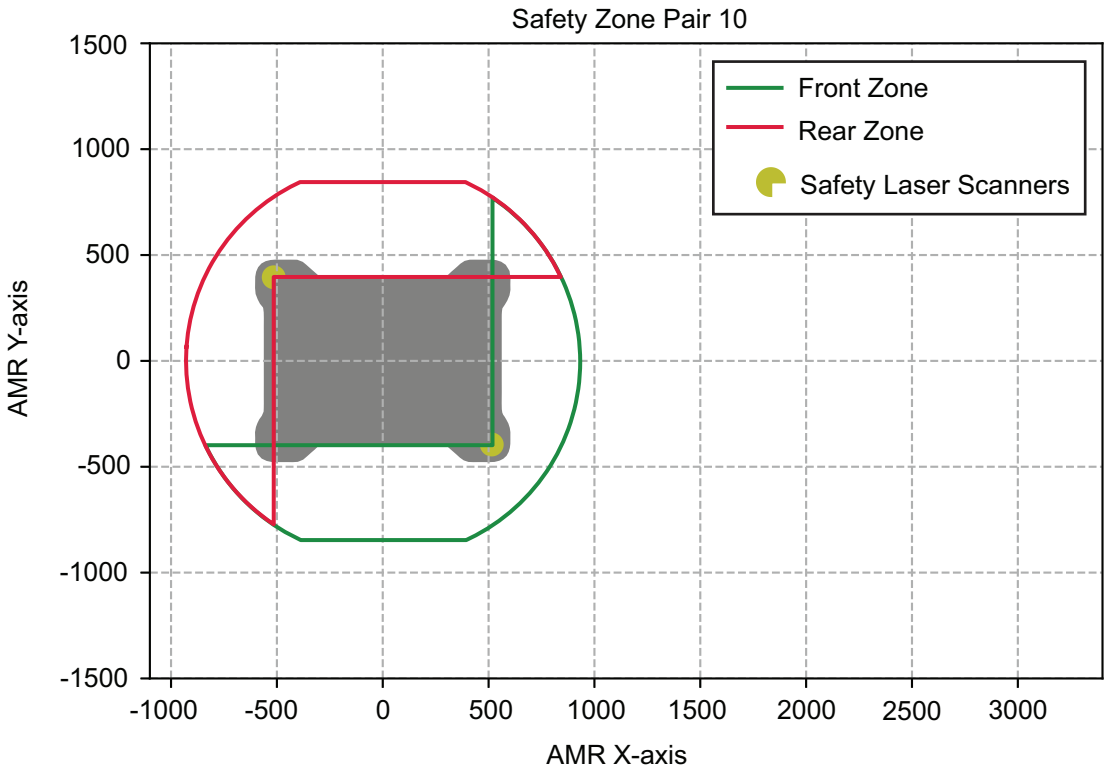
● Rotating While Driving Slowly

Safety zone pairs 8 to 10 are used when the AMR is rotating while driving slowly with the following speeds.

Safety Zone Pair	Applicable Speeds	
	Linear (mm/s)	Rotational (degrees/s)
8	0 to 100	11 to 30 counterclockwise
9		11 to 30 clockwise
10		31 to 60


Safety Zone Pair 8
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000


Safety Zone Pair 9
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000

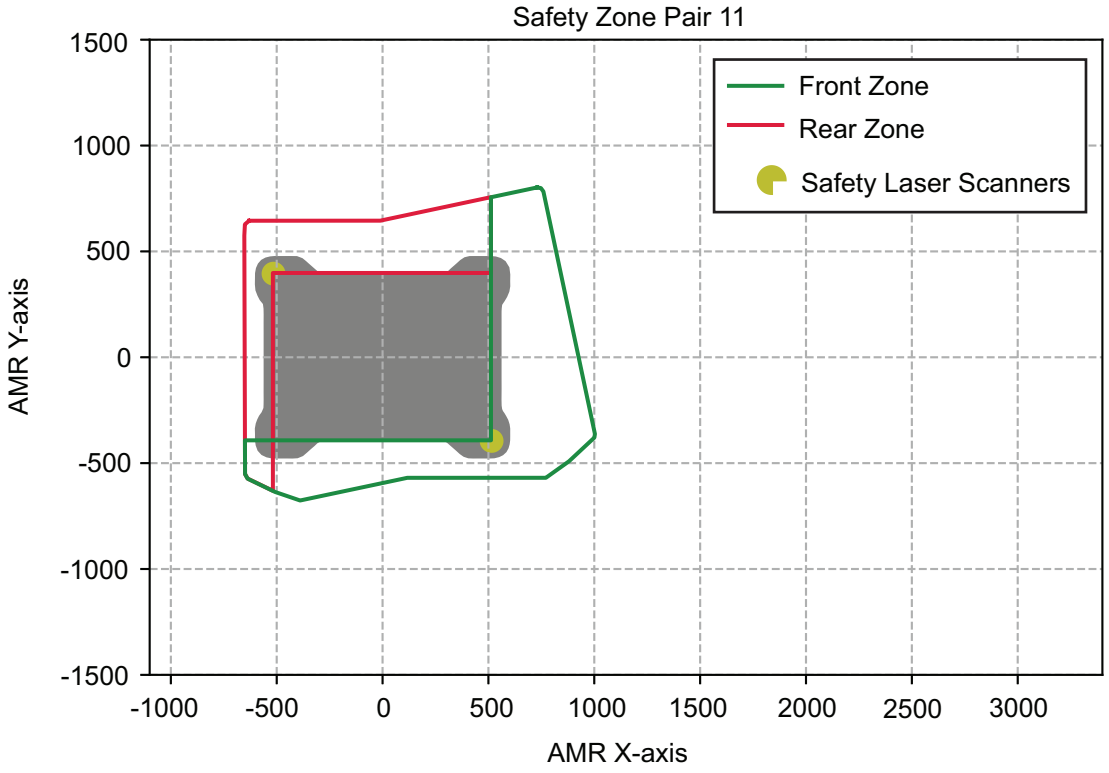


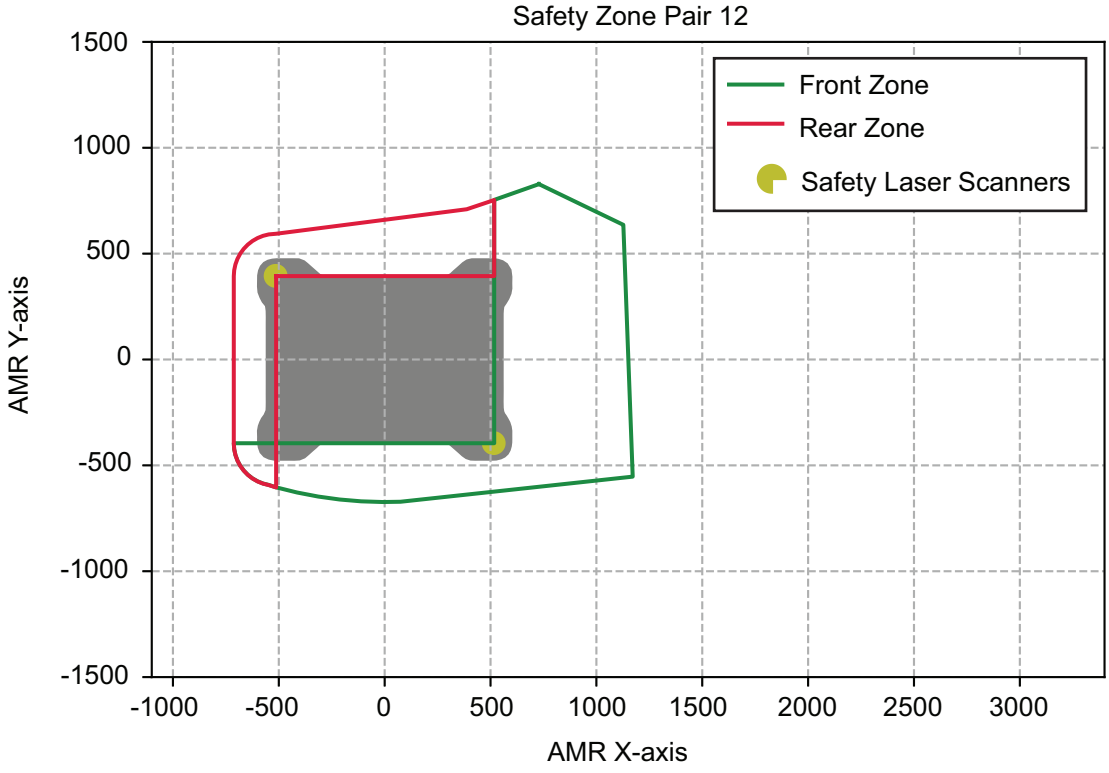
● Driving in an Arc (Turning)

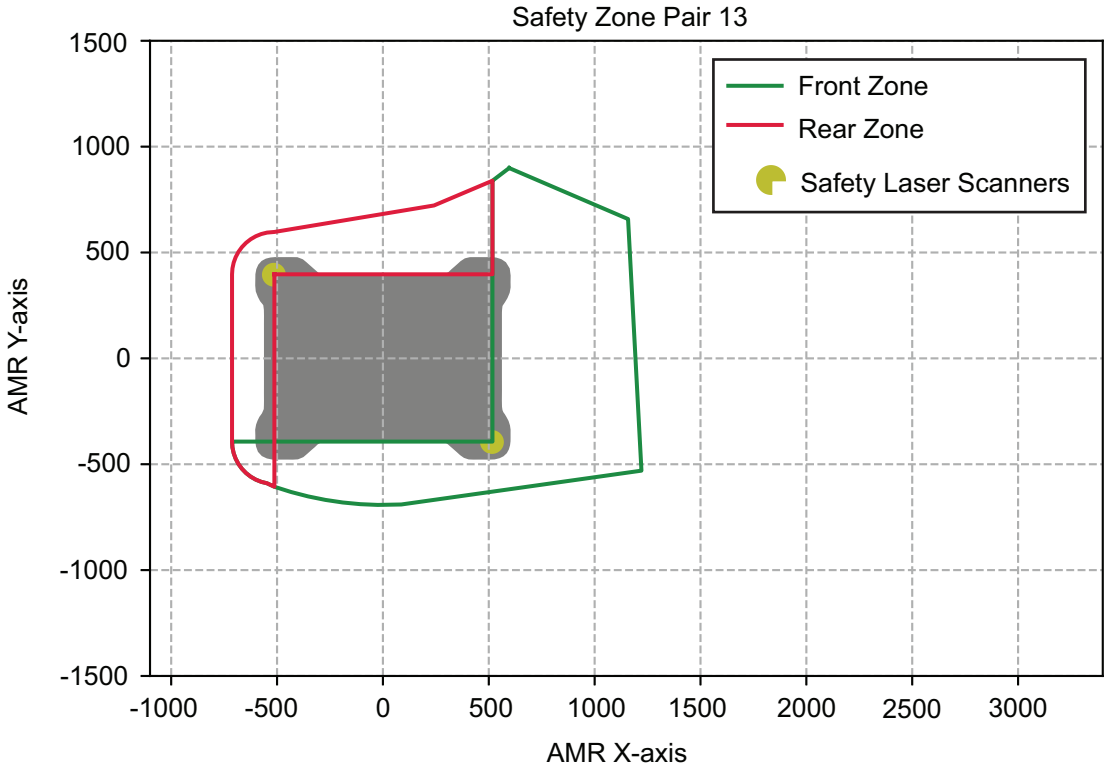
Safety zone pairs 11 to 32 are used when the AMR is driving in an arc (turning) with the following speeds.

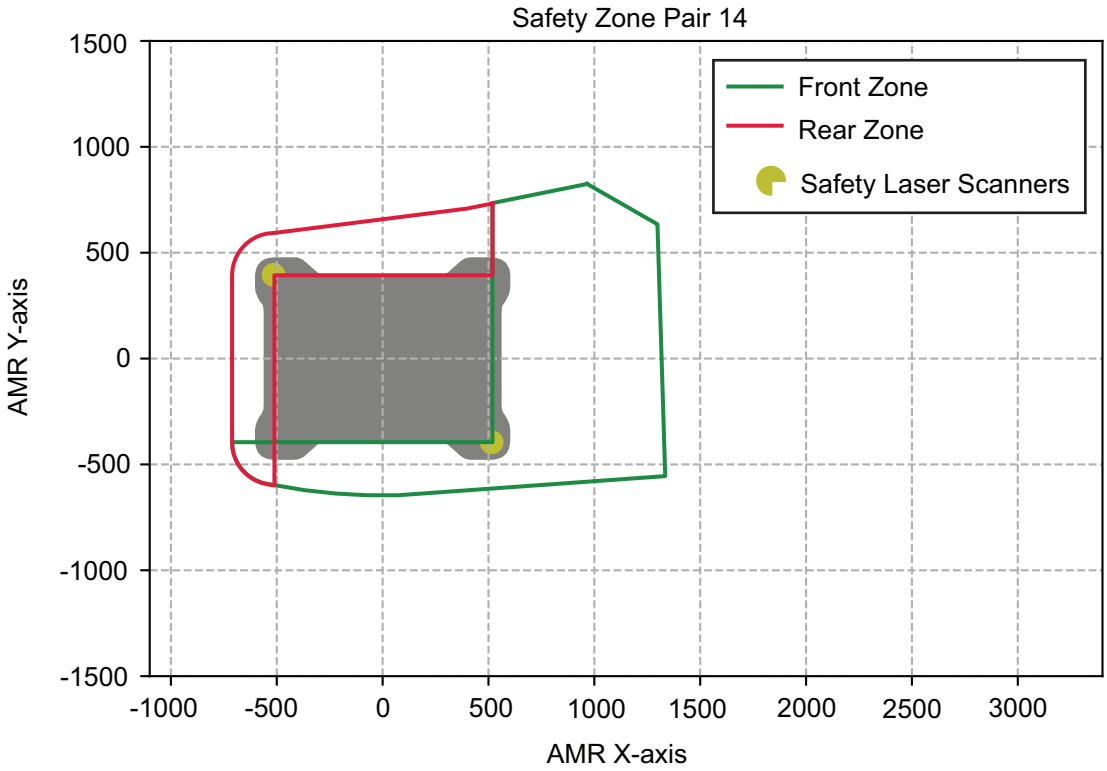
Safety Zone Pair	Applicable Speeds	
	Linear (mm/s)	Rotational (degrees/s)
11	101 to 300	11 to 30 counterclockwise
12	301 to 700	
13	101 to 700	31 to 45 counterclockwise
14	701 to 900	11 to 20 counterclockwise
15		21 to 30 counterclockwise
16		31 to 45 counterclockwise
17	901 to 1200	11 to 20 counterclockwise
18		21 to 32 counterclockwise
19	1201 to 1600	11 to 24 counterclockwise
20	1601 to 1900 (for MD-650) 1601 to 1800 (for MD-900)	11 to 20 counterclockwise
21	1901 to 2200 (for MD-650) Not applicable for MD-900	
22	101 to 300	11 to 30 clockwise
23	301 to 700	
24	101 to 700	31 to 45 clockwise
25	701 to 900	11 to 20 clockwise
26		21 to 30 clockwise
27		31 to 45 clockwise
28	901 to 1200	11 to 20 clockwise
29		21 to 32 clockwise
30	1201 to 1600	11 to 24 clockwise

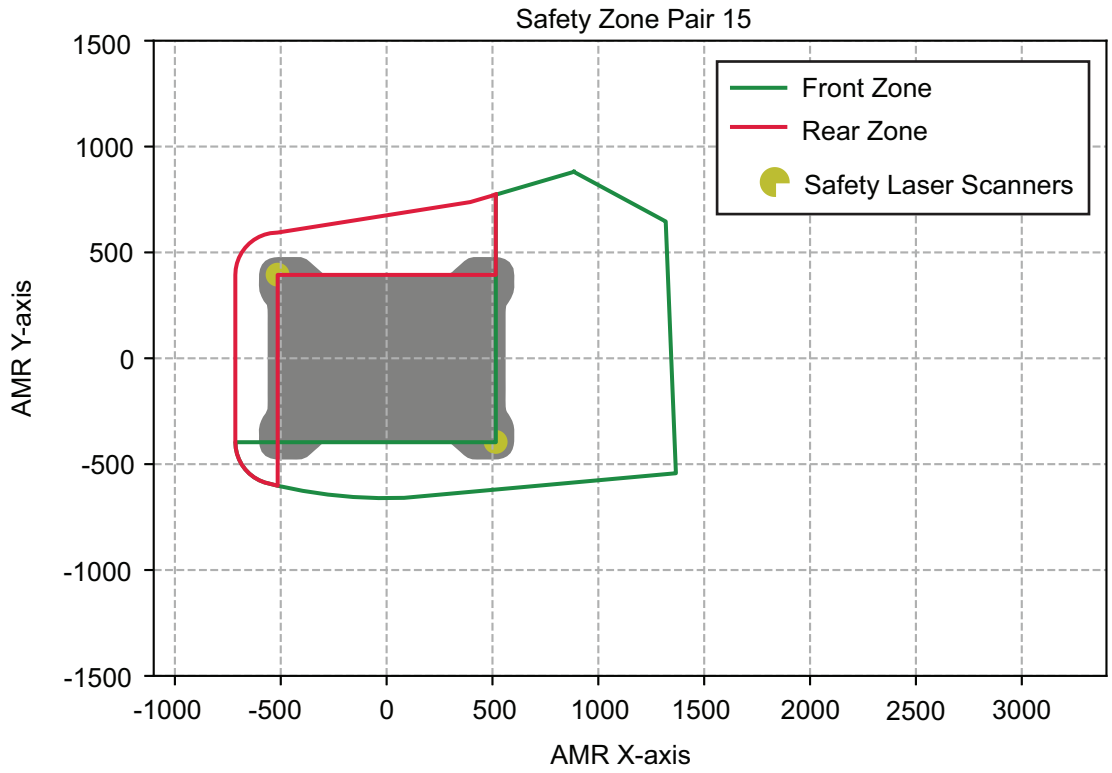
Safety Zone Pair	Applicable Speeds	
	Linear (mm/s)	Rotational (degrees/s)
31	1601 to 1900 (for MD-650) 1601 to 1800 (for MD-900)	11 to 20 clockwise
32	1901 to 2200 (for MD-650) Not applicable for MD-900	

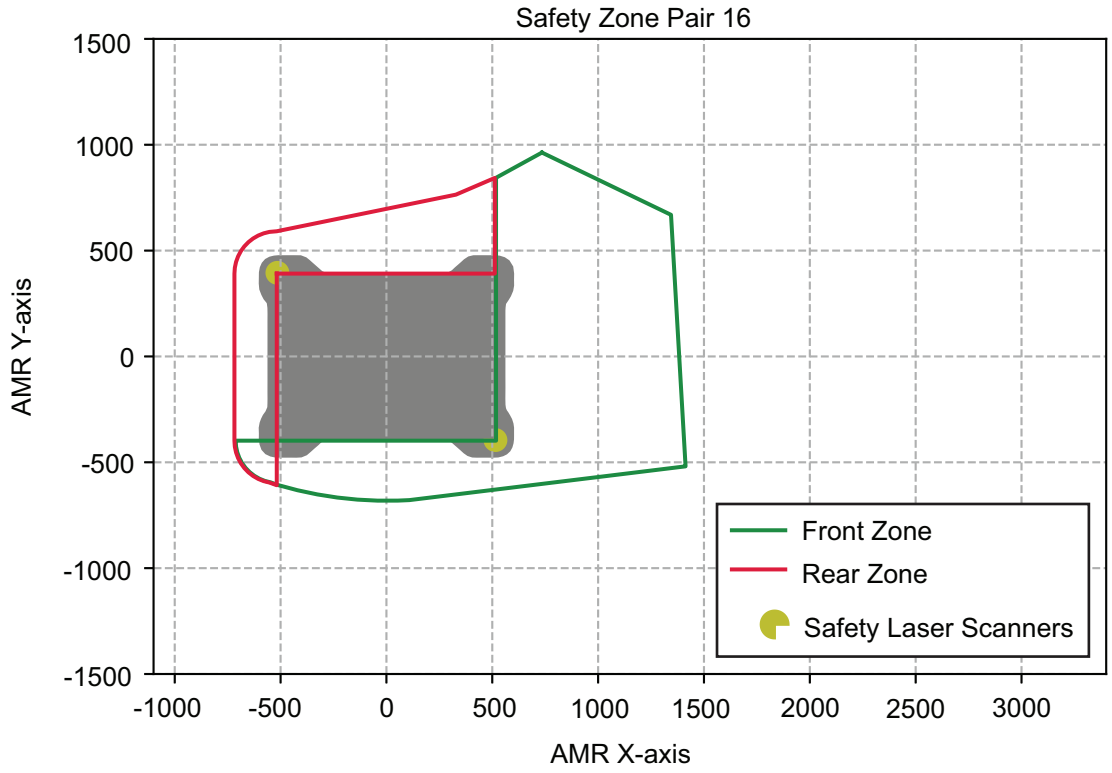


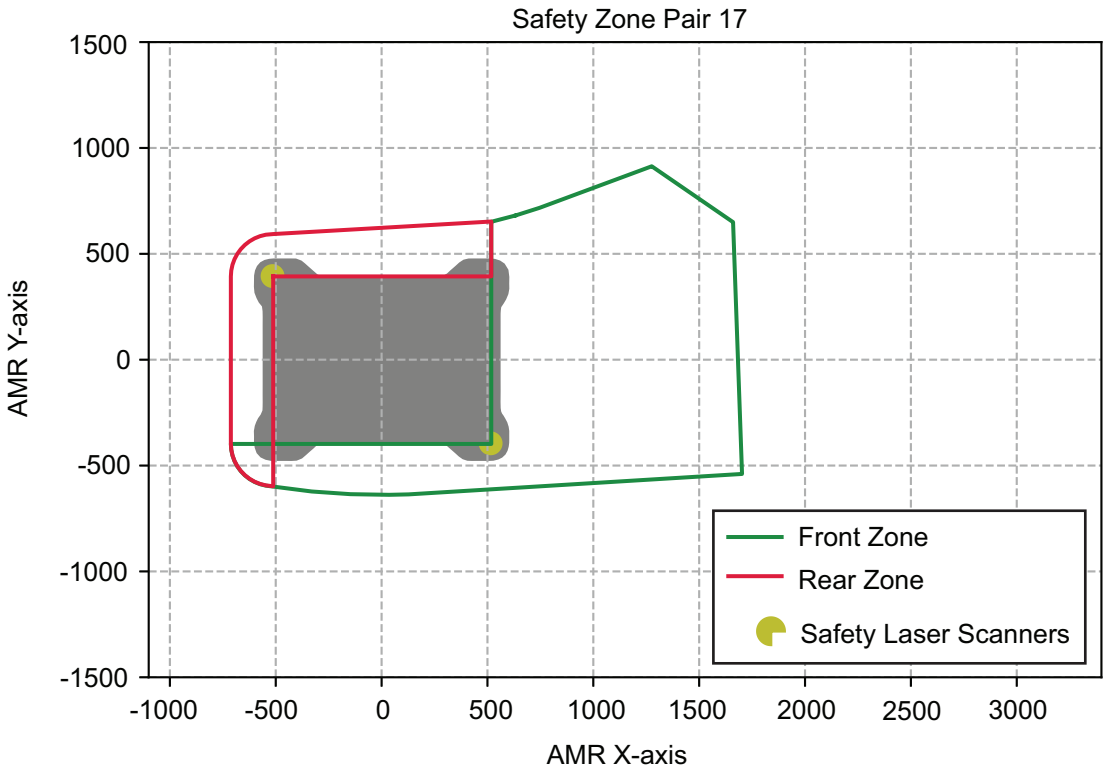


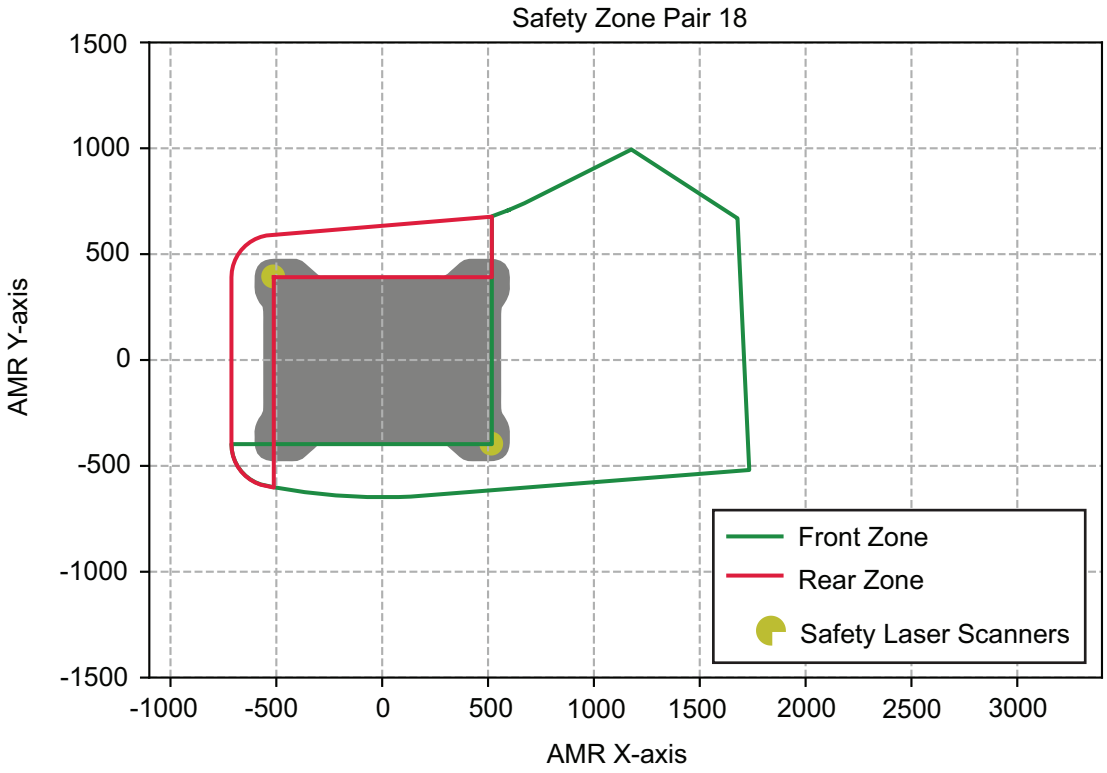

Safety Zone Pair 13
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000

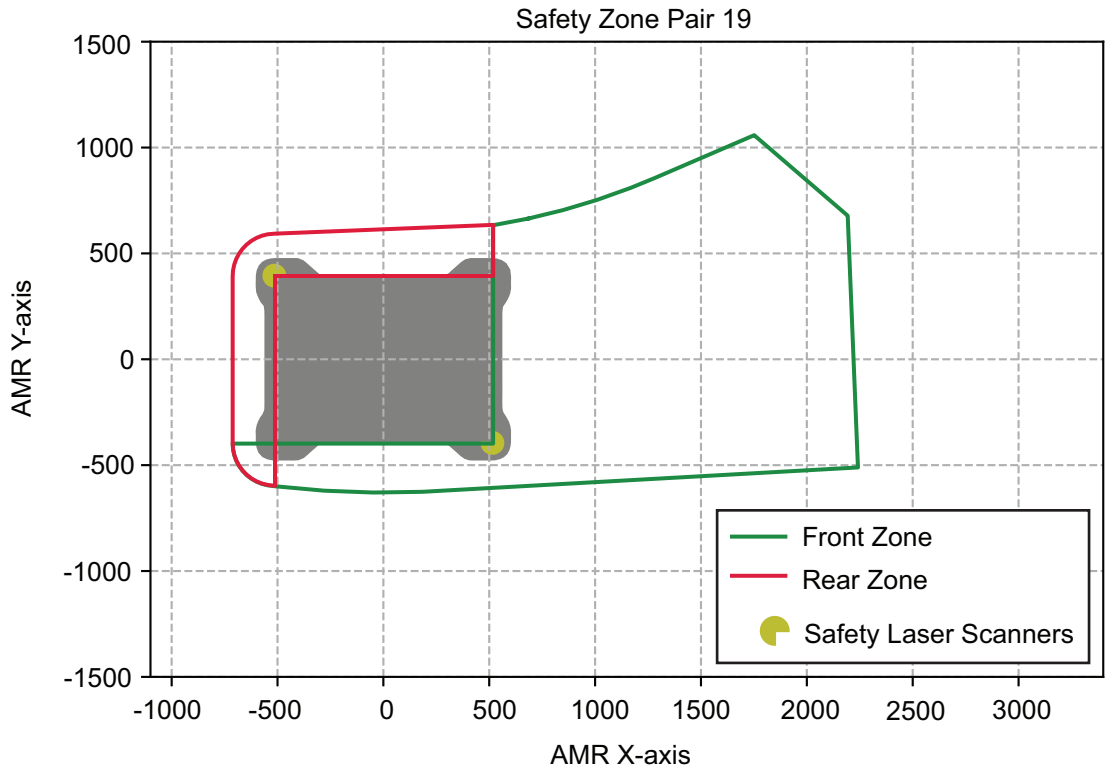

Safety Zone Pair 14
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000

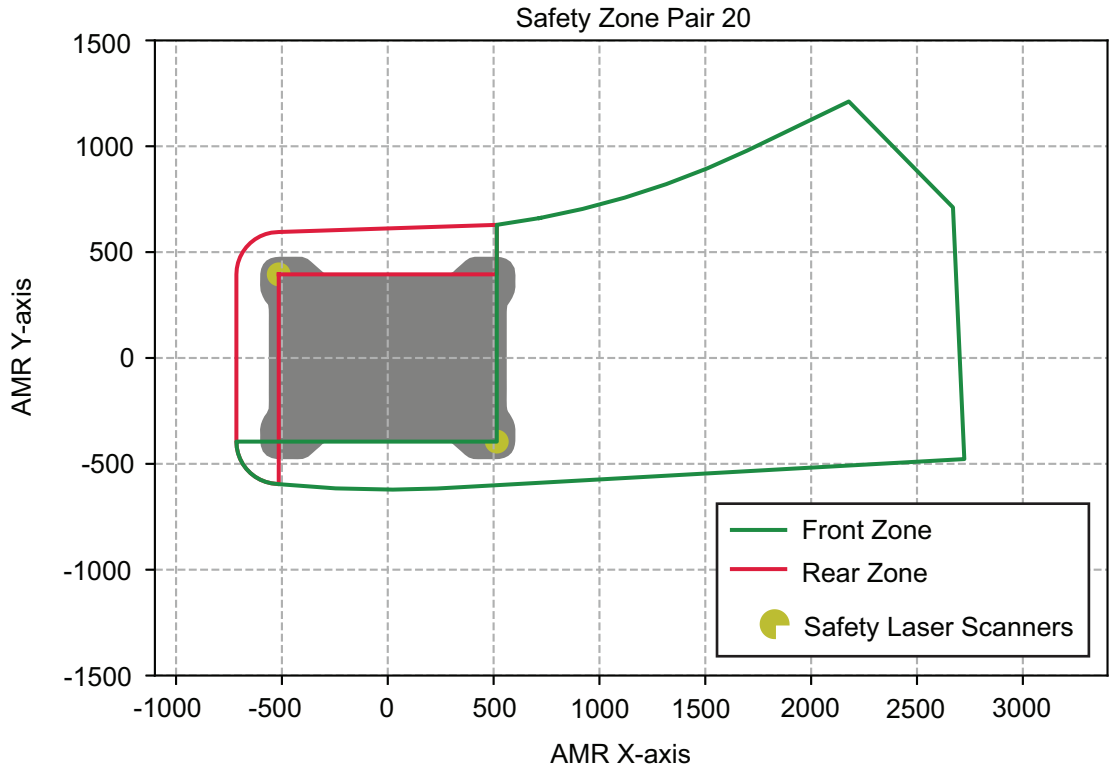

Safety Zone Pair 15
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000

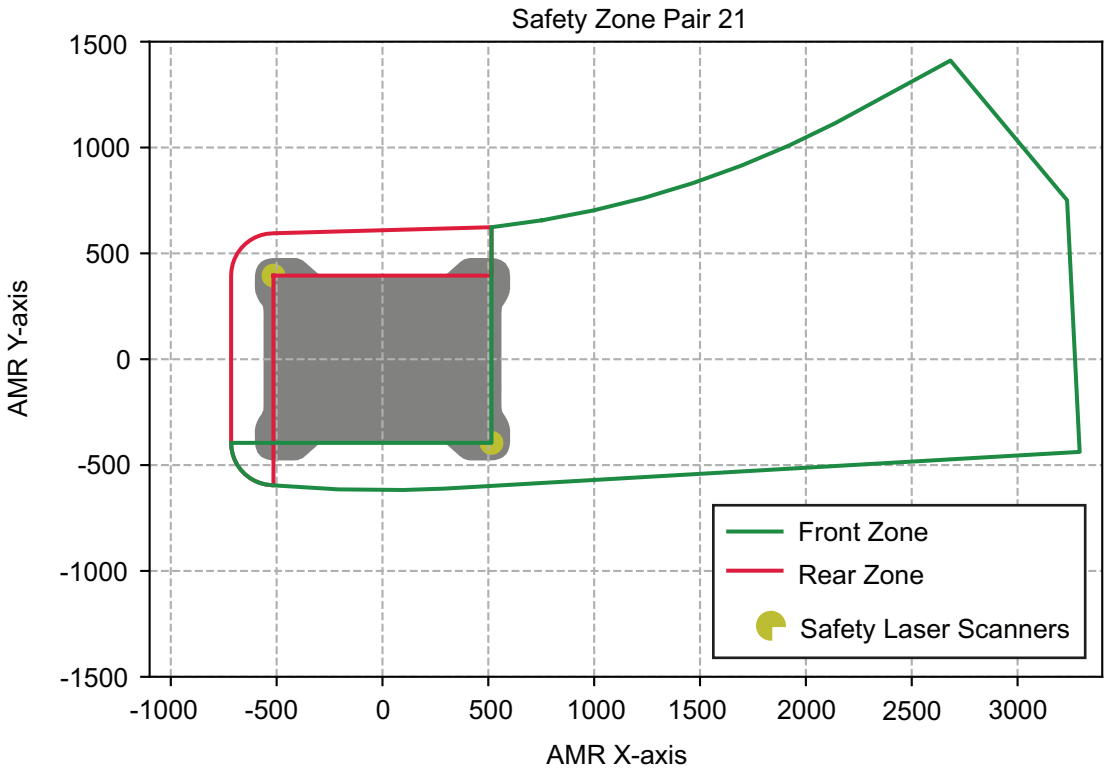

Safety Zone Pair 16
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000

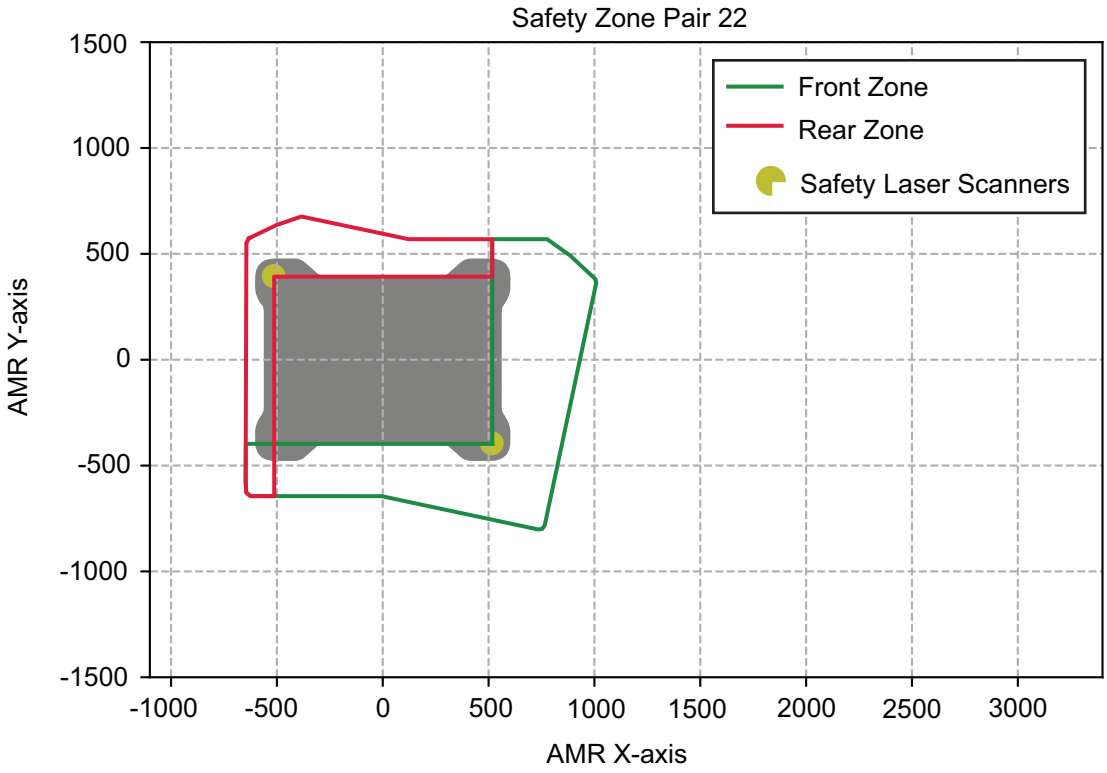

Safety Zone Pair 17
1500
1000
500
0
-500
-1000
-1500
AMR Y-axis
-1000
-500
0
500
1000
1500
2000
2500
3000
AMR X-axis
Front Zone
Rear Zone
Safety Laser Scanners

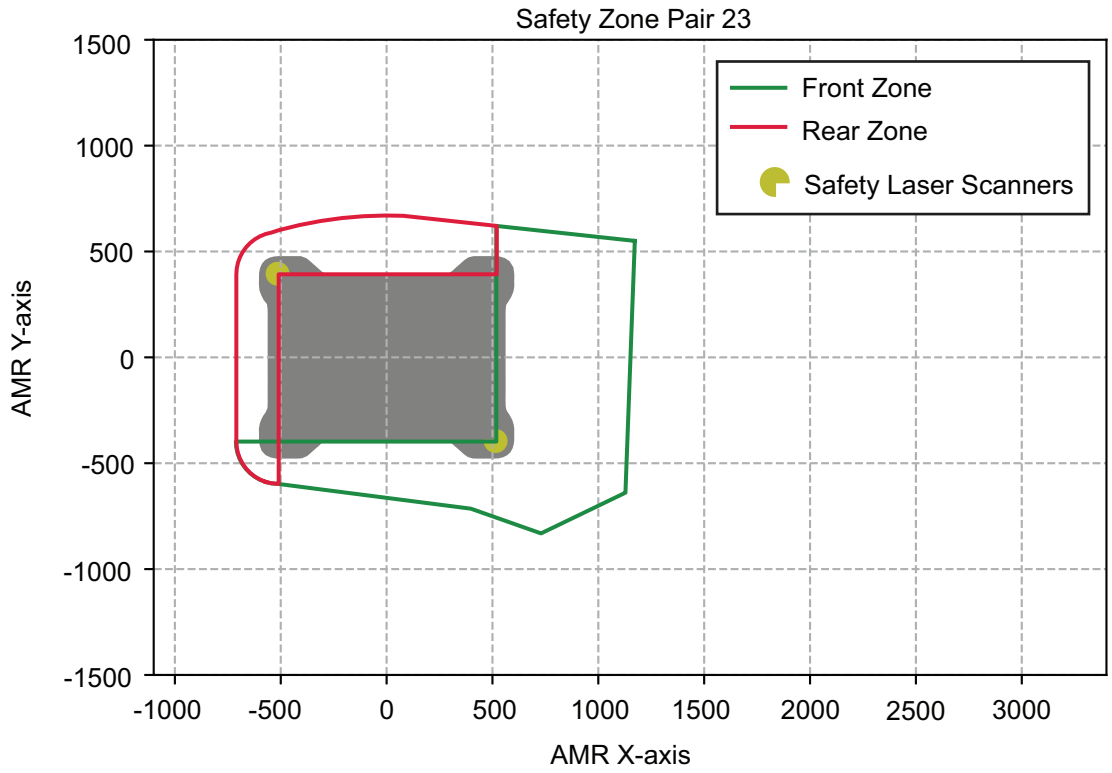

Safety Zone Pair 18
1500
1000
500
0
-500
-1000
-1500
AMR Y-axis
-1000
-500
0
500
1000
1500
2000
2500
3000
AMR X-axis
Front Zone
Rear Zone
Safety Laser Scanners

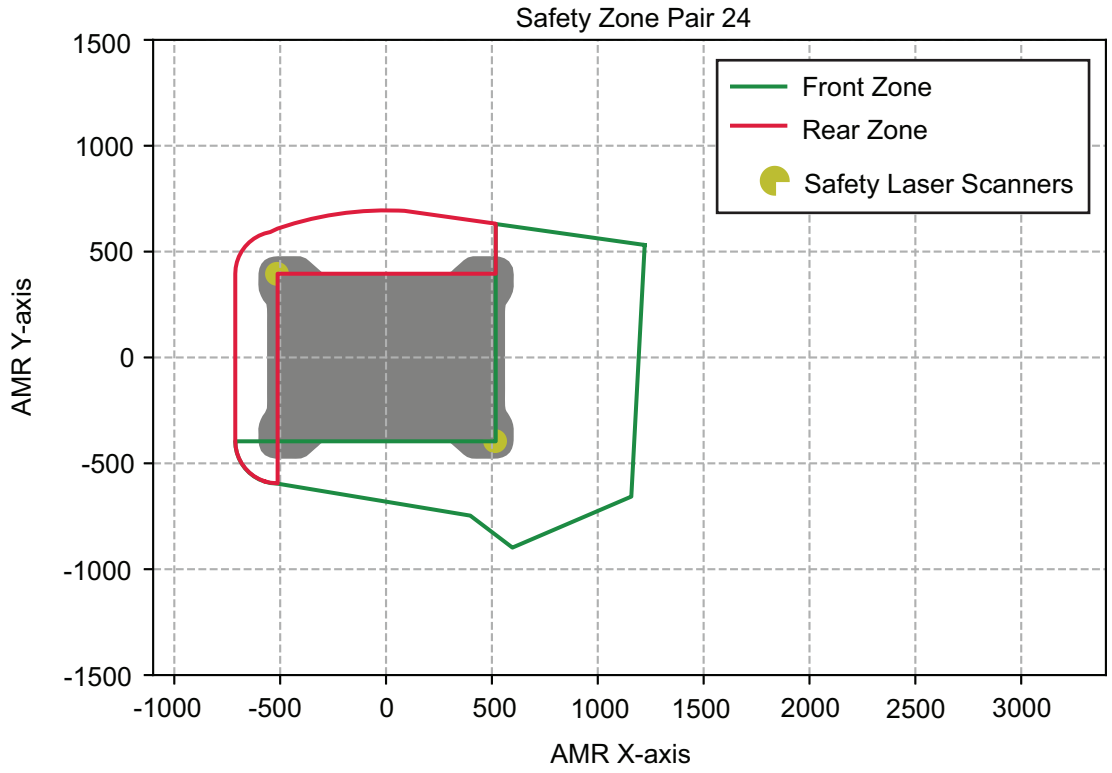

Safety Zone Pair 19
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000
Front Zone
Rear Zone
Safety Laser Scanners

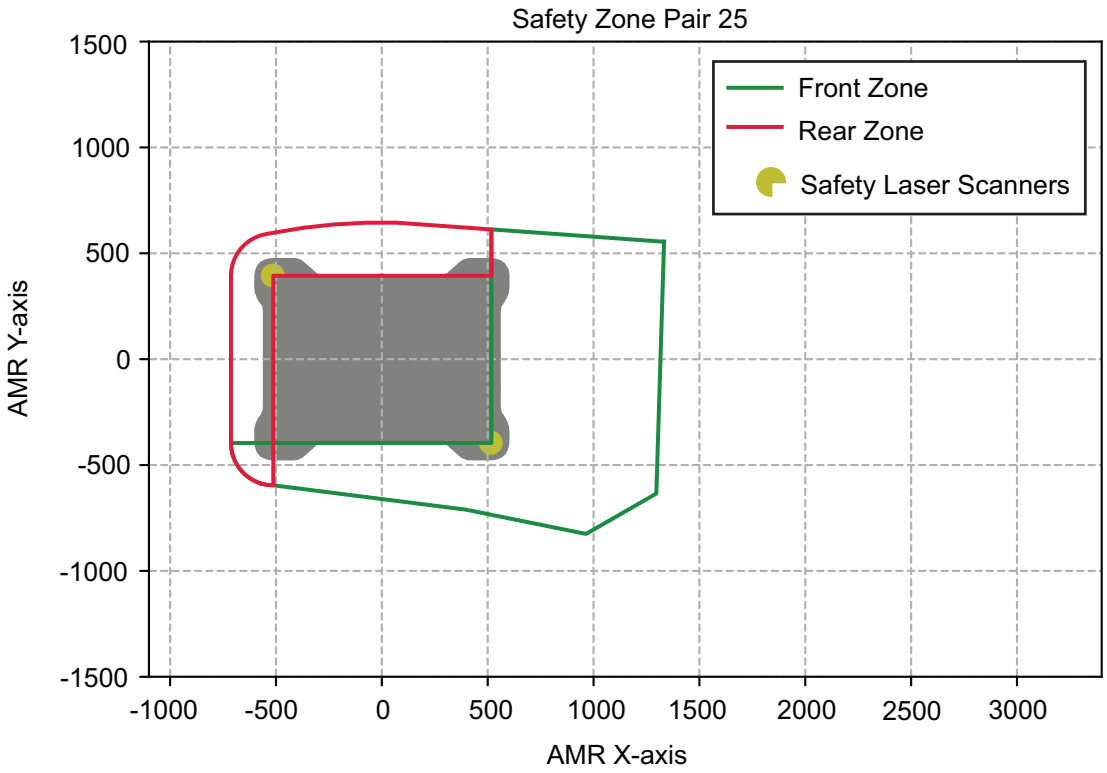

Safety Zone Pair 20
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000
Front Zone
Rear Zone
Safety Laser Scanners

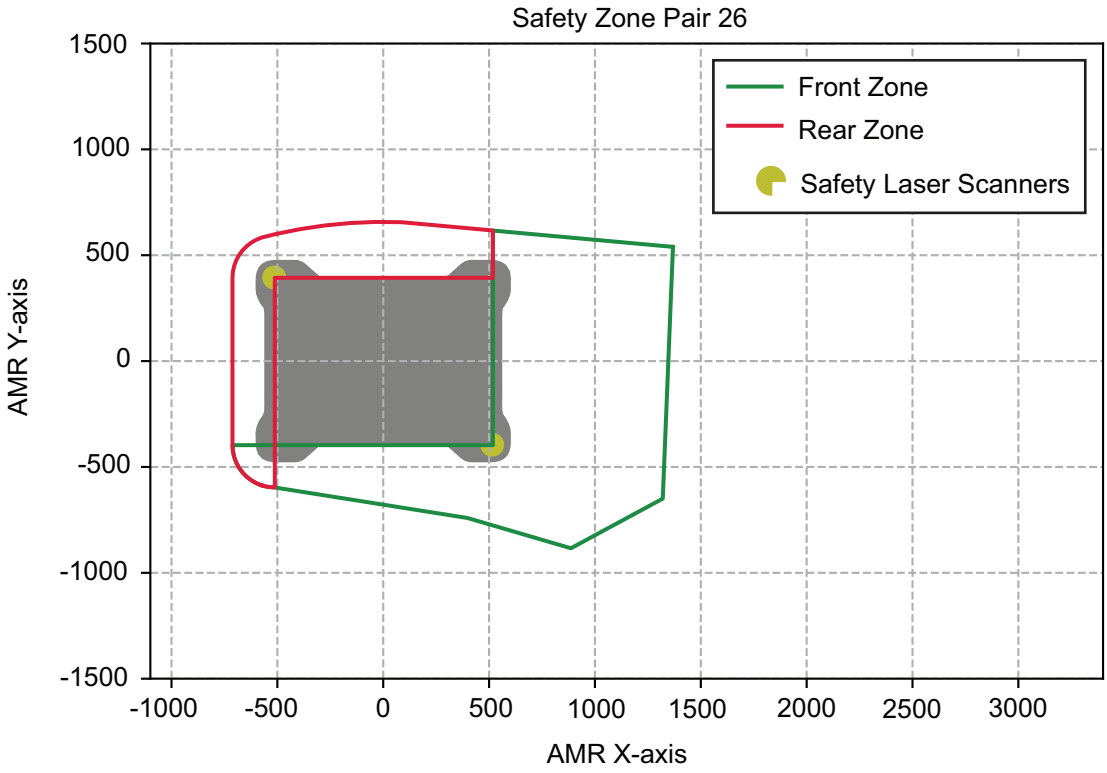

Safety Zone Pair 21
1500
1000
500
0
-500
-1000
-1500
AMR Y-axis
-1000
-500
0
500
1000
1500
2000
2500
3000
AMR X-axis
Front Zone
Rear Zone
Safety Laser Scanners

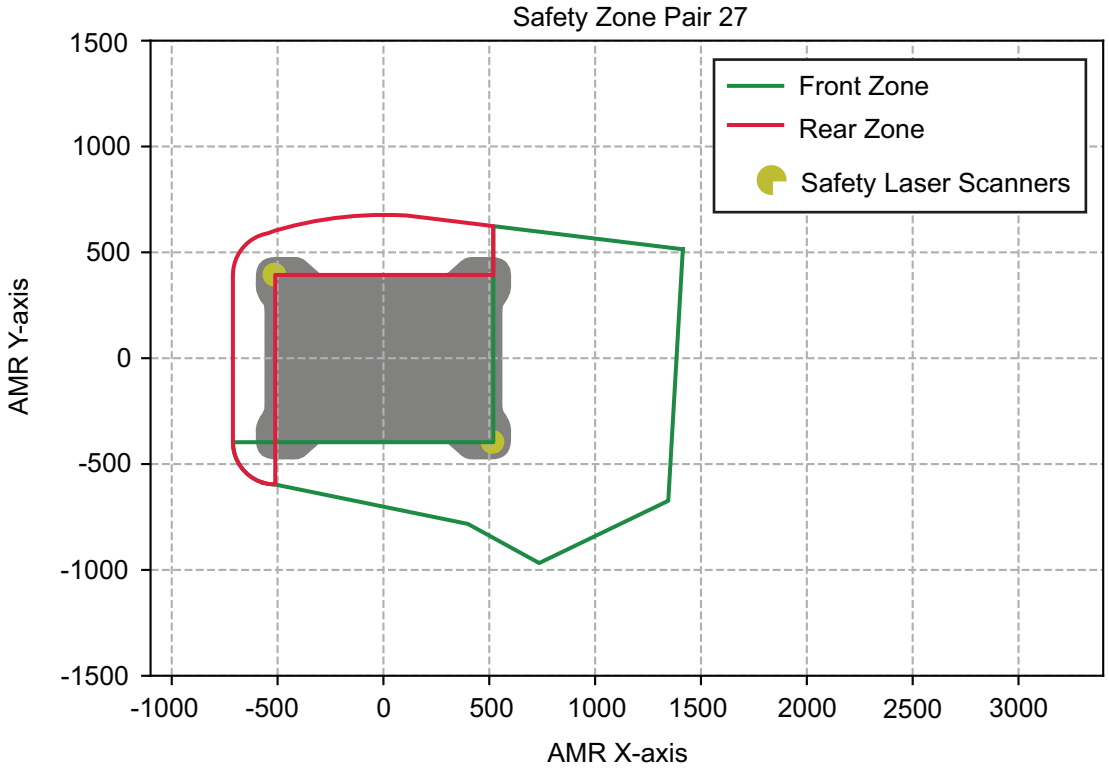

Safety Zone Pair 22
1500
1000
500
0
-500
-1000
-1500
AMR Y-axis
-1000
-500
0
500
1000
1500
2000
2500
3000
AMR X-axis
Front Zone
Rear Zone
Safety Laser Scanners

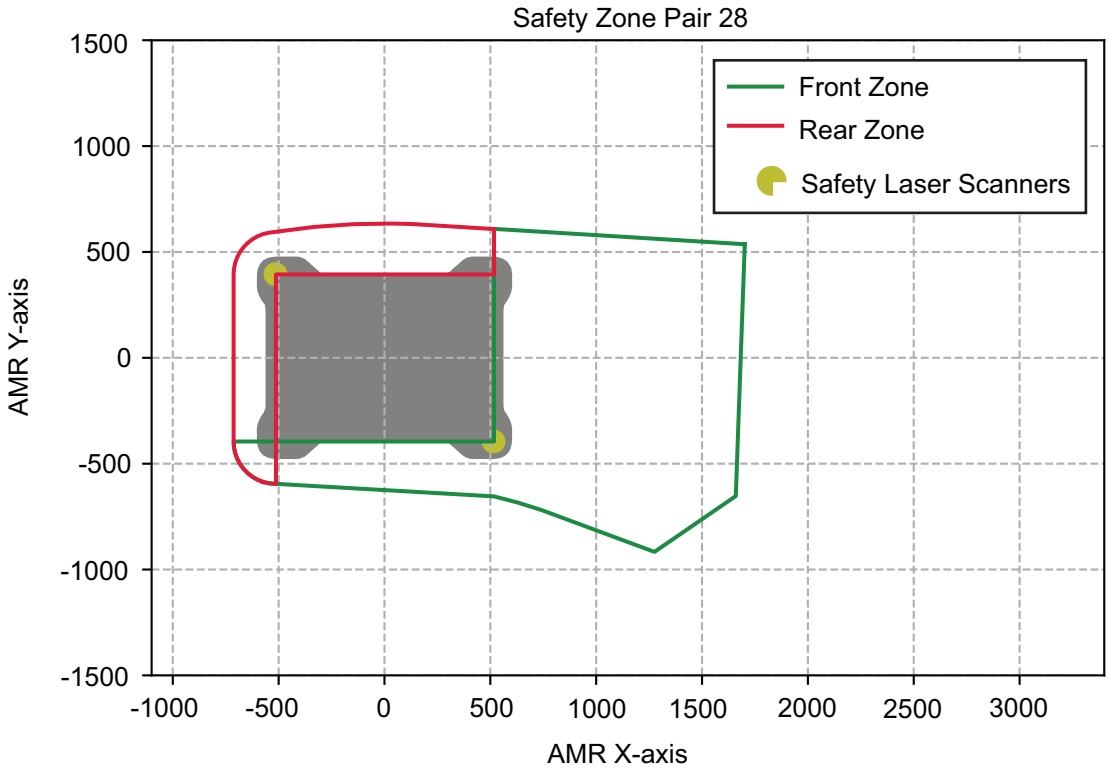

Safety Zone Pair 23
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000

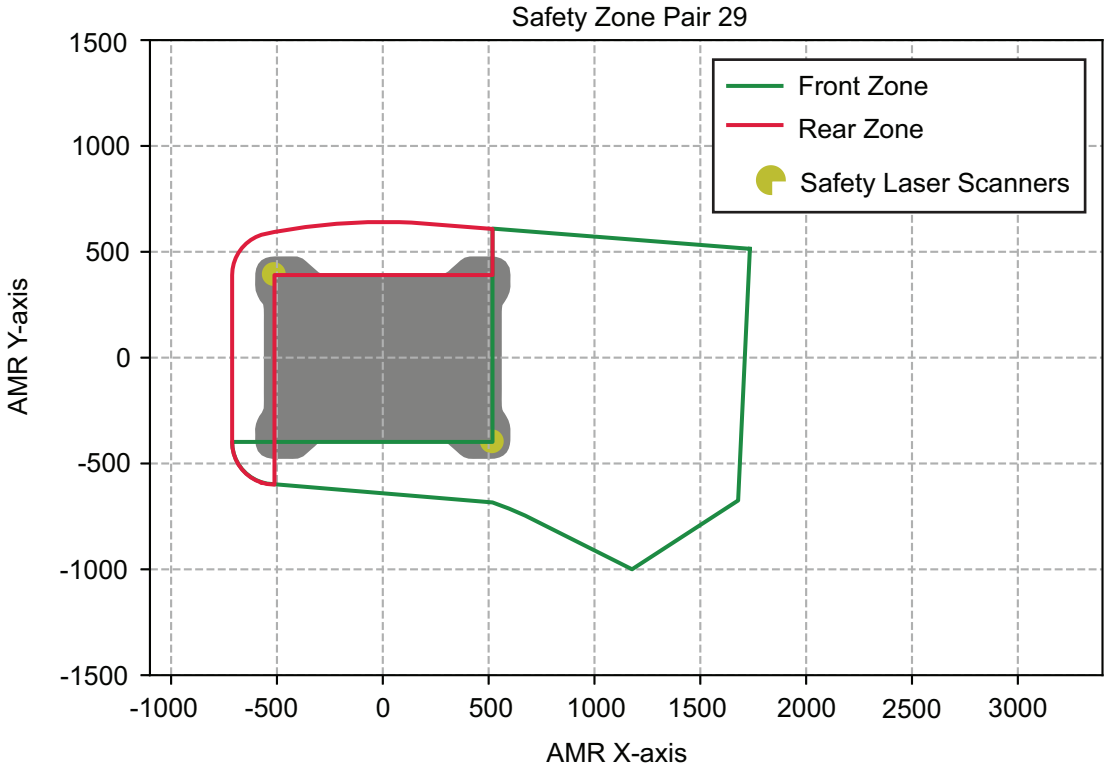

Safety Zone Pair 24
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000

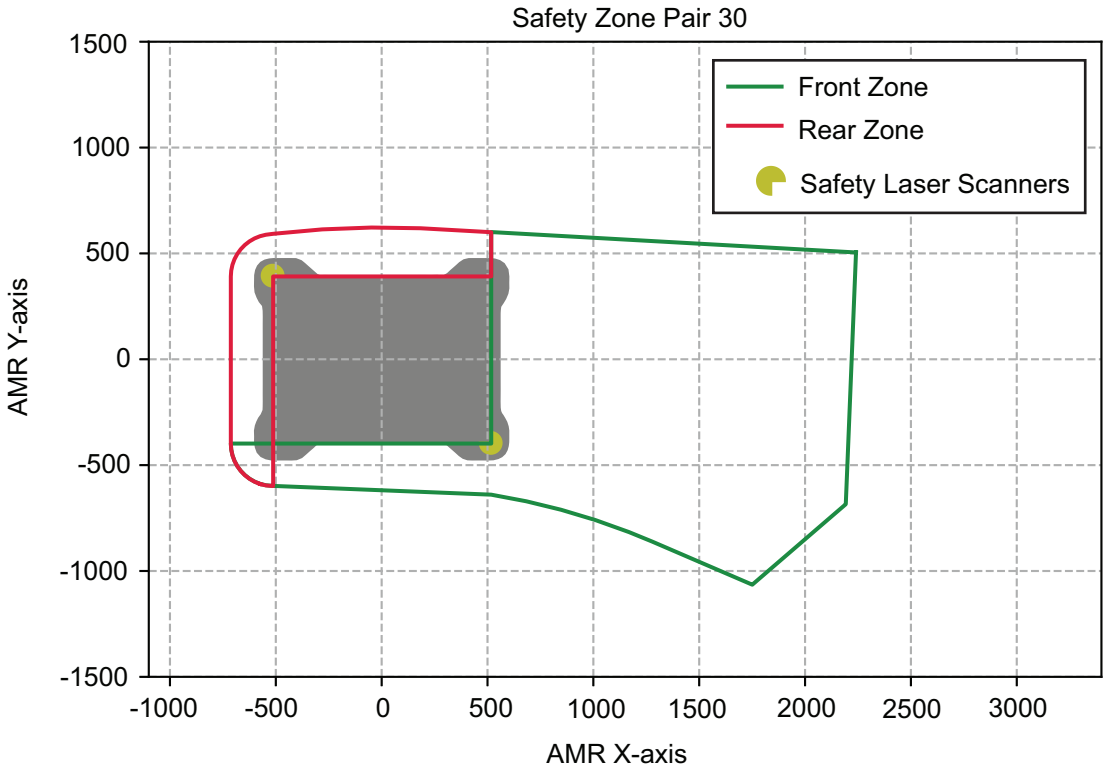

Safety Zone Pair 25
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000

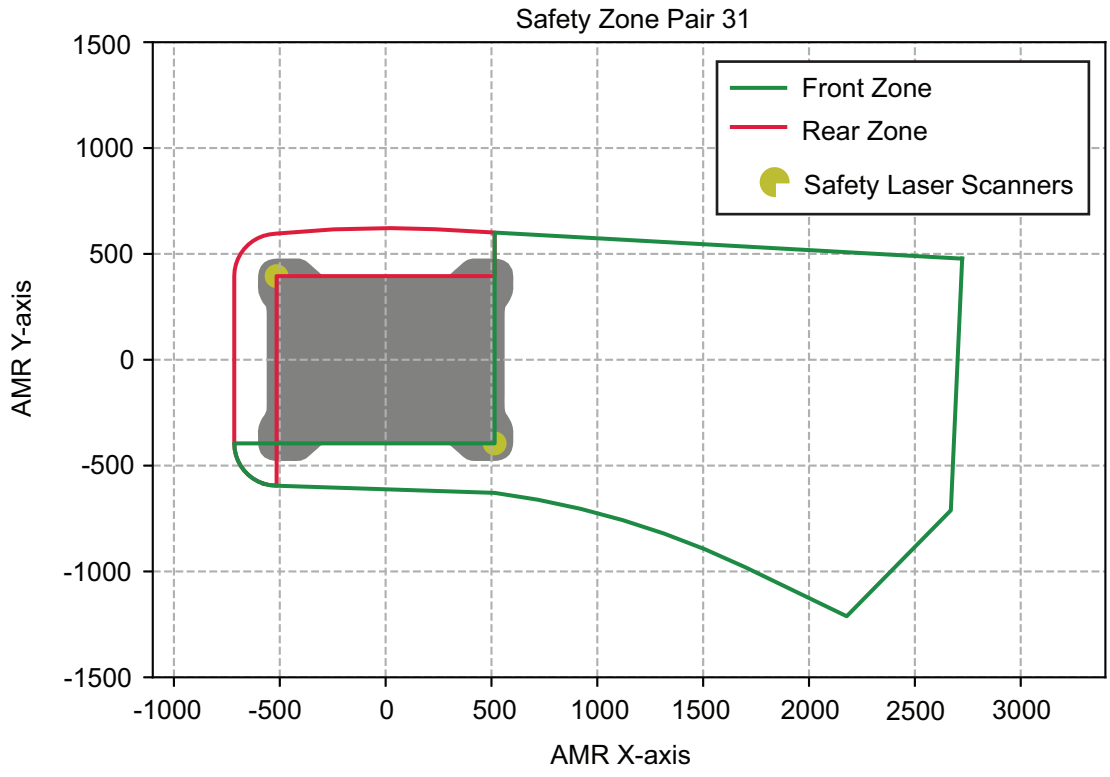

Safety Zone Pair 26
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000

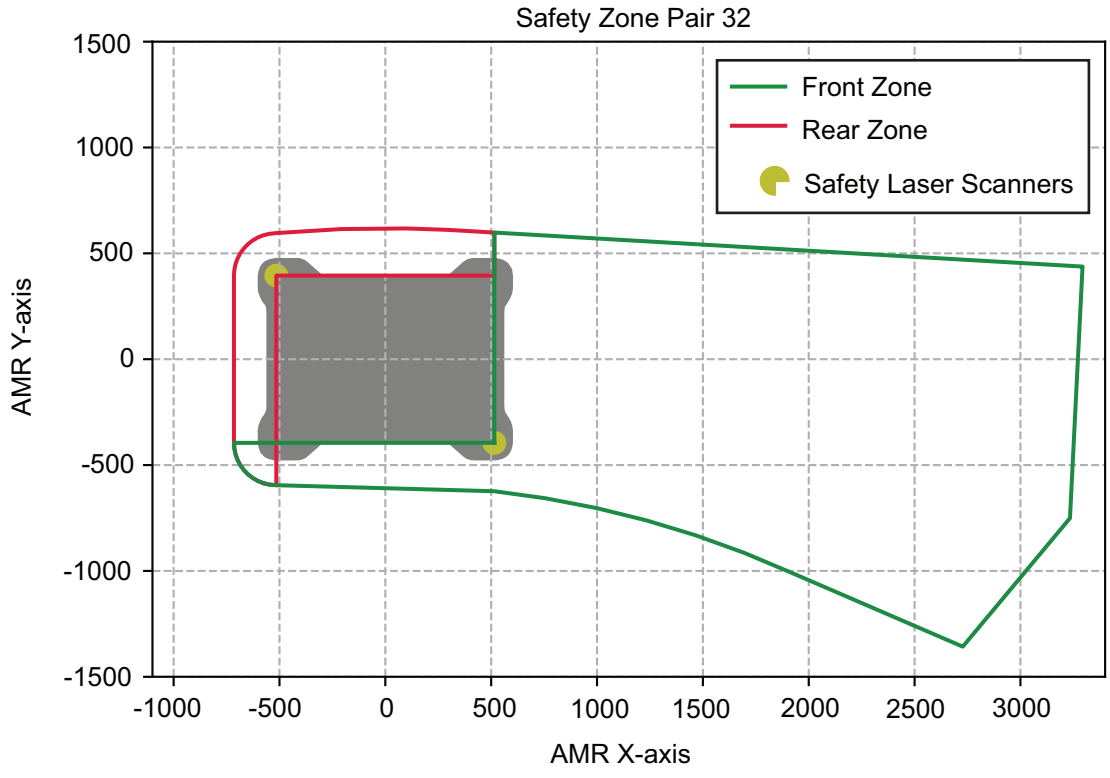

Safety Zone Pair 27
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000


Safety Zone Pair 28
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000


Safety Zone Pair 29
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000


Safety Zone Pair 30
Front Zone
Rear Zone
Safety Laser Scanners
AMR Y-axis
AMR X-axis
1500
1000
500
0
-500
-1000
-1500
-1000
-500
0
500
1000
1500
2000
2500
3000

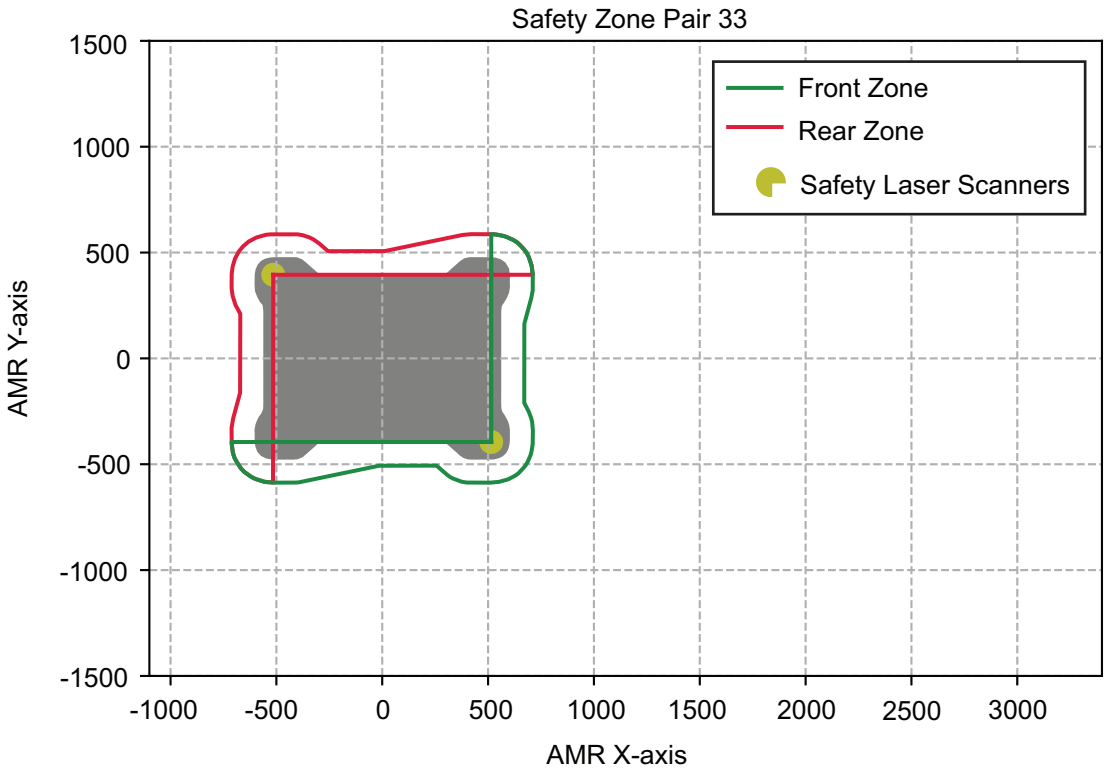




● Traveling at Slow Speeds

Safety zone pair 33 is used when the AMR is traveling at slow speeds as described below.

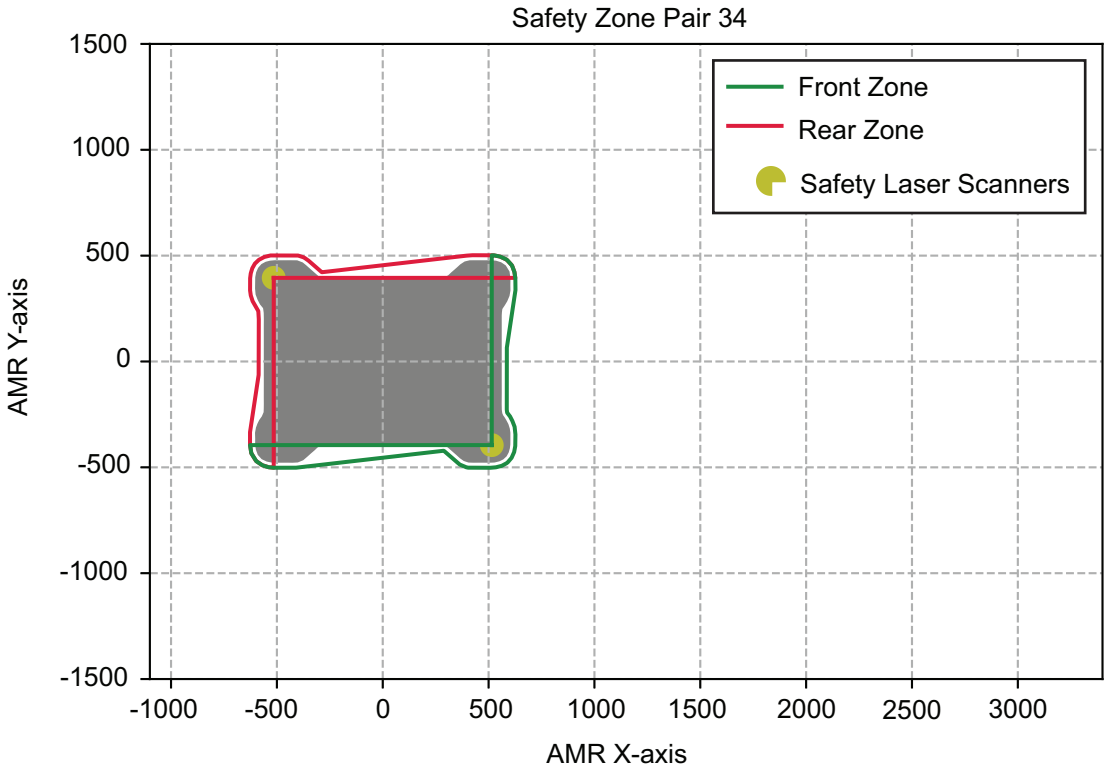
- Linear Speed: 0 to 100 mm/s
- Rotational Speed: 0 to 10 degrees/s



● Moving at Very Slow Speeds with the Pendant Disconnected

Safety zone pair 34 is used when the AMR is moving at the following speeds with the Pendant disconnected.

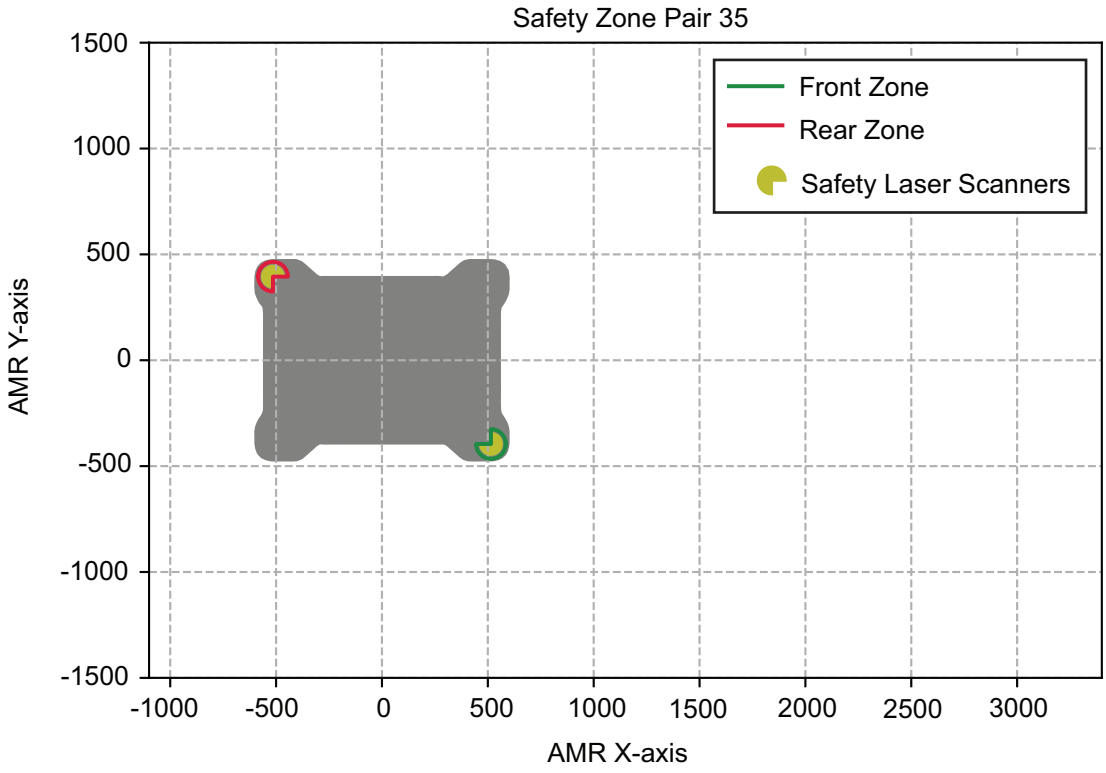
- Linear Speed: 0 to 20 mm/s
- Rotational Speed: 0 to 3 degrees/s



● Moving at Very Slow Speeds with the Pendant Connected

Safety zone pair 35 is a nulled zone pair. It is used when the AMR is moving at the following speeds with the Pendant connected.

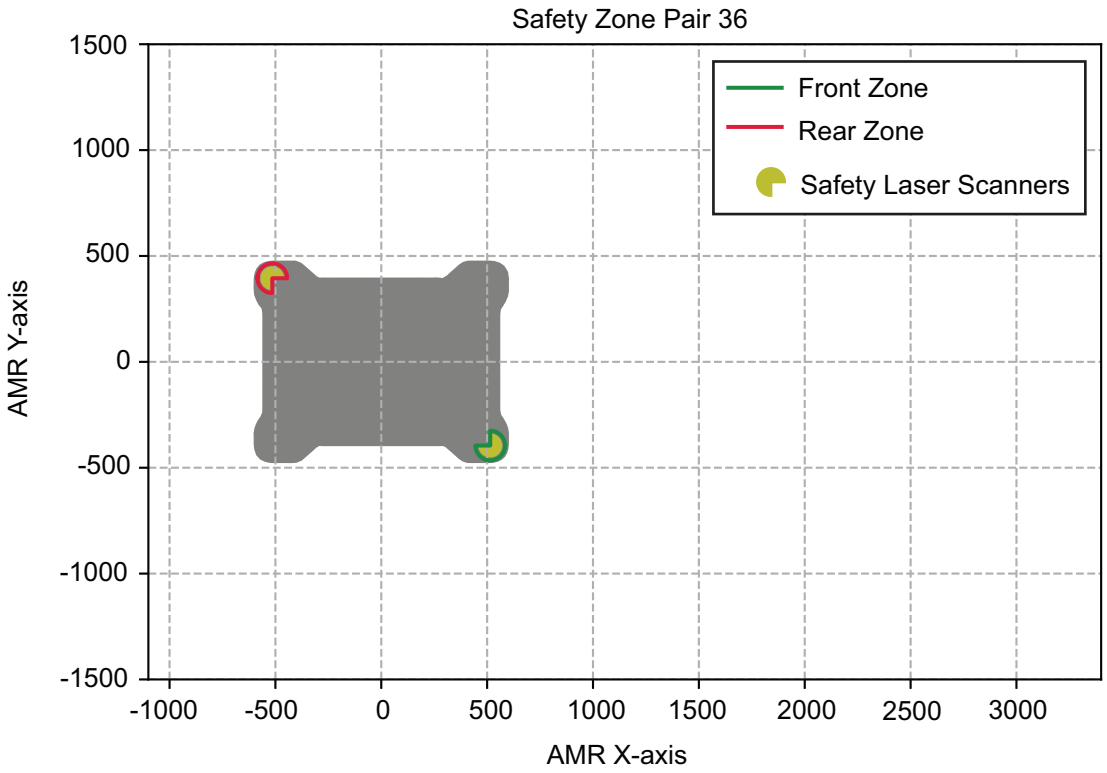
- Linear Speed: 0 to 20 mm/s
- Rotational Speed: 0 to 3 degrees/s



● Operate inside a designated MutePersonnelDetectionSector Area

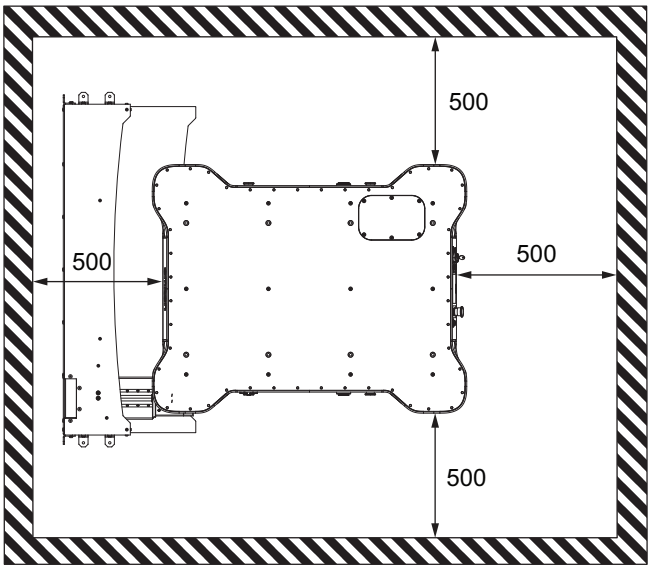
Safety zone pair 36 is a nulled zone pair. It is used when the AMR must operate inside a designated MutePersonnelDetectionSector Area. This area provides a sector which mutes the safety rated personnel detection means of the Safety Laser Scanners per applicable standards. This area must be set on the map with the MutePersonnelDetectionSector area in MobilePlanner.

When muting of personnel detection is required, the personnel detection means shall be muted as late as possible to ensure the absence of persons, for example less than 180 mm from an object.



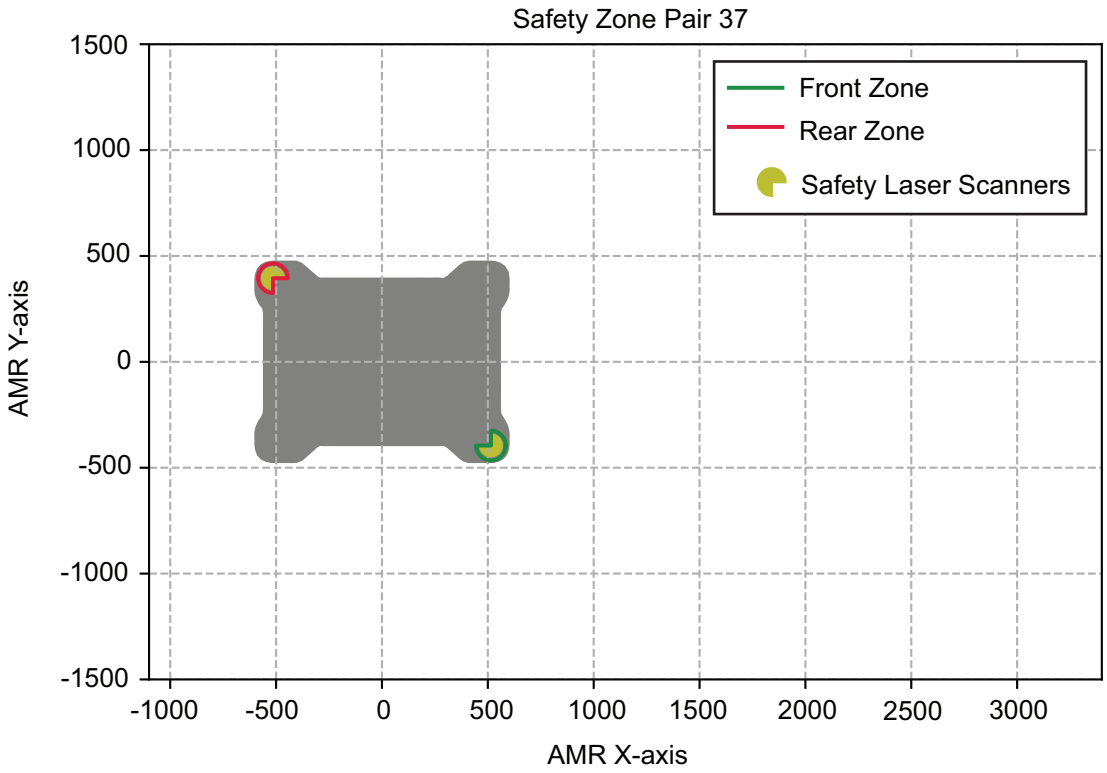
⚠ WARNING

If the AMR is in an operational hazard or restricted zone, these areas must be properly marked or restricted according to applicable standards.



● Creating an Exclusion Zone

Safety zone pair 37 is an exclusion zone pair. It is used during a user-supplied protective stop when the AMR is not moving. The safety outputs stay high when the AMR is in a user-supplied protective stop and is not moving. But if the safety laser detects an obstacle in this safety zone, the safety outputs turn low. Users can customize this safety zone to suit their applications.



4-25-2 Alternate Safety Laser Scanner Zones

The AMR is equipped with a pair of safety-rated Alternate Safety Zone inputs that can be used to toggle Safety Laser Scanner Zones between a default configuration or an alternate configuration. This may be useful if the payload varies in size for certain applications.

These inputs are located on the SCPU connector in the User Connections area. Refer to *SCPU* on page 3-20 for more information.

The alternate Safety Laser Scanner zones are identical to the default zones when the default configuration is present. Activating the alternate zones has no effect until new zones are created. Contact your local OMRON representative for a Safety Laser Scanner zone generation tool.

Precautions for Correct Use

If alternate Safety Laser Scanner Zones are used for varying payload sizes, an alternate AMR footprint should also toggle for navigation purposes. Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information about configuring the AMR footprint clearances.

4-26 Wireless Considerations

It is recommended to use wireless network industry best practices to conduct a comprehensive workspace survey and test your wireless service before AMR configuration and operation begins.
Make the following considerations when an AMR is communicating with a wireless network. Refer to *2-4-18 Wireless Specifications* on page 2-24 for more information.

4-26-1 Signal Availability

The wireless network should provide constant service throughout the workspace. Consider the following signal availability requirements.

- 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.
  AMRs should have a dedicated network separate from public traffic.
- 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 1-6 for more information about the location of wireless antennas.

4-26-2 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.

4-26-3 Port Forwarding

Port forwarding can be configured between the USER LAN network and the wireless network. This allows the onboard NX102 controller to send and receive messages via the wireless network. Contact your local OMRON representative for more information.

4-27 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 1300 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.

⚠ CAUTION

If you change *AbsoluteMaxTransVel* parameter, you should commission the AMR before putting it into service.

Precautions for Safe Use

For payload applications where you cannot easily reduce the size and weight of the payload, or if the AMR's center of gravity is not within the recommended limits, contact your local OMRON representative for support.

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. All acceleration and deceleration parameters have a significant impact. If the payload is asymmetric, you might need to adjust the value of *AbsoluteMaxRotVel* parameter.

Parameter	Default	Minimum	Maximum
AbsoluteMaxTransVel (mm/s)	2200 for MD-650 1800 for MD-900	1	2200 for MD-650 1800 for MD-900
AbsoluteMaxTransNegVel (mm/s)	-2200 for MD-650 -1800 for MD-900	-2200 for MD-650 -1800 for MD-900	-1
AbsoluteMaxTransAccel (mm/s^2)	900	1	1500
AbsoluteMaxTransDecel (mm/s^2)	1300	1300	2000
AbsoluteMaxRotVel (deg/s)	60	1	60
AbsoluteMaxRotAccel (deg/s^2)	150	1	200
AbsoluteMaxRotDecel (deg/s^2)	150	150	200

4-28 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 Charging Station, you must turn OFF the Power Supply Box's power using the Main Disconnect Switch.

Precautions for Safe Use

In case of fire, use a type ABC or type BC dry chemical fire extinguisher.

4-29 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, an emergency stop is triggered and a driving fault error is displayed in MobilePlanner.

Precautions for Safe Use

The tilt detection feature will not prevent an improperly loaded AMR from toppling.

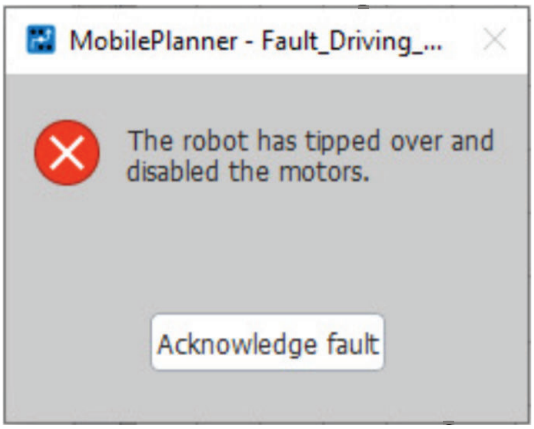
4-29-1 Tilt Detection Event Recovery

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.

4-30 No Motion Signals

A pair of safety-rated no motion outputs turn ON when the AMR has traveled less than 4 mm in a 1.5 second time frame. These outputs can be used to safely detect when the AMR stops moving.
These outputs are located on the SCPU connector in the User Connections area. Refer to *SCPU* on page 3-20 for more information.

5

Troubleshooting

This section provides troubleshooting information.

5-1 Collecting Troubleshooting Information 5-2

5-2 Restoring the Default Configuration 5-3

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5-9-2 Circuit Breaker Panel 5-13

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

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 3-16 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 Restoring the Default Configuration

The AMR configuration may need to be restored under special circumstances, such as replacing the AMR Controller.

You can restore the AMR's configuration with one of the following items.

- A previously saved Debug Info File.
- A previously saved configuration file.
- A default model file distributed on the software USB thumb drive provided with the AMR.

The AMR includes a model-specific configuration file specifying the default parameter values for the AMR model-specific features.

SetNetGo provides a restore option to revert the AMR to its default configuration. You can download the default configuration file from SetNetGo in the System/Backup & Restore Options. Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.

Although some parameters concerning the location of the Safety Laser Scanners are included in the configuration file, the Safety Laser Scanner configuration and safety parameters are not stored in the SetNetGo restore function. Contact your local OMRON representative for restoring laser default configuration.



Additional Information

You can obtain the default Config File from your OMRON representative if you accidentally lose or overwrite it.Contact your local OMRON representative for more information.

5-3 Power Supply Box Problems

Use the information in the following table to troubleshoot Power Supply Box problems.
Upon initial power-up, all LEDs will turn ON briefly to confirm they are not faulty.

Condition	Assumed Cause	Remedy	Additional Information
All indicators OFF.	Power supply wiring problem.	Check for correct wiring.	
	Power supply problem.	Check for correct power supply.	
	Main Disconnect Switch is in the OFF position or circuit breaker(s) is tripped.	• Check the circuit breakers inside the electrical access panel. • Check the position of the Main Disconnect Switch. Check the position of the Main Disconnect Switch.	
Red ERROR LED flickering / unstable.	Unstable supply power.	Confirm correct wiring.	An undervoltage or neutral connection issue may be present.
Blue AC POWER LED ON while all other LEDs OFF.	Critical component failure.	• Cycle power. • Contact your local OMRON representative. • Disconnect the battery load and then cycle power.	After powering ON, self diagnostics may take up to 60 seconds and then an additional indicator should turn ON to provide status.
Yellow DC POWER LED ON and red ERROR LED ON.	Non-critial failure.	• Confirm that no AMR or battery is connected. • Contact your local OMRON representative.	An internal failure has been detected but charging is still possible. Charging time may be affected. Continued operation in this state may lead to critical failure.
Yellow DC POWER LED OFF and red ERROR LED ON while AMR is engaged with Docking Target.	Charging paddle overheating condition.	• Allow charging paddle to cool. • Reduce ambient operating temperature. • Inspect AMR and Docking Target charging contacts for wear or dirt. Clean or replace if necessary.	The AMR will need to re-engage with the Docking Target to resume charging after the problem is resolved.
Yellow DC POWER LED OFF and red ERROR LED ON while a battery is directly connected, outside of the AMR.	Battery problem detected.	Disconnect and reconnect the battery.	If a spare battery is available, try connecting it directly to isolate the problem to the suspect battery.

Condition	Assumed Cause	Remedy	Additional Information
Red ERROR LED flashing while all other LEDs OFF when connecting or disconnecting a battery.	Critical failure.	Cycle AC supply power with no battery connected. Contact your local OMRON representative if problem persists.	
Red ERROR LED flashing while all other LEDs OFF during charging operation.	Critical failure.	Cycle AC supply power with no battery connected. Contact your local OMRON representative if problem persists.	
Green OPERATION LED ON while red ERROR LED ON.	Non-critical problem detected.	• Confirm that the Service button is not continuously depressed. • Allow system to cool. • Cycle AC power supply.	Charging may be possible but the charging time may be affected. Continued operation in this state may lead to critical failure.
Green OPERATION LED ON while yellow DC POWER LED flashing.	An absolutely depleted battery has been detected.	Press the Service button to acknowledge charging of an absolutely depleted battery.	If the system stops charging shortly after button is pressed and the red ERROR LED turns ON, a problem with the battery was detected. Contact your local OMRON representative for more information.

5-4 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.



5-4-1 Low Battery Recovery

If the AMR cannot drive to a Docking Target for charging due to a low battery, the battery should be removed and charged outside of the AMR. Refer to *Charging a Battery Outside of the AMR* on page 4-26 for more information.

5-4-2 Battery Charging Problems

Use the information in the table below to understand battery charging problem indications and solutions.

Additional Information

Many battery charging problems are caused by incorrect Power Supply Box electrical connections during installation. Confirm that the Power Supply Box wiring is correct if battery charging problems occur. Refer to *3-2 Charging Station Installation* on page 3-4 for more information.

Condition	Assumed Cause	Remedy	Additional Information
Power Supply Box indicators: • Yellow DC POWER LED flashing. • Red ERROR LED OFF.	An absolutely depleted battery has been detected.	Connect the external battery and then press the Service button on the Power Supply Box.	Refer to *Charging a Battery Outside of the AMR* on page 4-26 for more information.
Power Supply Box indicators: • Yellow DC POWER LED ON. • RED ERROR LED ON	A minor problem has been detected.	Contact your local OMRON representative.	Charing may still be possible, but the charging time may be impacted.

Condition	Assumed Cause	Remedy	Additional Information
Power Supply Box indicators: • Yellow DC POWER LED OFF. • Red ERROR LED ON	Charging paddle over-temperature condition	• Lower the ambient operating temperature. • Allow charging paddle to cool and retry. • Inspect AMR and Docking Target charging contacts for wear or dirt.	A non-critical error has occurred.
	Battery synchronization problem.	• Disconnect and reconnect battery. • Inspect AMR and Docking Target charging contacts for wear or dirt.	
	Battery fuse blown.	Contact your local OMRON representative.	
Power Supply Box indicators: • Yellow DC POWER LED OFF. • Red ERROR LED flashing	A component failure has occurred	Contact your local OMRON representative.	A critical error has occurred.
A battery problem message is displayed on the Operator Panel screen.	Contact your local OMRON representative for more information if necessary.		
The LED charge light does not illuminate when charging.	Check the CHARGE LIGHT fuse located at the Fuse Panel and replace if blown.		*5-9 Circuit Breakers and Fuses* on page 5-13
No problem indications.	A battery connection issue may present.	• Ensure the Power Supply Box has power supplied. • Ensure the Power Supply Box disconnect switch is in the ON position. • Check all cables and connections for damage or faulty connections.	• *3-2 Charging Station Installation* on page 3-4 • *4-12-2 Charging Station* on page 4-22
	The CHARGE SENSE fuse is blown.	Check the fuse and replace if necessary.	*5-9 Circuit Breakers and Fuses* on page 5-13

5-4-3 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 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) for removing, installing, and lifting the battery or when working around a leaking battery.

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.



5-5 Exposure to Liquids

Use the following procedure if the AMR comes into contact with any liquid.

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 OMRON representative.

1. Power OFF the AMR immediately and then turn the Main Disconnect Switch to the OFF position.
2. Remove and dry as much liquid as possible.
3. Allow the AMR to air dry thoroughly before attempting to restore power.

5-6 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 for blown fuses and tripped circuit breakers. If a fuse is replaced or a circuit breaker is reset, wait 5 minutes before attempting to power ON. Refer to *5-9 Circuit Breakers and Fuses* on page 5-13 for more information.
- Make sure the Main Disconnect Switch is in the ON position. Refer to *4-15 Main Disconnect Switch* on page 4-32 for more information.
- Check the battery's state of charge to ensure sufficient power is available. Refer to *4-12-1 Battery Indicators and Controls* on page 4-21 for more information.

If the AMR does not start-up after the actions above, contact your local OMRON representative.

5-7 AMR Controller Errors

Use the information in the table below to troubleshoot AMR Controller errors.
Refer to *4-4 AMR Controller LED Indicators* on page 4-6 for more information.

AMR Controller LED State	Issue	Corrective Action
Flashing red	The AMR Controller's internal battery is low.	This battery is not user-replaceable. The battery lifespan is 10 years. Contact your local OMRON representative for more information.
Solid red	A thermal shut-down has occurred from excessive heat.	Reduce the environment's ambient operating temperature. Ensure excessive heat is not generated from payload devices
	Power supply input under / over voltage or power supply defective.	Power supply errors occur when there is an issue with the incoming power to the AMR Controller. This error can also occur if the PSU (power supply unit) board inside the AMR Controller is broken. Such conditions could be the result of excessive shock or vibration, or incorrect wiring of the AMR.

5-8 Operator Panel Information

Troubleshooting information about Operator Panel information is provided in the following sections. Refer to Main Screen for more information.

5-8-1 Stop Flags

Use the following information to understand to cause and corrective actions for stop flags that may appear on the Operator Panel.

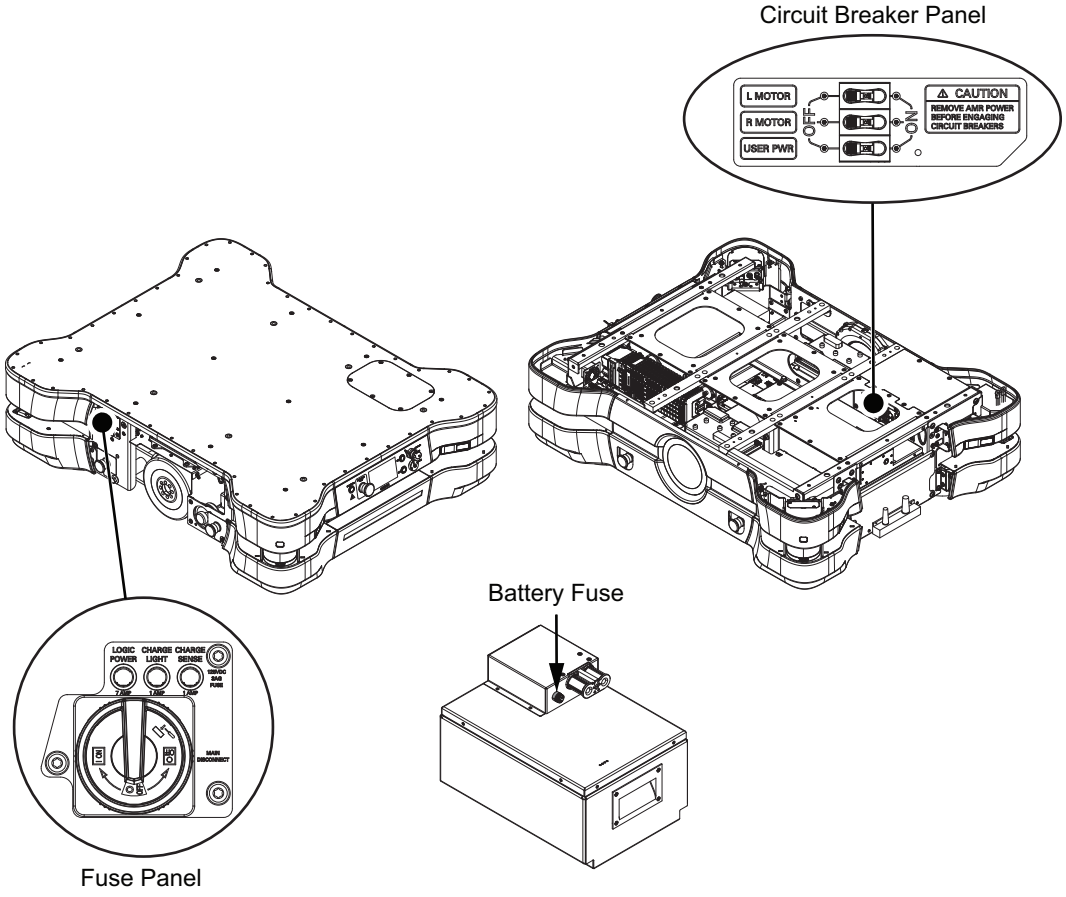
Stop Flag	Cause	Corrective Action
Front Laser	A protective stop has occurred because an object has been detected by the front Safety Laser Scanner.	Remove the object or manually drive the AMR away from the object.
Rear Laser	A protective stop has occurred because an object has been detected by the rear Safety Laser Scanner.	
User ESTOP	An emergency stop condition has been detected with the circuit associated with the SCPU connector.	Check circuits connected to the SCPU connector. If user-supplied safety equipment is connected to the SCPU connector, check those devices to ensure safety conditions are satisfied. Refer to *4-18-1 Emergency Stop Recovery Procedure* on page 4-36 for more information.
Skin ESTOP	An E-STOP button on the sides of the AMR has been depressed.	Refer to *4-18-1 Emergency Stop Recovery Procedure* on page 4-36 for more information
ESTOP Latched	The AMR is in an emergency stop state after all emergency stop devices have been reset and the safety circuit is satisfied.	Refer to *4-18-1 Emergency Stop Recovery Procedure* on page 4-36 for more information
Panel ESTOP	An E-STOP button on the Operator Panel of the AMR has been depressed.	Refer to *4-18-1 Emergency Stop Recovery Procedure* on page 4-36 for more information
Pendant ESTOP	The pendant is plugged into the AMR and its E-STOP button is depressed and/or the three-position enabling device is not in the middle position.	Check the position of the pendant E-STOP and three-position enabling device. Refer to *4-23 Pendant Operation* on page 4-48 for more information.

5-8-2 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.

5-9 Circuit Breakers and Fuses

Use the following information to understand circuit breaker and fuse location and functionality. Circuit breakers and fuses are found in the following locations.



5-9-1 Fuse Panel

The following information describes fuses located in the Fuse Panel.

Fuse Label	Protection	Type
LOGIC POWER	Logic control module	3AG, 125 VDC 7 A
CHARGE LIGHT	LED Charge Light	3AG, 125 VDC 1 A
CHARGE SENSE	Internal charging contactor	

5-9-2 Circuit Breaker Panel

The following information describes circuit breakers located in the Circuit Breaker Panel.

Fuse Label	Protection
L MOTOR	Left-side drive motor
R MOTOR	Right-side drive motor
USER PWR	User Power

5-9-3 Battery Fuse

The battery fuse is a 3AG type with a rating of 250 VDC, 7 A.

5-10 Localization Problems

Localization problems may occur that affect navigation, accuracy, or repeatability during AMR operation. Take the following actions to improve or correct localization:

- If the AMR becomes lost frequently, use the localization feature in MobilePlanner to relocalize the AMR.
- If the AMR does not localize in a certain area, check the localization score. If the score is below 70%, remapping may be necessary.
- If more than 50% of the original map is occluded, remapping may be necessary.
- Keep the areas near the pickup and drop-off points closely aligned with the map. Frequent changes in these areas can reduce performance.



Additional Information

Refer to *3-10 Map Creation Overview* on page 3-38 for more information.

5-11 Other AMR Problems

Other AMR problems and corrective actions are provided below.

Problem	Possible Cause	Corrective Action
AMR suddenly powers OFF.	A motor circuit breaker was tripped.	Reset the motor circuit breaker, wait 5 minutes, and then turn the AMR ON.
	Battery problem.	Remove the battery and connect it directly to the Power Supply Box. If battery will not charge, contact your local OMRON representative.
Operator Panel displays "Unknown Driving Fault"	A motor circuit breaker was tripped.	Reset the motor circuit breaker, wait 5 minutes, and then turn the AMR ON.
No power is supplied to external equipment connected to the USER PWR connector.	The USER PWR circuit breaker was tripped.	Reset the USER PWR circuit breaker.

6

Maintenance

This section covers periodic maintenance and user-serviceable parts replacement for the AMR and the Charging Station.

6-1 Maintenance Introduction 6-2
6-2 AMR Lock-out Tag-out Procedure 6-4
6-3 Inspection Intervals 6-5
6-4 Charging Station Lock-out Tag-out Procedure 6-6
6-5 Lifting the AMR 6-7
6-6 Mechanical Brake Inspection Procedure 6-9
6-7 Docking Target Charging Contacts Inspection 6-10
6-8 AMR Charging Contact Inspection 6-11
6-9 Safety and Warning Labels 6-12
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6-10-3 Cleaning the Power Supply Box Cooling Ducts 6-14
6-10-4 Cleaning Lasers Lenses 6-15
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6-11-1 Removing and Replacing Skins 6-17
6-11-2 Removing and Replacing Operator Panel 6-18

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

- The Charging Station, battery, and AMR transfer high electric power and contain hazardous voltages. You must take necessary precautions to avoid electric shock. Follow appropriate Lock-Out, Tag-Out (LOTO) instructions prior to any installation and maintenance work performed on or near these items.
- Use only the specified tools, equipment, and OMRON-supplied spare parts to service and maintain the AMR according to the specified service intervals. Failure to do so could result in an unsafe operating state that might result in personal injury or damage to property.
- The AMR battery and the Charging Station outputs have high current. You must take appropriate precautions to avoid potential short circuit.
- Do not attempt to lift the AMR from the bottom with a forklift or similar devices. Doing so could damage 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.



⚠ WARNING

The Power Supply Box, charging contacts on both the Docking Target and the AMR, and the drive wheel motors can get hot during operation. Allow these items to cool down prior to servicing.



⚠ WARNING

- There are no user-serviceable parts inside the Charging Station and high voltage may be present in this area. Do not remove the covers of the Charging Station.
- Risk of Fire - No User Serviceable Parts
  AVERTISSEMENT: Risque d'incendie - Aucune des pièces ne peut être.



⚠ CAUTION

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



Precautions for Correct 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. Shut down the AMR by pressing the OFF button on the Operator Panel.
2. Turn the AMR Main Disconnect Switch to the OFF position (vertical).
3. Lock and tag the Main Disconnect Switch according to your facility requirement and regulations.
4. Wait 60 seconds and then press the ON button. Confirm that the AMR does not power ON.
   If the AMR powers ON, repeat the steps above.
   If the AMR does not power ON, the Lock-out Tag-out procedure is complete.

6-3 Inspection Intervals

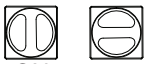
Perform inspections of the following safety and warning devices for proper function.

Item	Inspection Frequency	Additional Information
Signal Beacons (optional)	Weekly	Check for proper operation of any optional signal beacons.
Light Discs	Weekly	Check for proper operation of the light discs. Make sure all segments and colors are functioning properly.
Buzzer	Weekly	Check the audible buzzer for proper operation.
E-STOP Buttons	Weekly	Check for proper operation of the E-STOP buttons. Refer to *3-9 Commissioning* on page 3-37 for more information.
Check safety and warning labels	Weekly	Verify all labels are present, legible, and undamaged. Refer to *6-9 Safety and Warning Labels* on page 6-12 for more information.
Caster, Drive Wheel, and Drive Assembly	3 months	Contact your OMRON representative.
Caster and Drive Wheel Treads	3 months.	Contact your OMRON representative.
Caster Swivels	3 months	Contact your OMRON representative.
Docking Target Charging Contact Assembly	3 months	Inspect the Docking Target Charging Contact assembly. Refer to *6-7 Docking Target Charging Contacts Inspection* on page 6-10 for more information.
AMR Charging Contacts	3 months	Check the AMR charging contacts for wear or debris. Refer to *6-8 AMR Charging Contact Inspection* on page 6-11 for more information.
User Connections area Cooling Fan	3 months	Check the fan for air flow while the AMR is powered ON. Contact your OMRON representative for replacement details.
Batteries (in-use and stored)	3 months	Check the battery for charge state, leaks, or damage. Refer to *4-12-5 Storing Batteries* on page 4-27 for more information.
Mechanical Brakes	6 months	Check for proper operation of the mechanical brakes. Refer to *6-6 Mechanical Brake Inspection Procedure* on page 6-9 for more information.
Speakers	As needed	Check the speakers for proper operation (if used).

6-4 Charging 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 Charging Station.

1. Disconnect the Power Supply Box from the battery or Docking Target and then lock and tag the Power Supply Box output power cord connector.
2. Turn the AC input power OFF by switching the Main Disconnect Switch to the OFF position (horizontal).



3. Lock and tag the Main Disconnect Switch according to your facility requirement and regulations.
4. Verify that all the Power Supply Box LEDs are OFF to complete this procedure.

6-5 Lifting the AMR

Use the following procedure to lift the AMR. A lifting kit is supplied with the AMR that includes four lifting rings and four straps.

⚠ WARNING

- Lifting straps must be fastened with consideration to even weight distribution to ensure that the AMR is level and stable when lifted. Uneven weight distribution while lifting may cause the AMR to shift or become unstable which may result in injury or damage to equipment.
- Equipment used to lift the AMR must be adequately rated. It is the end user's responsibility to review lifting equipment and apply appropriate safety factors before lifting.
- Do not attempt to lift the AMR from the bottom with a forklift or similar devices. Doing so could damage the AMR.



Precautions for Safe Use

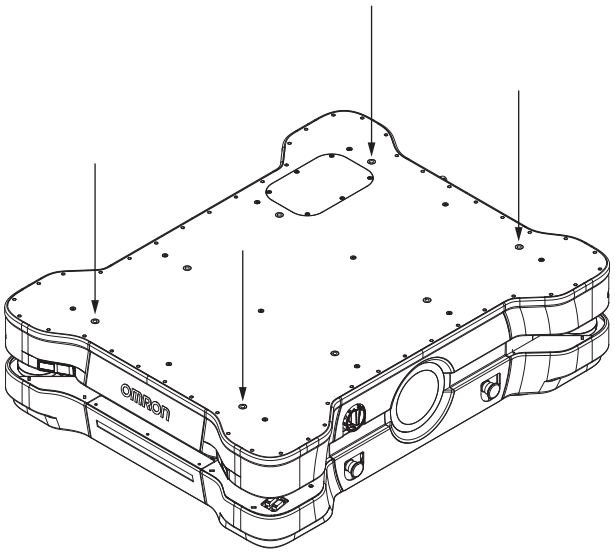
- Do not exceed the maximum allowable tension force of 10 kN for designated M16 x 2.0 lifting points. Lifting points are rated for the AMR weight without a payload.
- A minimum of 8 mm of thread engagement must be present for each lifting ring (11 mm if a Top Plate is present).
- To prevent damage to the lifting points, AMR chassis, or lifting rings, do not exceed a 30° angle from vertical when attaching the lifting straps to the lifting device.
- Inspect lifting straps for signs of wear and tear or any damages before attaching to the lifting rings and lifting the AMR.
- It is the end user's responsibility to ensure that the person operating the overhead hoist or forklift has successfully completed the required training, and is certified to operate these machines.
- When placing the AMR back on the floor after lifting, you must make sure that all safety precautions have been taken to prevent personal injury or property damage.

The following equipment is required for this procedure.

- 4 lifting rings (supplied with AMR)
- 4 safety slings (supplied with AMR)
- Personal Protective Equipment (eye protection, toe protection, gloves).
- Overhead hoist or forklift rated for a minimum of 600 kg.

1 Perform the appropriate Lock-out Tag-out procedures.

2 Attach the OMRON-supplied lifting rings using to the locations shown in the figure below.



3 Using an overhead hoist or a forklift, lift the AMR.

4 After the AMR is no longer lifted, remove the lifting rings and straps from the AMR to complete this procedure.

6-6 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 three-position enabling device to ensure that the AMR is in emergency 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 *4-17 Manually Pushing the AMR* on page 4-35 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.

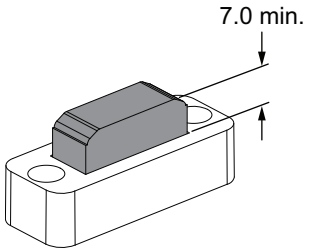
6-7 Docking Target Charging Contacts Inspection

The Docking Target charging contacts and assembly should be inspected every 3 months with the following actions.

- Inspect the contacts to ensure they are securely attached and that there are no signs of pitting.
- Inspect the charging contact cover assembly to ensure in moves freely.

6-8 AMR Charging Contact Inspection

The AMR charging contacts wear during normal operation and should be inspected every 3 months to determine if they need to be replaced. Measure the overall height of each charging contact. If the height is less than 7.0 mm, the charging contacts must be replaced.



6-9 Safety and Warning Labels

Perform periodic checks to ensure safety and warning labels are not damaged or removed. Yellow backings for emergency stop buttons must also remain in place. Refer to *1-4 Labels* on page 1-19 for more information about label locations.

6-10 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.

6-10-1 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 *6-10-2 Cleaning AMR Charging Contacts* on page 6-13 for more information.
Clean the Power Supply Box cooling duct.	6 months, 2,000 charge cycles, or as needed.	Refer to *6-10-3 Cleaning the Power Supply Box Cooling Ducts* on page 6-14 for more information.
Clean all laser lenses.	6 months / as needed.	Refer to *6-10-4 Cleaning Lasers Lenses* on page 6-15 for more information.
Clean caster treads.	As needed.	Refer to *6-10-5 Cleaning Caster Treads* on page 6-15 for more information.
Clean drive wheel treads.	As needed.	Refer to *6-10-6 Cleaning Drive Wheels* on page 6-15 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.

6-10-2 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.

⚠ WARNING

The Power Supply Box, charging contacts on both the Docking Target and the AMR, and the drive wheel motors can get hot during operation. Allow these items to cool down prior to servicing.



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.

6-10-3 Cleaning the Power Supply Box Cooling Ducts

The cooling duct of the Power Supply Box must be cleaned to ensure that airflow is maintained for proper cooling.

⚠ WARNING

Prior to cleaning the Charging Station, you must ensure that the AMR is not engaged with the Docking Target.



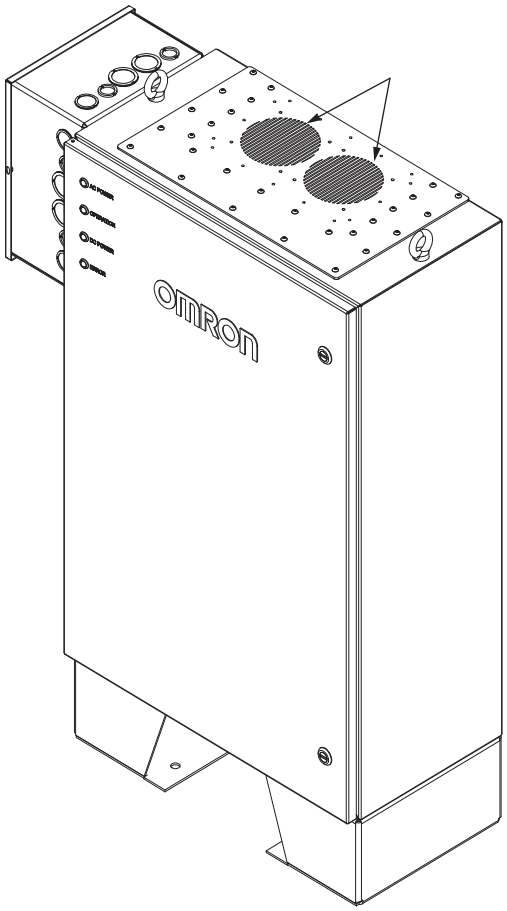
⚠ WARNING

The Power Supply Box, charging contacts on both the Docking Target and the AMR, and the drive wheel motors can get hot during operation. Allow these items to cool down prior to servicing.



Precautions for Safe Use

Prior to cleaning the Charging Station, you must ensure that the AMR is not engaged with the Docking Target.



6-10-4 Cleaning Lasers Lenses

Clean the lenses of all lasers. Use only a soft cloth with alcohol-based, non-abrasive cleaners. Wipe the lens thoroughly and take care not to scratch or damage the lens during the cleaning process.

Precautions for Correct Use

The operation of the lasers may be affected by substances in the AMR operating environment, such as fog, smoke, steam, and other small particulate. You must clean the lenses of all lasers periodically and as guided in this document to avoid operational failures.

6-10-5 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.

6-10-6 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.

6-11 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.

⚠ WARNING

- Use only the specified tools, equipment, and OMRON-supplied spare parts to service and maintain the AMR according to the specified service intervals. Failure to do so could result in an unsafe operating state that might result in personal injury or damage to property.
- The AMR battery and the Charging Station outputs have high current. You must take appropriate precautions to avoid potential short circuit.



⚠ 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.



⚠ WARNING

The Power Supply Box, charging contacts on both the Docking Target and the AMR, and the drive wheel motors can get hot during operation. Allow these items to cool down prior to servicing.



⚠ CAUTION

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.



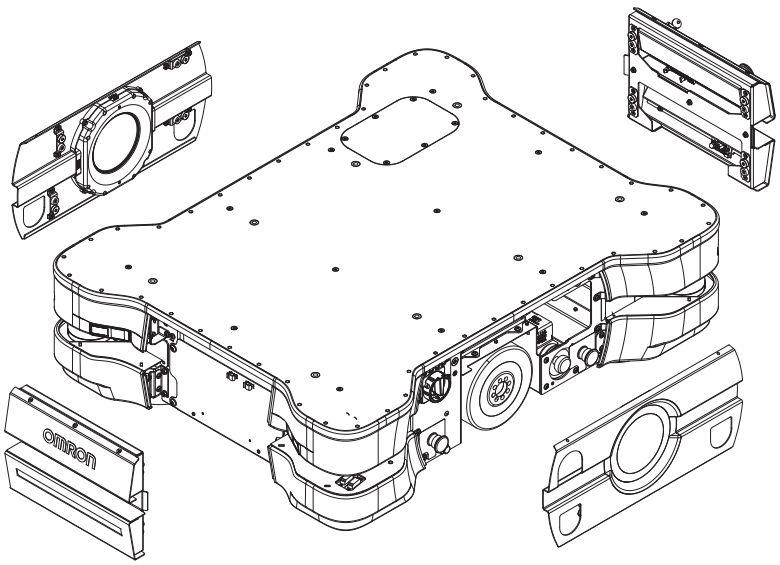
Precautions for Safe Use

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.



6-11-1 Removing and Replacing Skins

Skins need to be removed or replaced during various maintenance and installation procedures.



Make the following considerations when removing or replacing skins.

- No tools are required for skin removal. Skins are fastened to the AMR chassis with magnets.
- Right-side and left-side skins are not symmetrical.
- All skins have cables that need to be disconnected when removing. Preserve cable routing and connections replacing skins.
- Pull skins from the bottom when removing.
- Ensure skins are aligned and straight after fastening them.

⚠ WARNING

The motor and motor assemblies will be exposed when the side skins are removed, exposing potential pinch points. Take necessary precautions when moving an AMR without its skins attached. The rear and top of the AMR also pose pinch hazards when the rear skin and the top plate are removed.

Precautions for Safe Use

After you remove or replace the skins, you must make sure that the light strips and discs are operational once the AMR is powered back ON.

Precautions for Correct Use

After removing the skin panels, place them inner-side down so that the outer surfaces do not get scratched.

6-11-2 Removing and Replacing Operator Panel

Use this procedure to remove and replace the Operator Panel.

The following items and tools are required for this procedure:

- Replacement Operator Panel Assembly (part number 73150-000F)
- T25 star bit

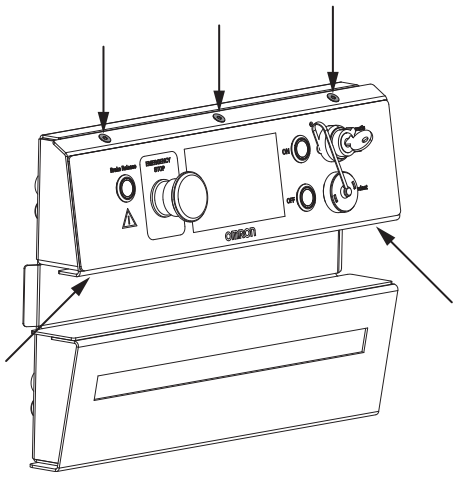
1 Turn the AMR OFF.

2 Place the Main Disconnect Switch in the OFF position.

3 Remove the Rear Skin.
Refer to *6-11-1 Removing and Replacing Skins* on page 6-17 for more information.

4 Disconnect the ribbon cable and the Ethernet cable from the rear of the Operator Panel.

5 Remove 5 screws using T25 star bit from the following locations on the Rear Skin and retain for reuse.



6 Remove the Operator Panel from the Rear Skin.

7 Place the replacement Operator Panel on the Rear Skin and fasten the 5 screws using the T25 star bit.

8 Connect the ribbon cable and the Ethernet cable to the rear of the Operator Panel.

9 Attach the Rear Skin to the AMR to complete this procedure.

A

Appendices

A-1 Parts List A-2
A-2 Network Port Allocation A-4
A-3 Input and Output Control A-6
A-4 Shipping the AMR A-7

A-1 Parts List

AMR spare parts and accessories are provided in the following table.

Item	Part Number	Details	Included
Top Plate Seal Kit	24861-000	Kit includes eight M16 screws, PTFE seal tape, and tape application instructions.	Yes
Left Skin	73121-000F	Exterior left removable panel of the AMR.	Yes
Right Skin	73123-000F	Exterior right removable panel of the AMR.	Yes
Front Skin	73125-000F	Exterior front removable panel of the AMR.	Yes
Rear Skin	73126-000F	Exterior rear removable panel of the AMR.	Yes
Operator Panel Assembly	73150-000F	The Operator Panel includes a screen, an E-STOP button, ON and OFF buttons, a brake release button, and a Pendant port.	Yes
Lift Kit	68000-890	Kit includes four lift eyebolts and four lift straps	Yes
Pendant	68940-000L	Handheld, external input device for manually driving an AMR, typically used for map creation.	Optional
Side Laser communications extension cable	22115-000F	Cable length is 1 m. Includes connectors on both ends	No
	22117-000F	Cable length is 2 m. Includes connectors on both ends.	No
Side Laser power extension cable	22800-000F	Cable length is 1 m. Includes connectors on both ends.	No
	22802-000F	Cable length is 2 m. Includes connectors on both ends.	No
Power Supply Box	73990-000	Includes mounting hardware.	Yes
Docking Target	68910-000	Includes mounting hardware.	Optional
Docking Target mounting brackets	68910-105	Single bracket for fastening Docking Target to a wall or the floor.	Optional
Battery	73330-100	Battery for the MD-Series AMR can be ordered separately.	Optional
Side Laser Kit	73945-010	Kit includes two supplementary laser assemblies, two open ended M12 A coded power cables, 2 m, two M12 D coded RJ45 network cables, 2 m, four Ferrules.	Optional
Maintenance Port Extension Kit	73955-000	Kit includes one Ethernet Passthrough connector, one Ethernet patch cable, 1 ft, two M3 screws and nuts.	Optional
Operator Panel Relocation Kit	73953-000	Kit includes one blanking plate, one Passthrough connector, Ethernet cable Cat 5e, 1 m, five M5 screws, two M3 screws and nuts, edge guard strip.	Optional
Wireless Antenna Extension Kit	68955-000	Kit includes two Dipole antennas with RP-SMA connectors, two 2 m coaxial cables, two 0.6 m coaxial cables.	Optional
HAPS Kit Single	73925-010	Kit includes one HAPS sensor, one cable, and two M3 screws.	Optional
HAPS Kit Double	73925-020	Kit includes two HAPS sensors, two cables, and four M3 screws.	Optional

Item	Part Number	Details	Included
HAPS magnetic tape	14925-000	25 mm wide magnetic tape (south top side, 49 m roll). Included with the HAPS Kits.	Optional
Mobile I/O Box	23419-802	Used with Fleet Manager to summon an AMR to a goal or control connected devices with I/O.	Optional
Mobile I/O Box Power Supply	23419-812	Recommended for purchase with the Mobile I/O Box.	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	

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 Input and Output Control

The AMR has built-in digital I/O that is typically used for autonomous control of user-supplied objects on the payload structure. Customized user programs can be created for the onboard NX102 controller that utilize these inputs and outputs for specific applications. An interface exists between the AMR Controller and the NX102 controller for event-based control functions.

Precautions for Safe Use

The NX102 contains factory-installed programs and configurations that control the safety functions in the AMR. Do not attempt to modify the safety program or configuration.

This interface provides the following functionality.

- Output signals from the AMR Controller to the NX102 controller configured with *CustomOutput* tasks.
- Inputs signals from the NX102 controller to the AMR Controller configured with *CustomInput* tasks.

Configuring *CustomInput* and *CustomOutput* tasks with MobilePlanner allows interaction between these two controllers for event-based control applications. A user-created logic program for the NX102 controller can be created and transferred using Sysmac Studio. For example, a user-defined NX102 controller program can execute a routine that controls several devices connected to the output terminals in the User Connections area. This routine can be triggered by a *CustomOuput* task signal from the AMR Controller. When the routine completes, a signal can be sent from the NX102 controller to the AMR Controller with a *CustomInput* task.

Macros defined with MobilePlanner can also be utilized to trigger an NX102 controller program sequence.

An example program named *UserIO_example* is pre-loaded in the NX102 controller. This provides direct pass-through signals between the NX102 controller to the AMR Controller of the digital I/O in the User Access Panel.

Access the NX102 controller by connecting a PC (with Symac Studio installed) to the LAN port. Set the PC's IP address to a static value between 172.16.0.100 to 172.16.0.149. The NX102 IP address is 172.16.0.220.

Additional Information

- Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.
- Refer to the *Sysmac Studio Version 1 Operation Manual (Cat. No. W504)* for more information.

A-4 Shipping the AMR

Make the following considerations when shipping the AMR to another location.

- Keep the original crate and shipping materials supplied with the AMR. Use these to repackage the AMR before shipping. Refer to the *Autonomous Mobile Robot (AMR) MD-series Platform Safety and Unpacking Guide (Cat. No. I682) for more information.*
- Before shipping a battery, ensure it is in good, working condition and has not been subjected to conditions that may have caused damage.
- Keep the AMR and battery within the specified environmental ranges during transportation. Refer to *2-3 Environmental Specifications* on page 2-13 for more information.
- Do not subject the AMR or battery to excessive shock or vibration during transportation.
- Place the Main Disconnect Switch in the OFF position. Refer to *4-15 Main Disconnect Switch* on page 4-32 for more information.
- Turn the battery OFF using the battery pushbutton. Refer to *Battery Pushbutton* on page 4-21 for more information.
- If the battery is shipped with the AMR, replace padding that was removed during the unpacking procedure. Refer to *Autonomous Mobile Robot (AMR) MD-series Platform Safety and Unpacking Guide (Cat. No. I682)* for more information.
- Check the battery charge level for compliance with shipping regulations.
- Plan adequate shipping times to prevent battery depletion during transit or storage.

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