OMRON

HD-1500 Platform

User's Manual

I645-E-03

NOTE

Trademarks

Copyrights

Introduction

Thank you for purchasing the HD-1500 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.
- 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.

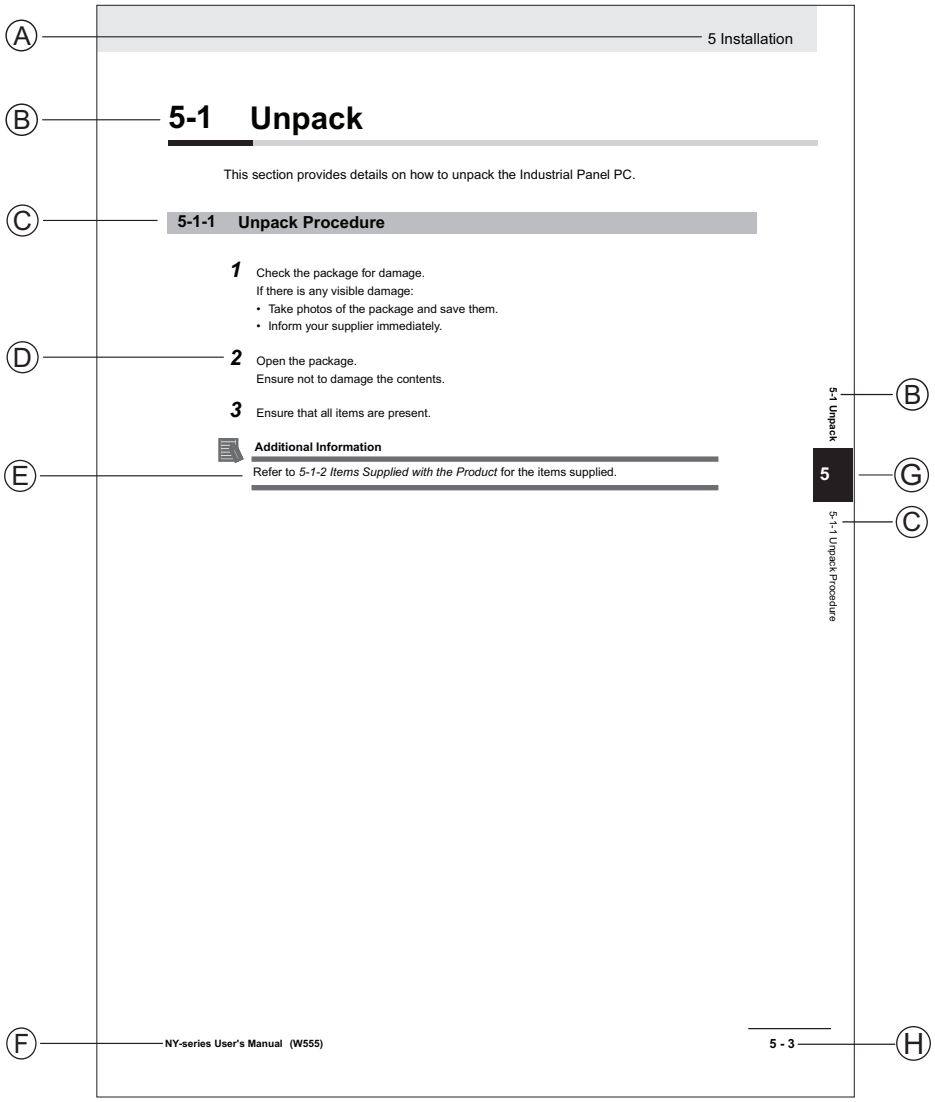
Units

Unless otherwise noted, length dimensions are in millimeters and all units are metric.

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.

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Terms and Conditions Agreement

Warranty and Limitations of Liability

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

Errors and Omissions

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

Safety Precautions

Definition of Precautionary Information

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

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

Symbols

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

Dangers

⚠ DANGER

The 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

General

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 on inclined floors or surfaces.
- 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.

Implementing methods to circumvent the need for a person to enable the AMR's motor power at start-up is prohibited.	
Any modifications made to the AMR can lead to loss of safety or functionality of the AMR. 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 safety 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.	
Objects protruding out, above, or below the AMR lasers' scanning planes shall be configured as restricted zones during workspace map creation. This will eliminate possible collision risk during operation.	
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 safety 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.	
A pallet jack, overhead hoist, or forklift used to lift the AMR and Power Supply Box shipping crates must be rated for at least 1100 kg.	
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.	
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 AMR interlock switches shall not be defeated or bypassed as this would energize the AMR and expose the user to potential electrical hazards.	
Do not perform maintenance work on the AMR until the measured voltage of the motor controller capacitors are below 7 VDC.	
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.	

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.	

Charging Station strain reliefs and the power cords must be installed by a licensed or appropriately certified electrician.	
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.	
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.	
The Charging Station has AC power inside. Its covers are not interlocked. You must disconnect the power prior to maintenance work.	
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 3 people are required to lift the battery.	
At least 2 people are required to lift the Docking Target.	
Always use safe lifting practices when removing or installing the battery.	
The access covers on the Charging Station are not interlocked. During maintenance and repair, you must turn OFF power to the Charging Station. Remove and secure the power cord and all other electrical inputs to prevent unauthorized power application.	
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.	
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.	

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.	
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.	
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. • Repeat the safety commissioning procedure. • 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.	
The AMR is not intended to be operated on ramps or sloped surfaces. 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.	
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 rain or moisture.	
An AMR can be unsafe if operated under environmental conditions other than those specified in this manual.	

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 a fully-loaded AMR while using the brake release button is not recommended. If you must manually move a fully-loaded 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 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.	
Although the AMR respects its software-based obstacle-avoidance clearances at all speeds, the user must be aware of the location of the E-STOP buttons at all times, and keep out of the unprotected areas.	
It is the end user's responsibility to ensure that the area within the radius of 2 m from the center of the AMR is kept clear when it is traveling at less than 115 mm/s.	
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.	

Personnel should not be near the AMR when it is rotating with no forward motion.	
The electronics bay has high current components that are exposed when side skins are removed. Avoid contact with electrical terminals to prevent electric shock.	

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 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 *Mobile Robot HD Safety Manual (Cat. No. I647)*.
  - 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 25 kN per lifting mount point.
- 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.
- 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 overhead hoist or forklift 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.

- 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 (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 other 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.
- 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 OMRON representative.
- 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 chargers and batteries supplied by OMRON. The charger shall only be used to charge an HD-1500 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.

Precautions for Correct Use

- Never expose the battery to water.
- Do not connect user-supplied equipment to the Ethernet switches located in the electronics bay.
- 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 EM2100 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 EM2100, 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, the *LaserIgnore* parameter can be used to constrain sensing to zones that do not include the payload. However, this method might compromise the detection ability of the sensors and should be avoided if possible.
- Laser lenses can easily get scratched and damaged. Care must be taken to prevent scratching the laser lens during any maintenance or installation procedures.
- Factory installed Side Lasers are protected by guards. If you relocate the Side Lasers, consider using protective guards to prevent damage. Make sure that user-installed guards do not block the scanning area or extend outward excessively.
- Map creation is required before normal operation of the AMR.
- The Integration Toolkit only runs on an EM2100 appliance configured as a Fleet Manager.
- 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.
- If you do not use appropriate fasteners, the Docking Target will move during the docking attempts and cause docking and charging failures.
- Do not over-torque the charging paddle adjustment screws if they reach their limits.
- 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.
- During the initial AMR installation and configuration, install a fully-charged battery.
- 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. The jumper is provided as part number 68410-218L.
- Do not exceed 10 kN per payload structure mounting point.
- 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.
- 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 and level 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.
- An environmental hazard 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 button and procedures for safely pushing an AMR.
- IATA regulations (UN 3480, PI 965) require that air freight shipped lithium ion batteries must be transported at a state of charge not exceeding 30%. To avoid total discharge, fully charge the battery immediately upon receipt. 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 *Mobile Robot HD Safety Manual (Cat. No. I647)* 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.
- The position of the antenna is critical to correct operation. You must make sure to attach a new antenna to the correct location etched on the base plate.
- 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.

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 Harmonized 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).

UL / Canada 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).

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
HD Mobile Robot Safety Manual (Cat. No. I647)	Contains general safety information for HD-1500 AMRs.
Safety Laser Scanner OS32C Series User's Manual (Cat. No. Z296-E1)	Describes the use of the OS32C Safety Laser Scanner.
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.
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 Simulator User's Manual (Cat. No. I649)	Describes the configuration and use of the Fleet Simulator software on an EM2100 appliance.
Fleet Operation Workspace Core Integration Toolkit User’s Guide (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.
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.
Sysmac Studio Version 1 Operation Manual (Cat. No. W504)	Describes the operating procedures of the Sysmac Studio.
AMR Controller User's Guide (Cat. No. I650)	Describes the information necessary to use the AMR Controller.
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 Analog I/O Units User's Manual for Analog Input Units and Analog Output Units (Cat. No. W522)	Describes the information necessary to use NX-series Analog Input Units and Analog Output Units.

Glossary

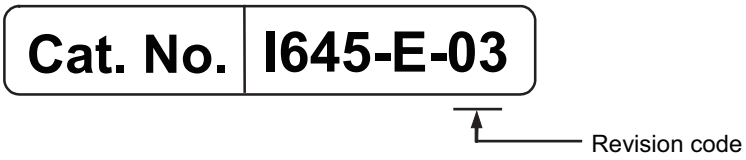
Term / Abbreviation	Description
Ambient Operating Temperature	The temperature range of the AMR's environment in which continued operation is possible.
AMR	This term is used to refer to the HD-1500 autonomous mobile robot.
AMR Controller	The AMR's main computing system that provides all navigational controls 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.
Balance	The charging operation that equalizes each cell in the battery to maintain consistent runtime and performance.
Beacon	An optional indicator lamp mounted on the AMR to provide additional visual indication and signaling of the operating state.
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.
Debug Info File	A zip file downloaded from SetNetGo that contains detailed information about the status of the system used by OMRON engineers for troubleshooting.
Docking 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.

Term / Abbreviation	Description
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
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.
Immobilization	An AMR state where it cannot physically move due to circumstances related to physical, electrical, and other limiting factors.
Instructed persons	Persons that are adequately advised or supervised by skilled persons to enable them to avoid electrical and mechanical dangers.
Interlock	A mechanical or electrical device intended to prevent machines from operating unless certain conditions are met.
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.
Macro	In MobilePlanner, a virtual container with a series or sequence of nested tasks and / or goals typically used to perform the same sequence of discrete functions in different tasks.
Map	A representation of the AMR's environment within MobilePlanner that it uses for navigation.

Term / Abbreviation	Description
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.
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.
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
03	August 2021	Reformatted and updated.
02	August 2020	Minor modifications
01	December 2020	Original production

1

Overview

This section provides general information about the AMR.

1-1 Intended Use

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

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

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

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

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

The AMR shall be commissioned as instructed in this manual.

⚠ DANGER

- 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 on inclined floors or surfaces.
- 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.
- 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

- Any modifications made to the AMR can lead to loss of safety or functionality of the AMR. 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.
- Do not expose the AMR to rain or moisture.

⚠ CAUTION

Personnel must not be near the AMR while it is rotating with no forward motion.

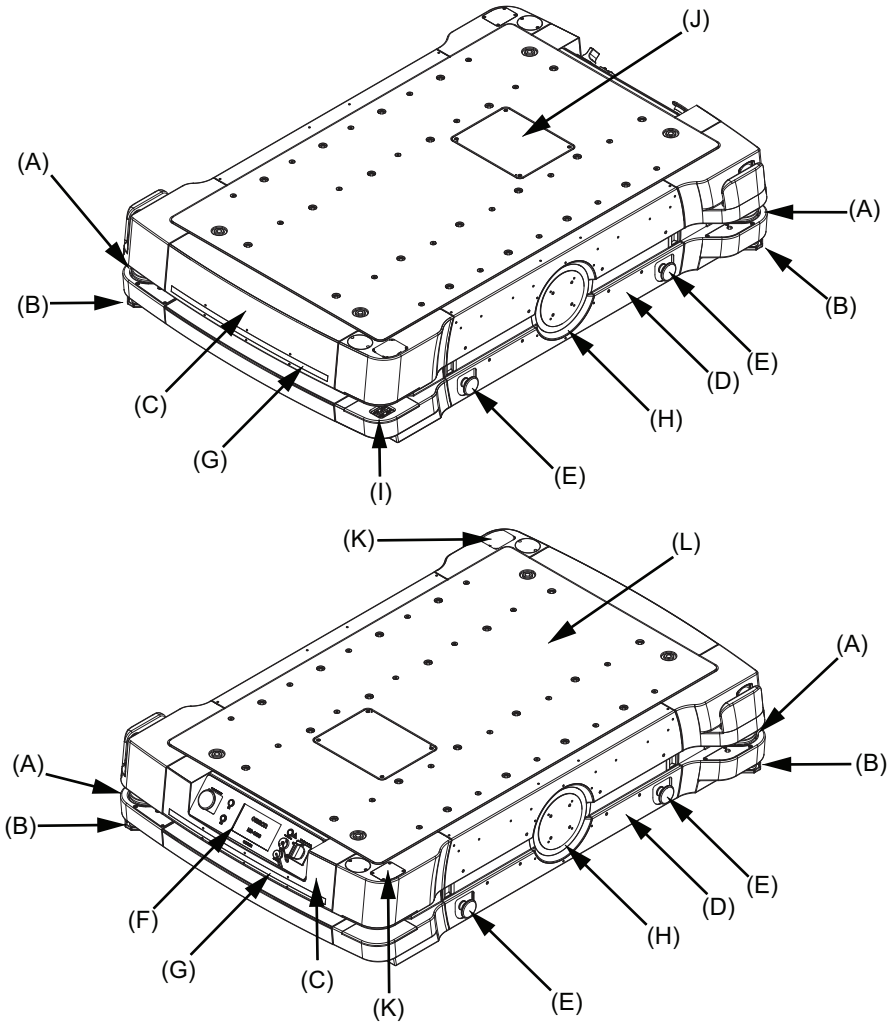
Precautions for Safe Use

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 *Mobile Robot HD Safety Manual (Cat. No. I647)*.
- 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	G	Light Strip
B	Low Laser	H	Light Disc
C	Front / Rear Skin	I	Charging Contacts
D	Side Skin	J	User Access Panel
E	E-STOP Button*1	K	Wireless Antennas
F	Operator Panel	L	Payload Mounting Surface (Top Plate shown)

*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 type that use invisible laser radiation and are safe under all conditions of normal use.

Precautions for Safe Use

- Although the lasers used are Class 1 (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 1-23 for more information.

Safety Laser Scanner

Each Safety Laser Scanner provides detection in a 270° 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.

Low Lasers

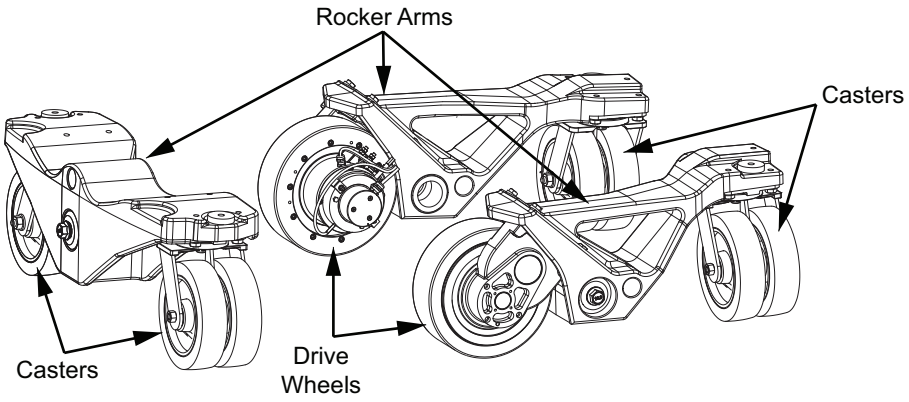
Two Low Lasers detect obstacles below the scanning plane of the Safety Laser Scanner, such as an empty pallet or fork truck blades, which are too low for the Safety Laser Scanner's detection plane. The Low Lasers are positioned near the floor and can detect objects that are at least 65 mm tall. The Low 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 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 solid polyurethane tread 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.
The drive wheels discharge accumulated electrical charge to ground. This prevents damage to sensitive AMR electronics.

Precautions for Correct Use

- 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.



1-2-3 Skins

Skins are removable panels at various locations on the exterior of the AMR.

⚠ 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.

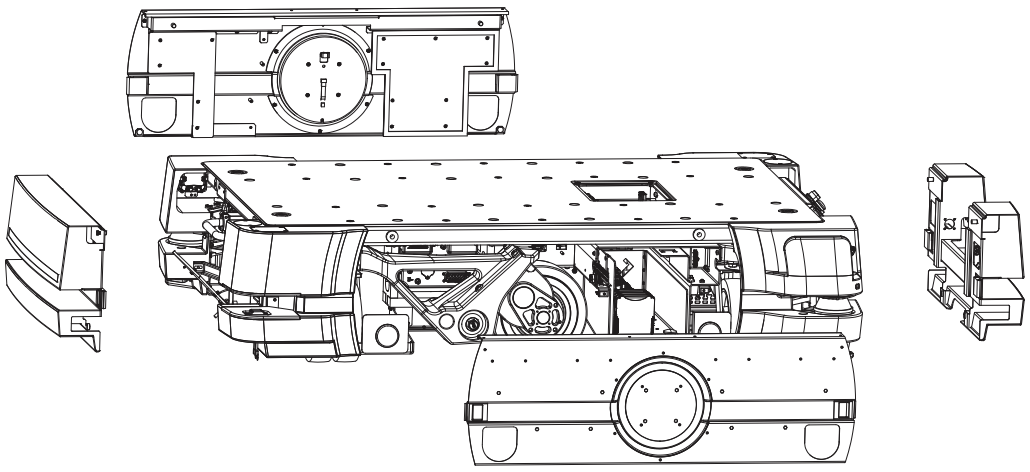
- Battery compartment.
- Light strip (front).
- Side Laser (front).
- Speakers.
- HAPS sensor (optional).
- Charging contacts.

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

- Operator Panel connections.
- Light strip (rear).
- Side Laser (rear).
- HAPS sensor (optional).
- Caster assemblies (rear).

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

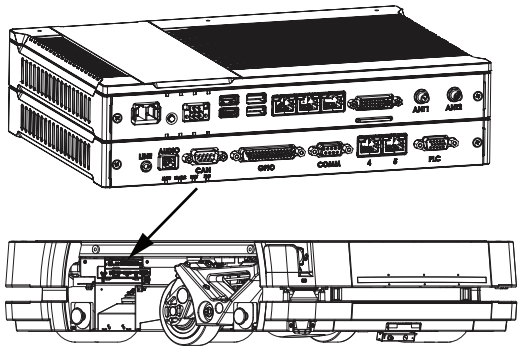
- E-STOP buttons.
- Light discs.
- Electronics bay.
- Drive wheels.



1-2-4 AMR Controller

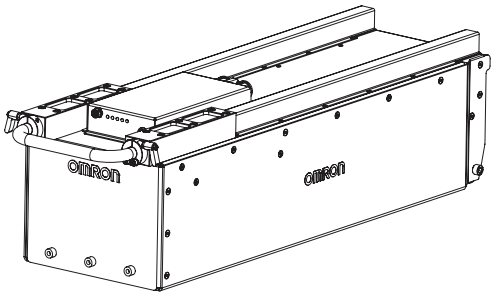
The AMR controller is the AMR's main computing system that provides all navigational controls and application interfaces. The AMR controller consists of two main components: the Base Layer containing standard PC interfaces and the Mobile Robot Layer for the processing of the AMR control interfaces and 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 (MARC), called 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.



1-2-5 Battery

A rechargeable lithium ion battery consisting of 8 modules 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.



Additional Information

The battery is shipped separately from the AMR to comply with dangerous goods shipping regulations.

1-2-6 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

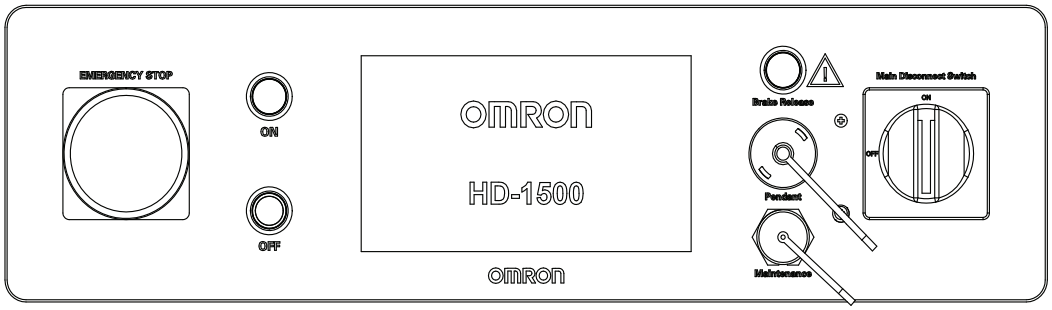
Additional E-STOP buttons can be added to the system when required.

1-2-7 Operator Panel

The Operator Panel features are described below.
You can relocate the operator panel to any preferred position on your payload structure.

Precautions for Safe Use

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



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.

E-STOP Button

The E-STOP button is connected to the safety circuit and has the same function that all other E-STOP buttons have on the AMR.

Brake Release Button

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

Pendant Port

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

Maintenance Ethernet Port

A Maintenance 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.

Main Disconnect Switch

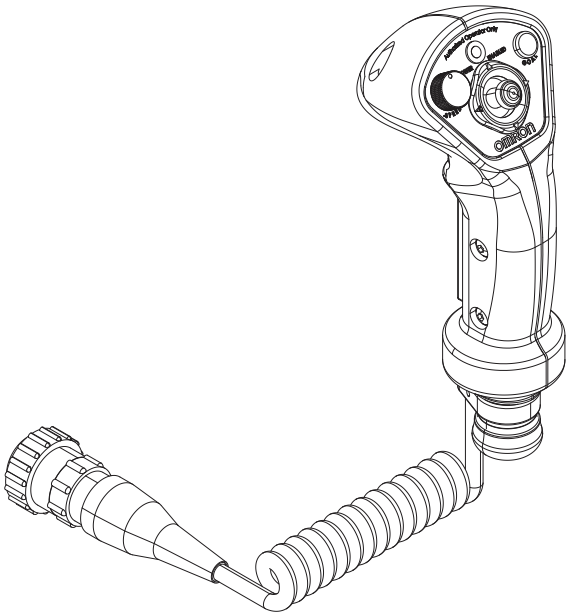
The main disconnect switch completely removes all battery power from the AMR for maintenance or other abnormal situations.

1-2-8 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 protective stop state unless an operator is present and holding the switch in the center position.

Additional Information

A Pendant is required for one or more AMRs.



1-2-9 Light Strips and Discs

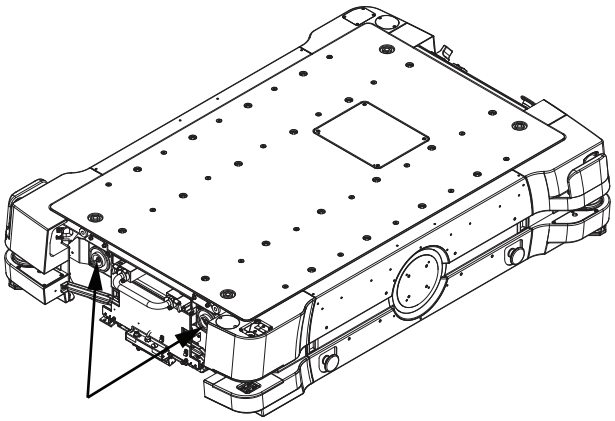
Colored light discs and strips are provided at highly visible locations on the exterior of the AMR. These provide visual indication about the AMR's status and its pending movement.

1-2-10 Speakers

Two speakers are 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.

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.



1-2-11 Charging Station

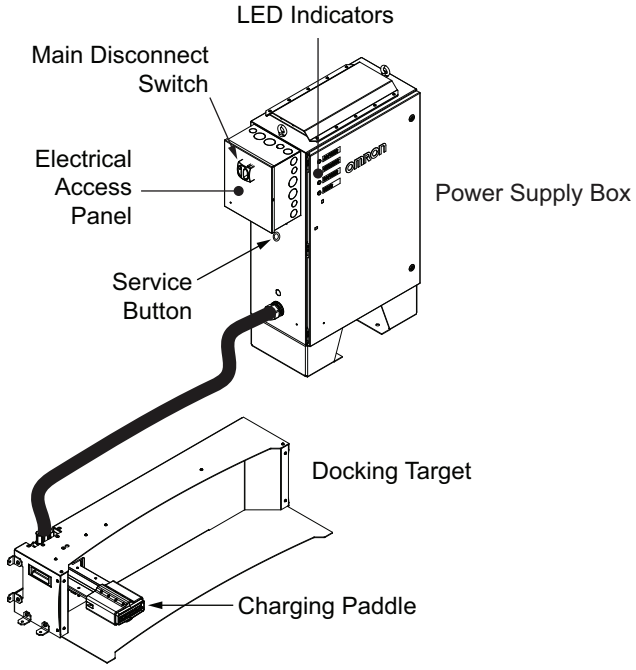
The Charging Station enables the AMR to charge autonomously.

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.



1-2-12 Charging Contacts

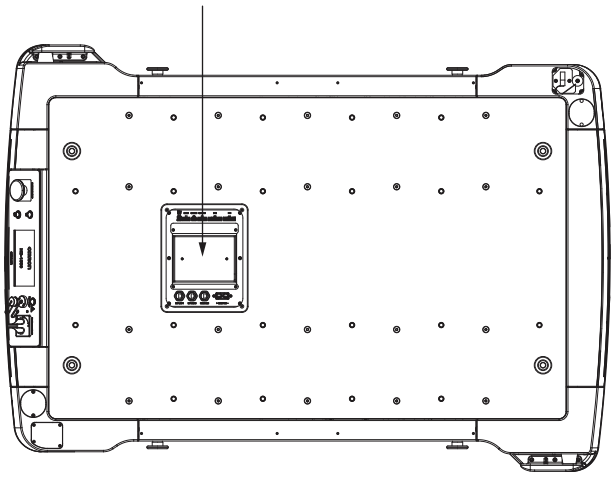
Charging contacts are used to mate with the Docking Target to transfer power to the battery during autonomous recharging.

1-2-13 User Access Panel

Connections for power, communications, safety devices, inputs, outputs, and other optional items are provided in the User Access Panel. These connections are typically used for powering and controlling a payload structure.

The User Access Panel also provides space for mounting user-supplied control devices if required, such as an NX-series EtherCAT Coupler unit with various NX-series I/O units attached.

The User Access Panel is protected with a removable cover.



1-2-14 Input and Output Control

The input and output terminals in the User Access Panel are directly connected to an internally mounted 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. The USER LAN connector in the User Access Panel is provided for connecting to the NX102. Refer to *3-5-2 User Access Panel Connections* on page 3-15 for more information.

1-2-15 Wireless Antennas

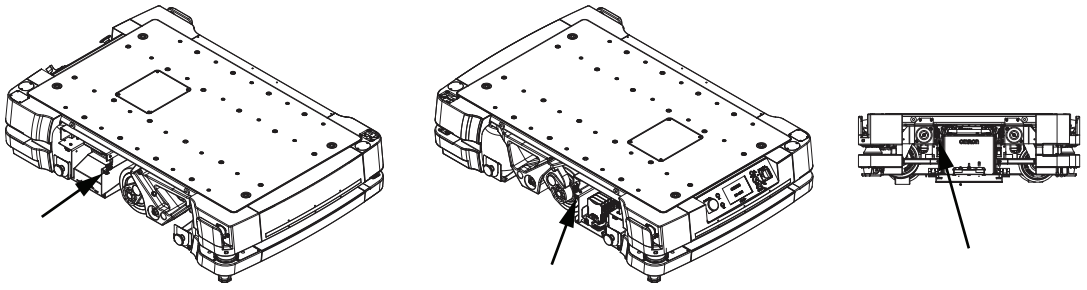
Two wireless antennas are factory-installed on the top of the AMR to provide optimal range. These wireless antennas are tamper resistant and low profile. They can also be relocated if a payload structure obscures them.

1-2-16 Localization Sensors

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.
This sensor data is combined with information from the Safety Laser Scanners, Low Lasers, and optional Side Lasers to calculate its position in the map for localization functions.

1-2-17 Interlock Switches

The AMR is equipped with the interlock switches located on the battery door and the side skins. The interlock switches are continuously monitored and ensure that the battery door and the side skins are properly attached to the AMR. This is to ensure that the internal components are isolated and protected from unauthorized and unsafe access.



1-2-18 Electronics Bay

The electronics bay houses the AMR Controller, network switches, and all associated cables and connections. You can access the electronics bay compartment from the right or left side of the AMR if the skins are removed.

1-2-19 Payload Mounting Surface

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

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.

The AMR will frequently adjust its path to go around an obstacle. 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 Safety Scanning Lasers 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 Scanning Lasers.
- Encoders (one on each drive motor) provide information on the distance traveled by each drive wheel and direction of travel.

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 Access Panel 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.

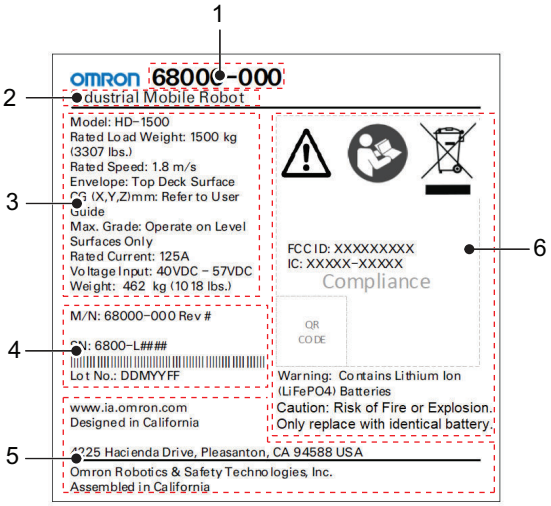
- Editing the workspace map to include features that restrict the AMR's operation in specific areas, such as preferred lines, resisted areas, and movement parameter sectors to reduce speed.
- Editing the AMR's configuration to affect its behavior in all locations, such as restricting its maximum speed.

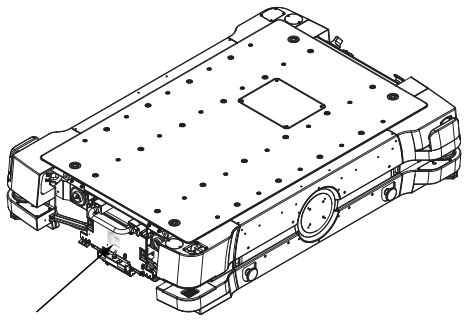
1-4 Information Labels

The information labels contain relevant information about the AMR and Charging Station components. The following examples may be different from your product label.

1-4-1 AMR Information Label

The AMR information label is described below.

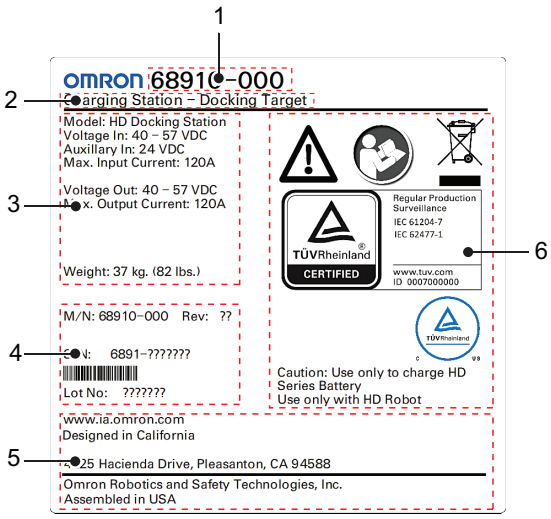


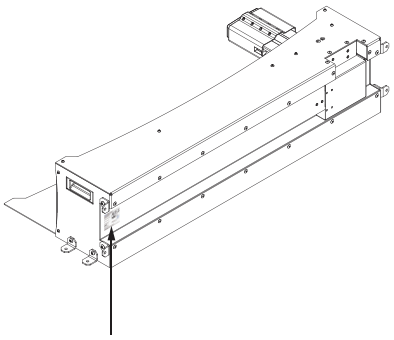


Item	Name	Description
1	Part Number	The AMR part number is provided.
2	Product Type	The product type is provided.
3	AMR Information	General information about the AMR is provided.
4	Production Information	The following information is provided. • M/N indicates the model number and revision level. • SN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

1-4-2 Docking Target Information Label

The Docking Target information label is described below.

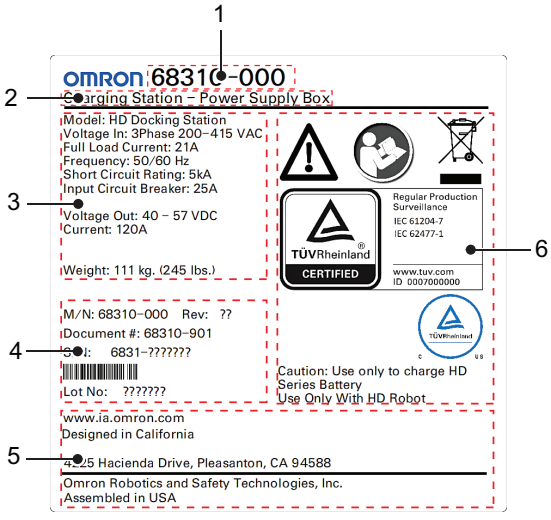


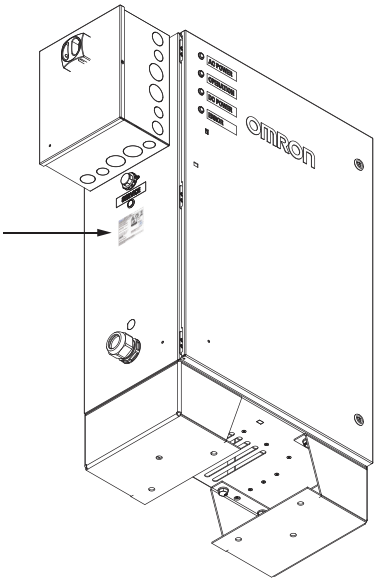


Item	Name	Description
1	Part Number	The Docking Target part number is provided.
2	Product Type	The product type is provided.
3	Docking Target Information	General information about the Docking Target is provided.
4	Production Information	The following information is provided. • M/N indicates the model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

1-4-3 Power Supply Box Information Label

The Power Supply Box information label is described below.





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 DDMMYYFF. Month number 1 to 9 for January to September, X for October, Y for November, and Z for December. FF is reserved for internal use.
5	Product Origin Information	Product origin information is provided.
6	Alerts and Compliance	General alerts and compliance information is provided.

1-5 Model Numbers

Model numbers are provided in the table below.

Additional Information

A battery (part number 68330-000) is not included with the AMR and must be ordered separately.

Model Number	Included Items
37480-00000	HD-1500 AMR
37480-00100	• HD-1500 AMR • Single HAPS sensor (factory installed)
37480-00200	• HD-1500 AMR • Dual HAPS sensors (factory installed)
37480-00010	• HD-1500 AMR • Side Lasers (factory installed)
37480-00110	• HD-1500 AMR • Single HAPS sensor (factory installed) • Side Lasers (factory installed)
37480-00210	• HD-1500 AMR • Dual HAPS sensors (factory installed) • Side Lasers (factory installed)
37480-10004	• HD-1500 AMR • Charging Station • Pendant • Top Plate (factory installed)
37480-10104	• HD-1500 AMR • Charging Station • Single HAPS sensor (factory installed) • Pendant • Top Plate (factory installed)
37480-10204	• HD-1500 AMR • Charging Station • Dual HAPS sensor (factory installed) • Pendant • Top Plate (factory installed)
37480-10114	• HD-1500 AMR • Charging Station • Single HAPS sensor (factory installed) • Pendant • Top Plate (factory installed) • Side Lasers (factory installed)
37480-10214	• HD-1500 AMR • Charging Station • Dual HAPS sensor (factory installed) • Pendant • Top Plate (factory installed) • Side Lasers (factory installed)

1-6 Optional Items

Information about optional items is provided in this section.

1-6-1 EM2100 Fleet Manager

To manage and administer multiple AMRs in the same workspace, you must use an EM2100 appliance configured as a Fleet Manager running the Fleet Operations Workspace (FLOW) software. The EM2100 appliance 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 an EM2100 appliance shares the map between all AMRs in the fleet. This provides a common frame of reference for navigation and localization, preventing contention between AMRs while managing traffic flow and ensuring job completion. Refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.

When two or more AMRs operate in the same workspace, they may not be able to accurately detect each other or to precisely determine each other's dimensions without a Fleet Manager. This occurs because the Safety Laser 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 EM2100 appliance 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 ever 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 improving the efficiency of AMR operations by sharing the information between all AMRs in the fleet. The shared information includes functions for improving the efficiency of AMR operations with 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 EM2100 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 EM2100, 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 3-12 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 Guide (Cat. No. I649)*.

1-6-2 Additional E-STOP Buttons

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 safety 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 Correct Use

The emergency stop or the 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 *3-5-2 User Access Panel Connections* on page 3-15 for more information about additional E-STOP connections.
- If no additional E-STOP buttons are added, a jumper with a part number of 68410-218L must be placed on the SCPU port. Refer to *SCPU* on page 3-17 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 and the light strips in front and back 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. Refer to *3-5-2 User Access Panel Connections* on page 3-15 for more information.

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 Safety Controller.

The buzzer must be audible above the ambient noise of the environment that the AMR operates in. Depending on your environment's noise level, you may need to add an additional buzzer installed on your payload structure so that the buzzer can be heard over the ambient noise level. It is the end-user's responsibility to verify this requirement.

The LIGHTS port in the User Access Panel can support a user-supplied warning buzzer. You can install it in either the AMR or in a location of your choice in your payload structure. Refer to *3-5-2 User Access Panel Connections* on page 3-15 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, factory-installed 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.

Side Lasers can be relocated to the payload structure to prevent the structure from interfering with the scanning plane. 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. Refer to *3-8 Side Laser Relocation to the Payload Structure* on page 3-27 for more information.

⚠ 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

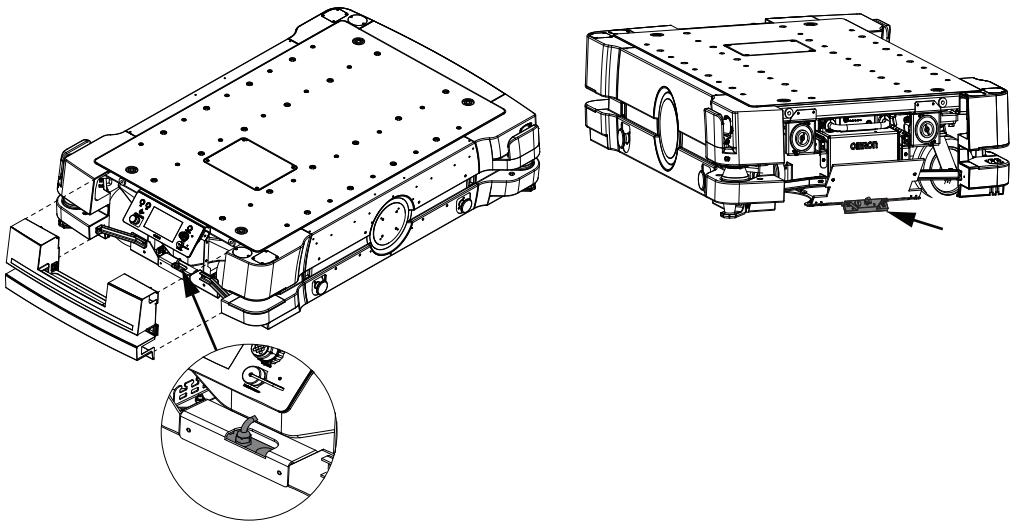
- If it is not possible to prevent some interference between the payload and the Side Lasers' sensing plane, the *LaserIgnore* parameter can be used to constrain sensing to zones that do not include the payload. However, this method might compromise the detection ability of the sensors and should be avoided if possible.
- Factory installed Side Lasers are protected by guards. If you relocate the Side Lasers, consider using protective guards to prevent damage. Make sure that user-installed guards do not block the scanning area or extend outward excessively.

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.
Refer to *Charging a Battery Outside of the AMR* on page 4-25 for more information.

1-6-7 High-accuracy Positioning System

The High-Accuracy Positioning System (HAPS) is a sensor that detects magnetic tape applied to the floor. HAPS allows the AMR to very accurately align itself at a specific location, such as a fixed conveyor.
A protective covering needs to be installed when applying the magnetic tape to the floor to prevent damage from the AMR traffic. OMRON does not provide the protective coverings with the HAPS option. The protective covering must be supplied by the user.
The factory-supplied component is the HAPS sensor itself. The standard AMR includes all wiring if a HAPS sensor needs to be added. 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.
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.
The simplest installation 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 *3-9 HAPS Installation and Configuration* on page 3-30 for more information.
For locations with multiple places where you want the AMR to stop, use a continuous tape strip with one marker at each stop (one goal for each marker) and an Engage task for each goal. The goals would all be at the same location, near the start of the tape. The Engage tasks allow an AMR to follow the tape performing tasks from the successive goals without ever needing to return to the location of the goals.
The following figure displays the mounting locations for the HAPS sensors.

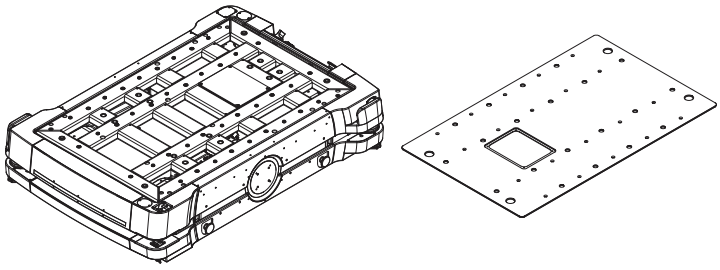


Additional Information

Contact your OMRON representative for information about the HAPS sensor replacement.

1-6-8 Top Plate

An optional Top Plate is available that can be attached to the AMR chassis. This Top Plate is used to protect the AMR, but it is not required. The AMR can be ordered with or without a Top Plate depending on the application requirements.



1-7 Software

The AMR requires the licensed software described in this section. Software is factory-installed on the AMR Controller. Features and functions can be added to the AMR by activating licenses as described in *Fleet Operations Workspace Core User's Manual (Cat. No. I635)*.

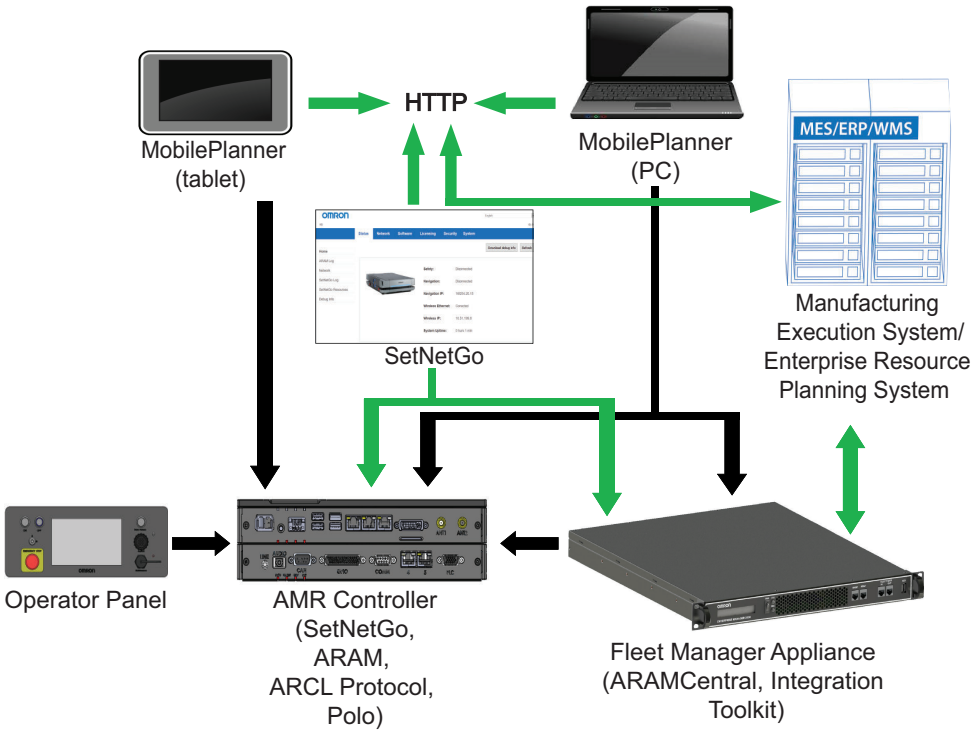
The minimal operating configuration for an AMR is managed by a person(s) using a Microsoft Windows® PC or optionally from an Android or iOS tablet.

If you have more than one AMR, you must install and configure an EM2100 appliance (running the Fleet Operations Workspace software) to manage multiple AMRs as a fleet. Refer to *1-6-1 EM2100 Fleet Manager* on page 1-21 for more information.

The following figure shows the devices that you might use to manage one or more AMRs and the software components required for each device, if applicable.

AMR administration includes both configuring and operating an AMR and also using the AMR (or a fleet of AMRs) to perform useful work. The FLOW Core software that enables you to perform these functions consists of the following items.

- MobilePlanner / MobilePlanner Tablet Edition
- ARCL protocol
- Integration Toolkit
- SetNetGo
- ARAM
- Polo



1-7-1 System Requirements

Access to software features is permitted by use of a USB license dongle that contains secure, encrypted electronic copies of the operating licenses. Some licenses might have a restricted term and expire after a specific date. You will receive several warning alerts before the license expires.

PC Requirements

A PC running a supported version of Microsoft Windows® is required to configure and manage an AMR (Windows 7, Windows 8, and Windows 10 are supported). The PC requires 200 megabytes of available hard-disk storage.

Additional Information

Wireless is a requirement for managing multiple AMRs as a fleet. Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.

Mobile Device Requirements

If MobilePlanner Tablet Edition software is used, an Android or iOS tablet device is required to run the MobilePlanner Tablet software.

The following requirements must be met for the tablet device.

- Android OS version 9 or newer.
- iOS version 10 or newer.
- Android devices need at least 2 GB of RAM. Sites with large or complex maps may require more RAM.

1-7-2 ARAM Software

The Advanced Robotics Automation Management software (ARAM) runs on the AMR Controller.

ARAM is responsible for the following AMR functions and features:

- Interaction with on-board sensors such as the Safety Laser Scanner, Low Lasers, and optional Side Lasers.
- High-level, autonomous robotics functions such as:
  - Obstacle avoidance
  - Path planning
  - Localization
  - Navigation
- Motion commands to the Polo firmware.
- Battery management.

ARAM provides the AMR with an interface to external entities by managing the following:

- Wired and wireless Ethernet communications with external software for external monitoring,development, and systems coordination.
- Fleet coordination of AMRs through the optional Fleet Manager.
- Integration with other systems.
- External monitoring, setup, and control via the MobilePlanner graphical interface.
- Digital and analog I/O ports accessible from the User Access Panel that enable you to integrate application-specific sensors and effectors into your payload structure. Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for instructions on how to configure I/O connections.

1-7-3 ARAMCentral Software

ARAMCentral runs on the Fleet Manager as part of the Fleet Operations Workspace software.

When managing a fleet, the ARAMCentral software does the following:

- Stores and distributes the shared workspace map used by all AMRs in a fleet.
- Stores and distributes the common AMR configuration.
- Controls AMR traffic, including multi-AMR avoidance, AMR destinations and standby, and Docking Target access.
- Queuing of jobs.
- Manages remote I/O (if used).

1-7-4 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.

Before you assign tasks to an AMR, you use MobilePlanner to create and edit a digitized map of its work space. During this procedure, you use the pendant to drive the AMR around the workspace. In mapping mode, the Safety Laser Scanner detects features of the workspace, such as walls, columns, doorways and corners. After you create the map, you open it in MobilePlanner and edit it to add or remove features. For example, if there is an area of the map where you want the AMR to follow a specific path, you can draw a *PreferredLine* feature on the map. Be aware that the AMR will deviate from the *PreferredLine* if an obstacle enters its path.

MobilePlanner is also used to configure ARAM operating parameters that control the AMR's operation in the mapped workspace. For example, you might assign a preferred Docking Target to the AMR or the Fleet Manager by specifying the unique map identifier for that Docking Target. This configuration can be shared with identically-equipped AMRs in your fleet. The map generated by one AMR can be shared across a fleet, with both identical and non-identical OMRON AMRs.

MobilePlanner can also be used for the following functions.

- Configuring the AMR operating parameters.
- Monitoring and manually controlling the AMR.
- Scheduling autonomous operations.

Precautions for Correct Use

Map creation is required before normal operation of the AMR.

Additional Information

- A USB flash drive containing software and documentation is included with the AMR.
- Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.

Administrator Mode

Depending on your level of access (controlled by your account), the graphical interface provides the following options.

- Managing AMR fleet jobs.
- Creating and editing workspace maps.
- Accessing the AMR through the SetNetGo Web interface.

- Commissioning and configuring an AMR and modifying its configuration by changing ARAM parameters.
- Issuing custom ARCL commands.

Additional Information

The portable tablet version of MobilePlanner has some restrictions. Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.

Operator Mode

MobilePlanner can operate in a restricted Operator mode that permits only limited access user interface features and functions. This mode allows you to monitor one or more AMR activities and assign tasks in the mapped space.

1-7-5 ARCL Programming Language

The Advanced Robotics Command Language (ARCL) is a programming language integrated into ARAM and ARAMCentral. Its operating format is a text-based command and response server. Use ARCL to integrate one ore 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 using the onboard NX102 controller or some other user-supplied controller.

Additional Information

Refer to the *Mobile Robots Advanced Robotics Command Language Reference Guide (Cat. No I617)* for more information.

1-7-6 Integration Toolkit

The Integration Toolkit is an interface application enabling the integration of Fleet Manager with the end user's client application, such as a Manufacturing Execution System (MES) or Warehouse Management Software (WMS) system. The Integration Toolkit facilitates the full management and monitoring of all AMR job types, and allows tracking of the AMR data directly. It has a flexible architecture which provides multiple and simultaneous communication channel options, allowing the user to command and monitor fleet operations using Rest, SQL, and/or RabbitMQ. These communication channels provide flexibility and choice in how a system interacts with an AMR fleet and the Fleet Manager.

Precautions for Correct Use

The Integration Toolkit only runs on an EM2100 appliance configured as a Fleet Manager.

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

1-7-7 SetNetGo Software

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.
The SetNetGo operating system runs on the AMR Controller and the EM2100 appliance. It is the host operating system in which the FLOW components ARAM and ARAMCentral run.

Additional Information

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

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 of the payload must be made. Refer to *2-2-3 Payload Center of Gravity* on page 2-6 for more information.

⚠ DANGER

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

⚠ WARNING

- The 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.

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.

● Projections and Overhangs

Your payload should not overhang or project beyond the outer dimensions of the AMR. Doing so might place parts of the structure outside the safety envelope provided by the Safety Laser Scanners.

⚠ 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.
- Repeat the safety commissioning procedure.
- 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.

● Wireless Antennas

You must ensure that the payload does not obstruct the wireless antennas. If it is not possible to prevent some interference between the payload and the wireless antennas, you may relocate the wireless antennas to a payload position where the signal does not get attenuated. Refer to *3-5-1 Wireless Antenna Connections* on page 3-14 for additional information on how to relocate the wireless antennas.

Precautions for Correct Use

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

● 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 with a part number of 68410-218L must be placed on the SCPU port. Refer to *SCPU* on page 3-17 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.

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. You should 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 *2-8-4 USER PWR Connector* on page 2-18 and *2-8-5 REG PWR Connector* on page 2-18 for more information.

Overload Duration	Overcurrent Level
Continuous	50 A
100 ms	100 A
1 ms	200 A

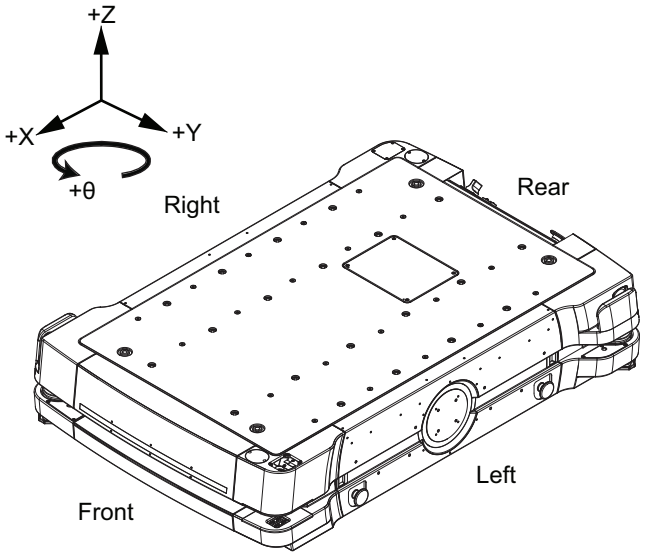
1-9 Coordinate System

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.

2-1 Performance Specifications

Performance specifications for the AMR are provided below.

Item	Specification
Maximum payload capacity	1500 kg
Swing radius	982 mm
Turn radius	0 mm
Maximum translational speed	1800 mm/s
Maximum translational acceleration	900 mm/s^2
Maximum rotational speed	60 degrees/s
Maximum rotational acceleration / deceleration	150 $degrees/s^2$
Maximum moment of inertia	490 $kg\text{-}m/s^2$
Stop position repeatability (single AMR)	• To a position: ±50 mm • To standard target: ±25 mm, ± 2° • With HAPS: ±8 mm, ±0.4° • With CAPS: ±8 mm, ±0.5°
Stop position repeatability (fleet)	• To a position: ±70 mm • To standard target: ±35 mm, ± 2° • With HAPS: ±10 mm, ±0.75° • With CAPS: ±16 mm, ±0.5°

2-2 Physical Specifications

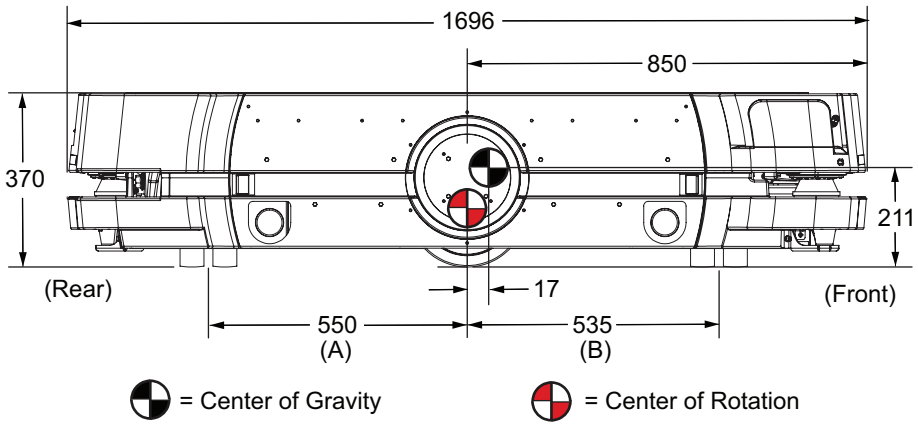
Physical specification of the AMR and other items are provided below.

2-2-1 Dimensions

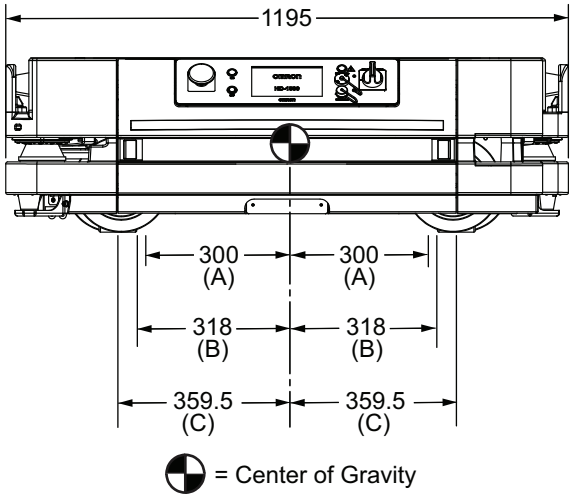
Dimensional specifications are provided in the following sections.

AMR Dimensions

Physical dimensions of the AMR are provided below.



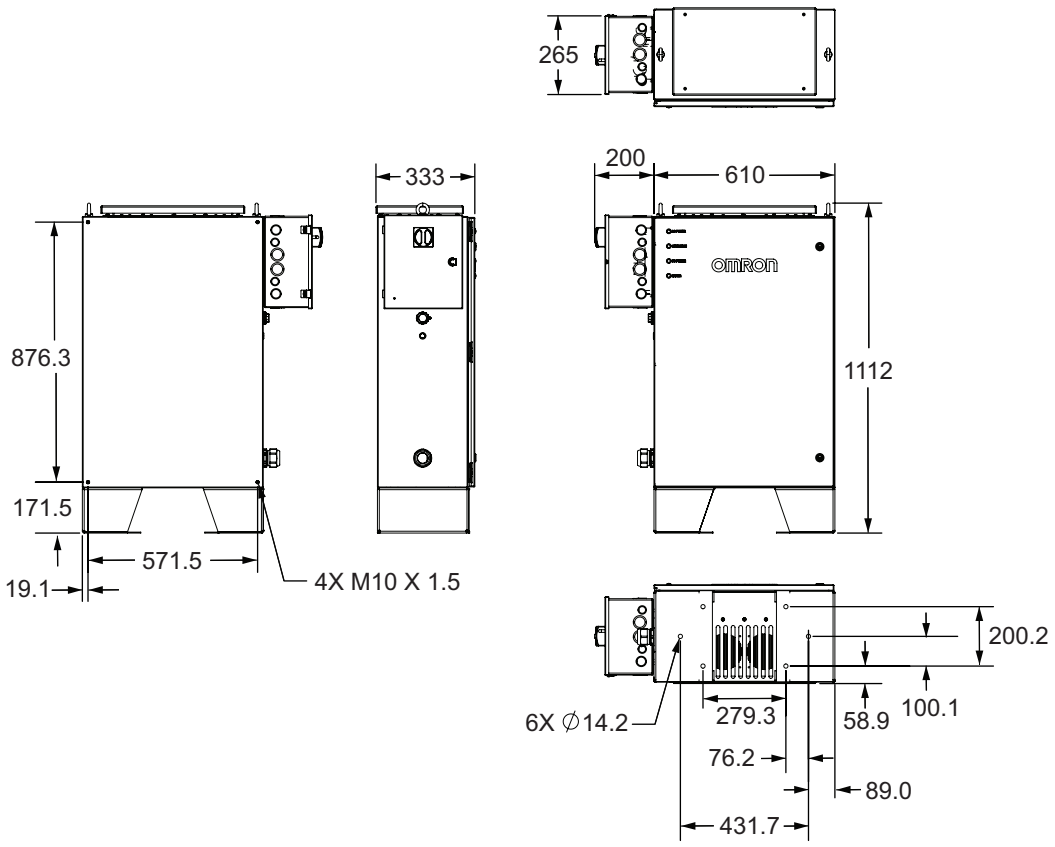
A = Rear caster pivot point to Center of Rotation
B = Front caster pivot point to Center of Rotation



A = Rear caster pivot point to Center of Gravity
B = Front caster pivot point to Center of Gravity
C = Drive wheel to Center of Gravity

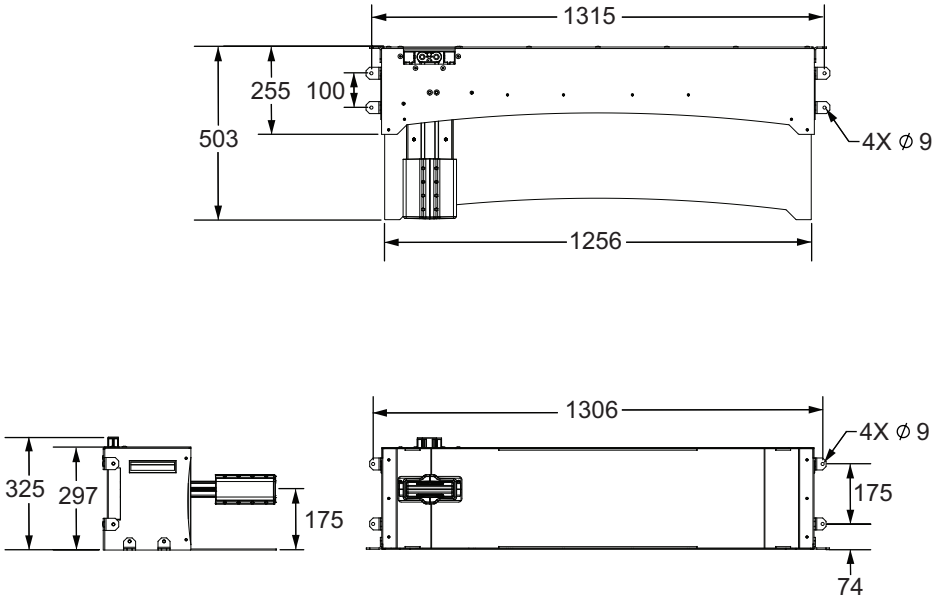
Power Supply Box Dimensions

Physical dimensions of the Power Supply Box are provided below.



Docking Target Dimensions

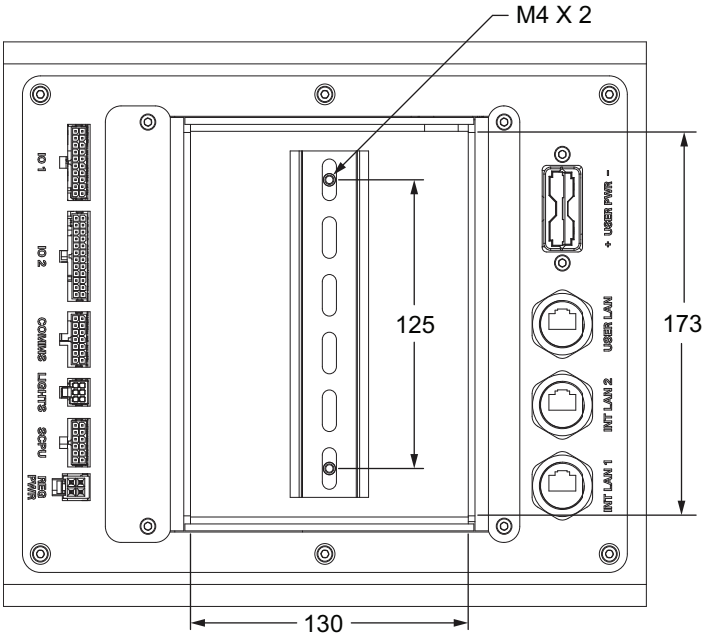
Physical dimensions of the Docking Target are provided below.



User Access Panel Dimensions

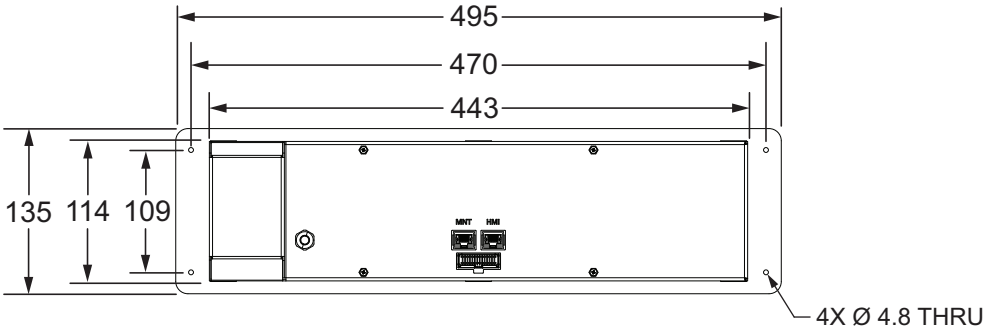
Physical dimensions for the User Access Panel are provided below. User-supplied DIN rail is shown in the following figure for reference.

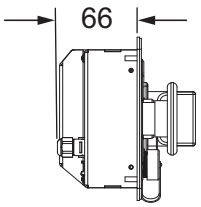
The distance from the base of the User Access Panel to the AMR mounting surface is 92 mm.



Operator Panel Dimensions

Physical Dimensions of the Operator Panel are provided below.





2-2-2 Weights

Weights are provided in the table below.

Item	Weight
AMR (no battery or accessories)	437 kg
Battery	69.5 kg
Power Supply Box	108 kg
Docking Target	27.5 kg

Item	Weight
Top Plate Kit	21.5 kg

2-2-3 Payload Center of Gravity

Center of gravity is a critical factor when placing items on the AMR for transport. Keep the payload's center of gravity centered over the AMR's own center of gravity and as low as possible. This provides optimum stability, particularly when the AMR traverses irregularities in the floor.
The AMR has a maximum payload of 1500 kg, which includes the payload structure and any load carried by that structure. You must ensure that the payload does not extend beyond the AMR's footprint.
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 when loading and unloading the AMR.

⚠ 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.

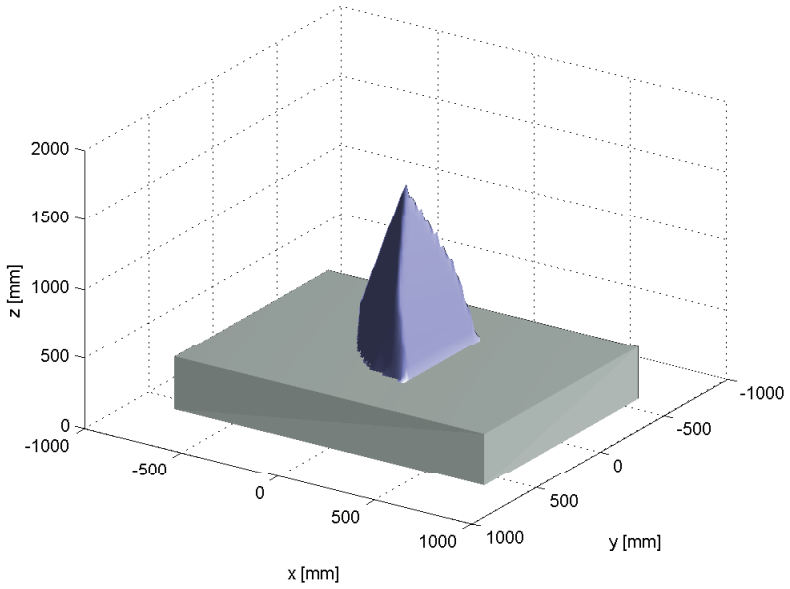
Additional Information

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

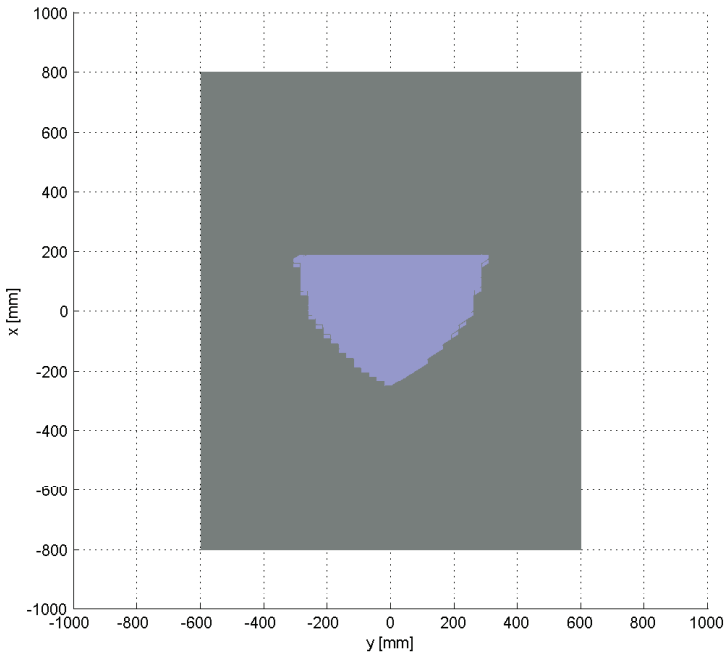
The following figures show the calculated safe center of gravity placements for AMR's maximum allowed payload weight. The payload's center of gravity must be within the area shown.
These calculations assume the following conditions.

- The payload is securely attached to the AMR and it does not shift due to the AMR's motion.
- The payload does not overhang the AMR.
- The AMR does not exceed its specified default limits for acceleration, deceleration, linear velocity, angular velocity, and coefficient of friction (0.6 minimum).

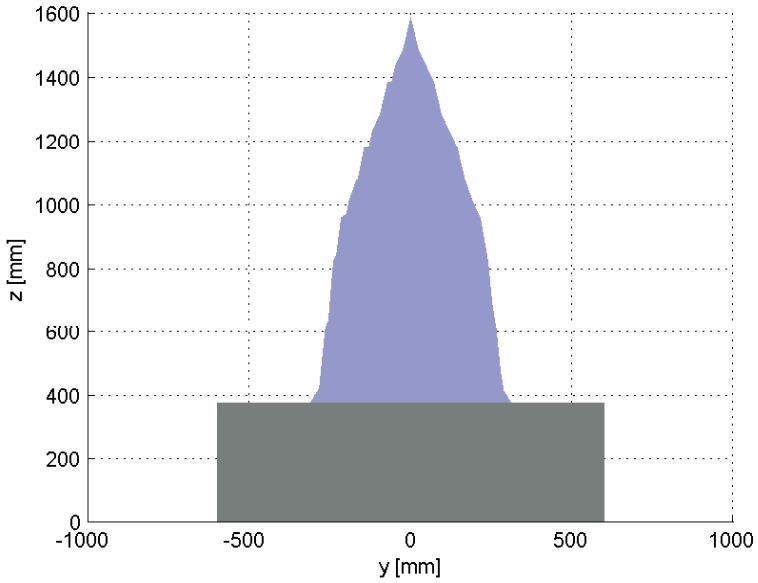
In the following graphs, X represents the direction of the AMR's motion (rear to front). Y is perpendicular to the AMR's direction of motion (side-to-side). Z is the vertical dimension (height). Refer to *1-9 Coordinate System* on page 1-34 for more information.
A 3D view of the recommended payload center of gravity is shown below.



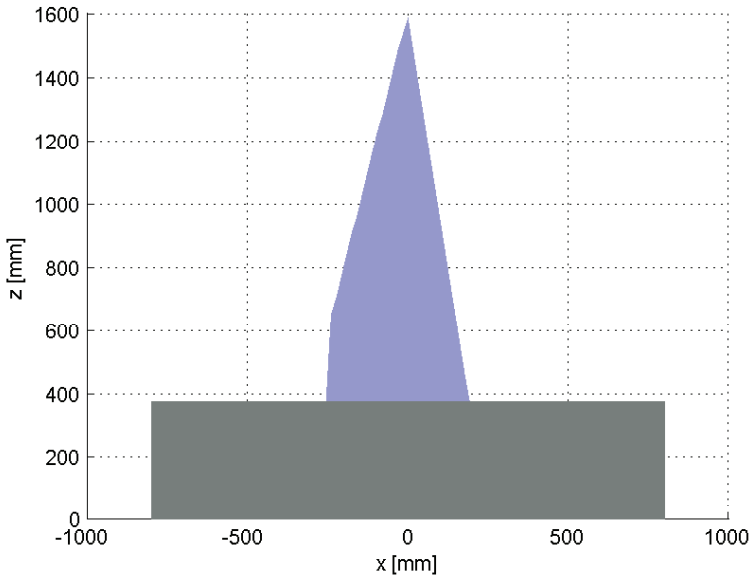
A top view of the recommended payload center of gravity is shown below.



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



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



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		IP20 (IP10 for charging pads)
Atmospheric		Non-hazardous environments (no explosive gas and oil mist).
Radiation		No environments with ionizing radiation.
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	Step traversal	10 mm maximum
	Gap traversal	20 mm maximum
	Flatness	F_F25 (per ACI 117 standard)
	Levelness	F_L25 (per ACI 117 standard)
	Weight rating	2.1 MPa

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 60°C (less than 2 weeks) -20 to 35°C (more than 2 weeks)
Humidity	5% to 95%, non-condensing

Item	Specification
Altitude	Operation: 4500 m Transportation: 15240 m
Pollution degree	2
Ingress protection class	IP20

*1. Refer to *4-11-6 Storing Batteries* on page 4-26 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 Laser Specifications

Specifications for the lasers are provided below.

Item		Specification
Safety Laser Scanner	Scanning plane	Horizontal plane 175 mm from floor surface
Low Laser	Scanning plane	Horizontal plane 65 mm from floor surface.
Side Laser	Scanning plane	Vertical plane
Laser class		Class 1 in accordance with the following standards: • IEC 60825-1 • CDRH 21 CFR 1040.10 • 1040.11

2-5 Battery Specifications

Battery specifications are provided below.

Item	Specification
Run-time	With full payload: approximately 9 hours
	With no payload: approximately 12.5 hours
Duty cycle (depth of discharge)	80%
Voltage	48-56 VDC (52.8 VDC nominal)
Capacity	70 Ah nominal
Energy	3.7 kWh nominal
Recharge time	40 minutes (from empty to full)
Life span	Approximately 9000 cycles

2-6 HAPS Specifications

Specifications for HAPS is provided below.

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

2-7 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.

2-8 Other Specifications

Specifications for other items are provided below.

2-8-1 Safety Functions

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 button on Pendant • E-STOP button on Operator Panel • 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.	d	3	5.67E-07
Emergency stop connection on User Access Panel*2	Emergency Stop	Manual Reset	User-supplied E-STOP button(s) can be attached to the SCPU connection located in the User Access Panel. 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	5.79E-08

Safety Function	Safety Stop Type	Reset Type	Description	PL	Category	PFHd
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). 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 two seconds.	d	3	6.50E-07
Enabling device on Pendant	Protective Stop	Automatic Reset	Releasing the enabling device or compressing it beyond the center position will cause a Category 1 Stop [*1] on the AMR. This is a protective stop and the AMR resumes its operation automatically after a two-second delay, and when the pendant enabling device is held in the center enable position.	d	3	5.67E-07
Overspeed protection	Protective Stop	Manual Reset	This function monitors for overspeed and speed inconsistency. The AMR linear speed is limited to 1800 mm/s (both forward and backward). If the calculated speed exceeds this speed limits, the AMR protective stop is triggered.	d	3	5.67E-07

Safety Function	Safety Stop Type	Reset Type	Description	PL	Category	PFHd
Protective Stop connection on User Access Panel*2	Protective Stop	Automatic Reset	User-supplied protective stop devices initiate a protective stop 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.		5.79E-08
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	7.13E-06
Warnings	N/A	N/A	This function is for the visual warning system.	b	B	5.71E-06
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	7.13E-06

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

*2. The SCPU connector on the User Access Panel 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.

2-8-2 Drive Train

Drivetrain specifications are provided below.

Description	Specification
Drive wheels	Steel wheels with ESD tread
Drive wheel dimensions	250 mm diameter. x 80 mm width
Drive wheel motor	1500 W PMS servo motor
Casters	Cast iron wheels with polyurethane tread
Caster dimensions	203.2 mm diameter. x 120.7 mm wide
Brakes	195 N·m holding torque
Steering	Differential

2-8-3 Operator Panel Screen

Operator Panel screen specifications are provided below.

Item	Specification
Display type	Color TFT backlit with 256 k colors, 178 mm diagonal
Resolution	800 x 480
Brightness	400 cd/m^2

2-8-4 USER PWR Connector

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

Item		Specification
AMR connector		Anderson Power Pole SBS-50
User-supplied mating connector		
User-supplied connector pins		Anderson Power Pole: • 16 mm^2 wire size: 1339G2 • 10 mm^2 wire size: 1339G5 • 2.5mm^2 to 6 mm^2 wire size: 1339G3
Voltage range		48-56 VDC (unregulated)
Current limits (REG and USER power combined)*1	Continuous	50 A
	100 ms	100 A
	1 ms	200 A

*1. Momentary current spikes that are over the thresholds specified here 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. You should use external current limiting devices to prevent transient current overload.

2-8-5 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	Molex Mini Fit Jr. receptacle (part number: 0469920410)
User-supplied mating connector pins	Molex, 18-24 AWG (part number: 0039000074)
Voltage range*1	23.0 to 25.2 VDC
Current limits (REG and USER power combined)*2	Continuous: 50 A
	1 ms: 200 A
	100 ms: 100 A

*1. Momentary current spikes that are over the thresholds specified here 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. You should use external current limiting devices to prevent transient current overload.

*2. Momentary current spikes that are over the thresholds specified here will activate current limiting protection and cause power loss at the REG power connector. Simultaneous inrush loads might trip the over current protection at the battery. You should use external current limiting devices to prevent transient current overload.

2-8-6 SCPU Connector

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

Item	Specification
AMR connector	TE Connectivity Micro Mate N Lok., 2 x 6
User-supplied mating connector	TE Connectivity Micro Mate N Lok receptacle (part number: 1-794617-2)
User-supplied mating connector pins	TE Connectivity AMP connectors, 20-24 AWG (part number 1-794610-2)
Input type	PNP / sourcing
Rated input voltage	24 VDC (20.4 to 28.8 VDC)
Safety input current	3.0 mA
Safety output current	500 mA

2-8-7 LIGHTS Connector

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

Item	Specification
AMR connector	TE Connectivity Micro Mate N Lok., 2 x 3
User-supplied mating connector	TE Connectivity Micro Mate N Lok receptacle (part number: 794617-2)
User-supplied mating connector pins	TE Connectivity AMP connectors, 20-24 AWG (part number 1-794610-2)
Output type	PNP / sourcing
Rated output voltage	24 VDC (20.4 to 28.8 VDC)
Maximum output current	500 mA

2-8-8 IO 1 Connector

Electrical and other specifications for the IO 1 connector are provided below.

Additional Information

The IO 1 connector is connected to the NX-ID4442 and NX-AD3603 units in the AMR. Refer to the *NX-series Digital I/O Unit User's Manual (Cat. No. W521)* and the *NX-series Analog I/O Units User's Manual for Analog Input Units and Analog Output Units (Cat. No. W522)* for more information.

Item	Specification
AMR connector	TE Connectivity Micro Mate N Lok., 2 x 10
User-supplied mating connector	TE Connectivity Micro Mate N Lok receptacle (part number 2-794617-0)
User-supplied mating connector pins	TE Connectivity AMP connectors, 20 to 24 AWG (part number 1-794610-2)
I/O type	8 digital PNP / sourcing inputs 4 Analog inputs ± 10 VDC
Rated input voltage	Digital inputs: 24 VDC (15 to 28.8 VDC) Analog inputs: -10 to 10 VDC (-15 to 15 VDC max.)
Input current	Digital inputs: 3.5 mA typical at 24 VDC, rated current

Item	Specification
ON voltage / ON current (digital inputs)	Digital inputs: 15 VDC min. / 3 mA min. (each signal)
OFF voltage / OFF current	5 VDC max. / 1 mA max. (between IOG and each signal)
ON / OFF response time (digital inputs)	20 µs max. / 400 µs max.

2-8-9 IO 2 Connector

Electrical and other specifications for the IO 2 connector are provided below.

Additional Information

The IO 2 connector is connected to the NX-OD4256 and NX-DA3603 units in the AMR. Refer to the *NX-series Digital I/O Unit User's Manual (Cat. No. W521)* and the *NX-series Analog I/O Units User's Manual for Analog Input Units and Analog Output Units (Cat. No. W522)* for more information.

Item	Specification
AMR connector	TE Connectivity Micro Mate N Lok., 2 x 12
User-supplied mating connector	TE Connectivity Micro Mate N Lok receptacle (part number 2-794617-4)
User-supplied mating connector pins	TE Connectivity AMP connectors, 20 to 24 AWG (part number 1-794610-2)
I/O type	8 digital PNP / sourcing outputs 4 Analog outputs ± 10 VDC
Operating load voltage	Digital outputs: 15 to 28.8 VDC Analog outputs: -10 to 10 VDC
Output load current	Digital outputs: 0.5 A / signal Analog outputs: 5 kΩ min. allowable load resistance
Leakage current	Digital outputs: 0.1 mA max.
Residual voltage	Digital outputs: 1.5 VDC max.
Analog resolution	1/8000
Analog conversion time	250 µs / point
Analog output impedance	0.5 Ω max.

2-8-10 COMMS Connector

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

Item	Specification
AMR connector	TE Connectivity Micro Mate N Lok., 2 x 7
User-supplied mating connector	TE Connectivity Micro Mate N Lok receptacle (part number: 1-794617-4)
User-supplied mating connector pins	TE Connectivity AMP connectors, 20-24 AWG (part number 1-794610-2)
Communication types	RS-232, RS-422, CAN Bus

3

Installation

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

3-1 Installation Introduction

The general AMR installation steps are provided below.

⚠ 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.

Additional Information

Unpack all equipment before beginning the AMR configuration procedure.
Refer to *A-1 Unpacking* on page A-2 for more information.

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

2 Install and charge the battery.
Refer to *3-3 Battery Installation Procedure* on page 3-9 and *2-7 Charging Station Specifications* on page 2-14 for more information.

3 Configure the network connections.
Refer to *3-4 Network Connections* on page 3-11 for more information.

4 Install the payload structure and make all electrical connections..
Refer to *3-6 Attaching the Payload* on page 3-23 and *3-5 Electrical Connections* on page 3-14 for more information.

5 Install optional items.
Refer to *1-6 Optional Items* on page 1-21 for more information.

6 Attach warning labels.
Refer to *3-10 Attaching Warning Labels* on page 3-35 for more information.

7 Perform safety commissioning.
Refer to *3-11 Safety Commissioning* on page 3-36 for more information.

8 Generate a map for the AMR.
Refer to *3-12 Map Creation Overview* on page 3-37 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 3-4 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

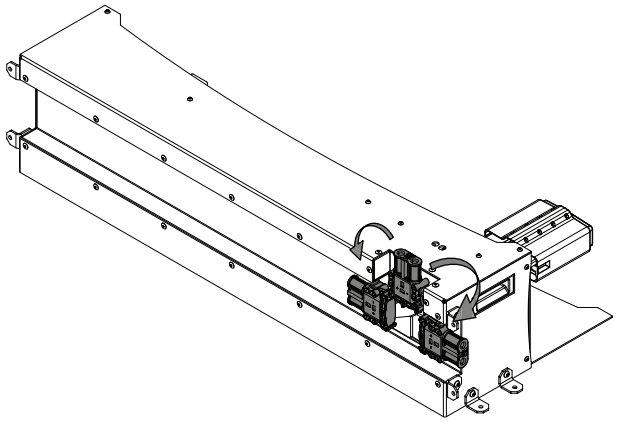
- The Power Supply Box must be installed according to the local regulations or codes, and by authorized personnel or licensed electricians.
- The Power Supply box and the Docking Target must be properly secured to the wall or floor prior to operation.

Precautions for Correct Use

Vertical orientation of the Power Supply Box allows for heat dissipation, which prevents over-heating 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 Considerations

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

Precautions for Correct Use

- If you do not use appropriate fasteners, the Docking Target will move during the docking attempts and cause docking and charging failures.
- 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.

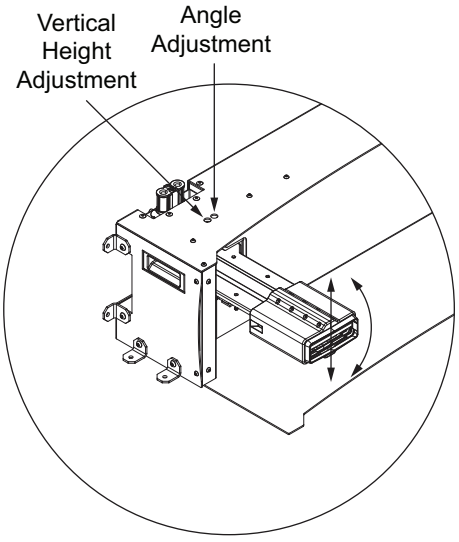
- Six M12 bolts and fender washers are required if fastening the Power Supply Box to the floor.
- Six M10 bolts and washers are required if fastening the Power Supply Box to a wall.

The following hardware is required to fasten the Docking Target.

- At least 4 (max. 8) M8 button head cap screws and washers.
- Four Docking Target mounting brackets (supplied with the unit).

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 setting screws.



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.

Precautions for Correct Use

- 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.

3-2-3 Electrical Considerations

The Power Supply Box is a 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.

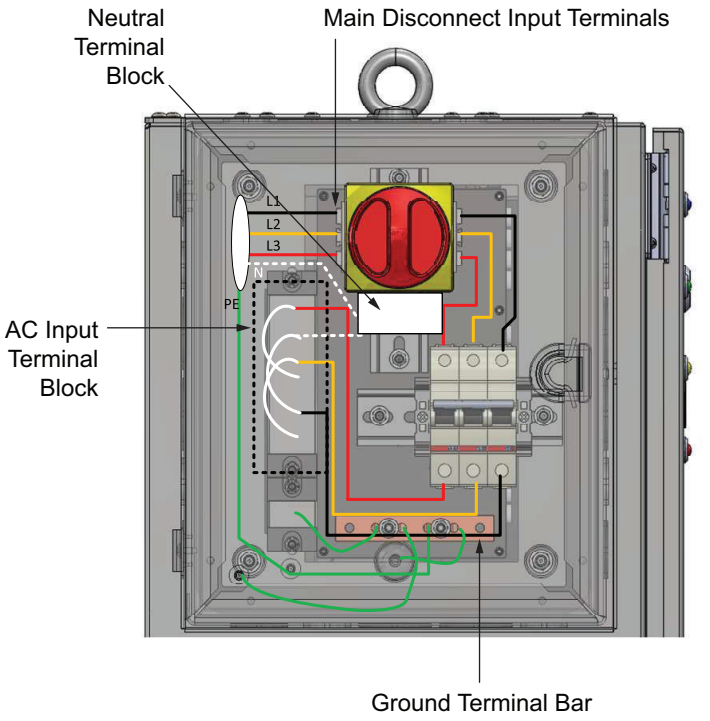
⚠ WARNING

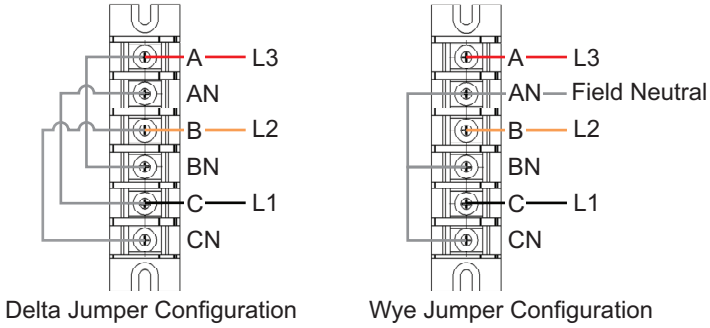
Improper installation or wiring misconfiguration of the Power Supply Box could result in electrical shock hazard. You must ensure the safe and proper installation of the Power Supply box in accordance with the applicable rules and regulations, and by qualified personnel.

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 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.



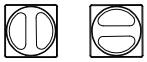


3-2-4 Commissioning Procedure

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 *3-2-3 Electrical Considerations* on page 3-6. 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 Installation Procedure

⚠ WARNING

- At least 3 people are required to lift the battery.
- You must wear proper Personal Protective Equipment (PPE) for removing, installing, and lifting the battery or when working around a leaking battery.

⚠ WARNING

Always use safe lifting practices when removing or installing the battery.

Precautions for Safe Use

Only use chargers and batteries supplied by OMRON. The charger shall only be used to charge an HD-1500 AMR battery.

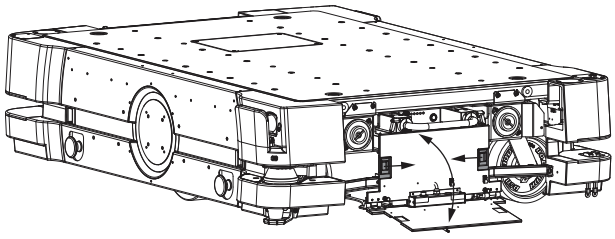
Precautions for Correct Use

During the initial AMR installation and configuration, install a fully-charged battery.

Follow these steps to install a battery.

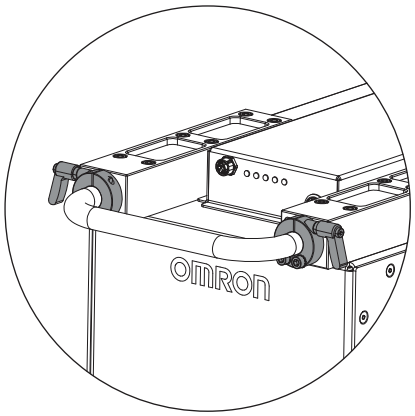
1 Remove the AMR front skin to access the battery compartment.
Refer to *6-9-1 Removing and Replacing Skins* on page 6-18 for more information.

2 Unlatch and open the battery door. The battery door pivots downward and rests on the floor. This allows you to use the battery door as a ramp.



3 Use the extended handle to push the battery into the AMR.
As the battery gets pushed in, the power connector installed on top of the battery case makes a blind-mate connection with the power connector attached to the chassis.

4 Collapse the handle before pushing the battery all the way into the AMR.
Release the locking collars and then slide the handle into the battery.



5 Tighten the two locking collars to secure the battery handle in place.

6 Push the battery all the way into the AMR and then close the battery door.
The battery door secures the battery in place and prevents it from shifting inside the compartment.

7 Install the AMR front skin to complete the 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 on the Operator Panel 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	169.254.10.15
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 169.254.10.100 to 169.254.10.149.

3 Verify the settings by opening a browser window and accessing https://169.254.10.15. 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 3-11 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://169.254.10.15 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	802.11ac/n	802.11
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 Wireless Antenna Connections

Wireless antennas may need to be relocated from the factory installed position to new locations if the payload interferes with the signal.

Precautions for Correct Use

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

A wireless antenna extension kit is available (part number 68955-000) if wireless antennas need to be relocated. The kit includes the following items.

- Two low loss extension cables (2 m)
- Two dipole antennas with reverse SMA plug and 90° pivot (137 mm in length)

Additional Information

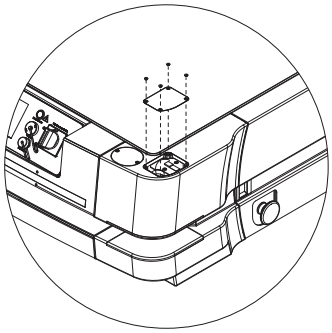
- Contact your local OMRON representative if longer extension cables or different antennas are required.
- The AMR Controller provides two connections for wireless antennas. Refer to *1-2 Features and Components* on page 1-6 for more information.

Wireless Antenna Relocation Procedure

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

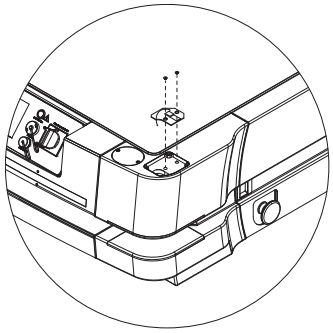
- A wireless antenna extension kit (part number 68955-000).
- 2.5 mm hex key.
- 8 mm wrench or socket driver.

1 Use a 2.5 mm hex key to remove the four screws that fasten the wireless antenna cover to the AMR and then remove the cover.
The cover is not used when the wireless antenna is relocated.



2 Gently pull the antenna connector off of the AMR adapter coupling. This is a friction fitting which requires very little force.

3 Using a 2.5 mm hex key, remove the two retaining screws that fasten the antenna backing plate to the compartment and then remove the assembly from the AMR.



4 Remove the adapter coupling from the antenna connector on the AMR using an 8 mm wrench or socket driver.

5 Connect the extension cable to the antenna connector on the AMR.

6 Route the cable to avoid pinching, chafing, or damage to the new antenna position.

7 Mount the antenna and then connect it using the adapter coupling and the extension cable to complete this procedure.

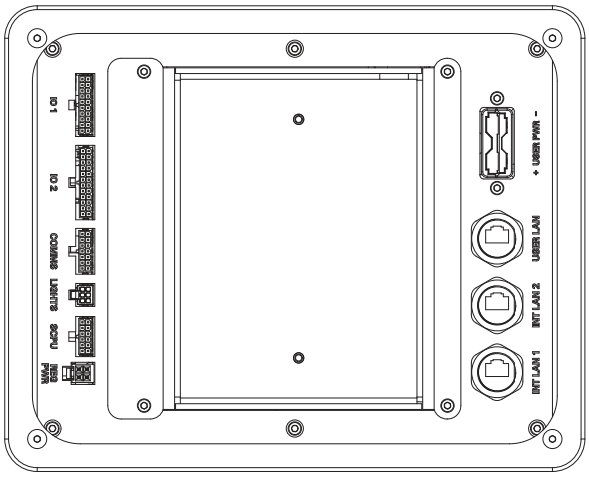
3-5-2 User Access Panel Connections

Use the following information to make all necessary User Access Panel connections.

Additional Information

Refer to *2-8 Other Specifications* on page 2-15 for more information on User Access Panel connector and electrical specifications.

The User Access Panel can be reached from the top of the AMR by removing the cover. This requires a 3 mm hex key to remove the four M5 screws. After the screws are removed, the cover can be removed.
The cover may become adhered to the AMR chassis over time. Threaded holes in the cover are provided for use with the fastening screws to extract the cover in this condition.
The following connections are available on the User Access Panel.

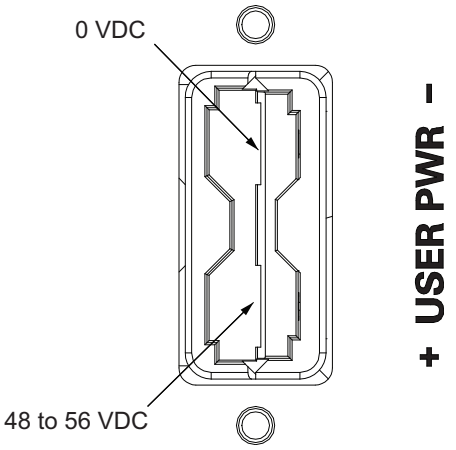


USER PWR

The USER PWR connector on the User Access Panel provides unregulated battery power for payload structure devices. Use the information below to understand all USER PWR connections.

Additional Information

Refer to *2-8-4 USER PWR Connector* on page 2-18 for connector type and specifications.

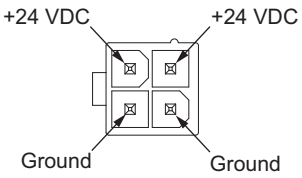


REG PWR

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

Additional Information

Refer to *2-8-5 REG PWR Connector* on page 2-18 for connector type and specifications.



SCPU

The SCPU connector on the User Access Panel provides connections for user-supplied safety devices. Use the information below to understand all SCPU connections.
Each of the emergency stop inputs has a direct connection to the AMR internal Safety Controller and is not connected to any other device or input.

⚠ WARNING

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

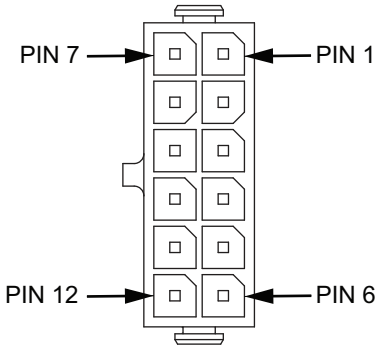
Precautions for Safe Use

The emergency stop or other 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 jumper is provided as part number 68410-218L.

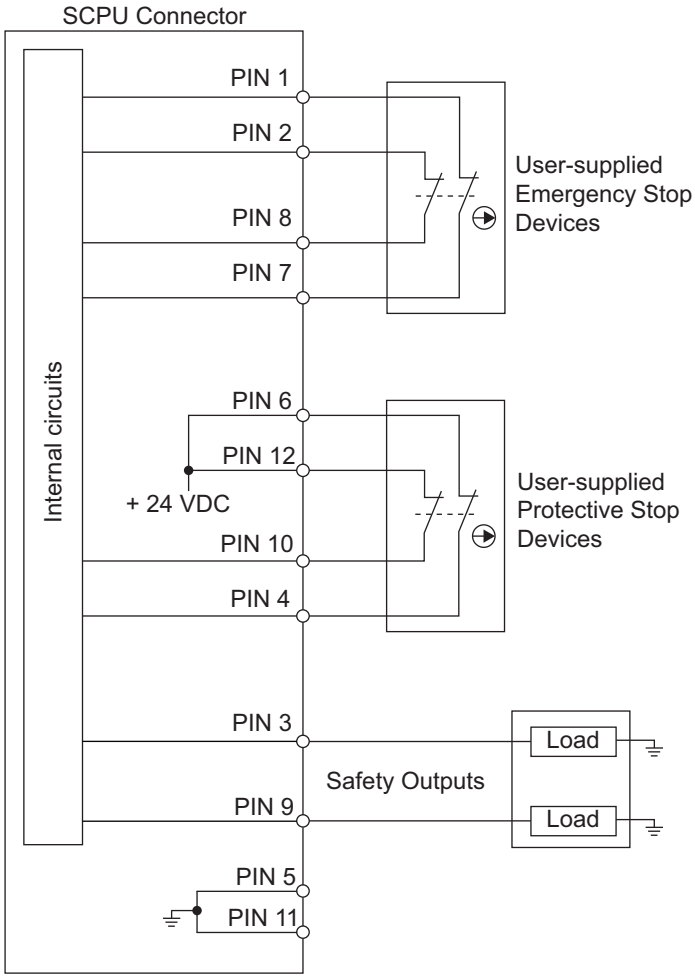
The following figure shows the pin arrangements for the SCPU connector on the AMR.



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

Pin Number	Description
1	Emergency stop channel 1 input
2	Emergency stop channel 2 input
3	Safety output 1
4	Protective stop channel 1 input
5	Ground
6	24 VDC
7	Emergency stop channel 1 output
8	Emergency stop channel 2 output
9	Safety output 2
10	Protective stop channel 2 input
11	Ground
12	24 VDC

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. An SCPU circuit diagram is provided below.



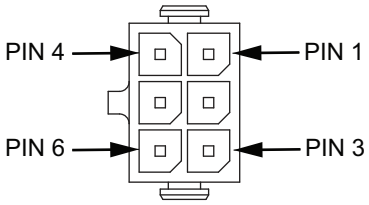
Refer to the following sections for information about the behavior of the emergency stop, protective stop, and safety output operations.

- *2-8-1 Safety Functions* on page 2-15
- *4-15 Emergency Stop* on page 4-32
- *4-16 Protective Stops* on page 4-34
- *4-16-1 AMR Response During Protective Stops* on page 4-34

- *2-8-6 SCPU Connector* on page 2-19

LIGHTS

The LIGHTS connector on the User Access Panel 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.

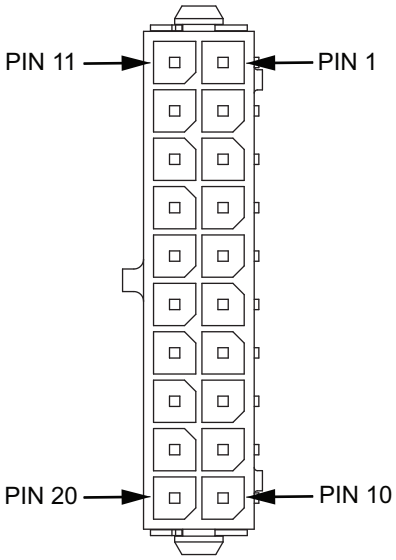
Pin Number	Description
1	Red light
2	Ground
3	Yellow light
4	Green light
5	Ground
6	Buzzer*1

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

Refer to the following sections for information about the behavior of the LIGHT signals.
- *4-18 Light Discs and Optional Beacon States* on page 4-36
- *2-8-7 LIGHTS Connector* on page 2-19

IO 1

The IO 1 connector on the User Access Panel provides analog and digital inputs for user-supplied devices that are typically used for control of a payload structure system. Use the information below to understand all IO 1 connections.
The following figure shows the pin arrangements for the IO 1 connector on the AMR.



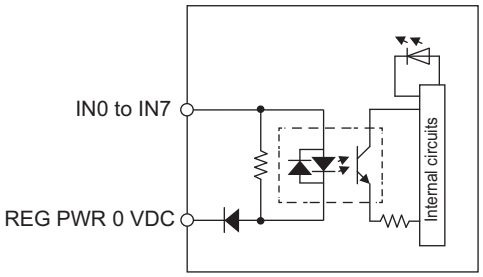
The information in the table below describes the signal designations for the IO 1 connector.

Additional Information

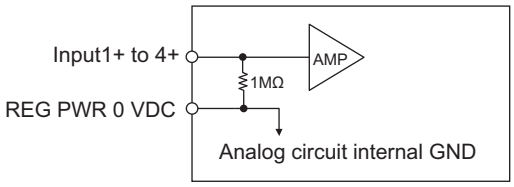
Use REG PWR pins 2 and 4 (0 VDC) for IOG ground connections. Use REG PWR pins 1 and 3 for sensor 24 VDC connections. Refer to *REG PWR* on page 3-16 for more information.

Pin Number	NX-series Unit	NX-series Unit Terminal	Description
1	NX-ID4442	IN0	24 VDC sourcing (PNP) digital input
2		IN1	
3		IN2	
4		IN3	
5 to 7	IOG		Ground
8	NX-AD3603	Input1+	-10 to +10 VDC analog input
9		Input2+	
10	IOG		Ground
11	NX-ID4442	IN4	24 VDC sourcing (PNP) digital input
12		IN5	
13		IN6	
14		IN7	
15 to 17	IOG		Ground
18	NX-AD3603	Input3+	-10 to +10 VDC analog input
19		Input4+	
20	Connected to chassis for shielding		

A circuit diagram is provided below for the digital inputs.

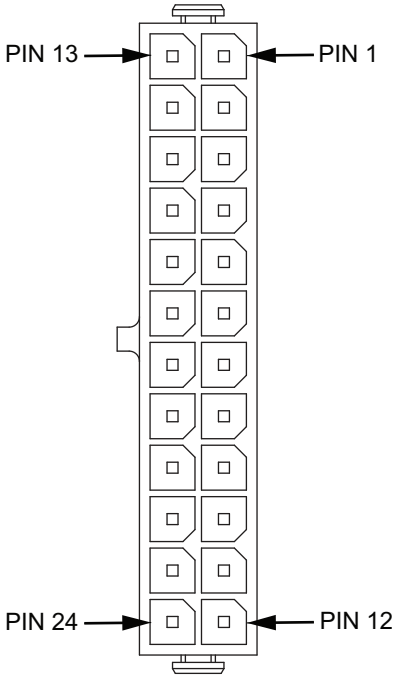


A circuit diagram is provided below for the analog inputs.



IO 2

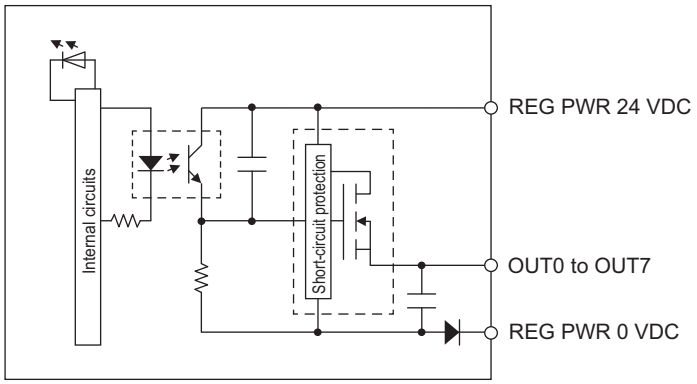
The IO 2 connector on the User Access Panel provides analog and digital outputs for user-supplied devices that are typically used for control of a payload structure system. Use the information below to understand all IO 2 connections.



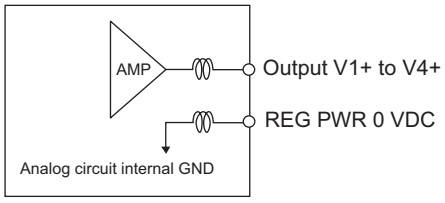
Pin Number	NX-series Unit	NX-series Unit Terminal	Description
1	NX-OD4256	OUT0	24 VDC sourcing (PNP) digital output
2		OUT1	
3		OUT2	
4		OUT3	
5 and 6	IOG		Ground
7	NX-DA3603	V1+	-10 to +10 VDC analog output
8		V2+	
9 and 10	IOG		Ground
11	NX-OD4256	OUT4	24 VDC sourcing (PNP) digital output
12	IOG		Ground
13	NX-OD4256	OUT5	24 VDC sourcing (PNP) digital output
14		OUT6	
15		OUT7	
16 and 17	IOG		Ground
18	NX-DA3603	V3+	-10 to +10 VDC analog output
19		V4+	

Pin Number	NX-series Unit	NX-series Unit Terminal	Description
20 to 23	IOG		Ground
24	Connected to chassis for shielding		

A circuit diagram is provided below for the digital outputs.



A circuit diagram is provided below for the analog outputs.



COMMS

The COMMS connector on the User Access Panel is reserved for future use.

INT LAN1

The INT LAN1 connector on the User Access Panel is reserved for future use.

INT LAN2

The INT LAN2 connector on the User Access Panel is reserved for future use.

USER LAN

The USER LAN connector on the User Access Panel is used to access the internally mounted NX102 unit. Use this connector to transfer user-defined programs to the NX102 unit for application-specific functionality such as I/O control or ARCL command operations. This connector can also be used for periodic updates to the safety control system issued by OMRON.

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 mounting points are provided for various payload structure designs. These mounting points allow you to adjust and position your payload in relationship to the AMR's center of gravity. Refer to *2-2-3 Payload Center of Gravity* on page 2-6 for more information.

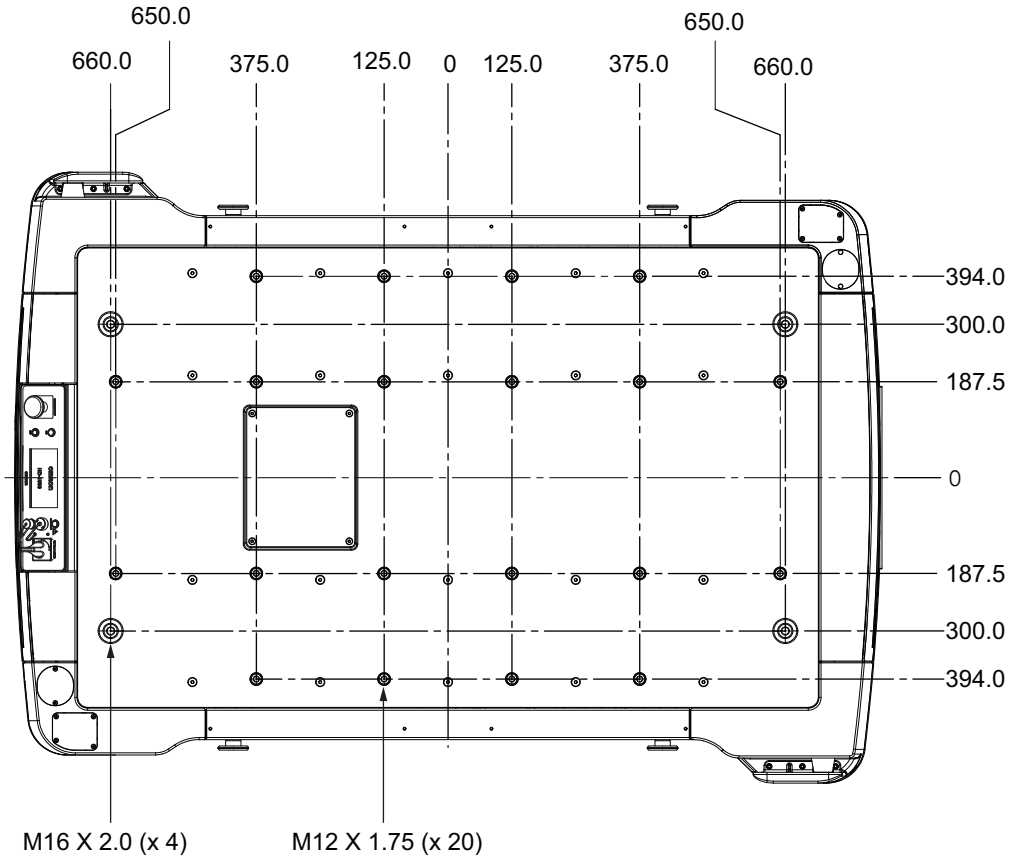
Make the following considerations when using payload structure mounting points.

- 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.
- There are four AMR lifting points that can also be used as payload structure mounting points. The payload structure may need to be removed to lift the AMR if these are not accessible. These lifting points have M16 x 2.0 threaded holes with a maximum thread depth of 35 mm. Fastener torque for these mounting points is 270 N·m.
- If a Top Plate is not present, the chassis mounting surface is recessed 4 mm below the top surface of the outer edges of the AMR. Design considerations should be made to avoid interferences.
- If a Top Plate is not present, special considerations for the rivet nuts must be made. Refer to *Rivet Nut Considerations* on page 3-24 for more information.

Precautions for Correct Use

Do not exceed 10 kN per payload structure mounting point.

Mounting points are arranged in a longitudinal and transverse pattern. Mounting point dimensions are provided in the following figure.

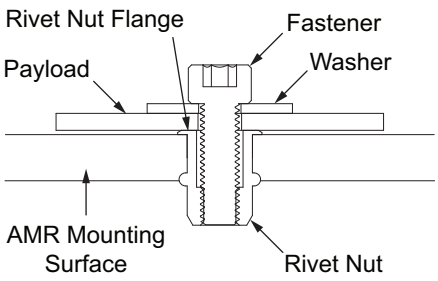


Rivet Nut Considerations

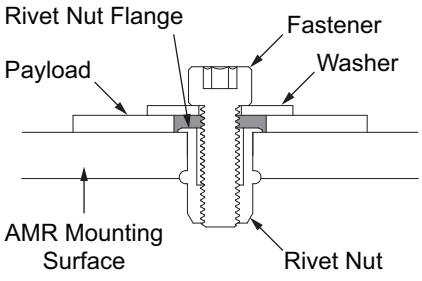
There are 20 M12 X 1.75 rivet nuts that are provided for payload structure mounting points. Rivet nuts have internal threads used to attach the payload to the AMR mounting surface. The M12 X 1.75 rivet nut locations are detailed in *3-6-1 Payload Structure Mounting Points* on page 3-23.

Make the following rivet nut considerations when designing the payload structure.

When a Top Plate is not present, the payload should be designed to rest on top of the rivet nuts and make contact with its flange. If the payload structure is designed incorrectly and does not make contact with these rivet nut flanges, the rivet nuts could spin in place and prevent proper fastener torque. The rivet nut flanges are 1.19 mm tall. Thread engagement for fasteners should be from 18 to 45 mm. A maximum torque of 65 N·m should be applied.



Correct Installation



Incorrect Installation

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 and repeat safety commissioning. Contact your OMRON representative for more information on modifying the safety zones.

⚠ 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 Relocating the Operator Panel

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

Refer to *6-9-4 Operator Panel Replacement / Removal Procedure* on page 6-25 for information about removing the Operator Panel.

Refer to *Operator Panel Dimensions* on page 2-5 for more information about Operator Panel dimensions.

3-8 Side Laser Relocation to the Payload Structure

This section provides details about relocating Side Lasers to the user-designed payload structure.
Side Lasers must be removed from the AMR before mounting them on the payload structure. Refer to *3-8-1 Side Laser Removal from the AMR* on page 3-27 for more information.
If Side Lasers are required but not present on the AMR, contact your local OMRON representative for more information about ordering, installing, and configuring them.

⚠ 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

Laser lenses can easily get scratched and damaged. Care must be taken to prevent scratching the laser lens during any maintenance or installation procedures.

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

- When installing Side Lasers on the payload structure, you will need to change the configuration parameters in MobilePlanner and update the X, Y, and Z positions of the Side Lasers. Refer to *A-3 Side Laser Configuration* on page A-11 for more information.
- When installing 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 structure itself.
- Since Side Lasers may protrude from the payload structure, consider adding protective guard fins similar to those found on the AMR's default Side Laser installation location.
- Side Laser extension cables are required. Order the following extension cables while considering the cable routing length required for your installation location.
  - 1 m Side Laser communication extension cable: 22115-000F
  - 2 m Side Laser communications extension cable: 22117-000F
  - 1 m Side Laser power extension cable: 22800-000F
  - 2 m Side Laser power extension cable: 22802-000F
- 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.

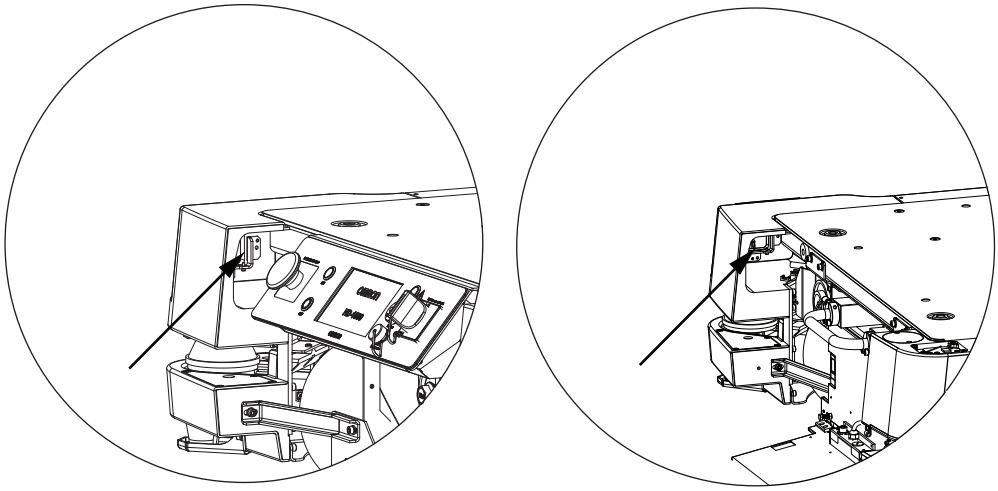
3-8-1 Side Laser Removal from the AMR

Use the following procedure to remove Side Lasers from the AMR in preparation to relocate them. The procedure applies to both Side Laser locations on the AMR.
The following items are required for this procedure.

- Loctite 243 thread lock compound or equivalent.

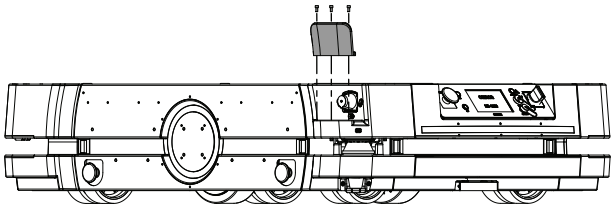
- Torque wrench.
- 2.5 mm, 3 mm, and 5 mm hex keys.

1 Remove the front and rear skins to access the Side Laser mounting locations.
Refer to *6-9-1 Removing and Replacing Skins* on page 6-18 for more information.

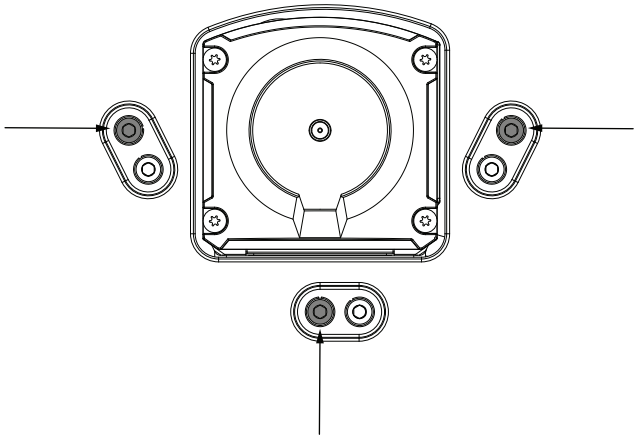


2 Disconnect the power and communication cables from the rear of the Side Laser.

3 Remove three M6 screws and then remove the laser cover protective fin.



4 Remove three mounting screws that secure the Side Laser bracket to the AMR.
Take care to prevent the Side Laser from falling when removing these screws. If the Side Laser falls, it could scratch the lens and damage the unit.
The other three screws are used for alignment purposes. Avoid altering the position of these screws.



5 Remove the Side Laser from the AMR.

6 Reinstall the laser cover protective fin using the previously removed M6 screws. Apply Loctite 243 or equivalent and tighten to a torque of 7.5 N·m.

7 Install the previously removed AMR skins to complete this procedure.

3-9 HAPS Installation and Configuration

The following sections provide details about HAPS tape and marker installation and other configuration requirements.
If HAPS sensors are required but not present on the AMR, contact your local OMRON representative for more information about ordering, installing, and configuring them.

3-9-1 Tape and Marker Application

Use the information in this section to understand HAPS tape and marker application.

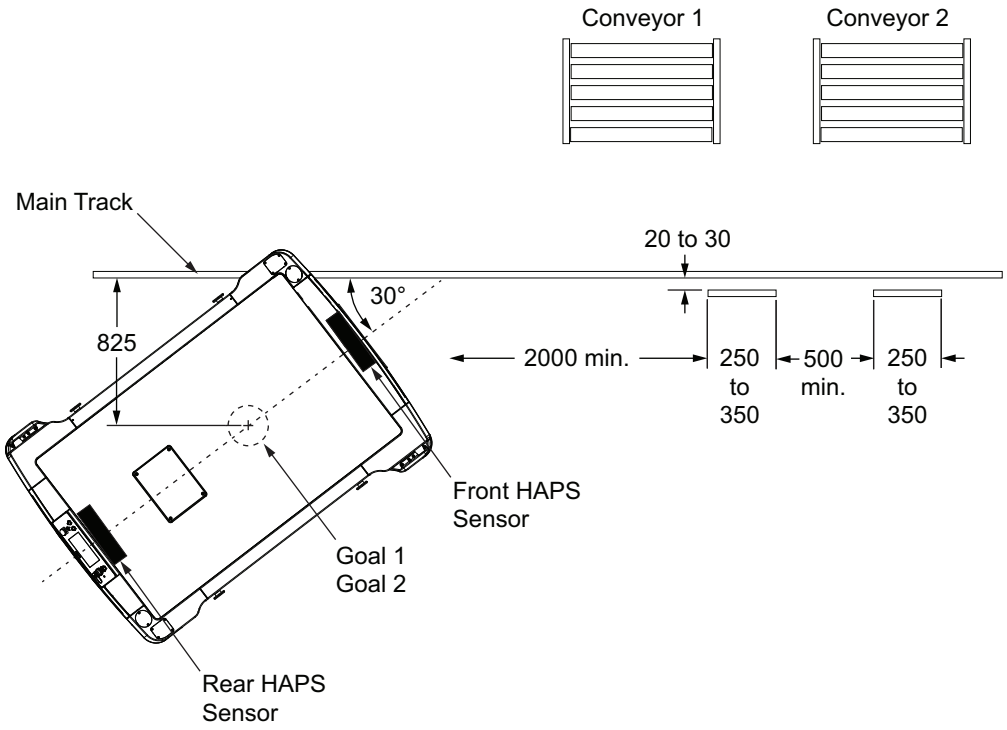
Precautions for Correct Use

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.

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

- The recommended length of magnetic tape 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.

To determine the distance between the AMR and its final alignment goal (such as a machine with which it interfaces), refer to *AMR Dimensions* on page 2-3.
Since the AMR body is 1195 mm wide, setting a distance of 620 mm from the center of the tape to the intended conveyor creates a gap of 22.5 mm between the AMR's side and the goal. If your payload has an overhang at the side, you must adjust the width accordingly.
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 recommended marker length is 300 mm.
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. The AMR needs at least 2000 mm of tape for alignment. A suggested goal location is 825 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.

3-9-2 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/ttyUSB3.

GuideSensor_Rear parameter settings:

- Check the **AutoConnect** check box.
- Set the **Port** parameter value to /dev/ttyUSB4.

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 3-32 must be performed to make the following configuration items accessible.

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

- *ApproachSpeed*
- *FollowingSpeed*
- *ReverseFollowingSpeed*
- *SlowCaptureSpeed*
- *followingAccel*
- *followingDecel*
- *FrontClearance*
- *SideClearance*
- *AvoidLocationDependentObstacles*

3-9-3 Goals and Tasks

There are two tasks associated with the HAPS option: FollowGuide and Engage. Information about parameters for these tasks is provided below for configuration of the HAPS option.

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.

3-10 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.

3-11 Safety Commissioning

Use the information in this section to understand the emergency stop and Safety Laser Scanner commissioning procedures.

⚠ WARNING

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

Precautions for Correct Use

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.

You must repeat the emergency stop commissioning and the Safety Laser Scanner commissioning procedures under the following circumstances.

- Detection of an abnormality in any safety mechanism.
- Changing the shape or size of the Safety Laser Scanner zones.
- Adding user-supplied E-STOP.
- During regular preventative maintenance procedures.

3-11-1 Safety Commissioning Procedure

This procedure verifies that the Safety Laser Scanners report the *MovementParametersSectors* information correctly, and that the protective stop circuitry activates when an obstacle is detected in a safety zone.
It also verifies the correct safety stop functionality when any and all E-STOP buttons are pressed. You must repeat this procedure for every E-STOP button in the system.

Additional Information

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

1. Connect to the AMR and start the MobilePlanner software.
2. Select **Main Menu** > **Robot** > **Safety Commissioning**.
3. Follow the on-screen instructions to complete the test.
   You can print a certificate after successful completion of the commissioning.

3-12 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 protruding out, above, or below the AMR lasers' scanning planes shall be configured as restricted zones during workspace map creation. This will eliminate possible collision risk during operation.

The AMR's Safety Laser Scanners scan the workspace to create the map. The lasers scan only a narrow horizontal plane, parallel to the floor. The scanning plane height is 175 mm above the floor, so the lasers 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 Scanners' 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 *4-20-1 Driving with the Pendant* on page 4-42 for more information.

You may use a smaller size AMR such as an LD-series model for convenience of mapping.

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

- Minimal or no payload.
- Drive at low linear and rotational speed and acceleration.

You 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.

3-12-1 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.
- Driving 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.

4

Operation

This section provides information about the operation of the AMR.

4-1 Payload Movement and Transfer

A typical AMR application uses a payload structure to transport objects within a facility. For example, the AMR might pick up and carry a crate of parts from one conveyor belt then deliver it to another conveyor belt.

⚠ 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.

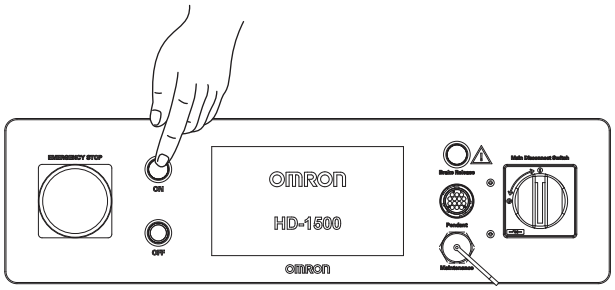
Precautions for Safe Use

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

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

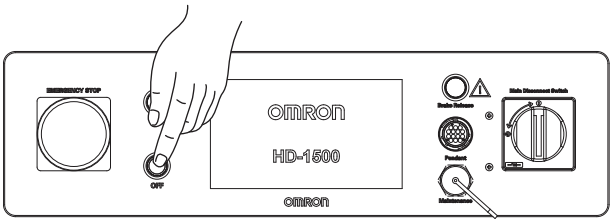
Implementing methods to circumvent the need for a person to enable the AMR's motor power at start-up is prohibited.

Additional Information

Refer to *4-18 Light Discs and Optional Beacon States* on page 4-36 for more information about start-up state indicators.

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.



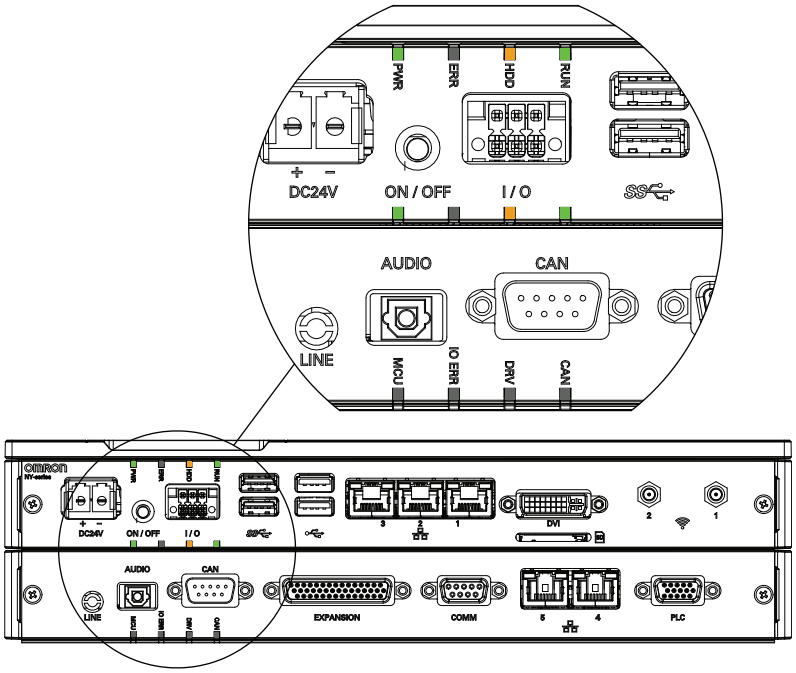
An LED ring around the button flashes red during the shut-down procedure.
When the AMR is shut down using the OFF button, it enters a standby state. In this state, some systems remain active and consume low power. For prolonged periods of AMR shut-down, use the OFF button and then turn OFF the main disconnect 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, level, 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.
Take measures to avoid the following items in the workspace.

- Transparent doors, walls, or barriers.
- Floors with access panels removed.
- Cables, hoses, etc.
- Highly reflective objects.

If an obstacle has protrusions outside of the plane of the AMR's Safety Laser Scanners, 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 Lasers mitigate the risk presented by protrusions near the floor that are below the plane of the safety scanning lasers. 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 Scanners or the Low Lasers.
Any steps in the AMR's path must have a smooth, rounded profile. Avoid steps or ledges taller than the AMR's specified step-traversal ability that do not have adequate physical barriers. The AMR might not be able to traverse the step height specified when traveling at less than the recommended speeds.
Make the following considerations when traversing steps or gaps.

- A maximum speed of 500 mm/s forward and 400 mm/s in reverse must be used.
- Frequent encounters with steps and gaps will shorten the lifespan of the drivetrain components.

⚠ 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

- 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 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.

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 and level 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.
- Using the EM2100 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.

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 hazard that is within its operating area. Such hazards include the following items.

- The edge of a loading dock or ramp.
- Entrance to downward stairs.
- Any other vertical drop that exceeds the AMR's maximum step height.

Required characteristics of physical barriers are listed below.

- Strength: 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.
- Continuity: The barrier must extend around the hazard completely.
- Visibility: 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.

⚠ 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.

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 zones. 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 *FrontPaddingAtFast-Speed* to increase the AMR's safety clearances. This causes the AMR to decelerate as it approaches a hazard. Refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for more information.

4-5-3 Obstacles

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

Positive obstacles are those which would block the AMR's path. Detecting positive obstacles is the primary and recommended use for Side Lasers.

Negative obstacles are voids in the driving area of the AMR, such as downward stairs, loading docks, or missing floor tiles. Negative obstacle detection with Side Lasers should not be used as the primary method for avoiding negative obstacles. It is intended to be used as a secondary method of detection. Primary methods employ traditional safety techniques to aid avoiding negative obstacles, such as blocking off areas or restricting traffic in dangerous areas.

Negative obstacle detection by the AMR is implemented in software only and does not consist of CAT 3/PLd safety lasers. A test plan should be developed and executed prior to adding new functionality to equipment that currently exists in a production environment. Perform testing with each specific application and configuration to ensure the AMR's safety. Test detection after changing parameters for each different expected obstacle. Dynamic testing must be completed for any payload design, at field application speed to ensure AMR safety.

4-5-4 Environmental Hazards

Environmental hazards are areas where it is unsafe for the AMR to operate. Provide physical barriers that the AMR can detect accurately with its Safety Laser Scanners so that it does not attempt to drive near the hazard.

Precautions for Correct Use

An environmental hazard 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 Restricted Zones

Restricted zones are areas of inadequate clearance which cannot be protected by the AMR detection devices. Only authorized persons are permitted to enter restricted zones. Use map features such as forbidden areas to keep AMRs within their designated area of operation. Refer to the *Fleet Operations Workspace Core User's Manual (Cat. No. I635)* for information about adding restricted zones to your workspace map.

4-5-6 Operating Hazard Zones

Operating hazard zones are areas between the AMR and an obstacle that would not leave sufficient room for a person to escape and avoid getting crushed. These are areas of inadequate clearance less than 500 mm between the sides or front / rear of the AMR and an obstacle. It can also be an area which cannot be protected by the AMR detection devices.

4-5-7 Confined Zones

Confined zones are areas of inadequate clearance where the AMR detection devices may be omitted, at any speed.

4-5-8 Payload Transfer Stations

Payload transfer stations are designated areas where the payload is transferred to or from the AMR. When the payload transfer stations are outside the restricted or confined zones, these stations shall be designed to prevent personal injury by the rigid parts of the AMR or its payload. These payload transfer stations shall be designated as operating hazard zones as defined in this section of the manual.

4-6 Clearances

The AMR must operate in an environment that is generally flat and level, 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.
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.
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.
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.

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.

4-6-1 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.

⚠ CAUTION

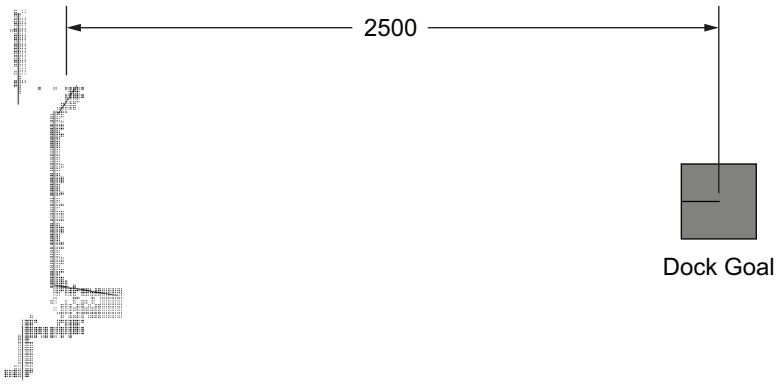
Personnel should not be near the AMR when it is rotating with no forward motion.

Additional Information

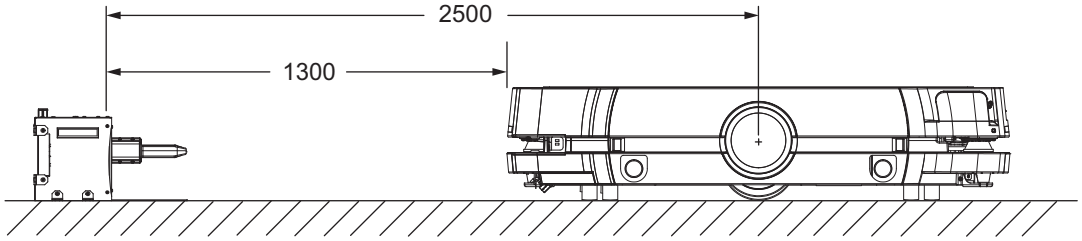
The AMR's Light Discs as well as its front and back light strips display a distinct turn signal pattern when it rotates. Refer to *4-18 Light Discs and Optional Beacon States* on page 4-36 and *4-19 Light Strips and Optional Beacon States* on page 4-39 for more information.

4-6-2 Docking Clearances

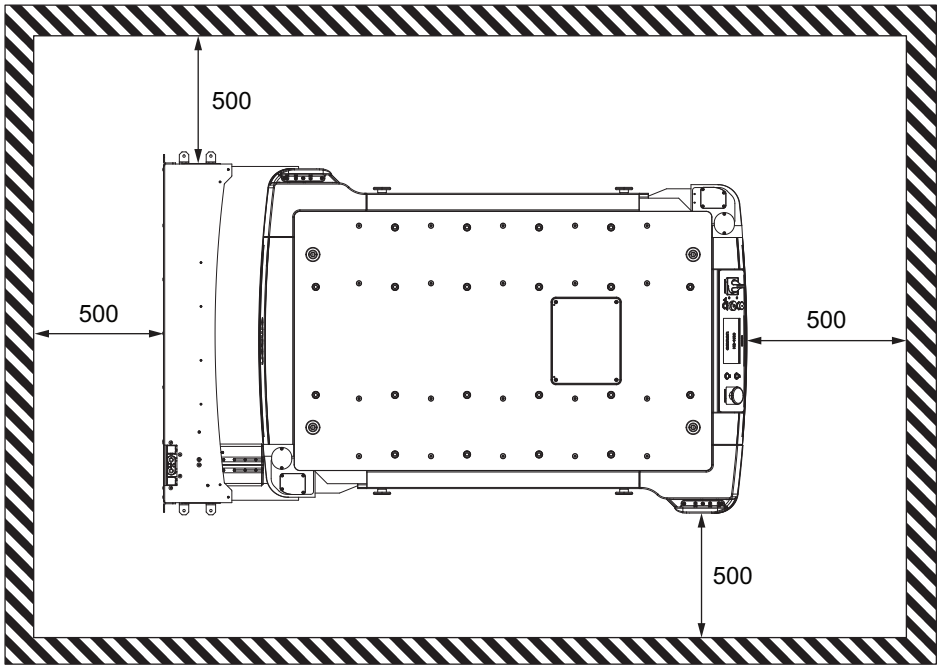
Set a 2500 mm distance between the Docking Target goal (defined in the map) and the dock goal position of the AMR using MobilePlanner. This distance provides sufficient room for the AMR to align with the Docking Target during the docking operation.



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. Operating areas where the clearance between the AMR and its surroundings is 500 mm or less are considered hazard zones. You must make these areas visually distinct. Personnel that will work near these zones must be trained and informed about your chosen method used to make docking area hazard zones visually distinct. An example of this is shown below, utilizing floor markings to draw attention to the docking area hazard zones.



4-7 Narrow Passageway Behavior (Linear)

The AMR can operate at its maximum speed through a 2200 mm passageway and will traverse at a slower speed when approaching a 2100 mm passageway.
The practical minimum width for a passageway is 2 m. The most narrow passageway is 1.5 m. 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/sec.

Additional Information

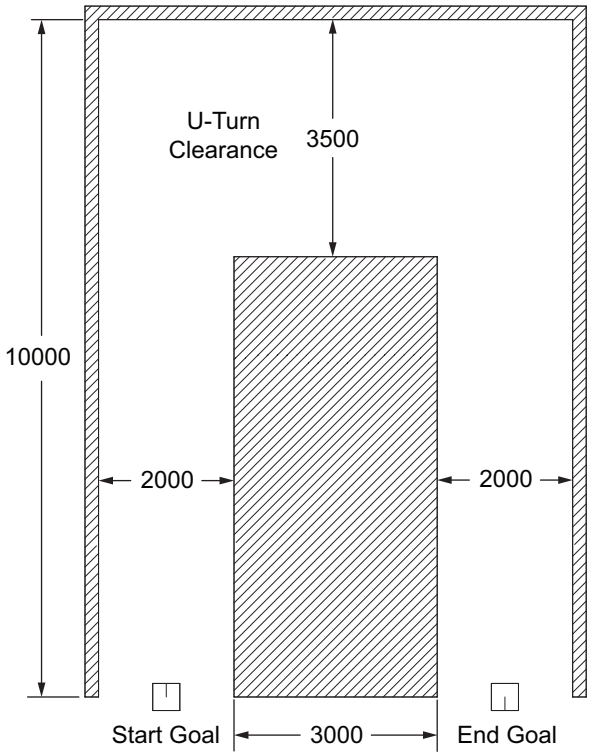
Use the Door Goals feature on the map for pre-alignment when the AMR travels through narrow passageways.

4-8 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 AMR speeds of less than 300 mm/sec.

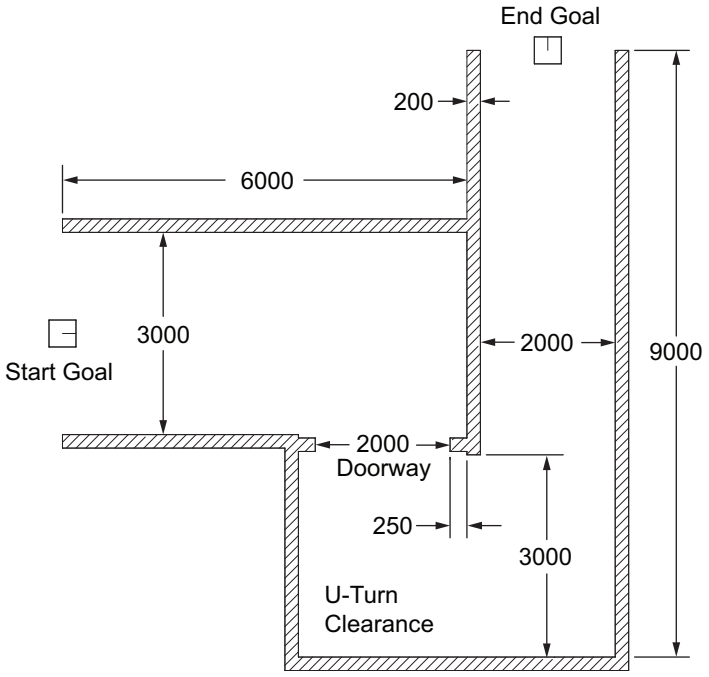
4-8-1 U-Turn in a Narrow Passageway

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.



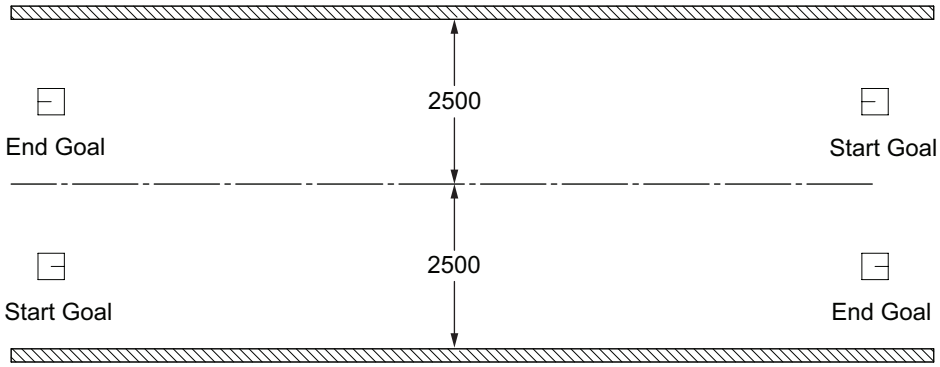
4-8-2 U-Turn Through a Narrow Doorway

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
2000
Doorway
250
3000
U-Turn
Clearance

4-9 Minimum Lane Width

The minimum lane width for two AMRs passing each other in a linear passageway is 2500 mm.



4-10 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.

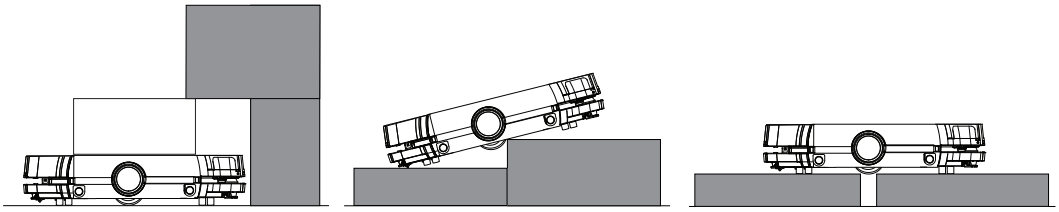
Precautions for Safe Use

Physical immobilization might cause motors in the AMR to overheat.

Additional Information

Side Lasers can help with detecting overhanging objects and floor obstacles. Refer to *1-6-5 Side Lasers* on page 1-23 for additional information.

Some examples of physical immobilization are shown in the following figure.



AMR Immobilized by Overhanging Object

AMR Immobilized by Excessive Ledge

AMR Immobilized by Excessive Gap

Refer to the following sections for information about recovering from immobilization.

- *6-4 Lifting the AMR* on page 6-6.
- *4-13 Releasing the Brakes* on page 4-30.
- *4-14 Manually Pushing the AMR* on page 4-31.
- *5-4-1 Low Battery Recovery* on page 5-6.
- *Section 5 Troubleshooting* on page 5-1.

4-11 Battery and Charging

The AMR battery supplies adequate power for the motors, electronics, and accessories.
Typical runtime with no load is approximately 12.5 hours. Typical fully-loaded runtime is approximately 9 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 (%):

- Manual status indicator, attached to the battery enclosure.
- Operator Panel screen.
- MobilePlanner software.

The AMR ships separately from the battery. You must fully-charge the battery prior to use as noted in *4-11-4 Charging the Battery* on page 4-23.
All onboard systems function continuously while the battery recharges inside the AMR.

⚠ 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.
- 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.

⚠ 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.

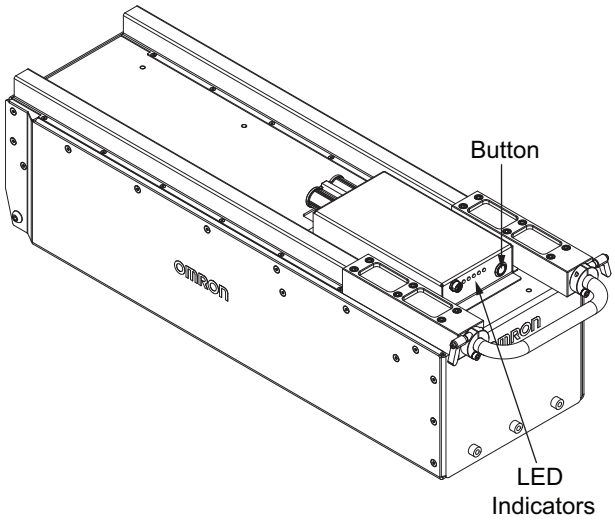
- Only use chargers and batteries supplied by OMRON. The charger shall only be used to charge an HD-1500 AMR battery.

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.

4-11-1 Battery Indicators and Controls

The battery includes 5 LED indicators and one button.



Pushing the button has different functions based on the battery location and the state of the AMR.
When the battery is not installed in the AMR, press and hold the button until the LED indicators illuminate purple to display the state of charge (refer to the table below). LEDs will flash yellow while pressing the button to indicate a battery charge level request is in progress. Displaying the battery's state of charge with this method can be useful when a battery is in storage.
If the battery is installed in the AMR while the AMR is ON, there is no need to press the button. The LED indicators are continuously illuminated to show the state of charge and the charge state is displayed on the Operator Panel. Refer to *4-12 Operator Panel* on page 4-27 for more information.
If the battery is installed in the AMR while the AMR is OFF, momentarily pressing the button will illuminate the LED indicators to display the state of charge.

LED	State	Meaning
1	ON	≥ 0% state of charge
1 and 2	ON	≥ 20% state of charge
1 to 3	ON	≥ 40% state of charge
1 to 4	ON	≥ 60% state of charge
1 to 5	ON	≥ 80% state of charge

4-11-2 Removing the Battery

Removal or installation of the battery must be performed by persons who have read and understood this manual as well as the *Mobile Robot HD Safety Manual (Cat. No. I647)*.
Before you begin, press an emergency button and then turn the AMR OFF.

⚠ WARNING

- Use safe lifting practices when removing or installing the battery.
- 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.
- You must wear proper Personal Protective Equipment (PPE) for removing, installing, and lifting the battery or when working around a leaking battery.
- At least 3 people are required to lift the battery.

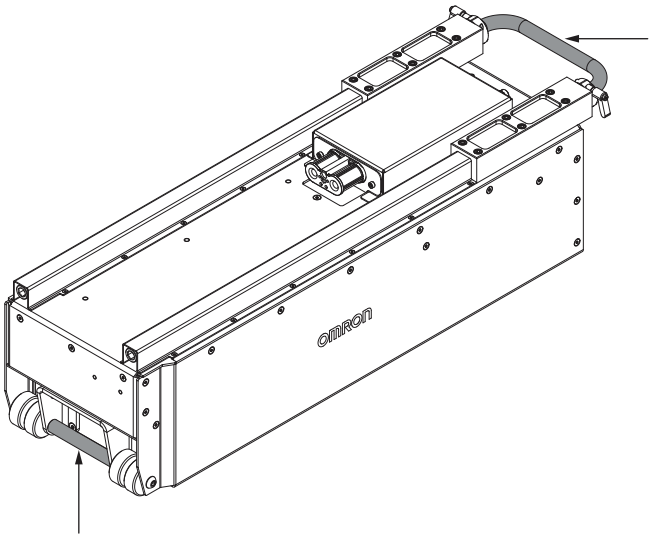
Precautions for Safe Use

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 or disconnect the battery's Ethernet cable while the AMR is ON.

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

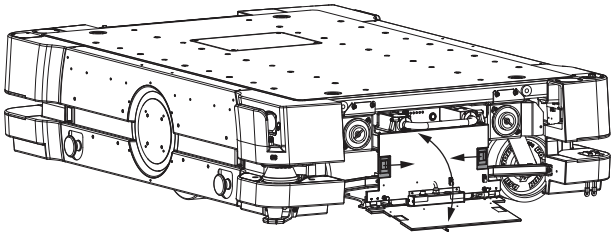


Battery Removal Procedure

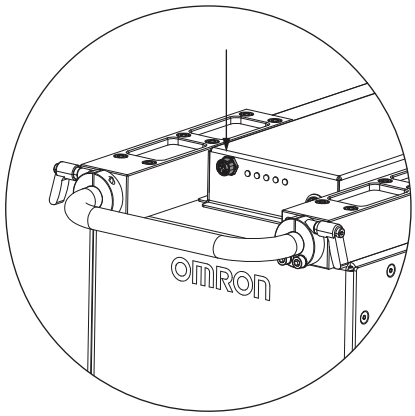
Use the following procedure to remove the battery from the AMR:

1. Remove the AMR front skin to access the battery compartment. Refer to *Front Skin Removal and Replacement Procedure* on page 6-19 for more information.

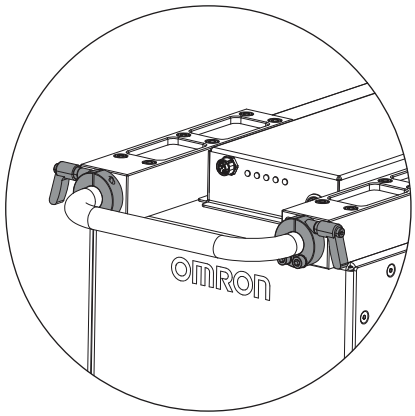
2. Unlatch and open the battery door.
   The battery door rests on the floor and allows you to use it as a ramp.



3. Use the handle to pull the battery out enough so you can disconnect the cable from the communications port.



4 Loosen the handle locks so you can extend the handle.



5 After extending the battery handle, pull and slide the battery out from its compartment.
The battery case has roller wheels at the bottom trailing edge. The wheels allows you to manually move the battery to another location across a smooth, flat floor.
After the battery is removed from the compartment, this procedure is complete.

4-11-3 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 4-25 for more information..
The Power Supply Box outputs a maximum of 6.84 kW of power and can charge an absolutely 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

Refer to *4-11-4 Charging the Battery* on page 4-23 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.
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	An absolutely 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.

4-11-4 Charging the Battery

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

Charing 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.

After receiving the battery, check its state of charge by pressing and holding in the push-button on the battery indicator. If the battery is in a low charge state, you must immediately charge to a full charge to avoid discharging the battery below a usable state which would require battery replacement. Refer to *4-11-1 Battery Indicators and Controls* on page 4-18 for more information.

⚠ WARNING

The Charging Station and the charging contacts on both the Docking Target, and the AMR can get hot during the operation. The operator must allow for 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 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.

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.

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 *4-18 Light Discs and Optional Beacon States* on page 4-36 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 *4-14 Manually Pushing the AMR* on page 4-31 for more information.
- If the battery level is absolutely depleted and the AMR cannot turn ON and the brakes cannot be released, the internal battery must be removed and charged while outside the AMR. Refer to *Charging a Battery Outside of the AMR* on page 4-25 for more information.

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

If you remove the side skins or open the battery door while the AMR is docked and is charging, the charging process will stop. Once the removed skin is re-installed or the battery door properly closed, the charging will not re-engage automatically. The AMR must repeat the normal docking process for charging to resume. Aside from interrupting charging, re-installing the skin(s) or closing the battery door will automatically return the AMR to its normal operating state.

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 *4-18 Light Discs and Optional Beacon States* on page 4-36 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 when a battery becomes absolutely depleted.
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.

4-11-5 Balancing the Battery

The AMR's battery consists of eight individual lithium battery module. Each battery module is composed of multiple cells which must stay balanced to maintain maximum run-time.
The time interval between battery balancing is related to the length of time required to balance a battery. A battery that is significantly out of balance can take 10 or more hours to balance after charging.
A battery that is removed from the AMR and connected directly to the 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 10 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 week. 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. OMRON recommends this mode if you are not charging the battery while it is inside the AMR. If you see a reduction in run-time, you should perform a battery exchange more frequently.

Additional Information

If the AMR's *DockUntilDoneCharging* parameter is set to **False** while the *StateOfChargeToChargeTo* and *MinutesToChargeFor* parameters are both set to a default value of 0, the AMR will never leave the Docking Target. Do not use this combination of parameter settings.

4-11-6 Storing Batteries

Make the following considerations when storing batteries.

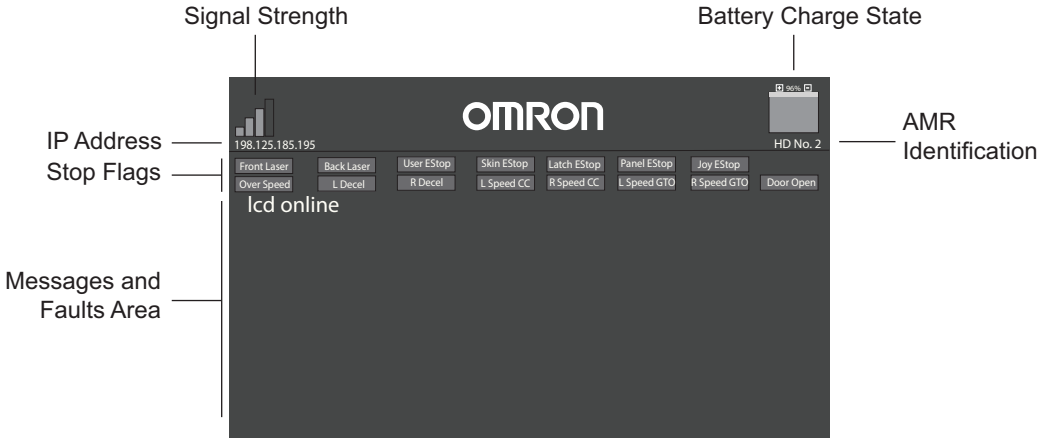
- The batteries must be stored in the upright position. Do not place the batteries on the side, top, or end when storing.
- Batteries stored at temperatures greater than 35°C or less than -20°C must stabilize for 4 to 8 hours until within the nominal operating temperature before use.
- Store the batteries 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.

4-12 Operator Panel

The information below describes the operator panel screen components and functions.

4-12-1 Main Screen

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



Additional Information

Refer to *5-8-1 Stop Flags* on page 5-12 for more information.

Boot-up Screen

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

4-12-2 ON Button

The ON button has the following functions.

- Turns the AMR ON. The ON button does not function until any in-progress shut-down is complete.
- 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 two-second delay between when the ON button is pressed and the AMR resumes its activity. During the two seconds, 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.

4-12-3 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.

4-12-4 Brake Release Button

The brake release button is used if you need to manually move the AMR. Refer to *4-13 Releasing the Brakes* on page 4-30 for more information.

Releasing the brakes requires a small amount of battery power. Without adequate battery power, the brakes remain engaged.

To release the brakes using this button, you must first press any E-STOP button, and then press and hold the brake release button on the Operator Panel. The brakes remain released while pressing the button. When the button is released, the brakes are automatically enabled.

4-12-5 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 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 3-11 for more information.

4-12-6 Main Disconnect Switch

When the main disconnect switch is in OFF (horizontal) 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 (vertical) 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.

Refer to *6-2 AMR Lock-out Tag-out Procedure* on page 6-4 for more information.

4-12-7 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.

4-13 Releasing the Brakes

The brakes on the drive wheels can be released with the brake release button in case of an emergency or abnormal situation. This may be required to manually move the AMR. Refer to *4-14 Manually Pushing the AMR* on page 4-31 for more information.
The brake button must be pressed continuously. Releasing the brake button will activate the brakes.
Battery power is required to release the brakes.

⚠ WARNING

- The AMR is not intended to be operated on ramps or sloped surfaces. 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 a fully-loaded AMR while using the brake release button is not recommended. If you must manually move a fully-loaded AMR, make sure to do this safely as this could result in personal injury or property damage.

4-14 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.
- Only push on the corners of the AMR. These are durable metal castings that can withstand pushing forces without damaging the AMR.
- Use at least 2 people to manually push the AMR. One person is required to hold the brake release button during the pushing process. Refer to *4-13 Releasing the Brakes* on page 4-30 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 a fully-loaded AMR while using the brake release button is not recommended. If you must manually move a fully-loaded 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 *Mobile Robot HD Safety Manual (Cat. No. I647)* should manually move the AMR.
- OMRON recommends that you train personnel on the safe use of the brake release button and procedures for safely pushing an AMR.

4-15 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.
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.

Activating an emergency stop by pressing one of the E-STOP buttons requires manual deactivation of the E-STOP button and manual reset of the AMR through the ON button for the AMR to restart its operation. The AMR will not automatically recover from an emergency stop. Refer to *4-15-1 Emergency Stop Recovery Procedure* on page 4-32 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 Access Panel. They are energized with +24 VDC during normal operation and turn OFF when an emergency stop event occurs. Refer to *3-5-2 User Access Panel Connections* on page 3-15 for more information.
An emergency stop differs from a protective stop. Refer to *4-16 Protective Stops* on page 4-34 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.

- *4-18 Light Discs and Optional Beacon States* on page 4-36
- *4-19 Light Strips and Optional Beacon States* on page 4-39
- *4-20 Pendant Operation* on page 4-42
- *4-12-1 Main Screen* on page 4-27
- *2-8-1 Safety Functions* on page 2-15

4-15-1 Emergency Stop Recovery Procedure

Enabling motor power, either at the start-up or after an E-STOP button is released, must be done through a manual action at the system and only after the operator has confirmed that it is safe to return the AMR to operation. Enabling the motor power is not automatic and must be an additional action after releasing an E-STOP button.
The AMR's drive motors remain disabled until you follow the procedure below: 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. Make sure that all surrounding areas are clear before you release the E-STOP button so that the AMR has room to maneuver.
2. Rotate the E-STOP button to release it.

3 Press the ON button on the operator panel.

Additional Information

- If only the E-STOP on the pendant is pressed, use the three-position enabling device to recover. Pressing the ON button is not required.
- There is a two-second delay between when the ON button is pressed and the AMR resumes its activity. During the two seconds, the AMR scans its path for potential obstacles and will resume its commanded motion if there is adequate space to maneuver.

4-16 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 two seconds before it resumes operation. No user intervention is necessary to recover from a protective stop.

The protective stop circuit is classified as a Category 1 stop.

Protective stops can be triggered by one of the following items.

- Safety Laser Scanners: The Safety Laser Scanners initiate a protective stop any time they detect unavoidable obstacles in the AMR's path. For example, 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.
- Pendant: The three-position device completely depressed or not depressed will initiate a protective stop.
- User-supplied protective stop devices connected to the SCPU connector in the User Access Panel can initiate a protective stop. Refer to *3-5-2 User Access Panel Connections* on page 3-15 for more information.

A protective stop differs from an emergency stop. Refer to *4-15 Emergency Stop* on page 4-32 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.

- *4-16-1 AMR Response During Protective Stops* on page 4-34
- *2-8-1 Safety Functions* on page 2-15

4-16-1 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	USER_PROTECTIVE_STOP input	ESTOP_USER input	AMR Response	USER_SAFFETY_OUT
Driving	LOW	HIGH	Protective Stop Automatic Reset	LOW
Driving	HIGH	HIGH	No Change	HIGH
Driving	N/A	LOW	Protective Stop Automatic Reset	LOW
Stopped	LOW	HIGH	STO Active, Brakes engaged	HIGH
Stopped	HIGH	HIGH	No change	HIGH
Stopped	N/A	LOW	STO Active, Brakes engaged	LOW

4-17 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.

If the AMR operates outside the specified speed limit, the safety controller registers a Channel 1 or Channel 2 system fault and begins a protective stop sequence. This event causes the AMR's motion controllers to execute a protective stop (stop category 1). When the protective stop is engaged, 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 *2-8-1 Safety Functions* on page 2-15 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 breaks 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 override the brake release, 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 in the ARAM software (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.

4-18 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 Strips and an optional beacon (light tower).

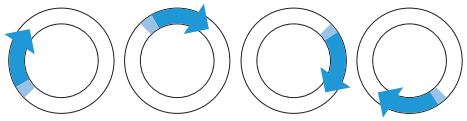
Refer to the following sections for more information.

- *LIGHTS* on page 3-19.
- *4-19 Light Strips and Optional Beacon States* on page 4-39

4-18-1 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.

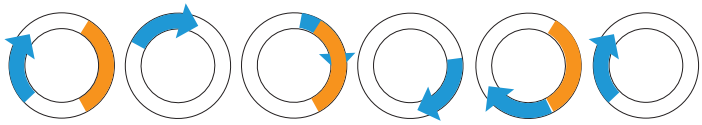
An optional beacon will blink green during this operation.



4-18-2 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.

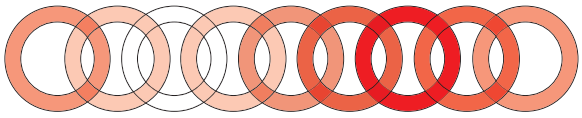
An optional beacon will blink green during this operation.



4-18-3 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.

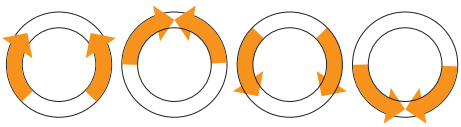
An optional beacon will blink red during this operation.



4-18-4 Lost

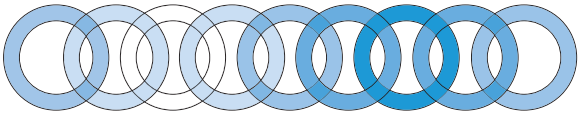
When the AMR is lost, the light discs each display two orange arcs traveling from the 6 o'clock to the 12 o'clock position and back in opposite directions.

An optional beacon will blink green during this operation.



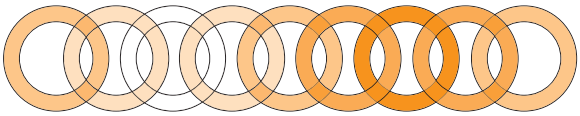
4-18-5 Stopped or Booting

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



4-18-6 Stopped with Warning

When the AMR is stopped with a warning, the light discs pulse orange instead.
An optional beacon will blink green during this operation.

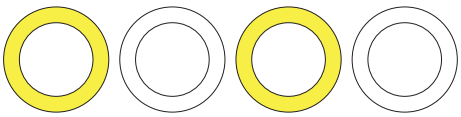


4-18-7 Obstacle Detected

The light disc blinks yellow if the AMR stops for an obstacle detected in its safety zone.
An optional beacon will blink yellow during this operation.

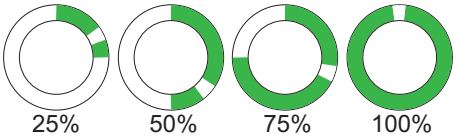
Additional Information

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



4-18-8 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 blink 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.

4-19 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 3-19.
- *4-18 Light Discs and Optional Beacon States* on page 4-36

4-19-1 Driving Straight

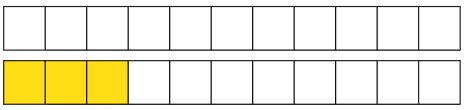
When driving straight, the front light strip displays solid white and the rear light strip displays solid blue.

An optional beacon will blink green during this operation.

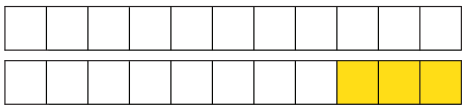
4-19-2 Turn Signal

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.

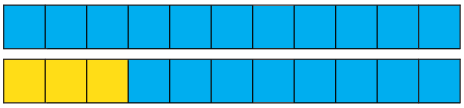
An optional beacon will blink green during this operation.



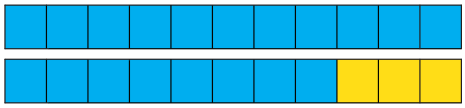
Front Light Strip - Left Turn



Front Light Strip - Right Turn



Rear Light Strip - Left Turn

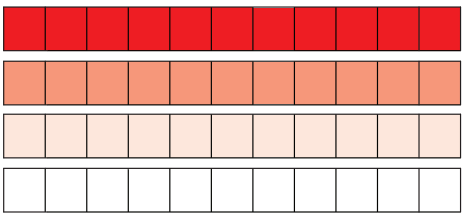


Rear Light Strip - Right Turn

4-19-3 Emergency Stop

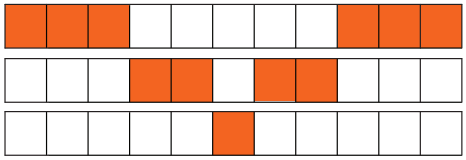
The light strip pulses red while the AMR is in an emergency stop state. The LED pulses at a 0.25 Hz frequency as it fades ON and OFF.

An optional beacon will blink red during this operation.



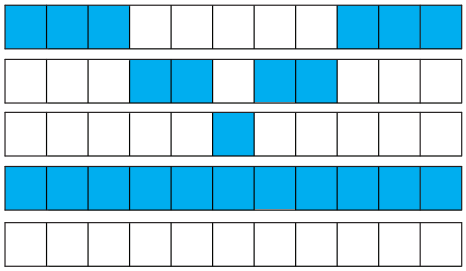
4-19-4 Lost

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.
An optional beacon will blink green during this operation.



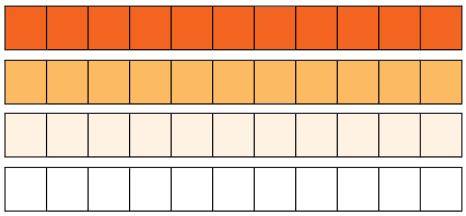
4-19-5 Stopped or Booting

While the AMR is stopped or 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 be solid green during this operation.



4-19-6 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 blink green during this operation.



4-19-7 Obstacle Detected

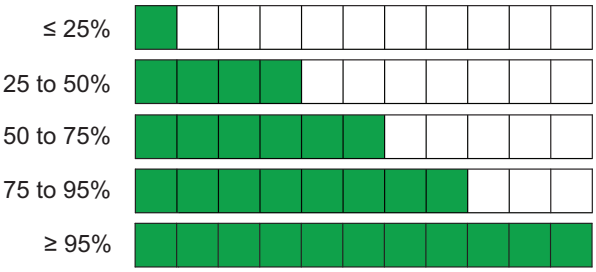
The front and rear light strips display yellow blinking at the center if the AMR stops for an obstacle detected in its safety zone.
An optional beacon will blink yellow during this operation.

Additional Information

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

4-19-8 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 blink green during this operation.



Additional Information

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

4-20 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 Scanner is 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.

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.
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.

4-20-1 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 Connect the pendant to the Operator Panel Pendant port.

3 Turn the speed dial counterclockwise to the lower speed limit.

4 Release the E-STOP button.

5 Press the AMR ON button.

6 Squeeze and hold the three-position enabling device with medium pressure so it is in the middle position

7 Move the directional control stick to drive the AMR in that direction.
Push the directional control stick forward or back to make the AMR move in that direction. Push the directional control button to the left side to make the AMR rotate in place 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.

8 To stop the AMR, you can release the three-position enabling device or depress it completely. This will disable the drive motors. 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).

4-21 Warning Buzzer

The AMR has a configurable warning buzzer (via MobilePlanner). You should configure this buzzer while considering the facility in which the AMR will be operating. The buzzer must be audible above the ambient noise of the environment that the AMR operates in. In environments with higher levels of noise, you may need to supply and install an additional warning buzzer to an appropriate location on the payload structure. Refer to *1-6-4 Additional Warning Buzzers* on page 1-23 for information on how to install an additional warning buzzers.

⚠ CAUTION

Changing 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

Buzzer parameter values are only available with Fleet Operations Workspace version 1.1 and later.

You can configure the buzzer to activate under the following conditions.

- Continuously and whenever the AMR moves
- Any time the AMR moves at a linear speed below 20 mm/s, or a rotational speed of less than 3 deg/sec for longer than 2 seconds to alert the users of a very slowly moving AMR which is not configured with hardware-based safety zones by default. This is used to allow the AMR to be driven away from obstacles that have come too close to the AMR. The AMR will turn on audible buzzers when using this zone for 2 seconds or longer. Refer to *Moving at Very Slow Speeds* on page 4-55 for more information.
- 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.
- For 2 seconds when an emergency stop or a protective stop from hardware-based safety zones is triggered.

4-22 Safety Laser Scanner Zones

The AMR's Safety Laser Scanner are 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.

⚠ CAUTION

- Personnel should not be near the AMR when it is rotating with no forward motion.
- Although the AMR respects its software-based obstacle-avoidance clearances at all speeds, the user must be aware of the location of the E-STOP buttons at all times, and keep out of the unprotected areas.

Additional Information

- A password is required to make any safety-critical changes to the Safety Laser Scanner configuration and zones. This password can be changed by the user to limit access by unauthorized users. For instructions on how to change the password, refer to *Safety Laser Scanner OS32C Series User's Manual (Cat. No. Z296)* for more information.
- With the exception of safety zones 40 and 42, 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.

4-22-1 Safety Zone Pairs

Each Safety Laser Scanner has several individually configurable safety zones. With each Safety Laser Scanner scanning a 270° 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 42 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.
- Moving slowly.
- Driving in an arc (turning).
- Driving at very slow speeds.
- Approaching the Docking Target.

Additional Information

- Safety zone pairs were designed for AMR operation with the maximum payload on a concrete floor with a coefficient of friction of 0.6.
- A specific safety zone pair is used when docking to prevent the charging paddle from stopping motion when it is near the front of the AMR. This safety zone pair is also used any time the AMR is operating within the speeds specified. Refer to *Approaching the Docking Target* on page 4-56 for more information.

Safety Zone Pair Operational Details

The operational details of safety zone pairs are described below.

Additional Information

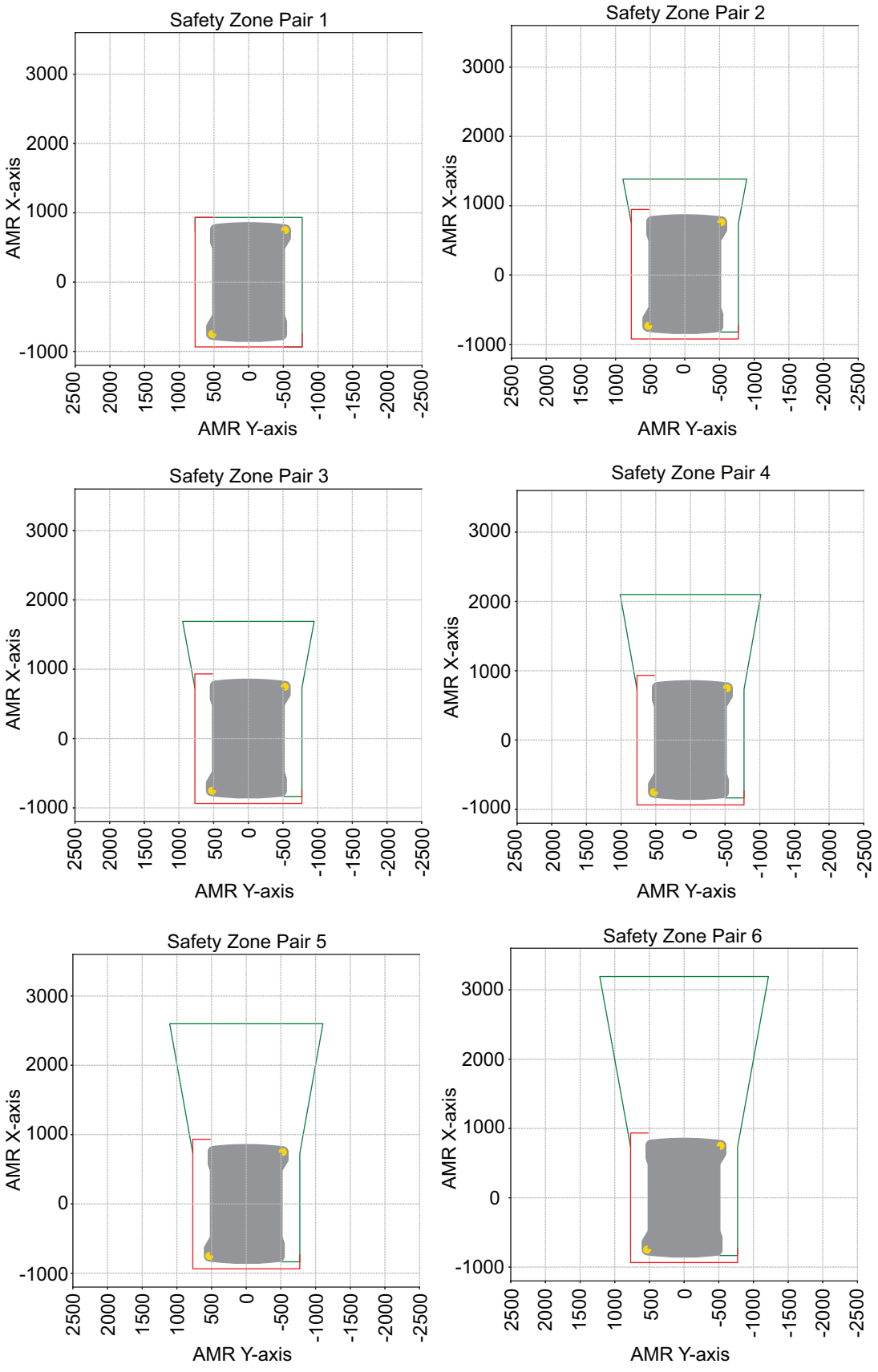
Not all speeds are achievable for safety zone pairs associated with an operational condition.

Safety Zone Pair(s)	Operational Conditions	Active Speed Ranges (linear and rotational)
1 to 6	Enabled when the AMR is driving straight with minimal turning. Refer to *Driving Straight with Minimal Turning* on page 4-47 for more information.	115 to 1800 mm/s 0 to 12 degrees/s
7	Enabled to protect against over-speed conditions.	
8 to 10	Enabled when the AMR is rotating while driving slowly. Refer to *Rotating While Driving Slowly* on page 4-48 for more information.	0 to 115 mm/s 12 to 60 degrees/s
11	Enabled when the AMR is moving slowly. Refer to *Moving Slowly* on page 4-49 for more information.	115 to 580 mm/s 12 to 60 degrees/s
12 to 39	Enabled when the AMR is driving in an arc (turning). Refer to *Driving in an Arc (Turning)* on page 4-50 for more information.	115 to 1530 mm/s 12 to 45 degrees/s
40	Enabled when the AMR is driving at very slow speeds with the Pendant connected. Refer to *Moving at Very Slow Speeds* on page 4-55 for more information.	0 to 20 mm/s 0 to 3 degrees/s
41	Enabled when the AMR is approaching the Docking Target or traveling at slow speeds. Refer to *Approaching the Docking Target* on page 4-56 for more information.	0 to 115 mm/s 0 to 12 degrees/s
42	Enabled when the AMR is driving at very slow speeds with the Pendant disconnected. Refer to *Moving at Very Slow Speeds* on page 4-55 for more information.	0 to 20 mm/s 0 to 3 degrees/s

● Driving Straight with Minimal Turning

Safety zone pairs 1 to 6 are used when the AMR is driving straight with minimal turning (0 to 12 degrees/s).

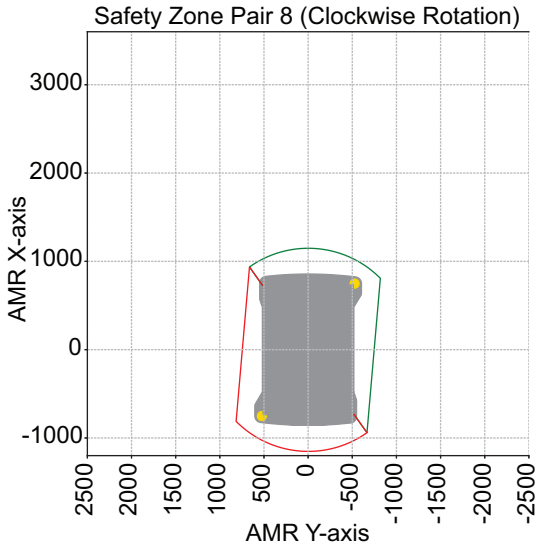
Safety Zone Pair	Applicable Speed
1	115 to 275 mm/s
2	275 to 580 mm/s
3	580 to 890 mm/s
4	890 to 1228 mm/s
5	1228 to 1530 mm/s
6	1530 to 1800 mm/s

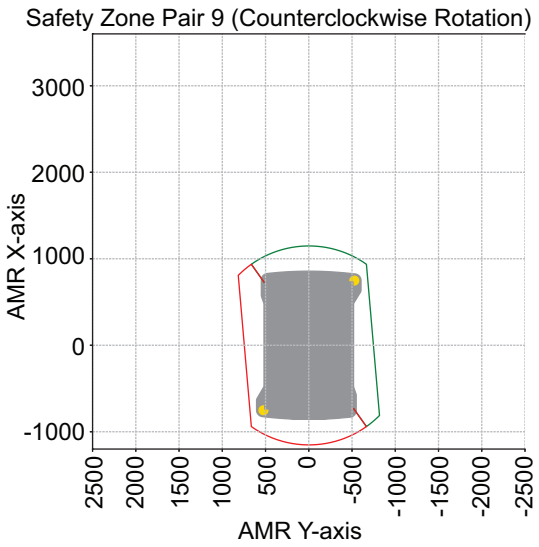


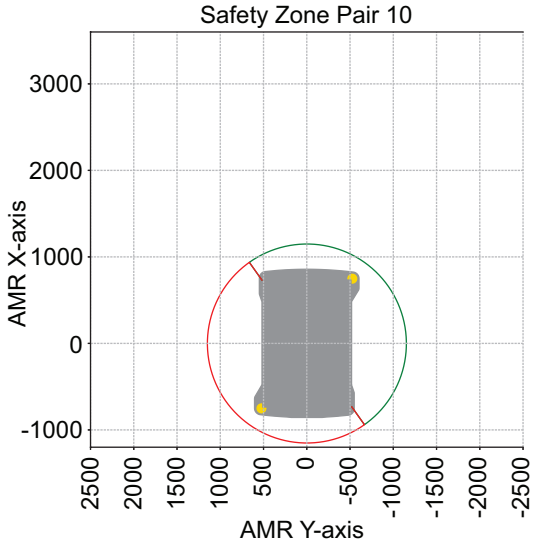
● Rotating While Driving Slowly

Safety zone pairs 8 to 10 are used when the AMR is rotating in place.

Safety Zone Pair	Applicable Speed
8 and 9	0 to 115 mm/s 12 to 30 degrees/s
10	0 to 115 mm/s 30 to 60 degrees/s



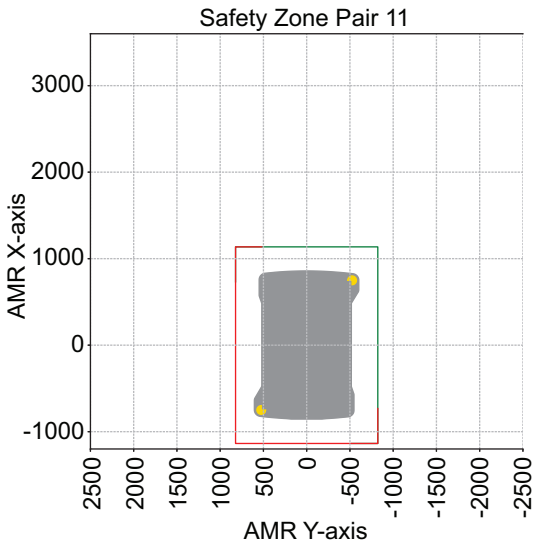




● Moving Slowly

Safety zone pair 11 is used when the AMR is driving slowly.

Safety Zone Pair	Applicable Speed
11	275 mm/s and 12 to 60 degrees/s 580 mm/s and 12 to 14 degrees/s

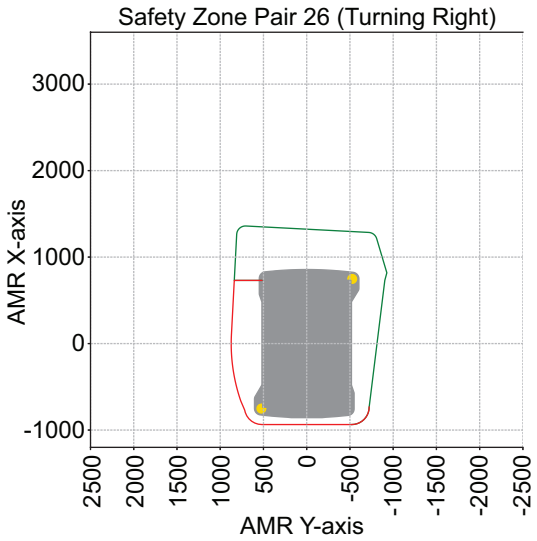


● Driving in an Arc (Turning)

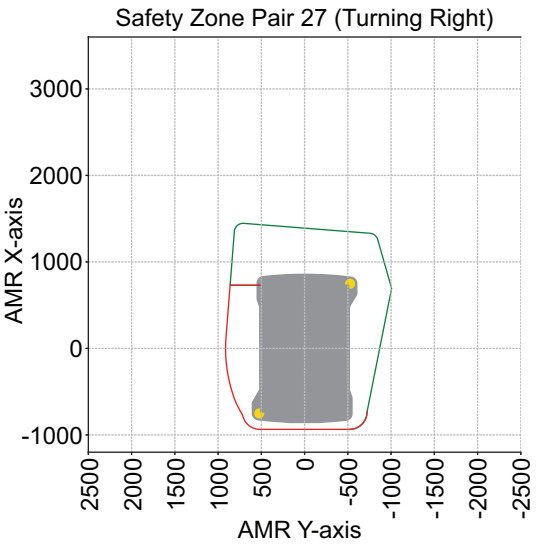
Safety zone pairs 12 to 39 are used when the AMR is driving in an arc (turning).

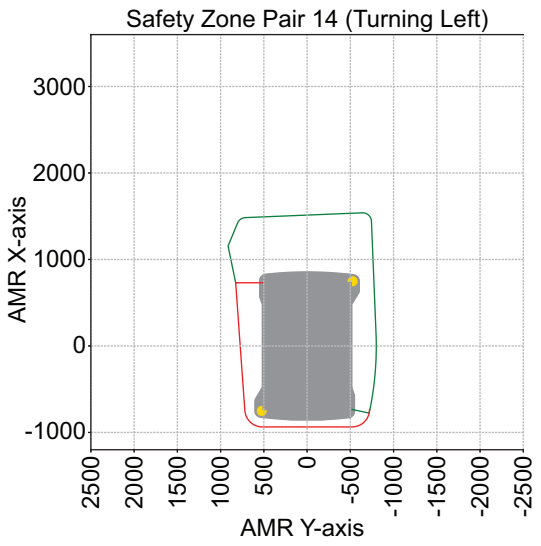
Safety Zone Pair	Applicable Speed
12 and 26	275 to 580 mm/s 24 to 30 degrees/s
13 and 27	275 to 580 mm/s 30 to 45 degrees/s
14 and 28	580 to 890 mm/s 12 to 18 degrees/s
15 and 29	580 to 890 mm/s 18 to 24 degrees/s
16 and 30	580 to 890 mm/s 24 to 30 degrees/s
17 and 31	580 to 890 mm/s 30 to 45 degrees/s
18 and 32	890 to 1228 mm/s 12 to 18 degrees/s
19 and 33	890 to 1228 mm/s 18 to 24 degrees/s
20 and 34	890 to 1228 mm/s 24 to 30 degrees/s
21 and 35	890 to 1228 mm/s 30 to 45 degrees/s
22 and 36	1228 to 1530 mm/s 12 to 18 degrees/s
23 and 37	1228 to 1530 mm/s 18 to 24 degrees/s
24 and 38	1228 to 1530 mm/s 24 to 30 degrees/s
25 and 39	1228 to 1530 mm/s 30 to 45 degrees/s

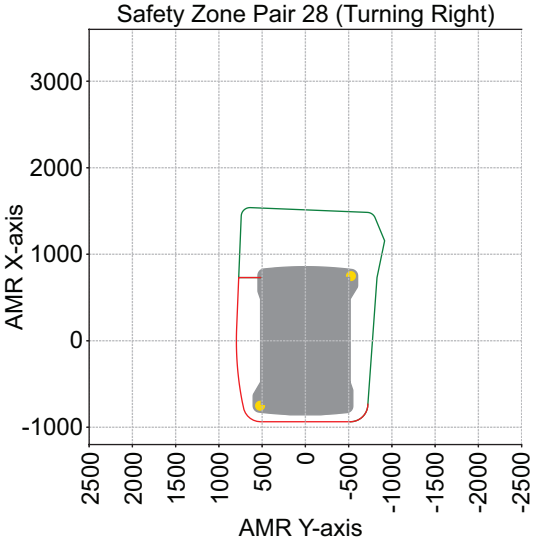

Safety Zone Pair 12 (Turning Left)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500


Safety Zone Pair 26 (Turning Right)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500


Safety Zone Pair 13 (Turning Left)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500


Safety Zone Pair 27 (Turning Right)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500


Safety Zone Pair 14 (Turning Left)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500


Safety Zone Pair 28 (Turning Right)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500


Safety Zone Pair 15 (Turning Left)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500


Safety Zone Pair 29 (Turning Right)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500


Safety Zone Pair 16 (Turning Left)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500


Safety Zone Pair 30 (Turning Right)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500

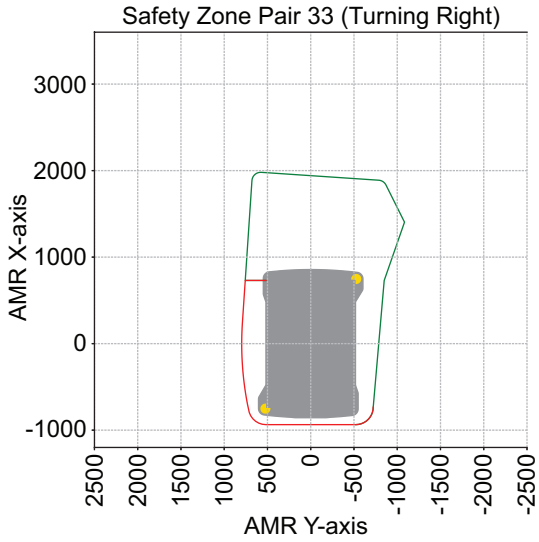

Safety Zone Pair 17 (Turning Left)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500

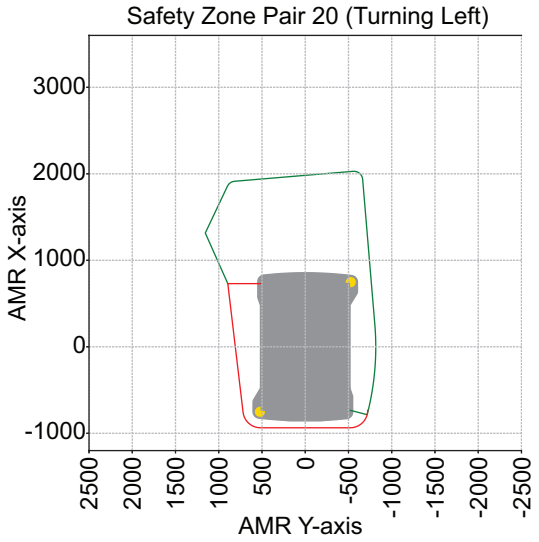

Safety Zone Pair 31 (Turning Right)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500


Safety Zone Pair 18 (Turning Left)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500

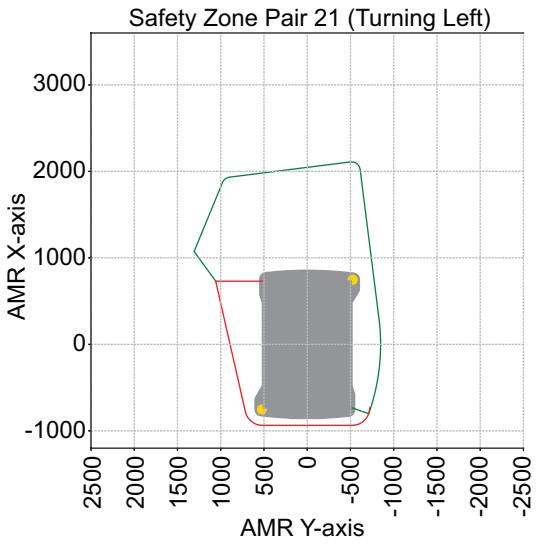

Safety Zone Pair 32 (Turning Right)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500

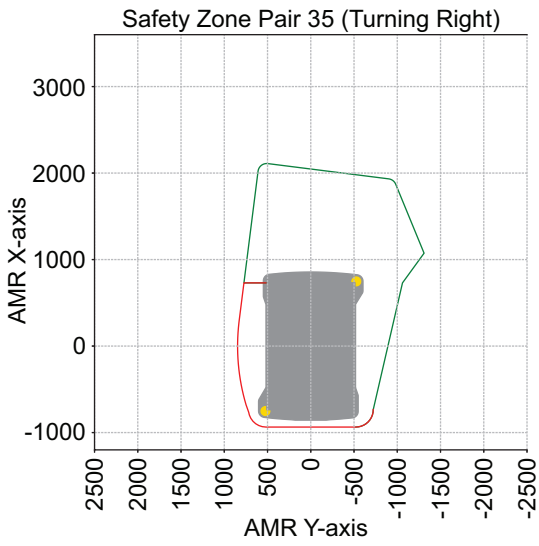

Safety Zone Pair 19 (Turning Left)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500


Safety Zone Pair 33 (Turning Right)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500


Safety Zone Pair 20 (Turning Left)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500


Safety Zone Pair 34 (Turning Right)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500

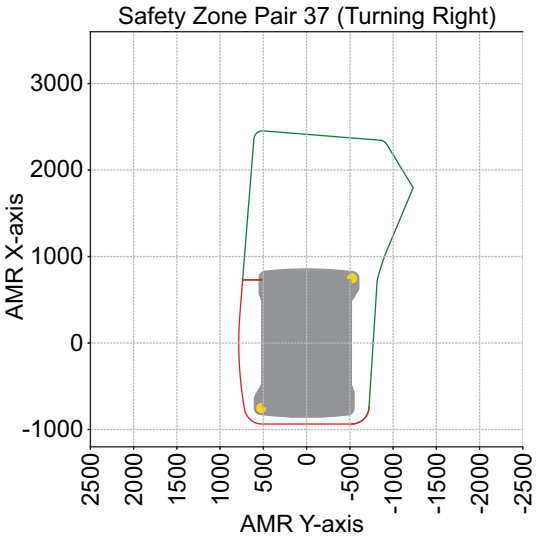

Safety Zone Pair 21 (Turning Left)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500

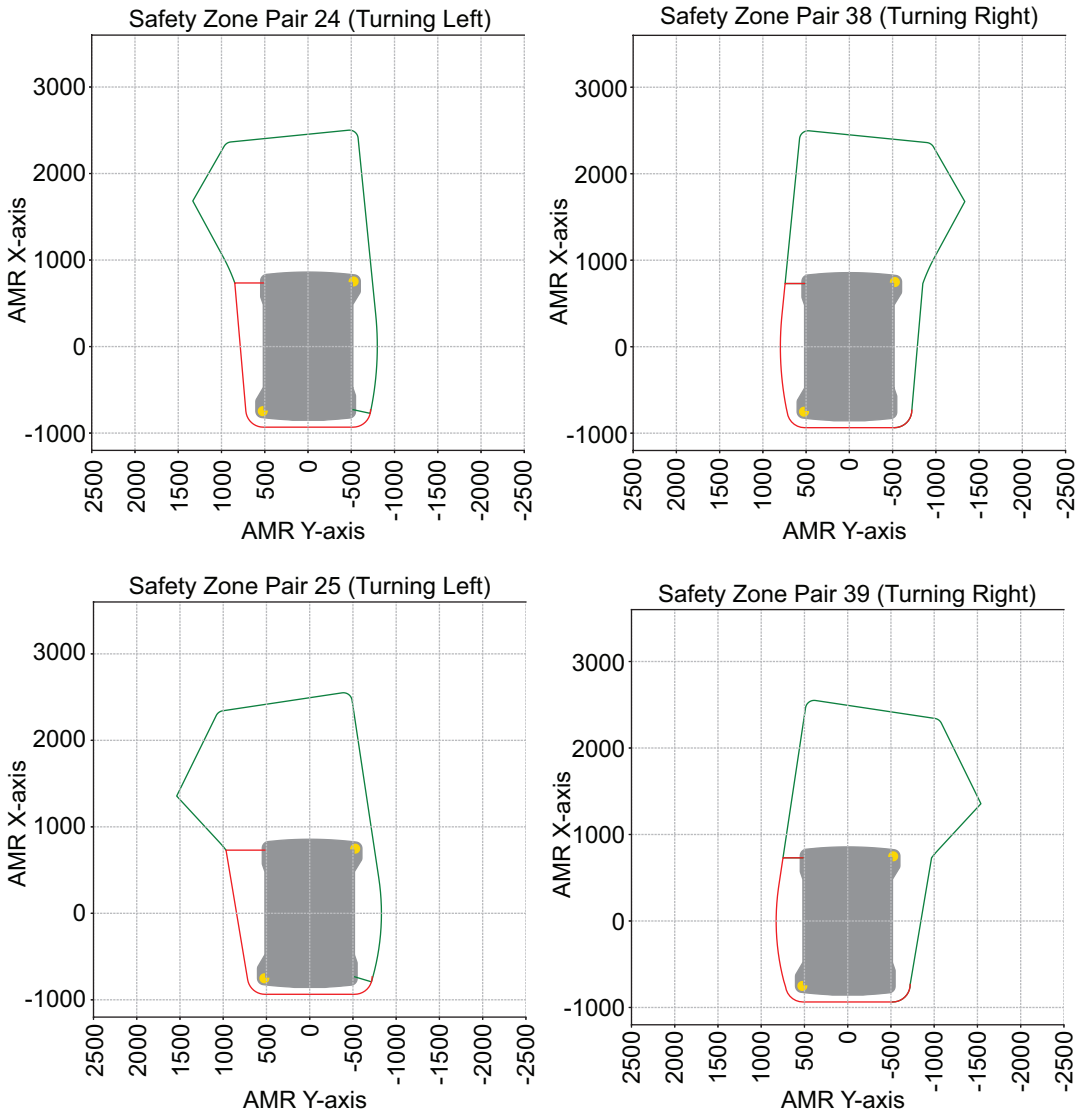

Safety Zone Pair 35 (Turning Right)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500


Safety Zone Pair 22 (Turning Left)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500


Safety Zone Pair 36 (Turning Right)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500


Safety Zone Pair 23 (Turning Left)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500


Safety Zone Pair 37 (Turning Right)
AMR X-axis
AMR Y-axis
3000
2000
1000
0
-1000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500



● Moving at Very Slow Speeds

Safety zone pairs 40 and 42 are used when the AMR is moving at very slow speeds between 0 to 20 mm/s and 0 to 3 degrees/s. When moving at very slow speeds for 2 seconds or longer, the AMR will activate the audible buzzer.

Safety zone pair 40 is used only when the pendant is connected. Safety zones are minimized in this state to allow manual driving away from an object that may be contacting an outer edge of the AMR.

Safety zone pair 42 is used when the AMR is moving at very slow speeds without the pendant connected.

● Approaching the Docking Target

Safety zone pair 41 is used when the AMR is approaching the Docking Target or the AMR operating at the speeds indicated below.

An area near the charging contacts on the AMR is unprotected while operating at the speeds used for docking.

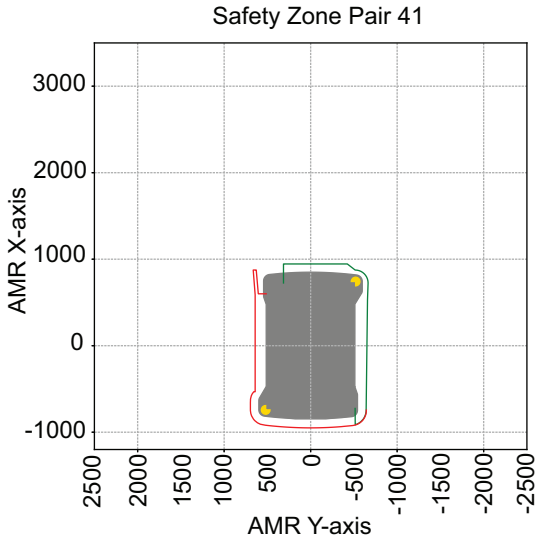
⚠ CAUTION

It is the end user's responsibility to ensure that the area within the radius of 2 m from the center of the AMR is kept clear when it is traveling at less than 115 mm/s.

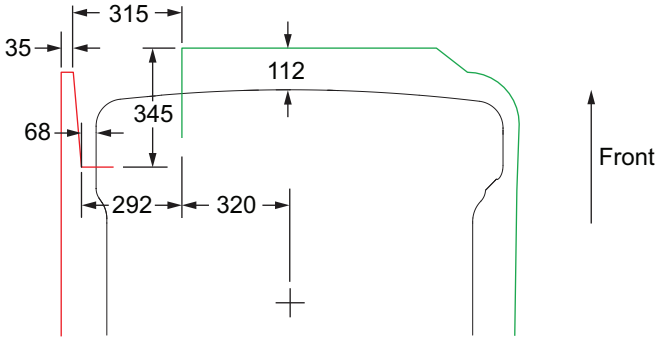
Precautions for Safe Use

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.

Safety Zone Pair	Applicable Speed
41	0 to 20 mm/s and 3 to 12 degrees/s 20 to 115 mm/s and 0 to 12 degrees/s



The following figure provides dimensions of the AMR unprotected area at the front of the AMR.



4-23 Wireless Considerations

Make the following considerations when an AMR is communicating with a wireless network.
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.

4-23-1 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.

4-23-2 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 an EM2100 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, uploading ARAM / SetNetGo, and viewing the ARAM log 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.

4-23-3 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.

4-24 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 OMRON representative.

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 **Accel* and **Decel* 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)	1800	1	1800
AbsoluteMaxTransNegVel (mm/s)	-1800	-1800	-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

4-25 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.

4-26 Tilt Detection

The tilt detection feature monitors the angle of the AMR with respect to flat ground during its operation. If the AMR tilts 60 degrees or more in any direction, motion will stop and power is removed from any user-supplied equipment.

Precautions for Safe Use

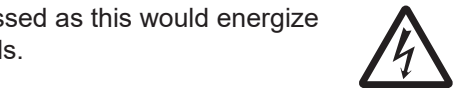
The tilt detection feature will not prevent an improperly loaded AMR from toppling.

4-27 Interlock Switches

If the interlock switches detect that the battery door is open or that any of the side skins are removed, the AMR's motion is disabled and power is removed from the main bus bars.
To restore power, you must re-install the removed skin or close the battery door.
If you remove the side skins or open the battery door while the AMR is docked and charging, the charging process will stop. Once the removed skin is re-installed or the battery door is closed, the charging will not re-engage automatically. The AMR must repeat the normal docking process for charging to resume. Aside from interrupting charging, re-installing the skin(s) or closing the battery door will automatically return the AMR to its normal operating state.

⚠ WARNING

The AMR interlock switches shall not be defeated or bypassed as this would energize the AMR and expose the user to potential electrical hazards.



Additional Information

Refer to *1-2-17 Interlock Switches* on page 1-14 for more information about the locations of interlock switches.

5

Troubleshooting

This section provides troubleshooting information.

5-1 Collecting Troubleshooting Information

Troubleshooting information can be collected from the AMR by downloading a Debug Info File using SetNetGo. This is a collection of configuration, log, and system status files that support personnel can use for debugging and troubleshooting. Use the following procedure to download a Debug Info File for troubleshooting or diagnostic purposes.

Precautions for Correct Use

The AMR's internal clock must be set correctly to ensure that accurate timestamps are present in the Debug Info File. 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 3-11 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 ARAM configuration file, the Safety Laser Scanner configuration and safety parameters are not stored in the SetNetGo restore function. Refer to the *Safety Laser Scanner OS32C Series User's Manual (Cat. No. Z296)* for more information about backup and restore functions for the Safety Laser Scanners.

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 must be removed and charged outside of the AMR. Software interlocks are in place that prevent the AMR from being physically pushed to a Docking Target for charging. Refer to *Charging a Battery Outside of the AMR* on page 4-25 for more information.

5-4-2 Battery Charging Problems

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

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 4-25 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 overtemperature 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.		
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.	

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 items:

- Check the battery's state of charge to ensure sufficient power is available. Refer to *4-11-1 Battery Indicators and Controls* on page 4-18 for more information.
- Check that the skins are in place and fastened correctly and that all interlock switches are satisfied. Refer to *4-27 Interlock Switches* on page 4-62 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 *4-12-1 Main Screen* on page 4-27 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.
Back 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 *4-15-1 Emergency Stop Recovery Procedure* on page 4-32 for more information.
Skin Estop	An E-STOP button on the sides of the AMR has been depressed.	Refer to *4-15-1 Emergency Stop Recovery Procedure* on page 4-32 for more information
Latch Estop	The AMR is in an emergency stop state after all emergency stop devices have been reset and the safety circuit is satisfied.	Refer to *4-15-1 Emergency Stop Recovery Procedure* on page 4-32 for more information
Panel Estop	An E-STOP button on the Operator Panel of the AMR has been depressed.	Refer to *4-15-1 Emergency Stop Recovery Procedure* on page 4-32 for more information
Joy 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 *4-20 Pendant Operation* on page 4-42 for more information.
Door Open	An interlock switch detected that a side skin is not properly fastened to the AMR or the battery door is not closed.	Check that the side skins are properly fastened. Check that the battery door is completely latched and closed. Check the operation of the interlock switches. Refer to *1-2-17 Interlock Switches* on page 1-14 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.

6

Maintenance

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

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.
- The access covers on the Charging Station are not interlocked. During maintenance and repair, you must turn OFF power to the Charging Station. Remove and secure the power cord and all other electrical inputs to prevent unauthorized power application.

⚠ 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.

⚠ WARNING

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.

⚠ WARNING

Do not perform maintenance work on the AMR until the measured voltage of the motor controller capacitors are below 7 VDC.

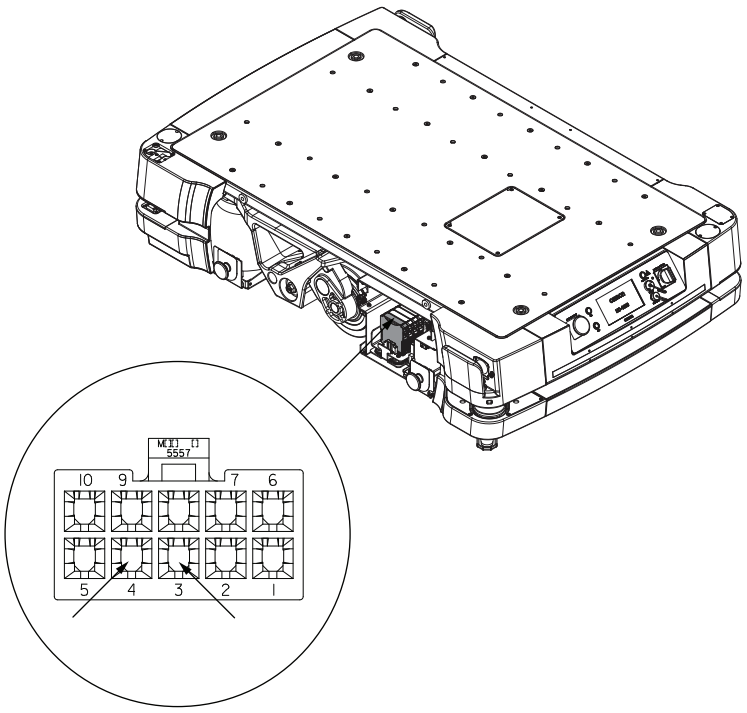
1 Press an E-STOP button.

2 Shut down the AMR by pressing the OFF button on the Operator Panel.

3 Turn the AMR main disconnect switch to OFF position (horizontal).

4 Lock and tag the main disconnect switch according to your facility requirement and regulations.

5 Probe the appropriate connector pins on the module shown below using a digital multimeter.
Probe the back of the pin 4 (positive) and pin 3 (negative).
Each motor controller is equipped with a capacitor that stores energy. You must check and make sure that the voltage is less than 7 VDC.



6 After the voltage is less than 7 VDC, verify that the AMR is de-energized by pressing the ON / OFF button on the Operator Panel and then repeat step 5.
After confirming the voltage remains less than 7 VDC, this procedure is complete.

6-3 Charging Station Lock-out Tag-out Procedure

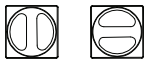
Use the following procedure to execute Lock-out Tag-out before performing any maintenance or installation work on the Charging Station.

⚠ WARNING

The access covers on the charging station are not interlocked. During maintenance and repair, you must turn OFF power to the charging station. Remove and secure the power cord and all other electrical inputs to prevent unauthorized power application.

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 the all Power Supply Box LEDs are OFF to complete this procedure.

6-4 Lifting the AMR

Use the following procedure to lift an AMR without a payload or payload structure. A lifting kit is supplied with the AMR that includes 4 lifting rings and 4 straps (1.2 m).

⚠ 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.

⚠ CAUTION

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

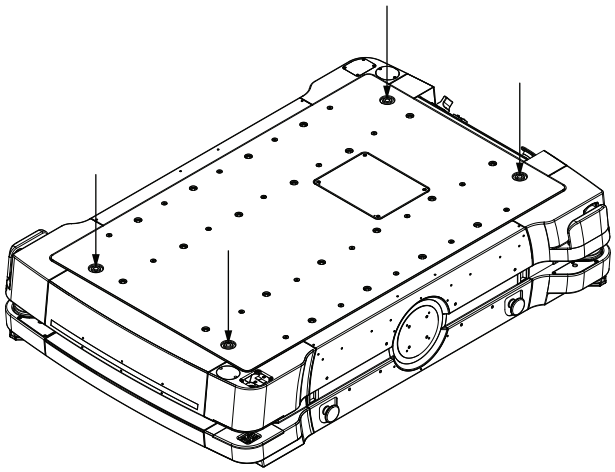
- Do not exceed 25 kN per lifting mount point.
- To prevent damage to the lifting points, AMR chassis, or lifting rings, do not exceed a 30° angle from vertical when attaching the lifting straps to the lifting device.
- Inspect lifting straps for signs of wear and tear or any damages before attaching 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 the AMR).
- 4 safety slings (supplied with the AMR).
- Personal Protective Equipment (eye protection, toe protection, gloves).
- Forklift, hoist, or other lifting device rated for a minimum of 1100 kg.

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

2 Attach the OMRON-supplied lifting rings using to the locations shown in the figures below. There are four bolt holes on the AMR for attaching the lifting rings. Once the lifting rings are attached, tie and secure the straps.



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

4 Remove the lifting rings and straps from the AMR to complete this procedure.

6-5 Drive Power Indicator Check Procedure

Use the following procedure to test and confirm the operation of the drive power indicator light.
A user-supplied drive power indicator light must be installed and connected before beginning this procedure.

1. Press one of the E-STOP buttons on the AMR.
2. Connect your pendant to its connection on the operator panel.
3. Reset the E-STOP button.
4. Press the ON button.
5. Squeeze and hold the three-position enabling device with medium pressure to place it in the middle position. This will enable high power to the drive motors.
6. When the drive motors are enabled, the drive power indicator light must turn ON. This confirms that the drive power indicator light is functional.
7. Next, release the three-position enabling device. This will remove the high power to the drive motors.
8. Check the drive power indicator light. It must turn OFF to indicate there is no high power going to the drive motors.

6-6 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. Refer to *6-5 Drive Power Indicator Check Procedure* on page 6-8 for more information.
Light Discs	Weekly	Check for proper operation of the light discs. Make sure all segments and colors are functioning properly.
Light Strips	Weekly	Check for proper operation of the light strips. Make sure all segments and colors are functioning properly.
Buzzer	Weekly	Check the audible buzzer for proper operation.
Speakers	As needed	Check the speakers for proper operation (if used).
E-STOP Buttons	Weekly	Check for proper operation of the E-STOP buttons. Refer to *3-11 Safety Commissioning* on page 3-36 for more information.
Safety Laser Scanners	Weekly	Check for proper operation of the Safety Laser Scanners. Refer to *3-11 Safety Commissioning* on page 3-36 for more information.
Mechanical Brakes	Annually	Check for proper operation of the mechanical brakes. Refer to *6-6-1 Mechanical Brake Inspection Procedure* on page 6-9 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	Check the caster swivels and tighten if loose.
AMR Charging Contacts	3 months	Check the AMR charging contacts for wear or debris. Refer to *6-6-2 AMR Charging Contact Inspection* on page 6-10 for more information.
Docking Target Charging Contact Assembly	3 months	Inspect the Docking Target Charging Contact assembly. Refer to *6-6-3 Docking Target Charging Contacts Inspection* on page 6-10 for more information.
Labels	Weekly	Verify all labels are present, legible, and undamaged.
Batteries (in-use and stored)	Six months	Check the battery for charge state, leaks, or damage. Refer to *6-7 Stored Batteries* on page 6-13 for more information.
Check safety and warning labels	Weekly	Refer to *6-6-4 Safety and Warning Labels* on page 6-10 for more information.

6-6-1 Mechanical Brake Inspection Procedure

Perform annual inspection of the mechanical brakes for proper operation. Before you begin, make sure it is safe to manually move the AMR to an open area with level floor.
Use the following procedure to verify that the mechanical brakes engage and disengage properly. This procedure does not require a Lock-out Tag-out procedure in advance.

1 Connect the pendant to the AMR and drive forward approximately 2 m in order to align the casters in the direction of motion.

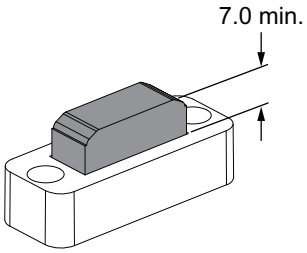
2 Release the three-position enabling device to ensure that the AMR is in protective stop mode.

3 Press and hold the brake release button and then push the AMR straight forward. One or two people should be able to push an unloaded or lightly loaded AMR. For a heavily loaded AMR, you may need more people.
You will hear a click sound when the brake release button is pressed and then the AMR should roll smoothly. Contact your OMRON representative if the AMR does not move.
Refer to *4-14 Manually Pushing the AMR* on page 4-31 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.

6-6-2 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.



6-6-3 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.

6-6-4 Safety and Warning Labels

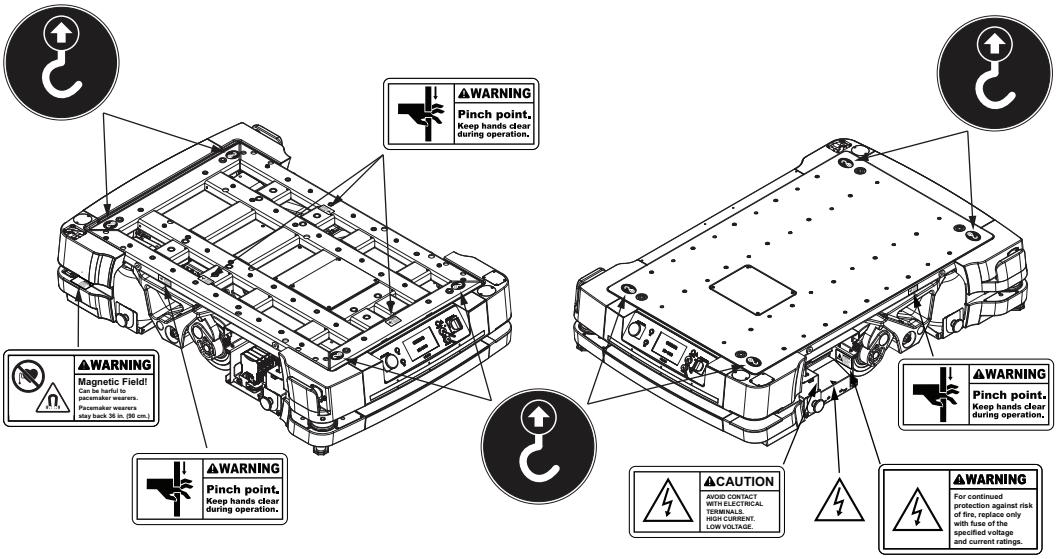
This section identifies safety and warning labels and their locations on the AMR and Charging Station components. Use this information to perform periodic checks to ensure safety and warning labels are not damaged or removed.

AMR Safety and Warning Label Locations

Use the following information to understand all safety and warning label locations on the AMR.
The following labels are located on the AMR as indicated below.

- Four lifting point labels.
- Five pinch point warning labels.
- One electric shock caution labels.
- One electric shock label.

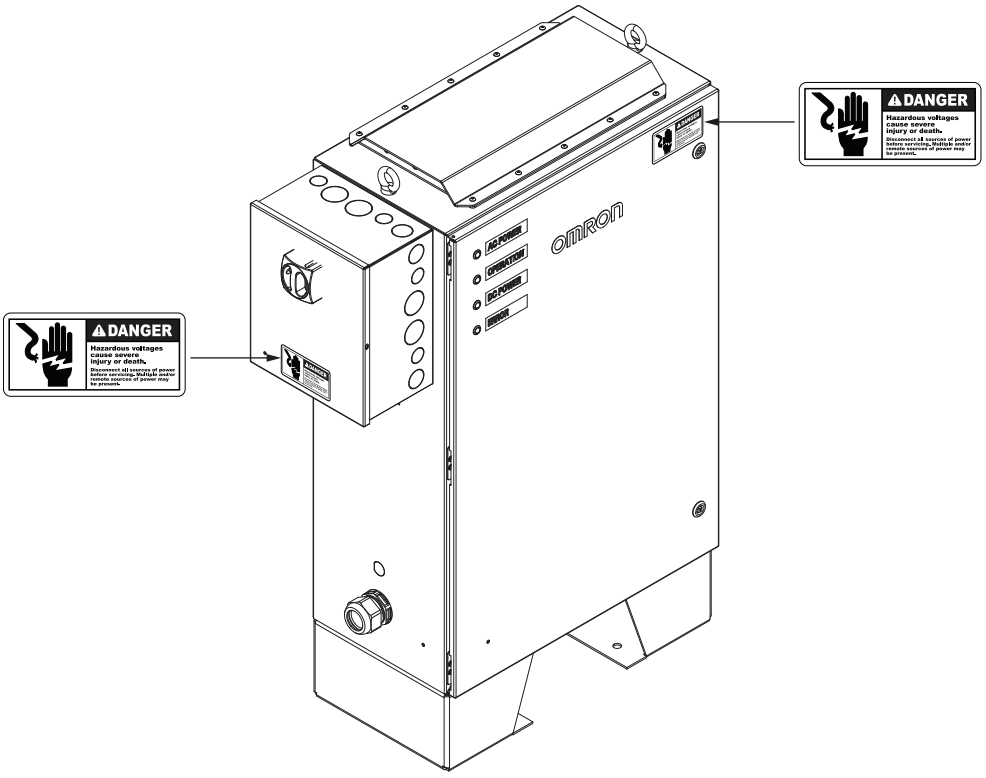
- One fuse replacement warning label.
- One magnetic field warning label.



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.

Two hazardous voltage labels are located on the surface of the Power Supply Box as indicated below.

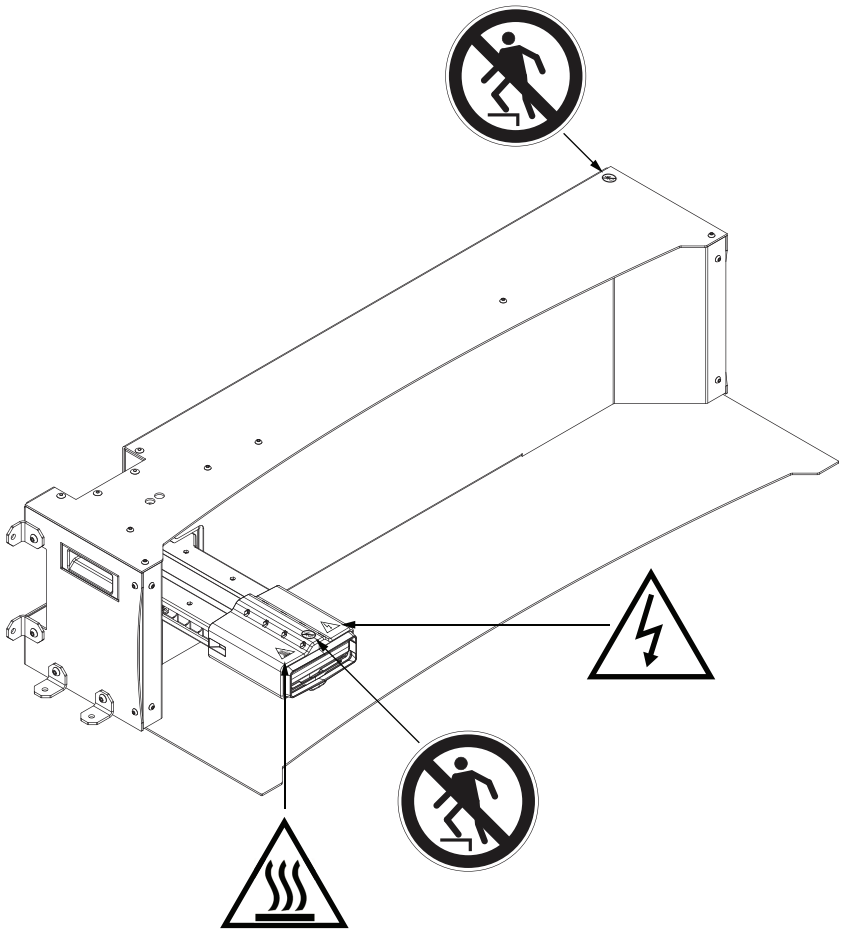


Docking Target Safety and Warning Label Locations

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

The following labels are located on the Docking Target as indicated below.

- Two do not step labels.
- One hot surface label.
- One electric shock label.



6-7 Stored Batteries

Use the following information when storing batteries.
The battery should start the storage period completely charged.
The batteries must be stored in the upright position (as it is positioned when installed in the AMR). Do not place the batteries on their sides, top, front, or rear.
When a battery is stored for a period of more than six months, perform the following tasks at six month intervals to properly maintain the batteries.

- Inspect the batteries for damage or leaks.
- Connect the battery to the Power Supply Box and allow it to completely charge and balance.

Additional Information

- Refer to *2-3 Environmental Specifications* on page 2-9 for more information.
- Refer to *4-11 Battery and Charging* on page 4-18 for more information.

6-8 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.

6-8-1 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 *6-8-2 Cleaning AMR Charging Contacts* on page 6-14 for more information.
Clean the Power Supply Box cooling duct.	6 months, 2,000 charge cycles, or as needed.	Refer to *6-8-3 Cleaning the Power Supply Box Cooling Ducts* on page 6-15 for more information.
Clean all laser lenses.	6 months / as needed.	Refer to *6-8-4 Cleaning Lasers Lenses* on page 6-16 for more information.
Clean caster treads.	As needed.	Refer to *6-8-5 Cleaning Caster Treads* on page 6-16 for more information.
Clean drive wheel treads.	As needed.	Refer to *6-8-6 Cleaning Drive Wheels* on page 6-16 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.

6-8-2 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.

6-8-3 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

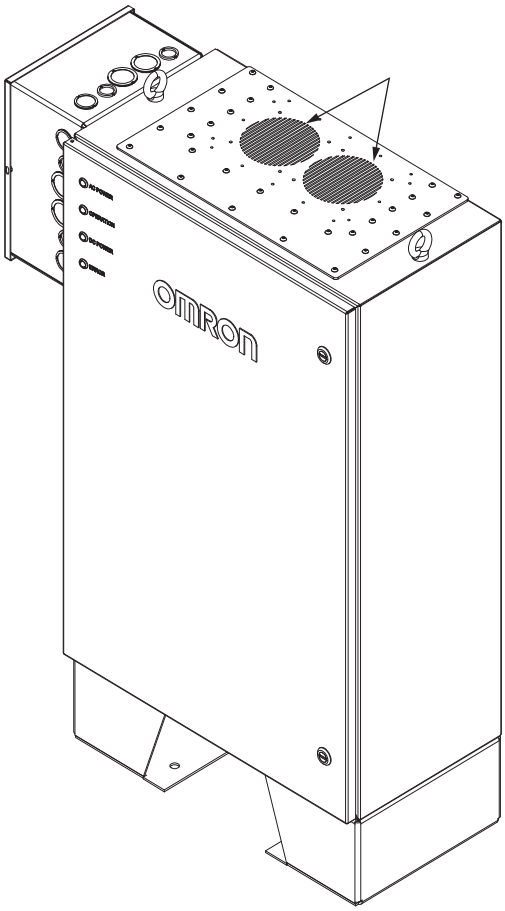
Prior to cleaning the Charging Station, you must ensure that the AMR is not engaged with the Docking Target.

⚠ 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.



6-8-4 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.

6-8-5 Cleaning Caster Treads

Remove any accumulated dirt or debris on the treads to prevent AMR’s performance degredation. Clean the caster treads with a mild soapy solution.

6-8-6 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.

6-9 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.

6-9-1 Removing and Replacing Skins

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

Skins are secured to the chassis by two latches found on each side of the skin. The skins include alignment pins that fit into holes in the chassis. No tools are required for skin removal.
The left side and right side E-STOP buttons are not attached to the skins and remain attached to brackets on the chassis after removal of the skins.

⚠ 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.

⚠ WARNING

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.

⚠ CAUTION

The electronics bay has high current components that are exposed when side skins are removed. Avoid contact with electrical terminals to prevent electric shock.

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.

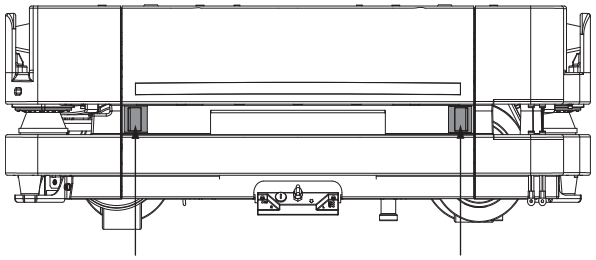
Precautions for Correct Use

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

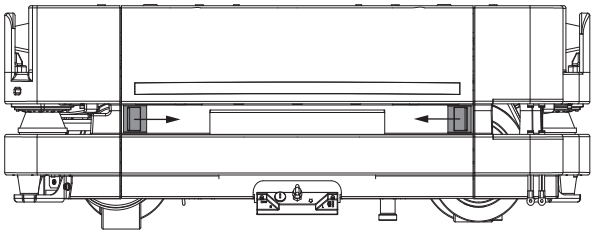
Front Skin Removal and Replacement Procedure

Use the following procedure to remove or replace the front skin on the AMR.
The front skin covers the battery compartment and must be removed prior to installation or removal of the battery.
No tools are needed for either the removal or replacement of the front skin.

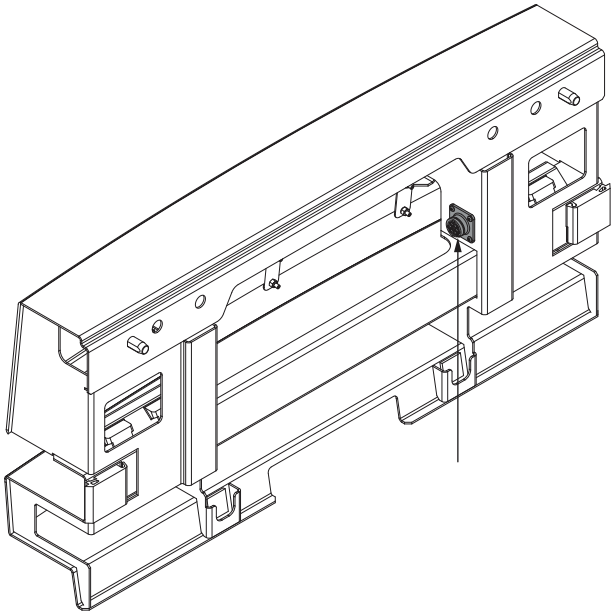
1 Locate the front skin latches found in the recessed groove as shown in the following figure. The latches also act as recessed handles for easy grip.



2 Slide the latches towards the center (inward) to unlatch them from the AMR chassis.



3 Once unlatched, pull the skin away from the chassis enough so that you can access front light strip connector and then disconnect the cable.
The front skin cannot be completely removed until the front light strip cable is disconnected.
Two pins near the top of the front skin are used for alignment. Observe the location of these pins. These are used when placing the front skin on the AMR.

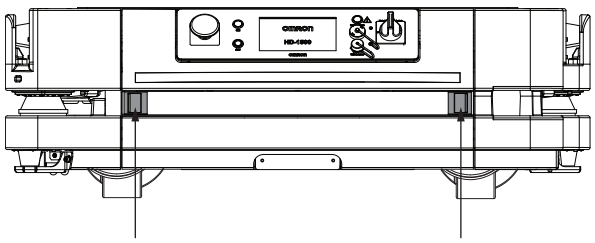


4 Remove the front skin.
This completes the front skin removal process. Reverse the steps above to replace the front skin.

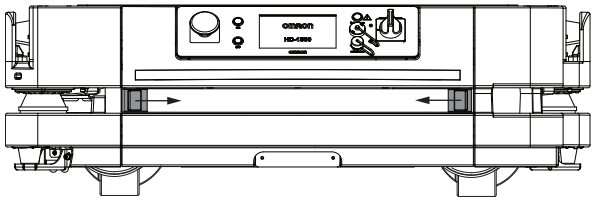
Rear Skin Removal and Replacement Procedure

Use the following procedure to remove or replace the rear skin on the AMR.
No tools are needed for either the removal or installation of the rear skin.

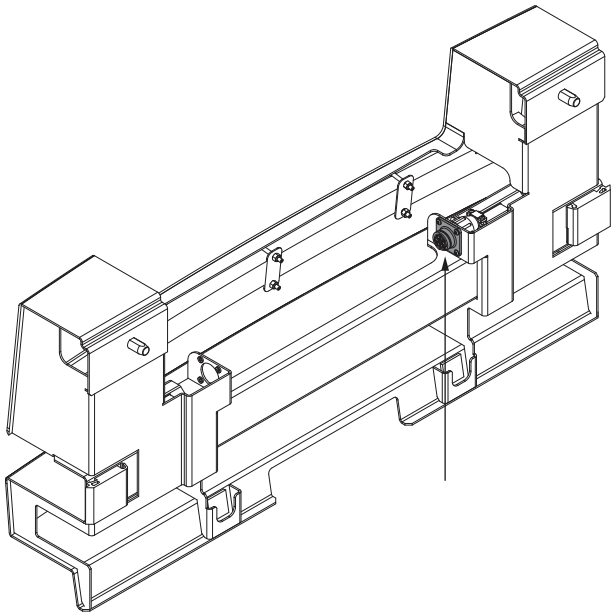
1 Locate the rear skin latches found in the recessed groove as shown in the following figure.
The latches also act as recessed handles for easy grip.



2 Slide the latches towards the center (inward) to unlatch them from the AMR chassis.



3 Once unlatched, pull the skin away from the chassis enough so that you can access rear light strip connector and then disconnect the cable.
The rear skin cannot be completely removed until the front light strip cable is disconnected.
Two pins near the top of the rear skin are used for alignment. Observe the location of these pins. These are used when placing the rear skin on the AMR.

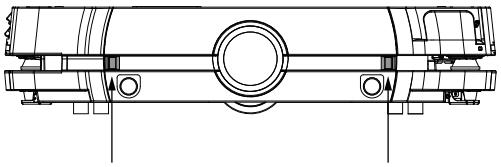


4 Remove the rear skin.
This completes the rear skin removal process. Reverse the steps above to replace the rear skin.

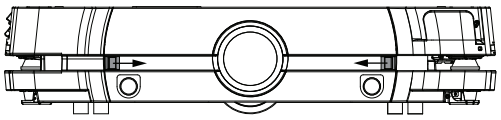
Side Skin Replacement Procedure

Use the following procedure to remove or replace the side skins on the AMR. The same procedure can be used for both the left and right side skins.
No tools are needed for either the removal or installation of the rear skin.

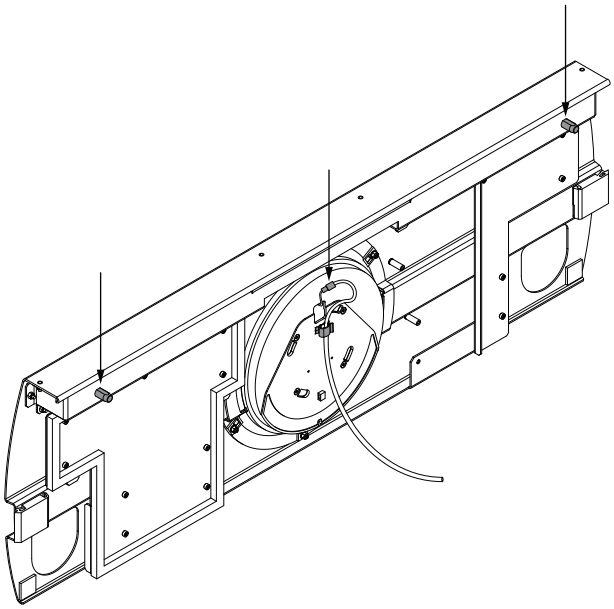
1 Locate the side skin latches as shown in the following figure.
The latches also act as recessed handles for easy grip.



2 Slide the latches towards the center (inward) to unlatch them from the AMR chassis.



3 Once unlatched, pull the skin away from the chassis just enough so you can access the light disc connector. Disconnect the cable and remove it from the retaining clip.
The side skin cannot be completely removed until the light disc cable is disconnected.
Two pins near the top of the side skin are used for alignment. Observe the location of these pins. These are used when placing the side skin on the AMR.



4 Remove the side skin.
This completes the side skin removal process. Reverse the steps above to replace the side skin.

6-9-2 Light Disc LED Replacement Procedure

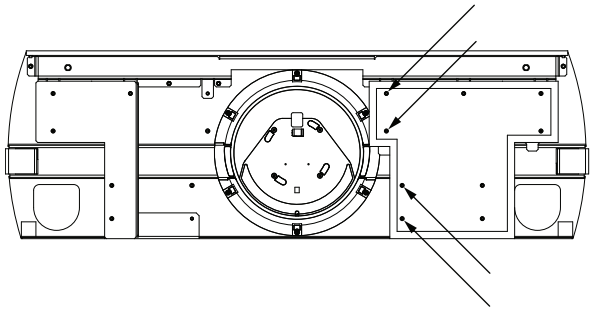
Use the following procedure to replace the LED light inside the AMR light disc.
The following items are required for this procedure.

- A replacement LED light.
- 7 mm nut driver.
- 2.5 mm hex wrench.

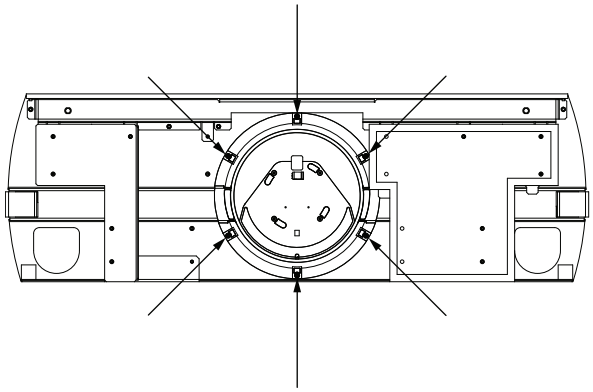
1 Unlatch the skin and pull it away from the AMR so that you can disconnect the cable. Refer to *6-9-1 Removing and Replacing Skins* on page 6-18 for more information.
Move the skin to an adequate working area after detaching it from the AMR.

2 After the cable is disconnected, remove the skin completely.

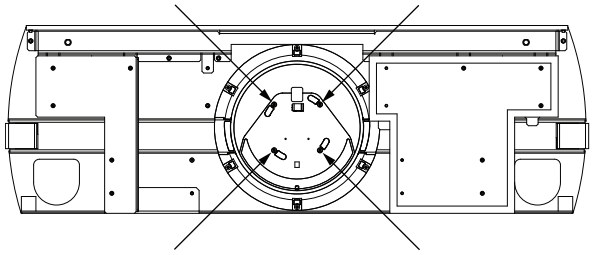
3 Remove the four screws near the edge of electronics bay seal cover using a 7 mm nut driver. This will allow the LED mount plate to be removed once unscrewed from the skin.



4 Remove the six nuts holding the LED mount plate to the side skin using a 7 mm nut driver.



5 Remove the four screws holding the diffuser plate to the LED mount plate using a 2.5 mm hex wrench.



6 Carefully lift the electronics bay seal cover and then remove the LED mount plate completely to expose the LED light assembly.

7 Disconnect the LED light electrical connector.

8 Remove the LED light by peeling away from the LED mount plate.
Take note of the LED light orientation before removing it. Installing the new LED light in the incorrect orientation will cause the lighting patterns to display in reverse.

9 Position the replacement LED light so that it is located around the entire circumference of the LED mount plate and in the correct orientation.

10 Adhere the new LED light to the LED mount plate.

11 Connect the LED light electrical connector.

12 Reverse steps 1 to 6 to complete this procedure.

6-9-3 Light Strip LED Replacement Procedure

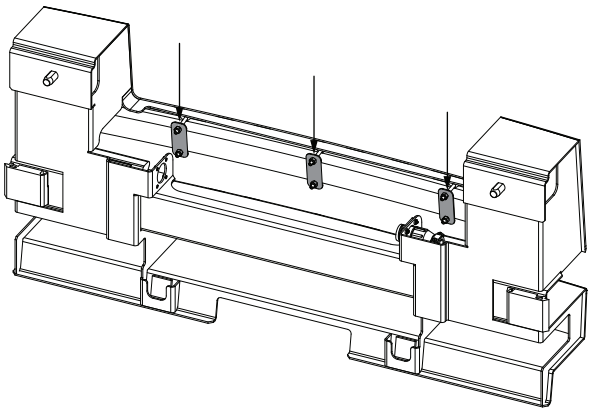
Use the following procedure to replace the LED light inside the AMR light strip on the front or rear skin.
The following items are required for this procedure.

- A replacement LED light.
- 7 mm nut driver.
- Cable tie.

1 Unlatch the skin and pull it away from the AMR so that you can disconnect the cable. Refer to *6-9-1 Removing and Replacing Skins* on page 6-18 for more information.
Move the skin to an adequate working area after detaching it from the AMR.

2 Remove the cable that connects directly to the PCA board.

3 Remove the three brackets that secure the LED light mounting channel by unscrewing the 6 bolts using a 7 mm nut driver as shown below (rear skin shown).



4 Remove the LED light mounting channel from the skin.

5 Disconnect the LED light electrical connector from the PCA board and then remove the cable tie that secures the cable assembly.
Take note of the cable routing for re-installation.

6 Remove the LED light by peeling it away from the mounting channel.
Take note of the LED light positioning for re-installation.

7 Adhere the replacement LED light to the mounting channel in the same location that was observed in step 6.

8 Connect the LED light electrical connector to the PCA board and then secure the cable with a new cable tie using the same orientation that was observed in step 5.

9 Reverse steps 1 to 3 to complete this procedure.

6-9-4 Operator Panel Replacement / Removal Procedure

Use the following procedure to remove or replace the Operator Panel located on the AMR.

Additional Information

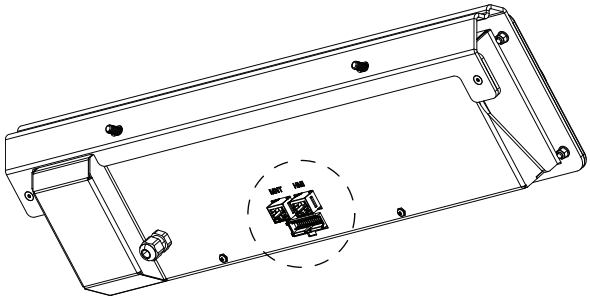
If the Operator Panel has been relocated to the payload structure, its replacement procedure will vary accordingly.

The following items are required for this procedure.

- A replacement Operator Panel (if replacing and not relocating).
- 7 mm nut driver.
- Cable tie.

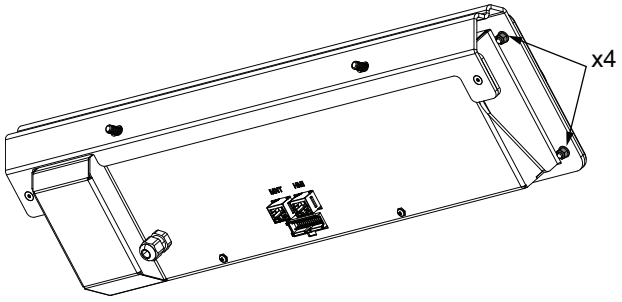
1 Unlatch the skin and pull it away from the AMR so that you can disconnect the cable. Refer to *6-9-1 Removing and Replacing Skins* on page 6-18 for more information.

2 Remove the cables from the connectors on the back of the Operator Panel.



3 Disconnect the remaining cable from its corresponding connector that is fastened to the AMR. Take note of the cable ties that need to be removed and the cable routing for reassembly.

4 Remove the four locknuts that attach the Operator Panel to the mount bracket using a 7 mm nut driver.
The locknuts are located on the back of the mounting bracket as shown below.



5 Remove the Operator Panel from the mounting bracket.

This step concludes the procedure for Operator Panel removal. Proceed to the next steps to replace the Operator Panel.

6 Insert the replacement Operator Panel into the mount bracket.

7 Reverse steps 1 to 4 to complete this procedure.

6-9-5 Wireless Antenna Replacement Procedure

Use the following procedure to remove and replace the wireless antenna located on the AMR.

Precautions for Correct Use

The position of the antenna is critical to correct operation. You must make sure to attach a new antenna to the correct location etched on the base plate.

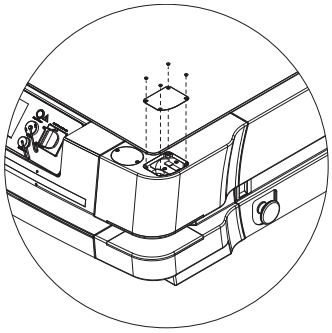
Additional Information

If the wireless antenna(s) has been relocated to the payload structure, its replacement procedure will vary accordingly.

The following items are required for this procedure.

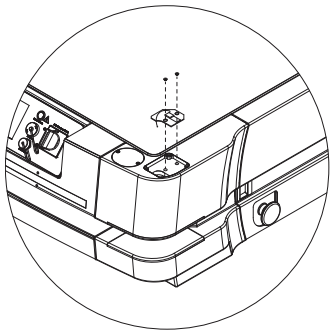
- A replacement wireless antenna.
- 2.5 mm hex key.
- 8 mm wrench or socket driver.

1 Use a 2.5 mm hex key to remove the 4 screws that fasten the wireless antenna cover to the AMR and then remove the cover.



2 Gently pull the antenna connector off of the AMR adapter coupling. This is a friction fitting which requires very little force.

3 Using a 2.5 mm hex key, remove the two retaining screws that fasten the antenna backing plate to the compartment and then remove the assembly from the AMR.



4 Remove the adapter coupling from the antenna connector on the AMR using a 8 wrench or socket driver.

5 Reverse steps 1 to 4 to complete this procedure.

6-9-6 AMR Charging Contact Replacement Procedure

Use the following procedure to replace worn AMR charging contacts.

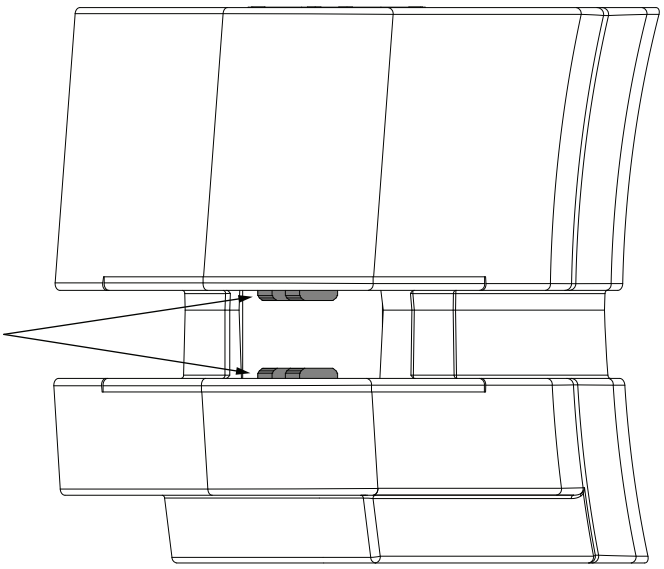
Additional Information

Refer to *6-6-2 AMR Charging Contact Inspection* on page 6-10 for more information.

The following items are required for this procedure.

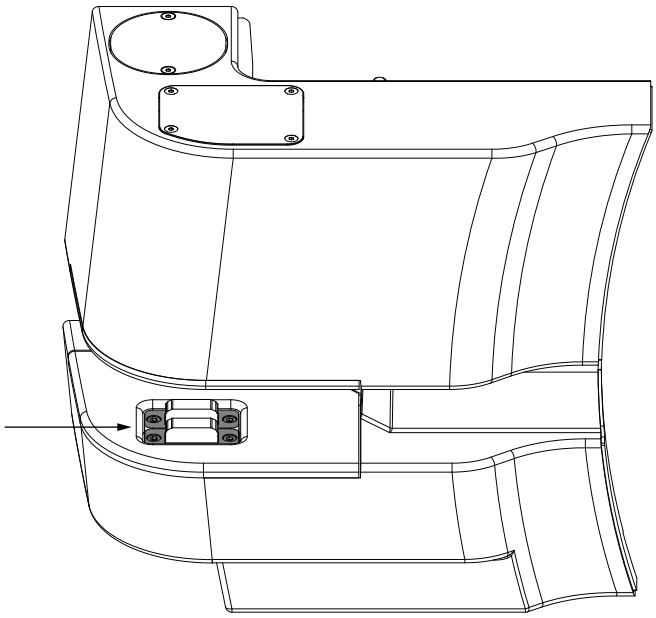
- 4 mm hex key
- Replacement AMR charging contacts.
- Torque wrench
- Locktite 222 thread lock compound or equivalent.

There are two sets of two charging contacts at the top and the bottom of the charging slot. This procedure applies to both sets of charging contacts.

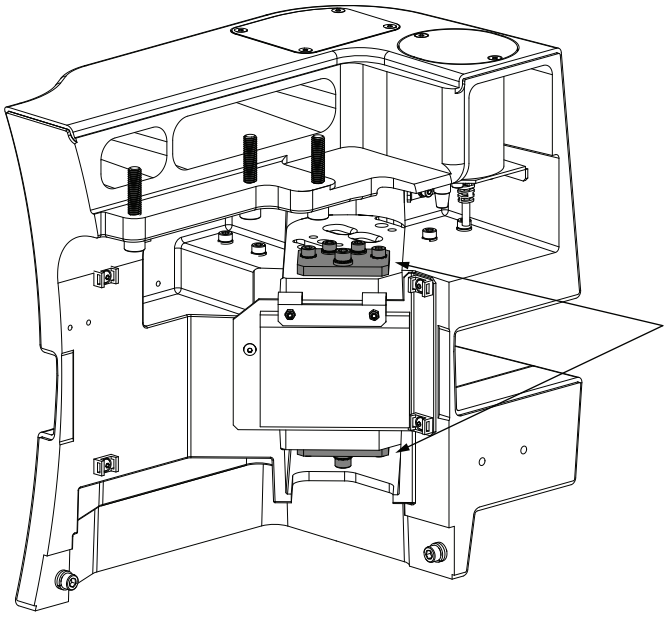


1 Remove the front skin. Refer to *Front Skin Removal and Replacement Procedure* on page 6-19 for more information.

2 Remove the four M5 screws with a 4 mm hex key that attach the contact housings to the base plate.



3 Locate the bus bars inside the corner assembly and remove two M5 screws with a 4 mm hex key that attach the two charging connector leads.
Do not disconnect the single power lead from the bus bar.



4 Remove the charging contact assemblies.
Two springs are present in the assemblies. These springs are not fastened and may fall out of position.

5 Insert the new charging contact assemblies and route the cables to the corresponding bus bar.

6 Insert two M5 screws through the charging contact lead terminals and attach them to the corresponding bus bar using a 4 mm hex key. Tighten to a torque of 4.5 N·m.

7 Attach the contact housing to the base plate. Apply Loctite 222 thread lock compound or equivalent to the four M5 screws. Use a 4 mm hex key and tighten to a torque of 4.5 N·m to complete this procedure.

A

Appendices

A-1 Unpacking

The fully assembled AMR, Power Supply Box, Docking Target, and battery are packed and shipped in separate crates. Any optional devices or accessories purchased with the AMR are packed in a carton and placed in the main crate containing the AMR. Use the information in this section to understand the unpacking information for the AMR and other components supplied with the system.

⚠ WARNING

- Follow all unpacking safety instructions and use appropriate tools and equipment. Failure to do so could result in personal injury or property damage.
- Use safe lifting practices when moving the heavy objects such as the Power Supply Box, Battery, Docking Target, and AMR.
- At least 3 people are required to lift the battery.
- You must wear proper Personal Protective Equipment (PPE) for removing, installing, and lifting the battery or when working around a leaking battery.

⚠ WARNING

A pallet jack, overhead hoist, or forklift used to lift the AMR and Power Supply Box shipping crates must be rated for at least 1100 kg.

Precautions for Safe Use

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.

Precautions for Correct Use

IATA regulations (UN 3480, PI 965) require that air freight shipped lithium ion batteries must be transported at a state of charge not exceeding 30%. To avoid total discharge, fully charge the battery immediately upon receipt. The battery might arrive fully charged if it is not shipped by air freight.

Make the following considerations before unpacking the equipment.

- Carefully inspect all shipping boxes and crates for evidence of damage during transit. If any damage is indicated, request that the carrier’s agent be present at the time the crate is unpacked.
- Before signing the carrier’s delivery sheet, compare the actual items received with your equipment purchase order. Verify that all items are present and that the shipment is correct and free of visible damage.

  If the items received do not match the packing slip or have been damaged, do not accept the delivery.

  If the items received do not match your order, contact your local OMRON representative.
- Retain the containers and packaging materials. These items may be necessary to settle claims or to relocate the equipment at a later date.
- Make sure you have 7 m of clear working space in front of the AMR shipping crate for unloading purposes. You should also have 2 m of clear space behind the AMR shipping crate to allow the crate to be pushed back.

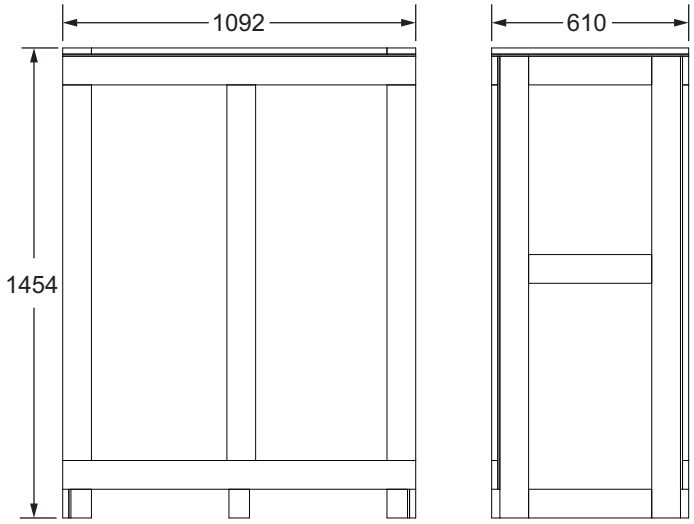
- Before driving the AMR down the ramp, ensure the Pendant speed knob is set at the lowest speed and remains at that setting during the driving process.
- If the AMR is stopped on the ramp, do not release the brakes.
- Do not rotate the AMR while driving on the ramp.

The general unpacking steps are provided below.

1. Unpack the Power Supply Box.
   Refer to *A-1-1 Power Supply Box Shipping Crate Information* on page A-3 for more information.
2. Unpack the battery.
   Refer to *A-1-2 Battery Shipping Crate Information* on page A-4 for more information
3. Unpack the Docking Target.
   Refer to *A-1-3 Docking Target Shipping Crate Information* on page A-5 for more information
4. Unpack the AMR.
   Refer to *A-1-4 AMR Shipping Crate Information* on page A-6 for more information

A-1-1 Power Supply Box Shipping Crate Information

The shipping crate with Power Supply Box weighs a total of 174 kg. The overall dimensions are provided below.



Power Supply Box Unpacking Procedure

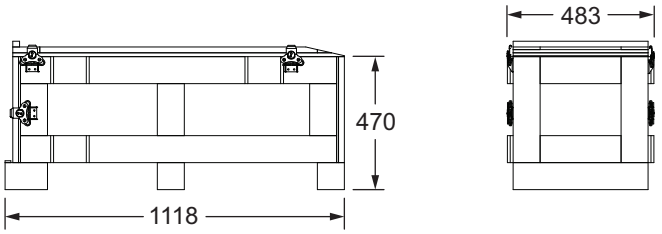
Use the following procedure to unpack the Power Supply Box from its shipping crate.
The following tools and equipment are required for this procedure.

- Personal Protective Equipment including eye protection, toe protection, and gloves.
- 13 mm socket with impact driver.
- 14 mm socket.
- Impact driver.
- Pry bar.
- Four safety-rated slings.
- Lifting device rated for at least 1100 kg capacity.

1. Remove the metal clips attaching the front panel to the housing crate using a pry bar. Place the pry bar between the crate and the metal clips and apply enough force to remove the clips.
2. Pull the front panel and remove it completely.
3. Remove the screws attaching the base pallet to the housing crate using a 13 mm socket and impact driver.
4. Remove the plastic wrap covering the Power Supply Box.
5. Remove the housing crate from the base pallet.
6. Remove the six bolts attaching the Power Supply Box to the base pallet using a 14 mm socket and impact driver.
7. Attach safety-rated slings to the two eye bolts on the Power Supply Box.
   The slings must be evenly distributed to ensure that the Power Supply Box is leveled when lifted up.
8. Using a lifting device, carefully lift the Power Supply Box off the base pallet and then place the unit on the ground to complete this procedure.

A-1-2 Battery Shipping Crate Information

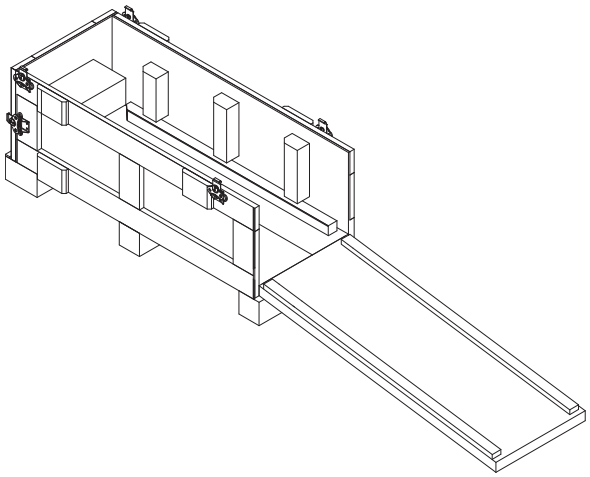
The shipping crate with battery weighs a total of 96 kg. The overall dimensions are provided below.



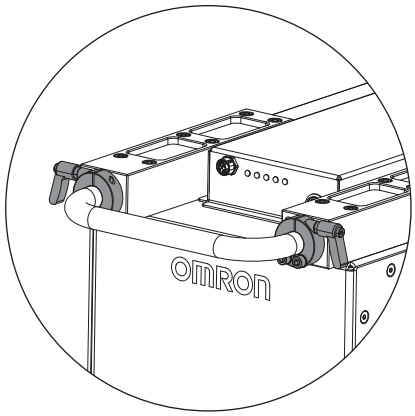
Battery Unpacking Procedure

Use the following procedure to unpack the battery from its shipping crate.
Personal Protective Equipment including eye protection, toe protection, and gloves are required for this procedure.

1. Unlock the top cover latches.
2. Remove the cover.
   The top cover is used as a ramp to move the battery out of the crate and onto the floor.
3. Unlock the front panel latches and then remove the front panel.
4. Place the rear edge of the top cover over crate's front edge and then remove the protective foam pads.



5 Loosen the two locking collars and then extend the battery handle out. After the handle is extended, tighten the locking collars.



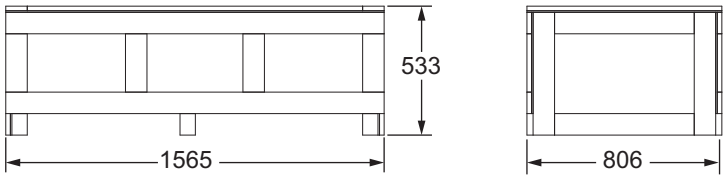
6 Pull the battery out of the crate using the extended handle and drag it down the ramp to the floor. Wheels are provided on the trailing edge of the battery to assist this transfer.
After the battery has been transferred from the crate to the floor, this procedure is complete.

A-1-3 Docking Target Shipping Crate Information

The shipping crate with Docking Target weighs a total of 97 kg. The overall dimensions are provided below.

⚠ WARNING

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



Docking Target Unpacking Procedure

Use the following procedure to unpack the Docking Target from its shipping crate.
The following tools and equipment are required for this procedure.

- Personal Protective Equipment including eye protection, toe protection, and gloves.
- 13 mm socket.
- Impact driver.
- Pry bar.

1 Remove the metal clips attaching the front panel to the housing crate using a pry bar.

2 Remove the front panel.

3 Remove the side screws attaching the crate housing to the base pallet using a 13 mm socket and impact driver.

4 Remove the housing by pushing it away from the base pallet.

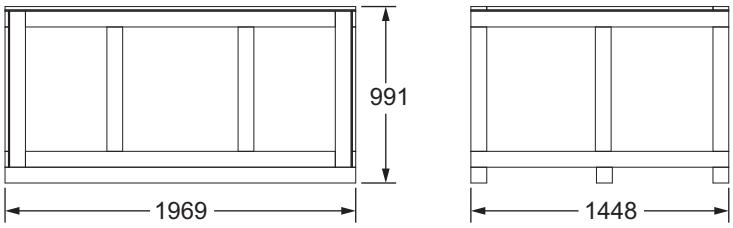
5 Loosen the strap securing the protective wood on top of the Docking Target. Once the strap is loosened, remove the protective wood along with the strap.

6 Loosen the bolts nuts attaching the wooden board to the base pallet. Unstrap the protective foam and remove the wooden board.
Take care not to damage or scratch the copper charging pads while removing the wooden board.

7 Using the handles on each end, lift the Docking Target and place it on the floor.
After the Docking Target is placed on the floor, the procedure is complete.

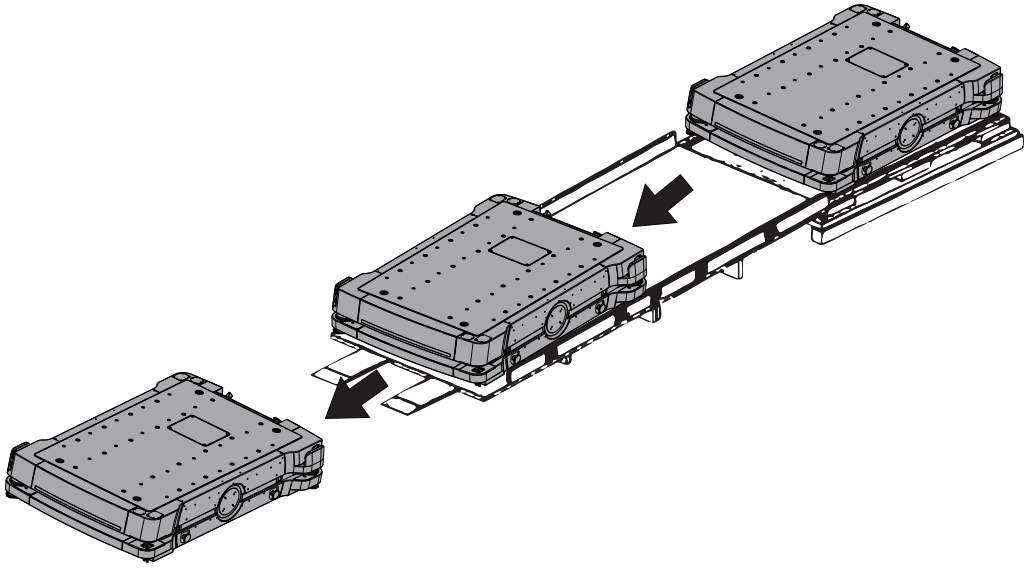
A-1-4 AMR Shipping Crate Information

The shipping crate with the AMR weighs a total of 739 kg. The overall dimensions are provided below.



AMR Unpacking Procedure

The AMR is secured to a base pallet with straps. Ramps are included so that the AMR can be driven from the base pallet to the floor.



Before beginning this procedure, there must be at least 7 m of open area in front of the AMR shipping crate for unloading purposes. There must be 2 m of open area behind the AMR shipping crate to allow the housing to be pushed back.

Use the following procedure to unpack the AMR from its shipping crate.

⚠ WARNING

Do not attempt to lift the AMR from the bottom with a forklift or similar devices. Doing so could damage the AMR.

The following tools and equipment are required for this procedure.

- Personal Protective Equipment including eye protection, toe protection, and gloves.
- Pendant for driving the AMR.
- An unpacked and charged battery.
- 13 mm socket.
- Impact driver.
- Pry bar.
- Safety box cutter.

1 Remove any weatherproof film or plastic sheet material wrapped around the shipping crate using a safety box cutter.

2 Remove the 4 screws along the bottom of the sides of the crate, near the bottom edge, using a 13 mm socket and impact driver.
These screws attach the housing to the base pallet.

3 Remove three screws on the bottom of the front panel using a 13 mm socket with impact driver.

4 Remove the metal clips attaching the front panel to the housing crate using a pry bar.

5 Remove the front panel from the crate.

6 Remove the carton containing the accessories or optional devices and set it aside.

7 The AMR crate contains two ramps located on the top section of the crate. Pull the ramps out of the crate (two people required) and place them on the floor. Use the ramp handles located on each side of the ramp to carry them.
The first ramp is located on top of the second ramp.

8 Support bars are located on the underside of the ramps. Rotate them to the upright position to support the weight of the AMR when it is on the ramp.

9 Position the first ramp over the edge of the crate.

10 Position the second ramp so it is aligned with the first one. Connect and secure the two ramps using the locking clips on the sides.

11 Two ramp transitions are provided that reduce the ledge at the end of the second ramp. Position them so they lay flat on the floor.

12 Remove the housing crate using at least two people by pushing it backwards away from the ramp to expose the AMR.

13 Two shipping bars are fastened to the top of the AMR and straps secure them to the base pallet. Loosen the straps and move them away from the AMR.

14 Unscrew and remove the wood bars used to secure the AMR to the pallet.

15 Install a charged battery.
Refer to *3-3 Battery Installation Procedure* on page 3-9 for more information.

16 After the battery is installed, turn ON the AMR and then use the Pendant to drive the AMR down the ramp.
The AMR will travel in the forward direction as it exits the crate.
Guide lines are present on the ramps. Use these to keep the AMR on the correct path as it travels down the ramp. The path is not centered on the ramp in order to keep the front Low Laser away from the edge. Align the front Low Laser with the guide line below it to ensure that the AMR travels down the ramp successfully in a slow and controlled manner.
Refer to the following information.
- *A-1 Unpacking* on page A-2
- *4-2 AMR Start-up* on page 4-4
- *4-20 Pendant Operation* on page 4-42

After the AMR has been driven down the ramp and is located on the floor, this procedure is complete.

A-2 Parts List

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

Item	Sub-assembly	Part Number	Details	Included
Light disc	LED mount plate	68121-107	The printed circuit assembly and the light strip mount on the LED mount plate.	Yes
	Diffuser plate	68121-104	Light ring diffuser plate.	
	LED strip	68124-000	LED light strip, RGB.	
	Printed circuit assembly	68122-000	LED differential receiver.	
Light strip	Light strip holding bracket	68125-111	This fastens the light strip in place.	Yes
	LED strip	68124-000	LED light strip, RGB.	
Operator Panel		68150-000	The Operator Panel includes a screen, an E-STOP button, ON and OFF buttons, a brake release button, Pendant port, Maintenance Ethernet Port, and a main disconnect switch.	Yes
Side Laser communications extension cable (1 m)		22115-000F		No
Side Laser communications extension cable (2 m)		22117-000F		No
Side Laser power extension cable (1 m)		22800-000F		No
Side Laser power extension cable (2 m)		22802-000F		No
Wireless antenna		68530-401	Antennas for wireless Ethernet connection.	Yes
Wireless antenna extension kit		68955-000	Includes the following items: • Two coaxial cables (2 m), female to panel-mount male. • Two coaxial cables (0.6 m), female to panel-mount male. • Two dipole antennas.	No
Power Supply Box		68310-000	Includes the electrical access panel.	Yes
Docking Target		68910-000	Includes mounting hardware.	Yes
Docking Target Mounting Brackets		68910-105	Single bracket for fastening Docking Target to a wall or the floor.	Yes
Charging power cord		68915-225L	4 m in length. Contact your local OMRON representative for replacement details.	Yes
AMR charging contact replacement kit		68129-120	One set of replacement charging contacts for the AMR. Set includes springs, contacts, charging leads, and housings. Two sets are required when replacing upper and lower charging contacts.	Yes
Battery pack		68330-000	Battery pack assembly.	Yes
AMR skins	Front skin	68125-000	Front skin assembly.	Yes
	Rear skin	68126-000	Rear skin assembly.	Yes
	Side skin, left	68121-000	Left side skin assembly.	Yes
	Side skin, right	68123-000	Right side skin assembly.	Yes

Item	Sub-assembly	Part Number	Details	Included
Docking Target mounting brackets		68910-105	Eight are supplied with the Docking Target.	Yes
Safety Laser Scanner (front)		22160-000F	Pre-configured Safety Laser Scanner for front position.	Yes
Safety Laser Scanner (rear)		22159-000F	Pre-configured Safety Laser Scanner for rear position.	Yes
Lifting hardware kit		68000-890	Includes the following items. • 4 eye bolts • 4 lifting straps (1.2 m)	Yes
SCPU Jumper		68410-218L	For use when no user-supplied safety devices are present.	Yes
Top plate		68110-106	The AMR is initially ordered with or without the top plate.	- - -

A-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.

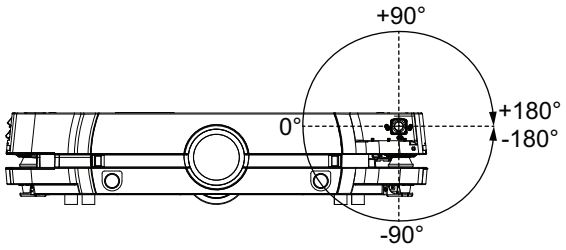
Use the information below to manually configure a Side Laser.

You must enable Laser_5 and Laser_6 using MobilePlanner.

The first set of parameters to adjust are in the **Robot Physical** section. Laser_5 parameters are associated with the front, right Side Laser and Laser_6 parameters are associated with the rear, left Side Laser. These parameter details are provided below.

- *LaserAutoConnect*
  This should be enabled and indicates to the system that the laser exists and it should be connected at start-up.
- *LaserX*, *LaserY*, and *LaserZ*.
  These values indicate the physical 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.
  LaserX is the x-axis (front-to-rear) distance in mm of the laser center to the AMR's center of rotation.
  LaserY is the y-axis (side-to-side) distance in mm of the laser center to the AMR's center of rotation.
- *LaserZ* is the z-axis (vertical) distance in mm of the laser center to the floor.
- *LaserIgnore*
  This value indicates the sensor scanning radial range and can be used to specify the range in degrees for unused (ignored) segments of the Side Laser scanning field. Readings inside these angles will be ignored. The format for the angles is startangle1: stopangle1, startangle2: stopangle2. Example values would be -20:-180, 45:180. You must also consider the scanning field orientation and whether the laser is tilted when calculating the ignored field segment. This area should be modified so that the laser does not sense parts of the AMR. Zones entered here will be excluded from the scanning area.
  Default settings when the Side Laser is mounted on the AMR are as follows.
  - Laser_5: -135° to 90°
  - Laser_6: 90° to 135°

  The Side Laser has a maximum scanning field that spans 270° of arc. However, the usable portion of this scanning arc depends on factors such as the physical location of the Side Laser on the AMR, or whether the scanning field is blocked by the payload structure or the AMR structure. Use the *LaserIgnore* parameter to identify and exclude the ignored segment of the scanned field, so that the AMR does not process data for objects detected in the ignored field segment.
  The following considerations apply to the calculation of the ignored field segment.
  - The degrees of arc is based on the AMR's coordinate system, and not on the Side Laser's angular range. You specify the arc values in the ranges of 0° to +180° and 0° to -180°.
  - 0 degrees specifies the AMR's forward direction of travel.
  - The value for an ignored segment cannot span +180° and -180°. To ignore a ten degree segment between +175° and -175°, you must specify two ranges: -175° to -180°, and 180° to 175°. Specifying the range of -175° to 175° results in the AMR Controller ignoring a 350° segment, counterclockwise from 175° to -175°.



- *LaserTh* is the angular difference between the forward direction of the laser and the AMR's X-axis. Adjust this parameter if the Side Laser's 0° reference is not at the AMR's forward direction when mounted.
- *LaserType* should be set to tim551 unless otherwise requested.
- *LaserPortType* should be set to tcp.
- *LaserPorts* should be set to 169.254.20.30 for Laser_5 and 169.254.20.31 for Laser_6.
- *LaserIsTilted* should be selected to designate that the lasers are side-mounted and will scan vertically.
- *LaserIsTiltedNegativeSensor* should be disabled.
- *TiltedFlipped* designates that the laser is inverted and will scan vertically. Make this selection only for Laser_6.
- *Cumulative* parameters may need to be modified in select cases. These can be found in the **Laser_5 Tilted** and **Laser_6 Tilted** section in MobilePlanner.
  Sensor readings are often held on the map so that the AMR remembers an obstacle even when it cannot be actively seen. The length of time that the AMR will remember these readings is *MaxSecondstoKeepCumlative*. In dynamic environments where the AMR will be encountering many obstacles, but many open paths for the AMR exist, this value should be about five seconds. If your environment has a restricted number of possible AMR paths, this number should stay relatively large, such as thirty seconds, so that the AMR does not rediscover the same obstacle multiple times. Contact your OMRON representative if you have difficulty adjusting these parameters for your environment.
  - *FloorAllowedHeight*, *FloorAllowedAngle*, *CeilingAllowedHeight*, and *CeilingAllowedAngle* parameters, in conjunction with the values of the *LaserZ* and *LaserTh* parameters, allow the AMR to filter out the readings from the ceiling and the floor so that they are not detected as obstacles. The *CeilingAllowedHeight* (in mm) must be larger than the overall height of the AMR (including the payload structure). The *FloorAllowedHeight* and *FloorAllowedAngle* parameters should only be adjusted if the lasers detect too many false positives from the floor. Before adjusting these floor parameters, you should physically adjust your laser to make sure its orientation and position matches the configuration set in the *LaserZ* and *LaserTh* parameters.

After each laser is configured, ensure that the laser designated to be on the left side is physically mounted on the left side of the AMR. Confirmation can be made by turning OFF one of the lasers using the *LaserAutoConnect* parameter and then checking the laser readings in MobilePlanner.

A-4 Input and Output Control

The AMR has built-in digital and analog 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. 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 Access Panel. 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 of 192.168.251.X. The NX102 IP address is 192.168.251.1.

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.

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