MUL
TECHNOLOGIES ®

MARC® 4475

MARC® 4470

User's Guide

Mobile Autonomous Robotic Cart
4 Series Model 4470 and Model 4475

MūL TECHNOLOGIES ®

Congratulations – and thank you!

MARC® is made by the highly experienced team at MūL Technologies® – manufacturers who want to bring autonomous mobile robots (AMR) that make practical sense to warehousing, manufacturing and logistics companies.

MūL Technologies' approach to AMR is different: We take commercial off-the-shelf (COTS) components and add minimum custom hardware to create intelligence/movement. MARC is the most cost-effective autonomous material handling solution on the market.

Finally, "the rest of us" have an affordable way to get all the benefits of AMR.

Thanks again – and know we are here for you!

Sincerely,
The MūL Technologies team.

PLEASE READ THIS ENTIRE MANUAL BEFORE USING MARC. IT CONTAINS CRITICAL INFORMATION ON USING MARC SAFELY AND BEST PRACTICES FOR A SUCCESSFUL IMPLEMENTATION.

DESIGNED & MADE IN USA MūL Technologies Products are proudly designed and manufactured in the United States.

Table of Contents

Packing list

- MARC cart
- 20Ah Battery (packaged separately)
- Battery keys (in battery packaging)
- Battery charger
- User's Guide (this document)
- Quick Start Guide

System overview

Power Button

EZ-Go Navigation™

Battery Lock / Switch

Battery Charging Port

Proximity Sensors (x16)

LED Indicator Lights

Proximity Sensors (x16)

High Resolution 3D Depth Camera (x2)

Emergency Stop Button
(Shown below)

Drive wheels

Robotic Cart Platform
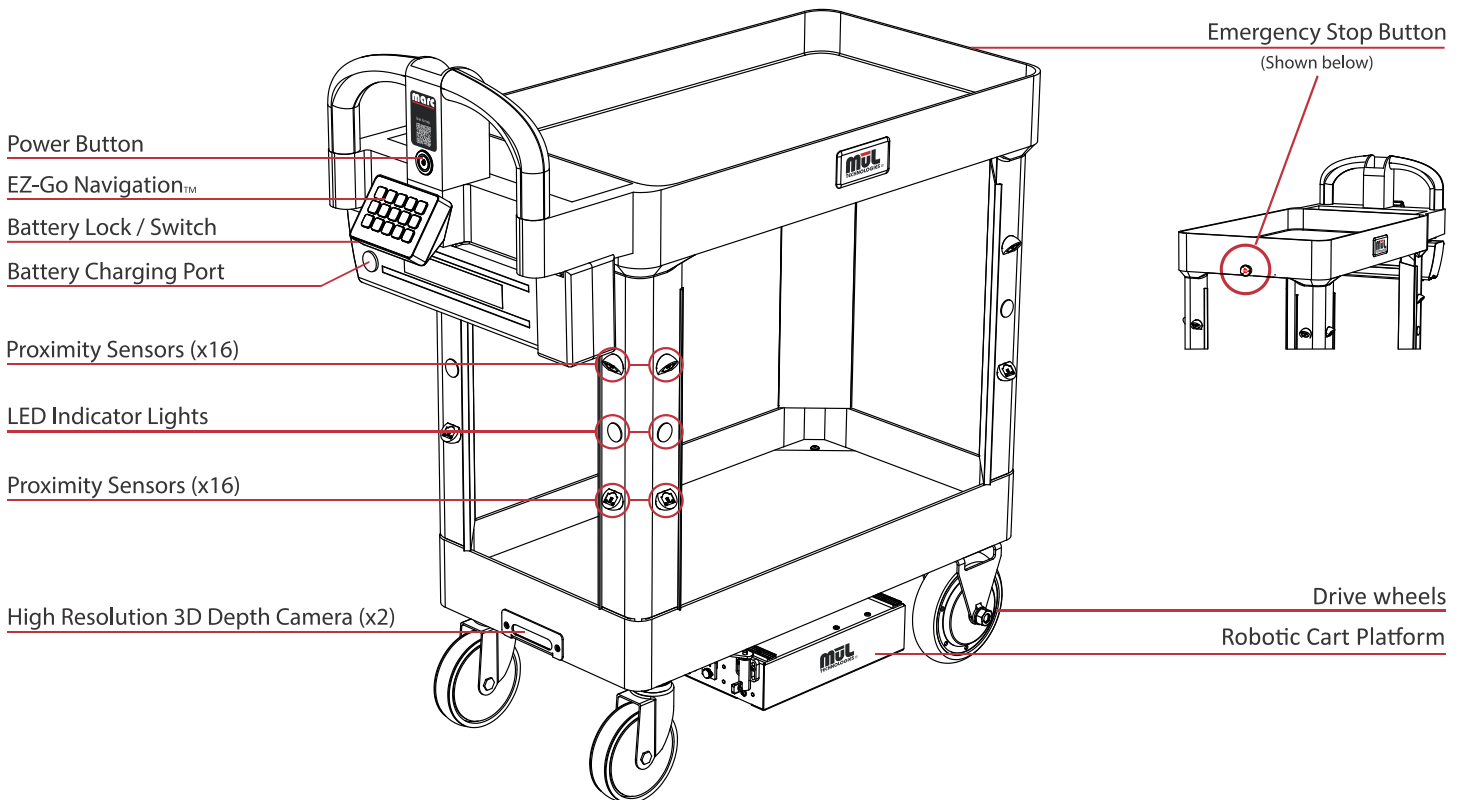
Where to find additional resources

Additional resources for MūL Technologies MARC systems can be found in a variety of places.

Item	Location / description	QR code (if applicable)
Product documentation (including User's Guide)	www.multechnologies.com/documentation	
Contact the MūL Technologies support team	Visit our web site: multechnologies.com Reach out to the team: support@multechnologies.com or by phone at 262-242-8830 Mailing address: MūL Technologies 10202 North Enterprise Drive Mequon, WI 53092	
MARC system FAQs	www.multechnologies.com/faq	
MARC online assistance	www.multechnologies.com/support	

Understanding the safety information in this document

MARC has been developed to be simple and safe to use. Please make sure anyone who will be in the area where MARC robots are in operation has read and understands all the safety information before working with or around the autonomous carts.

Symbol	Meaning
⚠ DANGER	Indicates a potentially hazardous situation that could result in death or severe personal injury if proper precautions are not taken.
⚠ WARNING	Indicates a situation that could result in personal injury or damage to the equipment if proper precautions are not taken.
⚠ CAUTION	Indicates a situation that could result in property damage if proper precautions are not taken.
ⓘ INFO	Indicates generally useful information, tips and best practices to assist user with the setup, operation and maintenance of the equipment, including MARC systems and battery packs.
⚡ DANGER	Indicates danger of electrical shock. Please use extreme caution when working with lithium-ion batteries. Always disconnect power before contacting any electrical components.
⚠ CAUTION	Indicates components with potential for damage from electro-static charges. Always use caution when handling ESD sensitive parts.

Important safety information

Table of important safety information

General hazards	

⚠️ **WARNING**	• Always maintain a safe distance from MARC when in motion. You risk being hit, run over, or trapped if you do not maintain a safe perimeter during operation.
	• Human traffic must yield right-of-way to MARC autonomous products.
	• Ensure proper mounting of loads during use. See **Loading MARC safely** on page **32**.
	• Danger of personal injury from overturning robot or falling load.
	• All accessories and loads mounted on top of the robot should be fastened correctly and meet specifications.
	• Do not drive vehicle irresponsibly.
	    o There is danger of personal injury and/or damage to the robot.
	    o The robot should not be driven over edges or in other ways operated irresponsibly.
	• Always maintain a minimum 3-foot distance from MARC when robot is in motion.
	• Do not use the robot to transport people
	    o There is risk of personal injury and/or damage to the robot.
	    o This will revoke compliance with the standard **EN 1525 Safety for Unmanned Trucks**.

⚠️ **CAUTION**	• Indoor use only
	    o The robot is made for indoor use only and should never be used outdoor.
	• Avoid small objects on the floor in the robot's area.
	    o There is risk of property damage and/or damage to the robot.
	    o The robot cannot detect some obstacles at a height of .75" (20 mm) or lower and may run over small objects. It is designed to detect and avoid obstacles taller than 1.5".
	    o For obstacles in between .75" and 1.5", it may depend upon the material, size, and color of the obstacle if the robot will identify it or not.
	• The robot should not be moved to a different floor of your facility. If you are using MARC on the first floor and transport it to another floor, it will not be able to navigate properly. Always reset the destinations and create a new map when using on a different level.
	• The robot will go around objects that are not part of the map, but this may influence the efficiency of the planned route.
	• The ambient temperature in the robot's environment must be between 5°C / 41°F and 50° C / 122°F for operation of the robot or charging the battery pack.
	• Avoid exposure of the robot to excessively humid or extremely dry environments.
	    o The ambient humidity in the robot's environment must be within 0˜85% RH (without condensation).
	• This equipment is not intended for use by persons (including children) with reduced physical, sensory, or mental capabilities, or lack of experience and knowledge, unless they have been given supervision or instruction concerning use of the appliance by a person responsible for their safety. Children should be supervised to ensure that they do not play with MARC. Failure to do so may cause an accident or injury.
	• Certain reflective objects can confuse the laser system and can cause the product to think there is an object in its way when there is not. These objects can include items with a chrome finish, mirrored surfaces, and other similar objects with a highly reflective finish.

ℹ️	• Only operate on even, clean and dry surfaces.
	    o Avoid gradients (ramps etc.) on the route.
	    o There is risk of personal injury and/or damage to the robot.
	    o Wet and uneven surfaces may cause the robot to skid.
	• Do not overload the robot.
	    o There is risk of personal injury and/or damage to the robot.
	    o The maximum payload for MARC:
	        ▪ In autonomous operation: 110 kg or approximately 250 lbs combined across both shelves.
	        ▪ In manual push mode: 225 kg or approximately 500 lbs.
	    o Individual shelves must never be loaded over 55 kg or approximately 125 lbs.

	o If exceeded, it may cause overturning, falling load and damage to the robot.
	   o See also **Loading MARC safely** on page **32**.
	• Turn off the main power and remove battery before attempting any troubleshooting or repair.
	• While mapping do not push the cart at speeds greater than 1.3M/second (3 MPH) to allow for accurate data.
	• Do not use the cart to tow or push any other item.
	   o For example, do not attach a trailer, broom, or plow to the cart.
	• Do not try to manually push or move the cart in any way while it is moving on its own.

Lithium-ion battery use, storage and safety

Lithium batteries are power sources with high energy content and are designed to represent the highest possible degree of safety.

	Potential hazards
⚠️ WARNING	Lithium-ion battery packs may get hot, explode, or ignite and cause serious injury if they are abused electrically or mechanically. Observe the following precautions when handling using and storing lithium-ion batteries: • Never leave power on to battery when not in use. • Never short-circuit or connect loads other than the intended system to the battery. • Do not connect with false polarity. • Do not expose to temperature beyond the specified temperature range or incinerate the battery. • Do not crush, puncture, or disassemble the battery. The battery contains safety and protection devices, which, if damaged, may cause the battery to generate heat, explode or ignite. • Do not allow the battery to get wet. • In the event the battery leaks and the fluid gets into a person's eyes, do not rub the eye. Rinse well with water and immediately seek medical care. If left untreated, the battery fluid could cause damage to the eye. • Use only the original charger, and always follow the instructions from the battery manufacturer. • Disposal: The U.S. Environmental Protection Agency (EPA) does not regulate the disposal of batteries in small quantities. While there are no federal regulations for disposal of lithium-ion batteries, many individual states or localities have established their own guidelines for battery disposal and should be contacted for any disposal guidelines that they may have.
⚠️ CAUTION	Lithium-ion batteries are presently the most commonly used energy storage devices on motorized equipment. Learning how to maintain lithium-ion batteries can not only prolong battery lifetime but also protect your device from potential damage. • **Charge new batteries** It is not necessary to charge over 12 hours when first used. When a device powered by batteries is purchased, sellers will usually tell us the batteries must first be charged 12 hours before using. This is unnecessary. Unlike common Ni-CD or Ni-MH batteries, most lithium-ion batteries are activated before leaving the factory. Due to their low self-discharge, it is unnecessary to charge lithium-ion batteries for such a long cycle when new. Lithium-ion batteries are ready for use when the charger indicates so, and they will reach their best capacity after 3 or 5 charge/discharge cycles. • **Use appropriate chargers** When choosing a charger, original MūL Technologies chargers are the best choice. A low quality or inappropriately rated battery charger can lead to shorter run times, premature battery failure, or even fire or explosion. • **Avoid overcharging** Over charging may let the battery's interior rise to a high temperature which is bad for both the battery and the charger. Simply charging to 'full' is good enough and will increase the life of the battery and charger. • **Avoid touching metal contacts** All contacts on batteries need to be kept clean for best performance. When carrying batteries around, do not let the contacts touch metal objects such as keys; this could cause a short circuit, damaging the battery or potentially resulting in a fire or explosion. • **Avoid using often in high or low temperature environments** Lithium-ion batteries have optimal working and storage temperatures. If they're continually used in extreme temperature environments, this will negatively affect battery use time and useful life.

Intended use of MARC carts

The MūL Technologies MARC autonomous cart products are tools that help you optimize efficiency. MARC eliminates the steps taken that add no value while working alongside employees. They are not intended to be used in any manner outside the scope of this manual. The below list provides general example use applications. It is limited and should not be considered comprehensive.

All MARC systems are intended to be used in indoor industrial environments where access for the public is restricted.

The MūL Technologies MARC system is designed;

- for indoor use only.
- for use only on solid, stable, non-moving areas. It is not designed for ships, moving vehicles or similar modes of transportation.
- for climate-controlled areas between 41°F and 122°F (5°C and 50°C).
- for use in dry conditions only.
- for use in areas where the floor is free of objects smaller than 1.5" (40mm) from ground level.
- for use on flat, level, surfaces with no ramps, inclines or transitions.
- to carry only non-liquid materials.
- to carry only non-hazardous materials.
- to operate in areas with at least 24" clearance on both sides for a total width of approximately 6 feet. Aisles or paths with a width less than 6 feet may prevent proper path planning and cause MARC to abandon its route.

One of the most important steps in achieving a safe installation of any autonomous robot is to complete a thorough risk assessment. Since every facility presents unique issues and risks, it is critical that the individual or organization that is implementing MūL Technologies MARC automated products complete this assessment based on their own facility.

Considerations for this assessment include in part;

- foot traffic and moving equipment must maintain a minimum 3-foot distance from autonomous MARC products when robot is in motion.
- human traffic must yield right-of-way to MARC autonomous products.
- low hanging objects or obstructions that are above the sight line of MARC.
- small items on the floor that may be missed by MARC's sensors.
- high value items that are transported by, or in the area of, MARC products.
- dangerous materials transported by, or in the area of, MARC products.
- placement of ladders, scaffolds, metals carts or similar equipment in the robot's work environment.
- consideration of the general environment for safety issues prior to deploying MARC products.

We recommend that guidelines in ISO 12100, EN 1525, ANSI B56.5 or other relevant standards be used to complete the risk assessment. EN 1525, clause 4 contains a list of significant hazards, hazardous situations and events which can be used as further reference for consideration.

MARC products must not be modified in any way. MūL Technologies will not be responsible for damage caused by products that have been altered or modified in any way.

MūL Technologies cannot be held responsible for any damages caused to MARC products or accessories, or any other equipment due to programming errors or malfunctioning of MARC robots.

MARC 4 Series features overview

MARC robots have been developed with simplicity in mind.

| #	Feature
1	Power button (also serves as emergency power-off button)
2	15-button EZ-Go Navigation panel
3	Battery assembly (including ON/OFF key switch)
4	Proximity sensors (16 total, 4 each side)
5	LED status indicators (8 total, 2 each leg)
6	High resolution 3D depth camera (2 total – front and rear)
7	Free turning rear wheels
8	RCP (Robotic Cart Platform) module
9	Drive wheels
10	Emergency stop button (on front of cart – not shown in image)

System and sensor overview

Combination of 3D cameras, lasers and proximity sensors create a complete view

- Two high resolution 3D depth cameras allow MARC to build accurate maps, see at extreme angles, and operate safely.

- LIDAR scans the environment in real-time to build a completely independent map that is used to navigate through an ever-changing facility.

- 16 proximity sensors create an anti-collision system with 360° view of the area near the cart.

- Internal 3-axis digital gyroscope combined with a 3-axis accelerometer for measuring tilt, acceleration, and shock.
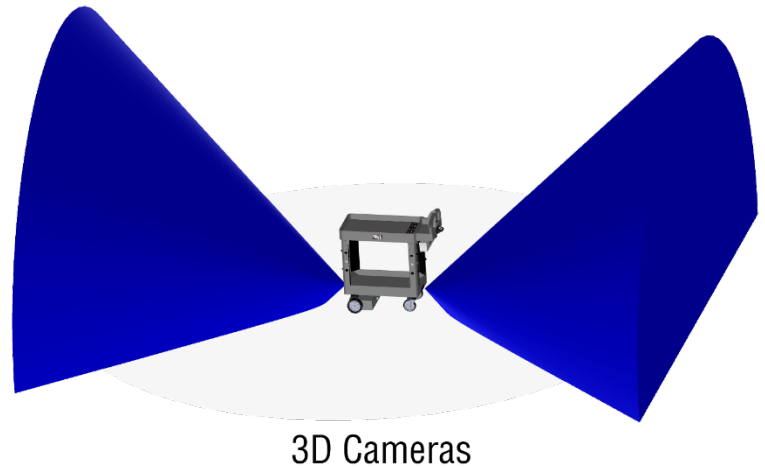
3D Cameras

Sensor parameters

- • LIDAR scans 360° at 16000 samples per second measuring at a distance of 25m with 1° angular resolution and 2mm distance resolution.

- 16 proximity sensors with 1m range and 1mm distance resolution.

- 3D camera with up to 1280 × 720 active stereo depth resolution at up to 90 fps.

- Active IR stereo depth technology with a field of view of 87°±3° × 58°±1° × 95°±3°.

Proximity Sensors

Laser Scanner
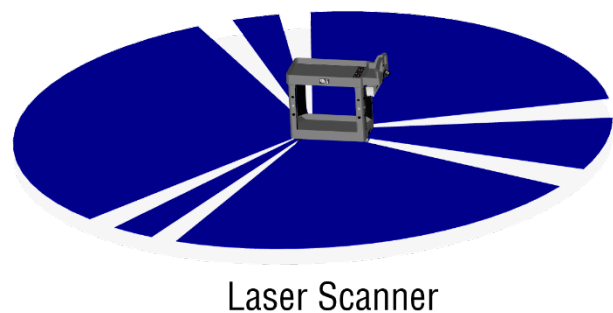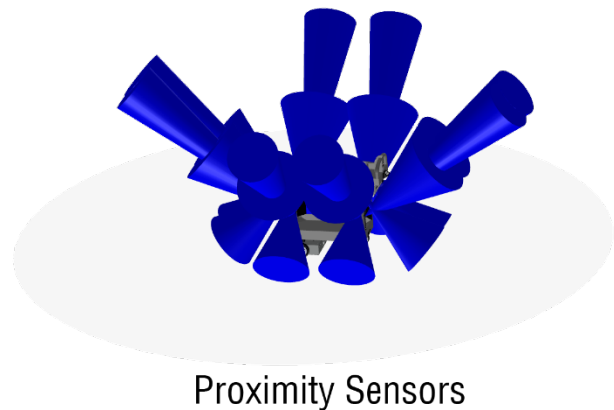
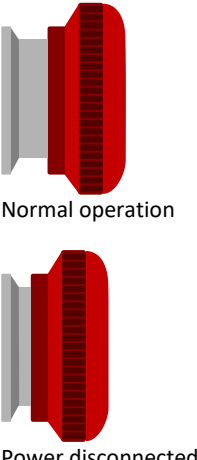# Unpacking and getting started

	Remember to retain all the original packaging and shipping materials for MARC. These materials have been custom made to ship MARC units and are the best option for any future shipping needs of the system to avoid damages during shipment.

1. Place the unit on flat, solid surface with space to move around the package.

2. Cut the plastic straps holding the top corrugated cover and discard.

3. Using two people, lift the corrugated cover upward and remove.

4. Loosen and remove the 2 ratcheting straps holding MARC to the pallet.

5. Using two people, lift MARC upward and remove from pallet.

6. Unbox the battery (packaged separately), making sure to remove the keys from the packaging.

    o Battery may need to be charged before use, please see **Charging the batteries** on page **29**.

    o Insert key and verify the battery remains in the unlocked position (#1 below).

    o Slide the battery onto the rails on the system battery holder (#2) and push till engaged.

    o Turn the key to the "On" position (#3).

        ▪ This will lock the battery in place and offer power to MARC.

        ▪ To move from unlocked position to "Locked with power off" position, it is important to push the key inward slightly and then release slowly while turning the key to the next position.

    o For additional information, see **Inserting the battery pack into MARC** on page **31**.
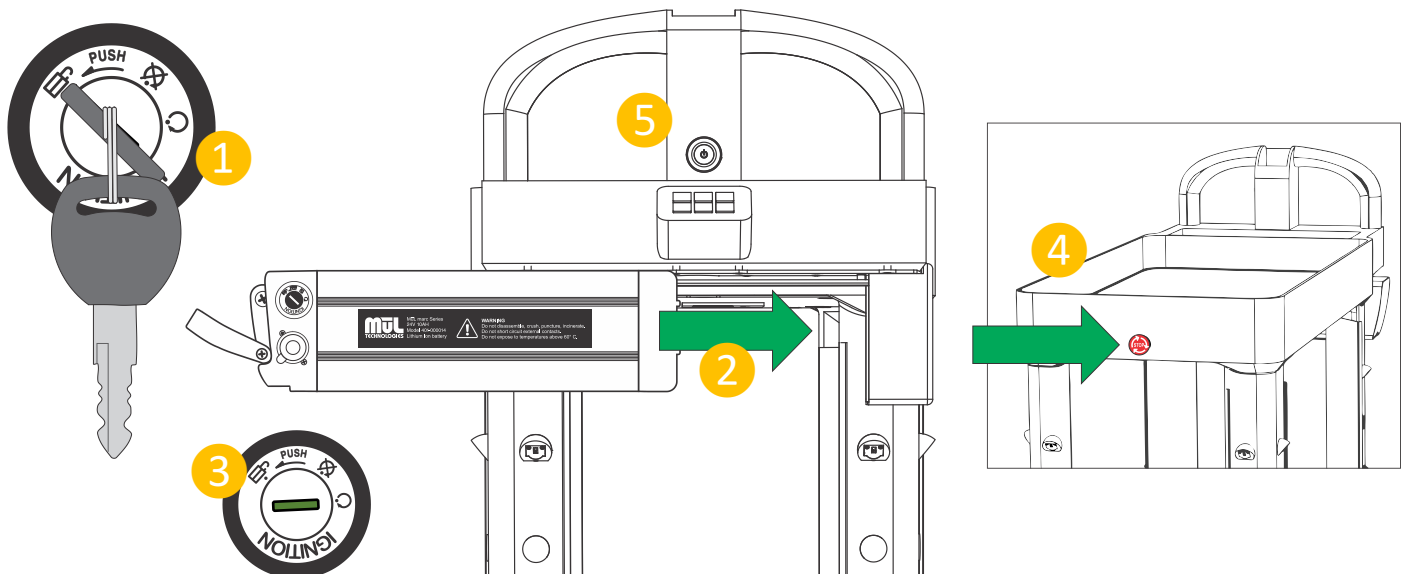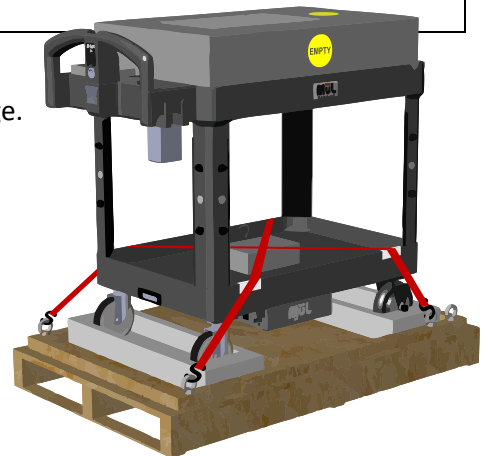
7. Verify the Emergency Stop button (#4 above left) is not engaged. This can be found at the front of the cart (the end away from the handle). If engaged, turn the button in the direction of the arrows to reset – the button will pop out when disengaged.

|	
	The emergency stop button is located on the end of the cart opposite the handle. This button is used to shut MARC off immediately when activated.
  Normal operation Power disconnected	The emergency stop button is activated when pushed inward. The upper image on the left shows the button from the side when in a normal state. The lower image shows the button in an activated, or off state. The cart will not operate with the emergency stop button activated.

8. **Note that boot time can be as long as 2 minutes** and is complete when the audio cue "Cart ready" is heard and the indicator LEDs are pulsing green.

9. **You are ready to use MARC!** Please read and understand this manual before use – while operation is simple, it is important to understand how MARC works. Continue next page to program your first locations.

|	
  INFO	MARC should not be moved while it is starting up. The cart is ready for use when the cart announces, "Cart ready" and the LED indicators illuminate in a pulsing green pattern.
	As a best practice, move the cart to the area you wish to use MARC before powering up. This will reduce the amount of unnecessary mapping the system saves, since the mapping is constant while on.
	For additional tips on using MARC, see section What to expect during normal operation**What to expect during normal operation** on page **22**.
	Each end has an emergency power-off option – the front has the red emergency stop button and rear the has the power button which also immediately powers down the unit.
	Note that any time MARC is powered off in Active Map Mode, it will need to be reprogrammed. For information on operating modes, see **Operating modes: Active Map and Fixed** on page **20**.

Programming your first destinations

Now that you're ready to roll, let's give MARC a try!

1. If cart is booted up and ready, go to step 5.
2. Turn the key switch to ON position.
3. Press power button. If the cart does not power up, verify the emergency stop button is not engaged and disengage if needed (rotate clockwise with arrows until it pops out).
4. Wait for MARC to boot up, up to 2 minutes.
   - Cart is ready when audio cue "Cart ready" is heard and indicator LEDs are pulsing green.
   - Wherever MARC is physically located will be the destination when a button is programmed.
   - Speed between locations can be a normal walking speed (up to 1.3 m/second or 3MPH) or less.
   - Start and end points should be a minimum of 1m (3 feet) from all stationary objects.
   - Entire route should include 6 feet of available space.
5. Press and hold any un-programmed station key (grey) for 3 seconds until you hear the double-beep sound.
   - In this example, we used "3." Station button will turn green, indicating programming completed.
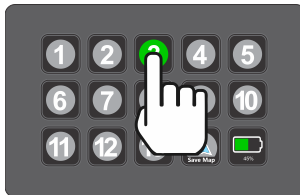
TIP: If you see the second screen, press the battery level button to return to the first screen with station buttons.
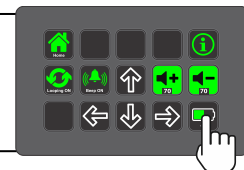
6. Using the handle, manually push the cart to a second location you wish to program as a destination.
7. Press and hold any un-programmed station key (grey) for 3 seconds until you hear the double-beep sound.
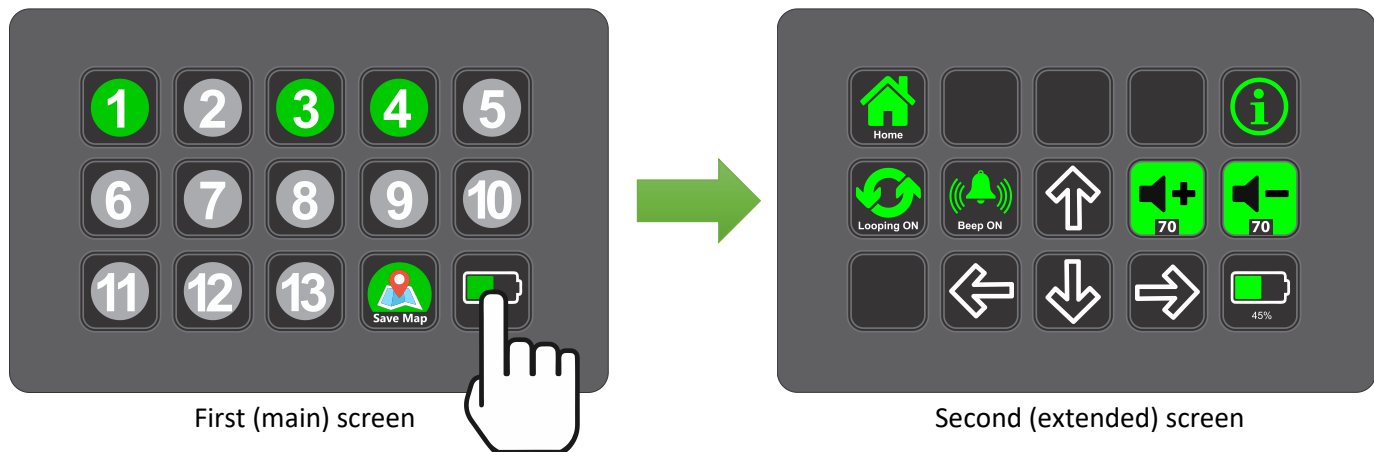   - Use any unused station key 1-13 (in this example, we used "1").
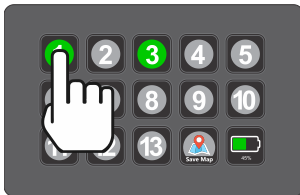
That's it! You have programmed MARC for 2 destinations in Active Map Mode and can put him to work. Press the station button for each programmed key (in our example 1 and 3), and MARC will travel to the location programmed for that button.
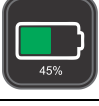
Additional tips:
- In Active Map Mode, MARC does not retain information when powered down or restarted.
- This section describes Active Map Mode. You can also use MARC in Fixed Map Mode if you plan to use MARC in a specific area. See **Operating modes: Active Map and** Fixed on page **20** for more information.
- You can add a new destination at any time using any additional un-programmed station button.
- MARC will prioritize the path you took when programming destinations.
- You can *re*-program any station button by moving the cart to a new destination and pressing a pre-programmed button (green) for 3 seconds and the current location replaces the previous destination.
- You can also remove a destination from a button without programming a new one. Hold the programmed button (green) 6 seconds until you hear a triple-beep. The button will turn grey and will not be associated with a destination.
- In Active Mapping Mode, you can also move your MARC system to any additional, non-programmed locations (for example, to get inventory items from shelves), and then tap one of the pre-programmed buttons to send MARC back to that location.

For detailed information on using the EZ-Go Navigation panel, see **EZ-Go Navigation system overview** on page **18** or Error! Reference source not found. on page Error! Bookmark not defined..

EZ-Go Navigation system overview

First (main) screen   Second (extended) screen

3 (grey)	Station buttons 1-13 display in grey when they are *not* programmed for a specific destination. Press and hold a grey button until you hear the double-beep indication (approximately 3 seconds) to program that station with the unit's current location. The button will then turn green indicating it is programmed.
1 (green)	Station buttons 1-13 display in green when they are programmed for a specific destination. Tap these buttons to send the unit to its destination designated for the specific number pressed. **CLEARING:** If you wish to clear a set location for a station button, press and hold the button for more than 6 seconds but less than 10 seconds until you hear the triple-beep indication. When released, the button will return to a grey color. **REPROGRAMMING:** If you wish to set a programmed button to its current location, press and hold the button for approximately 3 seconds until you hear the double-beep indication.
5 (blue)	Station buttons are Blue when the cart is in Looping Mode. For more information on Looping Mode, see **Operating modes: Looping Mode** on page **22**.
(battery 45%)	Under normal operating conditions, the bottom right button is reserved to display the battery's current charge status. This button also allows users to switch between the first and second screens.
Save Map	The Save Map button is used to save or erase the currently mapped area and also used to indicate the current map status. The button appears grey if there is currently not a saved map (Active Map Mode) and green when a map is saved (Fixed Map Mode). To save a map, press the button for 3 seconds till the double-beep confirmation is heard. The button will turn green and the audio cue "Map saved" will be heard. To erase the currently saved map, press the map button for 6 seconds but less than 10 seconds until you hear the triple-beep tone. The button will turn grey, indicating the map has been erased, and the audio cue "Map erased" will be heard. When a map is not saved (Active Map Mode), turning the cart off or rebooting will cause the currently mapped area to be deleted from the system. See **Operating modes: Active Map and** Fixed on page **20** for more information.
Home	The Home button allows for realignment of the mapped area in the instance that MARC becomes disoriented or is 'lost'. This can happen in a variety of scenarios, including for example the cart hits a wet slippery spot on the floor that causes the wheels to slip. To tell MARC that it is in the Home location, press and hold the button for 3 seconds till you hear the double-beep tone. This will allow the map to realign to a known point of origin. To learn more about using the Home functions, see the section titled **Using the Home Button** on page **23.**

Looping ON / **Looping OFF**	To turn Looping Mode on, press and hold the Looping Mode button for 3 seconds till you hear the double-beep tone. The icon will turn green to indicate is has been activated. To turn looping mode off, press and hold the button for more than 6 seconds until the triple-beep sound is heard. The icon will turn grey to indicate Looping Mode has been deactivated. For detailed information on using MARC carts in looping mode, see the section **Operating modes: Looping Mode** on page **22**.
(Info icon)	The Info button displays pertinent system information. When pressed it cycles through software version (2.1.3, for example), the model number (4470, for example) and the system level serial number.
Beep ON / **Beep OFF**	MARC carts offer a safety beeping option, which is heard while MARC is moving in autonomous mode. This beeping, similar in sound to a traditional forklift, is a double-beep active while in motion to warn workers nearby that the cart is in motion. Note the volume is increased and decreased using the volume buttons that control the audible system notifications and both are adjusted together. Warning beeps can be enabled or disabled using the single button, and current status is displayed on the button as shown to left. To turn the beeping on, press and hold the button for 3 seconds till you hear the double-beep tone. The icon will turn green to indicate is has been activated. To turn of the beeping, press and hold the button for more than 6 seconds until the triple-beep sound is heard. The icon will turn grey to indicate beeping has been turned off.
(Volume buttons, 70)	The volume (+) button increases the volume in increments of 10%, and the volume (–) button decreases volume in increments of 10%. When in the main screen showing the programmed location buttons, tap the battery level button on the lower right to access the second screen with the volume adjustment buttons.
(Directional arrow buttons)	Powered Assist manual drive buttons allow the user to operate the cart manually. The buttons will move the cart in the direction shown when pressed. **Use caution, as during manual movements the safety features of the cart are disabled**. When in the main screen showing the programmed station buttons, tap the battery level button on the lower right to access the second screen with the manual drive buttons. For more information on using manual movement, please see **Powered manual movement mode** on page **26**.
	⚠ **DANGER** **WARNING: All safety features are disabled while using the powered manual movement mode.** Operator is responsible for safe movement of MARC in *any* manual movement mode. Great care must be taken while using powered manual movement mode.
(Yellow check engine)	A yellow check engine symbol indicates there is an urgent issue with the cart. It is still possible to operate the cart, but the issue should be addressed as soon as possible. For more information, see **Troubleshooting** on page **37**. Press the battery level indicator button to return to the main screen.
(Red check engine)	A red check engine symbol indicates there is a critical issue with the cart. Autonomous mode and powered manual drive mode are both disabled when there is a critical issue. For more see **Troubleshooting** on page **37**.

(i) **INFO**	Tapping any button during movement will cancel the route. If you tap the wrong location, for example, you can immediately press any key to abandon the route and then press the correct location button.

Operating modes: Active Map and Fixed Map modes

MARC carts operate in two distinct mapping modes. It is important to understand the differences between these modes to ensure the most value for your unique scenario. Below is a comparison chart, followed by an overview of each mode.

Depending on how you plan to use each MARC, you have options to most efficiently leverage the benefits of automation that will help save you the most time possible. Each mode of operation is described below.

Active Map Mode Overview

While in Active Map Mode, all areas MARC travels through will be added to its internal map. This means there are no 'predefined' areas where the unit is required to operate within.

In Active Map Mode, MARC units will not remember mapped areas when they are powered down. This includes during a battery swap. To save the map, the Save Map button should be used, which then puts MARC into the Fixed Map Mode.

Fixed Map Mode Overview

Fixed Map Mode is the most efficient option when you plan to use MARC in a consistent area and can leverage the saved map for that area.

While in Fixed Map Mode, MARC units must be kept in their mapped area. If they are removed from a known mapped area, the "Out of mapped area" audio cue will be heard.

Once MARC is in Fixed Map Mode, the map will become saved permanently (until an "Erase Map" process is executed or the software is updated). Additionally, the unit must now remain in the currently mapped area while operating, or the message "Out of mapped area" will be heard and the cart will need to be returned to the mapped area for use.

Optionally, the map can be erased, returning MARC to Active Map Mode. In this case, the mapping process must be redone.

 	The Save Map button is used to save the currently mapped area and used to indicate the current map status. The button appears grey if there is currently not a saved map (Active Map Mode) and green when a map is saved (Fixed Map Mode). To erase the currently saved map, press the map button for 6 seconds but less than 10 seconds until you hear the triple-beep tone. The button will turn grey, indicating the map has been erased, and the audio cue "Map erased" will be heard. When a map is not saved (Active Map Mode), turning the cart off or rebooting will cause the currently mapped area to be deleted from the system. See **Operating modes: Active Map and** Fixed on page **20** for more information.

Mode Comparison Chart

	Active Map Mode	Fixed Map Mode
Ability to save map (move to Fixed Map Mode)	X	
Ability to retain map on power-off or restart		X
MARC can only be used in mapped area		X
Quickly use cart in varied areas – shared usage	X	

Using MARC in Active Map Mode

 MARC defaults to Active Map Mode from the factory and is indicated by the Save Map button appearing grey. Active Map Mode will remain in effect until the Save Map button is used to save a map. This results in the mode of operation moving from Active Map Mode to Fixed Map Mode.

Adding a new destination while in Active Map Mode.
- Simply add the desired destination to an unused station button or reprogram an existing station button. Press the desired station button until you hear the double-beep confirmation tone.

Saving a map (move to Fixed Map Mode)
- Press and hold the Save Map button until you hear the double-beep confirmation tone. MARC will also announce "Map saved". It may take some time to save the map depending on the size of the map. If you press a button during saving process, an audio cue will prompt "Saving map."

 Do not move the cart while the map is being saved, as MARC is not actively mapping during the Map Save process. This will likely cause mapping errors and the appearance of a malfunctioning or lost cart.

Once you save a current map, you will be in Fixed Map Mode.

Using MARC in Fixed Map Mode

 Whenever a map is saved (Save Map icon is green as shown), MARC is in Fixed Map Mode. Fixed Map Mode will remain in effect until the Save Map button is used to erase a map or the software is updated. This results in the mode of operation moving from Fixed Map Mode to Active Map Mode.

Adding a new destination while in Fixed Map Mode.

- If the desired destination is within the area that has been mapped, you can simply add it to an unused station button or reprogram an existing station button. Press the desired station button till you hear the double-beep confirmation tone.
- To add a new point outside of the existing map, MARC will need to be reprogrammed by erasing the map (moving to Active Map Mode) and remapping the area to include all desired locations and then saving the map (moving to Fixed Map Mode) after the mapping of the entire area is complete.

Moving MARC outside of mapped area in Fixed Map Mode.

- If MARC units are moved outside of the mapped area, the announcement "Outside mapped area" will be heard repeatedly until MARC is back in the existing mapped area.
- If MARC is moved outside of its mapped area while off, the announcement "Outside mapped area" will be heard repeatedly until MARC is back in the existing mapped area while MARC is in a ready state.
- Once MARC is moved back into the existing mapped area, it will become operational and the announcement "Outside mapped area" will no longer be heard.

Operating modes: Looping Mode

MARC carts can operate in a mode where it moves from location to location automatically. In this mode, all preprogrammed destinations are shown in blue. The cart will move through all locations in sequential order without user intervention. The cart will wait at each location for 60 seconds. To send the cart to the next destination sooner, the button for the next destination can be pressed.

 While the cart is in Looping Mode, programmed buttons appear blue. Animated icon indicates next destination.

 The Looping Mode button is found on the second screen. Tap the battery status button to access the second screen.

	Looping mode is activated using the Looping Mode button on the second screen, which can be accessed by tapping the battery status button in the lower right. To activate Looping Mode, press and hold the button till the double-beep audio cue is heard. When the button is released, the looping icon will turn green to indicate Looping Mode is activated. The programmed destination buttons on the first screen will turn blue (instead of green) to indicate to operators that the cart is in Looping Mode and will operate automatically.

To disable Looping Mode, press and hold the button till the triple-beep audio cue is heard. The Looping Mode icon will turn grey to indicate Looping Mode is not active and the audio cue "Looping mode paused" will be heard. Note also that saved location on the first screen will turn green, indicating the cart is programmed but not in Looping Mode. |
| | Station buttons that are programmed appear Blue when the cart is in Looping Mode. Looping mode will automatically move the next destination after one minute. 5 seconds before the cart resumes movement to the next destination, the audio cue "Going to next destination" will be heard. To decrease the wait time, press one of the blue buttons to send the cart to the pressed station and continue operating in looping mode. |

Tips for using Looping Mode

- If the unit arrives at one of its loop locations, it will be still during the waiting period. If you wish to send the cart to its next location before the timer expires, simply tap the next button in the process. The cart will then announce "Calculating", followed by movement and the announcement "Looping mode enabled".
- While in Looping mode, the current route can be cancelled by tapping any button on the EZ-Go navigation panel. This will also pause Looping Mode, and the audio cue "Looping mode paused" will be heard. If the cart was in waiting mode, the animated icon will change to solid blue. To restart Looping Mode, press the button of the next destination to restart Looping Mode. Audio cue "Looping mode started" will be heard and the route reinstated.
- If any button is tapped while the cart is moving between locations, Looping Mode will be paused and the audio cue "Looping mode paused" will be heard. The cart will remain still until the next desired location button is pressed which reinstates Looping Mode.
- While in looping mode, the cart will travel to the destinations that are programmed in a sequential order.

Using the Home Button

On occasion, like any autonomous robot, MūL robotic carts can become disoriented. This typically happens because of carts being moved while they are powered off – mapping cannot be done while power is off or the battery removed, and the cart is not actively mapping. Someone, for example, may move the cart during a battery swap. It is also possible that the battery was completely discharged while in use and then moved to a different location with the newly charged battery.

In these instances, the Home button can function as a 'reset' to a known location.

If your cart becomes disoriented, you can often resolve this by 're-homing' the cart in its known home location.

	The Home button can be accessed on the second screen, which can be accessed by tapping the battery status button in the lower right. Once the cart is moved to the known Home location, press and hold the Home button till you hear the double-beep confirmation. The cart should now be correctly reoriented.

A few things to note about the Home functionality:

- The Home is automatically set when the cart is booted initially in Active Mapping Mode, which means prior to saving the map (moving to Fixed Map Mode). Once the unit is in Fixed Map mode, the Home location is saved and will remain consistent.
- The physical Home location cannot be changed once it has been set, which is automatic.
- Note that any time a map is erased, Home will automatically be set for the exact location the cart is in when the erase process has fully completed.
- Be sure not to move the cart during the boot-up process.

A tip for using the Home button functionality is to create a known 'parking spot' for a specific cart and use that as the physical Home location. Then, if the maps need to be realigned, the cart can be brought to that specific location (including orientation) and the Home button pressed for 3 seconds until the double-beep confirmation and audio cue "Homing" is heard.

TIP: For best results using the Home function, we suggest that you create a 'parking spot' for your robot. This will allow for simple use of the Home functionality. Remember to have the cart parked when it is initially booted (in Active Mapping Mode) to set the Home location. Note that orientation should be consistent as well.	

What to expect during normal operation

MARC products were designed to take extremely complex technology and make it simple. The simplicity allows users to easily and quickly engage the use of these carts and speed adoption. This will help MARC products offer an ROI at a much quicker pace.

Here are some things to expect during normal operation and best practices.

- The cart will show white LEDs in the direction it is travelling (similar to headlights) and red LEDs in the opposite direction (similar to taillights). Once the cart has arrived at a destination, the LEDs return to pulse green.

- In environments that change often you may find Active Map Mode will perform better as in this mode the mapped area is continuously updating.

- MARC units are capable of navigating through some narrow passageways, but it is recommended that the minimum width of open space along the entire programmed path be at least 6 feet.

- The cart may speed up and slow down frequently when travelling between destinations. This is normal behavior as the mapping and route planning software is continuously looking for the best possible route. The cart may also back up, rotate and/or turn around during normal operation.

- The cart will prioritize the path that was used during programming. If you have an area that you prefer the cart to avoid, do not use that path during the mapping (programming) process.

- If the cart is sent on an incline of more than 10°, the tilt sensor will automatically stop motion and wait for user intervention. This is by design and is a safety feature. An over-tilt red check engine light will be displayed until the user moves the cart back to a flat surface.

- The cart has been programmed to come within 1 meter of the destination. Within the 1m arrival, orientation of the cart may be different than when it was initially programmed.

- If the cart encounters an obstacle that blocks its path, the tone will be heard as it attempts to recalculate a path.

- If the cart cannot reach its destination and is prevented from progressing anywhere in its path for more than 45 seconds, the cart will indicate that it has abandoned its route. The cart will announce "Route abandoned" and the indicator LEDs will pulse orange. The audible announcement will repeat every 30 seconds until the condition is resolved by the operator. The numbered station button will flash indicating the desired destination.

- If the battery is low, the cart will indicate the current levels as follows:

  - For battery voltages below 20%, it will say "Battery low" and will repeat this message every 30 seconds.

  - For battery voltages below 10% the indicator LEDs will cycle between red, green and blue and the cart will continue to announce "Battery low." Note that other indication colors and sequences will not be shown when the critical battery status is reached.

  - In both battery warning states, the cart can still be used. When the battery is completely discharged, the cart will shut down completely.

  - Pressing the battery button for more than 3 seconds will silence the battery low audio cues.

  - When MARC is powered down in Active Map Mode, destination and mapping information will be lost. Rebooting MARC in Active Map Mode, including after changing the battery, will require remapping and saved destinations to be reprogrammed.

- The cart will generally not explore unknown areas. However, you may find the cart will take a path to a destination you were not expecting. If during the scanning of your facility the cart senses an alternative path that has been mapped is shorter, it may take that path.

- When multiple MARC units are in the same area, you may notice they occasionally interact strangely. This is normal behavior since both are considered dynamic obstacles and are trying to avoid each other in a safe manner.

Best practices and general tips for smooth operation

MARC products were designed to take extremely complex technology and make it simple.

Mapping tips:

- When mapping a new area (Active Map Mode), it is beneficial to 'close the loop' and return to the same point mapping began. This allows for a more accurate map. MARC's software will be able to reference that initial point to straighten any areas that may have shifted during the mapping process.

- When initially mapping an area (Active Map Mode) and planning to save the map (Fixed Map Mode) for use in a single area, it is best not to have temporary objects in the area. Once the map is saved, those temporary items will be part of the permanent map. This may include, but not limited to, pallets of good, parked or stationary forklifts, moveable staircases, similar large items, and people walking near the cart.

- When in Active Map Mode, be sure not to push MARC at speeds greater than 1.5m/sec (5mph) to avoid gaps in the map creation.

- When pushing the cart in Active Map Mode, only push from the handle side. Pushing from other sides can cause lower sensor visibility and result in a reduced quality map.

- When setting destinations, position the cart at least 1m (3 feet) away from any obstacle. This will generally prevent an abandoned route when returning to that destination.

- Never manually move or push the cart while it is moving autonomously, as this can cause the wheels to slip and thus interfere with the mapping process.

General tips:

- If you are using MARC in a specific area (in Fixed Map Mode), it is important not to move MARC outside of that area. You may want to include a 'parking spot' for MARC in the initial mapping to have a consistent place to put MARC when temporarily not in use.

- When in Fixed Map Mode, MARC should not be moved when powered down, as this may cause confusion when the unit is powered back on. This includes during powered-off storage, battery swapping or any other time the unit is powered off or the battery is removed or turned off.

- The area where MARC units are stored should have fixed objects nearby. Since the cart needs to recognize where it is, if the environment has changed while the cart was turned off or rebooted, it may become confused.

- When transporting heavy payloads, the cart may coast a short distance while coming to a stop.

- In large open areas the cart may become disorientated. This may present itself as abandoned route or the cart pausing. Returning the cart to an area with distinct obstacles will allow the cart to orientate itself.

    - Well defined areas include multiple distinct fixed objects, for example an inner walled corner or permanent shelving. More fixed objects will result in better results.

    - In order to match and navigate a mapped area, the cart will need to identify objects nearby. It may require less than 10 feet (3 meters) of distance between the cart and multiple fixed objects to properly orient itself. Large, open areas do not provide sufficient data to recognize its surroundings.

Powered manual movement mode
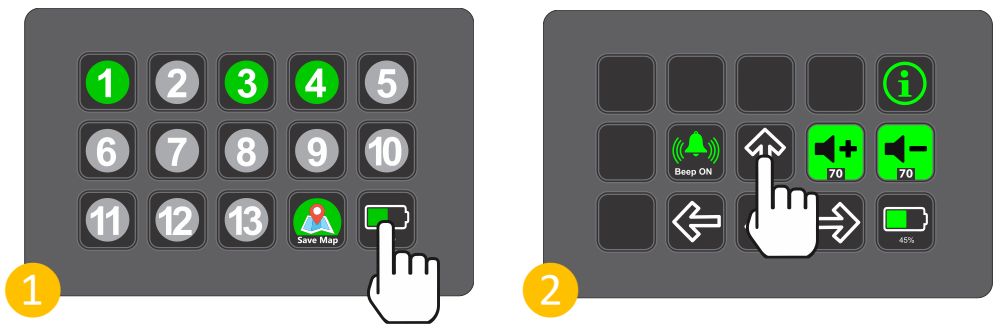

⚠️ **DANGER**	All safety features are disabled while using the powered manual movement mode. Operator is responsible for safe movement of MARC in powered manual movement mode. Great care must be taken while using powered manual movement mode.

Powered Manual Movement mode allows the user to control the cart motion manually if needed. To enter this mode, press the battery level indicator button (❶) from the main screen.

⬅️	Pressing the left arrow turns MARC toward the left until the key is released.
⬆️	Pressing the up arrow key moves the cart forward (away) until the key is released.
➡️	Pressing the right arrow turns MARC toward the right until the key is released.
⬇️	Pressing the down arrow key moves the cart backward (toward) until the key is released.
⬆️ ➡️	It is acceptable to press either a forward or reverse arrow key simultaneously with either a left or right arrow key to move the cart at various angles.
🔋 45%	Pressing the battery level indicator while in powered manual mode returns MARC to the default screen.

ⓘ **INFO**	The sequential beep tones will sound during manual mode. These can be ignored while operating the cart via the arrow keys.

Adjusting the volume
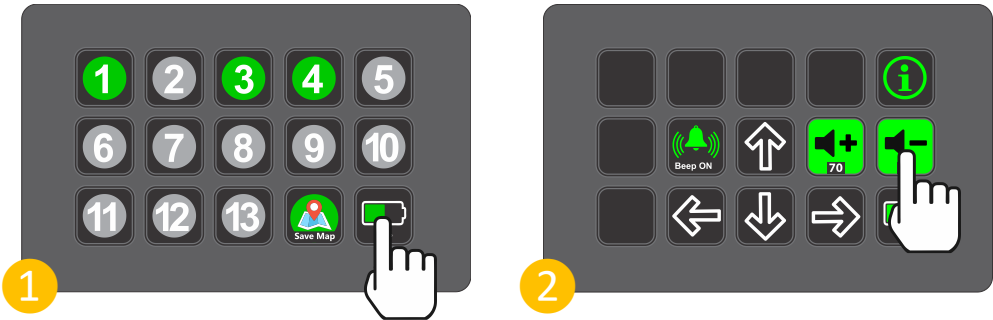
Users can control the cart volume for audio cues. To access the volume adjustments, press the battery level indicator button (❶) from the main screen.

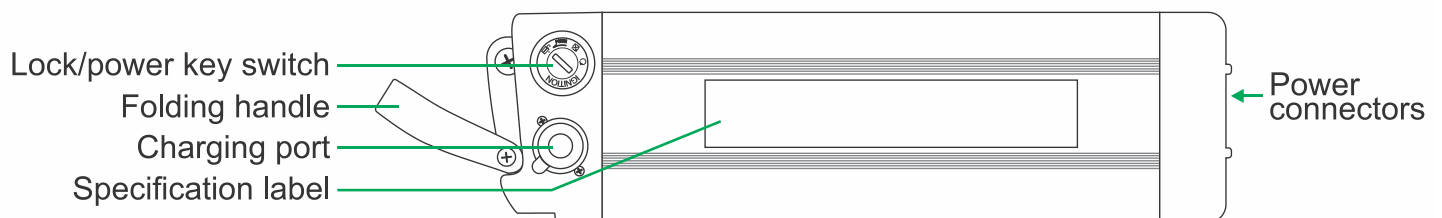|	
	Tap the volume (+) button to increase the volume. The current volume level is indicated in small text at the bottom of the button. Volume indicators are in percentages and increase in 10% increments with each tap.
	Tap the volume (-) button to decrease the volume. The current volume level is indicated in small text at the bottom of the button. Volume indicators are in percentages and decrease in 10% increments with each tap.

Using MARC battery packs

⚠️ **WARNING**	Lithium-ion battery packs may get hot, explode or ignite and cause serious injury if they are abused electrically or mechanically. Observe the following precautions when handling using and storing lithium-ion batteries: • Never leave power on to battery when not in use. • Never short-circuit or connect loads other than the intended system to the battery. • Do not connect with false polarity. • Do not expose to temperature beyond the specified temperature range or incinerate the battery. • Do not crush, puncture or disassemble the battery. The battery contains safety and protection devices, which, if damaged, may cause the battery to generate heat, explode or ignite. • Do not allow the battery to get wet. • In the event the battery leaks and the fluid gets into a person's eyes, do not rub the eye. Rinse well with water and immediately seek medical care. If left untreated, the battery fluid could cause damage to the eye. • Use only the original charger and always follow the instructions from the battery manufacturer.

Lock/power key switch
Folding handle
Charging port
Specification label
Power connectors

⚠️ **WARNING**	To prevent possible damage, use only use genuine MūL Technologies batteries and chargers. Using batteries other than MūL Technologies approved batteries could result in dangerous situations and cause injury or fire. Always use caution when working with batteries.

Charging the batteries

MūL Technologies battery packs and chargers are designed for use in MARC products exclusively. The battery packs are designed to offer many hours of service and have a charging life of over 800 cycles.

(i) INFO	The charging port cover rotates to open. Lifting the cover too high may result in damage. When accessing the port, be sure to lift the cover gently and rotate the port cover clockwise to allow charging cable to be inserted as shown at right.
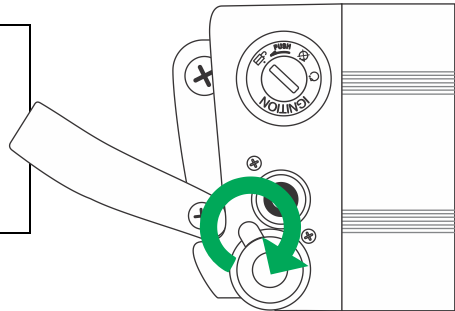
Charging procedure:

1. Verify the charger is not plugged into a wall outlet.
2. Place battery and charger on flat, stable non-flammable surface.
3. Ensure battery is in the OFF position with the key removed.
4. Gently lift and turn the charging access port cover to expose the charging port.
5. Insert the MūL Technologies battery charger connector into the charging port.
6. Plug the charger into a standard wall outlet.
7. Charging is complete when the green LED indicator is on solid.
8. Unplug the charger from the A/C outlet.
9. Remove the charger cord from the battery.
10. Reinstall battery into MARC system.
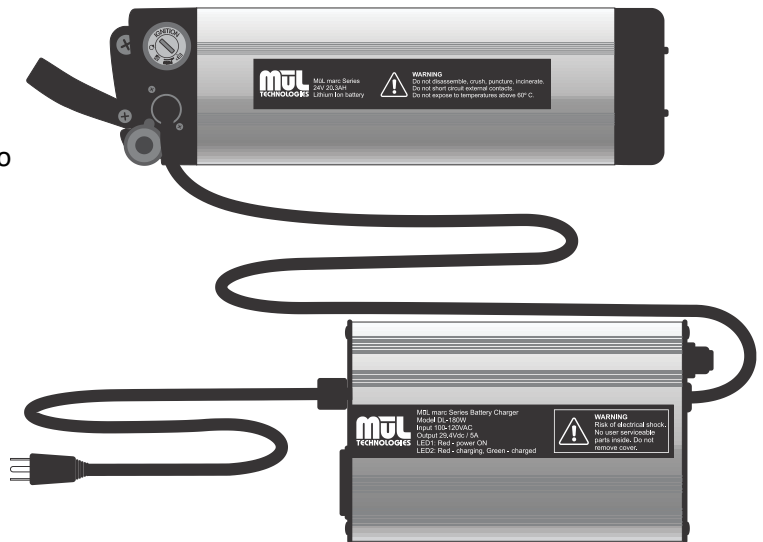
⚠ WARNING	The battery can be charged while installed in MARC. You must ensure that the same steps are followed in order and verify the battery's keys have been removed.
	Always plug the charger cable into the battery port before plugging the charger into an A/C outlet to avoid risk of damage to battery and charger.

Checking a battery's charge level:

The battery charge level indicator can be found on the exposed end of the MūL Technologies MARC battery when installed in MARC. To check if a battery is charged, press the button with the power symbol. While depressed, the charge LEDs will light on the power scale and indicate the battery's current charge level.
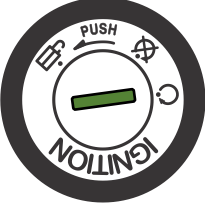
Please note that the status LEDs are not operational while the battery is actively being charged.
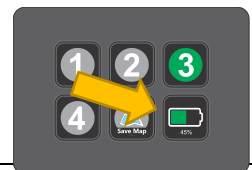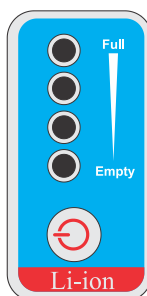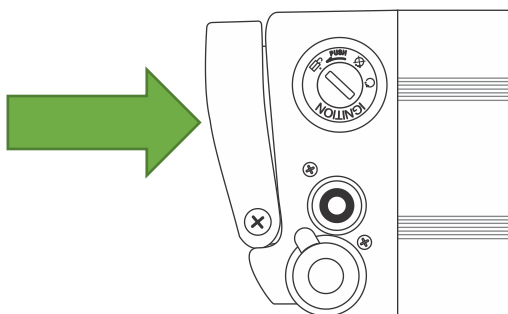
(i) INFO	While MARC is running, the battery status is also shown on the EZ-Go Navigation panel.

# Locking and unlocking battery packs

Using the keyed battery switch:

Unlocked	Indicates the battery pack is ready for removal or insertion. No power is supplied in this position and the battery slides freely into the battery bracket. **NOTE**: To move from unlocked position to "Locked with power off" position, it is important to push the key inward and then release slowly while turning the key to the next position.
NOTE: Push key in	NOTE: To move from unlocked position to "Locked but off" position, it is important to push the key inward and release as the key moves to the next position.
Locked, but off	Battery is inserted and secured in position but is not supplying power. This is the mode the cart can be stored during longer durations of non-use.
Locked and on	Battery is inserted and secured in position and is supplying power to the system. This is the normal setting during use.

## Inserting the battery pack into MARC

To insert a battery pack into MARC, follow these steps:

- Make sure battery is charged. You can check this by pressing the button on the battery level indicator.
  - See **Charging the batteries** on page **29**.
- Ensure the key switch is in the unlocked position. (❶ in figure below).
- Guide the battery slots to the battery rail on MARC and slide in (❷).
- Slide battery until the power connectors are snug.
- Flip the foldable handle upward.
- Turn the key to locked position, being sure to press key in and slowly release it as you turn it.
  - If you are going to use the cart immediately, insert and turn the key to powered **ON** position (❸), and press cart power button to boot up the cart. This process takes up to 2 minutes and ends with an announcement, "Cart ready" and LEDs pulsing green.

  - Leaving the key in the locked-but-off position is appropriate for storage.
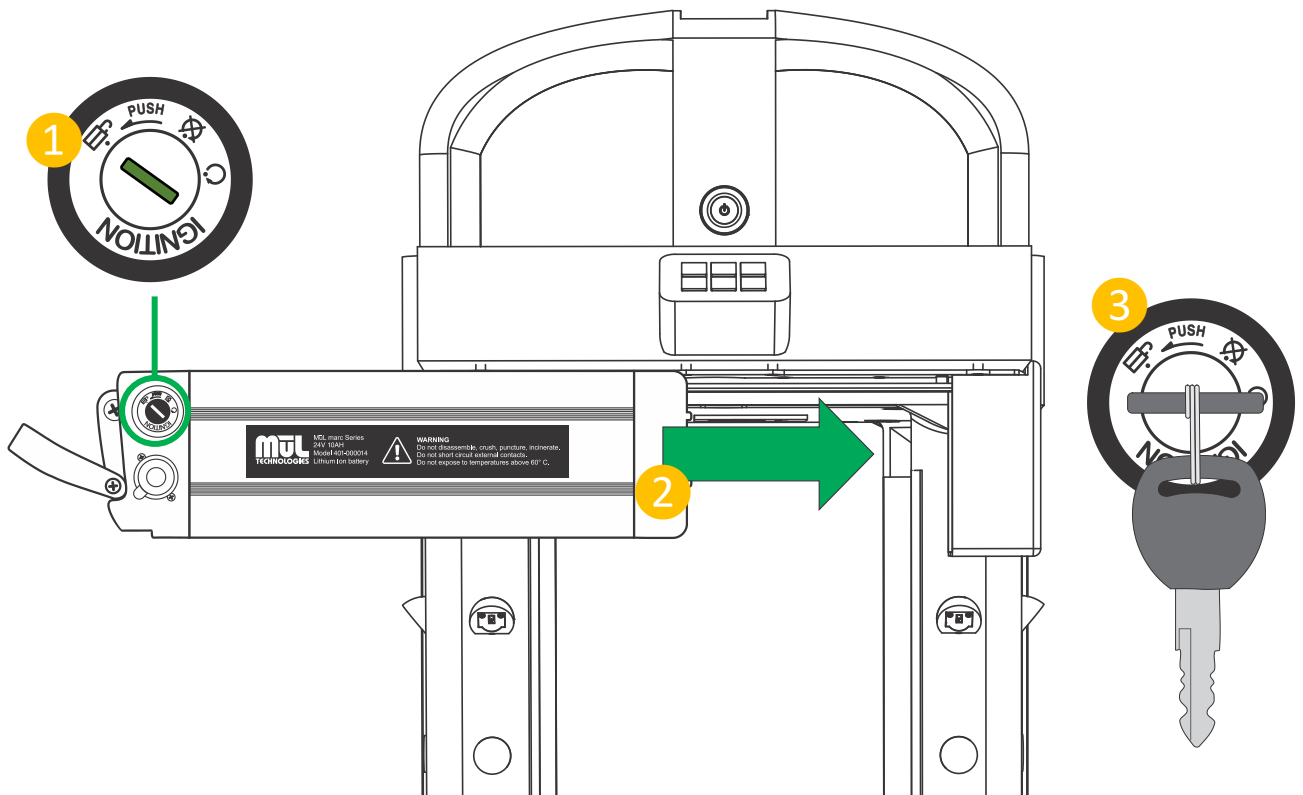
i INFO	Batteries should not be stored in very hot or very cold conditions, or to be subject to conditions of high moisture. They also should not be stored in a fully discharged state.
	Store your battery between 15 °C (59 °F) and 25 °C (77 °F) in a dry area.
	If your battery pack is not in use for an extended period of time, it is imperative that you charge the battery pack before storage and then charge the battery pack once a month to prevent deterioration.

Loading MARC safely
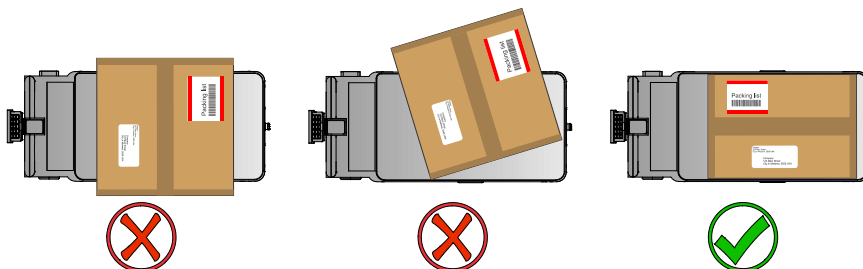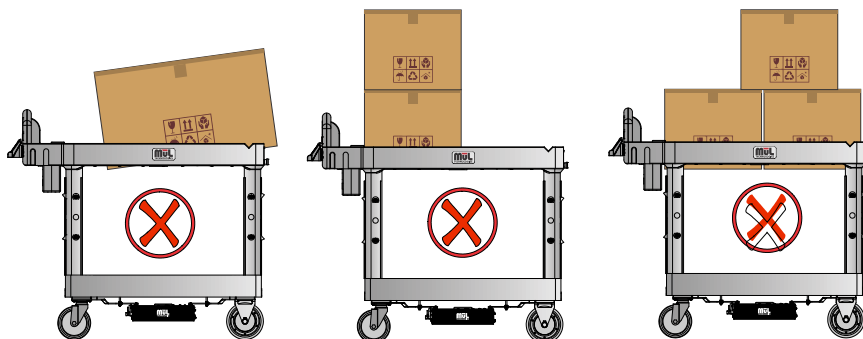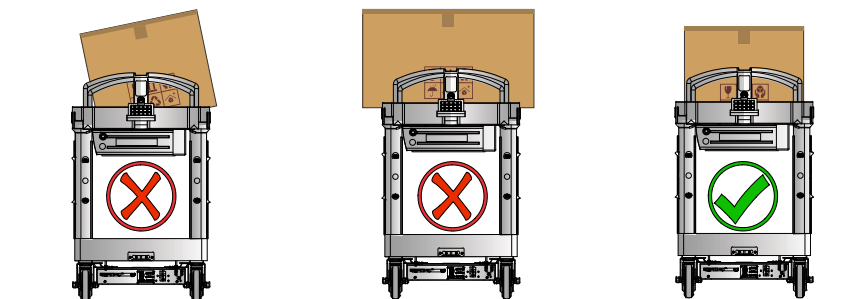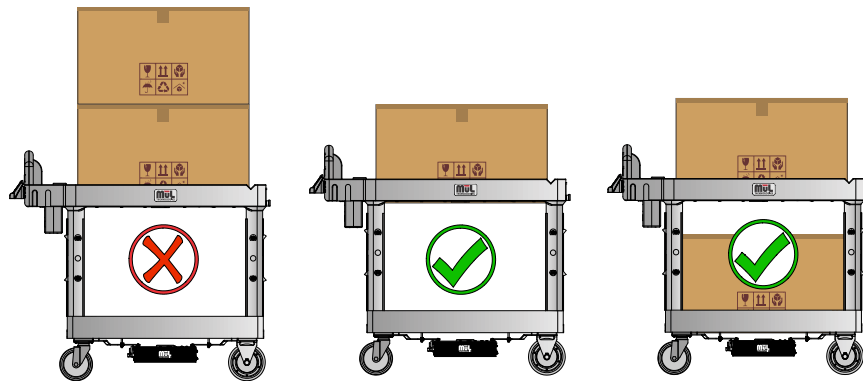
Important loading guidelines:

- Total load should not exceed:

  - 250 pounds / 110 kilograms during autonomous operation.

  - 500 pounds / 225 kilograms during powered manual push mode.

- Tall loads may strike low hanging objects above or become unstable and tip.

- Load height should not exceed 70 cm / 27 inches above surface of top shelf.

- Loads must not overhang the edges of shelf surface in any direction.

- Do not transport items that have the potential to roll or shift during cart movement.

- Always load cart with heaviest load away from handle (toward drive wheels).

- Do not transport hazardous materials.

- Do not transport open liquids.

- Avoid top-heavy loading. Place heavier loads on the bottom shelf.

Table of LED visual cues

	Pulsing green	Ready to accept commands (also lights when MARC arrives at destination).
		Normal movement – Pulsing white means the cart is heading toward you (headlight) while a pulsing red mean the cart is moving away from you (taillight).
	Pulsing orange	Impedance to movement; path blocked, route abandoned. Audio cue "route abandoned" will also be heard repeatedly.
	Pulsing purple	Failed Sensor – single leg shows failed sensor pair.
	Flashing red	Red check engine light, indicating a major failure. Intervention required.
	Solid green	Command Received.
	Solid yellow	System is booting up. Also used to indicate yellow check engine light is active during operation.
	Solid white	MARC is calculating a route.
		Cycling of red-green-blue indicates critical battery charge level (includes audible warnings as well).

Table of audio indicator cues

🔊	Beep	Button tap confirmation (<2 sec). This sound is confirmation every time a button is pressed.
🔊	Double beep	Medium button hold confirmation (2-6 sec) indicating button programming was successful. This applies to all programmable buttons.
🔊	Triple beep	Long button hold confirmation (9+ seconds) indicating removal of current programming of station button. This applies to all programmable buttons.
🔊	"Cart ready"	This audio cue indicates MARC has booted and is ready for use.
🔊	"Calculating"	This audio cue indicates the route is being planned and movement will begin momentarily.
🔊	"Arrived"	Cart has arrived at the destination.
🔊	"Map saved"	Save of the map is complete.
🔊	"Map deleted"	Deletion of the map is complete.
🔊	"Out of mapped area"	MARC is in Fixed Map Mode and is not in the mapped area. See **Operating modes: Active Map and Fixed Map modes** on page **20**.
🔊	"Entering mapped area"	MARC is in Fixed Map Mode and has now been pushed into a previously mapped area.
🔊	"Cannot set destination here"	MARC is in Fixed Map Mode and has been moved out of its mapped area. Destinations cannot be set outside the mapped area.
🔊	"Route abandoned"	Cart was unable to reach the destination. Generally, this would be caused by an object blocking MARC from reaching its destination.
🔊	"Route canceled"	A button was pressed by the operator (cancels process) while the cart was moving toward a destination. In this case, a destination button must be pressed a second time. If a check engine light has been detected during a route, this can also result in the "Route canceled" cue without user intervention. This will then display the cause of the trouble light.
🔊	"Battery low"	Battery charge level is low (repeats in 30 second intervals). Critical battery level also includes LED lights alternating colors (red, green, blue).
🔊	Triple "multi-tone" beep	Obstacle in path or recalculating route to destination.
🔊	"Looping mode started"	
🔊	"Looping mode paused"	For information on using Looping Mode, see **Operating modes: Looping Mode** on page **22**.
🔊	"Going to next destination"	
🔊	"Homing"	Indicates that the Home button alignment process has been initiated. See **Using the Home Button** on page **23**.

Cleaning MARC

MARC systems are made from an extremely durable polypropylene material that will not leak, rust, chip, dent or peel, and will maintain a professional appearance for many years. The RCP unit (drive system) is made from very thick, strong powder coated steel enclosure to ensure protection of the electronics.

⚠️ **WARNING**	There are sensitive electronic components in MARC. • Make sure to disconnect and remove the battery pack prior to cleaning. • Never submerge any part of MARC. • Never spray liquids directly at any parts of MARC. • Never use harsh chemicals to clean any parts of the cart. • Never spray cleaner directly onto any electronic components, including the EZ-Go Navigation panel, sensors or LIDAR unit. Instead, spray a small amount of mild cleaner onto a rag or towel, then gently wipe the surface of the button area with the moist cloth.

Here are some general tips for cleaning your MARC products:

- MARC is not waterproof and should not be sprayed directly or submerged.
- If using a household or industrial cleaner, be sure to test a small area to verify it does not damage the polypropylene material.
- Spray or dip a cloth into the cleaner and wipe the cart with a damp (not wet) cloth.
- For stubborn stains, consider using Mr. Clean Magic Eraser or similar product.
- If the drive wheels of MARC come in contact with liquids or any slippery materials, clean the wheels to ensure MARC will have sufficient traction for the surface it operates on.
- The cameras and proximity sensors may accumulate dust and should be cleaned on a regular basis.

Cleaning the sensors and cameras:

- Air is the best non-contact method for cleaning dust and debris from the sensor and camera surfaces.
- A clean, soft, lint-free cloth can be used to gently wipe sensor and camera surfaces.
- Chemical cleaners should not be used on electronic components or plastic mounting structures.

MARC system dimensions

Small cart dimensions:

Overall width 17.5"

Overall length 43"

Upper shelf inner dimensions 29.75" x 16.75"

Side opening 24" x 19.75"

Lower shelf inside dimensions 29.75" x 15.6"

Total height 41.5"

Ground clearance 2.8"

Large cart dimensions:

Overall width 25.5"

Overall length 47.5"

Upper shelf inside dimensions 36" x 24"

Side opening 29.5W" x 19.75H"

Lower shelf inside dimensions 35" x 23.5"

Total Height 41.75"

Ground clearance 2.8"
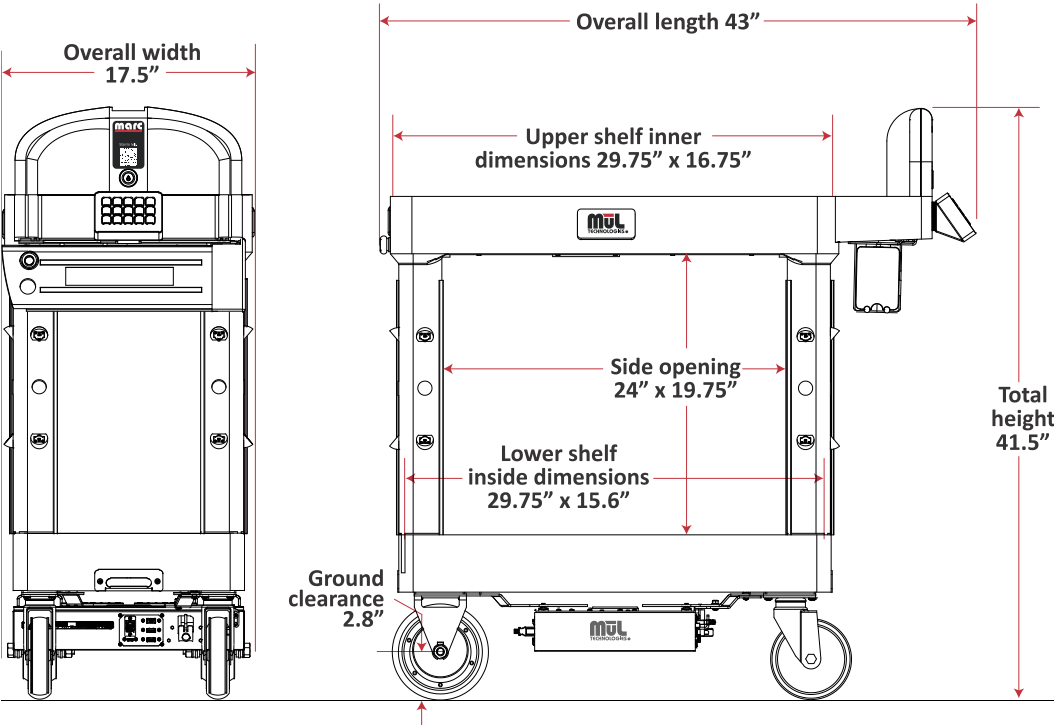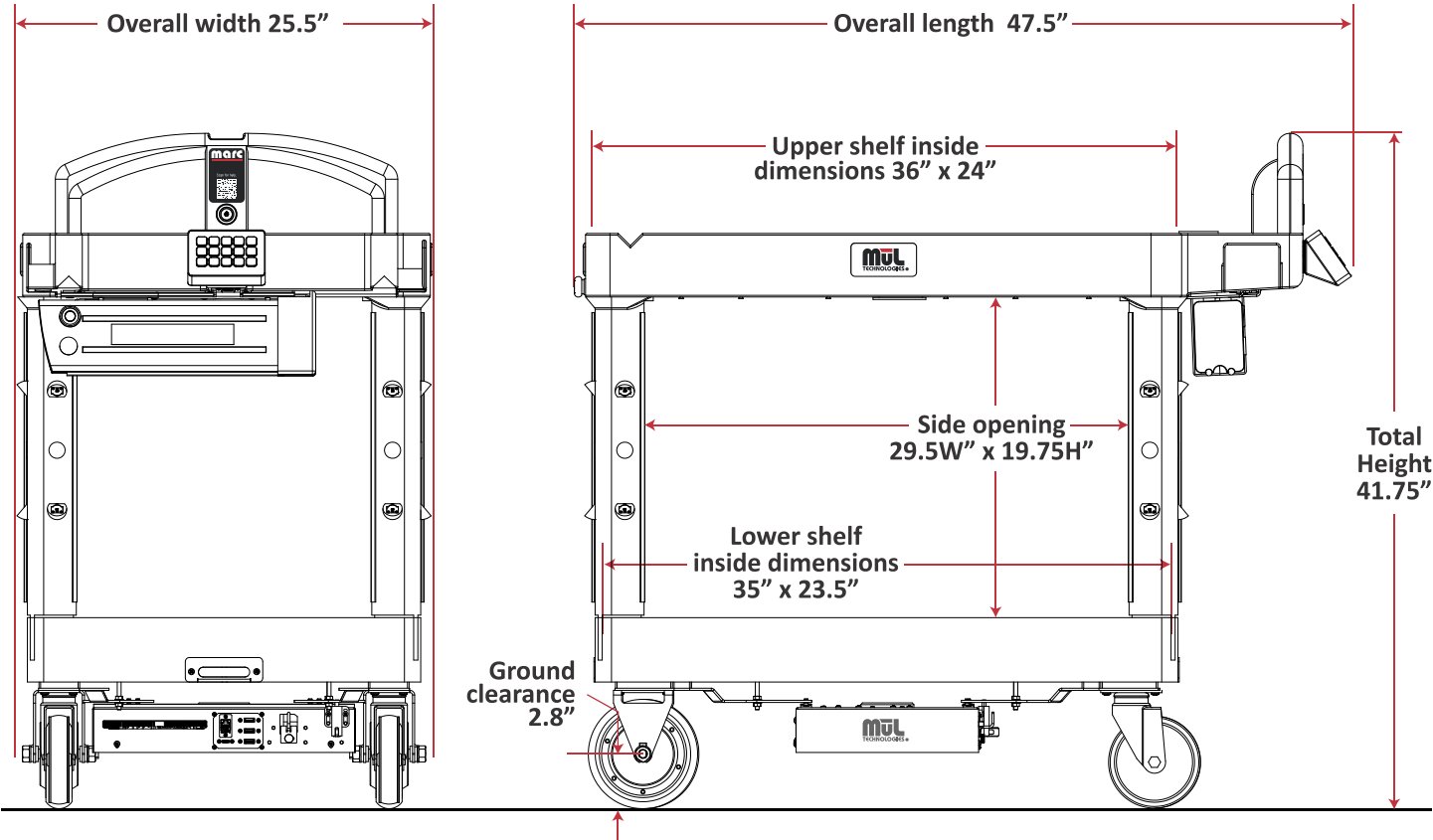
Troubleshooting

Problem	Things to try
After rebooting MARC, my preprogramed destinations are gone, and the buttons appear grey.	In Active Map Mode, this is by design; MARC does not retain maps or locations when powered down. Since programming is extremely easy, simply manually push MARC on the next route and reprogram the destinations. Note this includes powering down to change the battery. If you need the map and destinations to be saved, consider Fixed Map Mode. See **Operating modes: Active Map and** Fixed on page **20**.
Cart will not power up when power button is pressed.	Verify the emergency stop button located on the front of the cart is not engaged. Disengage button by turning in direction indicated by arrows until the button 'pops out'.
	Verify battery is inserted correctly and the key is in the "locked and on" position. See detailed information on using the battery properly in section **Inserting the battery** on page **31**.
	Verify your battery has a charge by pressing the charge indicator on the end of the battery. For detailed information, see section **Charging the batteries** on page **29**.
Red check engine light is illuminated.	The red check engine light indicates a critical issue with the system. The cart will cease to operate until the issue is resolved. In the event there are multiple check engine lights, you can press the check engine button to cycle through them for review. Things that can cause the red light include: - Safety system inoperable - Cable disconnected below cart - Tilted cart Possible resolutions: - Reboot MARC system to see if indicator light is cleared. - Make sure the cart is on a level surface. - If it does not clear on reboot, please contact the MūL Technologies team for assistance at (262) 242-8830 or support@multechnologies.com.
Yellow check engine light is illuminated.	A yellow check engine light indicates an urgent issue with the system. The cart will continue to operate, but the issue indicated needs to be addressed. In the event there are multiple check engine lights, you can press the check engine button to cycle through them for review. Things that can cause the yellow light include: - Indicator LEDs disconnected or not functioning - Sensor blocked or unresponsive - Speaker not connected or malfunctioning - Battery system not communicating properly with system - Access point is not connected or malfunctioning Possible resolutions: - Reboot MARC system to see if indicator light is cleared. - If it does not clear on reboot, please contact the MūL Technologies team for assistance at (262) 242-8830 or support@multechnologies.com.

Cart stops and there are no indicator LEDs flashing or sounds.	Make sure the emergency stop button has not been pressed. If it has, reset it by twisting in direction shown by arrows. Verify your battery pack has sufficient charge. The cart may have encountered a large bump that set off the tilt sensor.
Pressed a station button but the cart did not move.	Verify the destination key you pressed has been set. Verify the destination is more than 1m away from the current location of the cart. Verify a red check engine light is not displayed. Verify the cart has an open path towards the destination. Verify you pressed the destination key for less than 2 seconds.
Cart did not reach the destination and announces, "Route Abandoned."	The cart will stop when it is within ~1m of the programmed destination. Verify the destination is not blocked by obstacles and the path is open enough for the cart to navigate to the final destination. This condition can potentially occur anywhere along the defined path of the cart. If you encounter several instances of abandoned routes, it is possible that a cart reboot may solve the issue.
One of my set destinations is not correct.	Make sure that the cart has completely booted up. After you hear, "Cart Ready," the cart will accurately set a destination. Make sure the cart is not moving when you set a destination. Make sure only one station button is pressed at a time to set a location.
I hear a noise coming from the cart while it is not moving.	If the cart is in the process of moving, it may be calculating the path for it to follow. It may also be moving a small amount as it adjusts the orientation of the cart. During these times it is normal for the cart to be make a slight noise.
Cart seems confused or disoriented and cannot find destinations.	It is possible that the map software can 'shift' the map if the drive wheels slipped or were moving when the cart was still. This can cause the map to become disoriented. MARC is designed to be used on a flat, dry surface. It is also important not to move MARC units sideways or too quickly, as this may cause the wheels to slip. If the map shifted, the cart should be powered down and restarted. Please note that the destination points will need to be reprogrammed if operating in Active Map Mode.

For the latest troubleshooting information, visit https://www.multechnologies.com/support or scan this QR code:
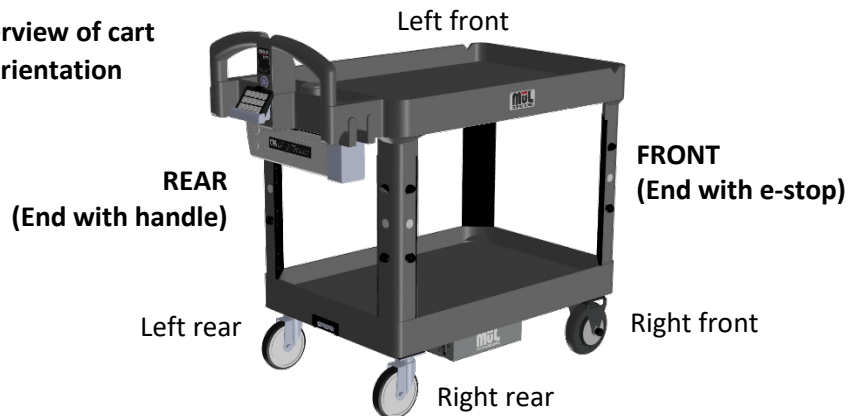

You can always contact the MūL Technologies team via email or phone to get assistance in resolving an issue.

support@multechnologies.com or (262) 242-8830, option 2.
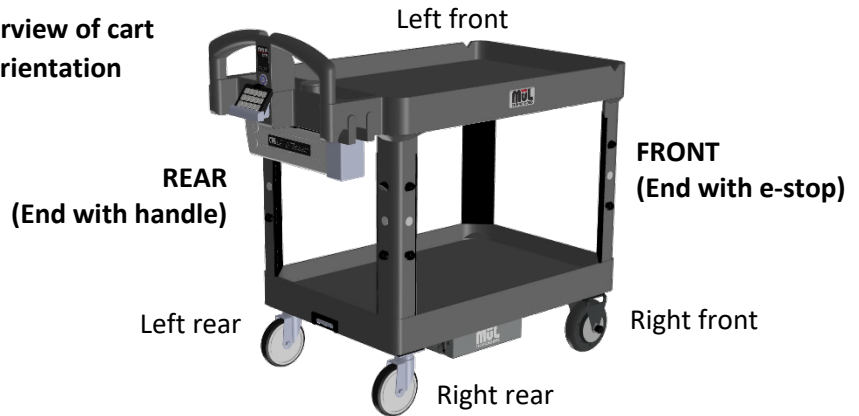
Check Engine light codes

Overview of cart orientation

Left front

REAR (End with handle)

FRONT (End with e-stop)

Left rear

Right front

Right rear

Yellow Check Engine light codes:

Code	Meaning	Comments
0000	LEDs missing.	The cart will operate normally but will not communicate direction or other status via the LED indicator lights.
0010	Battery pack missing.	The battery pack is not communicating its status to the mainboard. The battery can still be checked using the physical button on the battery itself. Please see section titled Using MARC battery packs.
1025	Distance sensor error (FL).	Front left distance sensor malfunctioning.
1026	Distance sensor error (FR).	Front right distance sensor malfunctioning.
1027	Distance sensor error (RL).	Rear left distance sensor malfunctioning.
1028	Distance sensor error (RR).	Rear right distance sensor malfunctioning.
1090	Access point error.	Access point missing or malfunctioning. MARC will perform normal operations, but the software update procedure will not function.
1100	Speaker error.	The cart will operate normally but will not communicate status via the audio cues.
1110	Weight sensor error.	Weight sensor missing or malfunctioning.

Overview of cart orientation

Left front

REAR
(End with handle)

FRONT
(End with e-stop)

Left rear

Right front

Right rear

Red Check Engine light codes:

Code	Meaning	Comments
0033	Motor error (L)	The left drive motor is not responding and is not operational.
0034	Motor error (R)	The right drive motor is not responding and is not operational.
0043	Encoder error (L).	The left wheel encoder is not responding or is not operational.
0044	Encoder error (R).	The right wheel encoder is not responding or is not operational.
0050	IMU error.	The inertial measurement unit is used to prevent MARC from tipping and is required for safe operation but is not responding.
0070	Battery being charged.	To prevent the cart from moving autonomously while the charging cord is attached, movement is disabled until the charger is removed.
1060	Cart tilted.	The cart experienced a tilt of greater than 10 degrees.
1130	Camera missing.	Front or rear high-definition depth camera is not responding.
1140	Digital board error.	The main communication board of MARC is not responding.
1150	LIDAR missing.	The laser measurement system has an error and is a critical part of MARC's ability to 'see' the world and to the map-creation process.
1160	Startup error.	The software has an issue. Please reach out to support for more information and troubleshooting assistance.

Updating MARC's software

i INFO	Though it is possible that the update process can be successful using a variety of wireless devices, it is highly recommended that a Windows based laptop is used. Chrome or Microsoft Edge browsers also offer the best experience.

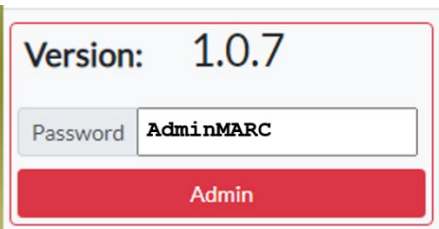|	
i INFO	Please note that upgrading the software will eliminate all mapping and programming. After software update has been executed, all mapping will need to be redone and destinations reprogrammed.

If you have been instructed to update the software on your MARC system, here is the step-by-step process.

1. Obtain the update package from MūL Technologies for your MARC.

2. Power on your MARC and verify your battery is at least 25% charged.

3. The serial number of your MARC can be found using the INFO button, which can be found on the second screen of the EZ-Go Navigation panel. Access the second screen by tapping the battery status button and then cycling through the information by tapping the info button.
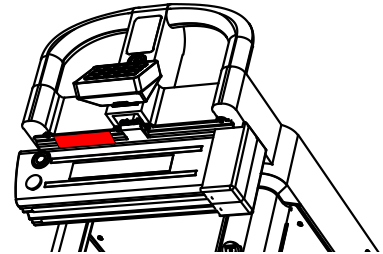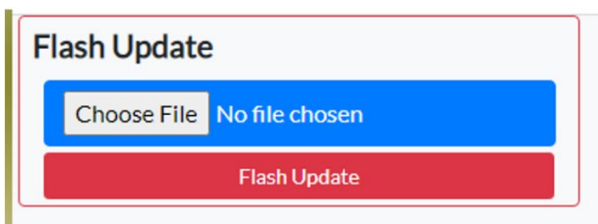
   NOTE: If you are unable to use the info button for some reason, the serial number can also be found on the label attached to the metal battery bracket under the handle of the cart (shown in red above).

4. With a wireless computing device (e.g. laptop) and while within range (10 feet) of MARC, connect to your MARC's wireless network. Closer is better, depending on your unique environment.

   o SSID will be MARCsetupXXXXX where XXXXX is your MARC's last five digits of the serial number.

   o Password is the same as the SSID used above.

5. Verify you have successfully connected to your MARC's wireless network.

6. Open a browser and go to http://192.168.100.10

7. You will see the current version of your MARC's software displayed along with an input box for entering a password and a button labeled Admin.

8. Enter in the password: **AdminMARC** and click the **Admin** button.

i INFO	The current revision of software installed on your MARC is shown at the top at this point (in this example, 1.0.7).

9. You will see a new message as shown below on the screen.

10. Click on the **Choose File** button.

11. A file explorer window will pop up. Select the update package file you previously obtained from MūL Technologies and wait till you see the message "**Update package uploaded**." This can take several minutes to upload depending on connection strength and speed.

|	
i INFO	Since the updates are large, uploading can take several minutes. Once uploaded, you will see an acknowledgement and the **Choose File** box will turn green. At that point, click on **Flash Update** to begin the updating process. If the **Flash Update** is pressed early, an error will occur.

i INFO	The device being used to connect and perform the update must remain near the cart being updated during the entire update process. If the device is moved away, powered off or otherwise disconnected the update process will halt and may leave the MARC unit inoperable.

12. After the file is uploaded, a pop-up box will indicate that the update package has been uploaded to your MARC.
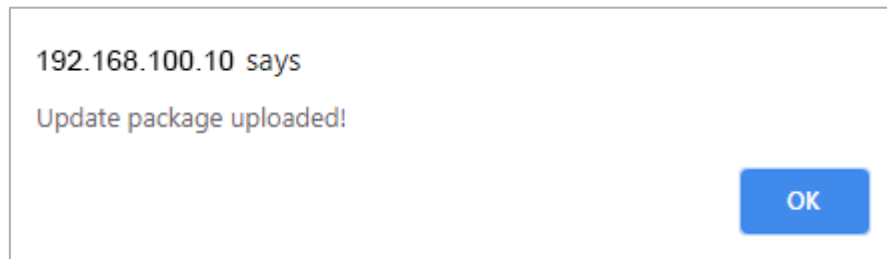
13. Click OK and you will then see the selected file's name show up with a green background. If you do not see the file name and a green background, the file is still uploading or has failed unexpectedly.
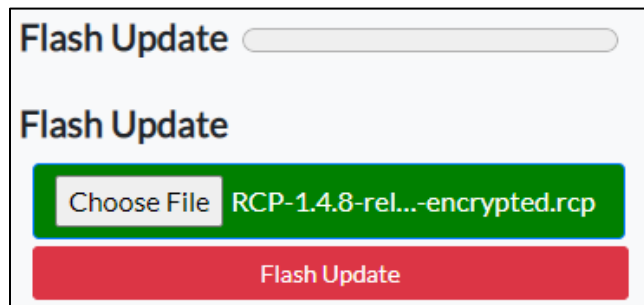
14. Next, click on the Flash Update button to begin the updating. Depending upon the update this may take a few seconds to several minutes.

15. Once complete you will see a Success message box pop up.

16. **Power off your MARC, then back on**.

17. Verify your MARC successfully boots up.

18. Repeat steps 5 through 8 to verify the new version is displayed.

Software update error codes

If the software update process fails, these codes will help diagnose and correct the condition causing the error.

Code	Message	Comments
0	SUCCESS	The updating process completed successfully.
1	FAILED_TO_VERIFY	There is an internal updating issue. Please contact the MūL Technologies team.
2	FAILED_TO_DECRYPT	
3	FAILED_TO_EXTRACT	
4	FAILED_TO_INSTALL	

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