ALERT® INNOVATION

Alphabot

User Manual

1000004-MN-01 - Rev C

This manual must always be placed in an operator accessible location near the Alphabot® System.

This manual is intended to provide generic information related to all models of Alphabot® System. Due to specific design changes, contents of this manual may not entirely apply to the purchased model of the system.

Alert Innovation, Inc. will not take responsibility for any malfunction resulting from improper operation of the Alphabot® System.

Alert Innovation, Inc. makes no representations or warranties with respect to the contents hereof. In addition, information contained herein is subject to change without notice. Every precaution has been taken in preparation of this manual. Nevertheless, Alert Innovation, Inc. assumes no responsibility for errors or omissions or any damages resulting from the use of the information contained in this publication.

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1. Introduction

1.1 Purpose & Scope of the Manual

This manual is intended to provide all necessary information for safe interaction with the Alphabot.

This user manual details the safety information relating specifically to the Alphabot, instructions to be followed by the user, steps involved in the operation of the bot, and basic diagnostic procedures.

***Note**: The term Alphabot is interchangeable with "Bot". This manual uses both terms to refer to the Alphabot.*

1.2 Reference Documents

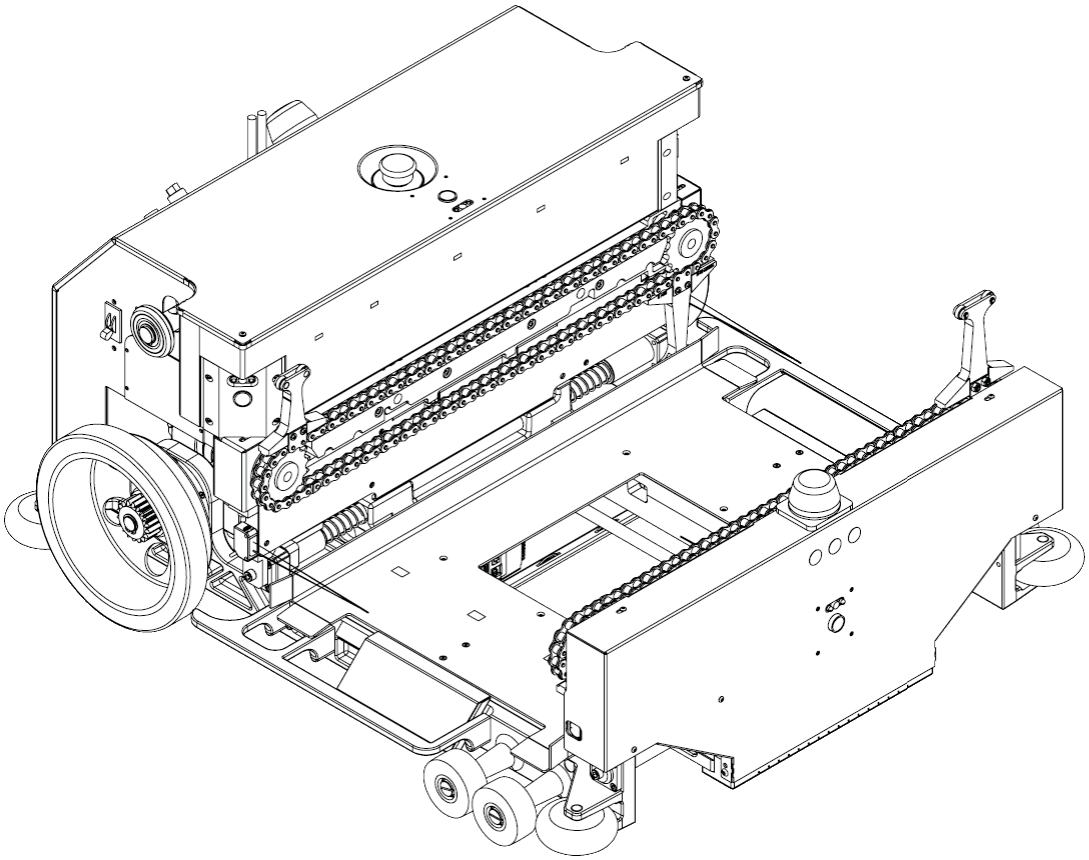
Document	Part Number / Link
Alert Academy	https://academy.alertinnovation.com/
Alphabot System Reference Guide	1010755-01
Alphabot Pre and Post Procedures	1000067-SR-01
Alphabot APSD System LOTO Manual	1000035-SF-01
Acronyms and Alert-Specific Terms	1000030-OP-01
Alphabot system Master Control System (MCS) User Manual	1000016-MN-01

1.3 Product Overview

The Alert Innovation, Inc. Alphabot is a compact, motorized, remote-controlled, semi-autonomous vehicle with vertical and horizontal movement capabilities. Alphabots handle all tote picking, transportation, and distribution within the larger “Alphabot System.”

The Alphabot System includes storage modules, totes & sub-totes, tower modules, transit planes, dynamic workstations, static workstations, and a Master Control System (MCS) software. Alphabots are at the heart of this system, moving product from station to station, and ultimately presenting the completed order to customers.

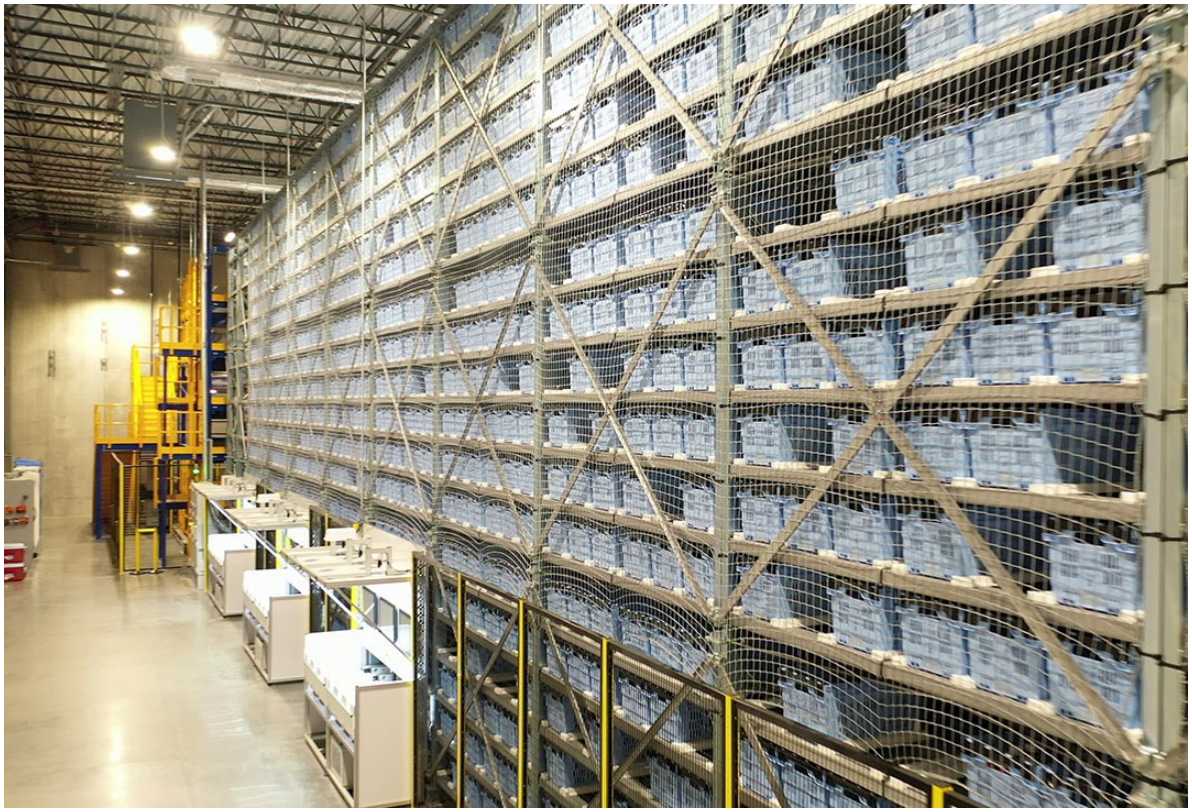
Alphabots have their own vertical-drive mechanism, which engages with vertical tracks in the Alphabot System structure to allow each bot to move from one elevation to another. A wheel retraction/extension mechanism enables the Alphabot to transition between vertical and horizontal modes at any point, and travel horizontally to any storage or workstation level. It is in this way that the Alphabot can transfer totes between its payload bay, and storage-rack locations, using a simple single-motor mechanism.



1.4 Supporting Products

The Alphabot is one part of the larger Alphabot System, working in concert with a number of other Alert products to fulfill customer orders.

Individual Alphabots are inducted into the Alphabot System and commanded by the Master Control System to arrive at workstations upon command. At the workstation, tote containers are loaded with product and handed off to the Alphabot, which will carry product throughout the system using structures, transit planes, and express planes.



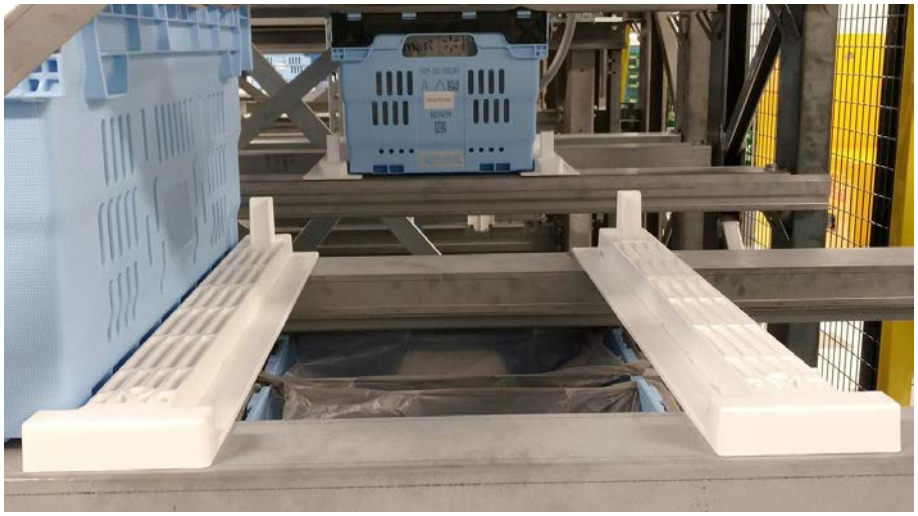
1.5 Totes and Sub-Totes

The Alphabot interacts with two kinds of totes, distinguished by their purpose: **Product Totes** and **Order Totes**.

- **Product Totes** are stored in racks within the Structure's storage module aisles. These totes contain "eaches" (individual items) that are made available to Pickers as stock to fulfill orders for sale.

- **Order Totes** contain all the picked product for any specific order.

Totes can be further divided into sub-totes, which are smaller compartments that can be slotted into a tote. Each sub-tote contains its own product, or type of product. This allows for higher tote density when storing small items.



1.6 Transit Planes

Transit planes are uniform platforms that allow the Alphabots to move two-dimensionally to access aisles and workstations. To reduce the amount of time a product remains out of its desired environmental zone, each Transit Plane can be vertically split into two zones: chilled and ambient.

The chilled portion connects frozen and chilled storage to a chilled dynamic workstation and the ambient portion connects ambient storage to ambient dynamic workstations.

1.7 Express Planes

Express planes are platforms that allow the Alphabots to move between different storage units, and can be used as buffer zones for the Alphabots to wait until a tower or lane is available. The express planes are not connected to a workstation.

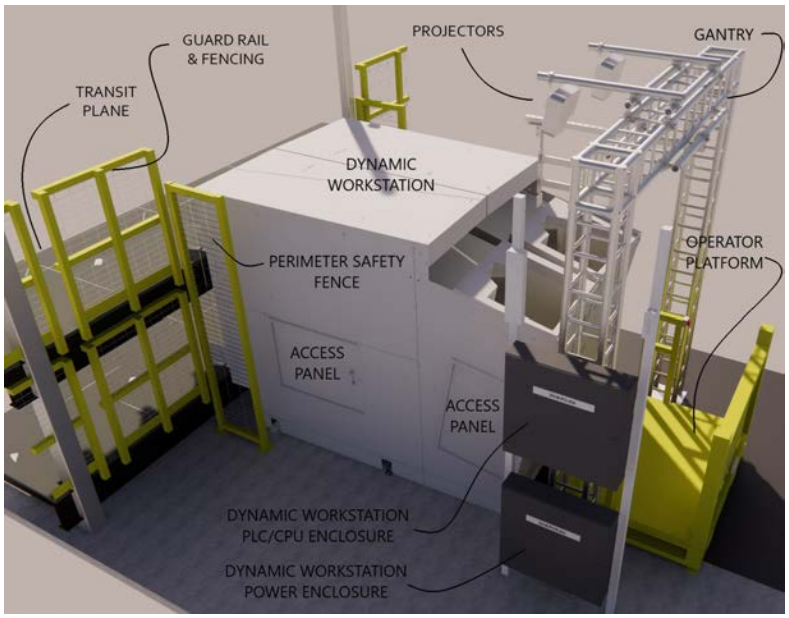
1.8 Static Workstation

Static workstations are fixed workstations that provide an interface to introduce product totes or sub-totes into the storage module of the Alphabot system. These workstations are also meant for collecting the completed/dispensed orders and for exception handling, a.k.a. “Hospital” functionality.

1.9 Dynamic Workstation / Picking Workstation

Dynamic workstations / Picking workstations are used in the Alphabot system to pick products from the product totes and place them in the order totes.

The Alphabot enters the picking workstation from a lower transit plane, ascends into the transfer position in front of the picker, and then exits to an upper transit plane. To ensure product accuracy, the workstation controller uses an overhead projector to illuminate both the pick and put locations (pick-to-light and put-to-light). Chilled and frozen products will be picked at a chilled workstation and ambient products will be picked at an ambient workstation only.



1.10 Master Control System (MCS)

MCS is an advanced software system responsible for processing all orders, scheduling all Alphabot tasks, managing all bot moves to optimize flow and throughput while preventing collisions between bots, and interfacing to the external systems. An MCS dashboard provides information regarding the general system health, current asset utilizations and system notifications.

2. Safety

This safety chapter explains the precautions and procedures for safe interaction with the Alphabot. Where appropriate, this Safety chapter identifies the safety features of the Alphabot, identifies components that pose a hazard if used incorrectly, provides instructions for safe use and access to the Machinery, locations and meanings of safety labeling, and regulatory compliances.

The Alphabot tote chains, sprockets, and drive wheels present a crushing hazard. Power off the main board and lockout the power disconnect switch prior to performing any maintenance on the internals of the bot.

Never perform tasks that you have not been trained to execute. Performing maintenance or repair tasks can result in serious injury or death and may cause damage to the equipment. Please contact DTE Support for assistance with the tasks outlined in this manual.

Alphabots require manual startup and shutdown by trained and qualified operators.

Never enter the Alphabot System if you have not been trained to do so. Only maintenance personnel trained to enter the Alphabot System may enter the locked entry gate.

Proper lockout/tagout (LOTO) procedures must be followed when performing service to an Alphabot. Failure to do so can result in unexpected machine motion or release of electrical energy.

2.1 Personnel Safety

2.1.1 Hazard Description

The Alphabot System shall be operated, maintained and serviced by trained personnel only.

Safety pictograms and labels are located on the equipment and used within this manual to make the user aware of potential hazards and to indicate lockout/tagout (LOTO) locations.

Visual alarms indicate possible hazardous conditions. Anyone operating this system must be fully conversant with all alarms and the actions to take when an alarm occurs.

Users must read the instruction manuals to gain a thorough understanding of the equipment and always use good judgment. Follow good practices to use the latest edition of any standards document to be compliant with safety requirements.

Installation, operation, and maintenance procedures that expose people, equipment, or data to possible risk are accompanied by specific hazard warnings of varying degrees of importance, as follows:

Danger	**DANGER** indicates a hazardous situation which, if not avoided, **will result in death or serious injury**.
Warning	**WARNING** indicates a hazardous situation which, if not avoided, **could result in death or serious injury**.
Caution	**CAUTION** indicates a hazardous situation or unsafe practice which, if not avoided, **may result in minor or moderate personal injury**.
Notice	**NOTICE** indicates a situation or unsafe practice which, if not avoided, **may result in equipment damage**.

2.1.2 Personal Protective Equipment (PPE)

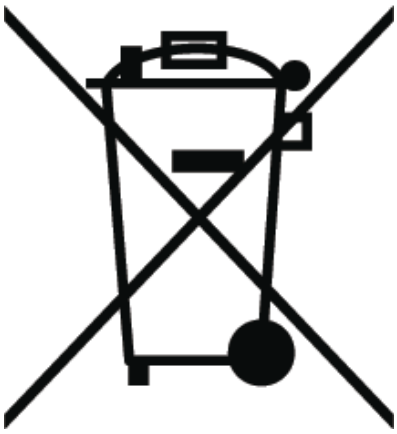
Some procedures in this manual require you to use personal protective equipment (PPE). The necessary PPE is detailed at the start of each procedure. However, you should always remain alert to the need to protect yourself while working in any capacity, on or near this equipment.

The following symbols are used in this manual to indicate the type of equipment required; note that each PPE needs to be inspected for defects before use:

	Wear safety glasses or goggles		Wear face shield
	Wear protective gloves	 	Wear shock resistant gloves
	Wear protective footwear		

2.1.3 Environmental Safety

Alert Innovation, Inc. is committed to designing and manufacturing products in an environmentally responsible manner. Alert recognizes that eliminating certain hazardous substances from our products is beneficial to the environment and to AI customers.



Dispose of capacitors in accordance with local regulations for electronic waste.

- Do not incinerate capacitors or recycle with batteries.
- Do no crush, cut, or otherwise damage the capacitors.
- Do no dispose the capacitors in trash.

2.1.4 Inherent Safety Hazards of the Alphabot

WARNING

UNEXPECTED BOT MOTION

Ensure that the Alphabot's main board breaker switch is in the OFF position, and that bot LOTO procedures have been performed.

This will prevent the bot from executing any move commands.

No actuation of the tote chain or drive wheels can occur while the breaker switch is OFF.

Failure to follow these guidelines could result in serious injury or death.

DANGER

ELECTRICAL SHOCK HAZARD

Verify that the bot is **fully discharged** before beginning this procedure.

Contact with the internal capacitor board prior to discharging the bot will result in serious injury or death.

DANGER

BODY CRUSH HAZARD

Do not stand under a Bot/object stuck in a tower at any level or under any condition. Serious injury or death may occur. Use a winch to attach the Bot from above when possible, or secure a maintenance cart under the Bot/object before attempting to move it.

Failure to comply will result in serious injury or death.

DANGER

CRUSH HAZARD

Do not have any part of your body under the bot at any time.

While brakes are disengaged on the bot, the bot may roll off the service cart or the rails. This presets a foot crush hazard.

Take special care while transferring the bot onto the cart. Ensure the brakes are ENGAGED after bot has been moved onto the service cart.

Failure to comply will result in serious injury or death.

⚠ CAUTION

PINCH HAZARD

Watch your fingers as you close the front panel.

The hinged segment at the bottom presents a pinch hazard.

Failure to do so may result in minor or moderate injury.

NOTICE

Operators / Authorized employees who perform operation activities on the Alphabot System shall be qualified and trained on proper handling of the equipment and safe entry procedures into the system.

2.1.5 Persons with Pacemakers

WARNING

MAGNETIC FIELD

Can be harmful to pacemaker wearers.

Pacemaker wearers approaching bots during troubleshooting or servicing must stay a minimum of 30 cm (12 in.) away from traction wheels and electronic assemblies.

Failure to follow these guidelines could result in serious injury or death.

2.1.6 Fire Safety

Alphabots are mainly metallic including UL 94 V- rated components, e.g. conformal coated printed circuit boards and flame-retardant components. The UltraCaps pack is protected against collision in the middle of the vehicle. A certified early smoke detection system is included with each system in compliance with local, state and federal regulations and connected to the building sprinkler system. The main SPLC has two reserved safety inputs to be connected with the building fire control unit, in order to stop all the Bots upon an early smoke detection alarm.

The Alphabot System is not designed for the storage of flammables or organic products.

2.1.7 Seismic

All Alphabot systems and subsystems are bolted to the floor. Seismic designs, engineering and anchoring is provided depending on the end user's location following the IBC code requirements (United States) or ISO 3010 for international use.

2.1.8 Ergonomics

⚠ CAUTION

HEAVY OBJECT

May cause strain or back injury.

Do not attempt to lift a bot. Bots weigh up to 95 kg (210lbs.) when loaded. Do not lift the driving wheels to push or pull a disabled Bot.

Use the provided power pack to release the bot brakes, then use standard lifting techniques to push or pull the disabled bot.

Failure to do so may result in minor to moderate injury.

2.1.9 RF Safety

NOTICE

The Bots use Wi-Fi wireless communication within the system, with bridges operating at 2.4/5 GHz. The vehicles use RFID wireless communication operating at 13.56 MHz. Both units comply with national and FCC requirements.

2.1.10 Safety Equipment Rules

Padlocks are used when servicing an Alphabot, and any time an access door must be opened to enter the structure. On an Alphabot, a padlock, or lockout hasp, is applied to the main switch to prevent the Alphabot form being turned on during service. When entering the structure, a padlock is applied to the access door to prevent the door from being closed when personnel is inside the system.

Padlock Rules

Alert Innovation, Inc. shall provide each Authorized Employee with a durable padlock for locking the Alphabot.
The padlock must meet the following minimum requirements:

- The padlock must have a key-retaining feature to ensure that the padlock is not accidentally left unlocked.
- Each padlock must be keyed differently and only have one key.
- Each Authorized Employee will be assigned unique padlocks and the padlocks shall be labeled with the Authorized Employee's name.
- The padlock shall be substantial enough to prevent removal without the use of excessive force or unusual techniques, such as, with the use of bolt cutters or other metal cutting tools.
- A lockout hasp, snap on is needed for multiple padlocks.

Padlock Removal Rules

Maintenance and/or service personnel servicing an Alphabot shall be trained on affixing and removing a padlock. Maintenance and/or service personnel servicing an Alphabot shall have their own padlock marked with their name. The person servicing the Alphabot shall keep their key with them at all times during the maintenance activity. This padlock rule ensures that no Alphabot under service will be re-inducted into the Alphabot system.

Padlock devices shall not be removed by anyone but the employee who placed the lock. Removing a padlock device from a Bot belonging to another employee, could result in a fatal or serious injury.

EXCEPTION CASE:

If an Authorized Employee becomes disabled inside the Alphabot Structure during access or is physically incapable of removing their padlock, the Supervisor is allowed to remove the Authorized Employee's padlock device from the interlock device under the following conditions:

- The Supervisor ensures that the Authorized Employee has been physically removed from the Structure.
- The Authorized Employee is incapable of removing the padlock device themselves.
- The Authorized Employee is informed that their padlock device has been removed.
- The reason for the padlock removal must be documented and the record maintained for a minimum of one year.

2.1.11 Corrective Action Records

Corrective Action records must be maintained for any violations of the safe entry procedure.

2.2 Product Safety

2.2.1 Bot Safety Features

The Bot is provided with the following safety features:

- On/Off Switch
- Local E-Stop Button
- Capacitor Discharge Connector
- Brakes

2.2.1.1 Lockout/Tagout Standards

Various national and international standards address the practices and procedures necessary to disable machinery or equipment, thereby preventing the release of hazardous energy while operators perform servicing and maintenance activities. These standards detail measures for controlling hazardous energies: electrical, mechanical, hydraulic, pneumatic, chemical, thermal, and other energy sources.

OSHA standard:

In USA, the OSHA standard The Control of Hazardous Energy (Lockout/Tagout), Title 29 Code of Federal Regulations (CFR) Part 1910.147.

***Note**: Alert Innovation, Inc. is responsible for providing the appropriate program(s) and lockout/tagout devices to ensure the safety of personnel operating and maintaining this equipment.*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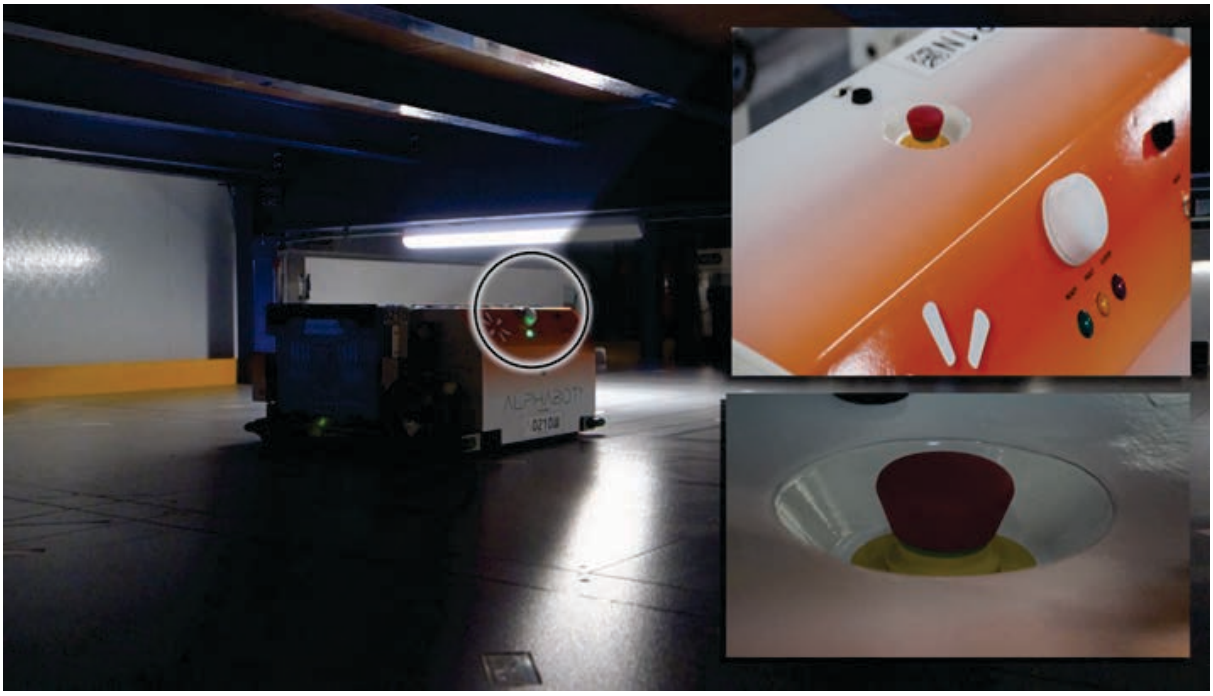
2.2.1.2 Local E-Stop Button & Function

The local emergency stop button, or "local E-Stop", is a red mushroom button on the top of the bot, slightly recessed to prevent inadvertent actuation. The local e-stop button is wired to the safety controller using a dual channel. The button is listed and approved to IEC 60947-5-1.

By pressing the bot's local emergency stop button, power to all drives (e.g. motion, tote, pinion extend & wheel retract) is removed and brakes are applied simultaneously on the motion drives, corresponding to a Category 0 stop per NFPA 79 and IEC 60204-1.

This E-stop function applies to the specific Bot with the pressed E-stop button and the rest of the system is still operating.



2.2.1.3 Bot Lockout/Tagout Procedure

See the "Bot Lockout Tagout" section of 1000035-SF-01: Alphabot Lockout Tagout Procedures for this procedure.

2.2.1.4 Discharge Bot

See the "Bot Discharge" section of 1000035-SF-01: Alphabot Lockout Tagout Procedures for this procedure.

2.2.1.5 Safety Controller

The safety controller is NRTL listed using approved safety software. The hardware was developed by the controller manufacturer based on a proven safety platform to fit the size and needs for the Bot.

2.2.1.6 Motion drives

The motion drives, e.g. right & left driving wheels and tote motor are PC board mounted and are provided with several safety features. Each drive is protected against over-temperature, over current and over voltage, etc. Each drive has a safe torque off enable function to remove the power to its motor when this signal is low. Communication between the Bot main processor and the drives takes place for any operational move.

2.2.1.7 E-stop Command or System E-Stop

When the on-board SPLC receives a system E-stop (E-stop button pressed outside the structure) or Main onboard Bot processor E-stop command, the drives will quickly decelerate in a controlled manner and stop motion before the onboard SPLC drive outputs drop and power to the brakes is removed, to perform a controlled stop corresponding to a Category 1 stop per NFPA 79 and IEC 60204-1.

2.2.1.8 Mechanical Brakes

Each drive motor is equipped with a failsafe mechanical brake. The brake power is sourced from the onboard SPLC safe outputs and the current is regulated to a minimum value to hold the brakes open to save power consumption.

2.2.1.9 Bot Switch and Connector

International standard symbols are located on the Bot to designate specific functions.

	MAINT	Multipurpose connector: Capacitor charge, Capacitor discharge & Brake release
	LOCAL	3 Way switch: Manual Mode (local commands only with Yellow flashing LED)
	STOP	3 Way switch: Stop Mode (Red LED ON)
	REMOTE	3 Way switch: Automatic Mode (Green LED ON and/or Yellow solid)

2.2.1.10 Mode Switch

The Bot is provided with a 3-way selector forced guided switch connected to the safe SPLC inputs.

- **Automatic:** The default mode is the Automatic mode. The Bot is operational within the system.
- **Off:** The Bot is immobilized with brakes on.
- **Manual:** The Bot is disconnected from the WiFi network, e.g. does not respond to operational commands or system E-stop. In this mode, only 1 axis can be moved locally at a time for a period of 4 seconds maximum repeatable. Since the motor controllers do not have a safe speed, the on-board SPLC disables the drive every 4 seconds to prohibit runaway conditions. The manual mode is generally used for service.

When the work is done, switching the switch back to Automatic will put the Bot in a system E-stop mode. Within the system, all door interlocks shall be satisfied in order to reset that Bot at any reset location.

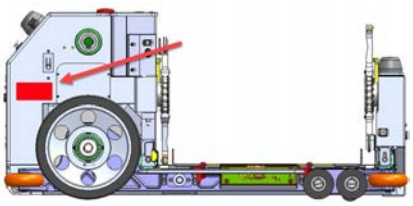
2.2.1.11 Manual Brake Release

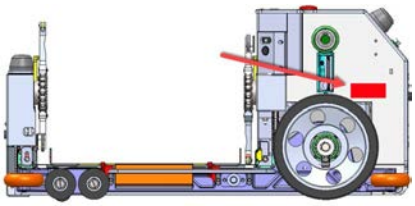
A portable autonomous charger with multiple functions can be plugged onto the circular connector to:

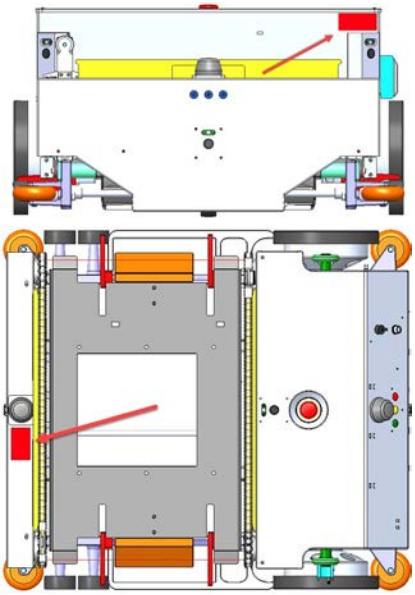
- Charge a bot when found discharged in the system
- Release the motion brakes to permit the bot to move in a lane, or wrangle a stuck bot in a tower after securing it with Alert Innovation, Inc.'s special maintenance tools.

2.2.2 Description and Location of Safety Labels

Descriptions and locations of safety labels in the Alphabot are listed below:

Label	Hazard	Text in Label	Location
 P/N 1001575-00-01	**DANGER**	Risk of electrical shock. Disconnect all power sources. Discharge capacitors before servicing.	Front-Left side of Alphabot. Under the main board disconnect breaker.
			

Label	Hazard	Text in Label	Location
 P/N 1001573-00-01	**WARNING**	Magnetic Field. Can be harmful to pacemakers wearers. Pacemaker wearers stay back 30 cm (12 in).	Front-Right side of Alphabot, to the right of the charge toe.
			

Label	Hazard	Text in Label	Location
 P/N 1001576-00-01	**WARNING**	Moving parts can crush and cut. Keep hands clear.	Top-right corner of backside of front section of Alphabot. Rear-middle, beside rear Wifi Antenna.
			 

Label	Hazard	Text in Label	Location
 P/N 1001574-00-01	**Shock Hazard Icon**	No text.	Inside Bot (2)

2.2.3 Repair and Maintenance of Safety-Relevant Modules

For safety-relevant modules such as the main board, the local E-stop module, or the motor boards: Safety functions have to be validated after exchange of hardware.

Defective safety-relevant modules shall only be exchanged and send back to Alert Innovation, Inc. No self-repair is allowed.

2.2.4 Decommissioning of Equipment

The decommissioning and dismantling of the Alphabot or the Alphabot System shall be performed by authorized personnel. Dispose of waste equipment and material in accordance with local regulations.

2.2.5 Radiation Exposure Statement

The device has been found to be compliant to the requirements set forth in CFR 47 Sections 2.1091 and Industry Canada RSS-102 for an uncontrolled environment. The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

Le dispositif a été jugé conforme aux exigences énoncées dans les articles 47 CFR 2.1091 et Industrie Canada RSS-102 pour un environnement non contrôle'. L'antenne(s) utilisée pour ce transmetteur doit etre installé pour fournir une distance de séparation d'au moins 20 cm de toutes les personnes et ne doit pas être co-localisés ou fonctionner en conjunction avec une autre antenne ou transmetteur.

2.2.6 Description of the Alphabot System E-Stop Circuitry

The Alphabot System uses a certified safety-programmable logic controller (“Master SPLC”) located in the main electrical enclosure. The main architecture includes conventional Safety I/O modules, and the Actuator Sensor interface (ASi) technology for safe & common connections to devices such as the emergency stop devices, safety interlocks, and conventional proximity sensors.

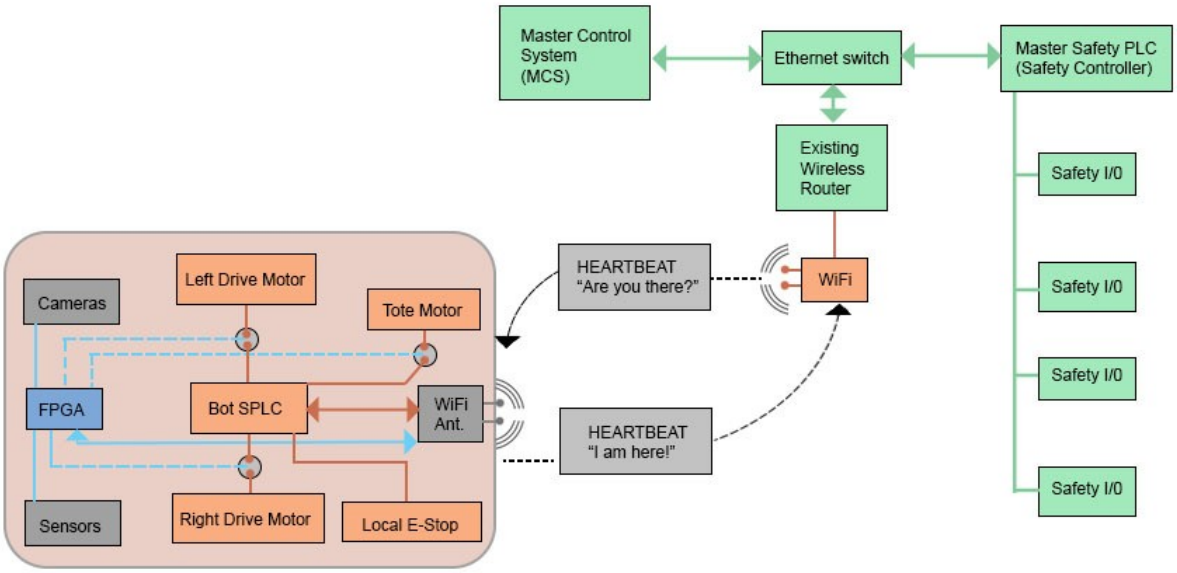
The emergency stop buttons are located at each operator station, on main enclosures, and at the rear of the structure, at each level. These "E-Stop" buttons are connected on the ASi bus within the system, originating from the ASi power supply and associated safety node in the main enclosures. The Ethernet communication permits the transmission of safe information throughout the entire system network. Any E-stop button activated within the system will generate a category 1 stop to the Bots per NFPA 79 and IEC 60204-1, and automatically de-energize the power to the rails.

Each Bot is provided with a certified simplified Bot SPLC to communicate via wireless Ethernet with the Master SPLC, and with a main CPU, to communicate with the Master Control Software (MCS) for operational purposes. A category 1 stop provides a Bot controlled stop with final power removal of drive motor, tote motor, and applied brakes to drive motors. The Bot SPLC directly removes the power to the redundant contactors, de-energizing the charging rails in the entire system as a category 0 stop.

A red LED is on at the depressed E-Stop button, as well as the electrical enclosures' tower lights. Each Bot is safely-stopped, with their red LEDs blinking red as well.

In order to start the system again, the E-Stop button must be unlatched (twist and/or pull to release) and any reset button must be pressed.

The E-stop circuitry corresponds to a Category 3 PLd per EN ISO 13849-1 and SIL2 per IEC 62061.


Master Control System (MCS)
Ethernet switch
Master Safety PLC (Safety Controller)
Existing Wireless Router
Safety I/0
Safety I/0
Safety I/0
Safety I/0
HEARTBEAT "Are you there?"
WiFi
Cameras
Left Drive Motor
Tote Motor
FPGA
Bot SPLC
WiFi Ant.
HEARTBEAT "I am here!"
Sensors
Right Drive Motor
Local E-Stop

2.2.6.1 Bot: Emergency Stop and Safe Torque Off (STO)

Each Bot is provided with an on-board certified SPLC and a main CPU. While the main CPU gives start, stop and operational commands over Wi-Fi communication with the MCS to fulfill customer orders, the on-board SPLC communicates with the main enclosure SPLC through the Wi-Fi communication and supersedes the main CPU for any safety related control or decision.

The on-board safe inputs are provided for the Bot E-stop button, manual/stop/automatic modes selector switch, each motor controller STO and each drive feedback.

The safe outputs are the STO command for the motor controllers, each brake, the Bot E-stop status to the network and the on board Red LED indicators.

There is one button provided on the top of the Bot electronics enclosure for ease of access at the Picking Work Station or during Bot manual commands in the system. Pressing the Bot E-stop button (also called local E-stop) will directly de-energize all motor controllers achieving a category 0 stop per NFPA 79 and IEC 60204-1. The Red LEDs are ON continuously, and the brakes are applied on the drive motor shafts. The E-stop circuitry corresponds to a Category 3 PLd per EN ISO 13849-1 and SIL2 per IEC 62061.

Pressing the E-stop button will only de-energize that Bot. In order to resume operations with a local E-stopped Bot, the following steps are necessary: pull the Red mushroom, the Bot will come to a system E-stop mode, the Red LEDs will now be blinking. The affected area needs to be cleared and all interlocks satisfied before pressing any reset button (may need to stop the entire system prior). The reset will allow the Bot to fulfill commands from the main CPU again.

The Bot SPLC generates the safe torque off commands. When the SPLC output goes to 0 V, the safe enable function to each drive and tote controllers remove power to their motors. Each controller STO feedback is monitored by the Bot SPLC, which also removes the 24V power to each brake to activate them on the drive motors instantly for a Category 0 stop. The feedback from brakes is also monitored by the on-board SPLC.

Safe Torque Off is applied during local and system E-stop conditions, but also performed upon main CPU requests for operational purposes, e.g. charging in towers and picking/placing a tote.

3. Hardware

3.1 General Description

Alphabots move inventory within an Alphabot System MCS. They are autonomous vehicles capable of lifting inventory totes and moving them as required to different locations within the confines of the Alphabot System. Alphabots operate on tracks within an assembled Structure, providing various pathways down which the bot may travel. Alphabots use RFID markers on the floor (flags) as known reference landmarks for guiding themselves to different regions of the tower.

3.2 Alphabot Components

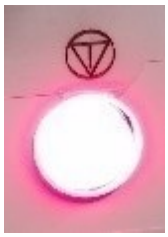
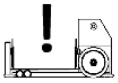
Capacitor board ("cap board")	Controls and distributes power to the Alphabot's systems.
Cameras	Used for QA purposes, allowing technicians to view the position and surroundings of specific bots within the system. There are 6 cameras in total - front, rear, up, down, left, and right. Each camera has an LED light to increase visibility, and a microphone to record sound if needed.
Caster wheel and suspension	Distributes load and providing a large base of support for the carried payload (tote).
Charge toe	Connects to the tower's charge rail during motion, recharging the internal Capacitor Board.
Covers (front and rear)	Provides a protective fairing for the Alphabot's interior components. Also enhances the appearance and allows for appropriate branding based on customer.
Drive Motors (left and right)	Powers the drive wheel movement.
Drive Wheels and Drive Motors (two sets)	Propels the Alphabot across the floor. Wheels may be driven in the same or opposing directions for complete directional control.

E-stop operator button	Used to trigger Alphabot emergency shutdown.
Guide wheels and V wheels (two sets)	Provides movement along the channels of the towers.
Magnetic detection strip ("Line Follower")	Used by the Alphabot to sense the magnetic strip that runs along the transit plane. By following this magnetic strip, the Alphabot is able to navigate when outside the channels of the tower.
Main board	Controls all major functions of the Alphabot.
Main board disconnect switch	Cuts all power to the Alphabot's main board, ceasing all autonomous action of the bot. Must be turned to the 'off' position before performing any maintenance to the Alphabot. If the bot is still connected to an active charge rail, note that the Capacitor Board and Power Supply Board are still powered.
Maintenance port	Provides external charging of the cap board and accessing brake control.
Positioning sensor (left and right)	Reads positioning flags situated along workstation channels, which trigger slowdown and stop of the bot when presenting a tote to the Operator.
RFID readers (left and right)	Used to determine the position of the Alphabot as it passes over the RFID blocks and passes by RFID flags within the structure.
Safety controller	Ensures safe operation, speed control and emergency stopping capabilities.
Status lights (front and rear)	Provides colored visual status information on the bot. Possible statuses include Ready, Fault, and E-stop. These status lights are present both at the front and rear of the bot.
Status Switch	Changes the state of the Alphabot. There are three options available: • Local: Maintenance mode. • Remote: Running state. • Stop: Complete stop.

Tote chains (front and rear)	Chains that run the width of the Alphabot, used in conjunction with Tote Fingers to pick up and release chains.
Tote fingers (front and rear)	Used by the Alphabot to grasp, hold, and ultimately push out a tote container by actuating the Tote Chains onto which they are attached. There are two types of Tote Fingers: Tote Grabber Fingers, which grab and hold the tote container, and Tote Pusher Fingers, which push the tote out at a workstation.
Tote motor	Provides actuation to the tote chains.
Tote sensors (front and rear)	Used to detect when a tote is or is not being held by the Alphabot's Tote Fingers.
Wifi Antenna (front and rear)	Used to communicate wirelessly with the MCS.

3.3 Bot LEDs

Each Bot is supplied with a set of 3 LEDs on the front and the back of the vehicle. Each LED is marked with an international pictogram and the color meanings comply with EN 60204-1.

	E-STOP		RED SOLID: Specific Bot E-stop button pressed RED FLASHING (2 Hz): Motion disabled, auto-reset possible, waiting for reset RED FLASHING (4 Hz): Motion disabled, auto-reset possible, loss of remote heartbeat
	FAULT		YELLOW: Fault YELLOW FLASHING: Manual mode
	READY		GREEN: Normal operation GREEN FLASHING: Initialization

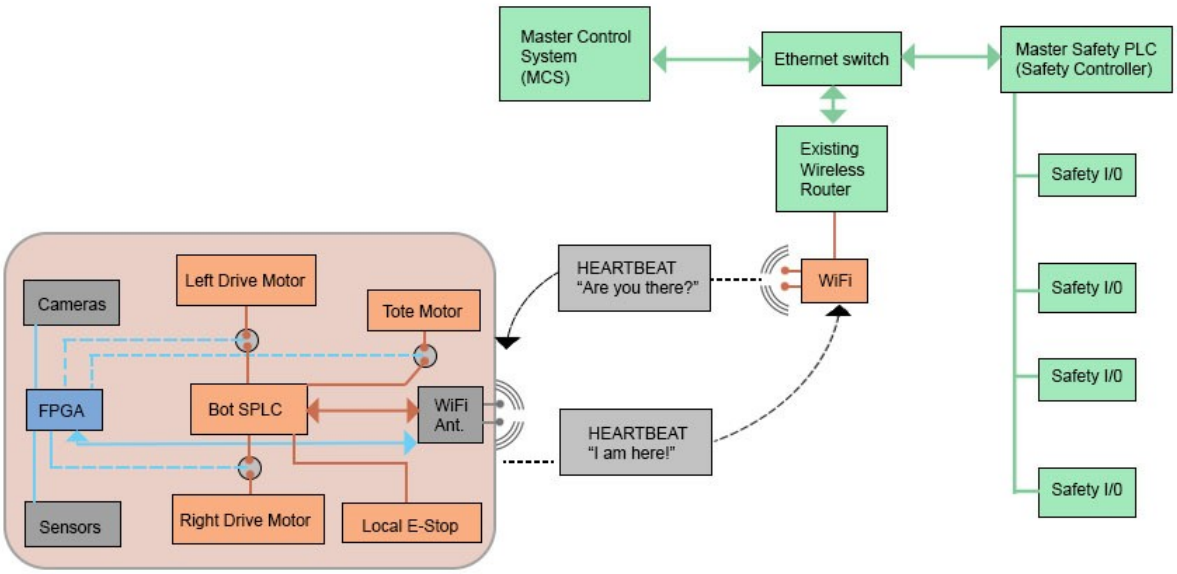
The Red LED is powered from the on-board SPLC safe output. This color is solely reserved to denote the Bot safety status, e.g. either blinking Red for system E-stop (all the Bots are safely stopped after pressing a system E-stop button) or loss of safety communication or solid Red for local E-stop (specific Bot E-stop button pressed).

3.4 Master Safety PLC Operation

The Main Control System (MCS) works with the Master Safety PLC ("Safety Controller") to indicate if it is safe for the Alphabot to continue running. If the bot is unable to detect a response from the MSC, the local Bot SPLC will request a controlled stop shortly before disabling motor actuation.

This "Heartbeat" communication is layered on top of the normal communication between the MSC and the individual Alphabot. Its purpose is to provide an additional layer of assurance that the bots are verifiably immobilized when the maintenance technician enters the Structure.

When a command is issued to the Alphabot by either the MCS or the Master SPLC, it is sent over Wifi and received by one or both of the Alphabot's Wifi Antenna. The command is then processed by the Main Board, which contains both the Bot Safety PLC (Bot SPLC) and the FPGA. The Bot SPLC may cease actuation of any motor if given the command to do so either by a triggering of the local E-stop button, or by a loss of connection to the MCS and Safety Controller.



3.5 Safety Controller Safe States and User Interaction

The Safety Controller is the device responsible for ensuring the Alphabot does not initiate an unsafe motor actuation. To accomplish this, the Safety Controller can put the bot into the Safe Torque Off state.

The Safe Torque Off (STO) function is provided to prevent the movement of the main drive wheels and tote load/unload motor during service and emergency stop conditions. When the structure is entered, either through the standard process (see the "RtE" procedure in *1000035-SF-01: Safety Manual, Lockout Tagout Procedures, APSD System, Alphabot*), or by using an emergency access key, all bots in the structure will stop and be safely disabled.

All bots can be disabled by pressing a global emergency stop button, situated around the perimeter of the system and at each workstation. In addition, a single bot's main drive wheels and tote load/unload motor can be safely disabled by pressing the local emergency stop button, mounted on the top of the bot.

To resume motion, all stop conditions must be cleared: E-Stop buttons are reset by rotating the button until a firm click is felt, and all service access doors are to be closed. To resume operation, the system reset button mounted to the outside of the perimeter fencing is pressed (see the "Return System to Normal Operation" procedure in *1000035-SF-01: Safety Manual, Lockout Tagout Procedures, APSD System, Alphabot*).

If the bot does not return to service on its own, an Elevated User can remotely reset the bot. If a remote reset of the bot does not return it to service, the Elevated User should escalate the issue to a Technician for further troubleshooting.

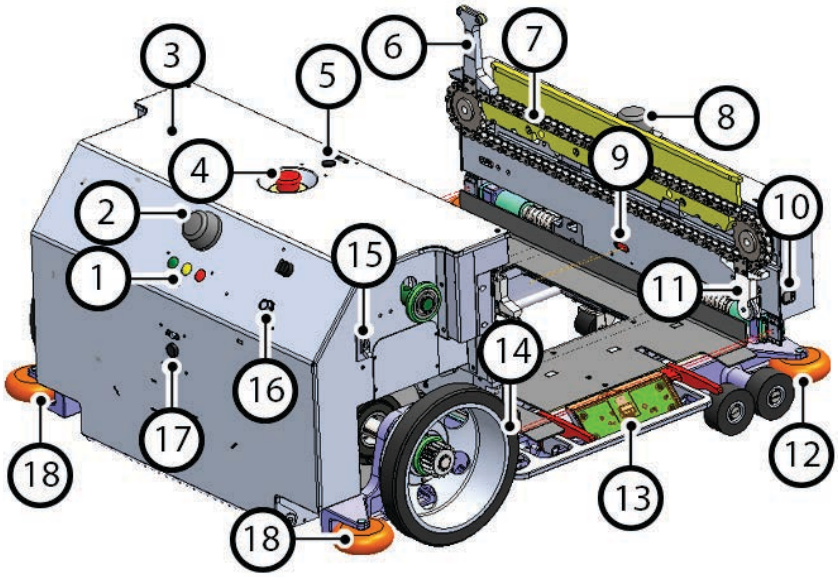
3.6 Alphabot Architecture

The Alphabot architecture consists of a **main board**, where all bot interconnect comes together. The main board provides the interconnect of the 4 motors, capacitor bank, maintenance debug connector, and all core components of the Alphabot.

The main board connects to the capacitor bank, and the capacitor bank connects to the power supply board. The main board controls the motor boards, each of which control their individual motors.

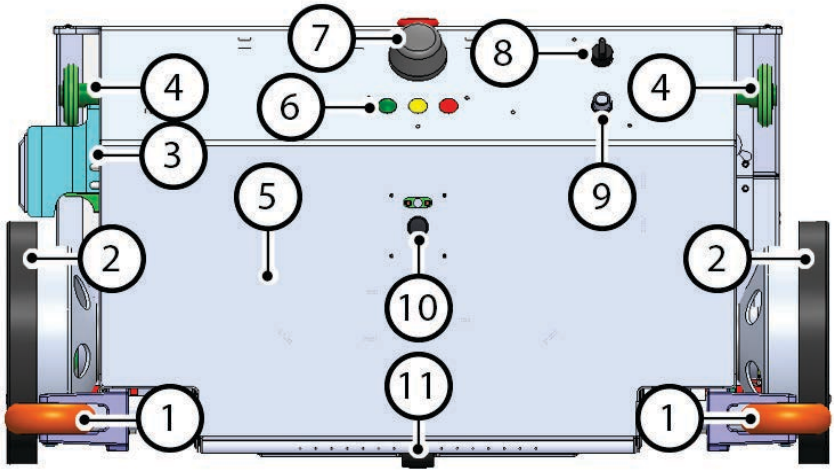
3.7 Alphabot Hardware Overview

The Alphabot and its external components are outlined in the diagrams that follow:



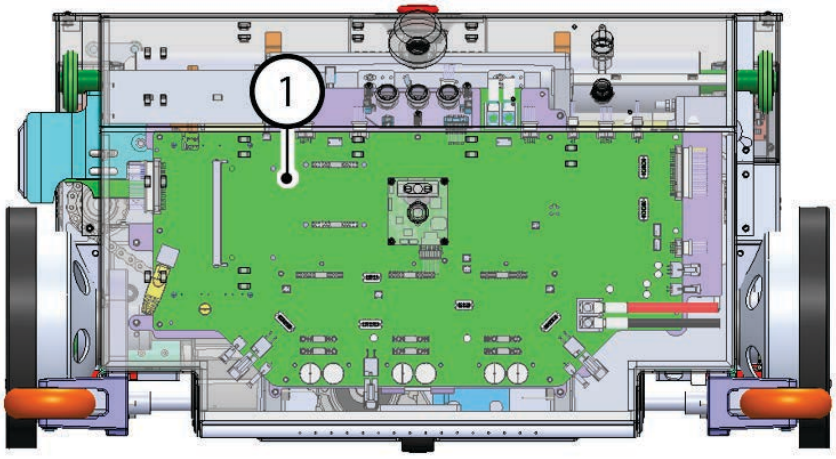
General View of the Alphabot®

1. Status Lights
2. WiFi Antenna (Front)
3. Front Cover
4. E-stop Button
5. Camera (Top)
6. Grabber Finger (Rear)
7. Line Motor Chain (Rear)
8. WiFi Antenna (Rear)
9. Tote Sensor (Rear)
10. Positioning Sensor (Left)
11. Pusher Finger (Rear)
12. Guide Wheel (Rear)
13. RFID Reader
14. Drive Wheel (Left)
15. Main Board Cutoff Switch
16. Service Switch + Maintenance Port
17. Camera (Front)
18. Guide Wheels (Front)



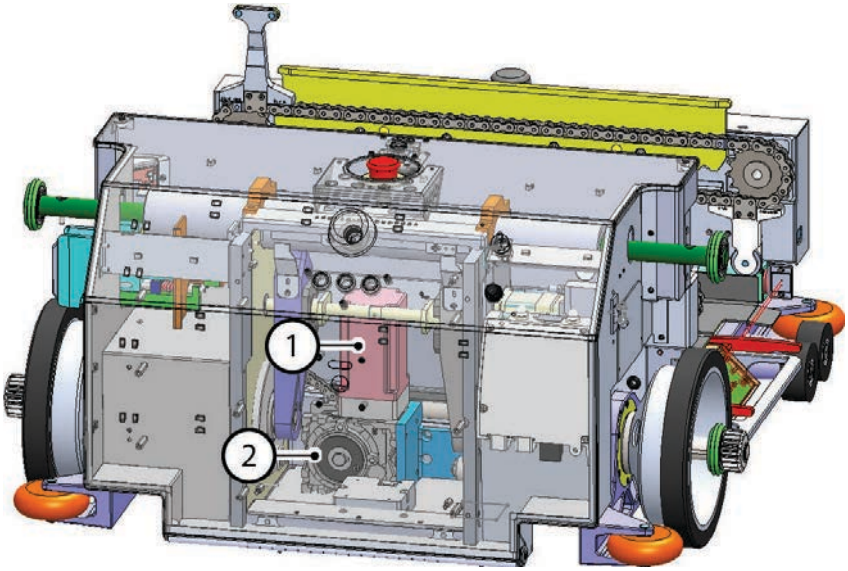
Front View With Cover On

1. Guide Wheel
2. Drive Wheel
3. Charge Toe
4. Vee Wheel
5. Cover
6. Status Lights
7. WiFi Antenna
8. Service Switch
9. Maintenance Port
10. Camera
11. Magnetic Detection Strip



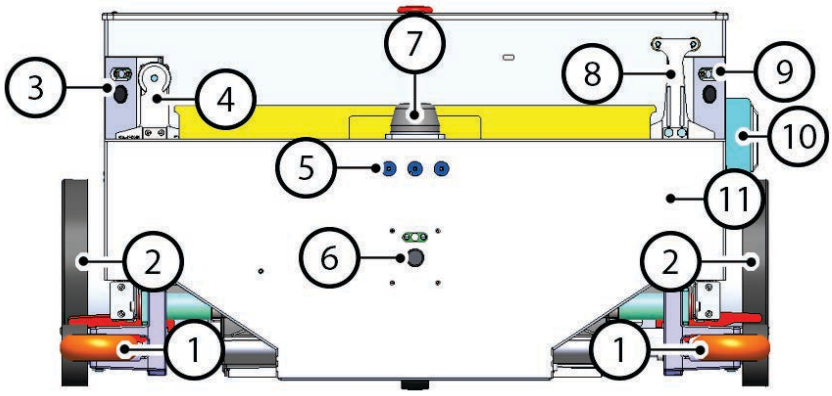
Front View Top-Down No Cover

1. Main Board



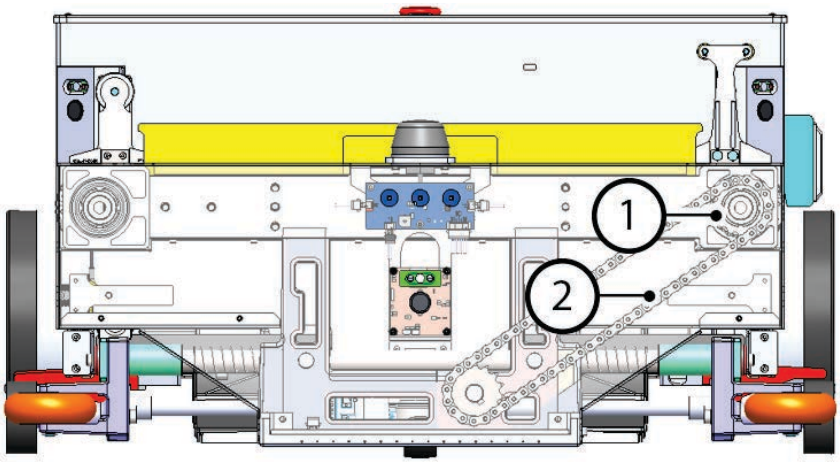
Front View No Cover

1. Tote Motor
2. Worm Gearbox



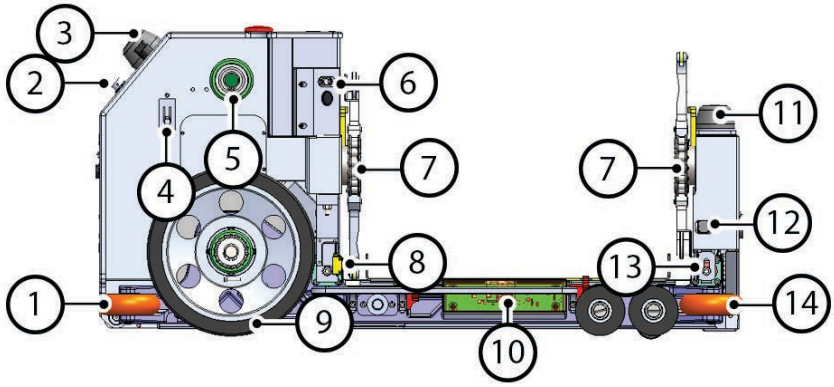
Rear View With Cover

1. Guide Wheel
2. Drive Wheel
3. Camera (Left)
4. Pusher Finger (Rear)
5. Status Lights (Rear)
6. Camera (Rear)
7. WiFi Antenna (Rear)
8. Grabber Finger (Rear)
9. Camera (Right)
10. Charge Toe
11. Cover



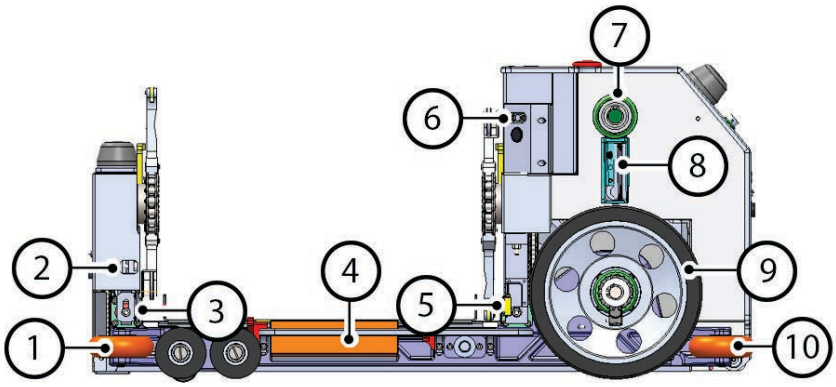
Rear View No Cover

1. Linkage
2. 30 Chain



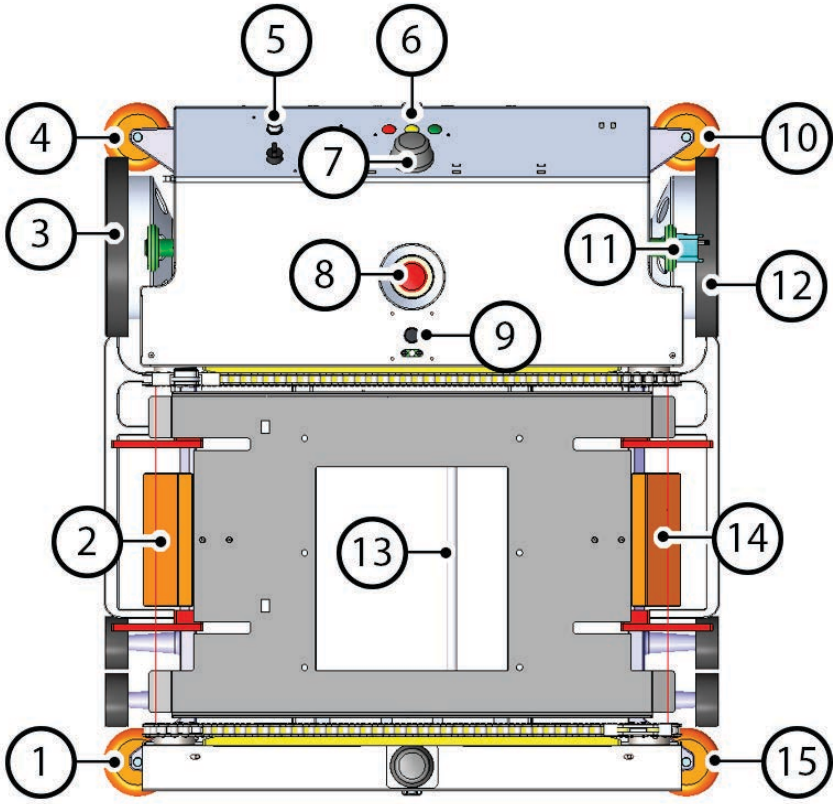
Left Side View With Cover

1. Guide Wheel (Left)
2. Maintenance Port
3. WiFi Antenna (Front)
4. Main Board Cutoff Switch
5. Vee Wheel
6. Camera (Left)
7. 40 Chain (Front and Rear)
8. Tote Sensor (Left)
9. Drive Wheel (Left)
10. RFID Reader (left)
11. WiFi Antenna (Rear)
12. Tote Sensor (Left)
13. Positioning Sensor (Left)
14. Guide Wheel (Left)



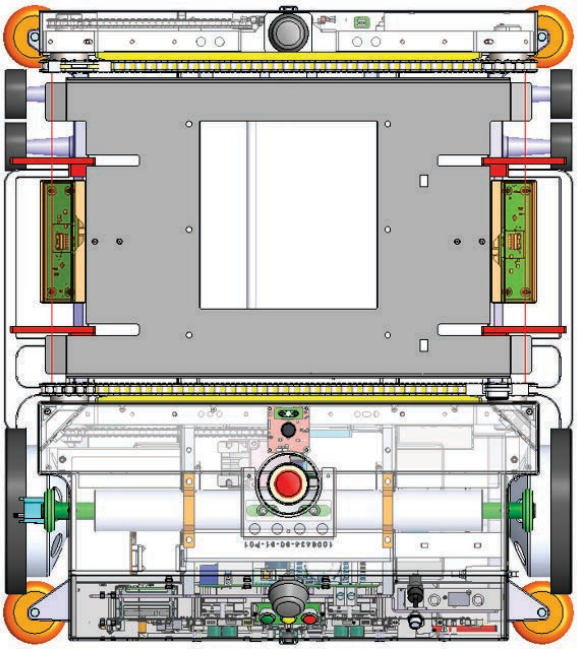
Right Side View With Cover

1. Guide Wheel (Right)
2. Tote Sensor (Right)
3. Positioning Sensor (Right)
4. RFID Reader (Right)
5. Tote Sensor (Right)
6. Camera (Right)
7. Vee Wheel (Right)
8. Charge Toe
9. Drive Wheel (Right)
10. Guide Wheel (Right)



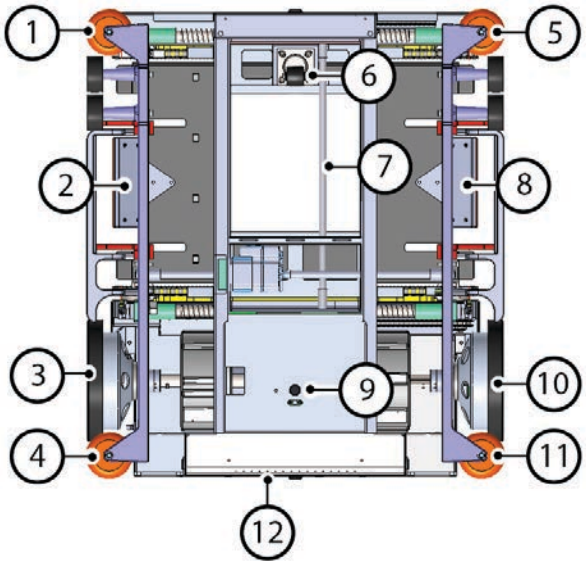
Top-Down View With Cover

1. Guide Wheel (Left)
2. RFID Reader (Left)
3. Drive Wheel (Left)
4. Guide Wheel (Left)
5. Maintenance Port
6. Status Lights (Front)
7. WiFi Antenna (Front)
8. E-stop Button
9. Camera (Up)
10. Guide Wheel (Right)
11. Drive Wheel (Right)
12. Charge Toe
13. Tote Transfer Shaft
14. RFID Reader
15. Guide Wheel (Right)



Top-Down View No Cover (Diagram)

Top-Down View No Cover (Photo)

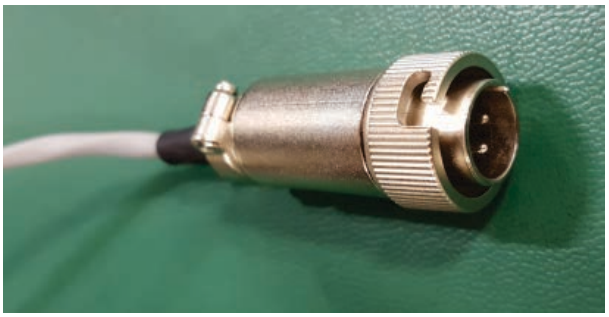


Bottom View With Cover (Diagram)

Bottom View No Cover (Photo)

1. Guide Wheel (Left)
2. RFID Reader (Left)
3. Drive Wheel (Left)
4. Guide Wheel (Left)
5. Guide Wheel (Right)
6. Caster Wheel
7. Tote Transfer Shaft
8. RFID Reader (Left)
9. Camera (Down)
10. Drive Wheel (Right)
11. Guide Wheel (Right)
12. Magnetic Detection Strip

Status Lights, WiFi Antennae, and Service Switch

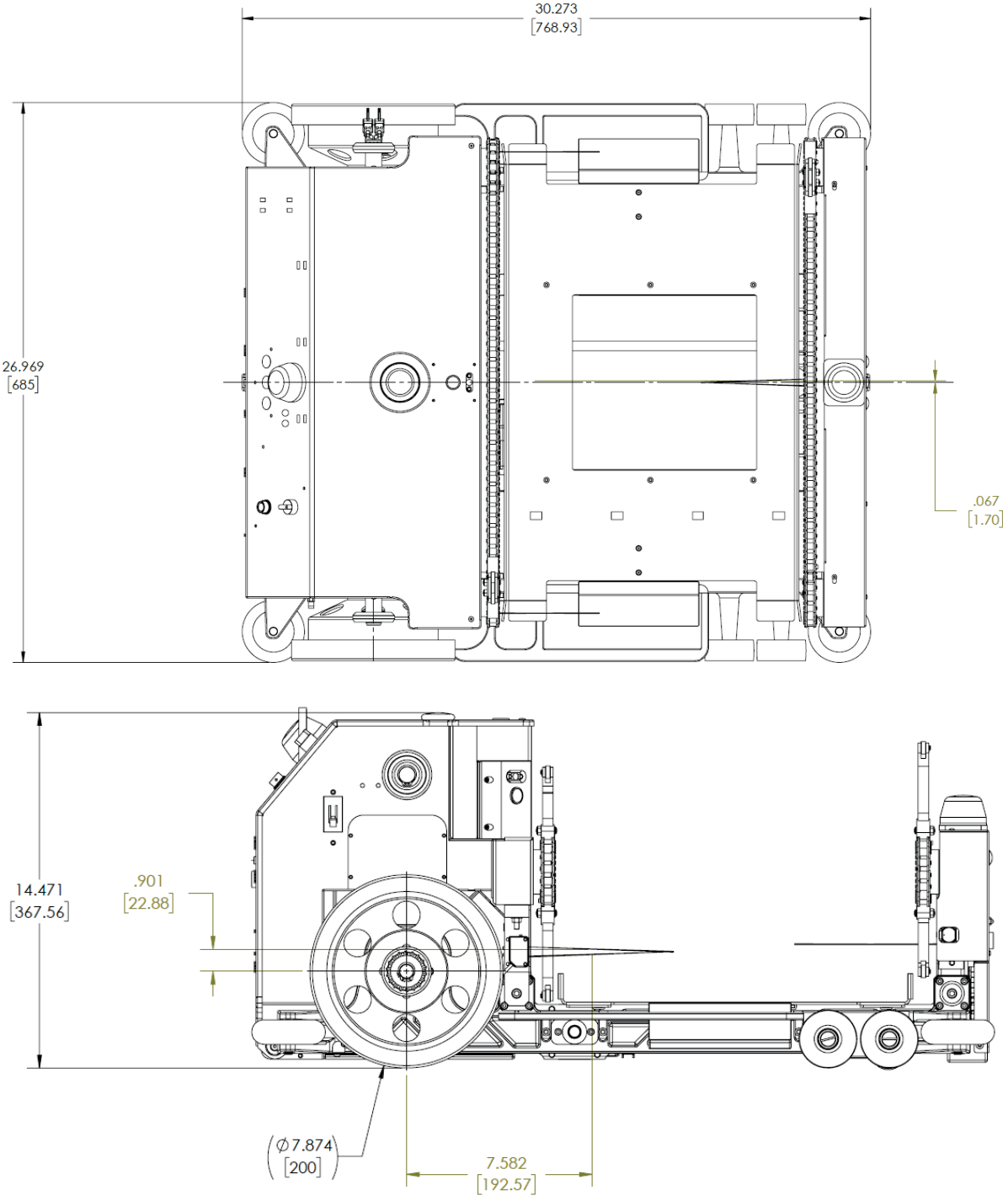


Maintenance Port Connector

Maintenance Port Connector and Maintenance Port

Breaker (Disconnect) Switch

3.8 Physical Specifications



3.9 Power Requirements

Power Storage	Capacitor Board
Required Charging Equipment	Structure Charge Rail
Standard State w/ Fully-Active Capacitor Bank (W)	3.5W-5W
Power-Save/Sleepy Bear Mode Usage (W)	<200mW

3.10 Technical Specifications, Capacity, Velocity

Max Alphabot Loads	**lbs.**	**kg.**
Alphabot Mass	141	63.95
Maximum Carried Package Weight	50	22.67
Maximum Combined Load on Wheels	191	86.63
Load per Drive Wheel	59	26.76
Maximum Load per Drive Wheel	115	52.16
Drive Wheel Contact Area (sq. in)	0.8	0.36
Portion of Total Load on each Caster Wheel	73	33.11
Load per Rear Wheel	18.25	8.27
Maximum Lead per Rear Wheel	64	29.02

Max Alphabot Loads	lbs.	kg.
Rear Wheel Contact Area	0.6	0.27
Caster Load	73	33.11
Max Load on Caster	165	74.8
Caster Contact Area	0.4	0.18

Alphabot Velocity	
Maximum Velocity (Horizontal)	4 mps
Maximum Velocity (Vertical)	1 mps
Stopping Time	2.5 s
Stopping Distance	4.6 m
Acceleration to Max Velocity	2 mps^2

3.11 Environmental Specifications

Indoor/Outdoor Usage	Indoor usage only.
Operating Ambient Temperature	0°C to 40°C
Storage Temperature	-40°C to 70°C
Humidity	10 - 95% relative humidity (non-condensing)
Dust	Designed for typical warehouse dust loads. Not for use on unpaved or loose surfaces. Regular cleaning in dusty environments is recommended to reduce bot maintenance intervals.
Altitude	-100m to 2000m (with respect to sea level)

3.12 Lifecycle

Alphabots are designed for 10 years of active service. Active service is defined as the time the Alphabot is either in motion, or otherwise in the process of executing a mission but temporarily idle.

4. Operation

4.1 Overview

During normal operation, Alphabots operate autonomously from direct human control, with the exception of when Alphabots are started up or shut down. Alphabots are started up when initially being inducted into the larger Alphabot System (when the MCS first becomes aware of their existence), and when recovering from a disabling condition within the Alphabot System that requires human intervention. Similarly, Alphabots are shut down during removal from the floor, or when recovering from a disabled condition.

4.2 Theory of Operation

The Alphabot constitutes one part of the larger Alphabot System, whose overall operation entails the fulfillment of customer product orders, or “eaches”.

The Alphabot System consists of four major systems:

1. Bot Subsystem: Comprised of a fleet of mobile vehicles called “Alphabots” (or simply "bots"), which perform all storage/retrieval and transport tasks required to assemble and ship customer orders and replenish the inventory of picking stock.
2. Structure Subsystem: Provides the physical/structural support for the storage of totes, the movement of bots, and the operation of process stations.
3. Workstation Subsystem: Comprised of process stations, including order-assembly (“picking”) workstations, replenishment (“decanting”) workstations, and order-transfer stations.
4. System-Control Subsystem: Comprised of the software that orchestrates all activities within the system, along with the necessary computing and communications-network infrastructure.

The order-assembly process is accomplished by creating a flow of bots, some of which carry product containers (“P-totes”) containing eaches from inventory and others of which carry order containers (or “O-totes”) through an array of picking workstations, where a human picker (or an automated picker in future embodiments) transfers ordered “eaches” from P-totes to O-totes. P-totes and O-totes are held in storage when not being used during this process, and the bots perform all storage/retrieval and transport moves required by the process. At the workstations, human pickers (or automated pickers in the future) transfer ordered eaches from the product containers to the order containers.

The physical interface of the system to the environment consists of an input where replenished product totes are provided into the system and an output where assembled order totes are handed over to their receivers (customer, delivery truck, etc.). Every bot has full access to all tote-storage locations, all workstations, the input, and output.

Alphabots can move in all three dimensions on their own power, i.e., with no mechanical assistance, and so all vertical space from floor to ceiling is used for both product storage and picking workstations, and the only handling mechanism is the bot fleet.

4.3 Unpacking an Alphabot

Alphabots are shipped fully assembled; therefore no material setup is required. Simply unpack the drive unit and move to a location where the drive unit is safe until it is ready for induction/installation onto the floor.

⚠ CAUTION	
	**LIFTING HAZARD** Lifting heavy objects without proper technique may result in minor to severe injury. Use safe lifting, handling and transportation techniques when loading the products at all times: o Keep legs bent o Keep back as straight as possible o Load close to body o Grip object from opposite corners o Lift with legs; not your back

4.4 System Start

The Alphabot system is set to start under the following conditions:

- Whenever the operator logs into any of the workstations
- System start-up initiated through the MCS directly (for advanced level users only)

4.5 System Shutdown

An end of day system shutdown is desirable to leave the Alphabot system in a known idle state and to minimize cooler loss during non-operational hours. The following conditions will trigger the system to go into a shutdown state:

- System is idle as listed below:
  - The system is outside of defined operational hours.
  - No active orders and no pending orders due within the next hour.
  - All workstations have gone into an inactivity state for at least 15 minutes.
- Fire alarm has been activated.
- Power loss to the system and UPS power has been activated for 2 minutes continuously.

4.6 Bot Removal

See the "Remove Bot from System" section of 1000067-SRF-01: Alphabot Pre and Post Procedures Manual for this procedure.

4.7 Bot Induction

See the "Return Bot to System" section of 1000067-SRF-01: Alphabot Pre and Post Procedures Manual for this procedure.

4.8 Alphabot Interactions with Workstations

4.8.1 Picking

Alphabots arrive to the dynamic workstation containing an empty order tote or a product tote. The operator then fills the customer order using product from the product tote. The Alphabot then stores the order inside the System.

4.8.2 Load Product

Alphabots deliver empty product totes to the Static Workstation. An operator pulls the empty totes onto the Static Workstation shelf, decants product into the tote, and loads it into the System where the Alphabot retrieves the tote. The bot then stores the tote in the System.

4.8.3 Pull Empty Tote

Alphabots deliver the empty totes to the Static Workstation. The operator then removes all empty totes from the Static Workstation.

4.8.4 Pull Product

Alphabots deliver expired and "past-fresh" totes to the Static Workstation. The operator then pulls the tote onto the Static Workstation shelf and is instructed to remove all product from the tote or sub tote. Once all product is removed, the operator pushes the tote back into the Alphabot system.

4.8.5 Load Order Tote

Alphabot retrieves loaded totes from associates that contain customer orders. The operator will then push the tote into the Alphabot system for the Alphabots to store for later retrieval.

4.8.6 Load Empty Tote

Alphabots retrieve empty totes that are loaded by operators and stores them in the System for later use.

4.8.7 Pull Order

Alphabots deliver all order totes for the given order to the Static Workstation. The operator will then retrieve the totes from the Static Workstation and deliver them to the customer.

5. Troubleshooting

When an Alphabot experiences an error within the Alphabot System, there are several troubleshooting procedures that an Operator or Elevated User are allowed to perform to attempt to resolve the error. Most of these procedures can be carried out remotely, requiring no entry into the Structure.

5.1 Scope of Troubleshooting

All troubleshooting procedures are carried out via the MCS Client. This application will allow an Elevated User to remotely diagnose and resolve a multitude of issues, without needing to enter the Structure.

All MCS troubleshooting procedures are completed by Elevated Users and can be found in the MCS User Manual (PN 1000016-MN-01).

In the event that the procedures in the MCS User Manual do not resolve the problem, the Elevated User will escalate to a Technician for further investigation. An Elevated User will not enter the Structure to attempt maintenance under any circumstances.

Technician troubleshooting procedures can be found in the Alphabot Maintenance Manual.

6. Regulatory Compliance Information

6.1 Standards Compliance

The Alphabot system is TUV-certified and in compliance with NFPA 79; CSA C22.2 No.301-2016 and UL 2011 standards. Other referenced standards of compliance are shown in the table below.

Standards Compliance	
Standard	**Title**
SA / UL 2011	**Outline of Investigation for Machinery**
NFPA 79	**Electrical Standard for Industrial Machinery**
UL 508A	**"Standard for Safety – Industrial control panels"**
CSA C22.2 No. 14	**Industrial Control Equipment**
ISO 13849 -1	**Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design**
ISO 12100	**Safety of machinery — General principles for design — Risk assessment and risk reduction**

Standards Compliance	
Standard	**Title**
IEC 61508	**Functional Safety Of Electrical/Electronic/Programmable Electronic Safety-Related Systems**
IEC 62061	**Safety Of Machinery - Functional Safety Of Safety-Related Electrical, Electronic And Programmable Electronic Control Systems**
IEC/UL/EN/CSA C22.2 # 61010-1	**Safety Requirements For Electrical Equipment For Measurement, Control, And Laboratory Use - Part 1: General Requirements**
IEC/EN 60204-1	**Safety Of Machinery - Electrical Equipment Of Machines - Part 1: General Requirements**
IEC 60947-5-1	**Low-voltage switchgear and controlgear - Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices**
ANSI Z535.xx	**American National Standards for Safety Signs and Colors**
ISO 13850	**Safety of machinery. Emergency stop function. Principles for design**
EN 842	**Safety of machinery - Visual danger signals - General requirements, design and testing**
UL 94 V	**Tests for Flammability of Plastic Materials for Parts in Devices and Appliances**

6.2 FCC Compliance

FCC Notice (for U.S. Customers):

This device complies with Part 15 of the FCC Rules:

Operation is subject to the following conditions:

1. *This device many not cause harmful interference, and*
2. *This device must accept any interference received, Including interference that may cause undesired operation*

Changes and Modifications not expressly approved by Alert Innovation, Inc. Inc. can void your authority to operate this equipment under Federal Communications Commissions rules.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. The antenna(s) used for this equipment must be installed to provide a separation distance of at least eight inches (20 cm) from all persons. This equipment must not be operated in conjunction with any other antenna.

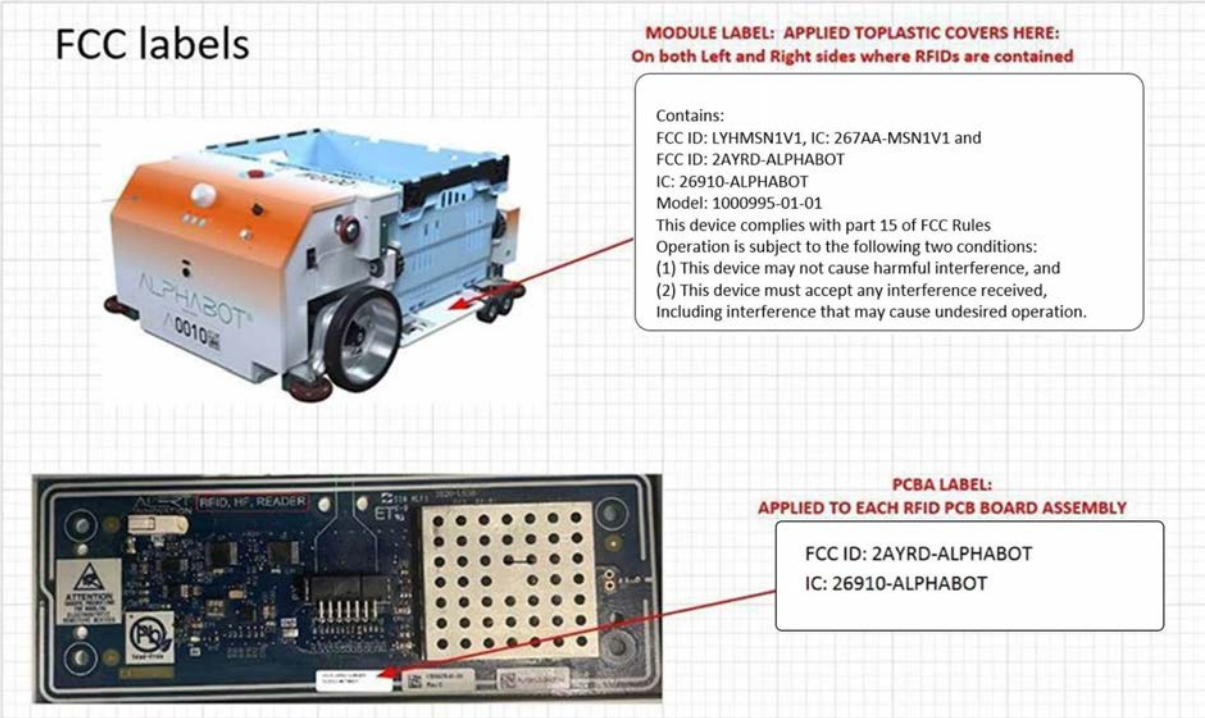
To fulfill FCC Certification requirements, an OEM manufacturer must comply with the following regulations:

1. The 1000479-01-04 modular transmitter must be labeled with its own FCC ID number, and, if the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following:

   IMPORTANT: Contains FCC ID: 2AYRD-ALPHABOT. This equipment complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation (FCC 15.19).

FCC Labels

Location of Labels



RFID Label on PCB Board

FCC ID: 2AYRD-ALPHABOT
IC: 26910-ALPHABOT

Alphabot Label Contents

Contains:
FCC ID: LYHMSN1V1, IC: 267AA-MSN1V1 and
FCC ID: 2AYRD-ALPHABOT
IC: 26910-ALPHABOT
Model: 1000995-01-01
This device complies with part 15 of FCC Rules
Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and
(2) This device must accept any interference received,
Including interference that may cause undesired operation.

6.3 ISED Regulatory Information

Canada (ISED) Regulatory Information:

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Le présent émetteur radio (IC: 26910-ALPHABOT) a été approuvé par ISED Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Let types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

Antenna Type: PCB Etch
Impedance: 50 ohm
Maximum Gain: 0 dBi

The OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

This Module is labelled with its own IC ID. If the IC ID Certification Number is not visible while installed inside another device, then the device should display the label on it referring the enclosed module. In that case, the final end product must be labelled in a visible area with the following:

"Contains Transmitter Module IC: 26910-ALPHABOT"

OR

"Contains IC: 26910-ALPHABOT"

Ce module est étiqueté avec son propre ID IC. Si le numéro de certification IC ID n'est pas visible lorsqu'il est installé à l'intérieur d'un autre appareil, l'appareil doit afficher l'étiquette sur le module de référence ci-joint. Dans ce cas, le produit final doit être étiqueté dans un endroit visible par le texte suivant:

“Contains Transmitter Module IC: 26910-ALPHABOT”

OR

“Contains IC: 26910-ALPHABOT”

7. Revision History

Revision	ECO	Date	Author	Change Description
A	ECO-001520	2/2/2021	J. Duane	Initial Release
B	ECO-001624	3/9/2021	J. Duane, A. Kleen	• Regulatory 70 chapter added. • Alphabot Architecture 47 section simplified. • Master Safety PLC 45 image corrected. • Description of System E-stop Circuitry 38 image corrected. • Updated formatting to another writing tool. Some tables, text, or images may appear differently. • Updated PPE 17 table for compliant ISO labels. • Updated Description and Location of Safety Labels 33 table for clarity. • Per the APSD Lockout Tagout Procedures Manual (PN1000035-SF-01), the following sections have been updated or added: o Bot Lockout procedure updated o Discharge Bot 29 added • Referenced Alphabot Pre and Post Procedures Manual (PN 1000067-SR-01), for the following: o Bot Induction 66 o Bot Removal 66 • Alphabot Components 41 section moved into a table and alphabetized. • Alphabot Hardware 48 section now has numbered labels and descriptions following for future translation ease. • Troubleshooting sections have been removed and replaced with a reference to the MCS User Manual (PN 1000016-MN-01). • Standards Compliance 70 table updated. • Added note to introduction 6. • Removed (R) symbol throughout.

				• Alphabot Components 41: Line Finder corrected to Line Follower. • General Safety renamed to Hazard Description 16 • System Lockout / Tagout 26 - removed European Standard • Mechanical Brakes 29 updated. • Bot LEDs 44 table updated for red flashing lights. • Remote Charging and Brake Release functions 32 renamed. • Re-organized document and took out unnecessary sections: o Intended Audience o UCC o Training Levels o Tower Light Indicators o Creeper Safety o Training Records • Bot Switch and Connector 30 - removed notice. • Inherent Safety Hazards of the Alphabot 19 updated • Environmental Safety 18 updated • Safety Controller Safe States 46 updated.
C	ECO-100404	9/29/2021	J. Duane, A. Kleen	• Changed "deck" to "transit plane". • Replaced all instances of "robot" with "bot" or "Alphabot". • Formatting improvements. Images added. • Added info to Safety Equipment Rules 24 to clarify how padlocks are used. • Updated Lockout/Tagout Standards 26 note. • Updated Standards Compliance 70 to show we are certified. • Added Radiation Exposure Statement 37 section. • FCC Compliance 72 section labels updated with latest.