SPOT INFORMATION FOR USE

VI.0 - Original Instructions
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1 Introduction

This document contains critical safety information.

Responsible use of Spot is crucial to prevent dangerous conditions for operators and others nearby. Make sure to read, understand and comply with this document to lessen the risk of injuries or damage to the robot or other property.

Please read the entire document before using Spot and keep the document in a readily accessible location afterwards.

1.1 Manufacturer information

Spot is manufactured by:

Boston Dynamics
78 4th. Street
Waltham, MA 02451
USA

1.2 Definition of a Spot owner

In the scope of the present document, an "owner" is the legal entity purchasing or leasing Spot for the purpose of operating the robot in industrial or commercial applications and environments. Owners are subject to workplace safety regulations and are active counterparts of the manufacturer in implementing residual risk reduction measures.

1.3 Definition of a Spot operator

In the scope of the present document, an "operator" is any person operating Spot under the responsibility of an Owner. Operators are assumed to be trained in the usage of Spot.

NOTE: Both Owners and Operators are often referred as "Users."
1.4 Description of the machinery

Spot is a legged robot capable of mobility on a variety of terrains. Spot uses multiple sensors and 3 motors in each leg to navigate in indoor and outdoor environments, maintain balance and attain postures.

For an overview about Spot, watch an introduction to Spot (link).

Refer to training and safety videos from Boston Dynamics Support for details about safe handling and usage.

https://www.youtube.com/c/BostonDynamicsSupport/featured
## 1.5 Specifications

<table>
<thead>
<tr>
<th><strong>Base robot dimensions</strong></th>
<th><strong>Battery</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length: 1100 mm</td>
<td>Battery capacity: 605 Wh</td>
</tr>
<tr>
<td>Width: 500 mm</td>
<td>Average runtime (no payload): 90 mins</td>
</tr>
<tr>
<td>Height (standing): 840 mm</td>
<td>Standby time: 180 mins</td>
</tr>
<tr>
<td>Height (sitting): 191 mm</td>
<td>Recharge time: 120 mins</td>
</tr>
<tr>
<td>Net weight: 32.5 kg</td>
<td>Weight: 4.2 kg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Battery charger</strong></th>
<th><strong>Connectivity</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input voltage: 100-240VAC 50/60Hz 5.5A Max</td>
<td>WiFi 2.4Ghz b/g/n</td>
</tr>
<tr>
<td>Output: 35-58.6 VDC 7.2A Max</td>
<td>Gigabit Ethernet</td>
</tr>
<tr>
<td>Operating temperature: 0 to 40°C</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Terrain sensing</strong></th>
<th><strong>Locomotion</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal field of view: 360°</td>
<td>Max speed: 1.6 m/s</td>
</tr>
<tr>
<td>Range: 4 m</td>
<td>Max slope: ±30°</td>
</tr>
<tr>
<td>Lighting: &gt; 2 Lux</td>
<td>Max step height: 300 mm</td>
</tr>
<tr>
<td>Collision avoidance: Maintains set distance from stationary obstacles</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Payloads</strong></th>
<th><strong>Environment</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Payloads can be mounted on Spot using the payload rails and payload ports, respectively.</td>
<td>Ingress protection = IP54</td>
</tr>
<tr>
<td></td>
<td>Operating temperature = -20 to 45°C</td>
</tr>
<tr>
<td></td>
<td>Operating Humidity – 0 to 70% RH</td>
</tr>
</tbody>
</table>
2 Product safety overview

Properties of the Spot robot:

- Spot is a self-propelled (battery powered) legged robot.
- The robot performs locomotion and navigation in a variety of indoor and outdoor environments.
- The robot uses embedded sensors for detecting the surrounding environment.
- The robot uses a complex set of control algorithms to balance and navigate.
- Spot capability can be expanded with a variety of payloads.
- Spot does not carry persons.
- Spot is operated remotely without a physical connection such as a cable between control units and the machinery.
Spot is a mobile robot with a high degree of autonomy in locomotion. The robot's behavior while in motion can be variable or unexpected with respect to planned trajectories or movements.

Use caution at all times when operating Spot. Carefully review the information in this document and follow all recommendations.

Spot is a quadrupedal robot with a sophisticated control methodology. Spot is a dynamically balancing robot.

The upright and/or balancing posture can only be attained with active control.

However, active control does not ensure that stable balancing is attained.

Stability is also determined by the conditions of the ground and the environment at any given time. Such conditions are not entirely predictable and Spot may fall unexpectedly.

Use caution at all times when operating Spot. Carefully review the information in this document and follow all recommendations.

Spot is a versatile and powerful machine. Some hazards — specifically mechanical hazards — depend on specific applications and the robot's posture during hazardous conditions.

Spot is a general purpose mobile autonomous robot and as such requires the Owner to perform a risk assessment for each specific application. Additional safeguarding may be necessary as a result of the application-specific risk assessment. The Owner is responsible for implementing and maintaining such additional risk reduction measures.
Designing, installing and integrating payloads with the Spot robot can influence the hazards and safety of the complete robot platform. You must take into account local regulatory requirements for the complete robot platform when integrating any payloads with Spot.

### 2.1 Intended use

Intended use and environmental conditions are essential for evaluating the risks and safety requirements reported in this document.

Typical usage situations involve:

- Indoor walking at nominal speed up to 1.2 m/s in supervised mode (operator follows Spot in direct drive mode) or autonomous mode. Locomotion includes climbing several flights of stairs and other uneven walking surfaces. Small obstacles, narrow passages (limited clearances) cluttered infrastructure are possible.
- Outdoor walking at nominal speed up to 1.2 m/s in supervised mode or autonomous modes (see above) on variable terrain with unpredictable shape/material and other physical properties. Clearances are large and operators maintain optimal observation of the operation most of the time.

### 2.2 Restrictions on the environment

#### 2.2.1 Definition of industrial environment

Within the scope of this document, an “industrial environment” is a workplace where the public is restricted from access or not reasonably expected to be present during the robot’s intended tasks and application.

Industrial environments are structured or semi-structured. Layout, infrastructure and hardware inside the environment have a designated purpose.

In particular, the following conditions apply for Spot applications:

- A working area for Spot must be delimited and all Operators and persons exposed to the robot are notified of this area before usage.
- Operating and observing personnel are expected to conform to their employer's safety guidelines for the use of PPE.
Access to the industrial environment is restricted to working adults who have been informed about the content of this document.

Public spaces are excluded from the definitions and conditions listed above.

Untrained personnel and children are excluded from the definitions and conditions listed above.

Research laboratories or temporary facilities are eligible for use provided that all conditions and restrictions apply.

Applications that are intended for frequent exposure to the robot by users or that could determine physical interaction with the robot are also excluded.

Failing to comply with the conditions listed above about the type of environment, personnel and condition of exposure to hazards, may expose users to risks higher than those estimated for the intended use.

2.2.2 Limitations on environmental conditions and types of applications

Spot is a legged robot. Locomotion and balance is based on a dynamic control principle. Sensors are used for the perception of the ground and the surrounding environment.

The conditions of the environment have a significant influence on the robot's stability and the possibility of failure during locomotion.

Hazardous conditions during locomotion could result in the following behaviors:

- Falls
- Instability and recovery attempts that cause unpredictable movements of the legs
- Large deviations from planned and expected paths
- Sudden accelerations of either the legs or the entire robot
- Tipping over
- Sliding or tumbling following a fall or tip over
- Any combination of the above
### 2.2.3 Environmental conditions

Environmental conditions that can cause hazards when operating the robot include, but are not limited to:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td><strong>Cliff edges</strong></td>
<td>Spot is not able to detect sudden termination of a walking surface (&quot;cliff&quot;). Cliff edges must be guarded with the use of blocks, guards, nets, or other infrastructure parts larger than 300 mm.</td>
</tr>
<tr>
<td><strong>Presence of sand, dust, and liquids</strong></td>
<td>Spot is able to walk on sand, dust, and liquids. However, particular slippery materials or round particles could compromise the robot’s stability. Verify the expected properties of material on the walking surfaces</td>
</tr>
<tr>
<td><strong>Presence of cords</strong></td>
<td>Spot is not able to detect cords, which could entangle its legs and cause a fall. Cords must be cleared from the robot’s path.</td>
</tr>
<tr>
<td><strong>Unstable objects that are less than 300 mm high</strong></td>
<td>Spot is not able to reliably detect objects lower than 300 mm above the walking surface. Clear the robot path from unstable objects that are less than 300 mm above the walking surface.</td>
</tr>
<tr>
<td><strong>Transparent, mirrored or very bright surfaces</strong></td>
<td>Spot is not able to reliably detect transparent, mirrored, or very bright obstacles. Surfaces should be visually textured.</td>
</tr>
<tr>
<td><strong>Walking surfaces that are not stable or moving</strong></td>
<td>Spot cannot rely on its sensors if ground surfaces are not stable. Avoid walking on moving surfaces, such as elevators, escalators, moving walkways and ramps, vehicles, or boats. Transportation on a moving platform is allowed if the robot is in lockout mode.</td>
</tr>
<tr>
<td><strong>Steep inclines</strong></td>
<td>Spot cannot maintain stability on inclinations exceeding +/- 30 degrees.</td>
</tr>
<tr>
<td><strong>Excessive stair step height</strong></td>
<td>Stair step and riser dimensions are within 175 x 255-280 mm, with a maximum step of 300 mm.</td>
</tr>
<tr>
<td><strong>Insufficient lighting</strong></td>
<td>Lighting that provides less than 2 lux.</td>
</tr>
<tr>
<td><strong>Out-of-range operating temperatures</strong></td>
<td>Operating temperature outside the range between -20°C and 45°C.</td>
</tr>
<tr>
<td><strong>Weak wireless connection</strong></td>
<td>Spot will enter in a stopping protection mode when losing its wireless connection to the controller. If this occurs on stairs, slope, or other uneven surface, Spot may slide or fall upon attempting to sit.</td>
</tr>
</tbody>
</table>
2.3 Misuse

Boston Dynamics considers the following motivations for foreseeable misuses:

- Behavior of a person resulting from lack of concentration, carelessness, or lack of training.
- Reflex behavior of a person in case of malfunction, incident or failure during the use of the machine.
- Operating the robot without sufficient awareness of specific applications and environments.

Behaviors that do not correlate with any operational need for accomplishing a mission/production objective are not considered foreseeable.

Behaviors that are considered not foreseeable misuses include, but are not limited to:

- Approaching and/or staying close to Spot during operation to observe the robot
- Attempting to access moving joints or other robot components during active Spot operations
- Attempting to make contact with the robot during the onset of instability for modifying the course of events
- A person misjudging their position relative to the robot as the robot moves on higher ground

Failure to operate Spot in accordance with environmental specifications is considered a misuse.

Other misuses include, but are not limited to:

- Transportation of persons or animals
- Transportation of hazardous materials or substances
- Intentionally harming any person
- Use for any illegal purpose
- Use as a climbing aid
- Use in potentially explosive environments

Any robot misuse can potentially cause severe personal injuries or result in significant material hazards.
2.4 PPE

While operating Spot, no additional PPE is needed other than what is required in the Owner's industrial environment. However, wearing safety footwear is recommended.

2.5 Non-ionizing radiation considerations

Information on non-ionizing radiation is provided below.

2.5.1 EMC considerations

Spot has been tested for EMC compliance according to standards related to heavy industrial environments. Spot should be able to withstand EMC disturbances typically found in Industrial environments.

See the section Compliance statement for details.

2.5.2 Radio considerations:

Spot uses a Wi-Fi radio that has been approved to the Radio Equipment Directive (RED). In addition, Spot has been evaluated in accordance with the appropriate RED standards for radio devices.

See the section Compliance statement for details.

2.6 Laser

The Spot robot contains 5 stereo camera systems that contain a Class I laser projection system.

This product is classified as a Class 1 Laser Product under the EN/IEC 60825-1, Edition 2 (2007) and Edition 3 (2014).
Tampering with or adjustments to any of the laser components is not allowed and may result in hazardous radiation exposure. Use of controls or adjustments or performance of procedures other than those specified herein may also result in hazardous radiation exposure.

### 2.7 Noise

The airborne noise generated by Spot is determined by the environment Spot is operating in.

The noise of Spot walking across a padded carpet floor will be much less than the noise from Spot walking up metal stairs. Before putting Spot into regular use, users should work with their EH&S staff to determine if additional PPE is required due to the noise generated by Spot in its working environment.
3 Transport, handling, and storage

3.1 Transport

Spot is transported in two customized cases designed exclusively for the robot and its associated components.

Do not discard the cases after removing Spot. The cases are designed for transporting the robot and its accessories, and for returning them to Boston Dynamics for service.

<table>
<thead>
<tr>
<th>Shipping case for the robot</th>
<th>Shipping case for battery pack/power supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length: 927 mm</td>
<td>Length: 559 mm</td>
</tr>
<tr>
<td>Width: 546 mm</td>
<td>Width: 432 mm</td>
</tr>
<tr>
<td>Height: 464 mm</td>
<td>Height: 267 mm</td>
</tr>
<tr>
<td>Empty container: 47.6 kg</td>
<td>Empty container: 9.2 kg</td>
</tr>
<tr>
<td>Combined weight: 80.1 kg</td>
<td>Combined weight (one battery): 18.1 kg</td>
</tr>
<tr>
<td></td>
<td>Combined weight (two batteries): 22.7 kg</td>
</tr>
</tbody>
</table>
3.2 Safe handling

Operational and safety instructions about handling Spot are collected in a series of training videos.

| ![Video Icon] | Video: Spot Safety: Safe Handling
In this video, please pay careful attention to the following items:
- Safe conditions for handling (check that power is off)
- Pinch points (locate them at each leg and beware of pinching)
- Handles (locate them and how to lift the robot)
- Proper two-person lift (illustrated procedure) |

3.2.1 Safe conditions for handling Spot

There are two safe handling conditions for the robot:

- Power OFF
- Power ON, motor lockout

Refer to the section Stopping the robot for information about safely powering down the robot.

![WARNING] Only handle Spot when the motors are locked out or robot power is off.

3.2.2 Pinch points

Spot's joints can pinch fingers and other body parts and entangle loose clothing, long hair, and jewelry.
3.2.3 Handles
Spot has a handle at each hip joint. Use these to lift, carry, and roll the robot.

**WARNING**
Always keep hands away from knee joint. Use caution when lowering Spot or closing the leg.

**WARNING**
Always keep hands away from hip joint, except when grabbing handles. Always make a fist when gripping handles to keep our fingers away from pinch points.

**WARNING**
When using the handles, hands and fingers can be pinched. Always make a fist with each hand. Do not extend the fingers to avoid potential pinch hazard.
To avoid pinch points, never carry Spot with fingers extended.

3.2.4 Proper two-person lift

Spot is heavy (32 kg) and can be awkward to carry, particularly with attached payloads. Grab the handles and maintain safe lifting precautions. Always use two people to lift Spot, one at the front and one at the rear.

Video: [Spot Operation: Spot Startup](#)

In this video, please pay careful attention to the following items:
- How to lift Spot in two persons
- Safest grabbing points for loose legs (end segment)
- Use of handles at the hips
3.2.5 PPE

While handling Spot, no additional PPE is needed other than what is required for operators in their industrial environment. However, it is recommended to wear safety footwear.

3.3 Storage

**NOTICE**

When not in use, remove the battery pack from Spot. Boston Dynamics recommends storing Spot in the transportation case provided with the robot.

Store Spot in a dry location that has adequate temperature controls. Spot can be safely stored in temperatures between -30C and 40C, with relative humidity between 30% and 70%.
3.3.1 Battery storage

Video: [Spot Safety: Battery and Charging](#).

In this video, please pay careful attention to the following items:

- How to remove and check batteries by carefully inspecting the battery slot
- How to handle the battery

- Store at -30 to 25°C. Charge at 0 to 40°C. Operate at -20 to 45°C.
- Spot operators should develop a battery storage and charging safety policy consistent with industry standards and local regulations.
- Remove battery from robot during transportation or storage.
4 Installation and commissioning

Because Spot is a mobile robot, it does not require any special structural hardware or installation fixtures such as special anchoring mechanisms, anti-vibration pads, etc.

4.1 Before starting

It is the Owner’s responsibility to ensure that operators, bystanders and all exposed persons are trained in safe behavior around Spot and that the operation of Spot does not put anyone at risk.

Refer to Definition of a Spot owner for details about users and their responsibility.

All personnel exposed to Spot, either actively using the robot or passively by-standing, are subject to hazards.

**WARNING**
Ensure that all persons are properly trained and informed about the instructions in this document.

Spot is not intended to be used for tasks that require operation in close proximity to people.

4.2 Preparation

General instructions about Spot setup are illustrated in a series of training videos.

| Video: Safety distances from Spot |
| Video: Spot set up and safe handling |

Before setting up Spot, ensure to have enough room and clearances around the robot to safely operate the robot.

**WARNING**
Check the availability of a separation distance of at least 2 m from Spot before operation.
4.2.1 Assemble and prepare payloads

Integration of payloads with the Spot platform may affect the stability of the robot. Custom payloads need to be validated and tested before use.

Refer to the Spot Payload Hardware Reference document for more information.

4.3 Battery setup

Spot is powered by a removable lithium-ion battery pack. The battery can be charged standalone or while inside the robot.

Only use the Spot battery provided by Boston Dynamics.

- Don’t short-circuit, burn, disassemble, submerge, puncture, crush, drop, or damage the battery.
- If a battery fire starts, do not try to put it out. Evacuate to a safe area and call the fire department. Battery fires create toxic fumes and cannot be put out with conventional fire extinguishers or water.

Only charge battery with the charger provided by Boston Dynamics.

To reduce the risk of electric shock and fire:
- Use a properly grounded outlet. Do not use ground adapters or replace plug.
- Do not touch uninsulated parts of the output connector or battery terminals.
- Do not open or disassemble the charger.
- Do not use if the AC cord is damaged.
With Spot on its back, slide the battery’s non-handle side into the rear of Spot’s battery compartment; latch the handle. Ensure the battery is properly latched.

4.4 Battery charging operating environment

Operating temperature: 0C to 40C
Input: 100-240 VAC, frequency 50/60Hz, Current 5.5A
Output: 35-58.6 VDC, 7.2 A Max
Max Charge time: 2.5 hours

Additional video training is available by viewing the following links:
- Video: Battery safety and storage
- Video: Battery Installation
- Video: Additional charging instructions
4.5 Power up the robot

Operating instructions for getting ready to use Spot include using buttons on the rear of the robot and checking the light status indicators at the front and rear of the robot. Details and illustrated procedures are collected in a series of training videos:

- Video: Operating lights explained
- Video: Battery management
5 Use of the machine

5.1 Modes of operation

Spot can be operated in various modes. General instructions for operating Spot are collected in a series of training videos.

- **Taking Spot for a walk**
- **Stay Spot, stay**
- **Spot on stairs**
- **How Spot sees the world around it**

5.1.1 Navigating stairs

When manually controlling Spot, follow these instructions for climbing/descending stairs:

1. Use controller to switch Spot to stairs gait.
2. Aim Spot up stairs.
3. Use left joystick to walk Spot up stairs, as if walking straight down hallway.
4. Always descend stairs with Spot in reverse. Always face Spot up the stairs.

The following conditions and/or actions are critical for safe stairway navigation:
• Grated stairs, open-riser stairs, or partially transparent stairways pose significant perception challenges during stair locomotion
• Turning while on stairs

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spot could fall from stairs and cause personal injuries or material hazards</td>
</tr>
</tbody>
</table>

**Do not stand below Spot.**

When driving Spot manually:
- Avoid turning on stairs
- Do not attempt to climb stairs by side-stepping, and
- Wait for complete landing and secured zone before turning
5.2 Spot controls

Spot battery and power controls
5.3 Stopping the robot

5.3.1 Manual stop

To suspend the robot motion:

1. Press the B button on the controller to stop Spot. The robot will pause and stand in place. If Spot is seated, it will remain seated.

To de-energize the robot motors:

2. Press the controller trigger buttons and the B button simultaneously.
   OR
3. Select the red STOP button in the controller's top right corner then Confirm.
5.3.2 Automatic stop

**Operational stop**: Spot monitors its sensors and can automatically pause movement or cut power in certain situations:

- In the event of signal loss, after 3 seconds without active communication with the controller, Spot will cease motion and try to sit. After 8 seconds without communication, Spot will turn off its motors.
- In the event of a fall, leg motors are de-energized and remain loose.

**Protective stop**: Spot can also be stopped interfacing an external signal to the payload port.

**WARNING**

Losing signal could result in a fall. Use caution to ensure strong communication on stairs and other hazardous environments.

5.3.3 Potential hazards associated with stopping Spot

Stopping Spot removes actuation energy to its motors. Spot will attempt to lower its body under gravity before de-energization.

**WARNING**

Energy removal from leg actuators would cause the loss of balancing capability (balancing is only possible under active control).

A stopping event may cause the loss of stability and potential hazards associated with falls or tipping over.

*Always keep a separation distance of 2 m.*
5.3.4 De-energized state

As a consequence of the unstable balancing locomotion principle, legged robots cannot define a de-energized steady state.

The actual de-energized state depends on the following conditions at the time of the stopping event:

- The orientation of Spot (body attitude and configuration of legs)
- Ground conditions (surface, inclination and geometry)

For instance, on a flat surface, a de-energization event would likely cause a vertical collapse event. On a slope, and depending on the attitude and position of legs/feet, a de-energization event could cause a tip-over falling event.
Spot's legs are not blocked when the robot is commanded to stop or de-energized. A random blocked configuration of the legs would likely result in an unbalanced condition for the whole robot.

Upon stopping, Spot will always reach the ground on loose joints to minimize the introduction of additional hazards.

5.3.5 Unexpected fast movements while stopping or maintaining balance

Dynamic balancing is heavily influenced by the conditions of the environment where locomotion occurs.

Spot will always try to keep balance. This may result in high-acceleration motion of the legs in attempting to keep or recover balance when stability is difficult to maintain because of the environment.

Loss of stability can occur suddenly or be anticipated by irregular motion patterns, eventually leading to loss of stability.

Failure in locomotion could happen unexpectedly and could result in de-energization of the robot's actuators.

A failure event may cause loss of stability and potential hazards associated with a fall or tipping over.

*Always keep a separation distance of 2 m*

Moving legs can be a source of shear/entanglement hazards at pinch points. Contact with legs can occur when the legs are flailing, such as when the robot is attempting to recover from an imbalance.

Spot's legs are capable of high speed movements in order to maintain stability (under non-faulty conditions) in a variety of environmental conditions. If the speed and power of Spot's leg movements were limited Spot could lose its balancing capability.
5.4 Starting back up after an unexpected stop

To resume operation after an unexpected stop:

1. First make sure safety conditions are met, and sufficient clearance is maintained.
2. Repeat the startup procedure.
3. If Spot continues to stop unexpectedly, contact Boston Dynamics Support.

See additional training material
- Video: Safety distances from Spot.
- Video: Spot Startup procedure.

5.5 Turning off Spot

When ready to turn off Spot, follow this procedure:

1. Walk Spot to a charging, storage, or transport location. Walk Spot instead of carrying it whenever possible.
2. Sit Spot.
3. Power off motors with the controller.
4. Engage the lockout button.
5. Power off the robot by pressing and holding the blue button at Spot's rear for two seconds.
6. Select the controller's Disconnect option.
7. Take the battery to the charger or plug the robot into a power source.

See additional training material
Video: Spot Operation: Spot Shutdown Procedure
6 Maintenance

Before conducting any cleaning or reboot operations make sure to maintain a safe distance from Spot.

6.1 Robot body fan cleaning

Periodic inspection of the robot's condition may indicate that the cooling fans on the robot's underside need to be cleaned. If the fans are clogged with dirt, an overheating fault may be generated.

For detailed instructions, please refer to the Spot System Administration documentation.

6.1.1 Cleaning the robot

Use a mild detergent to clean Spot's exterior. Do not use strong solvents. Only clean when the robot is off.

6.2 Recalibration with SpotCheck

SpotCheck is a feature that improves Spot's mobility with joint and vision calibration. SpotCheck can resolve problems with the robot's gait, such as stumbling on stairs or limping, by evaluating current settings and recalibrating, if needed.

Robot falls and ordinary usage over time can cause the robot's onboard cameras to lose calibration. If the robot starts running into obstacles that it had previously avoided, SpotCheck can evaluate and resolve camera calibration issues to restore perception accuracy.

SpotCheck offers two modes:

1. Joint calibration and camera check
2. Camera calibration
The joint calibration and camera check mode tests and recalibrates (as needed):

- Load cell sensor for hip and knee joints
- Joint position sensor for hip and knee
- Performs basic check (not calibration) of all onboard cameras, excluding Spot CAM, if installed.

The camera calibration mode:

- Determines if stereo intrinsics or extrinsics are out of calibration.
- Requires the use of the calibration panel shipped with the robot.

### 6.2.1 When to run SpotCheck

Any of the following behaviors may be a sign that the joints and/or camera have fallen out of calibration:

- The robot limps or stumbles more than usual.
- The robot runs into obstacles it has successfully avoided in the past.
- The robot has more difficulty on stairs than usual.

To return the robot to normal operation, run SpotCheck.

For detailed instructions, please refer to the Spot System Administration documentation.
7 Emergency situations

Spot is not meant to be repaired by Owners. If errors or other issues persist after rebooting the robot, the robot may need attention by Boston Dynamics Support engineers. Do not attempt to service the robot yourself. Contact Boston Dynamics Support.

Email support@bostondynamics.com. Please include the following information when contacting Support:

- Robot serial number
- Description of the issue

Any unauthorized repair or servicing of Spot will invalidate any guarantee of warranties and machine safety.

7.1 Fire

In the unlikely event of a fire, a fire extinguisher rated for use on lithium ion batteries must be used. If the battery is damaged and liquid leaks out, do not attempt to handle it. Contact your local fire department for help immediately.

7.2 Harm caused by Spot to persons or facilities

In the unlikely event that Spot damages the facility or causes bodily harm to a person, please follow your local EH&S (emergency response) policies and procedures and make sure that your EH&S staff report the incident to Boston Dynamics at our customer care contacts.
8 Risk assessment

This section includes information about risk assessment and reduction for Users. This section is intended to be read by the user’s EH&S expert or workplace safety officer.

Boston Dynamics has performed a risk assessment on the basis of expected typical applications and environmental conditions. In particular, Boston Dynamics has:

- Identified the hazards and estimated the risks for default expected conditions.
- Designed risk reduction measures.
- Evaluated the risk reduction process and the residual risks.
- Provided the information for use (in this document and in the form of signals on board the robot) to be implemented by Owners and Operators.

The severity of hazards assumed in the risk assessment is not valid for children or elderly users.

The probability of errors, the awareness and skills of users assumed in the risk assessment are not valid for non-professional users.

Following the risk evaluation from the manufacturer, Owners are recommended to perform their own risk assessment considering the suggestions in the section Guidance for risk assessment by Owners. In particular, Owners are recommended to:

- Check the scope and eligibility of the working environment.
- Find additional hazards specific to their application(s).
- Estimate the risks of additional hazards in their application(s).
- Implement additional safeguards, if necessary.
- Implement the instructions in this document.
## 8.1 Risk evaluation from the manufacturer

As part of the manufacturer risk evaluation process, the following table reports the main risk reduction strategies for the most common types of hazards, and the residual risks after the implementation of risk reduction measures.

<table>
<thead>
<tr>
<th>Hazard type</th>
<th>Risk reduction</th>
<th>Residual risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical - direct/indirect contact</td>
<td>Risks associated with direct contact with live parts are reduced by implementing intrinsically-safe design, specifically extra low-voltage (SELV) power supply, following the requirements in IEC 60204-1 for electrical equipment and IEC 62133 for batteries.</td>
<td>Negligible</td>
</tr>
<tr>
<td>Thermal - fire</td>
<td>Risks associated with fire and thermal effects caused by electrical energy are reduced by implementing intrinsically-safe design following the requirements in IEC 62368-1 for heating prevention/protection.</td>
<td>Negligible</td>
</tr>
<tr>
<td>Thermal - overheating</td>
<td>Risks associated with over-heating of motors and electrical components are reduced by implementing intrinsically-safe design following the requirements in IEC 60204-1.</td>
<td>Negligible</td>
</tr>
<tr>
<td>Radiation (non-ionizing)</td>
<td>Risks related to non-ionizing radiation are reduced in using Step 1 design methods compliant with relevant technical standards (IEC 60825-1 for Class I LASERs, CISPR 32:2012 and CISPR 11:2009/A1:2010 for EMI)</td>
<td>Negligible</td>
</tr>
<tr>
<td>Hazardous materials</td>
<td>Risks associated with lubricants are negligible. Battery pack contains cells that have electrolytes. All cells are fully enclosed in a sealed enclosure that has also passed UN 38.3 transportation testing. In addition, the pack has CB Certification to IEC 62133 and has passed drop testing with no leakage of electrolyte.</td>
<td>Negligible</td>
</tr>
<tr>
<td>Mechanical (collisions, moving elements, stored energy)</td>
<td>Risks cannot be sufficiently reduced with intrinsically safe design in some environmental conditions. External safeguards and other protective devices are not practicable for mobile platforms with dynamic motion of all the parts of the machinery. Information for use is provided.</td>
<td>Non-negligible, depending on the characteristics of terrain.</td>
</tr>
</tbody>
</table>
Mechanical hazards are further detailed in the following sections.

8.1.1 Risk evaluation of mechanical hazards (impacts)

The occurrence of mechanical hazards is not only associated with failures, but can occur during regular operations for the following reasons:

- The dynamic balancing control makes the robot behave unpredictably when adapting to different surfaces or obstacles. This situation is mostly limited to irregular terrain or hard conditions for perception.
- Completing certain tasks may require relatively high-speed movements or dynamic interactions with the environment.

In all cases, the result of failures or loss of control could cause an accidental contact with operators.

The risk is reduced at the level which is as low as reasonably possible given the state of the art of control techniques. Contact events cannot be further protected by design or by protective devices, but only implementing instructions for use.

See the section Potential hazards associated with stopping Spot for further details about the hazards of stopping and falls, and about the practicable conditions for risk reduction.
Residual risks are evaluated in the following table, with respect to the foreseeable conditions for the contact events.

<table>
<thead>
<tr>
<th>Foreseeable condition</th>
<th>Max elevation</th>
<th>Expected outcome</th>
<th>Residual risk</th>
<th>Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>300 mm (potential impact: feet, lower legs)</td>
<td>Accidental crush on feet of by-standers, who are nevertheless unlikely to be present.</td>
<td>Negligible.</td>
<td>Stay away 2 m.</td>
</tr>
<tr>
<td></td>
<td>1100 mm (potential impact: feet, legs)</td>
<td>Regular case: Worst case: collapse and roll-over, before/while sliding. Accidental impacts on lower legs of by-standers, who are nevertheless unlikely to be present.</td>
<td>Low. If the impact comes from the back, there are residual chances to determine a loss of balance in the bystander upon the impact (on shins) with potential hazardous fall. Severe impacts on human knee joints with injury is very unlikely.</td>
<td>Stay away 2 m (downhill) Stay uphill of Spot.</td>
</tr>
<tr>
<td></td>
<td>&gt;1100 mm (potential impact: full body)</td>
<td>Regular case: Worst case: collapse and roll-over, before/while sliding</td>
<td>High. Upper body (torso) potentially reached during a fall event</td>
<td>Implement safeguards depending on the specific properties of the environment</td>
</tr>
</tbody>
</table>
8.1.2 Risk evaluation of mechanical hazards (pinch points)

The severity associated with legs and hips pinch points hazards can be moderate or high, particularly for hands and fingers.

Pinch points are most likely accessible in static conditions (at startup or during maintenance) and during handling, when the motors are powered off. The probability associated with the occurrence of such hazards in operational modes is low. Occasional accesses to moving joints/legs while in motion are regarded as an unforeseeable misuse because they are not associated with any purposeful action for either self-protection, or improvement of robot performances.
8.2 Guidance for risk assessment by Owners

Boston Dynamics recommends that Owners perform their own application-specific risk assessment. The following flowchart may be used as a guideline for considering risk factors.

![User-side risk assessment flowchart](image-url)
8.2.1 Reviewing environmental conditions

In particular, Owners should review the environmental conditions and the properties of their layouts and determine whether their application causes additional hazards.

The following mechanical hazards determine high risk:

- Crushing due to loss of stability or falls
- Impact from frontal or lateral contact
- Entanglement within legs or between legs and body of Spot

To determine the risk level of additional/modified hazards, the following risk factors should be considered:

- Severity of mechanical hazards
- Occurrence of mechanical hazards

8.2.2 Determining the severity of mechanical hazards

The following is a non-comprehensive list of conditions that may determine a high severity in an environment different from the intended one or in a specific application:

- Consider the combined effect of impacts on lower legs and the presence of tripping points that may determine a further hazard (e.g., loss of balance)
- Consider the combined effect of contacts and variable layout, including but not limited to moving assets (vehicles, tracks, conveyors, etc.) changes to the location of objects, objects of variable size
- Consider the material properties of the objects in the layout where contacts could happen, including but not limited to sharp or scraping edges, pointed extremities, and trapping gaps with sharp or scraping edges
- Consider the direction of a potential impact and the human body part potentially hit
- Consider the type, shape, and properties of a custom attachment you may use
8.2.3 Determining the occurrence of mechanical hazards

Evaluating the occurrence of hazards involves making a risk assessment to identify factors such as the frequency of exposure to hazards and the probability of failures and human errors.

When estimating the risk, consider the following factors relevant to the occurrence of hazards:

- Will your application of the robot encounter a hazard more often than 4 times per hour, with duration of exposure longer than 1 minute?
- Could the Spot robot encounter a hazard outside of a planned routine?
- Will traveling conditions or other factors increase the duration of exposure to potentially hazardous situations?
- Will Spot be subject to occasional or frequent EMI disturbances that are peculiar to your environment?
- Have all planned walking surfaces been checked for stability? Or will there be movable platforms or portions of walking surfaces?
- Will Spot traverse locations where a sudden tilting or floating movement could occur, such as for actuated tracks, vehicle load surfaces, etc?
- Will Spot generate bouncing reactions while walking over a flexible surface?
- Will Spot pass through narrow passages and/or blind spots?
- Will Spot encounter open platforms, tripping objects/cords or other obstacles that are unknown at the time of programming a navigation mission?
- Are hazardous vapors or steam occasionally/frequently present in your environment?
- Are sparks or flames occasionally/frequently present in your environment?
- Are any liquids, specifically lubricants or hazardous materials occasionally and suddenly spilled on the ground?
9 Compliance statement

9.1 EU Declaration of Conformity

Products in the scope of the Declaration of Conformity:

- Spot robot (Model: 02-040236-001)

The Spot robot is to be used only with the following accessories:

- Spot Power Supply (Model: 02-044200-001)
- Spot Battery (Model: 02-036845-001)
- Spot Controller (Model: 03-000845-002)

Listed products fulfil all the relevant provisions of the following directives:

- Machinery Directive 2006/42/EC and amend. (MD), limited to the following Essential Safety and Health Requirements (EHSR) and supplementary requirements of Annex I: 1.1.2, 1.1.3, 1.3.2, 1.3.6, 1.3.4, 1.3.7, 1.5.6, 3.5.1, 1.5.1, 1.5.2, 1.5.10, 1.5.11, 1.5.12, 1.7.1, 1.7.2, 1.7.3, 1.7.4. The harmonized standards used for Presumption of Conformity to the MD, as referred to in Art. 7(2) of MD are: EN ISO 12100:2010, EN 60204-1:2018;


- Radio Equipment Directive 2014/53/EU and amend. (RED), limited to the Essential Requirements of Art. 3: 1(a), 1(b), 2. The harmonized standards used for Presumption of Conformity to the RED, as referred to in Art. 16 of the RED are: ETSI EN 301 489-1 V2.2.1 (2019), ETSI EN 301 489-17 V3.2.2 (2019), EN 55032:2012.

## 9.2 Markings

### WARNING:
Only for use with Boston Dynamics Spot Battery and Charger.

User Guide: Contact support@bostondynamics.com

Patent Information: www.bostondynamics.com/patents

Contains FCC ID: 2ATBY-NMDB-2 IC 25753-NMDB2M

This device 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.

当該機器には電波法に基づく、技術基準適合証明等を受けた特定無線設備を装着している。

DESIGNED BY BOSTON DYNAMICS IN MASSACHUSETTS. MADE IN USA
78 4th Avenue, Waltham, MA 02451 USA

<table>
<thead>
<tr>
<th>SPOT® ROBOT</th>
<th>Boston Dynamics</th>
</tr>
</thead>
<tbody>
<tr>
<td>P/N:</td>
<td></td>
</tr>
<tr>
<td>S/N:</td>
<td></td>
</tr>
</tbody>
</table>

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